Lucerne University of
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Modelling daylight in buildings

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CC Building Envelopes and Civil Engineering

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Facade 2021 Digital!
Session 4: Daylight and Facade

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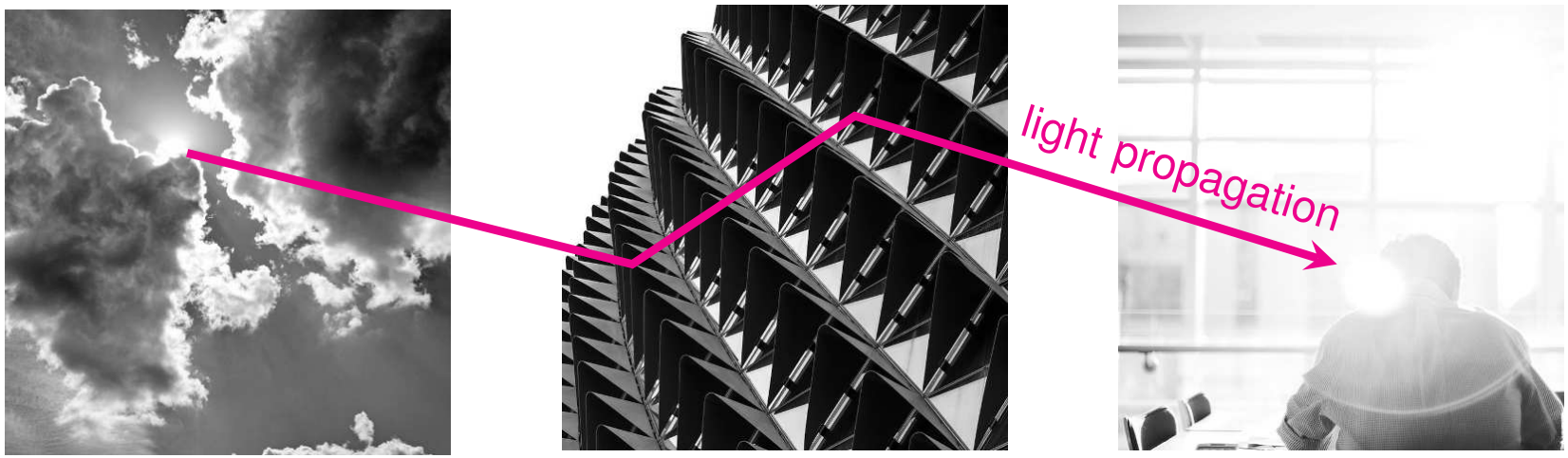
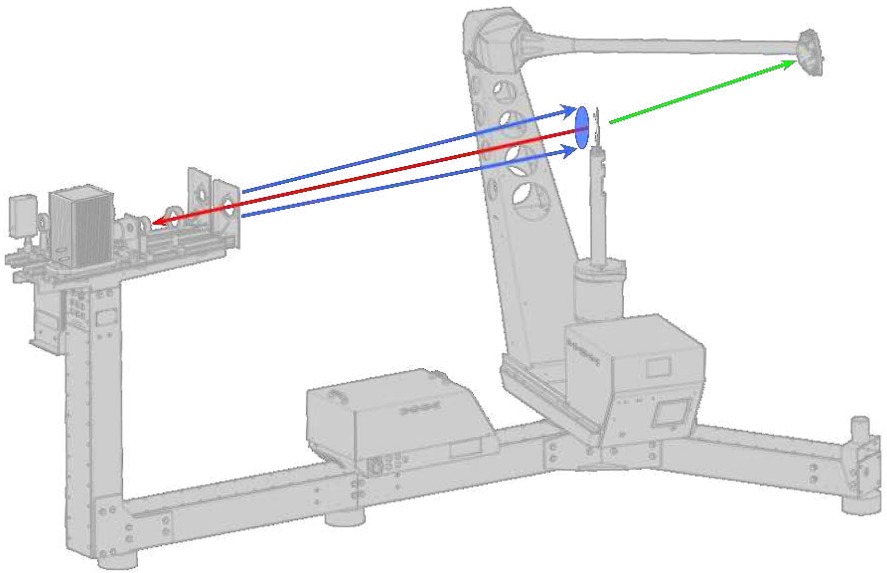
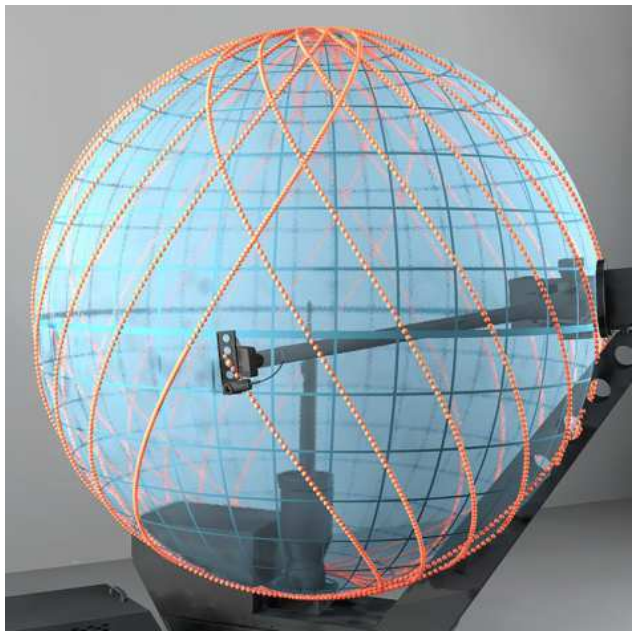
Domains of daylight modelling



