TECHNISCHE UNIVERSITÄT DARMSTADT

Lucerne University of Applied Sciences and Arts

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Engineering & Architecture

A model chain to simulate daylight in historic built environments

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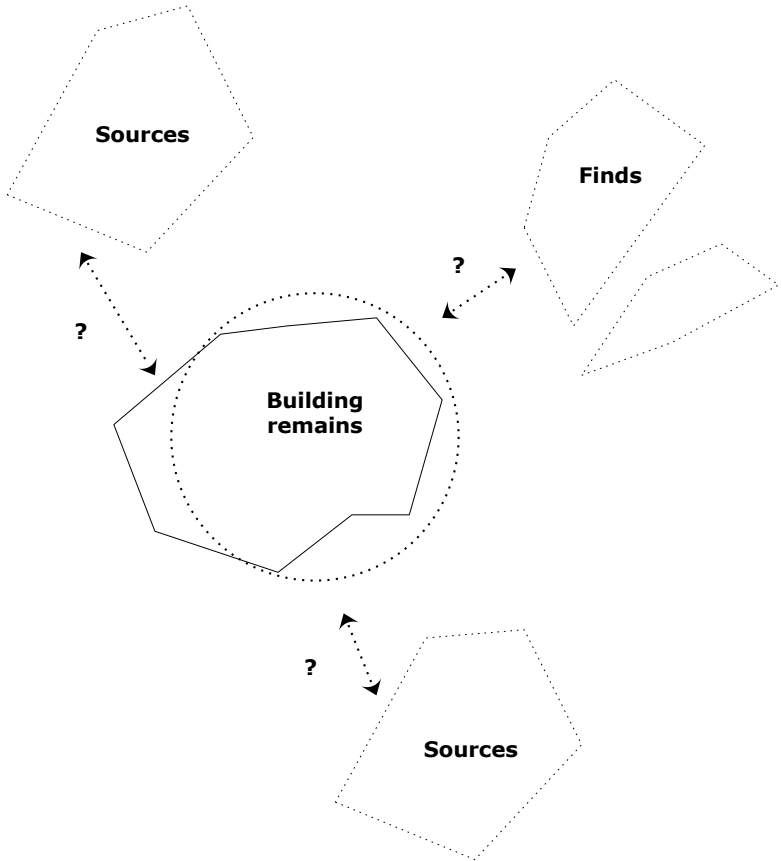
New technologies, new theories? Reflections on the perception and simulation of building environments and architecture.

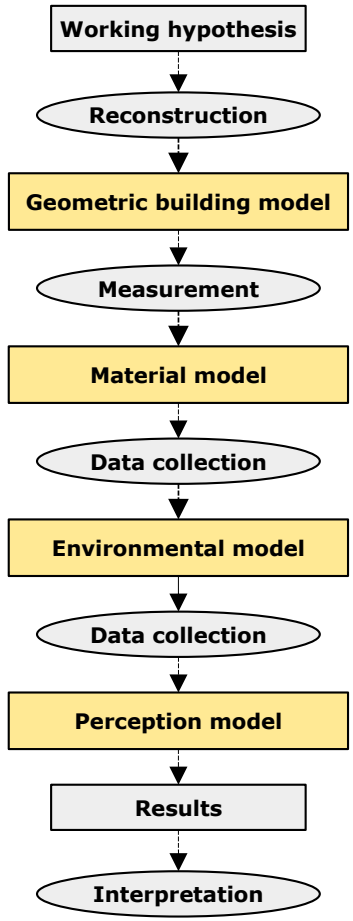
Widening Horizons: 27 Annual Meeting of the European Association of Archaeologists – Kiel, Germany

Bundesministerium für Bildung und Forschung

Incomplete evidence and lost context



Chain of modelling tasks in daylight simulation



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Architectural reconstruction: Hagia Sophia

