2015 Radiance Workshop, Philadelphia

How we use Radiance to guide design teams to the right decisions before they even start…

08.18.2015

Wait, who’s making the decisions here?

Navigating value engineering, cost estimates, the diminishing role of designers in building projects, and the growing influence of design build contractors…

Why Early Daylighting Simulation is Critical to Integrated, High Performance Building Design

Things Radiance and Daylighting Practitioners Can Integrate with High Performance Building Design:

- The measurement and simulation of optically complex shading materials

- Elegant shading device design

- Evaluating the impact of dynamic glazing

- Optimizing automated interior shade fabrics and controls

- Applying complex performance metrics like Spatial Daylight Autonomy to low and net zero energy buildings

- Successfully deploying new glazing technologies in façade design

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- Successfully deploying new glazing technologies in façade design

Things I've Heard Cost Estimators Mark as Prohibitively Expensive in pre-Schematic, Concept Phases of Projects:

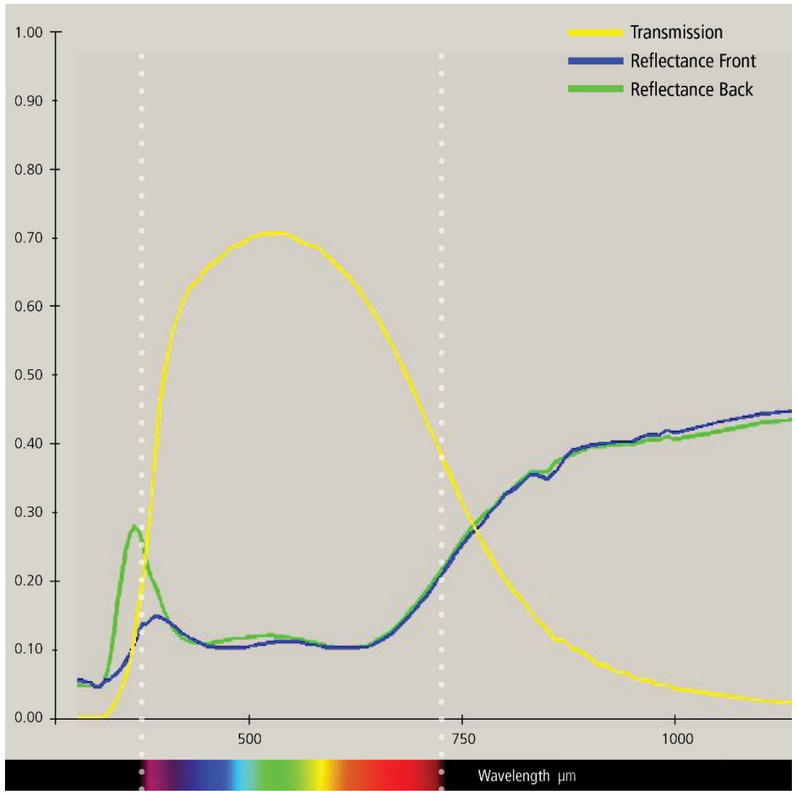
- Optically complex shading materials
- Exterior shading devices
- Dynamic glazing
- Automated interior shades
- "LEED"
- Daylight re-directing film

01. You Can Have 100% Glass on Your West Façade, *But…*

Building Performance: Thermal and Visual Experience, Architecture and Engineering Decisions

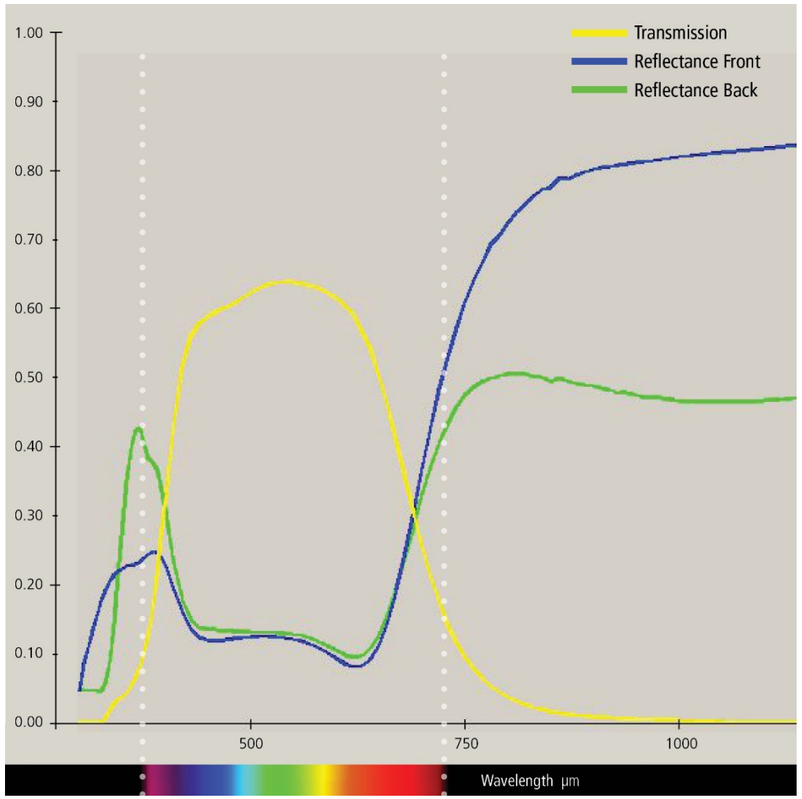
Glazing Specifications, Implications and Shared Goals

All double pane low-e IGU's with clear glass are not created equal



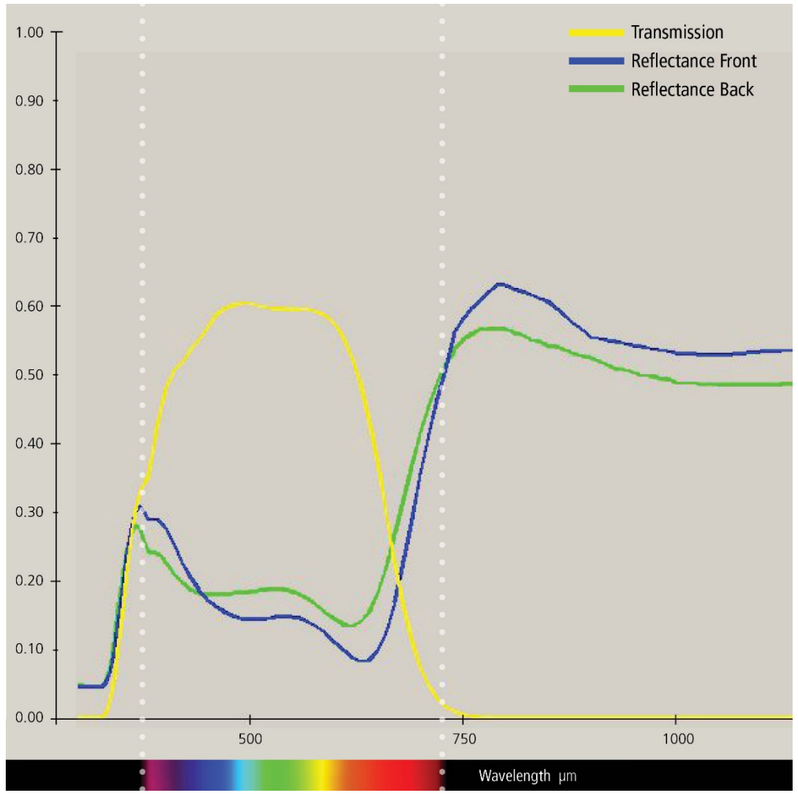
Viracon VE-12M

VLT = 0.70 / SHGC = 0.38



PPG Solarban 70xl

VLT = 0.64 / SHGC = 0.28



Saint Gobain Cool-Lite Extreme 60/28 II

VLT = 0.59 / SHGC = 0.25

Building Performance: Thermal and Visual Experience, Architecture and Engineering Decisions

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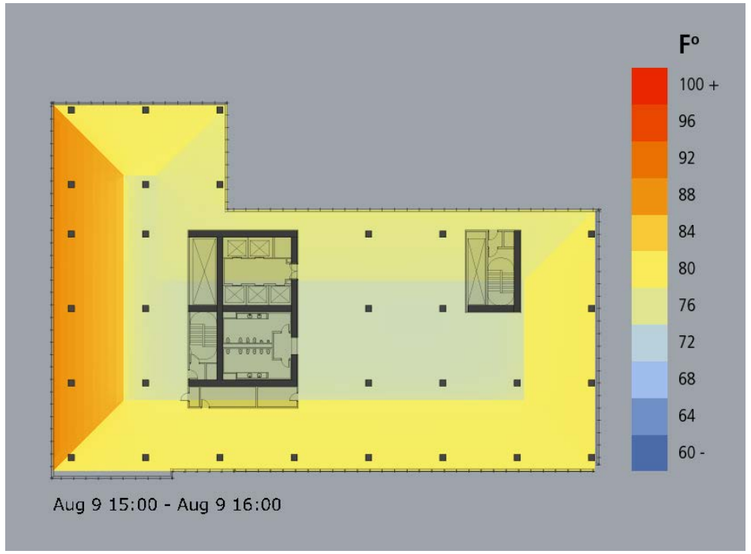
Glazing Specifications + Design Day Mean Radiant Temperature



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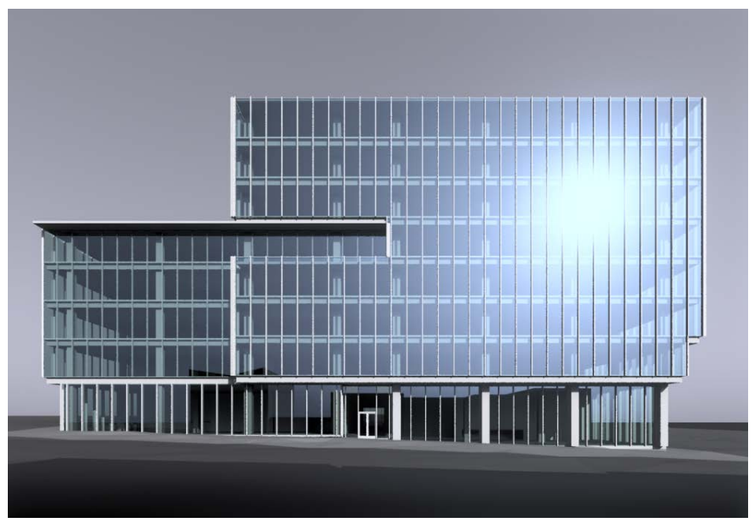

Saint Gobain Cool-Lite Extreme 60/28 II

VLT = 0.59 / SHGC = 0.25

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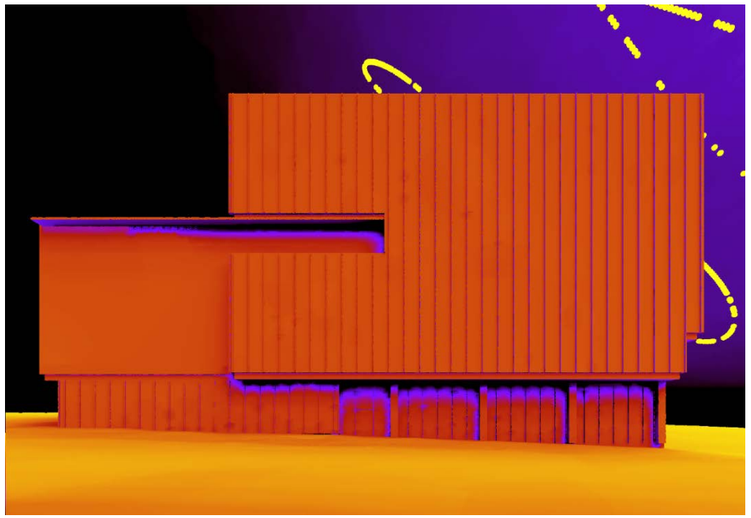
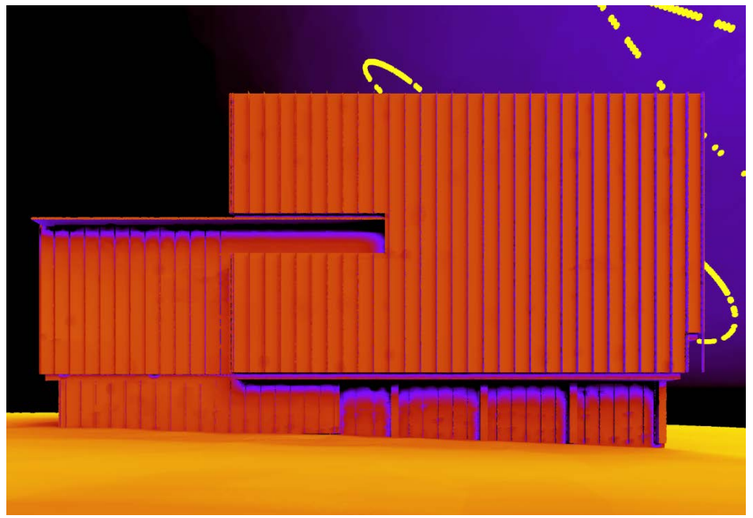
Façade Elements: Annual Insolation

Understanding the Efficacy of Fixed Shading Options

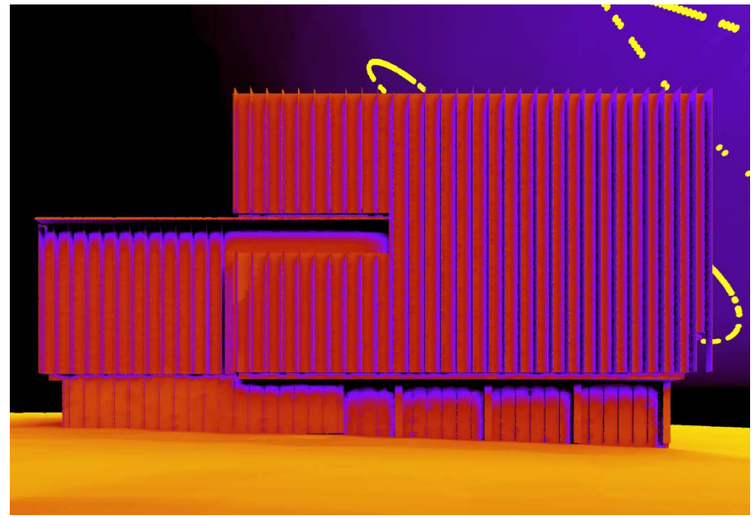
Total radiation from the sun and sky falling on the building skin



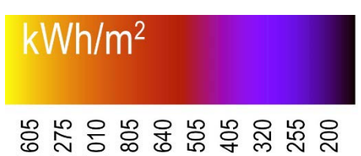
West Façade + No External Shading



West Façade + 9” West Façade Fins



West Façade + 30” West Façade Fins



Façade Elements + Design Day Mean Radiant Temperature

PPG Solarban 70xl

VLT = 0.64 / SHGC = 0.28

PPG Solarban 70xl + 9” West Façade Fins

VLT = 0.64 / SHGC = 0.28

PPG Solarban 70xl +30” West Façade Fins

VLT = 0.64 / SHGC = 0.28

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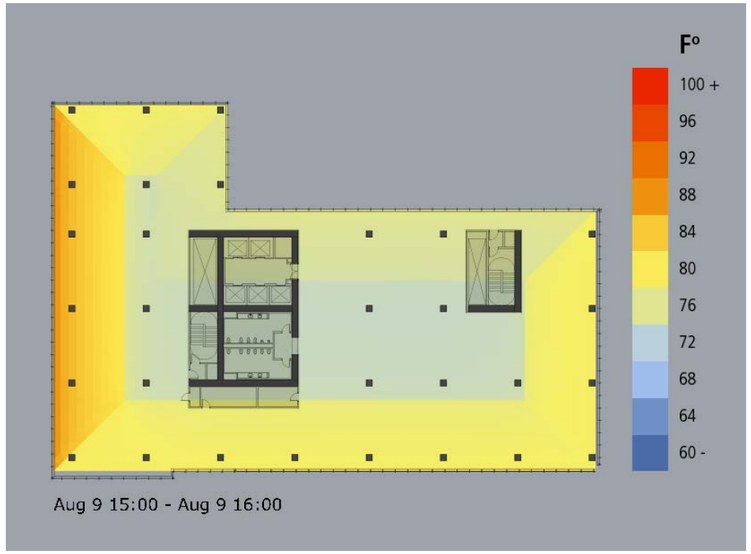
Façade Elements + Design Day Mean Radiant Temperature



PPG Solarban 70xl

VLT = 0.64 / SHGC = 0.28

PPG Solarban 70xl + 50% WWR

VLT = 0.64 / SHGC = 0.28

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Façade Design: Experiential Impacts

Thermal Impacts, Visual Impacts, Energy Impacts, Aesthetic Impacts, Cost Impacts…

Viracon VE-12M

EUI: 83
Tonnage: 680
System Cost: $816,000
$/sf 3.6

PPG Solarban 70xl

EUI: 72
Tonnage: 580
System Cost: $696,000
$/sf 3.1

Saint Gobain CLEX 60/28 II

EUI: 65
Tonnage: 530
System Cost: $636,000
$/sf 2.8

PPG Solarban 70xl

+ 9” West Façade Fins

EUI: 65
Tonnage: 570
System Cost: $684,000
$/sf 3.0

PPG Solarban 70xl

+ 30” West Façade Fins

EUI: 55
Tonnage: 570
System Cost: 684,000
$/sf 3.0

PPG Solarban 70xl

+ 50% WWR

EUI: 54
Tonnage: 430
System Cost: $516,000
$/sf 2.3

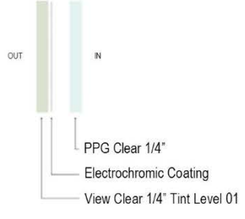
02. What Would Dynamic Glass Be Like on My Building?

Dynamic Glazing: Perception Shifts Over a Typical Day

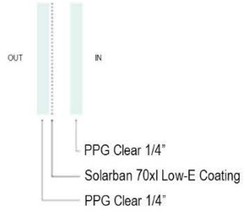
Exterior Façade Under Clear Sunny Skies

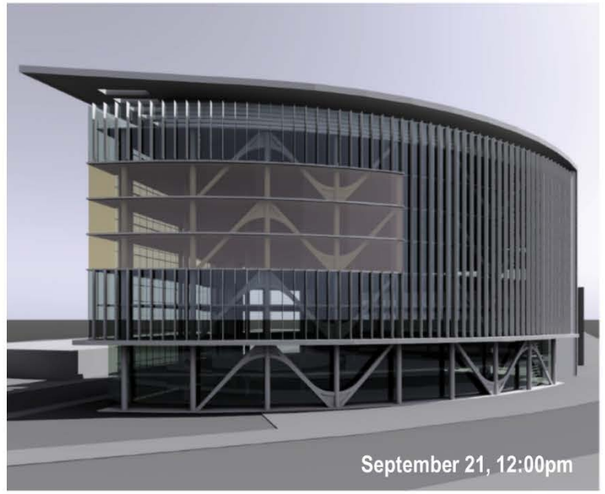
Dynamic IGU With Clear Inboard Pane

Dynamic IGU



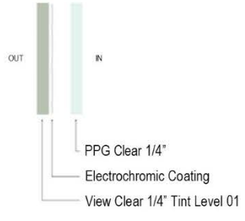
Clear IGU



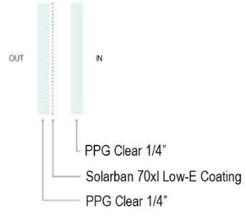


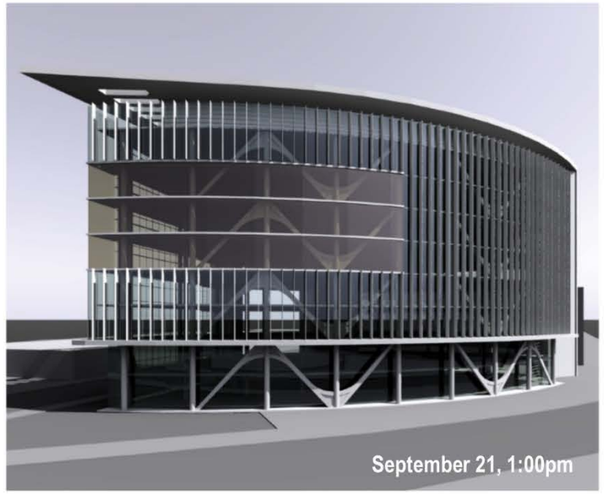
Dynamic Glass	Clear Glass
VLT: 0.58	VLT: 0.63
SHGC: 0.46	SHGC: 0.28

Dynamic IGU



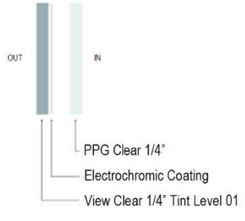
Clear IGU



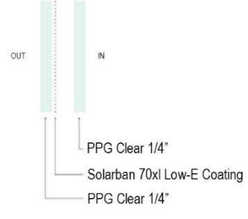


Dynamic Glass	Clear Glass
VLT: 0.40	VLT: 0.63
SHGC: 0.29	SHGC: 0.28

Dynamic IGU

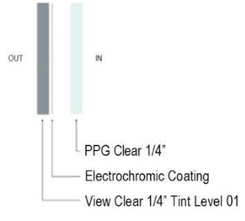


Clear IGU

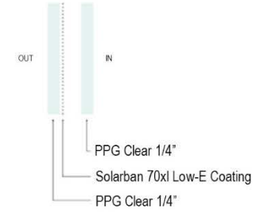


Dynamic Glass	Clear Glass
VLT: 0.20	VLT: 0.63
SHGC: 0.16	SHGC: 0.28

Dynamic IGU



Clear IGU



Dynamic Glass	Clear Glass
VLT: 0.03	VLT: 0.63
SHGC: 0.09	SHGC: 0.28

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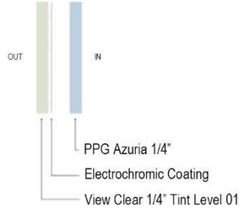
Dynamic Glazing: Perception Shifts Over a Typical Day

