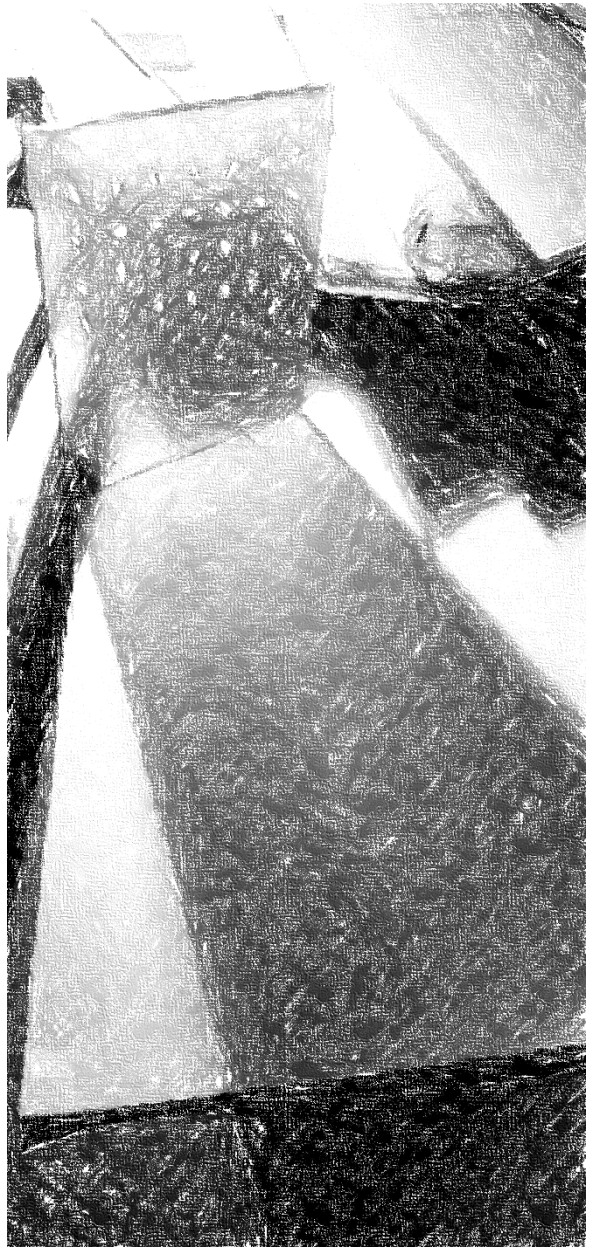

THE AMERICAN UNIVERSITY IN CAIRO
الجامعة الأمريكية بالقاهرة

# Pattern Optimization of a CFS made from recycled plastic using the five phase method

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THE AMERICAN UNIVERSITY IN CAIRO

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# INTRODUCTION

We needed a cost effective way to get the LEED credits for classrooms in a low-cost rural school project in Cairo sDA > 50% and ASE < 10%

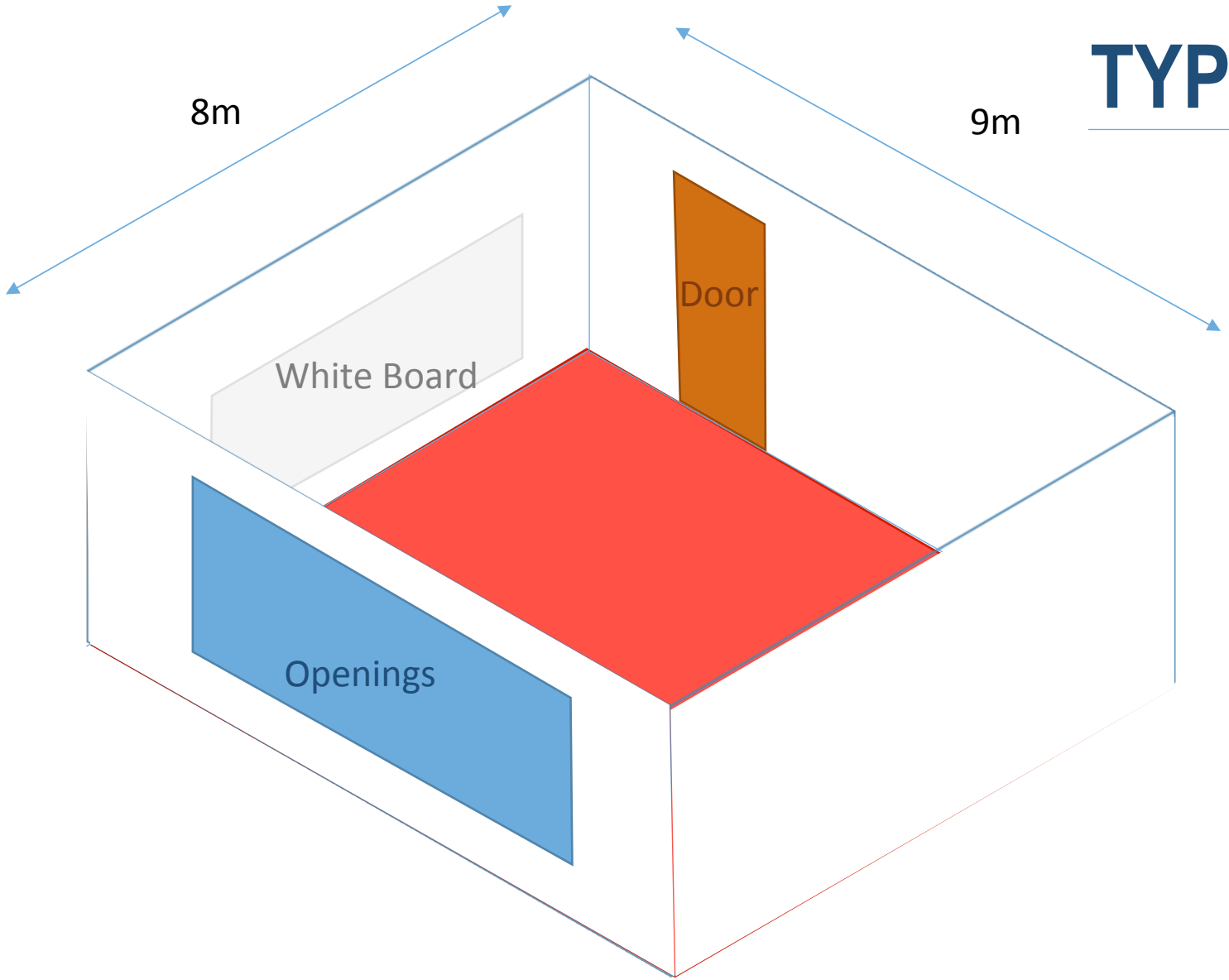
Classrooms are facing south!