Occlusion of windows

Andreas Noback et al. “Hagia Sophia’s sixth century daylighing”. In: *Proceedings of the International Hagia Sophia Symposium*. Ed. by Hasan Fırat Diker et al. 2020, pp. 687–706

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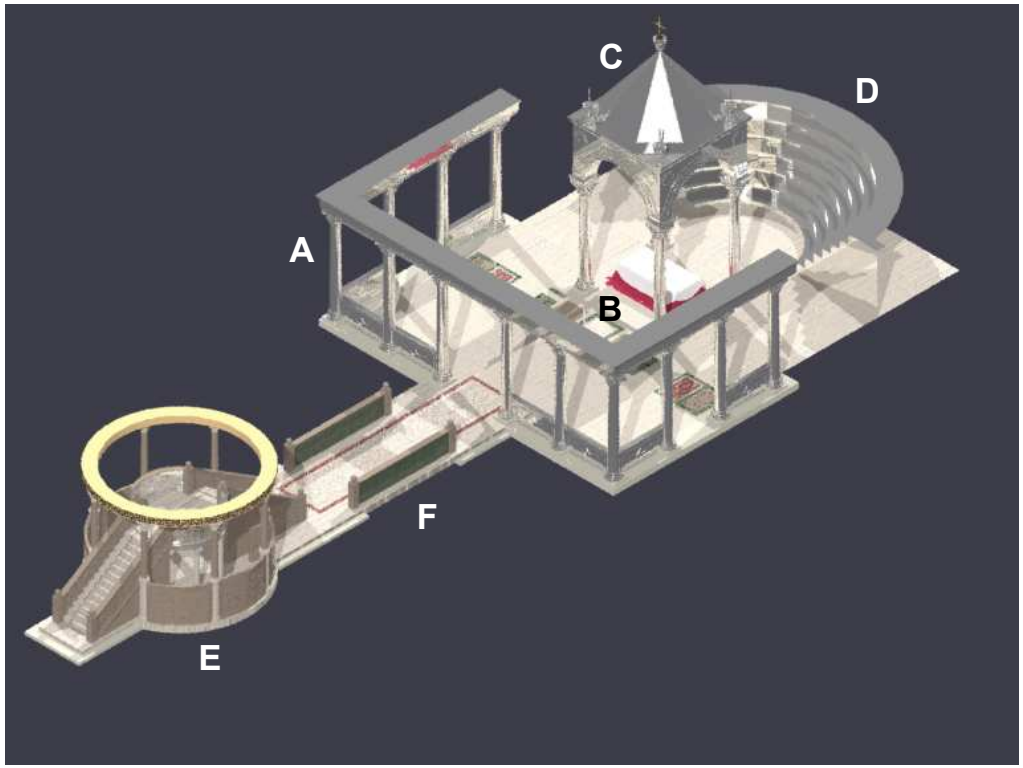
Architectural reconstruction: Hagia Sophia

Liturgical furnishing based on text, similar designs and practical considerations



Reconstruction by H. Svenshon, see: Rudolf H. W. Stichel. “Die Hagia Sophia Justinians, ihre liturgische Einrichtung und der zeremonielle Auftritt der frühbyzantinischen Kaisers”. In: *Byzanz - Das Römerreich im Mittelalter*. Ed. by Falko Daim et al. Vol. 2,1 Schauplätze. 2010, pp. 25–57

