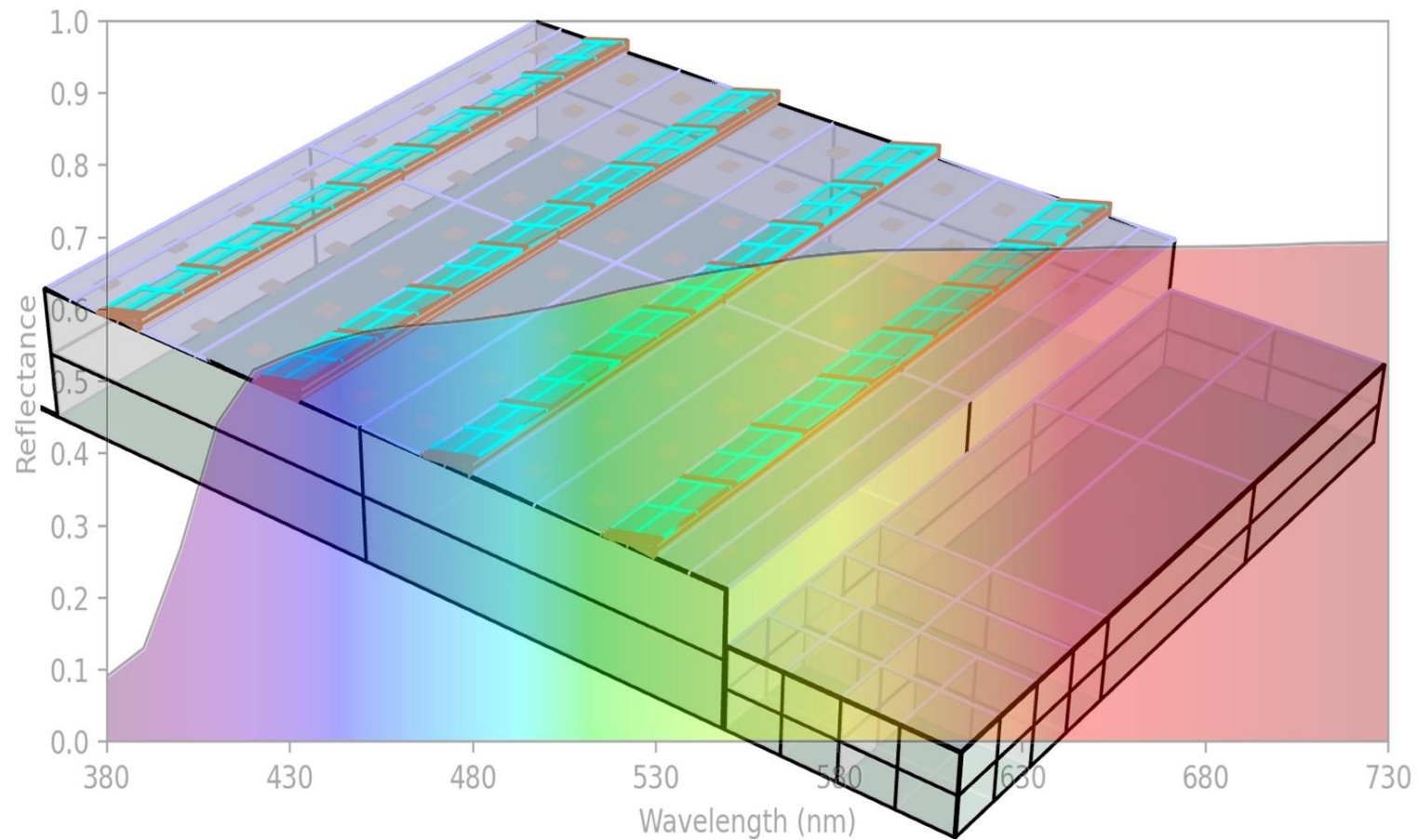




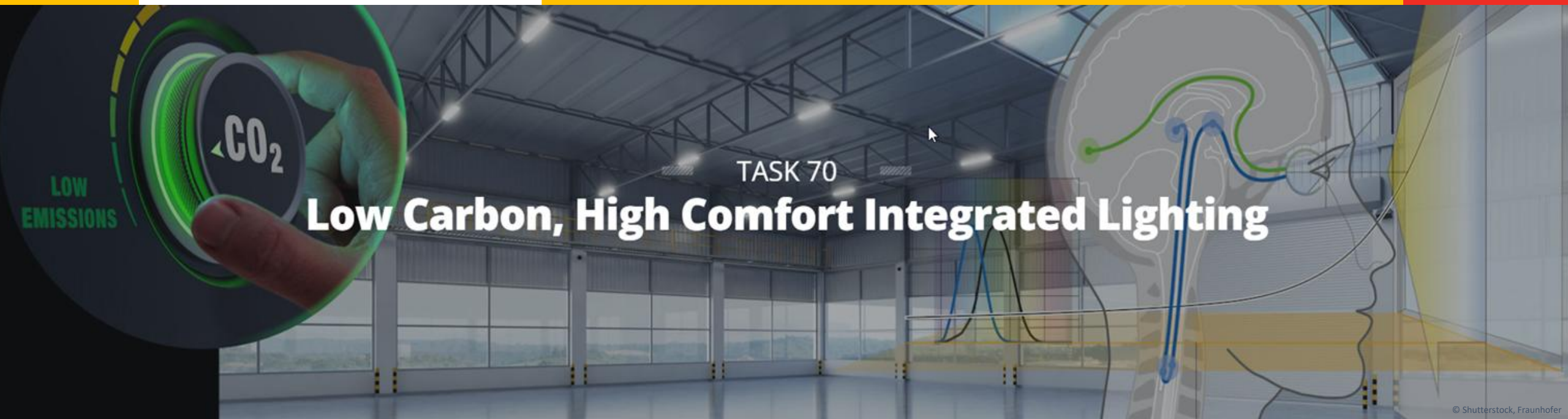
Reference models of an office space and a factory hall for hyperspectral Radiance simulations

David Geisler-Moroder, Greg Ward, Taoning Wang, Xuran Guo

24th International Radiance Workshop, August 31 – September 2, 2026, Seattle, WA



SOLAR HEATING & COOLING PROGRAMME
INTERNATIONAL ENERGY AGENCY



TASK 70

Low Carbon, High Comfort Integrated Lighting

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Low Carbon, High Comfort Integrated Lighting

Task Manager: J. de Boer, Germany

Project duration: 1/2023-6/2026

Joint Work

Subtask A

Luo Tao, China
J. de Boer, Germany

Low Carbon Lighting and
Passive Solar: Scenarios,
Strategies, Roadmaps

Subtask B

B. Matusiak, Norway
M. Sarey Khanie, UK

Visual and Non-Visual User
Requirements

Subtask C

D. Geisler-Moroder, Austria
Eleanor Lee, USA

Digitized lighting solutions
(Technology & Design Tools
/ Process)

Subtask D

Niko Gentile, Sweden
Natalia Giraldo Vasquez,
Denmark
Justyna Martyniuk-Pęczek,
Poland

Application and Case
Studies

Joint Work

ST A: Laying the basis

extend the life cycle
approach to integrated
lighting solutions

data, methods,
scenarios

ST B: Including the user

obtain real impact instead
of hypothetical technical
potential

visual/non-visual needs,
user behavior models

ST C: The tech part

make lighting techs
intelligent, connected, and
fully mapped in design work

(day)lighting systems and
controls, workflows, tools

ST D: Evaluating and validating

test the methods and
assess the real impact
in example scenarios

case studies, guidelines,
link to CIE

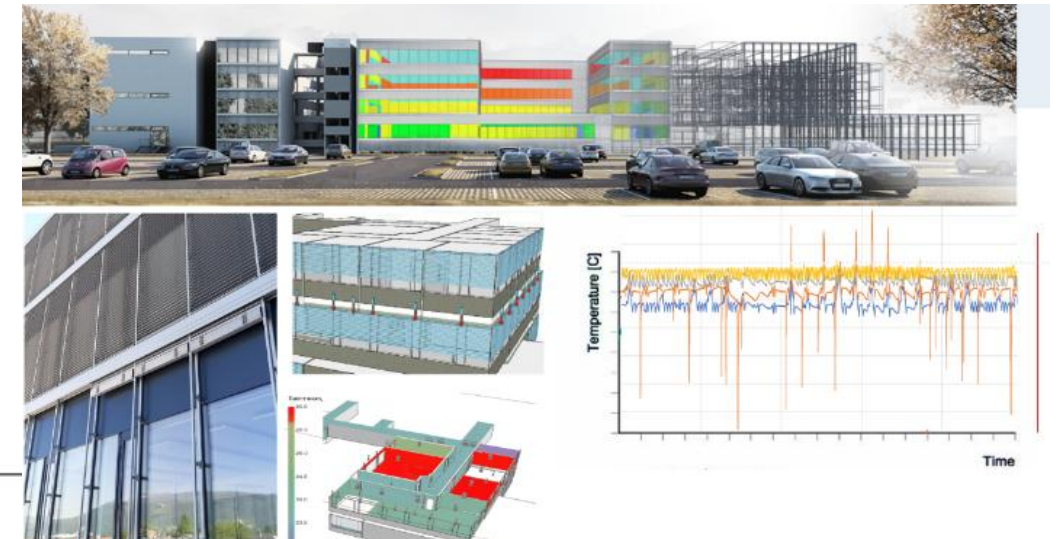
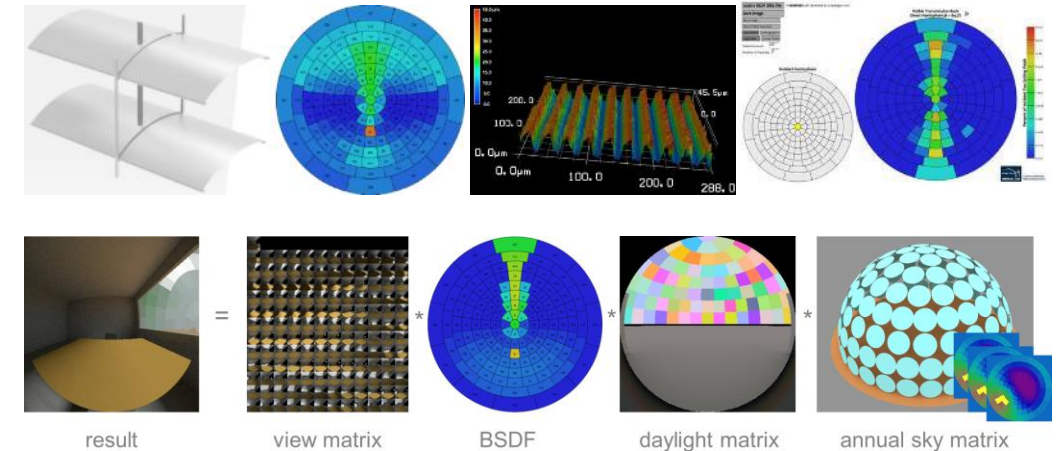
Complex Fenestration Systems for Low Carbon Buildings

CFS4LowCarb



- Integrated daylighting and shading technologies in complex fenestration systems
- Comprehensive utilization technologies and analysis integrated with solar energy
- Evaluation of key daylighting/ shading and photovoltaic/thermal technologies

<https://www.uibk.ac.at/en/energy-efficient-building/research/projects/cfs4lowcarb/>



CFS4LowCarb & IEA SHC Task 70

Complex Fenestration Systems for Low Carbon Buildings
CFS4LowCarb

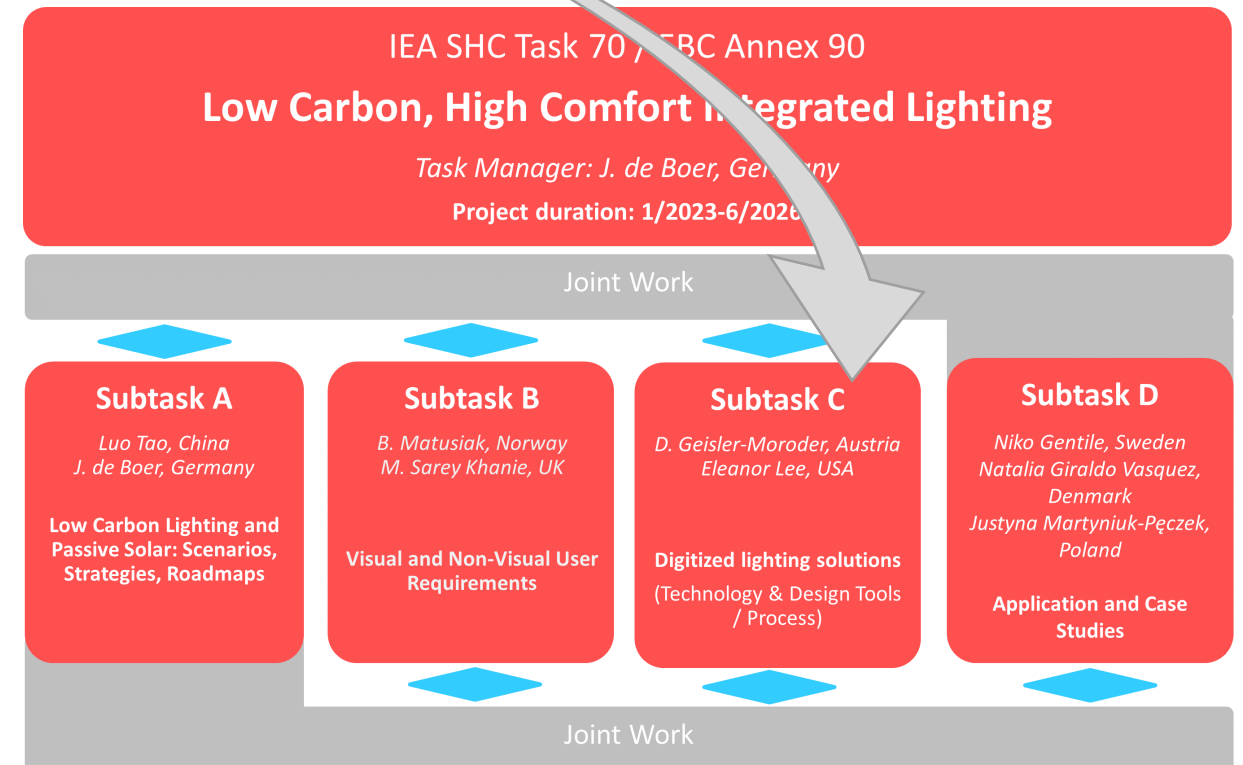
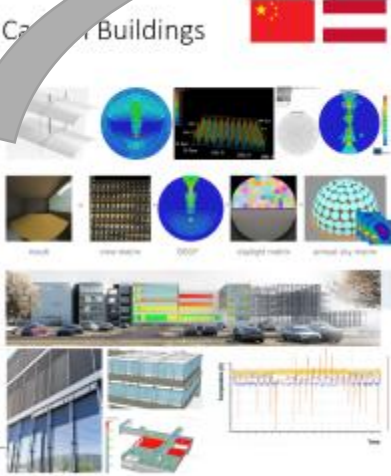
- Integrated daylighting and shading technologies in complex fenestration systems
- Comprehensive utilization technologies and analysis integrated with solar energy
- Evaluation of key daylighting/ shading and photovoltaic/thermal technologies

