VELUX Daylight Symposium
October 9th-10th 2019, Paris

CROWD-BASED ILLUMINANCE MAPS:

COMPARING DAYLIGHT PERCEPTION IN VIRTUAL REALITY TO EMPIRICAL METRICS

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DAYLIGHT SYMPOSIUM
大阪大学
OSAKA UNIVERSITY

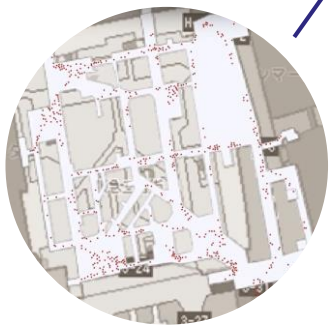
Architectural Morphology Lab,
Cybermedia Center
Osaka University, Japan

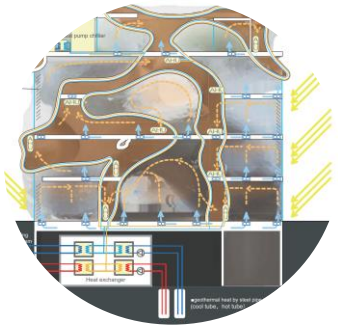
BIM | VR | User-Oriented Design | AI

Cyber Society | AR | Urban Regeneration

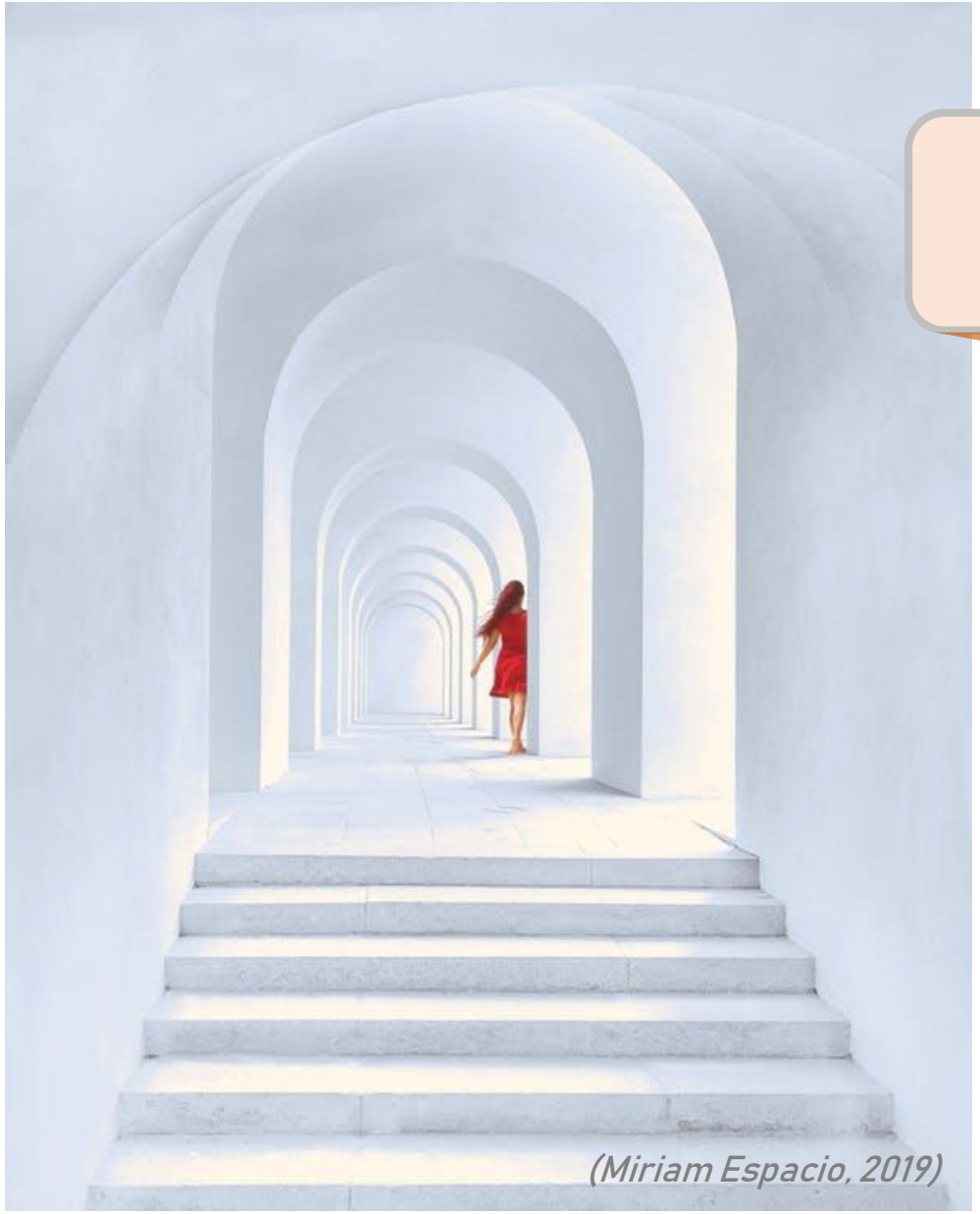
Game Design | Crowd Simulation | Real-time Rendering

