Image based lighting for glare assessment

Third Annual Radiance Workshop - Fribourg 2004

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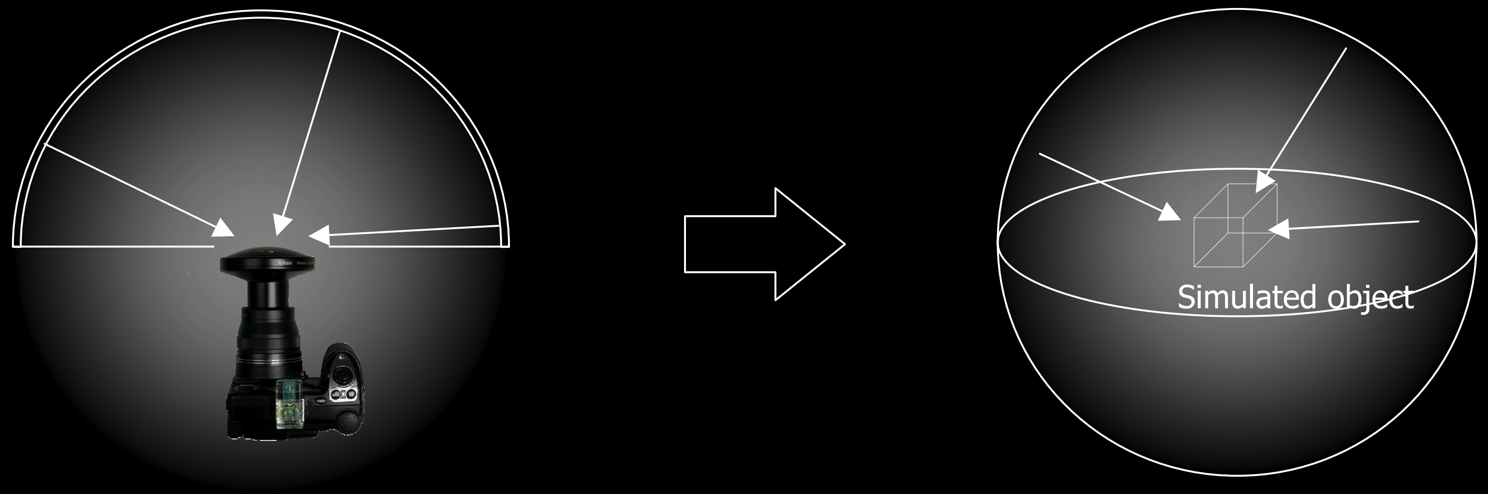
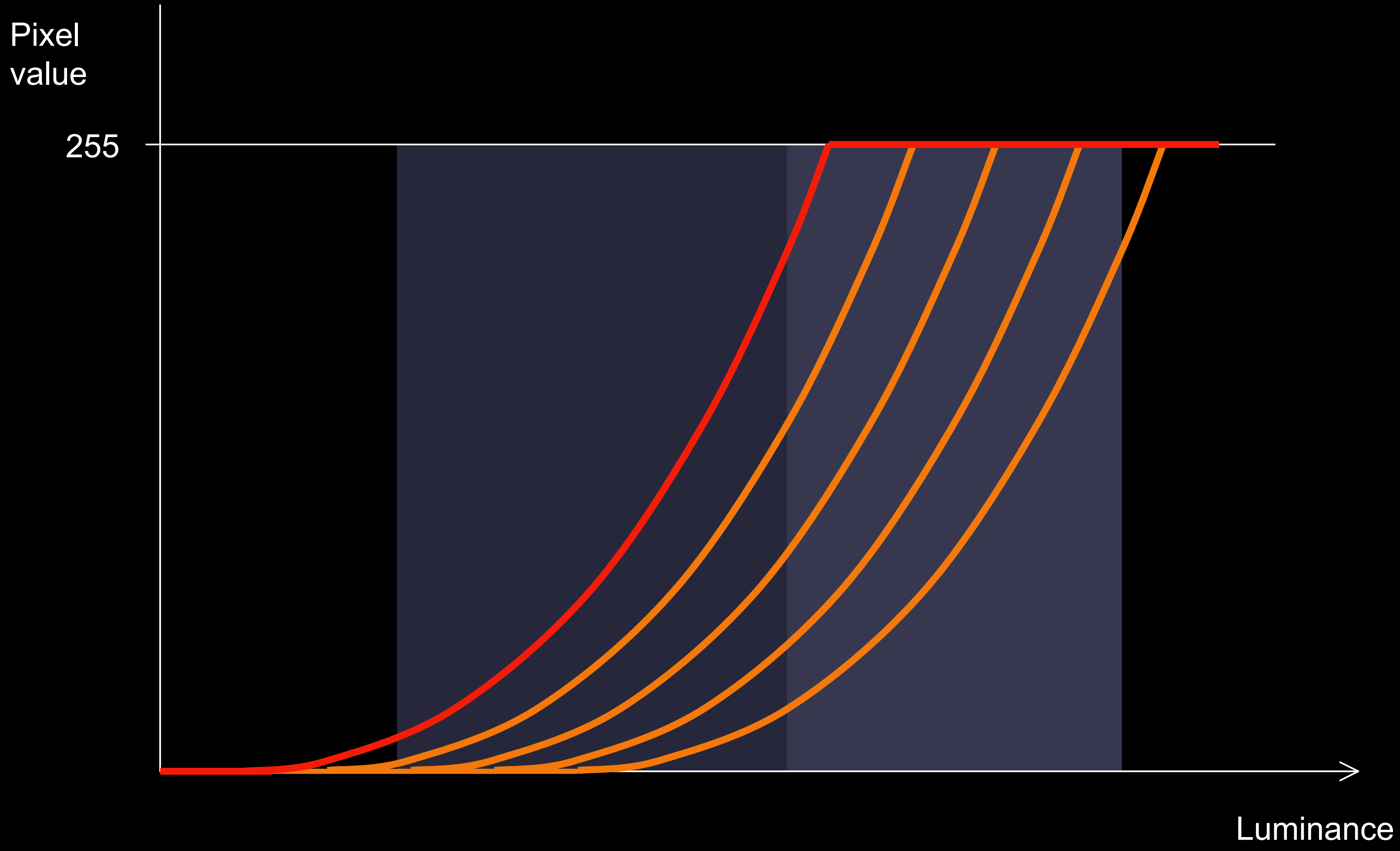
Include data acquired with a digital camera into visual comfort simulations

