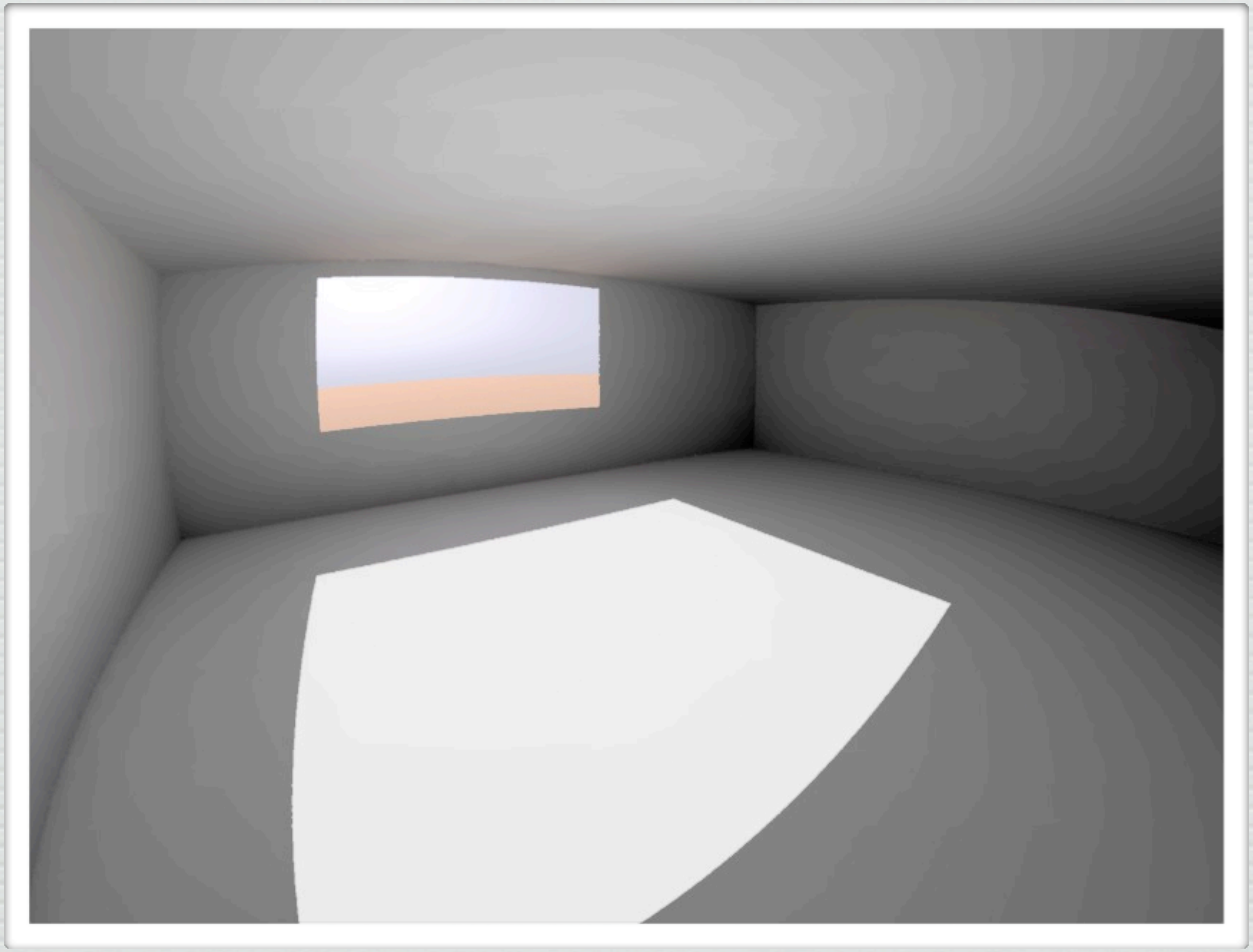
Modeling Complex Fenestration with **rtcontrib**

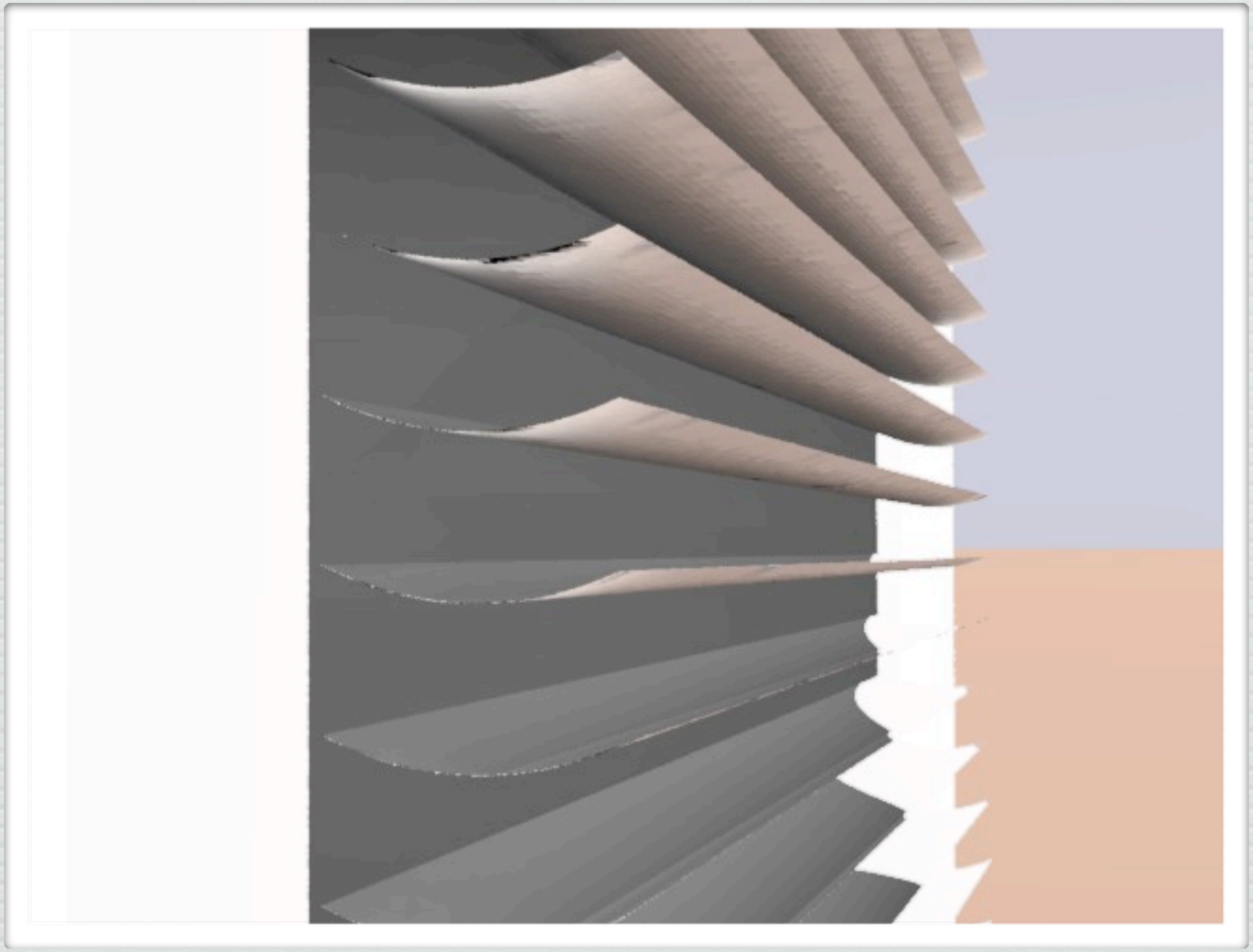
Greg Ward
Anyhere Software

What We'll Do

- Create a simple one-window daylit space
- MGF model of curved, specular blinds
- Compute transmission using **genBSDF**
- Create window distribution using **mkillum**
- Render with and without blinds geometry
- Perform annual simulation via 3-phase method



