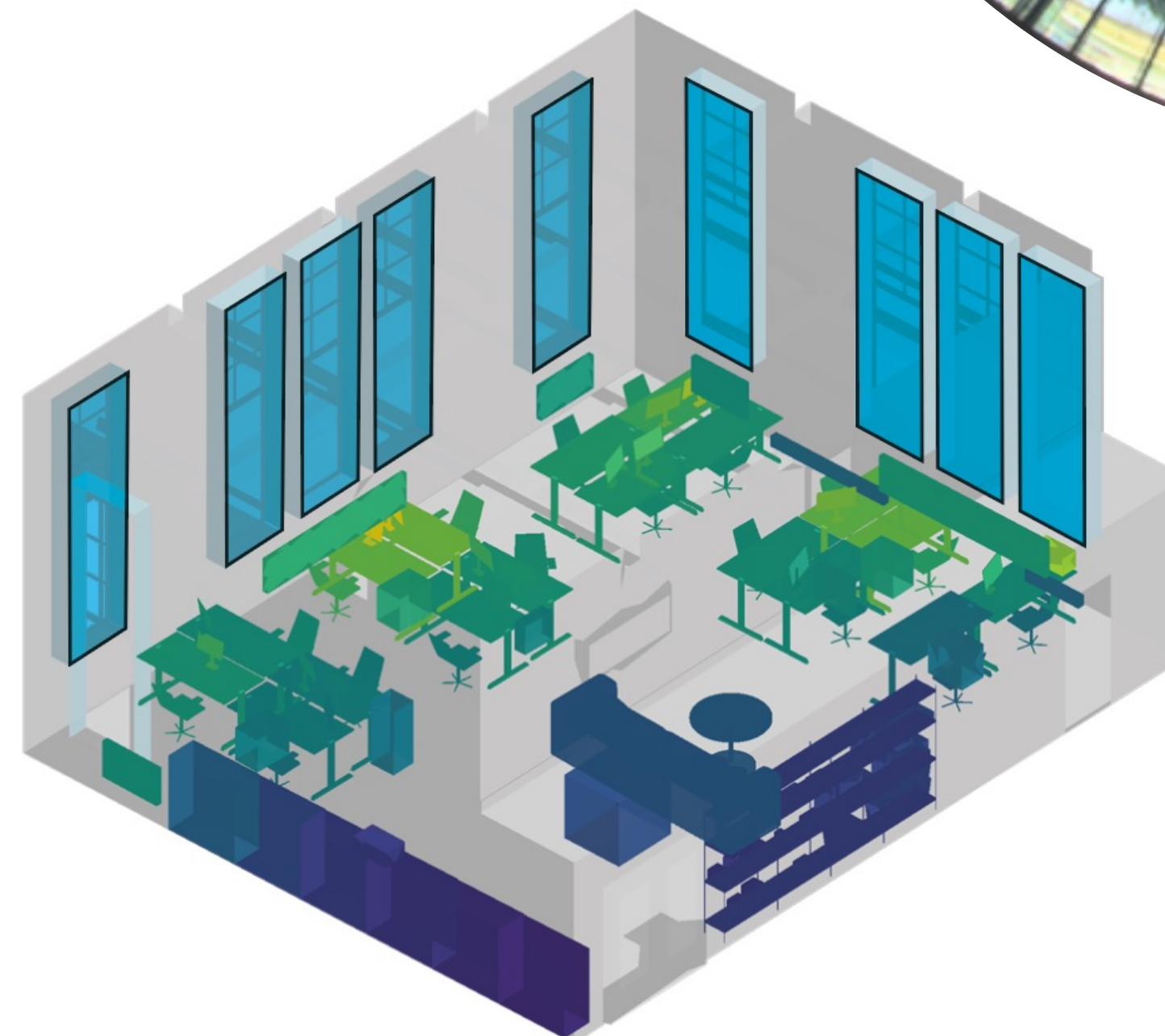
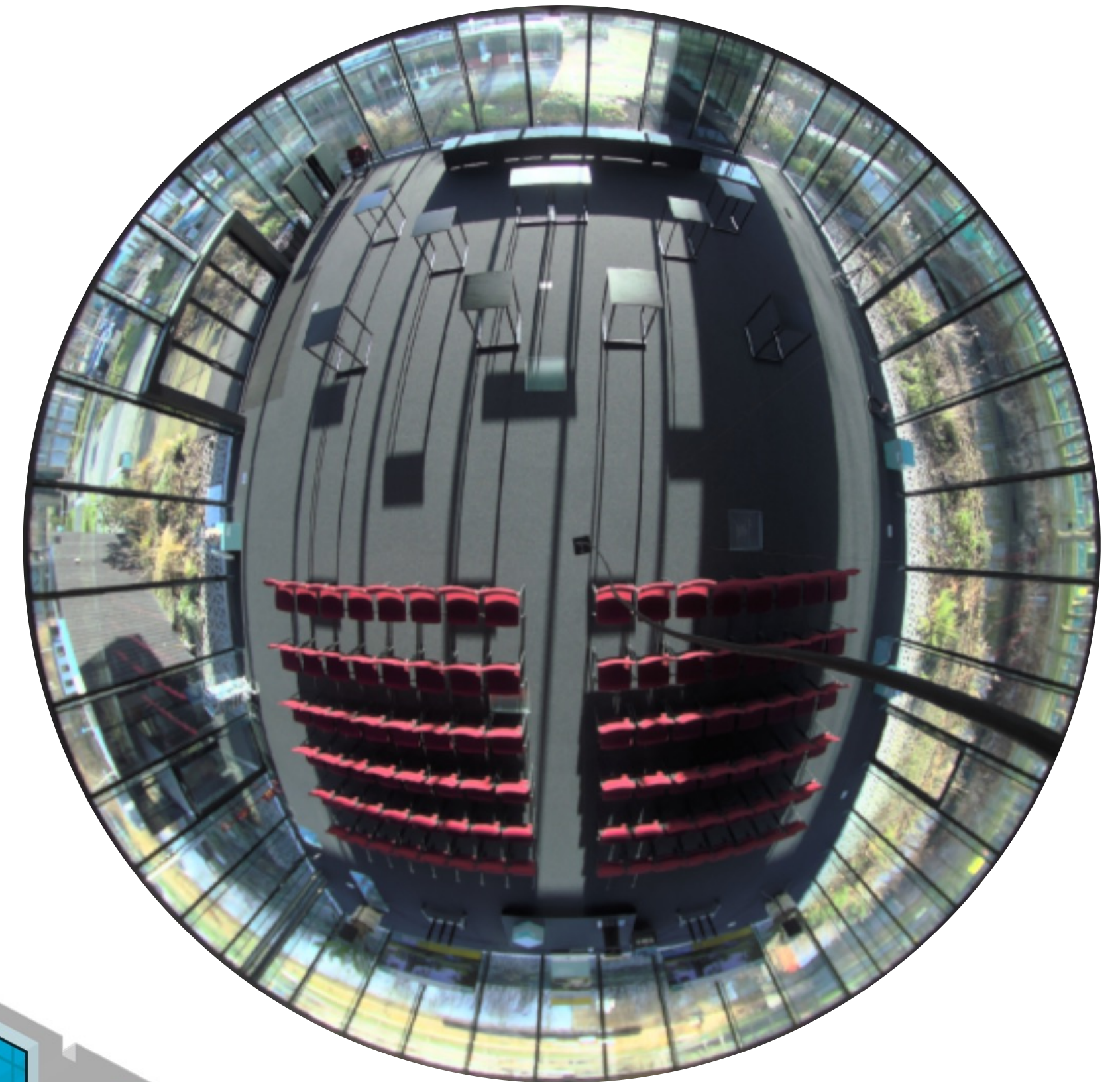


28 August 2025
International Radiance Workshop, EPFL

The Devil is in the Details: Challenges and Solutions for Monitoring Daylight in Existing Buildings

Eleonora Brembilla & Nima Forouzandeh

Department of Architectural Engineering
and Technology | ABE | TU Delft



Converge + Acapulco projects

RVO TKI Urban Energy + RVO MMIP

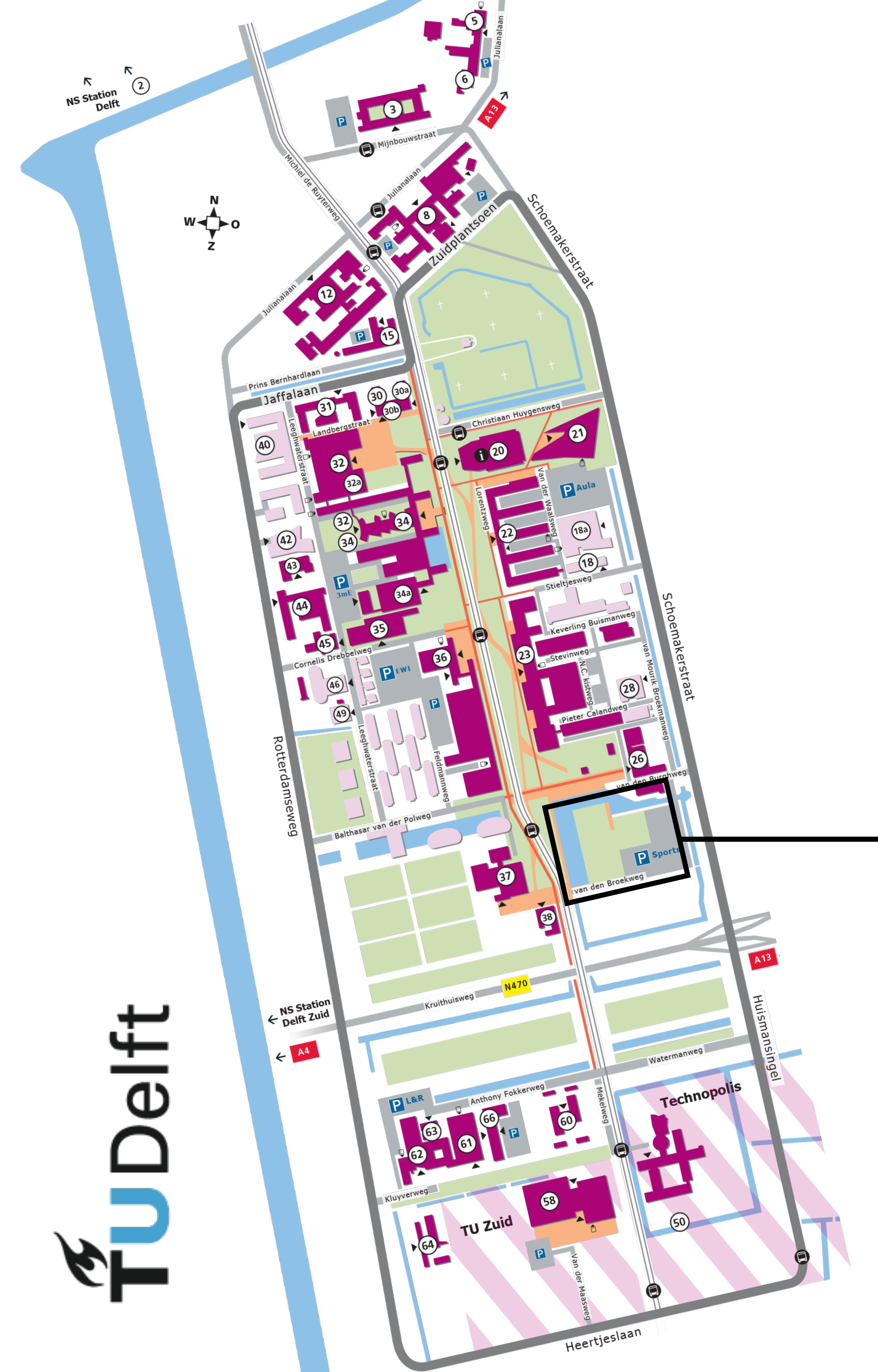
THE
GREEN
VILLAGE

PRIVA

ORANGE CLIMATE



TU Delft





nono house





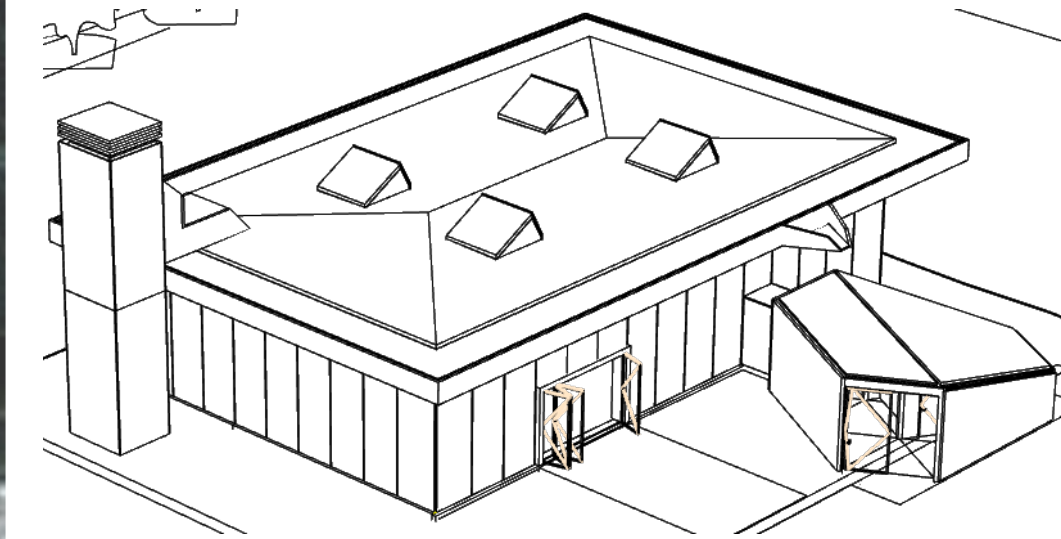




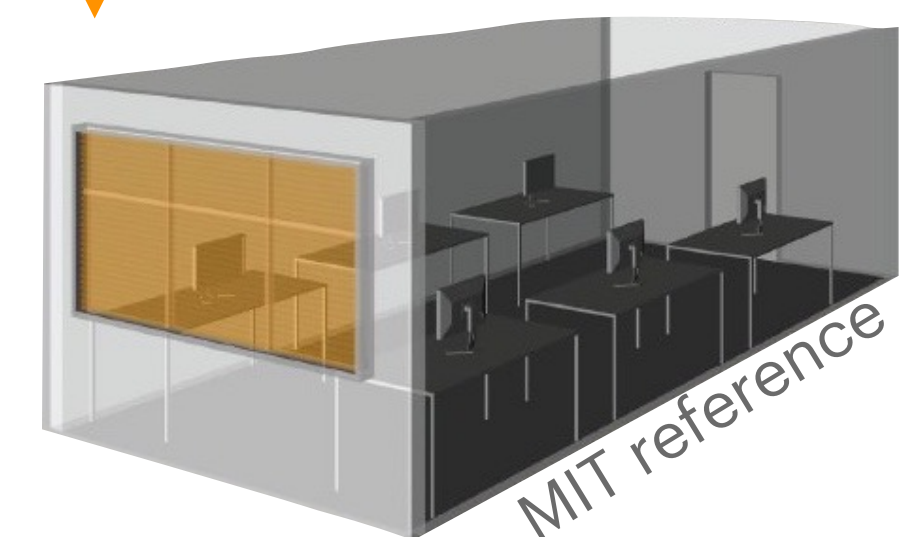


People are looking directly at the
outside environment
Light has no surfaces to re-diffuse
onto (all either black or transparent)

Extreme transparency



Highly
glazed
buildings

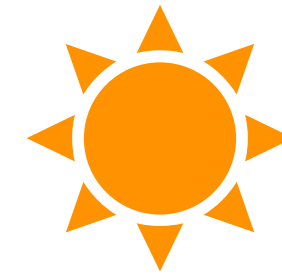


Extreme opaqueness



Building is occupied
(Comfort is prioritised)

Event in calendar
and duration



Blinds go in position
(up/down) for the entire
event if modelled IRR > X

Slat angle set to cut off angle

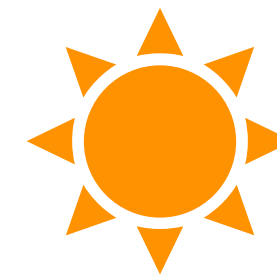


Manual or time-dependent
control



Building is occupied
(Comfort is prioritised)

Event in calendar
and duration



Blinds go in position
(up/down) for the entire
event if modelled IRR > X

Slat angle set to cut off angle



Manual or time-dependent
control

Higher comfort
Lower energy

Optimised slat angles for
given performance

Daylight-linked control

Presentation : $E_{wp} > 300 \text{ lx}$
Meeting : $E_{wp} > 500 \text{ lx}$
Workshop : $E_{wp} > 750 \text{ lx}$

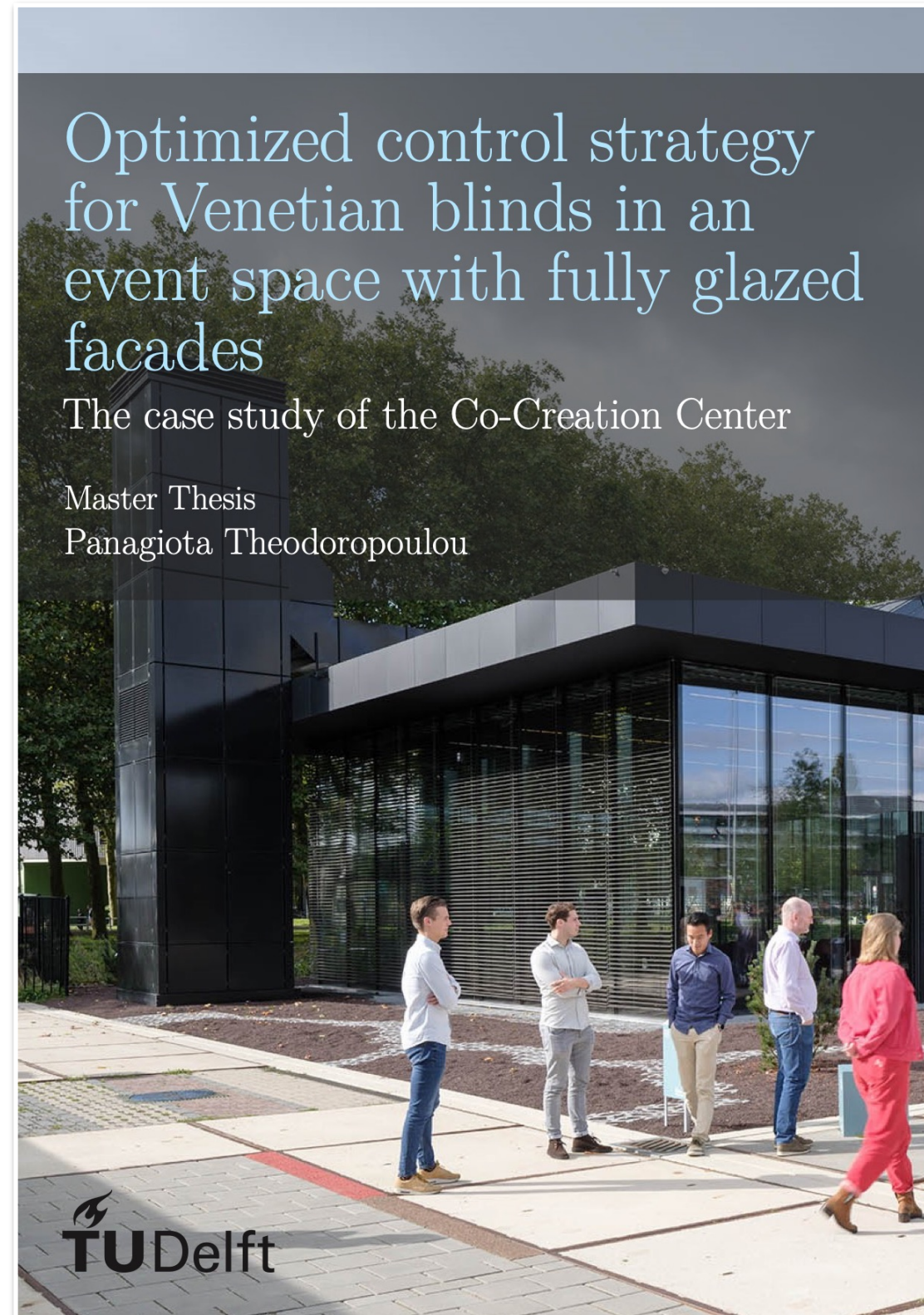
Optimised strategy:

