Bartenbach LichtLabor

INTEGRATED DAY- AND ARTIFICIAL LIGHT

David Geisler-Moroder

12th International Radiance Workshop
National Renewable Energy Laboratory, Golden, Colorado

Aug 13, 2013

MOTIVATION

Frankfurt airport, Aug 8, 2013, 13:00 CEST

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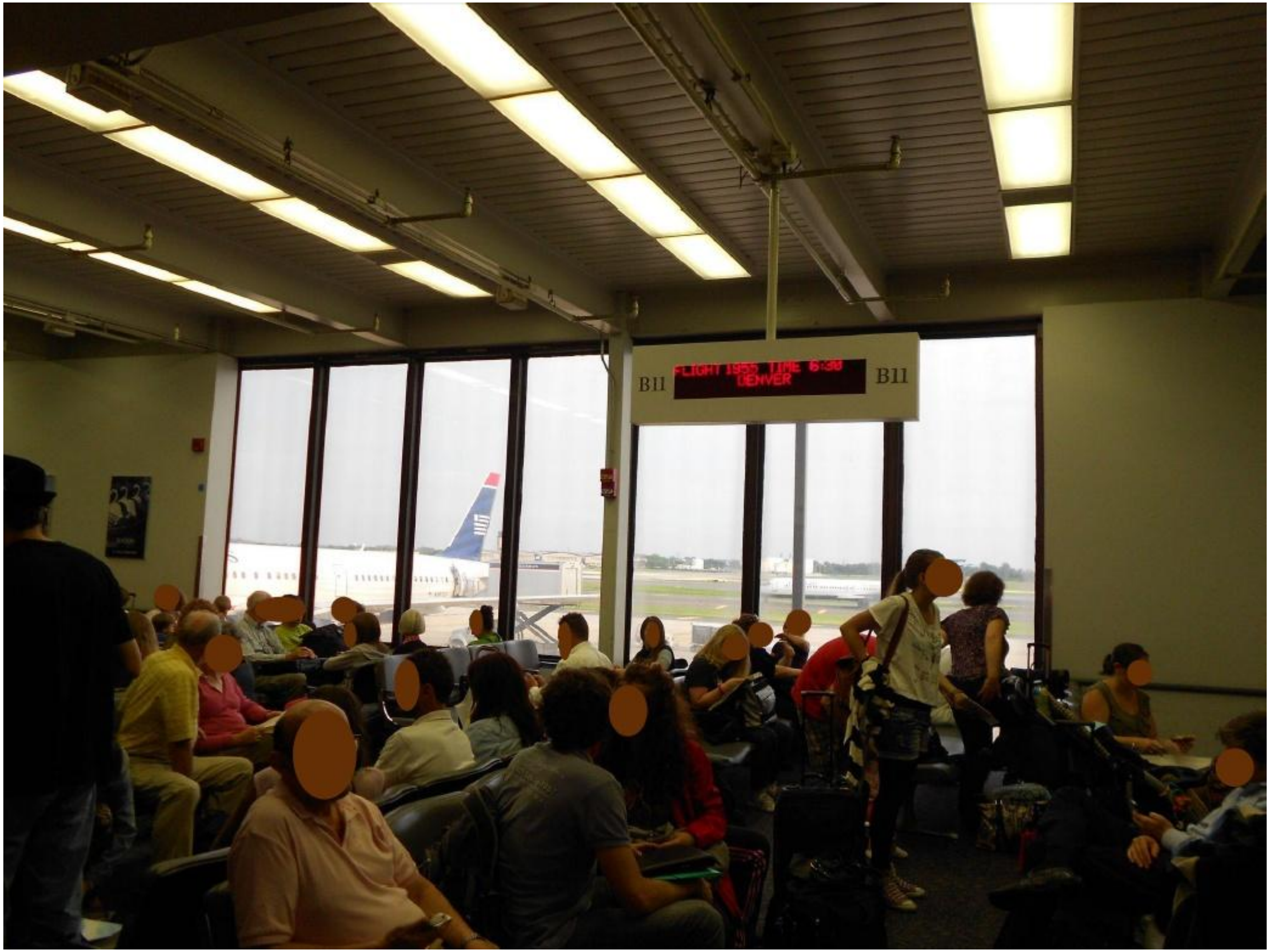
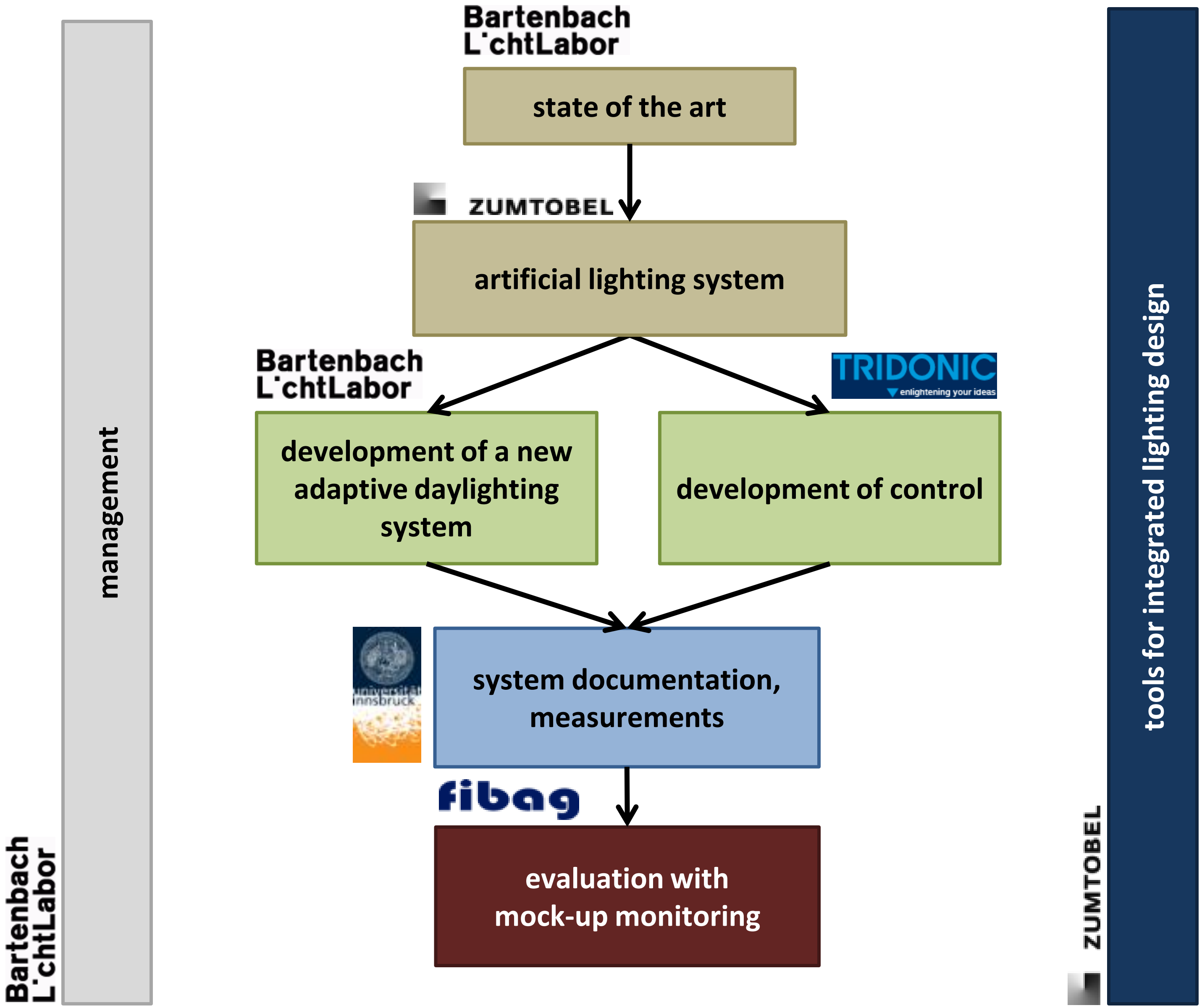