Often an overlit problem

Different solutions exist such as shading devices (which have been proven not functional, light-shelves which are costly, etc…

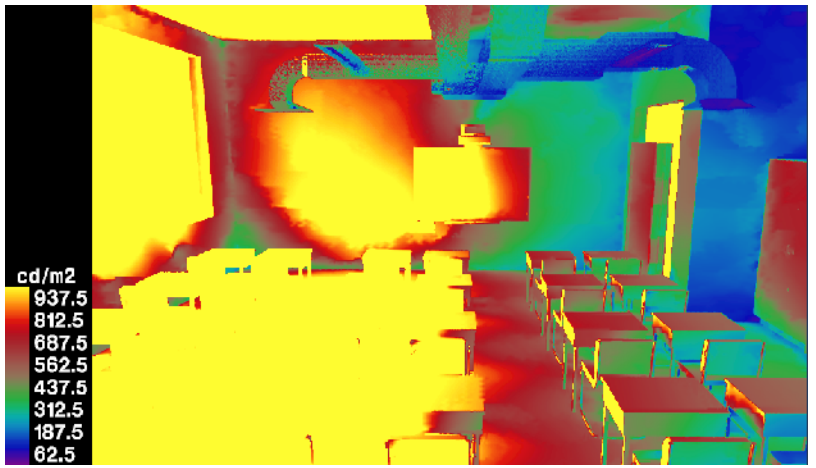
We needed a very cheap window panel

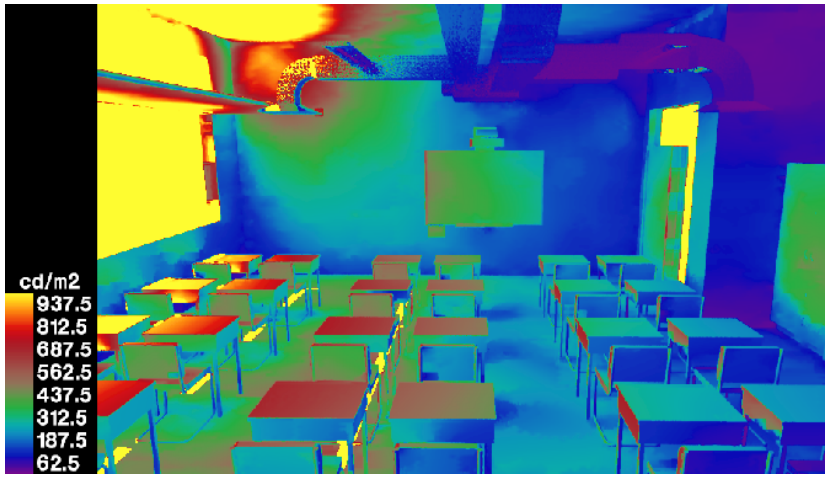
# TYPICAL CLASSROOM



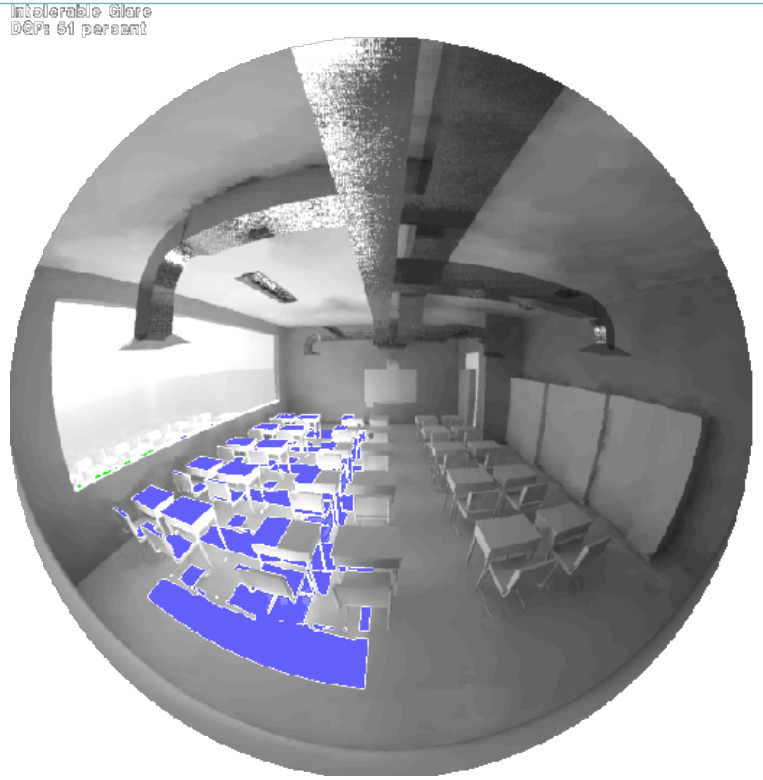

| Element | Reflectivity |
|---|---|
| Ceilings | 90% |
| Walls | 50% |
| Floors | 20% |