- Higher comfort (DGP+view)
- Slightly higher energy for electric lighting
- Lower solar radiation ingress

Practical findings:

- Real-time control possible only with 3PH or pre-computed/training dataset
- Cylindrical illuminance promising as control target for open spaces

Higher comfort
Lower energy



Penny Theodoropoulou's thesis

With thanks to:
Roel Schipper
Christian Louter
Wouter Beck
Taoning Wang

Optimised slat angles for
given performance

Daylight-linked control

Presentation : $E_{wp} > 300 \text{ lx}$
Meeting : $E_{wp} > 500 \text{ lx}$
Workshop : $E_{wp} > 750 \text{ lx}$

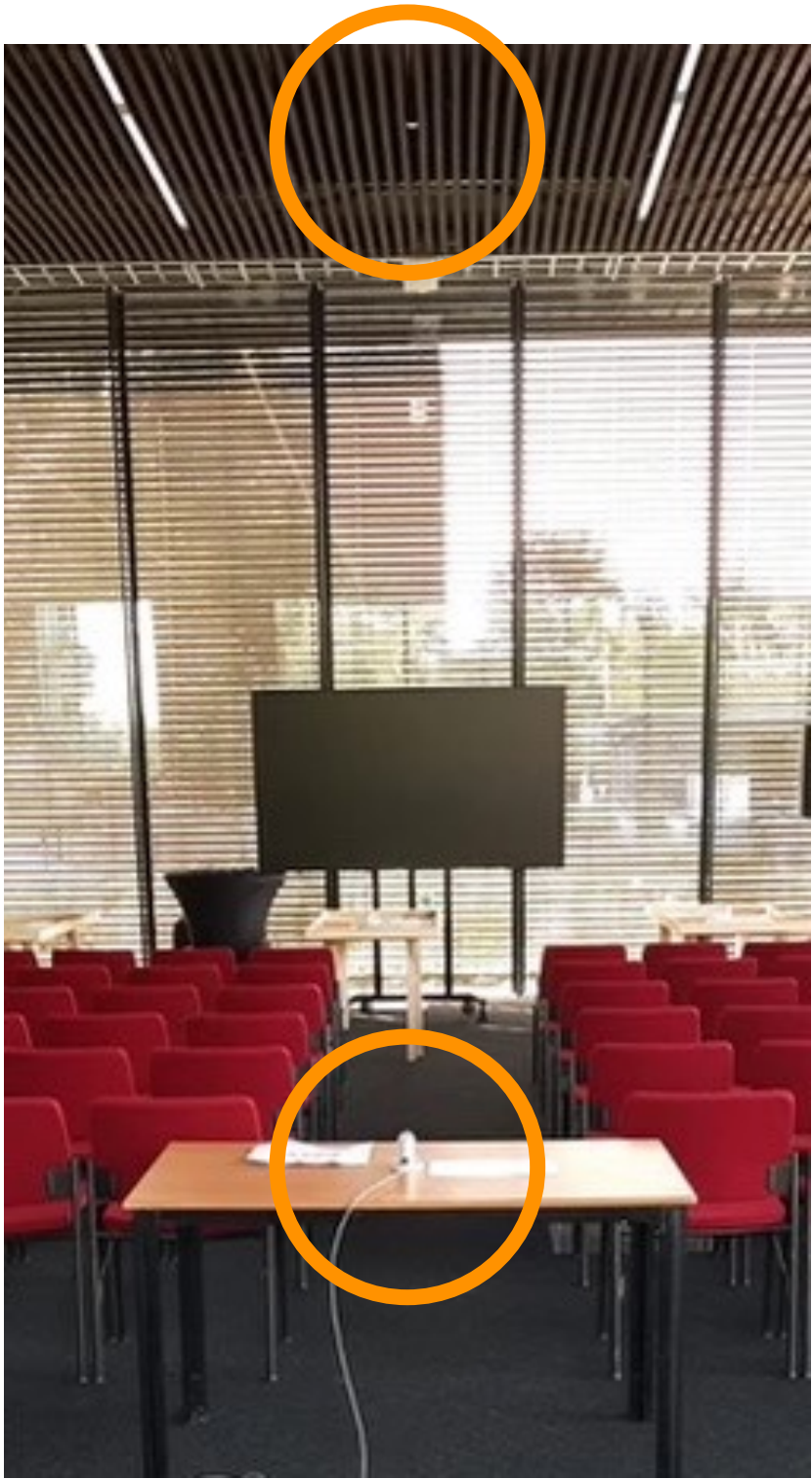
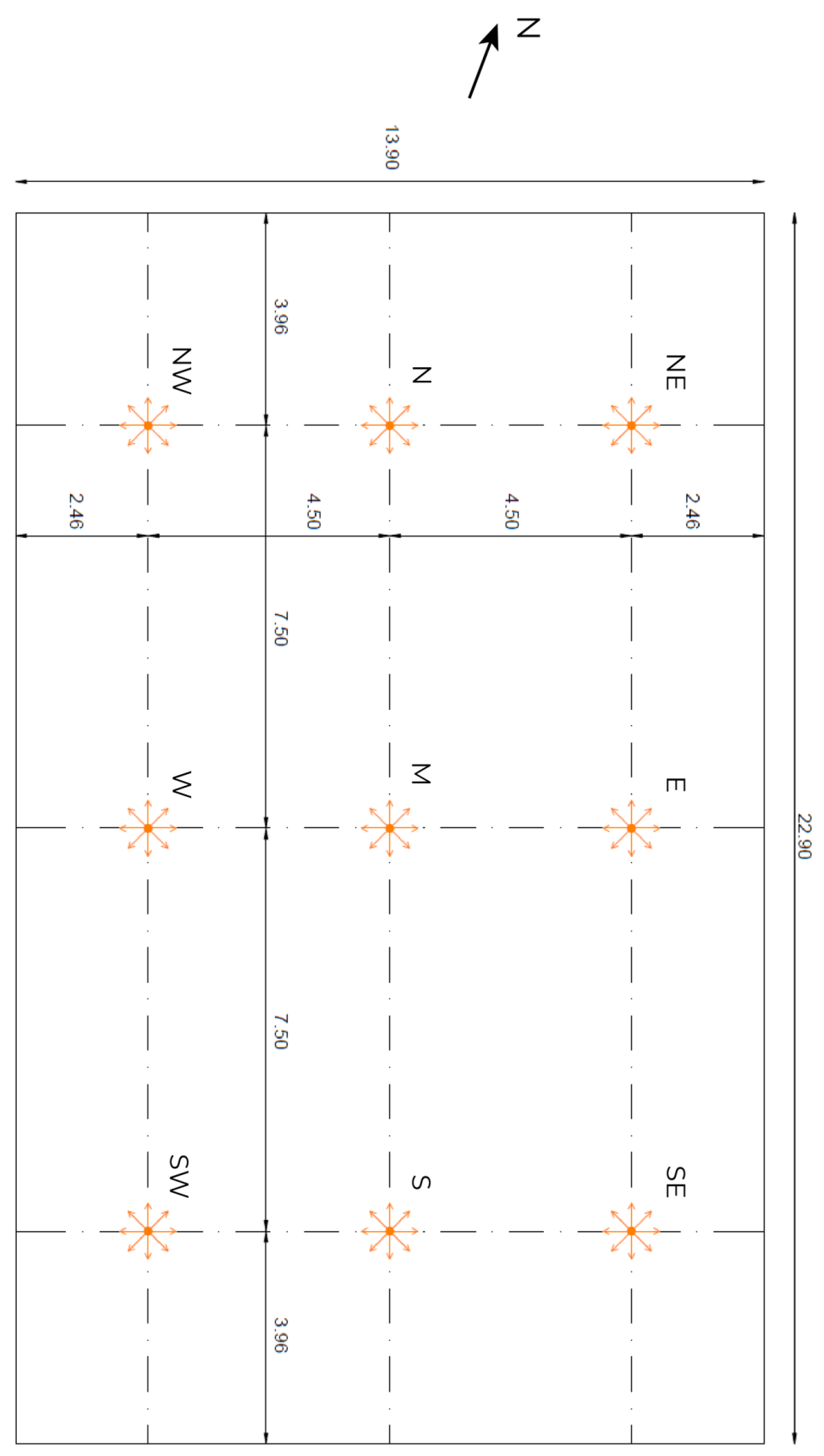
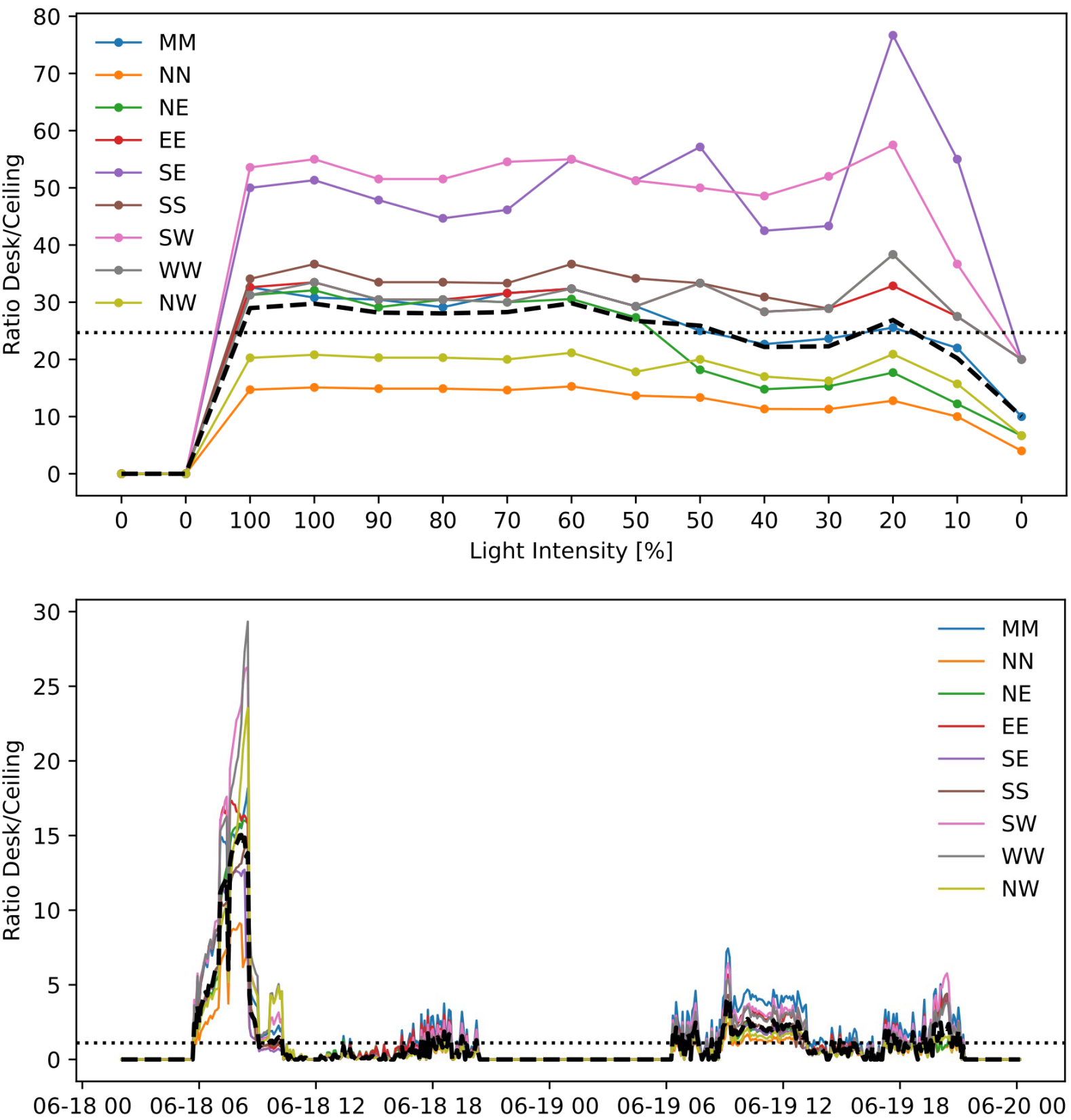
Ratio desk/ceiling
illuminance

Night-time:

- Fairly constant across space and dimming levels (till ~20%)

Day-time:

- Non-linear relationship throughout the day
- Non-linear effect of blinds deployment

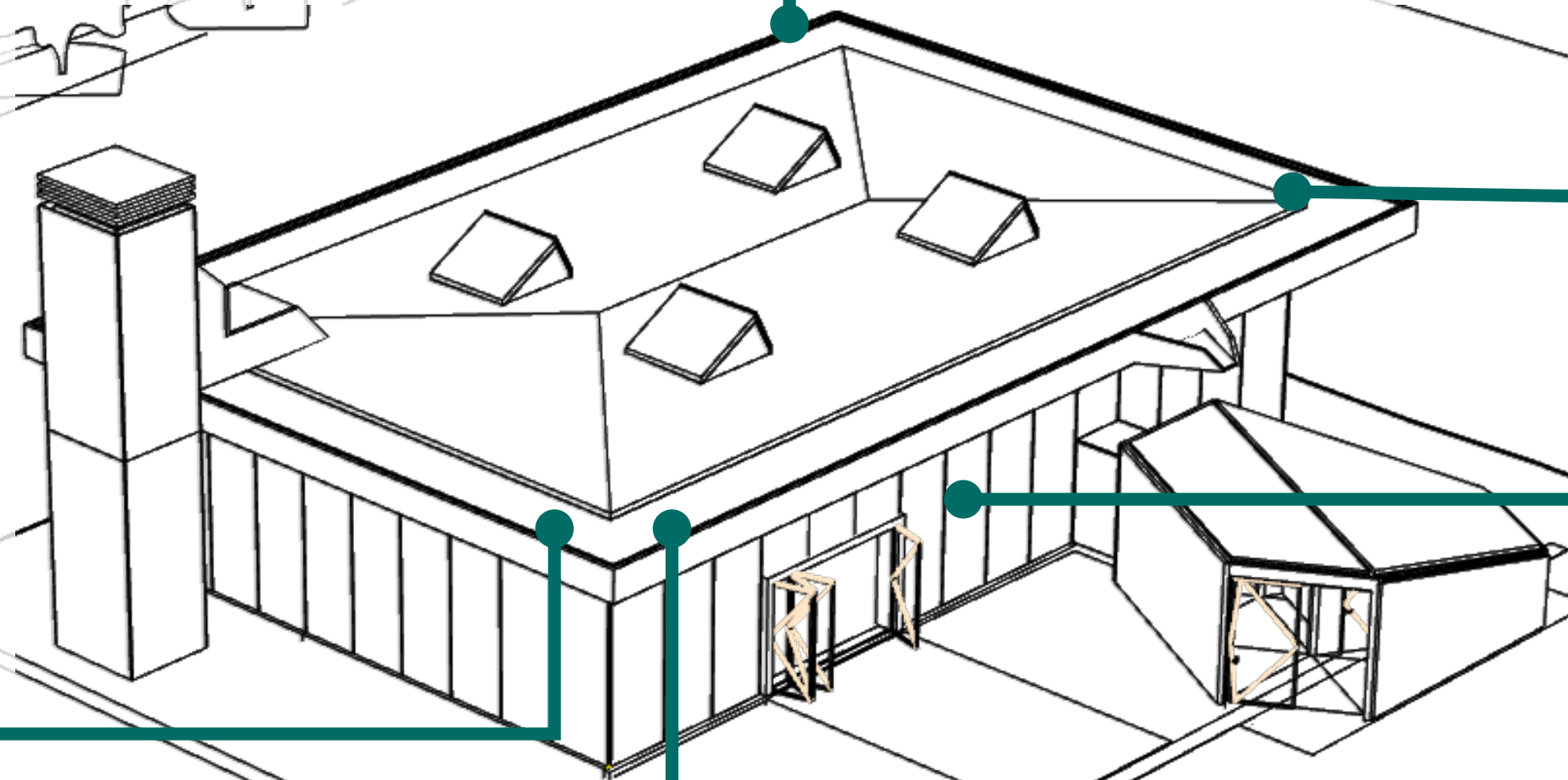
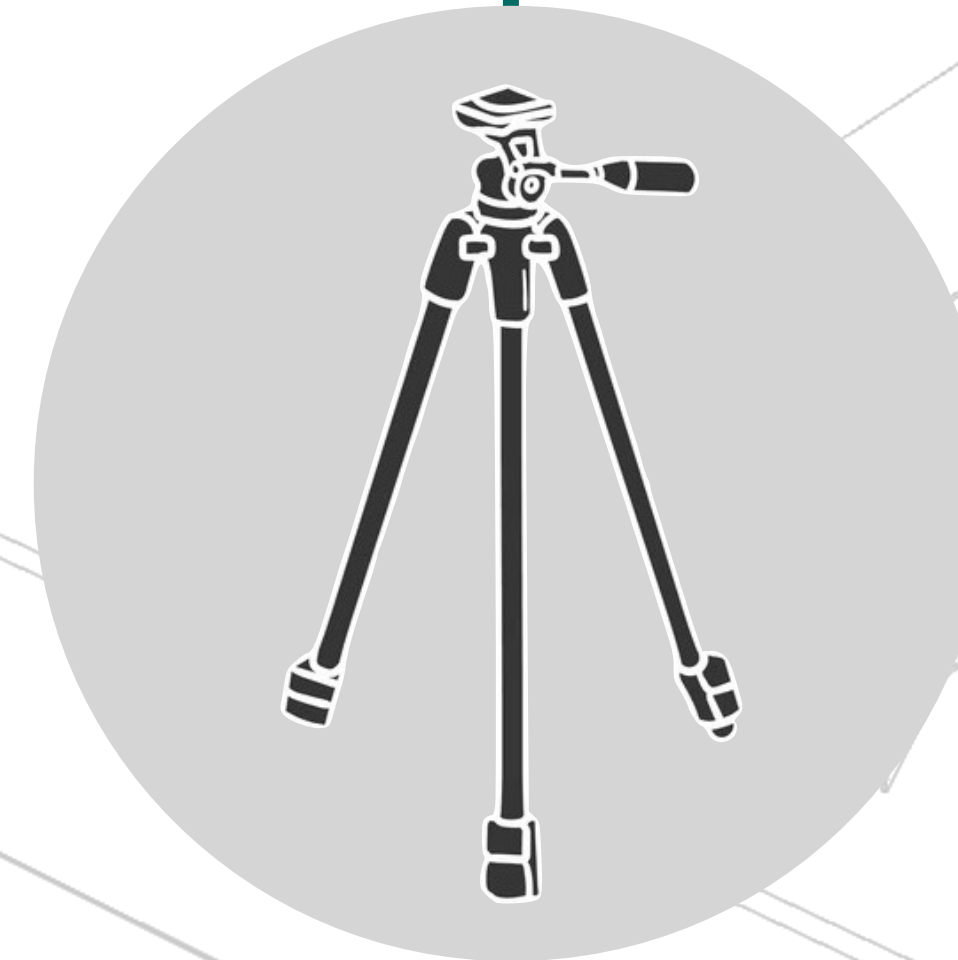


