

# Recent Case Studies

Santiago Torres – 2018 International Radiance Workshop

# Calculating circadian lighting for Well standard

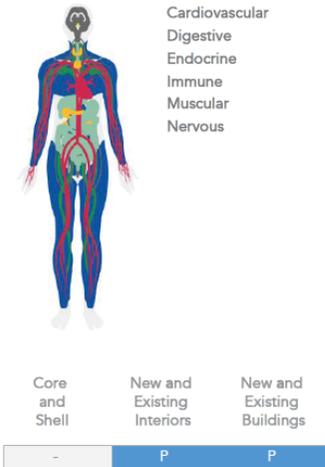


## 54

### CIRCADIAN LIGHTING DESIGN

Light is one of the main drivers of the circadian system, which starts in the brain and regulates physiological rhythms throughout the body's tissues and organs, affecting hormone levels and the sleep-wake cycle. Circadian rhythms are kept in sync by various cues, including light which the body responds to in a way facilitated by intrinsically photosensitive retinal ganglion cells (ipRGCs): the eyes' non-image-forming photoreceptors. Through ipRGCs, lights of high frequency and intensity promote alertness, while the lack of this stimulus signals the body to reduce energy expenditure and prepare for rest.

This feature promotes lighting environments for circadian health. The biological effects of light on humans can be measured in Equivalent Melanopic Lux (EML), a proposed alternate metric that is weighted to the ipRGCs instead of to the cones, which is the case with traditional lux. Tables L1 and L2 in Appendix C show how to calculate the EML of individual lamps and larger spaces.



#### PART 1: MELANOPIC LIGHT INTENSITY FOR WORK AREAS

At least one of the following requirements is met:

- Light models or light calculations (which may incorporate daylight) show that at least 250 equivalent melanopic lux is present at 75% or more of workstations, measured on the vertical plane facing forward, 1.2 m [4 ft] above finished floor (to simulate the view of the occupant). This light level is present for at least 4 hours per day for every day of the year.

*Circadian Lighting* ⇔ *Melanopic Light Intensity*

...minance on the vertical plane of equivalent melanopic lux, greater than or equal to the lux recommendations in the Vertical (Ev) Targets for the 25-65 category in Table B1 of IES-ANSI RP-1-12. For example, Reception Desks are provided with 150 equivalent melanopic lux from the electric lights.

## Calculating circadian lighting - Example

> 75% of workstations;

250 vertical equivalent melanopic lux;

4 hrs per day every day.

All workstations;

150 vertical equivalent melanopic lux;

All day every day when occupied.