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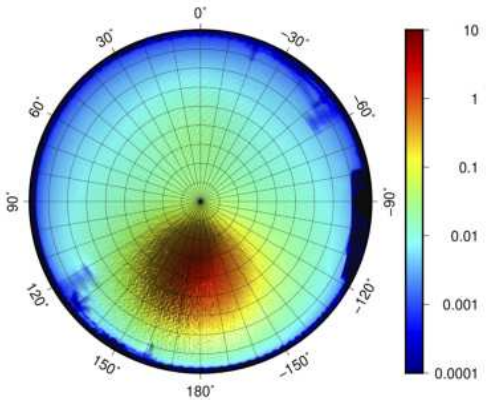
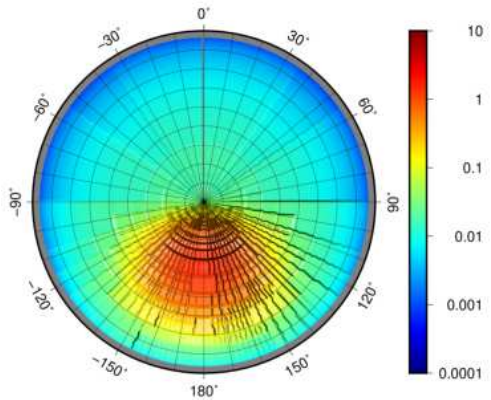
Material properties: Modelling scattering by glass

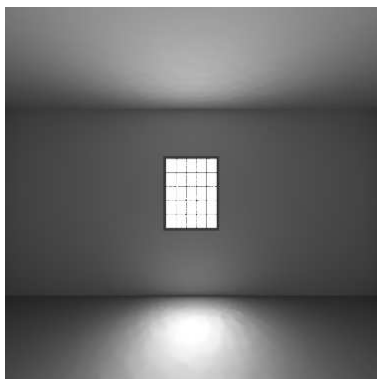
Direct measurement of light scattering

Gonio-photometric measurement:



Data-driven modelling:





Lars O. Grobe et al. “Daylight scattering by late antique window glass from Ephesus – Reconstructing the distribution of daylight in lost architecture”. In: *Proceedings CHNT24*. 2021, pp. 317–334