Higher comfort
Lower energy

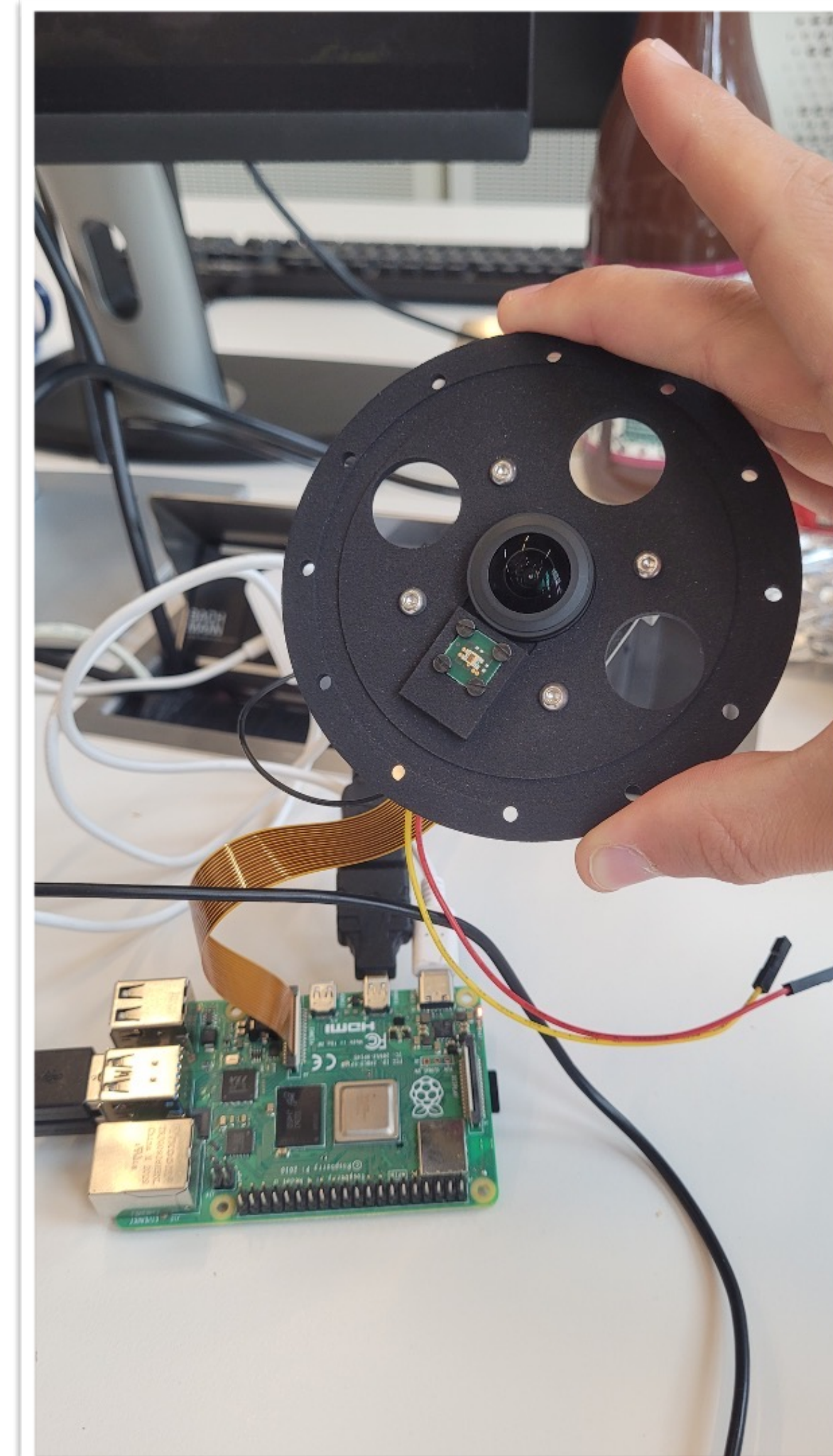
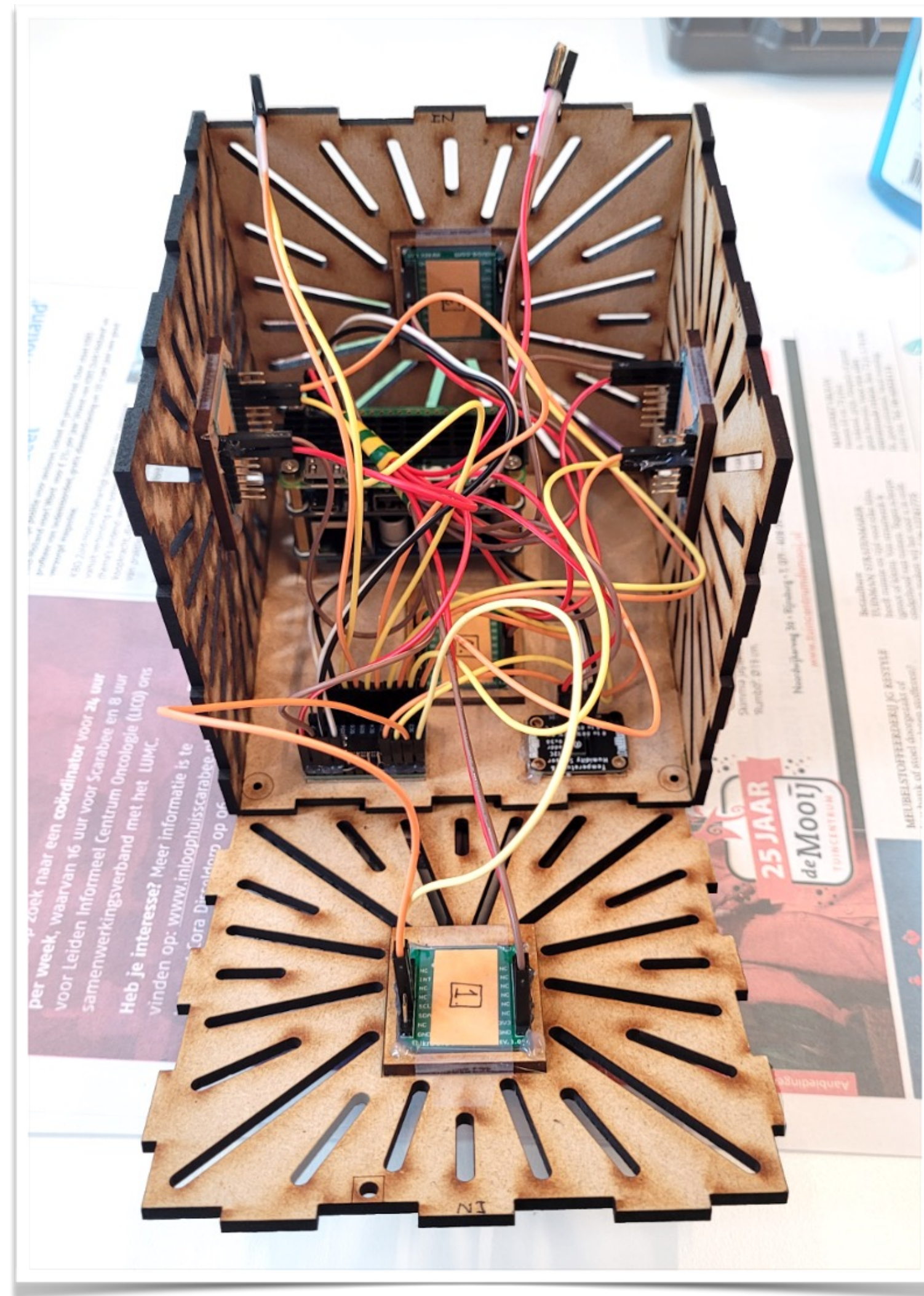
Optimised slat angles for
given performance

Daylight-linked control
Presentation : $E_{wp} > 300 \text{ lx}$
Meeting : $E_{wp} > 500 \text{ lx}$
Workshop : $E_{wp} > 750 \text{ lx}$

Existing illuminance meters (4 outdoors + 1 indoors)



The Cube & The Camera



Thanks to:

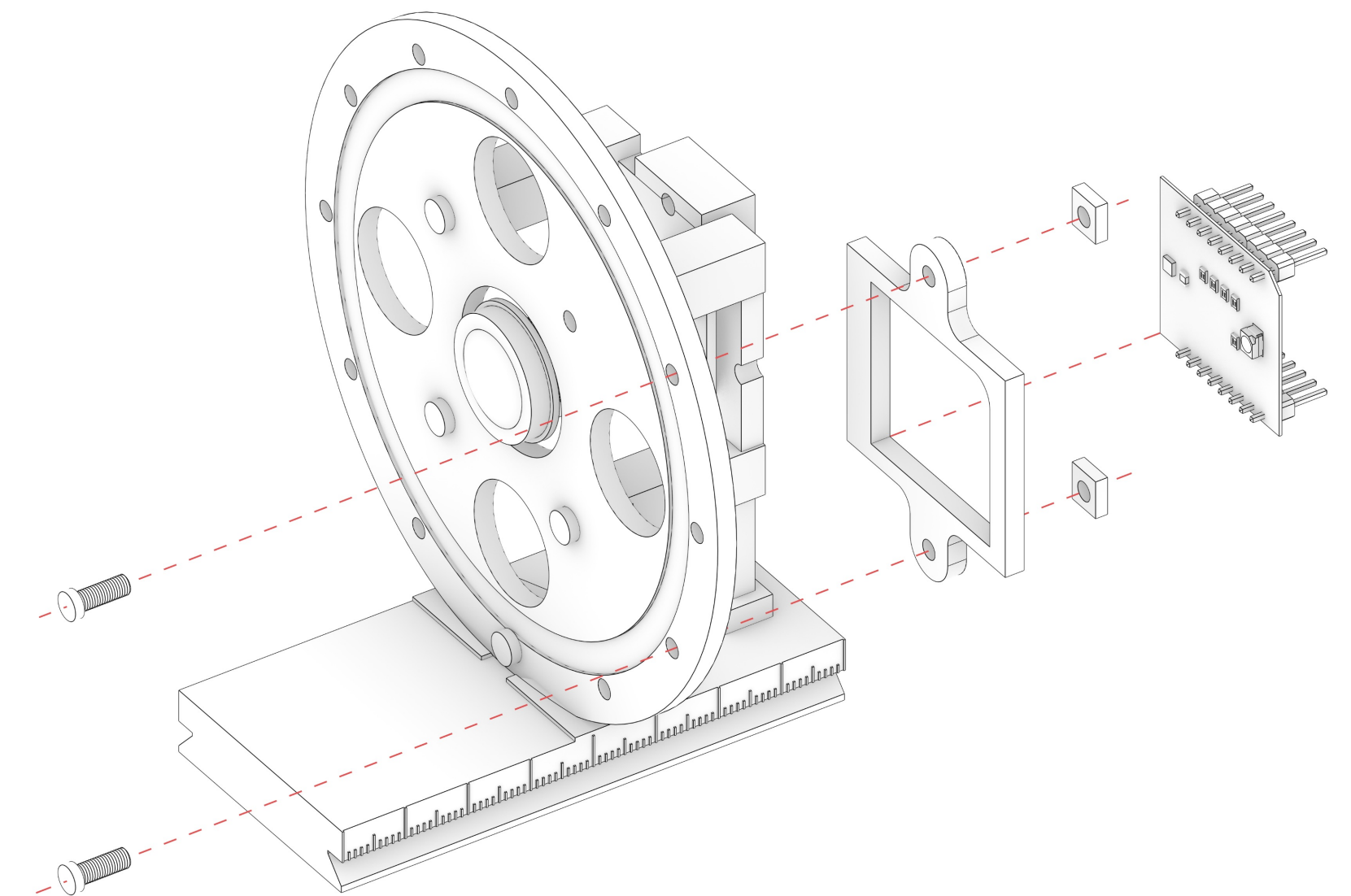
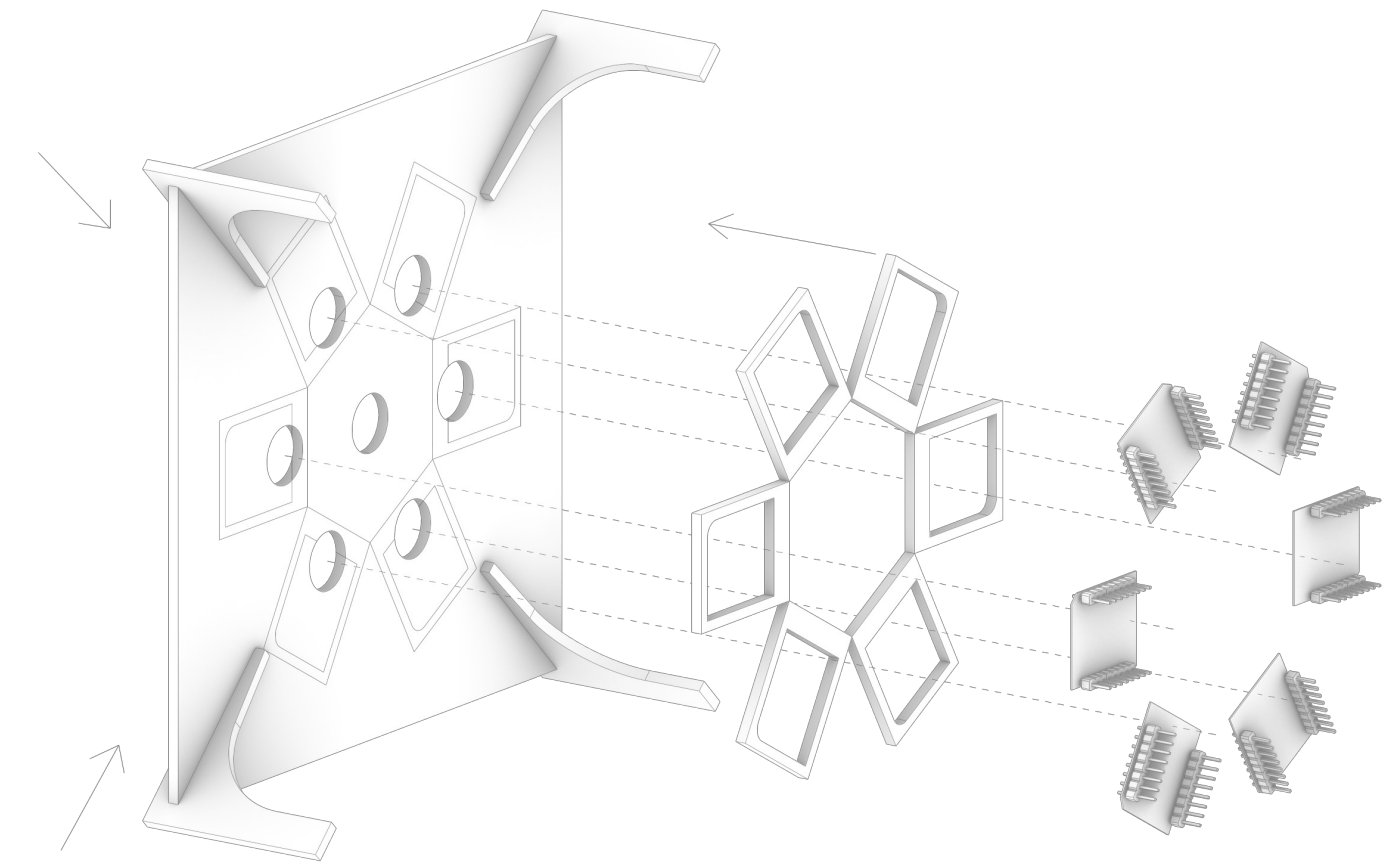
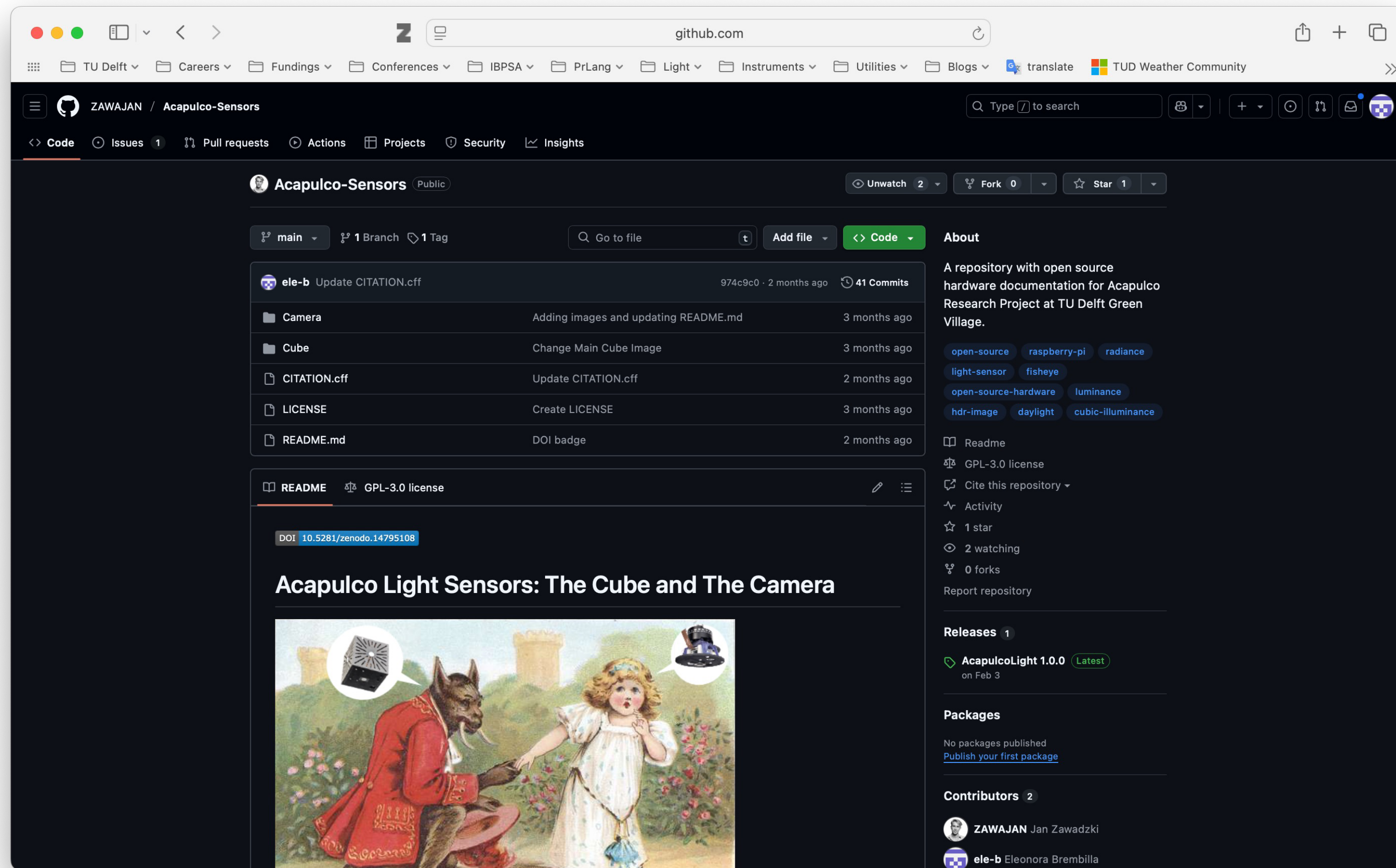
Jan Zawadzki

