FLEXLAB - Genentech Project

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BERKELEY LAB

WEBCOR BUILDERS

Genentech's big experiment: Biotech goes green, thanks to Berkeley lab

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Ron Leuty
San Francisco Business Times

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Biotech powerhouse Genentech Inc. is powering down on its energy use, thanks to plugging in to a cross-bay partnership.

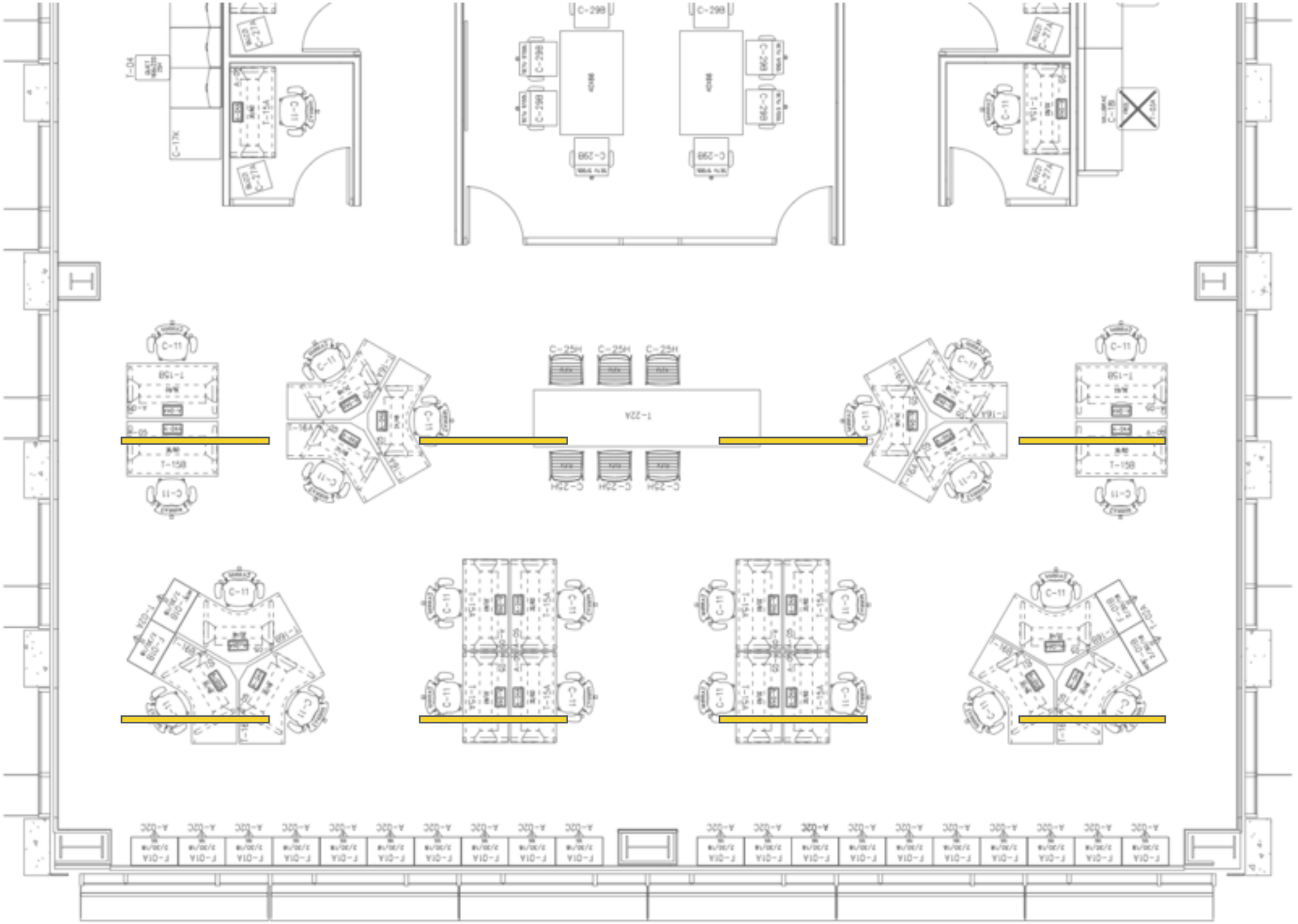
The South San Francisco-based company on Thursday opened a 255,000-square-foot building, dubbed "Building 35," that leans heavily on energy-saving techniques tested and refined by researchers at the Lawrence Berkeley National Laboratory's FlexLab facility.

What's more, said Carla Boragno, vice president of site services for Genentech, much of what Genentech learned through Lawrence Berkeley can be applied to many of the $2 billion worth of capital projects the company expects over the next five years.

The building has carpeting made from the snagged fish nets in the Philippines, for example. The blinds automatically ascend and descend based on the amount of sunlight coming through tinted windows. And windows high in the seven-story building's atrium open by themselves when the outdoor temperature is 65 to 78 degrees.

Those adjustments are more than techniques that allow Building 35 to consume 35 percent less energy than the national standard, Boragno

Building Floor Plan


C-29B
C-29H
C-25H
T-22A
T-15B
T-15A
C-11

Project Goals

1. **Evaluate the lighting and automated shading** control system performance and the resultant indoor environment determine if comfort criteria are being met, then adjust the shading and lighting systems' design and control system to the extent possible to **improve overall perimeter zone performance**;

2. **Quantify lighting energy and HVAC system load energy performance** over a summer test period for various shading and lighting test configurations;

3. **Evaluate space planning** issues that impact occupant density and allocation of space, including thermal and visual comfort issues related to proximity to facade and location of light fixtures;

4. Conduct evaluations noted above **for three primary prototypical spaces** in the HTA building by rotating the testbed, repositioning the exterior shading and repositioning the interior lighting.

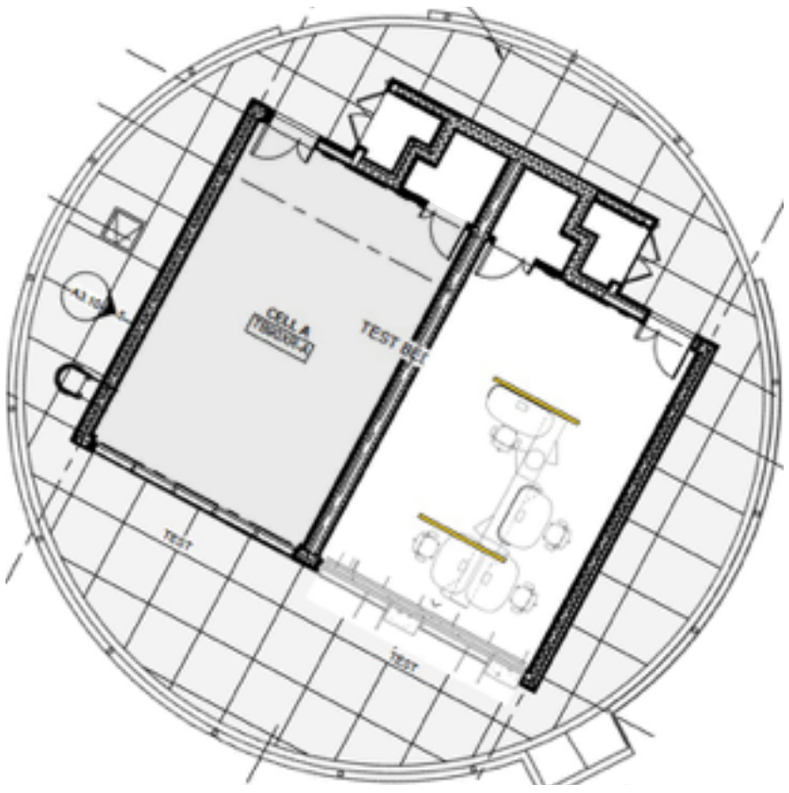
SystemsTested

- Electric Lighting: Vode (LED pendant fixture)
- Lighting Controls: Enlighted, Encelium
- Interior Shading: Mechosystems roller shade
- External Shading: Painted wooden overhangs & fins
- Finishes: Carpet, Ceiling, Furniture, Access Flooring

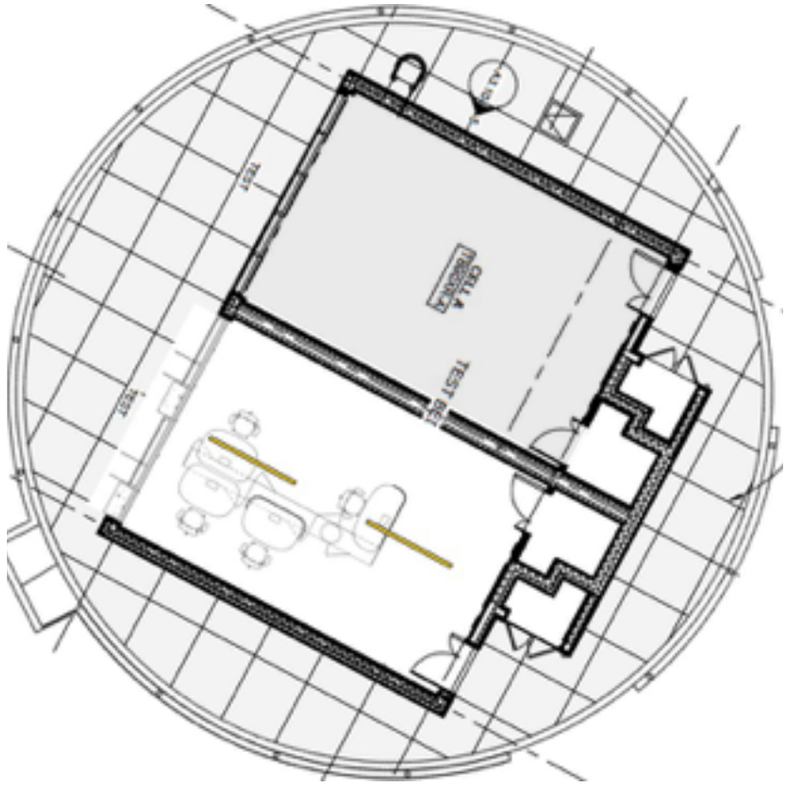
Test Cell Fitout

Test Procedure

- Testing three facade orientations: South, West, and East

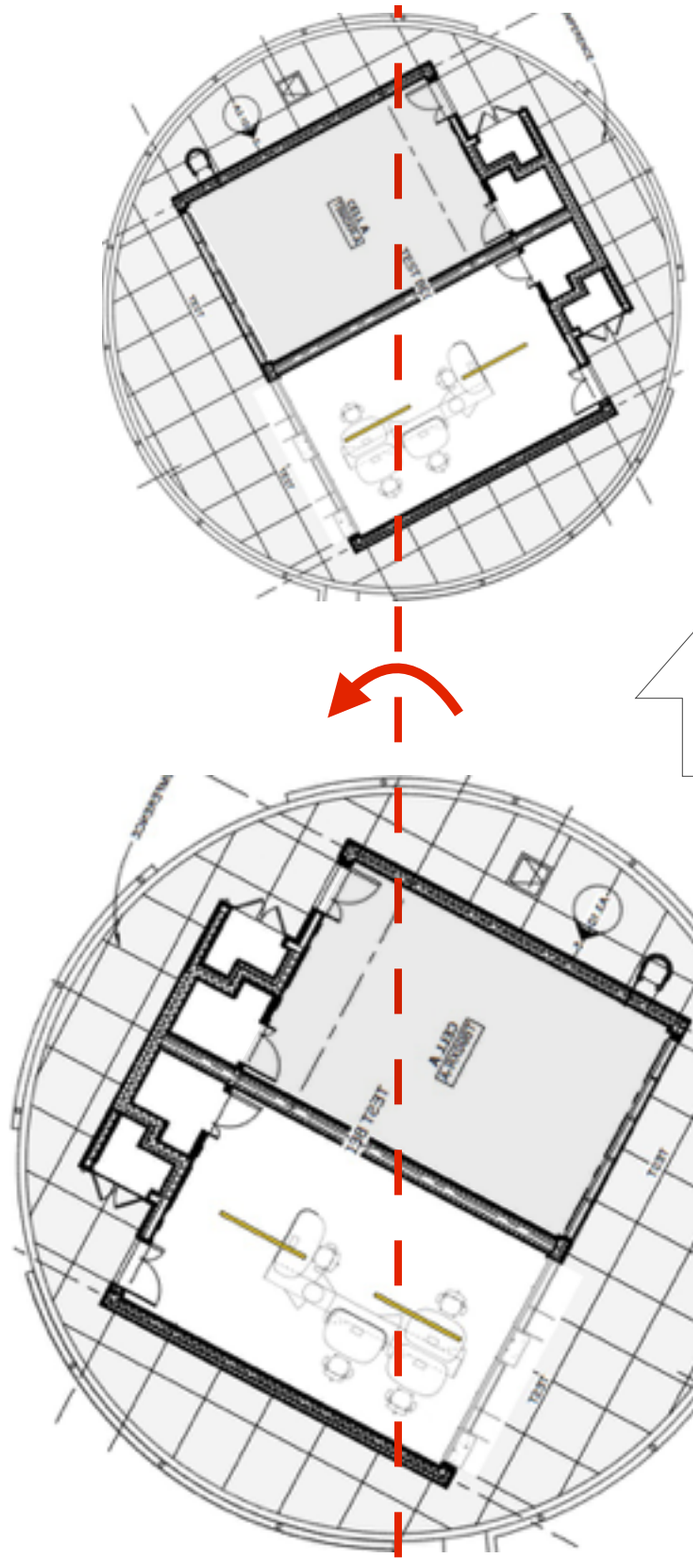


South Facade Orientation
208° (28° West of South)



West Facade Orientation
298° (28° North of West)

East Facing (testing) Orientation
242° (28° South of West)



East Facade (B35) Orientation
118° (28° South of East)

Test Schedule

- Testing occurred in three cycles.
- Each orientation was tested for six days during each cycle.
- Each lighting control system was tested for half of the six days.
- Changes were made between the test cycles to improve performance.

ORIENTATION	START	FINISH
Test cycle #1		
East Test	July 11	July 14
West Test	July 16	July 21
South Test	July 26	August 3
Test cycle #2		
South Test	August 9	August 14
East Test	August 16	August 21
West Test	August 23	August 28
Test cycle #3		
West Test	September 20	September 25
East Test	September 27	October 2
South Test	October 4	October 12
Tunable White	October 13	October 19

Facade

Facade Designation	Facade Orientation	Glazing Type	VLT	SHGC	Window to Wall Ratio	External Shading
East	118° (242° test)	GL-1	**42%**	**0.23**	**0.31**	One vertical fin per 10’ module
West	298°	GL-1	**42%**	**0.23**	**0.31**	Two vertical fins per 10’ module
South	208°	GL-2	64%	0.27	0.47	Two horizontal overhangs
FLEXLAB Fit Out	Rotating	GL-1	**42%**	**0.23**	**0.31**	Modified to suit orientation

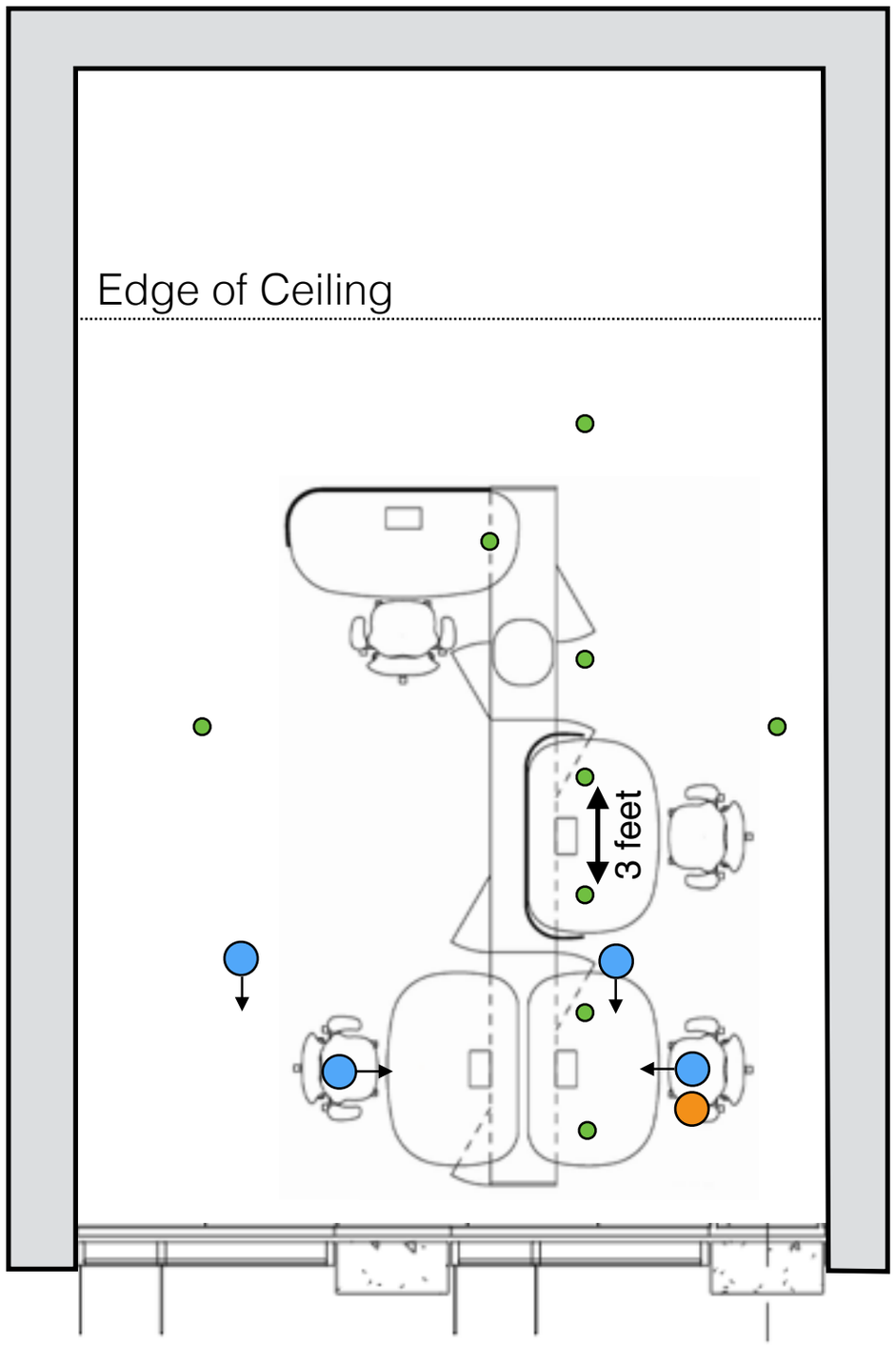
Facade

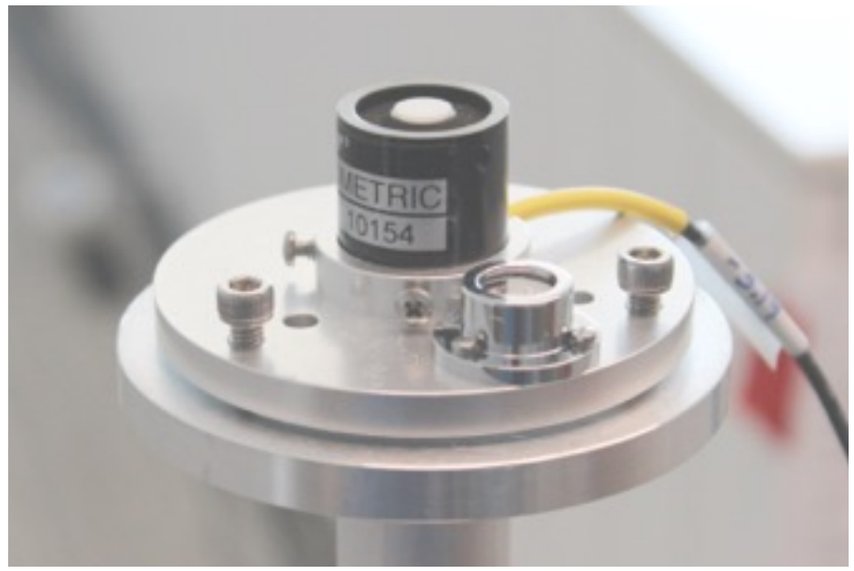
Sensors

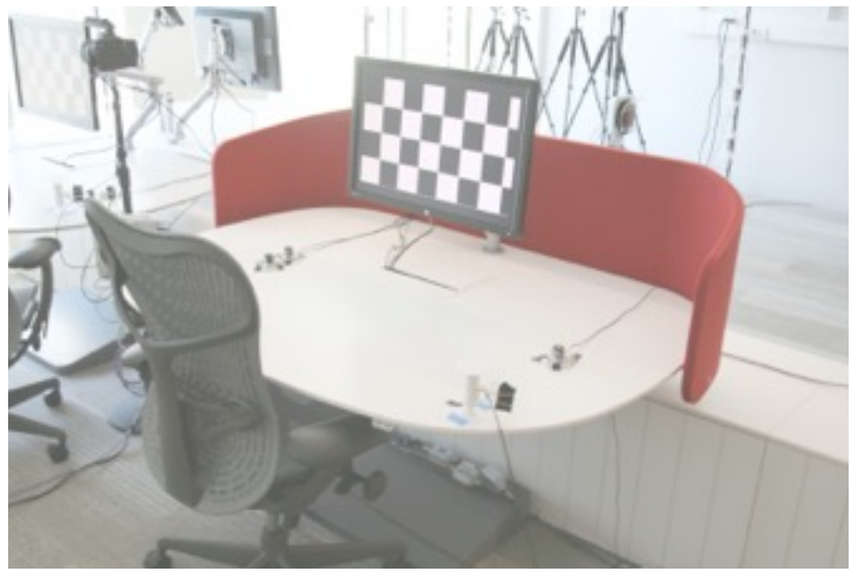
MEASUREMENT	UNITS	SENSOR(S)
Workplane Illuminance	Lux (lumens/meter^2)	Licor Photosensor
Dimming Signal to Ballast	Volts	Volt Meter
Lighting energy use (Current & Voltage)	Watts (Amps & Volts)	Current Transducer & Volt Meter
Temperature	Degrees Celsius	Shielded Thermistor
Thermal Comfort	PPD (Degrees Celsius, meters/second)	Shielded Dry-bulb Thermistor, Globe (radiant) temperature, and omni directional air velocity sensor.
Relative Humidity	%RH	RH Sensor
Discomfort Glare (Luminance Map)	DGP (candela/meter^2)	HDR imaging setup
Blind Position		Retrieved log from MechoSystems

MEASUREMENT	UNITS	SENSOR(S)
Room Temperature	Degrees Fahrenheit	Two Shielded Thermistors (averaged)
Supply Air temperature	Degrees Fahrenheit	Thermistor
Supply Air Flow	Cubic Feet per Minute (CFM)	Flow sensor
Outside Air Temperature	Degrees Fahrenheit	Thermistor
IR Imaging	Degrees Celsius	FLIR Camera
Exterior Global Horizontal Irradiance	Watts/Meter^2	Pyranometer
Direct Normal Irradiance	Watts/Meter^2	Heliostat
HDR Sky Luminance Map	Candela/Meter^2	Terrestrial Light Skycam

Test Setup







HDR Camera

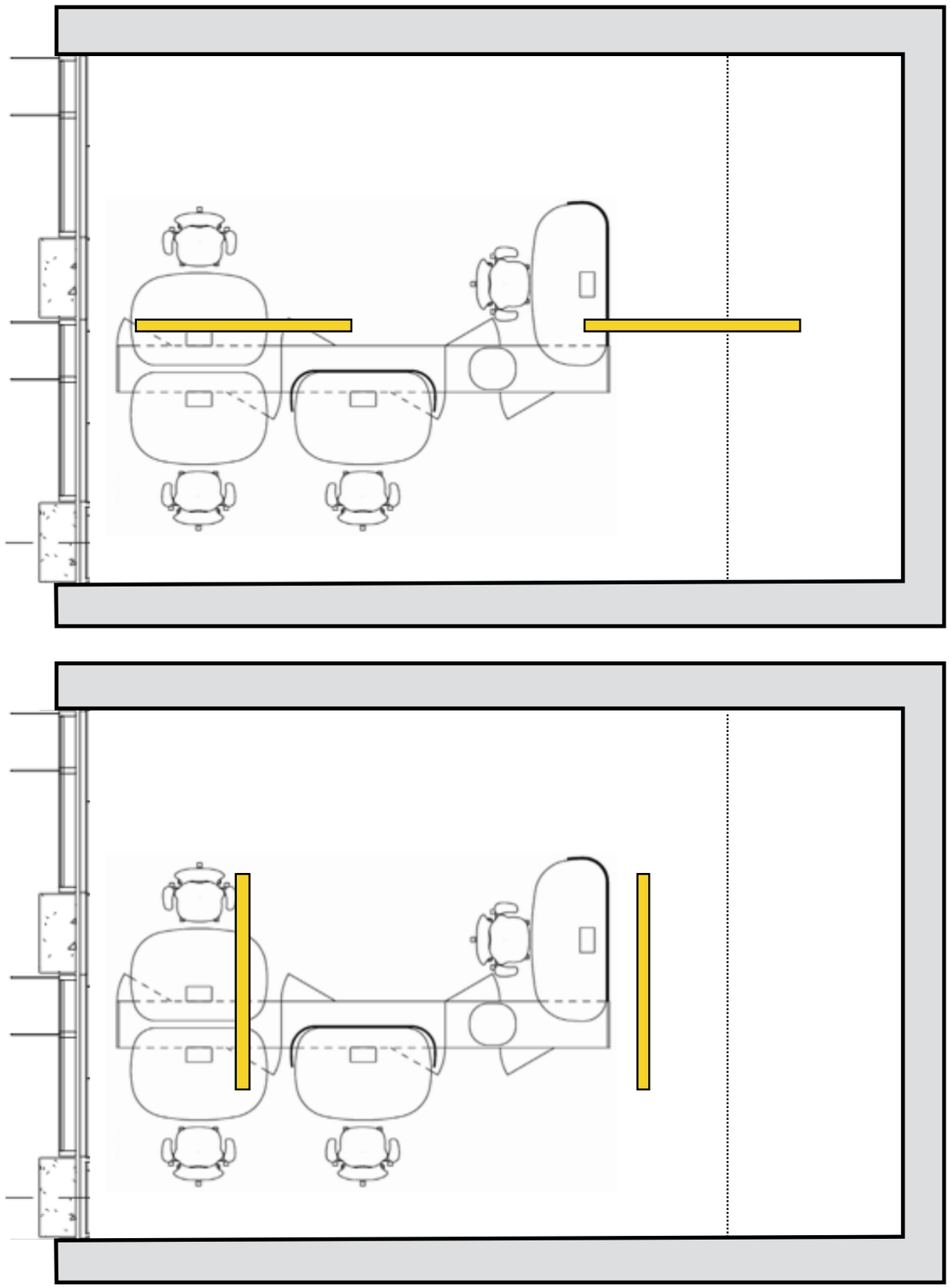
Licor Photometer & Shielded Thermistor

Thermal Comfort Sensing Package

Light Fixtures:
Vode Lighting

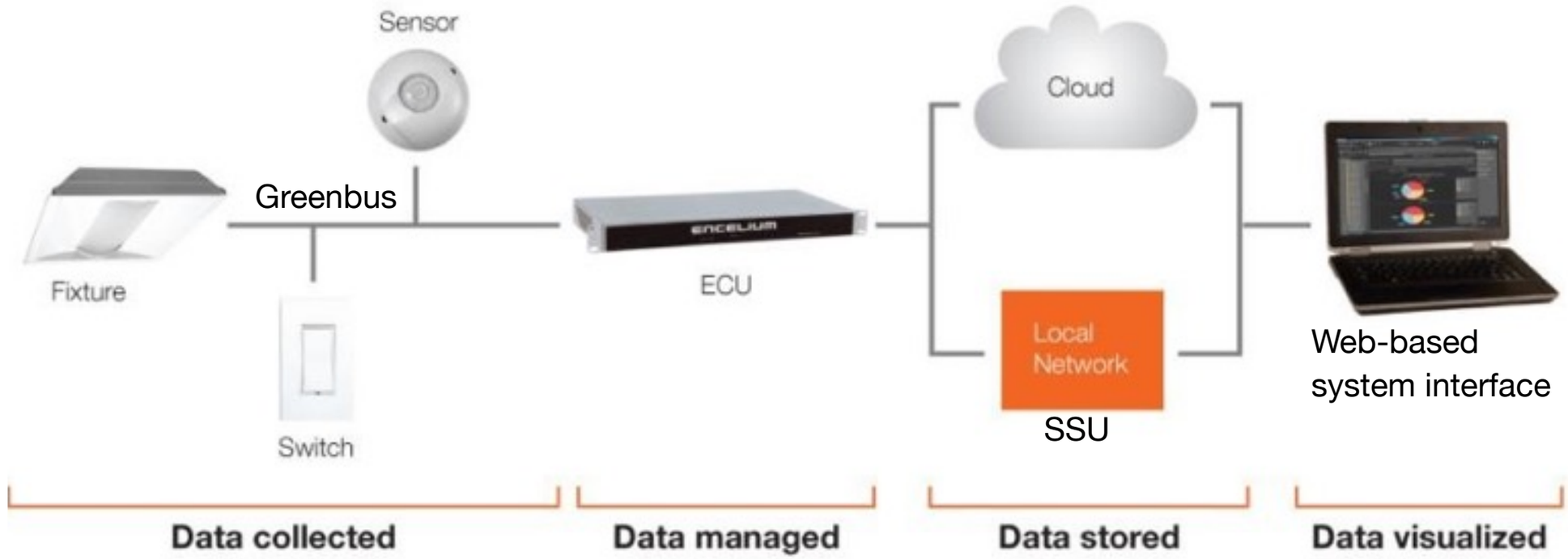
Lighting Layout

- 8 foot linear LED pendant
- Separate control of upward and downward light
- 128W per fixture (64W for upward light and 64W for downward light)
- B35
  - rows spaced 14 feet on center
  - 16 foot fixture spacing within rows
  - 0.57 W/ft2 LPD
- FLEXLAB
  - two fixtures
  - rotated based on Facade Orientation



