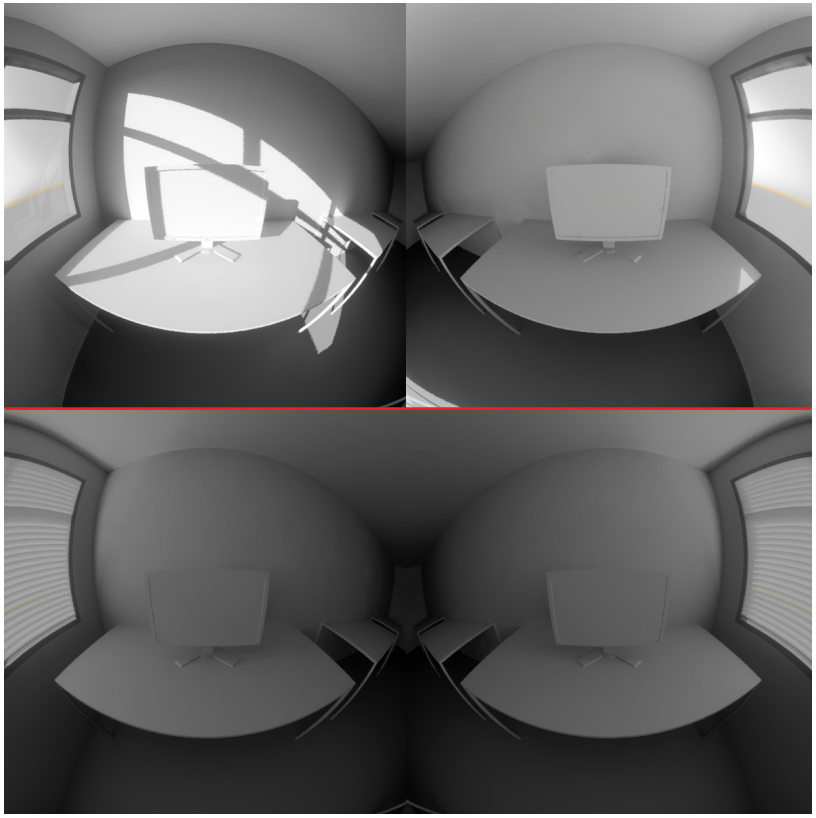
Overview and Introduction to DAYSIM and Current Research Developments



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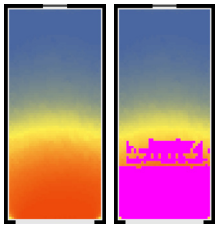
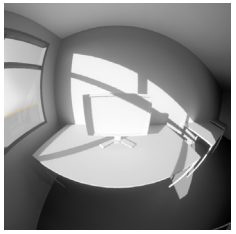
Christoph F. Reinhart

Massachusetts Institute of Technology, Building Technology Program

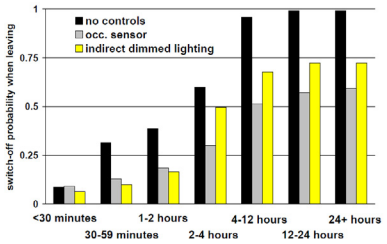
Presentation Outline



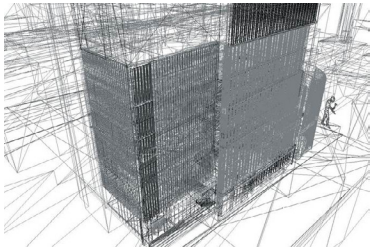
Introduction to DAYSIM



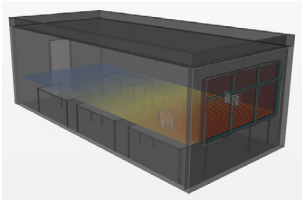
Simulation of Shading Devices



Electric Lighting Simulation



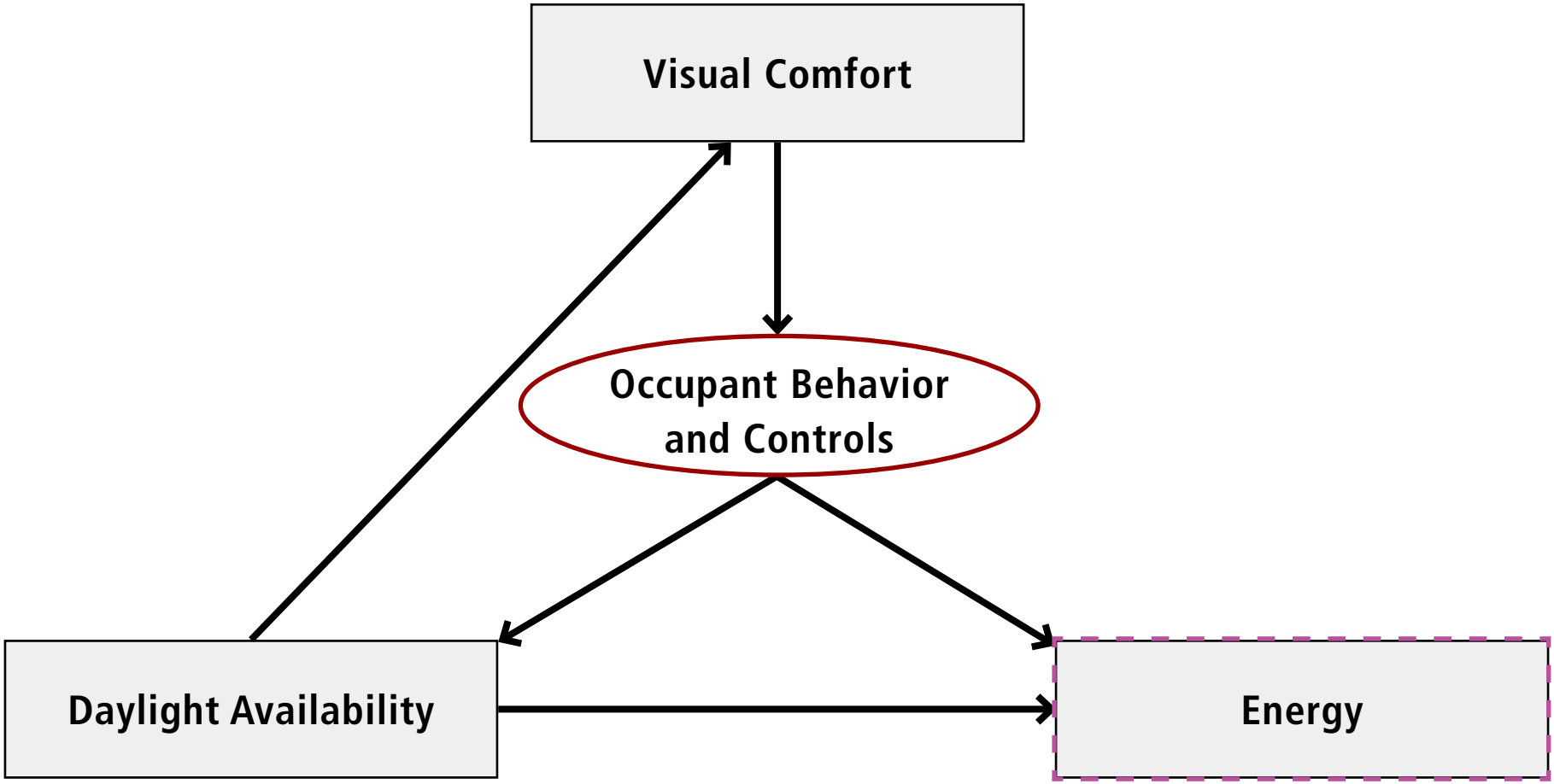
Examples and Implementation



Questions and Live Demonstration

Introduction to DAYSIM

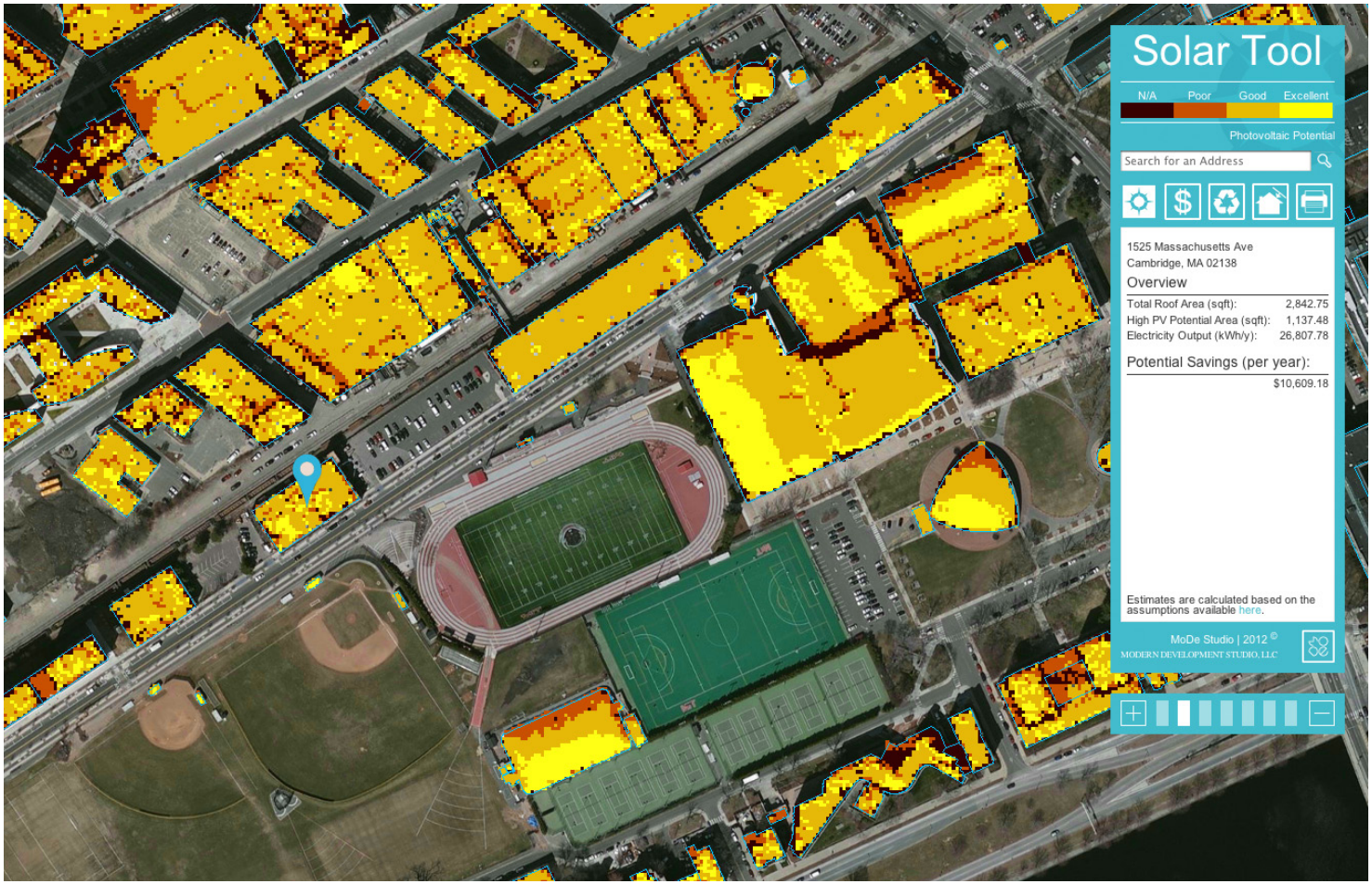
Annual Simulations in DAYSIM



DAYSIM models the effects of occupant behavior and experience on daylight availability and lighting energy use.

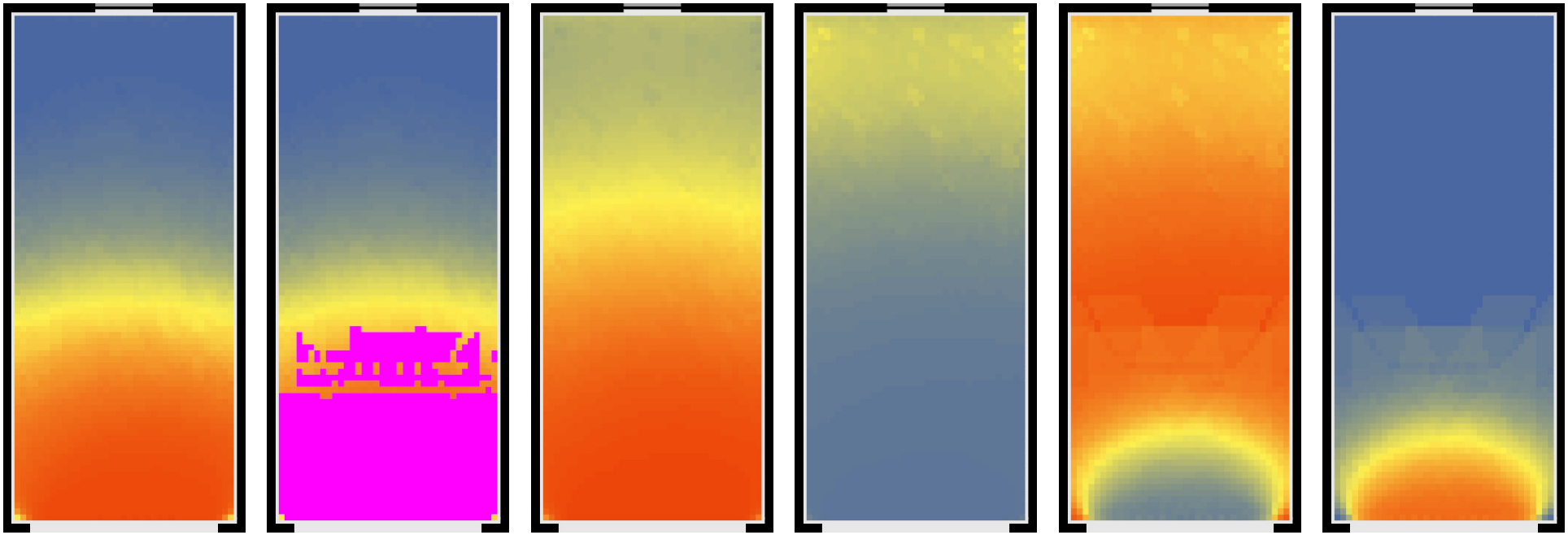
Annual Illuminance and Irradiance Calculations

Calculate hourly or sub-hourly illuminance (lx) or irradiance ($kWhm^{-2}$) values.



Screen Capture of Photovoltaic Potential Map, Cambridge, MA

Climate-Based Daylighting Metrics



Daylight Autonomy (500lx)

Daylight Availability (500lx)

Continuous Daylight Autonomy (500lx)

Useful Daylight Illuminance < 100lx

Useful Daylight Illuminance 100lx-2000lx

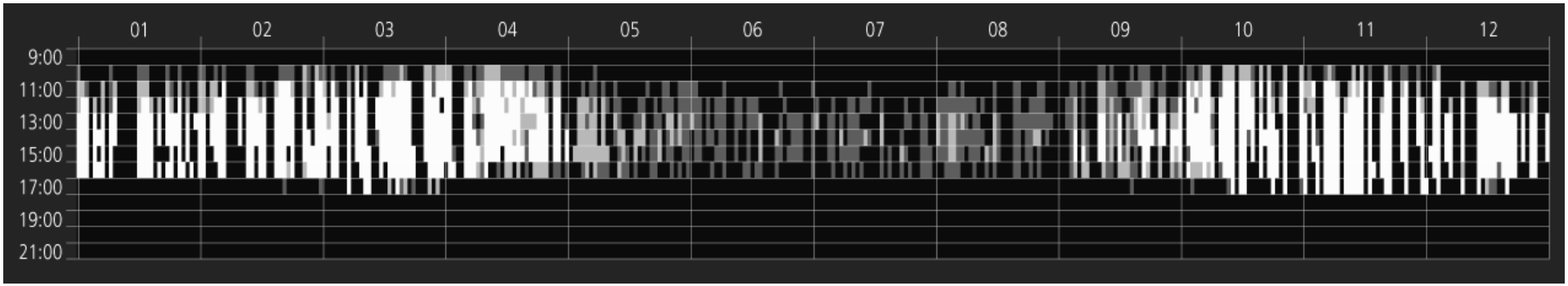
Useful Daylight Illuminance > 2000lx

Percent of Occupied Hours

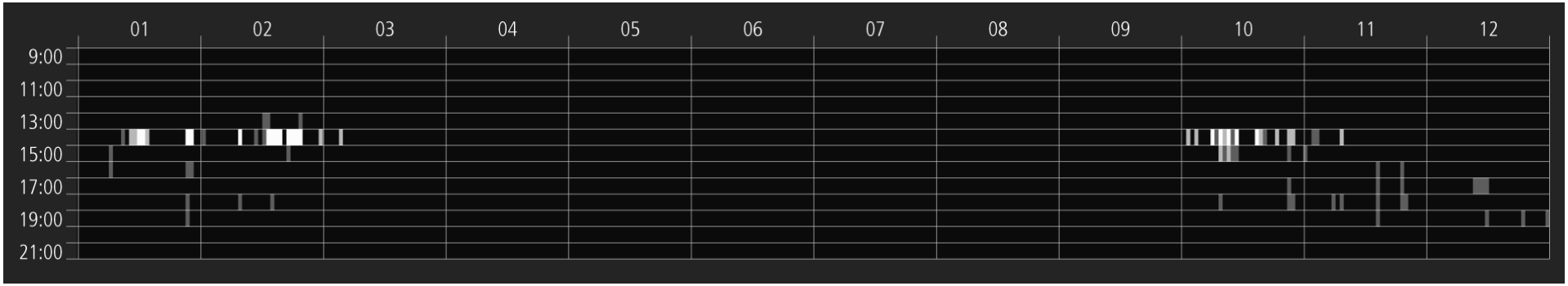
0 20 40 60 80 100%

Overlit Areas

Model Occupant Behavior and Automatic Control Systems with GenDGPProfile.exe

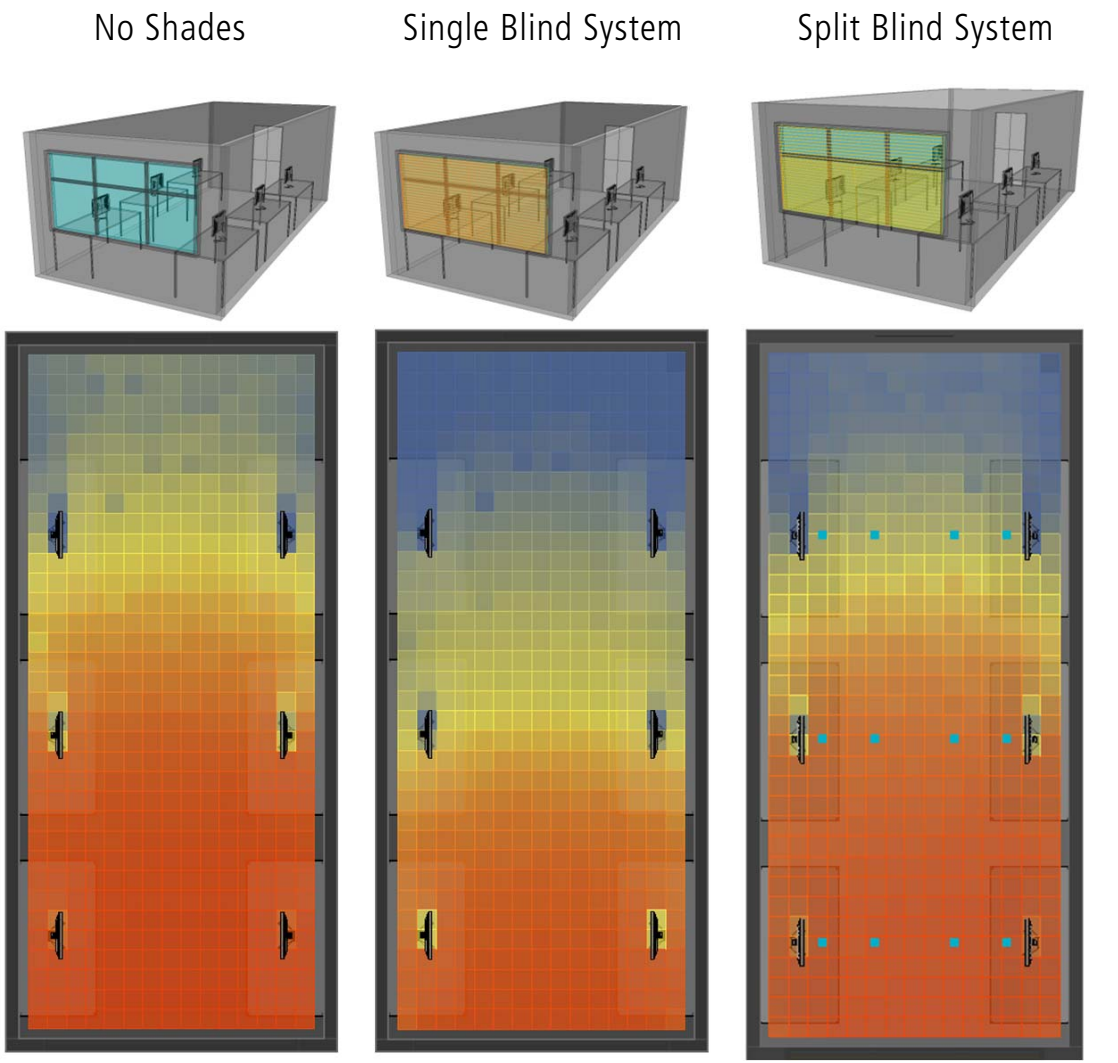


Annual Visual Discomfort from a Single Viewpoint



Annual Visual Discomfort of an Occupant who Can Adapt

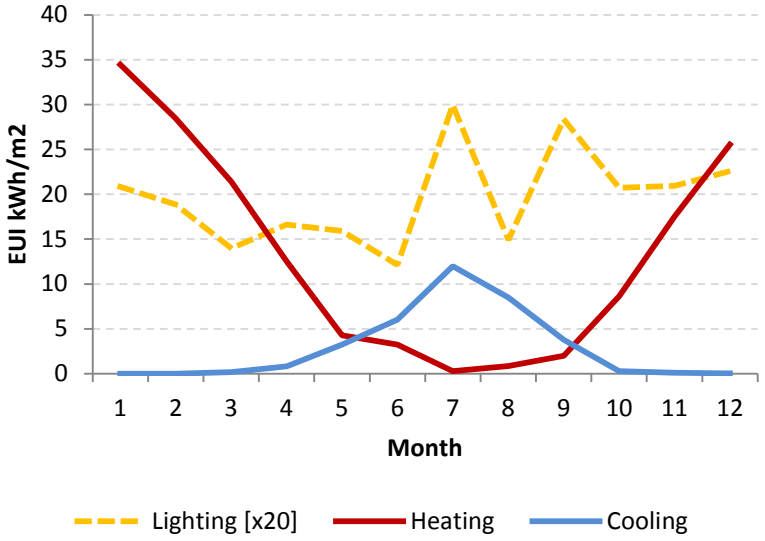
Model Annual Performance of Shading and Lighting Systems



Integrate Detailed Daylighting Analysis with Thermal Simulations

Output lighting and shading schedule files for use in separate thermal simulation programs.

