BIPV a-Si through façade

Development, evaluation and Radiance simulations

Francesco Frontini,
Wendelin Sprenger, Tilmann E. Kuhn,
Helen Rose Wilson

Fraunhofer Institute for
Solar Energy Systems ISE

Radiance Workshop
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Agenda

- INTRODUCTION: Why BIPV façade
- A new Idea (Patent Fraunhofer ISE)
- First Radiance simulations
- Building energy simulation
- Absorbing layer: simulation and modelling problems

- Discussion

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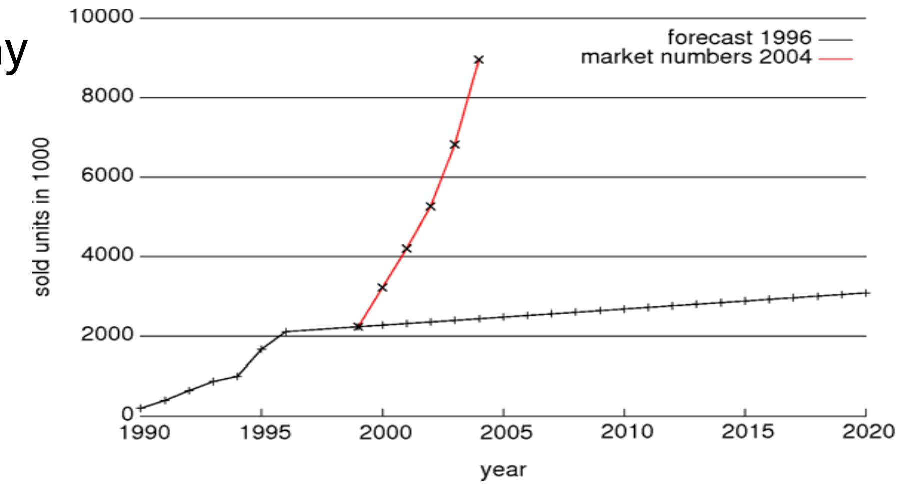
INTRODUCTION

Many recent researches attest that the 40% of the European energy consumption is due to the building.

- 80% of building energy consumption currently occurs during service-life.
- The energy for cooling is raising day by day.
- All the building, residential or commercial, have an enormous potential for improvement of the energy efficiency (Passive-House),
- and of energy systems integration, like pv-systems

Sold cooling systems



EU Study (EERAC) 1996

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INTRODUCTION

The current use of renewable is mainly concentrated in the sector of single family house

other matter is the integration into big or tall building (*façade integration*)

Sun protection is necessary (f.e.venetian blinds).

! PROBLEM !

- External shading, not good for high-rise buildings and windy locations.
- Control strategies
- Reduce solar gains
- Façade PV integration (NZEBs)

SOURCE: BEAR Architect, Viessmann

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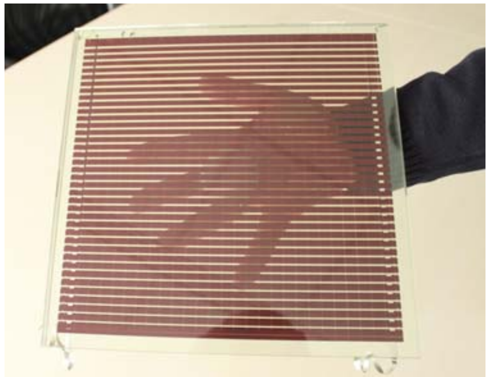
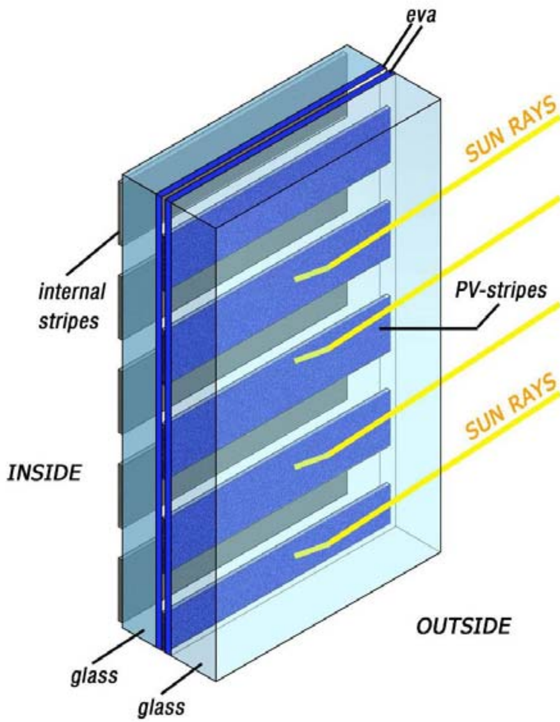
Angle selective façade

Consists of, at least, two laminated glass panes with two series of opaque stripes.

Three important tasks:

- solar protection,
- glare protection
- integrated pv-system.





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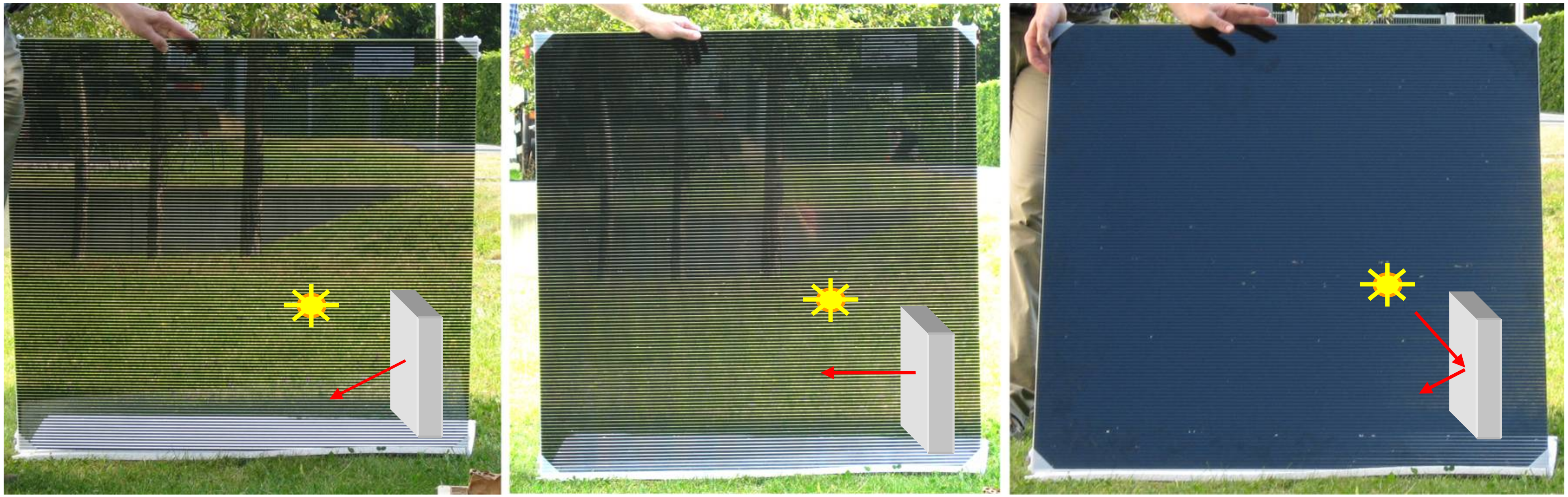
Angle selective façade - Prototype

A prototype was realized in collaboration
with a German Glass Industry.

