Supplemental Material
Extracting Microfacet-based BRDF Parameters from Arbitrary Materials with Power Iterations

Jonathan Dupuy[1,2] Eric Heitz[3] Jean-Claude Iehl[1] Pierre Poulin[2] Victor Ostromoukhov[1] *

[1]LIRIS, Université Lyon 1 [2]LIGUM, Université de Montréal [3]Karlsruhe Institute of Technology

This supplemental material accompanies our EGSR 2015 paper. It contains data from fitting a database of 100 measured materials [MERL], in order to validate our fitting algorithm against the raw data and a state-of-the-art fitting algorithm (SGD) [SGD]. Our fittings produce a tabulated model, as well as Gaussian and GGX models. Each material is rendered and plotted in the incidence plane against each fit. In addition, we provide plots of our reconstructed microfacet Fresnel term, microfacet normal distribution, and microfacet shadowing term, as well as color mapped difference images computed in the CIE dE00 color space. All rendered images were produced at 256×256 resolution using 512 samples per pixel, and both the SGD and reference materials were importance sampled according to our tabulated fit in order to speed up convergence. Before exposing our fitting results, we provide the necessary mathematics to design the fitting algorithm we used for our fits.

Inverting the BRDF

We show how to invert a microfacet BRDF based on the following equations

$$f_r(\mathbf{i},\mathbf{o}) = \frac{F(\theta_d)\, D(\mathbf{h})\, G(\mathbf{i},\mathbf{o})}{4\cos\theta_i \cos\theta_o} \tag{1}$$

$$D(\mathbf{h}) = \frac{P(\tilde{\mathbf{h}})}{\cos^4\theta_h} \tag{2}$$

$$G(\mathbf{i},\mathbf{o}) = \frac{G_1(\mathbf{i})\, G_1(\mathbf{o})}{G_1(\mathbf{i}) + G_1(\mathbf{o}) - G_1(\mathbf{i})\, G_1(\mathbf{o})} \tag{3}$$

$$G_1(\mathbf{k}) = \frac{\cos\theta_k}{\int_{\Omega_+} \mathbf{kh}\, D(\mathbf{h})\, d\omega_h}. \tag{4}$$

Given f_r, we wish to retrieve a microfacet slope probability density function P and a microfacet Fresnel term F.

Retrieving the Microfacet Slope Distribution

Mathematical Inversion In backscattering configurations, i.e., when $\mathbf{i} = \mathbf{o}$ (and hence, $\mathbf{h} = \mathbf{o}$), the microfacet BRDF equation takes a simpler form

$$f_r(\mathbf{o},\mathbf{o}) = \frac{F_0\, D(\mathbf{o})\, G(\mathbf{o},\mathbf{o})}{4\cos^2\theta_o} \tag{5}$$

$$G(\mathbf{o},\mathbf{o}) = \frac{G_1^2(\mathbf{o})}{2G_1(\mathbf{o}) - G_1^2(\mathbf{o})} \tag{6}$$

$$F_0 = F(0). \tag{7}$$

Note that the geometric attenuation term G in these equations is only approximate since, as we discuss in our associated paper, a physically sound model should give $G(\mathbf{o},\mathbf{o}) = G_1(\mathbf{o})$. We perform the inversion of

* {jdupuy | jciehl | victor.ostromoukhov}@liris.cnrs.fr
eheitz.research@gmail.com
poulin@iro.umontreal.ca

P with the assumption that G produces the correct physical behavior, i.e., $G(\mathbf{o},\mathbf{o}) = G_1(\mathbf{o})$. In this case, we can express the microfacet distribution of normals, i.e., D, as a the solution of an integral equation

$$F_0\, D(\mathbf{o}) = \frac{4 f_r(\mathbf{o},\mathbf{o}) \cos^2\theta_o}{G_1(\mathbf{o})} \tag{8}$$

$$= 4 f_r(\mathbf{o},\mathbf{o}) \cos\theta_o \int_{\Omega_+} \mathbf{oh}\, D(\mathbf{h})\, d\omega_h. \tag{9}$$

Due to the link between the microfacet distribution of normals and the microfacet distribution of slopes, it follows that P is also the solution of an integral equation

$$F_0\, P(\tilde{\mathbf{o}}) = \int_{\Omega_+} K(\mathbf{o},\mathbf{h})\, P(\tilde{\mathbf{h}})\, d\omega_h \tag{10}$$

$$K(\mathbf{o},\mathbf{h}) = 4 f_r(\mathbf{o},\mathbf{o}) \cos^5\theta_o\, \mathbf{oh}\, \sec^4\theta_h. \tag{11}$$

In the mathematics literature, the above equation is known as a Fredholm equation of the second kind, with kernel K. At this point, we can already retrieve P. However, we can reduce the dimensionality of the solution if P is isotropic. Indeed, if P is isotropic, then it may be rewritten as a 1D radial function of elevation angle

$$P(\tilde{\mathbf{h}}) = g(\theta_h) \tag{12}$$

$$\theta_h = \arctan\sqrt{\tilde{x}_h^2 + \tilde{y}_h^2}. \tag{13}$$

Hence, the problem of determining a 2D function P simplifies to the problem of determining a 1D function g, which is also the solution of an integral equation

$$F_0\, g(\theta_o) = \int_0^{\pi/2} K'(\theta_o,\theta_h)\, g(\theta_h)\, d\theta_h \tag{14}$$

$$K'(\theta_o,\theta_h) = \int_0^{2\pi} K(\mathbf{o},\mathbf{h})\, \sin\theta_h\, d\phi_h \tag{15}$$

$$\mathbf{o} = (0, \sin\theta_o, \cos\theta_o)^t \tag{16}$$

since we have

$$\begin{aligned} F_0\, g(\theta_o) &= \int_{\Omega_+} K(\mathbf{o},\mathbf{h})\, g(\theta_h)\, d\omega_h \\ &= \int_0^{2\pi}\int_0^{\pi/2} K(\mathbf{o},\mathbf{h})\, g(\theta_h)\, \sin\theta_h\, d\theta_h d\phi_h \\ &= \int_0^{\pi/2}\left[\int_0^{2\pi} K(\mathbf{o},\mathbf{h})\, \sin\theta_h\, d\phi_h\right] g(\theta_h) d\theta_h \\ &= \int_0^{\pi/2} K'(\theta_o,\theta_h)\, g(\theta_h)\, d\theta_h. \end{aligned}$$

Note that this solution is applicable to any isotropic BRDF such as those tested in the remainder of this document.

MERL Numeric Resolution In order to retrieve the microfacet slope probability density function from a MERL BRDF, we first re-express our 1D integral equation with the MERL quadratic half elevation angle parameterization with the change of variable $\theta_h = \theta^2$ ($d\theta_h = 2\theta d\theta$)

$$F_0\, g(\theta_o) = \int_0^{\sqrt{2\pi}/2} K''(\theta_o,\theta_h)\, g(\theta_h)\, d\theta \tag{17}$$

$$K''(\theta_o,\theta_h) = 2\theta K'(\theta_o,\theta_h). \tag{18}$$

We discretize the resulting 1D integral equation with a quadrature rule of $N = 90$ rectangles where the angles are computed according to the MERL parameterization

$$F_0\, g(\theta_j) = \sum_{k=1}^{N} w_k\, K''(\theta_j, \theta_k)\, g(\theta_k) \tag{19}$$

$$\theta_j = \frac{\pi(j-1)^2}{2N^2} \tag{20}$$

$$\theta_k = \frac{\pi(k-1)^2}{2N^2} \tag{21}$$

$$w_k = \frac{1}{N}. \tag{22}$$

Letting $\mathbf{g}$ denote the vector $\mathbf{g} = (g(\theta_1), \cdots, g(\theta_N))^t$ and $\mathbf{K}$ denote the matrix

$$\mathbf{K} = \begin{bmatrix} w_1 K''(\theta_1, \theta_1) & \cdots & w_1 K''(\theta_1, \theta_N) \\ \vdots & \ddots & \vdots \\ w_N K''(\theta_N, \theta_1) & \cdots & w_N K''(\theta_N, \theta_N) \end{bmatrix} \tag{23}$$

we can rewrite our 1D integral equation as the eigenvalue problem

$$\mathbf{K} \cdot \mathbf{g} = F_0\, \mathbf{g}. \tag{24}$$

Since the elements of $\mathbf{K}$ are all nonnegative, the Perron-Frobenius theorem states that the largest eigenvector is a valid solution to our problem. Letting $\mathbf{v}$ denote the largest eigenvector of $\mathbf{K}$, we compute it iteratively using the power iteration method

$$\mathbf{v}_{n+1} = \tilde{\mathbf{K}} \cdot \mathbf{v}_n \tag{25}$$

$$\mathbf{v}_0 = \mathbf{1}. \tag{26}$$

In practice, we used $n = 4$ for the entire MERL database. Algorithm 1 provides pseudocode for our method.

Retrieving the Fresnel Term

Once we have recovered the microfacet slope probability density function, we can generate a BRDF whose microfacets act as "ideal" mirrors, i.e., $F(\theta_d) = 1$ for any θ_d

$$f_{r,id}(\mathbf{i}, \mathbf{o}) = \frac{D(\mathbf{h})\, G(\mathbf{i}, \mathbf{o})}{4 \cos\theta_i \cos\theta_o} \tag{27}$$

By averaging the ratio between the input BRDF and the ideal response at each difference angle θ_d, we then retrieve the complete microfacet Fresnel term. The computation is straightforward using Rusinkiewicz's BRDF parameterization.

$$F(\theta_d) = \frac{1}{\pi^2(\pi - 2\theta_d)} \int_0^{\pi} \int_0^{2\pi} \int_0^{\pi/2-\theta_d} \frac{f_r(\mathbf{i}, \mathbf{o})}{f_{r,id}(\mathbf{i}, \mathbf{o})} d\theta_h d\phi_h d\phi_d \tag{28}$$

$$\mathbf{i} = \mathbf{R_z} \cdot \mathbf{R_x} \cdot \mathbf{d} \tag{29}$$

$$= \begin{bmatrix} \cos\phi_h & \sin\phi_h & 0 \\ -\sin\phi_h & \cos\phi_h & 0 \\ 0 & 0 & 1 \end{bmatrix} \cdot \begin{bmatrix} 1 & 0 & 0 \\ 0 & \cos\theta_h & \sin\theta_h \\ 0 & -\sin\theta_h & \cos\theta_h \end{bmatrix} \cdot \begin{bmatrix} \sin\theta_d \sin\phi_d \\ \sin\theta_d \cos\phi_d \\ \cos\theta_d \end{bmatrix} \tag{30}$$

$$= \begin{bmatrix} \cos\phi_h & \cos\theta_h \sin\phi_h & \sin\theta_h \sin\phi_h \\ -\sin\phi_h & \cos\theta_h \cos\phi_h & \cos\phi_h \sin\theta_h \\ 0 & -\sin\theta_h & \cos\theta_h \end{bmatrix} \cdot \begin{bmatrix} \sin\theta_d \sin\phi_d \\ \sin\theta_d \cos\phi_d \\ \cos\theta_d \end{bmatrix} \tag{31}$$

$$\mathbf{o} = 2(\mathbf{i} \cdot \mathbf{h})\mathbf{h} - \mathbf{i}. \tag{32}$$

Note that this solution is applicable to any BRDF. If the input BRDF is an actual microfacet BRDF, then the recovered Fresnel will match that of the input.

MERL Numeric Resolution For MERL input BRDFs, we perform the inversion with a quadratic distribution of half-vector elevation angles

$$F(\theta_d) = \frac{\sqrt{2}}{2\pi^2\sqrt{\pi - 2\theta_d}} \int_0^{\pi} \int_0^{2\pi} \int_0^{\sqrt{\pi/2-\theta_d}} \frac{f_r(\mathbf{i},\mathbf{o})}{f_{r,id}(\mathbf{i},\mathbf{o})} d\theta d\phi_h d\phi_d \tag{33}$$

$$\theta_h = \theta^2. \tag{34}$$

We then compute the Fresnel term for 90 discrete angles uniformily distributed between 0 and 90 degrees

$$F(\theta_d) = \frac{1}{180 \times 360 \times N} \sum_{j=1}^{180} \sum_{k=1}^{360} \sum_{l=1}^{N} \frac{f_r(\mathbf{i},\mathbf{o})}{f_{r,id}(\mathbf{i},\mathbf{o})} \tag{35}$$

$$N = \left\lfloor 90\sqrt{1 - \frac{2\theta_d}{\pi}} \right\rfloor \tag{36}$$

$$\phi_h = \frac{\pi(k-1)}{180} \tag{37}$$

$$\phi_d = \frac{\pi(j-1)}{180} \tag{38}$$

$$\theta_h = \frac{\pi}{2}\left(\frac{l-1}{90}\right)^2. \tag{39}$$

That way, we read all the values from the BRDF. Algorithm 2 provides pseudocode for our method.

Algorithms

Algorithm 1 Extract Isotropic P

```
function EXTRACT_P_ISOTROPIC
    for 1 ≤ j ≤ N, 1 ≤ k ≤ N do                          ▷ Build kernel matrix
        θ_o = π(j − 1)^2/(2 × N^2)
        θ_h = π(k − 1)^2/(2 × N^2)
        o = (sin θ_o, 0, cos θ_o)
        h = (sin θ_h, 0, cos θ_h)
        K̃_{i,j} = (4/N) f_r(o, o) cos^5 θ_o oh sec^4 θ_o
    end for
    v = 1
    for 0 ≤ i < M do                                     ▷ Power iteration (we set M = 4)
        v = K̃ · v
    end for
    P = normalize(v)                                     ▷ Normalize the eignevector so that it integrates to one
end function
```

Algorithm 2 Extract Fresnel Term F

```
function EXTRACT_F
    for 1 ≤ i ≤ 90 do
        θ_d = π(i − 1)/(2 × 90)
        F(θ_d) = 0
        for 1 ≤ j ≤ 180, 1 ≤ k ≤ 360 do
            φ_d = π(j − 1)/180
            φ_h = π(k − 1)/180
            N = ⌊90 √(1 − 2θ_d/π)⌋
            for 1 ≤ l ≤ N do
                θ_h = π(l − 1)^2/(2 × 90^2)
                i = Rusinkiewicz(h, d)        ▷ Retrieve i from the Rusinkiewicz parameterization
                o = 2(i · h)h − i             ▷ Retrieve o from the Rusinkiewicz parameterization
                F(θ_d) = F(θ_d) + f_r(i, o)/f_{r,id}(i, o)
            end for
            F(θ_d) = F(θ_d)/N
        end for
        F(θ_d) = F(θ_d)/(180 × 360)
    end for
end function
```

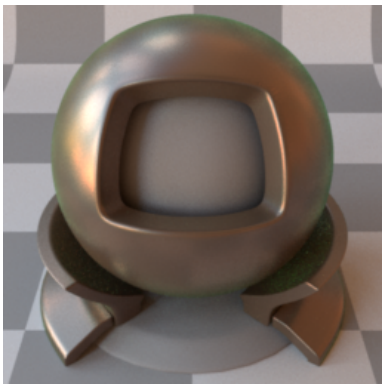
References

[MERL] Wojciech Matusik, Hanspeter Pfister, Matt Brand, and Leonard McMillan, 2003, "A Data-Driven Reflectance Model", *ACM Transactions on Graphics, 22* (3), 759-769.

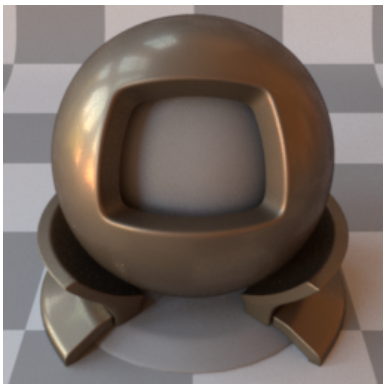
[SGD] Mahdi M. Bagher, Cyril Soler, and Nicolas Holzschuch, 2012, "Accurate Fitting of Measured Reflectances using a Shifted Gamma Micro-facet Distribution", *Computer Graphics Forum, 31* (4), 1509-1518.

1 alum-bronze

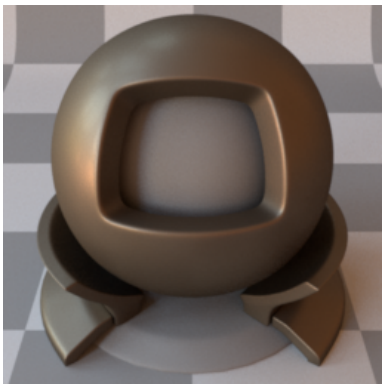
Renderings



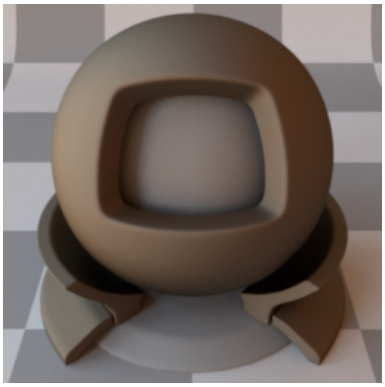
SGD



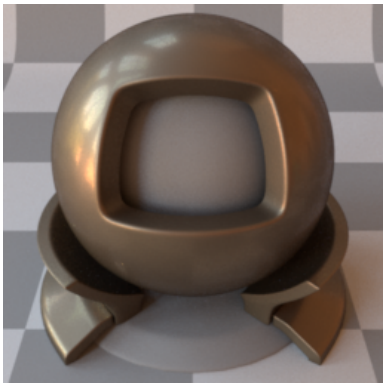
Reference



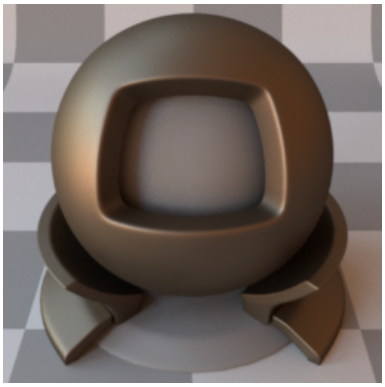
Ours: Tabulated



Ours: Gaussian

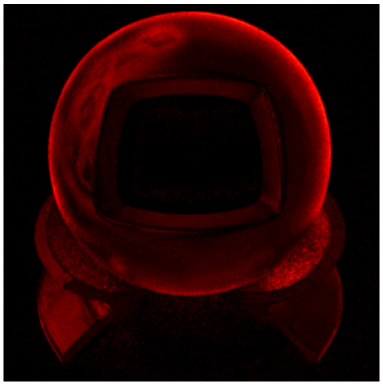


Reference

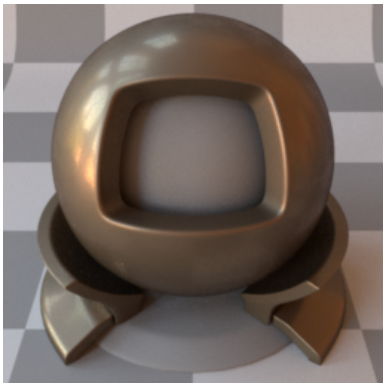


Ours: GGX

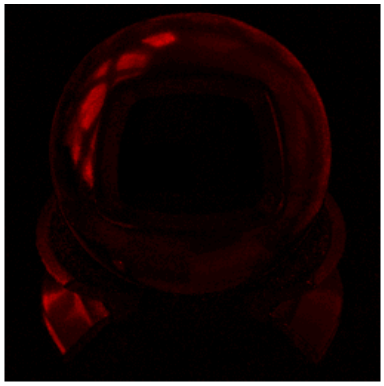
CIE dE00



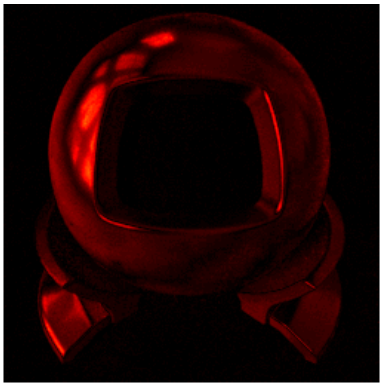
SGD



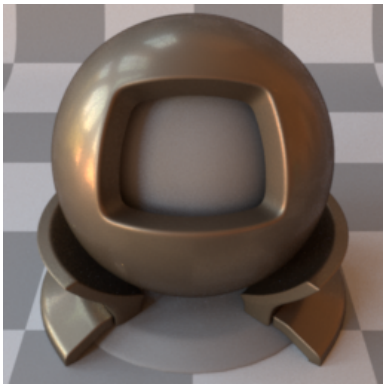
Reference



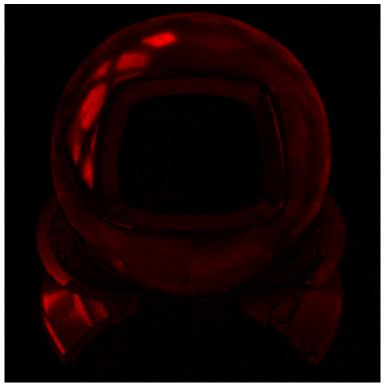
Ours: Tabulated



Ours: Gaussian

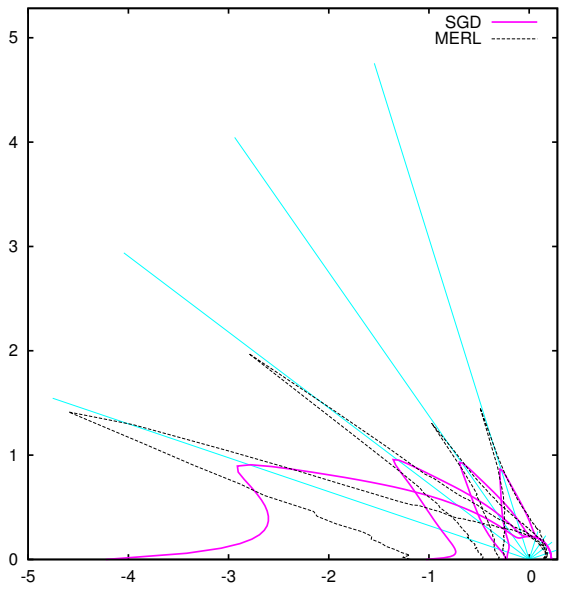


Reference

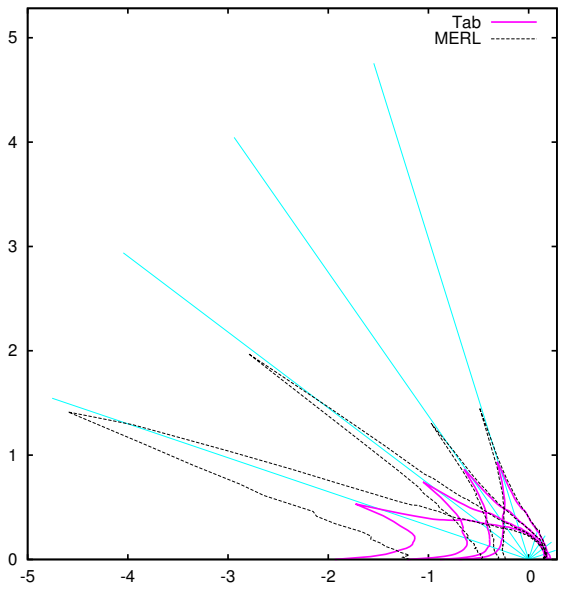


Ours: GGX

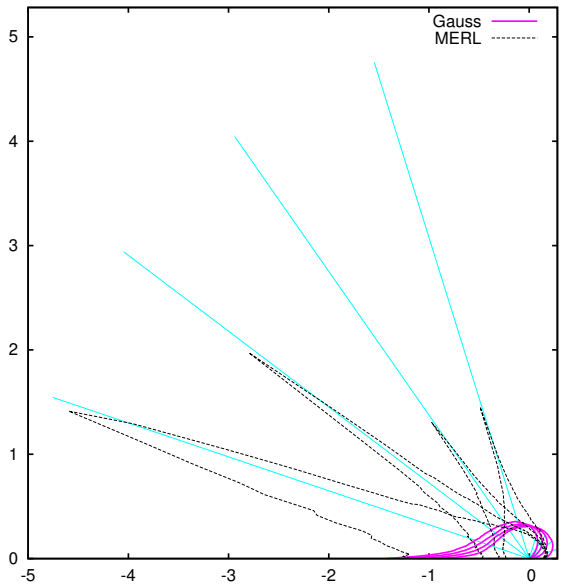
BRDF Lobes in the Incidence Plane (Cubic Root Applied)



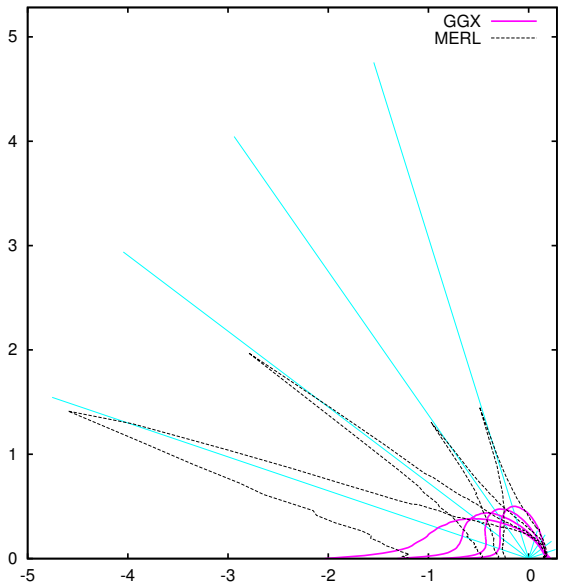
SGD



Ours: Tabulated

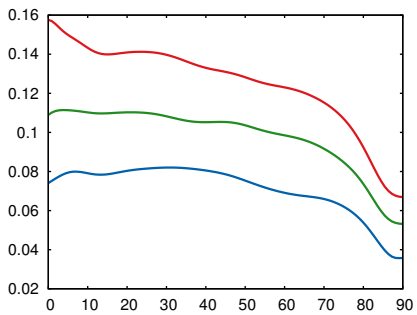


Ours: Gaussian

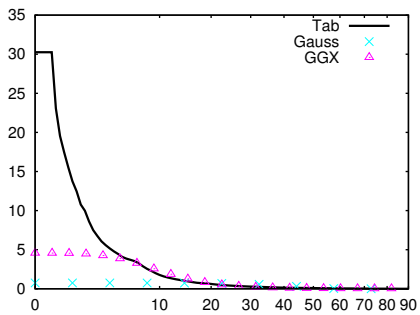


Ours: GGX

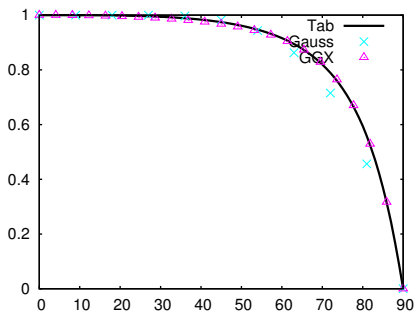
Fitted Microfacet Functions



Fresnel (R, G, B)



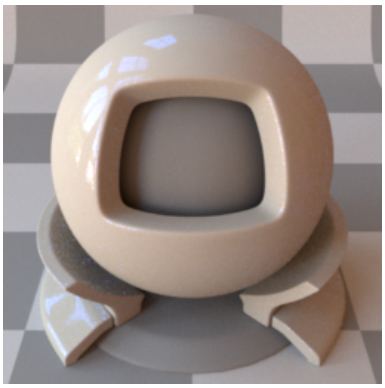
NDF (D)



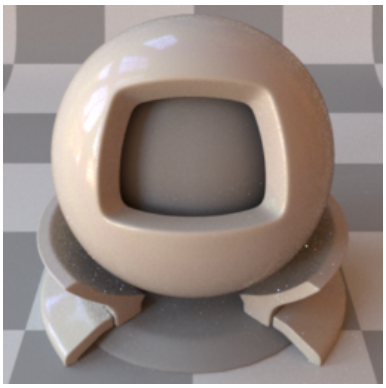
Smith (G_1)

2 alumina-oxide

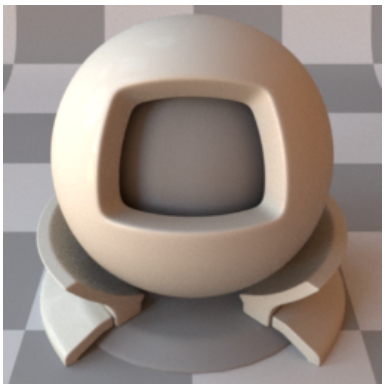
Renderings



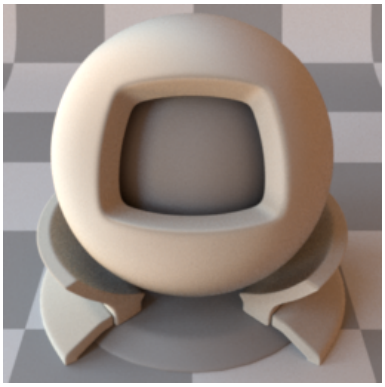
SGD



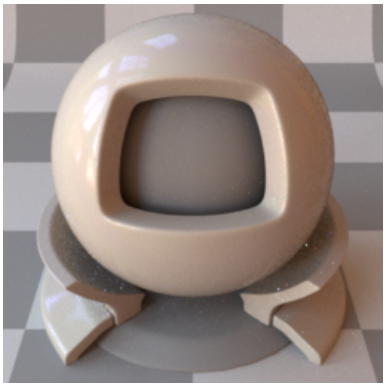
Reference



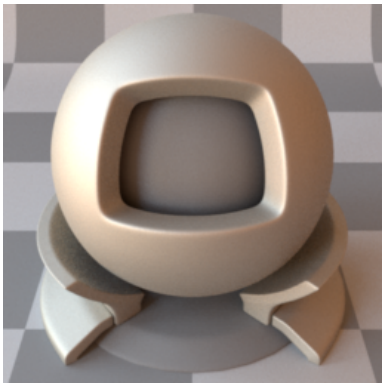
Ours: Tabulated



Ours: Gaussian

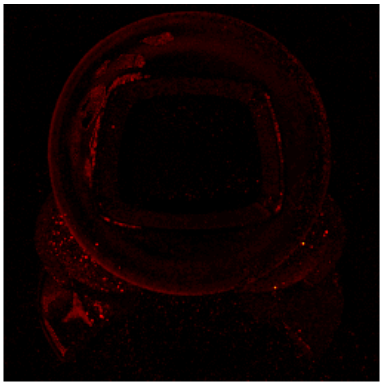


Reference

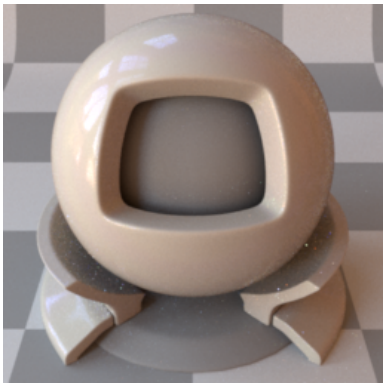


Ours: GGX

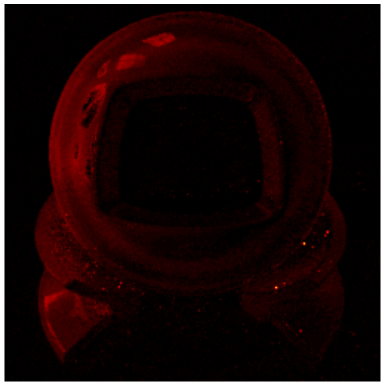
CIE dE00



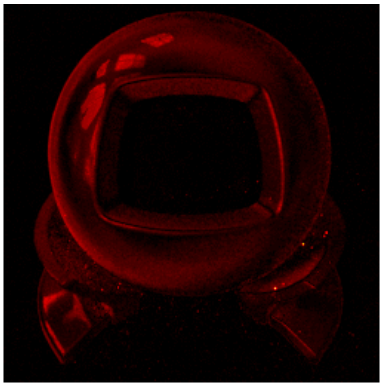
SGD



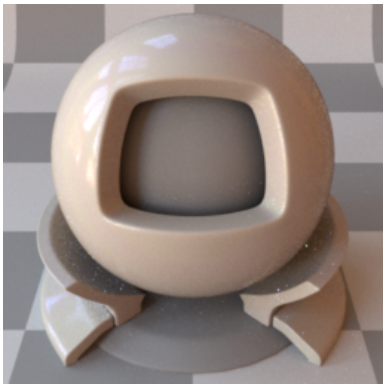
Reference



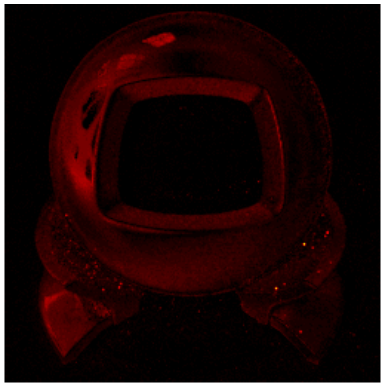
Ours: Tabulated



Ours: Gaussian

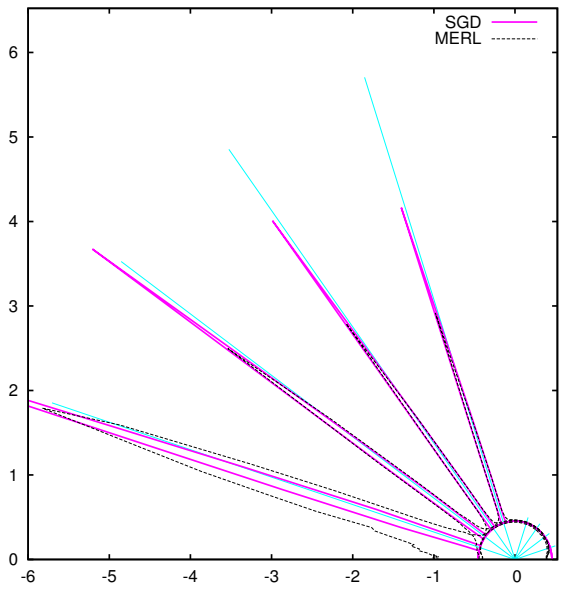


Reference

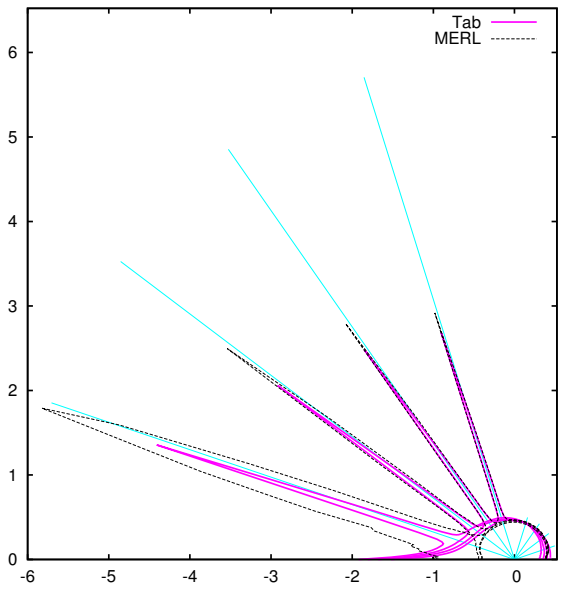


Ours: GGX

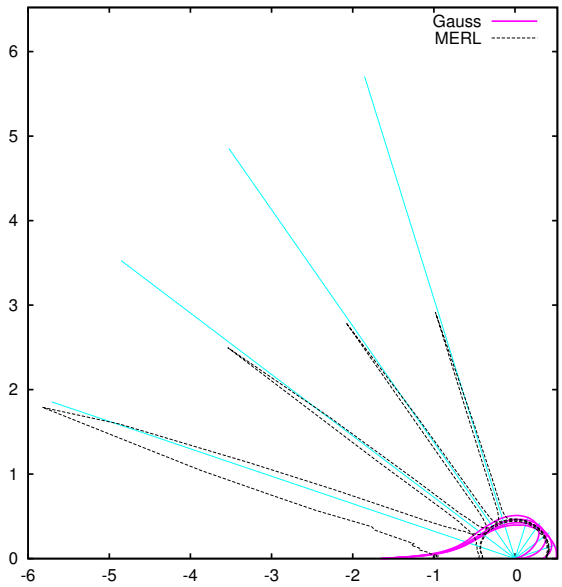
BRDF Lobes in the Incidence Plane (Cubic Root Applied)



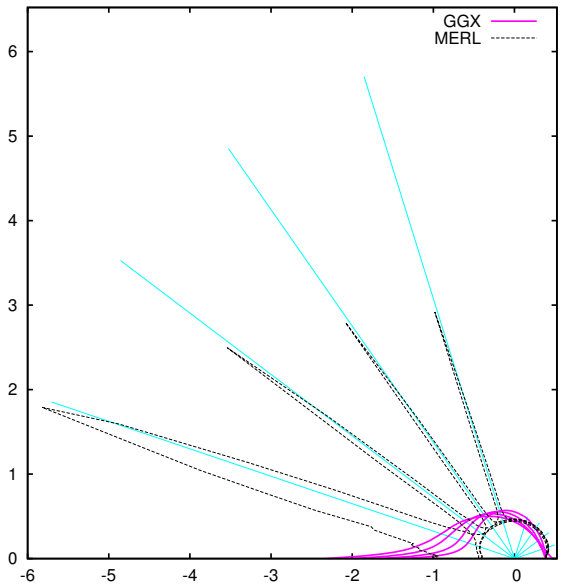
SGD



Ours: Tabulated

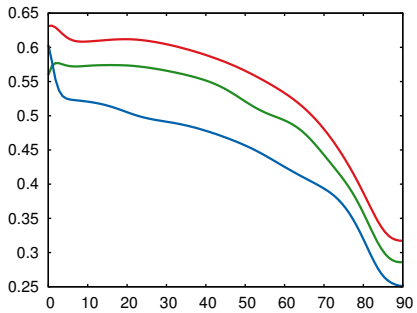


Ours: Gaussian

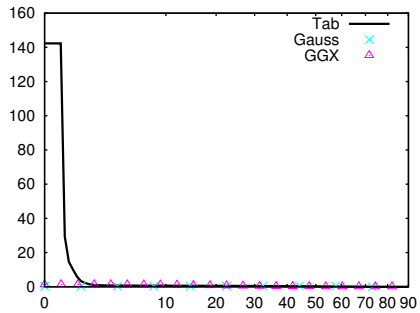


Ours: GGX

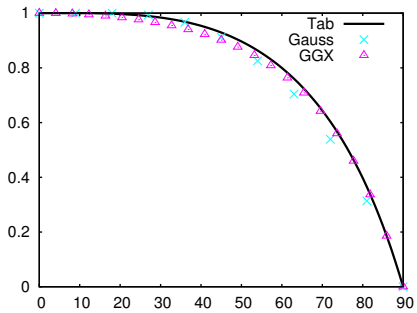
Fitted Microfacet Functions



Fresnel (R, G, B)



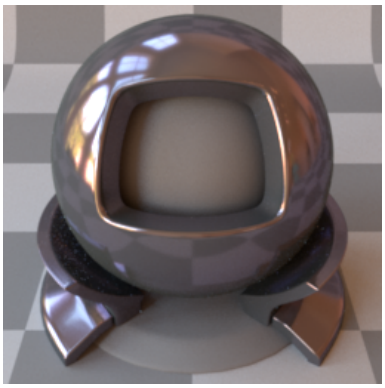
NDF (D)



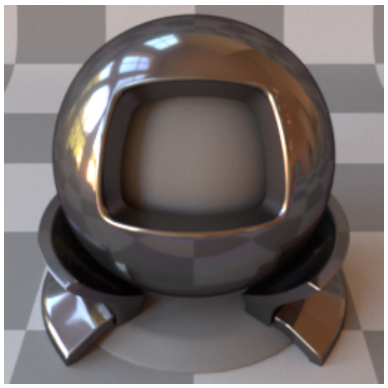
Smith (G_1)

3 aluminium

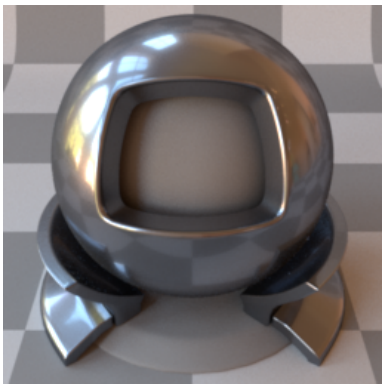
Renderings



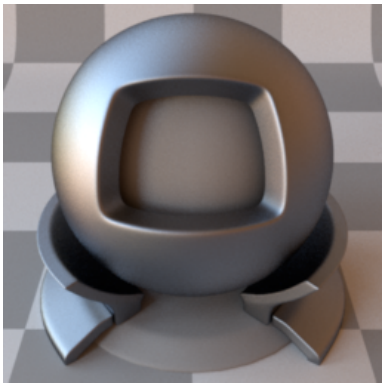
SGD



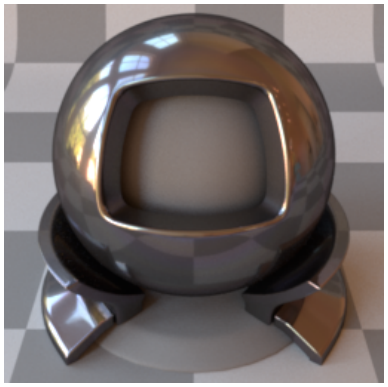
Reference



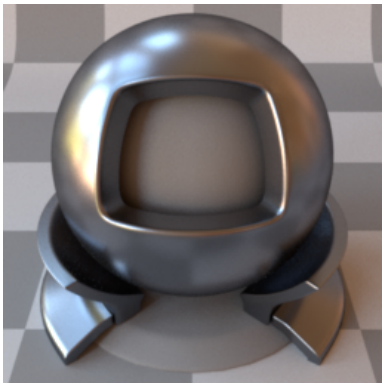
Ours: Tabulated



Ours: Gaussian

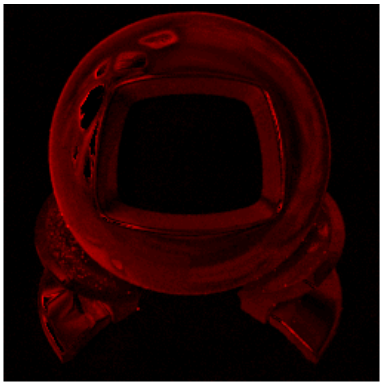


Reference

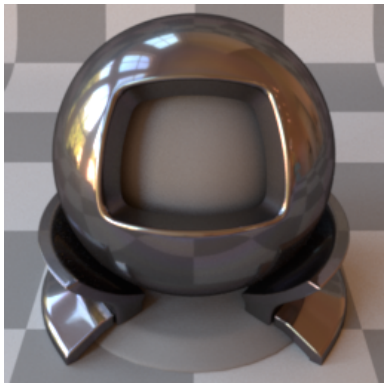


Ours: GGX

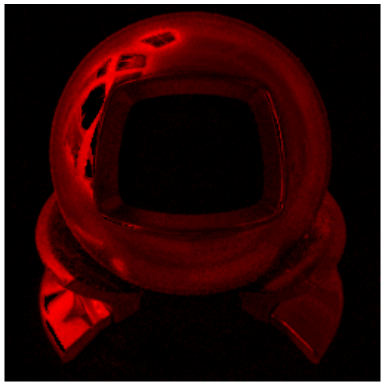
CIE dE00



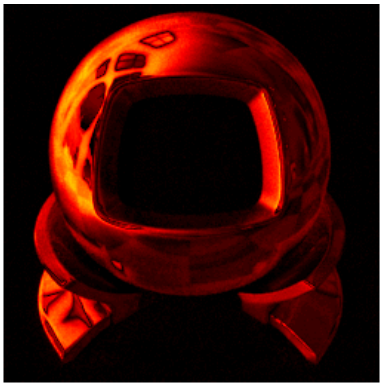
SGD



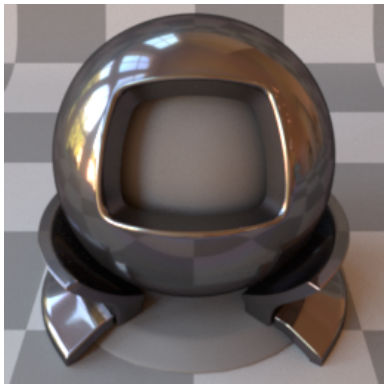
Reference



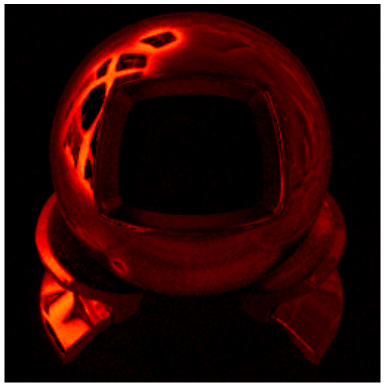
Ours: Tabulated



Ours: Gaussian

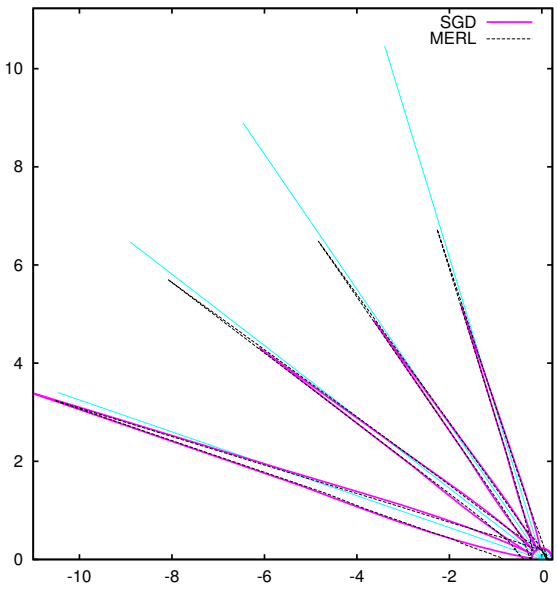


Reference

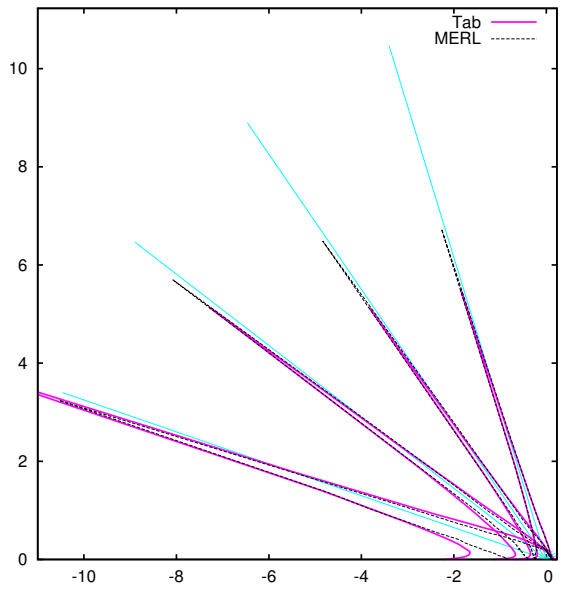


Ours: GGX

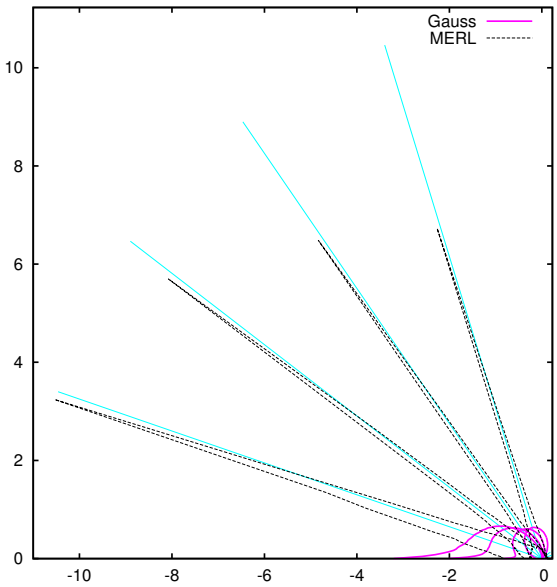
BRDF Lobes in the Incidence Plane (Cubic Root Applied)



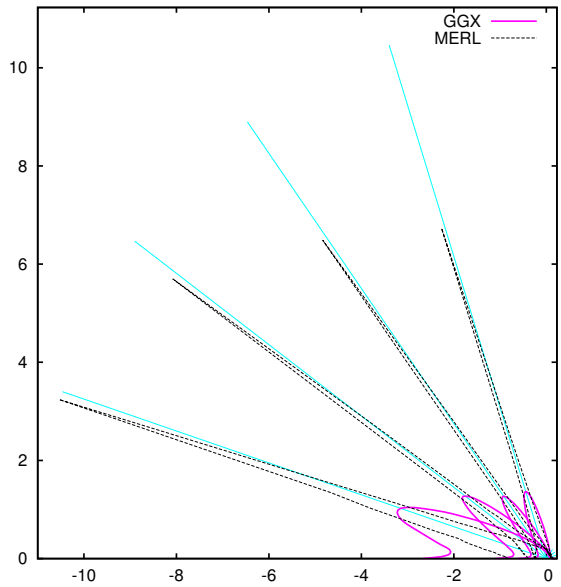
SGD



Ours: Tabulated

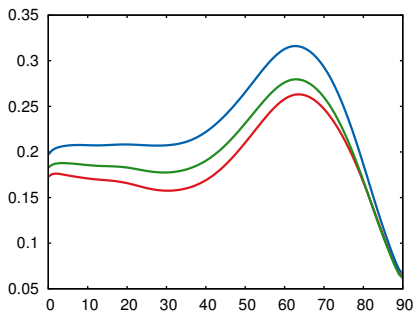


Ours: Gaussian

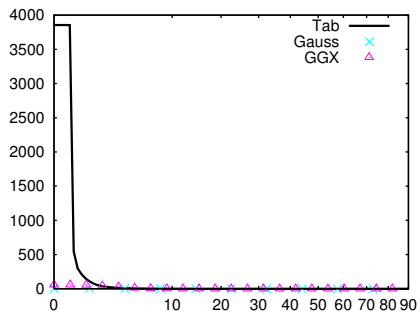


Ours: GGX

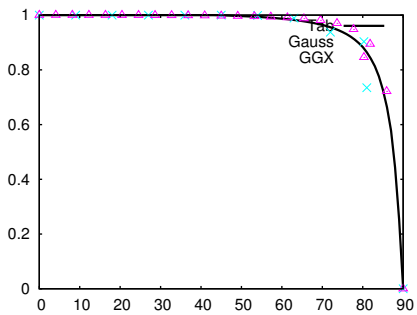
Fitted Microfacet Functions



Fresnel (R, G, B)



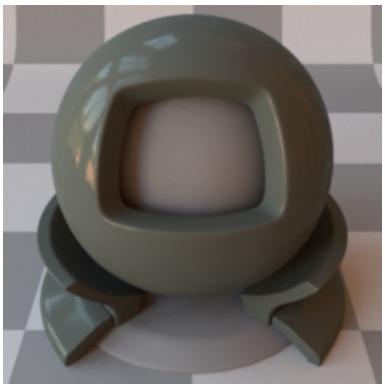
NDF (D)



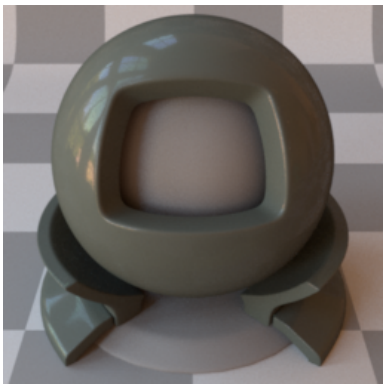
Smith (G_1)

4 aventurnine

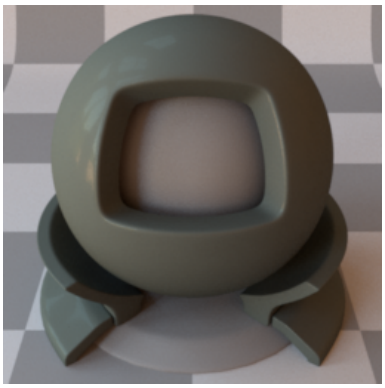
Renderings



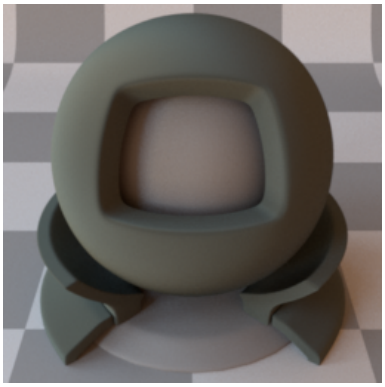
SGD



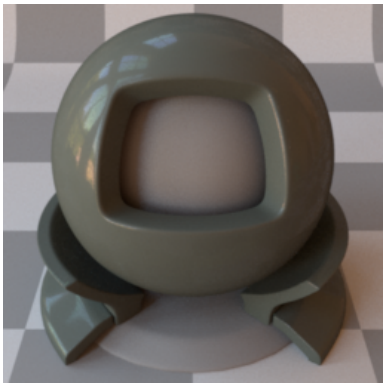
Reference



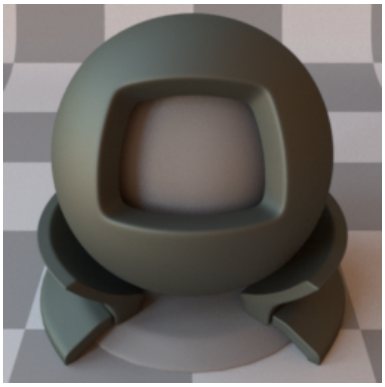
Ours: Tabulated



Ours: Gaussian

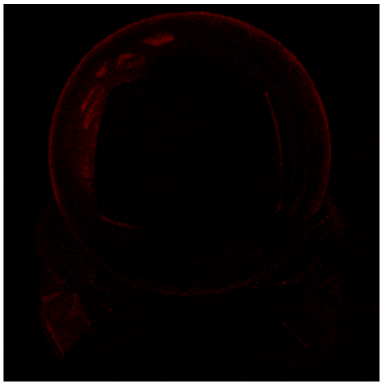


Reference

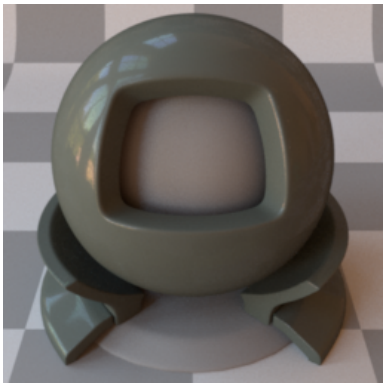


Ours: GGX

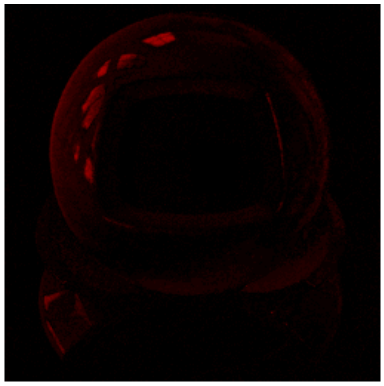
CIE dE00



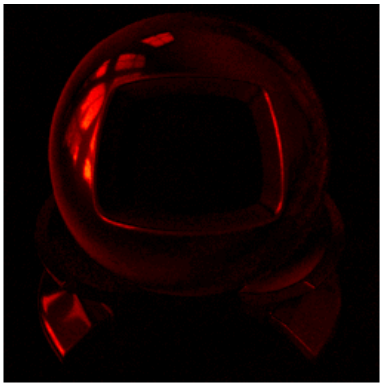
SGD



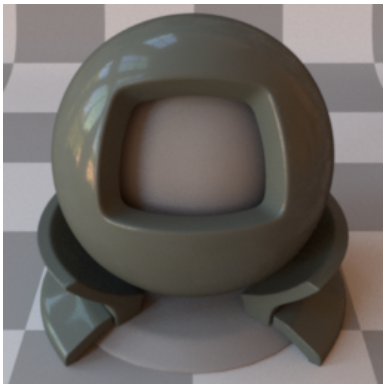
Reference



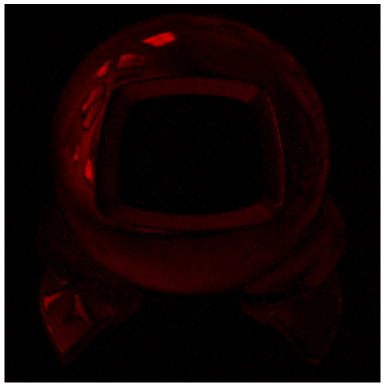
Ours: Tabulated



Ours: Gaussian

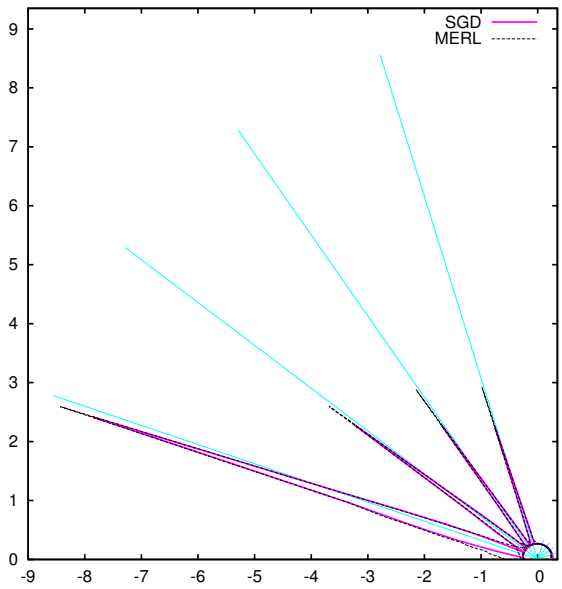


Reference

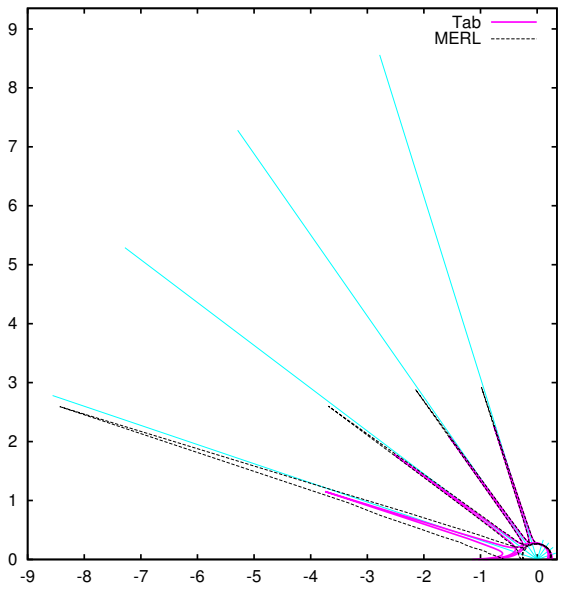


Ours: GGX

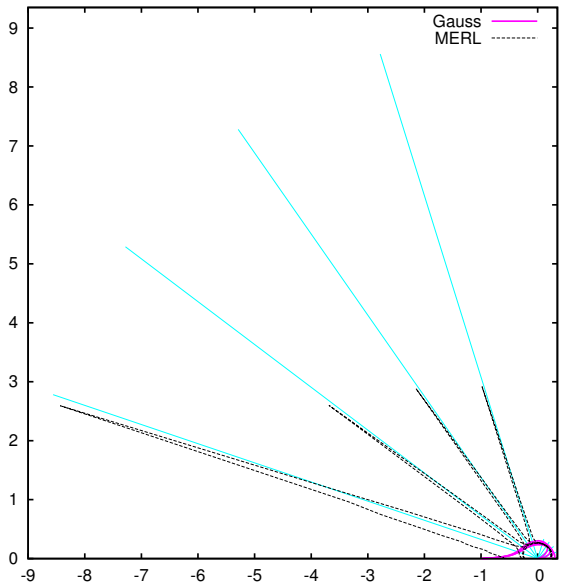
BRDF Lobes in the Incidence Plane (Cubic Root Applied)



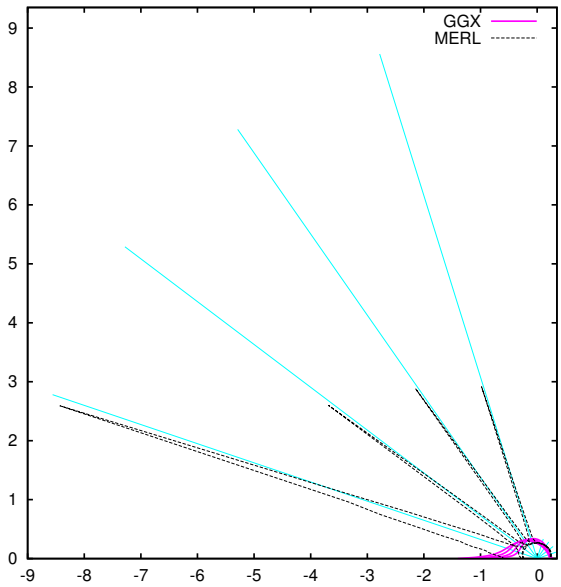
SGD



Ours: Tabulated

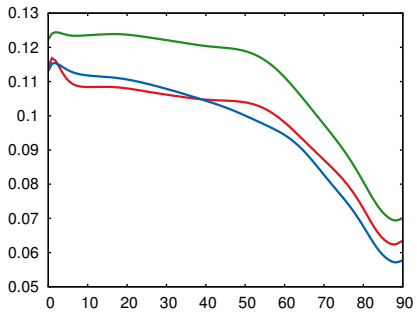


Ours: Gaussian

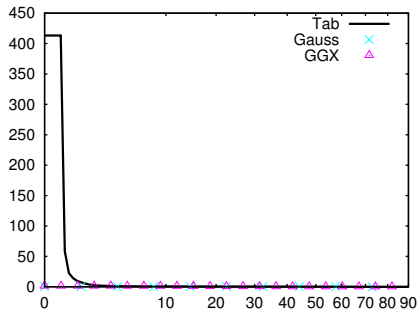


Ours: GGX

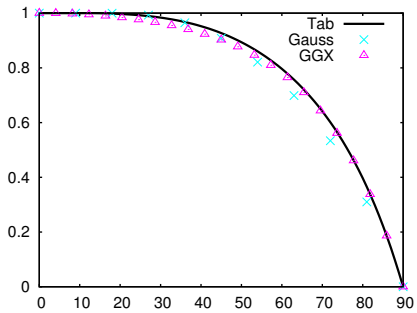
Fitted Microfacet Functions



Fresnel (R, G, B)



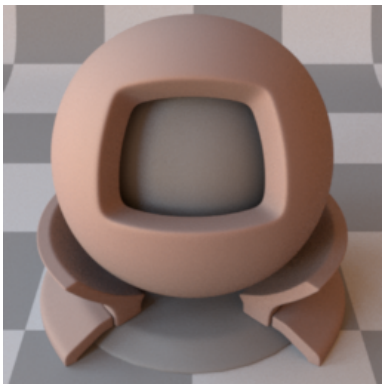
NDF (D)



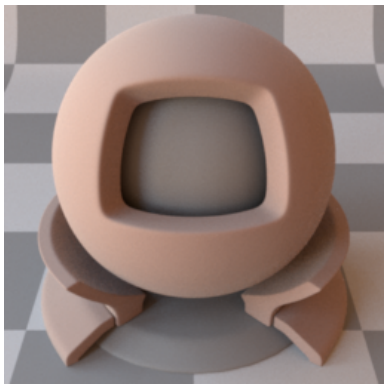
Smith (G_1)

5 beige-fabric

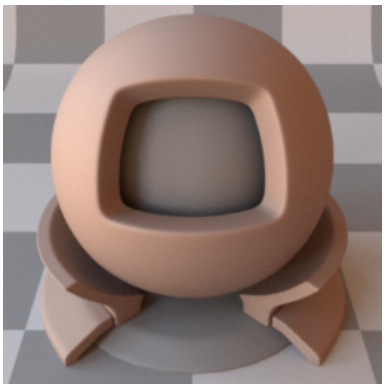
Renderings



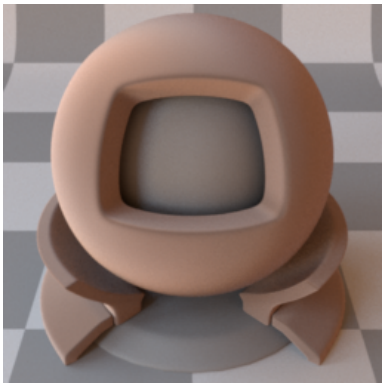
SGD



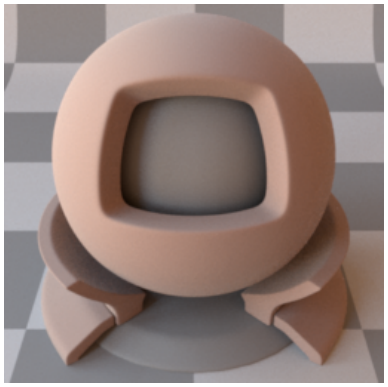
Reference



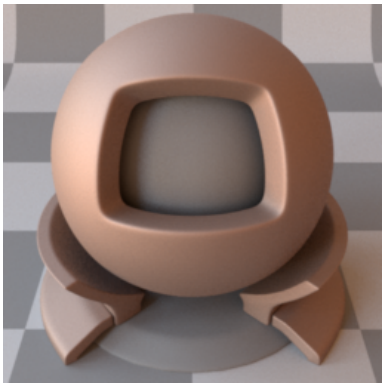
Ours: Tabulated



Ours: Gaussian

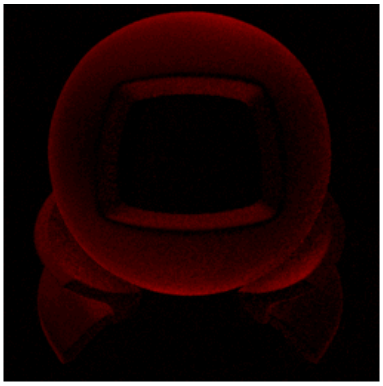


Reference

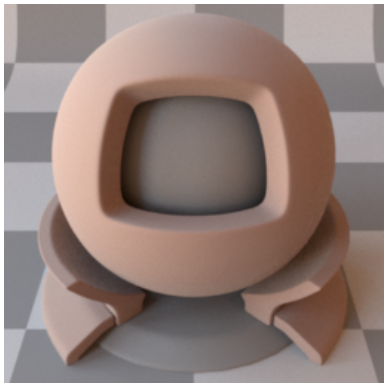


Ours: GGX

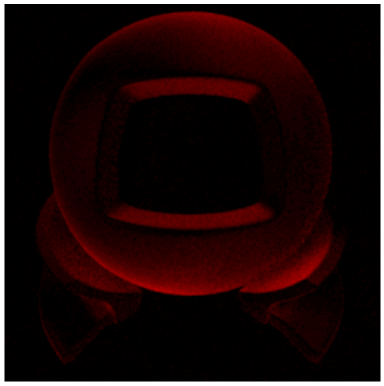
CIE dE00



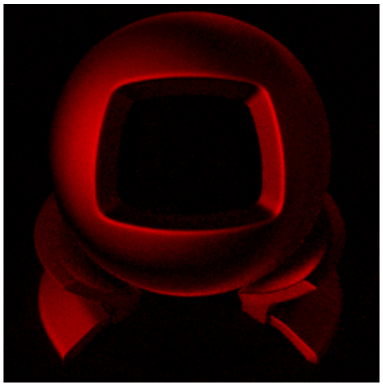
SGD



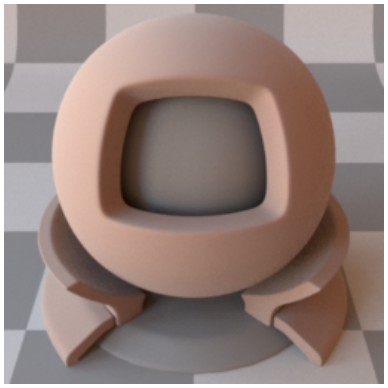
Reference



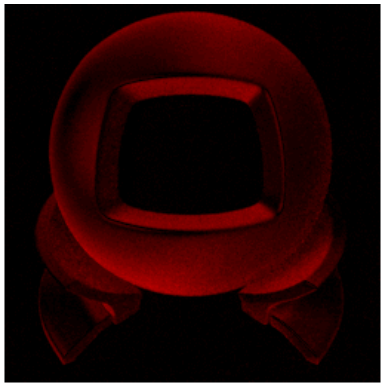
Ours: Tabulated



Ours: Gaussian

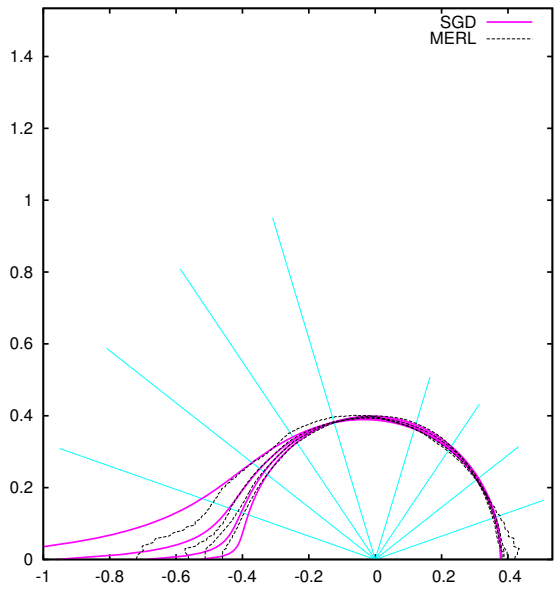


Reference

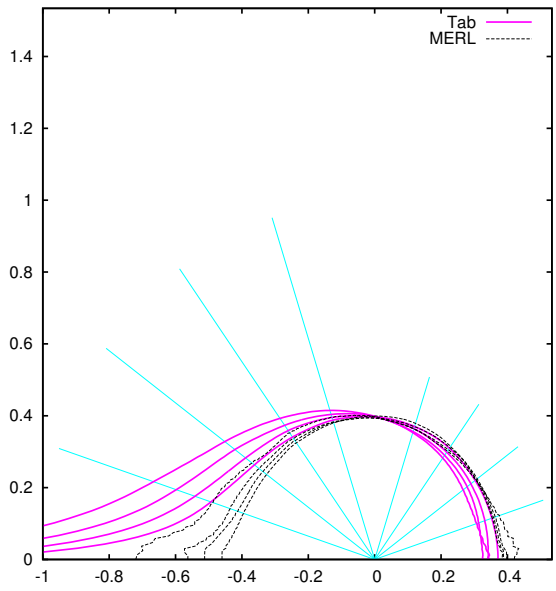


Ours: GGX

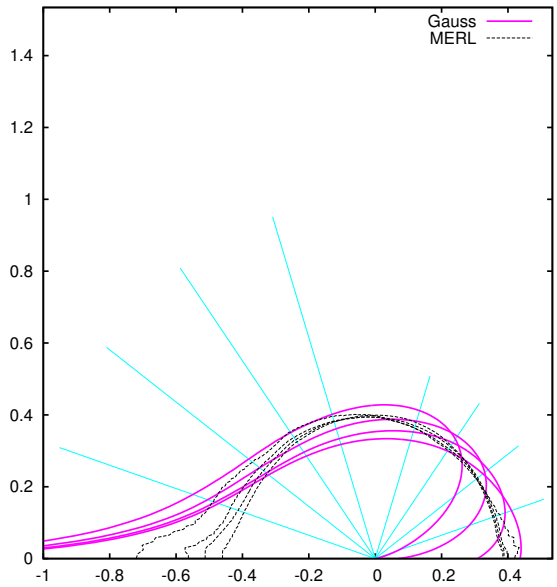
BRDF Lobes in the Incidence Plane (Cubic Root Applied)



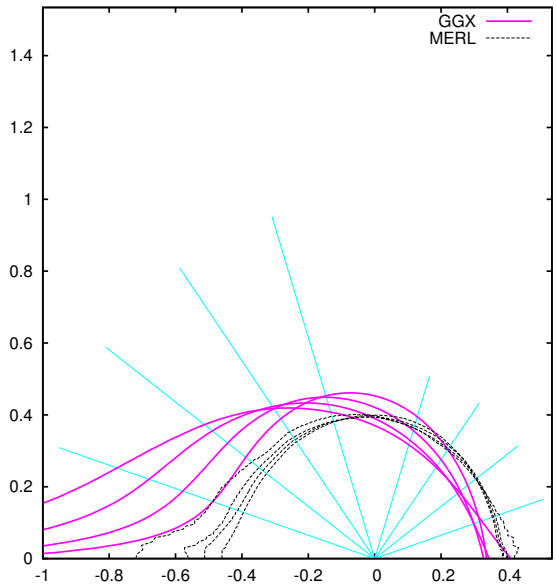
SGD



Ours: Tabulated

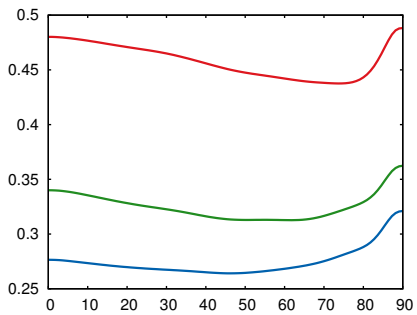


Ours: Gaussian

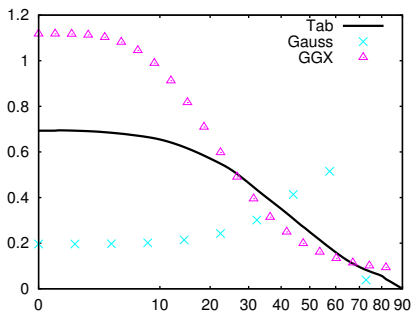


Ours: GGX

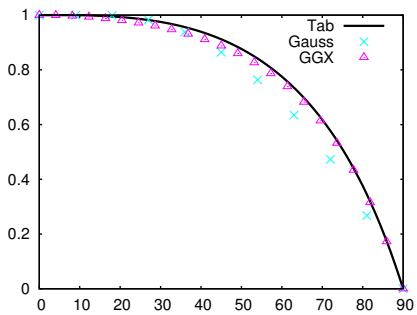
Fitted Microfacet Functions



Fresnel (R, G, B)



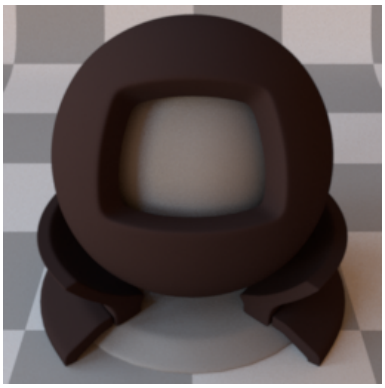
NDF (D)



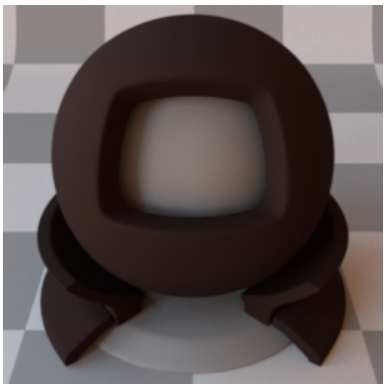
Smith (G_1)

6 black-fabric

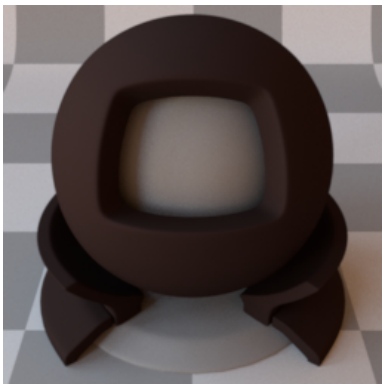
Renderings



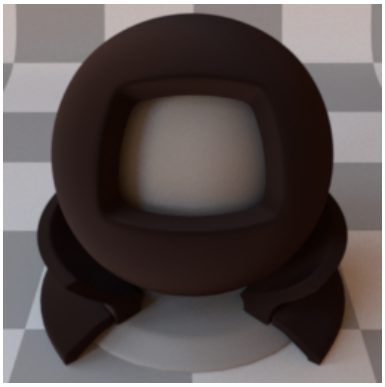
SGD



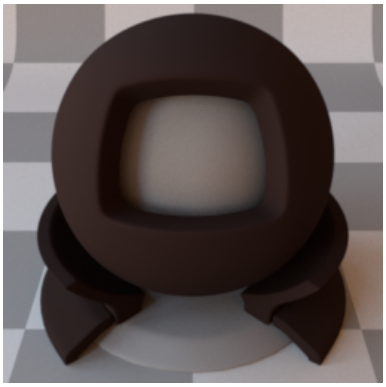
Reference



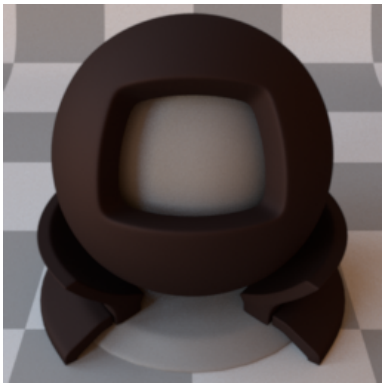
Ours: Tabulated



Ours: Gaussian

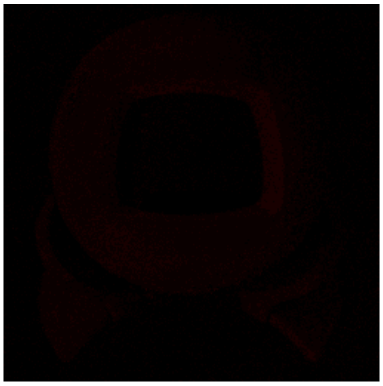


Reference

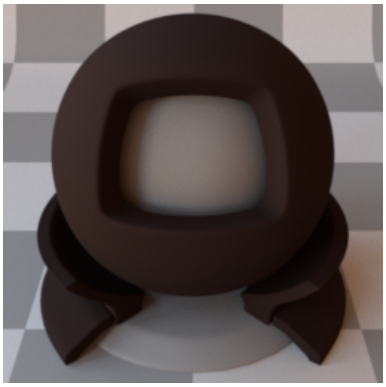


Ours: GGX

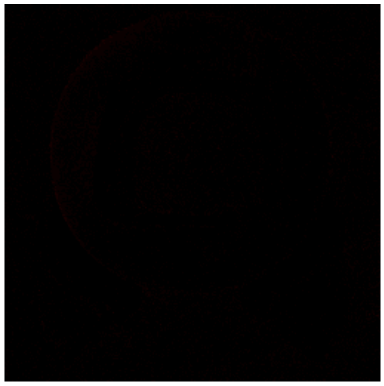
CIE dE00



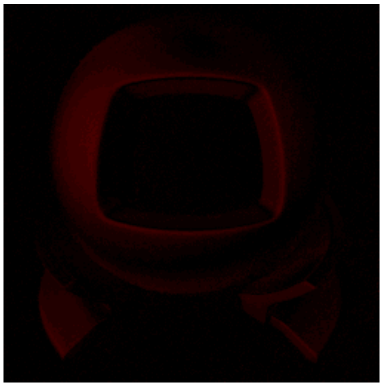
SGD



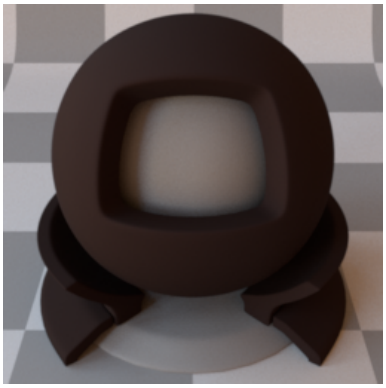
Reference



Ours: Tabulated



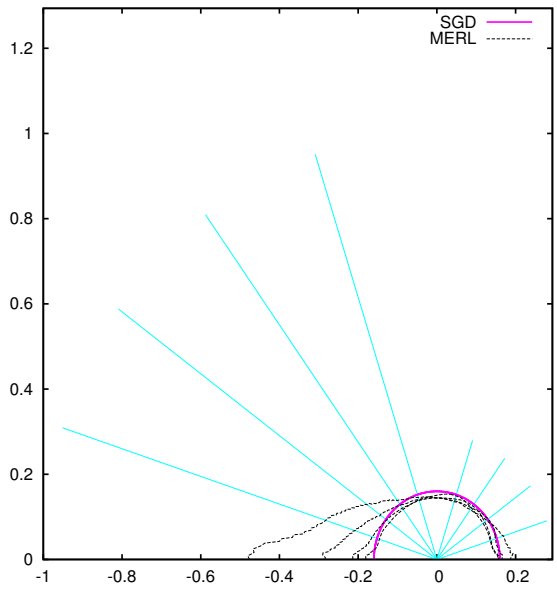
Ours: Gaussian



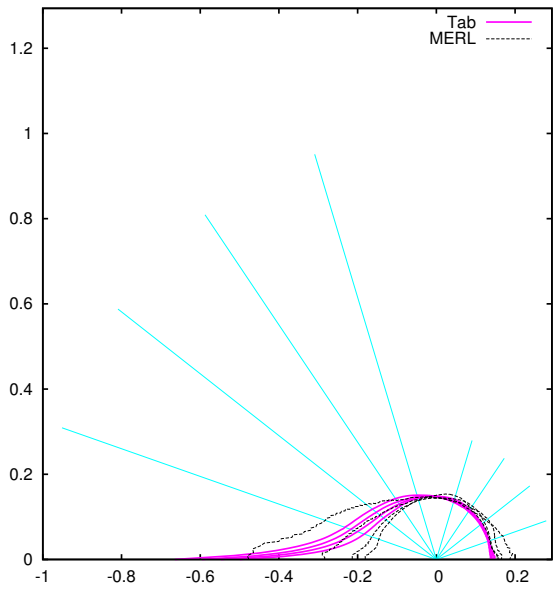
Reference

Ours: GGX

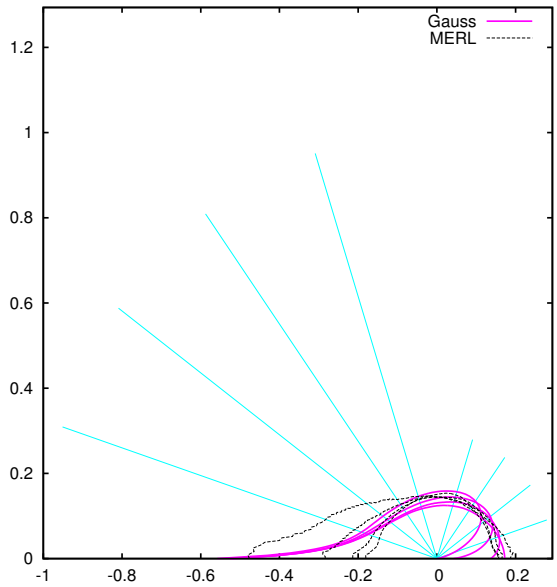
BRDF Lobes in the Incidence Plane (Cubic Root Applied)



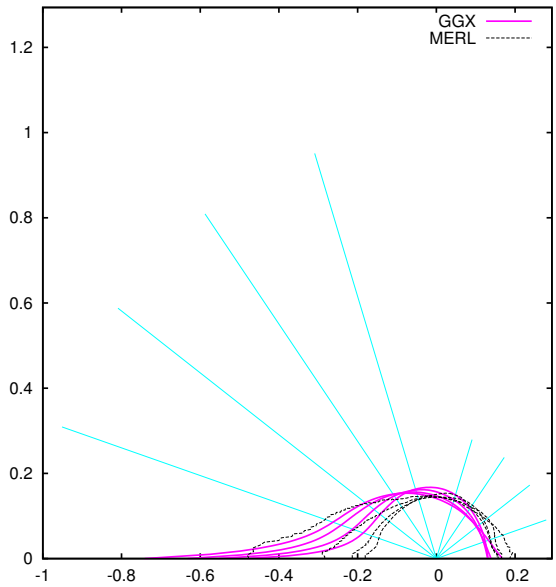
SGD



Ours: Tabulated

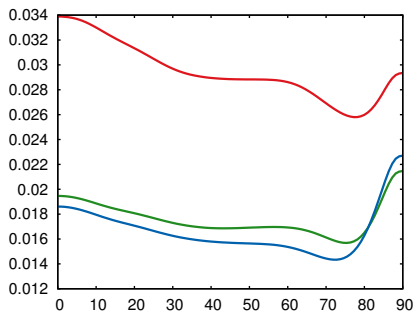


Ours: Gaussian

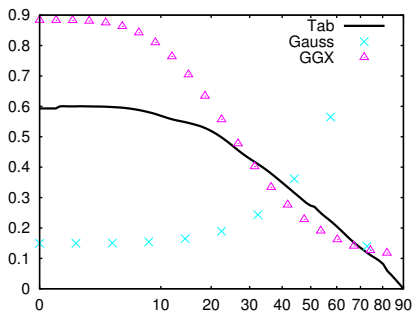


Ours: GGX

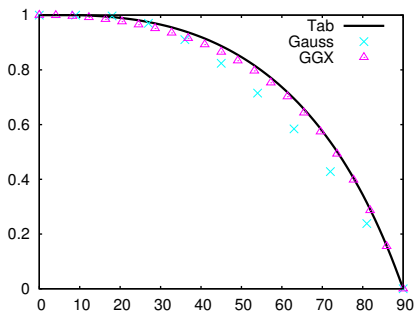
Fitted Microfacet Functions



Fresnel (R, G, B)



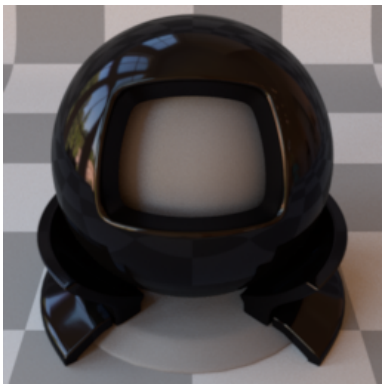
NDF (D)



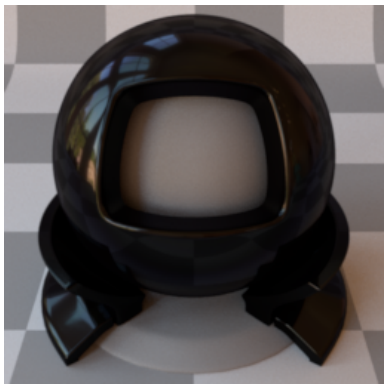
Smith (G_1)

7 black-obsidian

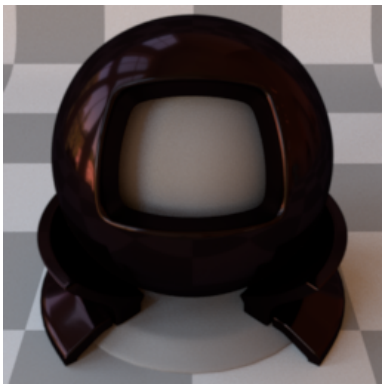
Renderings



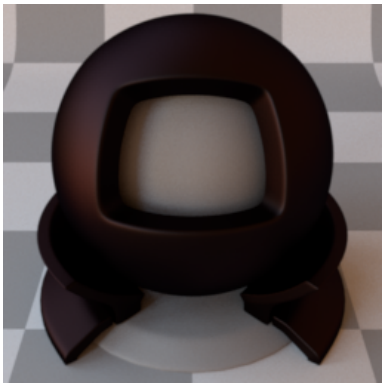
SGD



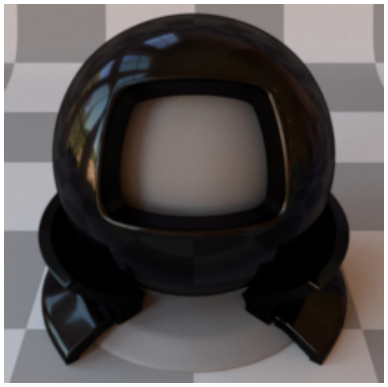
Reference



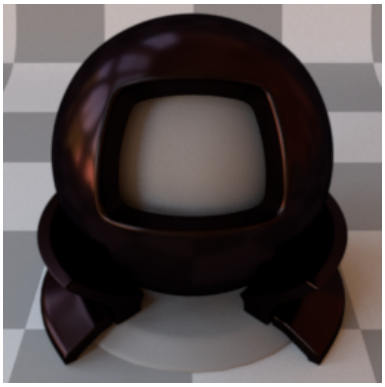
Ours: Tabulated



Ours: Gaussian

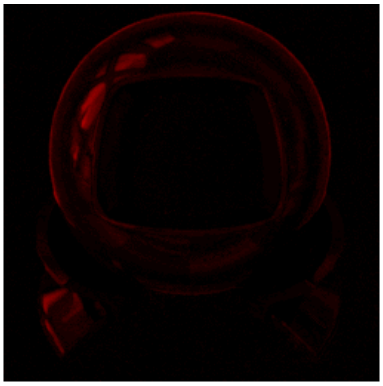


Reference

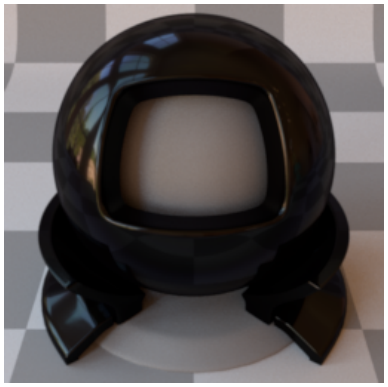


Ours: GGX

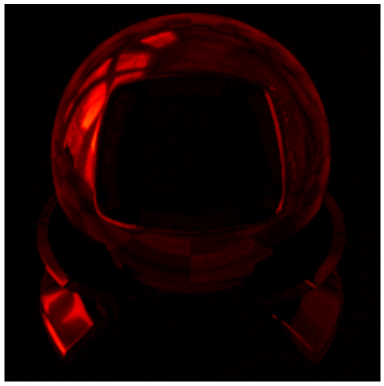
CIE dE00



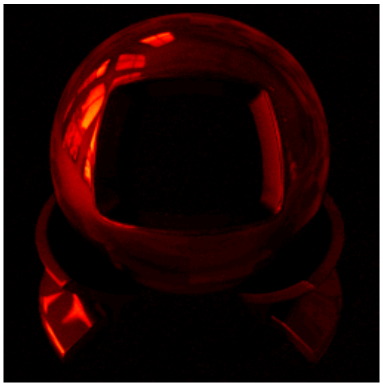
SGD



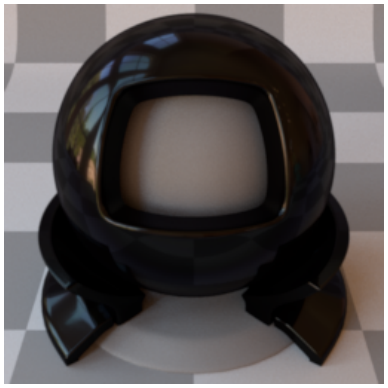
Reference



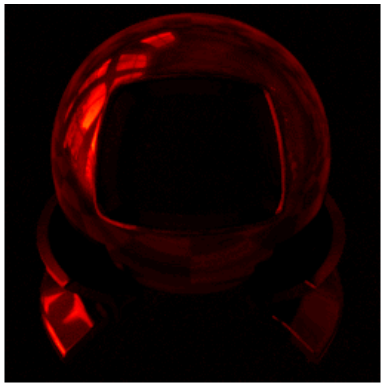
Ours: Tabulated



Ours: Gaussian

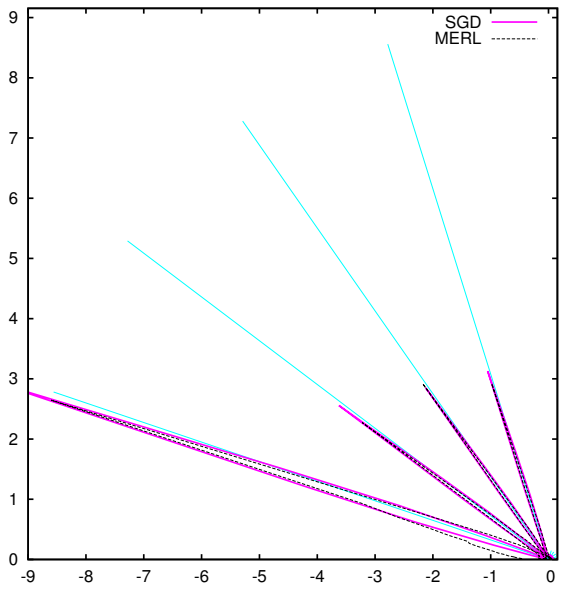


Reference

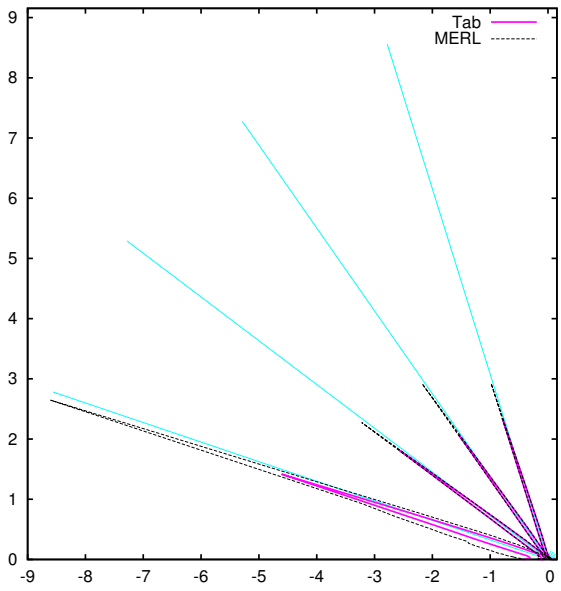


Ours: GGX

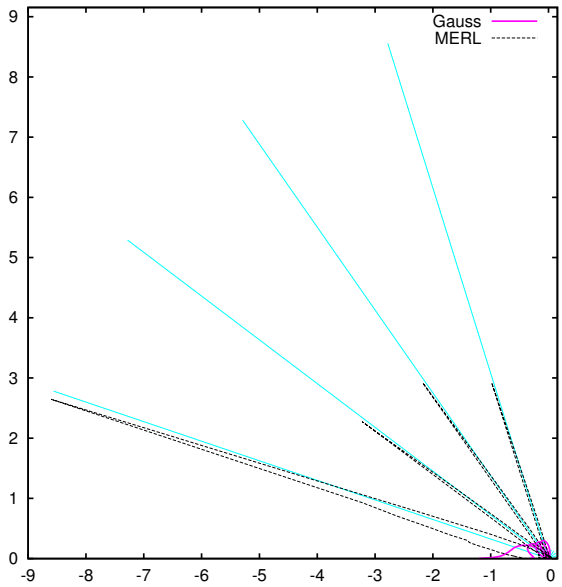
BRDF Lobes in the Incidence Plane (Cubic Root Applied)



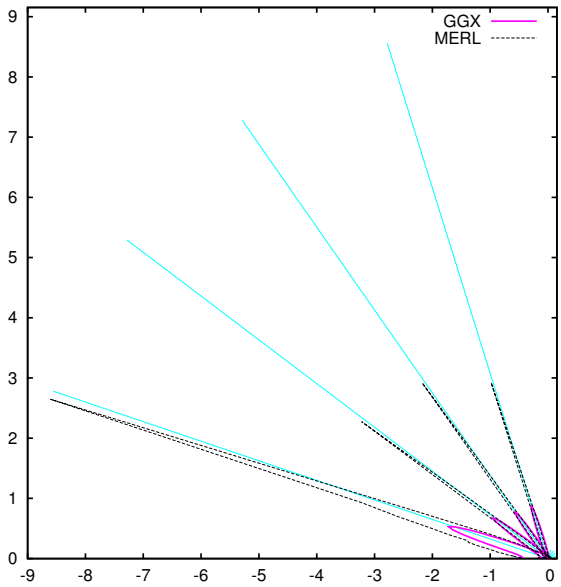
SGD



Ours: Tabulated

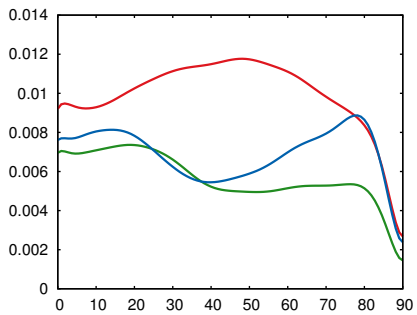


Ours: Gaussian

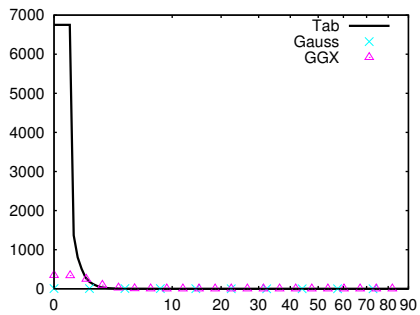


Ours: GGX

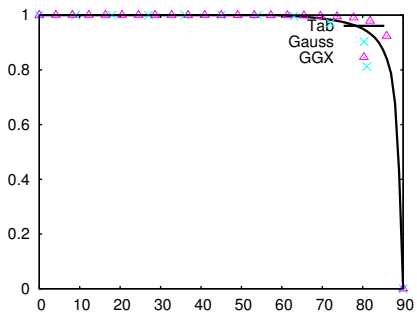
Fitted Microfacet Functions



Fresnel (R, G, B)



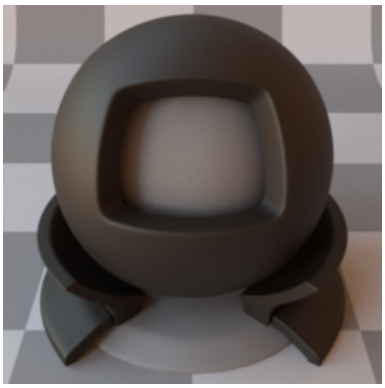
NDF (D)



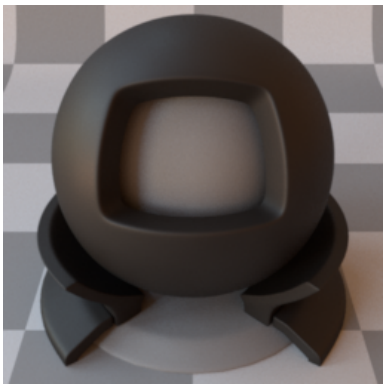
Smith (G_1)

8 black-oxidized-steel

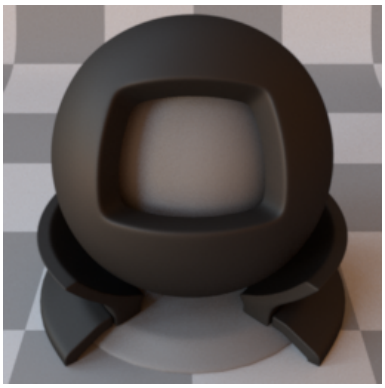
Renderings



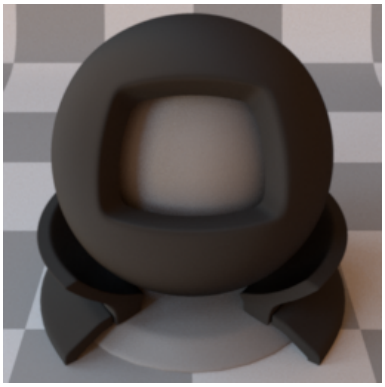
SGD



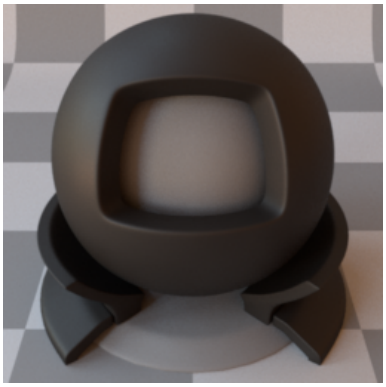
Reference



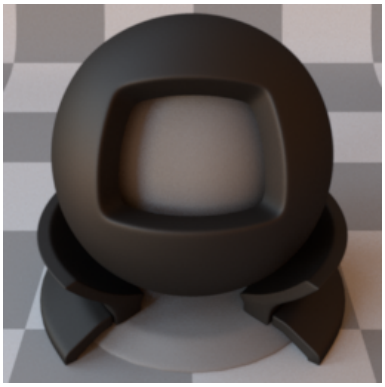
Ours: Tabulated



Ours: Gaussian

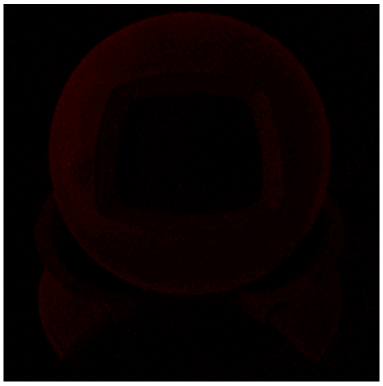


Reference

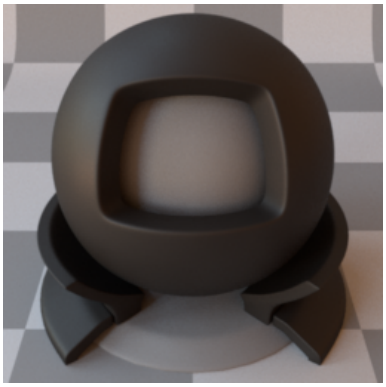


Ours: GGX

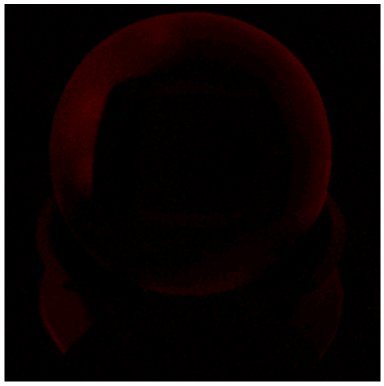
CIE dE00



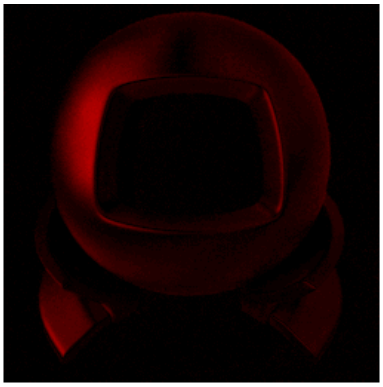
SGD



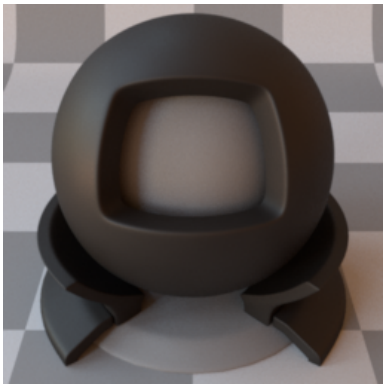
Reference



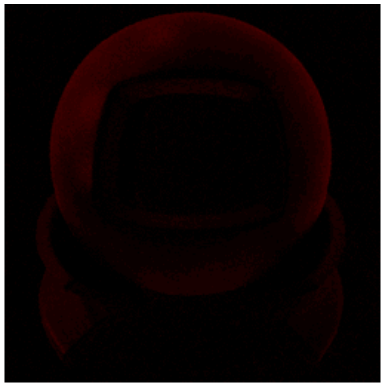
Ours: Tabulated



Ours: Gaussian

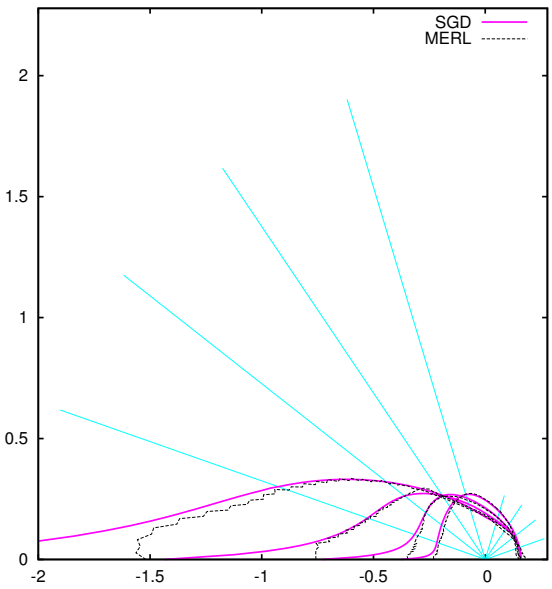


Reference

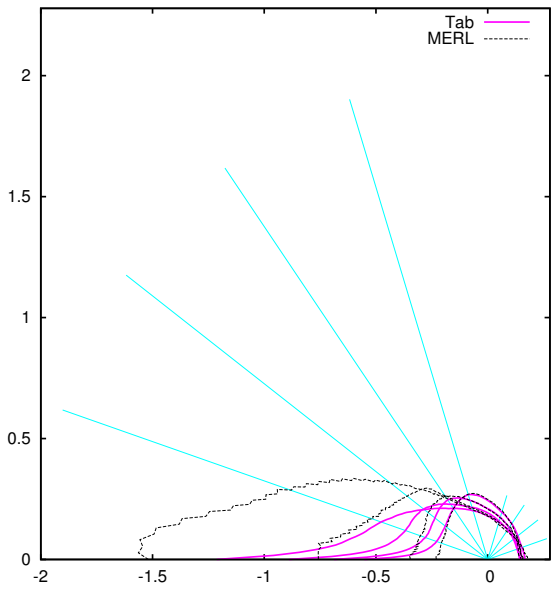


Ours: GGX

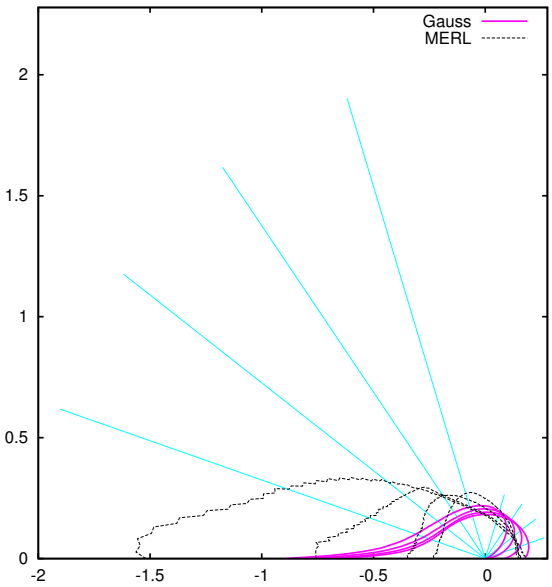
BRDF Lobes in the Incidence Plane (Cubic Root Applied)



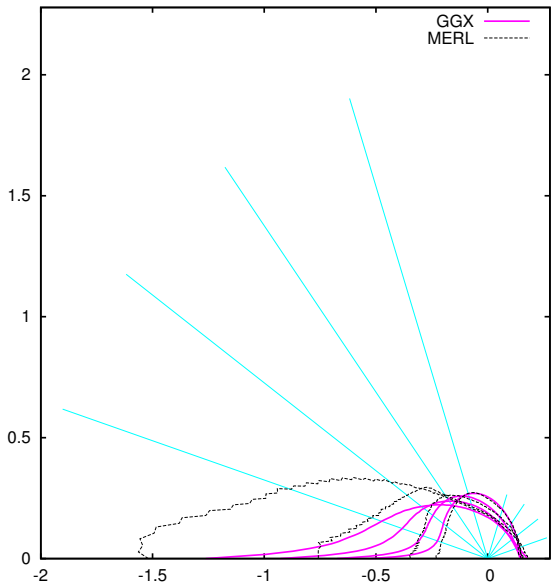
SGD



Ours: Tabulated

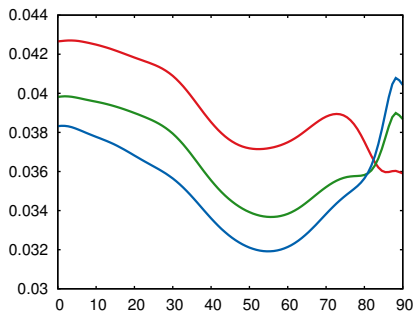


Ours: Gaussian

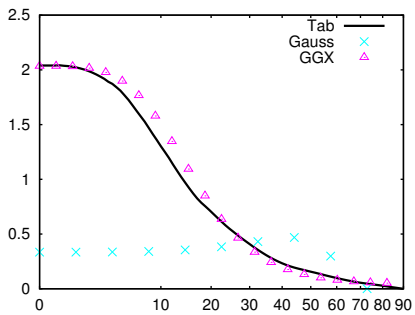


Ours: GGX

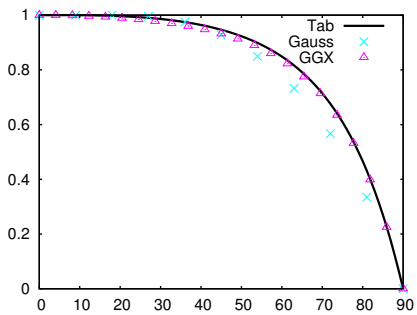
Fitted Microfacet Functions



Fresnel (R, G, B)



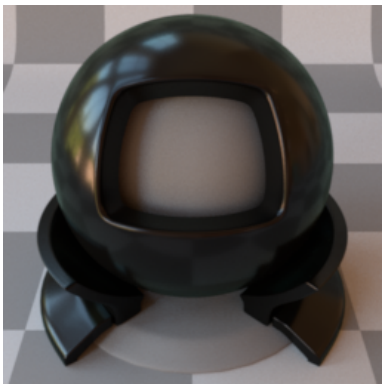
NDF (D)



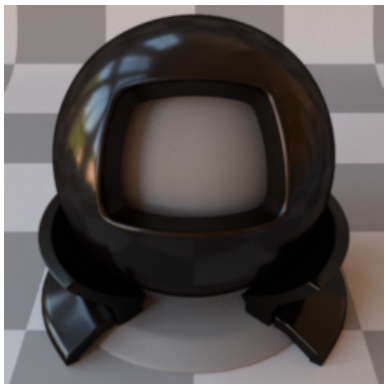
Smith (G_1)

9 black-phenolic

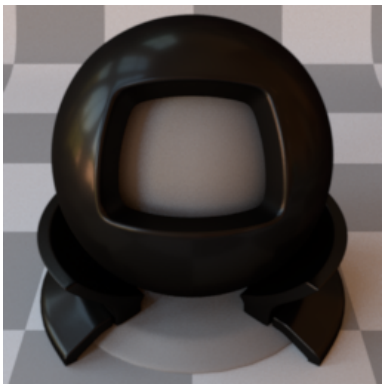
Renderings



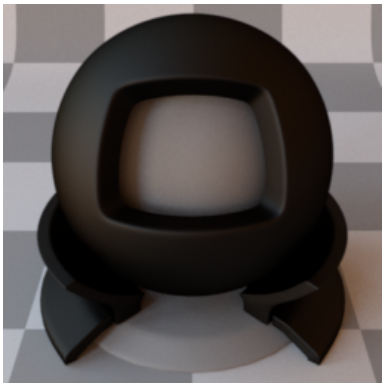
SGD



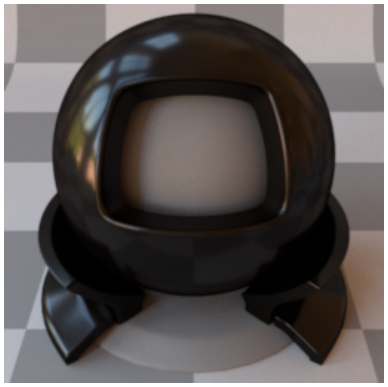
Reference



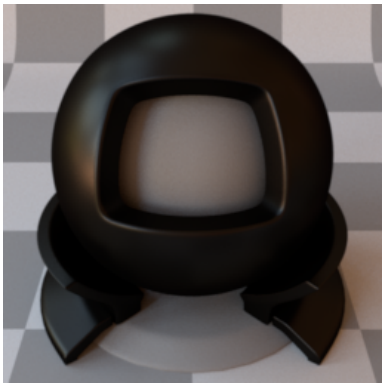
Ours: Tabulated



Ours: Gaussian

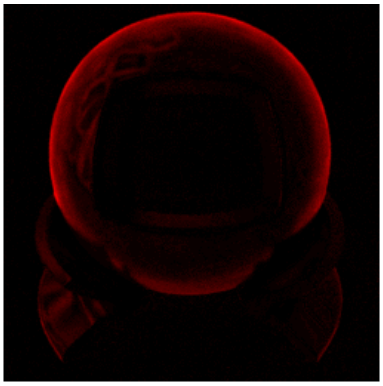


Reference

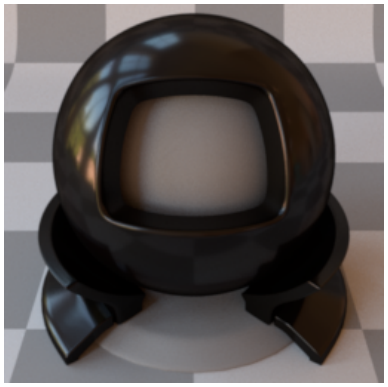


Ours: GGX

CIE dE00

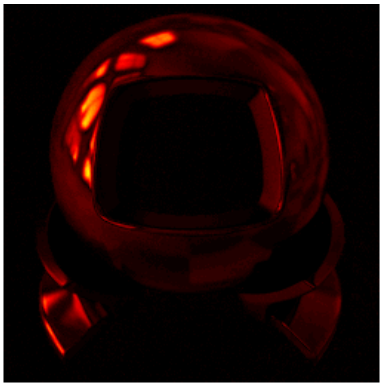


SGD

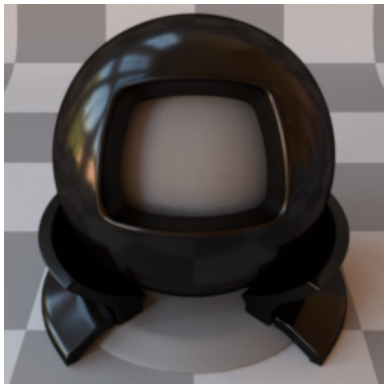


Reference

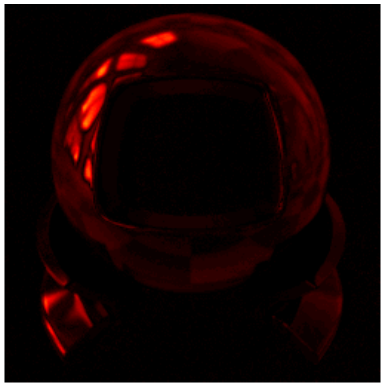
Ours: Tabulated



Ours: Gaussian

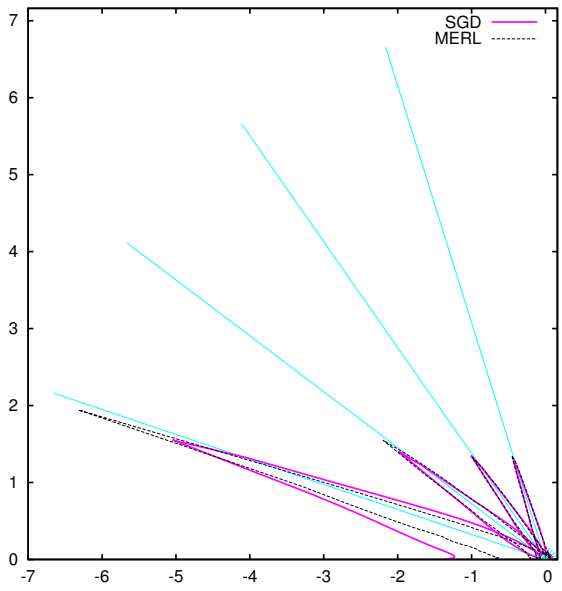


Reference

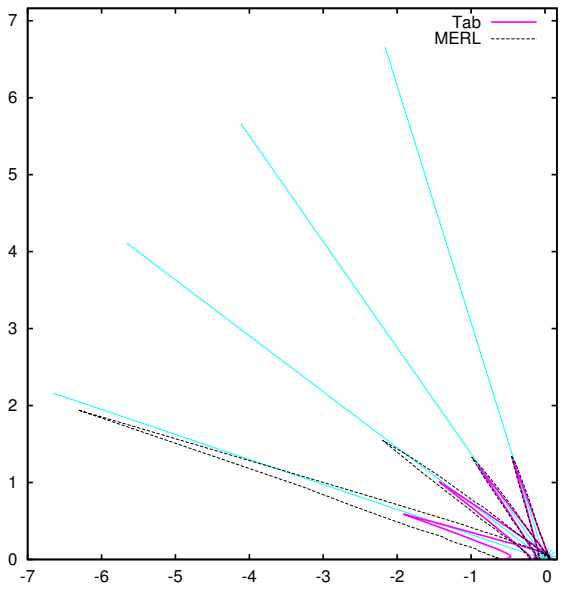


Ours: GGX

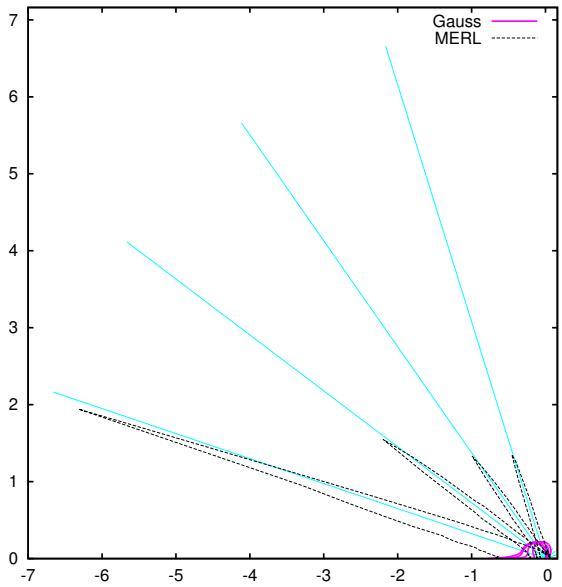
BRDF Lobes in the Incidence Plane (Cubic Root Applied)



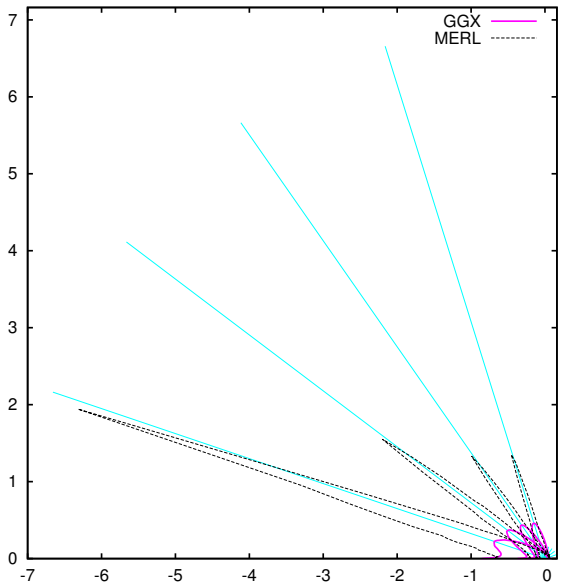
SGD



Ours: Tabulated

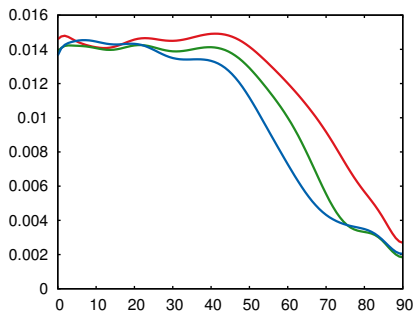


Ours: Gaussian

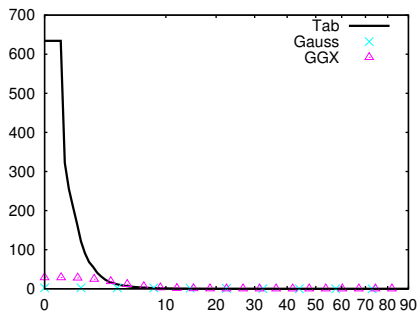


Ours: GGX

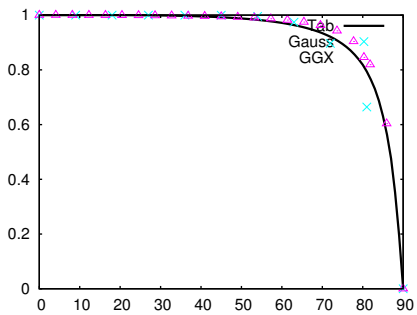
Fitted Microfacet Functions



Fresnel (R, G, B)



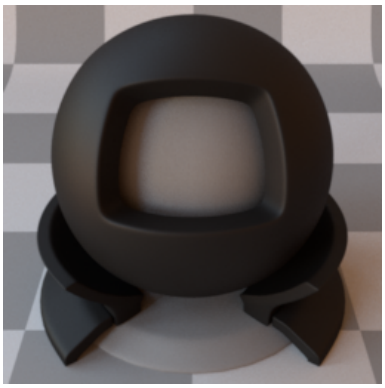
NDF (D)



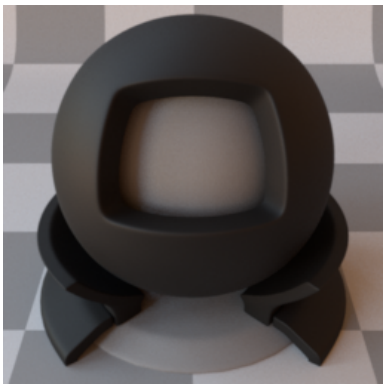
Smith (G_1)

10 black-soft-plastic

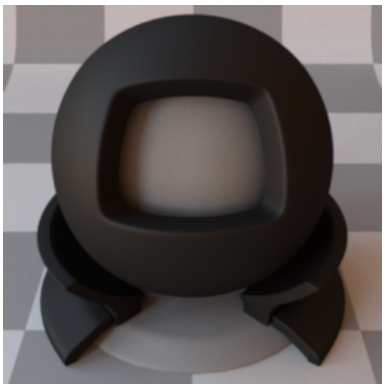
Renderings



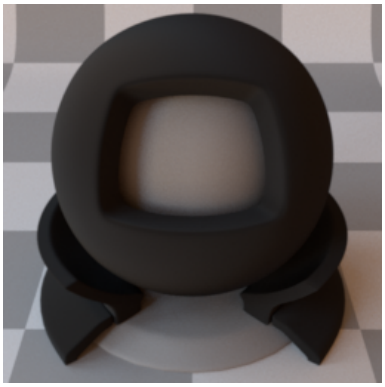
SGD



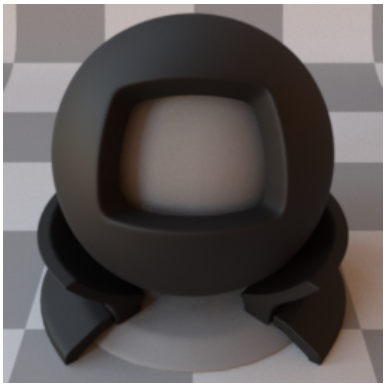
Reference



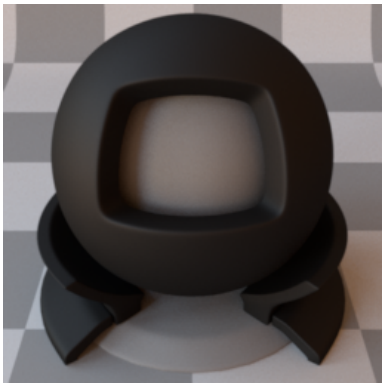
Ours: Tabulated



Ours: Gaussian

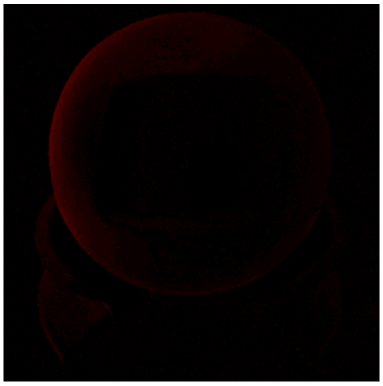


Reference

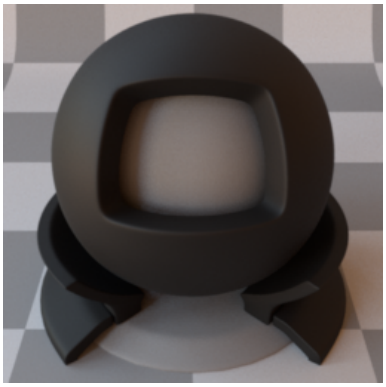


Ours: GGX

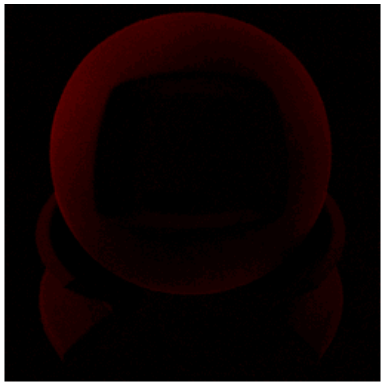
CIE dE00



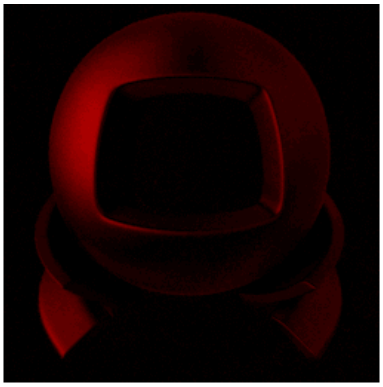
SGD



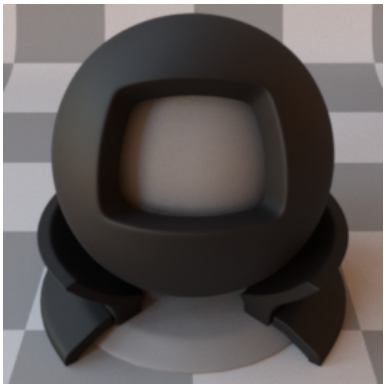
Reference



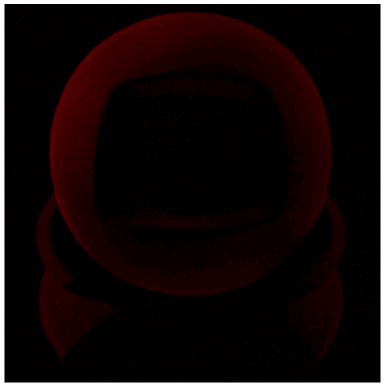
Ours: Tabulated



Ours: Gaussian

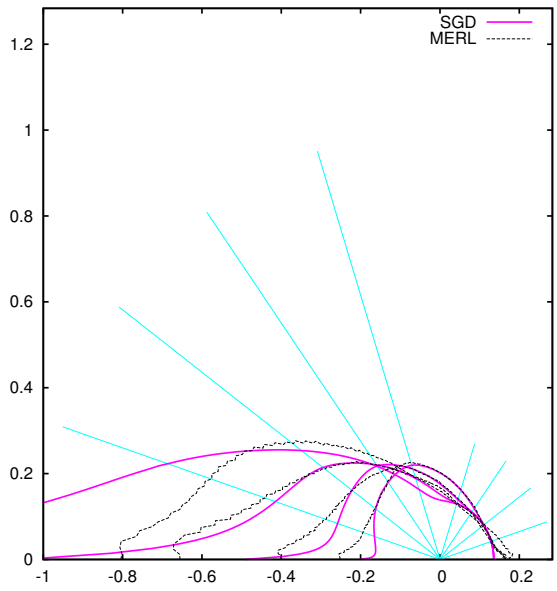


Reference

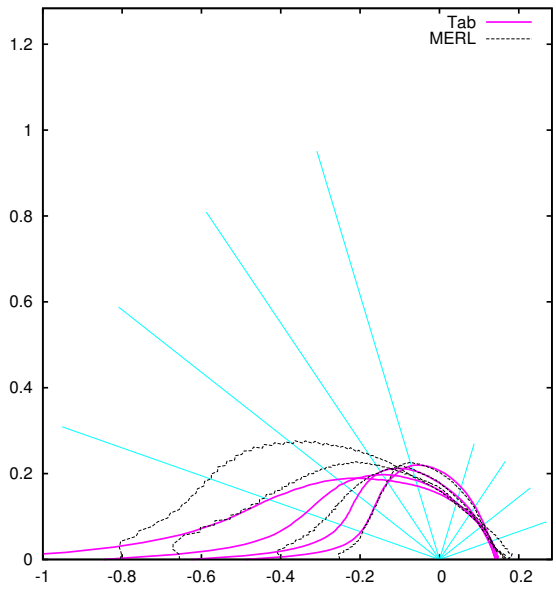


Ours: GGX

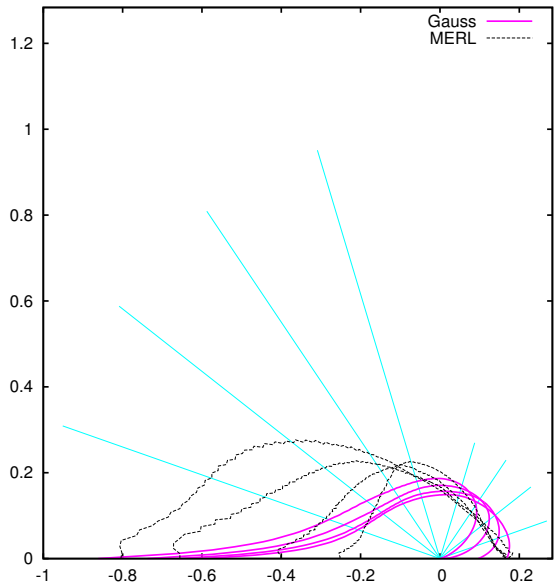
BRDF Lobes in the Incidence Plane (Cubic Root Applied)



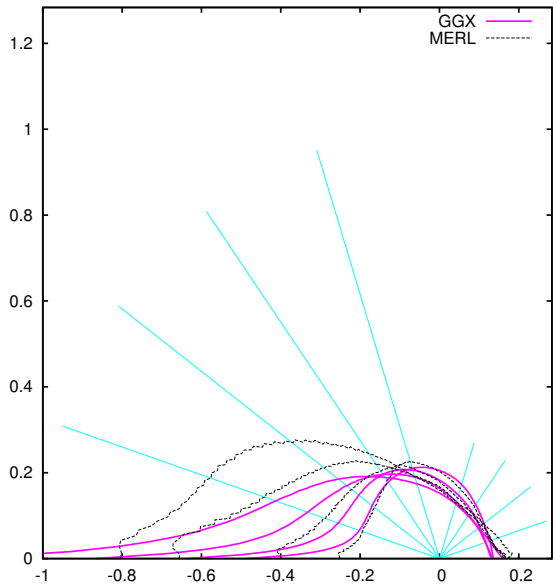
SGD



Ours: Tabulated

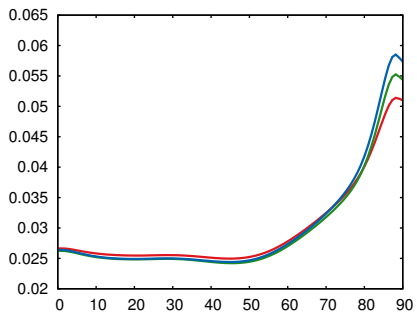


Ours: Gaussian

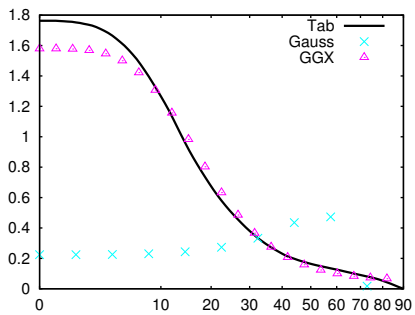


Ours: GGX

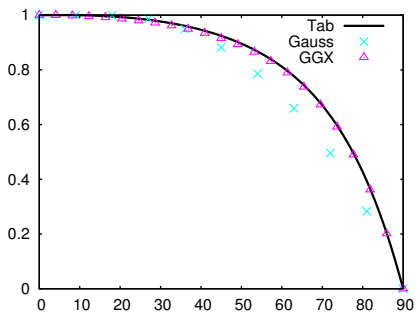
Fitted Microfacet Functions



Fresnel (R, G, B)



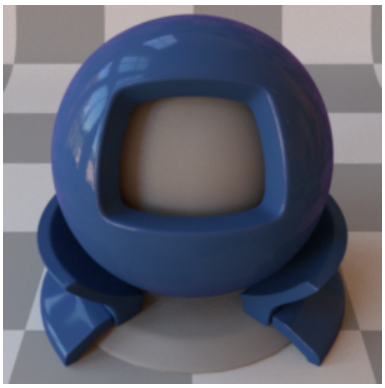
NDF (D)



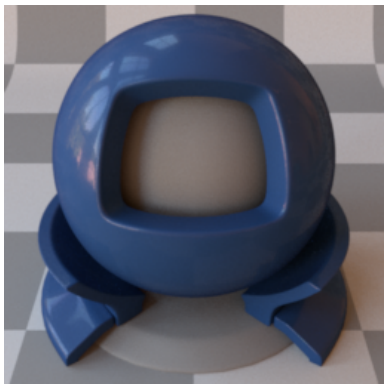
Smith (G_1)

11 blue-acrylic

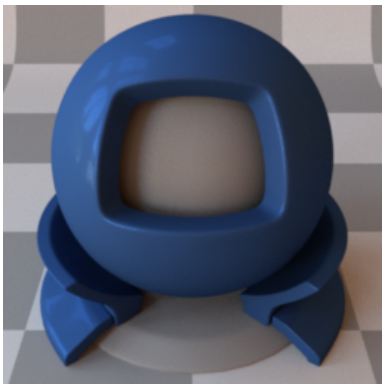
Renderings



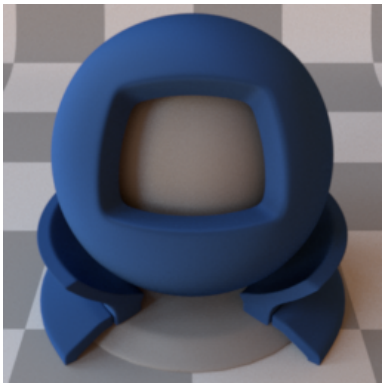
SGD



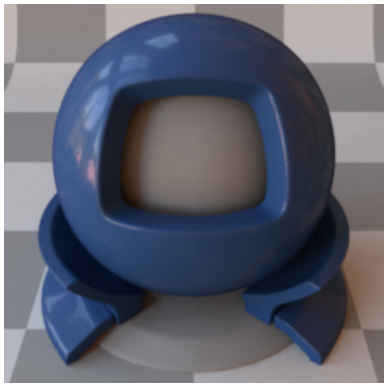
Reference



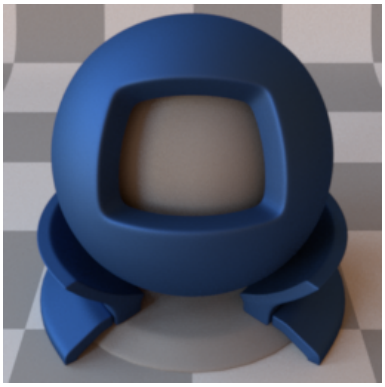
Ours: Tabulated



Ours: Gaussian

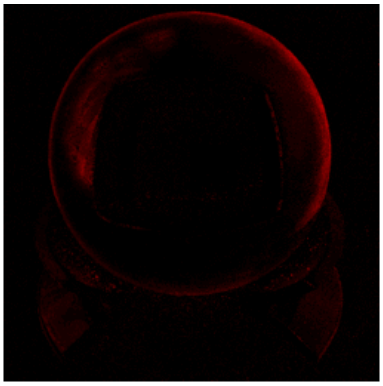


Reference

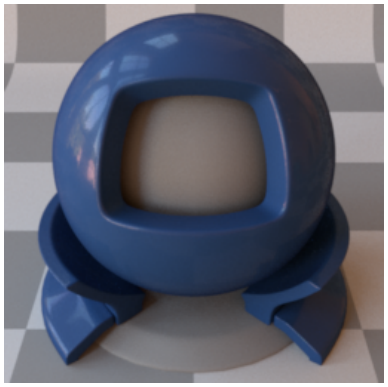


Ours: GGX

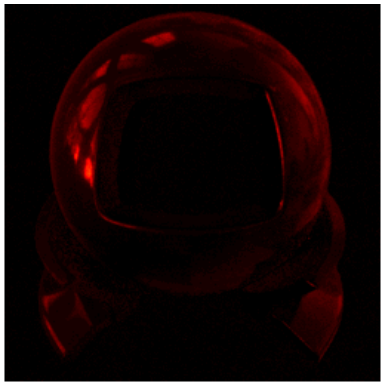
CIE dE00



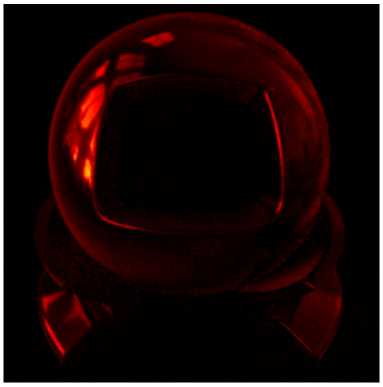
SGD



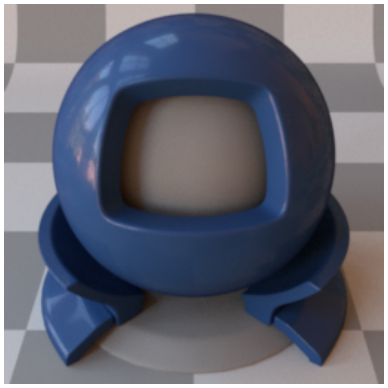
Reference



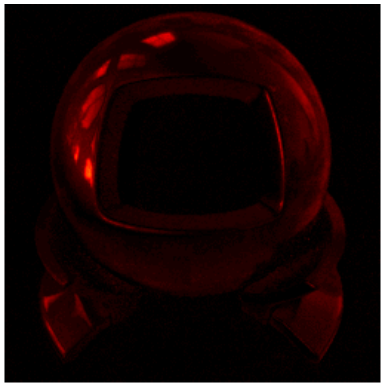
Ours: Tabulated



Ours: Gaussian

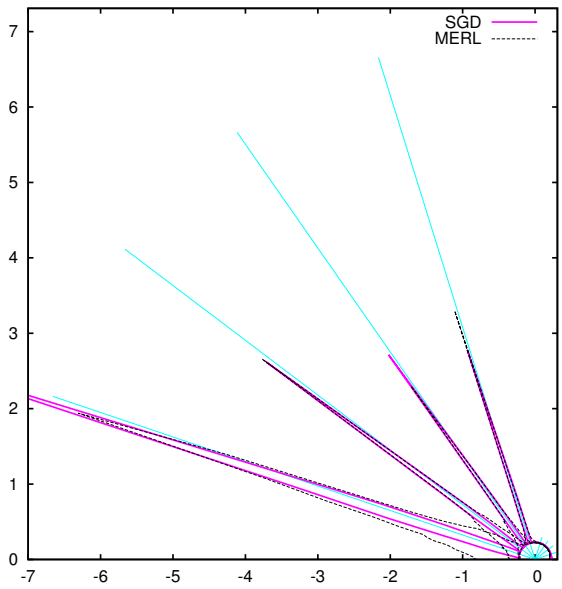


Reference

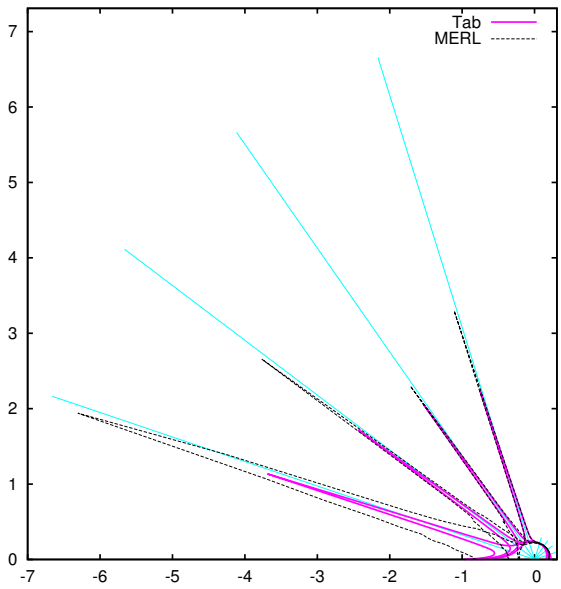


Ours: GGX

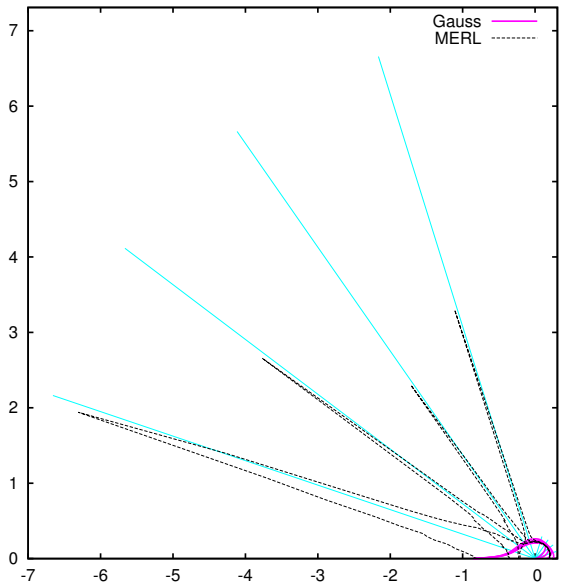
BRDF Lobes in the Incidence Plane (Cubic Root Applied)



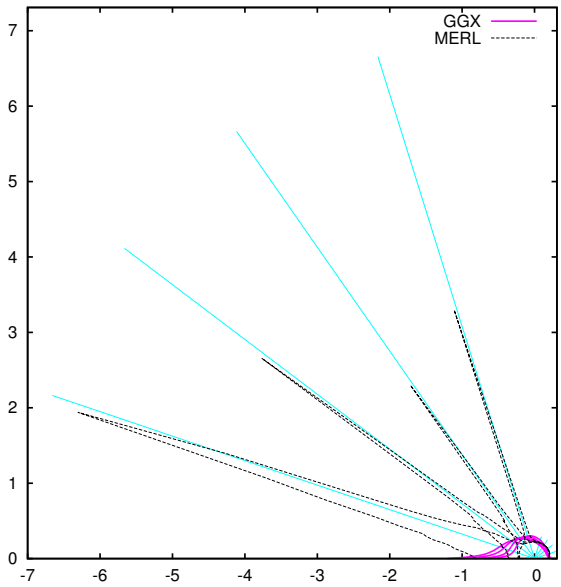
SGD



Ours: Tabulated

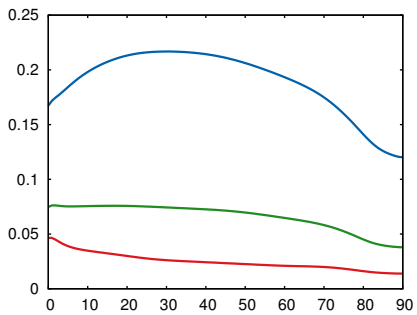


Ours: Gaussian

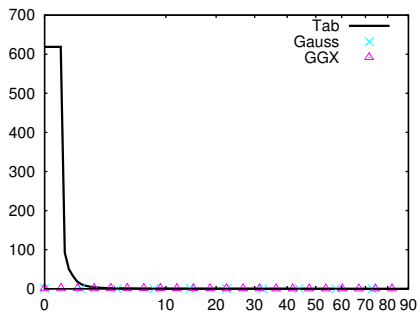


Ours: GGX

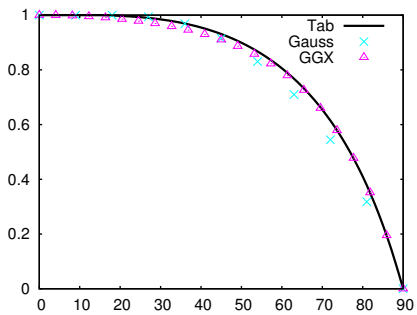
Fitted Microfacet Functions



Fresnel (R, G, B)



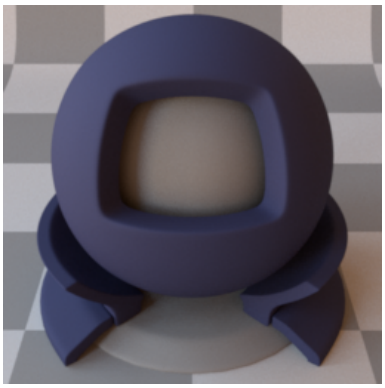
NDF (D)



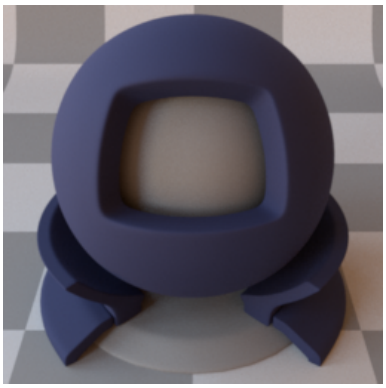
Smith (G_1)