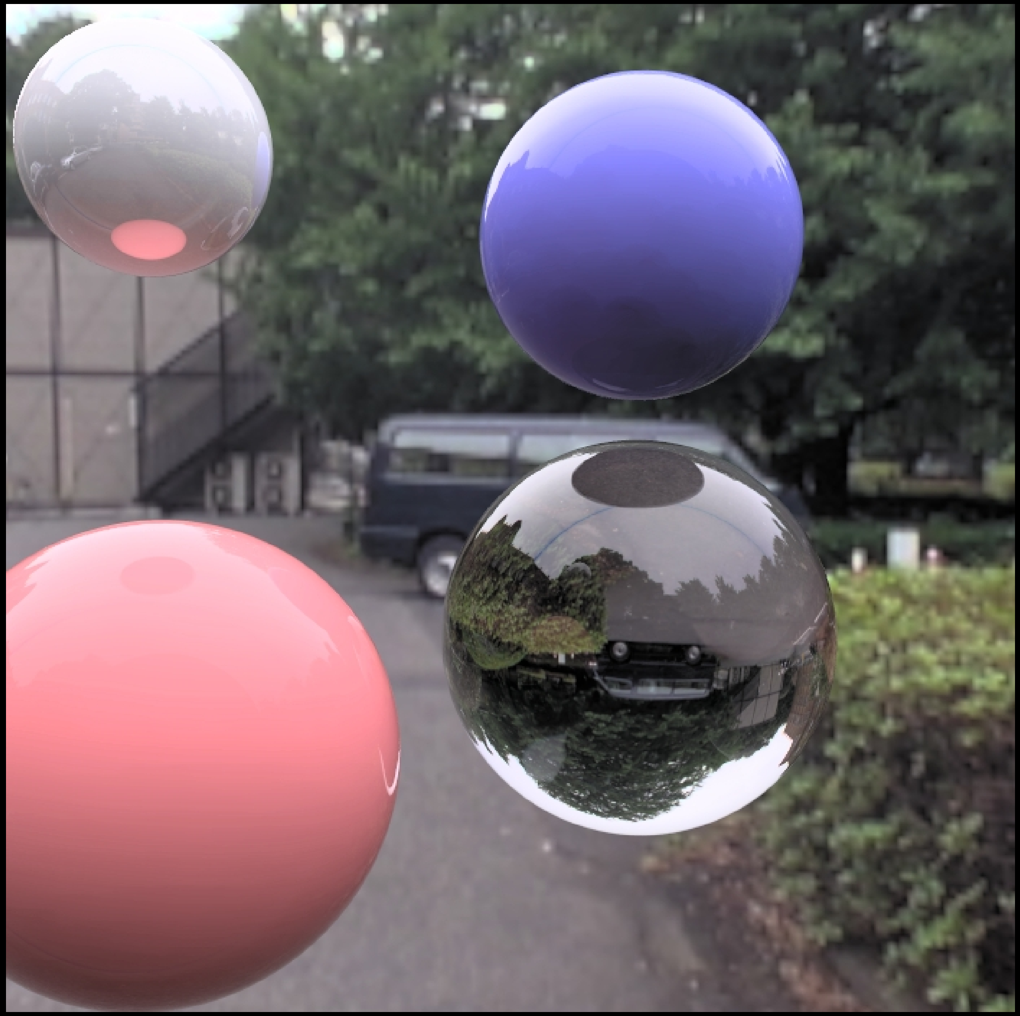
- Record luminance data in a high dynamic range image through a digital camera with fish-eye lens
- Map hemispherical data into a source object in Radiance
- Include a scene description and perform the simulation
- Use the visual comfort calculation in Radiance and obtain glare ratings

