



不同复杂度皮肤渲染方案对比

Unity中国 技术美术

梦魇

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用URP还原HDRP效果



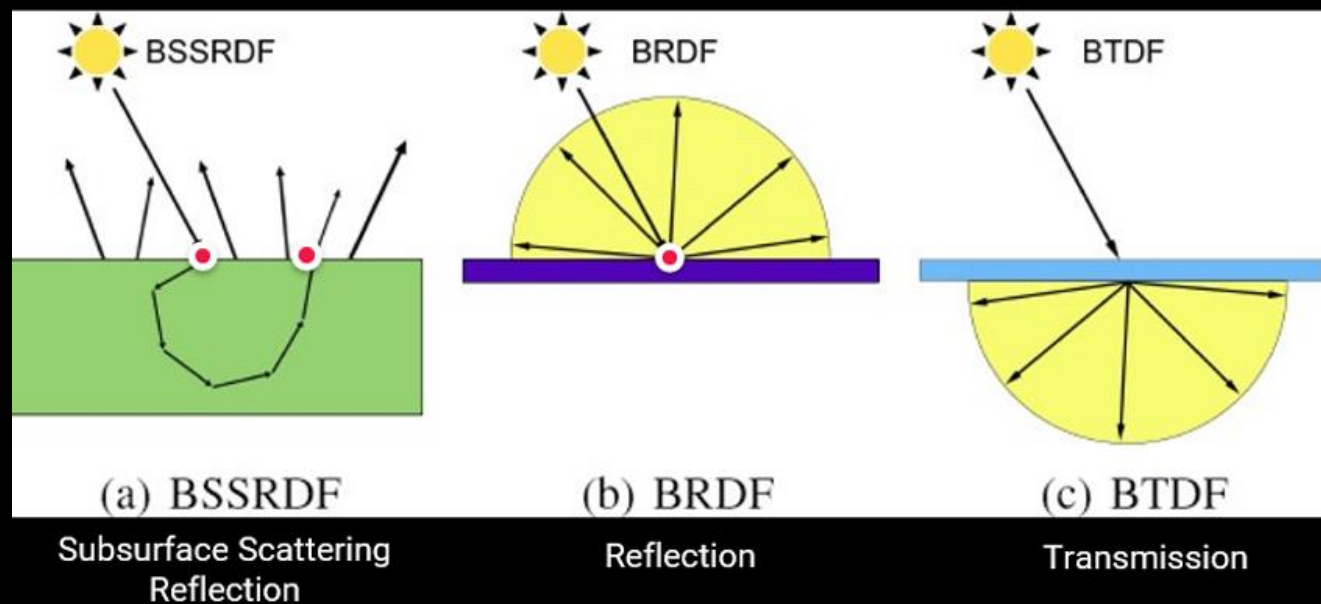




1. BSDF

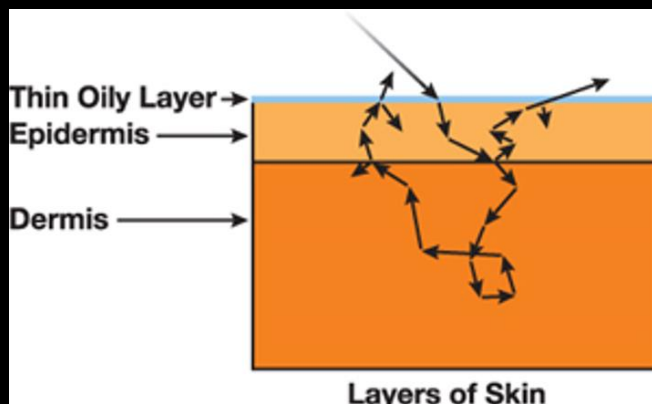
如何从图形学角度分析着色？

Bidirectional Scattering Distribution Function, BSDF



2. 皮肤的BSDF

皮肤的BSDF是如何构成的？如何实现？



Diffuse&Specular

3. 高光项

4. 漫反射项

4.1 BSSRDF

4.1.1 Texture Space Diffusion

4.1.2 Screen Space Diffusion

4.1.3 Pre-Integrated

4.1.4 Light Wrapping

4.2 BTDF

3. 高光项

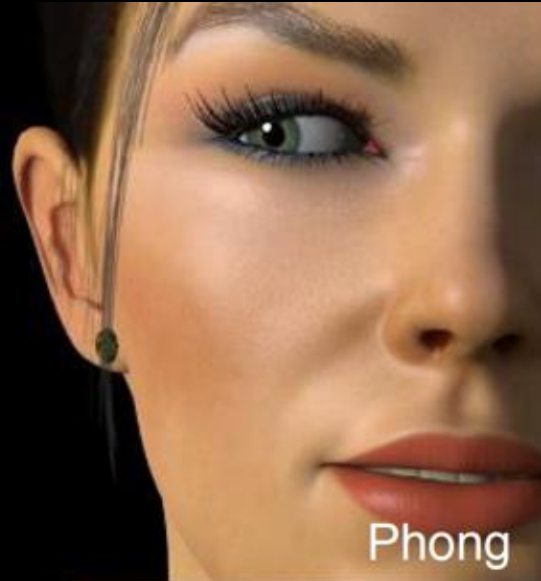
Traditional: Phong/Blinn-Phong model

Skin: Kelemen/Szirmay-Kalos model

Unity:

default - GGX

The Heretic - Dual Specular Lobe





Bloom Spec



Sharp Spec



Combined Spec



Beauty

3. 高光项



Single GGX



Double GGX

3. 高光项



URP Double GGX



HDRP Skin

4. 漫反射项

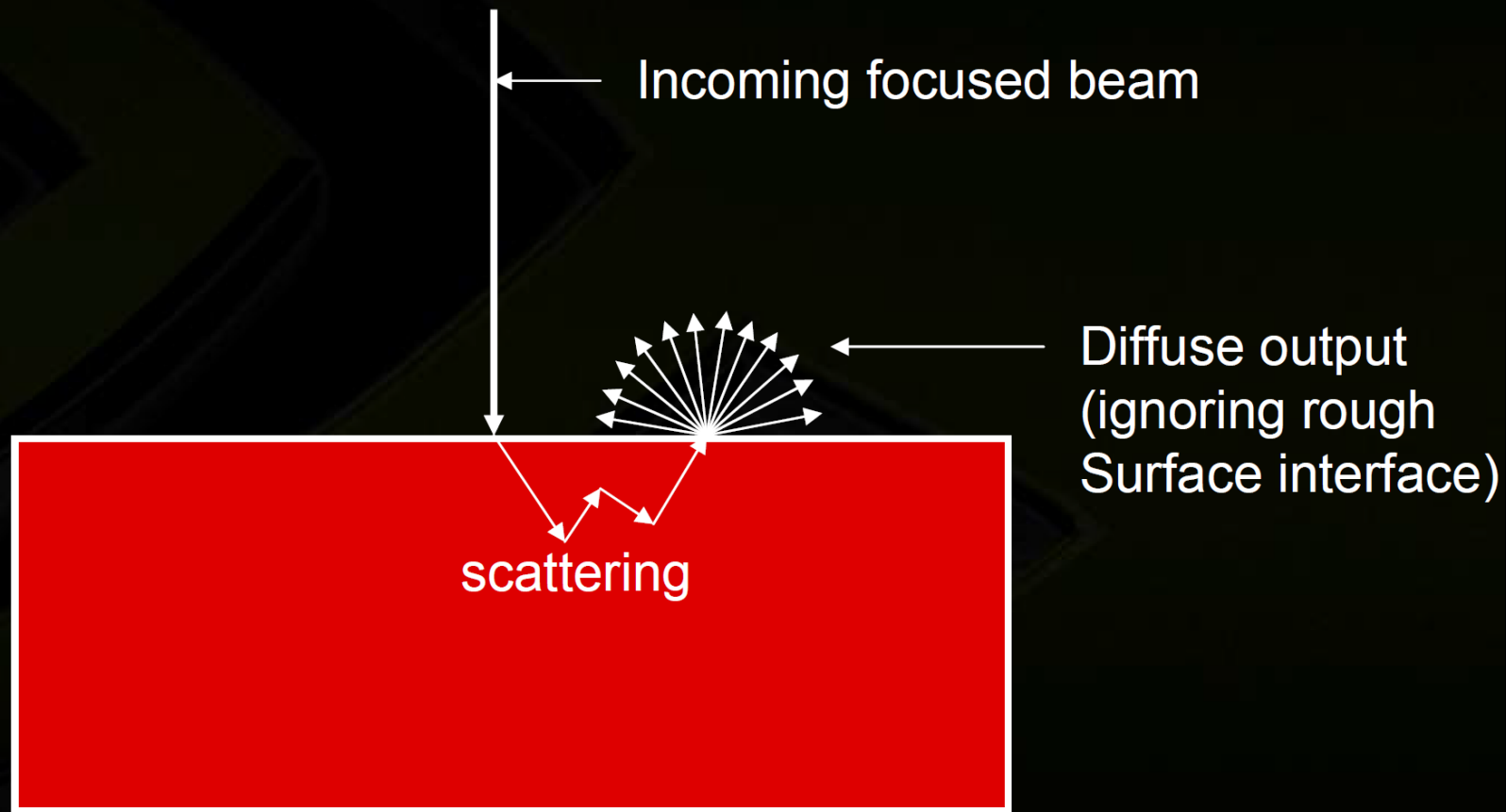


BTDF



BSSRDF

4.1 BSSRDF



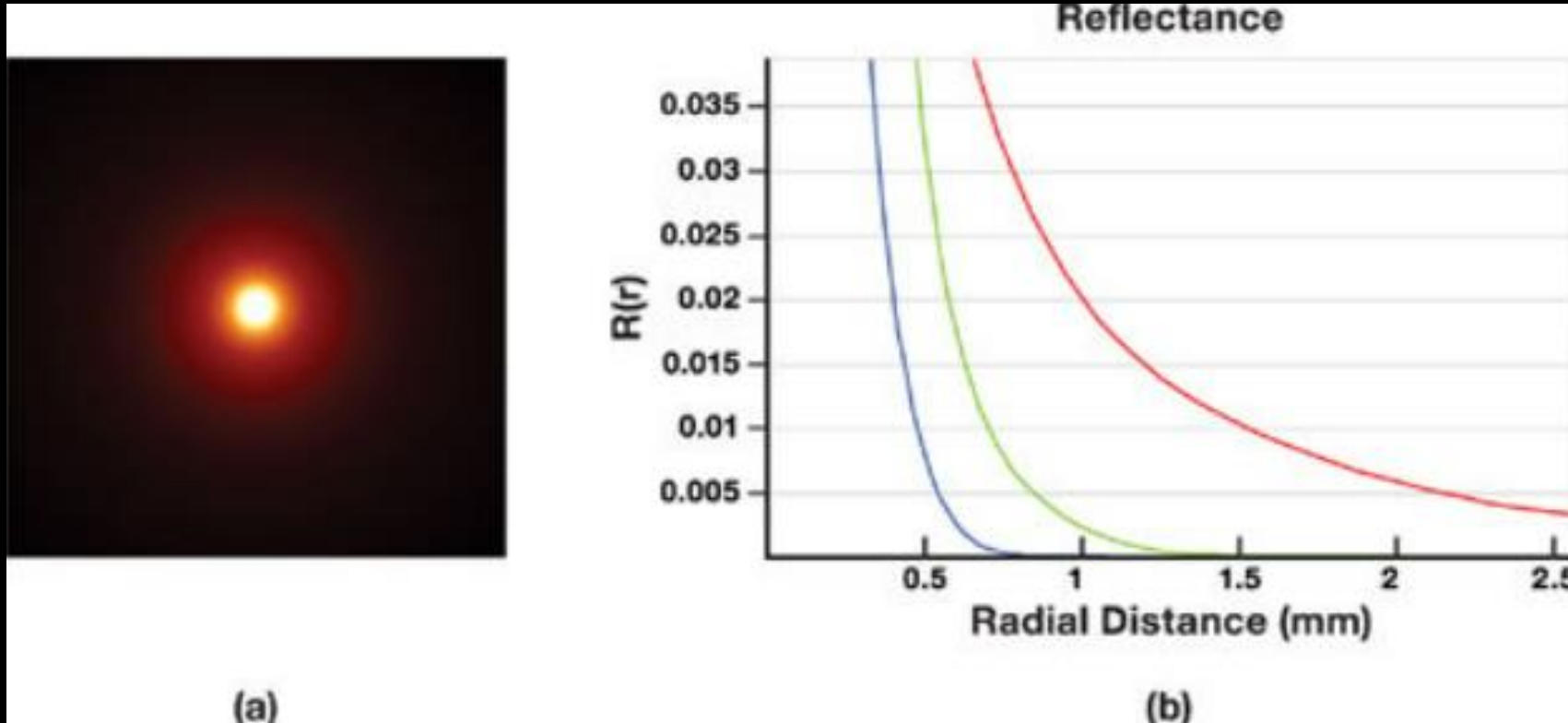
4.1 BSSRDF



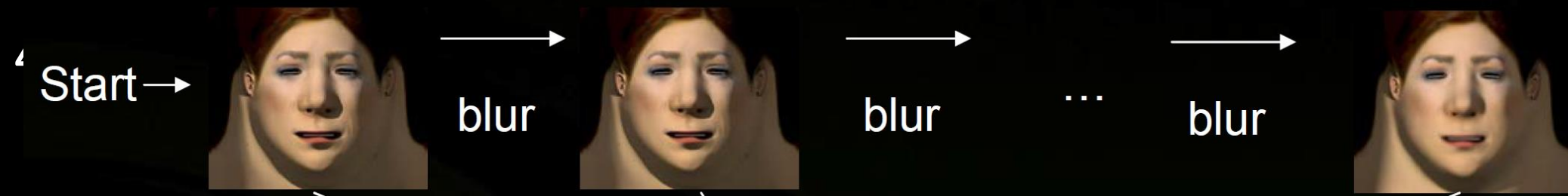
It is a blur!

