
Bartenbach
research & development

Application Examples of the Radiance Photon Mapping Extension

14th International Radiance Workshop

Consortium for Building Energy Innovation, Philadelphia Naval Yard
August 17-19, 2015

David Geisler-Moroder
Bartenbach GmbH, Aldrans, Austria

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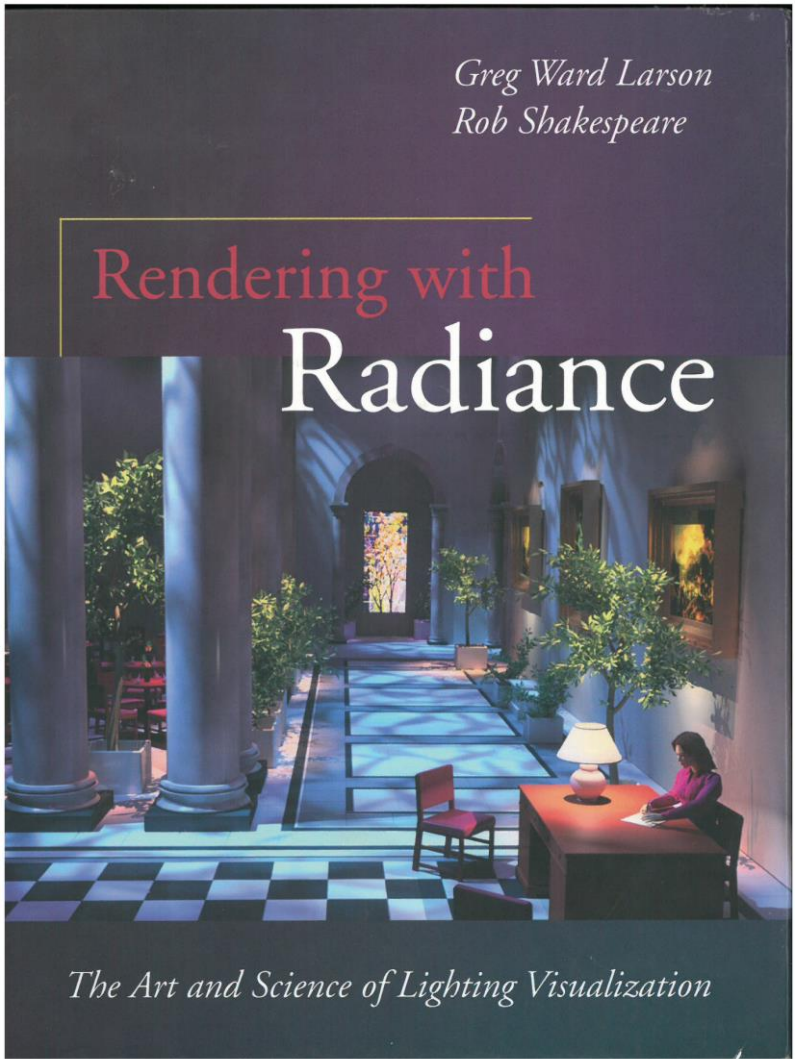
research & development

History – part 1



over the window, since the sun represents such a tiny target. The mkillum s parameter would have to be increased to a value of about 100,000 to get a reasonable

Other cases involving curved, specular reflectors pose similar difficulties for mkillum, and the only long-term solution seems to be the creation of a forward ray-tracing module for computing these kinds of illums.

13.2.3 Mkillum Parameters

Mkillum has two sets of parameters. One set is altered on the command line and is passed directly to rtrace to control the ray-tracing calculation. The second set is


```
            if d > 0 then call flatout
            call illumout
        else
            call printobj
        end if
end o_face
```

The `raysamp` routine passes a ray origin and direction to the rtrace process, and the `rayflush` routine completes any pending ray calculations. The `flatout` routine puts out the output distribution data, and `illumout` puts out the illum or light source and its geometry. If the surface radiance is below the b parameter threshold, `printobj` is called to put out the geometry unmodified.

The other surface handlers, `o_ring` and `o_sphere`, are essentially similar, except that the loop to find valid area samples is not necessary because they can be computed directly.

13.3 Conclusion

In this chapter, we have described some of the rationale and algorithms behind secondary light sources, which fall under the general category of *light reclassification* [SWZ96]. In general, it would be nice to automate this process beyond what it is now, so that it did not require you to identify these sources explicitly. Unfortu-

The limitation of mkillum with regard to curved, specular geometries is also something that calls for further development. A forward Monte Carlo ray-tracing process could certainly overcome some of these limitations, but the design and control of such a program is a very challenging and interesting problem. Regrettably, there has not been sufficient time or funding to pursue this to date, but no one knows what the future holds…

History – part 2

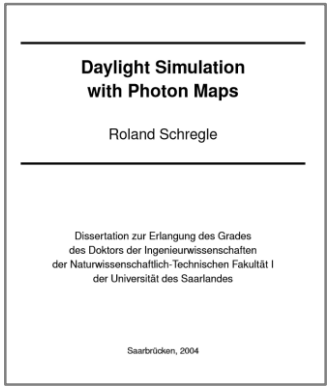
(see R. Schregle's talk @ Workshop Enhanced Photon Mapping in RADIANCE in Lucerne)

```
[Forwarded from the Radiance discussion group mailing list.  -G]

To:  raydisc@floyd.lbl.GOV
Date:  Thu,  27 Aug 1998 00:07:27 +0200 (MESZ)

Hi,

Fraunhofer ISE has funding for a PhD candidate to develop a
thesis on the modelling of light transport using ray tracing.
If you are a student in computer graphics or physics,
you  might want to check
       http://www.ise.fhg.de/radiance/diss1.html
for details.

regards
Peter

--
Peter Apian-Bennewitz  apian@ise.fhg.de  +49-761-4588-[123|302]
Fraunhofer Institute for Solar Energy Systems, D-79100 Freiburg
http://www.ise.fhg.de/~apian
```

Kick-Off: 1998

Roland Schregle

ongoing work:
1998 – 2015



PhD thesis

auto cvs mail: Radiance cvs commit

Greg Ward <greg@radiance-online.lbl.gov>
An: apian@radiance-online.lbl.gov, greg@radiance-online.lbl.gov, schorsch@schorsch.com

Tue Feb 24 11:39:27 PST 2015

Update of /cvs/radiance/ray/src/rt
In directory radiance-online:/tmp/cvs-serv26689/src/rt

Modified Files:
Rmakefile VERSION ambient.c aniso.c dielectric.c glass.c m_bsdf.c m_mirror.c normal.c ray.h raycalls.c raytrace.c rcmain.c renderopts.c rpict.c rpmain.c rtmain.c rvmain.c source.c
Added Files:
mkpmap.c oocbuild.c oococt.c oococt.h oocsort.c oocsort.h pmap.c pmap.h pmapamb.c pmapamb.h pmapbias.c pmapbias.h pmapcontrib.c pmapcontrib.h pmapdata.c pmapdata.h pmapdiag.c pmapdiag.h pmapdump.c pmapio.c pmapio.h pmapmat.c pmapmat.h pmapopt.c pmapopt.h pmapparm.c pmapparm.h pmaprand.c pmaprand.h pmapray.c pmapray.h pmapsrc.c pmapsrc.h pmaptype.c pmaptype.h
Log Message:
Initial check-in of photon map addition by Roland Schregle

RADSITE | radiance-online.org

Integration into RADIANCE head distribution 02/2015

Photon Mapping

More stuff (highly recommended…)

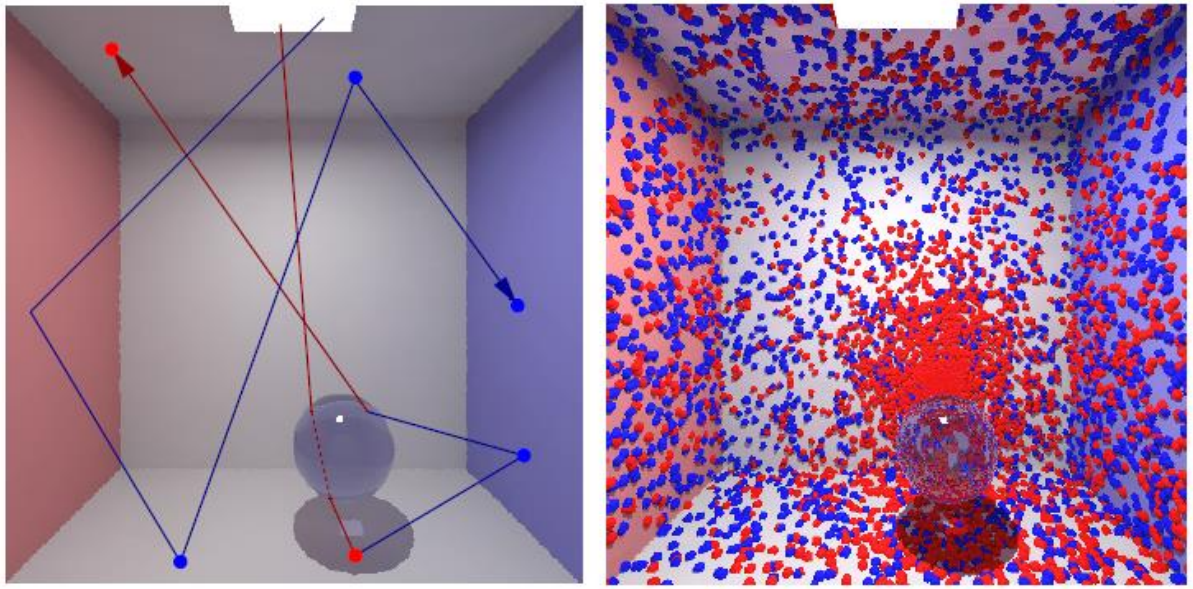
- The RADIANCE Photon Map Extension User Manual:
  www.researchgate.net/publication/277312871_The_RADIANCE_Photon_Map_Manual
- Technical Report:
  “Development and Integration of the RADIANCE Photon Map Extension”
  www.researchgate.net/publication/272497518_Development_and_Integration_of_the_RADIANCE_Photon_Map_Extension_v1.12
- Paper: “Progressive photon mapping for daylight redirecting components”
  www.sciencedirect.com/science/article/pii/S0038092X15000559
- Conference Paper
  “Workshop Enhanced Photon Mapping in RADIANCE”
  Friday, 29 May 2015, Hochschule Luzern, Engineering and Architecture, CC Envelopes and Solar Energy
  www.researchgate.net/publication/277569984_Workshop_Enhanced_Photon_Mapping_in_RADIANCE

Photon Mapping in RADIANCE

Basics

Photon mapping happens in two steps

- Photon distribution (forward raytracing) → `mkpmap`
- Photon gathering (backward raytracing, single bounce) → `rtrace / rpict`



Photon paths and photon distribution

(source: R. Schregle, The RADIANCE Photon Map Extension User Manual)

Photon Mapping in RADIANCE

Basics – Example

```
oconv sky.rad scene.rad > scene.oct
```

- usual RADIANCE behavior

```
mkpmap -apg scene.gpm 200k -apc scene.cpm 1m -apo glass80 scene.oct
```

- -apg: specify number of global photons
- -apc: specify number of caustic photons
- -apo: specify material for photon port

```
rpict -vf view.vf -x 3600 -y 3600 -ab 1
      -ap scene.gpm 100 [500] -ap scene.cpm 100 [500]
      scene.oct > pic.hdr
```

- -ab: any number ≥ 0 equals ab = 1 → photon gathering
  [for testing: any ab < 0 directly visualizes global photon irradiance at hitpoint]
- -ap: specify photon map and bandwidth(s) [bias compensation]

Photon Mapping in RADIANCE

Further important Photon Mapping options:

`mkpmap`

- -apv: volume photon maps
- -apC: contribution photon maps
- -apm: maximum number of bounces
- -aps: invisible sensor surfaces

