

2016 IRW

15th International Radiance Workshop



Daylight in Heritage Spaces

A Combined CBDM and HDR Project

J. Mardaljevic[▼], S. Cannon-Brookes[▼], K. Lithgow[▼] and N. Blades[▼]

[▼] School of Civil & Building Engineering, Loughborough University, UK

[▼] Bartlett School Env. Energy & Resources, UCL, London, UK

[▼] National Trust, Heelis, Kemble Drive, Swindon, UK

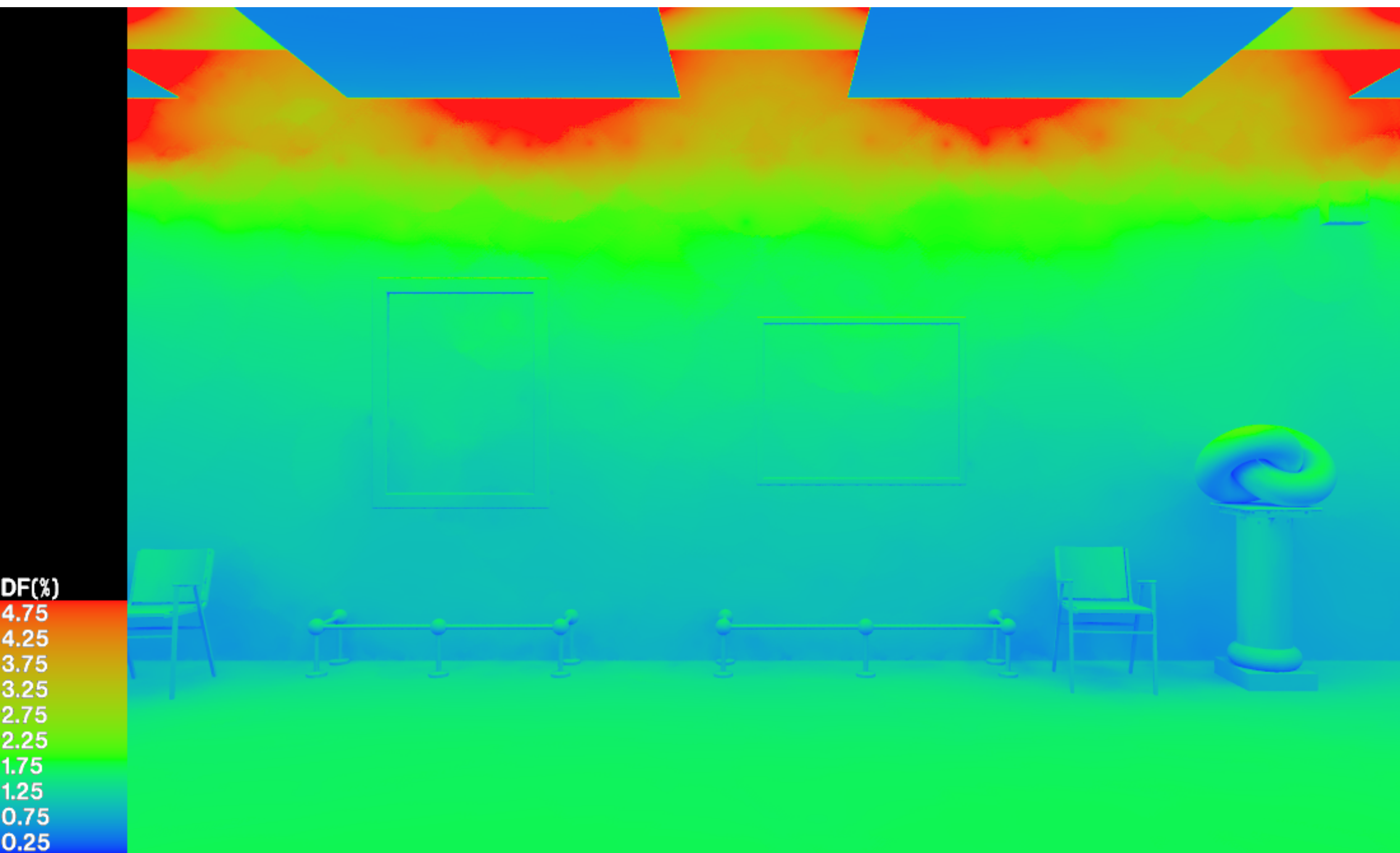




Measurement
Simulation
Or both?

ection
<<<

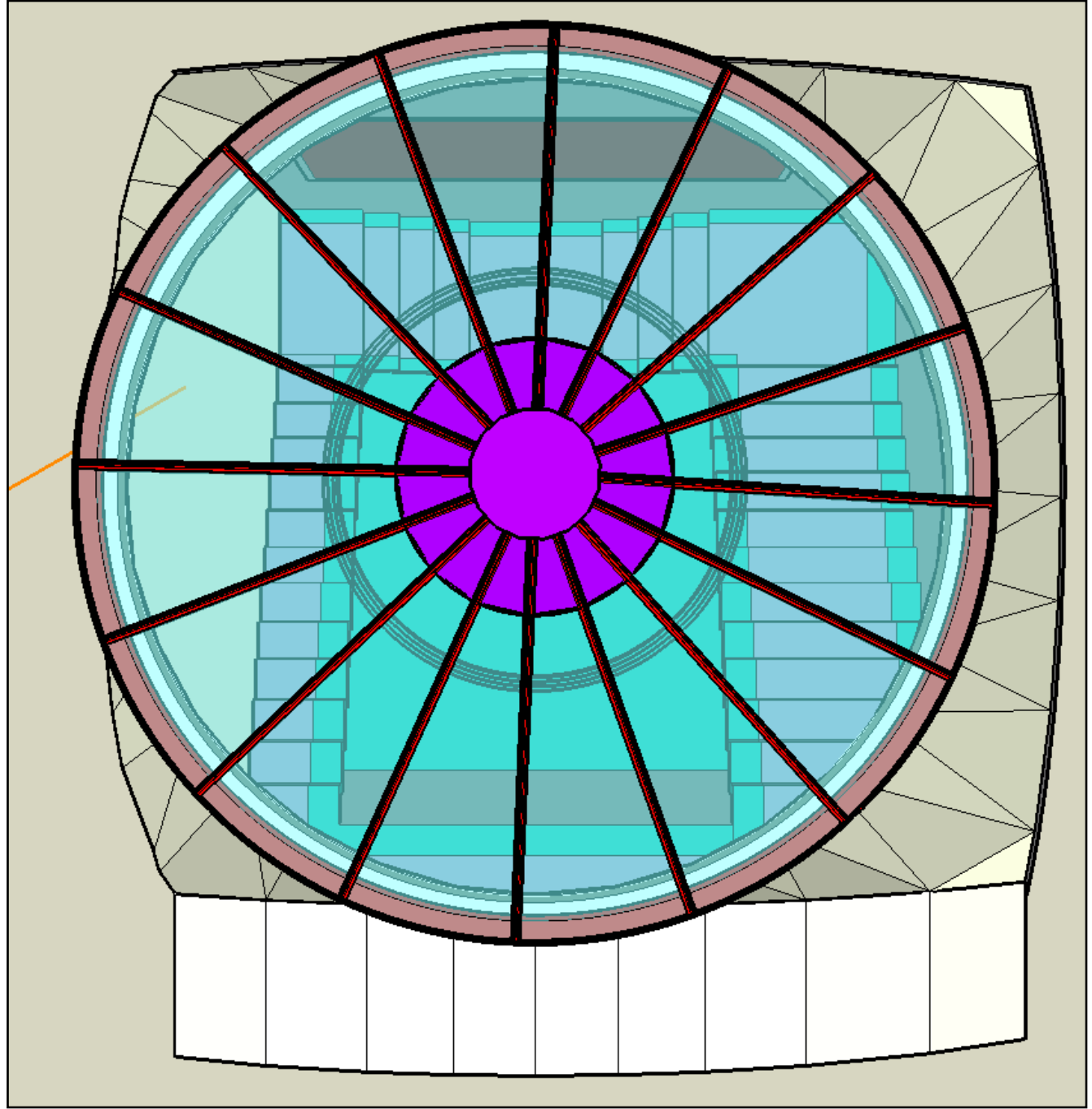
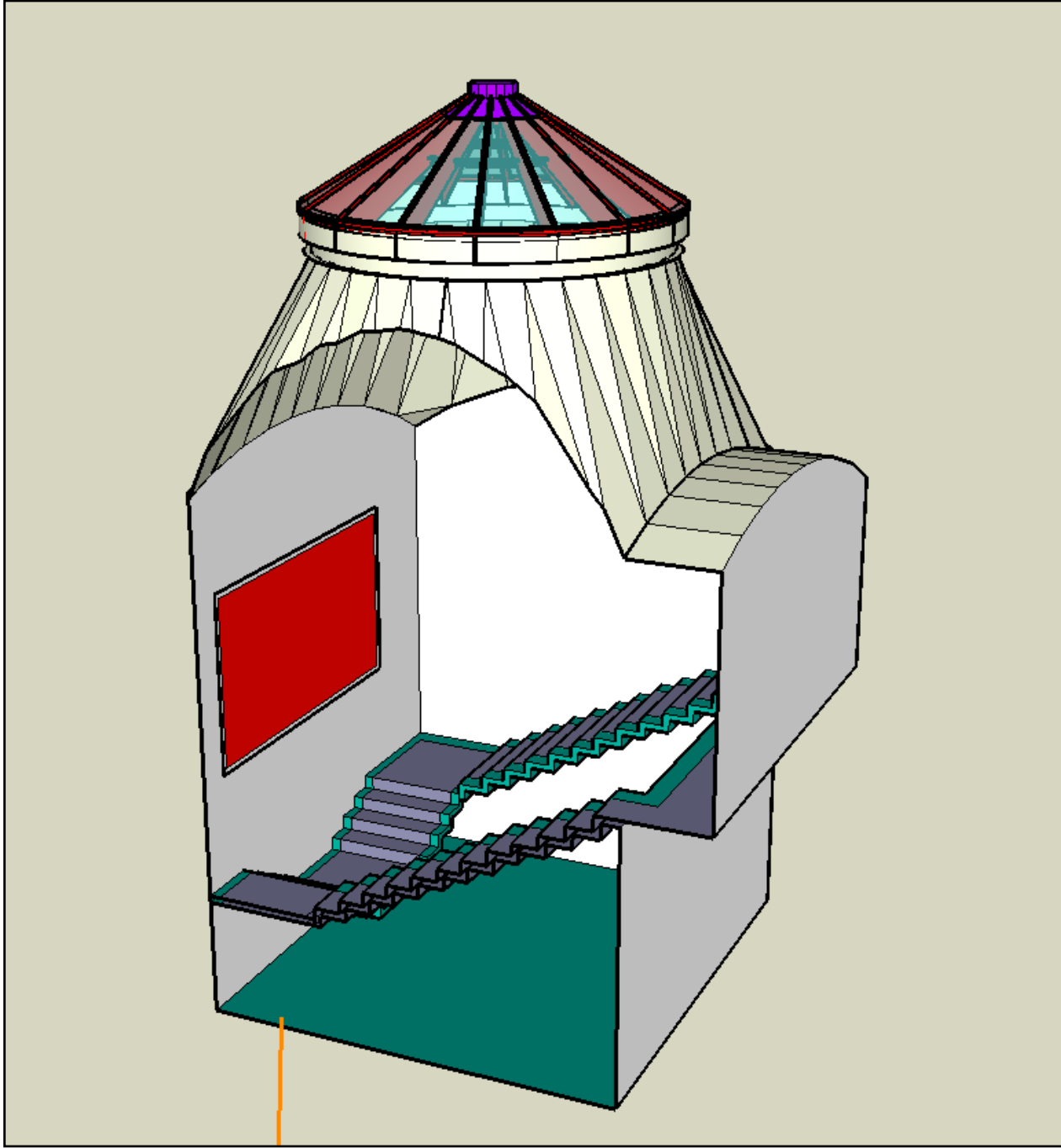




