Scripted Gaussian Scatter Model

INTRODUCTION
This knowledge base article will describe how to create a Gaussian scatter distribution using FRED’s Scripted BSDF scatter model. This distribution is commonly used for simulating diffuser elements.

SCRIPTED SCATTER MODEL
A scripted scatter model type can be created by one of the following methods:

1. Menu > Create > New Scatter Model
2. Ctrl + Alt + A
3. Toolbar button:
4. Right mouse click on the Scatterers folder and select “Create a New Scatterer…”

Once the Scatter dialog has been opened, the Scripted (BSDF given by user-script) type should be selected.

The scripted scatter model is defined in direction cosine space using the incident ray, specular ray, and scatter ray direction vectors as shown below:

WRITING THE SCRIPT
The definition of the Gaussian scatter distribution in this model uses the following form:

\[ BSDF = K e^{-\left(\frac{(x_p-x_s)^2}{a_0^2}\right) - \left(\frac{(y_p-y_s)^2}{b_0^2}\right)} \]

where the normalization factor \( K \) is given by:
\[ K = \frac{1}{\pi A_0 B_0 \text{Erf} \left( \frac{1}{A_0} \right) \text{Erf} \left( \frac{1}{B_0} \right)} \]

In this construction \( A_0 \) and \( B_0 \) are related to the FWHM of the distribution in the x and y directions, \( x_{sp} \) and \( x_{sc} \) are the X specular and scatter direction components, and \( y_{sp} \) and \( y_{sc} \) are the Y specular and scatter direction components. The normalization factor is included so that the total integrated scatter (TIS) is 100% at normal incidence.

For the Gaussian distribution we can relate the parameters \( A_0 \) and \( B_0 \) to the FWHM of the BSDF by the equations:

\[ FWHM_x = 2\sqrt{2\ln(2)} \sqrt{\frac{A_0^2}{2}} \]

\[ FWHM_y = 2\sqrt{2\ln(2)} \sqrt{\frac{B_0^2}{2}} \]

In the editor window for the scripted scatter model the comments header provides information regarding the available input and output variables for use in the BSDF definition. This scripted Gaussian scatter model will make use only of \( g_{Xspec}, g_{Xsc}, g_{Yspec}, g_{Yscat} \) and \( g_{bsdf} \), corresponding to \( x_{sp}, x_{sc}, y_{sp}, y_{scat} \) and BSDF as defined above.

The subroutine for the scripted scatter model is shown below:

```vbscript
Sub EvalScatter( ByVal g_Xinc#, ByVal g_Yinc#, ByVal g_Zinc#, ByVal g_Xspec#, ByVal g_Yspec#, ByVal g_Zspec#, ByVal g_Xscat#, ByVal g_Yscat#, ByVal g_Zscat#, ByVal g_ran#, ByVal g_TISrequest As Boolean, ByRef g_Xpos#, ByRef g_Ypos#, ByRef g_Zpos#, ByRef g_w#, ByRef g_frac#, ByRef g_numA& , ByRef g_numB&, ByRef g_bsdf# )
    Dim pi As Double, deg As Double, K As Double
    Dim A0 As Double, B0 As Double, delA As Double, delB As Double

    ' constants
    pi = ACos(-1)
    deg = pi / 180

    ' FWHM related values
    A0 = 30 * deg
    B0 = 5 * deg

    If Not g_TISrequest Then
```

440 SOUTH WILLIAMS BLVD, #106 – TUCSON, AZ 85711 – 1 - (520) – 733 – 9557 – SALES@PHOTONENGR.COM – WWW.PHOTONENGR.COM
\[ \text{delA} = \frac{(g_{X\text{spec}} - g_{X\text{scat}})}{A0} \]

\[ \text{delB} = \frac{(g_{Y\text{spec}} - g_{Y\text{scat}})}{B0} \]

'normalization constant

\[ K = \pi \cdot A0 \cdot B0 \cdot \text{Erff}(1/A0) \cdot \text{Erff}(1/B0) \]

\[ g_{\text{bsdf}} = \exp(-\text{delA} \cdot \text{delA}) \cdot \exp(-\text{delB} \cdot \text{delB}) / K \]

Else

\[ g_{\text{Xpos}} = 0 ; g_{\text{Ypos}} = 0 ; g_{\text{Zpos}} = 0 ; g_{\text{frac}} = 1 ; g_{\text{w}} = 0.5 \]

\[ g_{\text{numA}} = 101 ; g_{\text{numB}} = 101 \]

End If

End Sub

**VERIFYING THE SCATTER MODEL**

For the values \( A_0 = 30 \) degrees and \( B_0 = 5 \) degrees, we calculate using the equations above that FWHM\(_x\) = 49.95\(^\circ\) and FWHM\(_y\) = 8.33\(^\circ\). A model with a single ray incident on a scattering surface with this scripted scatter BSDF was raytraced to produce the following 3D BSDF plot in FRED.

The TIS at normal incidence is reported to be 99.956%, as expected due to the normalization factor. Additionally, the closest FWHM\(_x\) value is found on the plot at 51.2\(^\circ\) while the closest FWHM\(_y\) value is found on the plot at 8.5\(^\circ\).