Philadelphia airport, Aug 8, 2013, 18:15 EDT

PROJECT OVERVIEW



PROJECT CONSORTIUM

Bartenbach LichtLabor GmbH

Zumtobel Lighting GmbH

Tridonic GmbH & Co KG

HANS HÖLLWART - Forschungszentrum für integrales Bauwesen AG

University of Innsbruck

Competence Center Light

relevant – and conflicting – criteria:

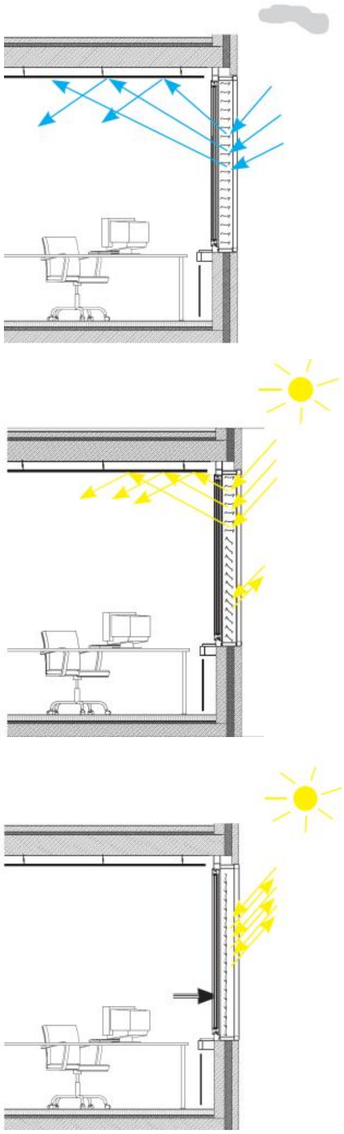
i. ***amount of daylight***
guide daylight into the depth of the building

ii. ***daylight distribution***
properly distribute daylight throughout the adjacent rooms

iii. ***thermal properties***
shade solar heat in summer,
provide solar gains in winter

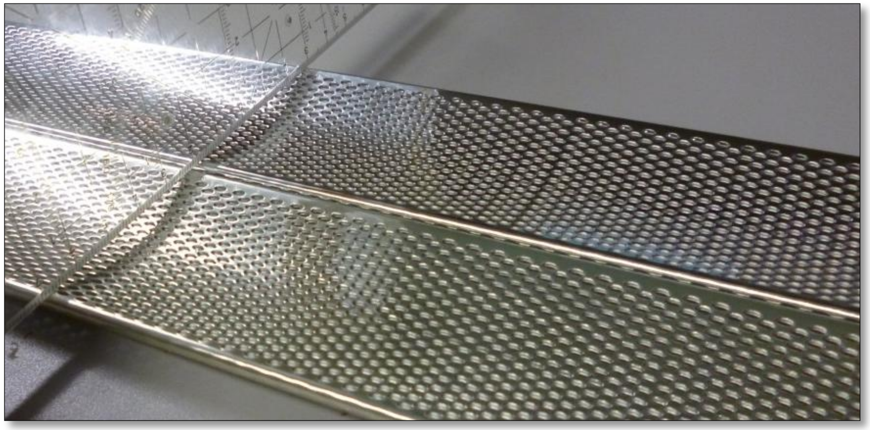
iv. ***glare protection***
provide visual comfort