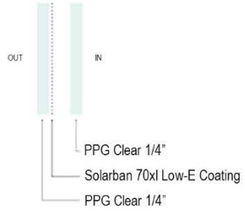
Exterior Façade Under Clear Sunny Skies

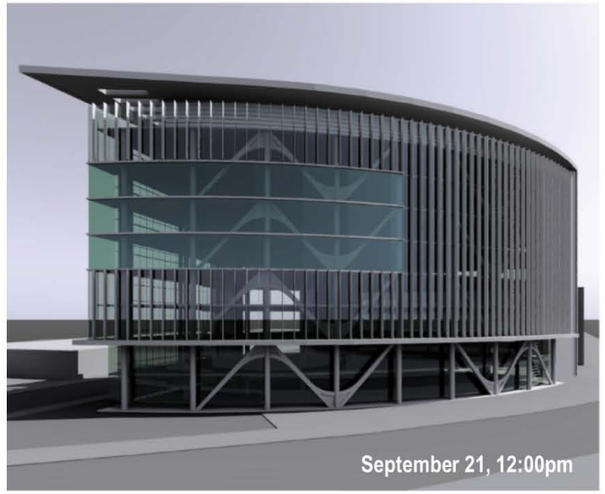
Dynamic IGU With Colored Inboard Pane

Dynamic IGU



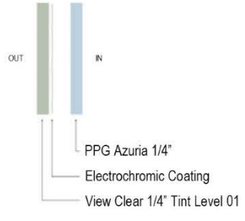
Clear IGU



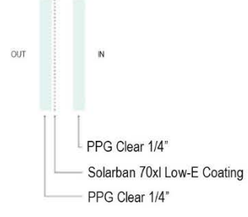


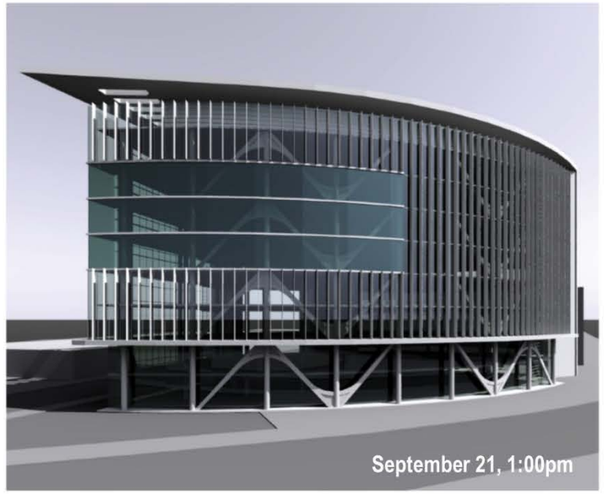
Dynamic Glass	Clear Glass
VLT: 0.44	VLT: 0.63
SHGC: 0.42	SHGC: 0.28

Dynamic IGU



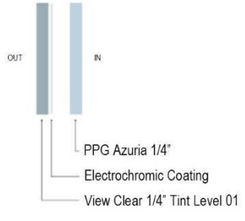
Clear IGU



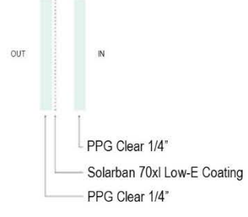


Dynamic Glass	Clear Glass
VLT: 0.31	VLT: 0.63
SHGC: 0.26	SHGC: 0.28

Dynamic IGU

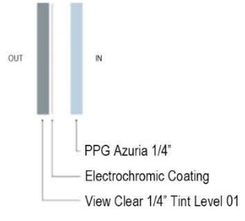


Clear IGU

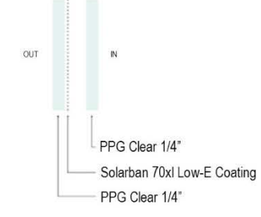


Dynamic Glass	Clear Glass
VLT: 0.16	VLT: 0.63
SHGC: 0.15	SHGC: 0.28

Dynamic IGU



Clear IGU



Dynamic Glass	Clear Glass
VLT: 0.02	VLT: 0.63
SHGC: 0.08	SHGC: 0.28

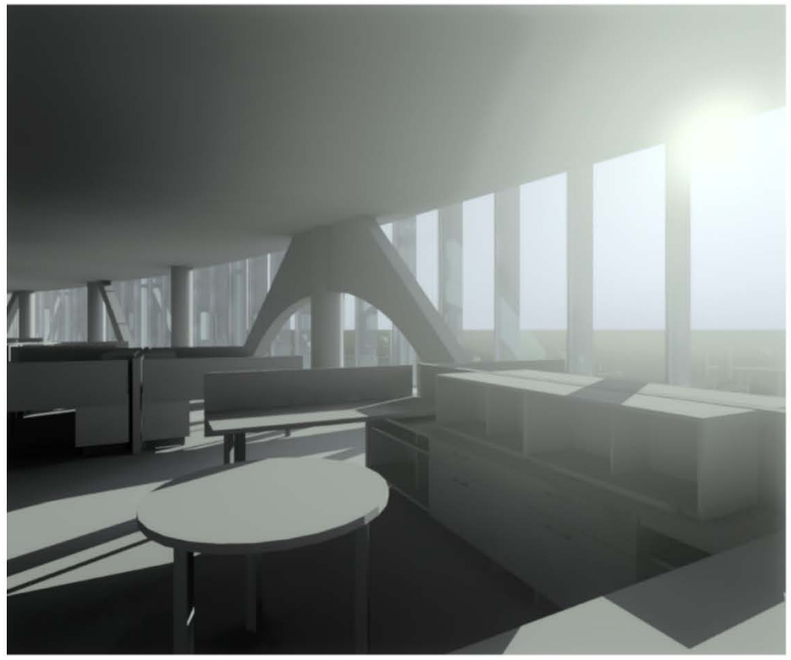
INTEGRAL GROUP

Daylighting Examples: Interior Luminous Environment

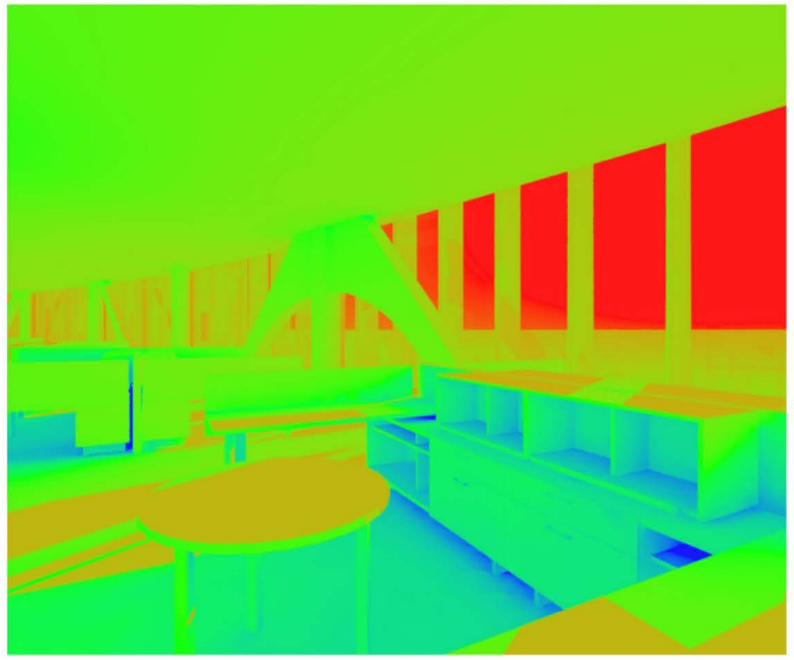
Interior View Looking West, September 21 at 4:30pm, Clear Sunny Skies

No Interior Shades

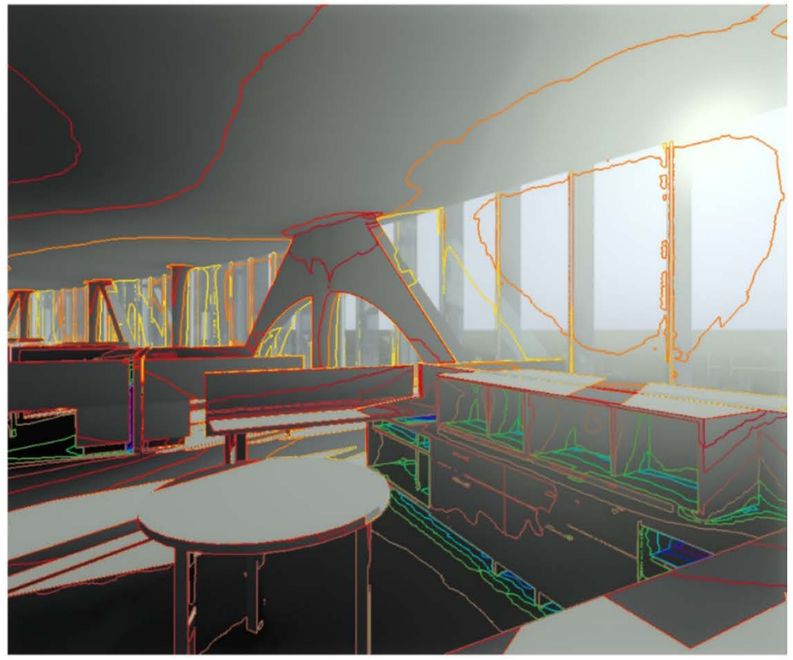
Rendered Perspective, Human Visual Acuity



Falsecolor Luminance Map, Surface Brightness



Iso-Lux Contours, Illumination Levels



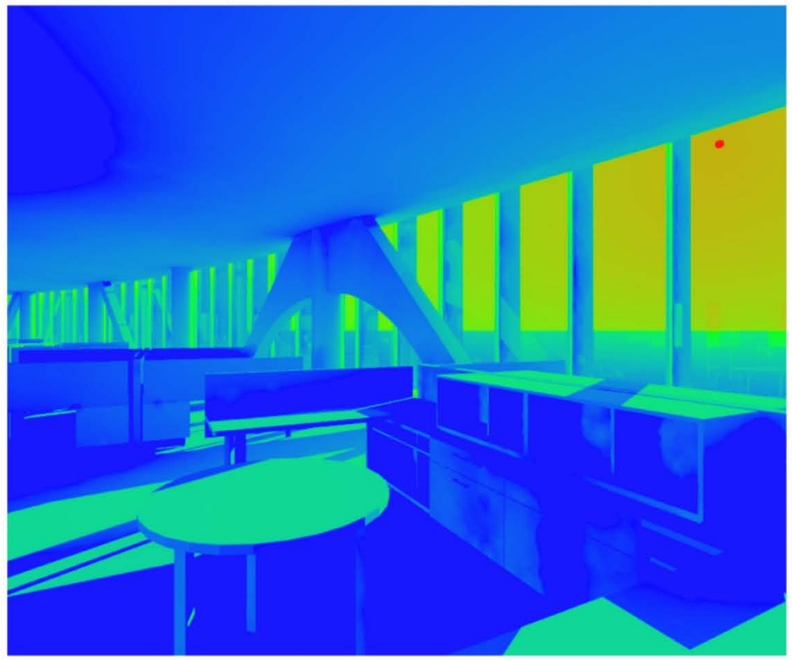
Daylighting Examples: Interior Luminous Environment

Interior View Looking West, September 21 at 4:30pm, Clear Sunny Skies

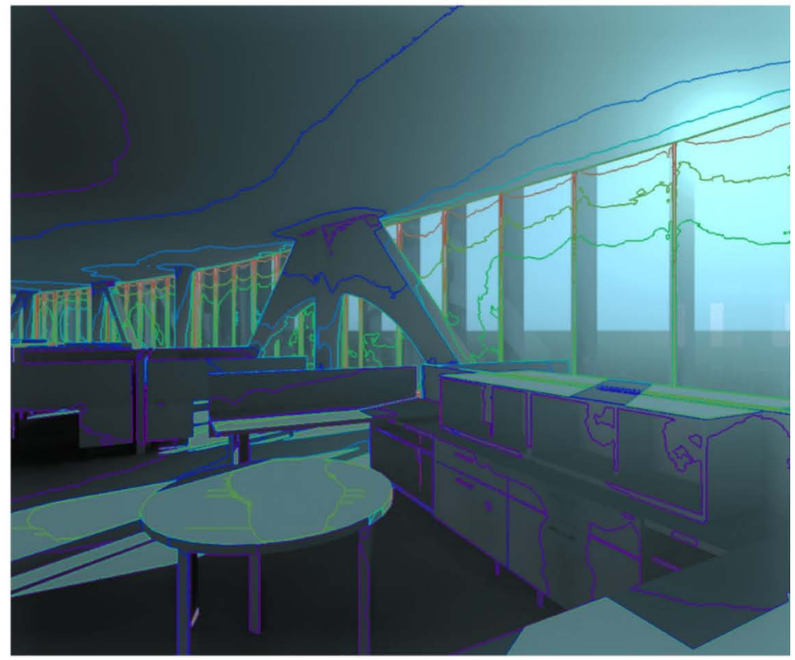
Dynamic Glass Tinted to 4%

Rendered Perspective, Human Visual Acuity

Falsecolor Luminance Map, Surface Brightness



Iso-Lux Contours, Illumination Levels



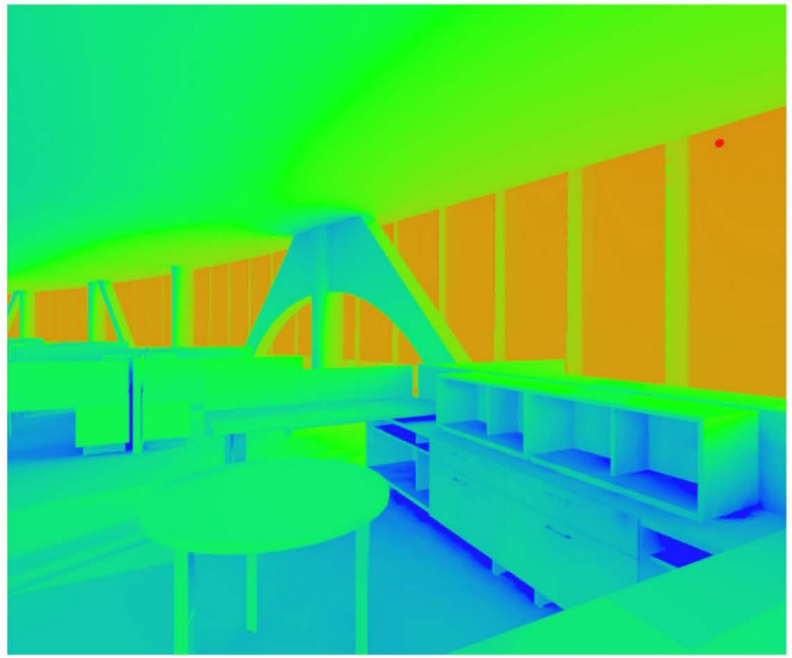
Daylighting Examples: Interior Luminous Environment

Interior View Looking West, September 21 at 4:30pm, Clear Sunny Skies

Automated Fabric Shades Deployed

Rendered Perspective, Human Visual Acuity

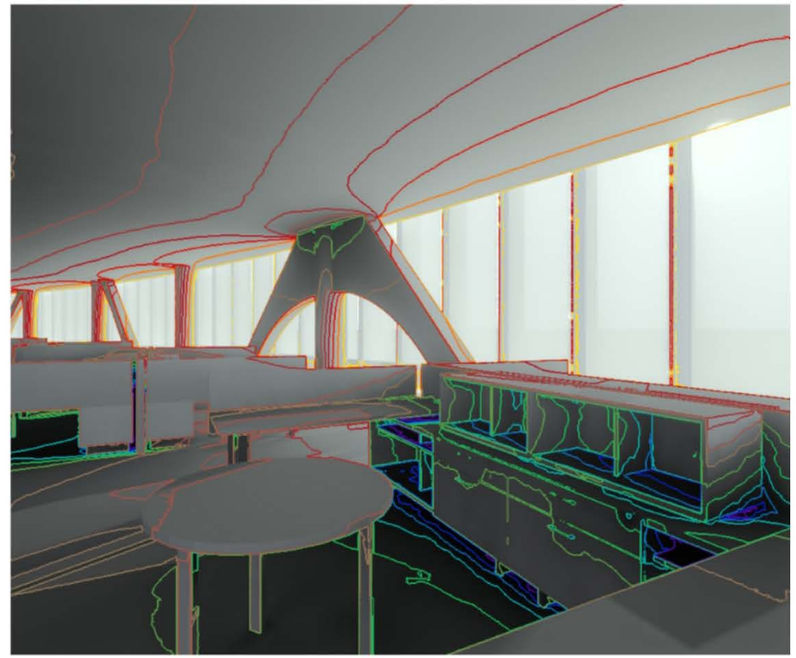
Falsecolor Luminance Map, Surface Brightness



cd/m²

7080
3500
1800
900
450
220
110
50
30
15

Iso-Lux Contours, Illumination Levels



footcandles

415
295
205
145
100
70
50
35
25
17
12
8
5

INTEGRAL GROUP

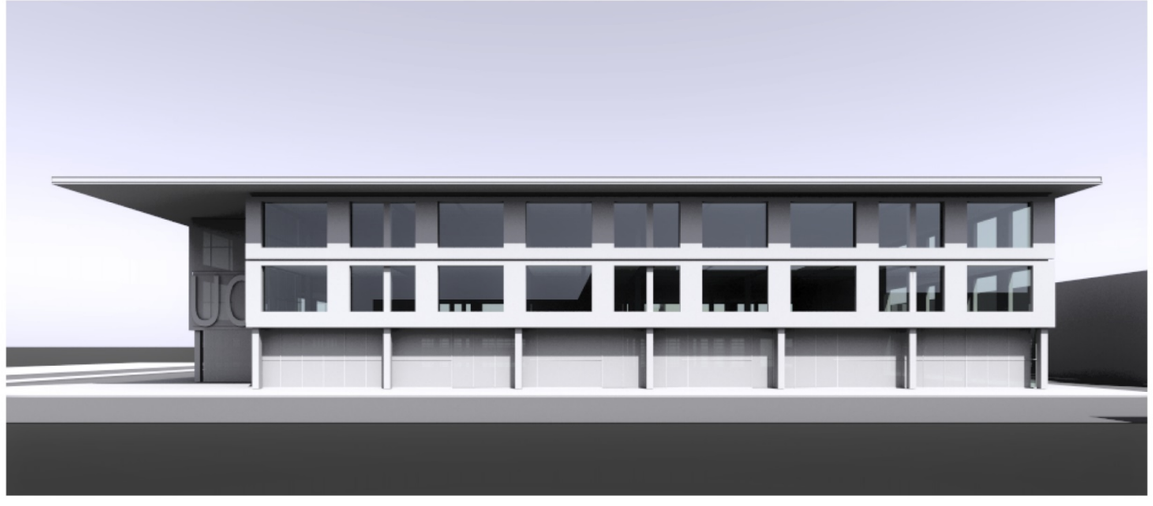
03. Daylighting and Shading for a Better Building, and it’s Cheaper!

Annual Insolation Study / Normative Building Without Shade Structure

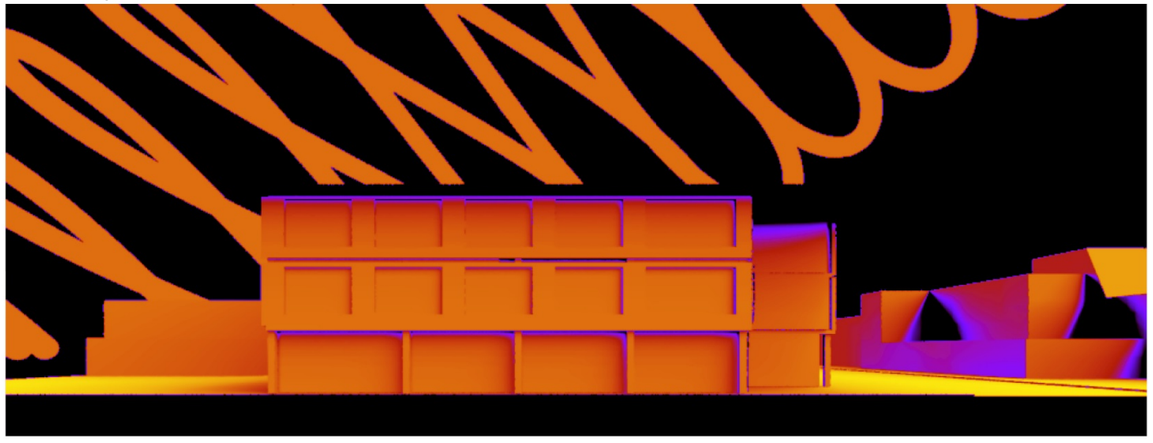
Cumulative Direct Solar Radiation Falling on Building Skin

West Façade Reference Image

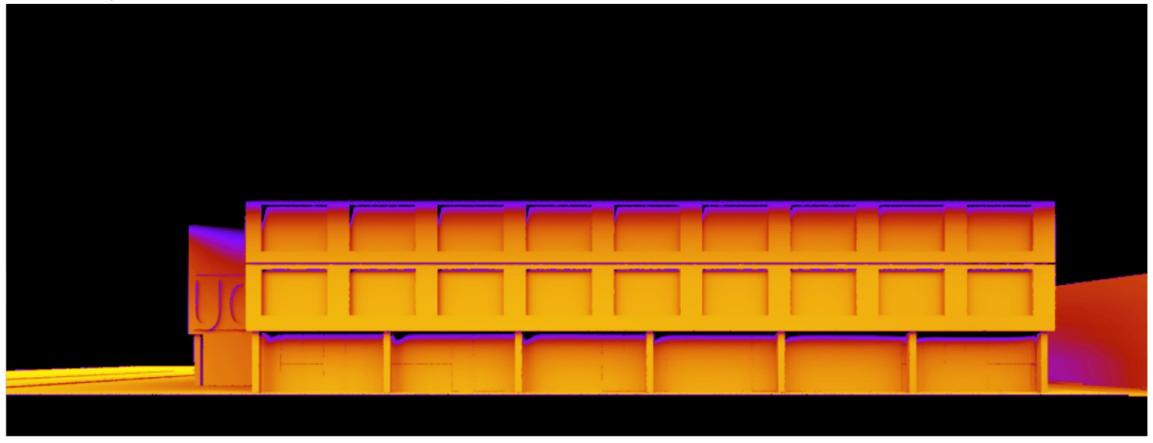
South Façade Reference Image



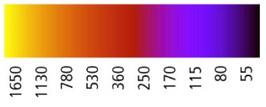
West Façade Annual Radiation on the Building Skin



