12th International
RADIANCE Workshop

August 12-14, 2013
National Renewable Energy Laboratory
Golden, Colorado

Spatial Daylight Autonomy & Annual Sunlight Exposure
The LM-83 Radiance Script (using 3-phase method)
8.14.2013

INTEGRATED DESIGN LAB
University of Idaho

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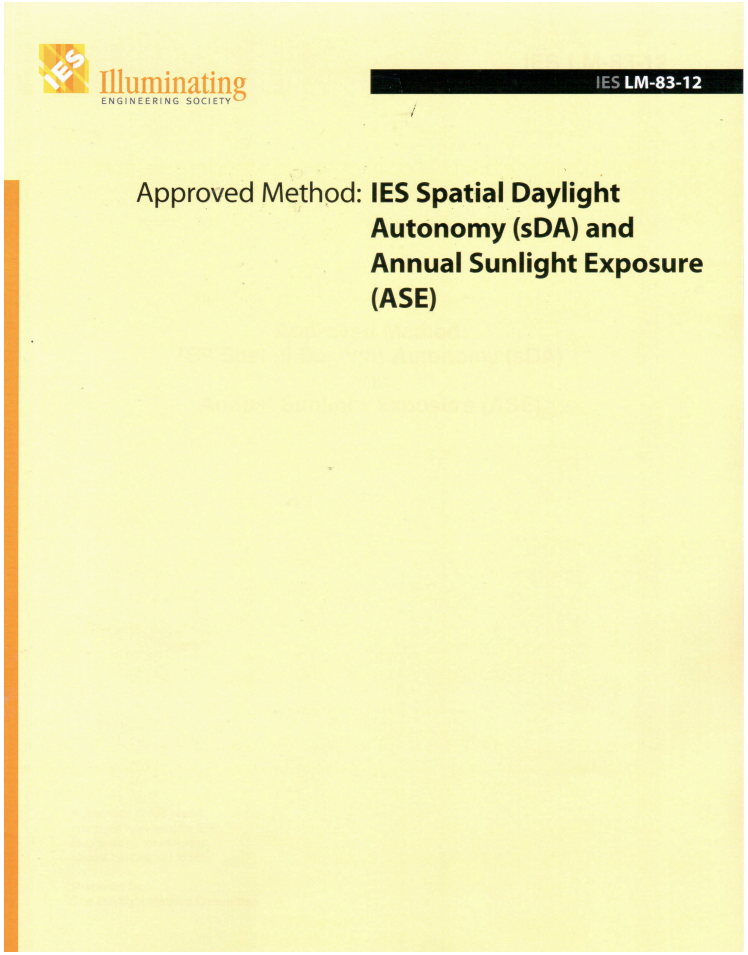
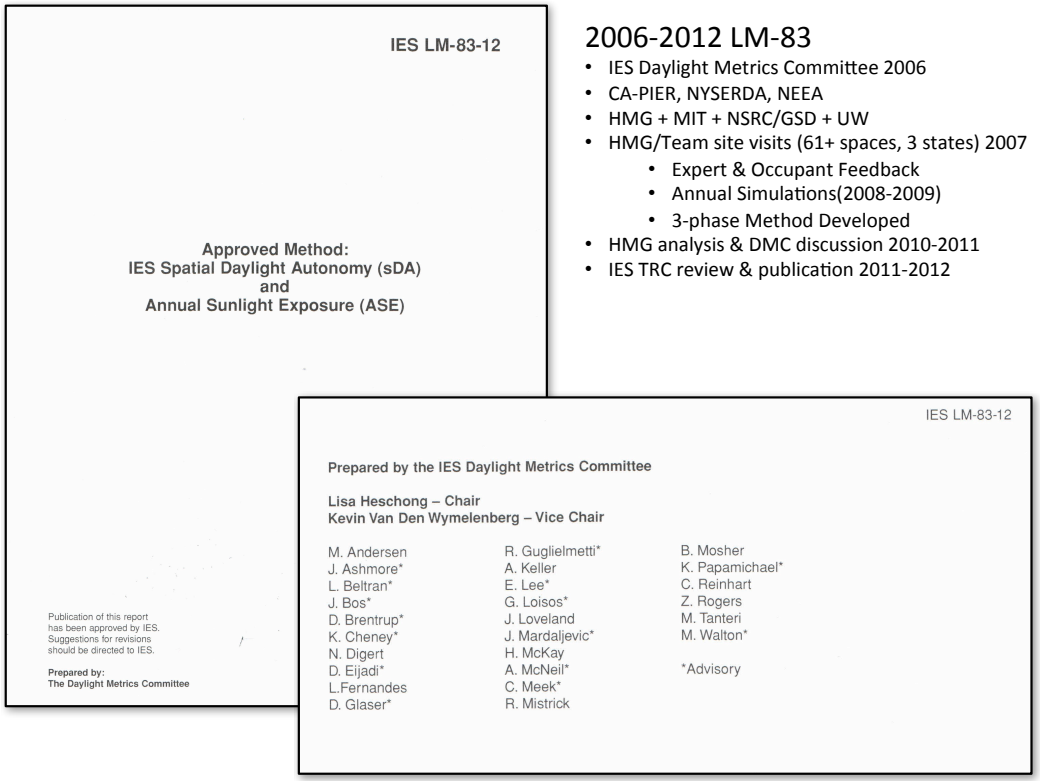