Characterising transmission through fenestration



HSLU gonio-photometer



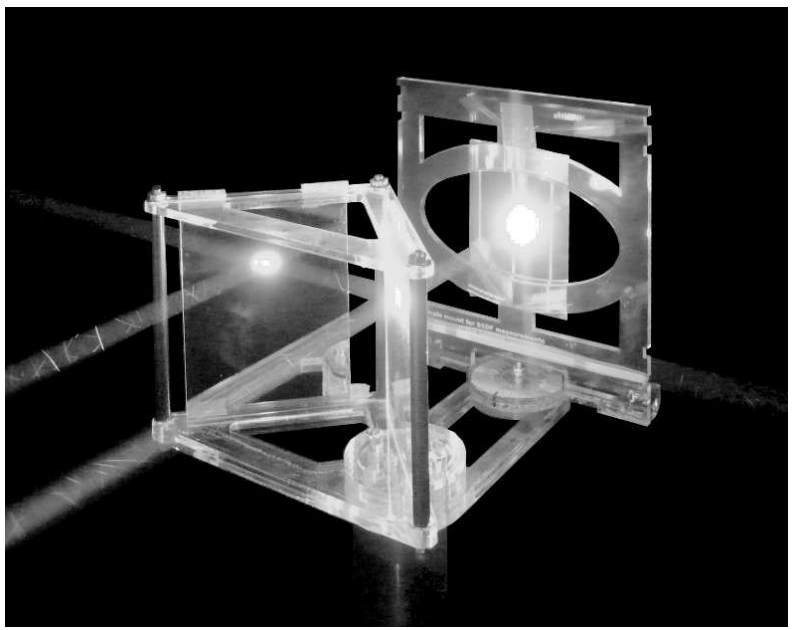
Scan path of detector

Image courtesy: P. Apian-Bennewitz, pab advanced technologies. A. Noback et al. “Accordance of light scattering from design and de-facto variants of a daylight redirecting component”. In: *Buildings* 6.3 (2016), L. O. Grobe. “Characterization and data-driven modeling of a retro-reflective coating in Radiance”. In: *Energy and Buildings* 162 (2018).

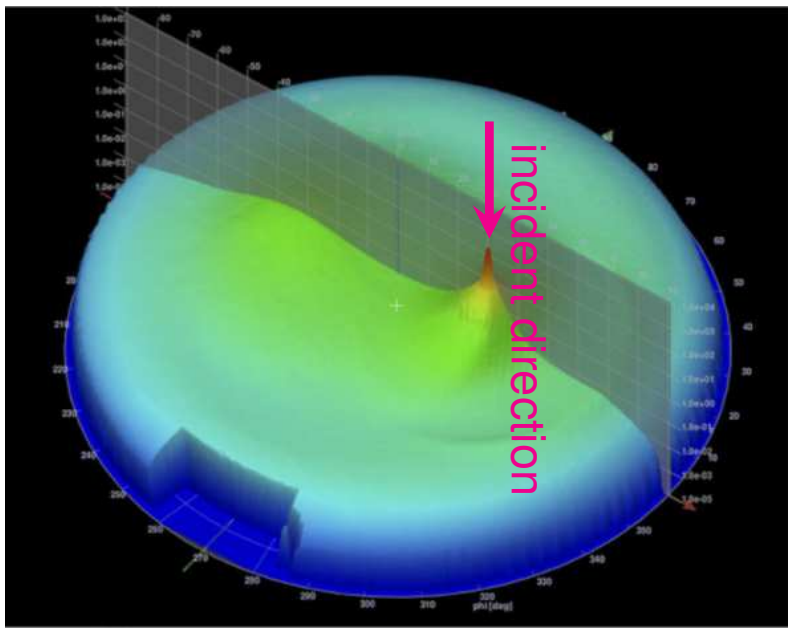
Characterising transmission through fenestration

- Supporting research, industry and planners
- Setup allows high degree of customisation to address specific requirements
- Extension for batch measurements supported by Swiss Federal Office for Energy (as part of the project *High Resolution Complex Fenestration Library BIMSOL*)
- Details: `www.hslu.ch/goniophotometer`