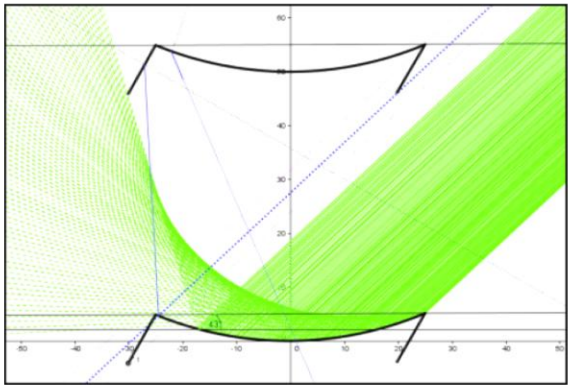
v. ***view to the outside***
allow a good contact to the outside

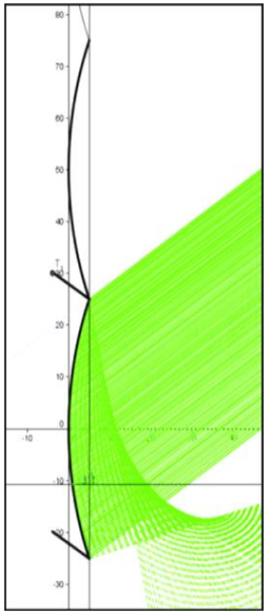


patented daylighting system “Daytec lamella”:

- highly specular material
- concave shape
- 2 types
  - non-perforated
  - 50% elliptically perforated with film applied on back side
- side-mounted







DAYLIGHTING SYSTEM

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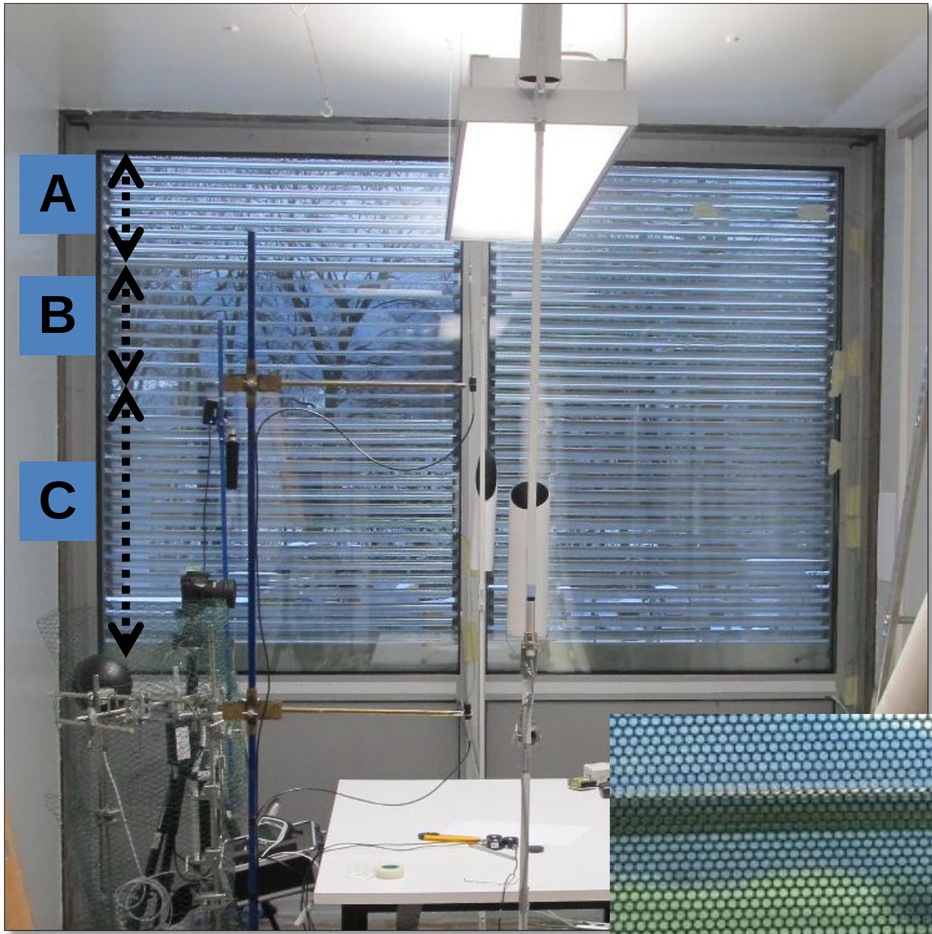
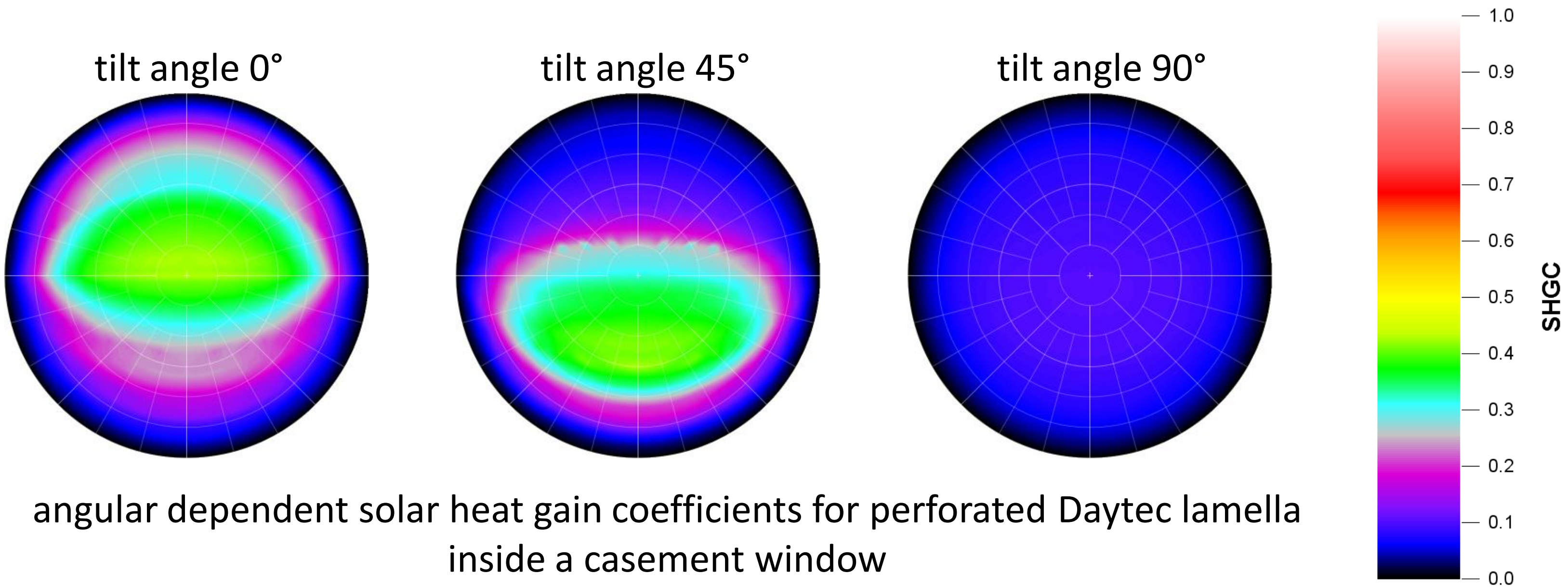