4.1 BSSRDF

- Diffusion Profile



Render texture
space light



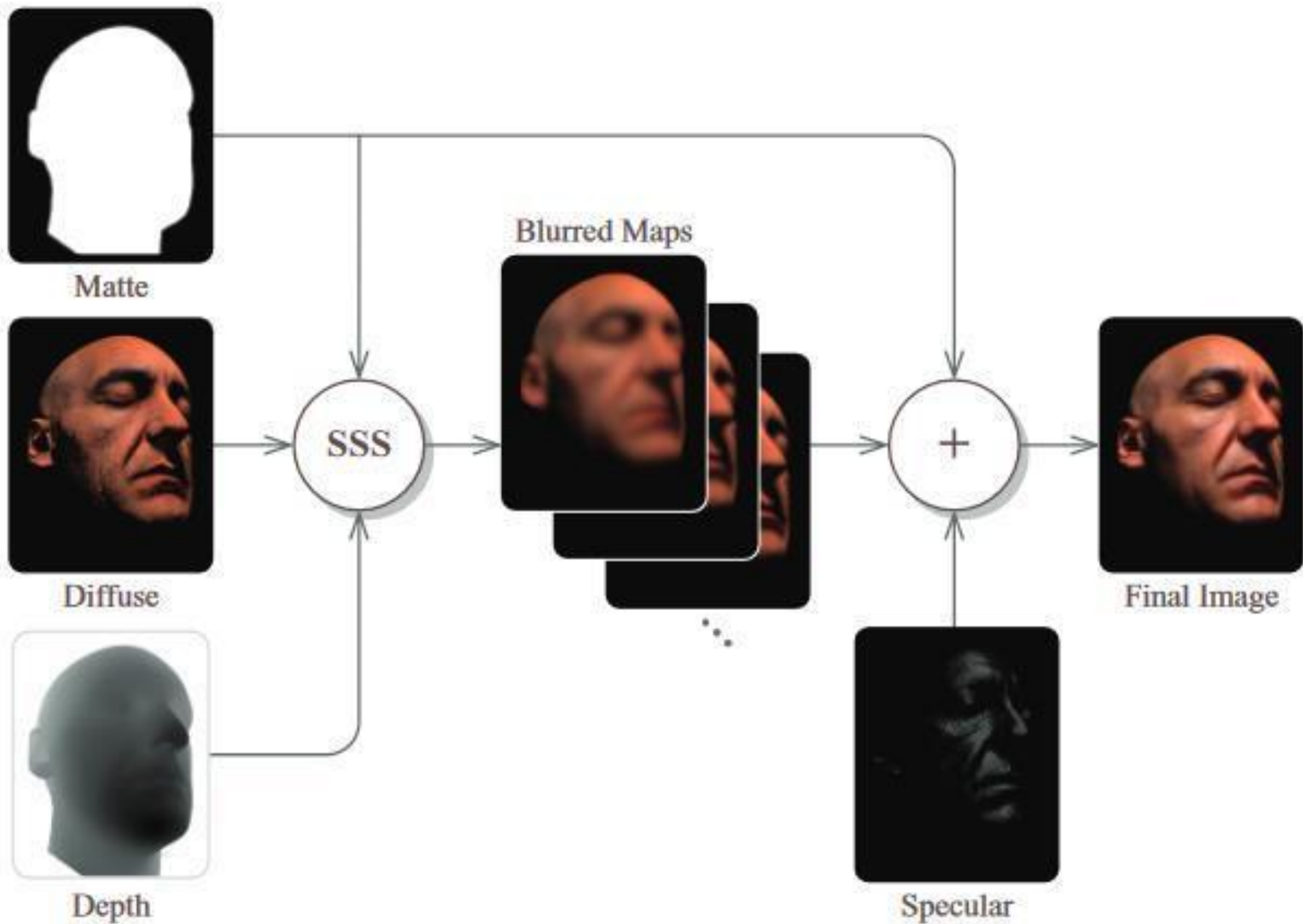
Linear
combination

texture mapping



Final pass: combine blurs + specular

4



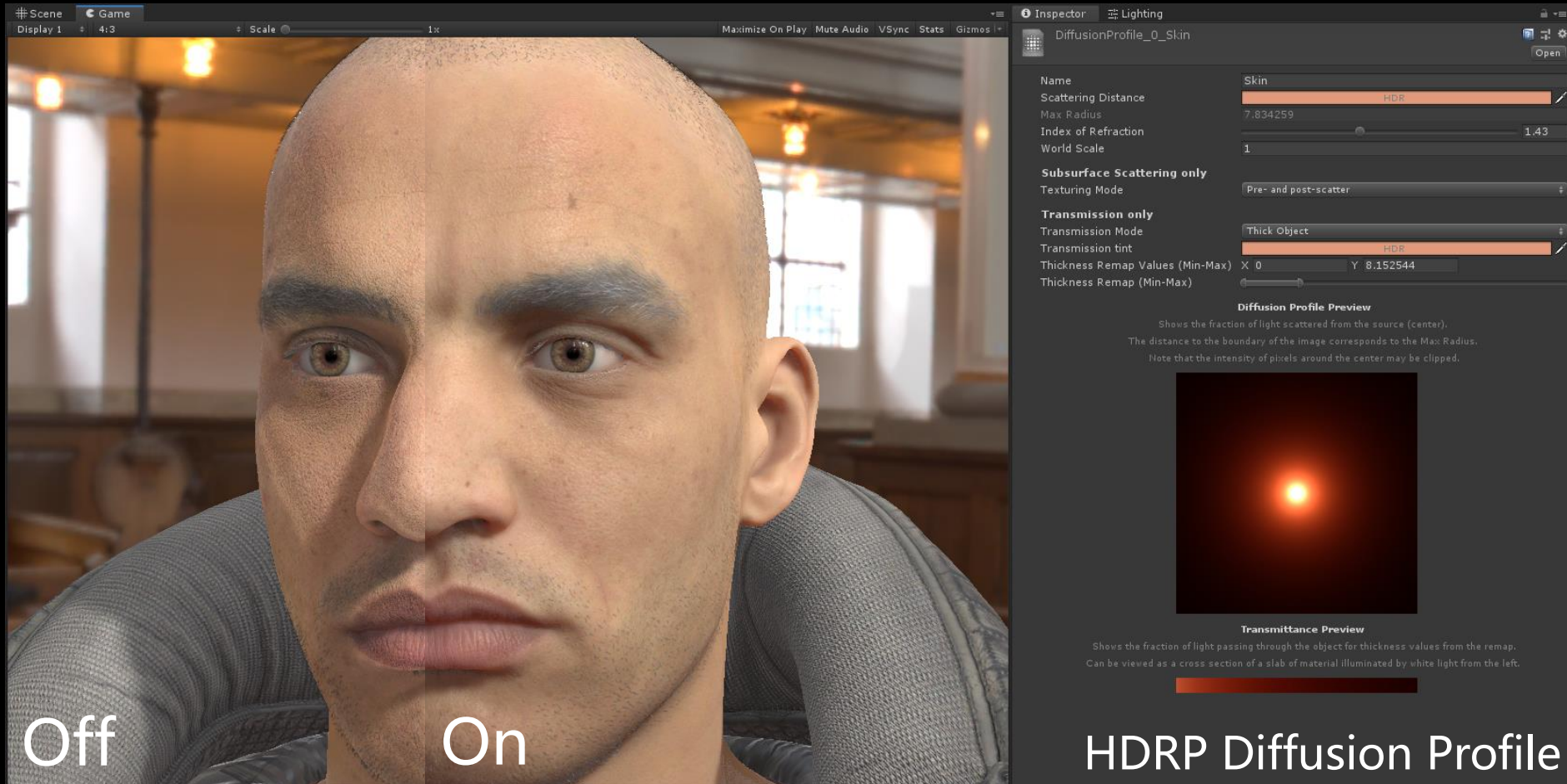
4.1 BSSRDF

Screen Space Diffusion



4.1 BSSRDF

Screen Space Diffusion



The image displays a game engine interface with a character's face split vertically to compare 'Off' and 'On' states of Screen Space Diffusion. The 'On' side shows more realistic skin shading. To the right is the Inspector panel for 'DiffusionProfile_0_Skin' with various settings and preview windows.

Inspector Panel Settings:

- Name: Skin
- Scattering Distance: HDR
- Max Radius: 7.834259
- Index of Refraction: 1.43
- World Scale: 1
- Subsurface Scattering only: Texturing Mode: Pre- and post-scatter
- Transmission only: Transmission Mode: Thick Object
- Transmission tint: HDR
- Thickness Remap Values (Min-Max): X 0, Y 8.152544
- Thickness Remap (Min-Max):