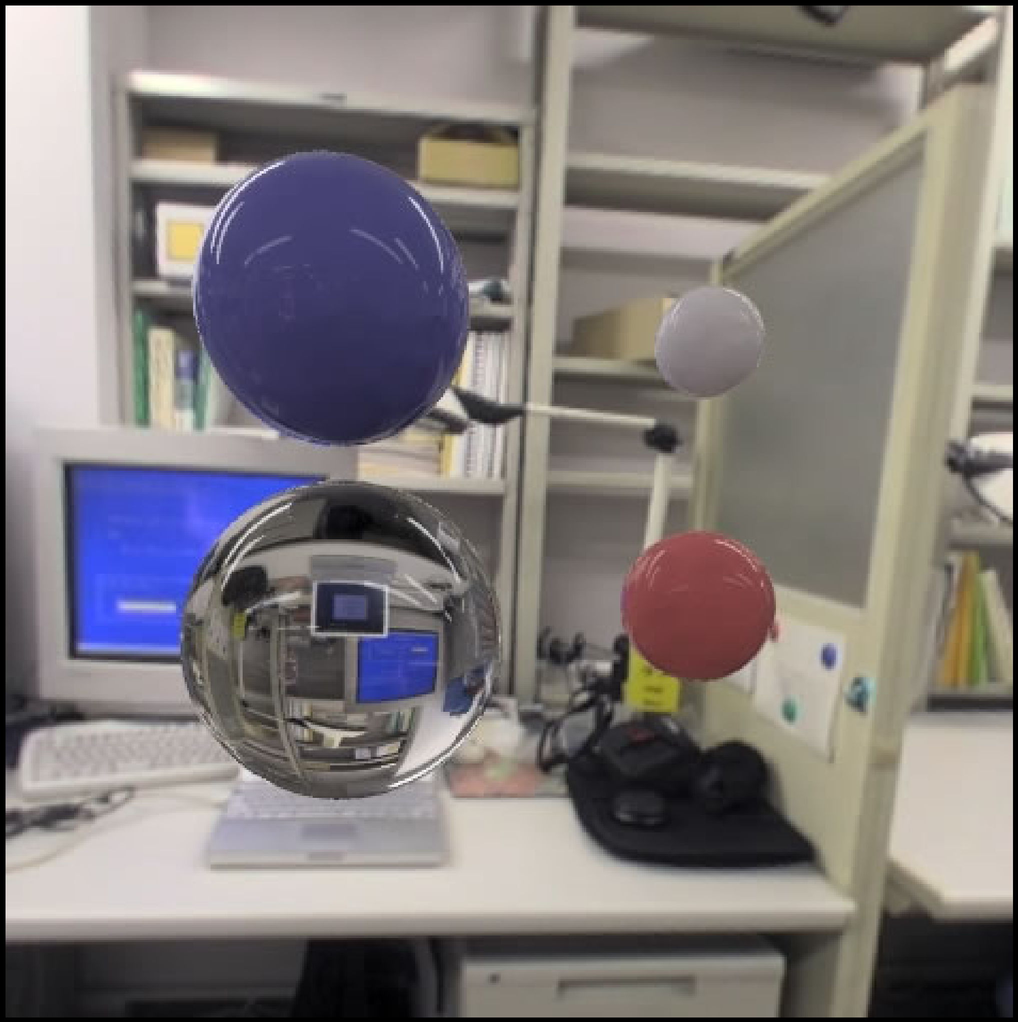


- Photosphere / HDRGen combine several exposures into one HDRI



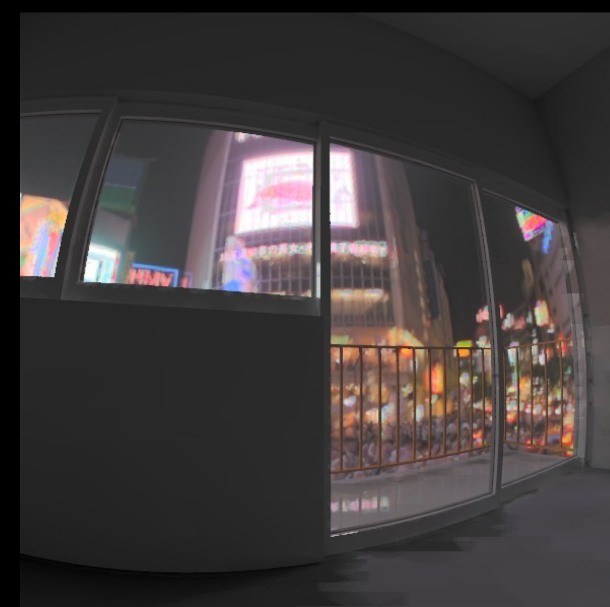
- fisheye.cal translates image coordinates into view directions





Examples

Examples



In order to use the mapping in daylighting simulations, the input data must be numerically accurate. This implies two calibrations:

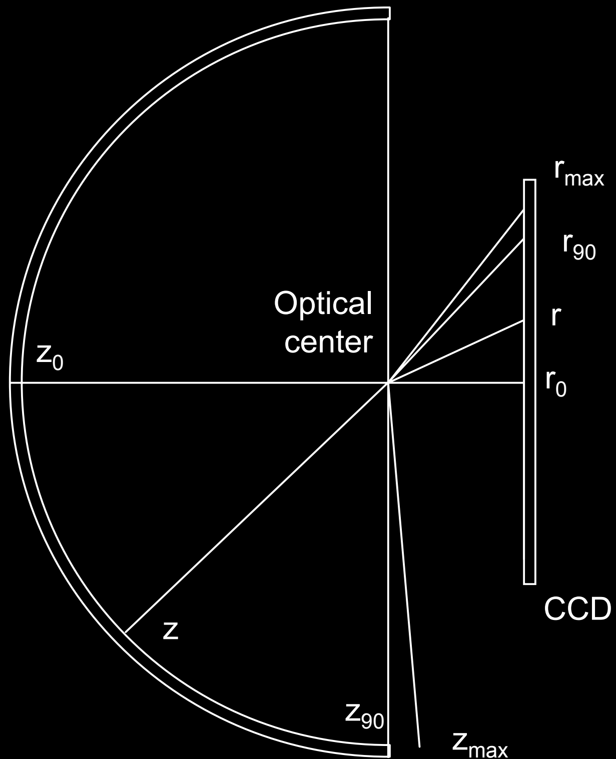
Geometry of the fish-eye lens

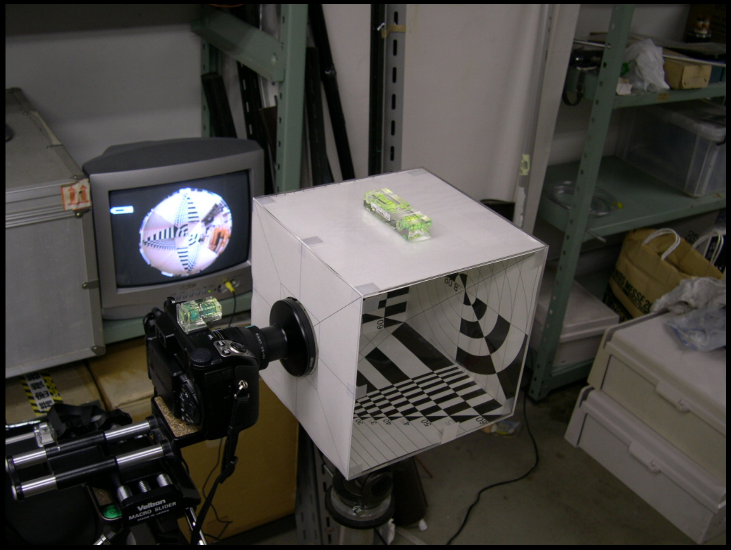
- Relation between incident angle and position in the image

