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Technik & Architektur

Comparing BSDF data from a real and a virtual goniophotometer

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Outline

- Why would you compare BSDF data from a real and a virtual goniophotometer?
- How to simulate a goniophotometer with Radiance photon mapping?
- How to compare high resolution BSDF data?
- What are the results?
- Outlook

Why would you compare BSDF data from a real and a virtual goniophotometer?

- Approve your models, quantify errors
- Understand the (unexpected) results of your measurements
- Find and quantify differences between design and production samples of optical components

Scanning goniophotometer PAB Advanced Technologies PG-2

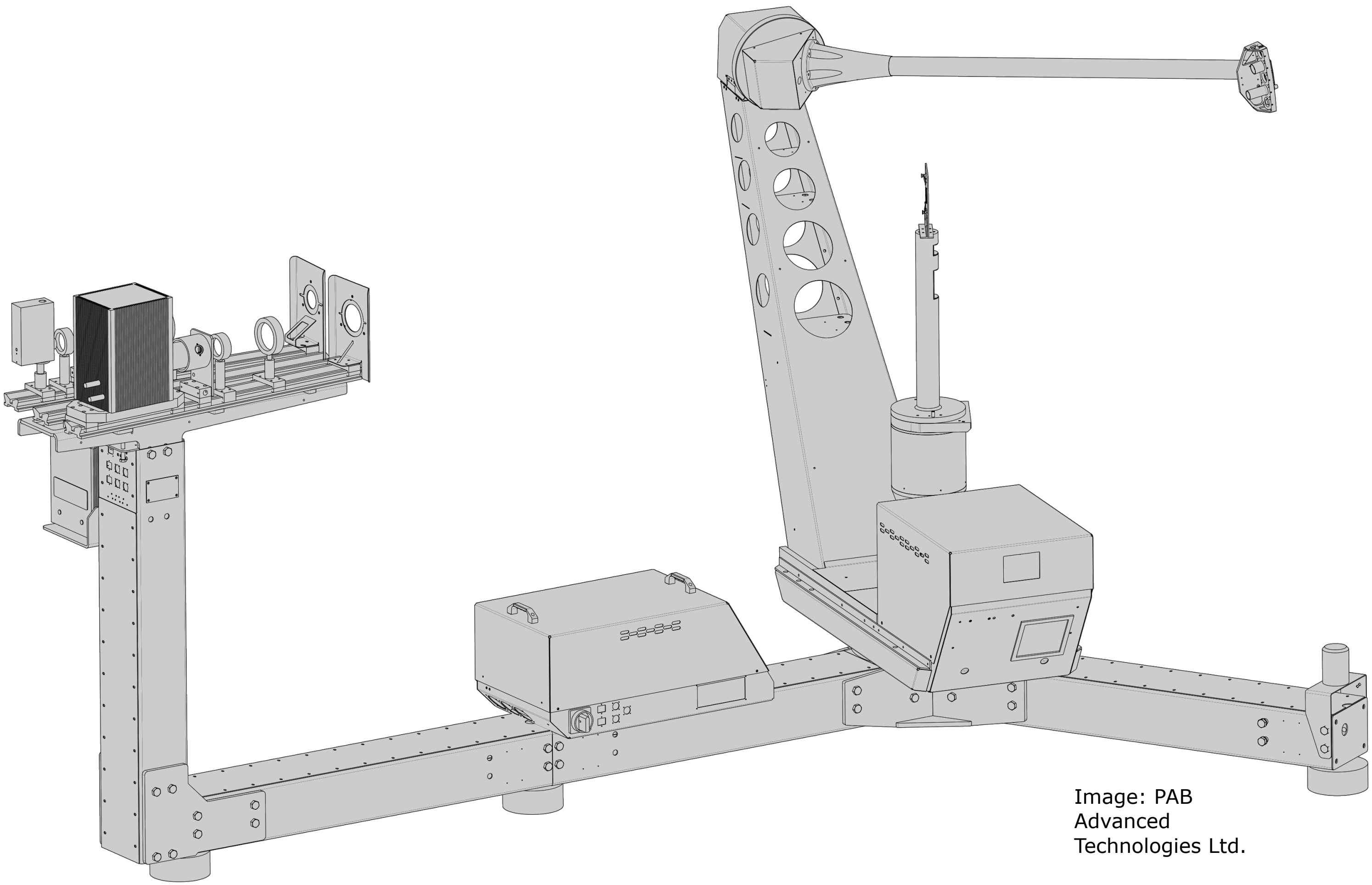
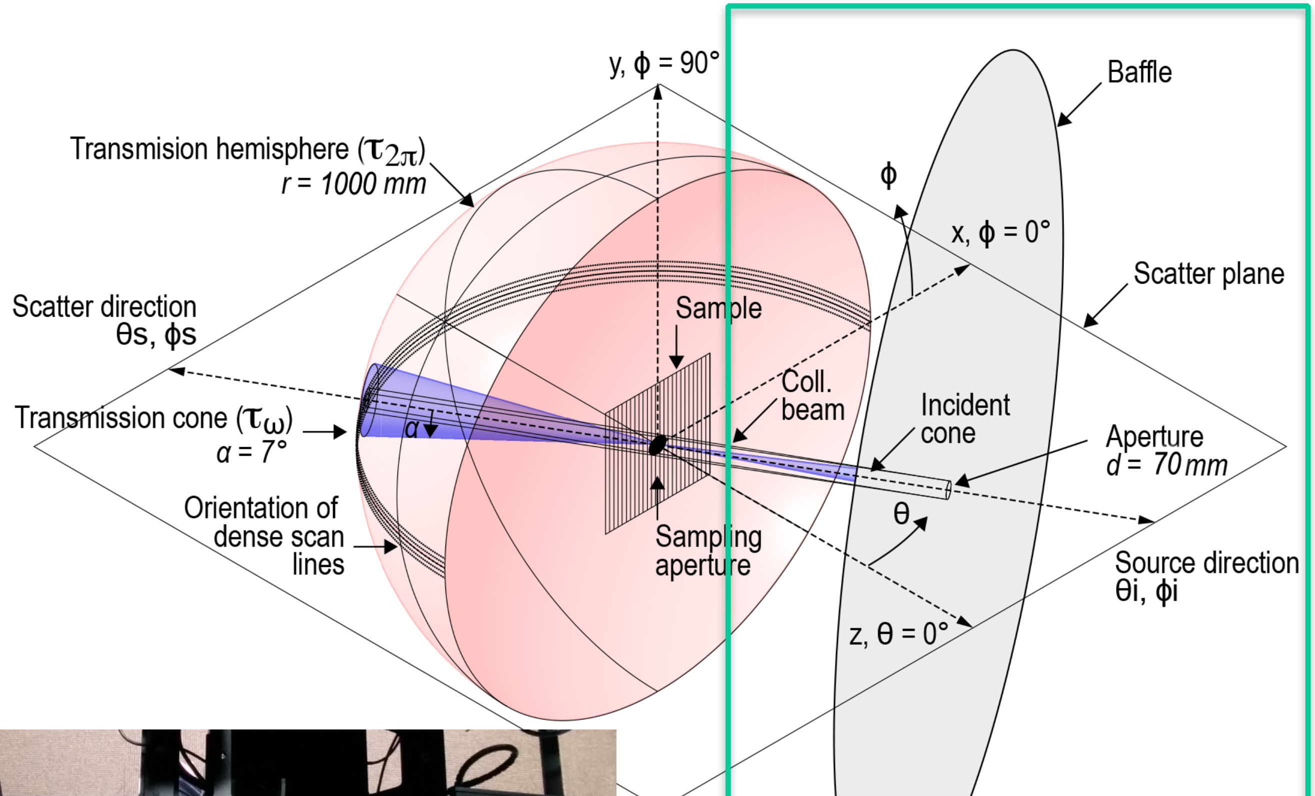