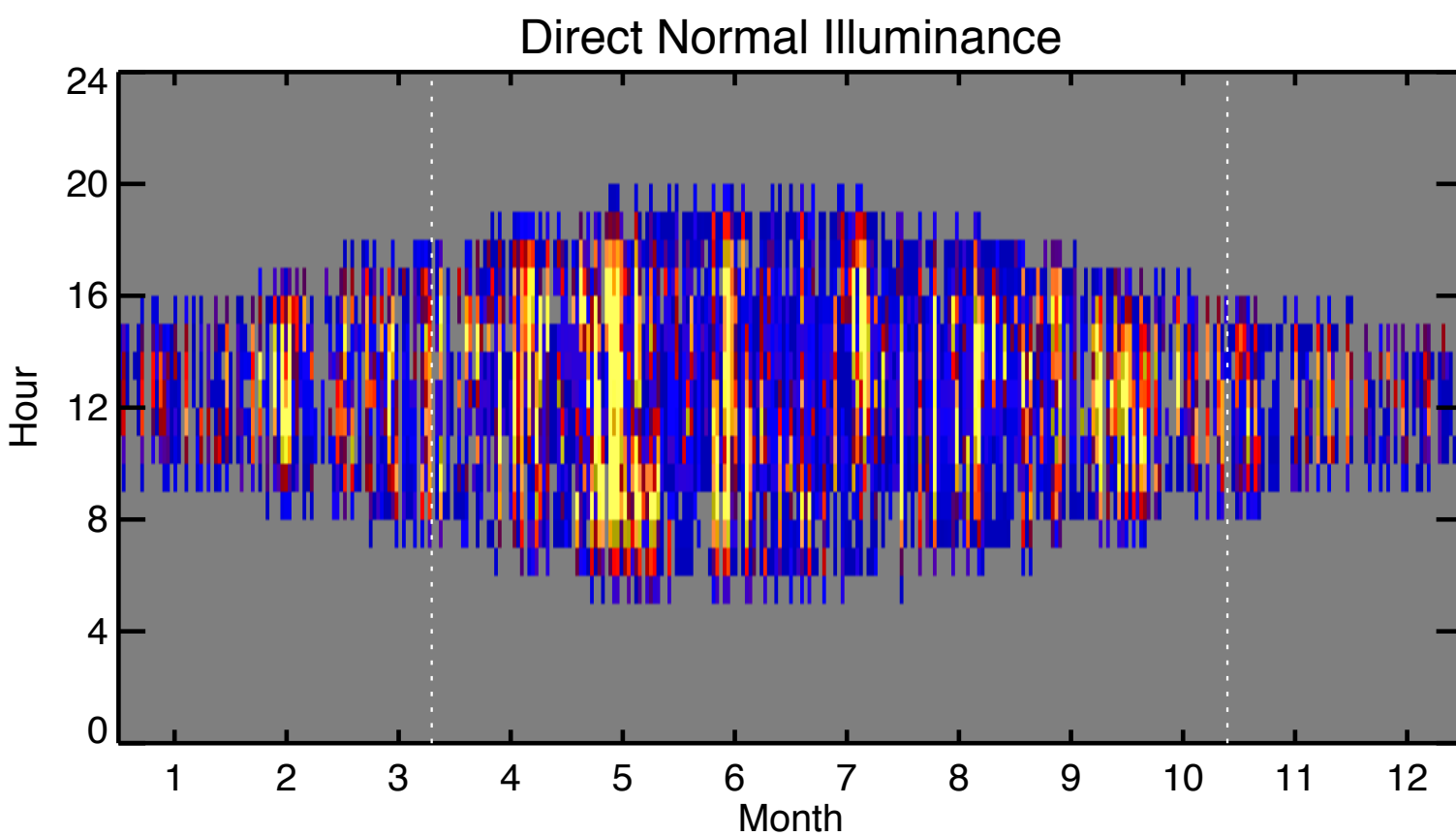
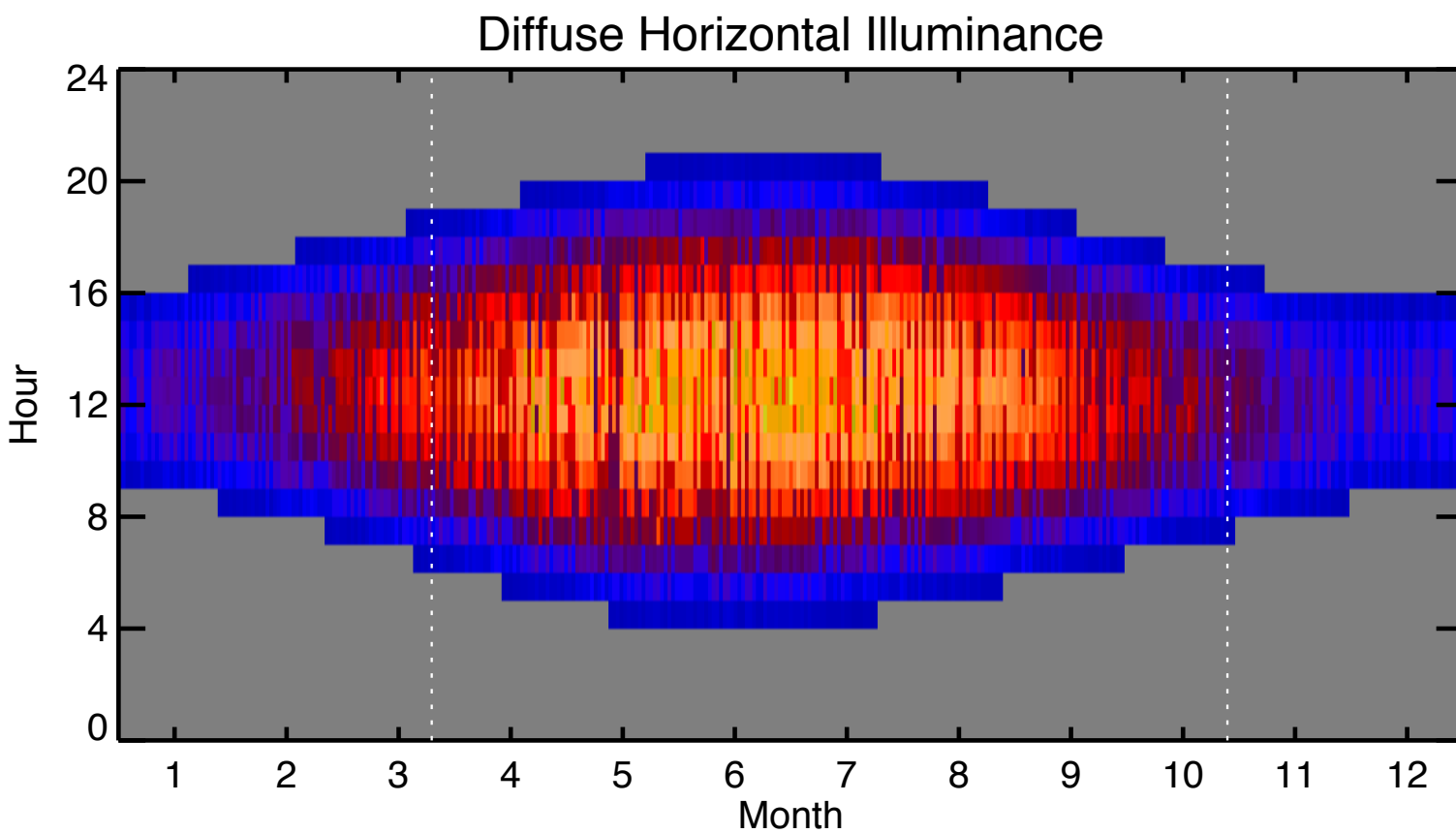


Mount Stewart, Belfast

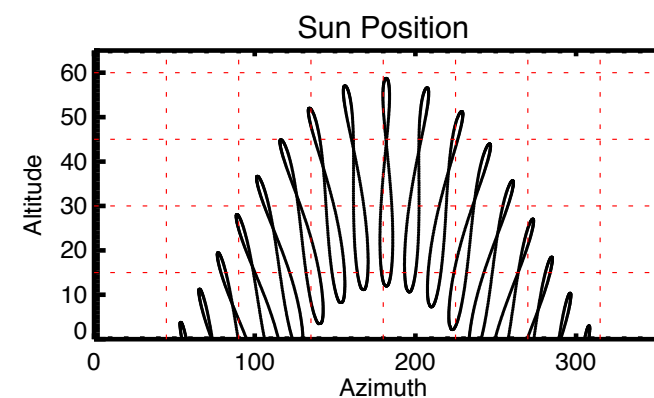
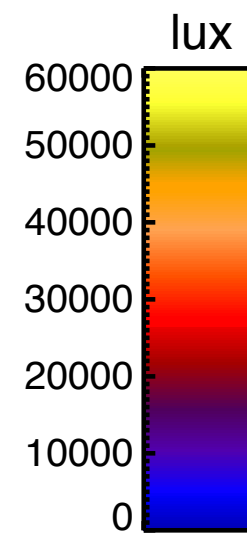
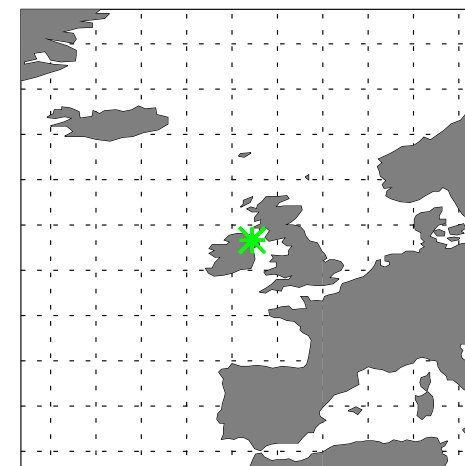




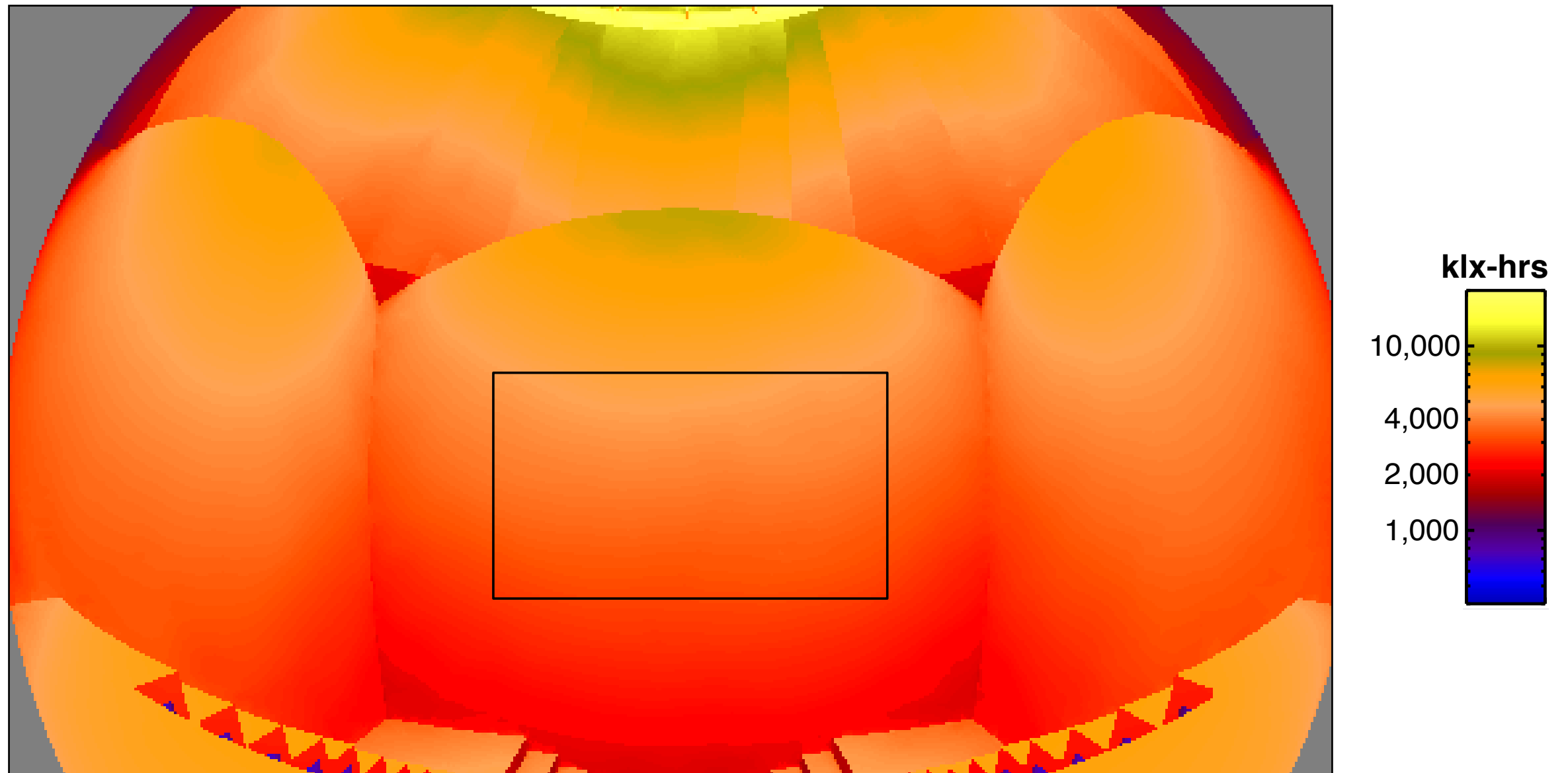
Climate-based daylight modelling predictions