daylighting system “Daytec lamella”

thermal characterization

full angular dependent SHGCs from:

- SHGC measurement of selected angles
- simulation/measurement of direct-hemispherical transmission
- inter- and extrapolation for remaining angels based on transmission

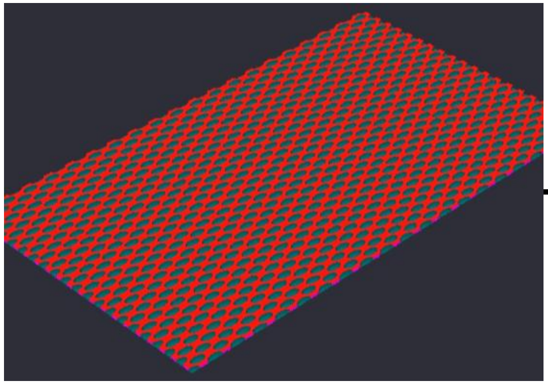


angular dependent solar heat gain coefficients for perforated Daytec lamella inside a casement window

lighting characterization

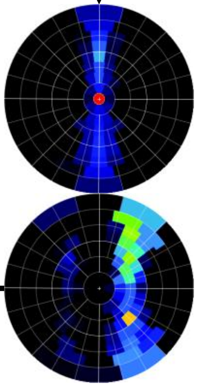
BSDF of overall system from:

1. simulation of system BSDF with genBSDF
2. combination with casement window in WINDOW7

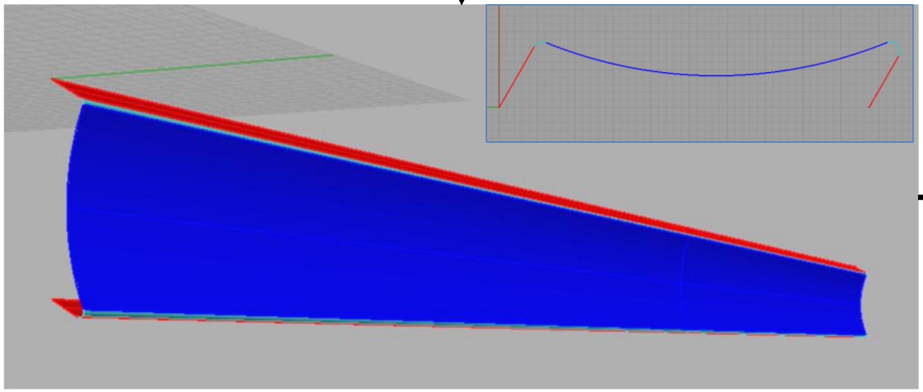


highly specular aluminum, perforated, applied film

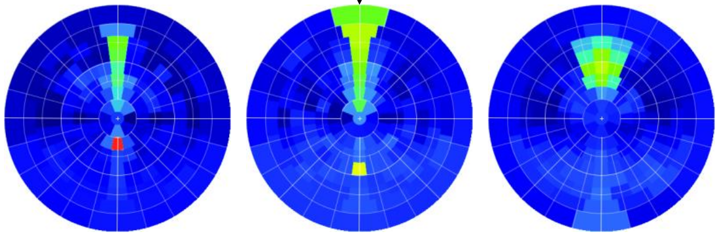
genBSDF (tensor tree BSDF)



apply material BSDF to geometry



genBSDF (Klems basis)



lighting characterization

BSDF of overall system from:

1. simulation of system BSDF with genBSDF
2. combination with casement window in WINDOW7