South Façade Annual Radiation on the Building Skin



kWh/m²



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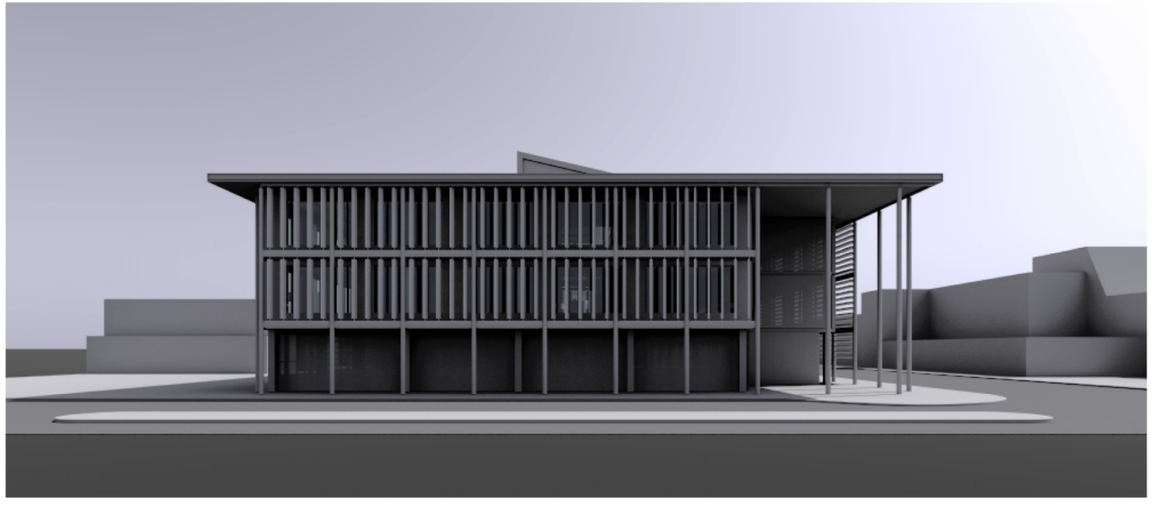
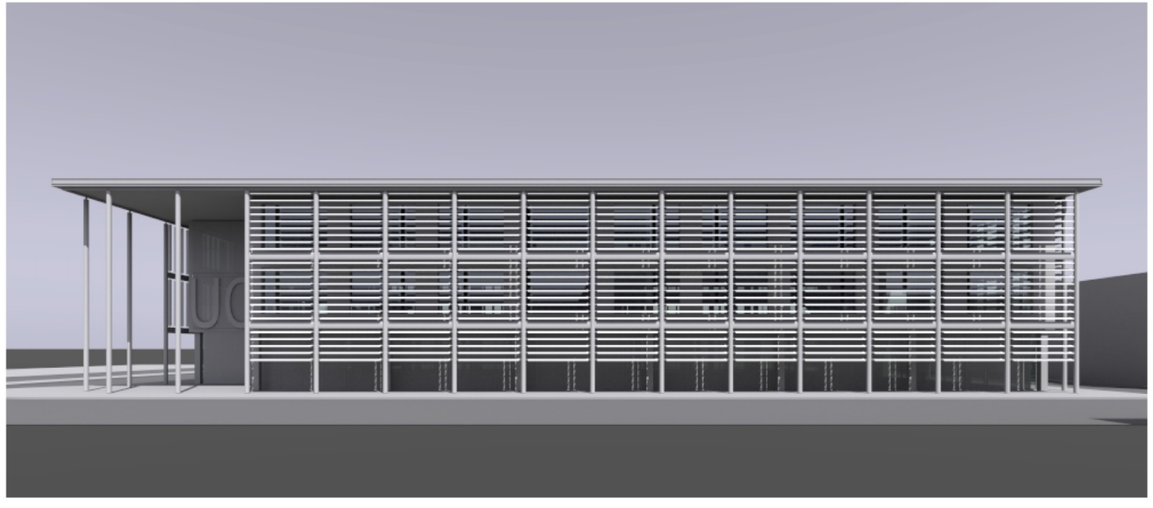
Annual Insolation Study / High Performance Building With Shade Structure

Cumulative Direct Solar Radiation Falling on Building Skin

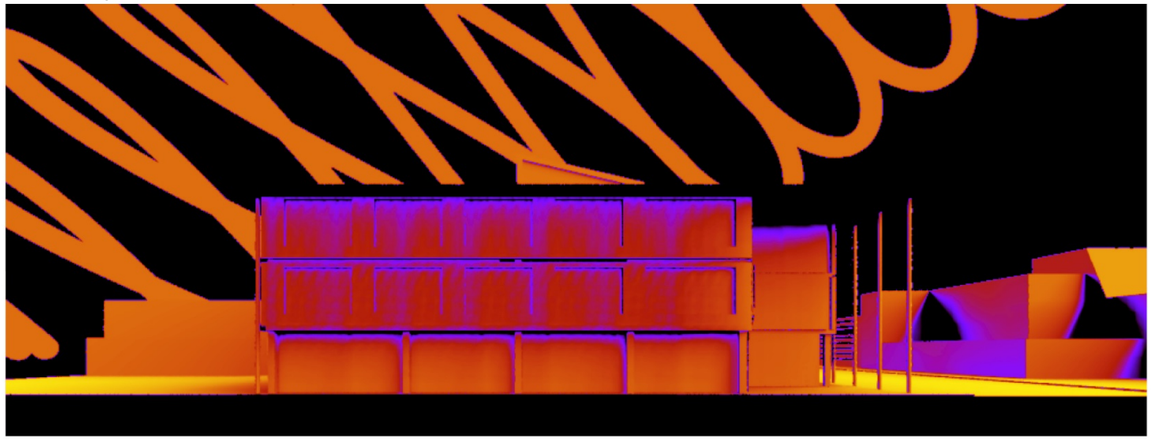
West Façade Reference Image



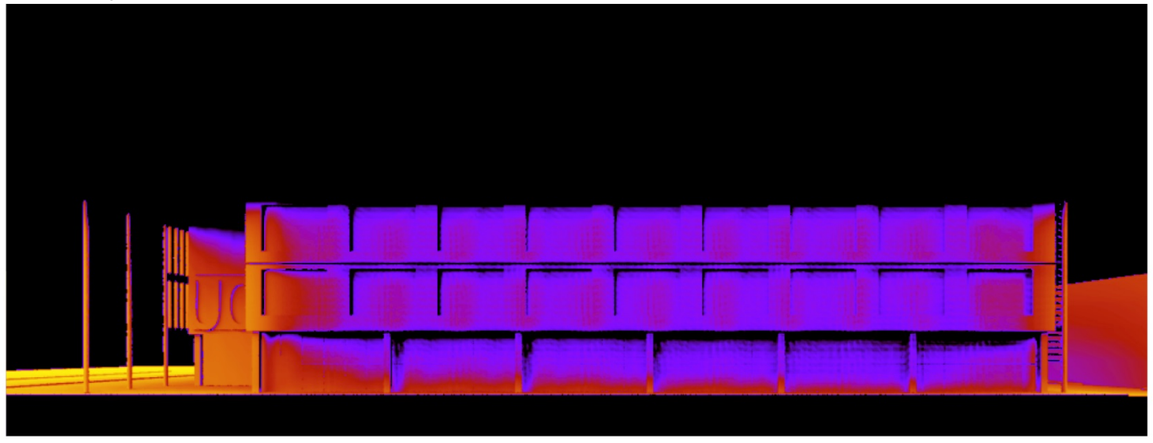
South Façade Reference Image



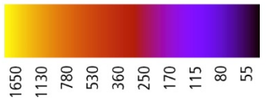
West Façade Annual Radiation on the Building Skin



South Façade Annual Radiation on the Building Skin



kWh/m²



~ 65% Reduction in Solar Radiation Striking the West Glass

~ 90 % Reduction in Solar Radiation Striking the South Glass

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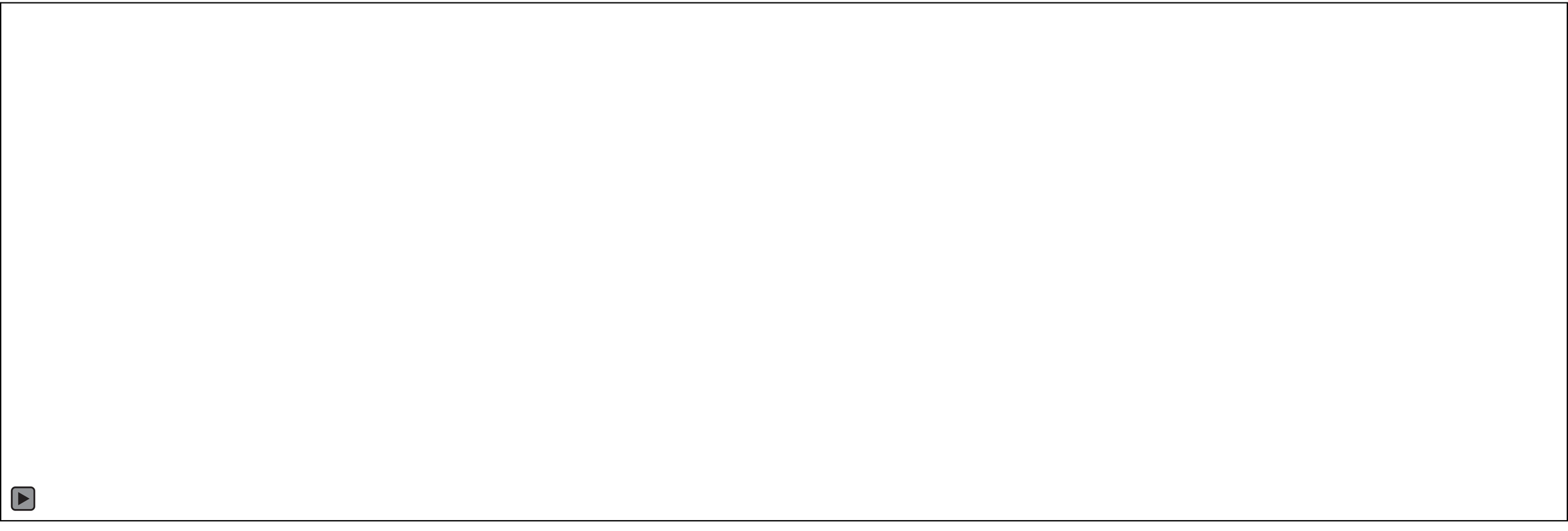
Annual Direct Sun Penetration Comparison Animation

High Performance Building with Shade Structure + Light Courts

Normative Building Without Shade Structure

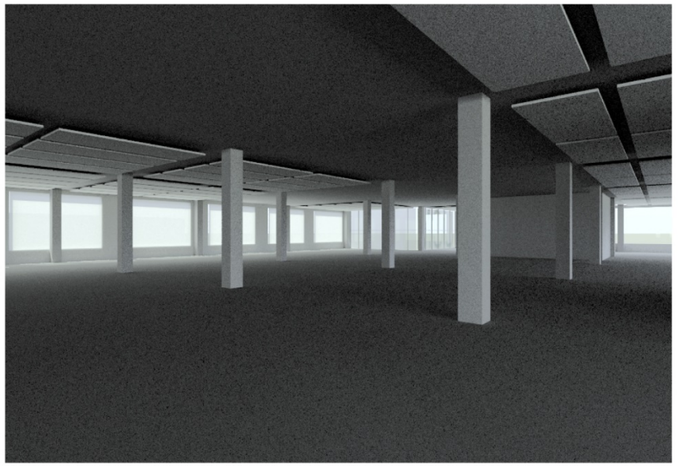


INTEGRAL GROUP

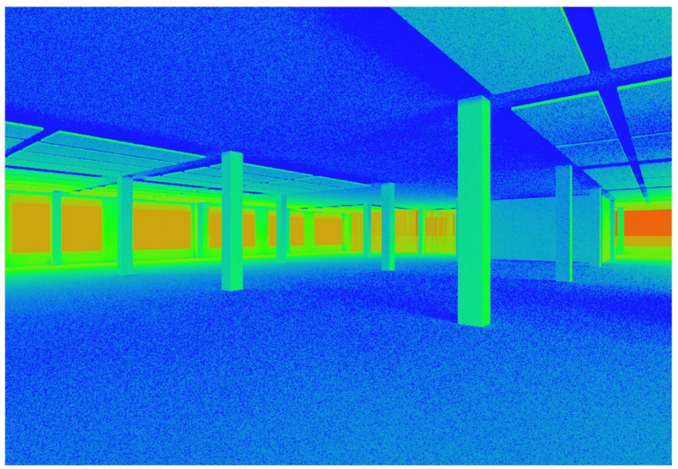
Typical Daylight Conditions / Normative Building Without Shade Structure

September 21, 12:00pm, Clear Sunny Skies

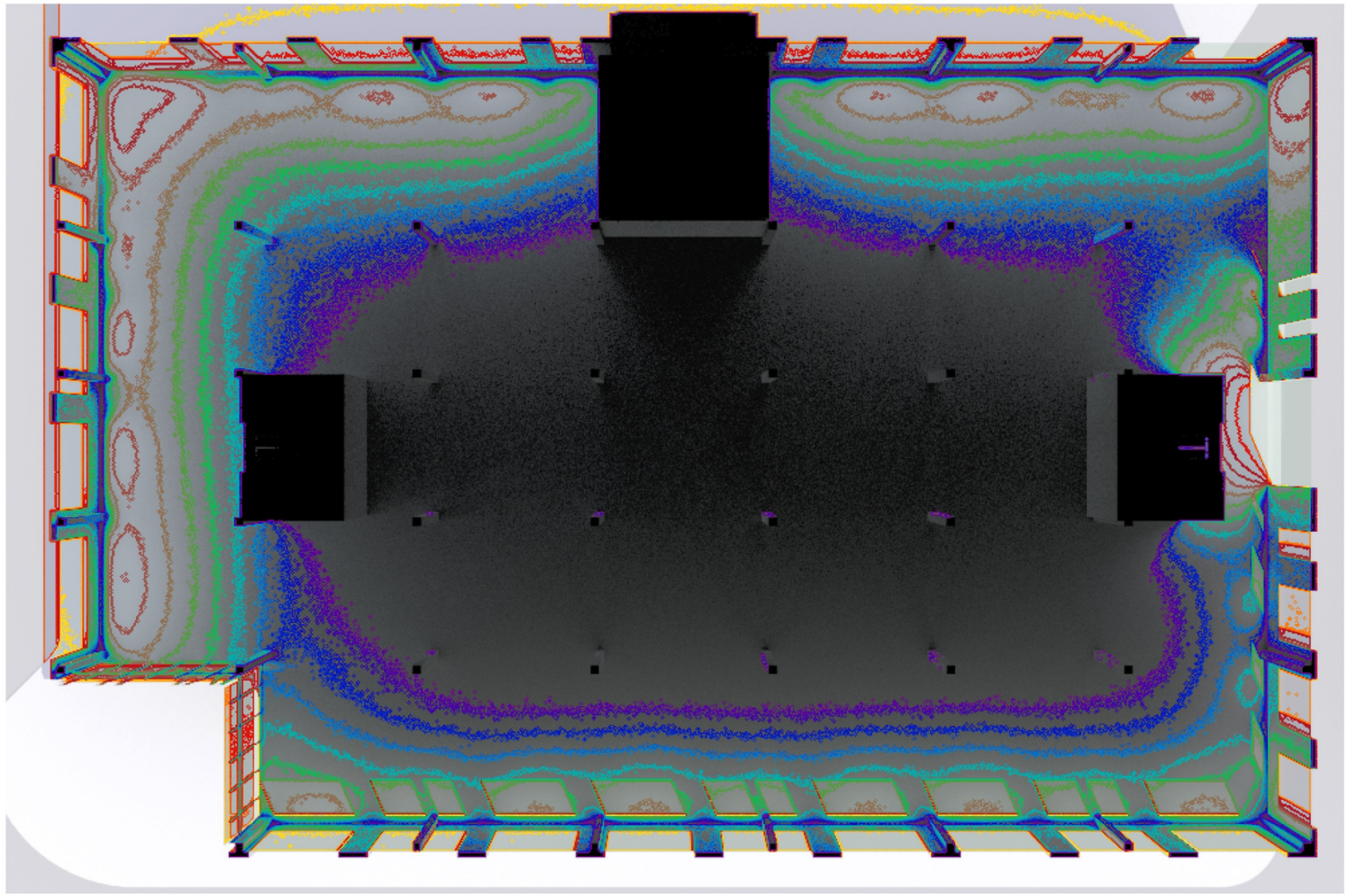
Rendered Perspective



Falsecolor Luminance Map, Brightness



Illuminance Diagram, Light Levels in Footcandles



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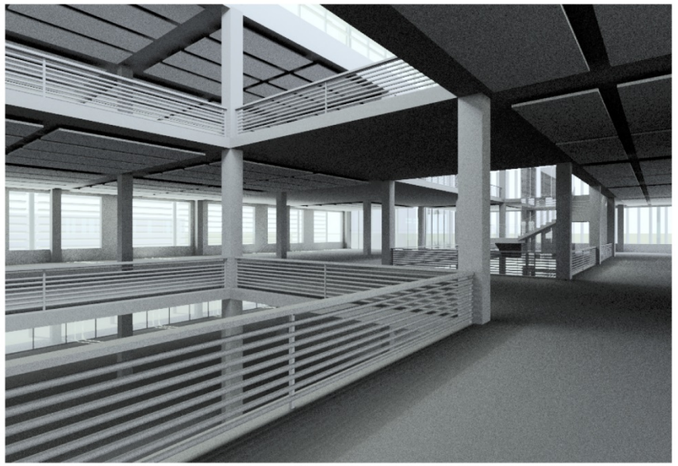
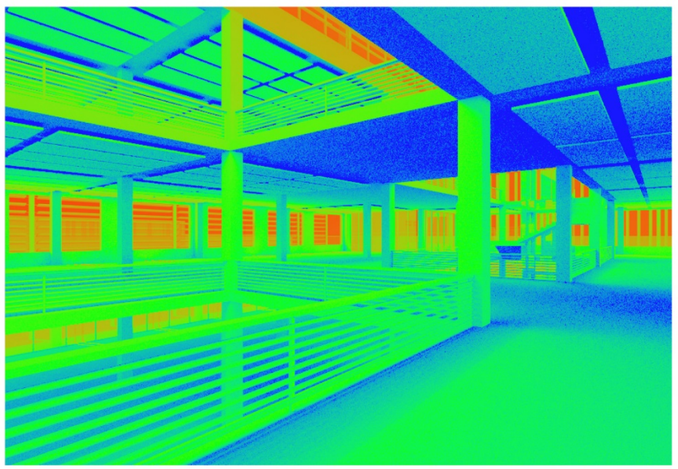
Typical Daylight Conditions / High Performance Building With Shade Structure + Light Courts