`rpict`

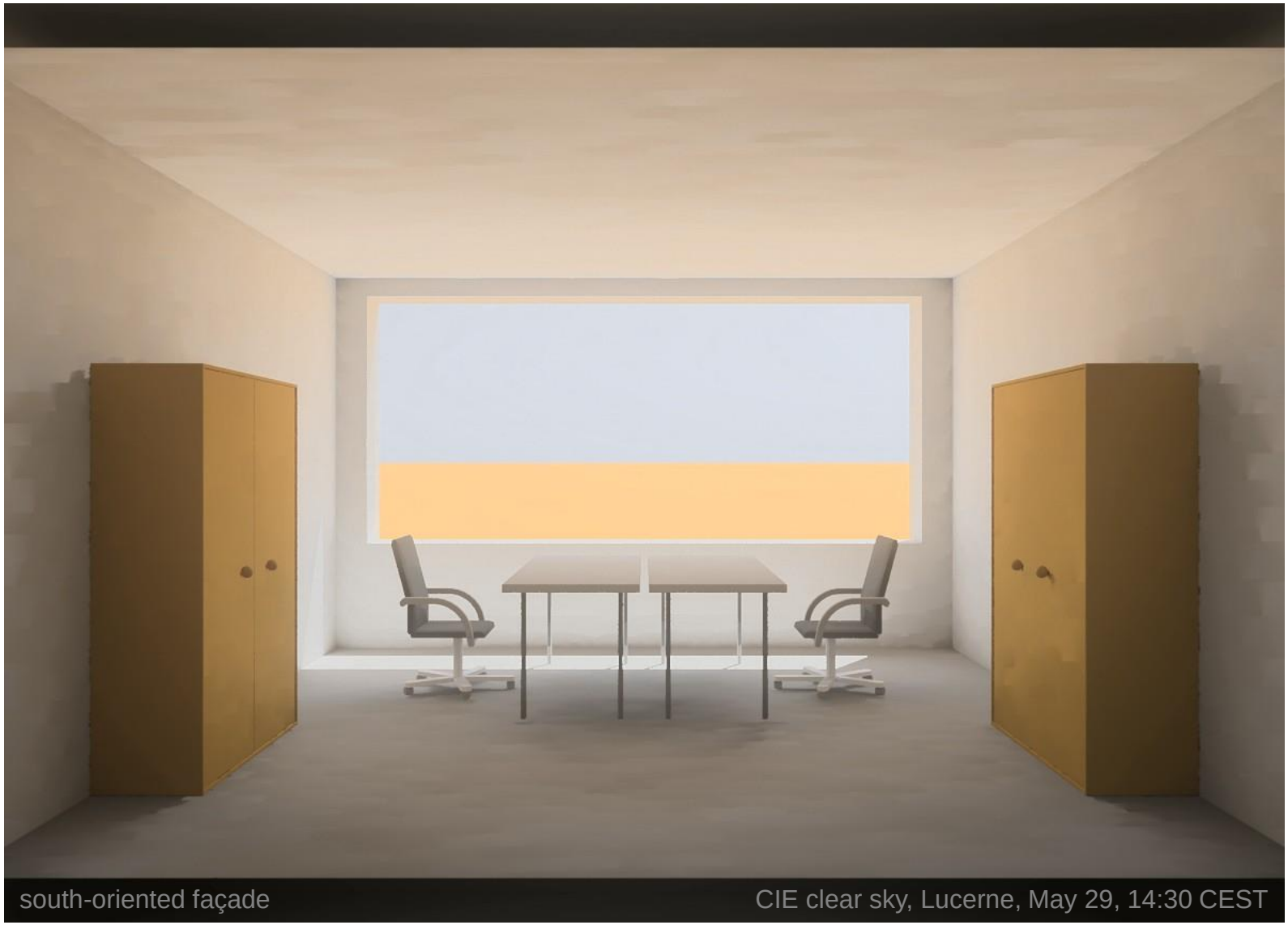
- -am: fixed maximum search radius

Even more options, parameter ranges, and help can be found in

The RADIANCE Photon Map Extension User Manual

Warm-Up

Simple Example



Warm-Up

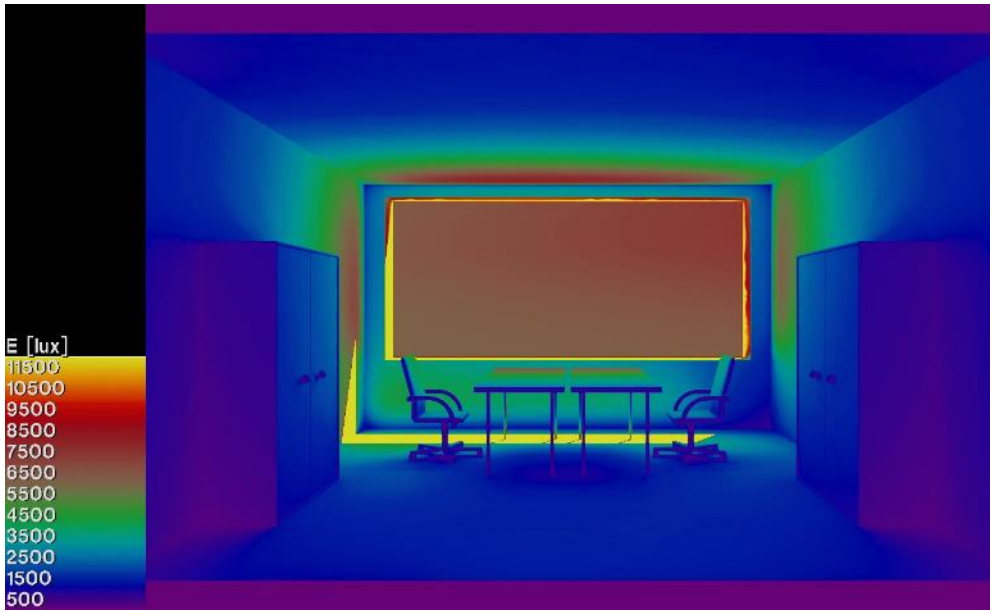
Simple Example - Glazing

RADIANCE classic

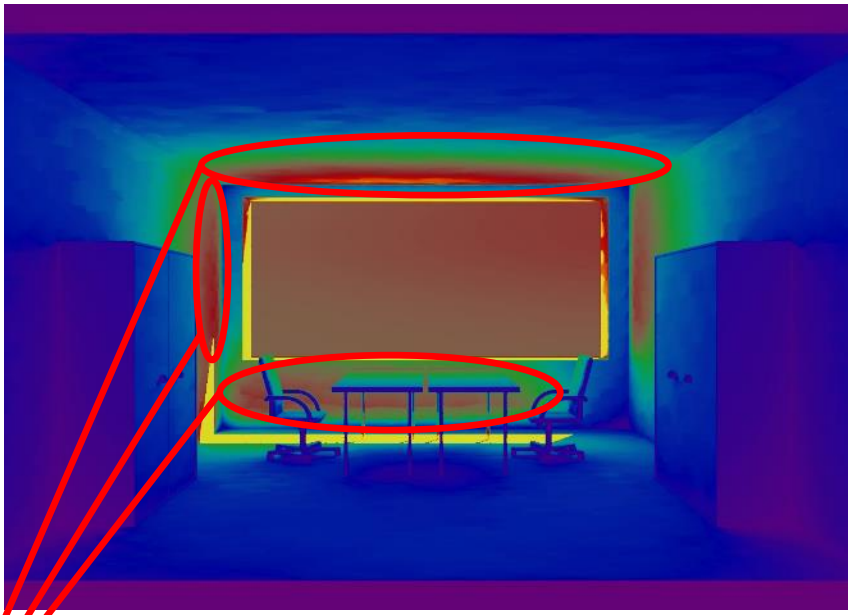
Photon Mapping

Warm-Up

Simple Example - Glazing



RADIANCE classic



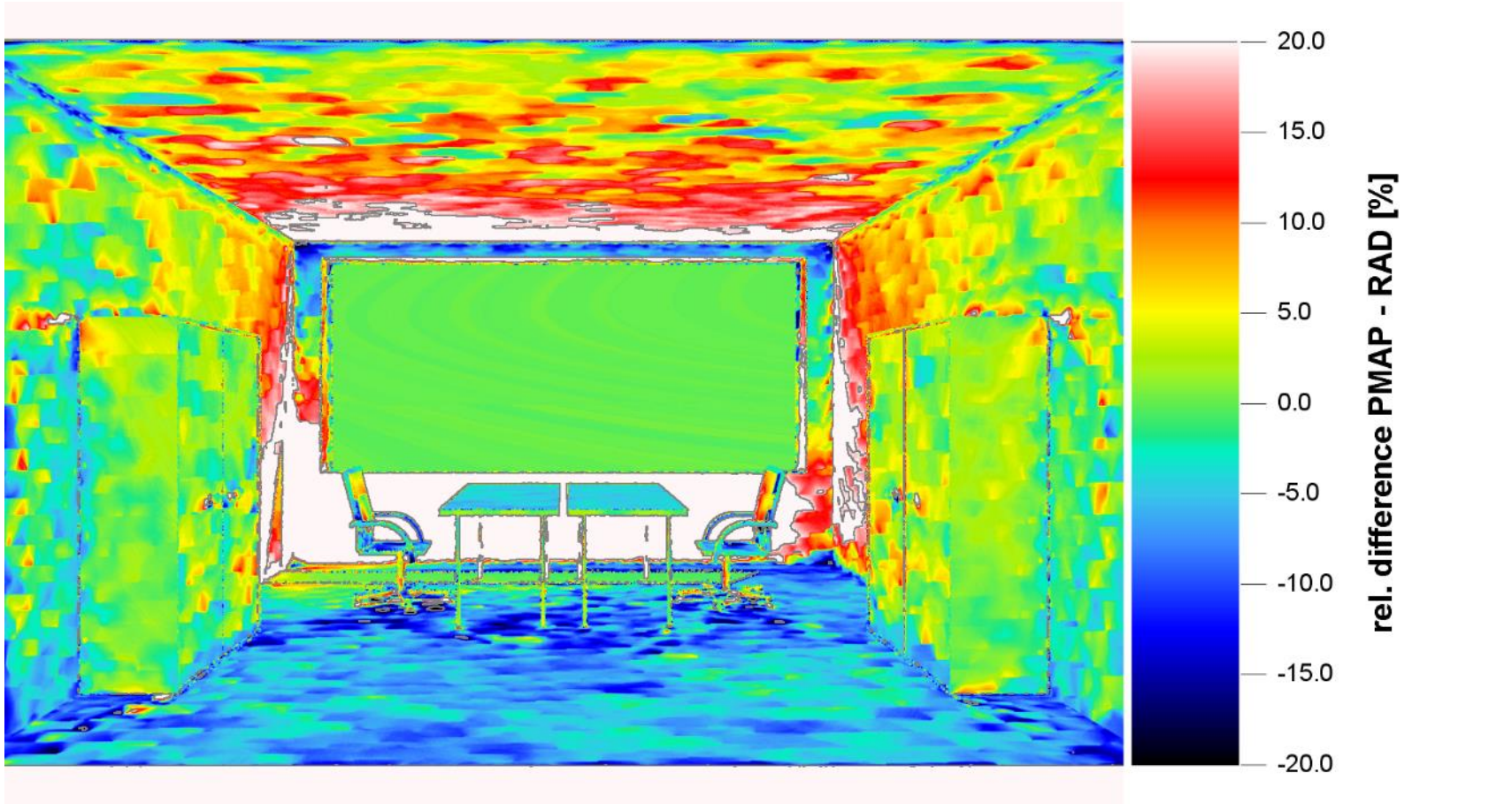
Photon Mapping

???

„double counting“ !

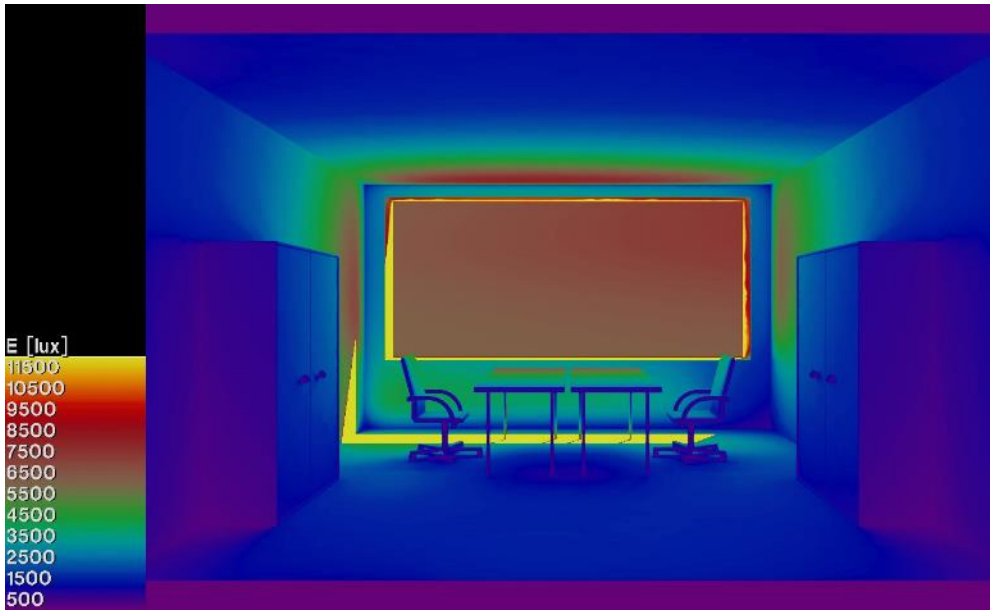
Warm-Up

Simple Example - Glazing

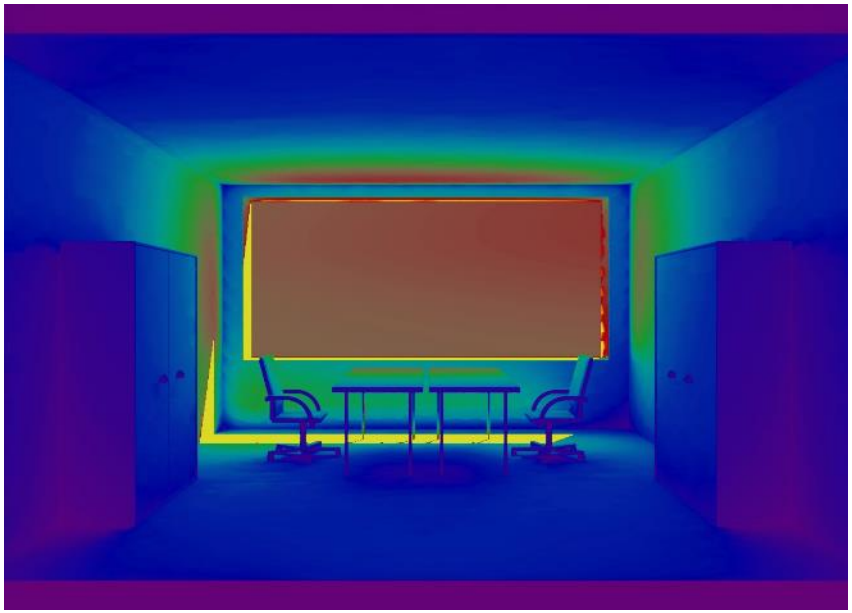


Warm-Up

Simple Example - Glazing



RADIANCE classic

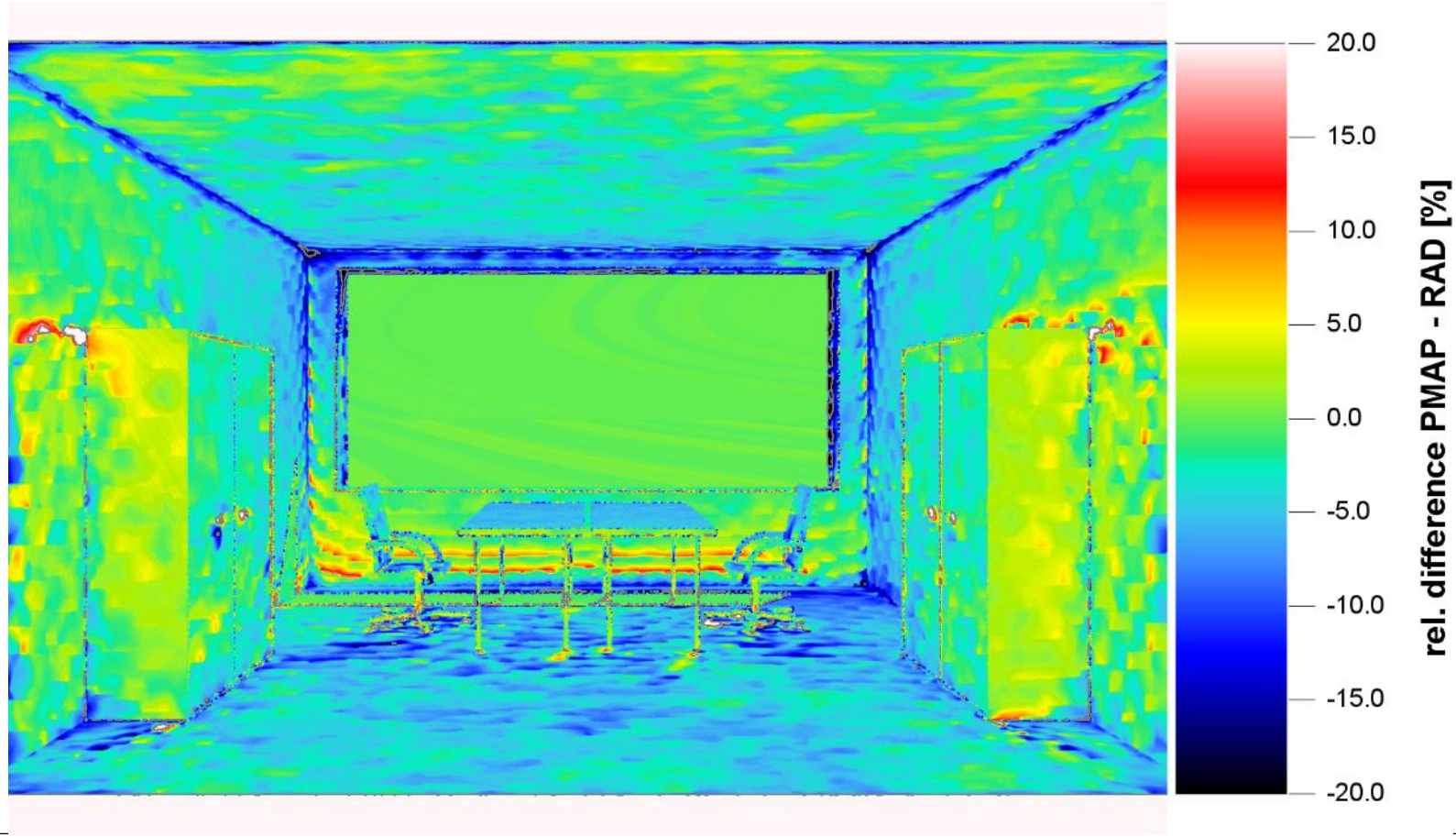


Photon Mapping

double counting
issue fixed!
(!#@?!*&>#$! macros…)