WINDOW7

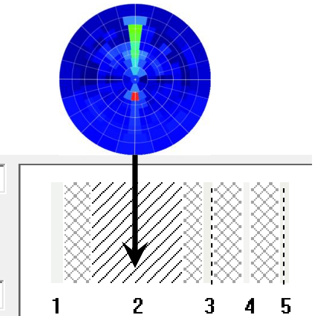
ID #: 116 Name: P01_DaytecPERF_00deg

Layers: 5 Tilt: 90 ° IG Height: 1000.0(mm

Environmental Conditions: CEN IG Width: 1000.0(mm

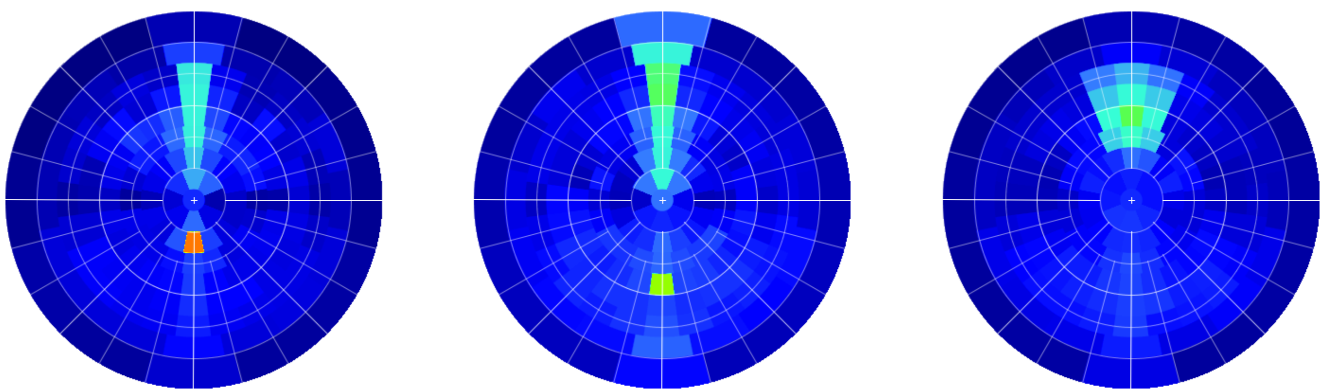
Comment: P01 perforated Daytec lamella in casement window

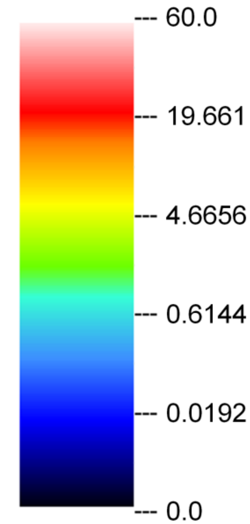
Overall thickness: 131.266 mm Mode: # Model Deflection



	ID	Name	Mode	Thick	Flip	Tsol	Rsol1	Rsol2	Tvis	Rvis1	Rvis2
Glass 1	11527	ExtraClear8.gre	#	7.7	☐	0.827	0.076	0.075	0.893	0.083	0.083
Gap 1	1	Air		15.0	☐						
Shade 2	20037	FluegLamPERF_00deg		50.0	☐						
Gap 2	1	Air		11.0	☐						
Glass 3	11686	CG_Premium6.gre	#	5.8	☒	0.561	0.272	0.326	0.863	0.067	0.049
Gap 3	9	Air (10%) / Argon (90%)		16.0	☐						
Glass 4	11524	ExtraClear4.gre	#	3.8	☐	0.870	0.079	0.079	0.904	0.084	0.084

Klems patch 22 (≈20°) Klems patch 64 (≈40°) Klems patch 130 (≈70°)