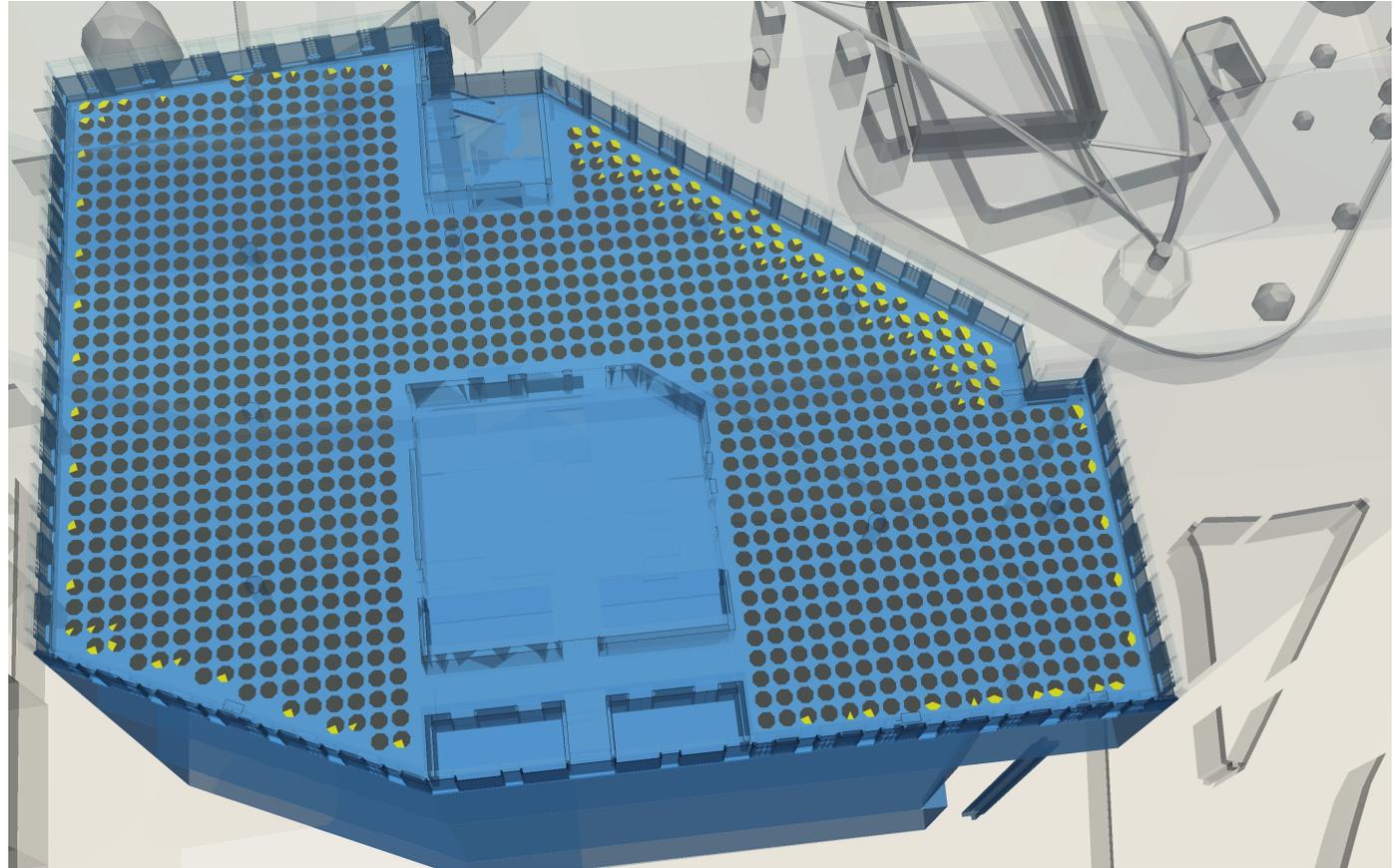


## Calculating circadian lighting – Daylight only

> 75% of  
workstations;

250 vertical  
equivalent  
melanopic lux;

4 hrs per day  
every day.