2006-2012 LM-83

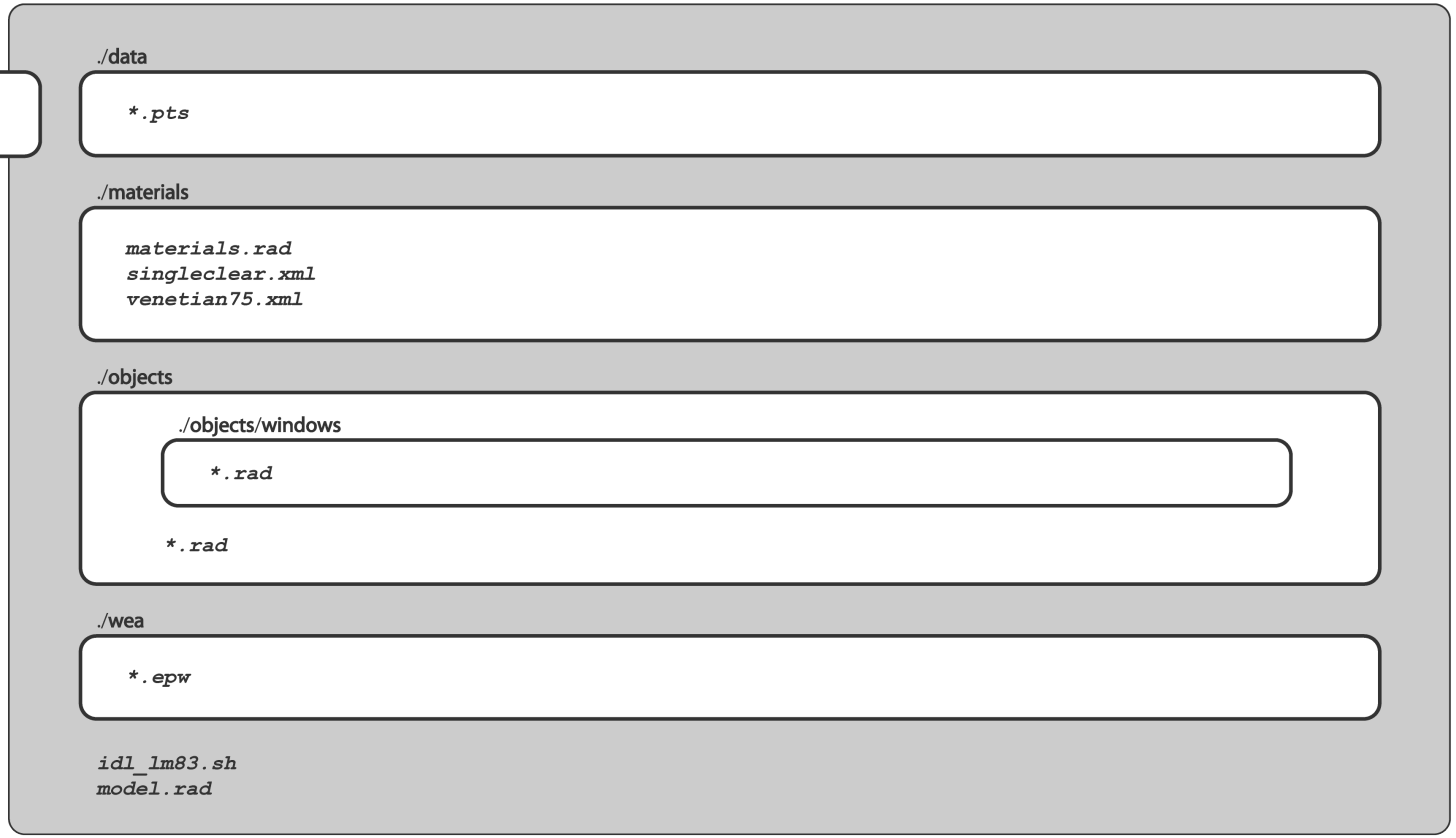
- IES Daylight Metrics Committee 2006
- CA-PIER, NYSERDA, NEEA
- HMG + MIT + NSRC/GSD + UW
- HMG/Team site visits (61+ spaces, 3 states) 2007
  - Expert & Occupant Feedback
  - Annual Simulations(2008-2009)
  - 3-phase Method Developed
- HMG analysis & DMC discussion 2010-2011
- IES TRC review & publication 2011-2012

Available at http://idlboise.com/design-tool/lm-83-automation

LM-83 automation – BASH-based Structure

Folder structure.

V1.0 – April 23 2013
V2.0 – Next week ☺



Simulation

Set up materials and models for the View Matrix, Daylight Matrix, and Direct Exposure analysis.

For all **window groups**

```
inherit alias "window_group" "light_material" >> $vmx
inherit alias "window_group" "glazing_material" >> $dmx
inherit alias "window_group" "wall_material" >> $dxp
```

```
oconv $materials $vmx $model > model_vmx.oct
oconv $materials $dmx $model $sky > model_dmx.oct
```

Generate Daylight matrices for all window groups.

For all **window groups**

```
genklemsamp -vd N N N window_group.rad |rcontrib -fo -faf -c 1000 \
-e MF:N -f reinhart.cal -o window_group.dmx -b rbin -bn Nrbins \
-m sky_glow model_dmx.oct

$modlist=$modlist -b kbinN|E|S|W -m window_group
```

Generate View matrices for all point analysis grids.

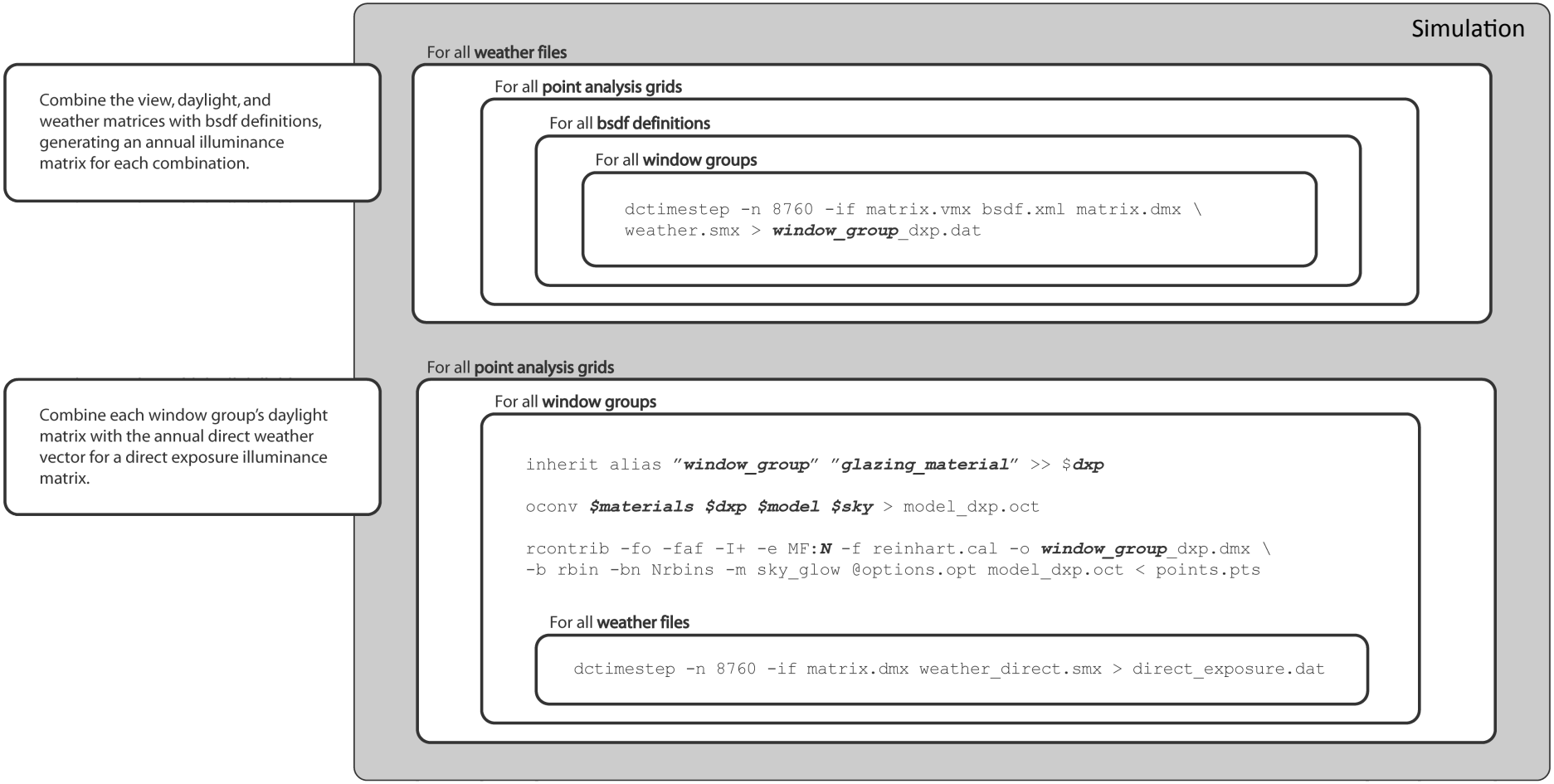
For all **point analysis grids**

```
rcontrib -fo -faf -f klems_int.cal -bn Nkbins -o points_%s.vmx \
$modlist -I+ @options.opt model_vmx.oct < points.pts >
```