Computational Design | Community-based Design

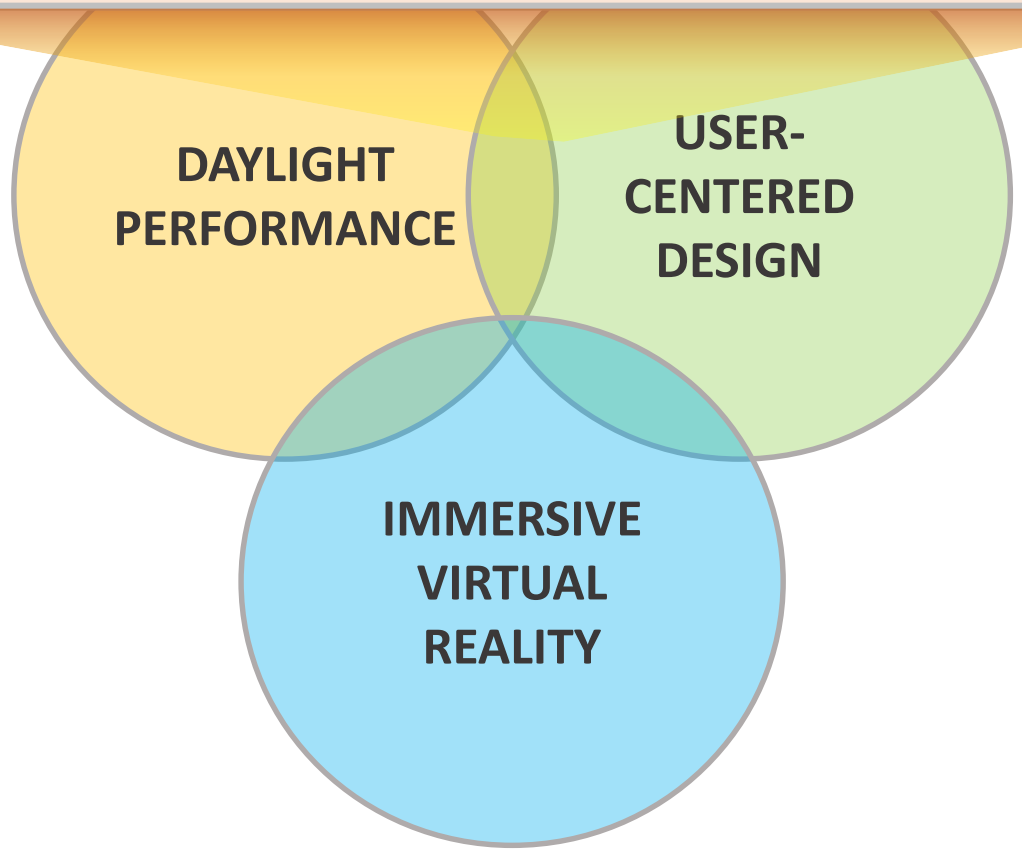




Muhammad Hegazy



HOW CAN DAYLIGHT PERFORMANCE METRICS BE MORE USER-ORIENTED?



Daylighting Impact on Buildings' Occupants

90%[1]
Time spent indoors

16%[2]
Variation of annual learning progress

15%[3]
More creative

44%[3]
State daylight as 1st need in workplace

Up to **40%**[1]
Gain in productivity

46 mins[4]
More sleep per night

(i-buildmagazine.com, 2019)

1.(Sustania, 2012)
2.(Barrett, 2015)
3.(Global Human Spaces Report, 2015)
4.(Boubekri, 2014)

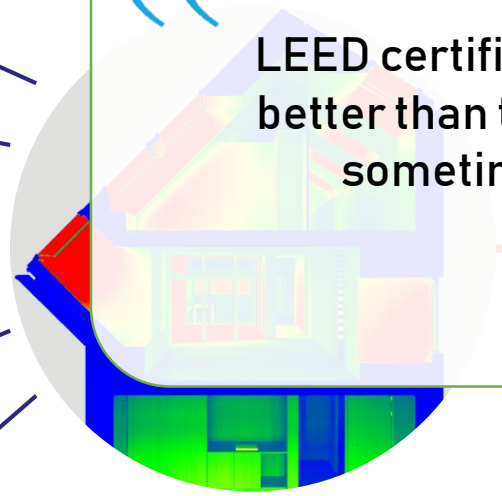
The dilemma of Daylight Quantitative Metrics

- Physically accurate.
- Essential for design stage.

- Don't reflect occupant behavior.
- "Generic" user models.

Building Performance Simulations (BPS)

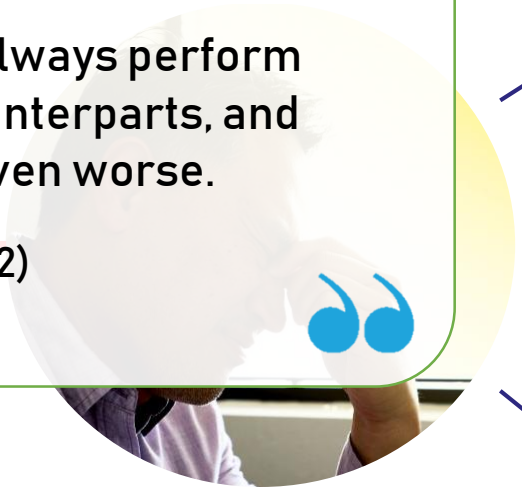
- Illuminance
- Luminance
- Useful Daylight Illuminance
- Daylight Autonomy
- Annual Sunlight Exposure



(Velux, 2019)

> LEED certified buildings don't always perform better than their traditional counterparts, and sometimes they perform even worse.
>
> (Newsham et al., 2012)

Building's occupants



(view.com, 2018)

- Visual comfort
- Productivity
- Perception
- Behaviors
- Occupational rates

Perceptual qualities of daylighting

Assessing daylight based on human perception is as important as quantitative measurements.

(Paredes, 2016)

Immersive Virtual Environments (IVEs) are adequate to investigate human perception of daylighting.

(Chamilothori, 2018)

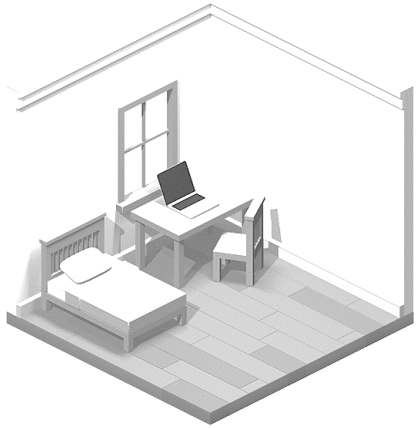
Immersive
full visual field, sensation of presence.

Virtual
mobile, flexible, safe, economic

Environment
realistic, scale-free, customizable

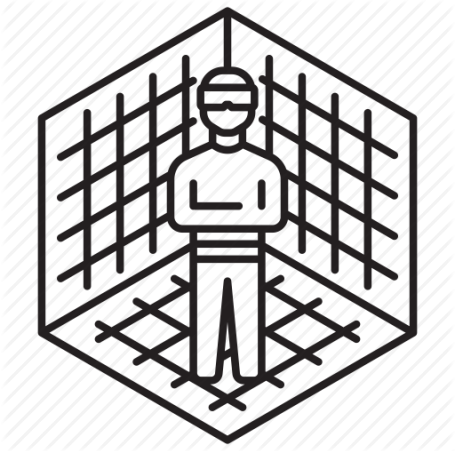
Limitations on current studies

Lack of Richness



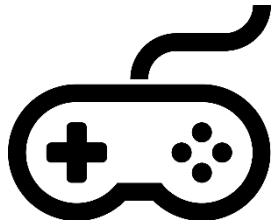
- simple, small scale spaces.
- focus on office spaces only.

