Enabling parametric analysis of non-coplanar shading system for daylight and energy performance

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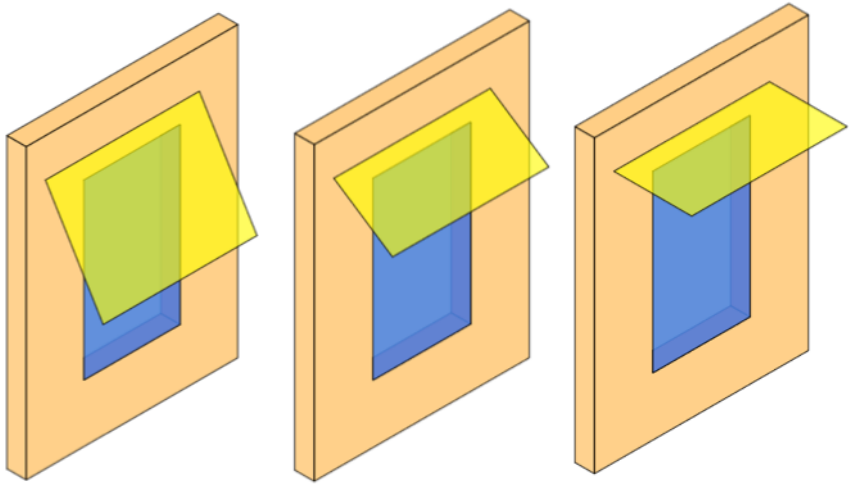
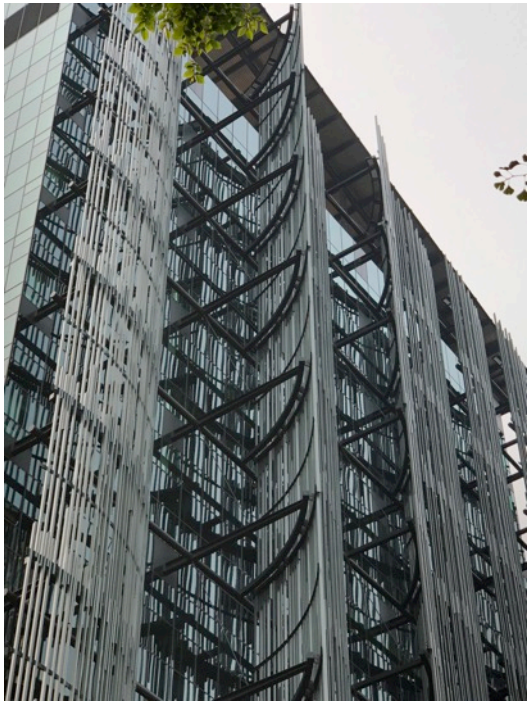
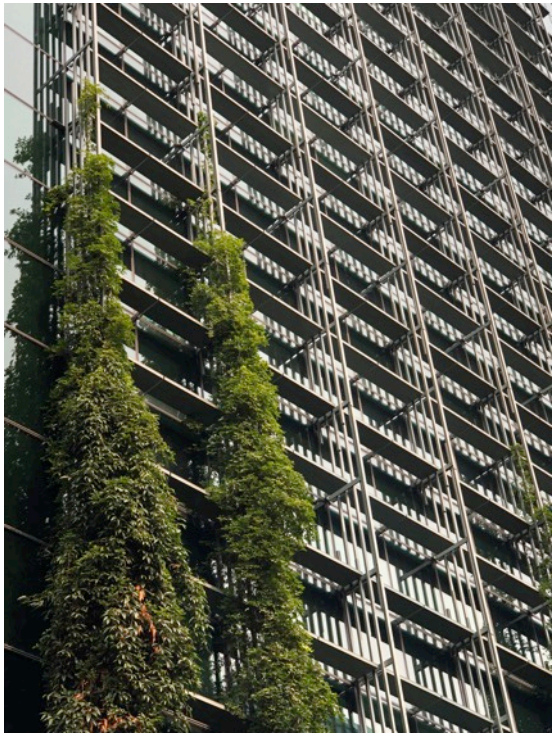
LBNL, Anyhere software



Non-coplanar shading system (NCP)