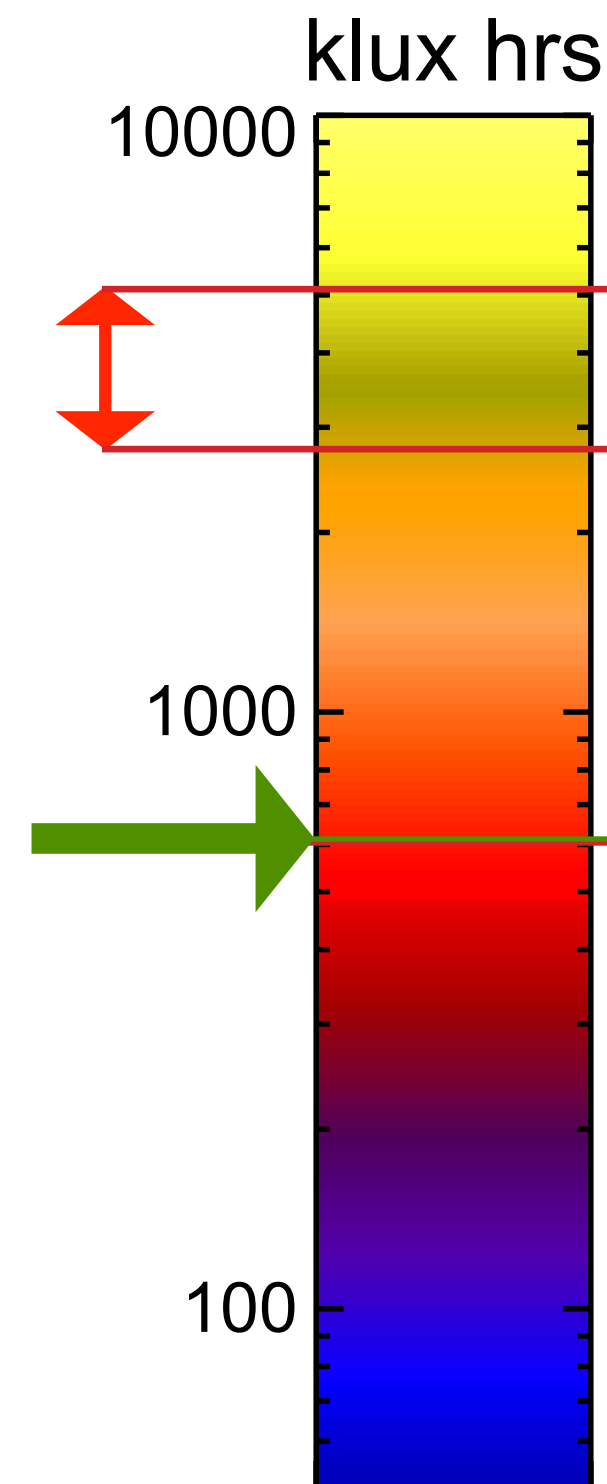
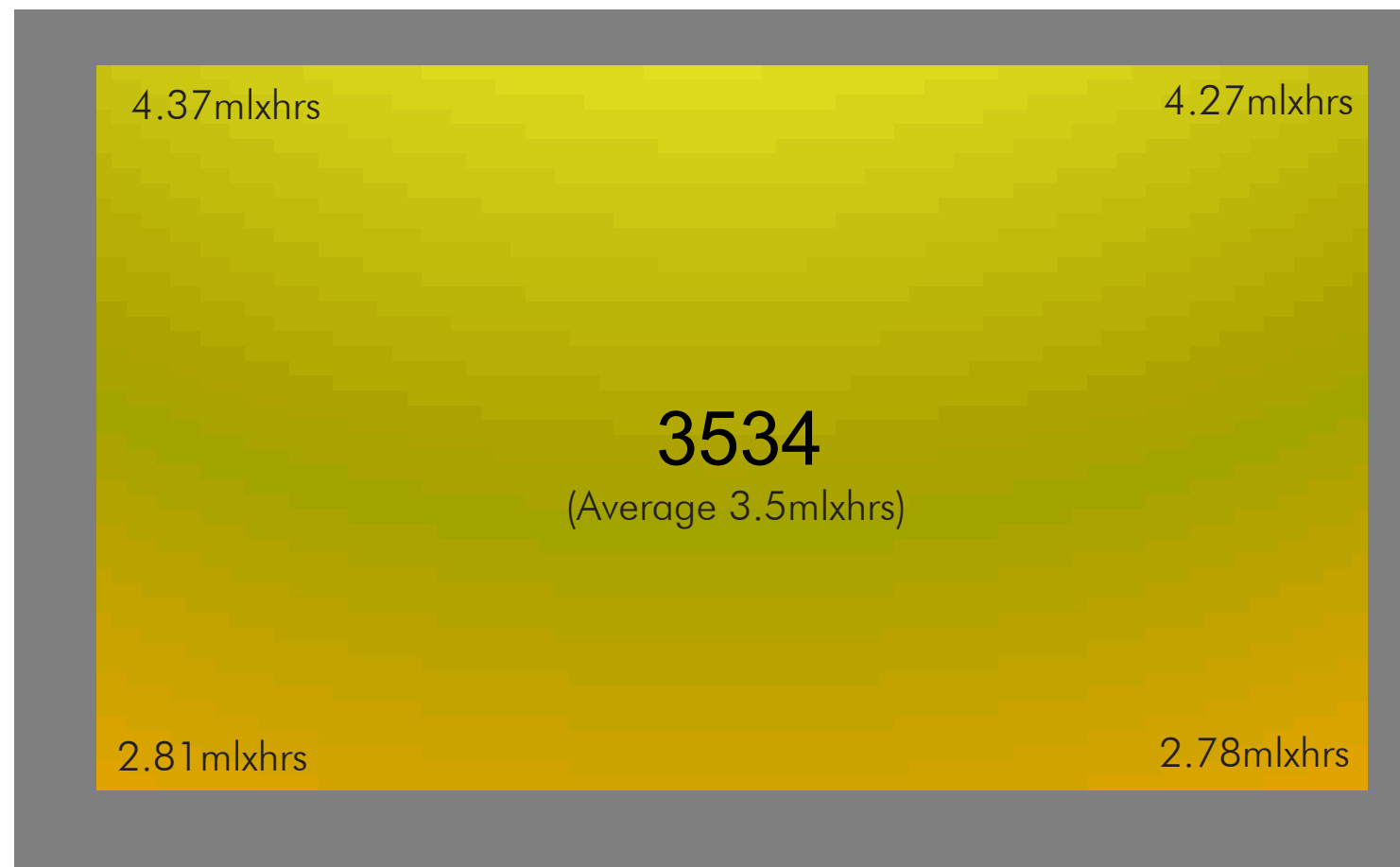


GBR-Belfast



Cumulative annual illumination





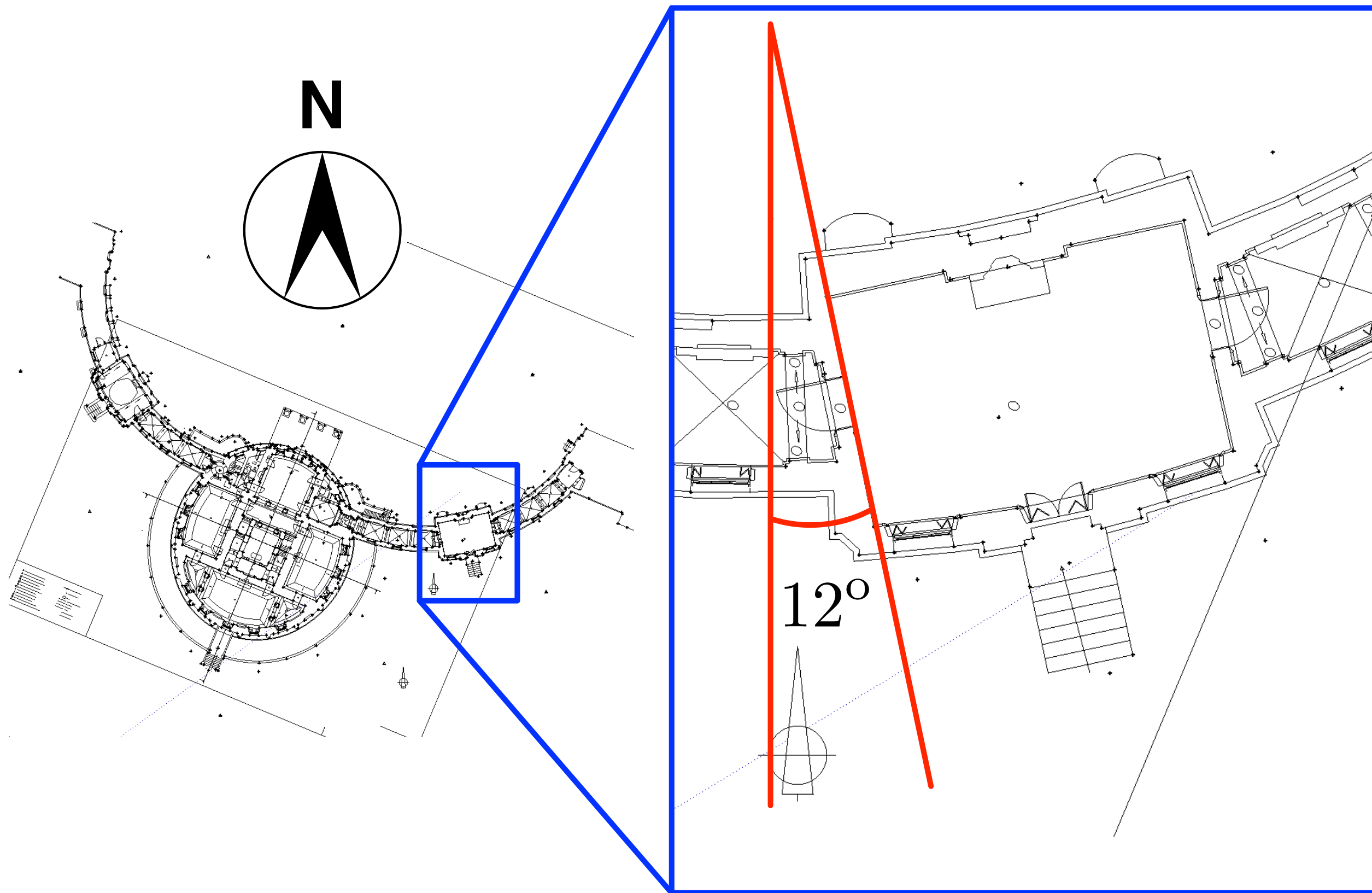


Interventions were
tested using simulation





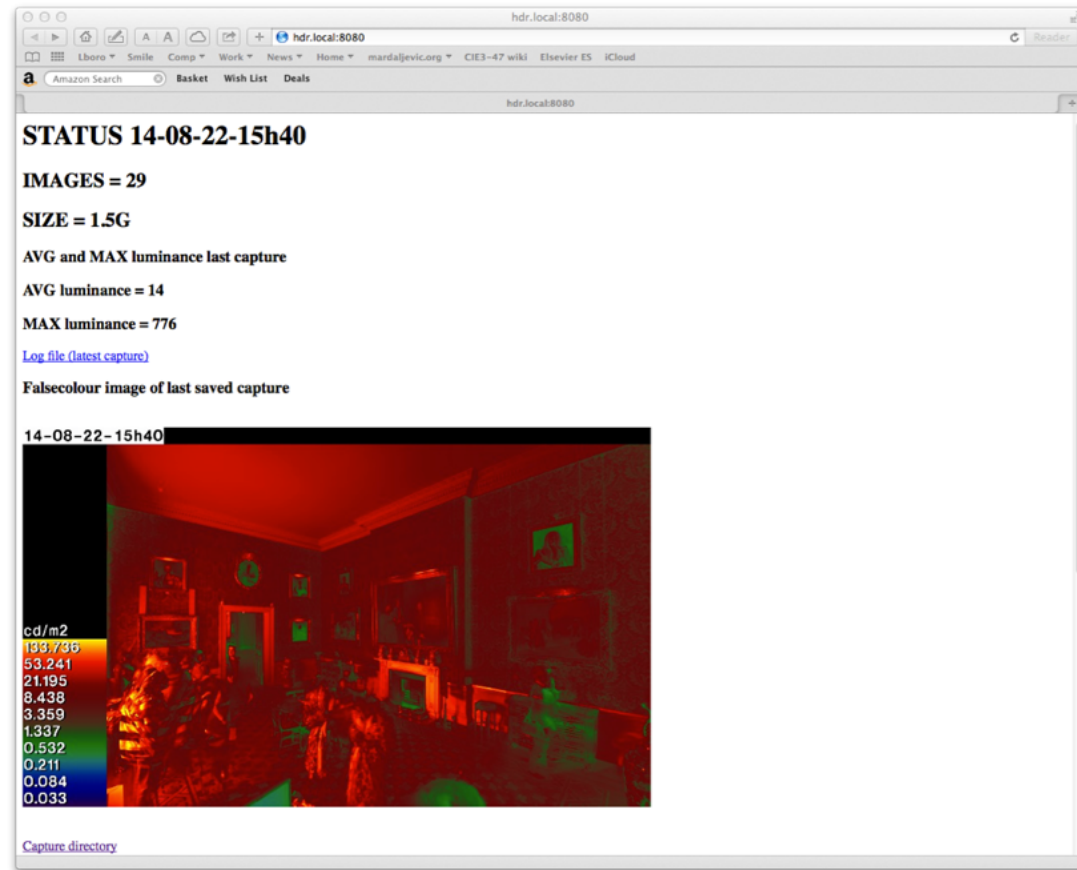
Ickworth House, Bury St. Edmunds



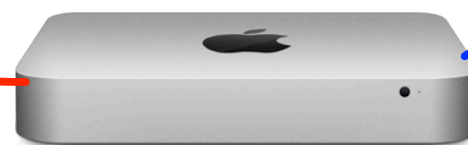
Measurement using
High Dynamic Range
(HDR) imaging