September 21, 12:00pm, Clear Sunny Skies

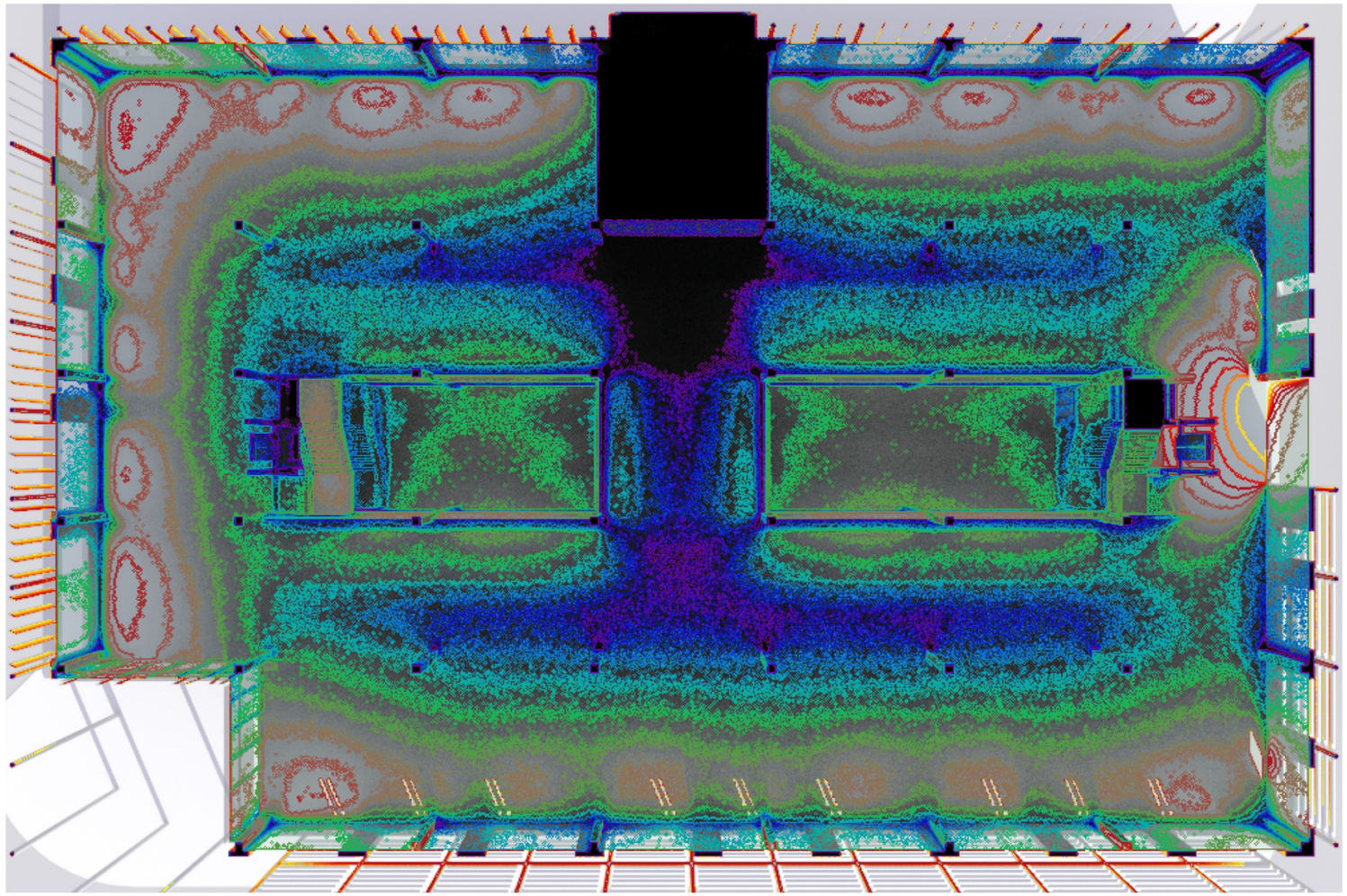
Rendered Perspective



Falsecolor Luminance Map, Brightness



Illuminance Diagram, Light Levels in Footcandles



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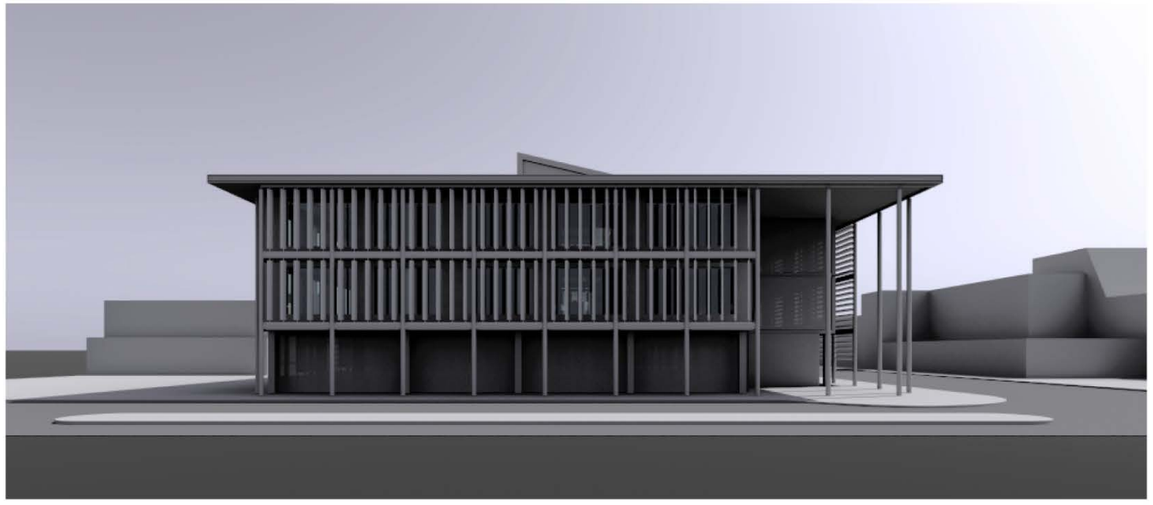
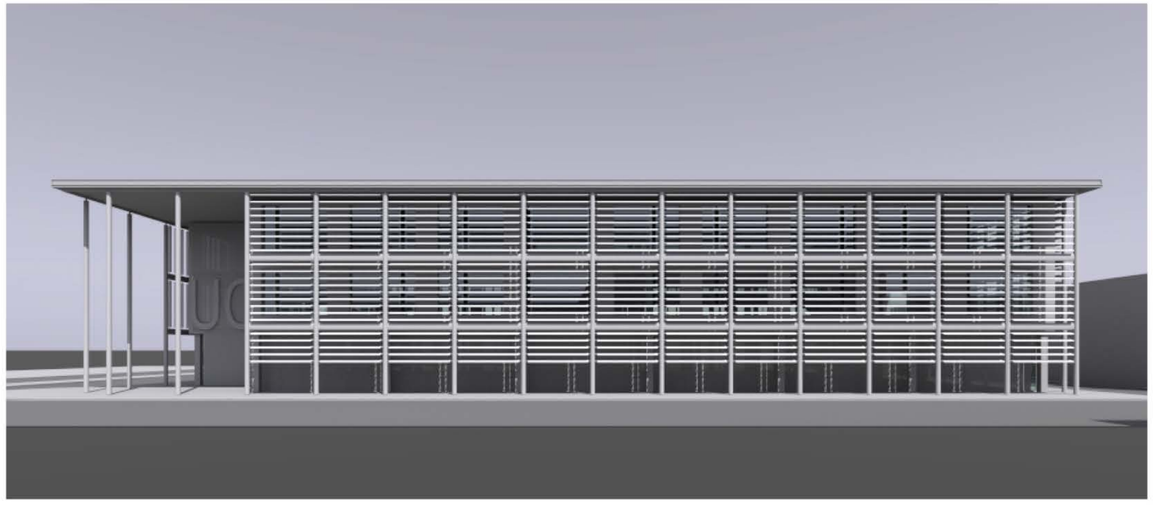
Energy Performance Impact of Shade Canopy

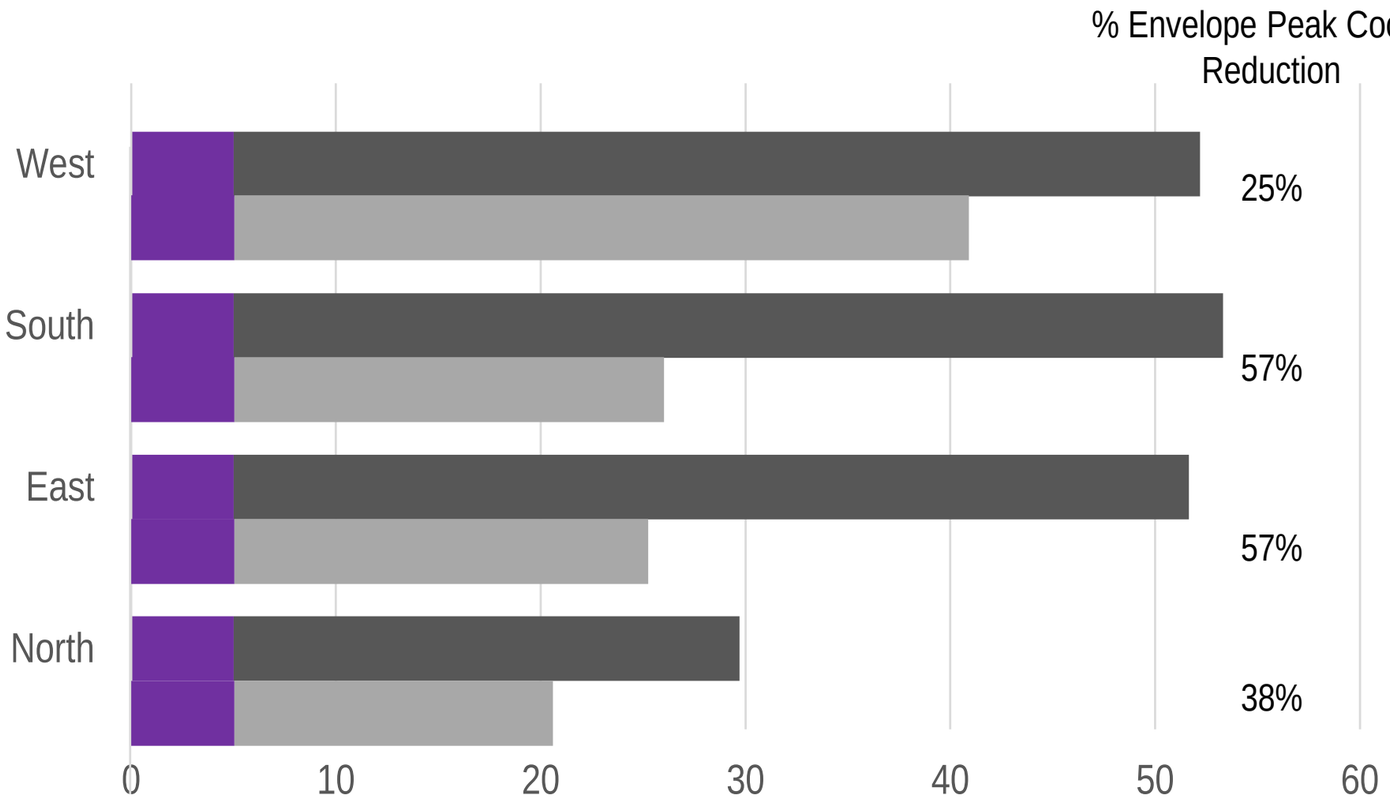
- Reduced Envelope Surface Temperatures > **Higher Likelihood of Consistent Occupant Thermal Comfort**
- Lower Cooling Loads Enable Radiant with DOAS, Opposed to Typical VAV with Reheat > **Simpler System with Lower Maintenance Costs**
- Reduction in Annual Energy Use > **Annual Cost Savings**
- Smaller Mechanical System > **First Cost Savings**

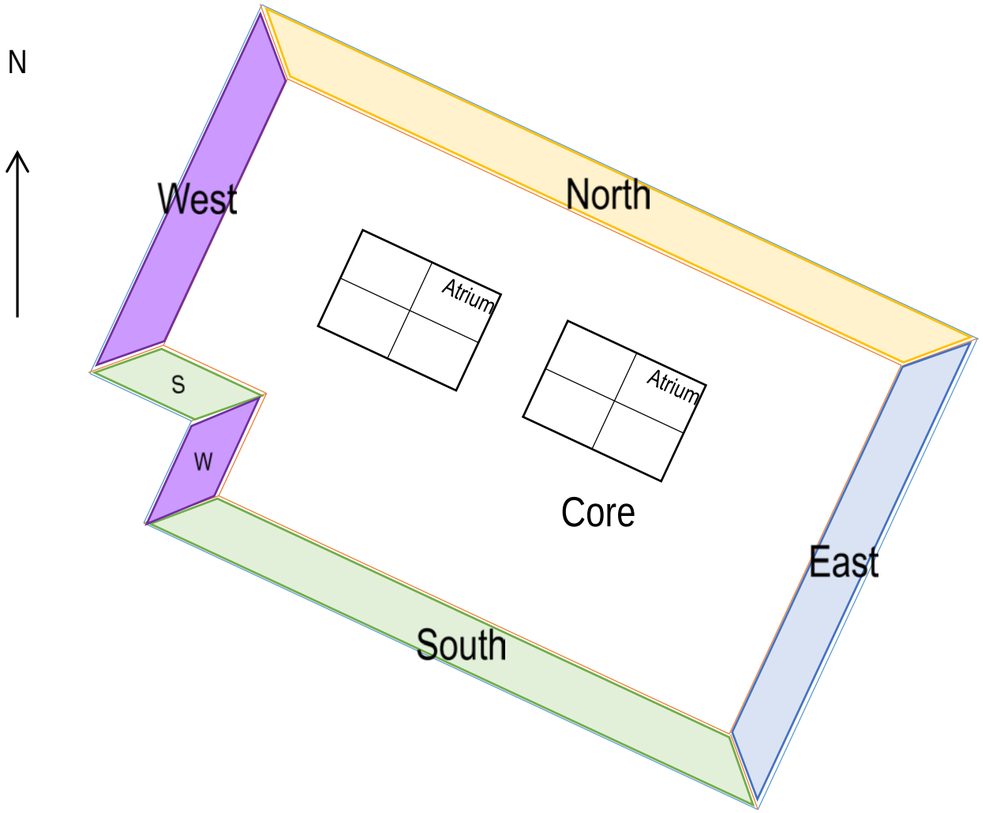




Peak Solar Reduction due to Shading

Reduced solar gains make radiant cooling possible, without shading air system required.
Improvements in the envelope reduce solar gains.
Reductions in solar gains reduces HVAC System size and complexity.





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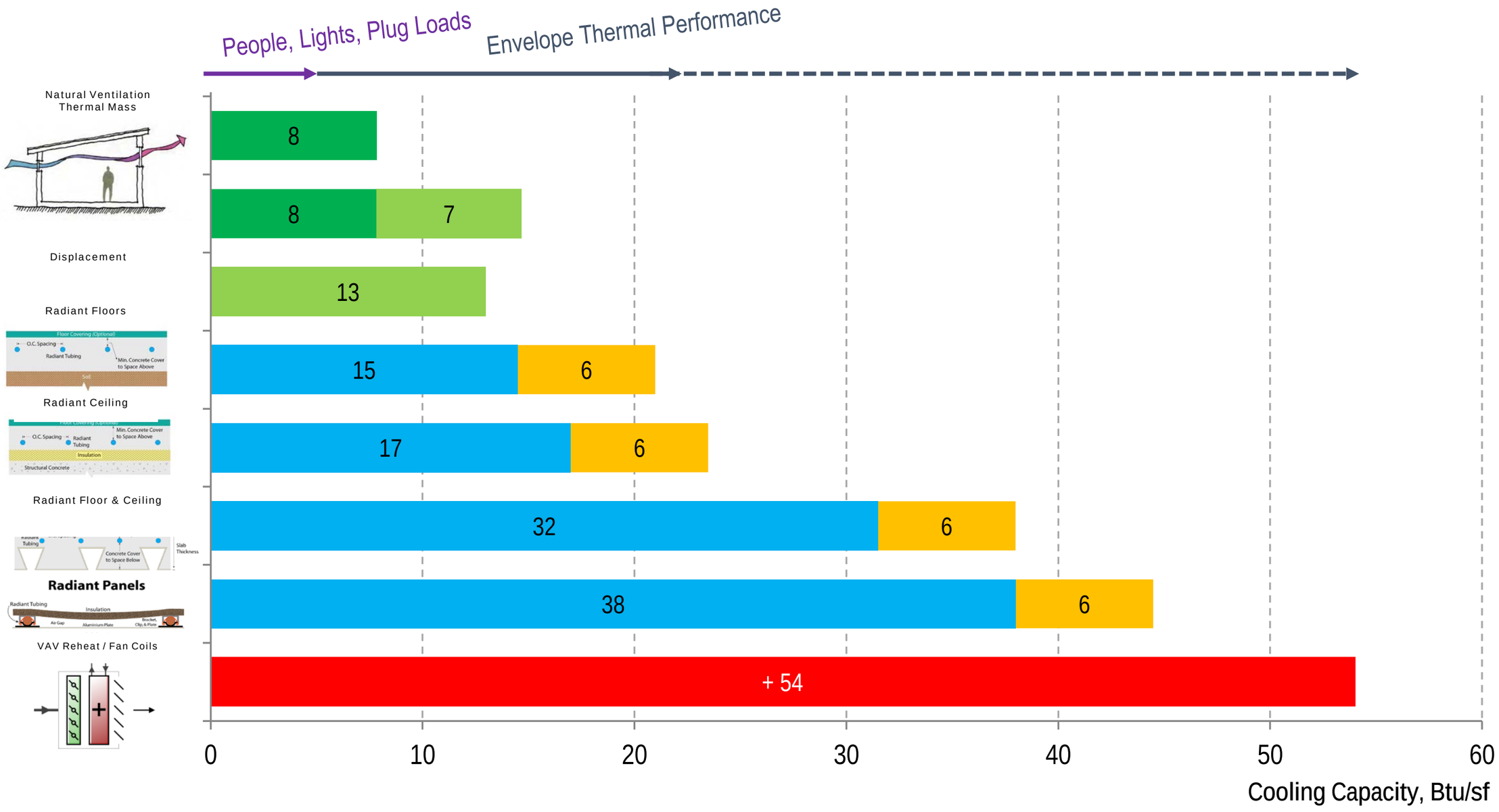
HVAC System Selection and Envelope Loads



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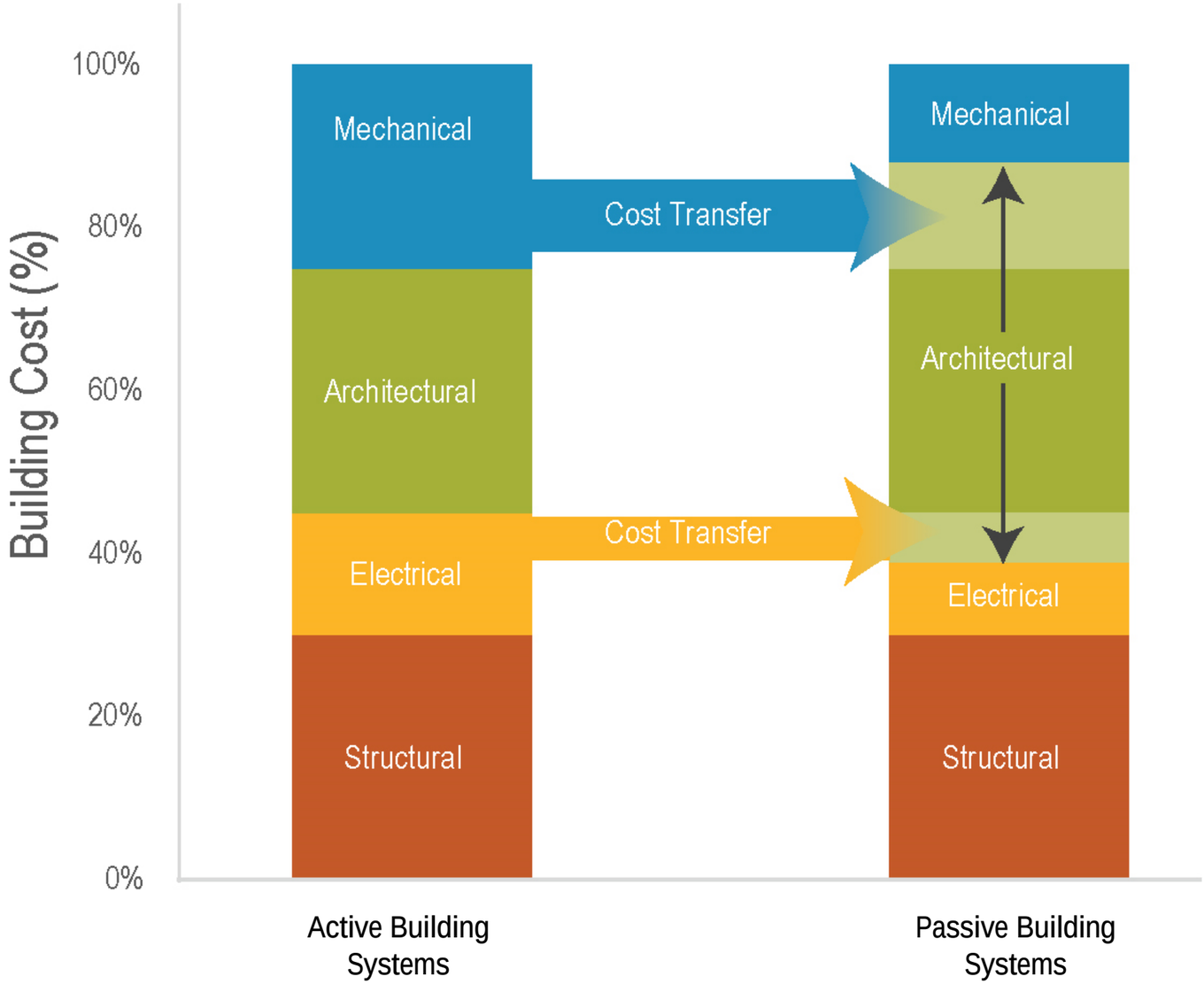
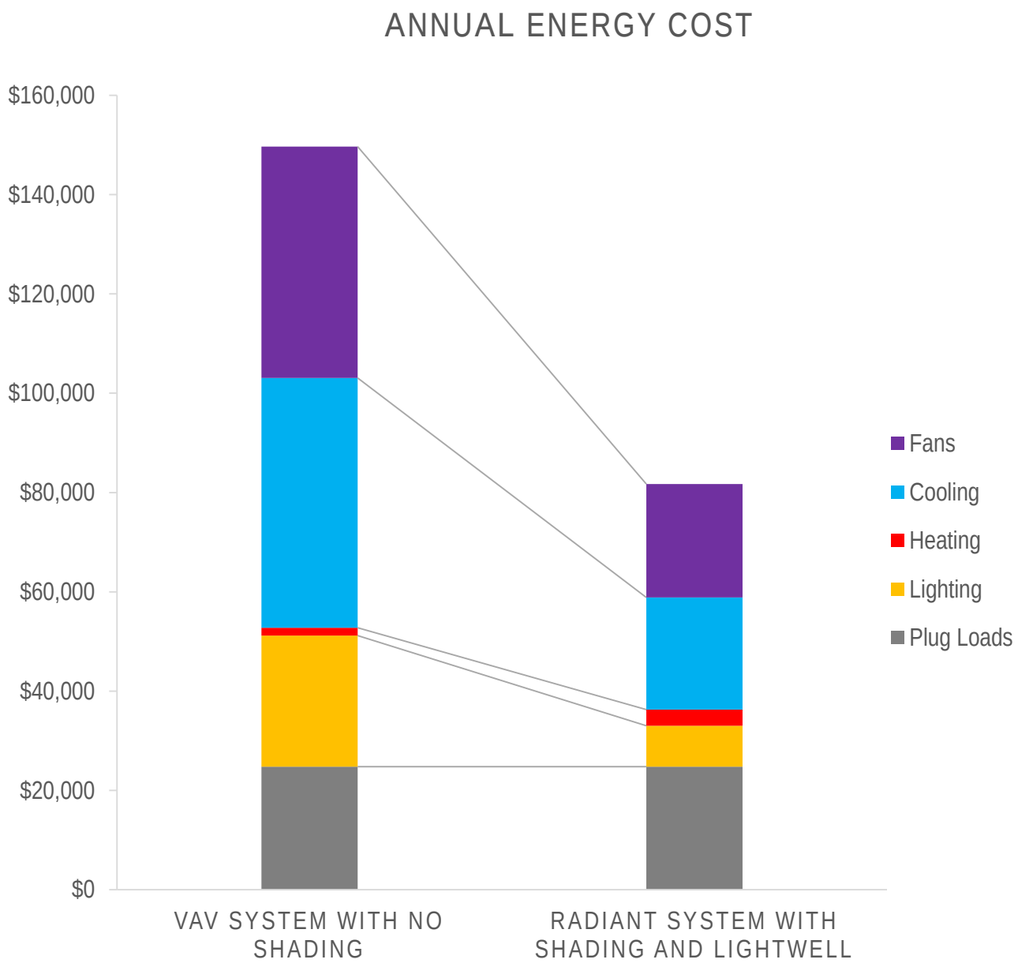
Cost Transfer Approach

Improvements in the envelope reduce solar gains, which reduce the size and cost of HVAC Systems.