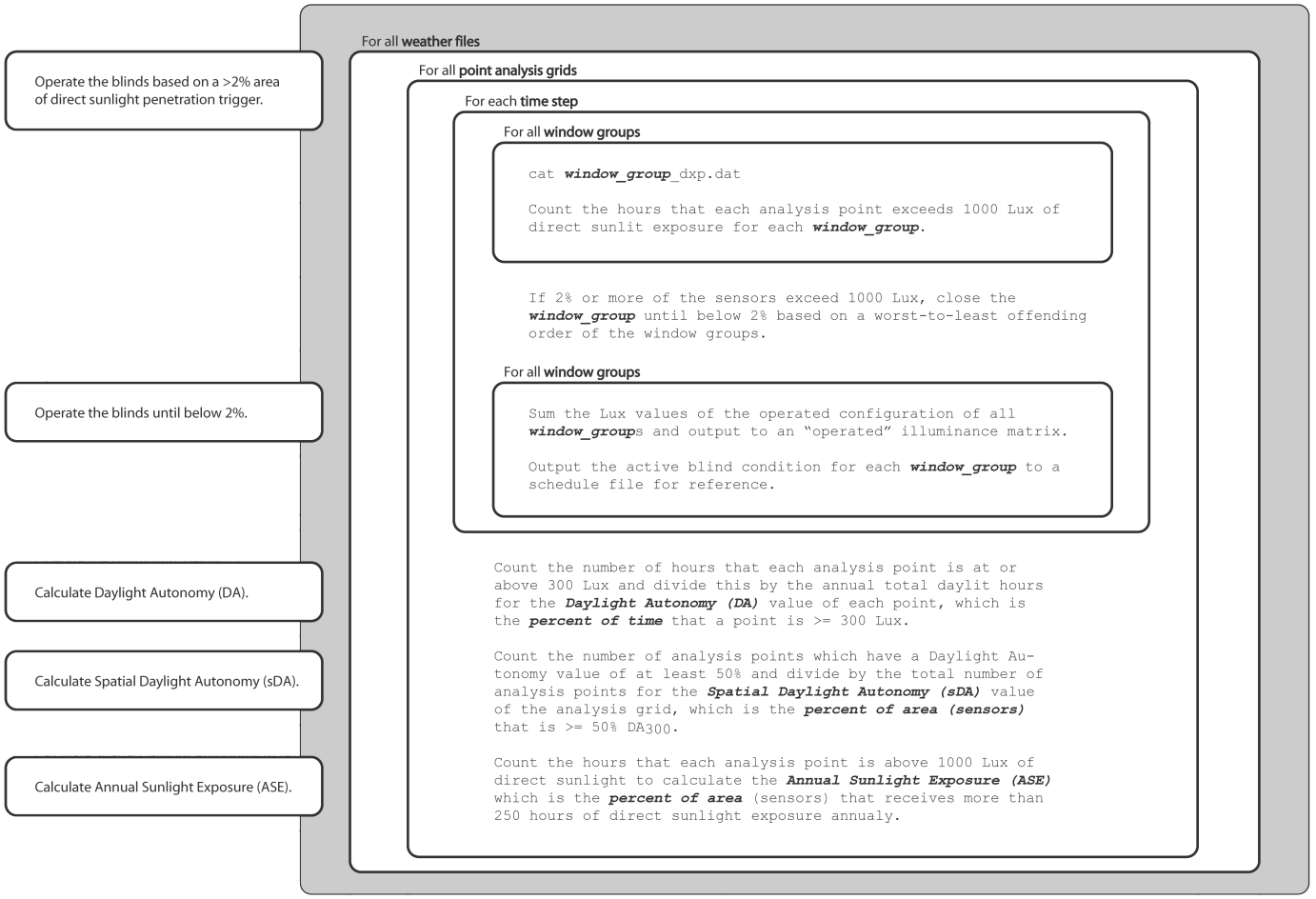
Generate annual weather data vectors, full and direct-only.

For all **weather files**

```
weather.epw > weather.wea
gendaymtx -r N -m N -of weather.wea > weather.smx
gendaymtx -d -r N -m N -of weather.wea > weather_direct.smx
```


Simulation
For all weather files
For all point analysis grids
For all bsdf definitions
For all window groups
dctimestep -n 8760 -if matrix.vmx bsdf.xml matrix.dmx \
weather.smx > window_group_dxp.dat
Combine the view, daylight, and weather matrices with bsdf definitions, generating an annual illuminance matrix for each combination.
For all point analysis grids
For all window groups
inherit alias "window_group" "glazing_material" >> $dxp
oconv $materials $dxp $model $sky > model_dxp.oct
rcontrib -fo -faf -I+ -e MF:N -f reinhart.cal -o window_group_dxp.dmx \
-b rbin -bn Nrbins -m sky_glow @options.opt model_dxp.oct < points.pts
For all weather files
dctimestep -n 8760 -if matrix.dmx weather_direct.smx > direct_exposure.dat
Combine each window group's daylight matrix with the annual direct weather vector for a direct exposure illuminance matrix.

Calculations



Ash Creek Elementary | Monmouth, OR | BOORA Architects
Photo: Nick Hubof, UI-IDL
Rendering: Nick Hubof, UI-IDL