Down-view Direct-view Sun is blocked



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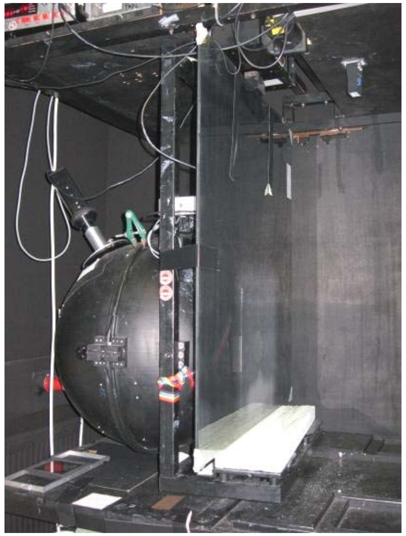
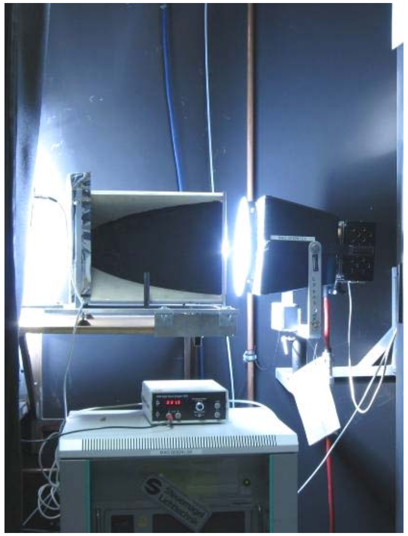
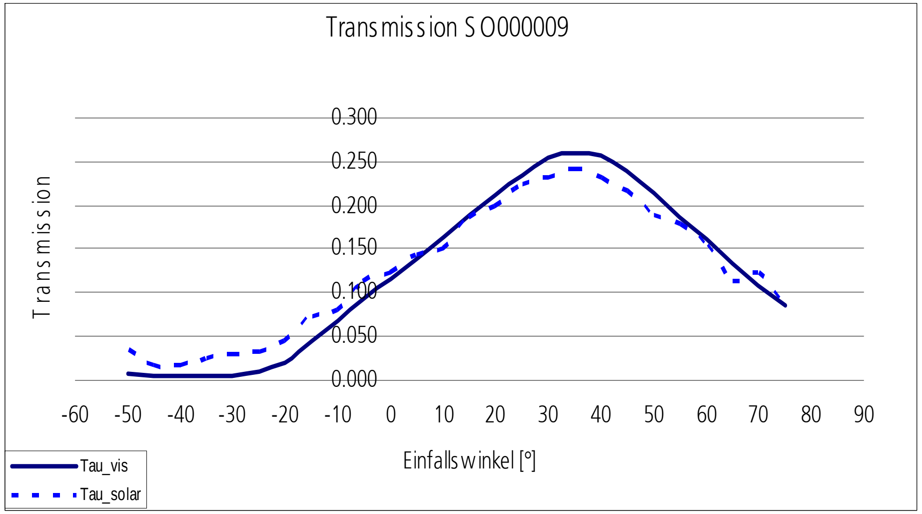
Angle selective façade measurement

Angle-dependent Transmittance (Ulbricht Sphere)

Reflectance measurements (Lambda-900 spectrometer)







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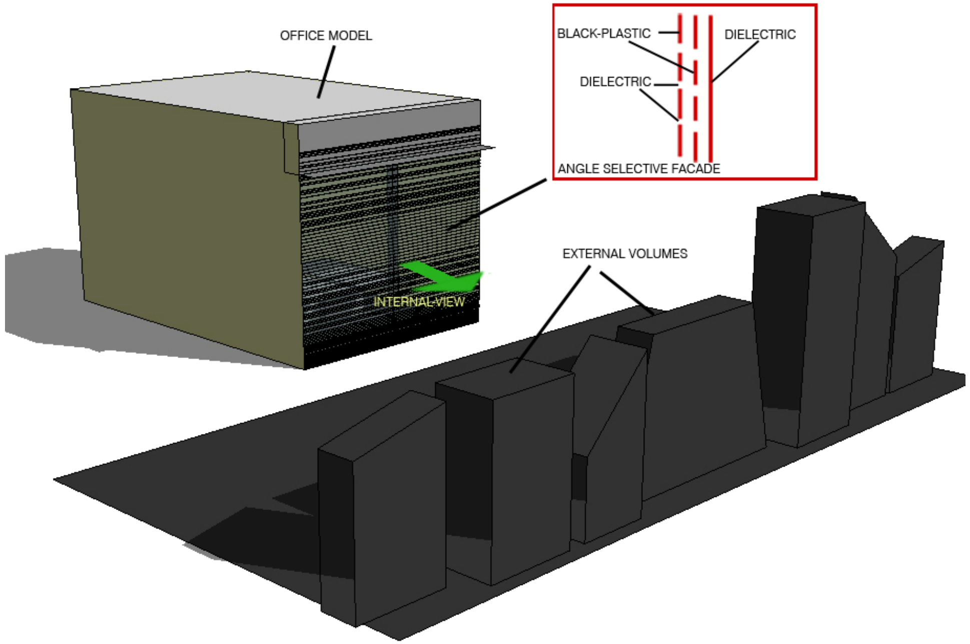
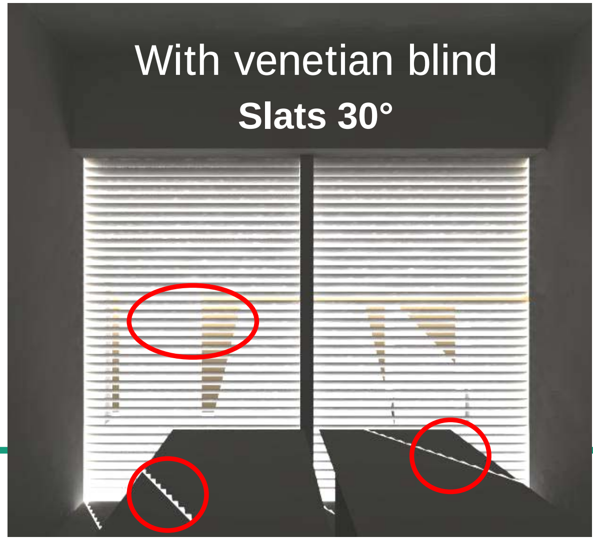
Radiance simulation – Visual Contact