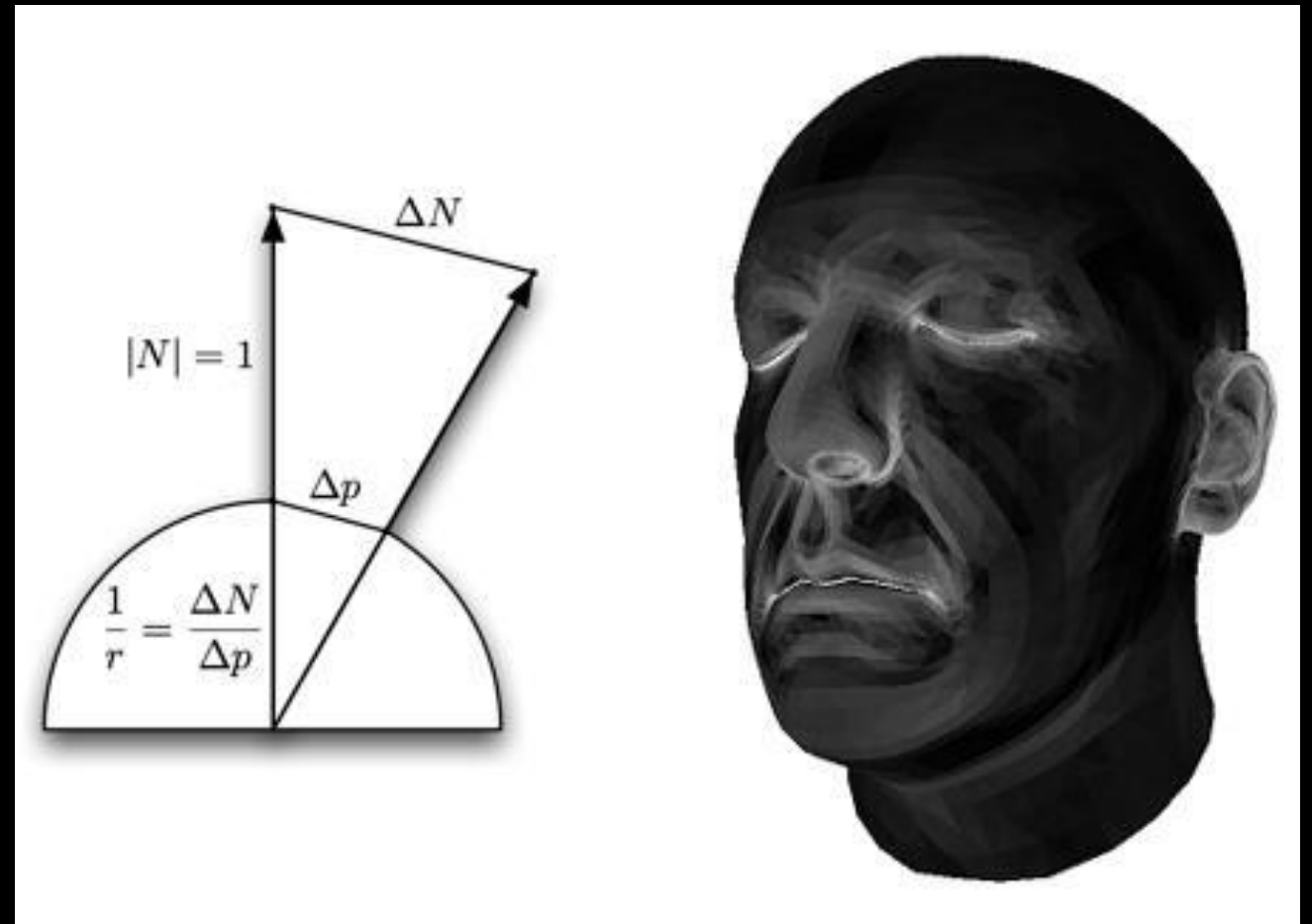
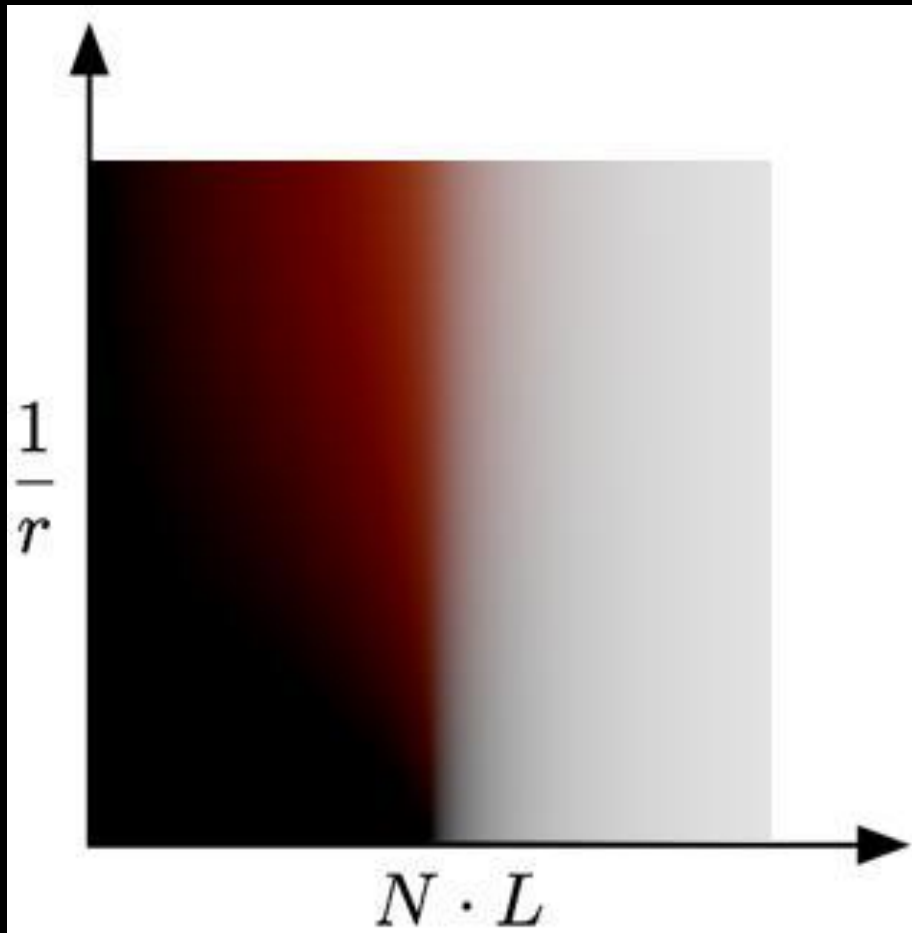
Diffusion Profile Preview:
Shows the fraction of light scattered from the source (center). The distance to the boundary of the image corresponds to the Max Radius. Note that the intensity of pixels around the center may be clipped.

Transmittance Preview:
Shows the fraction of light passing through the object for thickness values from the remap. Can be viewed as a cross section of a slab of material illuminated by white light from the left.