<https://www.uibk.ac.at/en/energy-efficient-building/research/projects/cfs4lowcarb/>

universität innsbruck

David Geisler-Moroder | 24th Intl. Radiance Workshop 2026 | Seattle, WA

Page 3



Comparison of Simulation Tools

Comparing the Tools in Three Steps

1. Simulation tools feature matrix (26 tools)
2. Simulation tools summary document
3. Simulation exercise

	Applies to Software																									
	+ = yes, o = partly, blank= no																									
	AfRad	ALFA	AG32	AM Tools	ClimateStudio	DALEC	DesignBuilder	DIALux	DIAL+	DL-Light	DWZ	ElumTools	frads	GB SWARE	Honeybee	IES VE	LARK	LightStanza	OpenStudio	OWL	PKPM	Radiance	RELUX	Sefaira	TRNSYS	Unreal Engine
SOFTWARE SUITED FOR																										
Lighting designers	+	+	+	+	+	+	o	+	+	+	+	+	o	+	+	o	+	+	o	+		+	+	+	o	o
Architects	+	+	o	+	+	+	+	+	+	+	+	+	o	+	+	o	+	+	+	+	+	o	+	+		+
Electric engineers	+	o	+		o	+	o	+	+			+		+	+	o			o			+	+	o		
HVAC engineers	o				+	+	+		+				+	+	+	+			+		+			+	+	
Building engineers/planners	+		o		o	+	+	o		+	+	o	o	+	+	+	+	o	+	+	+			+	+	o
Researchers	+	+	o		+	+	+	o		+	+	o	+	+	+	+	+	o	+	+		+		o	+	+
DESIGN PHASE																										
Suited for R&D	+	+	o		+		+	o				o	+	o	+	+	+	o	+			+	+	o	+	+
Suited for early design	+	+	+	+	+	+	+	+	+	+	+	+	o	+	+	o	o	+	+	+	+	o	+	+	+	+
Suited for detailed design	+	+	+		+		+	+			+	+	+	+	+	+	+	+	+	+	+	+	+	o	+	+
ELECTRIC LIGHTING																										
Illuminance values	+	+	+		+	+	+	+	+			+	+	+	+	+	+	+	+	+	+	+	+		+	
Luminance values	+		+					+				+	+	+	+	+	+	+	o	+		+	+	+	+	
Calculation of connected wattage	o	o	+		+	+	+	+	+			+	+			+	+			+	+	o	+	+	+	
Calculation of annual electricity consumption	o				+	+	+	+	+				+		+	+			+	+		o	+	+	+	
Import of luminaires (IES, Eulumdat, etc.)	+	+	+		+	o		+	+			+	+	+	+	+	+	+	+	+		+	+	+	+	
Data base of luminaires		+	+				o	+	+			+		+		+	o	o		o			+	o		

User-defined control strategies for daylight system
User-defined integrated control strategies for electric and daylight systems
Calculation of annual electricity consumption
VISUAL & NON-VISUAL EFFECTS
Reduced spectral simulations (3 channels)
Reduced spectral simulations (4-10 channels)
Full spectral simulations
Spectral models for electric lighting
Spectral sky models
Evaluation of α -opic irradiance
Evaluation of α -opic ELR
Evaluation of α -opic DER
Evaluation of α -opic EDI
Calculation of circadian stimulus CS
Electric lighting glare calculations (UGR, VCP, ...)
Daylight glare calculations (DGP, DGI, ...)
Calculation of light dose from electric lighting
Calculation of light dose from daylight
Occupant modelling beyond standard schedules
Evaluation of view out: access to view
Evaluation of view out: content of the view
Evaluation of view out: clarity of the view
LIFE-CYCLE ASSESSMENT
LCA for electric lighting installation
LCA for daylighting / shading / facade systems
LCA for integrated lighting solution
Built-in LCA methodology
Import / export links to LCA software
LCA database included
Links to external LCA database

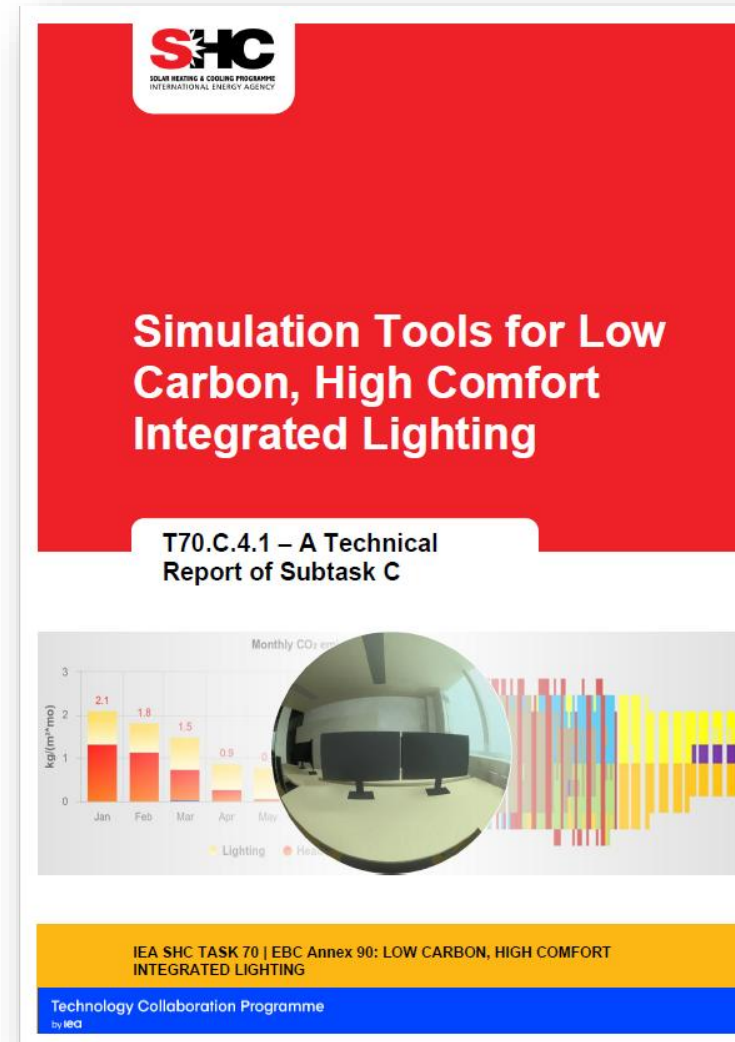
Comparison of Simulation Tools

Full report

- Simulation tools feature matrix (26 tools)
- Description of simulation tools
- Example simulation results

IEA SHC Task 70 Publications:

<https://task70.iea-shc.org/publications>



Comparison of Simulation Tools

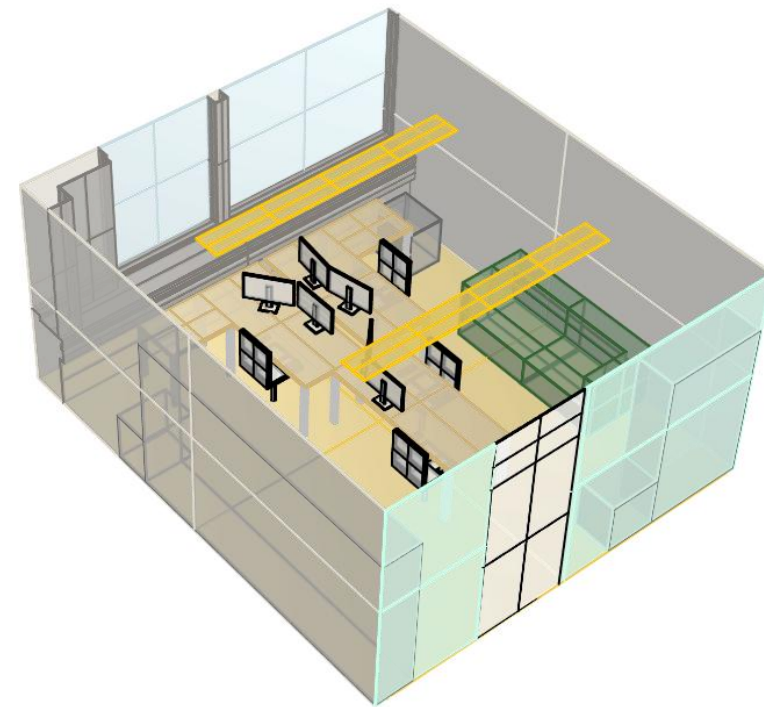
Comparing the Tools in Three Steps

1. Simulation tools feature matrix (26 tools)
2. Simulation tools summary document
3. Simulation exercise → reference rooms

Reference Rooms

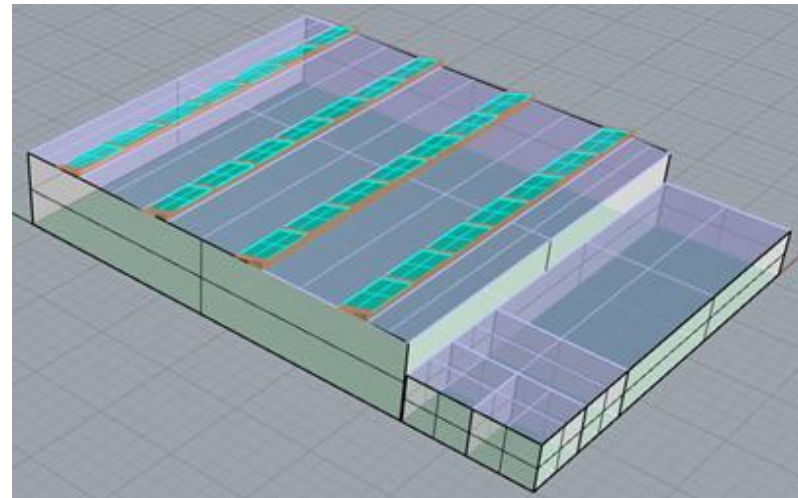
1. Reference Office

Group office building at University of Innsbruck,
Living Lab 518



2. Reference Hall

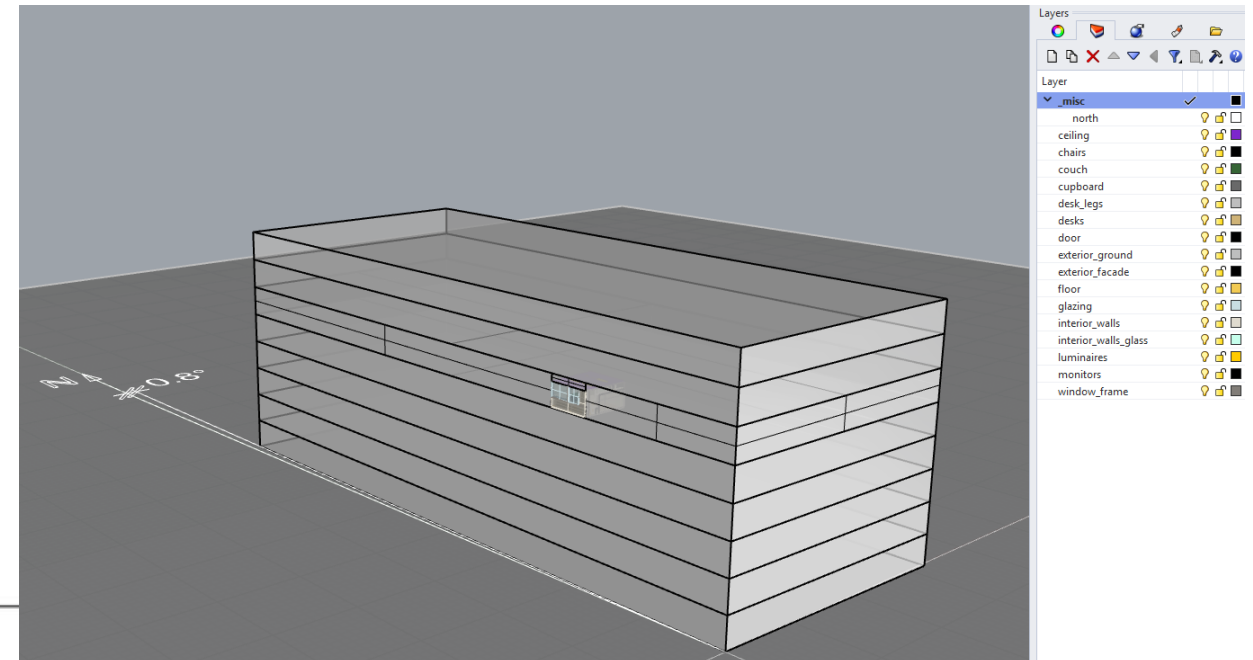
Reference factory hall according to Technical
Report CEN/TR 15193-2