Lack of Locomotion



- one standing point.
- Lack of interaction (customization)

Lack of Interactivity

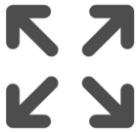


- Questionnaires dependent.
- No integrated challenges/tasks.

How to improve outputs of daylight perception in IVEs against quantitative metrics?


Photorealistic


Explorable


Large-Scale


Customizable


Gamified

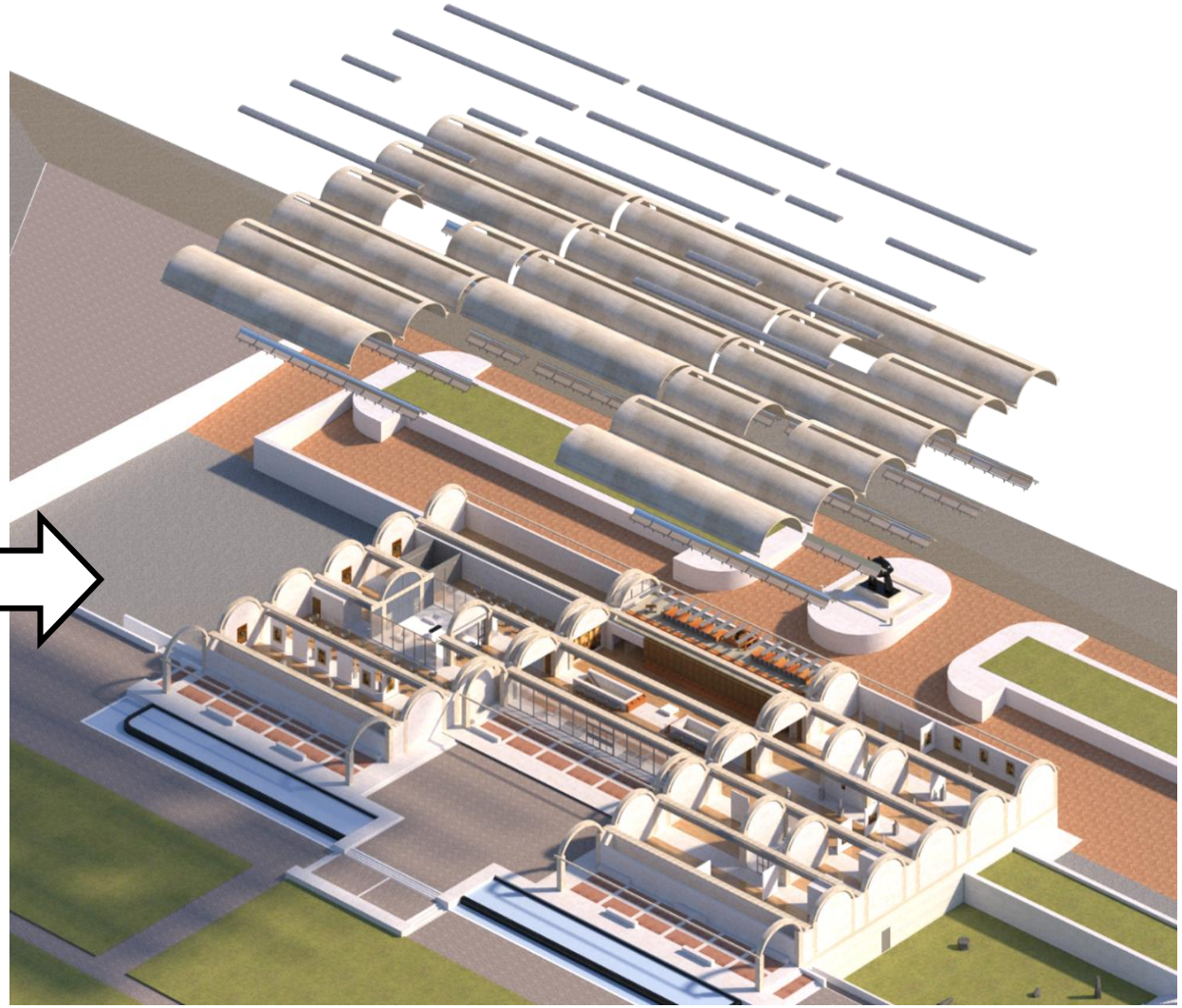
Crowd-Based Illuminance Maps

Experiment case study

Kimbell Art Museum, Fortworth TX

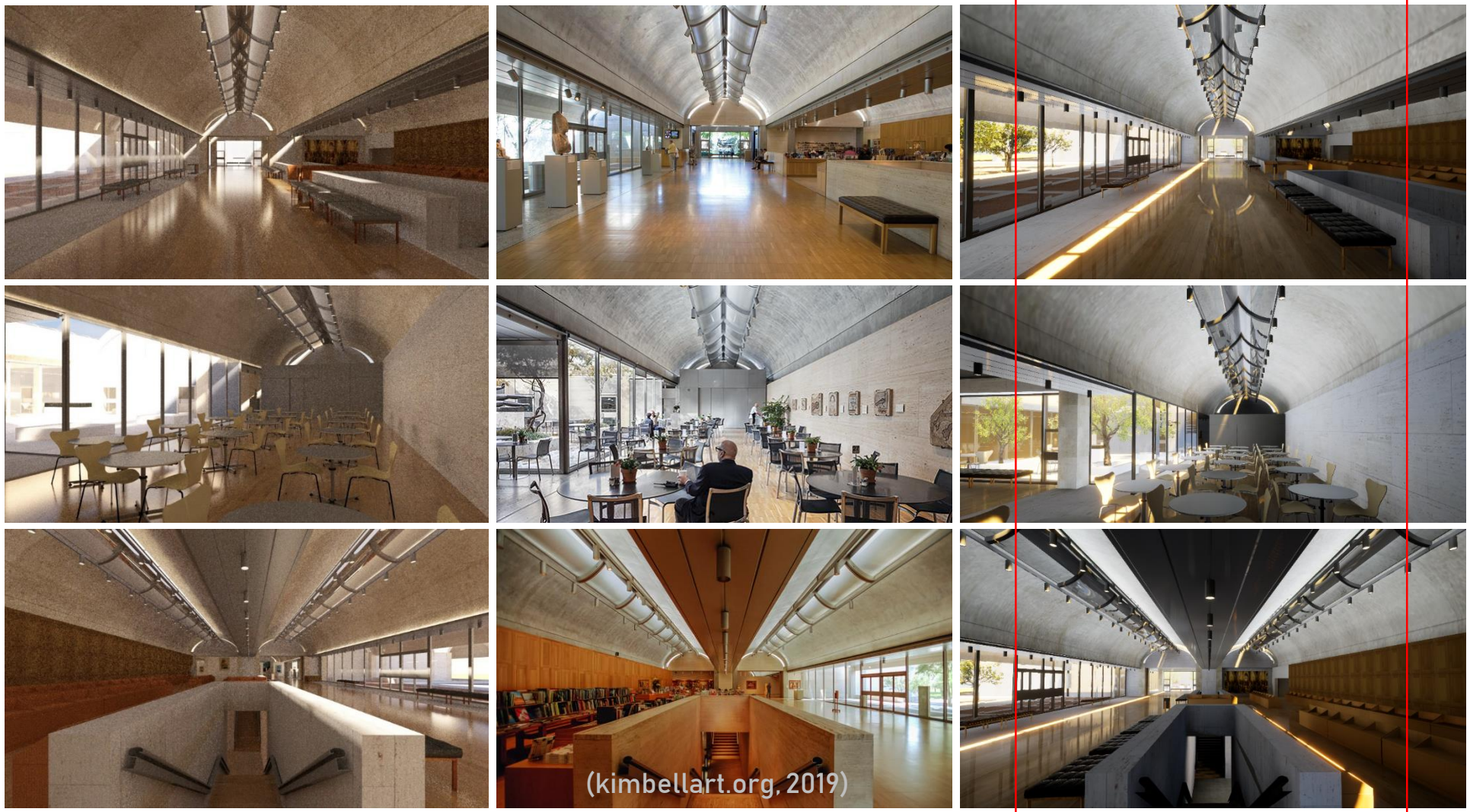
- By Louis Kahn.
- Unorthodox daylighting qualities.

