



Cincinnati Children's Hospital, ZGF. Photo by Ryan Kurtz

Visual and Non-visual Effects of Light on Health in Neonatal Intensive Care Units (NICU)

Zining Cheng, M.Arch and M.S. in Design Computing

TEAM



UW

University of Washington

Mehlika Inanici, PhD

Heather Burpee

ZGF

ZGF Architects

Marty Brennan

Kelly Chanopas

CCHMC

Cincinnati Children Hospital Medical Center

James M. Greenberg, MD

Richard A. Lang, PhD

Yuying (Sara) Cao

AGENDA



01

Background and Objectives

NICU, Light and Human Responses to light



02

Methodology: Tools and Simulation Setting

Lark, Sky, Materials, Model, Grids and Views



03

Conclusion: Simulation Results

OPN1, OPN4, OPN 5 and Improvements



04

Further Research



01 BACKGROUND | Light



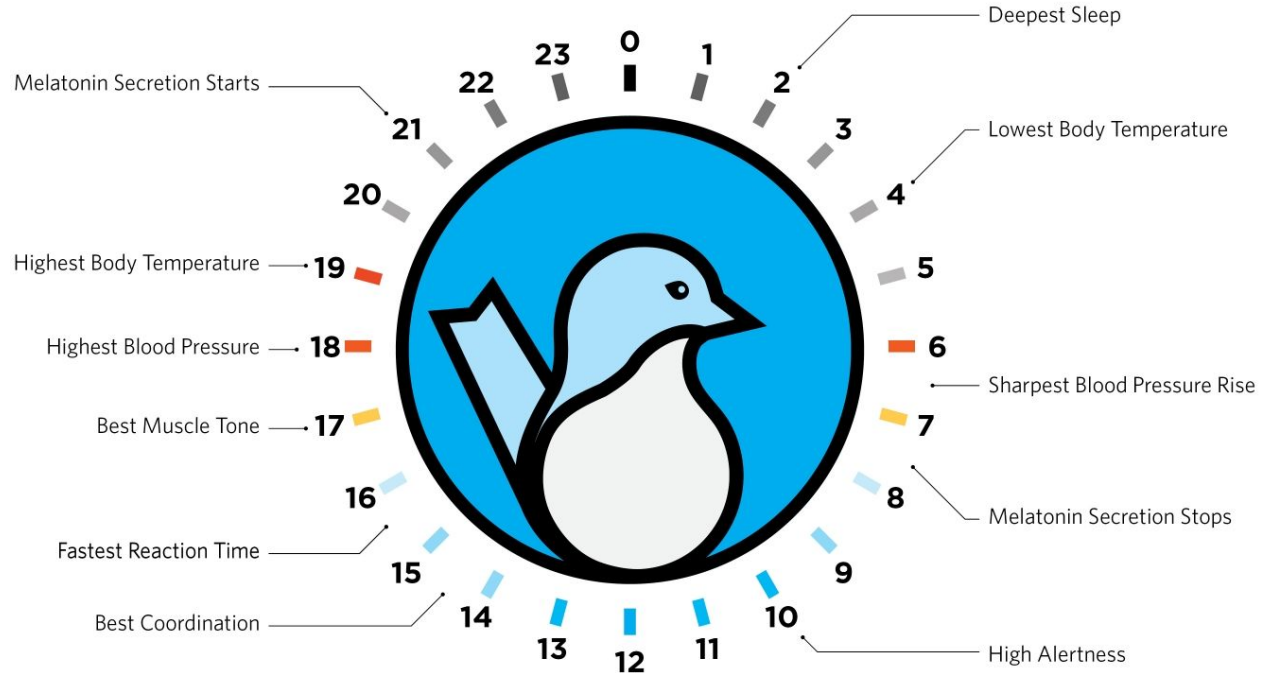
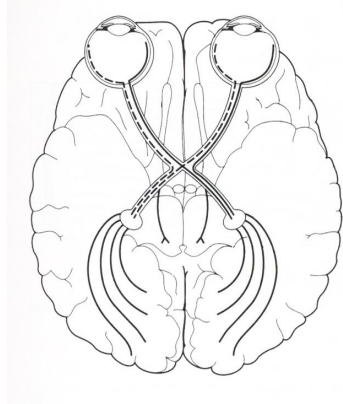
OUTDOOR

