10th International Radiance Workshop, August 24 – 26, 2011

Validation of genBSDF

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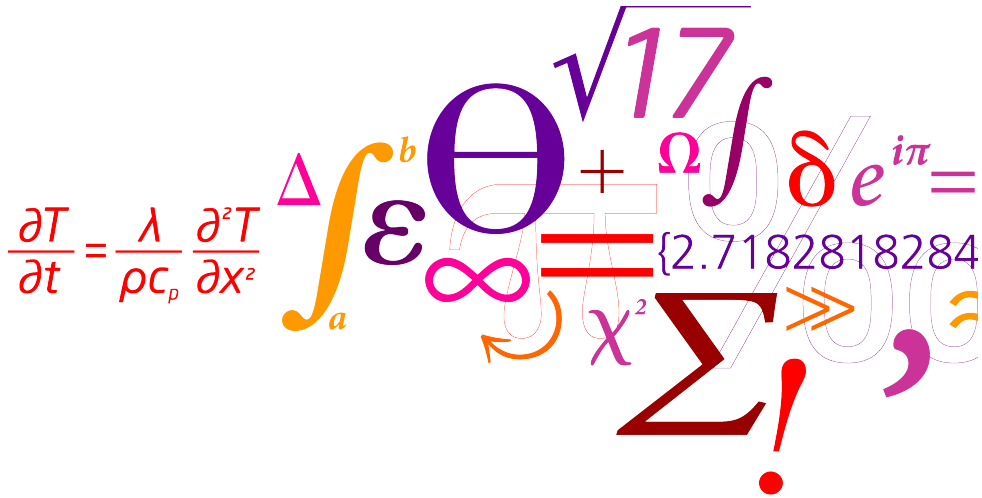
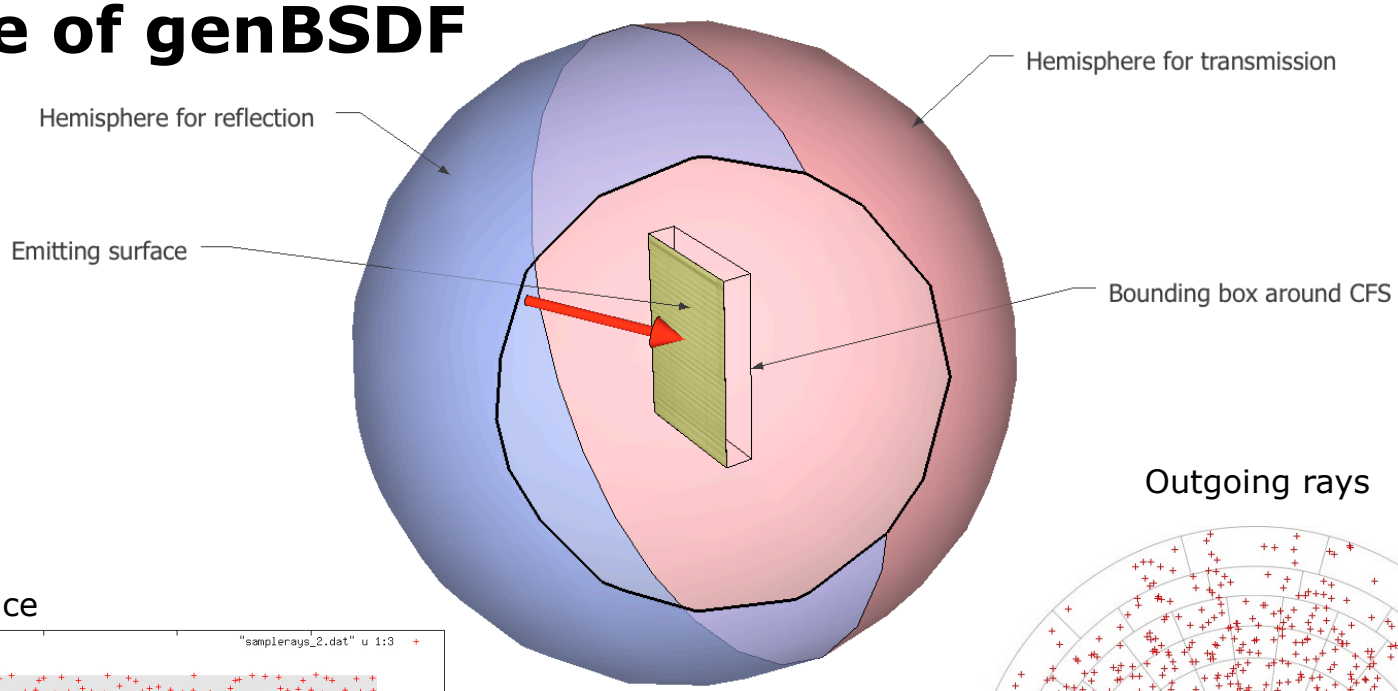