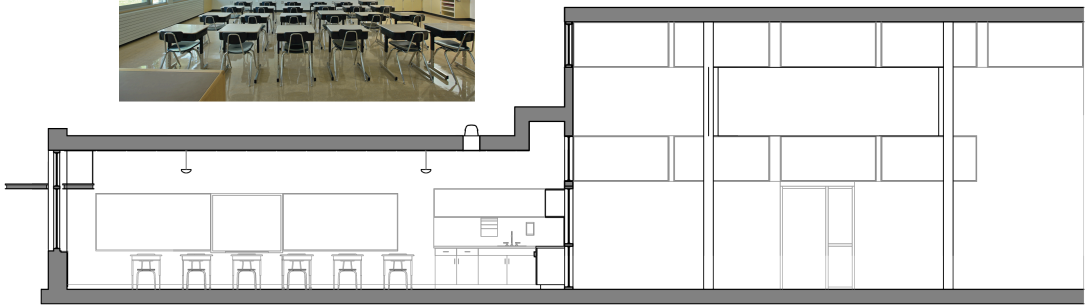
Annual metrics for a classroom model

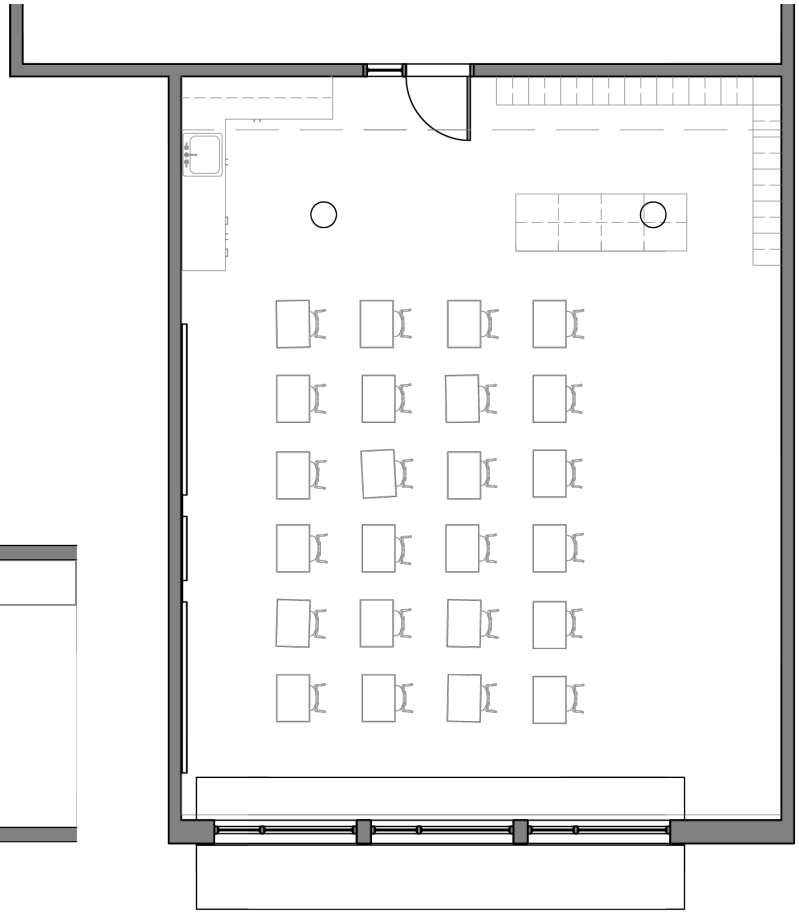
South face.

- Run with varied number of window groups.

North re-light.

- Run as a single north-facing window group.



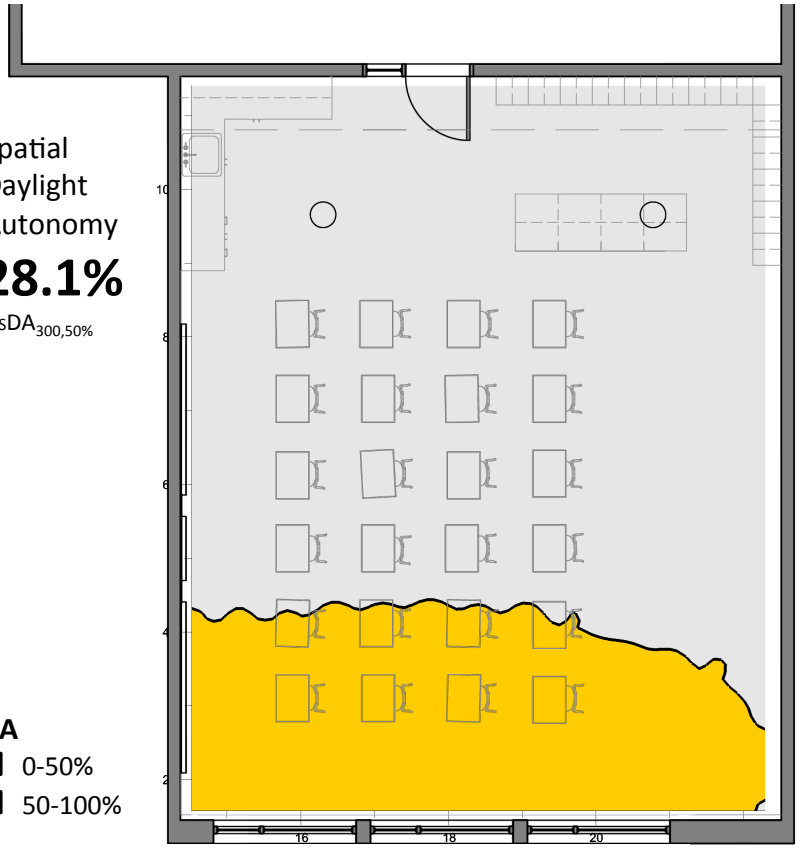


No shading 1 south window group

Spatial
Daylight
Autonomy

28.1%

$sDA_{300,50\%}$



DA

- 0-50%
- 50-100%

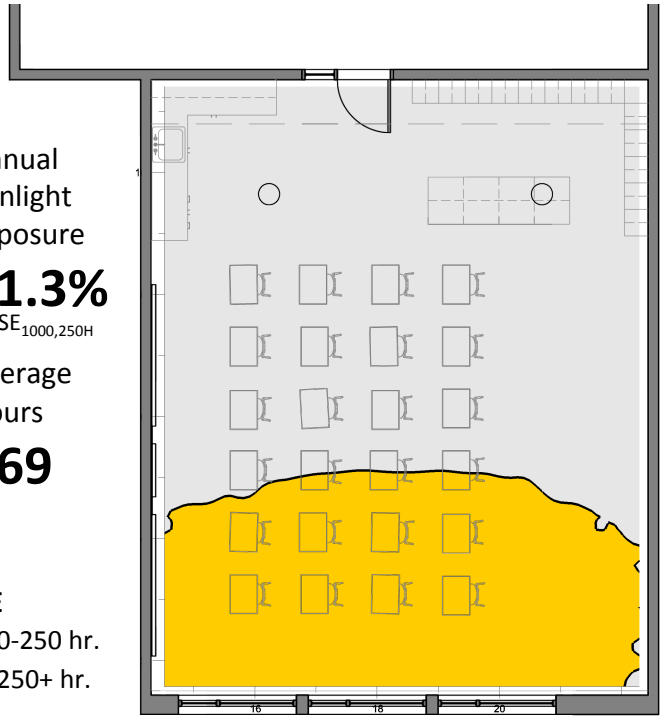
Annual
Sunlight
Exposure

31.3%

$ASE_{1000,250H}$

Average
Hours

669



ASE

- 0-250 hr.
- 250+ hr.