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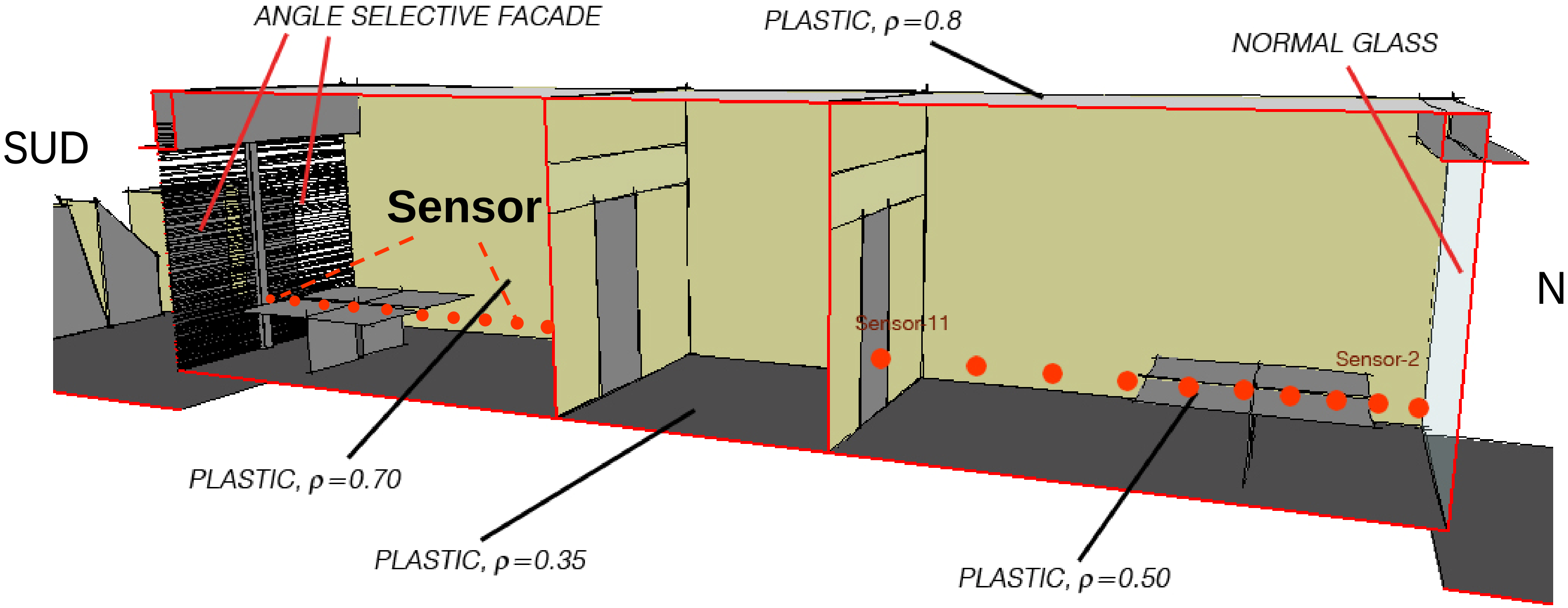
Dynamic Daylight simulation (Daysim)

Daylight autonomy

Percentage of occupied time per year when target illuminance can be maintained by daylight alone



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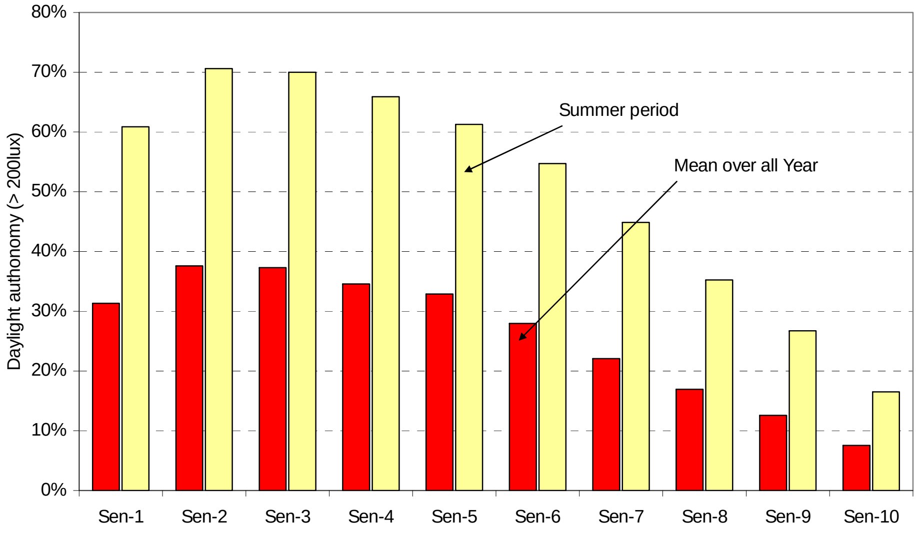
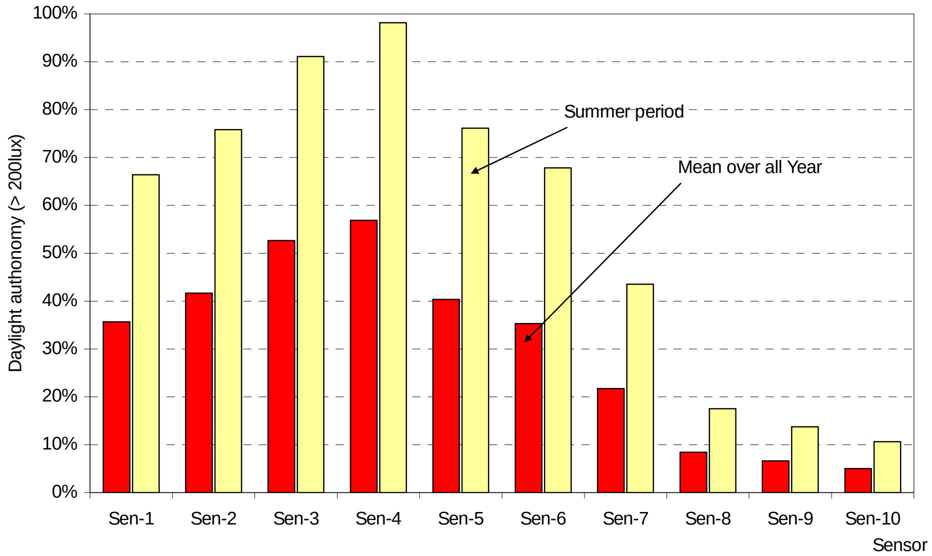
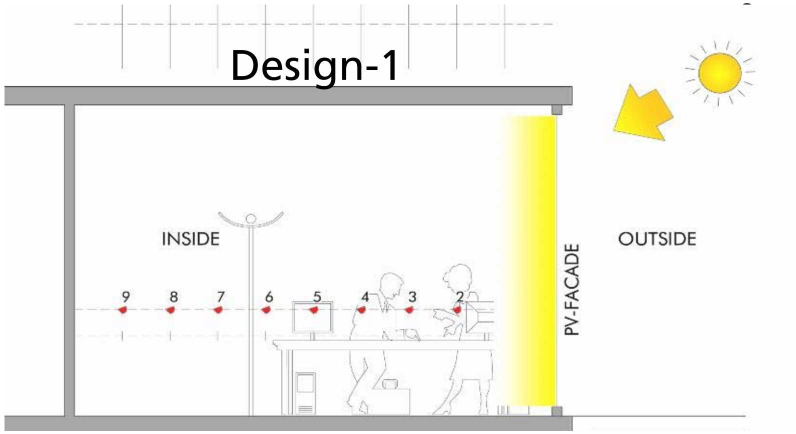
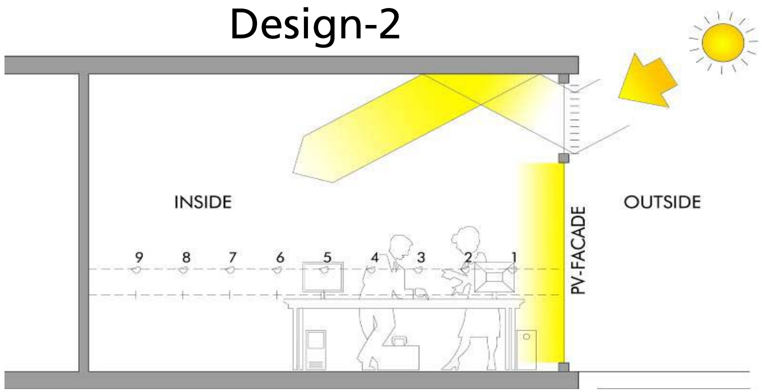
Dynamic Daylight simulation (Daylight autonomy)