Our Simple Model



Blinds Model

MGF Description

```
# Example of demi-specular blinds
# Upper surface is concave and specular
# Lower surface is diffuse
m _blind_specular =
     c
     rs .9 0
     rd .05
     sides 1
m _blind_diffuse =
     c
     rd .7
     sides 1
o demi-spec_blinds
xf -t 0 -.2 0 -rx -25 -a 22 -rx 2.273 -i 1 -t 0 .2 0 -a 30 -t 0 .1 0 -i 1 -t 0 0 -.1
v v1 =
     p    -2   1e-4      .008
     n    0    .2       -.008
v v2 =
     p    2    1e-4     .008
     n    0    .2      -.008
v v3 =
     p    2    1e-4     -.008
     n    0    .2         .008
v v4 =
     p    -2   1e-4     -.008
     n    0    .2         .008
m _blind_specular
f v1 v2 v3 v4
v v5 =
     p    -2   -1e-4      -.008
v v6 =
     p    2    -1e-4      -.008
v v7 =
     p    2    -1e-4        .008
v v8 =
     p    -2   -1e-4        .008
m _blind_diffuse
f v5 v6 v7 v8
xf
o
```

See http://radsite.lbl.gov/mgf

Compute BSDF

```
genBSDF +mgf spec_blinds.mgf \
    > spec_blinds.xml
```

I added `-c 4000`,
which took 5 hours on my laptop(!)

Gosh, wouldn't that be nice?

BSDF Visualization

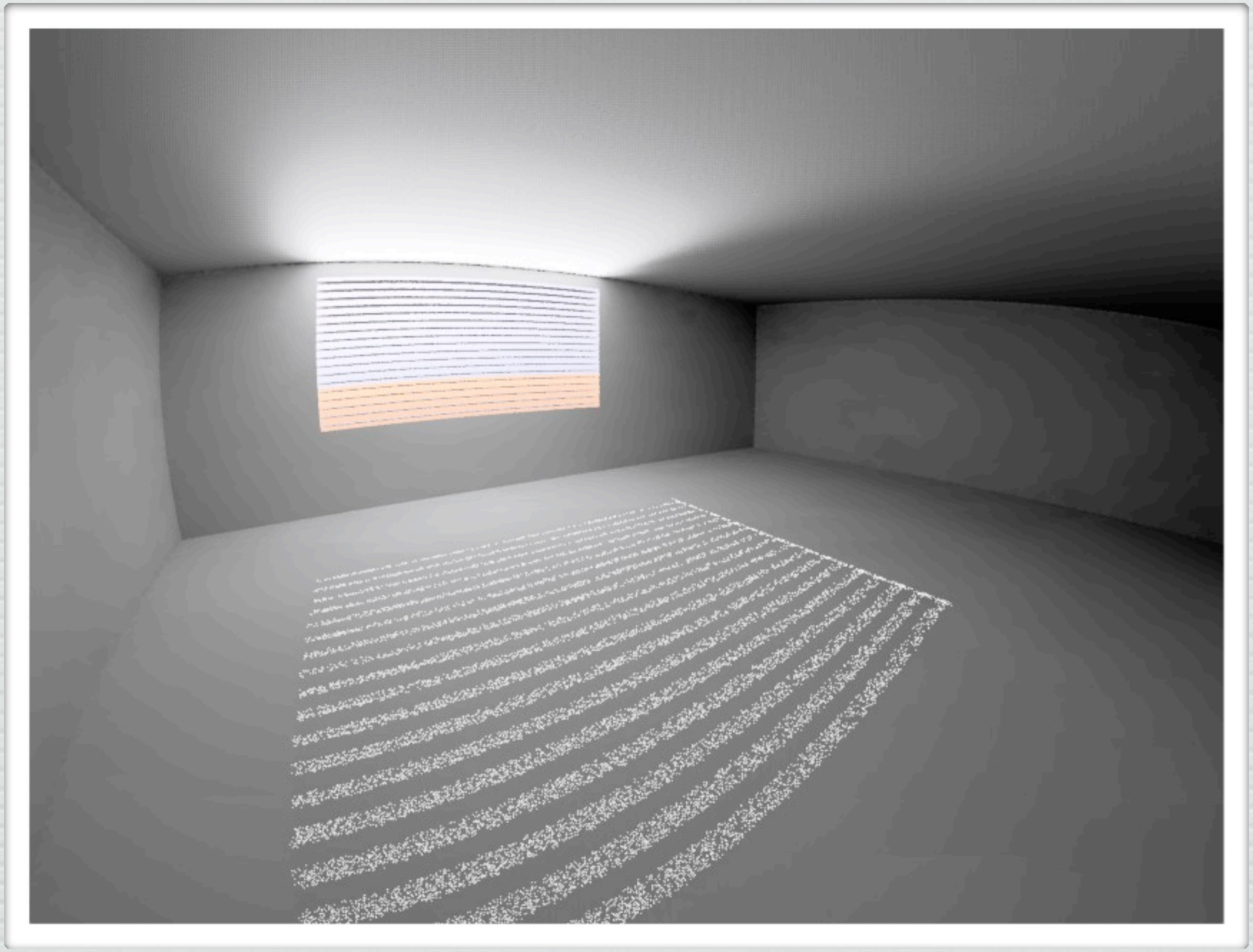
Running mkillum

Create illum with BSDF geometry

```
#@mkillum d=./spec_blinds.xml l- t=0 s=100
void polygon window
0
0
12
  0   2   1
  0   6   1
  0   6   2.8
  0   2   2.8
```

```
oconv sky.rad room-l.rad > base.oct
mkillum base.oct < room-l.rad \
| oconv sky.rad - > room-lmki.oct
```

```
rpict -ps 1 -vf room.vf -dj .99 -ab 2 -x 2048 -y 2048 room-lmki.oct\
| pfilt -1 -x /2 -y /2 -r .6 > room-lbmki.hdr
```



Rendered

Now, without Geometry

```
#@mkillum d=./spec_blinds.xml l+ s=100
void polygon window
0
0
12
  0   2   1
  0   6   1
  0   6   2.8
  0   2   2.8
```