(kimbellart.org, 2019)

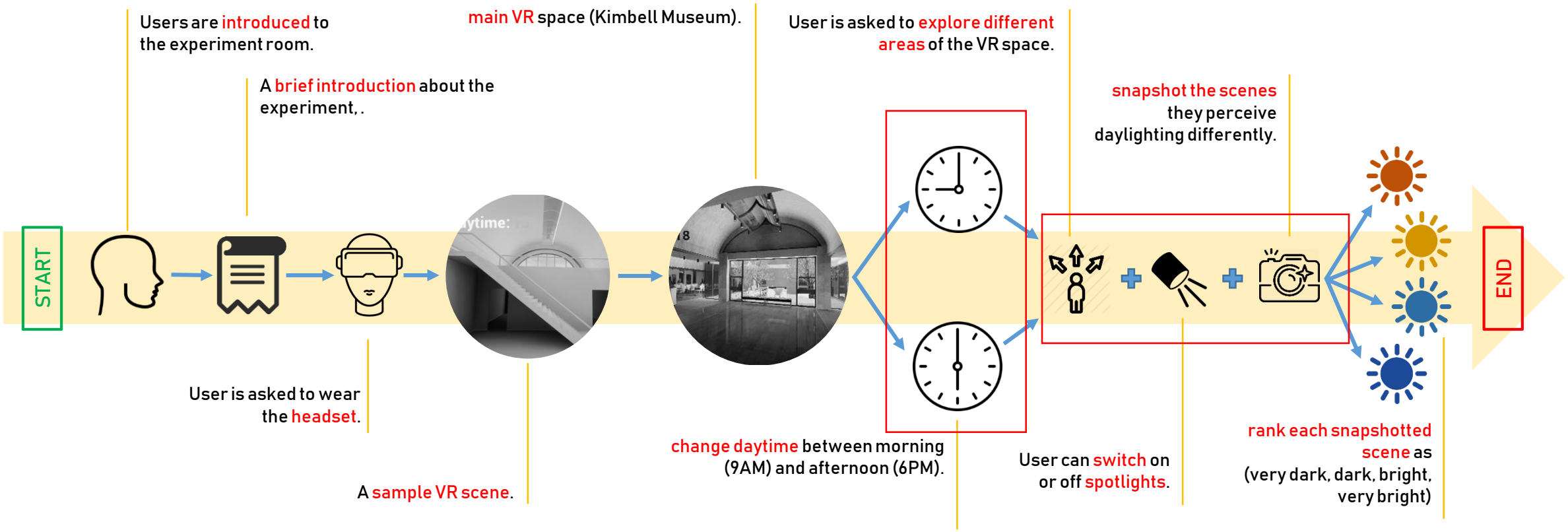


Experiment case study

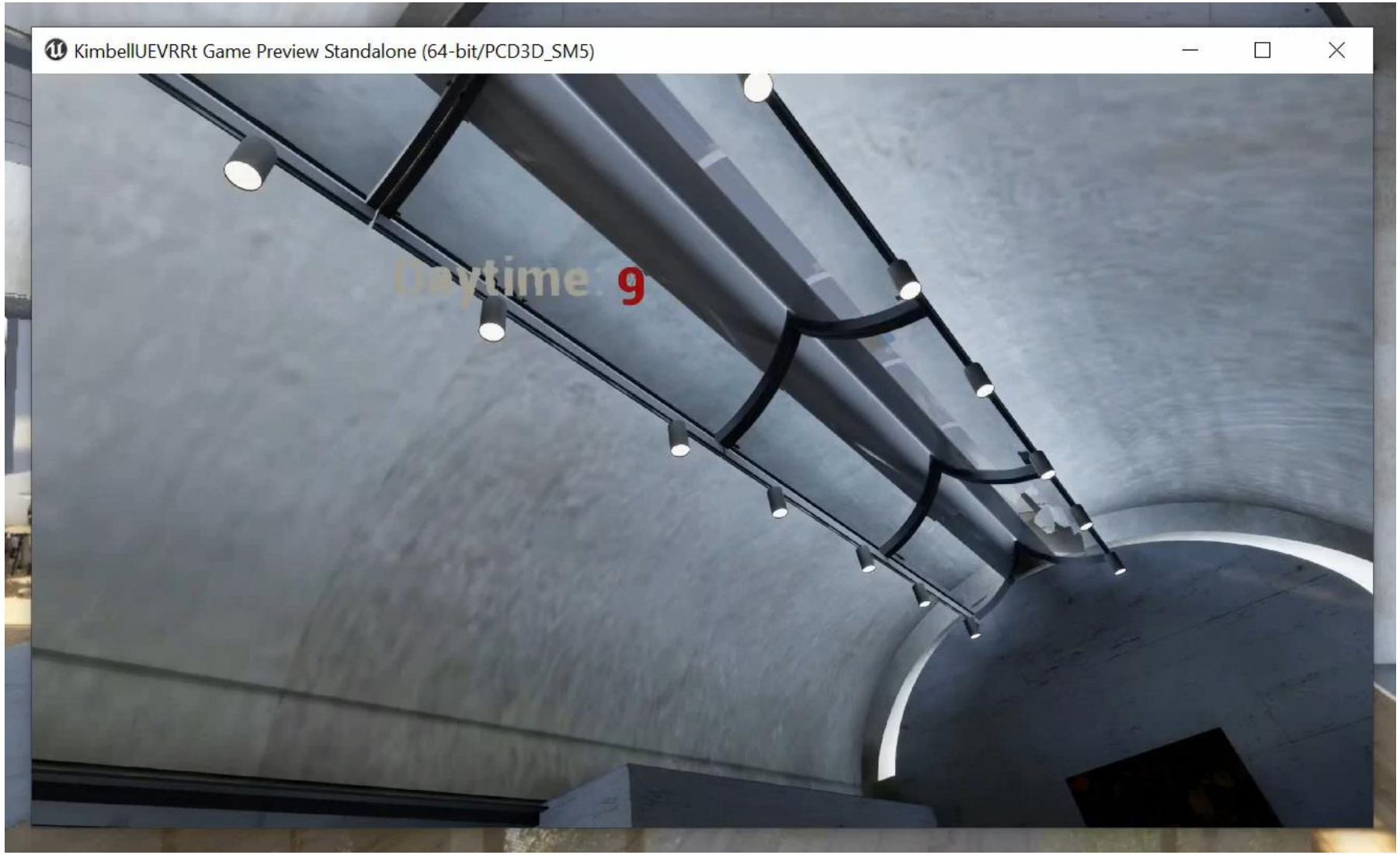
CPU Rendering | Real life | Real-time Raytracing