Long-term, autonomous HDR capture

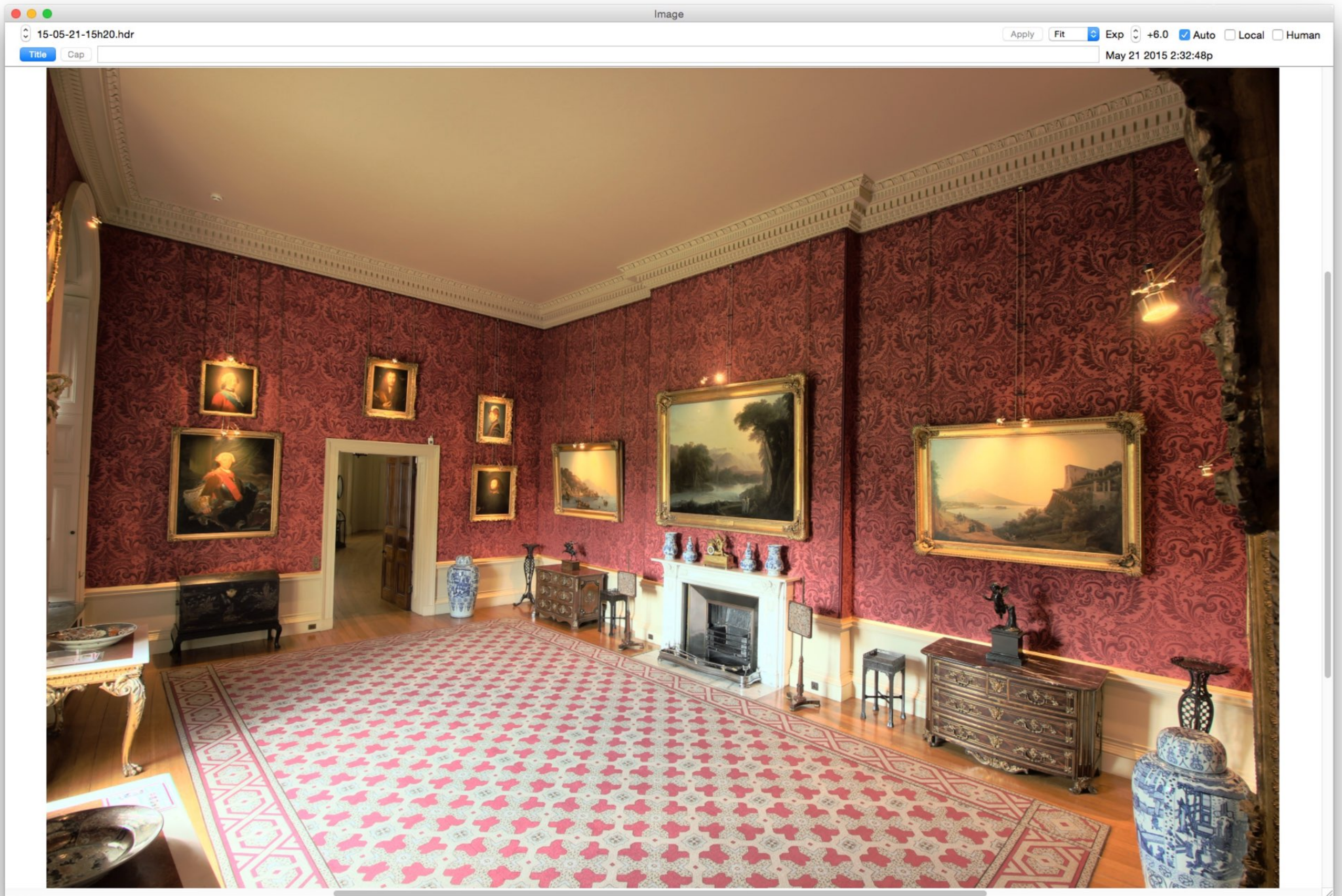
- HDR capture every 10 minutes.
- Maximum unattended duration ~6 to 9 months.
- On-the-fly deletion of 'dark' images.
- Status webpage broadcast on ad-hoc wifi network.

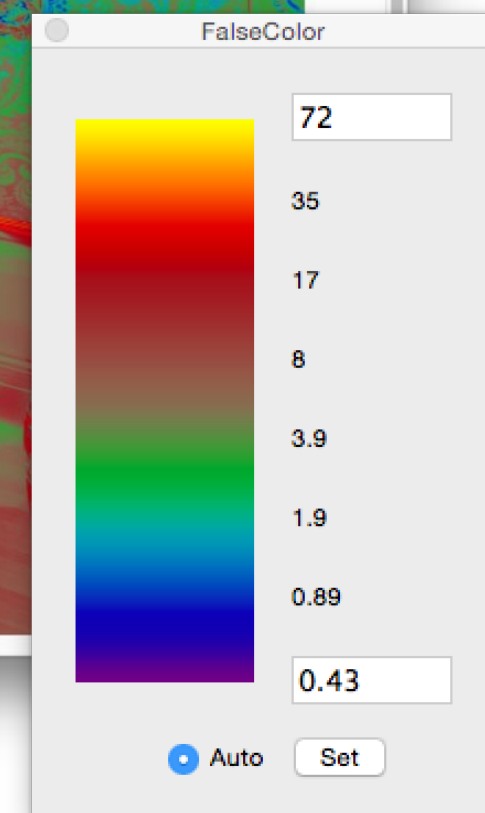
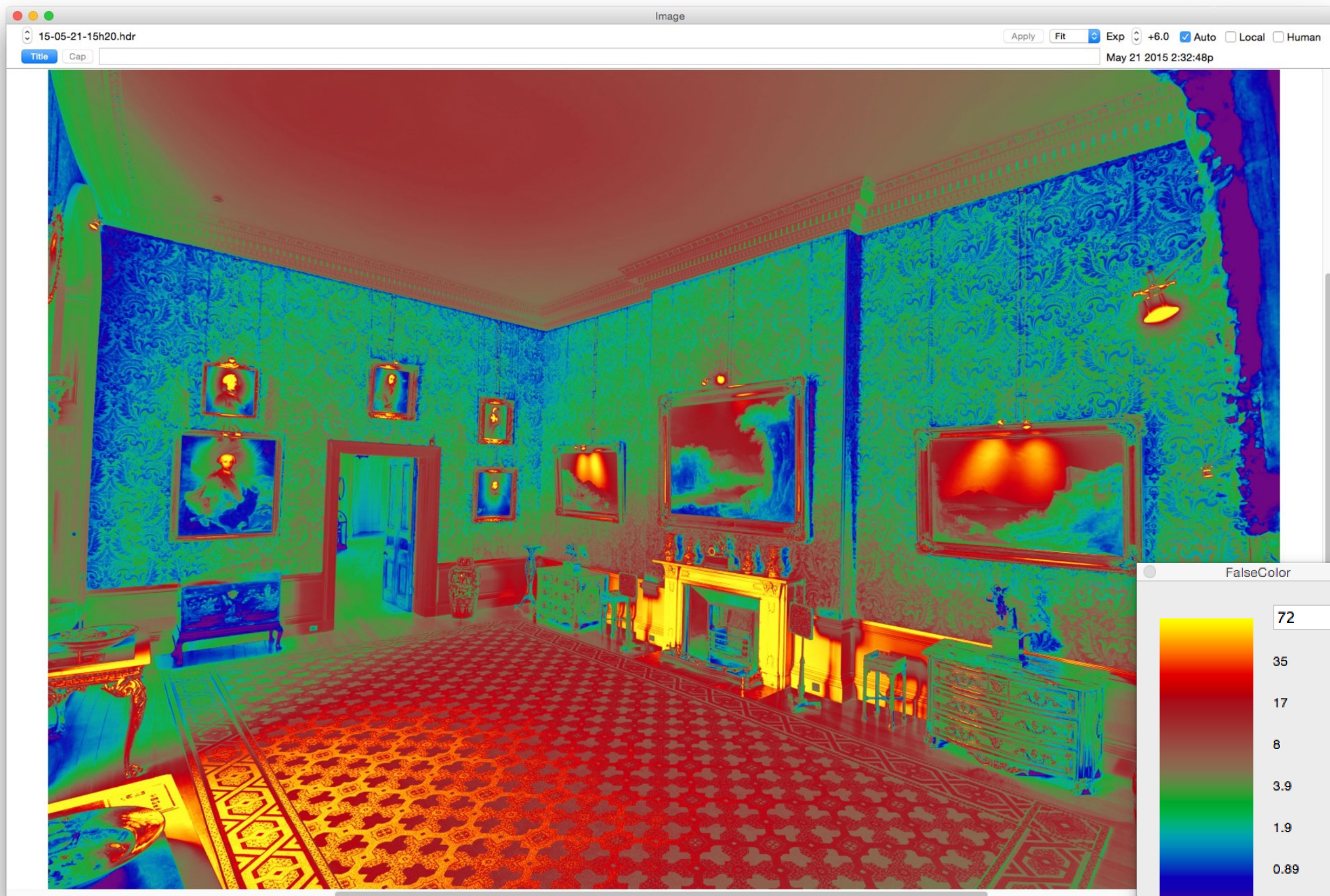