HDRP Diffusion Profile

4.1 BSSRDF

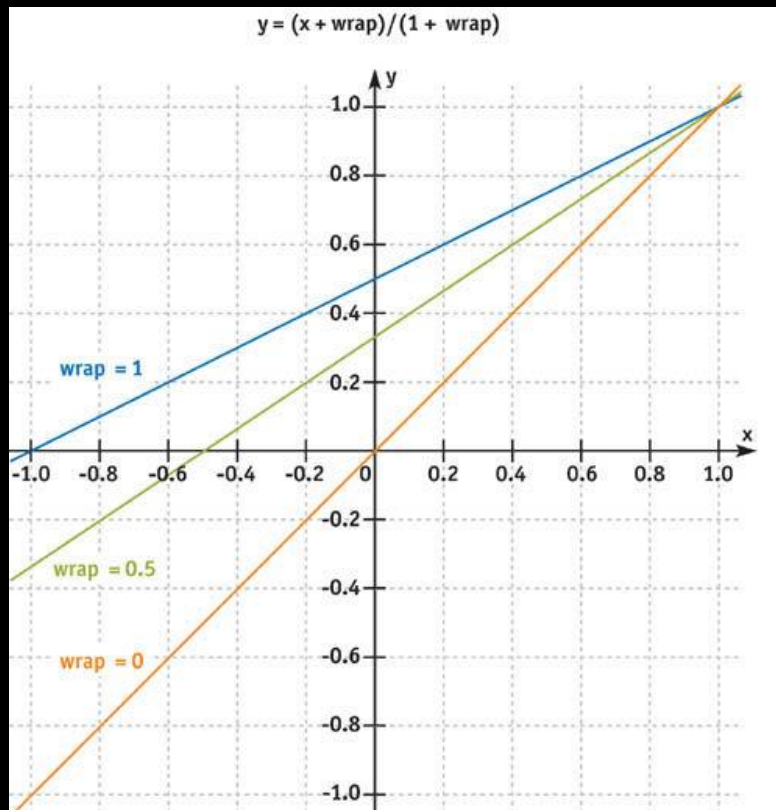
Pre-Integrated



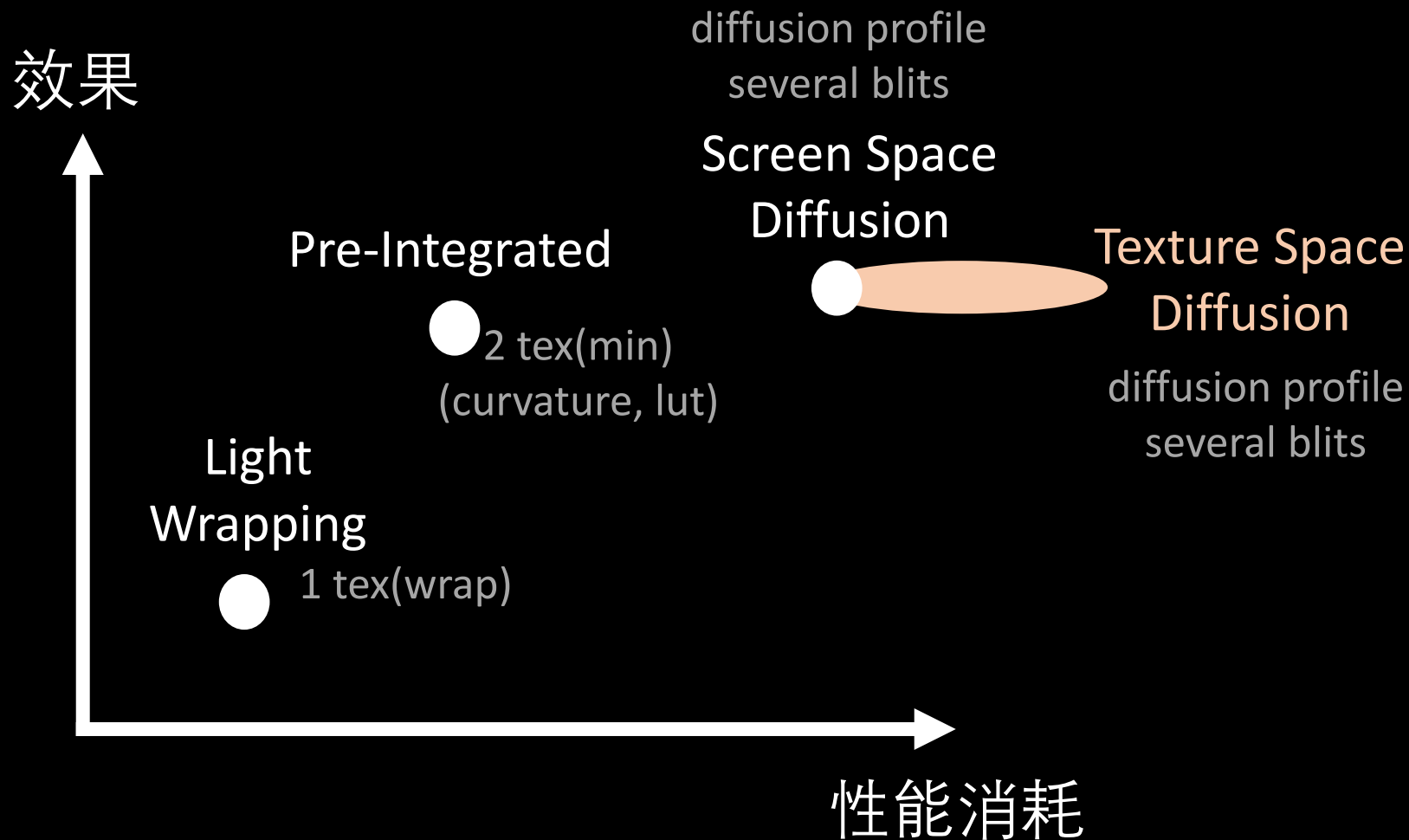
4.1 BSSRDF

Light Wrapping

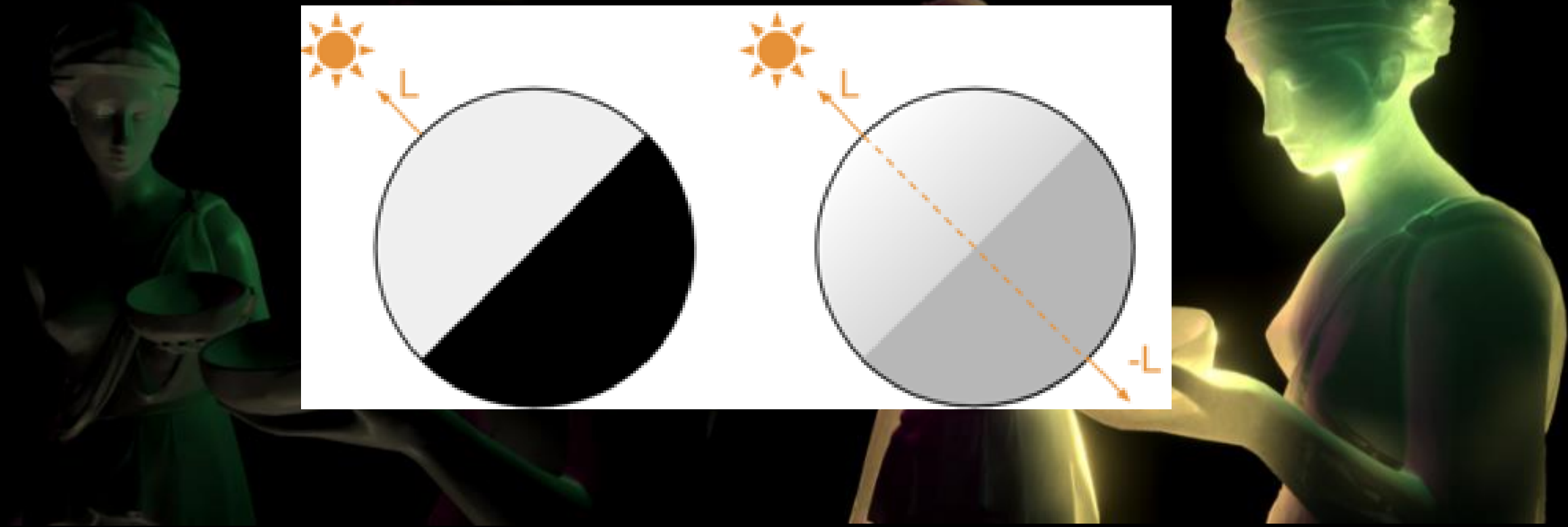
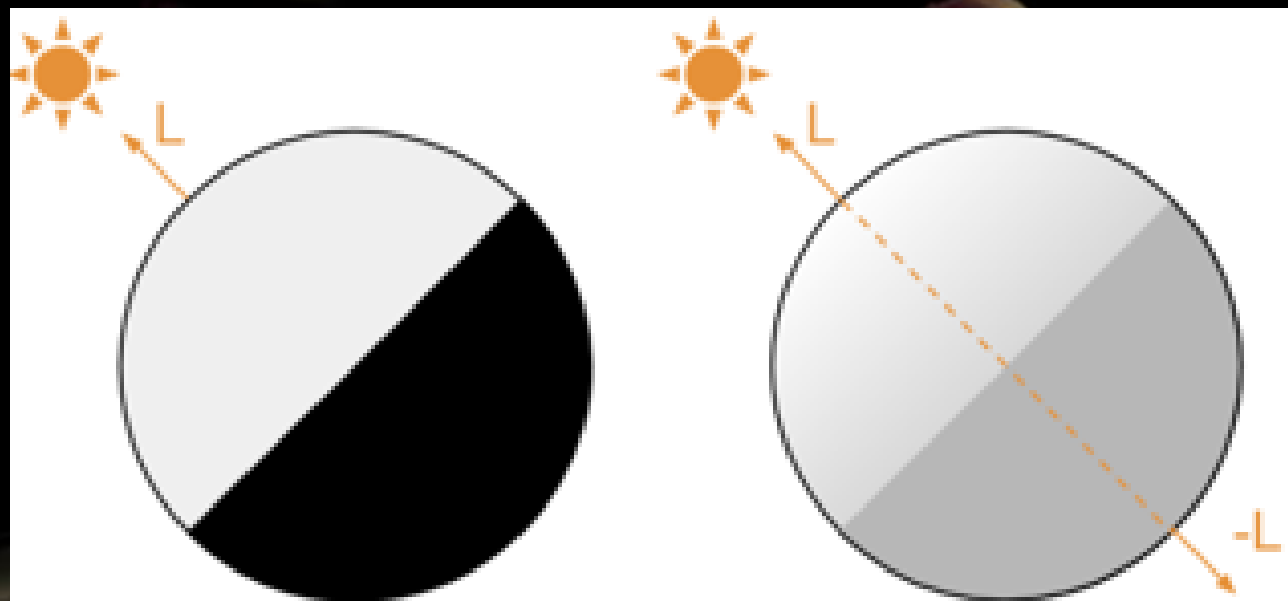
```
float diffuse = max(0, dot(L, N));  
float wrap_diffuse = max(0, (dot(L, N) + _WrapValue)  
/ (1 + _WrapValue));  
  
return wrap_diffuse;
```