Oriented Towards Window
(blinds primarily closed)

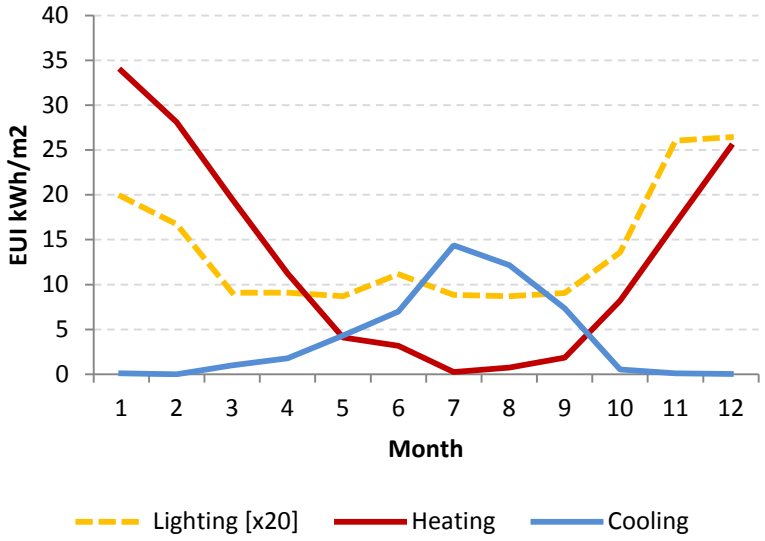


- Lighting – 11.8 kWh/m^2
- Heating – 159.1 kWh/m^2
- Cooling – 34.9 kWh/m^2

- Total – 205.8 kWh/m^2

(blinds closed 75% of occupied time)

Oriented Away From Window
(blinds open in Summer)



- Lighting – 8.4 kWh/m^2
- Heating – 153.2 kWh/m^2
- Cooling – 48.7 kWh/m^2

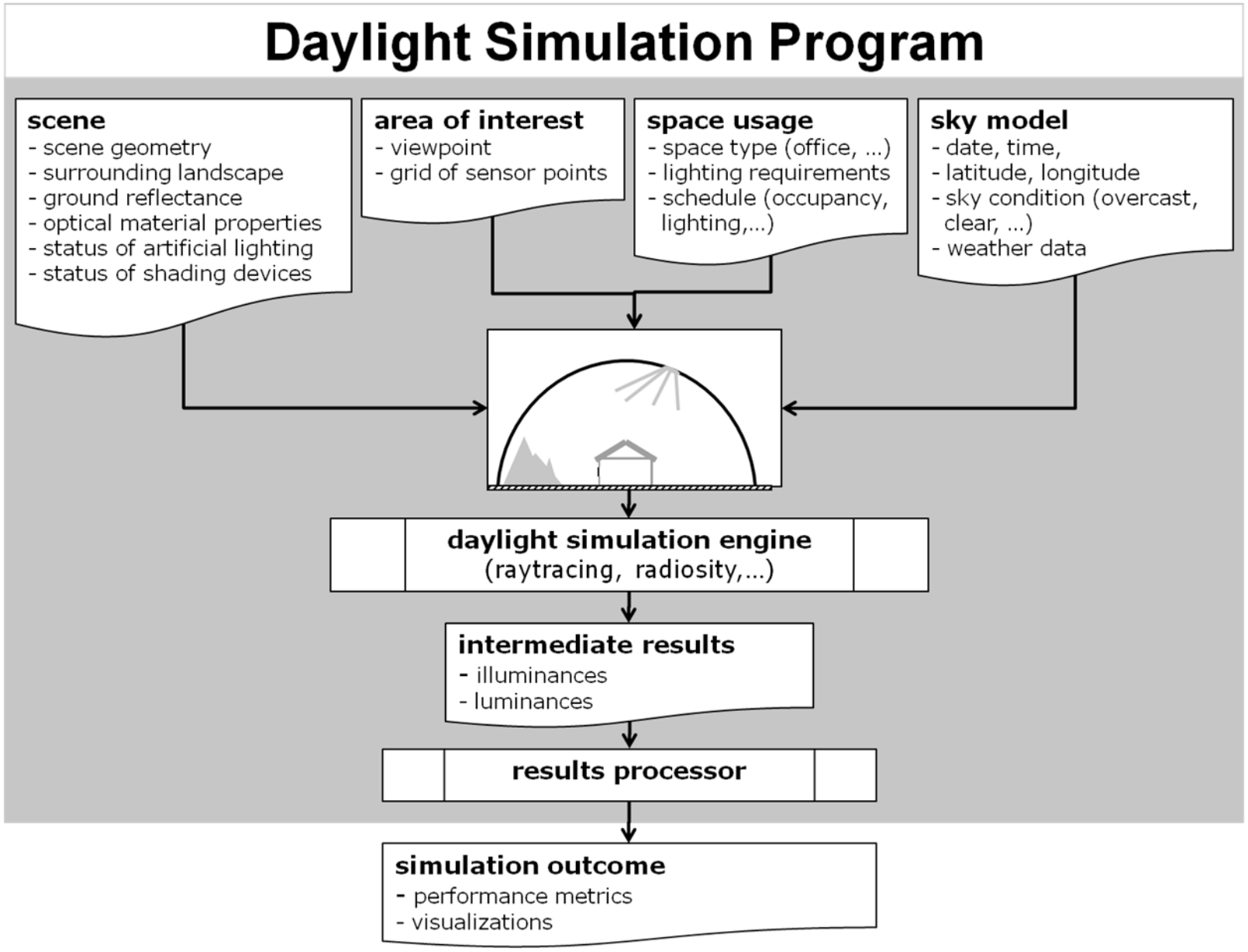
- Total – 210.3 kWh/m^2

(blinds closed 30% of occupied time)

The Mechanics

A brief explanation of how this works in DAYSIM.

Components of a Daylight Simulation

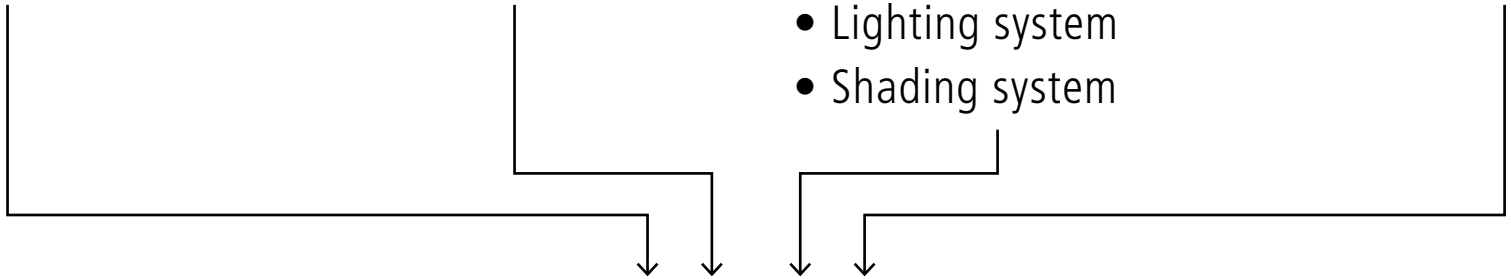


Scene Files
- Radiance format geometry and materials

Area of Interest
- User defined sensor points file
- Occupant viewpoints

Space Usage
- Occupancy schedule
- Furniture layout
- Lighting system
- Shading system

Sky Model
- Perez sky based on hourly or sub-hourly weather file



DAYSIM

↓

Illuminances

↓

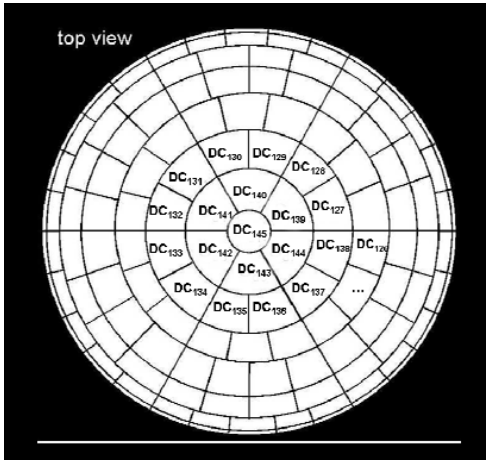
Results Processor

↓

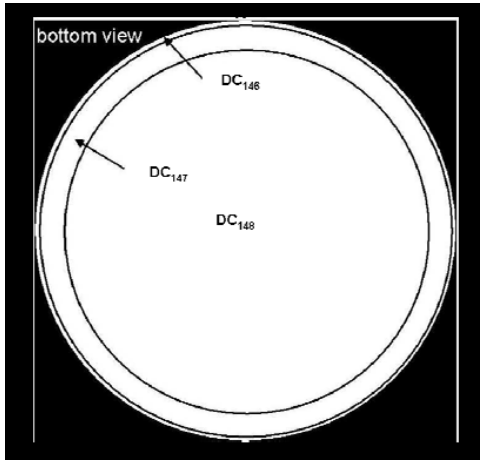
Simulation Outcomes

Daylight Autonomy / Availability
Useful Daylight Illuminance
Lighting Energy Consumption
Shading Device Use
Visual Comfort

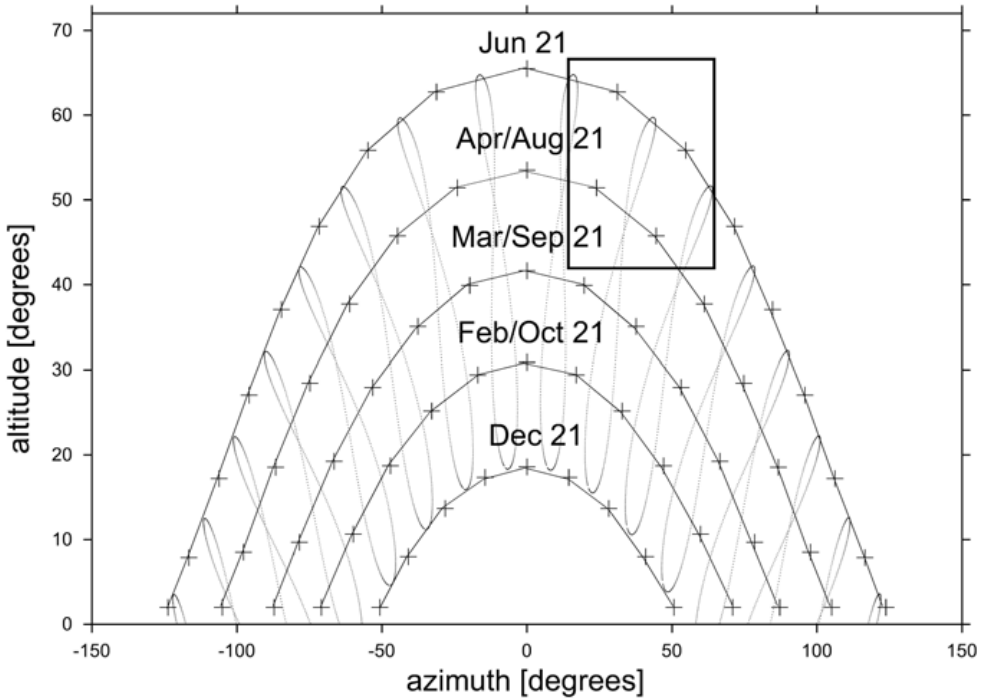
Default Sky Discretization Process (Daylight Coefficients)



145 Diffuse Sky Divisions



3 Ground Divisions



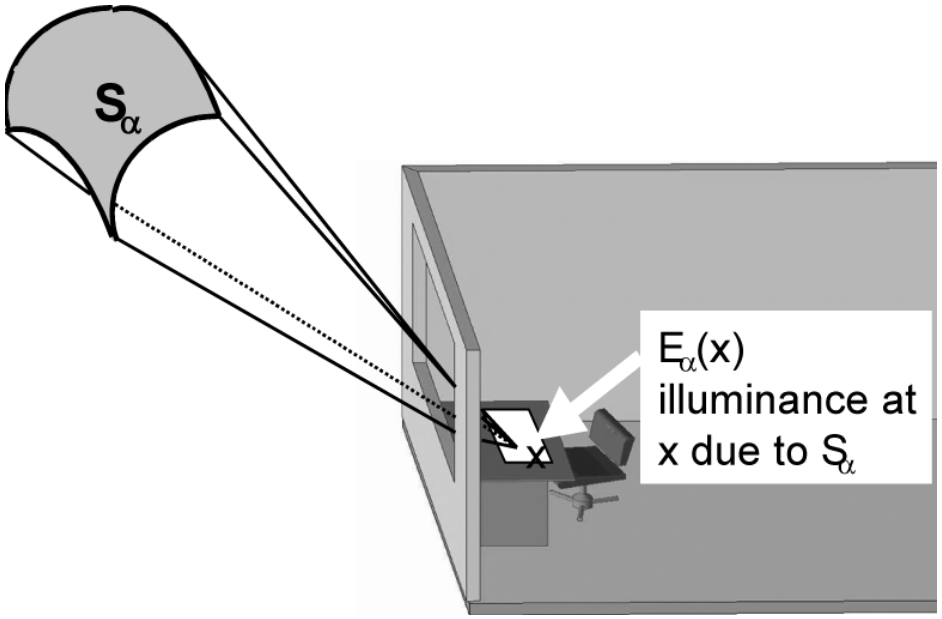
~65 Direct Solar Divisions in 'DS' Scheme

- Daylight coefficient method.
- 145 Tregenza diffuse sky subdivisions
- 3 ground divisions
- Approximately 65 direct solar positions.

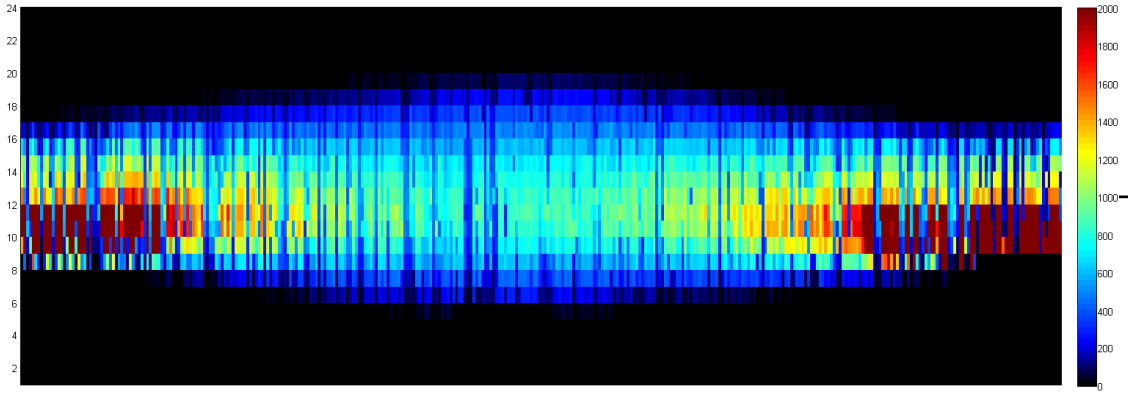
Bilinear interpolation used to calculate illuminance contribution in 'DS' scheme.

- 'DDS' method uses 2305 direct solar positions.

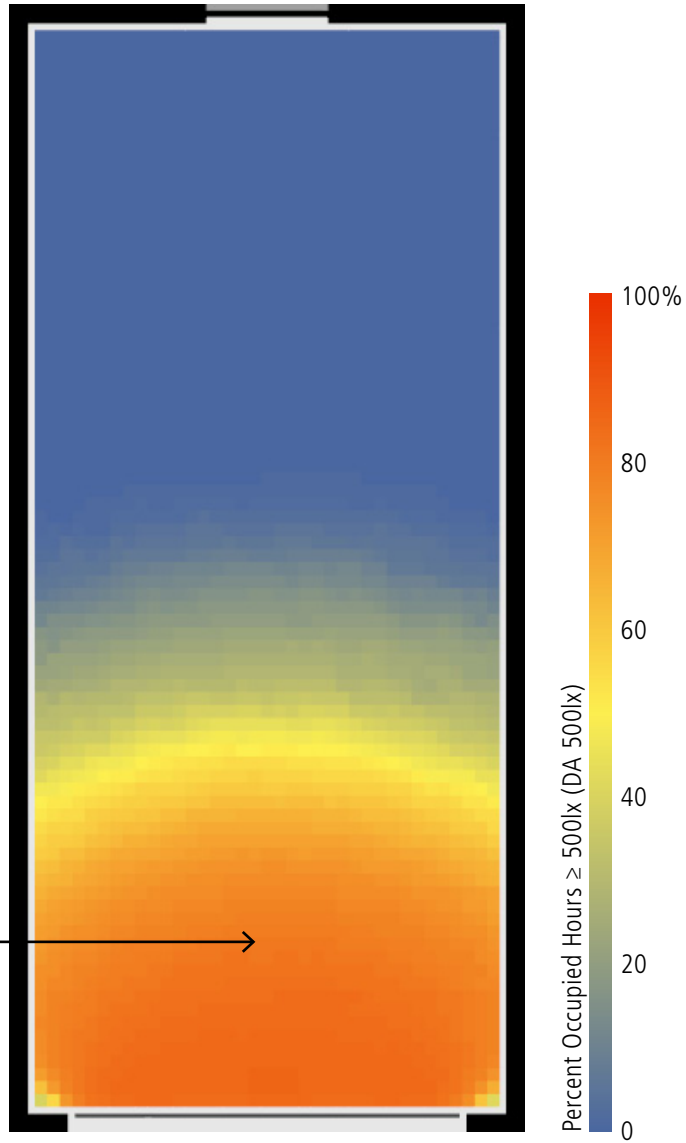
Calculating Illuminance and Turning into Useful Results



Contribution to Illuminance at
Each Sensor Point



Annual Unshaded Illuminance
Map at One Sensor Point



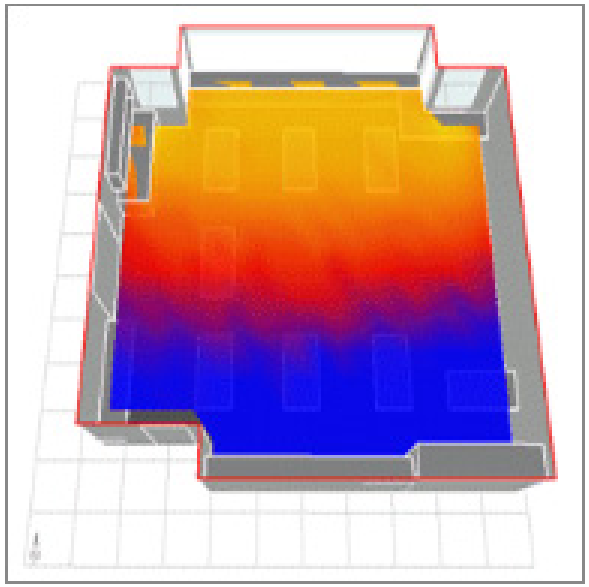
Daylight Autonomy Distribution
in Boston, MA

The 'Header' File

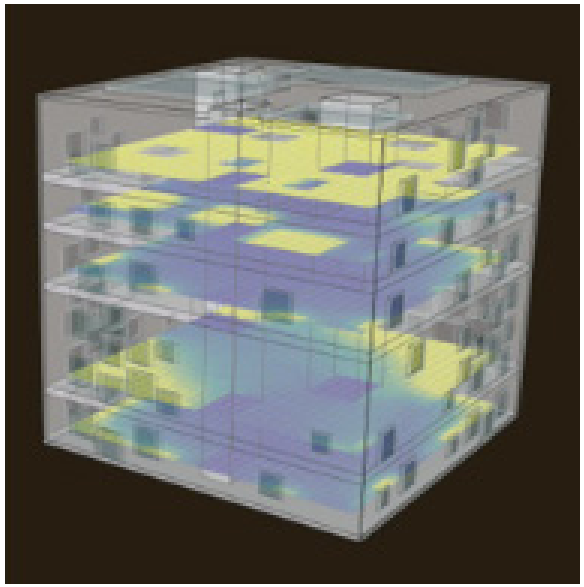
```
################################################
# DAYSIM 3.0 Project File Generated by DIVA v2.0
################################################
project_name   ReferenceOffice
project_directory   C:\DIVA\temp\ReferenceOffice\
bin_directory  C:\DIVA\DaysimBinaries\
tmp_directory  C:\DIVA\temp\ReferenceOffice\
Template_File C:\DIVA\DIVATemplate.htm

################################################
# site information
################################################
place Boston Logan IntL Arpt_USA
latitude 42.37
longitude 71.02
time_zone 75
site_elevation 6.0
first_weekday 1
time_step 60
wea_data_short_file USA_MA_Boston-Logan.Intl.wea
wea_data_short_file_units 1
lower_direct_threshold 2
lower_diffuse_threshold 2
output_units 2

################################################
# Building Information
################################################
occupancy-file 8to6withDST.60min.occ.csv
material_file ReferenceOffice_material_daysim.rad
geometry_file ReferenceOffice_daysim.rad
radiance_source_files 2, C:\DIVA\Daylight\material.rad,
C:\DIVA\temp\ReferenceOffice\ReferenceOffice.rad
...
```

- The header file is a list of inputs that controls everything DAYSIM does during a simulation.
  - ◊ Geometry and climate data
  - ◊ Occupant behavior
  - ◊ Shading and lighting systems
  - ◊ Results
- This presentation is not detailed documentation of the header file.
- As examples are shown, relevant parts of the header file will also be illustrated.
- This is a prelude to Department of Energy funded work on complete documentation of DAYSIM.

DAYSIM Program Interfaces



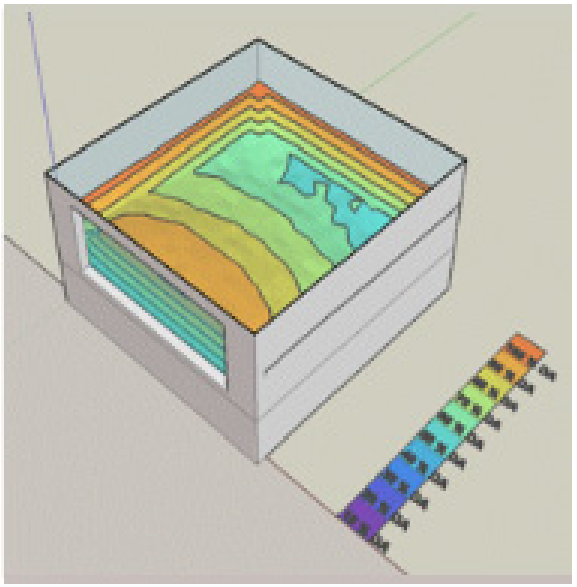
Ecotect



Rhinoceros 3D

DIVA

http://www.diva4rhino.com



SketchUp

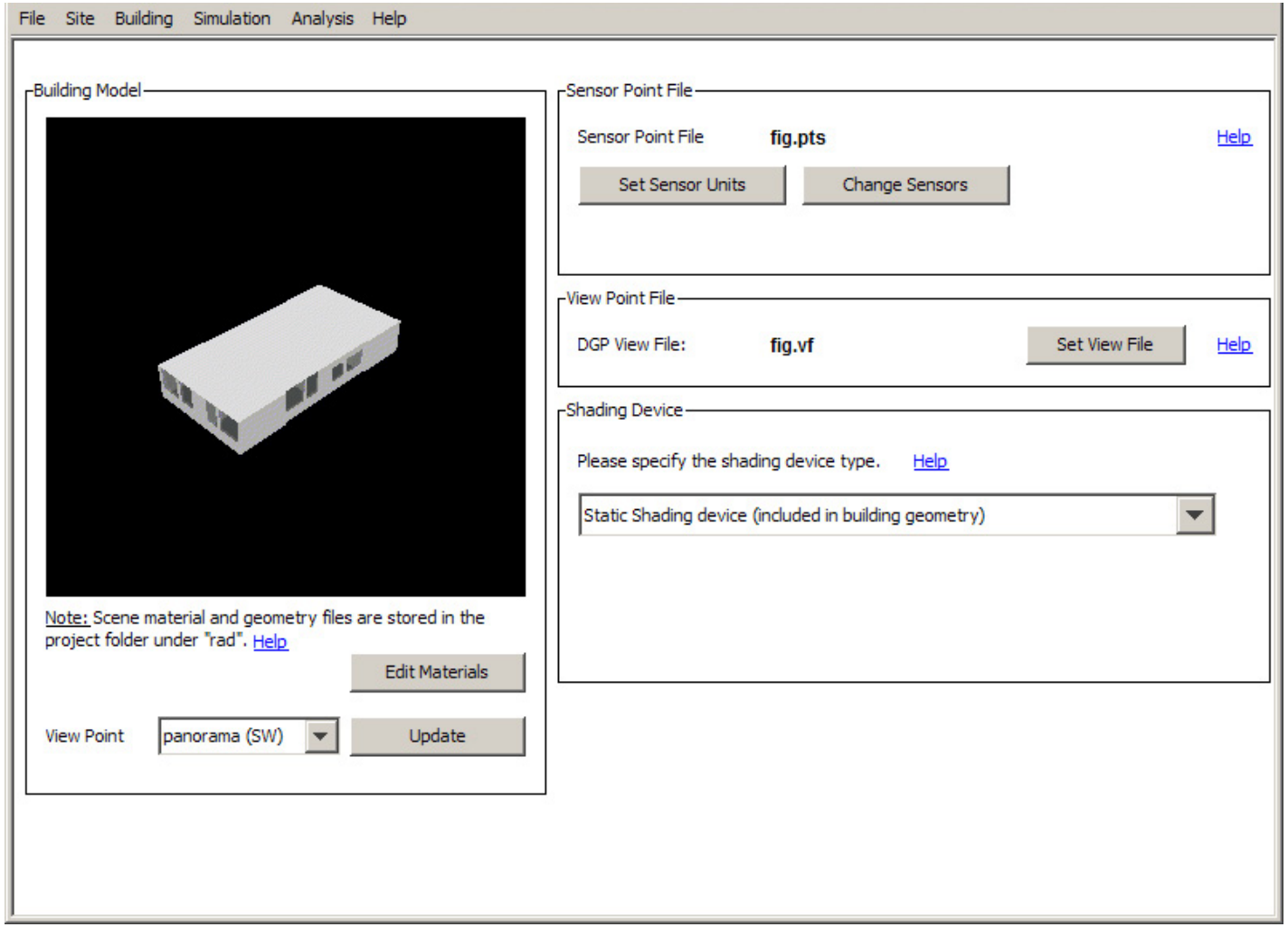
su2rad & su2ds

http://code.google.com/p/su2rad/

http://code.google.com/p/su2ds/

http://usa.autodesk.com/ecotect-analysis/

DAYSIM Program Interfaces



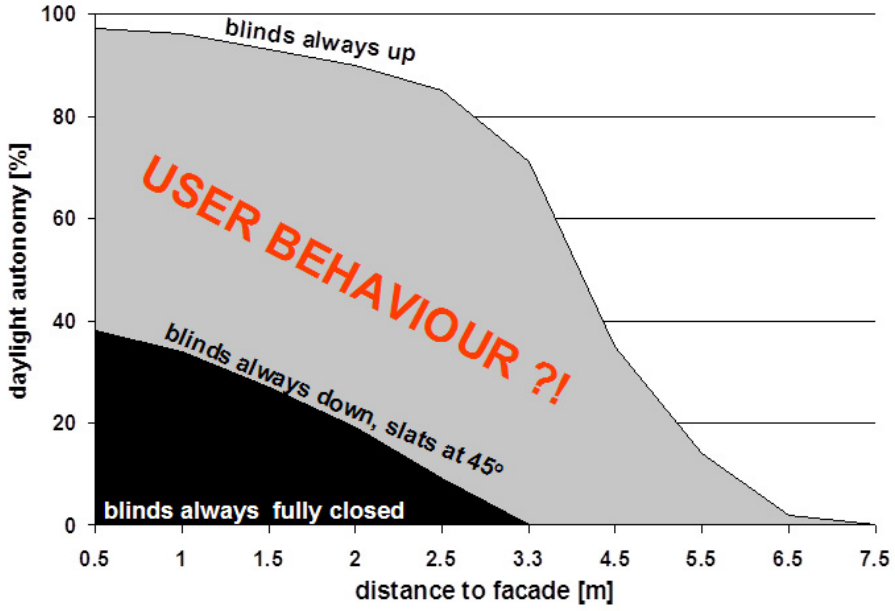
Or setup a project using the DAYSIM Java interface with existing Radiance files.