Consumer
DSLR

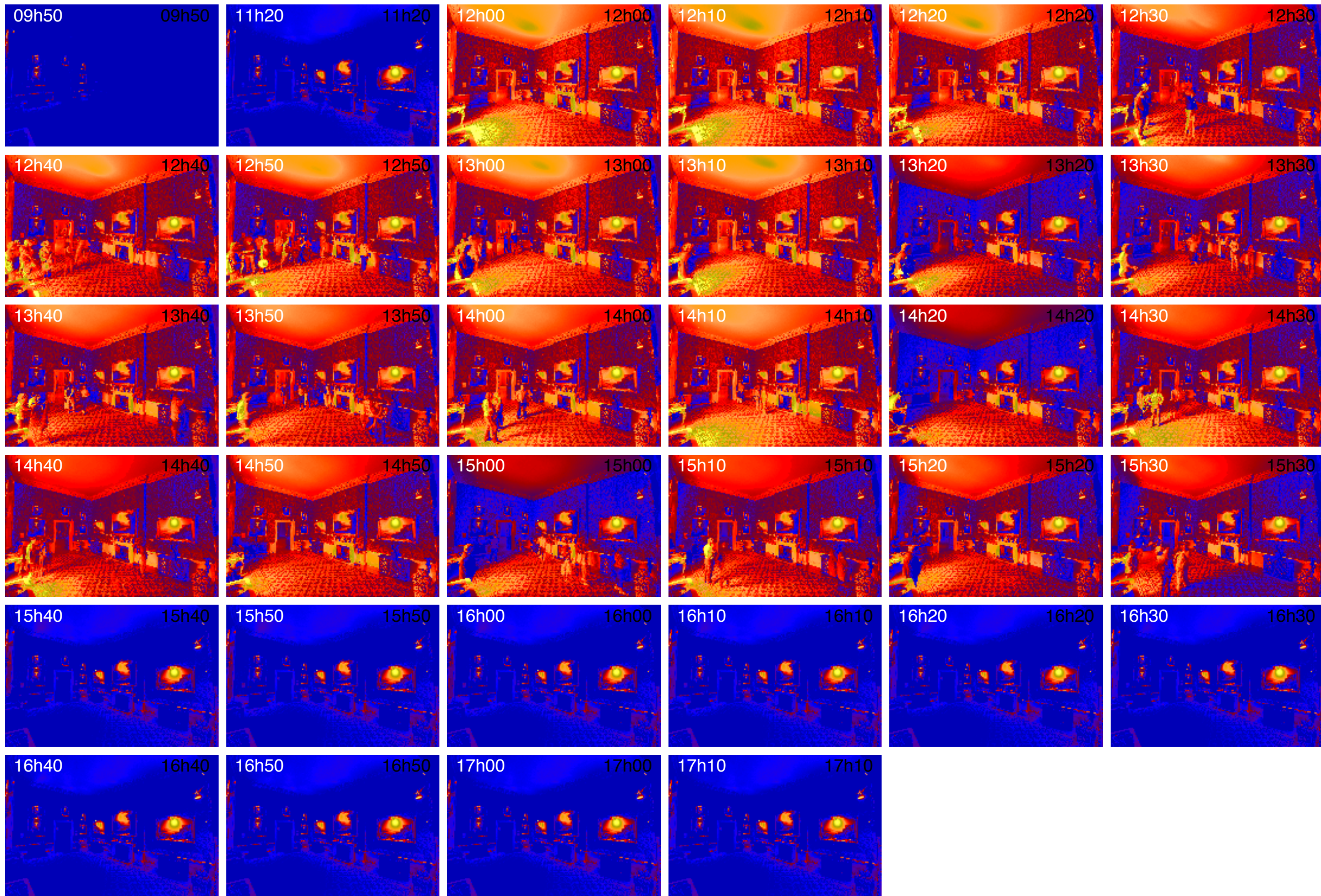


‘Headless’ Mac Mini

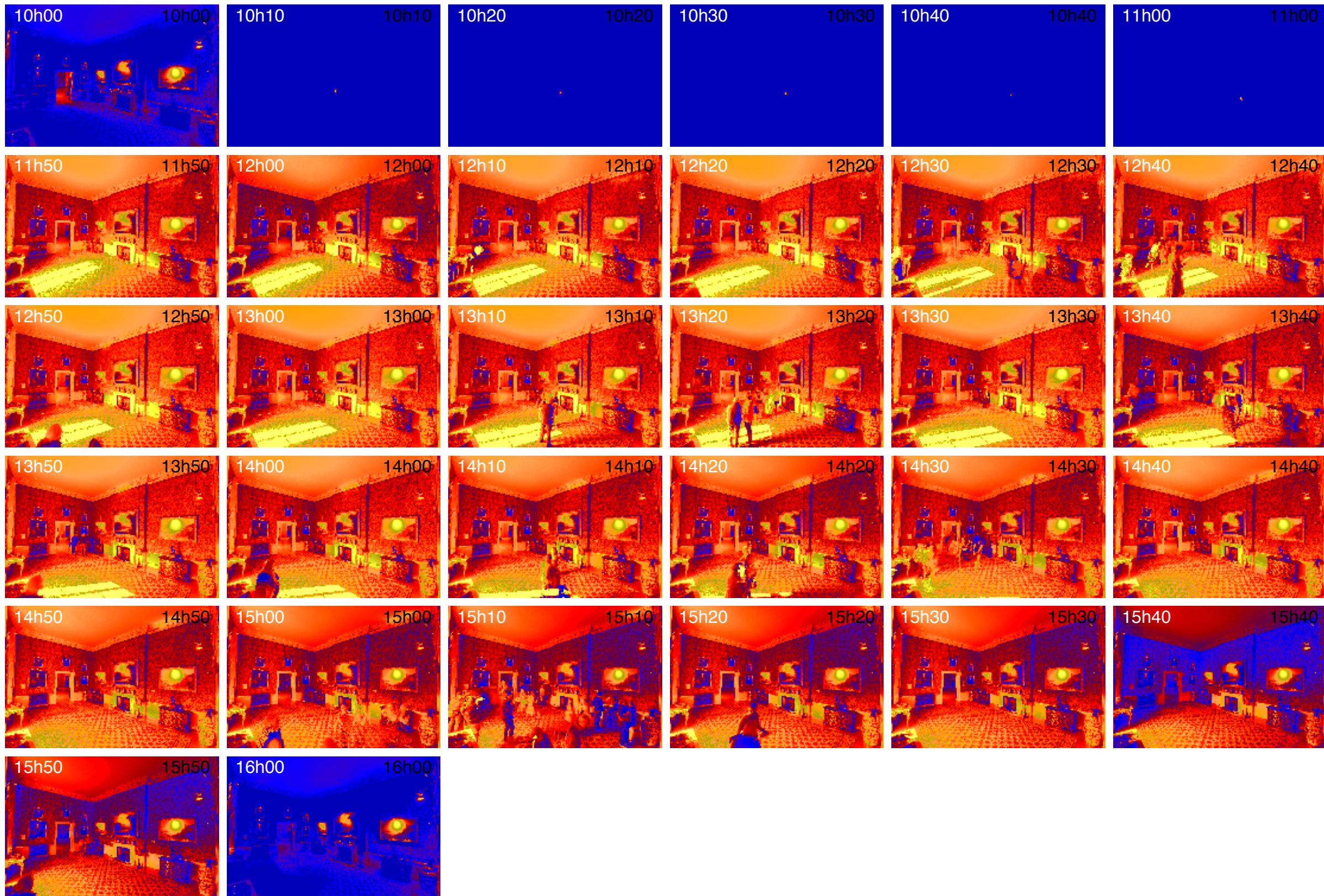




15-06-04



15-10-04

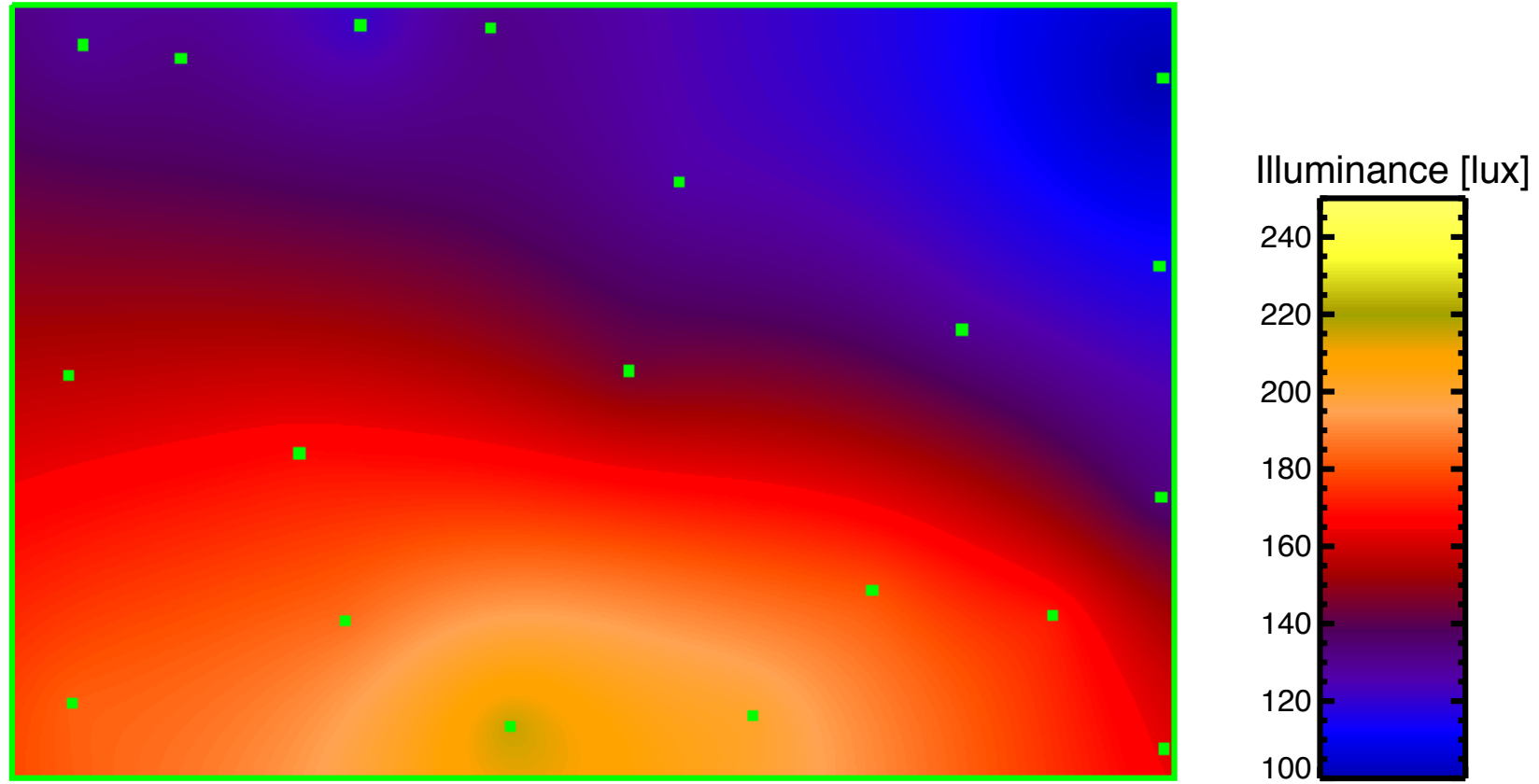


Derive illuminance from
HDR luminance

$$E_r = \frac{\pi L_r}{\rho_r}$$



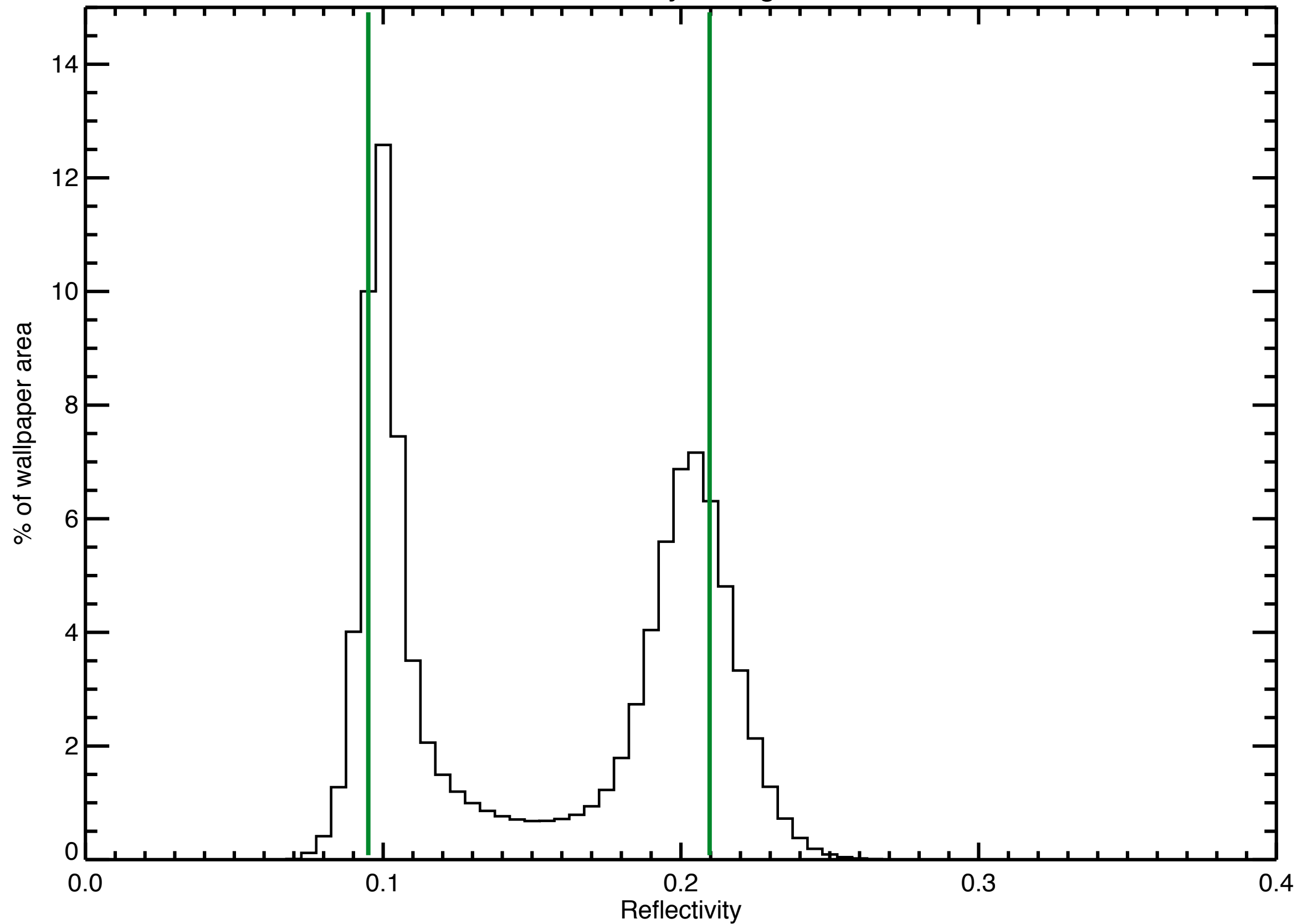
Interpolated illuminance field



Reflectance map



Reflectivity histogram



Average for image = 0.157

Random 350 pixels

Reflectance - box average



Mean for image = 0.157

Mean [stdev] of box samples = 0.155 [0.017]

Random 700 pixels

Reflectance - box average



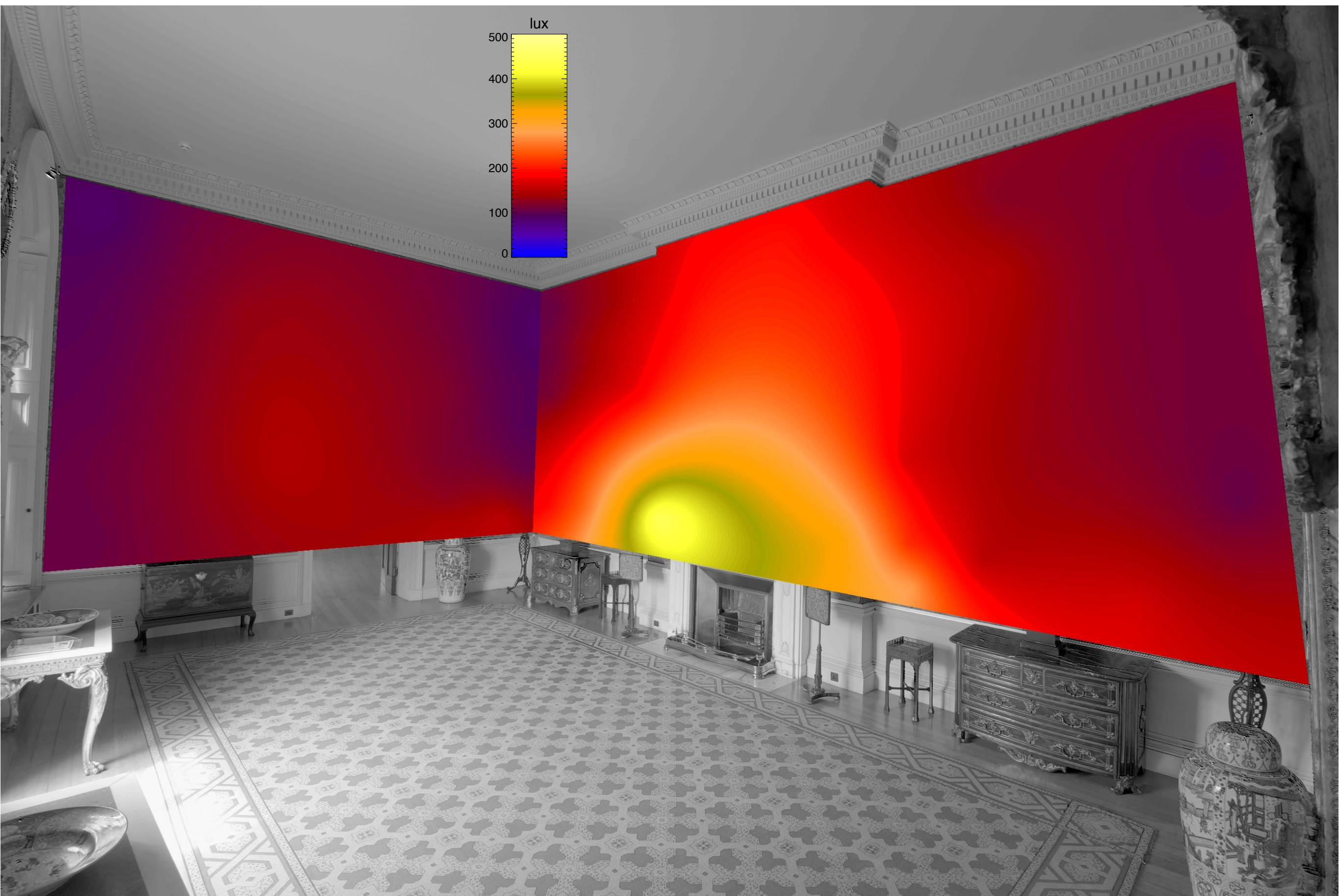
Mean for image = 0.157

Mean [stdev] of box samples = 0.156 [0.007]









Human
(and not so human)
factors

Ghostly encounters

Share spine-chilling thrills at some of the most haunted historic houses and castles across England, Wales and Northern Ireland. With ghostly tales from centuries past, there are plenty of ways to get into the spirit of things on a day out with us. Take an eerie walk with your family in a haunted house if you dare. Here's our pick of the most hair-raising haunted locations, and their spooky stories. Are you brave enough to pay them a visit?



i Are you ready to hunt for ghosts at Blickling Hall?



