
The New York Times Building
IPD/ BIM Thesis Team II
Erika Bonfanti | Pete Clarke | Dan Cox | Chris Wiacek

Building Overview

Team Workflow

Phase I : Façade
Phase II: Cogeneration
Phase III: Lateral System
Phase IV: Distribution Systems and Coordination

Results and Conclusions

Building Overview

[Image: nytimes.com]

Building Overview

Team Workflow

Phase I : Façade
Phase II: Cogeneration
Phase III: Lateral System
Phase IV: Distribution Systems and Coordination

Results and Conclusions

[Image: nytimes.com]

Statistics and Project Team

Building Overview

Team Workflow

Phase I : Façade
Phase II: Cogeneration
Phase III: Lateral System
Phase IV: Distribution Systems and Coordination

Results and Conclusions

Building: 52 story office building with ground floor retail
1.5 Million SF

Location: 8th Avenue & 41st Street, Manhattan

[Image: nytimes.com]

Building Overview

Team Workflow

Phase I : Façade
Phase II: Cogeneration
Phase III: Lateral System
Phase IV: Distribution Systems and Coordination

Results and Conclusions

Building: 52 story office building with ground floor retail
1.5 Million SF

Location: 8th Avenue & 41st Street, Manhattan

Cost: Approximately $1 Billion (2007)

[Image: nytimes.com]

Building Overview

Team Workflow

Phase I : Façade
Phase II: Cogeneration
Phase III: Lateral System
Phase IV: Distribution Systems and Coordination

Results and Conclusions

Building: 52 story office building with ground floor retail
1.5 Million SF

Location: 8th Avenue & 41st Street, Manhattan

Cost: Approximately $1 Billion (2007)

Architect: Renzo Piano Building Workshop
FXFowle
Gensler (Interiors)

[Image: nytimes.com]

Building Overview

Team Workflow

Phase I : Façade
Phase II: Cogeneration
Phase III: Lateral System
Phase IV: Distribution Systems and Coordination

Results and Conclusions

Building: 52 story office building with ground floor retail
1.5 Million SF

Location: 8th Avenue & 41st Street, Manhattan

Cost: Approximately $1 Billion (2007)

Architect: Renzo Piano Building Workshop
FXFowle
Gensler (Interiors)

Engineer: Thornton Tomasetti
Flack + Kurtz

[Image: nytimes.com]

Building Overview

Team Workflow

Phase I : Façade
Phase II: Cogeneration
Phase III: Lateral System
Phase IV: Distribution Systems and Coordination

Results and Conclusions

Building: 52 story office building with ground floor retail
1.5 Million SF

Location: 8^{th} Avenue & 41^{st} Street, Manhattan

Cost: Approximately $1 Billion (2007)

Architect: Renzo Piano Building Workshop
FXFowle
Gensler (Interiors)

Engineer: Thornton Tomasetti
Flack + Kurtz

CM: Amec (Core + Shell)
Turner (Interiors)

[Image: nytimes.com]

Building Overview

Team Workflow

Phase I : Façade
Phase II: Cogeneration
Phase III: Lateral System
Phase IV: Distribution Systems and Coordination

Results and Conclusions

[Image: nytimes.com]

Building Overview

Team Workflow

Phase I : Façade
Phase II: Cogeneration
Phase III: Lateral System
Phase IV: Distribution Systems and Coordination

Results and Conclusions

[Image: nytimes.com]