Irregular scattering: Measuring retro-reflection



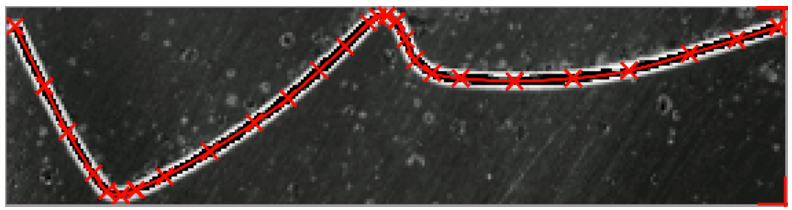
Retro-reflection setup

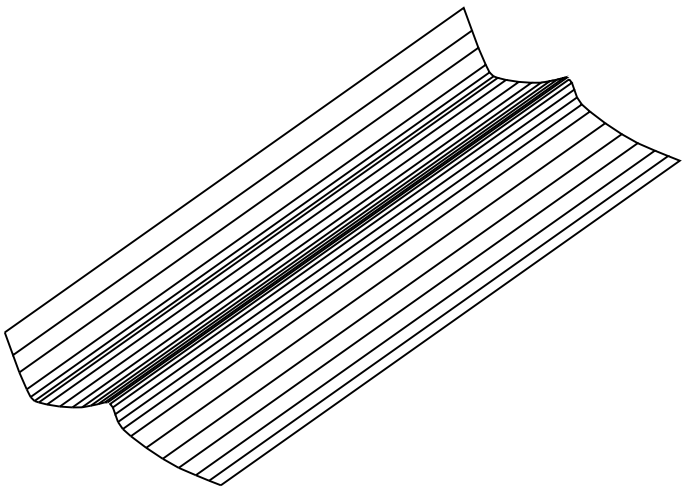


Distribution of reflected light

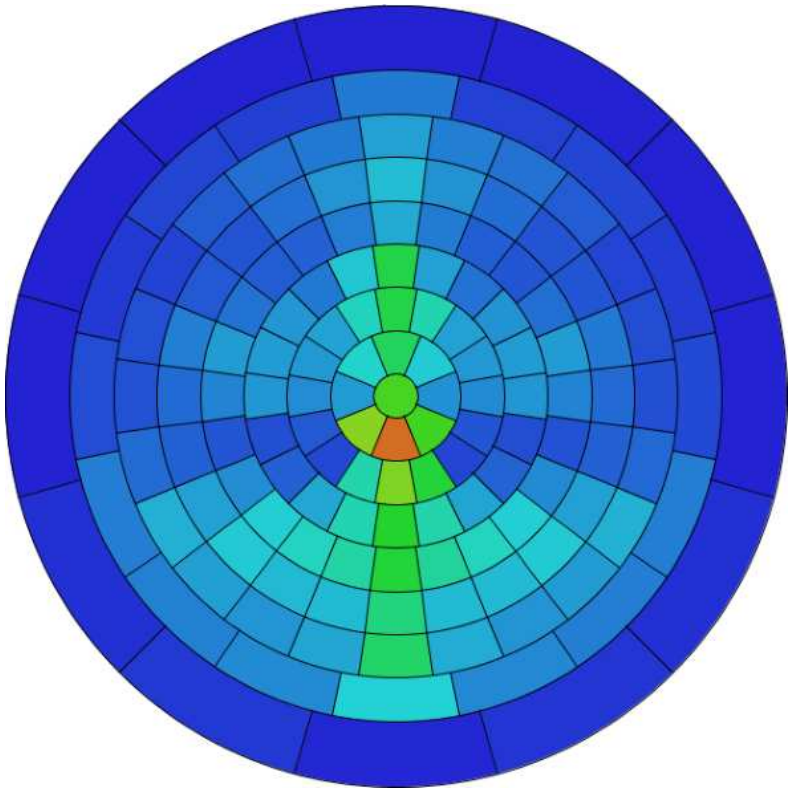
L. O. Grobe. “Characterization and data-driven modeling of a retro-reflective coating in Radiance”. In: *Energy and Buildings* 162 (2018)

Geometric or data-driven fenestration models





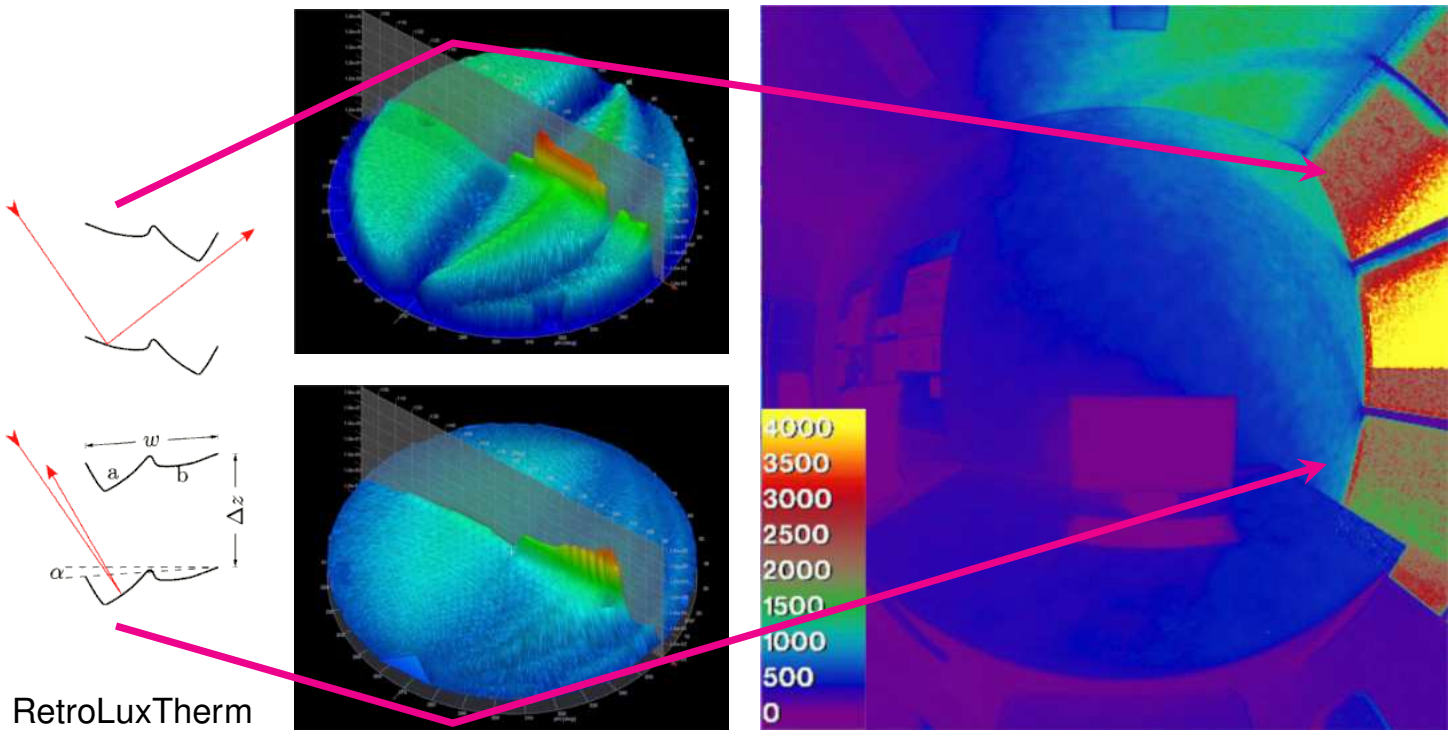
Internal composition



External effects

A. Noback et al. “Accordance of light scattering from design and de-facto variants of a daylight redirecting component”. In: *Buildings* 6.3 (2016)

High-resolution data-driven modelling



RetroLuxTherm
(patent Köster)