Blickling Estate
Norfolk



Blickling Hall, Norfolk

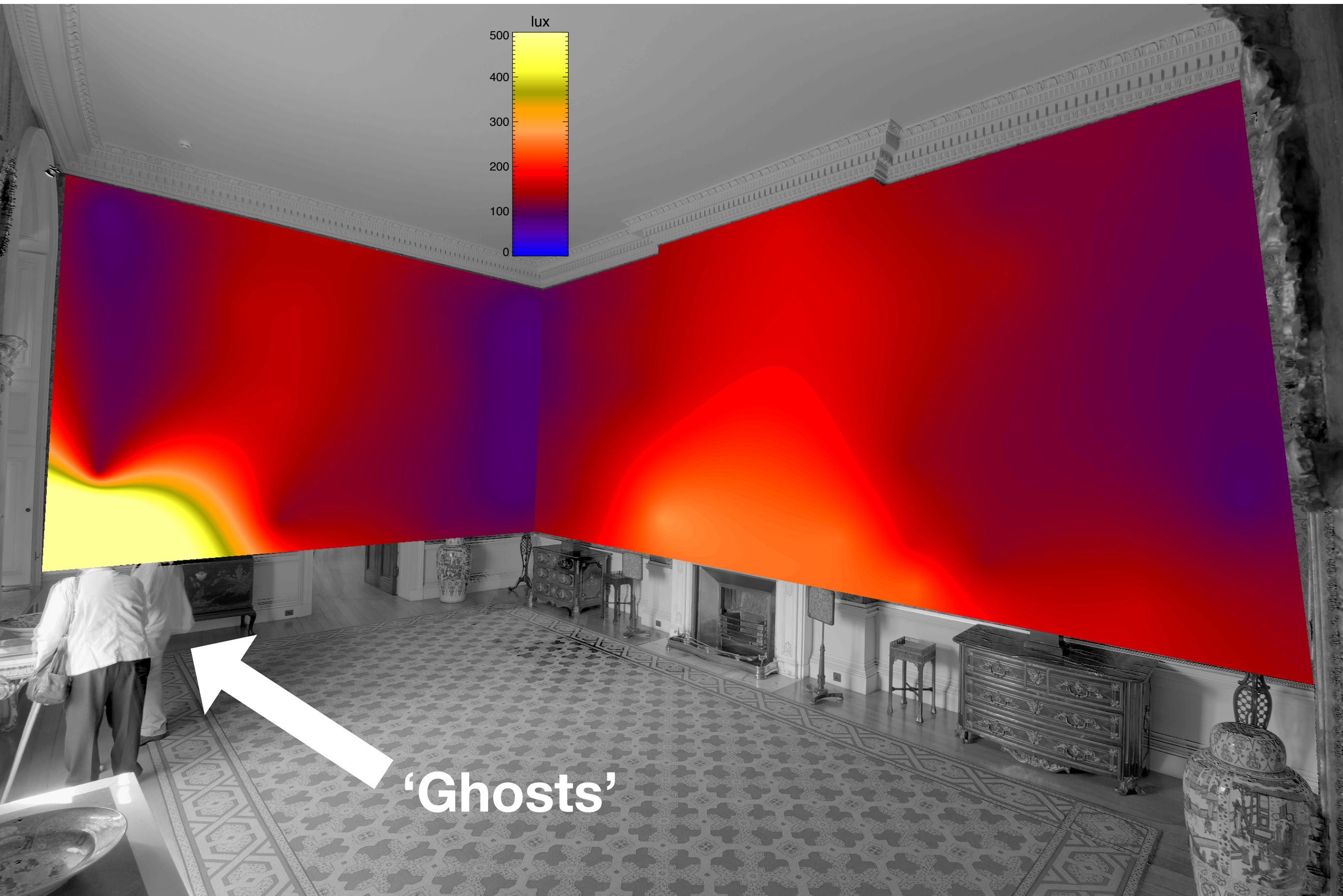
Thought to be the birthplace of Anne Boleyn, her headless ghost is said to return on the anniversary of her execution.

Other ghostly residents allegedly include Sir John Falstofe and Sir Henry Hobart, whose dying groans can be heard emanating from the West Turret Bedroom on the anniversary of his death.