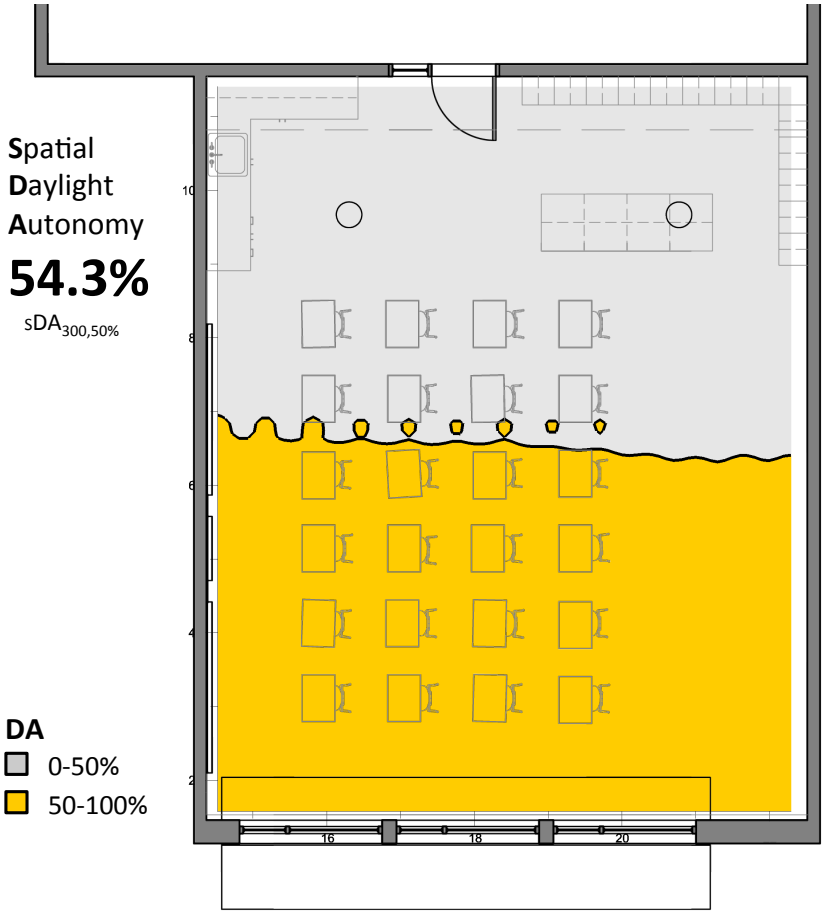
Using LM-83 script v1.0

Shading + light shelf 2 south window groups

Spatial
Daylight
Autonomy

54.3%

$sDA_{300,50\%}$



DA

- 0-50%
- 50-100%

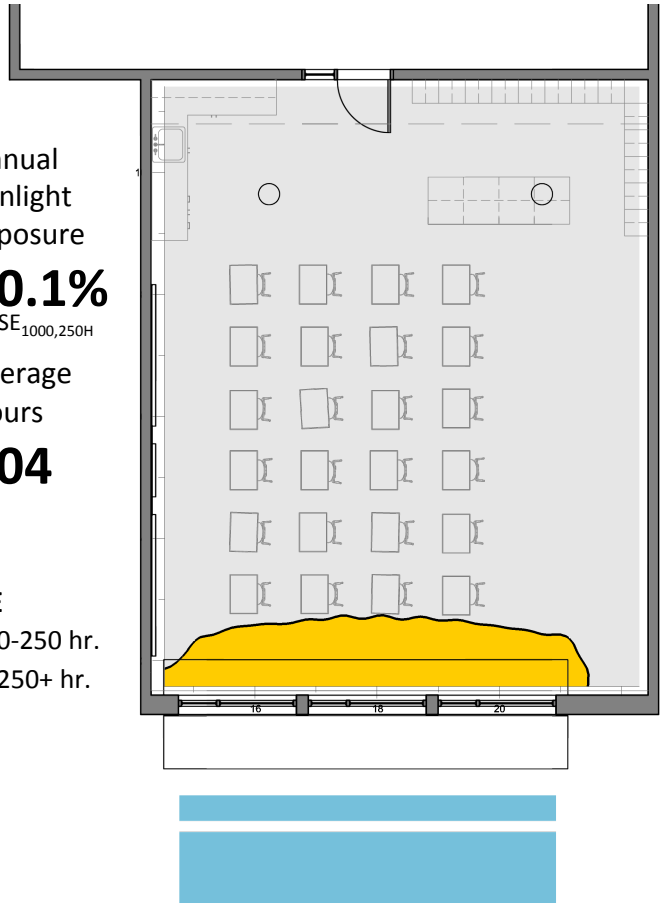
Annual
Sunlight
Exposure

10.1%

$ASE_{1000,250H}$

Average
Hours

604



ASE

- 0-250 hr.
- 250+ hr.