DTU Civil Engineering
Department of Civil Engineering

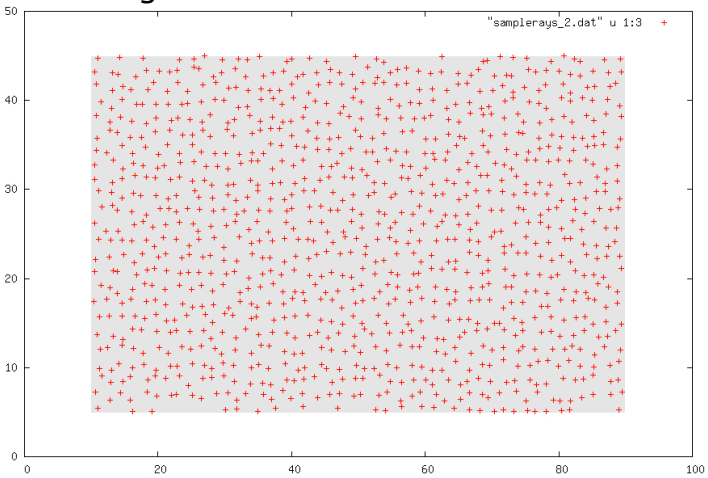
Outline

- How genBSDF works – basics
- Validation process
- Four validation cases

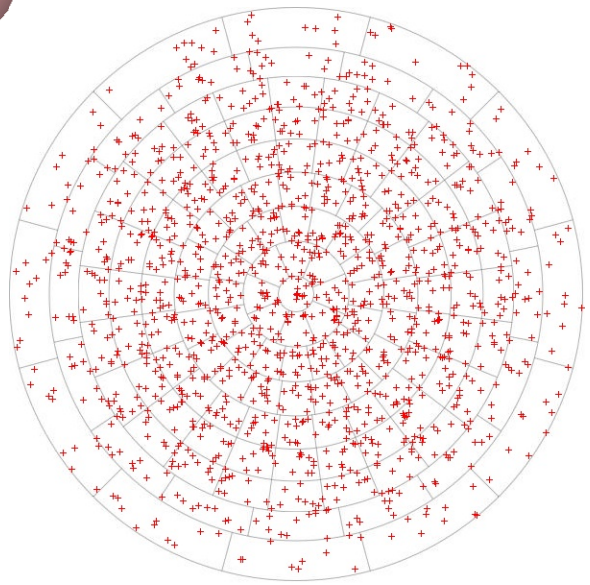
Usage of genBSDF



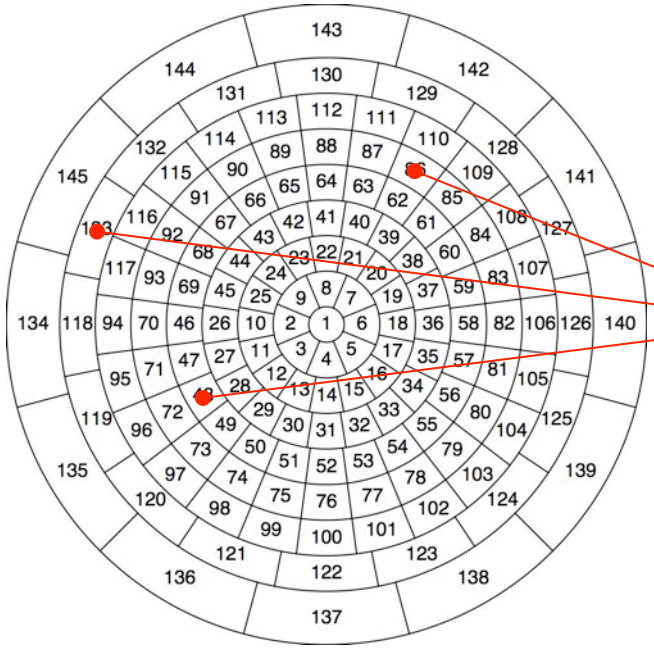
Emitting surface



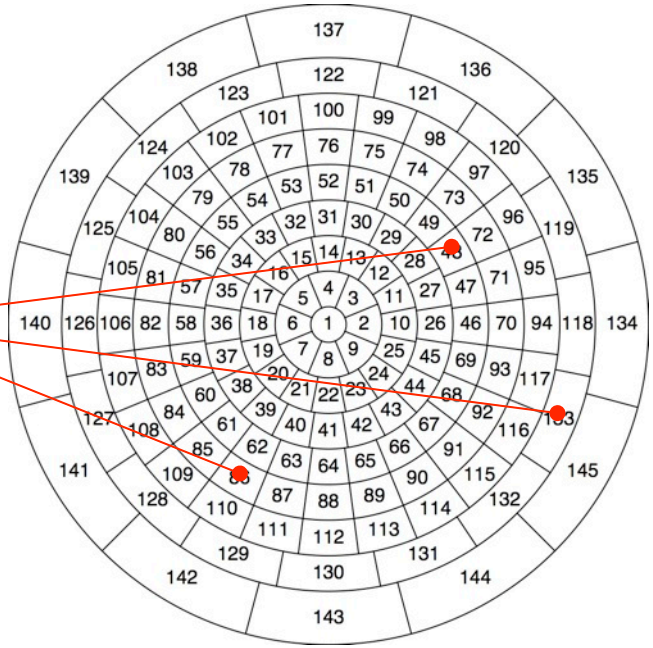
Outgoing rays



Incident angles



Outgoing angles - transmitted

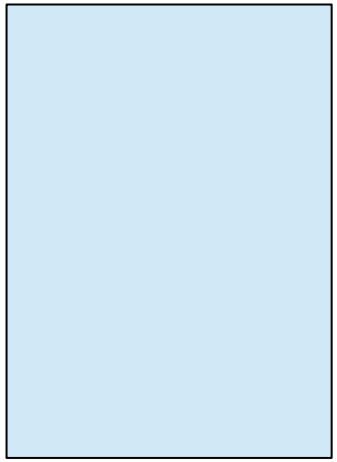


Validation examples

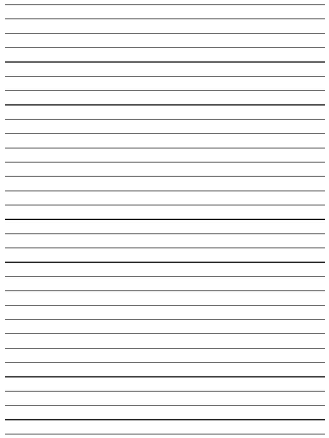
Test Case	Validated Against
Air (100% specular transmission)	Analytically derived values
50% lambertian transmission	Analytically derived values
Mirrored blinds with flat slats	TracePro simulation
Micro perforated shading film	Gonio-Photometer measurement