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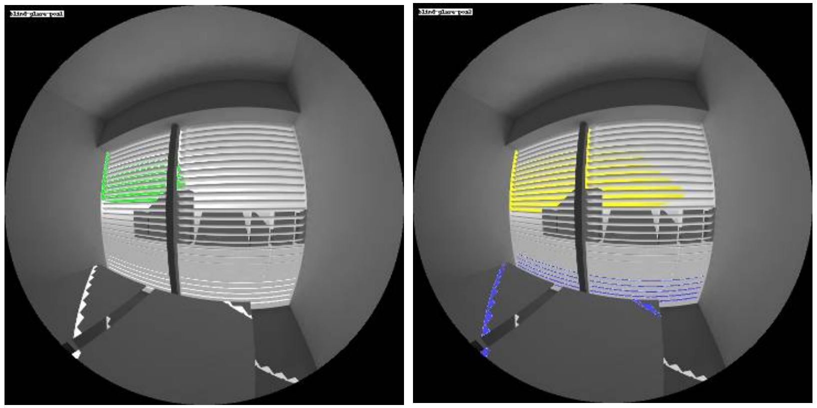
Glare analysis (DGP)

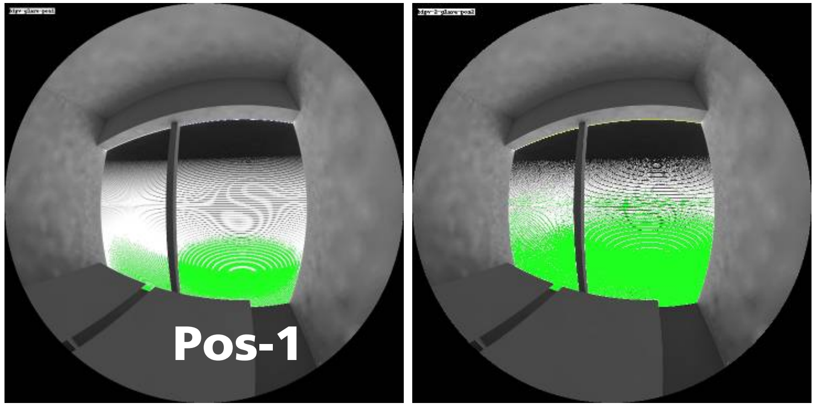
The DGP describes the probability that a person is disturbed by daylight glare and is an empirical equation, based on the vertical illuminance at eye level and a term considering the glare sources.

Venetian blinds (slats 45°)