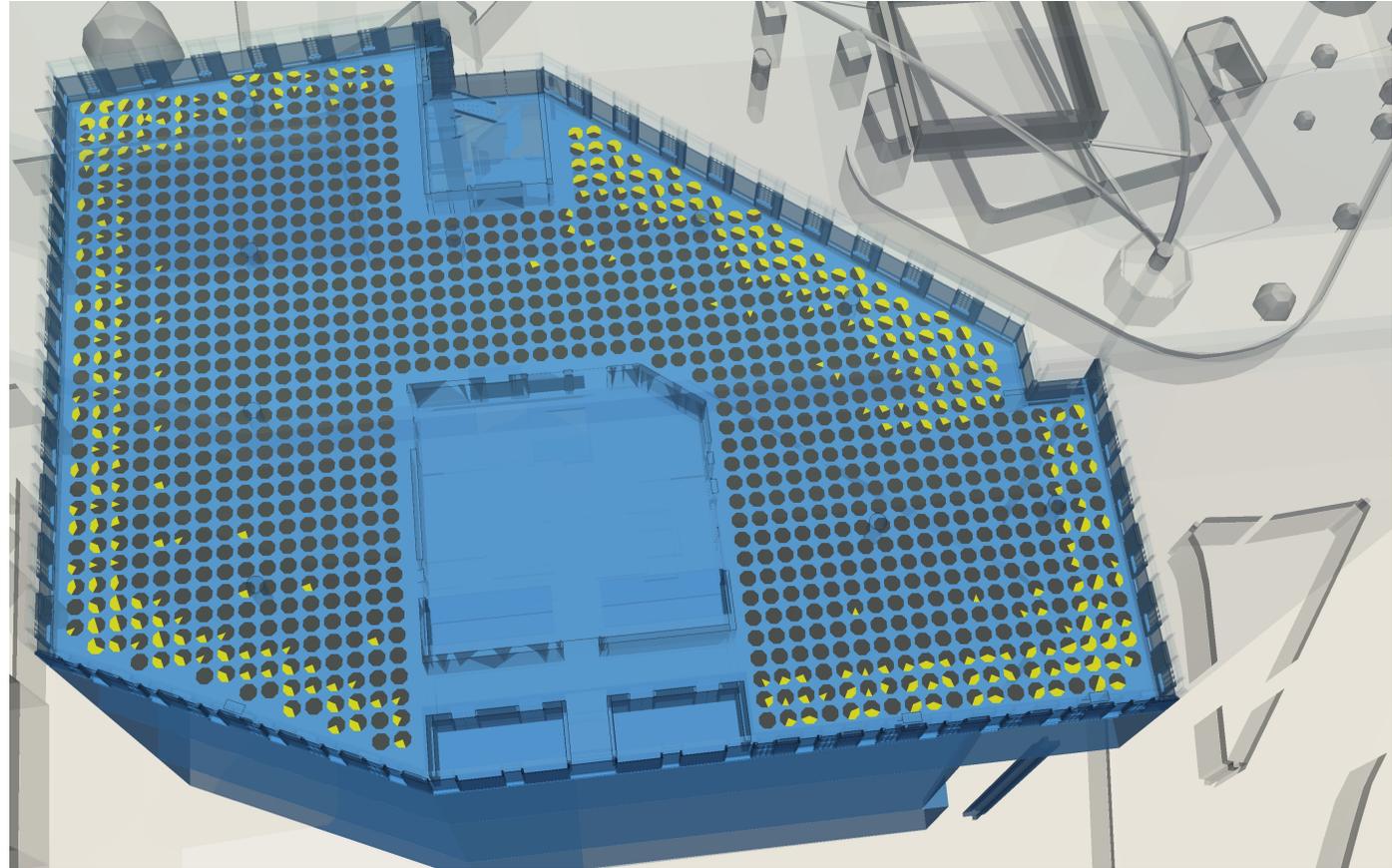


## Calculating circadian lighting – Daylight + electric lighting

> 75% of  
workstations;

250 vertical  
equivalent  
melanopic lux;

4 hrs per day  
every day.



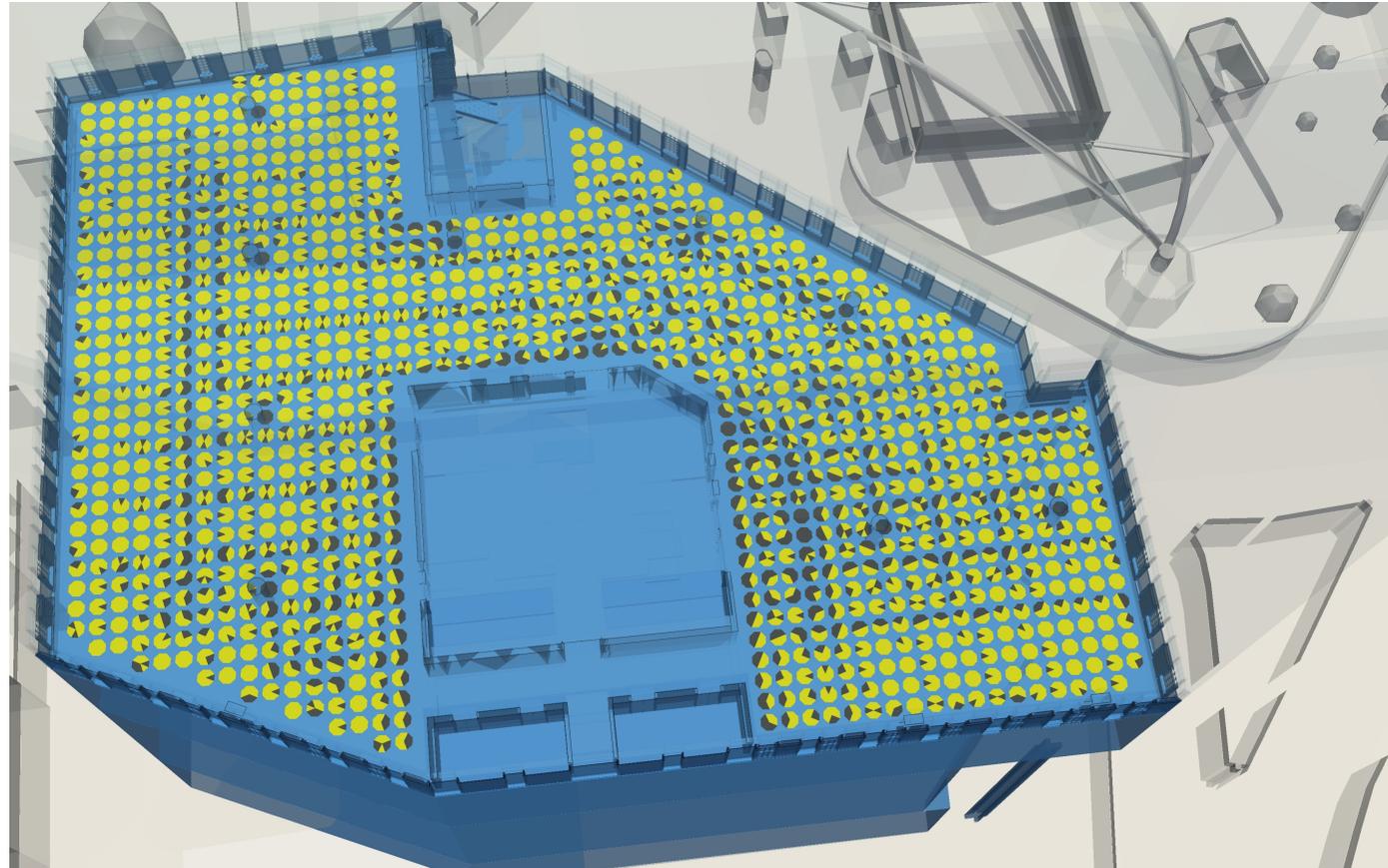
## Calculating circadian lighting – Daylight + electric lighting

> 75% of  
workstations;

250 vertical  
equivalent  
melanopic lux;

4 hrs per day  
every day.