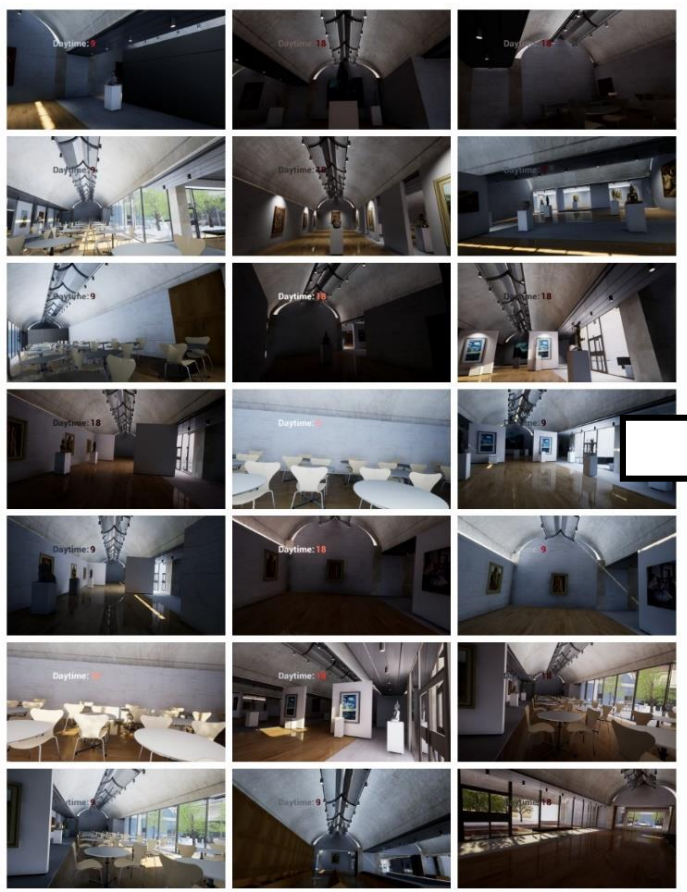
Experiment workflow



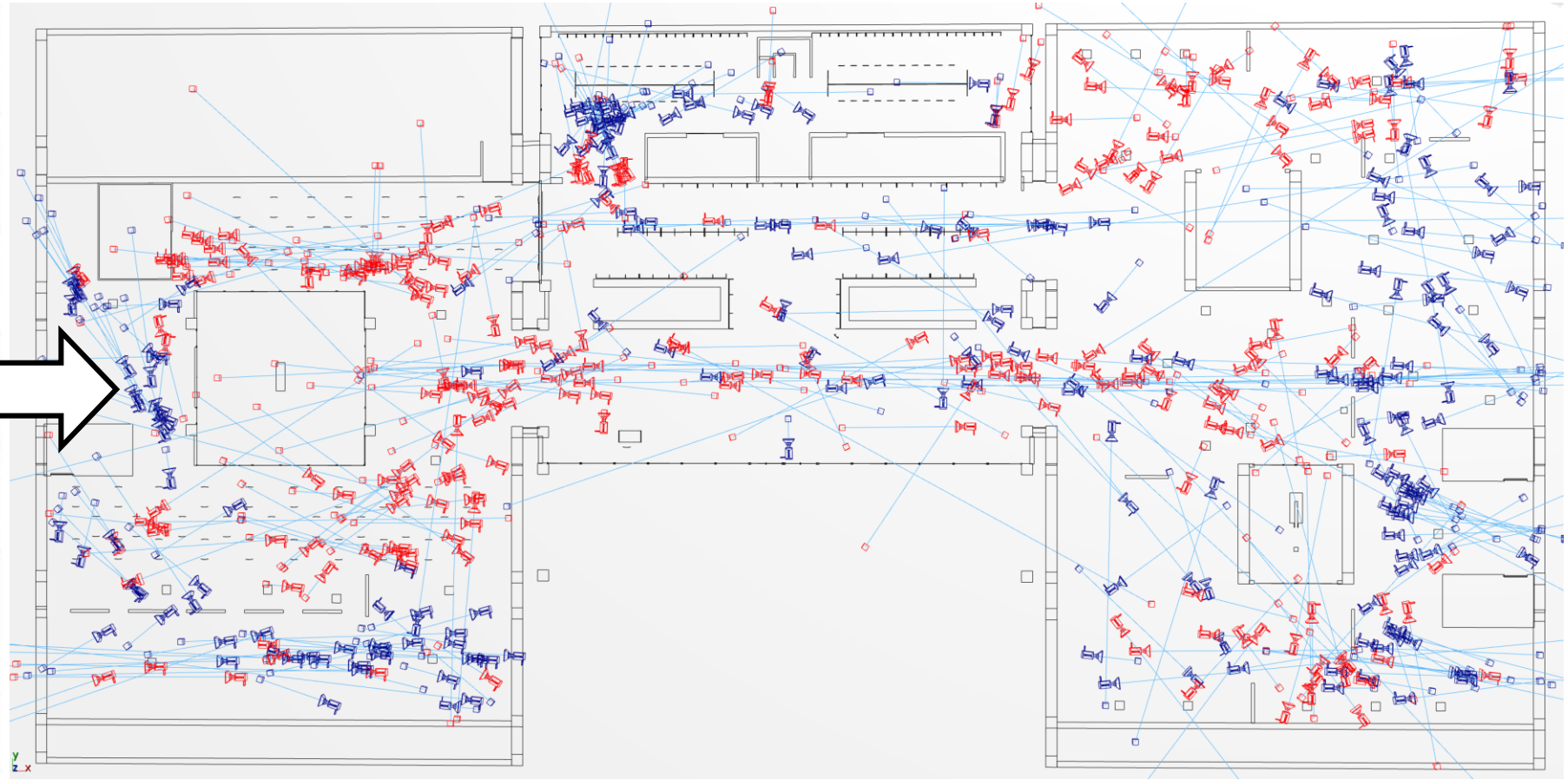
Experiment workflow



Generating crowd-illuminance maps

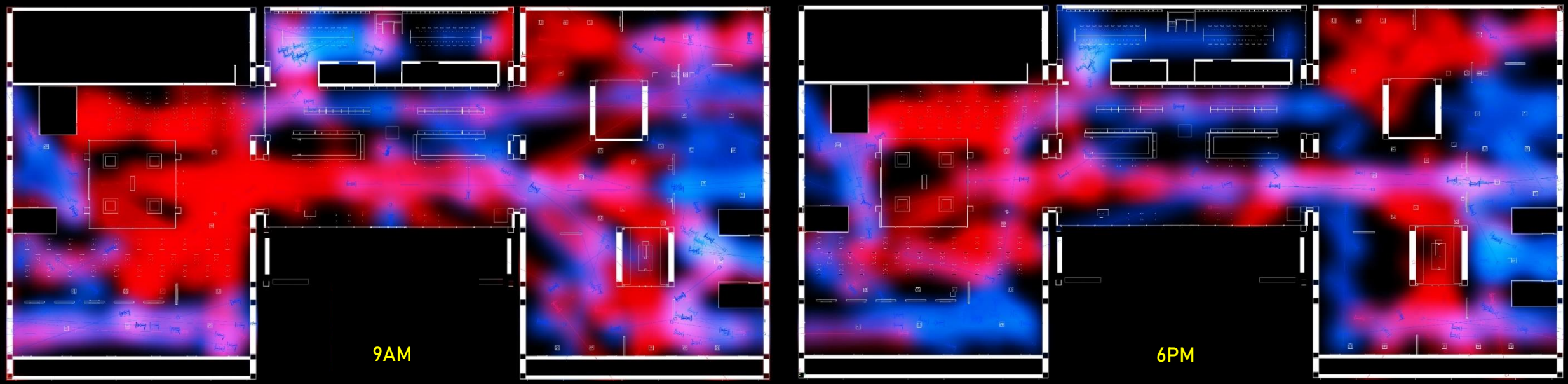


Users snapshots

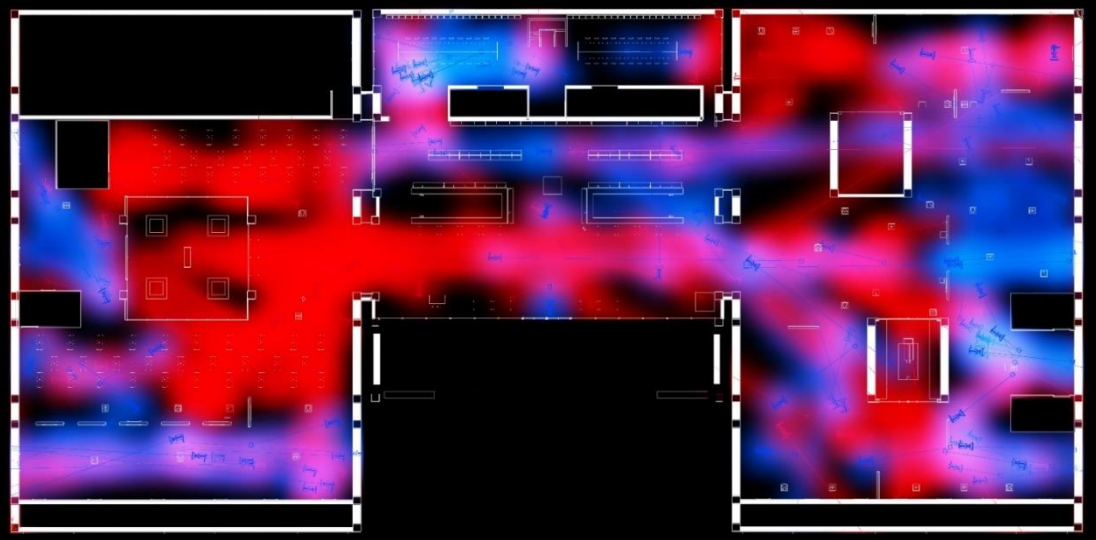


Crowd camera map

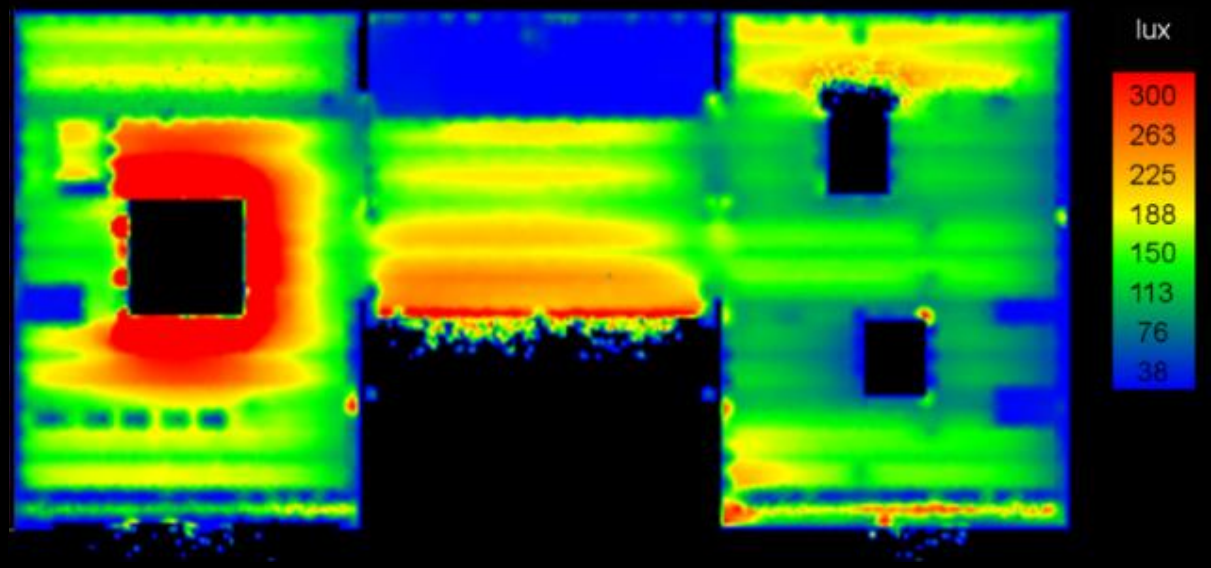