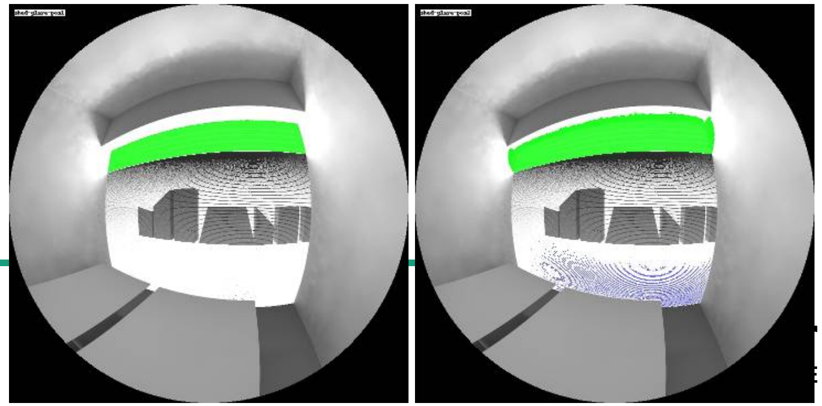


With venetian blinds

Design-1



Design-2



Disturbing glare or stronger glare occur for DGP values larger than 0.39

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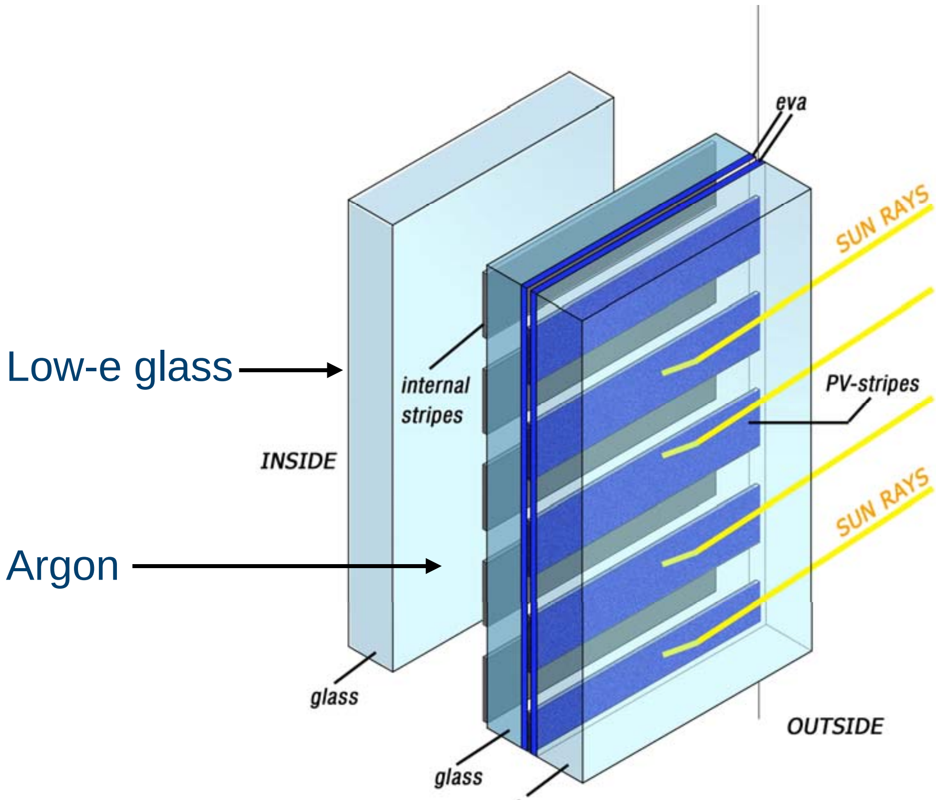
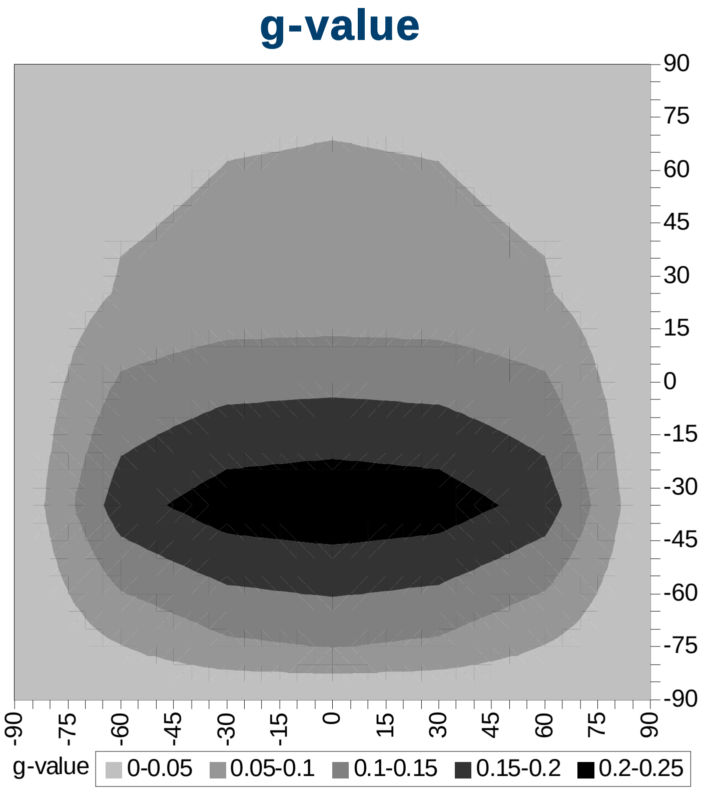
Angle selective façade – Building Simulation

Thermal analysis

Using the “new BBM” within ESP-r the impact into a standard office was assessed.





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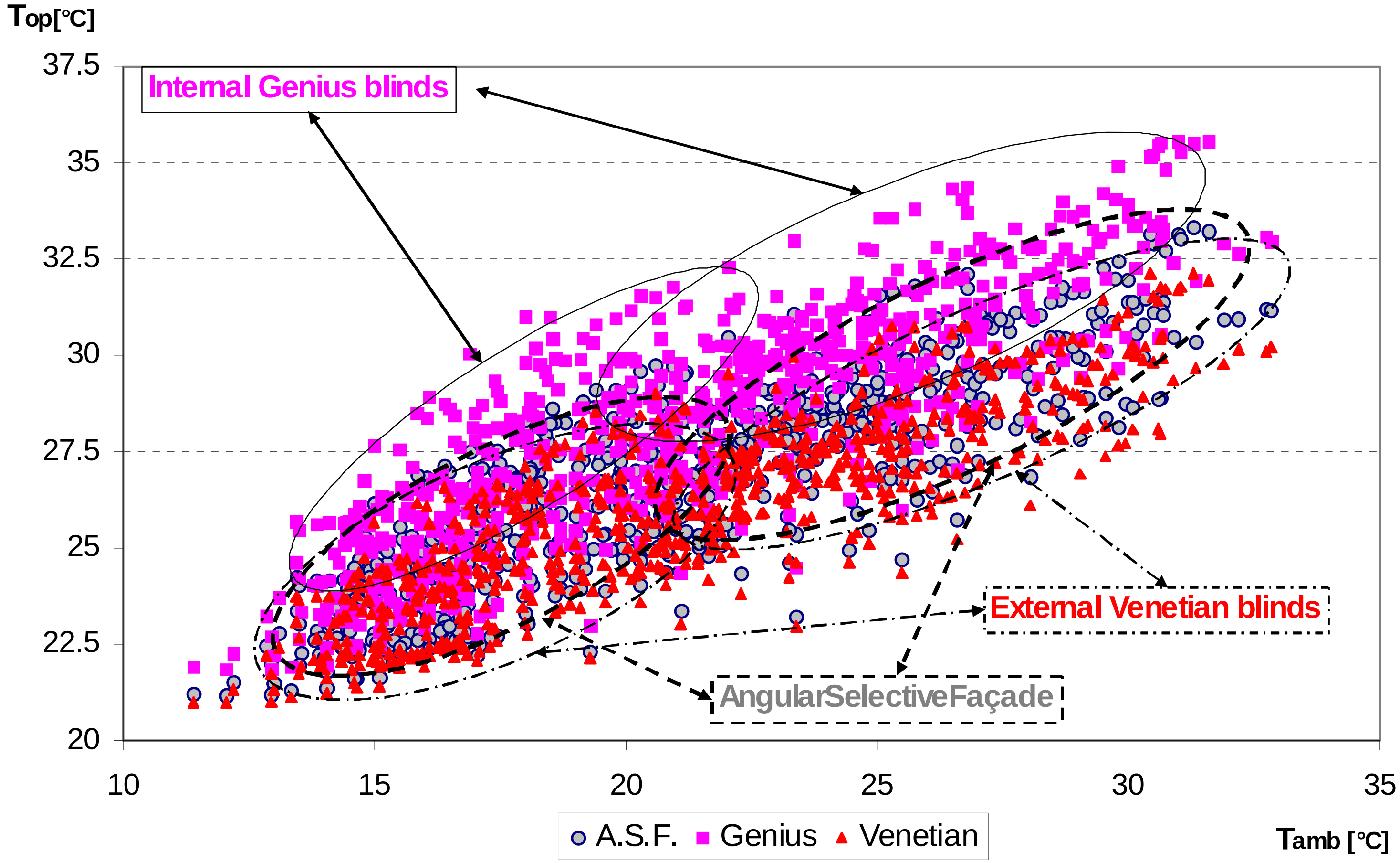
Angle selective façade – Building Simulation