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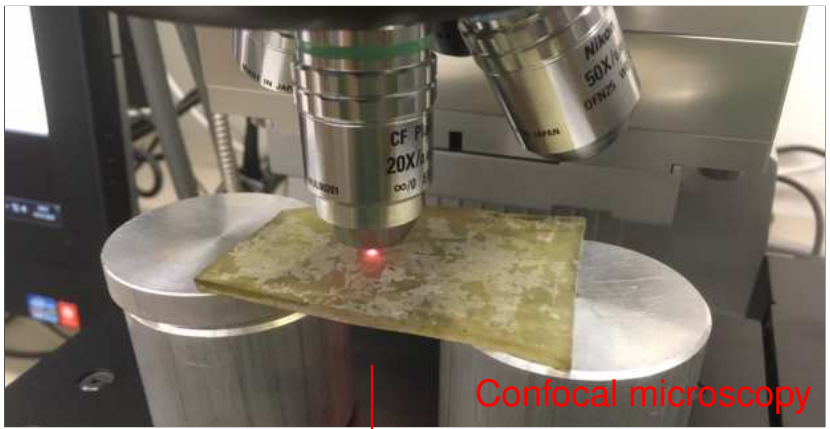
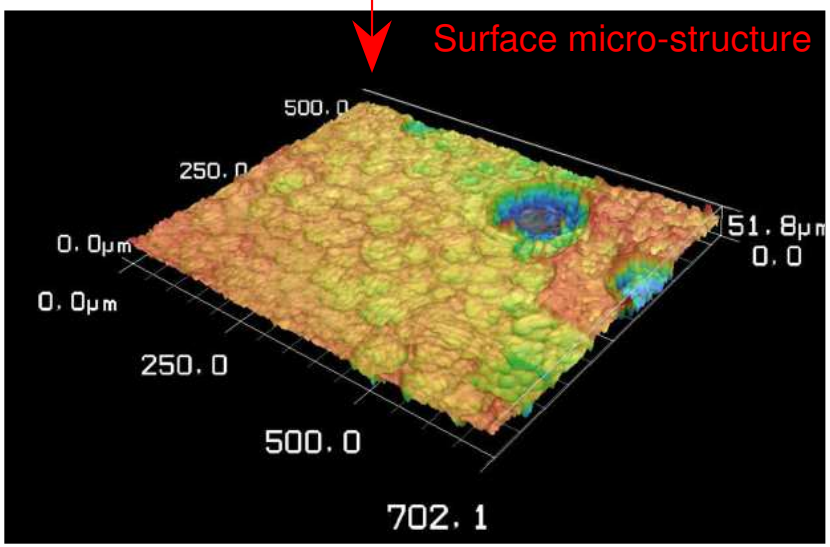
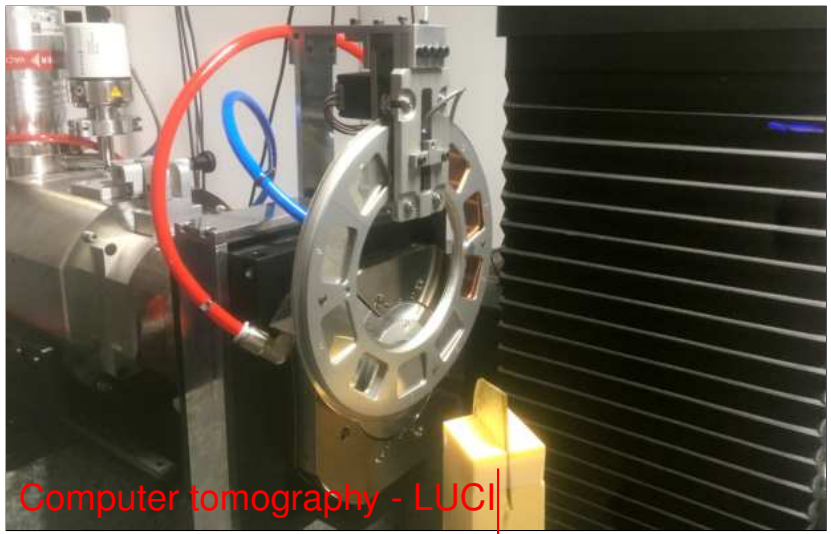
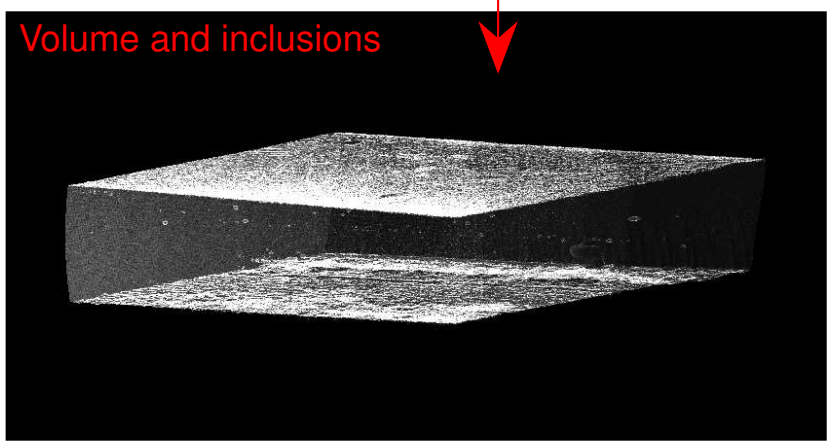
Material properties: Geometry of window glass