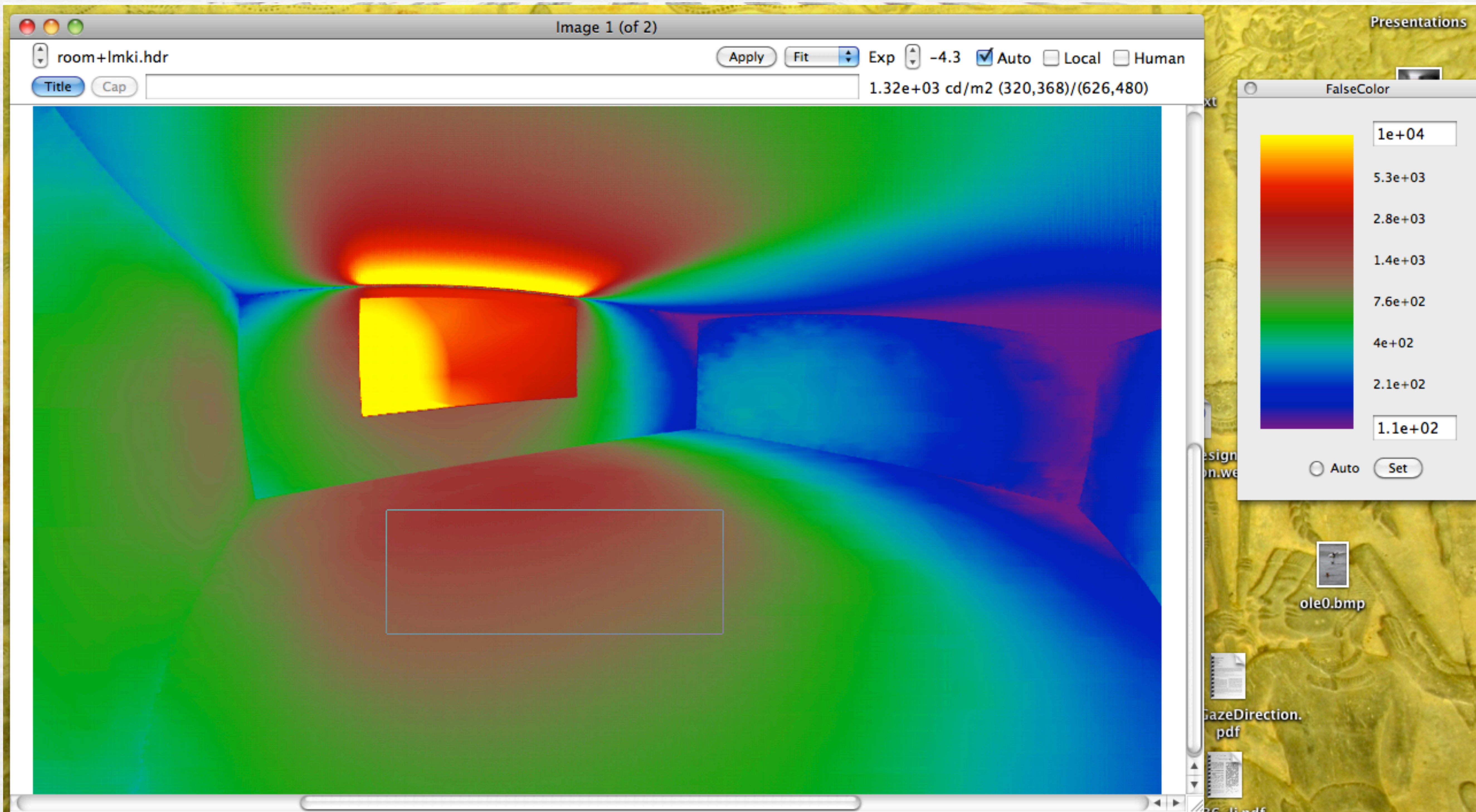
```
mkillum base.oct < room+l.rad \
| oconv - > room+lmki.oct
```

Notice sky.rad is gone

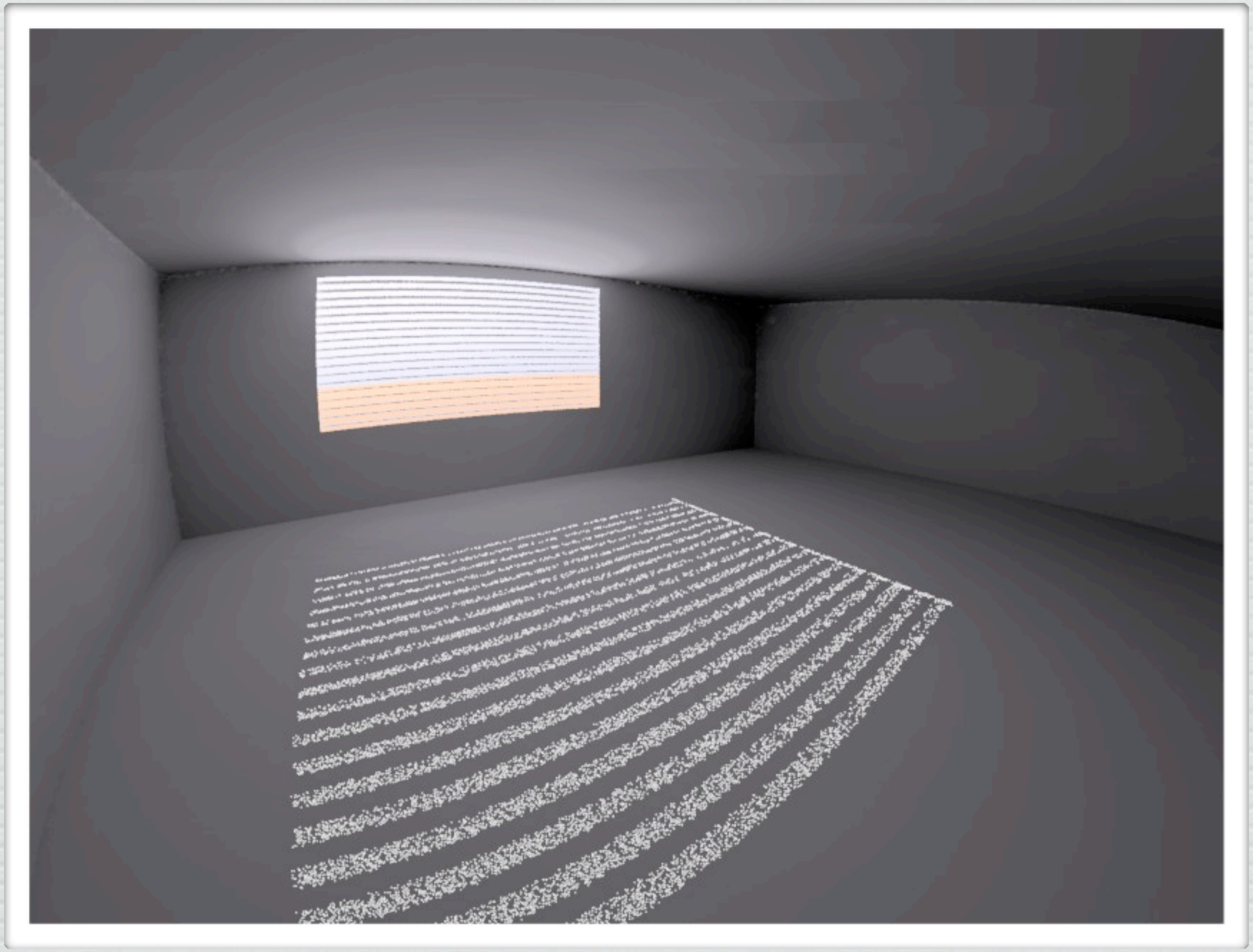
```
rpict -ps 1 -vf room.vf -dj .99 -ab 2 -x 2048 -y 2048 room+lmki.oct\
| pfilt -1 -x /2 -y /2 -r .6 > room+lbmki.hdr
```