Generating crowd-illuminance maps



Comparing perception maps to quantitative simulations



Crowd based illuminance

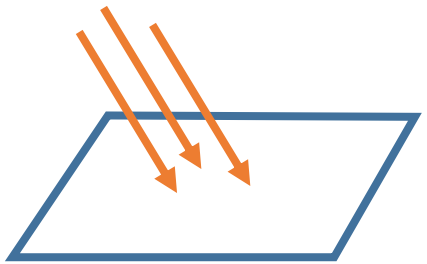


Illuminance map (VELUX Daylight Visualizer)

Ambient environment

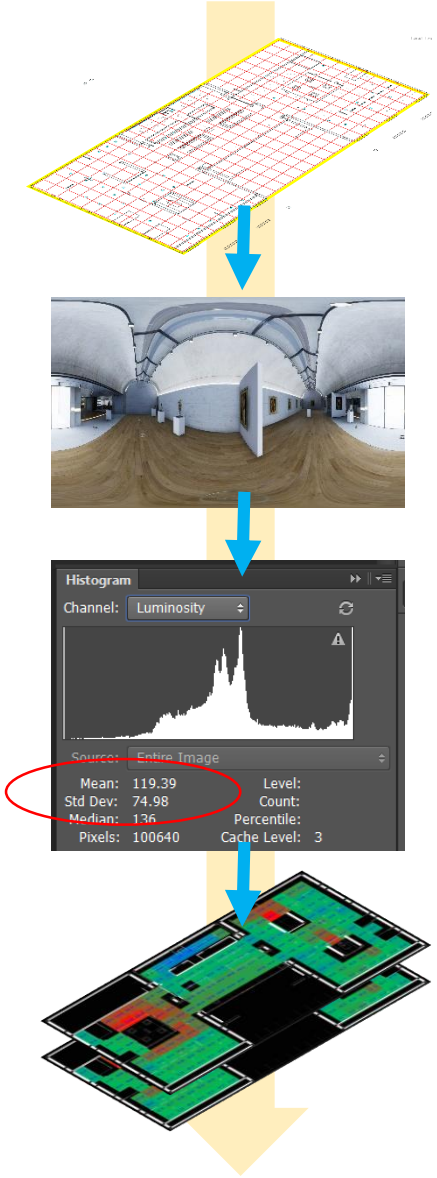
Surround Based Metric?