Surface and volume









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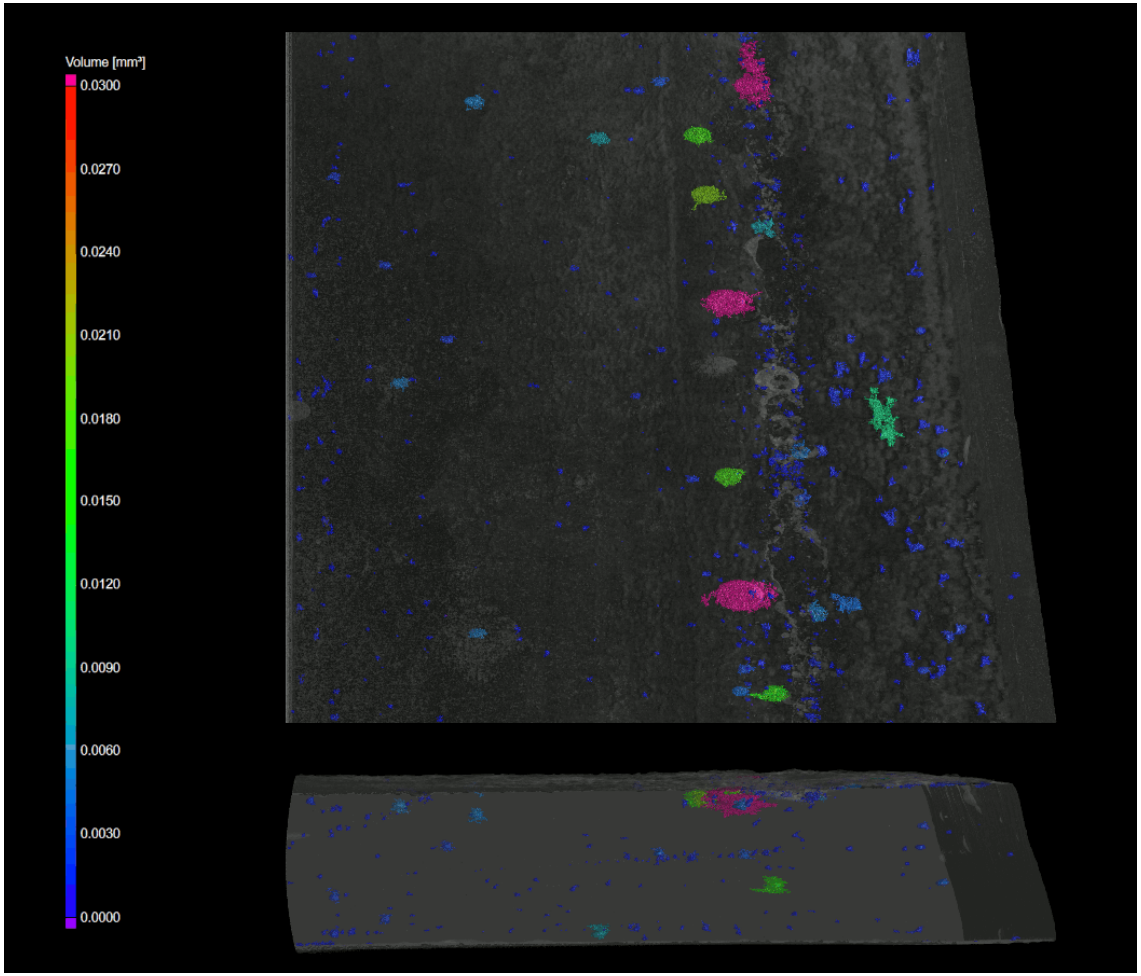
Material properties: Inclusions in window glass