Case 1

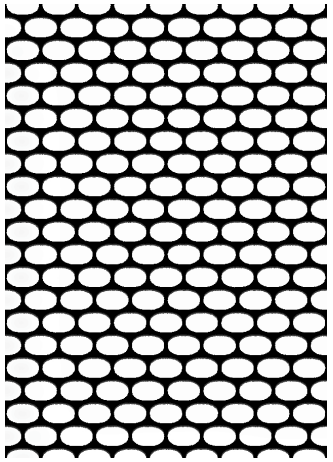
Case 2



Case 3



Case 4



Example 1

Air – 100% specular transmission

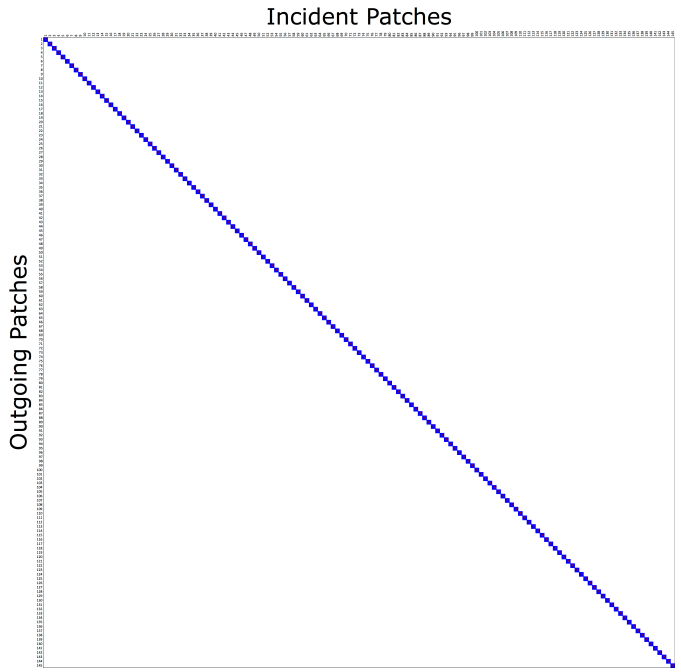
- ##Material

  void polygon plane
  0
  0
  12 0 0 0
  0 10 0
  10 10 0
  10 0 0

- Analytical solution $\frac{1}{cos\theta \times \Omega}$

- Diagonal matrix

- All results in theta bends are identical



Example 1

Air – 100% specular transmission

Theta band	Number of phi	Patch numbers	Theta range	Solid angle	Average cosine theta	BSDF value for specular patch	genBSDF result (mean for theta band)
1	1	1	0° - 5°	0.0239	0.9981	41.9043	41.9043
2	8	2-9	5° - 15°	0.0238	0.9811	42.8764	42.8764
3	16	10-25	15° - 25°	0.0234	0.9361	45.6281	45.6281
4	20	26-45	25° - 35°	0.0274	0.8627	42.333	42.333
5	24	46-69	35° - 45°	0.0293	0.7631	44.6724	44.6724
6	24	70-93	45° - 55°	0.0350	0.6403	44.6724	44.6724
7	24	94-117	55° - 65°	0.0395	0.4981	50.7996	50.7996
8	16	118-133	65° - 75°	0.0643	0.3407	45.6281	45.6281
9	12	134-145	75° - 90°	0.1355	0.1294	57.0215	57.0215

Example 2

Lambertian diffuser - 50% transmission

- ##Material

```
void trans diffuse50
      0
      0
      7 .5 .5 .5 0 0 1 0

diffuse50 polygon bottom
      0
      0
      12  0  0  0
          0  1  0
          1  1  0
          1  0  0
```

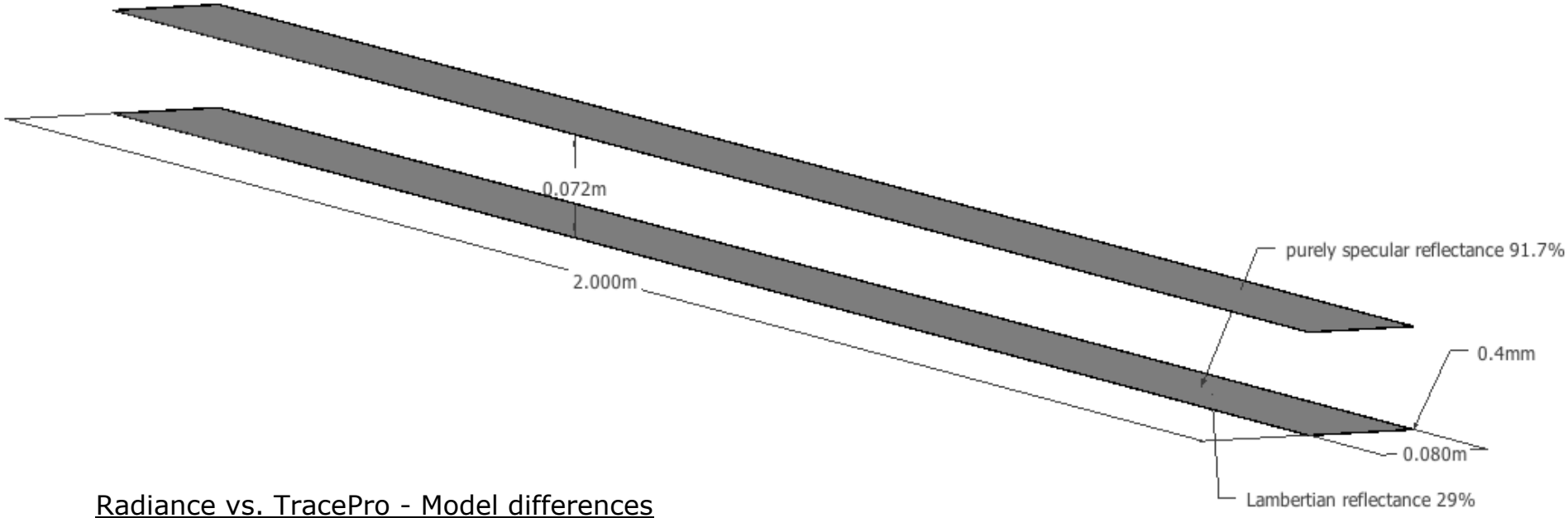
genBSDF settings	-c 1,000
mean	0.15916
maximum	0.16507 3.7% error
minimum	0.15250 - 4.2% error
Mean Bias Error	0.00058%
RMS Error	0.89%