# LIGHT SHELF SOLUTION



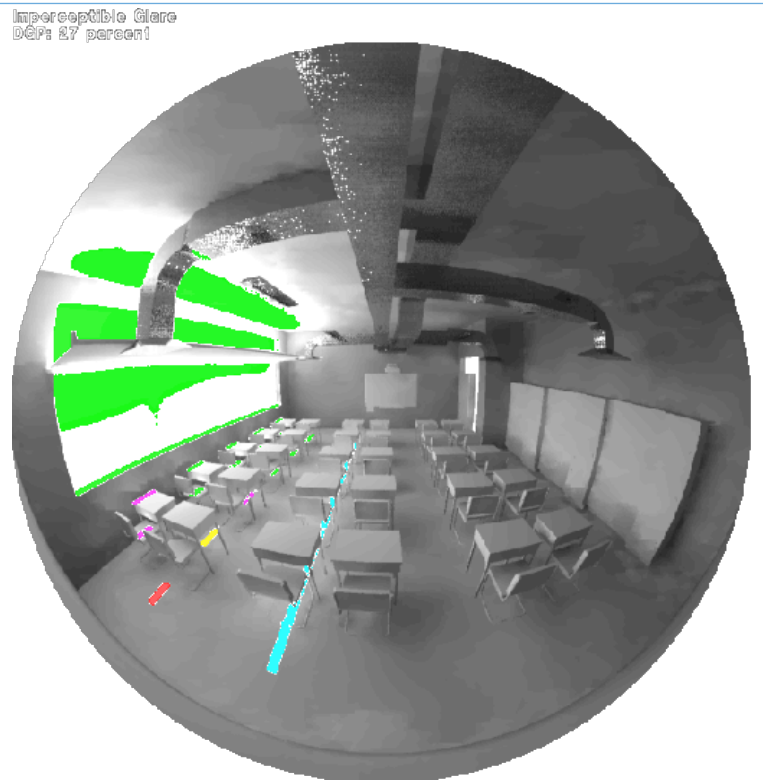




# GLARE ANALYSIS




DGP: 51

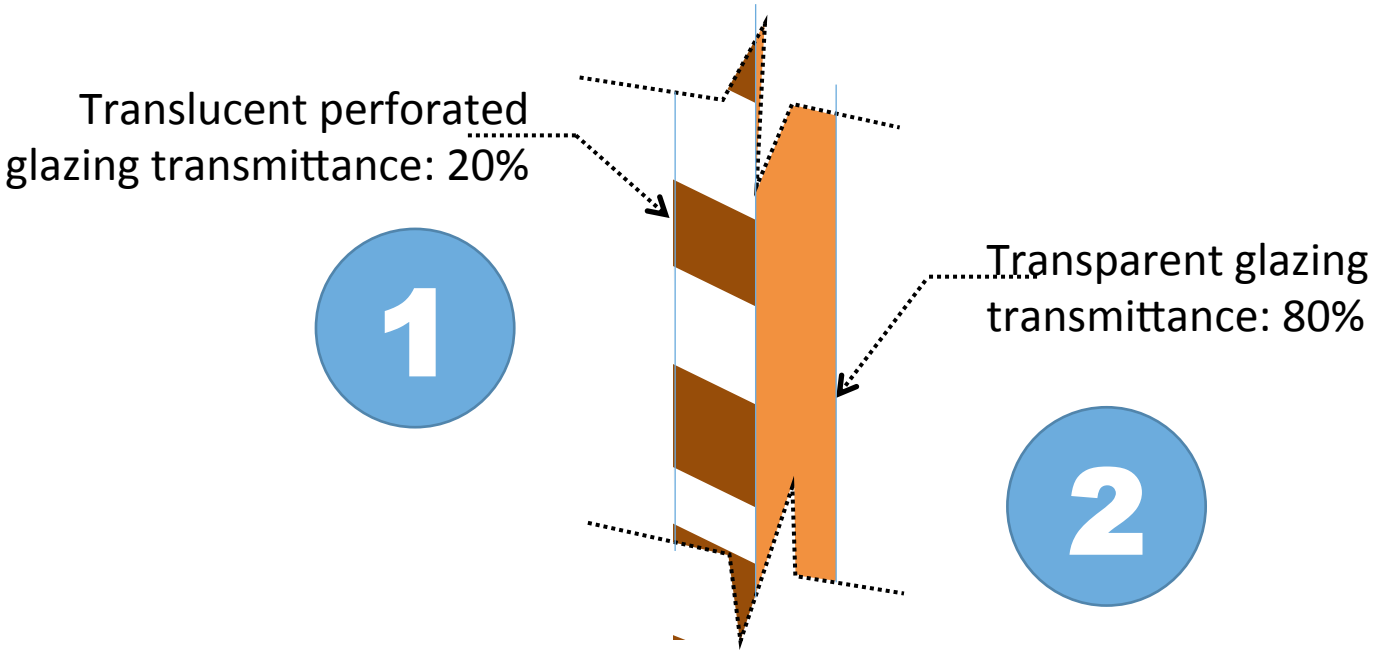
Intolerable glare




DGP: 27

Imperceptible glare

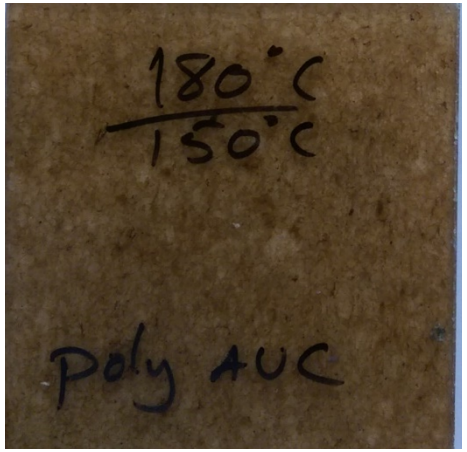
# RECYCLED PLASTIC PANELS

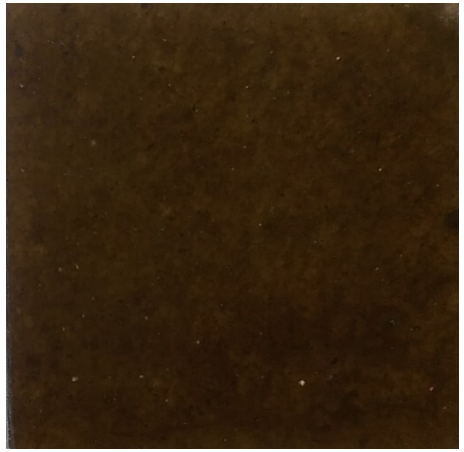


# CONTENTS

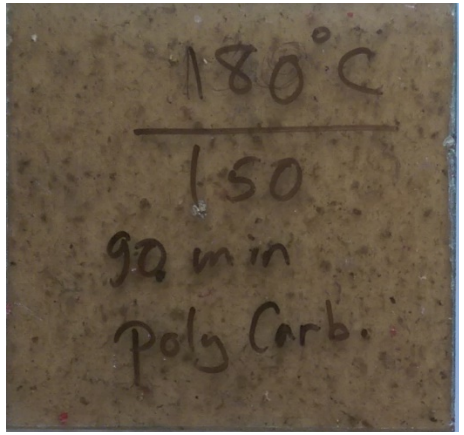
This is a small sample of the recycled plastic panel for an initial visual comparison. Actually this is the solution that is adopted by the

# TYPES OF RECYCLED PLASTIC PANELS



These are different options for the recycled plastic panel options made from different recycled content at different temperatures and times

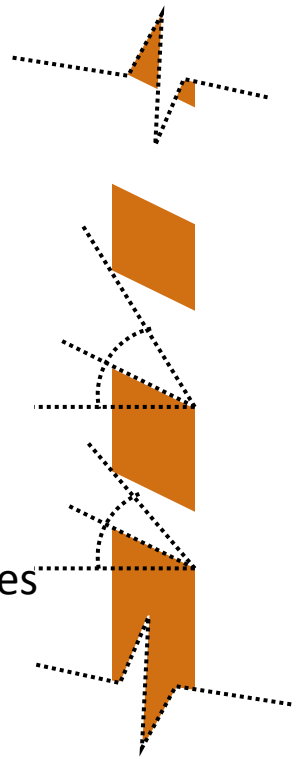

# TYPES OF RECYCLED PLASTIC PANELS

The interesting thing about this problem is you can control the design as well as the material.