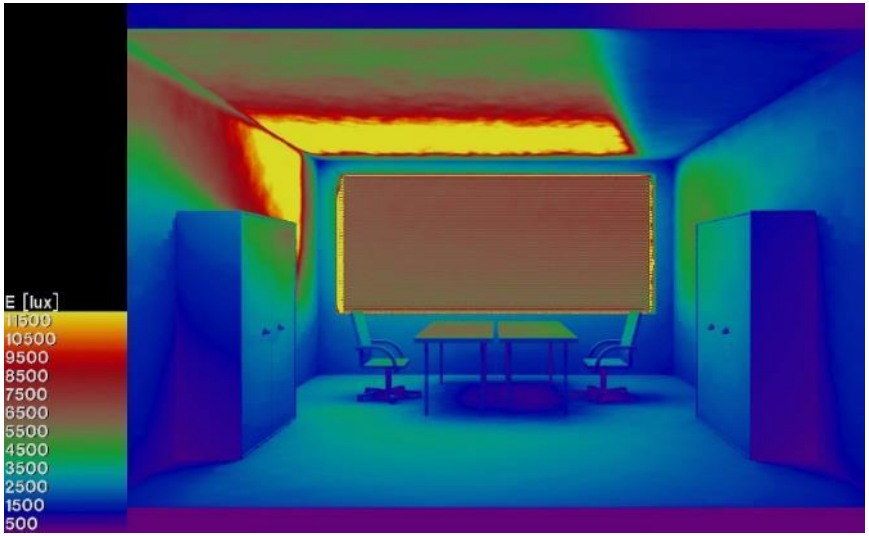
Warm-Up

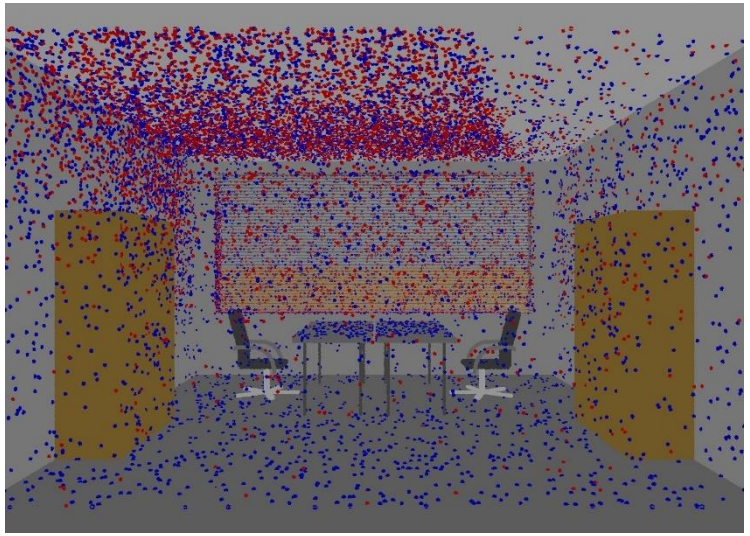
Simple Example - Glazing



Warm-Up

Simple Example – Redirecting Blinds

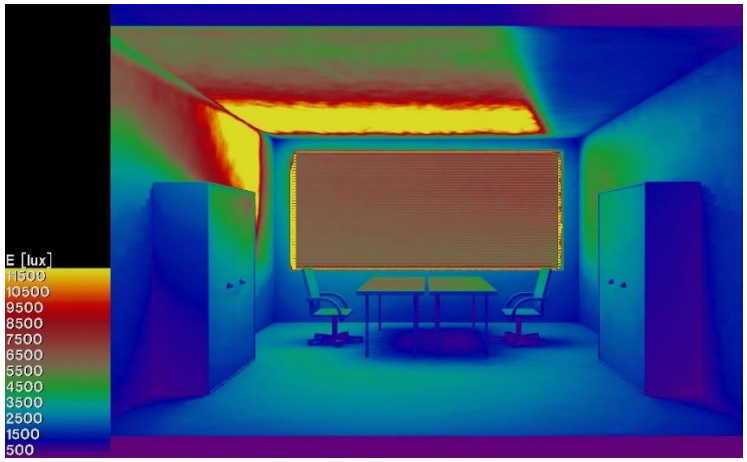


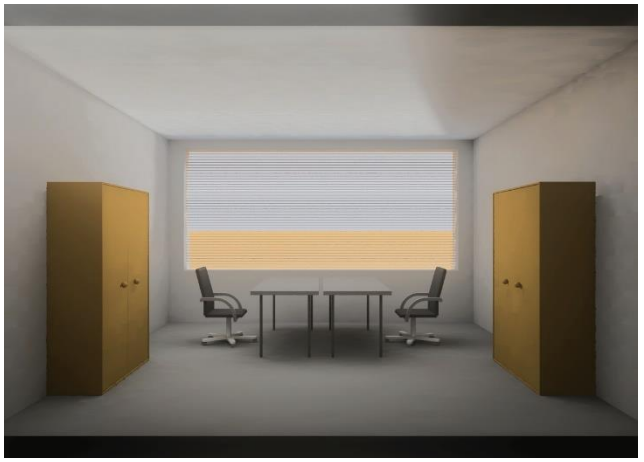


Now we‘re in the
Photon Mapping world ☺

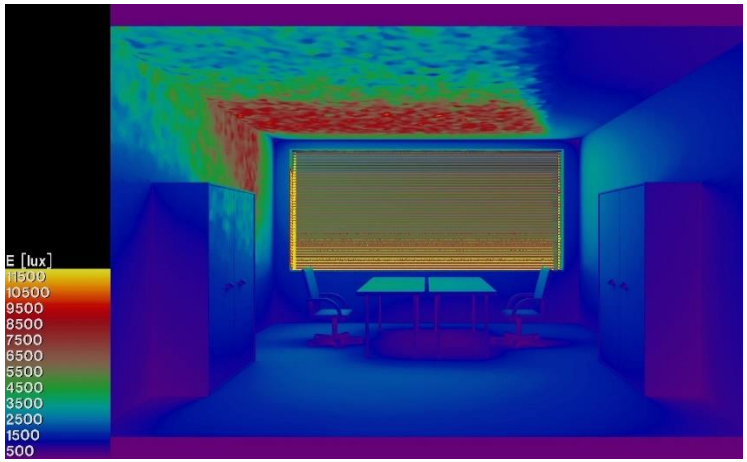
Warm-Up

Simple Example – Redirecting Blinds





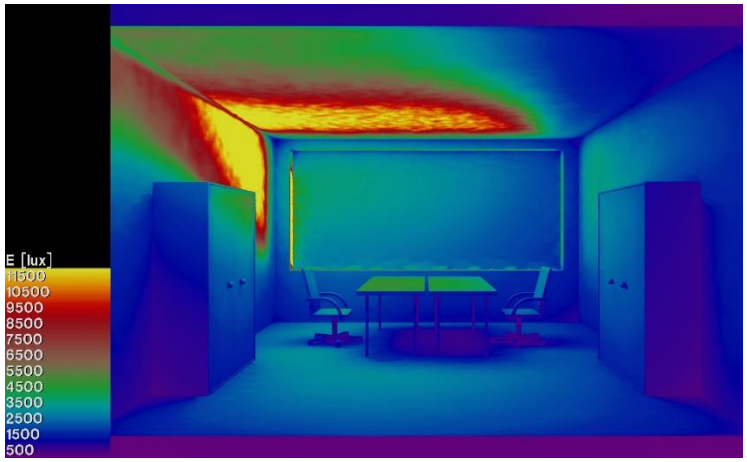
Photon Mapping

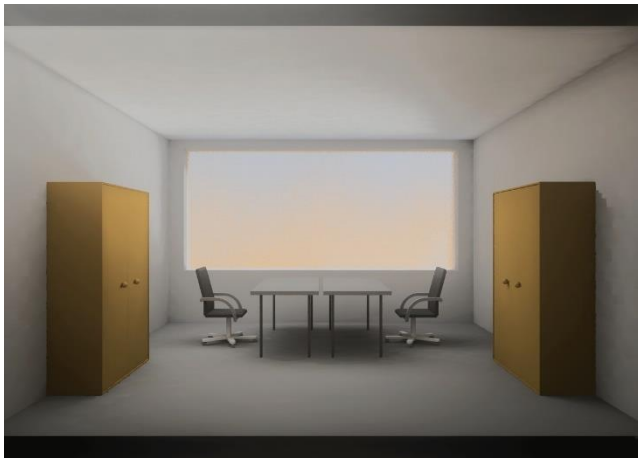


RADIANCE classic (+ roughness on blinds!)

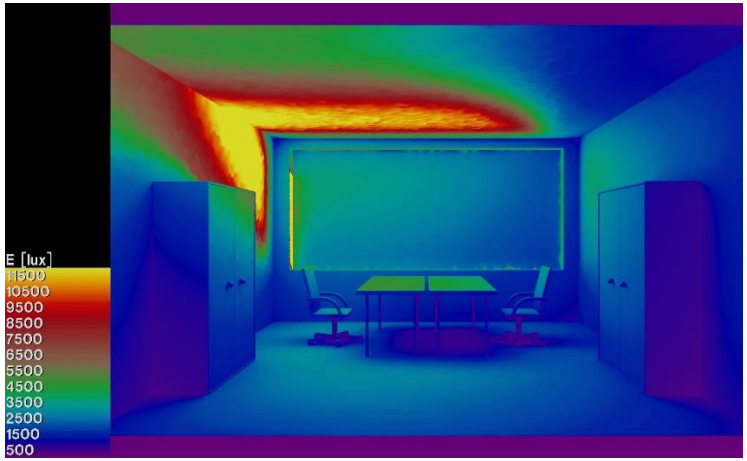
Warm-Up

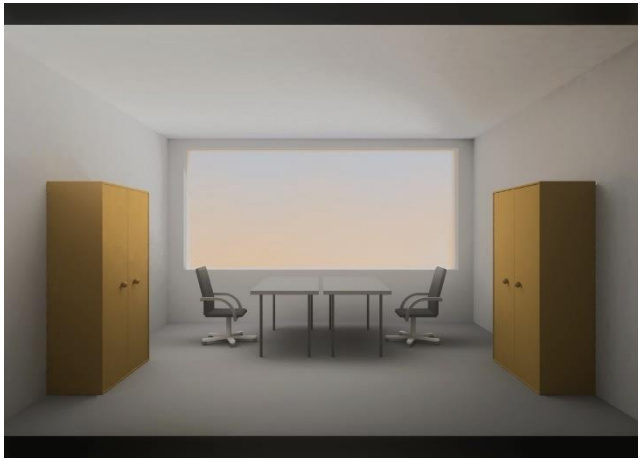
Simple Example – BSDF of Redirecting Blinds