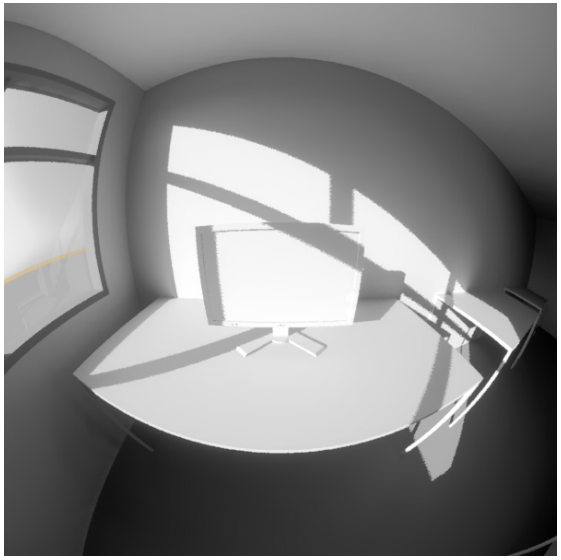
Disclaimer

I work for Solemma, LLC who develop and sell DIVA.

All of the simulations shown here were prepared using DIVA,
but could be performed using other software.

Simulation of Shading Devices





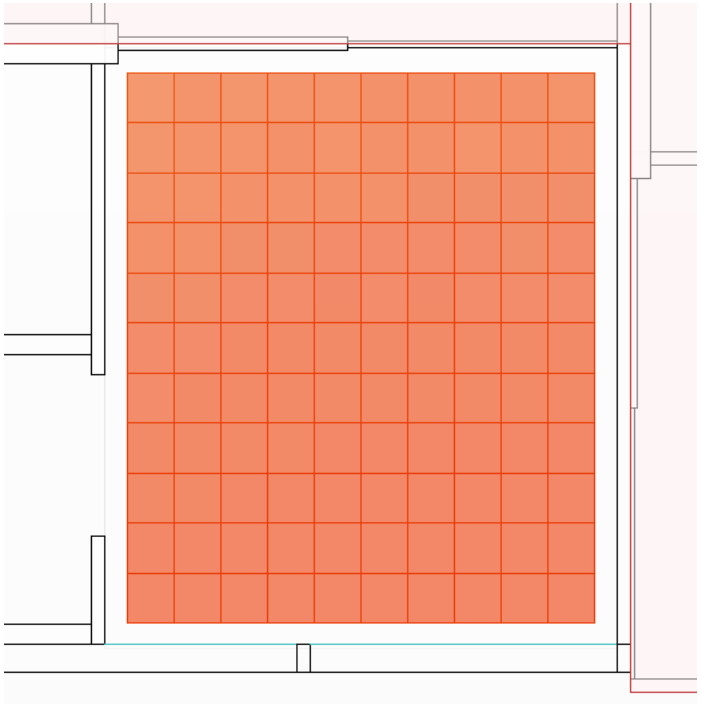
Blinds Open

- In a real building, windows are not always unobstructed.

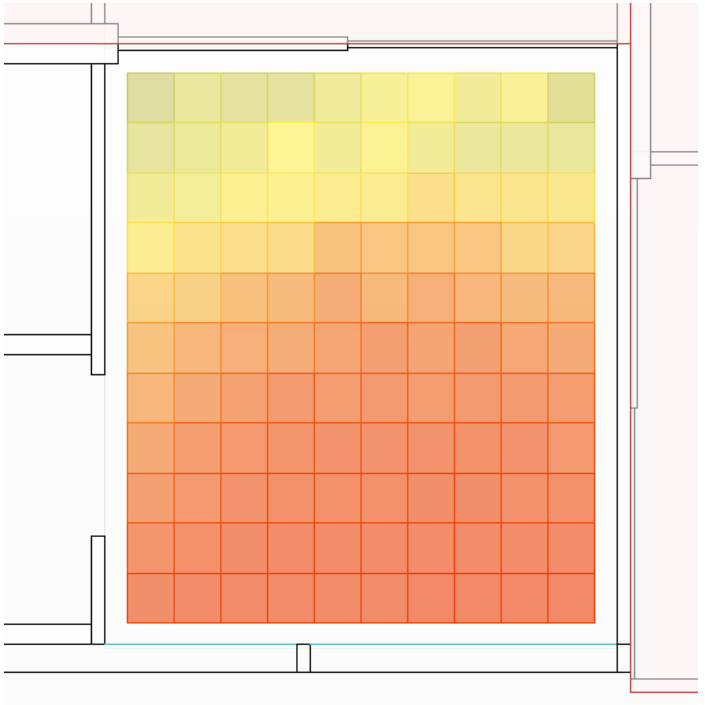
- It is important to predict how often a shading device might be open or closed as it makes a large difference in the amount of available daylight.

Blinds Closed by User

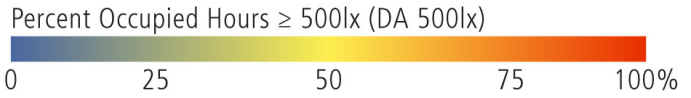
Effect of Shades in a Small Sidelit Space



Unshaded Result (Mean DA, 100%)

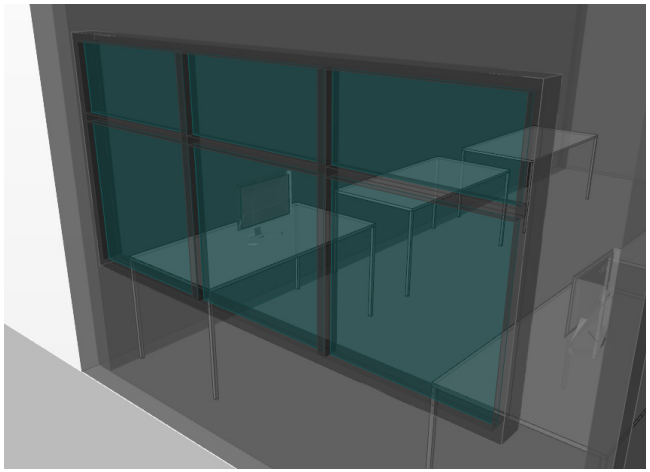


Shaded Result (Mean DA, 72%)



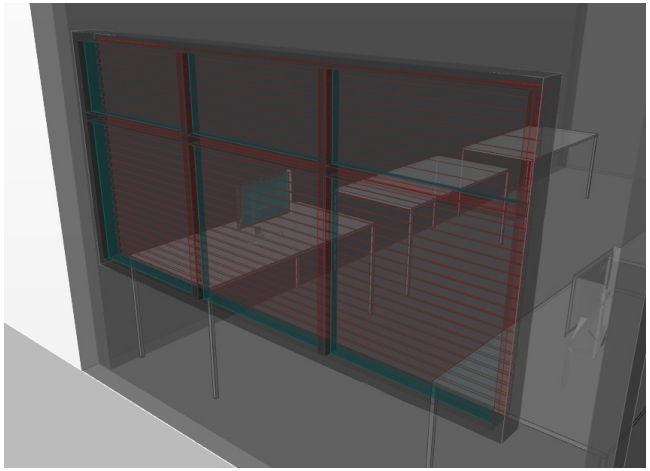
Two Ways to Model Contribution of Shading Devices

1. Conceptual Dynamic Shading



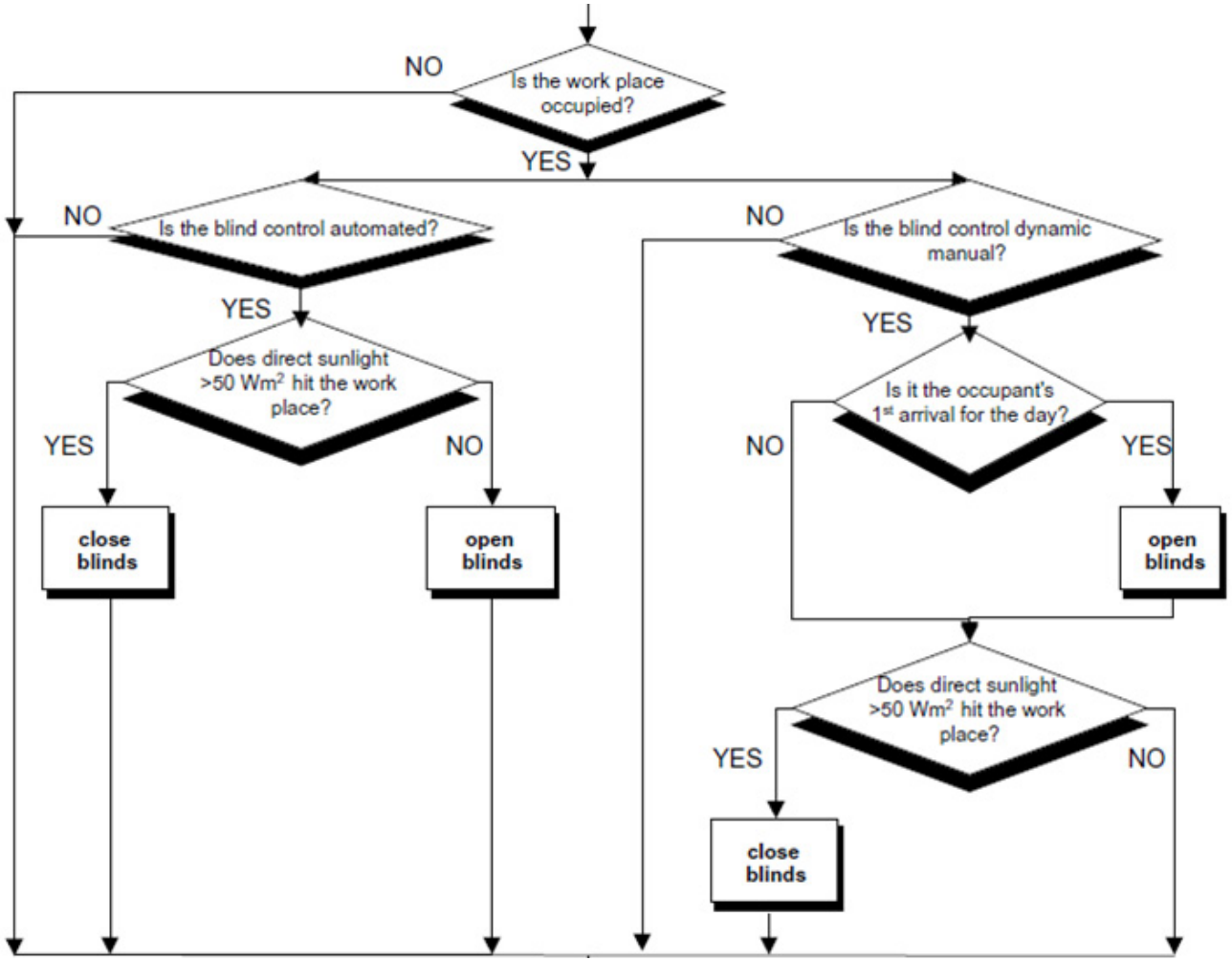
- When shades are closed, direct component is neglected and diffuse component scaled by 25%.
- Only one simulation.
- Unnecessary to model shading geometry, but above assumptions are made.

2. Detailed Dynamic Shading



- Each state of a shading device (up, half-open, down, etc.) is simulated separately and pieced together annually based on shading controls.
- As many simulations as shading device states.
- Geometry of shading devices must be created in separate Radiance files.

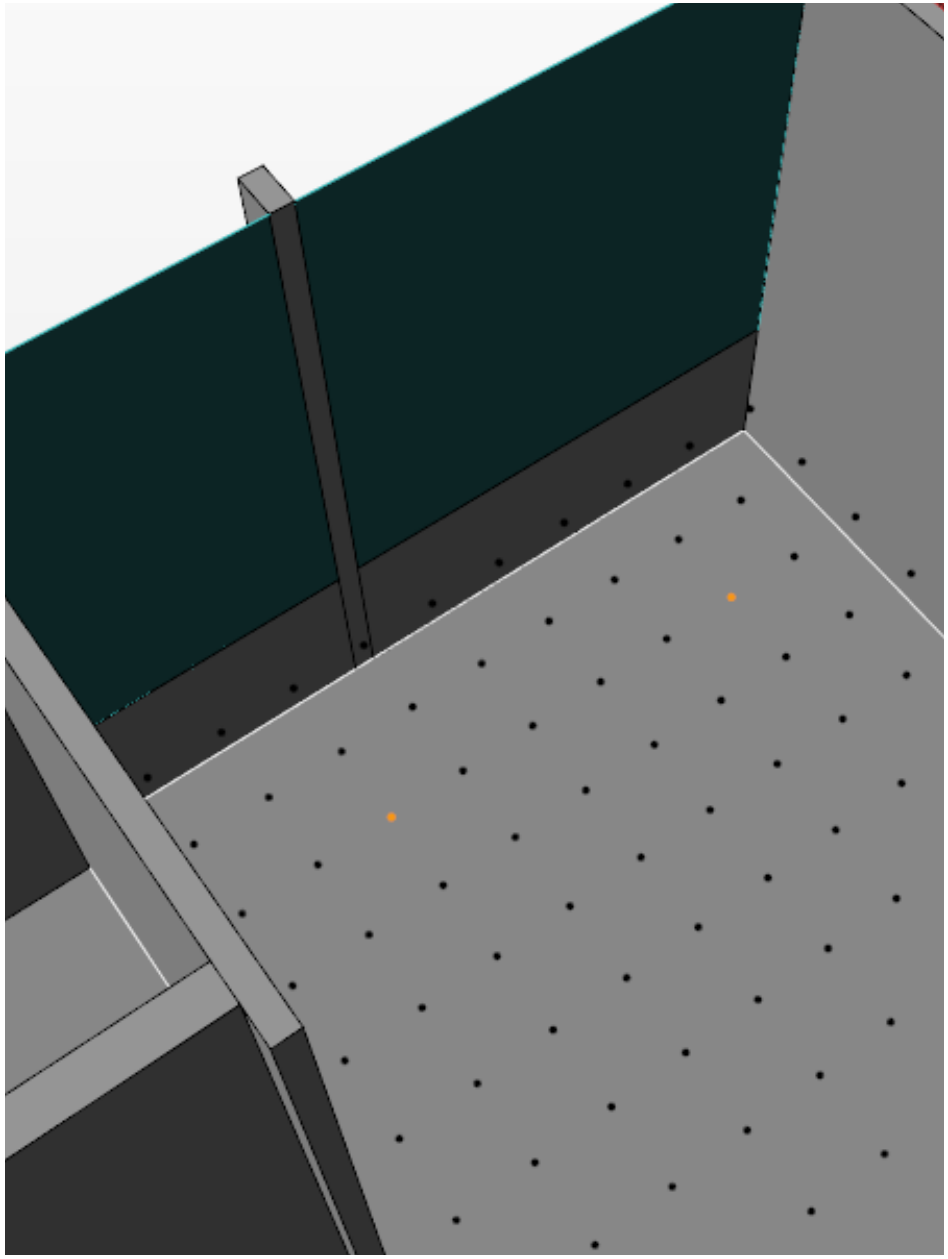
Conceptual Dynamic Shading



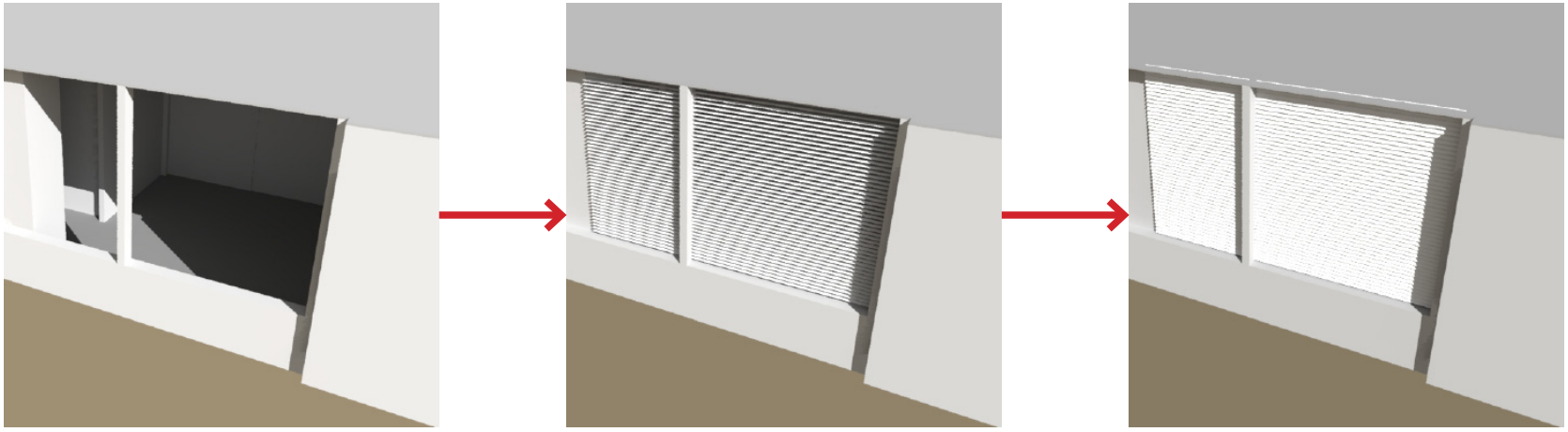
50 W/m² is the value controlling whether shades are opened or closed in 'Conceptual' dynamic shading controls.

Conceptual Dynamic Shading

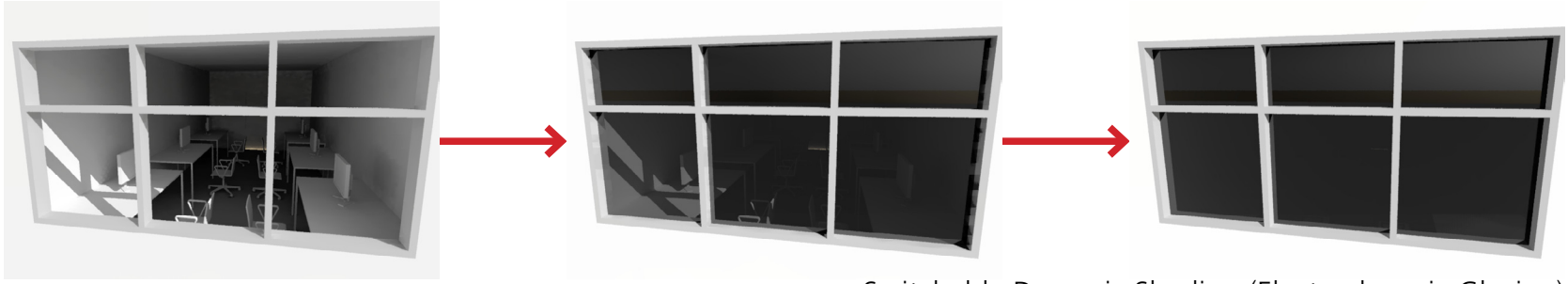
```
...
==========================
= Shading Control System
==========================
shading 0
conceptual_dynamic_system fig.dc shade_up.ill
shade_down.ill

...

sensor_file_info 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 BG1
0 0 0 0 BG1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0

# the above defines in the sensor points
# list file where occupants sit
# (which sensors are triggered by the
# 50 W/m2 threshold)
...
```



Detailed Dynamic Shading



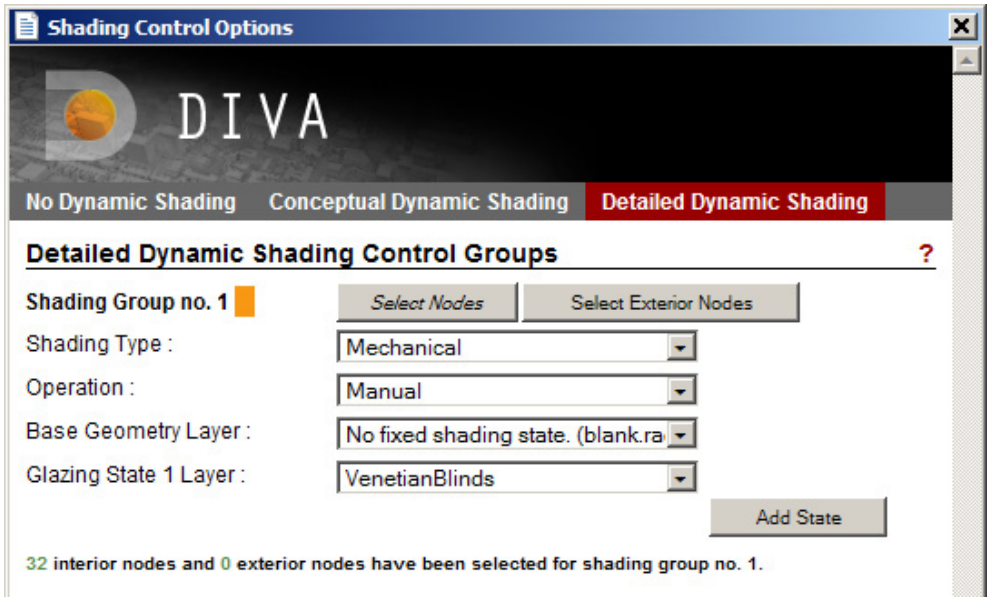
Mechanical Dynamic Shading (Blinds)

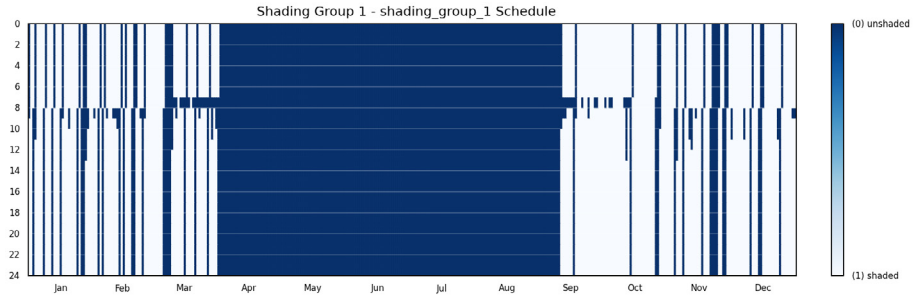


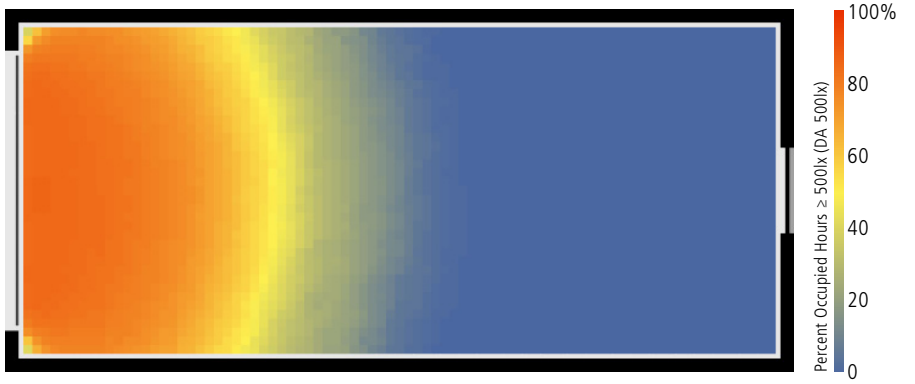
Switchable Dynamic Shading (Electrochromic Glazing)

Detailed dynamic shading allows control over the geometry of shades, their operation, the setting of multiple shading states and material properties.