Comparison

Averages Similar

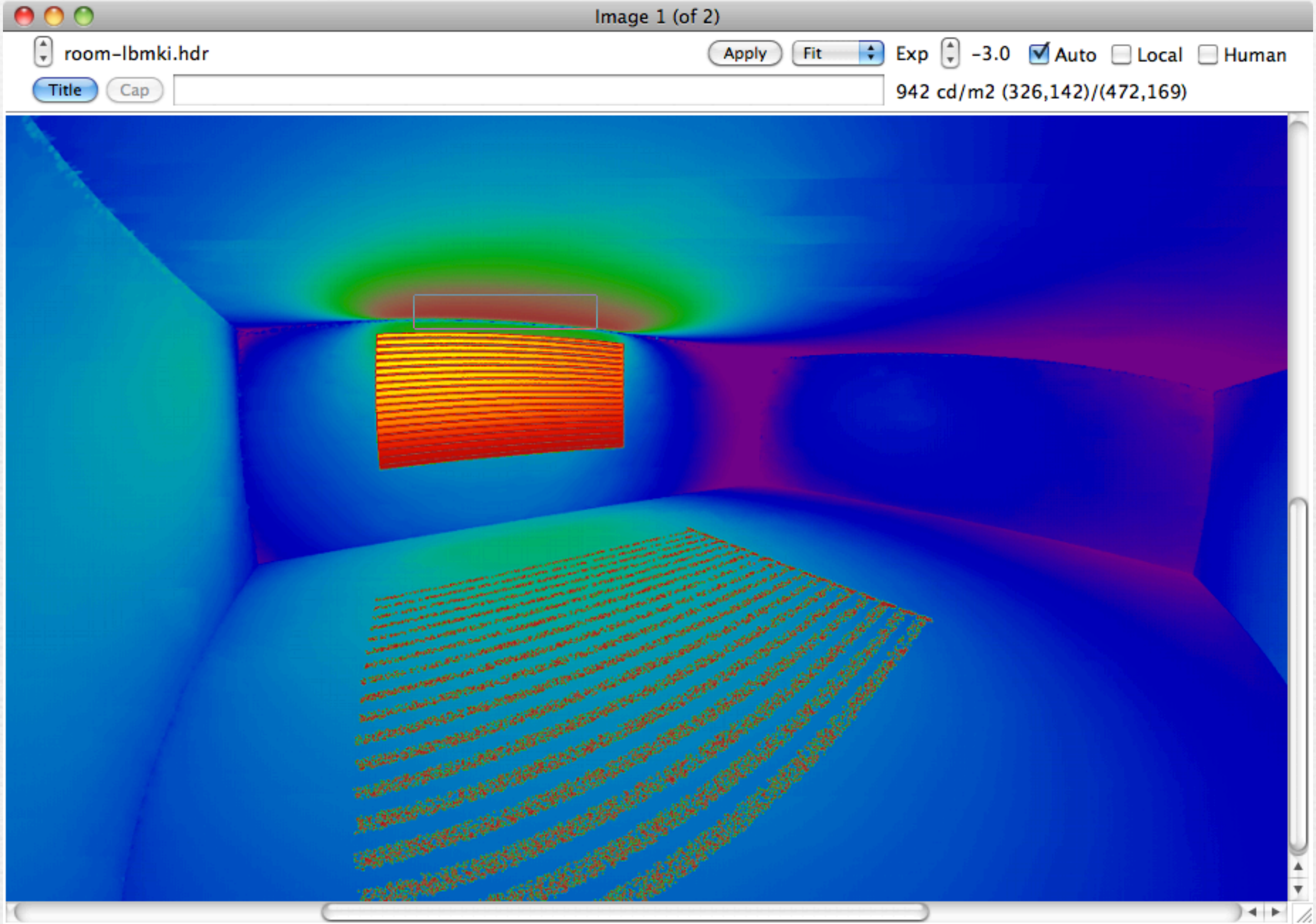


Q: Why Not Use **mkillum** by Itself?