INDOOR
GLAZING

ELECTRIC
LIGHT

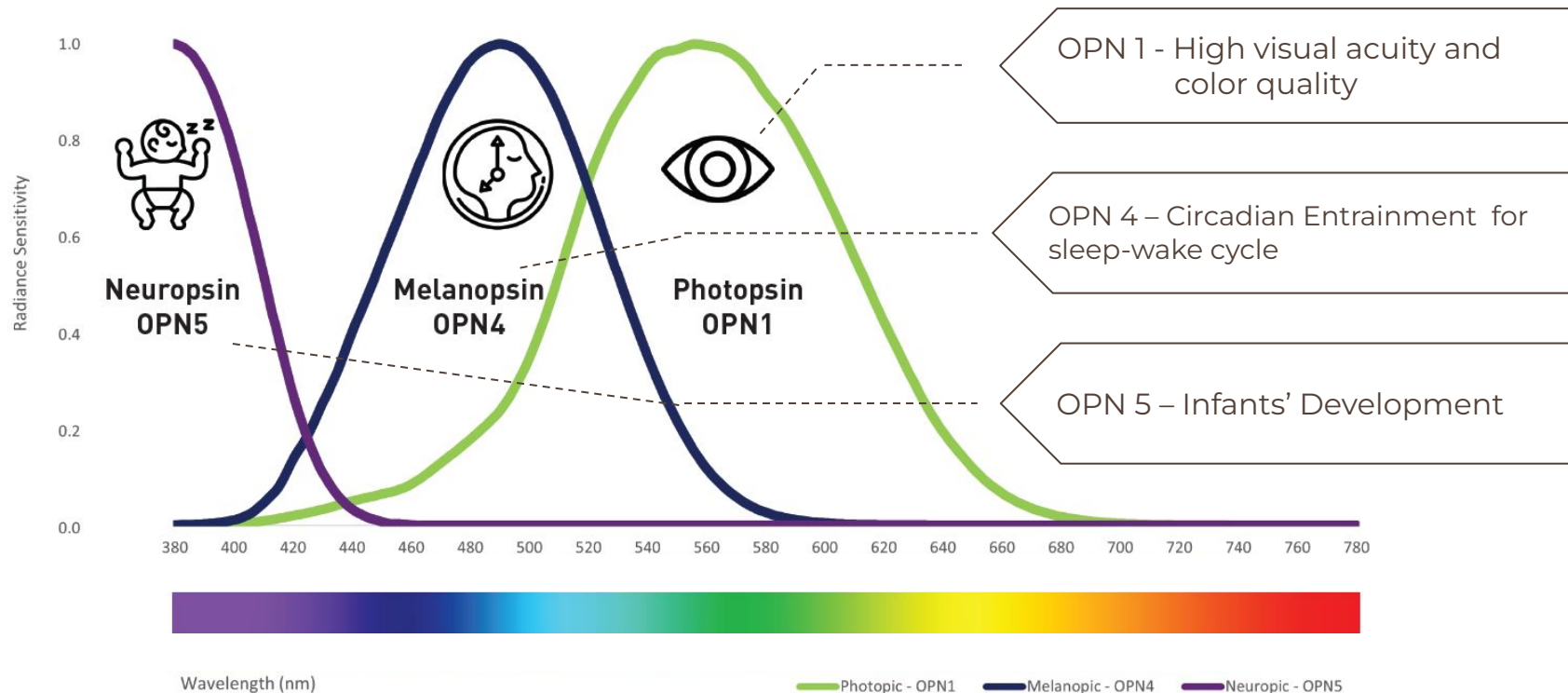


01 BACKGROUND | Visual & Non-Visual Response





01 BACKGROUND | Opsins



01 BACKGROUND | NICU

Historical Perspective

NICU in 1978 occupied one large room, St. Mary's Health in Georgia



Modern NICU

NICU Single Family Patient Room of Cincinnati Children Hospital



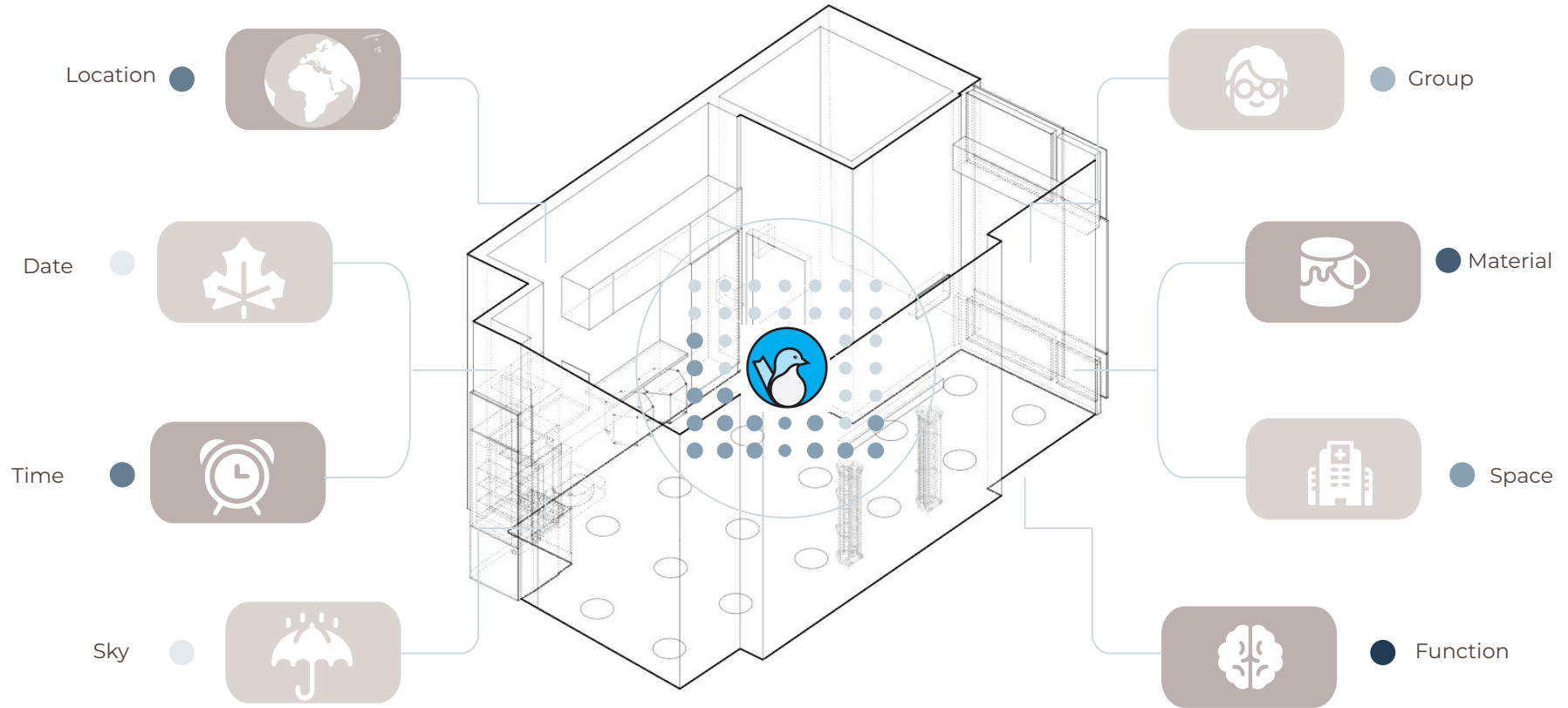
1 | Jun Zhang, Kun Sun, Yongjun Zhang. The rising preterm birth rate in China: a cause for concern. September, 2021. [https://www.thelancet.com/journals/langlo/article/PIIS2214-109X\(21\)00298-9/fulltext#seccite150](https://www.thelancet.com/journals/langlo/article/PIIS2214-109X(21)00298-9/fulltext#seccite150)

2 | NICU Single Family Patient Room of Cincinnati Children Hospital, ZGF. Photo by Ryan Kurtz

3 | Born Too Soon: The Global Action Report on Preterm Birth. https://www.who.int/pmnch/knowledge/publications/preterm_birth_report/en/index3.html



01 OBJECTIVES

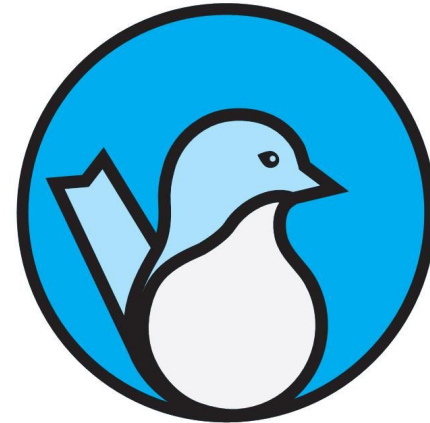




02 LARK | Multi-Spectral Lighting Simulation Tool

Updates

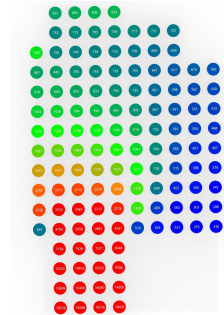
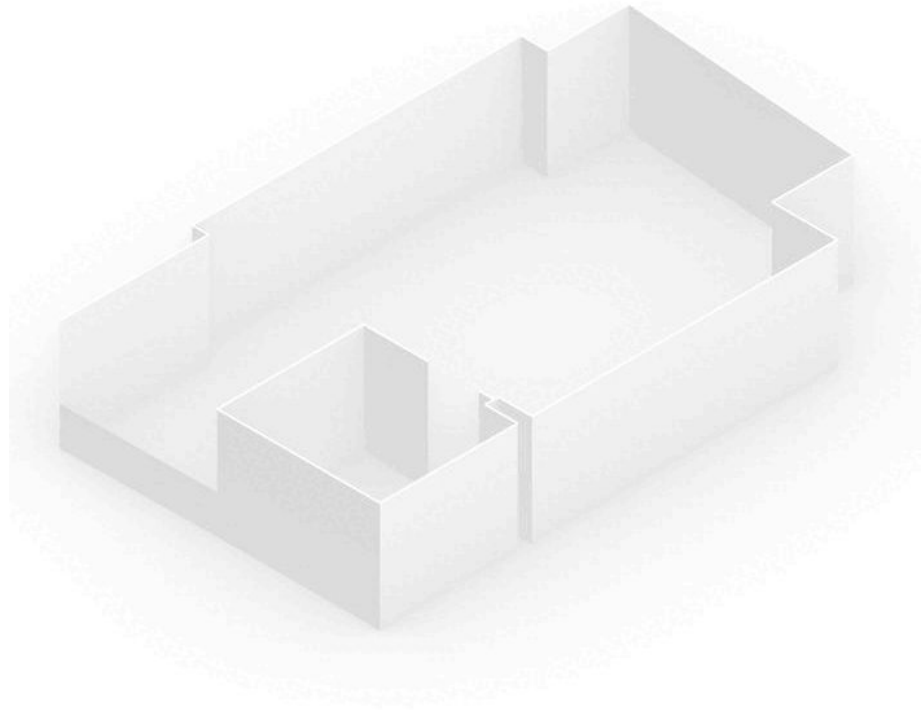
- Add new non-visual simulation: OPN5
- Update Coefficients for multi-channel calculation
- Add Grid simulation
- Different Views
- Visualize the simulation result



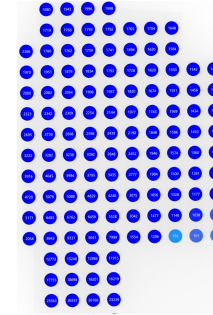
LARK
SPECTRAL LIGHTING



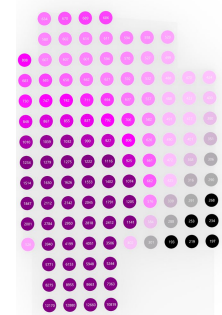
02 UPDATES | Opsins & Criteria



OPN 1
Photopsin



OPN 4
Melanopsin

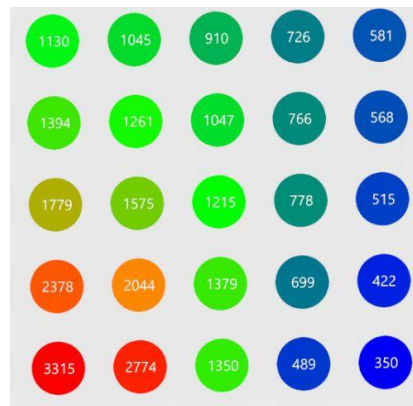
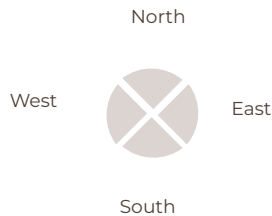
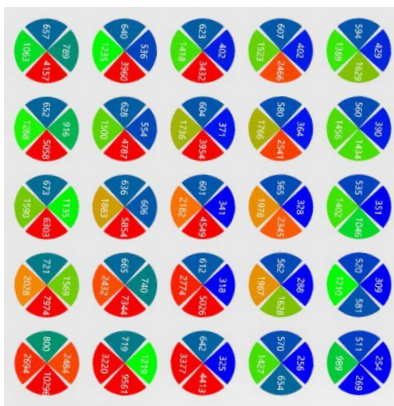