Image: PAB Advanced Technologies Ltd.

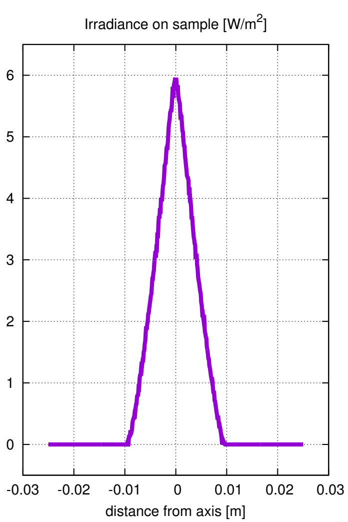
Implement a virtual goniophotometer with Radiance pmap: Illumination system

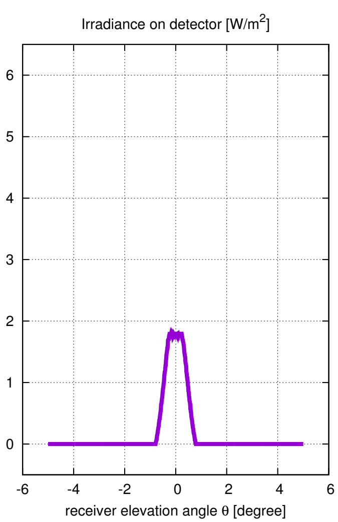
```
void light lampMat
0
0
3 100000 100000 100000

lampMat source lampObj
0
0
4 0 0 1 .5

void plastic baffleMat
0
0
5 0 0 0 0 0

baffleMat ring baffleObj
0
0
8 0 0 1.1 0 0 1 0.035 1.5

void antimatter photonMat
1 void
0
0

photonMat ring photonObj
0
0
8 0 0 1.1 0 0 -1 0 0.035
```

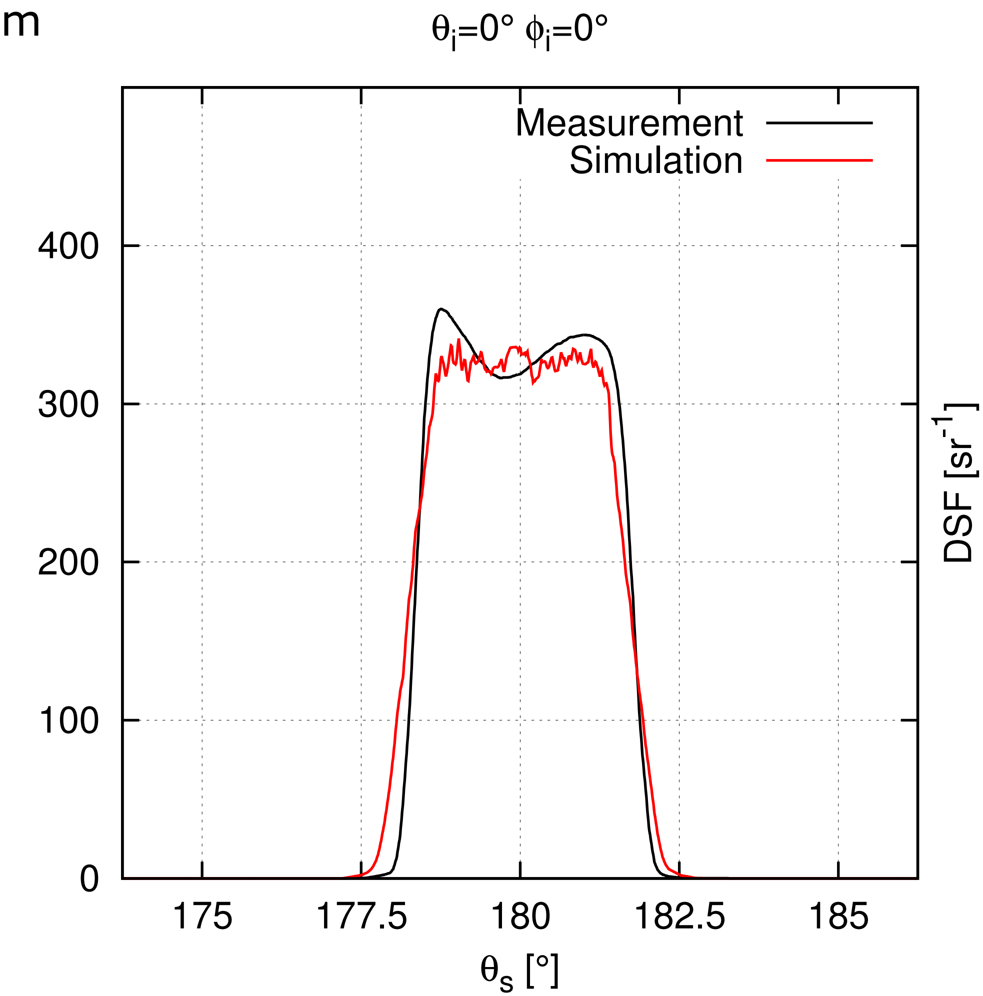


Implement a virtual goniophotometer: Illumination system

- Works well for a collimated beam
- Edge bias and half shadow is similar to falloff of the illumination system
- Works less good for smaller beams