Pedro de la Barra Luegmayer

Wouter Beck

Marijn Leeuwenberg

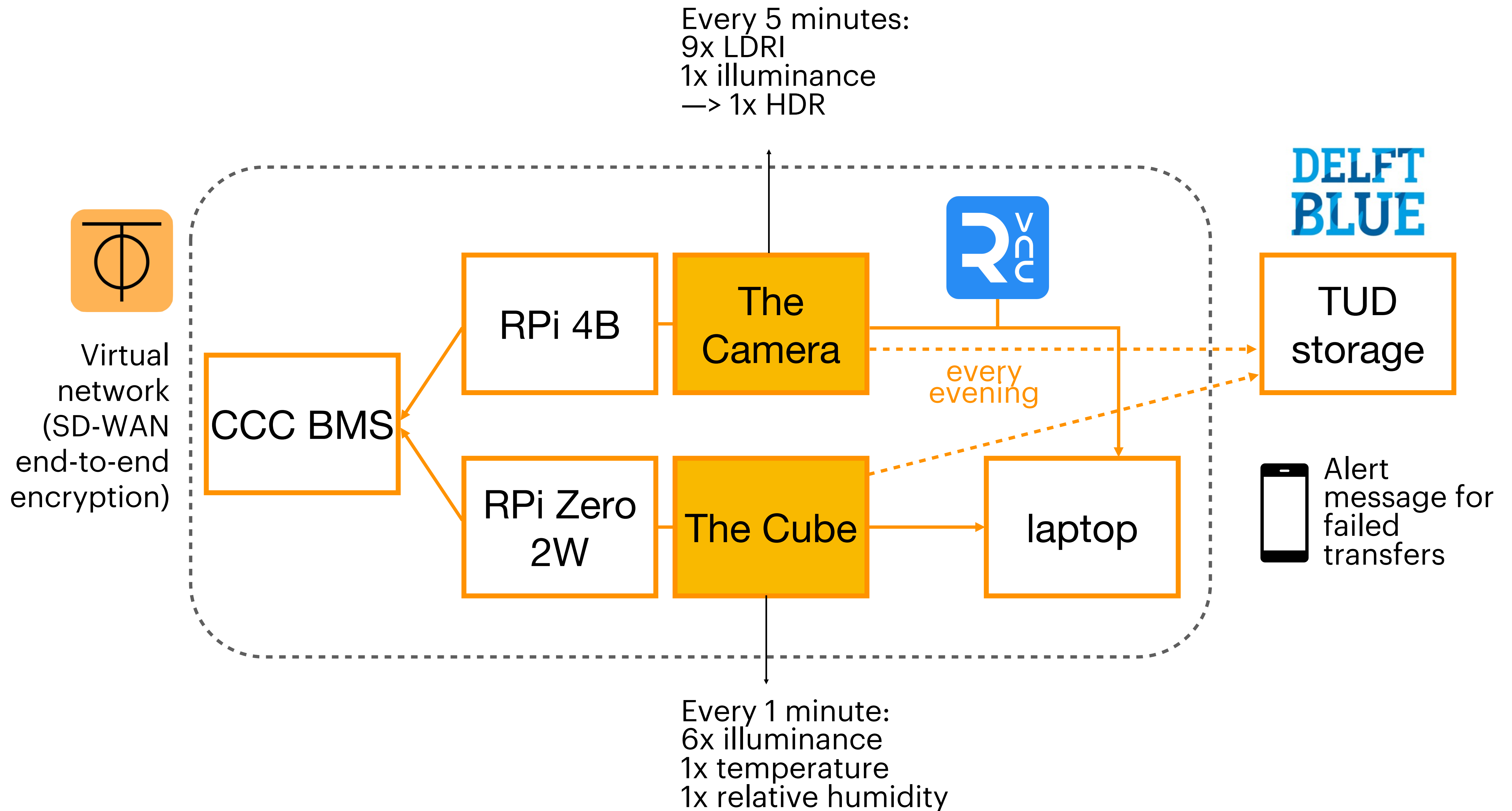
Online documentation including design of DIY calibration benches



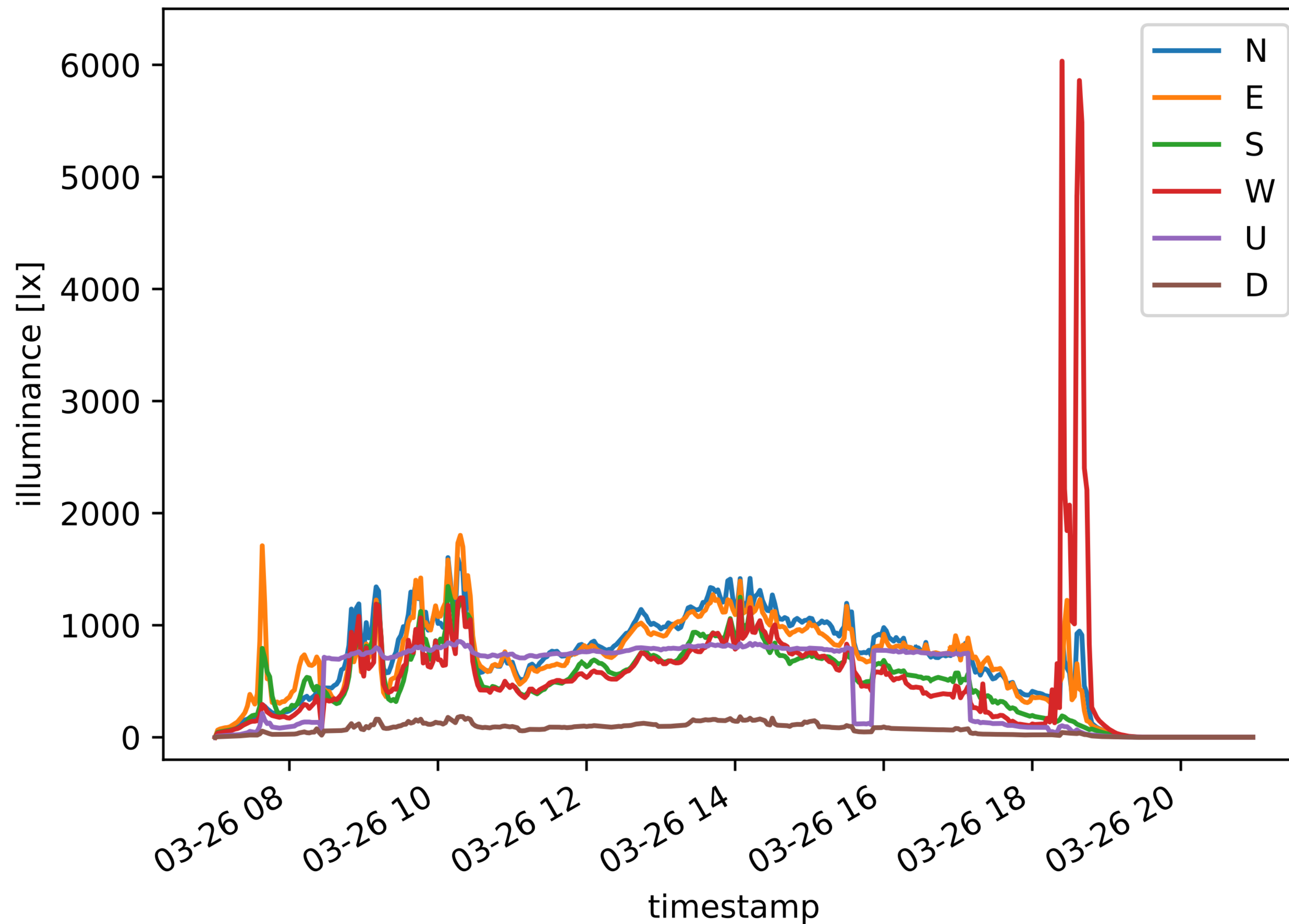
<https://github.com/ZAWAJAN/Acapulco-Sensors>

The Cube & The Camera

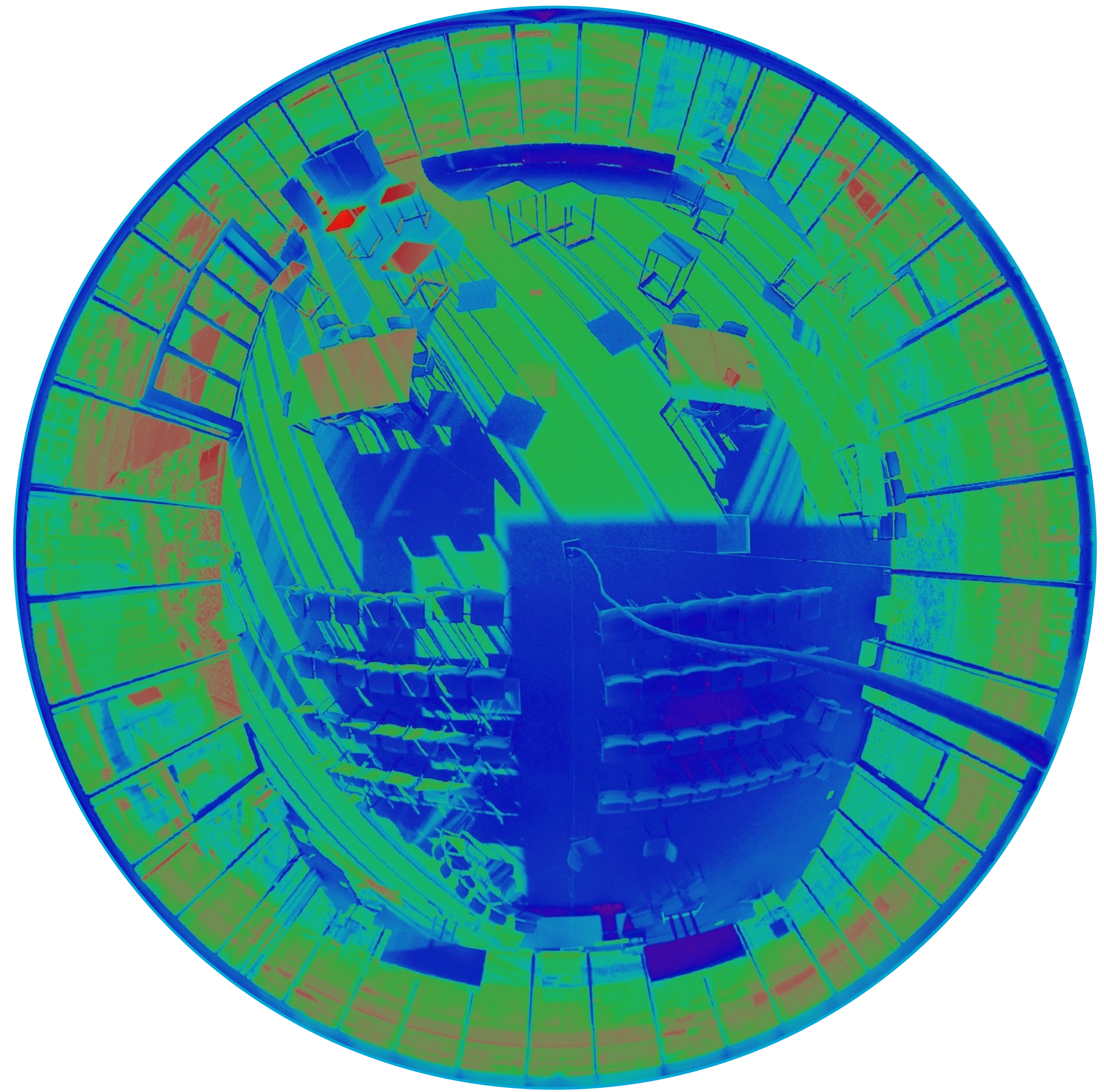
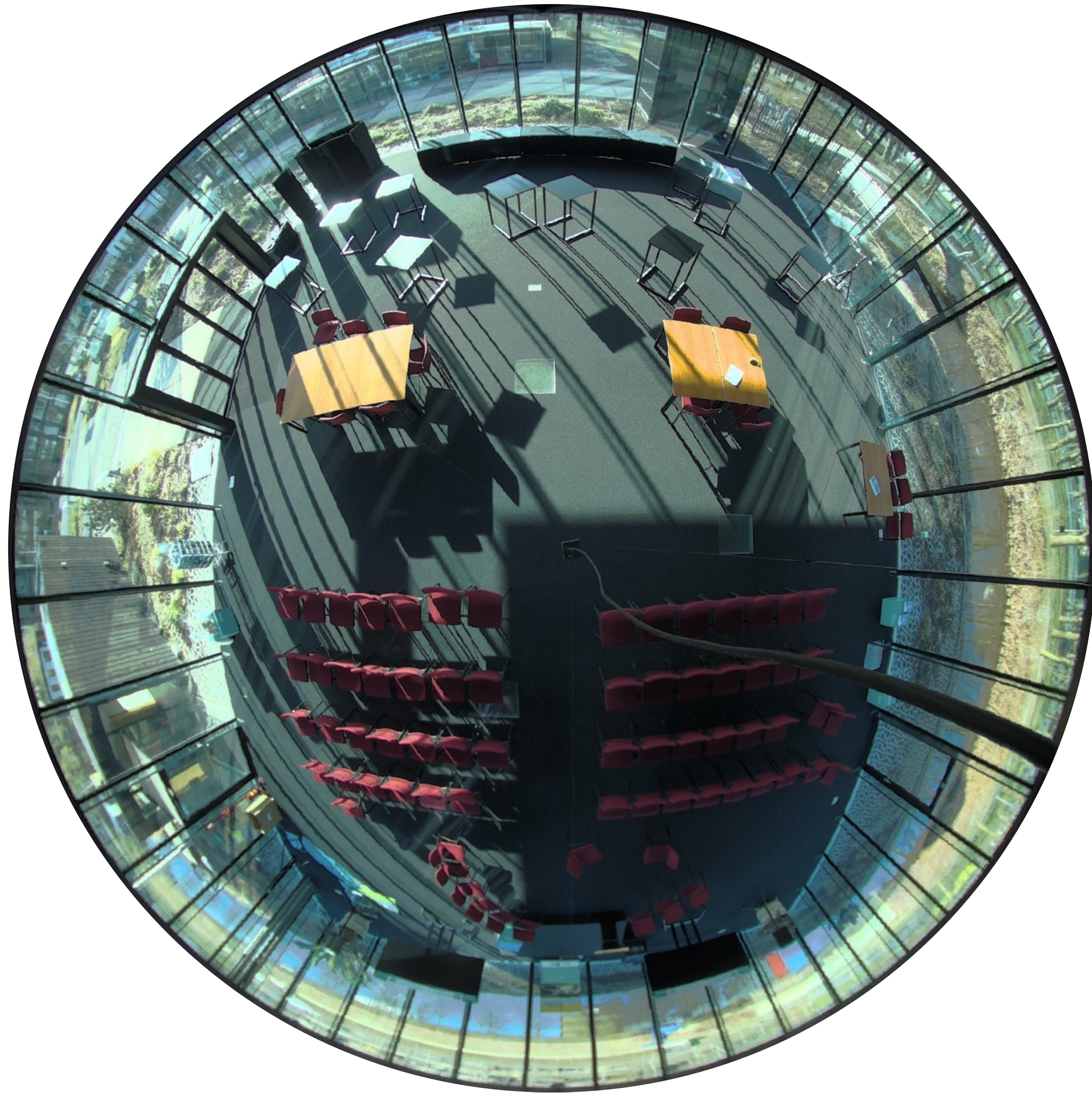




The Cube (6 illuminance values / 1')



The Camera (1 HDR / 5')



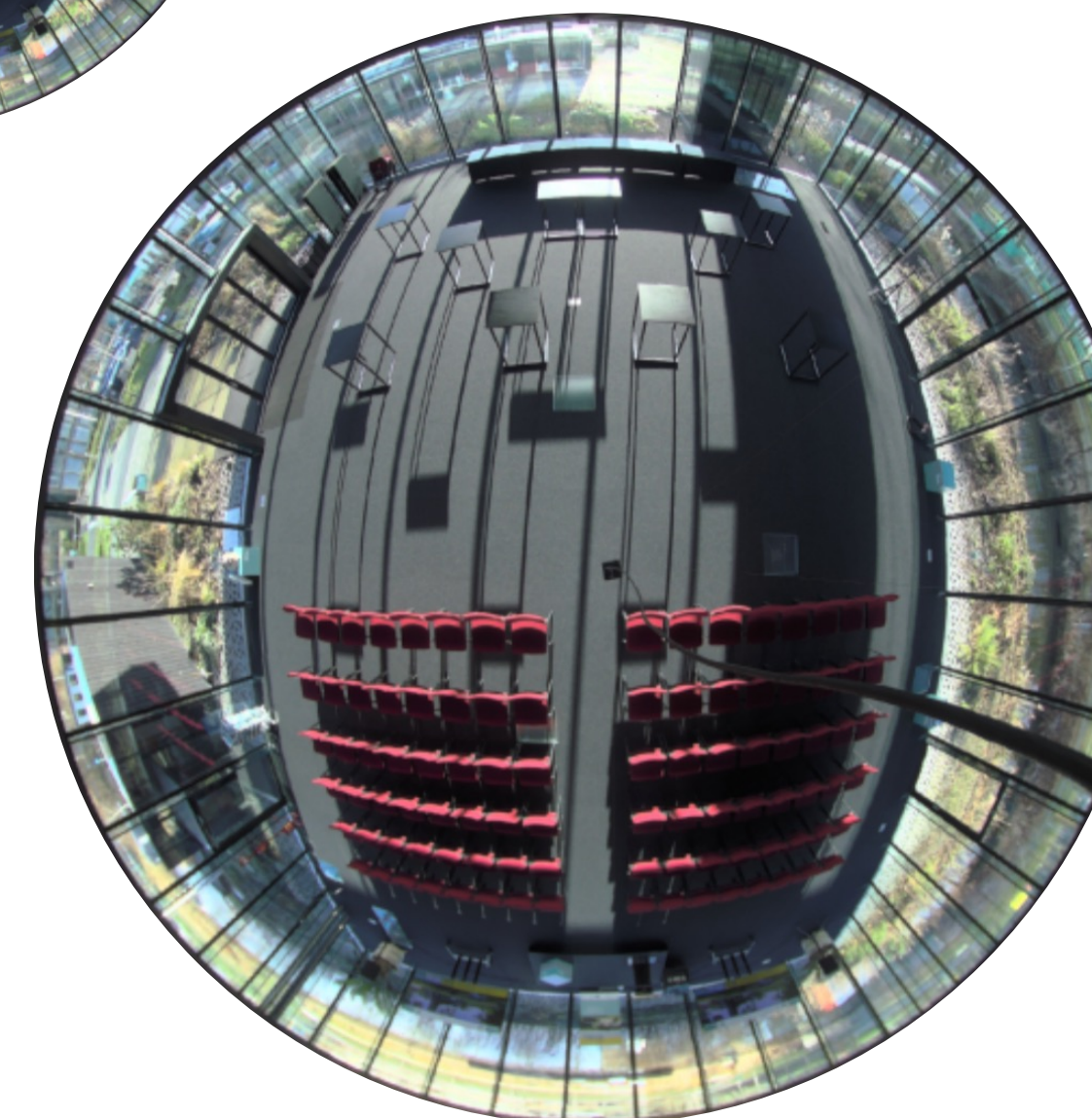
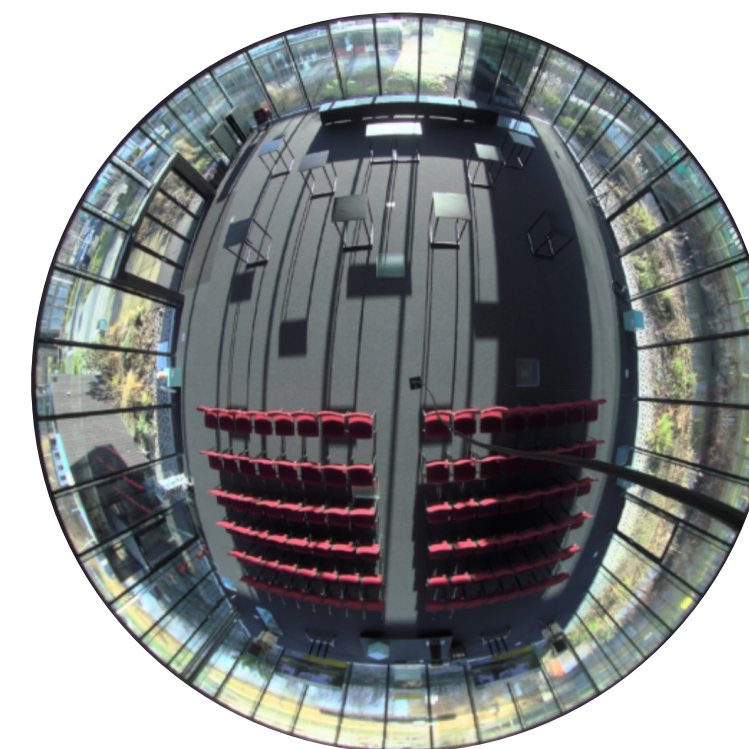
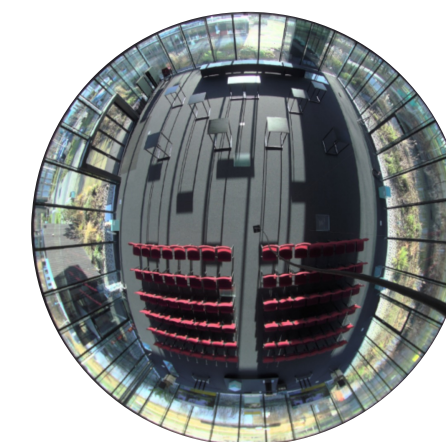
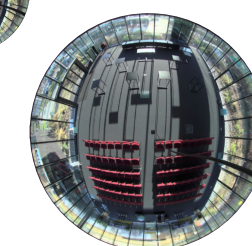
To be continued...