Lighting Controls:
Overview

Encelium System Overview



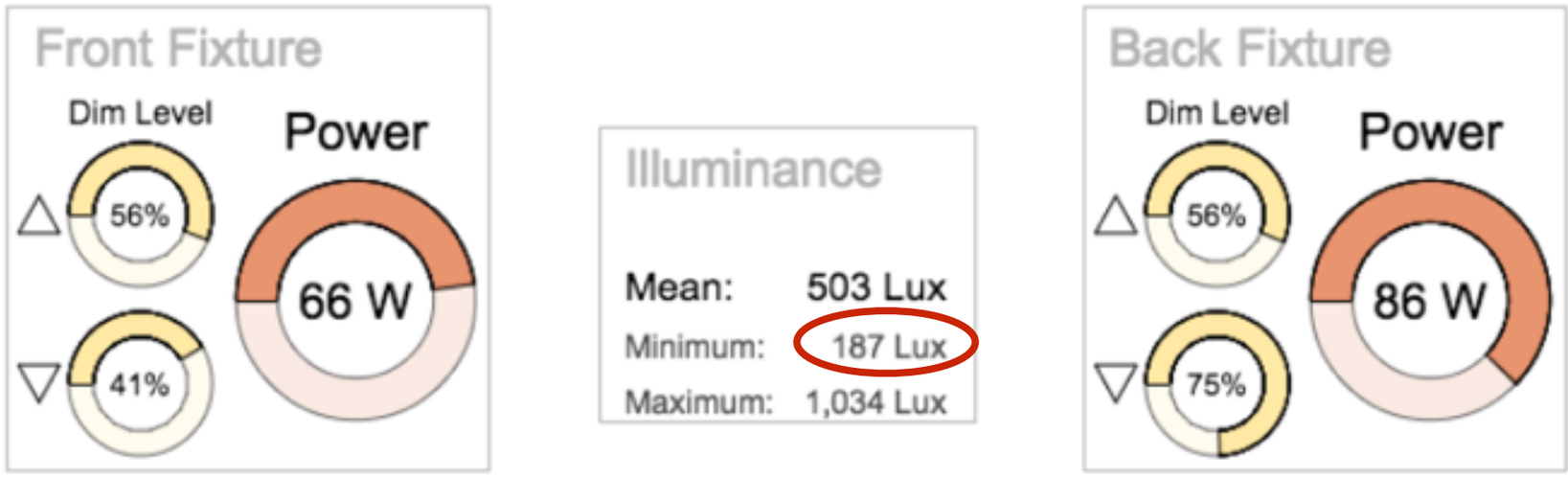
Control System Design Intent

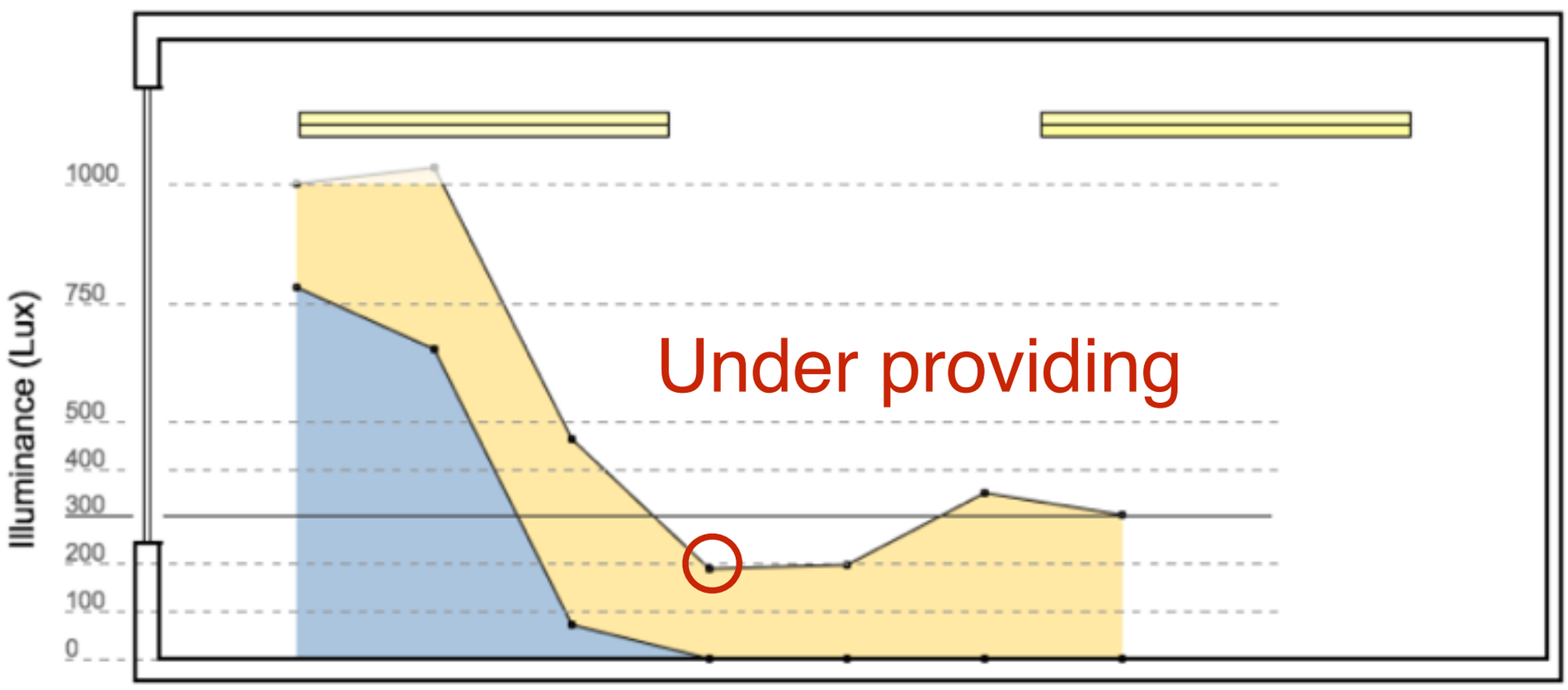
- 300 lux workplane illuminance (average).
- Uniform uplight across the open office space (dimmed based on daylight presence).
- Downlights dimmed individually to supplement.

We used minimum workplane illuminance to evaluate lighting control performance

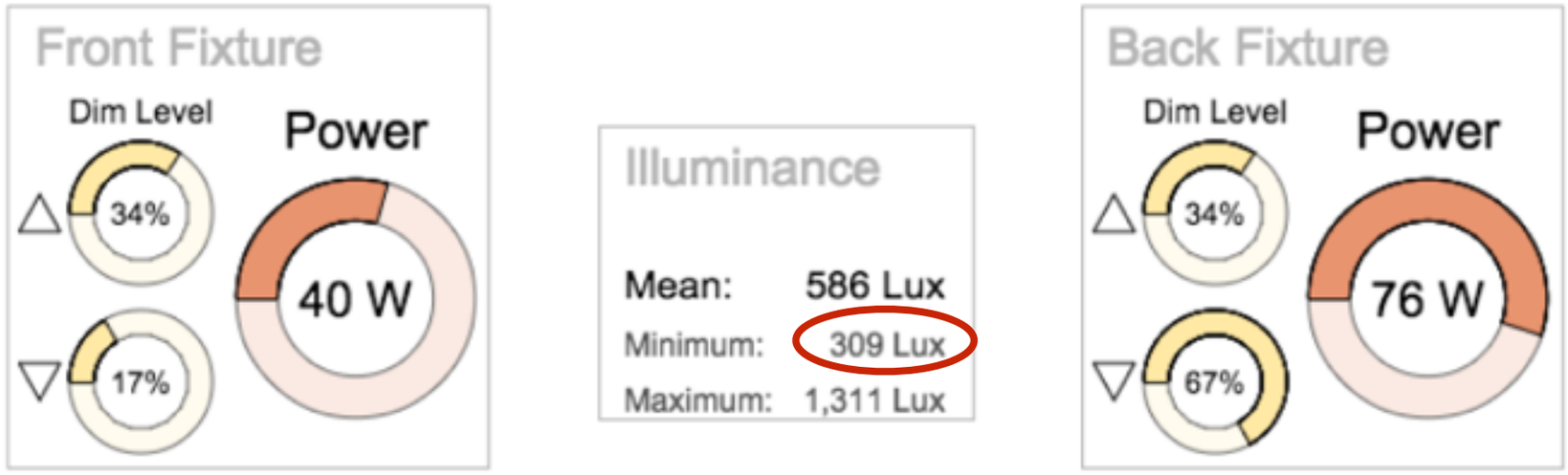
- Average workplane illuminance is skewed by high levels of daylight near the window.
- We want to make sure that there is acceptable illuminance throughout the work area.
- IESNA recommends a workplane illuminance uniformity ratio of 1.5:1 (average:minimum)
- When the design criteria is 300 lux average, we can accept a minimum workplane illuminance as low as 200 lux.

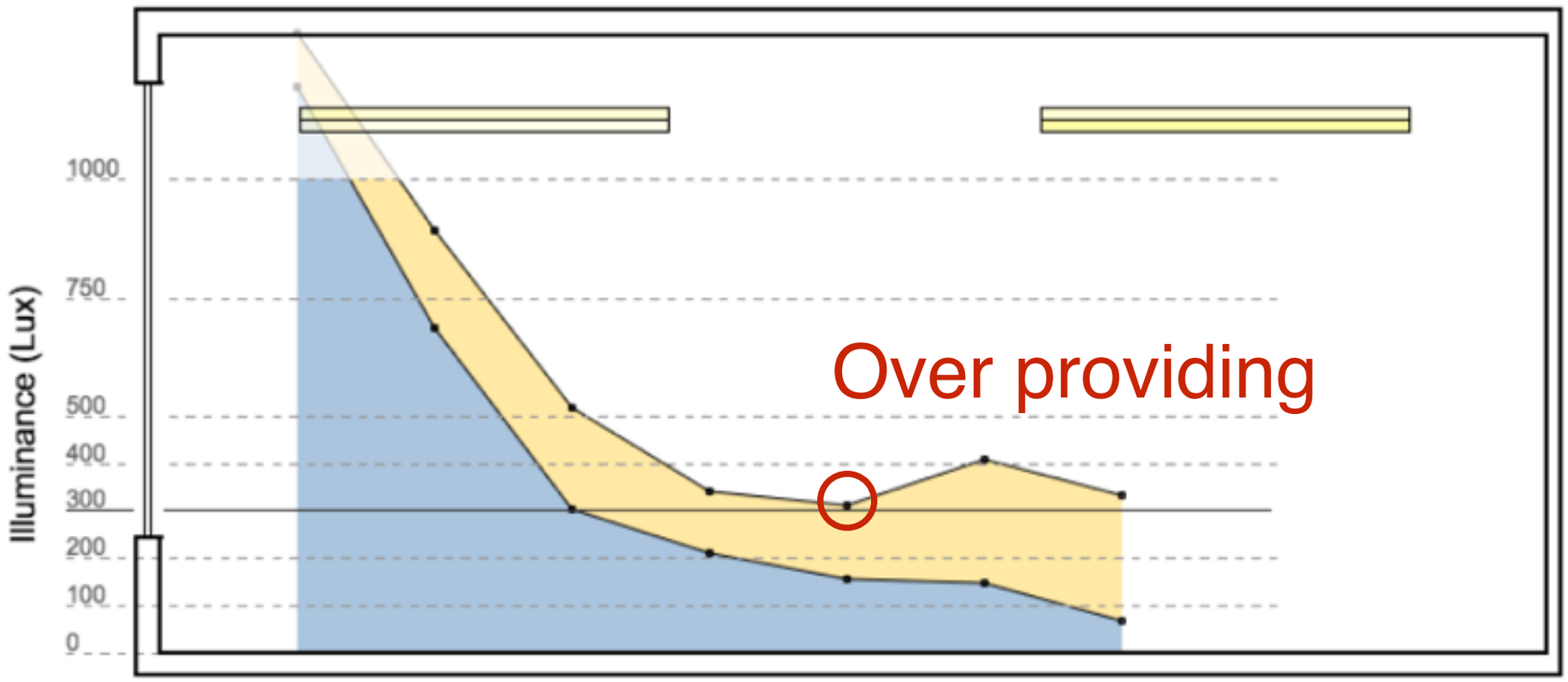
When the minimum illuminance falls below 200 lux, the system is under providing.





When the minimum illuminance is over 300 lux, the system is over providing.





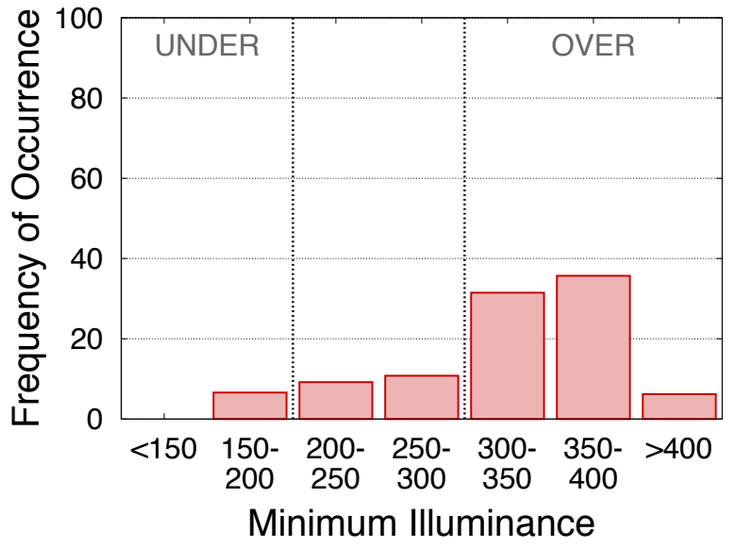
Encelium

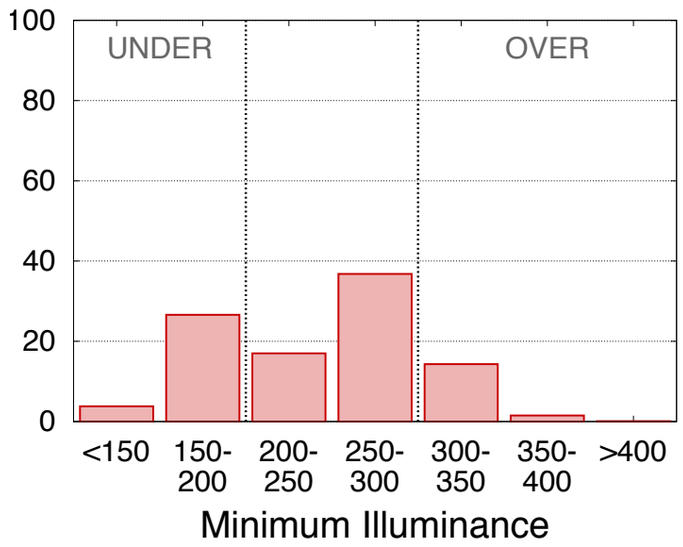
EAST

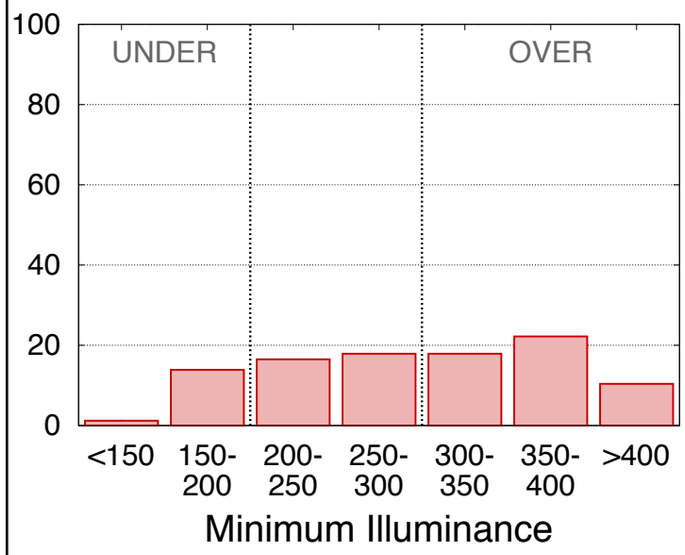
WEST

SOUTH

TEST #1







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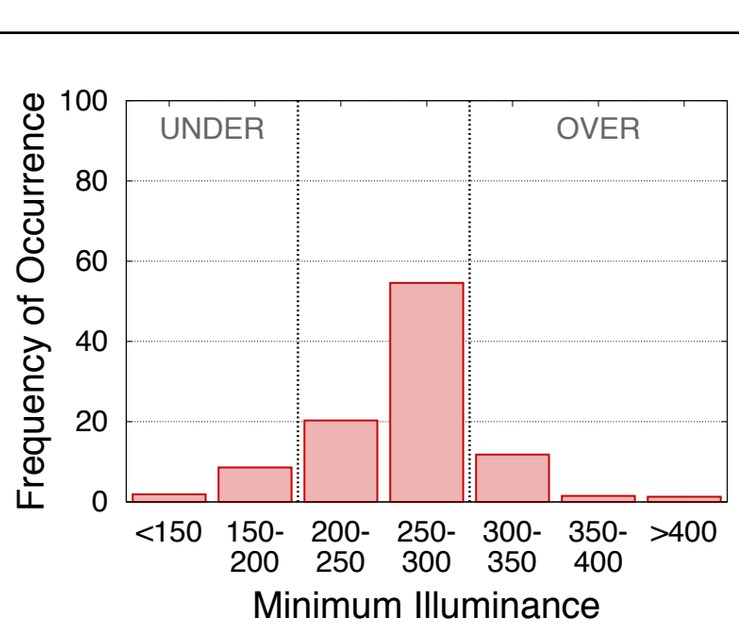

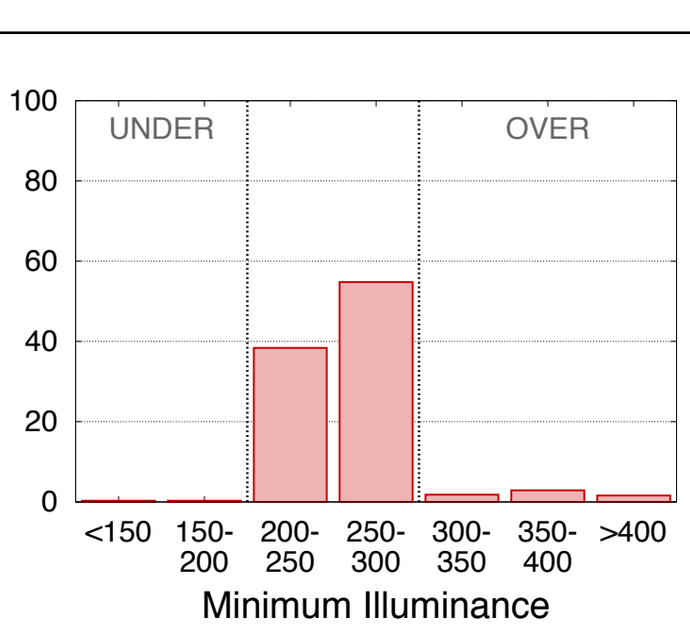

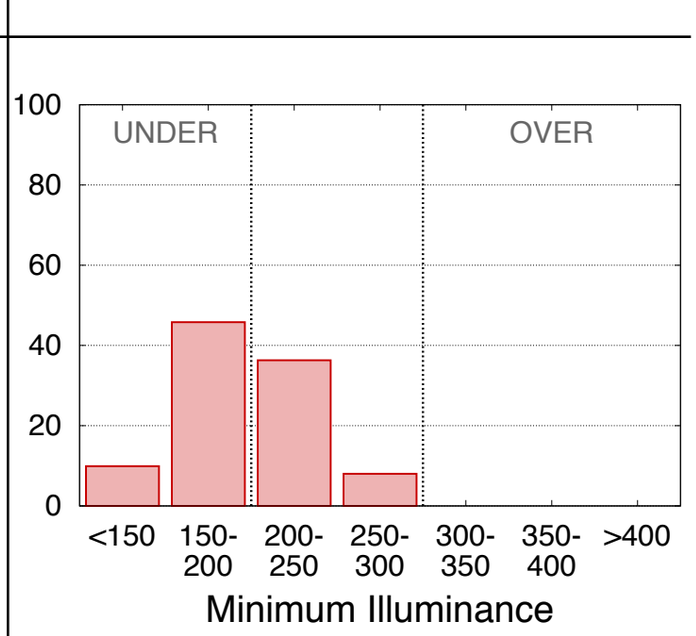

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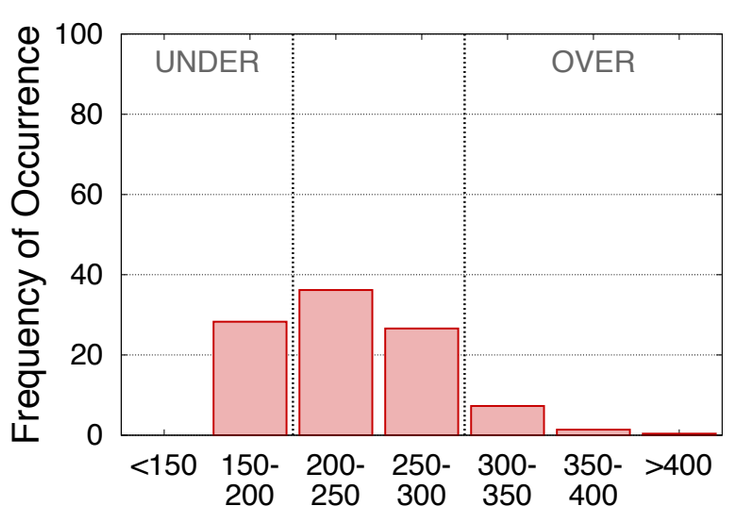
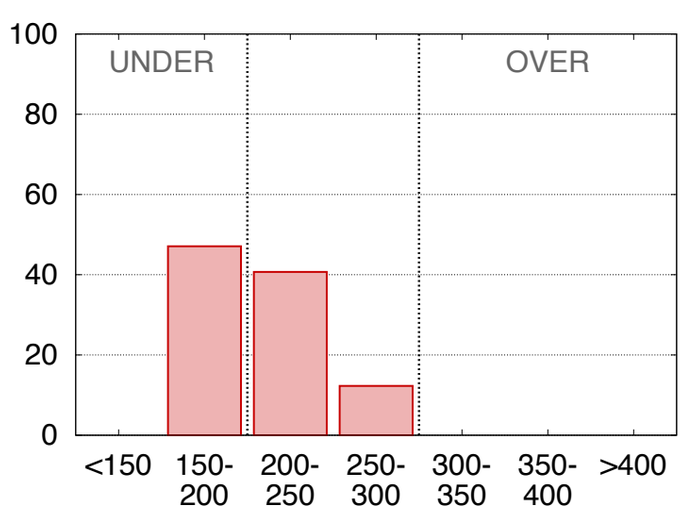
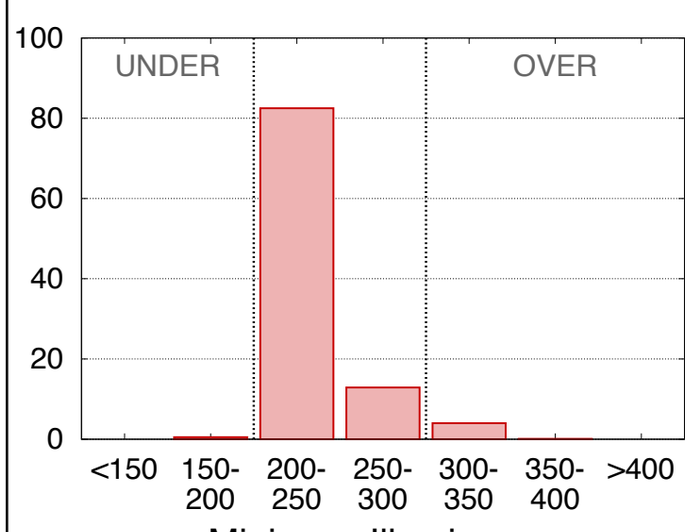
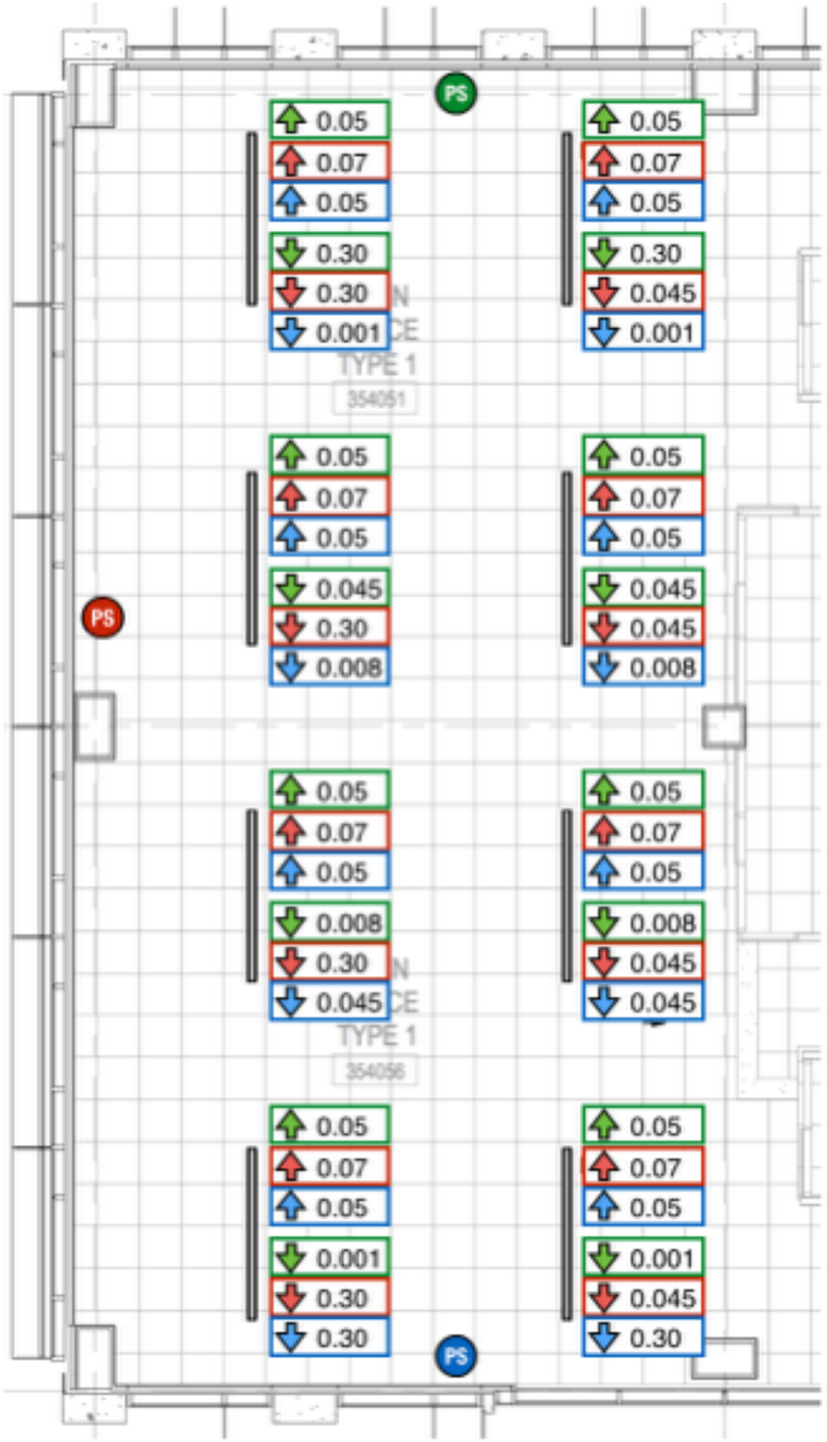
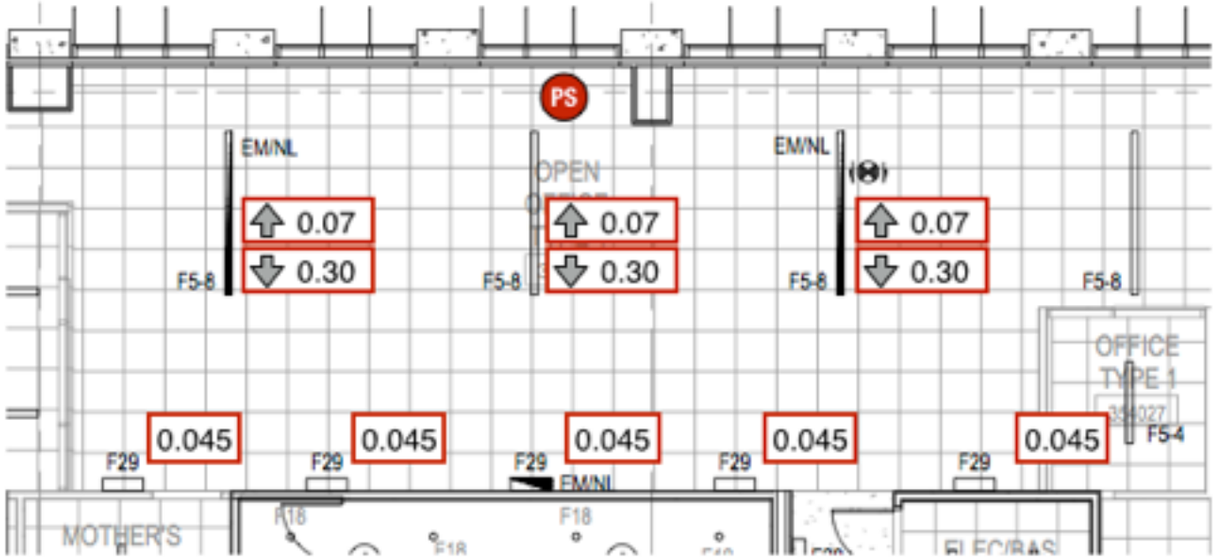