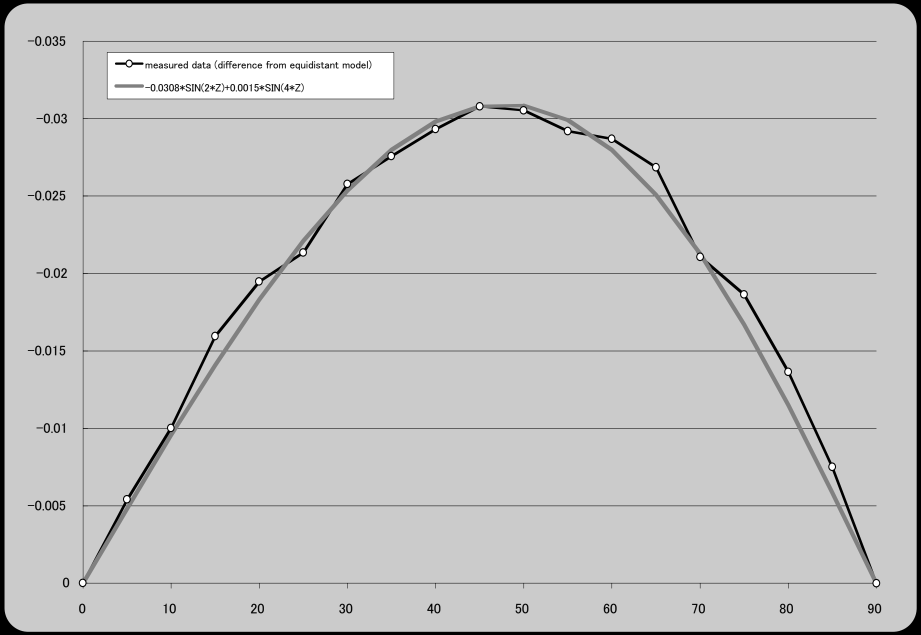
Luminance response of the CCD

- Pixel value relative to exposure and luminance
- Effect of incident direction on the fish-eye lens

Calibration - Lens distortion



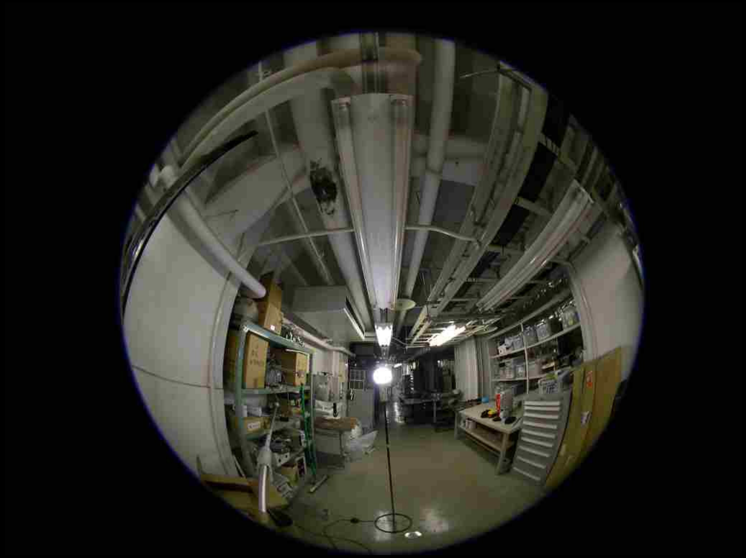


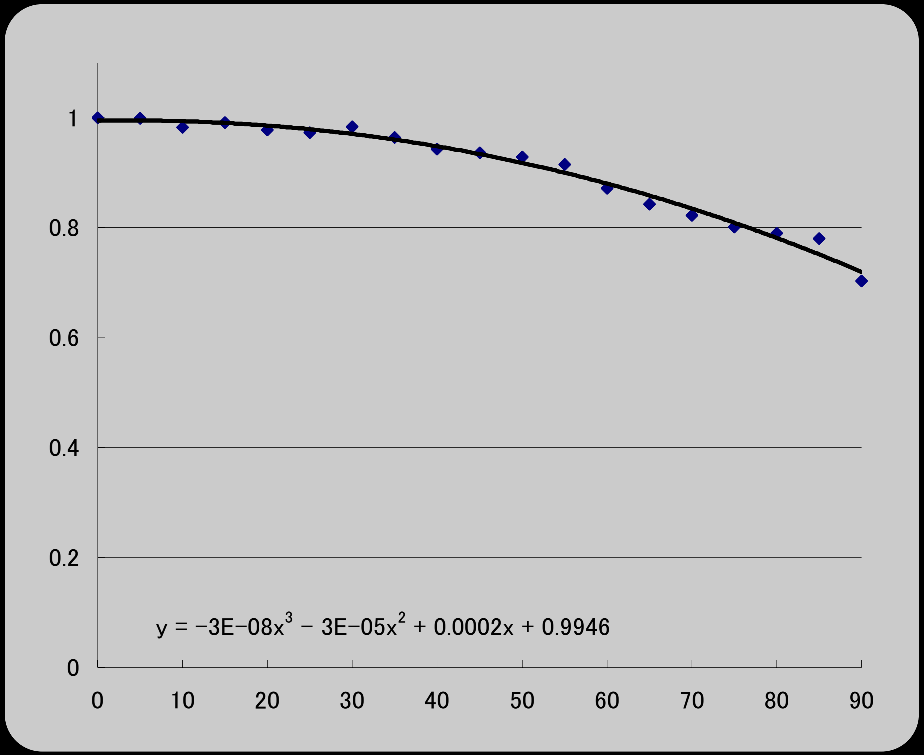


- Relation between incident angle and position in the image
- Geometry depends on camera lens + converter

z = angle from optical axis
r = radius in the image

Calibration - Luminance response





- Photosphere automatically applies an exposure value to the produced hdri to simplify the display of the images
- Colorpict maintains the Exposure when mapping into the source (useful for normalized images) this changes the luminance values
- It can be corrected with pfilt [e.g. exposure = 0.04 => 1/exp=25]

```
pfilt -1 -e 25 original.hdr > exposure_compensated.hdr
```