OPN 5
Neuropsin





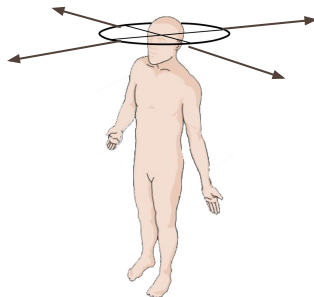
02 UPDATES | Grids & View



Clinician & Families

Looking Around

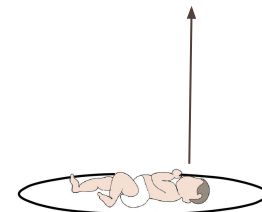
4 Directions



Patient

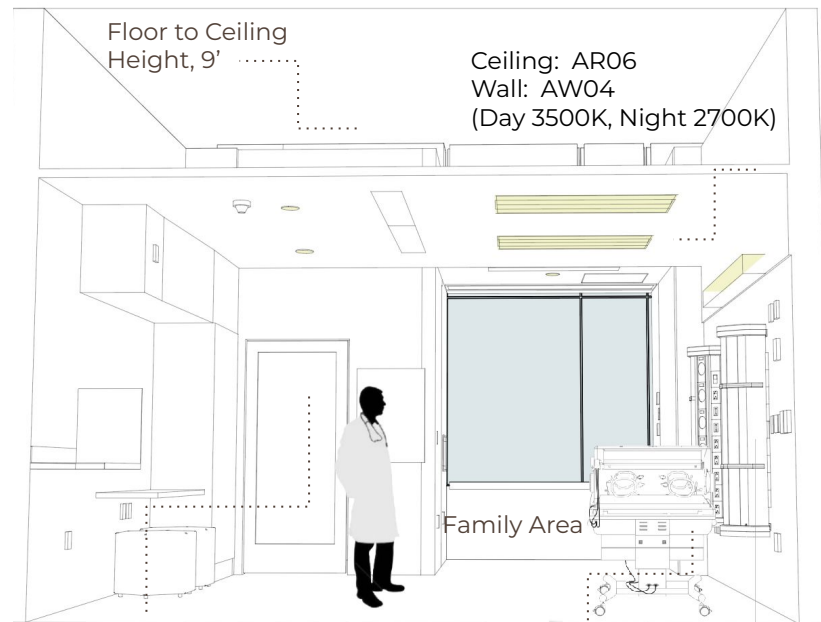
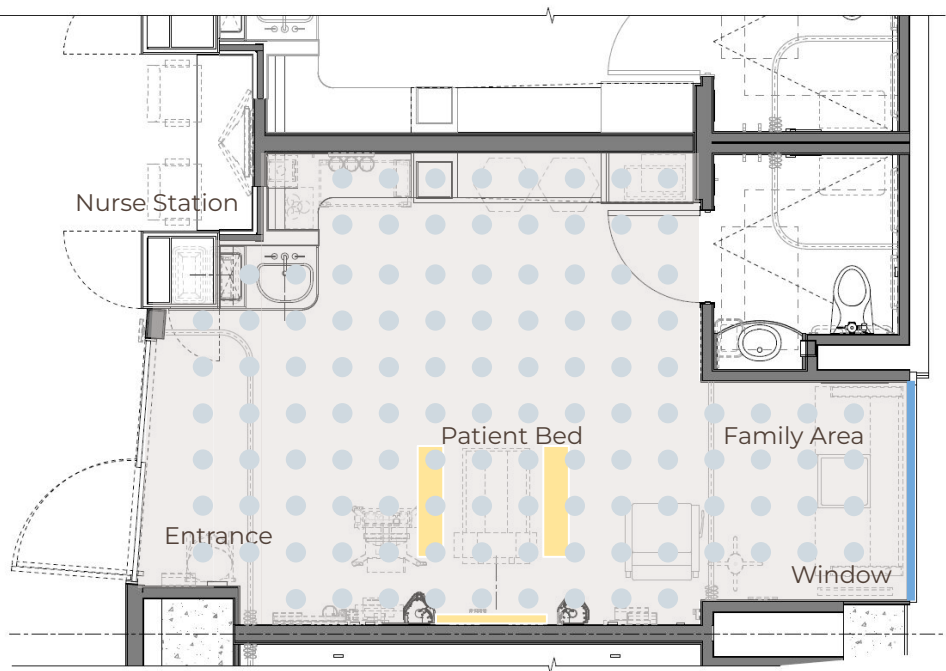
Looking Up

1 Direction



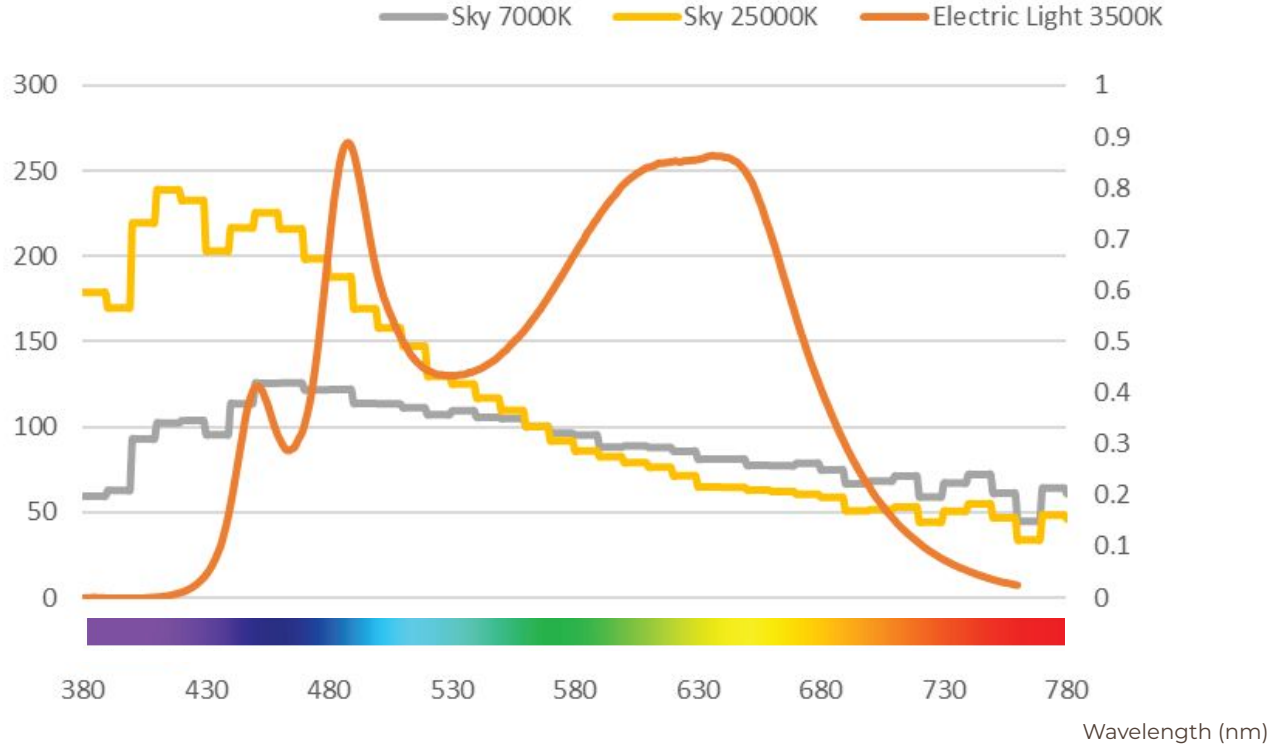


02 SETTING | Patient Room





03 RESULT | Electric light





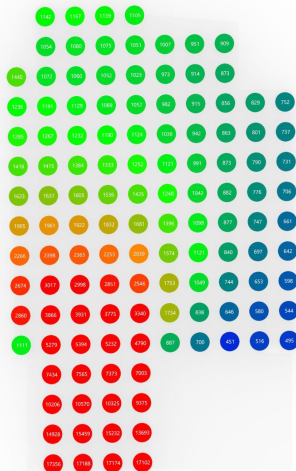
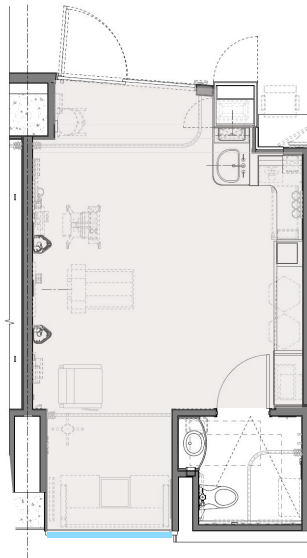
03 RESULT | June 21