- BSDF = trans/π => 0.15915

- Results from genBSDF ranging ± 4% from analytical method

Example 3

Mirrored blind



Radiance vs. TracePro - Model differences

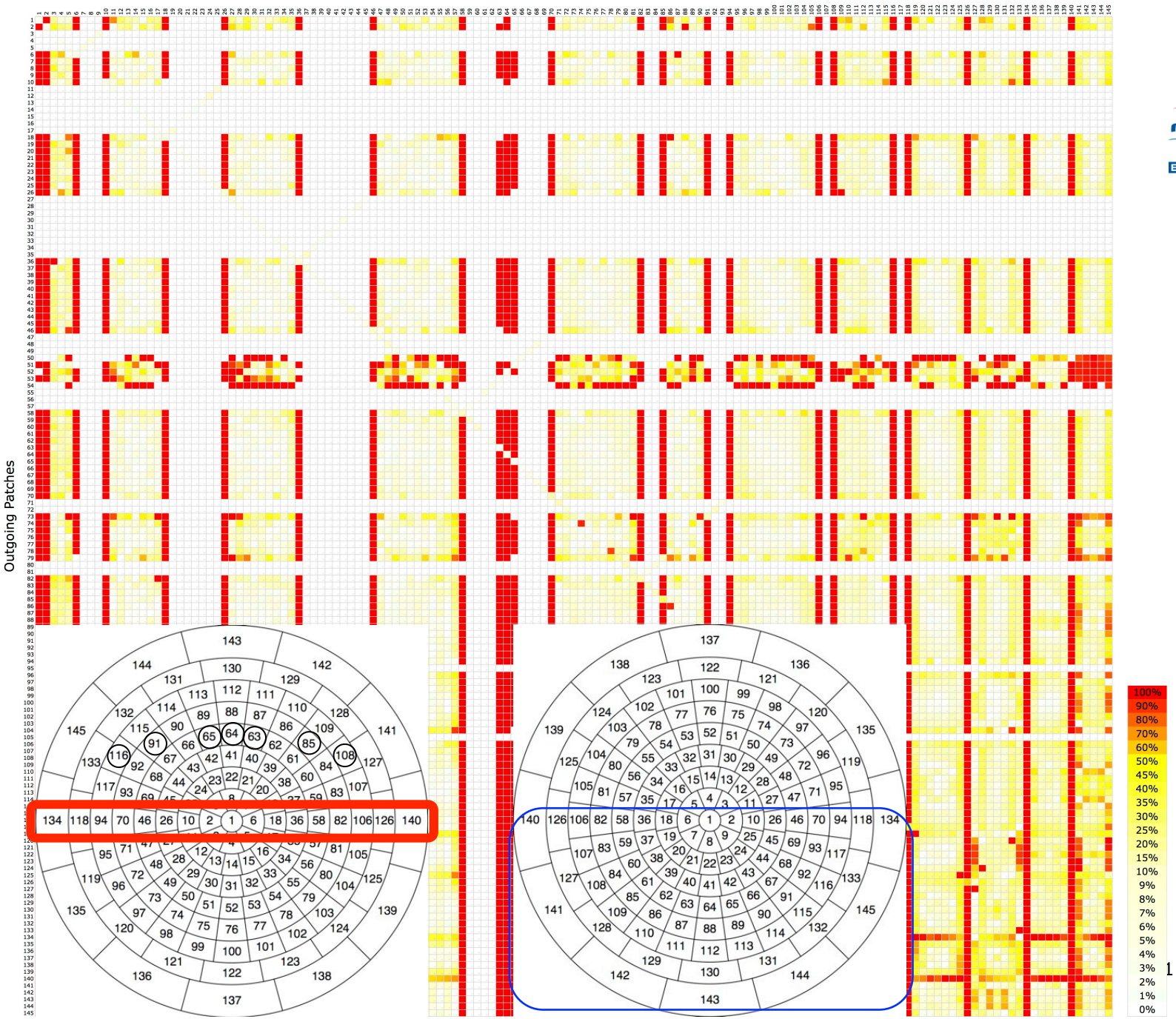
TracePro

- Two blind slats
- Sample rays were generated along the center line of the blind between the two slats
- The sample rays in Trace Pro were collimated.

Radiance

- Model approximately 2m wide and 2.016 m tall
- Ray samples origins were distributed randomly over the 2m by 2.016 m blind system.
- Ray directions were randomly distributed over each Klem's patch.
- Sample rays were not collimated