Three simulations were done to compare the new static system with a glazing façade with external venetian blinds or with internal Genius™ blinds.



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PV Integration

Possible Technologies:

- a-Si
- monocrystalline Si
- CIS
- CdTe

SOURCE: SCHOTT

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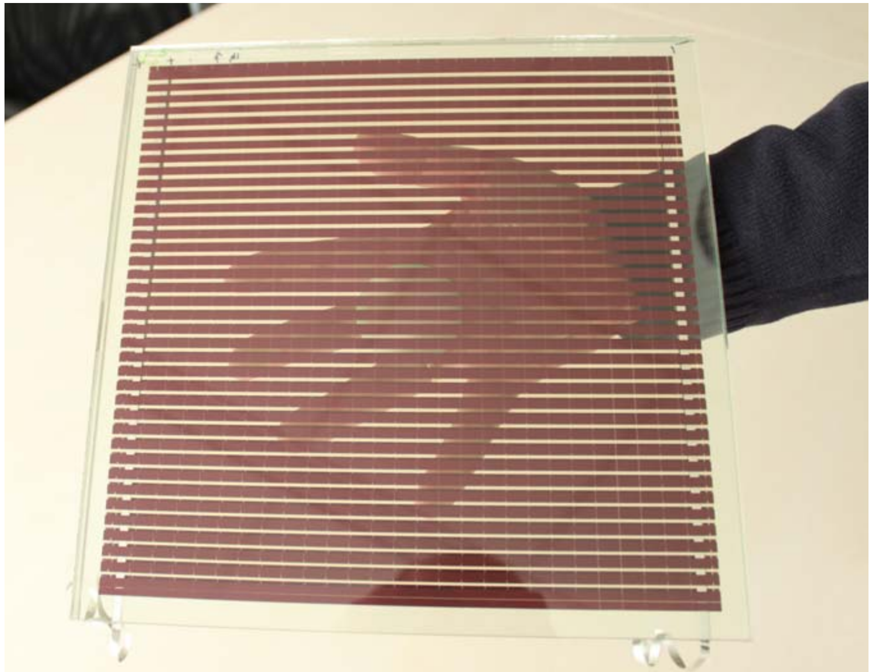
PV Integration

To be assessed:

- Optical and physical properties of the technologies
- Shadow dependency
- Temperature dependency
- Efficiency



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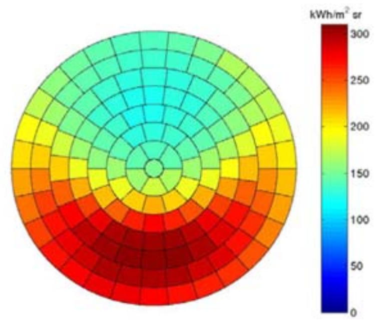
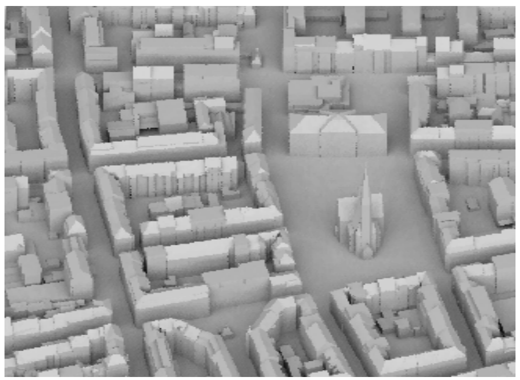
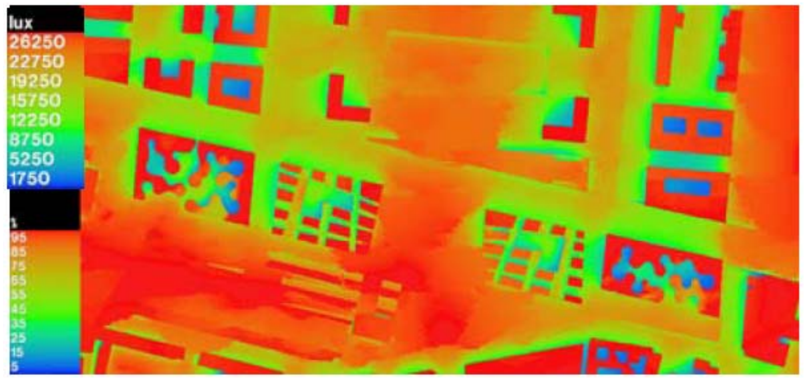
PV Integration

- Several tools already exist to asses the solar irradiation in an urban environment (f.e. iPPF).
- The „problem“ exists when complex facade with absorbing layers must be assessed.
- What happens inside a glass panel?