Both the material and the design are parameters

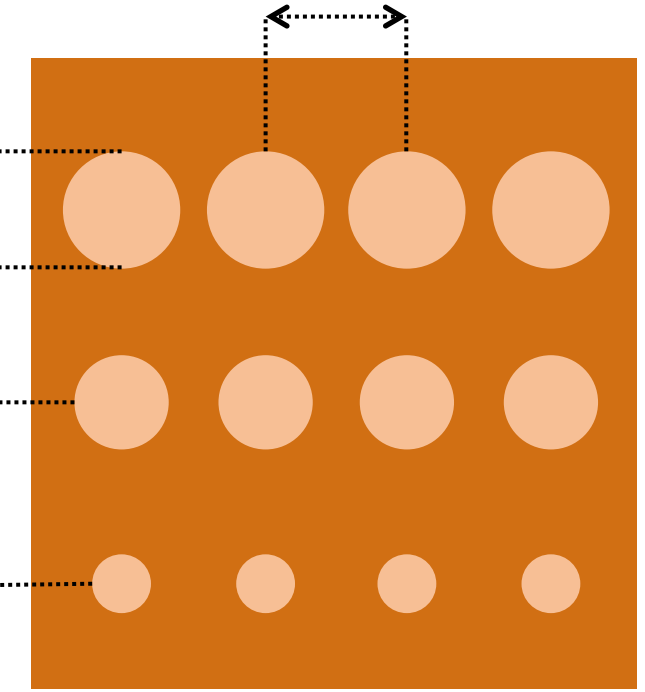
You can go back and make the material that fits your design!