$E = V\,T\,D$ $\longrightarrow$ $E = V\,T\,F\,D$

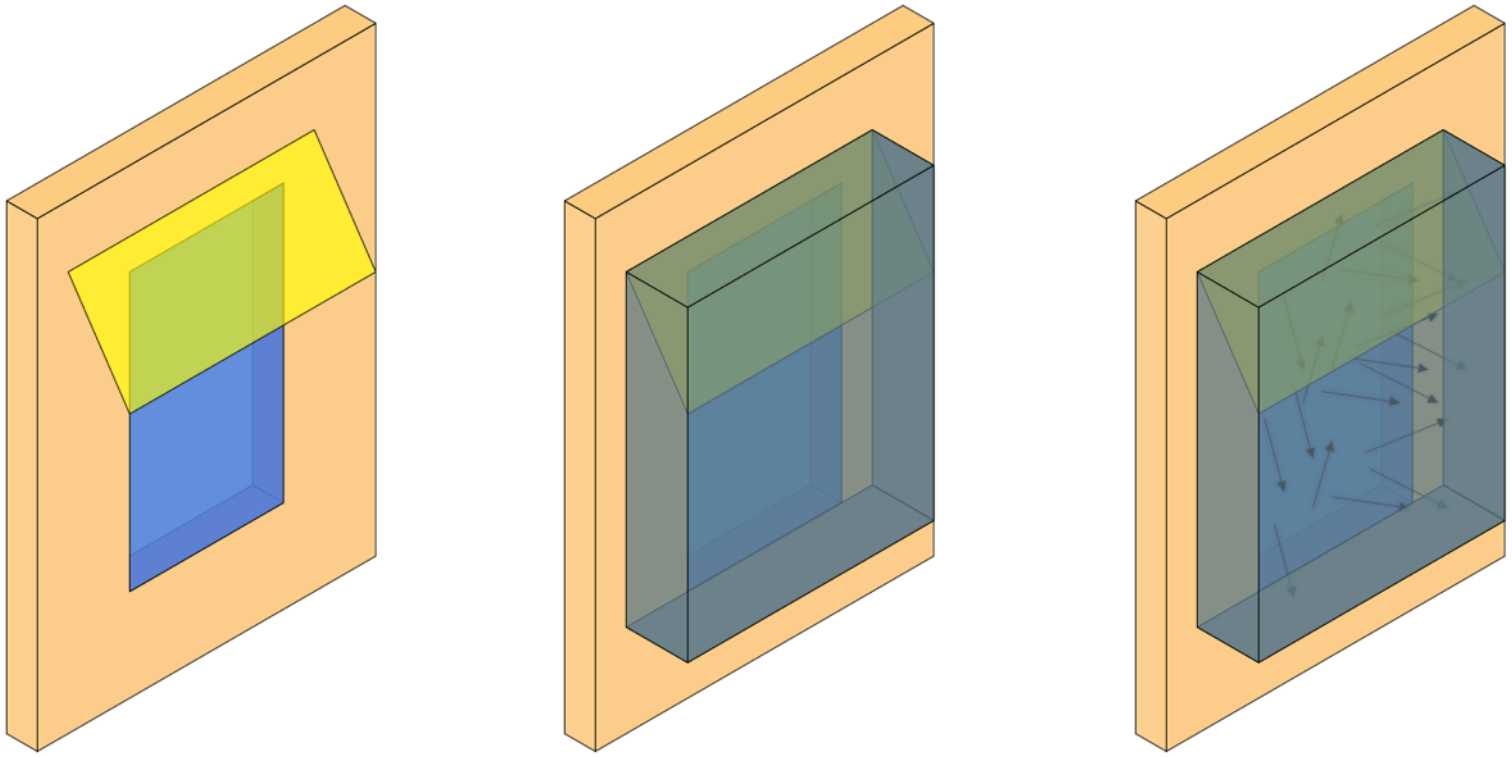
E: Illuminance or luminance;

V: view matrix;

T: Transmission matrix;

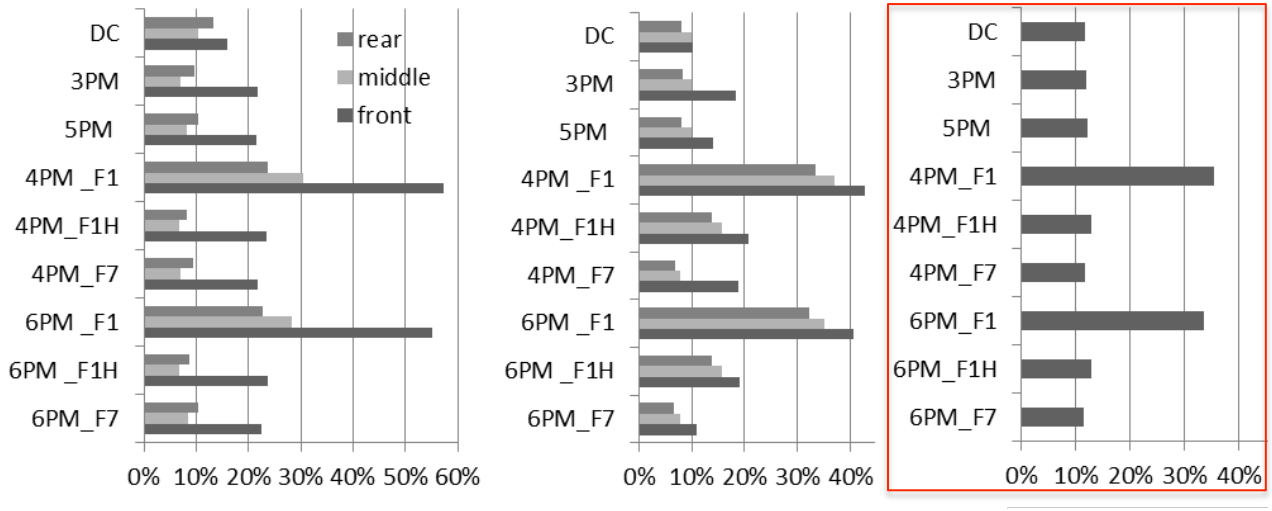
F: Façade matrix;