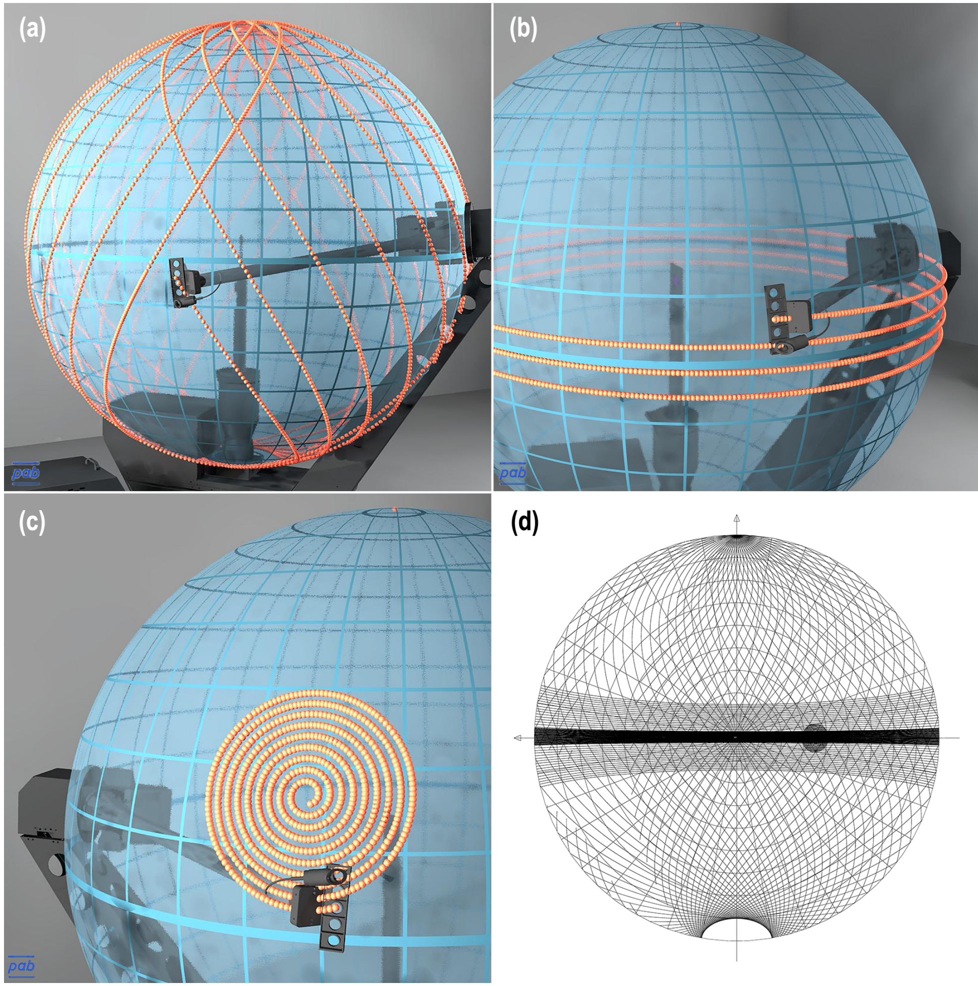


Implement a virtual goniophotometer with Radiance map: Sensor positions

[header]

#datapoints_in_file	505907	
#format: theta	phi	DSF
98.04440	59.79114	1.209e-03
98.04304	59.77517	1.327e-03
98.04214	59.75856	1.782e-03
98.04059	59.74181	9.321e-04
98.03952	59.72591	1.729e-03
98.03831	59.71072	1.432e-03
98.03691	59.69475	1.333e-03
98.03551	59.67878	1.351e-03
98.03429	59.66359	1.541e-03

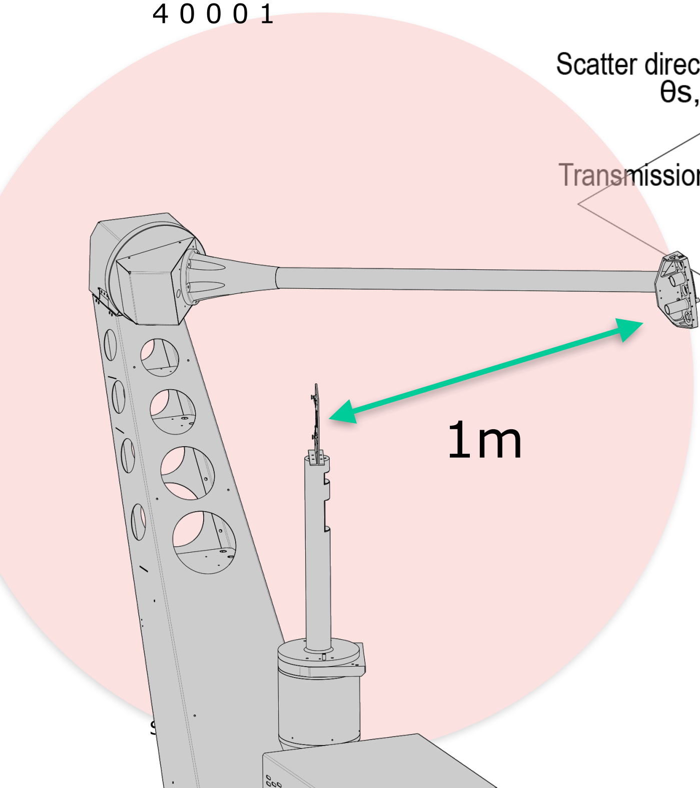
[…]