X



Luminous flux on surface

Comparing perception maps to quantitative simulations



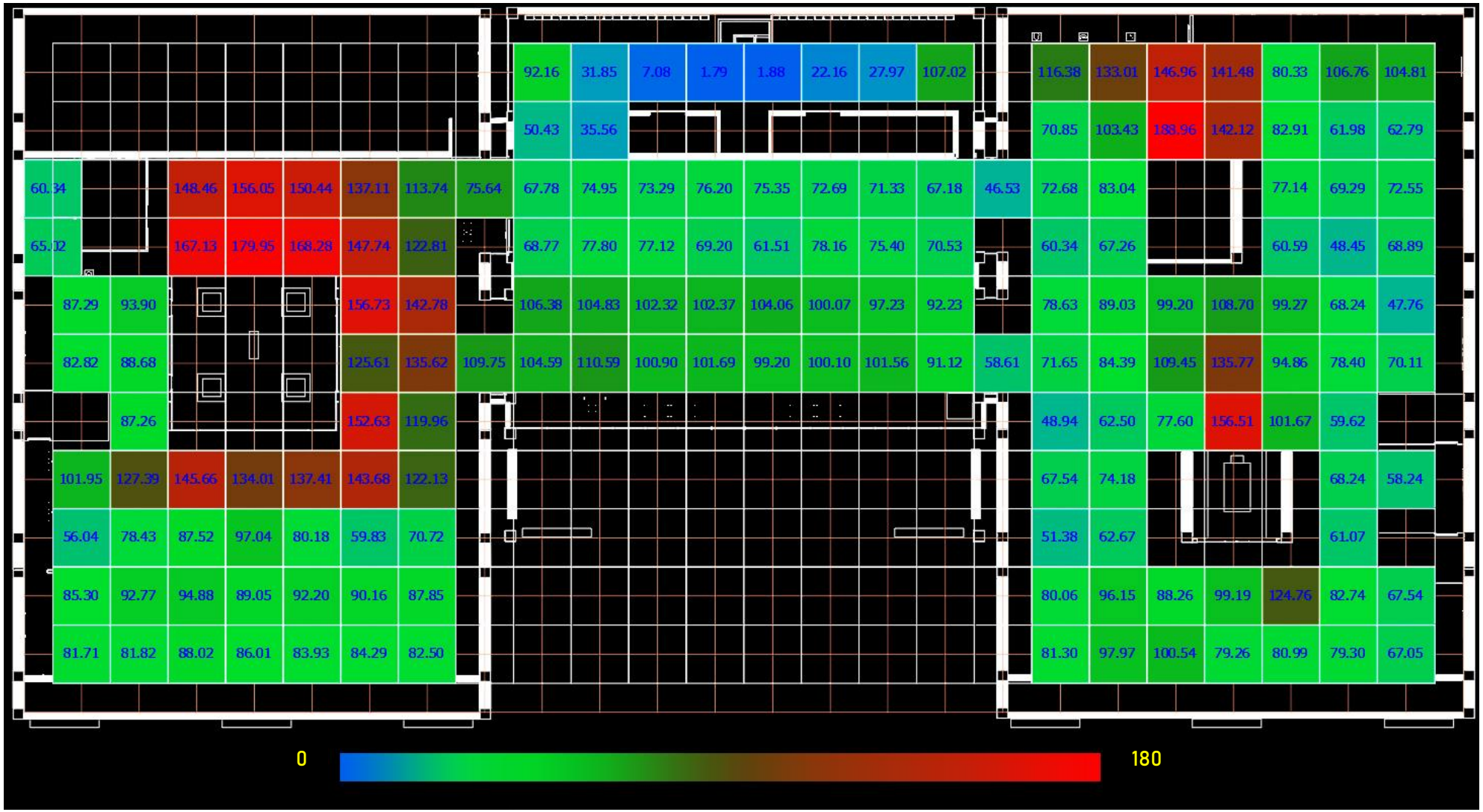
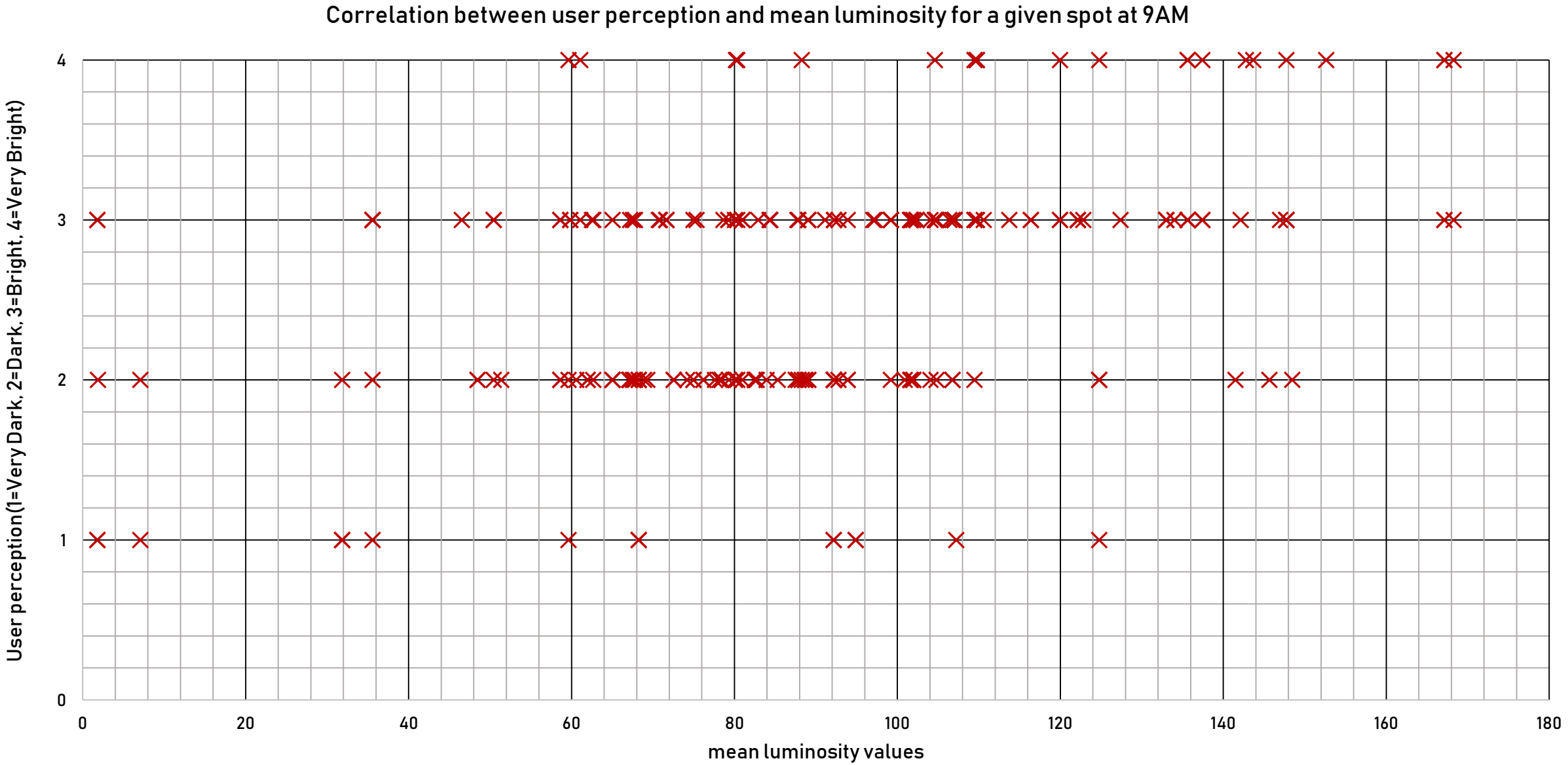


Image-based luminosity mean values (9 AM)

Comparing perception maps to quantitative simulations

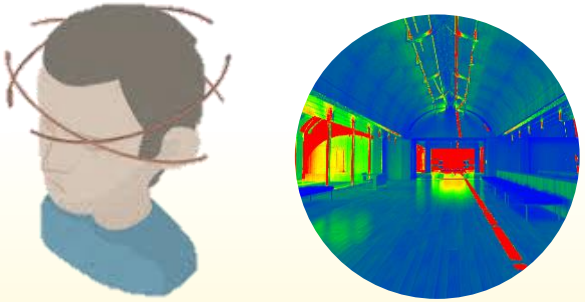


Comparing perception maps to quantitative simulations

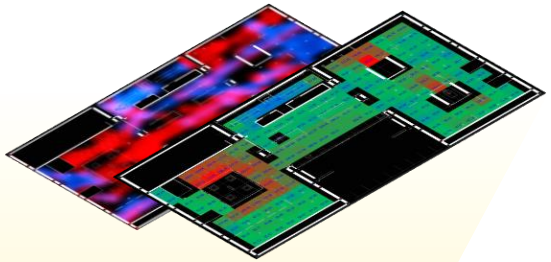
Future research challenges

Why mixed perception happen?

Overcoming VR limitations?



Consistency with further daylight metrics?



A unified metric that consider both subjective and quantitative qualities of daylighting

THANK YOU

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