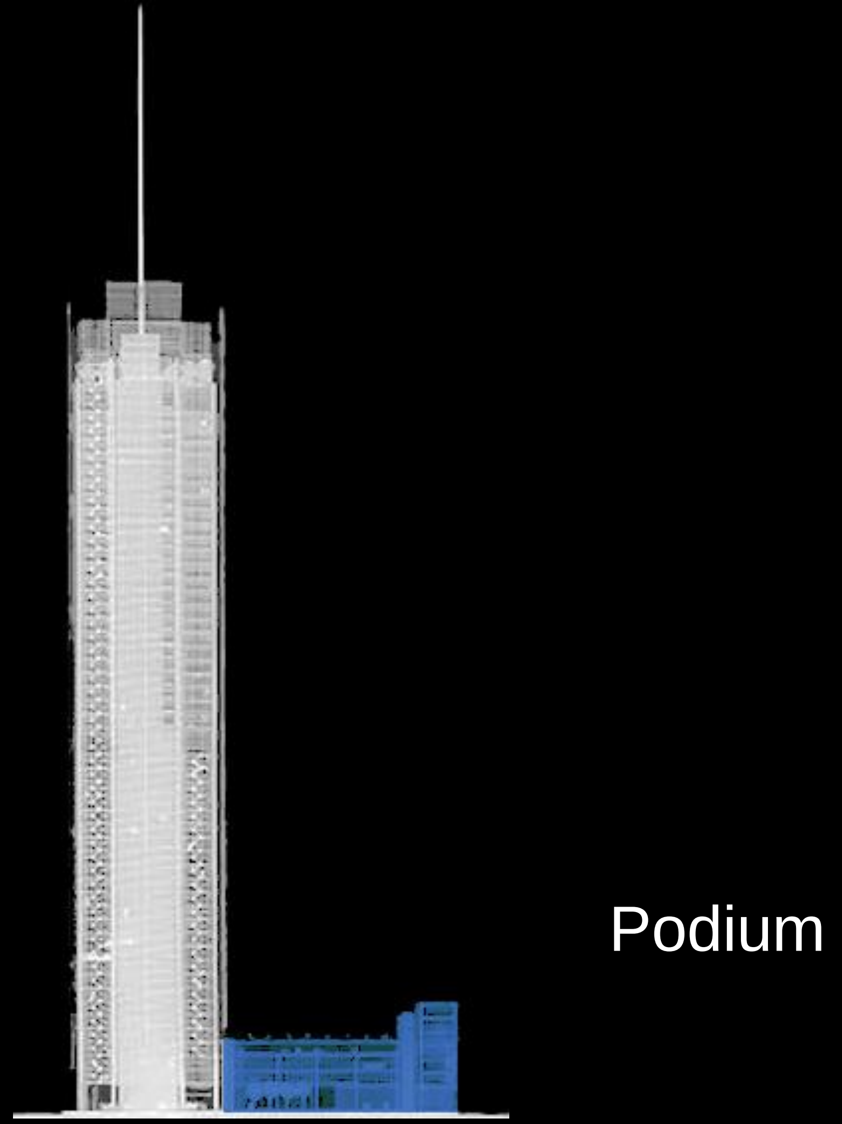
Configuration of Spaces

Building Overview

Team Workflow

Phase I : Façade
Phase II: Cogeneration
Phase III: Lateral System
Phase IV: Distribution Systems and Coordination

Results and Conclusions



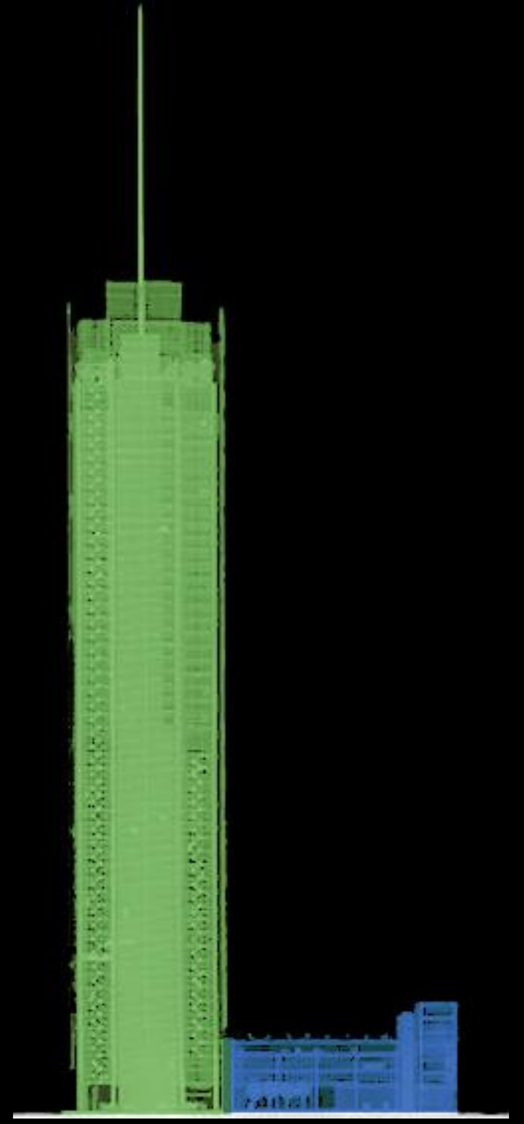
[Image: nytimes.com]

Building Overview

Team Workflow

Phase I : Façade
Phase II: Cogeneration
Phase III: Lateral System
Phase IV: Distribution Systems and Coordination