Spot ghosts at Blickling Hall





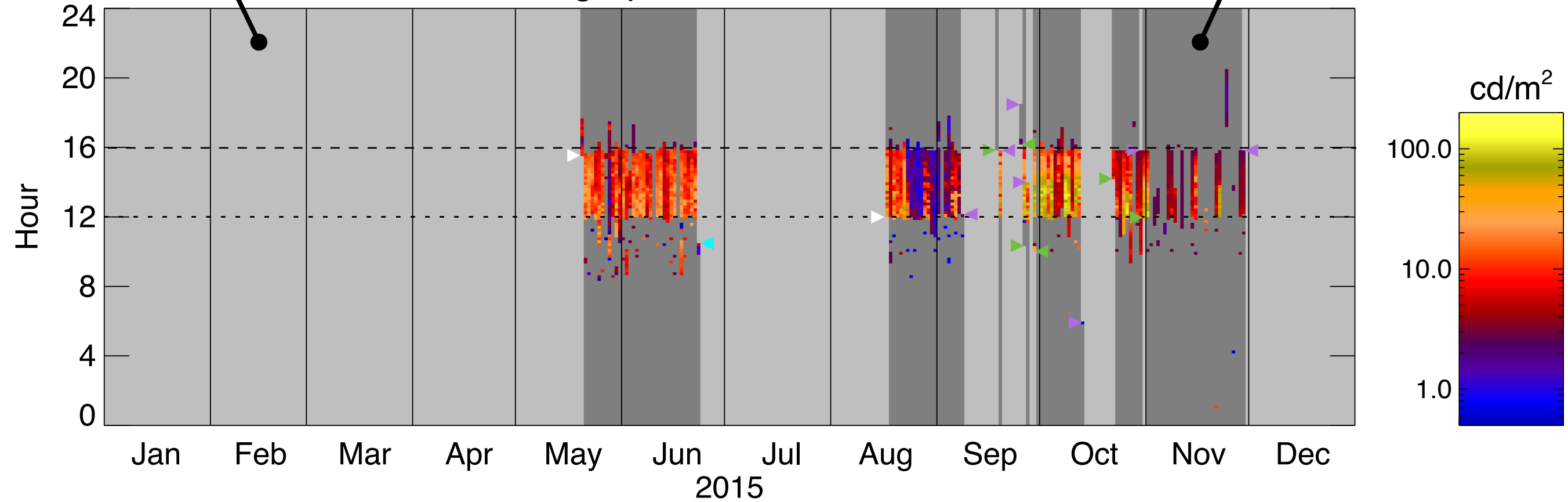


HDR capture failures

Light grey - no capture

Dark grey - capture very low light

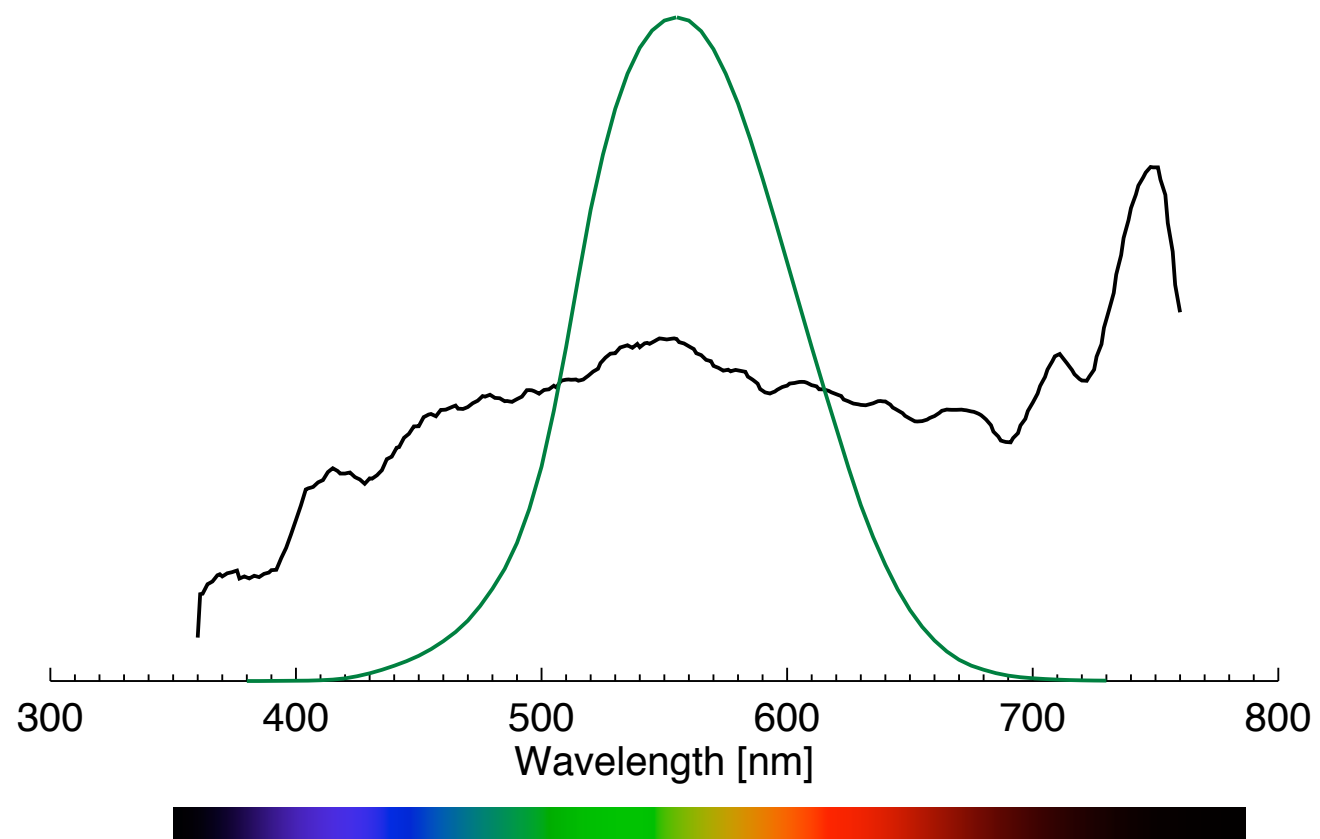
Average pixel HDR luminance



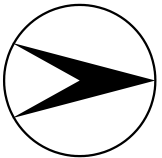
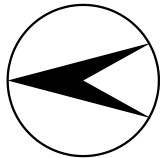
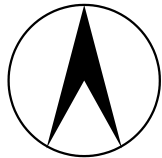
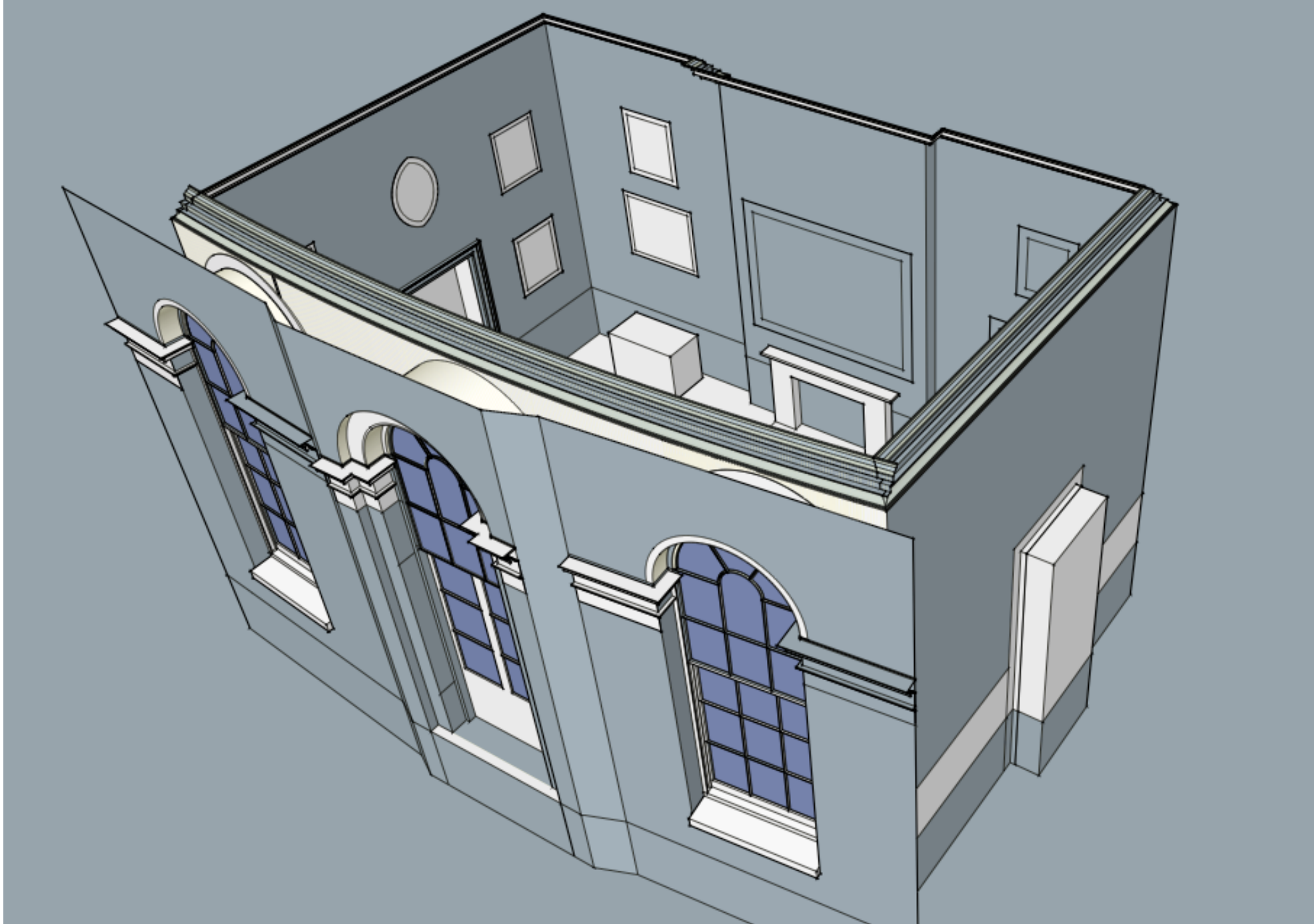
- ▷ Installation / reinstallation
- ▶ Capture stopped
- ▶ Capture restart
- ▶ Elective shutdown (16-01-07 not shown)
- ▶ Hardware failure

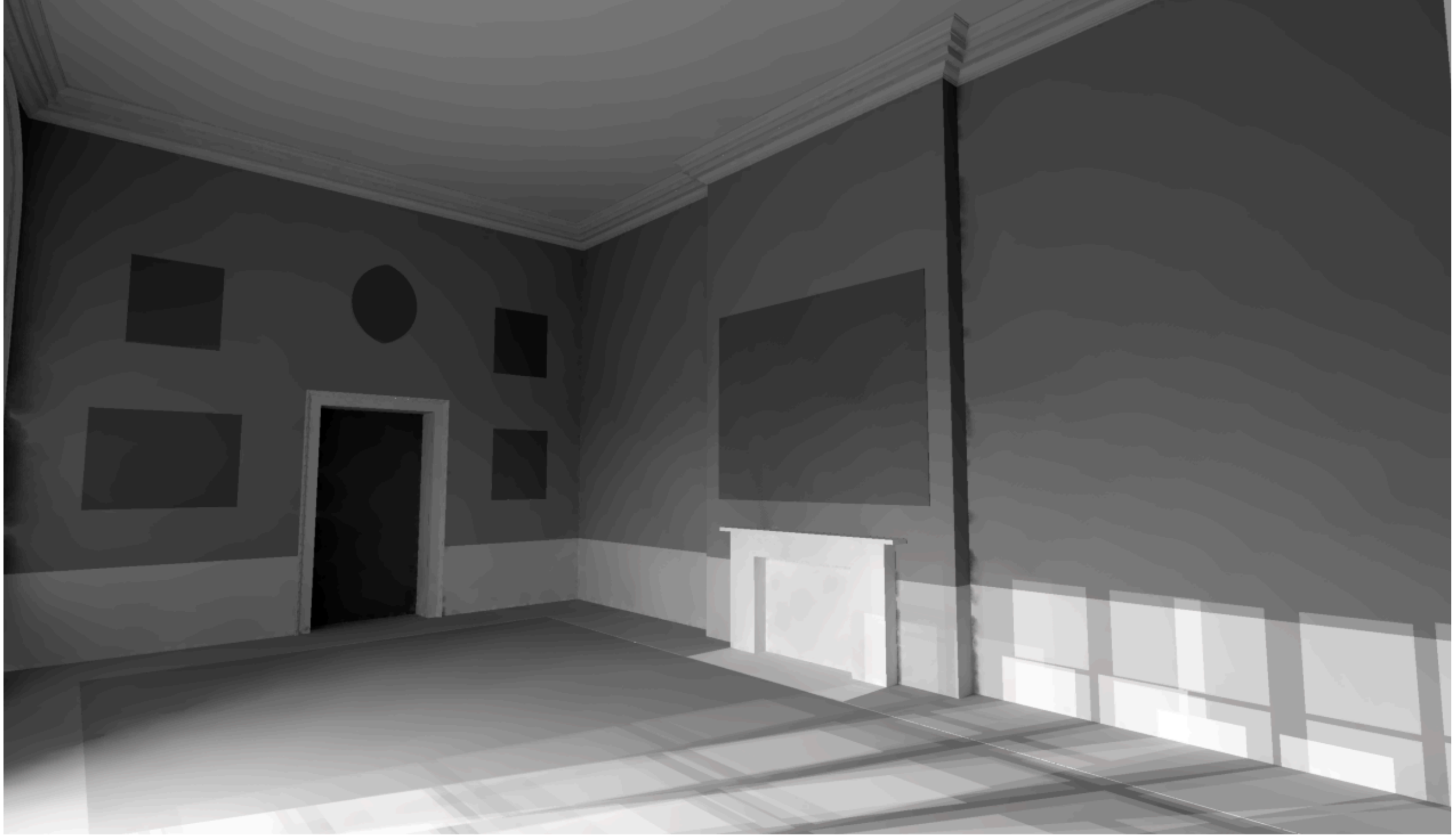


Phase II

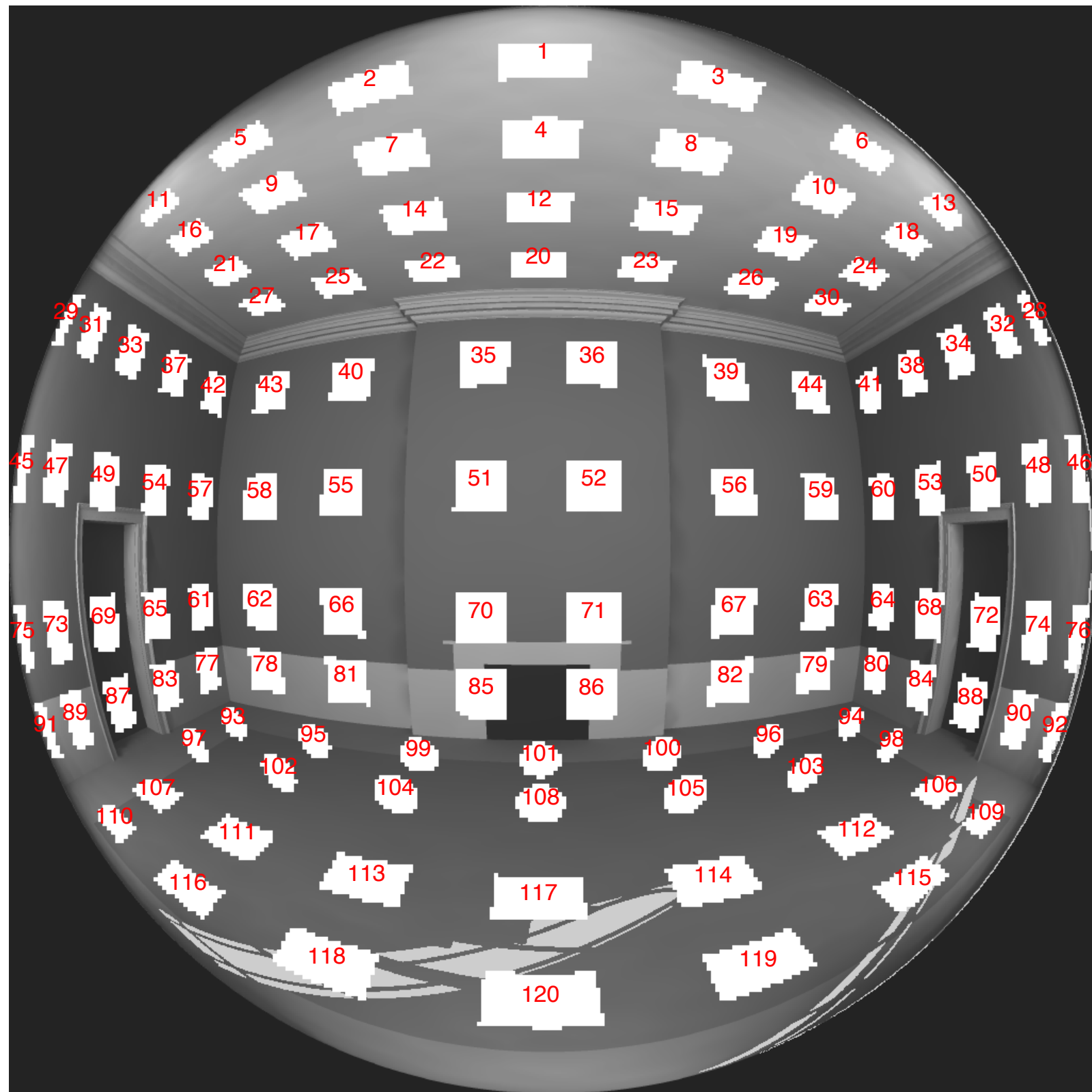


Simulation of cumulative
annual daylight exposure:
4 Component Method





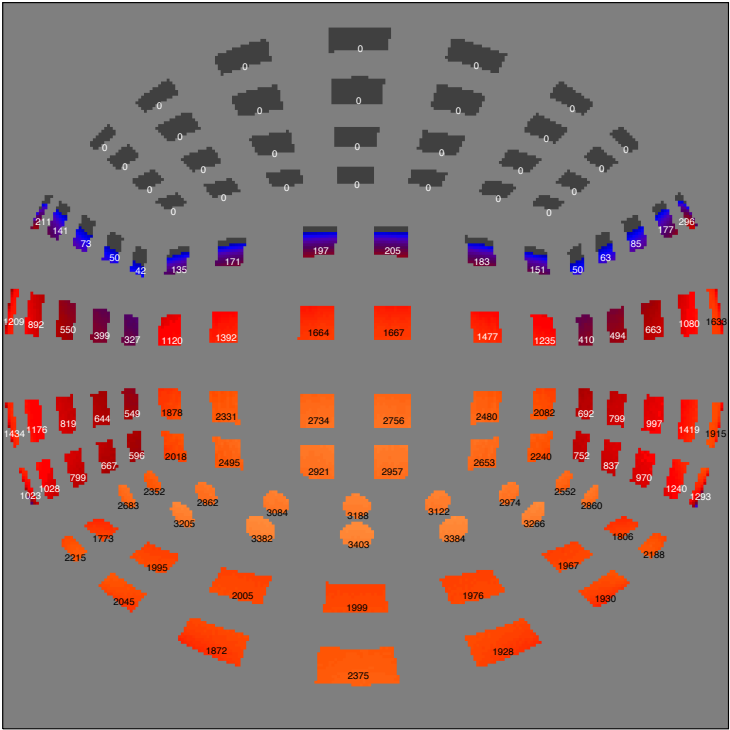




Metrics

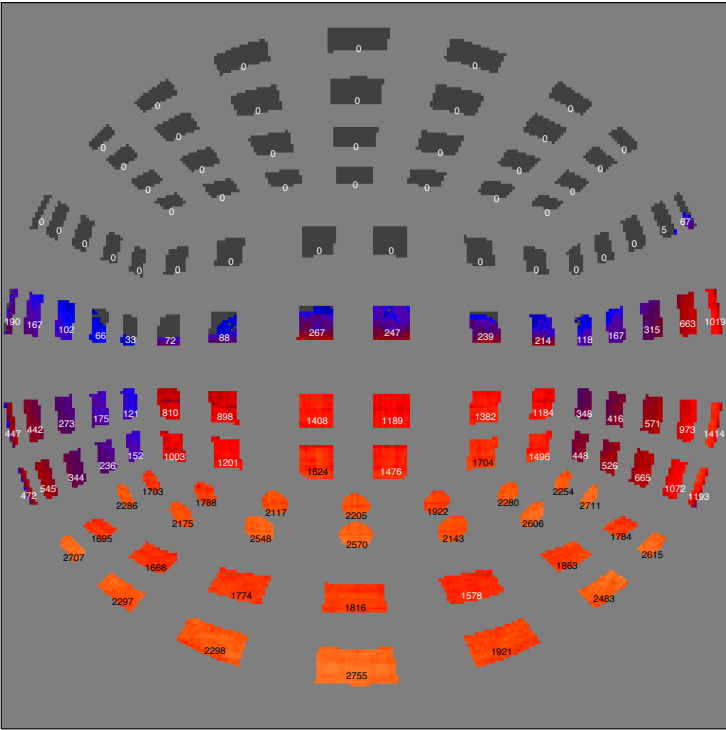
- Cumulative annual illumination + components
- Cumulative monthly illumination
- Clear sky sun hours
- Useful daylight illuminance 50, 200, 2000 lux
- 'Time-slices'