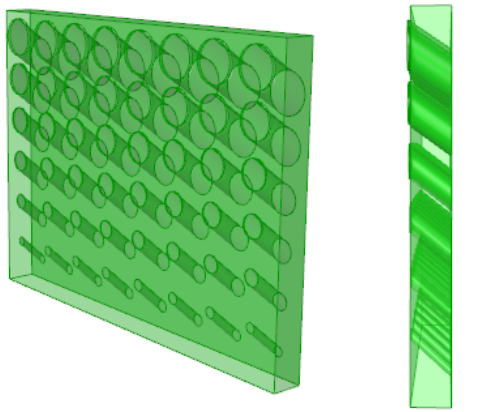
# PARAMETRIC VARIATIONS

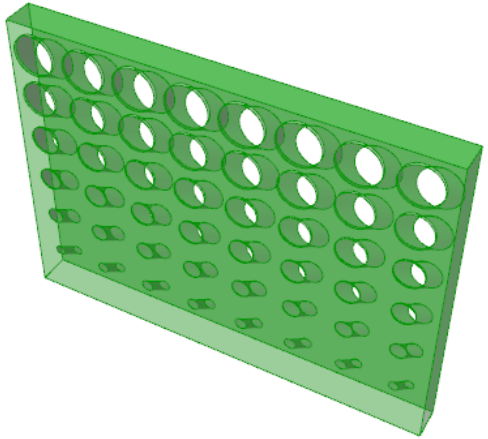


Blocking high
Solar altitudes
with smaller holes

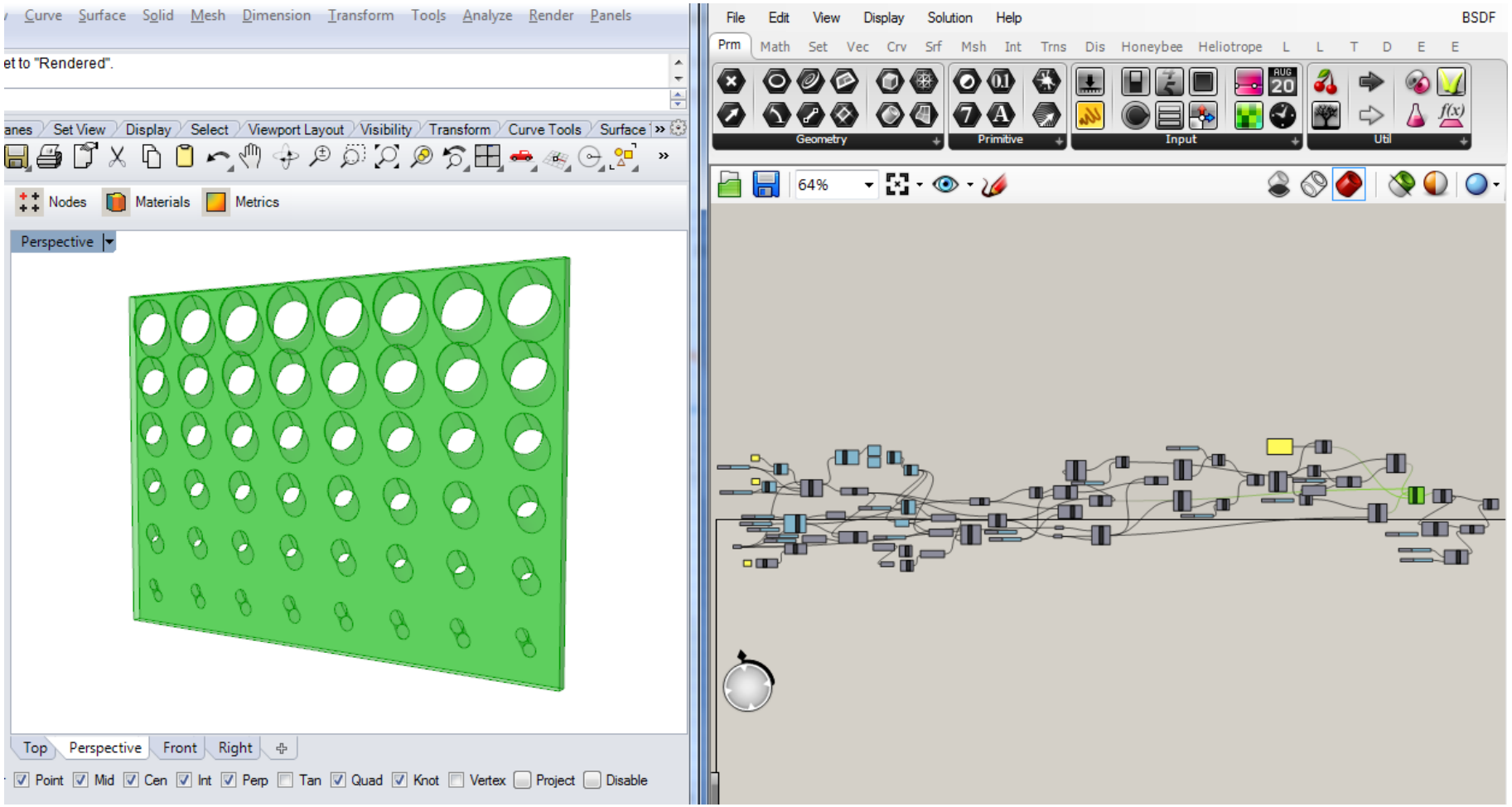
Smaller holes
as we go down



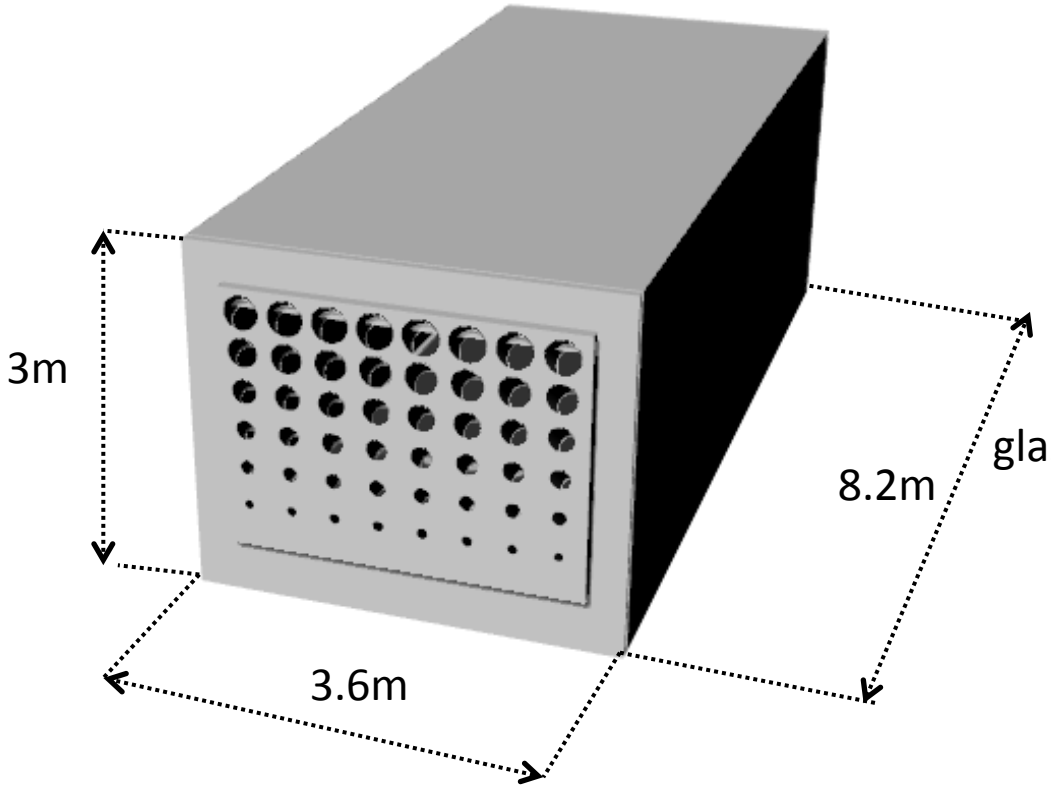




# PARAMETRIC VARIATIONS



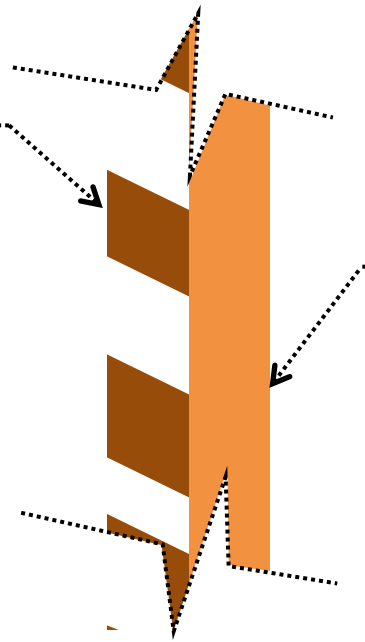
# BASIC SETUP




Window-to-wall ratio: 50%

Inner wall Reflectance: 80%

Translucent perforated glazing transmittance: 20%

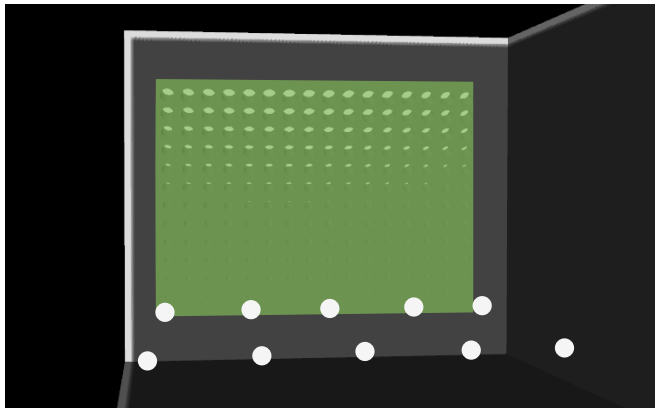


Transparent glazing transmittance: 80%

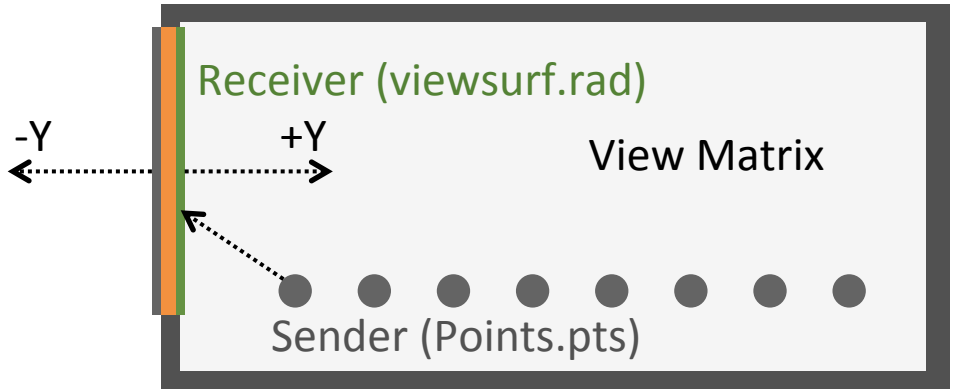
This is not to scale as the openings are much smaller

# VIEW MATRIX

rfluxmtx.exe -faa -I+ -ab 6 -ad 20000 -lw 1.52e-5 -y 45 <points.pts - viewsurf.rad materials.rad room.rad > viewmatrix.vmx