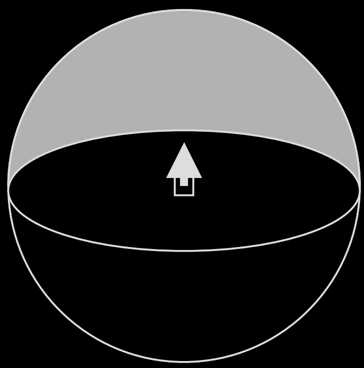
- shell script [by G.W.]

```
#!/bin/csh -fe
# Undo any exposure to one or more Radiance pictures
foreach i ($*)
set expos=`sed -n -e 's/^EXPOSURE=//p' -e '/^$/q' $i | total -p`
pfilt -1 -e `ev 1/$expos` $i > $i.$$
mv $i.$$ $i
end
```

"Put this in a file < ~/bin/fixexp >, make it executable, and run it like so:

```
% fixexp firstfile.hdr secondfile.hdr ..."
```

Comparing measured illuminances with values obtained in Radiance under a mapped sky

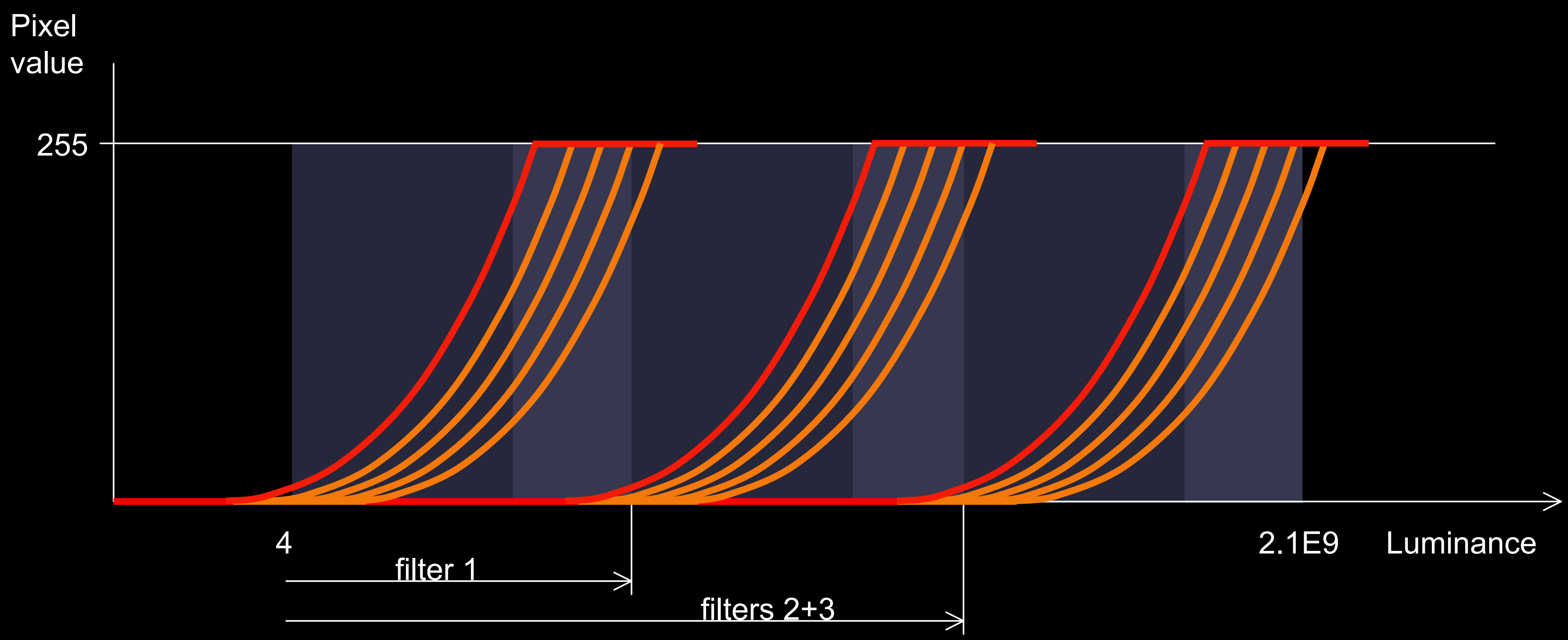


- Compensate for the fish-eye vigneting effect
- Map the HDR image according to the lens distortion
- Calculate the illuminance in the center of the Radiance simulation
- Compare with the value measured in situ