12 blue-fabric

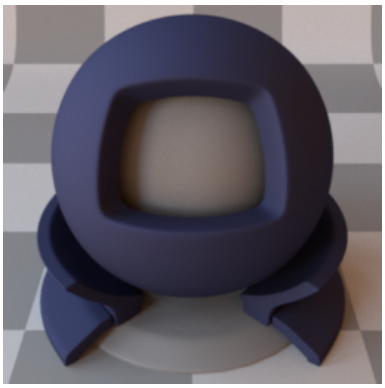
Renderings



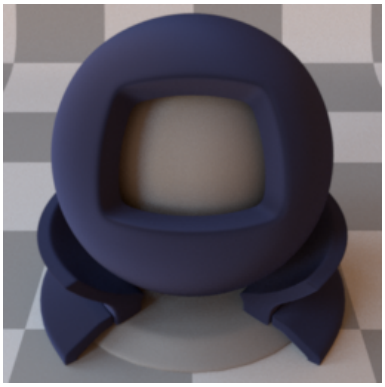
SGD



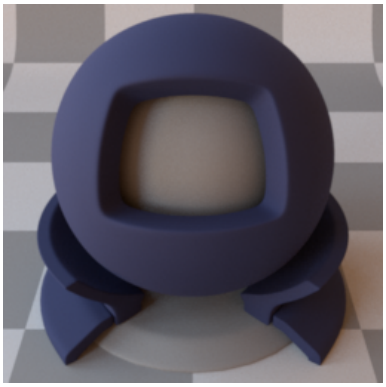
Reference



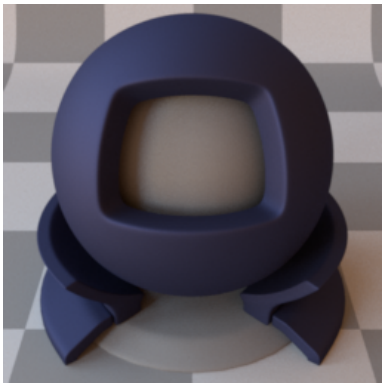
Ours: Tabulated



Ours: Gaussian

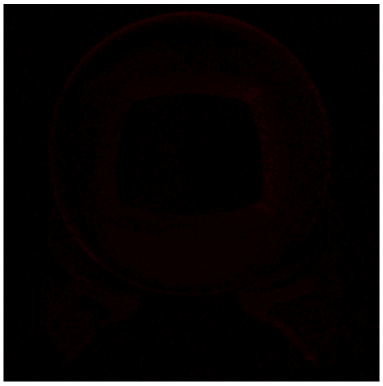


Reference

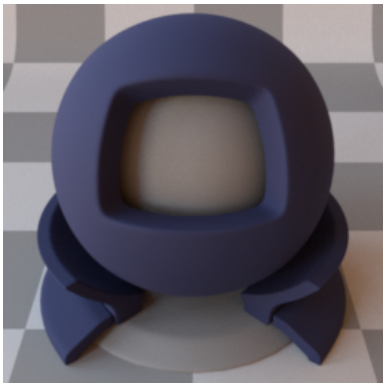


Ours: GGX

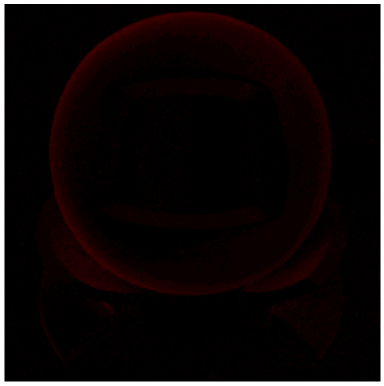
CIE dE00



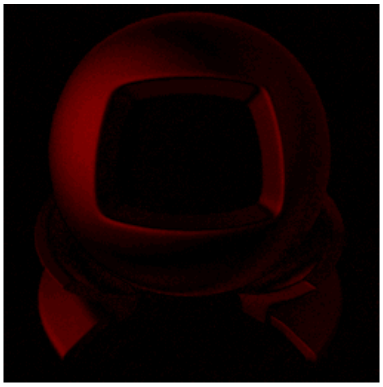
SGD



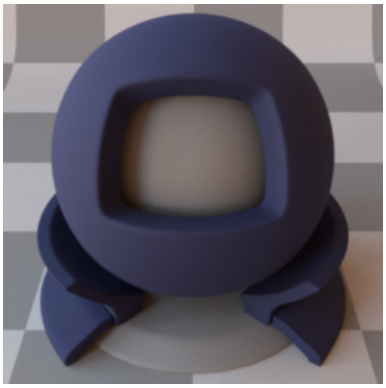
Reference



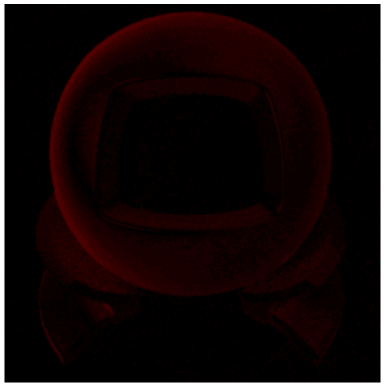
Ours: Tabulated



Ours: Gaussian

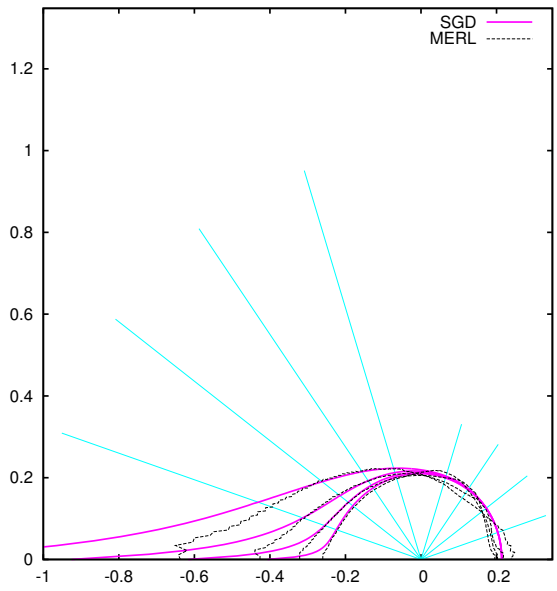


Reference

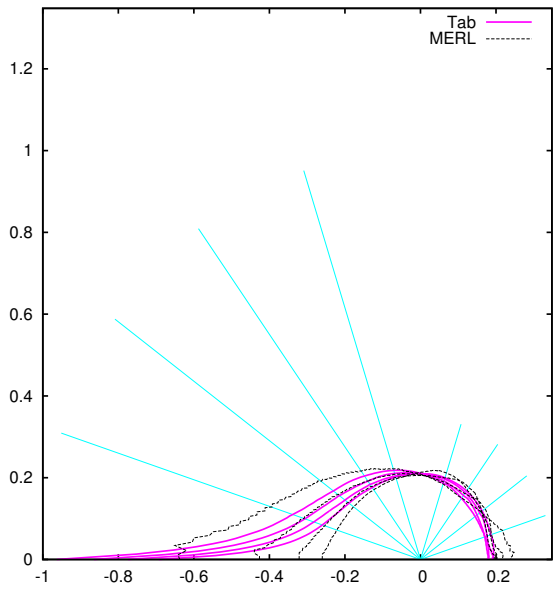


Ours: GGX

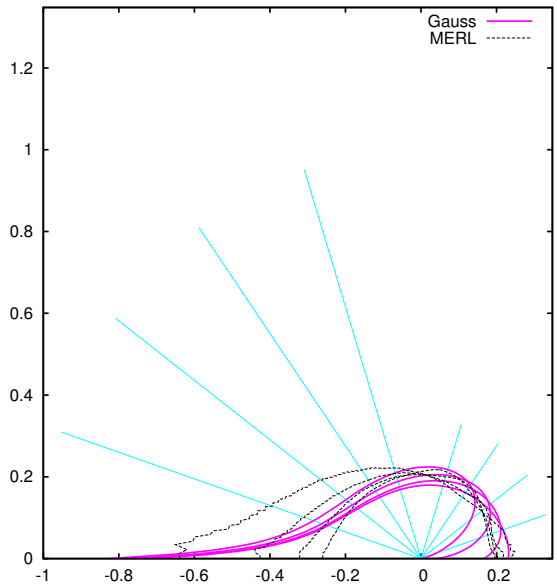
BRDF Lobes in the Incidence Plane (Cubic Root Applied)



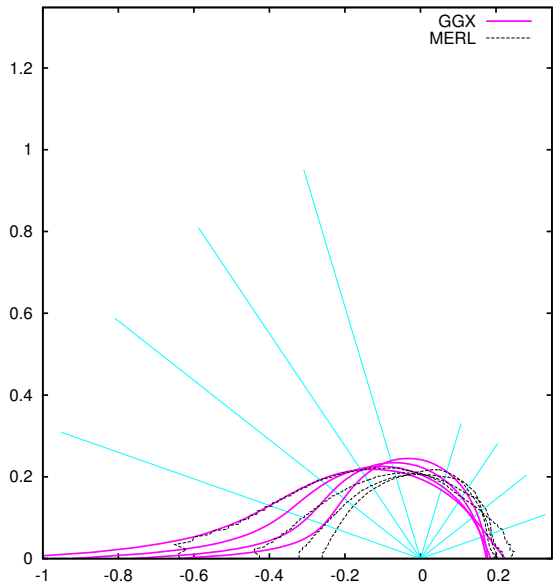
SGD



Ours: Tabulated

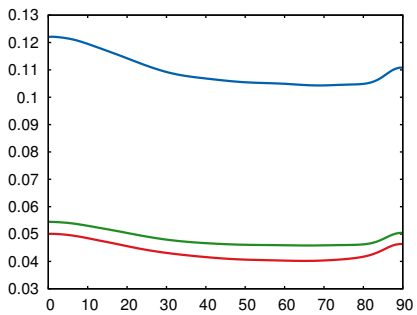


Ours: Gaussian

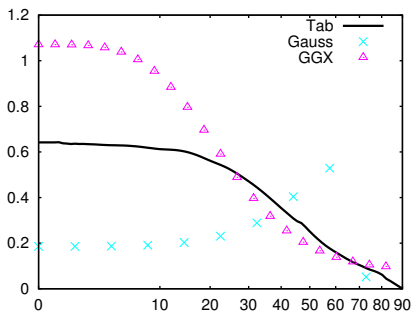


Ours: GGX

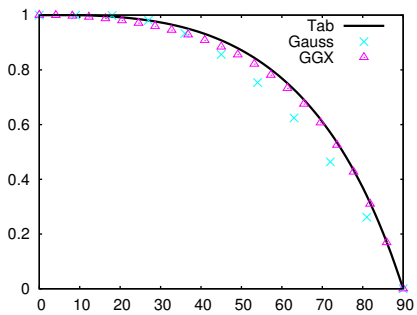
Fitted Microfacet Functions



Fresnel (R, G, B)



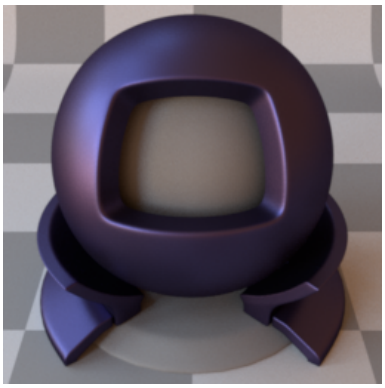
NDF (D)



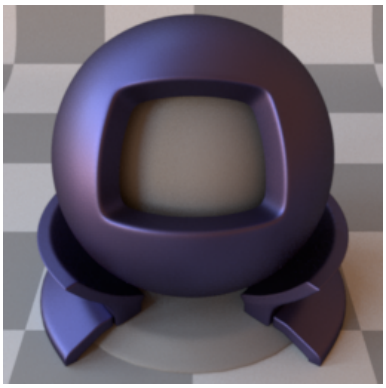
Smith (G_1)

13 blue-metallic-paint

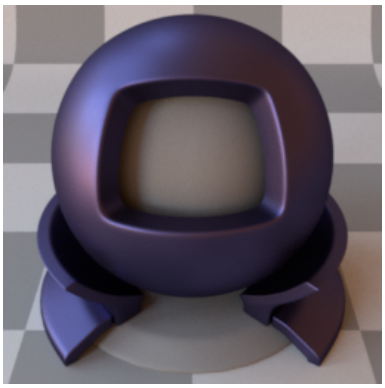
Renderings



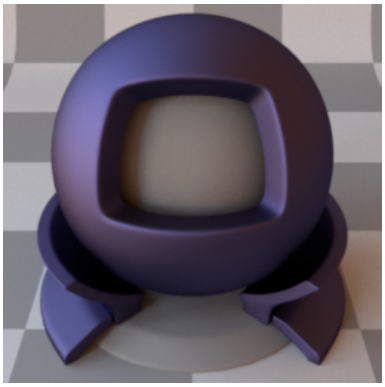
SGD



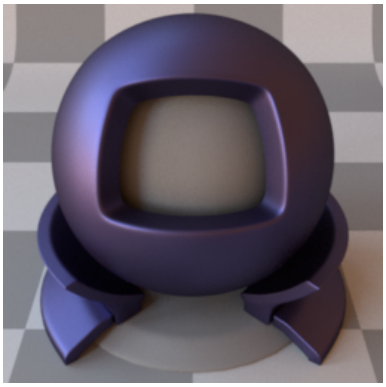
Reference



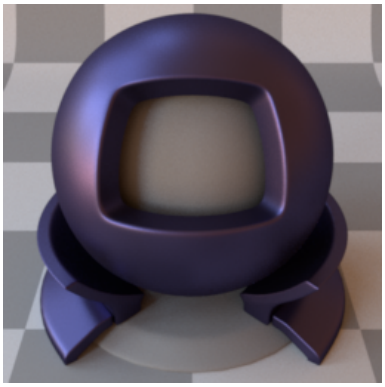
Ours: Tabulated



Ours: Gaussian

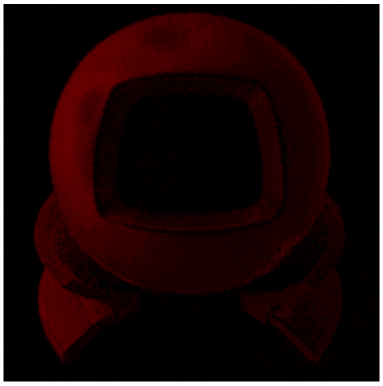


Reference

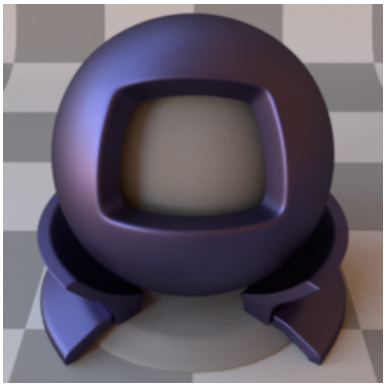


Ours: GGX

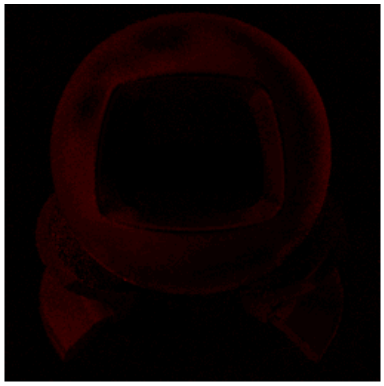
CIE dE00



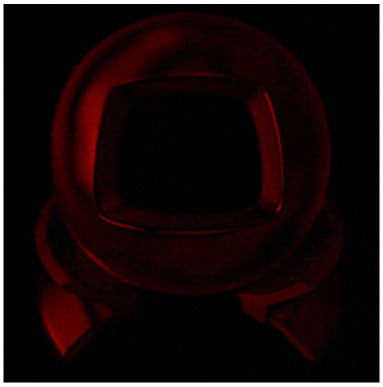
SGD



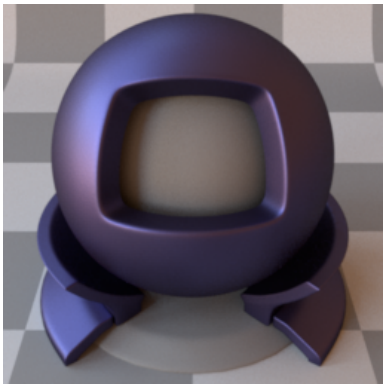
Reference



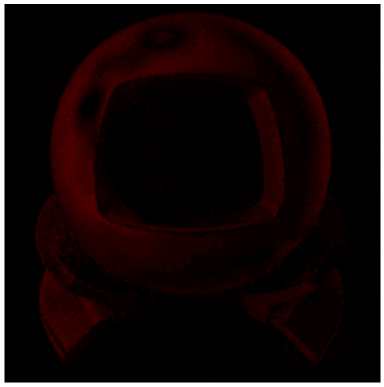
Ours: Tabulated



Ours: Gaussian

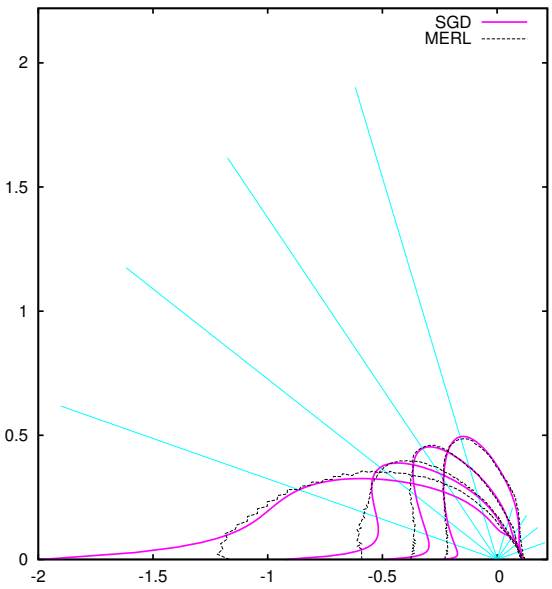


Reference

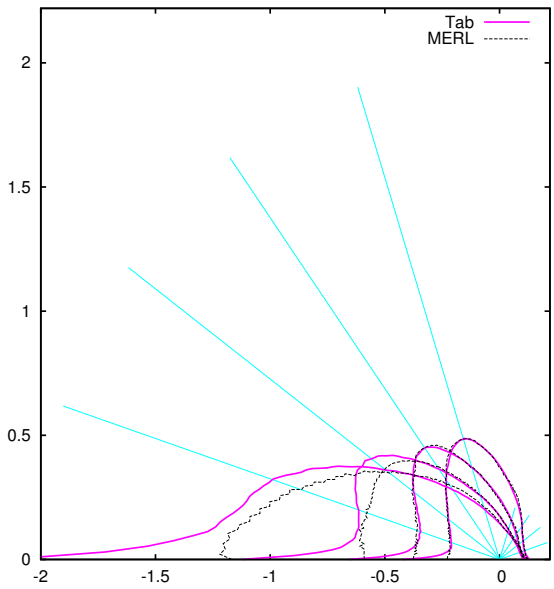


Ours: GGX

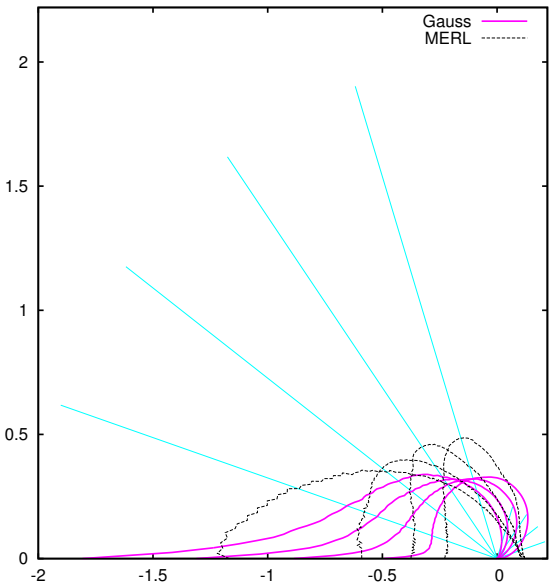
BRDF Lobes in the Incidence Plane (Cubic Root Applied)



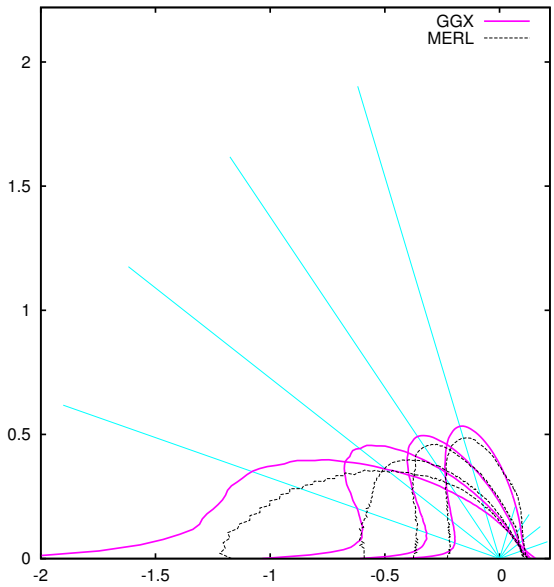
SGD



Ours: Tabulated

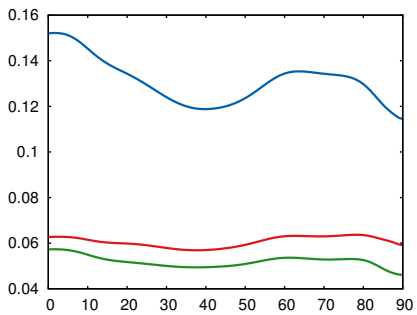


Ours: Gaussian

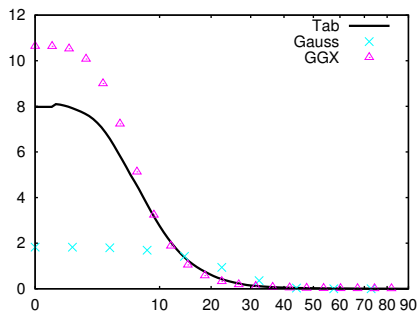


Ours: GGX

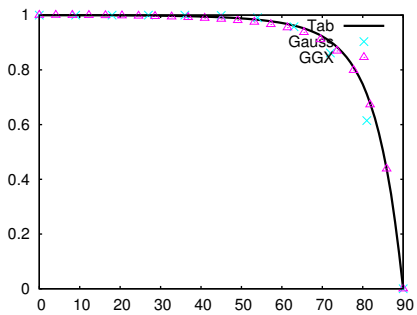
Fitted Microfacet Functions



Fresnel (R, G, B)



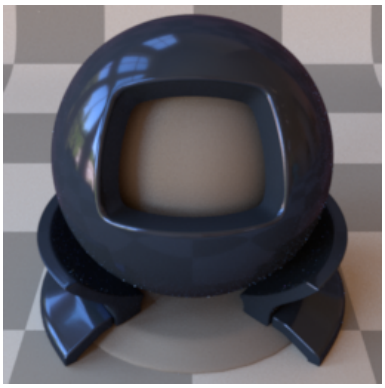
NDF (D)



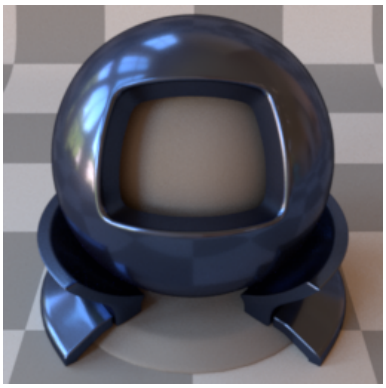
Smith (G_1)

14 blue-metallic-paint2

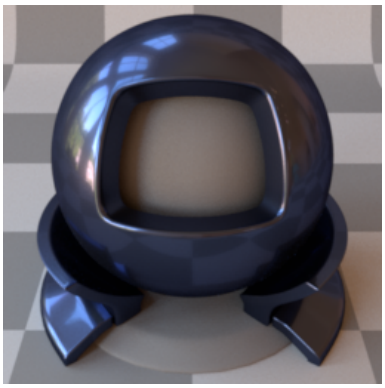
Renderings



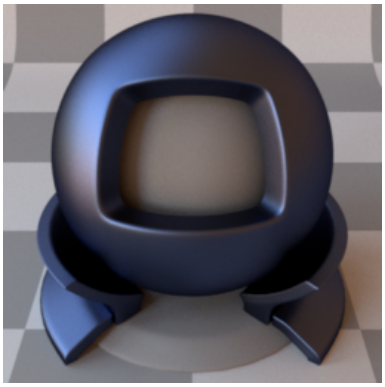
SGD



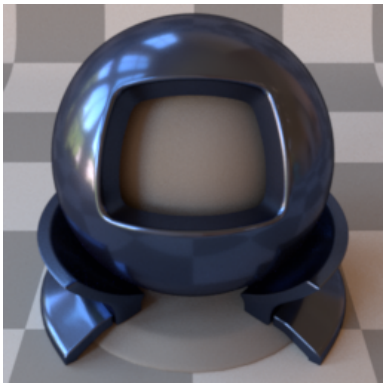
Reference



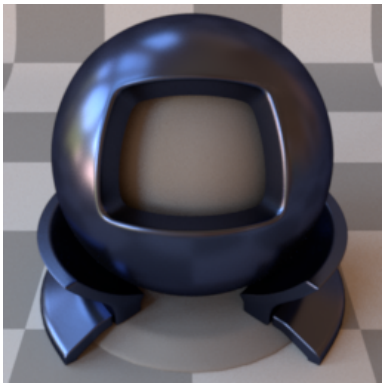
Ours: Tabulated



Ours: Gaussian

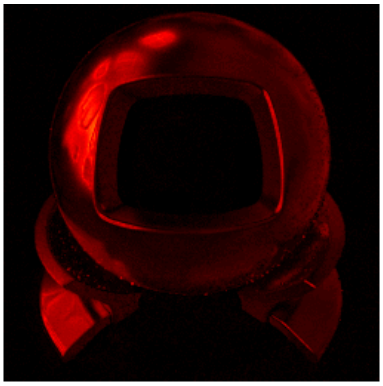


Reference

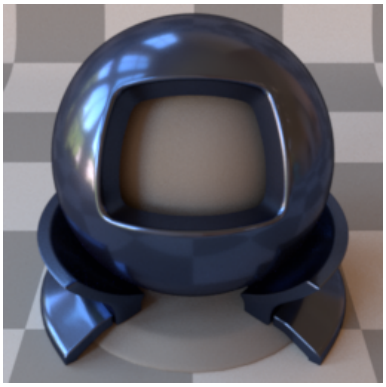


Ours: GGX

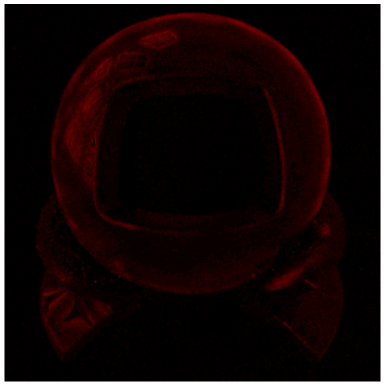
CIE dE00



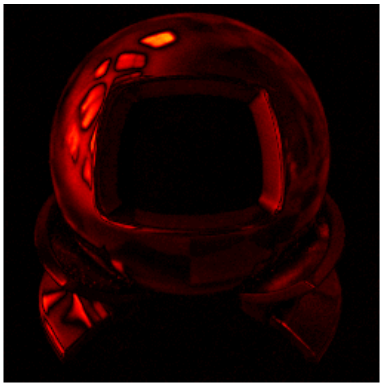
SGD



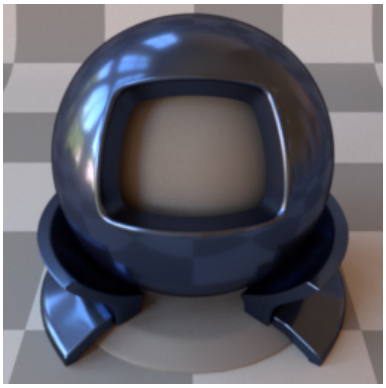
Reference



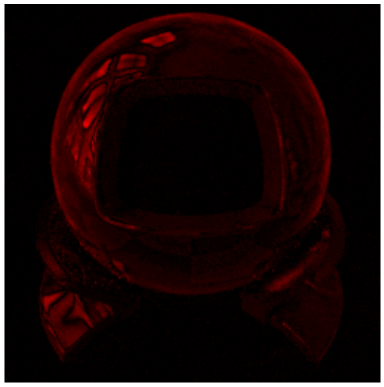
Ours: Tabulated



Ours: Gaussian

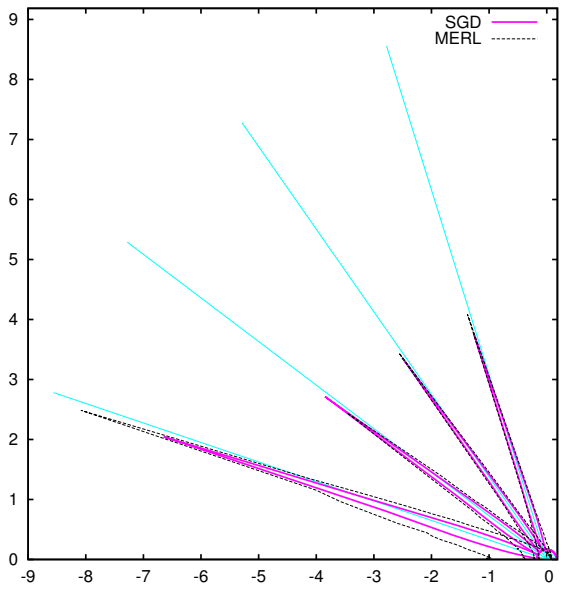


Reference

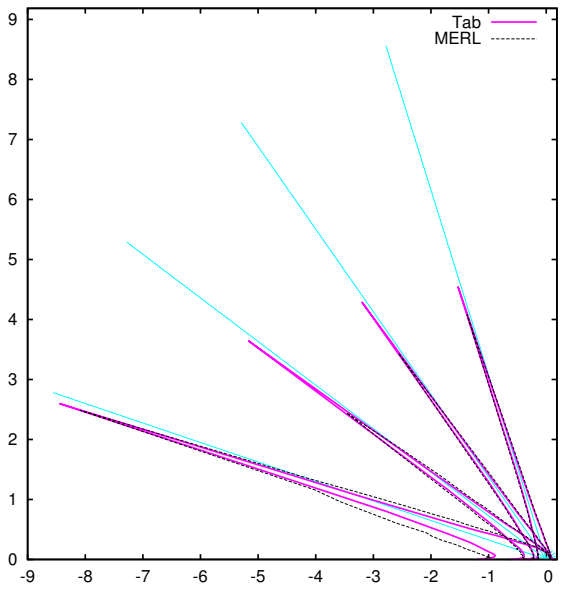


Ours: GGX

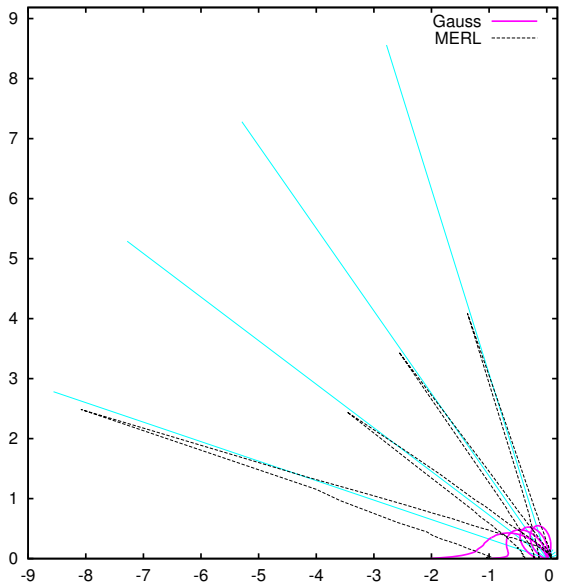
BRDF Lobes in the Incidence Plane (Cubic Root Applied)



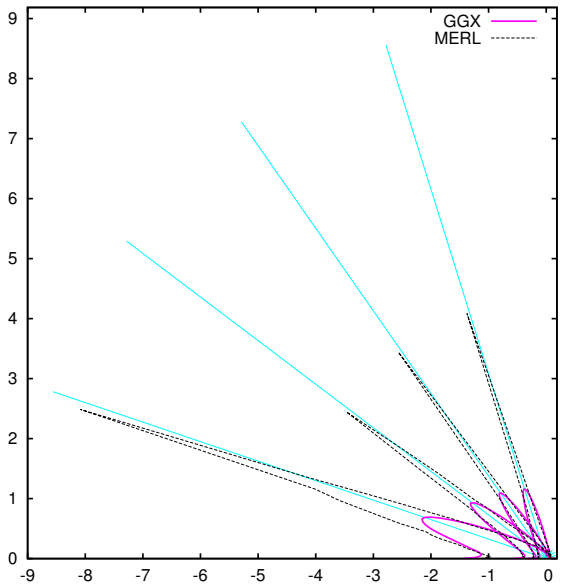
SGD



Ours: Tabulated

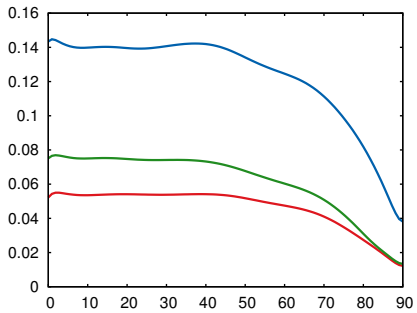


Ours: Gaussian

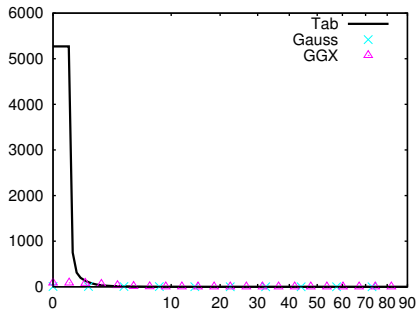


Ours: GGX

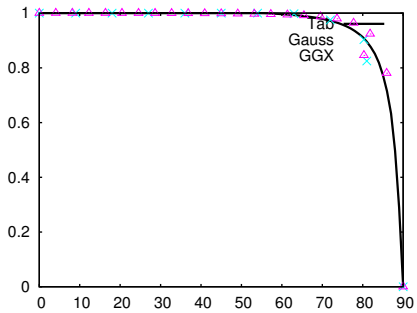
Fitted Microfacet Functions



Fresnel (R, G, B)



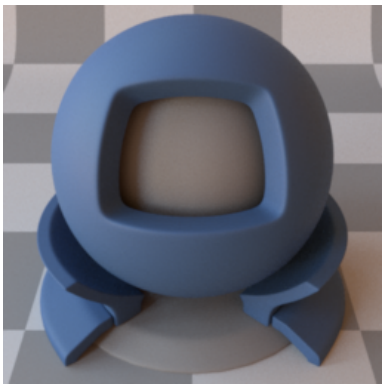
NDF (D)



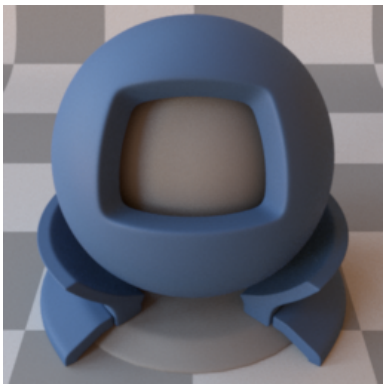
Smith (G_1)

15 blue-rubber

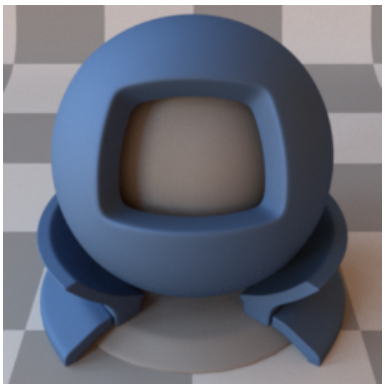
Renderings



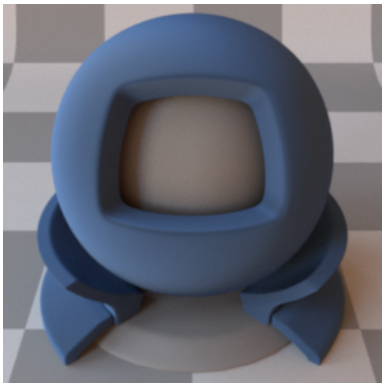
SGD



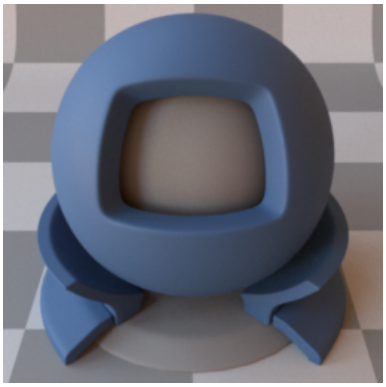
Reference



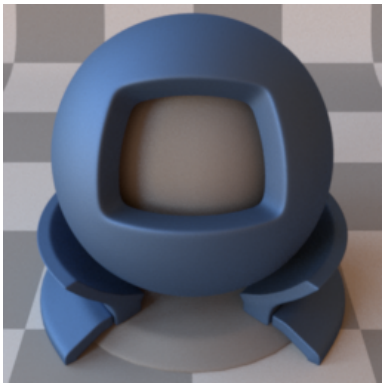
Ours: Tabulated



Ours: Gaussian

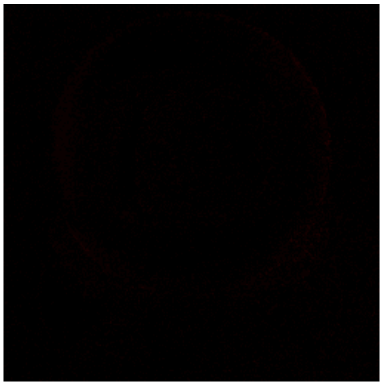


Reference

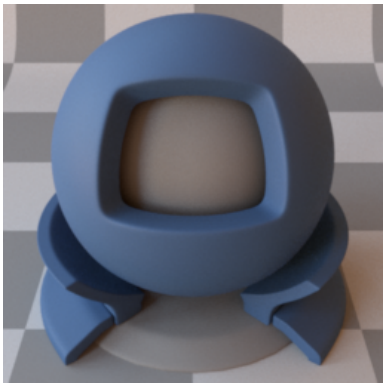


Ours: GGX

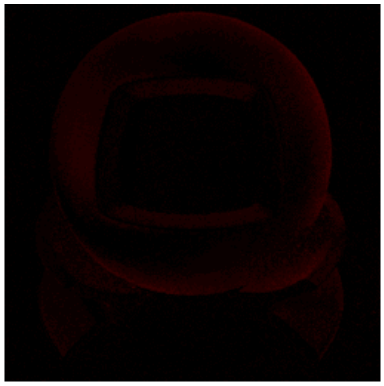
CIE dE00



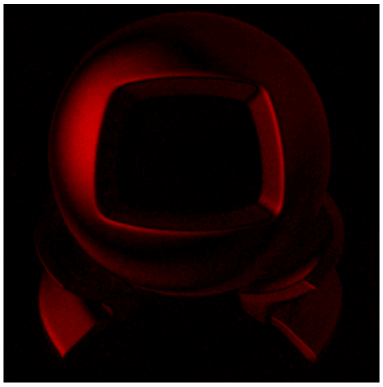
SGD



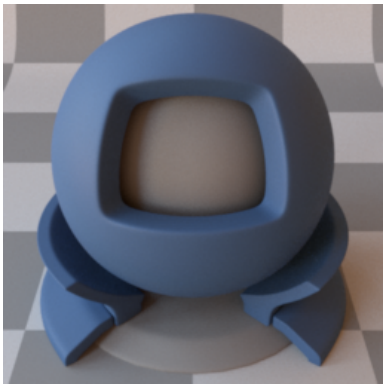
Reference



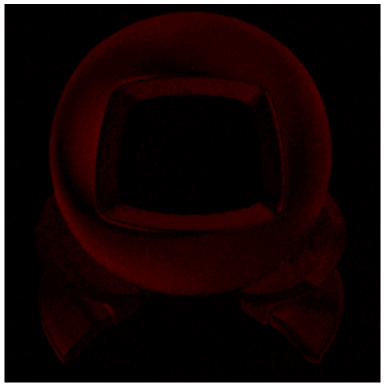
Ours: Tabulated



Ours: Gaussian

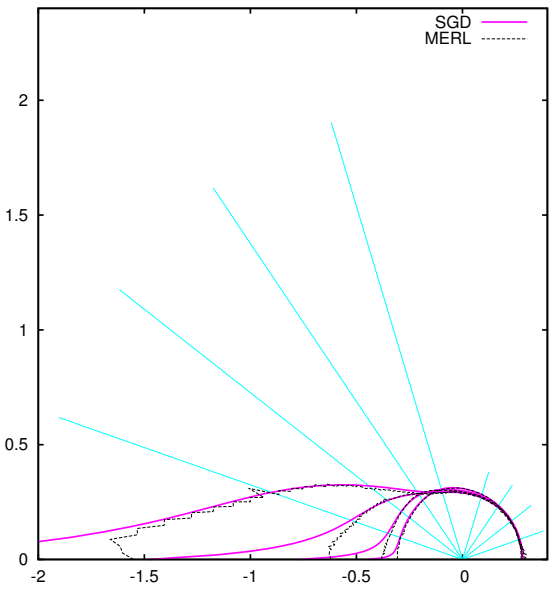


Reference

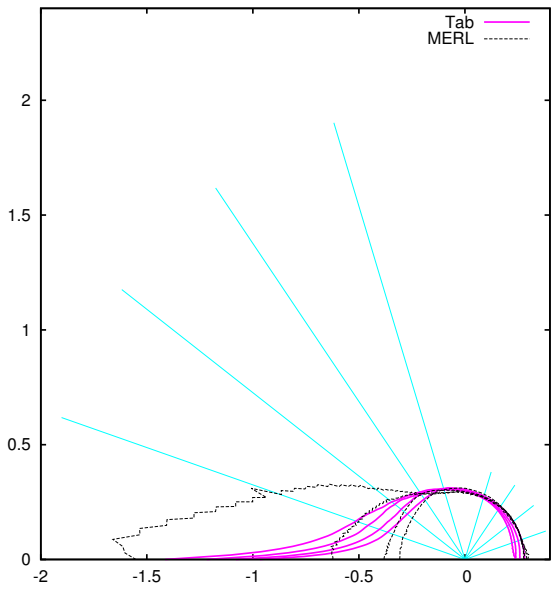


Ours: GGX

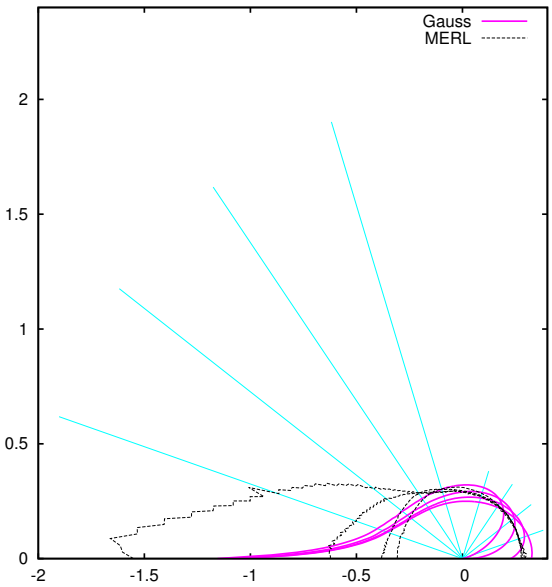
BRDF Lobes in the Incidence Plane (Cubic Root Applied)



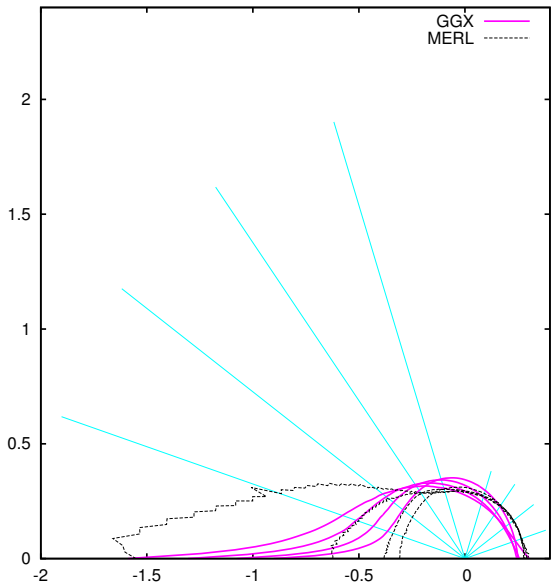
SGD



Ours: Tabulated

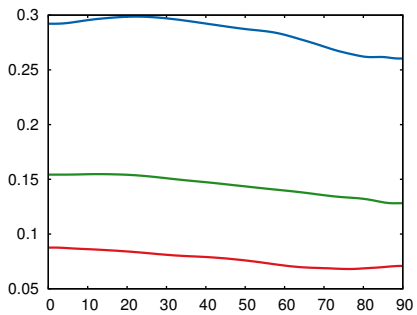


Ours: Gaussian

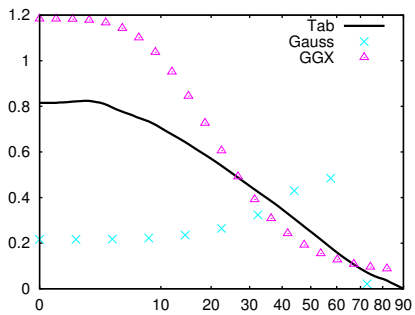


Ours: GGX

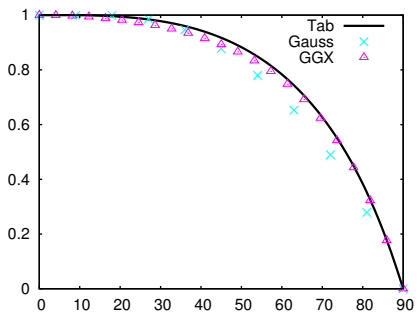
Fitted Microfacet Functions



Fresnel (R, G, B)



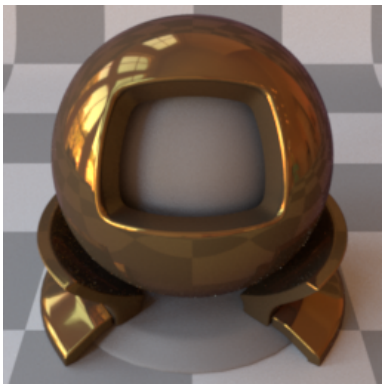
NDF (D)



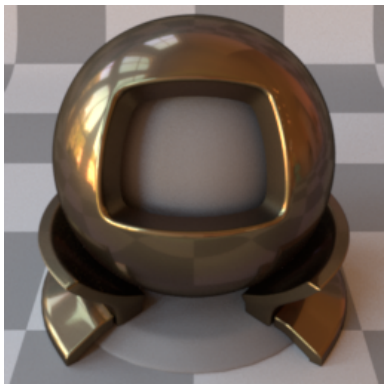
Smith (G_1)

16 brass

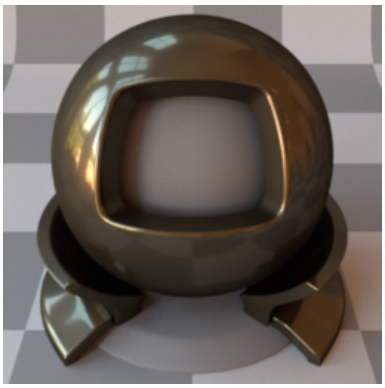
Renderings



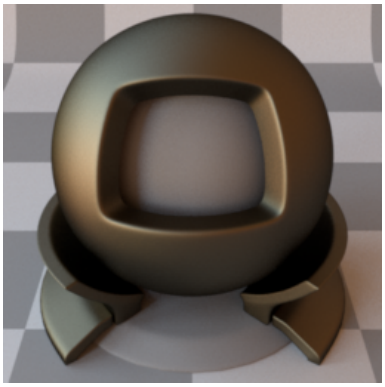
SGD



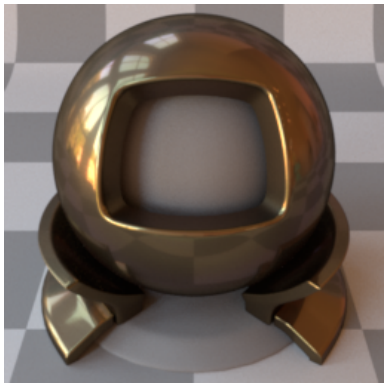
Reference



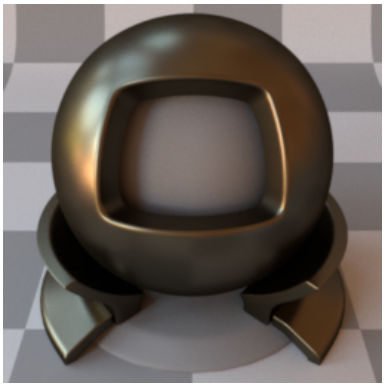
Ours: Tabulated



Ours: Gaussian

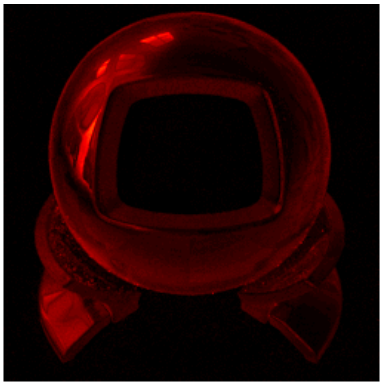


Reference

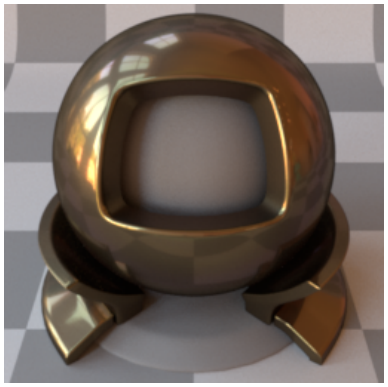


Ours: GGX

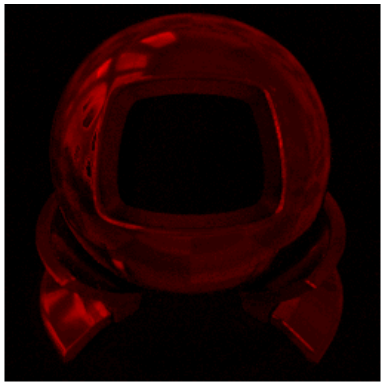
CIE dE00



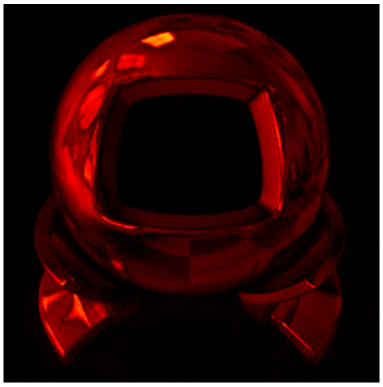
SGD



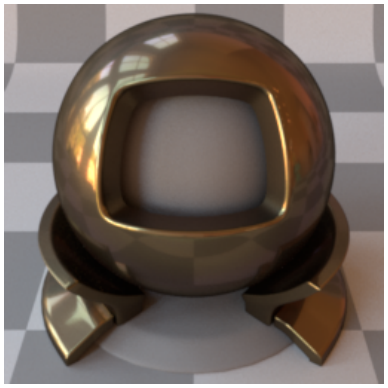
Reference



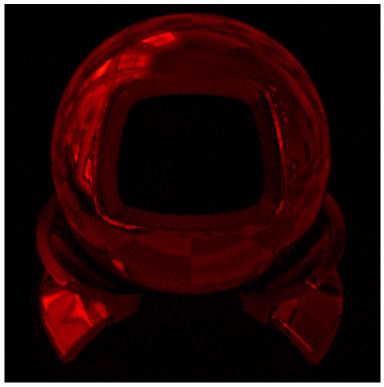
Ours: Tabulated



Ours: Gaussian

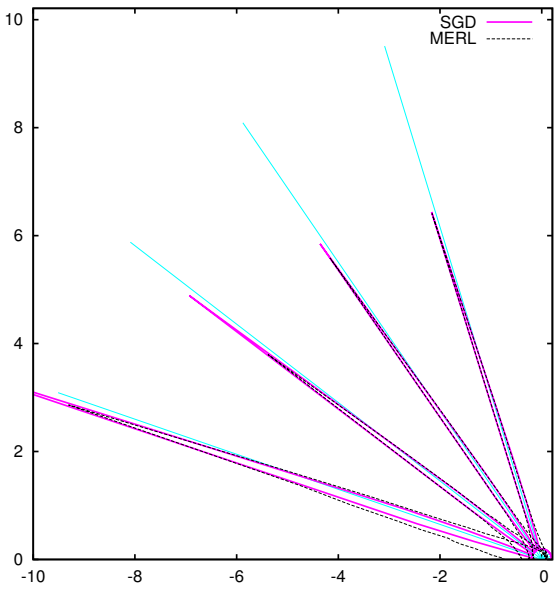


Reference

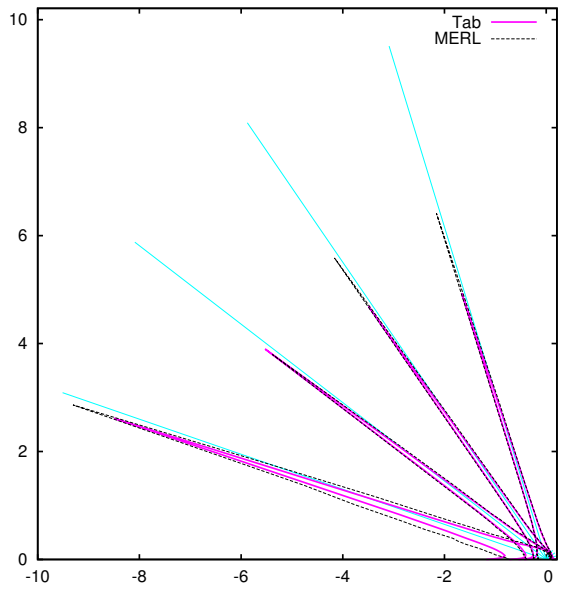


Ours: GGX

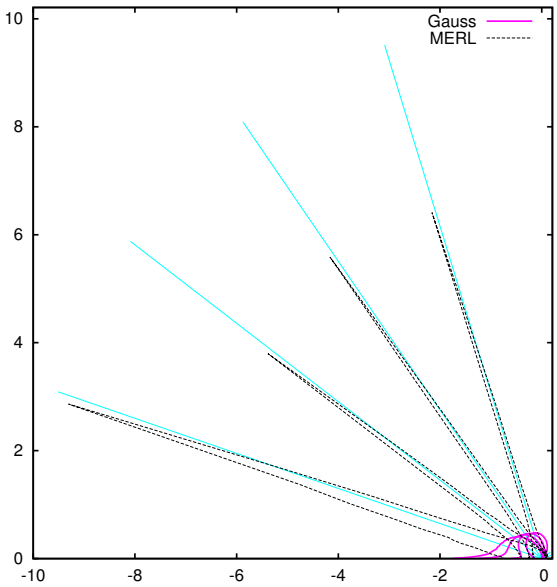
BRDF Lobes in the Incidence Plane (Cubic Root Applied)



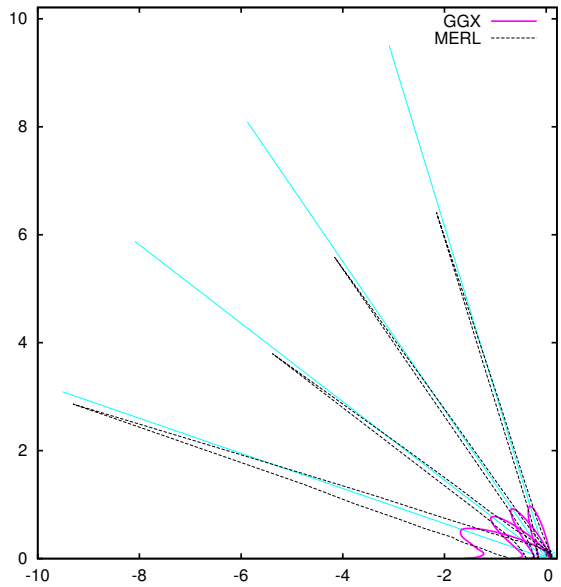
SGD



Ours: Tabulated

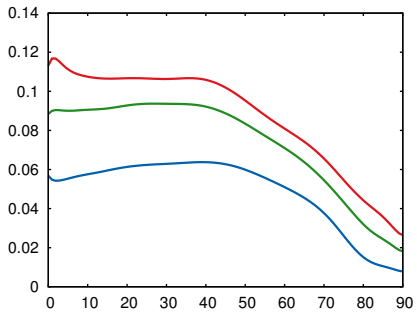


Ours: Gaussian

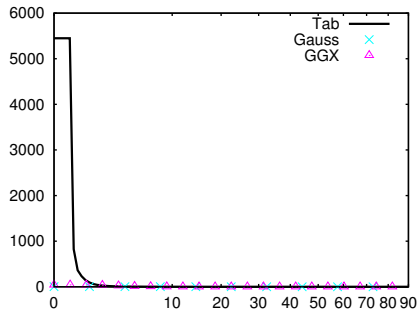


Ours: GGX

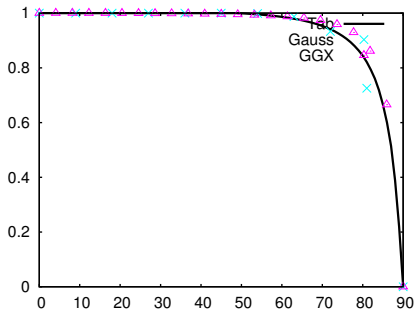
Fitted Microfacet Functions



Fresnel (R, G, B)



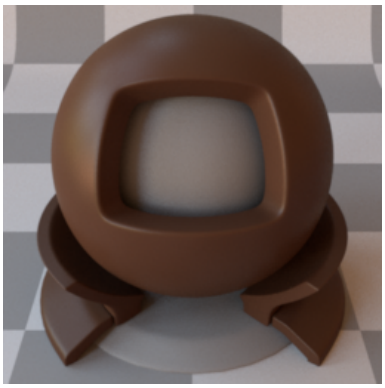
NDF (D)



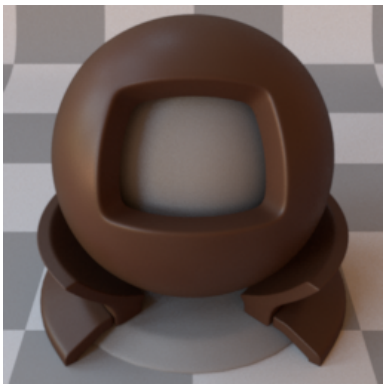
Smith (G_1)

17 cherry-235

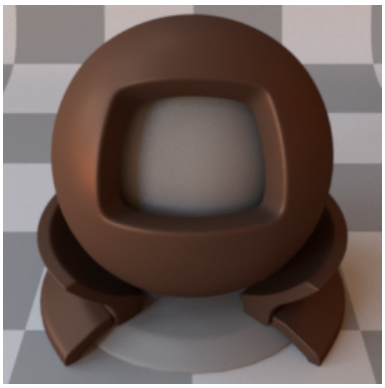
Renderings



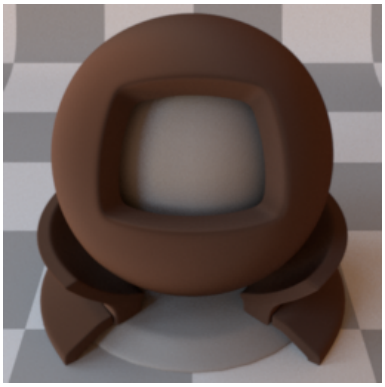
SGD



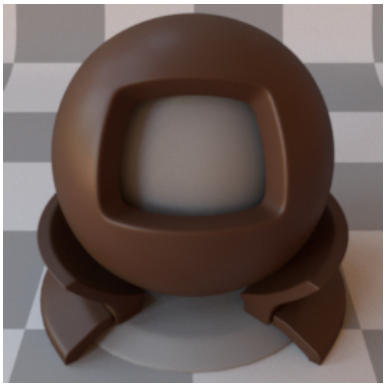
Reference



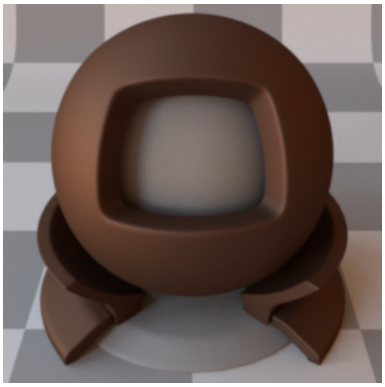
Ours: Tabulated



Ours: Gaussian

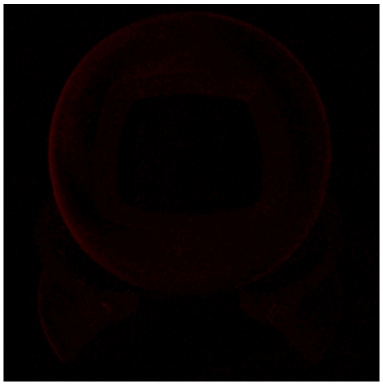


Reference

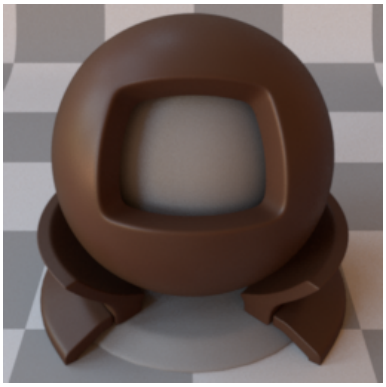


Ours: GGX

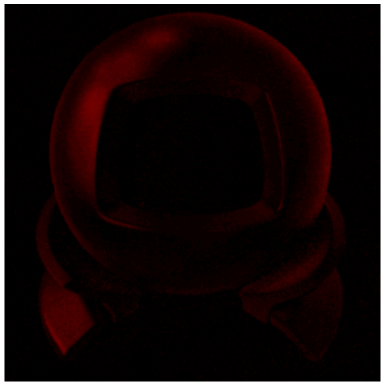
CIE dE00



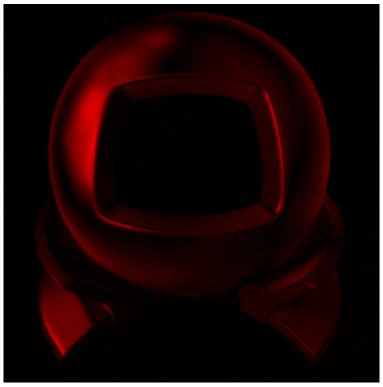
SGD



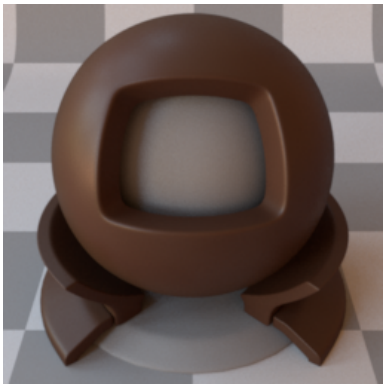
Reference



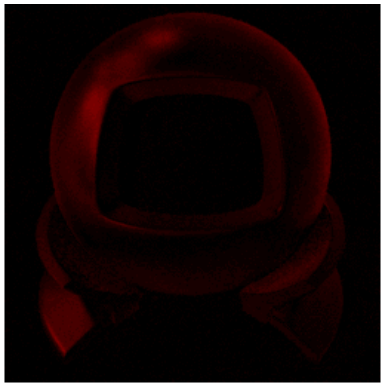
Ours: Tabulated



Ours: Gaussian

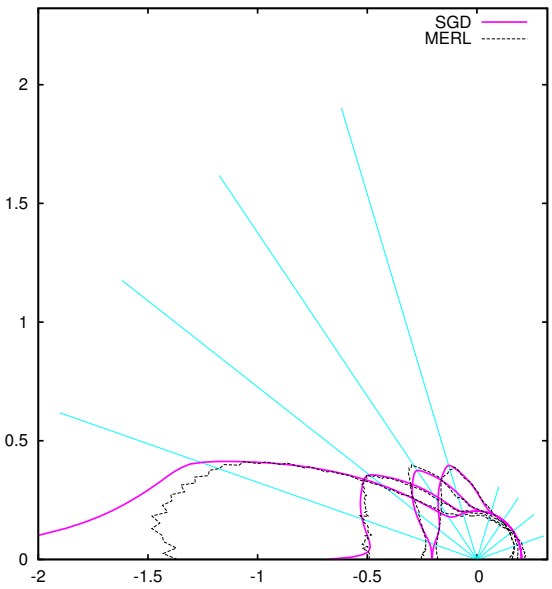


Reference

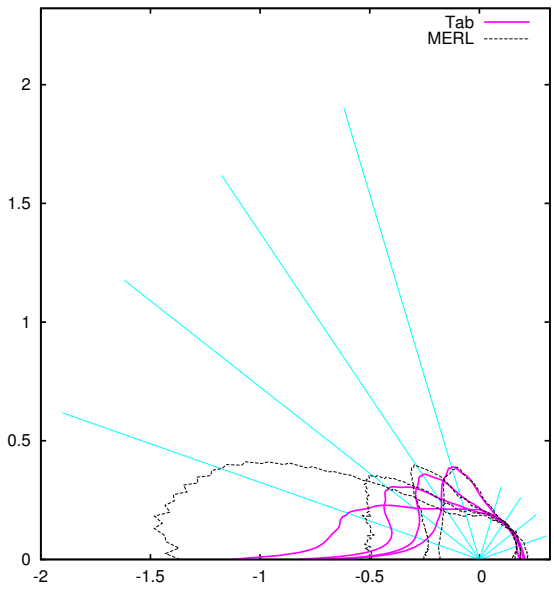


Ours: GGX

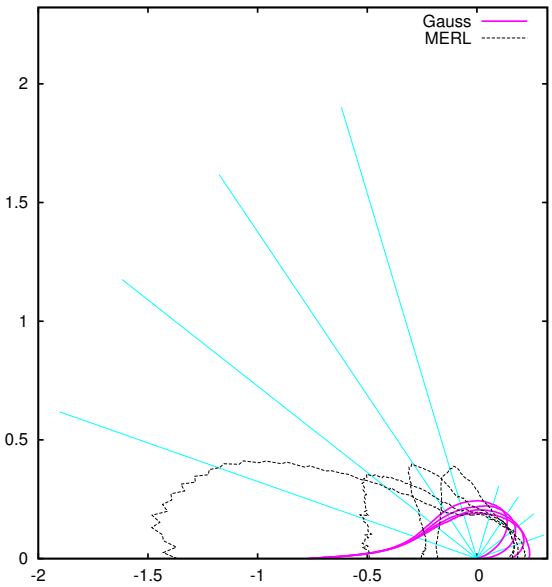
BRDF Lobes in the Incidence Plane (Cubic Root Applied)



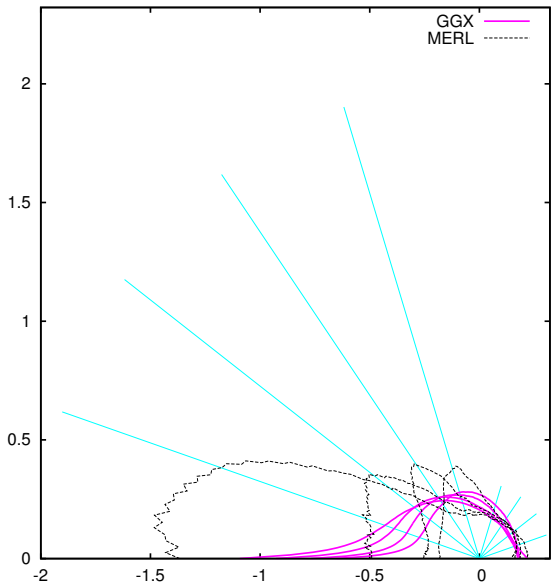
SGD



Ours: Tabulated

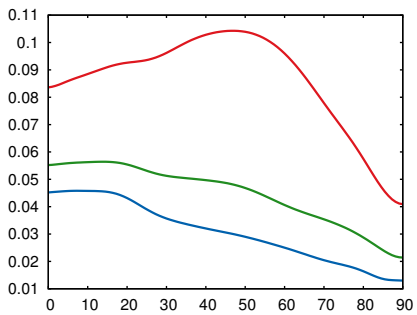


Ours: Gaussian

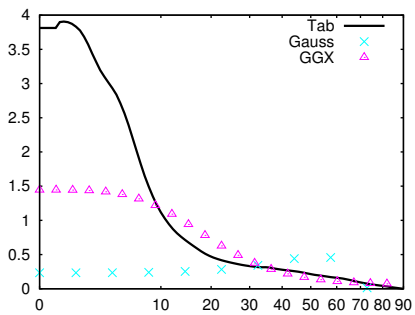


Ours: GGX

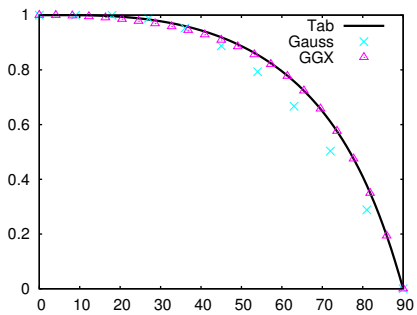
Fitted Microfacet Functions



Fresnel (R, G, B)



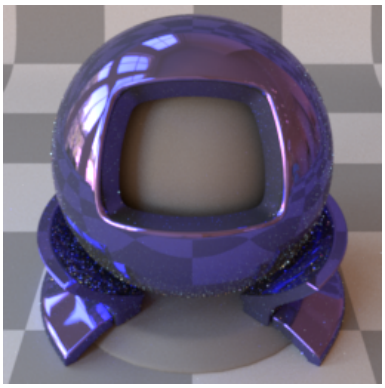
NDF (D)



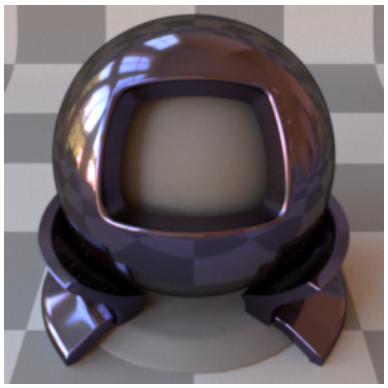
Smith (G_1)

18 chrome-steel

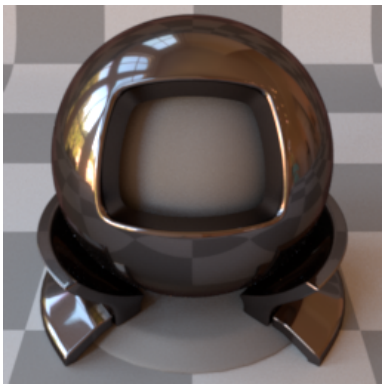
Renderings



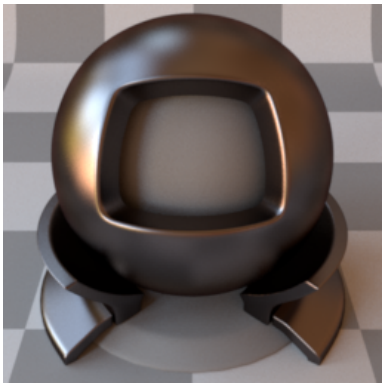
SGD



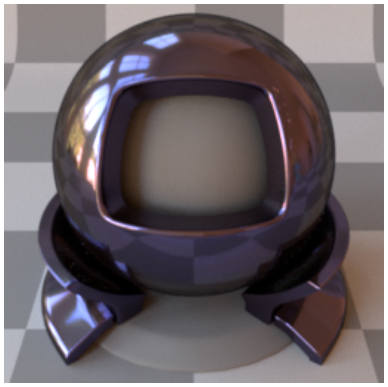
Reference



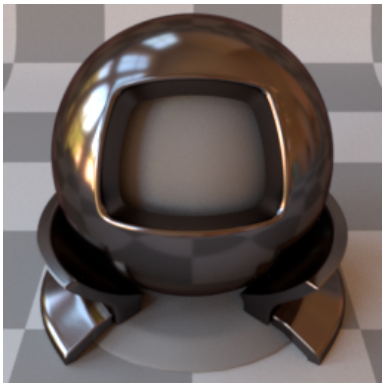
Ours: Tabulated



Ours: Gaussian

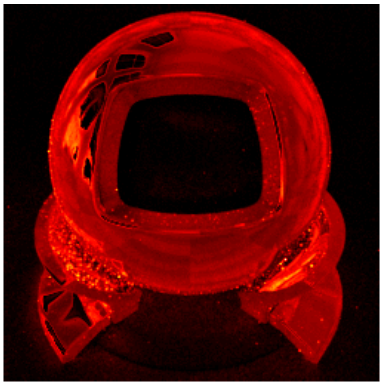


Reference

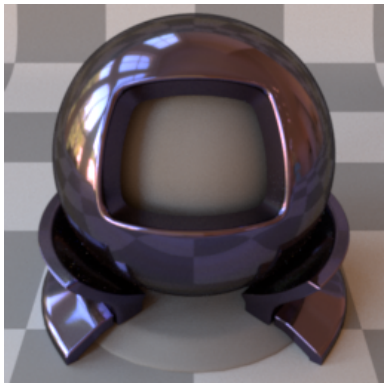


Ours: GGX

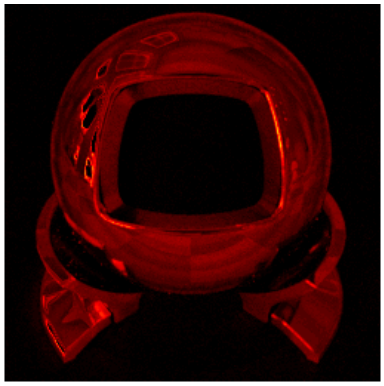
CIE dE00



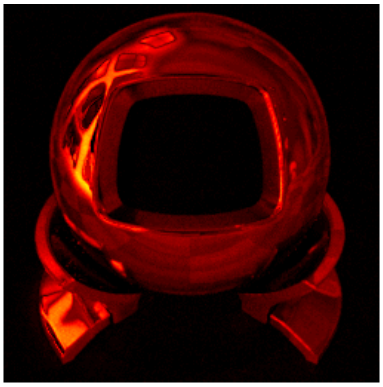
SGD



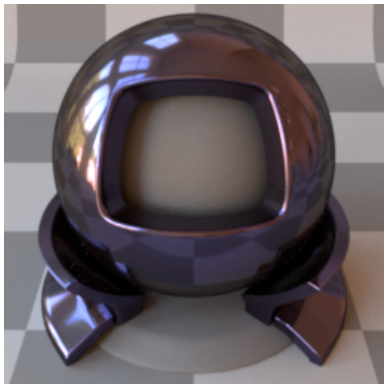
Reference



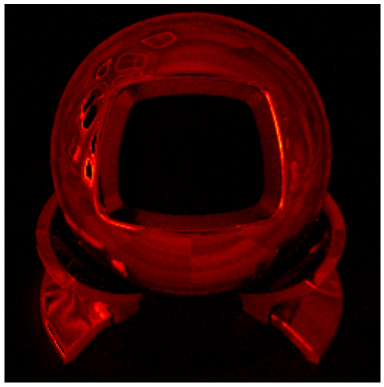
Ours: Tabulated



Ours: Gaussian

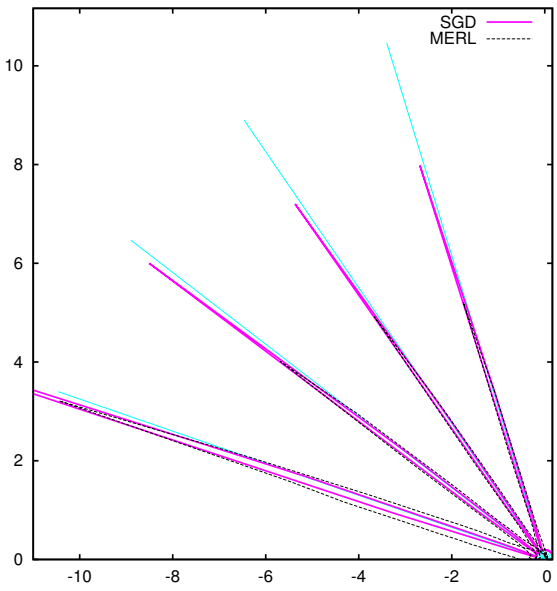


Reference

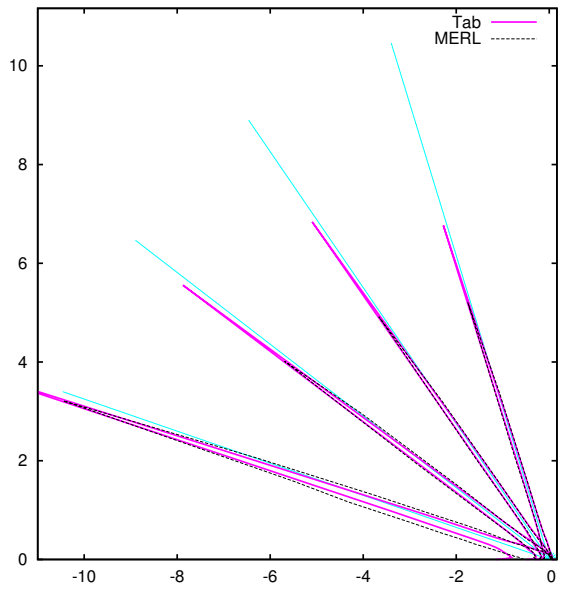


Ours: GGX

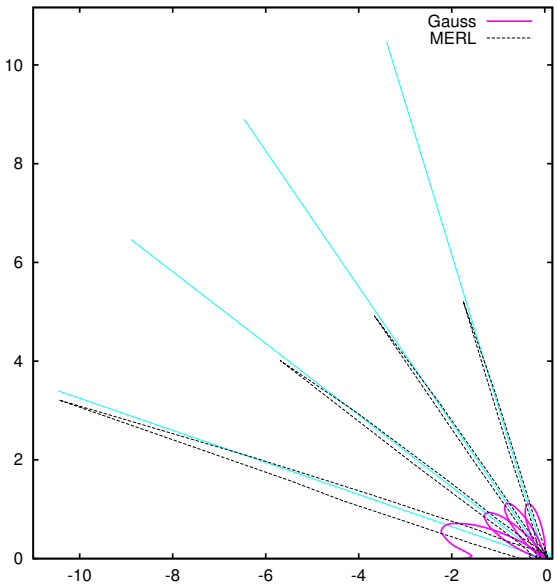
BRDF Lobes in the Incidence Plane (Cubic Root Applied)



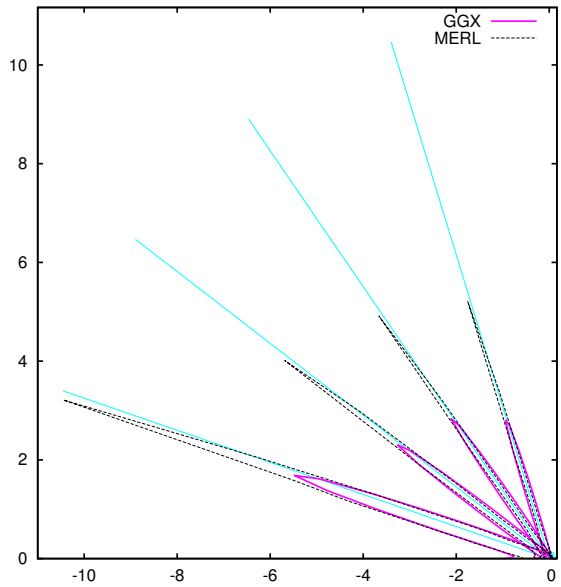
SGD



Ours: Tabulated

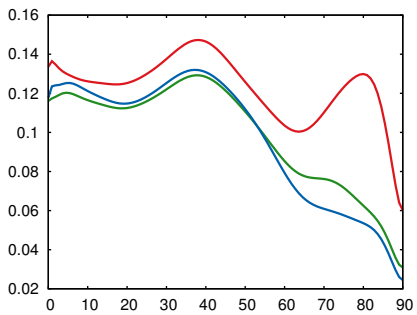


Ours: Gaussian

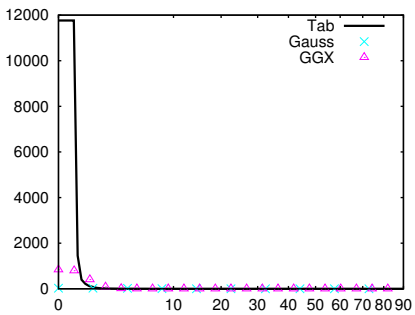


Ours: GGX

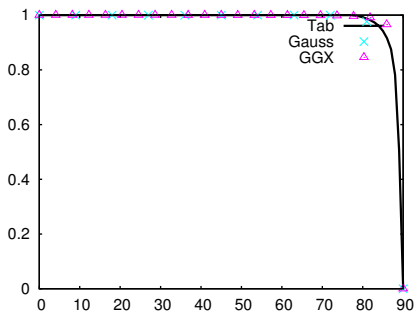
Fitted Microfacet Functions



Fresnel (R, G, B)



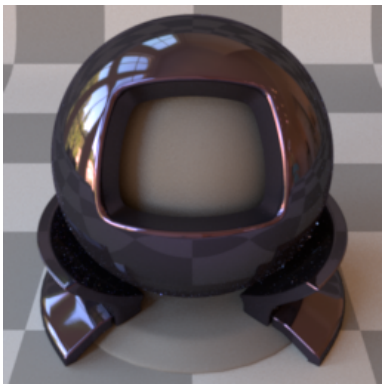
NDF (D)



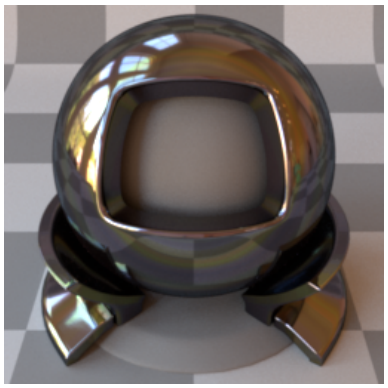
Smith (G_1)

19 chrome

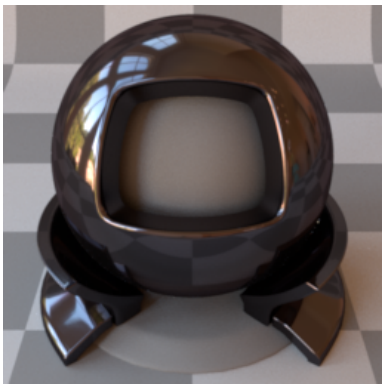
Renderings



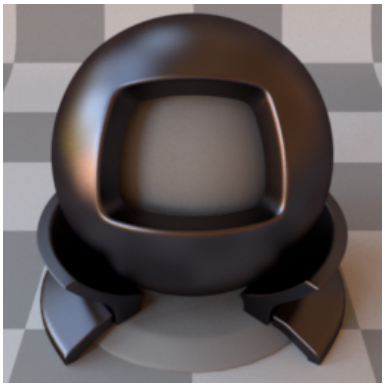
SGD



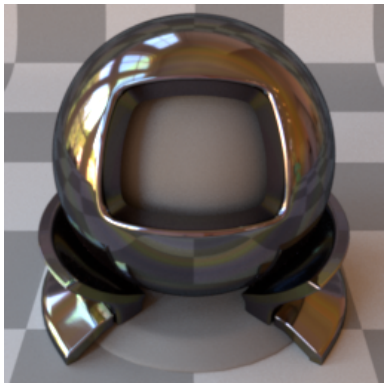
Reference



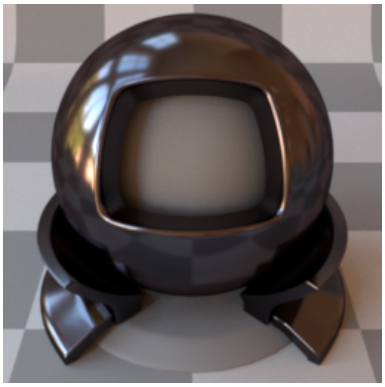
Ours: Tabulated



Ours: Gaussian

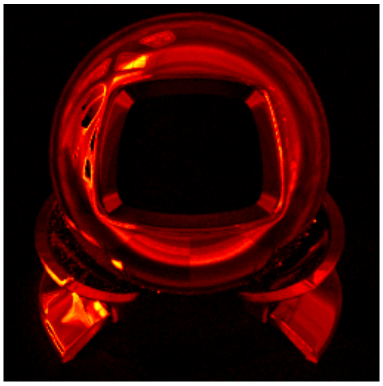


Reference

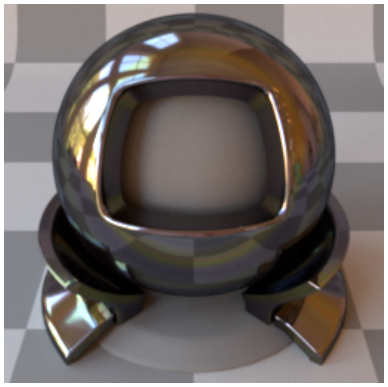


Ours: GGX

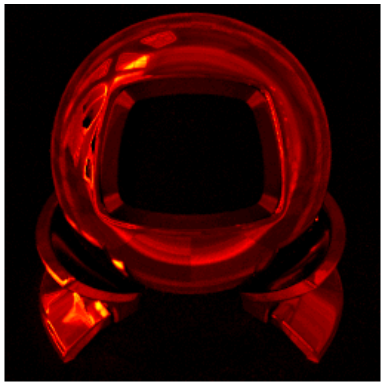
CIE dE00



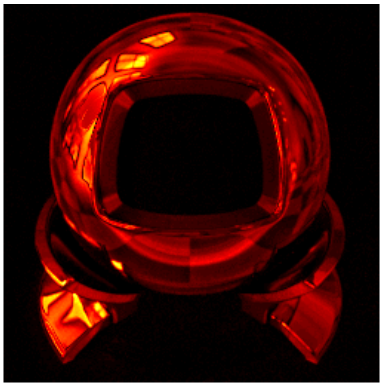
SGD



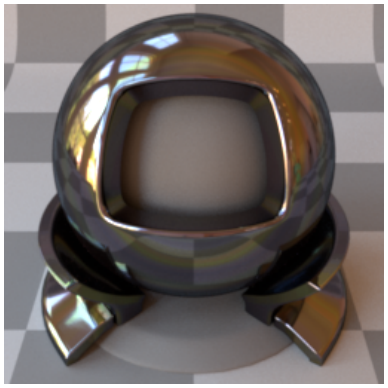
Reference



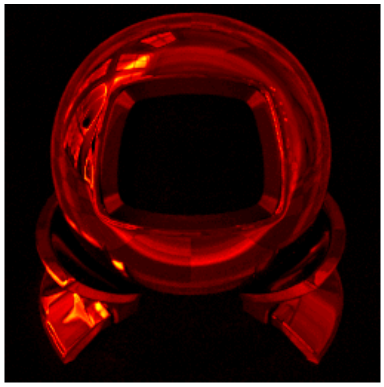
Ours: Tabulated



Ours: Gaussian

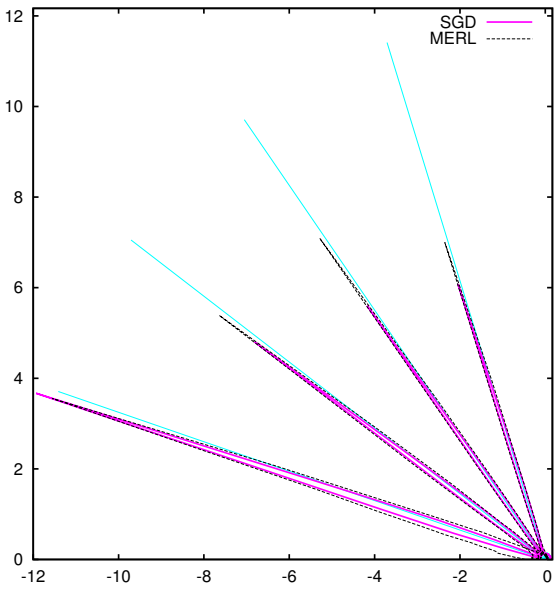


Reference

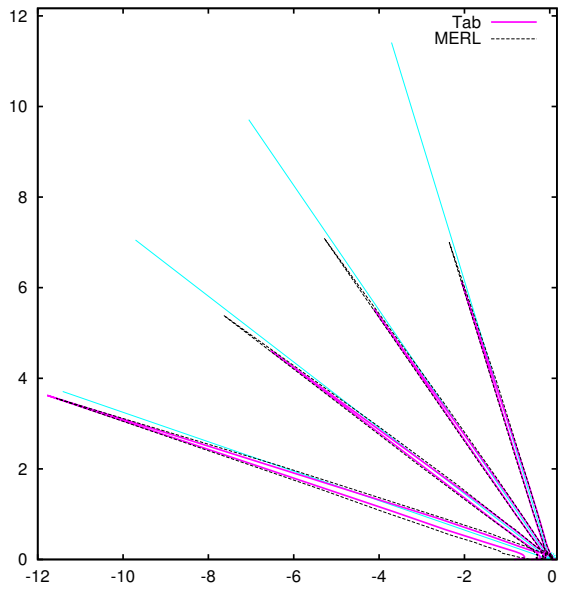


Ours: GGX

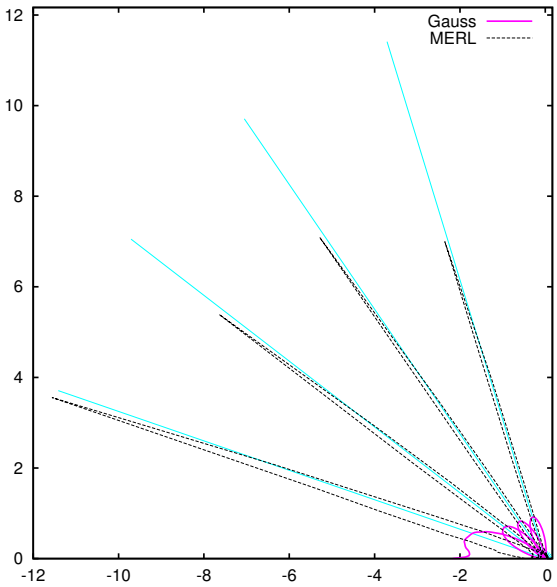
BRDF Lobes in the Incidence Plane (Cubic Root Applied)



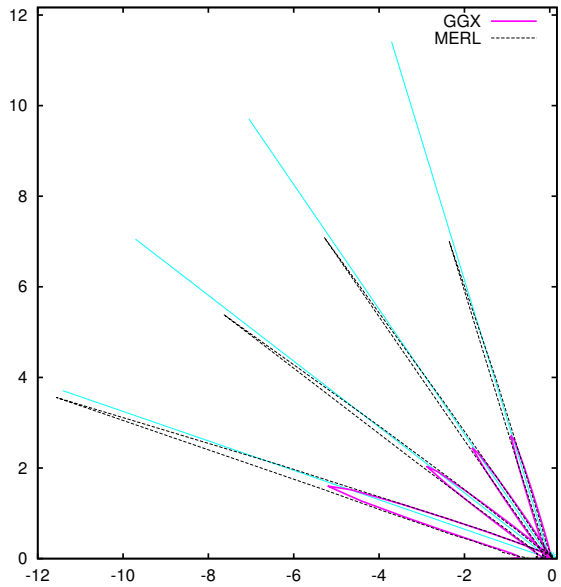
SGD



Ours: Tabulated

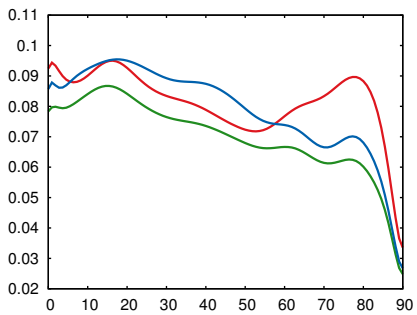


Ours: Gaussian

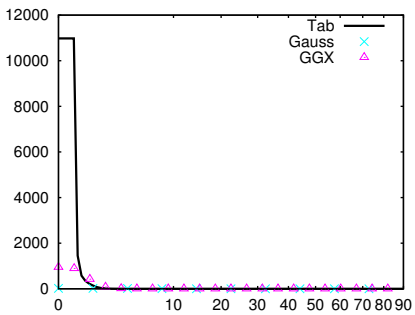


Ours: GGX

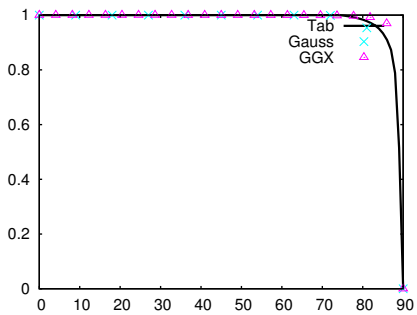
Fitted Microfacet Functions



Fresnel (R, G, B)



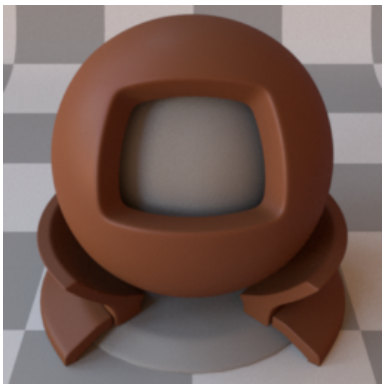
NDF (D)



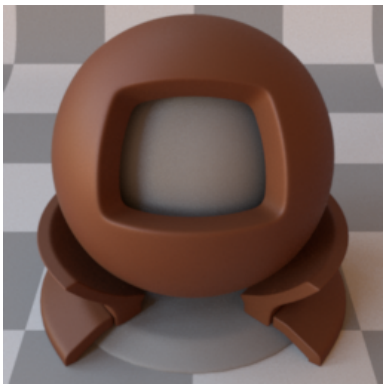
Smith (G_1)

20 colonial-maple-223

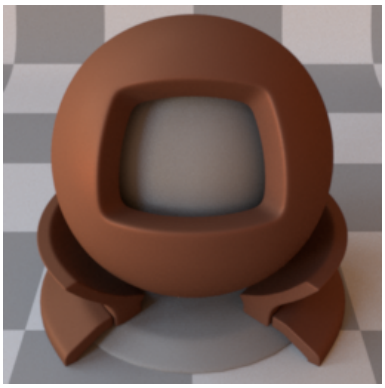
Renderings



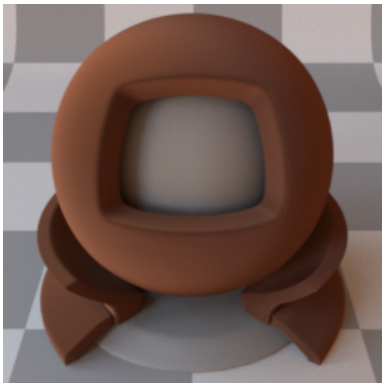
SGD



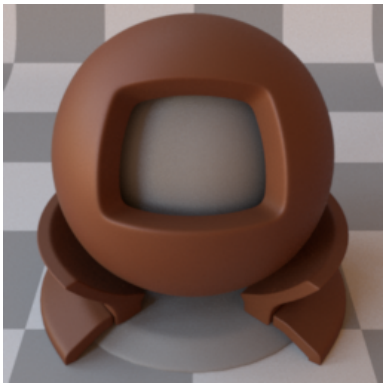
Reference



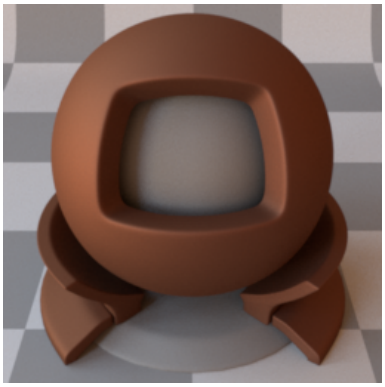
Ours: Tabulated



Ours: Gaussian

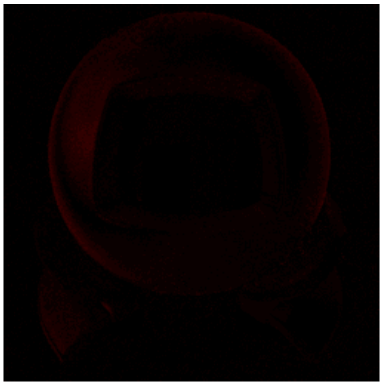


Reference

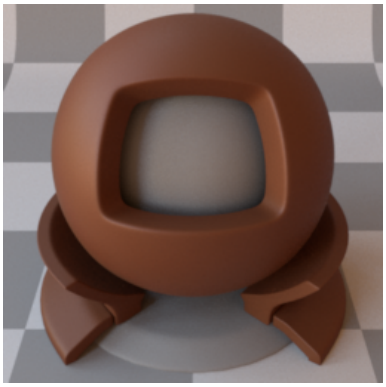


Ours: GGX

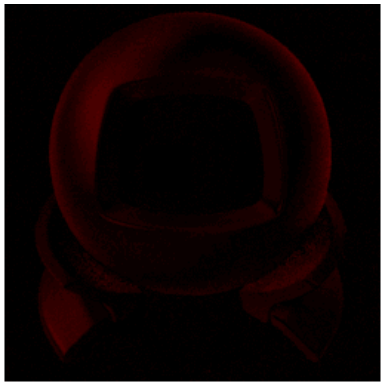
CIE dE00



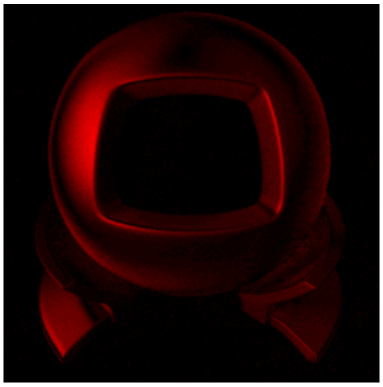
SGD



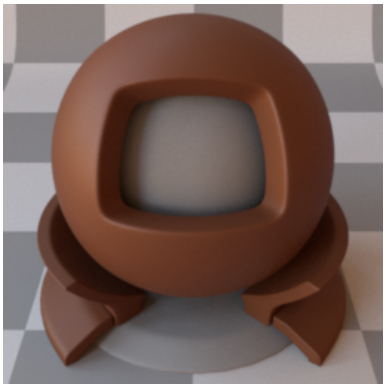
Reference



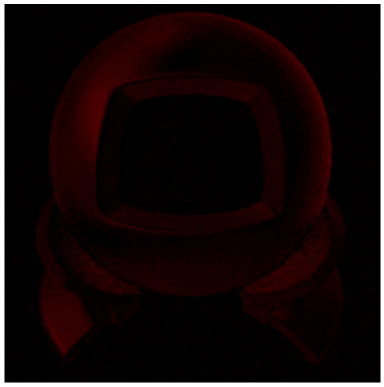
Ours: Tabulated



Ours: Gaussian

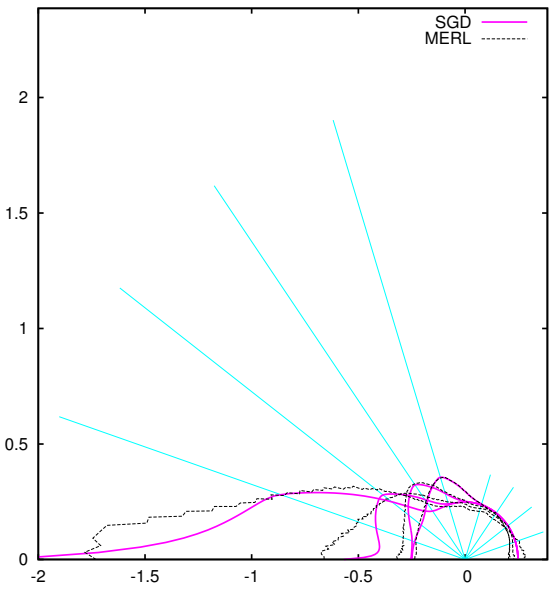


Reference

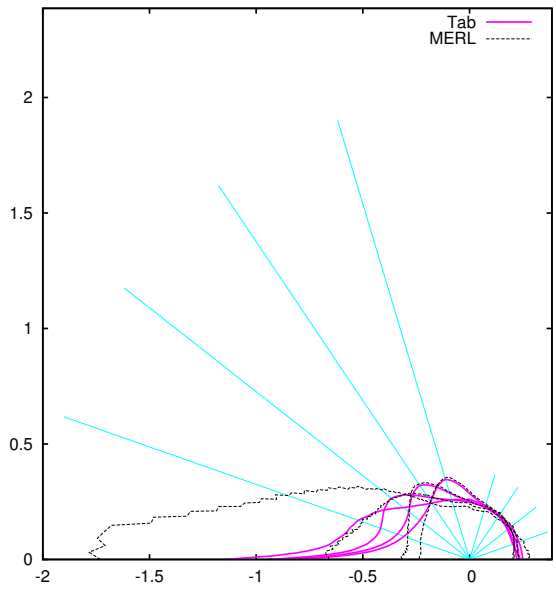


Ours: GGX

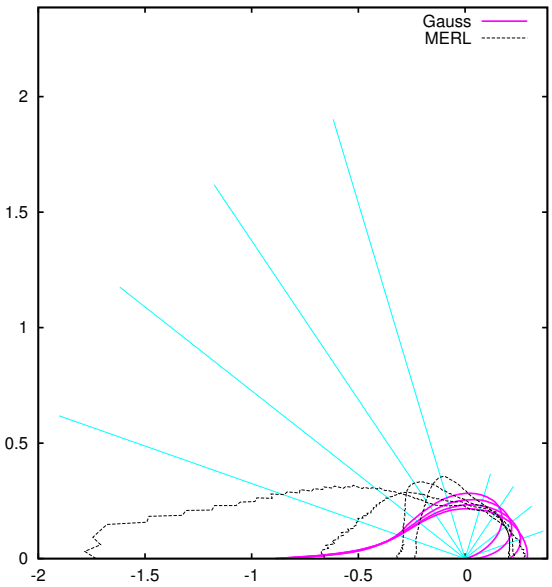
BRDF Lobes in the Incidence Plane (Cubic Root Applied)



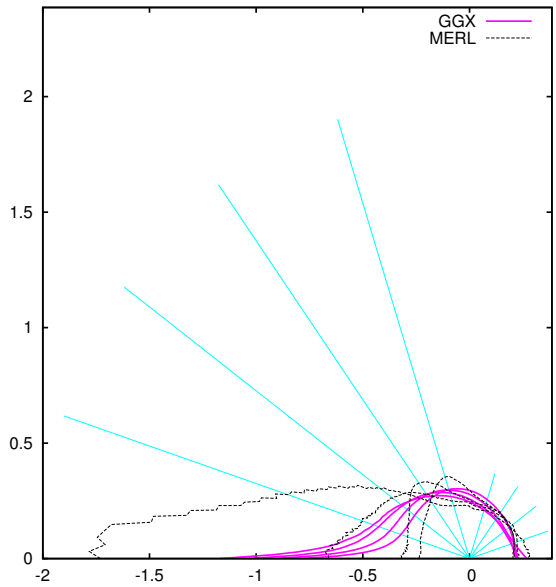
SGD



Ours: Tabulated

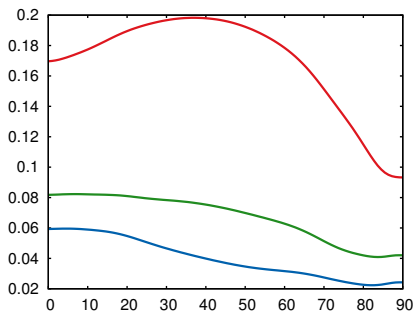


Ours: Gaussian

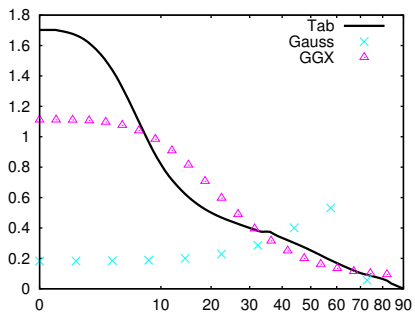


Ours: GGX

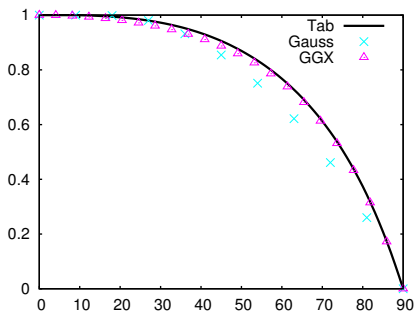
Fitted Microfacet Functions



Fresnel (R, G, B)



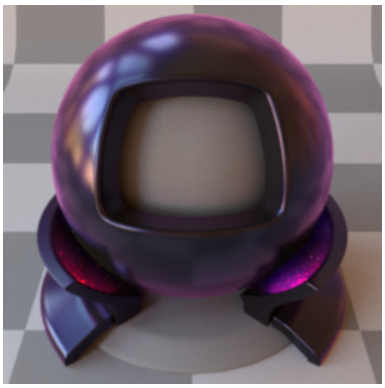
NDF (D)



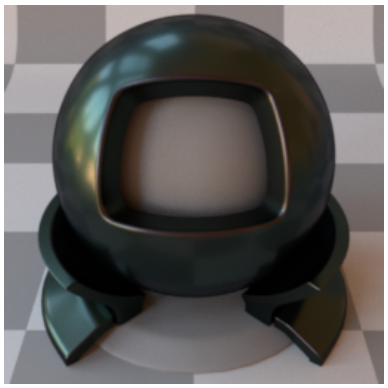
Smith (G_1)

21 color-changing-paint1

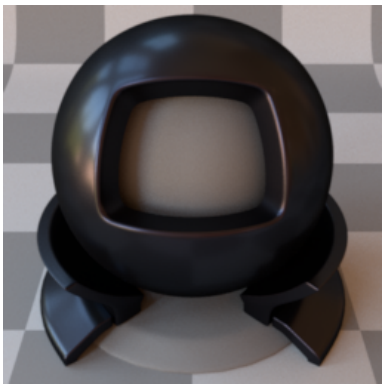
Renderings



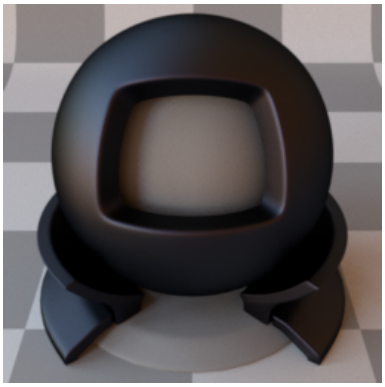
SGD



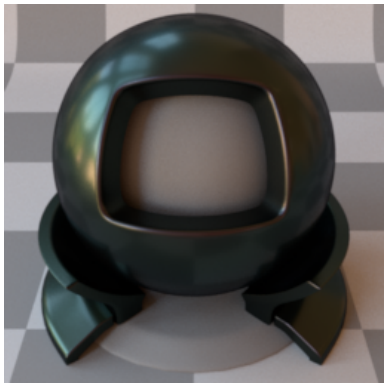
Reference



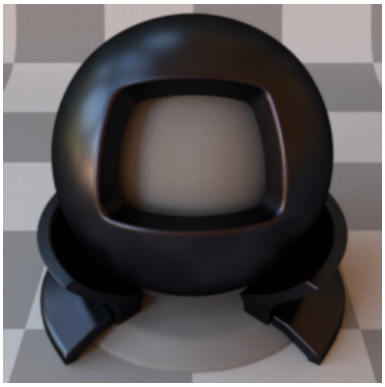
Ours: Tabulated



Ours: Gaussian

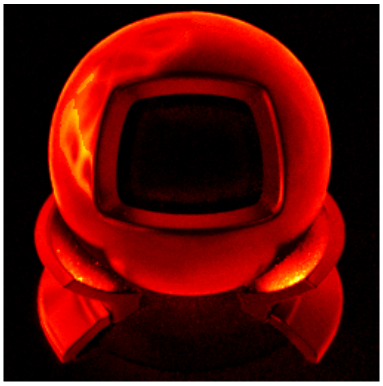


Reference

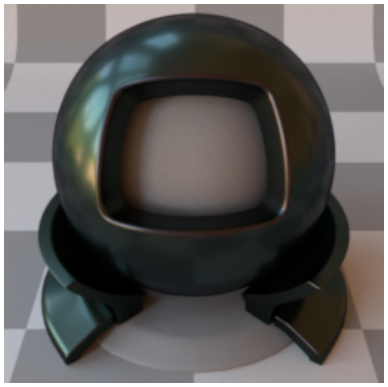


Ours: GGX

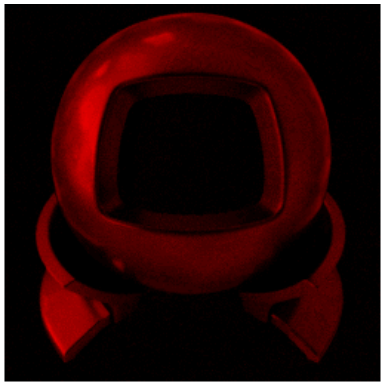
CIE dE00



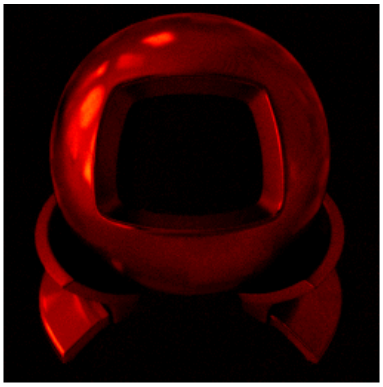
SGD



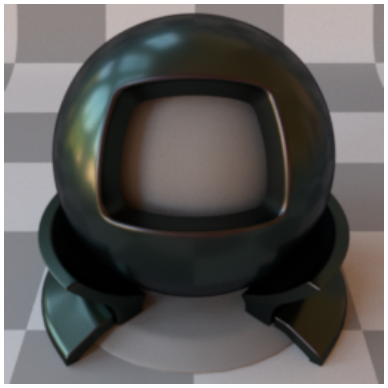
Reference



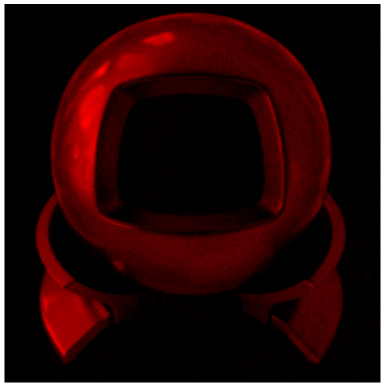
Ours: Tabulated



Ours: Gaussian

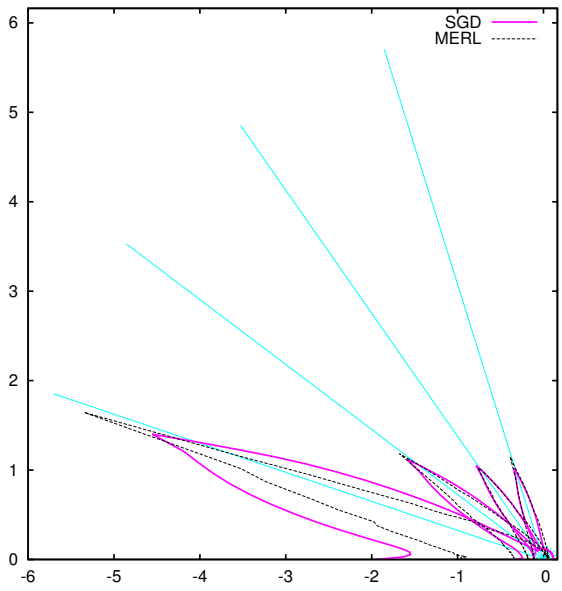


Reference

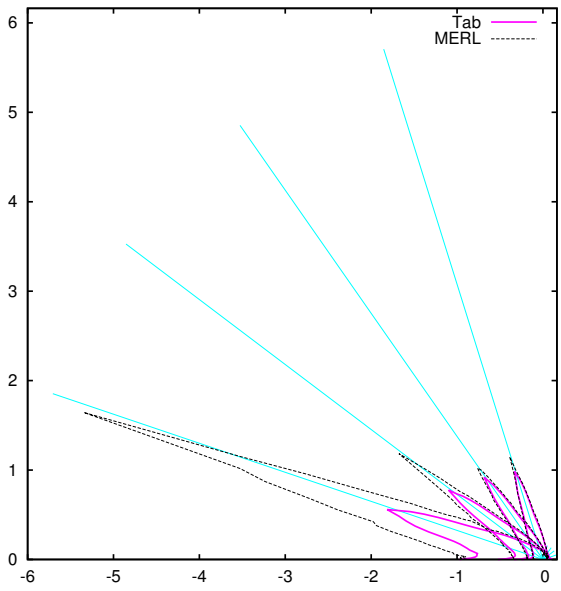


Ours: GGX

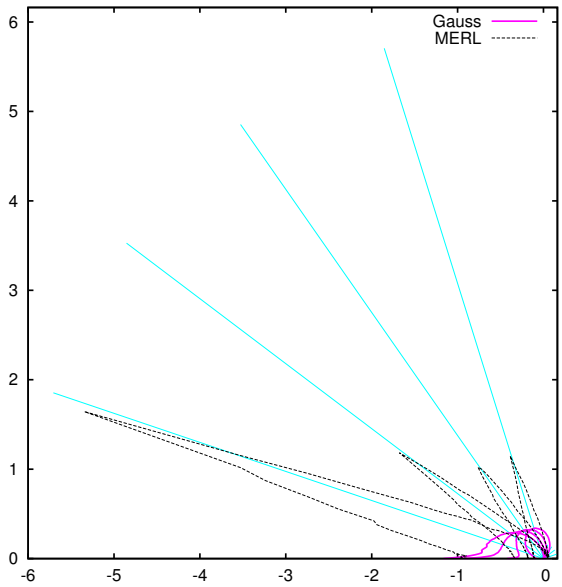
BRDF Lobes in the Incidence Plane (Cubic Root Applied)



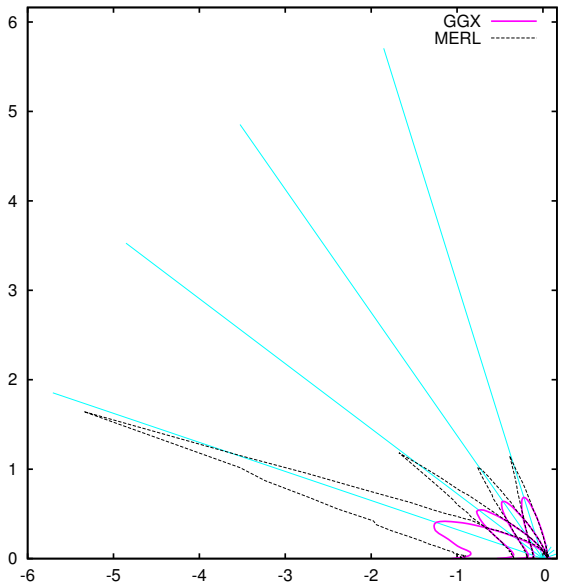
SGD



Ours: Tabulated

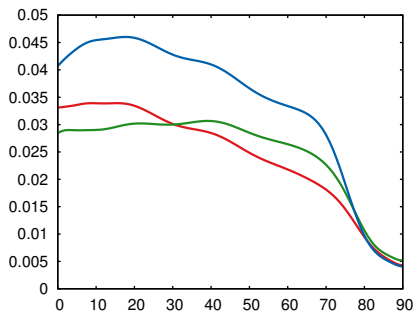


Ours: Gaussian

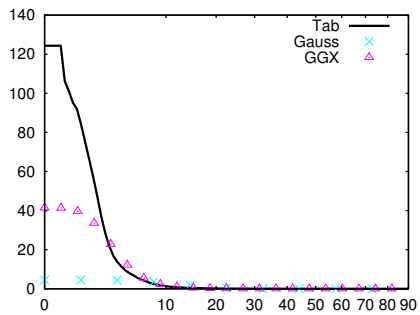


Ours: GGX

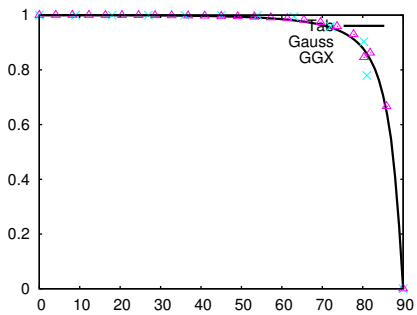
Fitted Microfacet Functions



Fresnel (R, G, B)



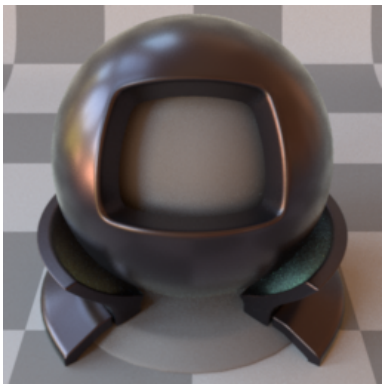
NDF (D)



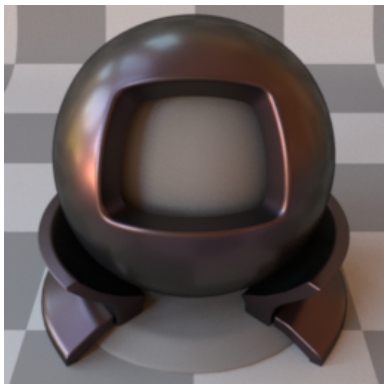
Smith (G_1)

22 color-changing-paint2

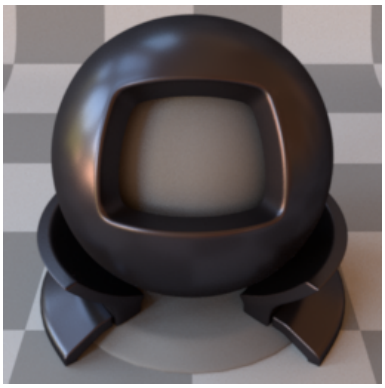
Renderings



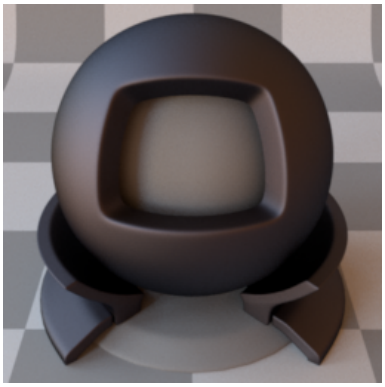
SGD



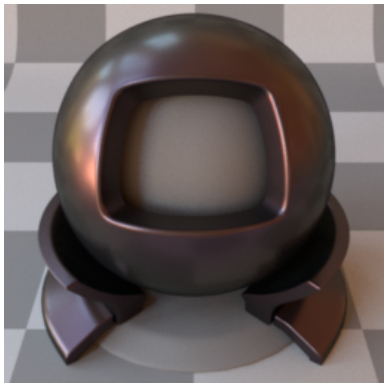
Reference



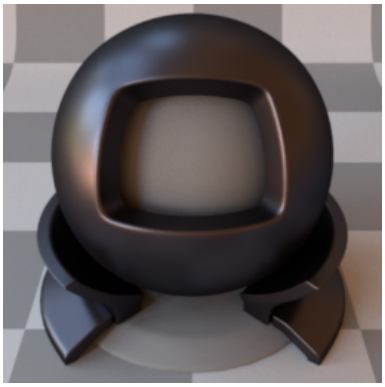
Ours: Tabulated



Ours: Gaussian

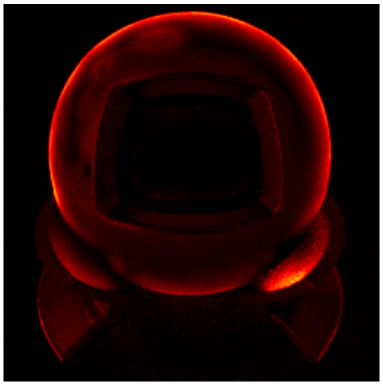


Reference

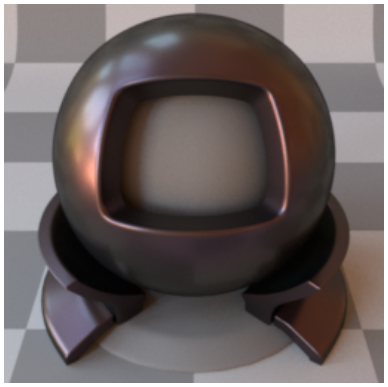


Ours: GGX

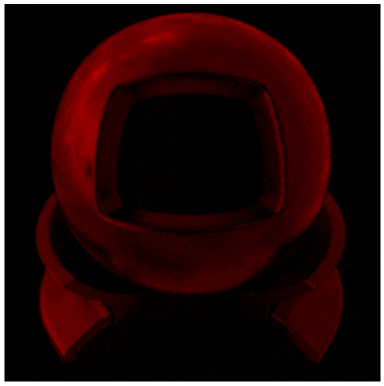
CIE dE00



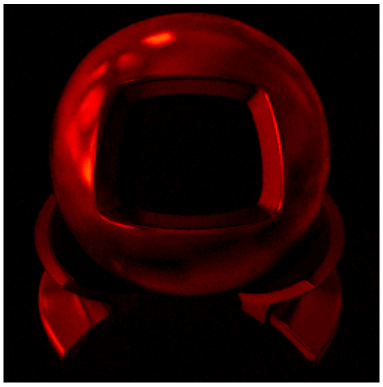
SGD



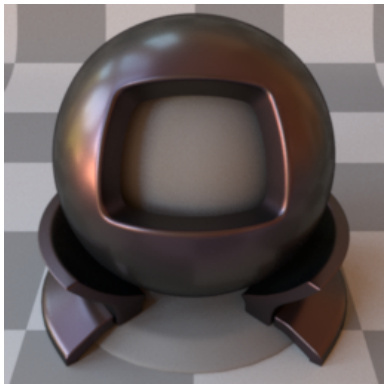
Reference



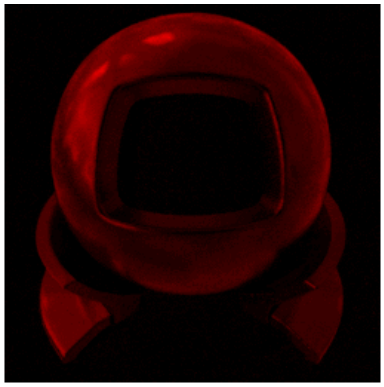
Ours: Tabulated



Ours: Gaussian

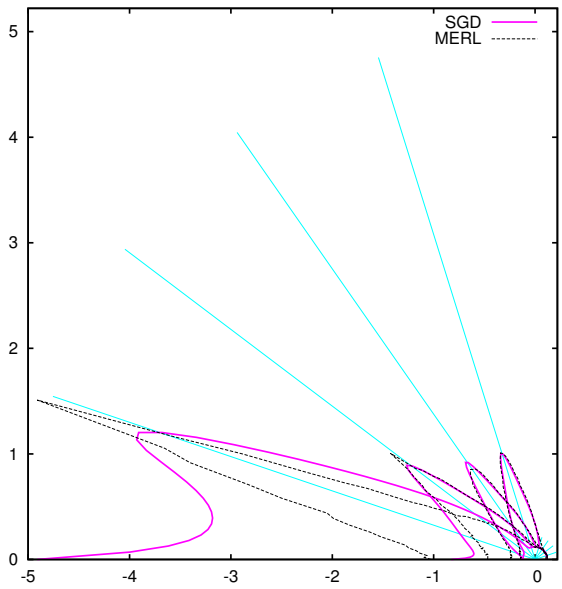


Reference

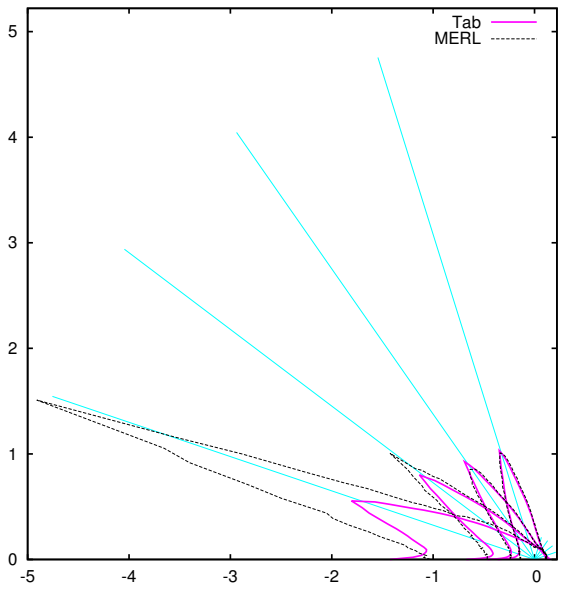


Ours: GGX

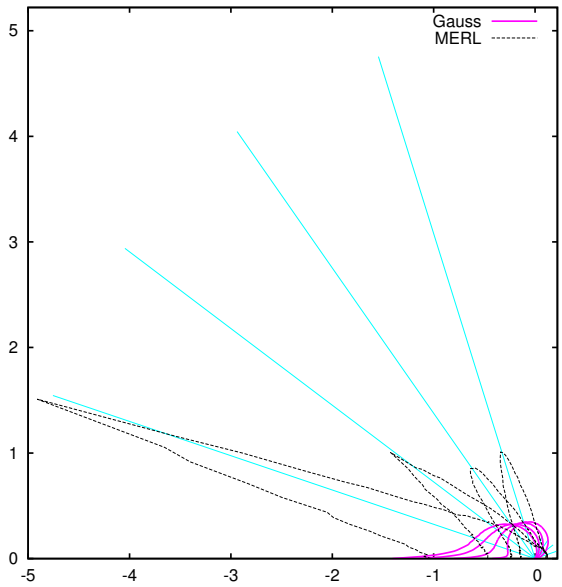
BRDF Lobes in the Incidence Plane (Cubic Root Applied)



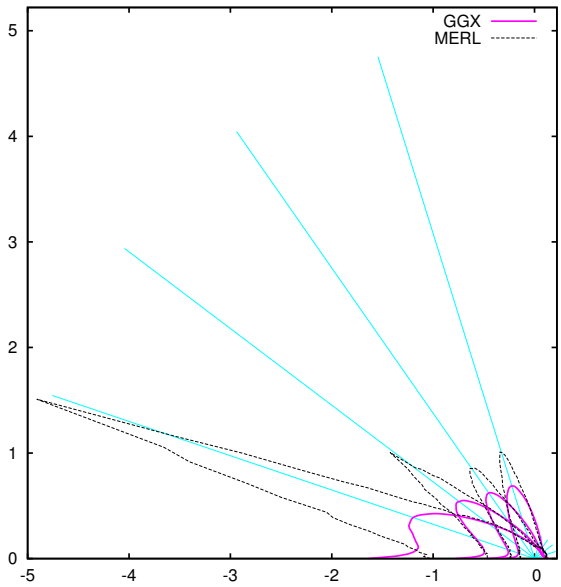
SGD



Ours: Tabulated

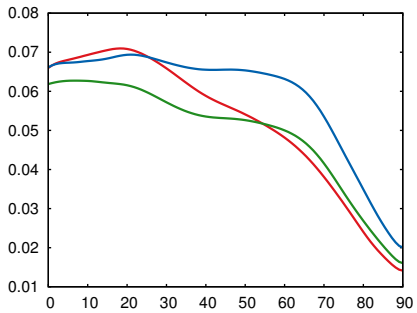


Ours: Gaussian

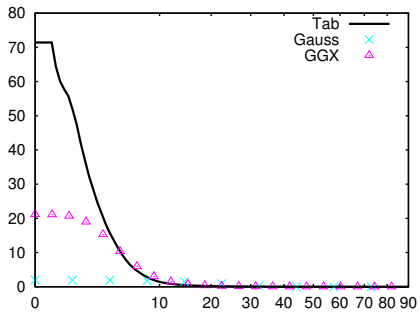


Ours: GGX

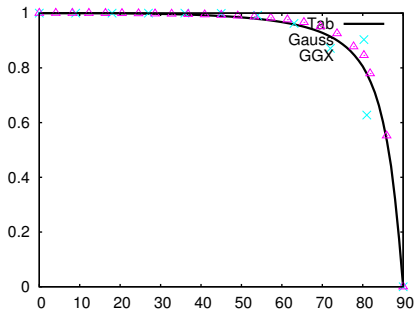
Fitted Microfacet Functions



Fresnel (R, G, B)



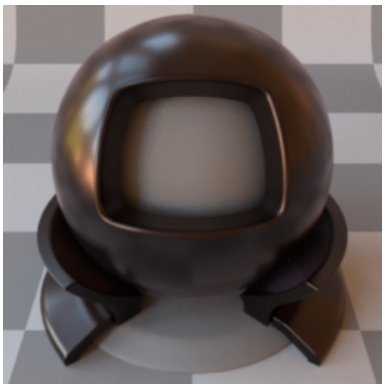
NDF (D)



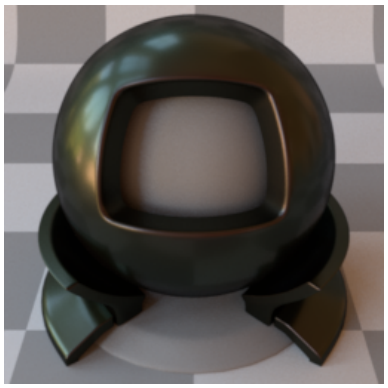
Smith (G_1)

23 color-changing-paint3

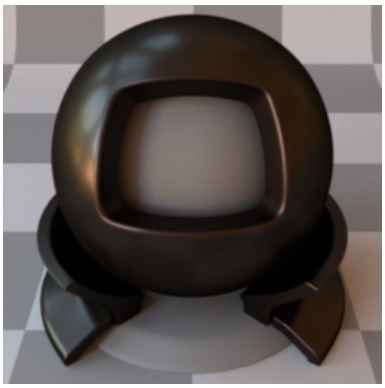
Renderings



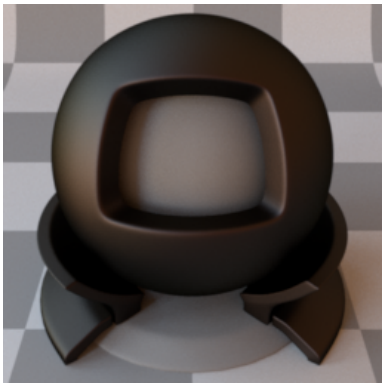
SGD



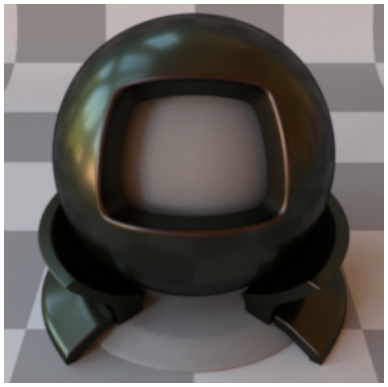
Reference



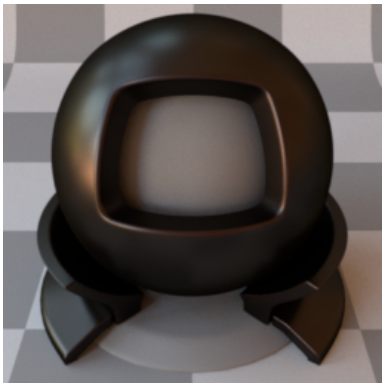
Ours: Tabulated



Ours: Gaussian



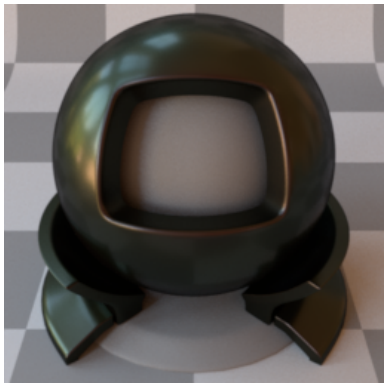
Reference



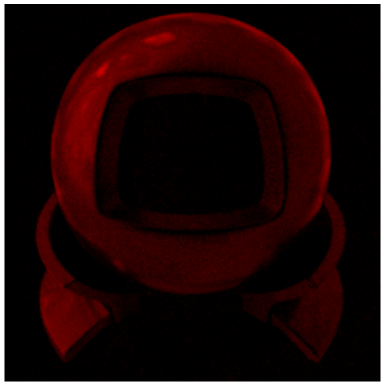
Ours: GGX

CIE dE00

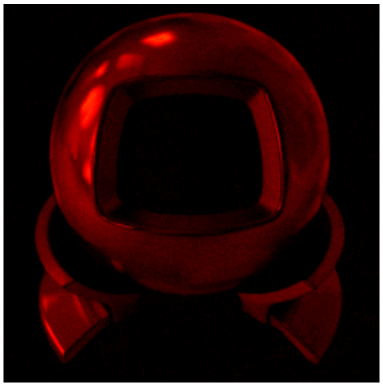
SGD



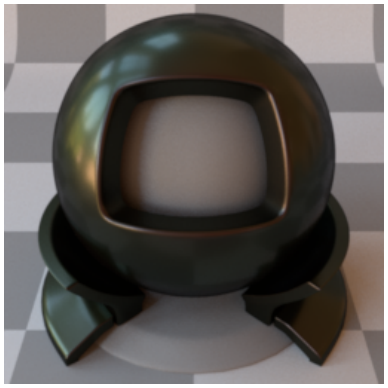
Reference



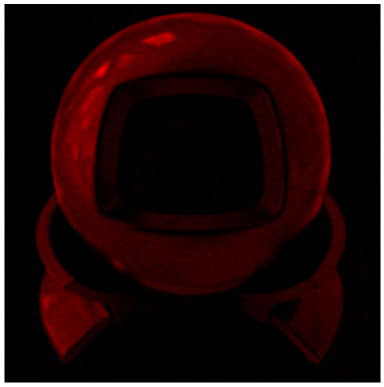
Ours: Tabulated



Ours: Gaussian

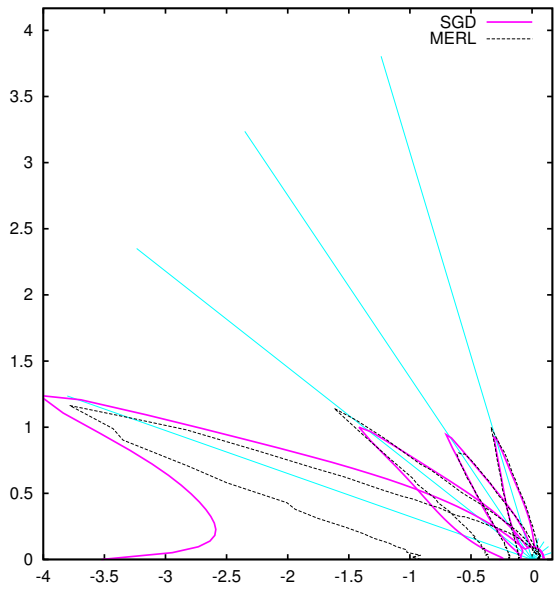


Reference

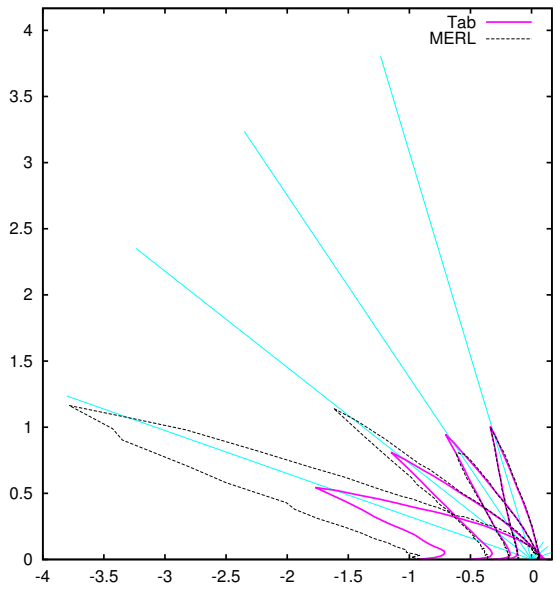


Ours: GGX

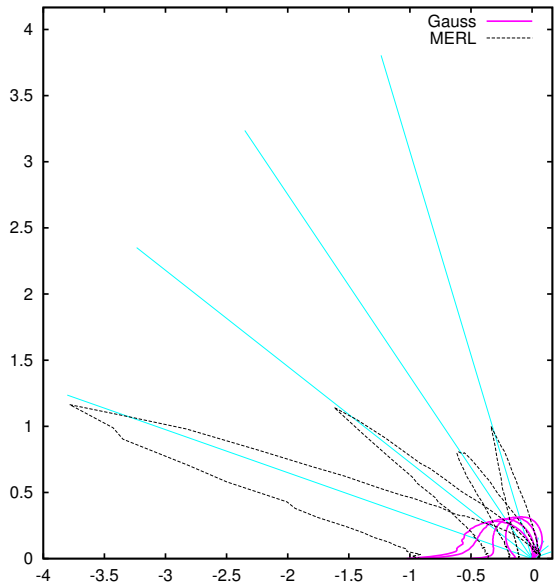
BRDF Lobes in the Incidence Plane (Cubic Root Applied)



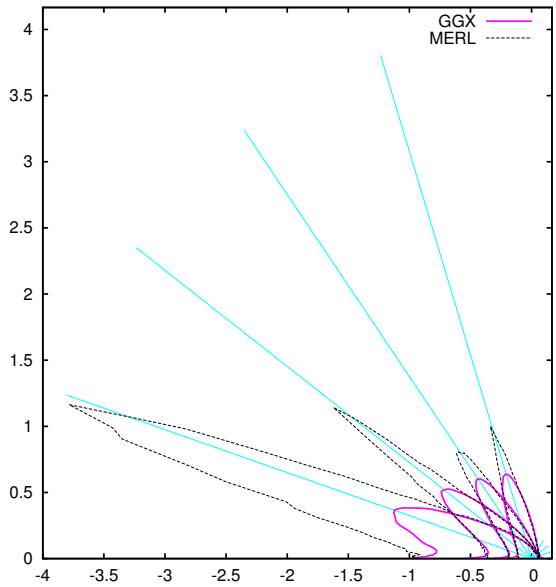
SGD



Ours: Tabulated

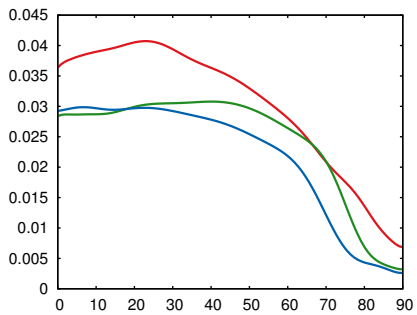


Ours: Gaussian

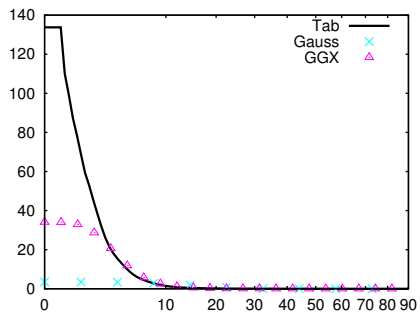


Ours: GGX

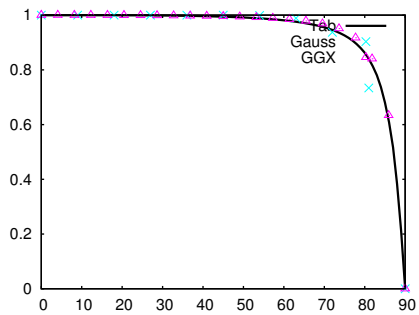
Fitted Microfacet Functions



Fresnel (R, G, B)



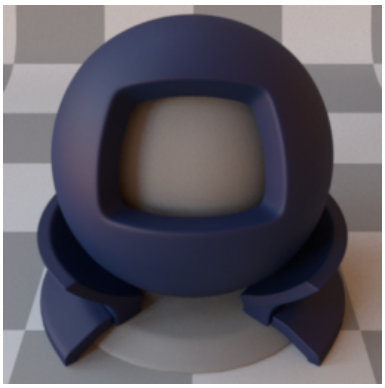
NDF (D)



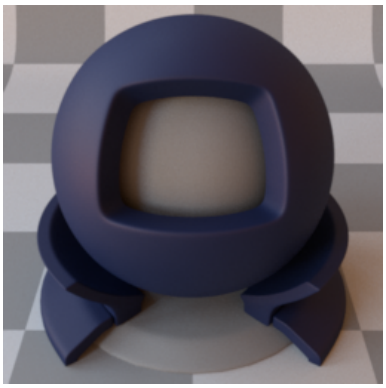
Smith (G_1)

24 dark-blue-paint

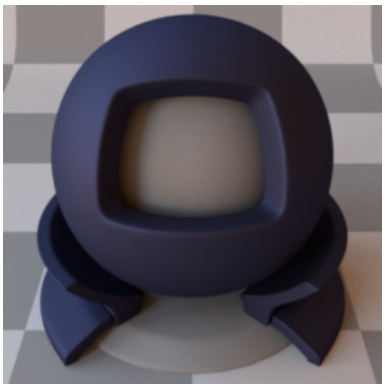
Renderings



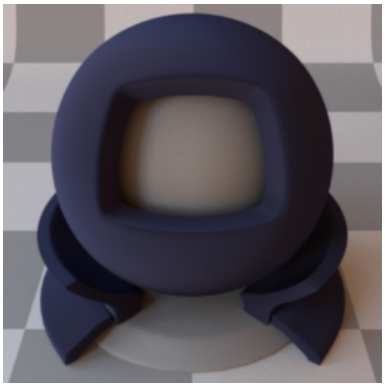
SGD



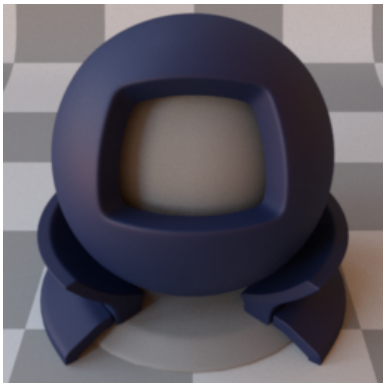
Reference



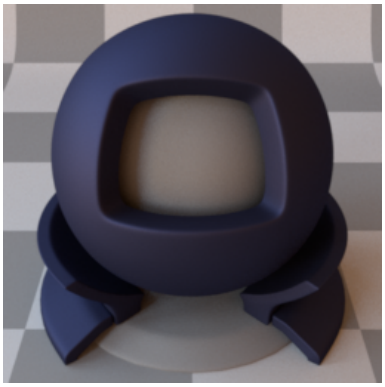
Ours: Tabulated



Ours: Gaussian



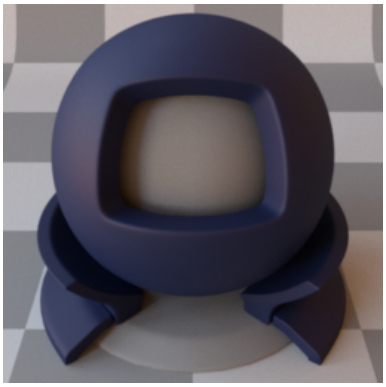
Reference



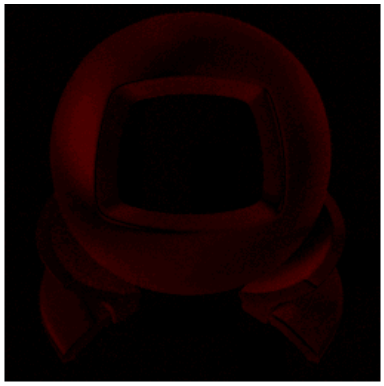
Ours: GGX

CIE dE00

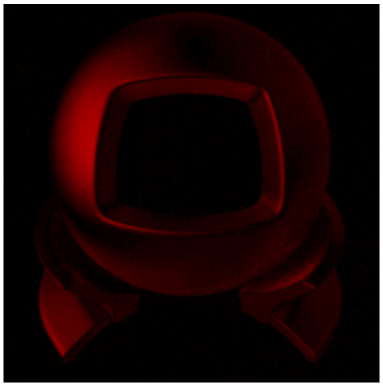
SGD



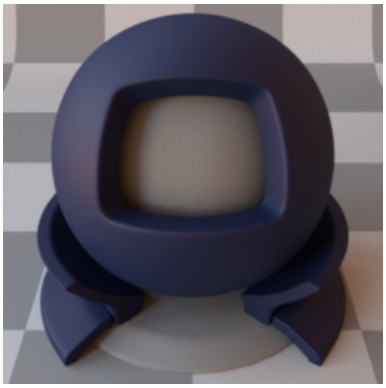
Reference



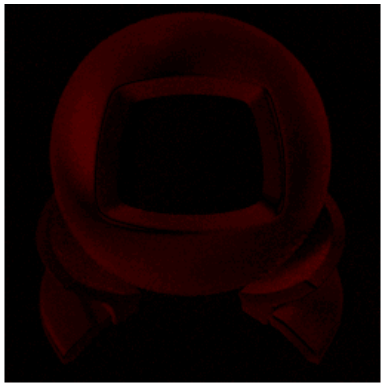
Ours: Tabulated



Ours: Gaussian

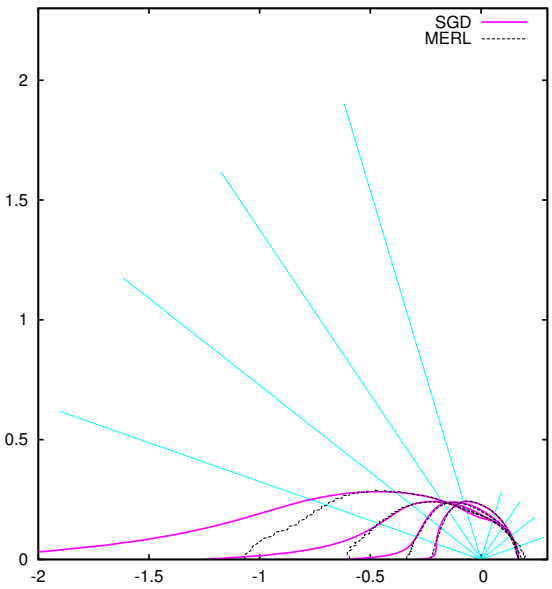


Reference

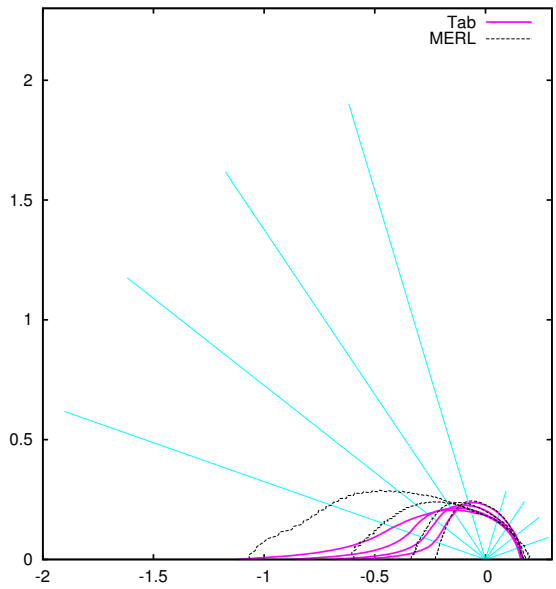


Ours: GGX

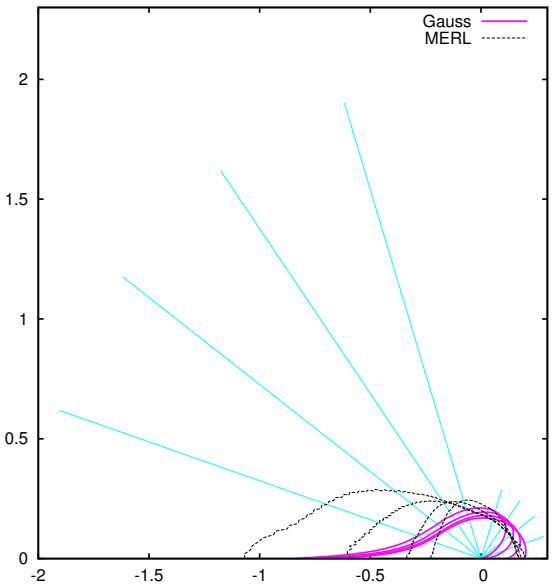
BRDF Lobes in the Incidence Plane (Cubic Root Applied)