4.1 BSSRDF



4.2 BTDF



5. Demo

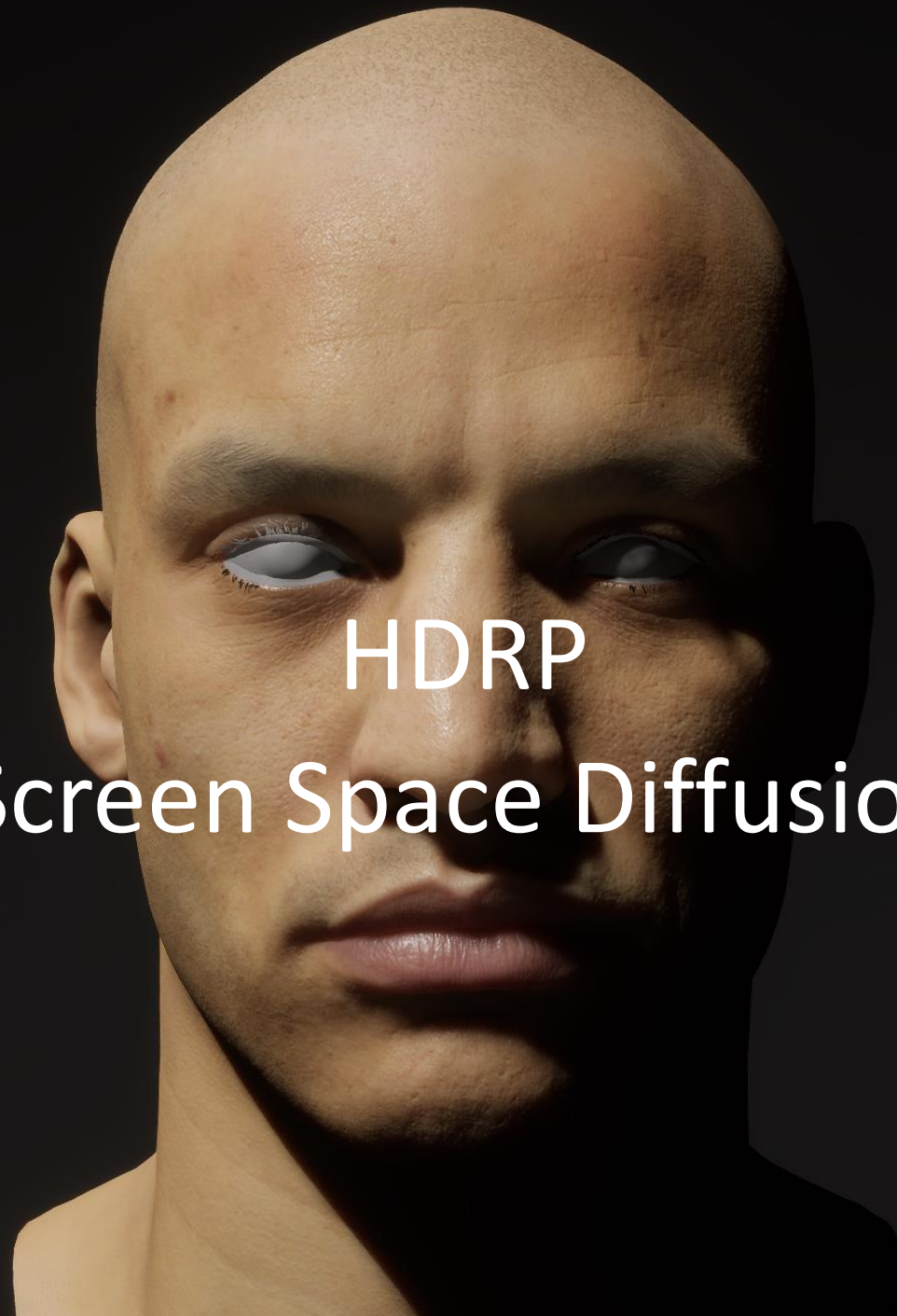
URP

Pre-Integrated

vs

HDRP

Screen Space Diffusion



5. Demo



URP

Pre-Integrated

vs



URP

Hard Surface(Lit)

5. Demo

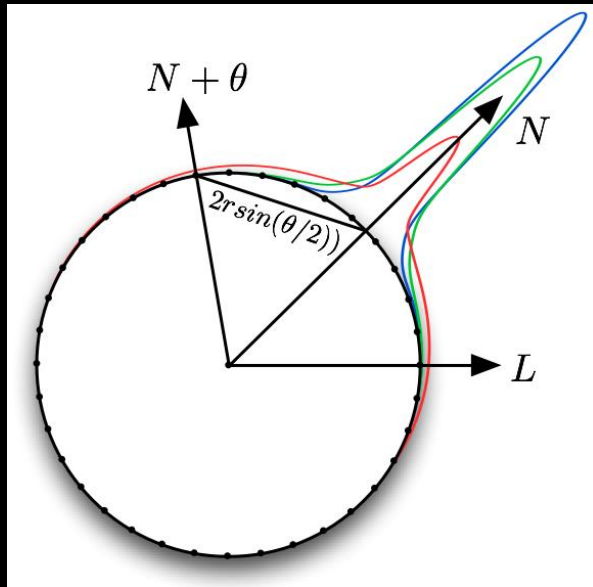
Pre-Integrated Skin Shading, Eric Penner, 2011

- Subsurface Scattering
- Detail Scattering
- Shadow

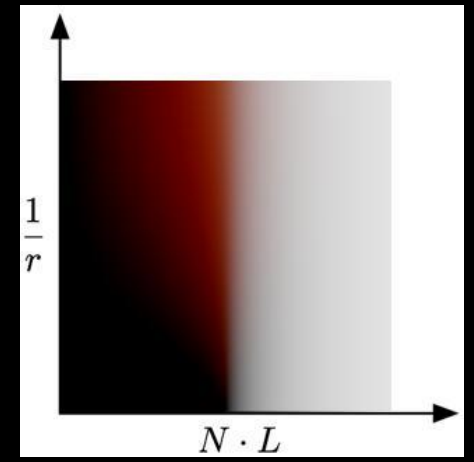
5. Demo

Pre-Integrated Skin Shading, Eric Penner, 2011

- Subsurface Scattering

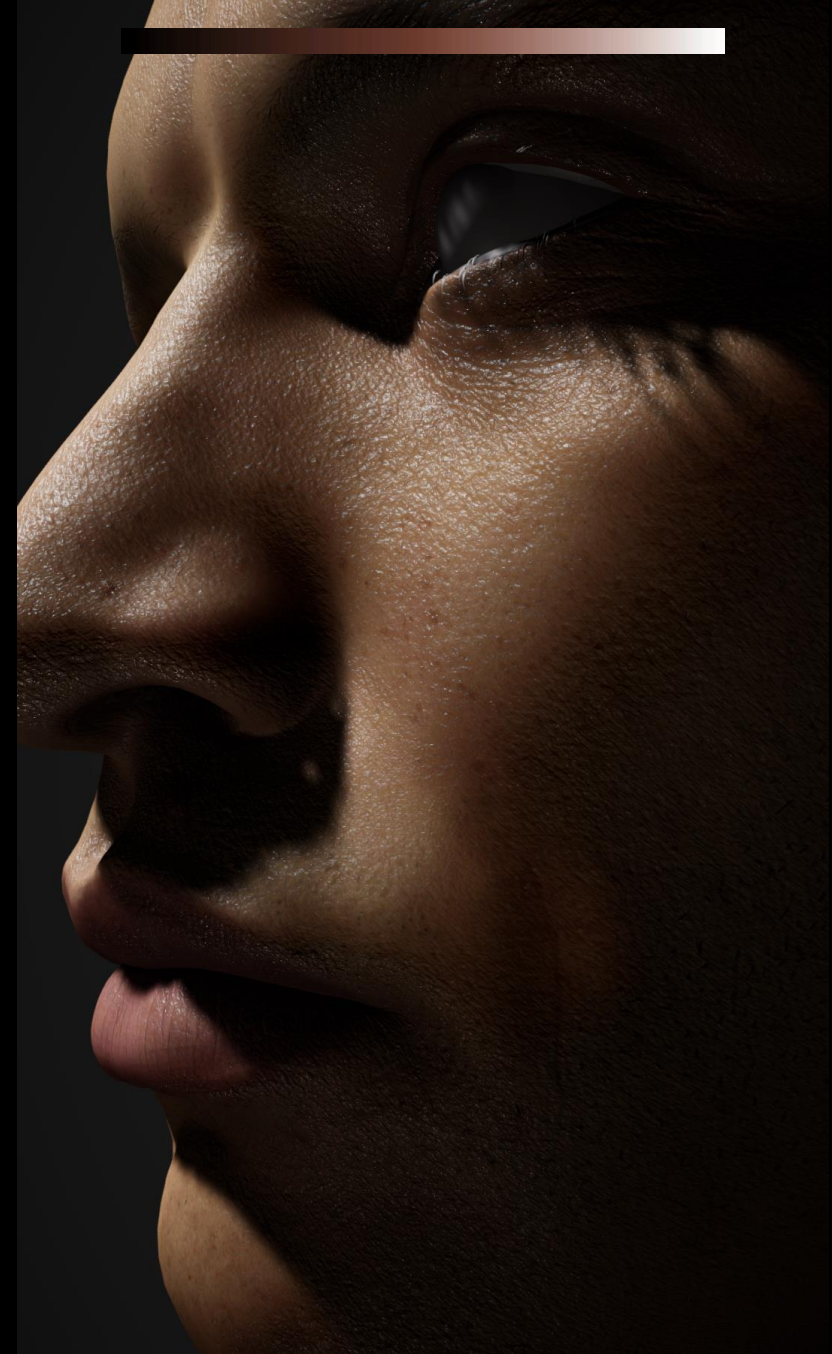


$$D(\theta, r) = \frac{\int_{-\pi}^{\pi} \text{saturnate}(\cos(\theta+x)) \cdot R(2r \sin(x/2)) dx}{\int_{-\pi}^{\pi} R(2r \sin(x/2)) dx}$$