**Increasing  
electric lighting  
230% for 4 hrs  
every day**

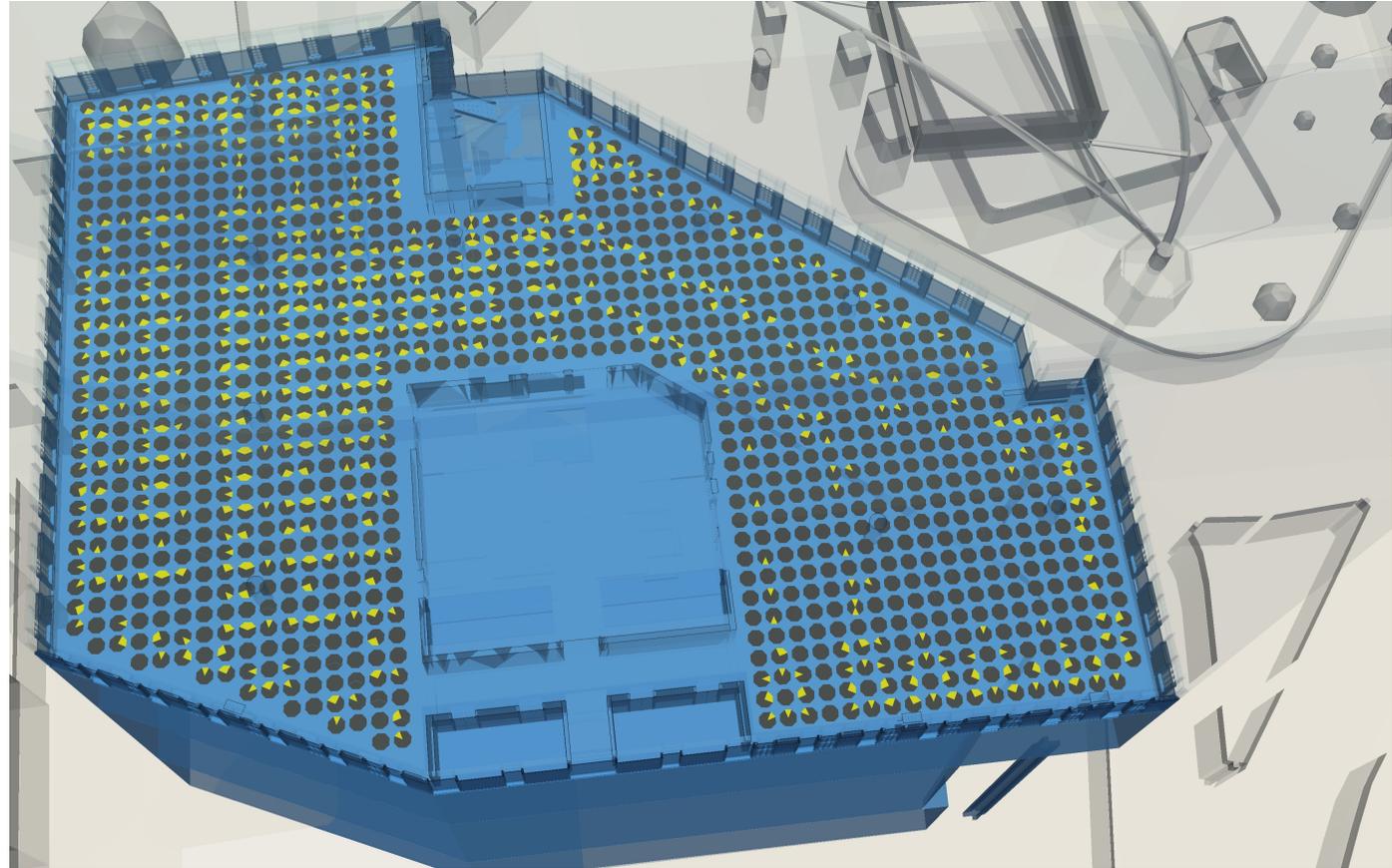


## Calculating circadian lighting – Electric lighting

All workstations;

150 vertical  
equivalent  
melanopic lux;

All day every  
day when  
occupied.