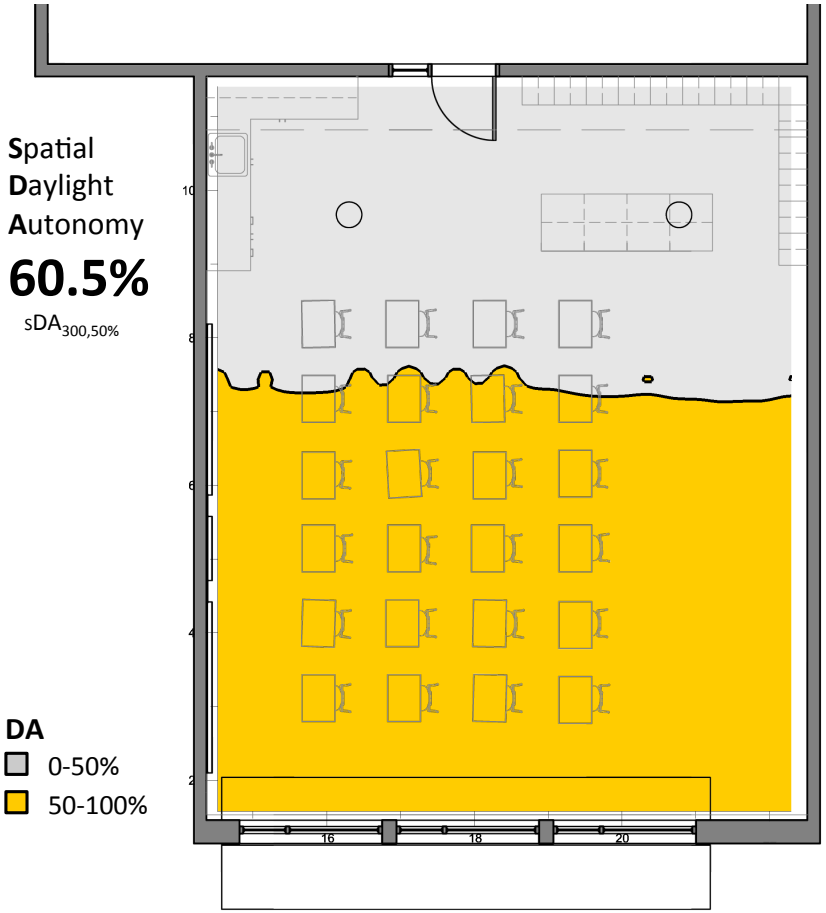
Using LM-83 script v1.0

Shading + light shelf 6 south window groups

Spatial
Daylight
Autonomy

60.5%

$sDA_{300,50\%}$



DA

- 0-50%
- 50-100%

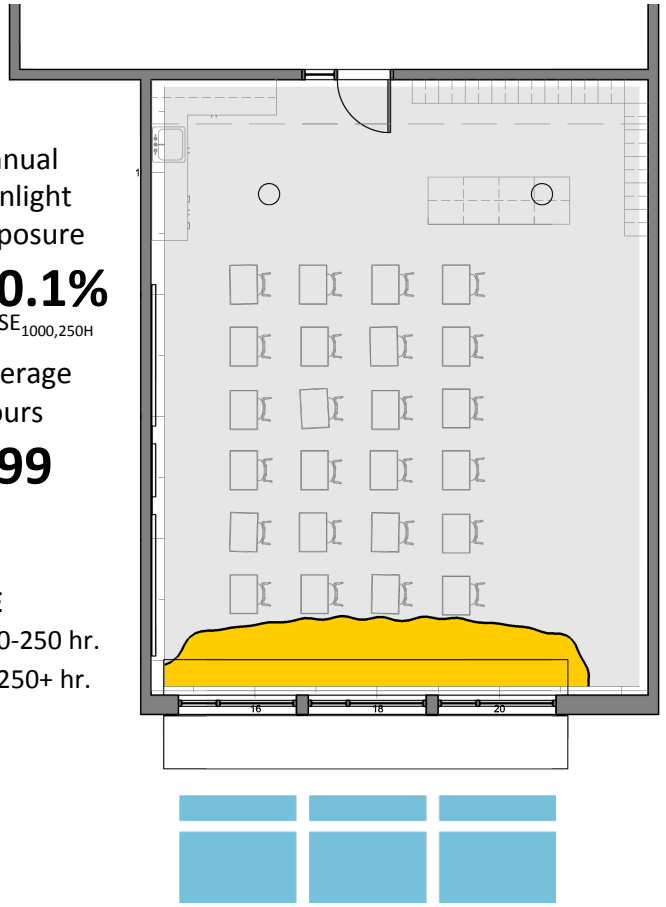
Annual
Sunlight
Exposure

10.1%

$ASE_{1000,250H}$

Average
Hours

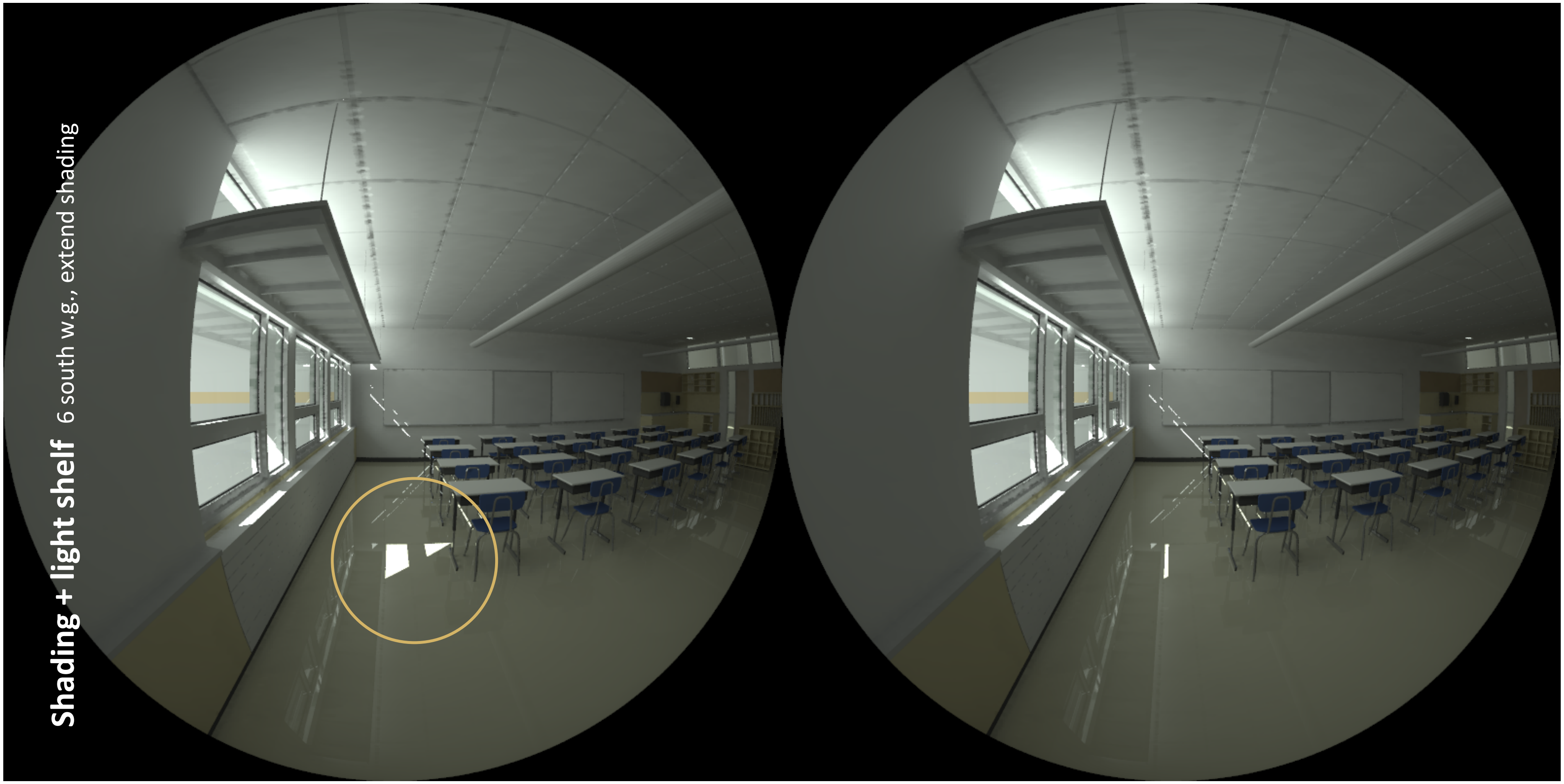
599



ASE

- 0-250 hr.
- 250+ hr.