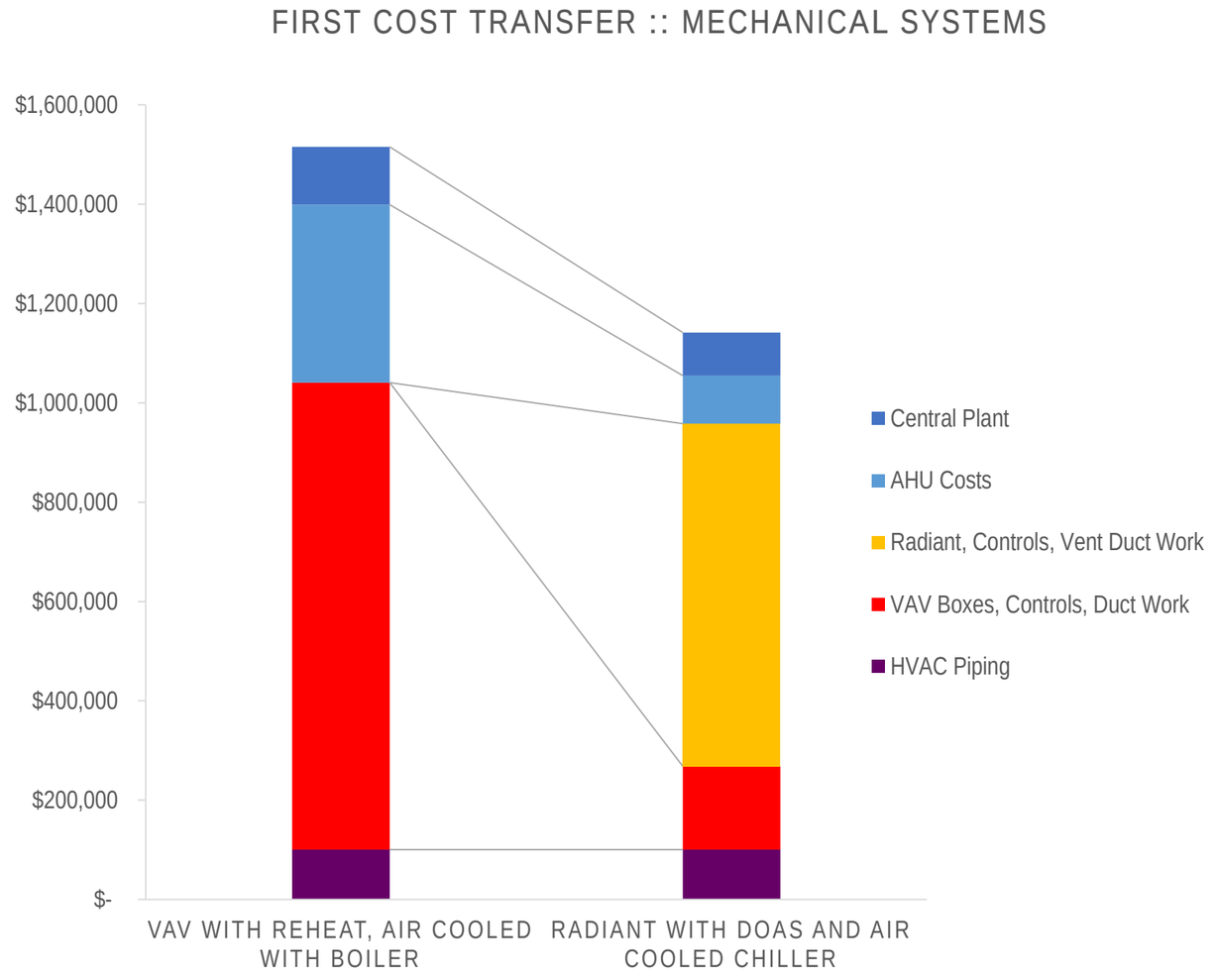


Energy Performance Cost Savings, High Performance Building vs Normative Building Without Shade Structure

Lower annual energy use, higher likelihood of achieving ZNE



$68,000 Annual Savings



$395,000 One Time Savings

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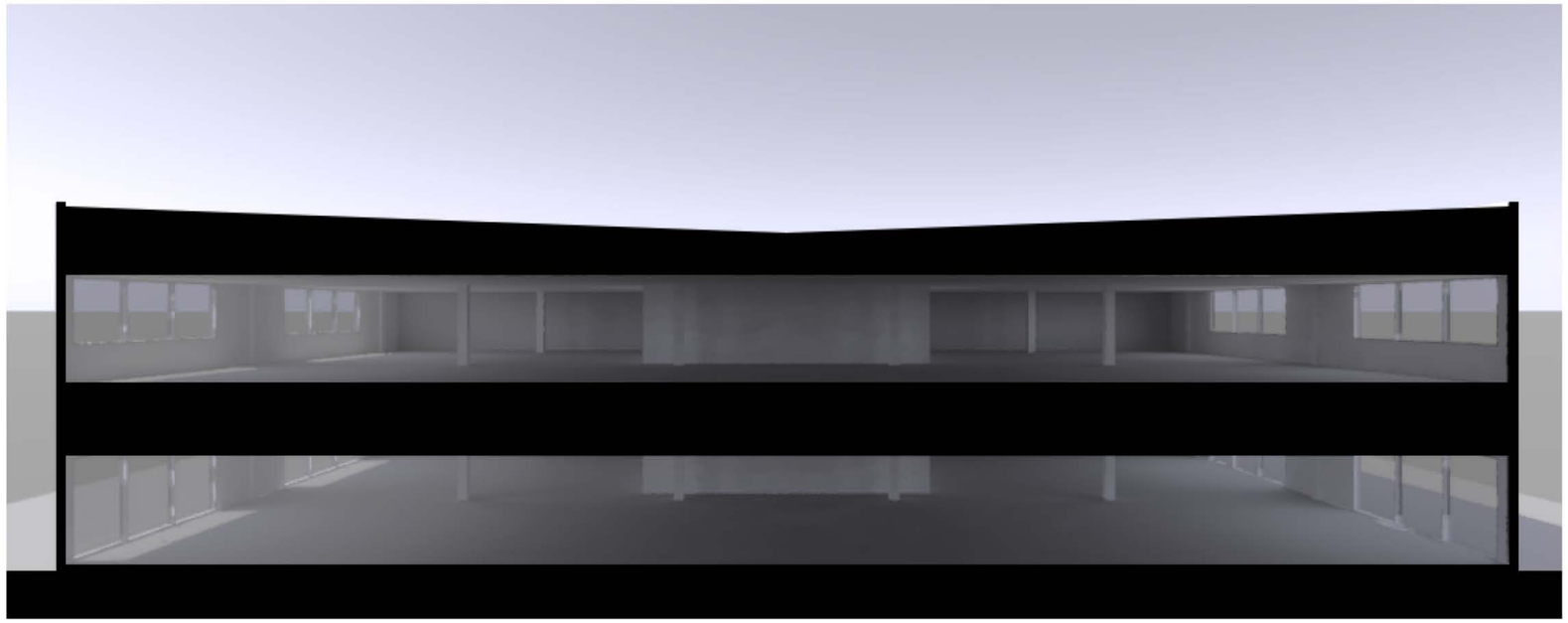
04. Sometimes it Only Takes One Simulation

Daylighting Retrofit Example: Existing Conditions

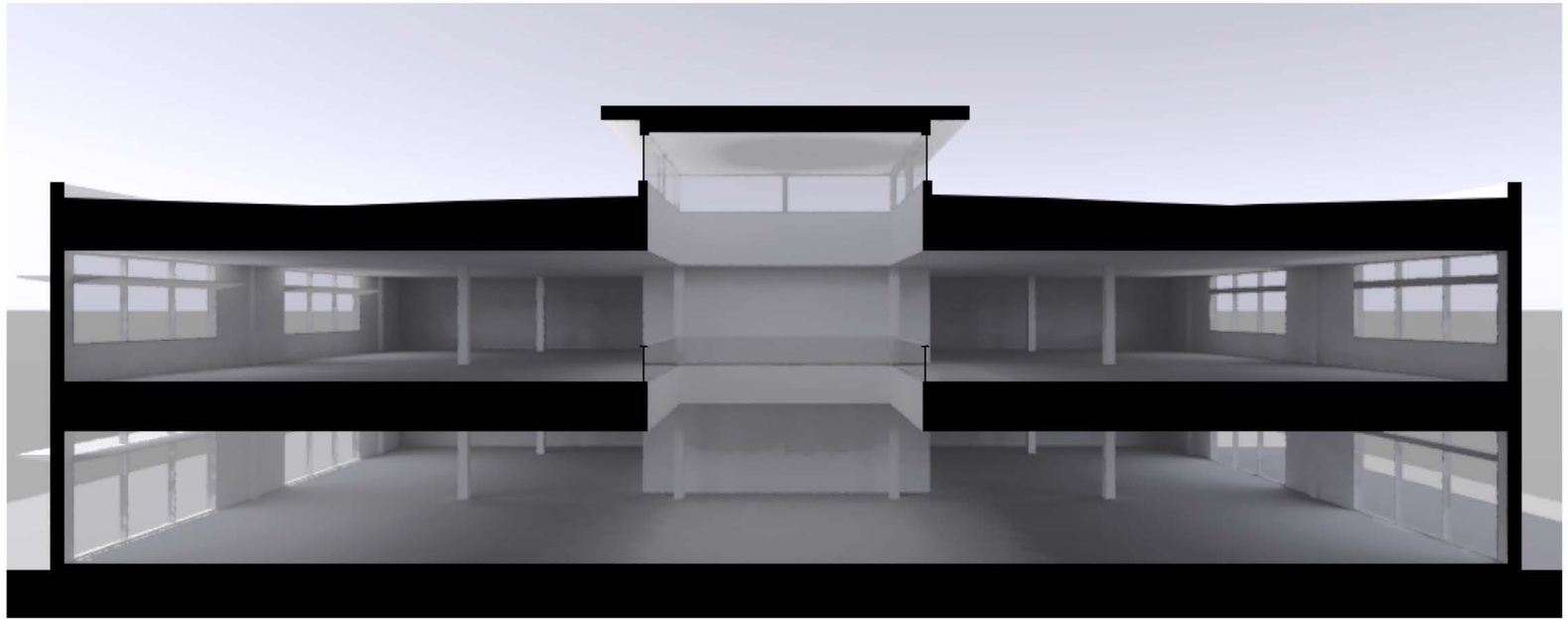
Section Perspective



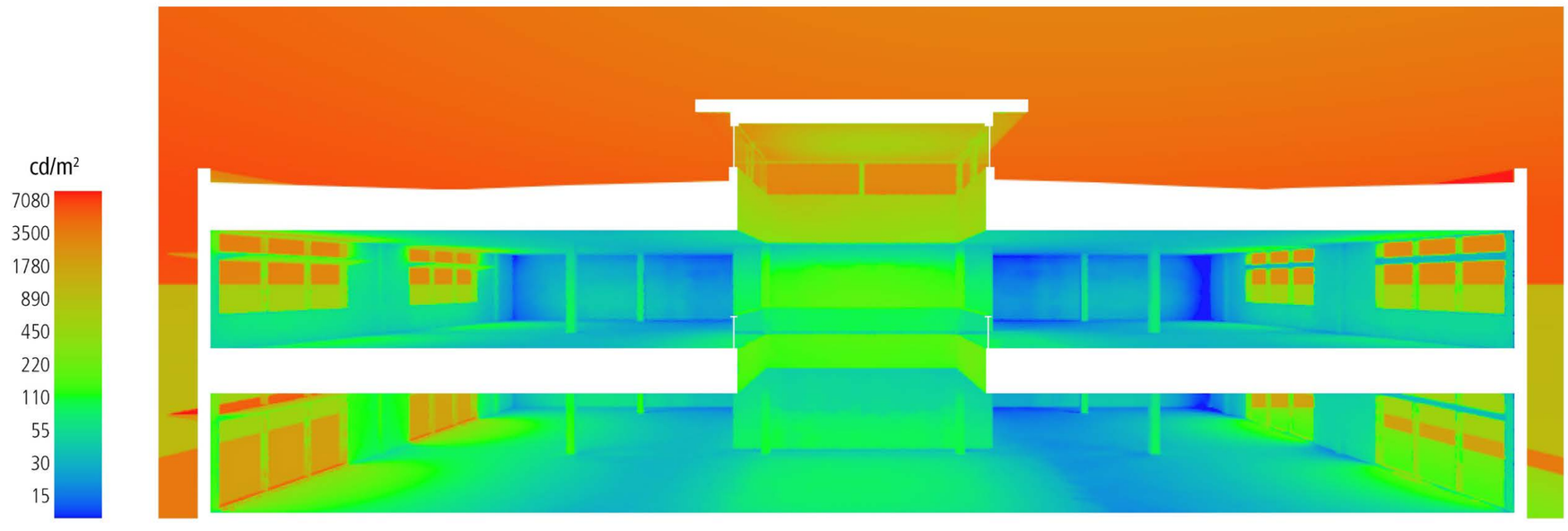
Falsecolor Luminance Map, Surface Brightness

Daylighting Retrofit Example: Concept Design Moves

Section Perspective



Falsecolor Luminance Map, Surface Brightness



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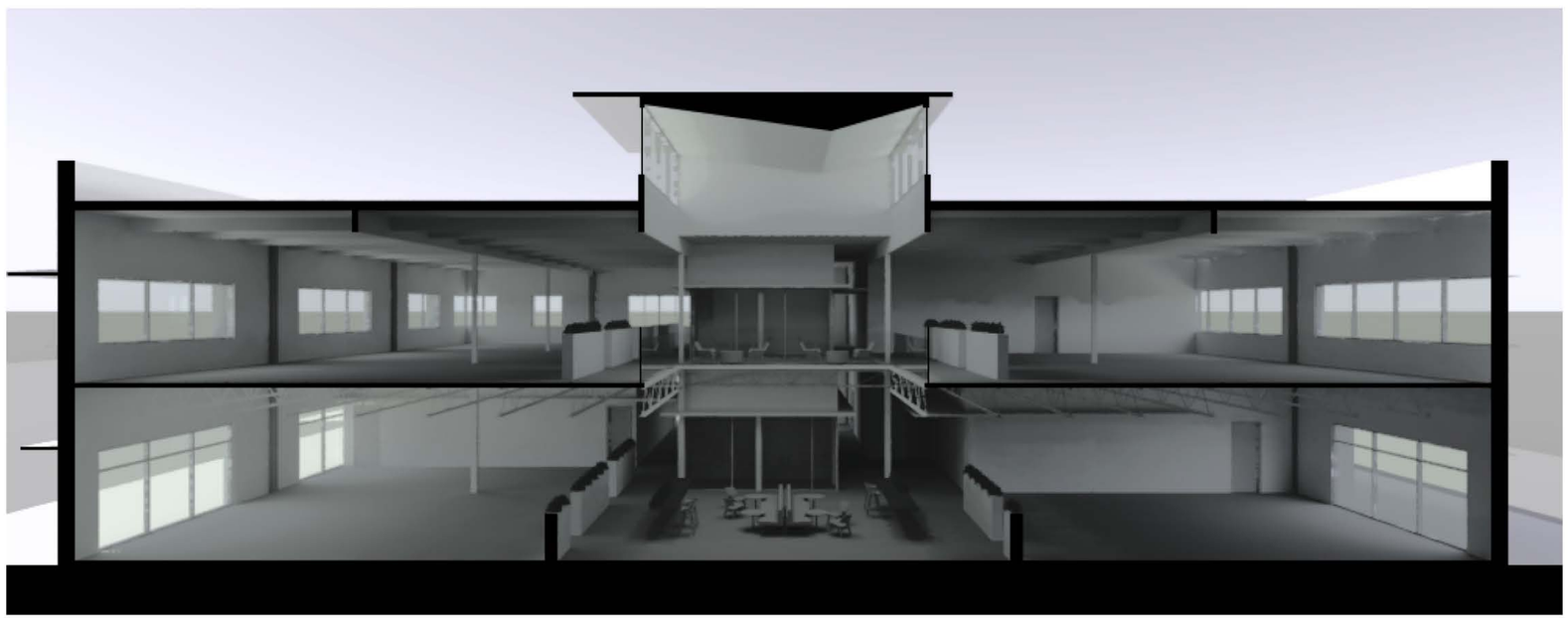
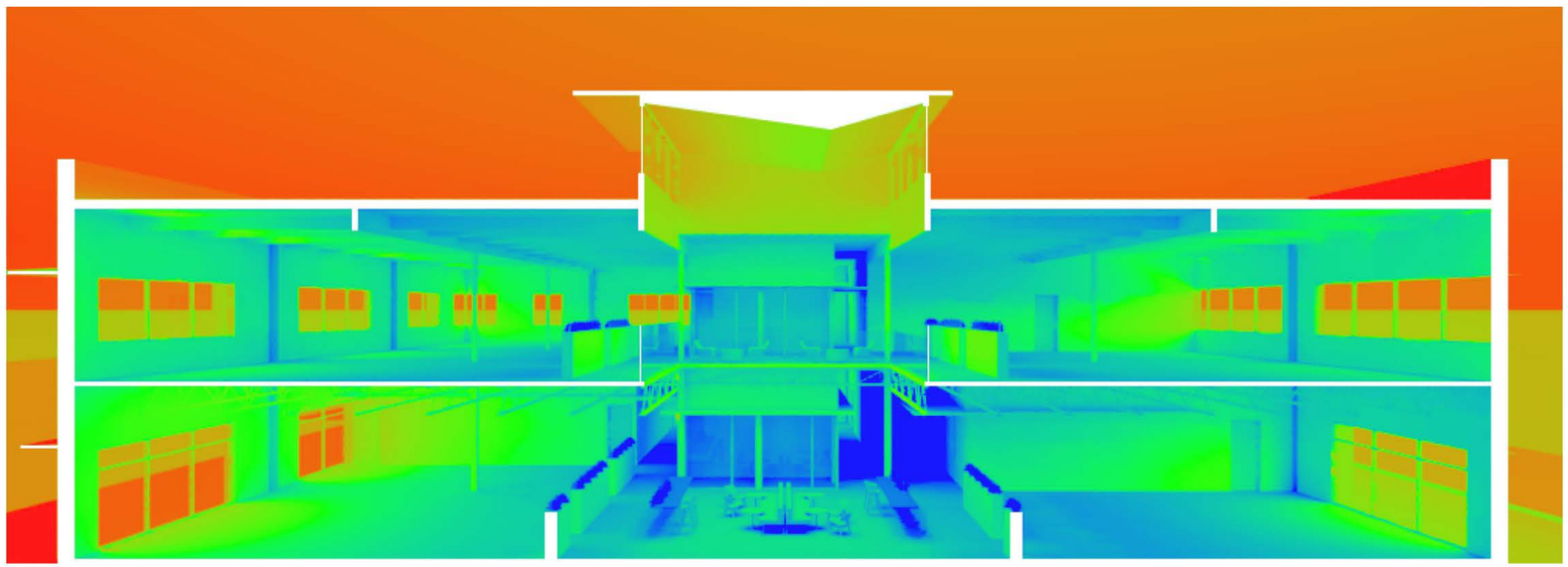
Daylighting Retrofit Example: Tuned Design

Section Perspective



Falsecolor Luminance Map, Surface Brightness



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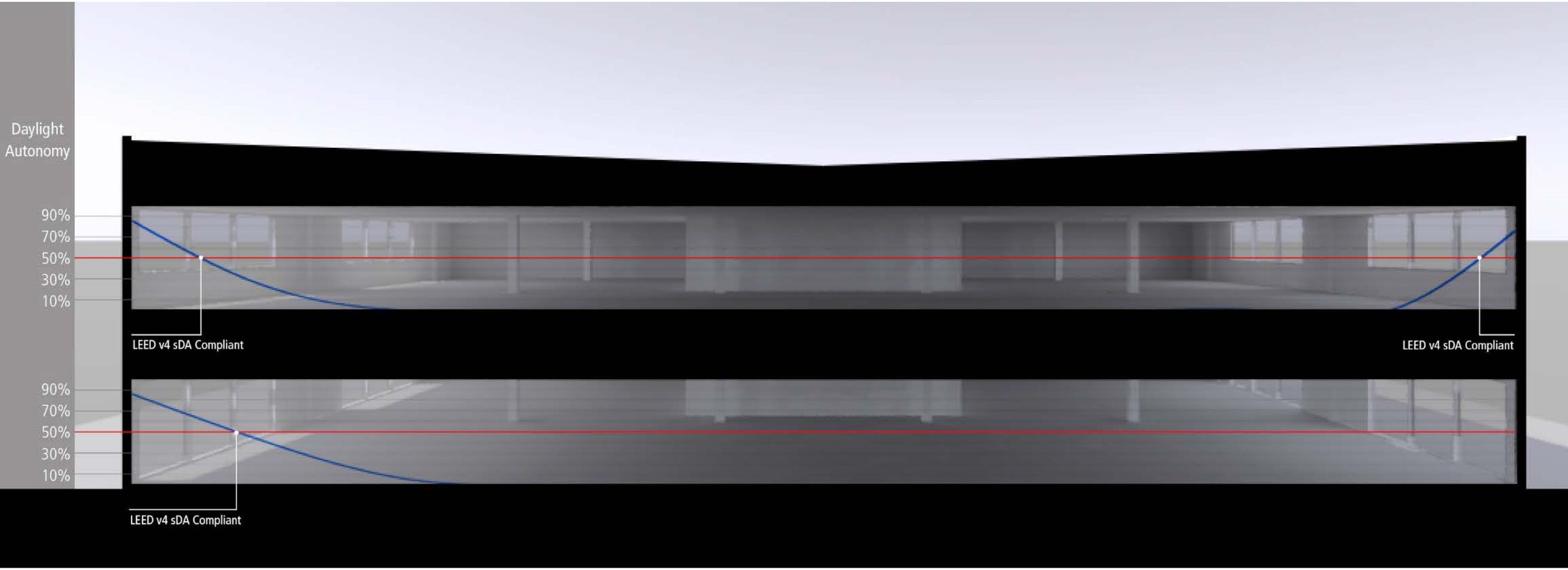
Daylight Autonomy Studies, Existing Conditions