The Acapulco Project

THE
GREEN
VILLAGE

PRIVA

ORANGE CLIMATE



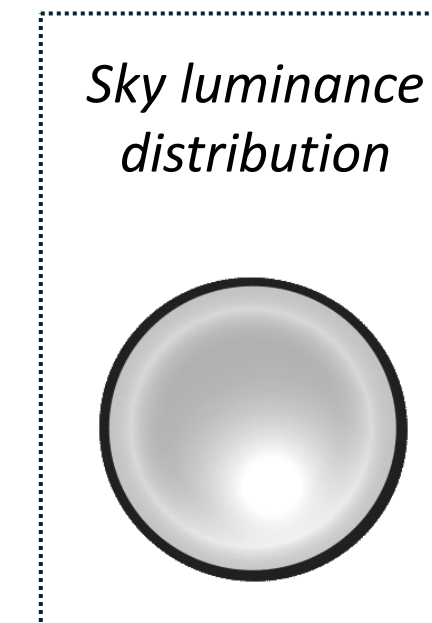
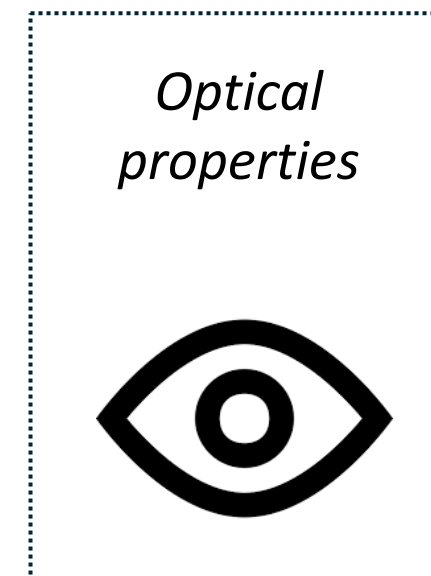
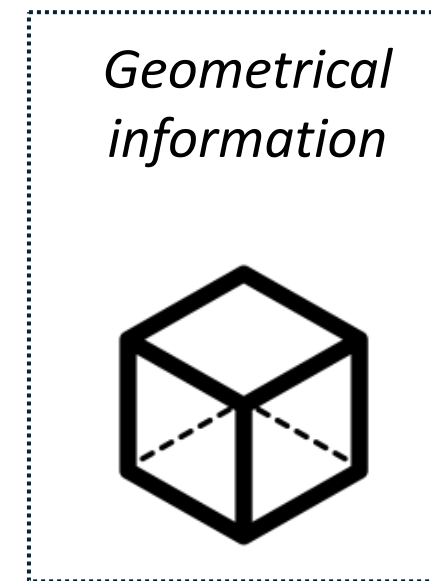


Nima Forouzandeh

PhD candidate - since 2021

The theme

Key inputs for daylight models



The theme

Key inputs for daylight models

*Geometrical
information*



*Optical
properties*



The theme

Formalization

*Geometrical
information*



*Optical
properties*



Automation

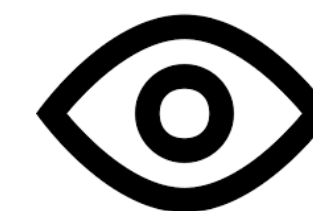
Main Themes

Formalization

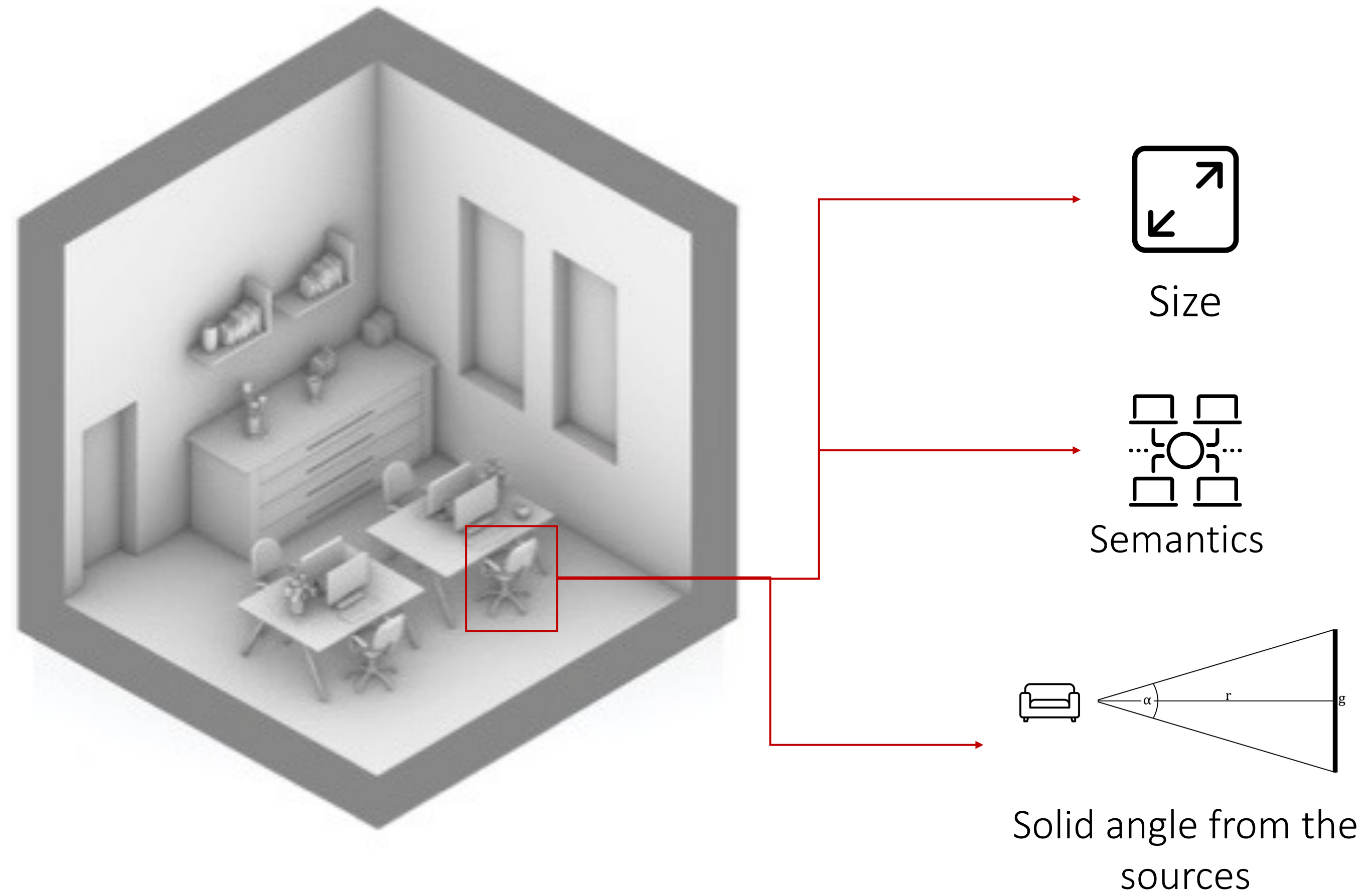
*Geometrical
information*



*Optical
properties*



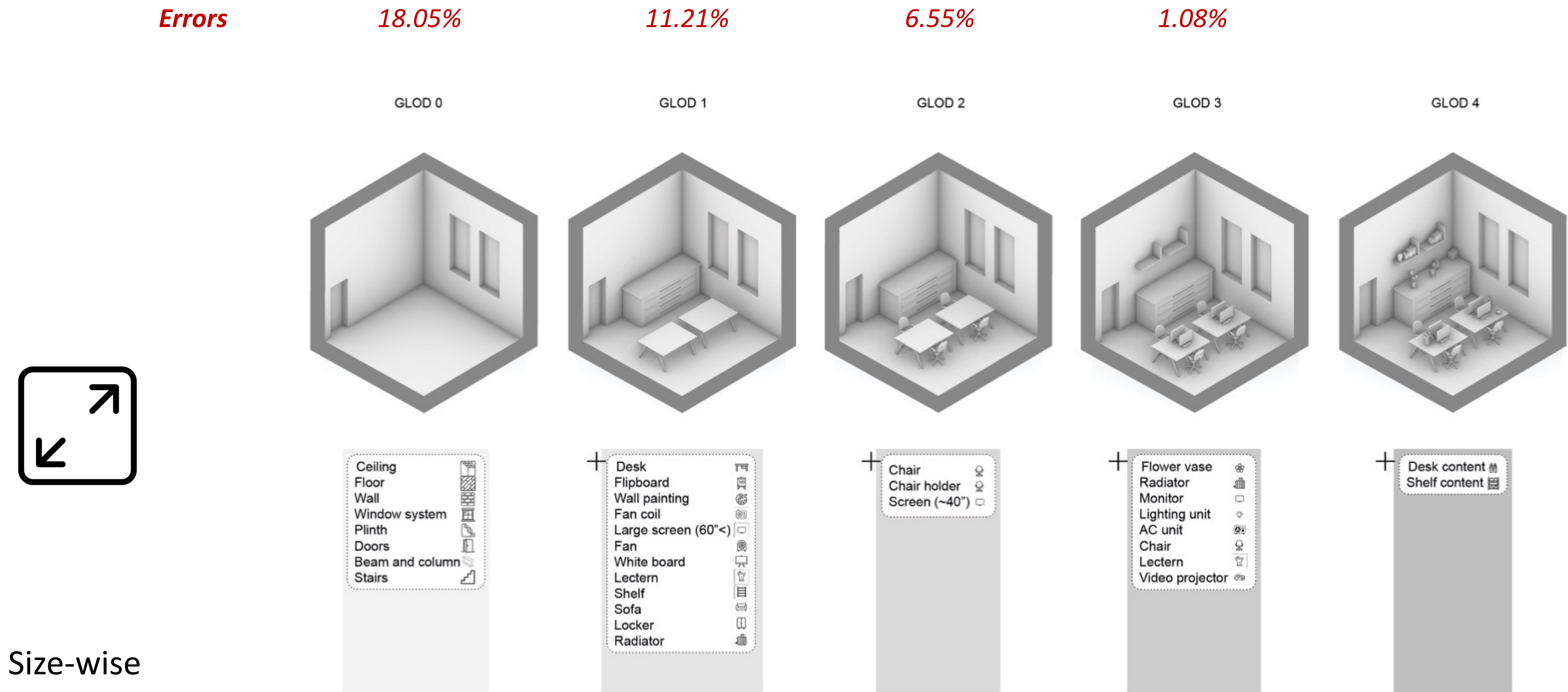
Formalization



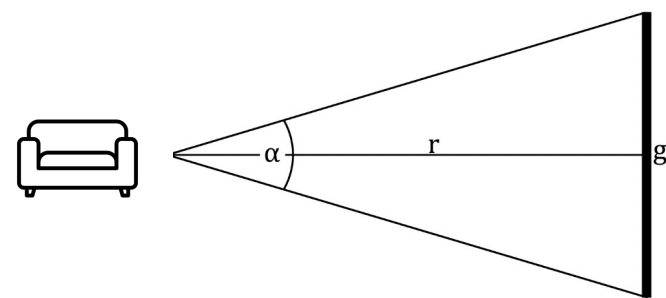
*Geometrical
information*



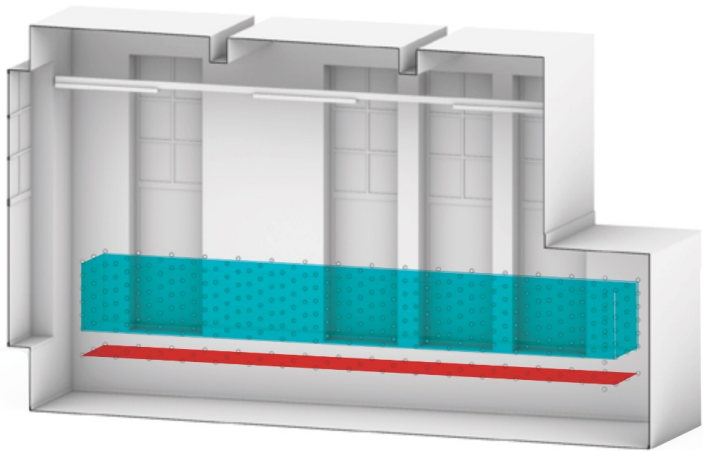
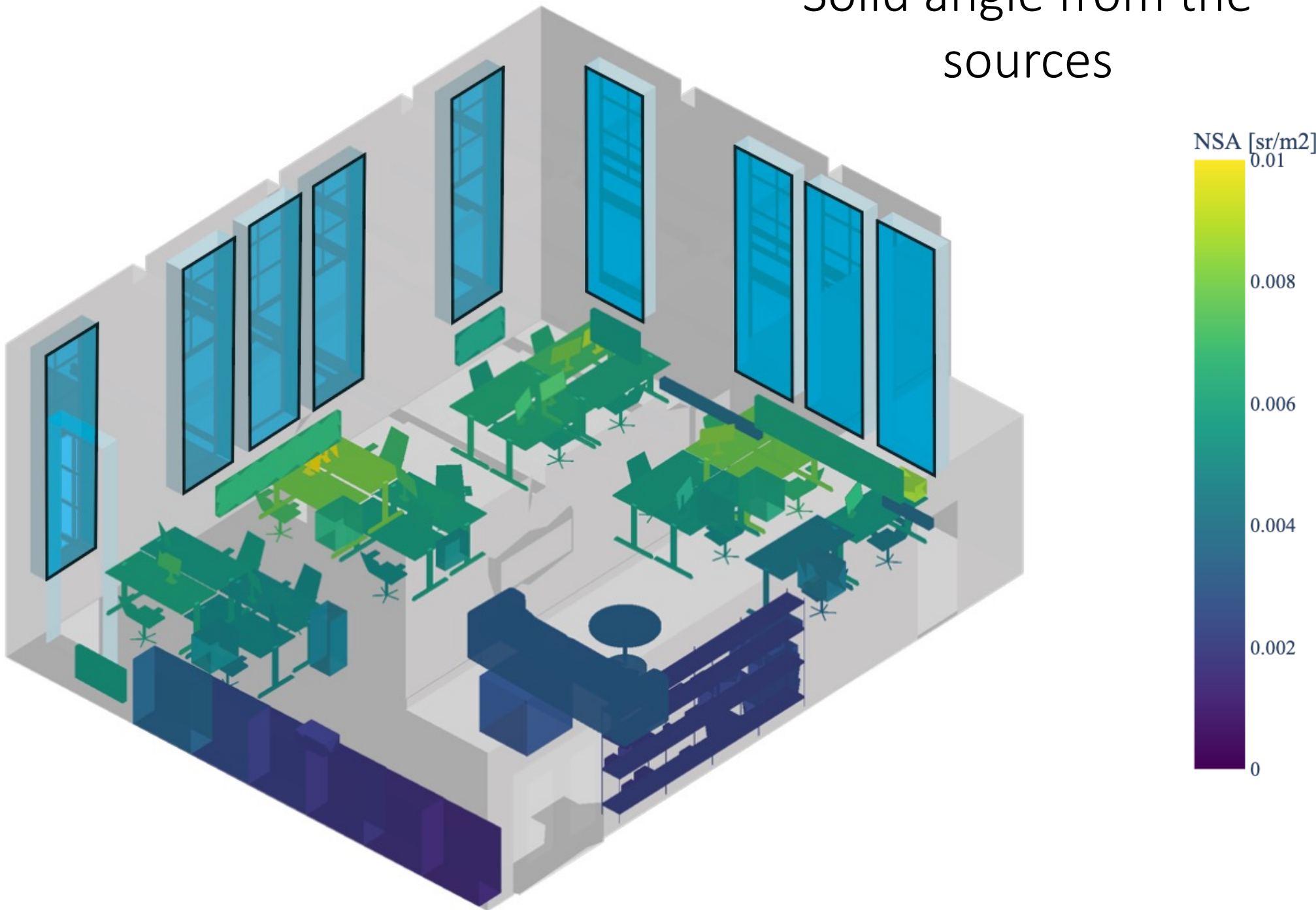
Formalization



Formalization



Solid angle from the sources

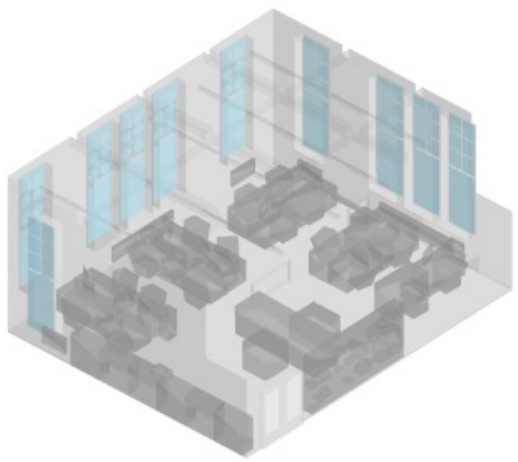
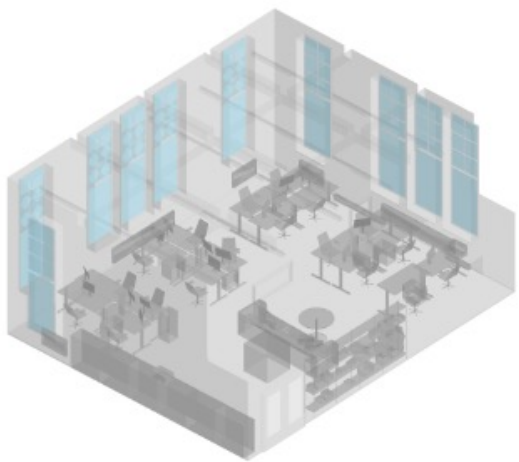


Directional illuminance
Workplane illuminance

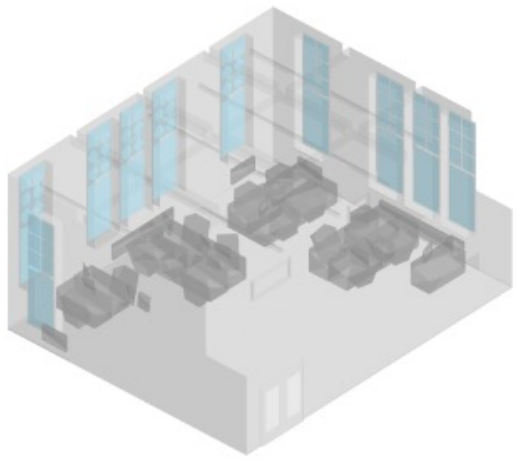
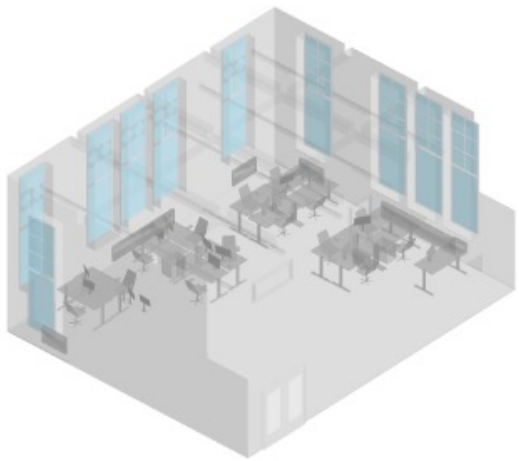
Actual

OBB

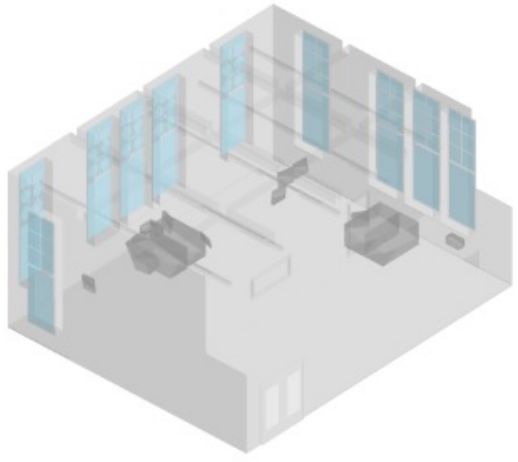
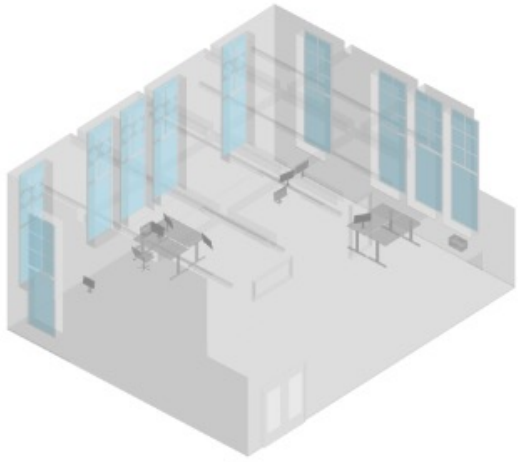
GLoD3