Reference Office

Building

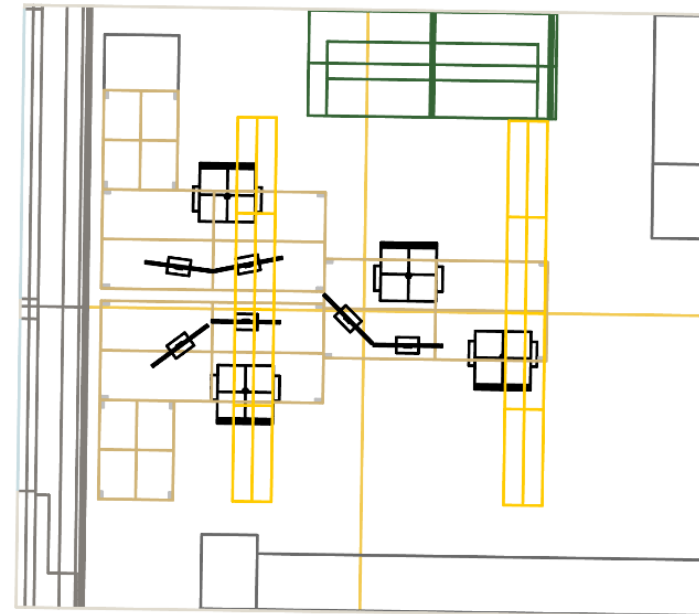
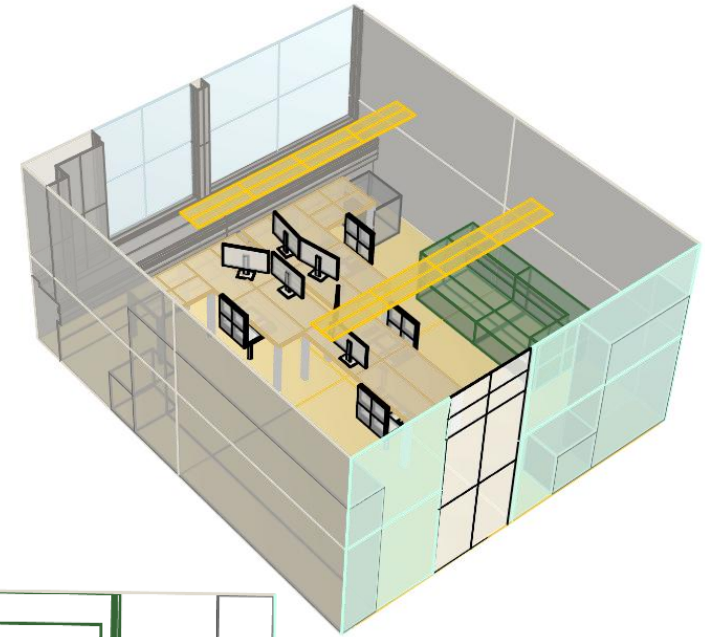
- Location: Innsbruck, Austria, 47° N, 11° E
<https://maps.app.goo.gl/tTSLDgKHeKrPP16Y7>
- Climate: AUT_Innsbruck.111200_IWEC.epw



Reference Office

Geometry

- 5.55 m x 4.86 m x 2.69 m sidelit office with two windows (2.34 m x 1.66 m and 1.39 m x 1.66 m)
- 3D model (3dm file)
- Facade orientation: West (270.8°)
- Shading lines: far and near shading specified as elevation angle per azimuth angle (txt file)



Reference Office

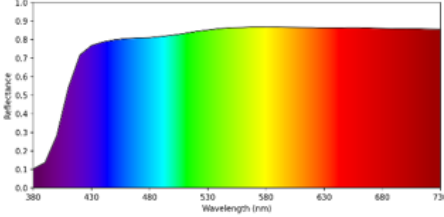
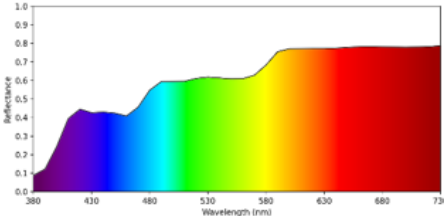
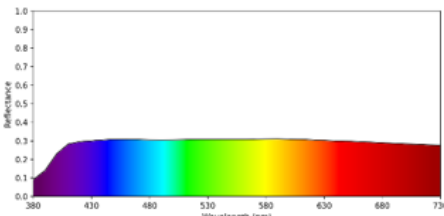
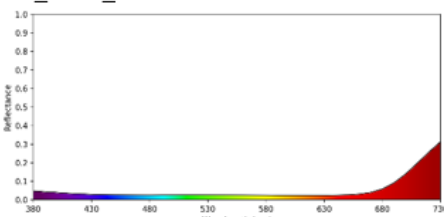
Materials

- most opaque materials measured with a handheld spectrometer (Gretag MacBeth Spectrolino) in the Living Lab office
- spectral data for “Façade” and “Exterior ground” selected from the Spectral Materials Database¹
- transparent materials generated using LBNL’s Optics² software based on spectral data from the IGDB³

1. <https://spectraldb.com/>

2. <https://windows.lbl.gov/optics-downloads>

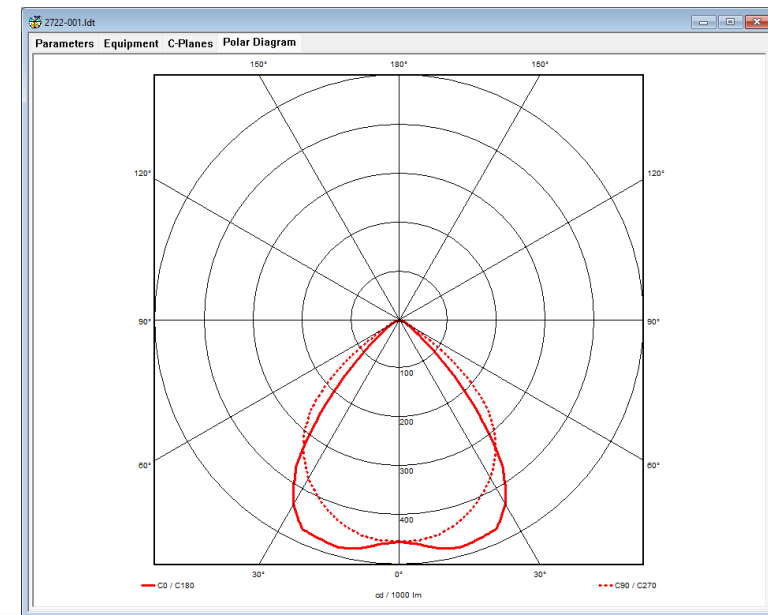
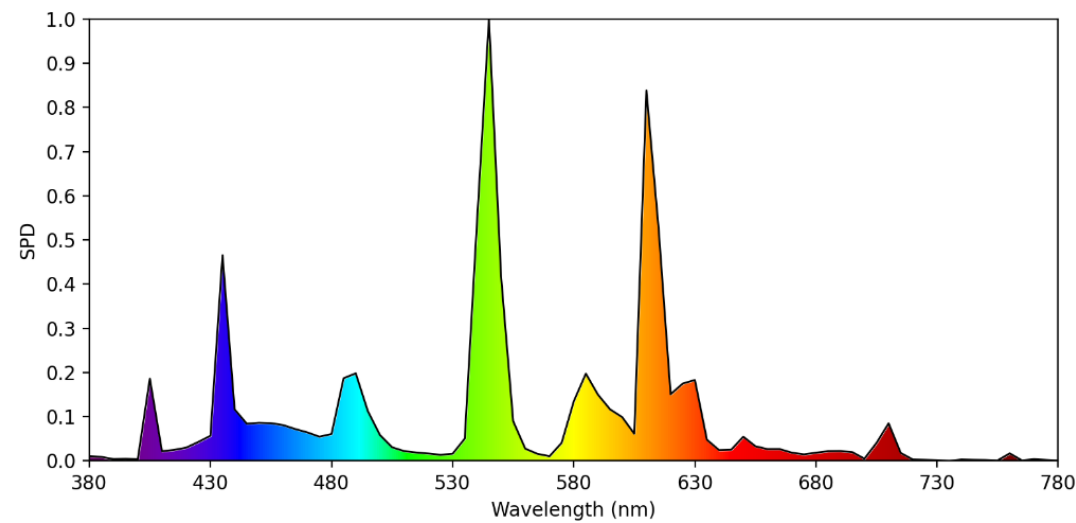
3. <https://windows.lbl.gov/igdb-downloads>

Door (door)	White	85.66%	85.57%	81.73%	T70_office_door.csv 
Desks (desks)	Wood	65.58%	64.98%	53.85%	T70_office_desk.csv 
Desk legs (desk_legs)	Aluminum	30.78%	30.78%	30.62%	T70_office_desk_legs.csv 
Chairs (chairs)	Black	2.60%	2.60%	2.67%	T70_office_chairs.csv 

Reference Office

Luminaires

- LIDC modeled from datasheet
- spectral data for 840 fluorescent lamp



Reference Office

Window system

- Closed cavity windows (internal triple pane thermal insulation glazing, venetian blinds in the cavity; external single-pane glass)
- Modeled in WINDOW
- Assumed spectrally neutral ($\rho_v = 0.7$)
- Data provided for glazing only and combination in 5° tilt angle steps
 - 2D-SHGC (angular data: SHGC, τ and α per layer)
 - BSDF (XML)
 - CSV (plain BSDF data)

Shading Layer Library

List New Copy Delete Save

ID #: 23020
Name: Lamelle_Bauinggeb_+00
Product Name:
Manufacturer:
Type: Venetian blind, horizontal
Material: 40021 Slat Metal_Bauinggeb

Permeability Factor 0.980

Update IGDB

Venetian Blind

Slat width: 35.000 mm
Spacing: 30.000 mm
Tilt: fully open (0°)
Tilt angle: 0.00000 degrees
Blind thickness: 35.000 mm
Rise: 3.000 mm

Help

Shade Material ID #: 40021 Thickness: 0.600 mm
Name: Slat Metal_Bauinggeb
Product Name: Opaque white colored slat mater
Manufacturer: Generic

Conductivity: 160.000 W/m-K

Solar
Trans, Front (Tsol): 0.000
Trans, Back (Tsol2): 0.000
Reflect, Front (Rsol1): 0.780
Reflect, Back (Rsol2): 0.790

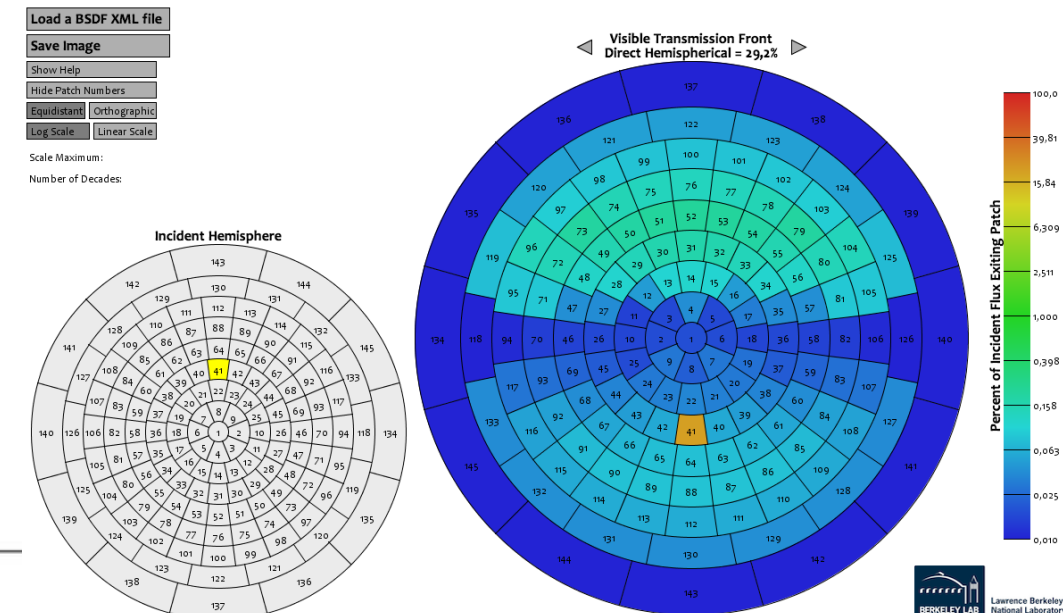
Visible
Trans, Front (Tvis): 0.000
Trans, Back (Tvis2): 0.000
Reflect, Front (Rvis1): 0.700
Reflect, Back (Rvis2): 0.700

IR
Trans (Tir): 0.000
Emis, Front (Emis1): 0.830
Emis, Back (Emis2): 0.830

Color:
☐ Non-specular
☐ Spectral data

Comment:
ISO 15099 Example Material

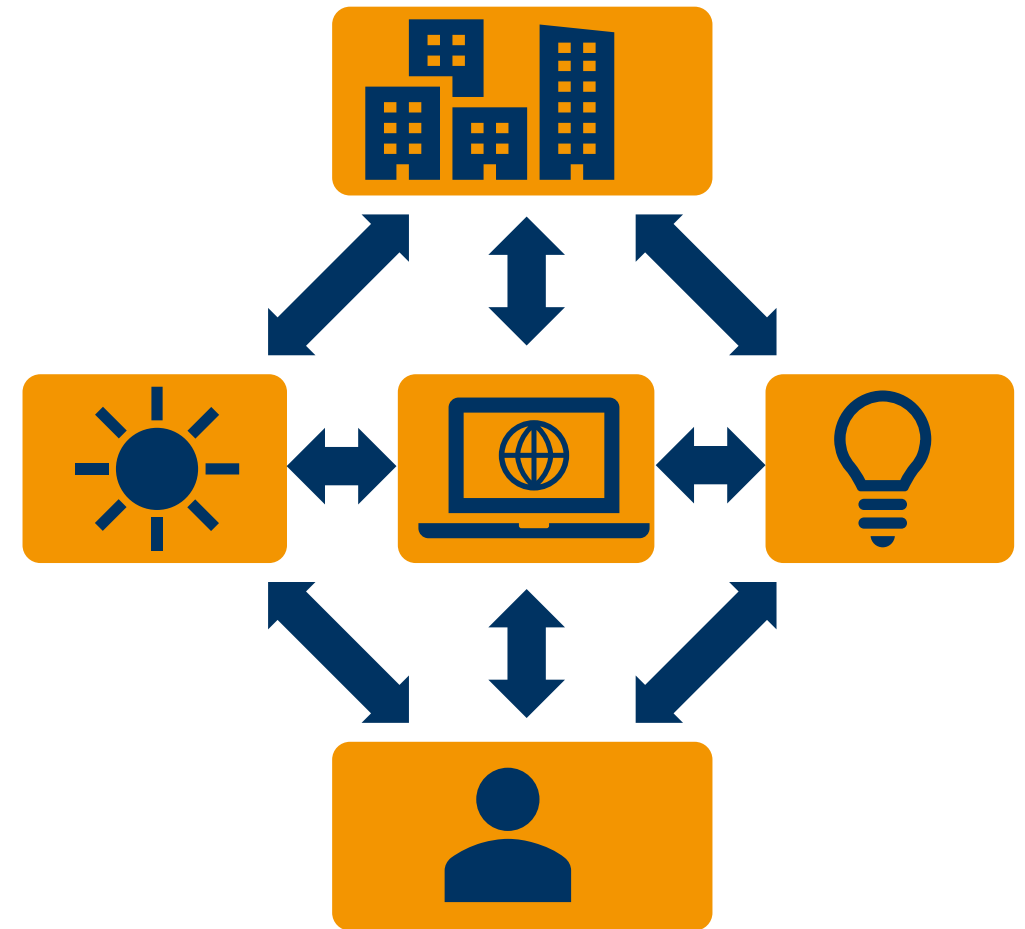
☐ Protected



Reference Office

Control

- Shading:
if global vertical irradiance $> 120 \text{ W/m}^2$, blinds are fully lowered in almost closed position (75° tilt angle; both windows simultaneously)
- Electric lighting:
daylight dependent control (combined PIR occupancy and look-down brightness sensor centered on ceiling), light is dimmed to an average of 500 lux at the two workplaces as well as the side table (third desk), maintenance factor 0.8
- Manual intervention:
possible via a button next to the door for both the shading system (up/down and tilting) as well as the luminaires (on/off, dimming), but not included in the specification of the reference office setup