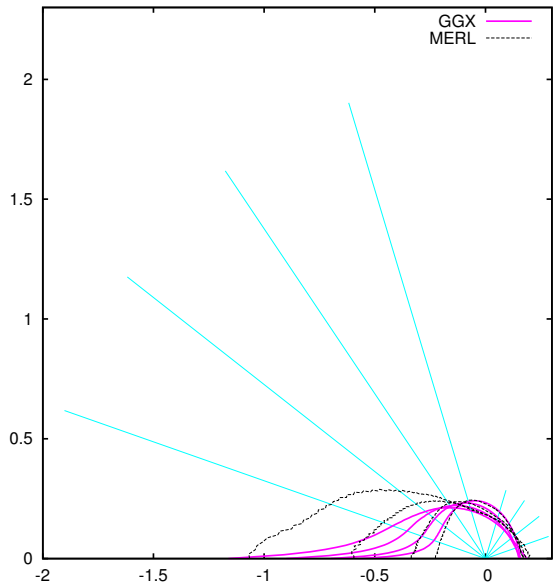
SGD



Ours: Tabulated

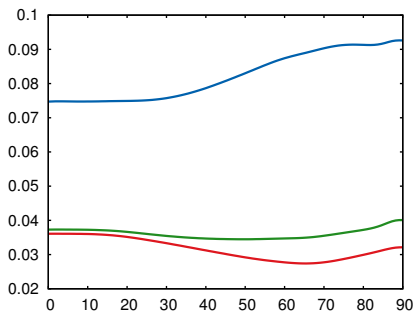


Ours: Gaussian

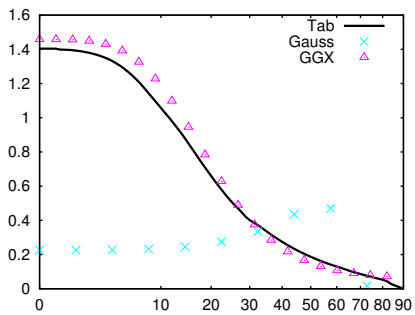


Ours: GGX

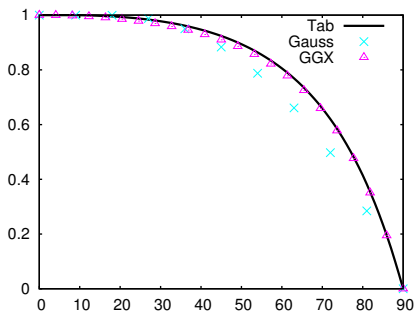
Fitted Microfacet Functions



Fresnel (R, G, B)



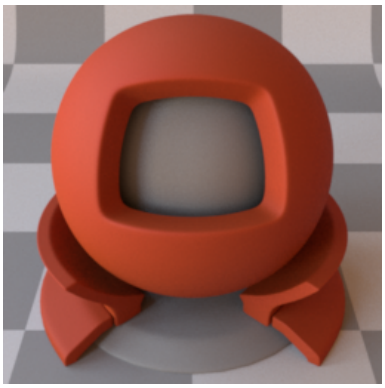
NDF (D)



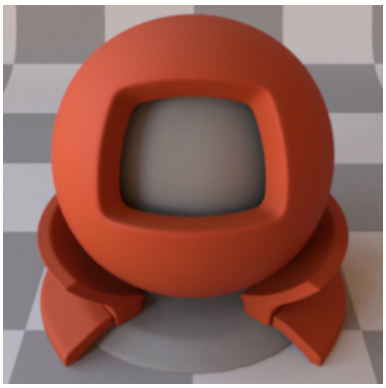
Smith (G_1)

25 dark-red-paint

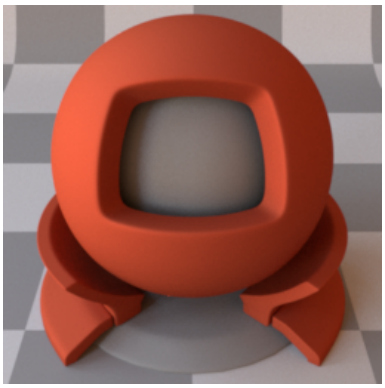
Renderings



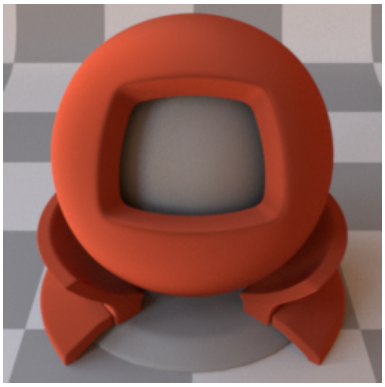
SGD



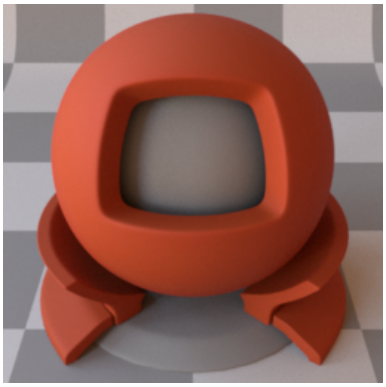
Reference



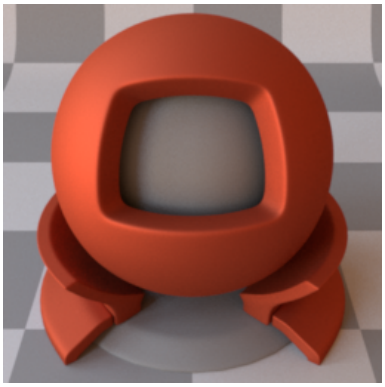
Ours: Tabulated



Ours: Gaussian



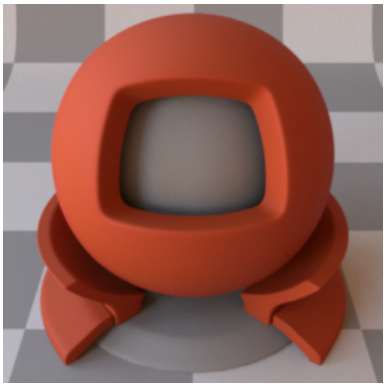
Reference



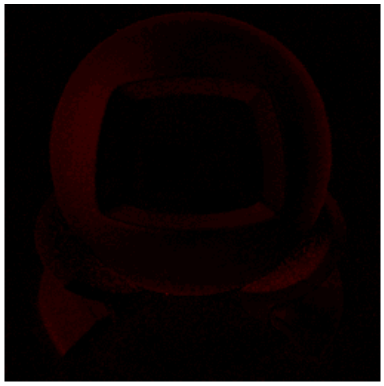
Ours: GGX

CIE dE00

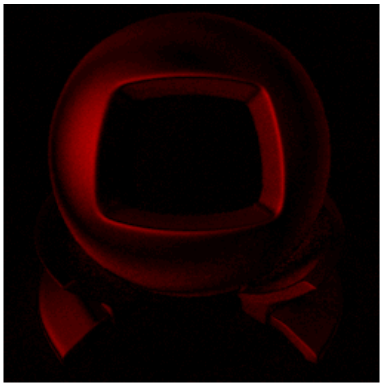
SGD



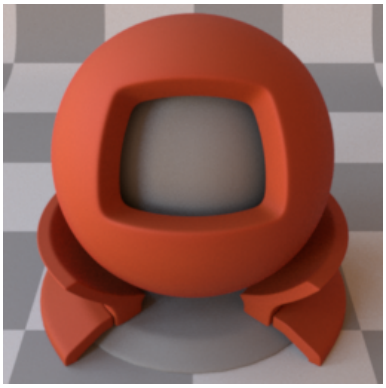
Reference



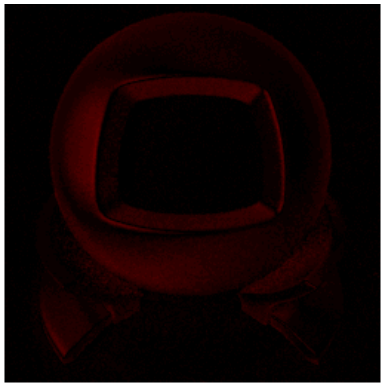
Ours: Tabulated



Ours: Gaussian

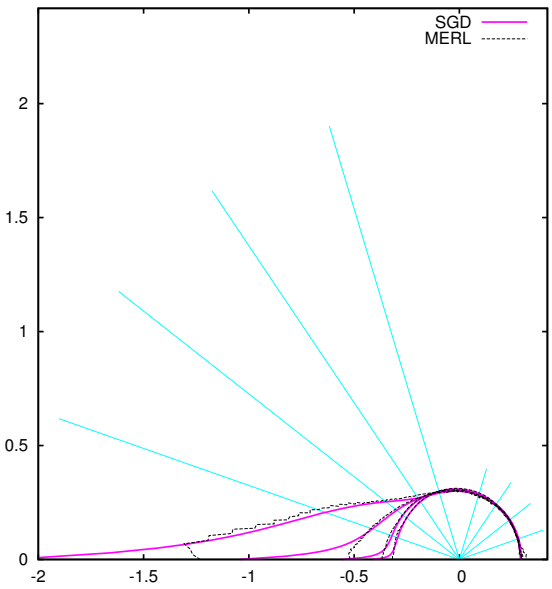


Reference

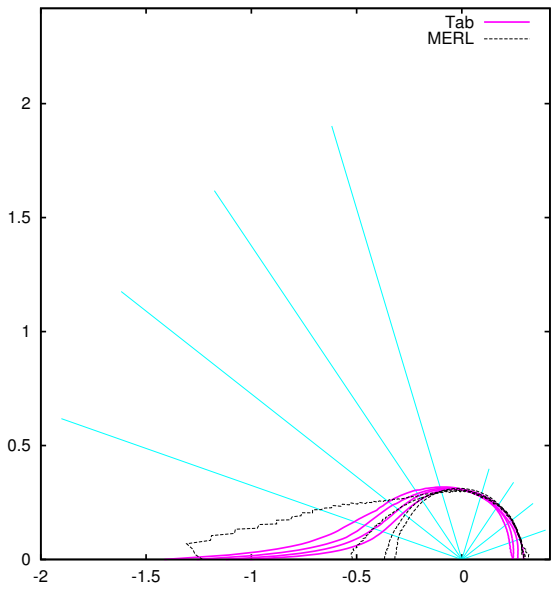


Ours: GGX

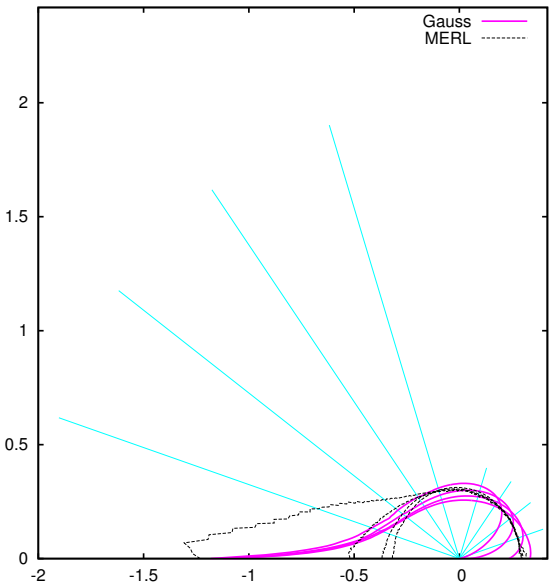
BRDF Lobes in the Incidence Plane (Cubic Root Applied)



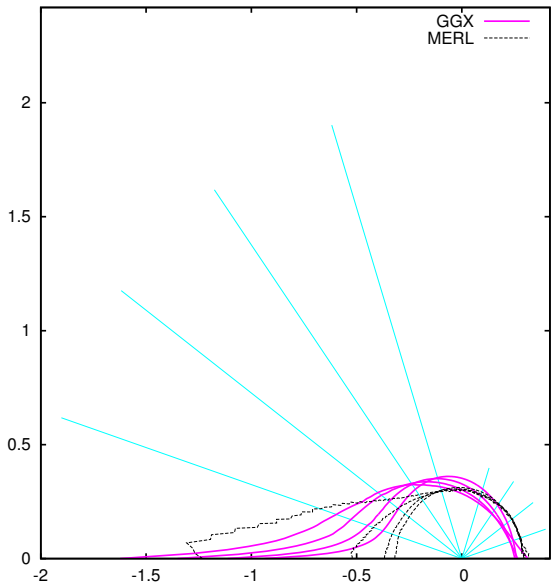
SGD



Ours: Tabulated

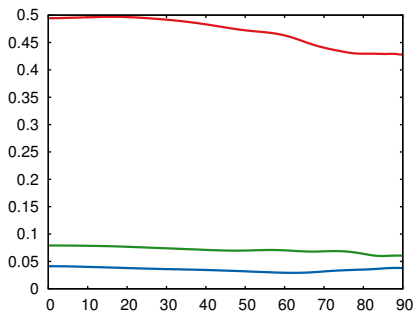


Ours: Gaussian

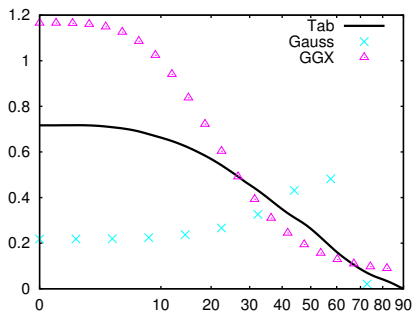


Ours: GGX

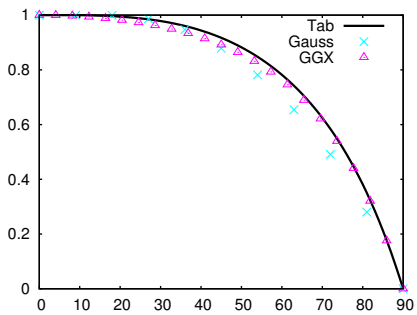
Fitted Microfacet Functions



Fresnel (R, G, B)



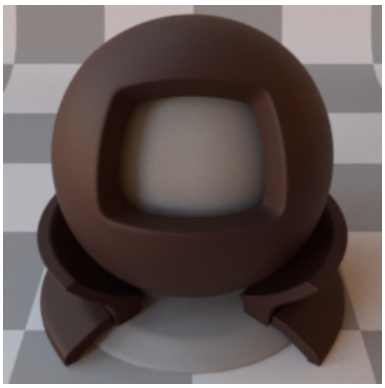
NDF (D)



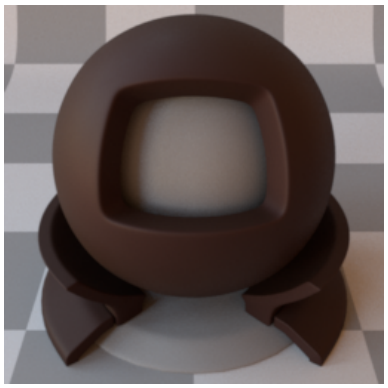
Smith (G_1)

26 dark-specular-fabric

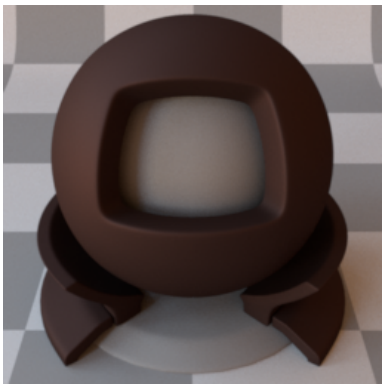
Renderings



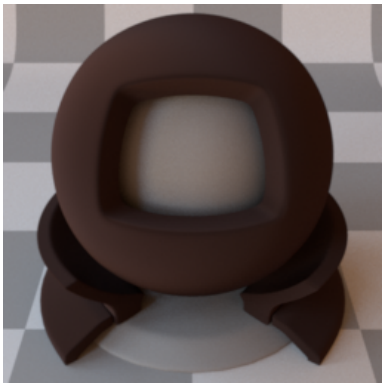
SGD



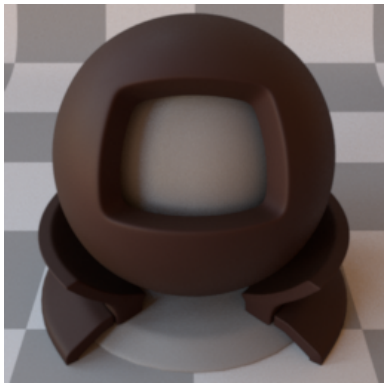
Reference



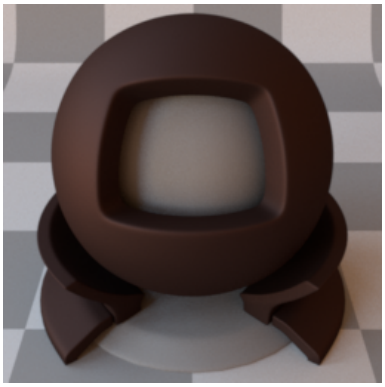
Ours: Tabulated



Ours: Gaussian

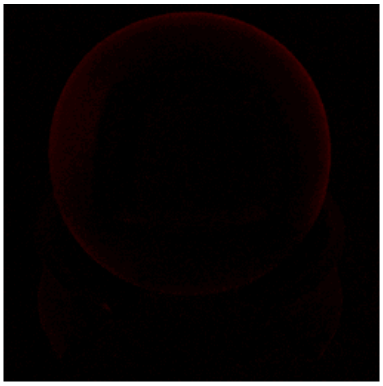


Reference

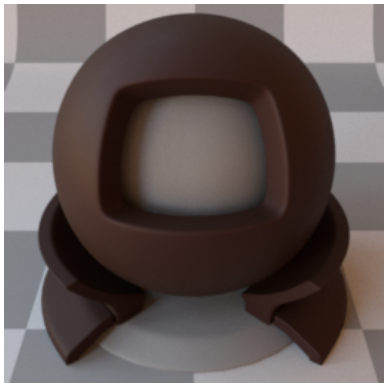


Ours: GGX

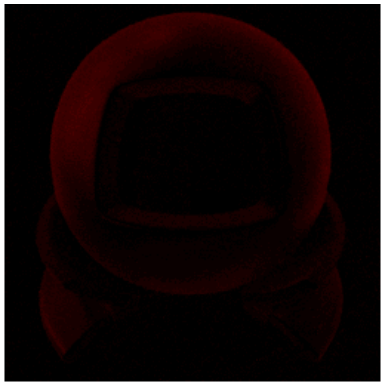
CIE dE00



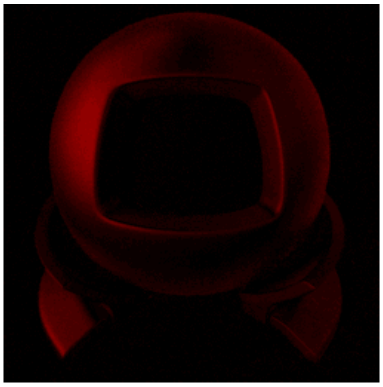
SGD



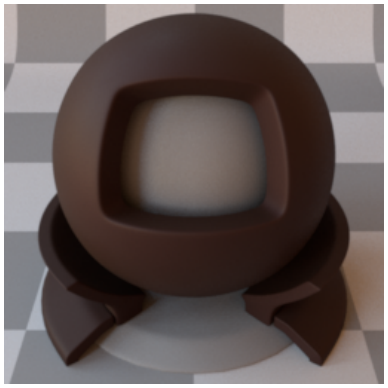
Reference



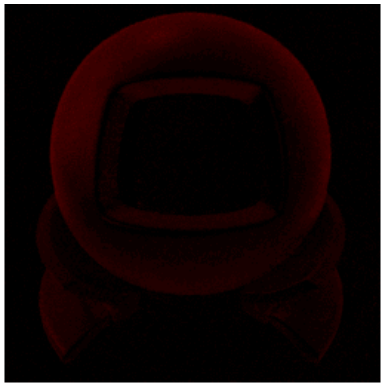
Ours: Tabulated



Ours: Gaussian

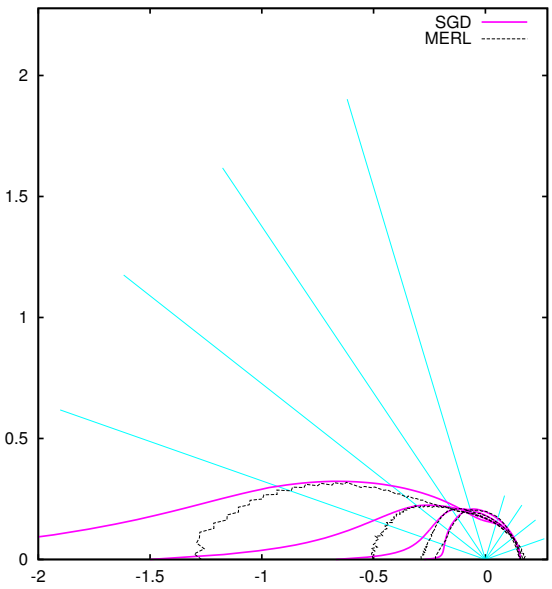


Reference

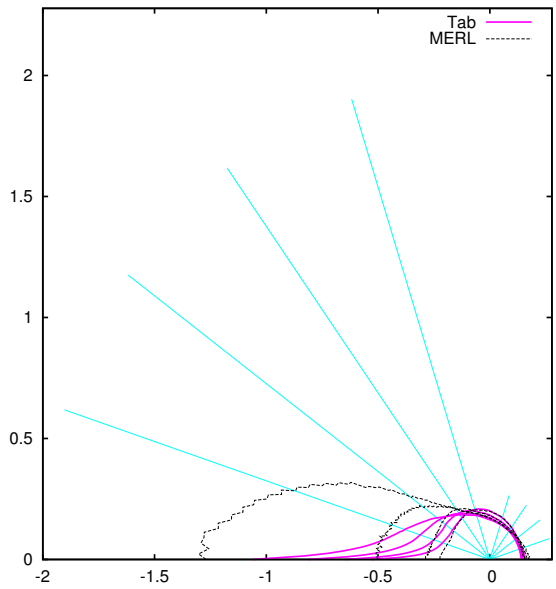


Ours: GGX

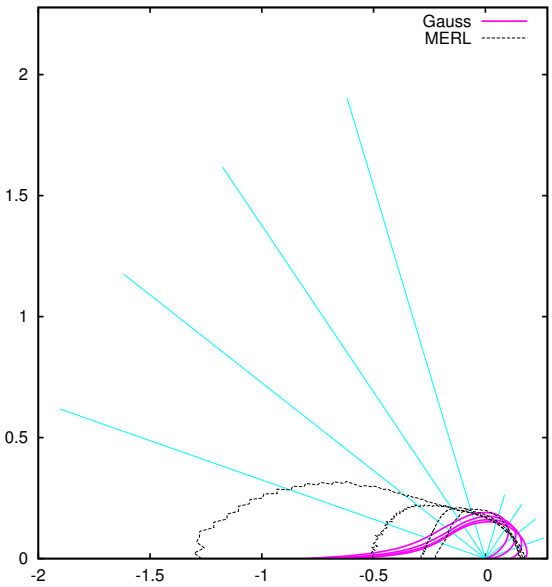
BRDF Lobes in the Incidence Plane (Cubic Root Applied)



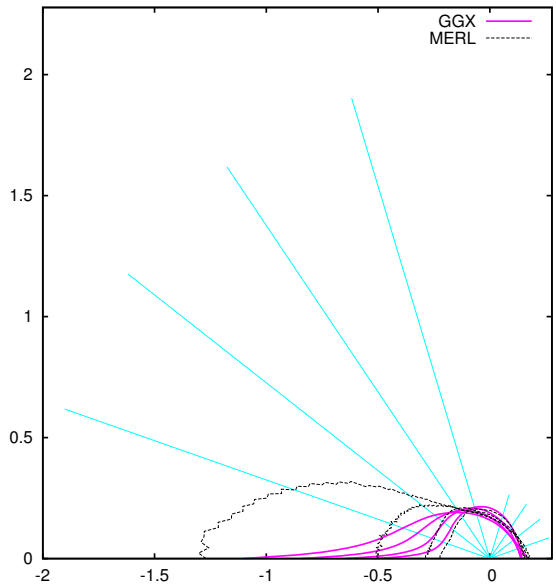
SGD



Ours: Tabulated

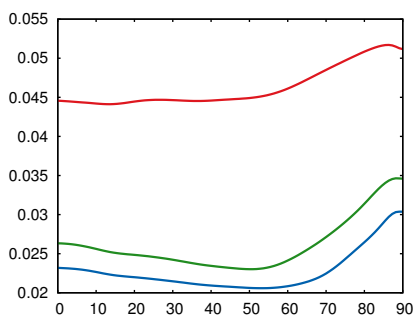


Ours: Gaussian

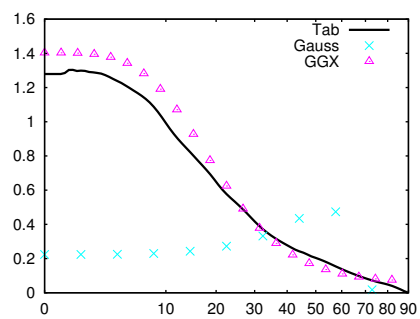


Ours: GGX

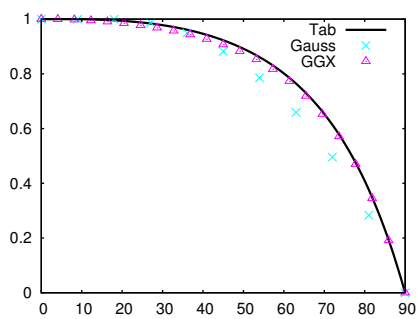
Fitted Microfacet Functions



Fresnel (R, G, B)



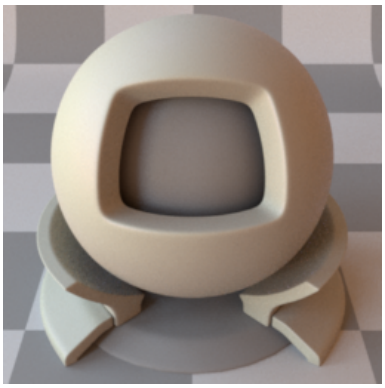
NDF (D)



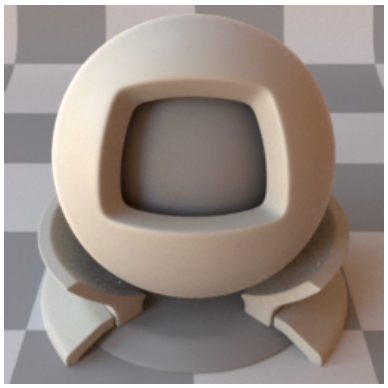
Smith (G_1)

27 delrin

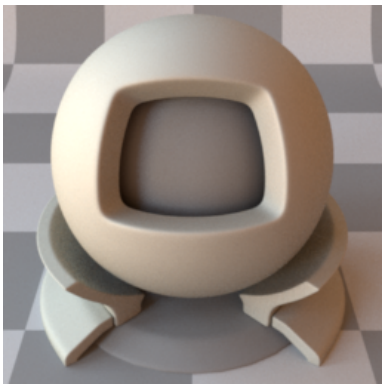
Renderings



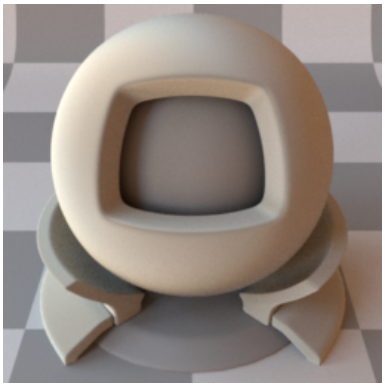
SGD



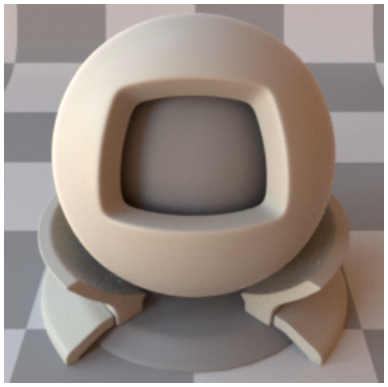
Reference



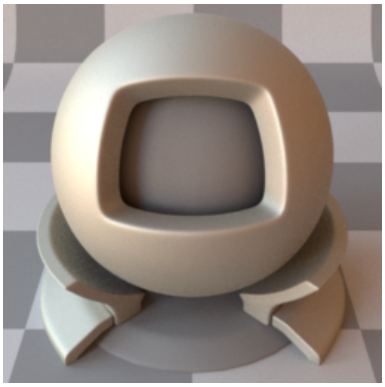
Ours: Tabulated



Ours: Gaussian

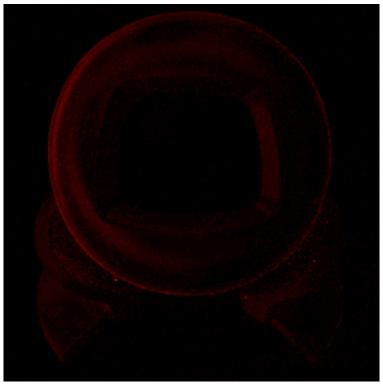


Reference

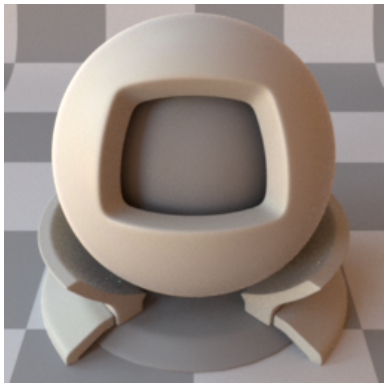


Ours: GGX

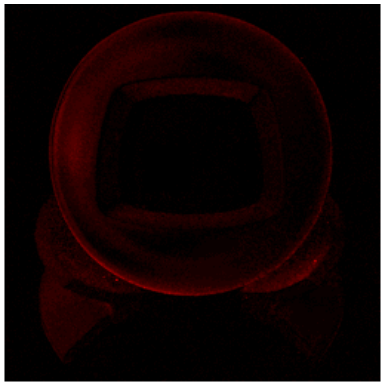
CIE dE00



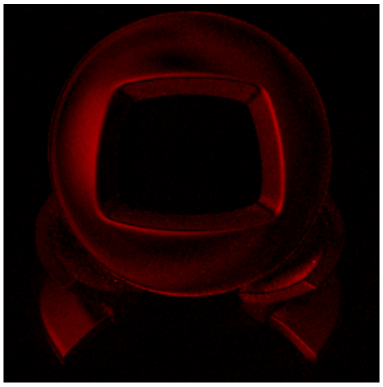
SGD



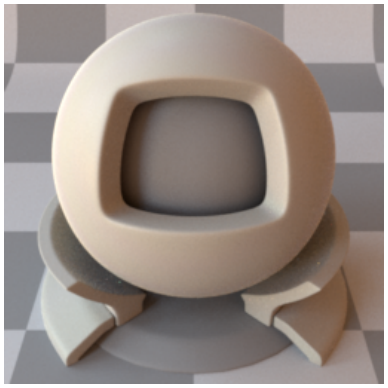
Reference



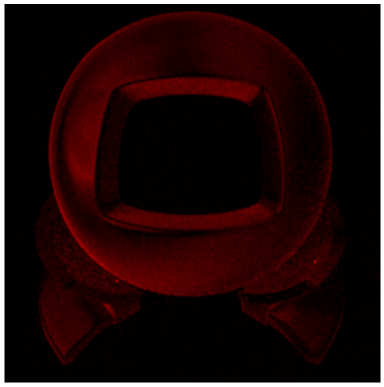
Ours: Tabulated



Ours: Gaussian

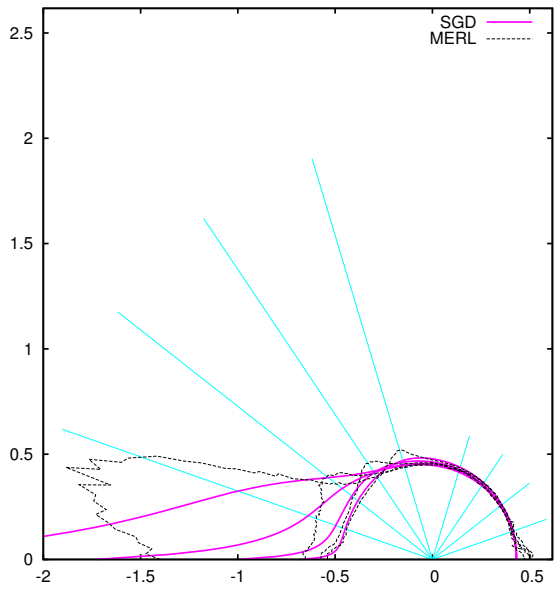


Reference

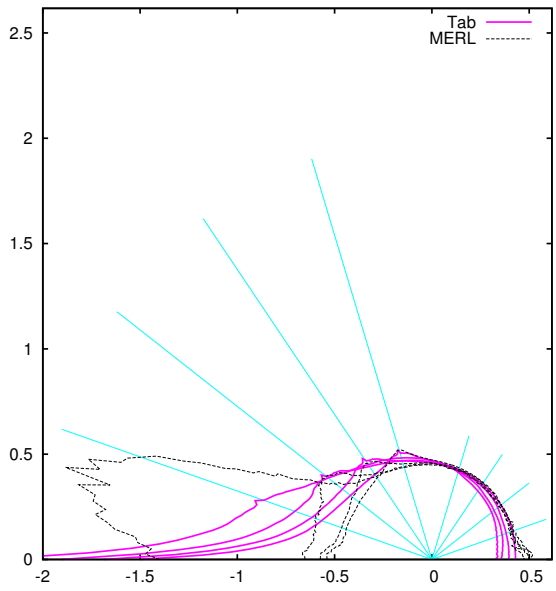


Ours: GGX

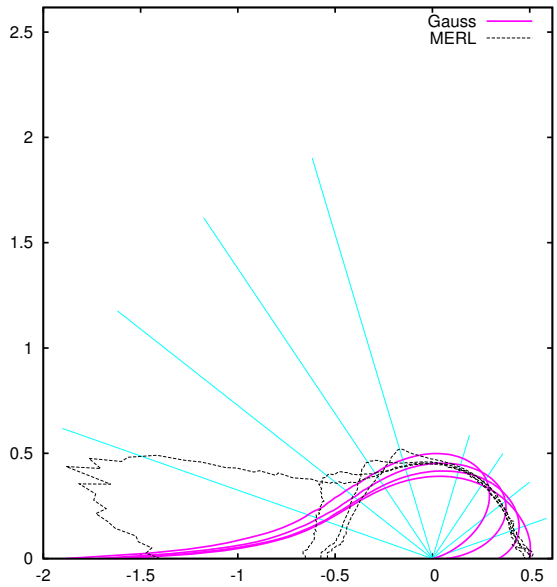
BRDF Lobes in the Incidence Plane (Cubic Root Applied)



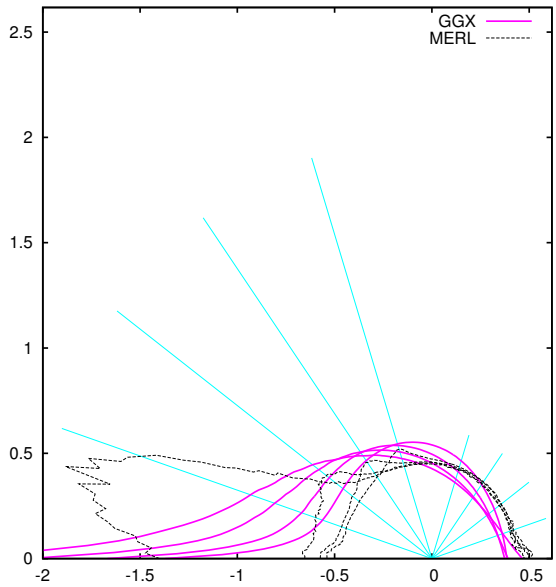
SGD



Ours: Tabulated

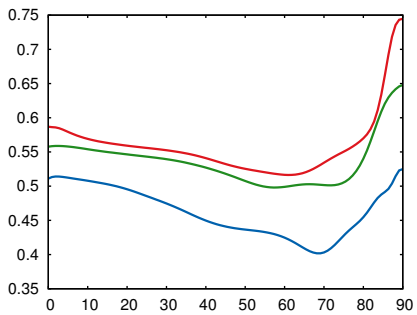


Ours: Gaussian

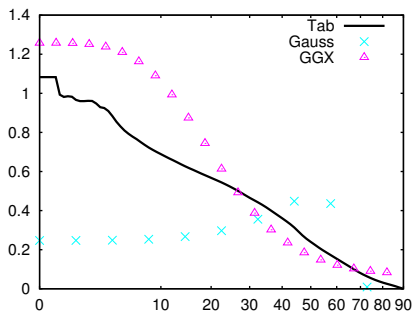


Ours: GGX

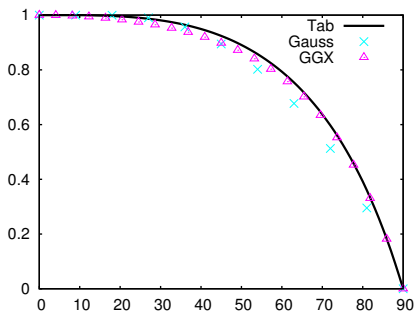
Fitted Microfacet Functions



Fresnel (R, G, B)



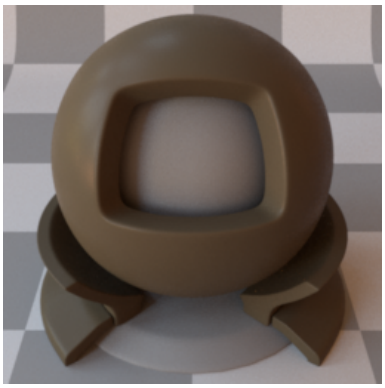
NDF (D)



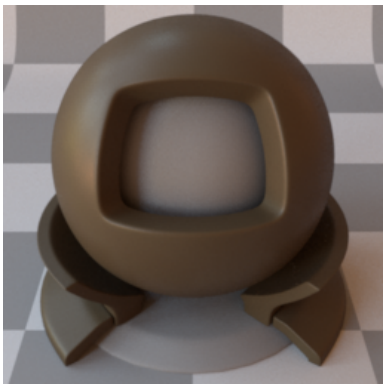
Smith (G_1)

28 fruitwood-241

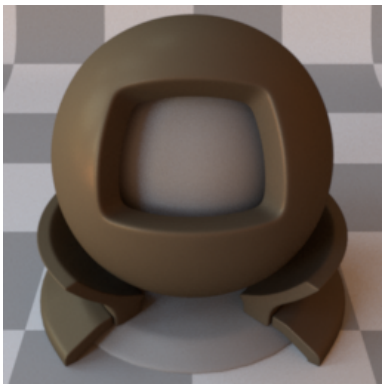
Renderings



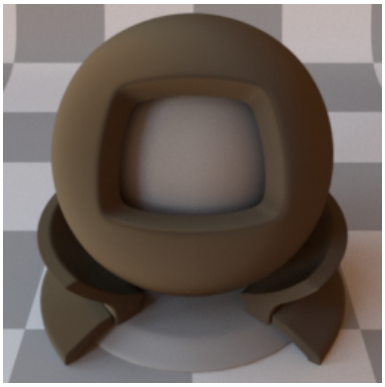
SGD



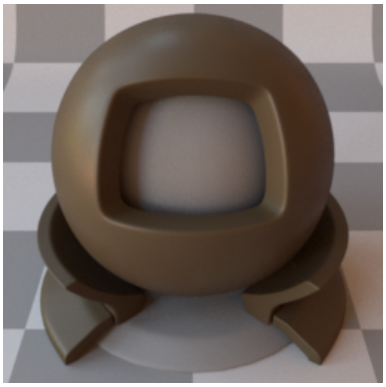
Reference



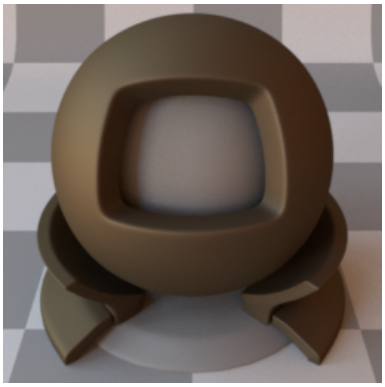
Ours: Tabulated



Ours: Gaussian

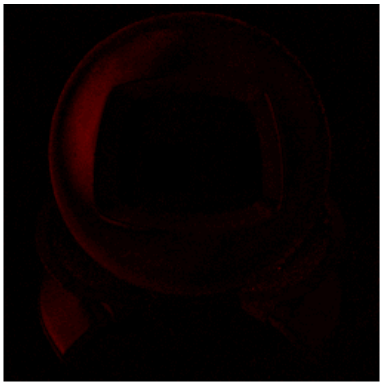


Reference

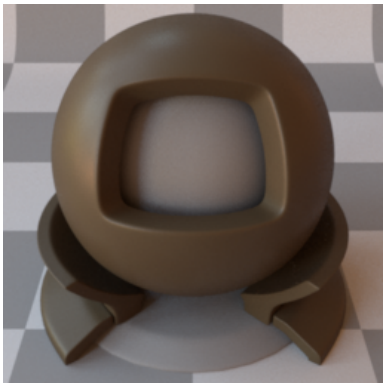


Ours: GGX

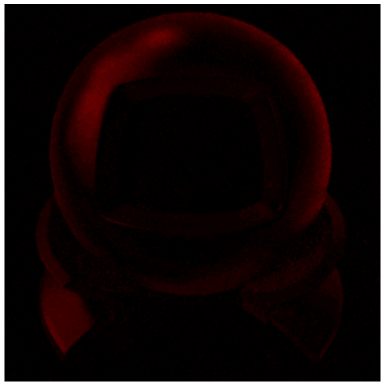
CIE dE00



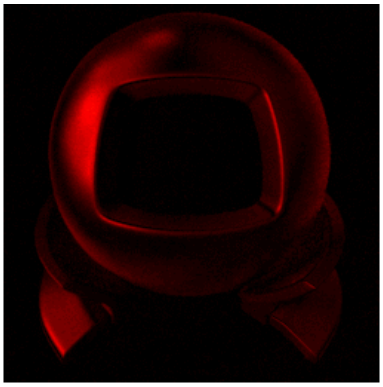
SGD



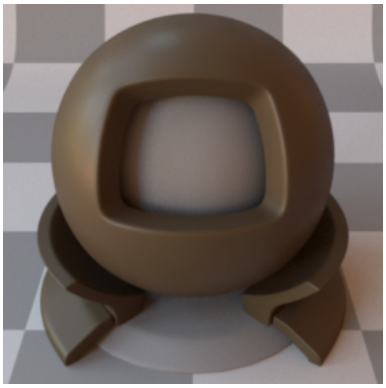
Reference



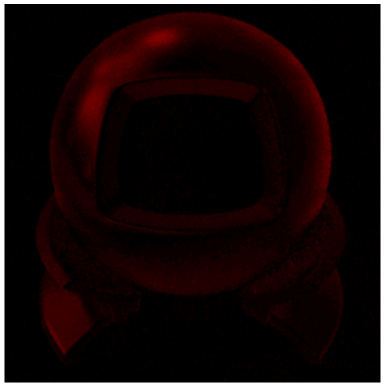
Ours: Tabulated



Ours: Gaussian

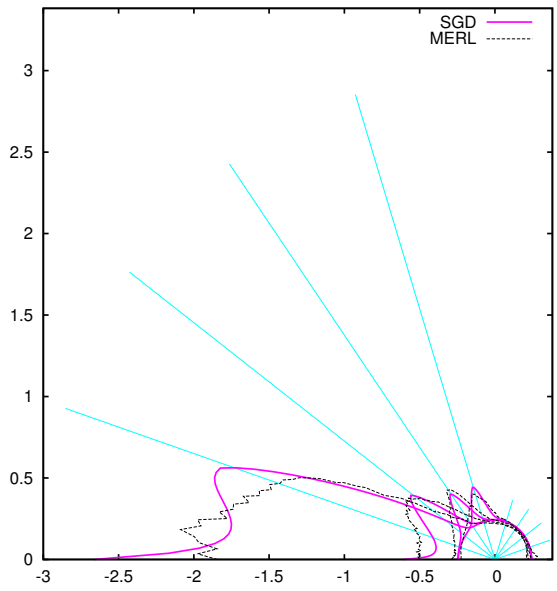


Reference

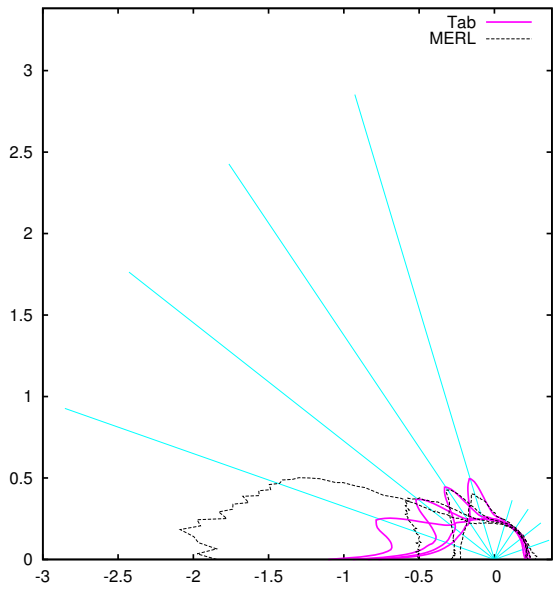


Ours: GGX

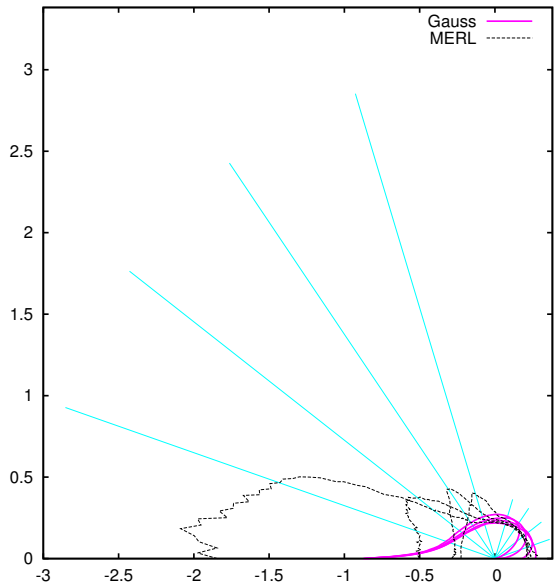
BRDF Lobes in the Incidence Plane (Cubic Root Applied)



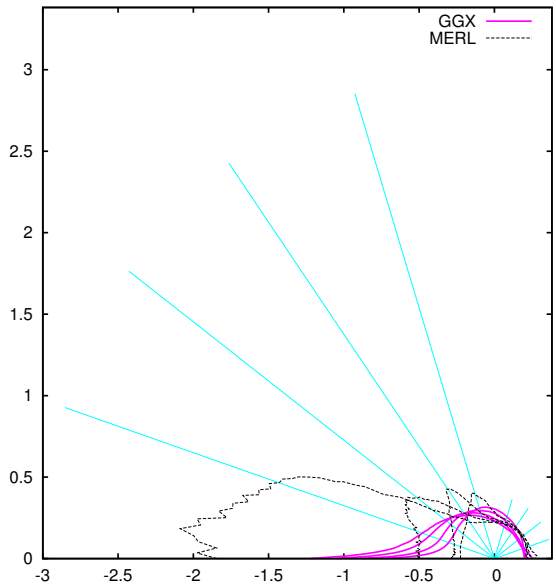
SGD



Ours: Tabulated

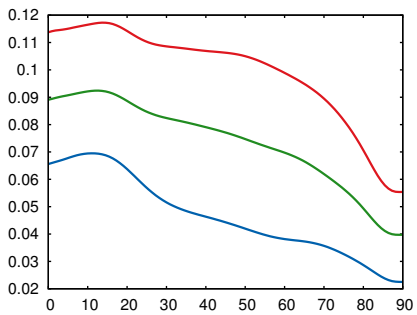


Ours: Gaussian

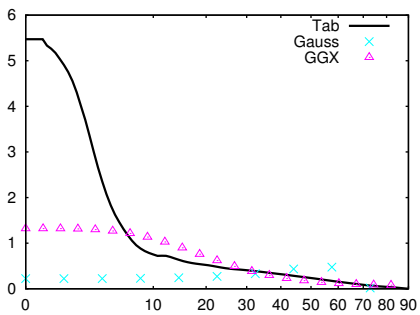


Ours: GGX

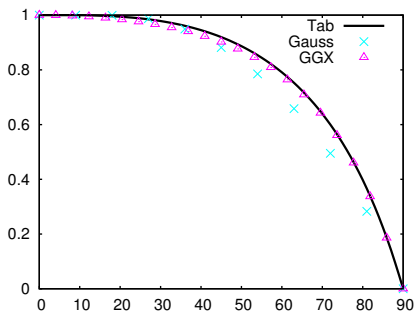
Fitted Microfacet Functions



Fresnel (R, G, B)



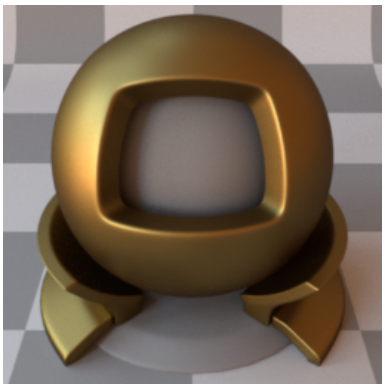
NDF (D)



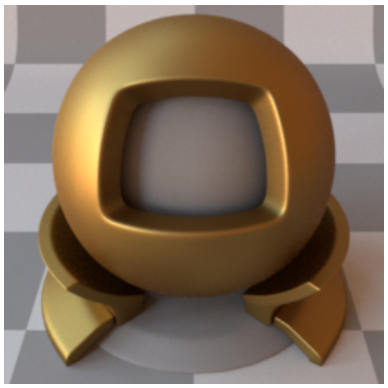
Smith (G_1)

29 gold-metallic-paint

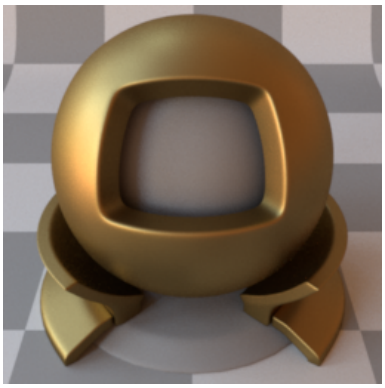
Renderings



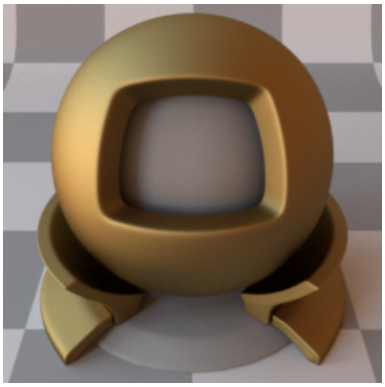
SGD



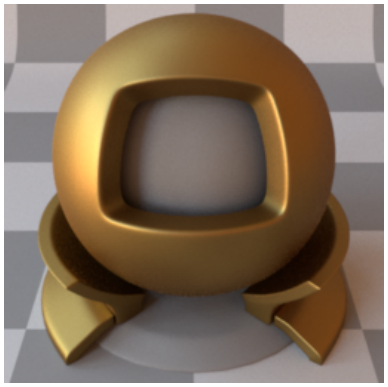
Reference



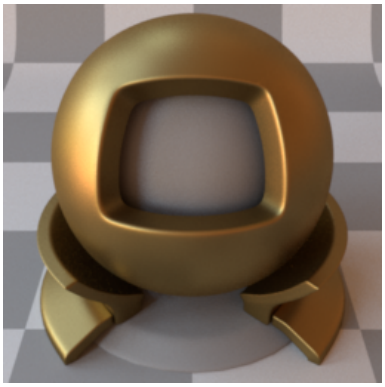
Ours: Tabulated



Ours: Gaussian

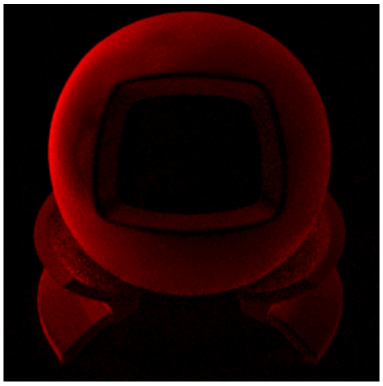


Reference

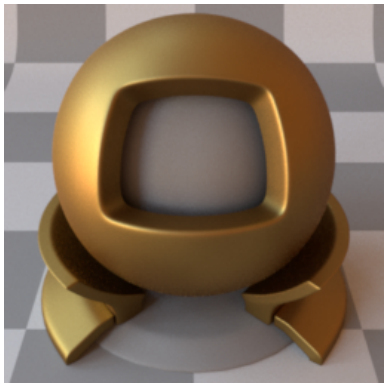


Ours: GGX

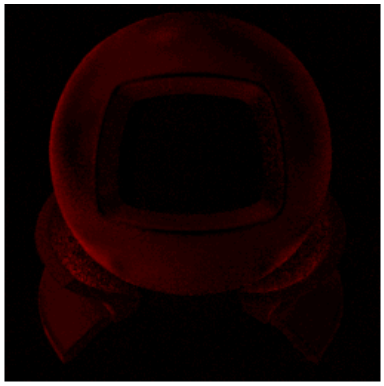
CIE dE00



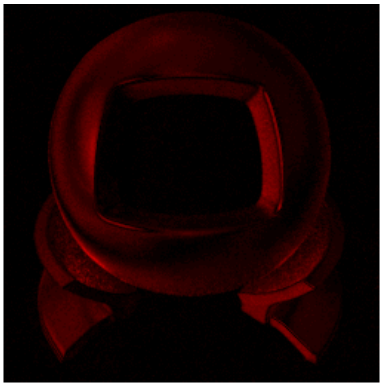
SGD



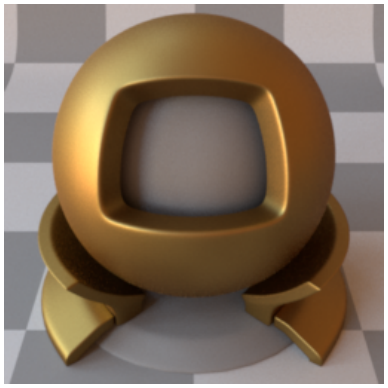
Reference



Ours: Tabulated



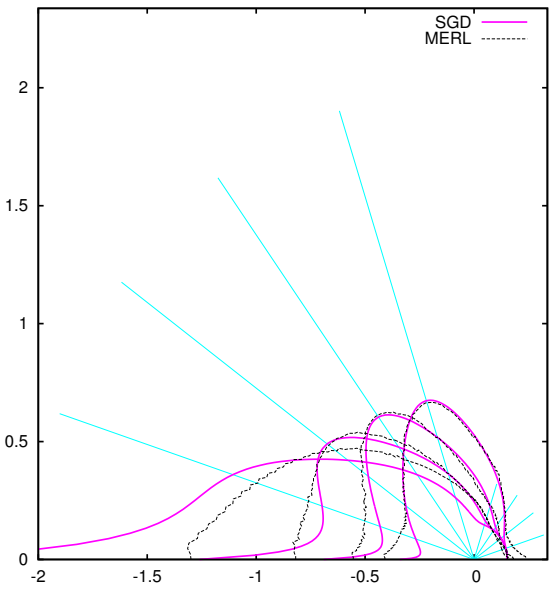
Ours: Gaussian



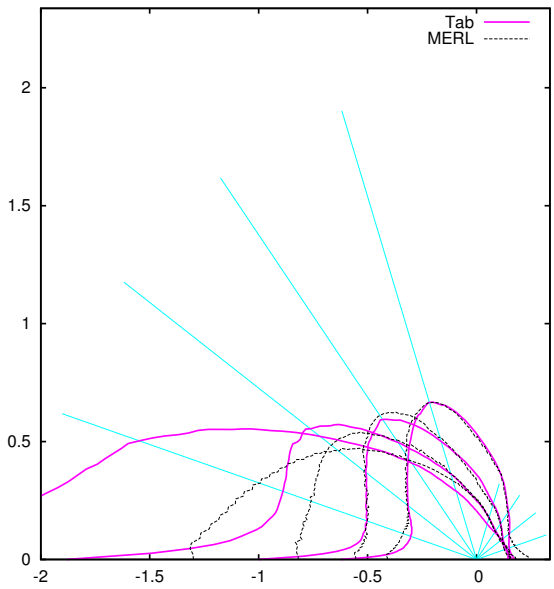
Reference

Ours: GGX

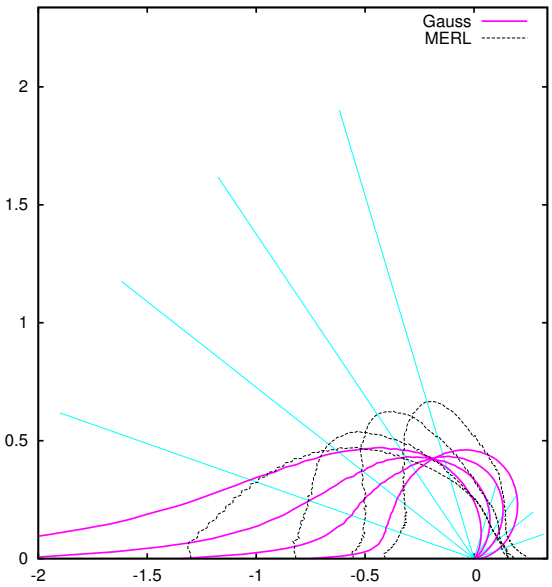
BRDF Lobes in the Incidence Plane (Cubic Root Applied)



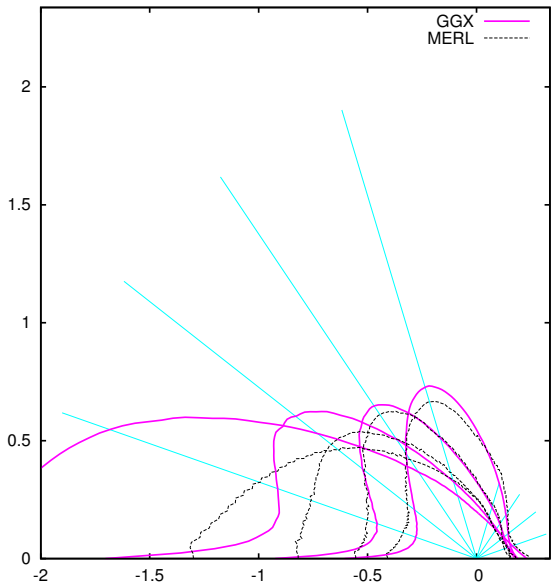
SGD



Ours: Tabulated

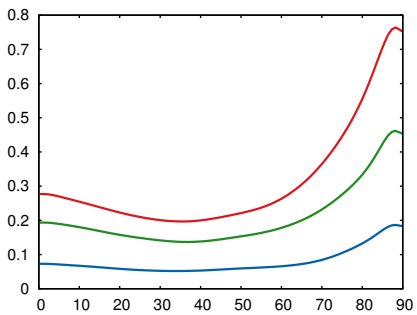


Ours: Gaussian

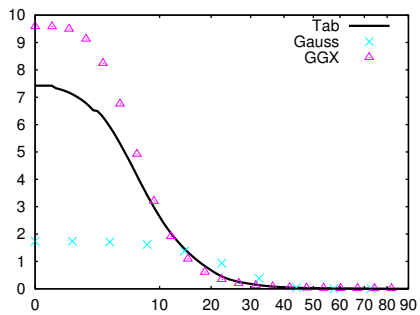


Ours: GGX

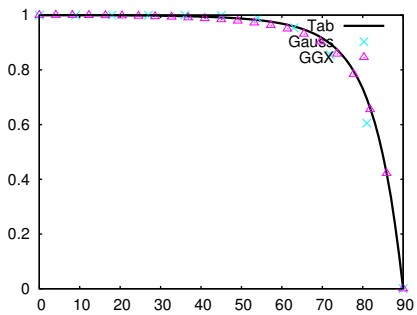
Fitted Microfacet Functions



Fresnel (R, G, B)



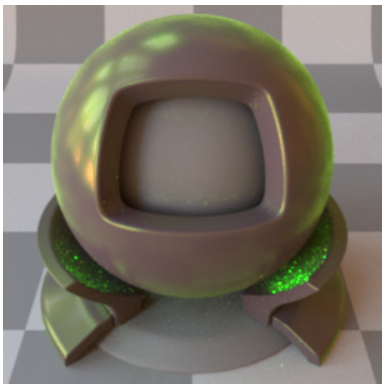
NDF (D)



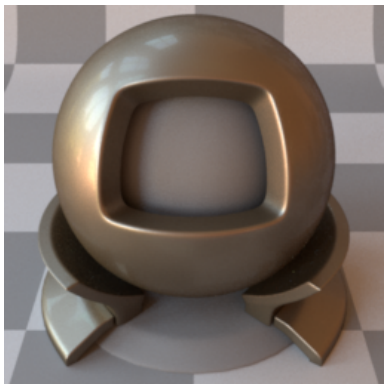
Smith (G_1)

30 gold-metallic-paint2

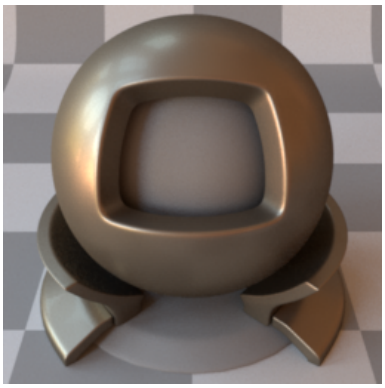
Renderings



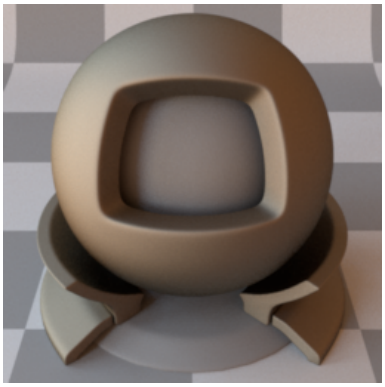
SGD



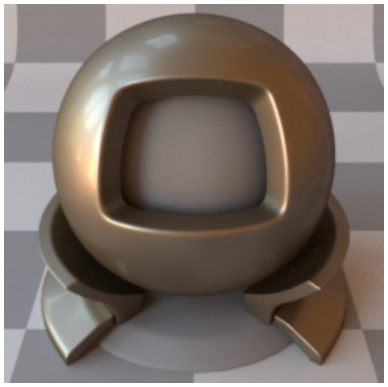
Reference



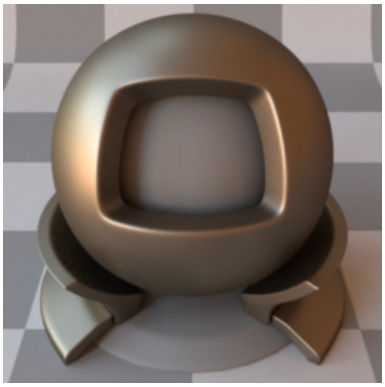
Ours: Tabulated



Ours: Gaussian

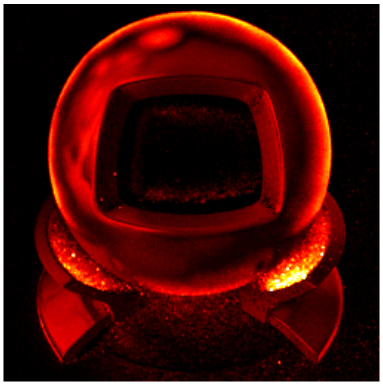


Reference

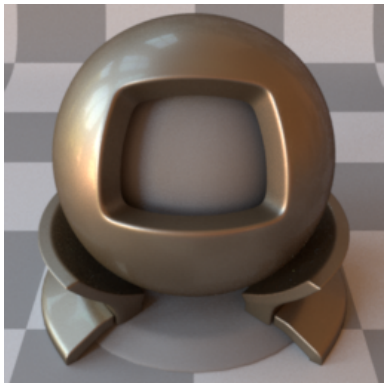


Ours: GGX

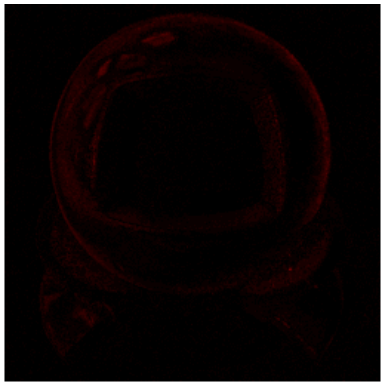
CIE dE00



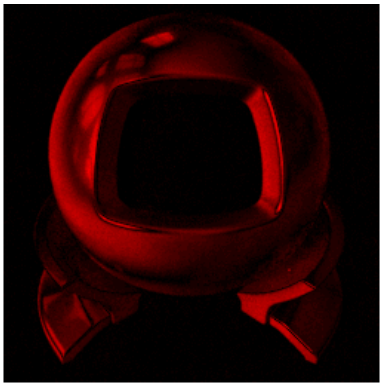
SGD



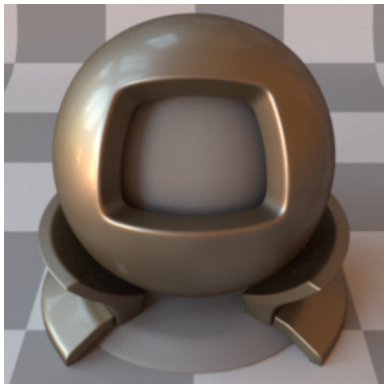
Reference



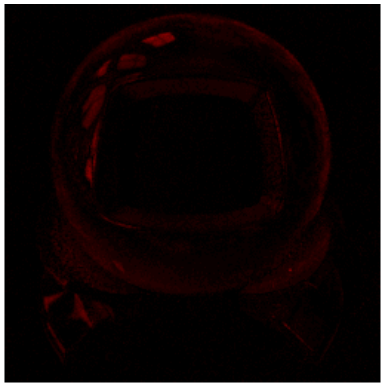
Ours: Tabulated



Ours: Gaussian

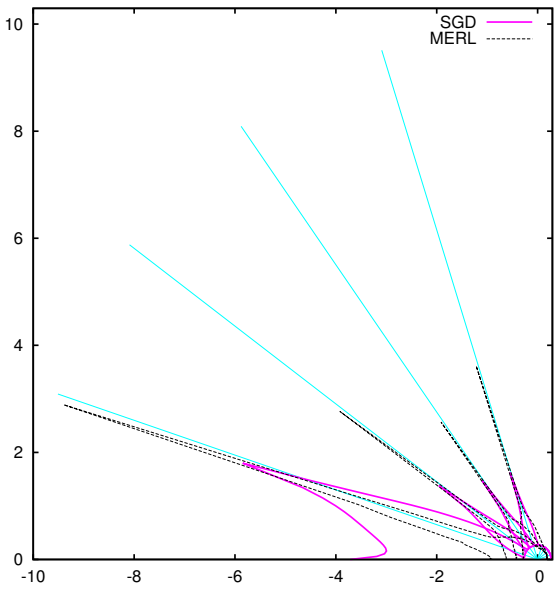


Reference

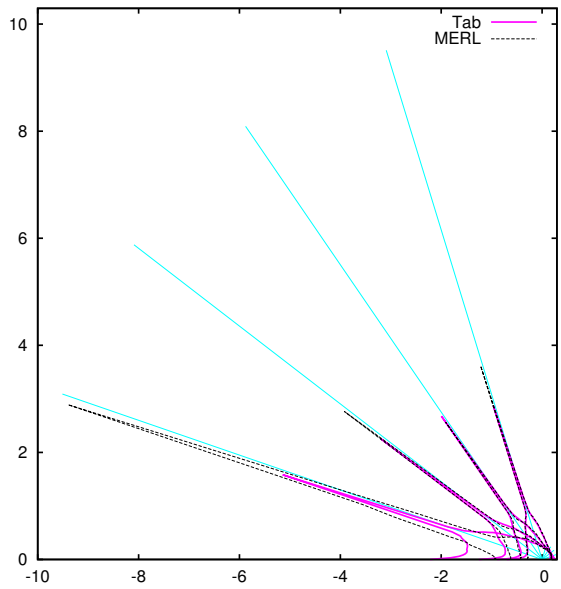


Ours: GGX

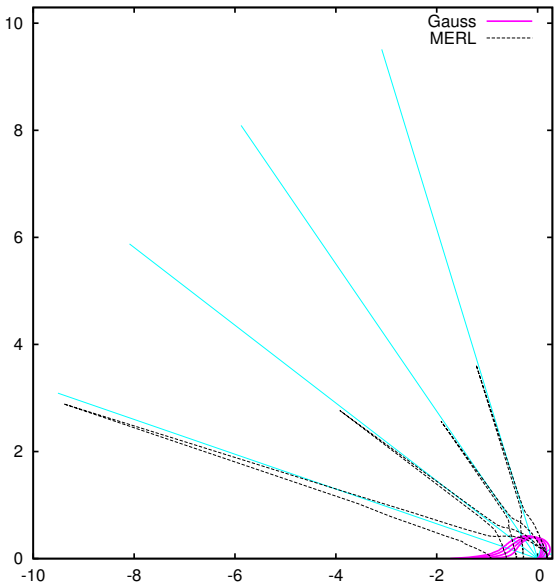
BRDF Lobes in the Incidence Plane (Cubic Root Applied)



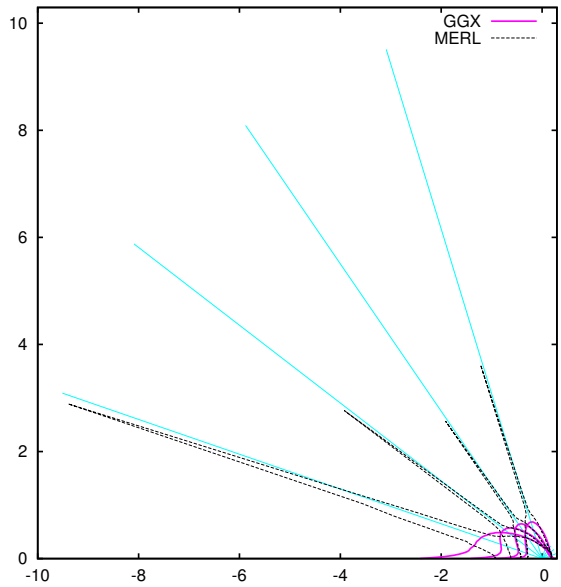
SGD



Ours: Tabulated

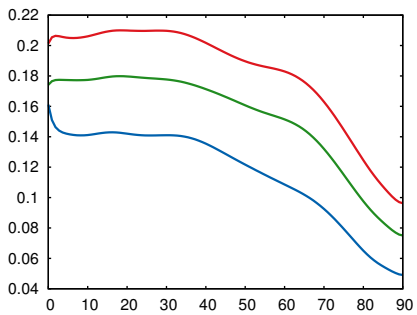


Ours: Gaussian

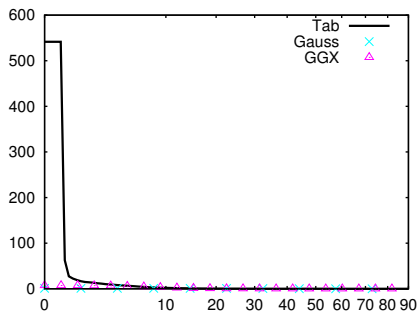


Ours: GGX

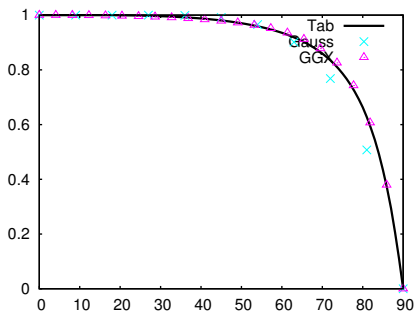
Fitted Microfacet Functions



Fresnel (R, G, B)



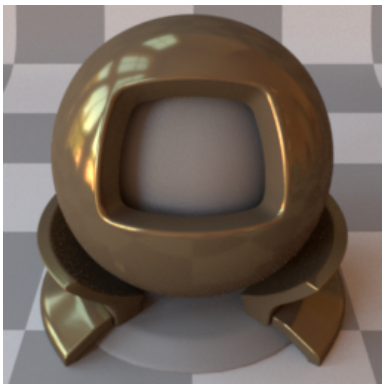
NDF (D)



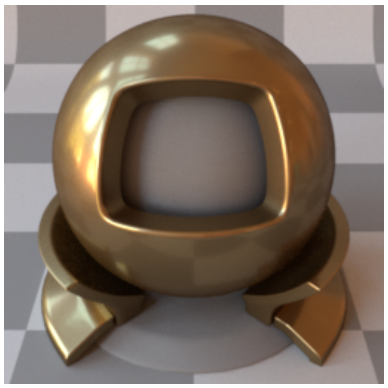
Smith (G_1)

31 gold-metallic-paint3

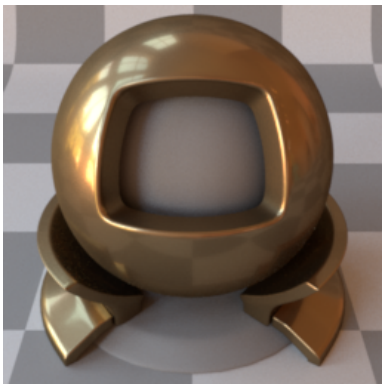
Renderings



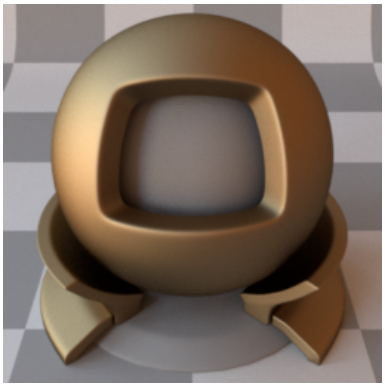
SGD



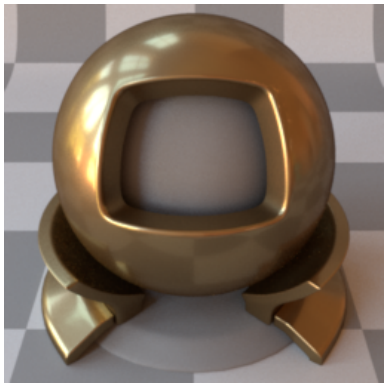
Reference



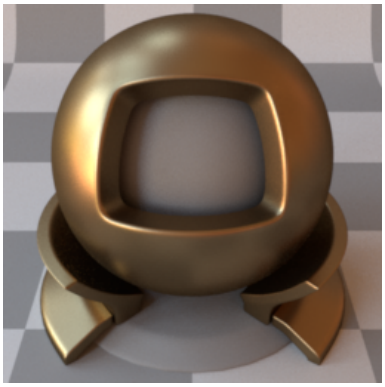
Ours: Tabulated



Ours: Gaussian

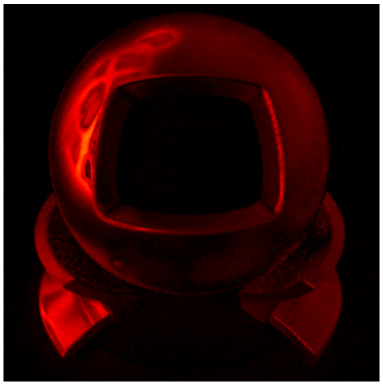


Reference

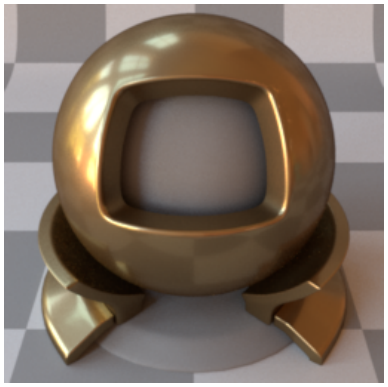


Ours: GGX

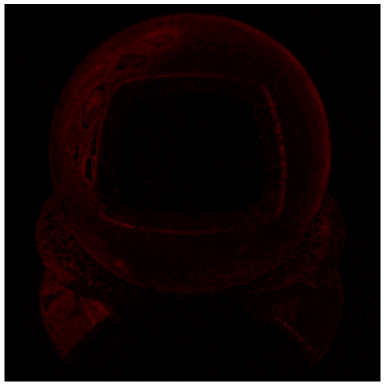
CIE dE00



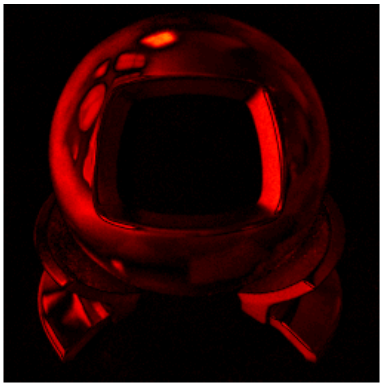
SGD



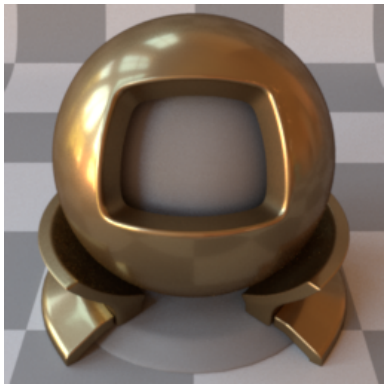
Reference



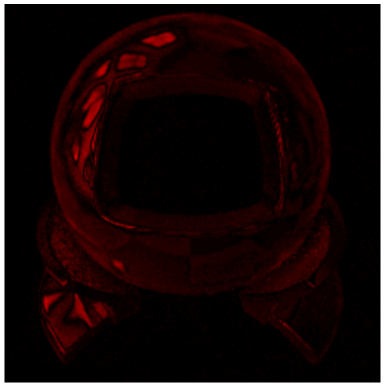
Ours: Tabulated



Ours: Gaussian

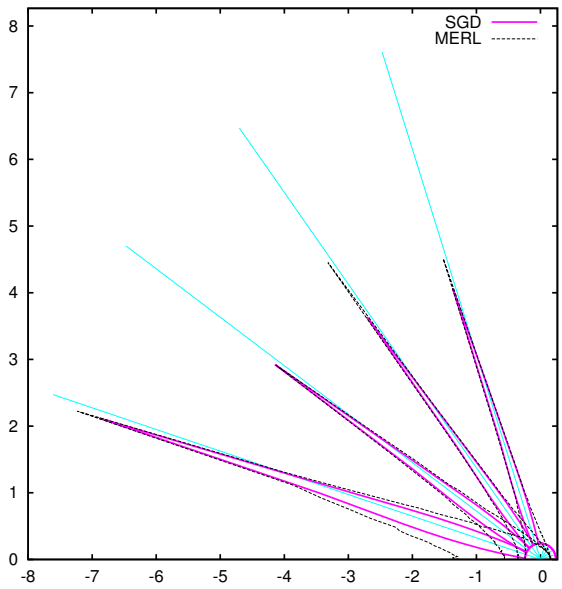


Reference

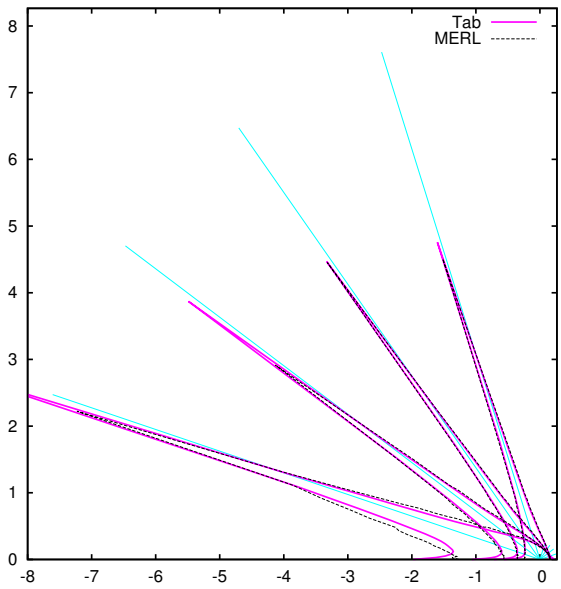


Ours: GGX

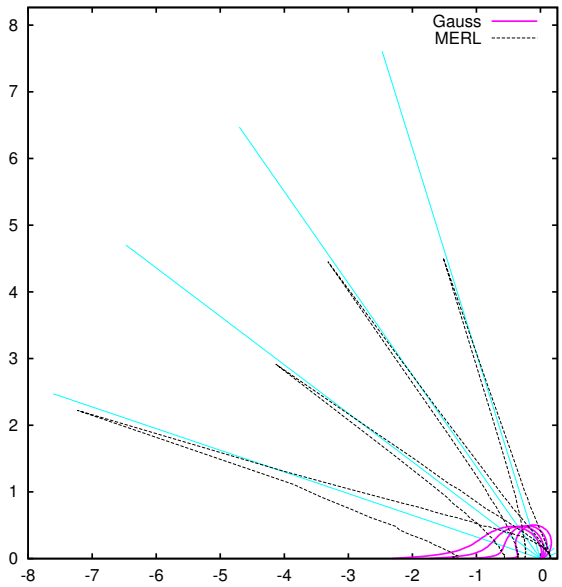
BRDF Lobes in the Incidence Plane (Cubic Root Applied)



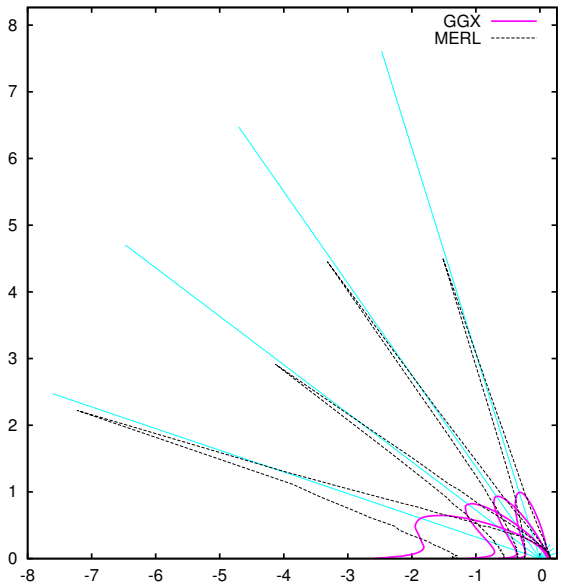
SGD



Ours: Tabulated

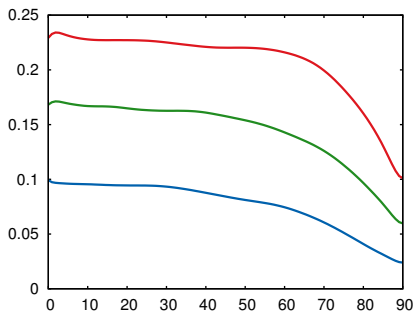


Ours: Gaussian

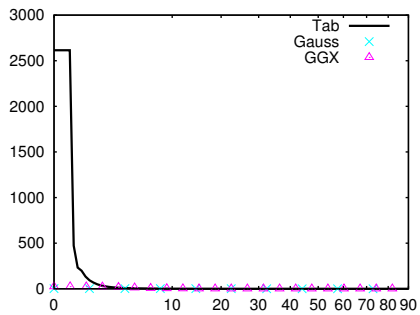


Ours: GGX

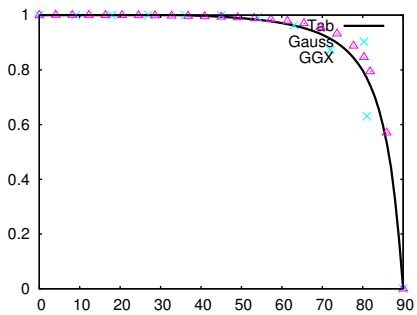
Fitted Microfacet Functions



Fresnel (R, G, B)



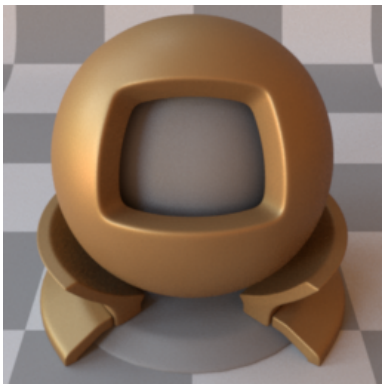
NDF (D)



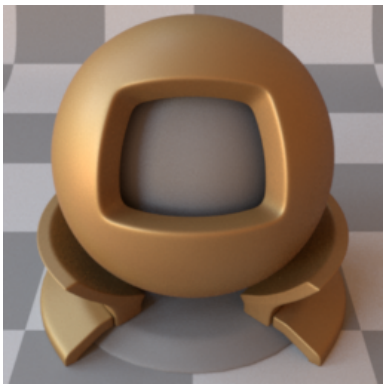
Smith (G_1)

32 gold-paint

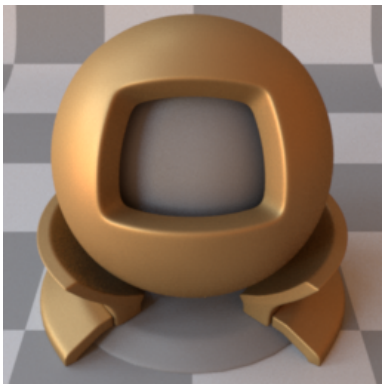
Renderings



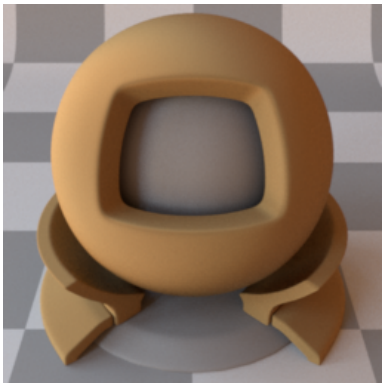
SGD



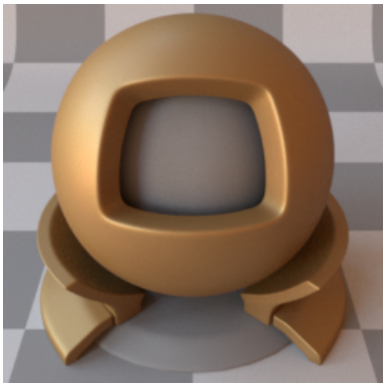
Reference



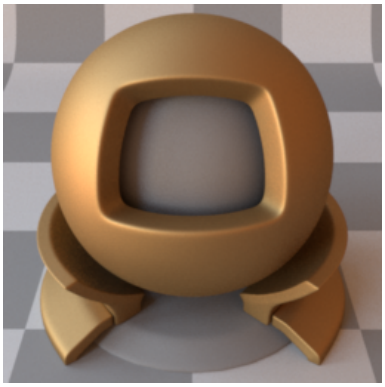
Ours: Tabulated



Ours: Gaussian

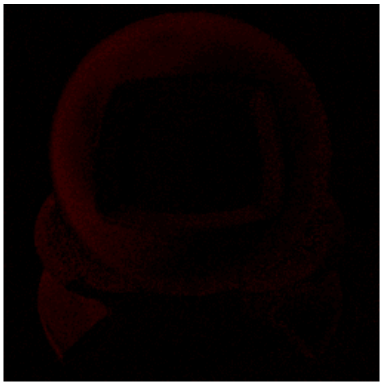


Reference

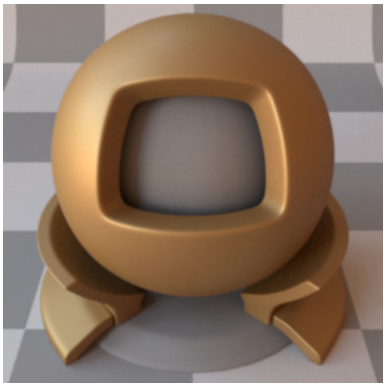


Ours: GGX

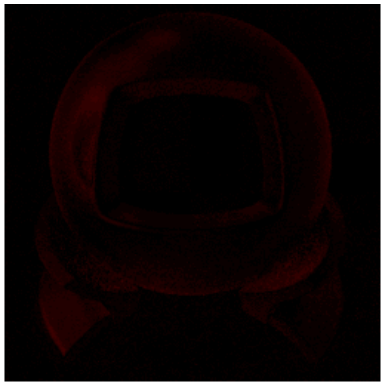
CIE dE00



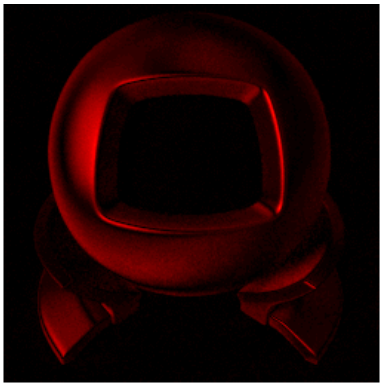
SGD



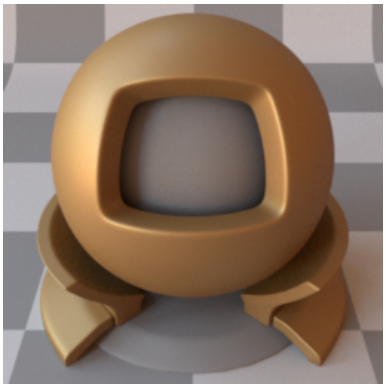
Reference



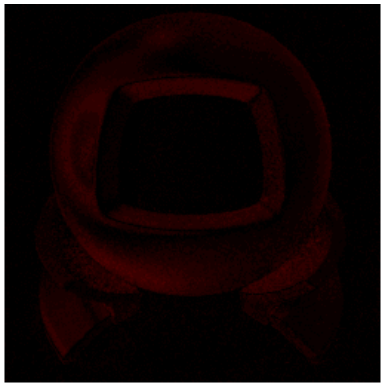
Ours: Tabulated



Ours: Gaussian

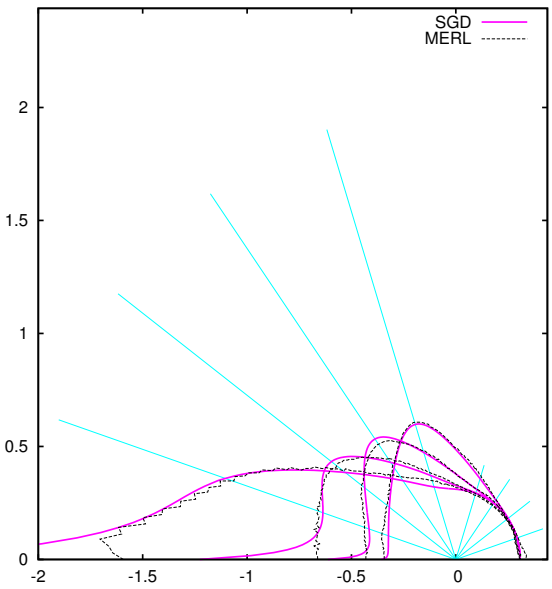


Reference

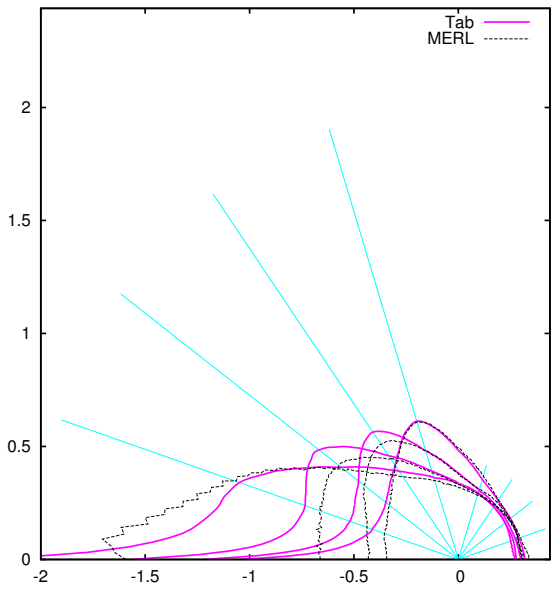


Ours: GGX

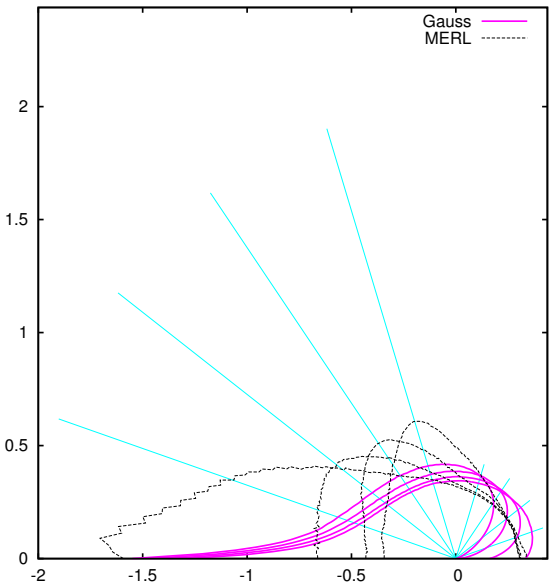
BRDF Lobes in the Incidence Plane (Cubic Root Applied)



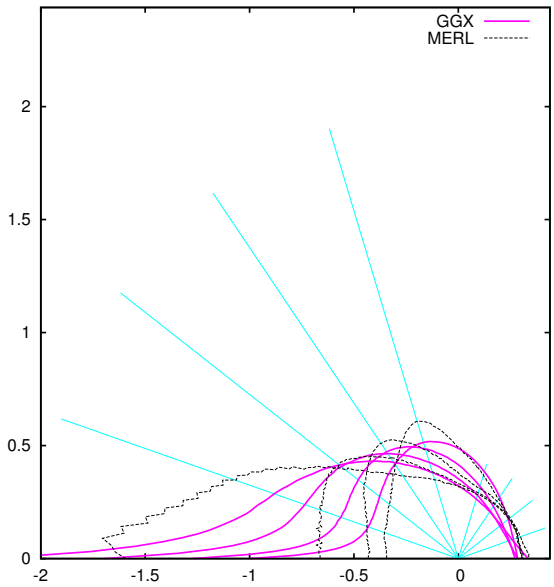
SGD



Ours: Tabulated

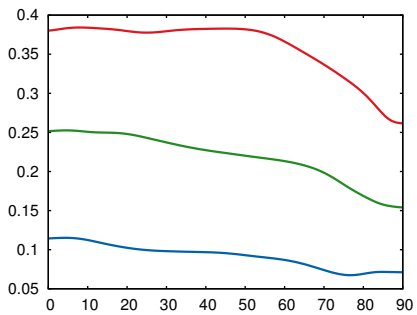


Ours: Gaussian

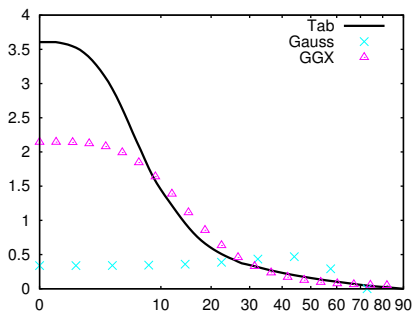


Ours: GGX

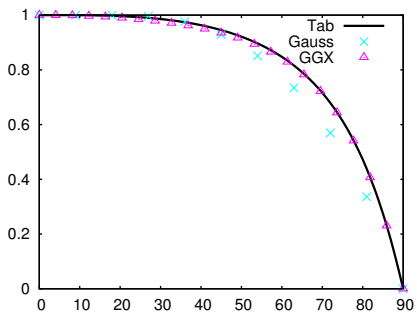
Fitted Microfacet Functions



Fresnel (R, G, B)



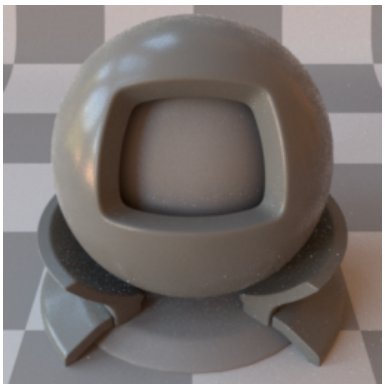
NDF (D)



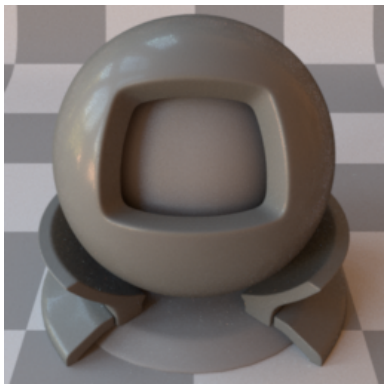
Smith (G_1)

33 gray-plastic

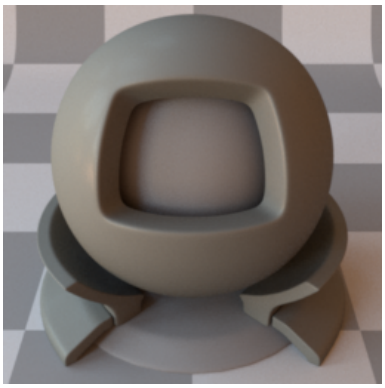
Renderings



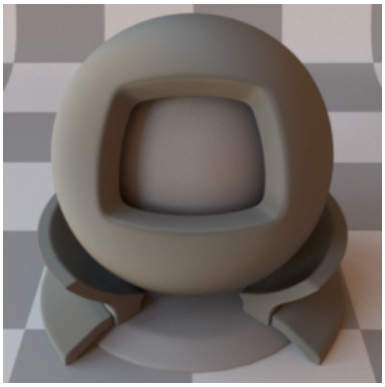
SGD



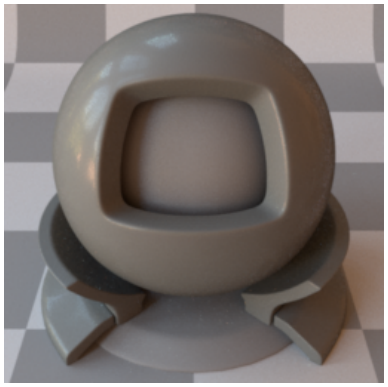
Reference



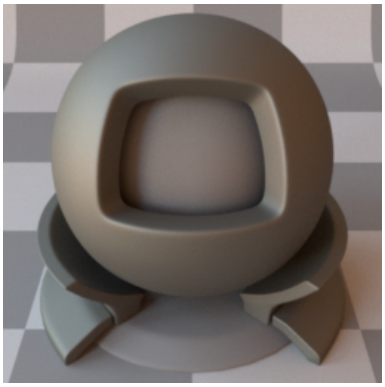
Ours: Tabulated



Ours: Gaussian

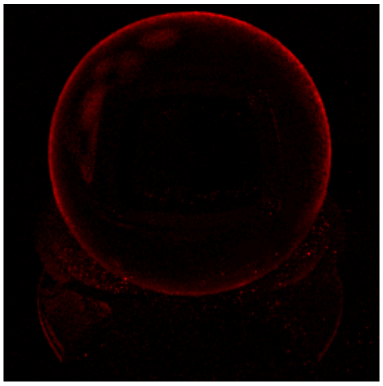


Reference

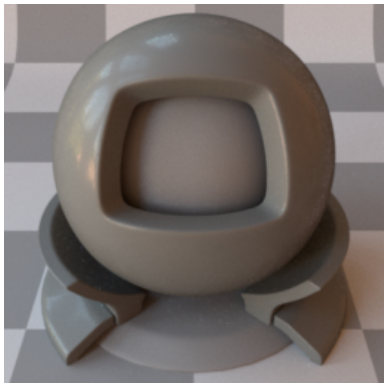


Ours: GGX

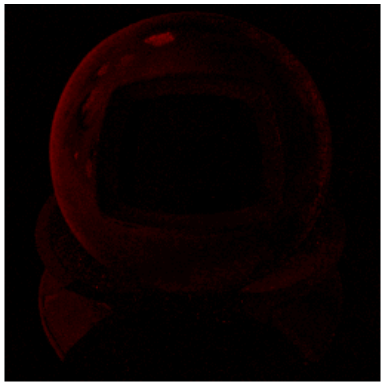
CIE dE00



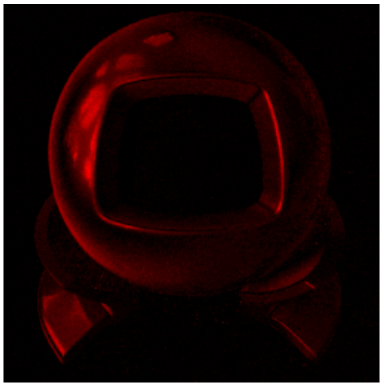
SGD



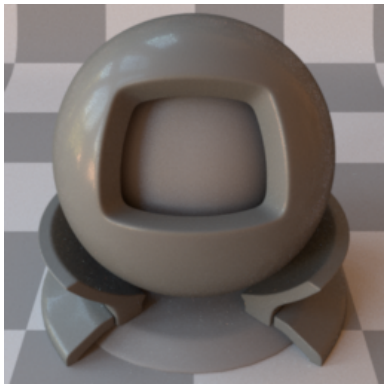
Reference



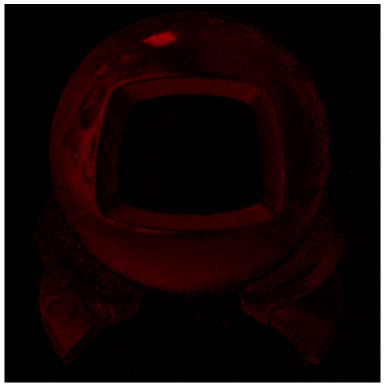
Ours: Tabulated



Ours: Gaussian

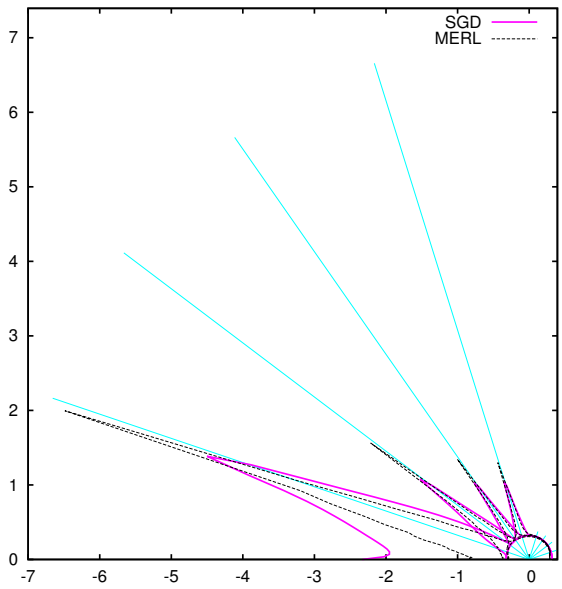


Reference

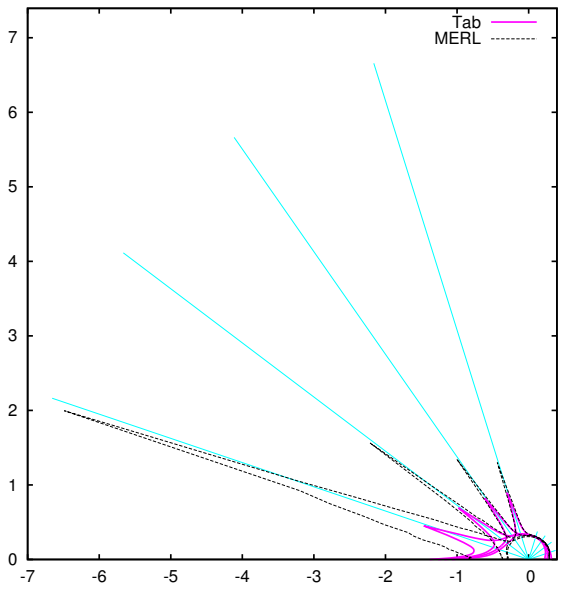


Ours: GGX

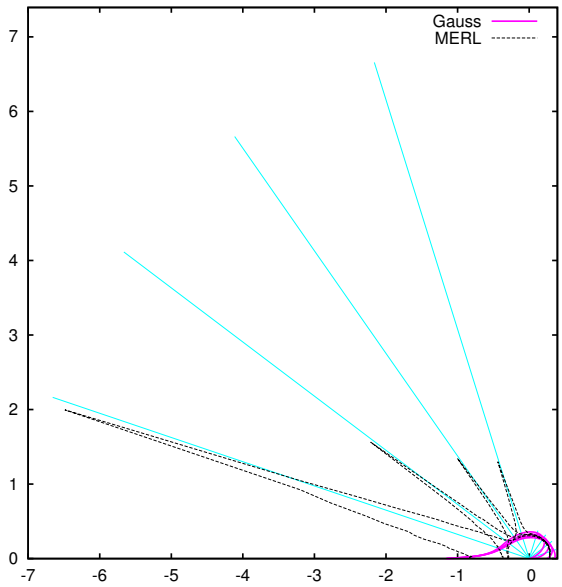
BRDF Lobes in the Incidence Plane (Cubic Root Applied)



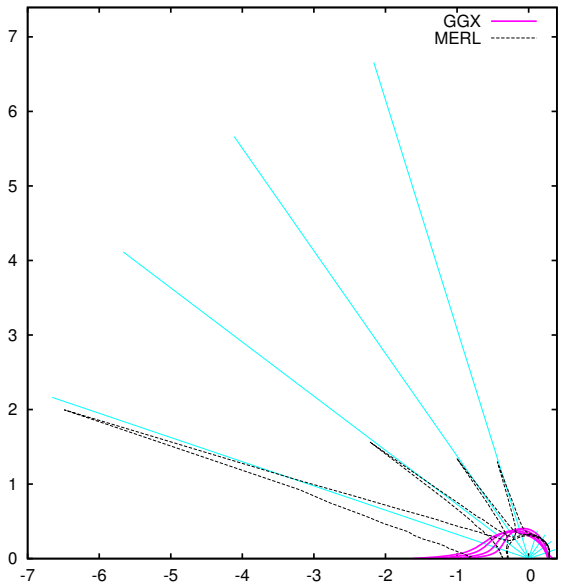
SGD



Ours: Tabulated

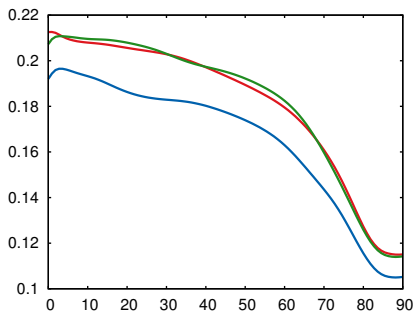


Ours: Gaussian

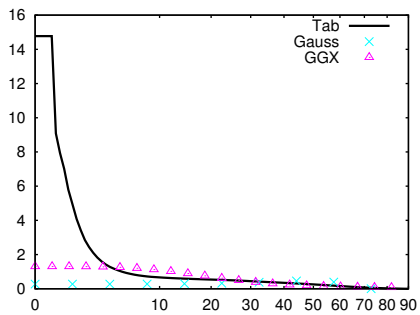


Ours: GGX

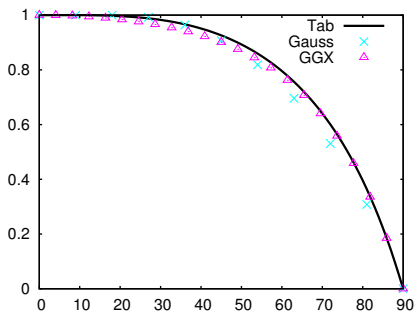
Fitted Microfacet Functions



Fresnel (R, G, B)



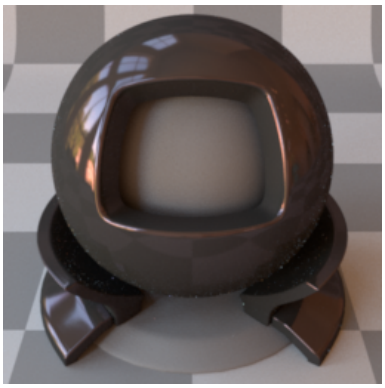
NDF (D)



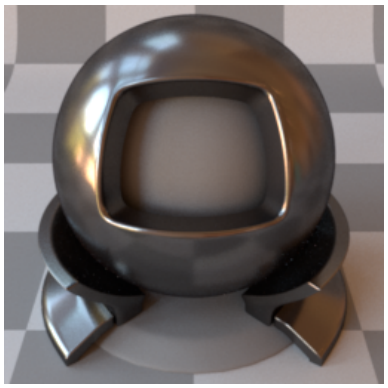
Smith (G_1)

34 grease-covered-steel

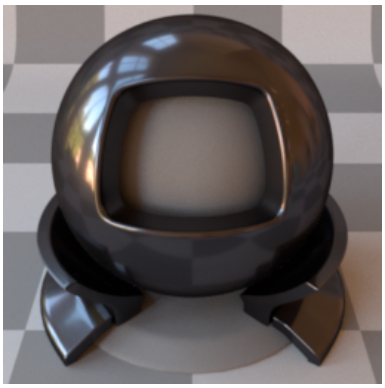
Renderings



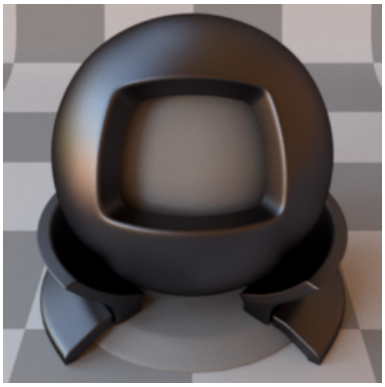
SGD



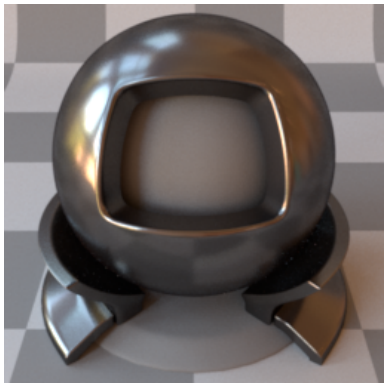
Reference



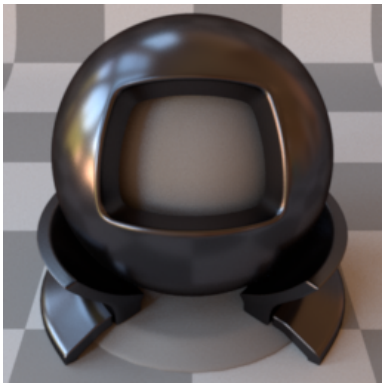
Ours: Tabulated



Ours: Gaussian

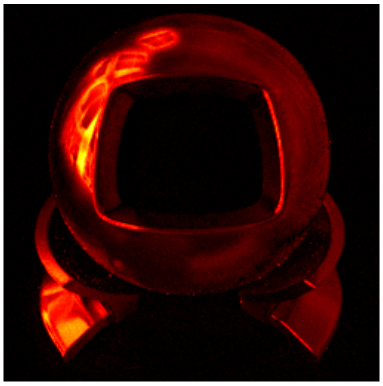


Reference

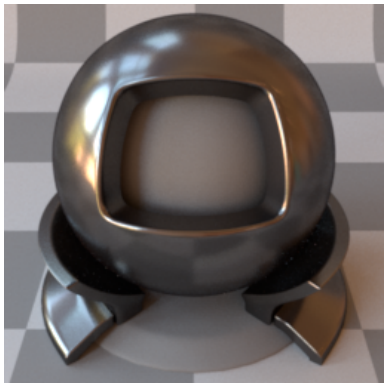


Ours: GGX

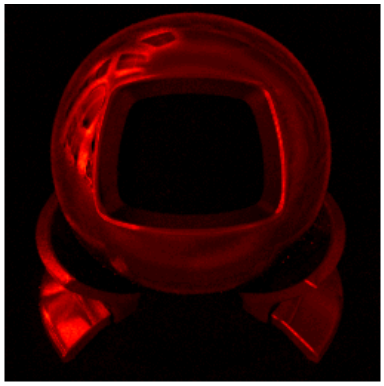
CIE dE00



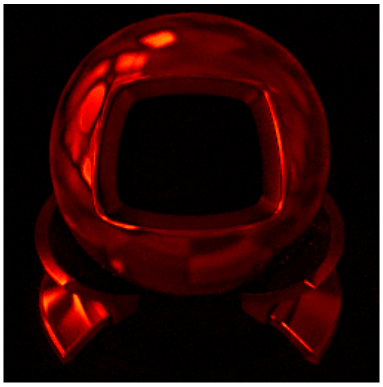
SGD



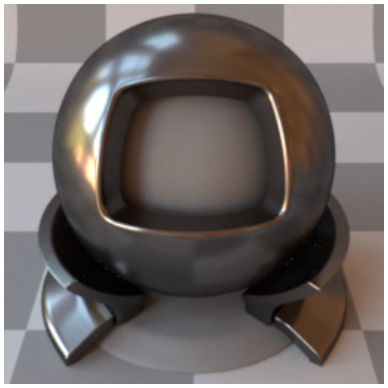
Reference



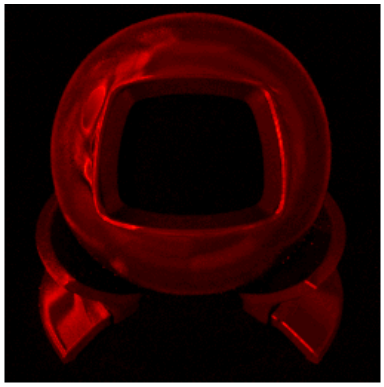
Ours: Tabulated



Ours: Gaussian

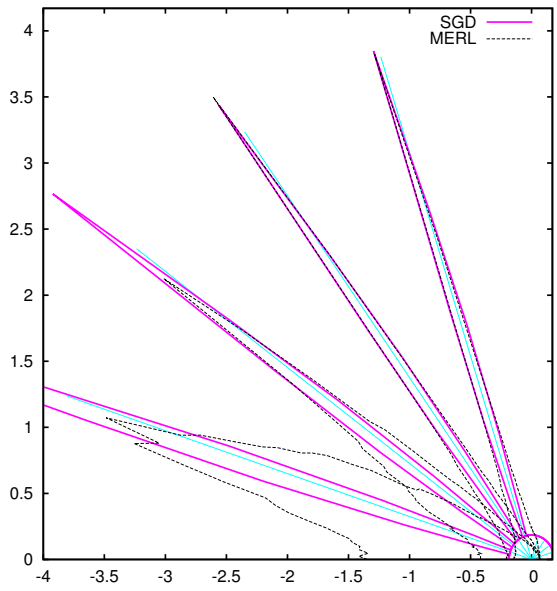


Reference

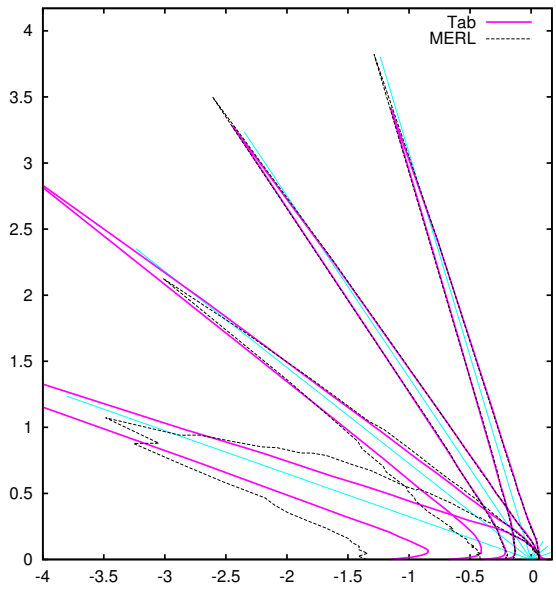


Ours: GGX

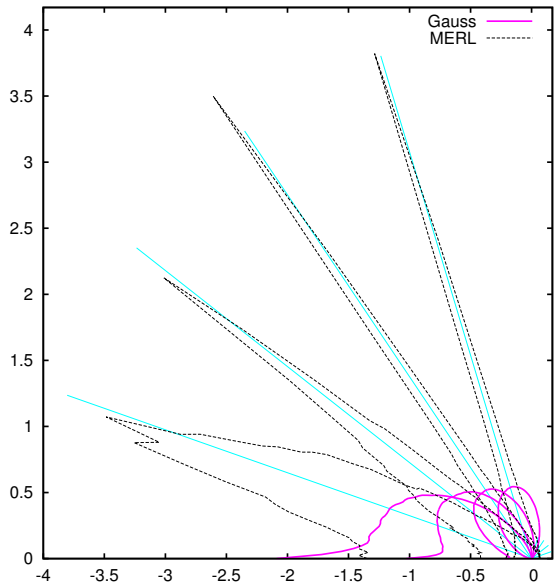
BRDF Lobes in the Incidence Plane (Cubic Root Applied)



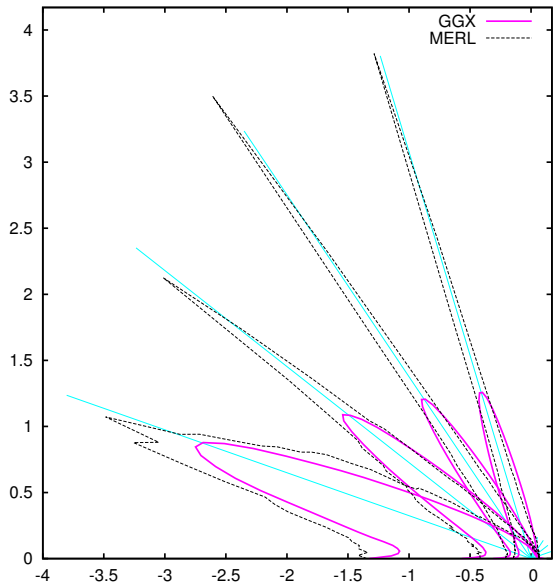
SGD



Ours: Tabulated

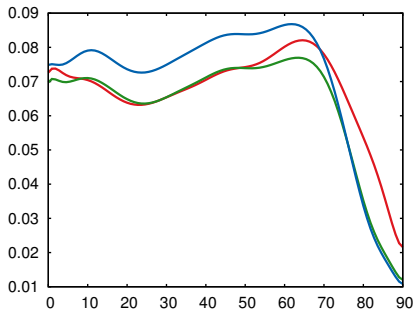


Ours: Gaussian

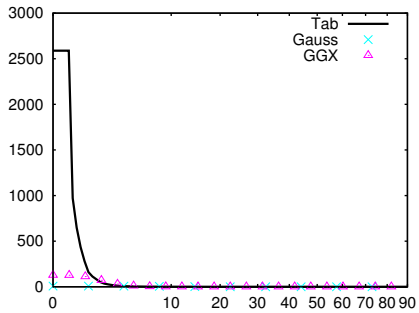


Ours: GGX

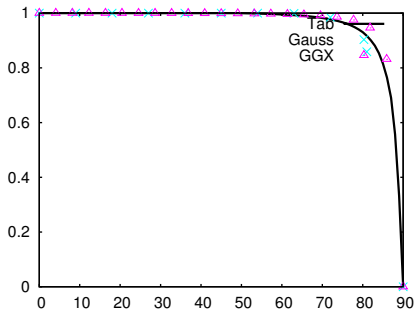
Fitted Microfacet Functions



Fresnel (R, G, B)



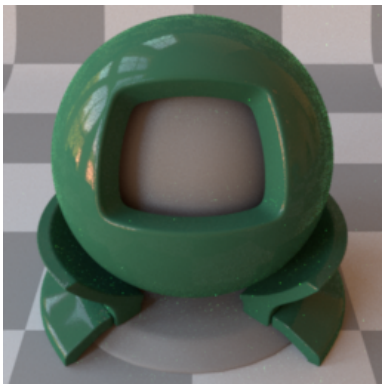
NDF (D)



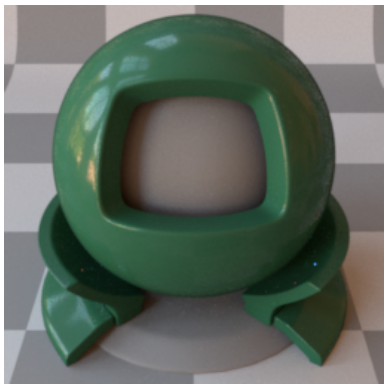
Smith (G_1)

35 green-acrylic

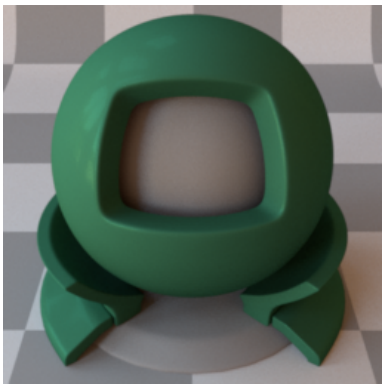
Renderings



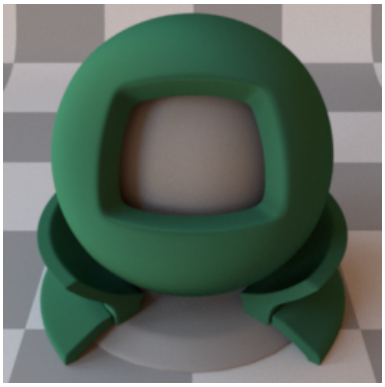
SGD



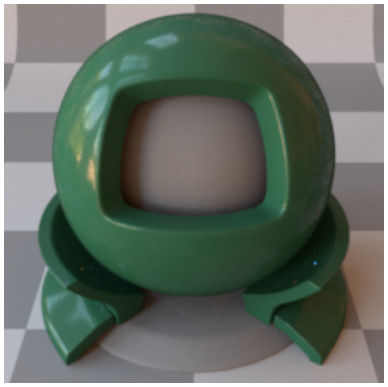
Reference



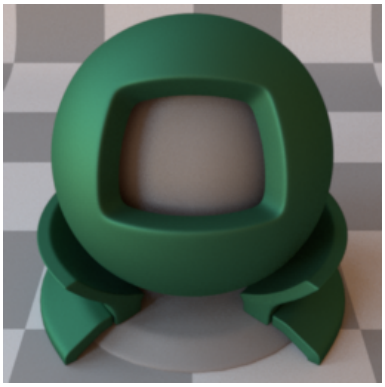
Ours: Tabulated



Ours: Gaussian

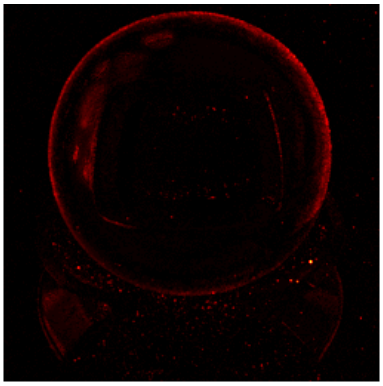


Reference

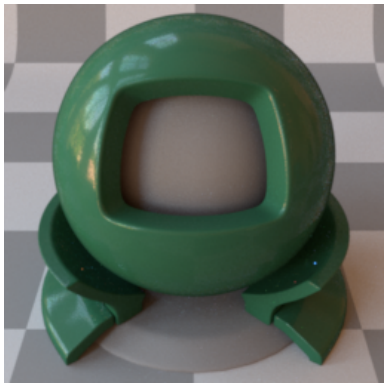


Ours: GGX

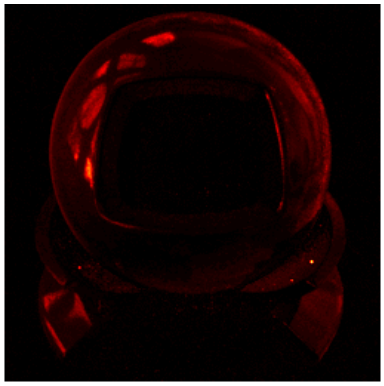
CIE dE00



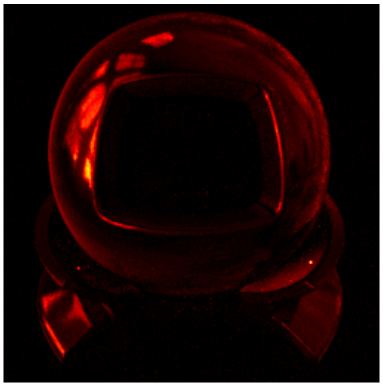
SGD



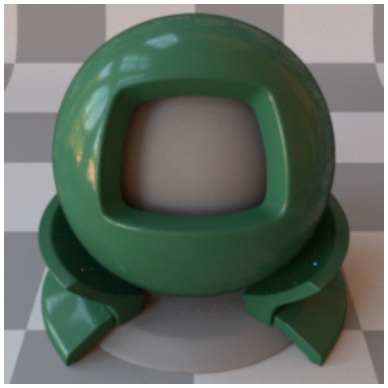
Reference



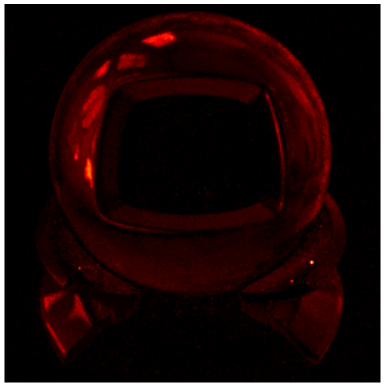
Ours: Tabulated



Ours: Gaussian

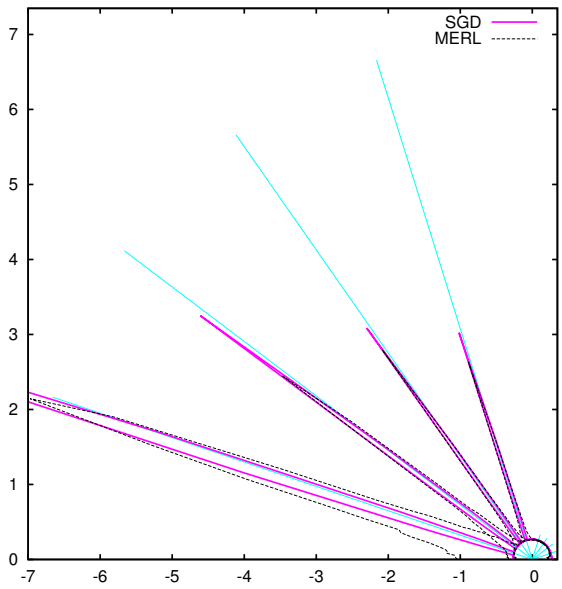


Reference

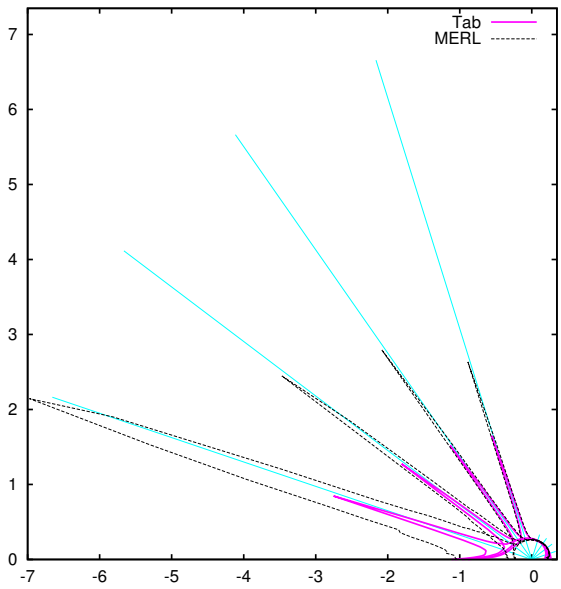


Ours: GGX

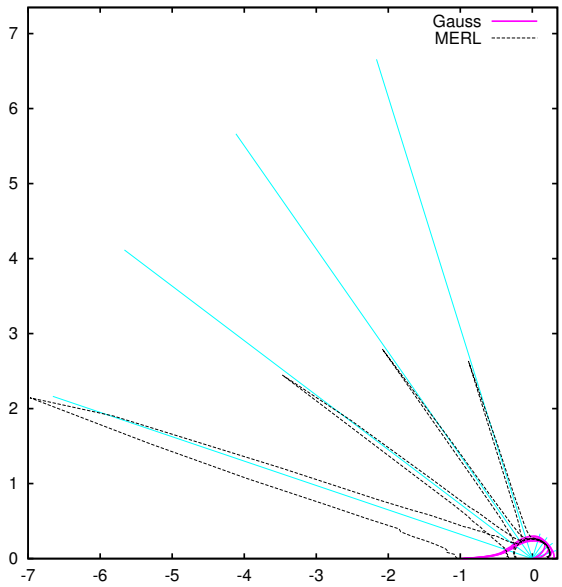
BRDF Lobes in the Incidence Plane (Cubic Root Applied)



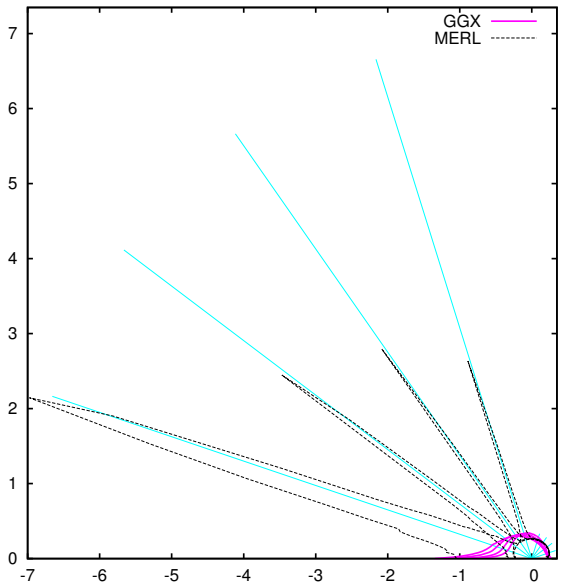
SGD



Ours: Tabulated

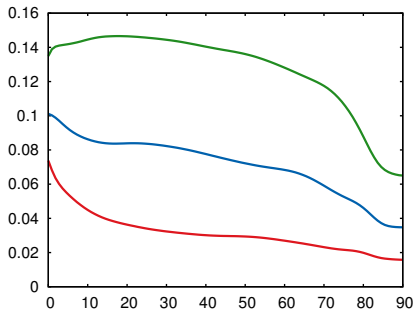


Ours: Gaussian

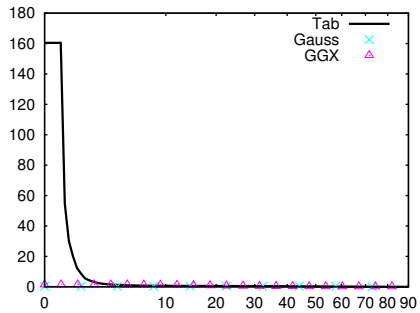


Ours: GGX

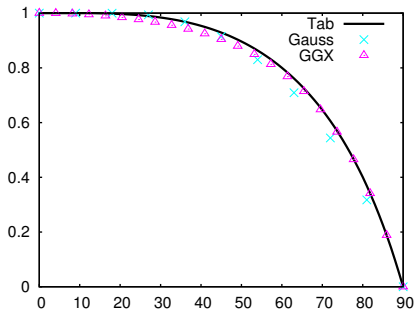
Fitted Microfacet Functions



Fresnel (R, G, B)



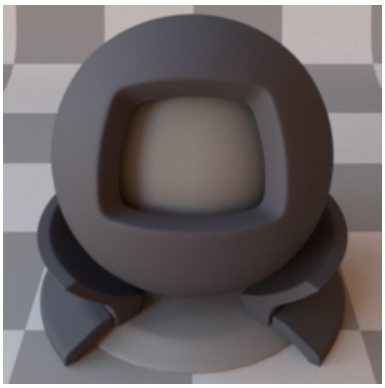
NDF (D)



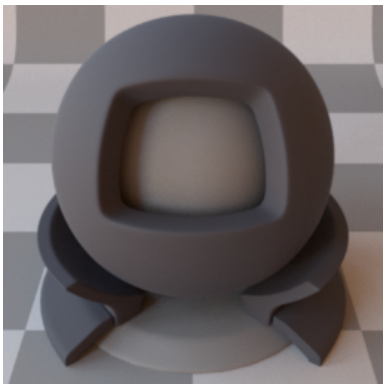
Smith (G_1)

36 green-fabric

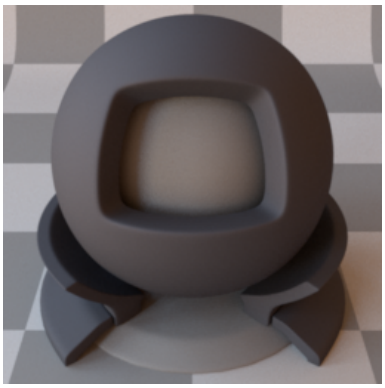
Renderings



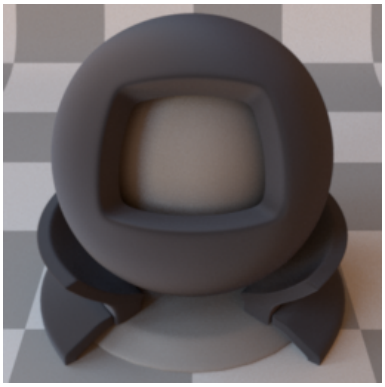
SGD



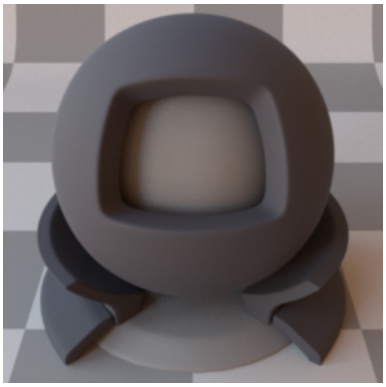
Reference



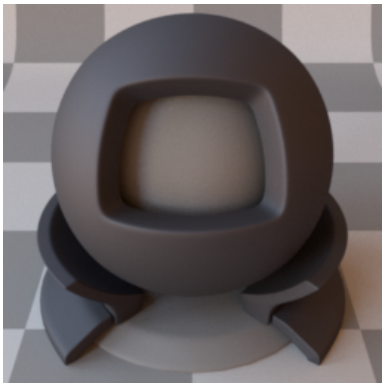
Ours: Tabulated



Ours: Gaussian

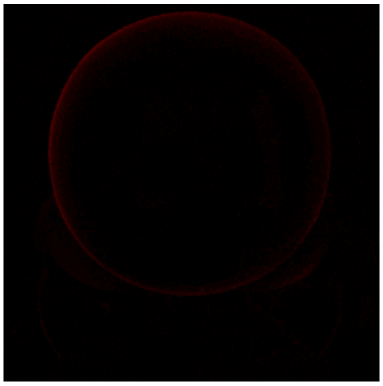


Reference

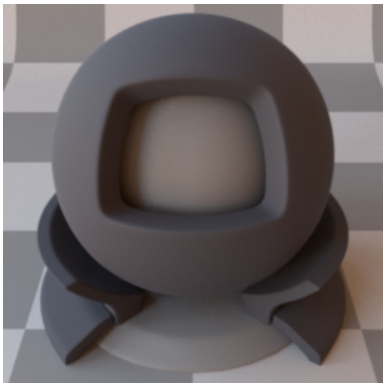


Ours: GGX

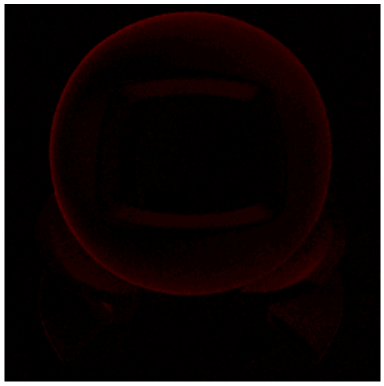
CIE dE00



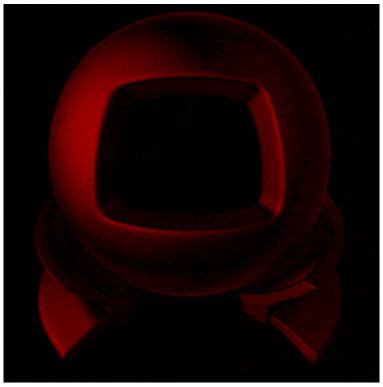
SGD



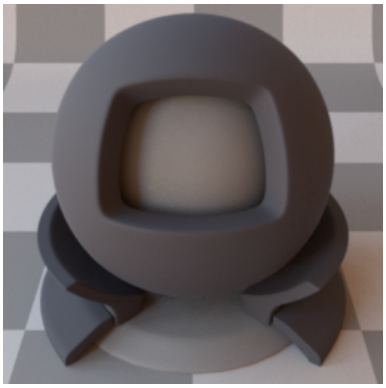
Reference



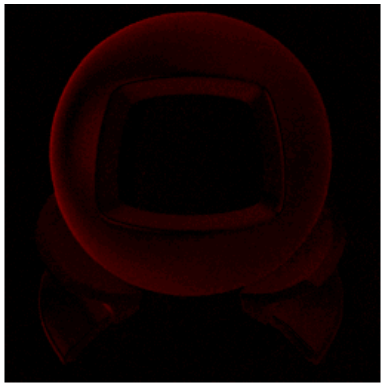
Ours: Tabulated



Ours: Gaussian

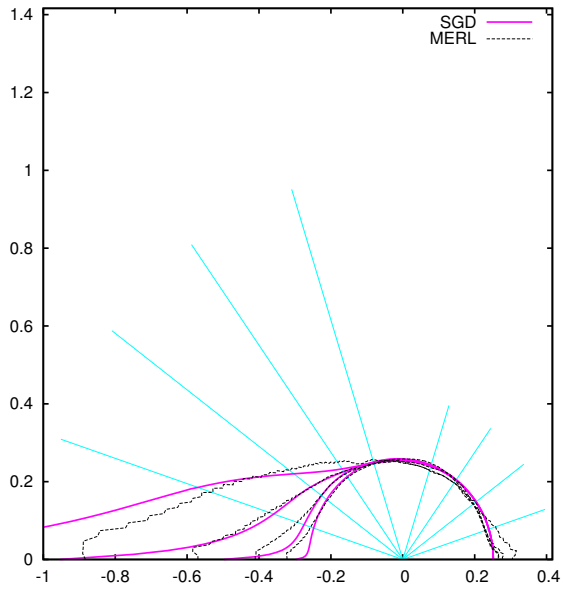


Reference

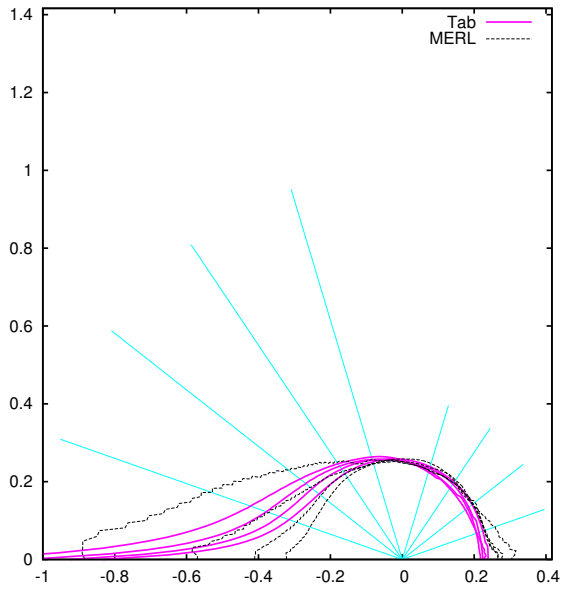


Ours: GGX

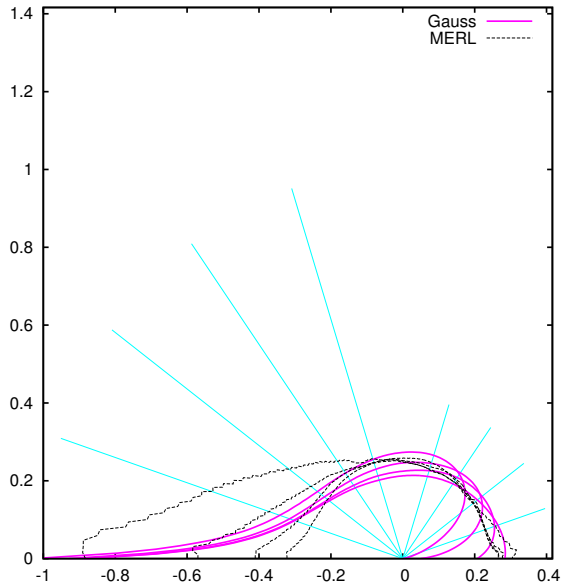
BRDF Lobes in the Incidence Plane (Cubic Root Applied)



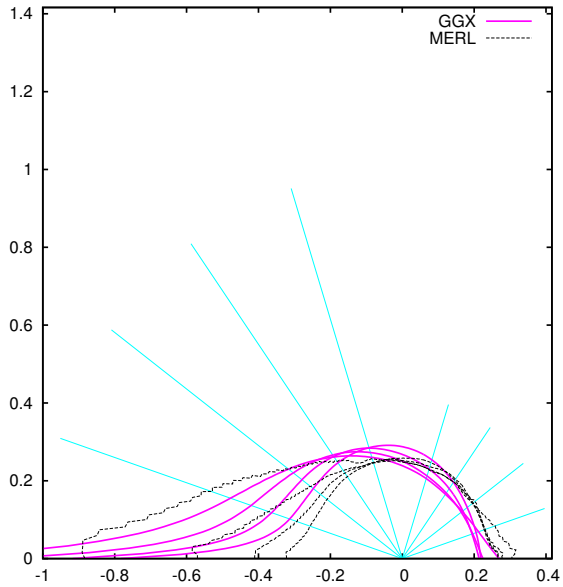
SGD



Ours: Tabulated

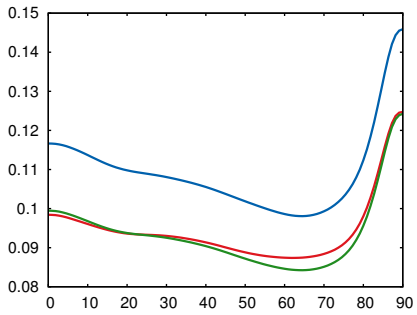


Ours: Gaussian

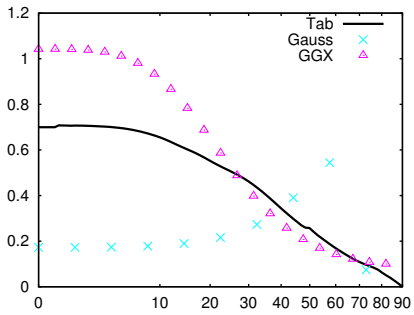


Ours: GGX

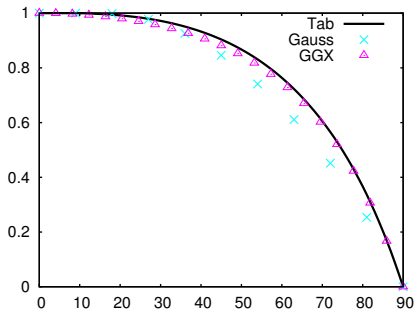
Fitted Microfacet Functions



Fresnel (R, G, B)



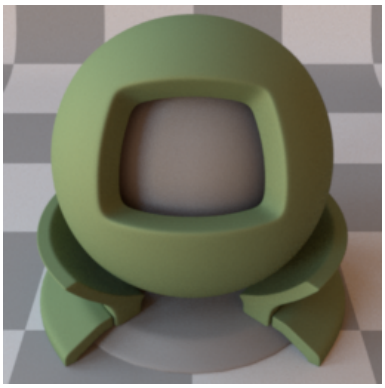
NDF (D)



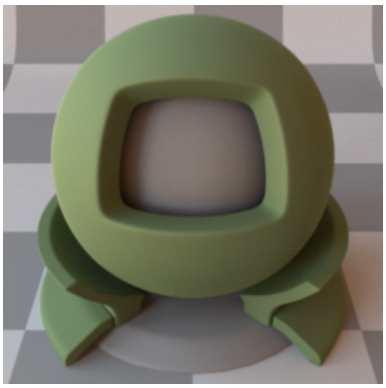
Smith (G_1)