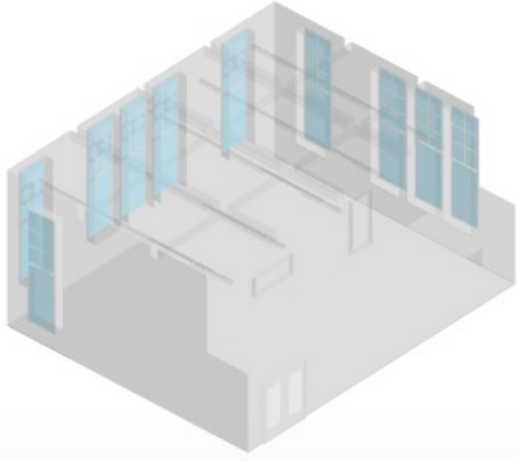
GLoD2



GLoD1



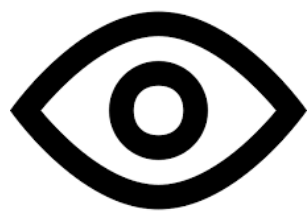
GLoD0



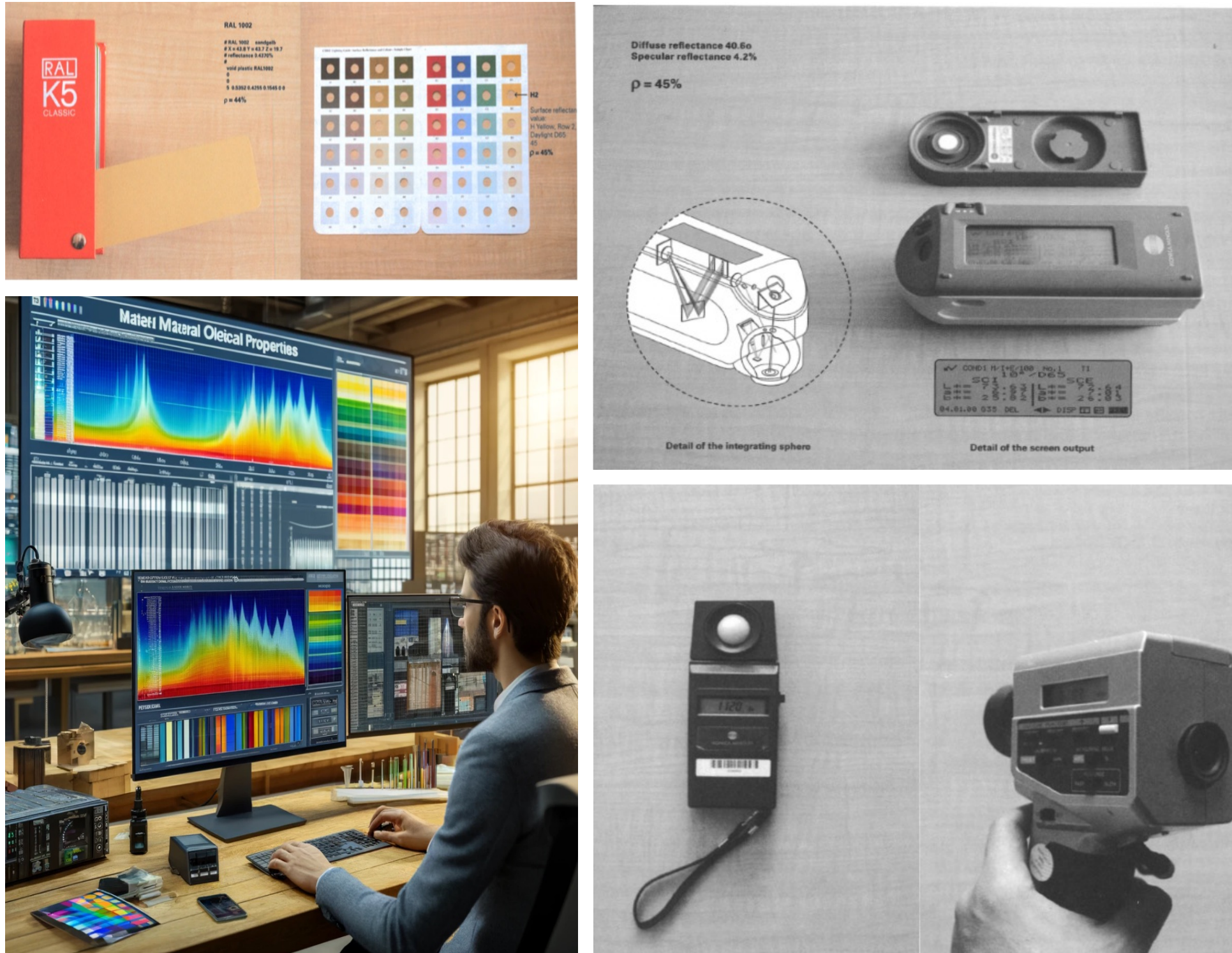
Formalization

Formalization

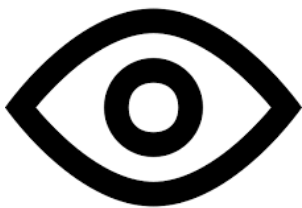
*Optical
properties*



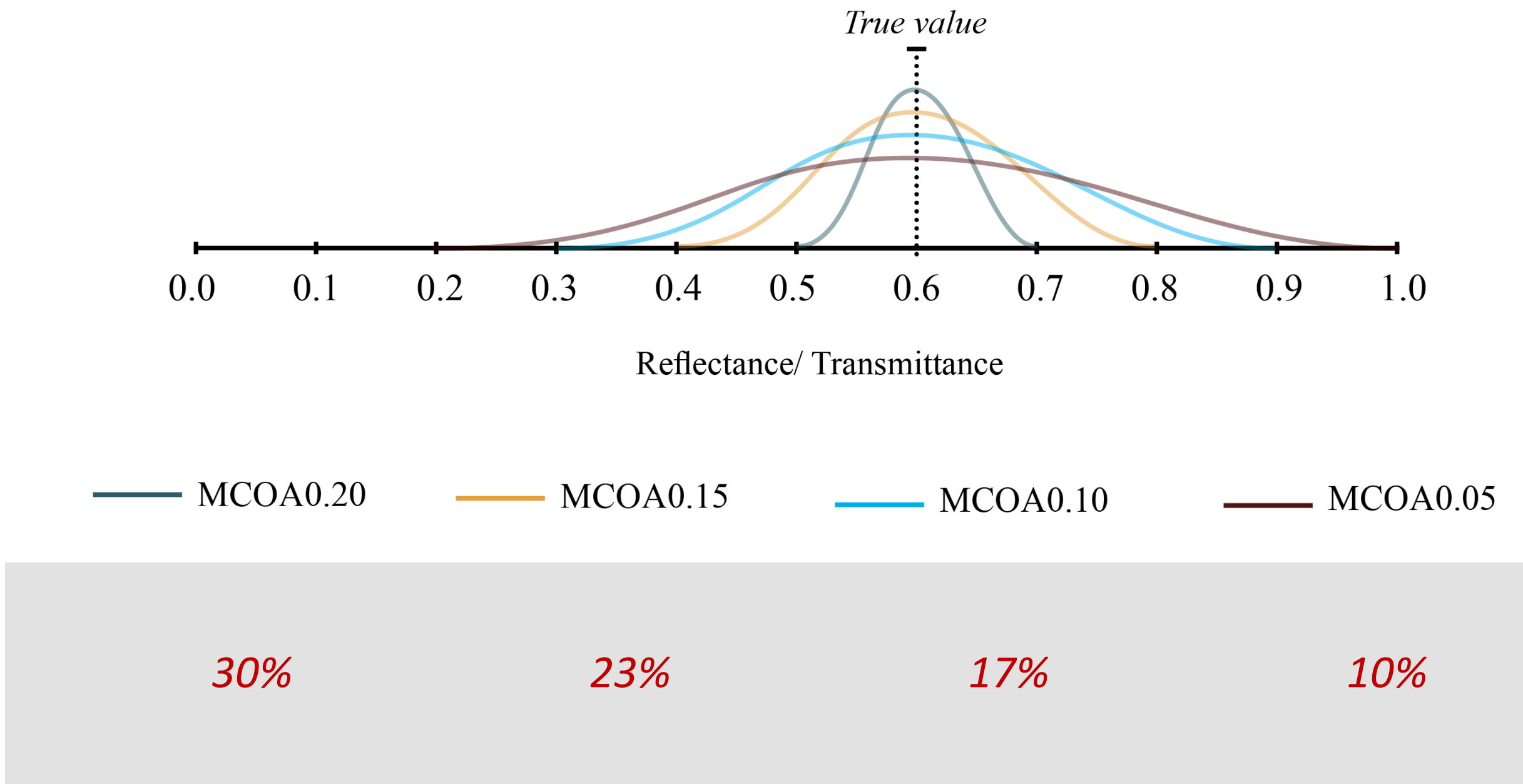
Formalization



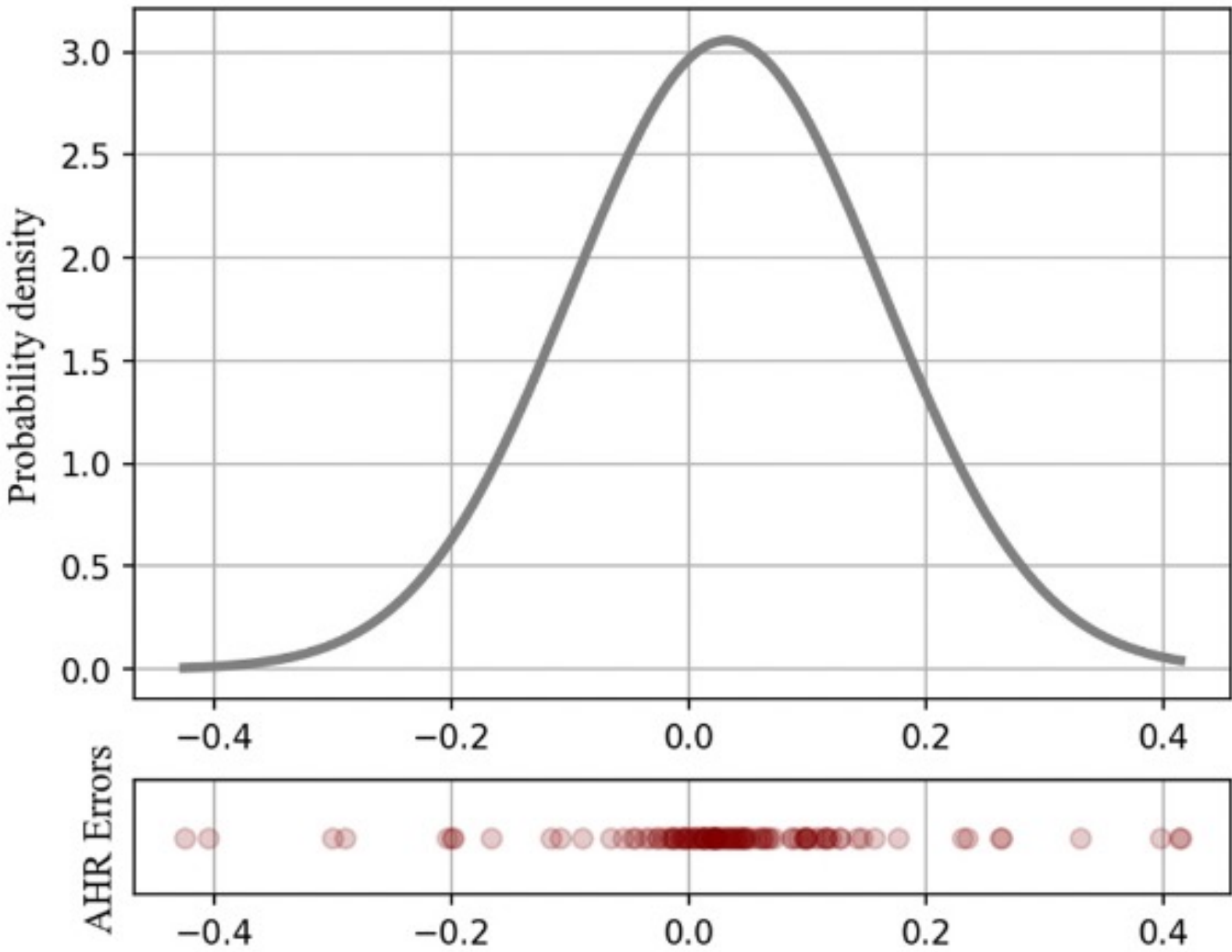
Optical
properties



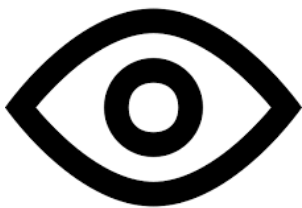
Formalization



*Influence of material accuracy on annual daylight results –
Mean percentage error in total annual illumination*



*Optical
properties*



Main Themes

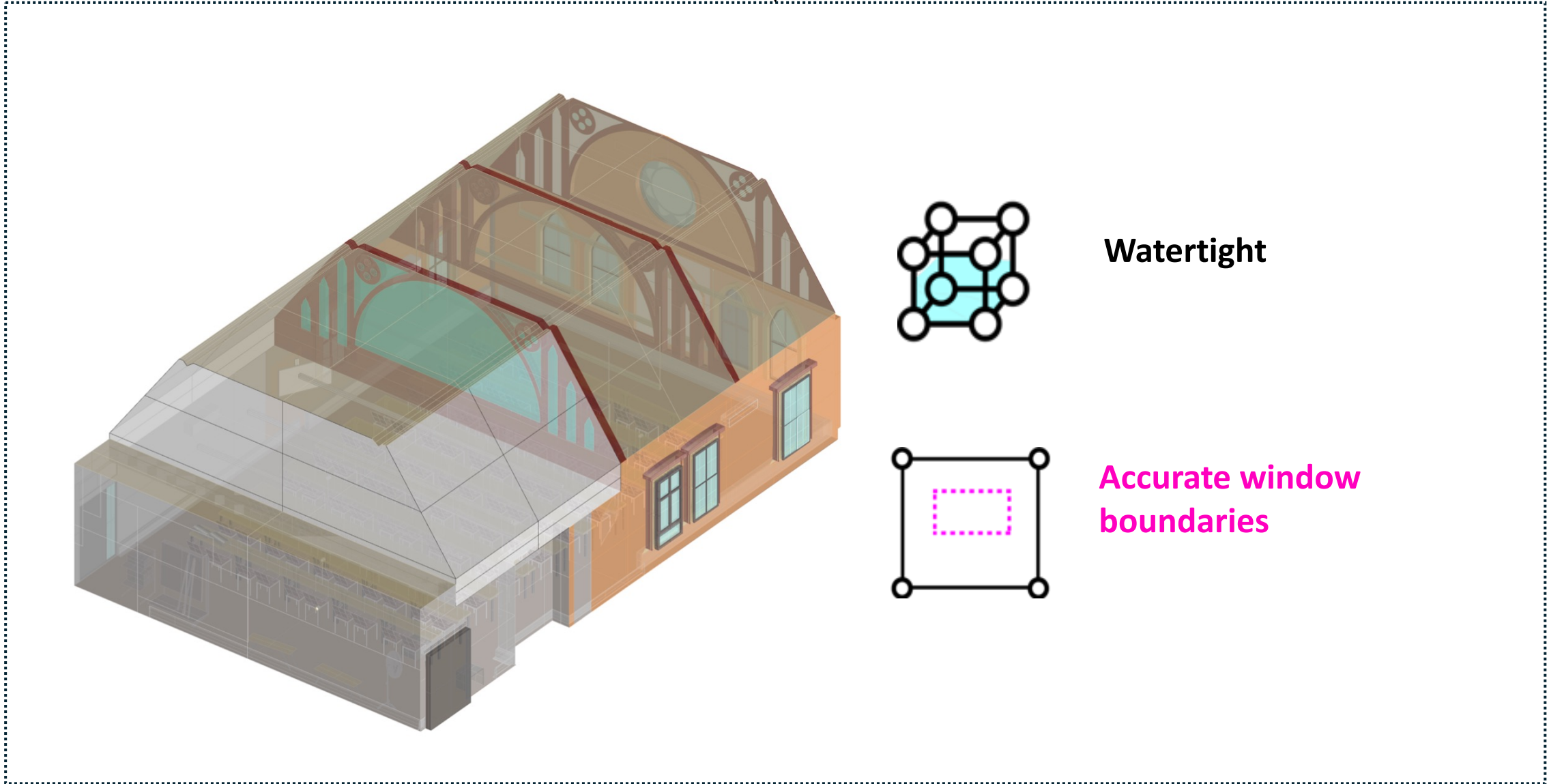
*Geometrical
information*



Automation

Automation

Reconstruction algorithms
Minimal user interactions



Automation



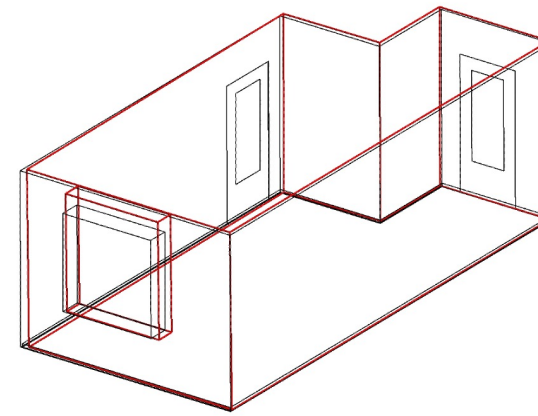
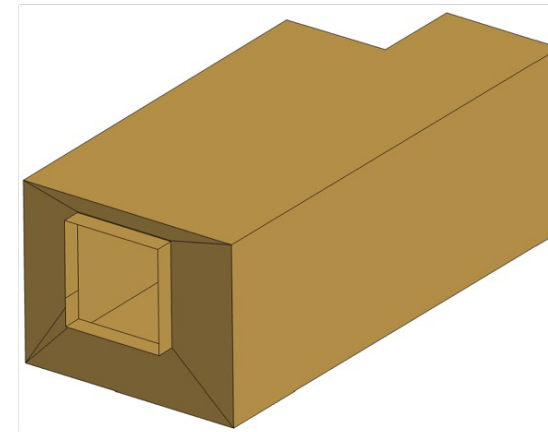
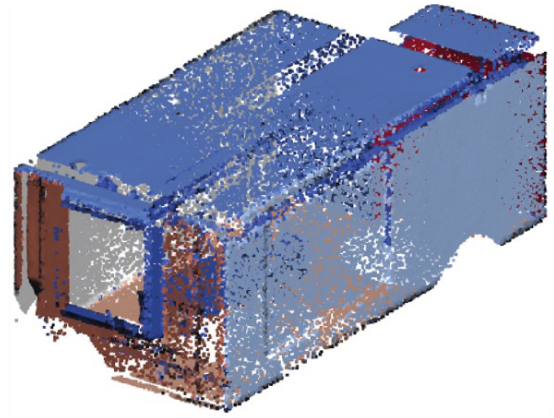
Input point cloud