Detailed Dynamic Shading: Manual Control



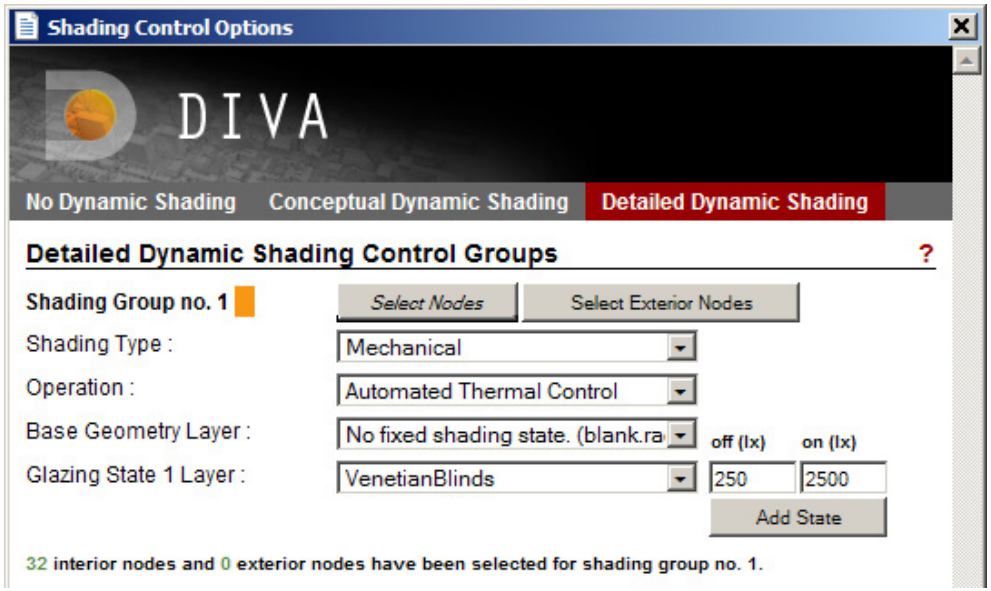


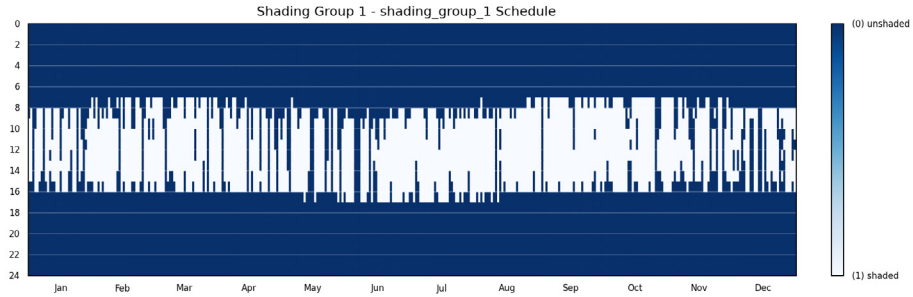


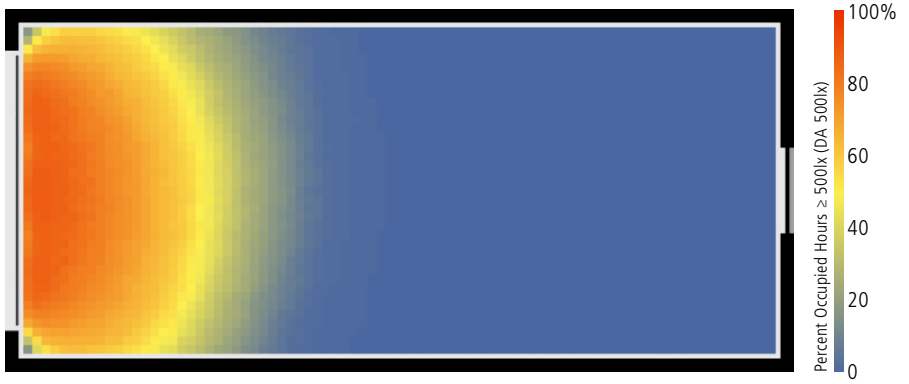

```
...
==========================
= Shading Control System
==========================
shading -1
     ReferenceOffice.dc ReferenceOffice.ill
shading_group_1
     1
     ManualControl C:\DIVA\Daylight\blank.rad
     SG0BS0.rad SG0BS0.dc SG0BS0.ill
...
```

- Operates in the same manner as conceptual dynamic shading.
- Or using a previously run daylight glare probability (DGP) calculation (more later).

Detailed Dynamic Shading: Automated Thermal Control



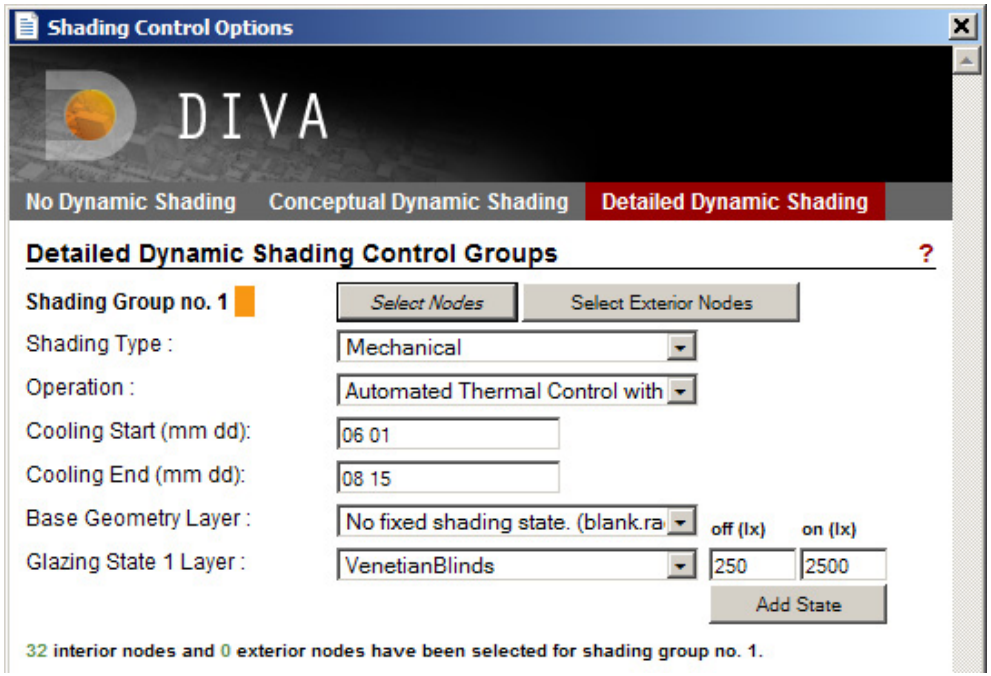


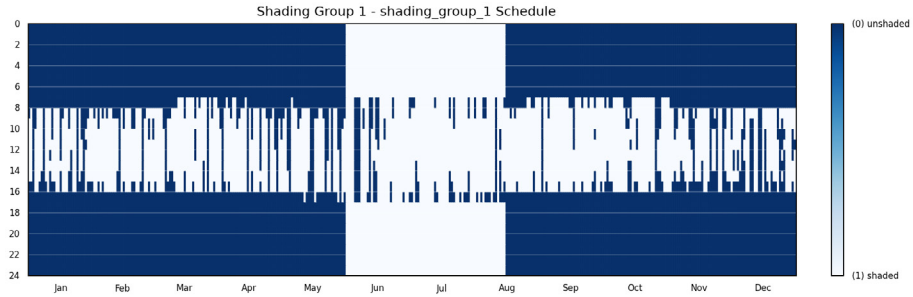


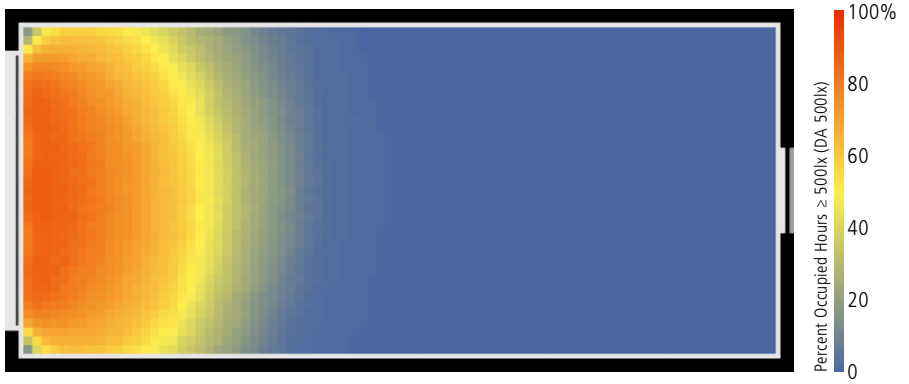

```
...
=========================
= Shading Control System
=========================
shading -1
     ReferenceOffice.dc ReferenceOffice.ill
shading_group_1
     1
     AutomatedThermalControl C:\DIVA\Daylight\
blank.rad
     250 2500 SG0BS0.rad SG0BS0.dc SG0BS0.ill
...
```

- Automatically closes shades when sensor detects 2500lx and opens blinds if selected sensors falls below 250lx.
- These values are user definable.

Detailed Dynamic Shading: Automated Thermal Control With Unoccupied or Cooling Period



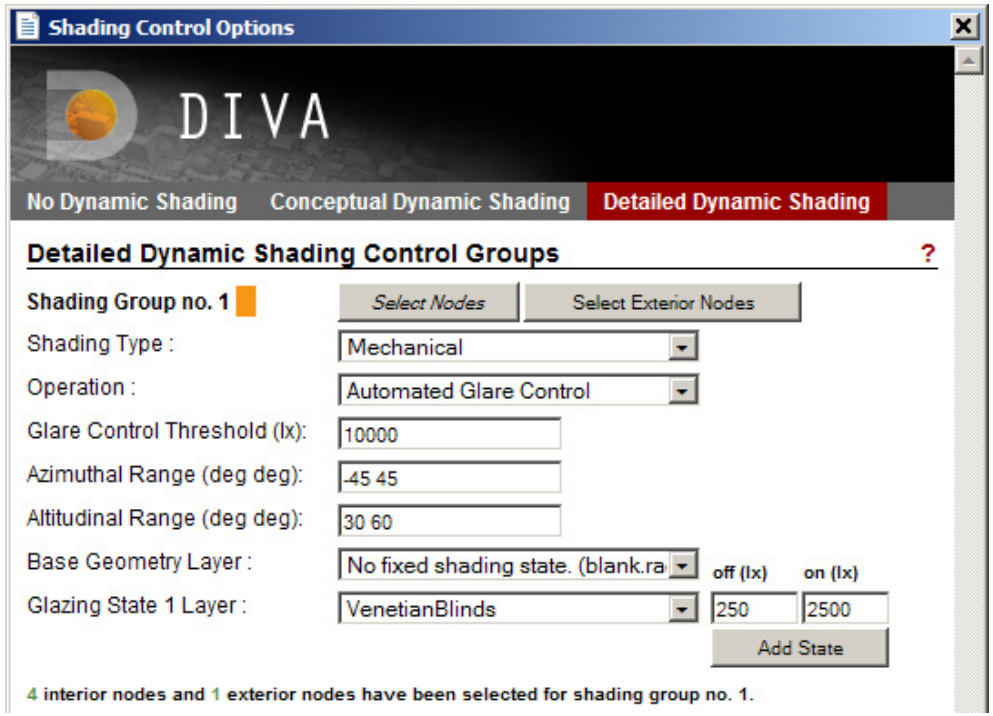





```
...
=========================
= Shading Control System
=========================
shading -1
     ReferenceOffice.dc ReferenceOffice.ill
shading_group_1
     1
     AutomatedThermalControlWithOccupancy 06 01 08
15 C:\DIVA\Daylight\blank.rad
     250 2500 SG0BS0.rad SG0BS0.dc SG0BS0.ill
...
```

- Blinds are always closed during the cooling period (06-01 to 08-15) during unoccupied hours and always opened during the heating period.

Detailed Dynamic Shading: Automated Glare Control

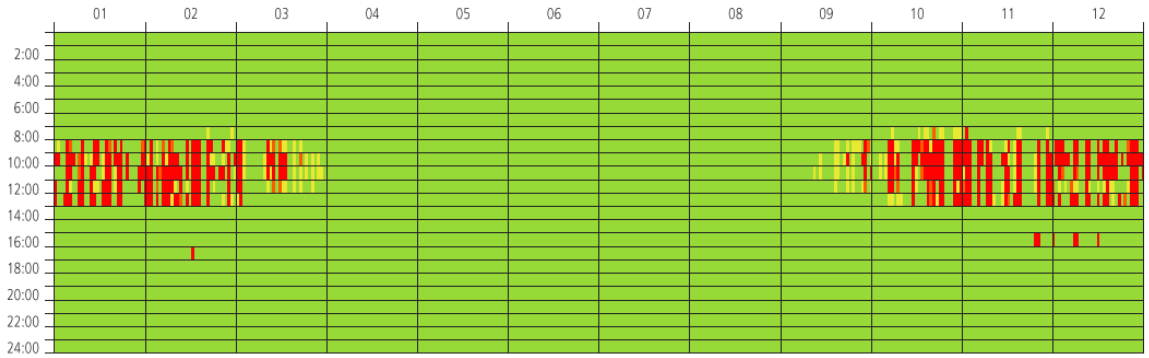


- Set outdoor sensors and control blinds based on exterior illuminance and/or position of the sun.

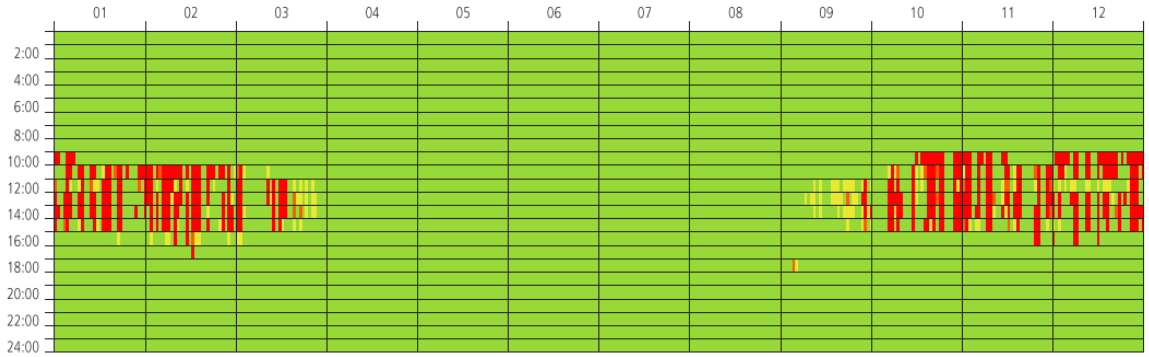
- This mode is a work in progress.

Manual Occupant Control Using Daylight Glare Probability

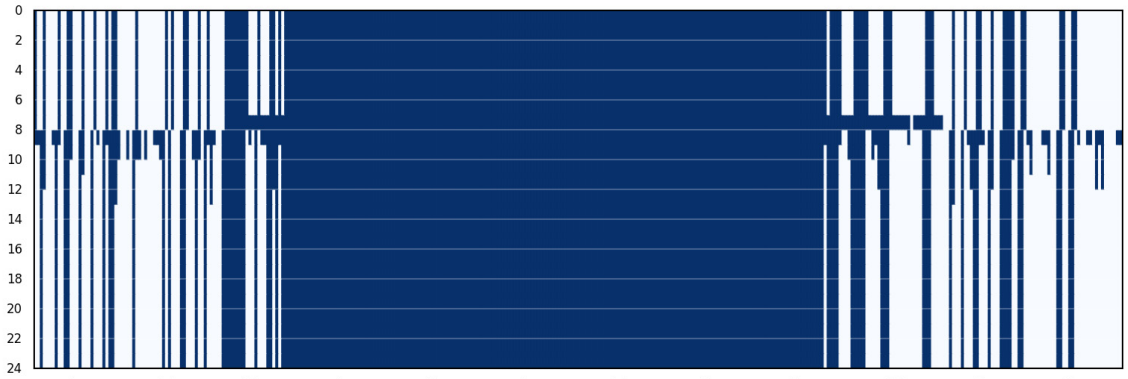
```
...
==========================
= User Description
==========================
occupancy 5 8to6withDST.60min.occ.csv
minimum_illuminance_level 500
daylight_savings_time 1
user_profile 1
active 100 1 3
...

# User type 3 means occupant adjusts
# shading devices to maintain visual
# comfort if DGP simulation results
# exist.

# User type 1, in contrast,
# uses selected sensor point values
# over 50 W/m2
```



East Facing Occupant Predicted Visual Comfort



West Facing Occupant Predicted Visual Comfort



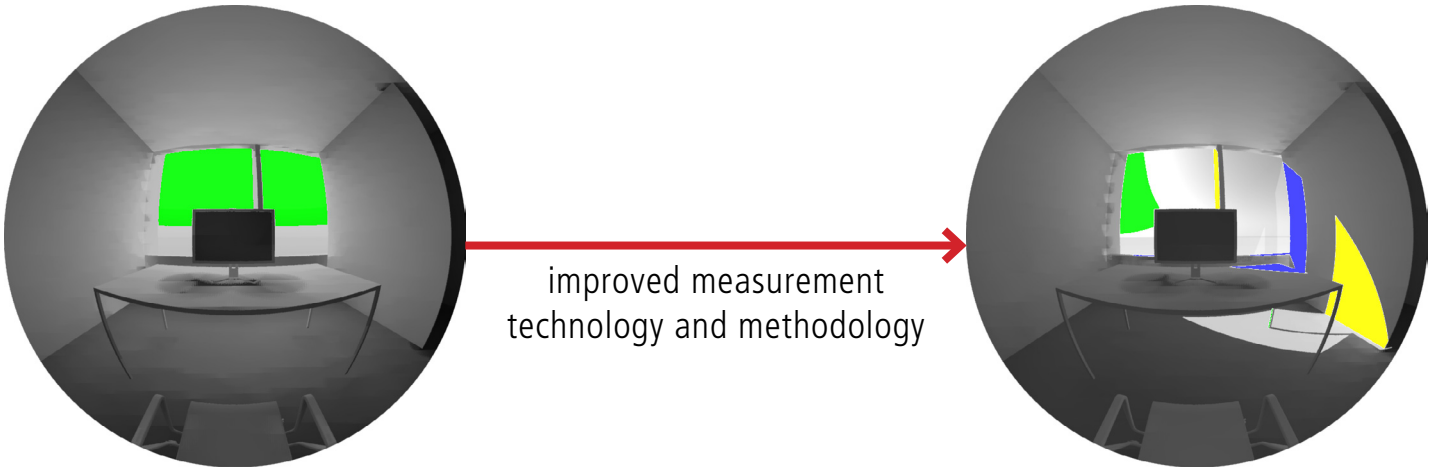
Resulting Shade Use

What is Daylight Glare Probability?

$$DGP = 5.87 \times 10^{-5} E_v + 9.18 \times 10^{-5} \log_{10} 2 \left(1 + \sum_{i=1}^{n} \frac{L_{si}^2 \omega_{si}}{E_v^{1.87} P_i^2} \right)$$

> 0.45 Intolerable

< 0.30 Barely Perceptible

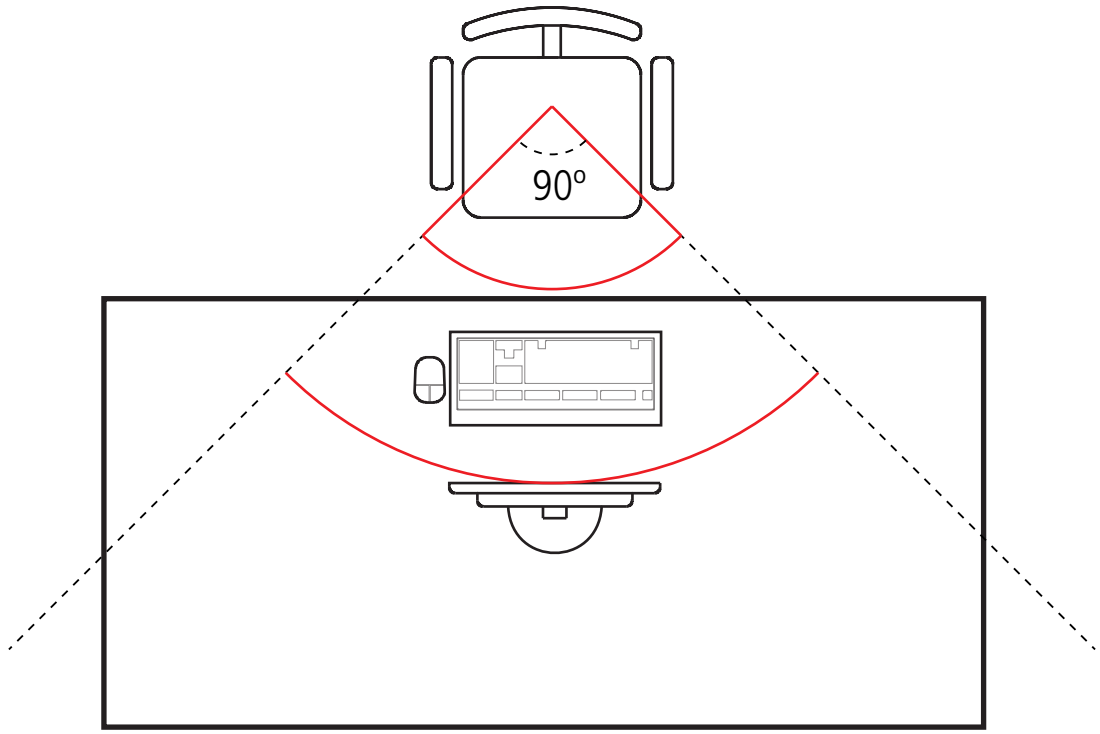


For more information see,

Wienold J, Christoffersen J. Evaluation methods and development of a new glare prediction model for daylight environments with the use of CCD cameras. Energy and Buildings 2006; 38: 743-757.

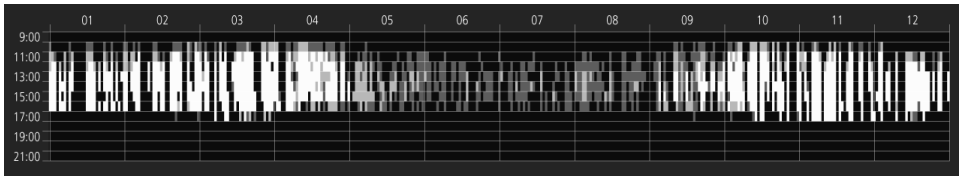
Wienold, J. Dynamic Daylight Glare Evaluation. Proceedings of Building Simulation; 2009.