37 green-latex

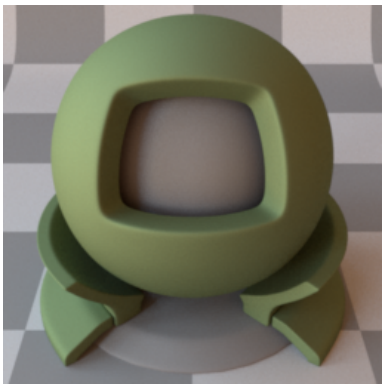
Renderings



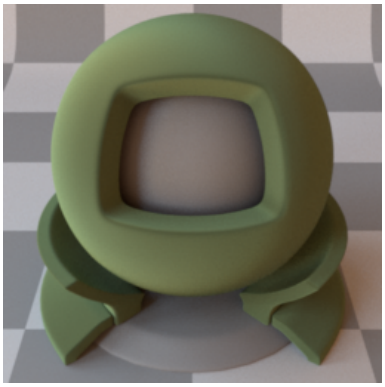
SGD



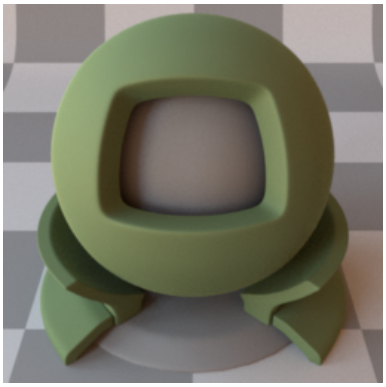
Reference



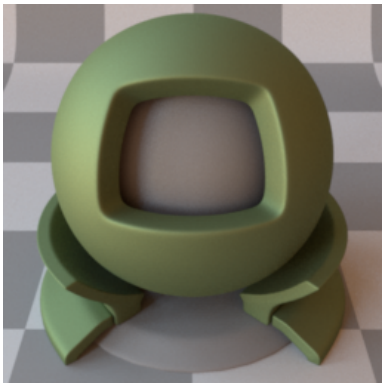
Ours: Tabulated



Ours: Gaussian

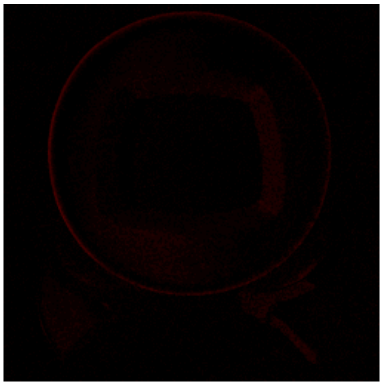


Reference

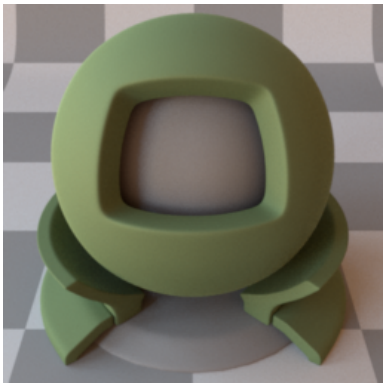


Ours: GGX

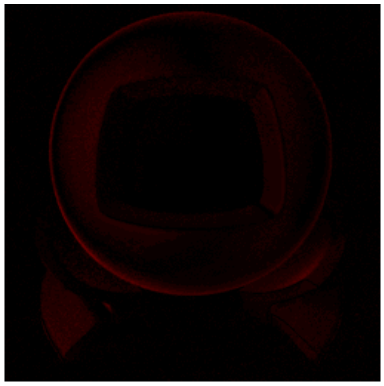
CIE dE00



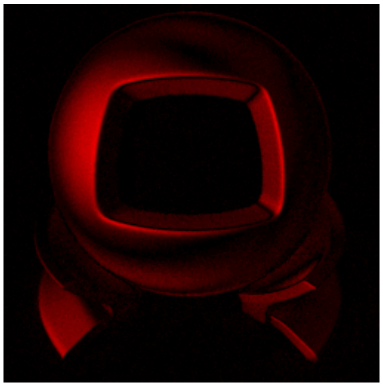
SGD



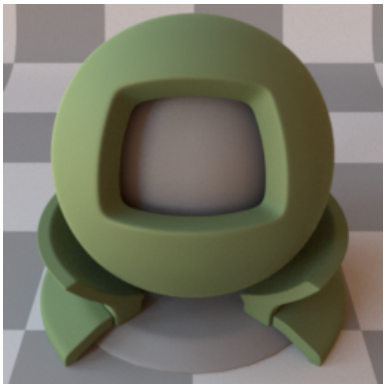
Reference



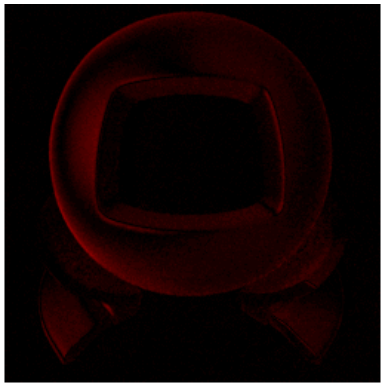
Ours: Tabulated



Ours: Gaussian

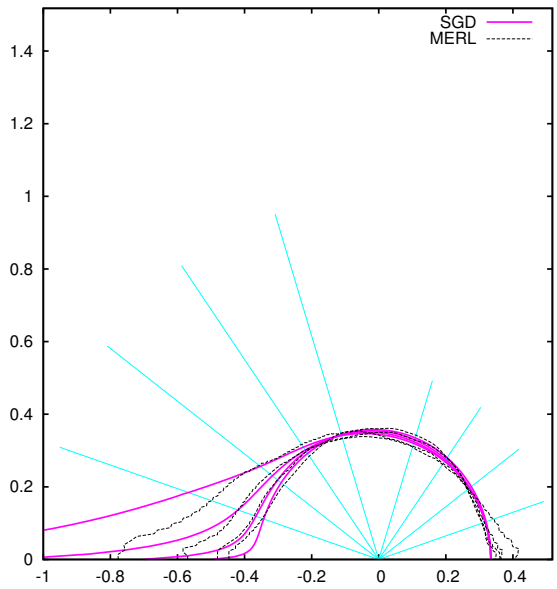


Reference

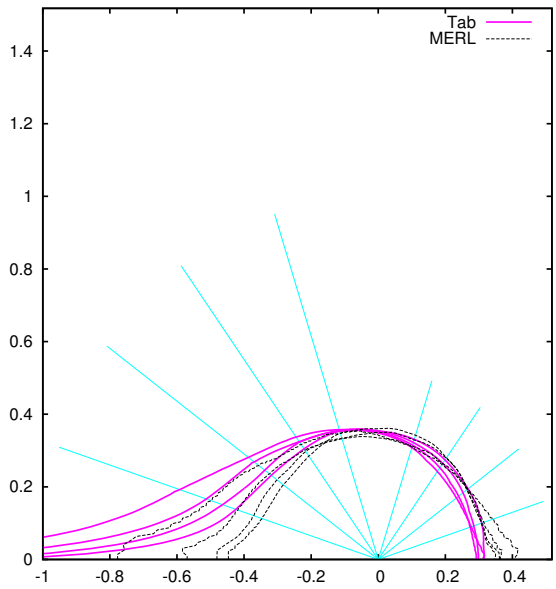


Ours: GGX

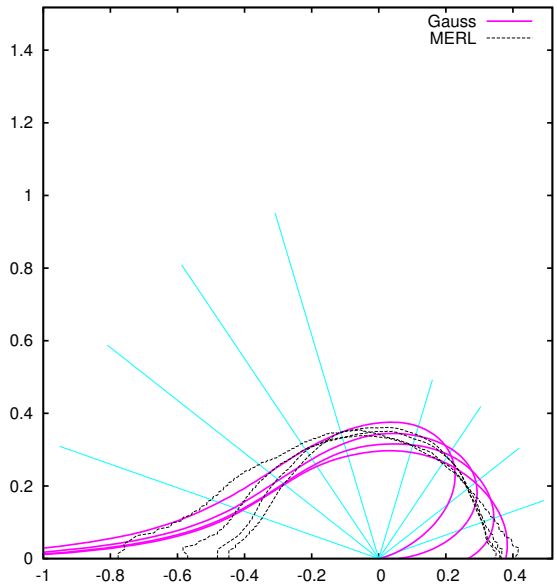
BRDF Lobes in the Incidence Plane (Cubic Root Applied)



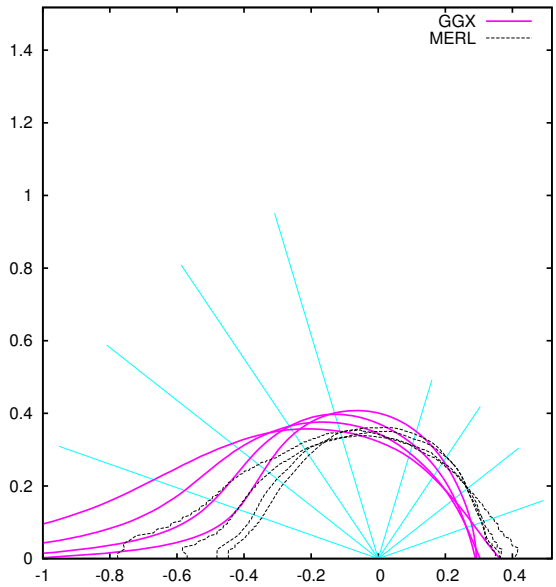
SGD



Ours: Tabulated

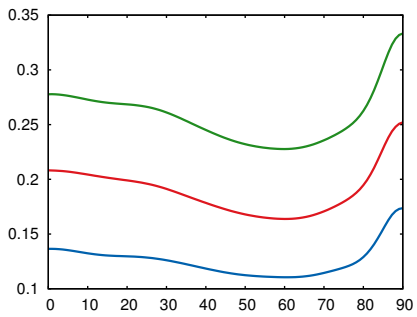


Ours: Gaussian

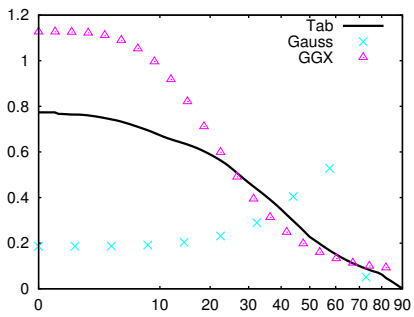


Ours: GGX

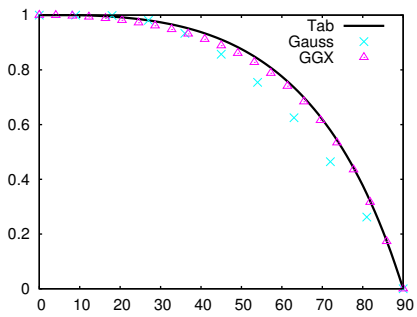
Fitted Microfacet Functions



Fresnel (R, G, B)



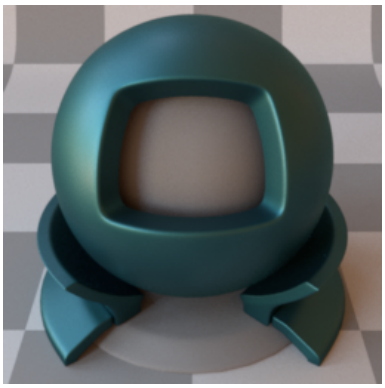
NDF (D)



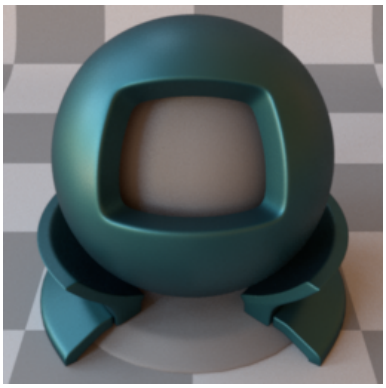
Smith (G_1)

38 green-metallic-paint

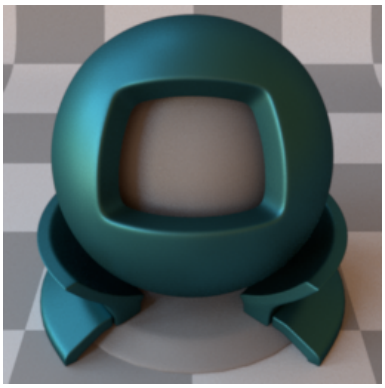
Renderings



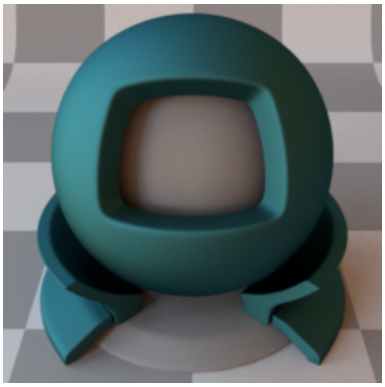
SGD



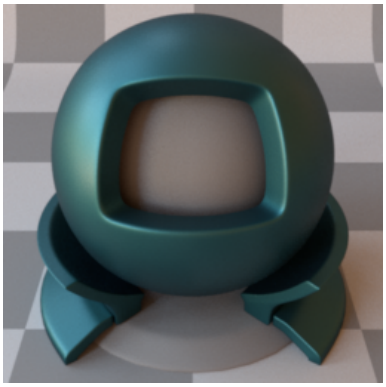
Reference



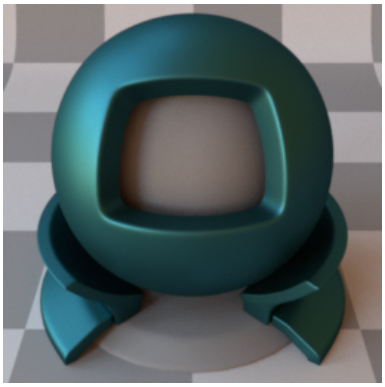
Ours: Tabulated



Ours: Gaussian

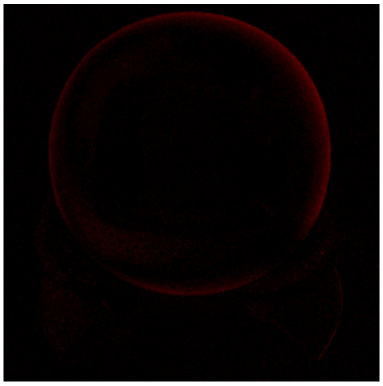


Reference

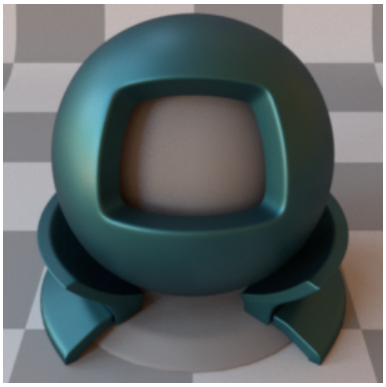


Ours: GGX

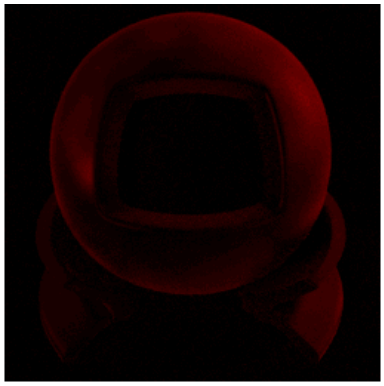
CIE dE00



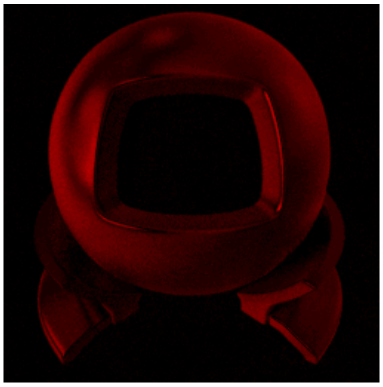
SGD



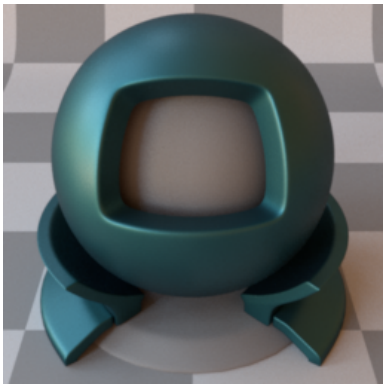
Reference



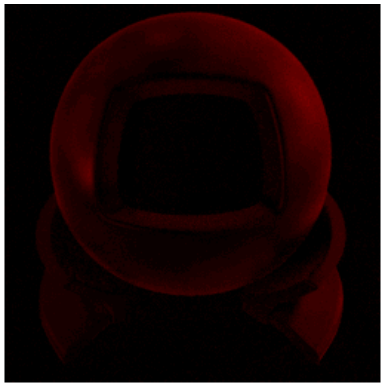
Ours: Tabulated



Ours: Gaussian

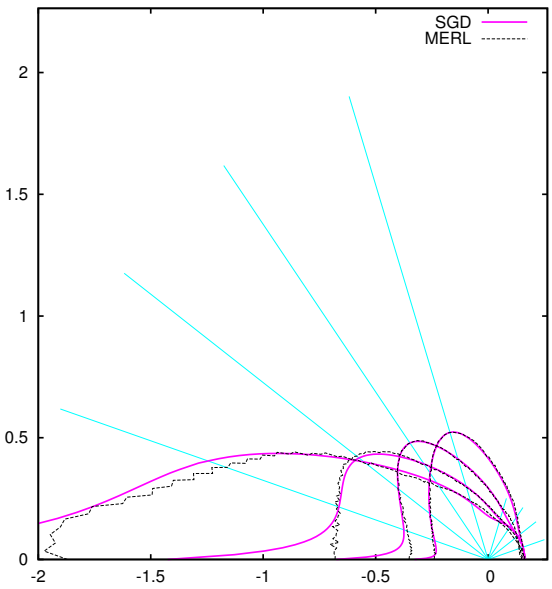


Reference

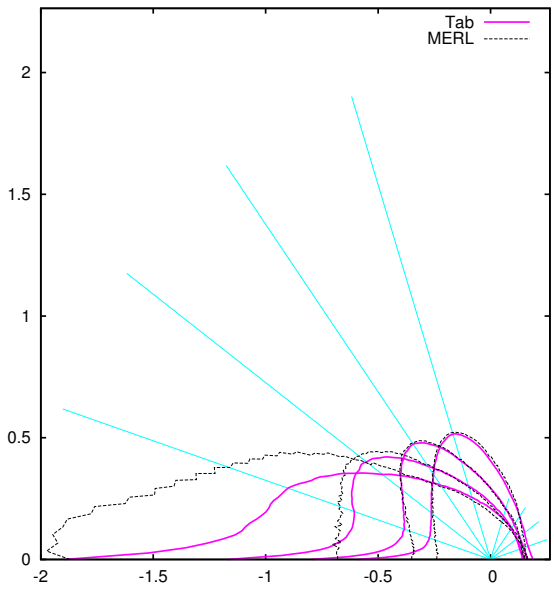


Ours: GGX

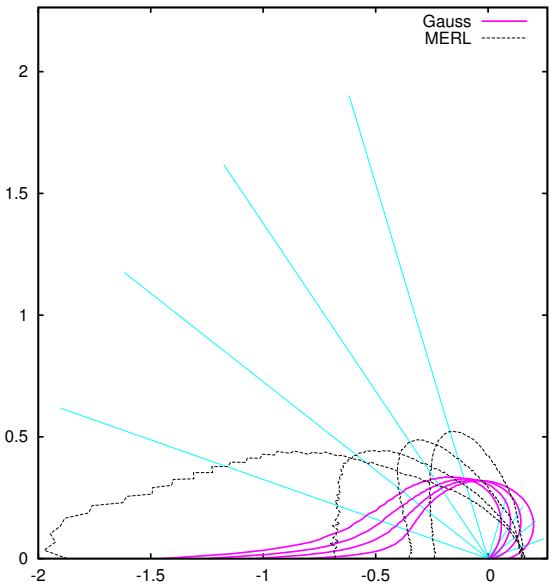
BRDF Lobes in the Incidence Plane (Cubic Root Applied)



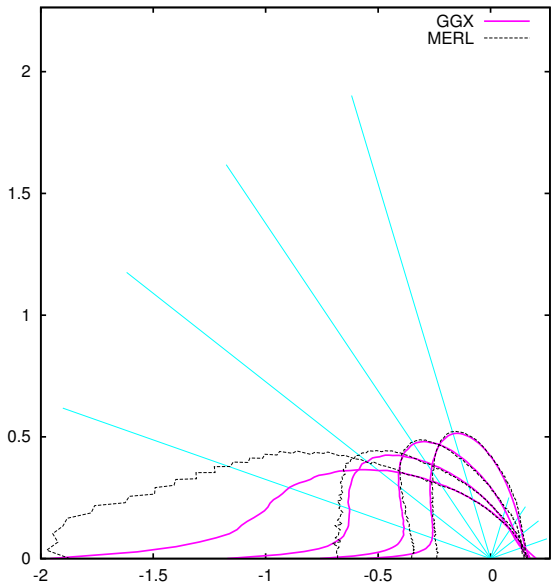
SGD



Ours: Tabulated

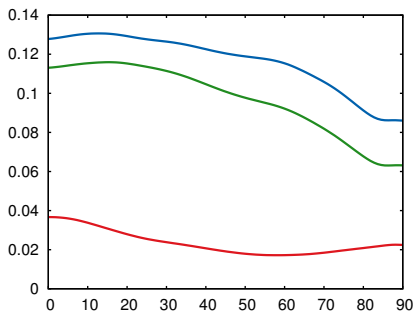


Ours: Gaussian

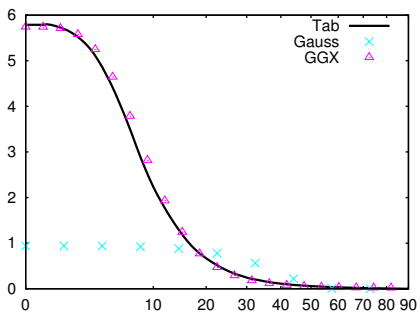


Ours: GGX

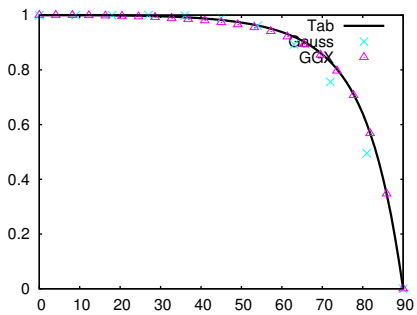
Fitted Microfacet Functions



Fresnel (R, G, B)



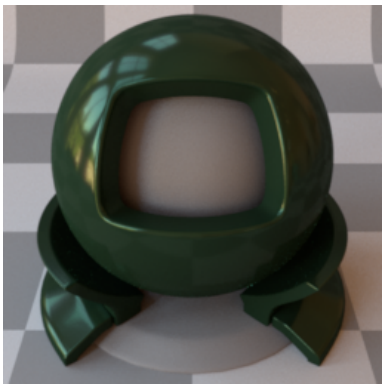
NDF (D)



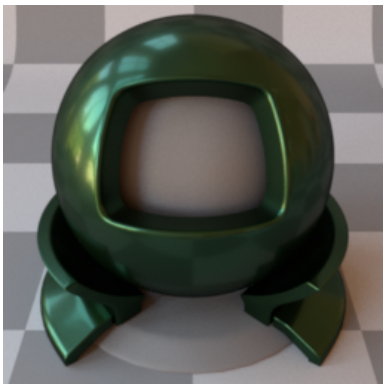
Smith (G_1)

39 green-metallic-paint2

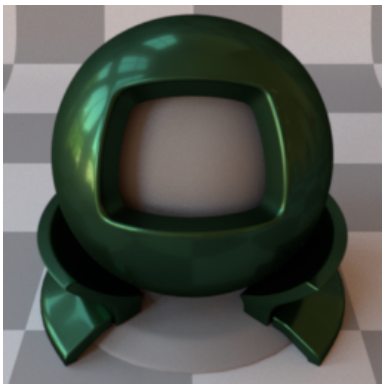
Renderings



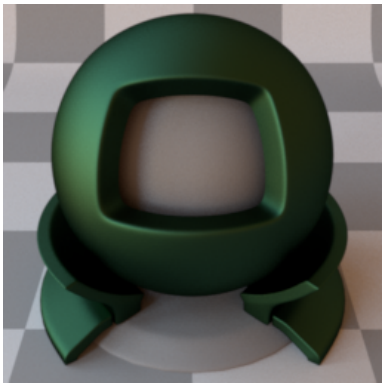
SGD



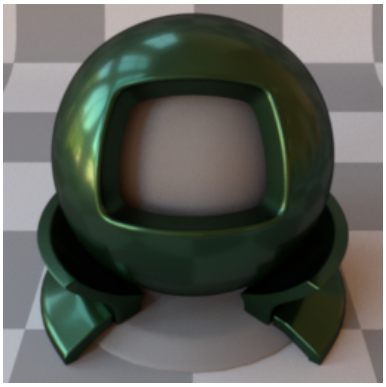
Reference



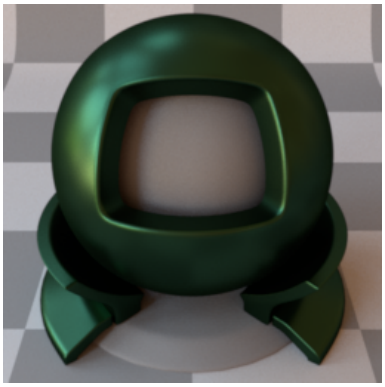
Ours: Tabulated



Ours: Gaussian

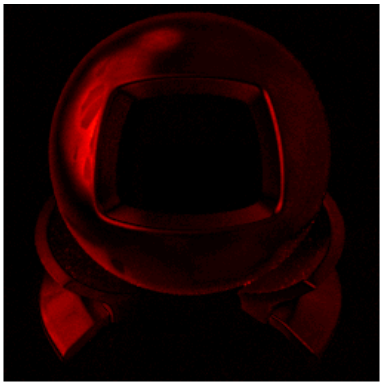


Reference

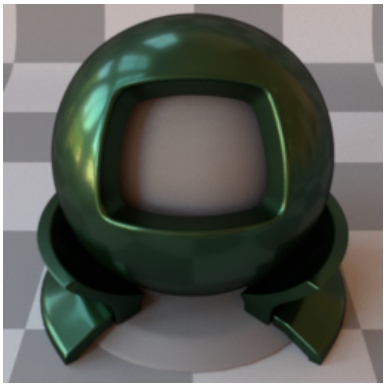


Ours: GGX

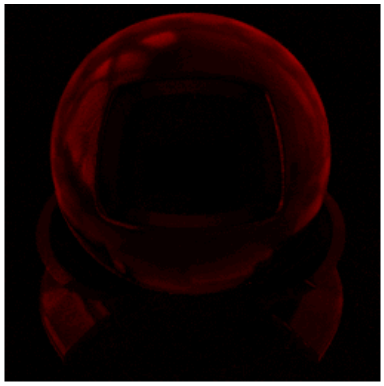
CIE dE00



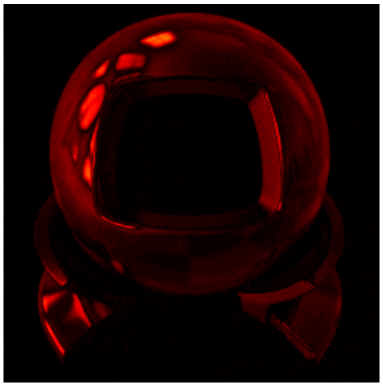
SGD



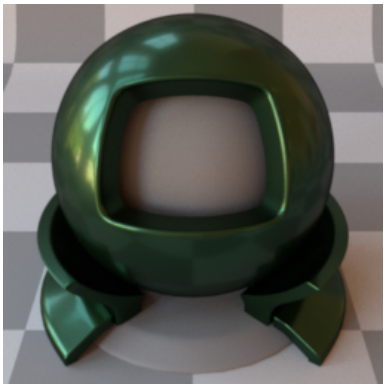
Reference



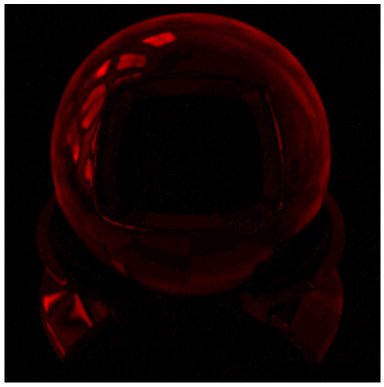
Ours: Tabulated



Ours: Gaussian

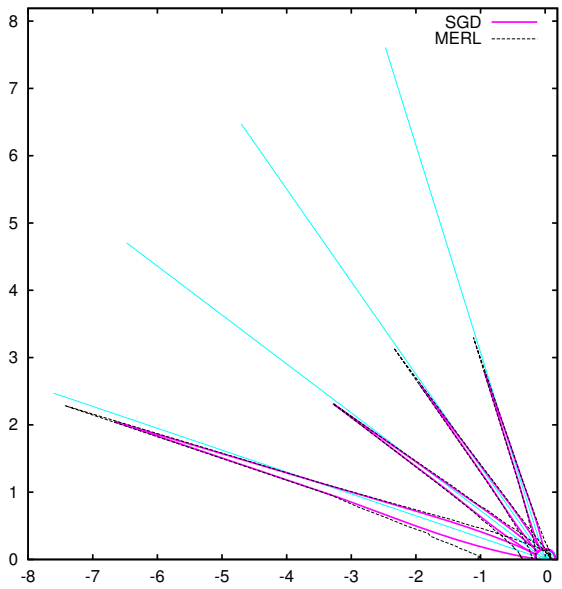


Reference

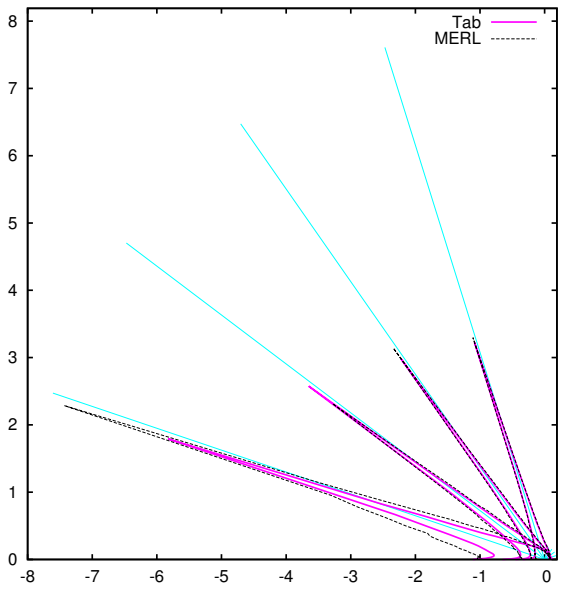


Ours: GGX

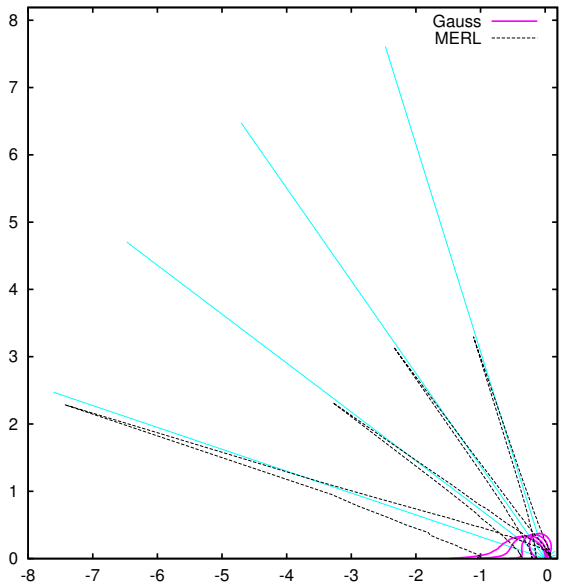
BRDF Lobes in the Incidence Plane (Cubic Root Applied)



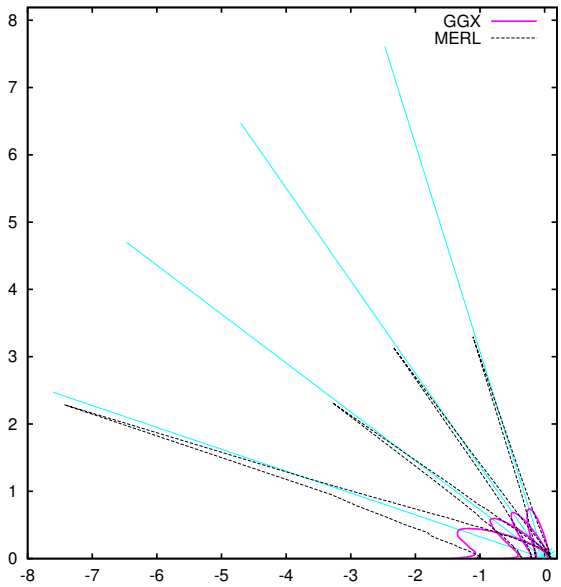
SGD



Ours: Tabulated

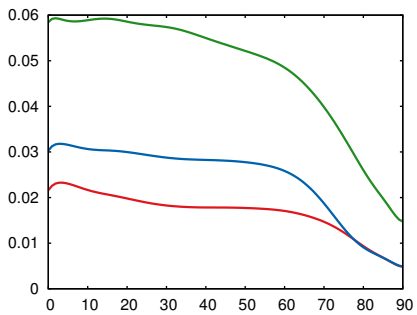


Ours: Gaussian

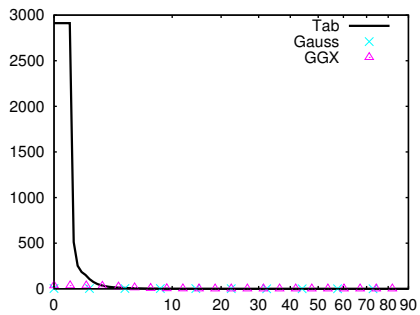


Ours: GGX

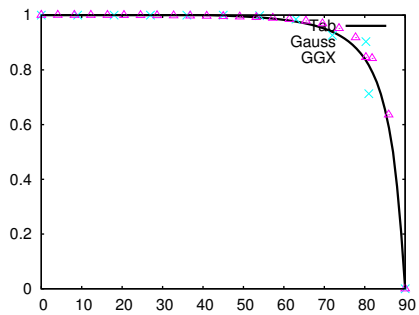
Fitted Microfacet Functions



Fresnel (R, G, B)



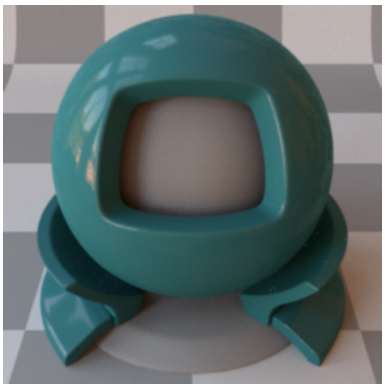
NDF (D)



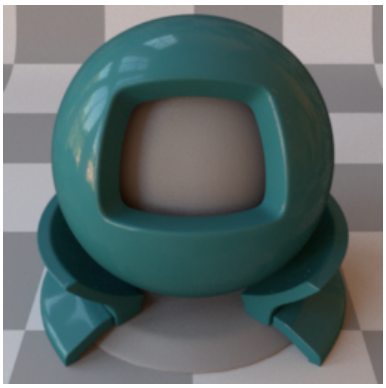
Smith (G_1)

40 green-plastic

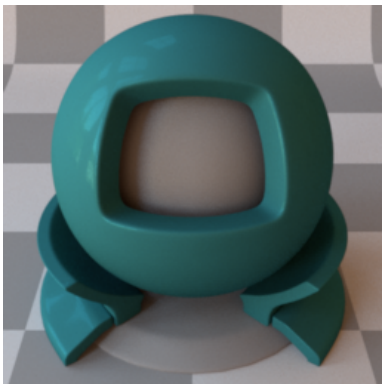
Renderings



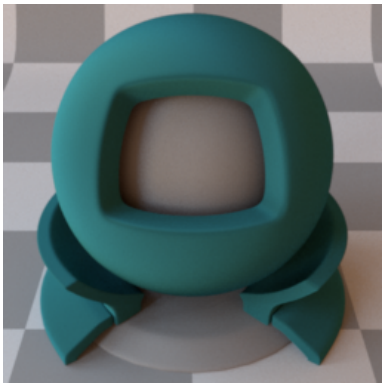
SGD



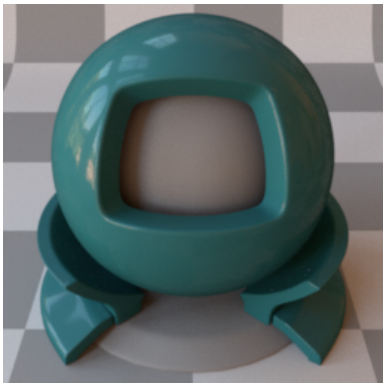
Reference



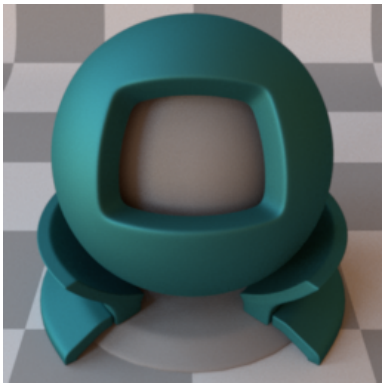
Ours: Tabulated



Ours: Gaussian

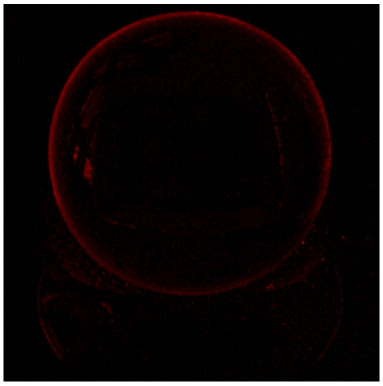


Reference

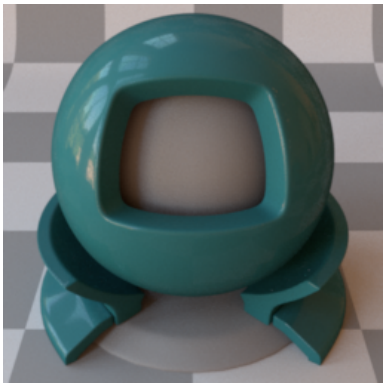


Ours: GGX

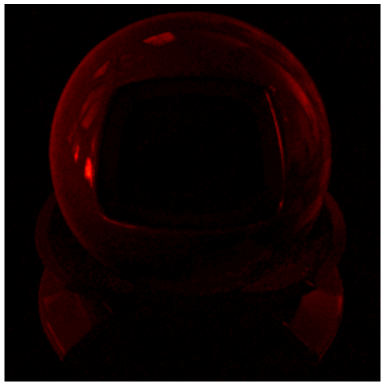
CIE dE00



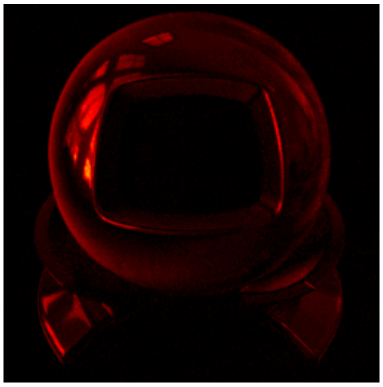
SGD



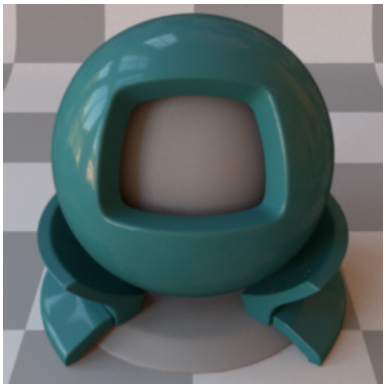
Reference



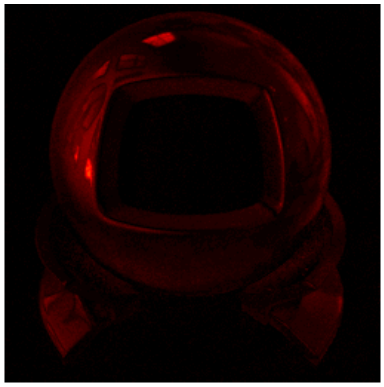
Ours: Tabulated



Ours: Gaussian

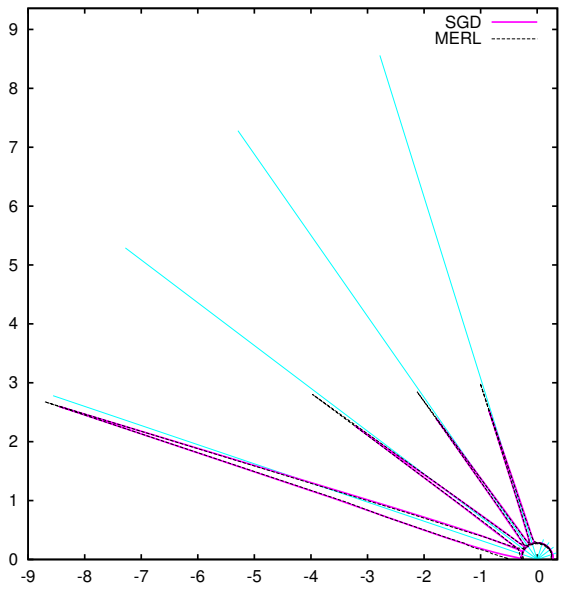


Reference

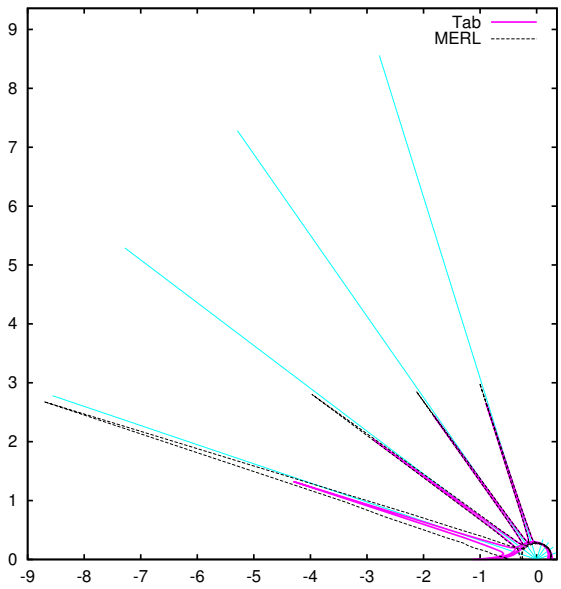


Ours: GGX

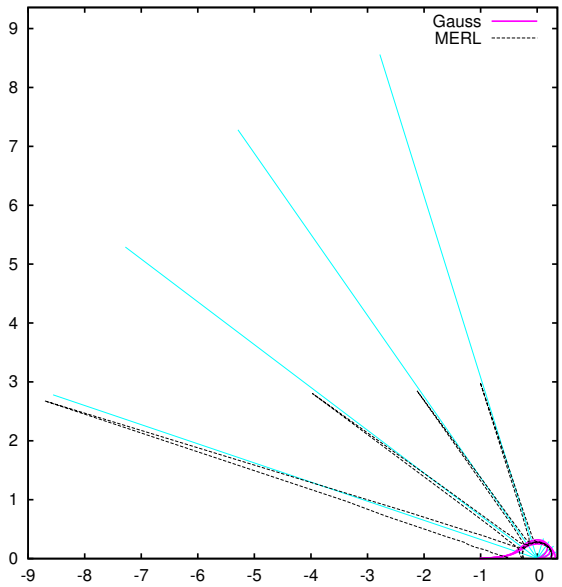
BRDF Lobes in the Incidence Plane (Cubic Root Applied)



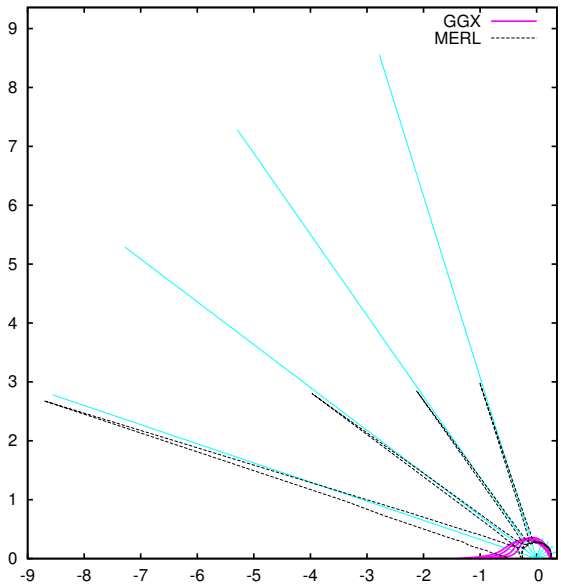
SGD



Ours: Tabulated

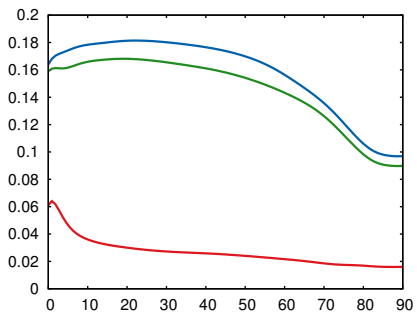


Ours: Gaussian

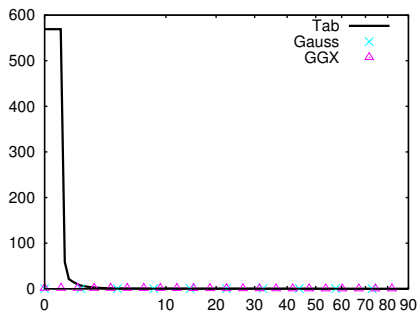


Ours: GGX

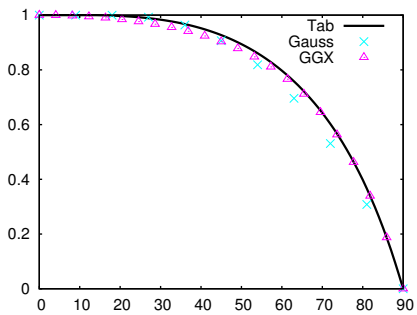
Fitted Microfacet Functions



Fresnel (R, G, B)



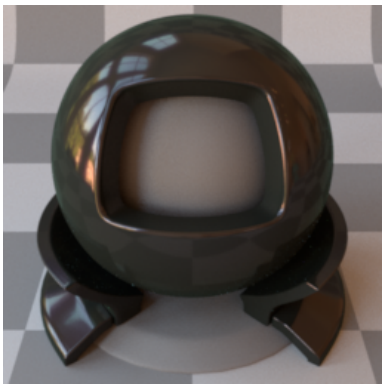
NDF (D)



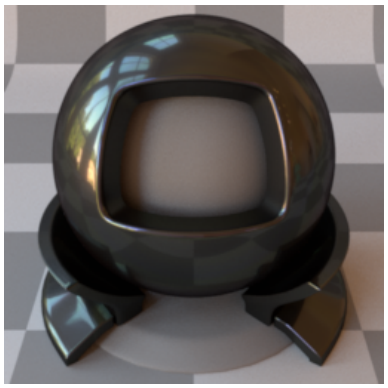
Smith (G_1)

41 hematite

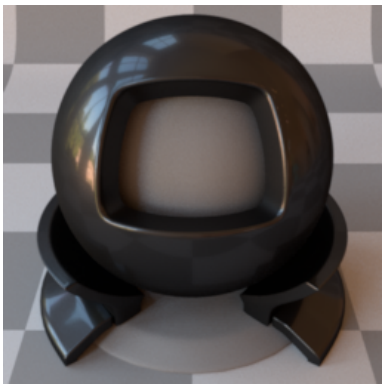
Renderings



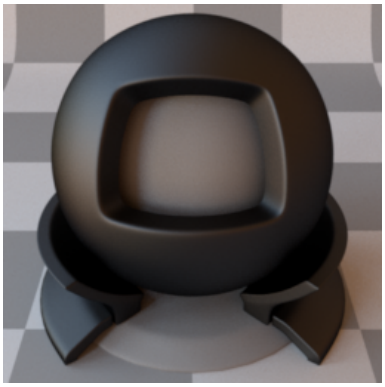
SGD



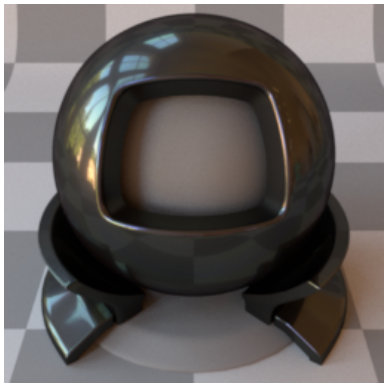
Reference



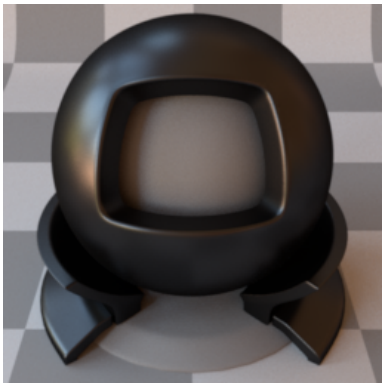
Ours: Tabulated



Ours: Gaussian

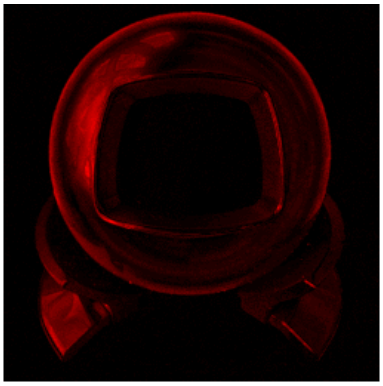


Reference

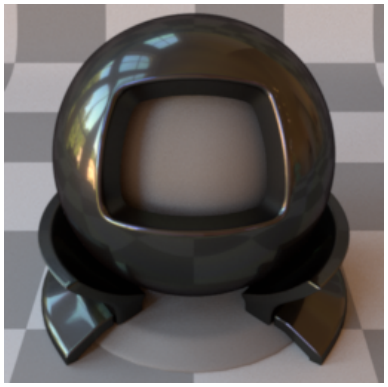


Ours: GGX

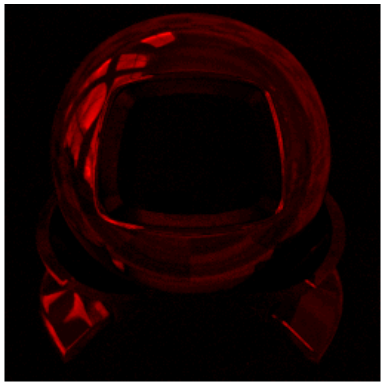
CIE dE00



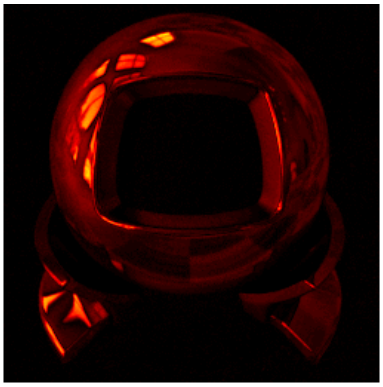
SGD



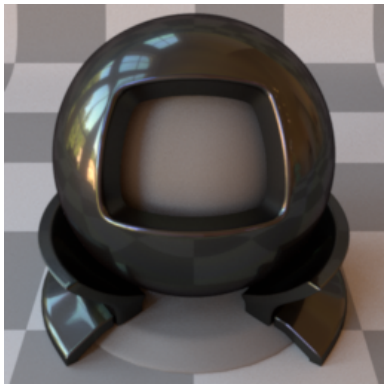
Reference



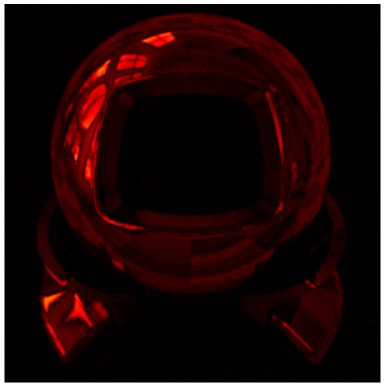
Ours: Tabulated



Ours: Gaussian

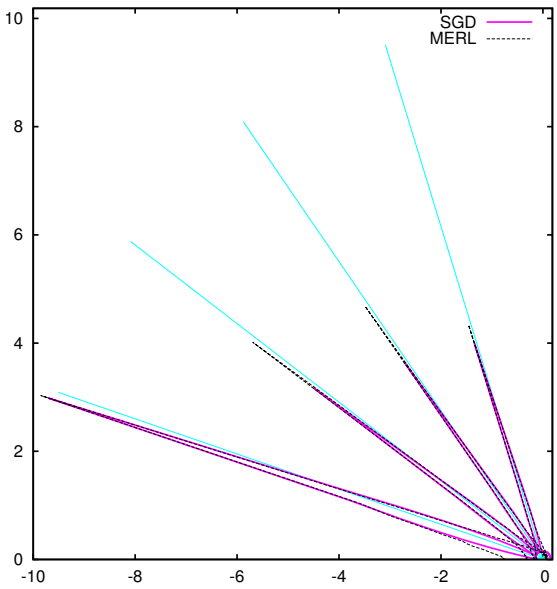


Reference

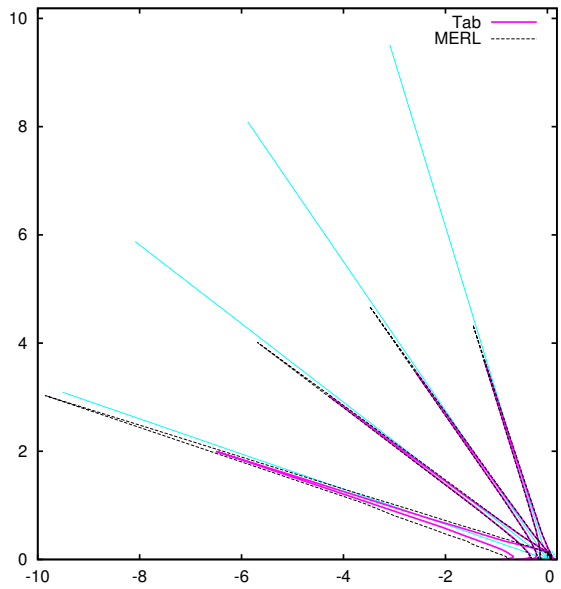


Ours: GGX

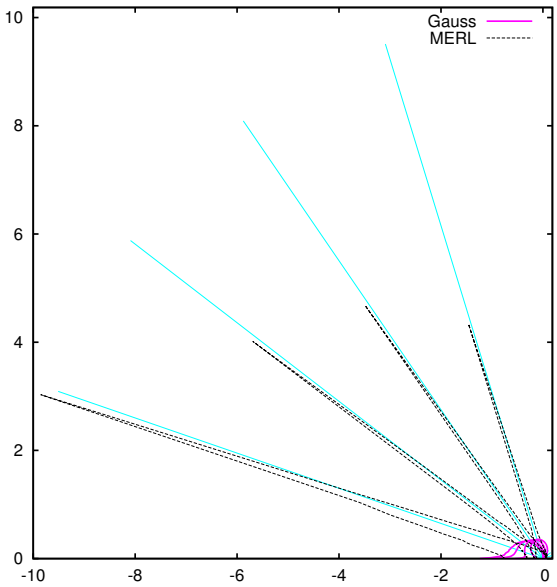
BRDF Lobes in the Incidence Plane (Cubic Root Applied)



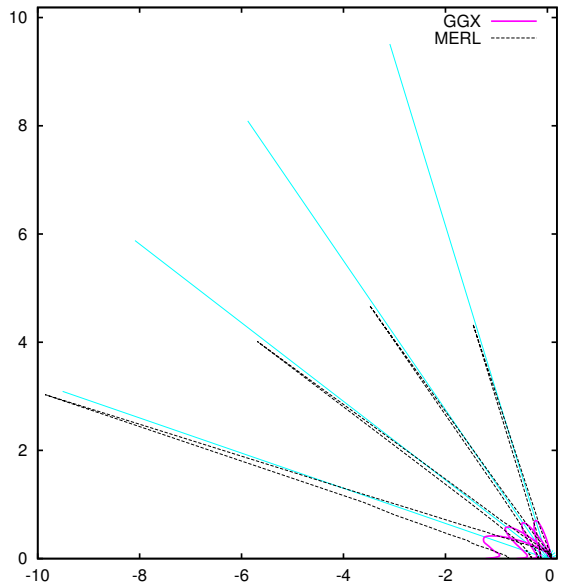
SGD



Ours: Tabulated

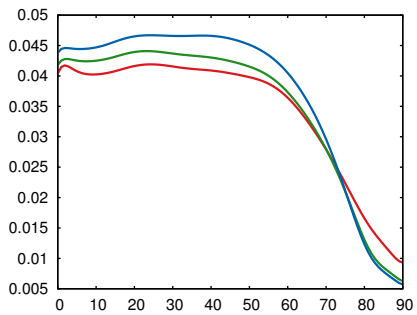


Ours: Gaussian

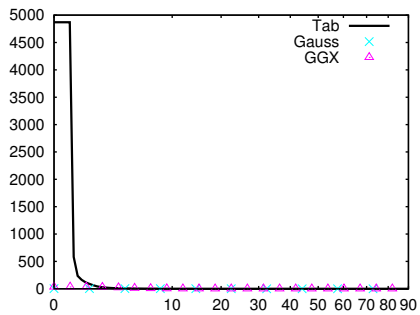


Ours: GGX

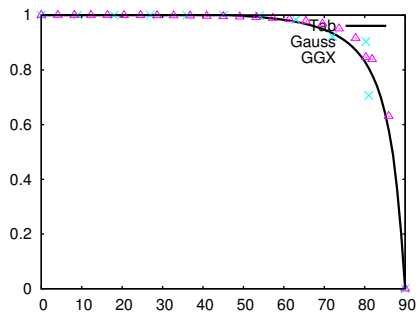
Fitted Microfacet Functions



Fresnel (R, G, B)



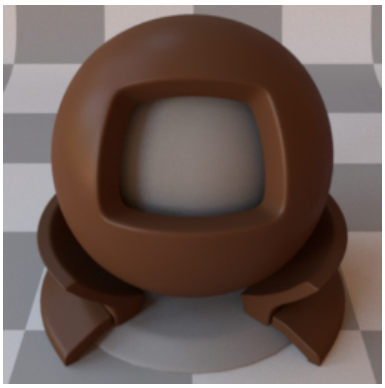
NDF (D)



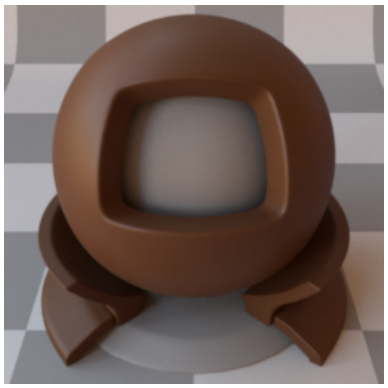
Smith (G_1)

42 ipswich-pine-221

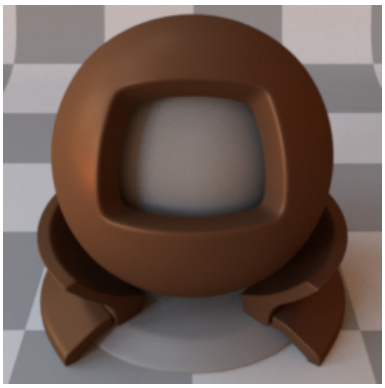
Renderings



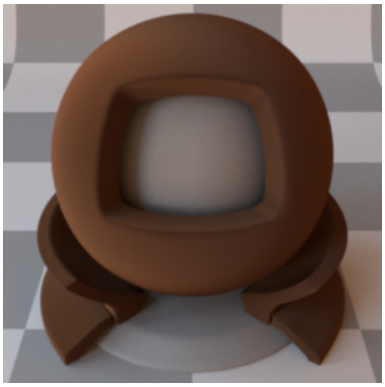
SGD



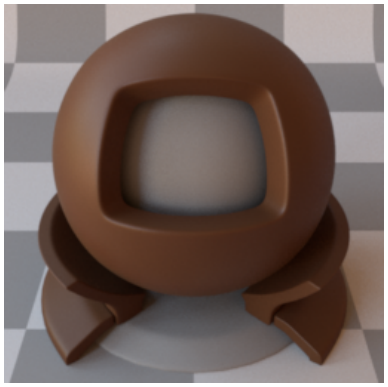
Reference



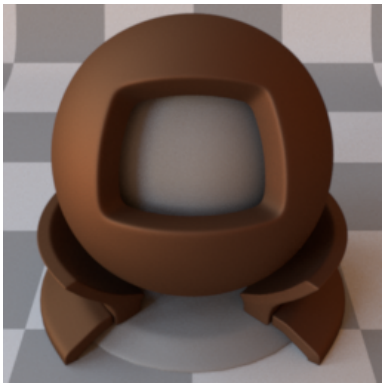
Ours: Tabulated



Ours: Gaussian

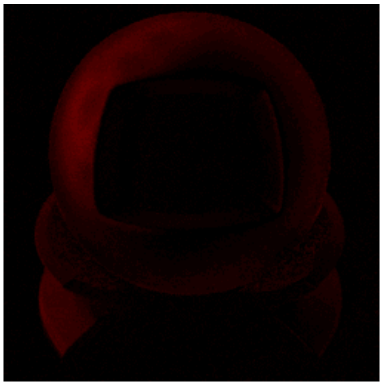


Reference

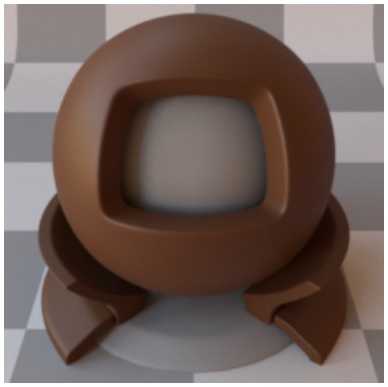


Ours: GGX

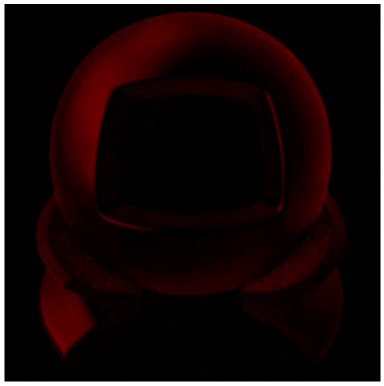
CIE dE00



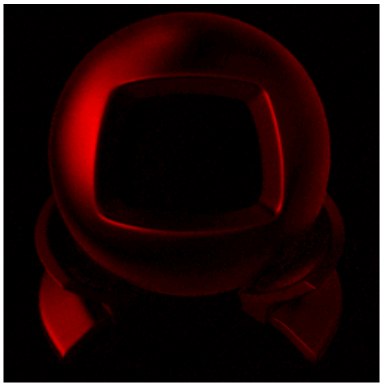
SGD



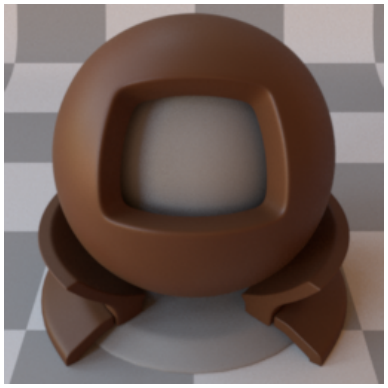
Reference



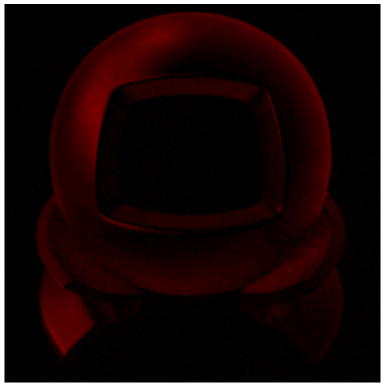
Ours: Tabulated



Ours: Gaussian

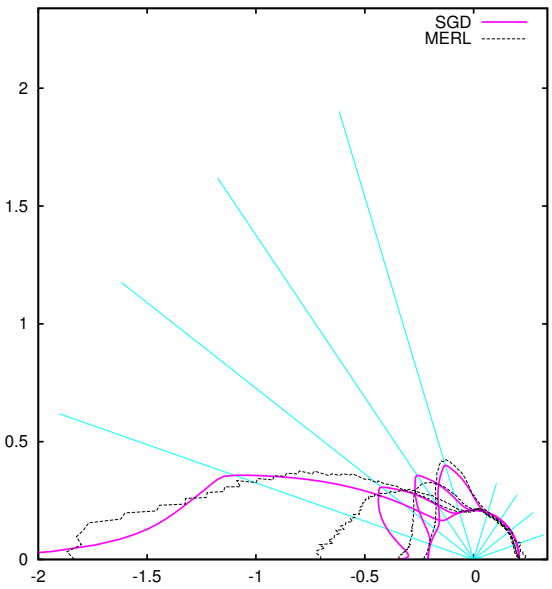


Reference

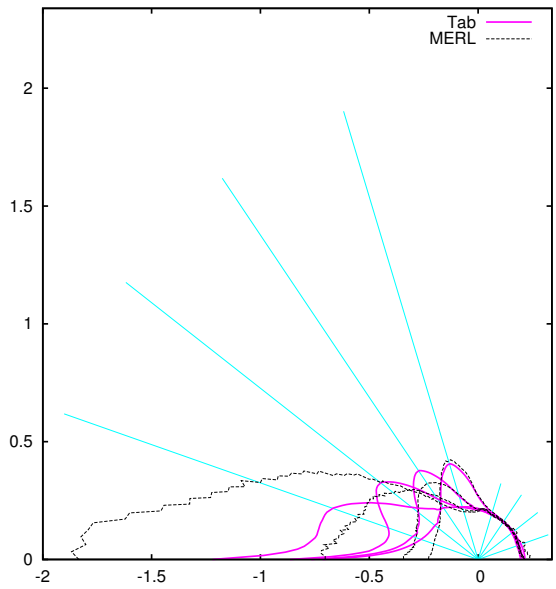


Ours: GGX

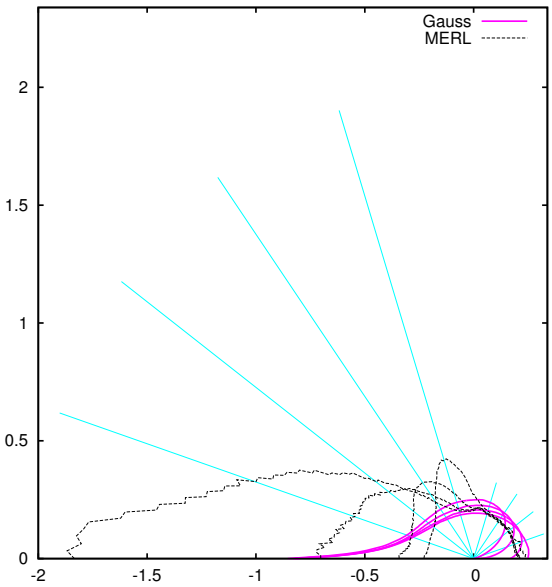
BRDF Lobes in the Incidence Plane (Cubic Root Applied)



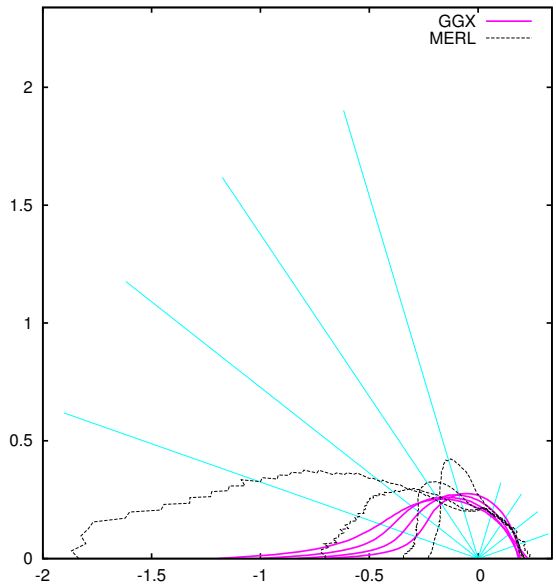
SGD



Ours: Tabulated

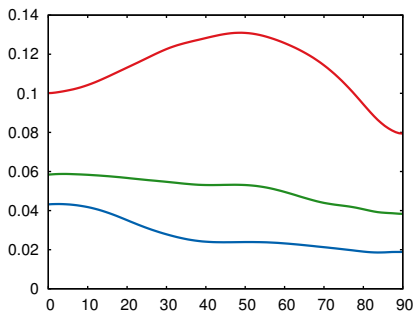


Ours: Gaussian

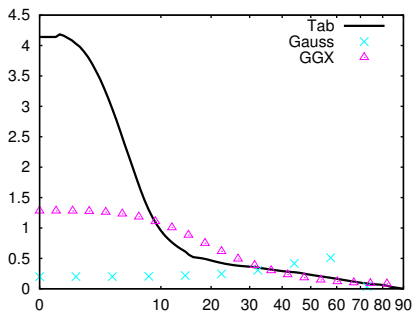


Ours: GGX

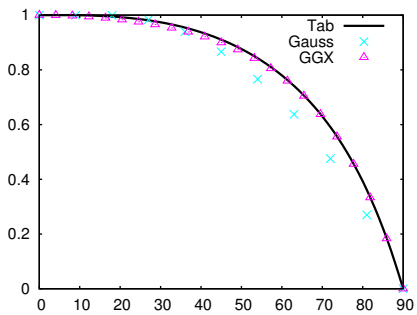
Fitted Microfacet Functions



Fresnel (R, G, B)



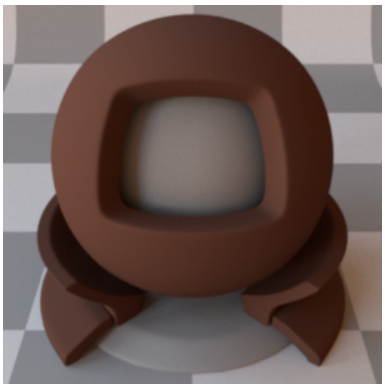
NDF (D)



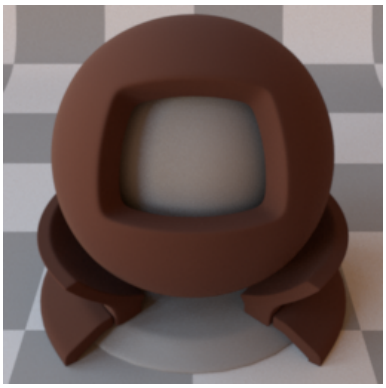
Smith (G_1)

43 light-brown-fabric

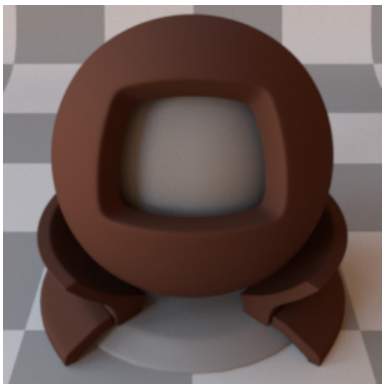
Renderings



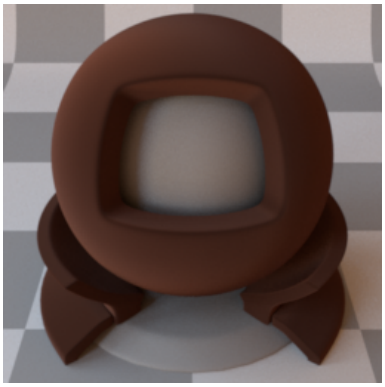
SGD



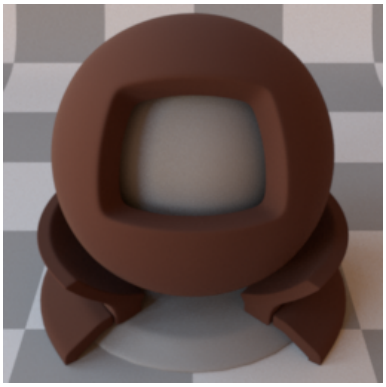
Reference



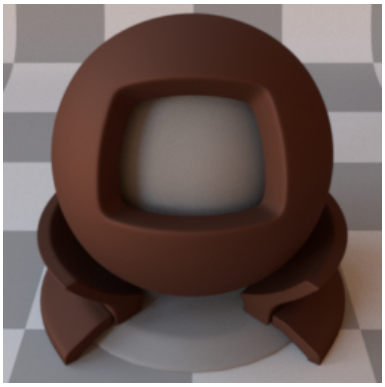
Ours: Tabulated



Ours: Gaussian

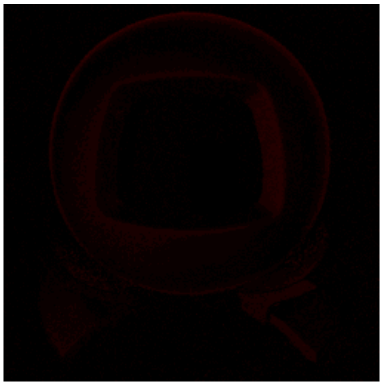


Reference

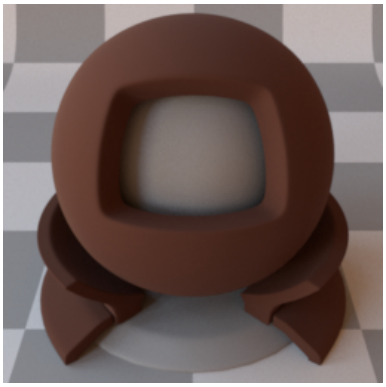


Ours: GGX

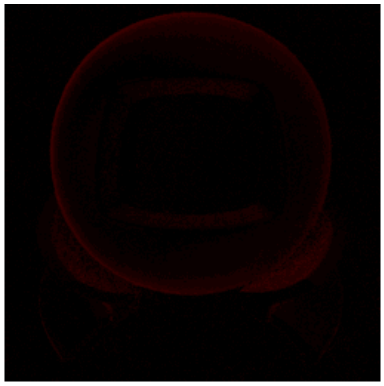
CIE dE00



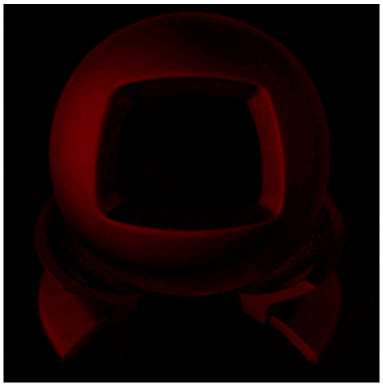
SGD



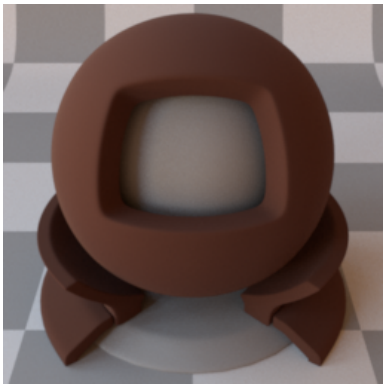
Reference



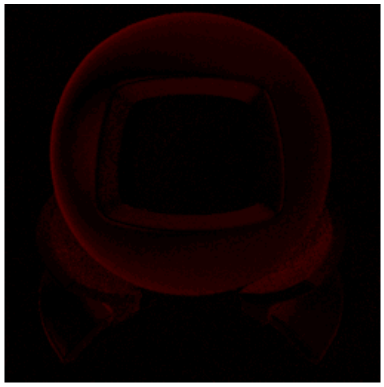
Ours: Tabulated



Ours: Gaussian

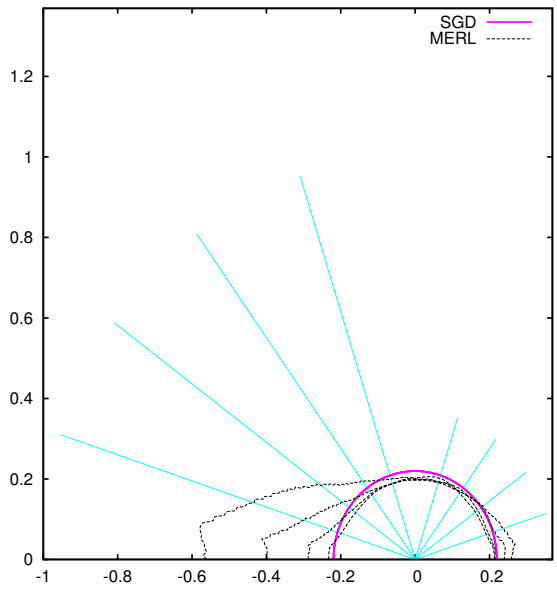


Reference

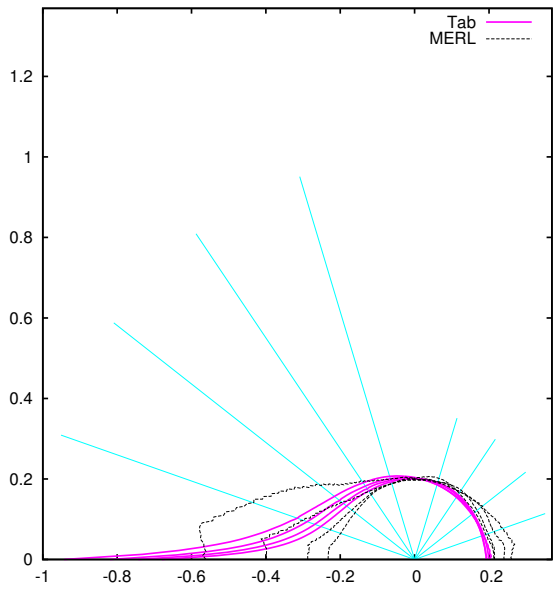


Ours: GGX

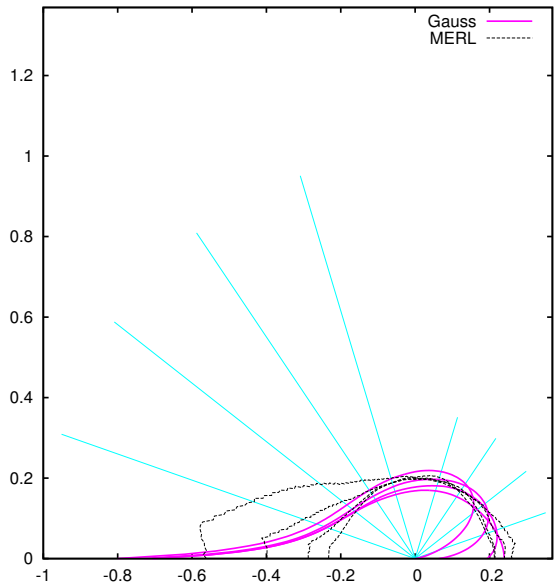
BRDF Lobes in the Incidence Plane (Cubic Root Applied)



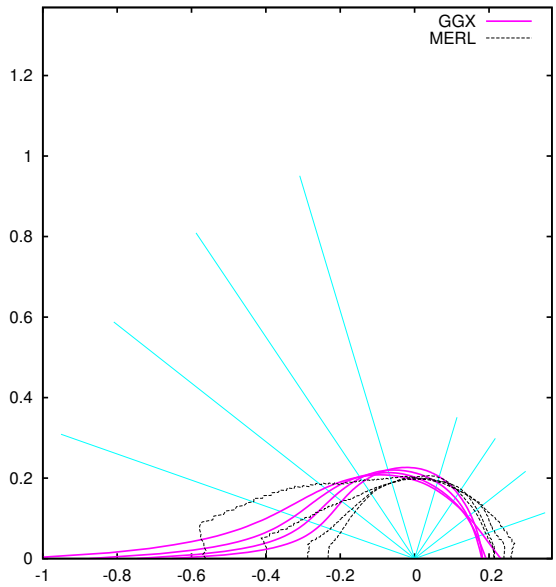
SGD



Ours: Tabulated

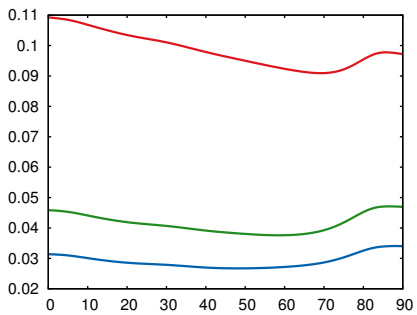


Ours: Gaussian

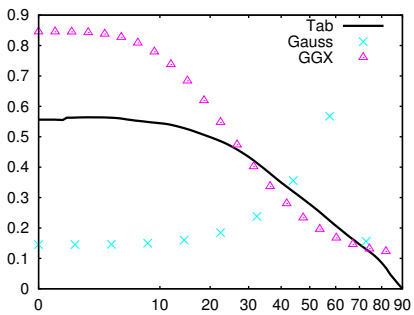


Ours: GGX

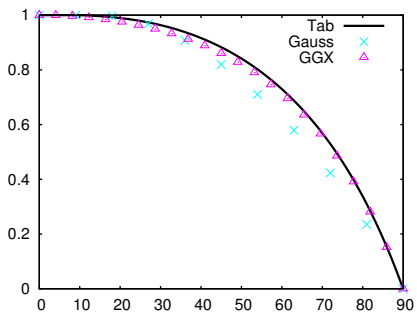
Fitted Microfacet Functions



Fresnel (R, G, B)



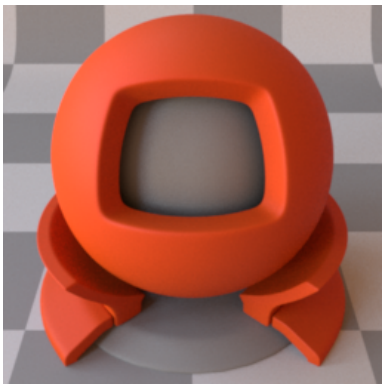
NDF (D)



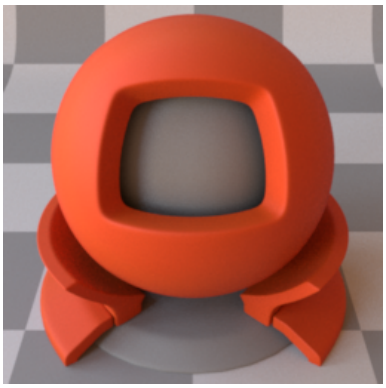
Smith (G_1)

44 light-red-paint

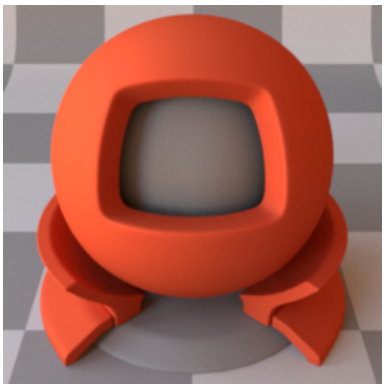
Renderings



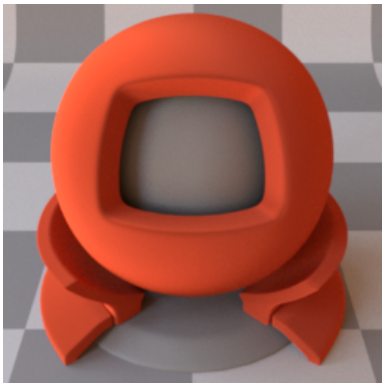
SGD



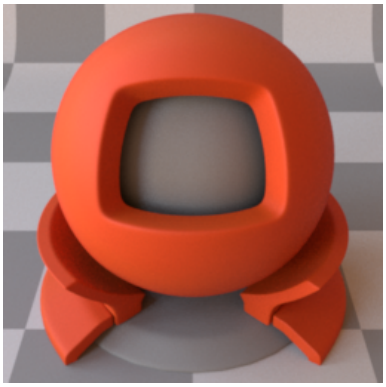
Reference



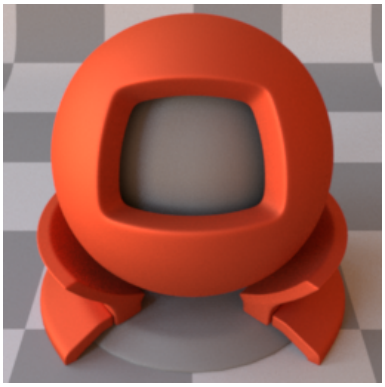
Ours: Tabulated



Ours: Gaussian

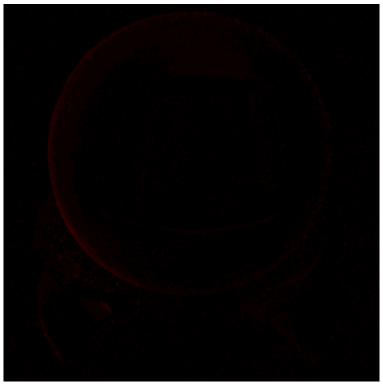


Reference

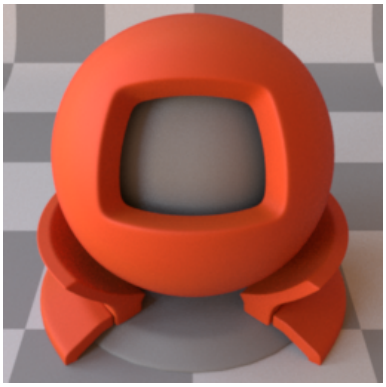


Ours: GGX

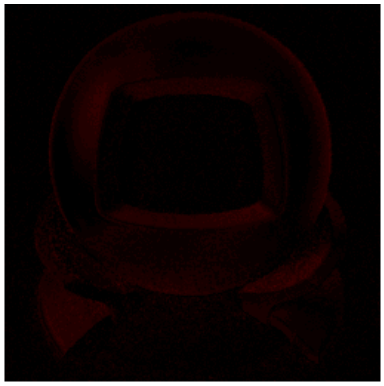
CIE dE00



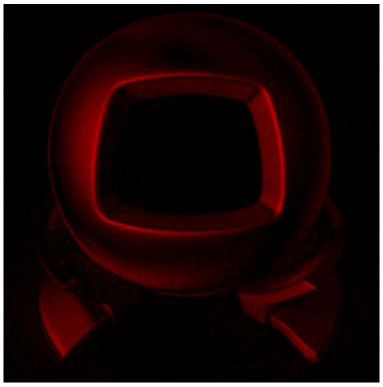
SGD



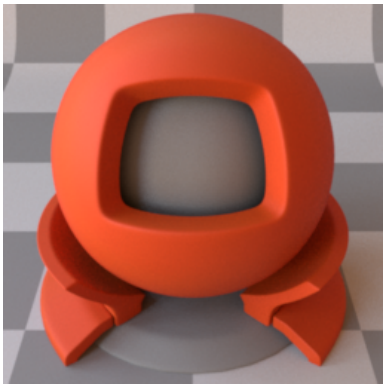
Reference



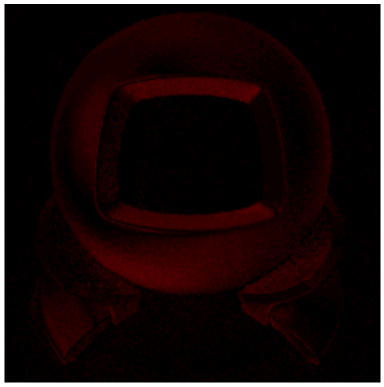
Ours: Tabulated



Ours: Gaussian

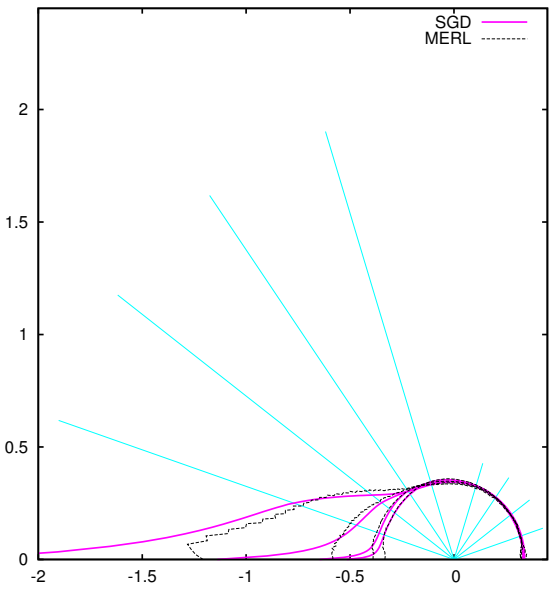


Reference

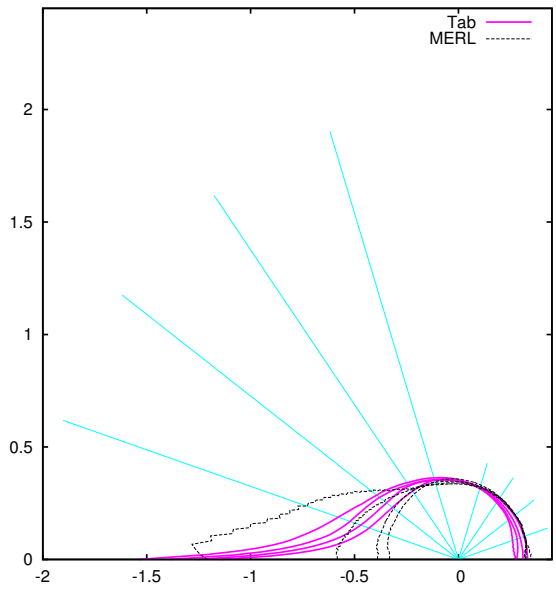


Ours: GGX

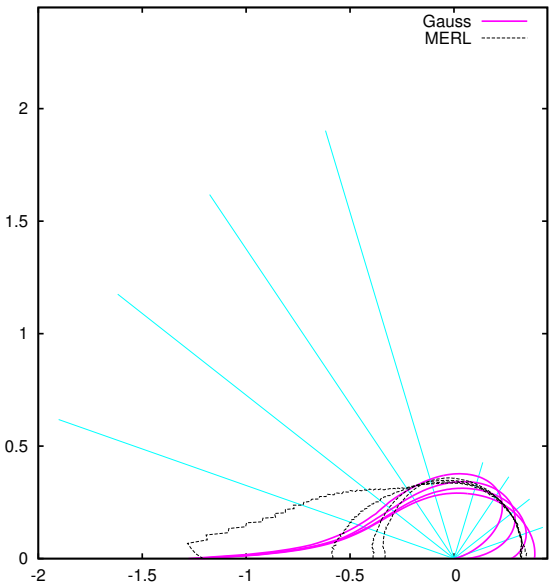
BRDF Lobes in the Incidence Plane (Cubic Root Applied)



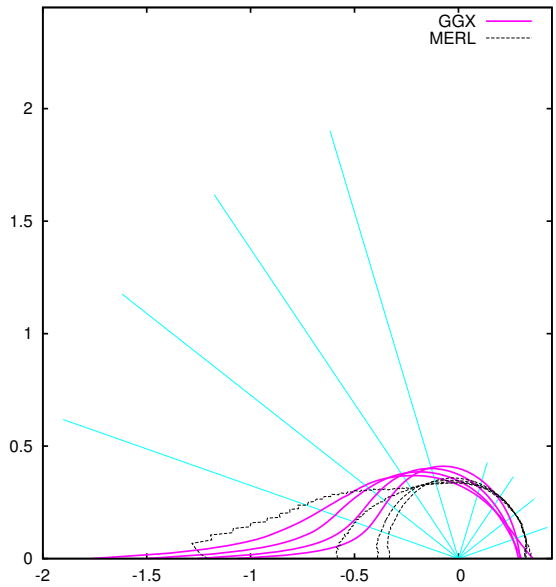
SGD



Ours: Tabulated

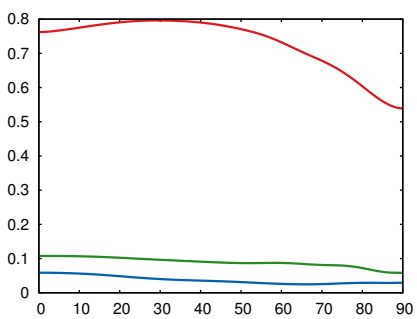


Ours: Gaussian

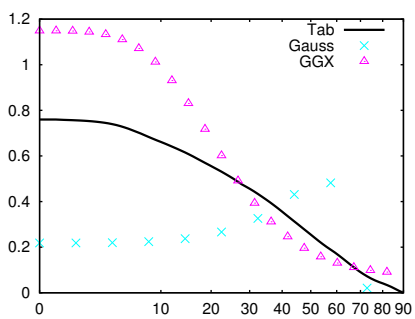


Ours: GGX

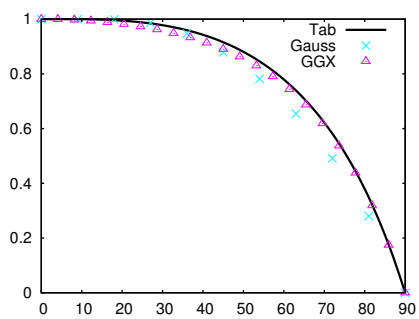
Fitted Microfacet Functions



Fresnel (R, G, B)



NDF (D)

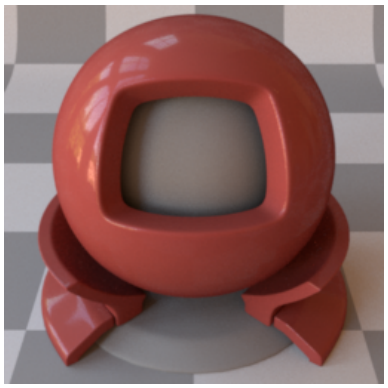


Smith (G_1)

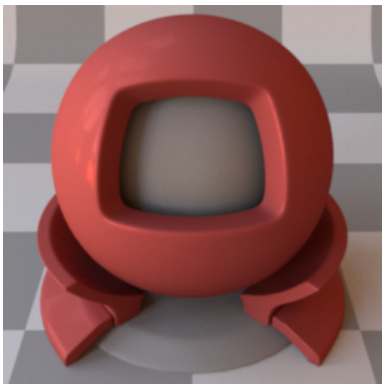
45 maroon-plastic

Renderings

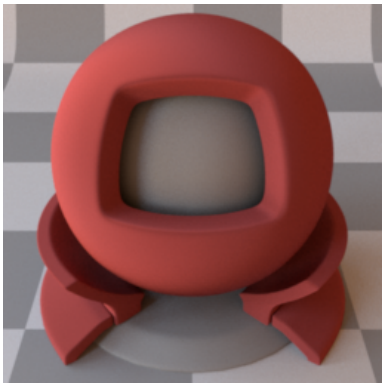
SGD



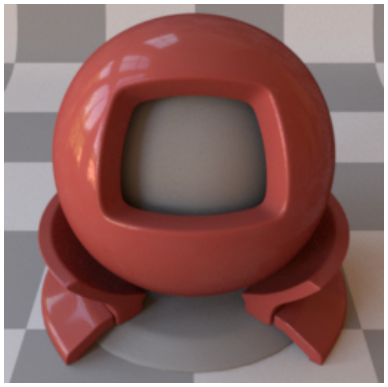
Reference



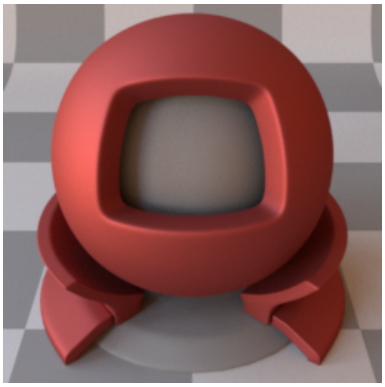
Ours: Tabulated



Ours: Gaussian

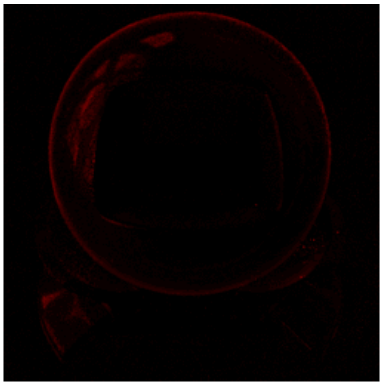


Reference

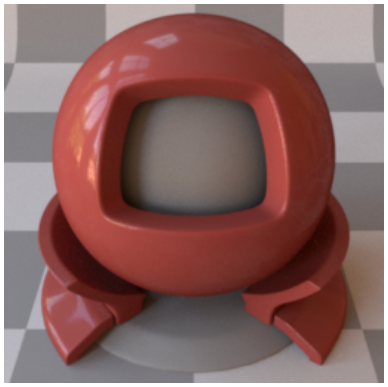


Ours: GGX

CIE dE00

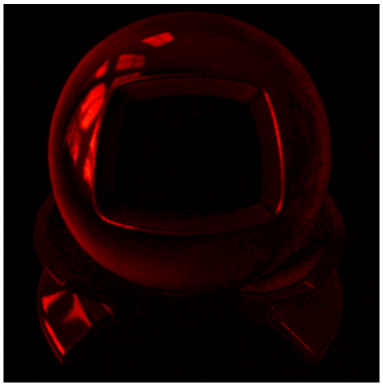


SGD

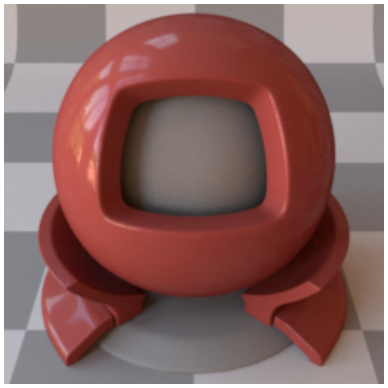


Reference

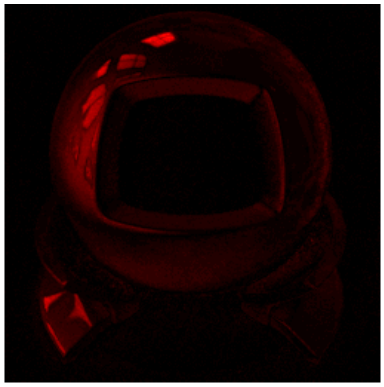
Ours: Tabulated



Ours: Gaussian

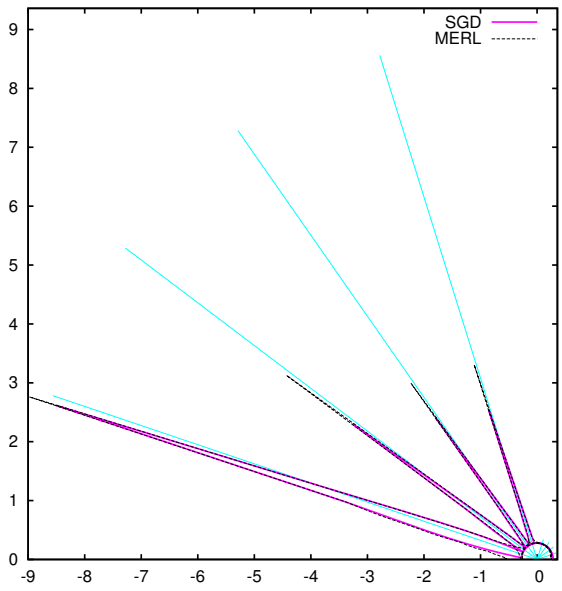


Reference

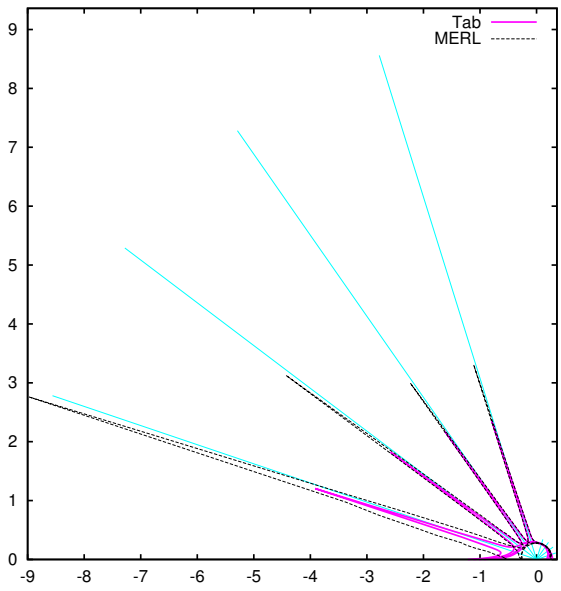


Ours: GGX

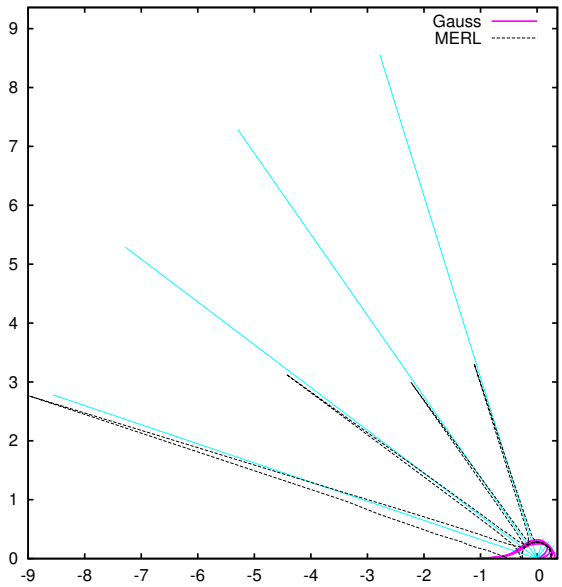
BRDF Lobes in the Incidence Plane (Cubic Root Applied)



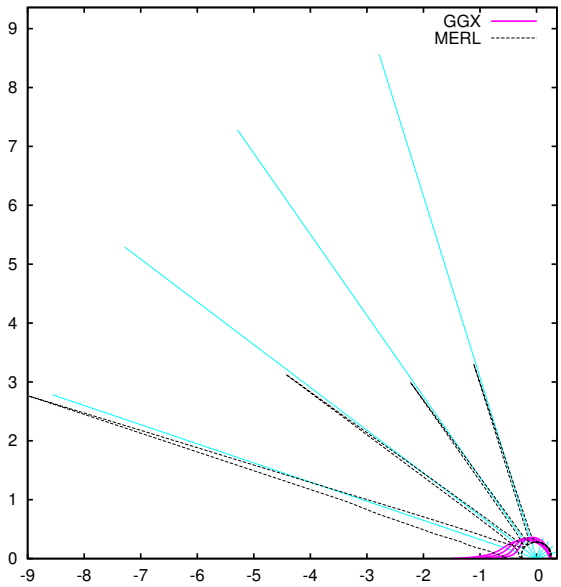
SGD



Ours: Tabulated

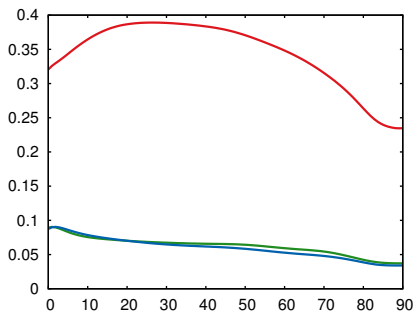


Ours: Gaussian

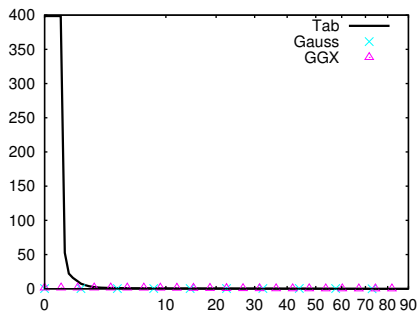


Ours: GGX

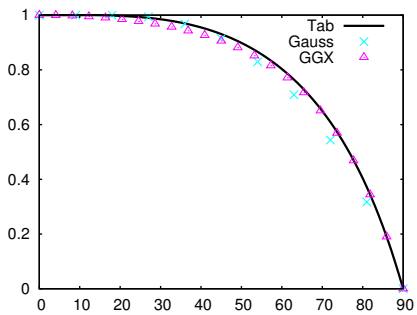
Fitted Microfacet Functions



Fresnel (R, G, B)



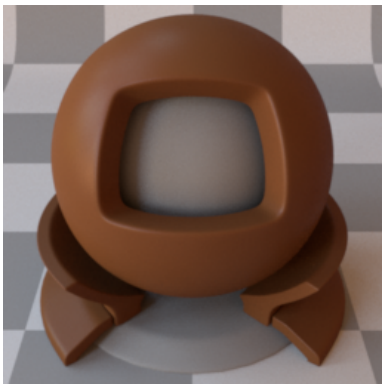
NDF (D)



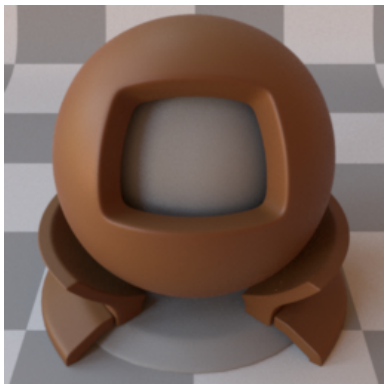
Smith (G_1)

46 natural-209

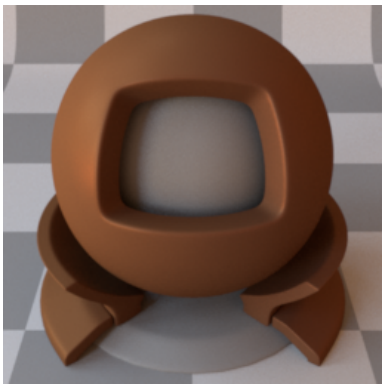
Renderings



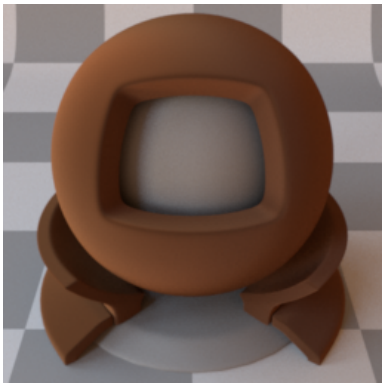
SGD



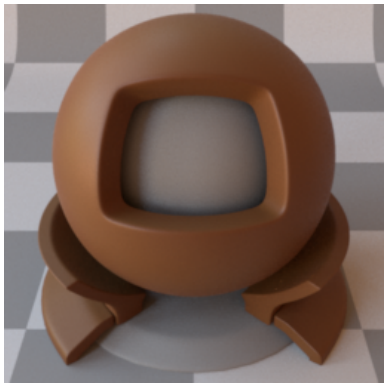
Reference



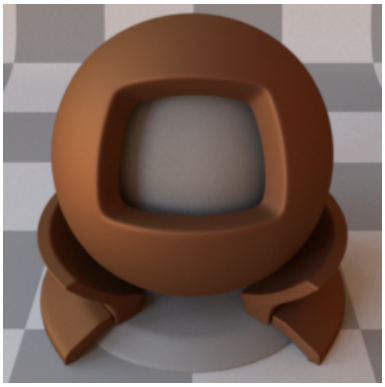
Ours: Tabulated



Ours: Gaussian

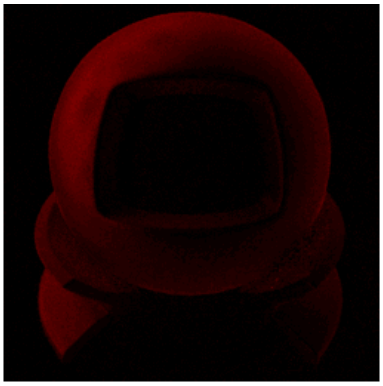


Reference

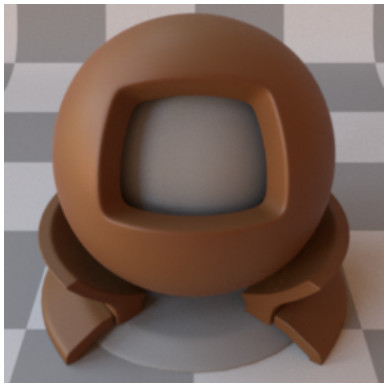


Ours: GGX

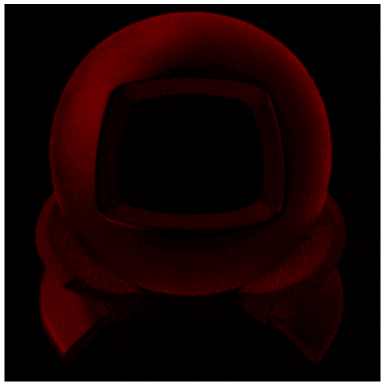
CIE dE00



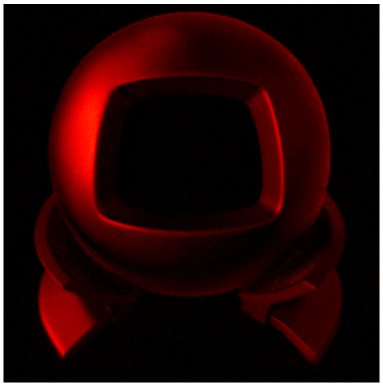
SGD



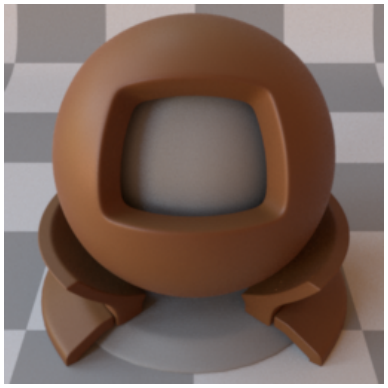
Reference



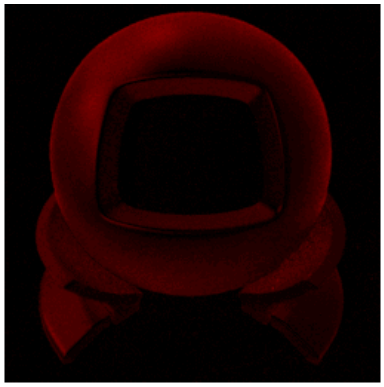
Ours: Tabulated



Ours: Gaussian

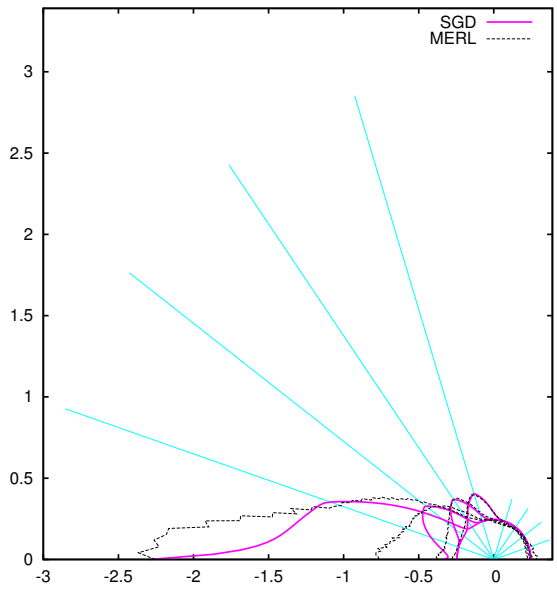


Reference

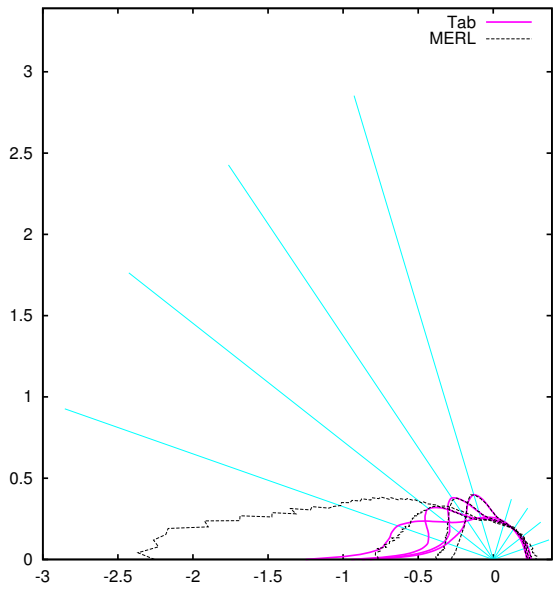


Ours: GGX

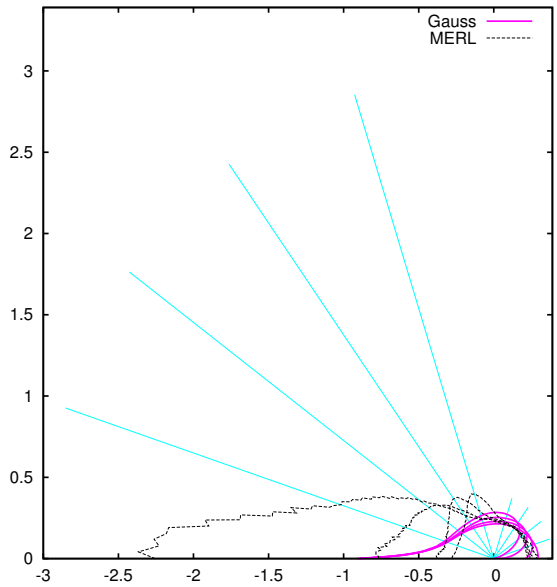
BRDF Lobes in the Incidence Plane (Cubic Root Applied)



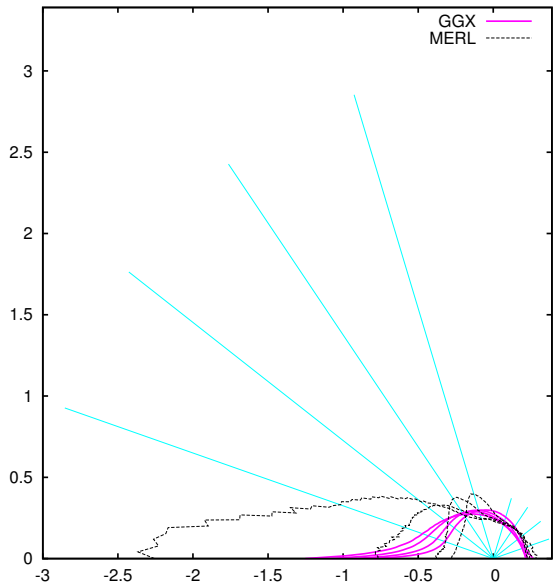
SGD



Ours: Tabulated

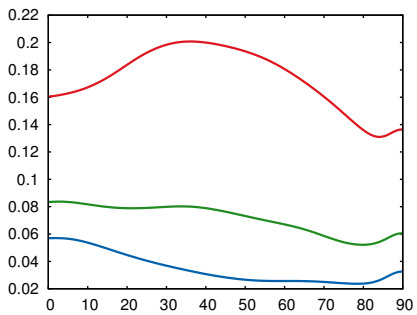


Ours: Gaussian

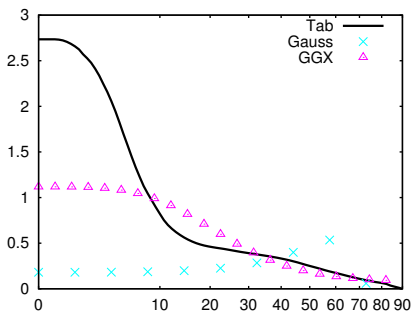


Ours: GGX

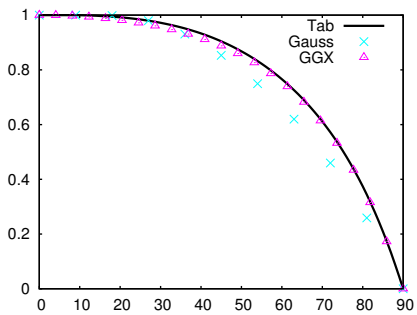
Fitted Microfacet Functions



Fresnel (R, G, B)



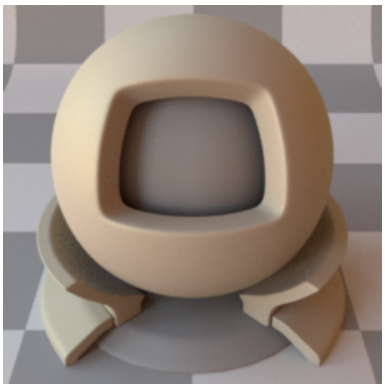
NDF (D)



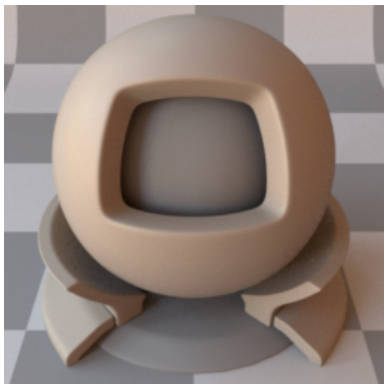
Smith (G_1)

47 neoprene-rubber

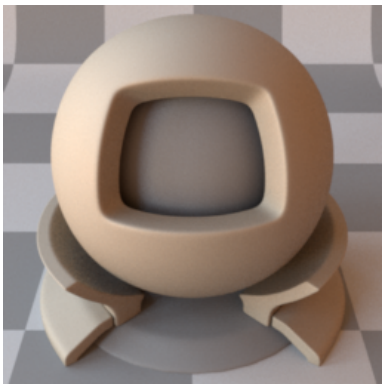
Renderings



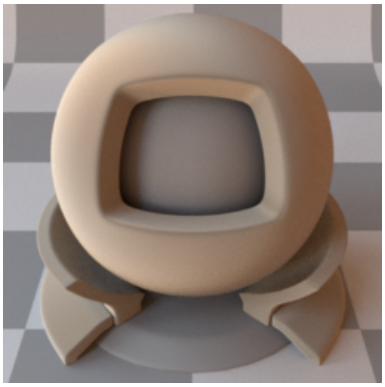
SGD



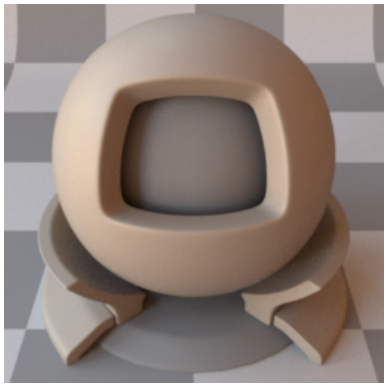
Reference



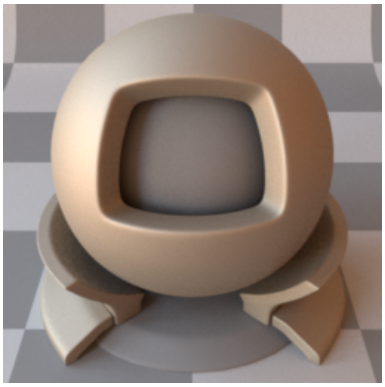
Ours: Tabulated



Ours: Gaussian

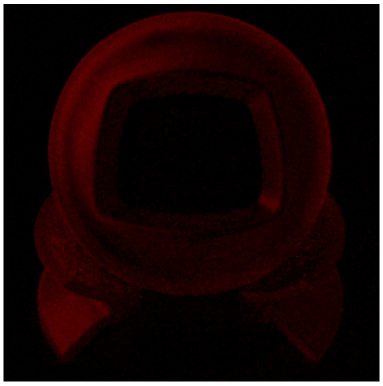


Reference

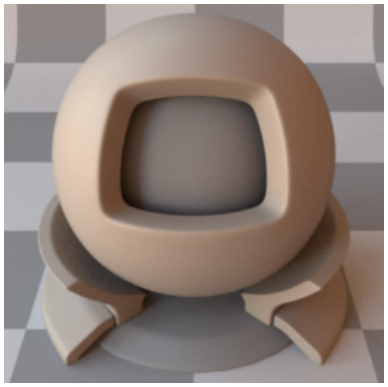


Ours: GGX

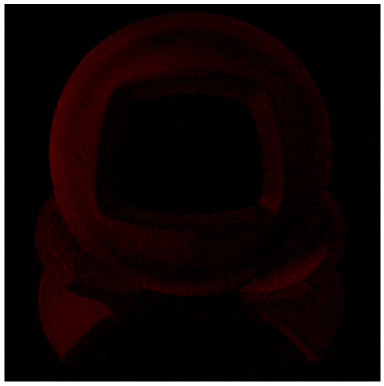
CIE dE00



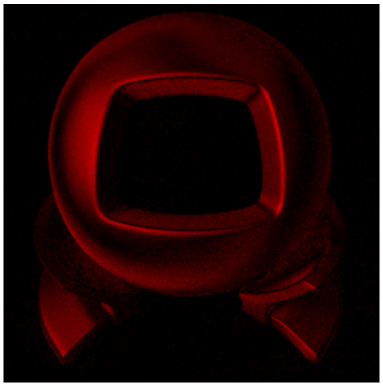
SGD



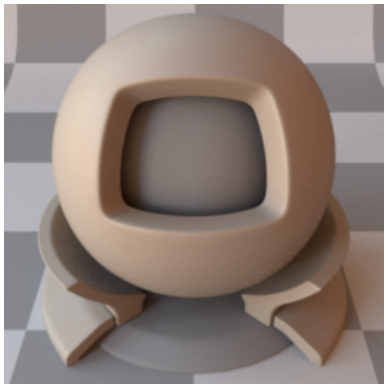
Reference



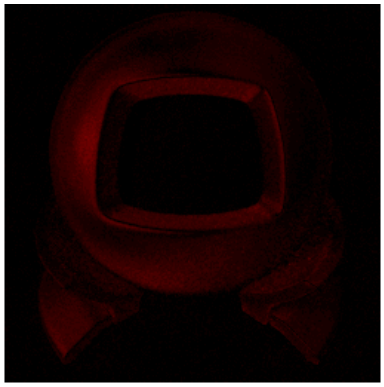
Ours: Tabulated



Ours: Gaussian

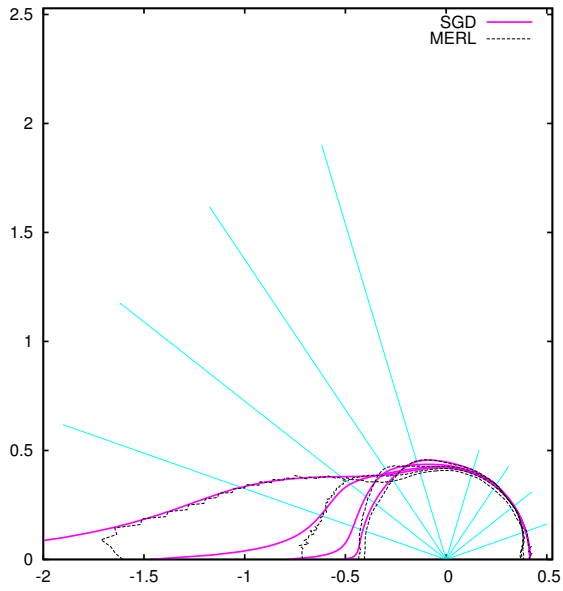


Reference

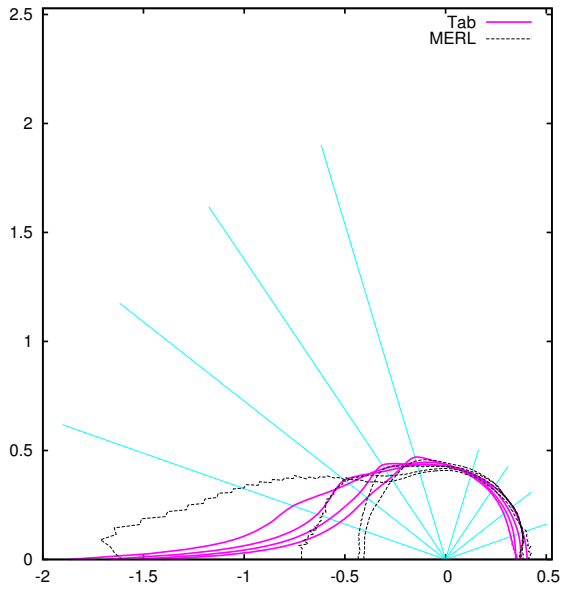


Ours: GGX

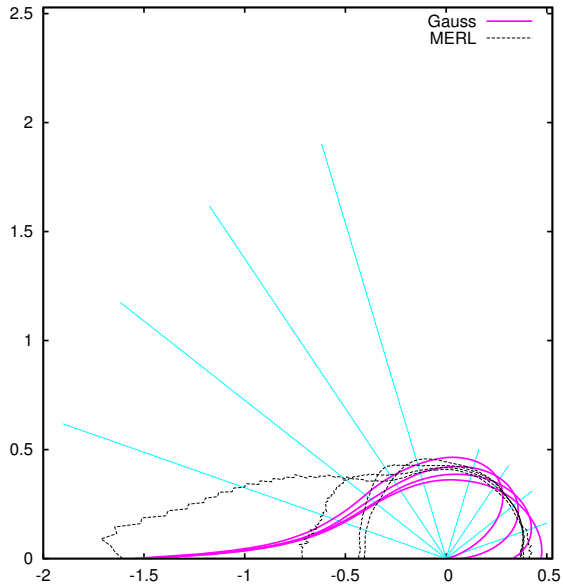
BRDF Lobes in the Incidence Plane (Cubic Root Applied)



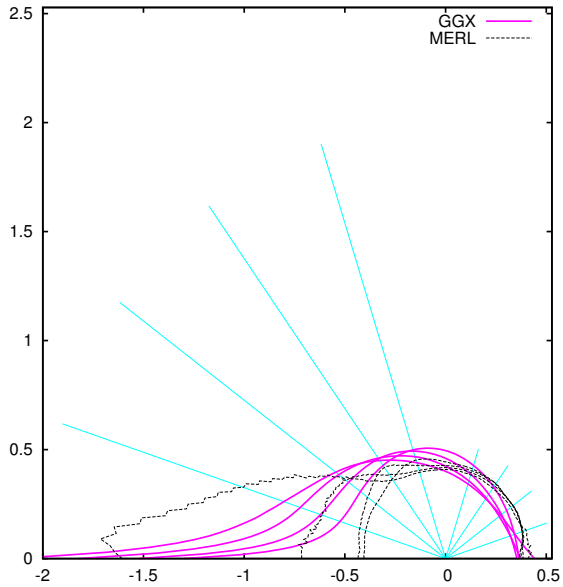
SGD



Ours: Tabulated

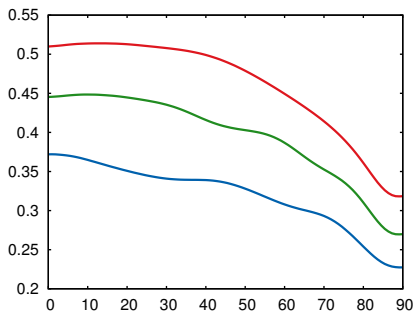


Ours: Gaussian

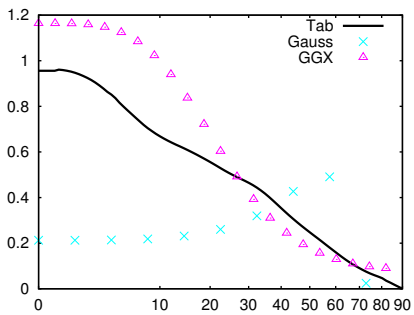


Ours: GGX

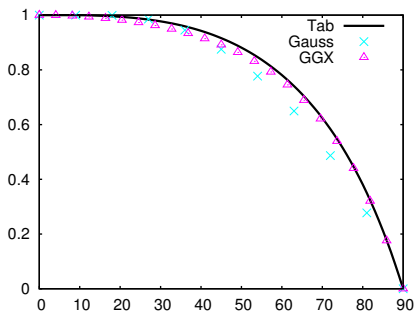
Fitted Microfacet Functions



Fresnel (R, G, B)



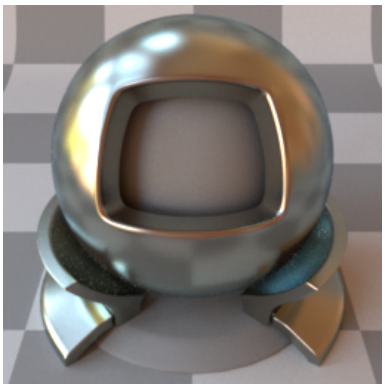
NDF (D)



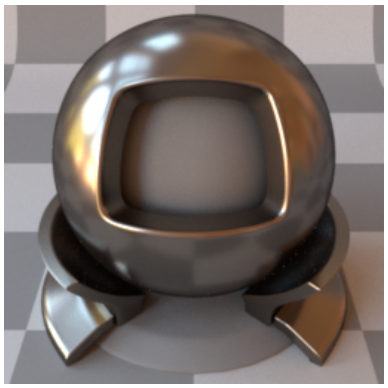
Smith (G_1)

48 nickel

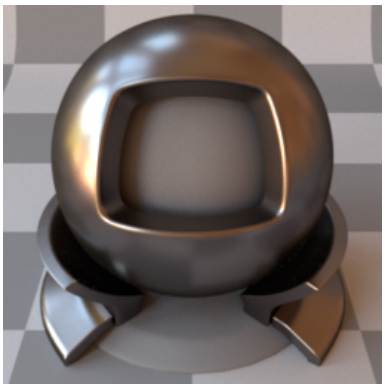
Renderings



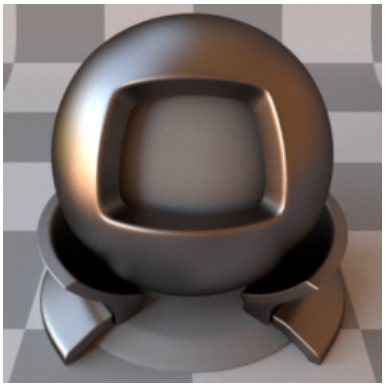
SGD



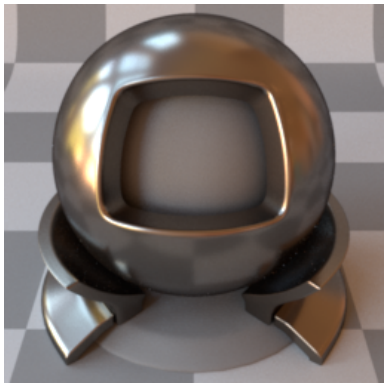
Reference



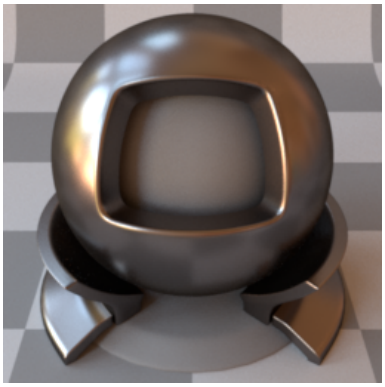
Ours: Tabulated



Ours: Gaussian

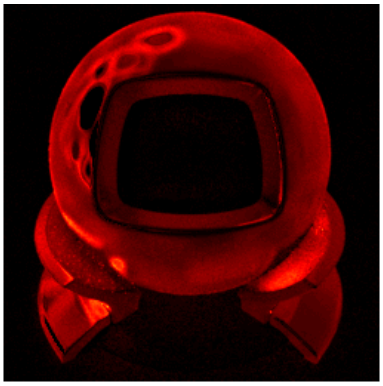


Reference

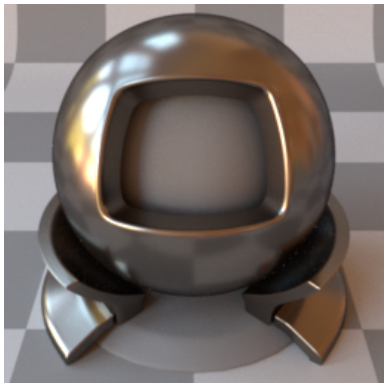


Ours: GGX

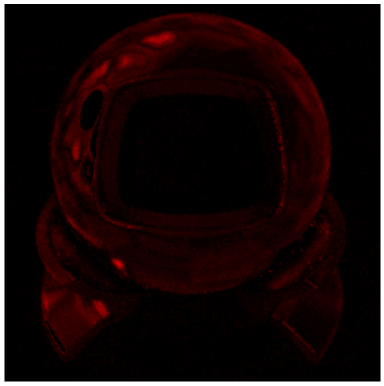
CIE dE00



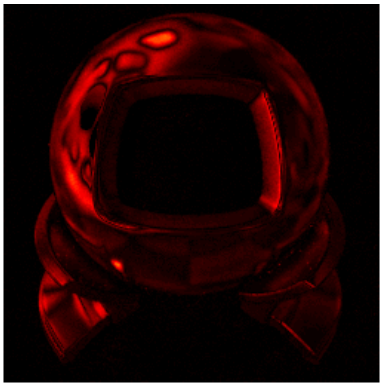
SGD



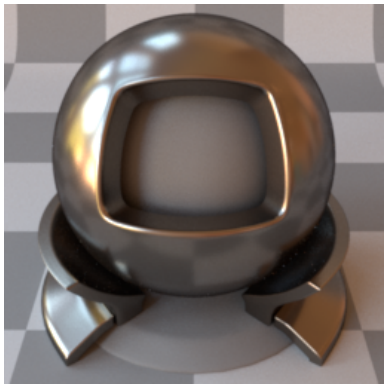
Reference



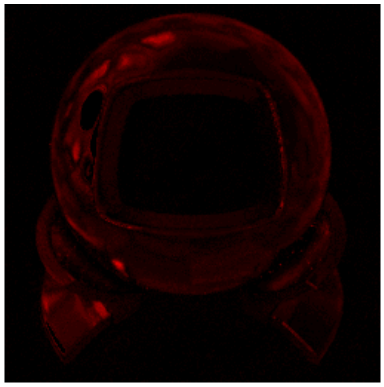
Ours: Tabulated



Ours: Gaussian

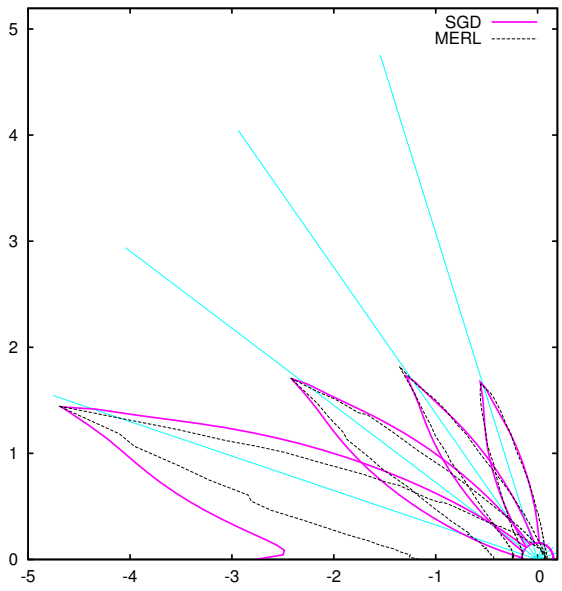


Reference

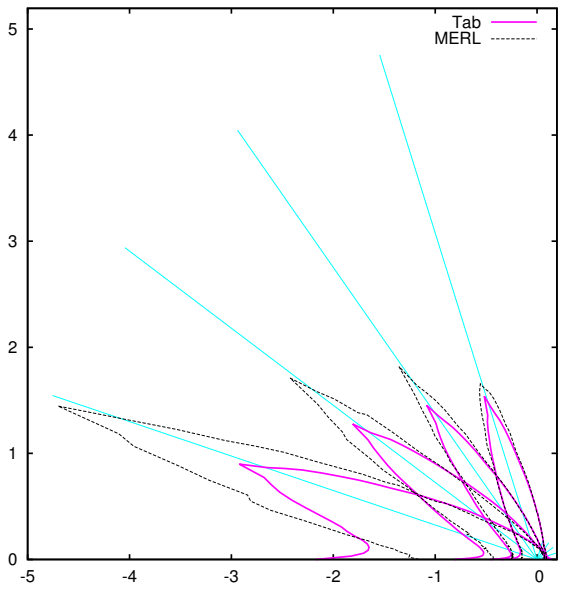


Ours: GGX

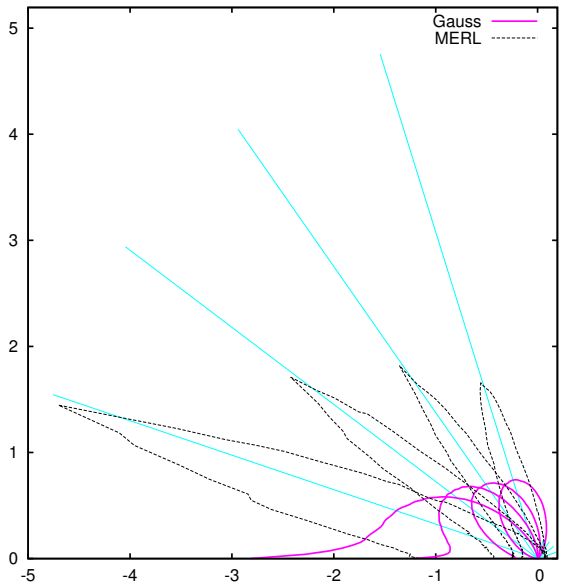
BRDF Lobes in the Incidence Plane (Cubic Root Applied)



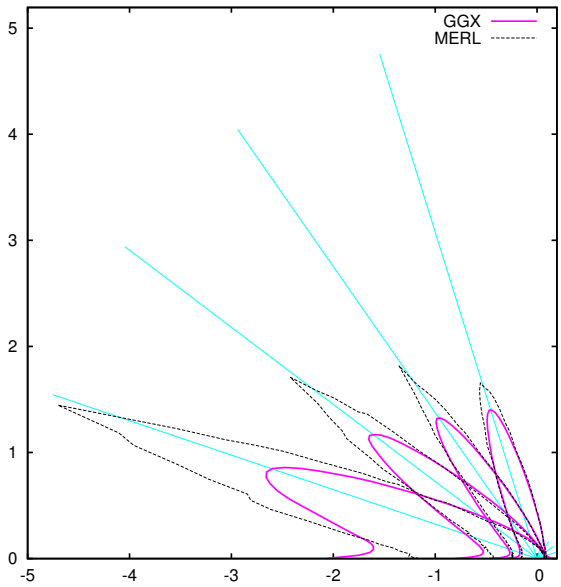
SGD



Ours: Tabulated

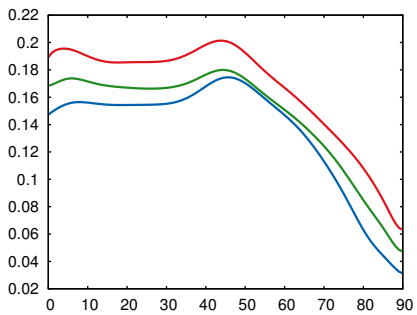


Ours: Gaussian

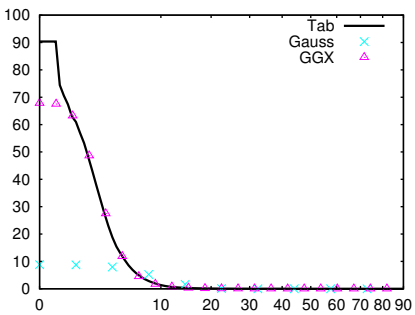


Ours: GGX

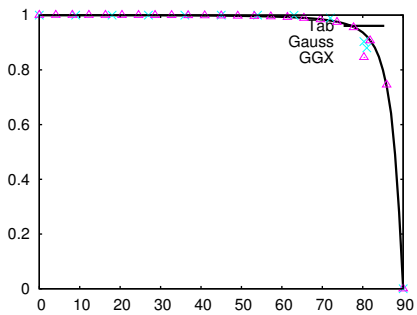
Fitted Microfacet Functions



Fresnel (R, G, B)



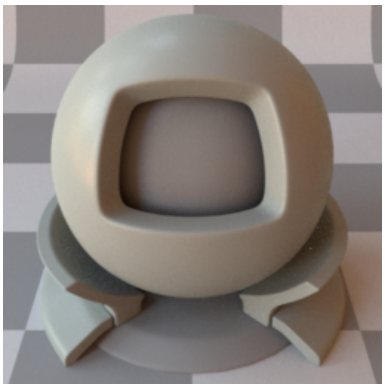
NDF (D)



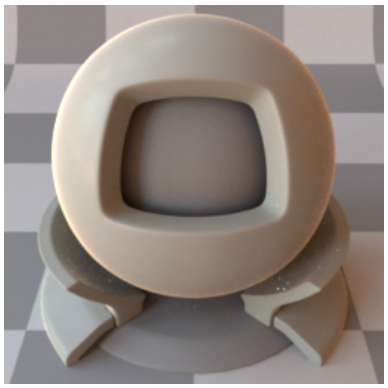
Smith (G_1)

49 nylon

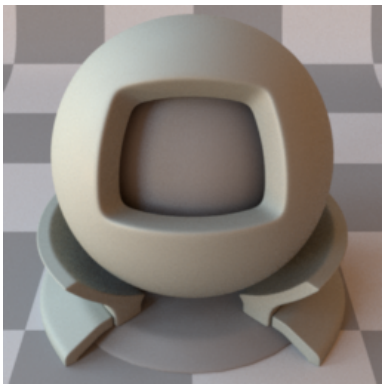
Renderings



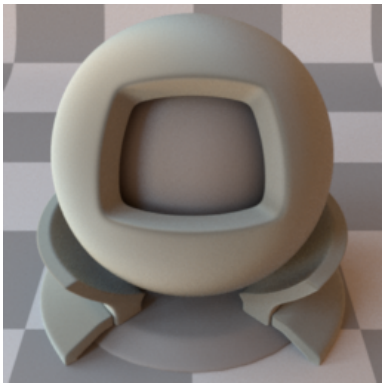
SGD



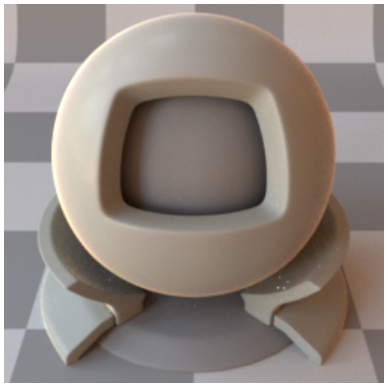
Reference



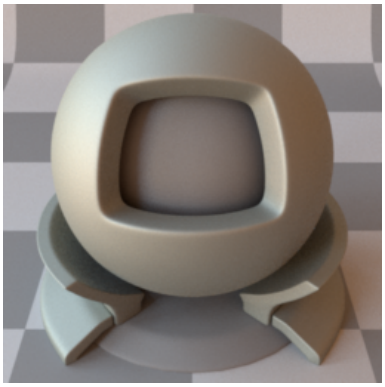
Ours: Tabulated



Ours: Gaussian

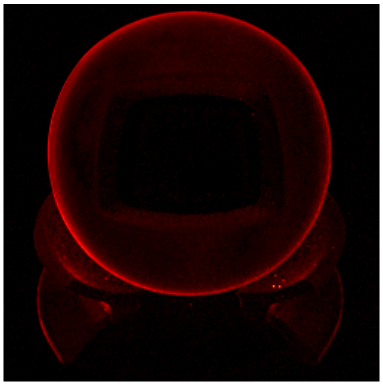


Reference

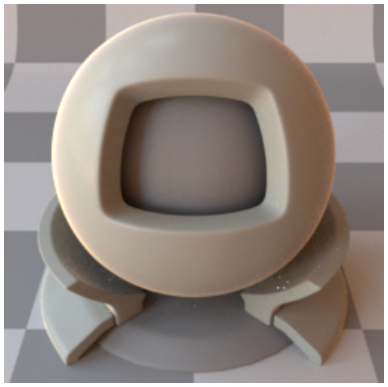


Ours: GGX

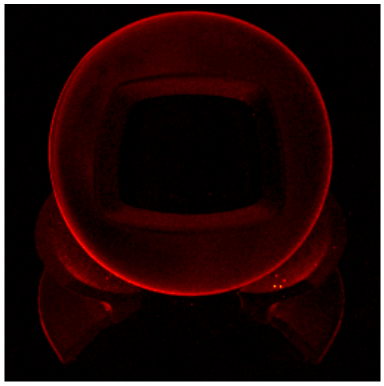
CIE dE00



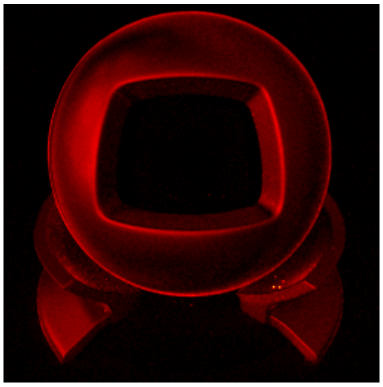
SGD



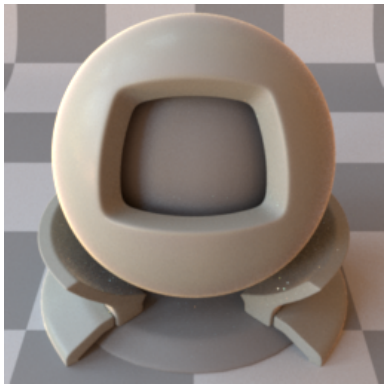
Reference



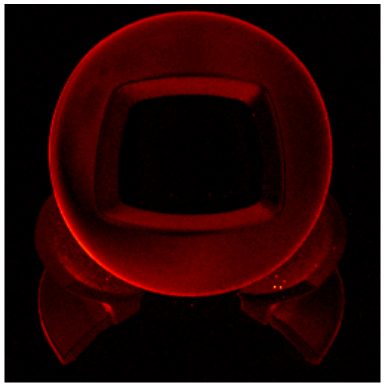
Ours: Tabulated



Ours: Gaussian

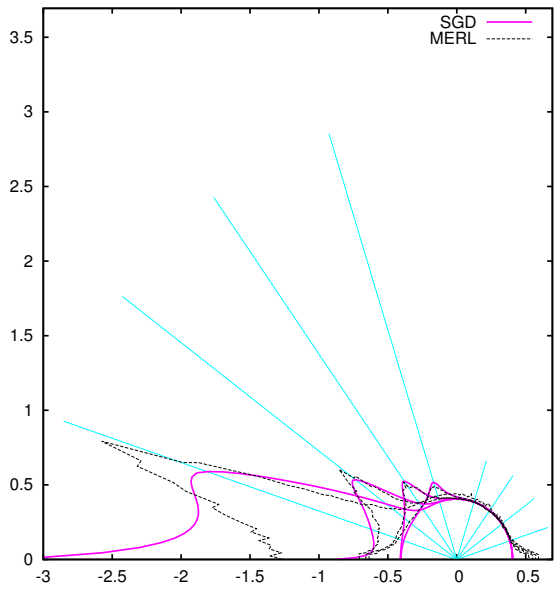


Reference

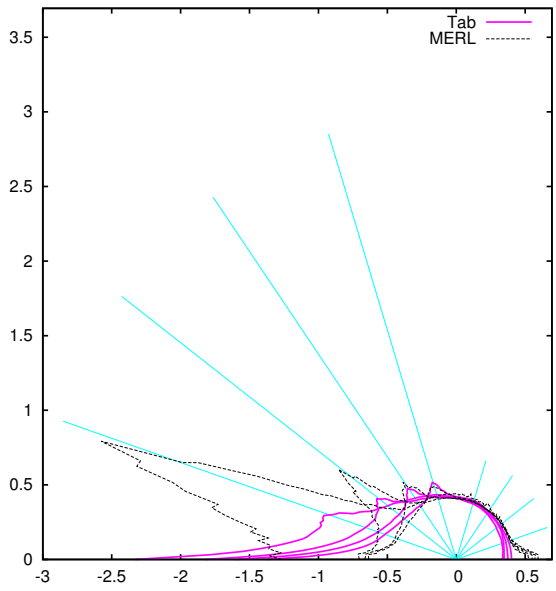


Ours: GGX

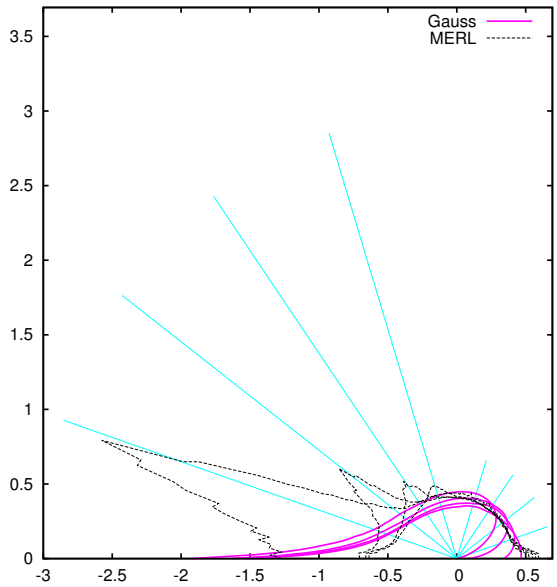
BRDF Lobes in the Incidence Plane (Cubic Root Applied)



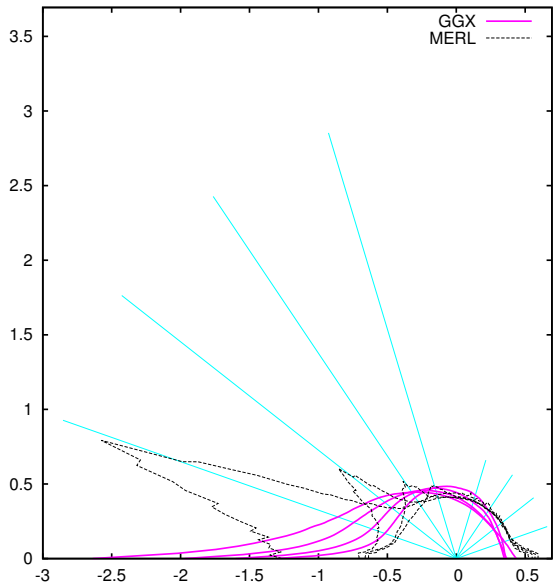
SGD



Ours: Tabulated

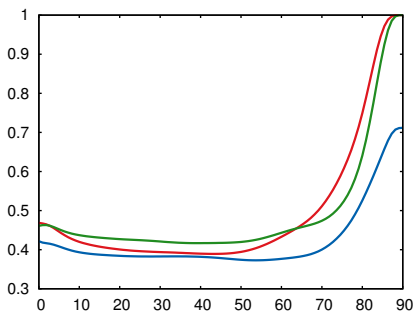


Ours: Gaussian

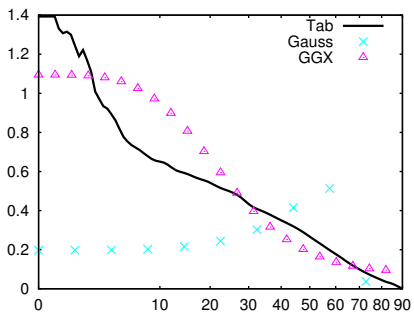


Ours: GGX

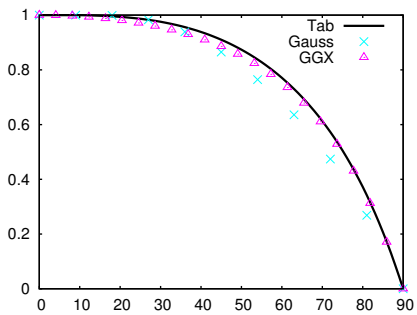
Fitted Microfacet Functions



Fresnel (R, G, B)