Photon Mapping

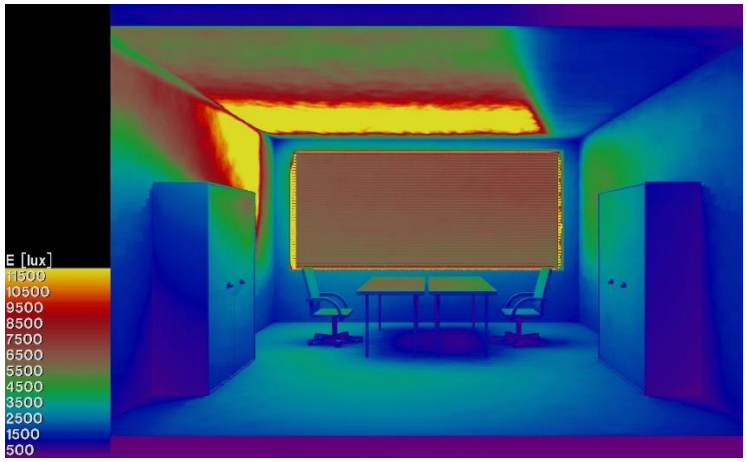


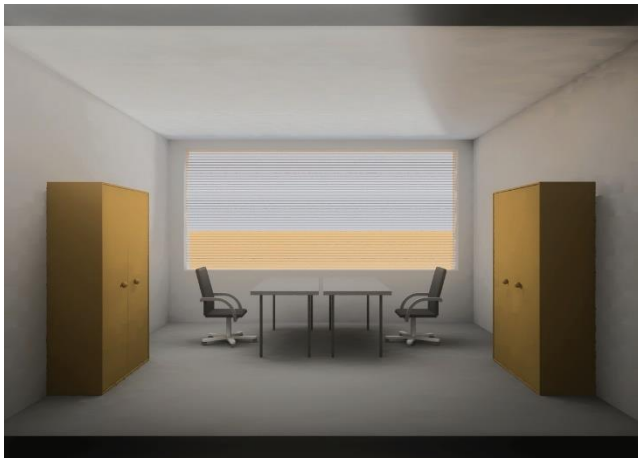


RADIANCE classic

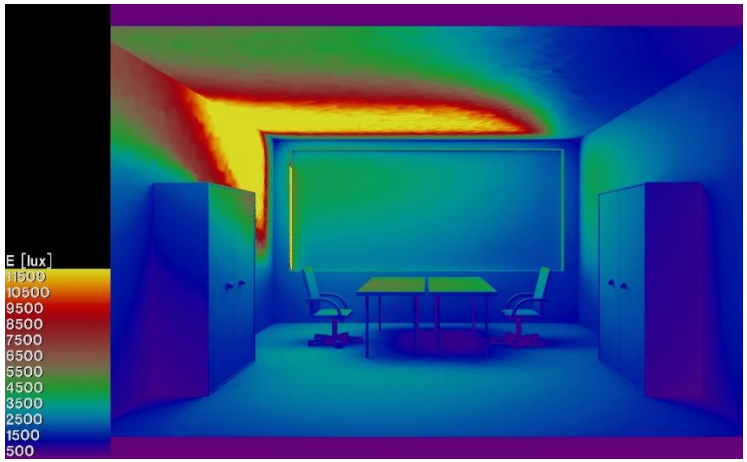
Warm-Up

Simple Example – Best of both worlds





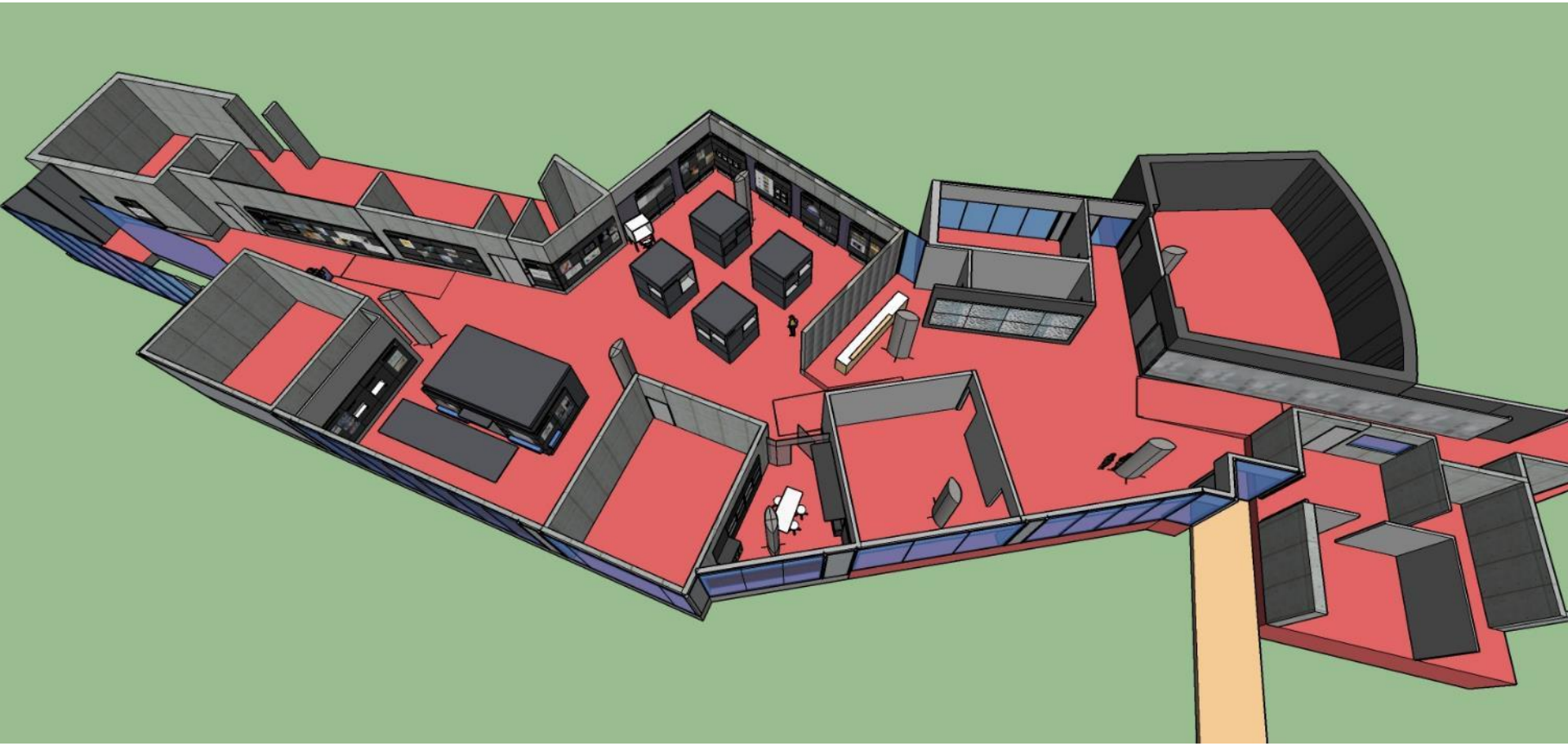
Photon Mapping (blinds geometrically modeled)



RADIANCE classic (BSDF + proxy geometry)