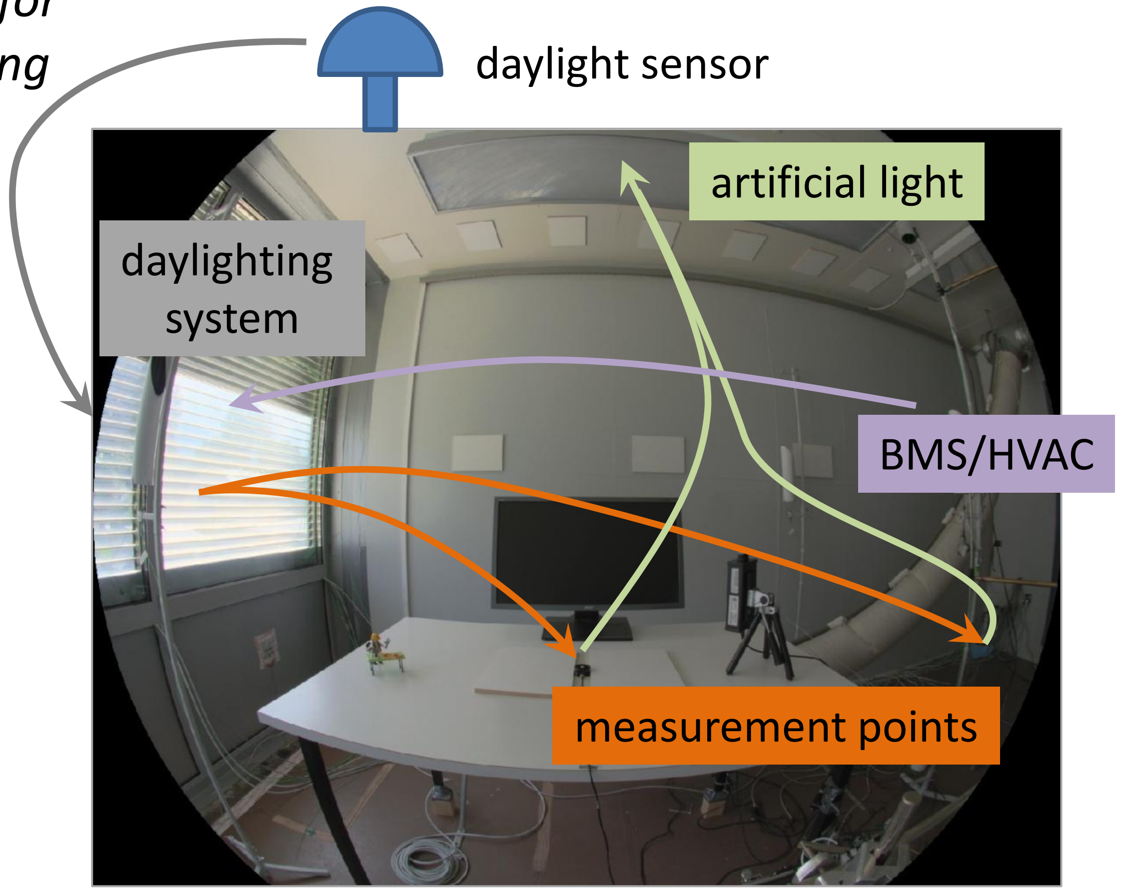




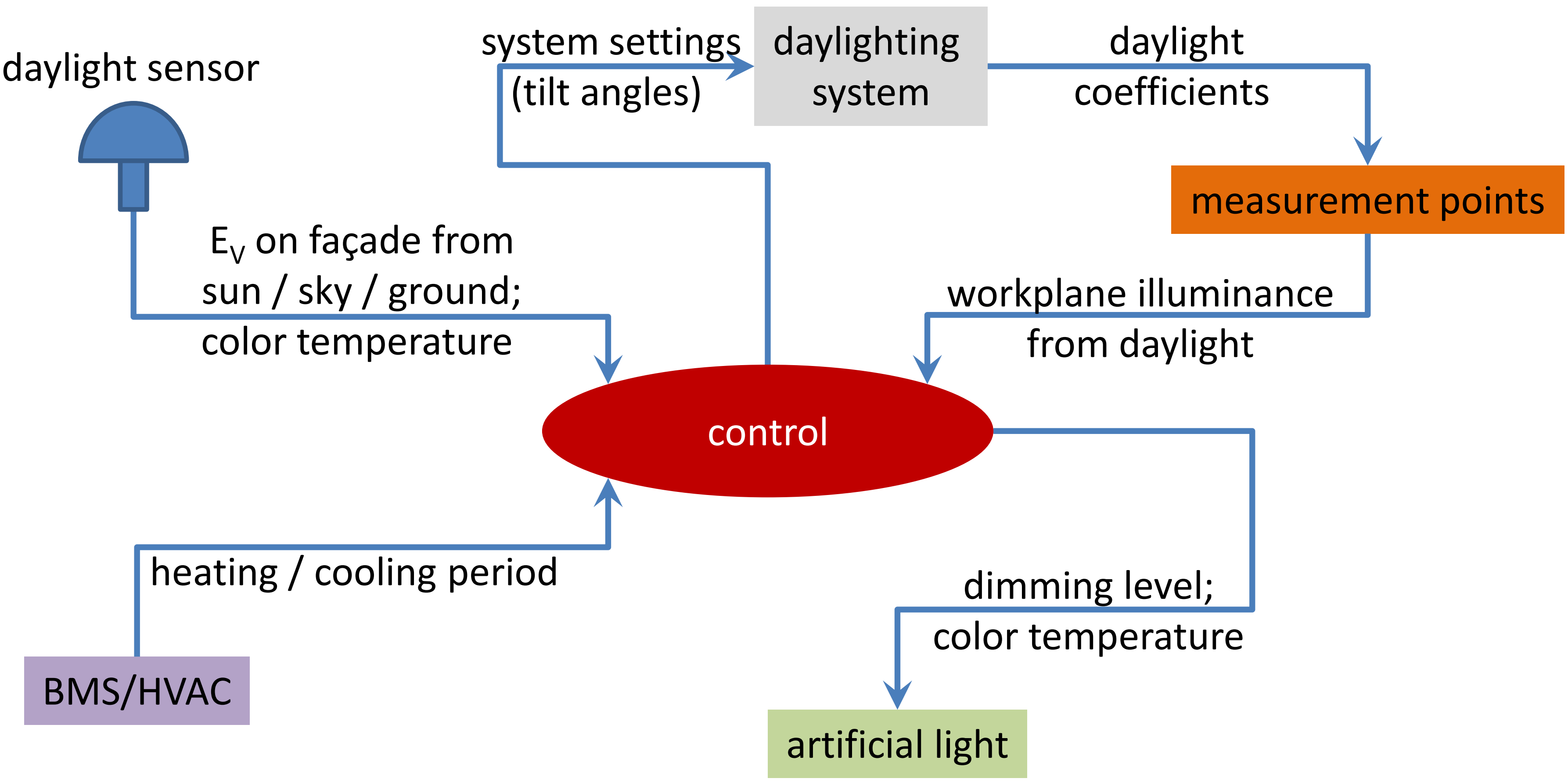
BSDF front transmission discretized in Klems patches for perforated Daytec lamella at 0° tilt angle for varying incident directions

approach

use a single sensor on the roof to control the daylighting system and the artificial lighting and account for the thermal behavior of the building



approach


daylight sensor
system settings
(tilt angles)
daylighting system
daylight coefficients
measurement points
E_V on façade from sun / sky / ground; color temperature
workplane illuminance from daylight
control
heating / cooling period
BMS/HVAC
dimming level; color temperature
artificial light