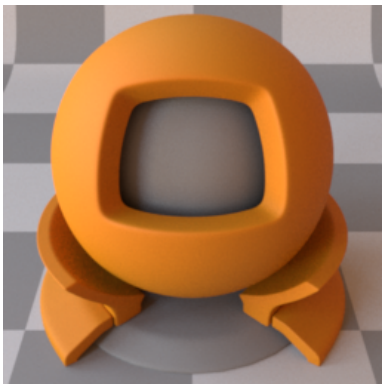
NDF (D)



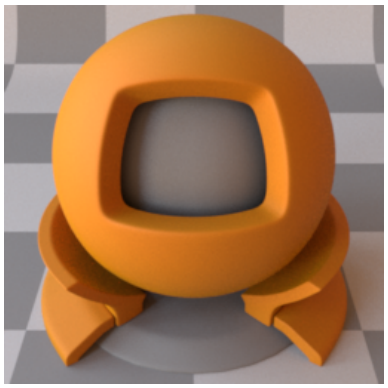
Smith (G_1)

50 orange-paint

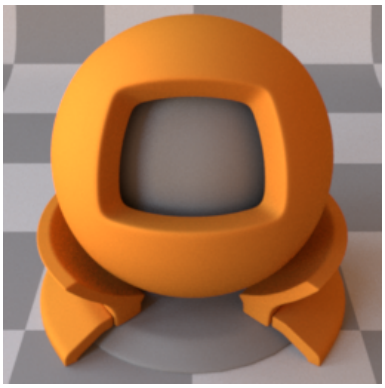
Renderings



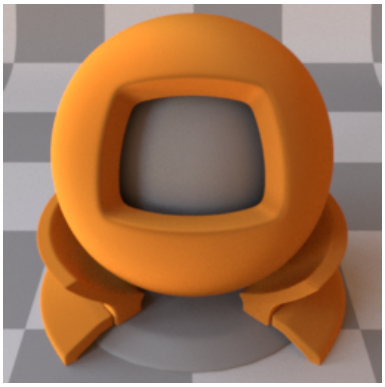
SGD



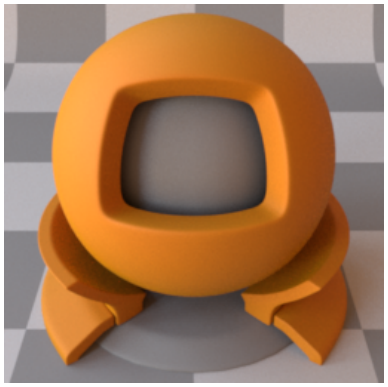
Reference



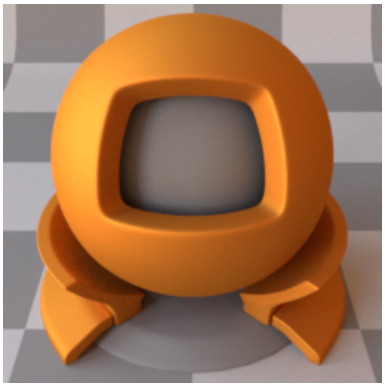
Ours: Tabulated



Ours: Gaussian

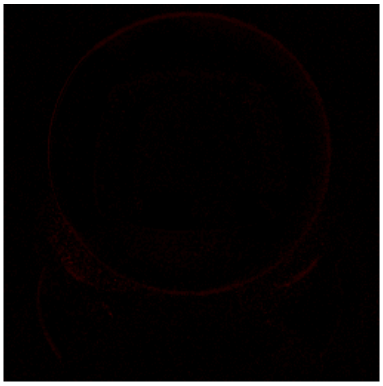


Reference

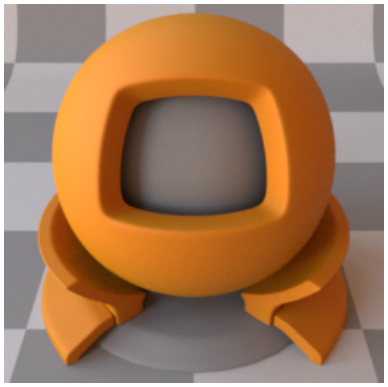


Ours: GGX

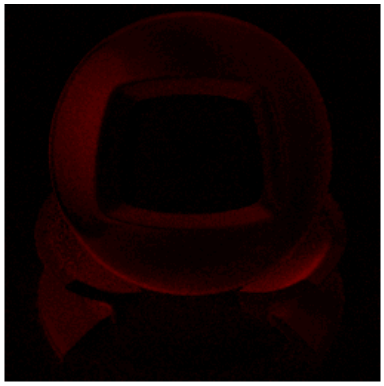
CIE dE00



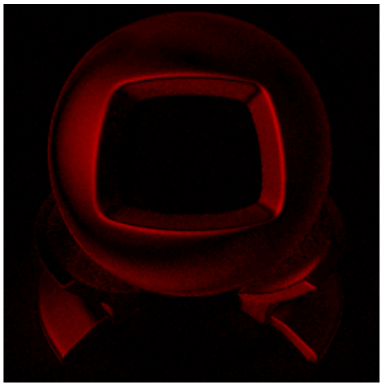
SGD



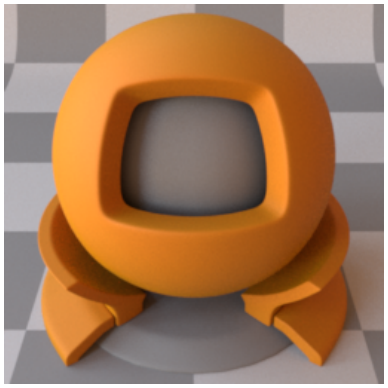
Reference



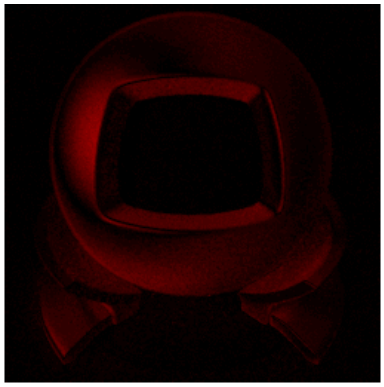
Ours: Tabulated



Ours: Gaussian

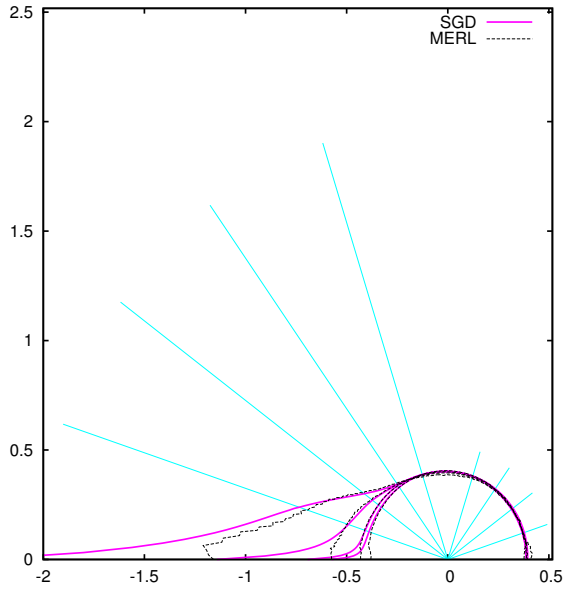


Reference

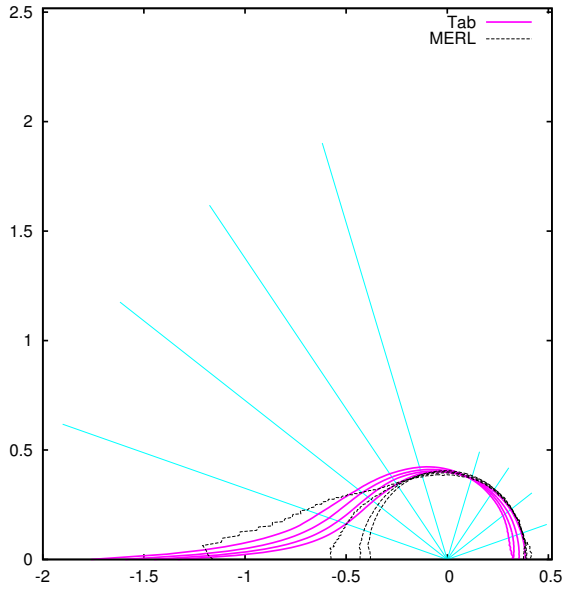


Ours: GGX

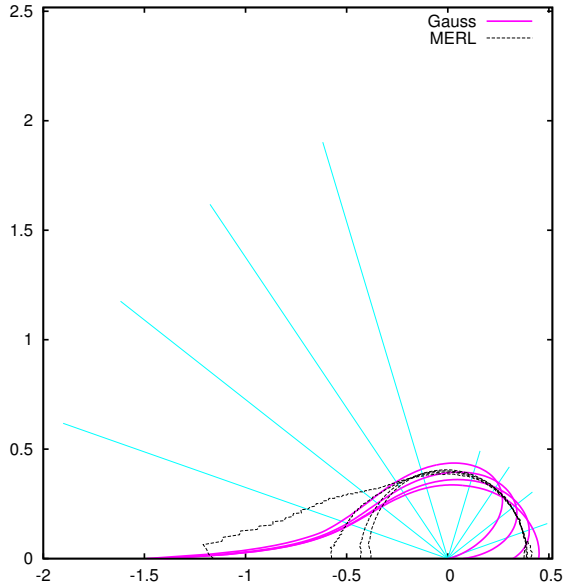
BRDF Lobes in the Incidence Plane (Cubic Root Applied)



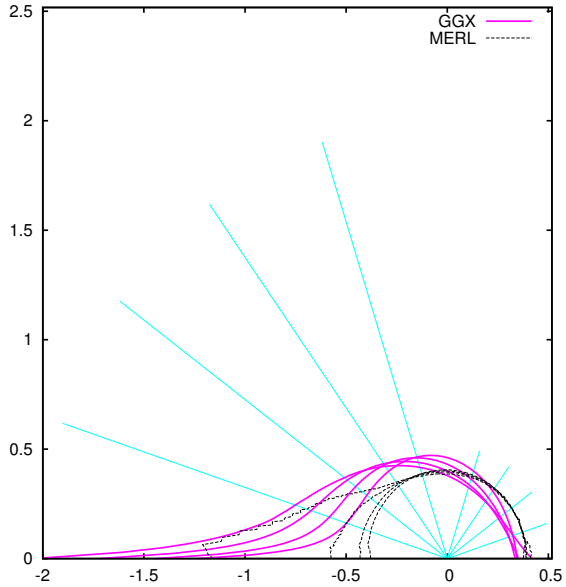
SGD



Ours: Tabulated

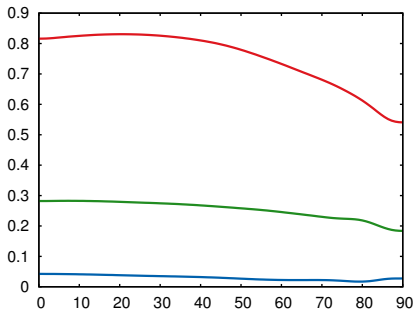


Ours: Gaussian

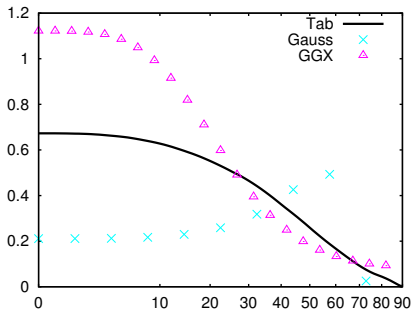


Ours: GGX

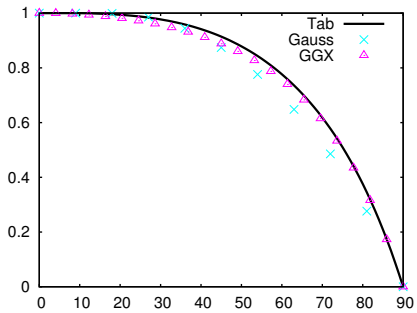
Fitted Microfacet Functions



Fresnel (R, G, B)



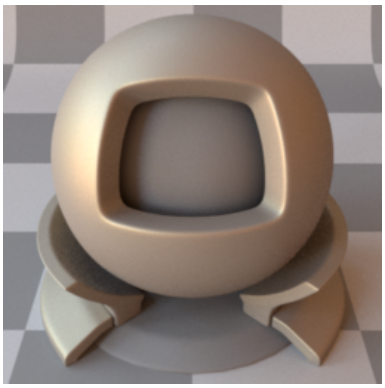
NDF (D)



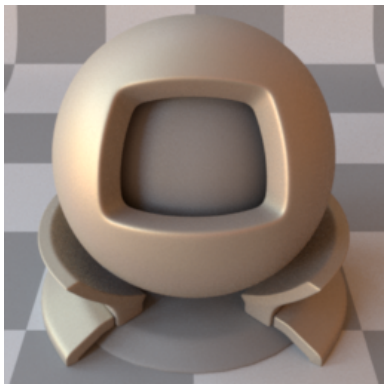
Smith (G_1)

51 pearl-paint

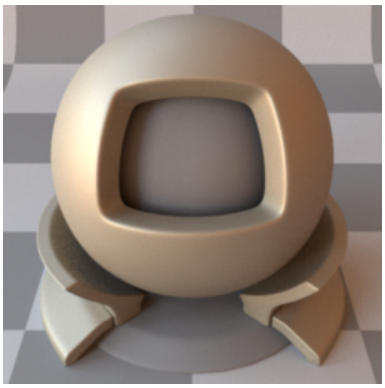
Renderings



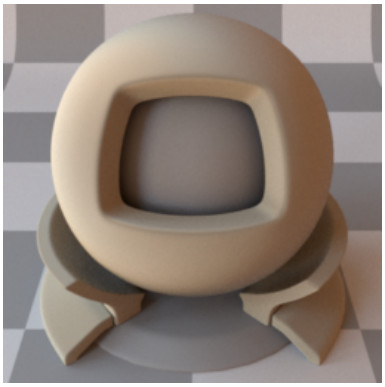
SGD



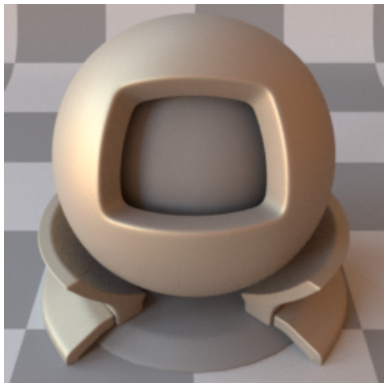
Reference



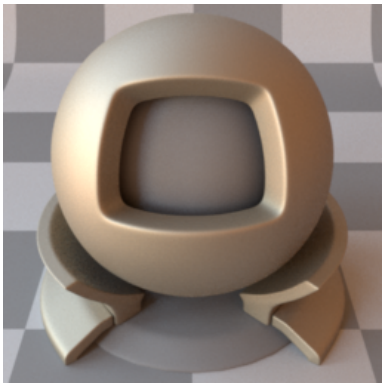
Ours: Tabulated



Ours: Gaussian

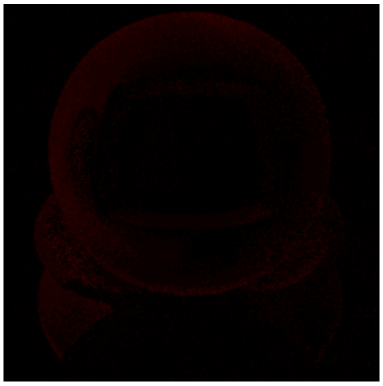


Reference

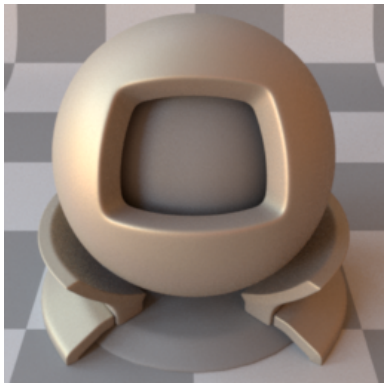


Ours: GGX

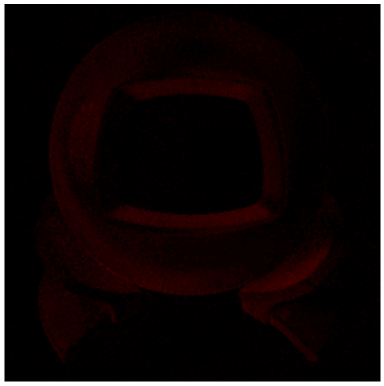
CIE dE00



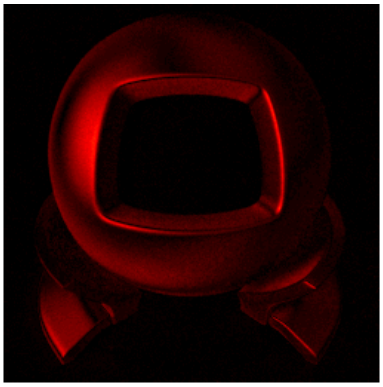
SGD



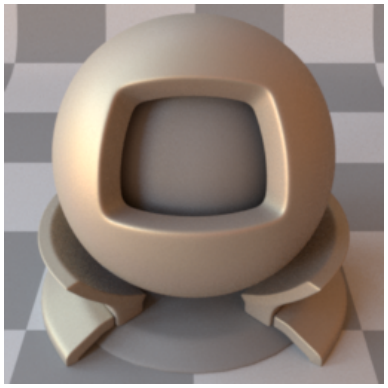
Reference



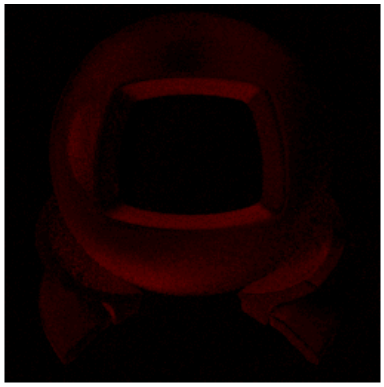
Ours: Tabulated



Ours: Gaussian

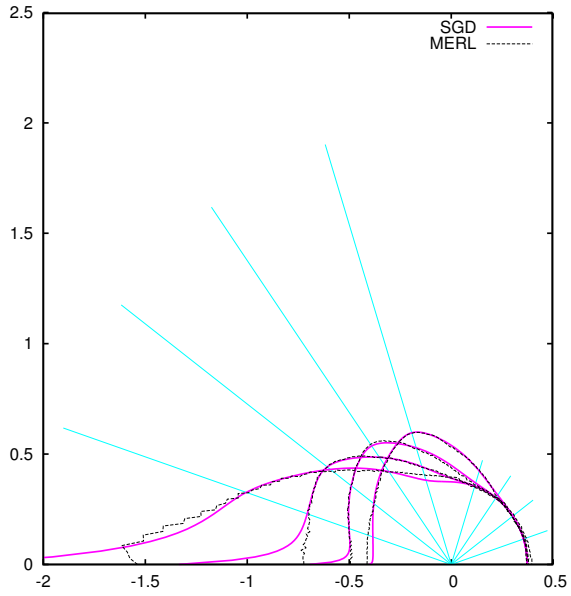


Reference

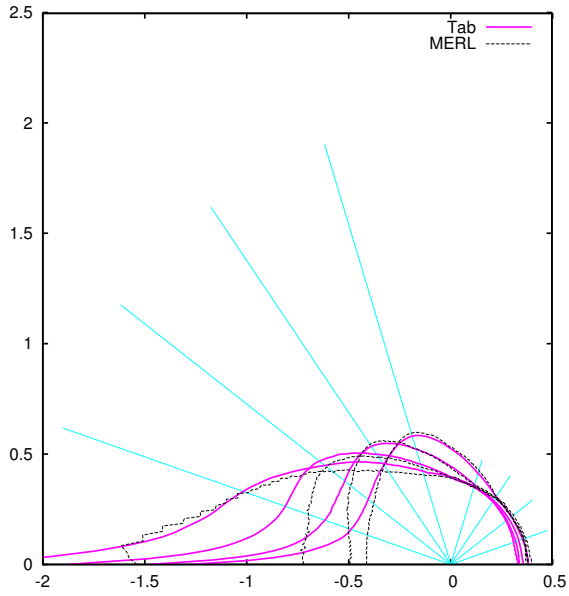


Ours: GGX

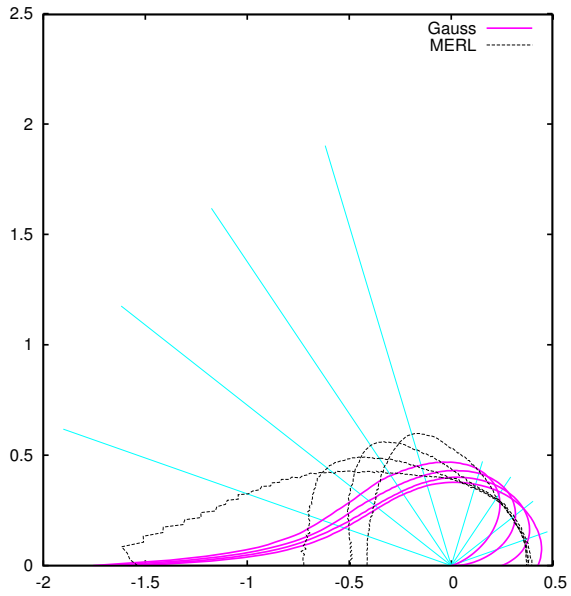
BRDF Lobes in the Incidence Plane (Cubic Root Applied)



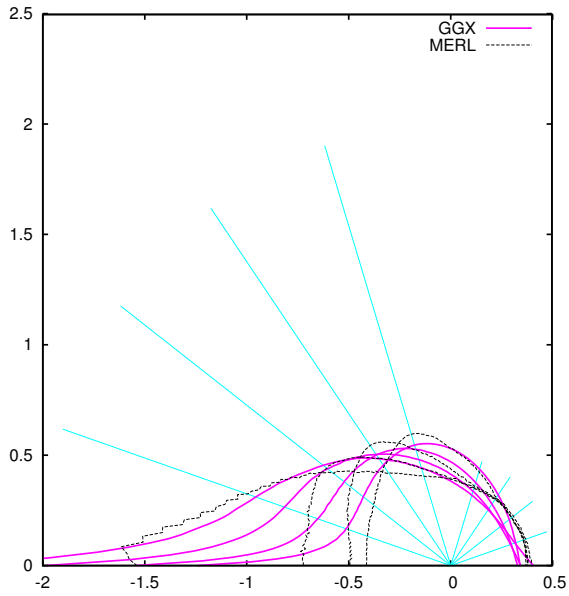
SGD



Ours: Tabulated

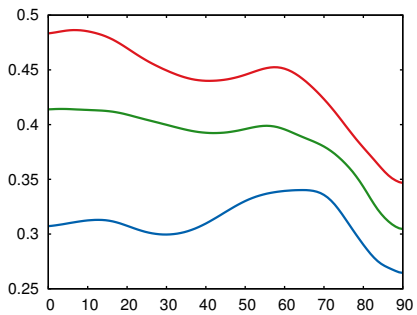


Ours: Gaussian

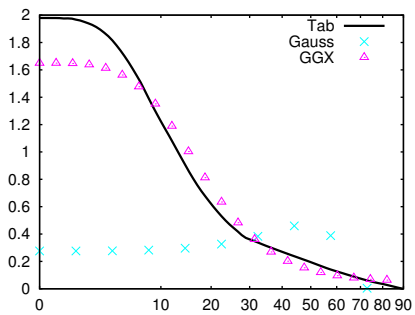


Ours: GGX

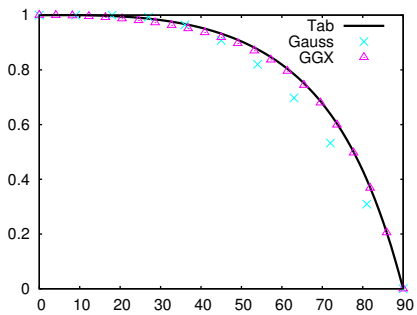
Fitted Microfacet Functions



Fresnel (R, G, B)



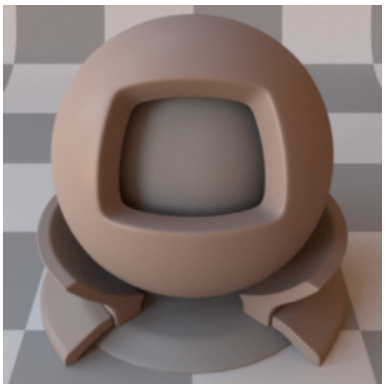
NDF (D)



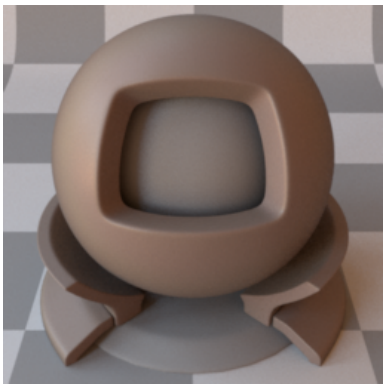
Smith (G_1)

52 pickled-oak-260

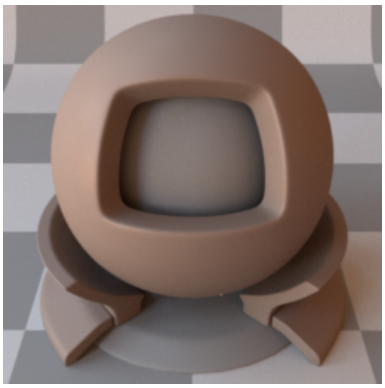
Renderings



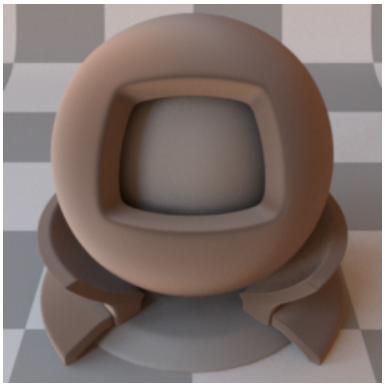
SGD



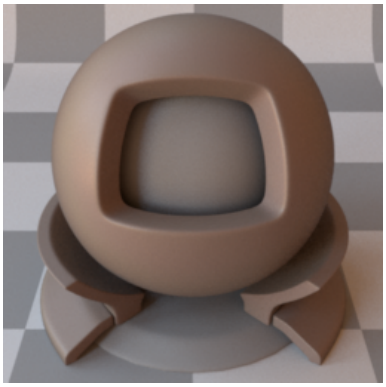
Reference



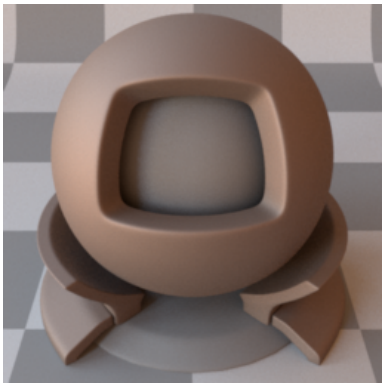
Ours: Tabulated



Ours: Gaussian

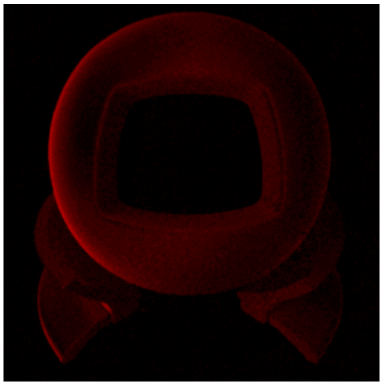


Reference

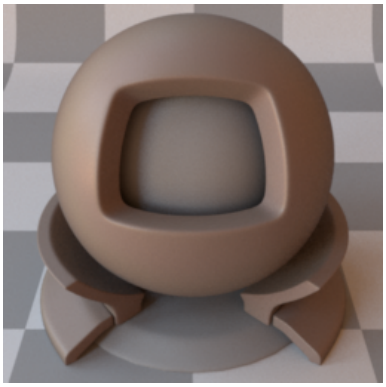


Ours: GGX

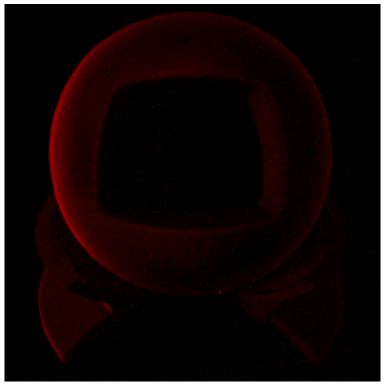
CIE dE00



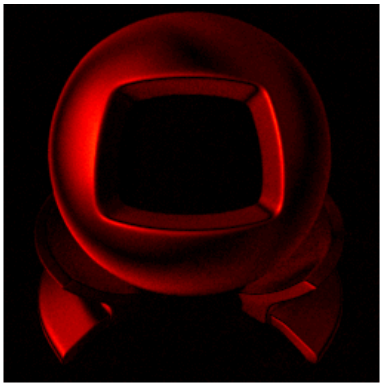
SGD



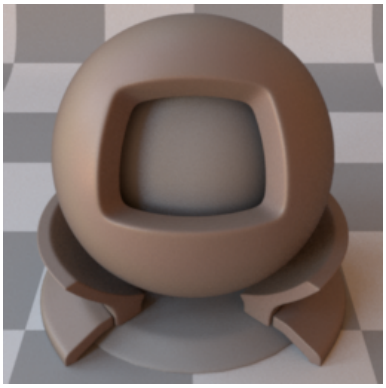
Reference



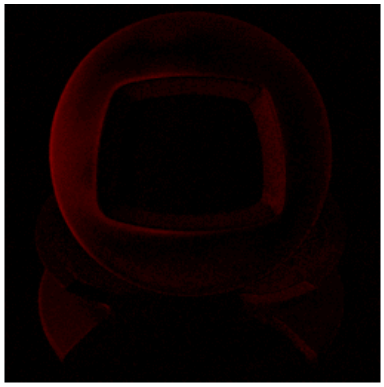
Ours: Tabulated



Ours: Gaussian

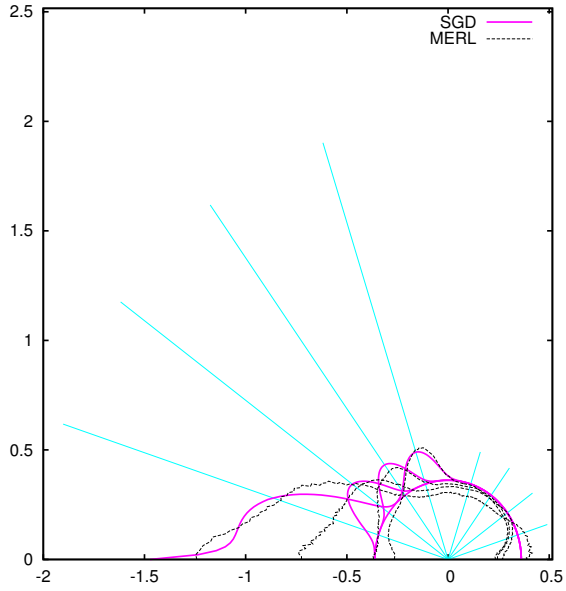


Reference

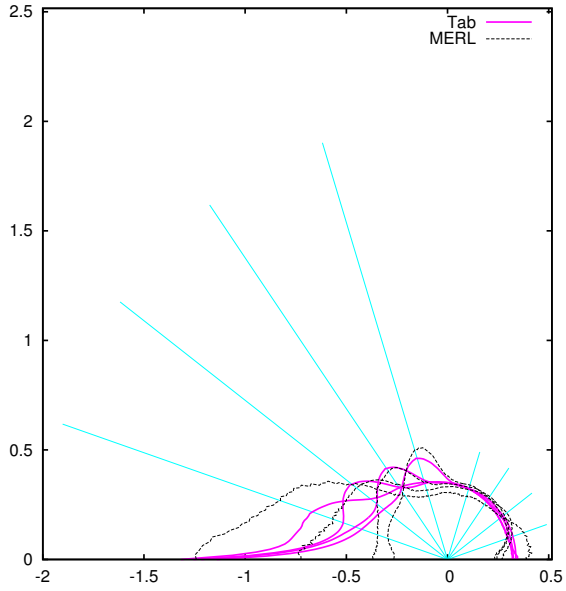


Ours: GGX

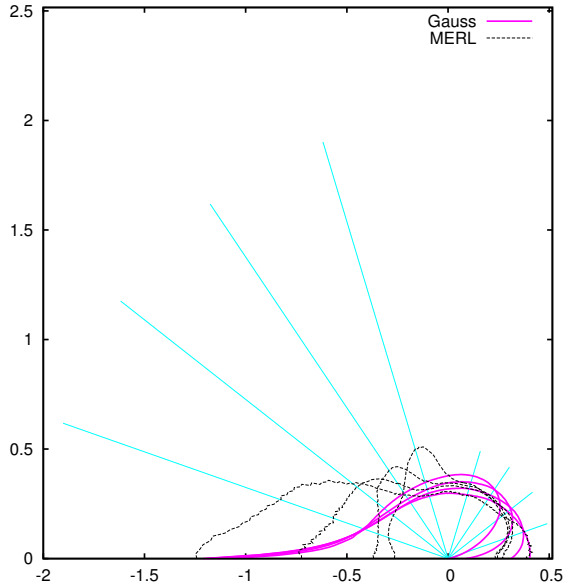
BRDF Lobes in the Incidence Plane (Cubic Root Applied)



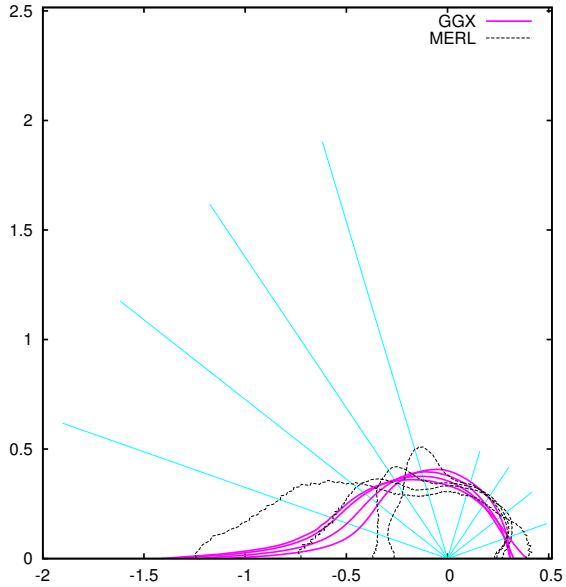
SGD



Ours: Tabulated

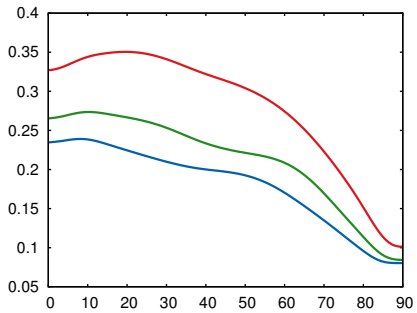


Ours: Gaussian

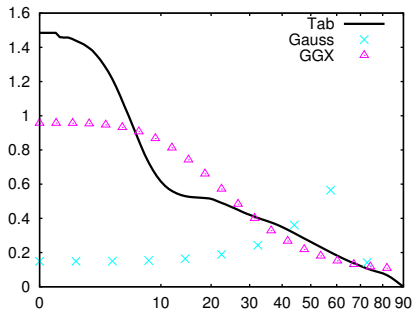


Ours: GGX

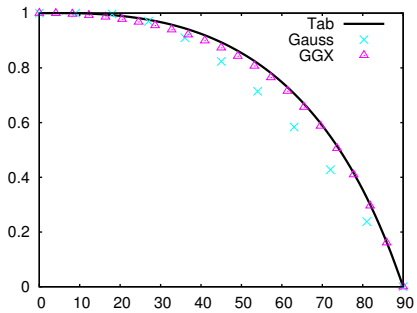
Fitted Microfacet Functions



Fresnel (R, G, B)



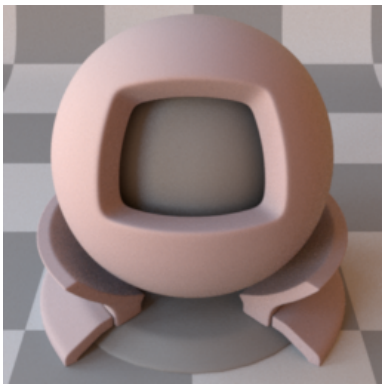
NDF (D)



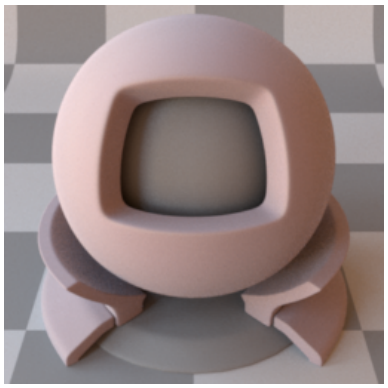
Smith (G_1)

53 pink-fabric

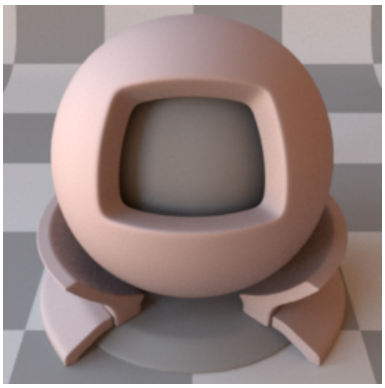
Renderings



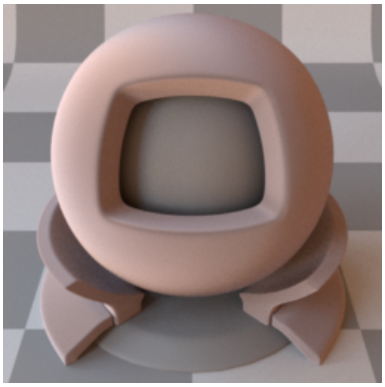
SGD



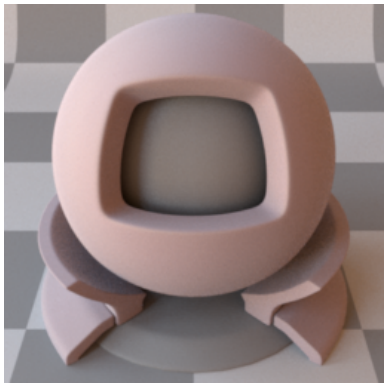
Reference



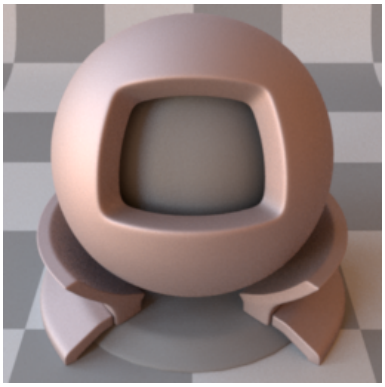
Ours: Tabulated



Ours: Gaussian

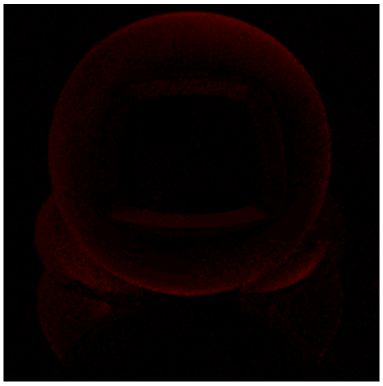


Reference

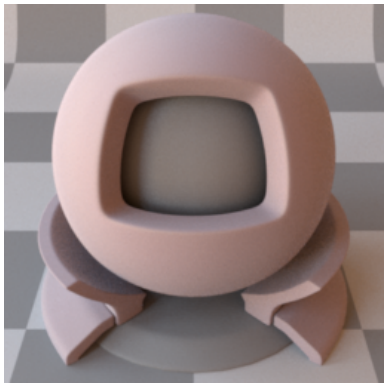


Ours: GGX

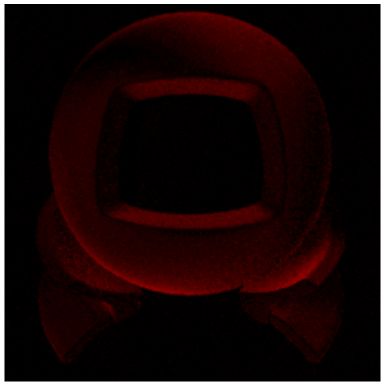
CIE dE00



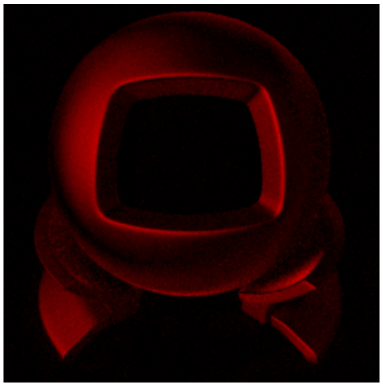
SGD



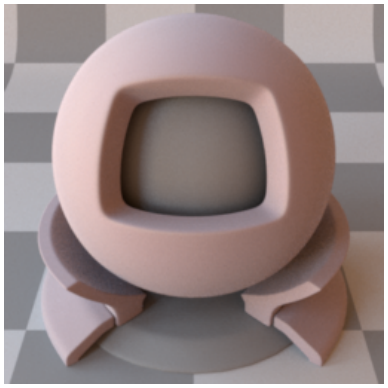
Reference



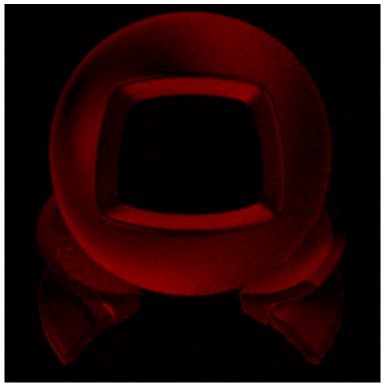
Ours: Tabulated



Ours: Gaussian

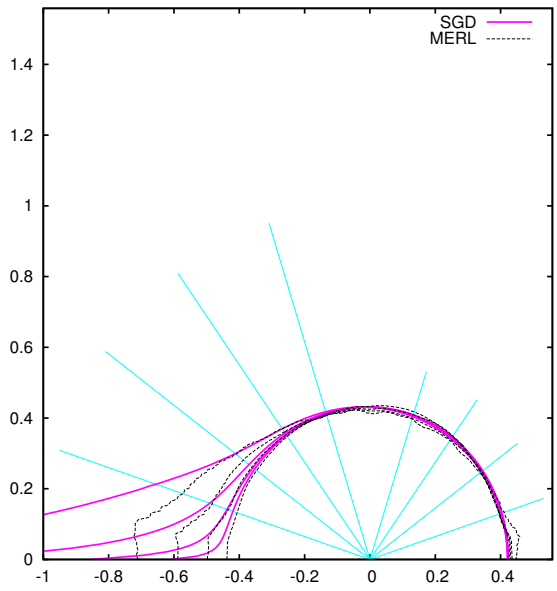


Reference

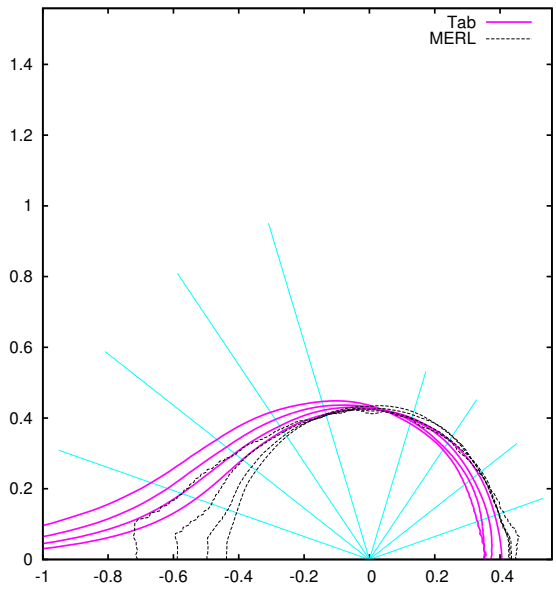


Ours: GGX

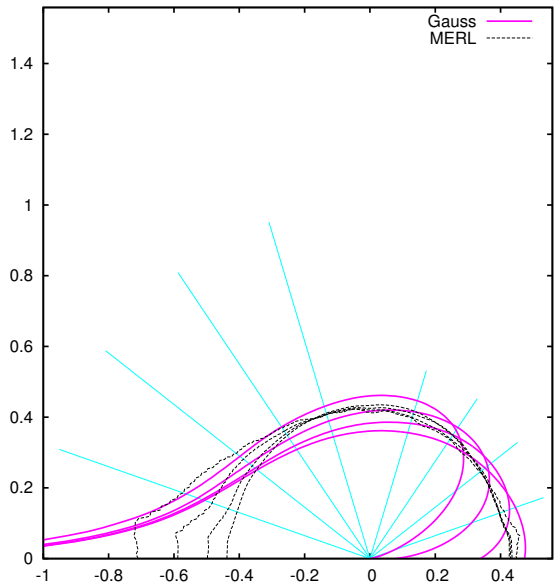
BRDF Lobes in the Incidence Plane (Cubic Root Applied)



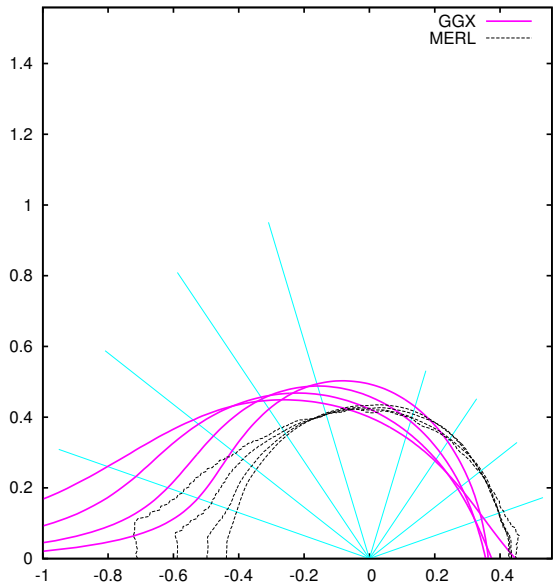
SGD



Ours: Tabulated

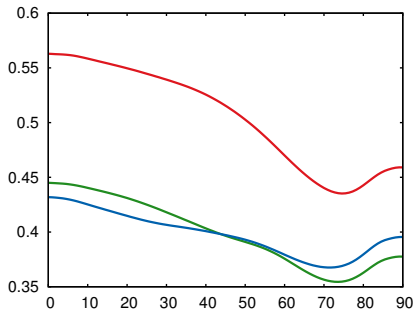


Ours: Gaussian

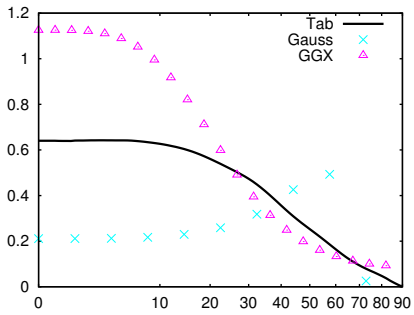


Ours: GGX

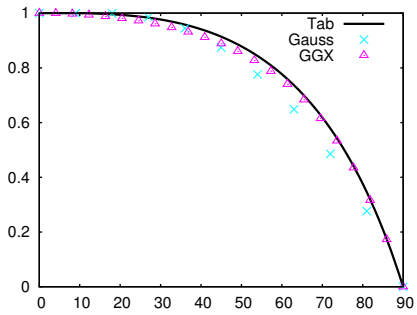
Fitted Microfacet Functions



Fresnel (R, G, B)



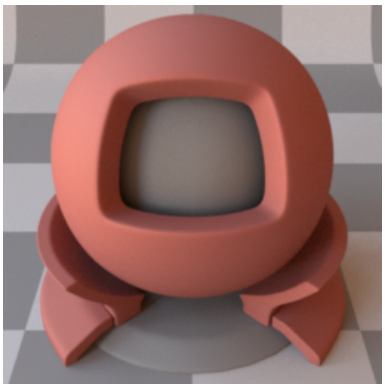
NDF (D)



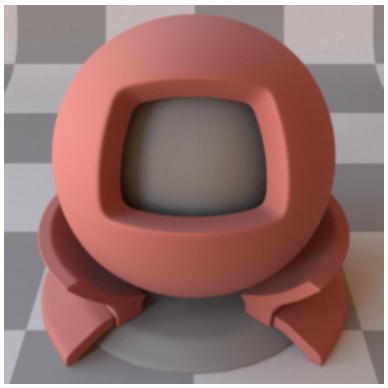
Smith (G_1)

54 pink-fabric2

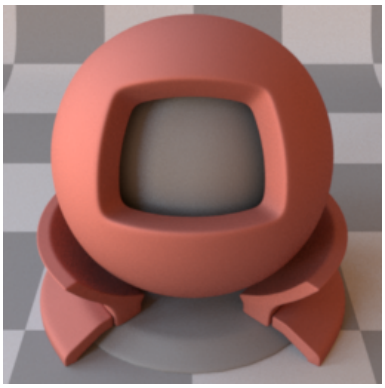
Renderings



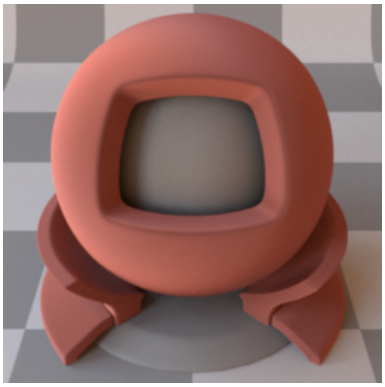
SGD



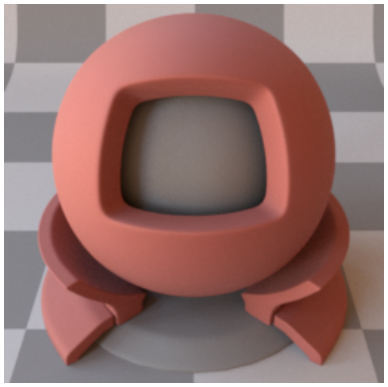
Reference



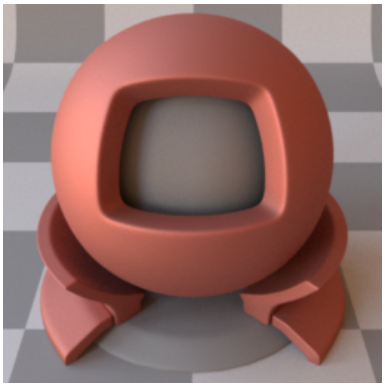
Ours: Tabulated



Ours: Gaussian

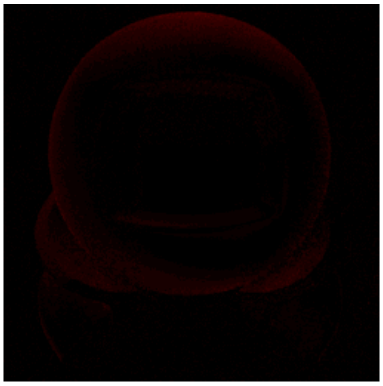


Reference

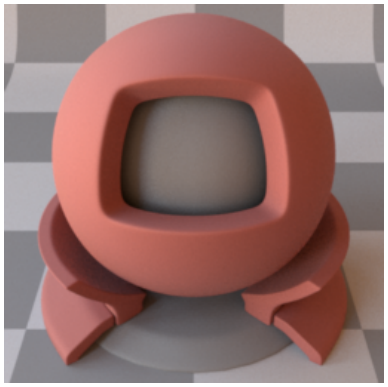


Ours: GGX

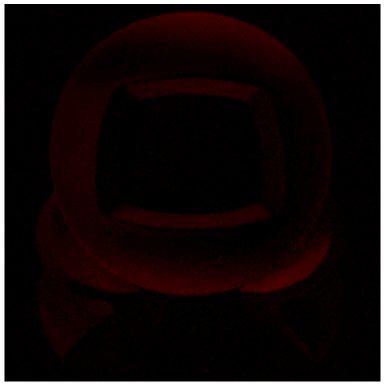
CIE dE00



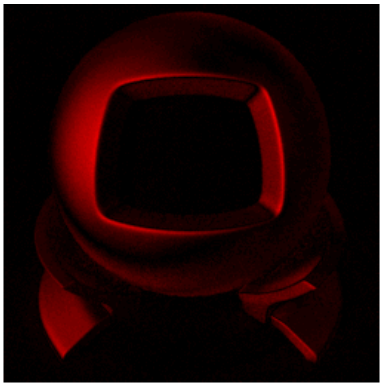
SGD



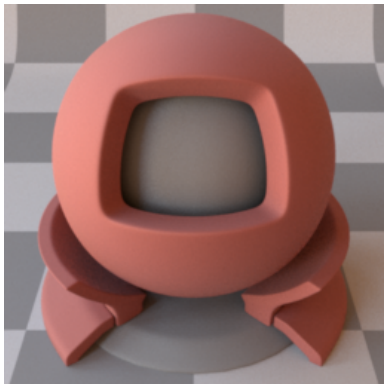
Reference



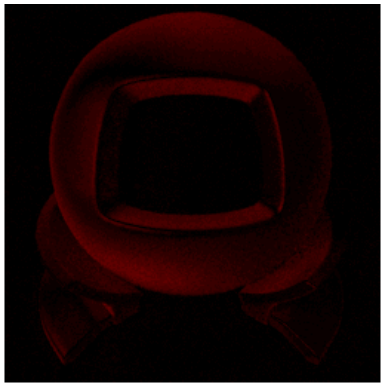
Ours: Tabulated



Ours: Gaussian

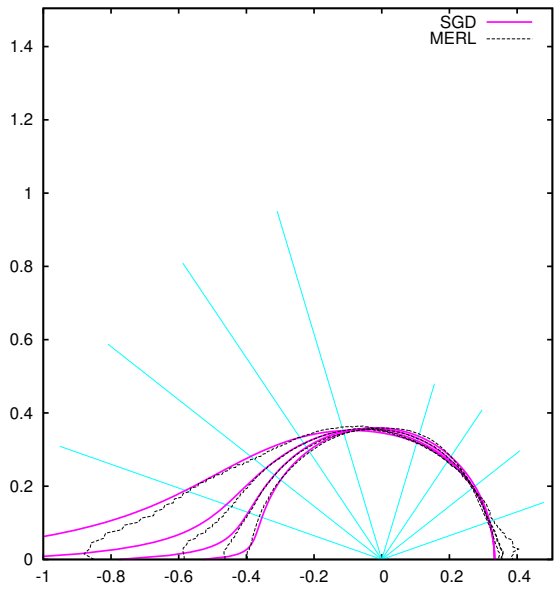


Reference

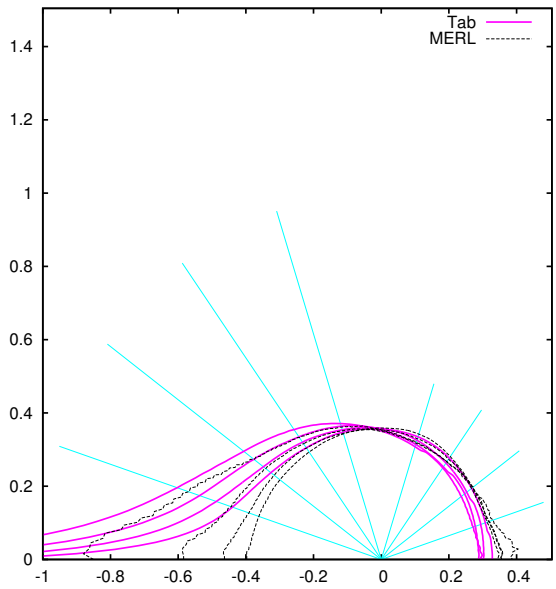


Ours: GGX

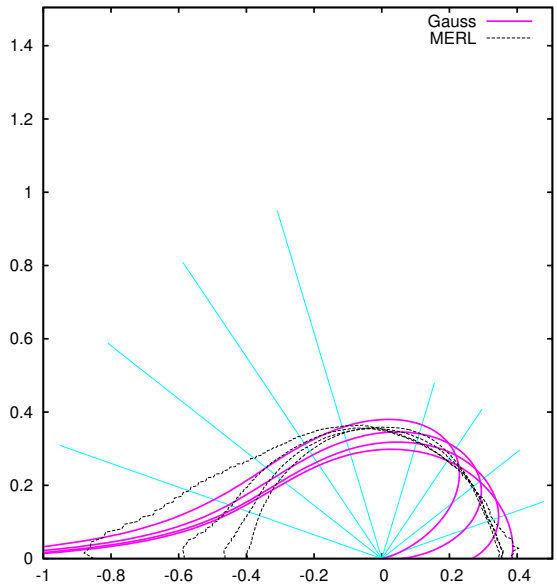
BRDF Lobes in the Incidence Plane (Cubic Root Applied)



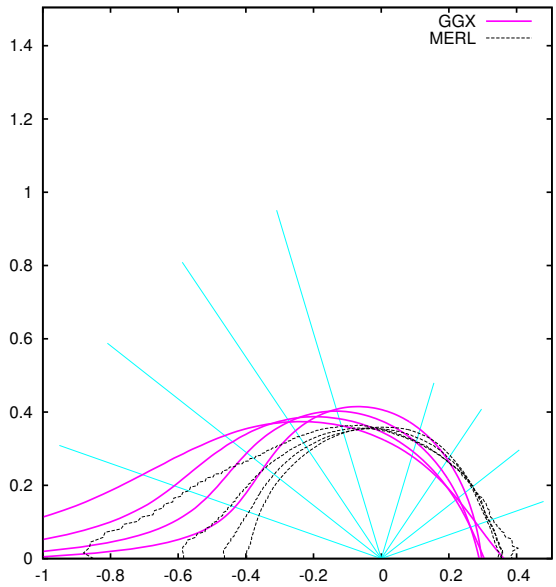
SGD



Ours: Tabulated

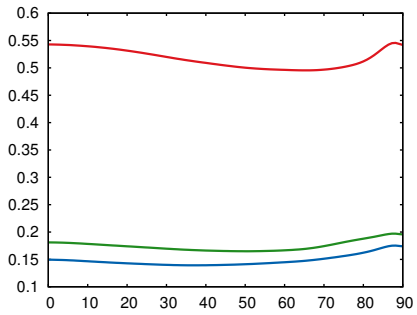


Ours: Gaussian

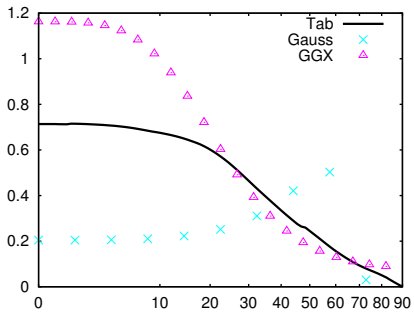


Ours: GGX

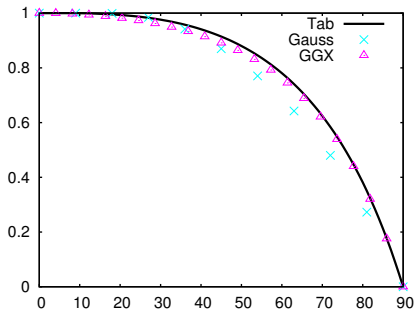
Fitted Microfacet Functions



Fresnel (R, G, B)



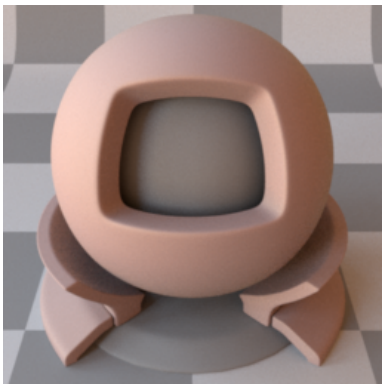
NDF (D)



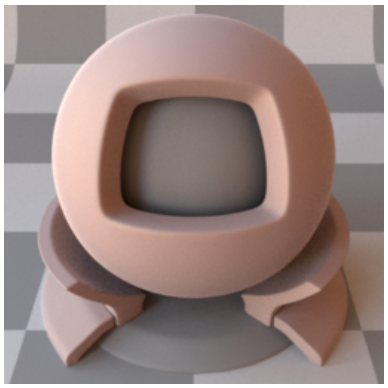
Smith (G_1)

55 pink-felt

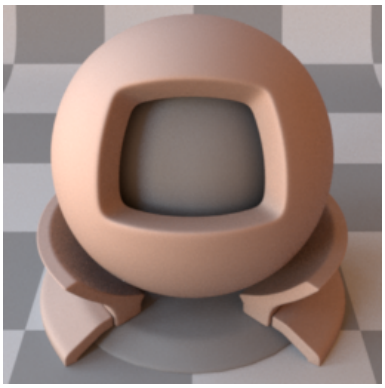
Renderings



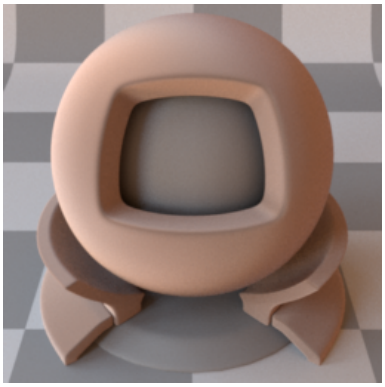
SGD



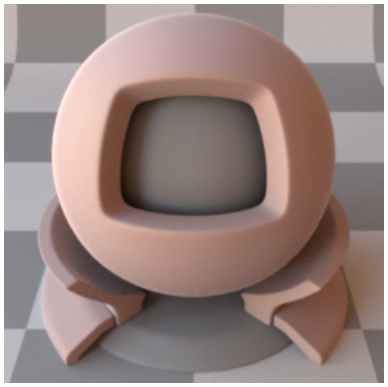
Reference



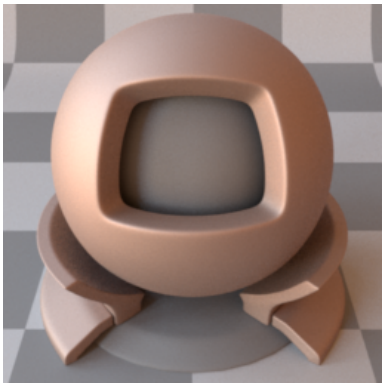
Ours: Tabulated



Ours: Gaussian

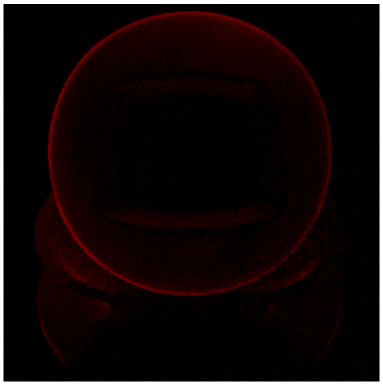


Reference

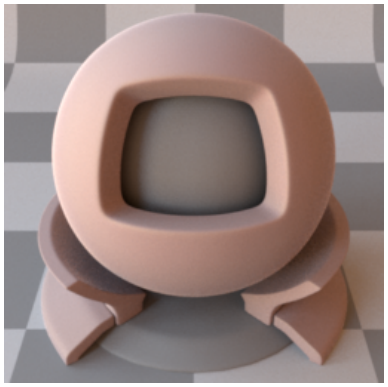


Ours: GGX

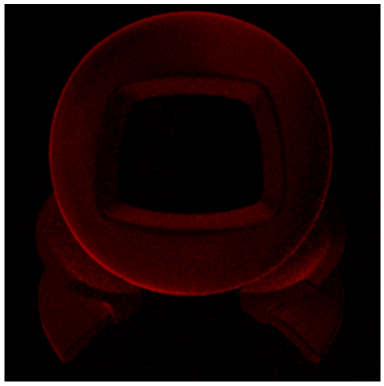
CIE dE00



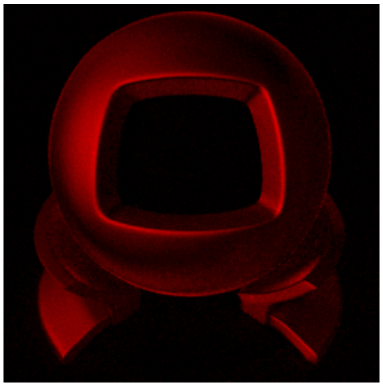
SGD



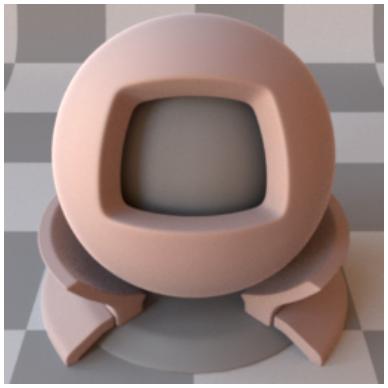
Reference



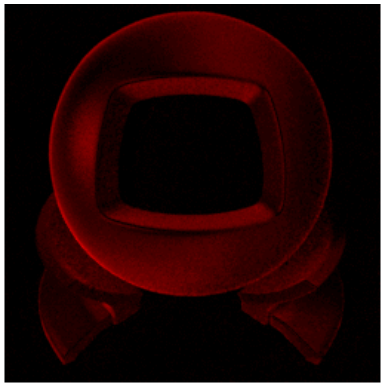
Ours: Tabulated



Ours: Gaussian

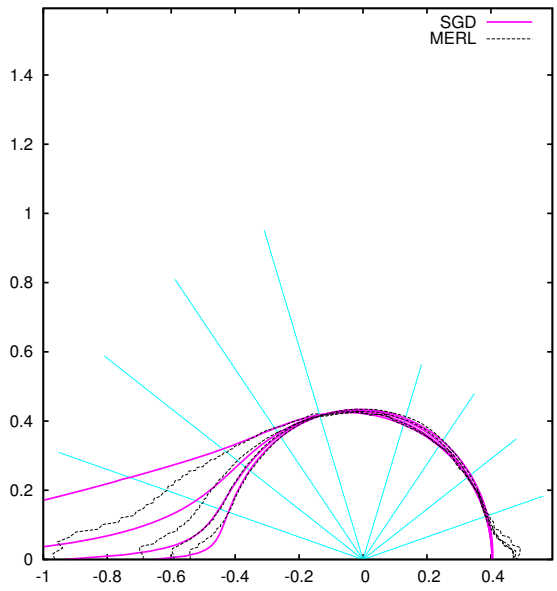


Reference

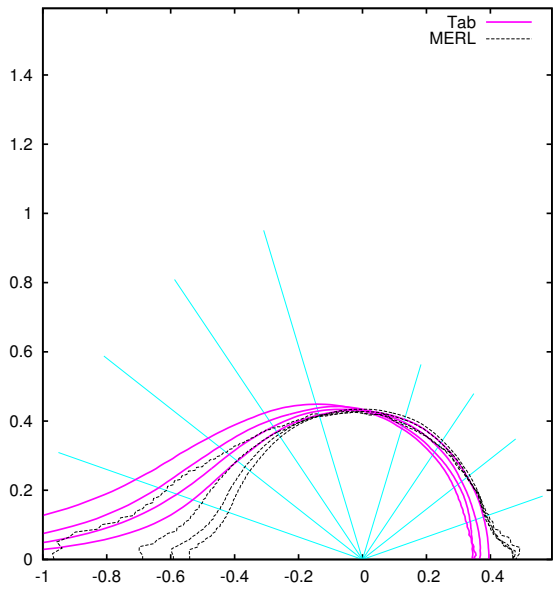


Ours: GGX

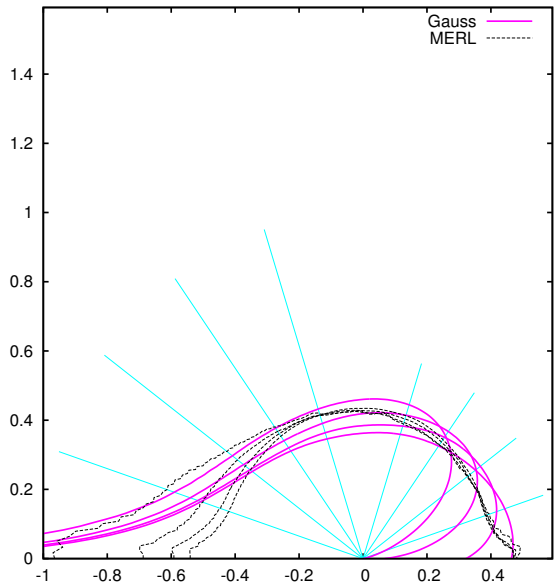
BRDF Lobes in the Incidence Plane (Cubic Root Applied)



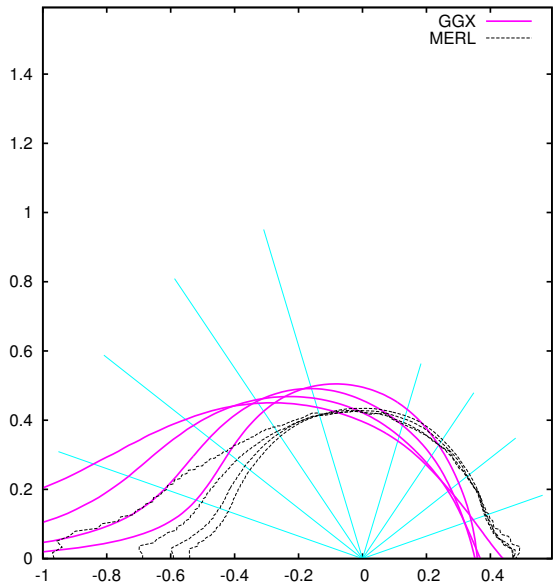
SGD



Ours: Tabulated

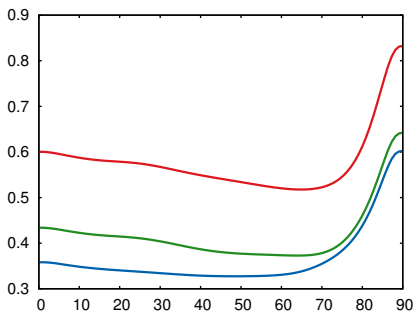


Ours: Gaussian

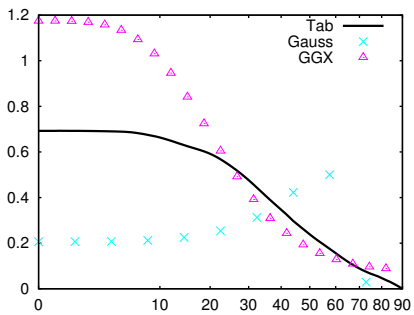


Ours: GGX

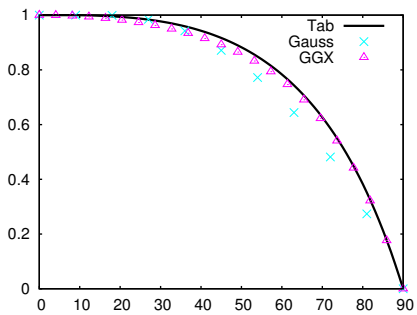
Fitted Microfacet Functions



Fresnel (R, G, B)



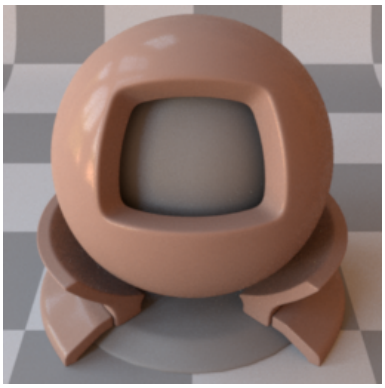
NDF (D)



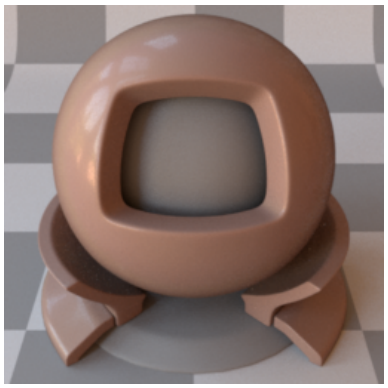
Smith (G_1)

56 pink-jasper

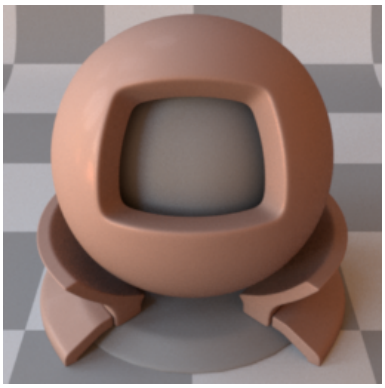
Renderings



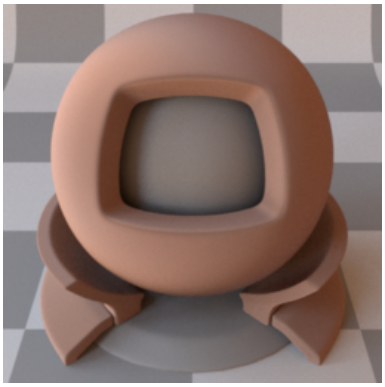
SGD



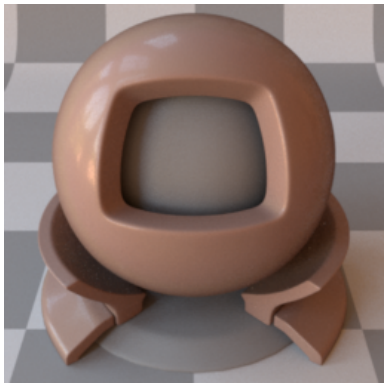
Reference



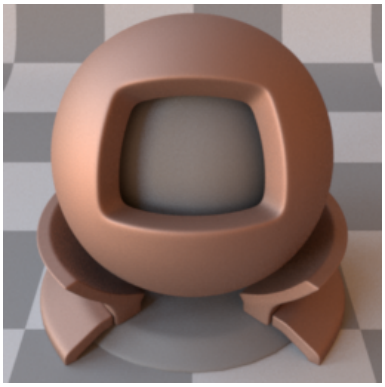
Ours: Tabulated



Ours: Gaussian

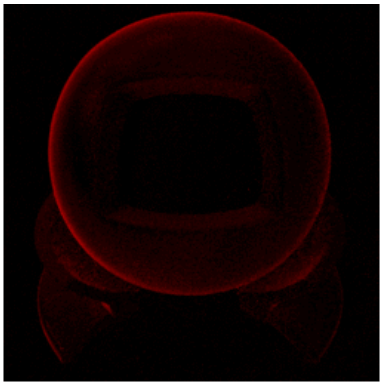


Reference

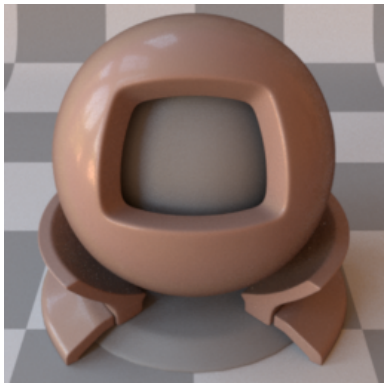


Ours: GGX

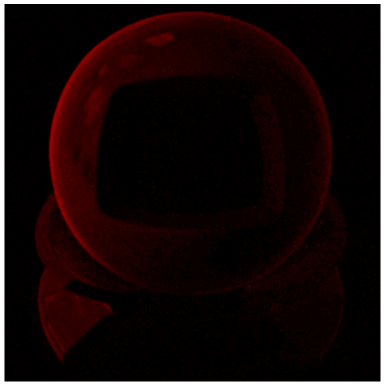
CIE dE00



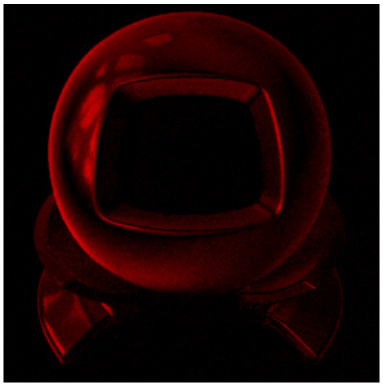
SGD



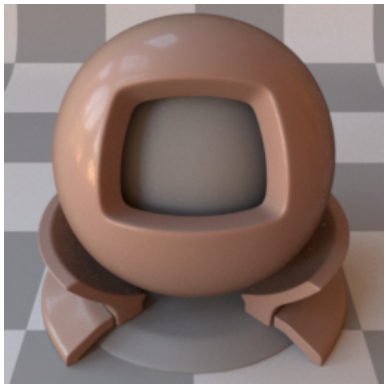
Reference



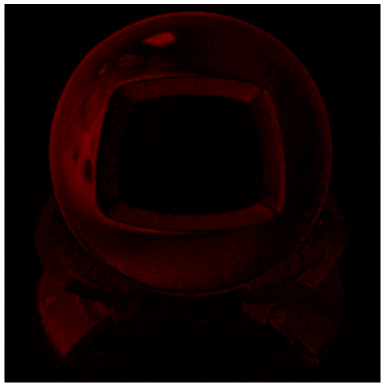
Ours: Tabulated



Ours: Gaussian

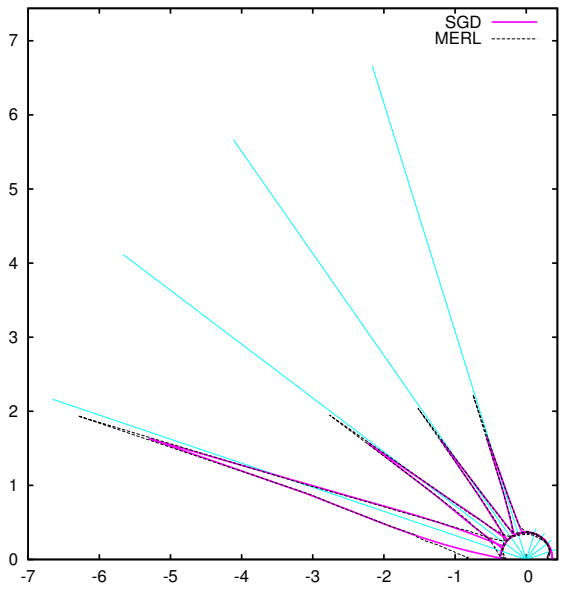


Reference

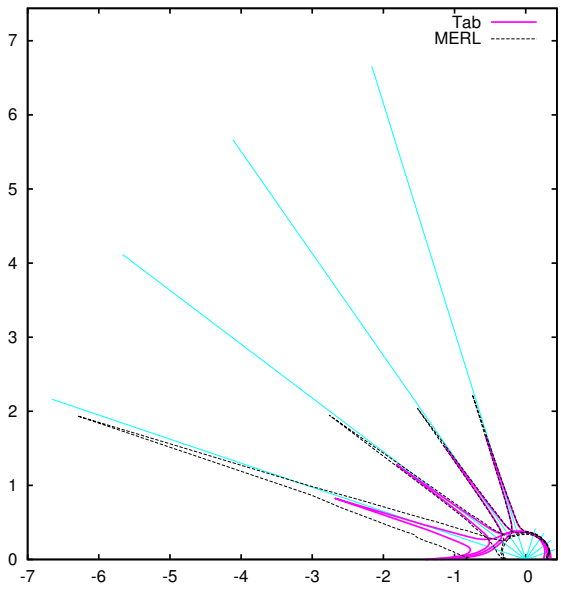


Ours: GGX

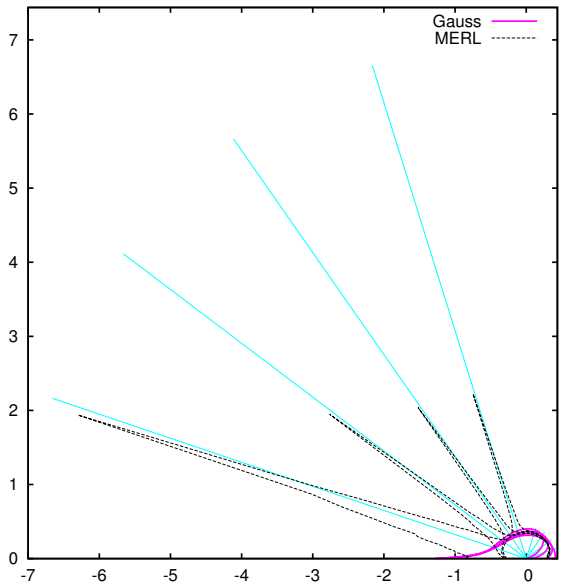
BRDF Lobes in the Incidence Plane (Cubic Root Applied)



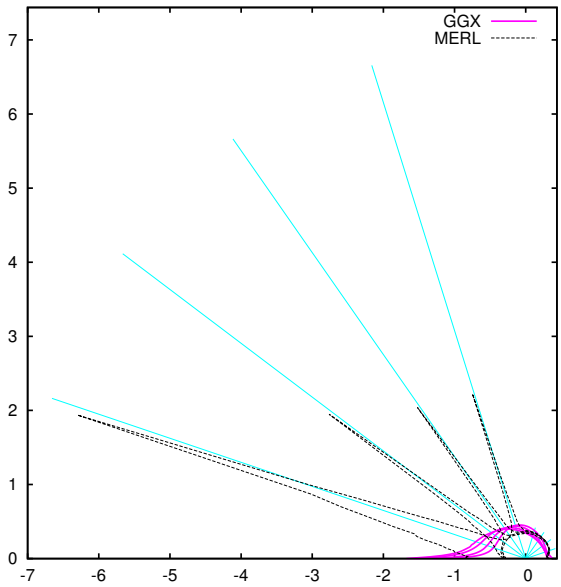
SGD



Ours: Tabulated

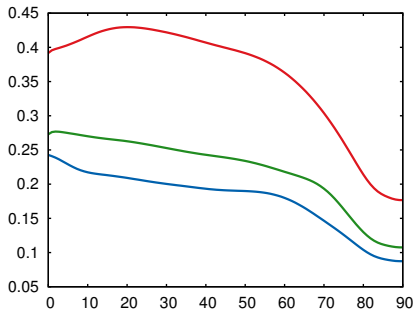


Ours: Gaussian

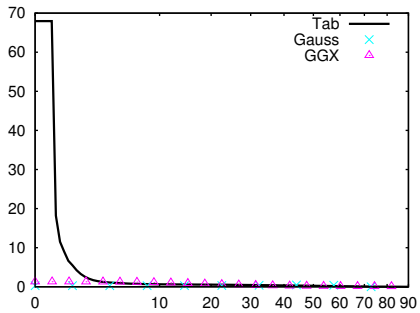


Ours: GGX

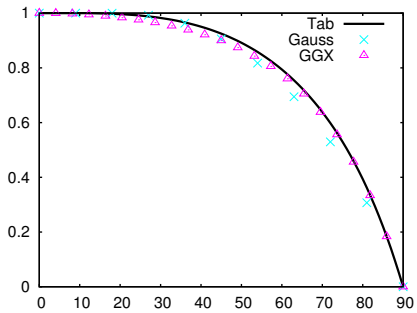
Fitted Microfacet Functions



Fresnel (R, G, B)



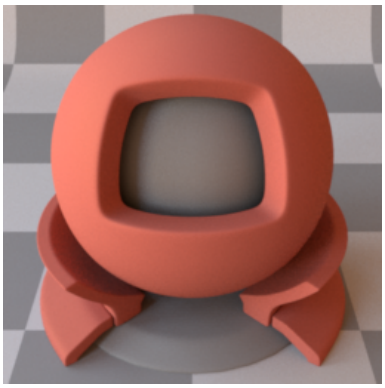
NDF (D)



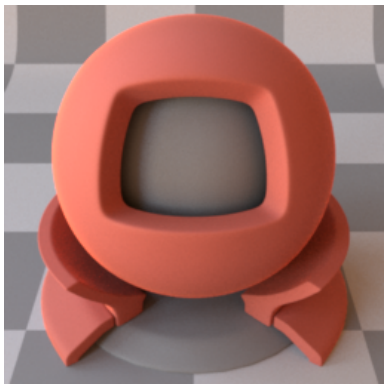
Smith (G_1)

57 pink-plastic

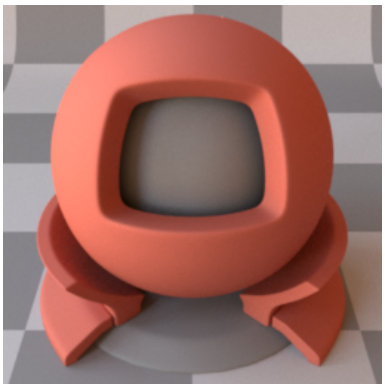
Renderings



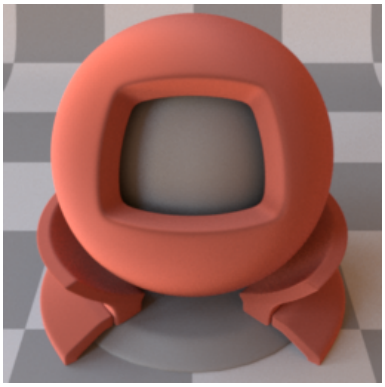
SGD



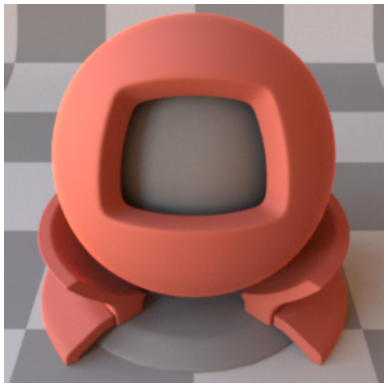
Reference



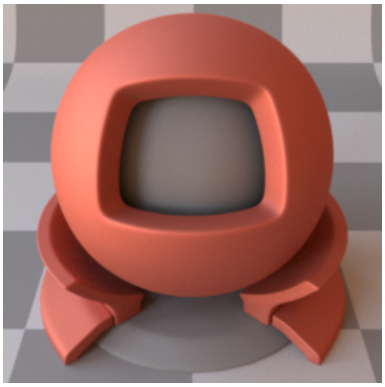
Ours: Tabulated



Ours: Gaussian

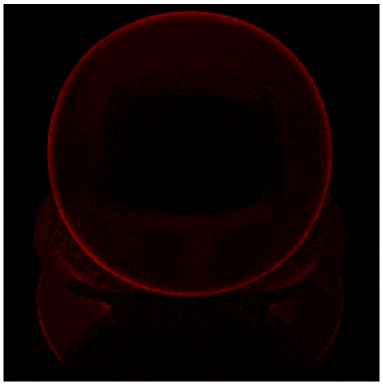


Reference

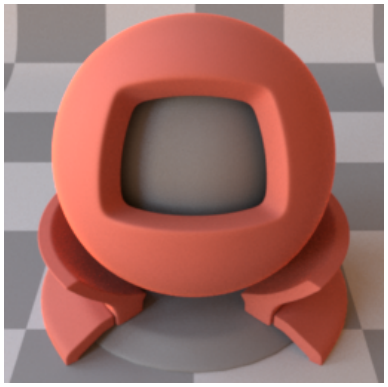


Ours: GGX

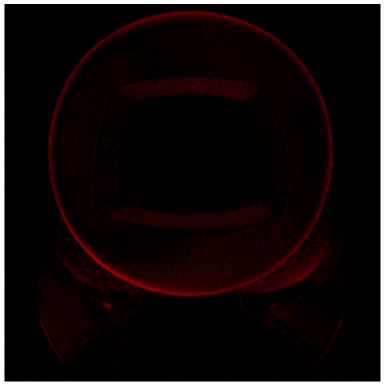
CIE dE00



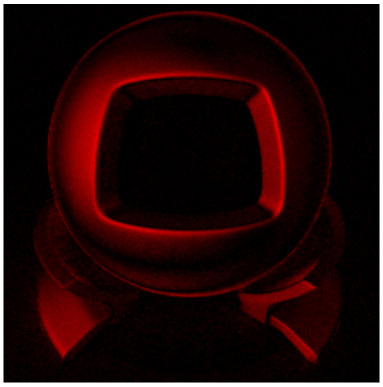
SGD



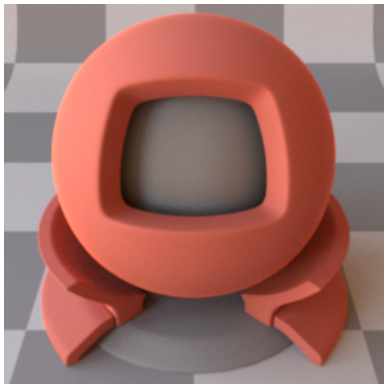
Reference



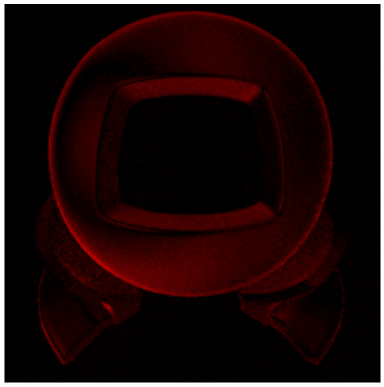
Ours: Tabulated



Ours: Gaussian

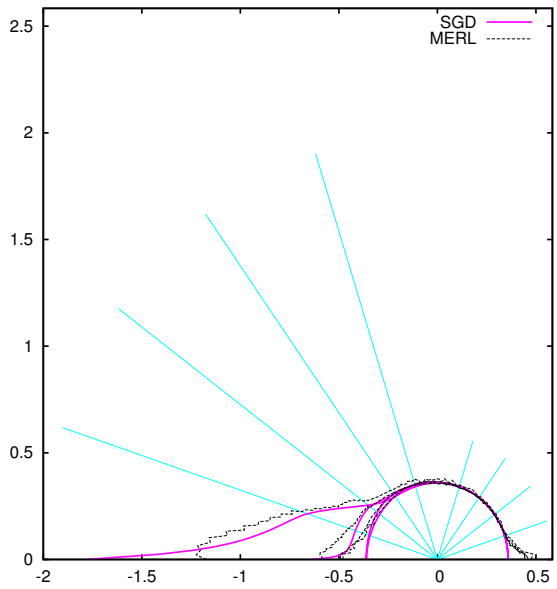


Reference

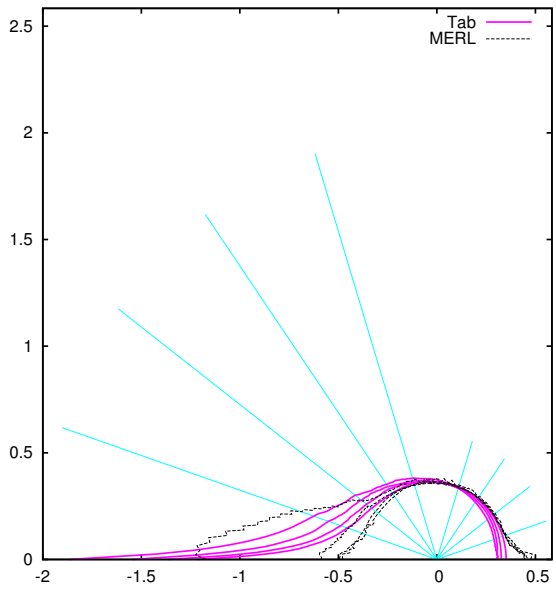


Ours: GGX

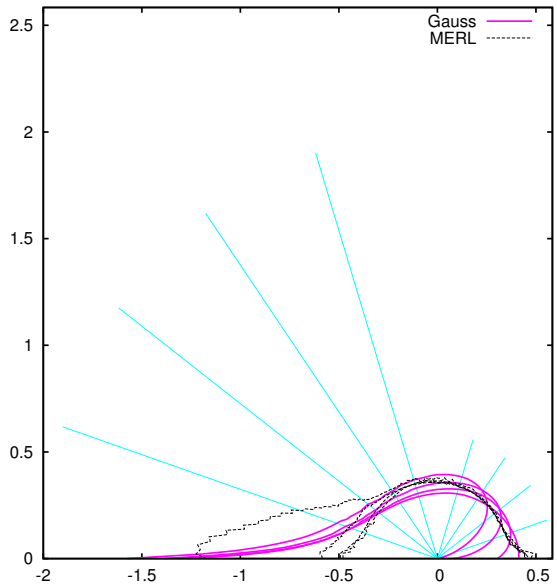
BRDF Lobes in the Incidence Plane (Cubic Root Applied)



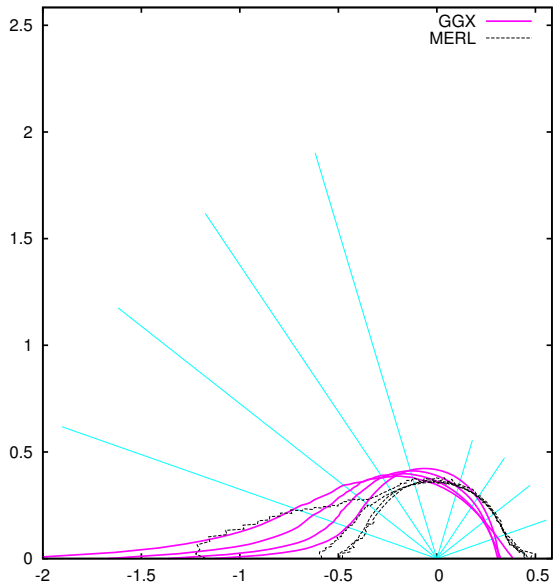
SGD



Ours: Tabulated

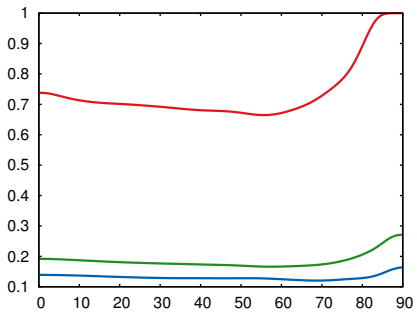


Ours: Gaussian

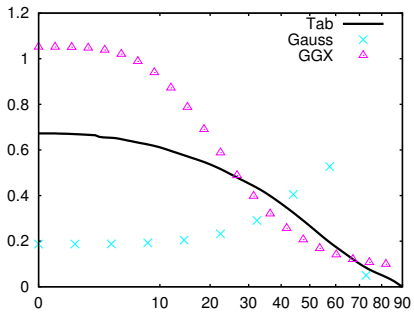


Ours: GGX

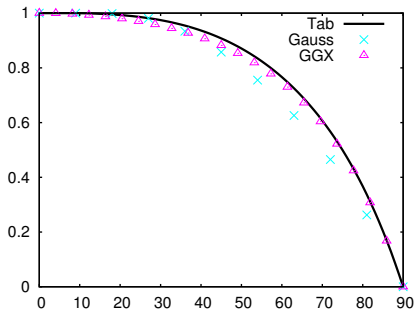
Fitted Microfacet Functions



Fresnel (R, G, B)



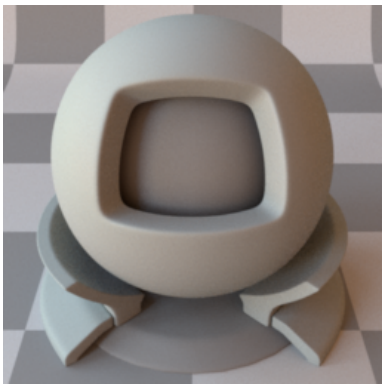
NDF (D)



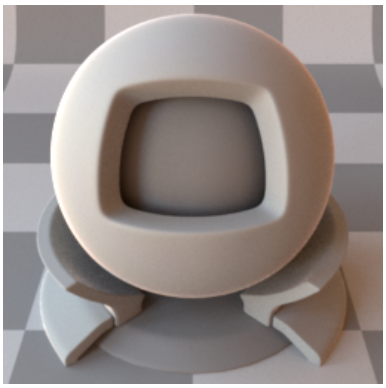
Smith (G_1)

58 polyethylene

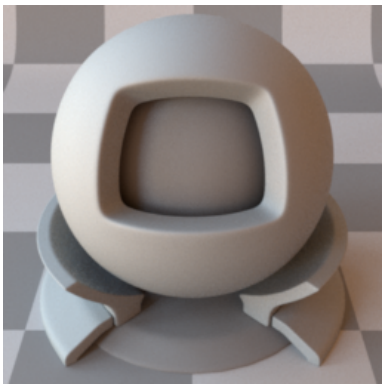
Renderings



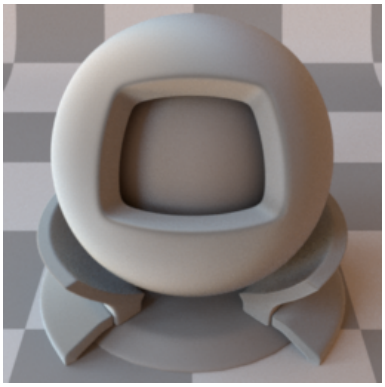
SGD



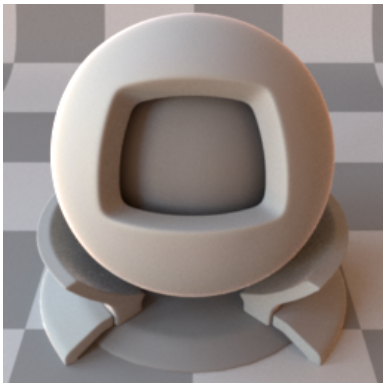
Reference



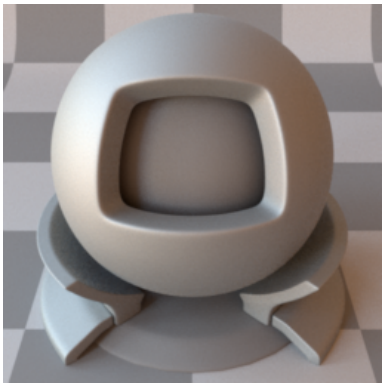
Ours: Tabulated



Ours: Gaussian

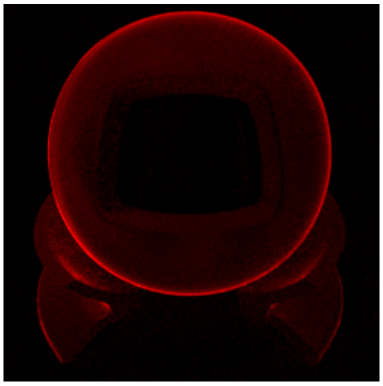


Reference

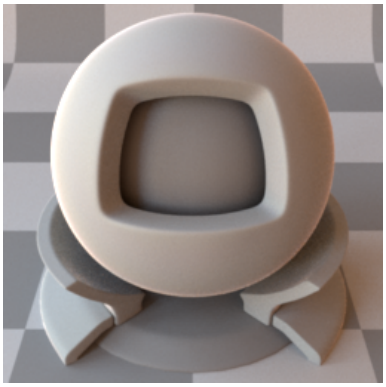


Ours: GGX

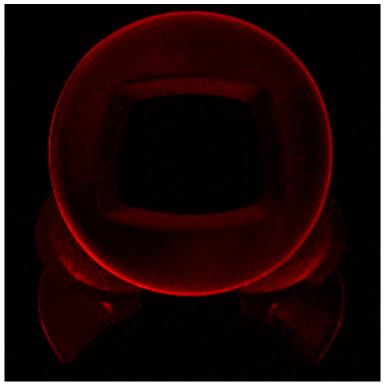
CIE dE00



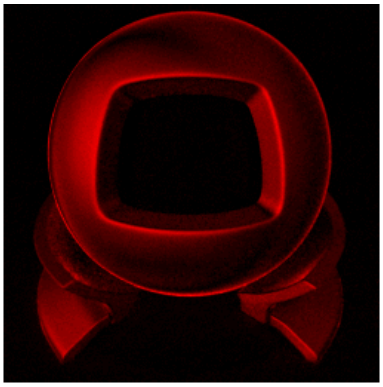
SGD



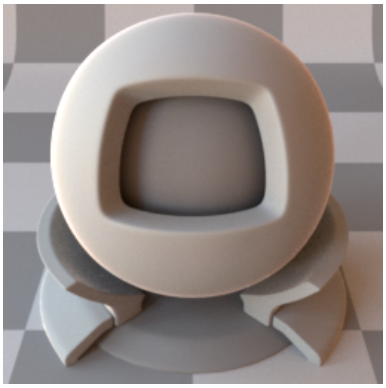
Reference



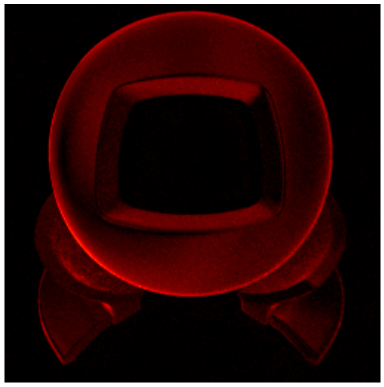
Ours: Tabulated



Ours: Gaussian

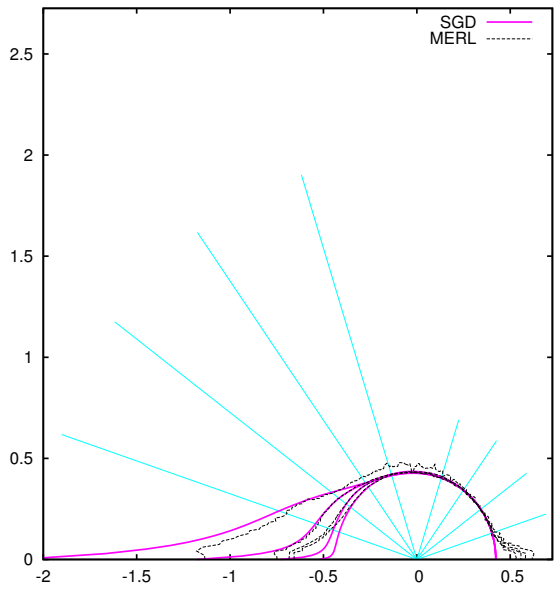


Reference

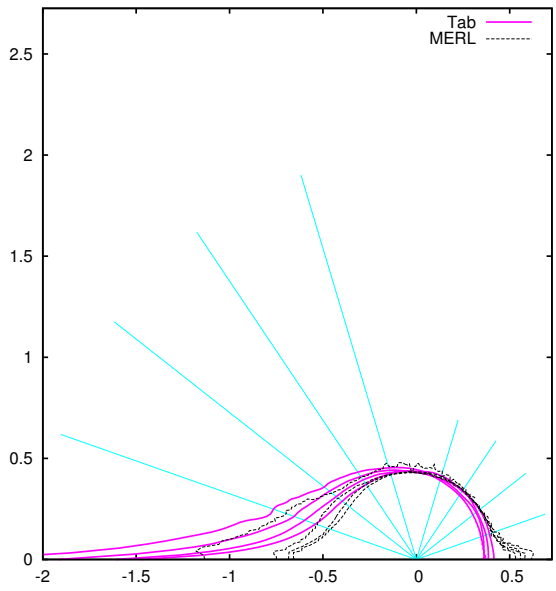


Ours: GGX

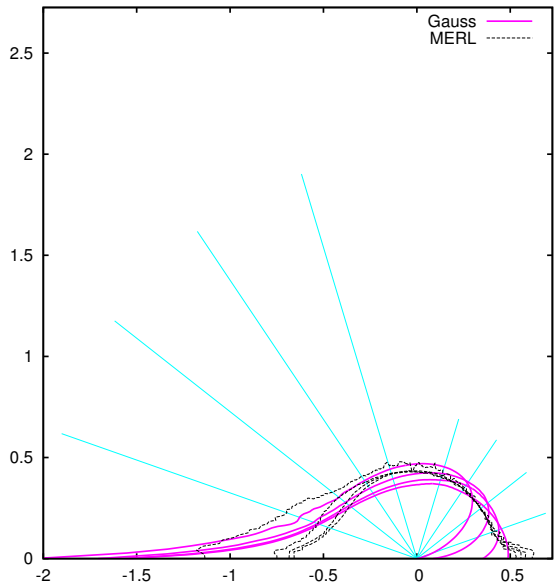
BRDF Lobes in the Incidence Plane (Cubic Root Applied)



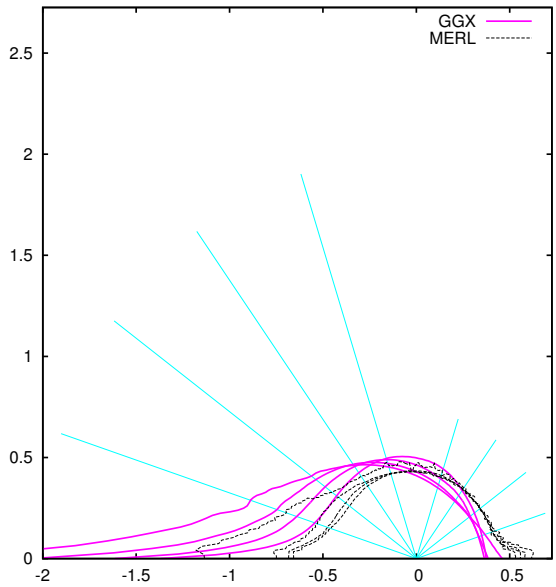
SGD



Ours: Tabulated

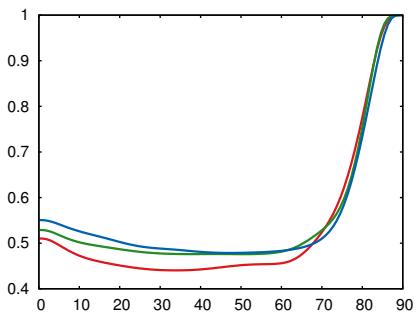


Ours: Gaussian

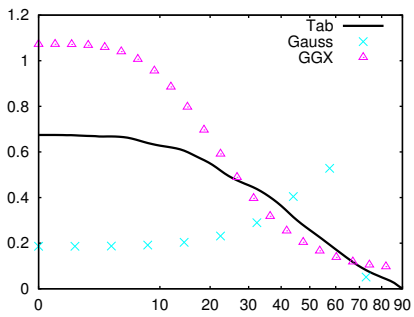


Ours: GGX

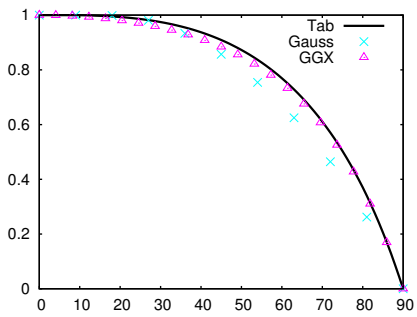
Fitted Microfacet Functions



Fresnel (R, G, B)



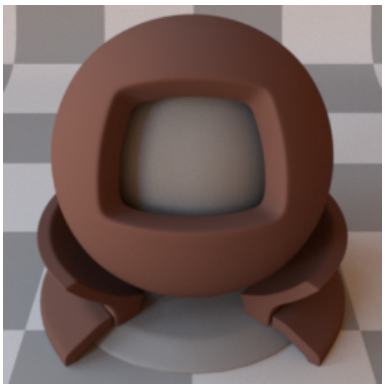
NDF (D)



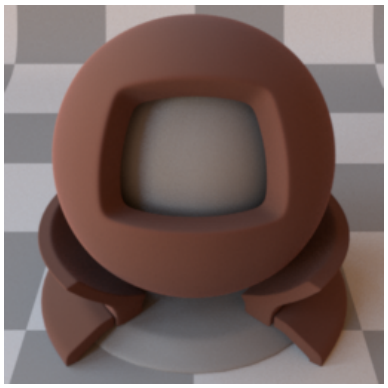
Smith (G_1)

59 polyurethane-foam

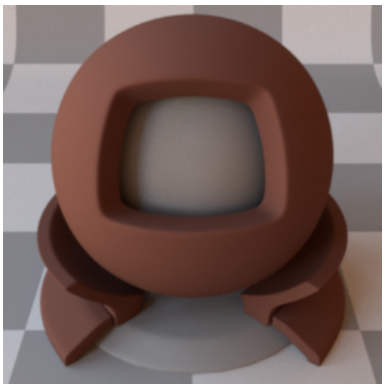
Renderings



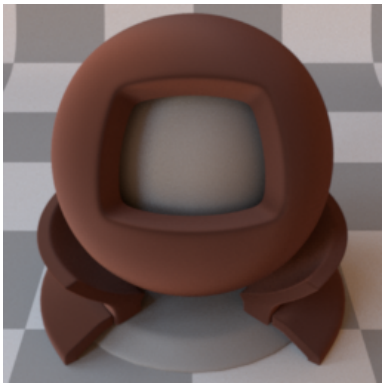
SGD



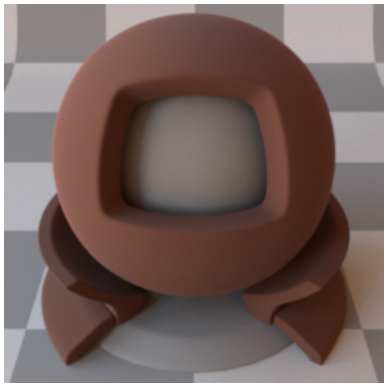
Reference



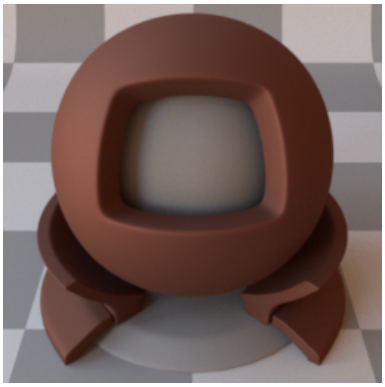
Ours: Tabulated



Ours: Gaussian

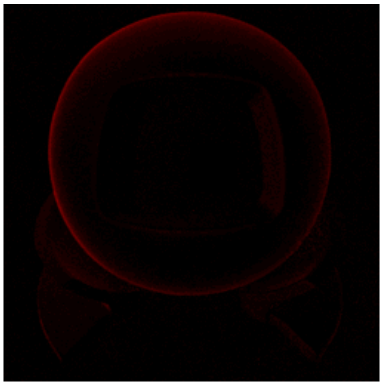


Reference

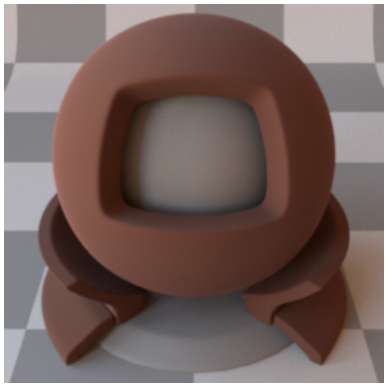


Ours: GGX

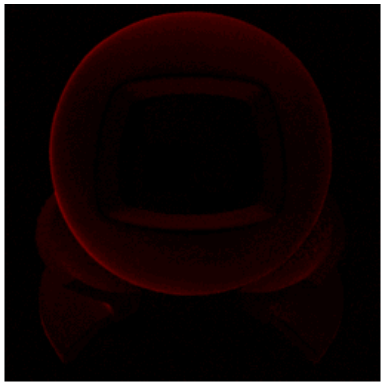
CIE dE00



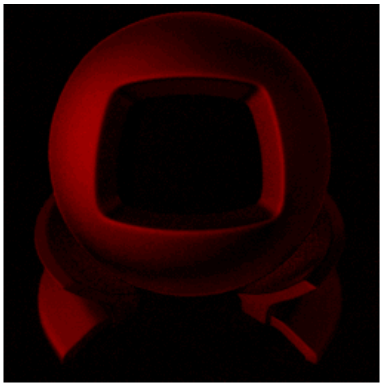
SGD



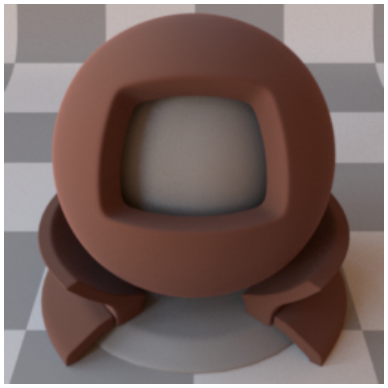
Reference



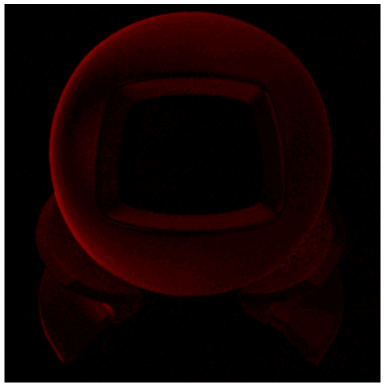
Ours: Tabulated



Ours: Gaussian

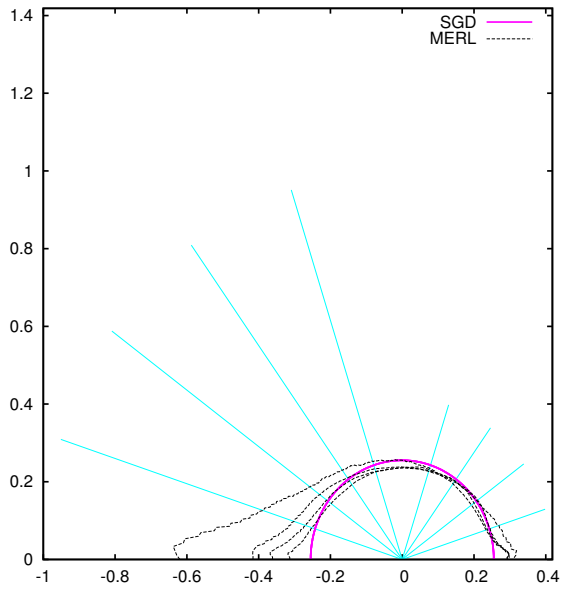


Reference

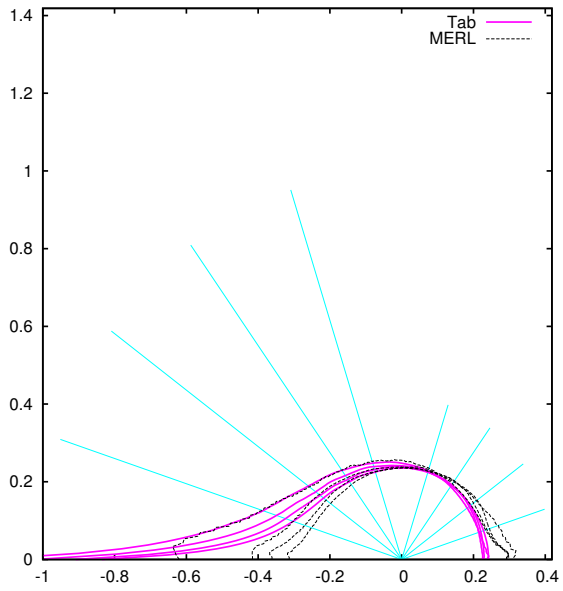


Ours: GGX

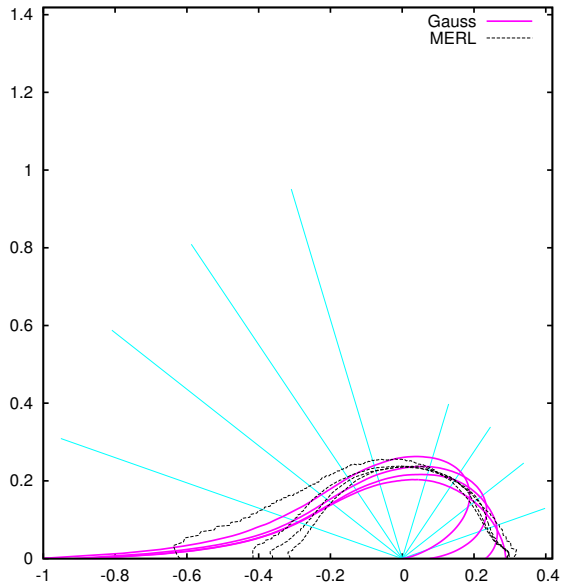
BRDF Lobes in the Incidence Plane (Cubic Root Applied)



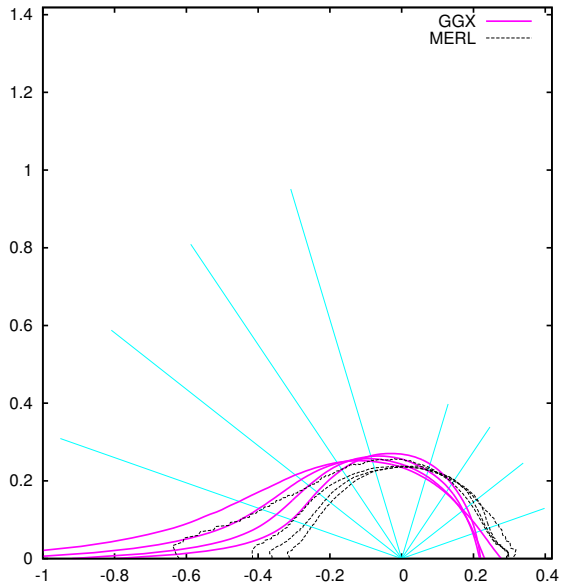
SGD



Ours: Tabulated

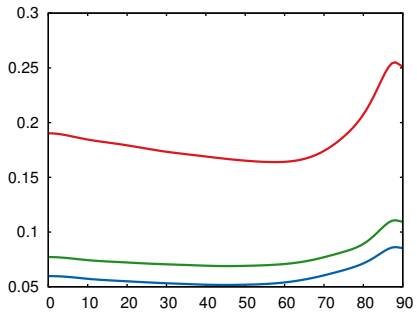


Ours: Gaussian

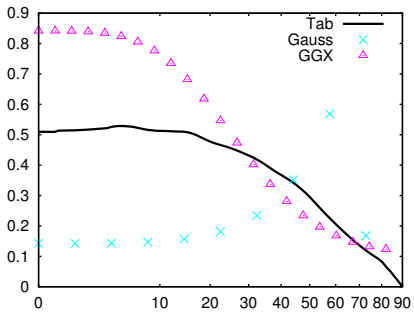


Ours: GGX

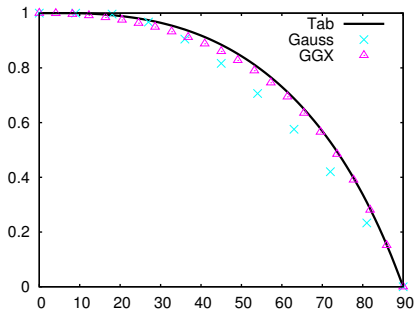
Fitted Microfacet Functions



Fresnel (R, G, B)



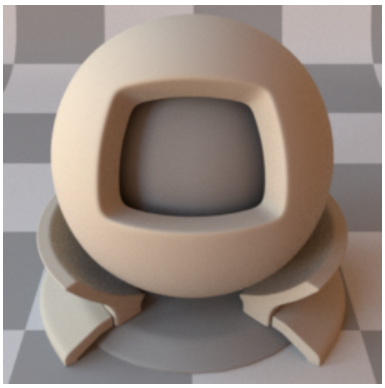
NDF (D)



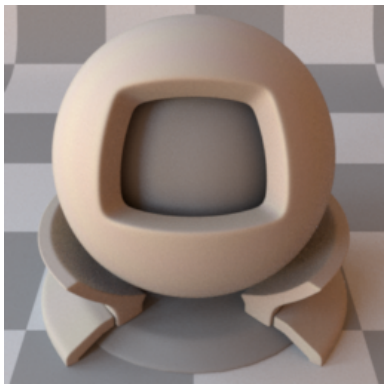
Smith (G_1)

60 pure-rubber

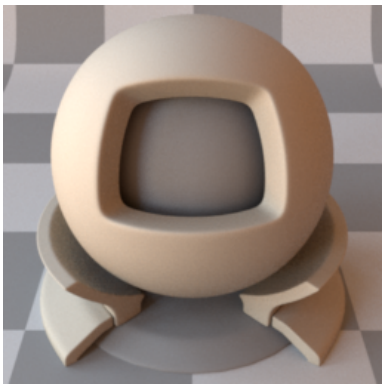
Renderings



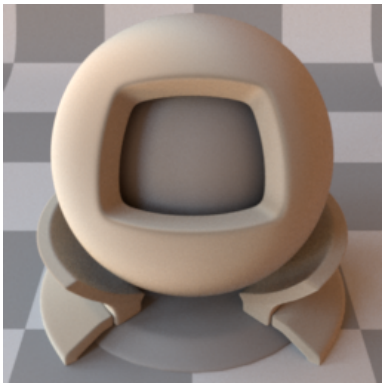
SGD



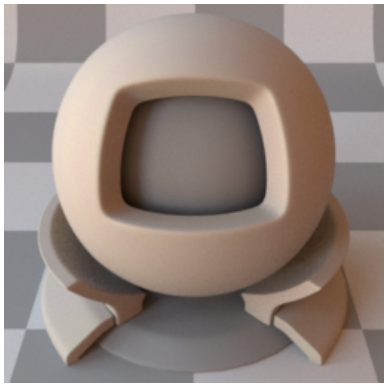
Reference



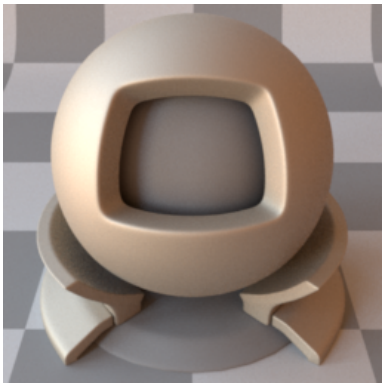
Ours: Tabulated



Ours: Gaussian

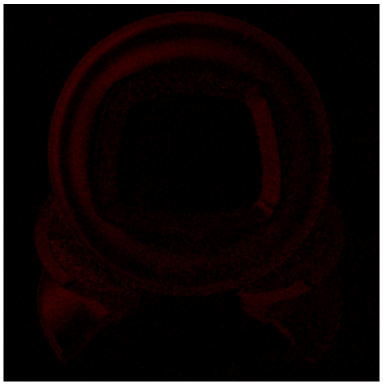


Reference

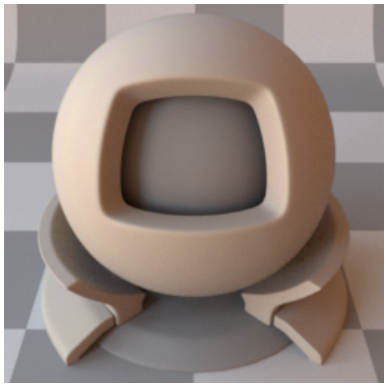


Ours: GGX

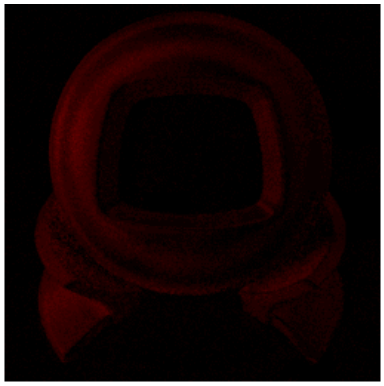
CIE dE00



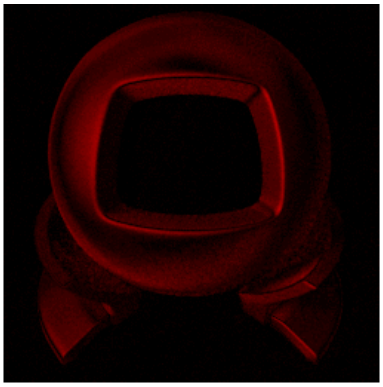
SGD



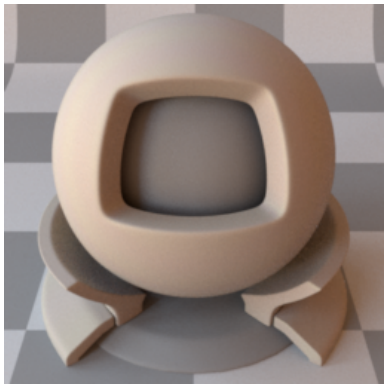
Reference



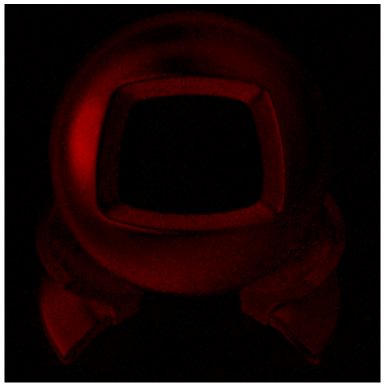
Ours: Tabulated



Ours: Gaussian

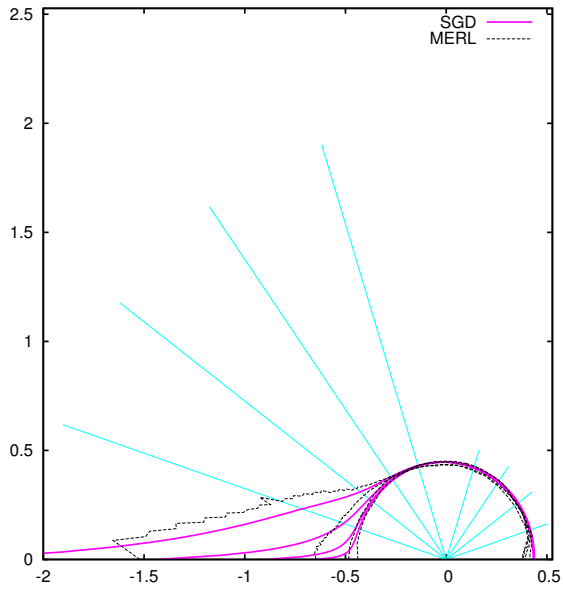


Reference

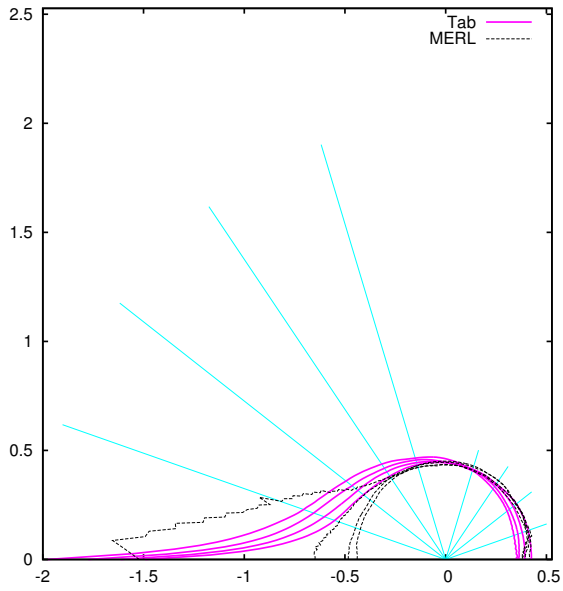


Ours: GGX

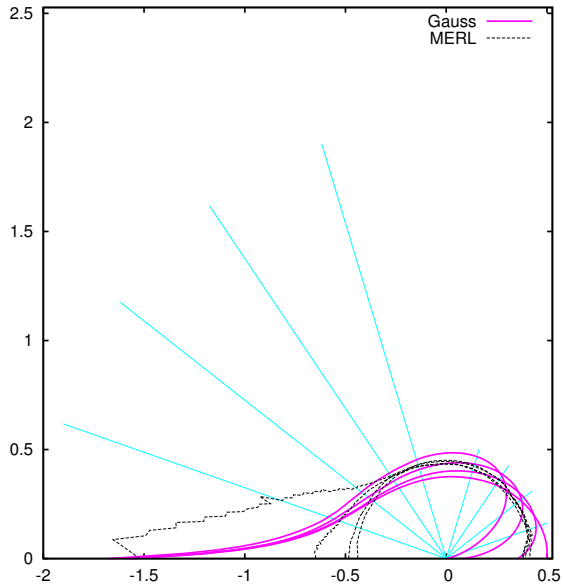
BRDF Lobes in the Incidence Plane (Cubic Root Applied)



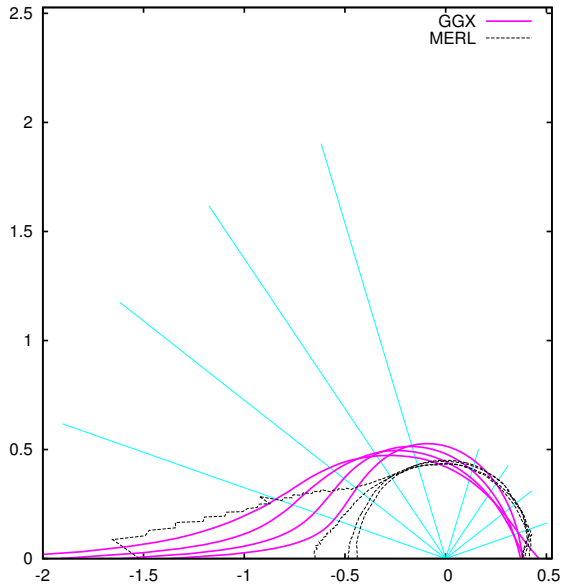
SGD



Ours: Tabulated

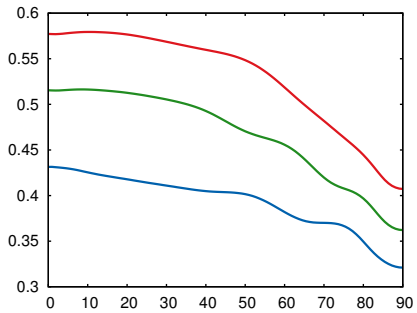


Ours: Gaussian

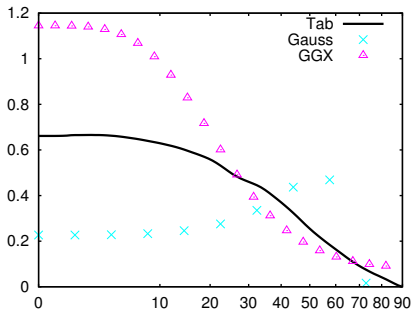


Ours: GGX

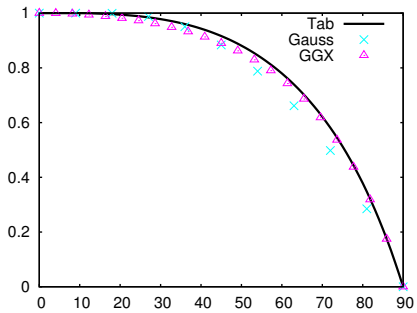
Fitted Microfacet Functions



Fresnel (R, G, B)



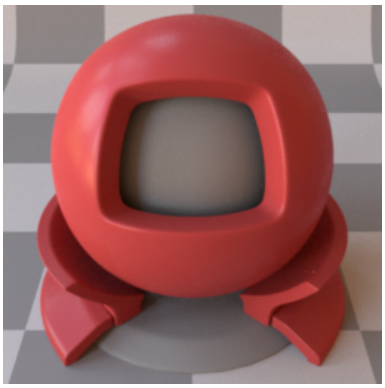
NDF (D)



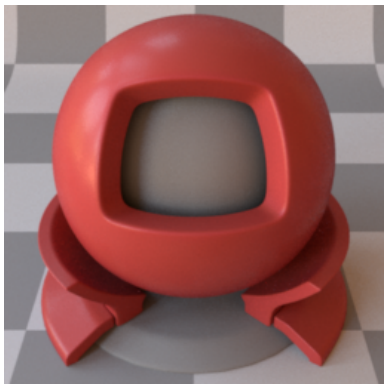
Smith (G_1)

61 purple-paint

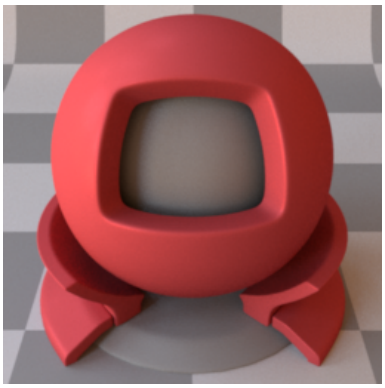
Renderings



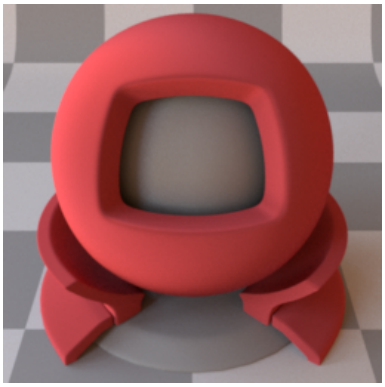
SGD



Reference

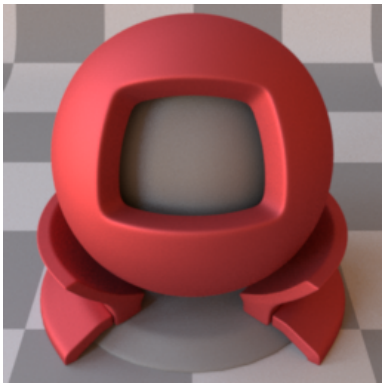


Ours: Tabulated



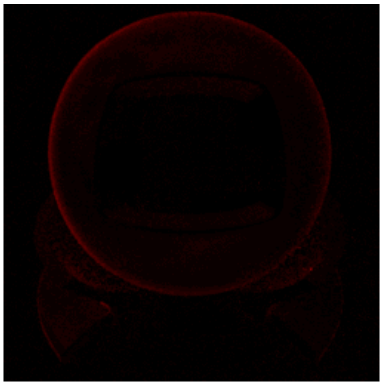
Ours: Gaussian

Reference



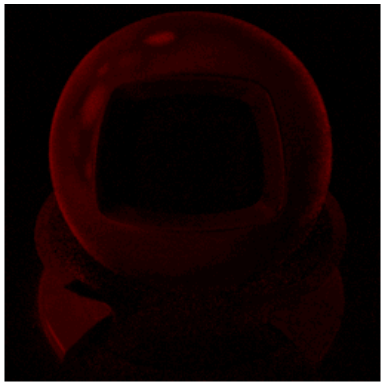
Ours: GGX

CIE dE00

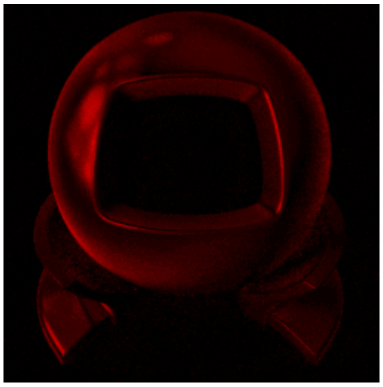


SGD

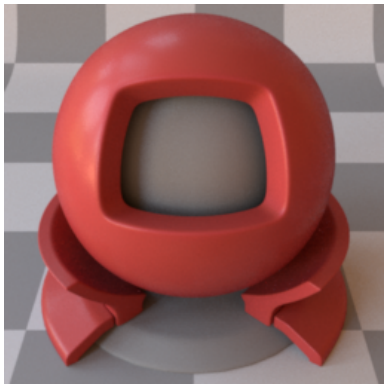
Reference



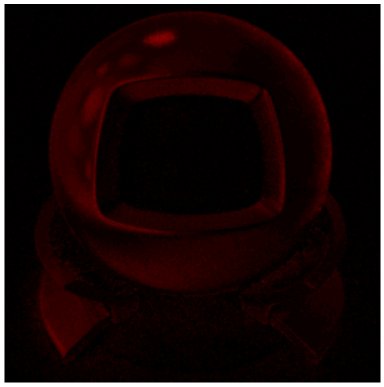
Ours: Tabulated



Ours: Gaussian

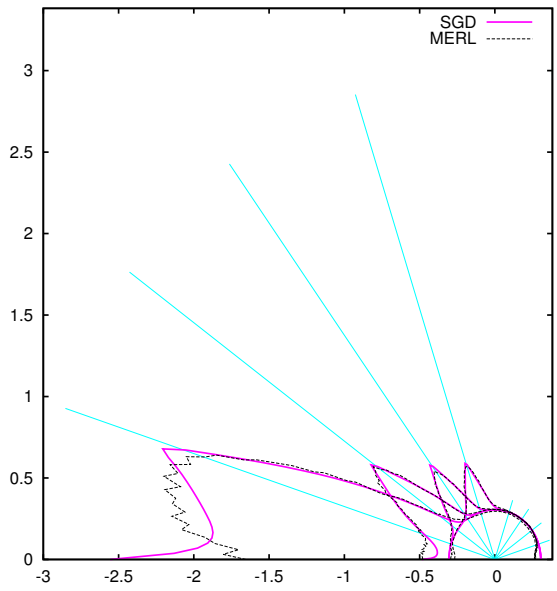


Reference

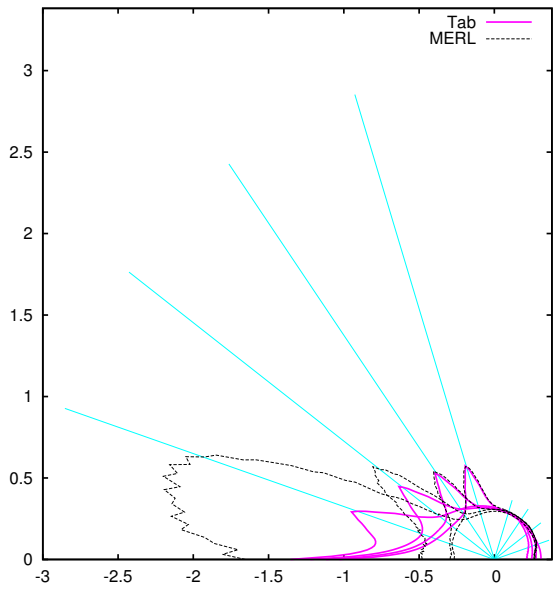


Ours: GGX

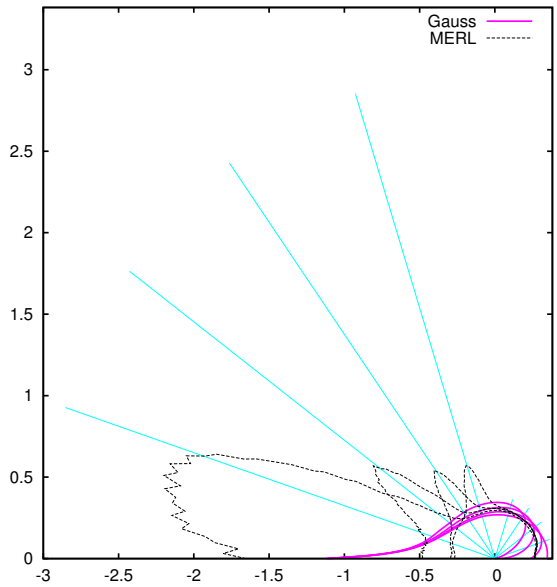
BRDF Lobes in the Incidence Plane (Cubic Root Applied)



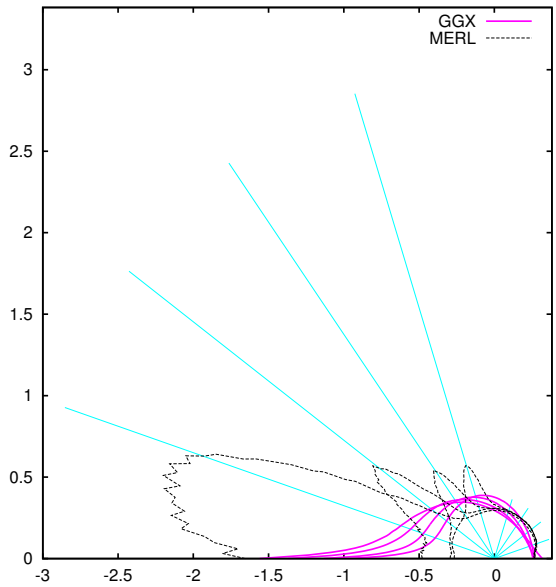
SGD



Ours: Tabulated

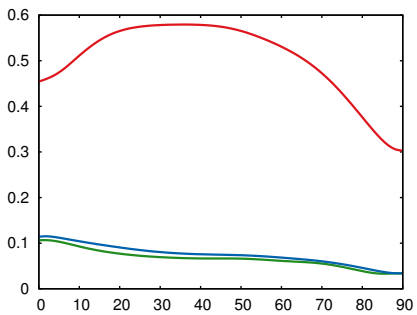


Ours: Gaussian

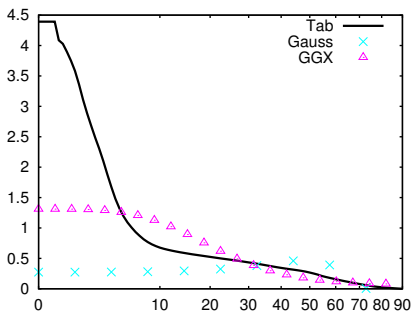


Ours: GGX

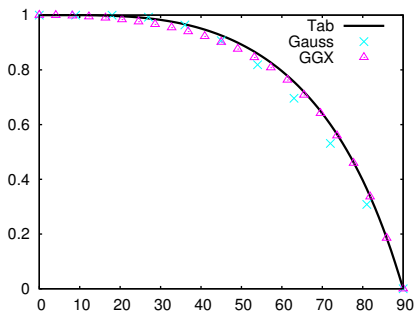
Fitted Microfacet Functions



Fresnel (R, G, B)



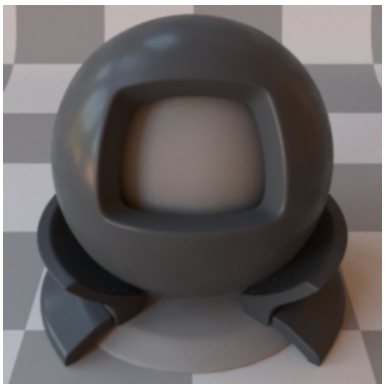
NDF (D)



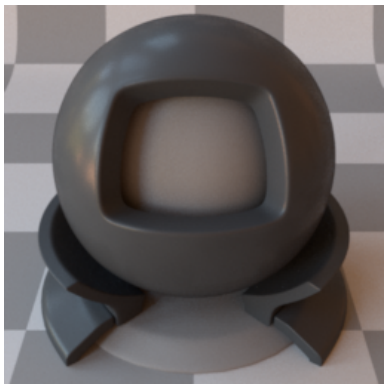
Smith (G_1)

62 pvc

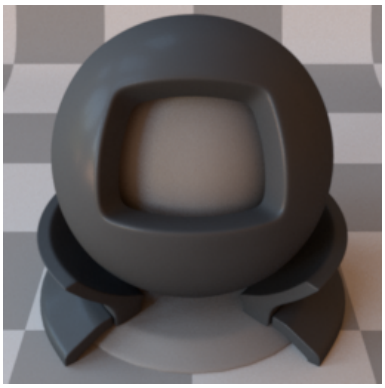
Renderings



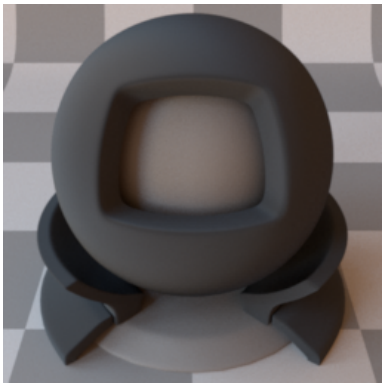
SGD



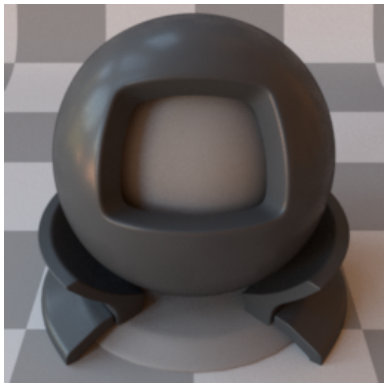
Reference



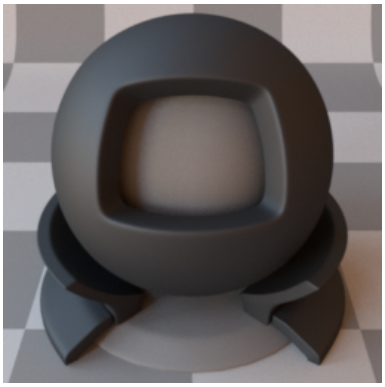
Ours: Tabulated



Ours: Gaussian

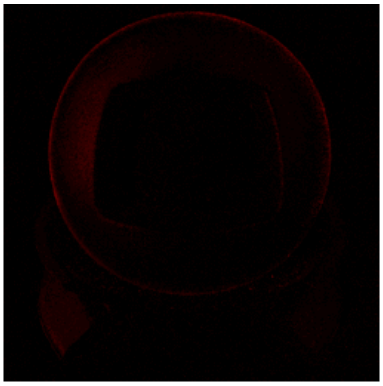


Reference

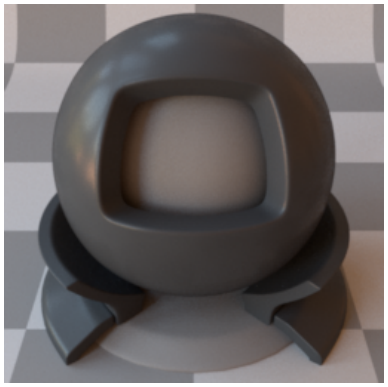


Ours: GGX

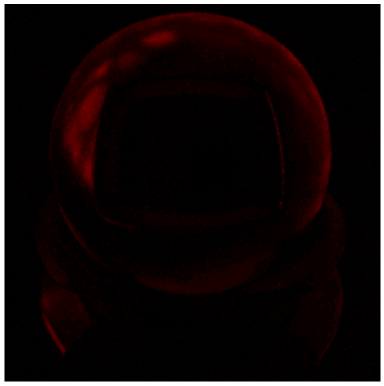
CIE dE00



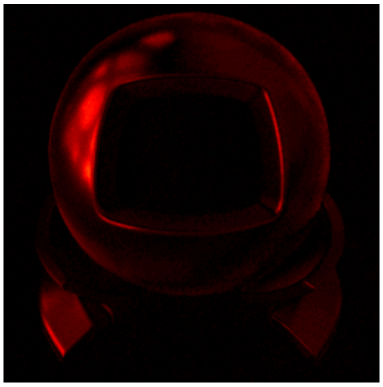
SGD



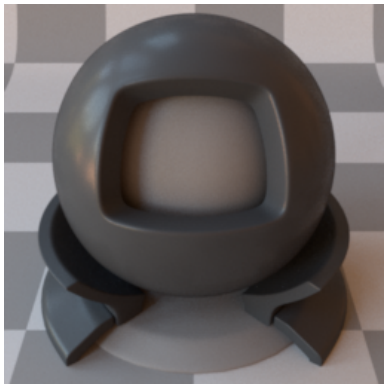
Reference



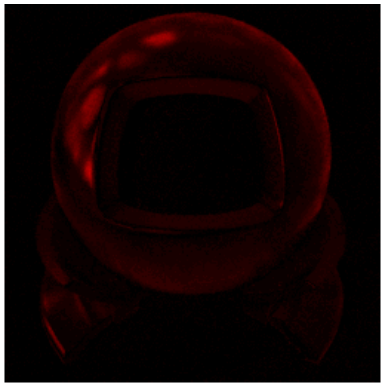
Ours: Tabulated



Ours: Gaussian

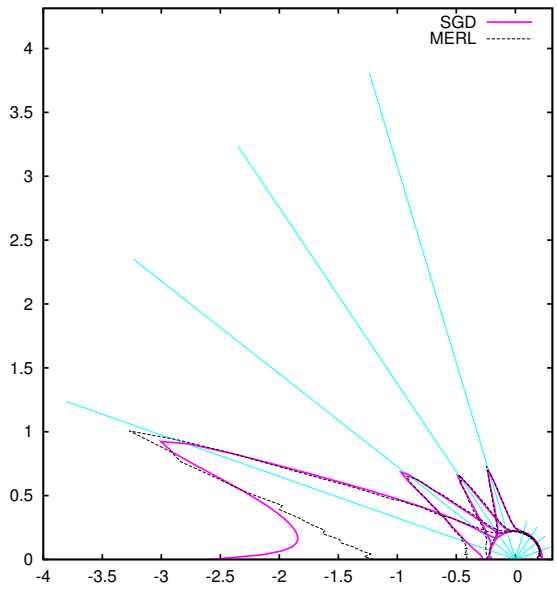


Reference

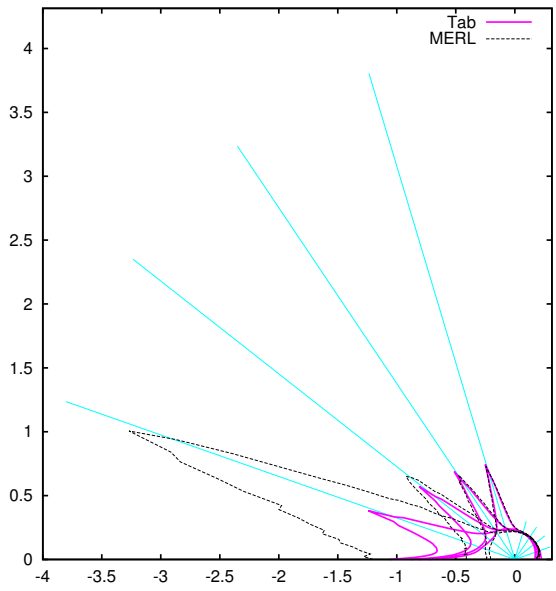


Ours: GGX

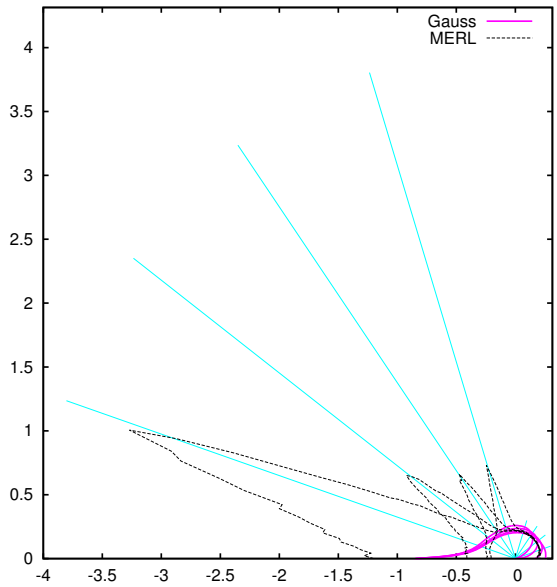
BRDF Lobes in the Incidence Plane (Cubic Root Applied)