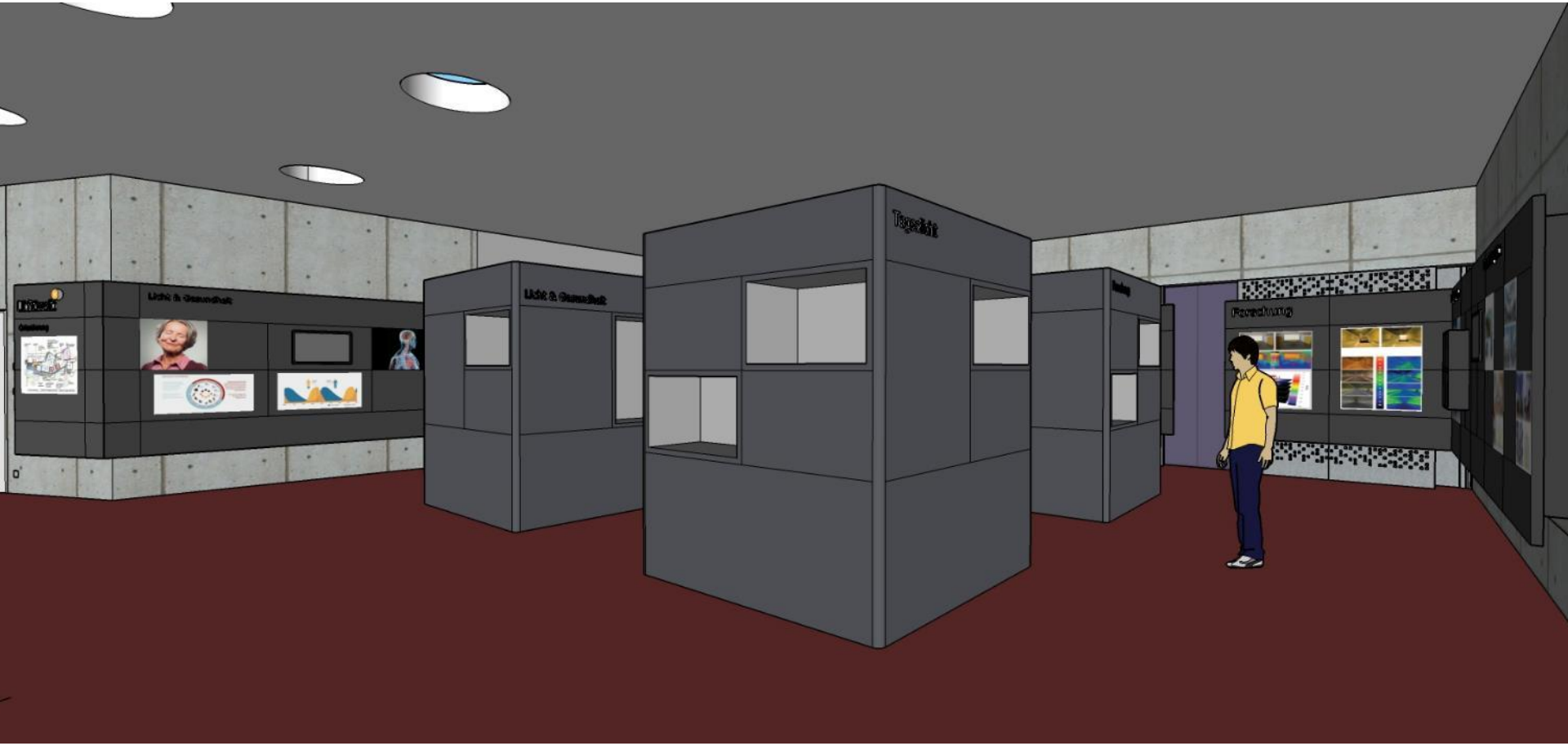
Lichtwelt „inspire“ @ Bartenbach

Application of Photon Mapping for Simulation of Light Tubes



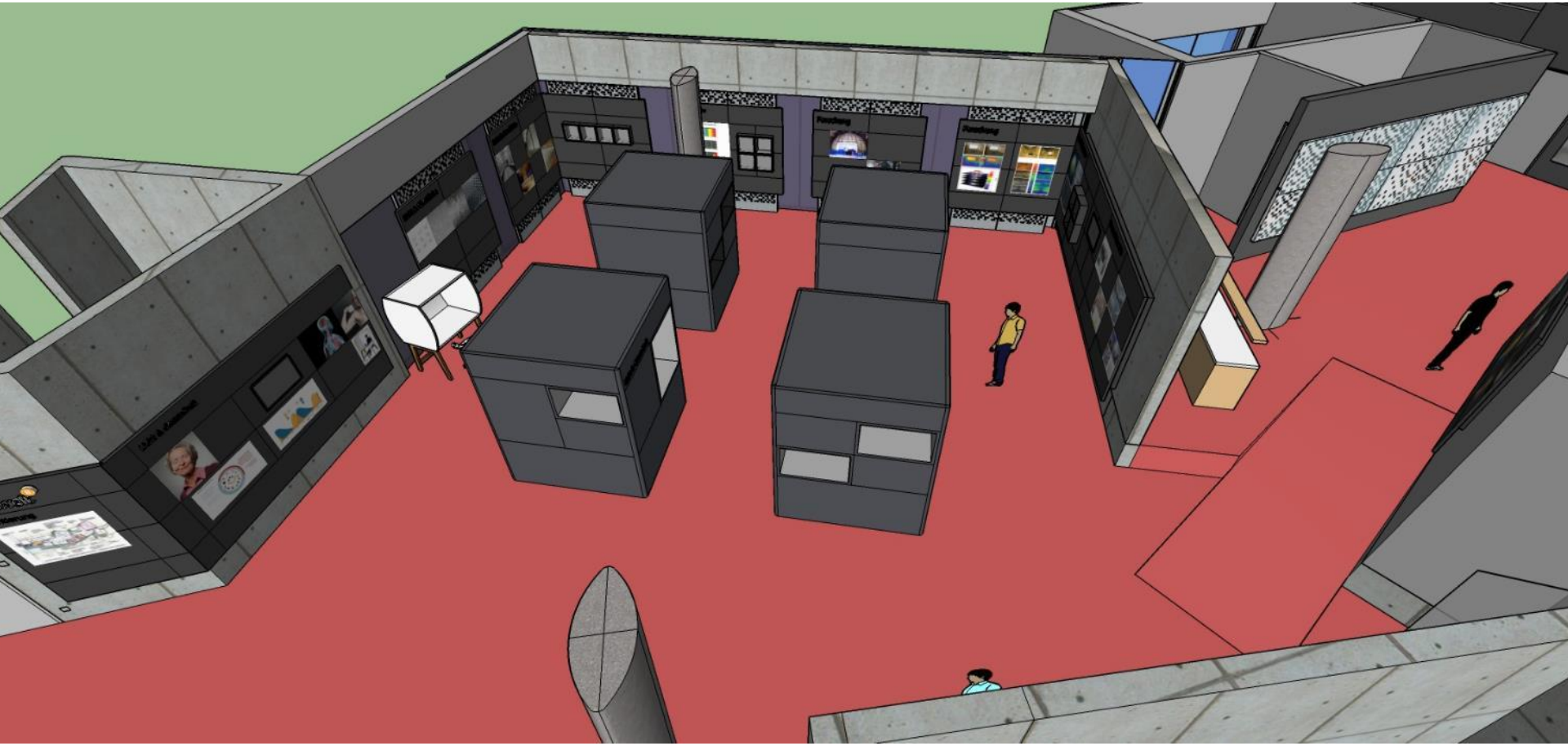
Lichtwelt „inspire“ @ Bartenbach

Application of Photon Mapping for Simulation of Light Tubes



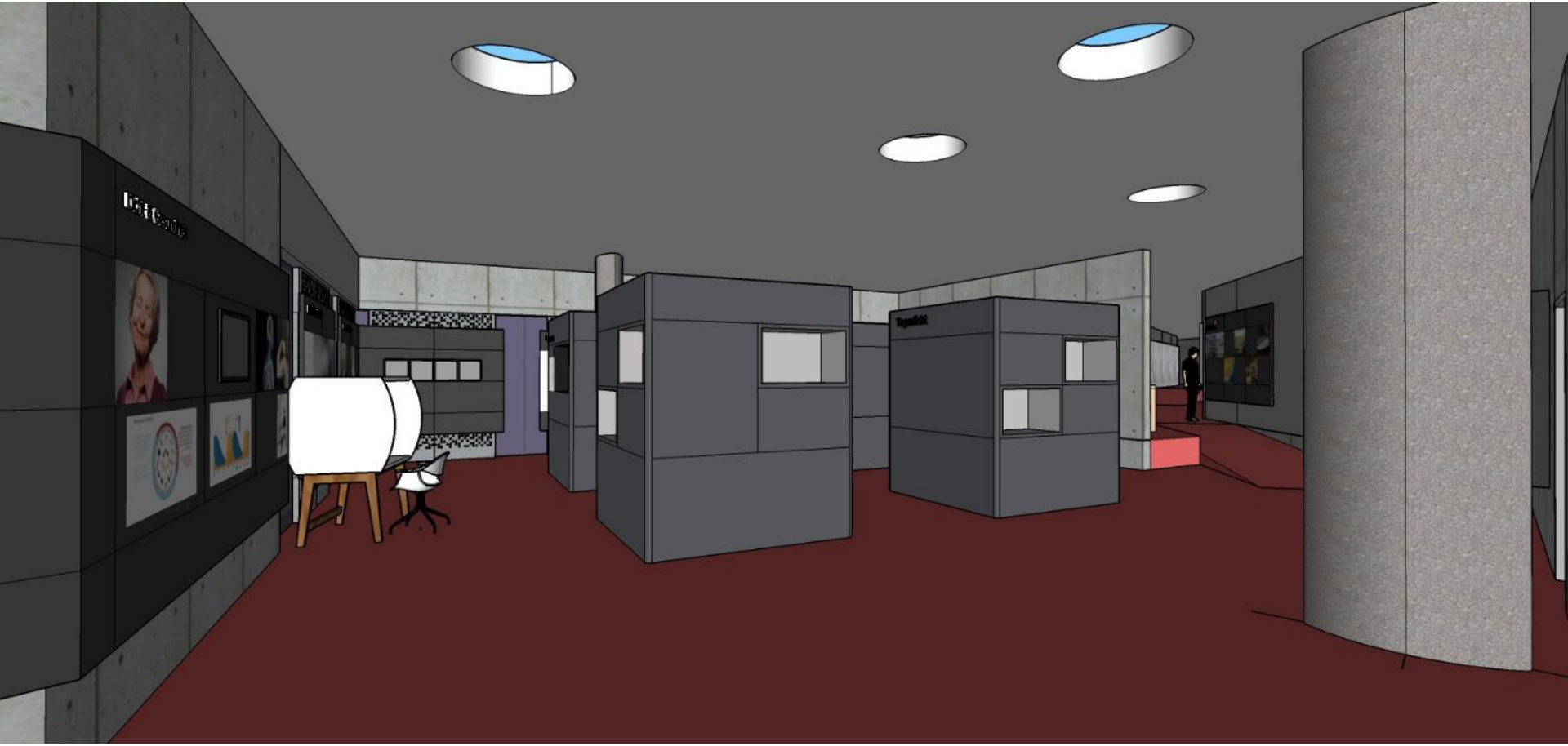
Lichtwelt „inspire“ @ Bartenbach

Application of Photon Mapping for Simulation of Light Tubes



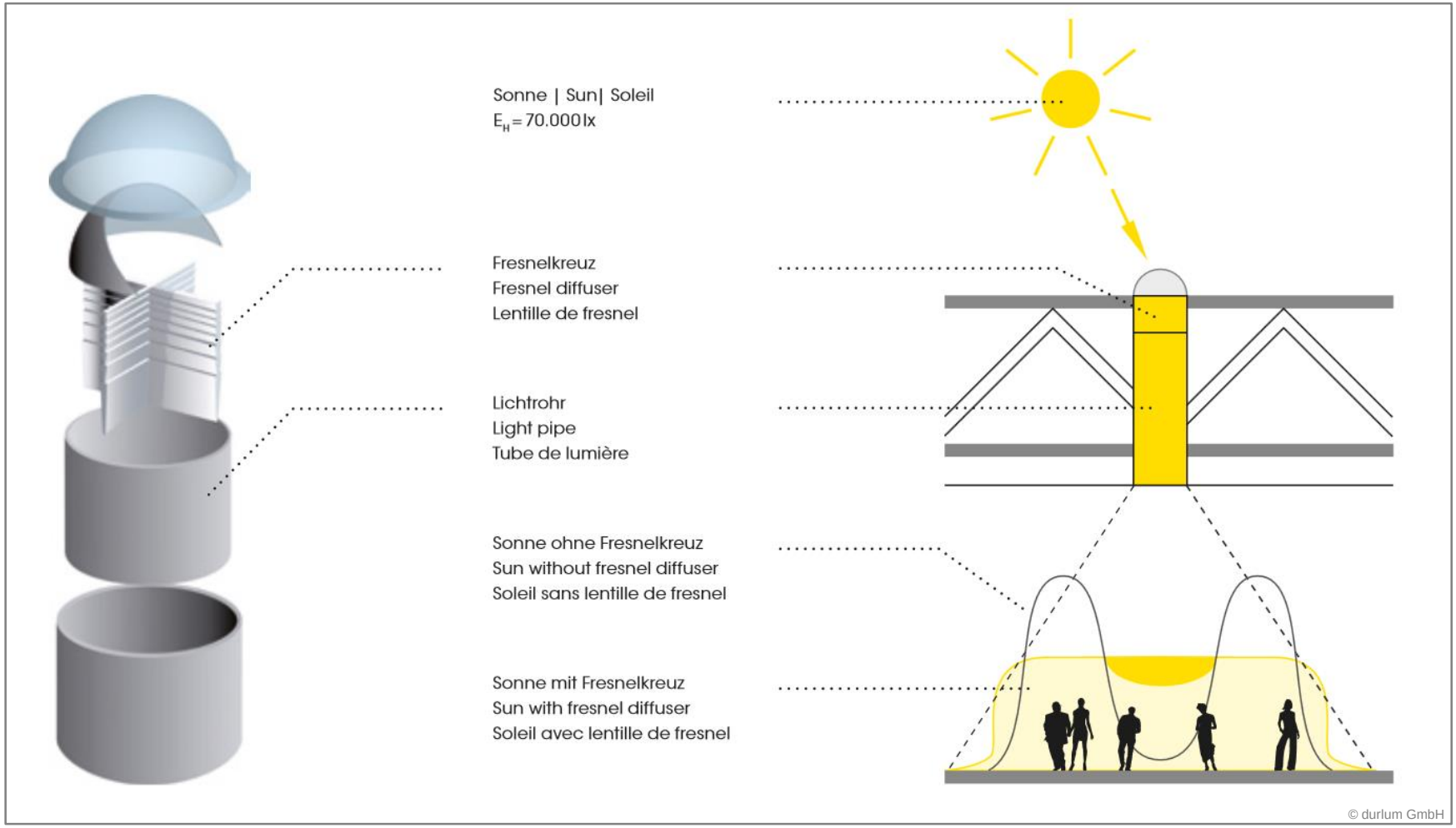
Lichtwelt „inspire“ @ Bartenbach

Application of Photon Mapping for Simulation of Light Tubes



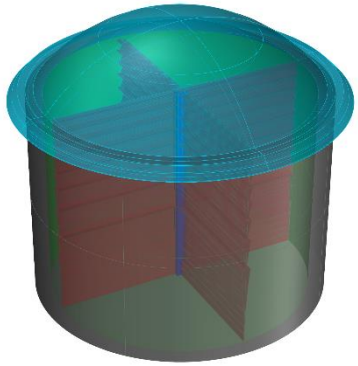
Lichtwelt „inspire“ @ Bartenbach

Application of Photon Mapping for Simulation of Light Tubes



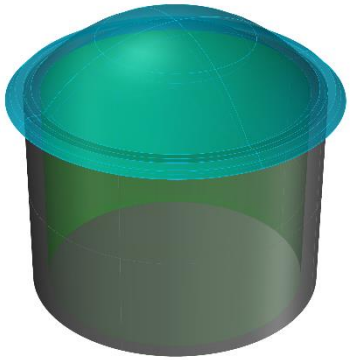
Lichtwelt „inspire“ @ Bartenbach

Application of Photon Mapping for Simulation of Light Tubes

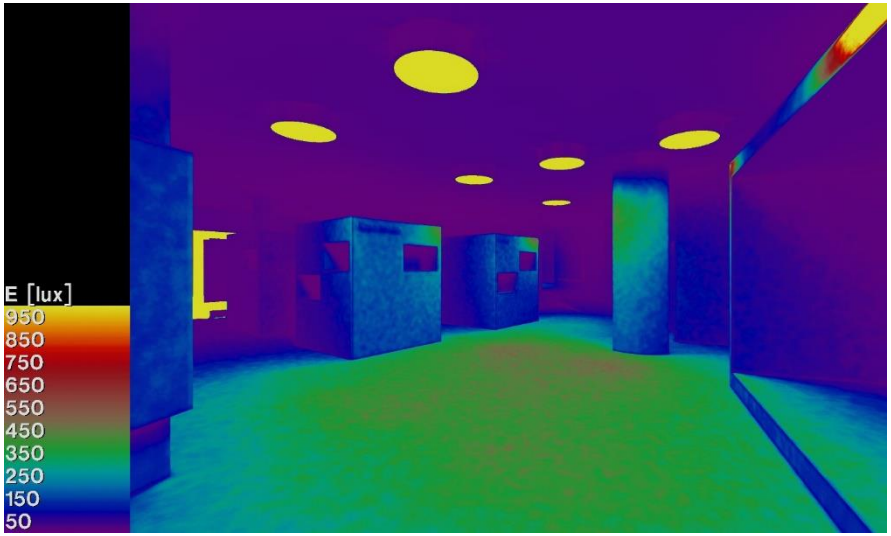


Lichtwelt „inspire“ @ Bartenbach

Application of Photon Mapping for Simulation of Light Tubes



Light tube without Fresnel structure



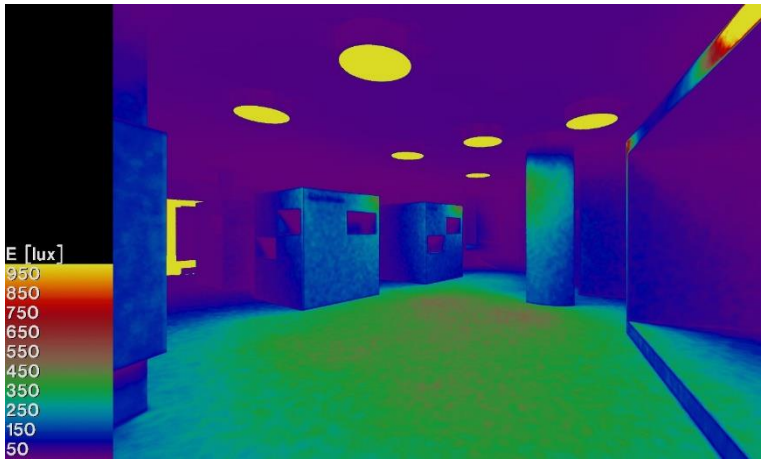
sky condition:
CIE overcast sky
Aldrans/Austria
March 21, 12:00 CET

Lichtwelt „inspire“ @ Bartenbach

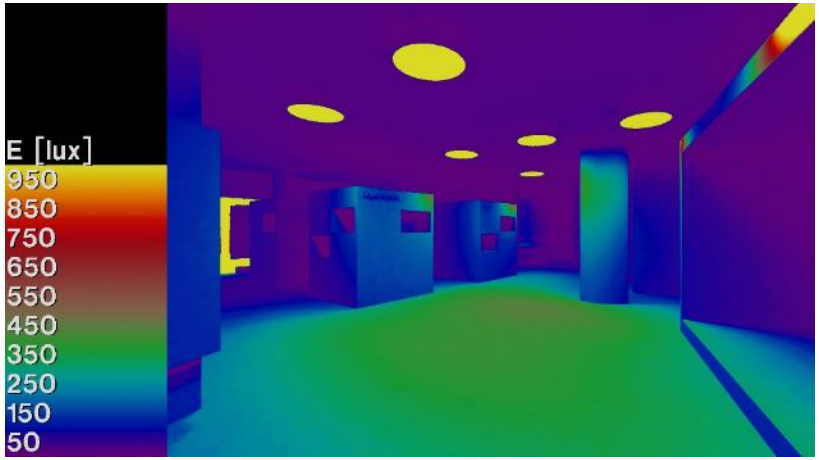
Application of Photon Mapping for Simulation of Light Tubes

Validation with classic RADIANCE

Photon Mapping



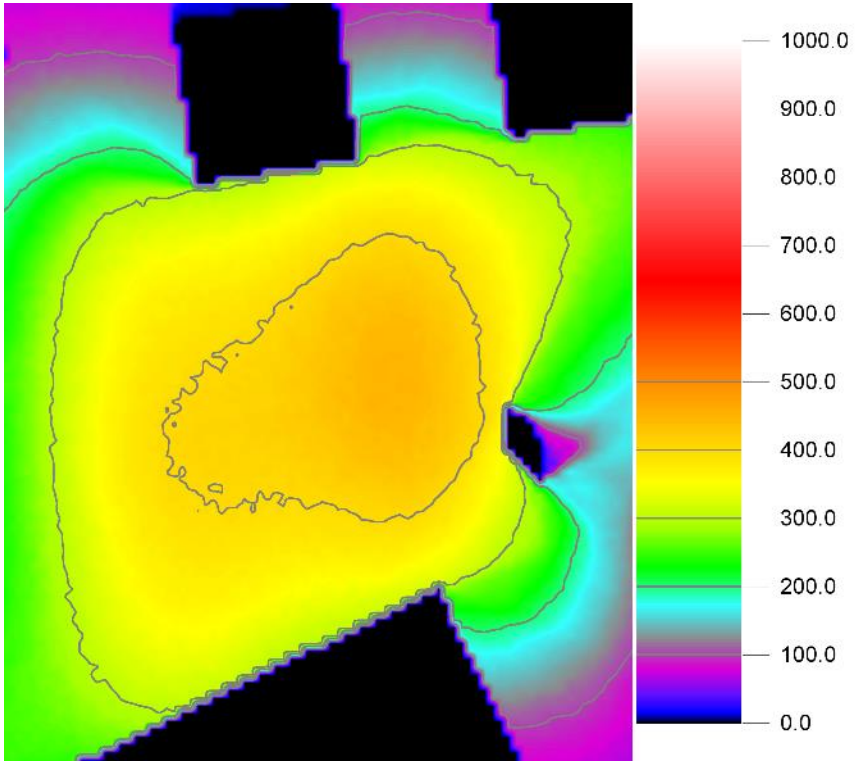
classic RADIANCE

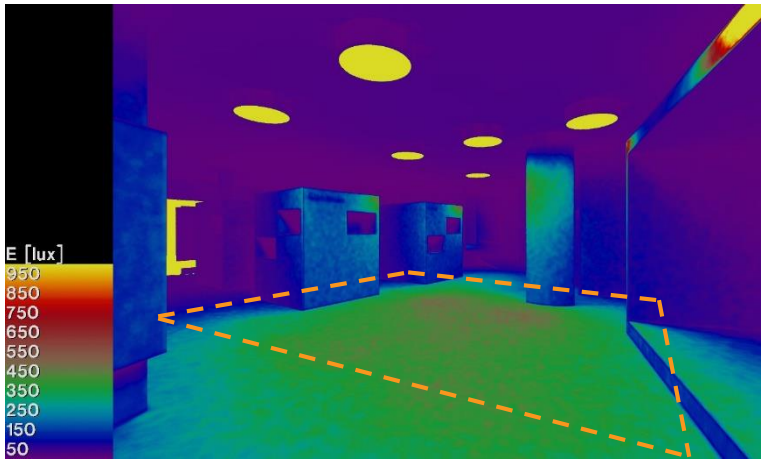


Lichtwelt „inspire“ @ Bartenbach

Application of Photon Mapping for Simulation of Light Tubes

Validation with classic RADIANCE





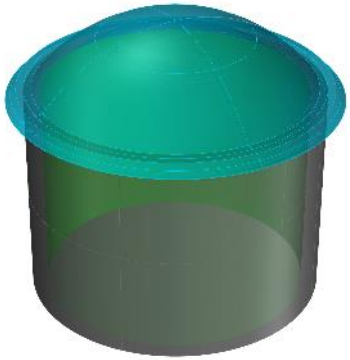
Photon Mapping

classic RADIANCE „ground truth“

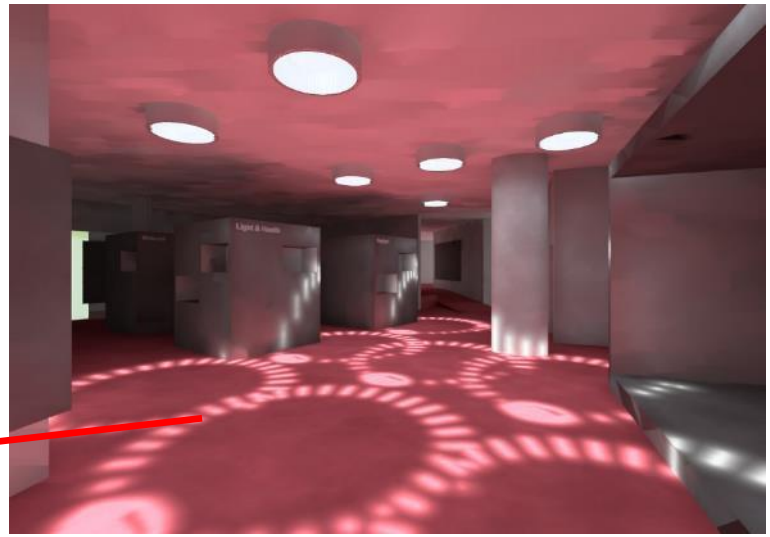
(rtrace -I -aa 0 -ab 9 -ad 20000 -lw 1e-12 -lr -20)

Lichtwelt „inspire“ @ Bartenbach

Application of Photon Mapping for Simulation of Light Tubes



Light tube without Fresnel structure



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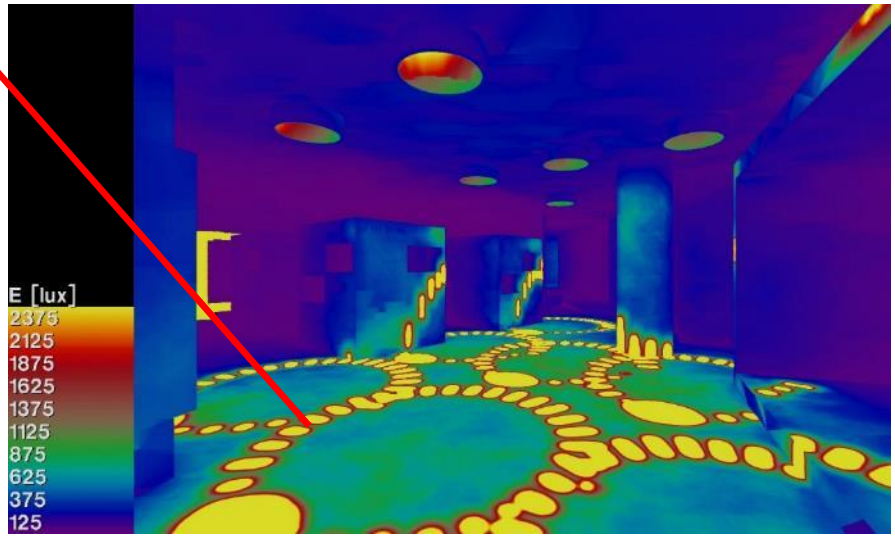


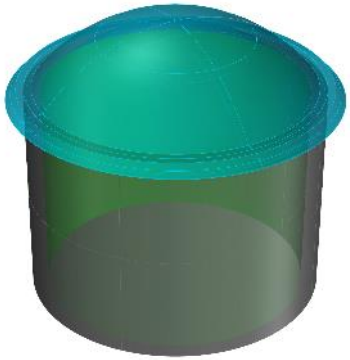
sky condition:
CIE clear sky
Aldrans/Austria
June 21, 13:00 CEST

Rhinoceros

sorry, that‘s my fault!