Output surface model

Manual | **ours**

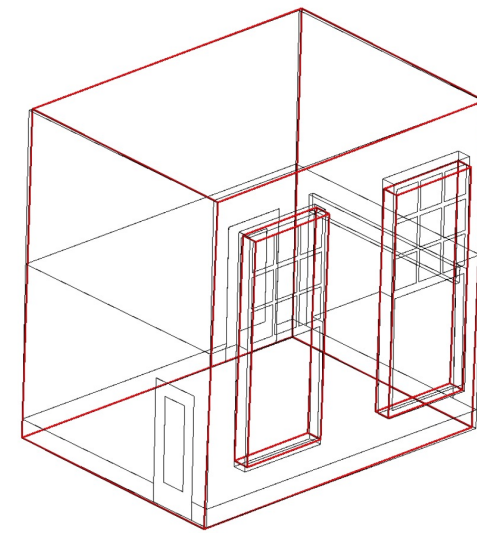
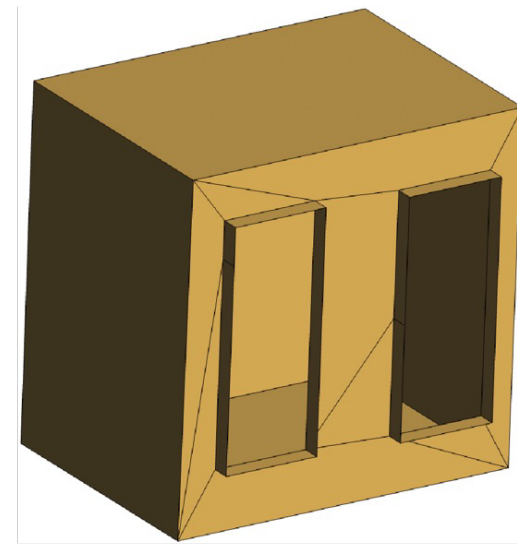
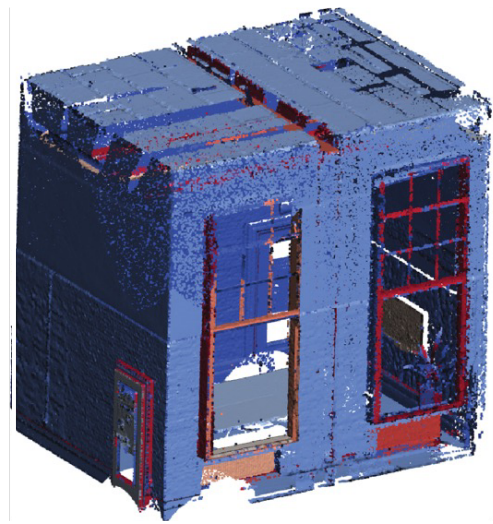
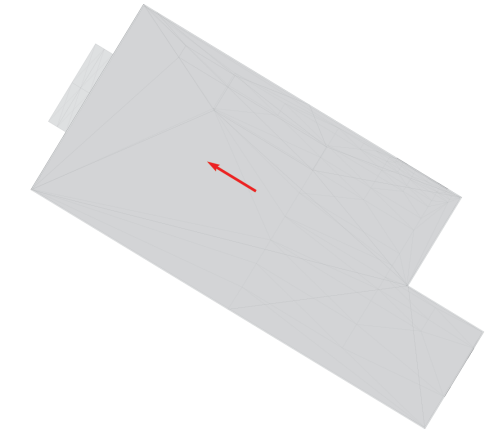
$E_{UDI,a}$ [%]

$RMSE_{DGP,9}$



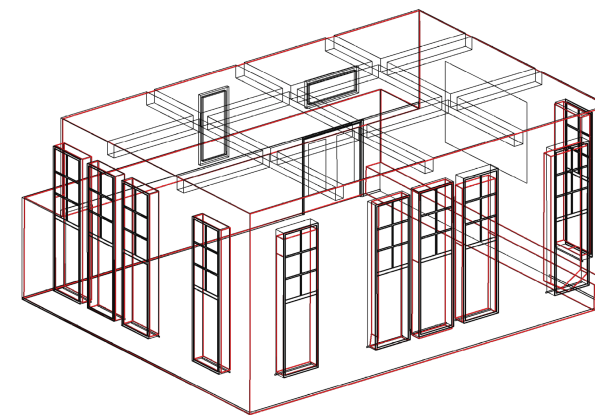
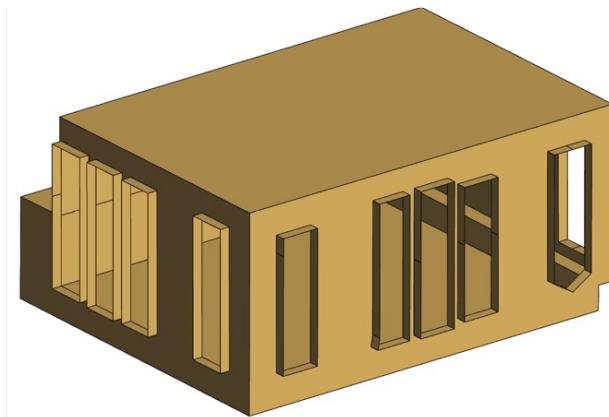
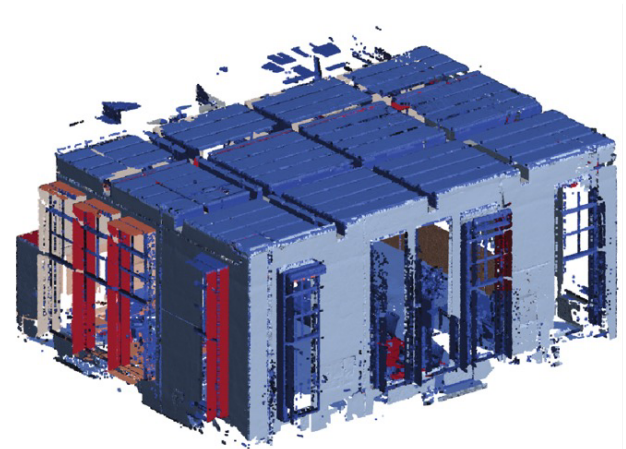
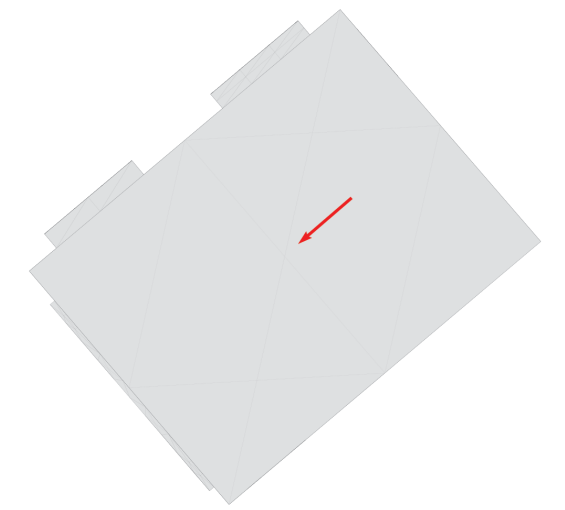
4.77

0.0042



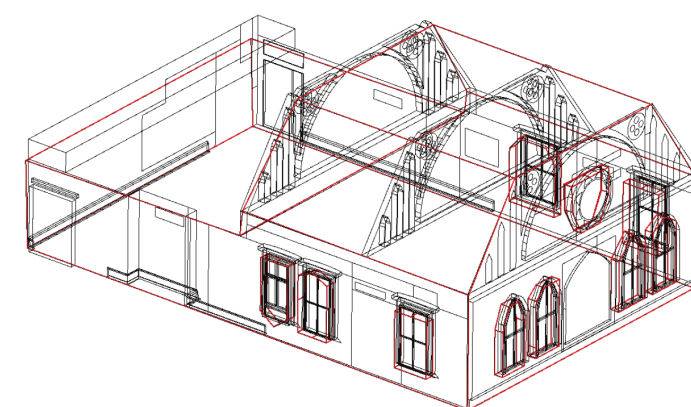
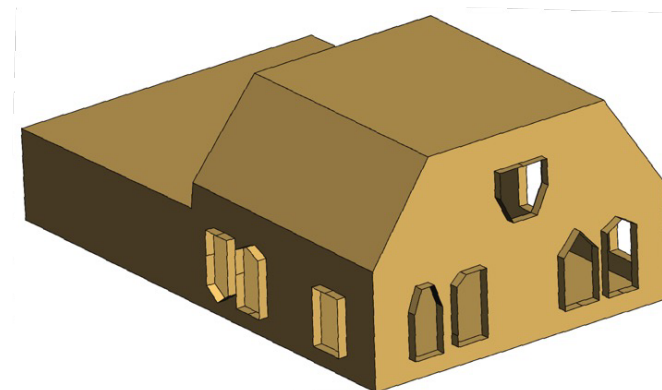
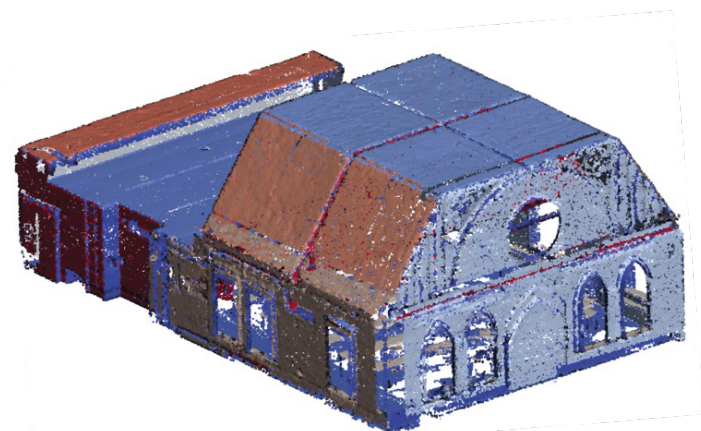
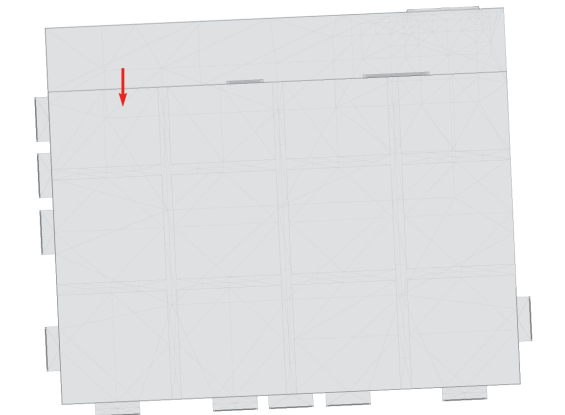
1.02

0.0034



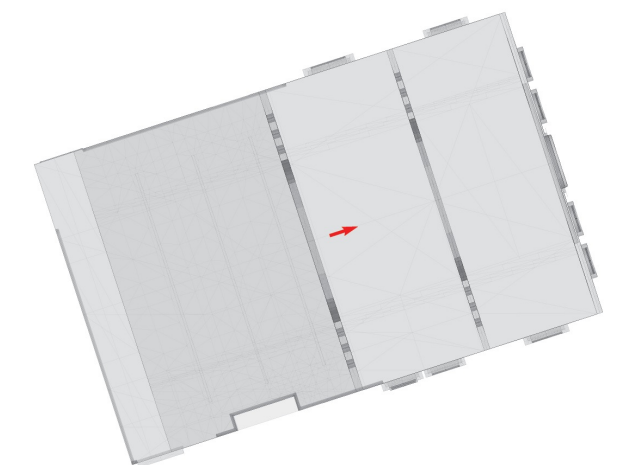
-5.38

0.0202



9.75

0.0034



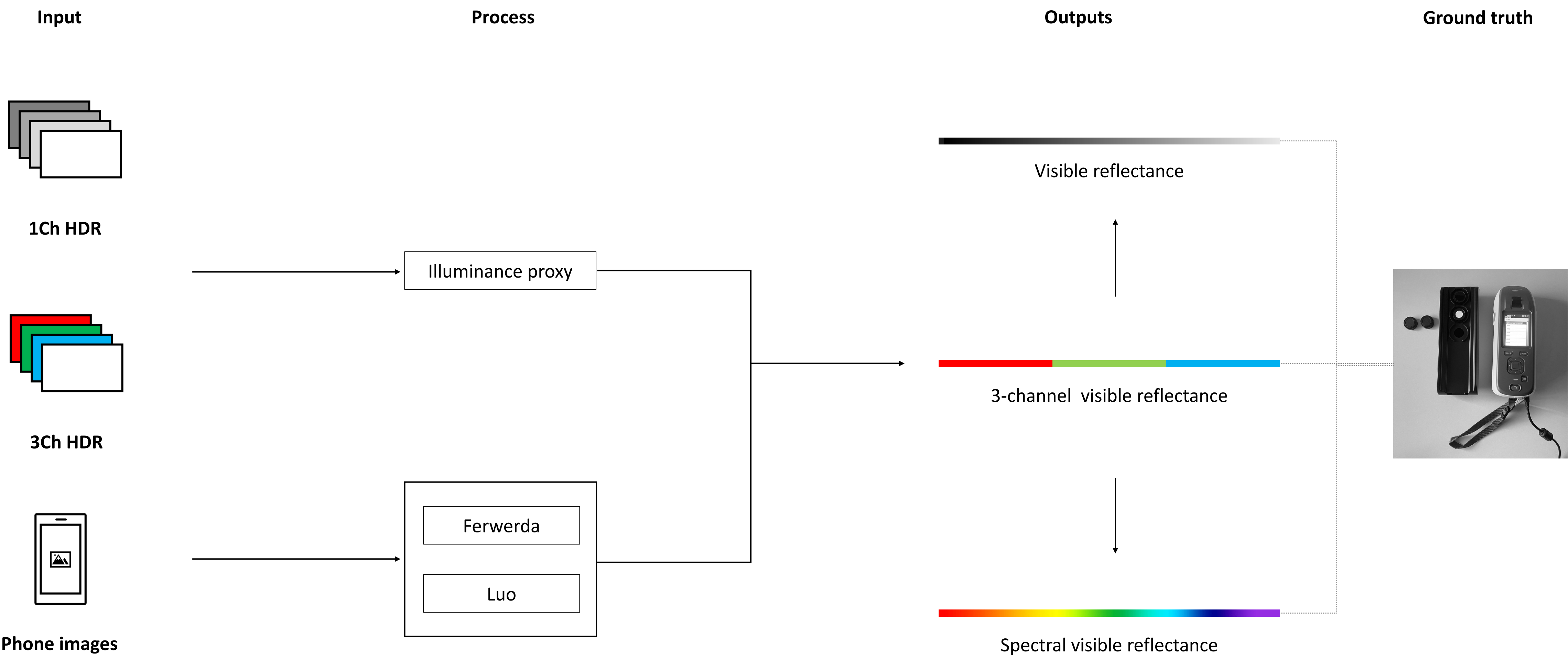
Main Themes

*Optical
properties*



Automation

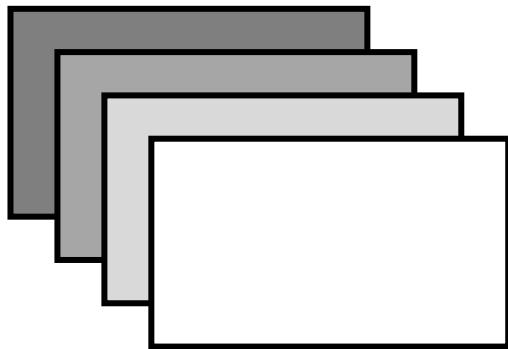
Image-based material characterization



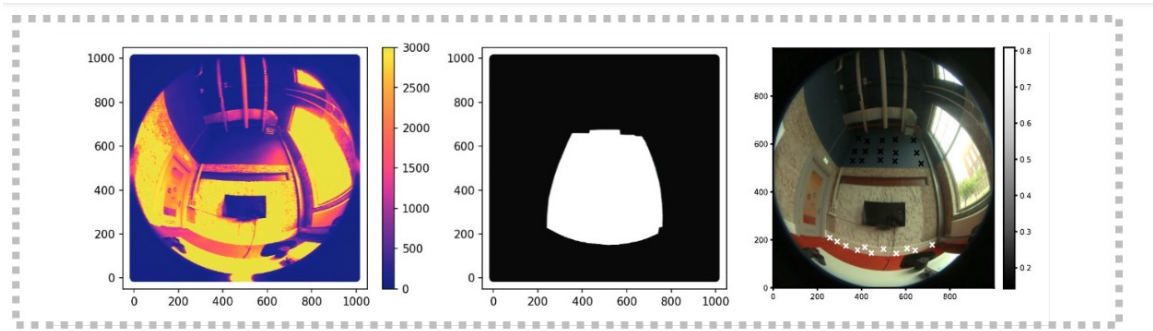
Ground truth



Illuminance proxy

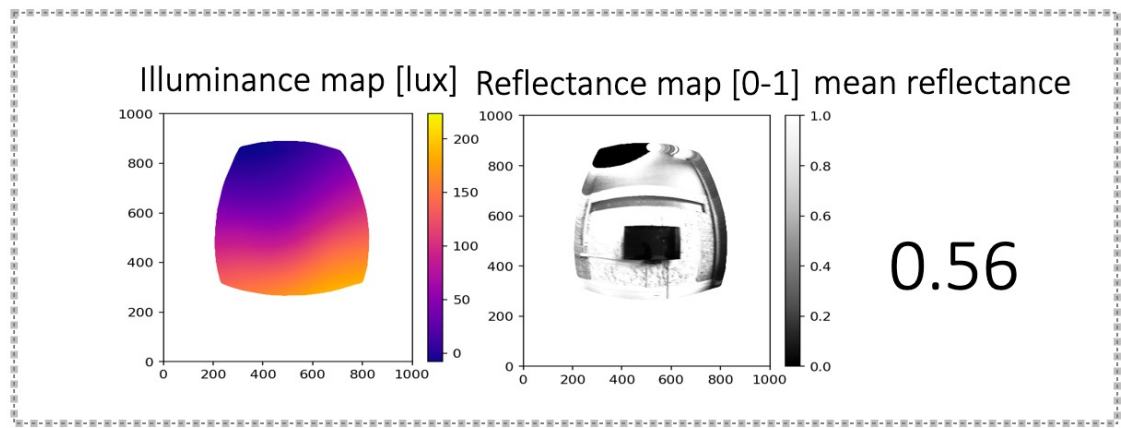


HDRI



Input

$$\rho = \frac{(L * \pi)}{E} + \text{Surface interpolation}$$



output

Ferwerda

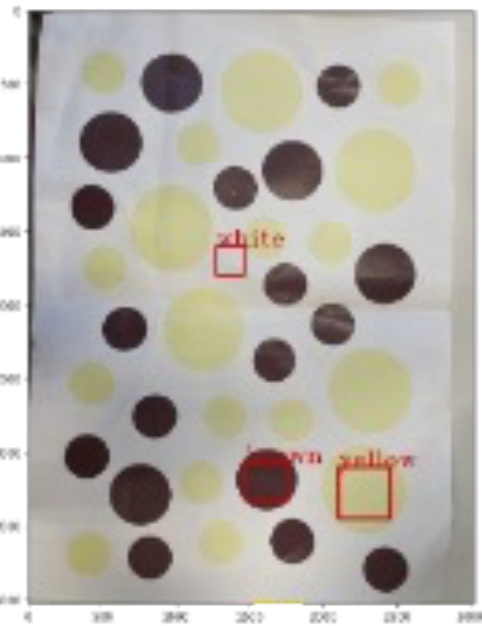
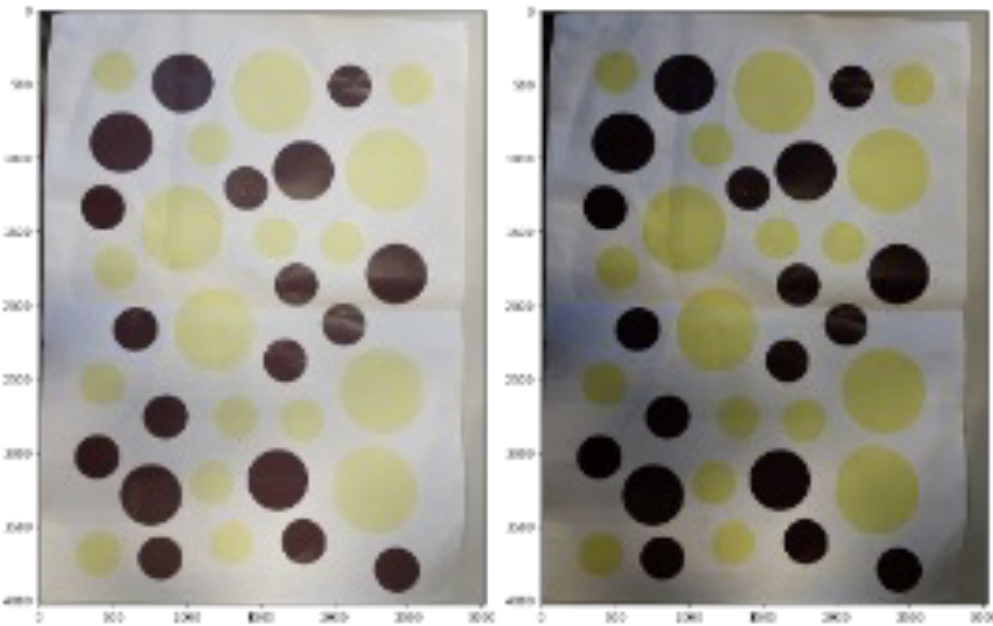
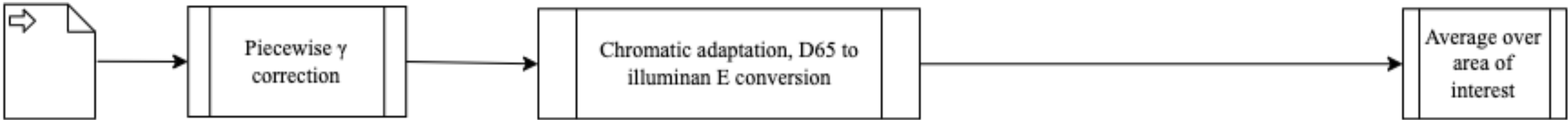
Luo