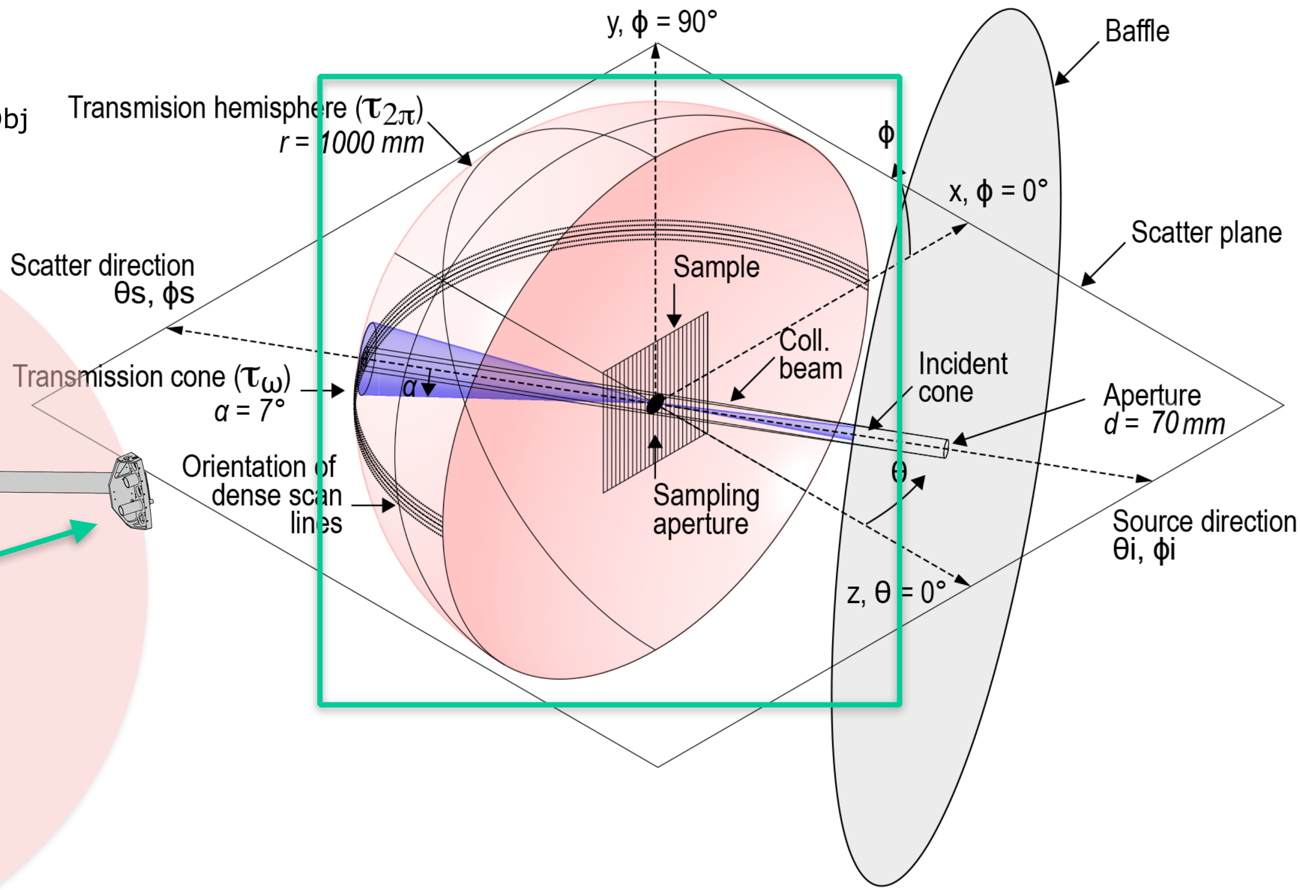


Images a-c: PAB Advanced Technologies Ltd.

Implement a virtual goniophotometer with Radiance pmap: Sensor sphere

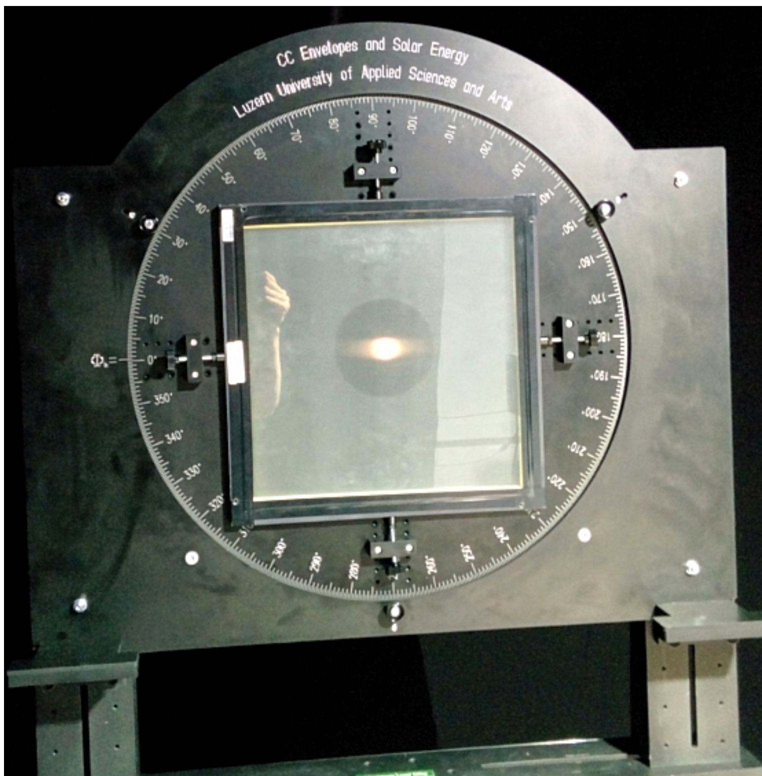
```
void antimatter photonMat
1 void
0
0

receiverMat bubble receiverObj
0
0
4 0 0 0 1
```