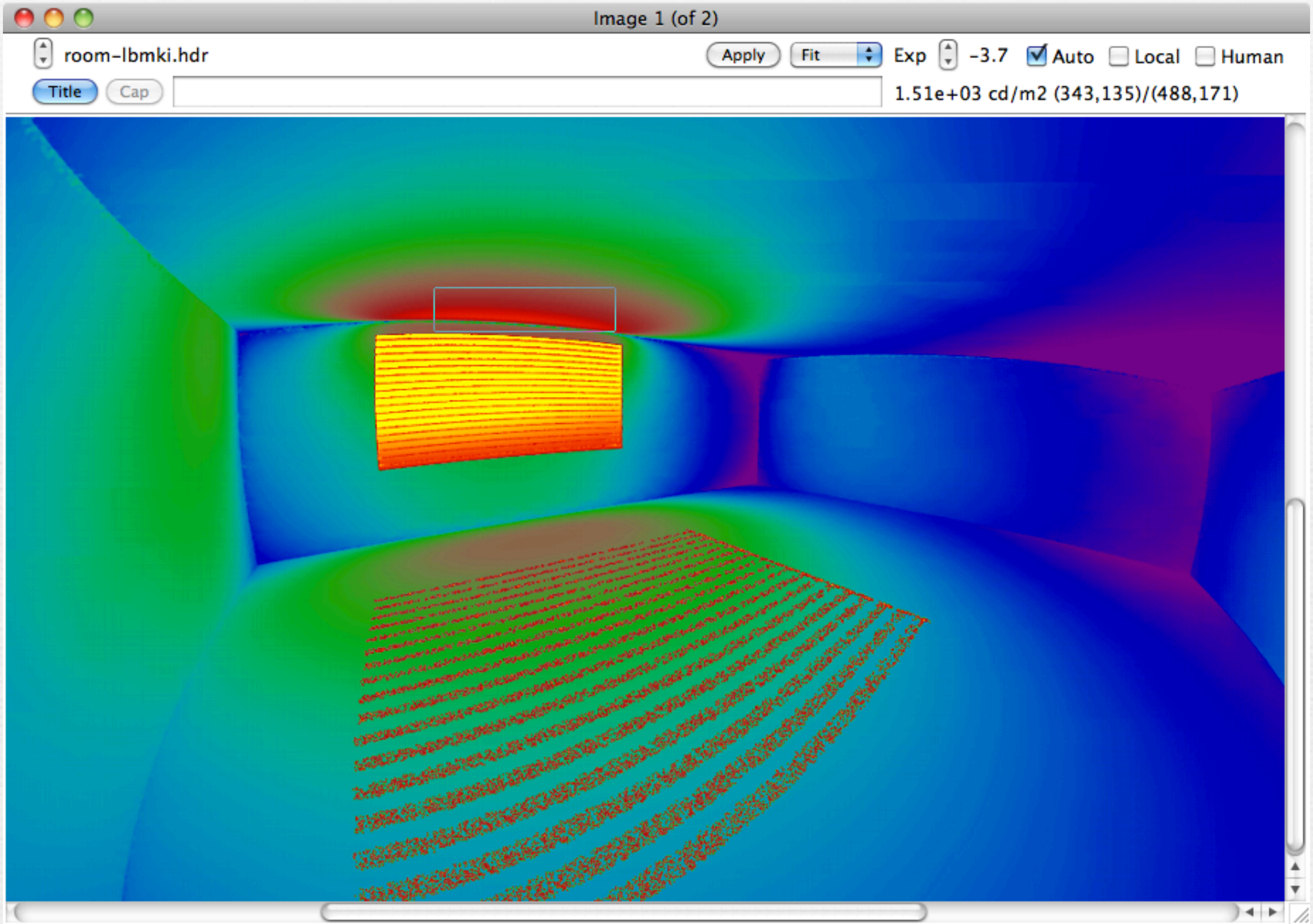


Looks OK

Check out Ceiling



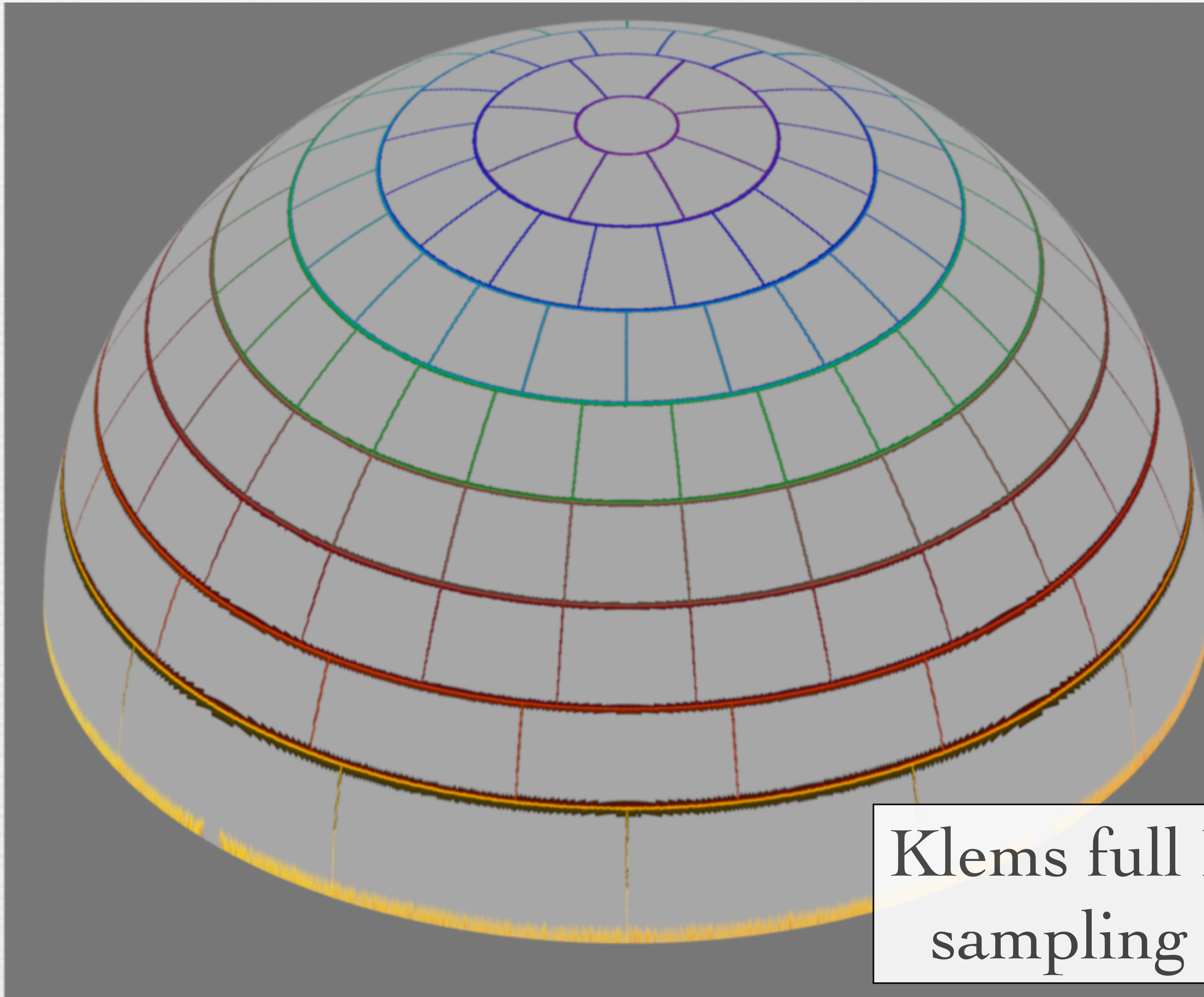
Diffuse Blind Case



Annual Simulation

- **Phase I**:
  Use **rtcontrib** to get daylight coefficients relating sky patches to incident directions
- **Phase II**:
  Use **rtcontrib** to relate exiting portal directions to desired measurement locations (e.g., image)
- **Phase III** (time-step calculation):
  sky * incident * BTDF * exiting

Phase I: Compute **D**



Klems full BSDF sampling basis

Phase I (cont'd)

```
oconv dummysky.rad room.rad > phase1.oct
```

```
# dummysky.rad

void glow skyglow
0
0
4 1 1 1 0

skyglow source sky
0
0
4 0 0 1 360
```

Phase I (cont'd)

Sample count

Window orientation

```
genklemsamp -ff -c 1000 -vd -1 0 0 \
window.rad | rtcontrib -c 1000 -ff \
-f tregenza.cal -b tbin -bn Ntbins \
-m skyglow -w phase1.oct > exterior.dmx
```

Subject material after bin options

Let's look inside...