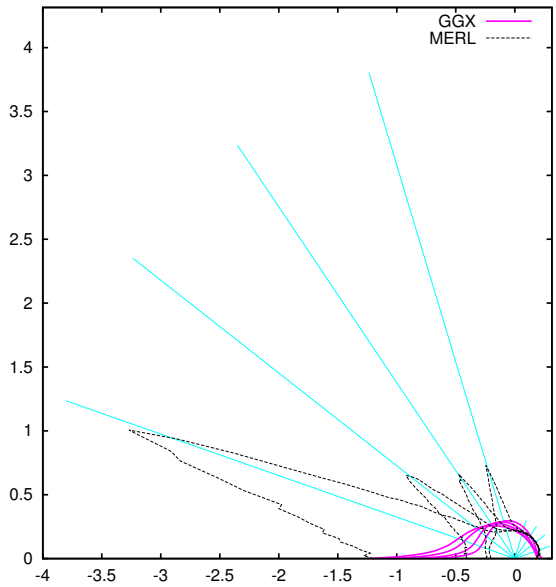
SGD



Ours: Tabulated

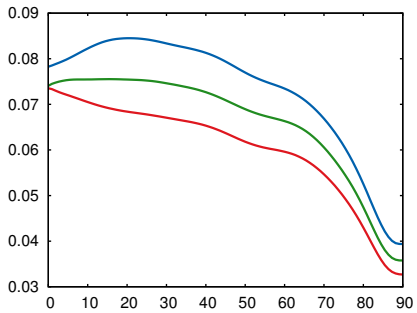


Ours: Gaussian

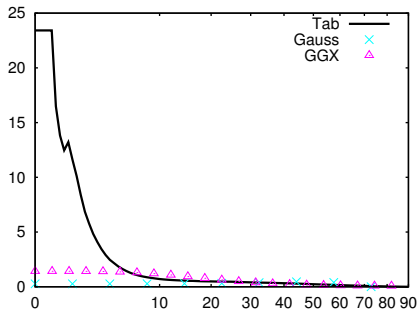


Ours: GGX

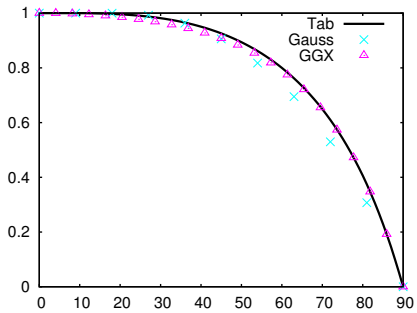
Fitted Microfacet Functions



Fresnel (R, G, B)



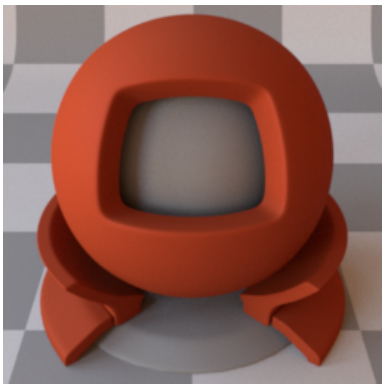
NDF (D)



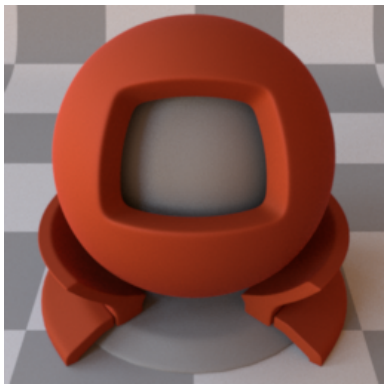
Smith (G_1)

63 red-fabric

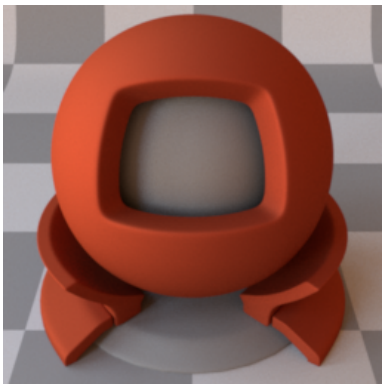
Renderings



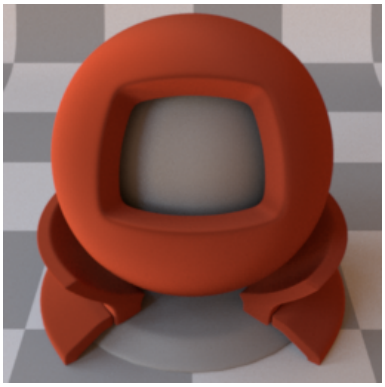
SGD



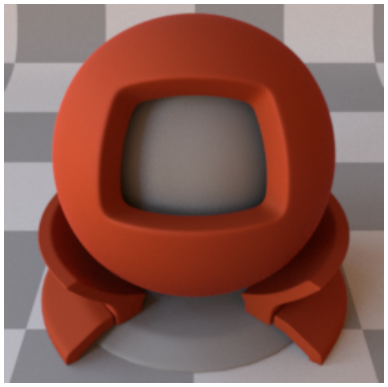
Reference



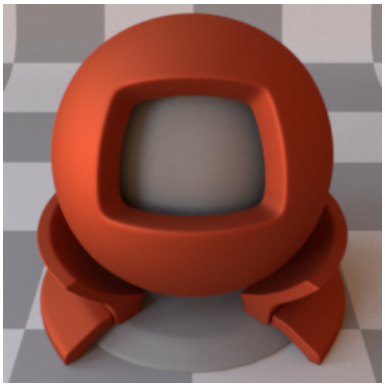
Ours: Tabulated



Ours: Gaussian



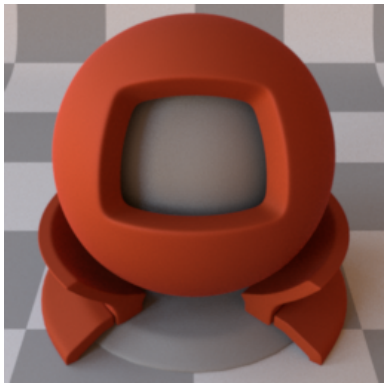
Reference



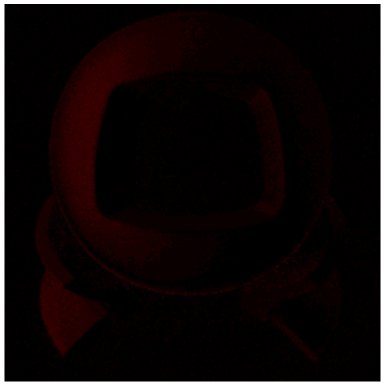
Ours: GGX

CIE dE00

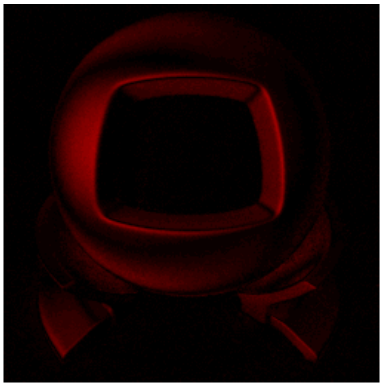
SGD



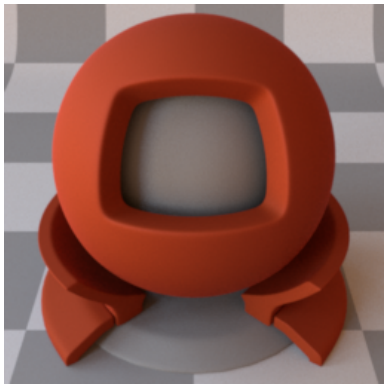
Reference



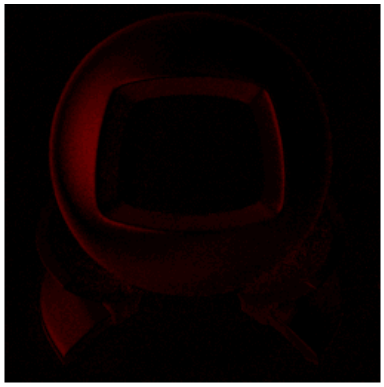
Ours: Tabulated



Ours: Gaussian

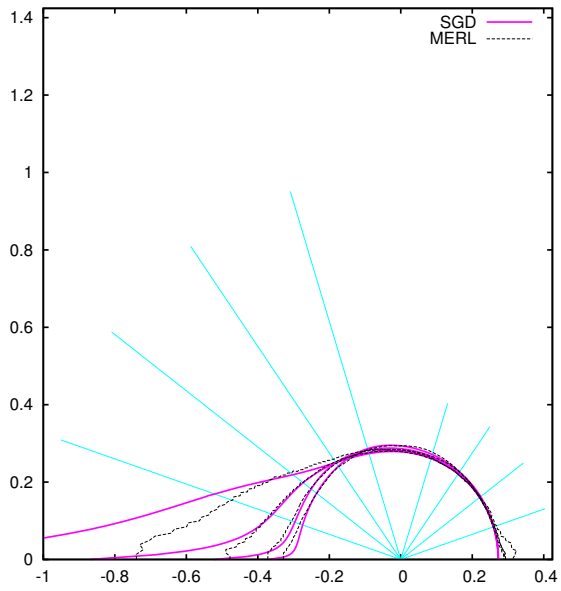


Reference

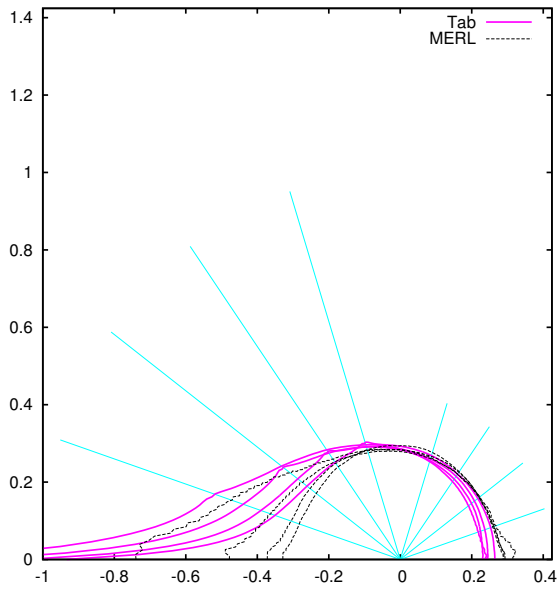


Ours: GGX

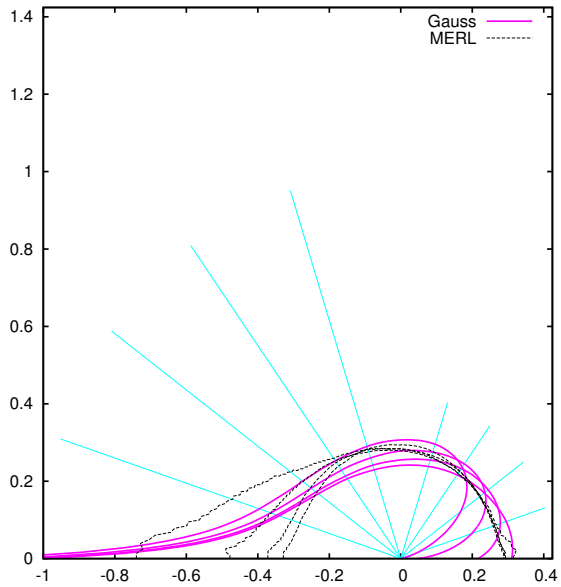
BRDF Lobes in the Incidence Plane (Cubic Root Applied)



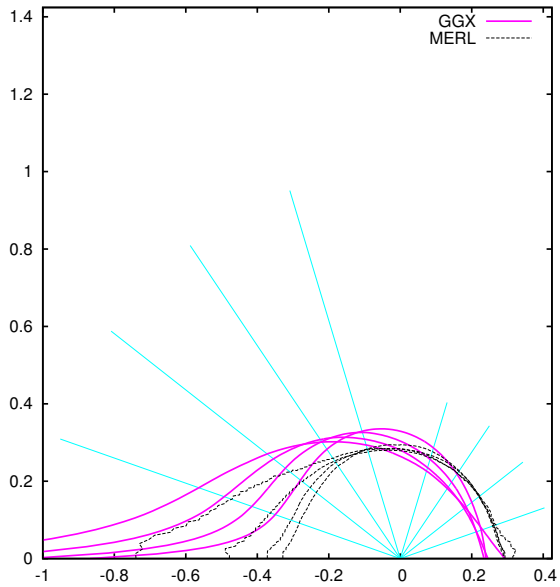
SGD



Ours: Tabulated

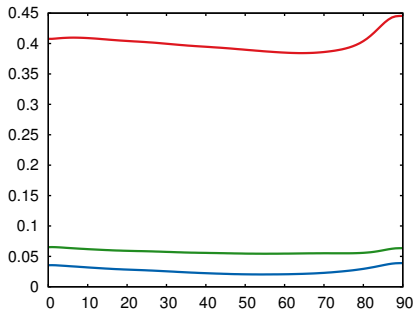


Ours: Gaussian

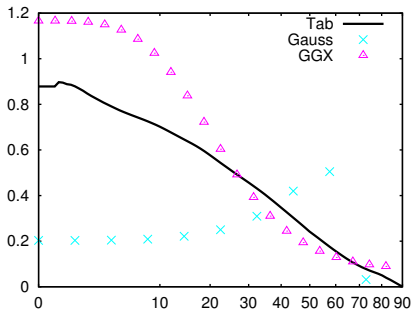


Ours: GGX

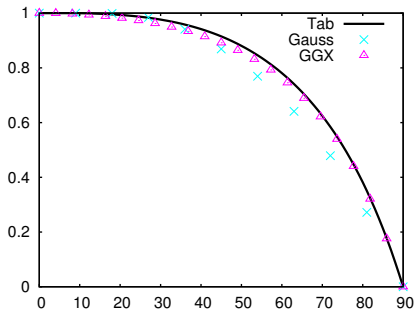
Fitted Microfacet Functions



Fresnel (R, G, B)



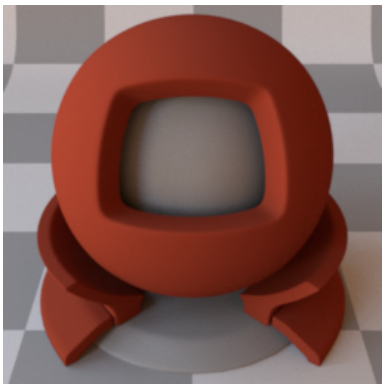
NDF (D)



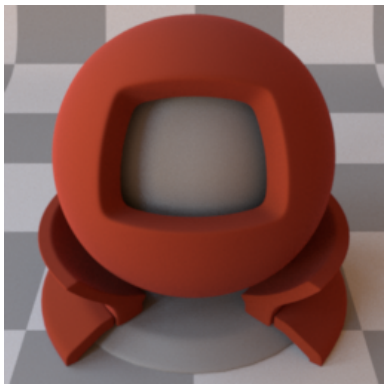
Smith (G_1)

64 red-fabric2

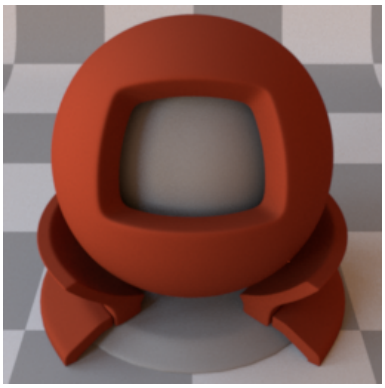
Renderings



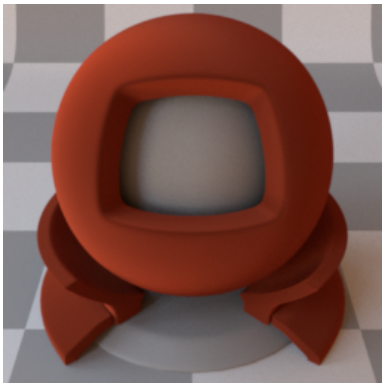
SGD



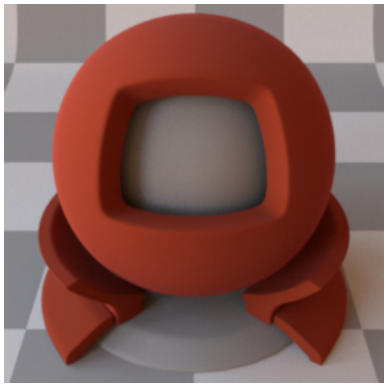
Reference



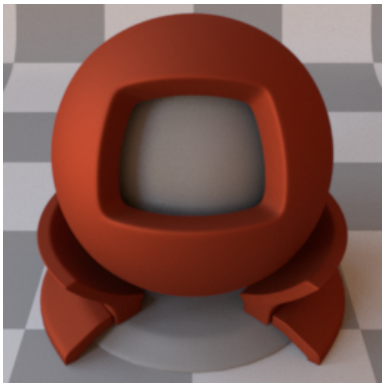
Ours: Tabulated



Ours: Gaussian

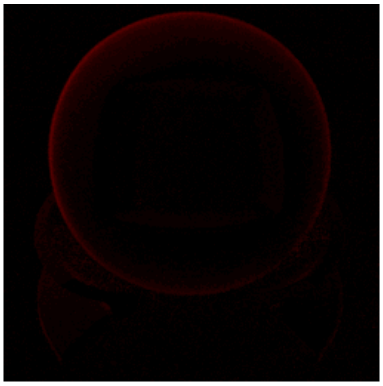


Reference

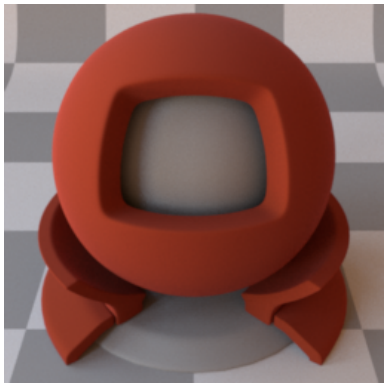


Ours: GGX

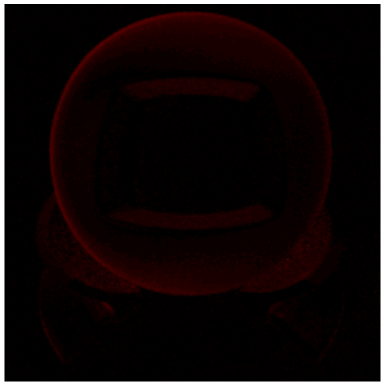
CIE dE00



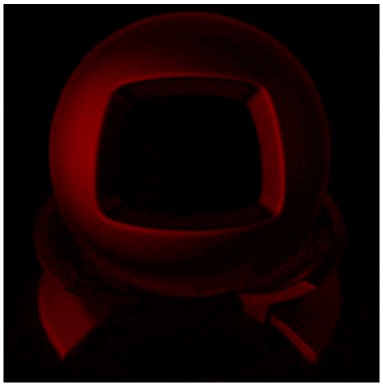
SGD



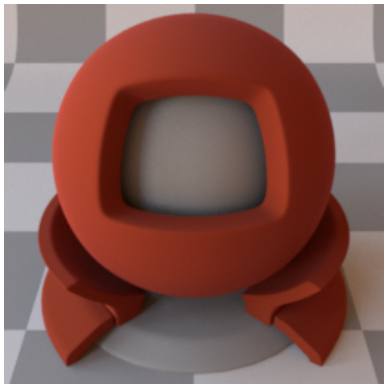
Reference



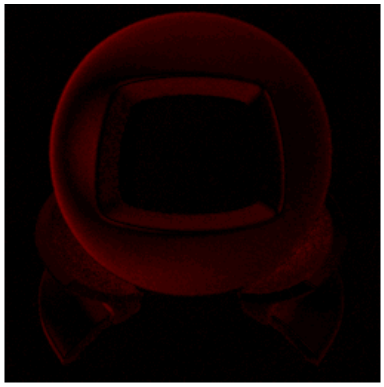
Ours: Tabulated



Ours: Gaussian

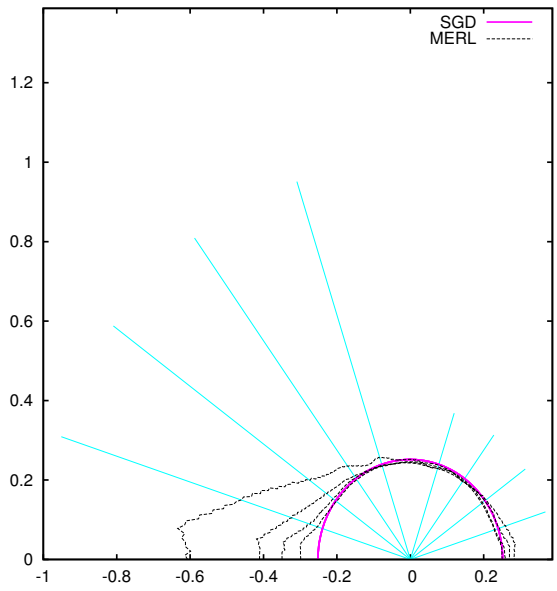


Reference

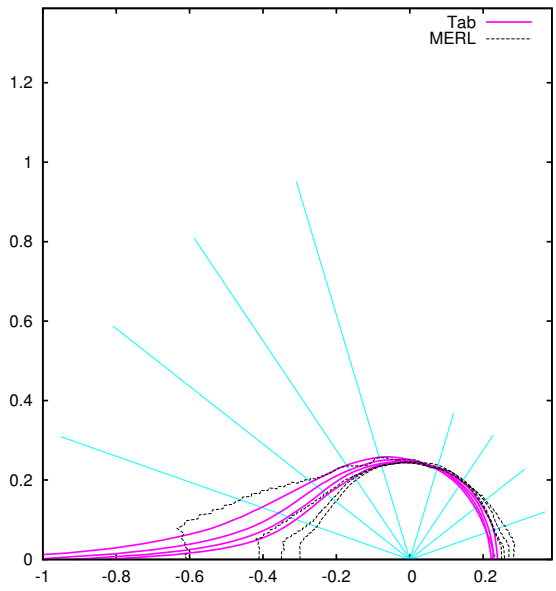


Ours: GGX

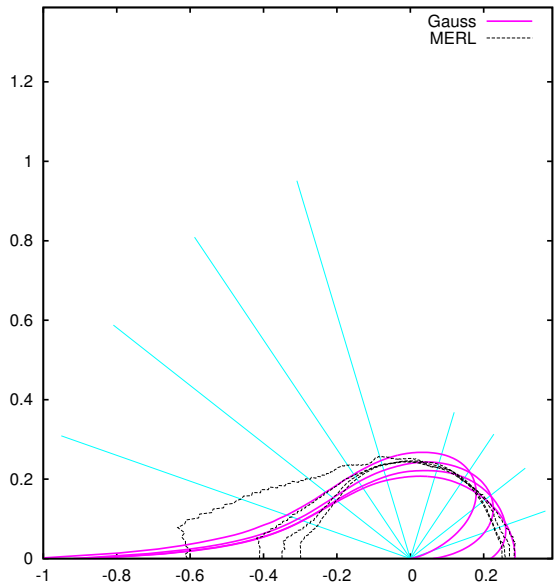
BRDF Lobes in the Incidence Plane (Cubic Root Applied)



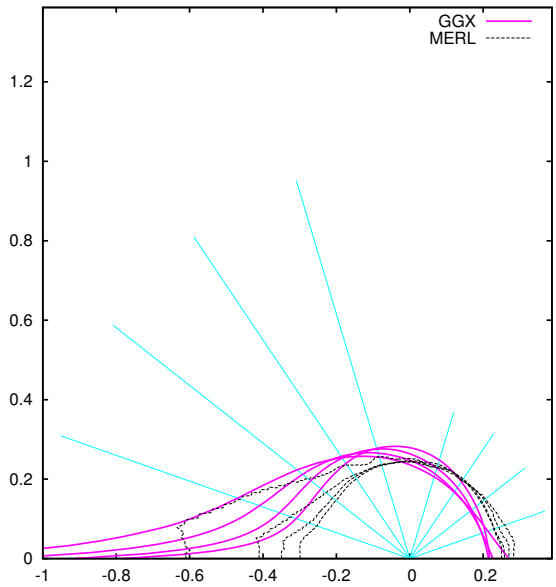
SGD



Ours: Tabulated

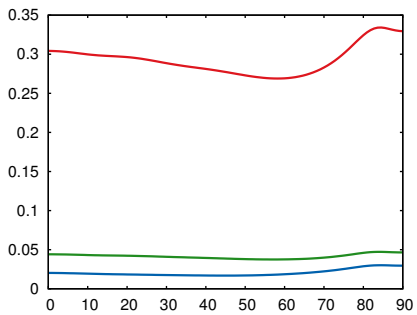


Ours: Gaussian

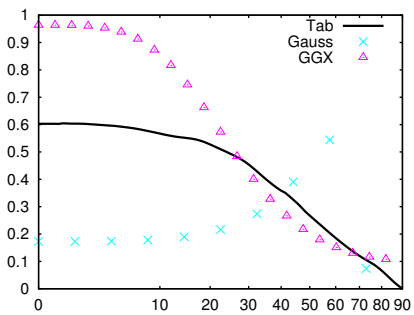


Ours: GGX

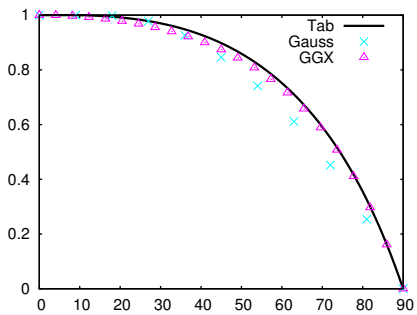
Fitted Microfacet Functions



Fresnel (R, G, B)



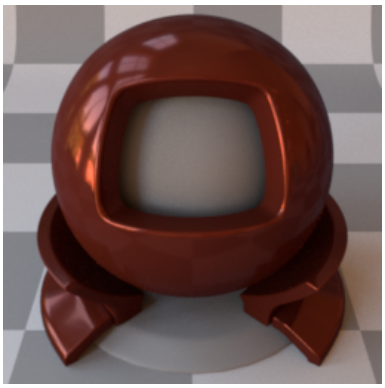
NDF (D)



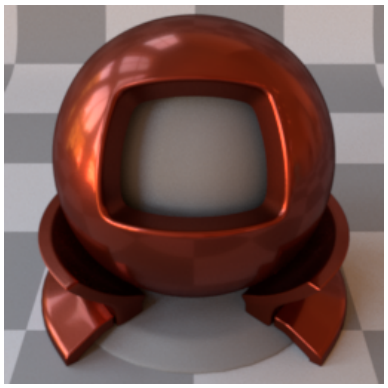
Smith (G_1)

65 red-metallic-paint

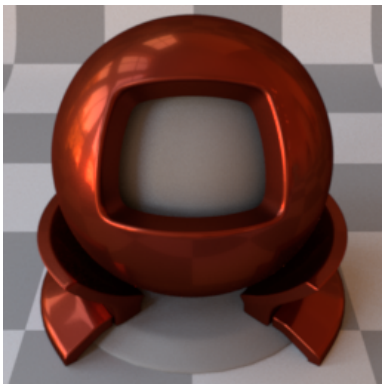
Renderings



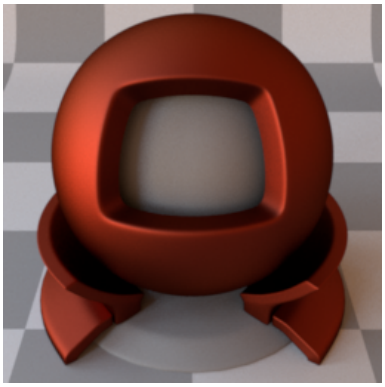
SGD



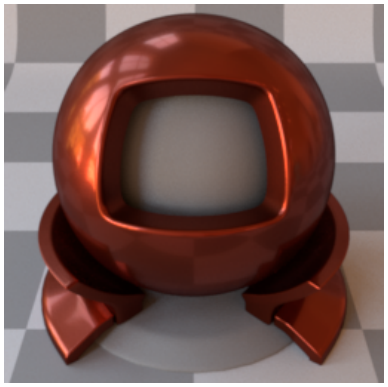
Reference



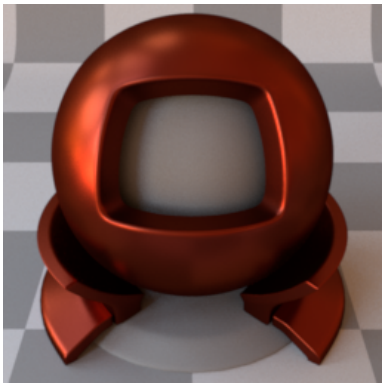
Ours: Tabulated



Ours: Gaussian

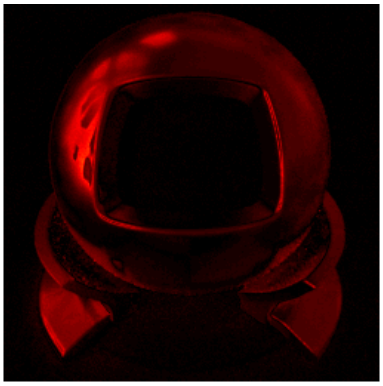


Reference

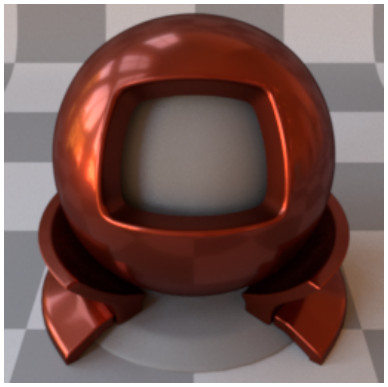


Ours: GGX

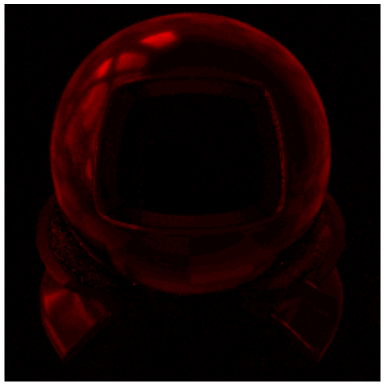
CIE dE00



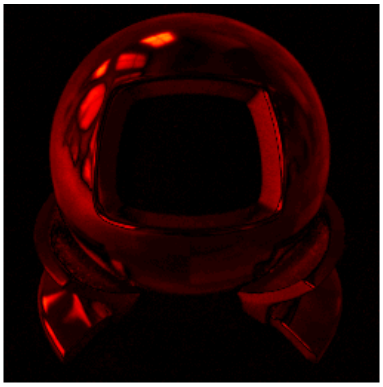
SGD



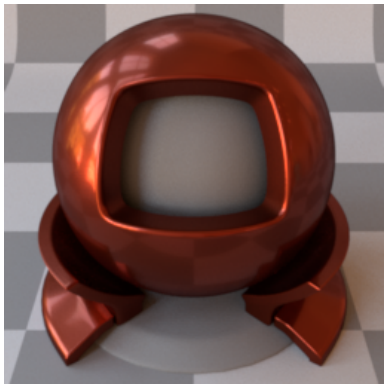
Reference



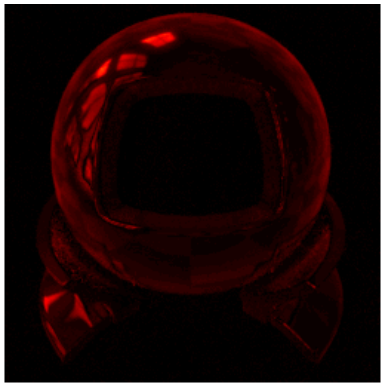
Ours: Tabulated



Ours: Gaussian

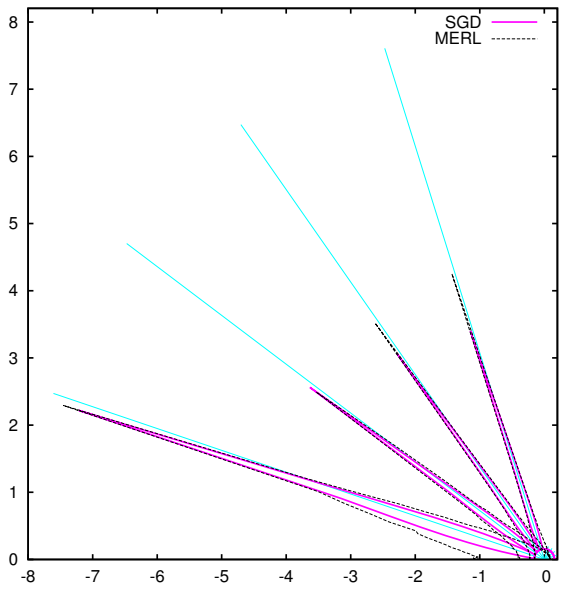


Reference

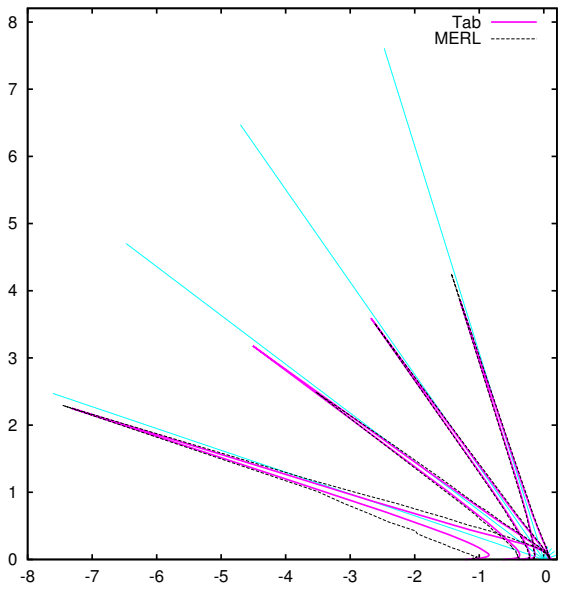


Ours: GGX

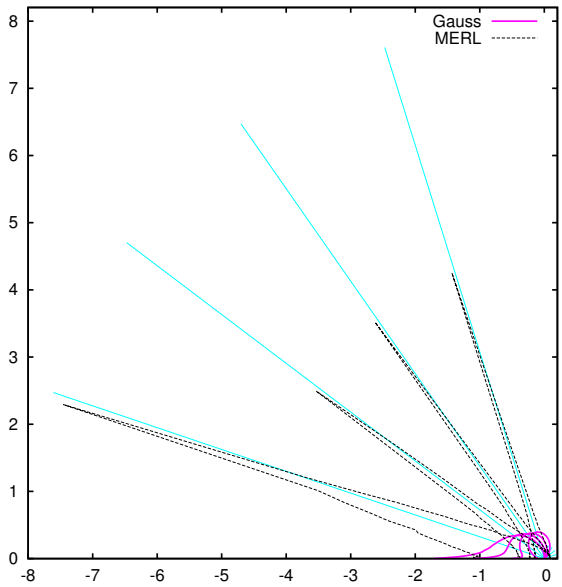
BRDF Lobes in the Incidence Plane (Cubic Root Applied)



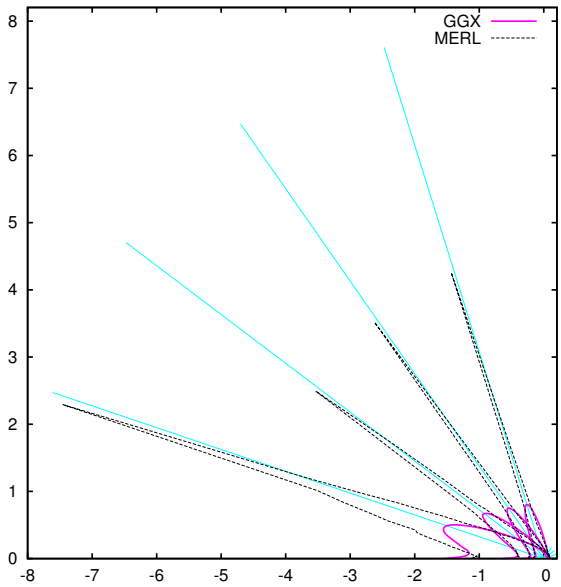
SGD



Ours: Tabulated

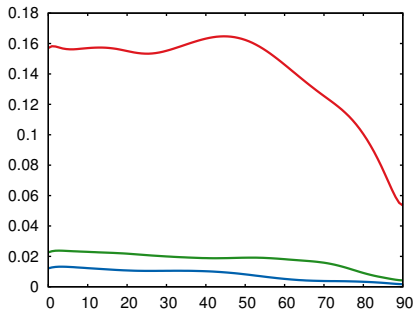


Ours: Gaussian

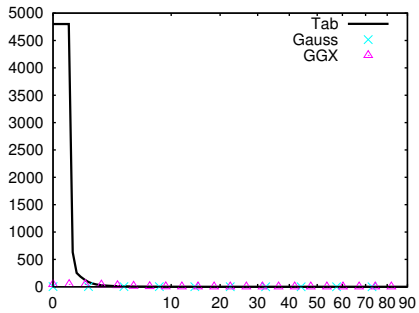


Ours: GGX

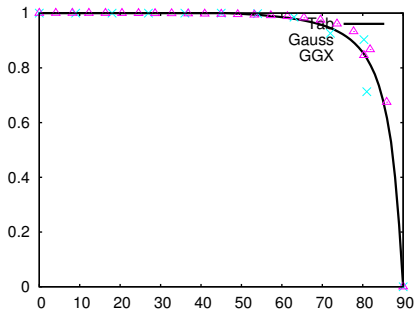
Fitted Microfacet Functions



Fresnel (R, G, B)



NDF (D)

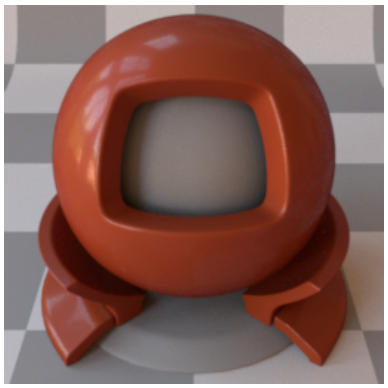


Smith (G_1)

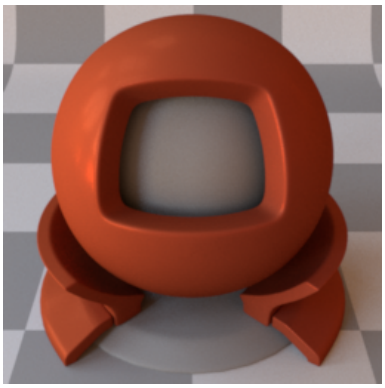
66 red-phenolic

Renderings

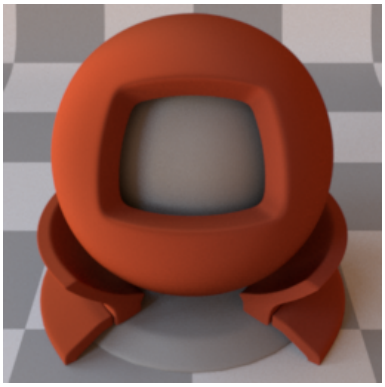
SGD



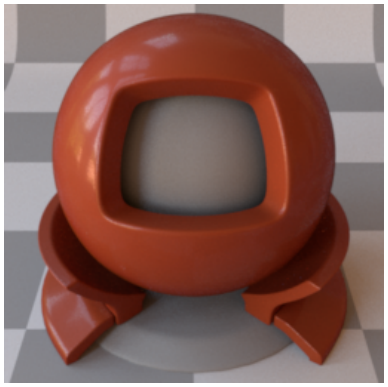
Reference



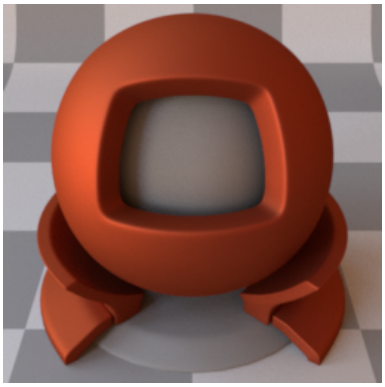
Ours: Tabulated



Ours: Gaussian

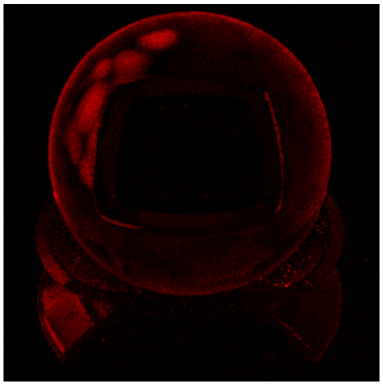


Reference

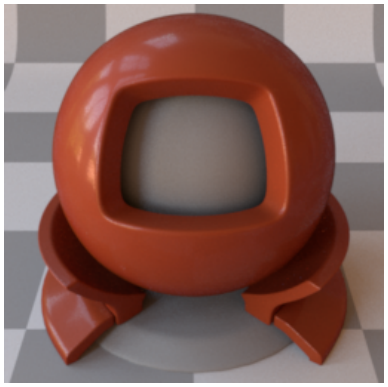


Ours: GGX

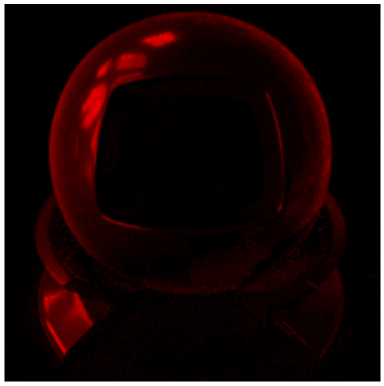
CIE dE00



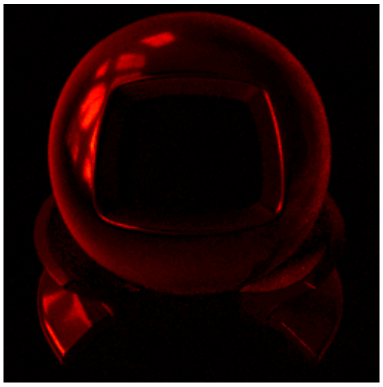
SGD



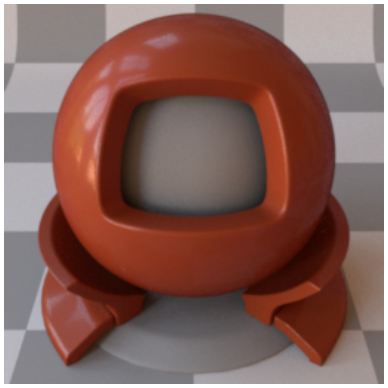
Reference



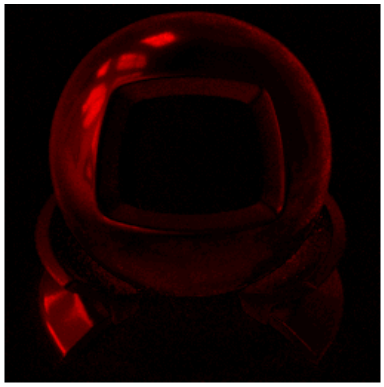
Ours: Tabulated



Ours: Gaussian

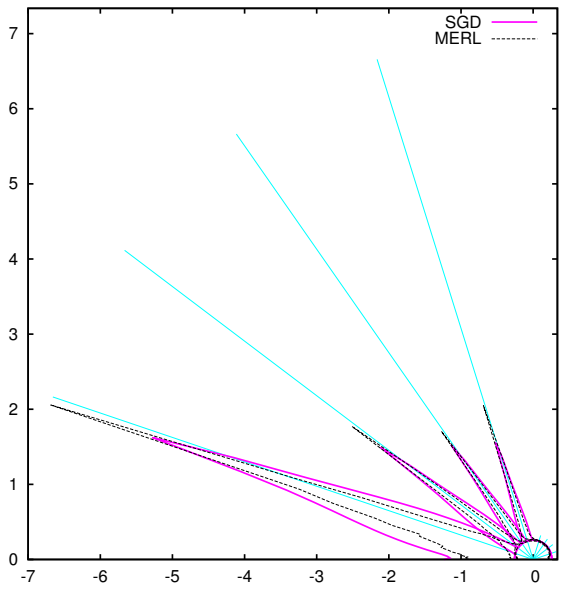


Reference

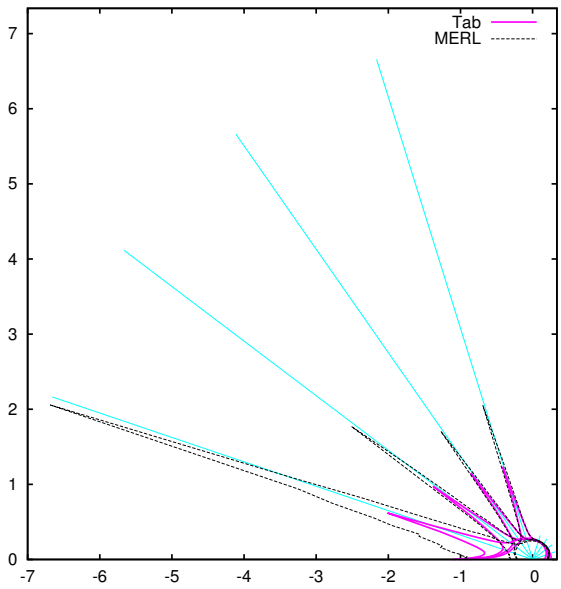


Ours: GGX

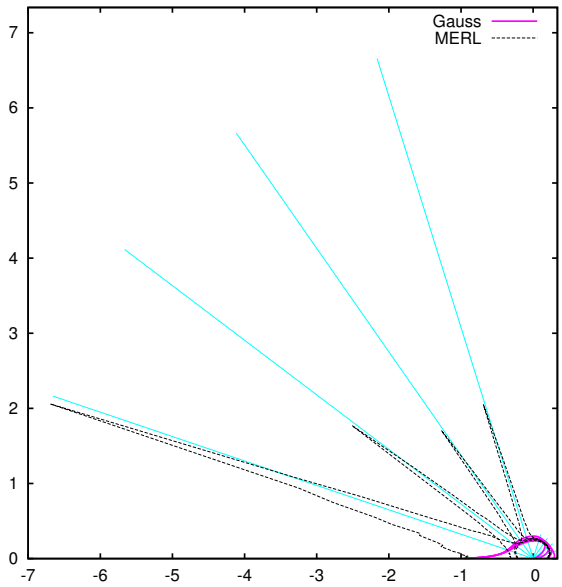
BRDF Lobes in the Incidence Plane (Cubic Root Applied)



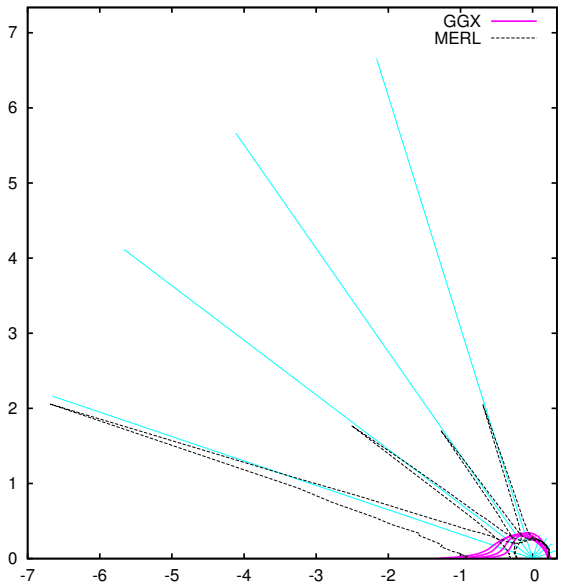
SGD



Ours: Tabulated

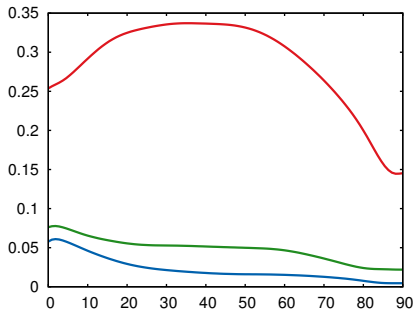


Ours: Gaussian

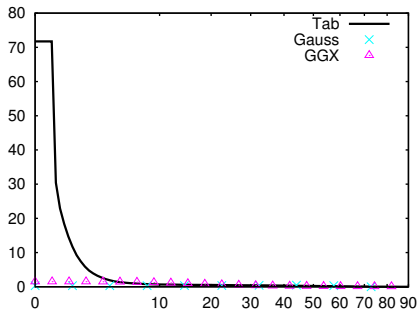


Ours: GGX

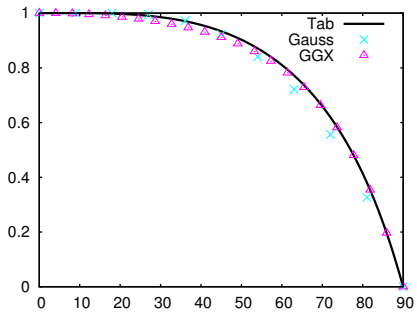
Fitted Microfacet Functions



Fresnel (R, G, B)



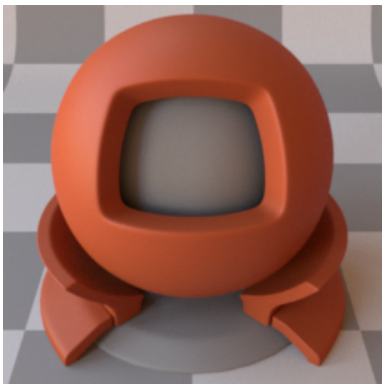
NDF (D)



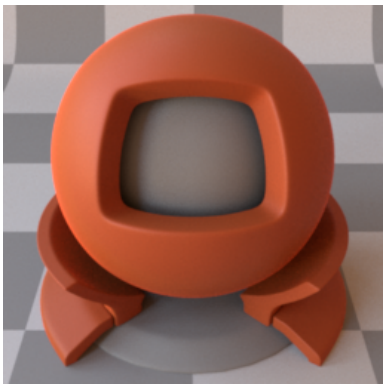
Smith (G_1)

67 red-plastic

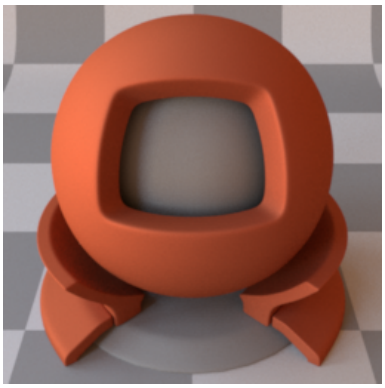
Renderings



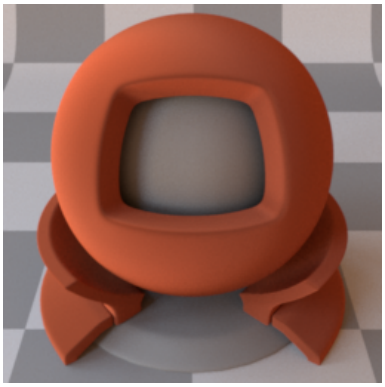
SGD



Reference

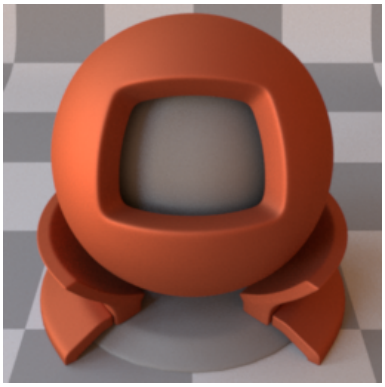


Ours: Tabulated



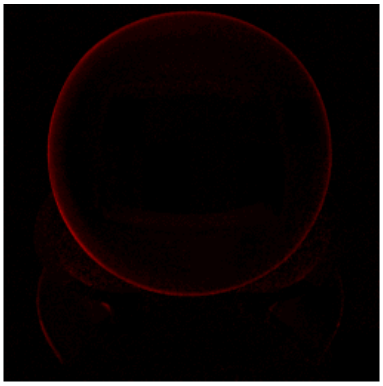
Ours: Gaussian

Reference



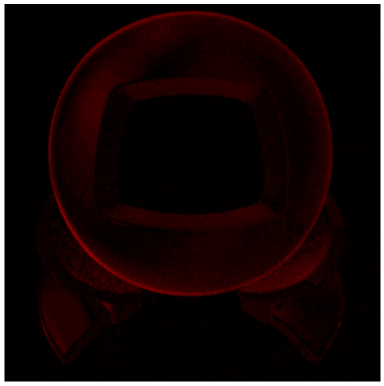
Ours: GGX

CIE dE00

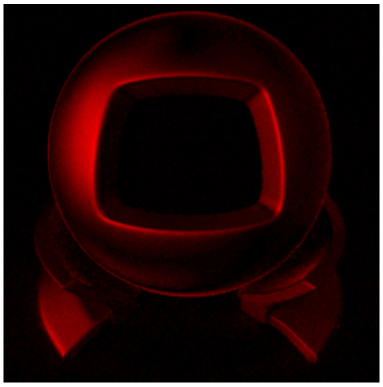


SGD

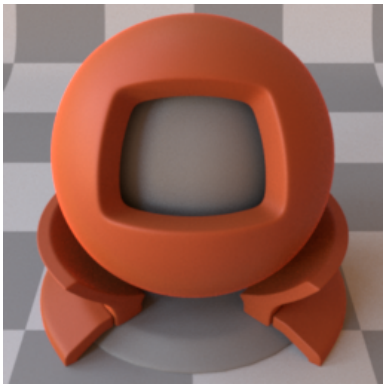
Reference



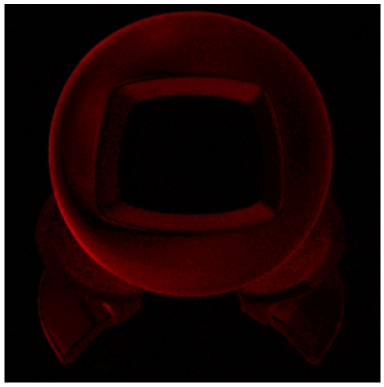
Ours: Tabulated



Ours: Gaussian

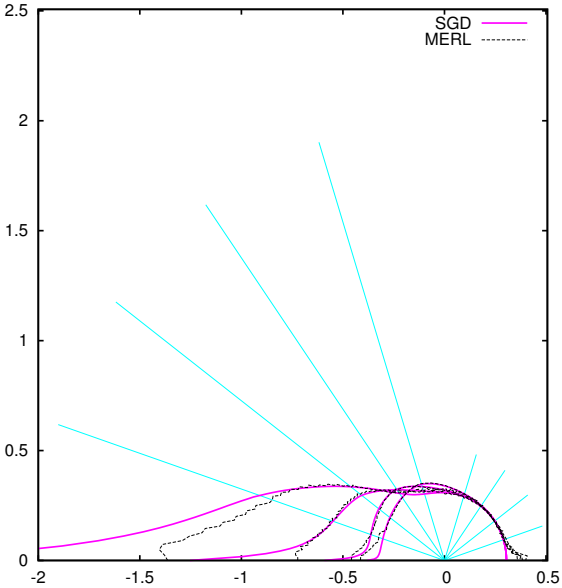


Reference

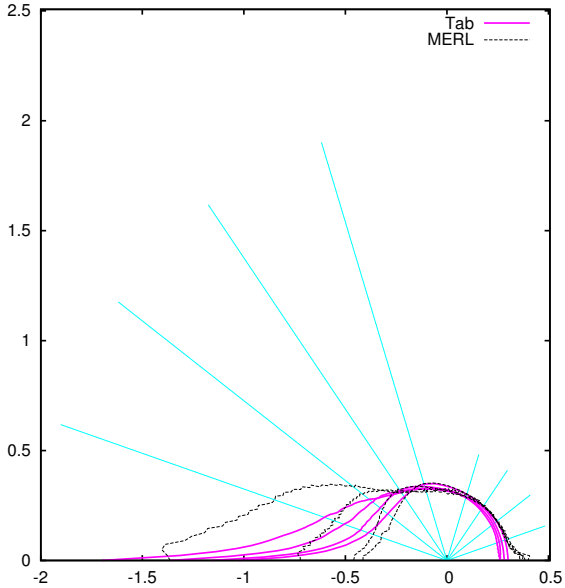


Ours: GGX

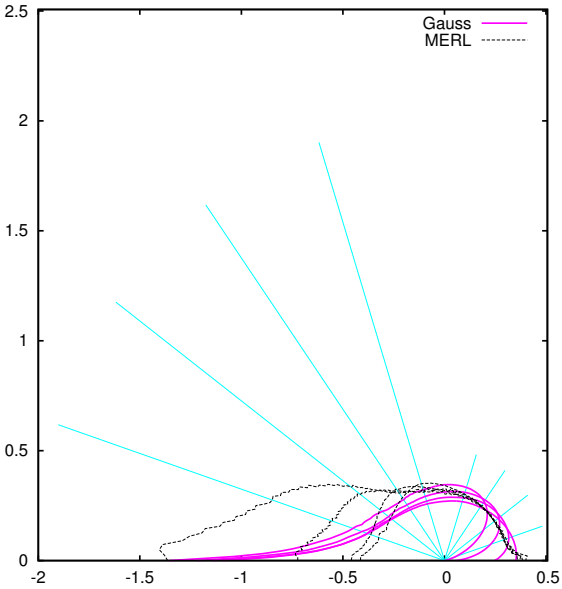
BRDF Lobes in the Incidence Plane (Cubic Root Applied)



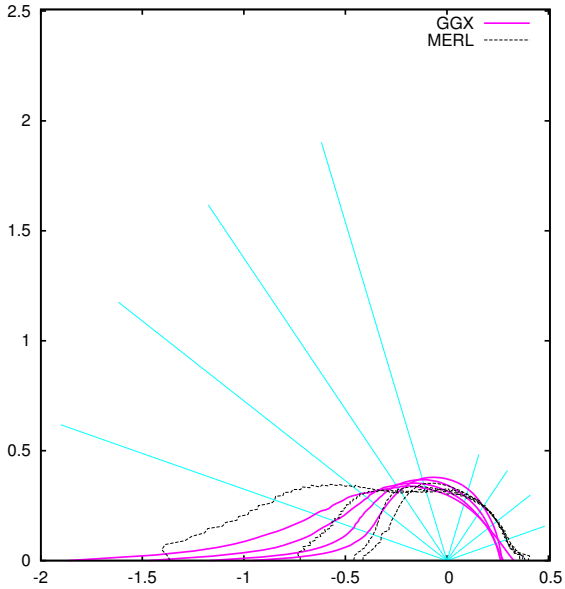
SGD



Ours: Tabulated

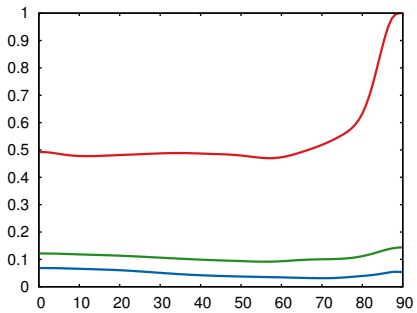


Ours: Gaussian

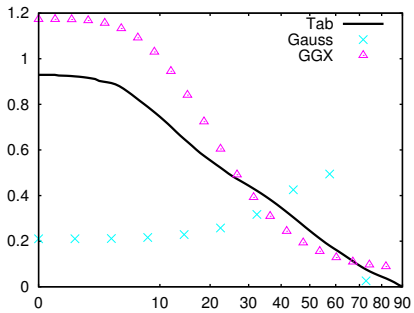


Ours: GGX

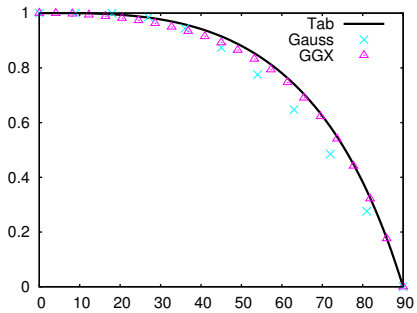
Fitted Microfacet Functions



Fresnel (R, G, B)



NDF (D)



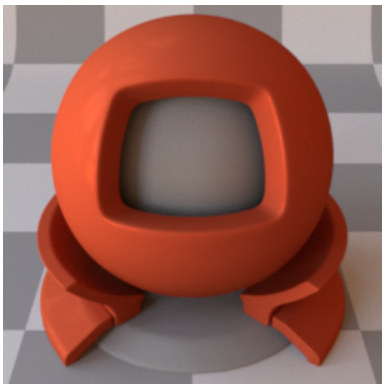
Smith (G_1)

68 red-specular-plastic

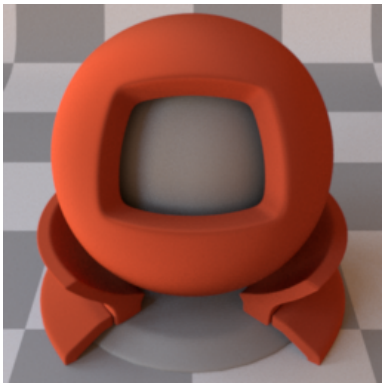
Renderings

SGD

Reference

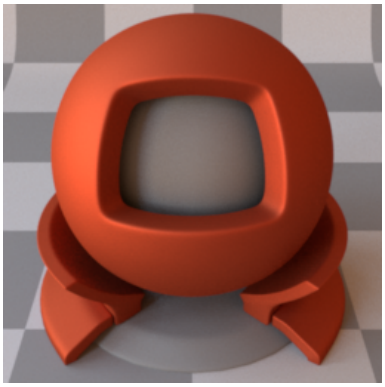


Ours: Tabulated



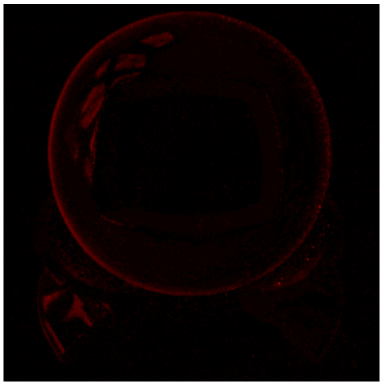
Ours: Gaussian

Reference



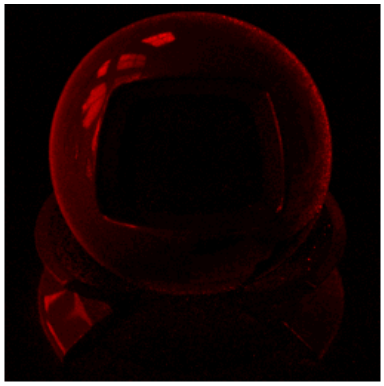
Ours: GGX

CIE dE00

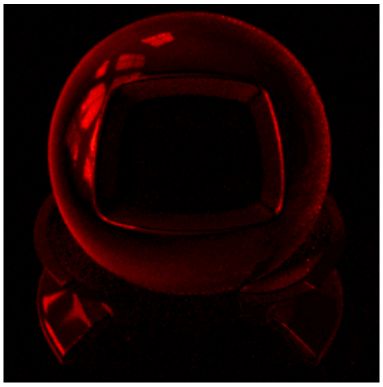


SGD

Reference

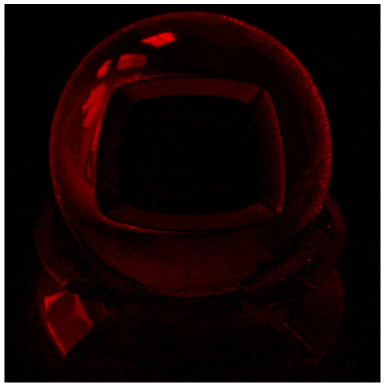


Ours: Tabulated



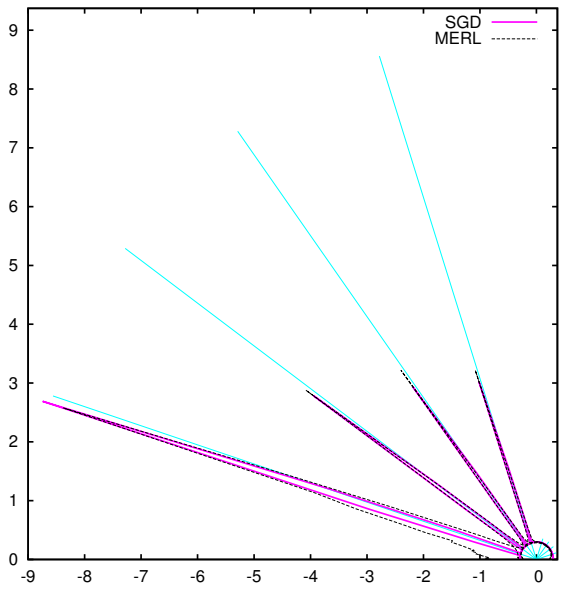
Ours: Gaussian

Reference

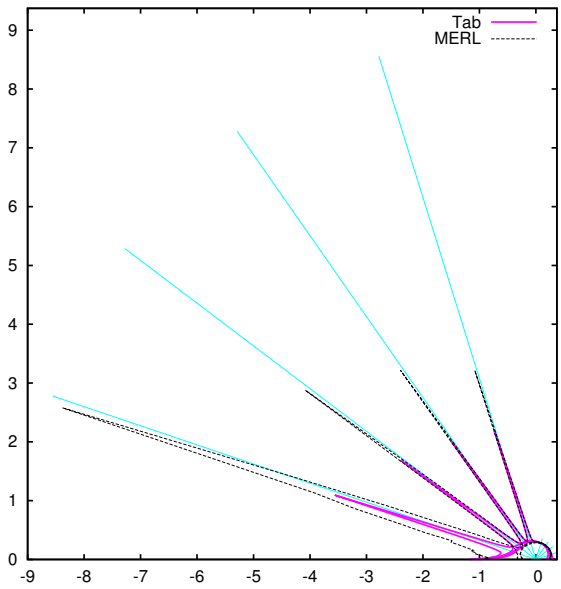


Ours: GGX

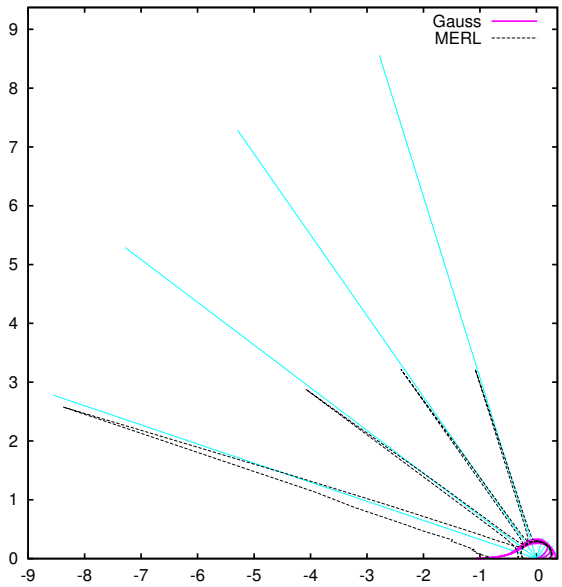
BRDF Lobes in the Incidence Plane (Cubic Root Applied)



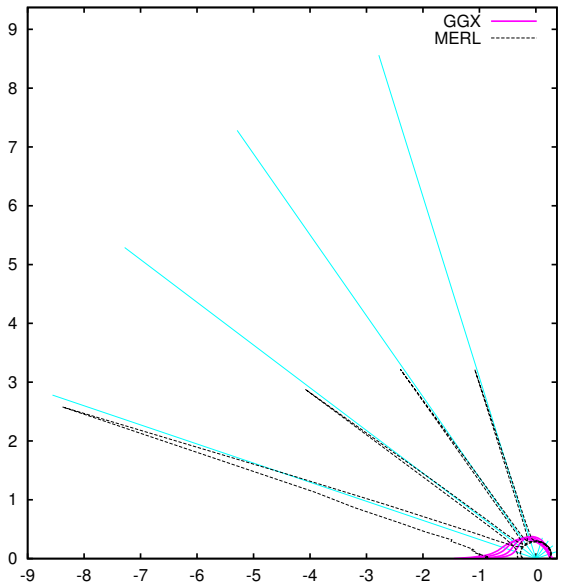
SGD



Ours: Tabulated

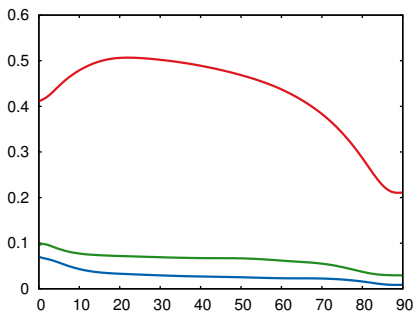


Ours: Gaussian

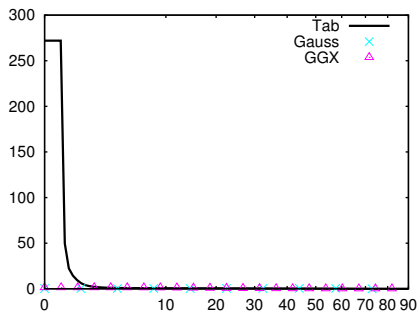


Ours: GGX

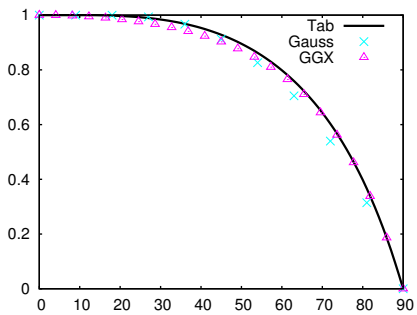
Fitted Microfacet Functions



Fresnel (R, G, B)



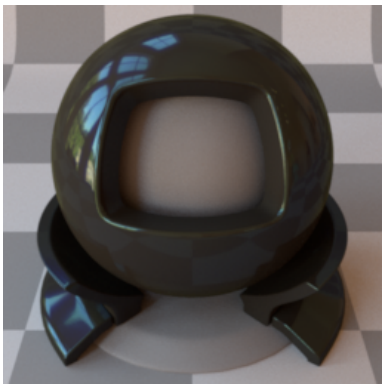
NDF (D)



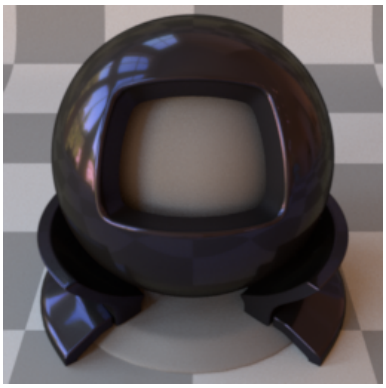
Smith (G_1)

69 silicon-nitrade

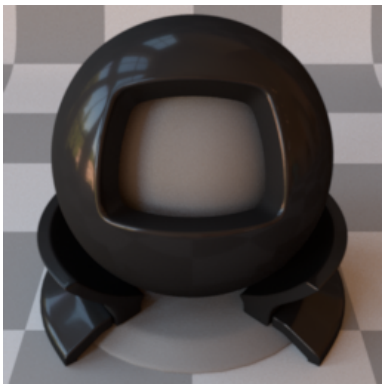
Renderings



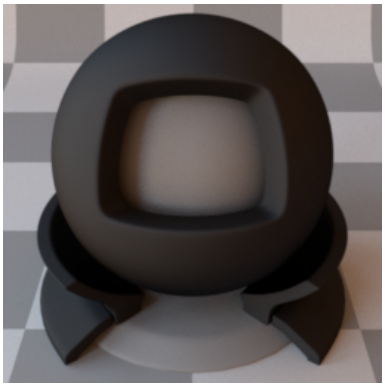
SGD



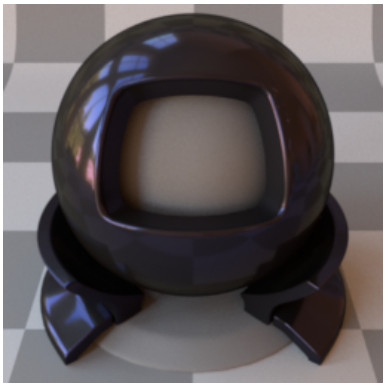
Reference



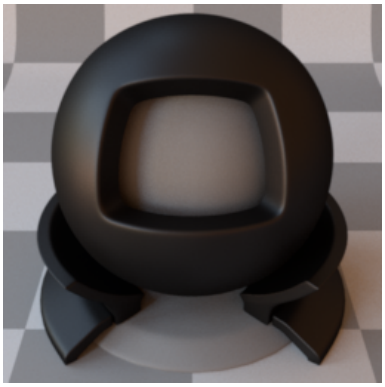
Ours: Tabulated



Ours: Gaussian

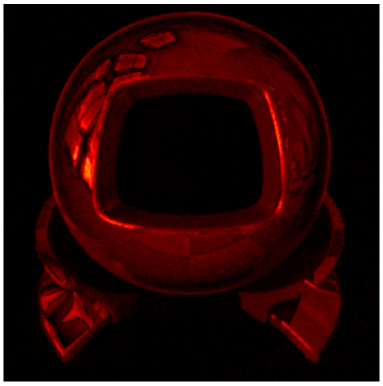


Reference

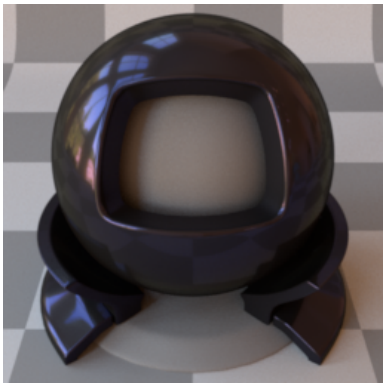


Ours: GGX

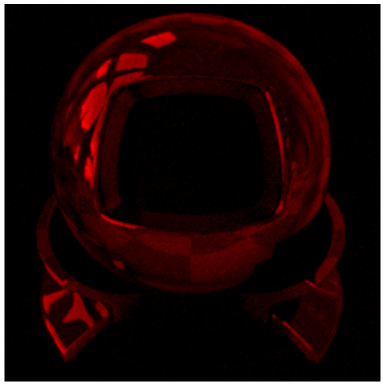
CIE dE00



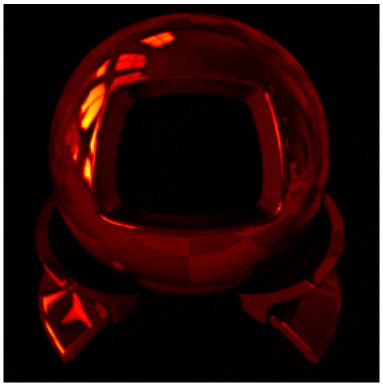
SGD



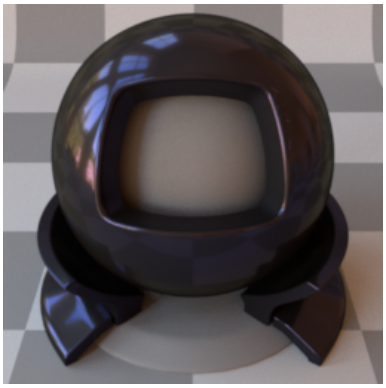
Reference



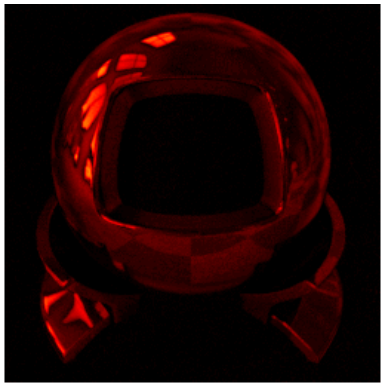
Ours: Tabulated



Ours: Gaussian

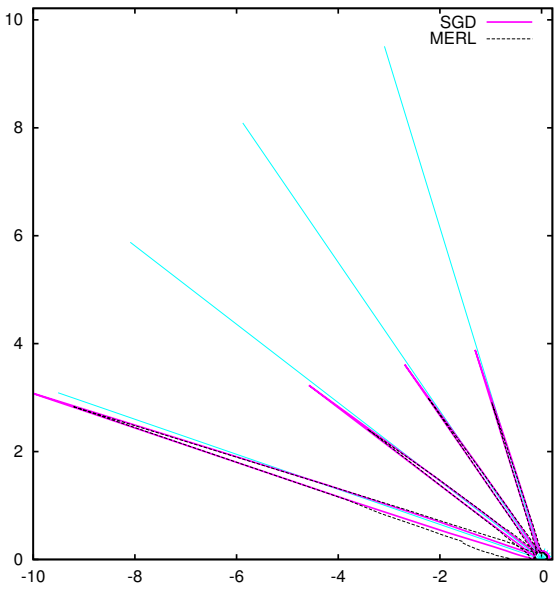


Reference

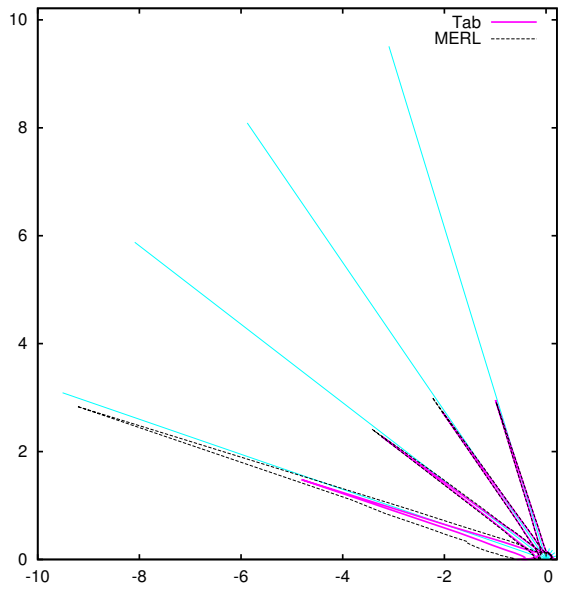


Ours: GGX

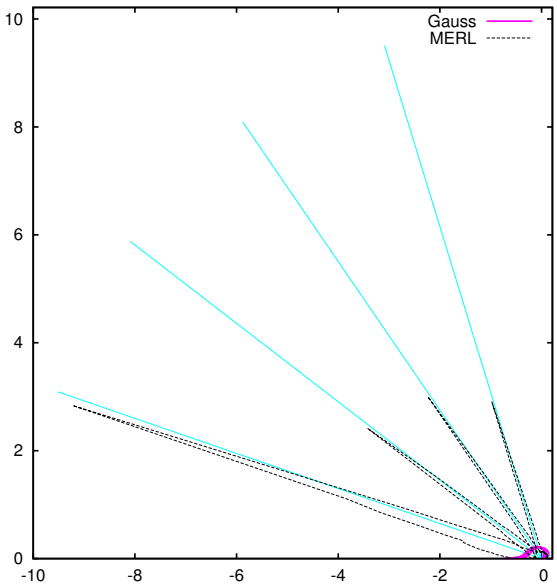
BRDF Lobes in the Incidence Plane (Cubic Root Applied)



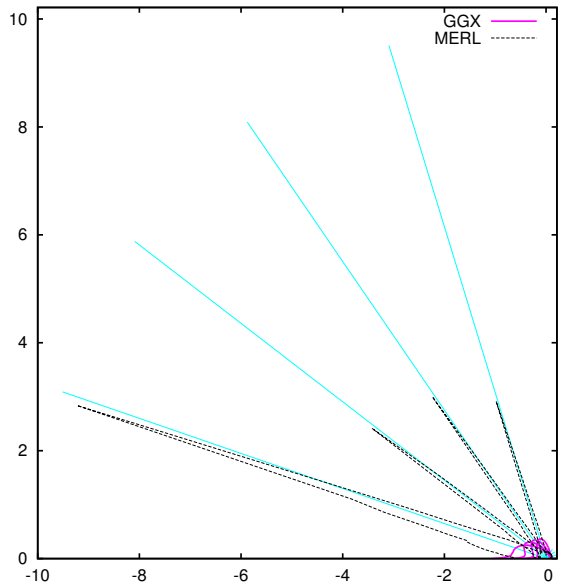
SGD



Ours: Tabulated

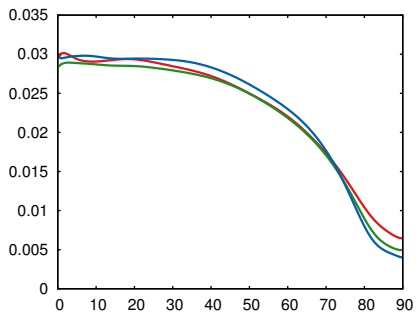


Ours: Gaussian

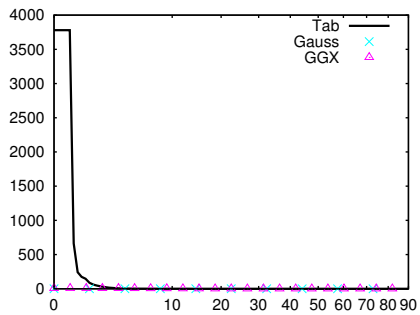


Ours: GGX

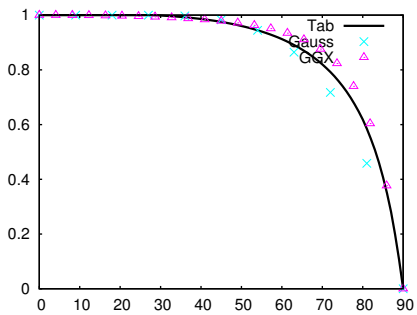
Fitted Microfacet Functions



Fresnel (R, G, B)



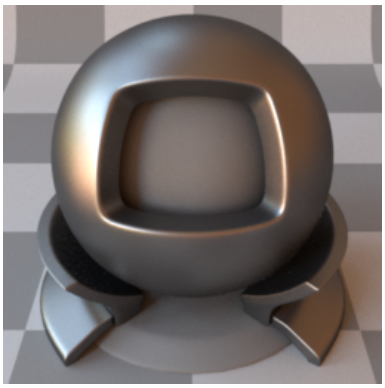
NDF (D)



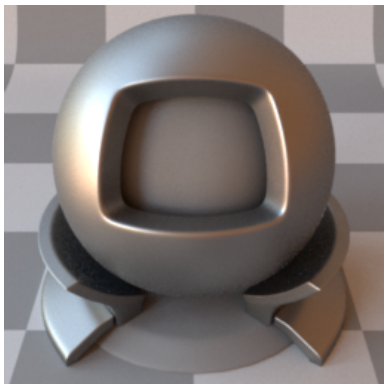
Smith (G_1)

70 silver-metallic-paint

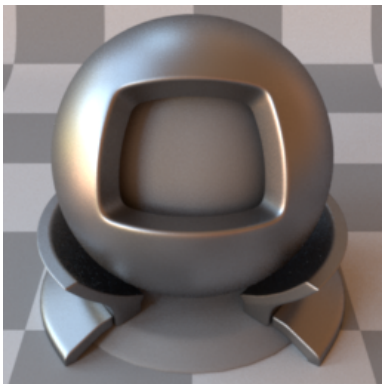
Renderings



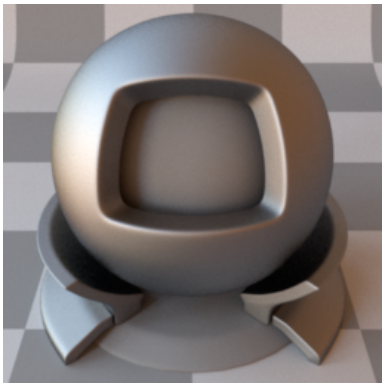
SGD



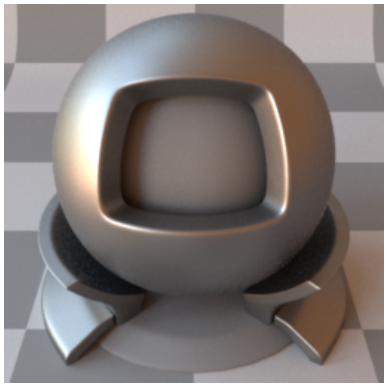
Reference



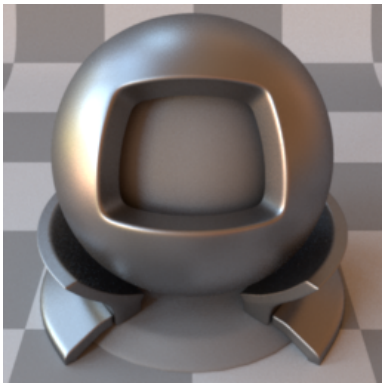
Ours: Tabulated



Ours: Gaussian

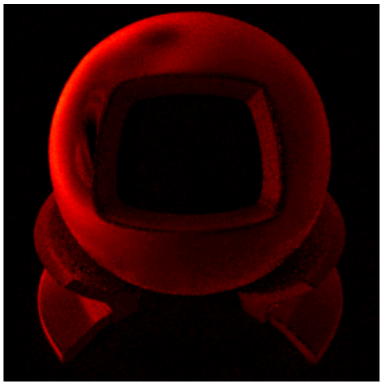


Reference

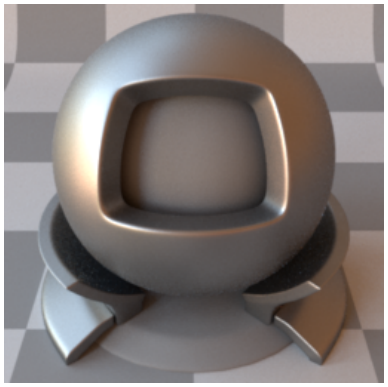


Ours: GGX

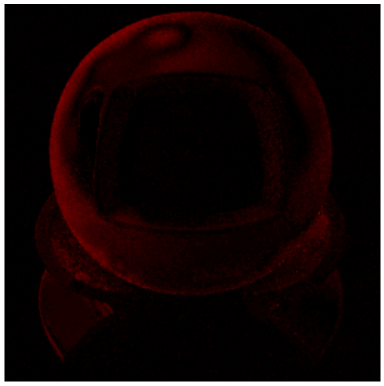
CIE dE00



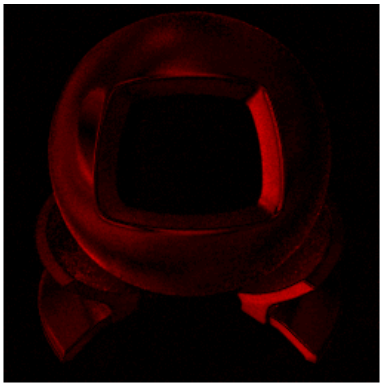
SGD



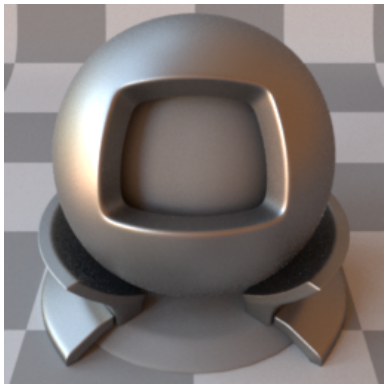
Reference



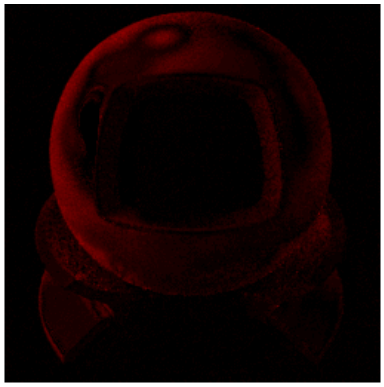
Ours: Tabulated



Ours: Gaussian

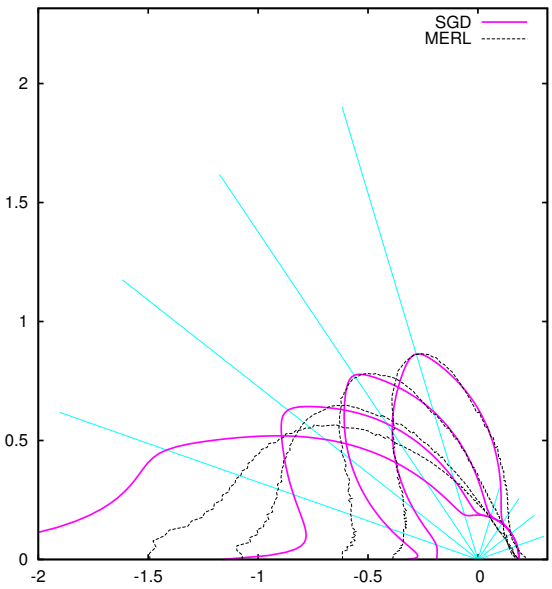


Reference

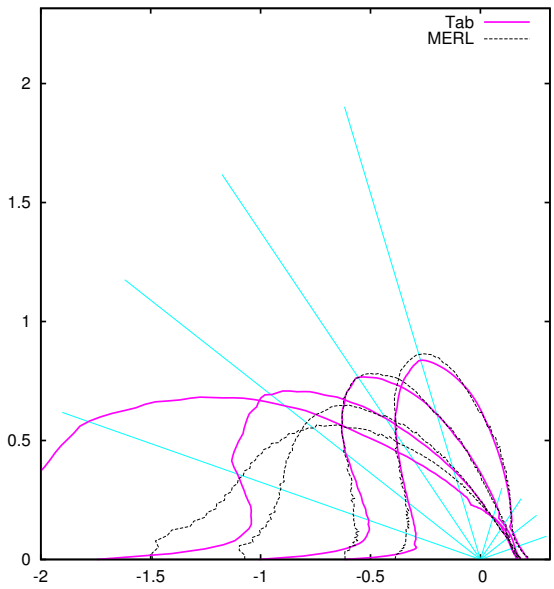


Ours: GGX

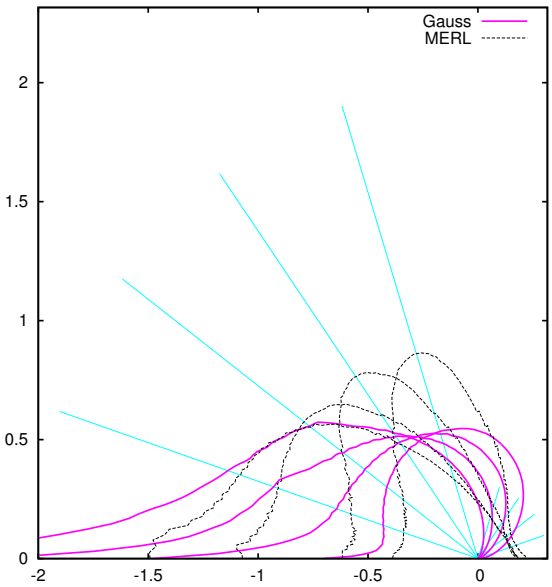
BRDF Lobes in the Incidence Plane (Cubic Root Applied)



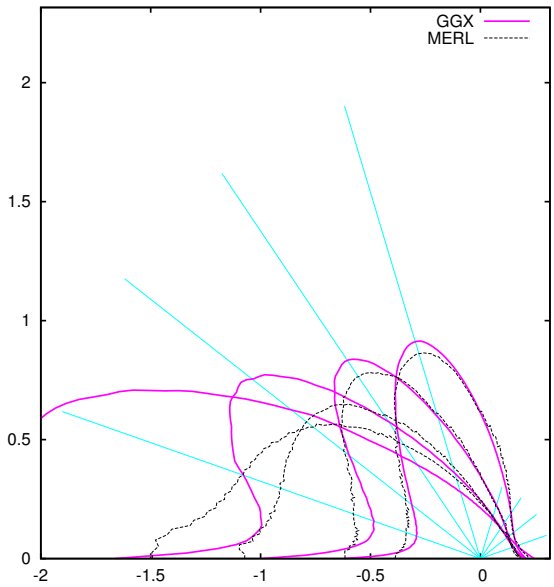
SGD



Ours: Tabulated

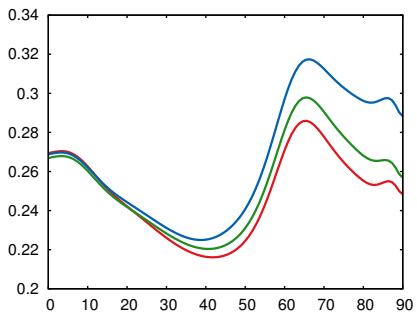


Ours: Gaussian

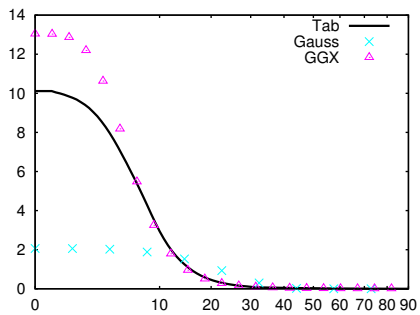


Ours: GGX

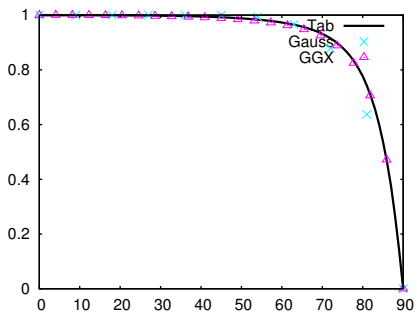
Fitted Microfacet Functions



Fresnel (R, G, B)



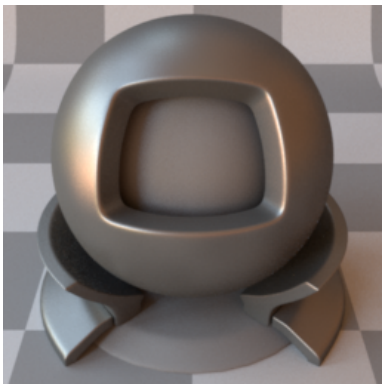
NDF (D)



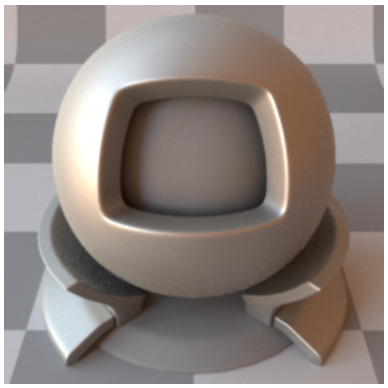
Smith (G_1)

71 silver-metallic-paint2

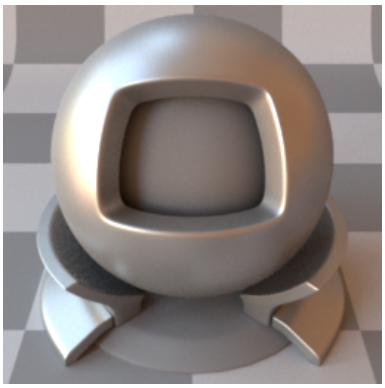
Renderings



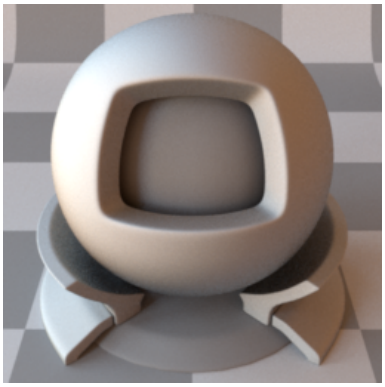
SGD



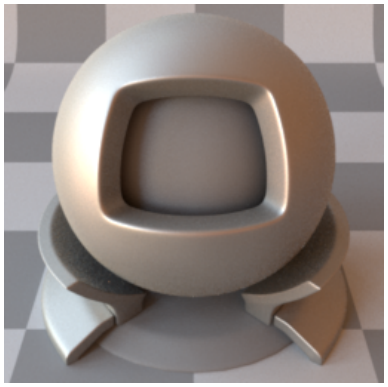
Reference



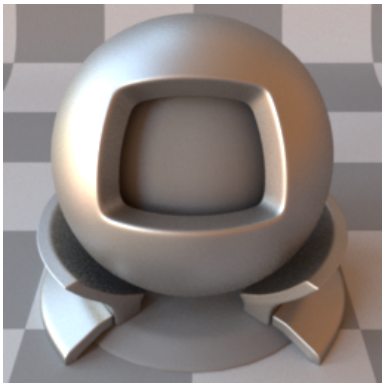
Ours: Tabulated



Ours: Gaussian

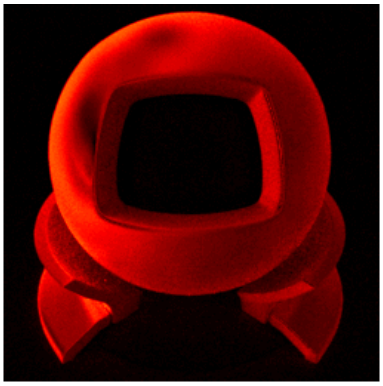


Reference

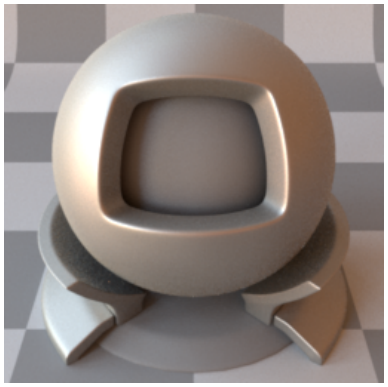


Ours: GGX

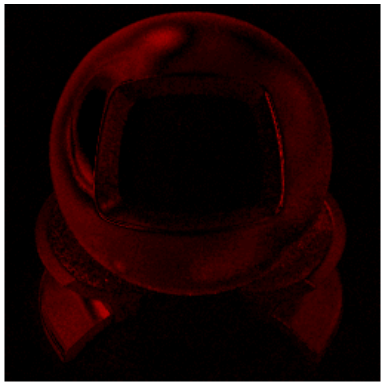
CIE dE00



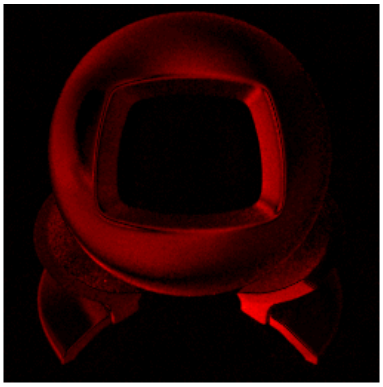
SGD



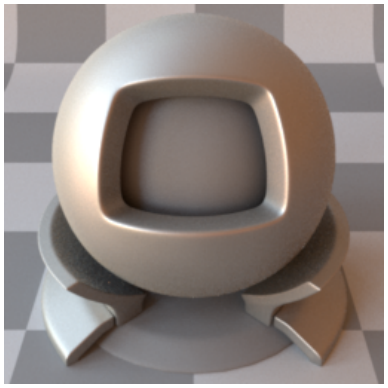
Reference



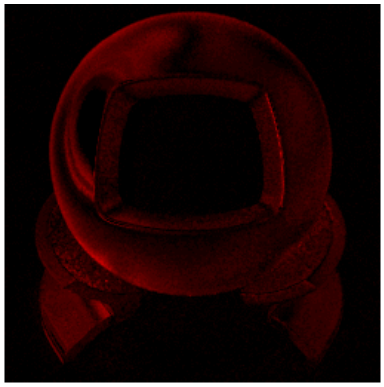
Ours: Tabulated



Ours: Gaussian

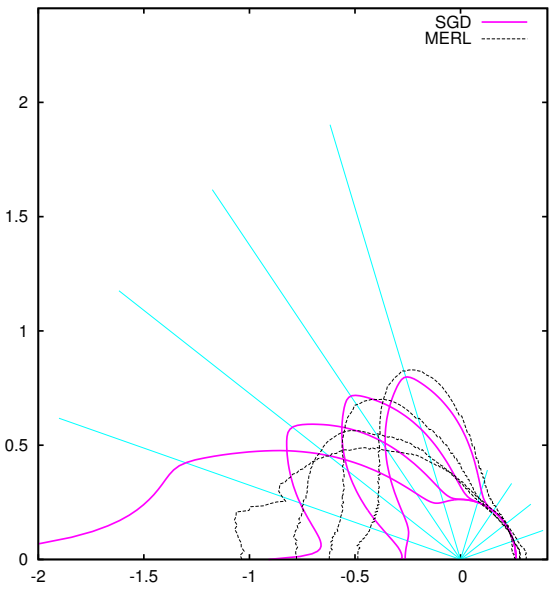


Reference

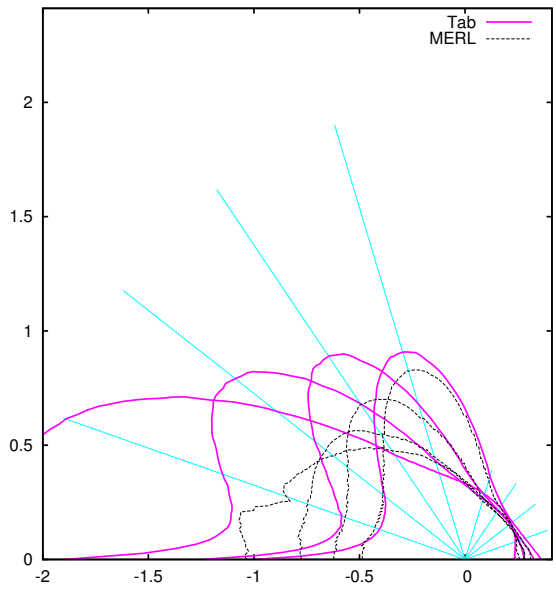


Ours: GGX

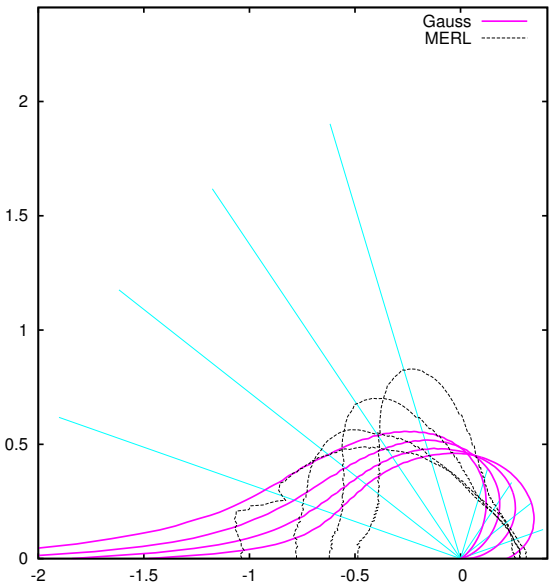
BRDF Lobes in the Incidence Plane (Cubic Root Applied)



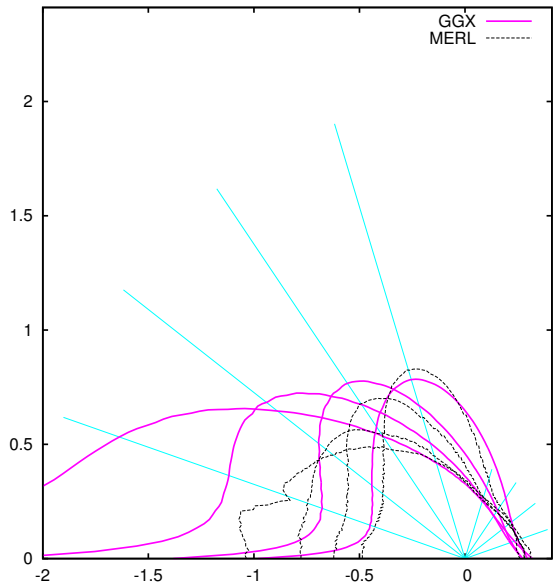
SGD



Ours: Tabulated

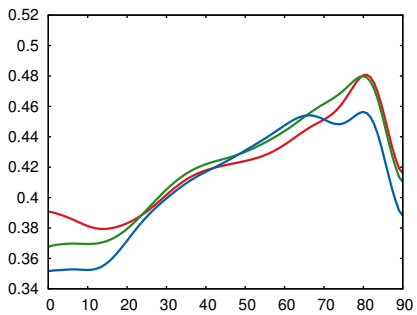


Ours: Gaussian

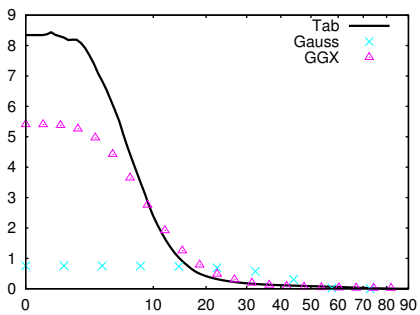


Ours: GGX

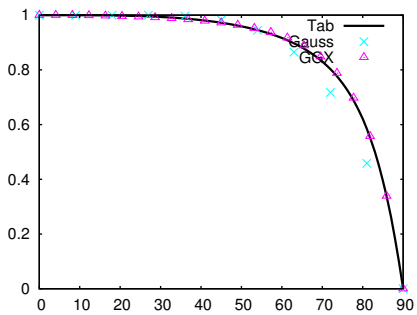
Fitted Microfacet Functions



Fresnel (R, G, B)



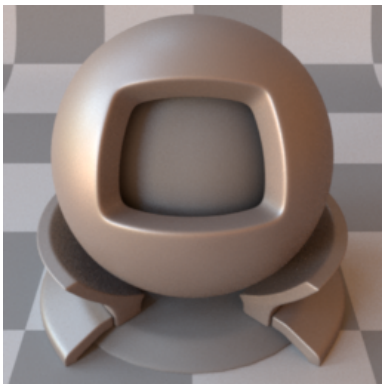
NDF (D)



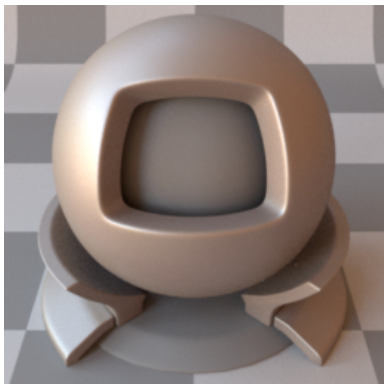
Smith (G_1)

72 silver-paint

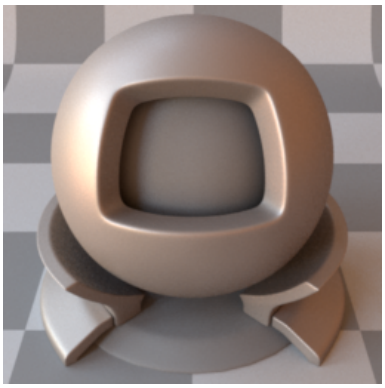
Renderings



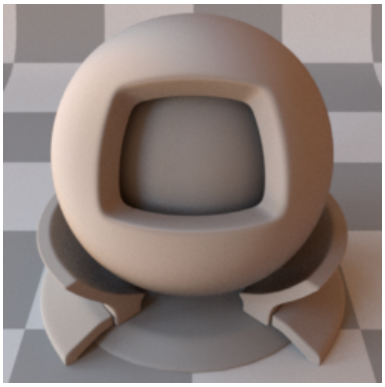
SGD



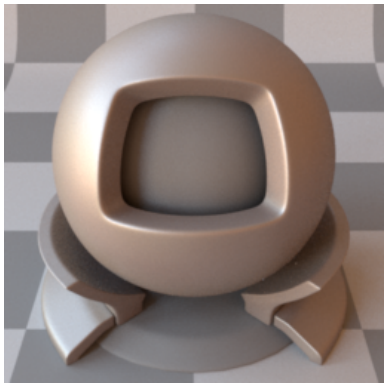
Reference



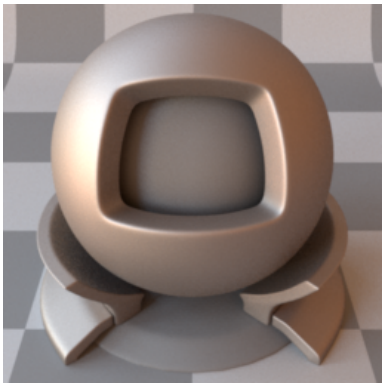
Ours: Tabulated



Ours: Gaussian

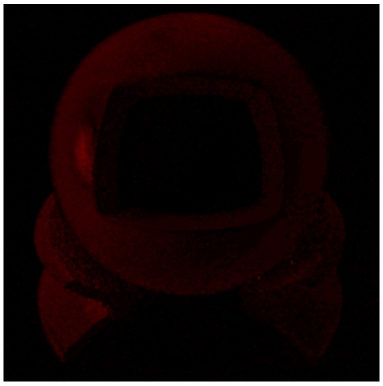


Reference

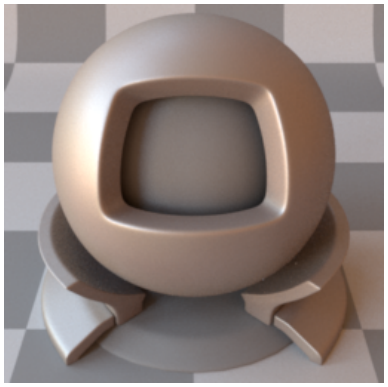


Ours: GGX

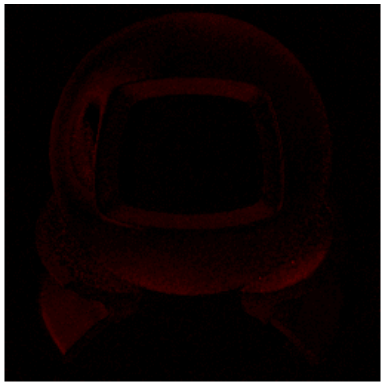
CIE dE00



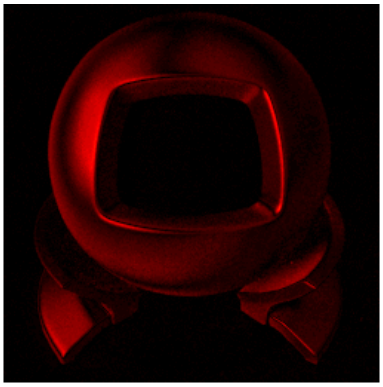
SGD



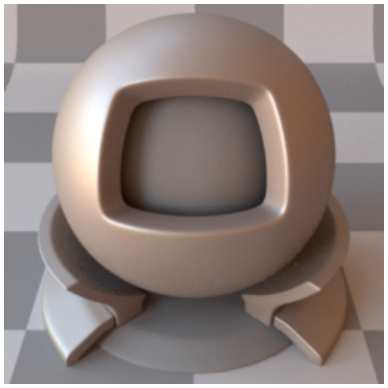
Reference



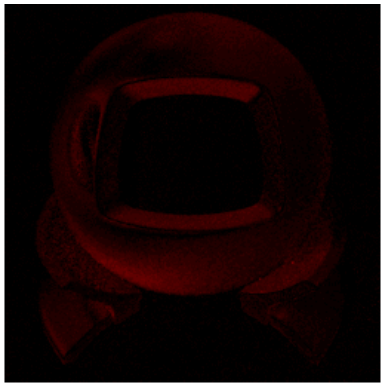
Ours: Tabulated



Ours: Gaussian

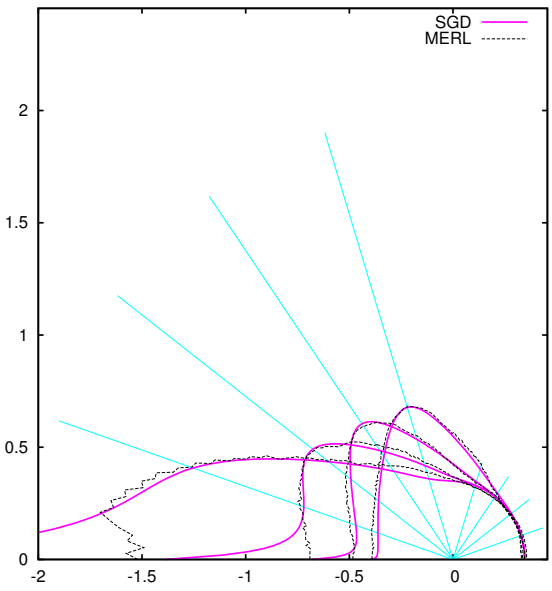


Reference

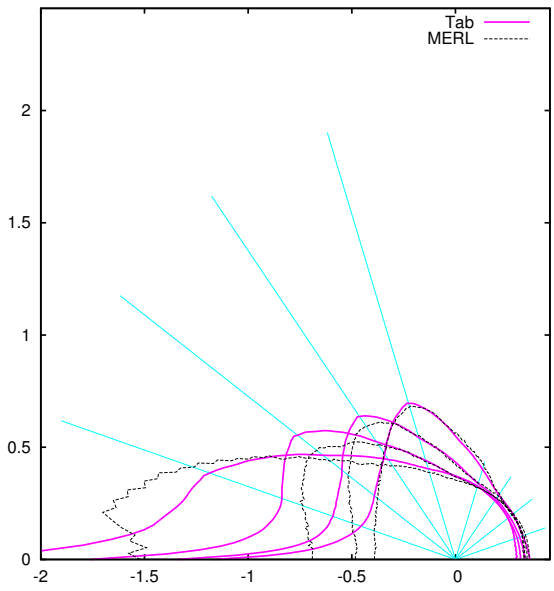


Ours: GGX

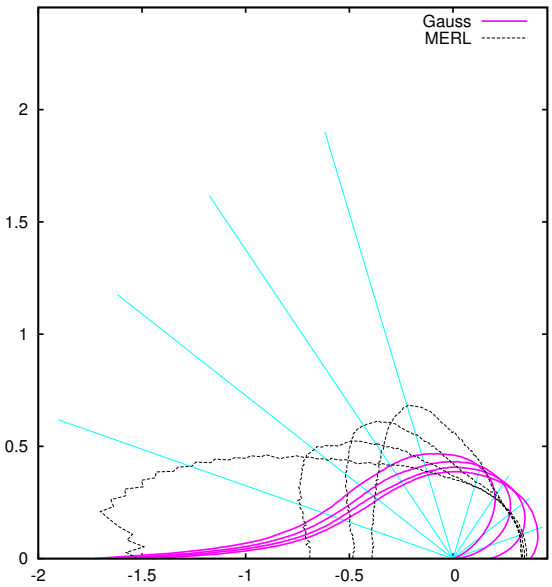
BRDF Lobes in the Incidence Plane (Cubic Root Applied)



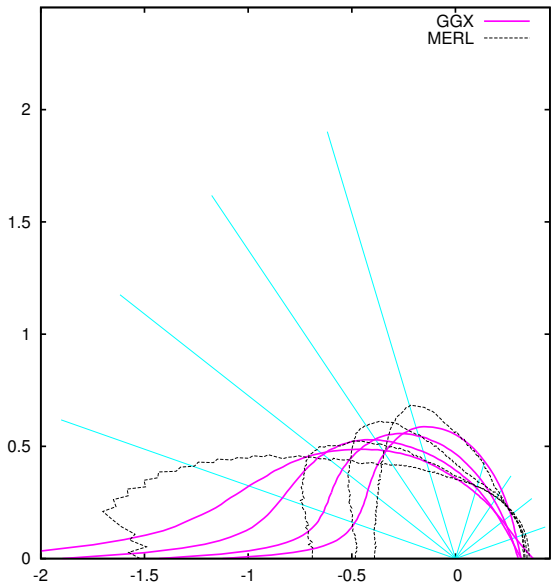
SGD



Ours: Tabulated

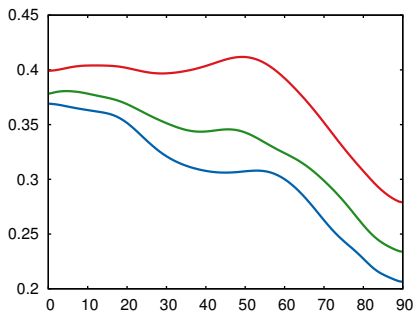


Ours: Gaussian

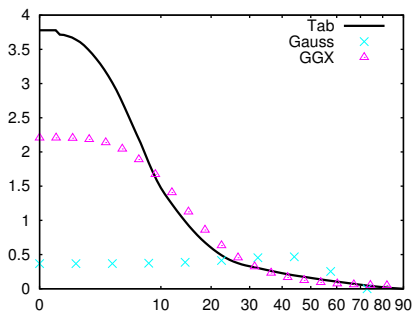


Ours: GGX

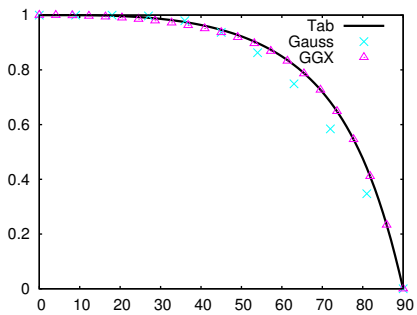
Fitted Microfacet Functions



Fresnel (R, G, B)



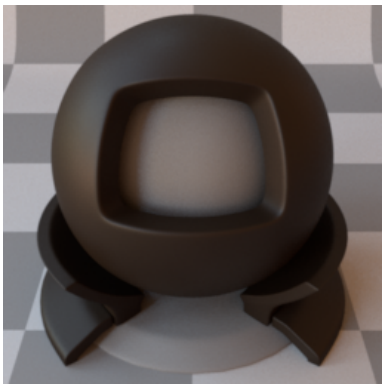
NDF (D)



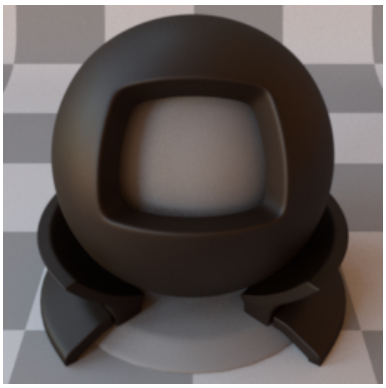
Smith (G_1)

73 special-walnut-224

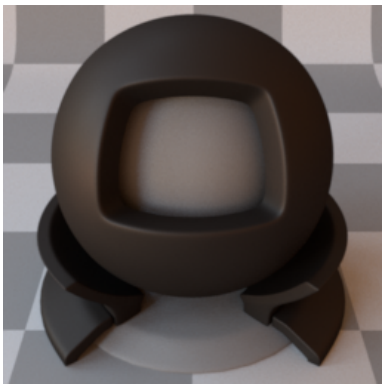
Renderings



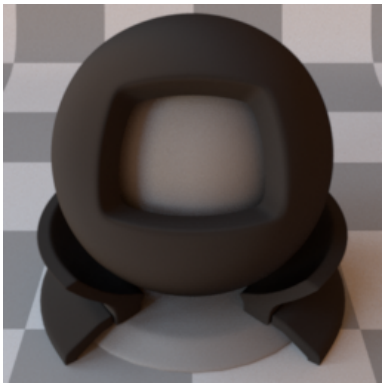
SGD



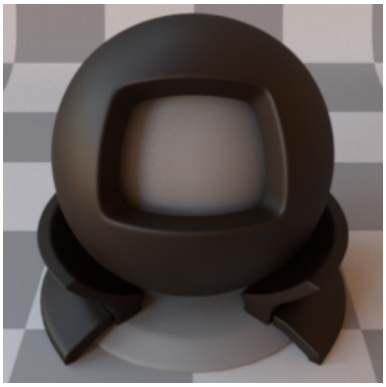
Reference



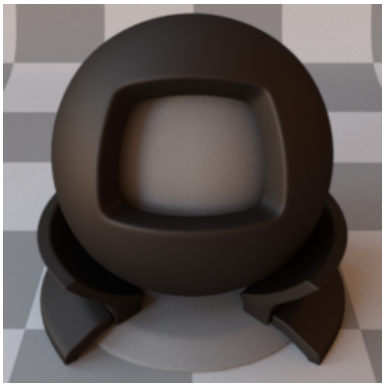
Ours: Tabulated



Ours: Gaussian



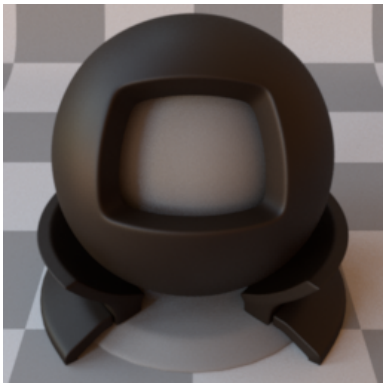
Reference



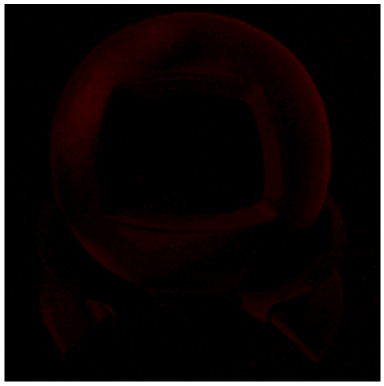
Ours: GGX

CIE dE00

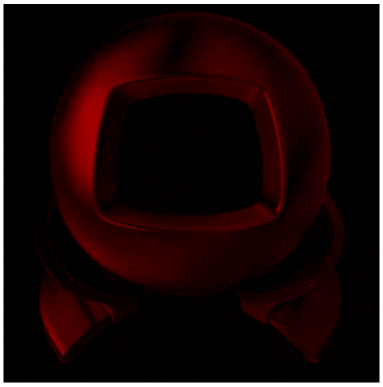
SGD



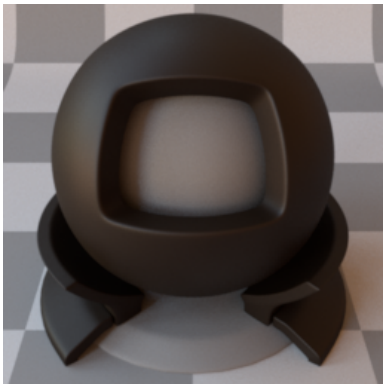
Reference



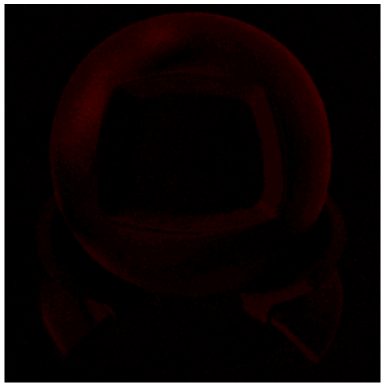
Ours: Tabulated



Ours: Gaussian

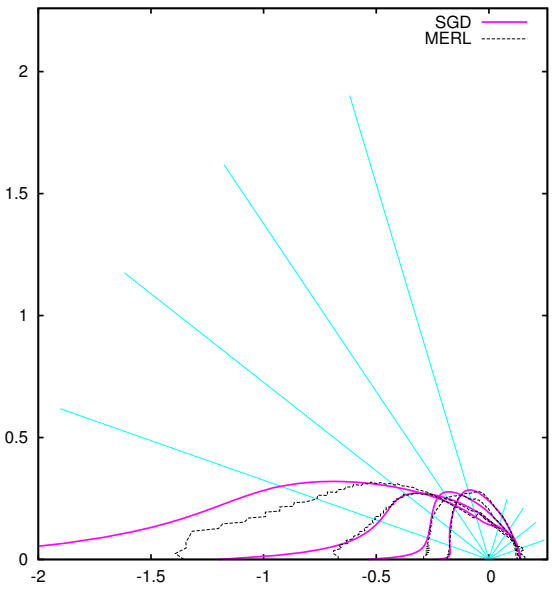


Reference

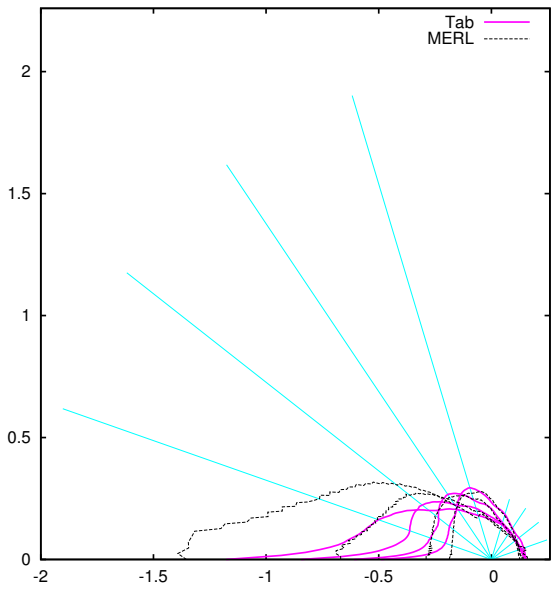


Ours: GGX

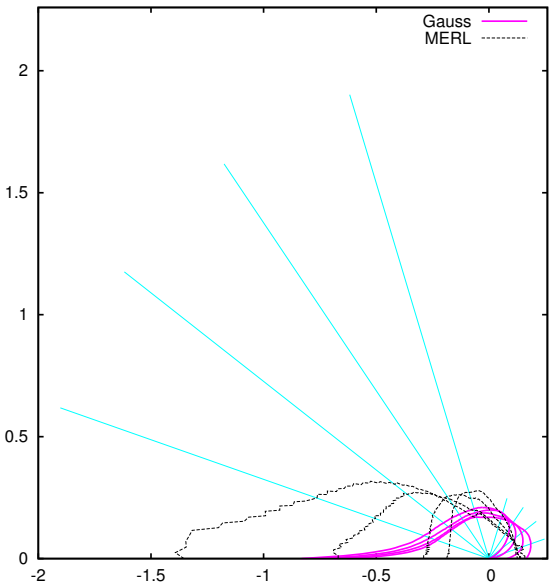
BRDF Lobes in the Incidence Plane (Cubic Root Applied)



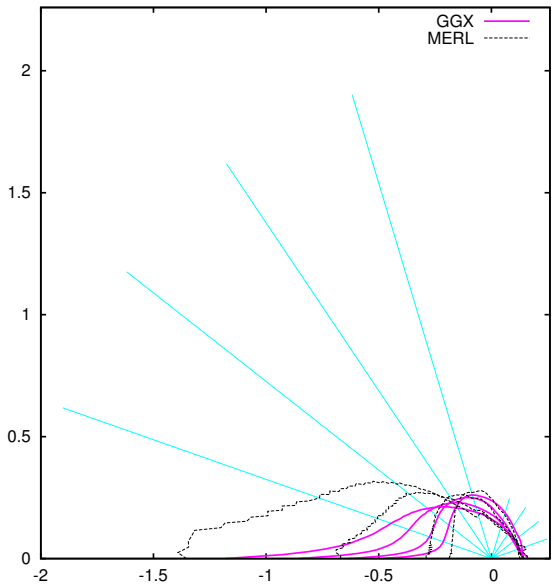
SGD



Ours: Tabulated

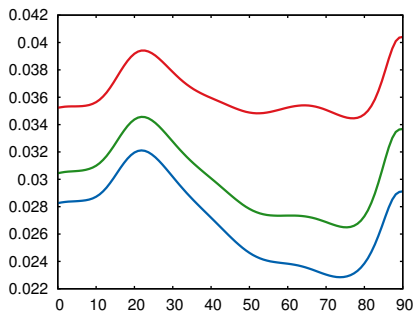


Ours: Gaussian

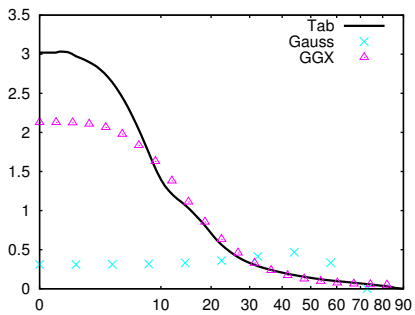


Ours: GGX

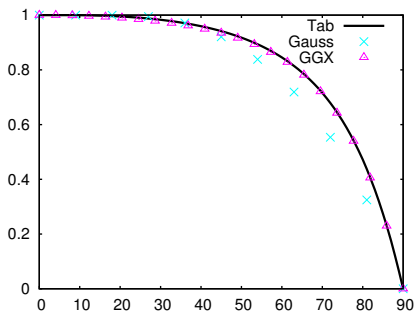
Fitted Microfacet Functions



Fresnel (R, G, B)



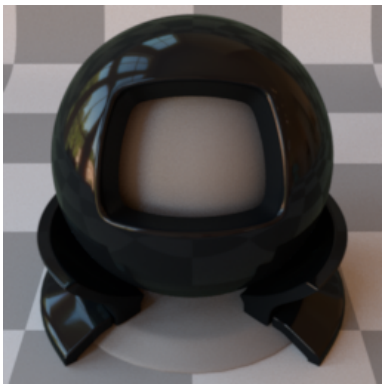
NDF (D)



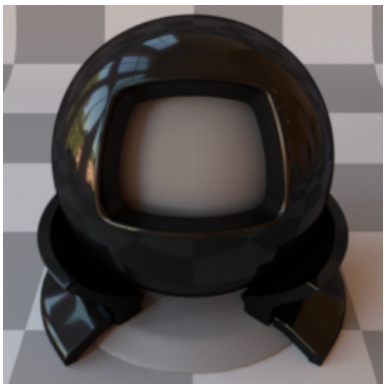
Smith (G_1)

74 specular-black-phenolic

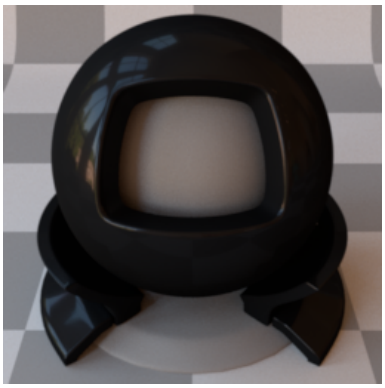
Renderings



SGD

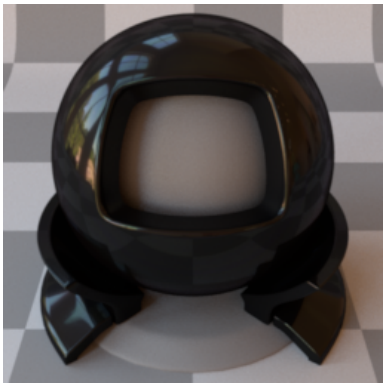


Reference

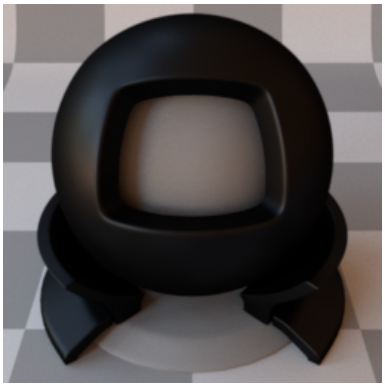


Ours: Tabulated

Ours: Gaussian

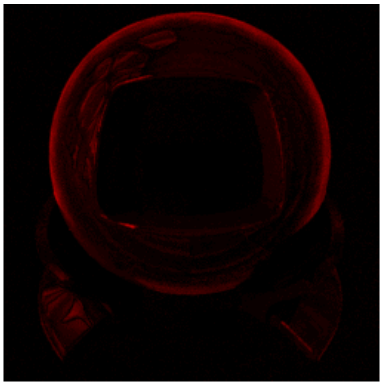


Reference

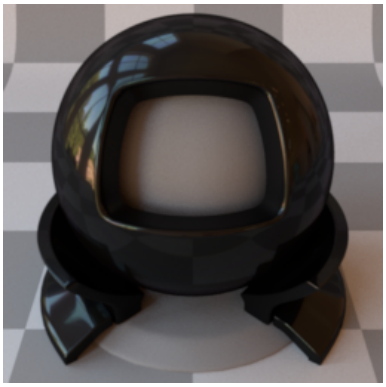


Ours: GGX

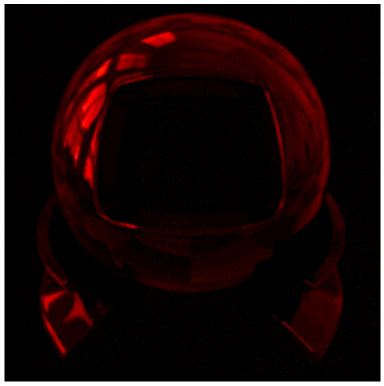
CIE dE00



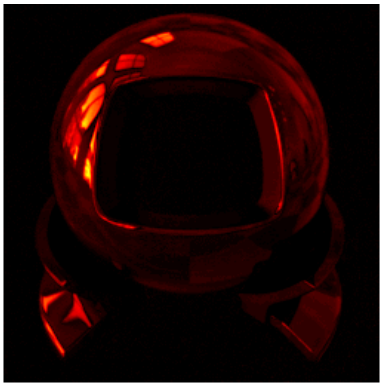
SGD



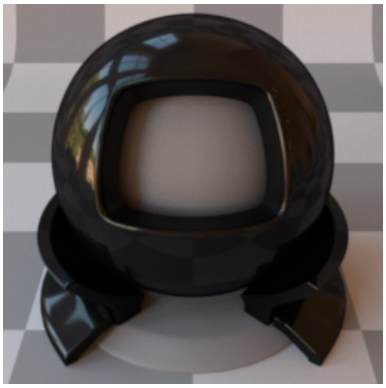
Reference



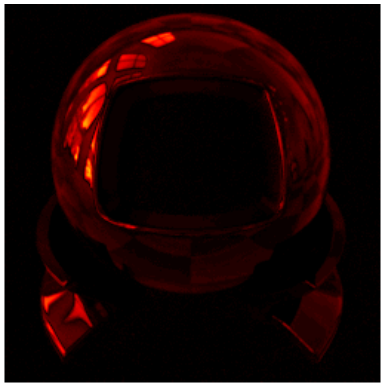
Ours: Tabulated



Ours: Gaussian

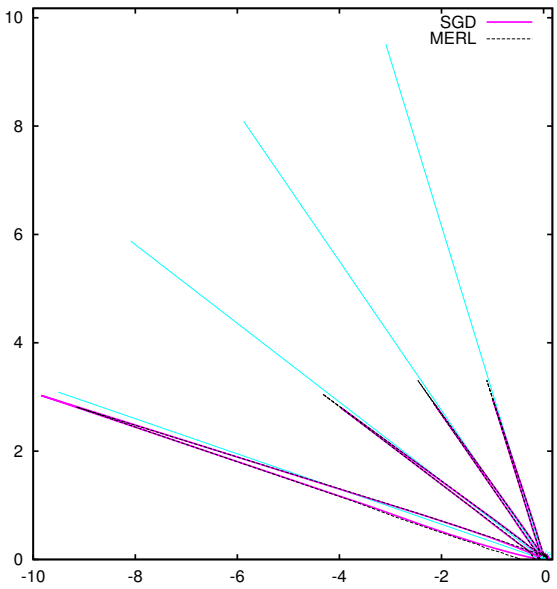


Reference

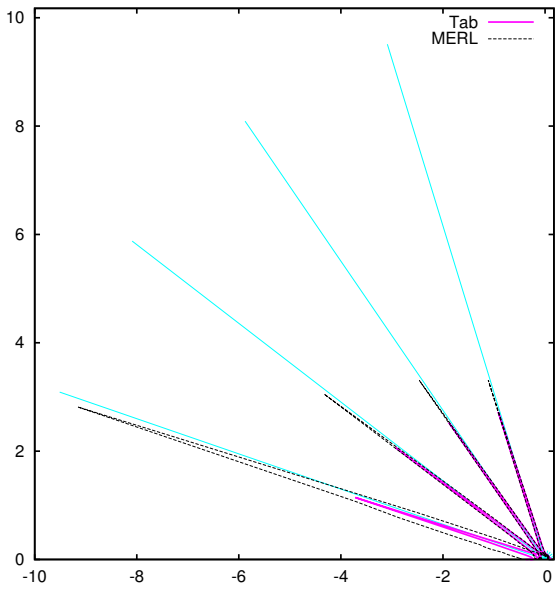


Ours: GGX

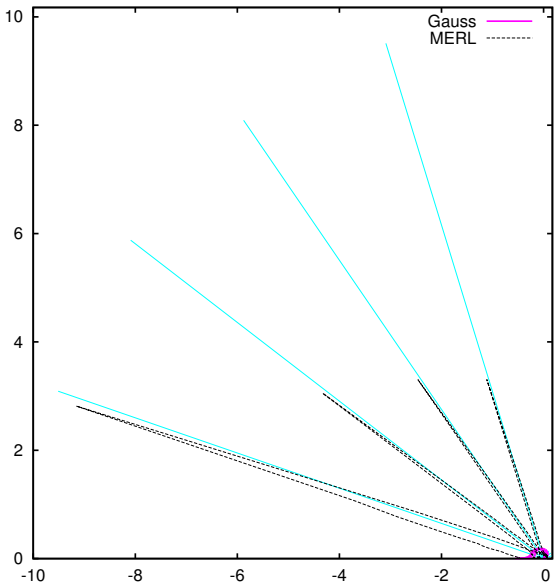
BRDF Lobes in the Incidence Plane (Cubic Root Applied)



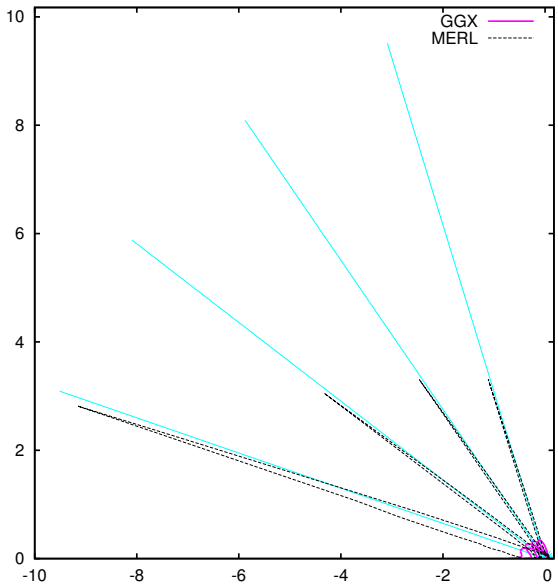
SGD



Ours: Tabulated

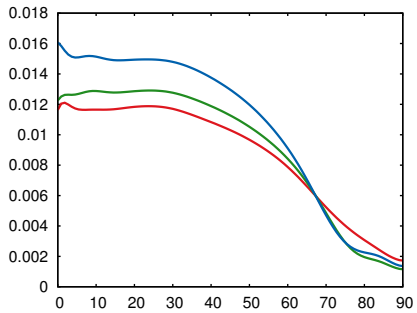


Ours: Gaussian

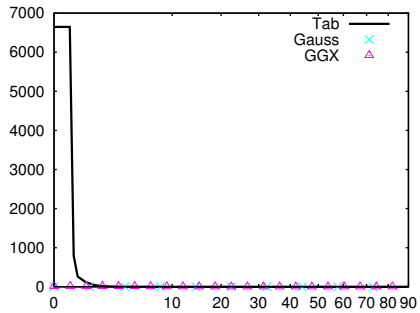


Ours: GGX

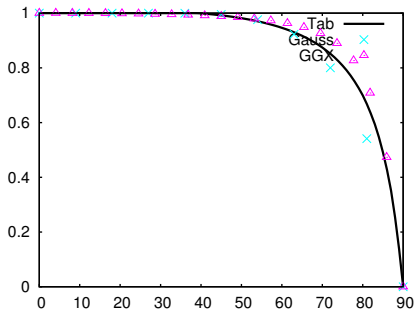
Fitted Microfacet Functions



Fresnel (R, G, B)



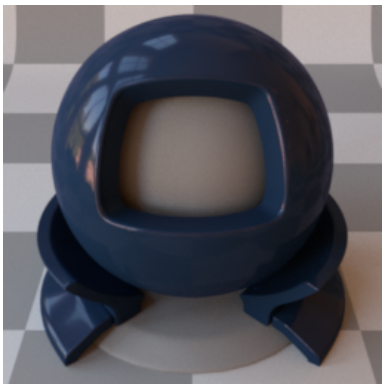
NDF (D)



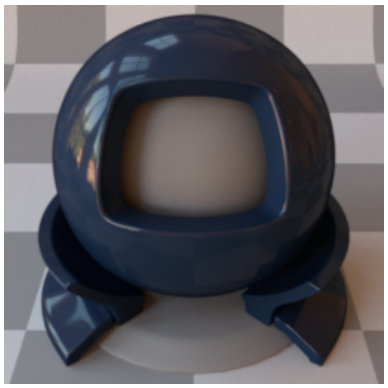
Smith (G_1)