Recommendations





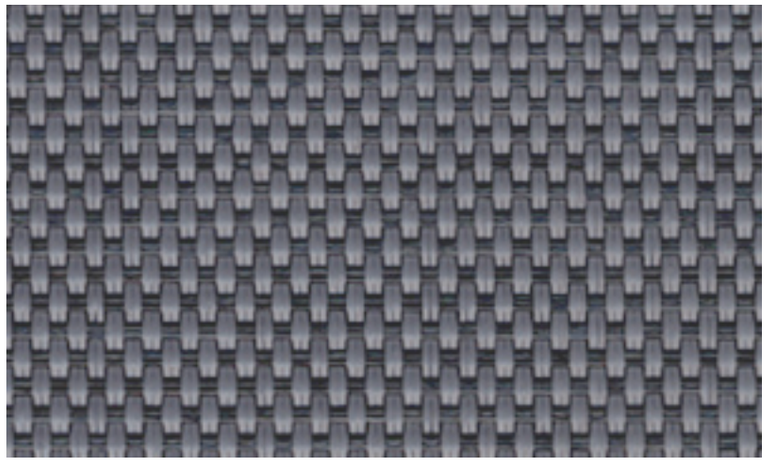
- We provide starting point dependency values based on FLEXLAB
- Lighting in the building ends should be influenced by three photocells, one at each facade.

Interior Shading:
Mechosystems

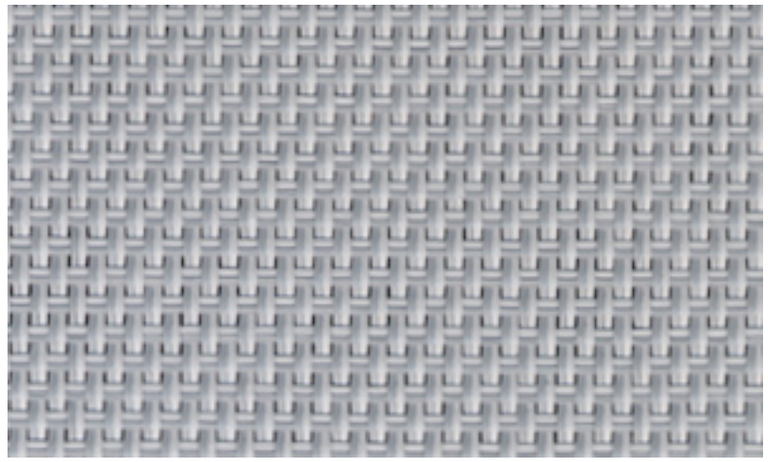
The shade has six stop positions: up, down and four equally spaced between.

POSITION	HEIGHT ABOVE FLOOR	HEIGHT ABOVE WINDOW SILL
0	98 inches	72 inches
1	81.5 inches	65.5 inches
2	63.75 inches	47.75 inches
3	46.5 inches	30.5 inches
4	30 inches	14 inches
5	14 inches	-3 inches

We tested two colors of shade fabric.



1570: Shadow Grey

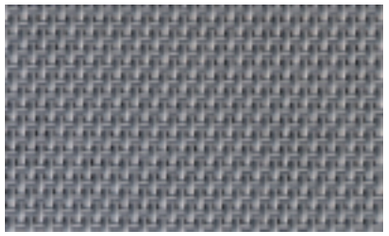


1563: Grey

MODEL	COLOR	OPENNESS	T_V	T_S	R_S	A_S
1570	Shadow Grey	3%	0.05	0.03	0.10	0.87
1563	Grey	3%	0.06	0.04	0.31	0.65

The darker color provides a better view of the exterior.

1570: Shadow Grey



1563: Grey

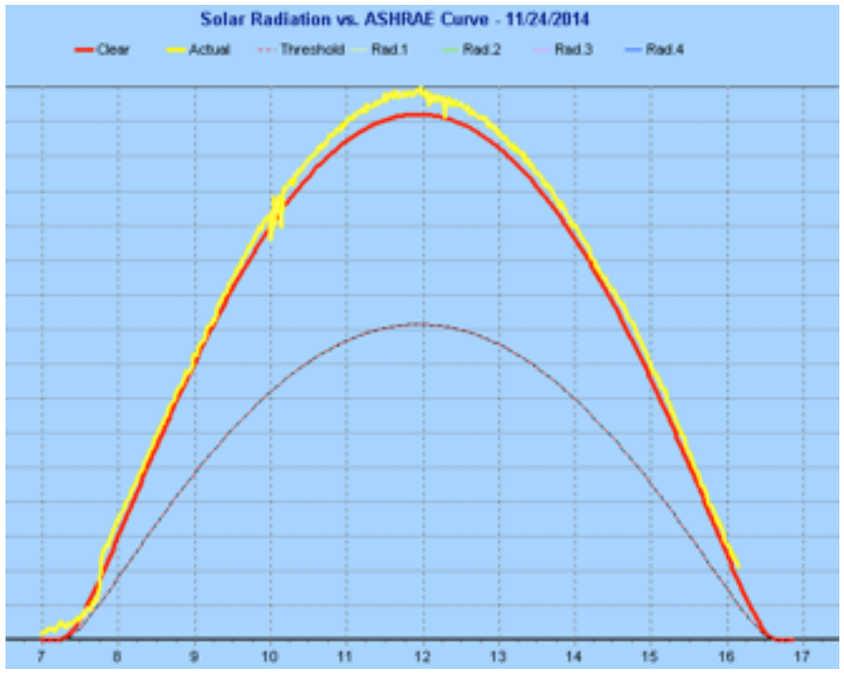
The darker shade was selected to improve exterior views.

- The darker shade provides a better view through to the exterior.
- The darker shade exhibits marginally lower glare index.
- The lighter shade transmits more daylight & reflects more interior light (presumably, this wasn’t tested in FLEXLAB).

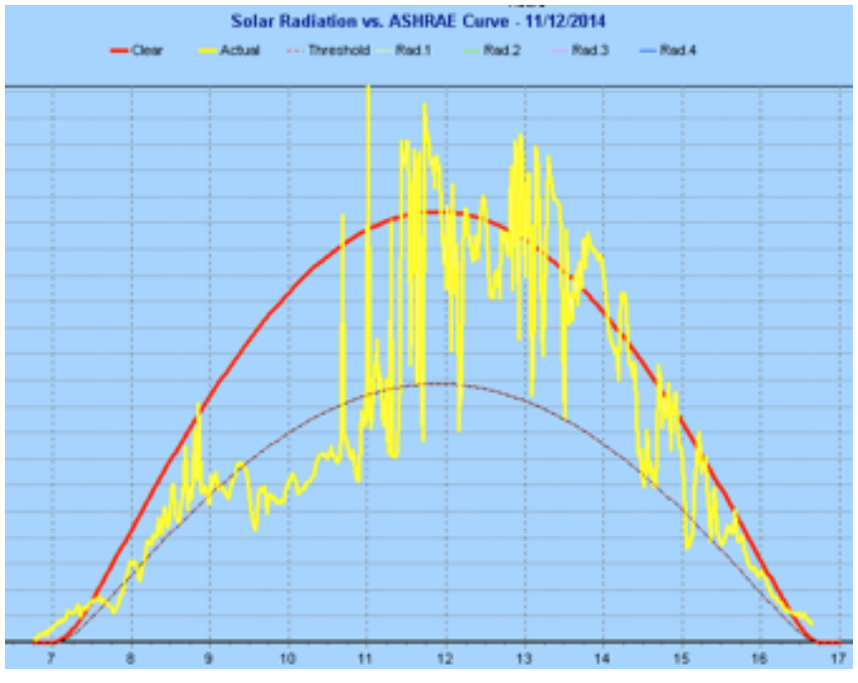
Shade Operation

1: Determines Sky Condition

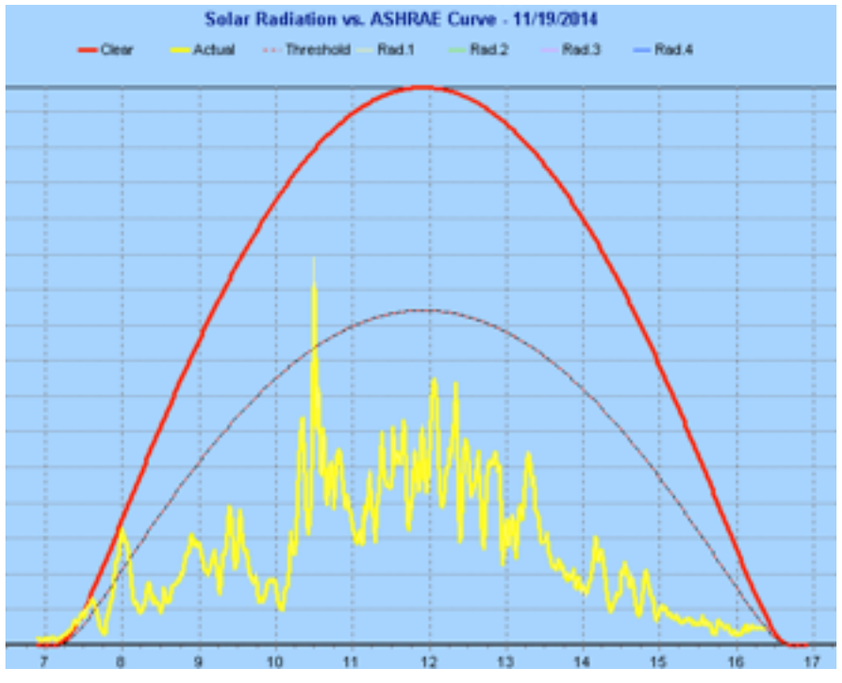
Rooftop irradiance sensor



Clear Sky



Intermediate Sky

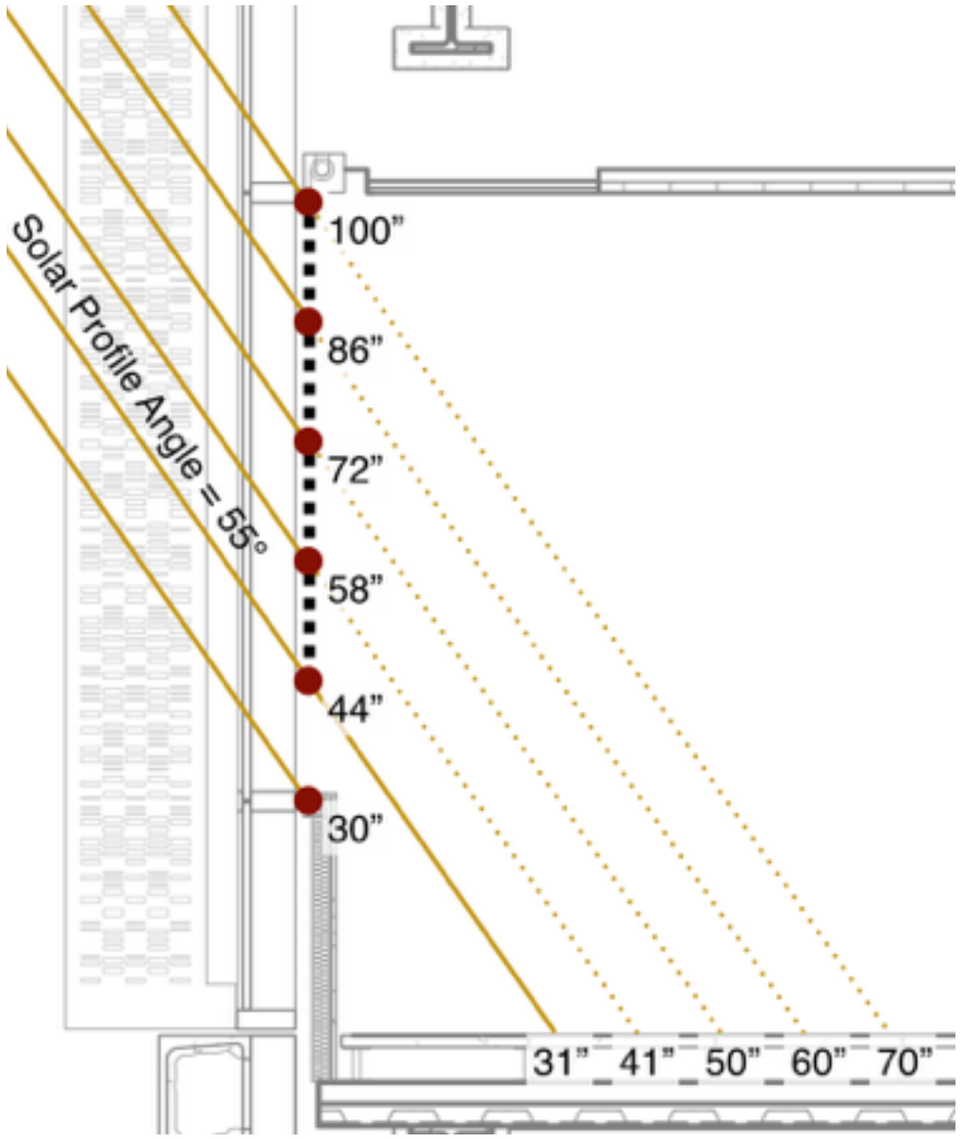


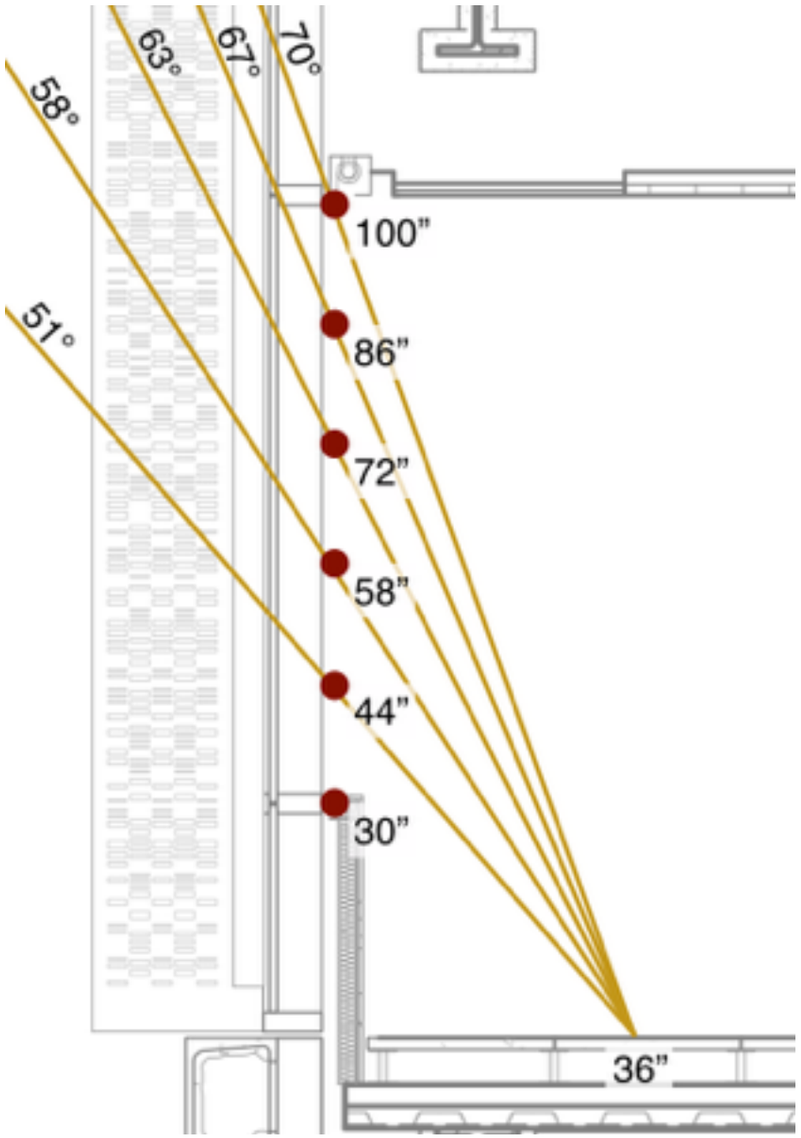
Overcast Sky

Note: y-axis is scaled to the plotted data and not consistent between charts.

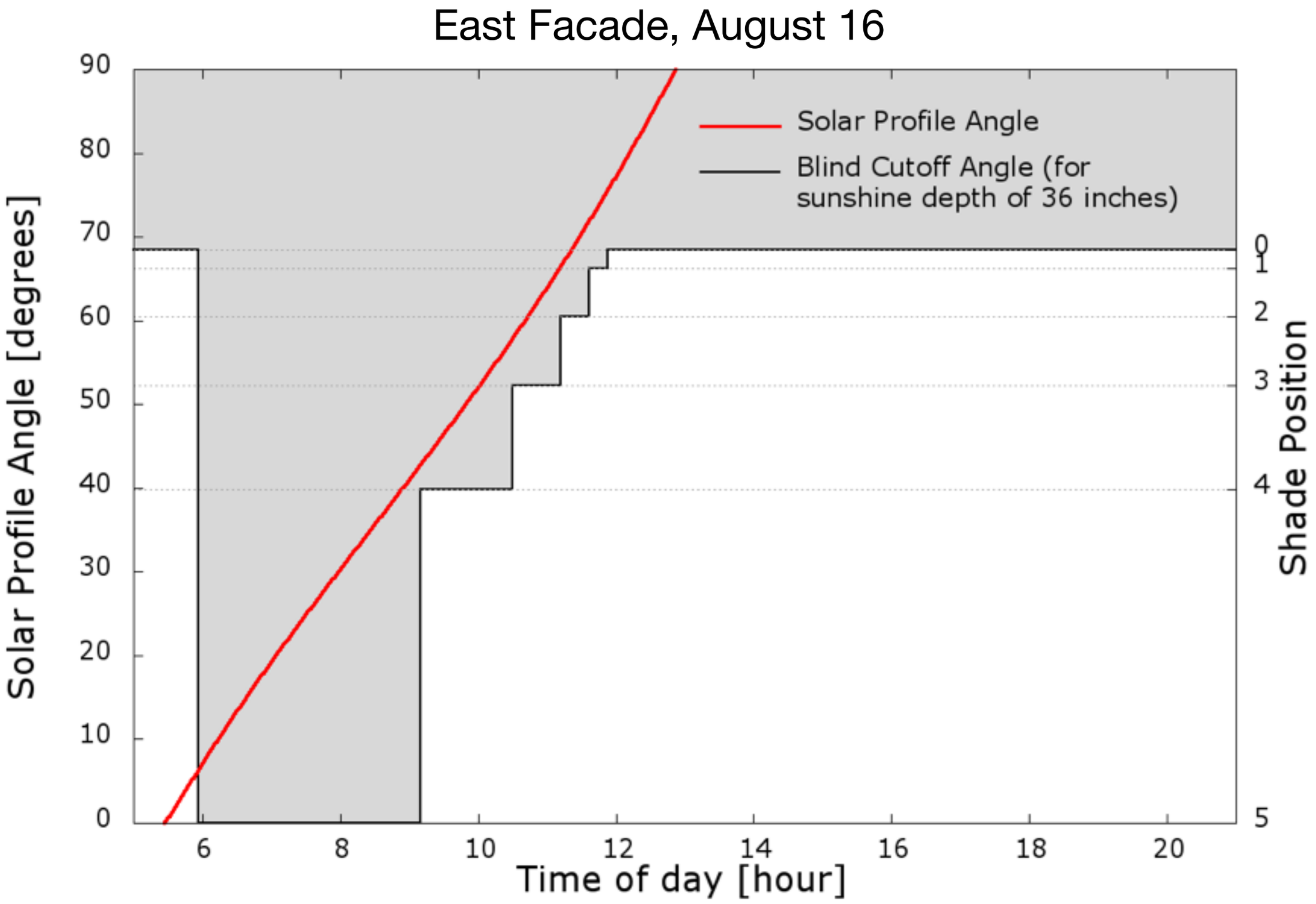
Shade Operation

2: Determines profile angle and select shade position to limit sun penetration.

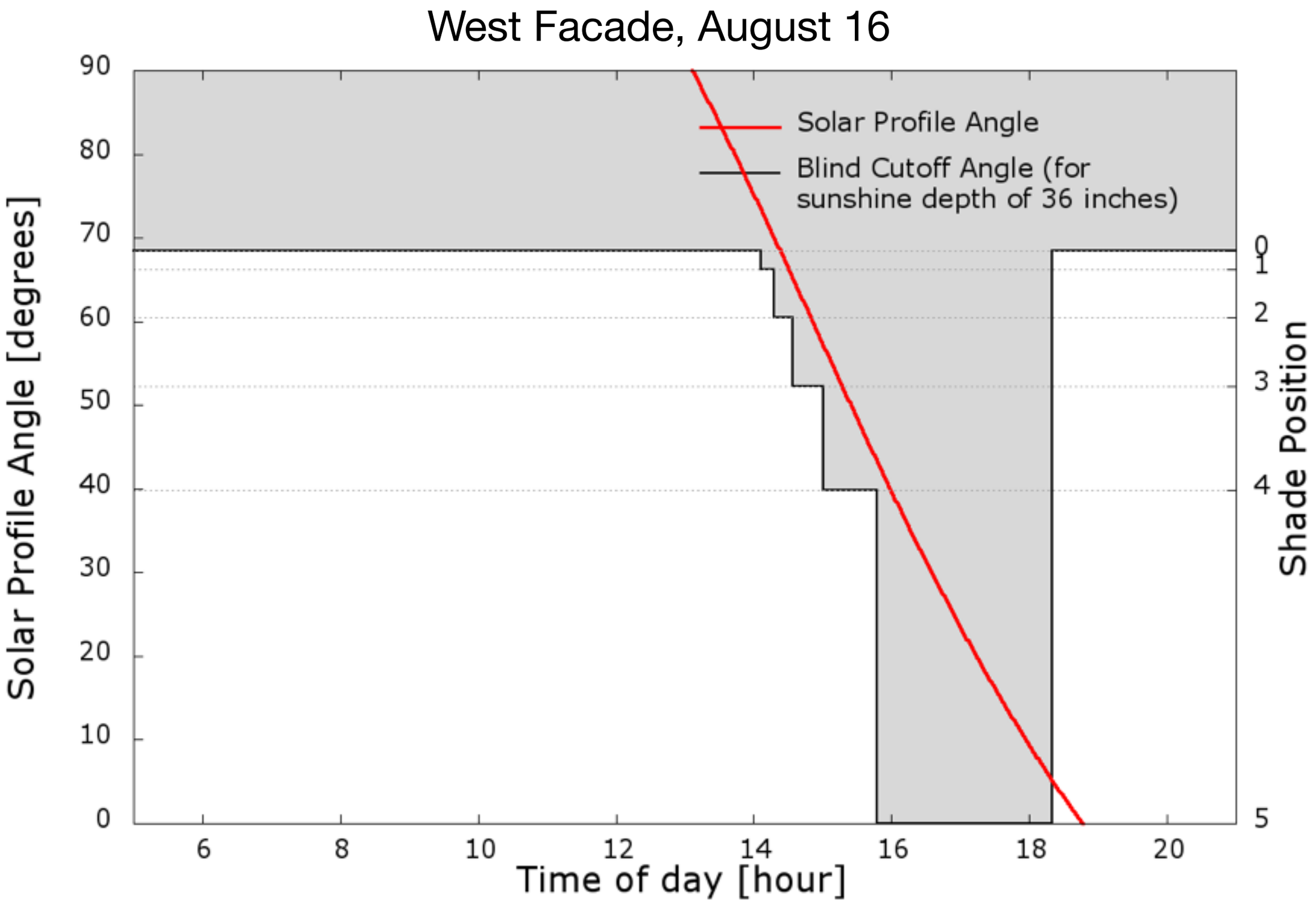




Shade operation on sunny days.