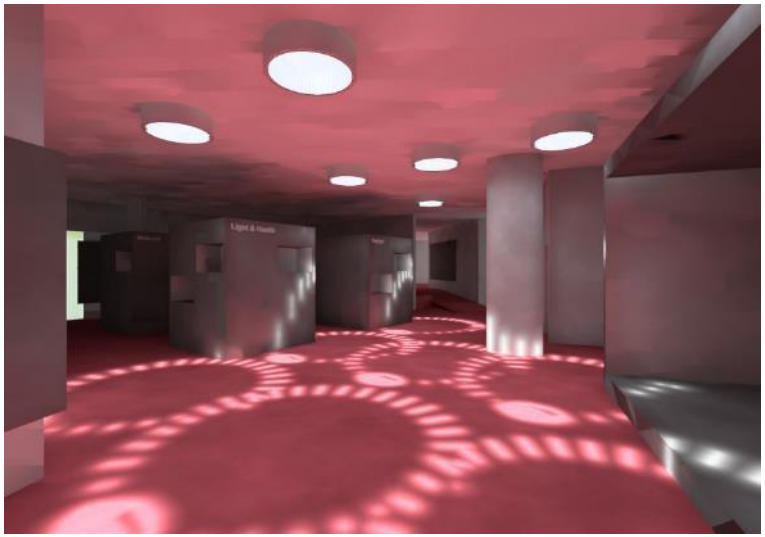
Lichtwelt „inspire“ @ Bartenbach

Application of Photon Mapping for Simulation of Light Tubes



Light tube without Fresnel structure

obj2rad -f



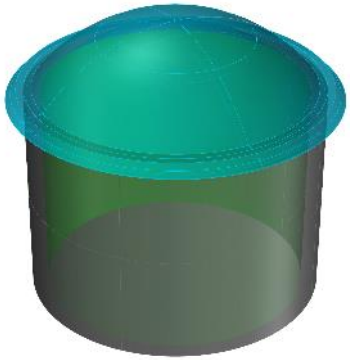
obj2rad

using the surface normal information and the *texfunc* functionality helps, but is still not satisfying…

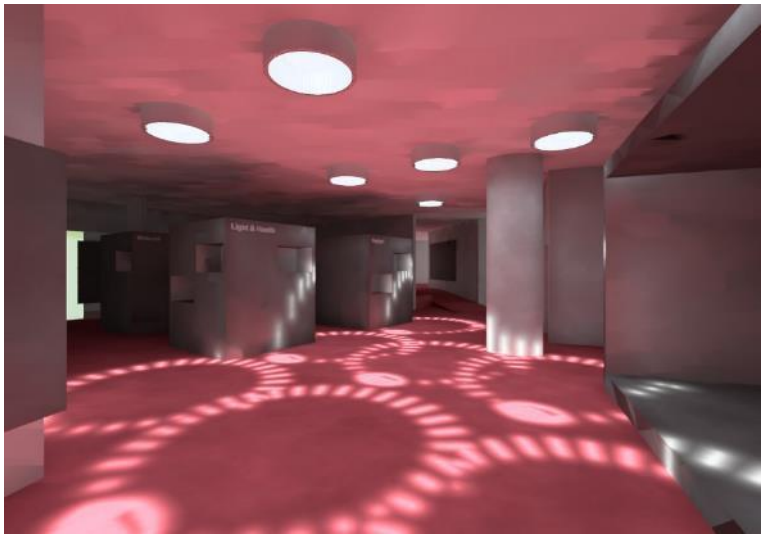
sky condition:
CIE clear sky
Aldrans/Austria
June 21, 13:00 CEST

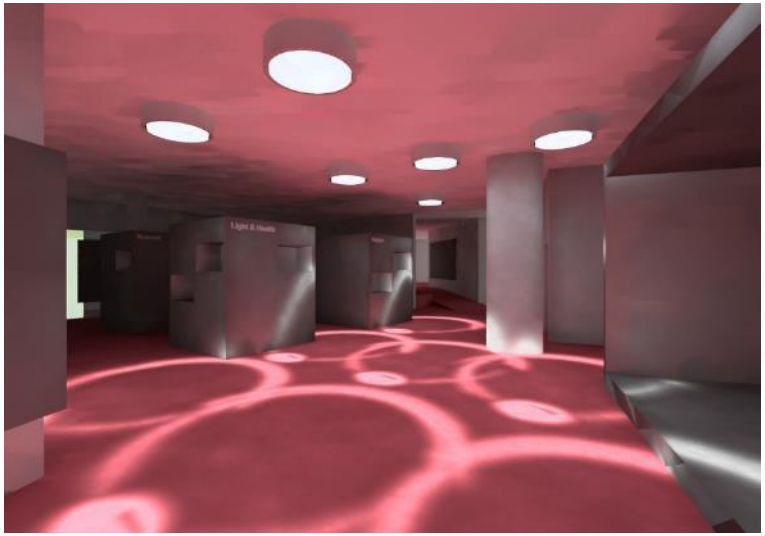
Lichtwelt „inspire“ @ Bartenbach

Application of Photon Mapping for Simulation of Light Tubes



Light tube without
Fresnel structure





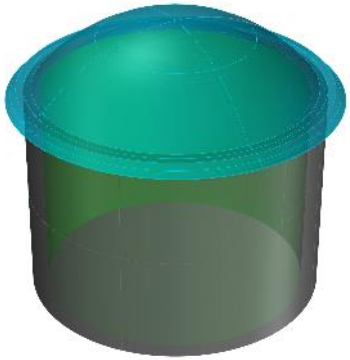
sky condition:
CIE clear sky
Aldrans/Austria
June 21, 13:00 CEST

modeling the light tubes
as native geometry

```
tube_plain__miro tube mirotube
0
0
7 0 0 0 0 0 0.65 0.4
```

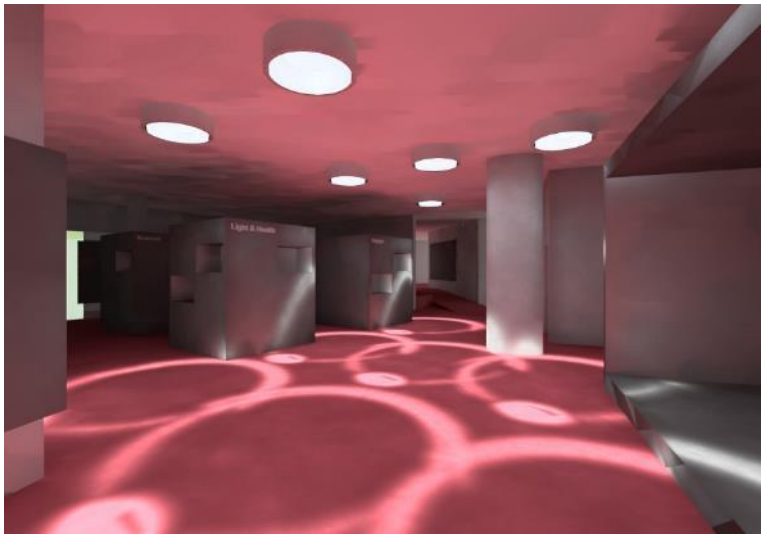
Lichtwelt „inspire“ @ Bartenbach

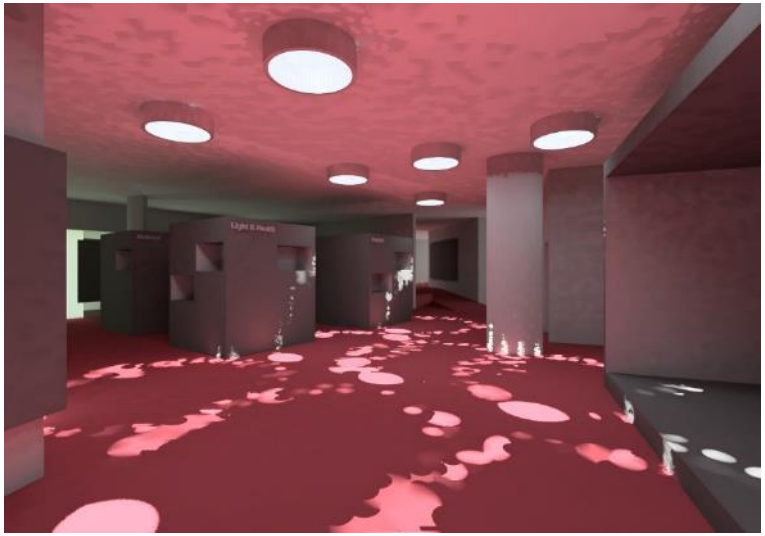
Application of Photon Mapping for Simulation of Light Tubes



Light tube without Fresnel structure

Photon Mapping





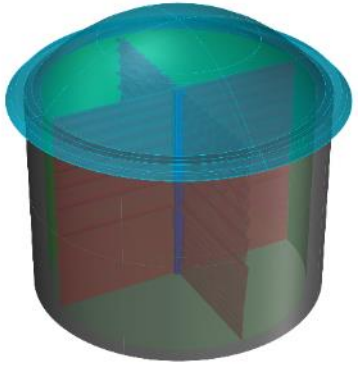
trying the same with classic RADIANCE

sky condition:
CIE clear sky
Aldrans/Austria
June 21, 13:00 CEST

Lichtwelt „inspire“ @ Bartenbach

Application of Photon Mapping for Simulation of Light Tubes

rpict -ab 1 -ap global.pmap 100 -ap caustic.pmap 100



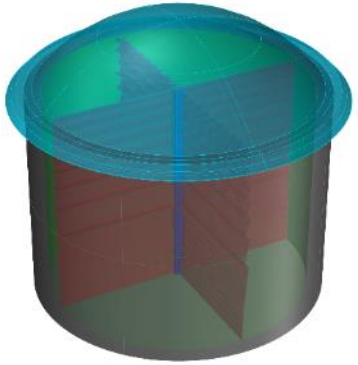
Light tube with
diffuser and
Fresnel structure

sky condition:
CIE overcast sky
Aldrans/Austria
March 21, 12:00 CET

Lichtwelt „inspire“ @ Bartenbach

Application of Photon Mapping for Simulation of Light Tubes

rpict -ab 1 -ap global.pmap 500 -ap caustic.pmap 500



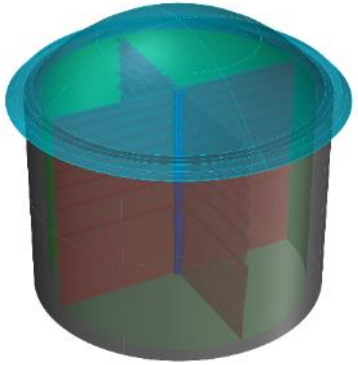
Light tube with diffuser and Fresnel structure

sky condition:
CIE overcast sky
Aldrans/Austria
March 21, 12:00 CET

Lichtwelt „inspire“ @ Bartenbach

Application of Photon Mapping for Simulation of Light Tubes

rpict -ab 1 -ap global.pmap 10 100 -ap caustic.pmap 10 100 -am 0.14



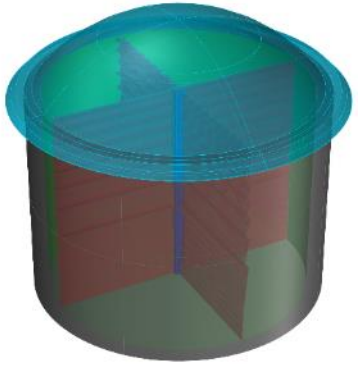
Light tube with
diffuser and
Fresnel structure

sky condition:
CIE overcast sky
Aldrans/Austria
March 21, 12:00 CET

Lichtwelt „inspire“ @ Bartenbach

Application of Photon Mapping for Simulation of Light Tubes

rpict -ab 1 -ap global.pmap 500 -ap caustic.pmap 500 -am 0.05



Light tube with diffuser and Fresnel structure

sky condition:
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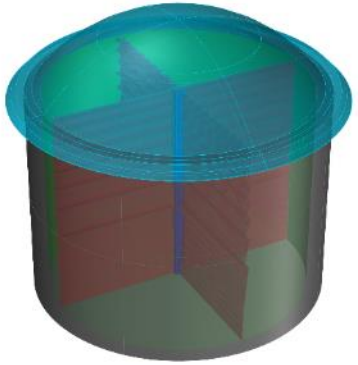
Aldrans/Austria
March 21, 12:00 CET

Lichtwelt „inspire“ @ Bartenbach

Application of Photon Mapping for Simulation of Light Tubes



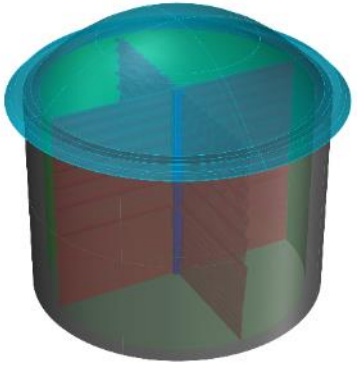
Light tube with
diffuser and
Fresnel structure

sky condition:
CIE overcast sky
Aldrans/Austria
March 21, 12:00 CET

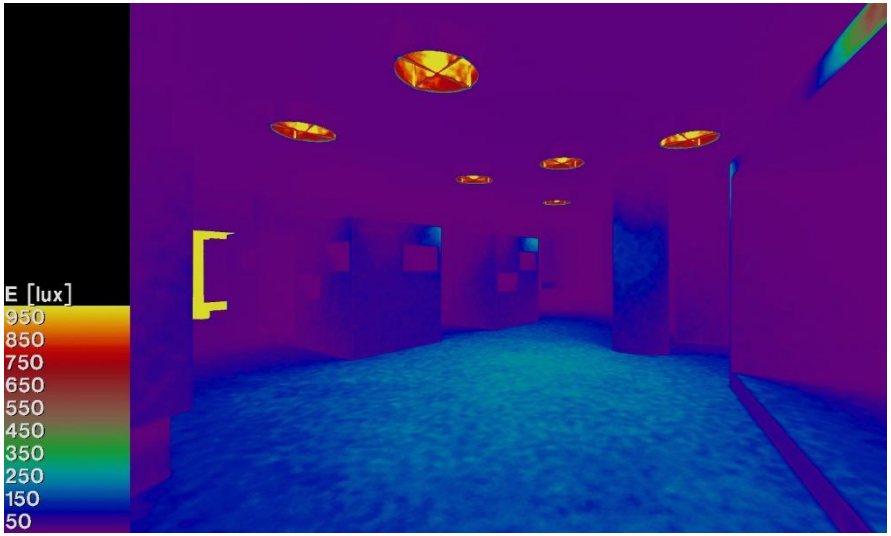
photon distribution: 50k global photons (total: 10m)
50k caustic photons (total: 30m)