75 specular-blue-phenolic

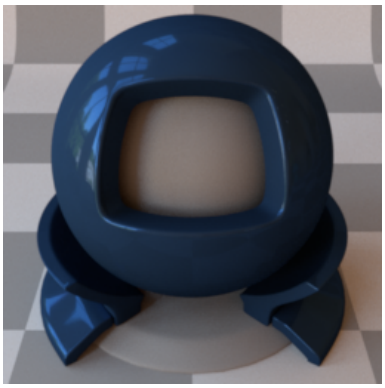
Renderings



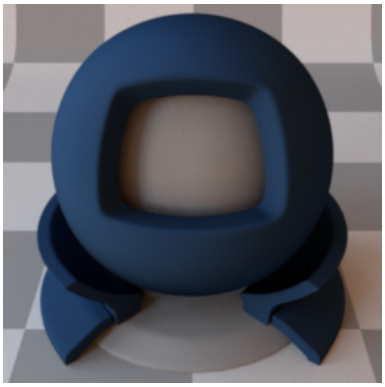
SGD



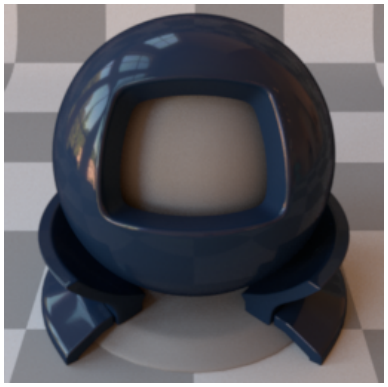
Reference



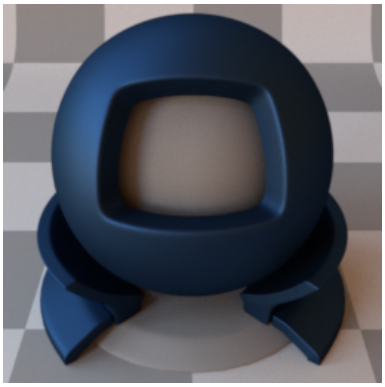
Ours: Tabulated



Ours: Gaussian

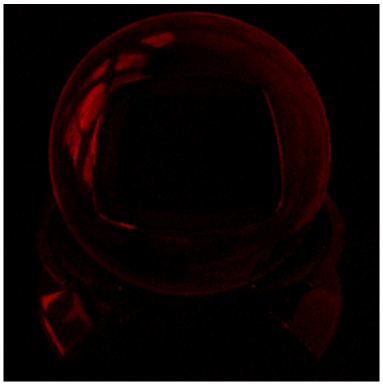


Reference

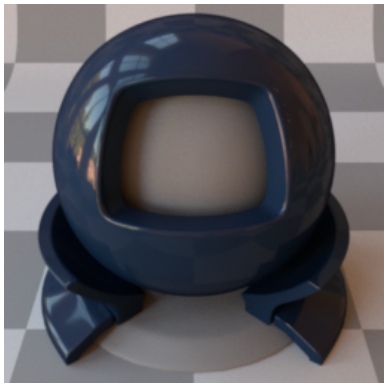


Ours: GGX

CIE dE00

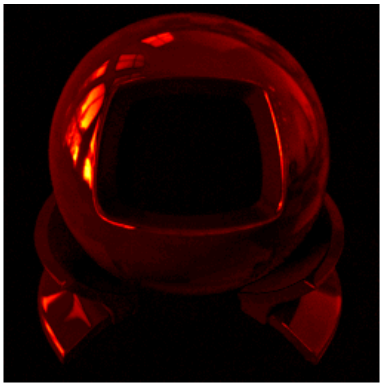


SGD

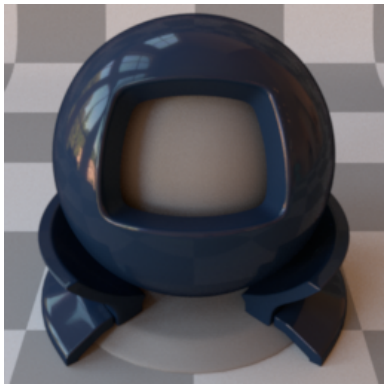


Reference

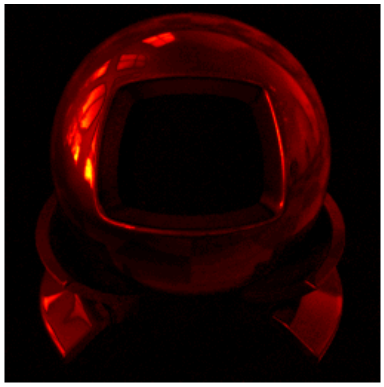
Ours: Tabulated



Ours: Gaussian

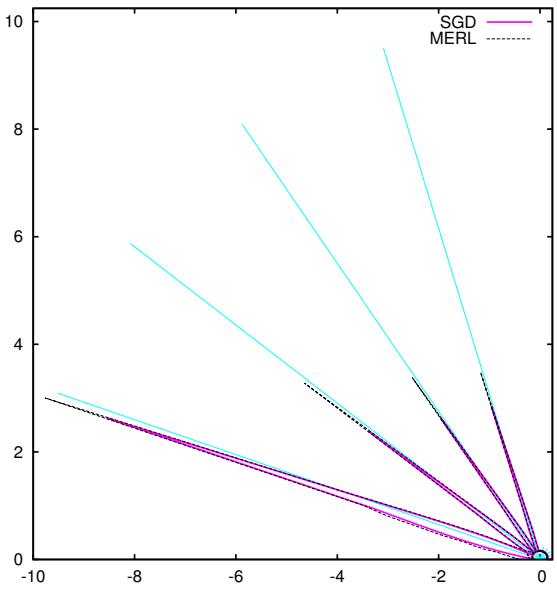


Reference

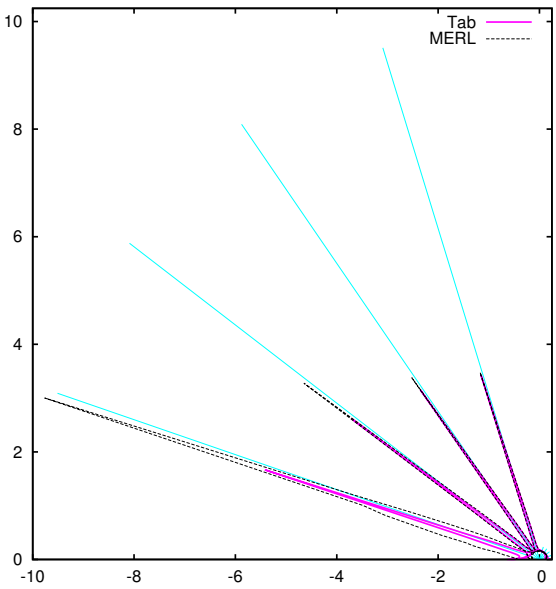


Ours: GGX

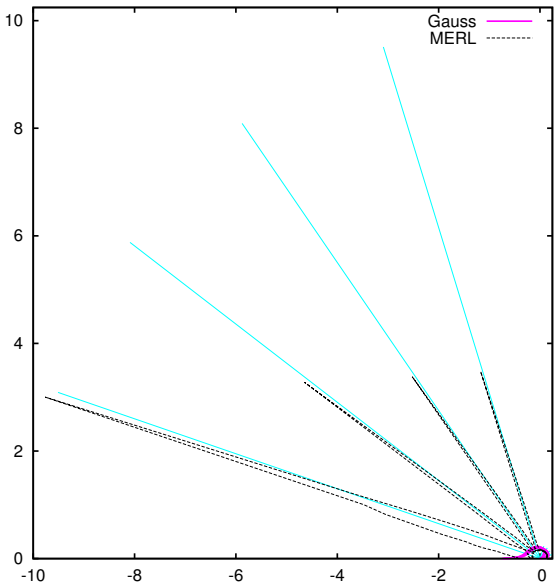
BRDF Lobes in the Incidence Plane (Cubic Root Applied)



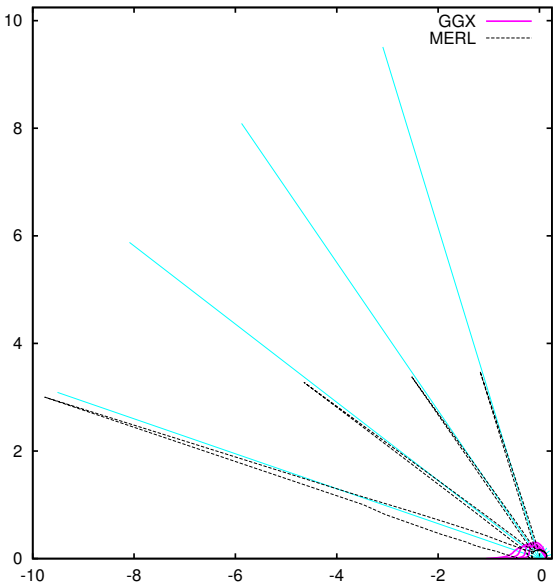
SGD



Ours: Tabulated

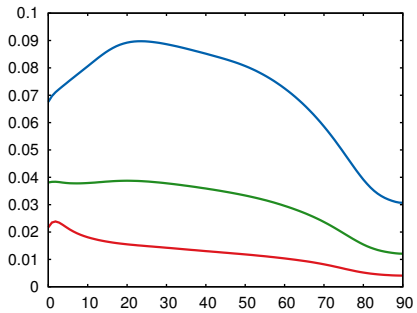


Ours: Gaussian

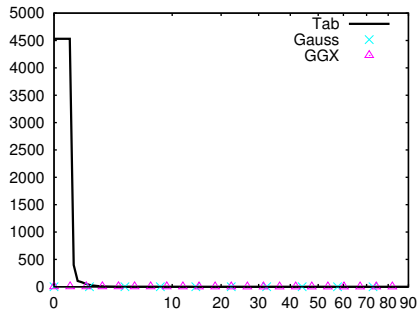


Ours: GGX

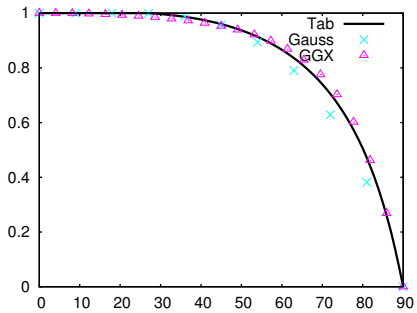
Fitted Microfacet Functions



Fresnel (R, G, B)



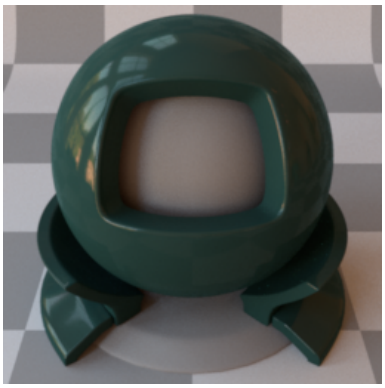
NDF (D)



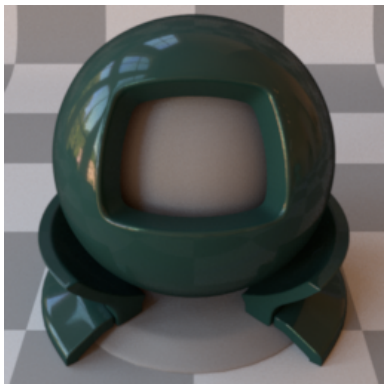
Smith (G_1)

76 specular-green-phenolic

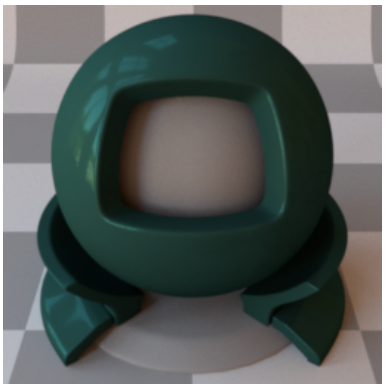
Renderings



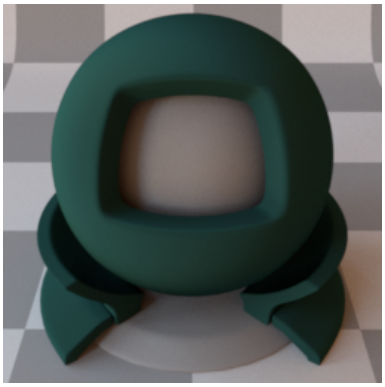
SGD



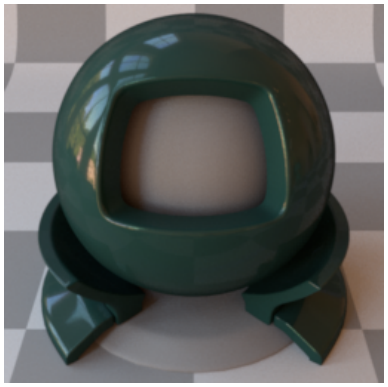
Reference



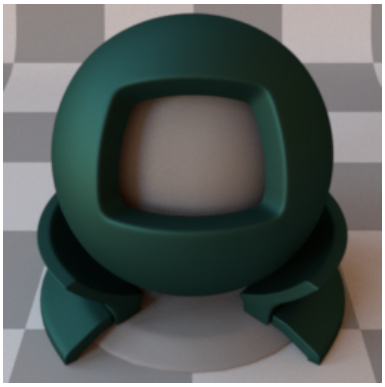
Ours: Tabulated



Ours: Gaussian

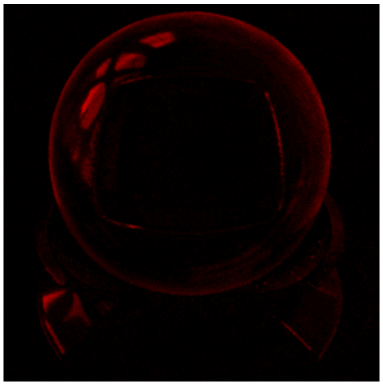


Reference

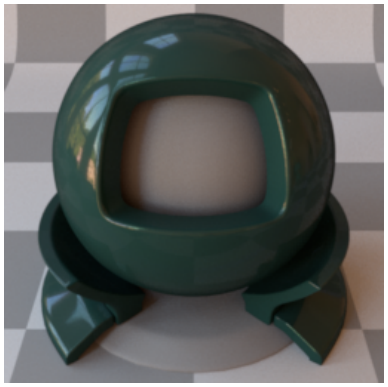


Ours: GGX

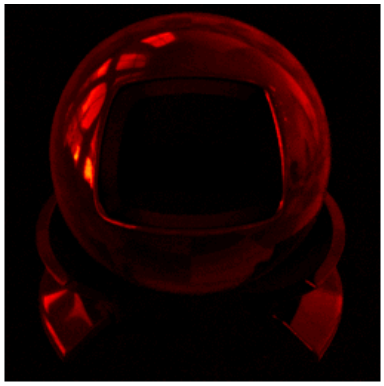
CIE dE00



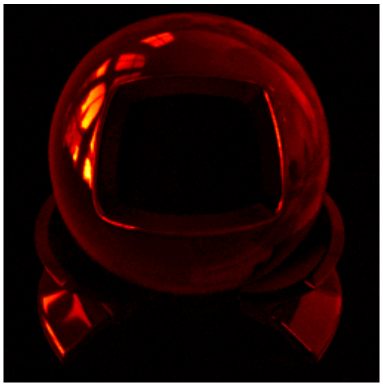
SGD



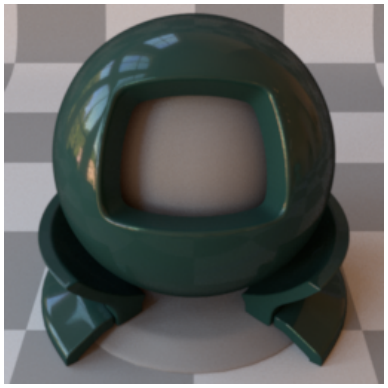
Reference



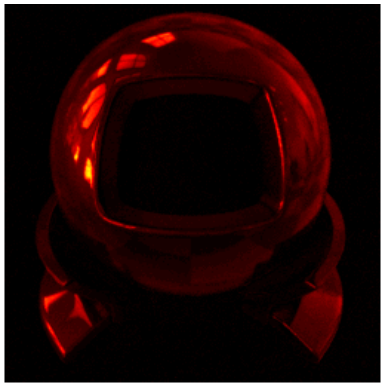
Ours: Tabulated



Ours: Gaussian

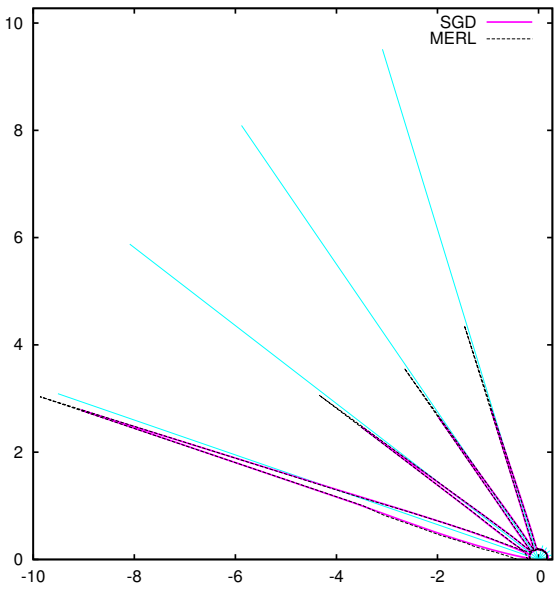


Reference

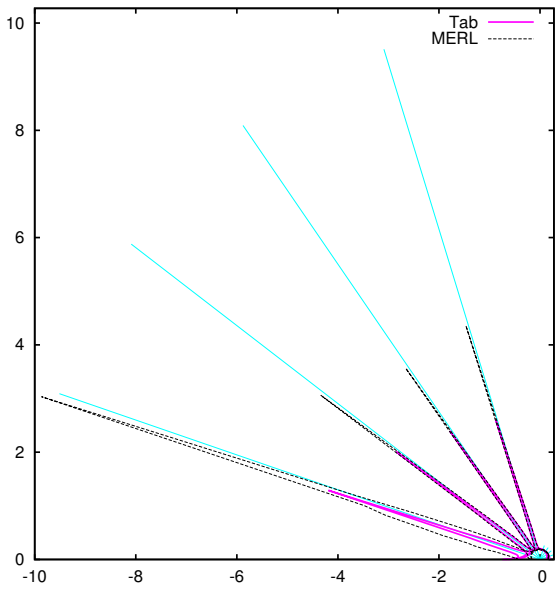


Ours: GGX

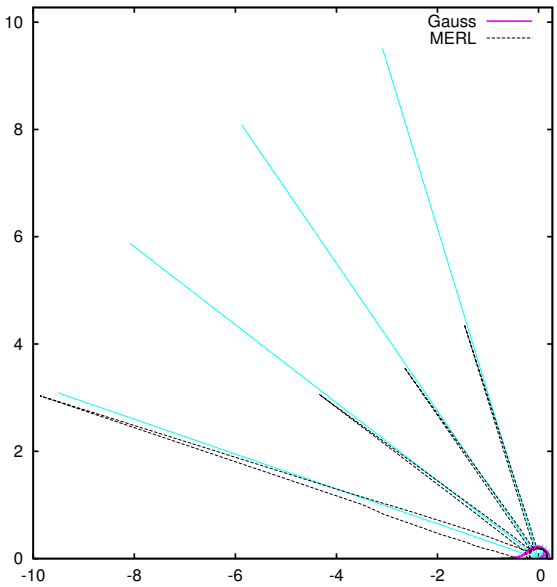
BRDF Lobes in the Incidence Plane (Cubic Root Applied)



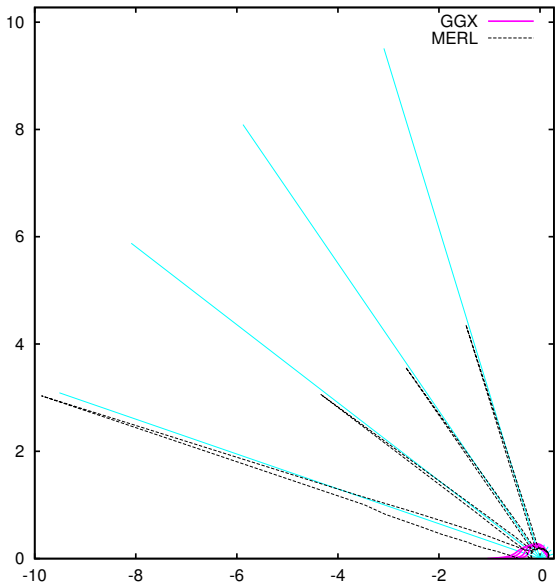
SGD



Ours: Tabulated

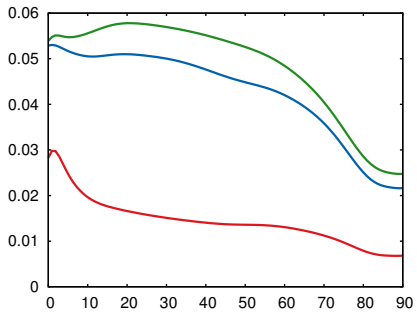


Ours: Gaussian

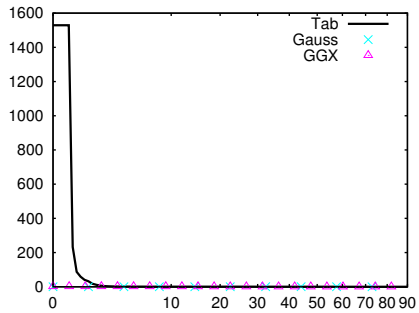


Ours: GGX

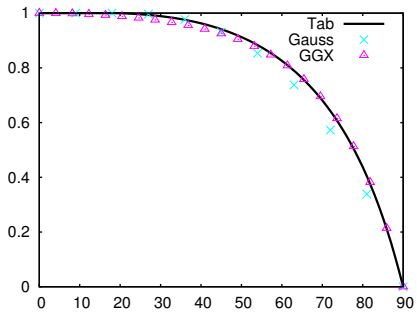
Fitted Microfacet Functions



Fresnel (R, G, B)



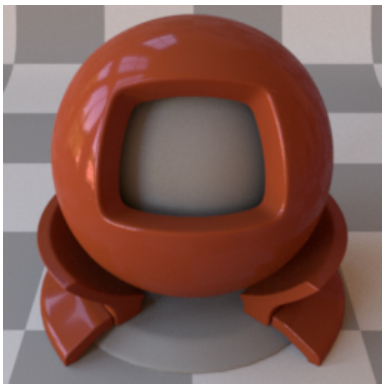
NDF (D)



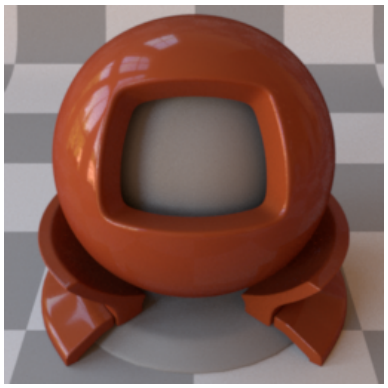
Smith (G_1)

77 specular-maroon-phenolic

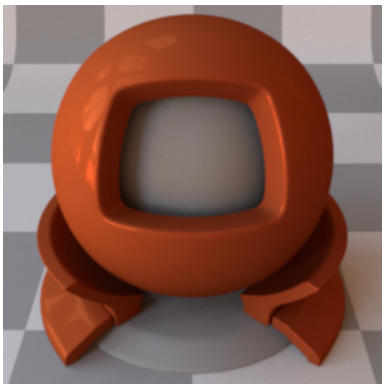
Renderings



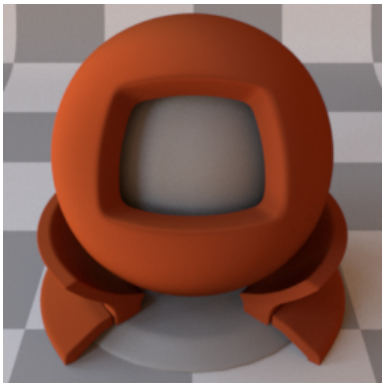
SGD



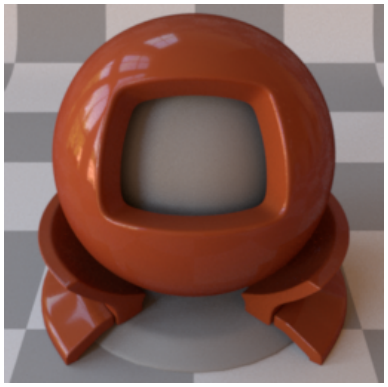
Reference



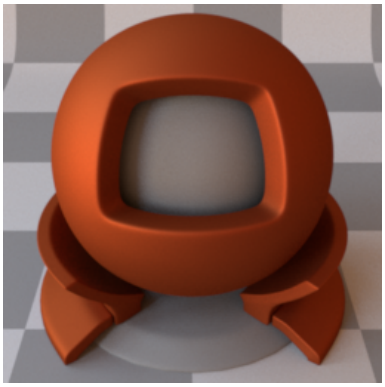
Ours: Tabulated



Ours: Gaussian

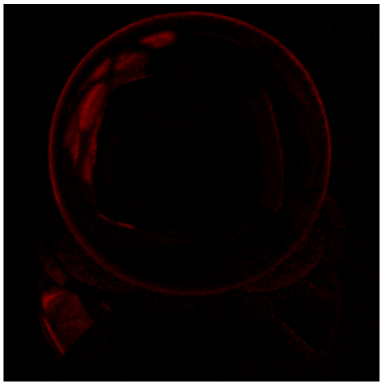


Reference

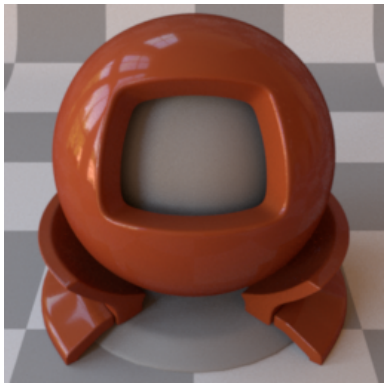


Ours: GGX

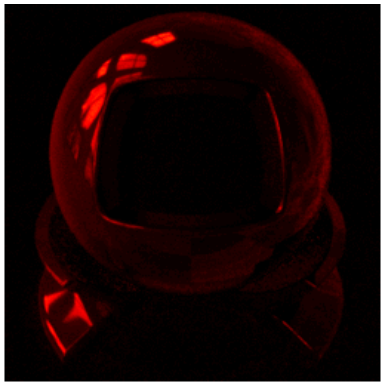
CIE dE00



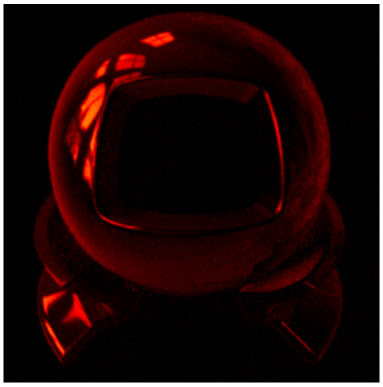
SGD



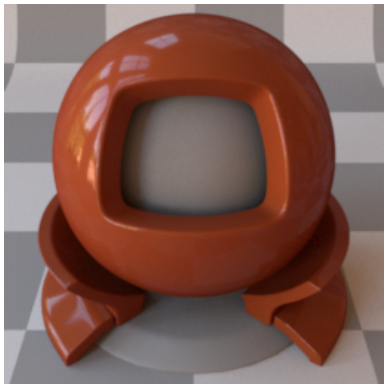
Reference



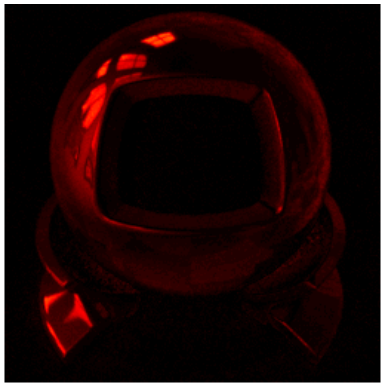
Ours: Tabulated



Ours: Gaussian

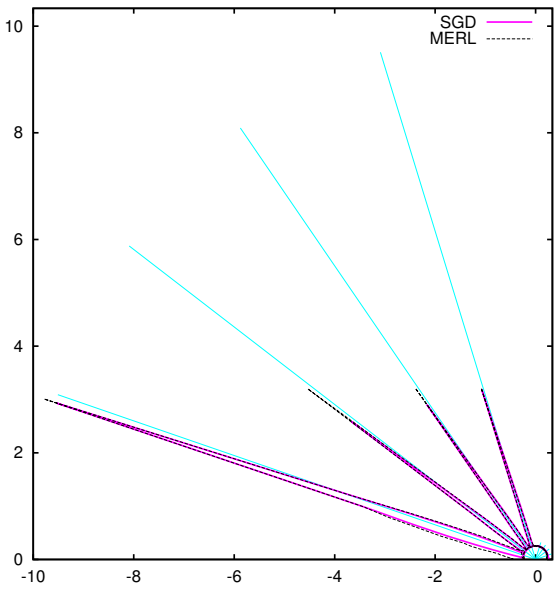


Reference

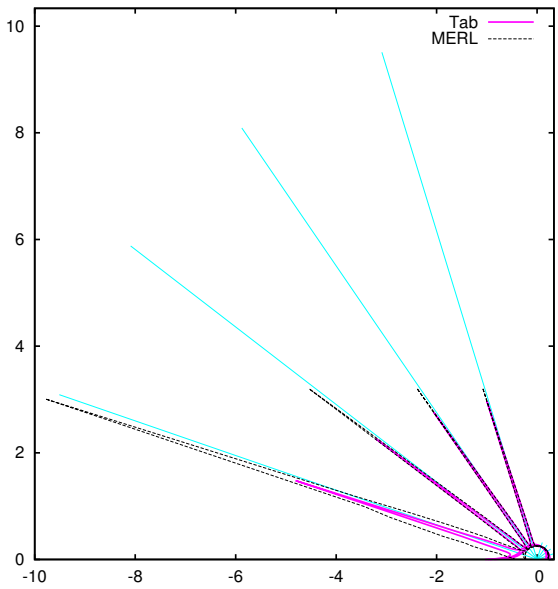


Ours: GGX

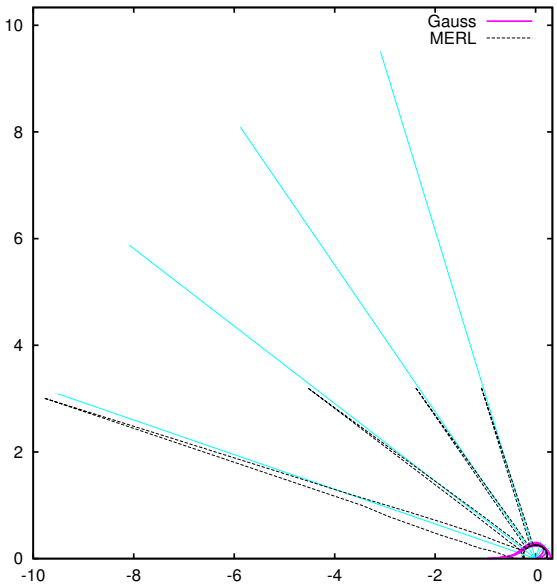
BRDF Lobes in the Incidence Plane (Cubic Root Applied)



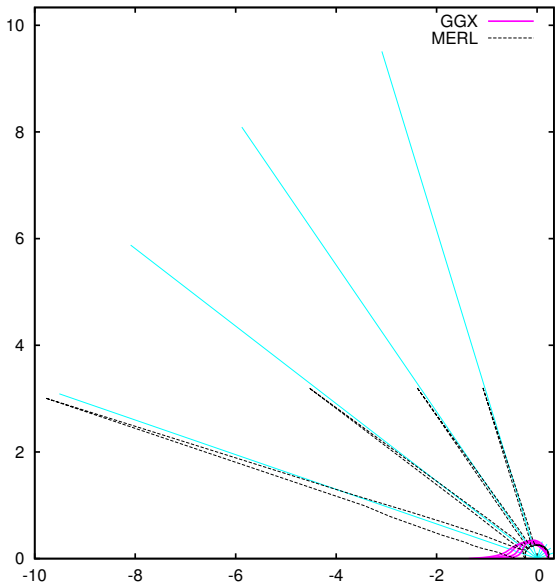
SGD



Ours: Tabulated

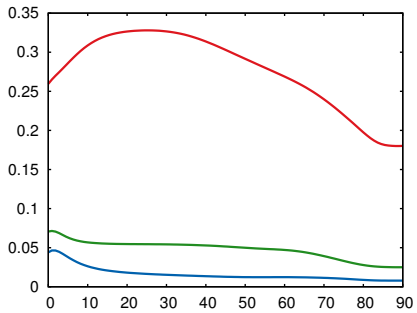


Ours: Gaussian

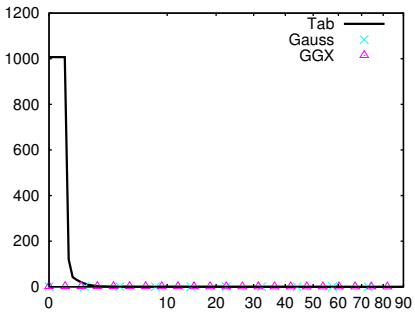


Ours: GGX

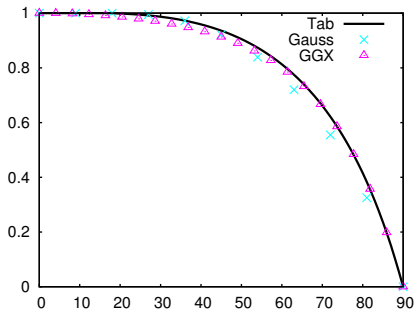
Fitted Microfacet Functions



Fresnel (R, G, B)



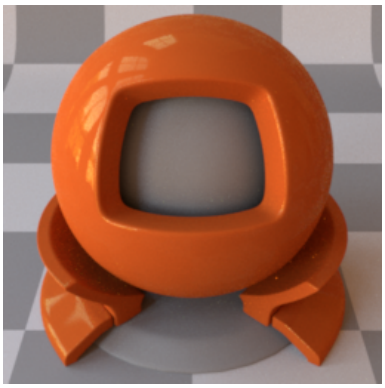
NDF (D)



Smith (G_1)

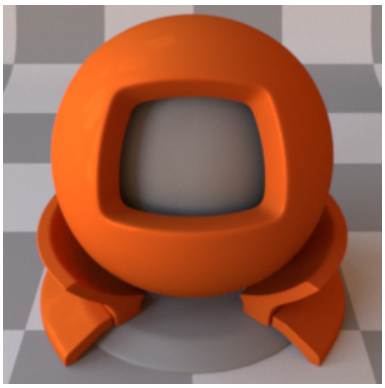
78 specular-orange-phenolic

Renderings

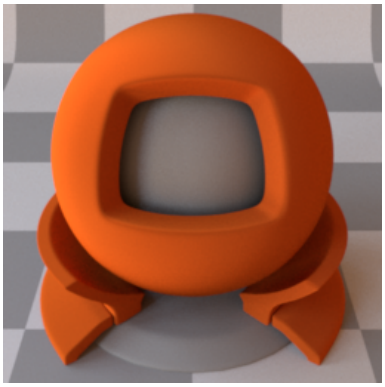


SGD

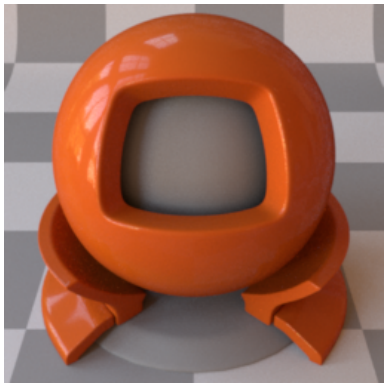
Reference



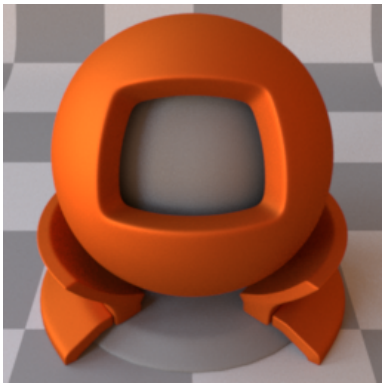
Ours: Tabulated



Ours: Gaussian

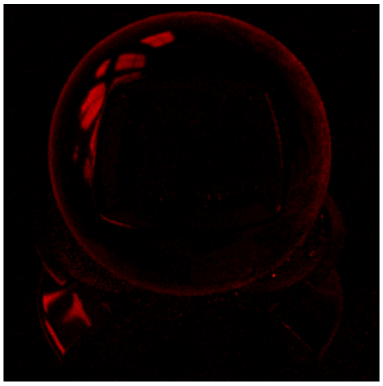


Reference

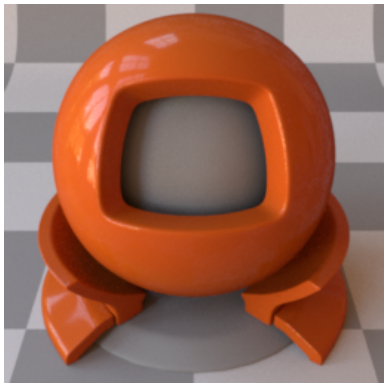


Ours: GGX

CIE dE00

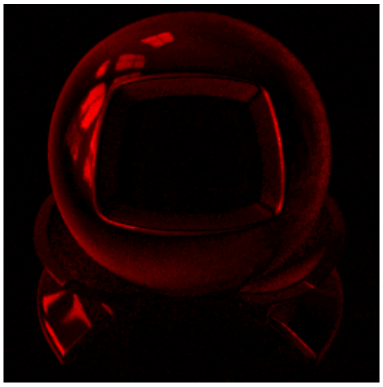


SGD



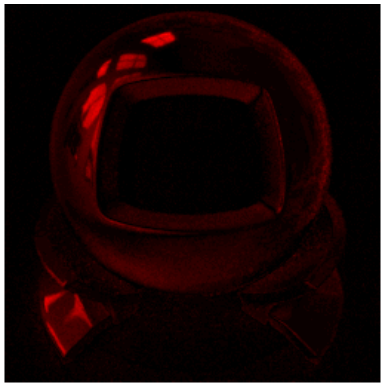
Reference

Ours: Tabulated



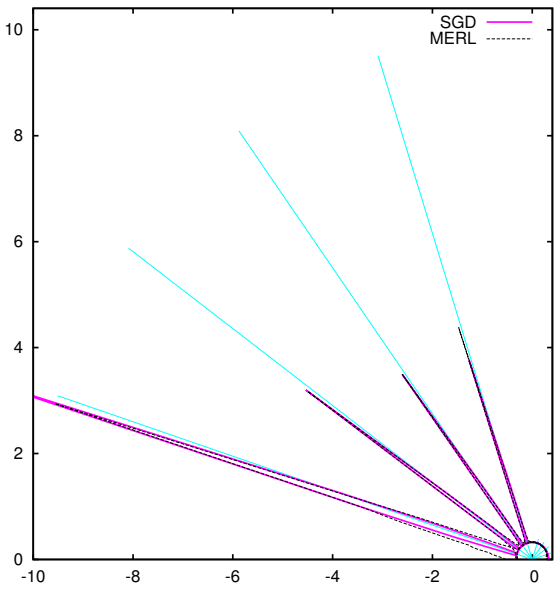
Ours: Gaussian

Reference

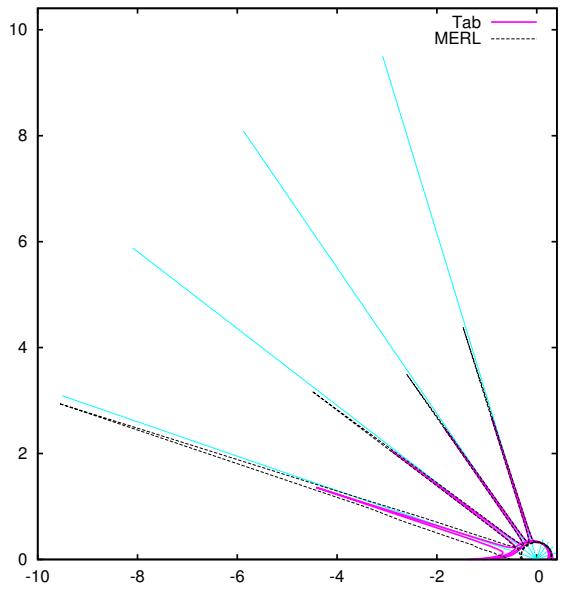


Ours: GGX

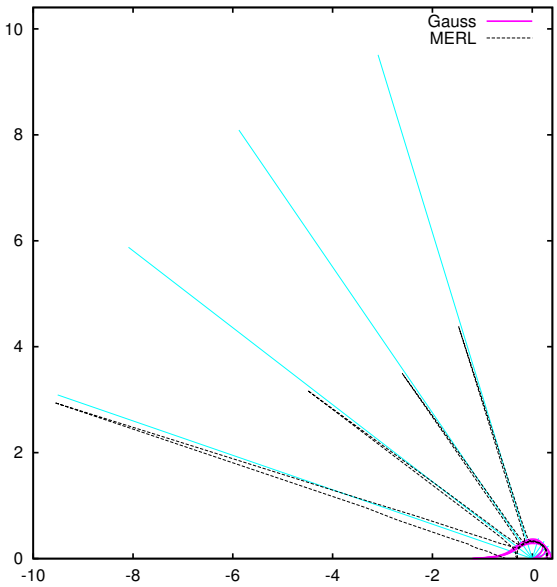
BRDF Lobes in the Incidence Plane (Cubic Root Applied)



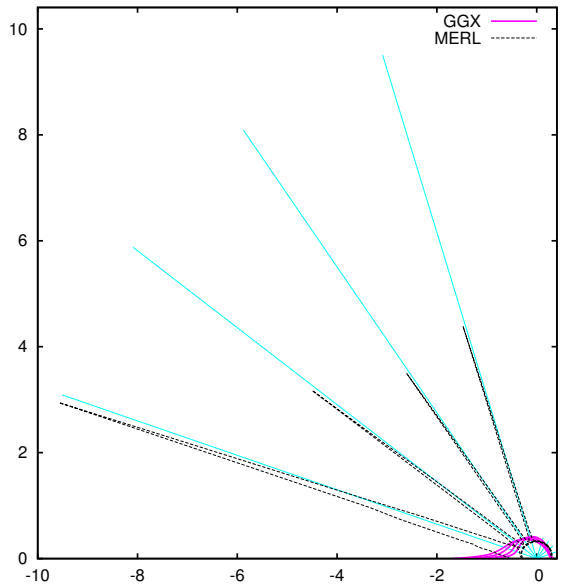
SGD



Ours: Tabulated

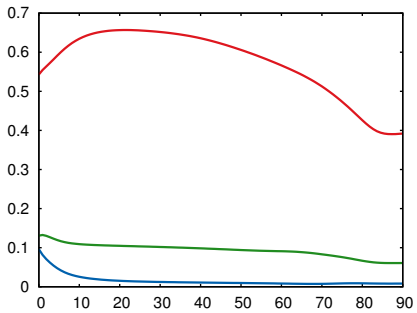


Ours: Gaussian

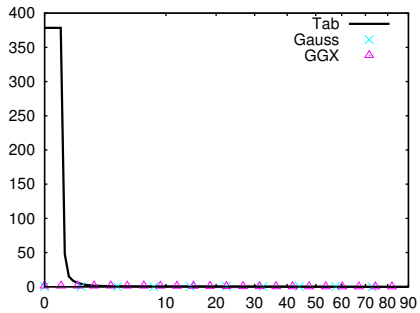


Ours: GGX

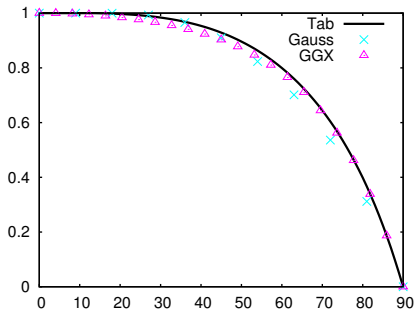
Fitted Microfacet Functions



Fresnel (R, G, B)



NDF (D)



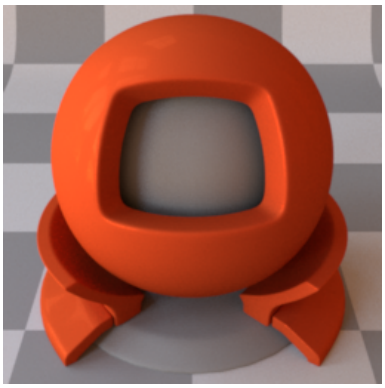
Smith (G_1)

79 specular-red-phenolic

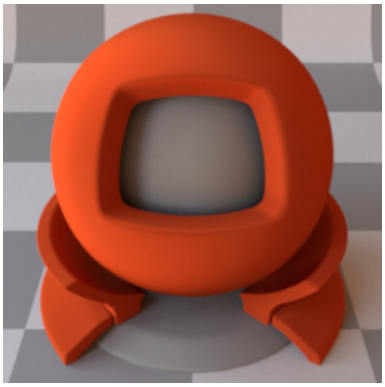
Renderings

SGD

Reference

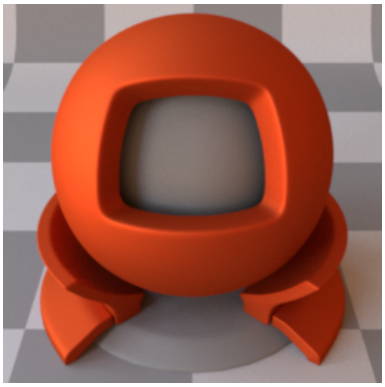


Ours: Tabulated



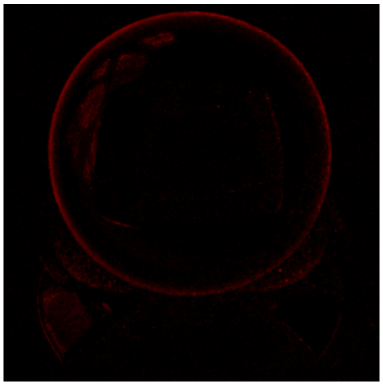
Ours: Gaussian

Reference



Ours: GGX

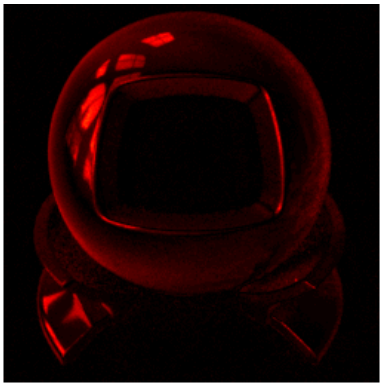
CIE dE00



SGD

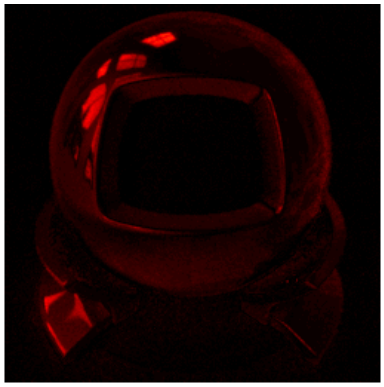
Reference

Ours: Tabulated



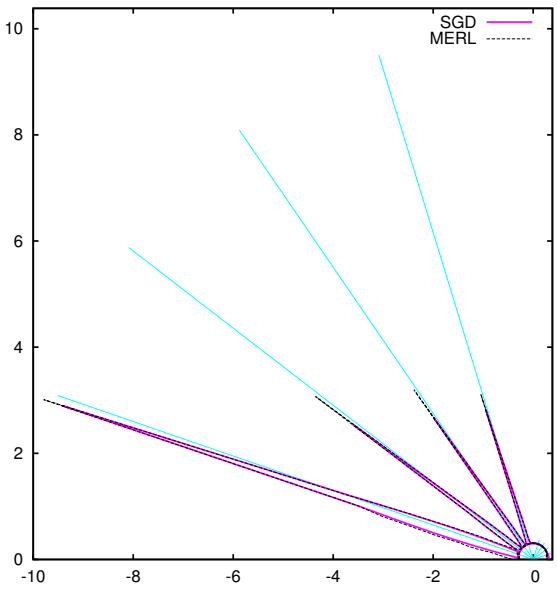
Ours: Gaussian

Reference

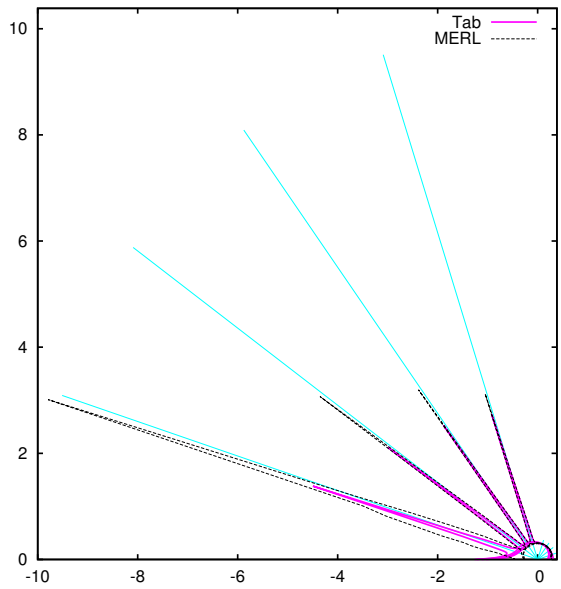


Ours: GGX

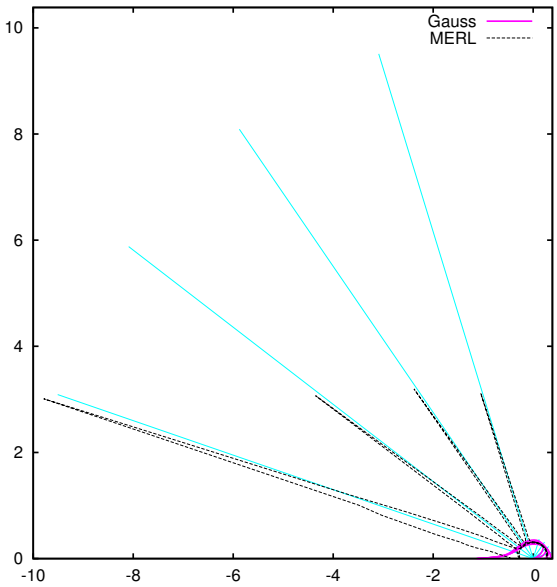
BRDF Lobes in the Incidence Plane (Cubic Root Applied)



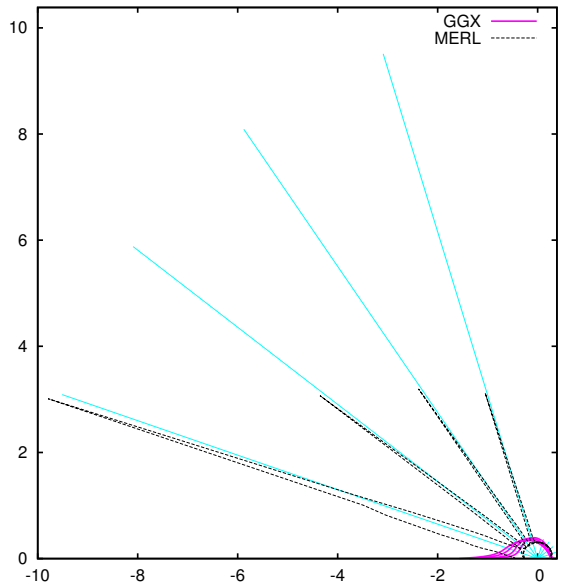
SGD



Ours: Tabulated

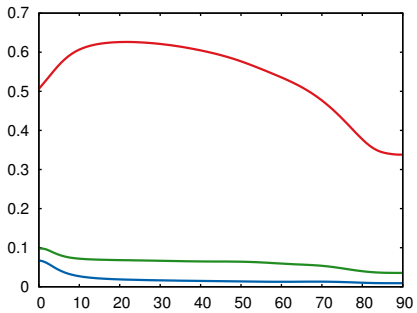


Ours: Gaussian

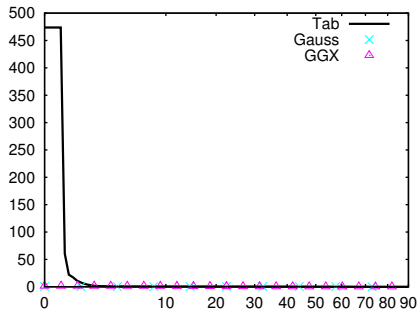


Ours: GGX

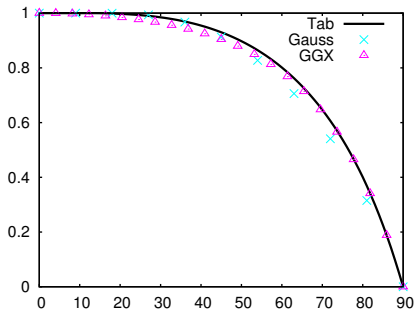
Fitted Microfacet Functions



Fresnel (R, G, B)



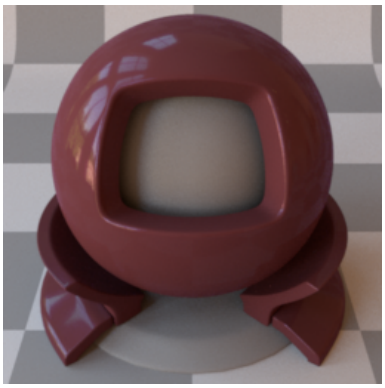
NDF (D)



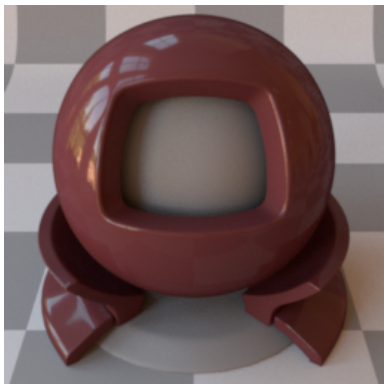
Smith (G_1)

80 specular-violet-phenolic

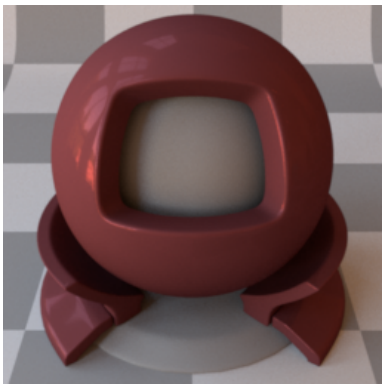
Renderings



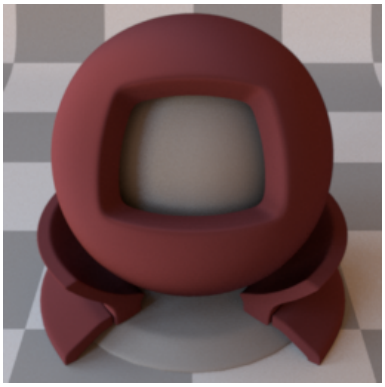
SGD



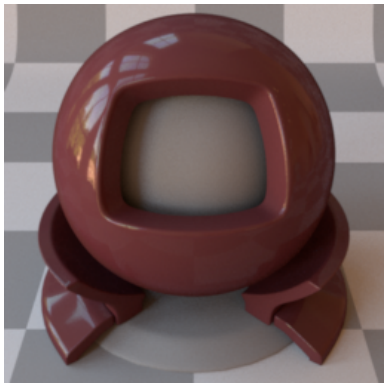
Reference



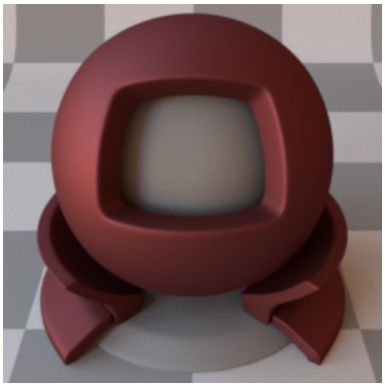
Ours: Tabulated



Ours: Gaussian

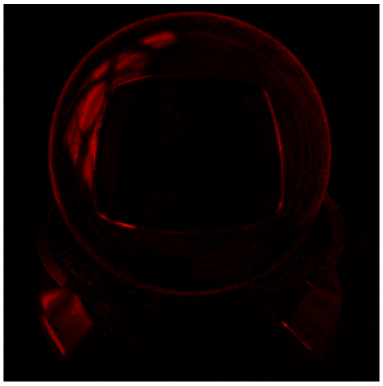


Reference

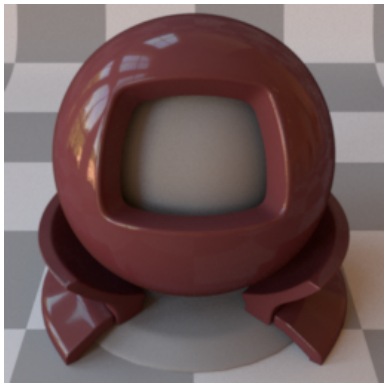


Ours: GGX

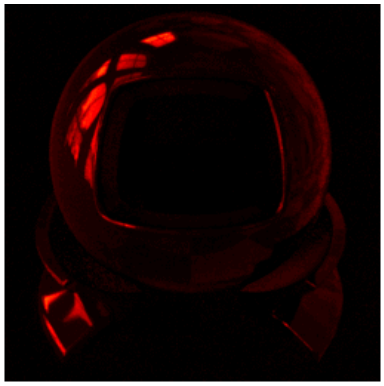
CIE dE00



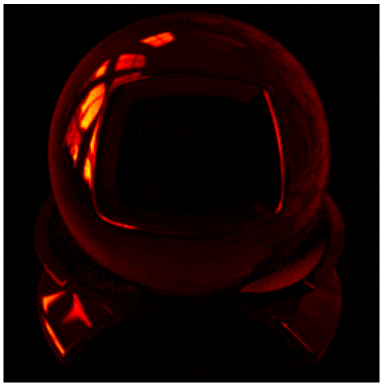
SGD



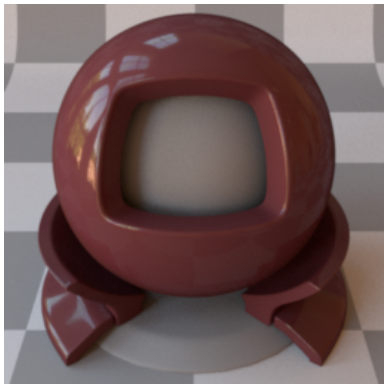
Reference



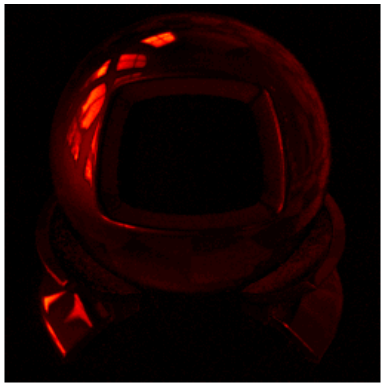
Ours: Tabulated



Ours: Gaussian

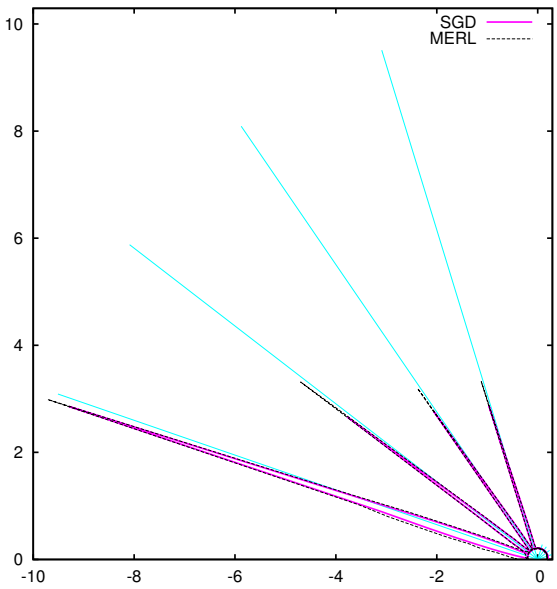


Reference

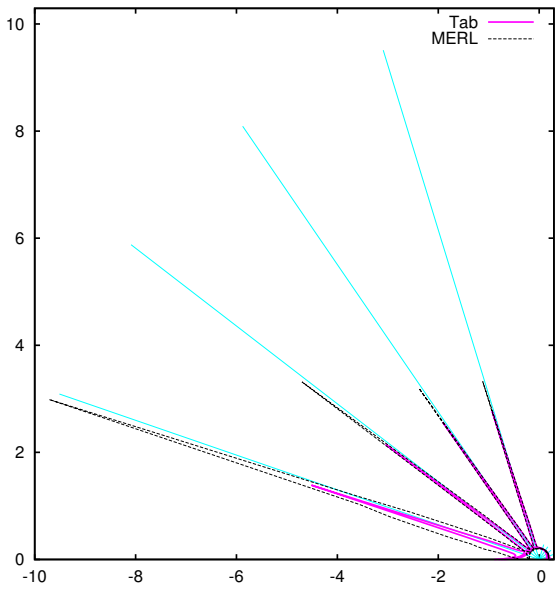


Ours: GGX

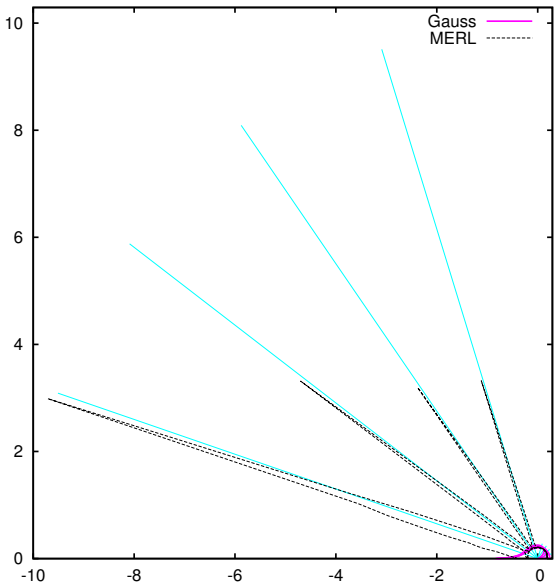
BRDF Lobes in the Incidence Plane (Cubic Root Applied)



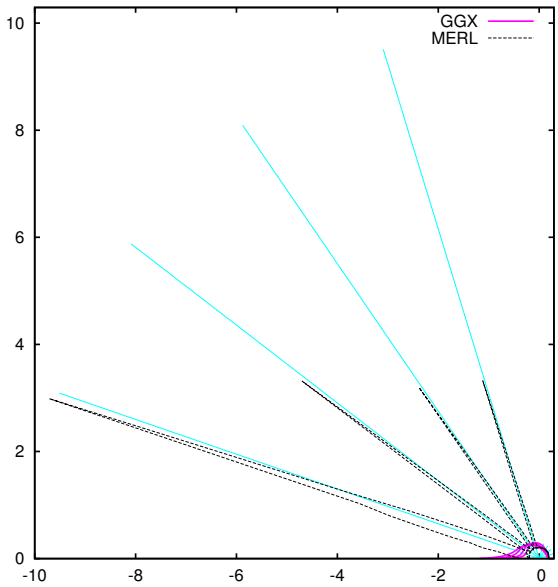
SGD



Ours: Tabulated

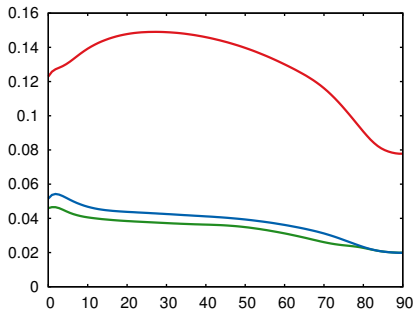


Ours: Gaussian

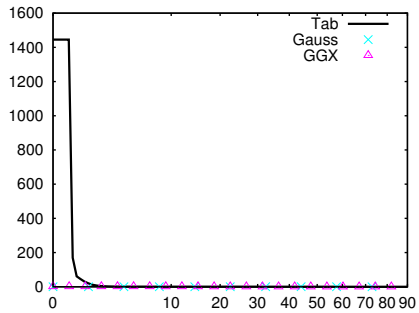


Ours: GGX

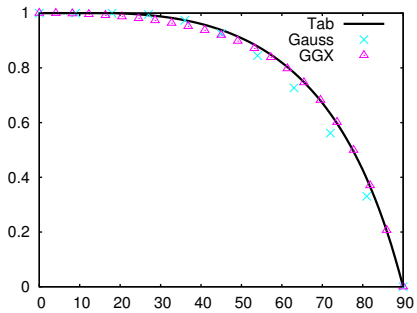
Fitted Microfacet Functions



Fresnel (R, G, B)



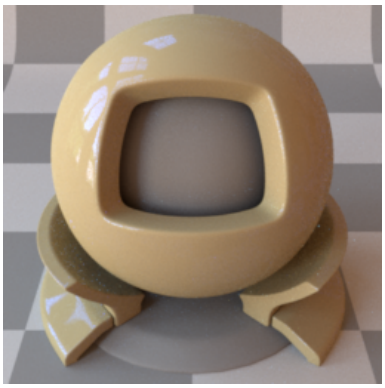
NDF (D)



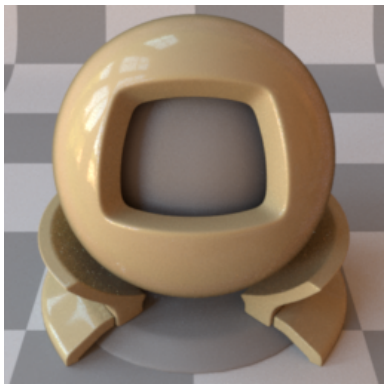
Smith (G_1)

81 specular-white-phenolic

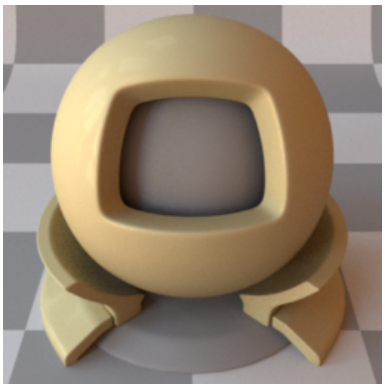
Renderings



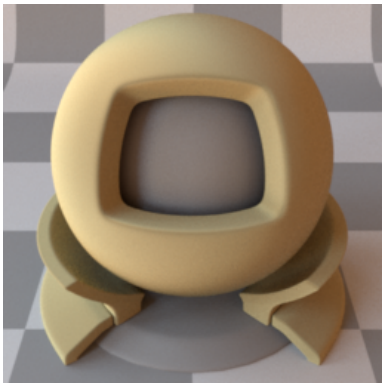
SGD



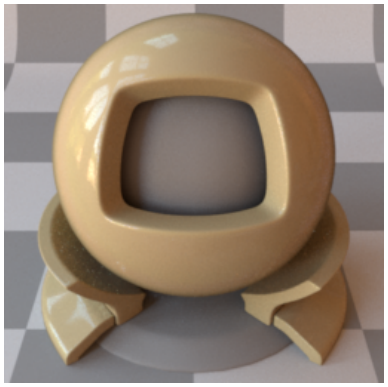
Reference



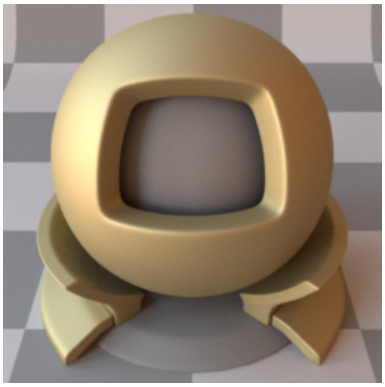
Ours: Tabulated



Ours: Gaussian

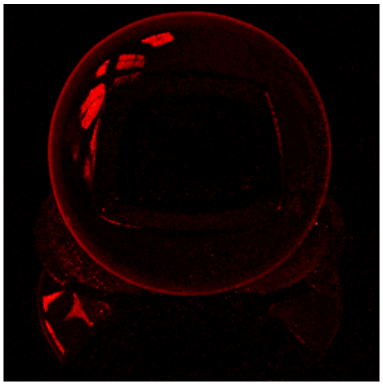


Reference

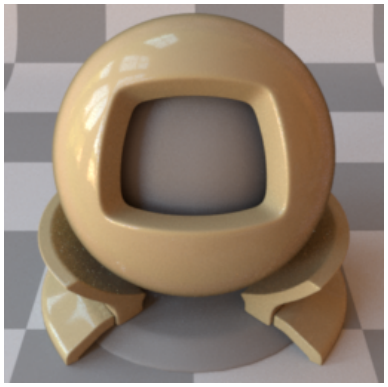


Ours: GGX

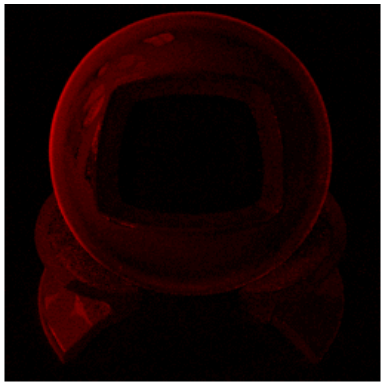
CIE dE00



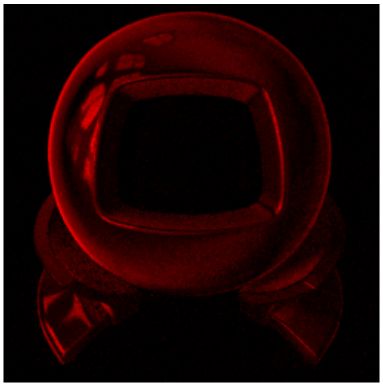
SGD



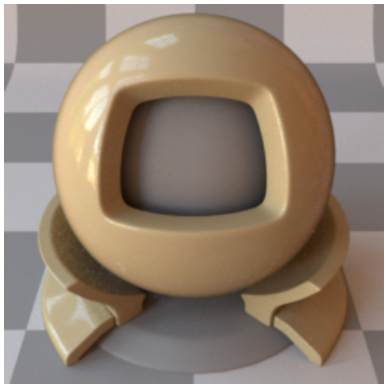
Reference



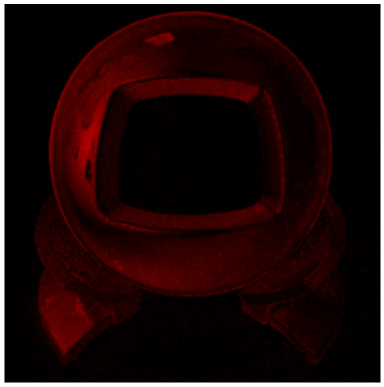
Ours: Tabulated



Ours: Gaussian

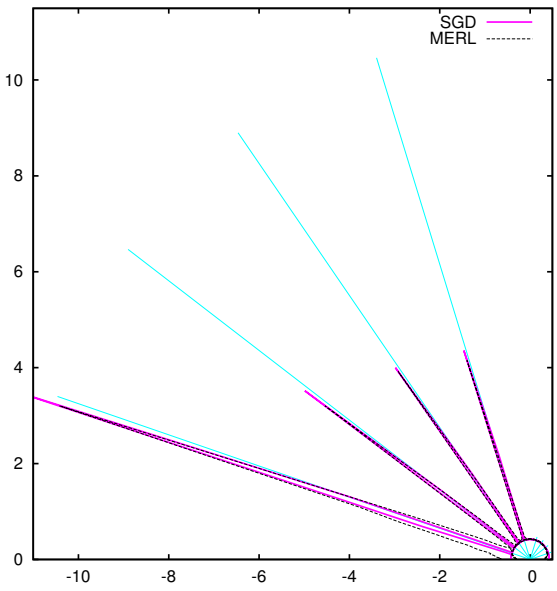


Reference

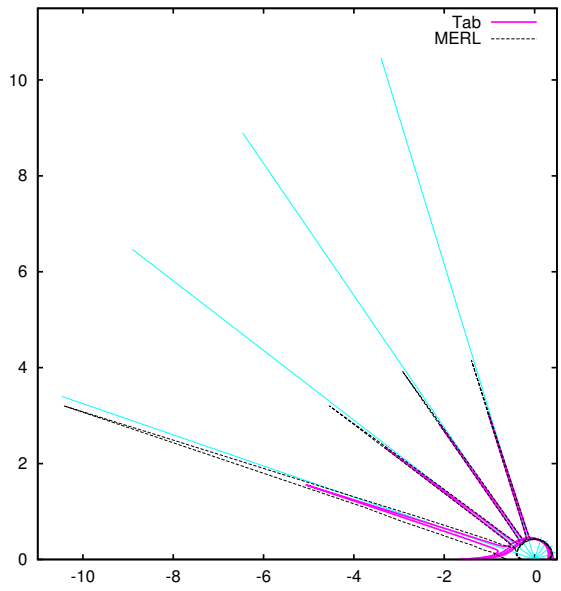


Ours: GGX

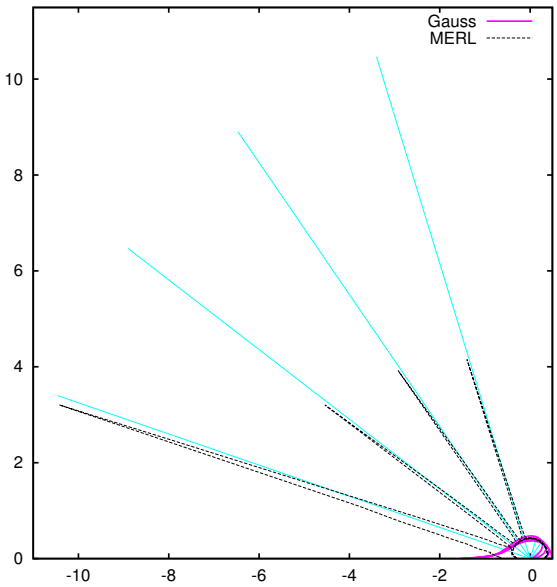
BRDF Lobes in the Incidence Plane (Cubic Root Applied)



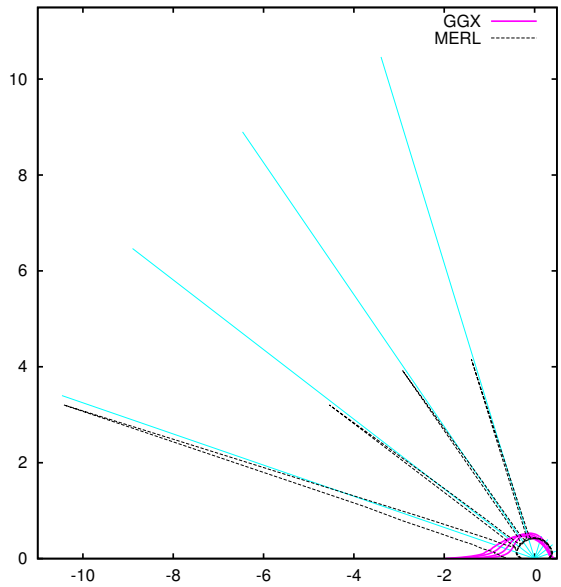
SGD



Ours: Tabulated

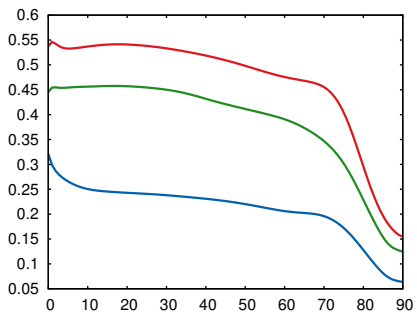


Ours: Gaussian

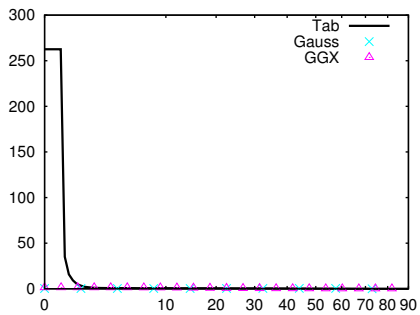


Ours: GGX

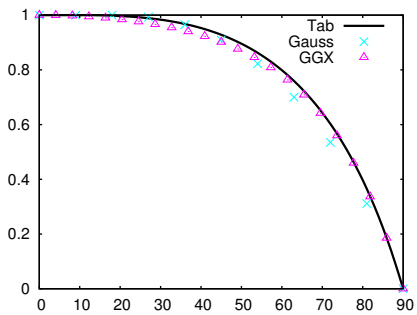
Fitted Microfacet Functions



Fresnel (R, G, B)



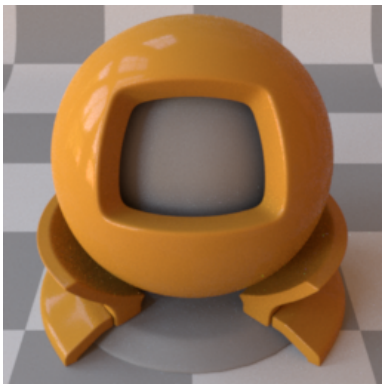
NDF (D)



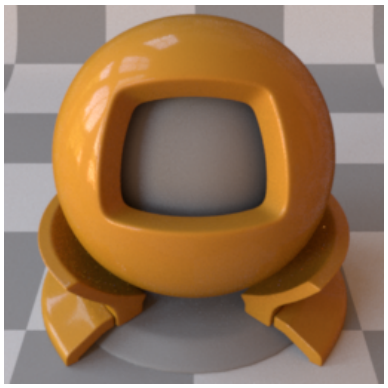
Smith (G_1)

82 specular-yellow-phenolic

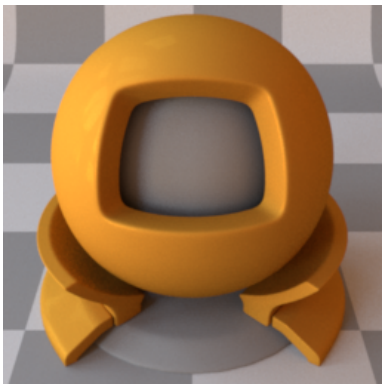
Renderings



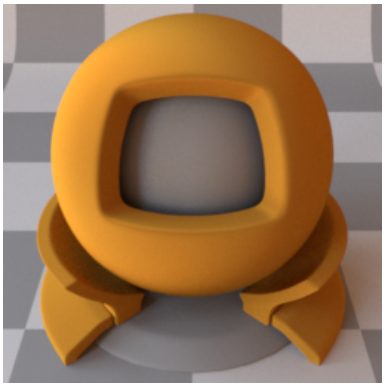
SGD



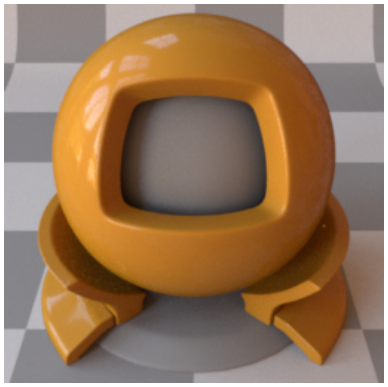
Reference



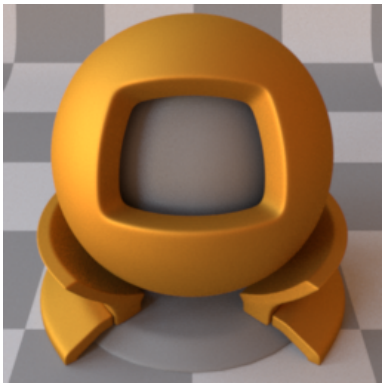
Ours: Tabulated



Ours: Gaussian

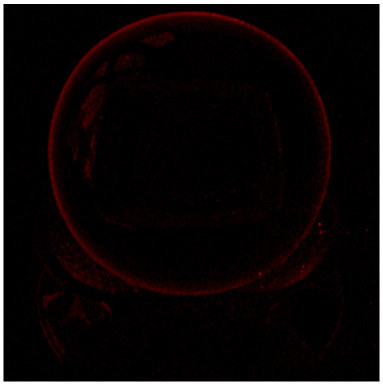


Reference

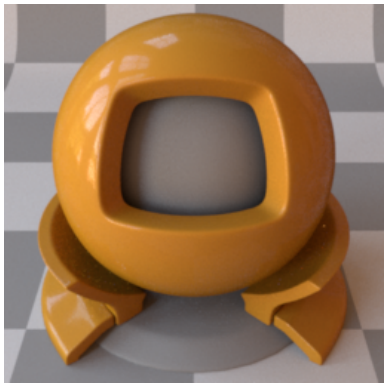


Ours: GGX

CIE dE00

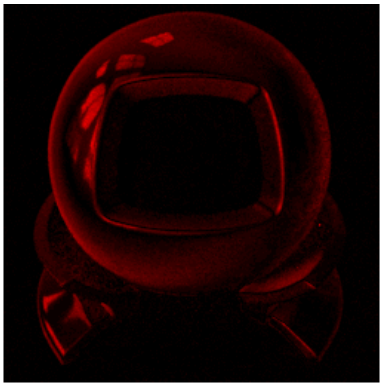


SGD

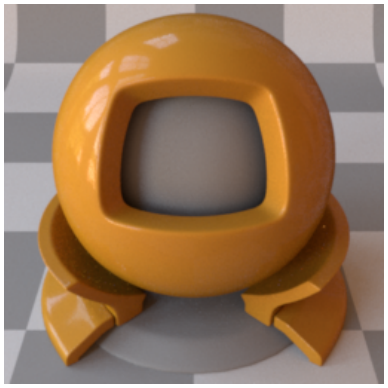


Reference

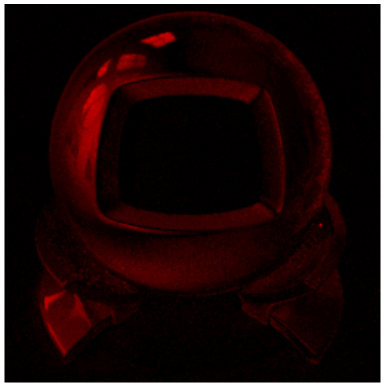
Ours: Tabulated



Ours: Gaussian

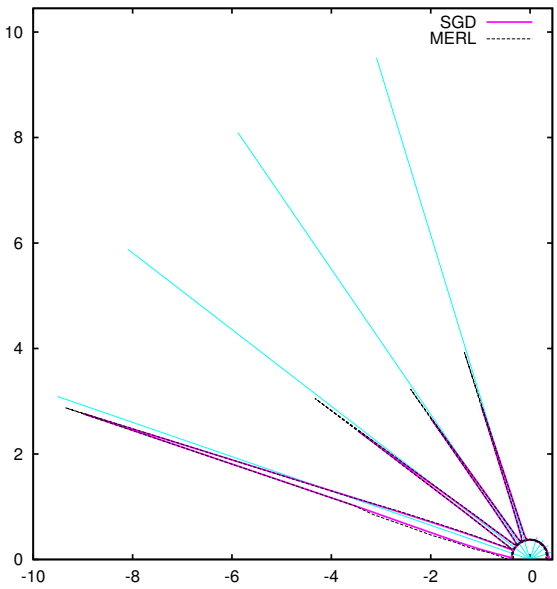


Reference

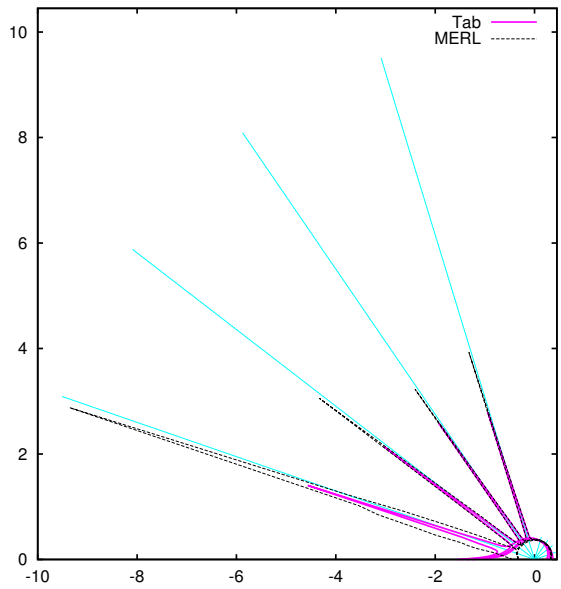


Ours: GGX

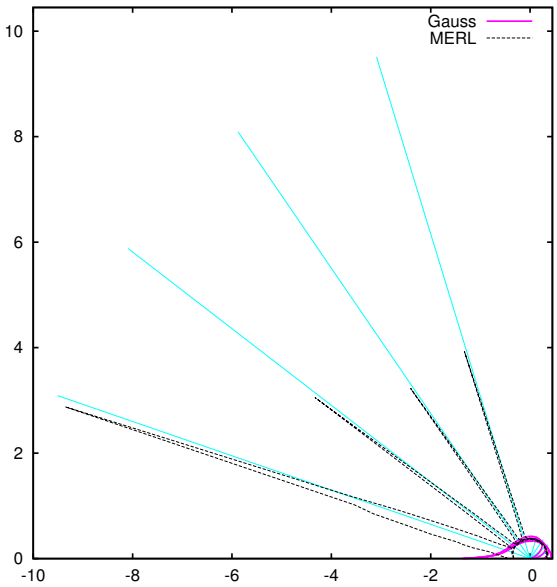
BRDF Lobes in the Incidence Plane (Cubic Root Applied)



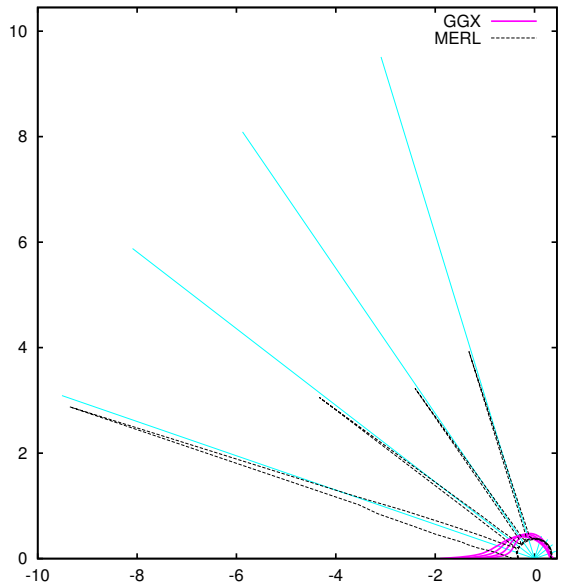
SGD



Ours: Tabulated

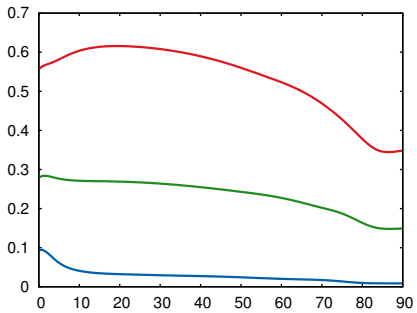


Ours: Gaussian

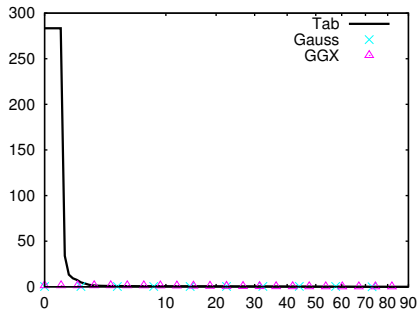


Ours: GGX

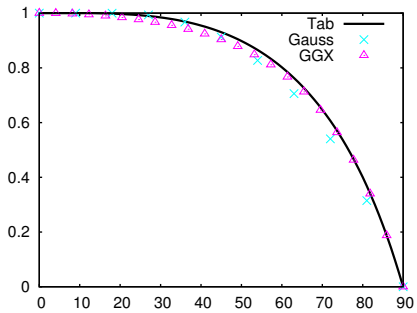
Fitted Microfacet Functions



Fresnel (R, G, B)



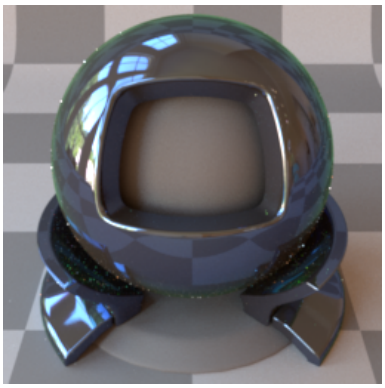
NDF (D)



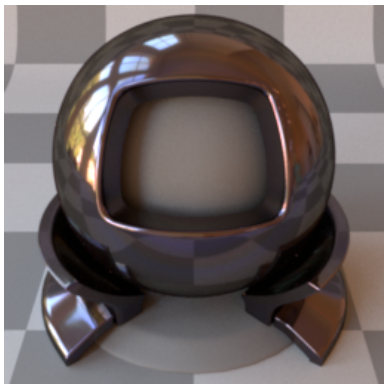
Smith (G_1)

83 ss440

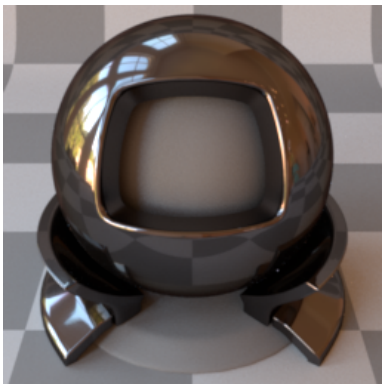
Renderings



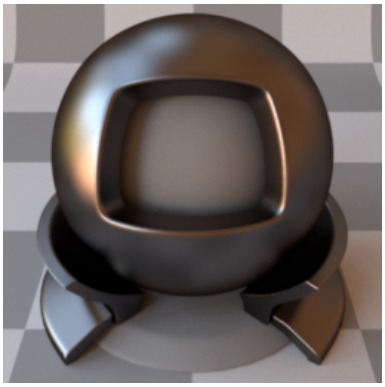
SGD



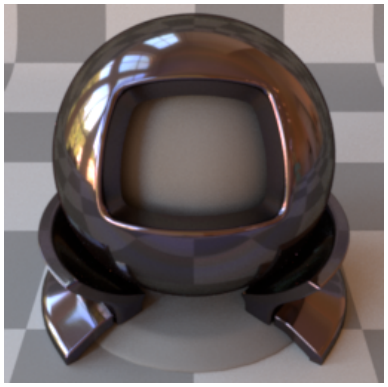
Reference



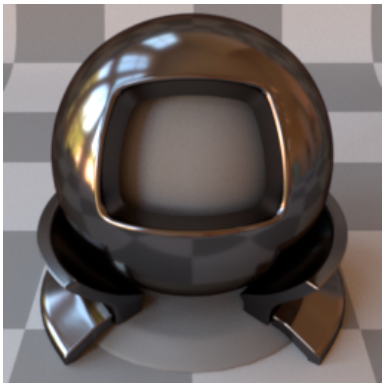
Ours: Tabulated



Ours: Gaussian

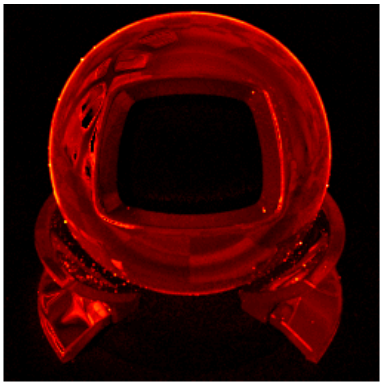


Reference

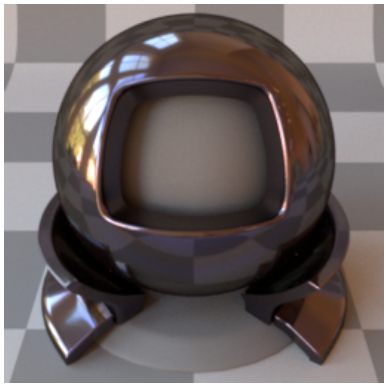


Ours: GGX

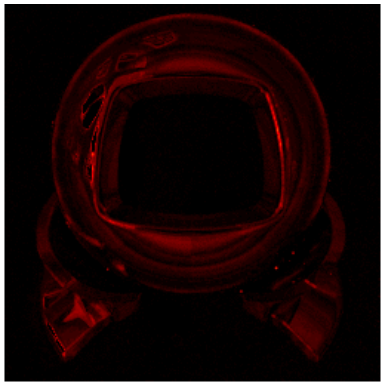
CIE dE00



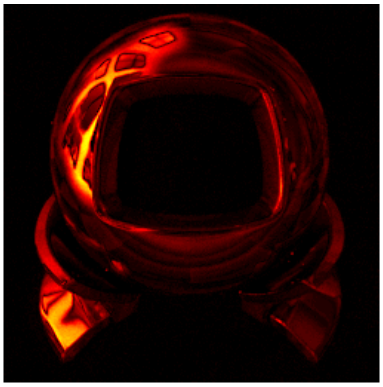
SGD



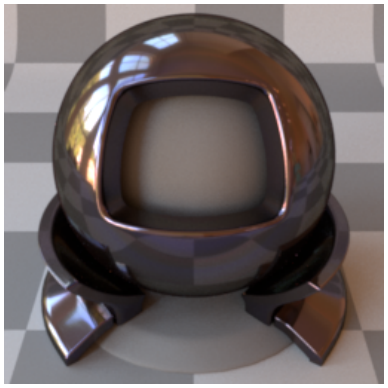
Reference



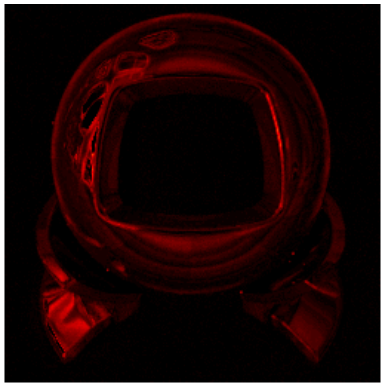
Ours: Tabulated



Ours: Gaussian

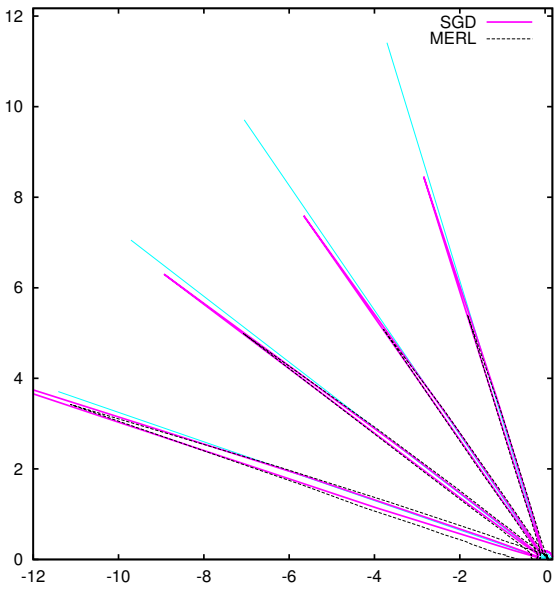


Reference

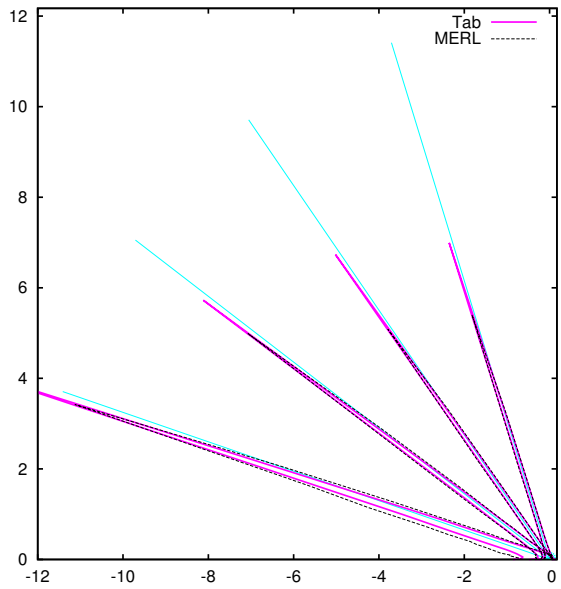


Ours: GGX

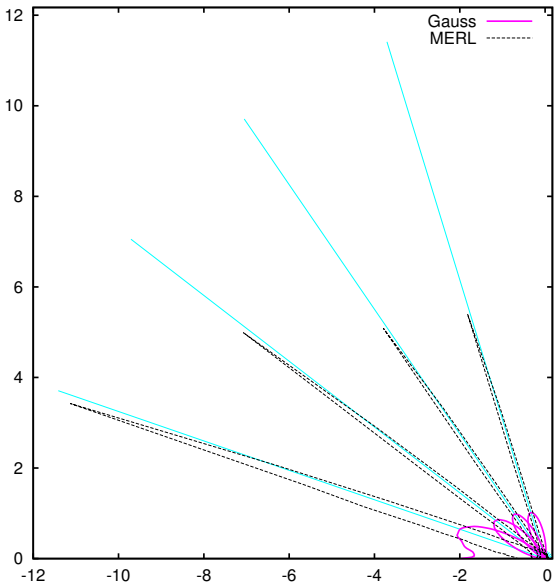
BRDF Lobes in the Incidence Plane (Cubic Root Applied)



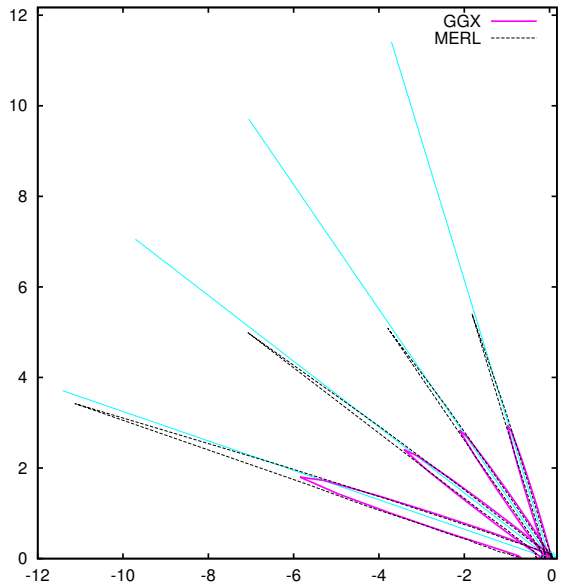
SGD



Ours: Tabulated

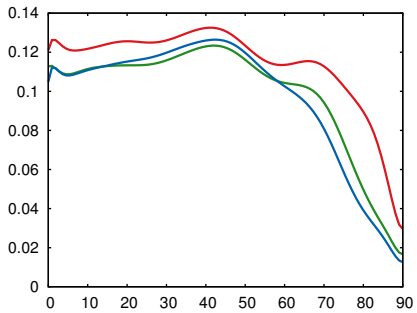


Ours: Gaussian

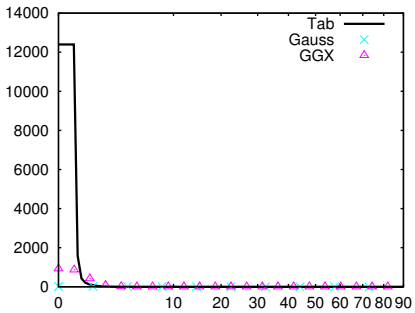


Ours: GGX

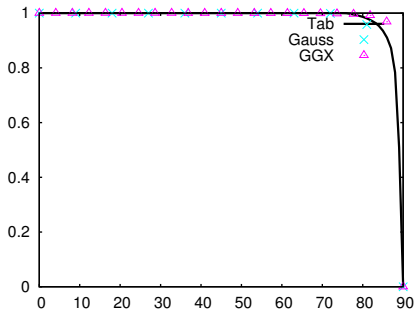
Fitted Microfacet Functions



Fresnel (R, G, B)



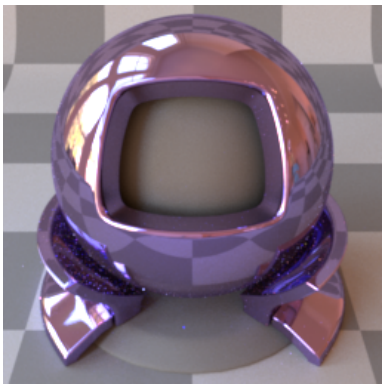
NDF (D)



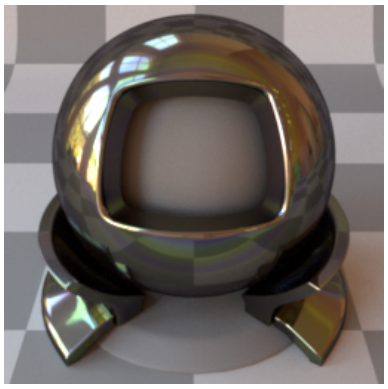
Smith (G_1)

84 steel

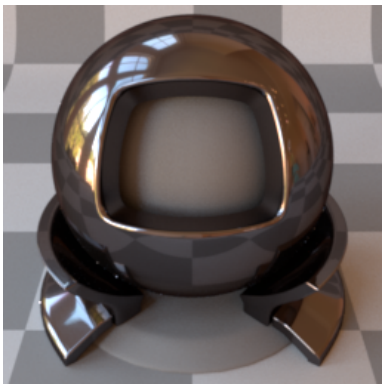
Renderings



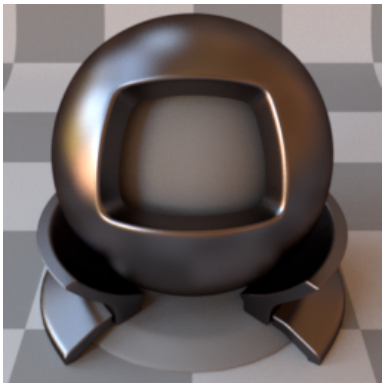
SGD



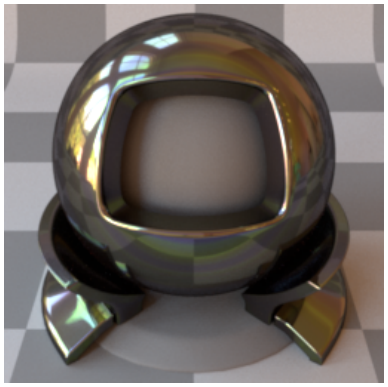
Reference



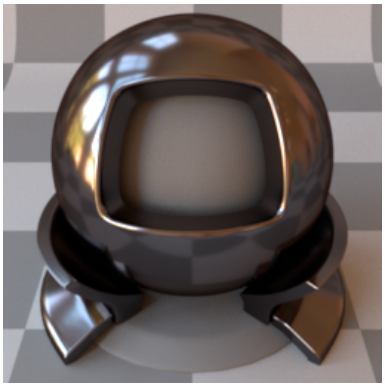
Ours: Tabulated



Ours: Gaussian

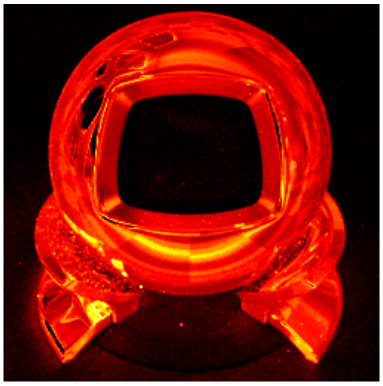


Reference

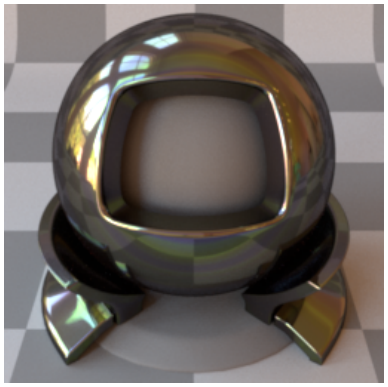


Ours: GGX

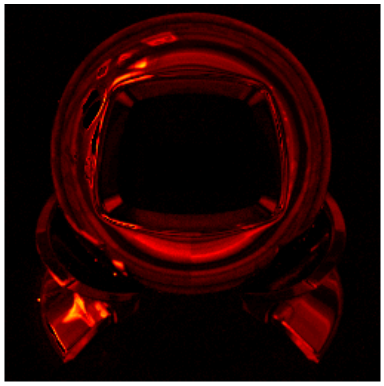
CIE dE00



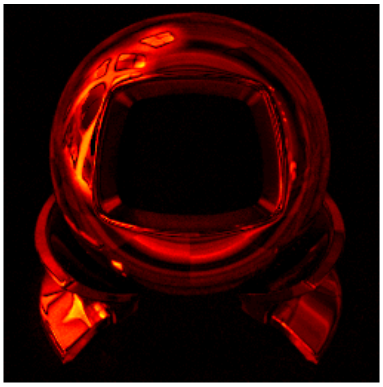
SGD



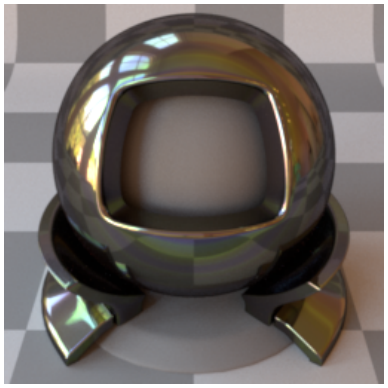
Reference



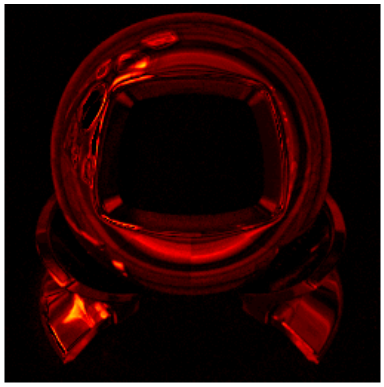
Ours: Tabulated



Ours: Gaussian

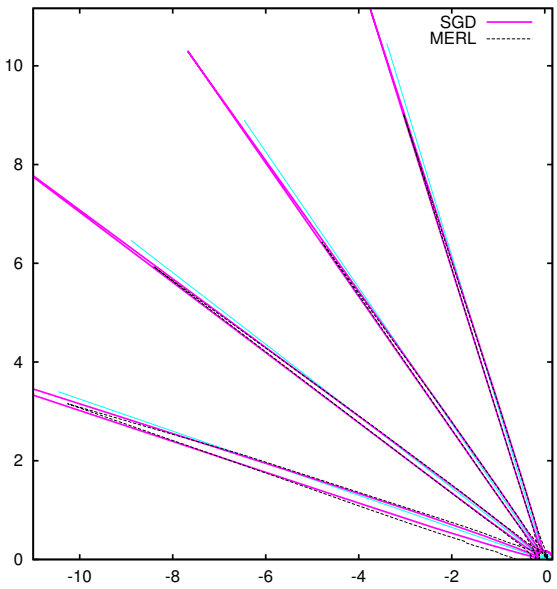


Reference

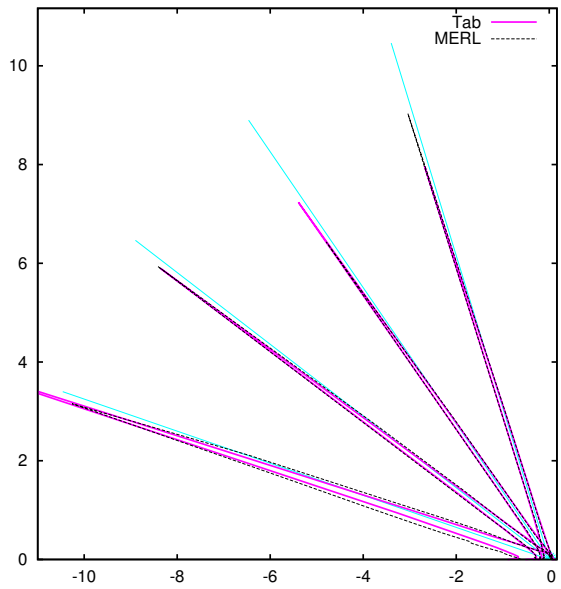


Ours: GGX

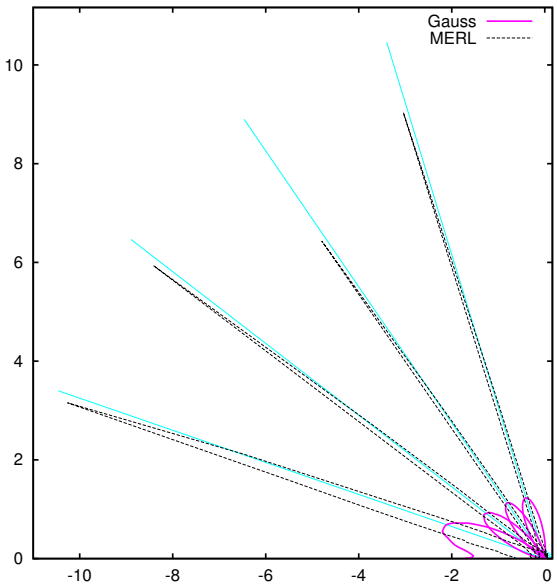
BRDF Lobes in the Incidence Plane (Cubic Root Applied)



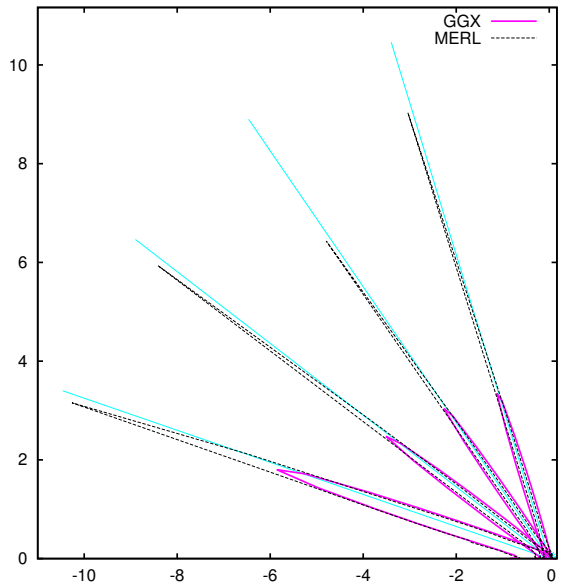
SGD



Ours: Tabulated

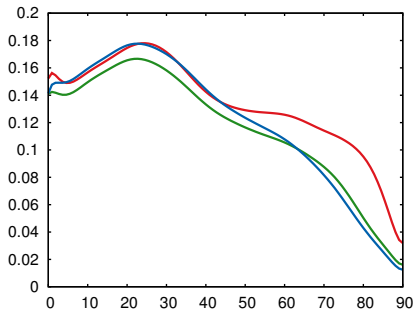


Ours: Gaussian

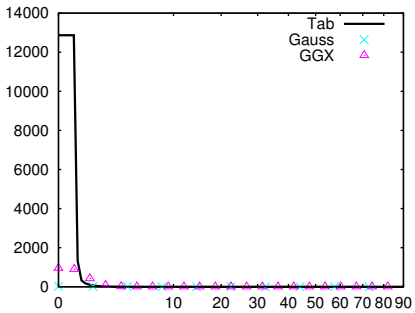


Ours: GGX

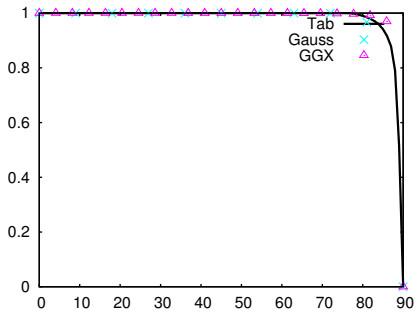
Fitted Microfacet Functions



Fresnel (R, G, B)



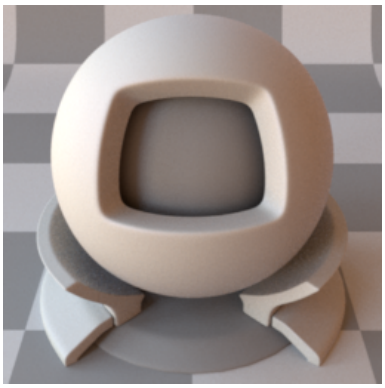
NDF (D)



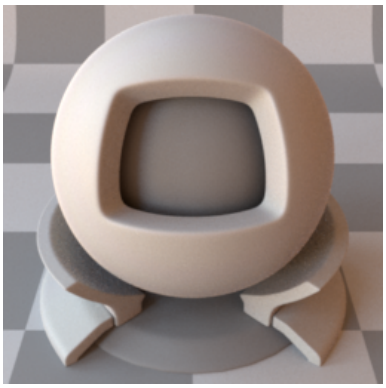
Smith (G_1)

85 teflon

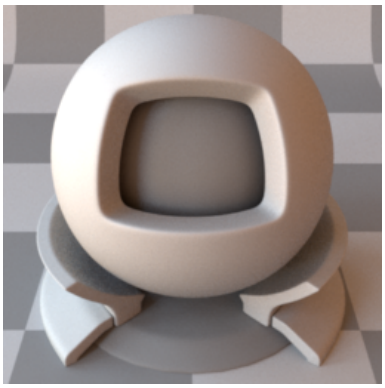
Renderings



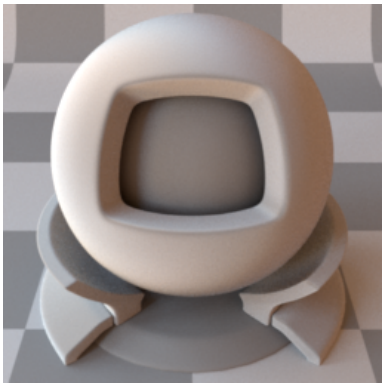
SGD



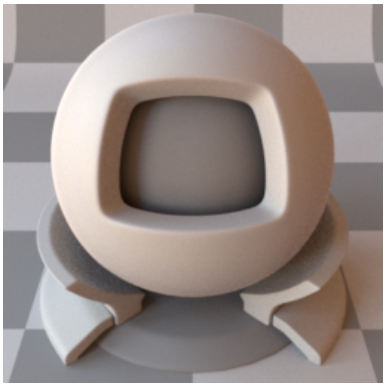
Reference



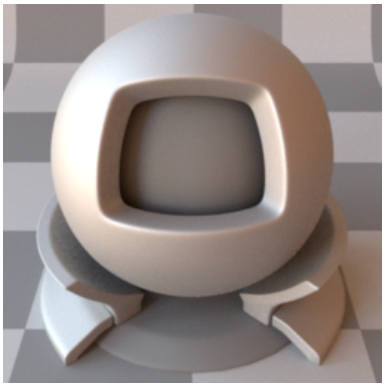
Ours: Tabulated



Ours: Gaussian

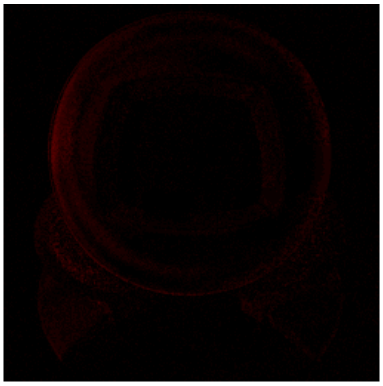


Reference

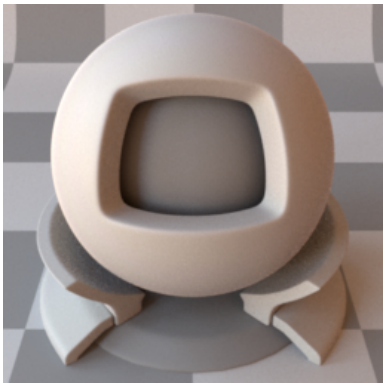


Ours: GGX

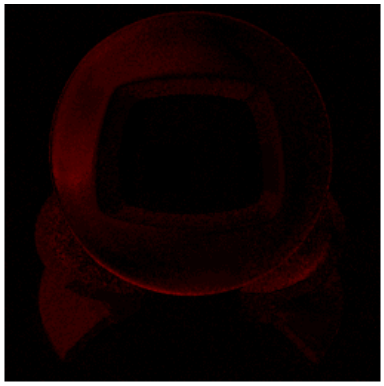
CIE dE00



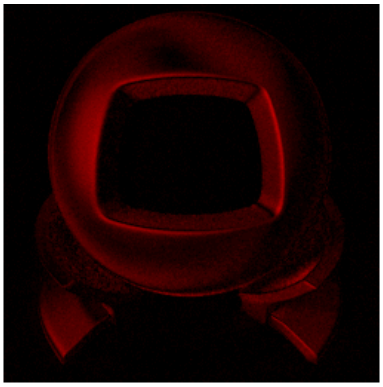
SGD



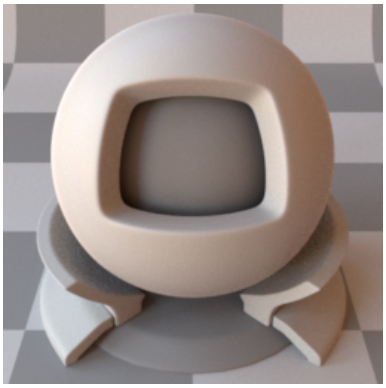
Reference



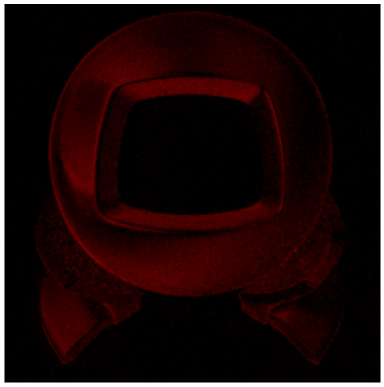
Ours: Tabulated



Ours: Gaussian

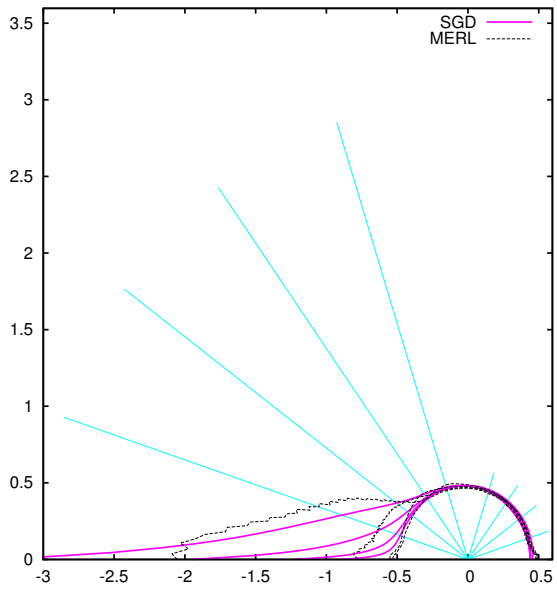


Reference

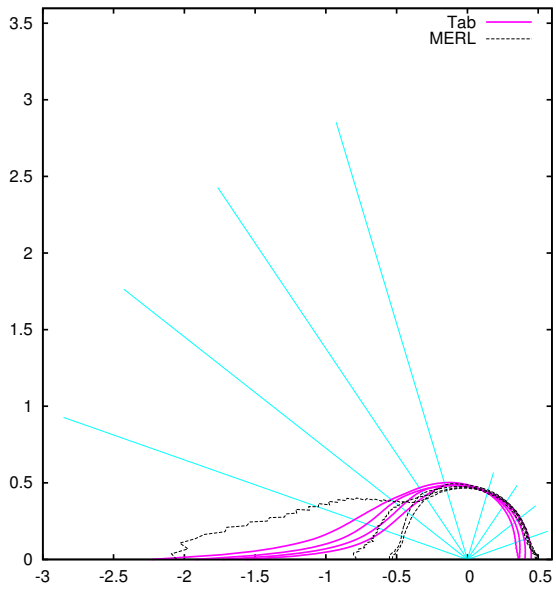


Ours: GGX

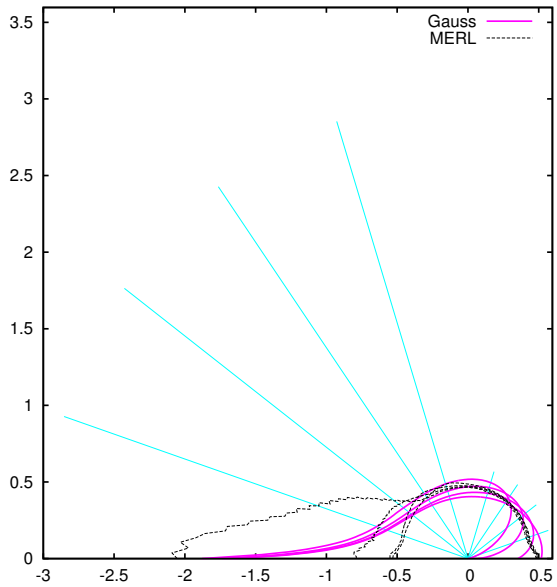
BRDF Lobes in the Incidence Plane (Cubic Root Applied)



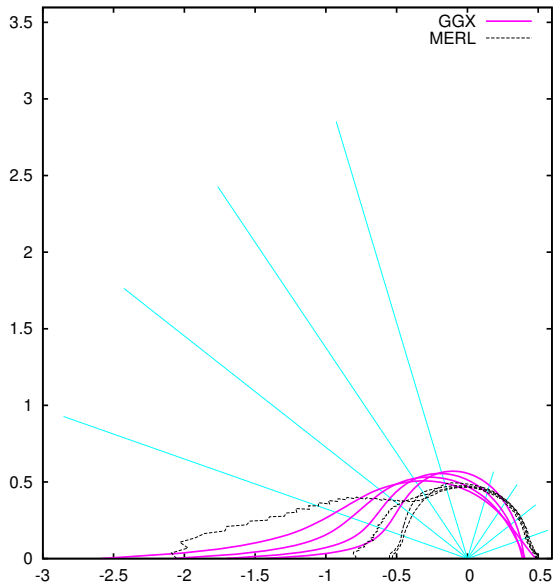
SGD



Ours: Tabulated

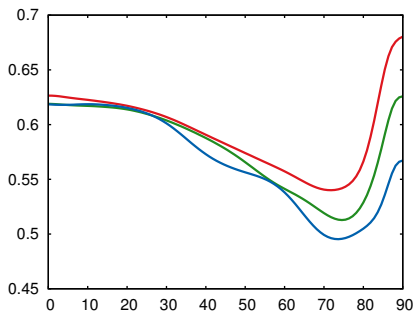


Ours: Gaussian

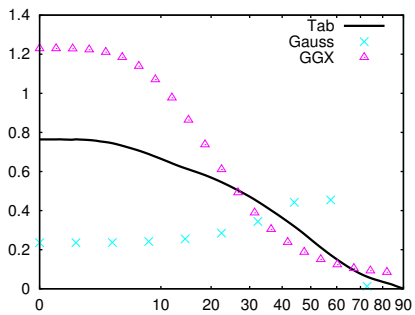


Ours: GGX

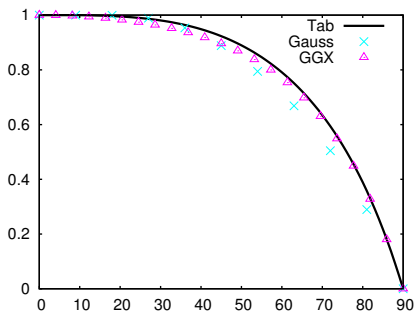
Fitted Microfacet Functions



Fresnel (R, G, B)



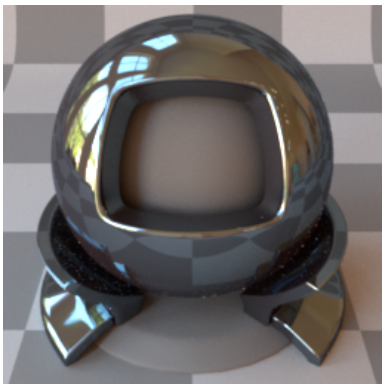
NDF (D)



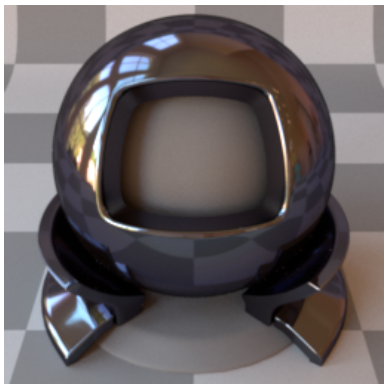
Smith (G_1)

86 tungsten-carbide

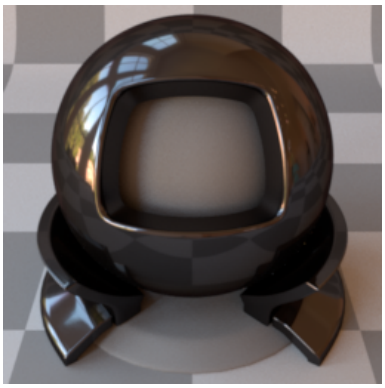
Renderings



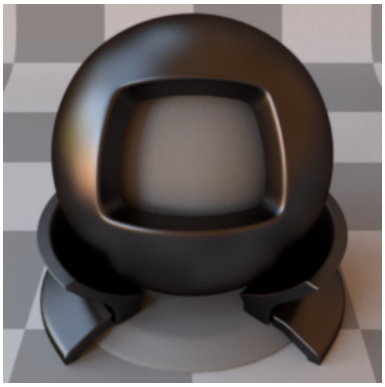
SGD



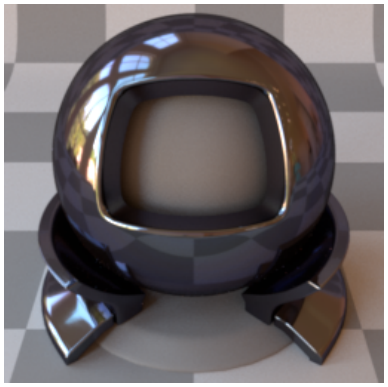
Reference



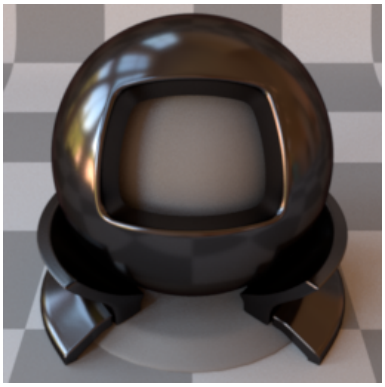
Ours: Tabulated



Ours: Gaussian

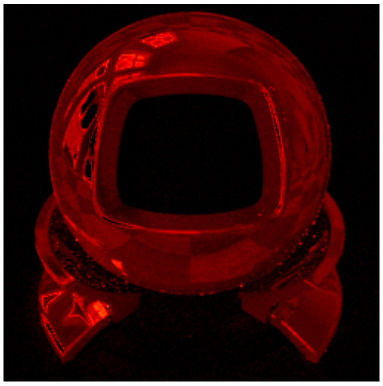


Reference

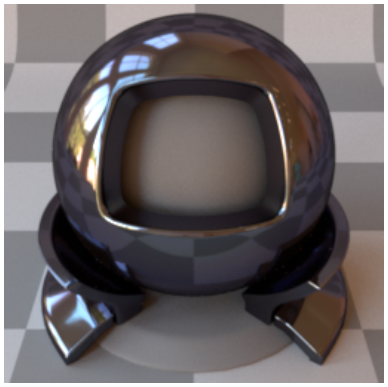


Ours: GGX

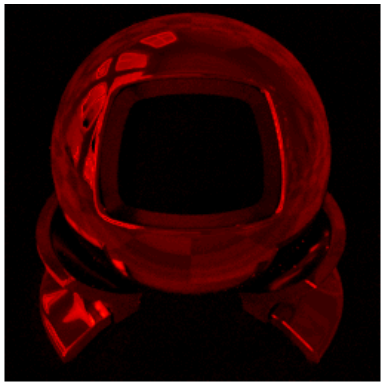
CIE dE00



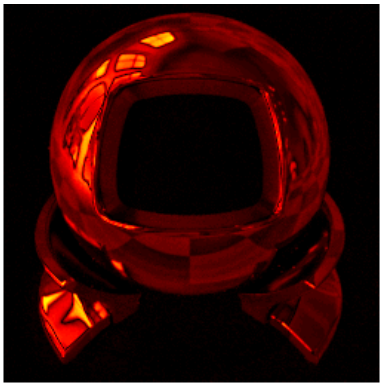
SGD



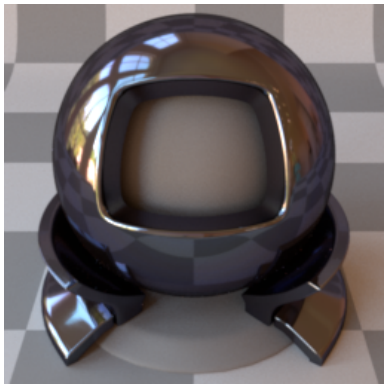
Reference



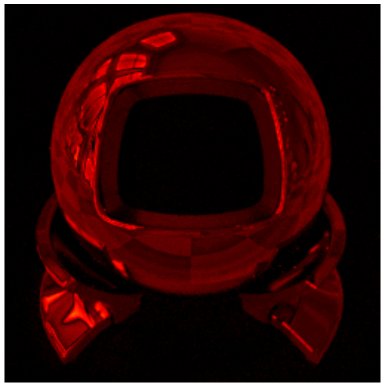
Ours: Tabulated



Ours: Gaussian

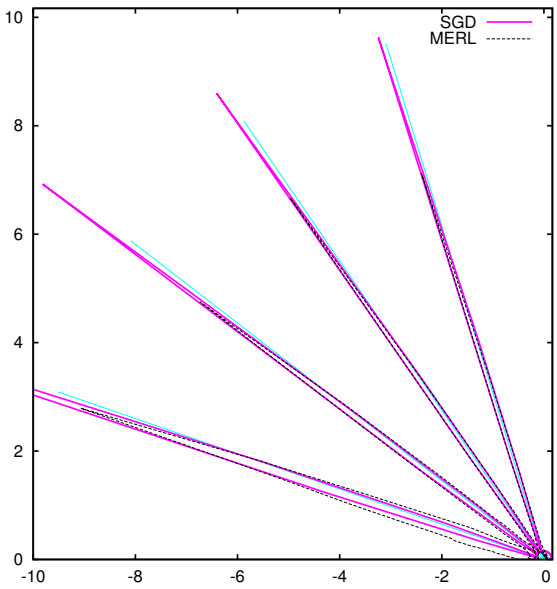


Reference

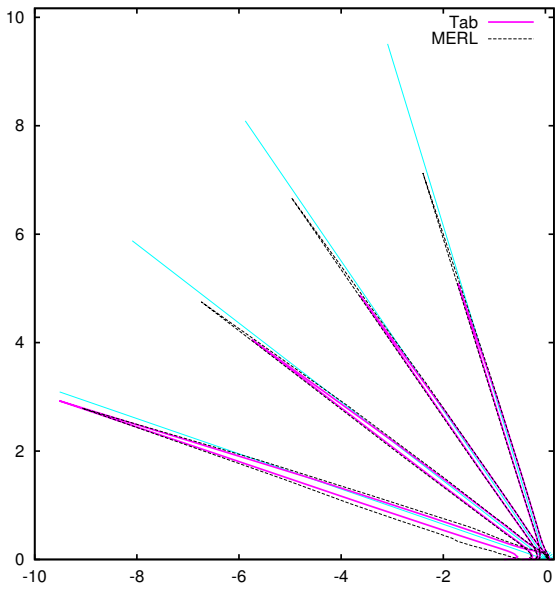


Ours: GGX

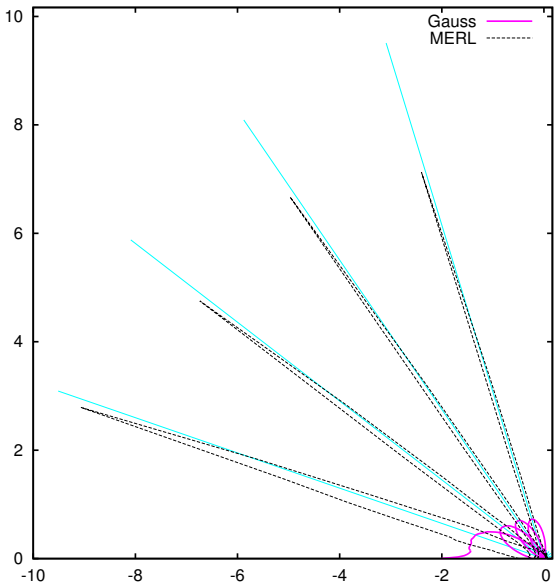
BRDF Lobes in the Incidence Plane (Cubic Root Applied)



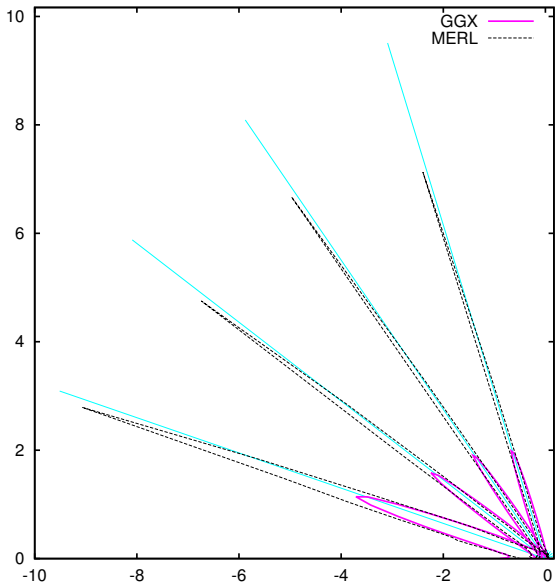
SGD



Ours: Tabulated

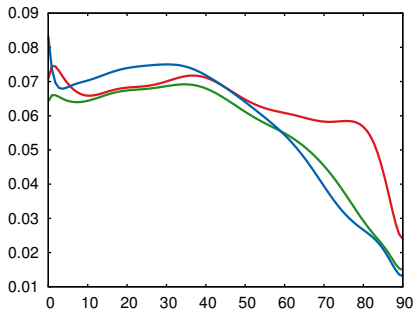


Ours: Gaussian

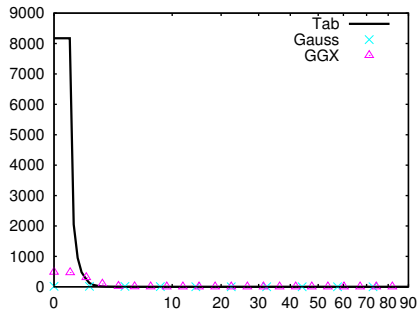


Ours: GGX

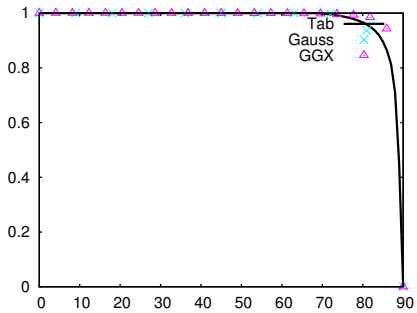
Fitted Microfacet Functions



Fresnel (R, G, B)



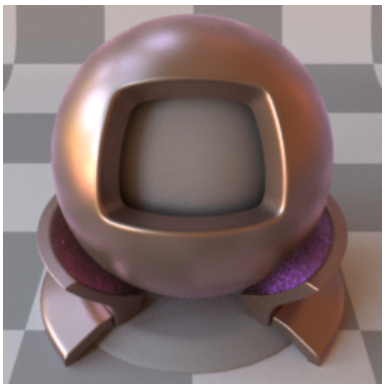
NDF (D)



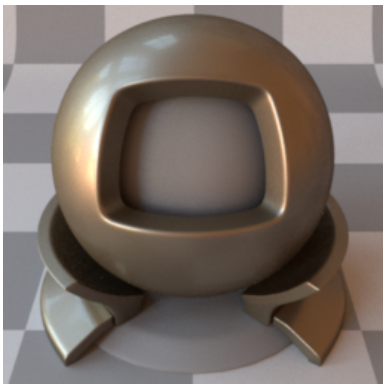
Smith (G_1)

87 two-layer-gold

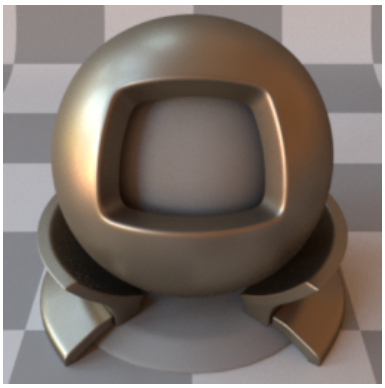
Renderings



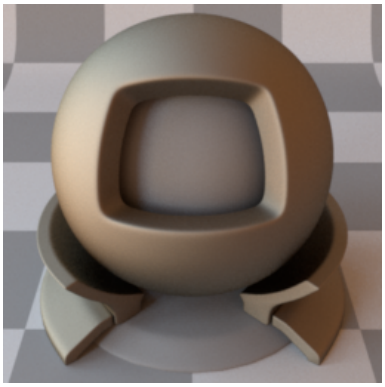
SGD



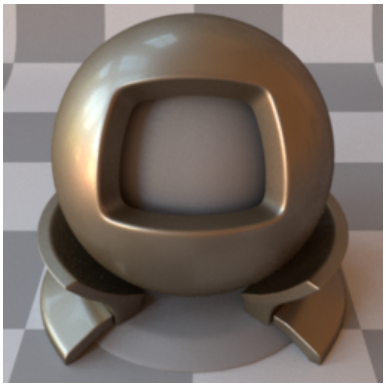
Reference



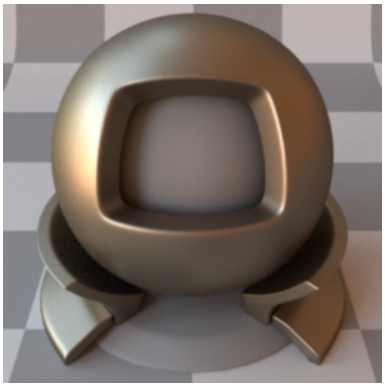
Ours: Tabulated



Ours: Gaussian

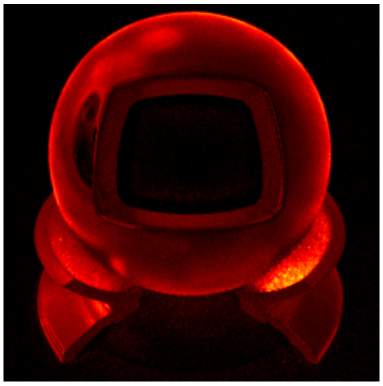


Reference

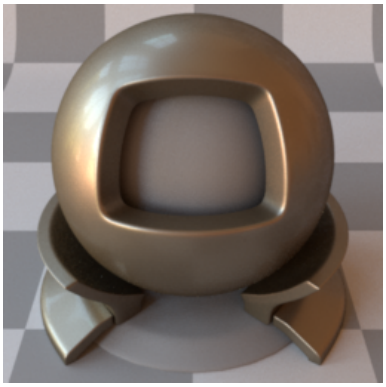


Ours: GGX

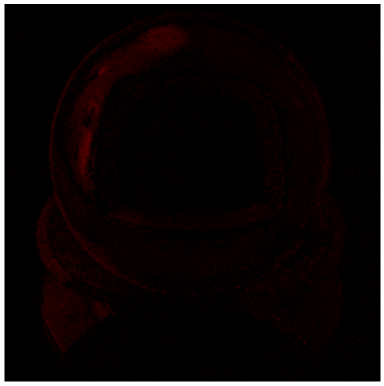
CIE dE00



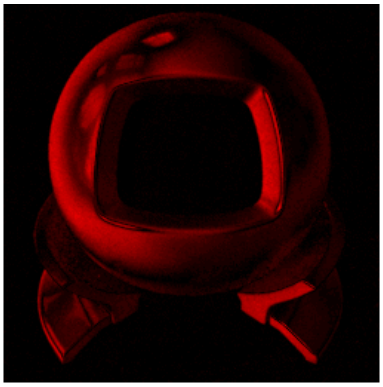
SGD



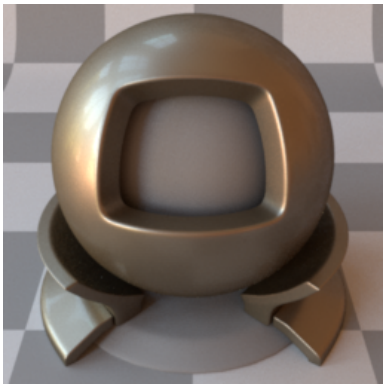
Reference



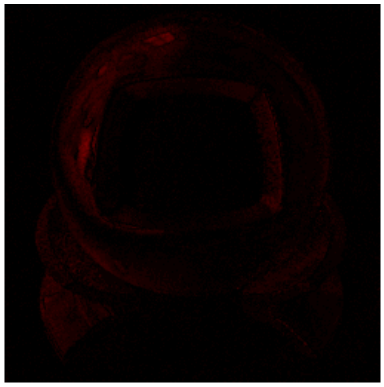
Ours: Tabulated



Ours: Gaussian

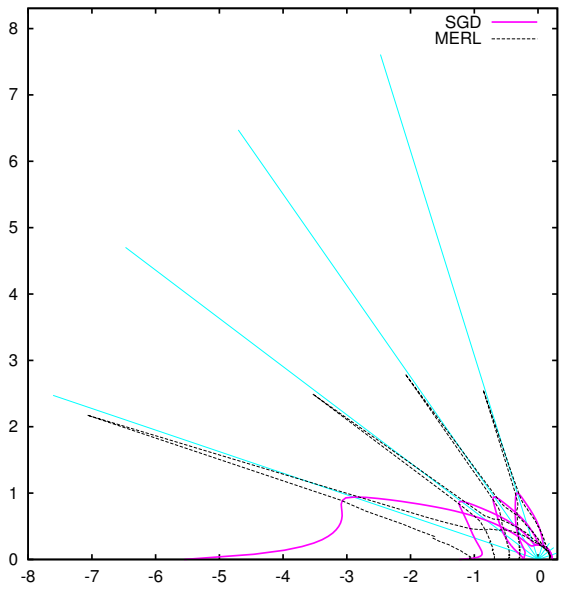


Reference

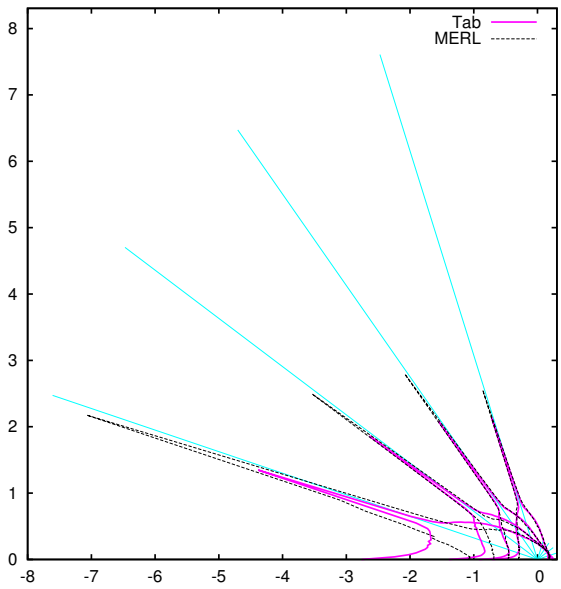


Ours: GGX

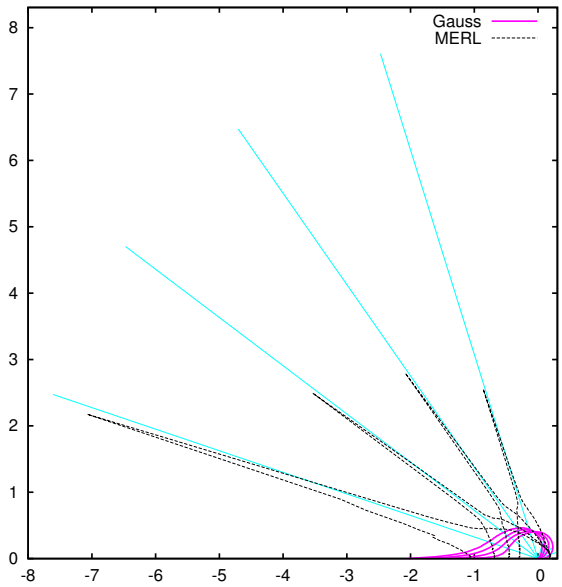
BRDF Lobes in the Incidence Plane (Cubic Root Applied)



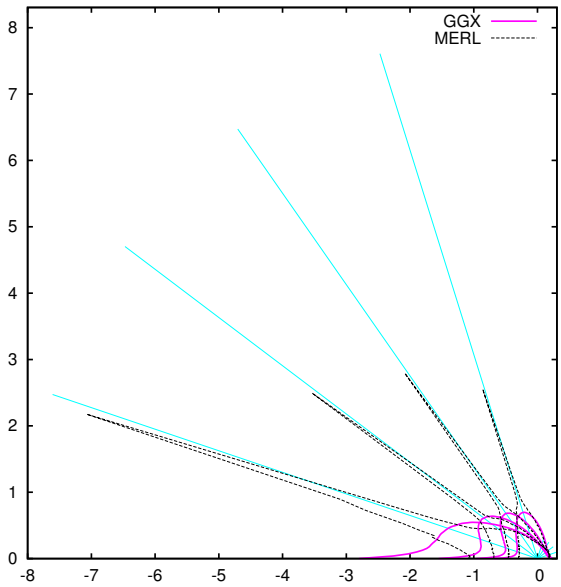
SGD



Ours: Tabulated

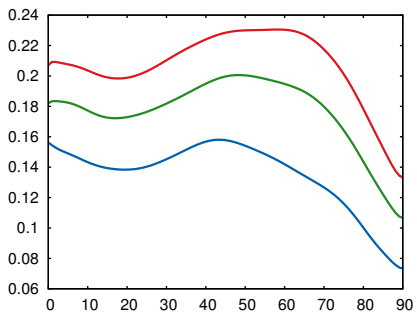


Ours: Gaussian

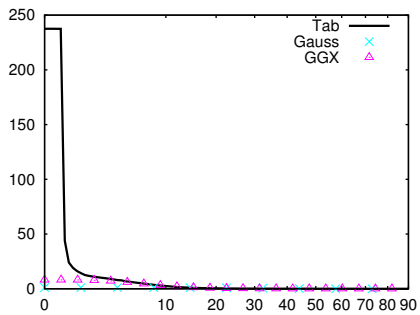


Ours: GGX

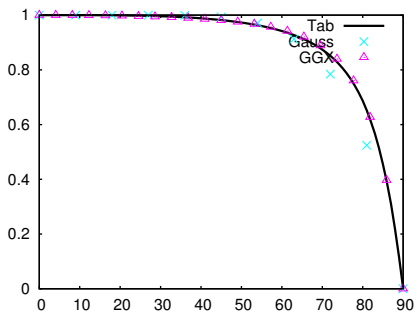
Fitted Microfacet Functions



Fresnel (R, G, B)



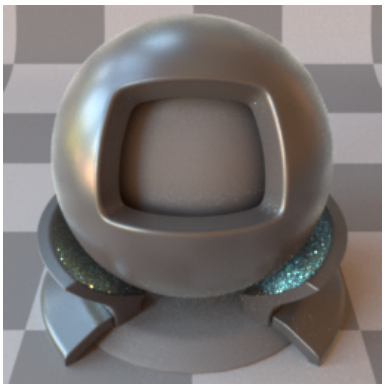
NDF (D)



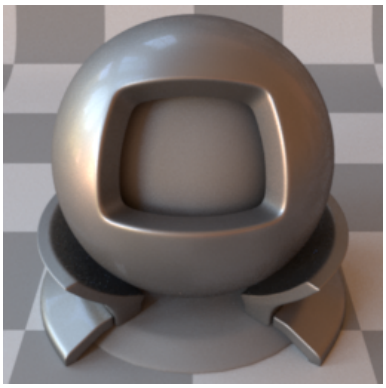
Smith (G_1)