Results and Conclusions



[Image: nytimes.com]

Building Overview

Team Workflow

Phase I : Façade
Phase II: Cogeneration
Phase III: Lateral System
Phase IV: Distribution Systems and Coordination

Results and Conclusions

[Image: nytimes.com]

Building Overview

Team Workflow

Phase I : Façade
Phase II: Cogeneration
Phase III: Lateral System
Phase IV: Distribution Systems and Coordination

Results and Conclusions

Owner Occupancy:

2-27, Podium The New York Times

[Image: nytimes.com]

Building Overview

Team Workflow

Phase I : Façade
Phase II: Cogeneration
Phase III: Lateral System
Phase IV: Distribution Systems and Coordination

Results and Conclusions

Owner Occupancy:

2-27, Podium	The New York Times
29-50	Forest City Ratner Companies

[Image: nytimes.com]

Building Overview

Team Workflow

Phase I : Façade
Phase II: Cogeneration
Phase III: Lateral System
Phase IV: Distribution Systems and Coordination

Results and Conclusions

Owner Occupancy:

2-27, Podium	The New York Times
29-50	Forest City Ratner Companies
27, 51	Jointly-owned MEP spaces

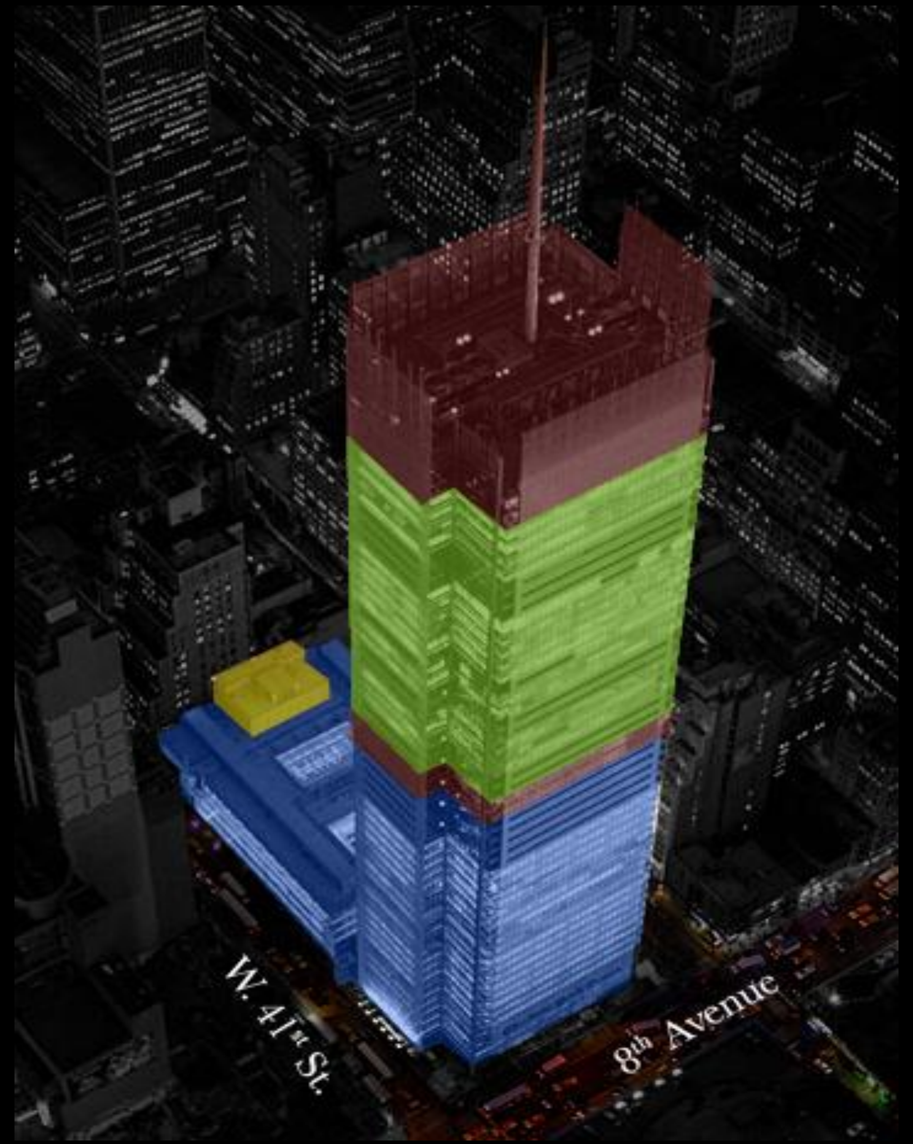
[Image: nytimes.com]