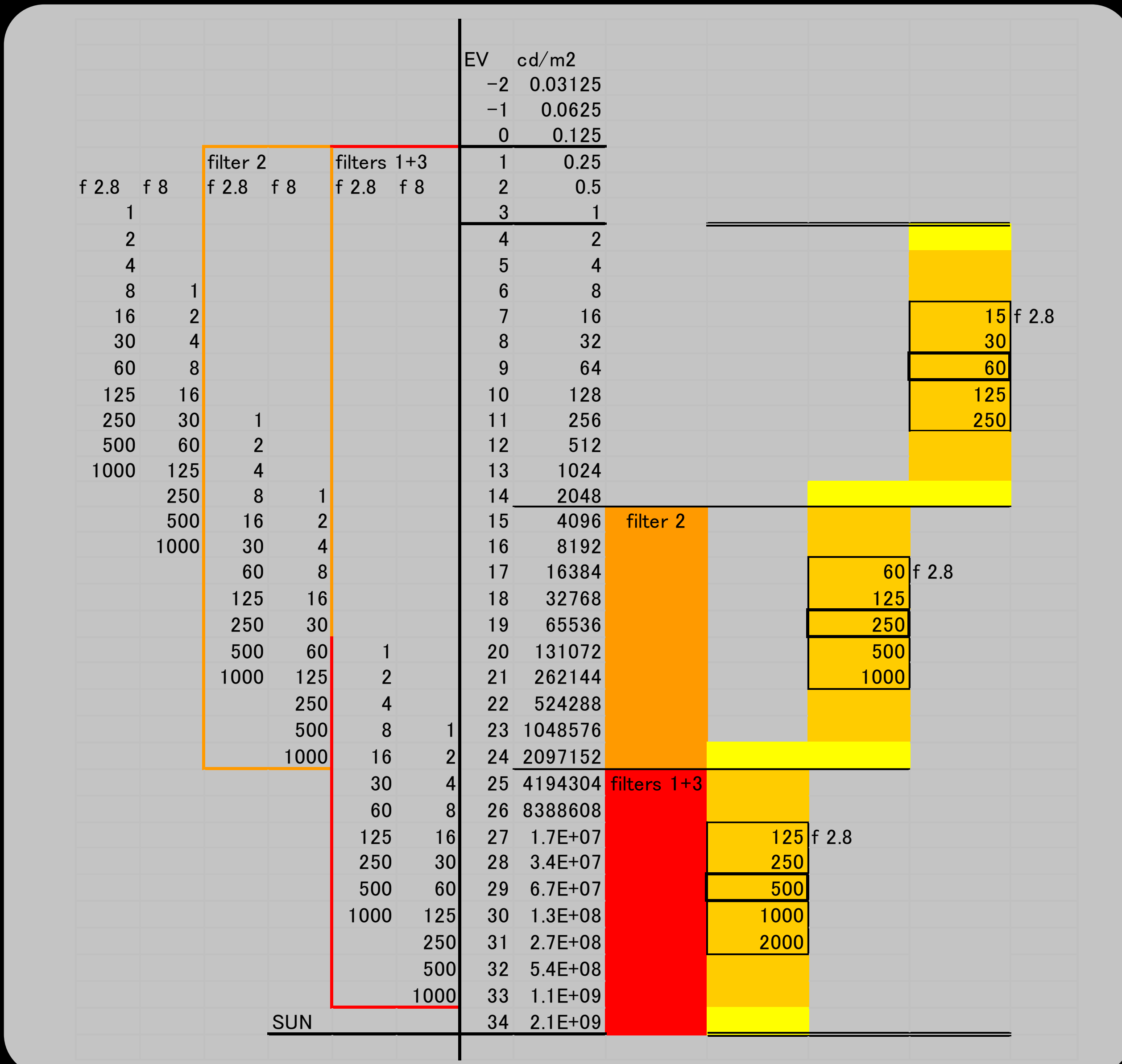
	measured	radiance	rel.
test 4	3480	3897.3	1.1199
test 5	3415	3902.1	1.1426
test 6	3360	3573.3	1.0634

Registering the sun

- The dynamic range of daylight exceeds the bracketing capability of the camera
- Three cameras with different combinations of filters are used
- This allows to record the dynamic range from 4 cd/m^2 to ~2.1E9 cd/m^2
- Total capture time can be less than 4s



Registering the sun



- EV [ISO 100] = $\log_2(f^2) + \log_2(1/s)$
- $2^{EV} = B\,Z / K$

EV: exposure value

f: aperture

s: speed [seconds]

B: luminance

Z: ISO sensitivity

K: constant
depends on units
[for cd/m^2 K = 12.5]

Two methods:

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- Produce one HDRI with the results of each camera
- Multiply by the corresponding filter factor
- Combine the three images with pcomb

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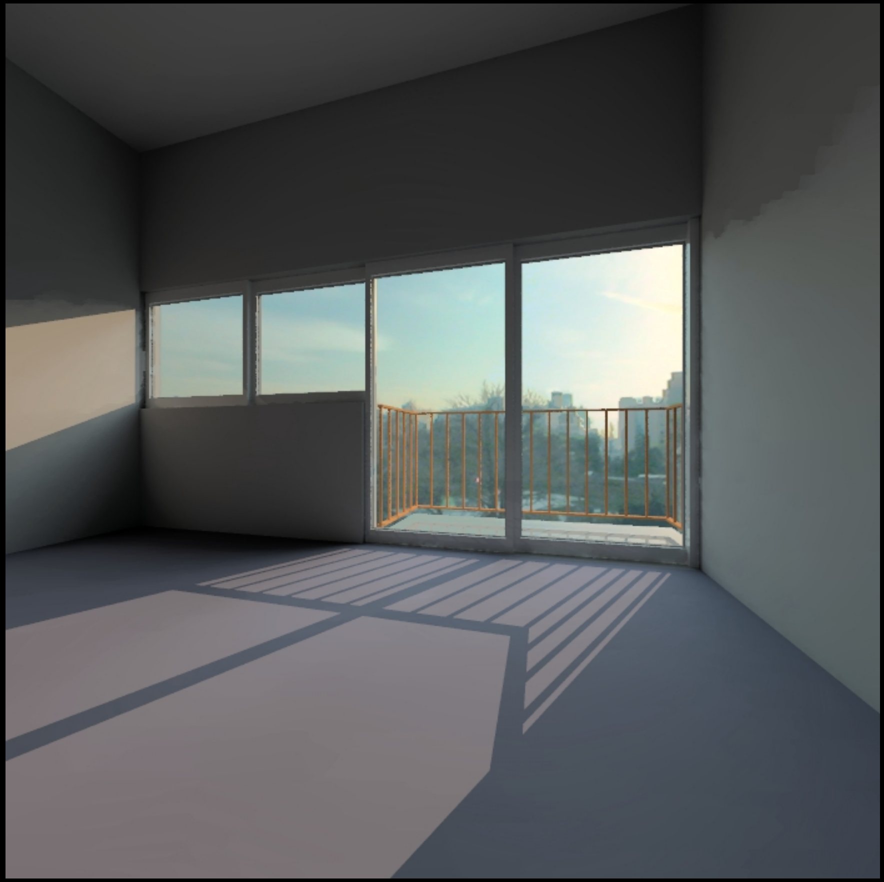
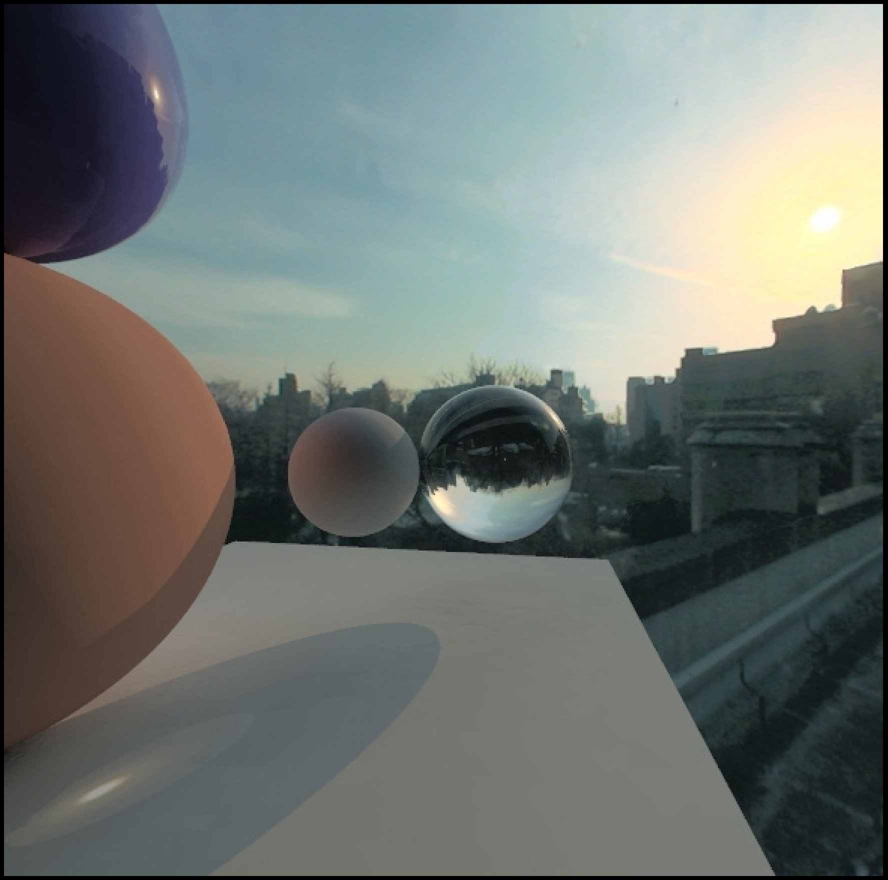
- Edit the exif information in the jpg images according to the filter factor
- Produce an HDRI directly with all the images