SOURCE: R. Compagnon





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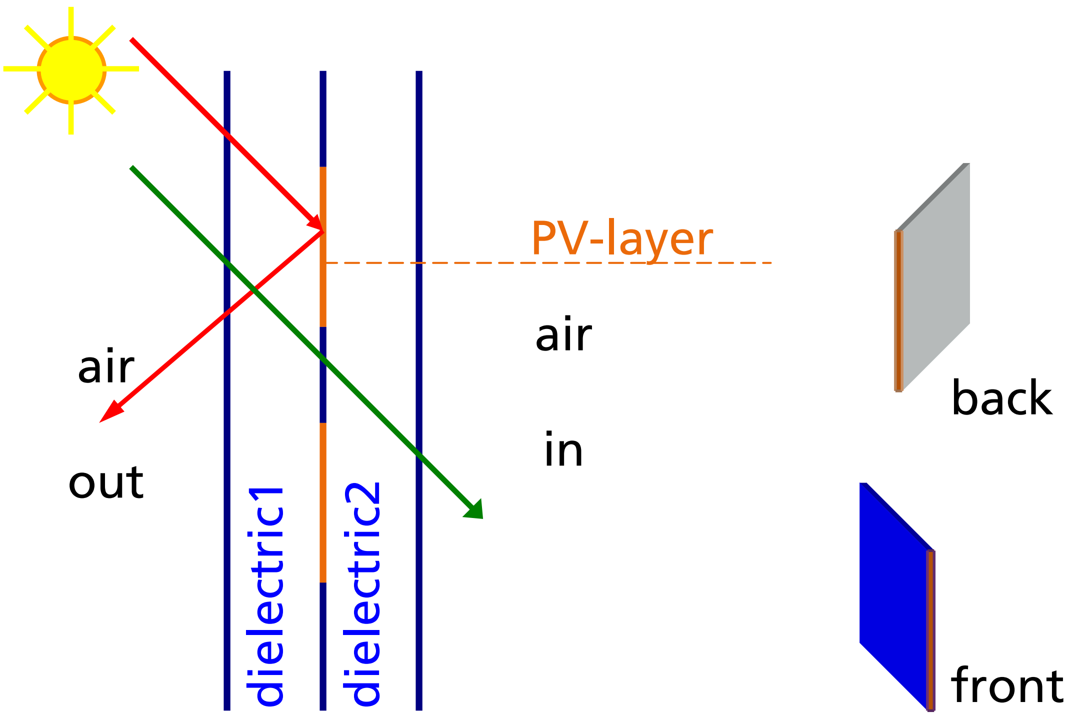
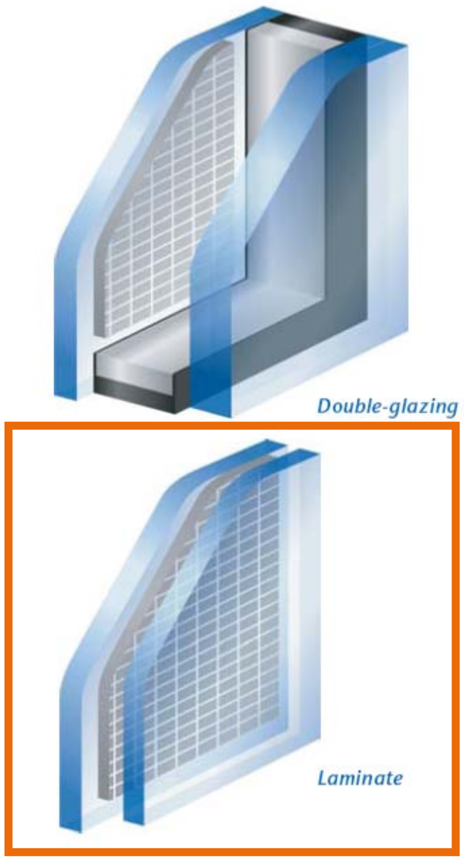
RADIANCE SIMULATION PROBLEMS

Material description:
front site of the PV layer has different optical properties than the back site





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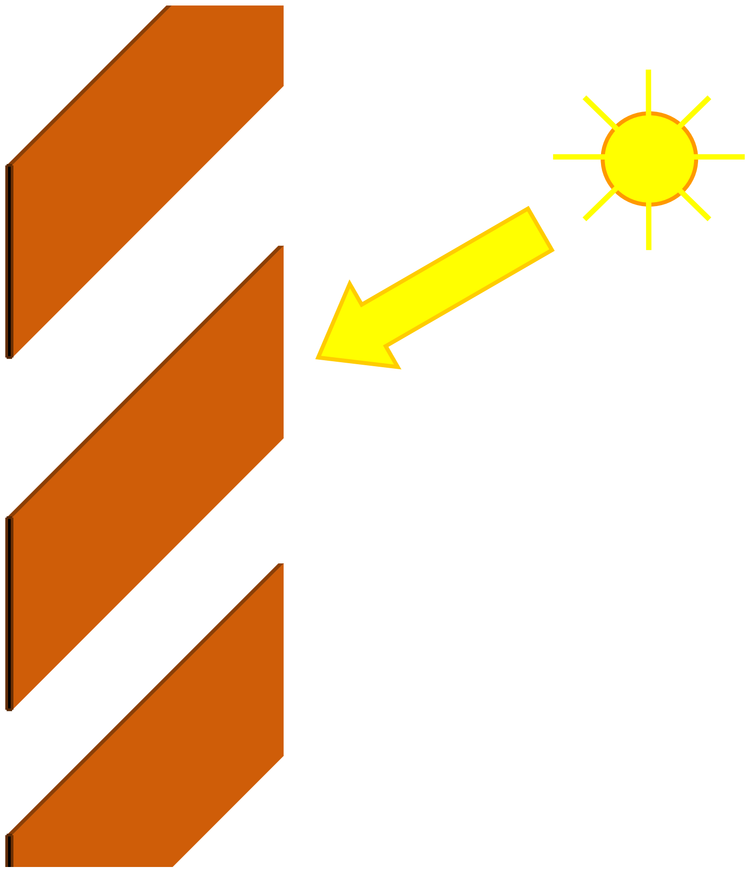
RADIANCE SIMULATION PROBLEMS



Incoming irradiation (W/m^2)

- Input of general BRDF and BSDF as a definition of the surface properties (instead of the refractive index)
- Input of the absorption coefficient (Beer-Lambert) as a material definition

(Aim: calculation of R and T without the input of wavelength, polarisation, complex refractive index)

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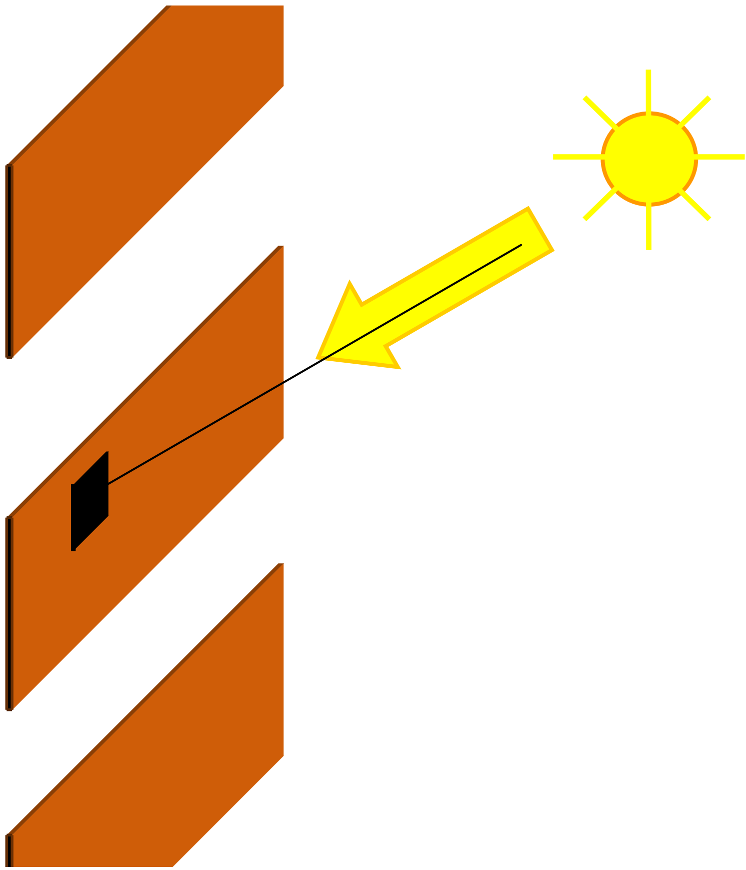
RADIANCE SIMULATION PROBLEMS