SEA, South, 25k, Clear sky, White Wall

Daylight

OPN 1 GLARE

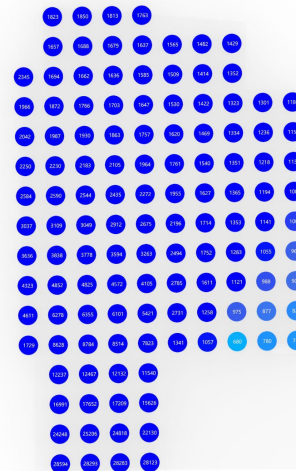
80% 300- 3000 lux



OPN 4 PASS

10.4% 275- 1100 EML

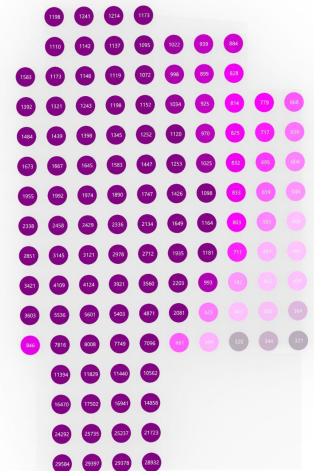
89.6% Over 1100 EML



OPN 5 PASS

36% 275- 1100 ENL

64% Over 1100 ENL



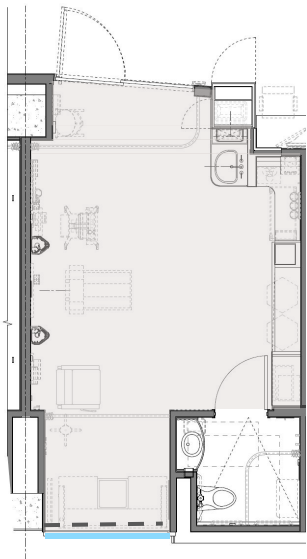


03 RESULT | June 21

SEA, South, 25k, Clear sky, White Wall

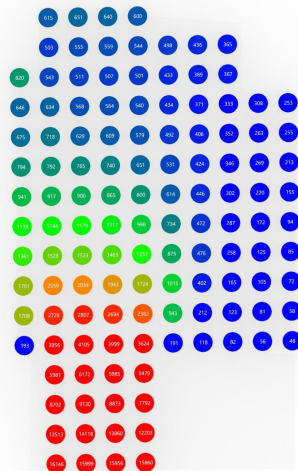
Daylight

+ Shade



OPN 1 DIM

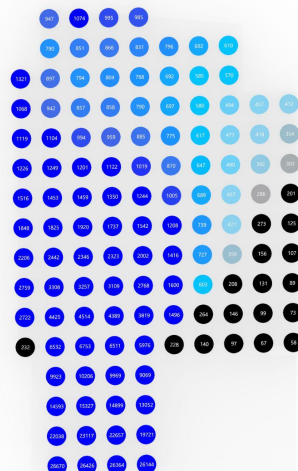
63.2% 300- 3000 lux



OPN 4 LESS

40.1% 275- 1100 EML

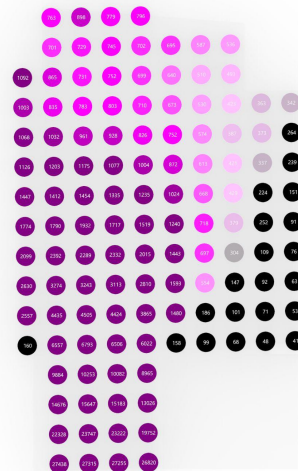
44.8% Over 1100 EML



OPN 5 LESS

41.6% 275- 1100 ENL

41.6% Over 1100 ENL





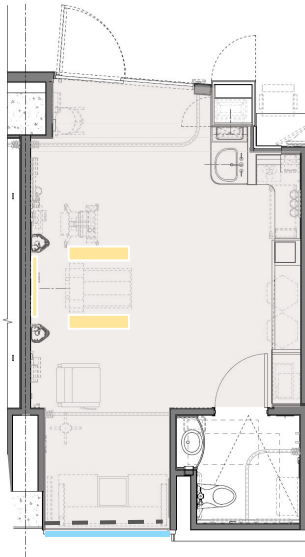
03 RESULT | June 21

SEA, South, 25k, Clear sky, White Wall

Daylight

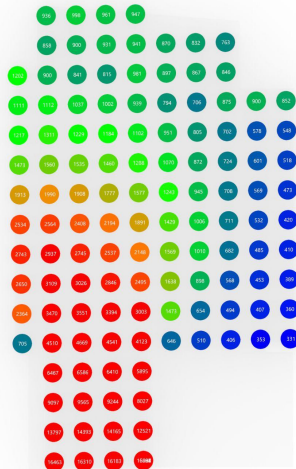
+ Shade

+ Electric Light



OPN 1 **PASS**

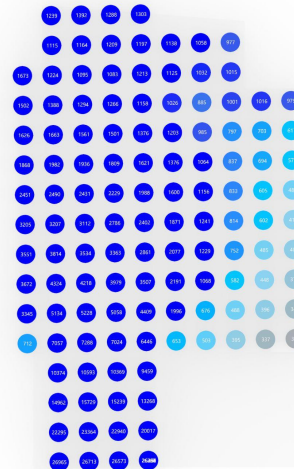
73.3% 300- 3000 lux



OPN 4 **PASS**

31.1% 275- 1100 EML

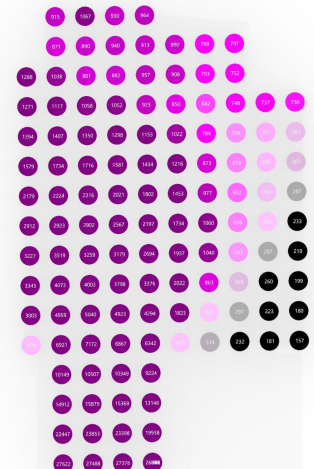
68.9% Over 1100 EML



OPN 5 **PASS**

38.5% 275- 1100 ENL

54.8% Over 1100 ENL





03 RESULT | December 21

SEA, South, 7k, Overcast sky, White Wall

Daylight

OPN 1 DIM

12.8% 300- 3000 lux

OPN 4 FAIL

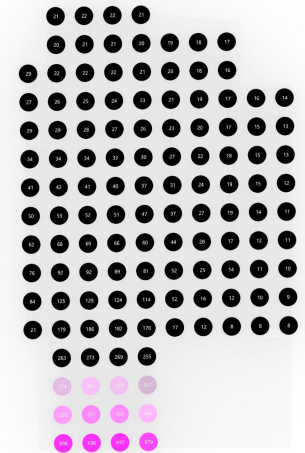
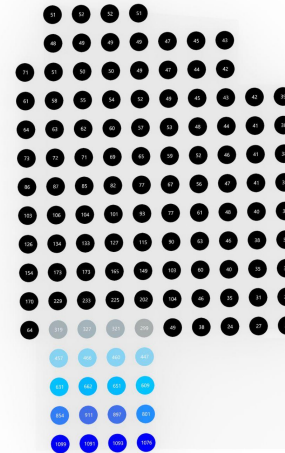
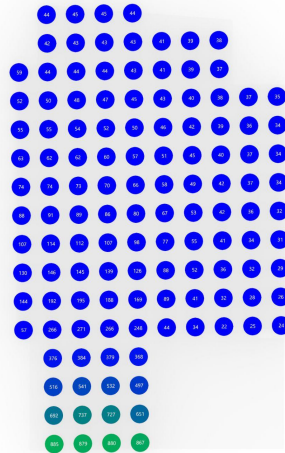
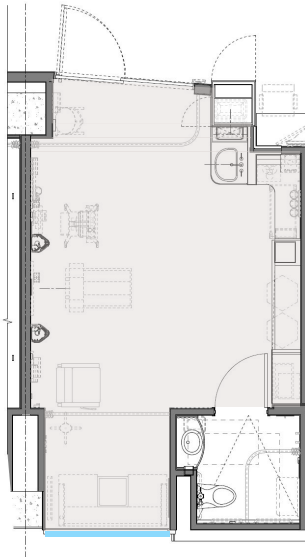
16% 275- 1100 EML