Measurement

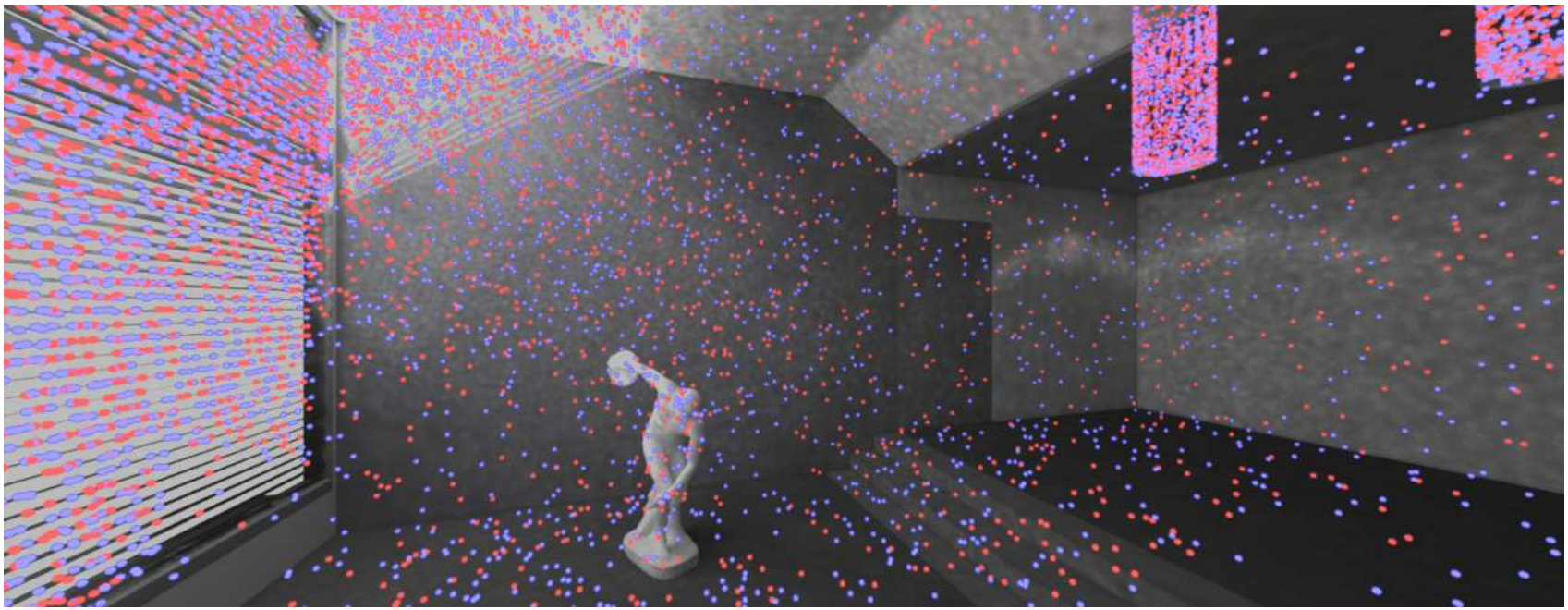
Simulation

L. O. Grobe. “Irregular light scattering properties of innovative fenestration for comfortable and energy-efficient buildings”. In: *International Journal of Digital Innovation in the Built Environment* 10 (2 2021)

Geometric and data-driven modelling

- Project *Modeling and simulation of daylight redirecting systems*
- Project $\Phi\Omega\Sigma$ *4D – Affordance-based evaluation of daylight in antique residential building* in collaboration with TU Darmstadt, Uni Leipzig
- Frequent collaborations with industry and planners to model reflection or transmission e. g. of fenestration, cladding, . . .