Results of computer tomography



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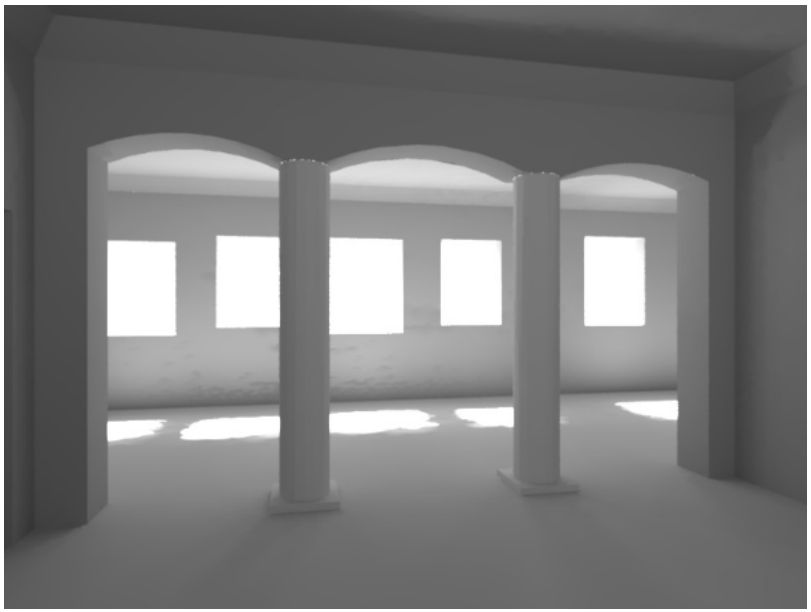
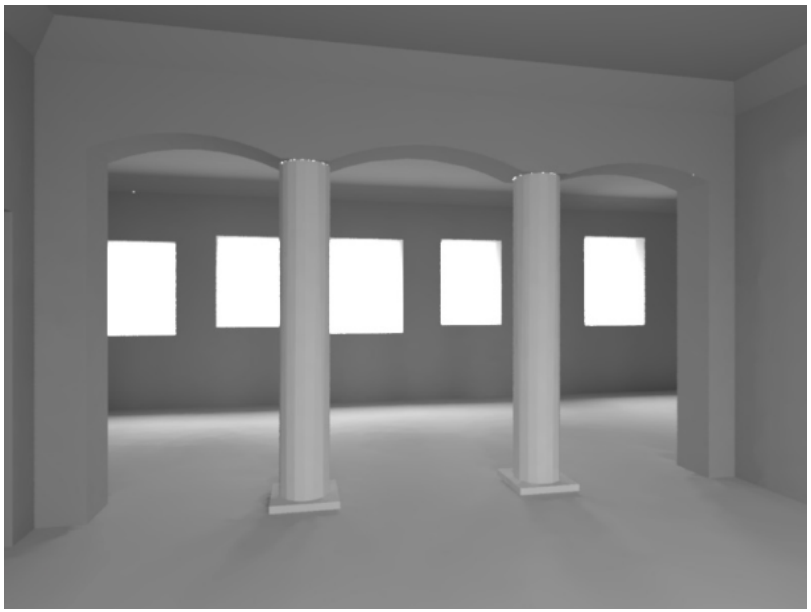
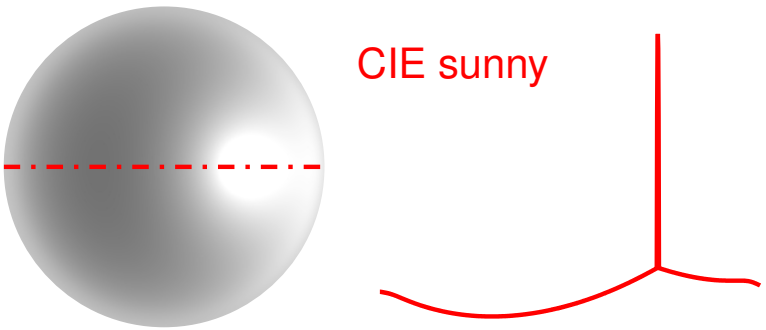
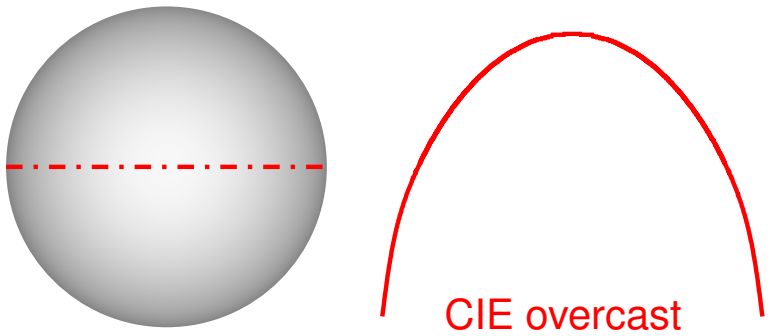
Environment: Ideal CIE sky models