10.8% Over 1100 EML

OPN 5 FAIL

9.6% 275- 1100 ENL

0.8% Over 1100 ENL



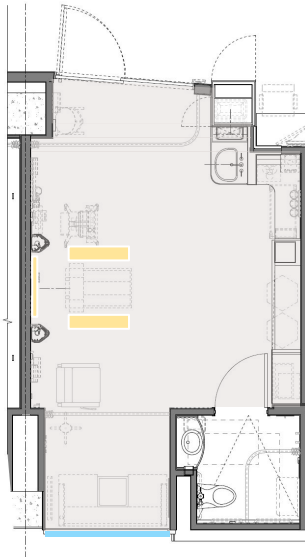


03 RESULT | December 21

SEA, South, 7k, Overcast sky, White Wall

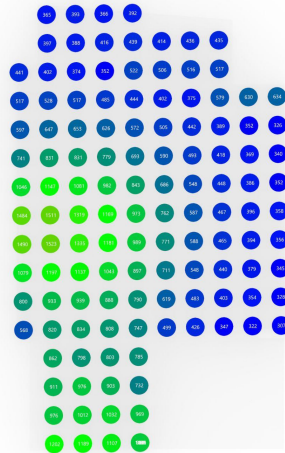
Daylight

+ Electric Light



OPN 1 **PASS**

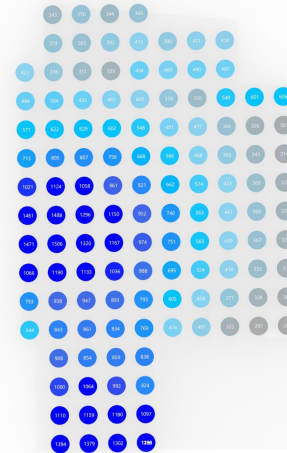
100% 300- 3000 lux



OPN 4 **PASS**

80% 275- 1100 EML

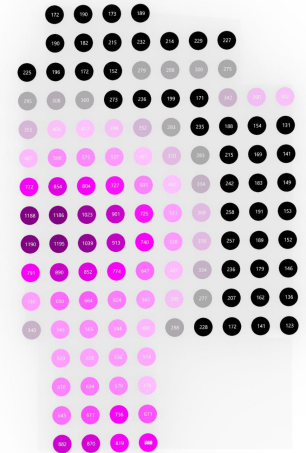
20% Over 1100 EML



OPN 5 **MORE**

63% 275- 1100 ENL

3% Over 1100 ENL

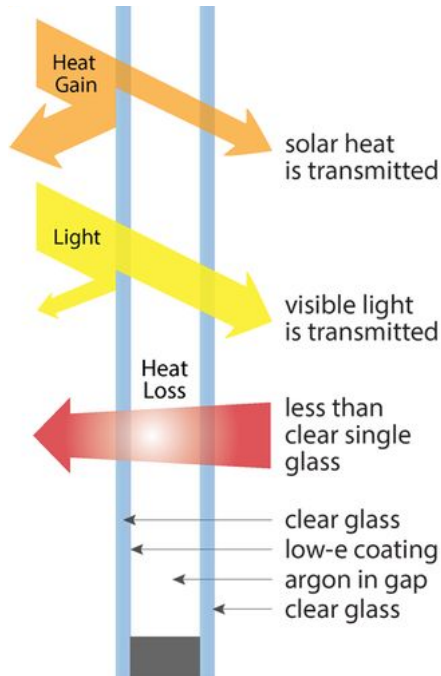
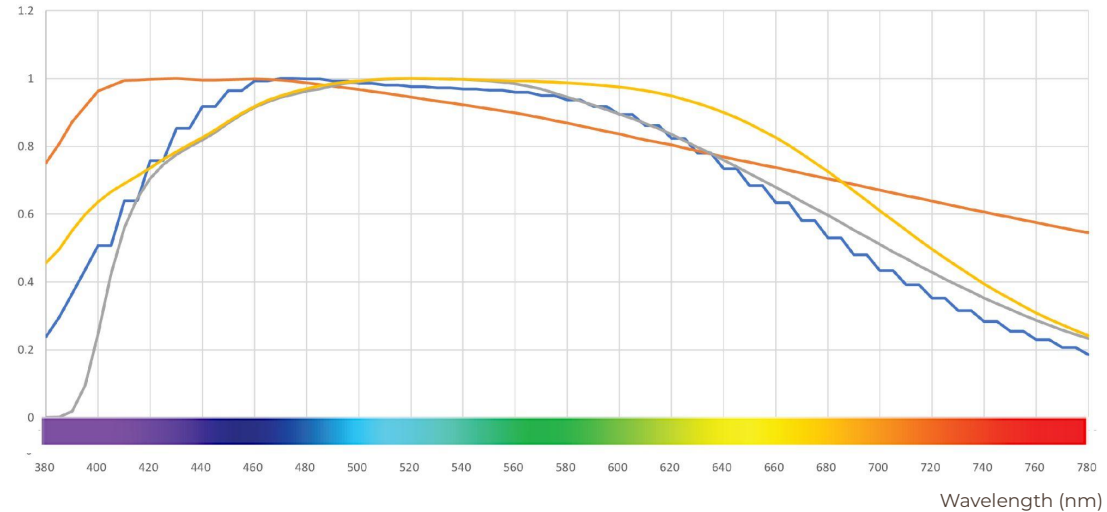




03 RESULT | GLAZING

SEA, South, 25k, Clear sky, White Wall

Normalized Spectra Power Distribution Curve - Glazing



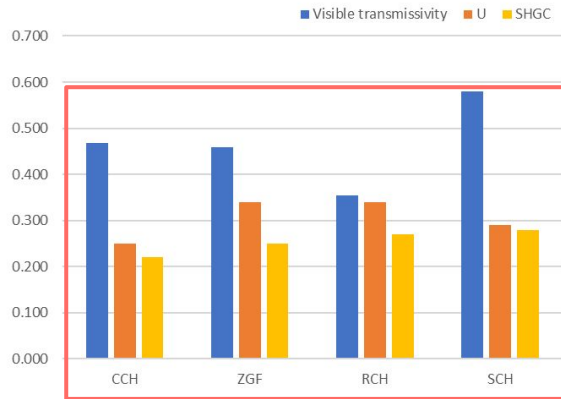
	Glazing 1	Glazing 2	Glazing 3	Glazing 4
Transmissivity	35.5 %	45.9 %	46.8 %	58 %
U-Value	0.34	0.34	0.25	0.29
SHGC	0.27	0.25	0.22	0.28



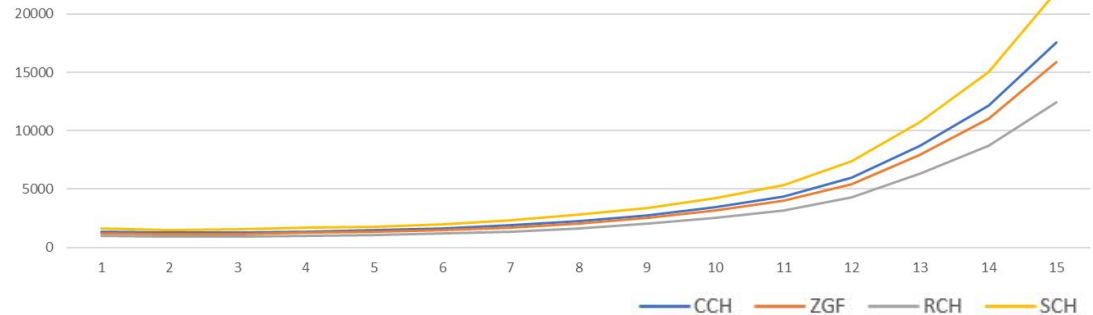
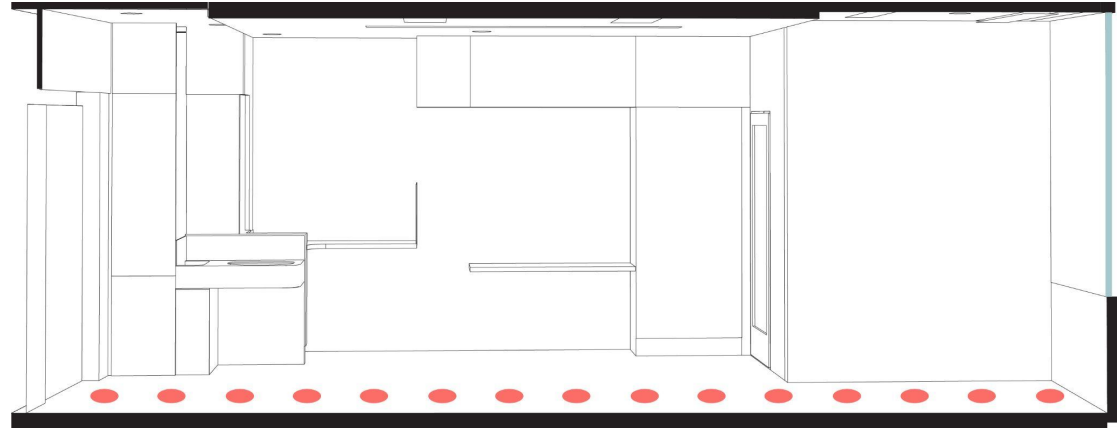
03 RESULT | GLAZING