Modelling light propagation: Photon mapping

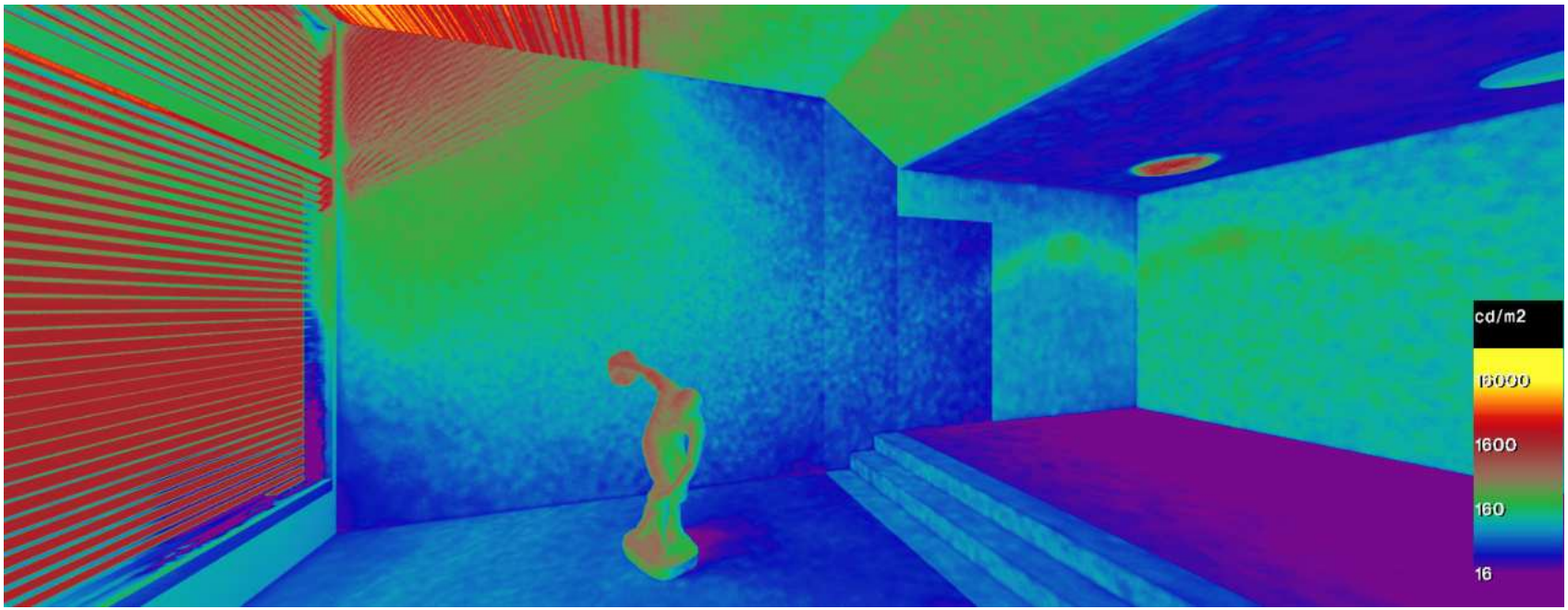


Result of forward photon distribution

Modelling light propagation: Photon mapping

Result of backward photon gathering and ray-tracing

Modelling light propagation: Photon mapping

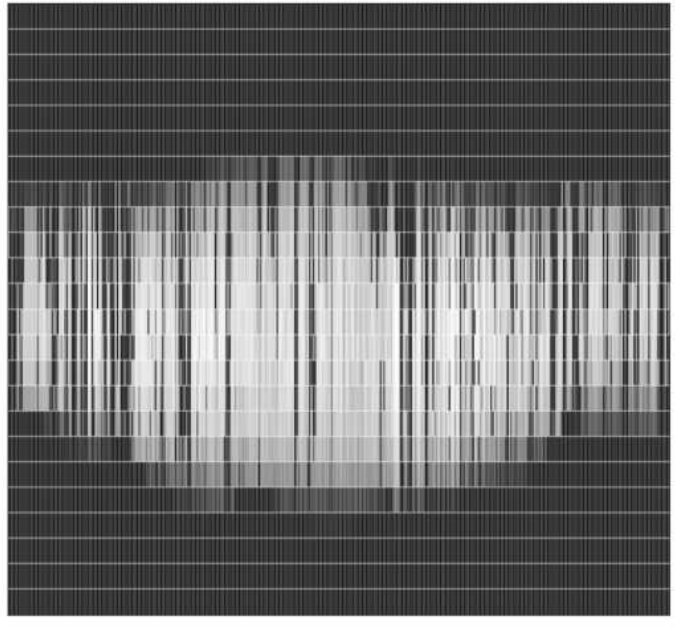


Quantitative evaluation of simulation results, e. g. in terms of luminance

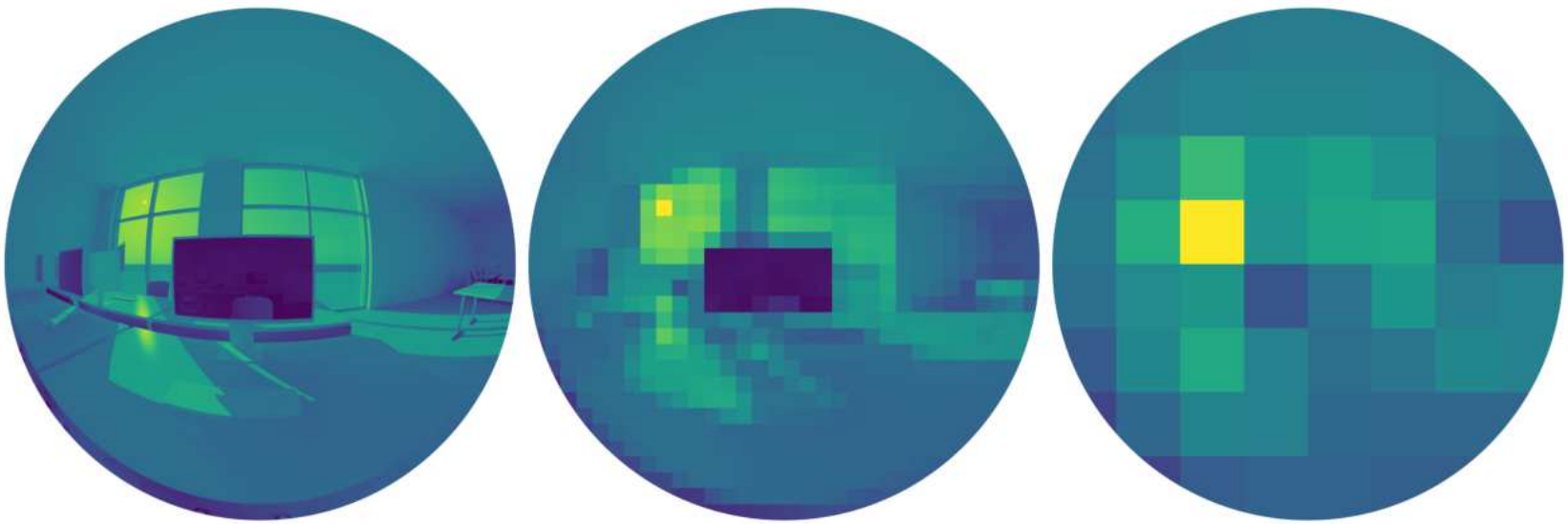
Modelling light propagation: Photon mapping

- Photon map extension for RADIANCE maintained at HSLU (by Roland Schregle as main author)
- Current focus on applications in climate-based daylight modelling
- Project *Three-Dimensional Light Flow in Architectural Spaces and its Visual Interpretation* in collaboration with Tokyo University of Sciences