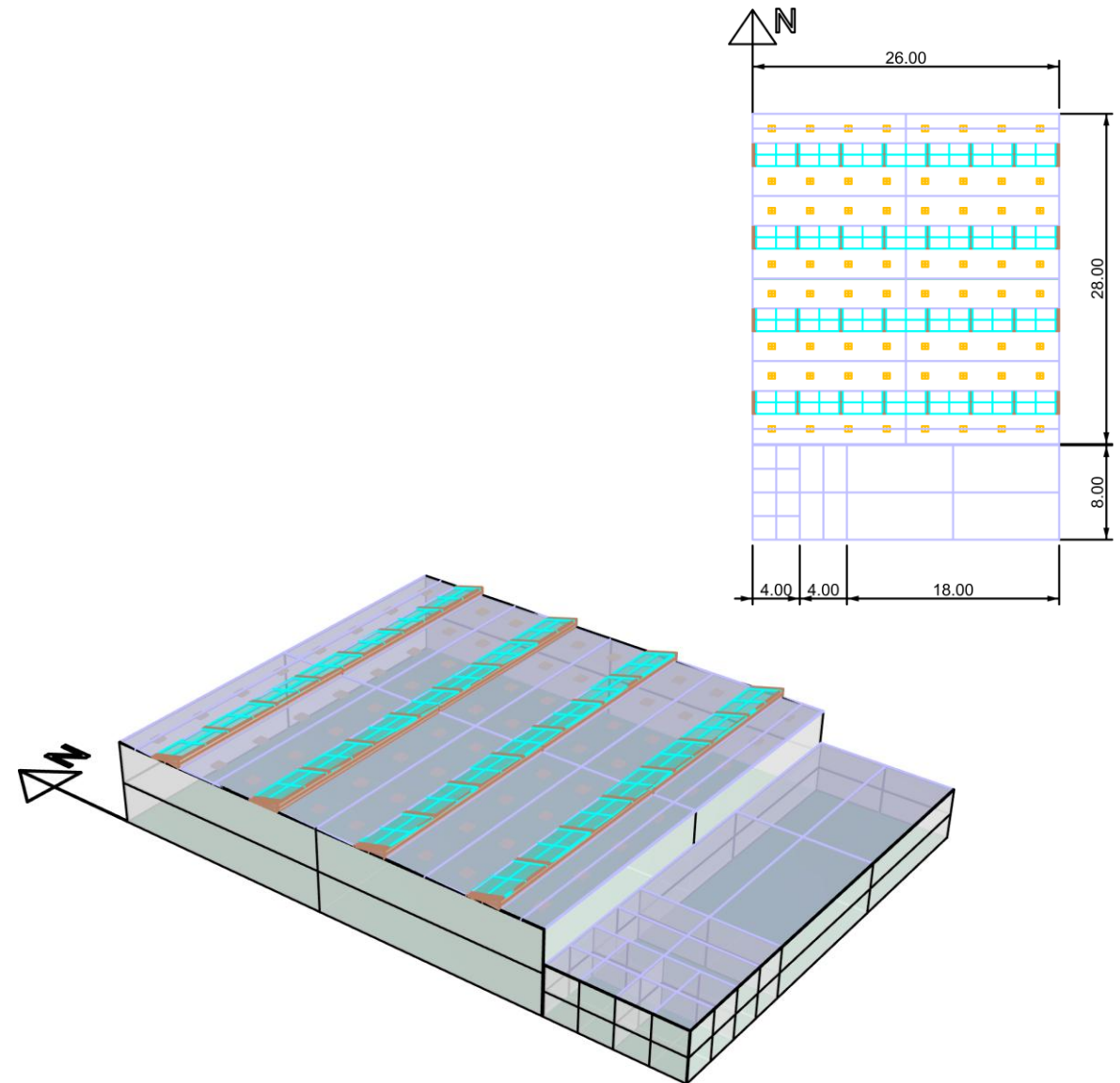
Reference Factory Hall

Building

- Location: Stuttgart, Germany
- Climate: DEU_Stuttgart.107380_IWEC.epw

Geometry

- 28 m x 28 m x 5 m
- 3D model (3dm file)
- Rooflight orientation: North
- No external shading

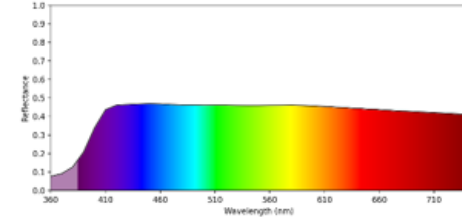
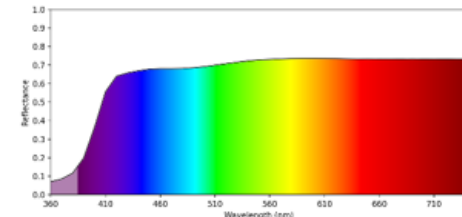
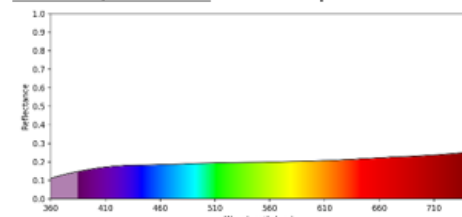


Reference Factory Hall

Materials

- Color neutral opaque materials matching the specified reflectances selected from the Spectral Materials Database¹
- transparent materials generated using LBNL's Optics² software based on spectral data from the IGDB³

1. <https://spectraldb.com/>
2. <https://windows.lbl.gov/optics-downloads>
3. <https://windows.lbl.gov/igdb-downloads>

Geometry (layer name)	Color	V(λ) reflectance	M(λ) reflectance	Spectral data
Walls (factory walls)	Neutral, 50%	45.83%	46.30%	00552_spectral.csv / 00552_spectral_sci.csv 
Ceiling (factory ceiling)	Neutral, 70%	72.33%	69.03%	00995_spectral.csv / 00995_spectral_sci.csv 
Floor (factory floor)	Neutral, 20%	20.06%	19.10%	00002_spectral.csv / 00002_spectral_sci.csv 

Reference Factory Hall

Luminaires

- CEN/TR 15193-2 specifies daylight dependent dimmable LED luminaire
- Typical high-bay luminaire selected from online catalogue
- Spectrum of typical LED lamp with 4000 K and Ra 85 (CIE LED lamp 03)

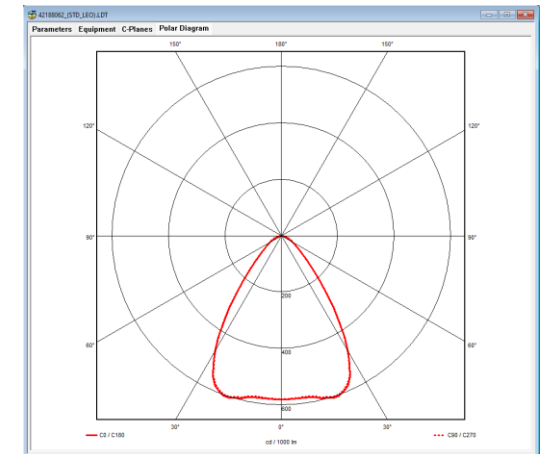
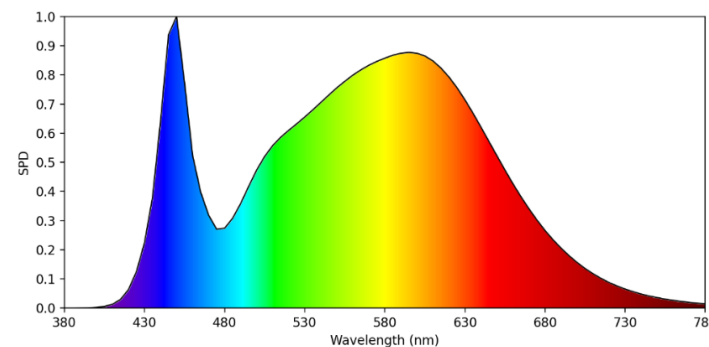
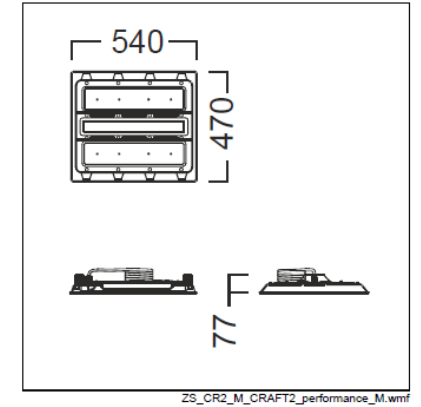
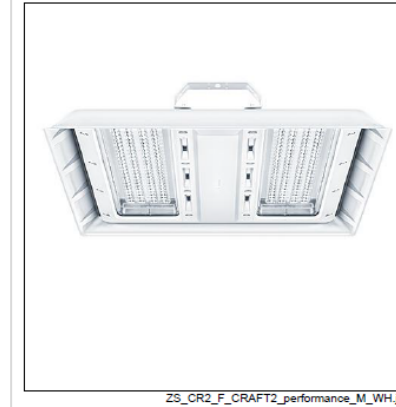
CRAFT II performance M

CR2 M10k-840 PM WB LDO WH

42188062

LED high-bay luminaire

LED high-bay luminaire Luminaire input power: 53.9 W, including LED converter, Slave luminaire for DALI control (DALI only), housing made of extra-robust, deep-drawn sheet steel, powder coated in colour white. Cover of clear polymethyl methacrylate (PM) with high breaking strength and optimised stress crack resistance, especially resistant to oils, alkalis, ammonia and UV radiation. Chromaticity tolerance (initial MacAdam): 2. Luminaire luminous flux: 9800 lm, Luminaire efficacy: 182 lm/W Colour rendering Ra > 80, colour temperature 4000 K, glare-free lighting: UGR < 22 (EN 12464:2011). Sealed optical lens system. Lenses with diagonal dome structure for maximum efficiency Luminaire with symmetric wide light distribution (wide beam). Pre-assembled 2m long 5 x 1 mm² connection cable for very high continuous temperatures (halogen-free, flame-retardant). Vibration resistant (EN 60598-1:2015/IEC 60598-1:2017 Ed. 8.1). LED risk group RG0 (IEC/EN 62471), luminaire wired with halogen-free leads, silicone-free. Note: please contact your consultant if you are planning to use in ambient atmospheres with chemical loads, high or condensed air humidity or large temperature fluctuations. Protection class: SC1; degree of protection: IP66; ambient temperature: -10°C to +65°C; Dimensions: 540 x 470 x 77 mm. Weight: 4.9 kg.



Reference Factory Hall

Rooflight

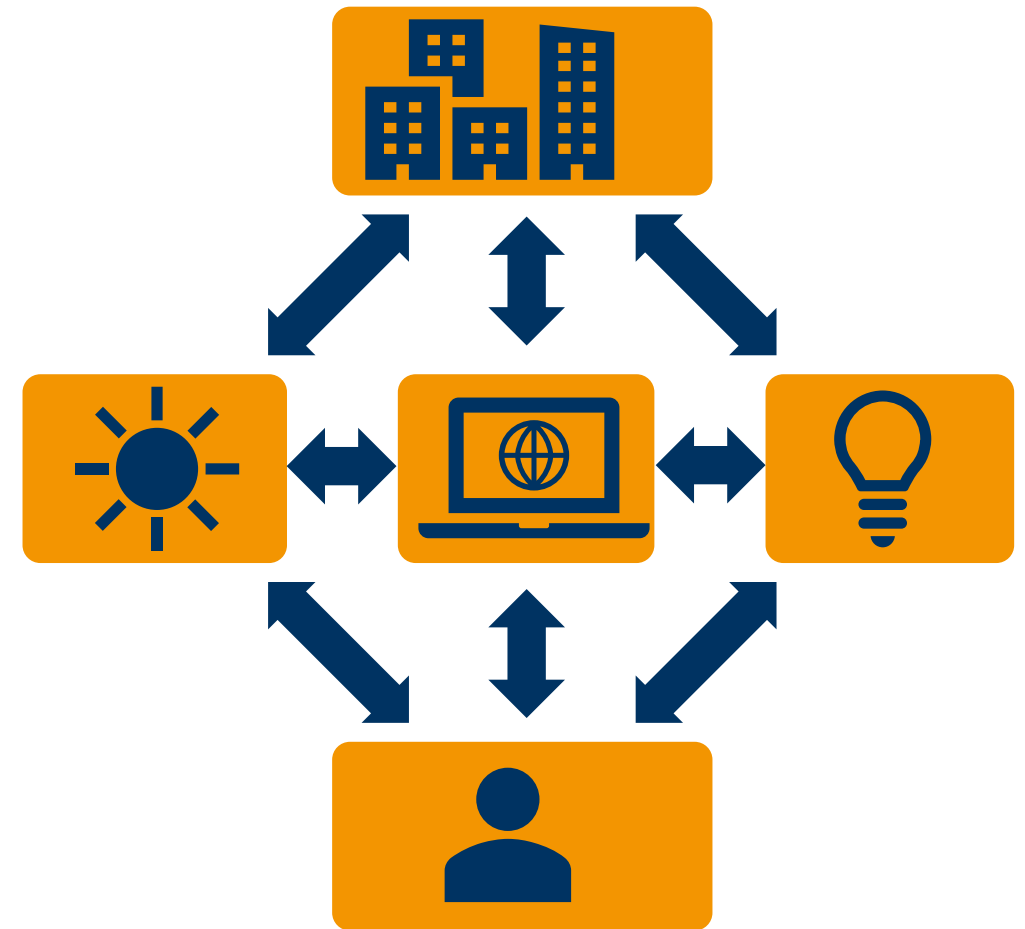
- Double pane insulation glazing with additional third diffusing pane on the exterior
- Modeled in WINDOW
- diffusing pane adapted from CGDB entry ID 31002 and defined as diffusing material with assumed spectrally neutral behavior
- Provided data:
 - BSDF (XML)
 - CSV (plain BSDF data)