D: Daylight matrix



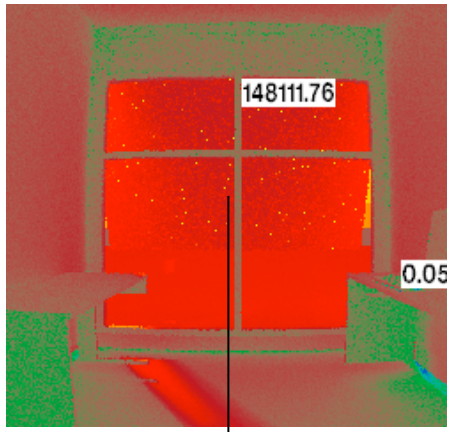
Illuminance

Overall illuminance error for awning angles (summer & winter) and for all periods

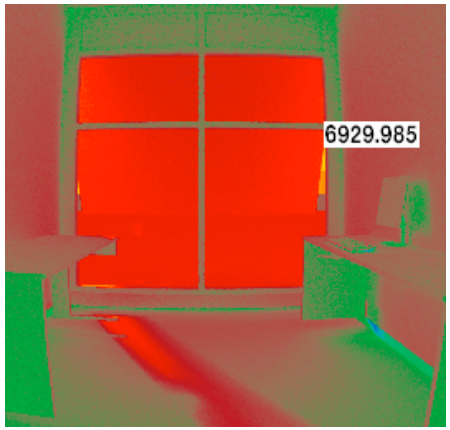


Glare

Matrix method	Overall error
DC	6.5%
3PM	6.8%
5PM	8.2%
4PM_F1	12.9%
4PM_F1H	7.9%
4PM_F7	6.4%
6PM_F1	15.2%
6PM_F1H	8.6%
6PM_F7	8.0%



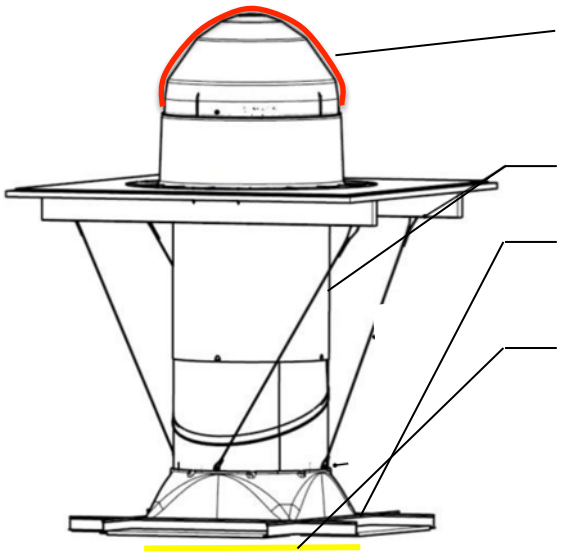
DC method with in scene Klems BSDF



Increase specular sampling (-ss) from 1 to 8000

Validation of simulating Tubular Daylighting Device (TDD), with *rfluxmtx*

Setup



Receiver surface: duplicate the acrylic dome surface and move up a little so that it sit just outside the dome

Tube: 99% reflectance from spectrophotometer measurement

Diffuser: Anisotropic tensor tree BSDF derived from scanning-goniophotometer measurement