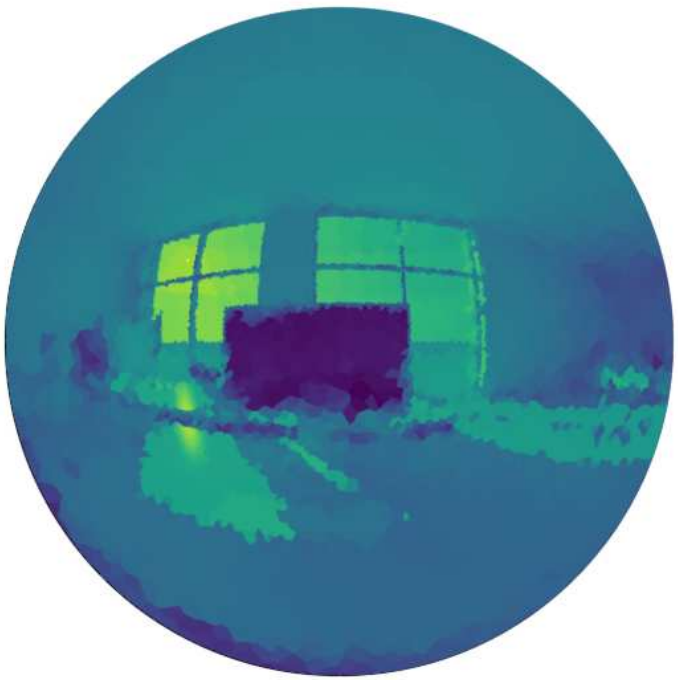
The Dimensions of Climate-Based Daylight Modelling