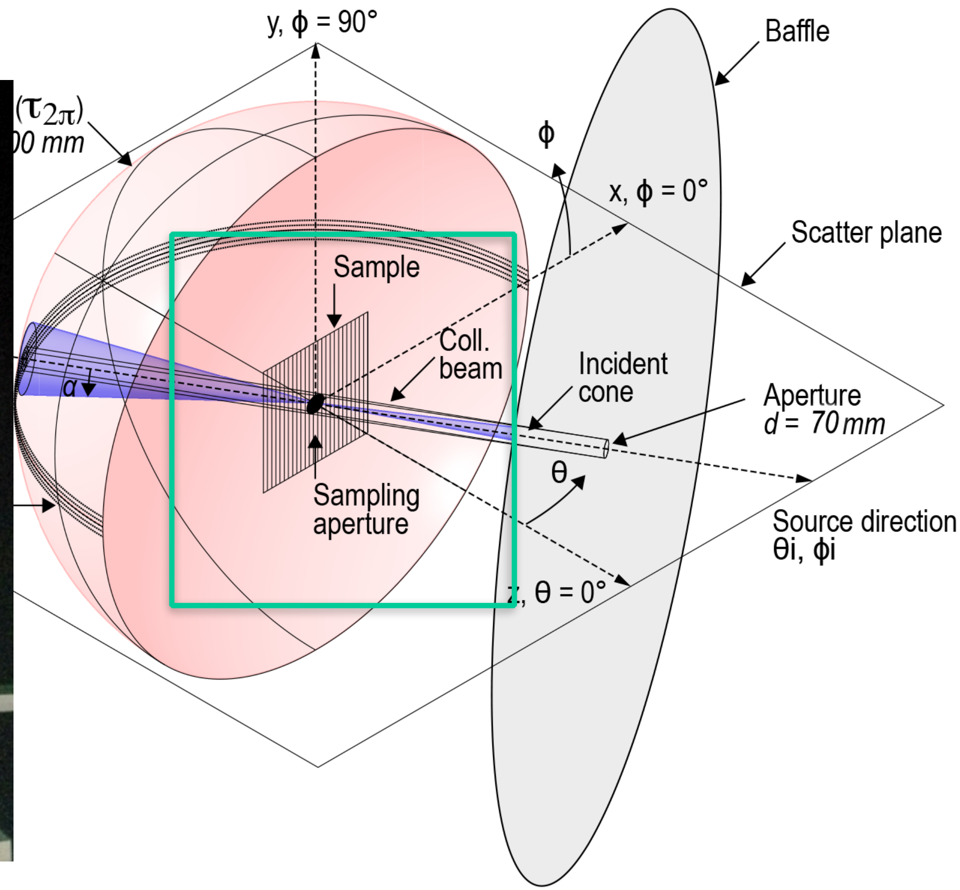




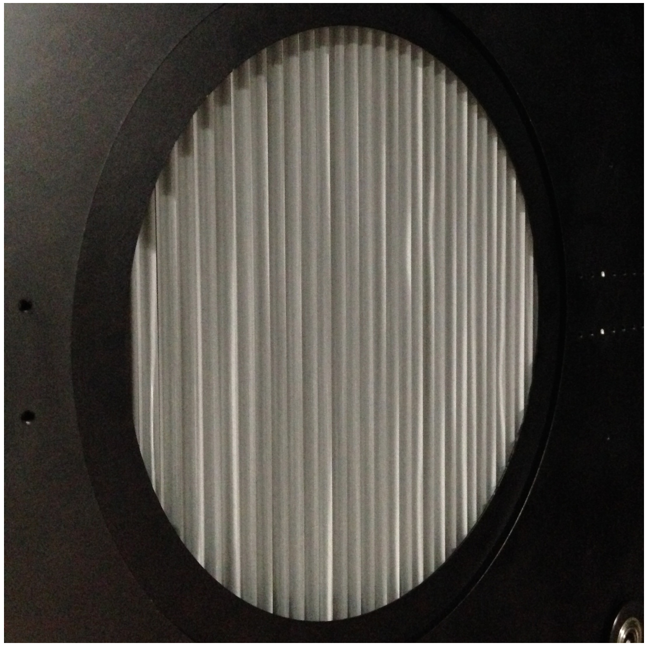
Implement a virtual goniophotometer with Radiance pmap: Sample