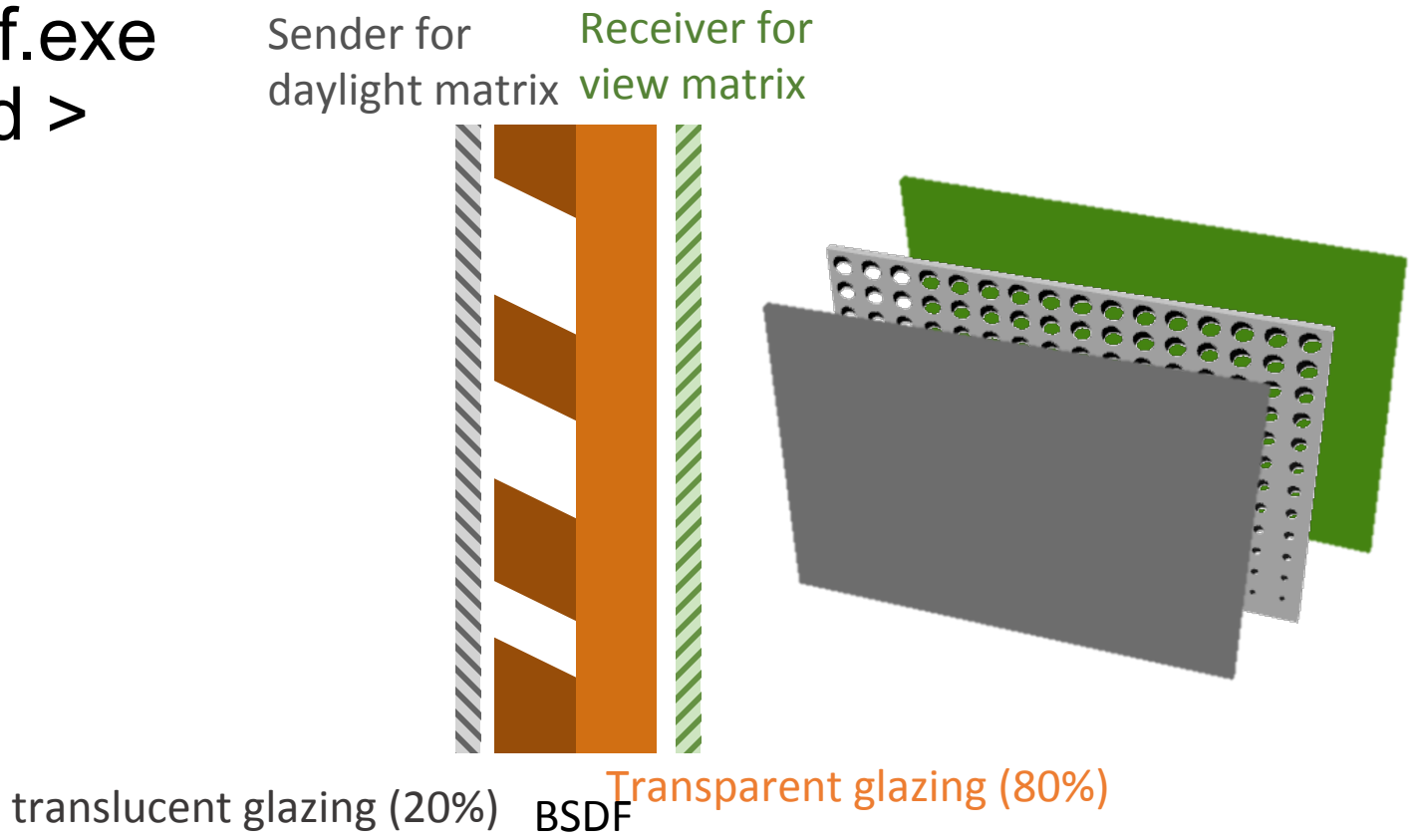


View Matrix



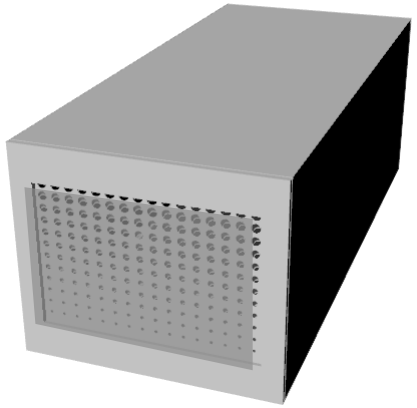
# BSDF TRANSMITTER

- C:\Radiance\bin\genbsdf.exe materialbsdf.rad bsdf.rad > bsdf.xml

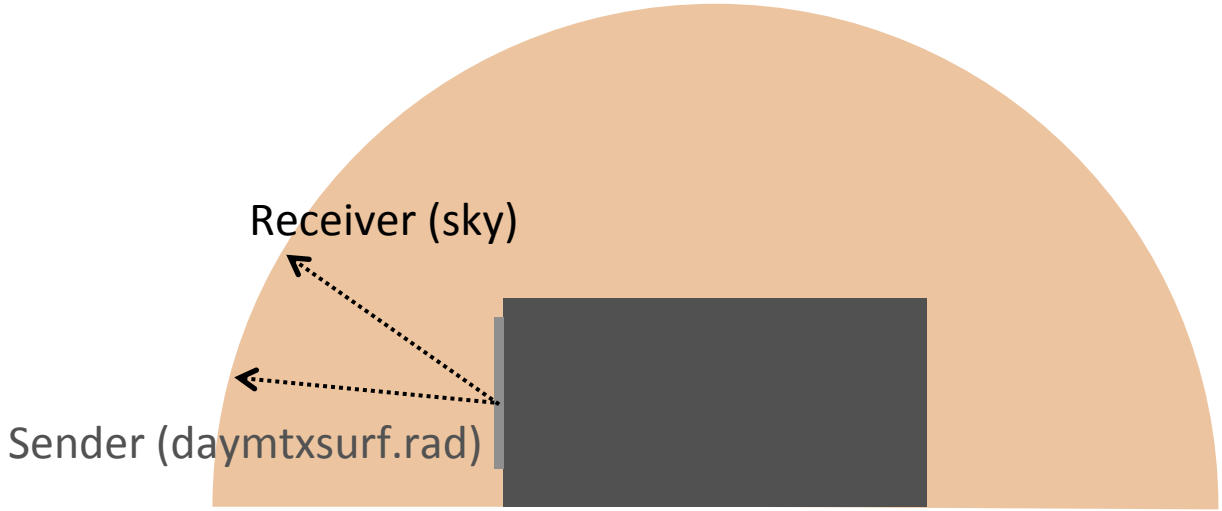


# DAYLIGHT MATRIX

- rfluxmtx.exe -faa -c 10000 -ab 2 -ad 5000 -lw 1e-4 daymtxsurf.rad sky.rad materials.rad room.rad > daylight2.dmx



Daylight Matrix




Daylight Matrix

# DIFFERENT DESIGN OPTIONS

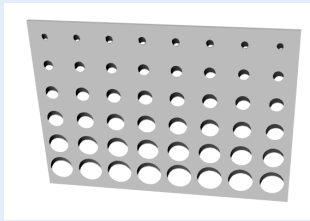
Glass

| | | | | |
|---|---|---|---|---|
| 92% | 92% | 92% | 92% | 91% |
| 89% | 89% | 89% | 89% | 89% |
| 85% | 85% | 85% | 85% | 84% |
| 80% | 80% | 80% | 80% | 80% |
| 76% | 77% | 77% | 76% | 76% |
| 68% | 69% | 69% | 69% | 68% |
| 60% | 61% | 61% | 61% | 60% |
| 53% | 54% | 54% | 55% | 54% |
| 46% | 48% | 48% | 47% | 46% |

sDA=89%

| | | | | |
|---|---|---|---|---|
| 77% | 79% | 79% | 79% | 75% |
| 66% | 68% | 68% | 68% | 67% |
| 56% | 56% | 57% | 57% | 56% |
| 43% | 43% | 44% | 44% | 42% |
| 29% | 30% | 31% | 30% | 29% |
| 16% | 17% | 17% | 17% | 16% |
| 7% | 8% | 9% | 9% | 7% |
| 1% | 3% | 3% | 3% | 2% |
| 0% | 0% | 0% | 0% | 0% |