Scenes with sun

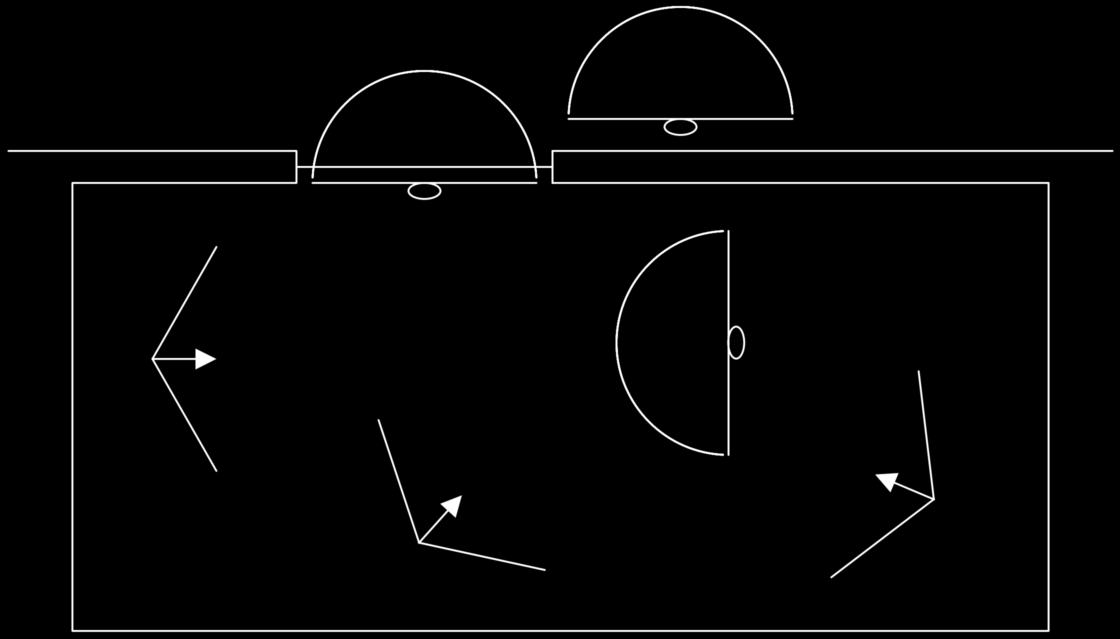




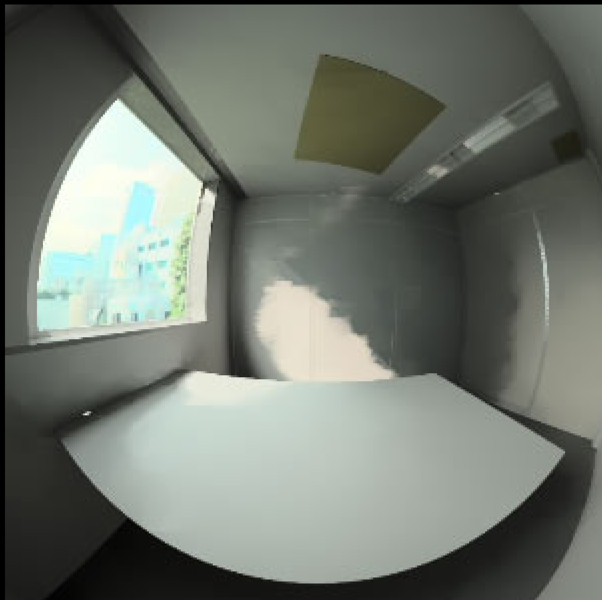
Applications for glare assessment:

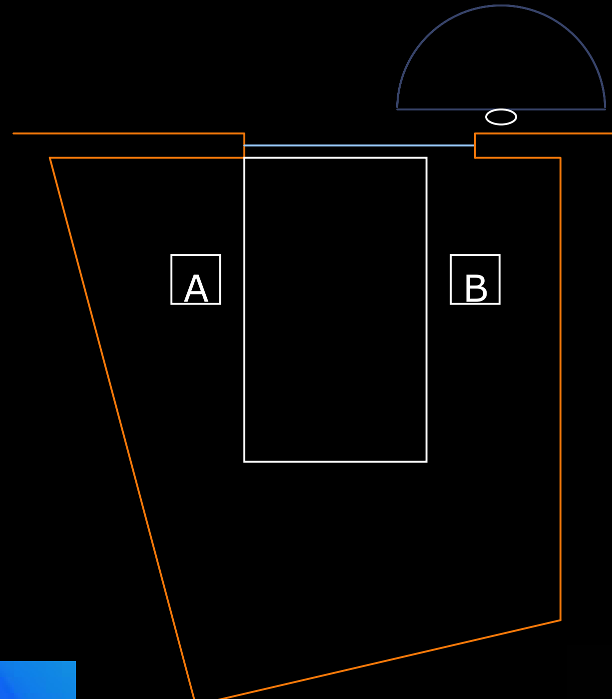
- Obtain the luminance environment from a certain point of view and compare with glare ratings

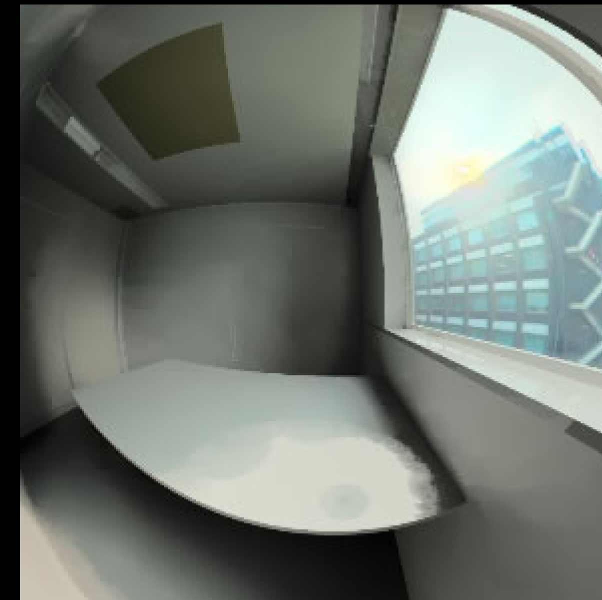
- Use the data of the luminance entering through windows to simulate the observer`s view from any perspective

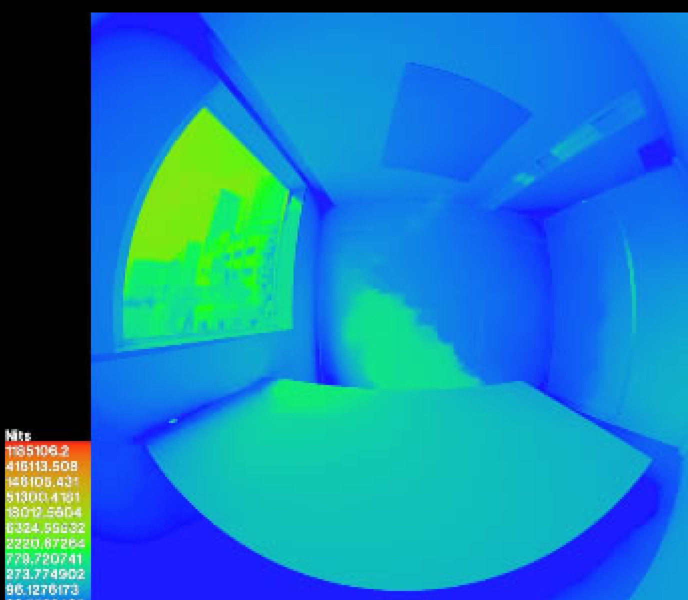


Glare assessment example

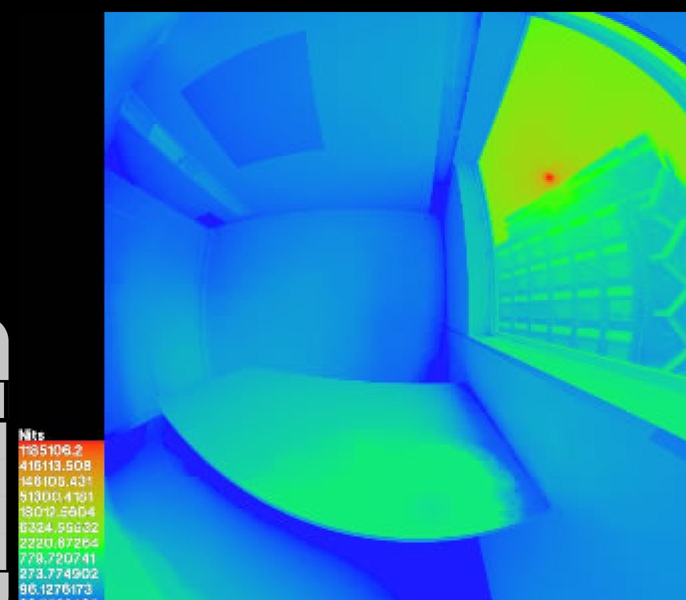








viewpoint	a	b
dgi	11.6	17.8
guth	74.6	7.4
cie	18.6	32.7
brs	13.3	23.1



The use of IBL can produce more realistic images from lighting simulations

With appropriate calibration, simulations can also be numerically consistent

IBL can be used in lighting simulations to overcome problems associated with synthetic skies

- luminance values can be accurate and show the same distribution as with real skies
- surrounding environment is included
- the whole range of daylight luminance can be recorded by using ND filters

The method has some inherent problems (ground and parallax problems) and shouldn't be used with near by obstructions