SEA, South, 25k, Clear sky, White Wall

Compare Tvis/U/SHGC Value



OPN 1

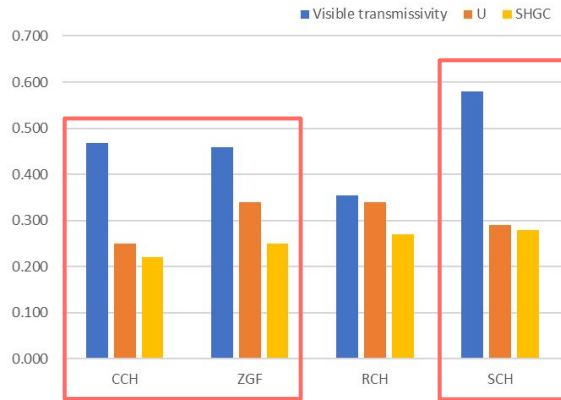




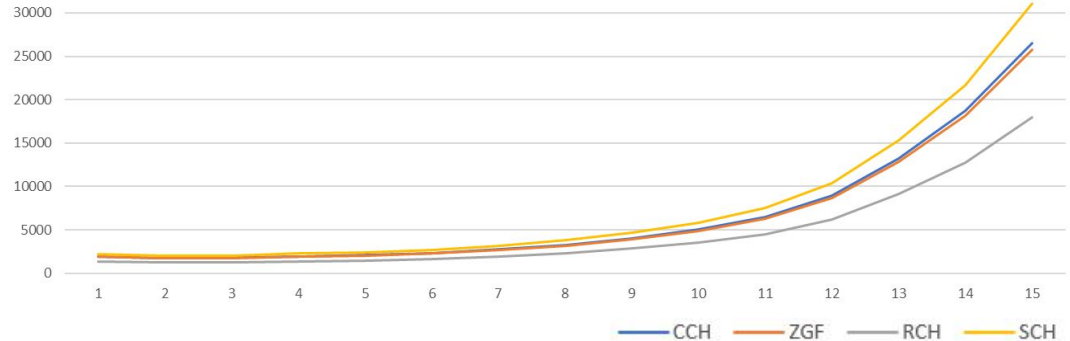
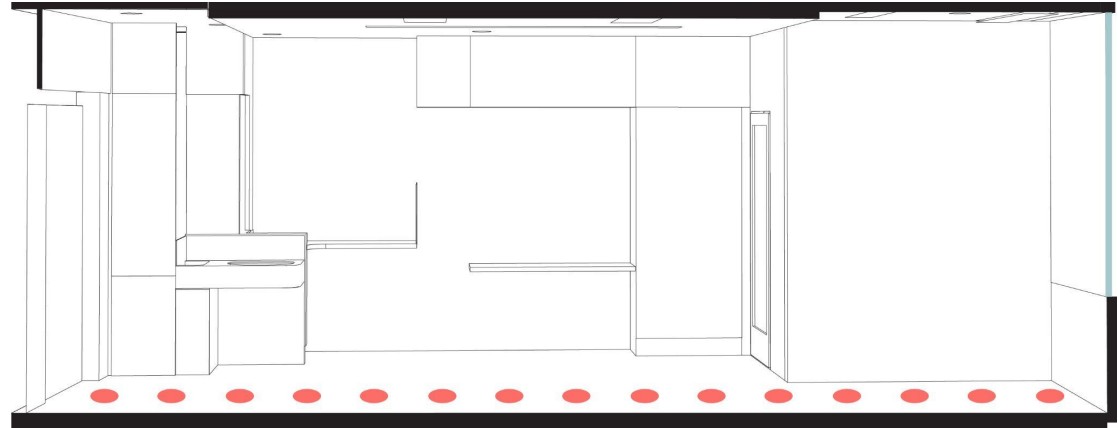
03 RESULT | GLAZING

SEA, South, 25k, Clear sky, White Wall

Compare Tvis/U/SHGC Value



OPN 4

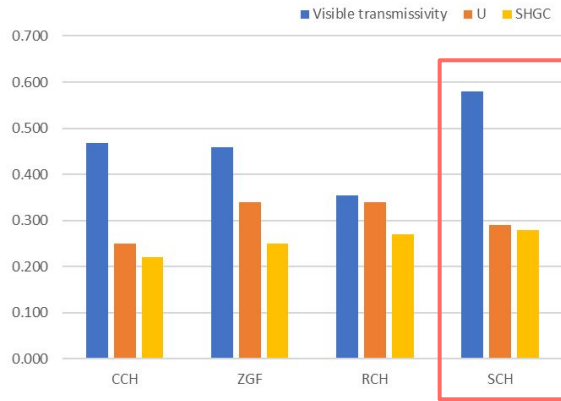




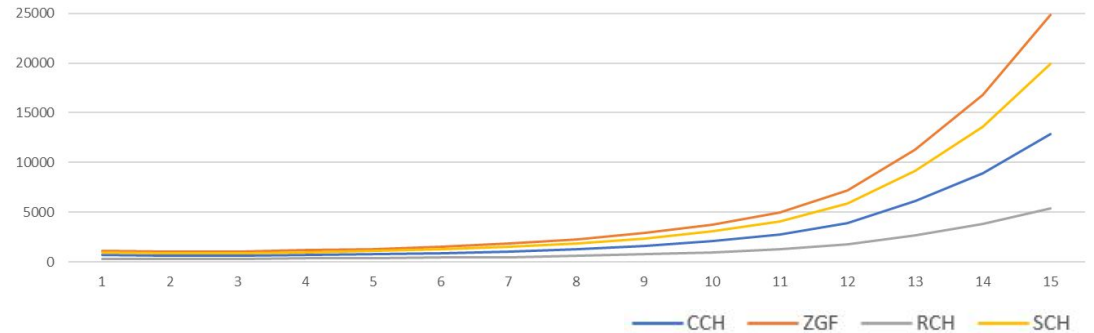
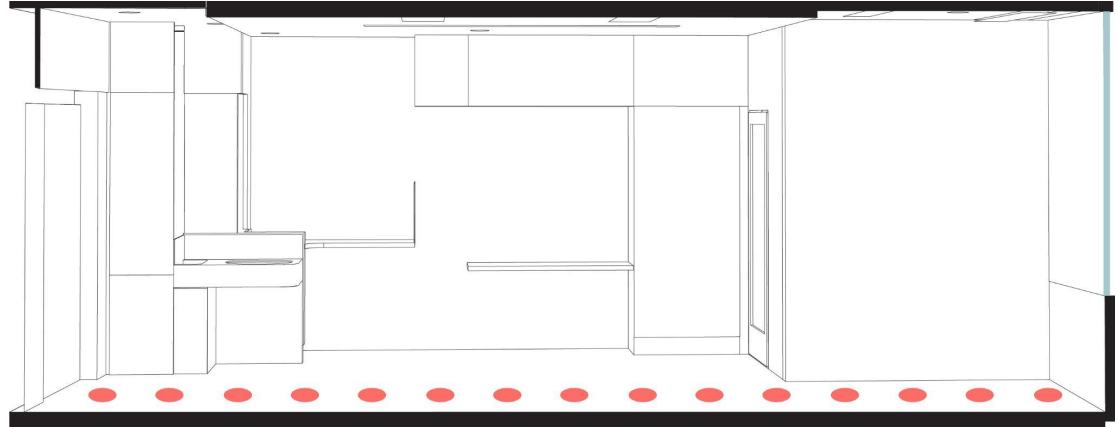
03 RESULT | GLAZING

SEA, South, 25k, Clear sky, White Wall

Compare Tvis/U/SHGC Value



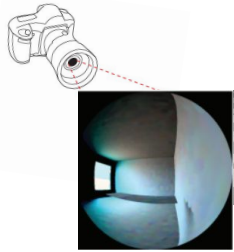
OPN 5



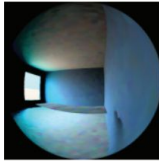


03 RESULT | Surface

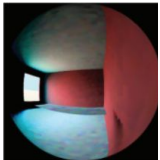
SEA, South, 6/21, 25k, Clear sky



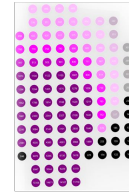
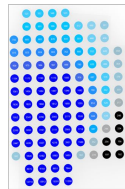
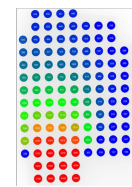
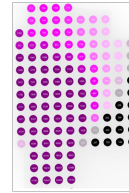
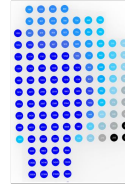
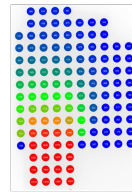
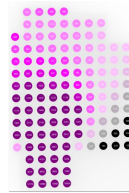
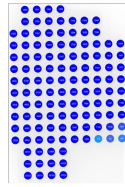
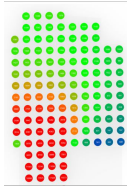
White Wall