ASE=80%

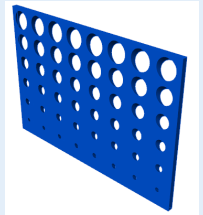


| | | | | |
|---|---|---|---|---|
| 57% | 62% | 63% | 61% | 56% |
| 48% | 52% | 53% | 51% | 47% |
| 33% | 35% | 37% | 37% | 34% |
| 19% | 21% | 21% | 21% | 19% |
| 8% | 8% | 10% | 8% | 8% |
| 0% | 0% | 0% | 0% | 0% |
| 0% | 0% | 0% | 0% | 0% |
| 0% | 0% | 0% | 0% | 0% |
| 0% | 0% | 0% | 0% | 0% |

sDA=18%

| | | | | |
|---|---|---|---|---|
| 11% | 16% | 16% | 16% | 10% |
| 6% | 10% | 9% | 10% | 8% |
| 1% | 3% | 3% | 3% | 2% |
| 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% |

ASE=22%

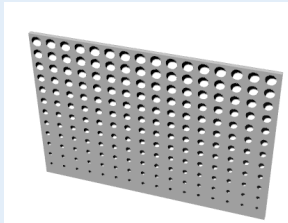


| | | | | |
|---|---|---|---|---|
| 74% | 77% | 78% | 77% | 75% |
| 68% | 70% | 72% | 71% | 69% |
| 59% | 60% | 61% | 60% | 59% |
| 45% | 47% | 47% | 47% | 45% |
| 32% | 32% | 33% | 32% | 32% |
| 18% | 19% | 19% | 19% | 17% |
| 9% | 9% | 10% | 10% | 8% |
| 2% | 4% | 4% | 5% | 4% |
| 0% | 0% | 0% | 0% | 0% |

sDA=44%

| | | | | |
|---|---|---|---|---|
| 22% | 27% | 28% | 27% | 23% |
| 15% | 19% | 20% | 18% | 15% |
| 5% | 7% | 8% | 8% | 6% |
| 1% | 1% | 0% | 1% | 1% |
| 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% |

ASE=22%



| | | | | |
|---|---|---|---|---|
| 40% | 47% | 50% | 48% | 42% |
| 33% | 38% | 39% | 37% | 33% |
| 18% | 22% | 23% | 22% | 19% |
| 6% | 8% | 9% | 9% | 7% |
| 0% | 0% | 1% | 0% | 0% |
| 0% | 0% | 0% | 0% | 0% |
| 0% | 0% | 0% | 0% | 0% |
| 0% | 0% | 0% | 0% | 0% |
| 0% | 0% | 0% | 0% | 0% |

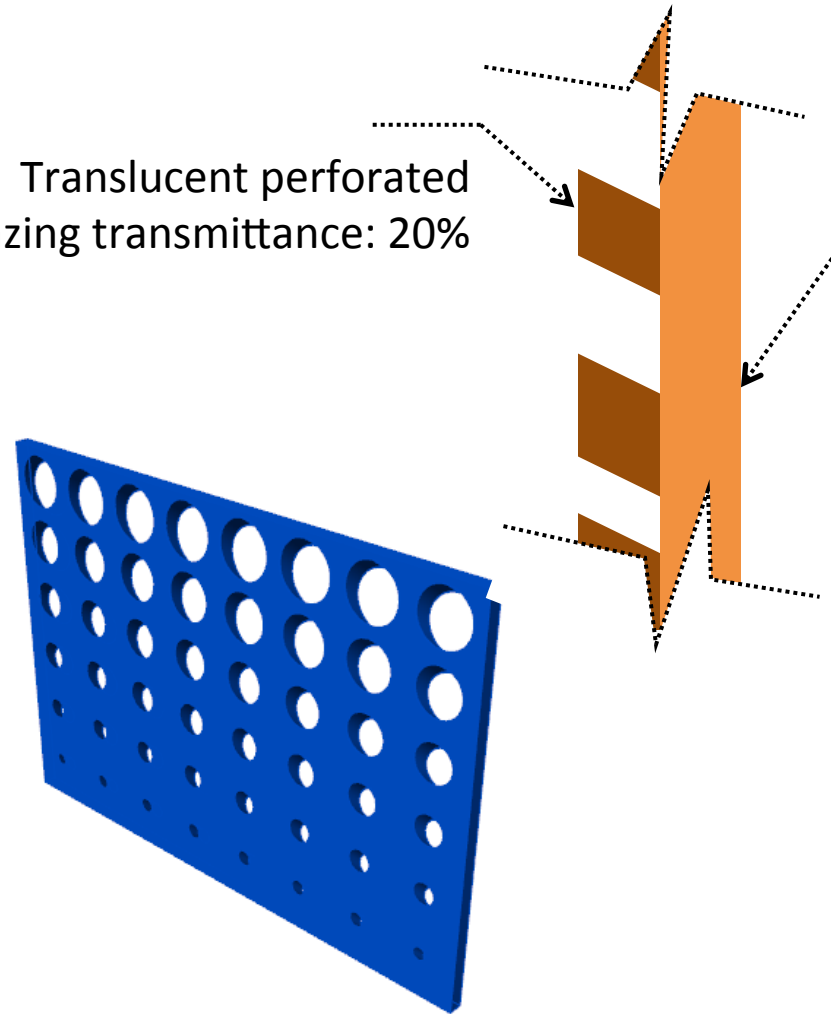
sDA=6%

| | | | | |
|---|---|---|---|---|
| 7% | 10% | 12% | 11% | 7% |
| 5% | 7% | 8% | 8% | 6% |
| 1% | 1% | 1% | 1% | 1% |
| 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% |

ASE=11%

# BEST DESIGN

Translucent perforated glazing transmittance: 20%



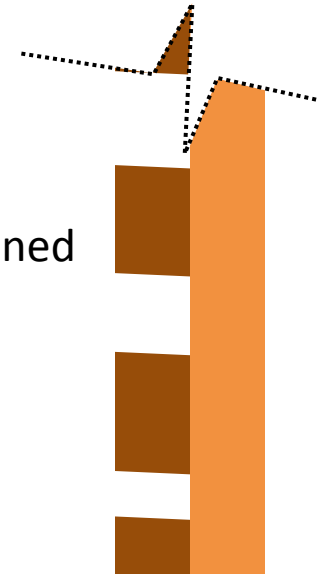
Transparent glazing transmittance: 80%

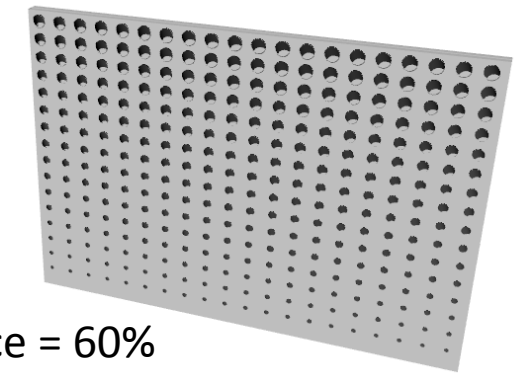
| | | | | |
|---|---|---|---|---|
| 67% | 71% | 71% | 71% | 68% |
| 61% | 63% | 64% | 63% | 61% |
| 55% | 58% | 57% | 57% | 53% |
| 49% | 49% | 51% | 50% | 46% |
| 45% | 48% | 49% | 46% | 46% |
| 33% | 31% | 29% | 31% | 28% |
| 20% | 21% | 19% | 18% | 17% |
| 9% | 9% | 9% | 8% | 0% |
| 0% | 1% | 0% | 0% | 0% |