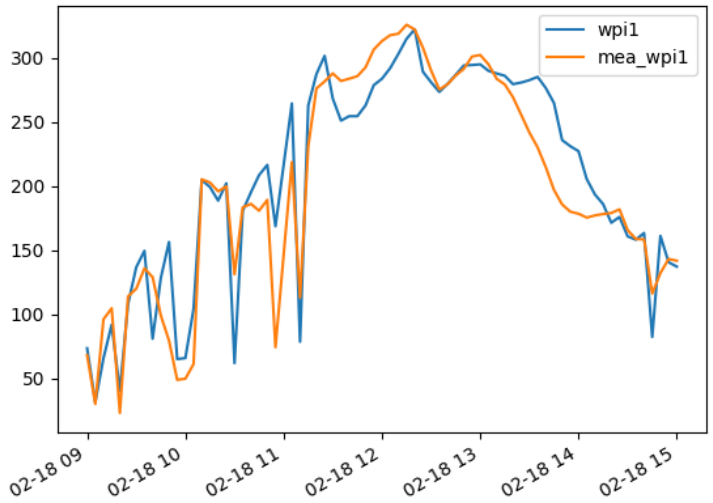
Sender surface : duplicate the diffuser surface and move down a little so that it's underneath the diffuser

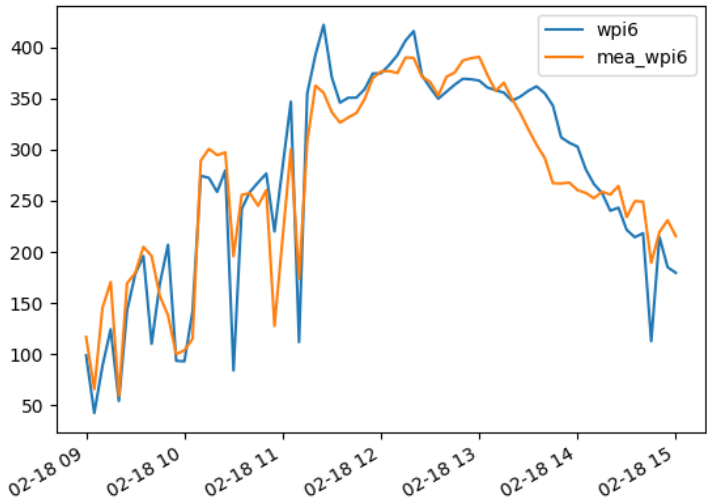

```
rfluxmtx -ab 10 -c
10000 sender
receiver tdd.rad -o
tdd.mtx
```

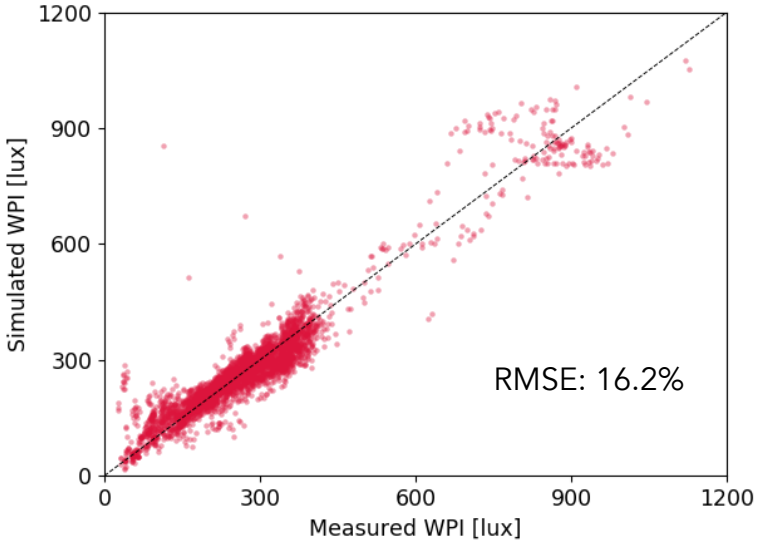
source: solutube.com

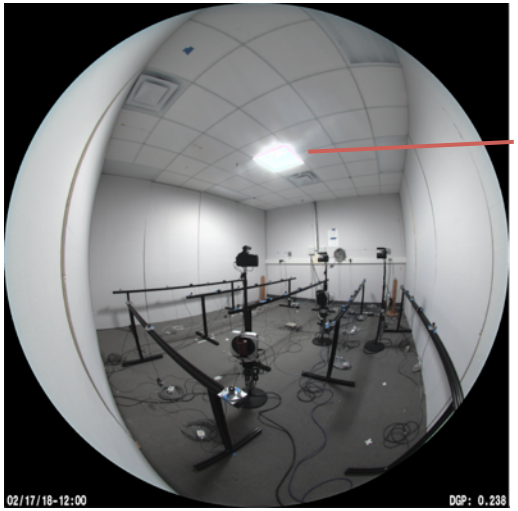
Validation of simulating Tubular Daylighting Device, with *rfluxmtx*