Shade Material	
ID #:	51010
Thickness:	6.000 mm
Name:	Diffusing shade material 60
Product Name:	Example
Manufacturer:	Generic
Conductivity 0.900 W/m-K	
Solar	
Trans, Front	0.600
Trans, Back (Tsol2):	0.600
Reflect., Front (Rsol1):	0.200
Reflect., Back (Rsol2):	0.200
Visible	
Trans, Front (Tvis):	0.600
Trans, Back (Tvis2):	0.600
Reflect., Front (Rvis1):	0.200
Reflect., Back (Rvis2):	0.200
IR	
Trans (Tir):	0.000
Emis., Front (Emis1)	0.840
Emis., Back (Emis2)	0.840
Color:	
☒ Non-specular	
☐ Spectral data	

Reference Factory Hall

Control

- Shading:
none (rooflight has no dynamic parts)
- Electric lighting:
daylight dependent control (look-down brightness sensor located between rooflight bands),
maintained illuminance is 500 lux, maintenance factor 0.8
- Working hours:
8 am to 5 pm, Monday through Friday, with no shut down for holidays



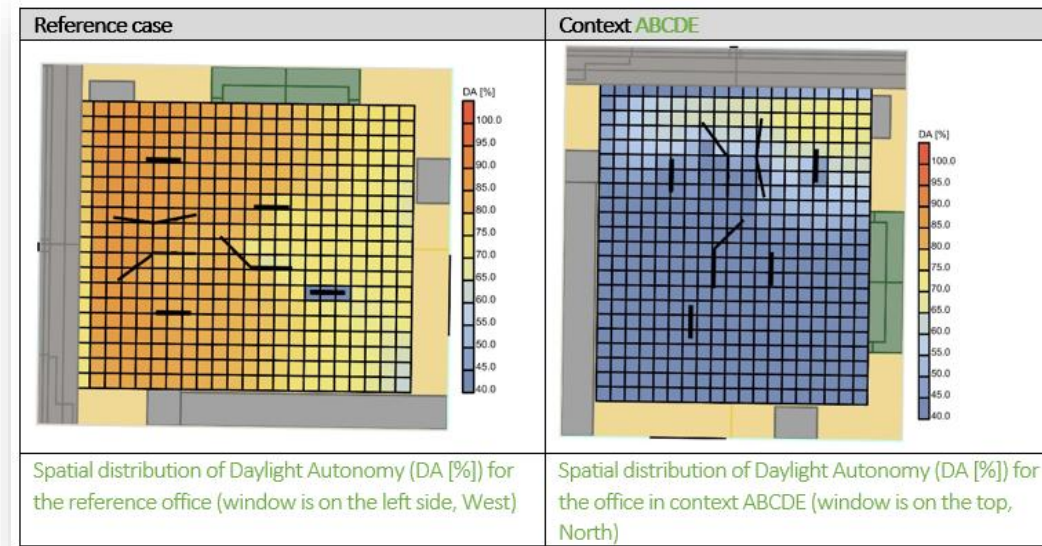
Reporting of Simulation Results

Template for reporting of simulations

- General
 - Author
 - Software / hardware
 - Comments
- Results
 - Daylight
 - Electric lighting
 - Circadian lighting
 - HVAC electricity / energy use

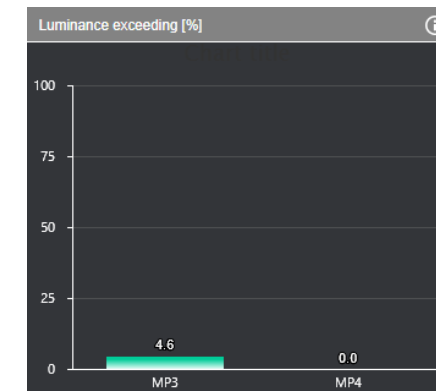
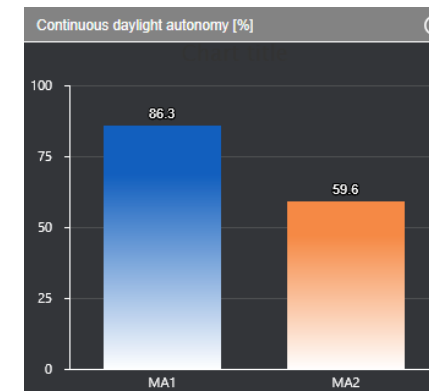
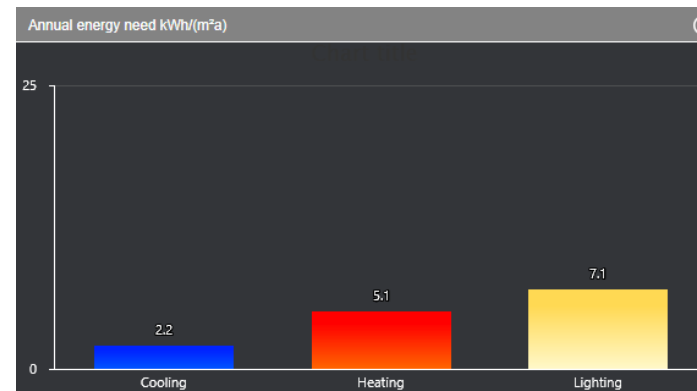
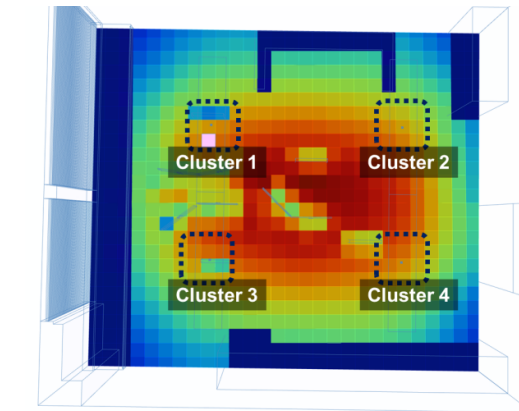
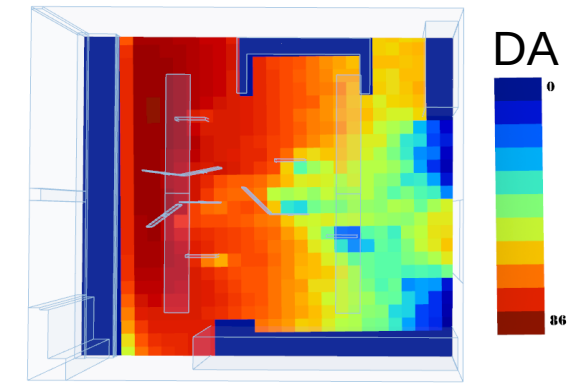
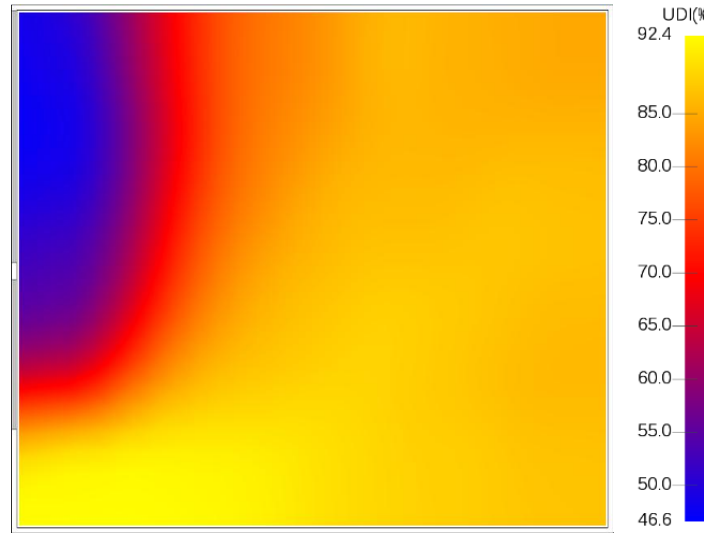
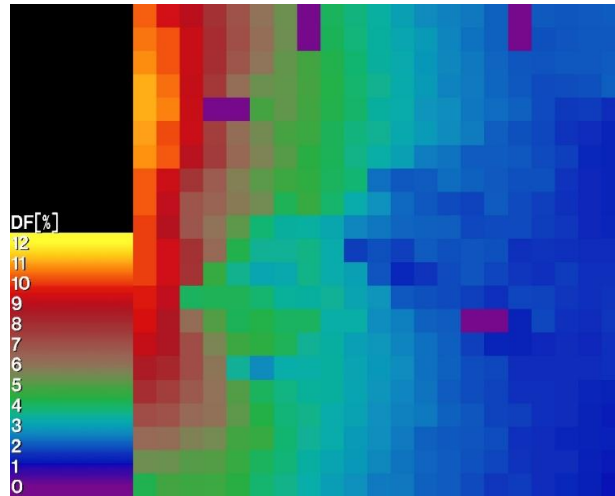
Results for reference case "office":

	Metric	Reference case	Context ABCDE
Daylight Factor (CIE overcast sky)	DF min	1.11 %	0.12%
	DF mx	9.99%	8.88%
	DF avg	5.55%	4.44%
	% area with at least 2% DF	33.3%	22.2%
Daylight metrics based on annual results	sDA _{300,50%}	77.7%	33.3%
	ASE _{1000,250h}	11.1%	2.22%
	% area with at least 50% UDI ₁₀₀₋₃₀₀₀	77.7%	55.5%
	F _{DGP=0.40,exceed} for view 1	4.44%	1.11%
	F _{DGP=0.40,exceed} for view 2	3.33%	2.22%
Circadian lighting	mEDI	222.2 lx	333.3 lx
Electric lighting	Annual electricity use for electric lighting	111.1 kWh / yr	222.2 kWh / yr



2345 h
11.1 kWh / yr (air-air heat pump)
— (no cooling)
44.4 kWh / yr
—
— (no cooling)
—

Example Results



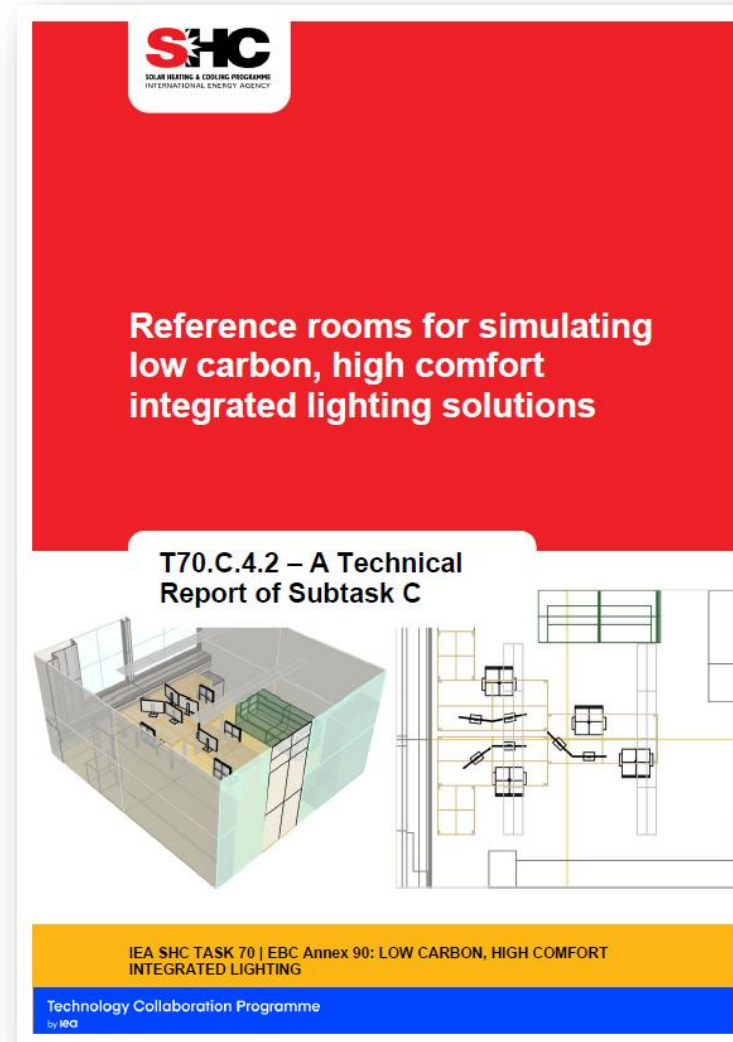
Reference Rooms

Full report

- Reference Office
- Reference Hall
- Template for Reporting Results

IEA SHC Task 70 Publications:

<https://task70.iea-shc.org/publications>



Dataset

Reference Model Dataset

Reference Models for Spectral Lighting and Daylight Simulations (Original version of dataset uploaded to be referenced by data paper.). Zenodo.

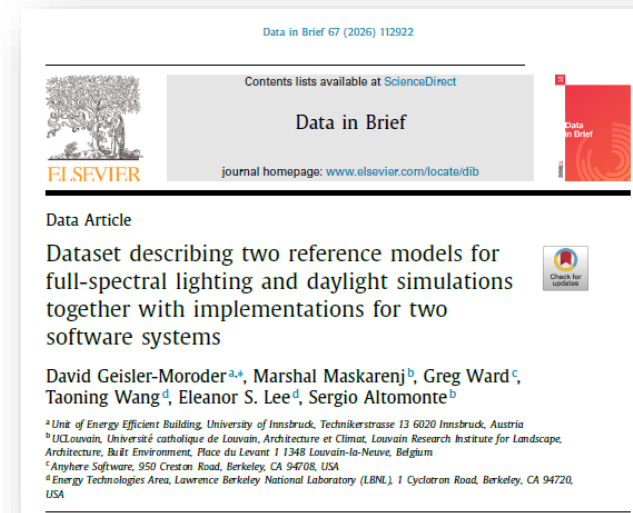
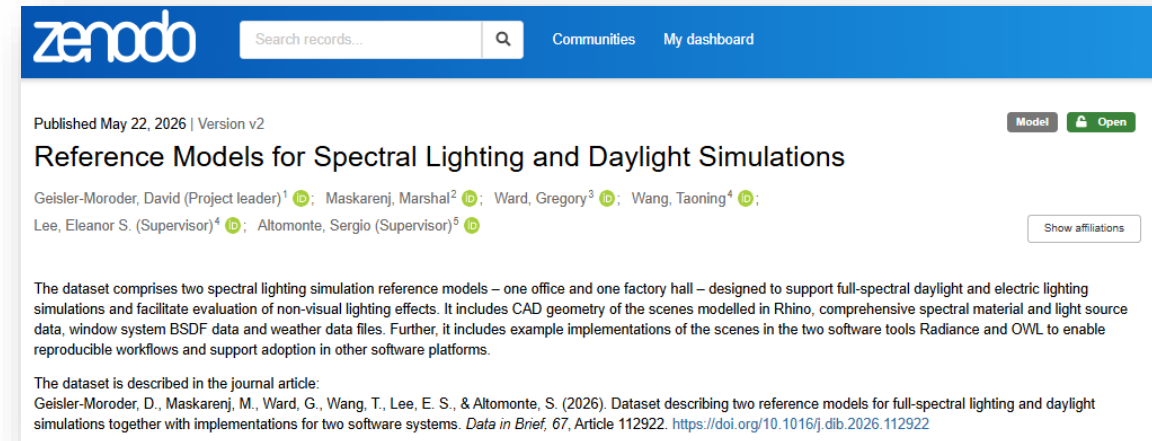
<https://doi.org/10.5281/zenodo.18836176>

Data Article

Dataset describing two reference models for full-spectral lighting and daylight simulations together with implementations for two software systems.