Edge cases - applied to a residential building in Ostia



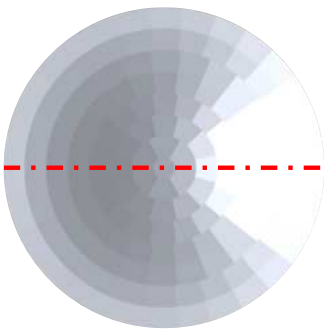






Environment: Climate-, image-based sky models

Representativity and realism



Perez, Tregenza

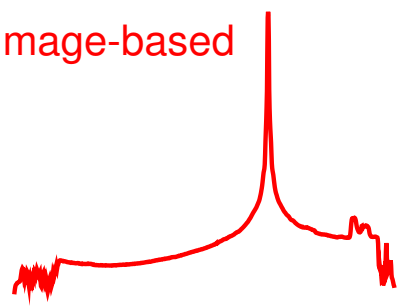


Image-based

Right: HDR acquisition from Axel Jacobs et al. *Per-pixel sky luminance with HDR photography*. International Radiance Workshop. 2008. HDR image from Mehlika Inanici. “Evaluation of high dynamic range image-based sky models in lighting simulation”. In: *Leukos* 7 (2 2010), pp. 69–84.

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Visual perception: Arrephorion, Athens

Reconstructed outward view, sunny sky, 21st Dec noon

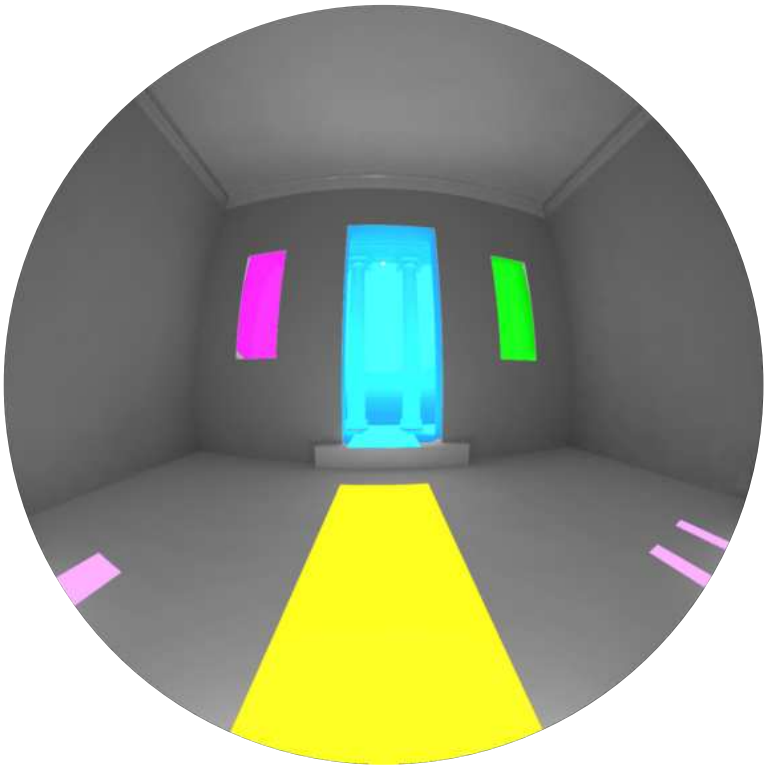

Image regions with $L \geq 2000\,\mathrm{cd\,m^{-2}}$.

Halo-like effects by scattering in the eye.