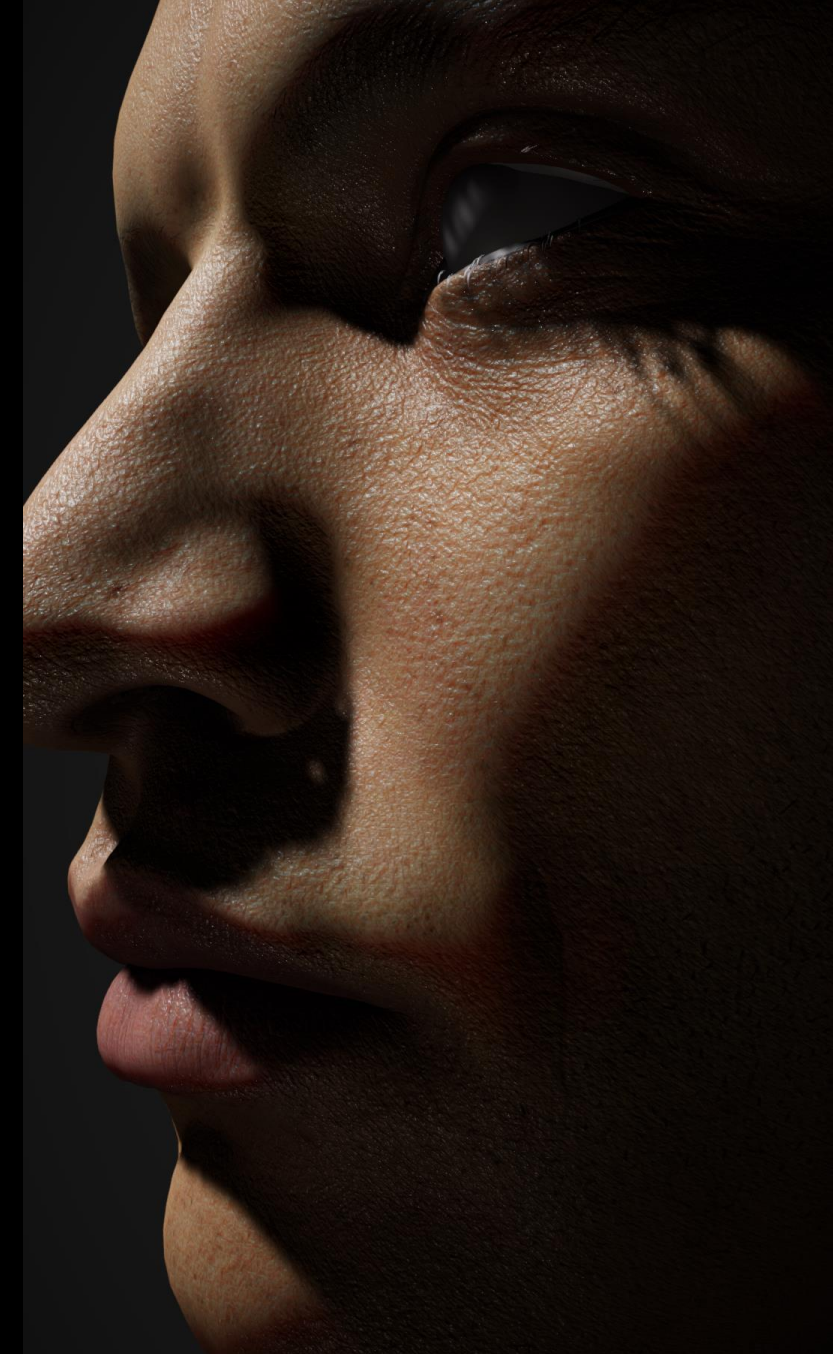




Hard Surface



Light Wrapping



Pre-Integrated



Hard Surface



Light Wrapping



Pre-Integrated





Hard Surface



Light Wrapping



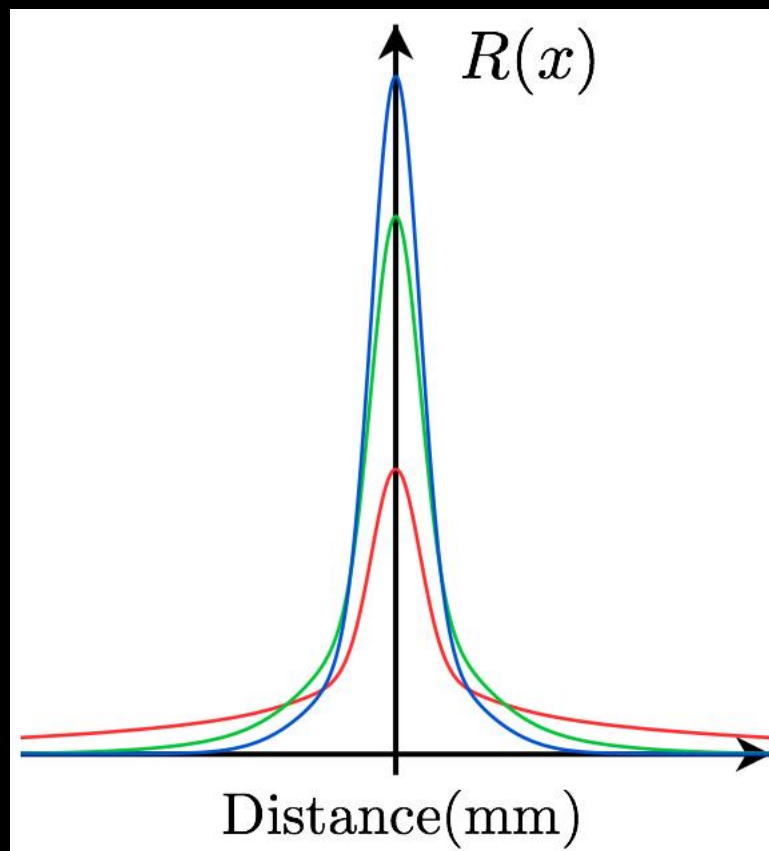
Pre-Integrated



5. Demo

Pre-Integrated Skin Shading, Eric Penner, 2011

- Detail Scattering



Channel	Normal Map	Rendering
Specular		
Blue		
Green		
Red		

Ma et al. 2007 - Rapid Acquisition of Specular and Diffuse Normal Maps

5. [

Pre-l

• Det

```
//N_high = Normal.SampleLevel(NormalSampler, UV, 0);  
//N_low = Normal.SampleLevel(NormalSampler, UV, BlurLevel);//也可以使用顶点法线
```

```
float rNoL = dot(N_low, L);  
float3 BlurFactor = saturate(1.0f - rNoL);  
BlurFactor *= BlurFactor;
```

```
float3 gN = lerp(N_high, N_low, 0.3f + 0.7f*BlurFactor);  
float3 bN = lerp(N_high, N_low, BlurFactor);
```

```
float3 NoL = float3( rNoL, dot(gN, L), dot(bN, L) );  
float3 lookup = NoL * 0.5f + 0.5f;
```

```
float curv = Curvature;//来自顶点色数据
```

```
float3 diffuse;  
diffuse.r = Texture2DSample( SkinRamp, SkinRampSampler, float2(lookup.r, curv) ).r;  
diffuse.g = Texture2DSample( SkinRamp, SkinRampSampler, float2(lookup.g, curv) ).g;  
diffuse.b = Texture2DSample( SkinRamp, SkinRampSampler, float2(lookup.b, curv) ).b;
```

```
return diffuse;
```

手机端皮肤渲染 (4)