Allowing an Occupant to Adapt to Daylight in a Space

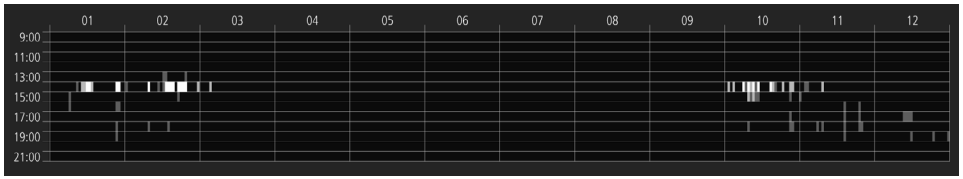


Range of Possible Seating Positions for a Single Occupant

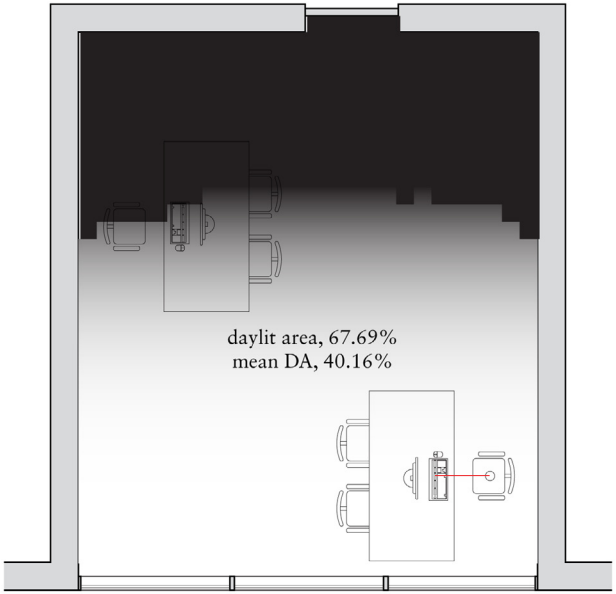
Allowing an Occupant to Adapt to Daylight in a Space

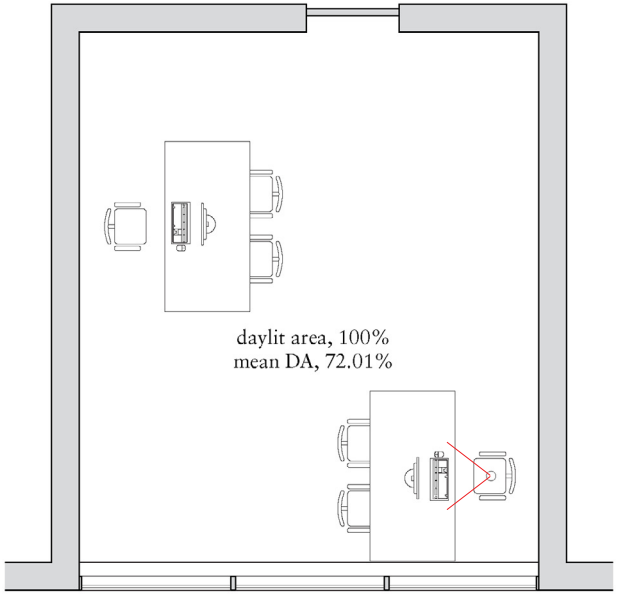


Annual Visual Discomfort from a Single Viewpoint



Annual Visual Discomfort of an Occupant who Can Adapt



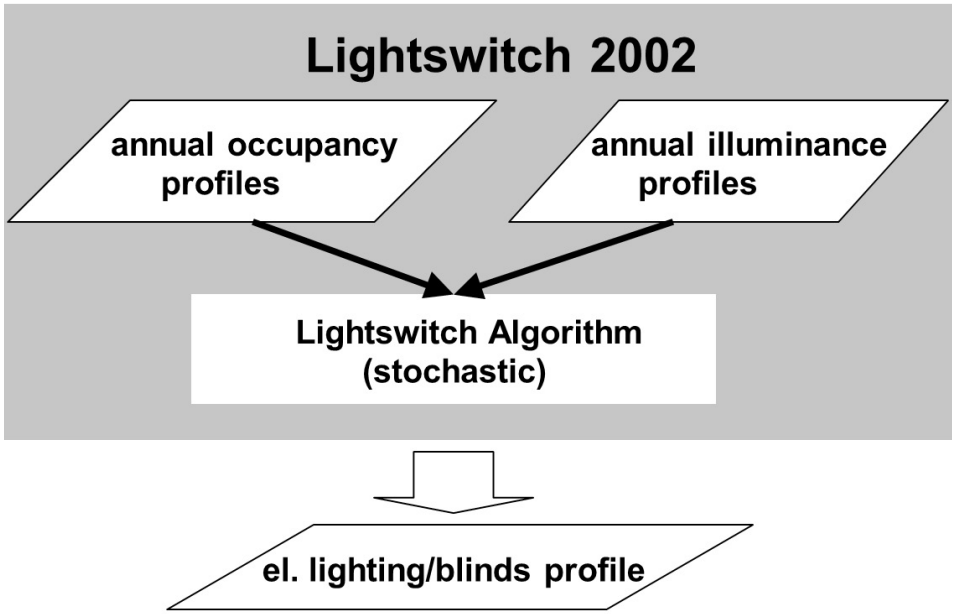



```
...
AdaptiveZoneApplies 1
...
```

- Simulate multiple DGP visual comfort viewpoints, and DAYSIM automatically chooses the most comfortable.
- Currently only works for a single occupant.

Electric Lighting Simulation

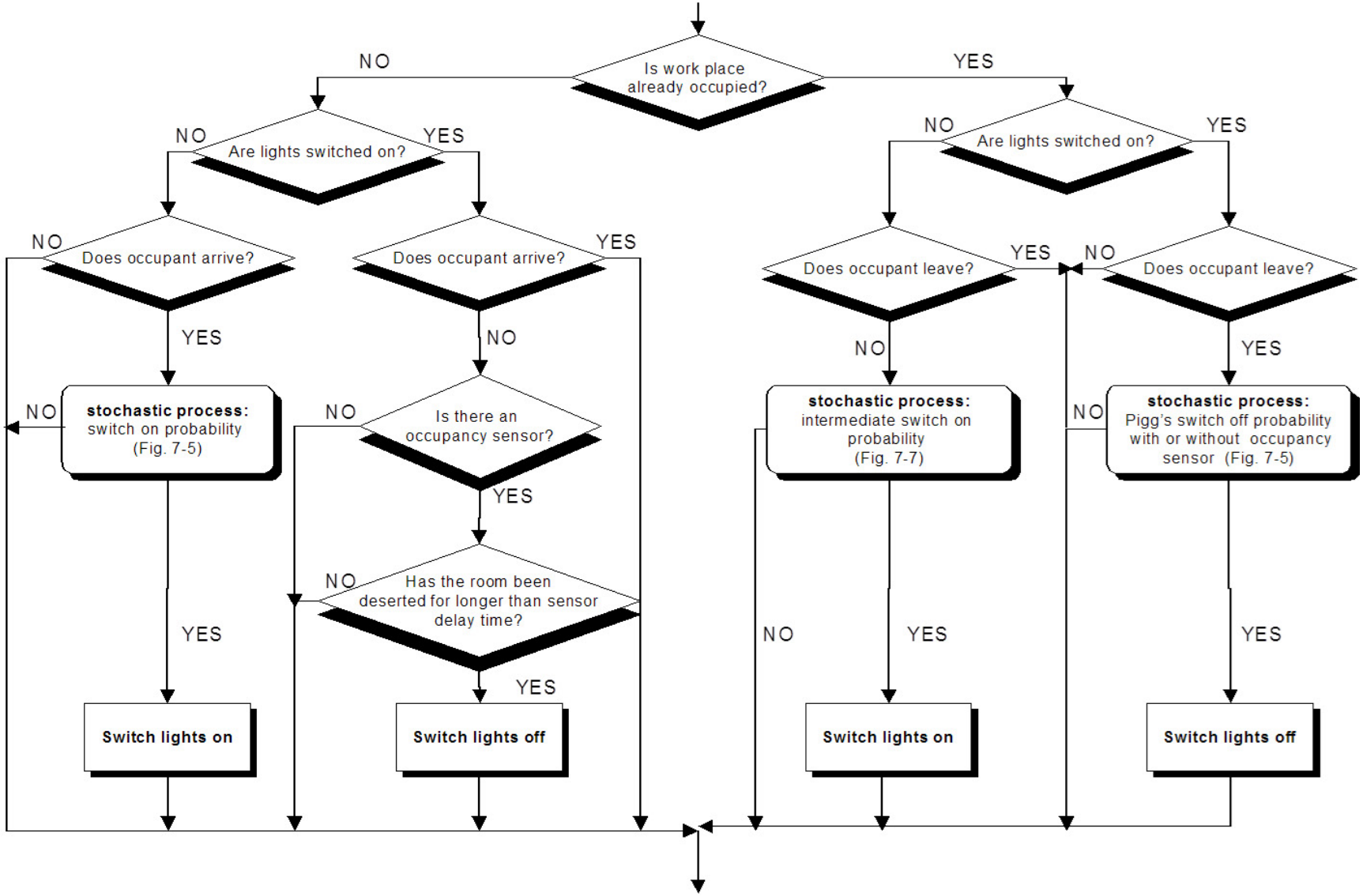
Electric Lighting Simulations: Occupant Control



Lightswitch Algorithm -- Stochastic Occupant Control

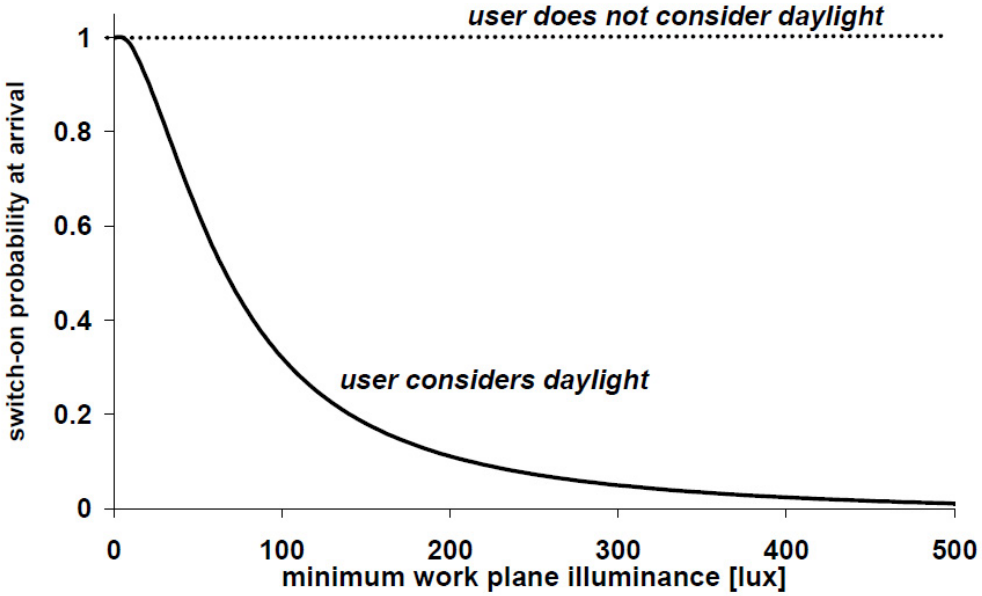
Based on a field study of one office building in Nürtingen.

Electric Lighting Simulations: Occupant Control

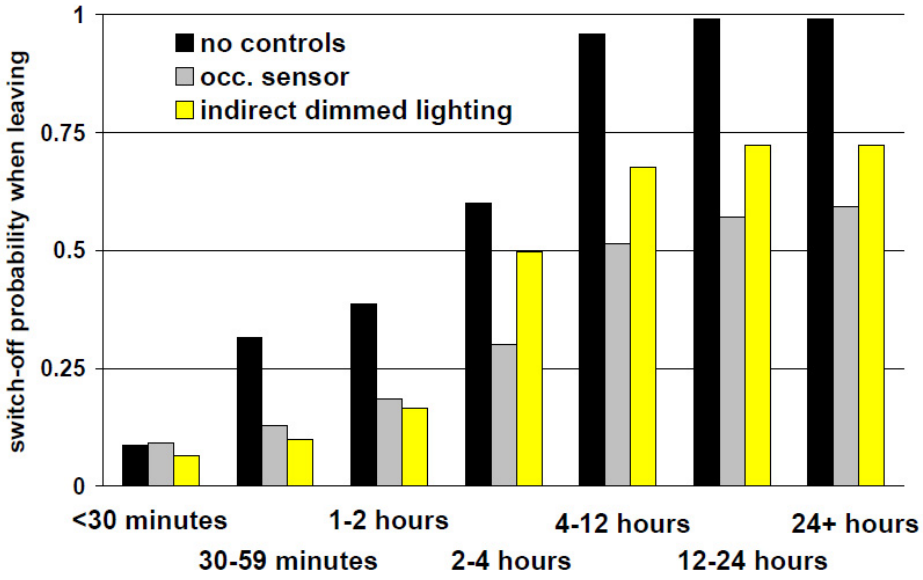


Lightswitch Algorithm

Lightswitch Occupant Behavior Probabilities



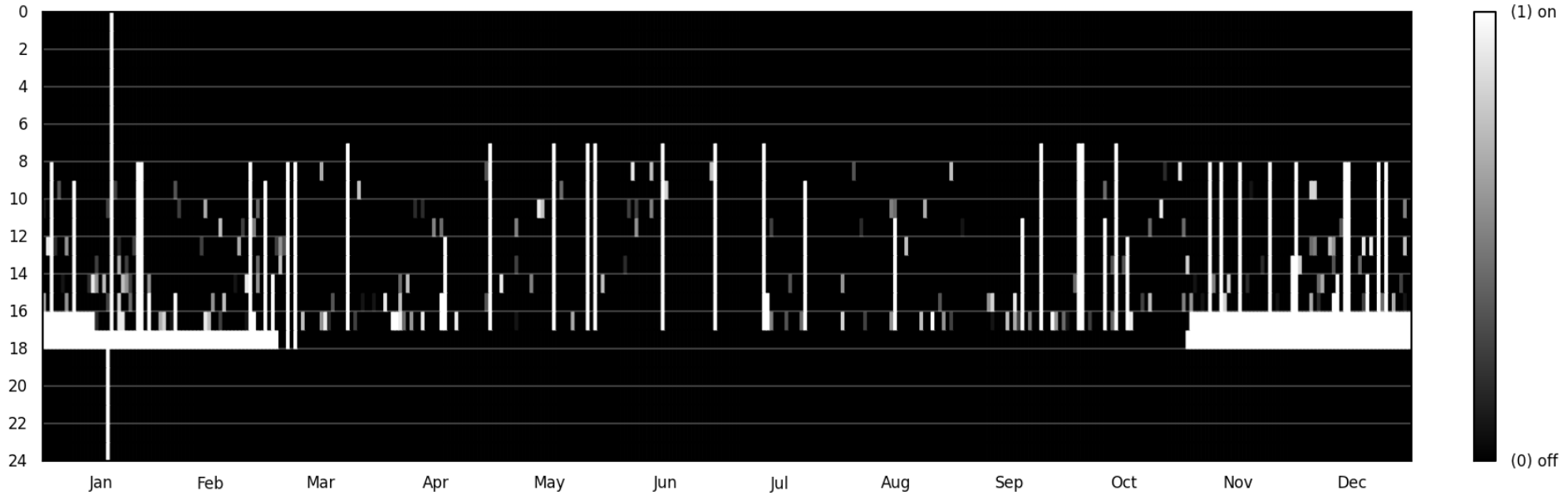
Probability of Turning On lights when Arriving



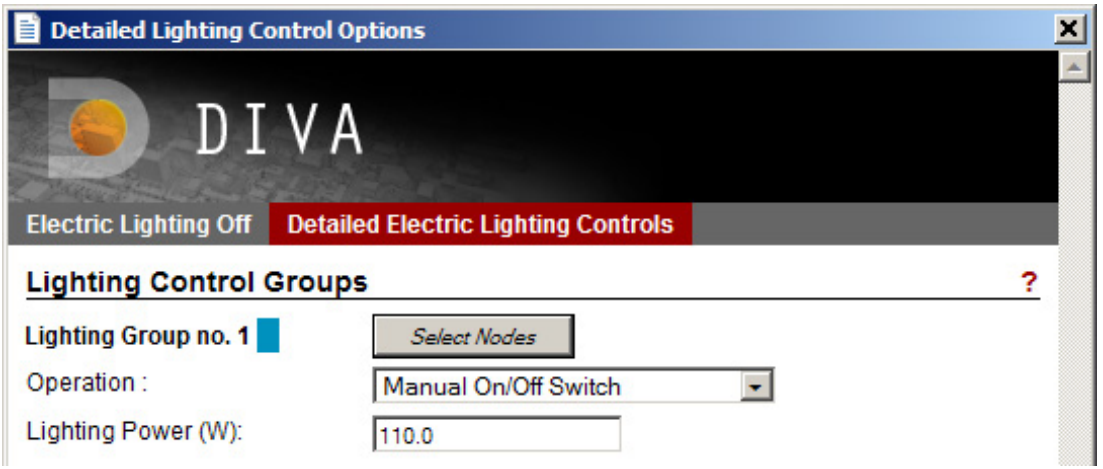
Probability of Switching Off Lights when Leaving

- Two user types: considers and does not consider daylight.
- Occupants unlikely to turn on lights unless illuminance is below 200lx.
- Sometimes people forget to turn off the lights, especially when they plan to come back soon. They forget to turn them off more often when there are occupancy or dimming sensors.

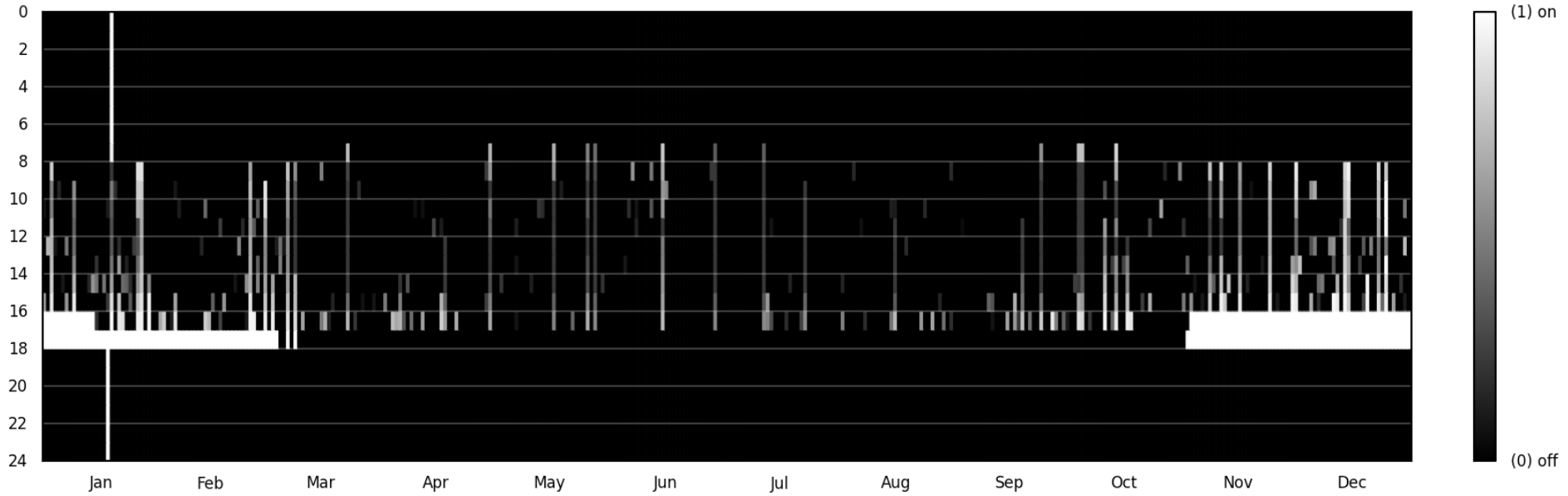
Manual Lighting Control



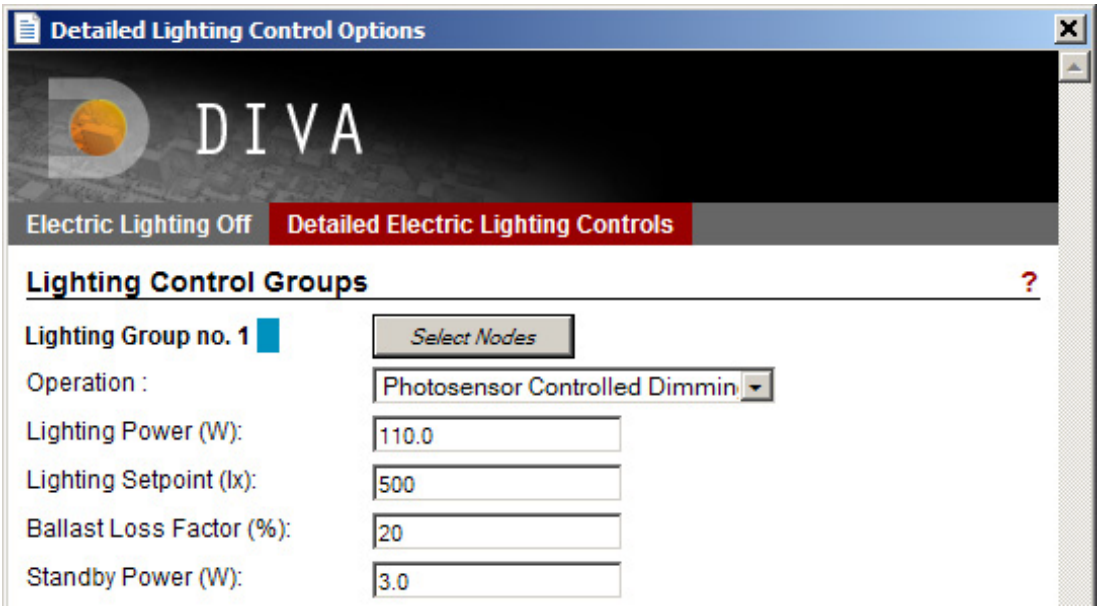

```
...
==========================
= Electric Lighting System
==========================
electric_lighting_system 1
1 manual_control    110.0 1
...
```



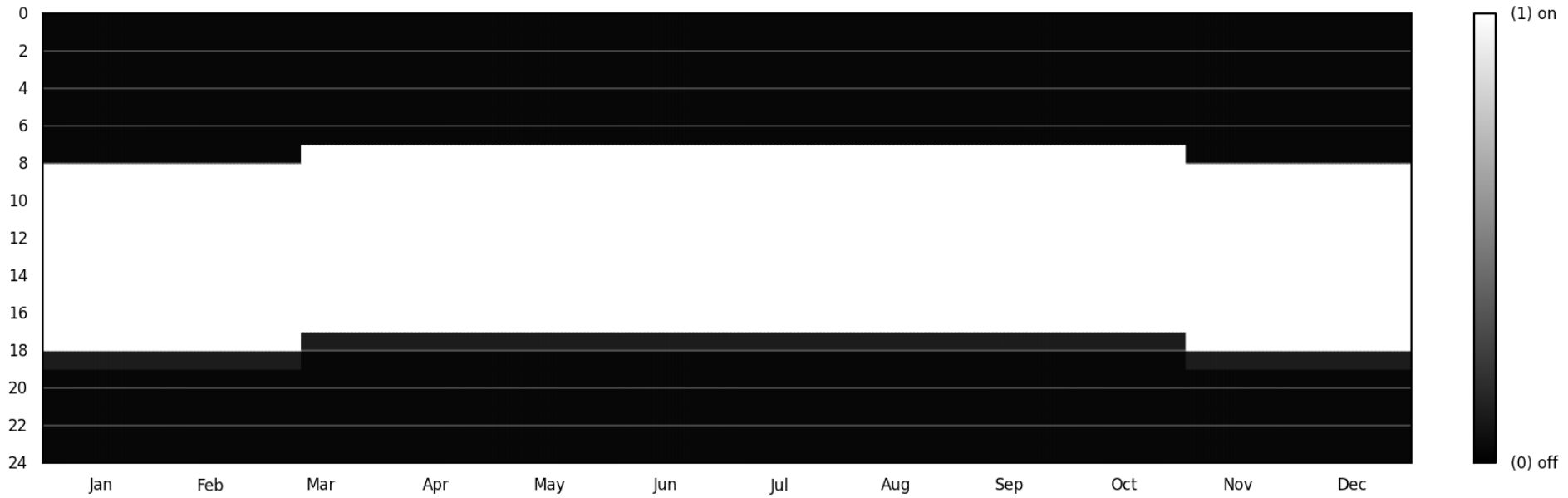
Manual Lighting Control with Dimming Sensor



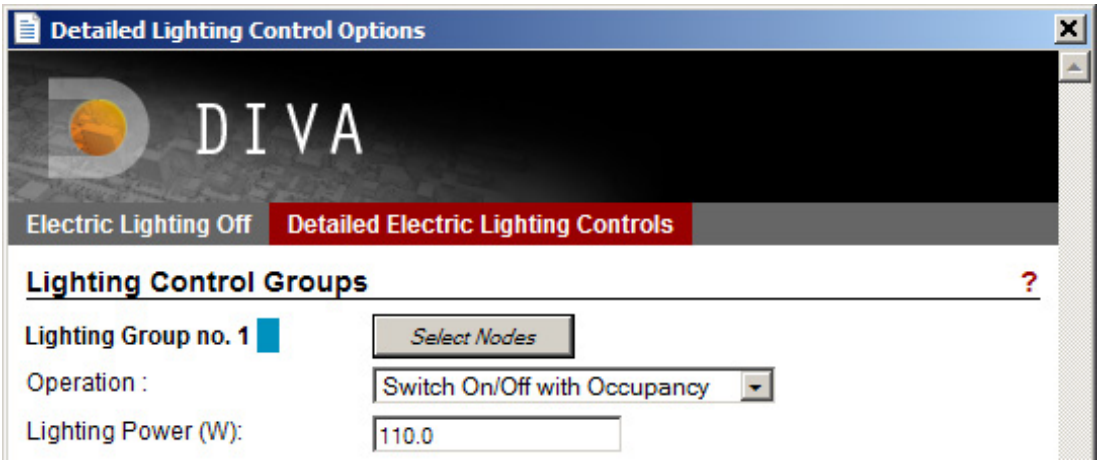

```
...
============================
= Electric Lighting System
============================
electric_lighting_system 1
4 manual_dimming    110.0 1 3.0 20 500
...
```