Data in Brief, 67, 112922.

<https://doi.org/10.1016/j.dib.2026.112922>



Models

Reference Model Dataset

<https://doi.org/10.5281/zenodo.18836176>

Example: Office

→ *README.md*

Repository: T70_Office

Overview

This directory contains the model data for the reference room "Office", including geometry, photometric properties, spectral measurements, weather data, and window/BSDF configurations used for simulation and analysis.

Directory Structure

```
T70_Office/  
├── geometry/  
├── luminaire/  
├── spectra/  
├── weatherdata/  
├── window/  
│   ├── BSDF/  
│   └── CSV/
```

File Inventory & Descriptions

T70_Office/

File	Type	Description
README.md	.md	This file

T70_Office/geometry/

Contains 3D model geometry and environmental obstruction data.

File	Type	Description
t70_reference_office_lab518.3dm	.3dm	3D geometry of the reference room "Office" modelled in Rhino
		Shading lines describing the near horizon, far horizon and total (both

Models

Reference Model Dataset

<https://doi.org/10.5281/zenodo.18836176>

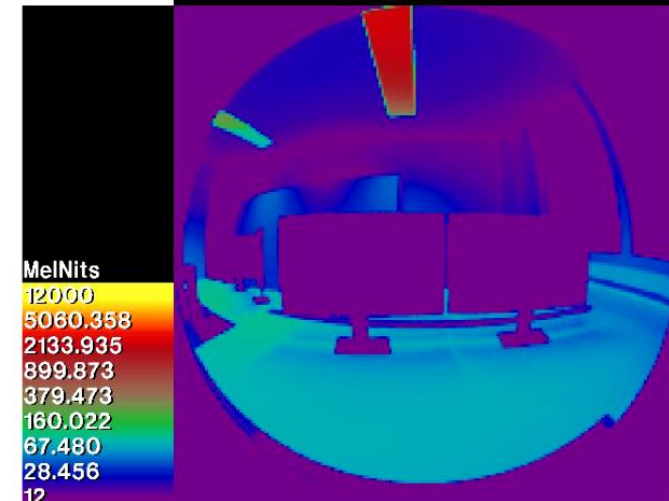
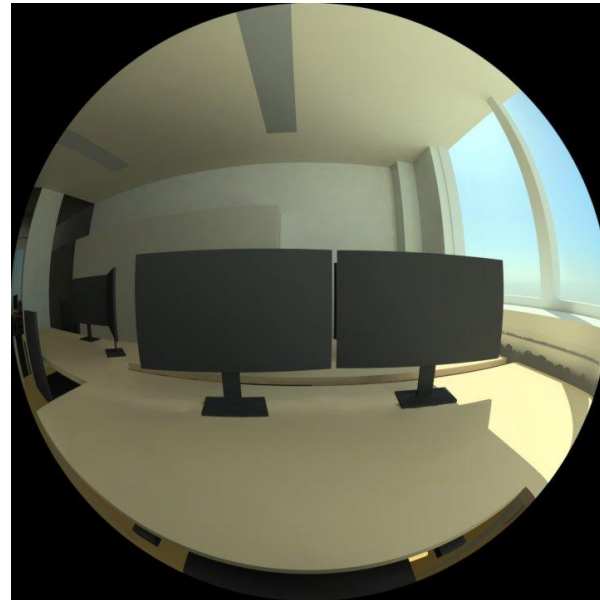
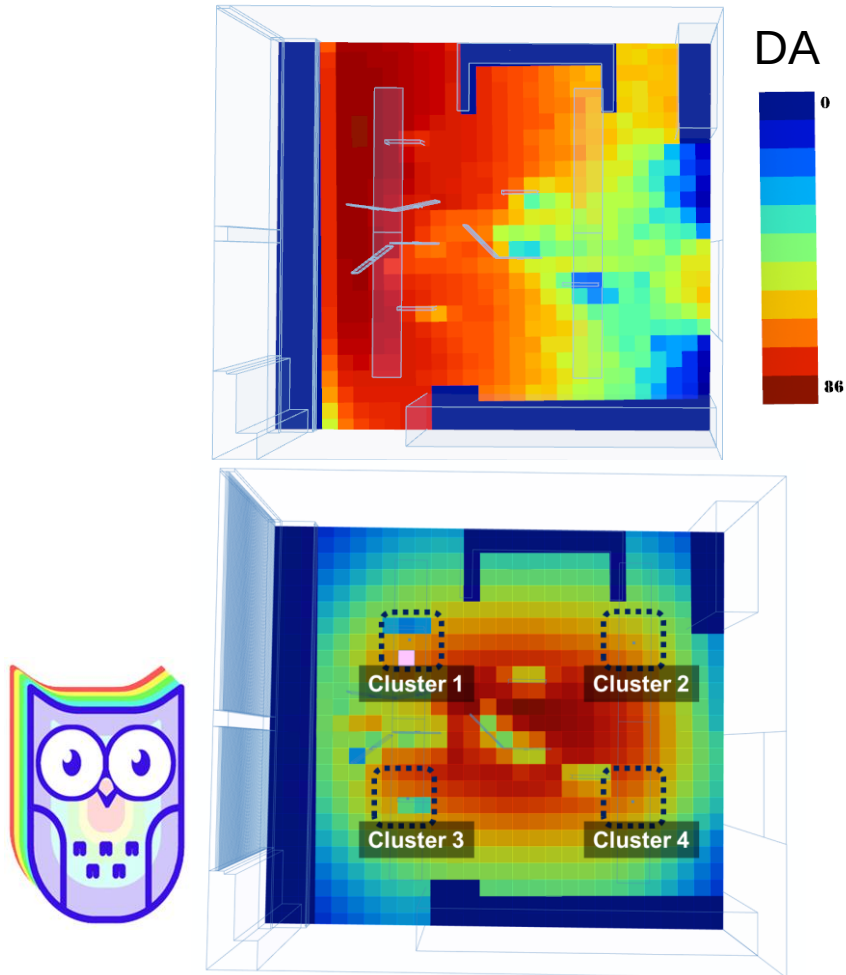
Example: Office

→ *Files*

Table 1
Presentation of the files describing the model data for the reference room "Office".

Folder	File(s)	Description
T70_Office/	-	Contains 5 subfolders
./geometry/	t70_reference_office_lab518.3dm lab518_shading_lines.txt	3D geometry of the reference room "Office" modelled in Rhino. Shading lines describing the near horizon, far horizon and total (both combined) outdoor obstructions surrounding the building.
./luminaire/	2722-001_98W.lgt	Luminous intensity distribution of the luminaires in the Eulumdat (LDT) file format.
./spectra/	00027_spectral.csv 00027_spectral_sci.csv 00769_spectral.csv 00769_spectral_sci.csv	Spectral reflectance data for the exterior façade cladding; *_sci.csv only includes the spectrum with specular component included; retrieved from [11]. Spectral reflectance data for the exterior ground; *_sci.csv only includes the spectrum with specular component included; retrieved from [11].
	Baulng_518_Window.usr Baulng_518_Window_t_vis.csv Fluorescent_840.csv	Spectral data for the window system without blinds defined and calculated in the OPTICS software. Spectral power distribution for a typical fluorescent 840 lamp used in the luminaire in the office.
	InterPane_Float_6mm.usr InterPane_Float_6mm_t_vis.csv T70_office_ceiling.csv T70_office_chairs.csv T70_office_couch.csv T70_office_cupboard.csv T70_office_desk.csv T70_office_desk_legs.csv T70_office_door.csv T70_office_floor.csv T70_office_frame.csv T70_office_monitors.csv T70_office_walls.csv	Spectral data for the interior glass wall defined and calculated in OPTICS the software. Spectral reflectance data for the acoustic ceiling; measured. Spectral reflectance data for the office chairs; measured. Spectral reflectance data for the couch; measured. Spectral reflectance data for the cupboard; measured. Spectral reflectance data for the desks; measured. Spectral reflectance data for the office desk legs; measured. Spectral reflectance data for the door; measured. Spectral reflectance data for the floor; measured. Spectral reflectance data for the window frames; measured. Spectral reflectance data for the monitors; measured. Spectral reflectance data for the walls; measured.
./weatherdata/	Download_EnergyPlus_AUT_Innsbruck.epw.url	Download link for EPW weather data for location Innsbruck.
./window/	Baulng_Fensteraufbau.txt	Output of WINDOW software describing the setup of the window system in the office space for the blind setting +00.
./window/CSV/	Baulng_ILM_Lamelle_XXX.csv Baulng_ILM_Lamelle_+00.csv Baulng_ILM_Lamelle_+???.csv Baulng_ILM_Lamelle_-???.csv	BSDF data for the office window system without blinds (XXX) in CSV format. The file contains 8 data blocks: Solar/Visible, Transmission/Reflection, Front/Back in all combinations. Each data block is in Klems resolution. At the end integral values are included for information, e.g., total transmission visible (Tvis) or solar (Tsol). BSDF data in CSV format for the office window system with blinds in horizontal position, i.e., 0 degree slat angle (+00). BSDF data in CSV format for the office window system with blinds in outward tilted positions in 5 degree steps, i.e., +?? Stands for +05 to +85 degrees slat angle. BSDF data in CSV format for the office window system with blinds in inward tilted positions in 5 degree steps, i.e., -?? Stands for -05 to -85 degrees slat angle.
./window/BSDF/	Baulng_ILM_Lamelle_XXX.xml Baulng_ILM_Lamelle_+00.xml Baulng_ILM_Lamelle_+???.xml Baulng_ILM_Lamelle_-???.xml	BSDF data for the office window system without blinds in XML format to be directly used in simulation software. The file contains the same 8 data blocks as the CSV file. BSDF data in XML format for the office window system with blinds in horizontal position. BSDF data in XML format for the office window system with blinds in outward tilted positions in 5 degree steps (+05 to +85). BSDF data in XML format for the office window system with blinds in inward tilted positions in 5 degree steps (-05 to -85).

Reference Implementations



RADSITE | radiance-online.org

Radiance Implementation

Reference Model Dataset

<https://doi.org/10.5281/zenodo.18836176>

→ *README.md*

Repository: Implementation_Radiance

Overview

This directory contains the files and data structure in the folder Implementation_Radiance describing

- the implementation of the hall reference model in Radiance,
- the implementation of the hall reference model in Radiance, including results,
- the implementation of the office reference model in Radiance, and
- the implementation of the office reference model in Radiance, including results.

It contains all scripts, geometry, materials, sensor definitions, spectral data, and weather inputs required to run a hyperspectral Radiance simulation of the reference rooms "Office" and "Hall".

The file inventory and descriptions are given in the single README files within each directory.

Directory Structure

```
Implementation_Radiance/  
├─ hall  
├─ hall_with_results  
├─ office  
└─ office_with_results
```

Radiance Implementation

Reference Model Dataset

<https://doi.org/10.5281/zenodo.18836176>

Example: Office

→ *README.md*

Repository: office

Overview

This directory contains the files and data structure in the folder Implementation_Radiance/office/ describing the implementation of the office reference model in Radiance.

It contains all scripts, geometry, materials, sensor definitions, spectral data, and weather inputs required to run a hyperspectral Radiance simulation of the reference room "Office".

The workflow is organized into modular simulation steps executed via shell scripts.

Directory Structure

```
office/  
├─ materials/  
├─ misc/  
├─ objects/  
├─ pts/  
├─ sources/  
├─ spectra/  
├─ weatherdata/  
└─ window/  
    └─ BSDF/
```

File Inventory & Descriptions

office/

File	Type	Description
_office_step00_all.sh	.sh	Shell script to run the overall Radiance simulation for the office model. This script subsequently calls all scripts _office_step*.sh
_office_step*.sh	.sh	Separate shell scripts for the single calculation steps 01 to 20
		Radiance scene description for daylight calculations including the

Radiance Implementation

Reference Model Dataset

<https://doi.org/10.5281/zenodo.18836176>

Example: Office

→ Files

Table 9

Presentation of the files and data structure in the folder *Implementation_Radiance/office/* describing the implementation of the office reference model in Radiance.

File / directory	Description
<code>_office_step00_all.sh</code>	Shell script to run the overall Radiance simulation for the office model. This script subsequently calls all scripts <code>_office_step*.sh</code> .
<code>_office_step*.sh</code>	Separate shell scripts for the single calculation steps 01 to 20.
<code>base_model.rad</code>	Radiance scene description for daylight calculations including the material definition and the scene objects, with luminaires switched off, and without window glazing.
<code>base_model_night.rad</code>	Radiance scene description for electric lighting calculations including the material definition and the scene objects, with luminaires switched on, and with window glazing.
materials/	Folder containing file <code>materials.mat</code> .
<code>./materials.mat</code>	Spectral Radiance material definition for the objects in the scene.
misc/	Folder containing file <code>glarefmt</code> .
<code>./glare.fmt</code>	String format definition of <code>evalglare</code> result output.
objects/	Folder containing scene objects in Radiance format <code>*.rad</code> .
<code>./ceiling.rad</code>	Geometry definition of office room ceiling.
<code>./ceiling_tiles.rad</code>	Geometry definition of office room ceiling tiles.
<code>./chairs.rad</code>	Geometry definition of chairs in office room.
<code>./couch.rad</code>	Geometry definition of couch in office room.
<code>./cupboard.rad</code>	Geometry definition of cupboard in office room.
<code>./desks.rad</code>	Geometry definition of desks in office room.
<code>./desk_legs.rad</code>	Geometry definition of desk legs in office room.
<code>./door.rad</code>	Geometry definition of office room door.
<code>./facade.rad</code>	Geometry definition of office room facade.
<code>./floor.rad</code>	Geometry definition of office room floor.
<code>./glazing.rad</code>	Geometry definition of office room glazing (window).
<code>./ground.rad</code>	Geometry definition of exterior ground.
<code>./interior_wall.rad</code>	Geometry definition of interior walls of office room.
<code>./interior_wall_bglass.rad</code>	Geometry definition of interior walls of office room.
<code>./interior_wall_glass.rad</code>	Geometry definition of interior glass wall of office room.
<code>./monitors.rad</code>	Geometry definition of interior glass wall of office room, modified with material description to block interior interreflections.
<code>./window_frames.rad</code>	Geometry definition of window frames in office room.
pts/	Folder containing sensor points definition files <code>*.pts</code> .
<code>./ceil_sensor.pts</code>	Sensor file describing a look-down sensor mounted centrally on the ceiling.
<code>./facade_sensor.pts</code>	Sensor file describing a vertical sensor mounted at the façade outside the window.
<code>./workplane.pts</code>	Sensor file describing 441 (21 × 21) sensor points on workplane height of 0.75 above the floor.