Result: compare again three days of workplane illuminance measurments









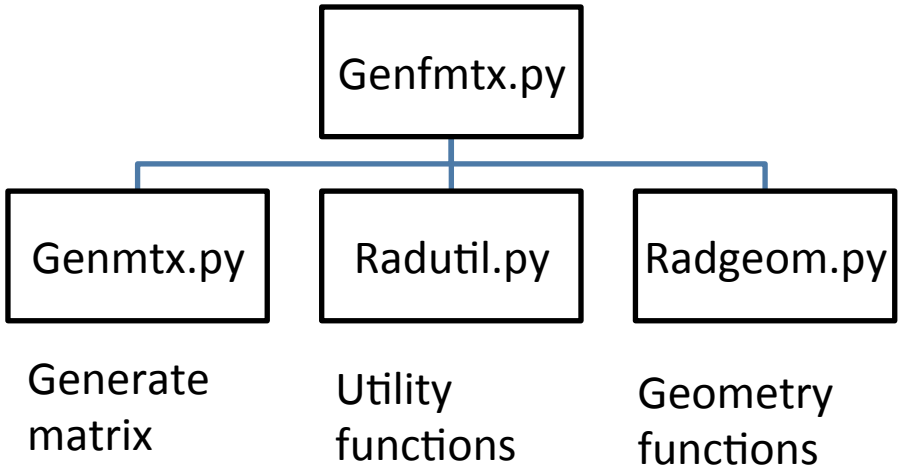
Flexlab, LBNL

To automate the process of generating façade matrices …

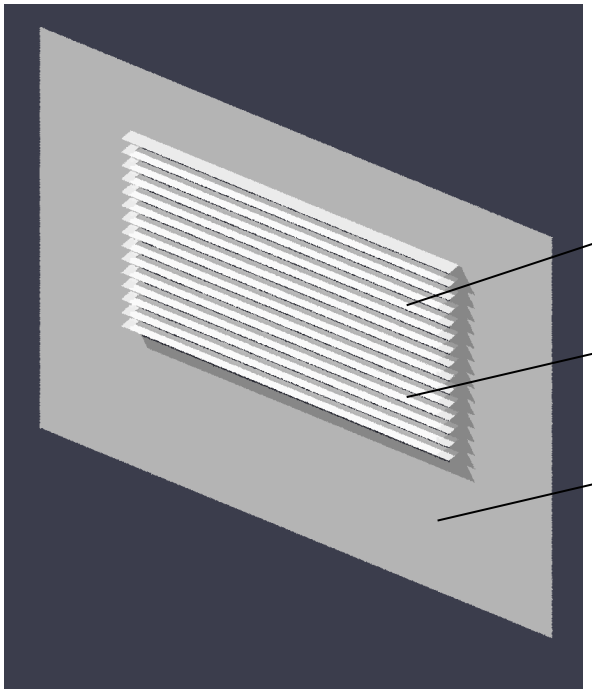
```
GENFMTX(1)                                                    GENFMTX(1)

NAME
       genfmtx - generate facade matrix / BSDF description from Radiance

SYNOPSIS
       genfmtx  [ -wf win_path ][ -sf ncs_path ][ -ss Sender basis ][ -rs Receiver
       basis ][ -o Ouput path ][ -wrap wrap to .XML ][ -env  Environment  ][  -opt
       rcontrib  options...   ][ -back 'backwards ][ -refl reflection ][ -FN using
       FN method ][ -depth system depth ][ -scale scale port ]
```



Example: venetian blind (comparing with genBSDF)



window.rad

venetian_blind.rad

ext_wall.rad

or

overhang.rad

vertical_fin.rad

awning.rad

```
genfmtx.py -wf window.rad -sf venetian_blind.rad
-rs kf -ss kf -opt '-ab 5 -ad 700 -lw 3e-6 -c
500' -o venetian_blind.mtx -wrap -env
material.rad venetian_blind.rad ext_wall.rad
```