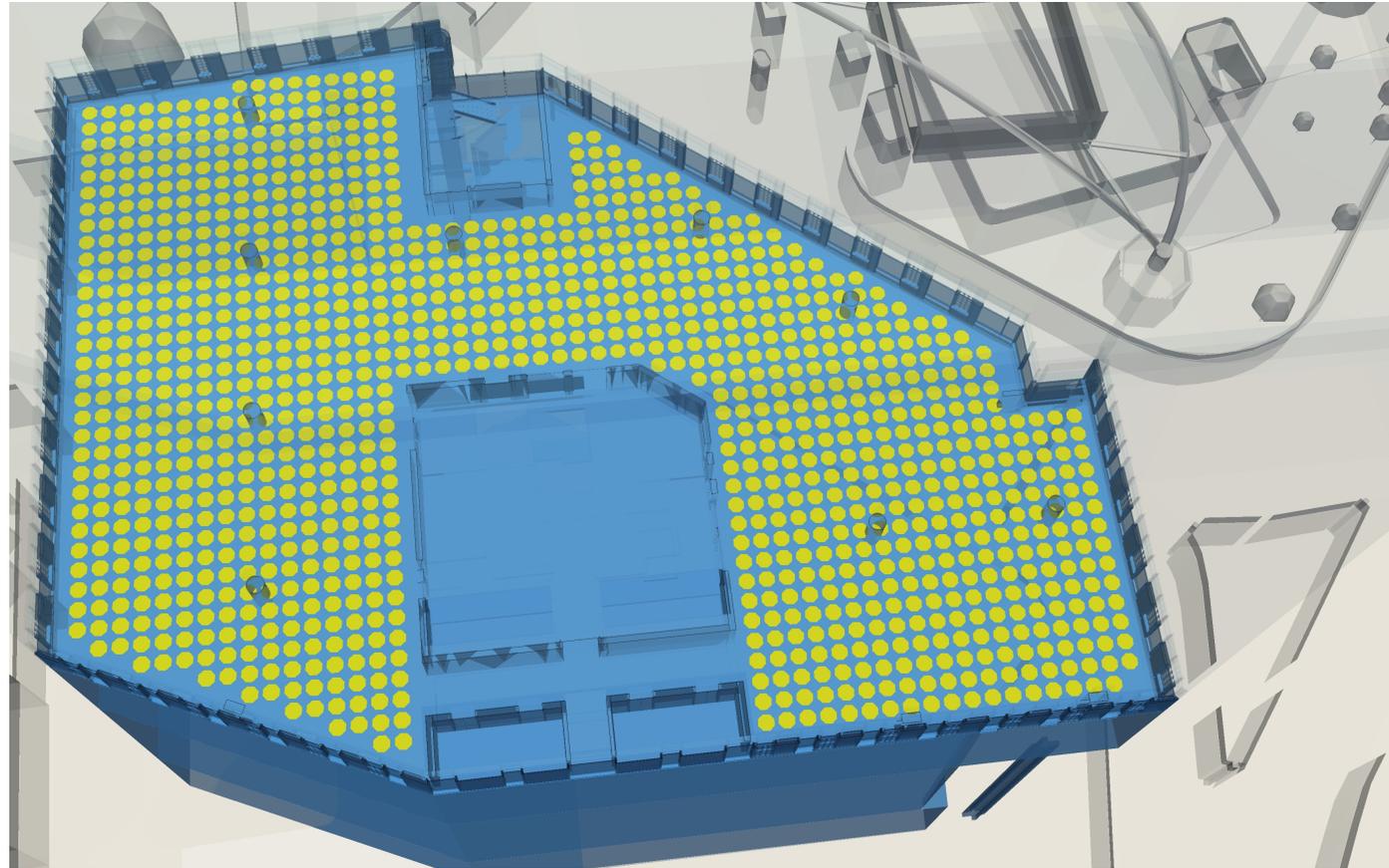
## Calculating circadian lighting – Electric lighting

All workstations;