| | | | | |
|---|---|---|---|---|
| 16% | 22% | 22% | 21% | 15% |
| 9% | 12% | 13% | 13% | 9% |
| 2% | 3% | 4% | 4% | 3% |
| 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% |

# BEST DESIGN

Less inclined holes





Transmittance = 60%

| | | | | |
|---|---|---|---|---|
| 72% | 75% | 76% | 76% | 73% |
| 65% | 67% | 68% | 67% | 67% |
| 58% | 58% | 59% | 58% | 57% |
| 52% | 55% | 56% | 54% | 52% |
| 49% | 50% | 44% | 48% | 40% |
| 39% | 38% | 41% | 38% | 40% |
| 29% | 32% | 30% | 20% | 27% |
| 15% | 16% | 15% | 14% | 14% |
| 10% | 9% | 11% | 11% | 7% |

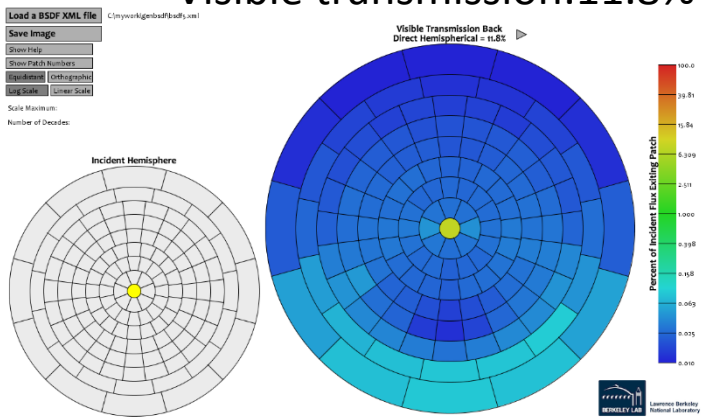
sDA=50%

| | | | | |
|---|---|---|---|---|
| 15% | 18% | 18% | 17% | 14% |
| 10% | 11% | 13% | 12% | 10% |
| 3% | 5% | 6% | 5% | 3% |
| 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% |

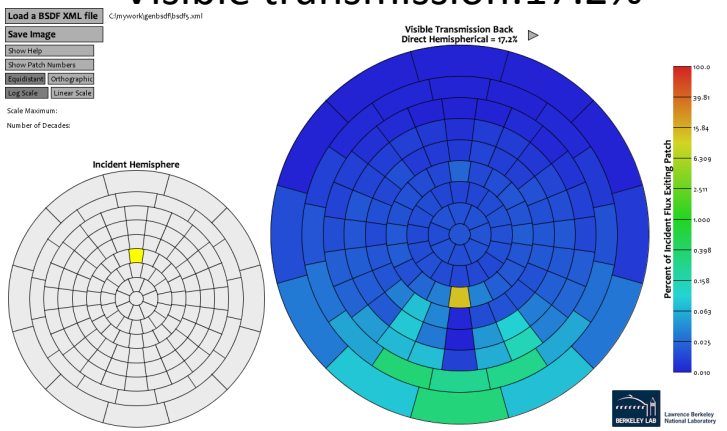
ASE=7%

# BEST CASE KLEMS PATCHS FOR BSDF

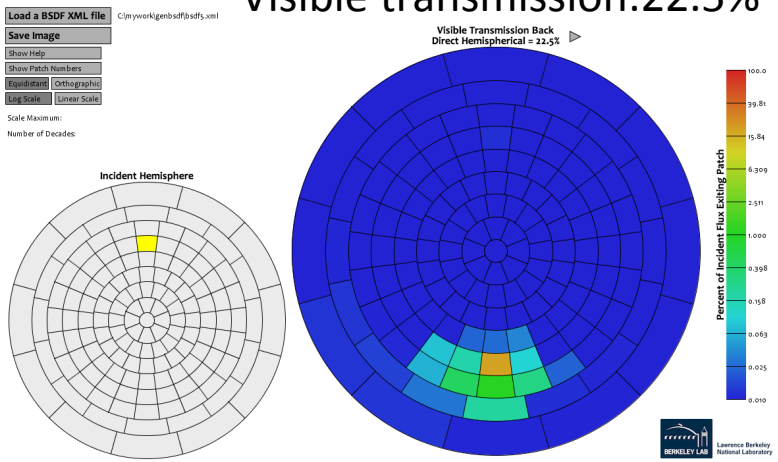
Visible transmission:11.8%



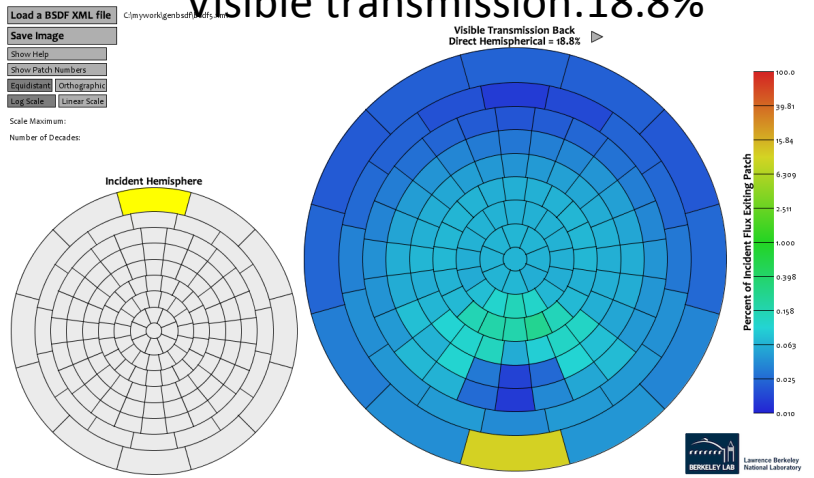

Visible transmission:17.2%




Visible transmission:22.5%




Visible transmission:18.8%



# SO WHAT's NEXT

So now we have to go back and make a recycled plastic panel that meets our requirements.

Verify and test!

# THE END