klems

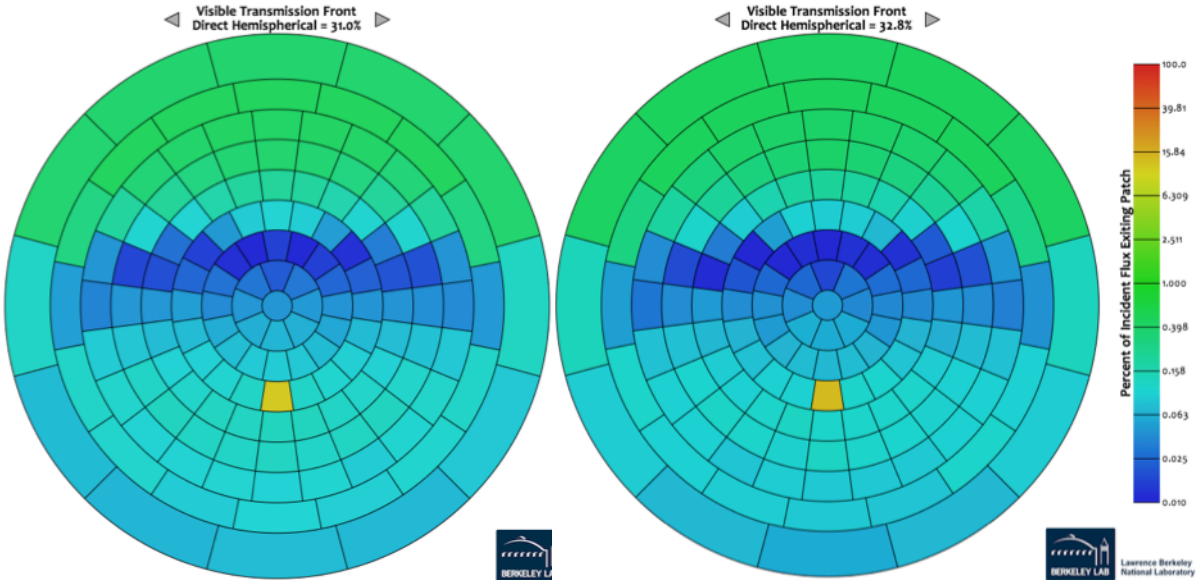
```
genfmtx.py -wf window.rad -sf venetian_blind.rad
-rs sc64 -ss sc64 -opt '-ab 5 -ad 700 -lw 3e-6 -
c 500' -o venetian_blind.mtx -wrap -env
material.rad venetian_blind.rad ext_wall.rad
```