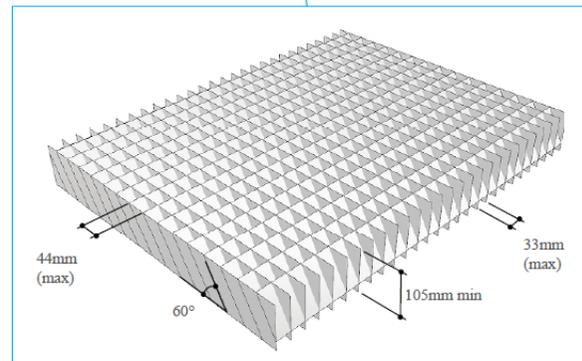
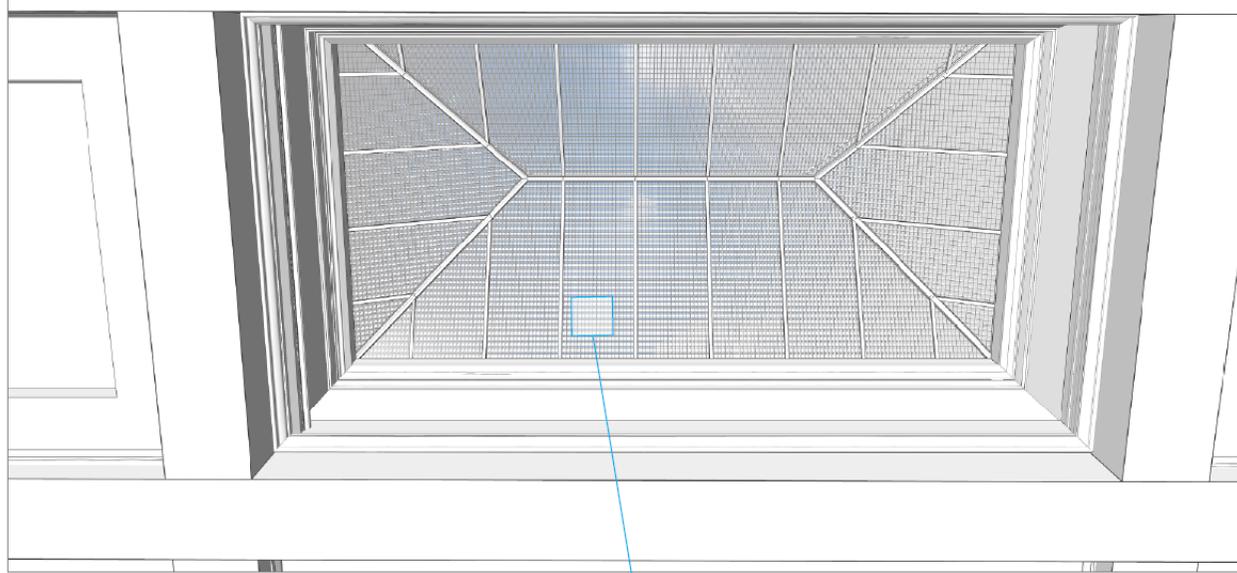
150 vertical  
equivalent  
melanopic lux;

All day every  
day when  
occupied.

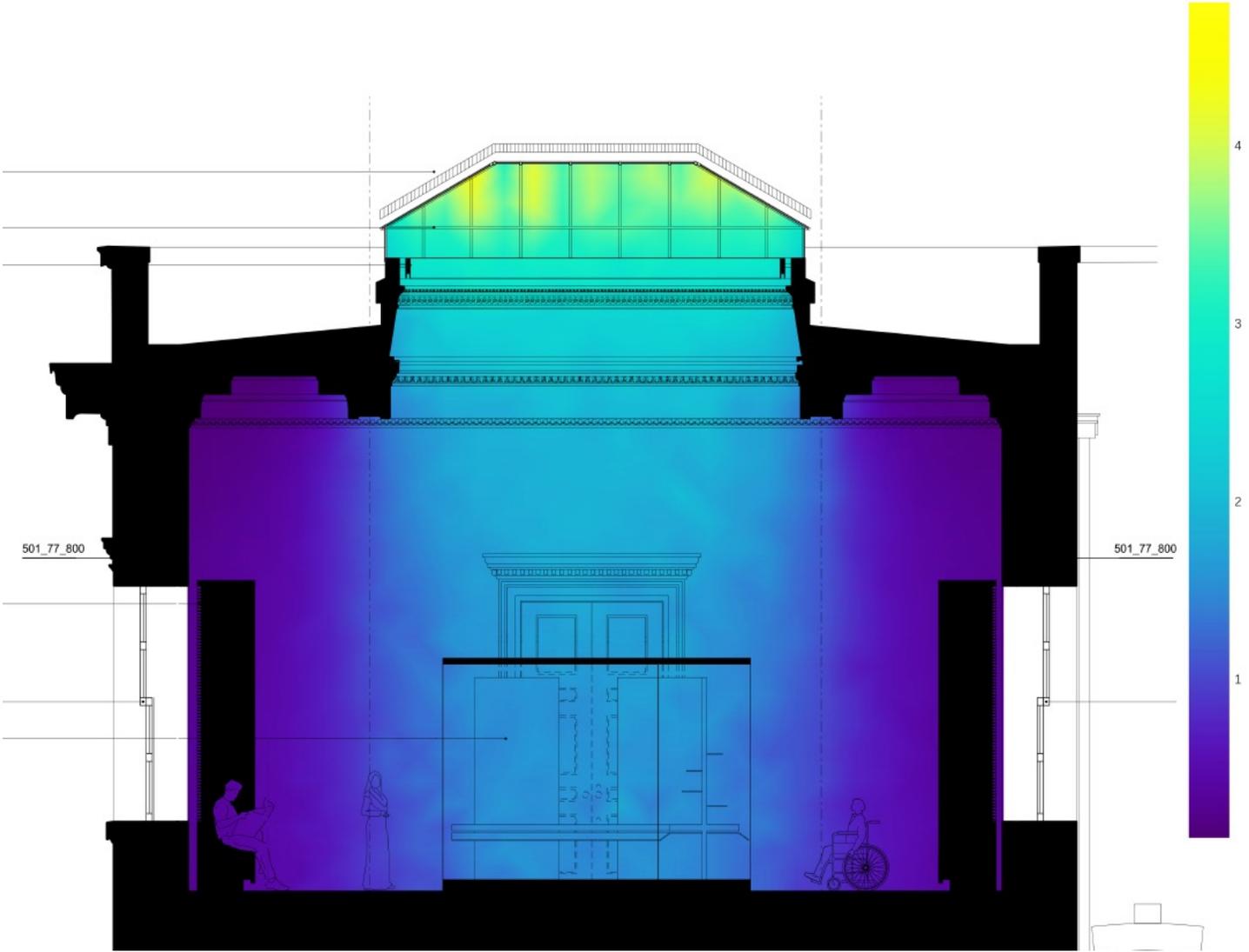
**Increase electric  
lighting to  
150%**