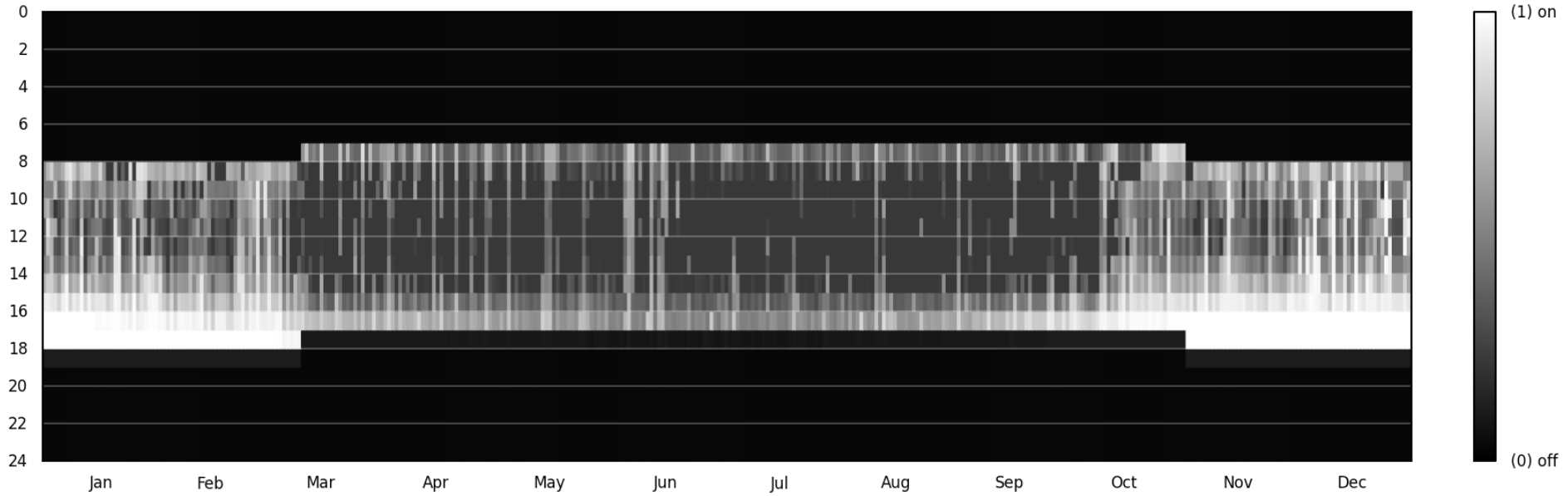
Occupancy On/Off Sensor



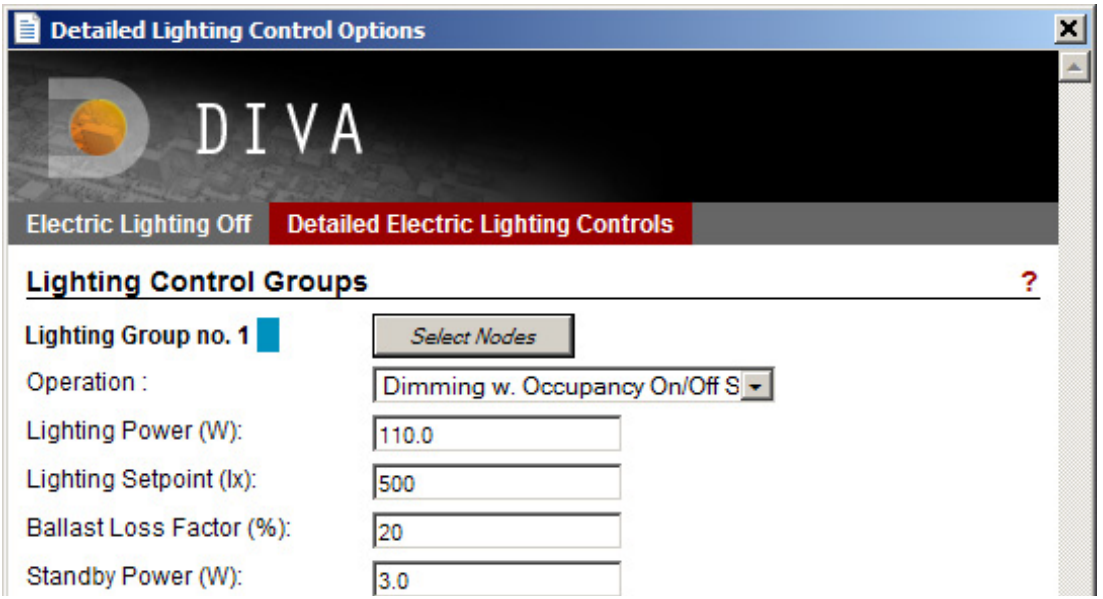

```
...
==========================
= Electric Lighting System
==========================
electric_lighting_system 3
3 occupancy_on_off  110.0 1 3.0 5
...
```



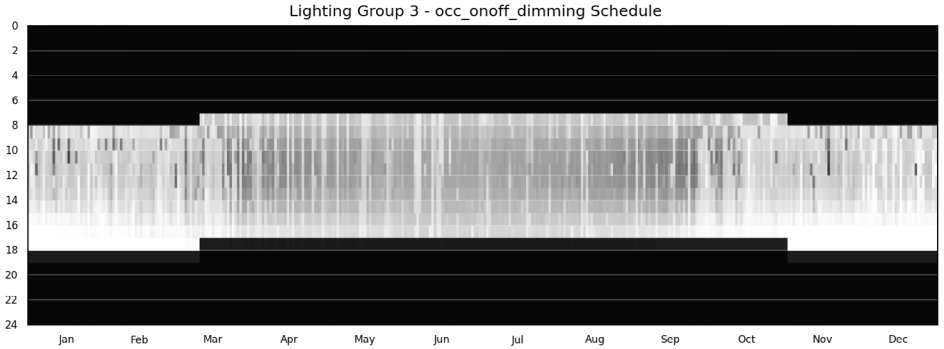
Occupancy On/Off Sensor with Dimming



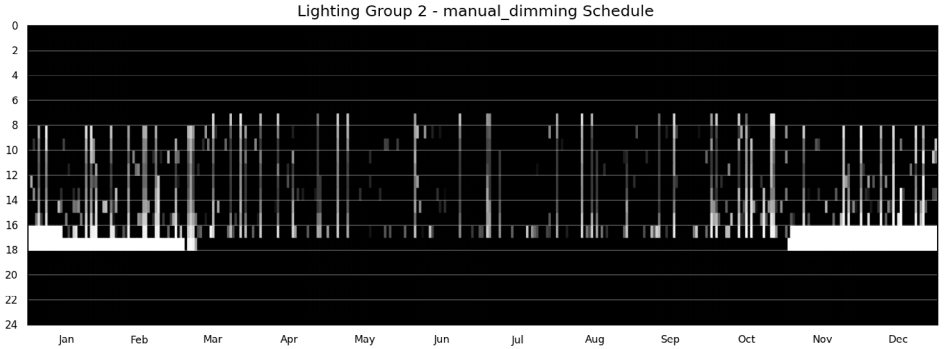

```
...
============================
= Electric Lighting System
============================
electric_lighting_system 1
6 occ_onoff_dim 110.0 1 3.0 20 500 5
...
```



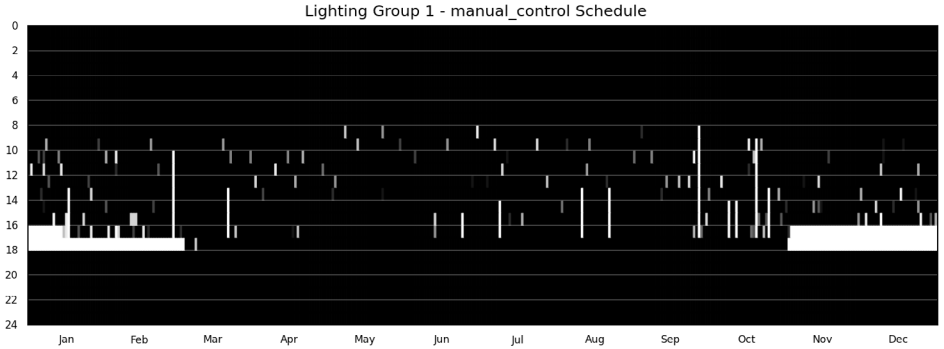
Several Lighting (or Shading) Systems Per Zone



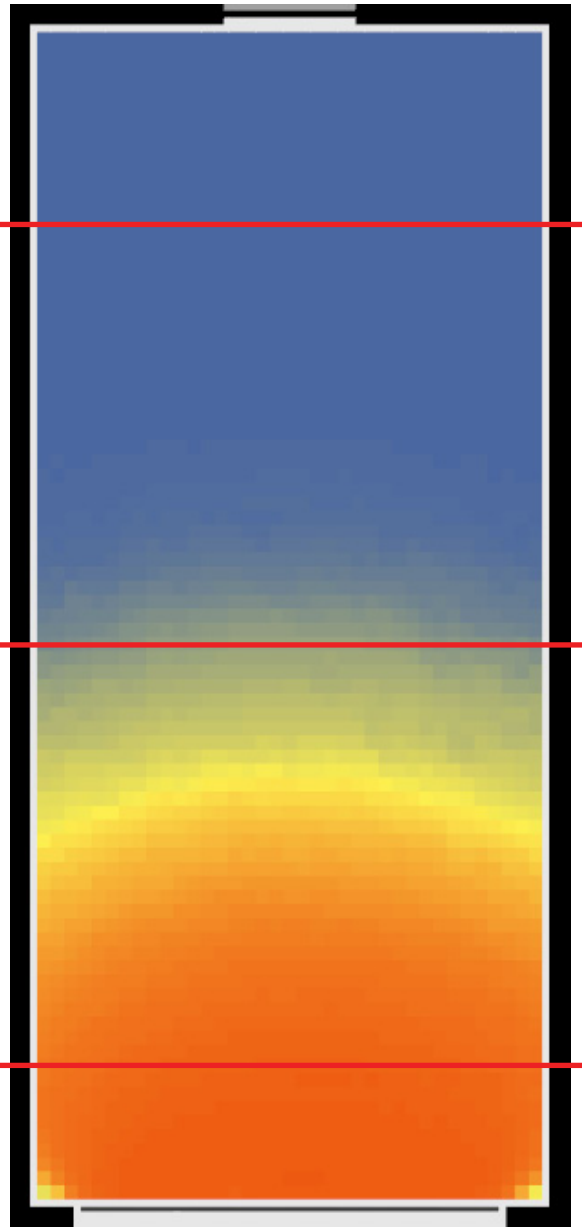
Occupancy On/Off with Dimming Sensor



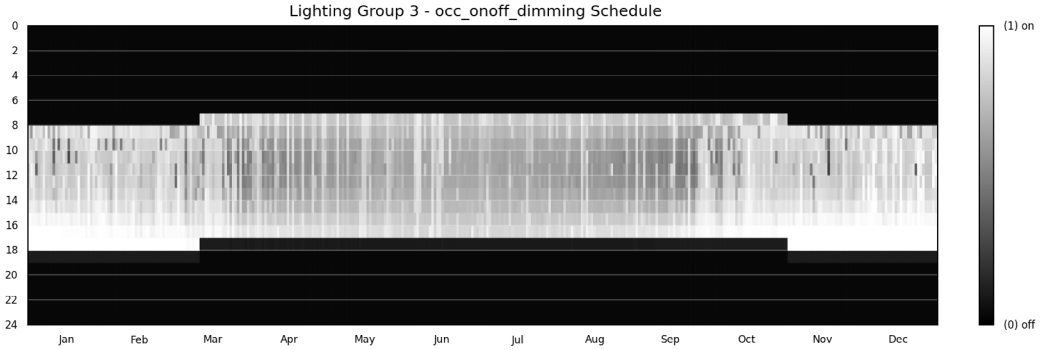
Manual Control with Dimming Sensor



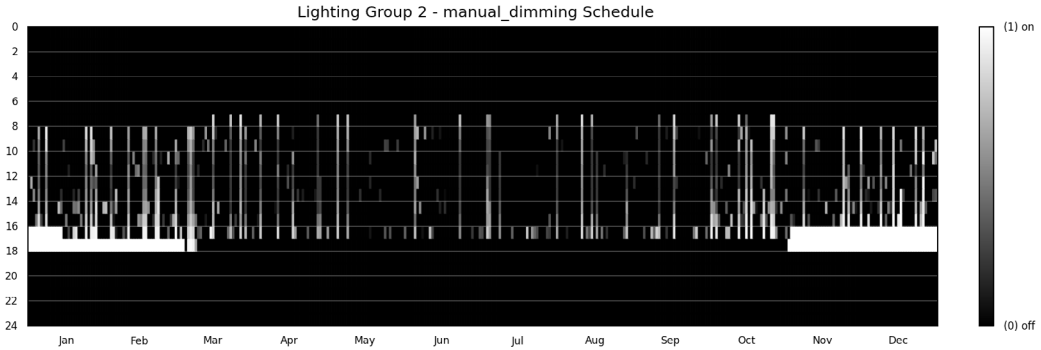
Manual Control



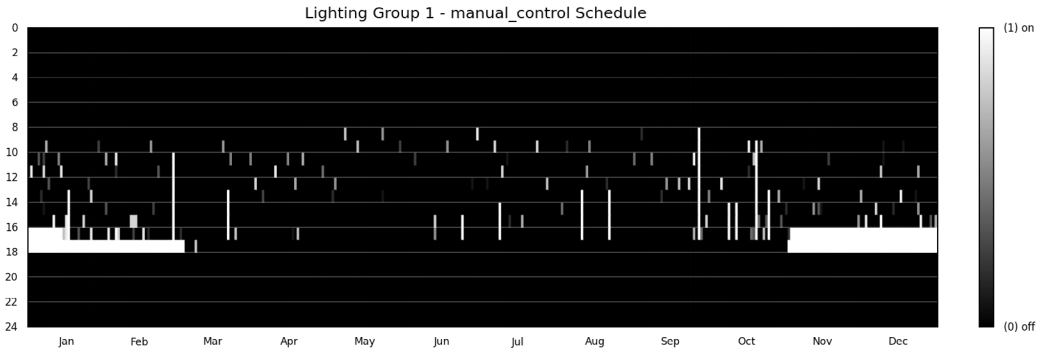
Several Lighting (or Shading) Systems Per Zone



Occupancy On/Off with Dimming Sensor



Manual Control with Dimming Sensor



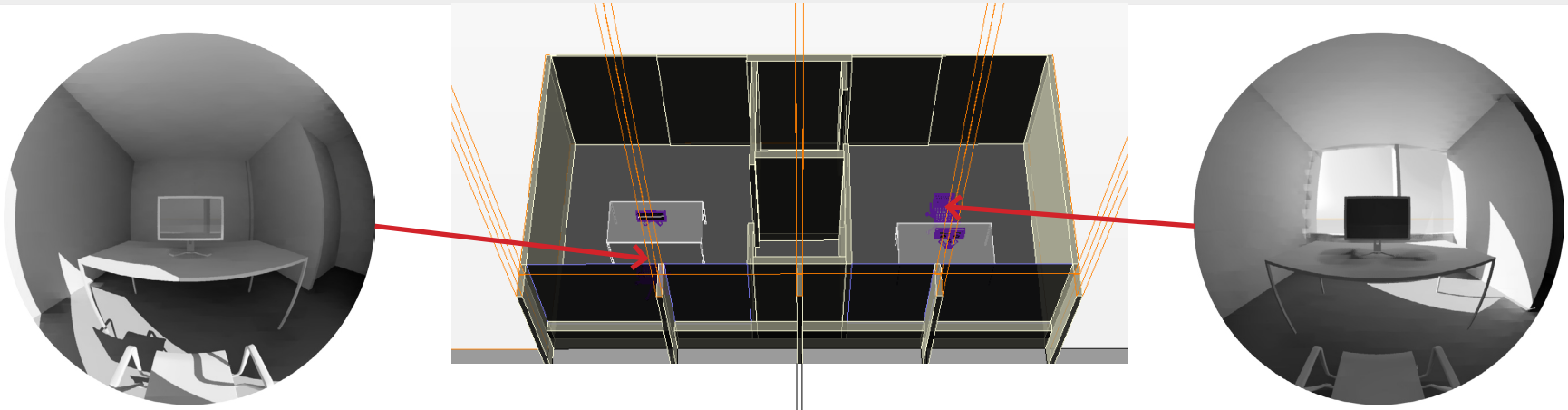
Manual Control

```
...
==========================
= Electric Lighting System
==========================
electric_lighting_system 3
1 manual_control    110.0 1
4 manual_dimming    110.0 1 3.0 20 500
6 occ_onoff_dimming 110.0 1 3.0 20 500 5
...
sensor_file_info 0 0 0 0 0 0 0 LG1 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 LG1 0 0 0
0 0 0 0 0 0 0 0 LG2 0 0 0 0 LG2 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 LG3 0 0 0 0 0 LG3 0 0
...
```

- Where dimming or shading sensors are located is important too.
- Currently DAYSIM assumes perfect sensor knowledge of Illuminance from daylight, but this is not always the case.

Some Examples

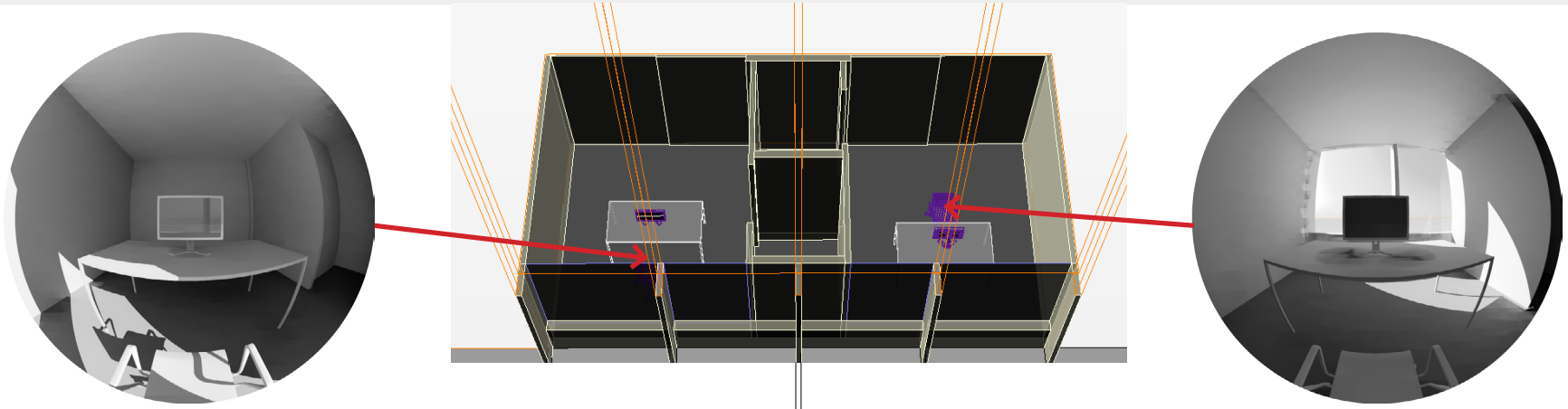
A simple question: How should I design the furniture in my space?



Oriented Away From Window

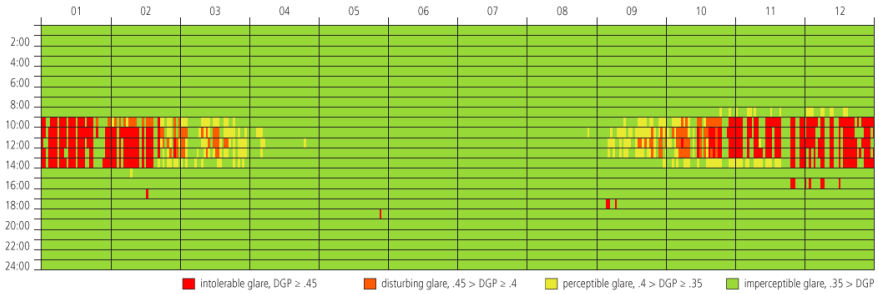
Oriented Towards Window

A simple question: How should I design the furniture in my space?



Oriented Away From Window

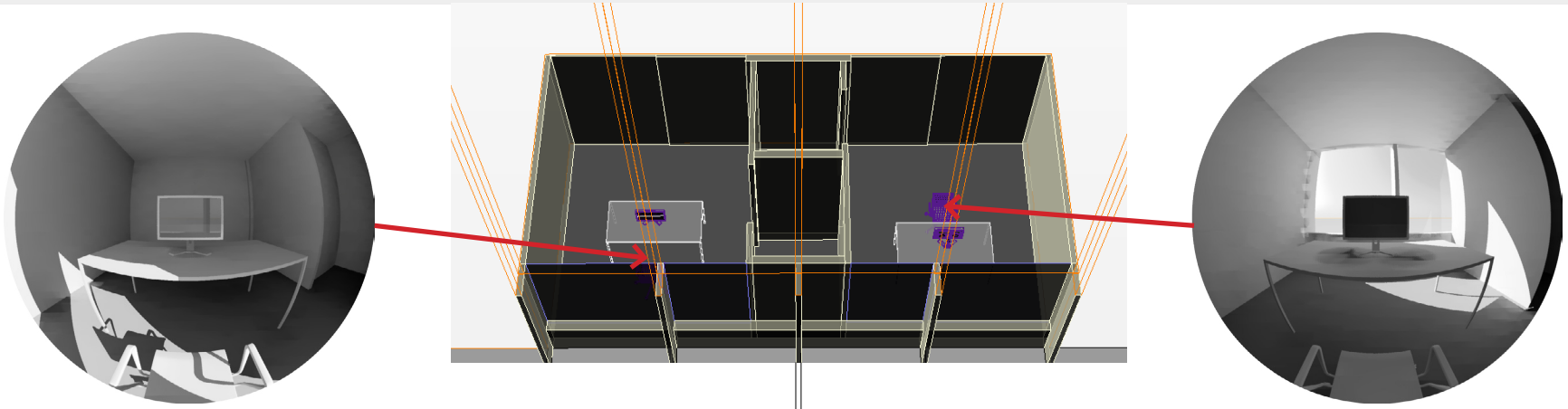
Oriented Towards Window



Visual Comfort: blinds closed 30% of occupied hours

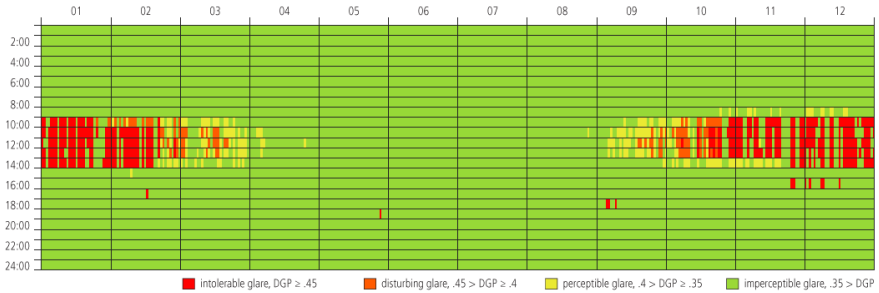
Visual Comfort: blinds closed 75% of occupied hours

A simple question: How should I design the furniture in my space?