tensor tree g6

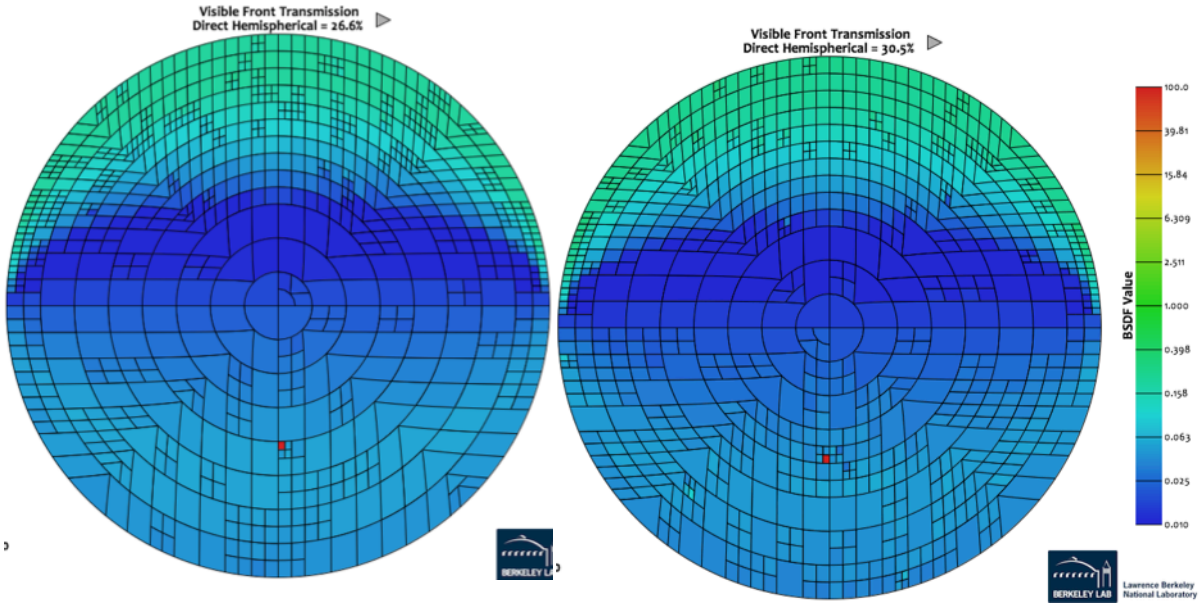
genBSDF

genfmtx

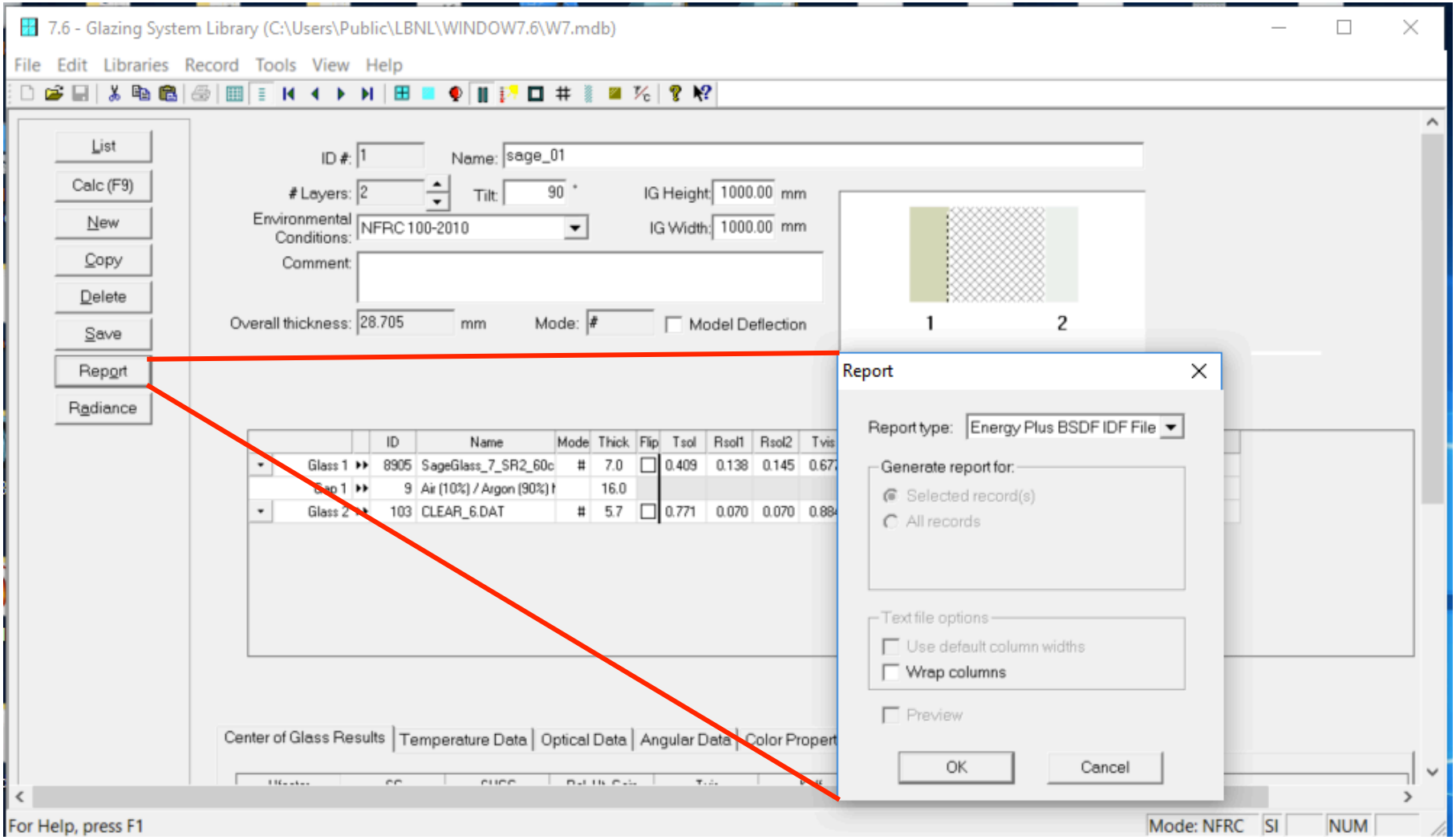
Full Klems



Tensor tree t4 g6



Validating matrix based method against EnergyPlus native NCP object

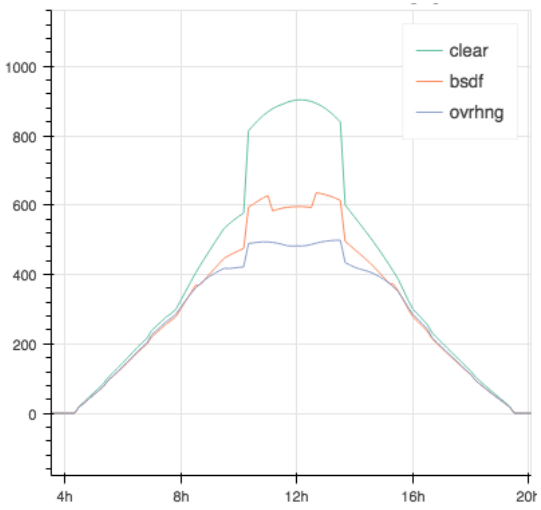


Validating matrix based method against EnergyPlus native NCP object

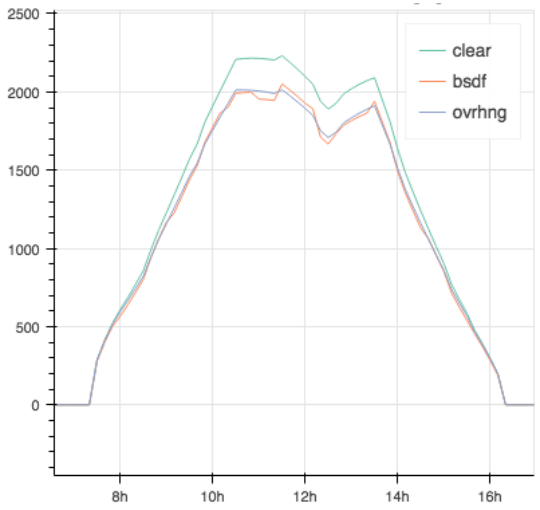
	NCP shading object	Description
'clear'	None	Single zone slide lit office with glazing unit represented as a CFS - BSDF object