Blue Wall



Red Wall

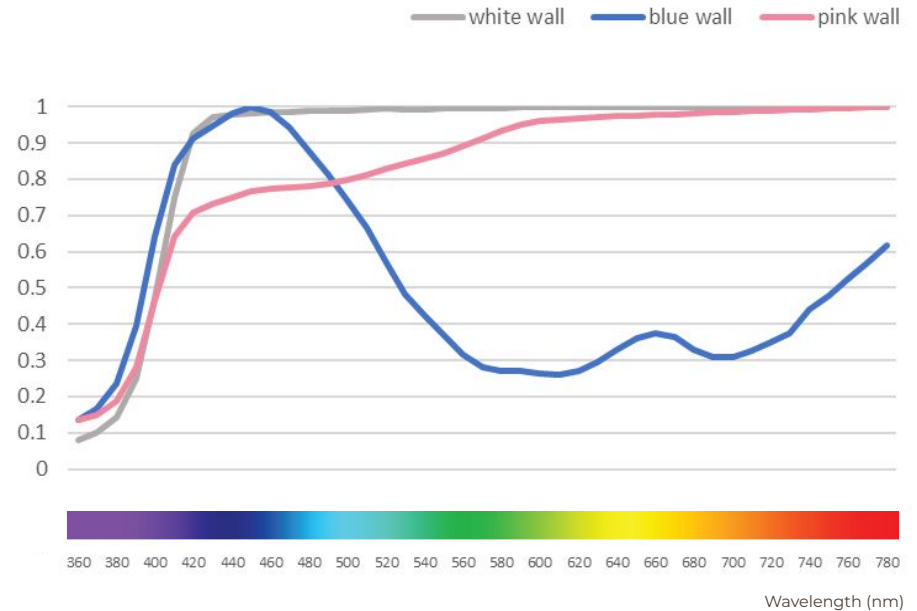


OPN 1

OPN 4

OPN 5

Spectral Power Distribution Curve - Wall Surface

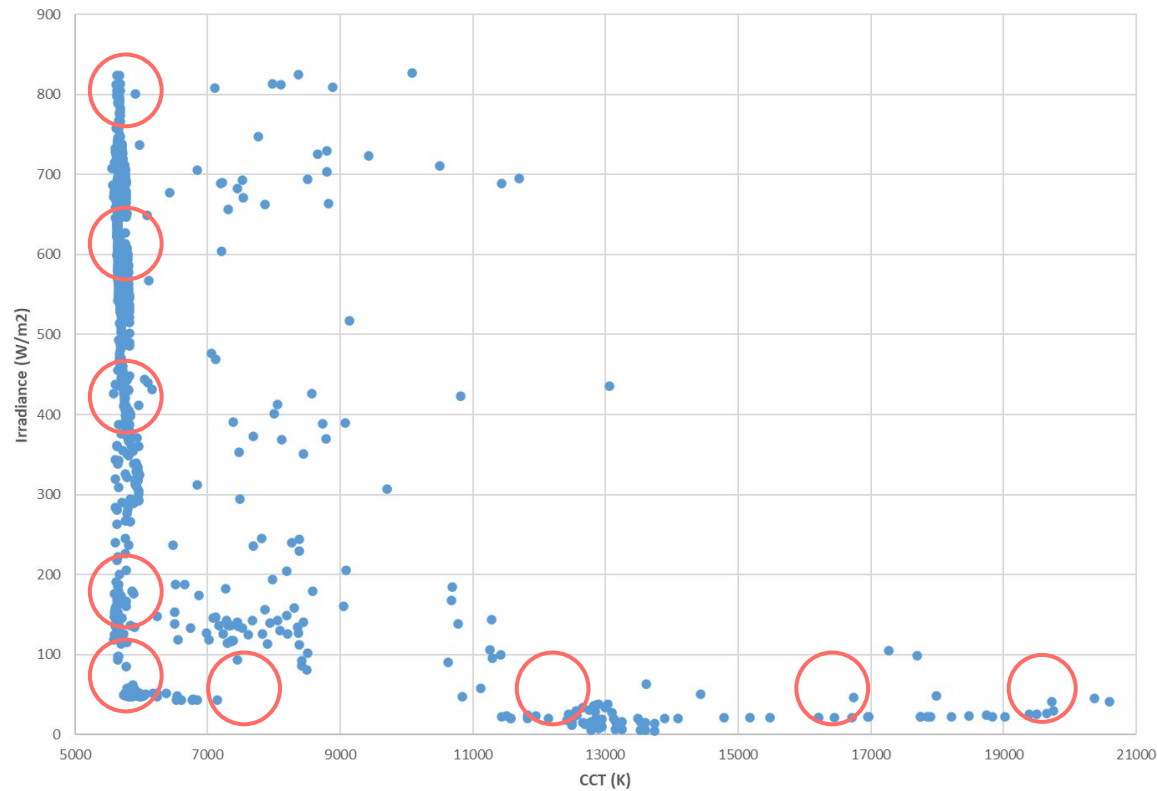




03 RESULT | Sky CCT & Irradiance

SEA, South, 6/9, White Wall

Raw Data





03 RESULT | Irradiance

SEA, South, 6/9, White Wall

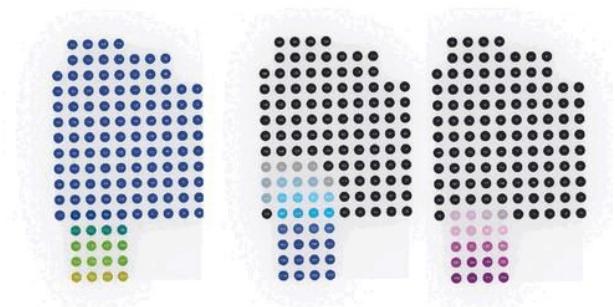
IRRADIANCE = 49.75

CCT = 5743.6

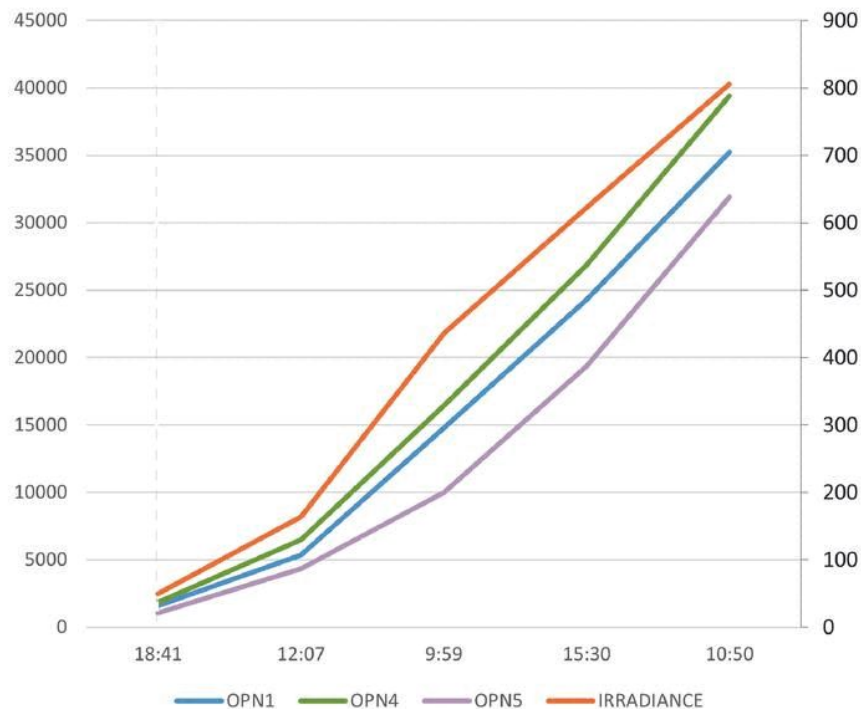
1588

1837

1054



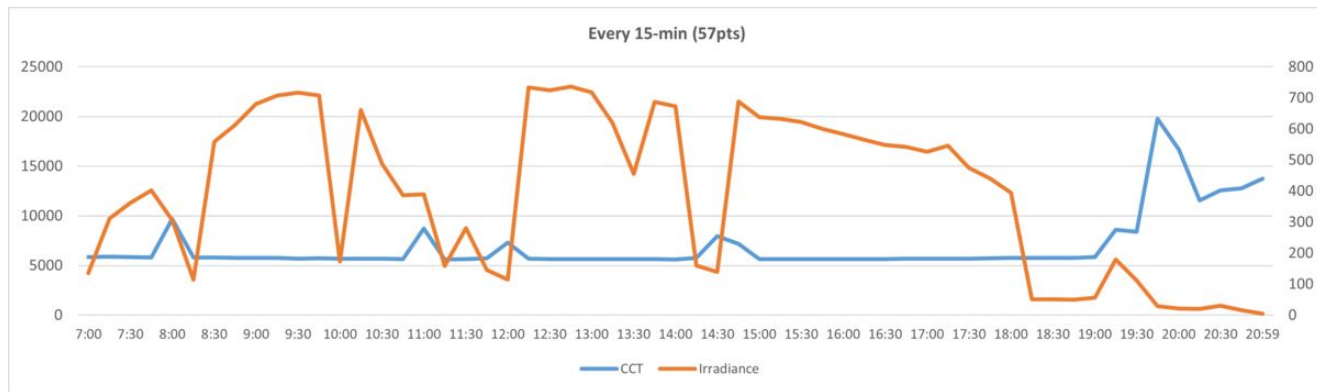
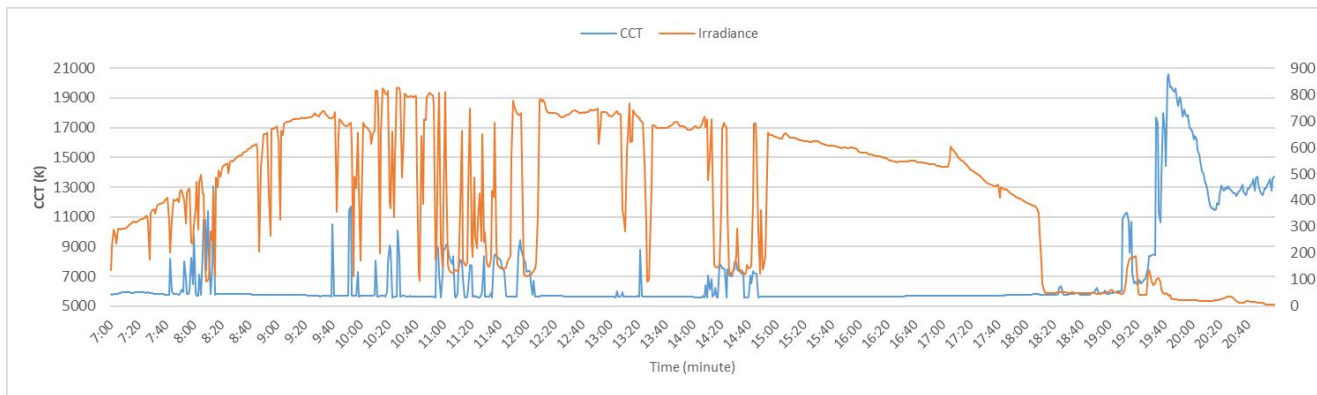
Compare Irradiance





03 RESULT | Single Day

SEA, South, 6/9, White Wall

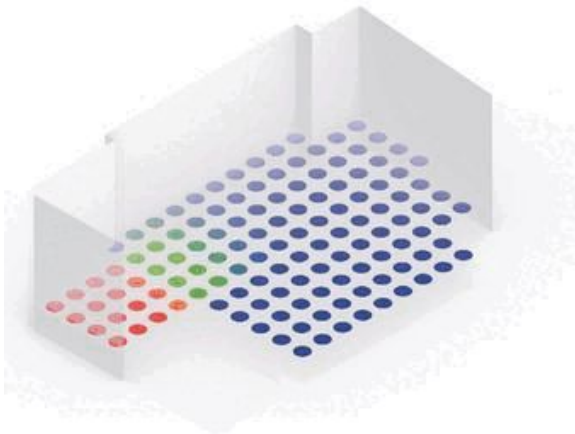