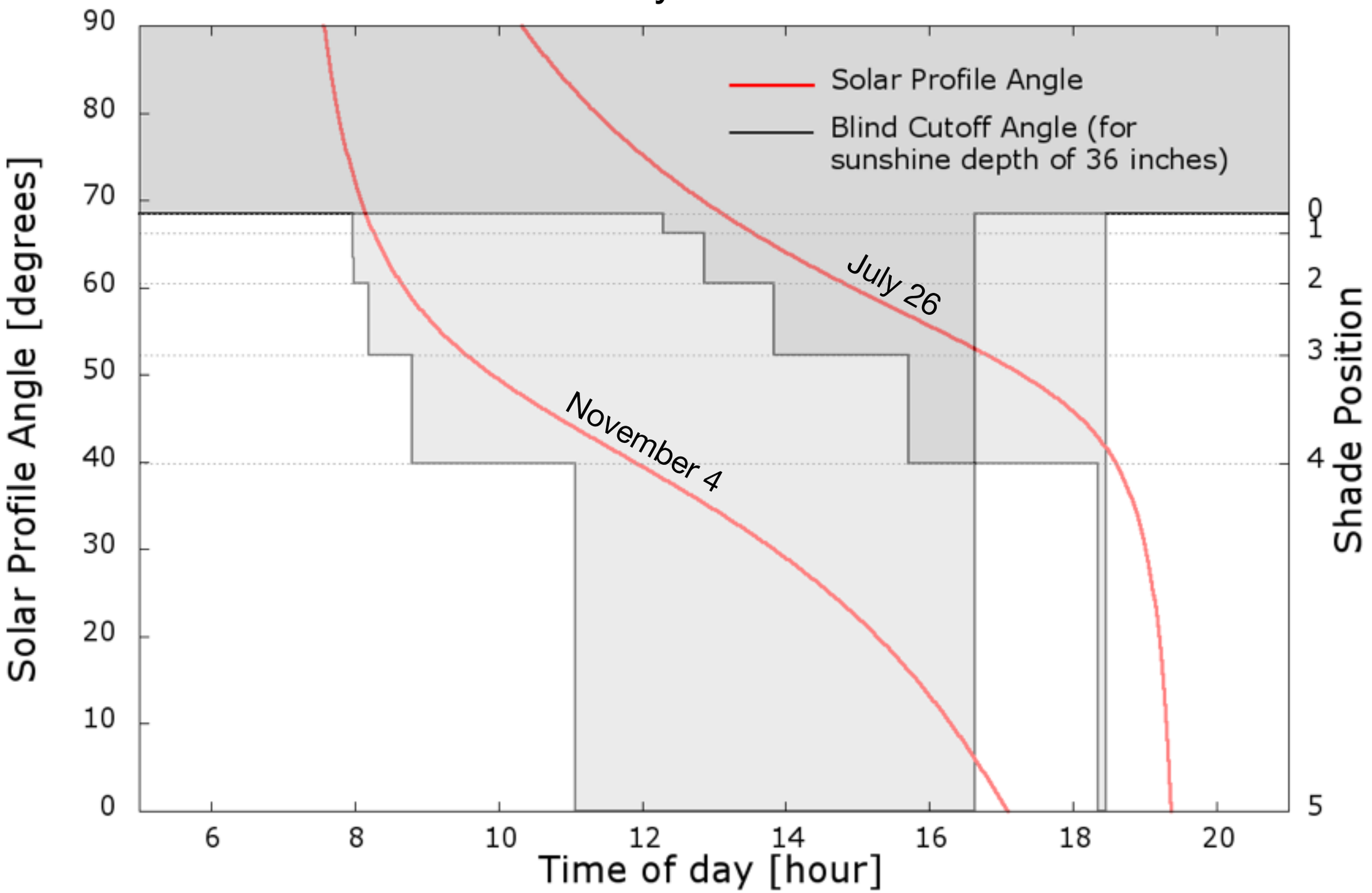


Shade operation on sunny days.



Shade operation on sunny days

South Facade: July 26 and November 4



Tradeoff: Daylight vs. Glare

OLD POSITION	NEW POSITION	AVERAGE LIGHTING POWER BEFORE	AVERAGE LIGHTING POWER AFTER	PERCENT CHANGE IN LIGHTING POWER
0	1	68 W	70 W	**+3%**
1	2	73 W	87 W	**+16%**
2	3	84 W	112 W	**+33%**
3	4	97 W	141 W	**+45%**
4	5	98 W	174 W	**+76%**

- Going from position 0 to 1 has negligible effect on lighting energy use.
- Going from position 4 to 5 has substantial effect on lighting energy use.

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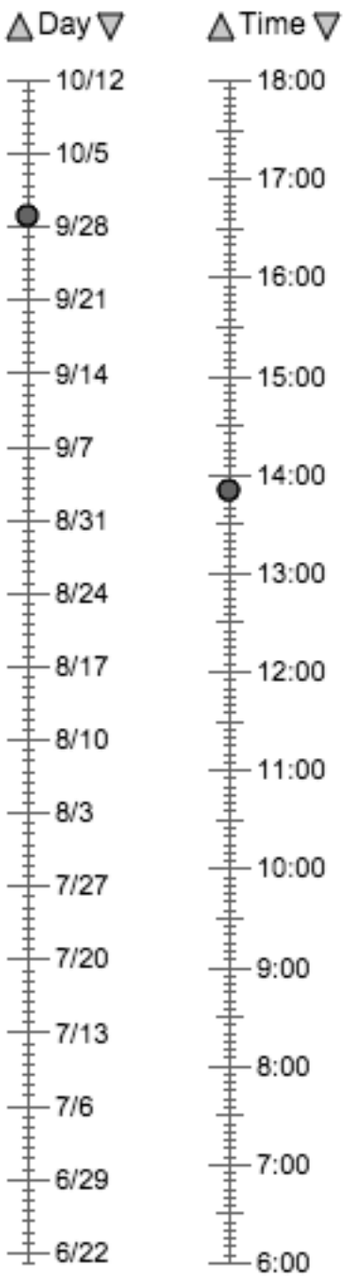

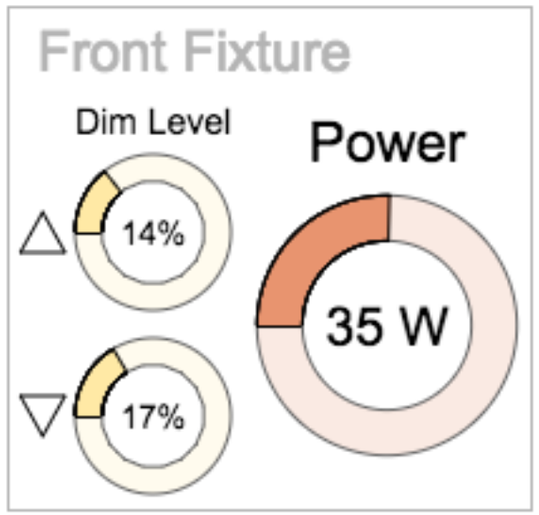

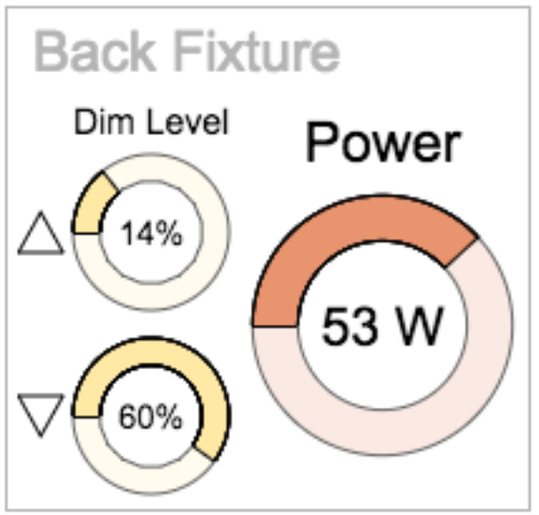

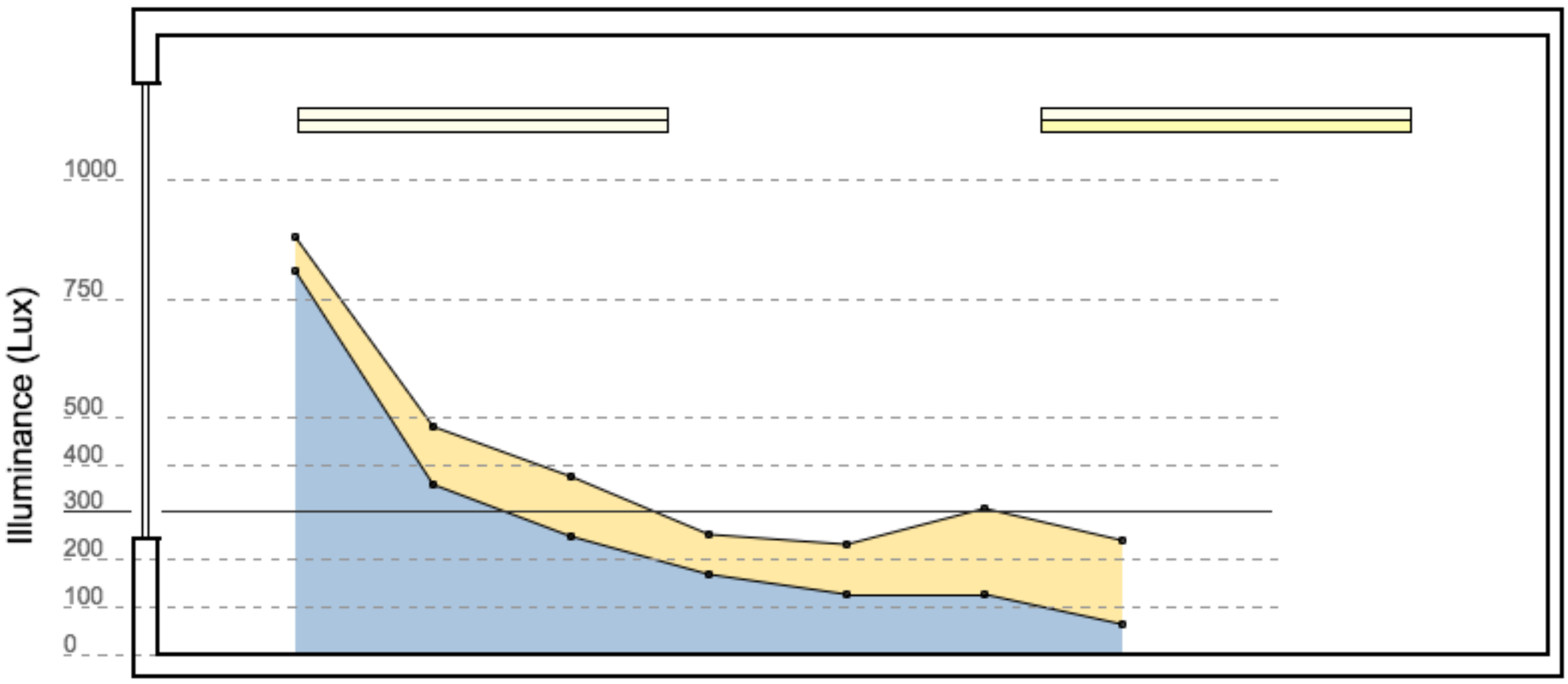

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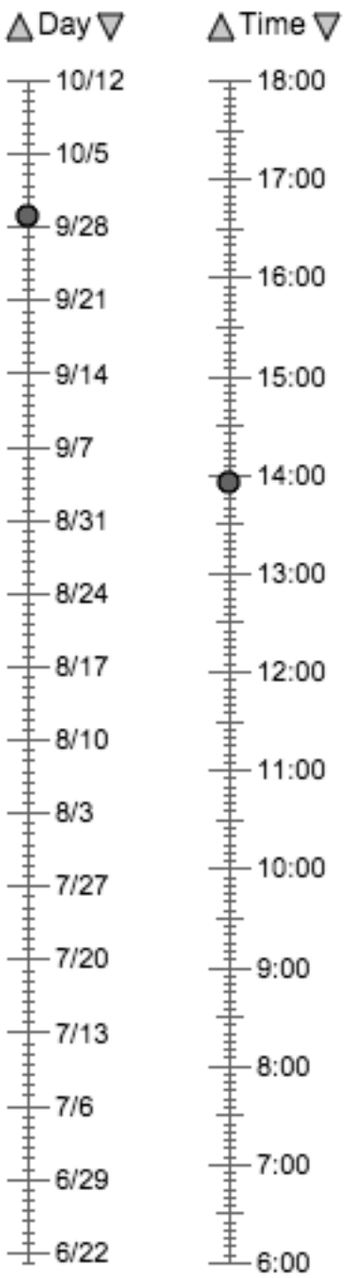

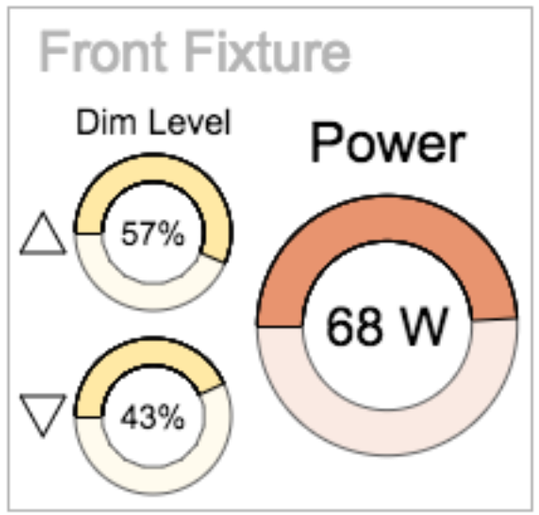

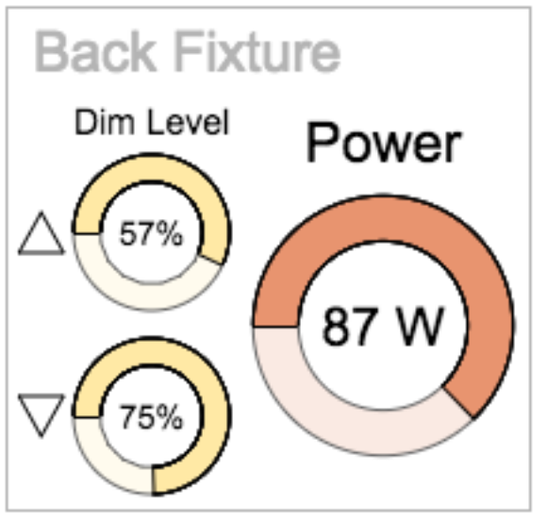

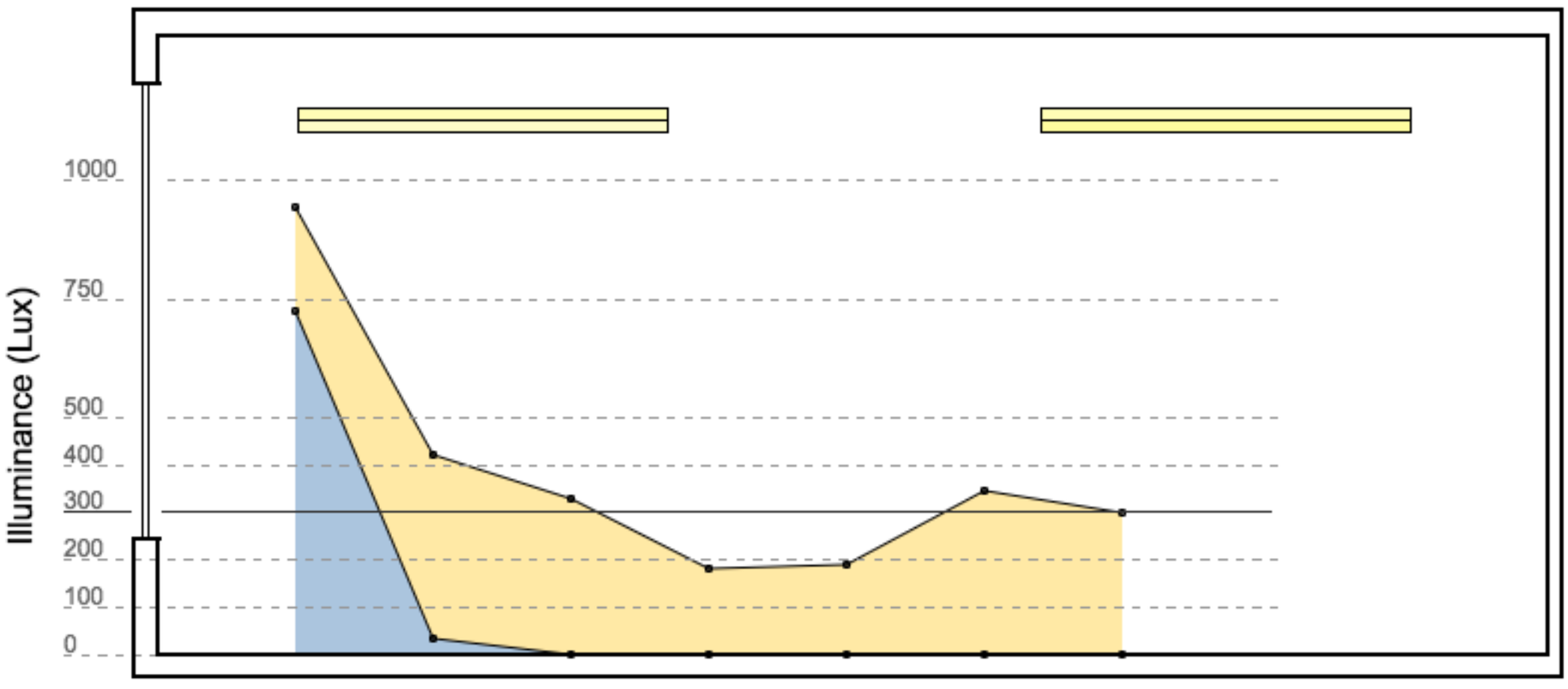

9/29/2014

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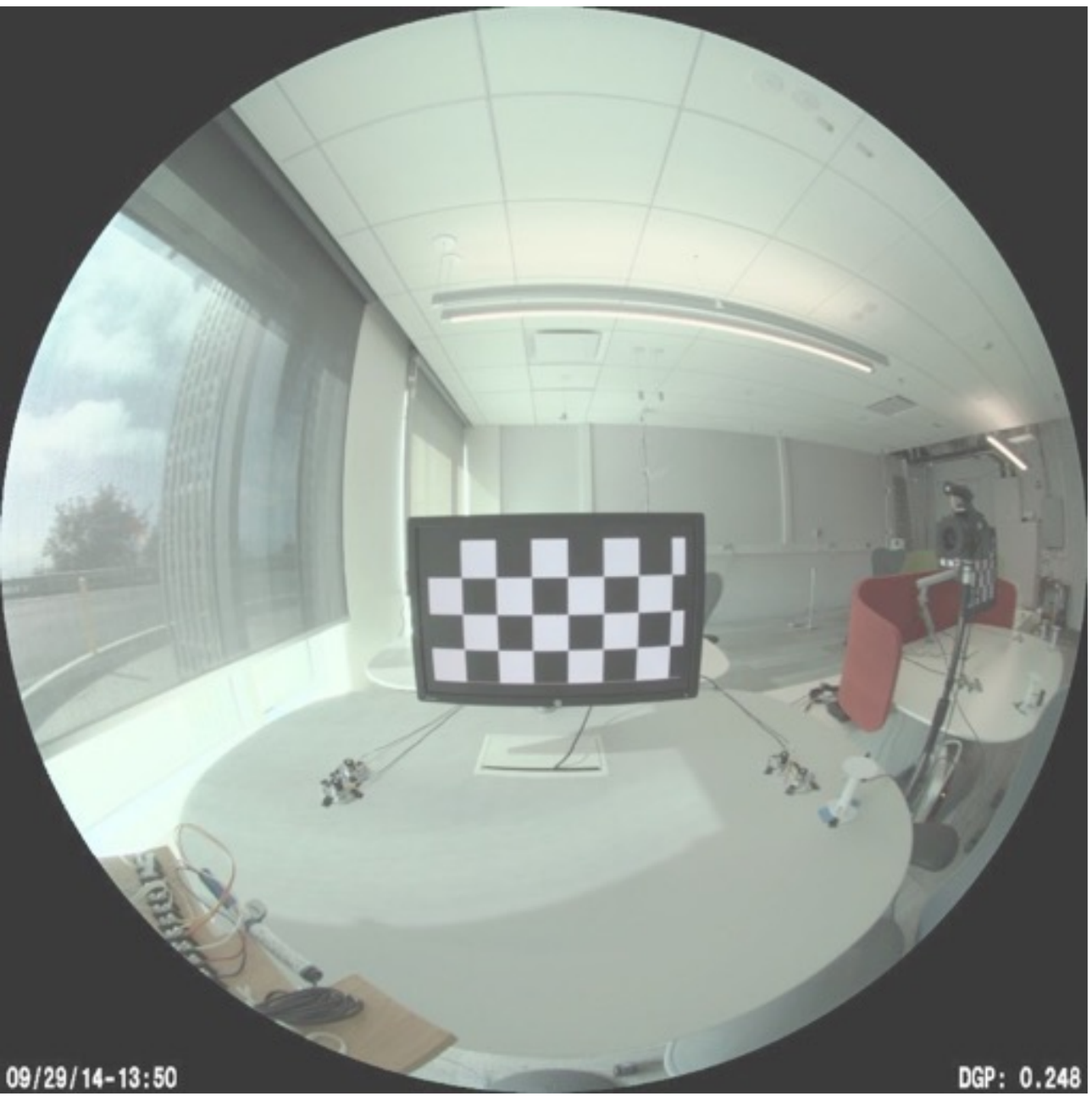

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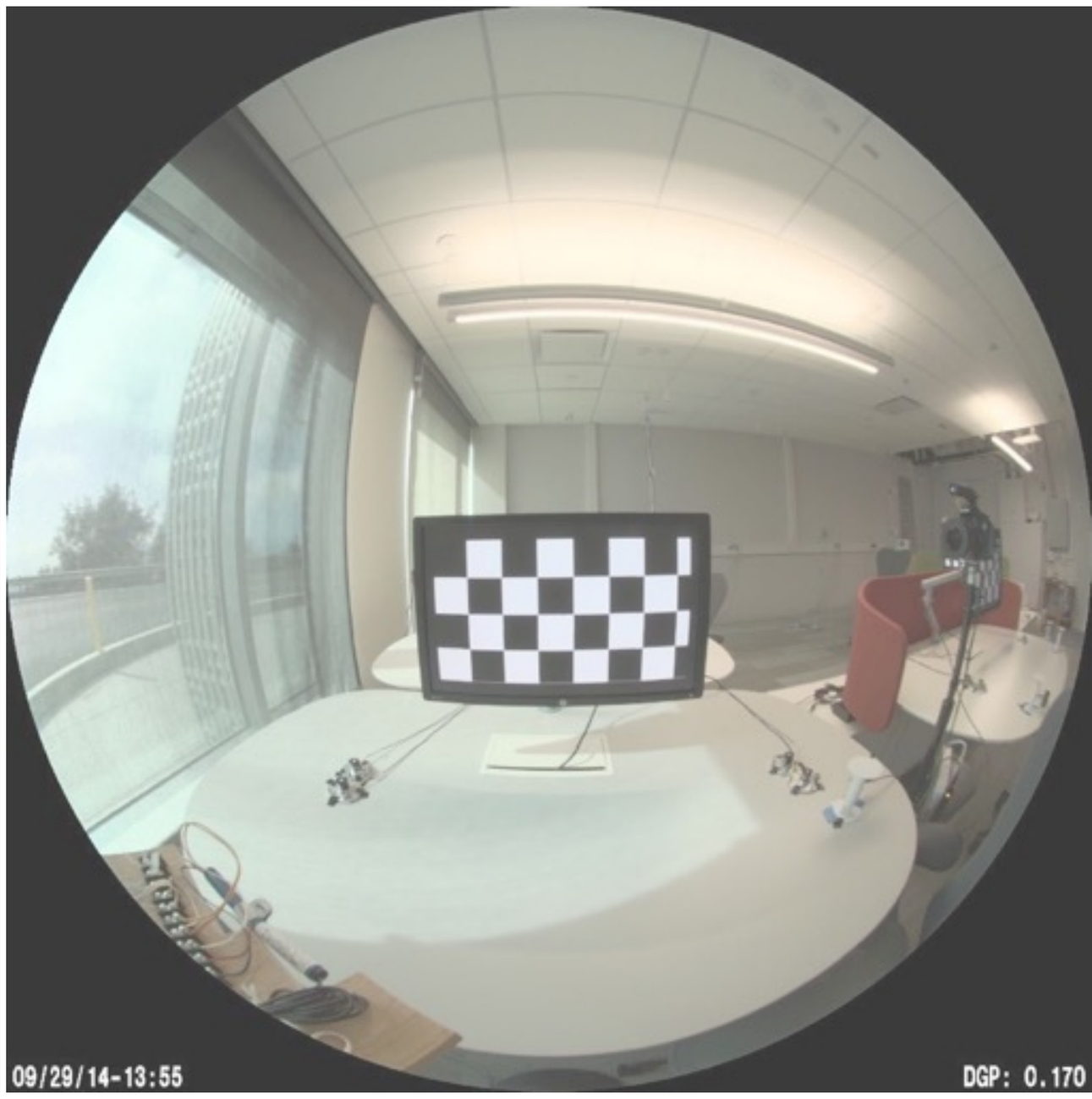
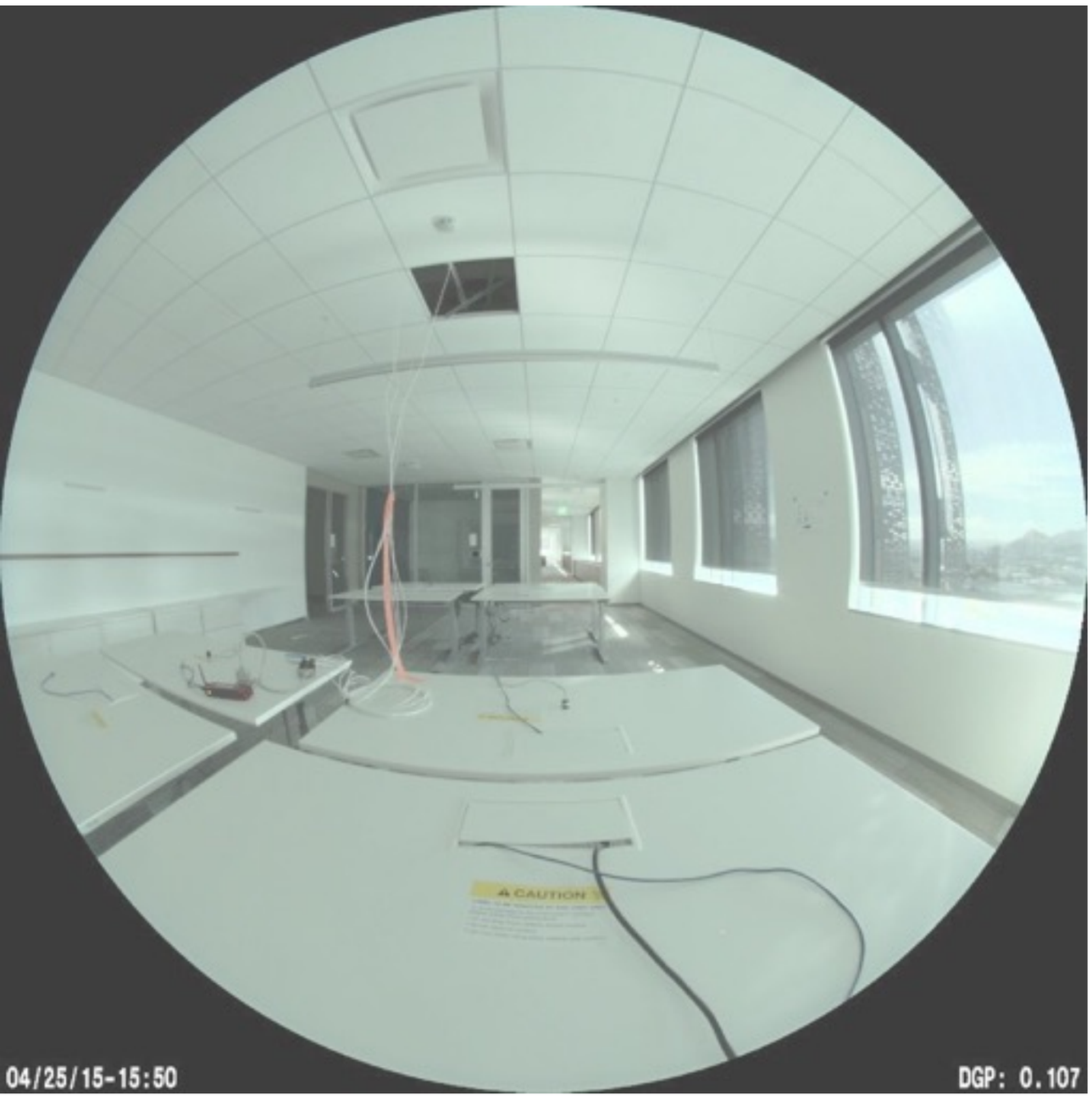
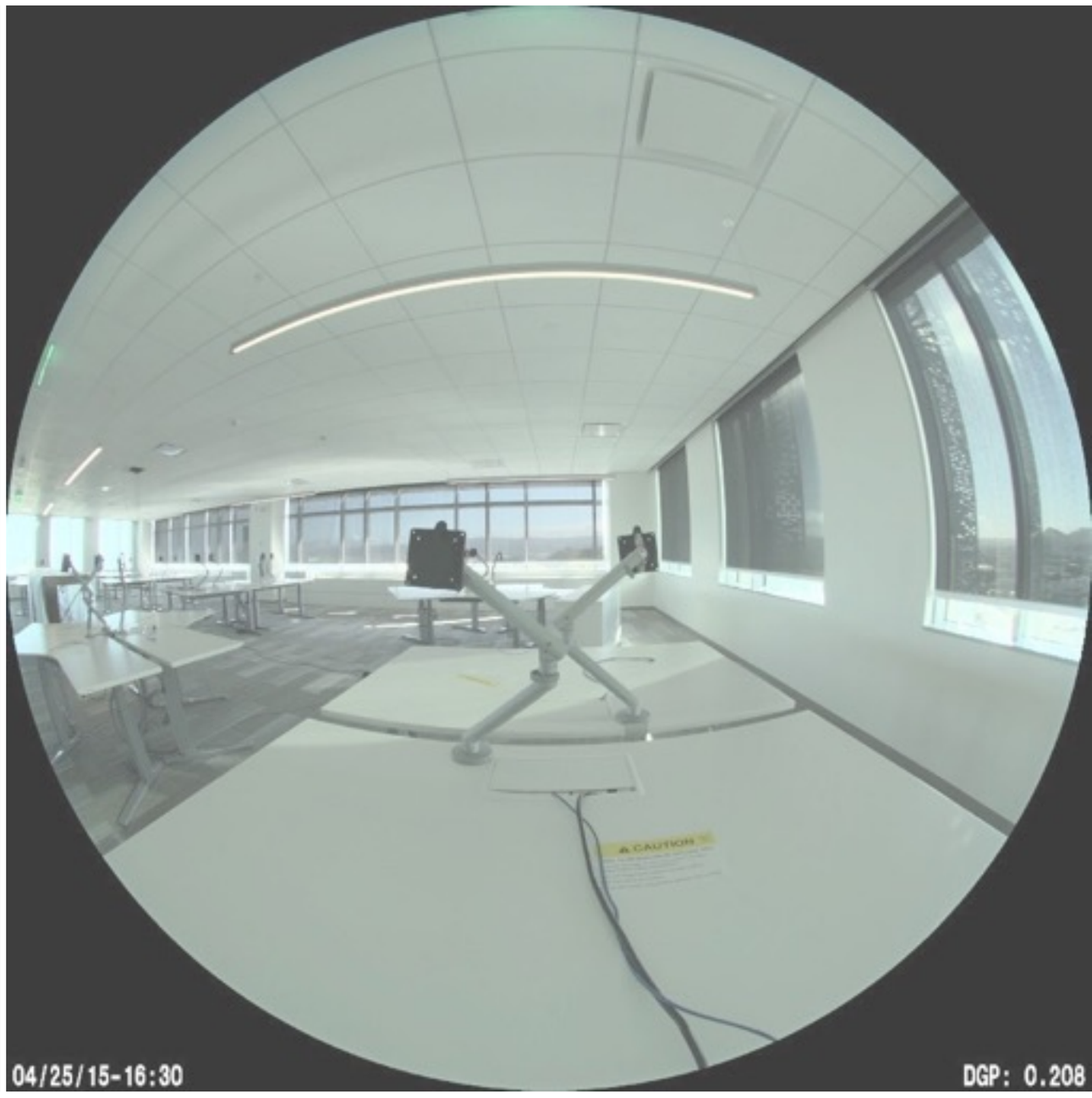


B35: Shades stop 6” above sill





Daylight glare probability (DGP) for office spaces (briefly)

- Instantaneous DGP correlates to subjective impression.