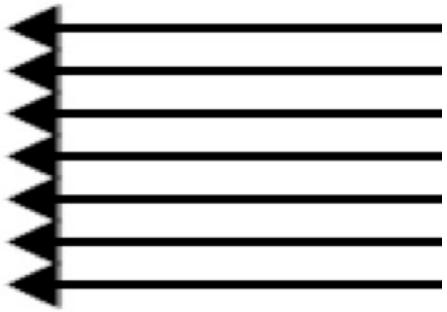
Percent Difference: genBSDF v. TracePro



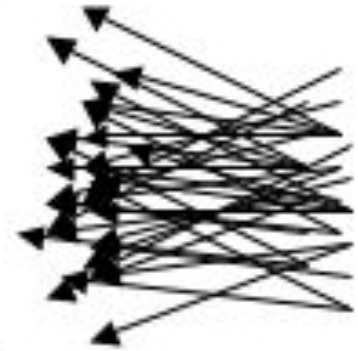
genBSDF-mod

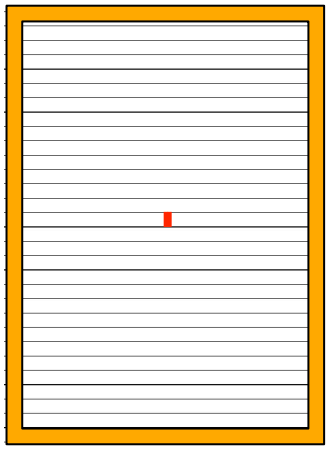
- Process closer to the simulation procedure in TracePro
- Illuminating source collimated instead of area source
- Emitting surface 2mm wide 72mm tall
- "receiving" surface was changed from a infinite hemisphere to a 20m disk