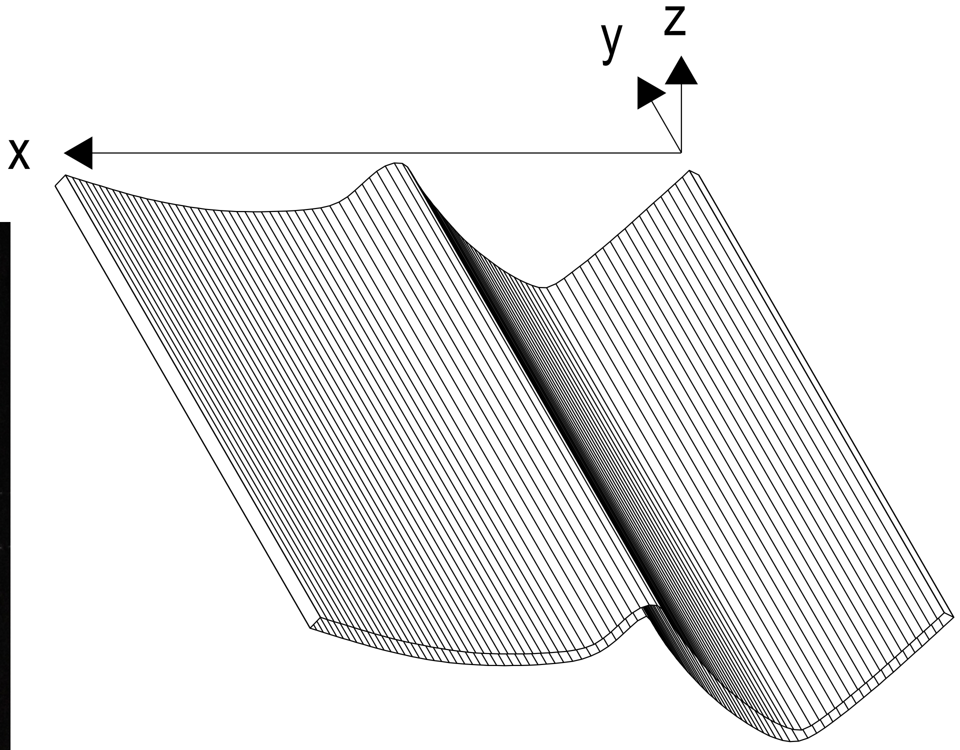
xform -ry $thetain -rz $phiin



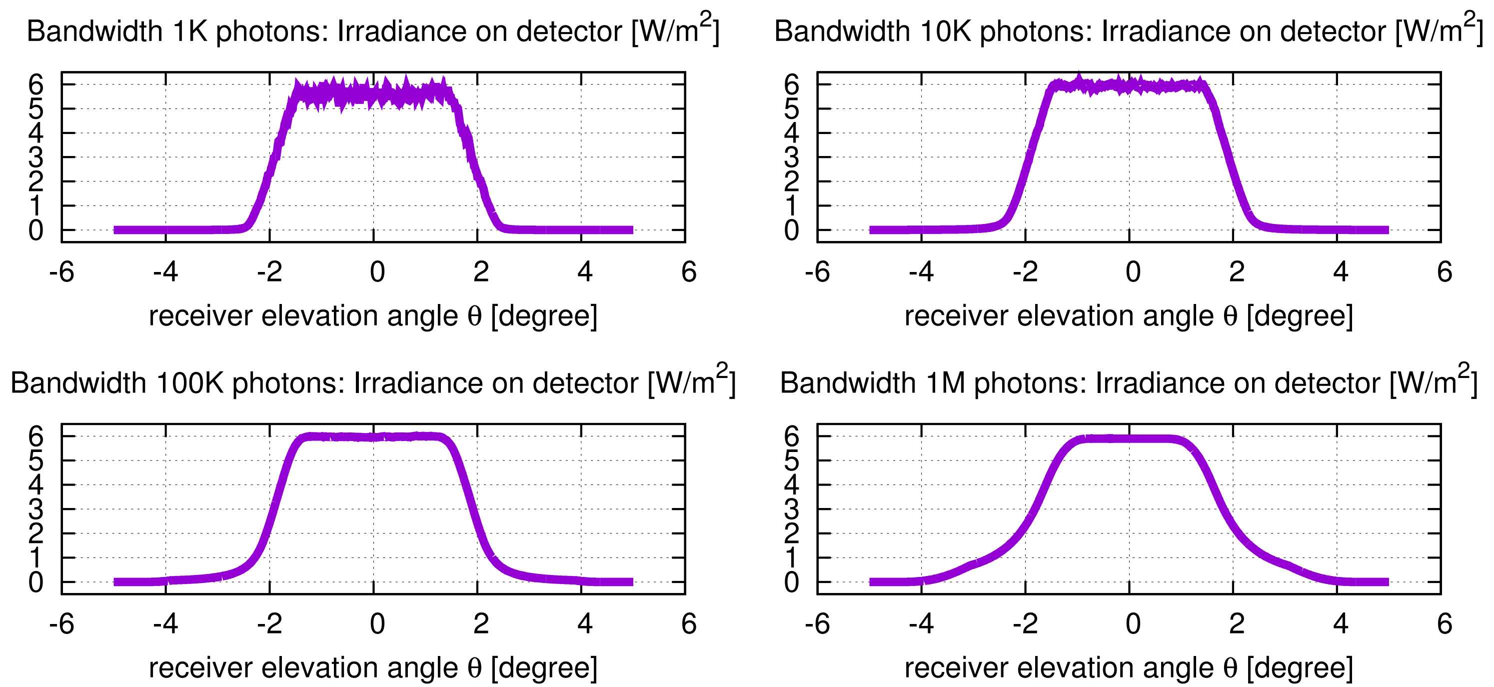


Implement a virtual goniophotometer with Radiance pmap: Sample





Implement a virtual goniophotometer with Radiance pmap: mkpmap and rtrace



mkpmap -apo photonMat -aps receiverMat -apg sample.gpm **8000000** sample.oct

rtrace $rtrace_opts **-ap 2000 -ab -1** sample.oct

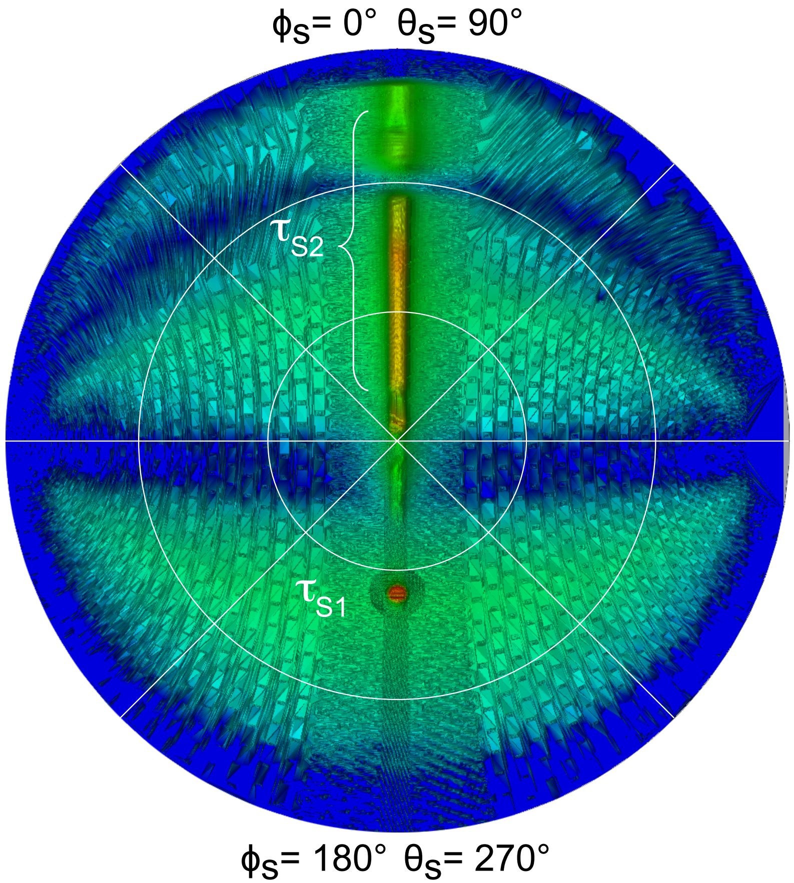
Implement a virtual goniophotometer with Radiance pmap: mkpmap and rtrace

```
cat input_vectors.dat | \
rcalc -e '$1=$1; $2=$2; $3=$3; $4=-.1*$1; $5=-.1*$2; $6=-.1*$3' | \
rtrace $rtrace_opts $pmapstring sample.oct > $out.dat
```