88 two-layer-silver

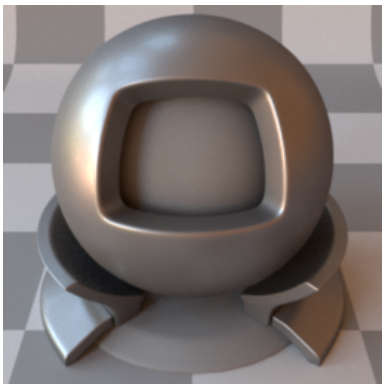
Renderings



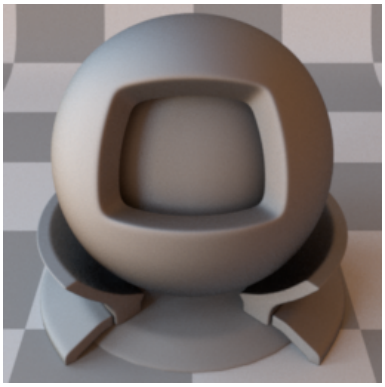
SGD



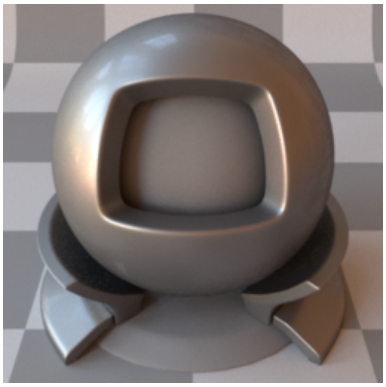
Reference



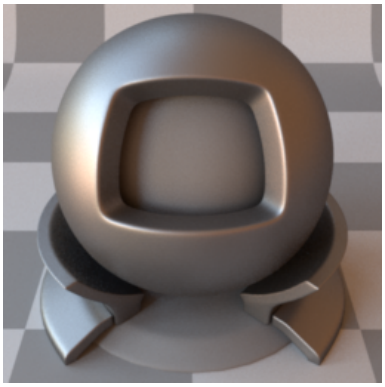
Ours: Tabulated



Ours: Gaussian

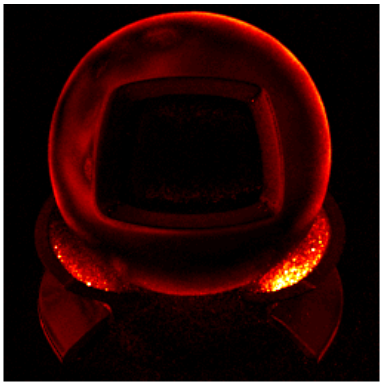


Reference

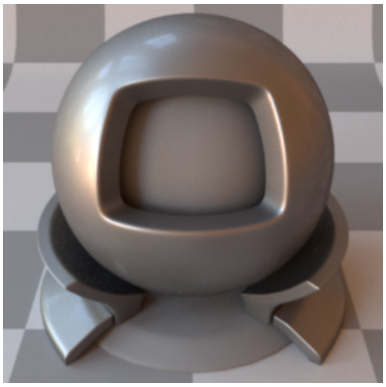


Ours: GGX

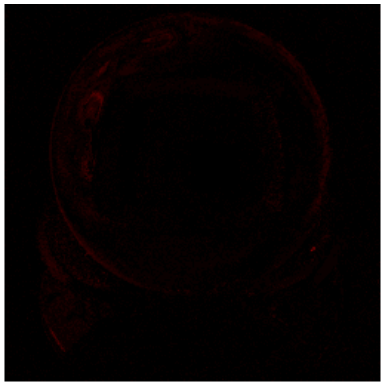
CIE dE00



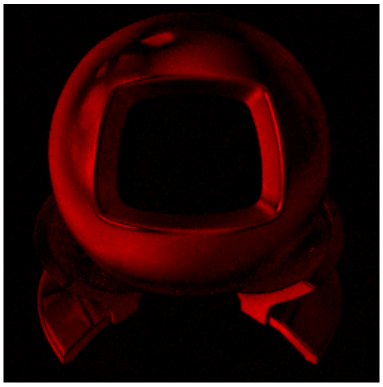
SGD



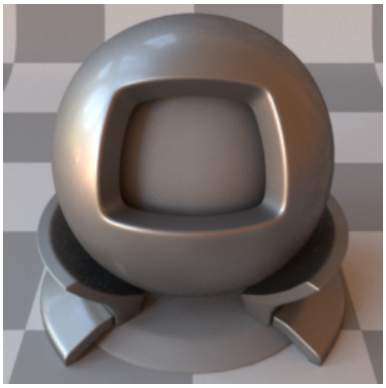
Reference



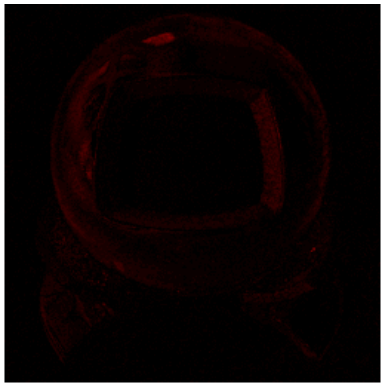
Ours: Tabulated



Ours: Gaussian

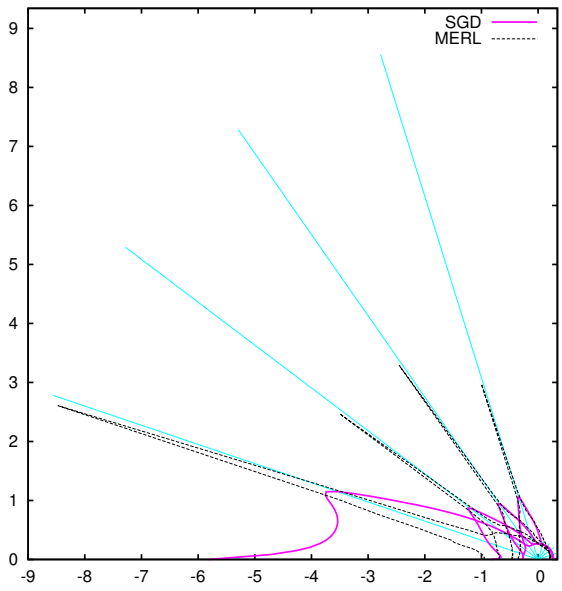


Reference

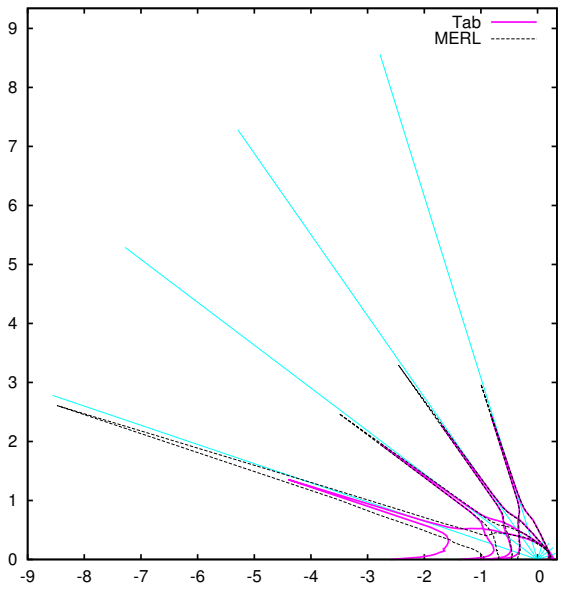


Ours: GGX

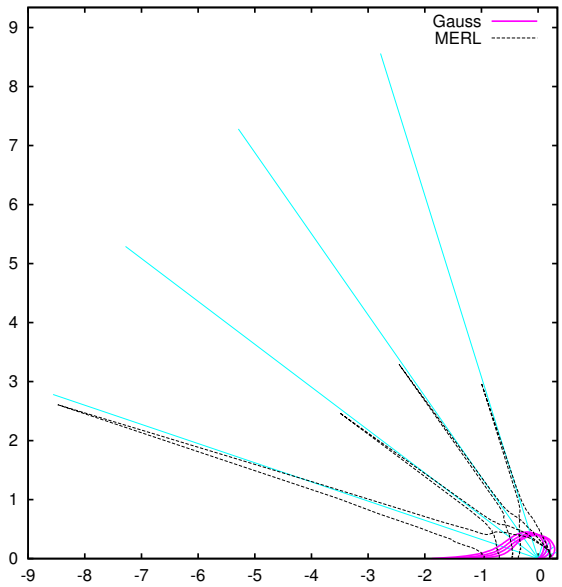
BRDF Lobes in the Incidence Plane (Cubic Root Applied)



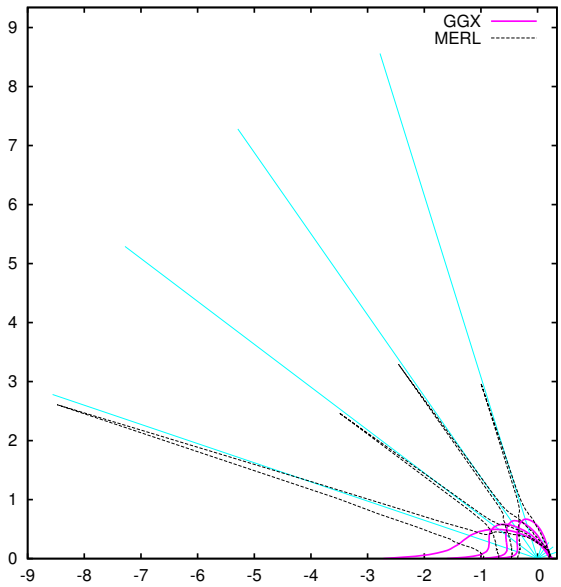
SGD



Ours: Tabulated

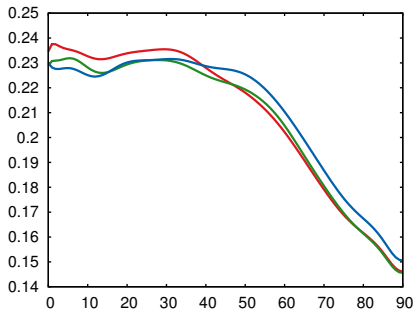


Ours: Gaussian

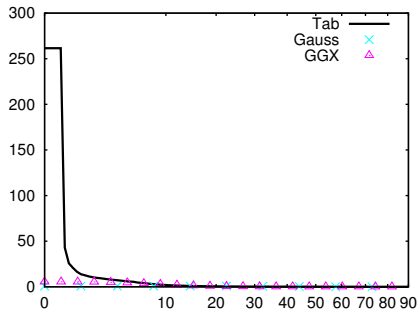


Ours: GGX

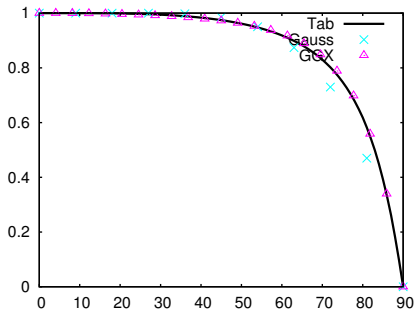
Fitted Microfacet Functions



Fresnel (R, G, B)



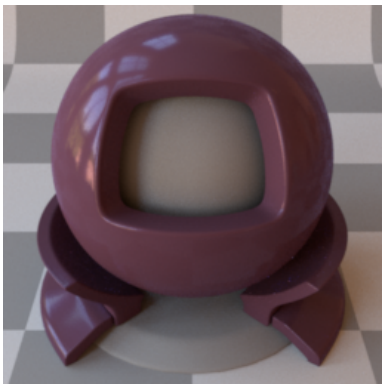
NDF (D)



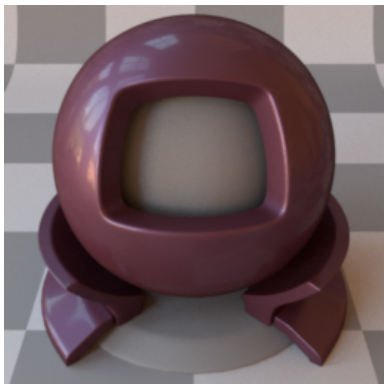
Smith (G_1)

89 violet-acrylic

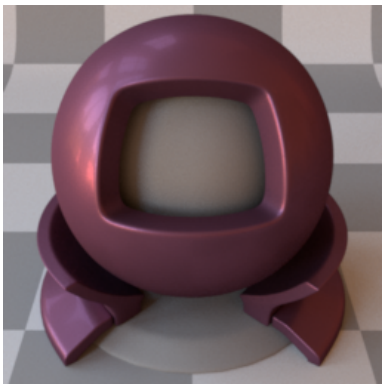
Renderings



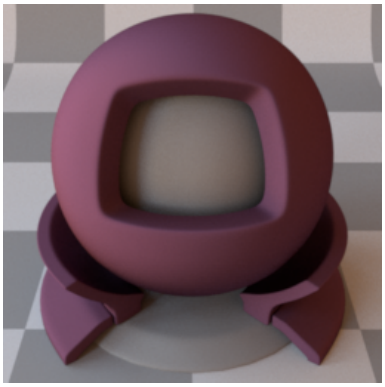
SGD



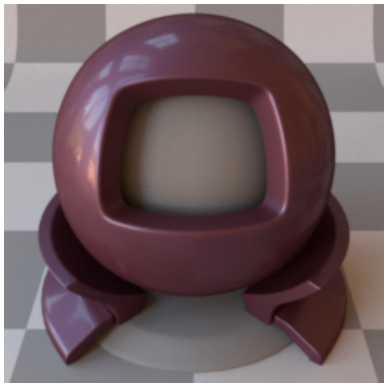
Reference



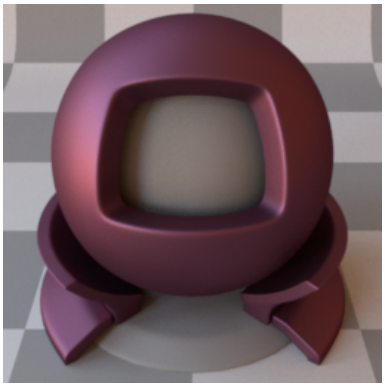
Ours: Tabulated



Ours: Gaussian

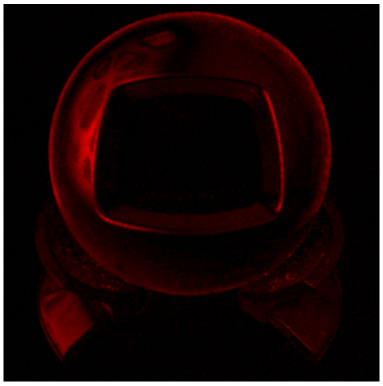


Reference

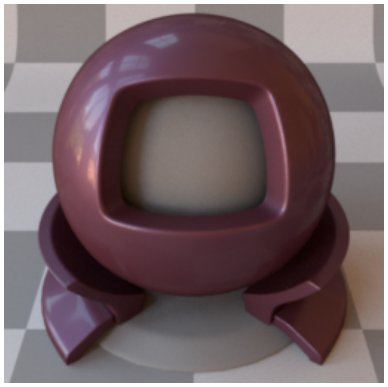


Ours: GGX

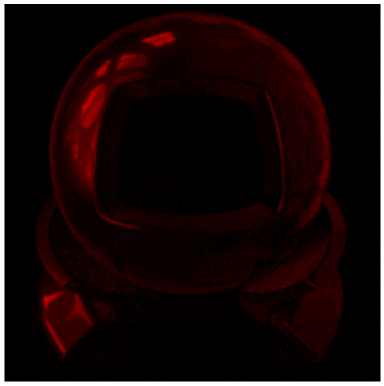
CIE dE00



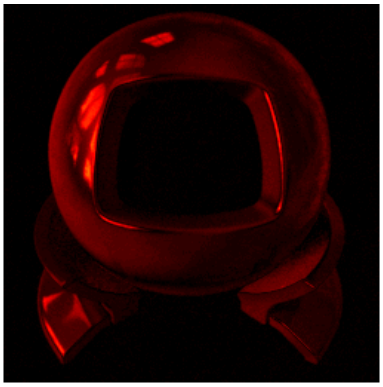
SGD



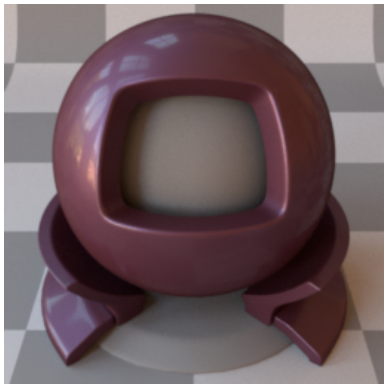
Reference



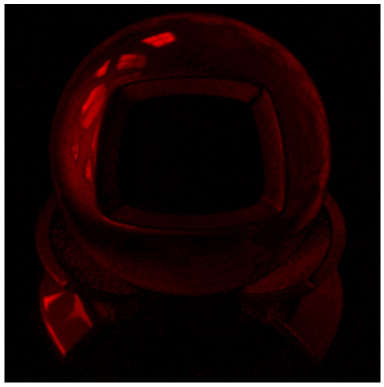
Ours: Tabulated



Ours: Gaussian

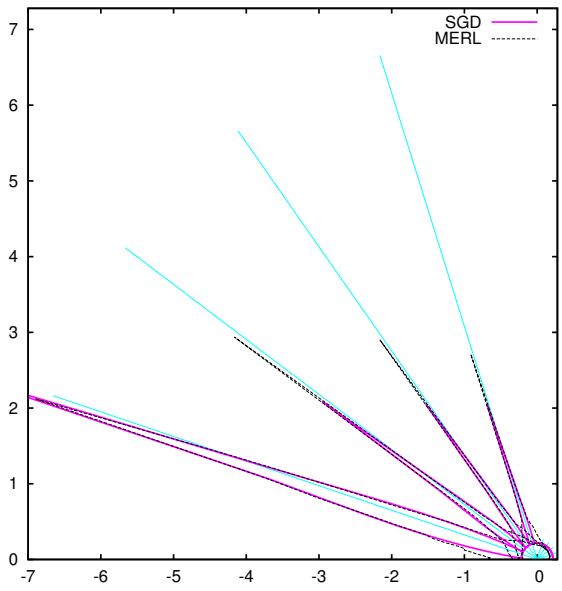


Reference

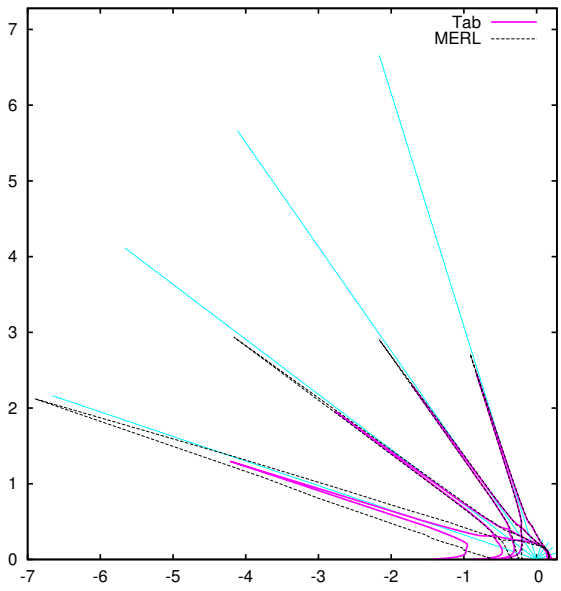


Ours: GGX

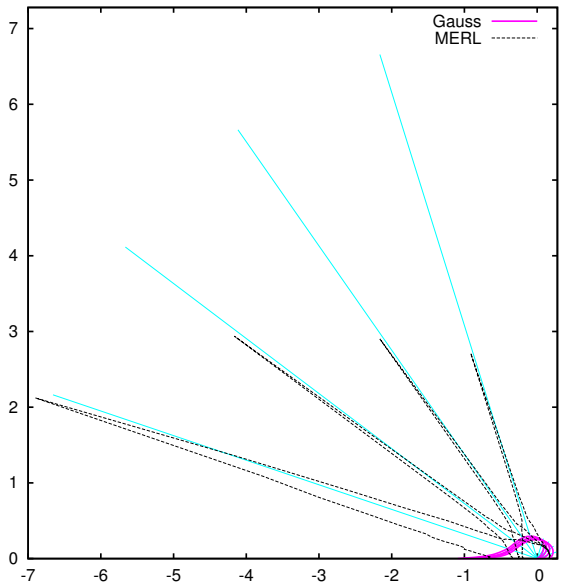
BRDF Lobes in the Incidence Plane (Cubic Root Applied)



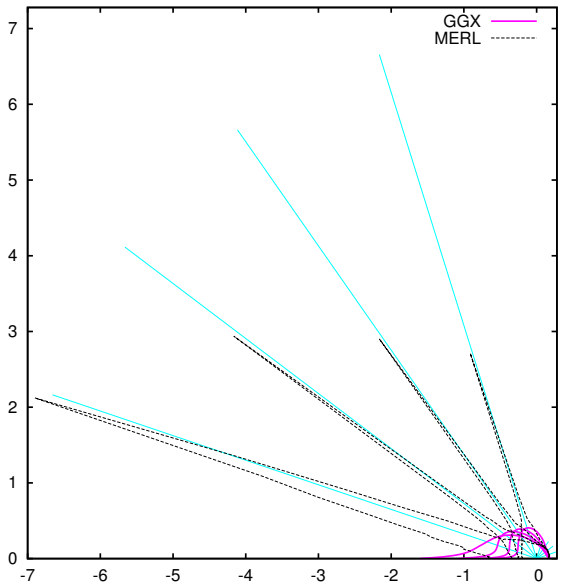
SGD



Ours: Tabulated

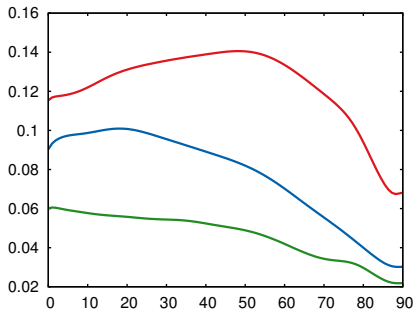


Ours: Gaussian

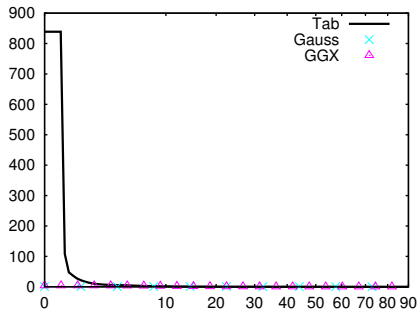


Ours: GGX

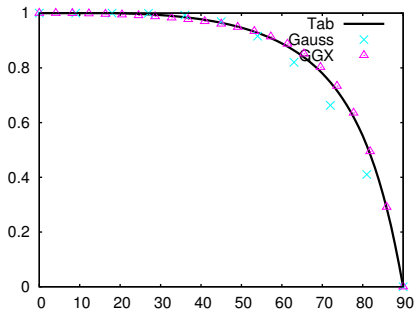
Fitted Microfacet Functions



Fresnel (R, G, B)



NDF (D)



Smith (G_1)

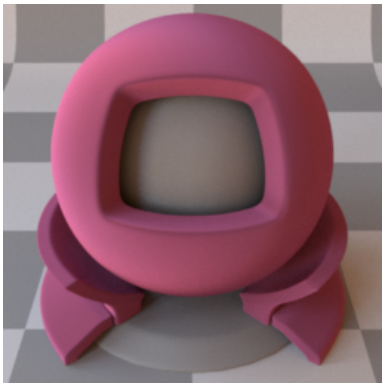
90 violet-rubber

Renderings

SGD

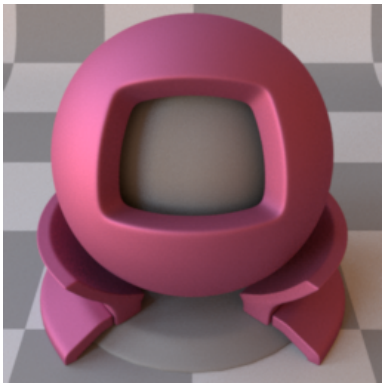
Reference

Ours: Tabulated



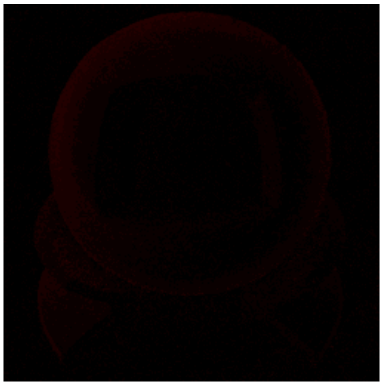
Ours: Gaussian

Reference



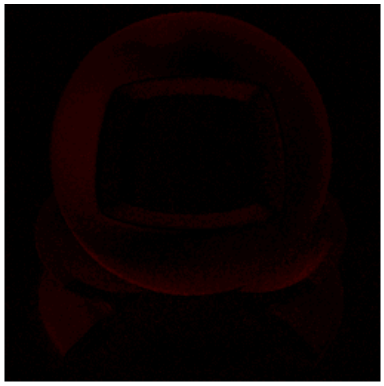
Ours: GGX

CIE dE00

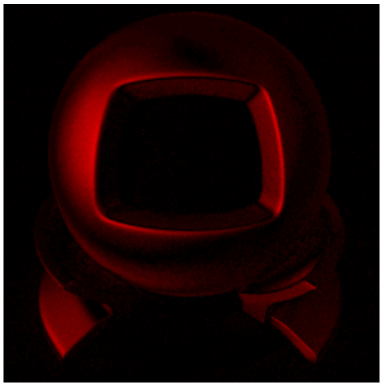


SGD

Reference

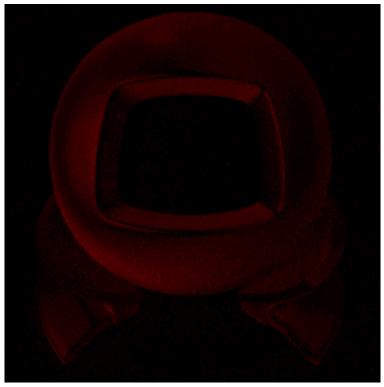


Ours: Tabulated



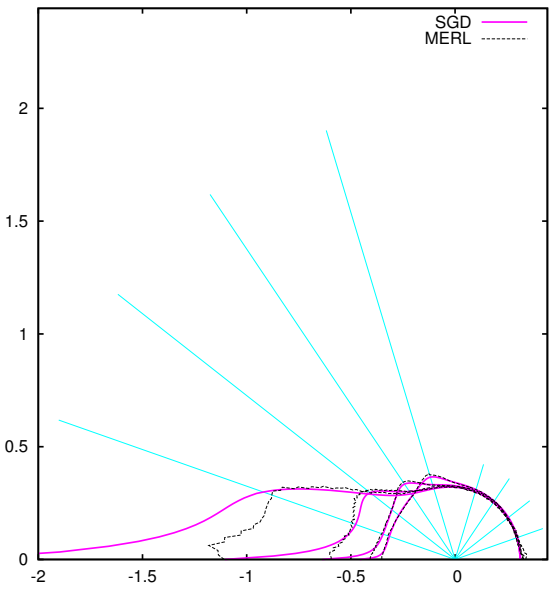
Ours: Gaussian

Reference

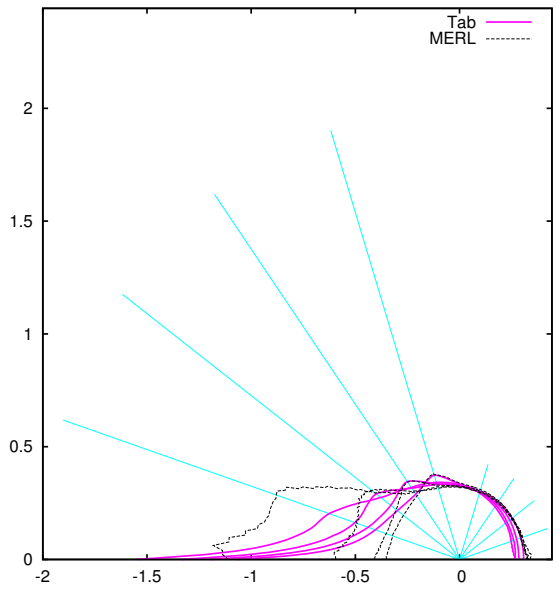


Ours: GGX

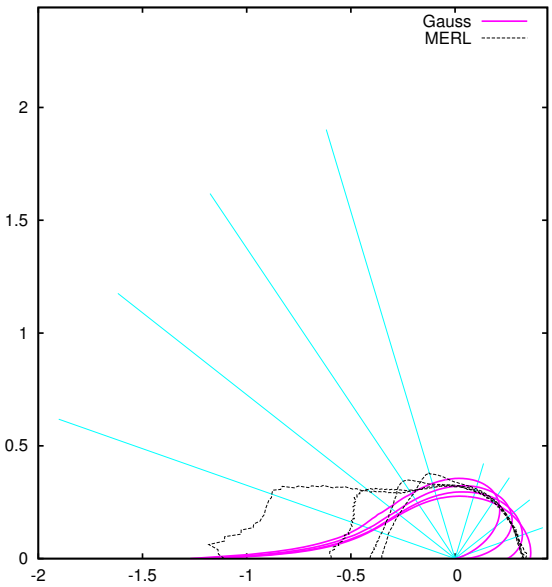
BRDF Lobes in the Incidence Plane (Cubic Root Applied)



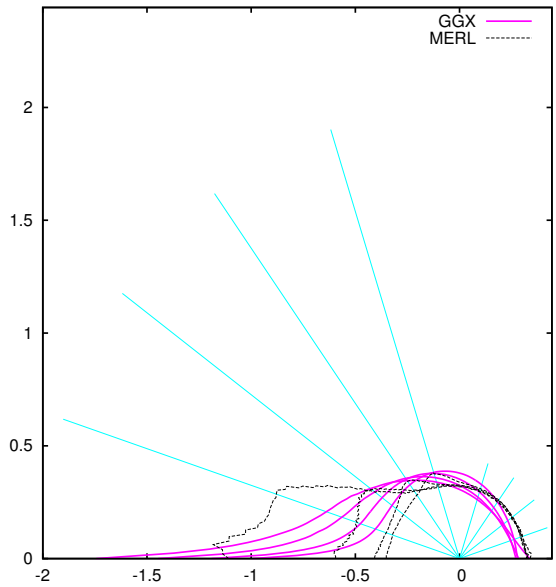
SGD



Ours: Tabulated

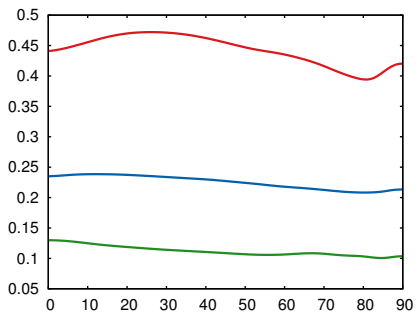


Ours: Gaussian

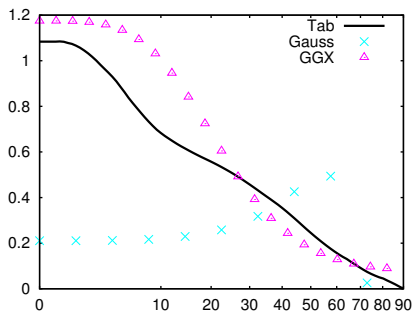


Ours: GGX

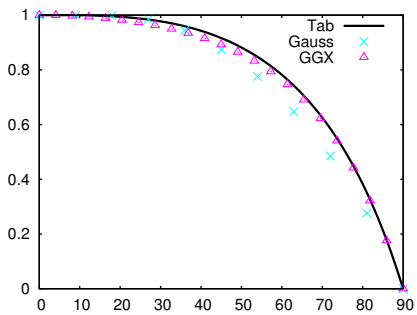
Fitted Microfacet Functions



Fresnel (R, G, B)



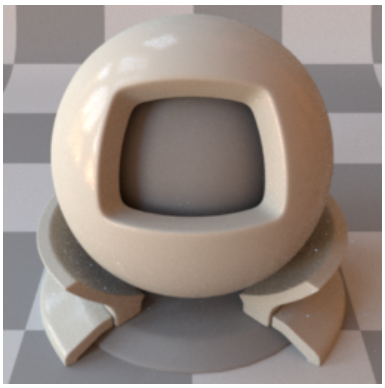
NDF (D)



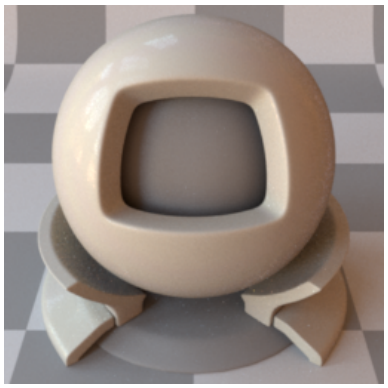
Smith (G_1)

91 white-acrylic

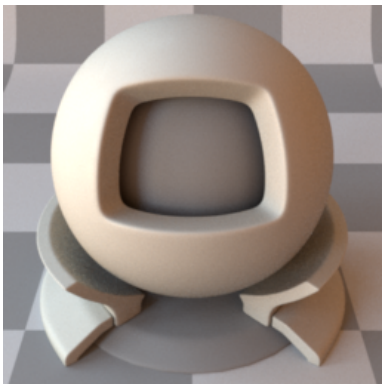
Renderings



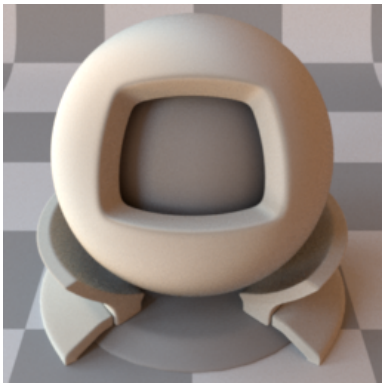
SGD



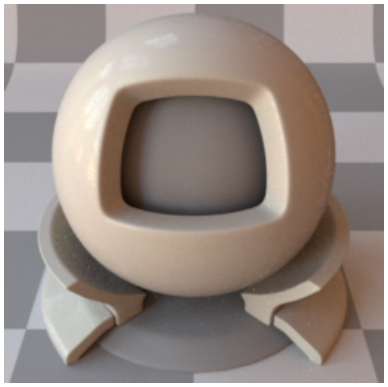
Reference



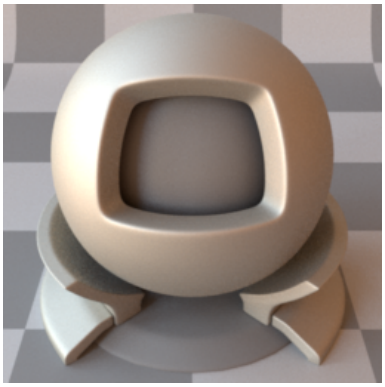
Ours: Tabulated



Ours: Gaussian

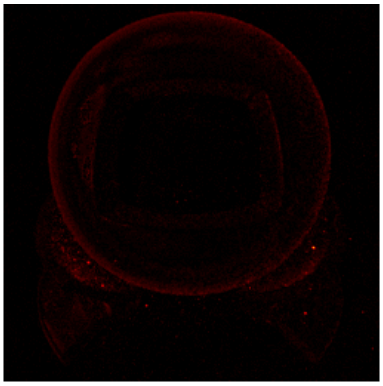


Reference

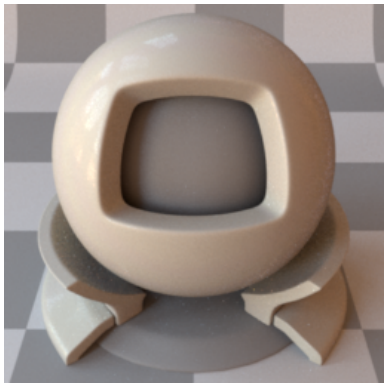


Ours: GGX

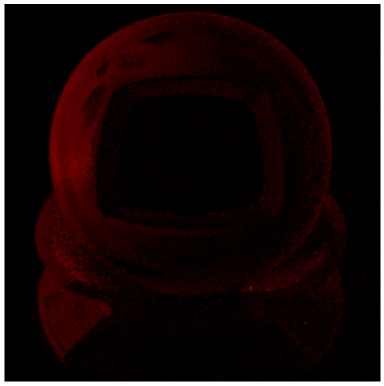
CIE dE00



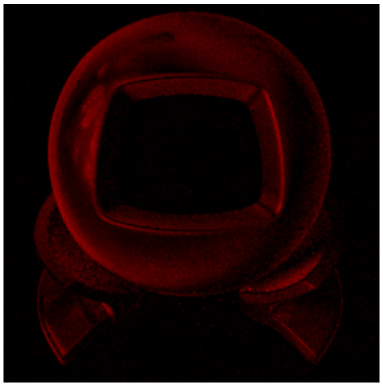
SGD



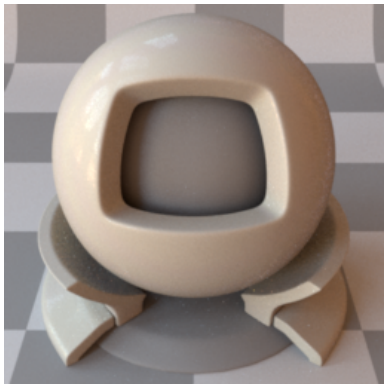
Reference



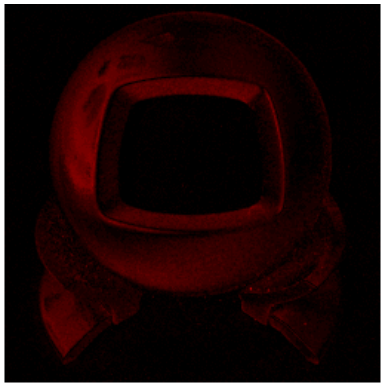
Ours: Tabulated



Ours: Gaussian

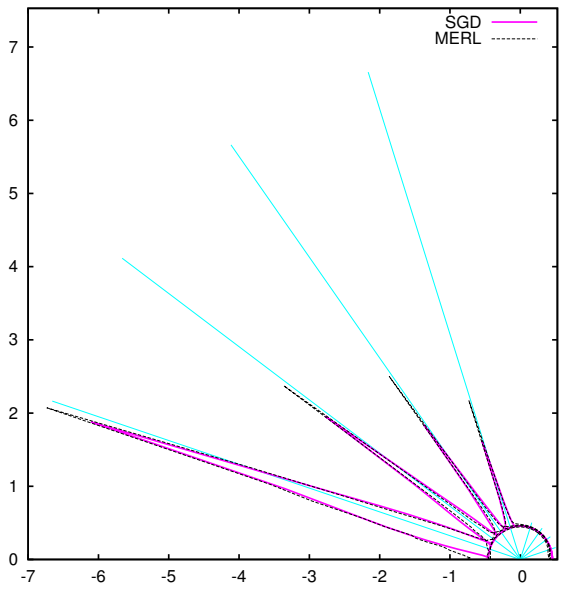


Reference

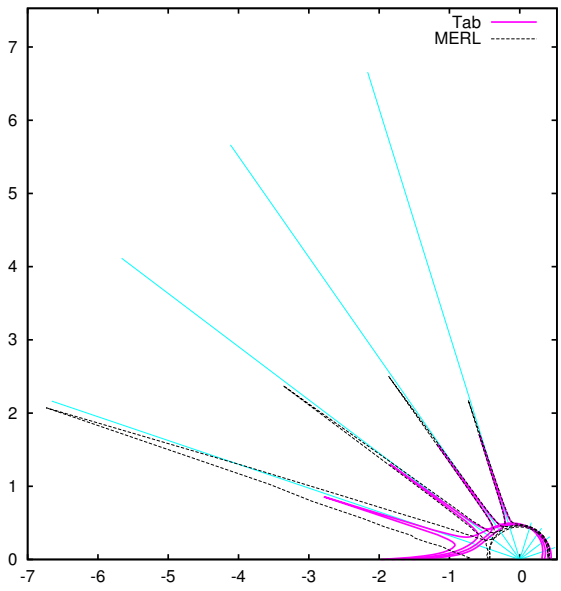


Ours: GGX

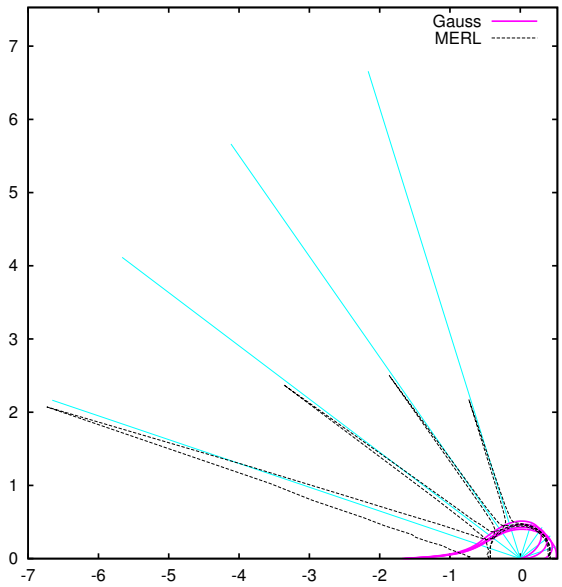
BRDF Lobes in the Incidence Plane (Cubic Root Applied)



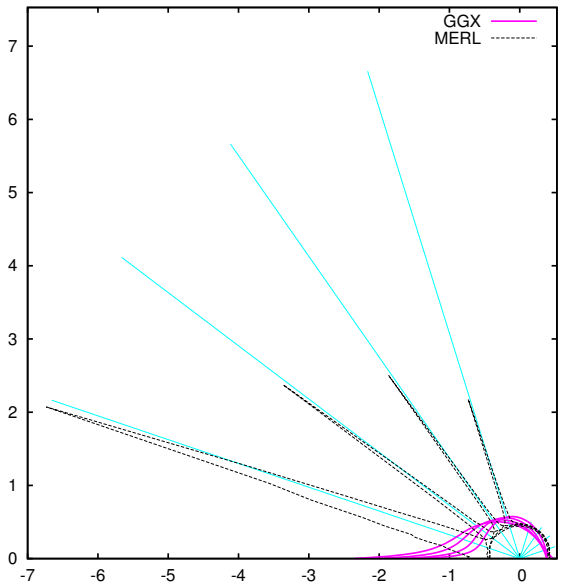
SGD



Ours: Tabulated

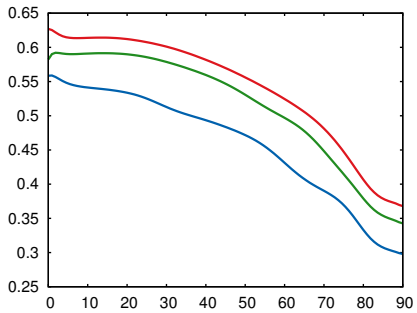


Ours: Gaussian

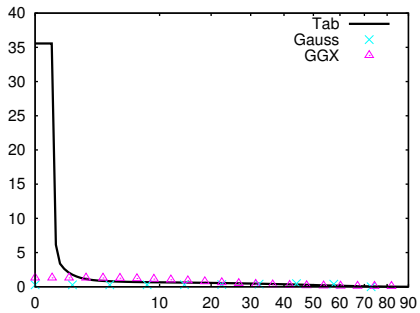


Ours: GGX

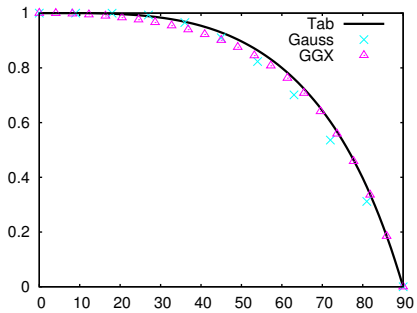
Fitted Microfacet Functions



Fresnel (R, G, B)



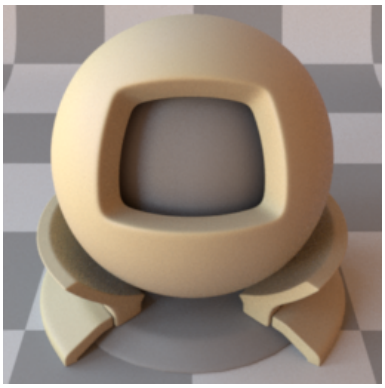
NDF (D)



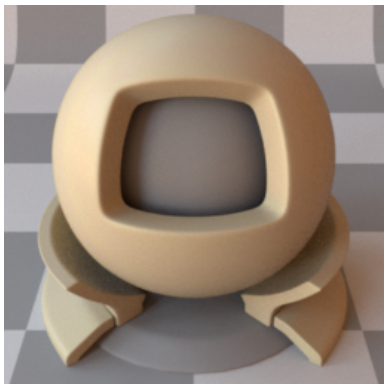
Smith (G_1)

92 white-diffuse-bball

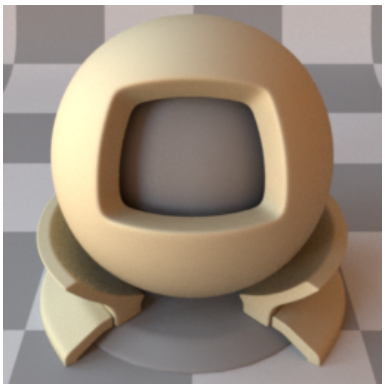
Renderings



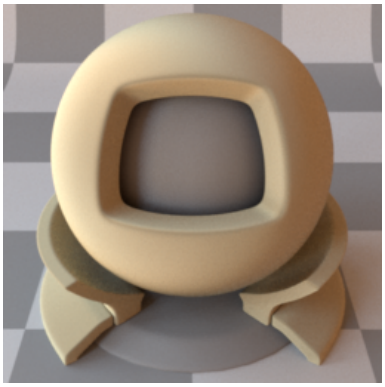
SGD



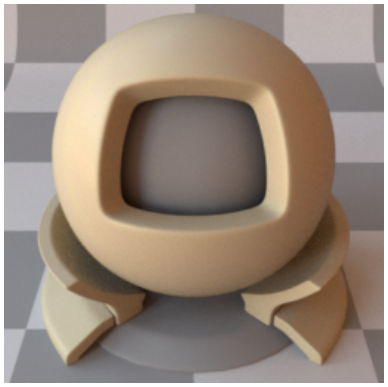
Reference



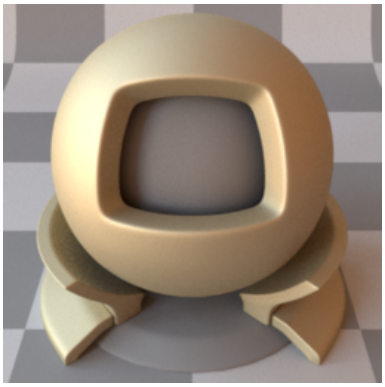
Ours: Tabulated



Ours: Gaussian

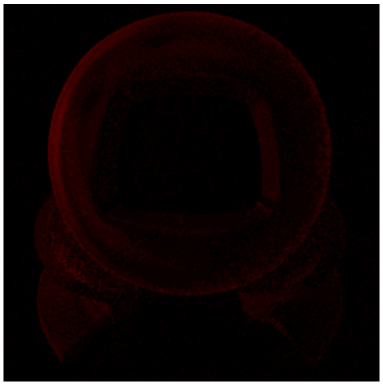


Reference

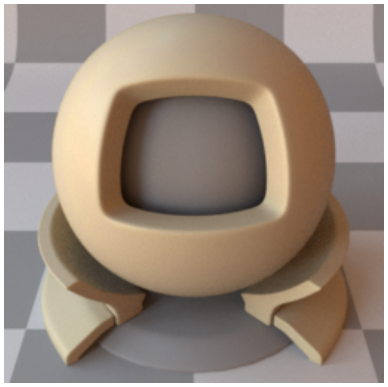


Ours: GGX

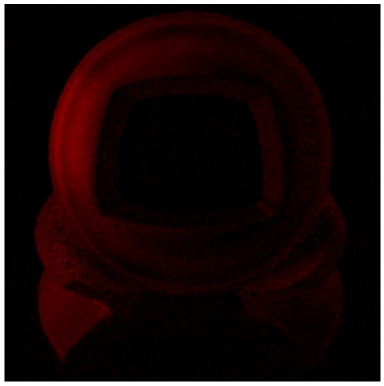
CIE dE00



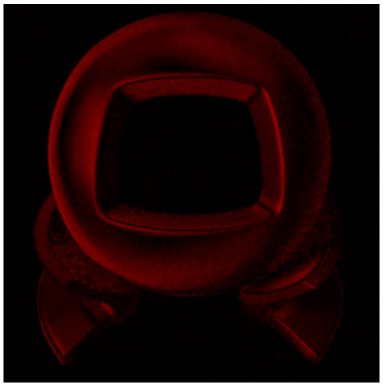
SGD



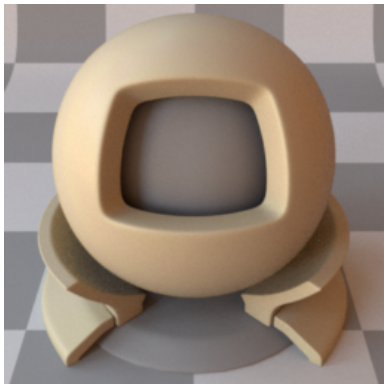
Reference



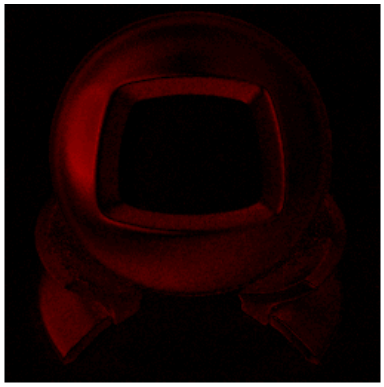
Ours: Tabulated



Ours: Gaussian

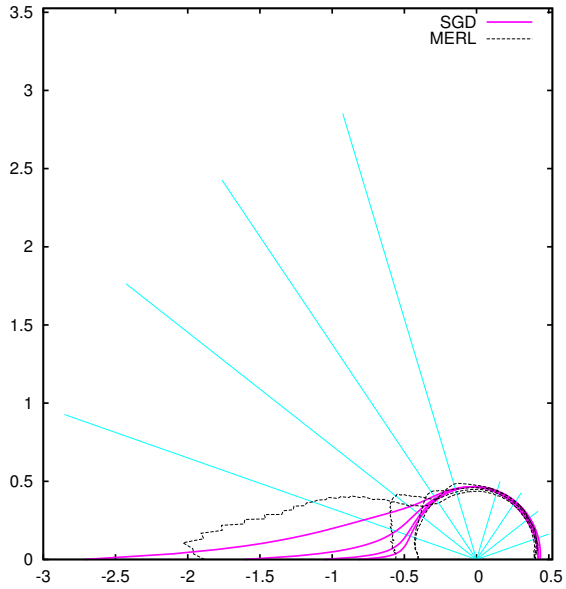


Reference

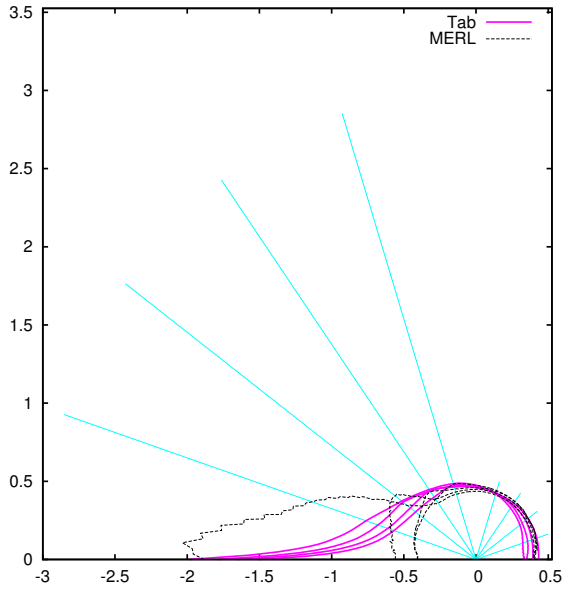


Ours: GGX

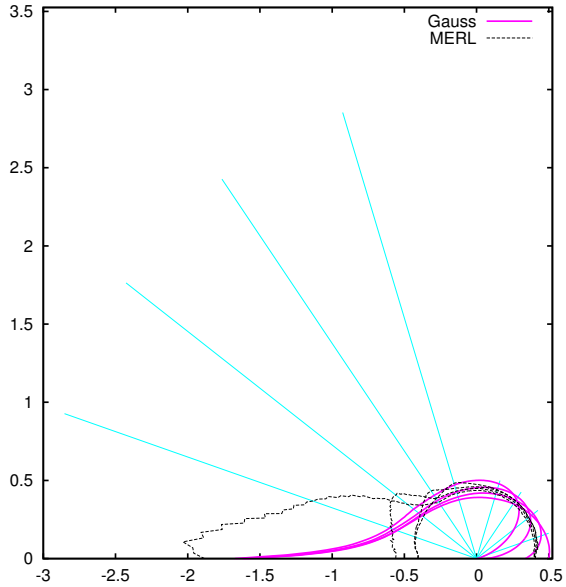
BRDF Lobes in the Incidence Plane (Cubic Root Applied)



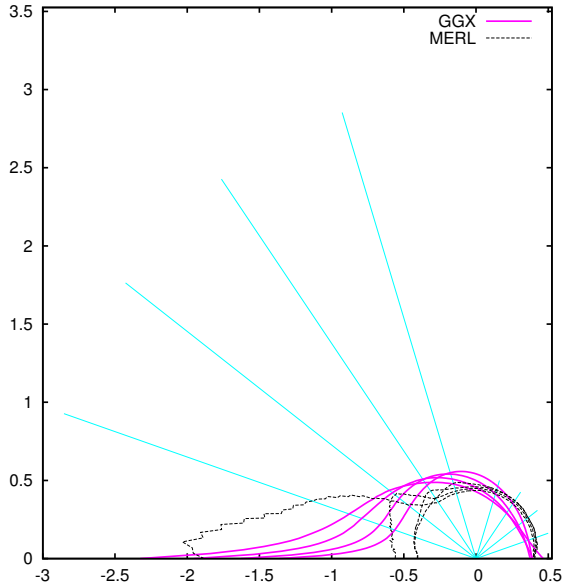
SGD



Ours: Tabulated

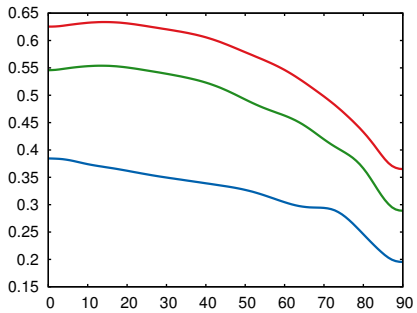


Ours: Gaussian

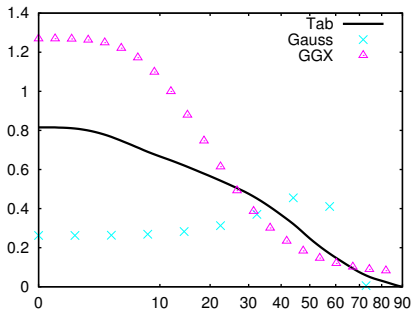


Ours: GGX

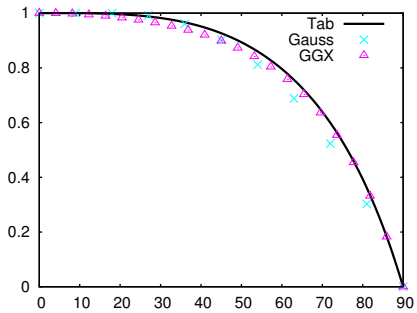
Fitted Microfacet Functions



Fresnel (R, G, B)



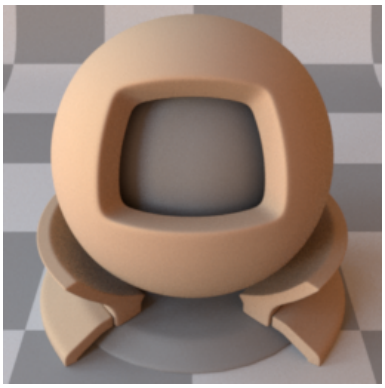
NDF (D)



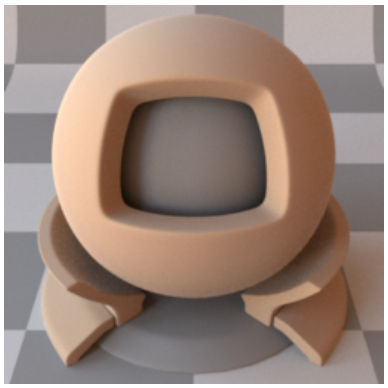
Smith (G_1)

93 white-fabric

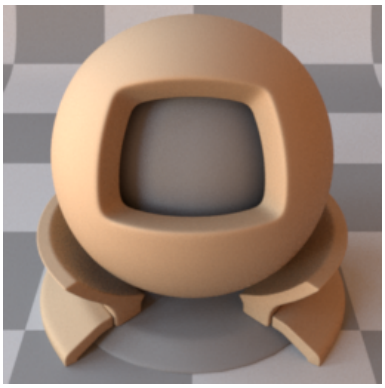
Renderings



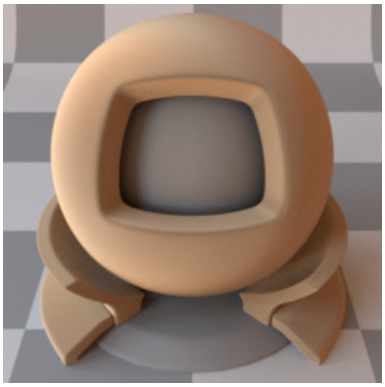
SGD



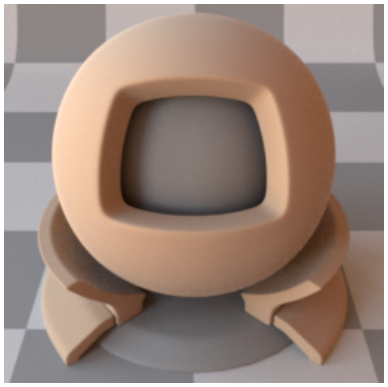
Reference



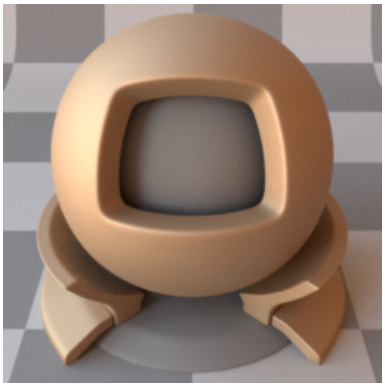
Ours: Tabulated



Ours: Gaussian

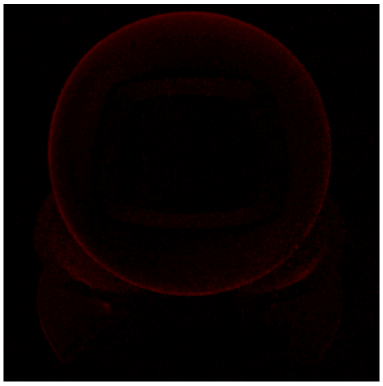


Reference

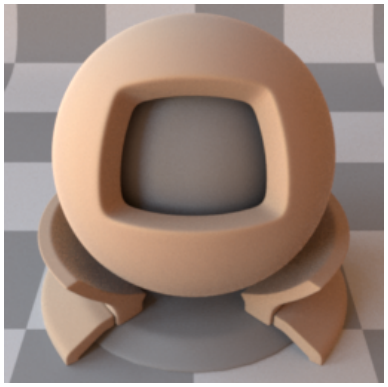


Ours: GGX

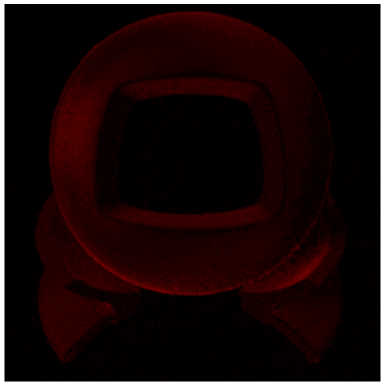
CIE dE00



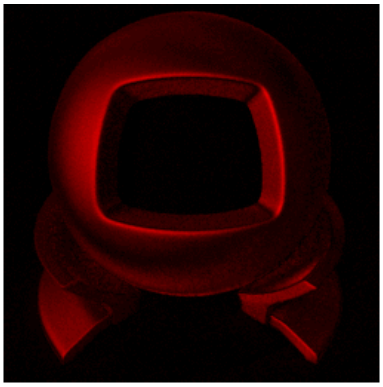
SGD



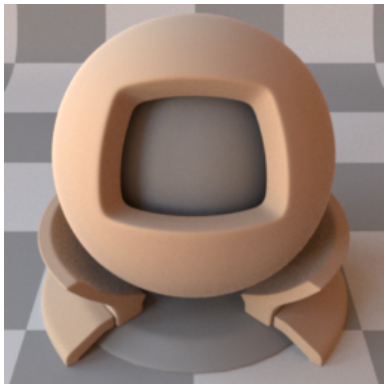
Reference



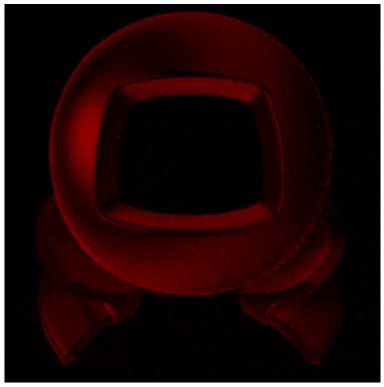
Ours: Tabulated



Ours: Gaussian

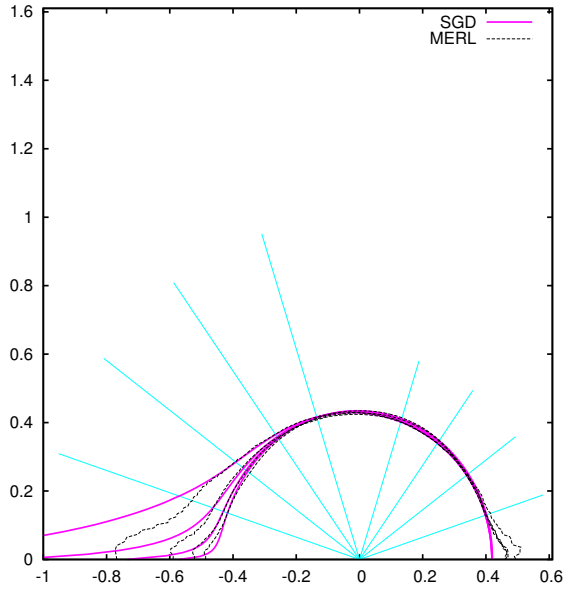


Reference

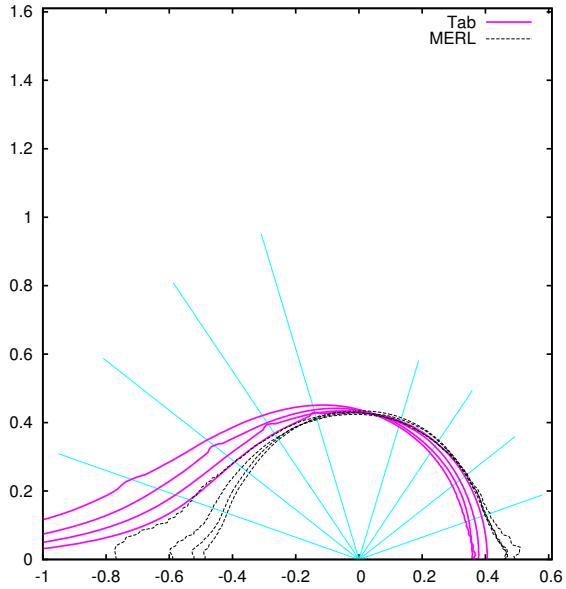


Ours: GGX

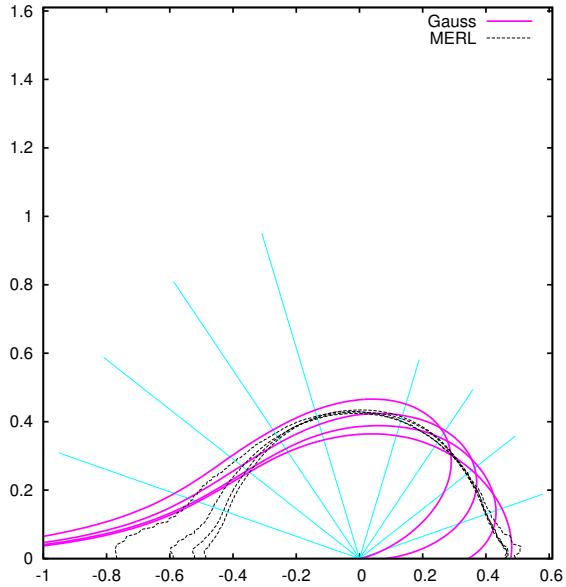
BRDF Lobes in the Incidence Plane (Cubic Root Applied)



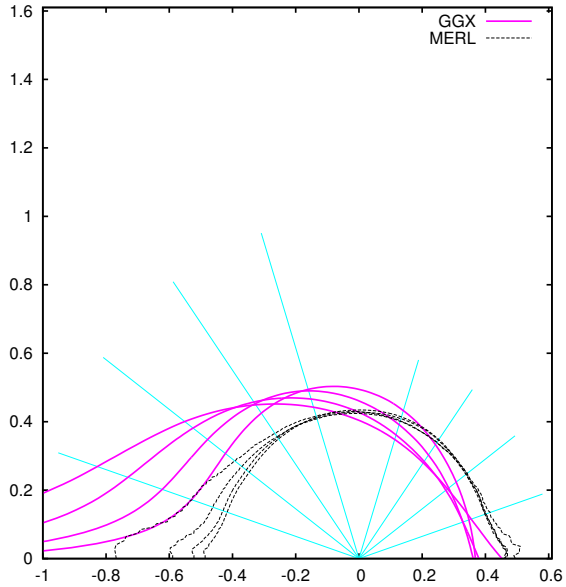
SGD



Ours: Tabulated

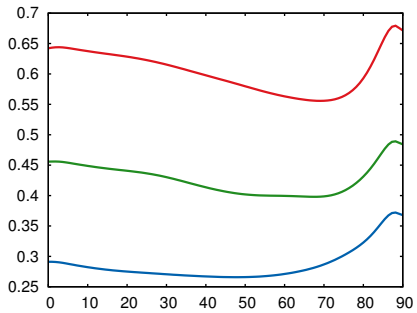


Ours: Gaussian

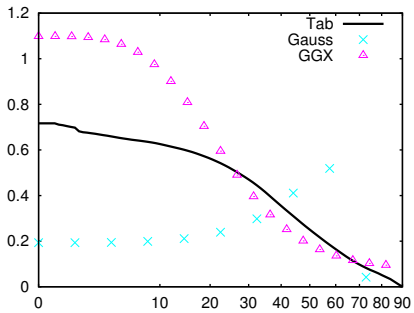


Ours: GGX

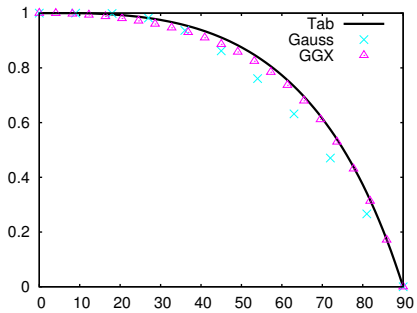
Fitted Microfacet Functions



Fresnel (R, G, B)



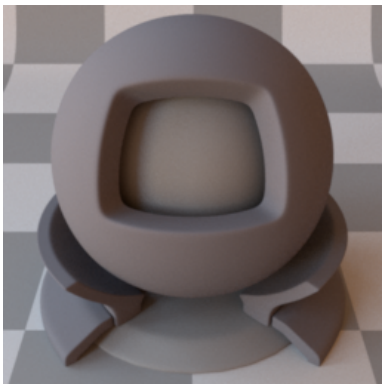
NDF (D)



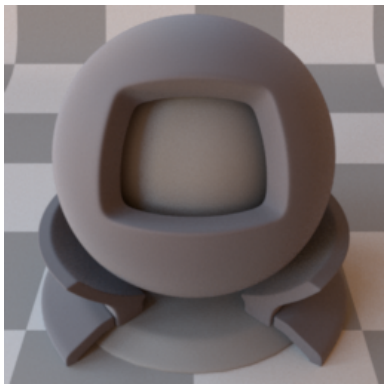
Smith (G_1)

94 white-fabric2

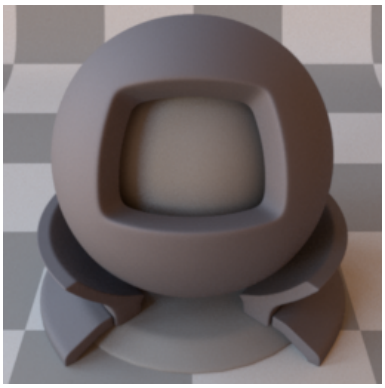
Renderings



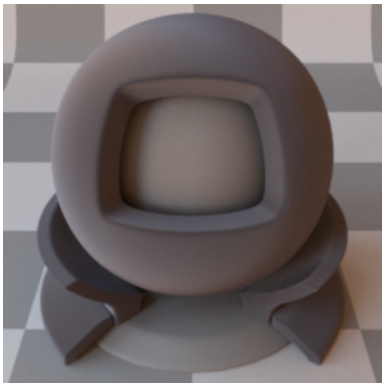
SGD



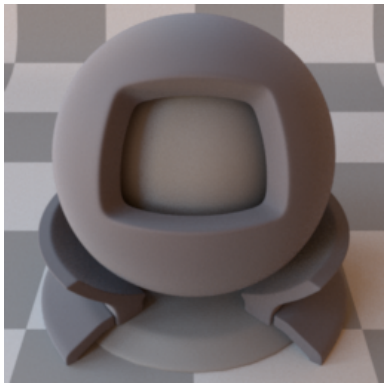
Reference



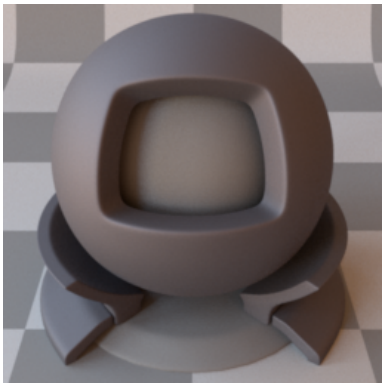
Ours: Tabulated



Ours: Gaussian

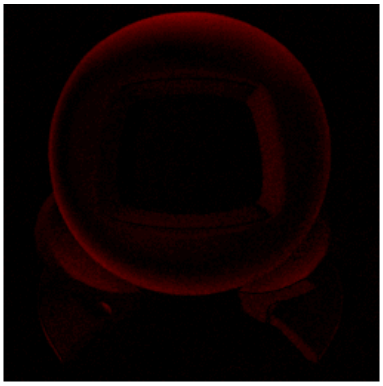


Reference

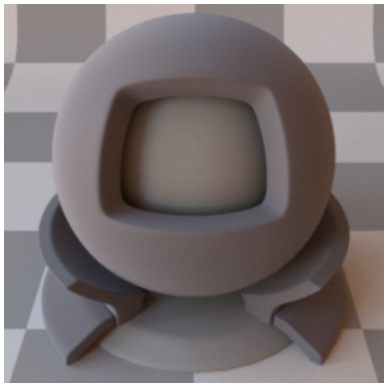


Ours: GGX

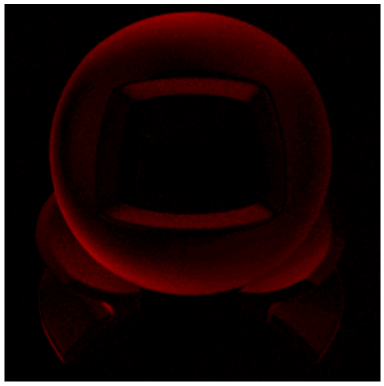
CIE dE00



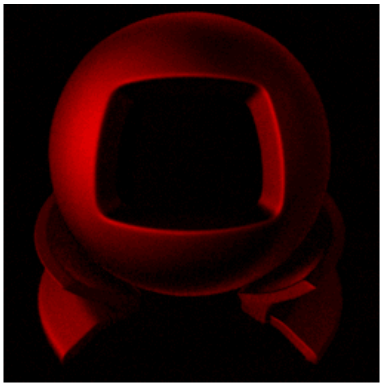
SGD



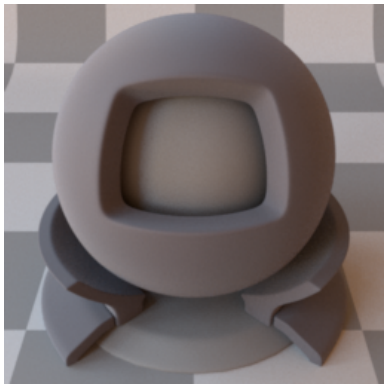
Reference



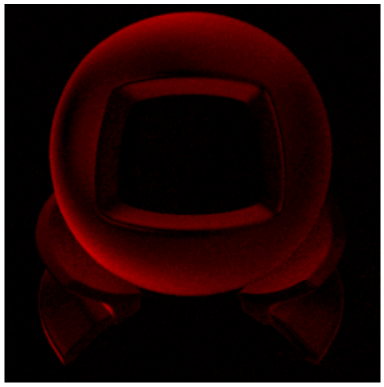
Ours: Tabulated



Ours: Gaussian

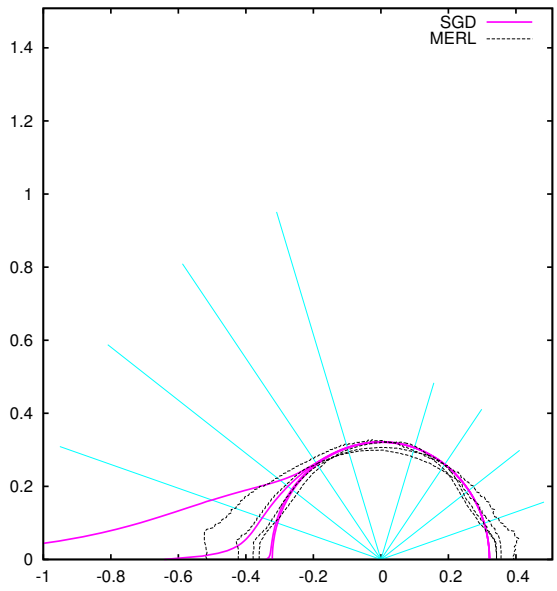


Reference

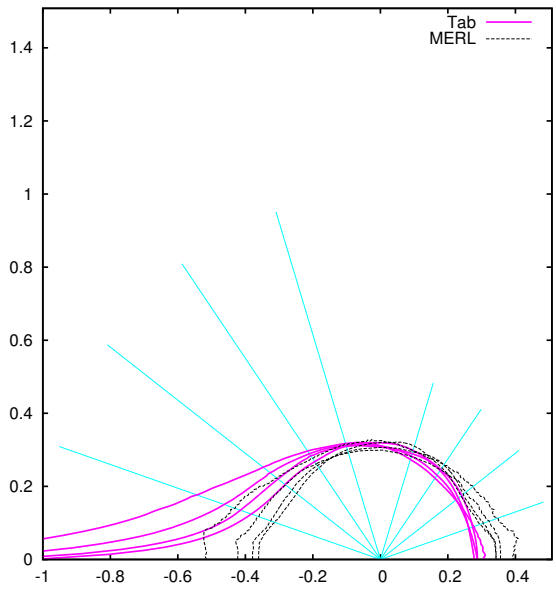


Ours: GGX

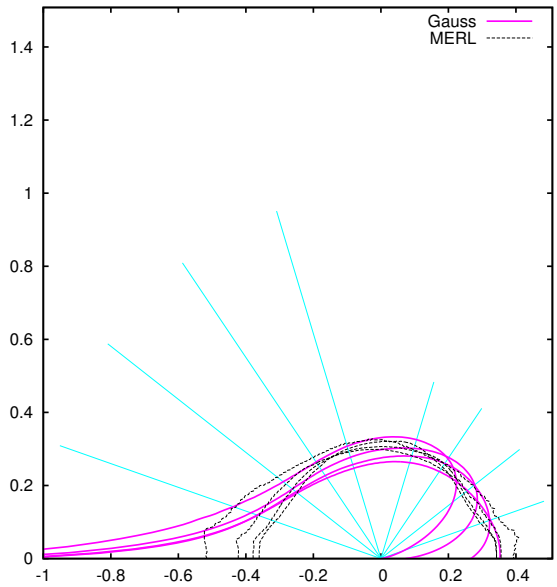
BRDF Lobes in the Incidence Plane (Cubic Root Applied)



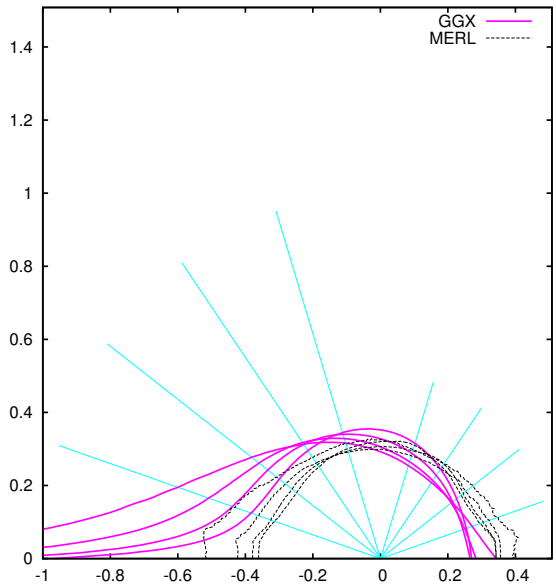
SGD



Ours: Tabulated

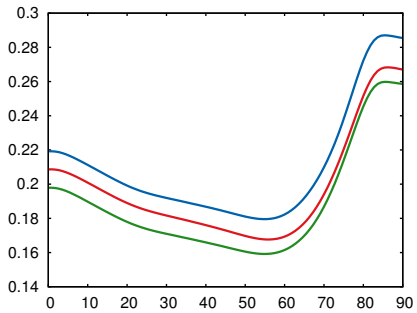


Ours: Gaussian

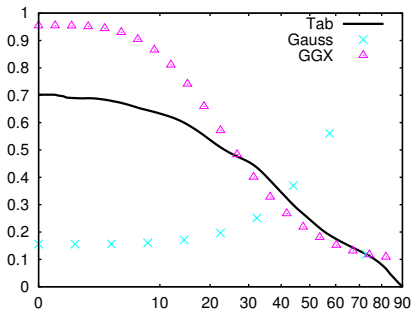


Ours: GGX

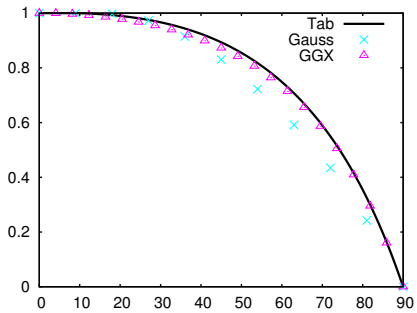
Fitted Microfacet Functions



Fresnel (R, G, B)



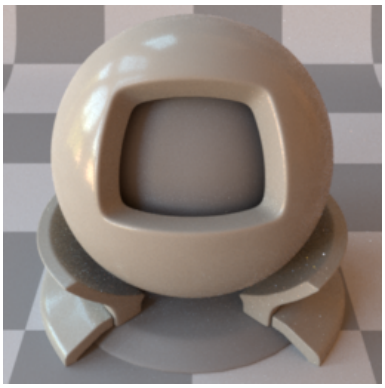
NDF (D)



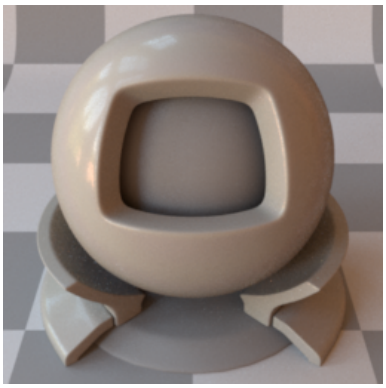
Smith (G_1)

95 white-marble

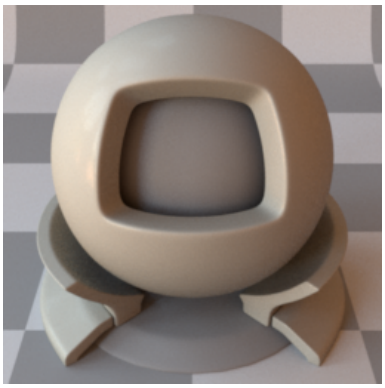
Renderings



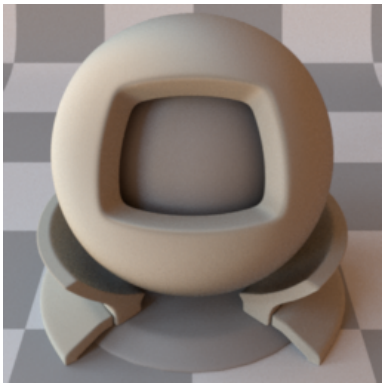
SGD



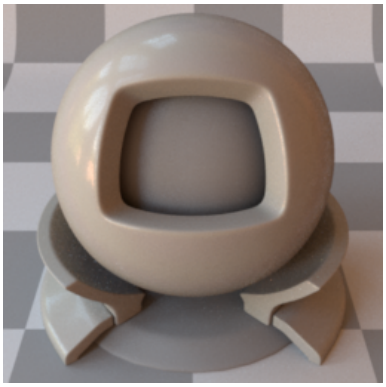
Reference



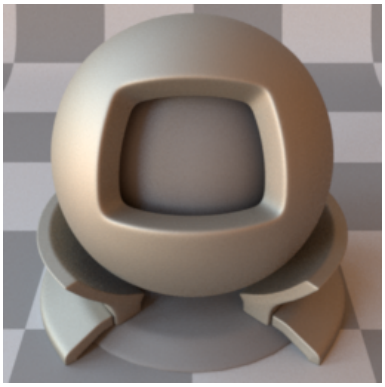
Ours: Tabulated



Ours: Gaussian

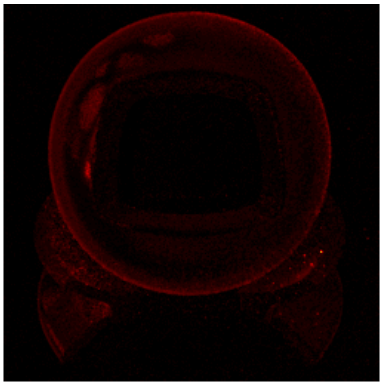


Reference

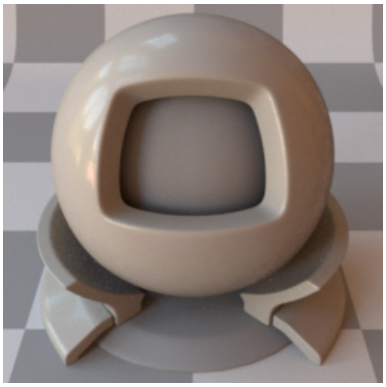


Ours: GGX

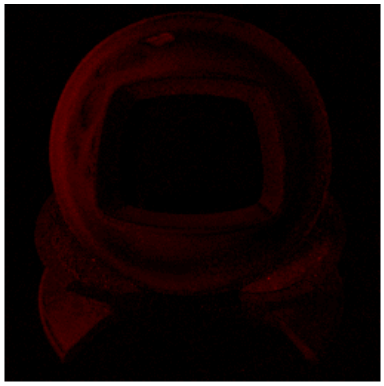
CIE dE00



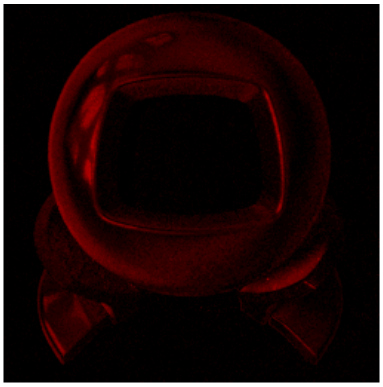
SGD



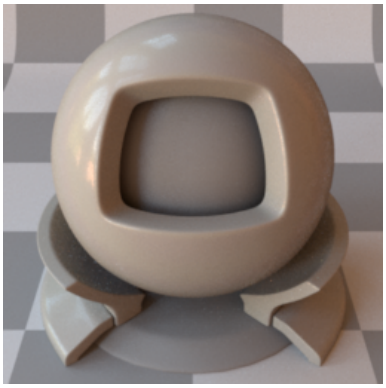
Reference



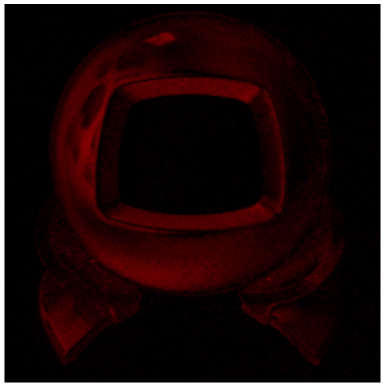
Ours: Tabulated



Ours: Gaussian

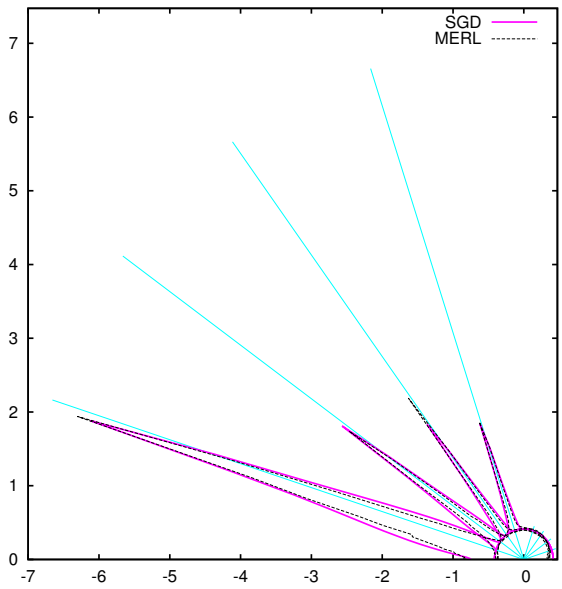


Reference

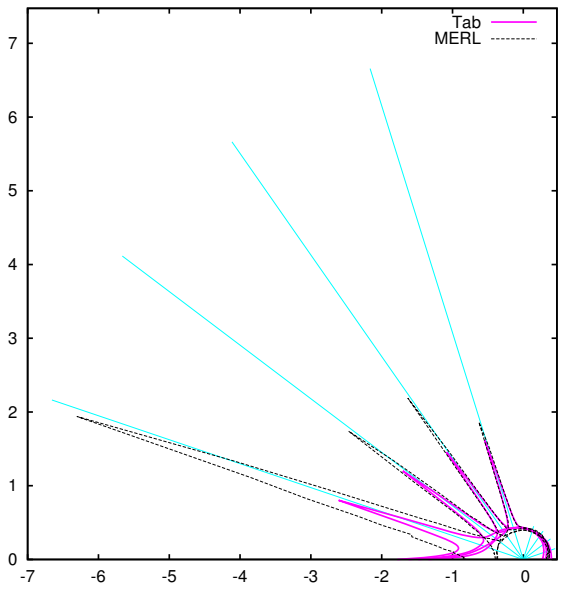


Ours: GGX

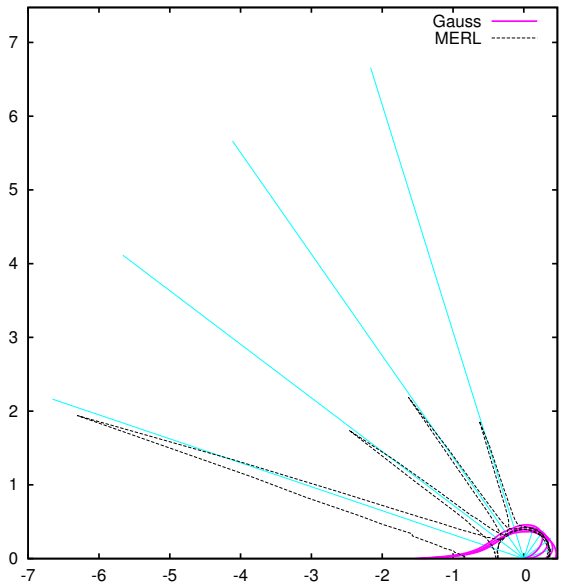
BRDF Lobes in the Incidence Plane (Cubic Root Applied)



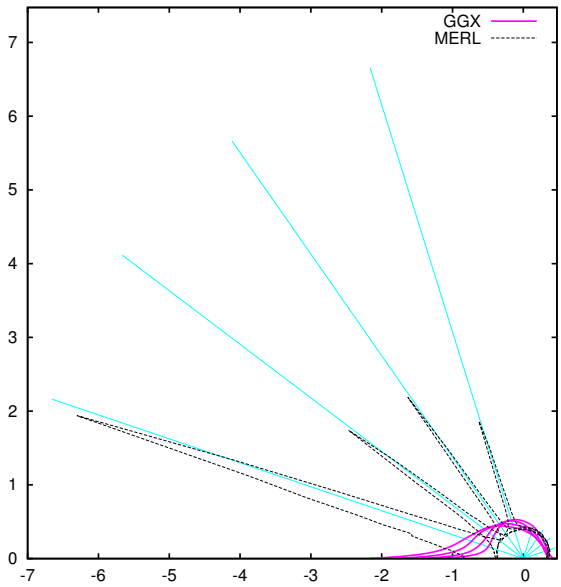
SGD



Ours: Tabulated

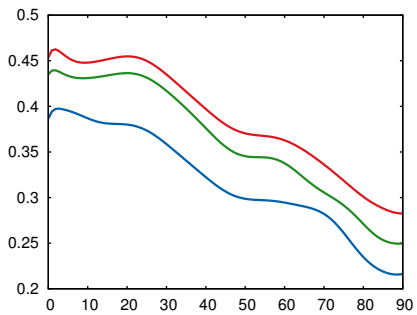


Ours: Gaussian

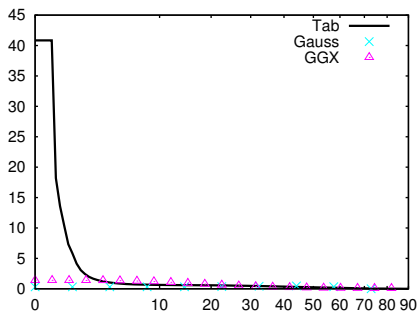


Ours: GGX

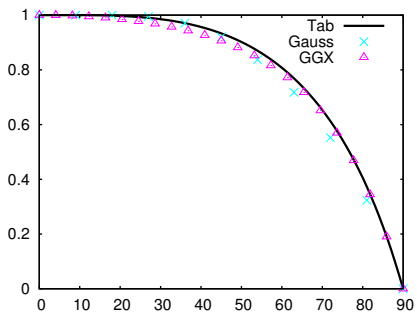
Fitted Microfacet Functions



Fresnel (R, G, B)



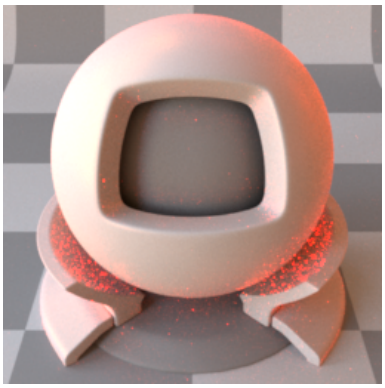
NDF (D)



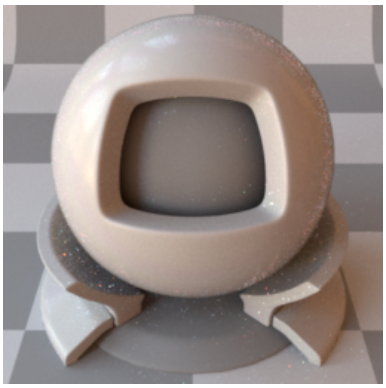
Smith (G_1)

96 white-paint

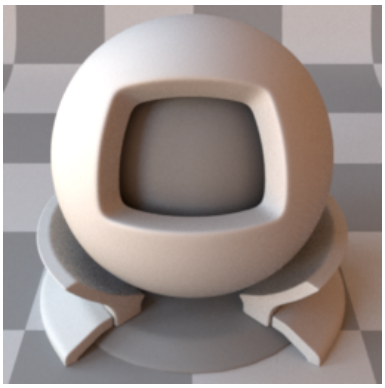
Renderings



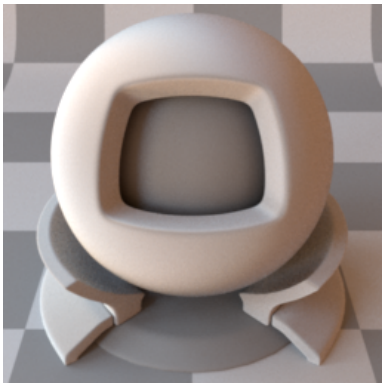
SGD



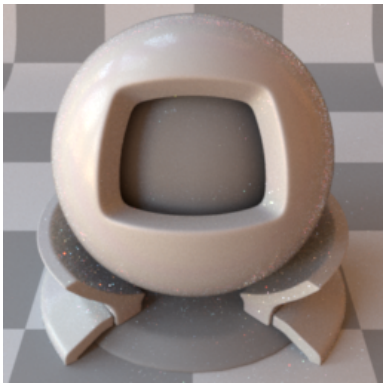
Reference



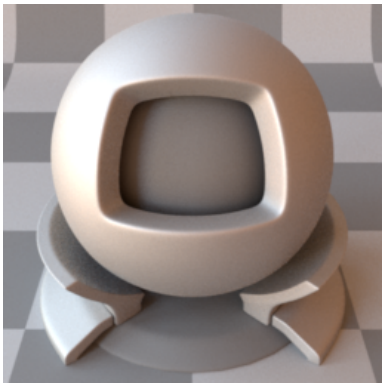
Ours: Tabulated



Ours: Gaussian

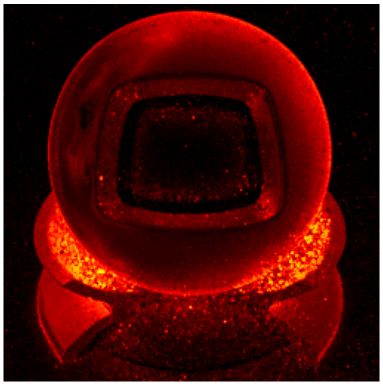


Reference

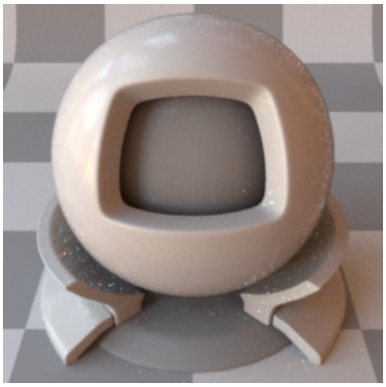


Ours: GGX

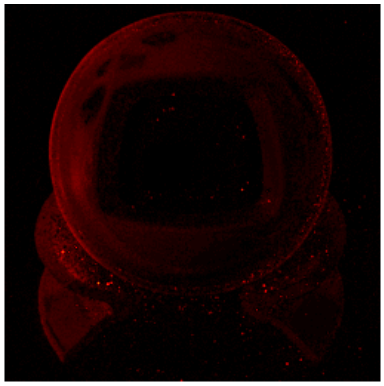
CIE dE00



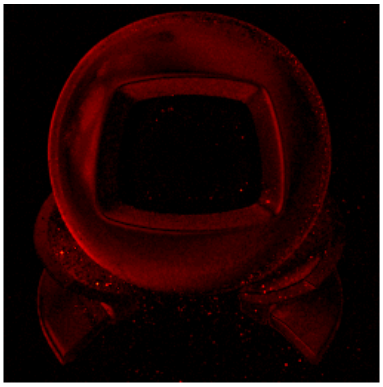
SGD



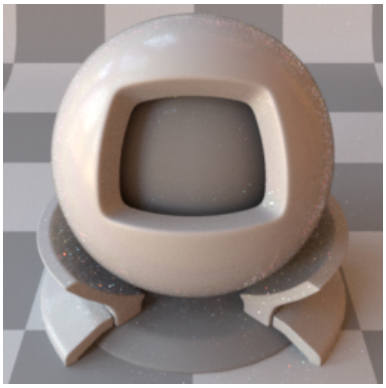
Reference



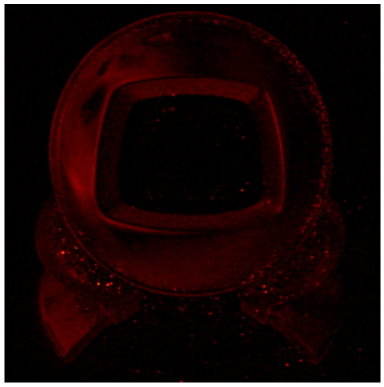
Ours: Tabulated



Ours: Gaussian

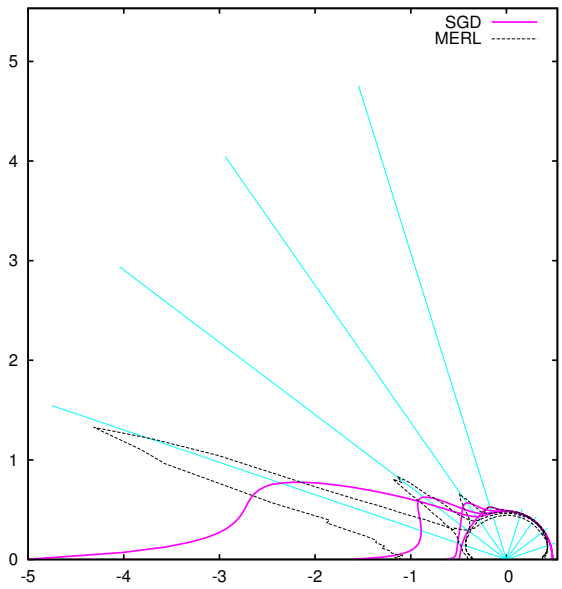


Reference

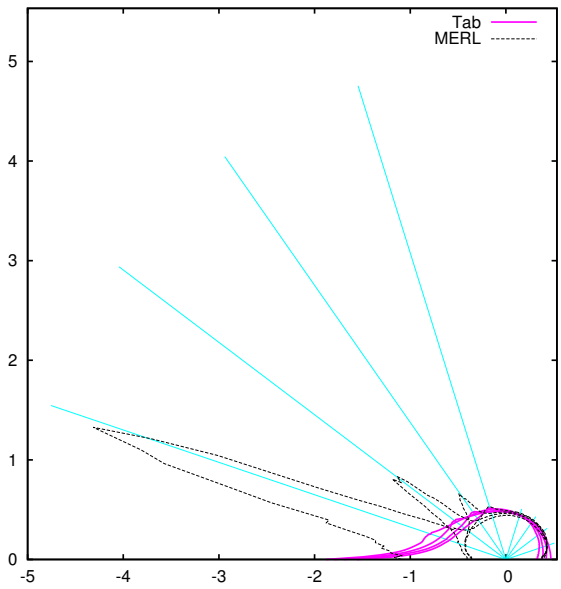


Ours: GGX

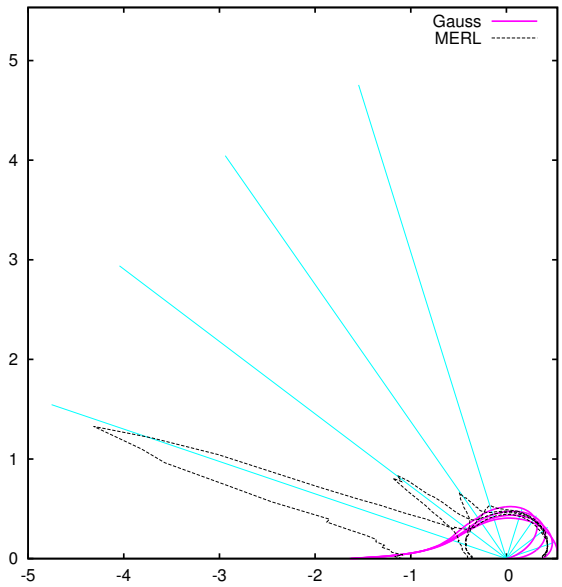
BRDF Lobes in the Incidence Plane (Cubic Root Applied)



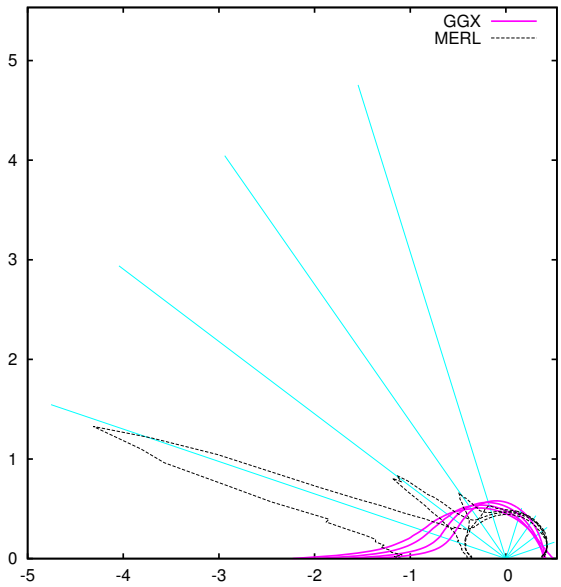
SGD



Ours: Tabulated

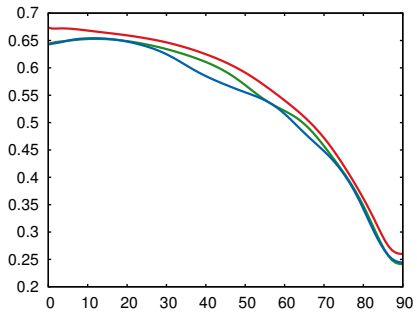


Ours: Gaussian

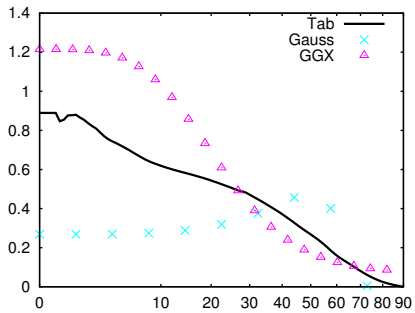


Ours: GGX

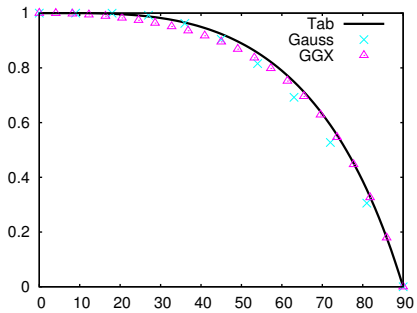
Fitted Microfacet Functions



Fresnel (R, G, B)



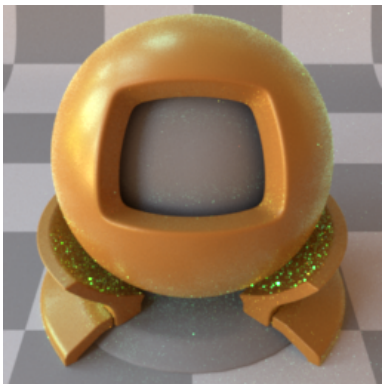
NDF (D)



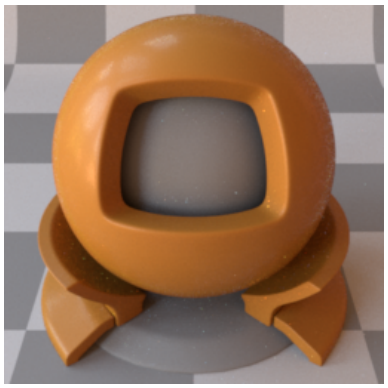
Smith (G_1)

97 yellow-matte-plastic

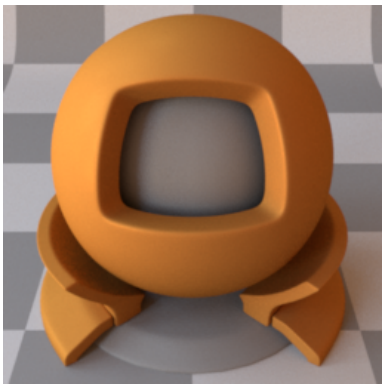
Renderings



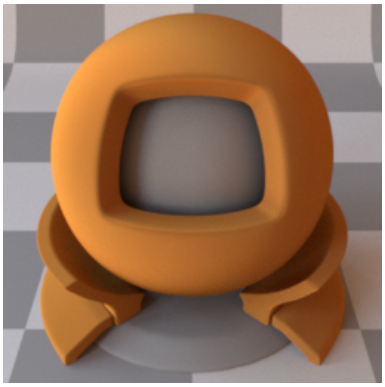
SGD



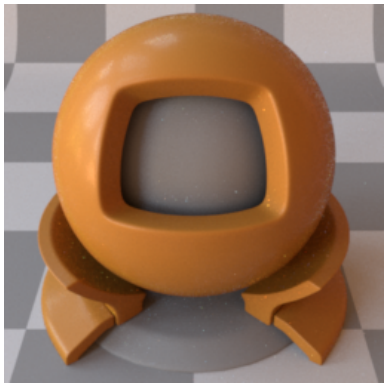
Reference



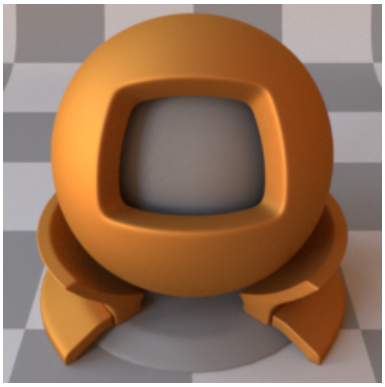
Ours: Tabulated



Ours: Gaussian

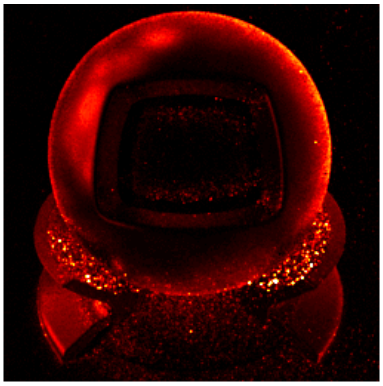


Reference

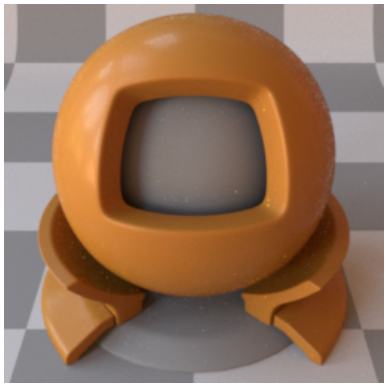


Ours: GGX

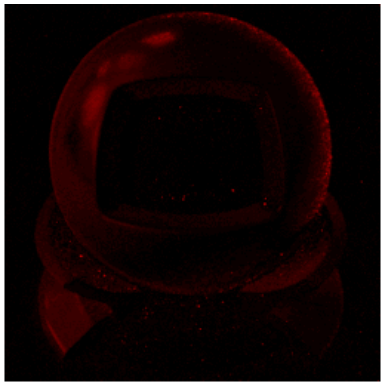
CIE dE00



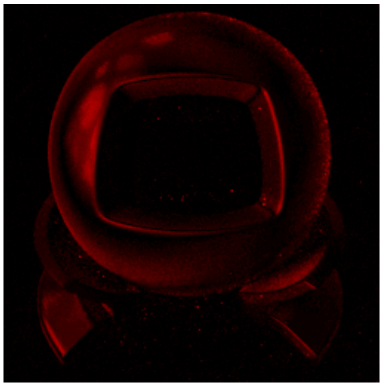
SGD



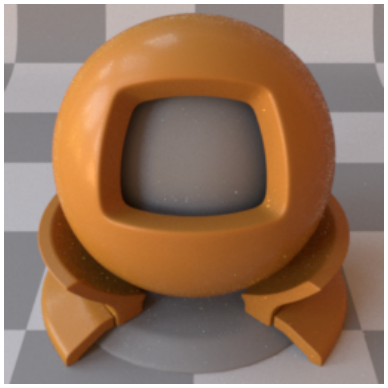
Reference



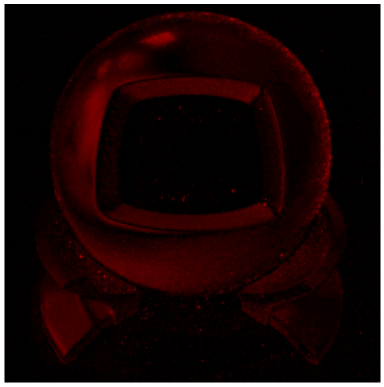
Ours: Tabulated



Ours: Gaussian

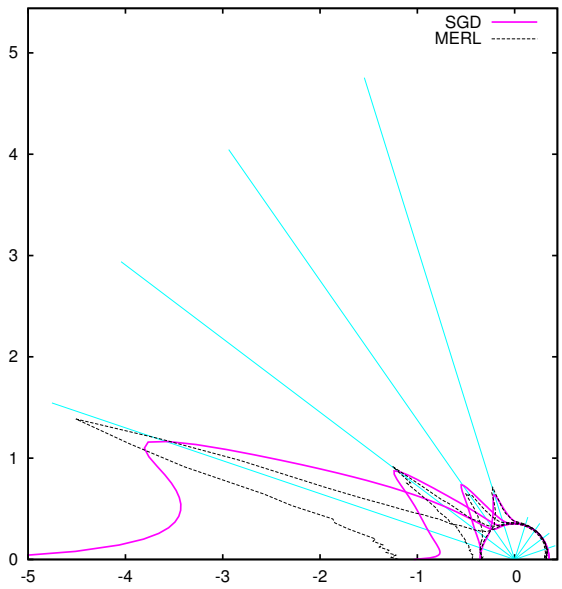


Reference

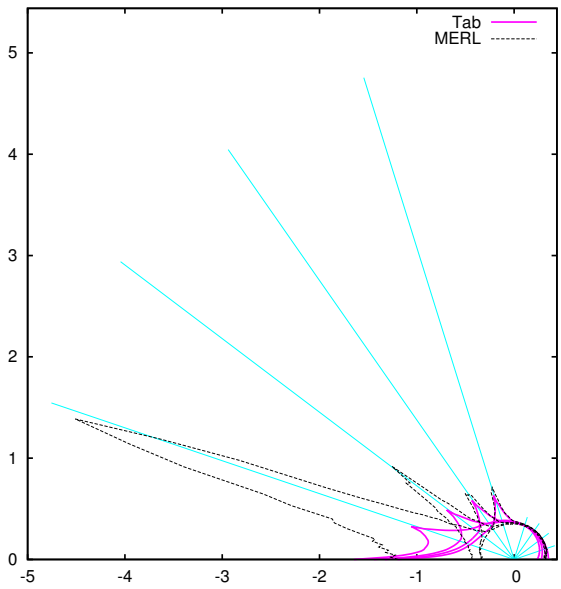


Ours: GGX

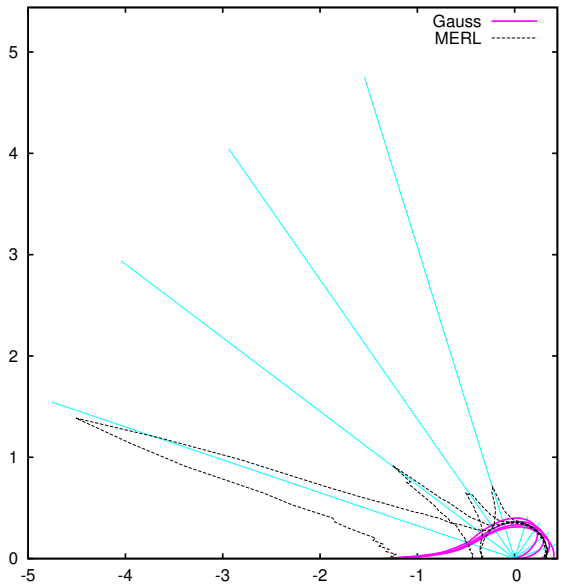
BRDF Lobes in the Incidence Plane (Cubic Root Applied)



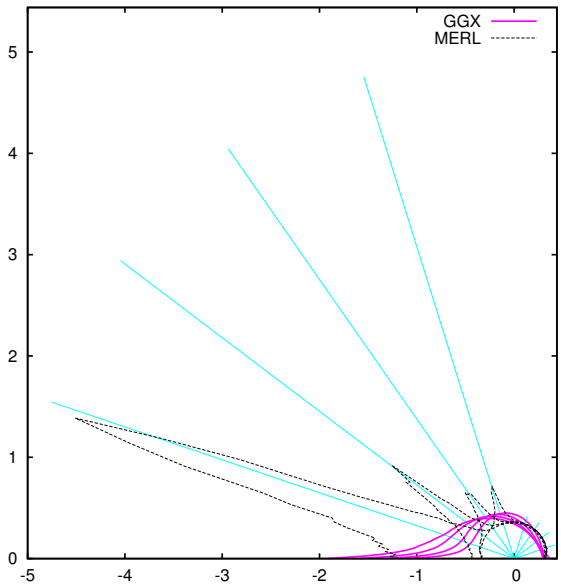
SGD



Ours: Tabulated

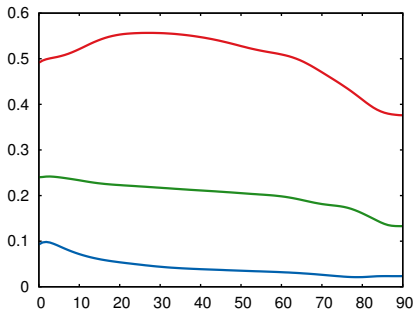


Ours: Gaussian

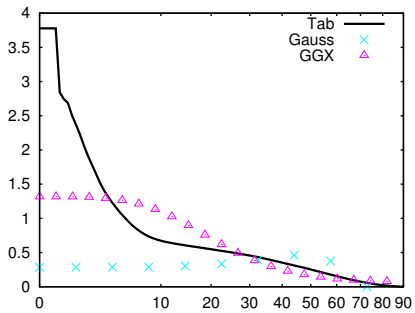


Ours: GGX

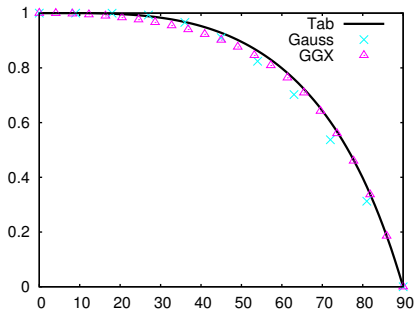
Fitted Microfacet Functions



Fresnel (R, G, B)



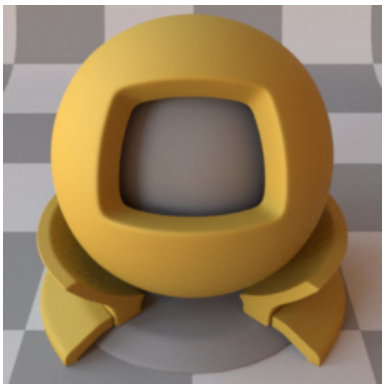
NDF (D)



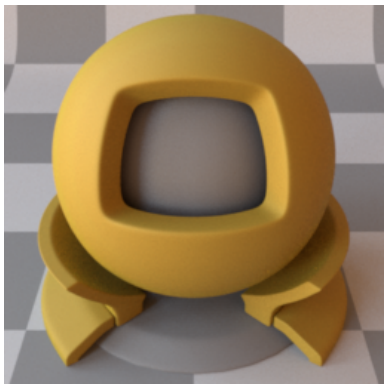
Smith (G_1)

98 yellow-paint

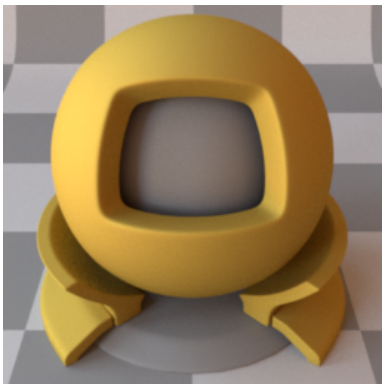
Renderings



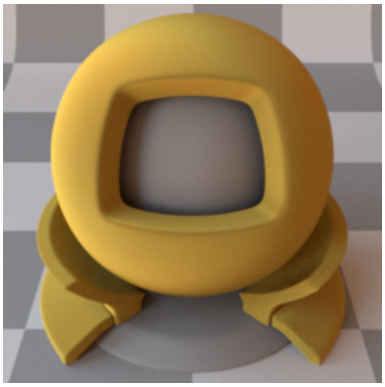
SGD



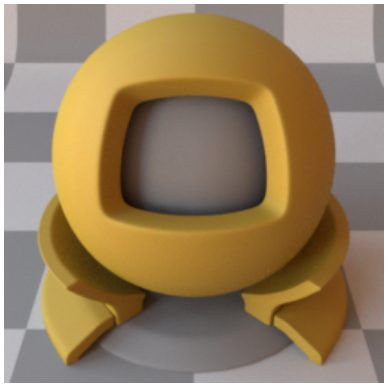
Reference



Ours: Tabulated



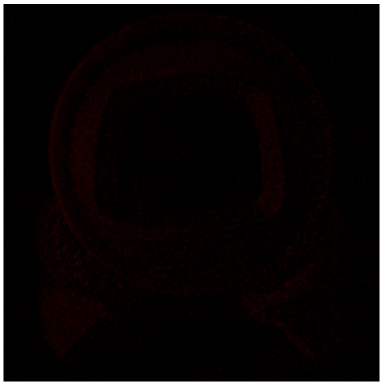
Ours: Gaussian



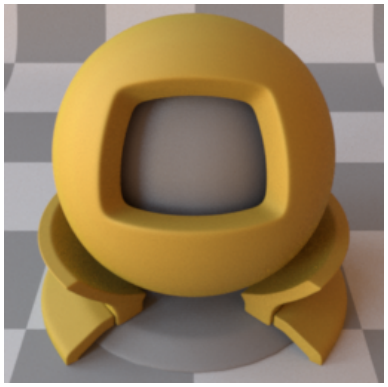
Reference

Ours: GGX

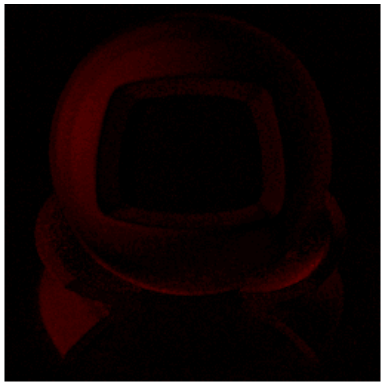
CIE dE00



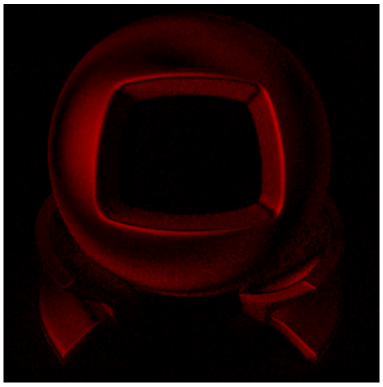
SGD



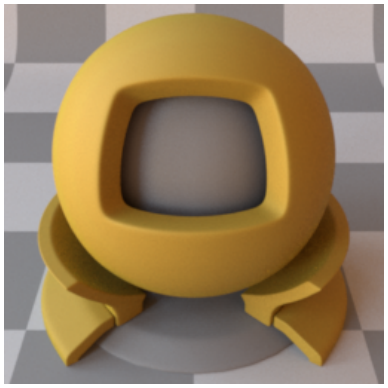
Reference



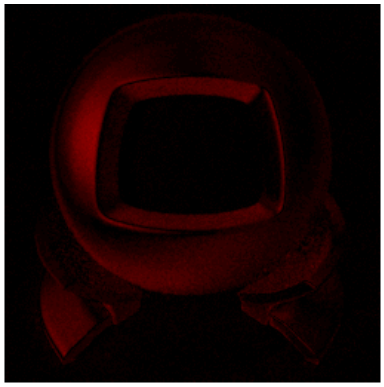
Ours: Tabulated



Ours: Gaussian

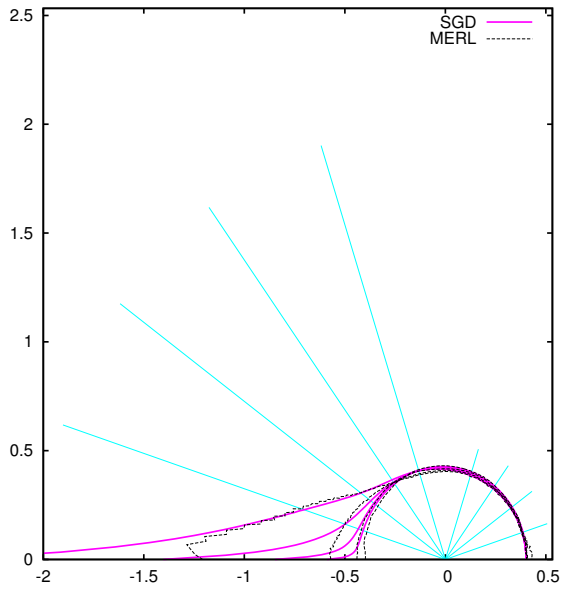


Reference

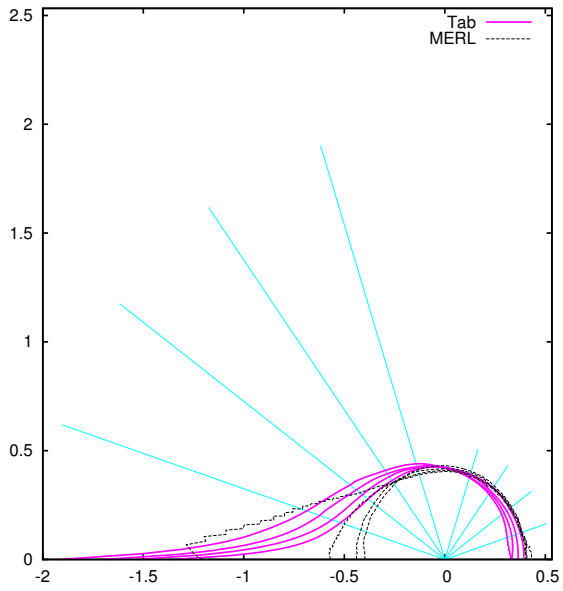


Ours: GGX

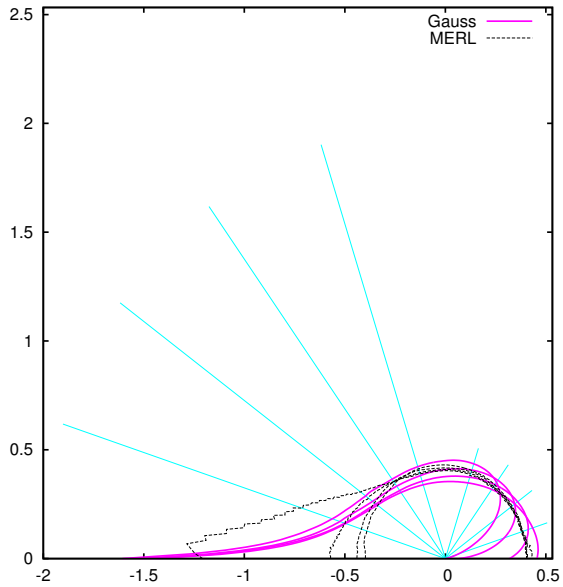
BRDF Lobes in the Incidence Plane (Cubic Root Applied)



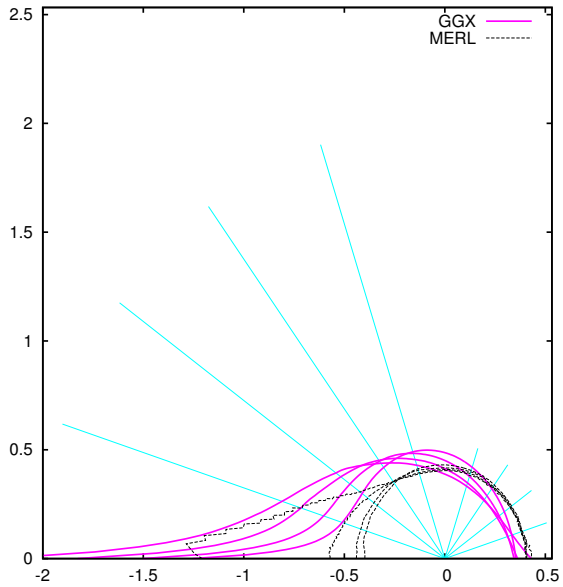
SGD



Ours: Tabulated

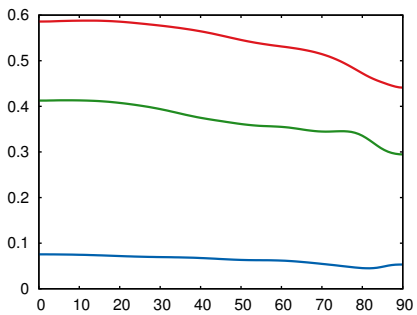


Ours: Gaussian

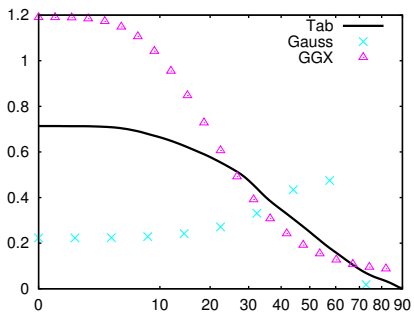


Ours: GGX

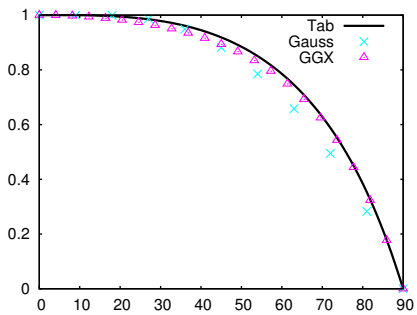
Fitted Microfacet Functions



Fresnel (R, G, B)



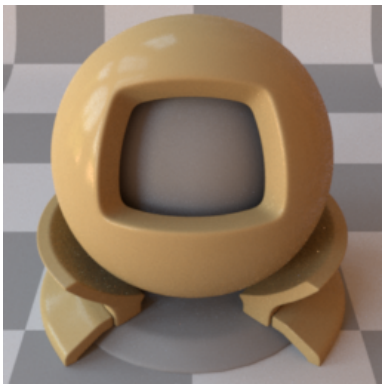
NDF (D)



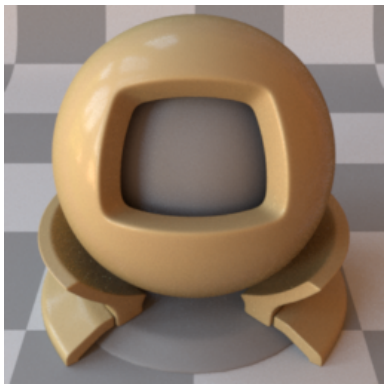
Smith (G_1)

99 yellow-phenolic

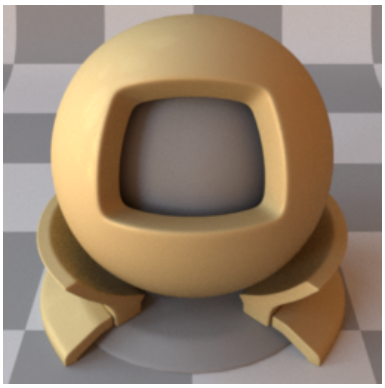
Renderings



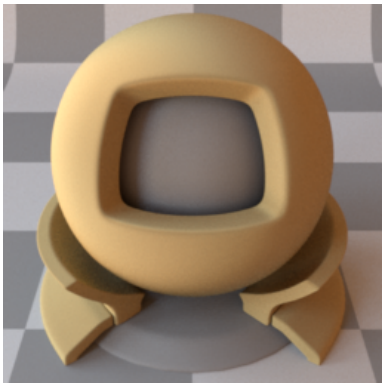
SGD



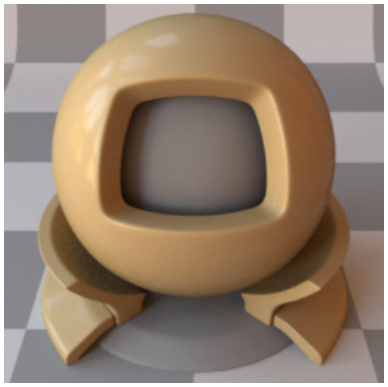
Reference



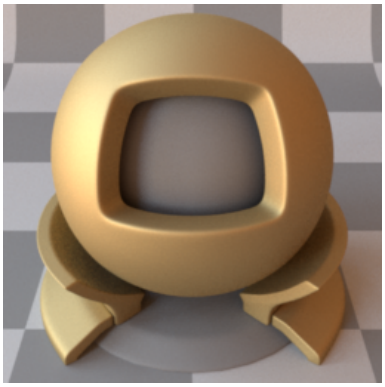
Ours: Tabulated



Ours: Gaussian

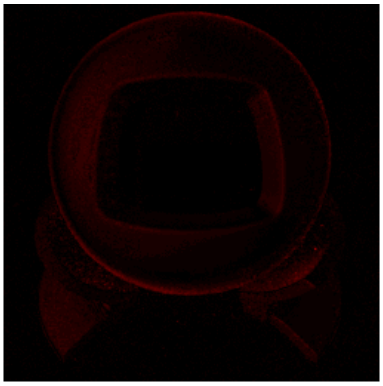


Reference

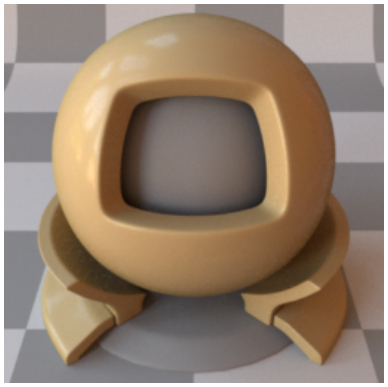


Ours: GGX

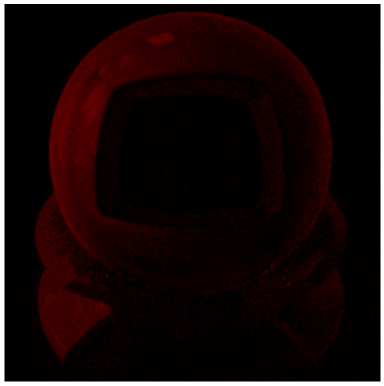
CIE dE00



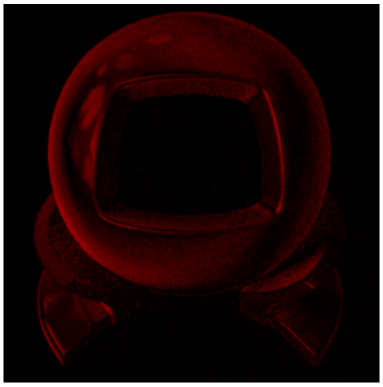
SGD



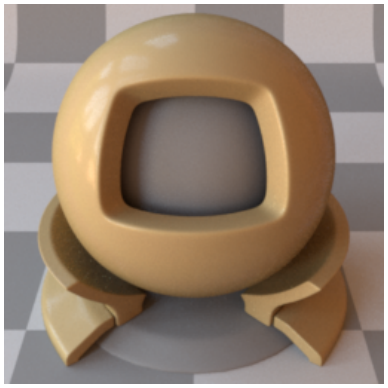
Reference



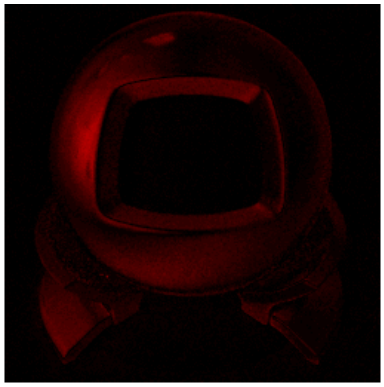
Ours: Tabulated



Ours: Gaussian

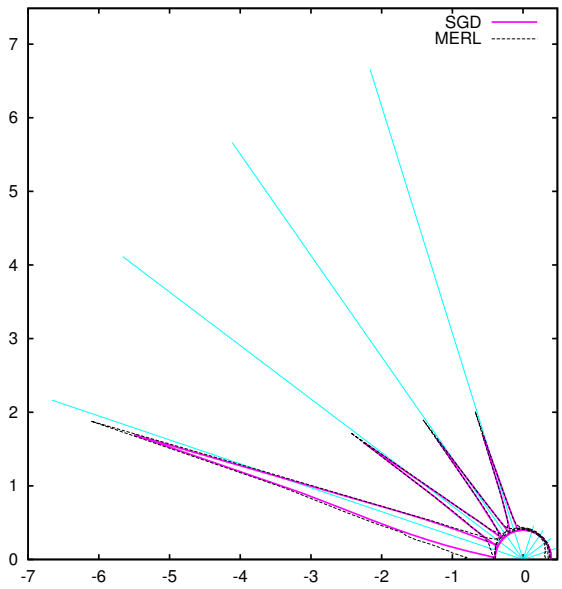


Reference

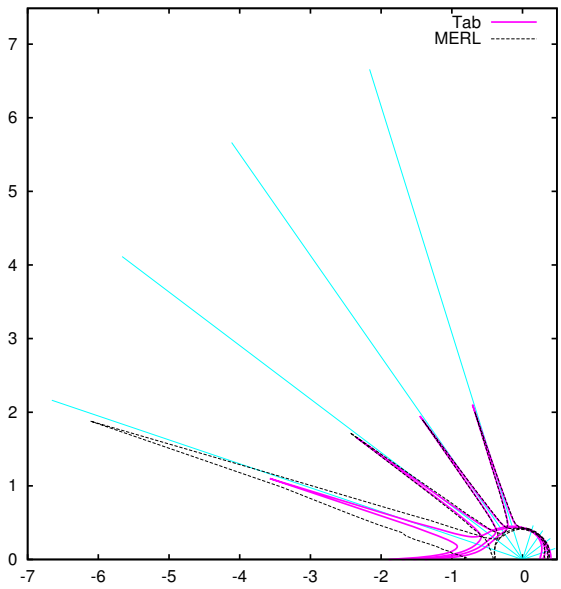


Ours: GGX

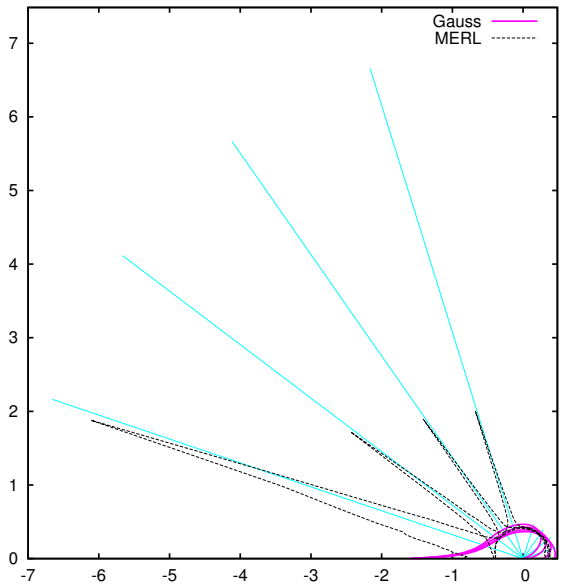
BRDF Lobes in the Incidence Plane (Cubic Root Applied)



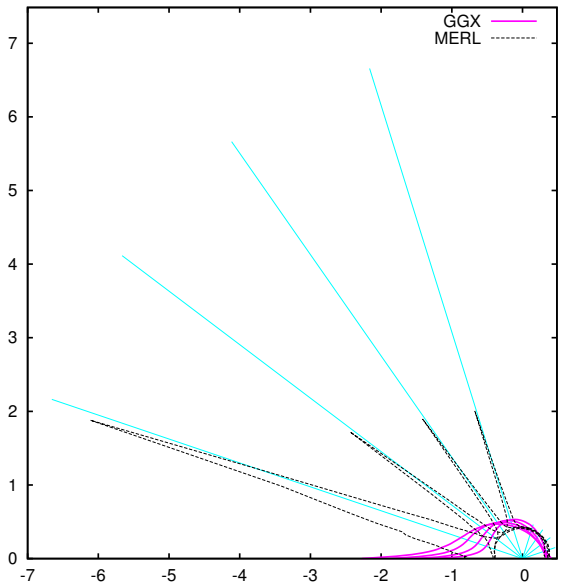
SGD



Ours: Tabulated

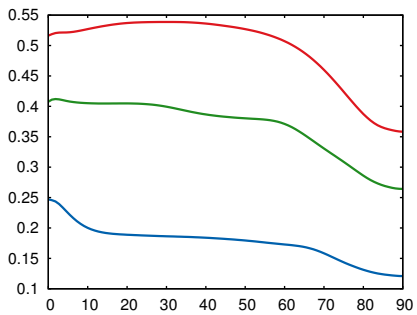


Ours: Gaussian

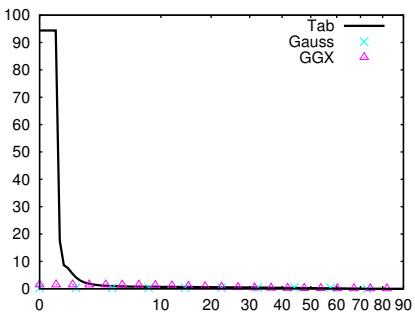


Ours: GGX

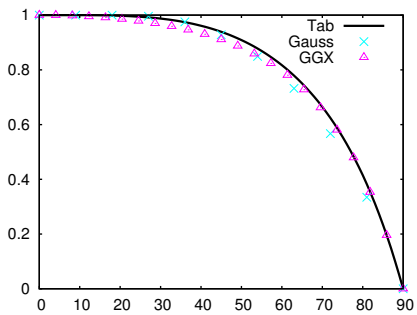
Fitted Microfacet Functions



Fresnel (R, G, B)



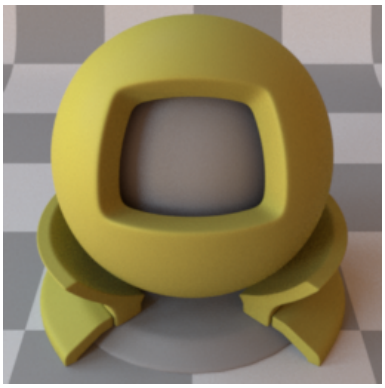
NDF (D)



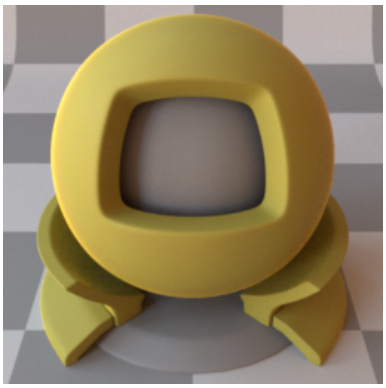
Smith (G_1)

100 yellow-plastic

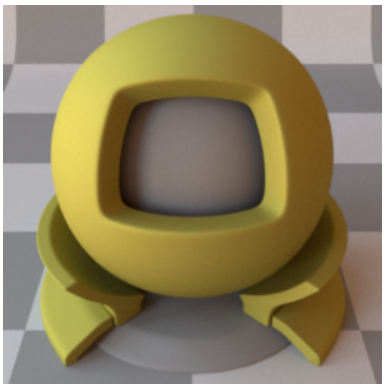
Renderings



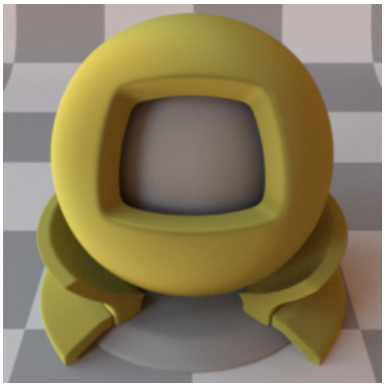
SGD



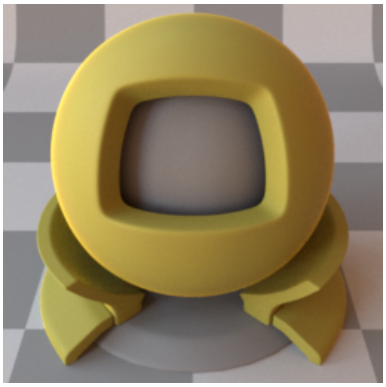
Reference



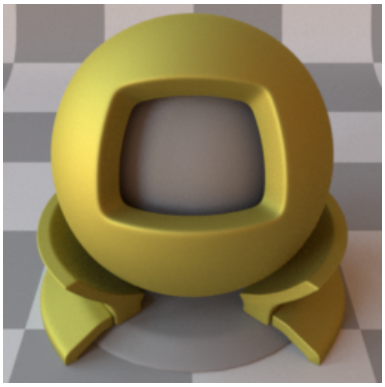
Ours: Tabulated



Ours: Gaussian

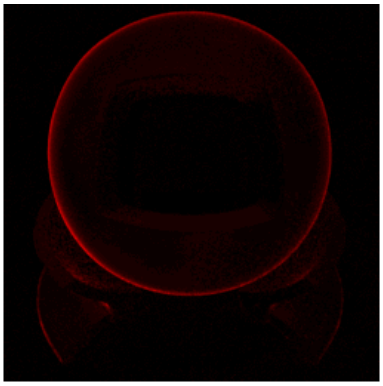


Reference

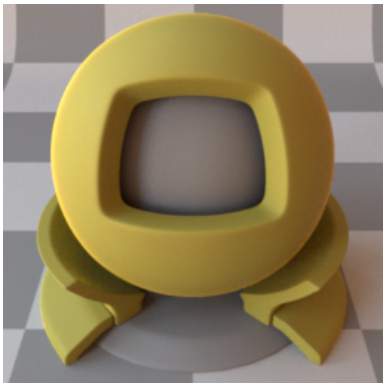


Ours: GGX

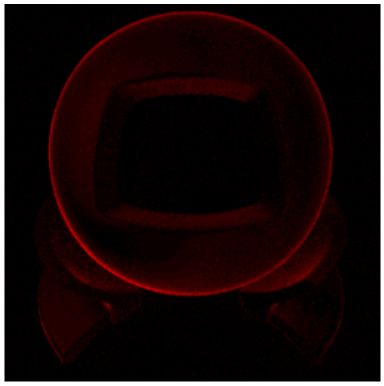
CIE dE00



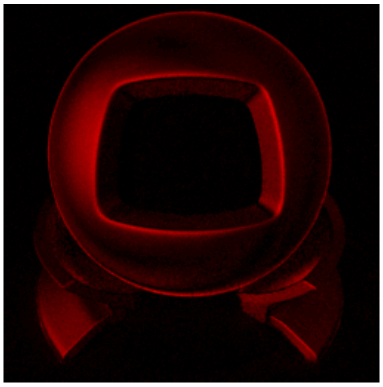
SGD



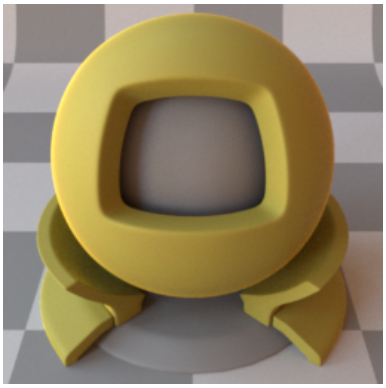
Reference



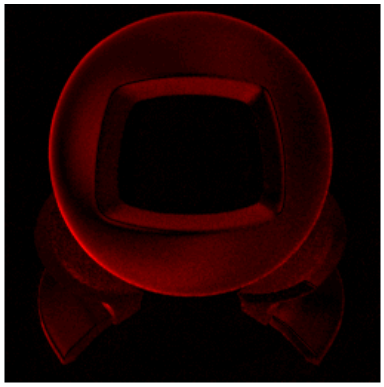
Ours: Tabulated



Ours: Gaussian

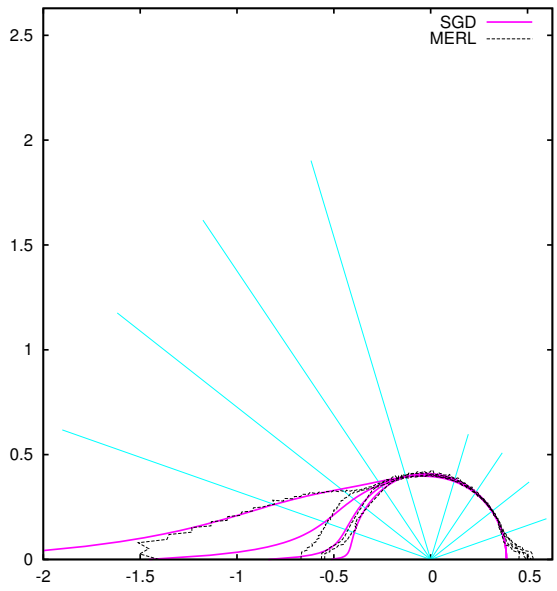


Reference

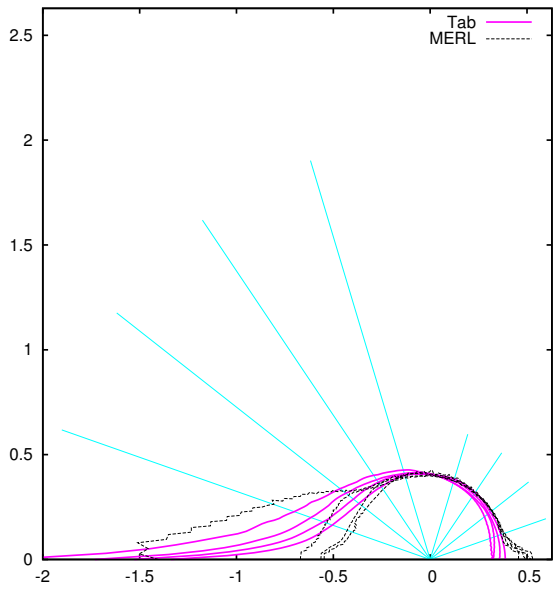


Ours: GGX

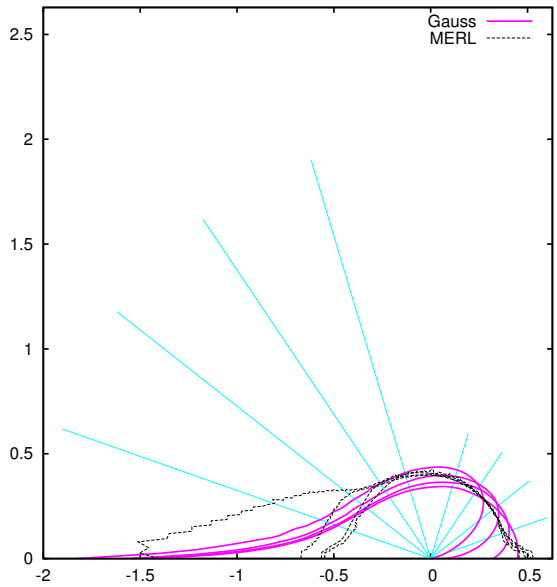
BRDF Lobes in the Incidence Plane (Cubic Root Applied)



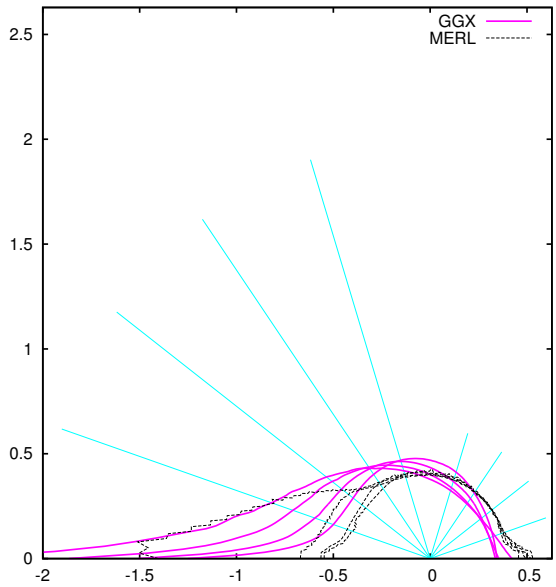
SGD



Ours: Tabulated

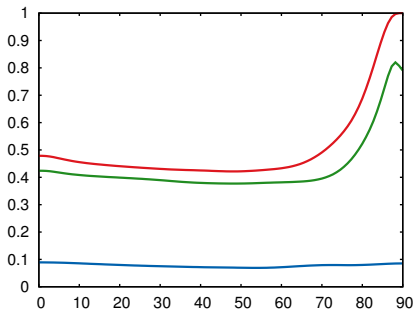


Ours: Gaussian

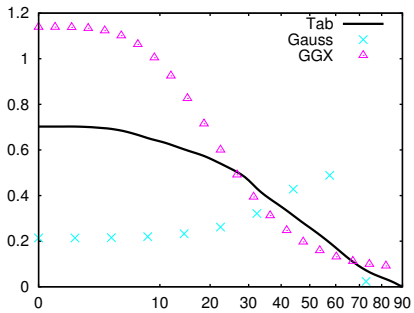


Ours: GGX

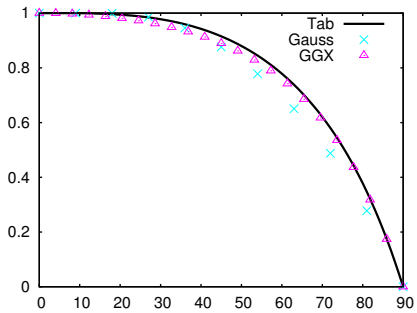
Fitted Microfacet Functions



Fresnel (R, G, B)



NDF (D)



Smith (G_1)