Irradiation (W/m²)
reaching a photovoltaic cell

- We would like to define a "area" sensor type to calculate the total incoming radiation on a surface (e.g. the cell).
- We would like to avoid the rastering with sensors.

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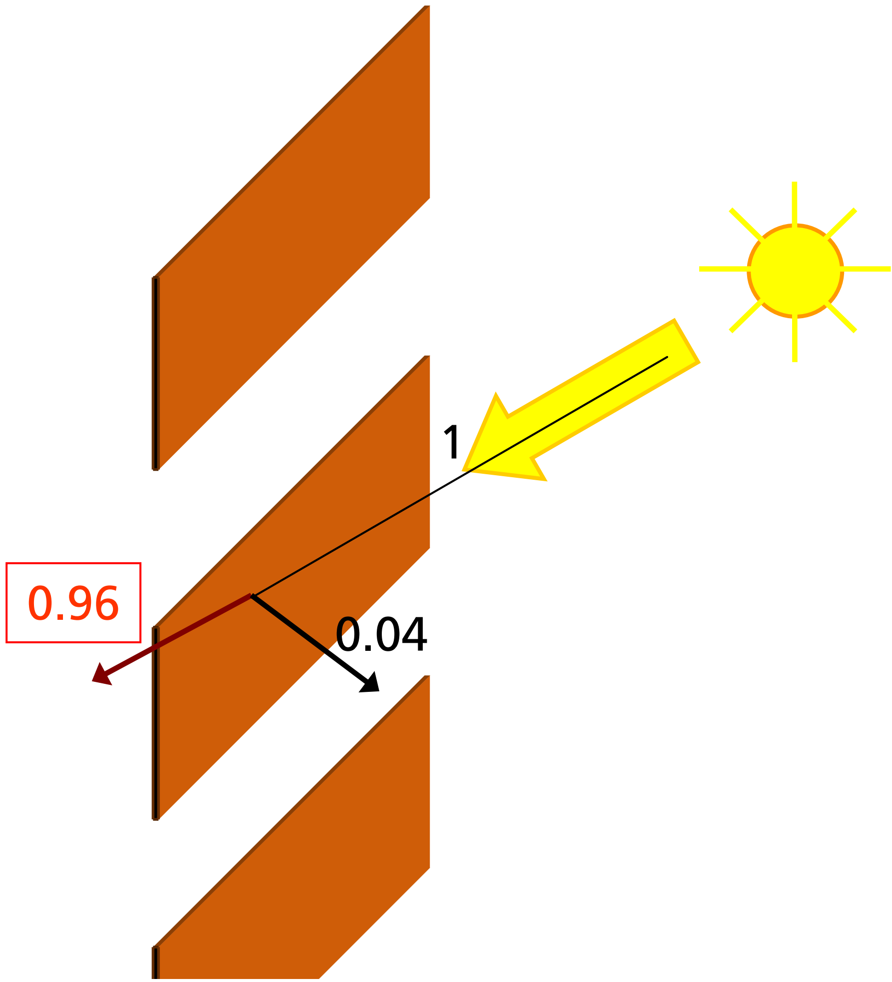
RADIANCE SIMULATION PROBLEMS



We need the intensity <u>transmitted by</u> a certain area on the surface.

We need the angle dependency information.
(no “–I” option)

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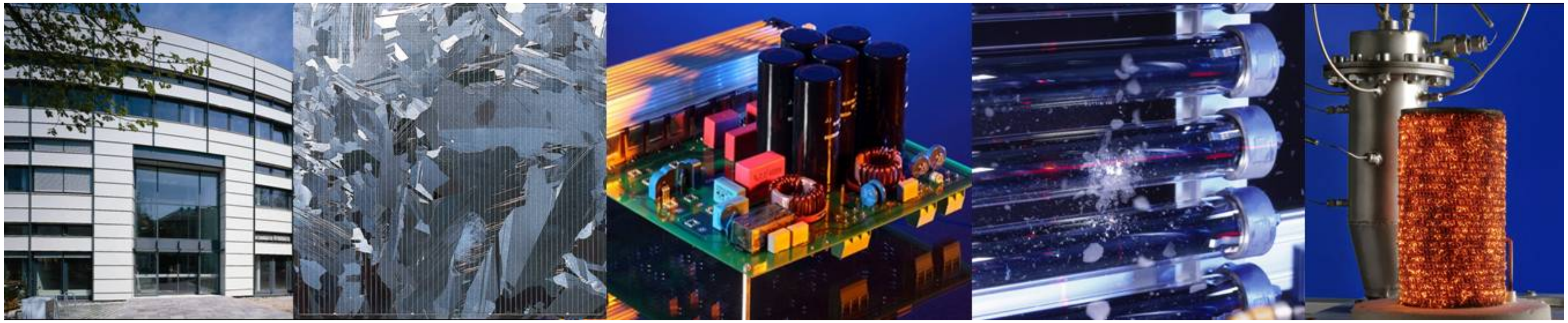
Thank You Very Much for Your Attention!



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Francesco Frontini

www.ise.fraunhofer.de
Francesco.frontini@ise.fraunhofer.de

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RADIANCE SIMULATION PROBLEMS

Dielectric (glass) material:

*A participating medium that refracts, and may absorb, but does not scatter radiation. A dielectric is generally characterized by an **index of refraction** and **an absorption** or transmission coefficient. In the case of the dielectric primitive used in Radiance, an additional Hartmann constant may be used to approximate the change in the index of refraction with wavelength.*

Transmission coefficient: *the fraction of light that is passed per unit length. This coefficient is given as part of a dielectric primitive's arguments, and is equal to 1 minus the absorption coefficient.*

Absorption: The fraction of light absorbed per unit distance in a participating medium.

(http://radsite.lbl.gov/radiance/book/glossary.html)

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