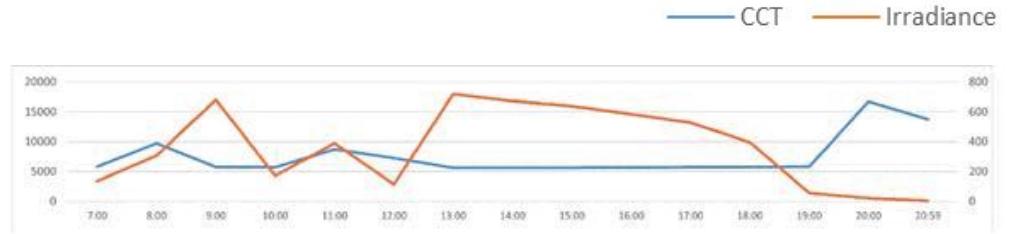




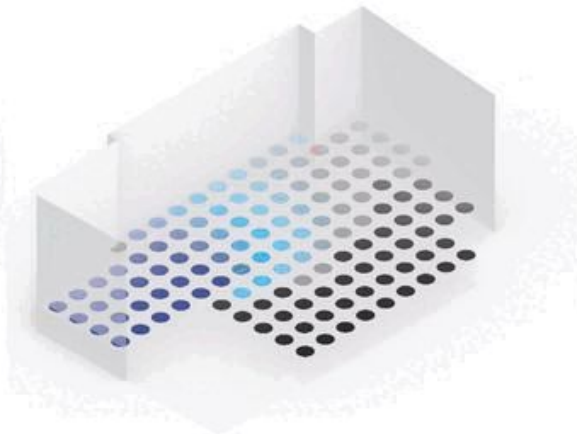
03 RESULT | Single Day

SEA, South, 6/9, White Wall

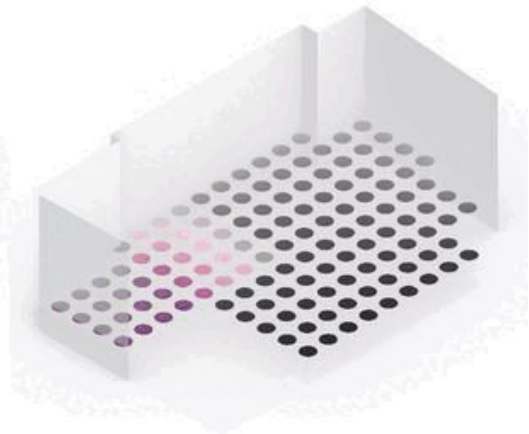
7:00 A.M.



OPN 1 46.4 %



OPN 4 64.8 %



OPN 5 28.0 %



THANK YOU

Zining Cheng
M.Arch and M.S. Design Computing

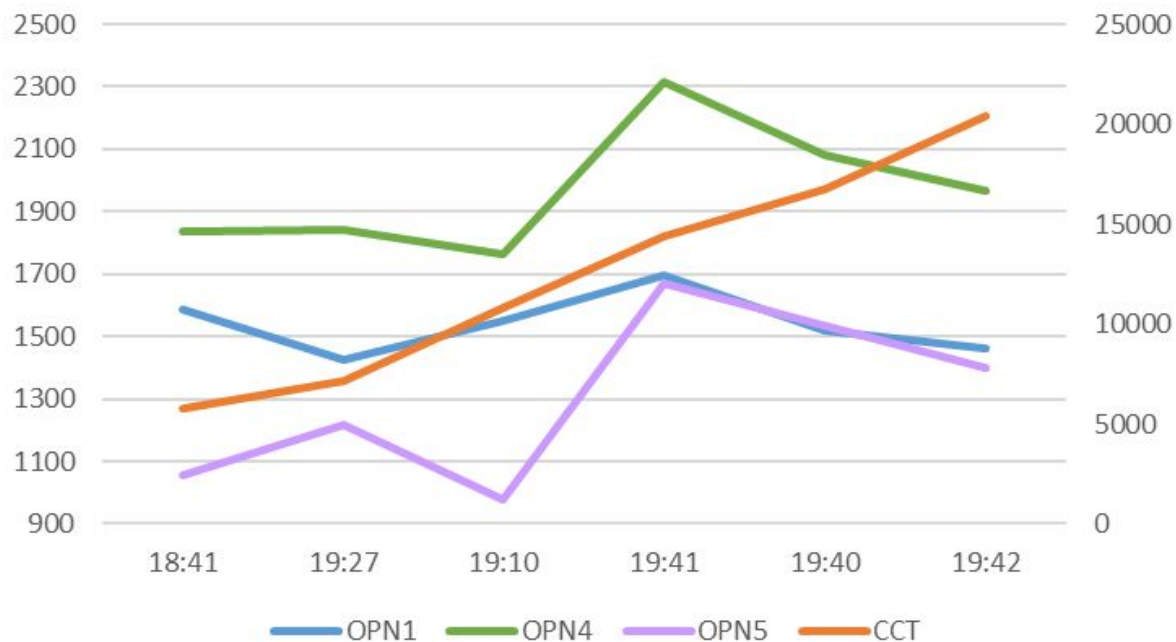
Newborn Intensive
Care Unit



03 RESULT | CCT

SEA, South, 6/9, White Wall

Compare Irradiance



3*. WWR

6/21, 25k, White Wall, Selected glazing, South

WWR	
15	
35	
55	
75	

5.Orientation

6/21, 25k, White Wall, Selected glazing

Orientation	
North	
East	
South	
West	