Radiance Implementation

Reference Model Dataset

<https://doi.org/10.5281/zenodo.18836176>

Example: Office

→ Files

sources/	Folder containing data for the recessed luminaires in the office model and a sky description file.
./2722-001_98W.dat	Radiance luminous intensity distribution data file.
./2722-001_98W.ies	Luminaire IES *.ies photometric data file.
./2722-001_98W.ldt	Luminaire Eulumdat *.ldt photometric data file.
./2722-001_98W.rad	Radiance description of luminaire.
./2722-001_98W_off.rad	Radiance description of luminaire, switched off.
./sky_r4.rad	Sky description in Radiance format using Reinhart -m 4 subdivision.
spectra/	Folder containing spectral data for window glazing and lamp, as well as CIE colour matching functions.
./Baulng_518_Window_t_vis.csv	Spectral transmittance data for the window glazing.
./CIE_xyz_1931_2deg.csv	CIE 1931 colour-matching functions, 2 degree observer.
./Fluorescent_840.csv	Spectral power distribution of fluorescent 840 lamp as used in the office luminaire.
./InterPane_Float_6mm_t_vis.csv	Spectral transmittance data for the interior glass wall.
weatherdata/	Folder containing reference weather data.
./ Download_EnergyPlus_AUT_Innsbruckgart.epw.url	Download link for Energy Plus weather data file for location Innsbruck, Austria.
window/	Folder containing BSDF files and Radiance window description.
./window_kf.rad	Geometry definition of office room glazing (window), modified with glow material description to act as emitter.

(continued on next page)

Table 9 (continued)

File / directory	Description
window/BSDF/	Subfolder containing BSDF data.
./BSDF/Bauing_ILM_Lamelle_+75.xml	BSDF data file in Klems resolution for the office window system with blinds in closed position (slat tilt angle 75° to the exterior).
./BSDF/Bauing_ILM_Lamelle_XXX.xml	BSDF data file in Klems resolution for the office window system without blinds (shading system retracted).

Radiance Implementation

Reference Model Dataset

<https://doi.org/10.5281/zenodo.18836176>

Example: Office

Run simulation:

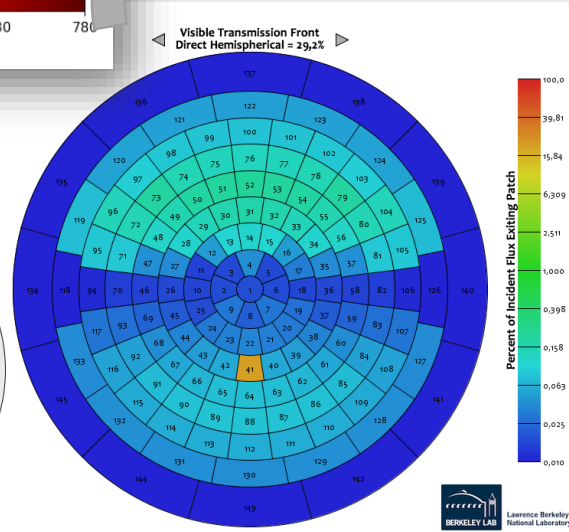
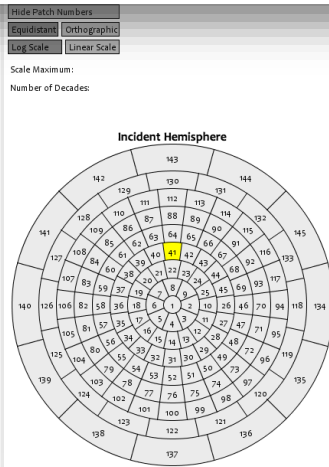
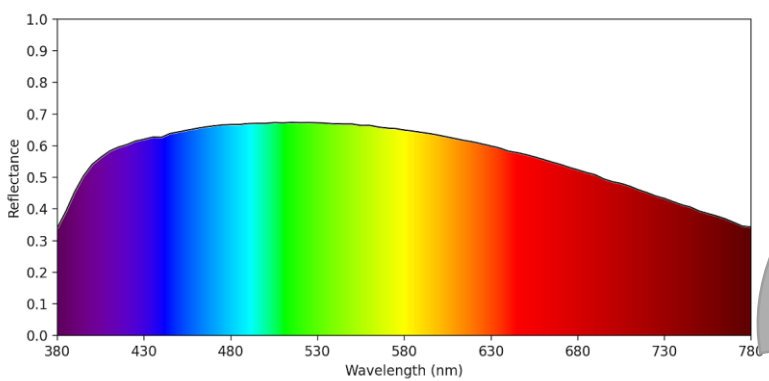
1. Download EPW files
2. Run *_office_step00_all.sh*

>> calls all scripts *_office_step*.sh*
running through all calculation steps.

Radiance Implementation: Office

Step 1a: Normalize spectra to $V(\lambda)$ to be used as multiplier.

Step 1b: Multiply spectrum against BSDF files



```
?#RADIANCE
rmtxop -ff -c 0.548290882 0 0 0.603472519 0 0 0.664478885 0 0 0.723645863 0 0 0.77944063 0 0 0.8292573
86 0 0.877081472 0 0 0.918314418 0 0 0.953262788 0 0 0.984225818 0 0 1.00553206 0 0 1.02499892 0 0 1.0
3113021 0 0 1.03082365 0 0 1.02714487 0 0 1.01580198 0 0 0.9869849 0 0 0.951270118 0 0 0.893329398 0 0 0
.697434585 0 window/BSDF/Bauing_ILM_Lamelle_+75.xml
NROWS=145
NCOLS=145
NCOMP=20
BigEndian=0
FORMAT=float

#+%0%09f*b9B
t#t0'.9@P$9-9-=-9t.59al.9*x 9Qn;9.b;j9-I 9U.-Y9..x59fi'9rU<9)`Z93A'9oM89cNK9Li]9.{n9'^i}9A'-t9-|E9LÖ'9í'-9[Ô
"9ÄIæ9âk.9p^~.9.f>9úý-9B*'+9=dU9.'69Ü.I9.q]9[)q9'ä-9Ä-59Í%'9-'."9|xZ9G
M9$.9<É±9.N«9.9.9C@9üuM9{,ž9ÄÚ"9(mh9öë<9[109töd9uVy9÷g†9
ÝZ9B-.9Ä4Z9'9.;-9ë.*9Tm±9Î-±9.ô*9M
'9^          =9:âf9Ü.9Np.±69Ü.I9.q]9[)q9'ä-9Ä-59Í%'9-'."9|xZ9G
M9$.9<É±9.N«9.9.9C@9üuM9{,ž9ÄÚ"9(mh93Ä'9oM89cNK9Li]9.{n9'^i}9A'-t9-|E9LÖ'9í'-9[Ô"9ÄIæ9âk.9p^~.9.f
>9úý-9B*'+9=dU9ÄÎ.9Ï/(9g099Æ-I9.:Y9D.g9èpt9Kî.9.Ö.,9§&9. .Æ9+ÖZ9ä~-9dM.9.! .9...9.¿99...„9$øx9`_B9Dæ.9K^
!9q®19-€A9.1P9=K]9.^j9"Žu9ñæ~9?-f9€p†9È
„9§Ü&9(Ö&9>T&9.D†9-ôf9&~9>àn9f~:9ÄÎ.9Ï/(9g099Æ-I9.:Y9D.g9èpt9Kî.9.Ö.,9§&9. .Æ9+ÖZ9ä~-9dM.9.! .9...9.¿99...
9,9§øx9`_B9Duf.9L^-9
â>9mâ090ë_9.;n9Öð(9!èf9Éí'9_-9Üo.9z;'9)."9â."9æš"9.é'9ÖÄ.9fM'9âQ9É¹\H9.à,9.F>9R,Q9.*d9žÄu9R»,9JfEŠ9ÆÄ.9d
G-9')>9S...ž9.-;9<žf9,,ç9'í;9i# 9ë~9&±*9'ÖE9cæ[96,:9"G9M9..b9u(v9-„9§
9ö.,9H0æ9÷!ç9 f§9Ü.«9MU°9c`9
S'9Y²9üÄ-9BPß9ÄE9;iôd-9i=m9Ñ@C9qcV9.;l9,ÜE9ÄÊ59&§9"x+æ9÷,£9Y»@9?~9ž
³9c.¶9a""9h<.9. ä¶9-p"9"%-9+a@9..Y9y|x9D,F9ø~Z9ž".p9Ö
f9"-9Q.-9°Cž9">|9A'-96-²9ç.¶9Jž¹9d±²9Äæ±9Cò¹9-ä.9.-²9c5-9` ,j9,,|9É±C9E5W9.+l9W..95Üš93Ý"9;dæ9eK£9Ü°90..
-f9.K³9ç(Ä¶9.ü.9.f.91&.9l u9.v-9&ž09cTÝ9K.v96.-9"G9M9..b9u(v9-„9§
```

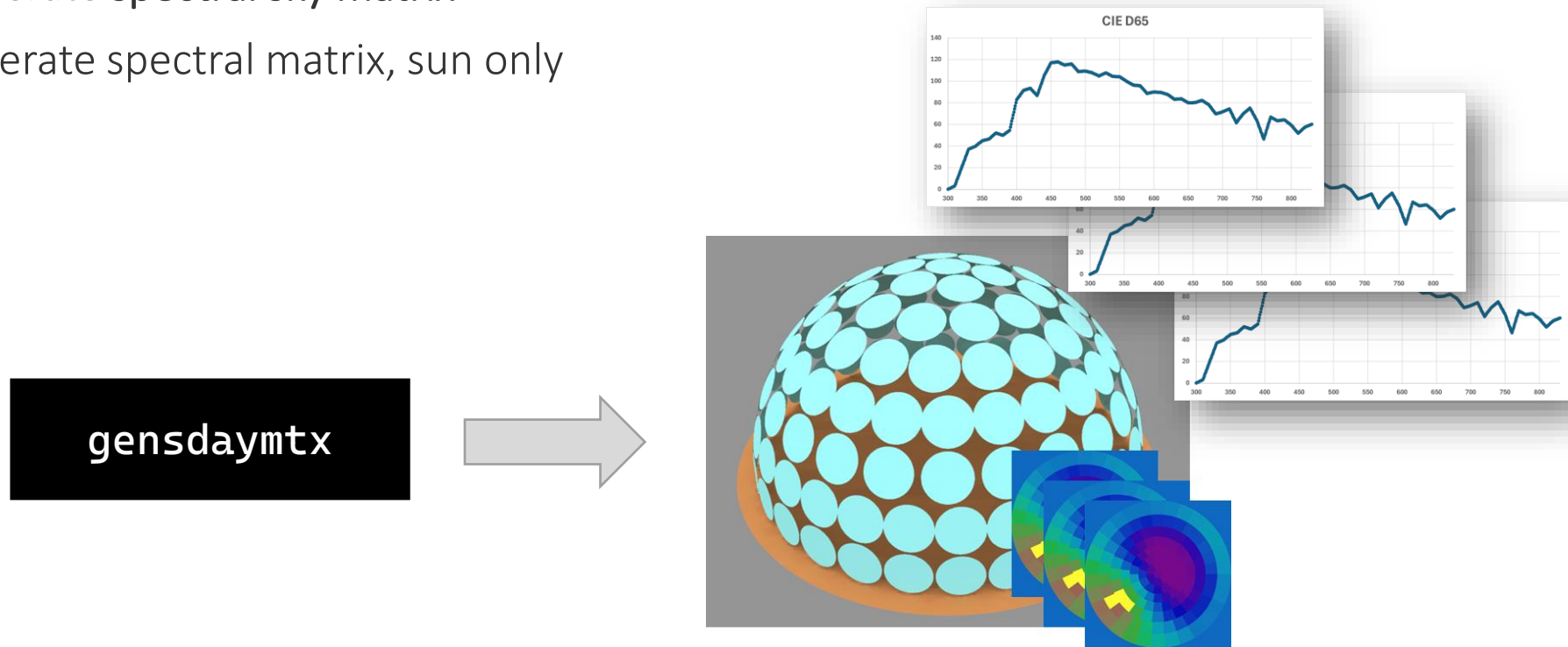
```
tabfunc
rcalc
rmtxop
```

Radiance Implementation: Office

Step 2a: Generate EPW file with only hours 8 to 18

Step 2b: Generate **spectral** sky matrix

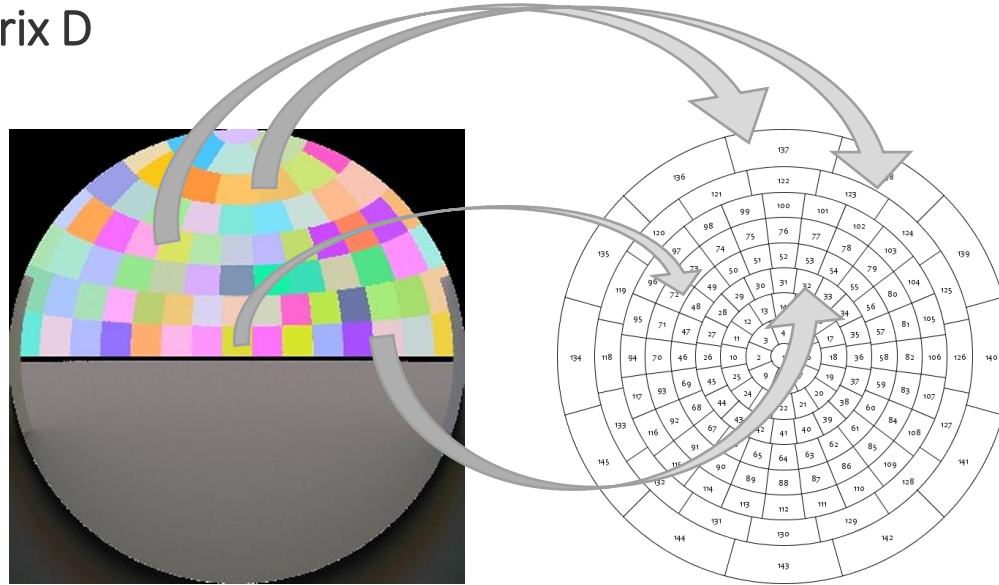
Step 2c: Generate spectral matrix, sun only



Radiance Implementation: Office

Step 3: Compute **daylight contribution matrix D** from window to sky.