Lichtwelt „inspire“ @ Bartenbach

Application of Photon Mapping for Simulation of Light Tubes



Light tube with
diffuser and
Fresnel structure

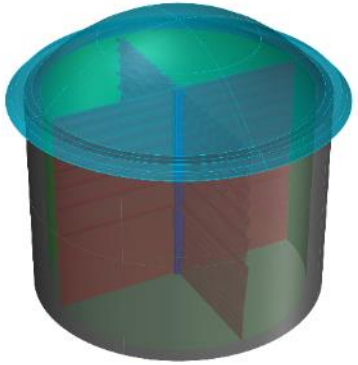


sky condition:
CIE overcast sky
Aldrans/Austria
March 21, 12:00 CET

Lichtwelt „inspire“ @ Bartenbach

Application of Photon Mapping for Simulation of Light Tubes

rpict -ab 1 -ap global.pmap 500 -ap caustic.pmap 500 -am 0.05

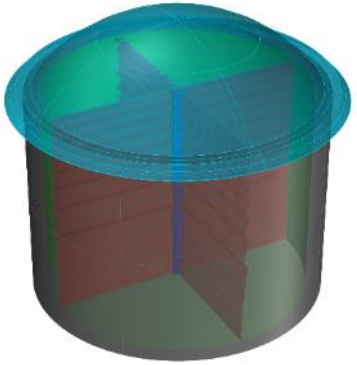


Light tube with diffuser and Fresnel structure

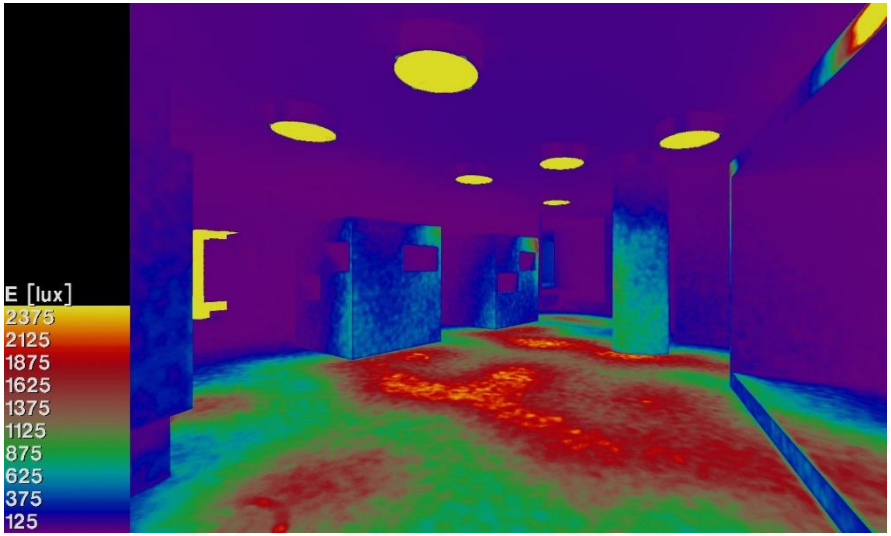
sky condition:
CIE clear sky
Aldrans/Austria
June 21, 13:00 CEST

Lichtwelt „inspire“ @ Bartenbach

Application of Photon Mapping for Simulation of Light Tubes



Light tube with
diffuser and
Fresnel structure



sky condition:
CIE clear sky
Aldrans/Austria
June 21, 13:00 CEST

Conclusion & outlook

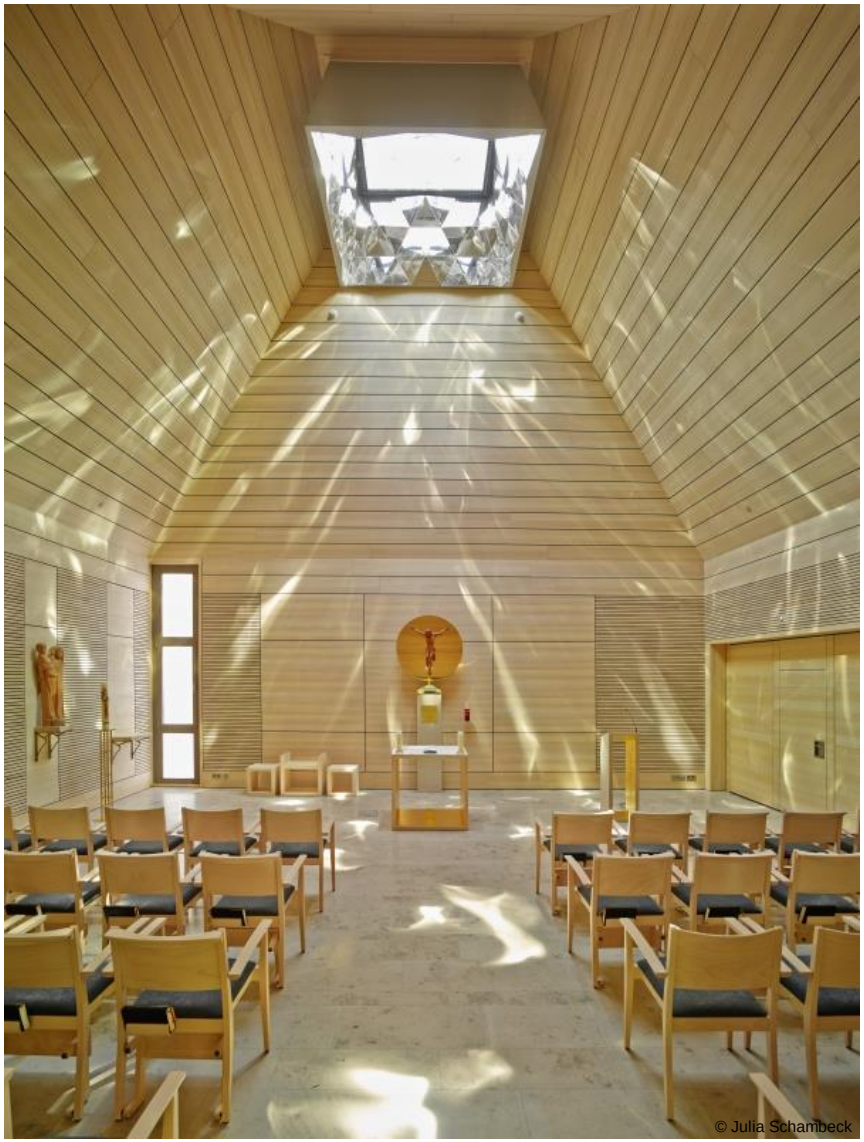
- Photon mapping extends existing RADIANCE functionality, it does not replace it!

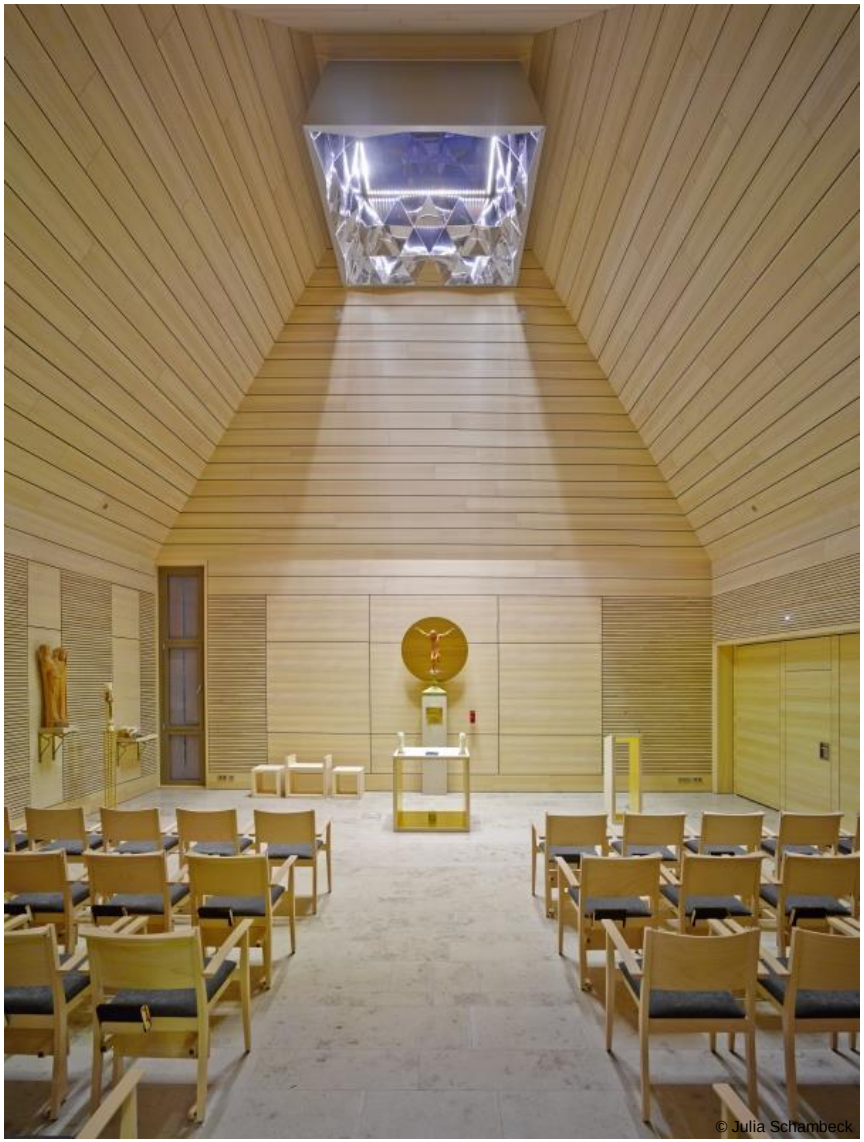
- It enables RADIANCE users to visualize and calculate additional lighting effects that were not possible before:
  - caustics
  - reflections on curved specular surfaces
  - daylight redirecting systems without BSDFs

- Idea for further development
  - pre-calculation for distribution of photon ports (à la *mkillum*)