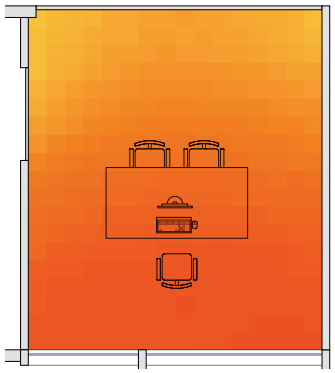
Oriented Away From Window

Oriented Towards Window

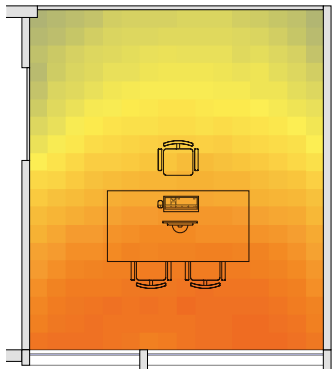


Visual Comfort: blinds closed 30% of occupied hours

Visual Comfort: blinds closed 75% of occupied hours

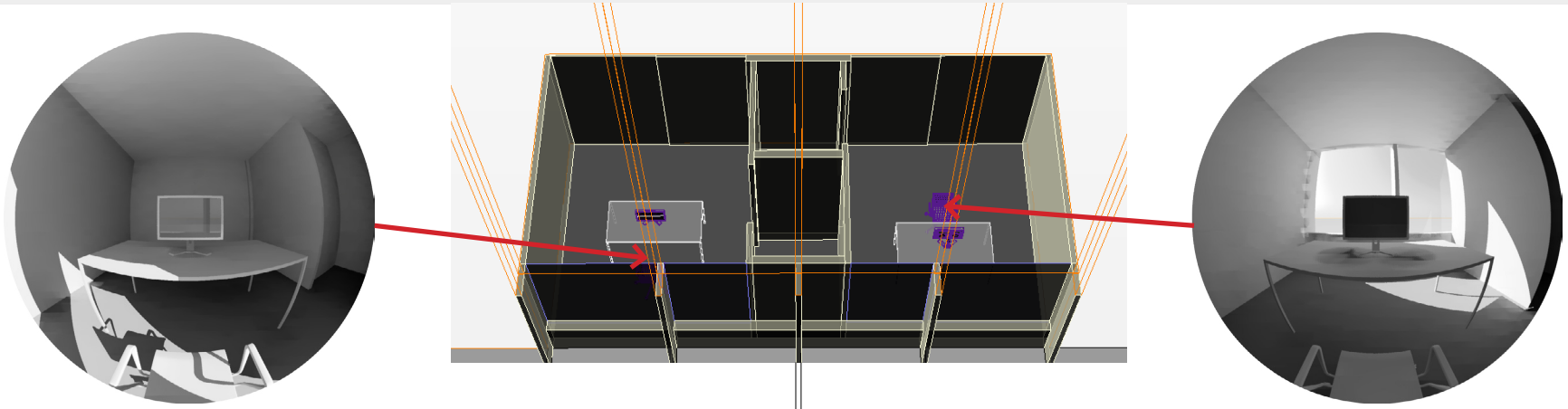


Daylight Autonomy: 82%



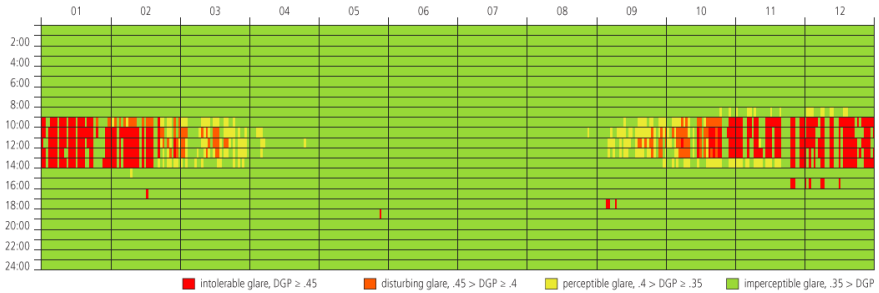
Daylight Autonomy: 61%

A simple question: How should I design the furniture in my space?



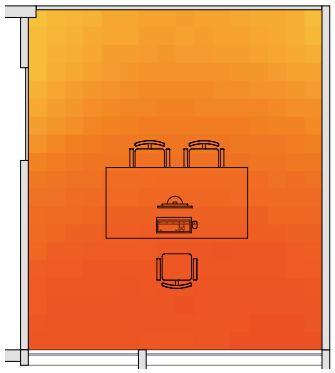
Oriented Away From Window

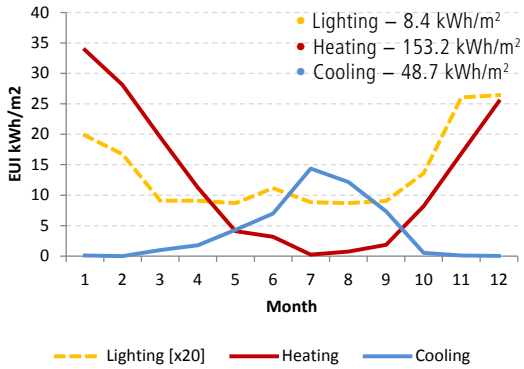
Oriented Towards Window



Visual Comfort: blinds closed 30% of occupied hours

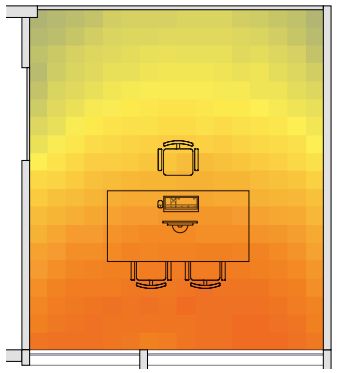
Visual Comfort: blinds closed 75% of occupied hours

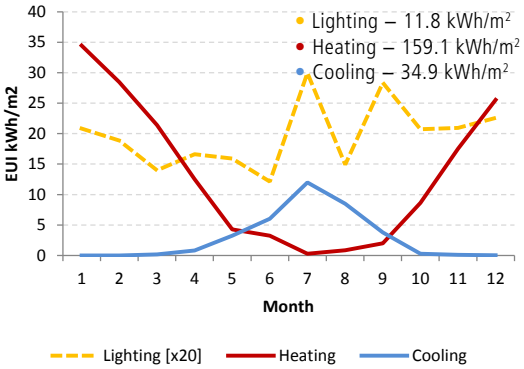




Daylight Autonomy: 82%

Energy Consumption





Daylight Autonomy: 61%

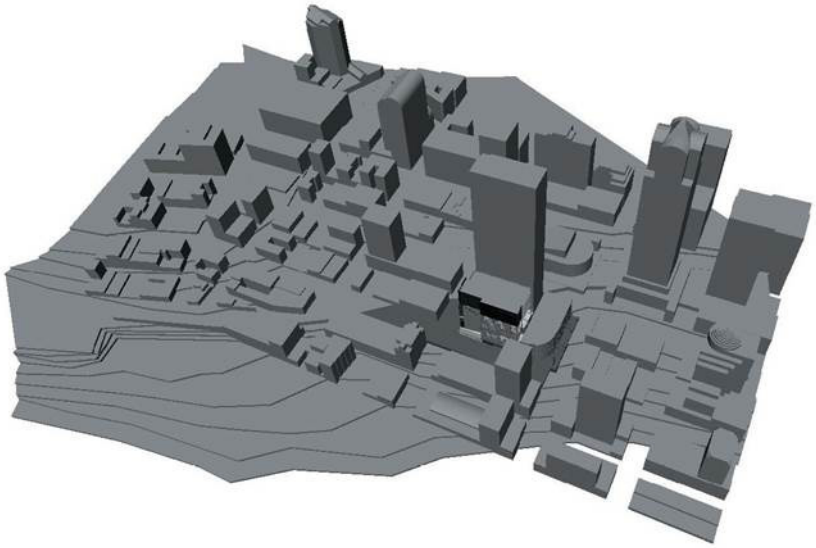
Energy Consumption

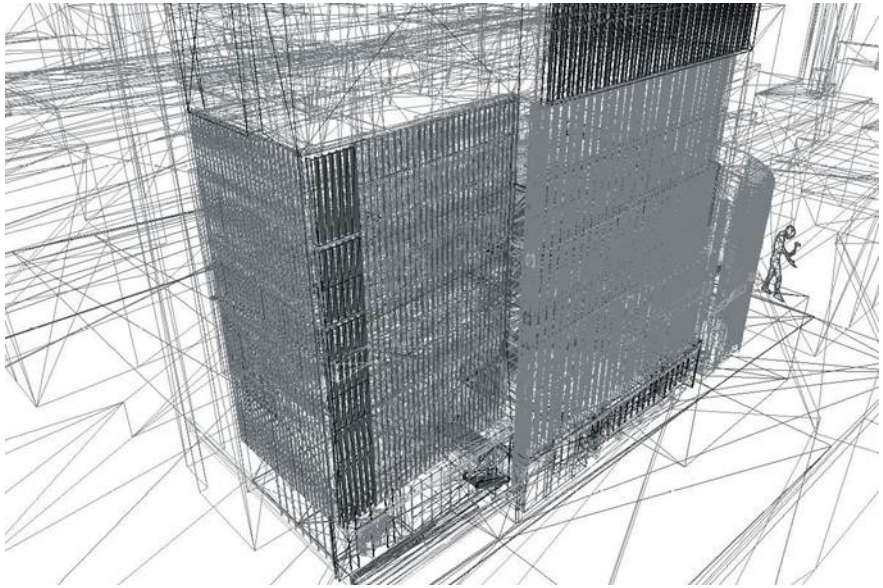
Museum Lighting Analysis by Arup Lighting

category	material classification	example of materials	lighting illuminance	limiting annual exposure
I	insensitive	metal, stone, glass, ceramic	no limit	no limit
II	low sensitivity	canvases, frescos, wood, leather	200 lux	600 000 lux h /yr
III	medium sensitivity	watercolor, pastel, various paper	50 lux	150 000 lux h/yr
IV	high sensitivity	silk, newspaper, sensitive pigments	50 lux	15 000 lux h/yr

source: Matt Franks, Arup Lighting
http://www.radiance-online.org/community/workshops/2005-montreal/PDF/Franks_ArupCaseStudies.pdf

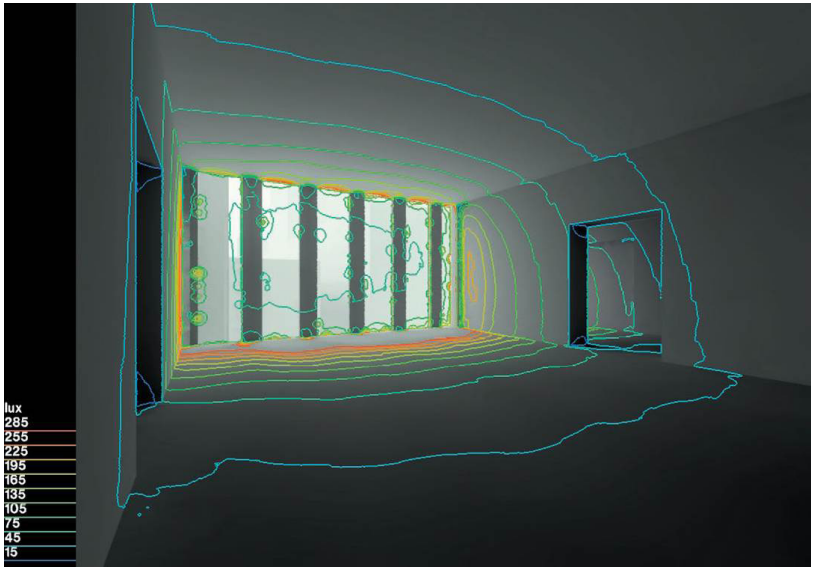
Museum Lighting Analysis by Arup Lighting

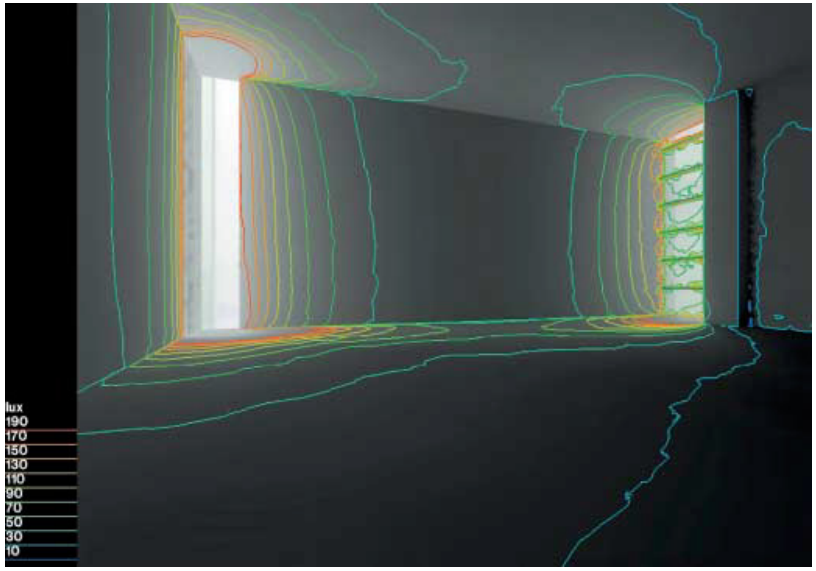




source: Matt Franks, Arup Lighting
http://www.radiance-online.org/community/workshops/2005-montreal/PDF/Franks_ArupCaseStudies.pdf

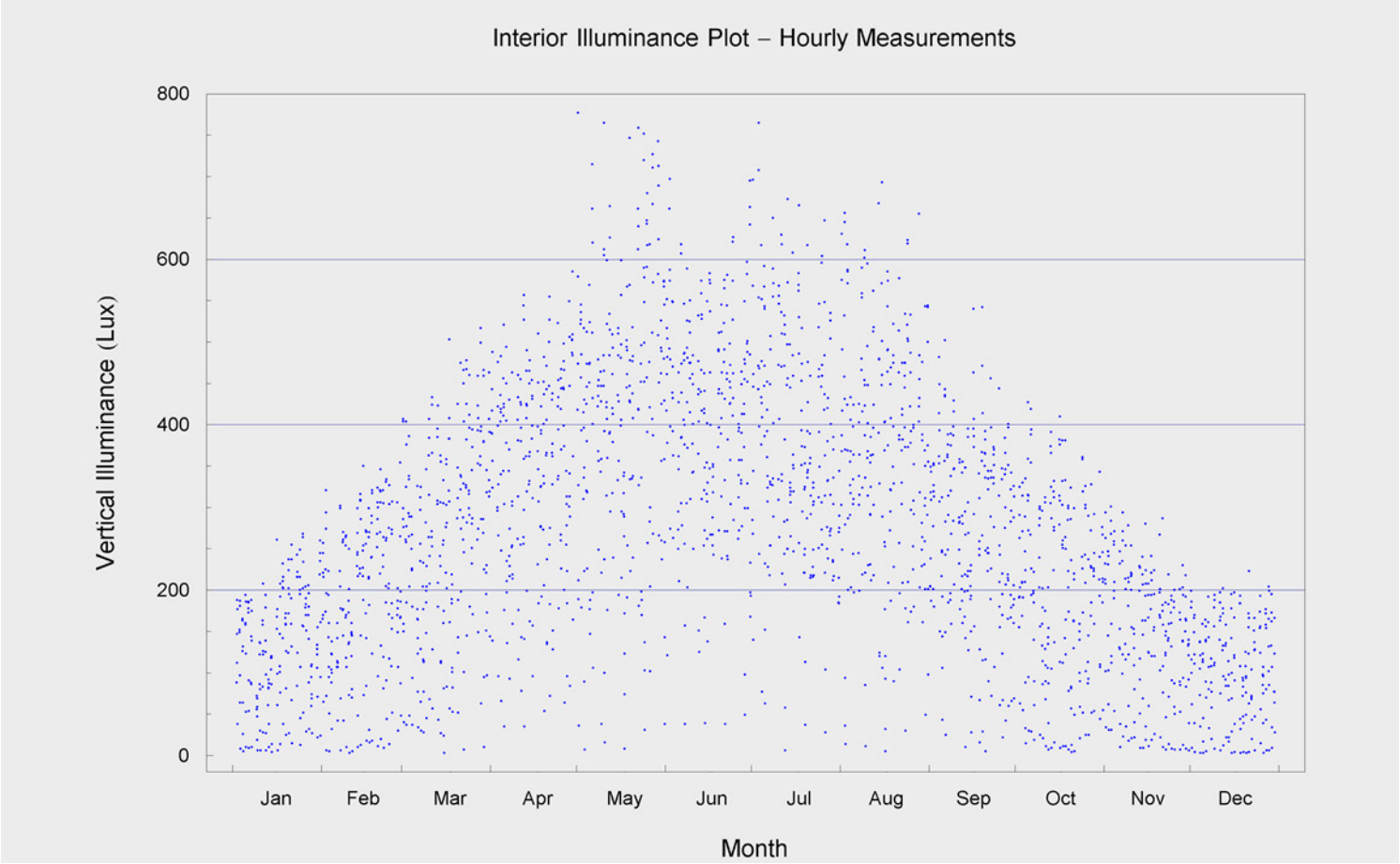
Museum Lighting Analysis by Arup Lighting





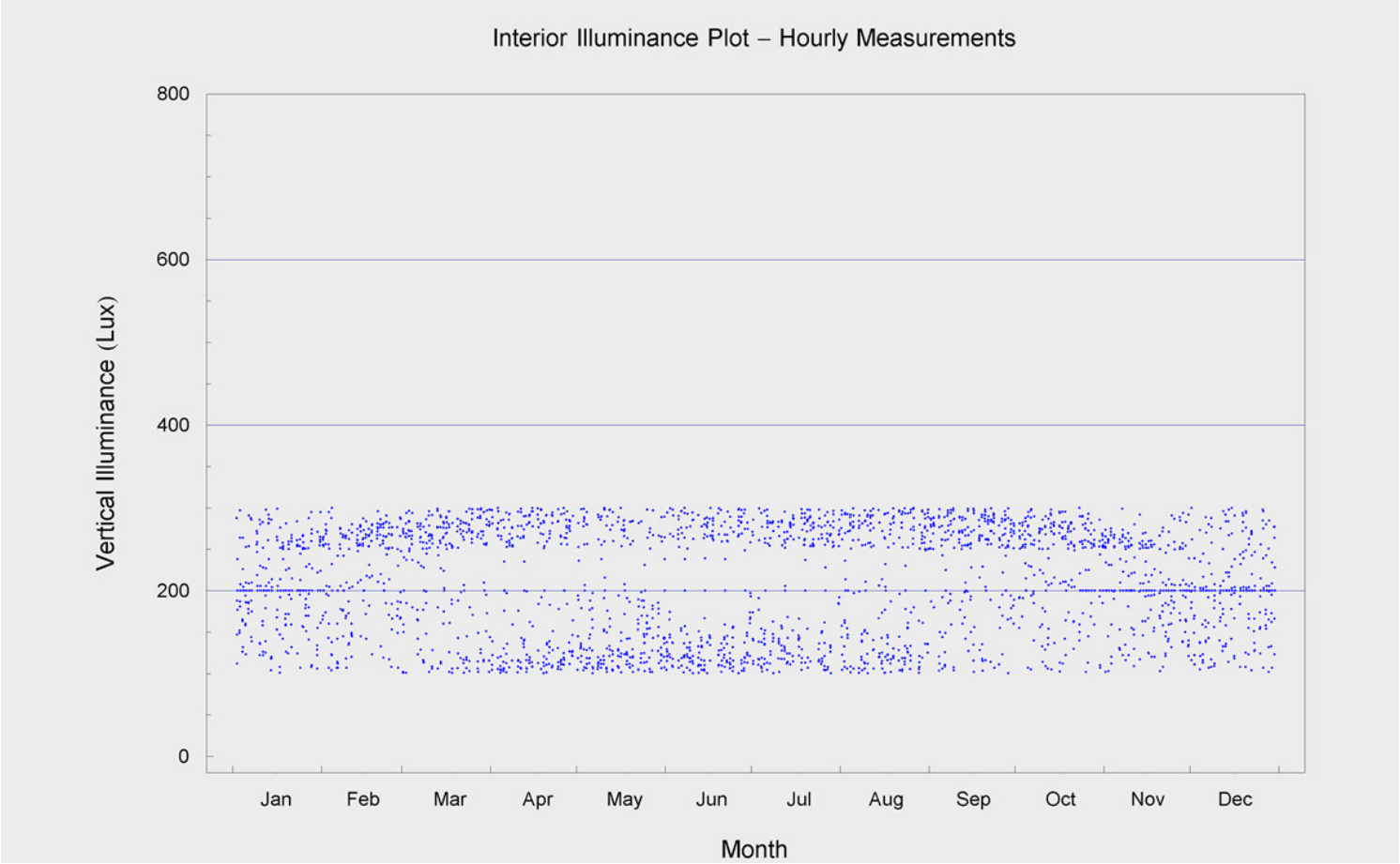
source: Matt Franks, Arup Lighting
http://www.radiance-online.org/community/workshops/2005-montreal/PDF/Franks_ArupCaseStudies.pdf

No Shading: > 1,500,000 lux-hours



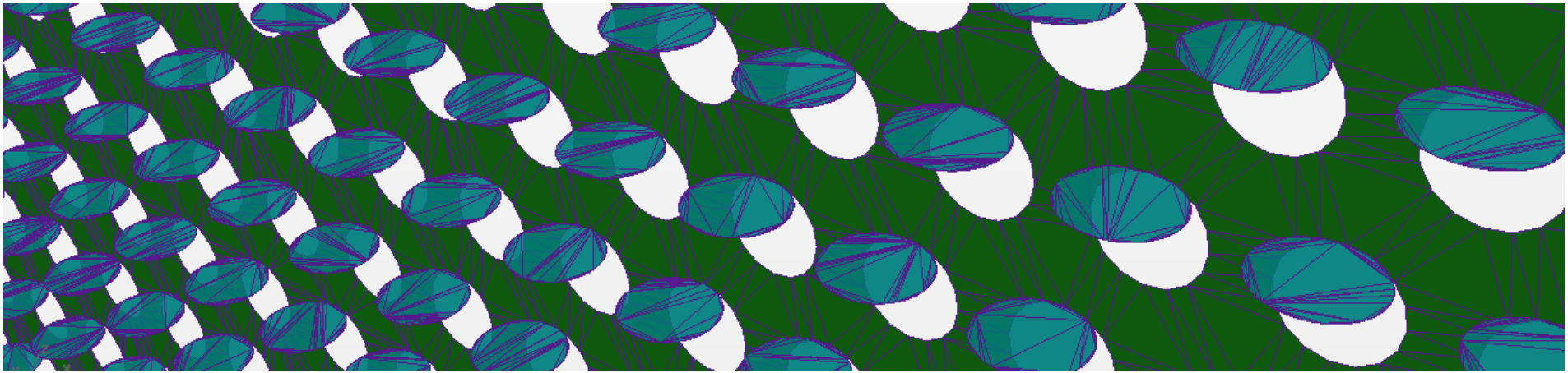
source: Matt Franks, Arup Lighting
http://www.radiance-online.org/community/workshops/2005-montreal/PDF/Franks_ArupCaseStudies.pdf

Automated Shading System: 555,000 lux-hours

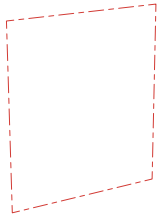


source: Matt Franks, Arup Lighting
http://www.radiance-online.org/community/workshops/2005-montreal/PDF/Franks_ArupCaseStudies.pdf

Complex Screen Analysis: New Jurong Christian Church



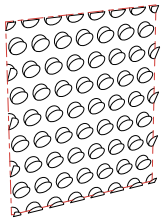
Complex Screen Analysis: New Jurong Christian Church



glazing only

Percent Time with View 68

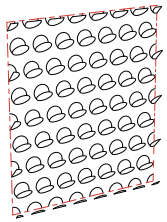
92	98	100	100	100
DA500lx	DA300lx	DA150lx	DA50lx	DA25lx



bottom-hinged 30 degrees

Percent Time with View 73

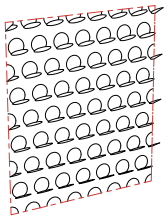
50	72	89	100	100
DA500lx	DA300lx	DA150lx	DA50lx	DA25lx



bottom-hinged 45 degrees

Percent Time with View 74

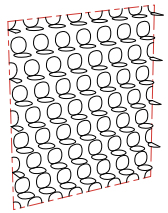
52	73	90	100	100
DA500lx	DA300lx	DA150lx	DA50lx	DA25lx



bottom-hinged 60 degrees

Percent Time with View 76

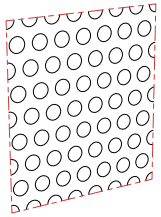
62	81	95	100	100
DA500lx	DA300lx	DA150lx	DA50lx	DA25lx



bottom-hinged 90 degrees

Percent Time with View 77

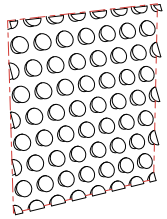
73	86	97	100	100
DA500lx	DA300lx	DA150lx	DA50lx	DA25lx



5cm punch screen only

Percent Time with View 73

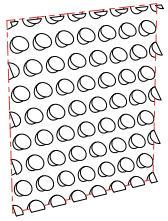
64	80	93	100	100
DA500lx	DA300lx	DA150lx	DA50lx	DA25lx



top-hinged 30 degrees

Percent Time with View 79

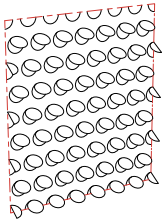
54	76	91	100	100
DA500lx	DA300lx	DA150lx	DA50lx	DA25lx



top-hinged 45 degrees

Percent Time with View 78

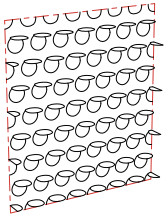
68	84	96	100	100
DA500lx	DA300lx	DA150lx	DA50lx	DA25lx



top-hinged 60 degrees

Percent Time with View 80

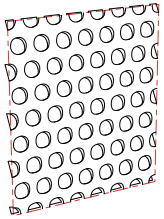
66	82	95	100	100
DA500lx	DA300lx	DA150lx	DA50lx	DA25lx



top-hinged 90 degrees

Percent Time with View 77

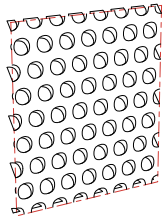
64	81	94	100	100
DA500lx	DA300lx	DA150lx	DA50lx	DA25lx



inside-hinged 30 degrees

Percent Time with View 78

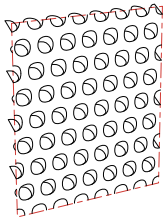
56	78	92	99	100
DA500lx	DA300lx	DA150lx	DA50lx	DA25lx



inside-hinged 45 degrees

Percent Time with View 78

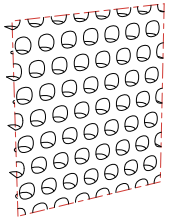
63	81	94	99	100
DA500lx	DA300lx	DA150lx	DA50lx	DA25lx



inside-hinged 60 degrees

Percent Time with View 77

47	71	88	99	100
DA500lx	DA300lx	DA150lx	DA50lx	DA25lx

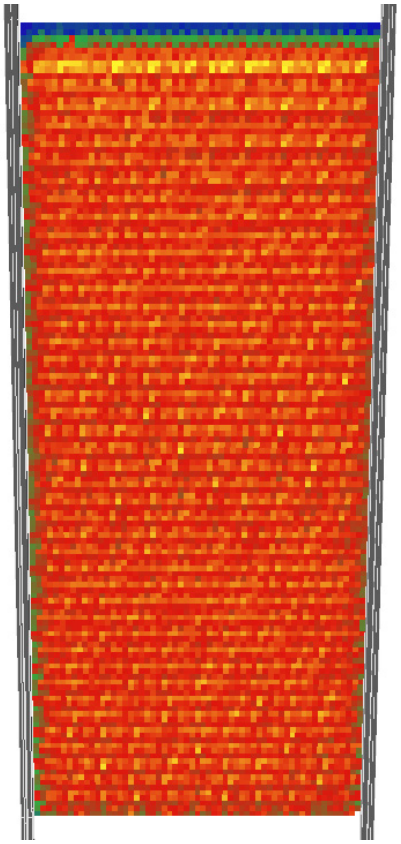


inside-hinged 90 degrees

Percent Time with View 77

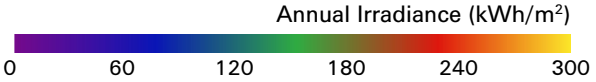
68	83	96	100	100
DA500lx	DA300lx	DA150lx	DA50lx	DA25lx

Complex Screen Analysis: New Jurong Christian Church

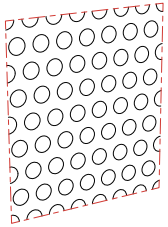


Annual Radiation Map of a Single Panel

- We create a hourly shading coefficient by taking the ratio of the irradiance of a shaded window over the irradiance of an exposed window.
- A caveat is that thermal interaction between the screen and the window is neglected.
- Electric lighting energy is determined by simulated daylight dimming systems in DAYSIM and is used as a schedule input into EnergyPlus.
- Blinds are closed any time a student experiences direct light on their desk. They are only opened twice per day if conditions are comfortable.