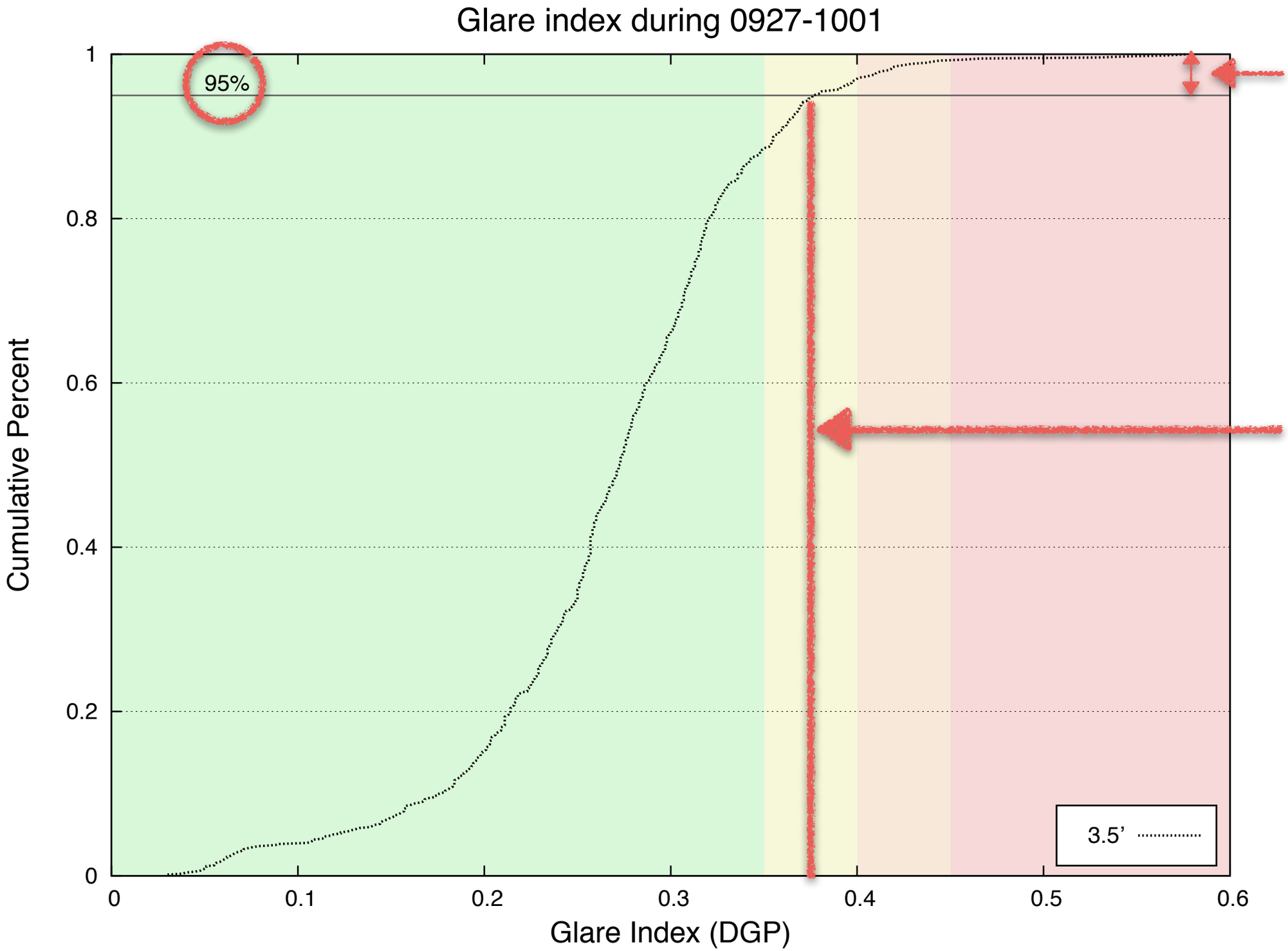
- Cumulative distribution of DGP over time can be used to rate an office space in three glare classes.

SUBJECTIVE IMPRESSION	DGP
Imperceptible Glare	< 0.35
Perceptible Glare	0.35 - 0.40
Disturbing Glare	0.40 - 0.45
Intolerable Glare	> 0.45

	A Best class 95% of office time glare is weaker than ‘imperceptible	B Good Class 95% of office tim glare is weaker than ‘perceptible	C Reasonable Class 95% of office time glare is weaker than ‘disturbing’
DGP Limit (95%)	0.35	0.40	0.45
Average DGP within top 5% band	0.38	0.42	0.53

Wienold, J., 2009. Dynamic Daylight Glare Evaluation. Eleventh International IBPSA Conference, Glascow Scotland

DGP Cumulative Distribution Function

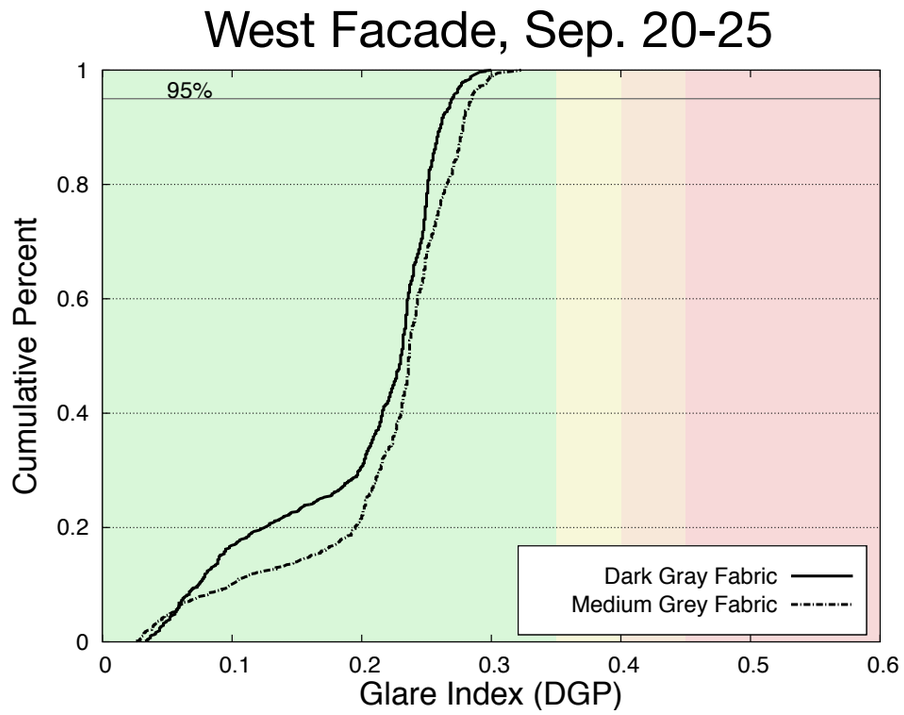


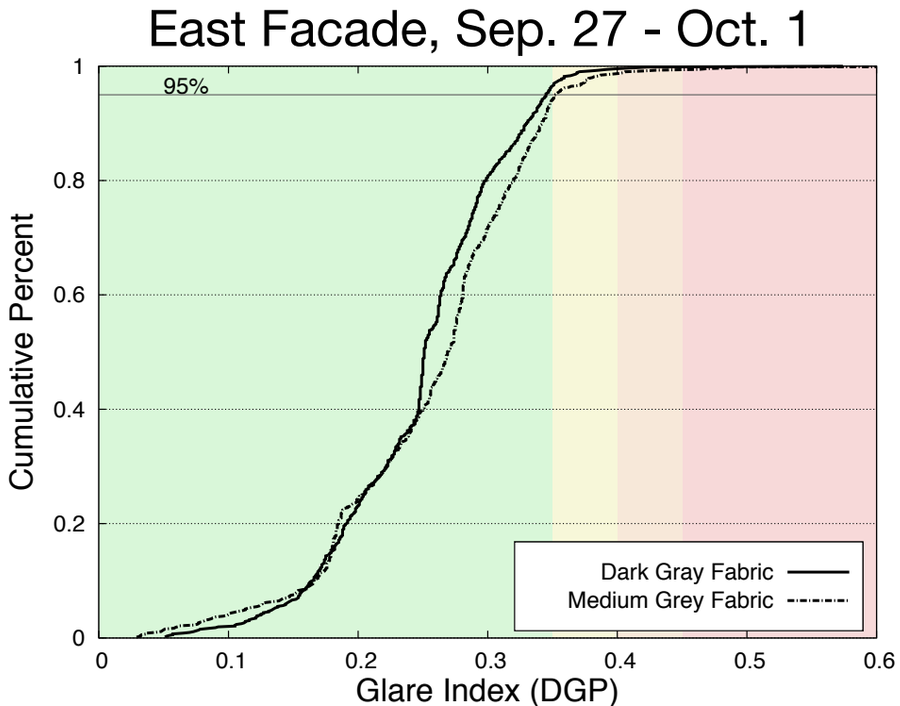
Top 5% band
The mean of values in top 5% is 0.436

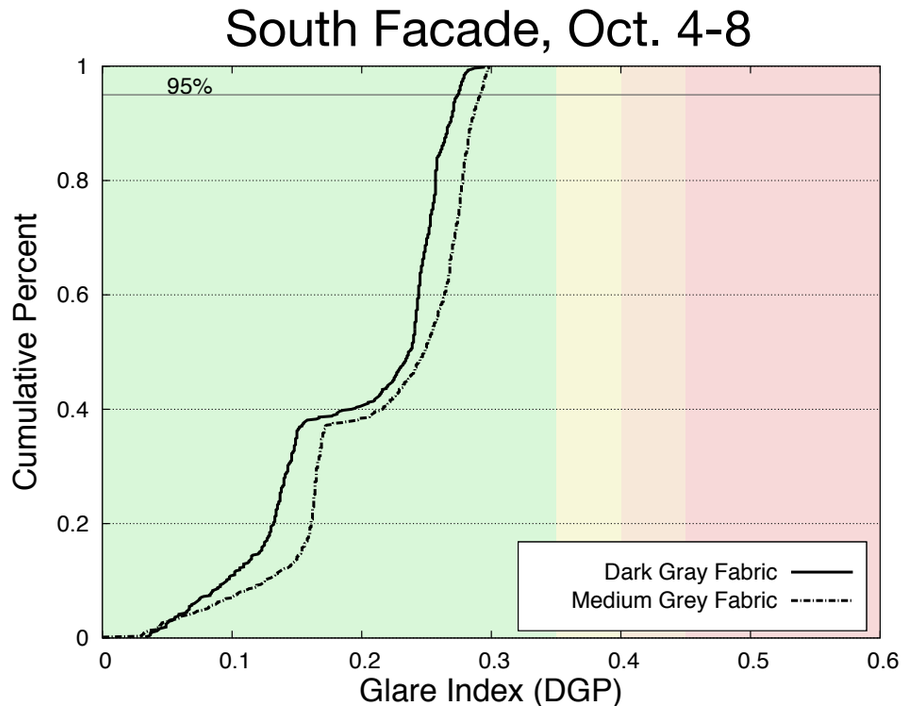
95% of time DGP less than 0.380

The dark shade exhibits marginally less glare.

FACADE	SHADE COLOR	95% LIMIT	TOP 5% BAND	CLASS
WEST	Light	0.285	0.299	A
	Dark	0.270	0.283	A
EAST	Light	0.353	0.406	B
	Dark	0.345	0.375	A
SOUTH	Light	0.292	0.301	A
	Dark	0.274	0.289	A







Shade Recommendations

- Reduce safety factor in SolarTrac or increase the permitted sunshine depth to counteract conservative adjustment.

- Program the lower stop limit to be 6 inches above the window to admit some daylight and reduce lighting energy use at times when the shade would otherwise have been fully closed.

- Use dark shade fabric to improve views to the exterior.

- Anecdotally, 3% openness provides sufficient glare protection for some people but not for others.

- Inform occupants that they should consider their preference for shading when selecting a seat for the day.

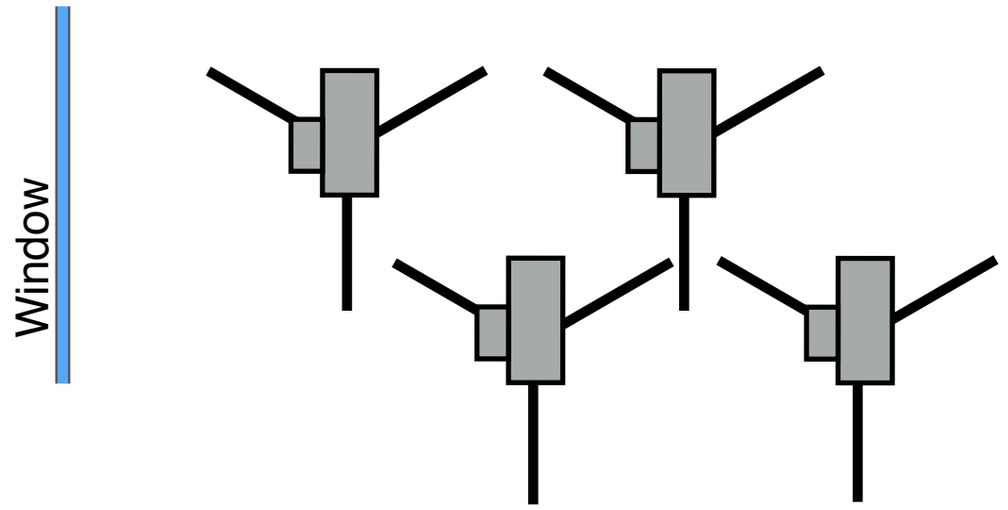
Glare Analysis:
Informing Proximity of Desks to the Facade

Four HDR cameras were setup in the mockup to analyze glare.

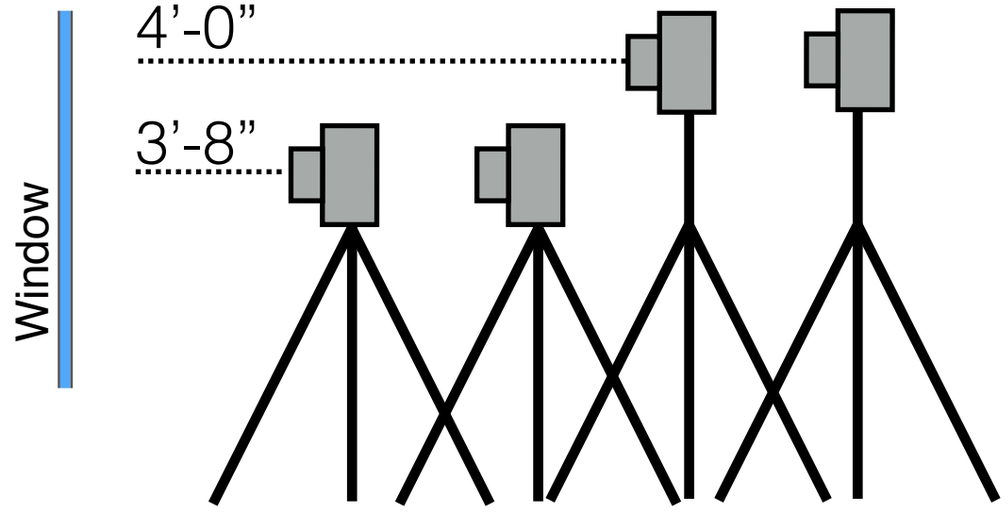
The cameras were set up in one foot increments from the facade.

Camera Positioning

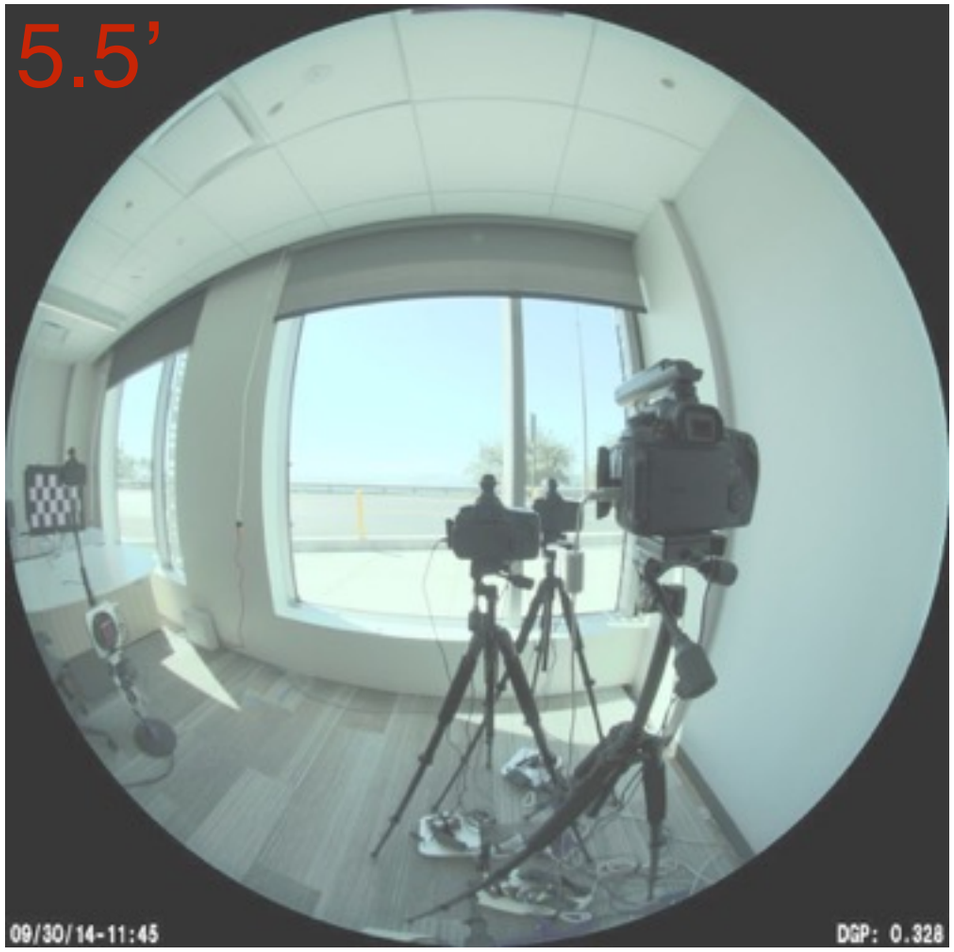
The camera positions were staggered and heights are offset to reduce blocking effects from other cameras.