Input is ray direction from rtcontrib

tregenza.cal

```
alt = Asin(Dz)/DEGREE;
azi = Atan2(Dx,Dy)/DEGREE;

tazi(inc) = if(359.9999-.5*inc - azi, floor((azi+.5*inc)/inc), 0);

tbin = if(-alt, 0,
    select(floor(alt/12) + 1,
        1 + tazi(12),
        31 + tazi(12),
        61 + tazi(15),
        85 + tazi(15),
        109 + tazi(20),
        127 + tazi(30),
        139 + tazi(60),
        145
    ) );
```

Output is tbin given to rtcontrib -b option

```
Ntbins : 146;    { total number of bins }
```

Total number of bins for –bn option

Phase II: Compute V

```
oconv winlight.rad room.rad > phase2.oct
```

```
void light winlight
0
0
3 1 1 1

winlight polygon window
0
0
12
     0     2     1
     0     6     1
     0     6     2.8
     0     2     2.8
```

Phase II (cont'd)

Gets bin from ray, similar to tregenza.cal

Generates view rays for image

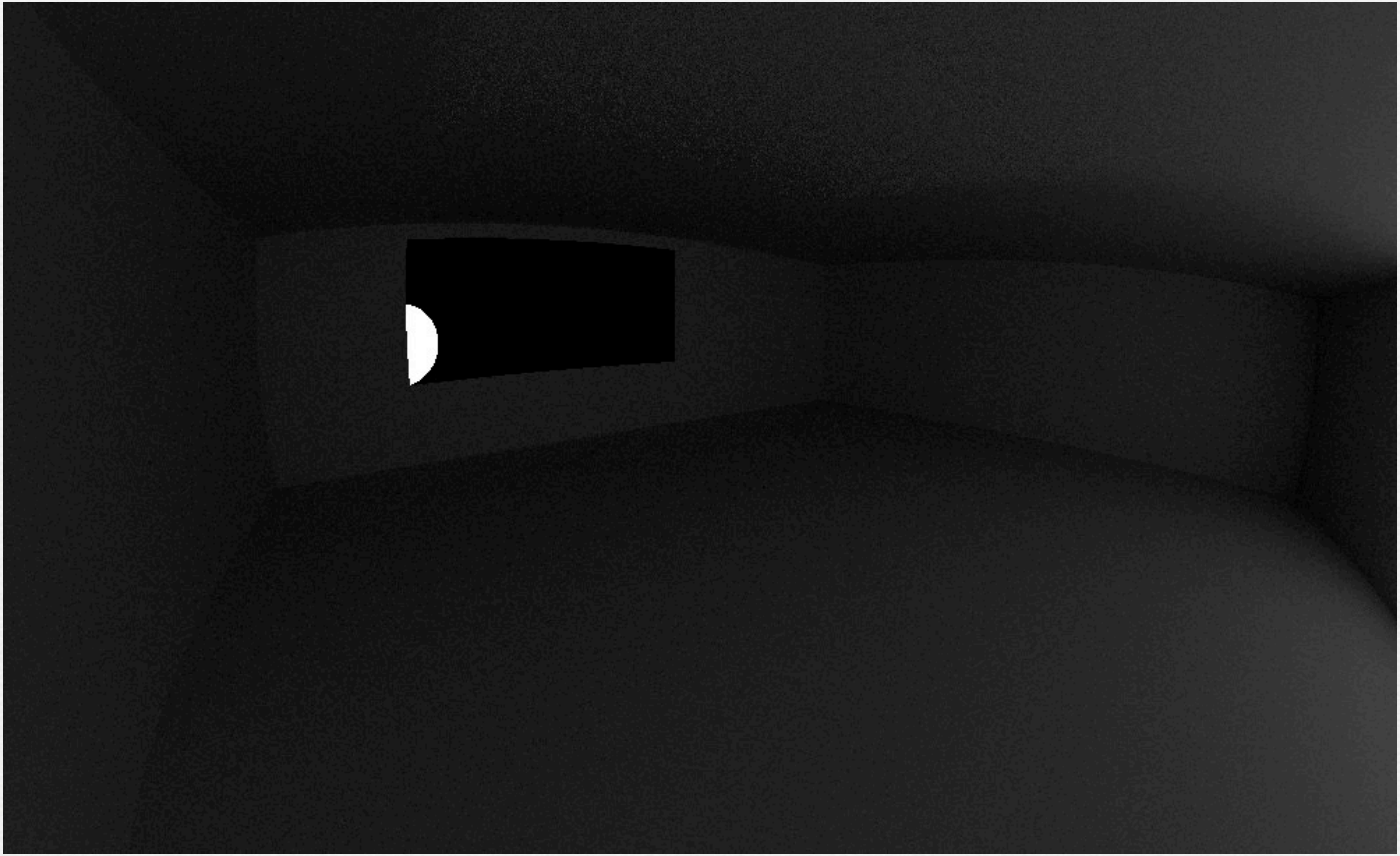
```
vwrays -ff -x 1000 -y 1000 -vf room.vf \
| rtcontrib `vwrays -x 1000 -y 1000 -vf room.vf -d` \
-ffc -o rend/part%03d.hdr -f klems_int.cal \
-b kbinW -bn Nkbins -m winlight -V- \
-ab 2 -ds .1 -dj .9 -ad 1500 -lw 4e-4 \
-n 3 phase2.oct
```

Images by bin number

Monte Carlo rendering parameters

2.5 hours later on my laptop...

View Components V



Phase III: Time Step

- Use **genskyvec** to create sky patch vector **s**
- Use **dctimestep** to multiply it all together

BTDF

Sky Patch Vector

Result Vector

$$i = VTDs$$

View Matrix

Daylight Matrix

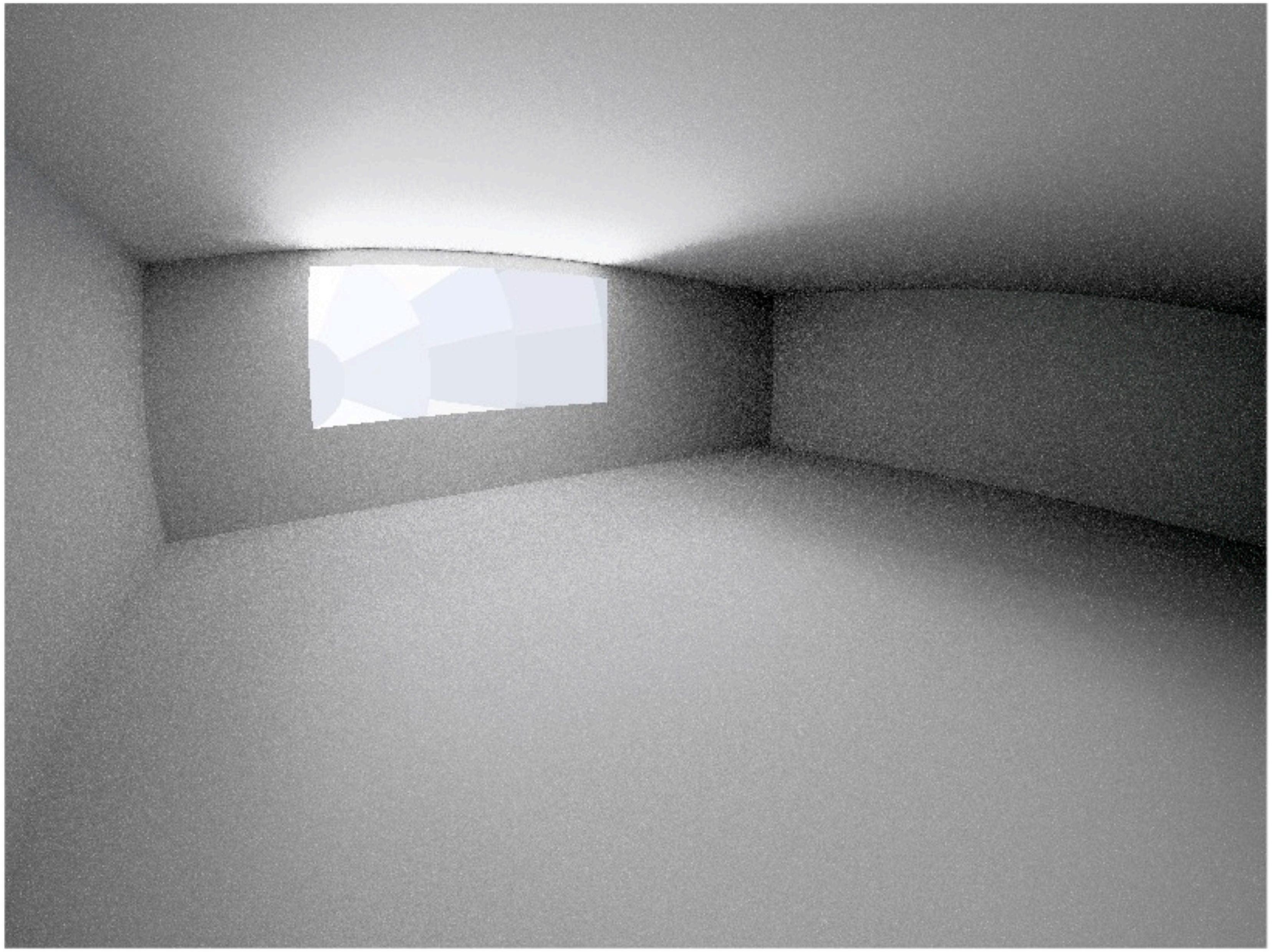
Phase III (cont'd)