张鹄

我就看看不说话





sha



Hard Surface



sha



Detail Scattering

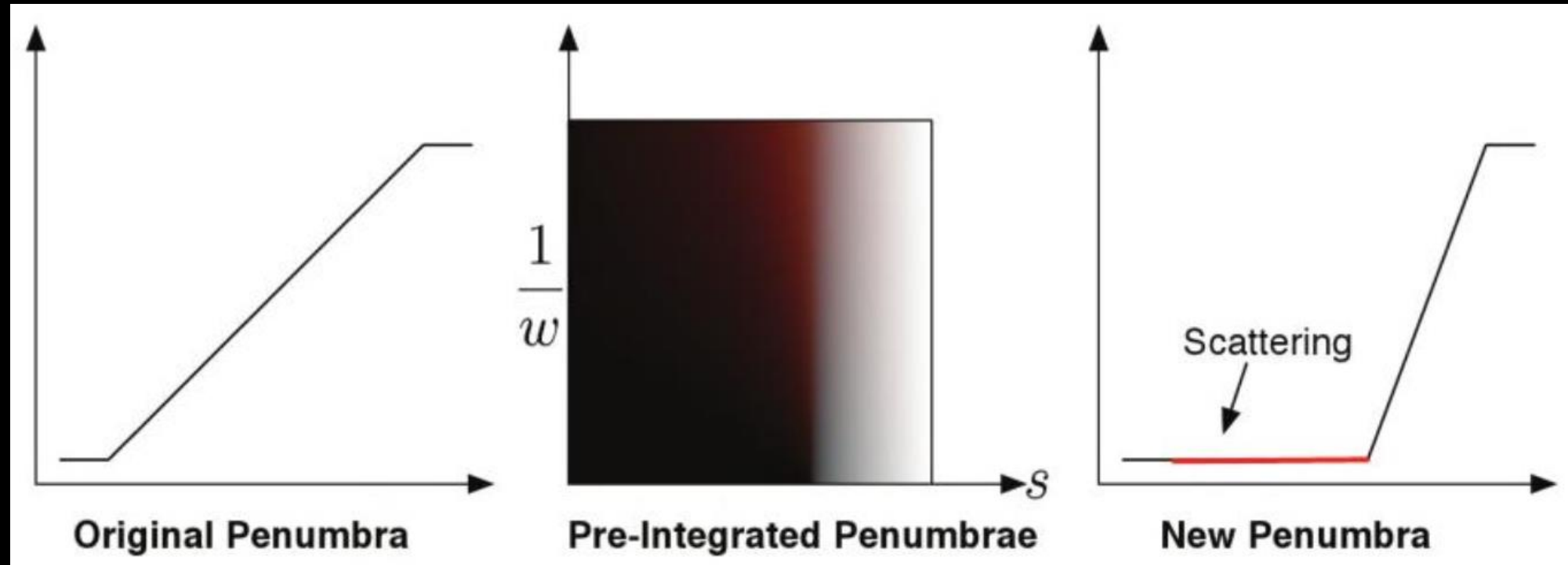


Blur Normal Map

5. Demo

Pre-Integrated Skin Shading, Eric Penner, 2011

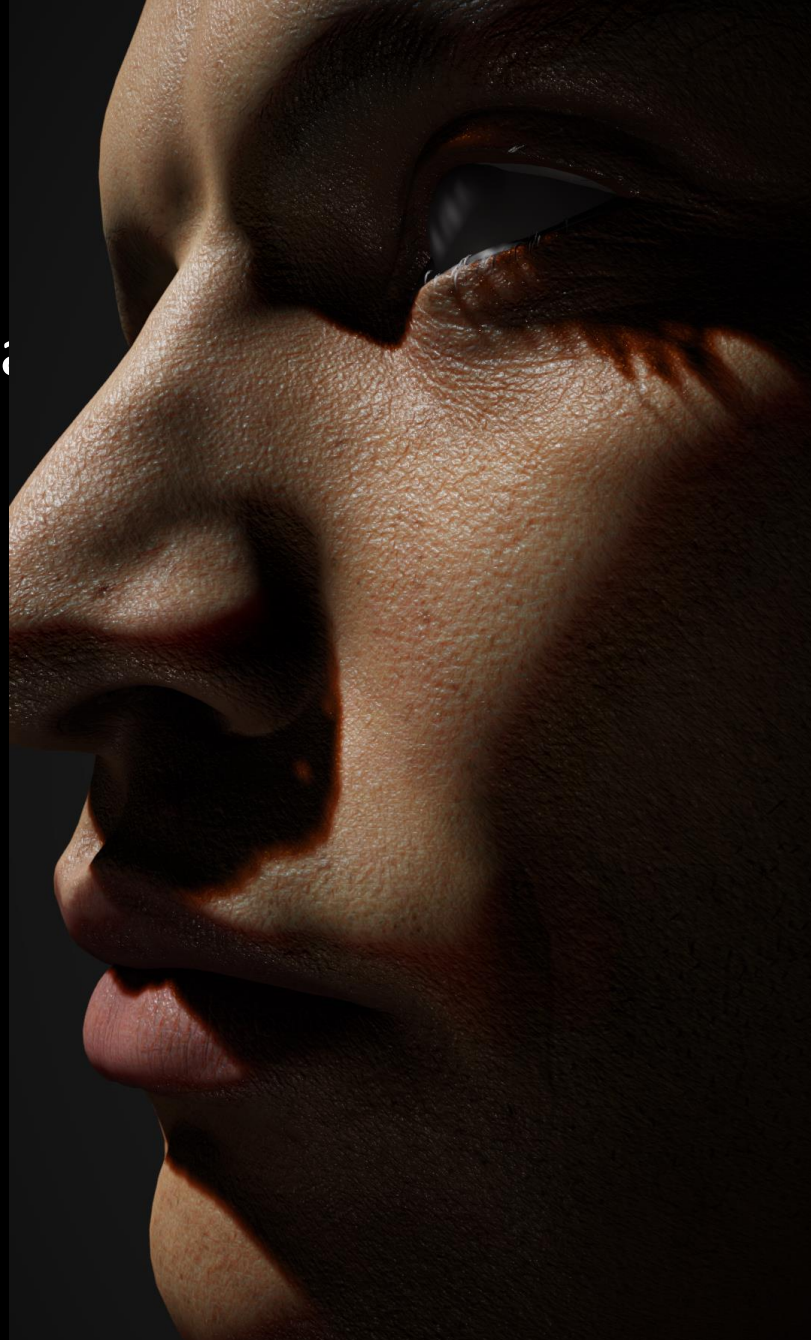
- Shadow



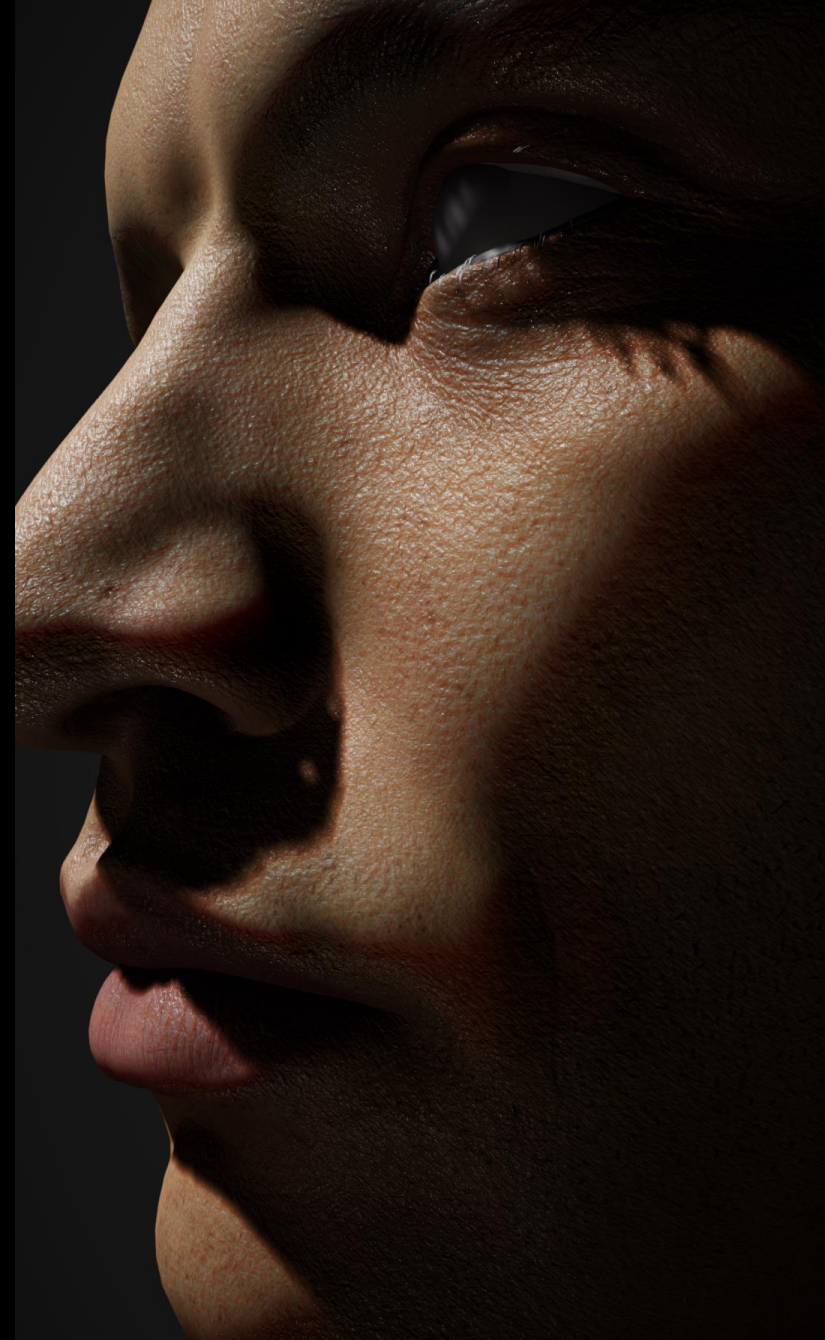


sha

Original



Remapped 1



Remapped 0.5