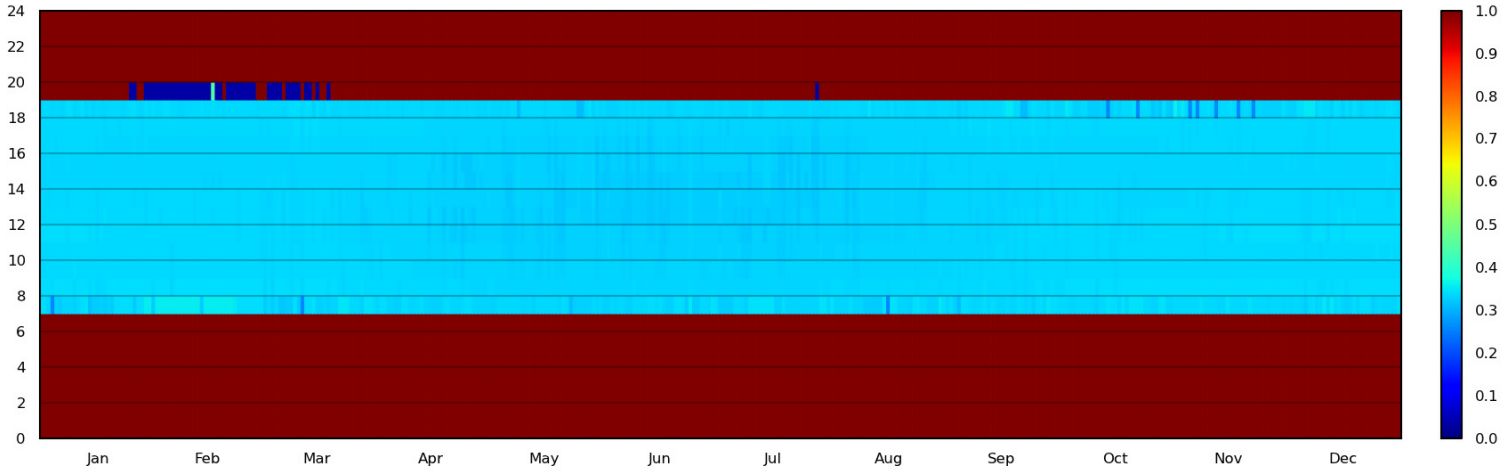
Calculated Screen Transmission Coefficients

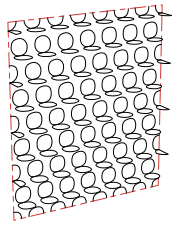


5cm punch screen only

Percent Time with View 73

64	80	93	100	100
DA500lx	DA300lx	DA150lx	DA50lx	DA25lx

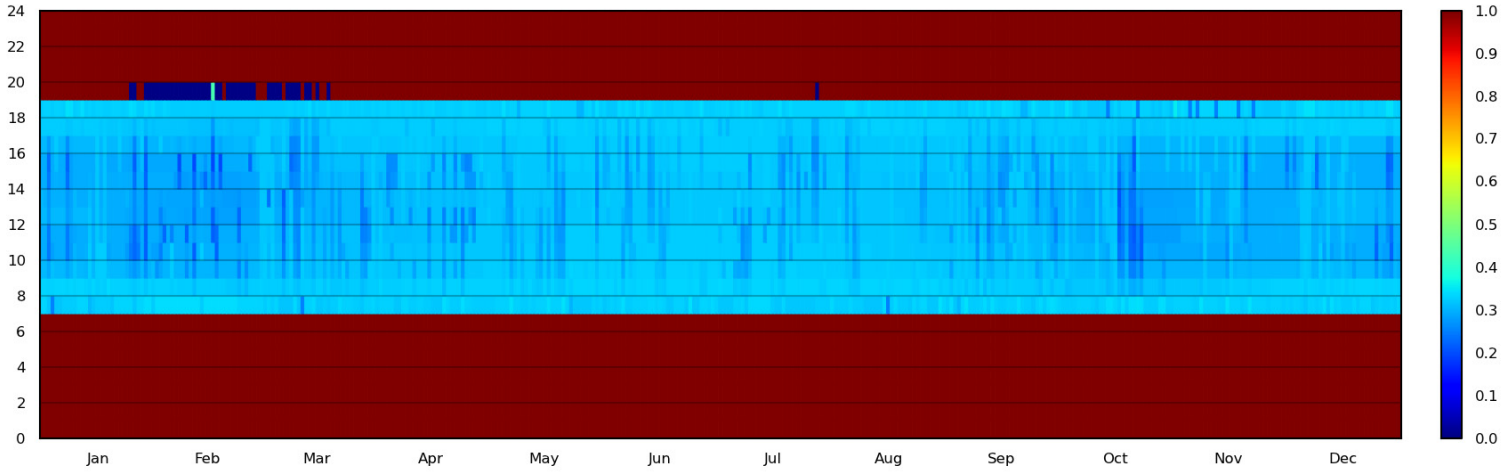




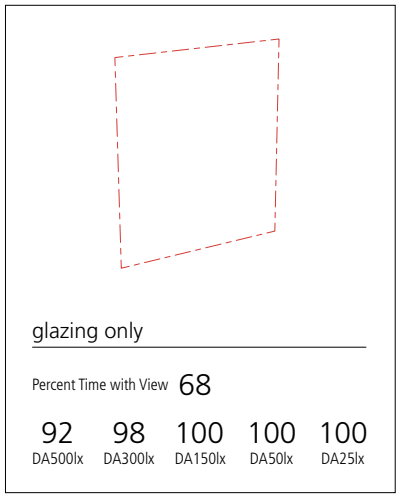
bottom-hinged 90 degrees

Percent Time with View 77

73	86	97	100	100



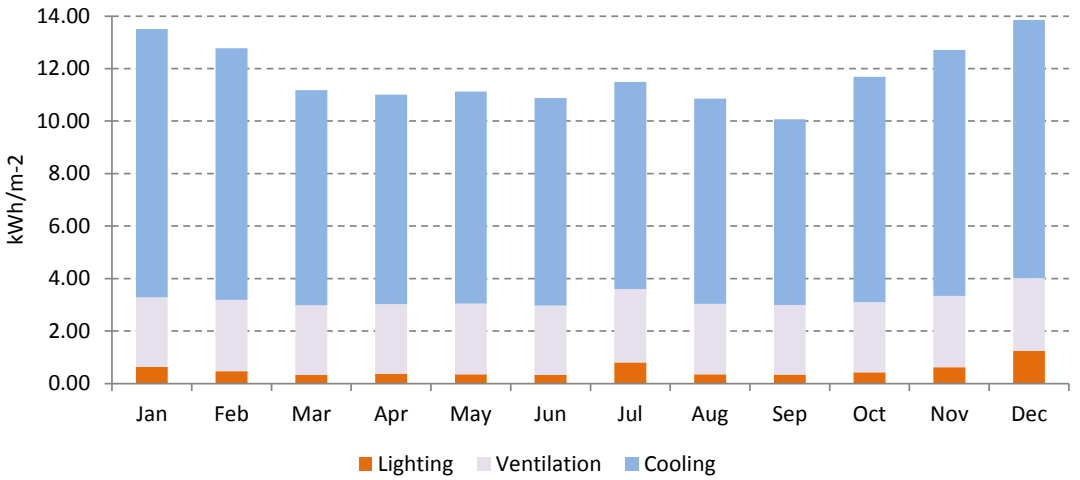
Thermal Simulation Results



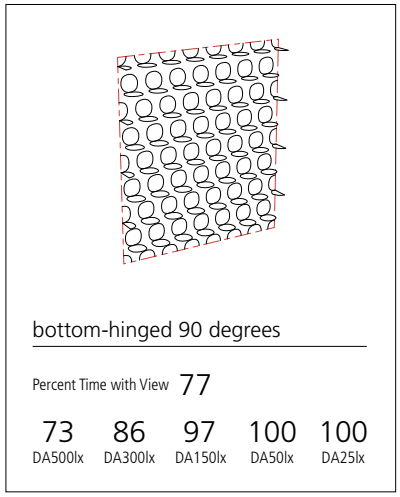
glazing only

Percent Time with View 68

92	98	100	100	100
DA500lx	DA300lx	DA150lx	DA50lx	DA25lx



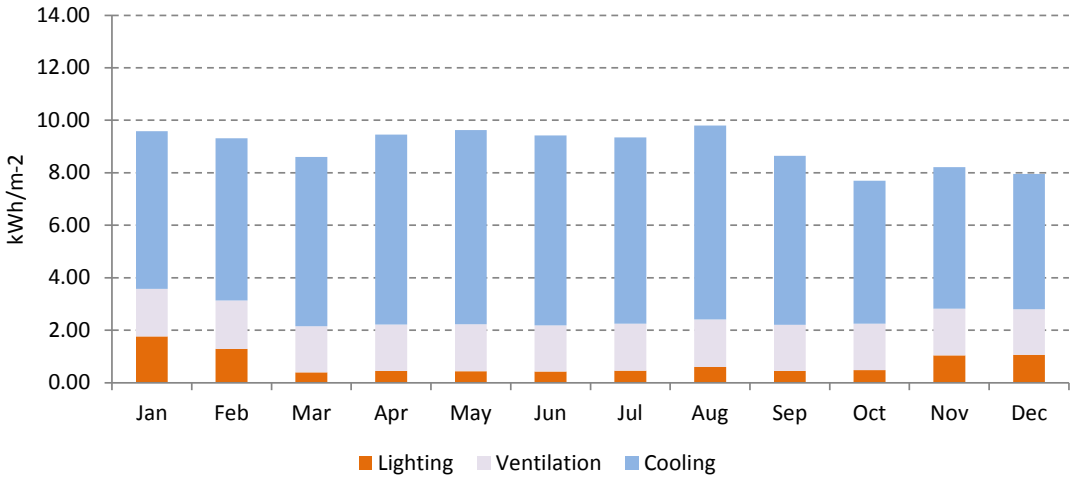
Lighting	6.28 kWh/m²
Ventilation	32.3 kWh/m²
Cooling	102.6 kWh/m²



bottom-hinged 90 degrees

Percent Time with View 77

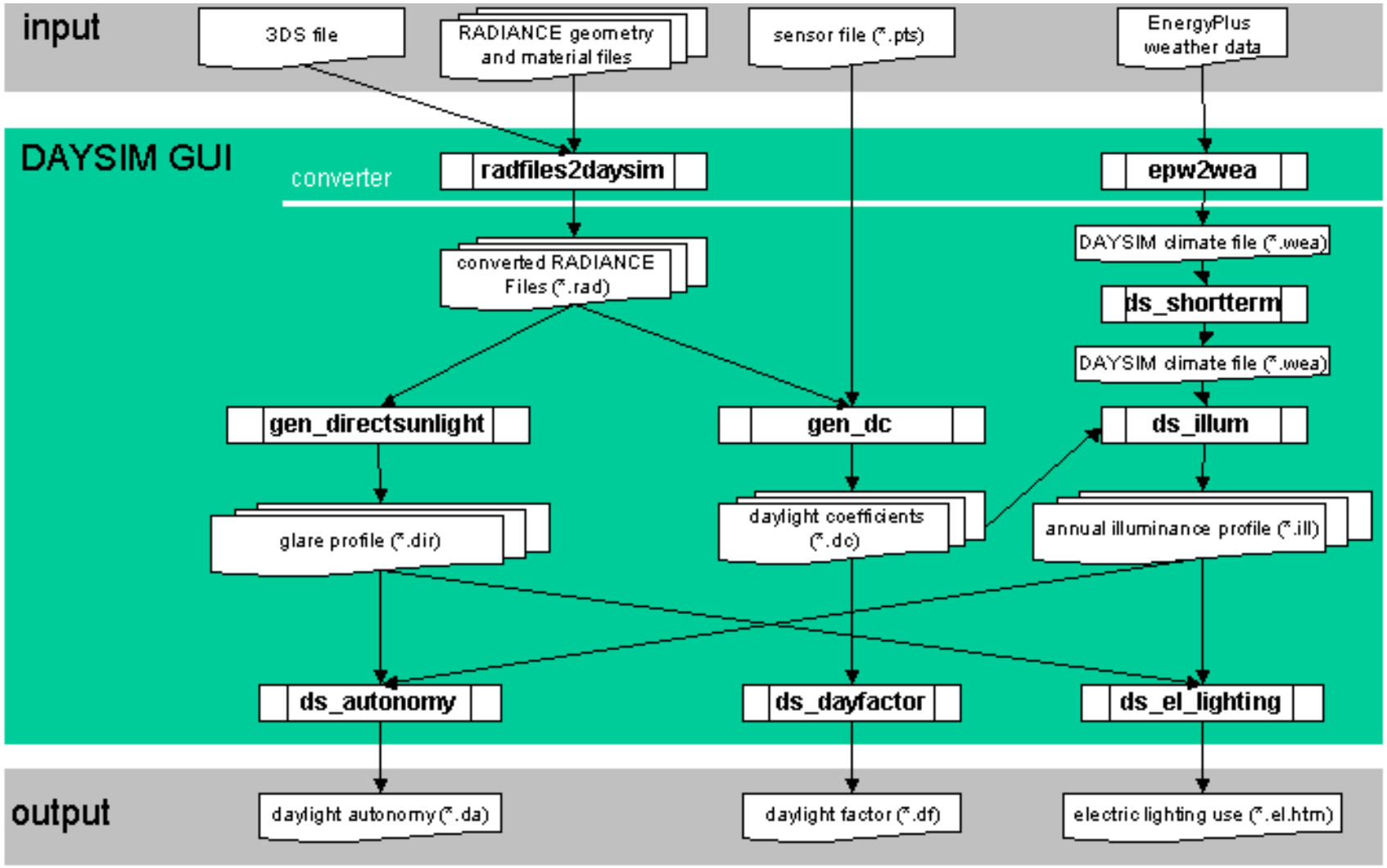
73	86	97	100	100
DA500lx	DA300lx	DA150lx	DA50lx	DA25lx



Lighting	8.9 kWh/m²
Ventilation	21.4 kWh/m²
Cooling	77.5 kWh/m²

A few closing comments...

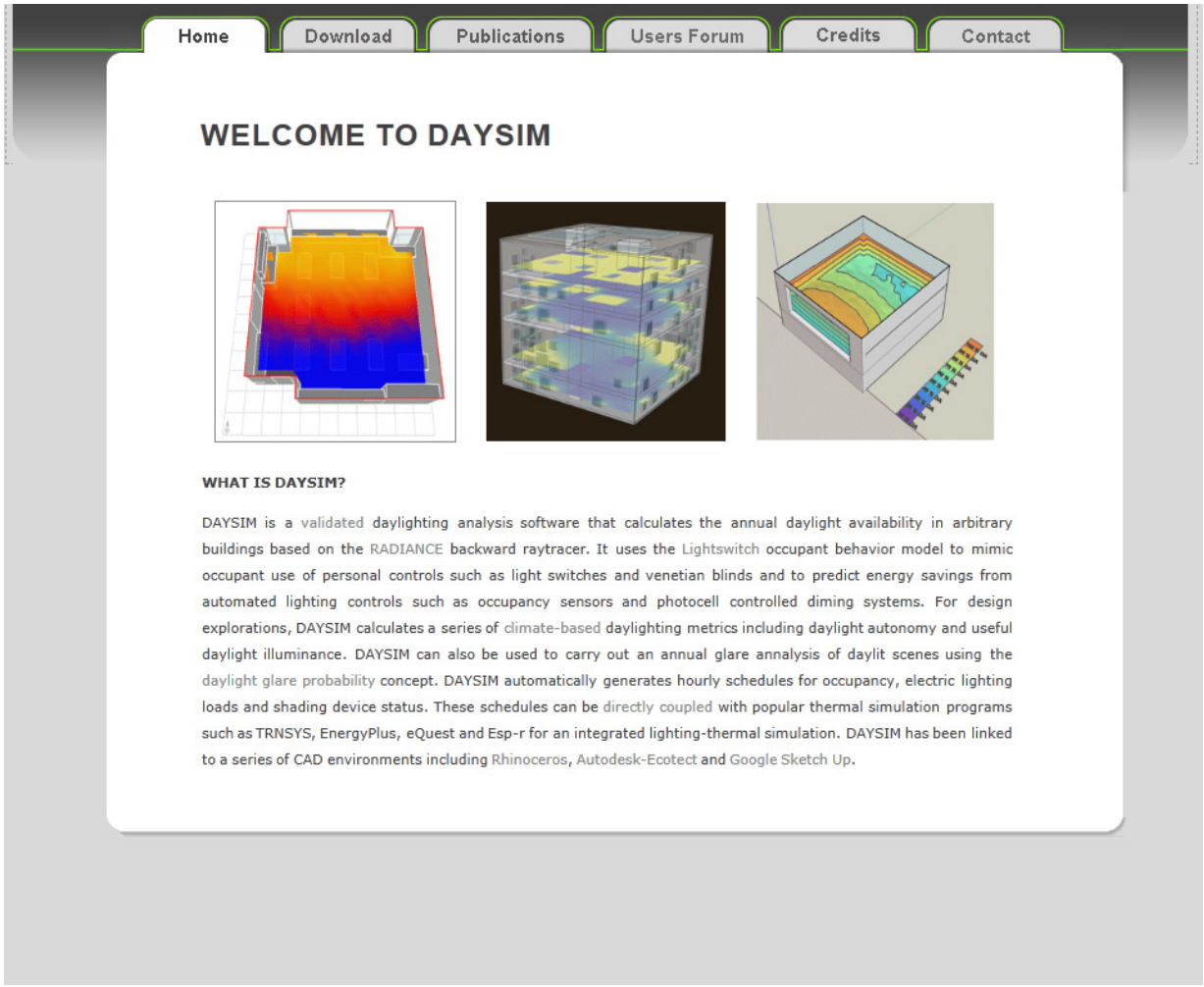
DAYSIM Programs Hierarchy



Interior Gains CSV File For Interfacing with Thermal Simulations

	A	B	C	D	E	F	G	H	I
1	Daysim schedule file (to be used in combination with a thermal simulation program)								
2	Daysim header file: C:\DIVA\t			**Occupied Hours: 3650**	**Lighting Group 1 - manual_control**	**Lighting Group 2 - manual_dimming**	**Lighting Group 3 - manual_dimming**	**Shading Group 1 - shading_group_1**	**Daylight Glare Probability**
3				Installed Lighting Power [W]	100	250	250	View 56	effective dgp scale
4	**month**	**day**	**hour**	*occupancy [0=absent...1=present]*	*lighting [0=off...1=full on]*	*lighting [0=off...1=full on]*	*lighting [0=off...1=full on]*	*blinds [0=up; 1=down]*	*[-999=user absent <30=imperceptilbe 3*
5	1	1	0.5	0	0	0	0	0	-999
6	1	1	1.5	0	0	0	0	0	-999
7	1	1	2.5	0	0	0	0	0	-999
8	1	1	3.5	0	0	0	0	0	-999
9	1	1	4.5	0	0	0	0	0	-999
10	1	1	5.5	0	0	0	0	0	-999
11	1	1	6.5	0	0	0	0	0	-999
12	1	1	7.5	0	0	0	0	0	-999
13	1	1	8.5	1	0	0	0.79	0	0.221
14	1	1	9.5	1	0	0.77	0.84	1	0.201
15	1	1	10.5	1	0	0	0.87	1	0.198
16	1	1	11.5	1	0	0	0.79	1	0.205
17	1	1	12.5	1	1	0.6	0.8	1	0.199
18	1	1	13.5	1	1	0.14	0.84	1	0.191
19	1	1	14.5	1	1	0.15	0.9	1	0.185
20	1	1	15.5	1	1	0.33	0.98	1	0.079
21	1	1	16.5	1	1	1	1	0	0.184
22	1	1	17.5	1	1	1	1	0	0.184
23	1	1	18.5	0	0	0	0	0	-999
24	1	1	19.5	0	0	0	0	0	-999
25	1	1	20.5	0	0	0	0	0	-999
26	1	1	21.5	0	0	0	0	0	-999
27	1	1	22.5	0	0	0	0	0	-999
28	1	1	23.5	0	0	0	0	0	-999
29	1	2	0.5	0	0	0	0	0	-999
30	1	2	1.5	0	0	0	0	0	-999
31	1	2	2.5	0	0	0	0	0	-999
32	1	2	3.5	0	0	0	0	0	-999
33	1	2	4.5	0	0	0	0	0	-999
34	1	2	5.5	0	0	0	0	0	-999
35	1	2	6.5	0	0	0	0	0	-999
36	1	2	7.5	0	0	0	0	0	-999
37	1	2	8.5	1	0	0	0.56	0	0.383
38	1	2	9.5	1	0	0	0.84	1	0.201
39	1	2	10.5	1	0	0	0.89	1	0.193
40	1	2	11.5	1	0	0	0.96	1	0.192
41	1	2	12.5	1	0	0	0.91	1	0.156
42	1	2	13.5	1	0.17	0.58	0.86	1	0.186
43	1	2	14.5	1	0	0.94	0.94	1	0.158

ReferenceOffice_intgain.500lx detailed dynamic shading.xlsx



Go to DAYSIM.com for help, questions and to download.

Thank you.

Questions?

(followed by a demonstration time permitting)