Gets Tregenza sky

```
gensky 7 12 17 | genskyvec -m 1 \
| dctimestep rend/part%03d.hdr spec_blinds.xml exterior.dmx \
> rend0712_17.hdr
```

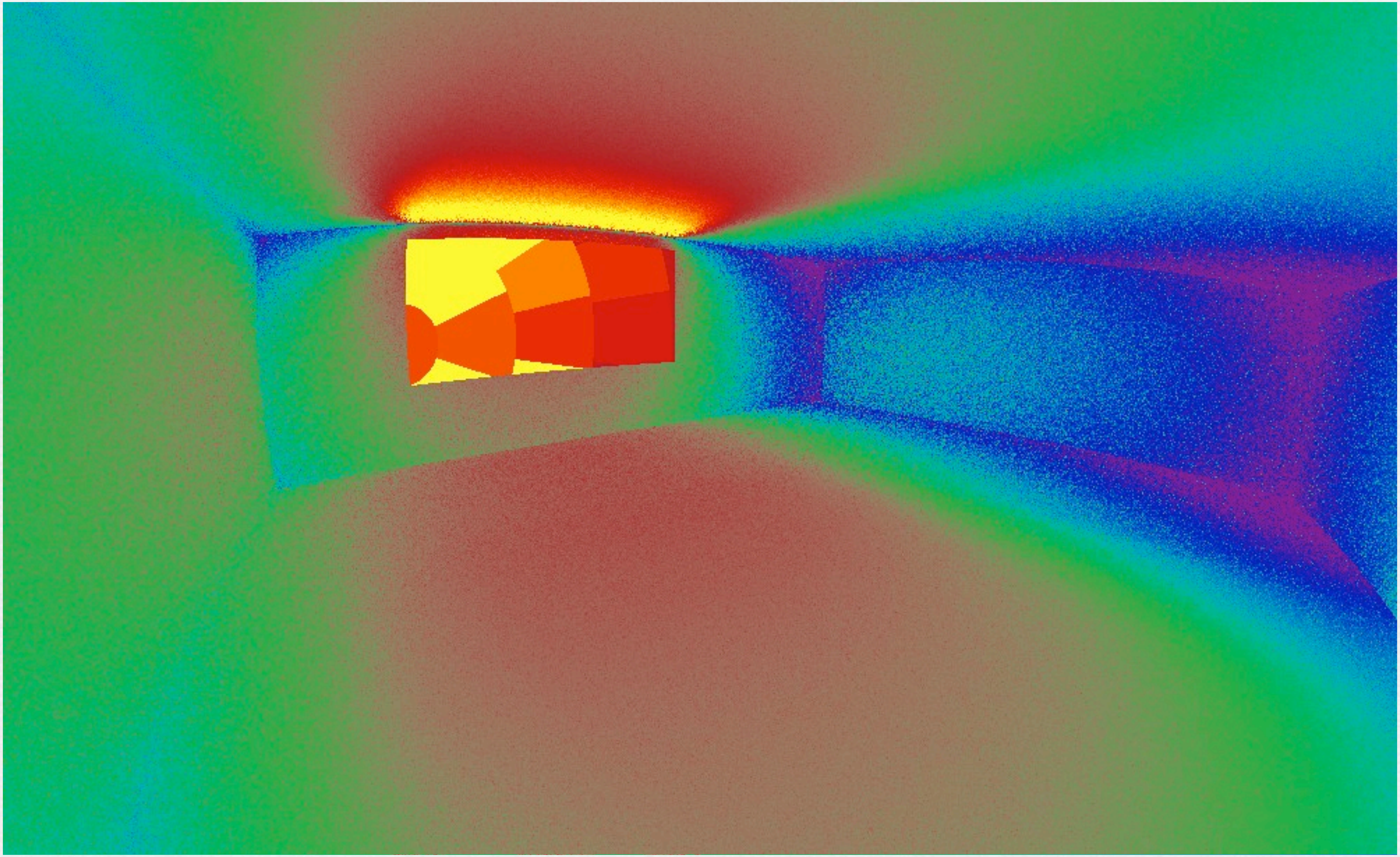
Can use diffuse blinds, too

Takes 3.5 seconds on my laptop



Final Result

Compared to **mkillum**

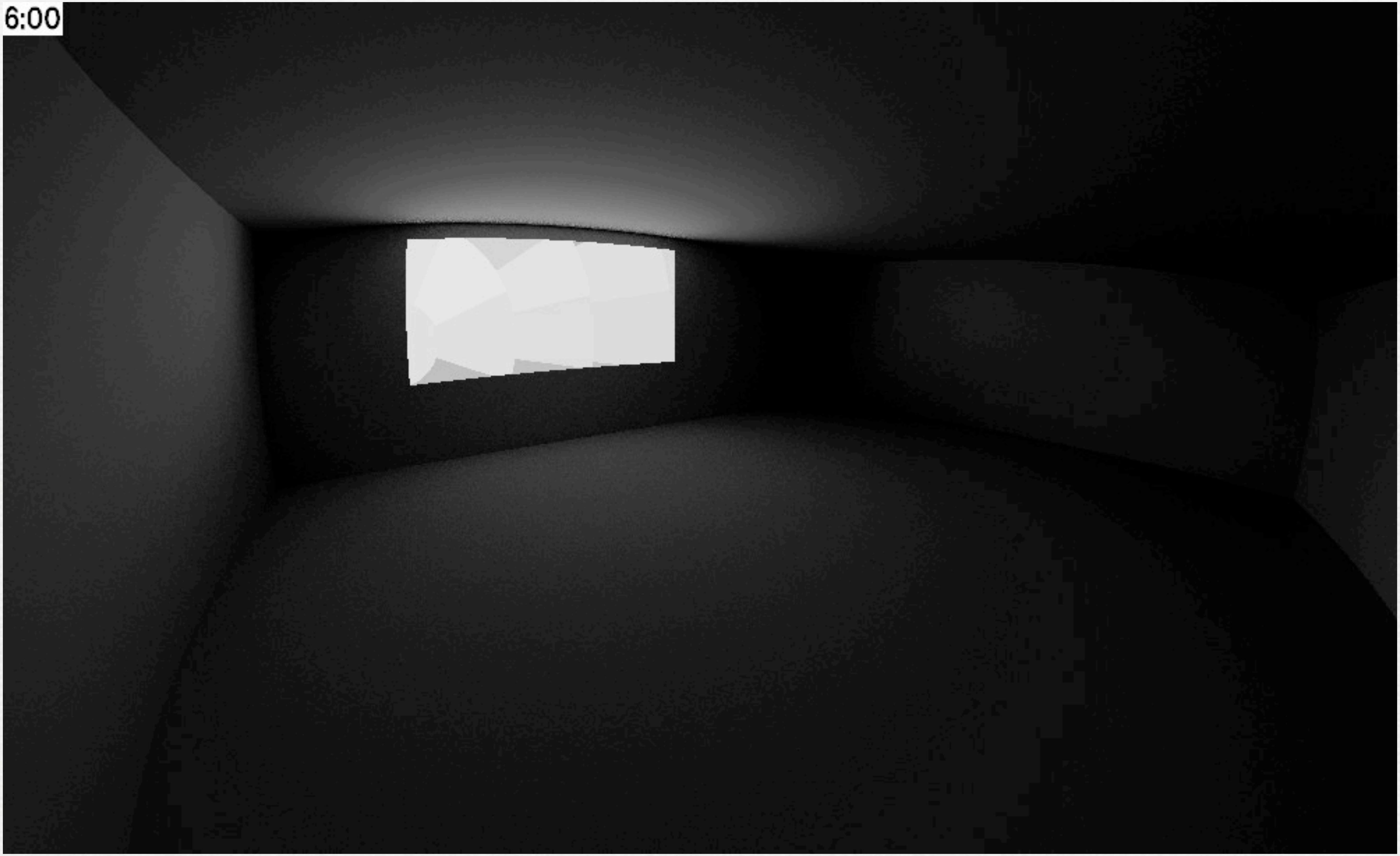


Animation of Day

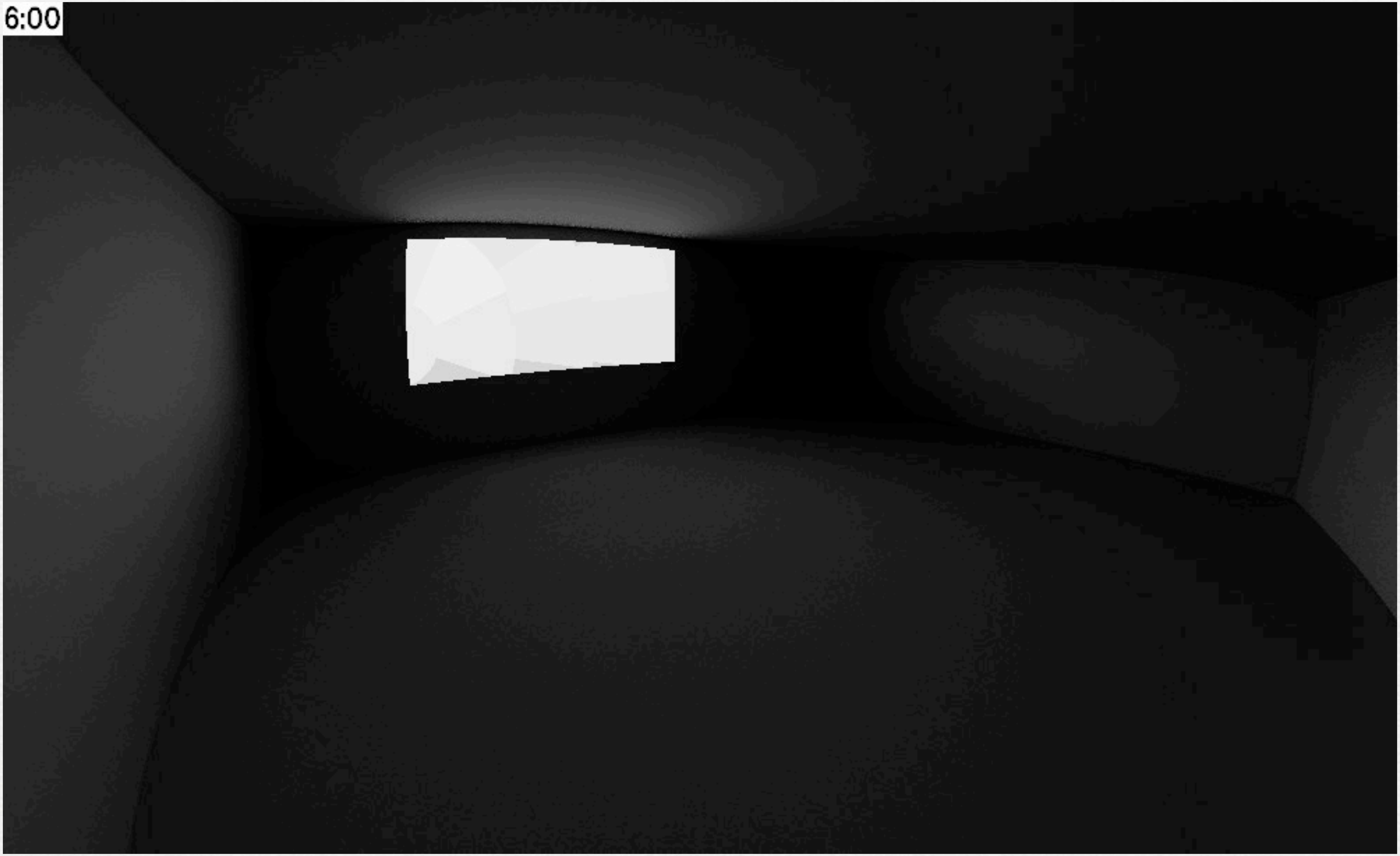
```
set i=1
foreach hr ( {6,7,8,9,10,11,12,13,14,15,16,17,18}:{00,15,30,45} )
gensky 7 12 $hr | genskyvec -m 1 \
| dctimestep rend/part%03d.hdr spec_blinds.xml exterior.dmx \
> anim1/frame$i.hdr
@ i++
end
```

```
set i=1
foreach hr ( {6,7,8,9,10,11,12,13,14,15,16,17,18}:{00,15,30,45} )
gensky 7 12 $hr | genskyvec -m 1 \
| dctimestep rend/part%03d.hdr diff_blinds.xml exterior.dmx \
> anim2/frame$i.hdr
@ i++
end
```

Specular Blinds



Diffuse Blinds



Resources

- Axel Jacobs' tutorial:
  "Understanding `rtcontrib`"
  http://luminance.londonmet.ac.uk/
  ➔ LEARNIX ➔ DOCUMENTATION