Reconstruction based on: Helge Olaf Svenshon. “Studien zum hexastylen Prostylos archaischer und klassischer Zeit”. PhD thesis. TU Darmstadt, 2002

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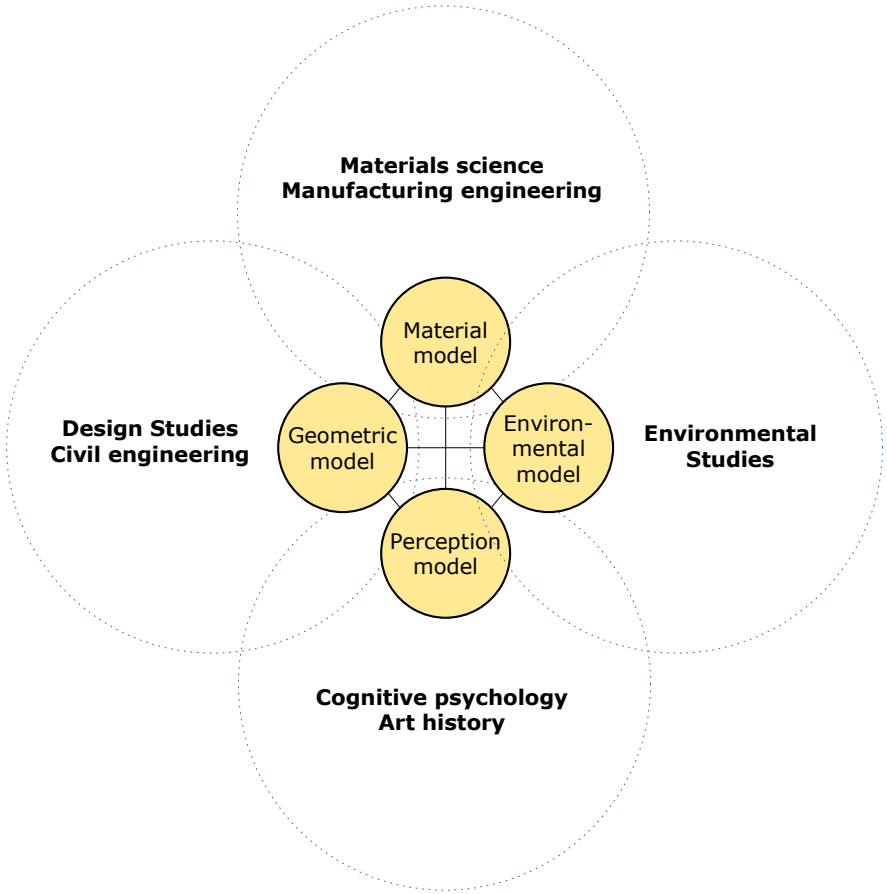
Visual perception

Effects of contrast on colour perception and haze,
Sunrise at Christmas morning

Andreas Noback et al. “Hagia Sophia’s sixth century daylighing”. In: *Proceedings of the International Hagia Sophia Symposium*. Ed. by Hasan Fırat Diker et al. 2020, pp. 687–706

Conclusions and outlook

Models as interfaces of associated research fields



Ongoing and further research

- φῶς 4D Affordance-based evaluation of daylight in antique residential buildings.
  Supported by the German Federal Ministry of Education and Research (2021-2024).
  TU Darmstadt / Uni Leipzig / HSLU Lucerne
- Measuring and modeling light scattering by Roman window glass
  Supported by the Fritz Thyssen Stiftung (2018). TU Darmstadt / HSLU Lucerne
- LUCI Lucerne Computed tomography imaging.
  HSLU Lucerne
- Gonio-photometry Lab Light scattering measurements.
  HSLU Lucerne
- New light from Pompeii Early imperial lighting devices in bronze from the Vesuvian cities (2021-2023).
  Supported by Deutsche Forschungsgemeinschaft. LMU Munich