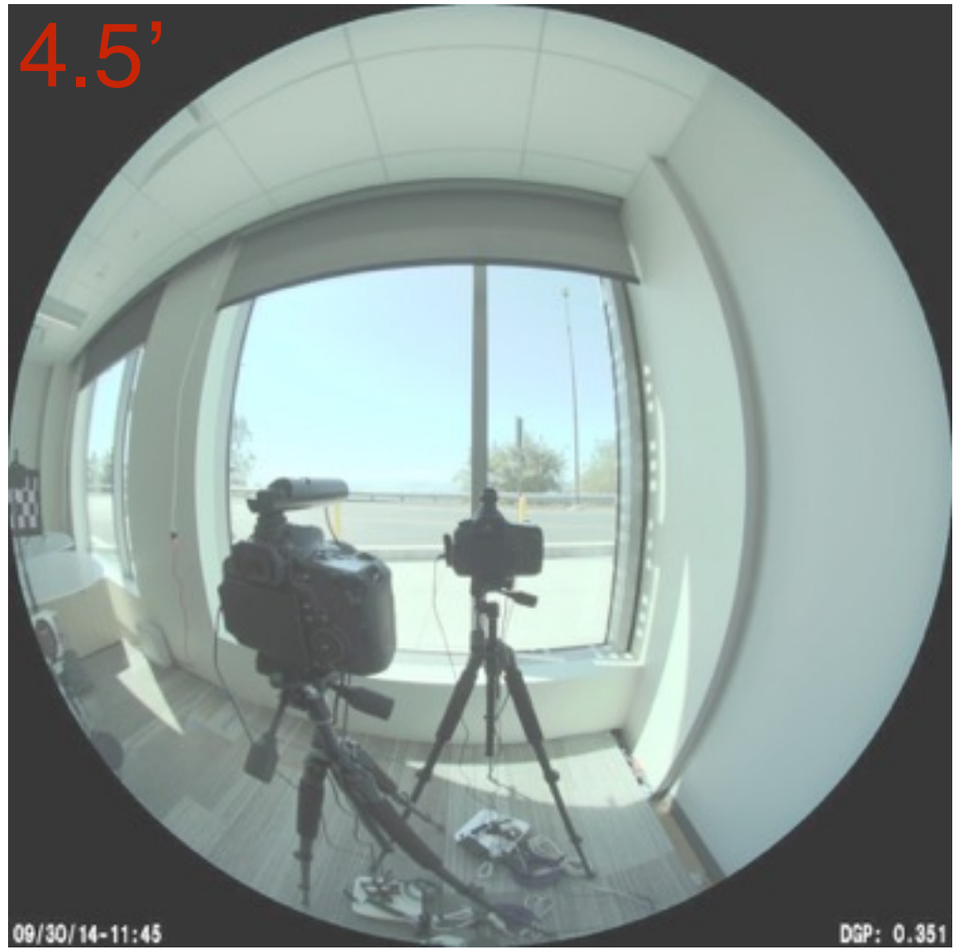


Plan View - Cameras staggered



Elevation View - Height Offset


5.5’
09/30/14-11:45
DGP: 0.328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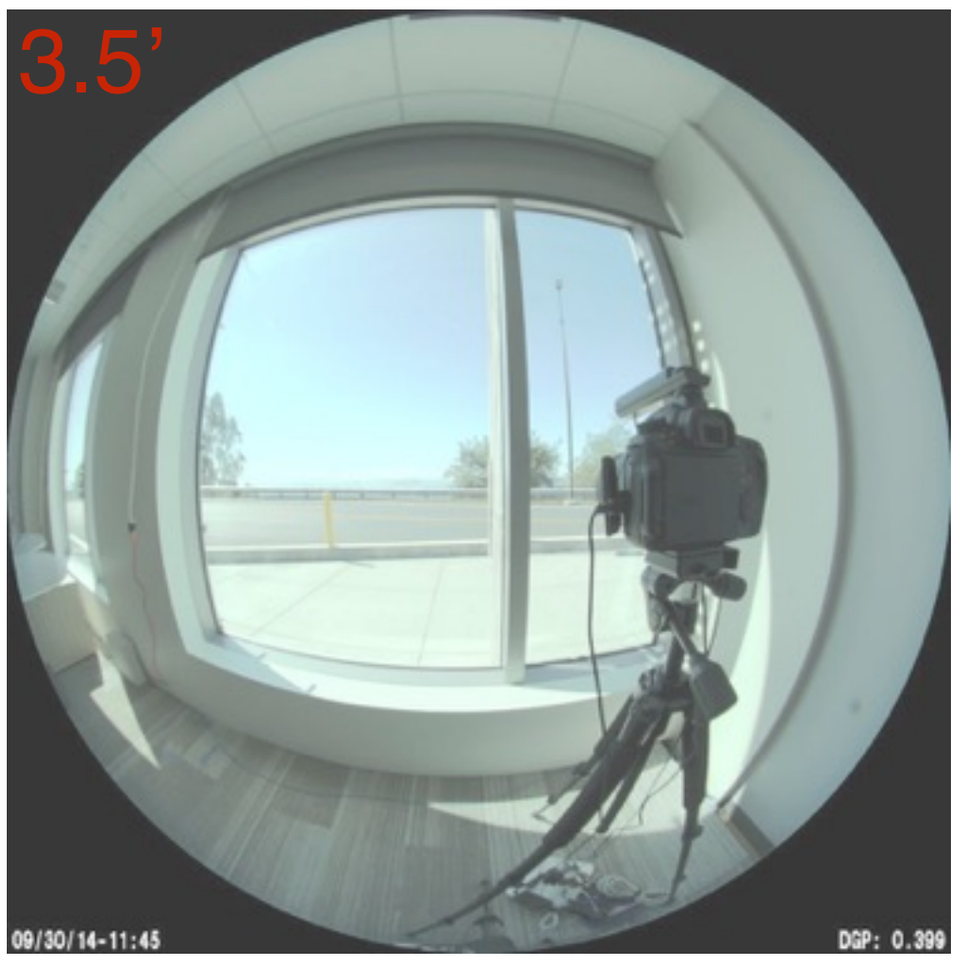
DGP: 0.351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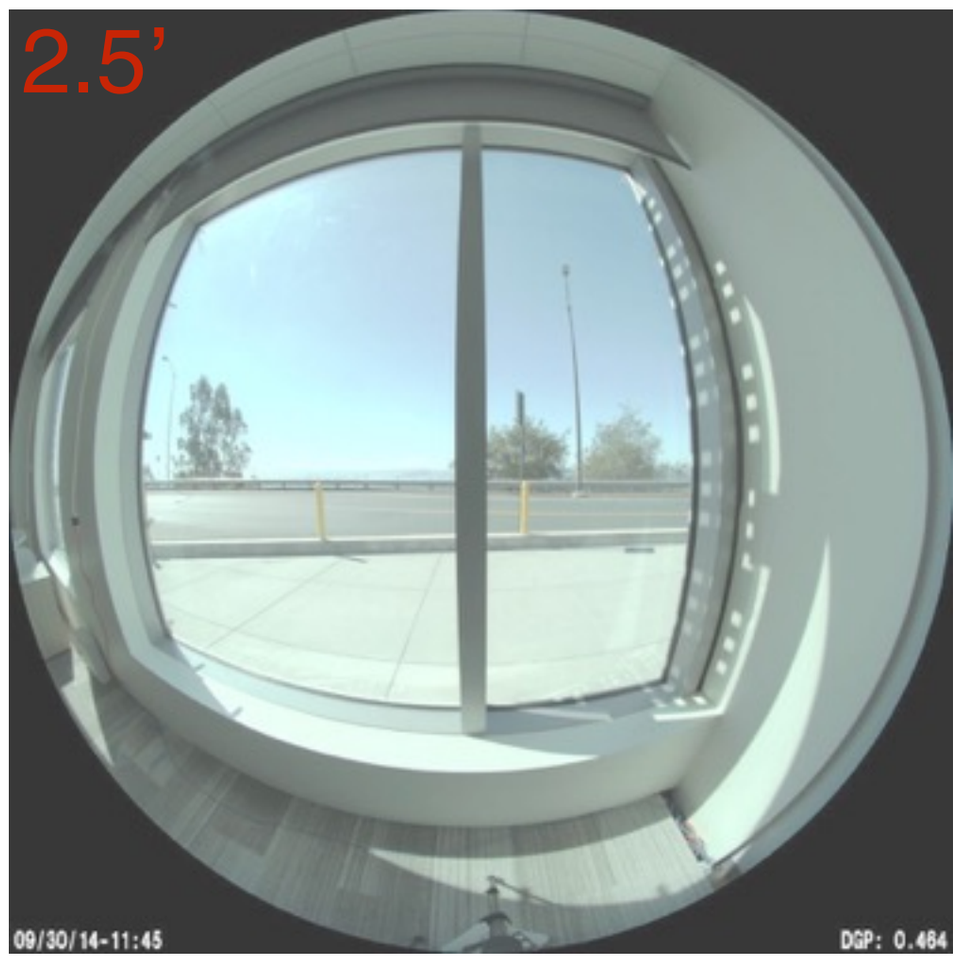
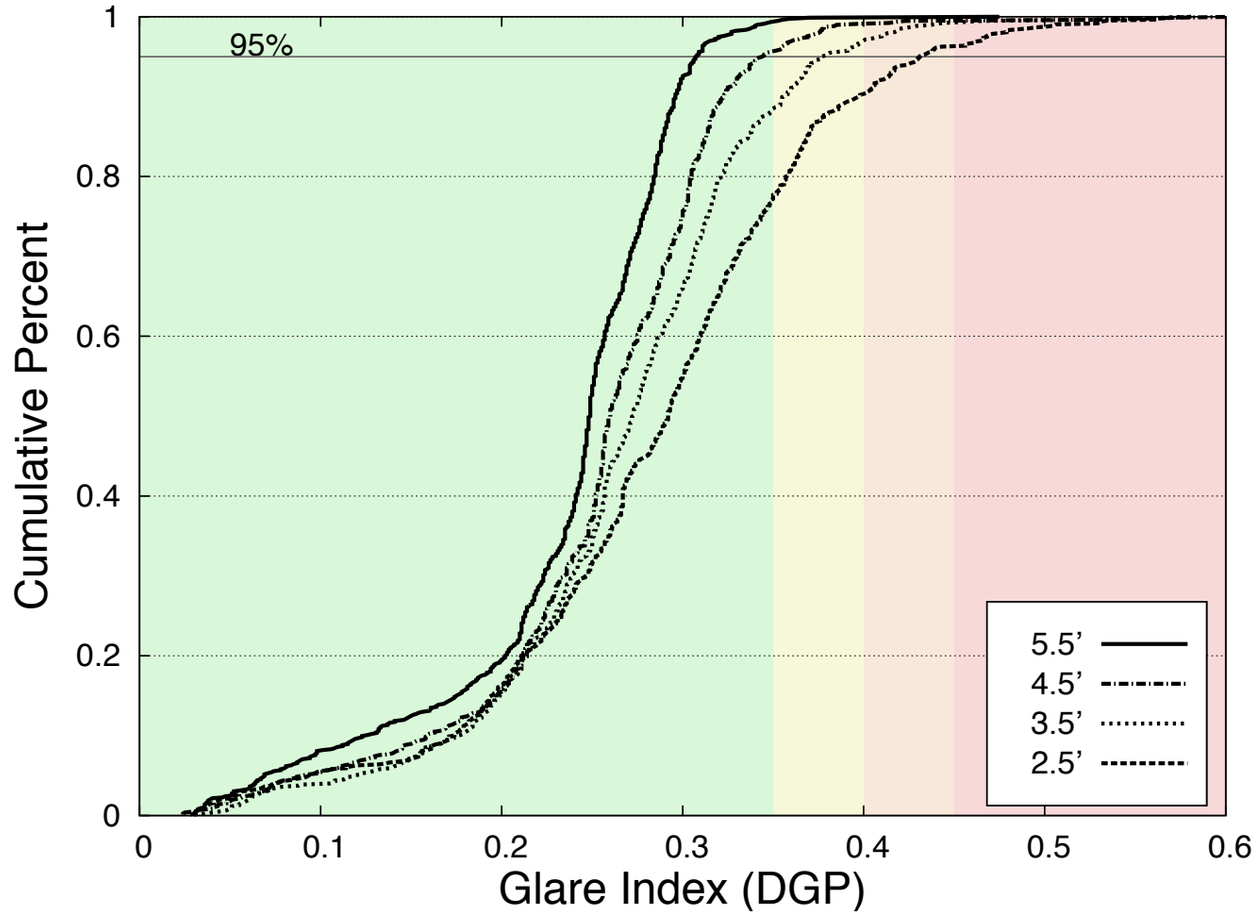
DGP: 0.399


2.5’
09/30/14-11:45
DGP: 0.464

West Facing, Automatic Shading

WEST FACADE

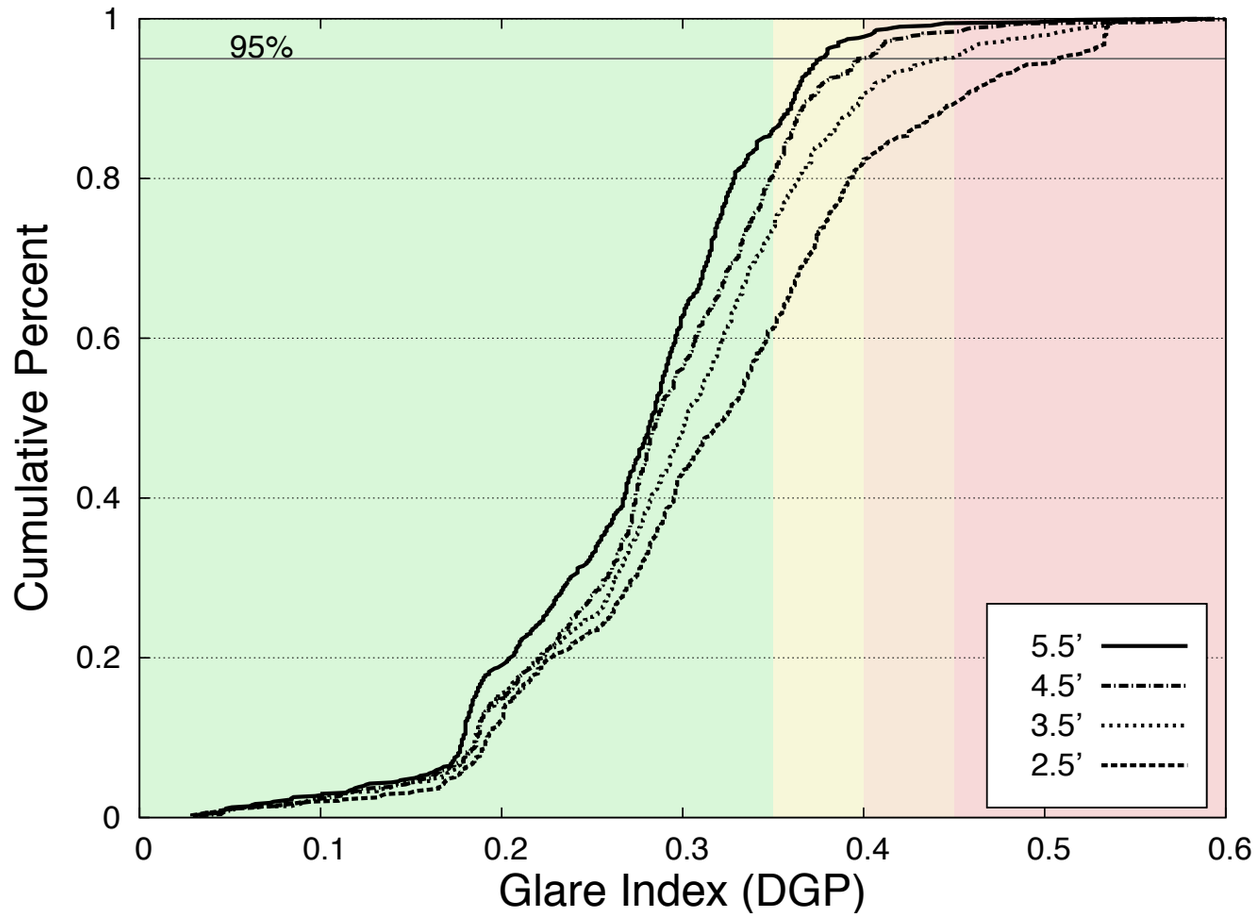
DISTANCE	95% LIMIT	TOP 5% BAND	CLASS
5.5 feet	0.309	0.332	A
4.5 feet	0.345	0.400	B
3.5 feet	0.380	0.436	C
2.5 feet	0.435	0.485	C



East Facing, Automatic Shading

EAST FACADE

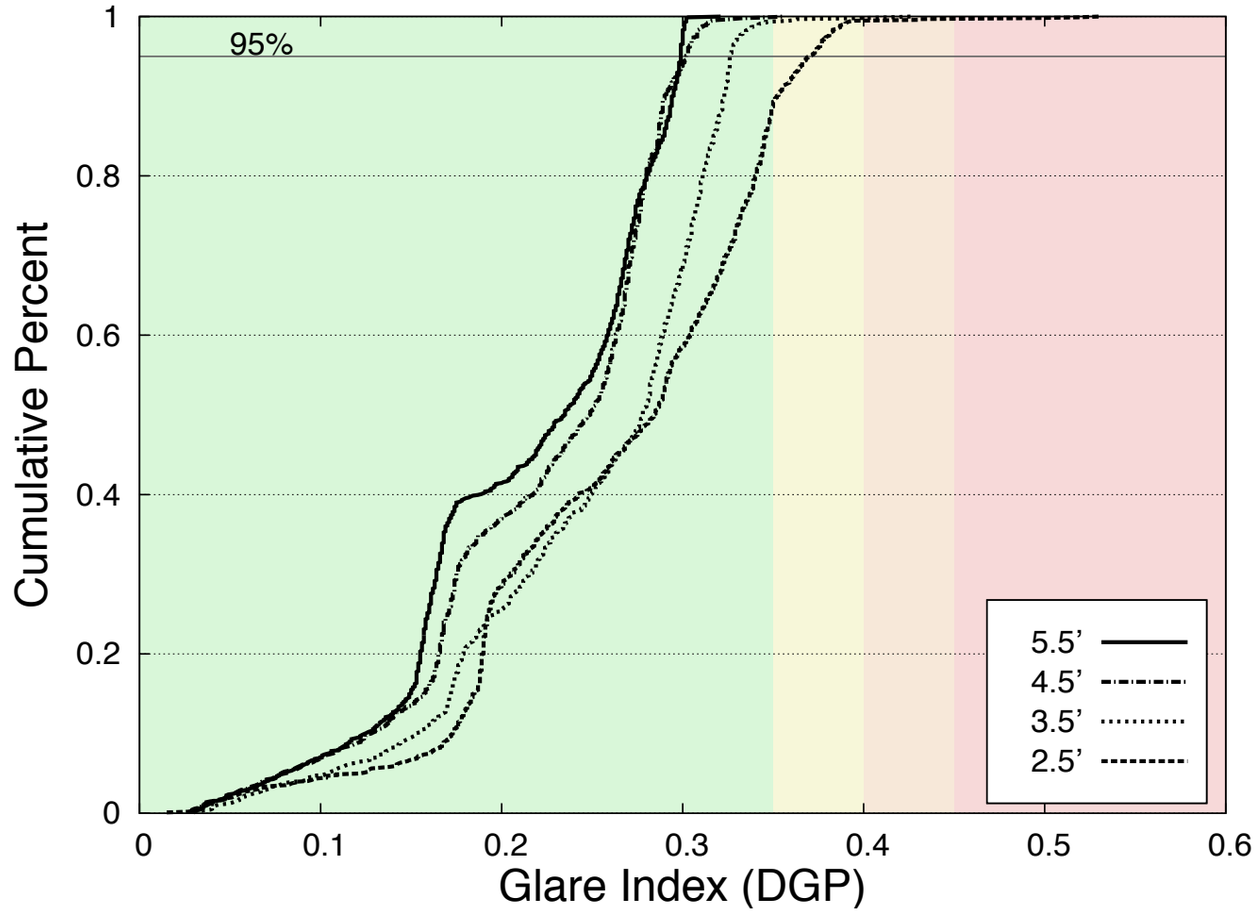
DISTANCE	95% LIMIT	TOP 5% BAND	CLASS
5.5 feet	0.376	0.418	B
4.5 feet	0.397	0.457	C
3.5 feet	0.443	0.505	C
2.5 feet	0.508	0.535	-



South Facing, Automatic Shading

SOUTH FACADE

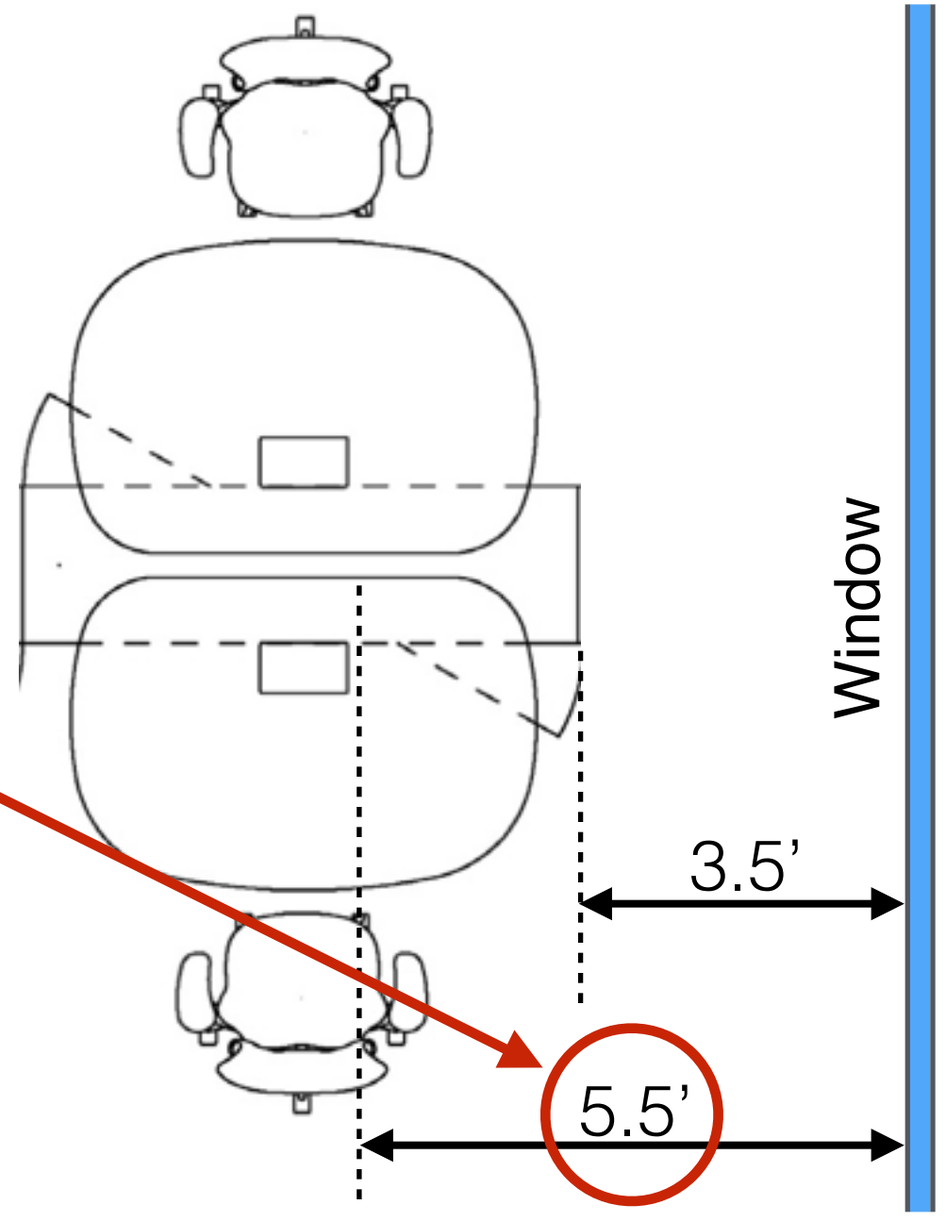
DISTANCE	95% LIMIT	TOP 5% BAND	CLASS
5.5 feet	0.299	0.302	A
4.5 feet	0.302	0.317	A
3.5 feet	0.326	0.341	A
2.5 feet	0.370	0.397	B



The distance is the position of the person’s head from the window.

FACADE	VIEW FACING WINDOW	VIEW PARALLEL TO WINDOW
SOUTH	3.5’	2.5’
WEST	5.5’	4.5’
EAST	> 6 feet	5.5’

*** THIS DISTANCE ASSUMES GLAZING AND GLAZED AREA INSTALLED IN FLEXLAB. THIS DISTANCE MIGHT NEED TO BE INCREASED TO ACCOUNT FOR INCREASED AREA AND TRANSMITTANCE.**



Acknowledgements

PRIMARY COLLABORATORS

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Magnum Drywall /Ceilings/Painting	Mark Malloy, Elisha Dawid Gary Robinson

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Pugliese	Robert Freddie
Redwood Electric	Julian Dodge, Steve Finau
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Ling Zhu
Anna Liao
Steve Greenberg
Douglas Brunkow
Joshua Brown

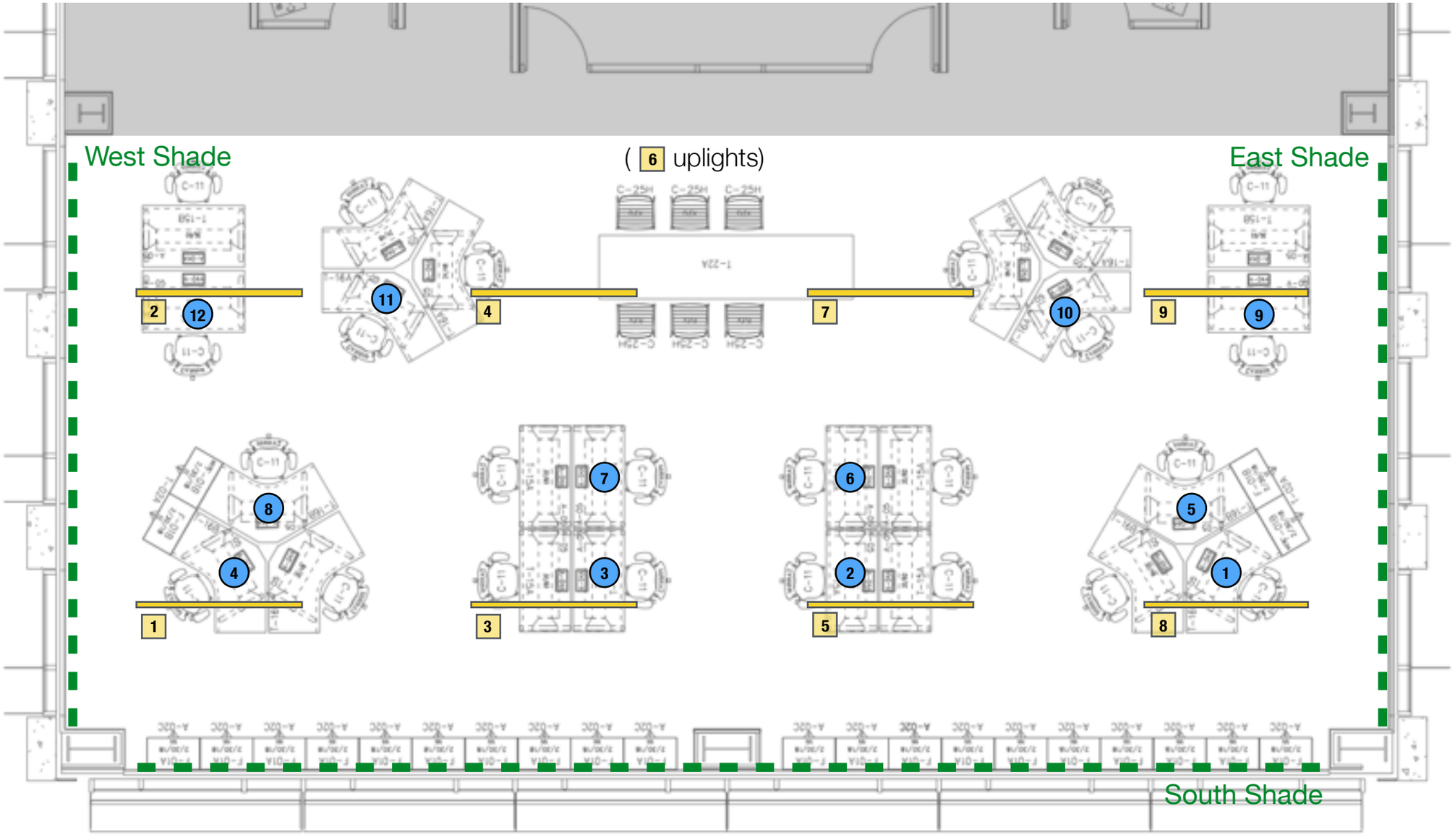
Next Steps

- Verification during month-long burn in
    - Evaluate operation of lighting and shading control systems.
    - Evaluate thermal comfort and glare.
- 6-month post occupancy evaluation
    - Analyze building energy use.
    - Occupant surveys to understand comfort.

April Burn-In Testing

Lighting Control Operation

Lighting Control Operation | **South Area**

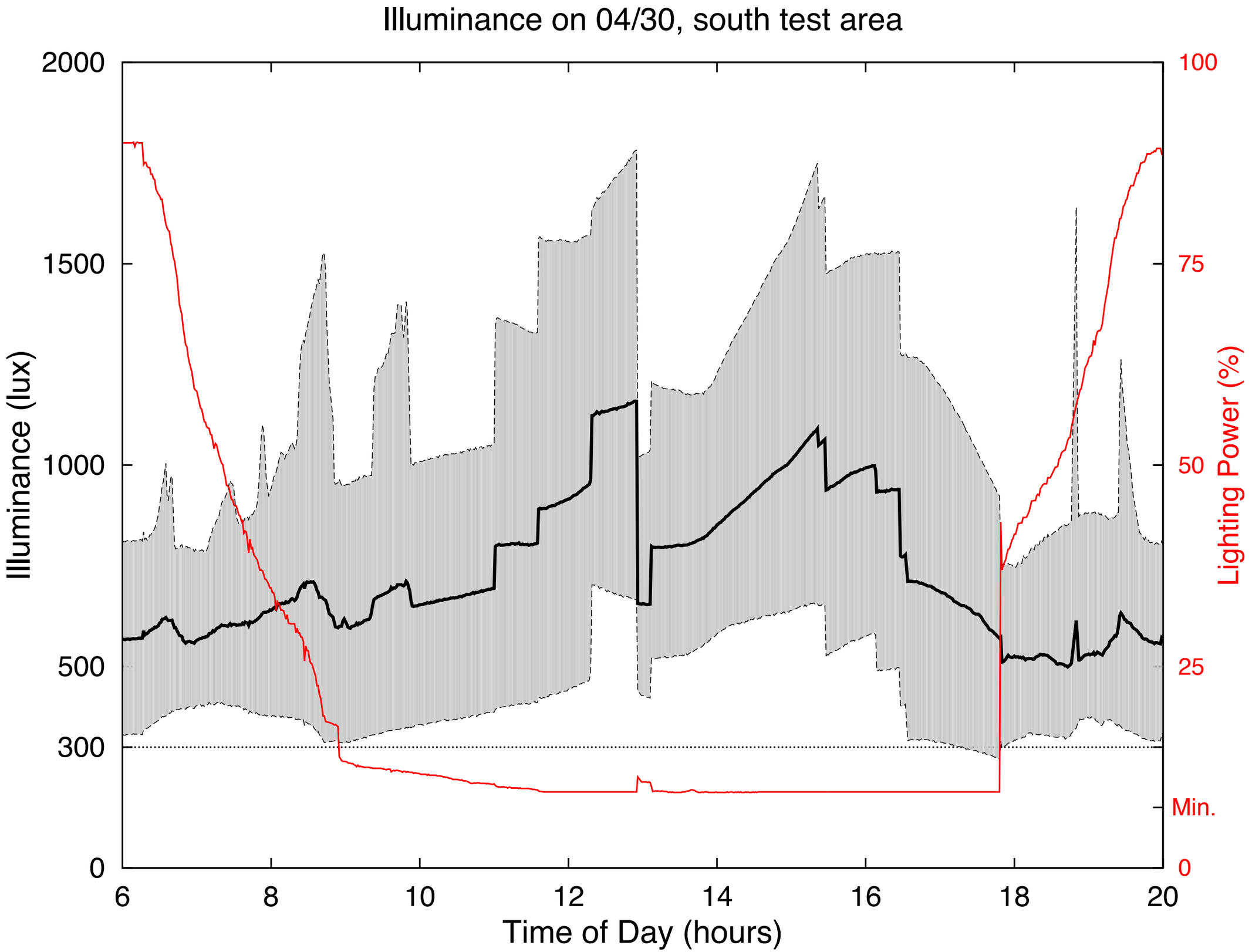


1 Li-cor Photometer (w/ ID #)

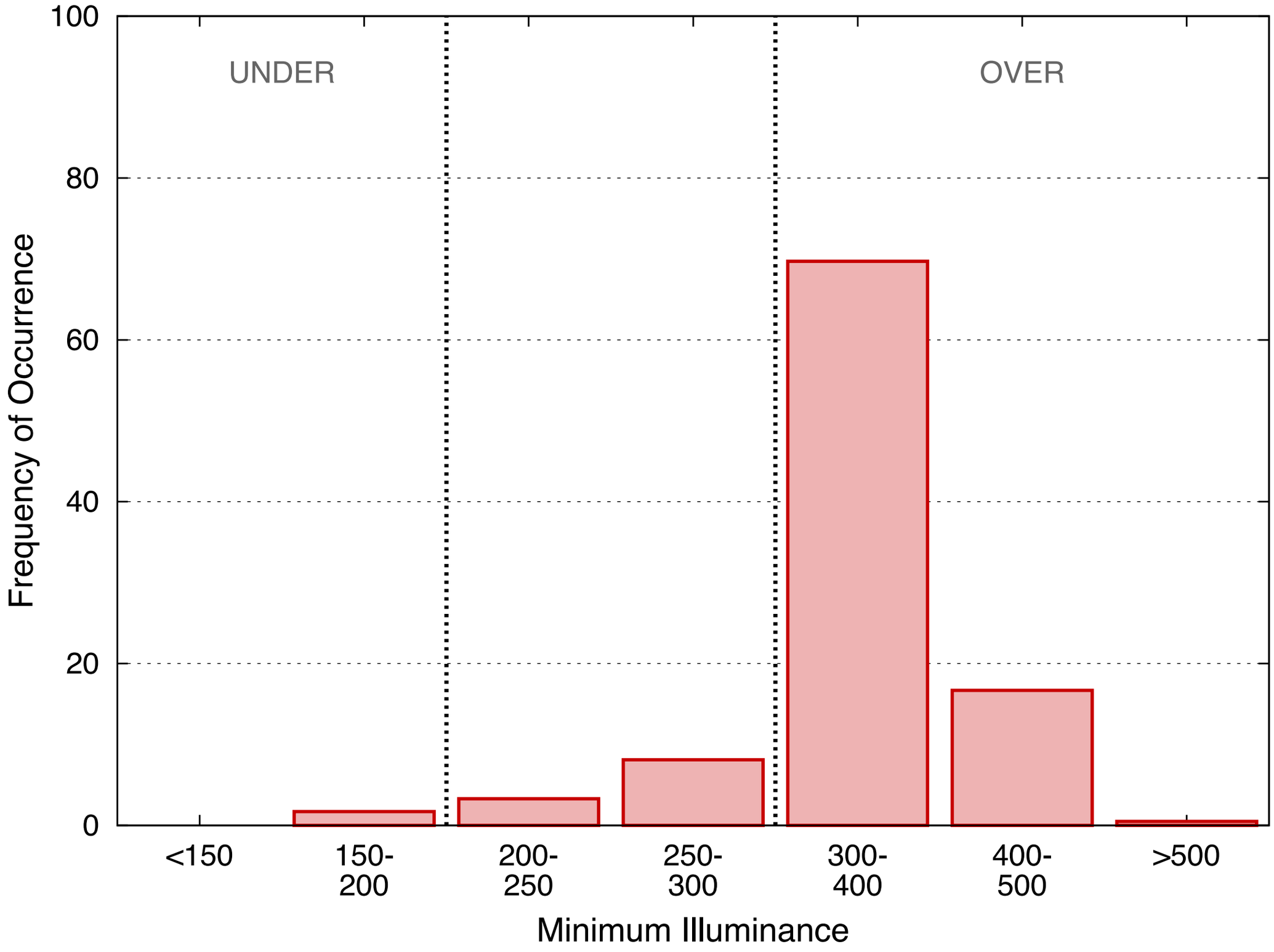
1 Pendant Light Fixture (w/ ID# for downlight)