Annual, Climate Based Calculation

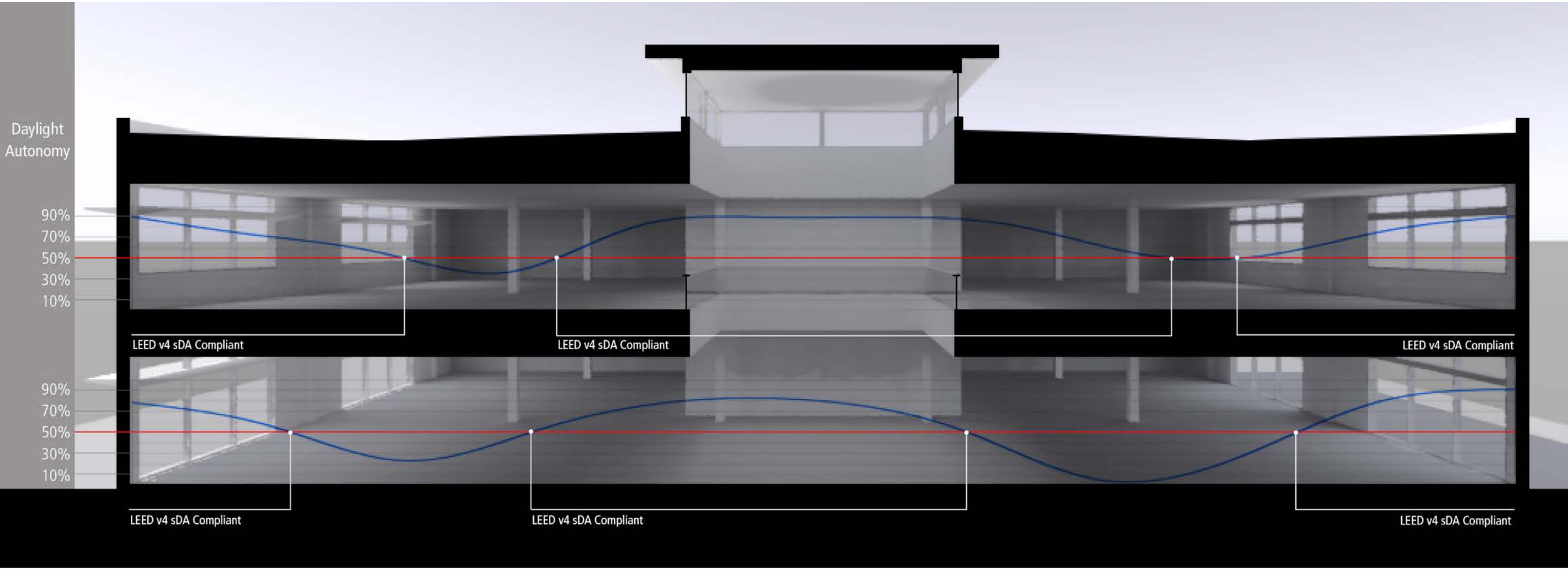
Given a work plane illuminance target, how many occupied hours can function with no electric lighting



Daylight Autonomy Studies, Proposed Scheme

Annual, Climate Based Calculation

Given a work plane illuminance target, how many occupied hours can function with no electric lighting

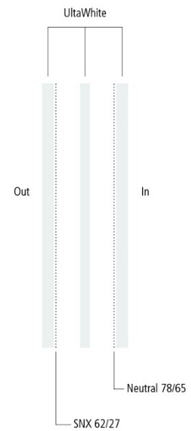


05. Transparency?

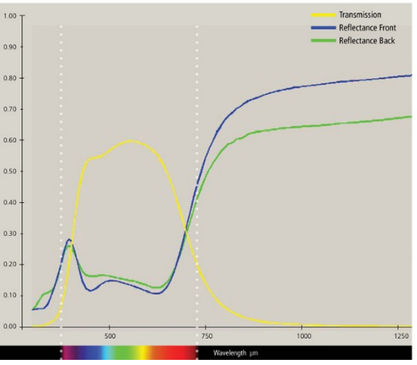
Glazing Specifications

Translating Concept Ideas to Reality

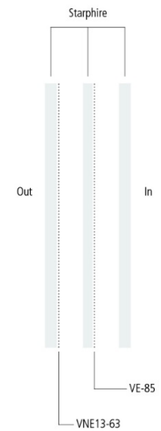
Guardian SNX 62/27 + Neutral 78/65



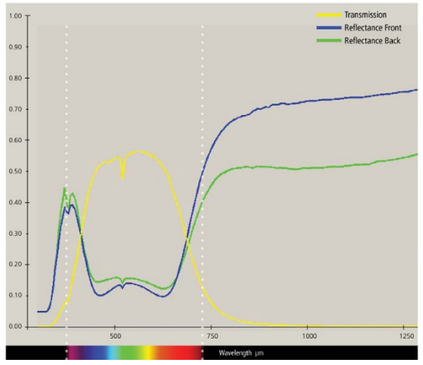
VLT - **0.56**
SHGC - **0.24**
U-Value - **0.16**
Front Face VLR - **0.13**



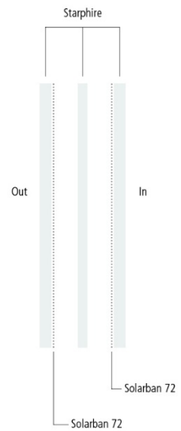
Viracon VNE13-63 + VE-85



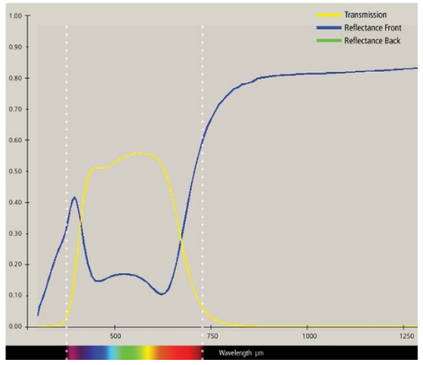
VLT - **0.59**
SHGC - **0.26**
U-Value - **0.16**
Front Face VLR - **0.14**



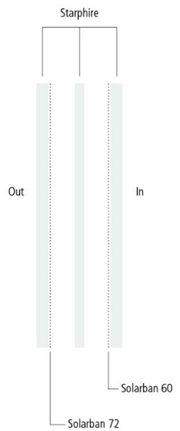
PPG Solarban 72 + Solarban 72



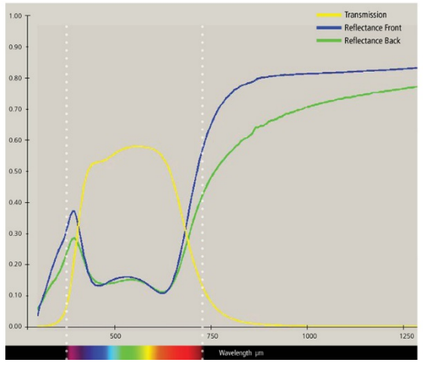
VLT - **0.55**
SHGC - **0.26**
U-Value - **0.15**
Front Face VLR - **0.16**



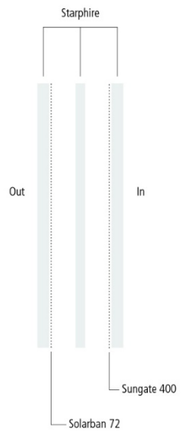
PPG Solarban 72 + Solarban 60



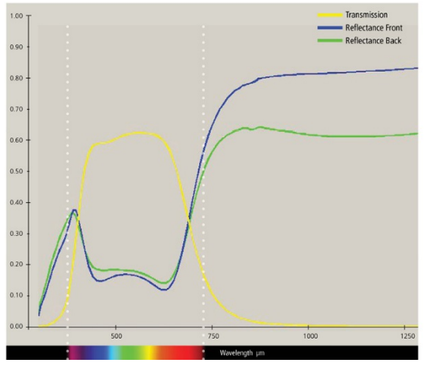
VLT - **0.56**
SHGC - **0.27**
U-Value - **0.15**
Front Face VLR - **0.15**



PPG Solarban 72 + Sungate 400

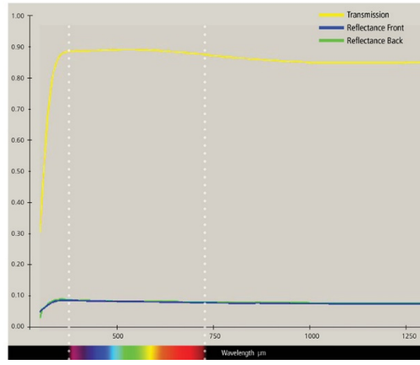


VLT - **0.61**
SHGC - **0.27**
U-Value - **0.17**
Front Face VLR - **0.16**



PPG Single Pane Starphire (For Reference Only)

VLT - **0.91**
SHGC - **0.89**
U-Value - **1.03**
Front Face VLR - **0.08**

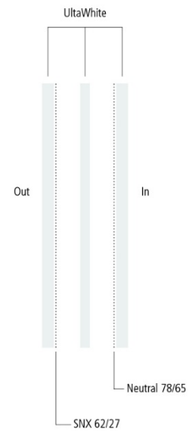


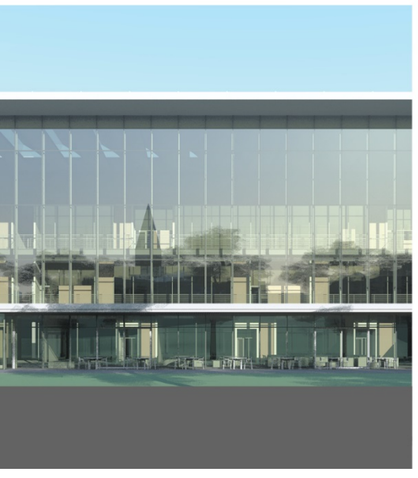
INTEGRAL GROUP

Glazing Specifications

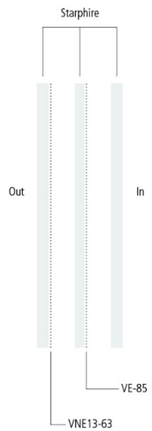
Translating Concept Ideas to Reality

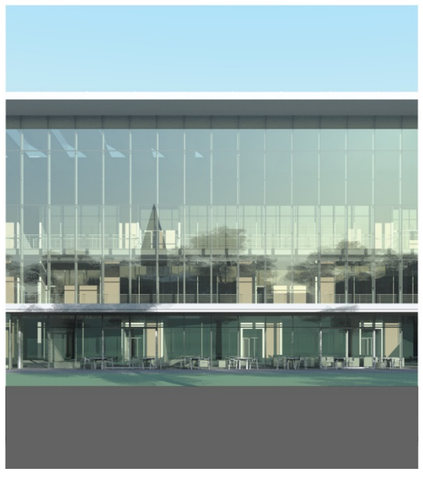
Guardian SNX 62/27 + Neutral 78/65



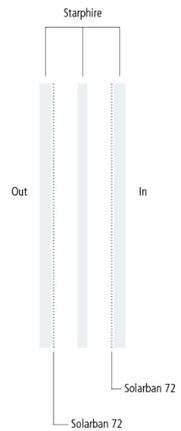


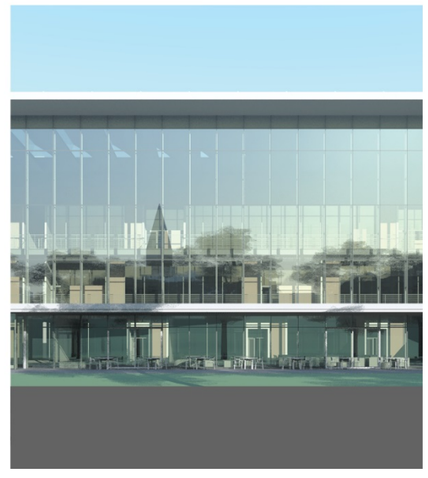
Viracon VNE13-63 + VE-85



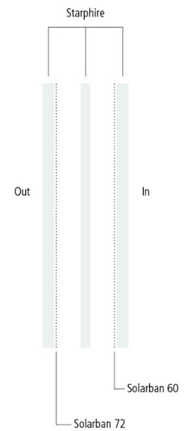


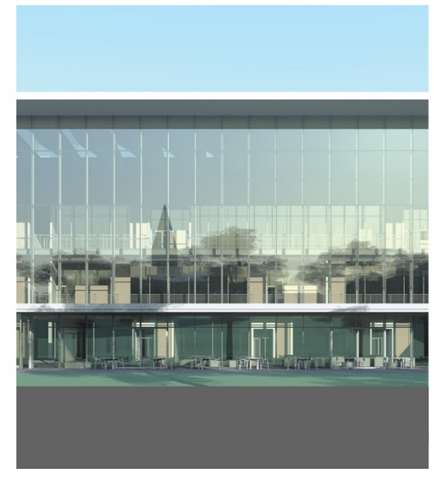
PPG Solarban 72 + Solarban 72



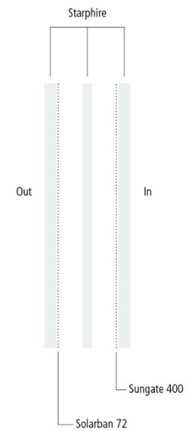


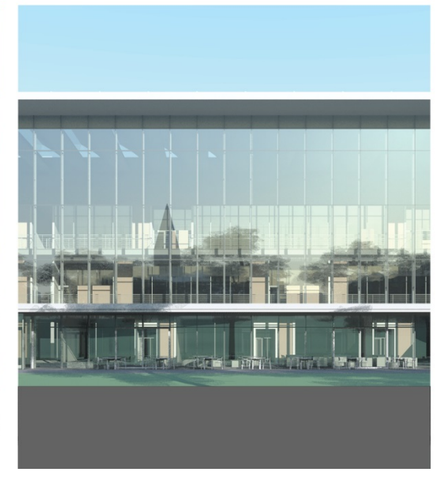
PPG Solarban 72 + Solarban 60



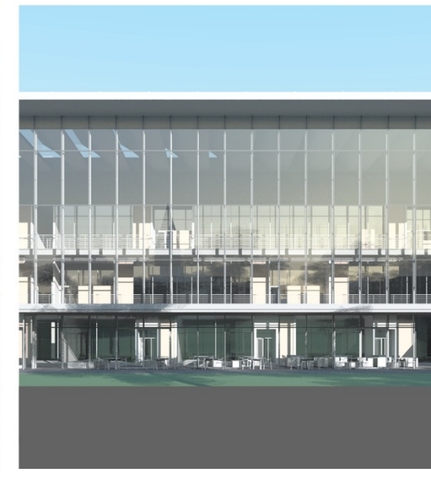


PPG Solarban 72 + Sungate 400





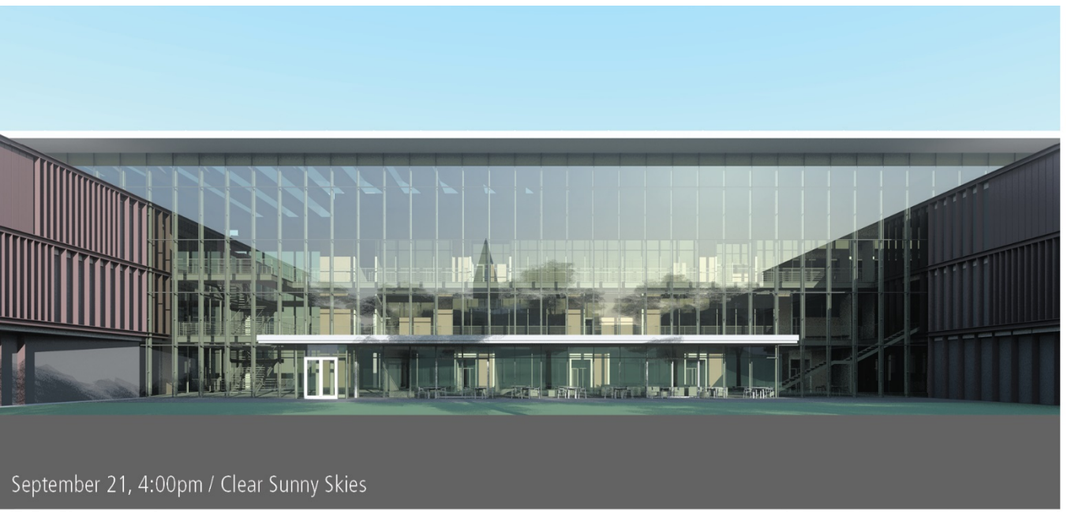
PPG Single Pane Starphire (For Reference Only)



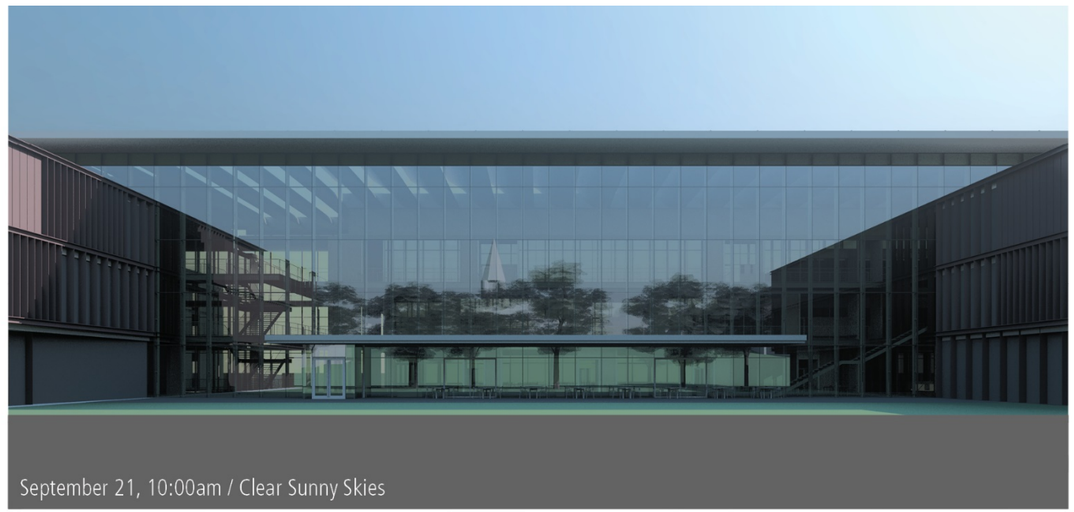
INTEGRAL GROUP

Guardian SNX 62/27 + Neutral 78/65

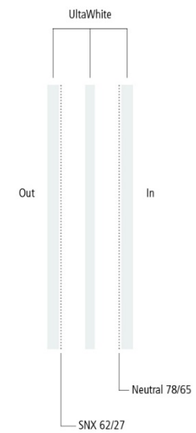
Visualizing Glass Types

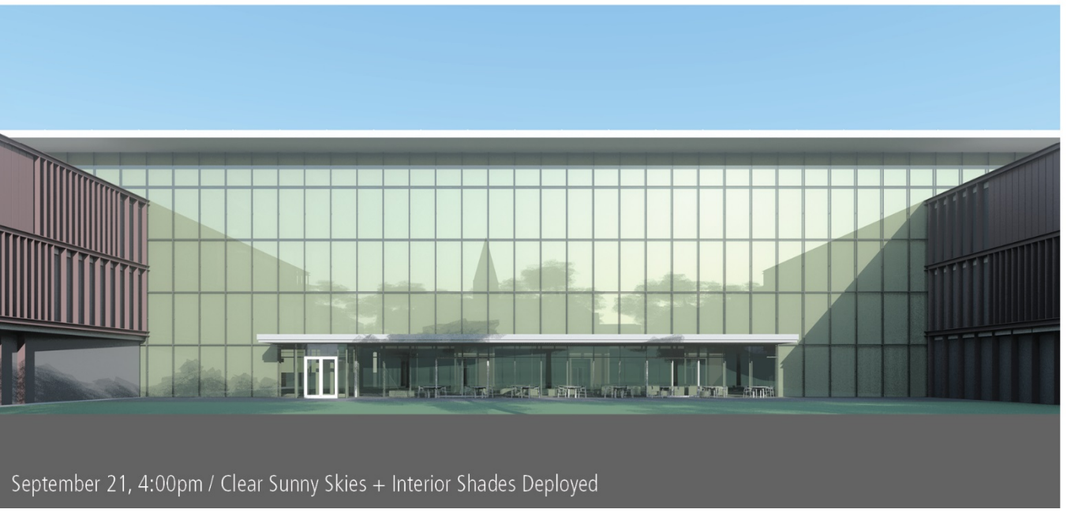


September 21, 4:00pm / Clear Sunny Skies

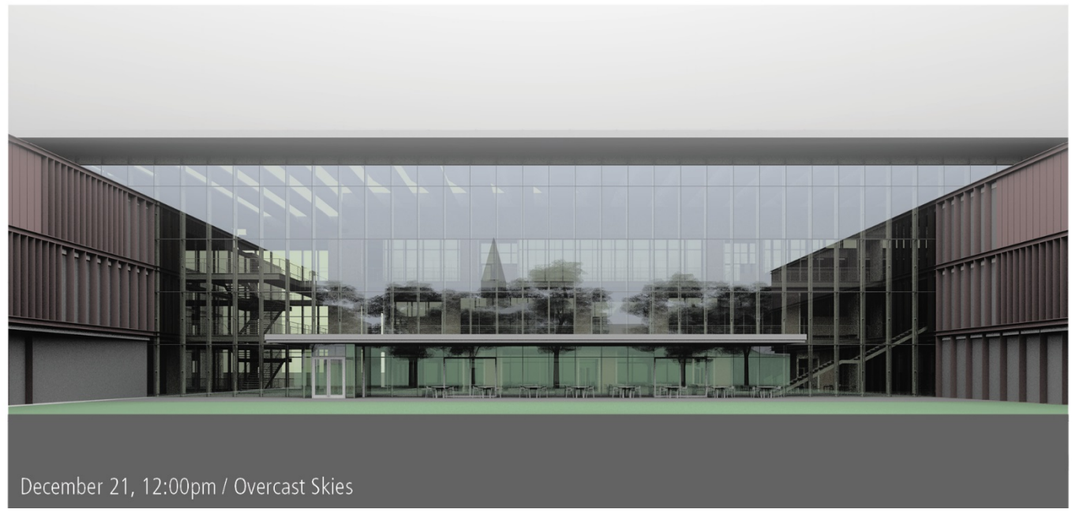


September 21, 10:00am / Clear Sunny Skies



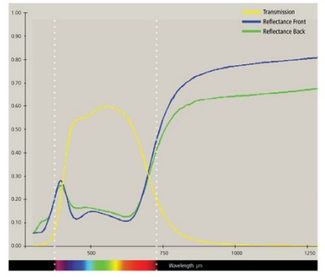


September 21, 4:00pm / Clear Sunny Skies + Interior Shades Deployed



December 21, 12:00pm / Overcast Skies

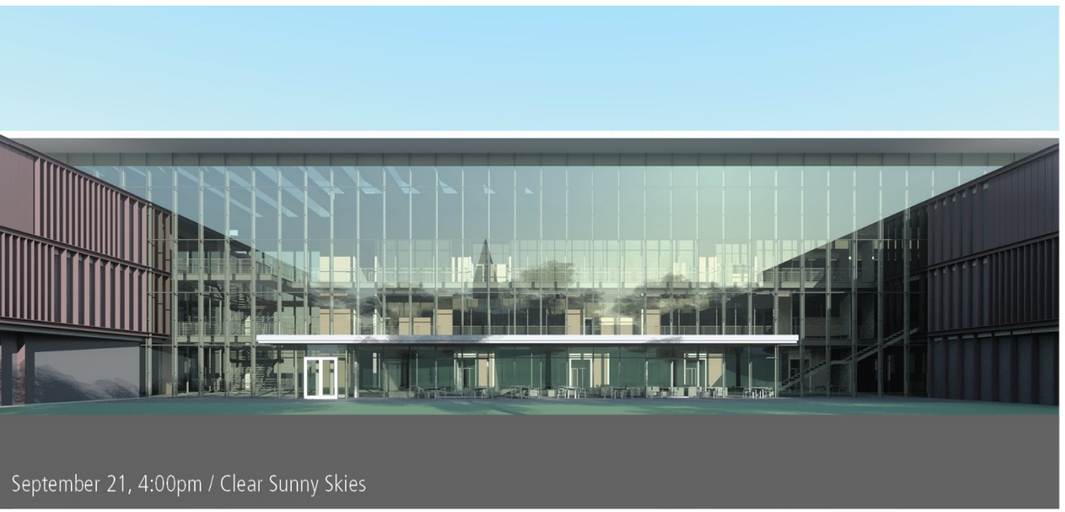
VLT - **0.56**
SHGC - **0.24**
U-Value - **0.16**
Front Face VLR - **0.13**