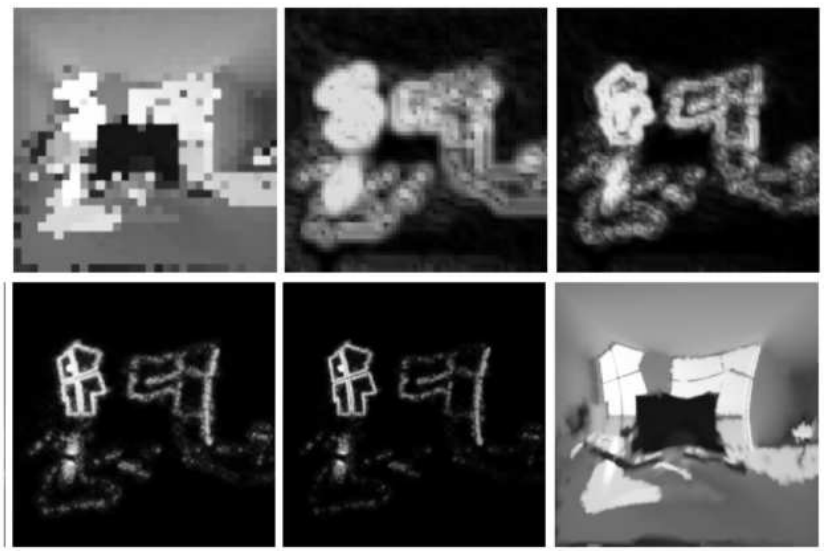


Sampling Density

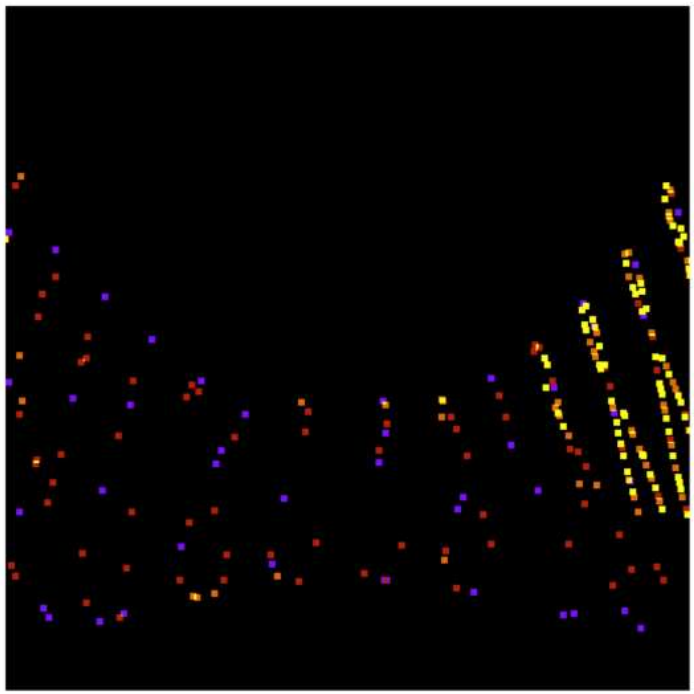


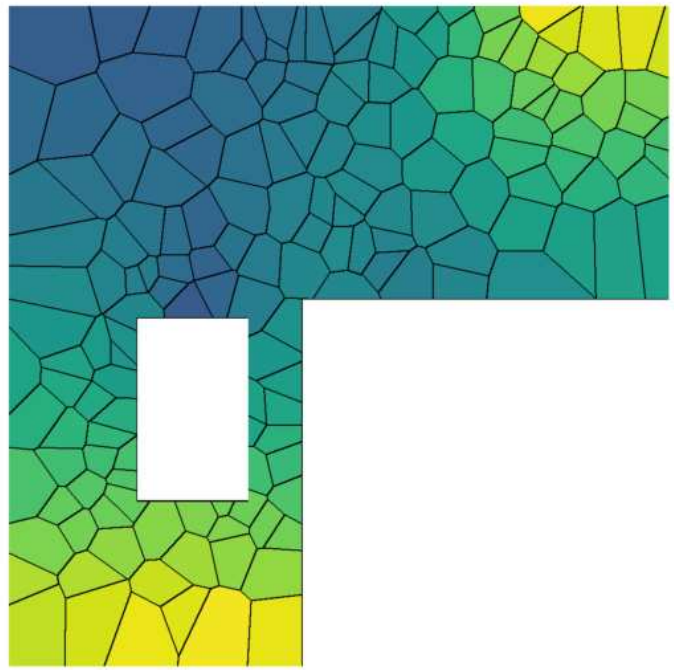
Raytraverse



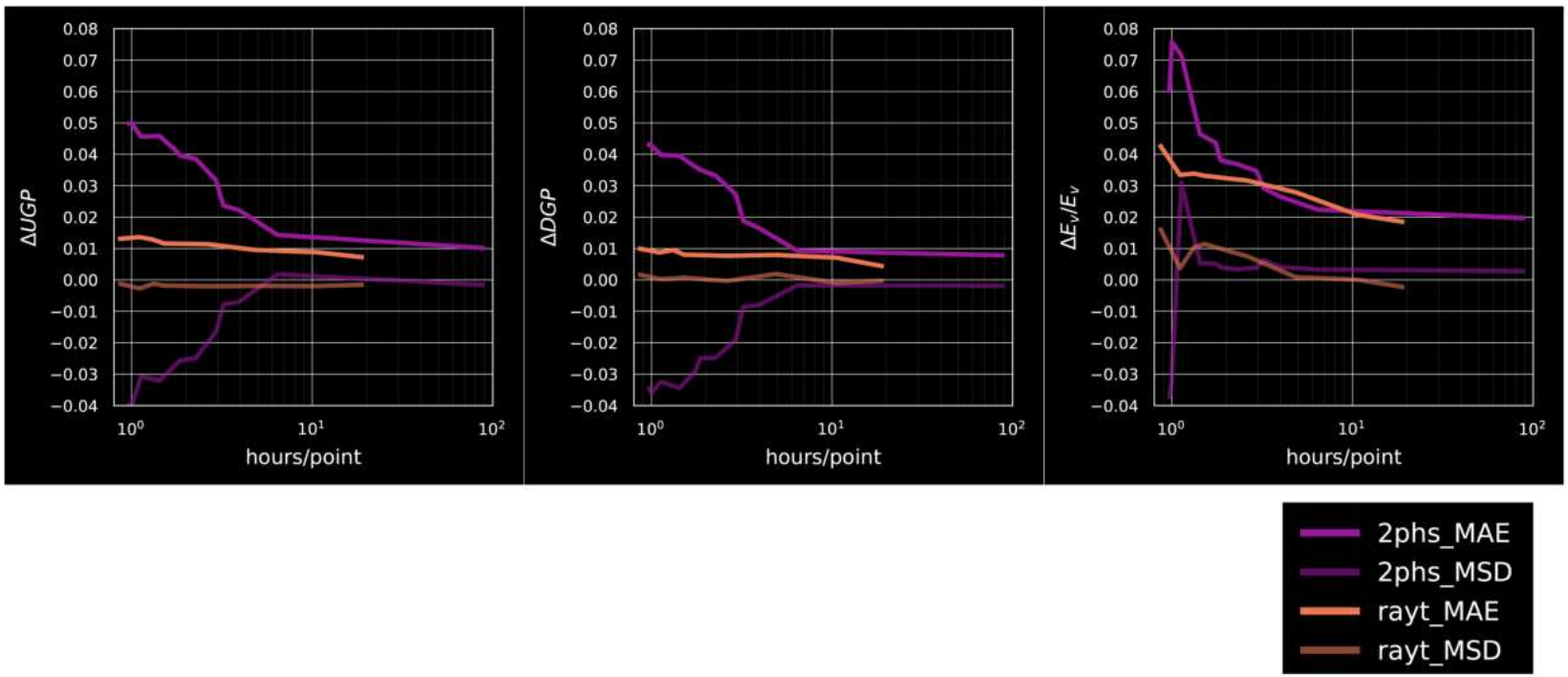


Raytraverse

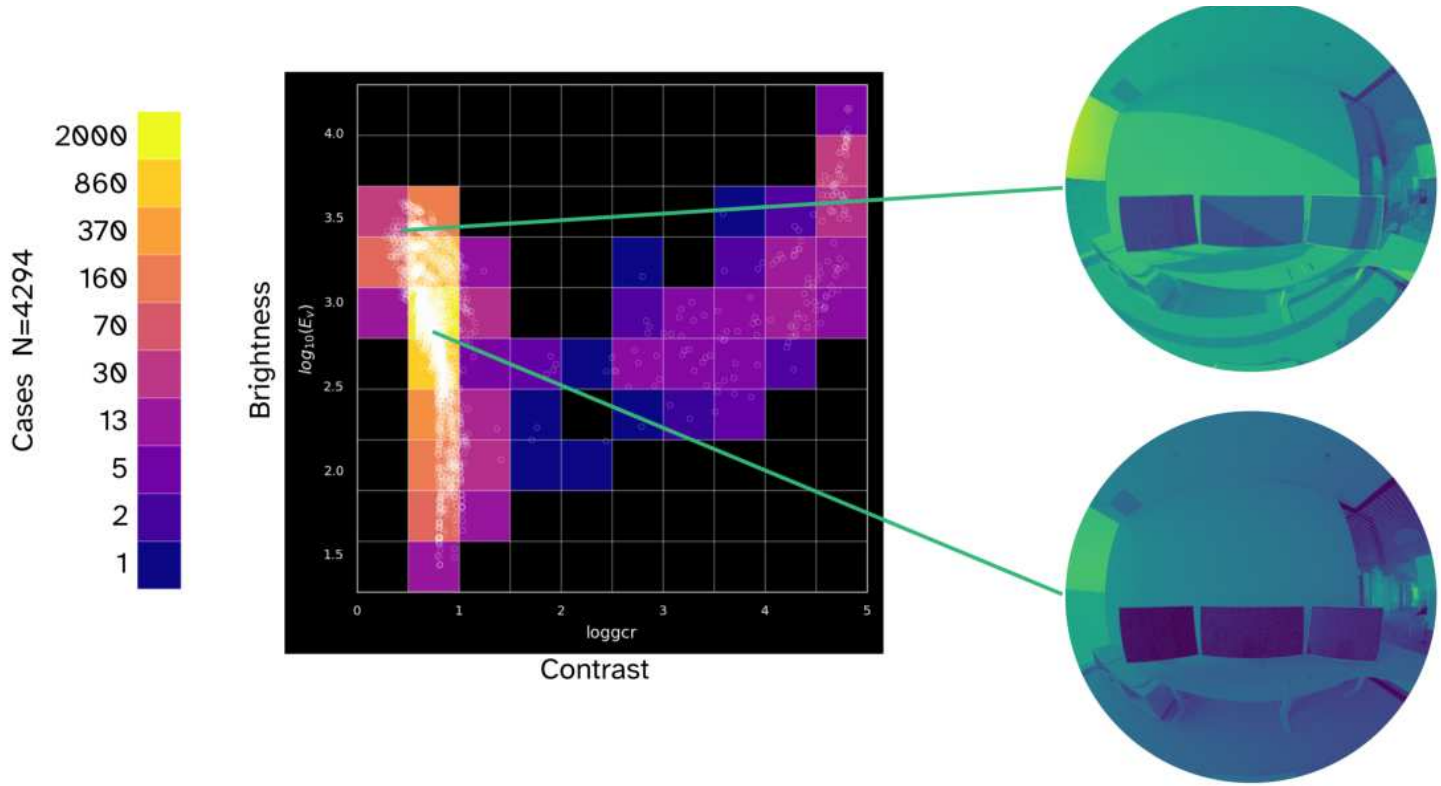




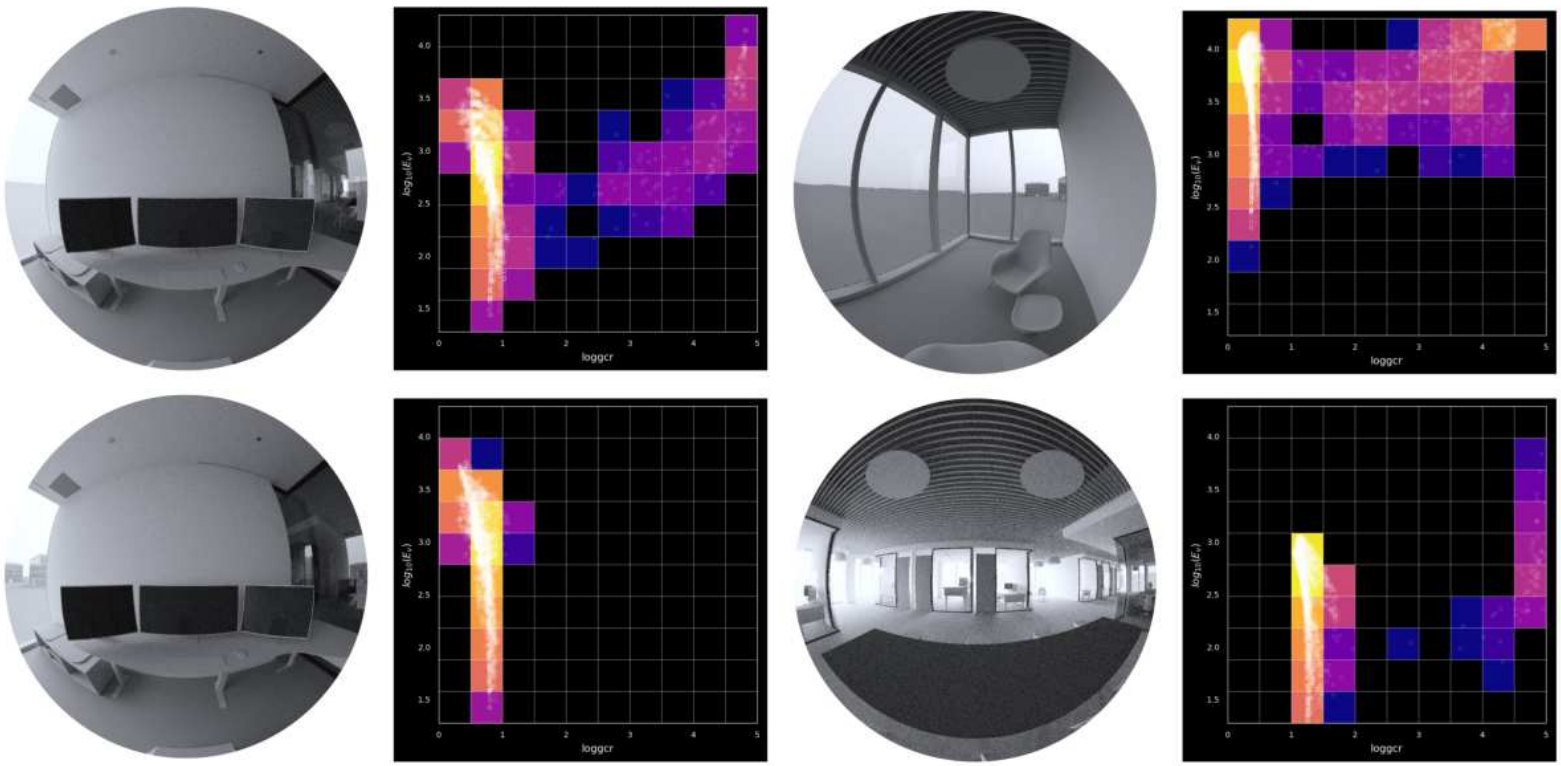
Simulation time vs. Accuracy



Annual distribution for a single view



Understanding the shape of daylight



Research in zonal glare assessment and spatio-temporal light simulation

- Supported by the Swiss National Science Foundation (SNSF #179067) Light fields in climate-based daylight modeling for spatio-temporal glare assessment
- Core of ongoing Ph.D. research by Stephen Wasilewski
- Collaboration with EPFL Laboratory of Integrated Performance in Design (LIPID)
- Results, publications etc.: `https://p3.snf.ch/project-179067`