Using LM-83 script v1.0

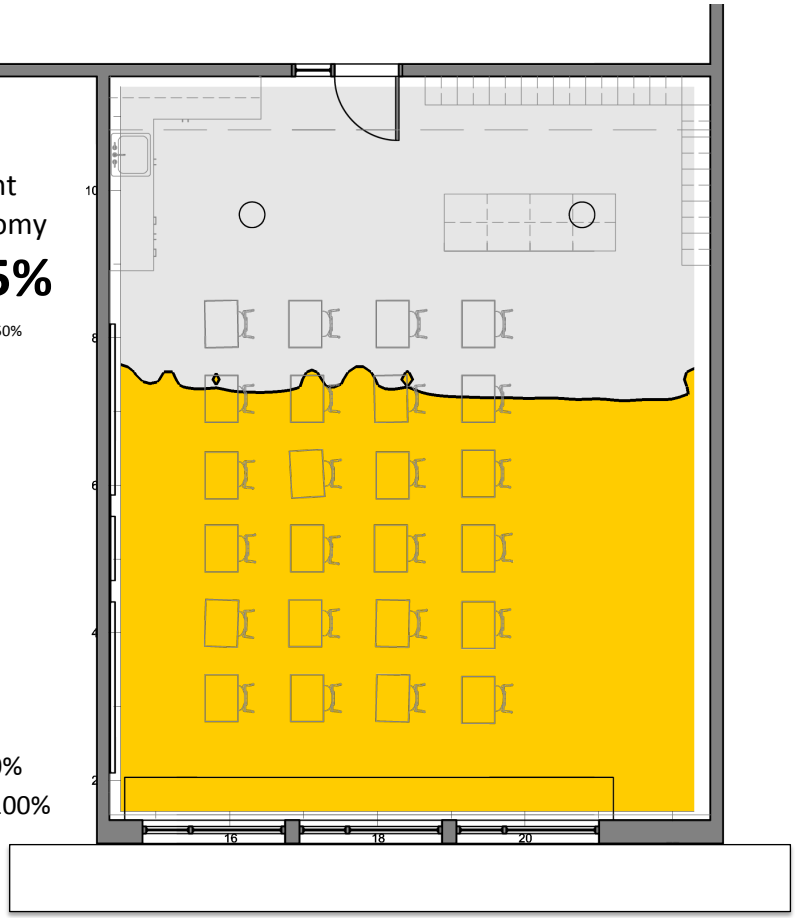

Shading + light shelf 6 south w.g., extend shading

Shading + light shelf 6 south w.g., extend shading

Spatial
Daylight
Autonomy

60.5%

$sDA_{300,50\%}$



DA

- 0-50%
- 50-100%

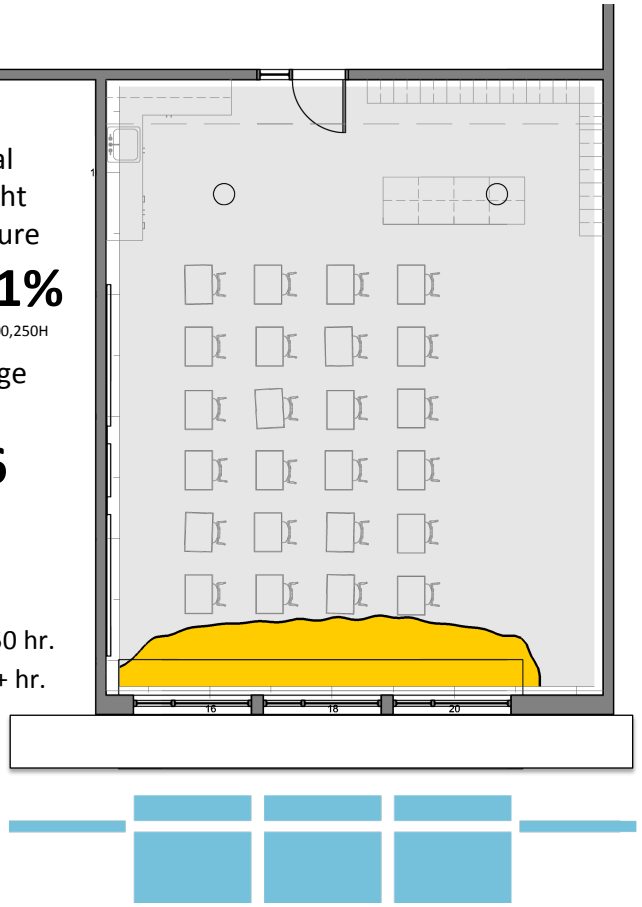
Annual
Sunlight
Exposure

10.1%

$ASE_{1000,250H}$

Average
Hours

576



ASE

- 0-250 hr.
- 250+ hr.

Using LM-83 script v1.0

Shading + light shelf 6 south w.g., extend shading

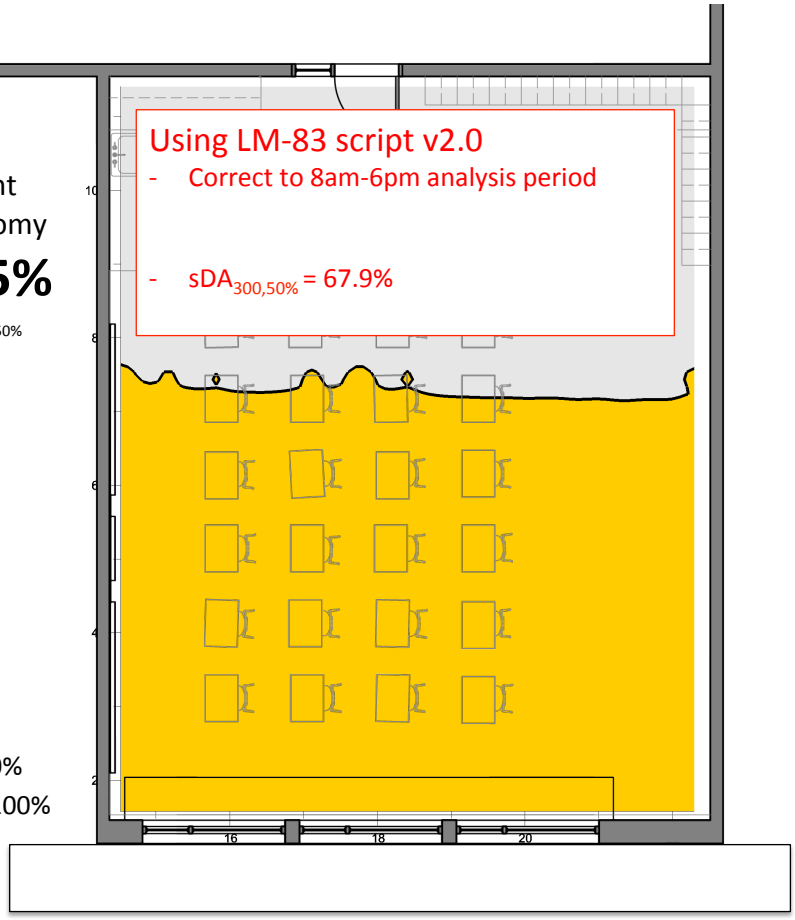
Spatial
Daylight
Autonomy

60.5%

$sDA_{300,50\%}$

Using LM-83 script v2.0
- Correct to 8am-6pm analysis period

- $sDA_{300,50\%}$ = 67.9%



DA
- 0-50%
- 50-100%

Annual
Sunlight
Exposure

10.1%

$ASE_{1000,250H}$

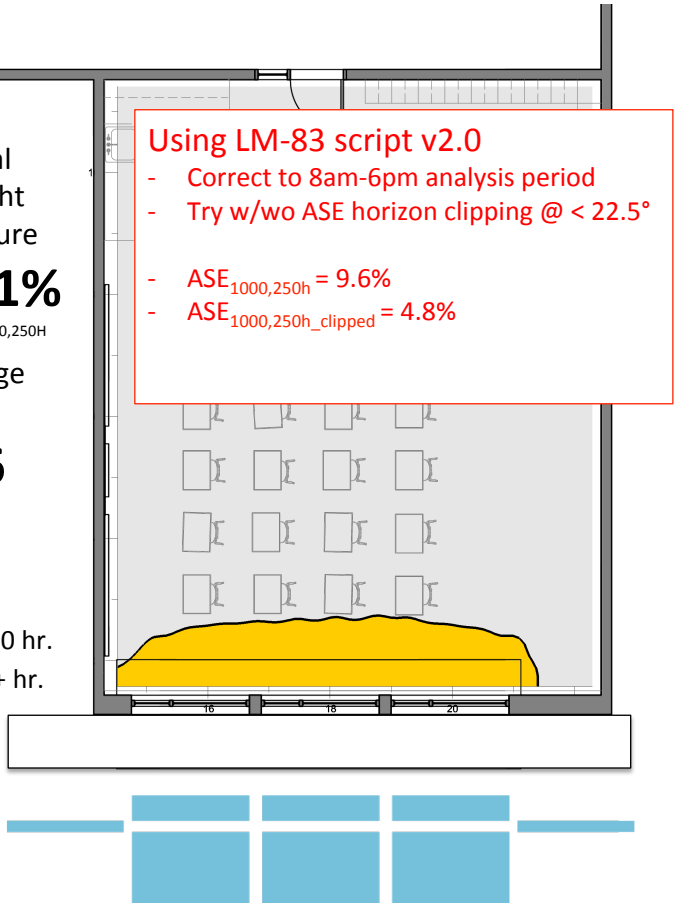
Average
Hours

576

Using LM-83 script v2.0
- Correct to 8am-6pm analysis period
- Try w/wo ASE horizon clipping @ < 22.5°

- $ASE_{1000,250h}$ = 9.6%
- $ASE_{1000,250h\_clipped}$ = 4.8%

ASE
- 0-250 hr.
- 250+ hr.