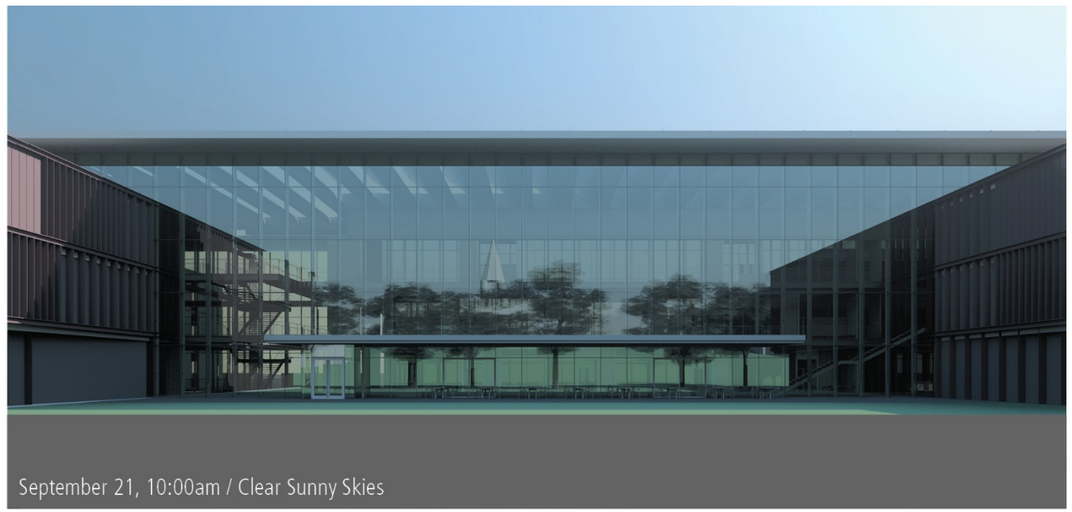
INTEGRAL GROUP

Viracon VNE13-63 + VE 85

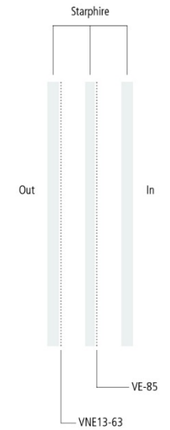
Visualizing Glass Types



September 21, 4:00pm / Clear Sunny Skies

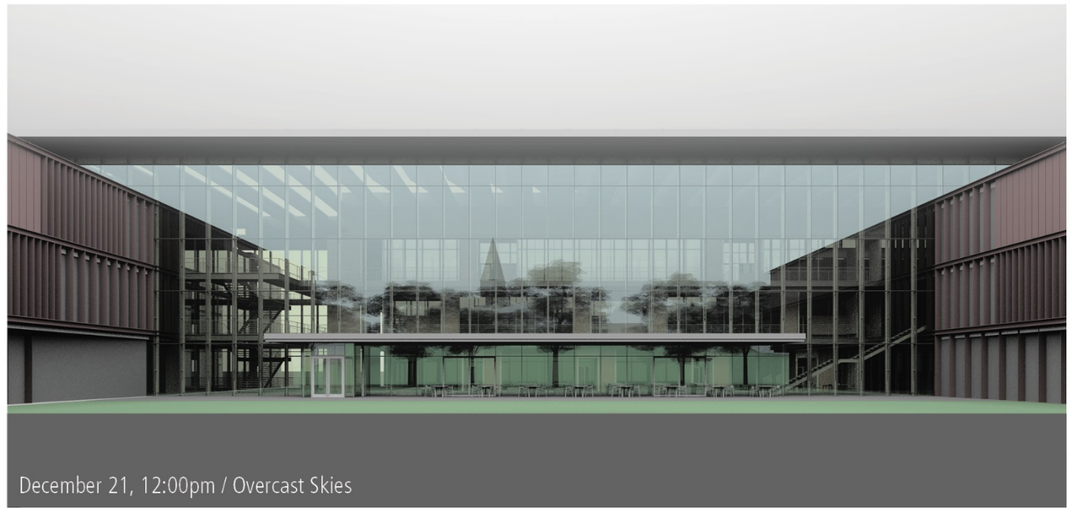


September 21, 10:00am / Clear Sunny Skies

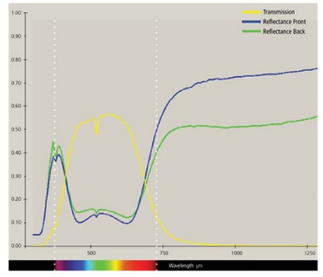


VLT - **0.59**
SHGC - **0.26**
U-Value - **0.16**
Front Face VLR - **0.14**

September 21, 4:00pm / Clear Sunny Skies + Interior Shades Deployed



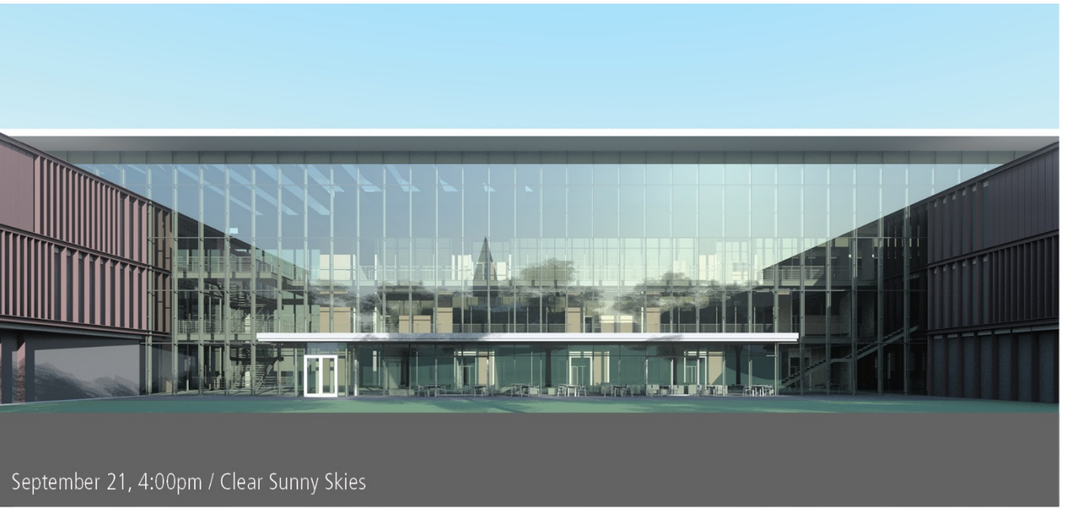
December 21, 12:00pm / Overcast Skies



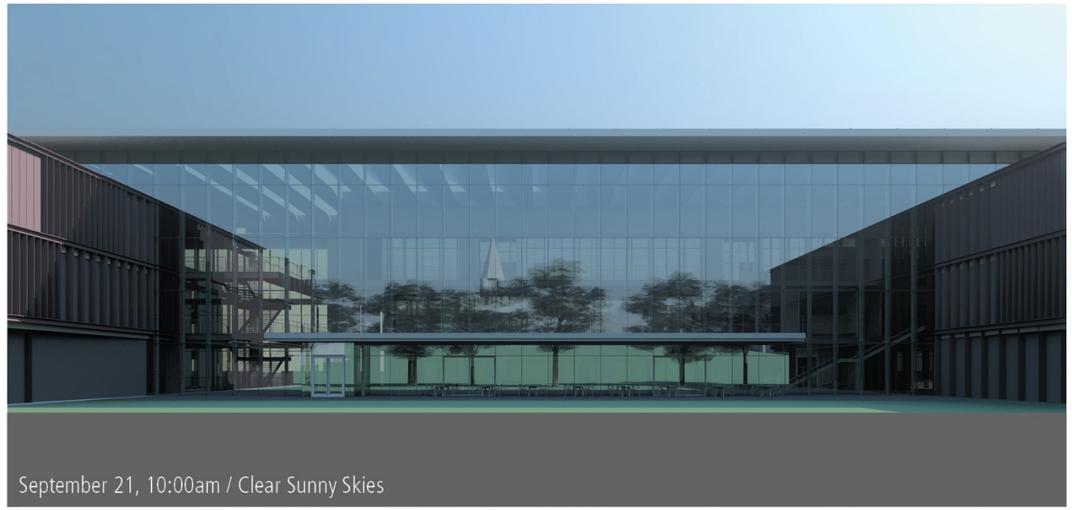
INTEGRAL GROUP

PPG Solarban 72 + Solarban 72

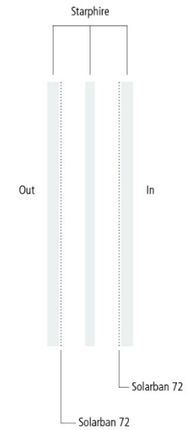
Visualizing Glass Types



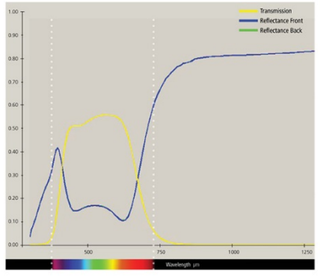
September 21, 4:00pm / Clear Sunny Skies