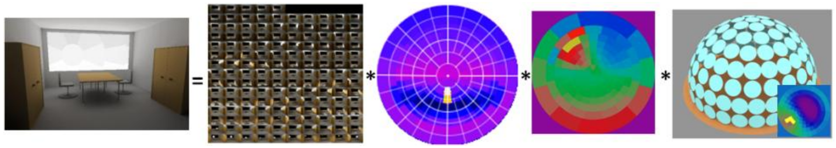
simulation

adapted daylight coefficient approach

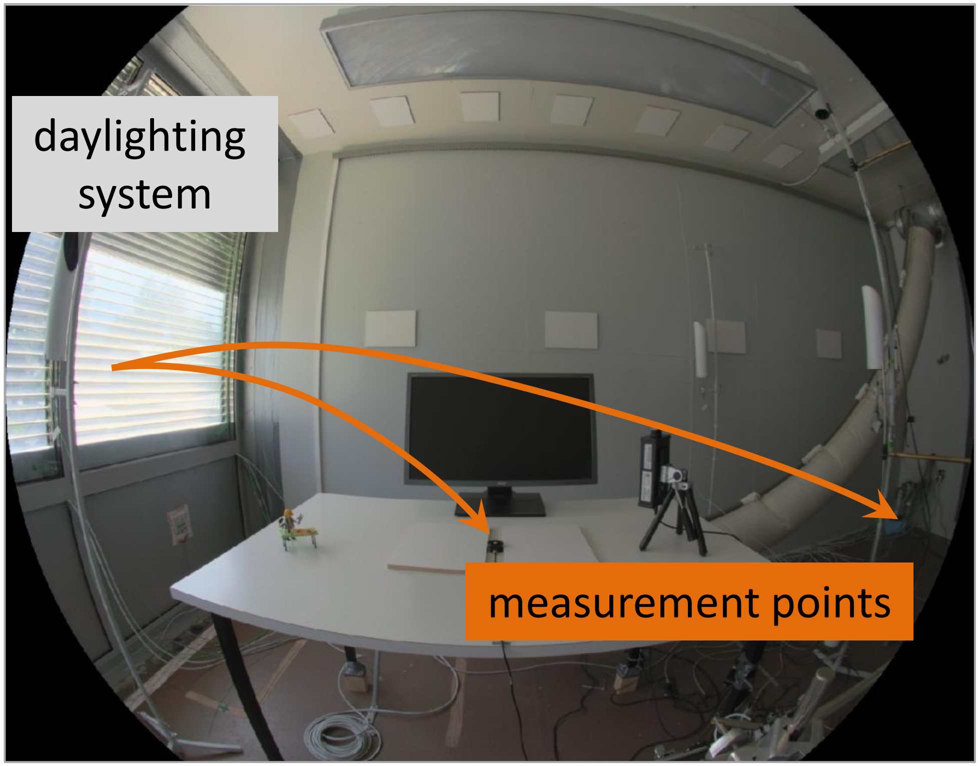
for each system position (tilt angle):

- 1 DC for sky (upper quarter-sphere)
- 1 DC for ground (lower quarter-sphere)
- 1387 DCs for sun (façade-based Cartesian grid 5°/5°)

→ *3-phase-DC method*



- Klems BSDF for daylighting system
- Reinhart sky subdivision (2305)



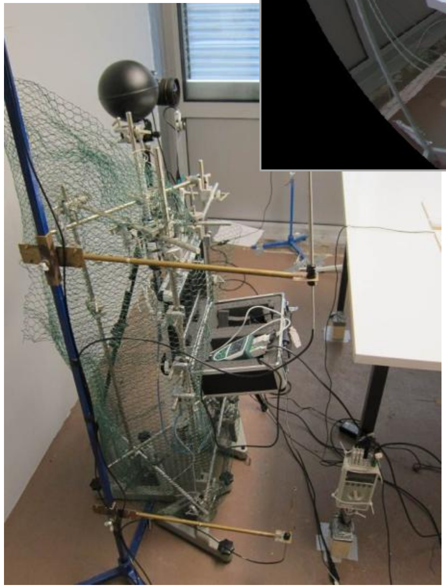
monitored values

light

- luminances
- illuminances
- color temperature
- spectrum

thermal

- temperatures
- humidity
- wind speed
- heating / cooling loads
- U-value
- SHGC



illuminances

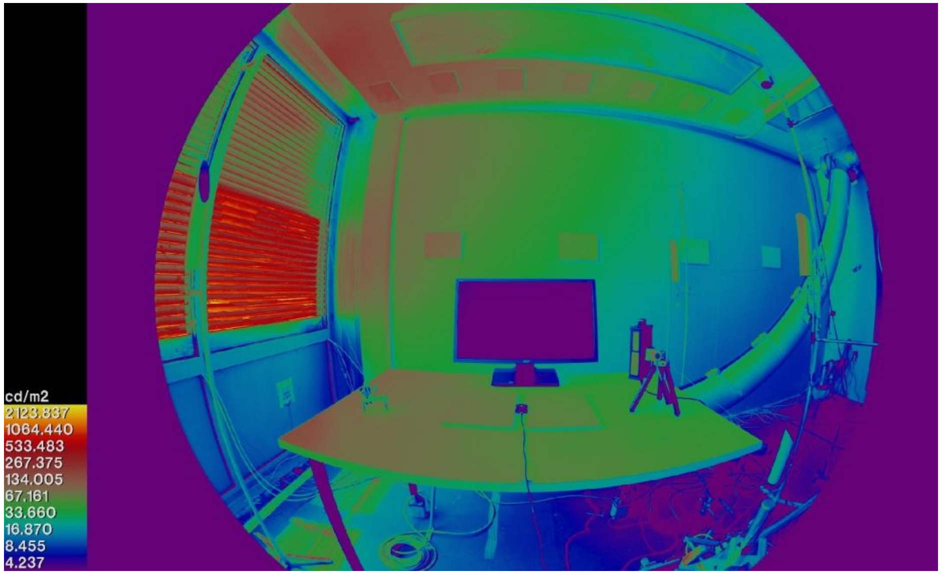
- from luxmeter
- from HDR (diffuse reference surfaces → E = L*π/ρ)

luminances

- from HDR (*pcomb*, *pvalue*, *total* and *psign* are your friends =))