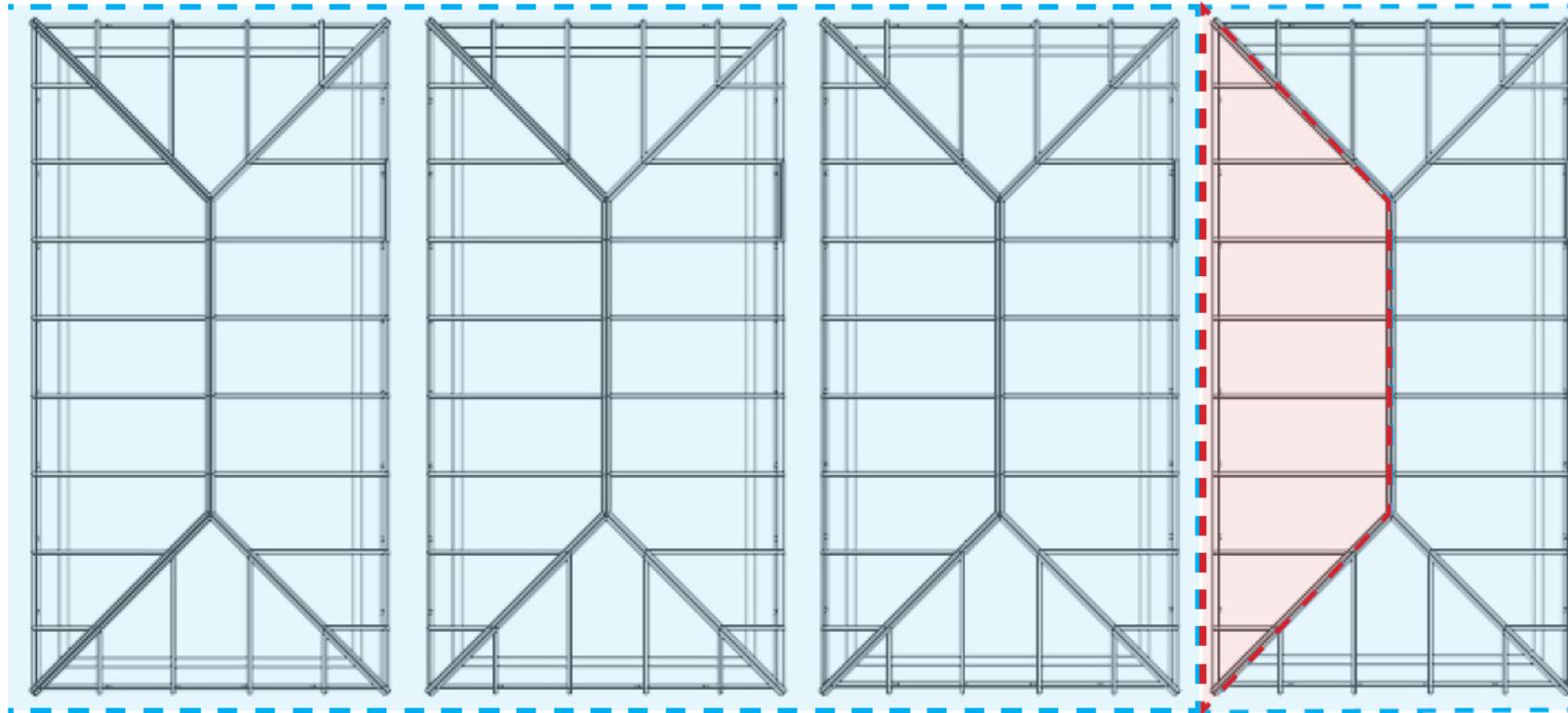
# Exhibition gallery with sunlight



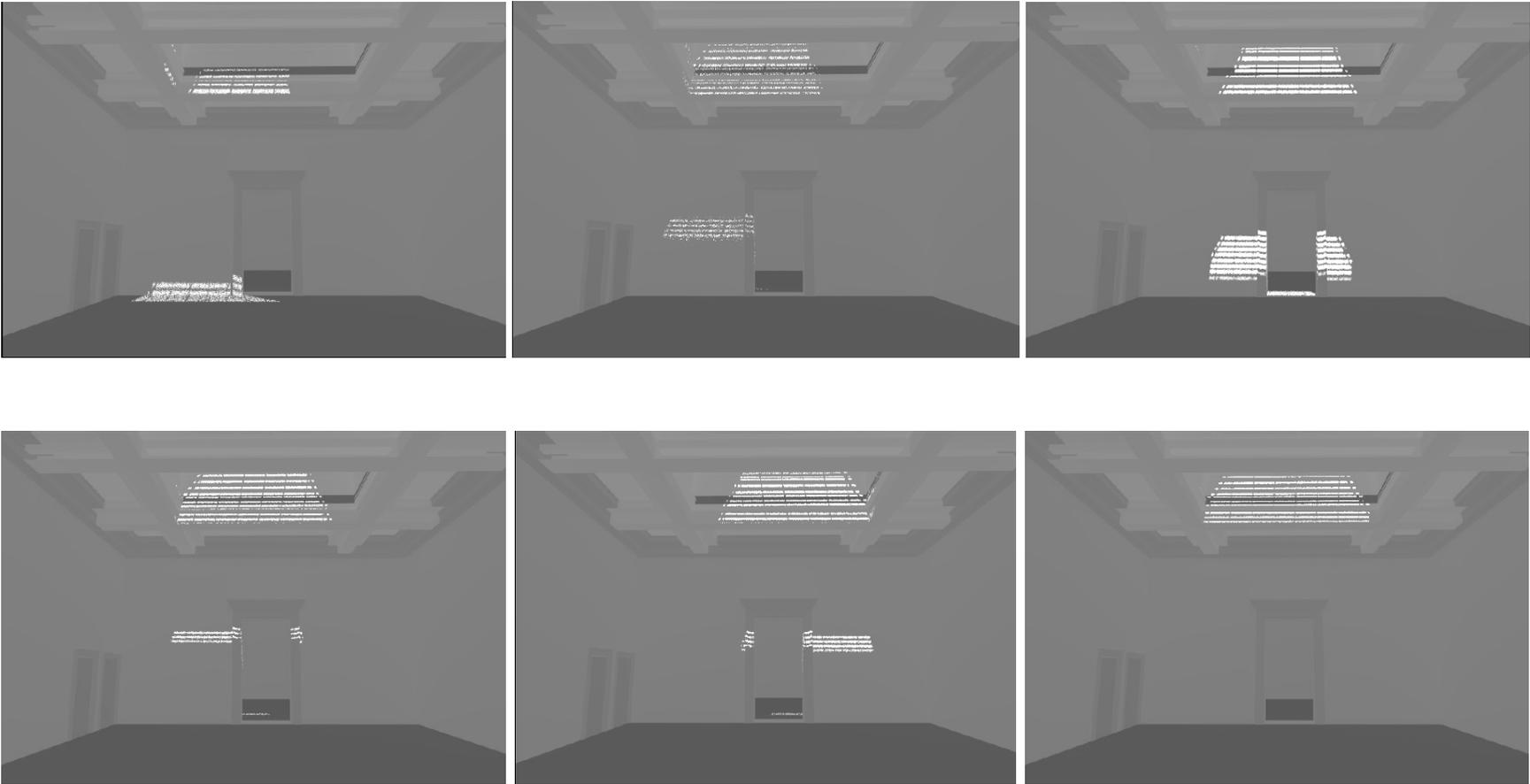
# General daylighting – diffuse only



## Controlling the entry of direct sunlight into the gallery



# Controlling the entry of direct sunlight into the gallery



# MAXSLIST in m\_mist.c

```
* The Heyney-Greenstein eccentricity parameter (-mg seccg) indicates how much
* scattering favors the forward direction. A value of 0 means isotropic
* scattering. A value approaching 1 indicates strong forward scattering.
*/
*/
#ifndef MAXSLIST
#define MAXSLIST 32 /* maximum sources to check */
#endif

#define RELAYDELIM '>' /* relay delimiter character */

static int inslist(int *sl, int n);
static int srcmatch(SRCREC *sp, char *id);
static void add2slist(RAY *r, int *sl);

static int
inslist( /* return index of source n if it's in list sl */
        int *sl,
        int n
)
{
    int i;
```

```
* The Heyney-Greenstein eccentricity parameter (-mg seccg) indicates how much
* scattering favors the forward direction. A value of 0 means isotropic
* scattering. A value approaching 1 indicates strong forward scattering.
*/
*/
#ifndef MAXSLIST
#define MAXSLIST 1200 /* maximum sources to check */
#endif

#define RELAYDELIM '>' /* relay delimiter character */

static int inslist(int *sl, int n);
static int srcmatch(SRCREC *sp, char *id);
static void add2slist(RAY *r, int *sl);

static int
inslist( /* return index of source n if it's in list sl */
        int *sl,
        int n
)
{
    int i;
```