Shade Group

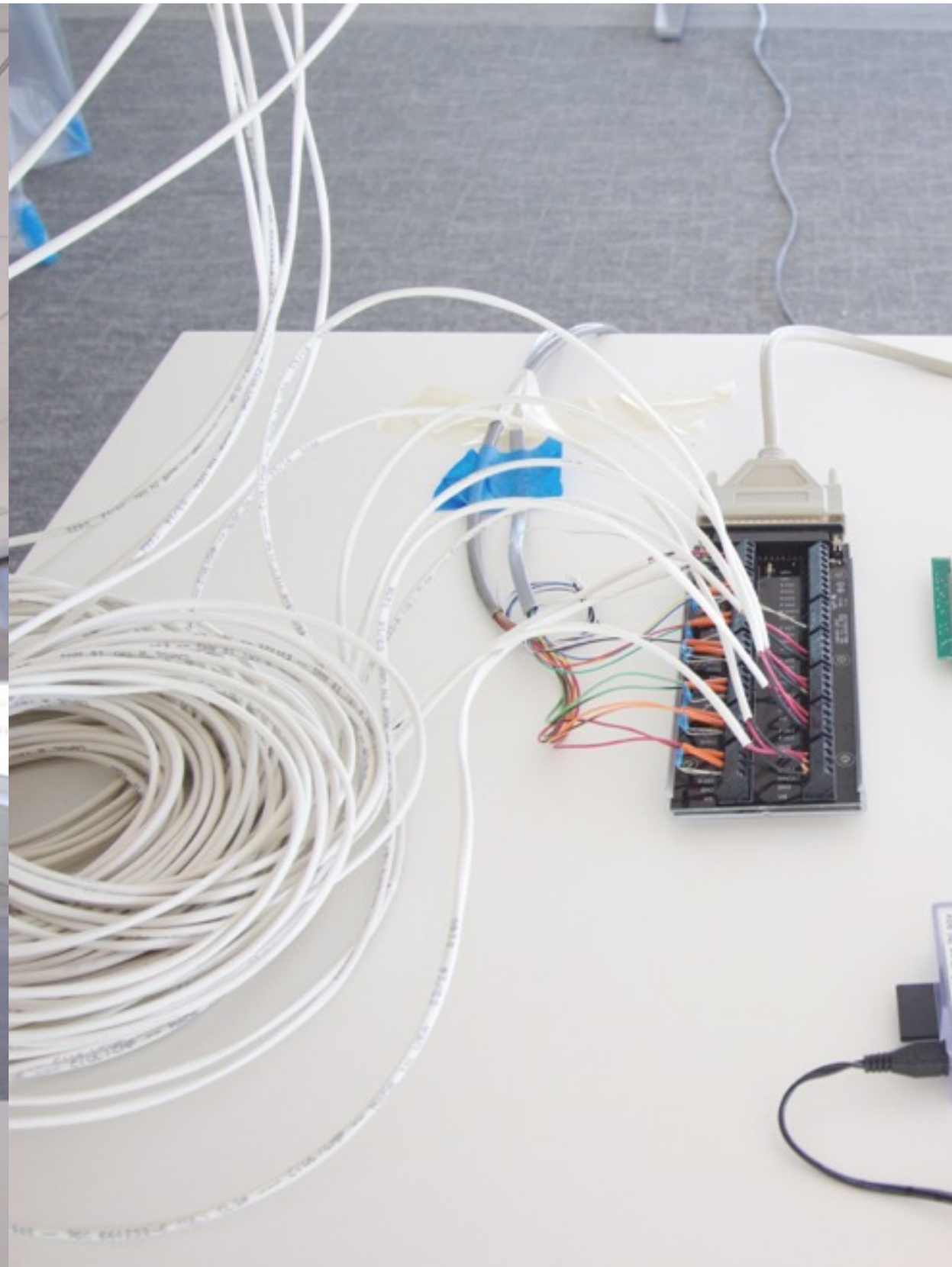
Lighting Control Operation | **South Area**



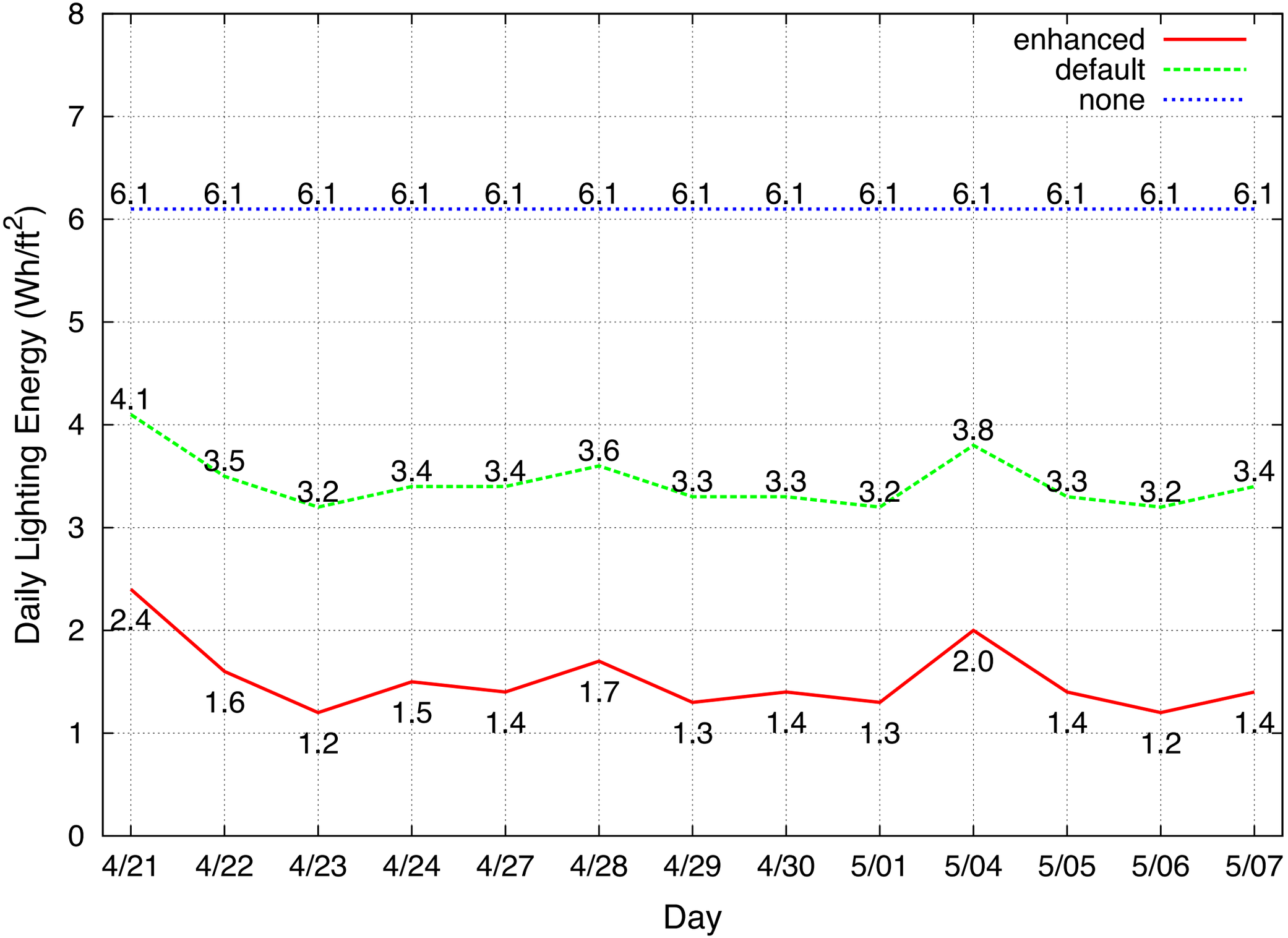
Lighting Control Operation | **South Area**



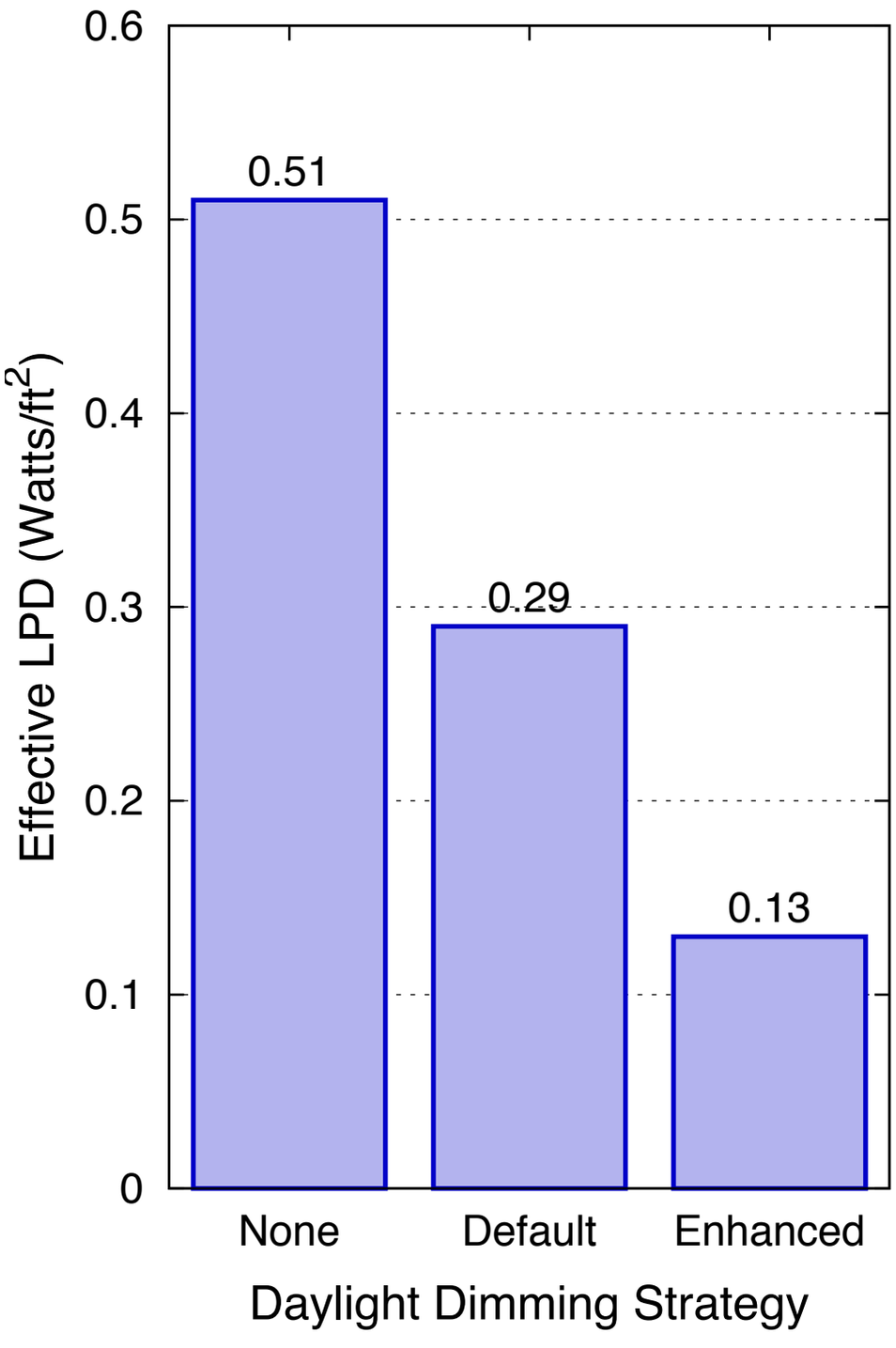
Lighting Energy Use

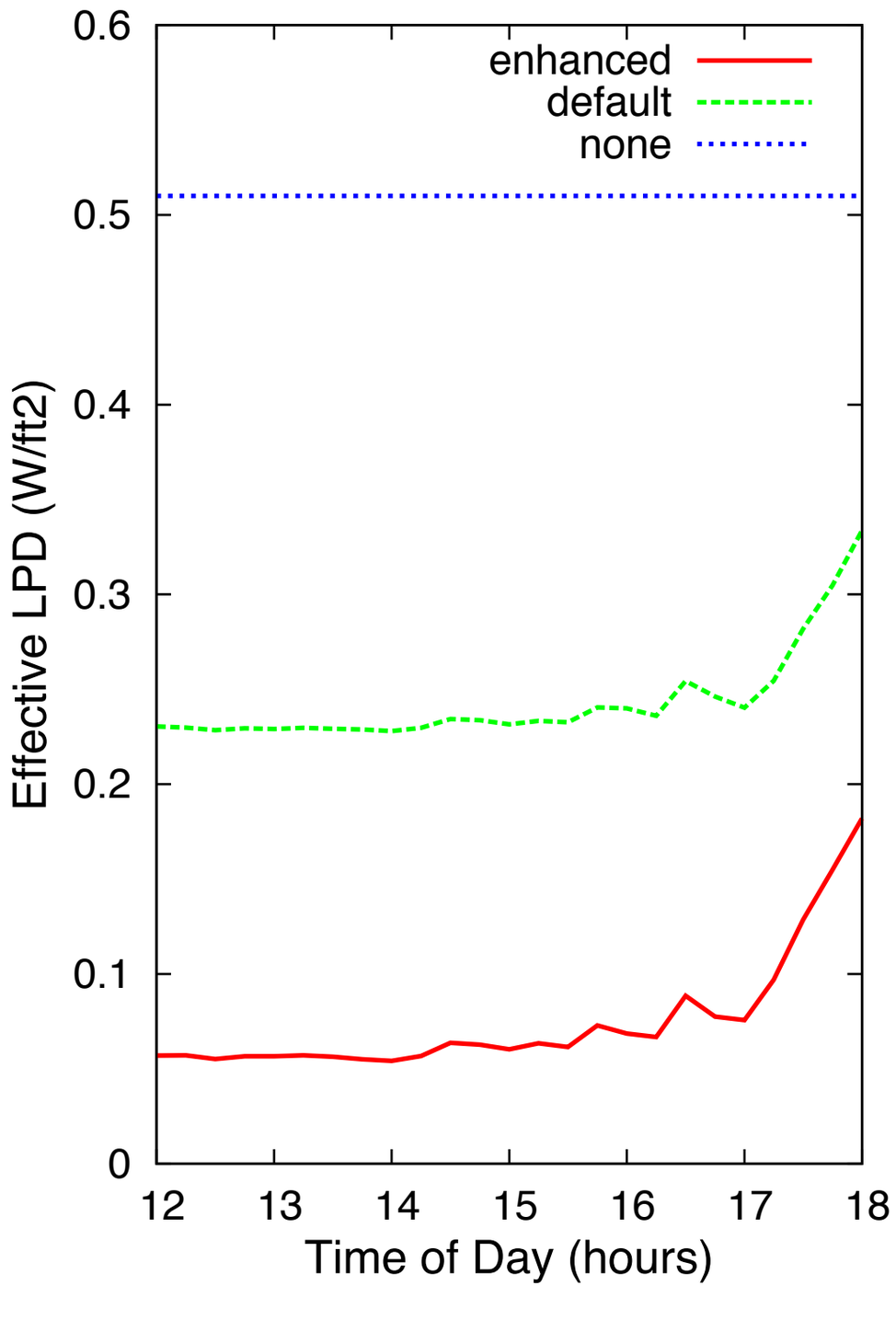


Lighting Energy Use | South Test Area



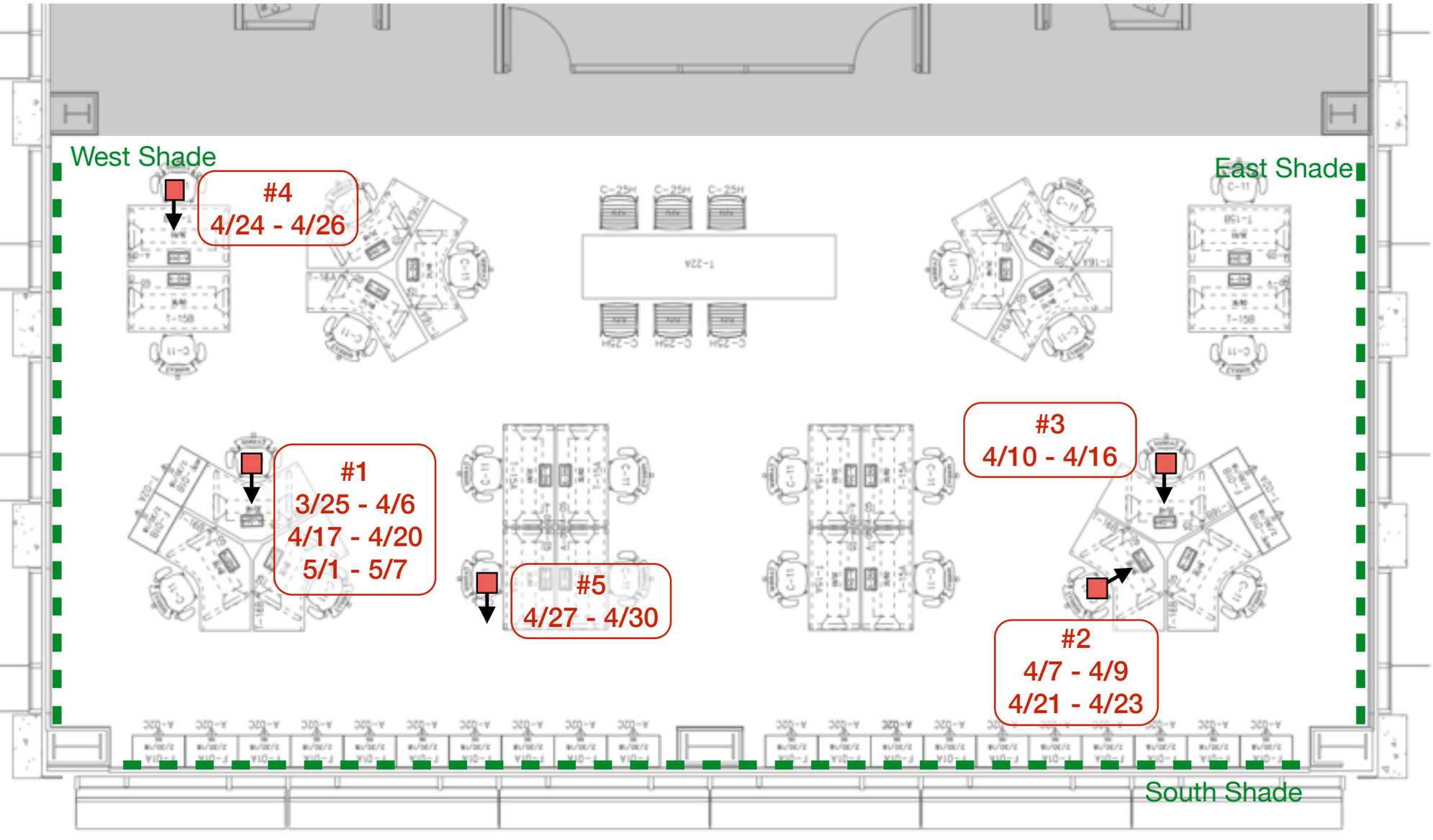
Lighting Energy Use | South Test Area





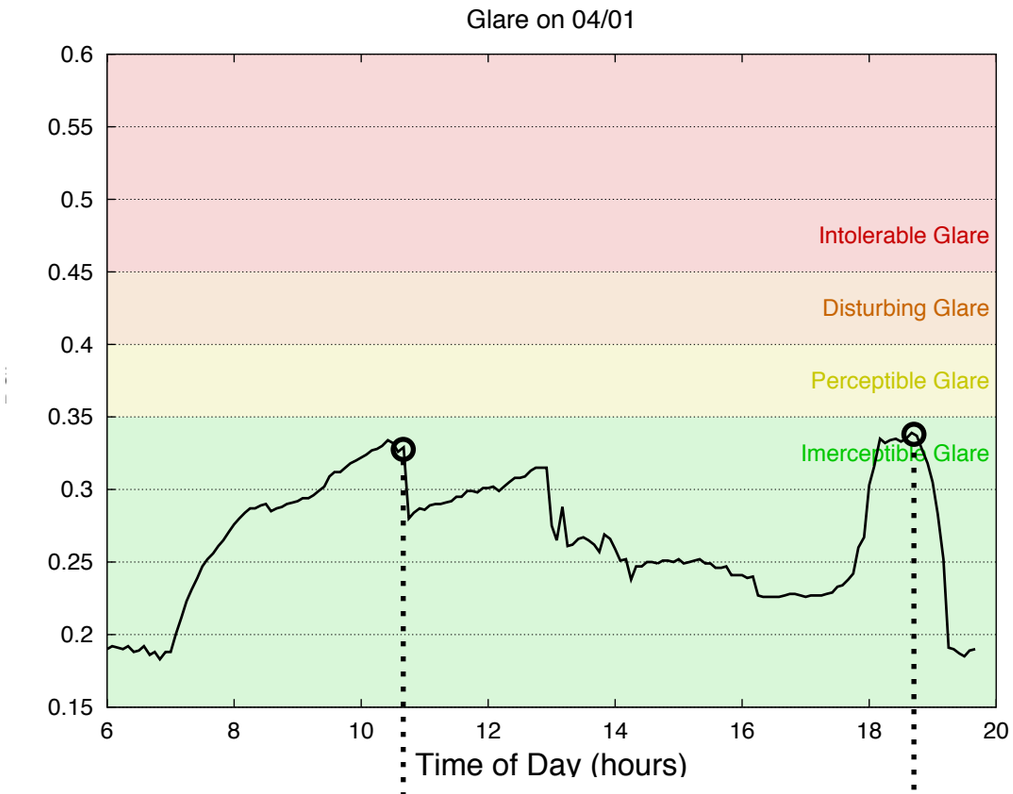
Glare Assessment

Glare | HDR Camera Locations, **South Area**



Glare | **South #1** 3/25-4/3, 4/14-4/20 & 5/1-5/7

Daily Glare Plot for April 1, 2015



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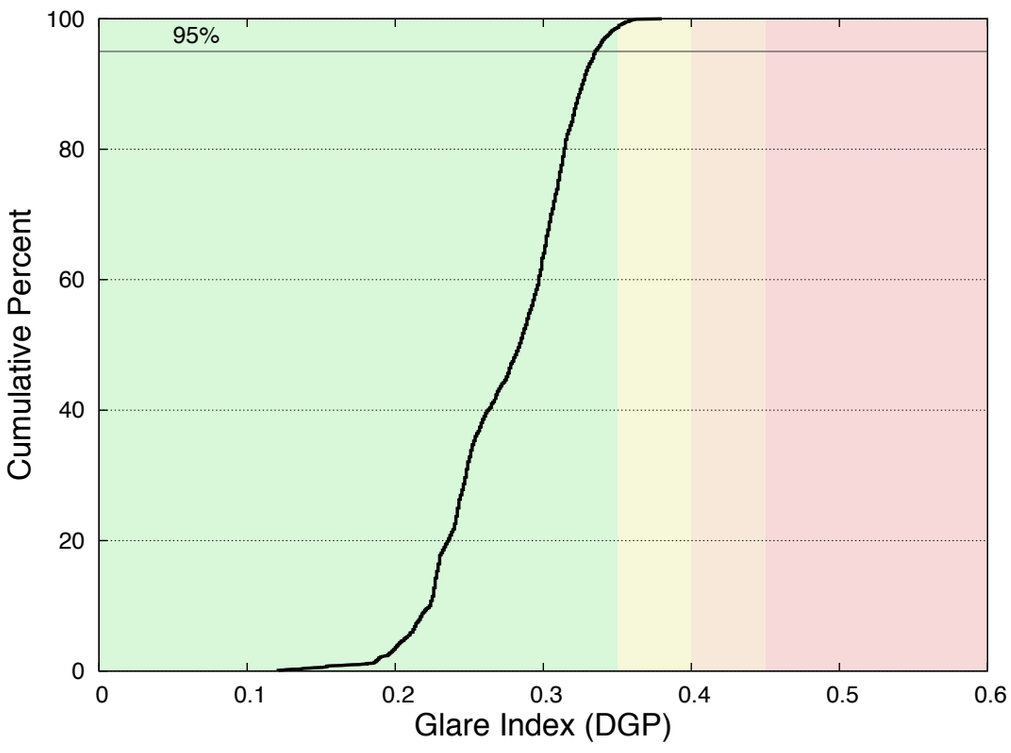
18:40

Cumulative DGP 3/25-4/3, 4/14-4/20 & 5/1-5/7



Cumulative DGP Statistics, Position #1, South Area	
95% DGP Threshold	0.335
Average DGP within top 5% band	0.346
Comfort Class Rating	A