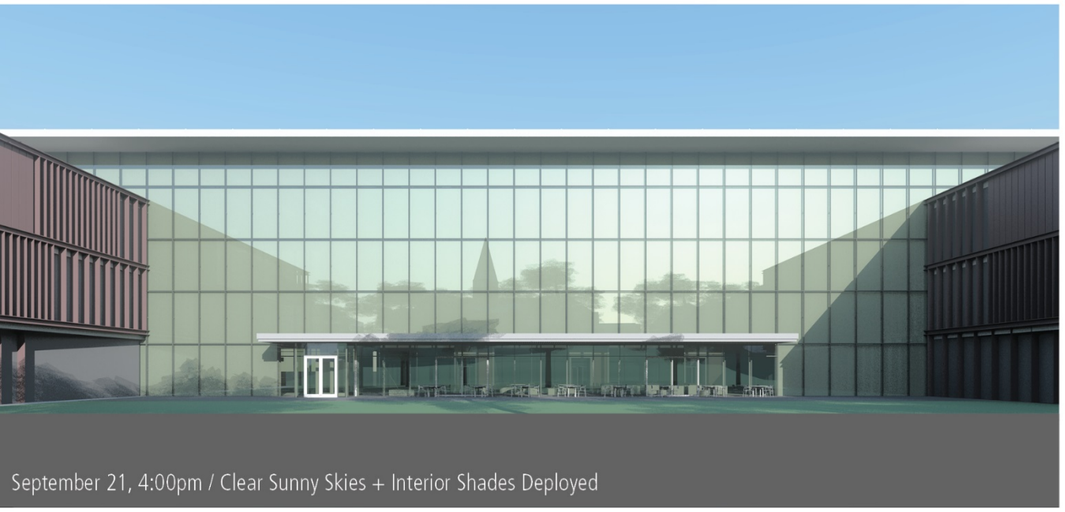


September 21, 10:00am / Clear Sunny Skies

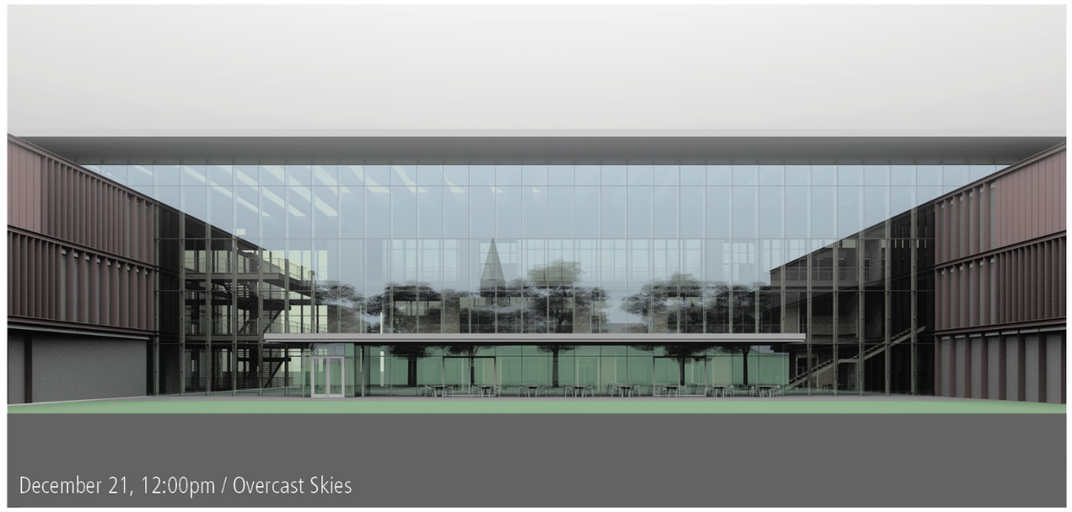


VLT - **0.55**
SHGC - **0.26**
U-Value - **0.15**
Front Face VLR - **0.16**





September 21, 4:00pm / Clear Sunny Skies + Interior Shades Deployed

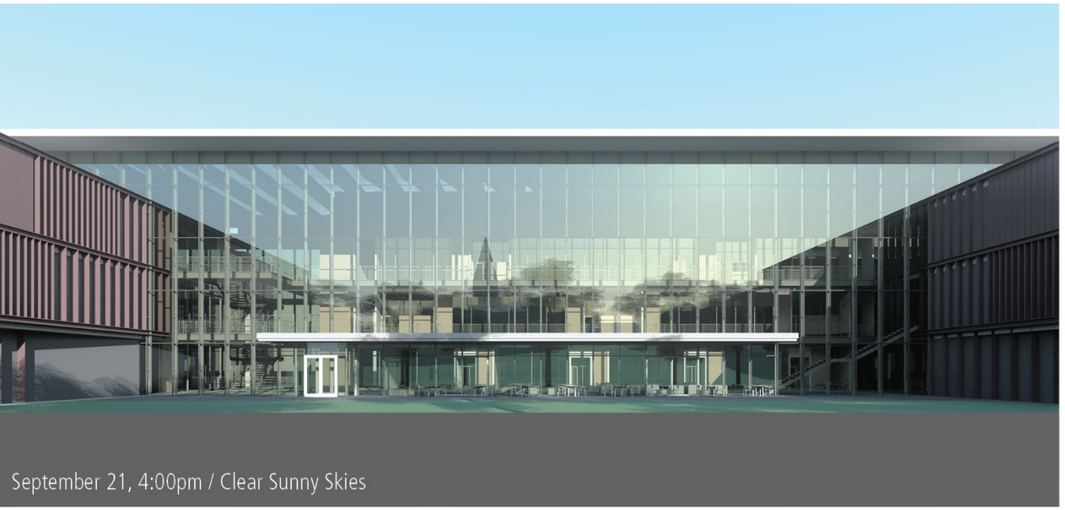


December 21, 12:00pm / Overcast Skies

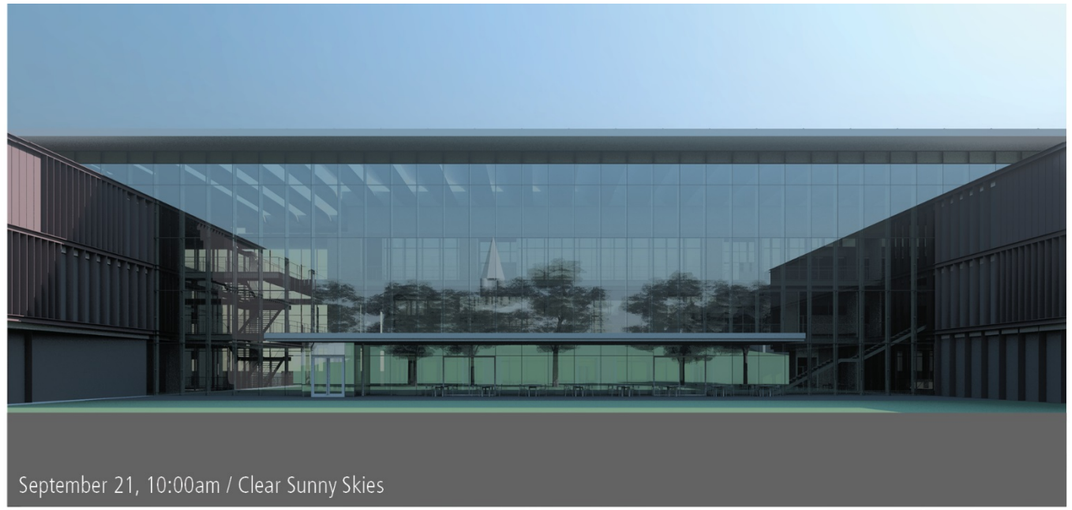
INTEGRAL GROUP

PPG Solarban 72 + Solarban 60

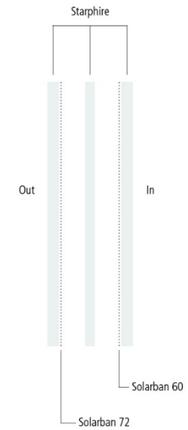
Visualizing Glass Types

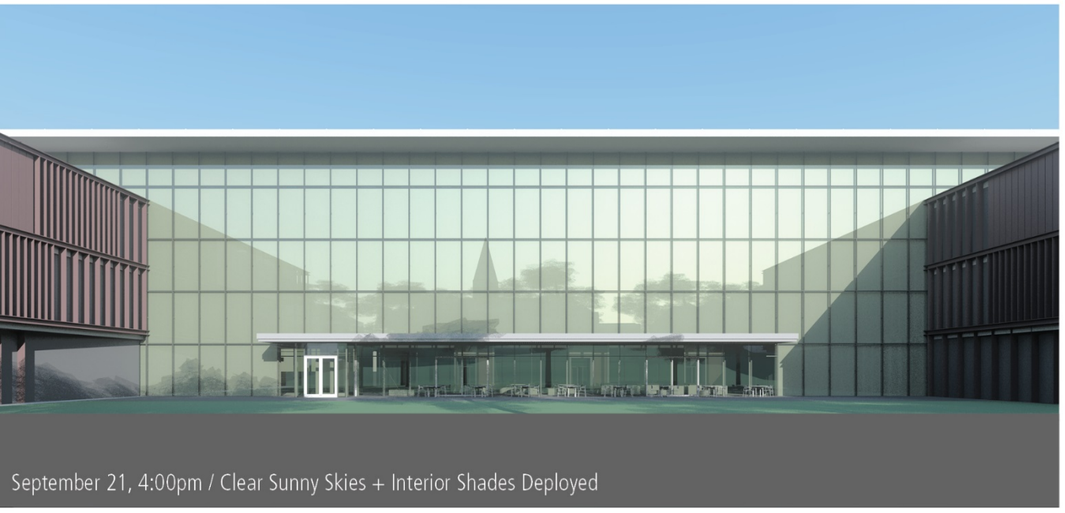


September 21, 4:00pm / Clear Sunny Skies

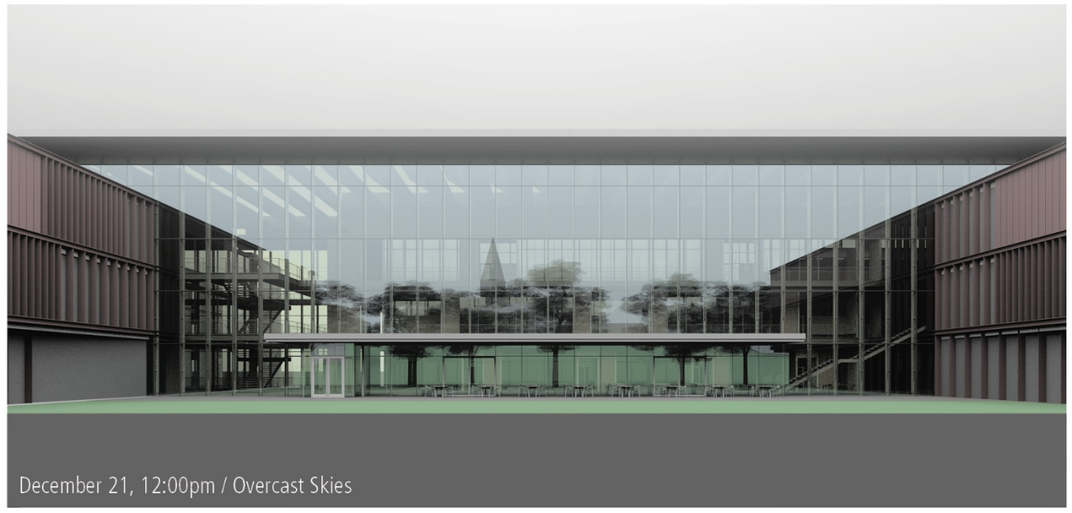


September 21, 10:00am / Clear Sunny Skies



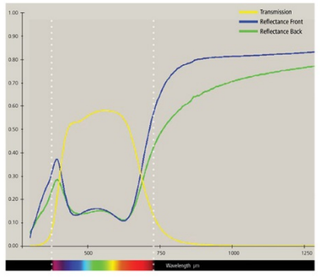


September 21, 4:00pm / Clear Sunny Skies + Interior Shades Deployed



December 21, 12:00pm / Overcast Skies

VLT - **0.56**
SHGC - **0.27**
U-Value - **0.15**
Front Face VLR - **0.15**



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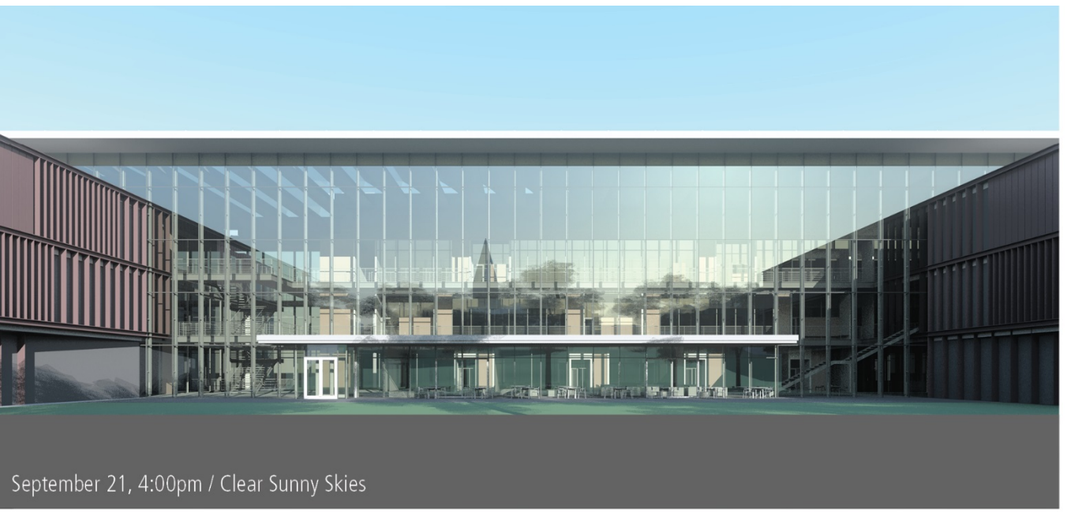
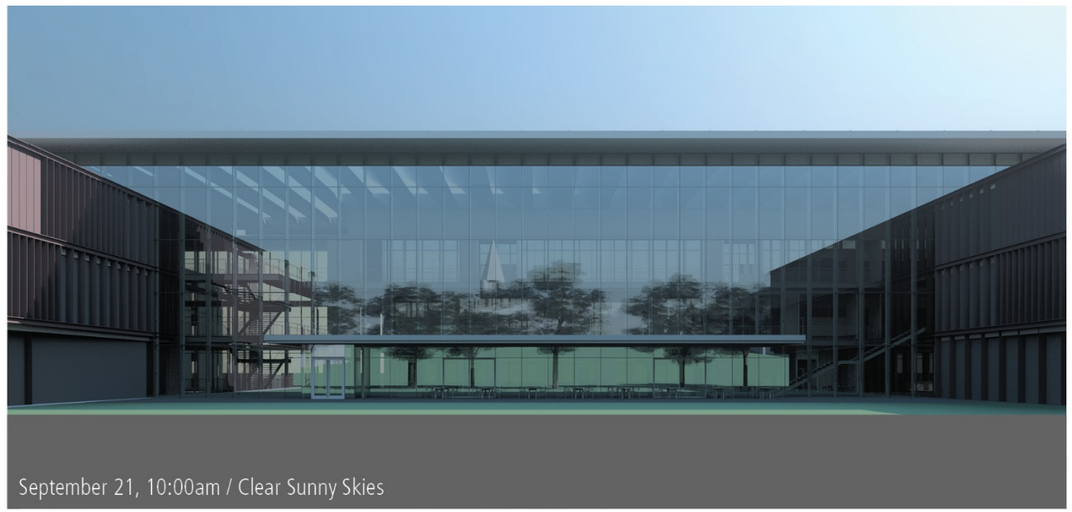
PPG Solarban 72 + Sungate 400

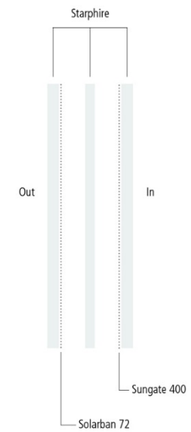
Visualizing Glass Types



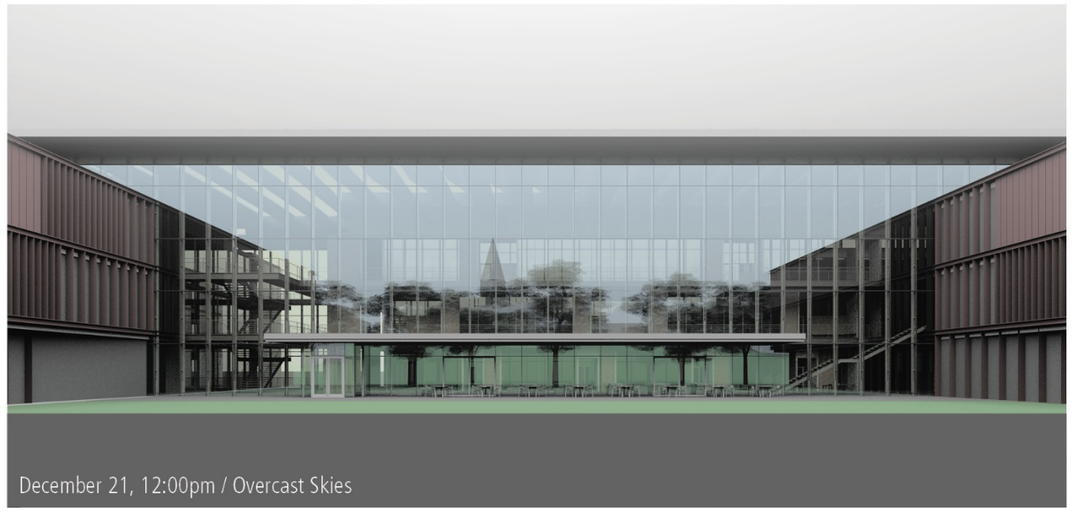
September 21, 4:00pm / Clear Sunny Skies



September 21, 10:00am / Clear Sunny Skies

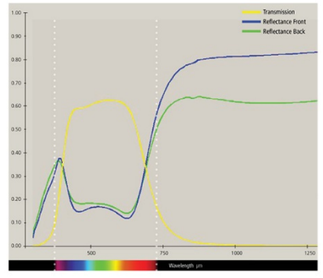


September 21, 4:00pm / Clear Sunny Skies + Interior Shades Deployed



December 21, 12:00pm / Overcast Skies

VLT - **0.61**
SHGC - **0.27**
U-Value - **0.17**
Front Face VLR - **0.16**



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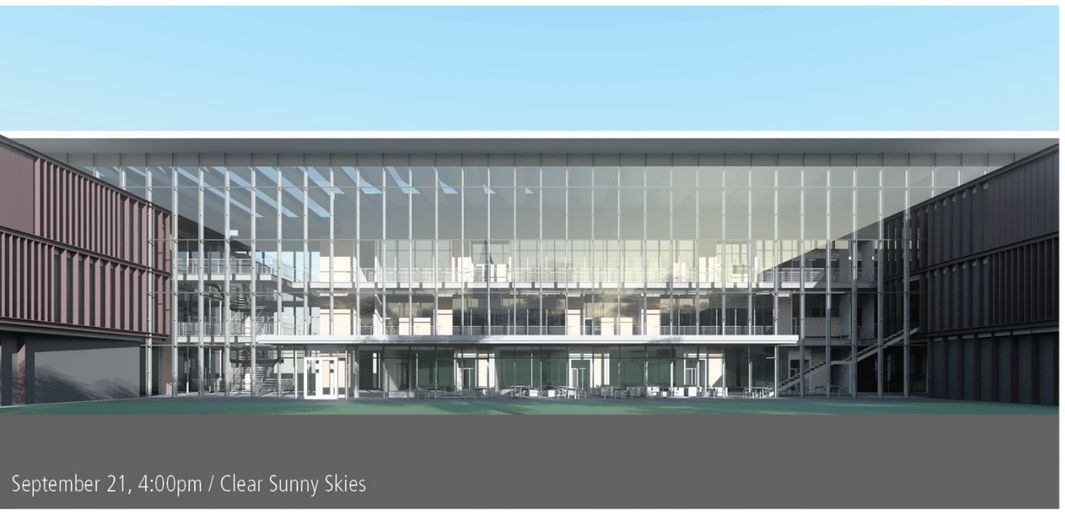
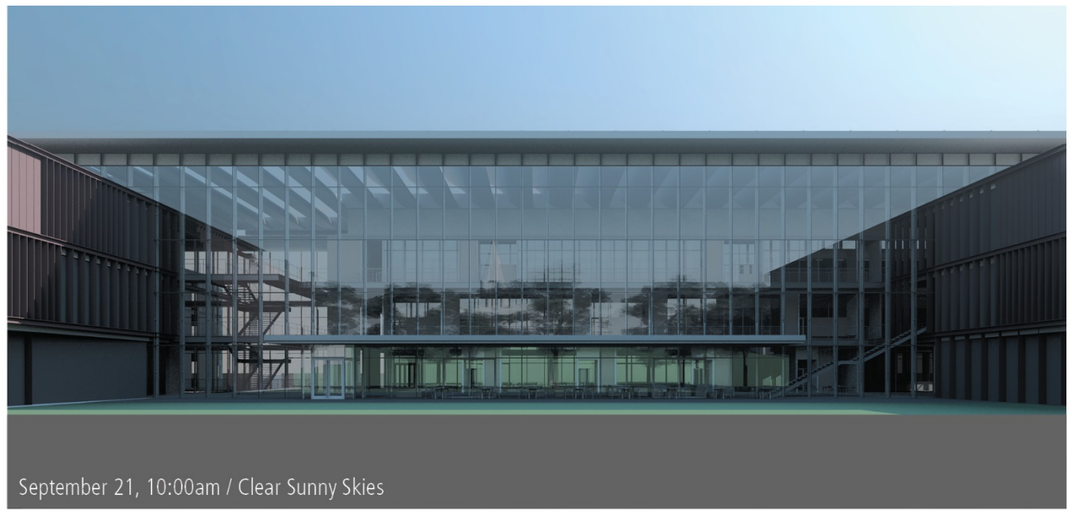
Single Pane Starphire Low Iron Glass, For Reference

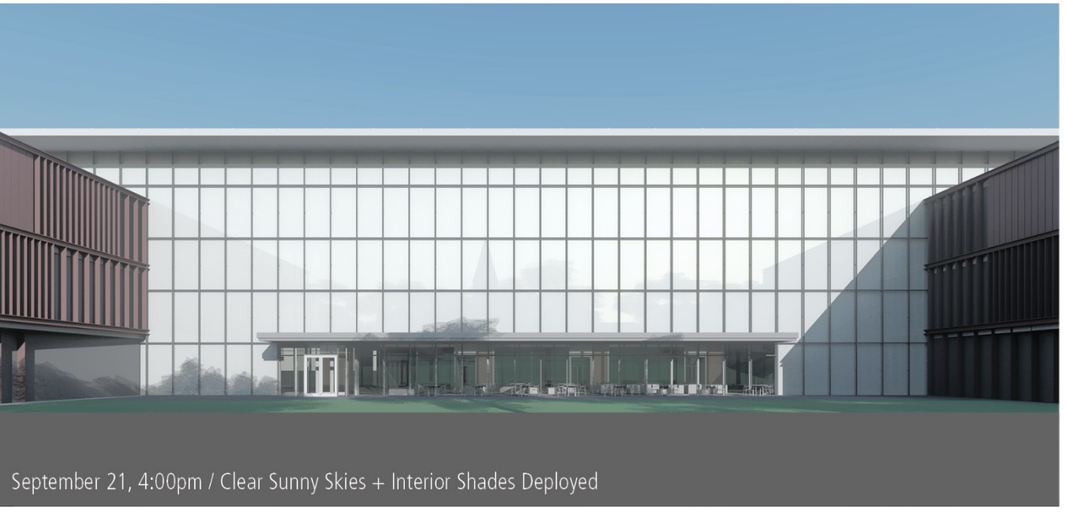
Visualizing Glass Types



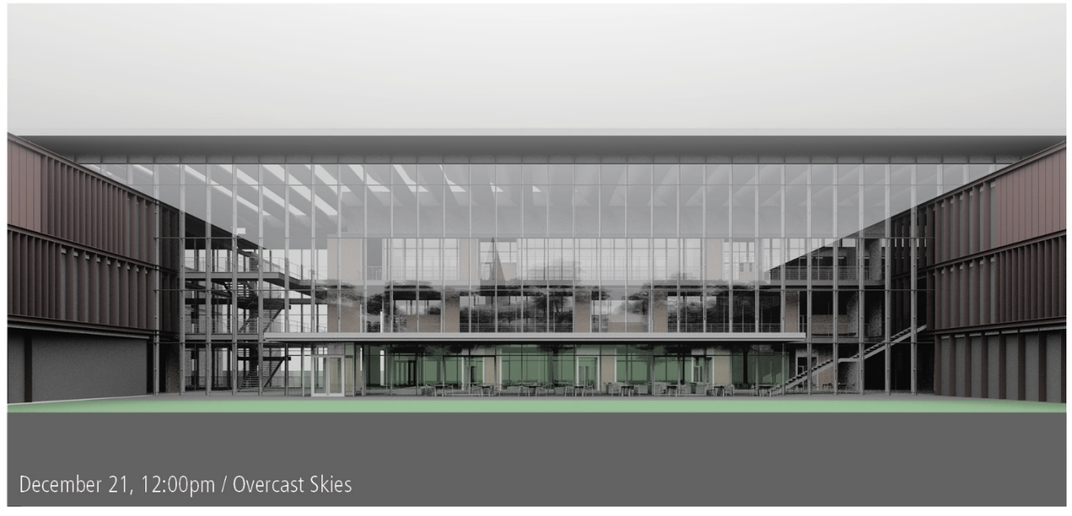
September 21, 4:00pm / Clear Sunny Skies



September 21, 10:00am / Clear Sunny Skies

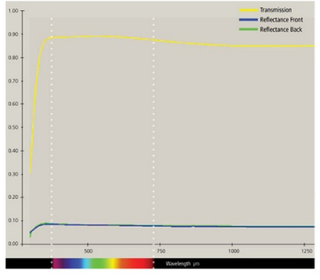


September 21, 4:00pm / Clear Sunny Skies + Interior Shades Deployed



December 21, 12:00pm / Overcast Skies

VLT - **0.91**
SHGC - **0.89**
U-Value - **1.03**
Front Face VLR - **0.08**



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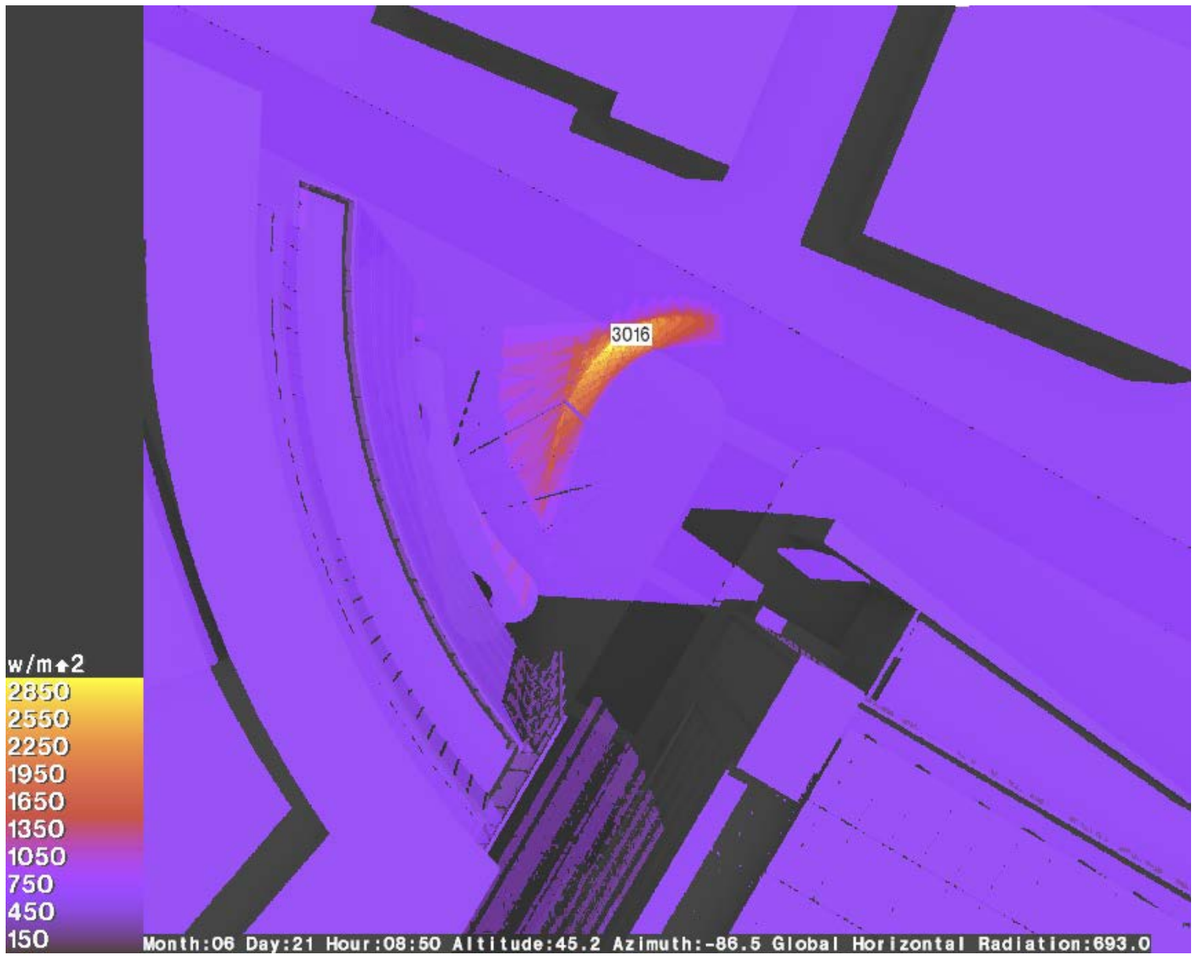
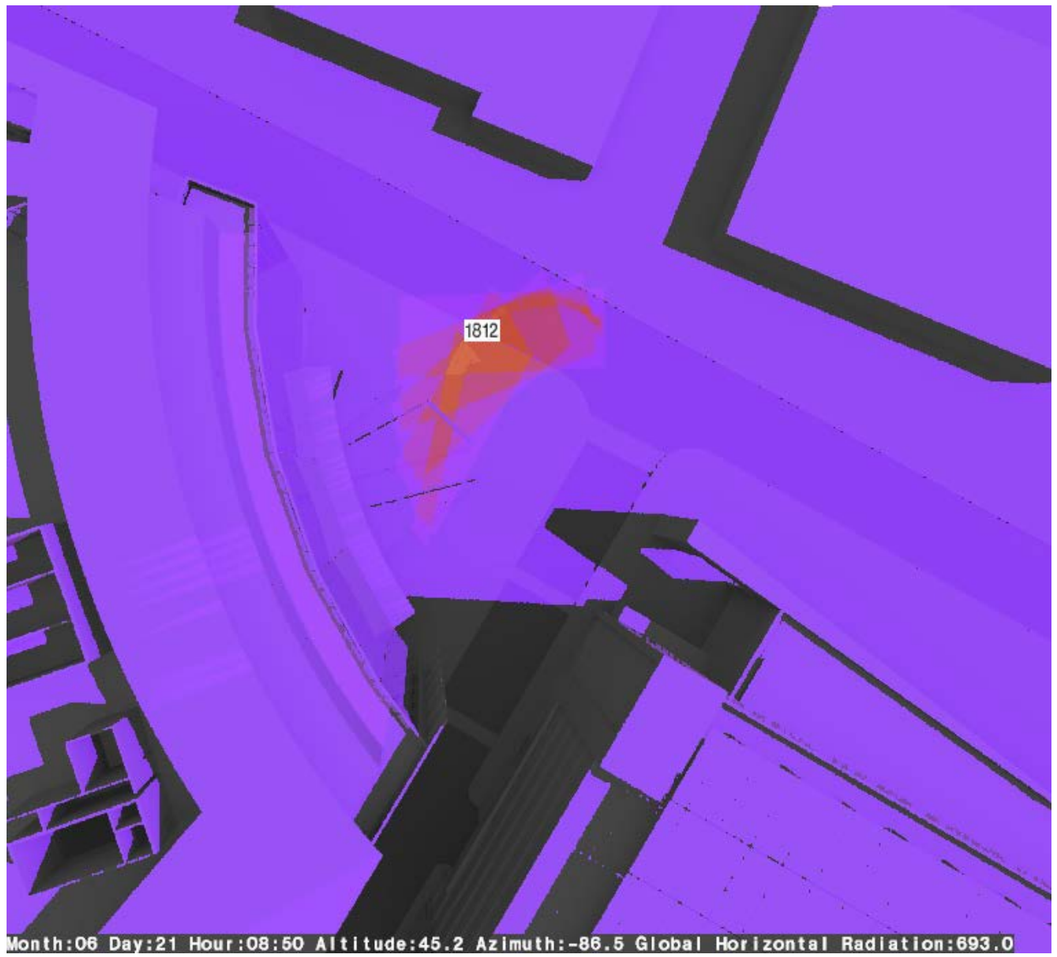
Bonus - Yet *Another* Convergence!

East Facing Façade in Menlo Park, California

East Facing Façade in Menlo Park, California





Thank You!

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