Ground truth

Illuminance proxy

Ferwerda

Luo



yellow
brown
white

L: 89.30 a: -2.84 b: 13.63
L: 33.94 a: 16.06 b: 1.19
L: 92.31 a: 1.41 b: -12.72

(gt - est)

L: 75.60 a: -2.06 b: 30.17
L: 23.41 a: 17.00 b: 7.92
L: 81.09 a: 3.36 b: 5.42

ΔE_{ab} : 21.49
 ΔE_{ab} : 12.54
 ΔE_{ab} : 21.42

Ground truth

Illuminance proxy

Ferwerda

Luo

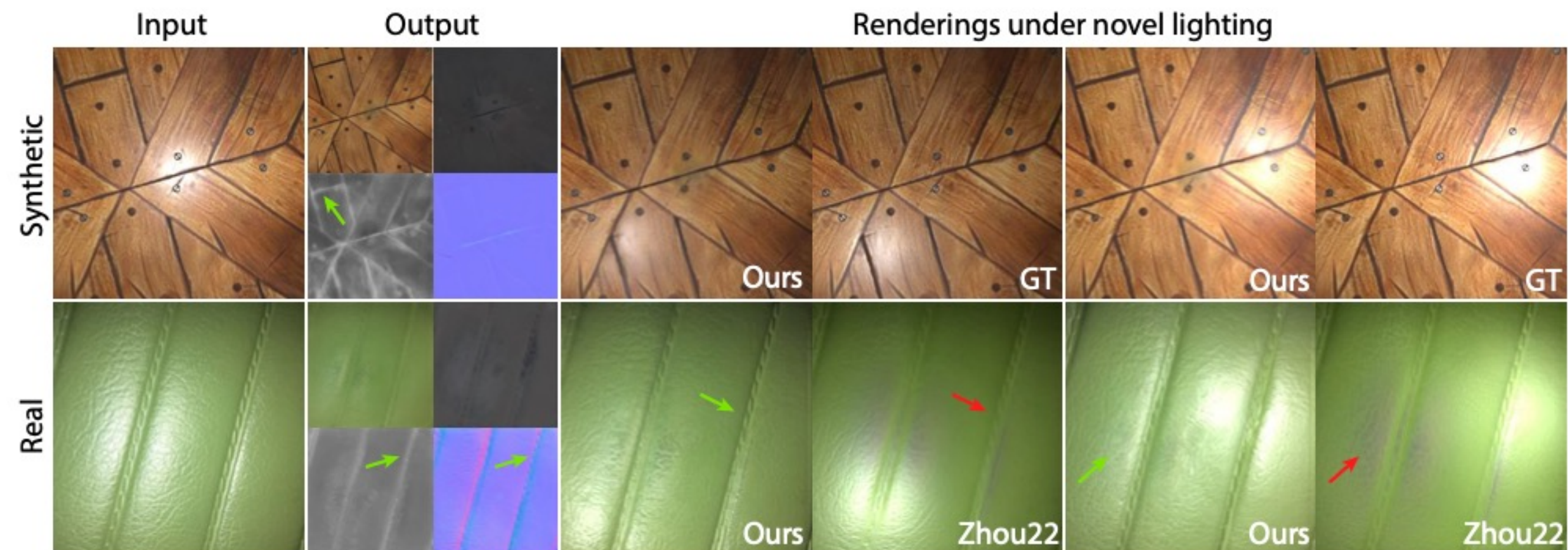
Single-Image SVBRDF Estimation with Learned Gradient Descent

X. Luo¹, L. Scandolo¹, A. Bousseau^{1,2} and E. Eisemann¹

¹Delft University of Technology, The Netherlands

²Inria, Université Côte d'Azur, France

1. Initial SVBRDF prediction
2. Render initial estimate
3. Compute reconstruction loss
4. Compute gradient
5. Feed into recurrent network
6. Predict update
7. Apply update
8. Repeat refinement



MBE

18

13

22

Ground truth

Illuminance proxy

Ferwerda

Luo



$RMSE_{DGP,9}$

0.0103

0.0103

0.0130

$PE_{TAI} [\%]$

101

65

133

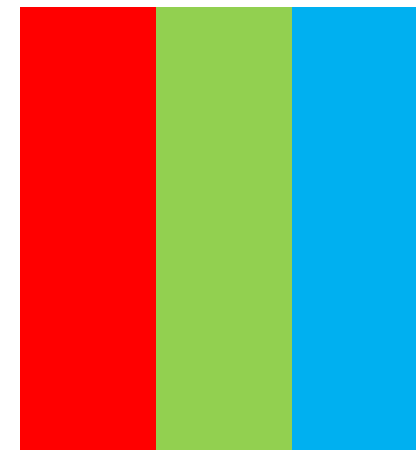
$e_{UDI,a} [\%]$

10

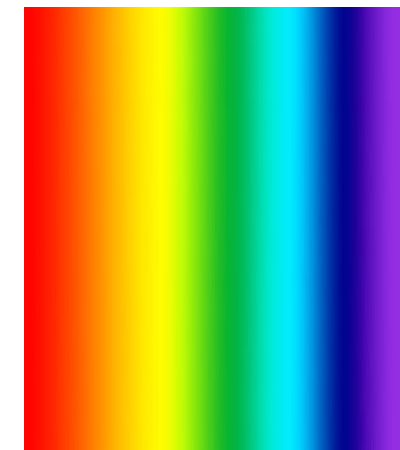
5

16

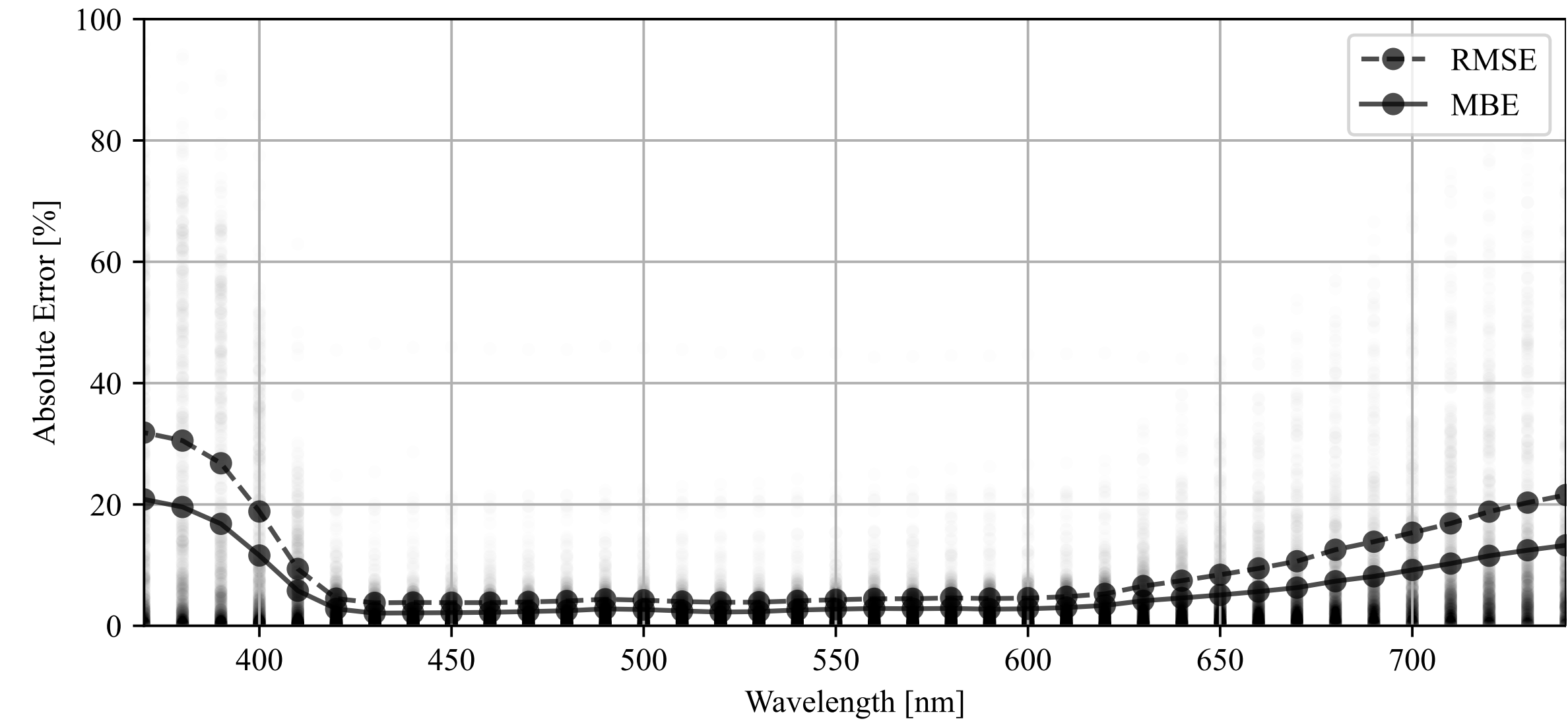
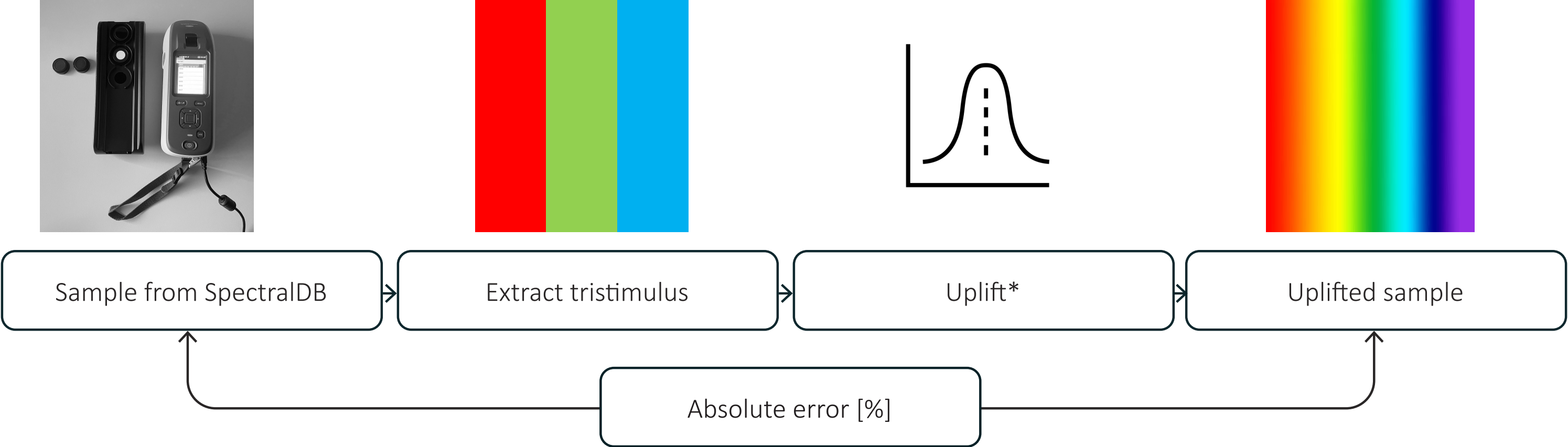
Spectral uplifting



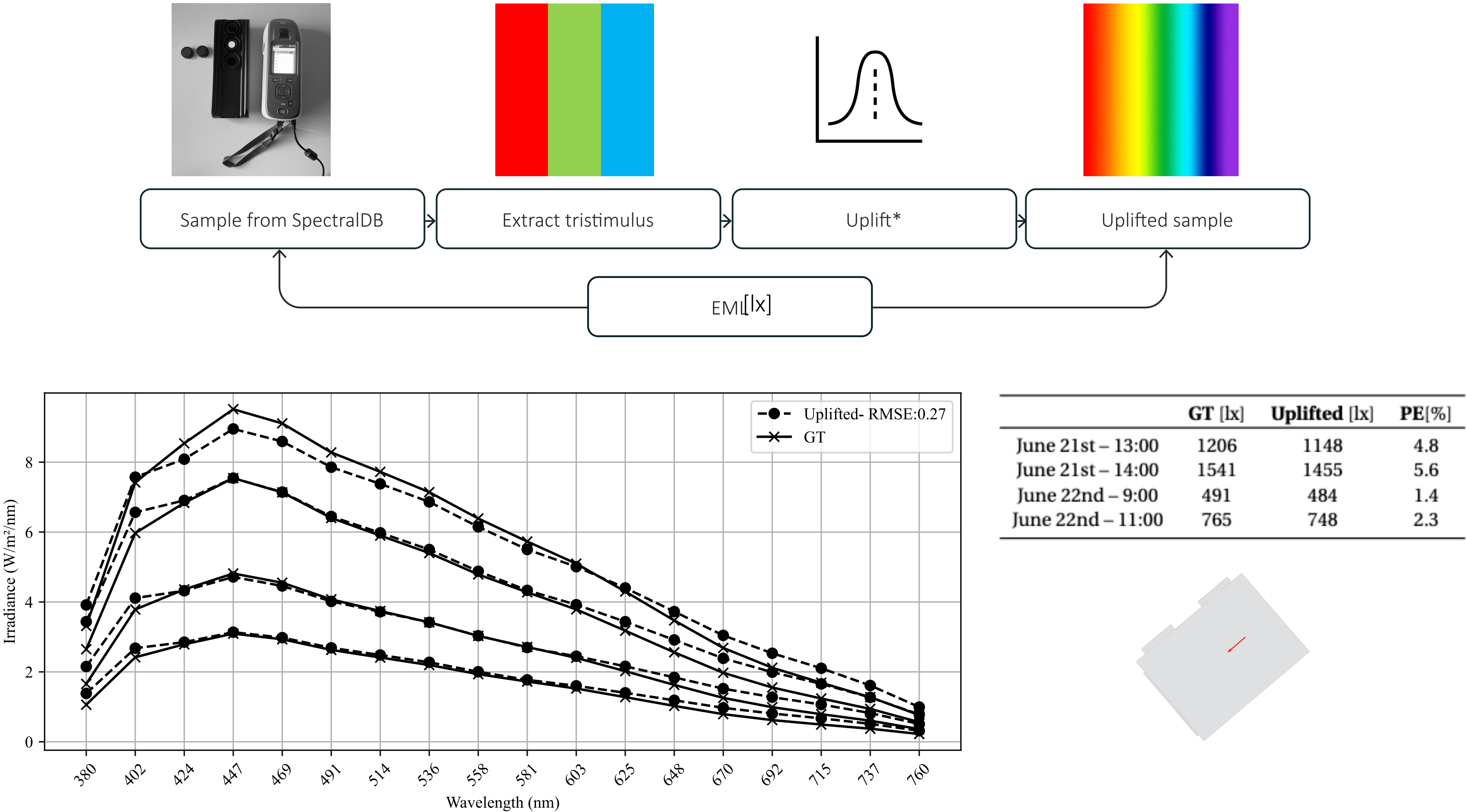
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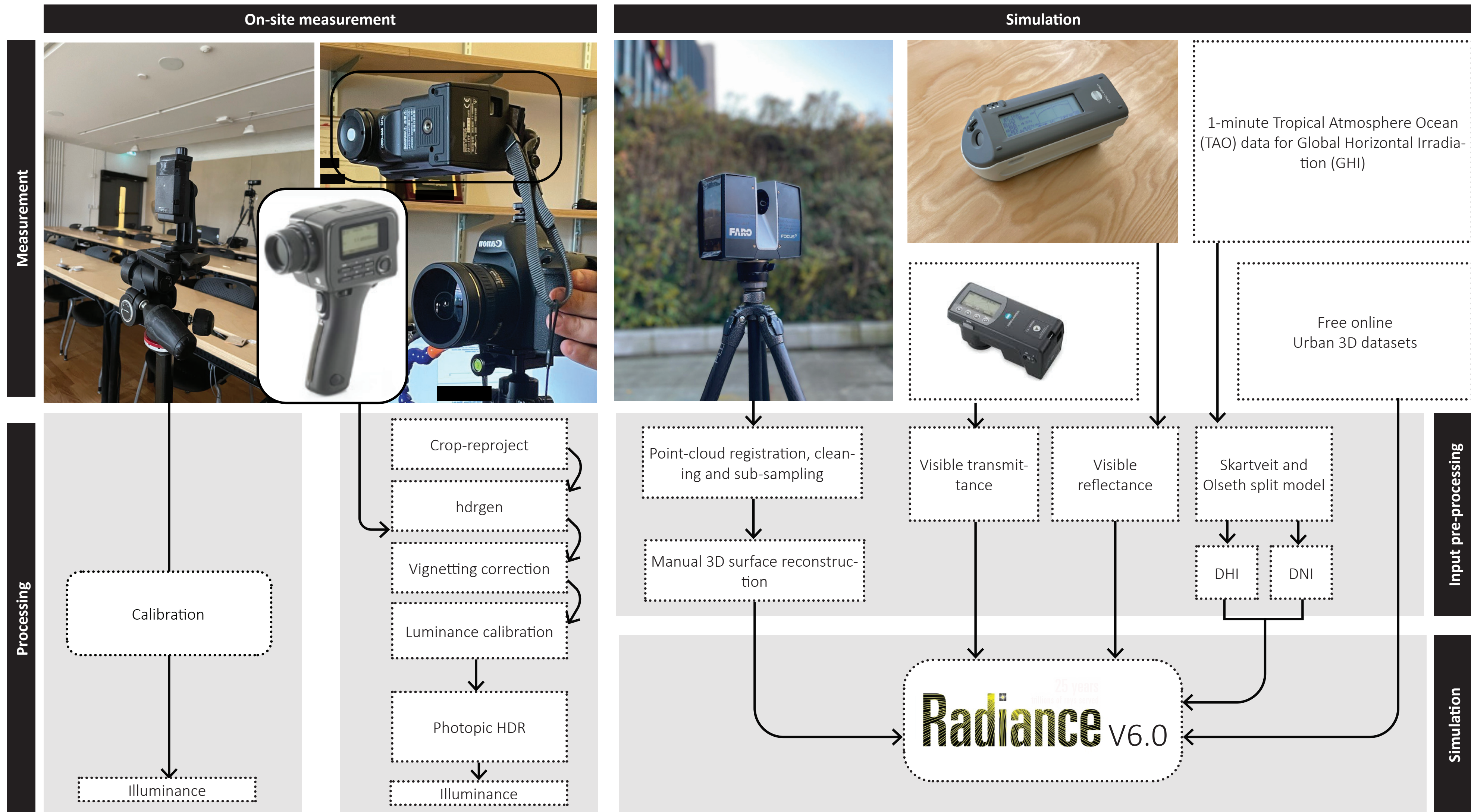


Spectral uplifting



Spectral uplifting





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Thank you!

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