'ovrhng'	E+ *shading zone detail object*	
'bsdf'	Radiance modeled F matrix	

} equivalent

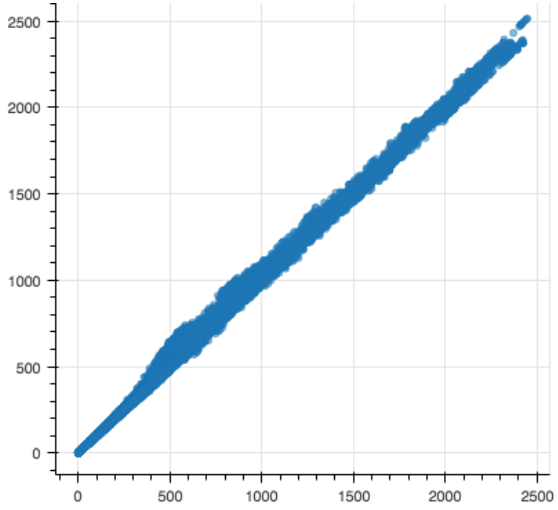
Transmitted solar [W]



Summer

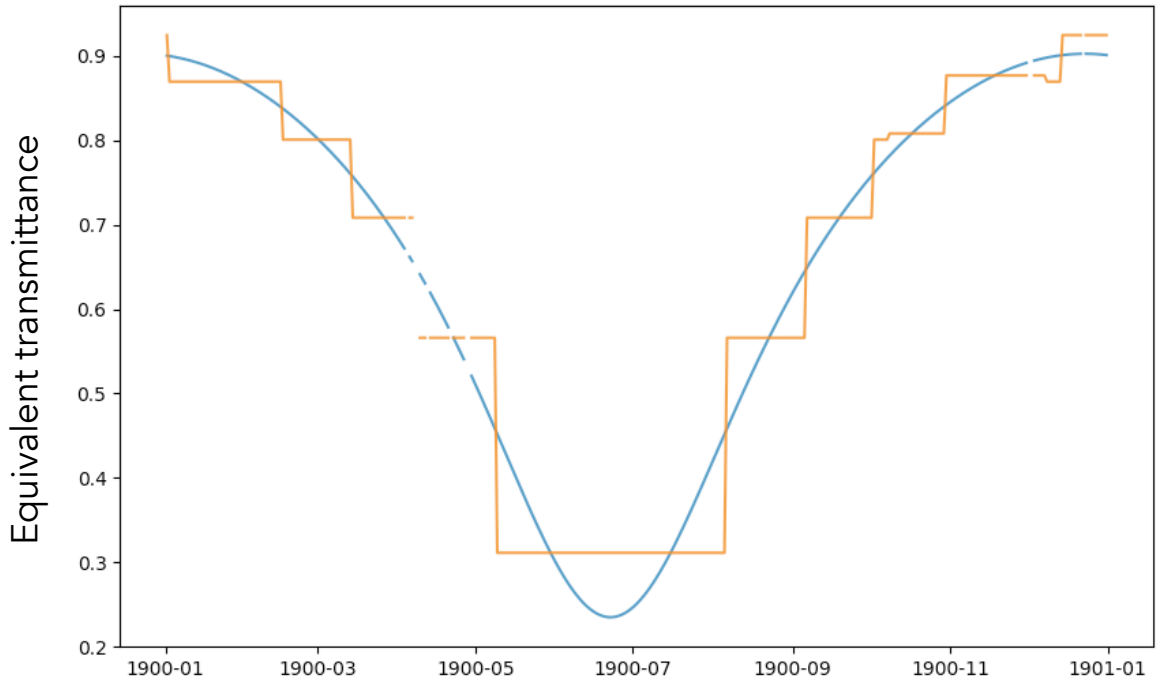


Winter



RMSE: 3.14W/m2 (9.5%)
Chicago TMY

Equivalent transmittance (percentage of shaded window area) of overhang at 12pm



- E+ native overhang (geometric);
- Matrix based overhang (Full Klems)

Acknowledgments

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https://facades.lbl.gov