St.Hedwig‘s Chapel

Königsbrunn, Germany



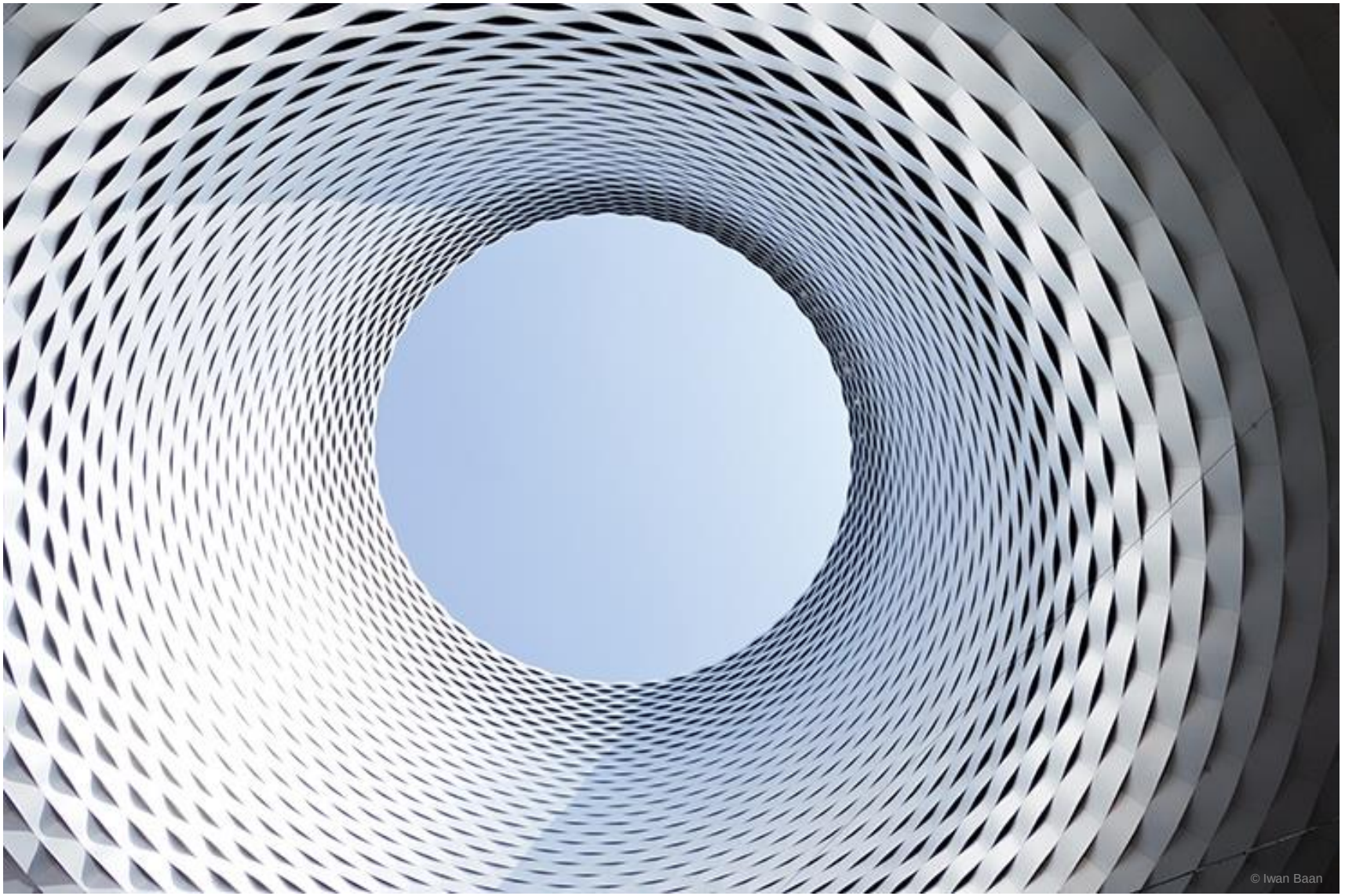


St.Hedwig‘s Chapel

Königsbrunn, Germany

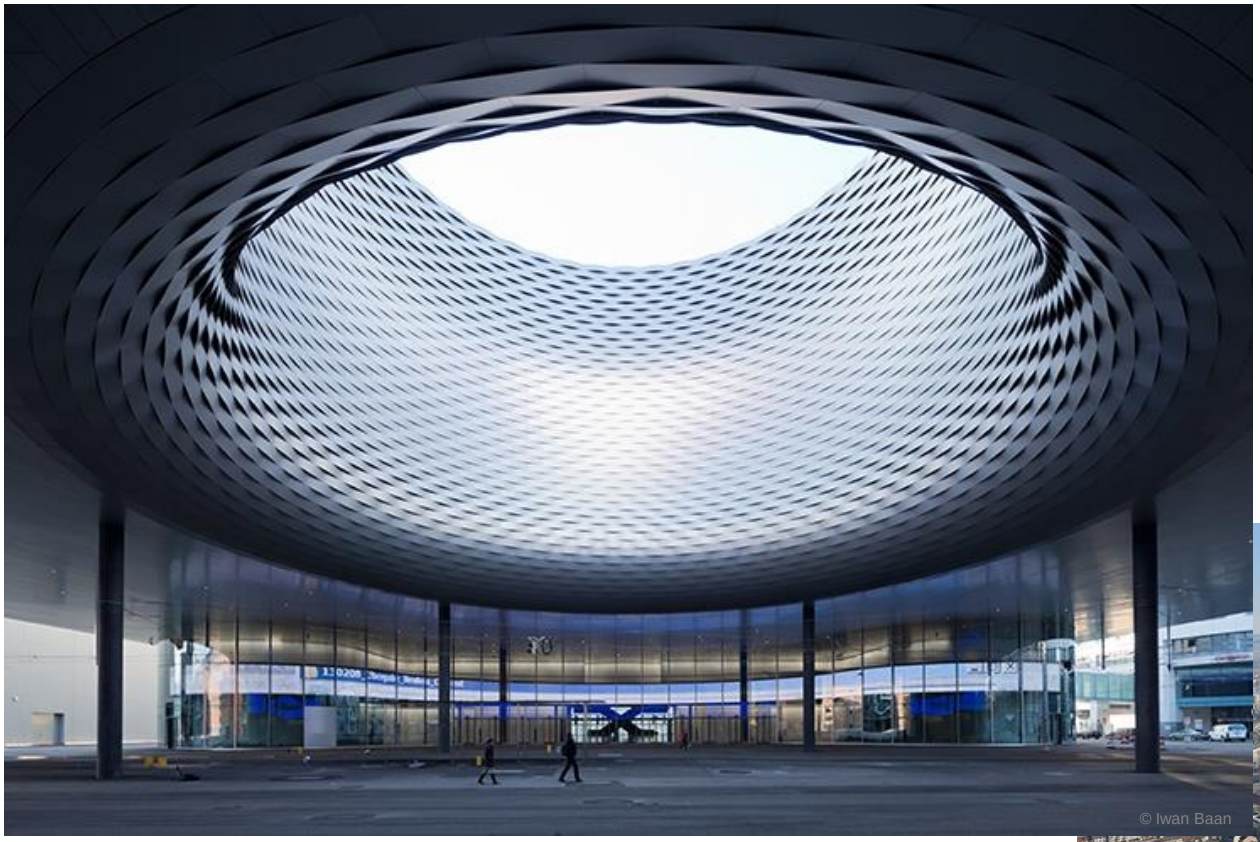
Messe Basel

Basel, Switzerland



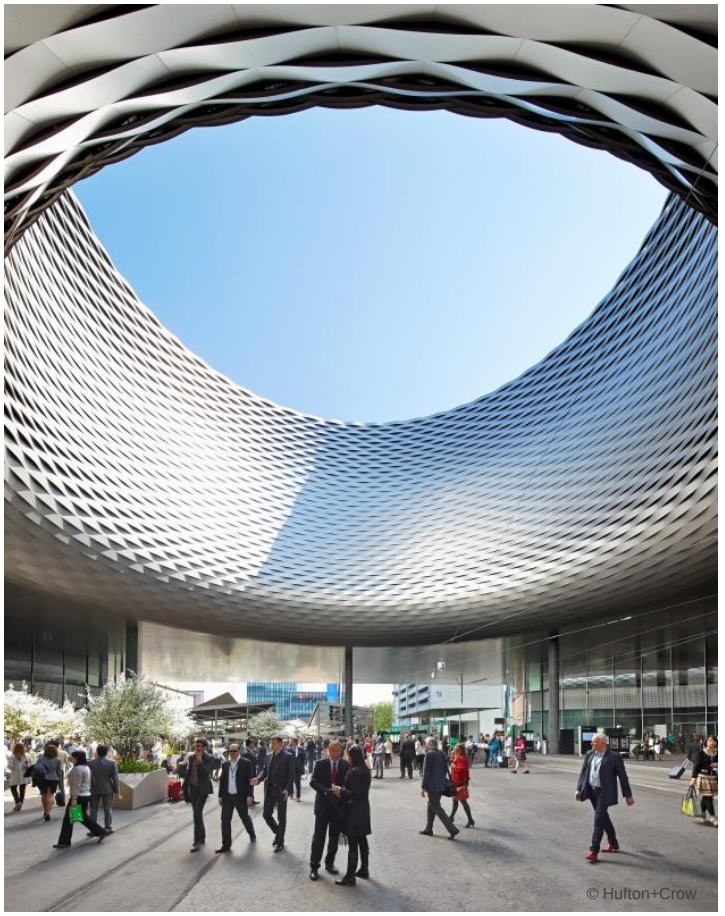
Messe Basel

Basel, Switzerland



Messe Basel

Basel, Switzerland



City Library Augsburg

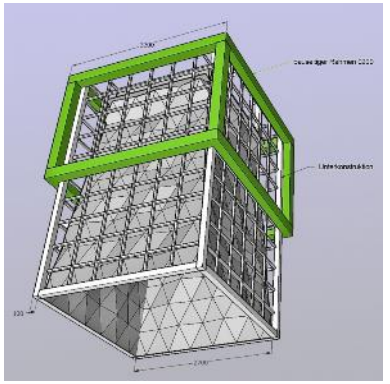
Augsburg, Germany

City Library Augsburg

Augsburg, Germany

City Library Augsburg

Augsburg, Germany



City Library Augsburg

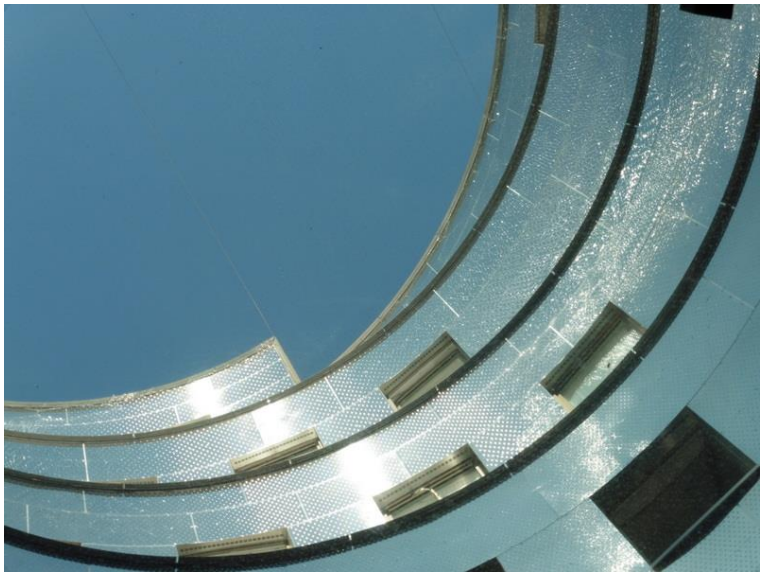
Augsburg, Germany

City Library Augsburg

Augsburg, Germany

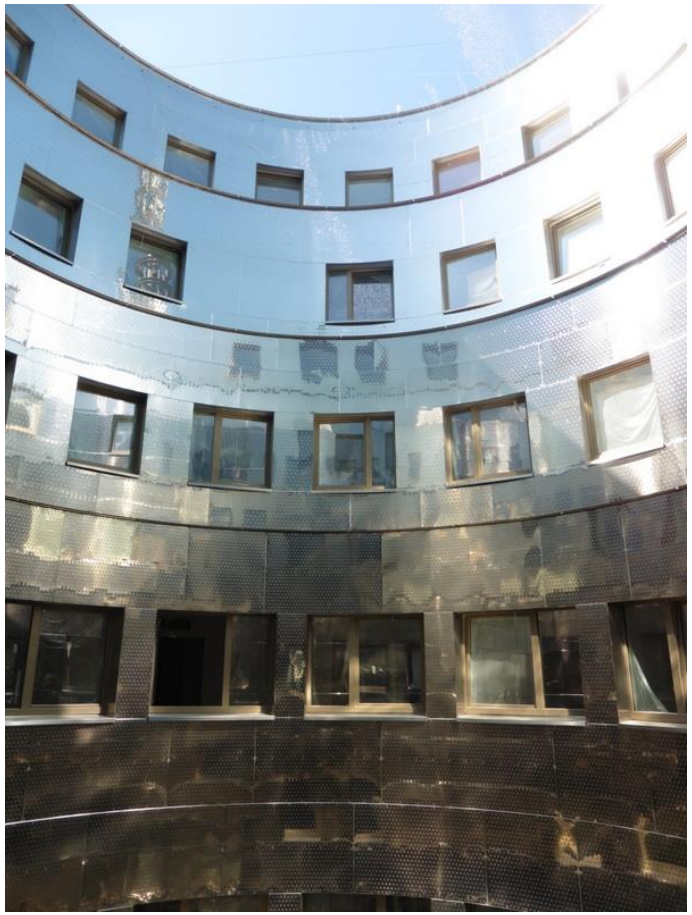
Hotel with inner courtyard

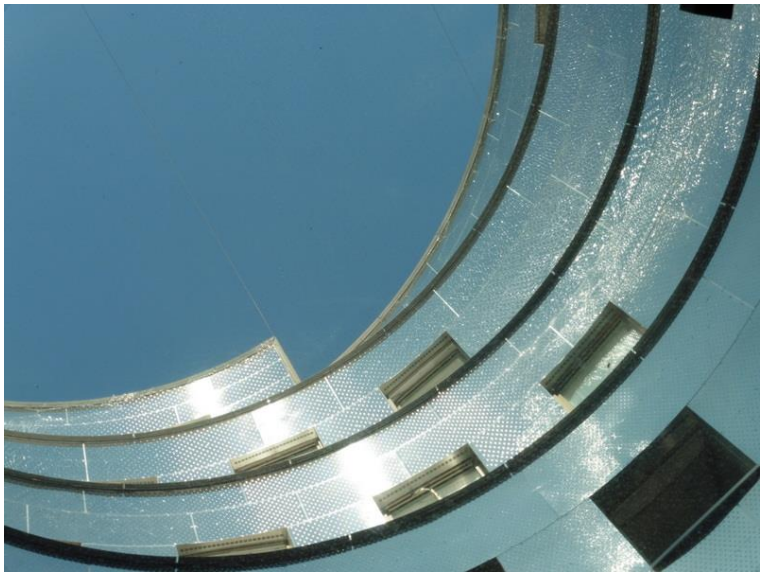
Vienna, Austria

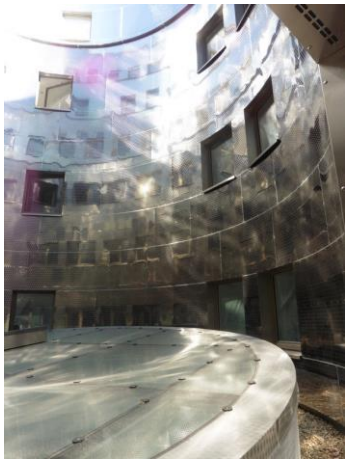


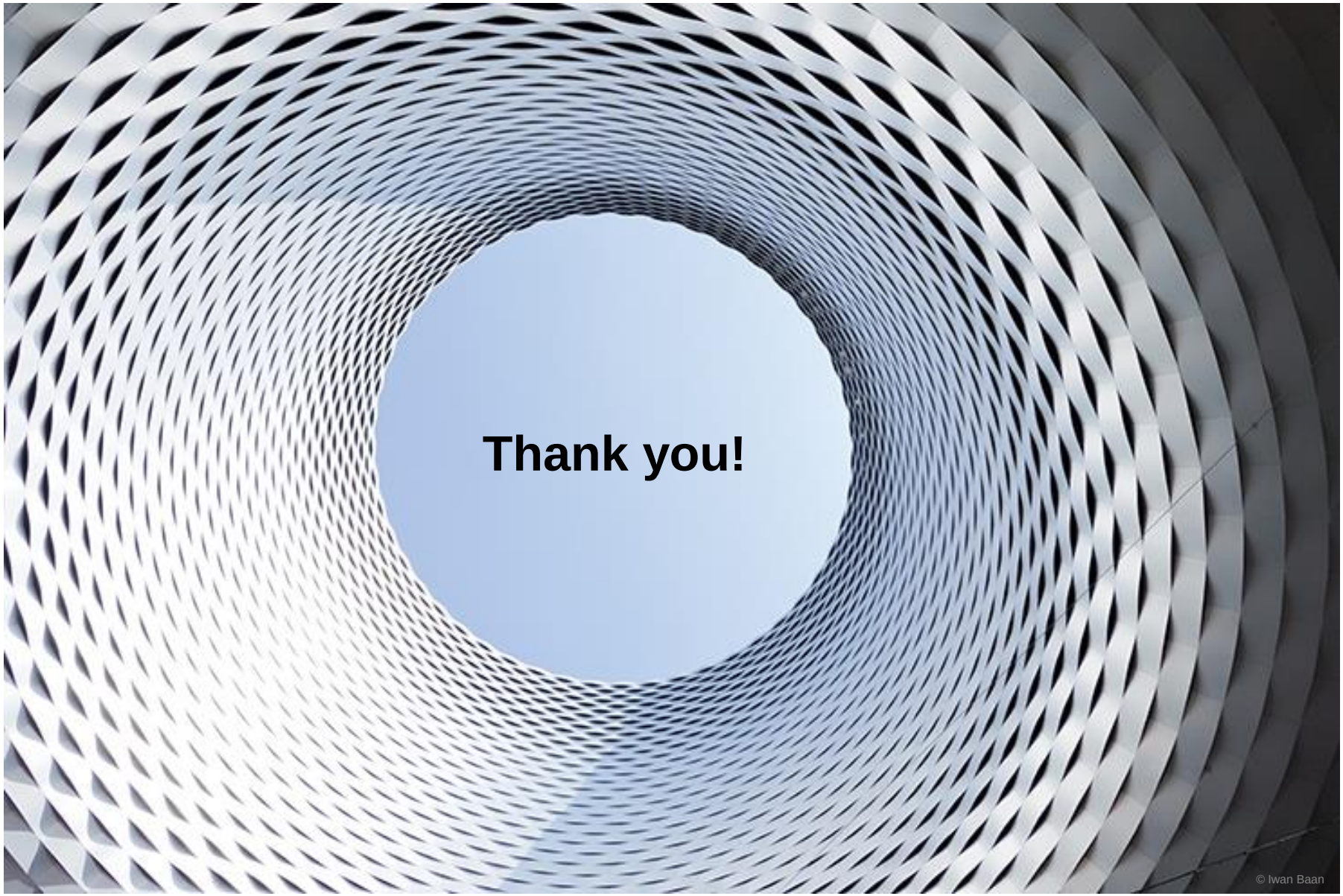
Hotel with inner courtyard

Vienna, Austria








Thank you!
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