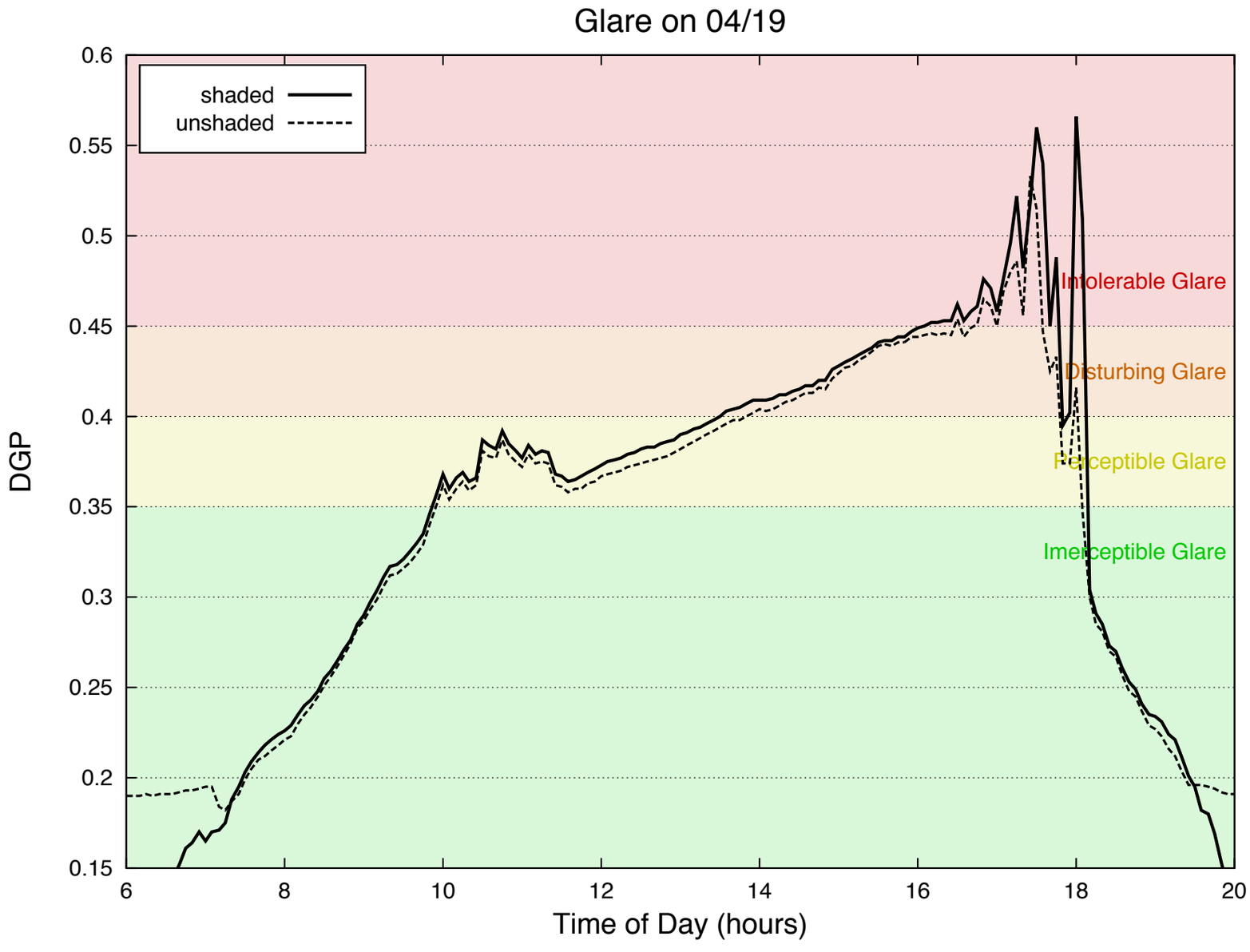
Glare | **Summary**

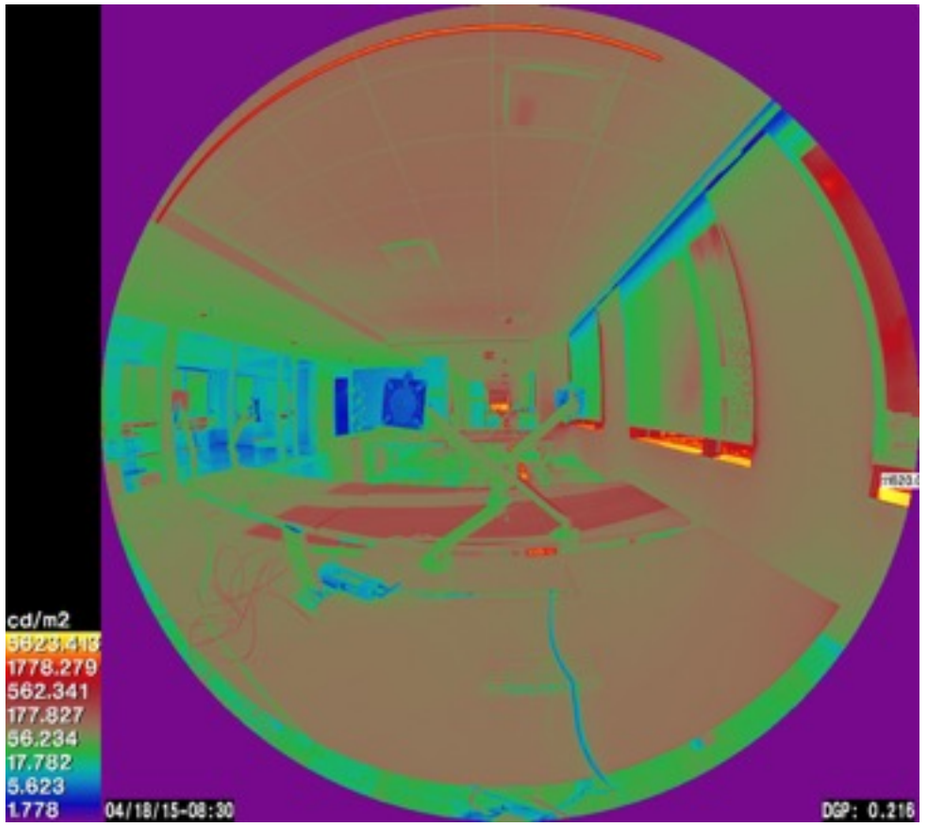
	COMFORT CLASS RATING
North #1	A
North #2	A
North #3	A
North #4	A
North #5	A
North #6	**B**
West #1	A
West #2	A
West #3	**B**

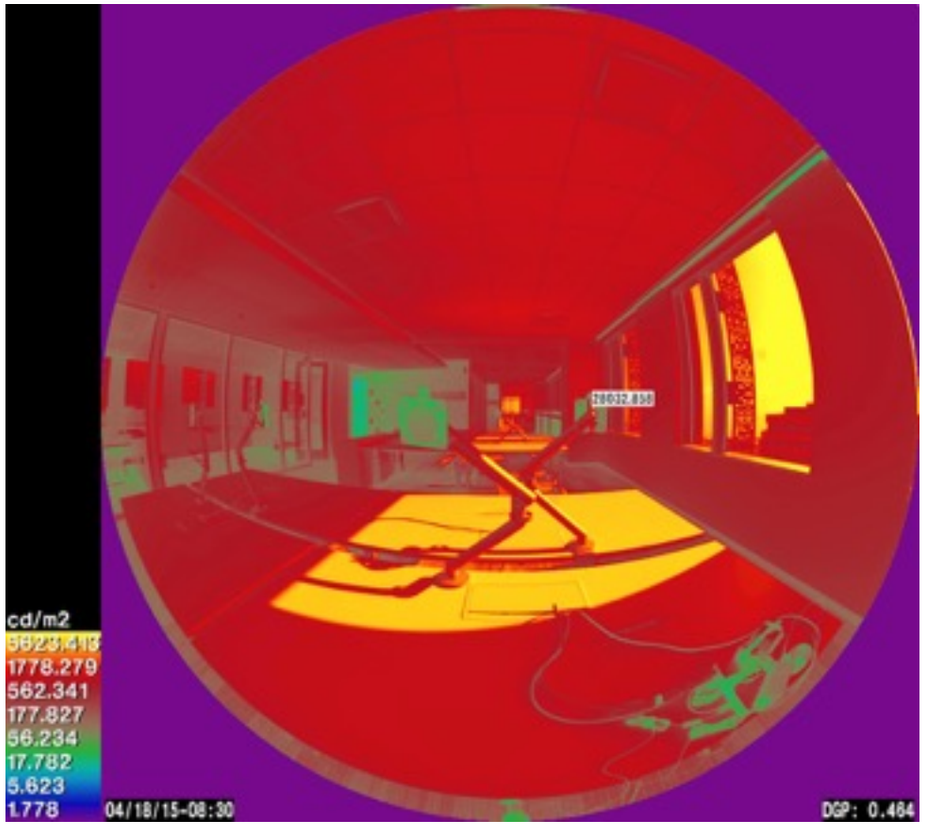
	COMFORT CLASS RATING
South #1	A
South #2	A
South #3	A
South #4	A
South #5	**B**
East #1	A
East #2	**B**
East #3	A
East #4	A

Automated Shade Operation

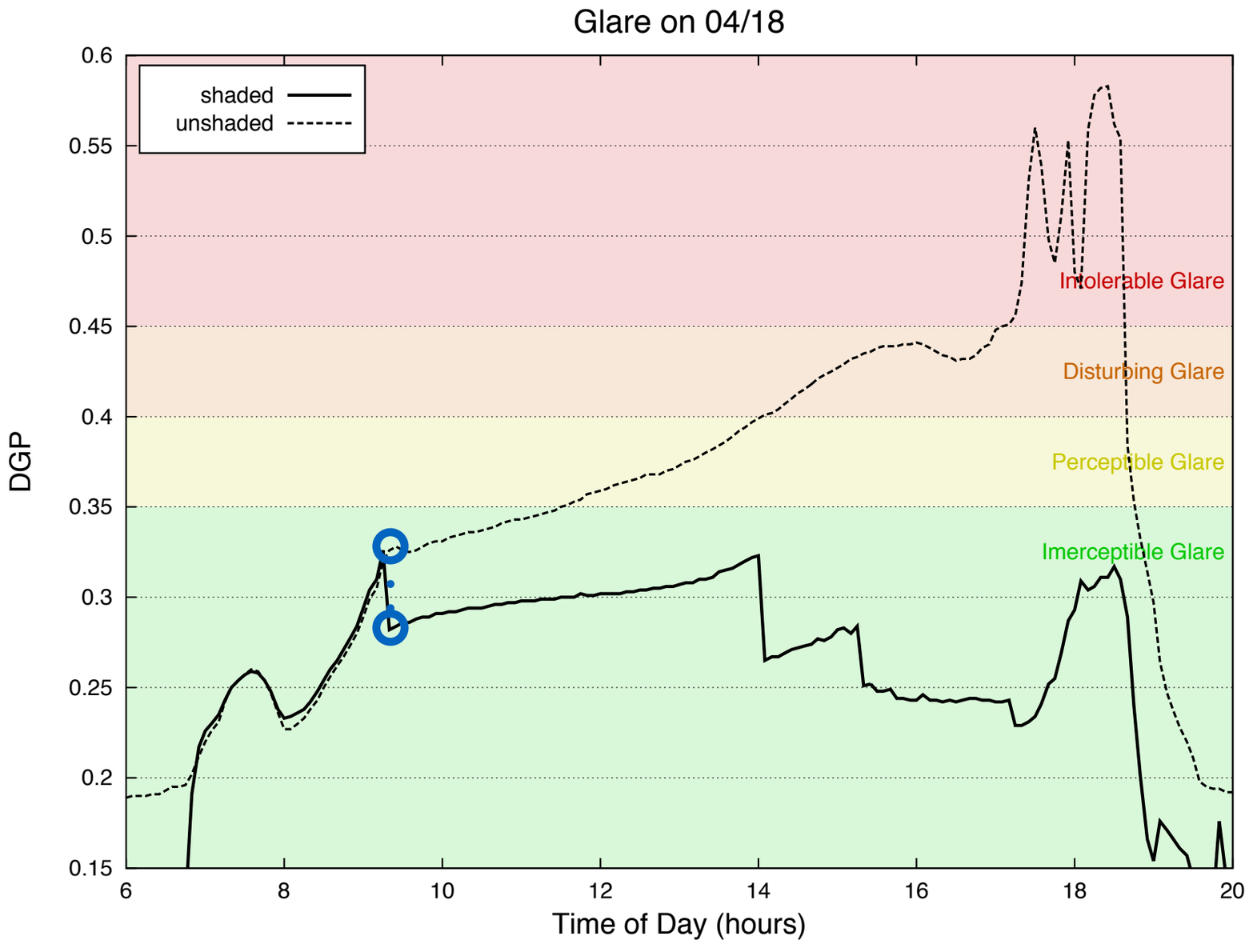
Shade Operation | **Method**

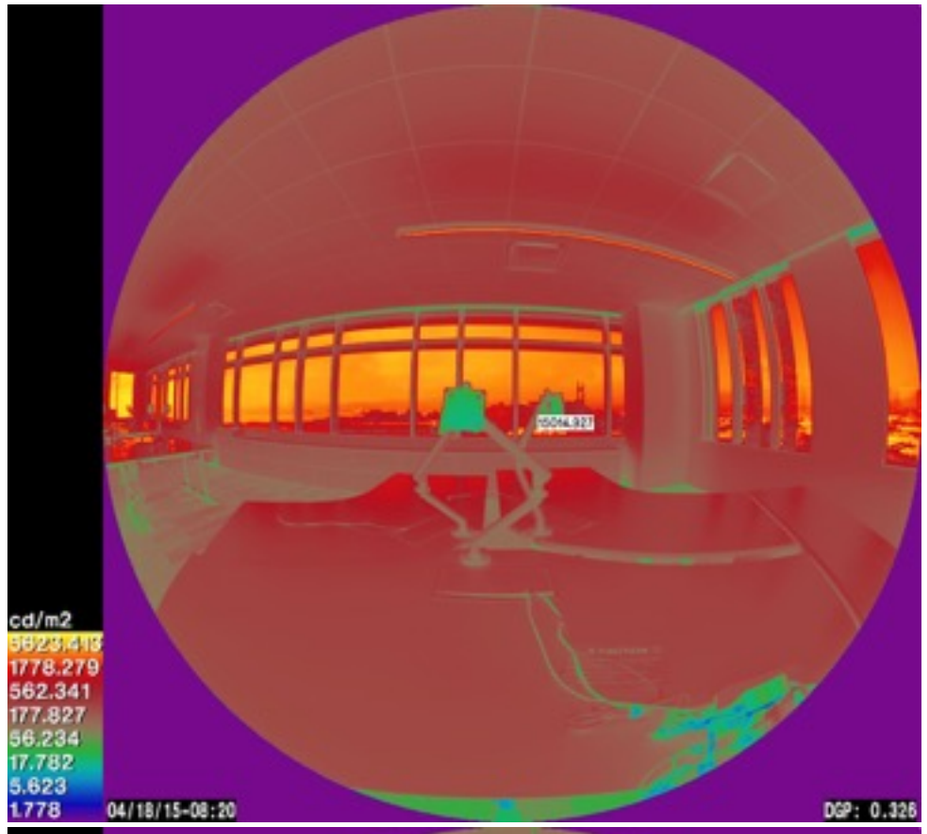


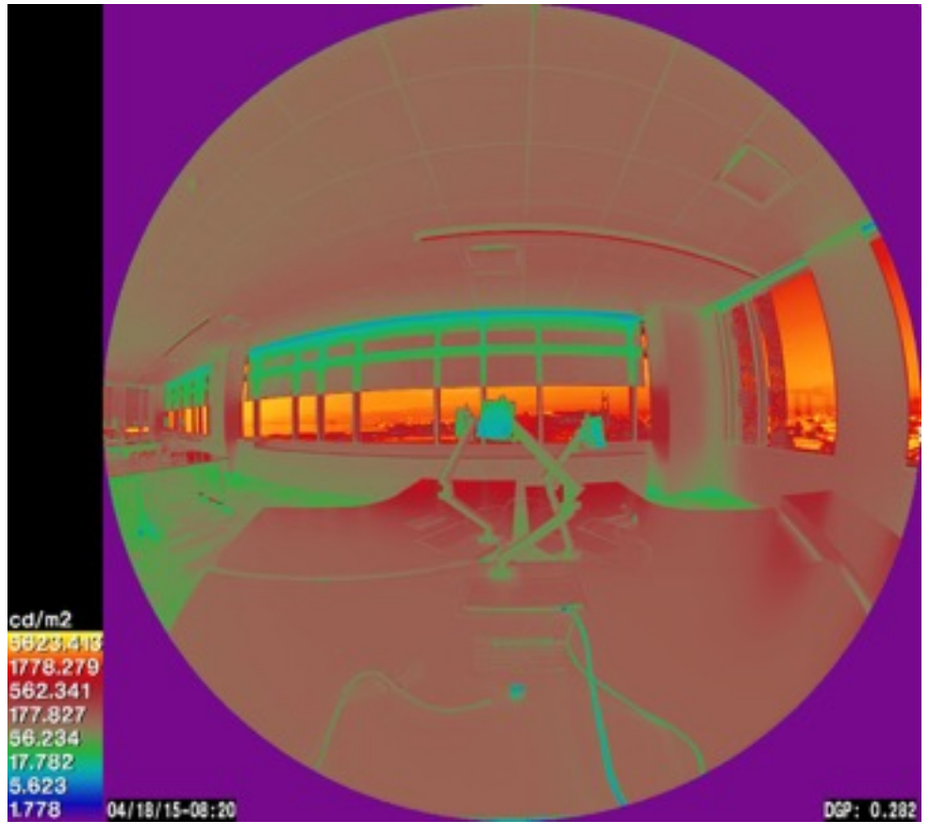




Shade Operation | **South Facade**







Thermal Comfort

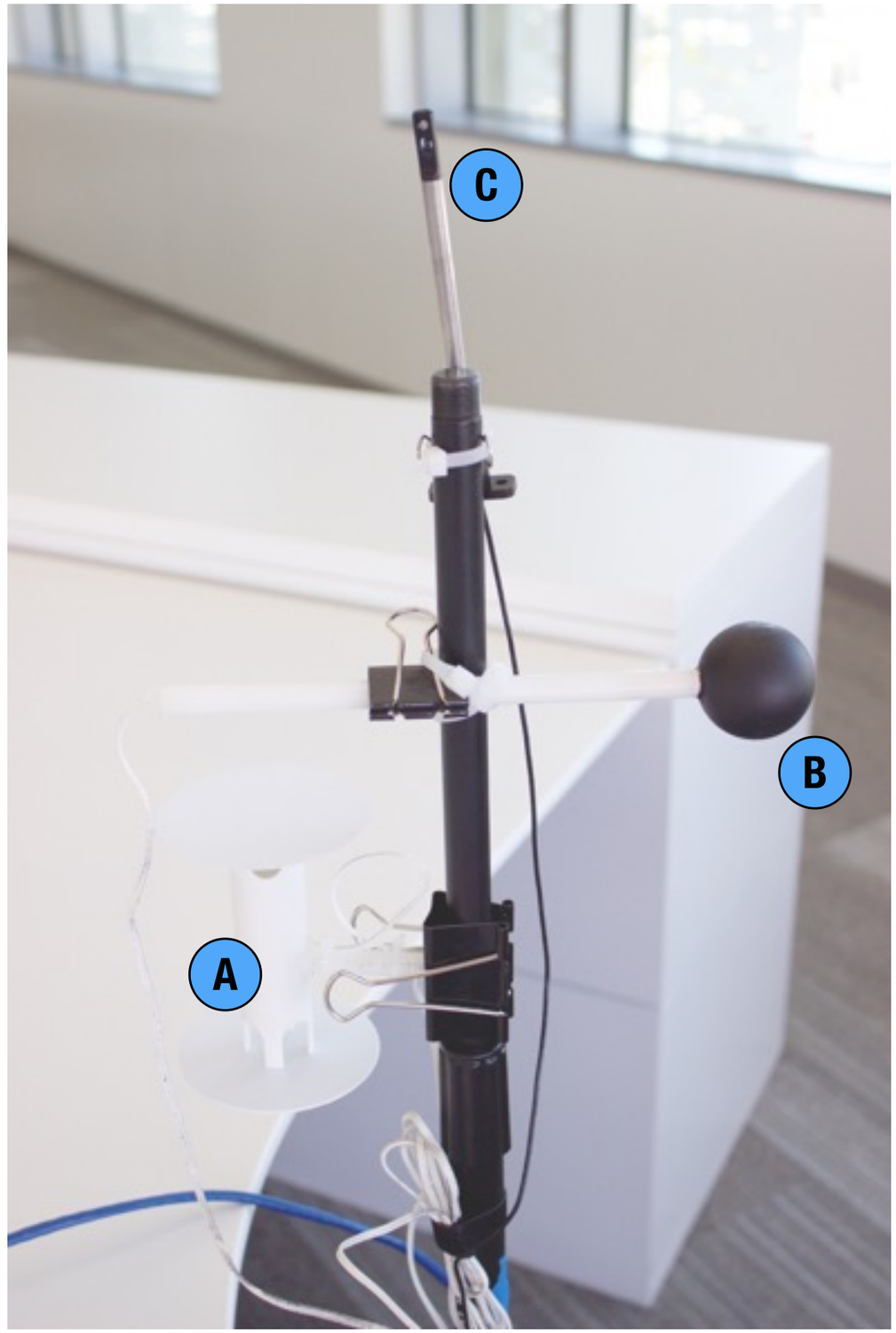
Thermal Comfort | **Methods**

Sensors

(A) shielded temperature sensor

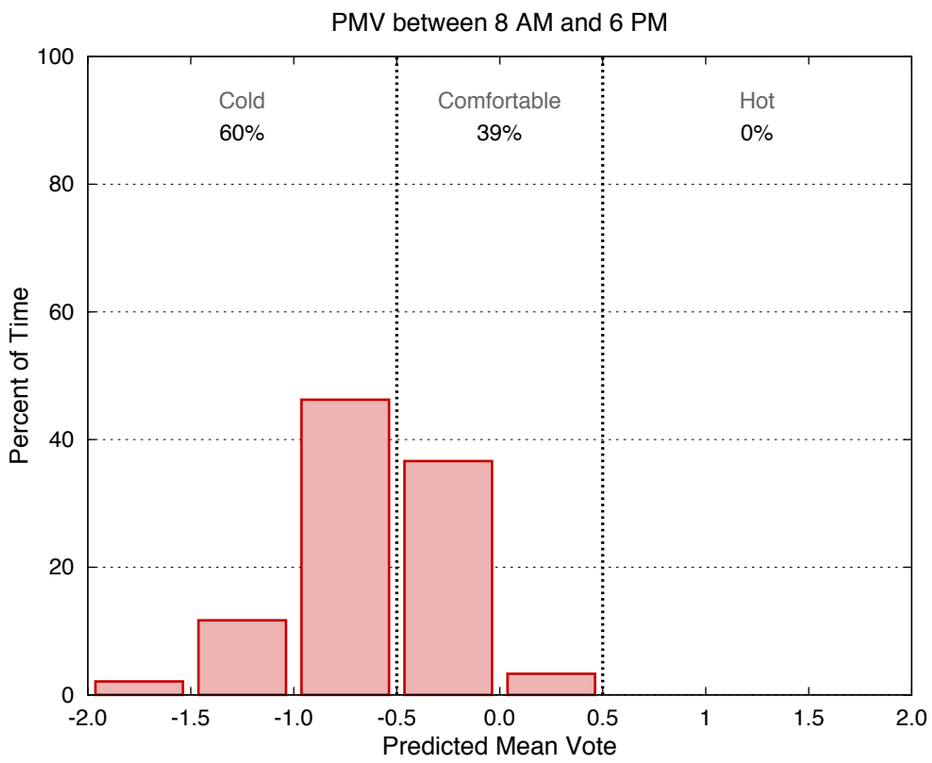
(B) a globe temperature sensor

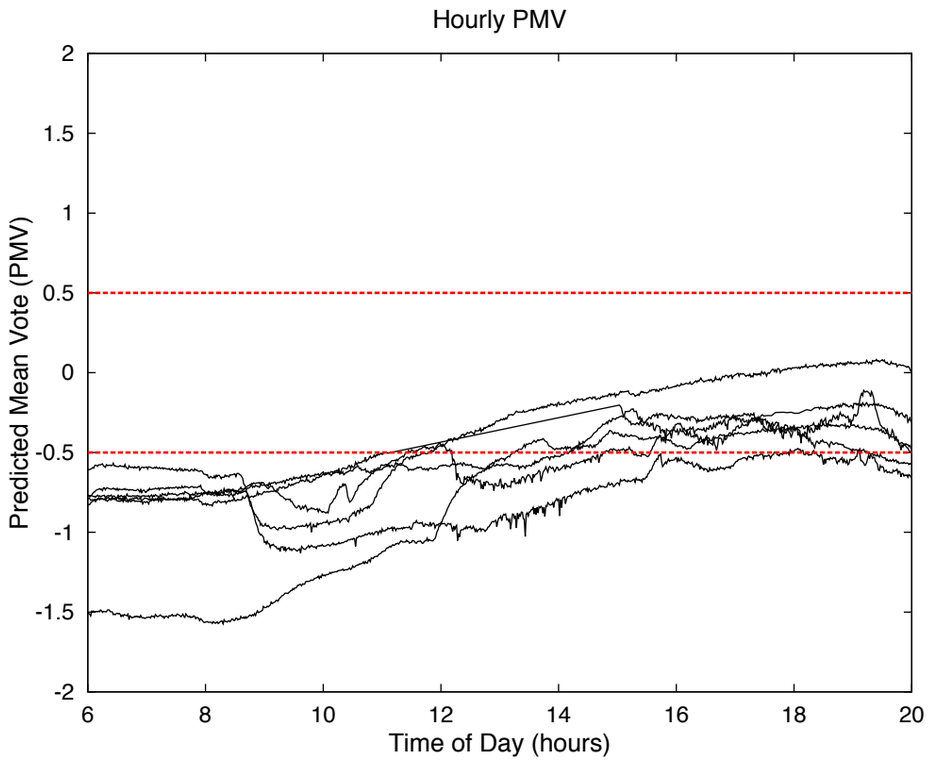
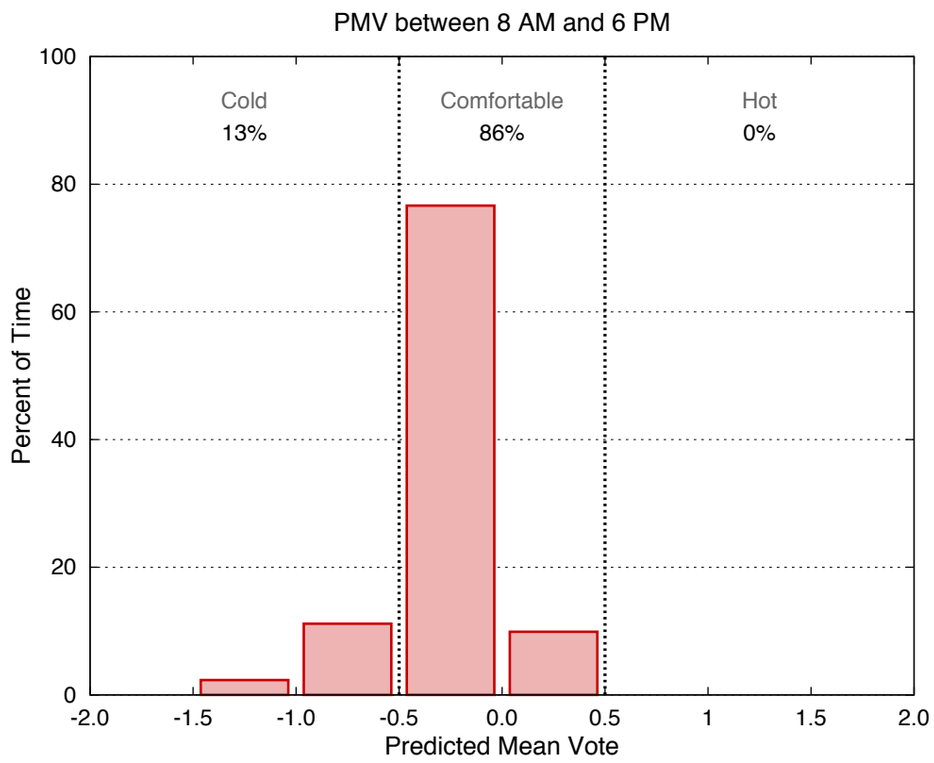
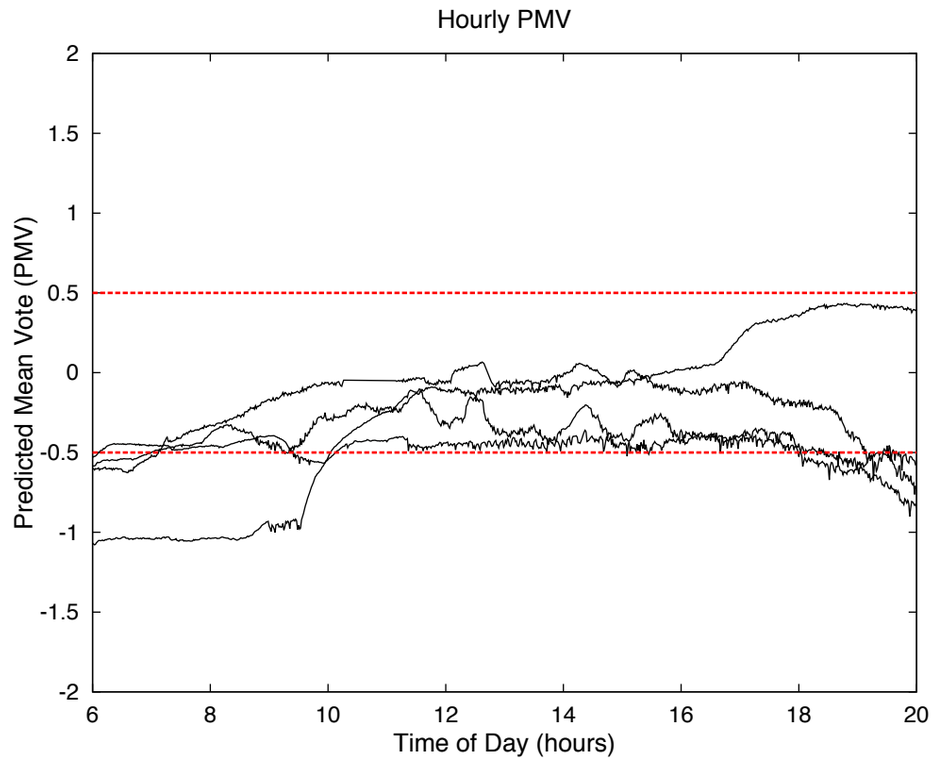
(C) hot wire anemometer



Thermal Comfort | **South**

Position #1 4/1-4/6





Position #2 4/27-4/30