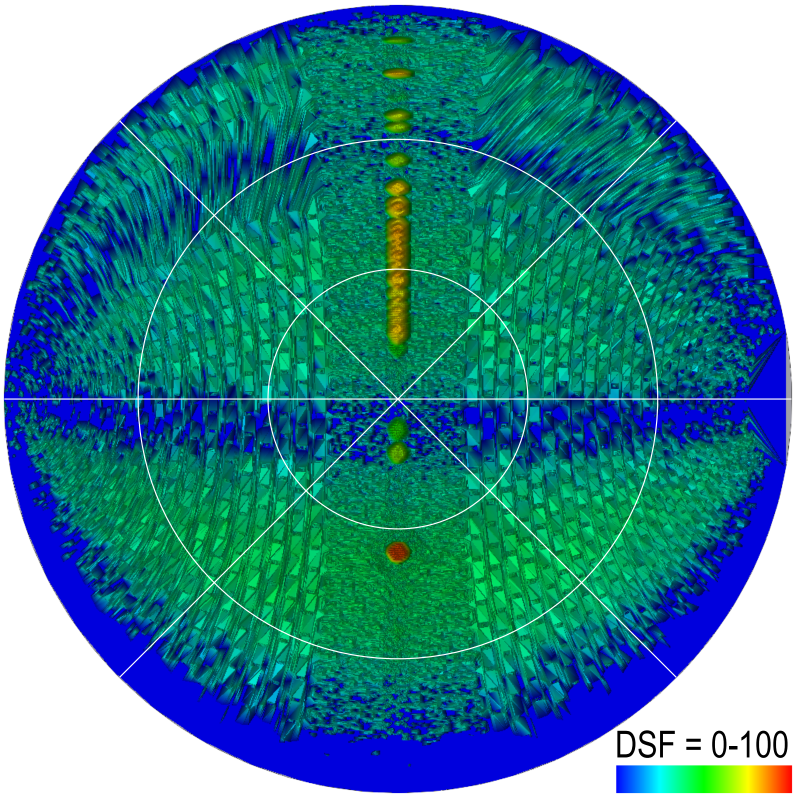
input_vector.dat = output pg2

```
[header]
#datapoints_in_file 505907
#format: theta      phi       DSF
98.04440 59.79114 1.209e-03
98.04304 59.77517 1.327e-03
98.04214 59.75856 1.782e-03
98.04059 59.74181 9.321e-04
98.03952 59.72591 1.729e-03
98.03831 59.71072 1.432e-03
98.03691 59.69475 1.333e-03
[...]
```

Implement a virtual goniophotometer with Radiance pmap: Results

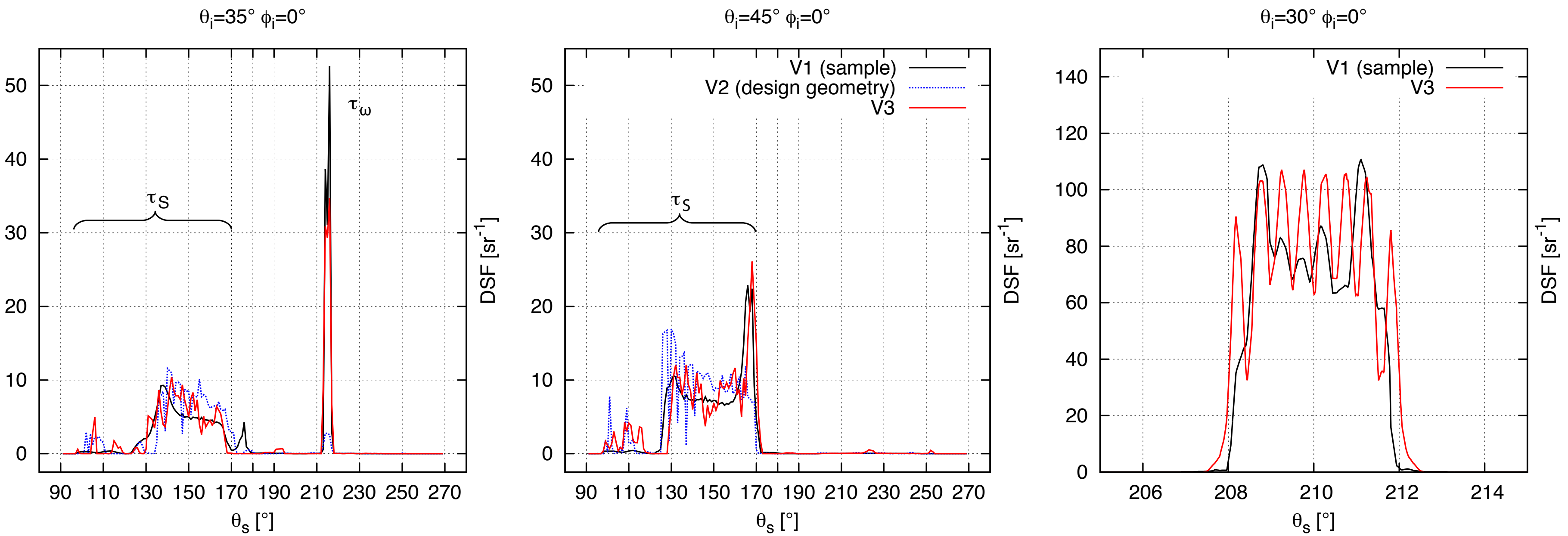


DSF Measurement θ_i = 35°



DSF Simulation θ_i = 35°

Implement a virtual goniophotometer with Radiance pmap: Results



How to compare high resolution BSDF data: Global and local accordance

Global accordance

$$f_{A,B} = 100 \left(1 - \sqrt{\frac{\sum_{j=1}^{n} \left(DSF_{A,j} - DSF_{B,j}\right)^2}{\sum_{j=1}^{n} \left(DSF_{A,j} + DSF_{B,j}\right)^2}} \right)$$