`rxflxmtx`



Step 4a: Compute **daylight hours matrix** and blinds-up, blinds-down matrices.

Step 4b: Calculate **sun hours matrix** and combined matrix with BSDF.

`rmtxop`

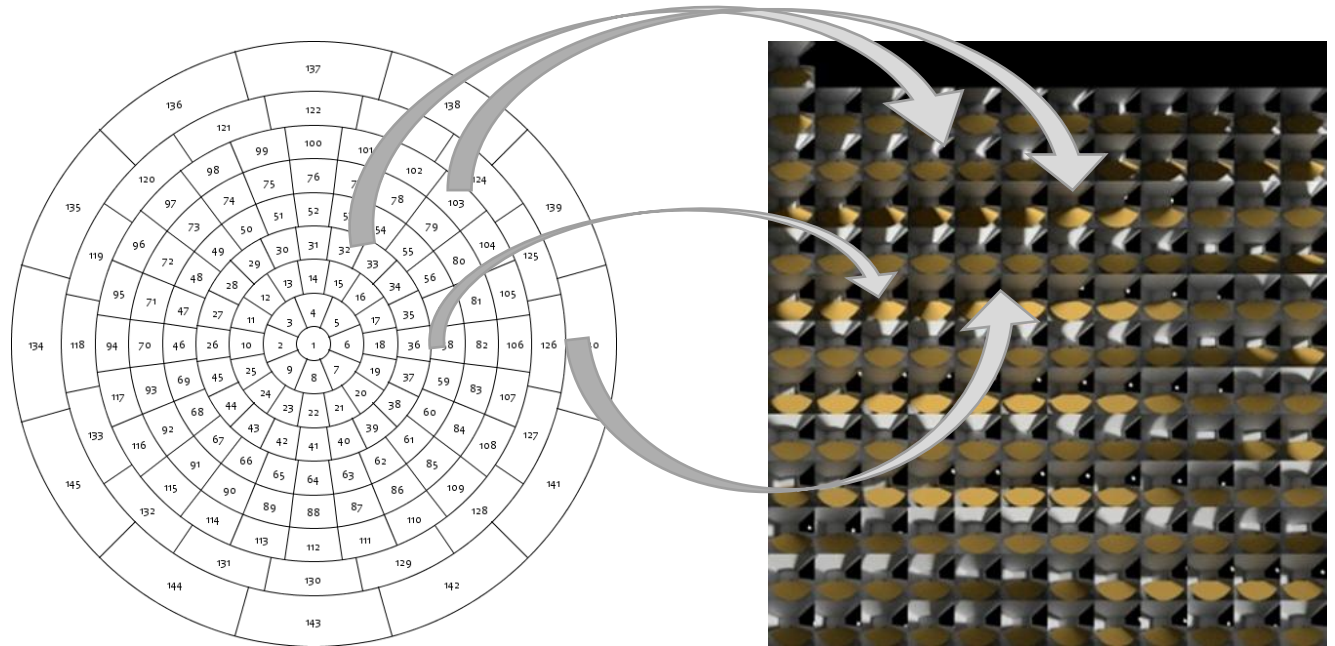
Radiance Implementation: Office

Step 5: Compute **view matrices** for views from sitting positions.

Step 6: Calculate **view matrix V** for illuminance on room-wide workplane.

Step 7: Calculate **direct-only view matrix V** for illuminance on workplane.

`rxflxmtx`



Radiance Implementation: Office

Step 8a/b: Setting w/ blinds (a) and noblinds (b):
Calculate annual illuminance on workplane for daylight time 8-18 and **compute metrics sDA and UDI**.

Step 9a/b: Setting w/ blinds (a) and noblinds (b):
Calculate annual illuminance from sun only on workplane for daylight time 8-18 and **compute ASE**.

```
rmtxop  
rcollate  
rcomb  
rcalc  
getinfo  
total
```

Radiance Implementation: Office

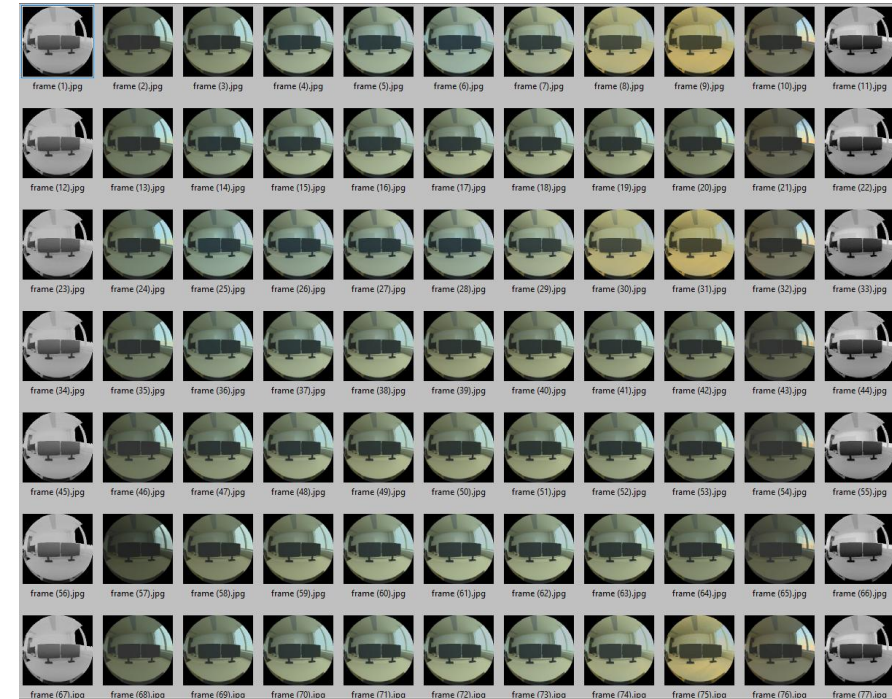
Step 10: Run **annual simulation timesteps** for views to generate images needed for glare evaluation.

```
pvsum
```

Step 11a: Run **evalglare** on the frames.

Step 11b: Derive the fraction of daylight hours w/ $DGP > 0.4$

```
evalglare  
rcalc  
total
```



Radiance Implementation: Office

Step 12a: Compute **spectral night-time views** from view points (example seat 2) and evaluate mEDI

```
oconv  
rxpiece
```

Step 12b: Compute mEDI: vertical melanopic lux divided by equivalence factor for daylight.

```
rcomb  
getinfo  
total  
rcalc
```

Step 12c: Convert hyperspectral image to HDR and TIF image.

```
ra_xyze  
ra_tiff
```



Radiance Implementation: Office

Step 13: Compute **workplane** illuminance from electric lights only.

```
rtrace
```

Step 14: Compute **centrally-located ceiling sensor** illuminance from electric lights only.

```
rtrace
```

Step 15: Get average workplane illuminance corresponding to the same condition with electric lighting at 100%.

```
getinfo  
total
```

Radiance Implementation: Office

Step 16: Compute **daylight** (Kleins direction) contributions at ceiling sensor (vector).

```
rxfluxmtx
```

Step 17: Compute the energy use, using linear assumption (i.e., perfect dimming efficacy).

```
rmtxop  
getinfo  
total  
rcalc
```

Step 18: Compute coefficient vector for exterior, facade-mounted sensor.

```
rxfluxmtx
```

Radiance Implementation: Office

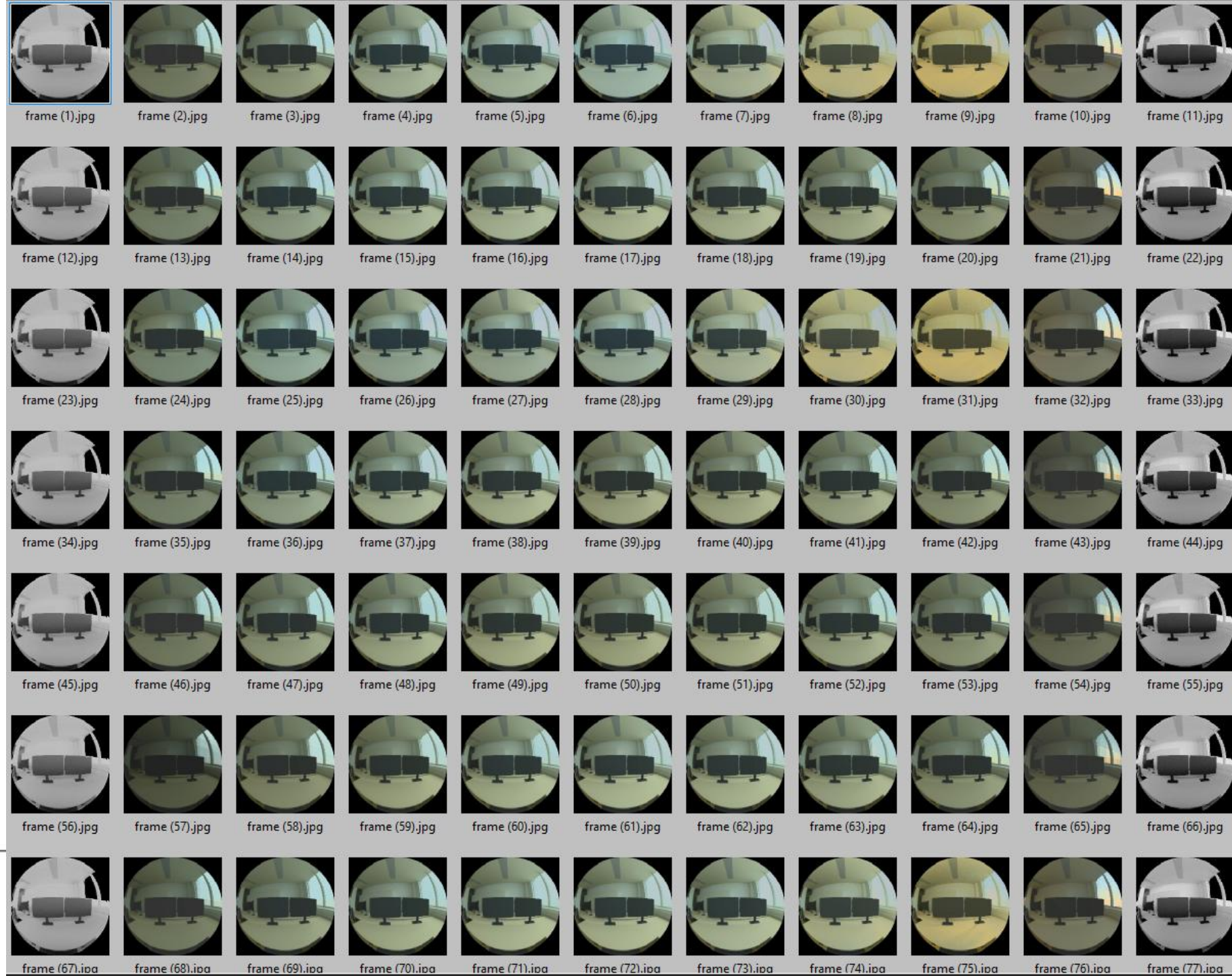
Step 19: Compute **annual exterior vertical irradiance** on facade-mounted sensor and control setting based on 120W/m² threshold.

```
rmtxop  
getinfo  
rcalc
```

Step 20: Compute **controlled electric lighting**: operating hours annual energy [kWh / a].

```
rlam  
rcalc  
total
```

Example Results



Access to reports and reference model dataset

IEA SHC Task 70 / EBC Annex 90 Project Website

<https://task70.iea-shc.org/>

Reports and Publications

<https://task70.iea-shc.org/publications>

Reference Model Dataset

Geisler-Moroder, D., Maskarenj, M., Ward, G., Wang, T., Lee, E. S., & Altomonte, S. (2026). Reference Models for Spectral Lighting and Daylight Simulations (Original version of dataset uploaded to be referenced by data paper.). *Zenodo*. <https://doi.org/10.5281/zenodo.18836176>

Data Article

Geisler-Moroder, D., Maskarenj, M., Ward, G., Wang, T., Lee, E. S., & Altomonte, S. (2026). Dataset describing two reference models for full-spectral lighting and daylight simulations together with implementations for two software systems. *Data in Brief*, 67, 112922. <https://doi.org/10.1016/j.dib.2026.112922>



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- **Alstan Jakubiec** for generously providing spectral reflectance data in the wonderful Spectral Materials Database (<https://www.spectraldb.com/>).

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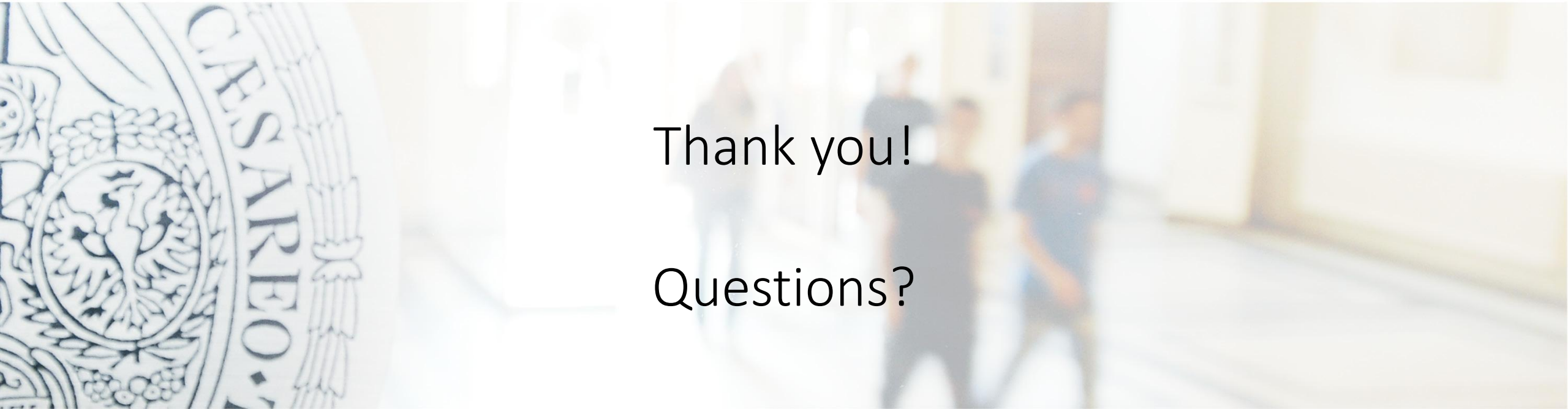
 Federal Ministry
Innovation, Mobility
and Infrastructure
Republic of Austria



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Thank you!

Questions?

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