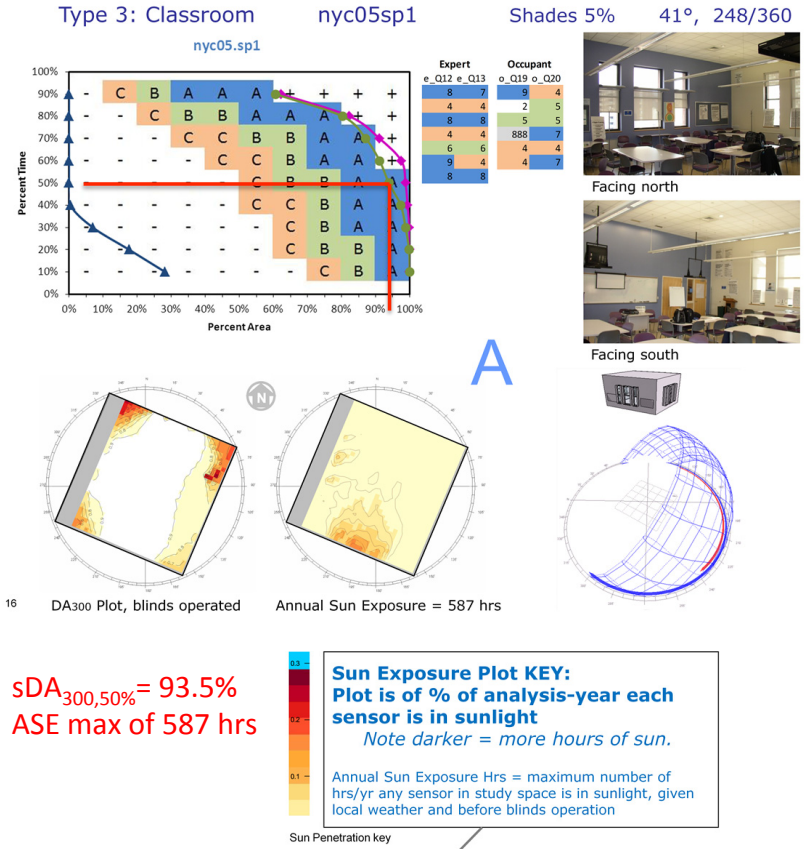
Using LM-83 script v1.0

V2.0 run on Ashcreek_boiseweather

- Shaded_h sDA=68.4% ASE=9.6% $ASE_{clipped}$=5.3% $ASE_{maxours}$= 945 $ASE_{clipped\_maxhours}$=740
- Shaded_h_ext sDA=67.9% ASE=9.6% $ASE_{clipped}$=4.8% $ASE_{maxours}$= 914 $ASE_{clipped\_maxhours}$=663
- Shaded_sola sDA=65.6% ASE=10.1% $ASE_{clipped}$=5.3% $ASE_{maxours}$= 916 $ASE_{clipped\_maxhours}$=698

Our guess??
H = high granularity of window groups up to 6 from 2
H ext = extended exterior overhang with 6 window groups
Sola = rerun with solatube bsdf, but don't think it worked

Validation: HMG Daylight Metrics NYC05sp1



$sDA_{300,50\%}$= 93.5%
ASE max of 587 hrs

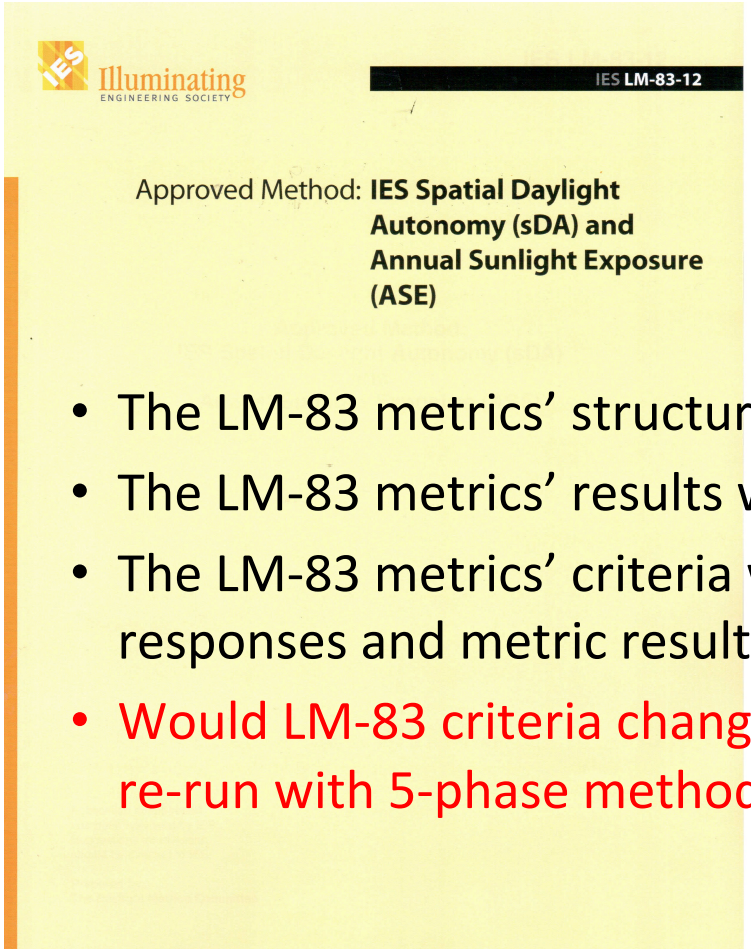
LM-83 script V2.0 (no glass to sw - oops)

$sDA_{300,50\%}$= 81.5%
$ASE_{1000,250h\_MaxHours}$=712
$ASE_{1000,250h\_MaxHours\_clipped}$=697
$ASE_{1000,250h}$=13.8%
$ASE_{1000,250h\_clipped}$=8.8%

LM-83 script V2.0 (no glass to ne)

$sDA_{300,50\%}$= 83.5%
$ASE_{1000,250h\_MaxHours}$=714
$ASE_{1000,250h\_MaxHours\_clipped}$=711
$ASE_{1000,250h}$=13.6%
$ASE_{1000,250h\_clipped}$=10.6%

Not there just yet…



LM-83 & 5-phase method?

- The LM-83 metrics' structure are indifferent between 3-phase & 5-phase
- The LM-83 metrics' results will likely change between 3-phase & 5-phase
- The LM-83 metrics' criteria were based on correlations between human responses and metric results from models run with 3-phase method
- Would LM-83 criteria change if HMG's 61 Daylight Metrics models were re-run with 5-phase methods and correlated with human responses?

conclude

- Draft of LM-83 sDA & ASE metrics available as V1.0 now
- V2.0 coming soon (validated)
- DMC ‘design guide’ coming soon
  - How to use the metrics in design examples
  - Sensitivity tests of allowed variable simulation parameters (window groups etc.)
- Test implications of 5-phase method on LM-83 recommended criteria