Direct sky comp of TAI



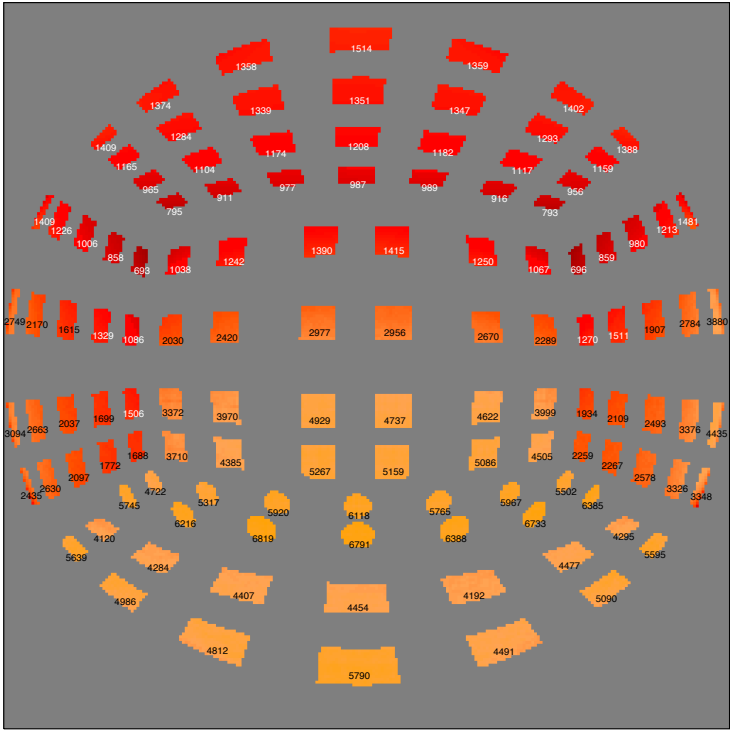
Area wght. 1244

Direct sun comp of TAI



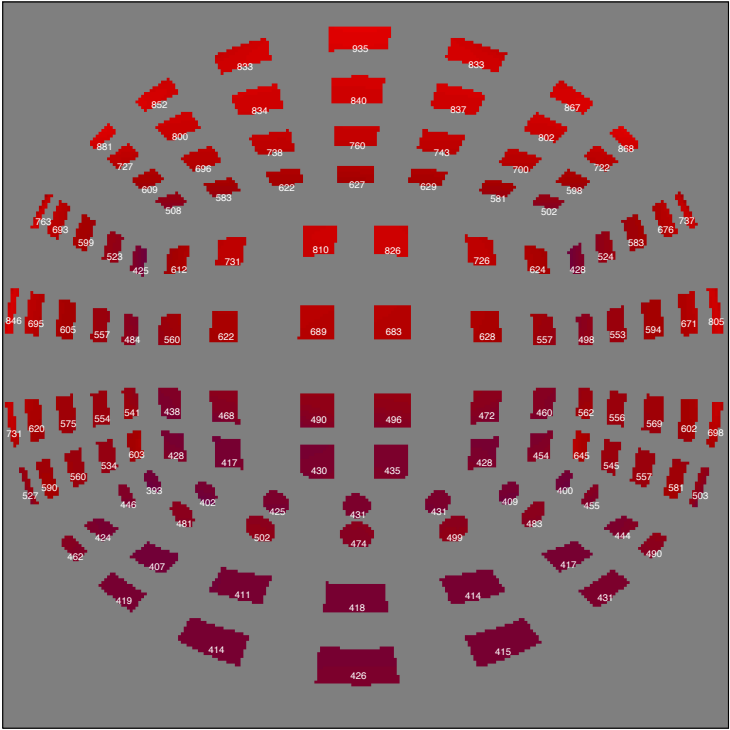
Area wght. 858

Total annual illumination



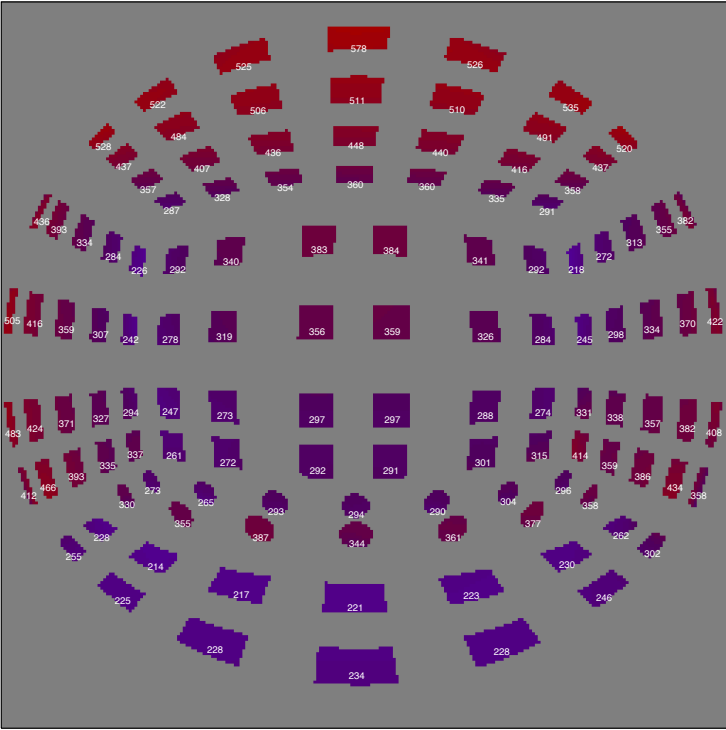
Area wght. 3029

Indirect sky comp of TAI



Area wght. 584

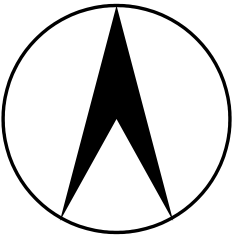
Indirect sun comp of TAI



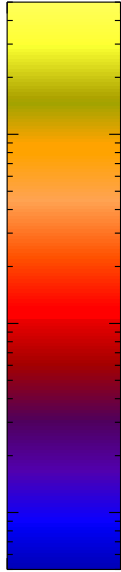
Area wght. 343

Cumulative metrics

mod01/p01
p01
Hours:11.00-17.00



klux hrs



000 London-CIBSE-TRY

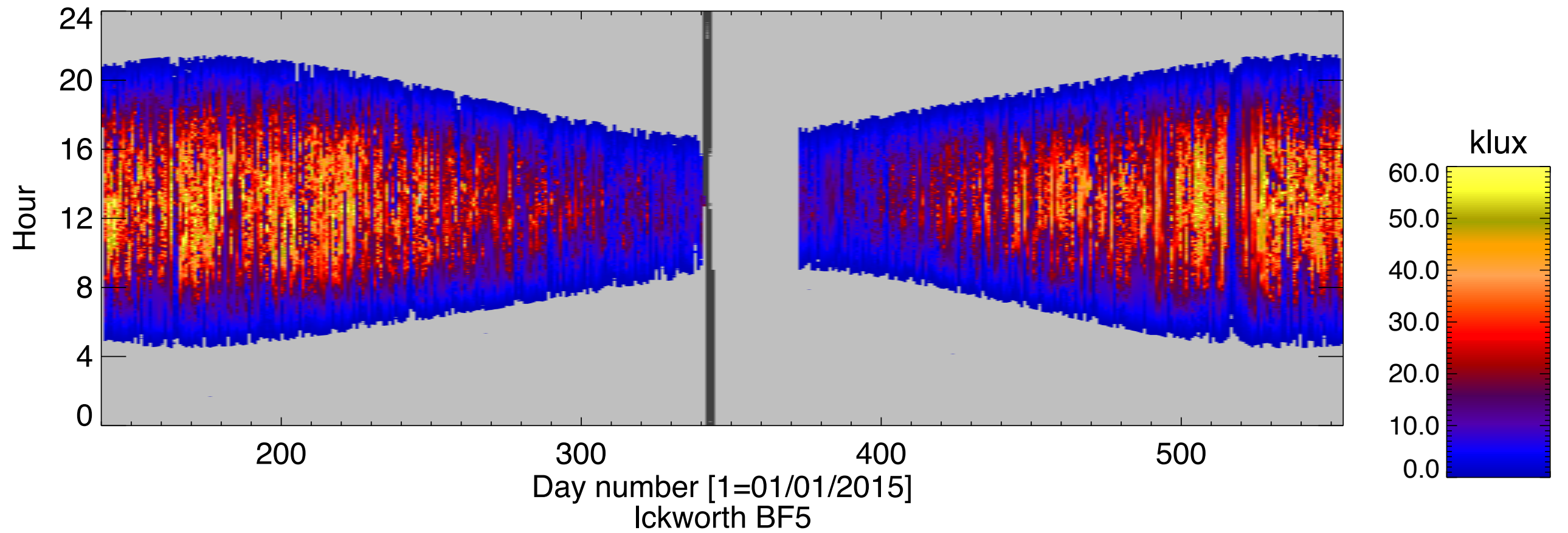
Validation



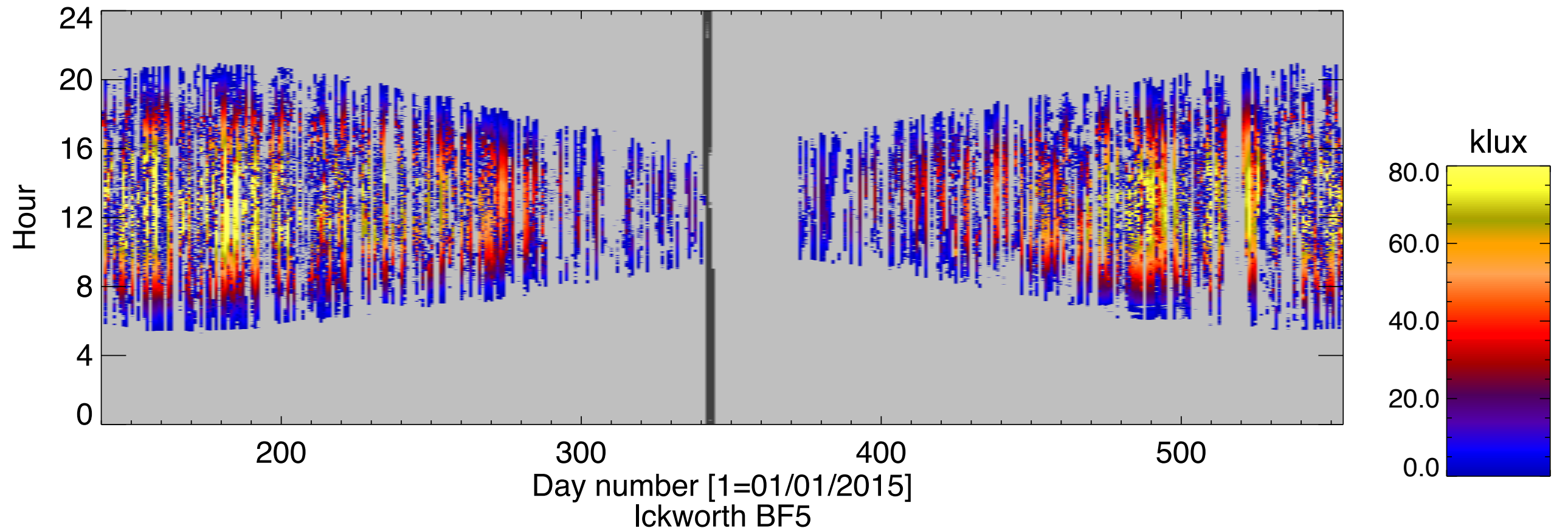
Delta-T BF5 Sunshine Sensor
Measures global and diffuse radiation



Diffuse horizontal



Direct horizontal



Acknowledgements:

The staff and volunteers at Mount Stewart and Ickworth House

J. Mardaljevic, S. Cannon-Brookes, K. Lithgow, and N. Blades. Illumination and conservation: A case study evaluation of daylight exposure for an artwork displayed in an historic building. *CIE 28th Session*, Manchester, UK, 2015.

J. Mardaljevic, S. Cannon-Brookes, K. Lithgow, and N. Blades. Applying science to daylight management in historic houses for collection and visitor benefit. *Turn and Face the Change: Conservation in the 21st Century*, ICON, Birmingham, UK, 16-17 June, 2016.

N. Blades, K. Lithgow, S. Cannon-Brookes, and J. Mardaljevic. New tools for managing daylight exposure of works of art: case study of Hambletonian, Mount Stewart, Northern Ireland. *Journal of the Institute of Conservation*, (in press), 2016.

[Link to Loughborough University Institutional Repository](#)

[Link to video](#)