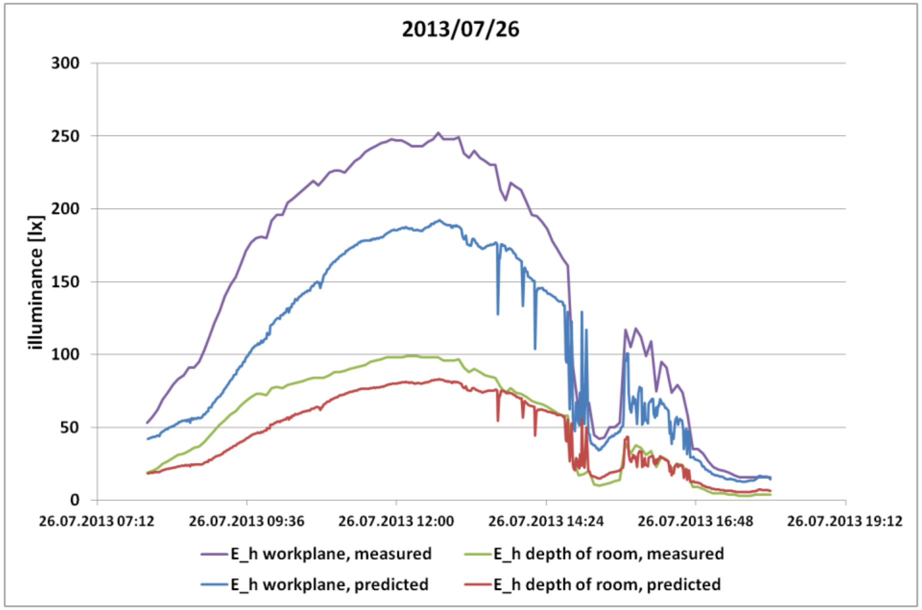
example: july 26, 2013, 13:00 (all system parts closed)

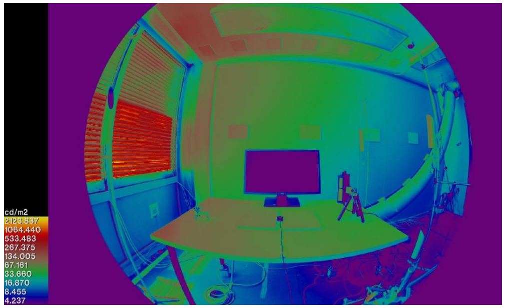
measured illuminance on workplane: 238 lx (sensor); 235 lx / 209 lx (HDR)
measured illuminance in depth of room: 91 lx (sensor)



bug fixing

- under-estimation of illuminances
  - daylight sensor → vertical illuminance on façade?
  - vertical illuminance on façade → interior illuminances?





further work

- monitoring & evaluation
- generalization possibilities to arbitrary rooms (without Radiance simulation)?

Q & A

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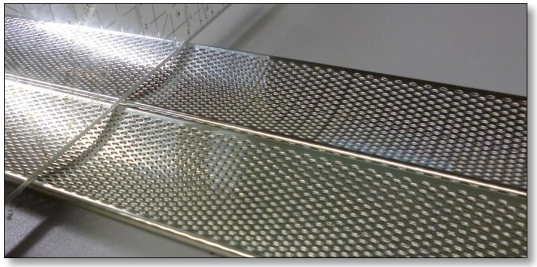
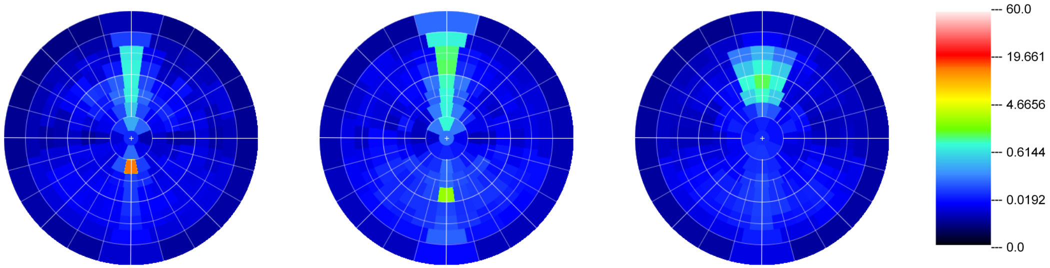
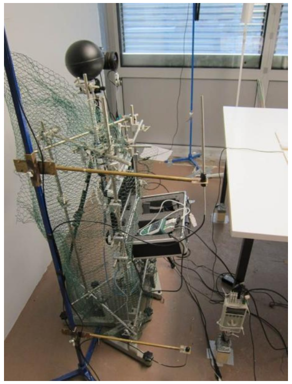
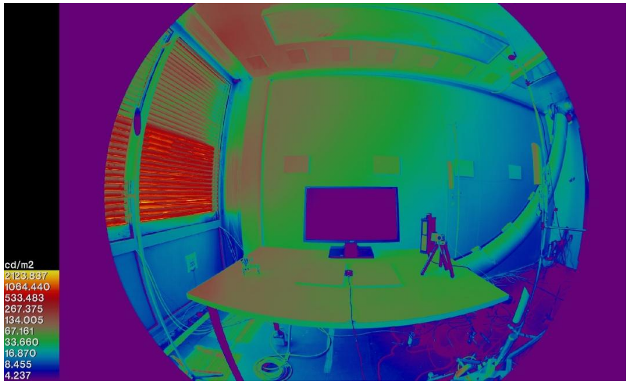


questions?







contact: david.geisler-moroder@bartenbach.com