Collimated source

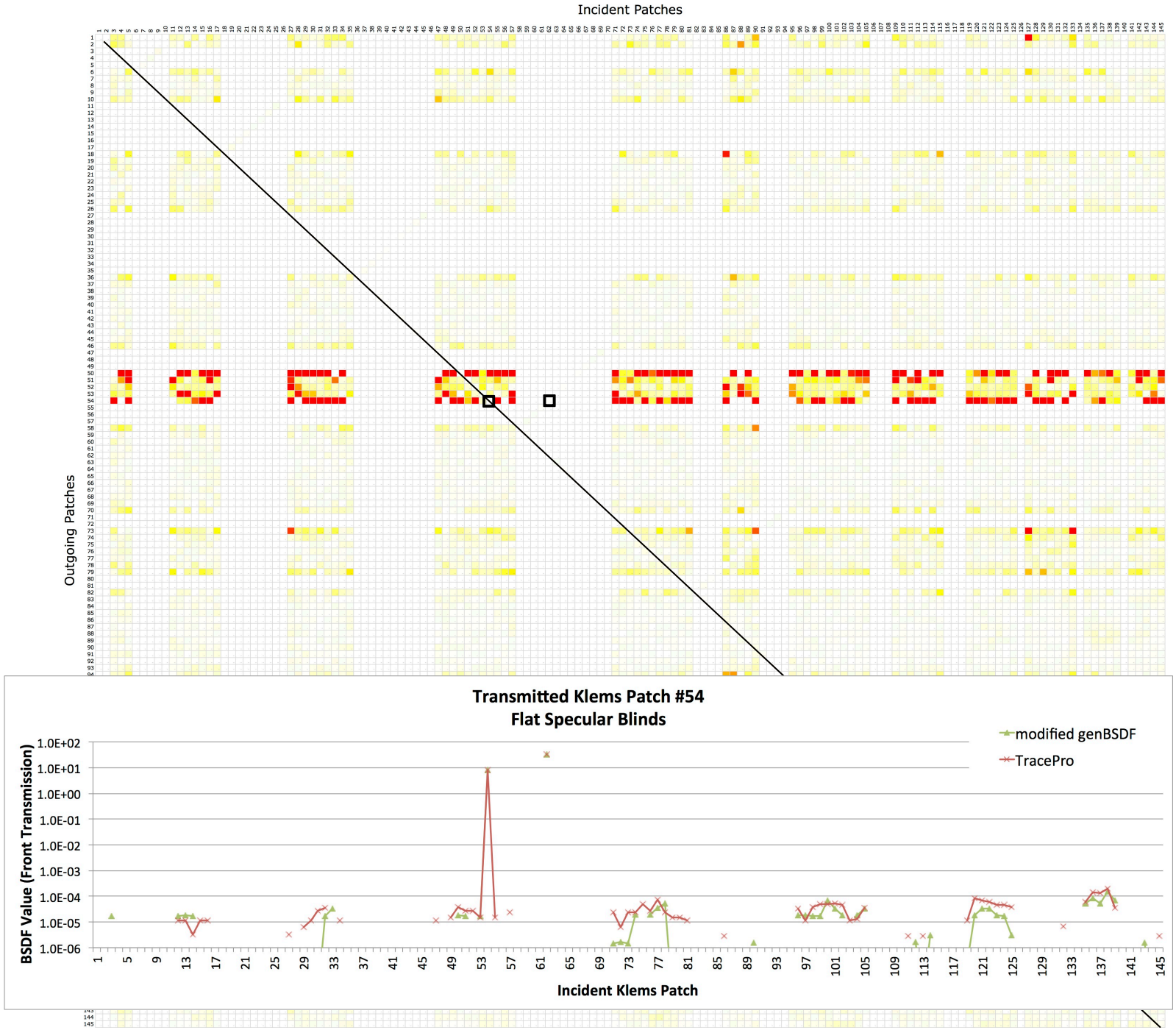


Area source





Percent Difference: modified genBSDF v. TracePro



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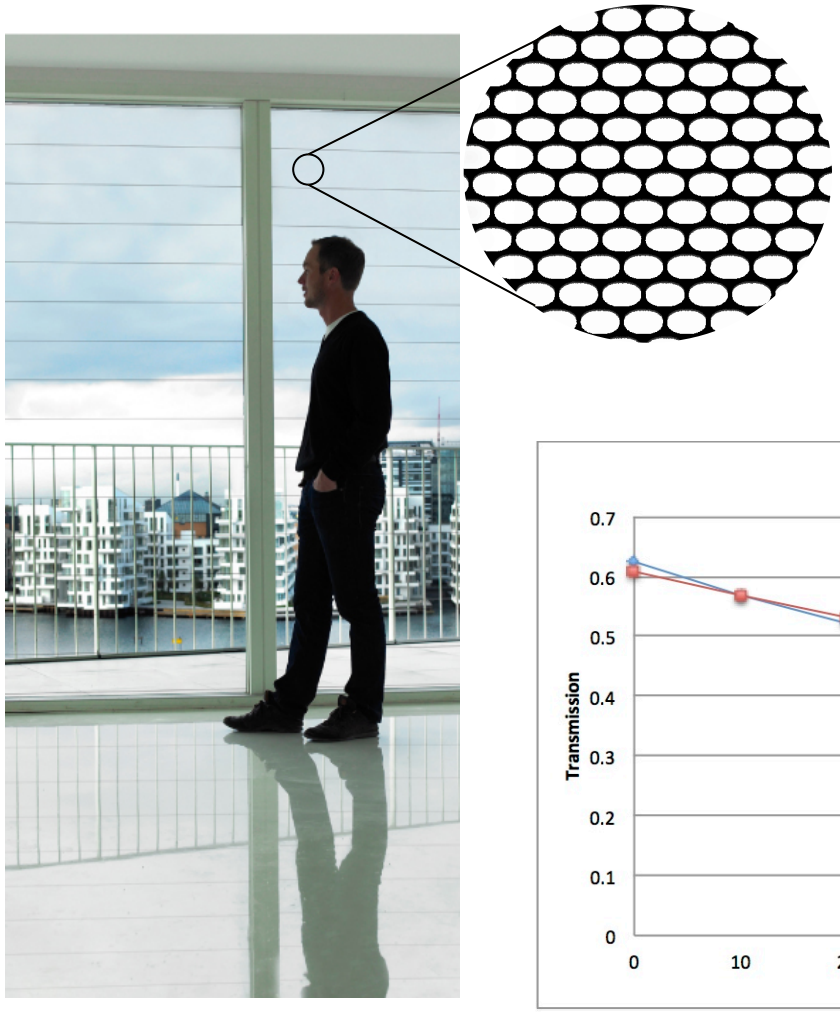
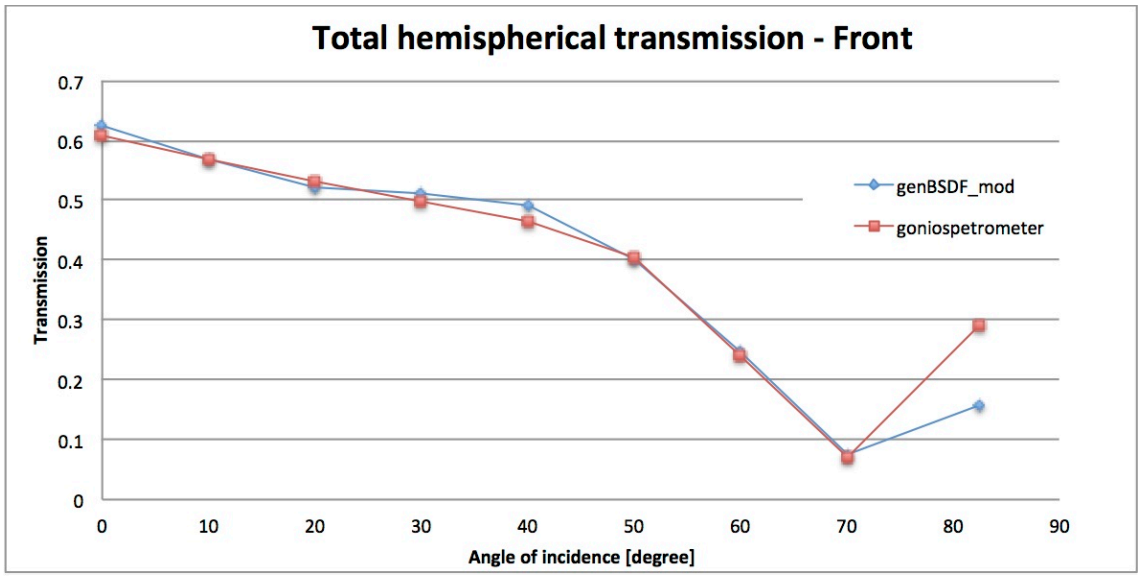
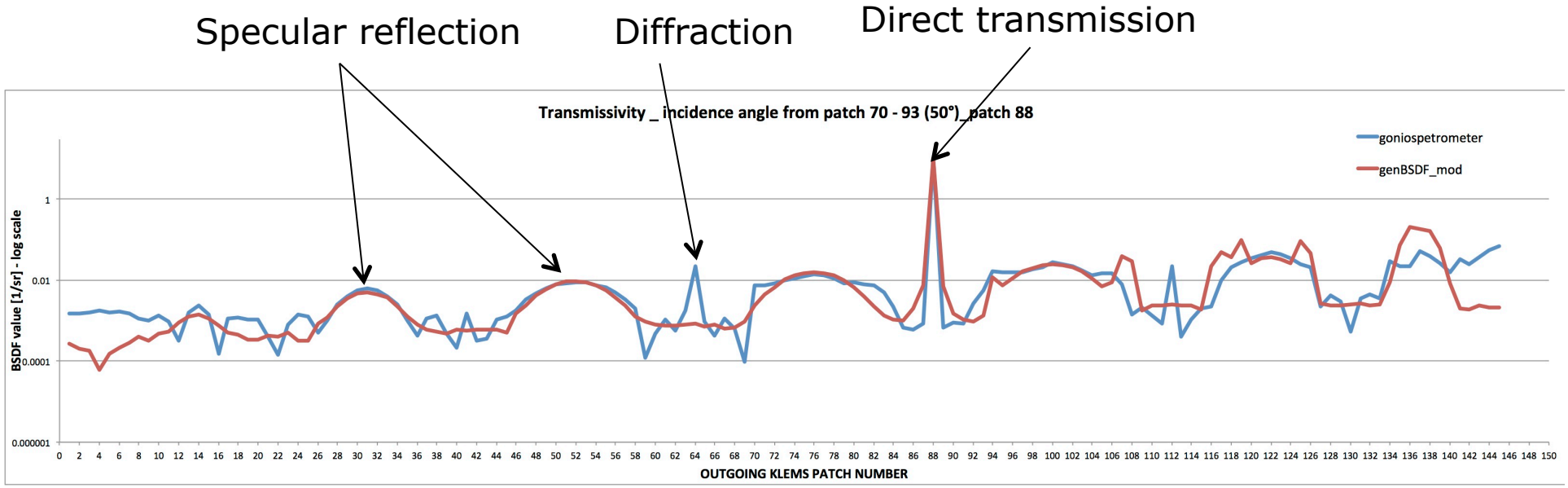
Example 4

Micro perforated shading film



Incidence angle	Trans. error to gonio.	
	direct	hemispherical
0	2	3
10	2	0
20	2	2
30	2	3
40	5	6
50	4	0
60	1	2
70	37	7
82.5	100	46




Specular reflection
Diffraction
Direct transmission
Transmissivity _ incidence angle from patch 70 - 93 (50°)_patch 88
goniospetrometer
genBSDF_mod
BSDF value [1/sr] - log scale
1
0.01
0.0001
0.000001
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42 44 46 48 50 52 54 56 58 60 62 64 66 68 70 72 74 76 78 80 82 84 86 88 90 92 94 96 98 100 102 104 106 108 110 112 114 116 118 120 122 124 126 128 130 132 134 136 138 140 142 144 146 148 150
OUTGOING KLEMS PATCH NUMBER

Conclusion

- Comparable results with other methods for obtaining BSDF data
  - Analytical solutions correlate well.
  - The optically complex systems correlate when the simulation procedures are the comparable.
- Radiance only simulates ray optics and will not reproduce wave optic phenomenon including diffraction.
- Model should be built in the way such that light is not escaping or leaking around the geometry.

Questions?