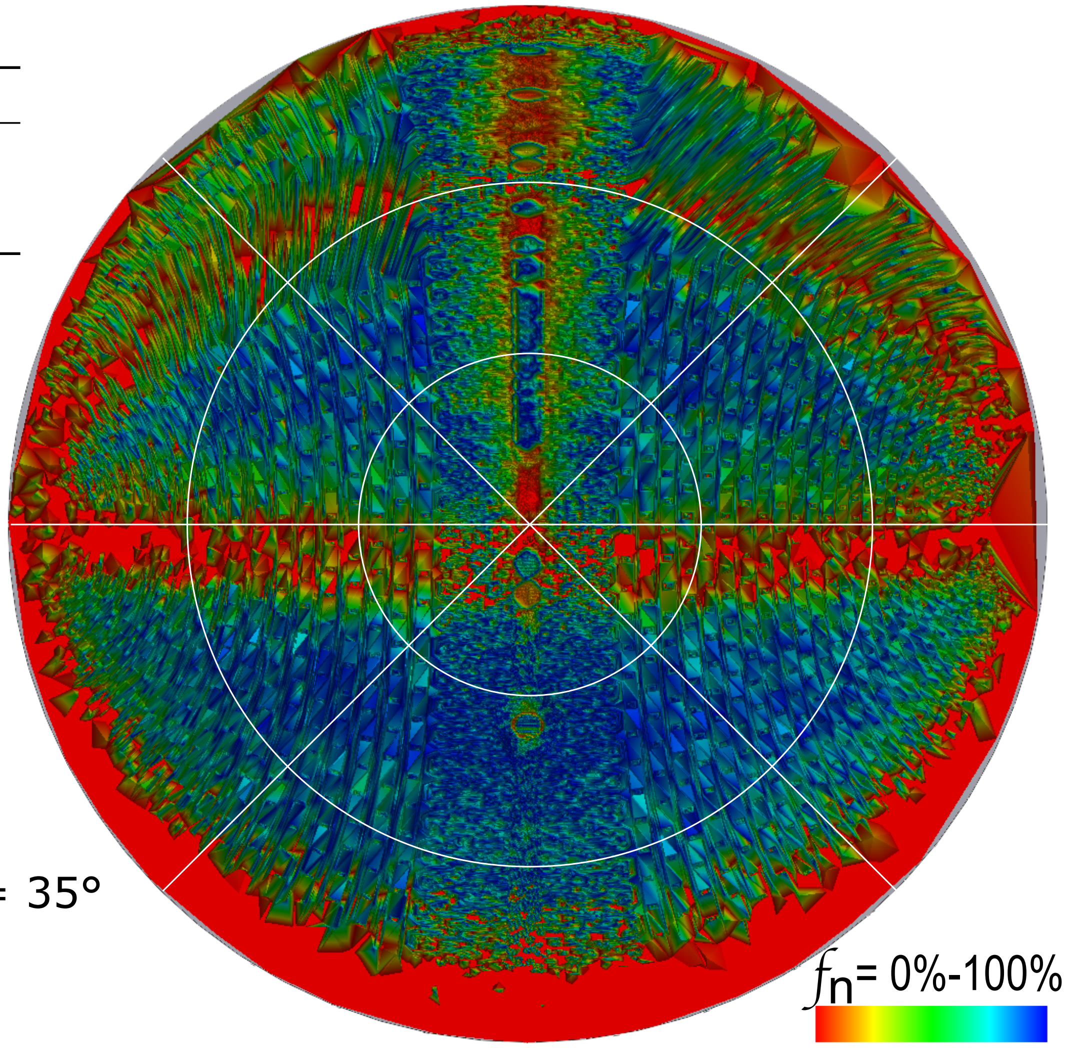
Local accordance

$$f_{j,A,B} = 100 \left(1 - \left| \frac{DSF_{A,j} - DSF_{B,j}}{DSF_{A,j} + DSF_{B,j}} \right| \right)$$

How to compare high resolution BSDF data: Global and local accordance

θ_i	0°	30°	35°	40°	45°	50°
$f_{V2,V1}$	–	75%	20%	68%	65%	66%
$f_{V3,V1}$	–	84%	74%	70%	71%	74%
f_{RB}	92%	–	–	–	–	–

Global accordance



Local accordance θ_i = 35°

Compare high resolution BSDF data: More Results

buildings MDPI

Article

Accordance of Light Scattering from Design and De-Facto Variants of a Daylight Redirecting Component

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Abstract: For the systematic development of a small-scale daylight-redirecting louver system the impact of manufacturing on light scattering characteristics has to be quantified, localized and understood. In this research, the accordance of the measured scattering distributions of a de-facto production sample *V1* with the computed predictions based on its design geometry *V2* are quantified for selected incident light directions. A metric describing the global accordance of distributions is adapted to quantify their overall difference. A novel metric of local accordance allows further analysis. A particular low global accordance between *V1* and *V2* is found for an incident elevation $\theta_i = 35°$. To test the hypothesis that this result can be explained by observed geometric deviations, a simulation model *V3* replicating these is compared to the design. The hypothesis is supported by the resulting high degree of accordance. The low local accordance for individual outgoing light directions indicates geometric non-uniformity of the sample *V1*. This method has been found useful for product development and quality assurance. Beyond their application in the proposed method, global and local accordance have potential applications in all fields of light scattering measurements.

Keywords: daylight redirection; BSDF; light scattering; simulation; goniophotometry; manufacturing deviation; quality assurance

Outlook

- How important are deviations from production for daylight autonomy or glare?
- Are there alternate metrics?
- How to compare data with deviating resolution?
- What is the relation of angular resolution and components size?
- Further Applications?
- How to get reliable BSDF for DRCs: repeat measurements, change sample size, measure multiple samples?
- Model the condenser system and optical bench of PG-2: would allow smaller beams and focus points.

- Suggestions?

Thank you for your attention!

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