Building Overview

Team Workflow

Phase I : Façade
Phase II: Cogeneration
Phase III: Lateral System
Phase IV: Distribution Systems and Coordination

Results and Conclusions



Owner Occupancy:

2-27, Podium	The New York Times
29-50	Forest City Ratner Companies
27, 51	Jointly-owned MEP spaces Jointly-owned Cogeneration plant

[Image: nytimes.com]

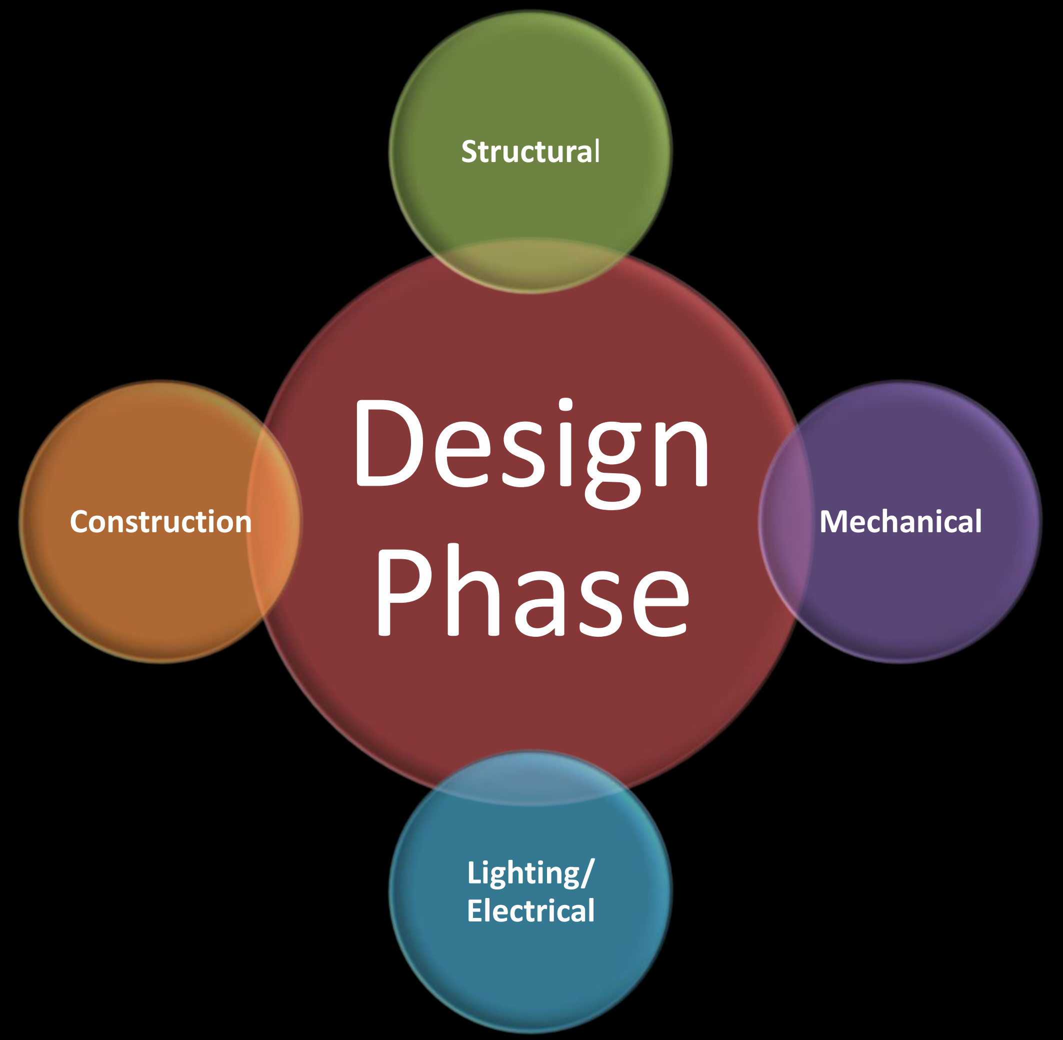
Team Workflow

Building Overview

Team Workflow

Phase I : Façade
Phase II: Cogeneration
Phase III: Lateral System
Phase IV: Distribution Systems and Coordination

Results and Conclusions

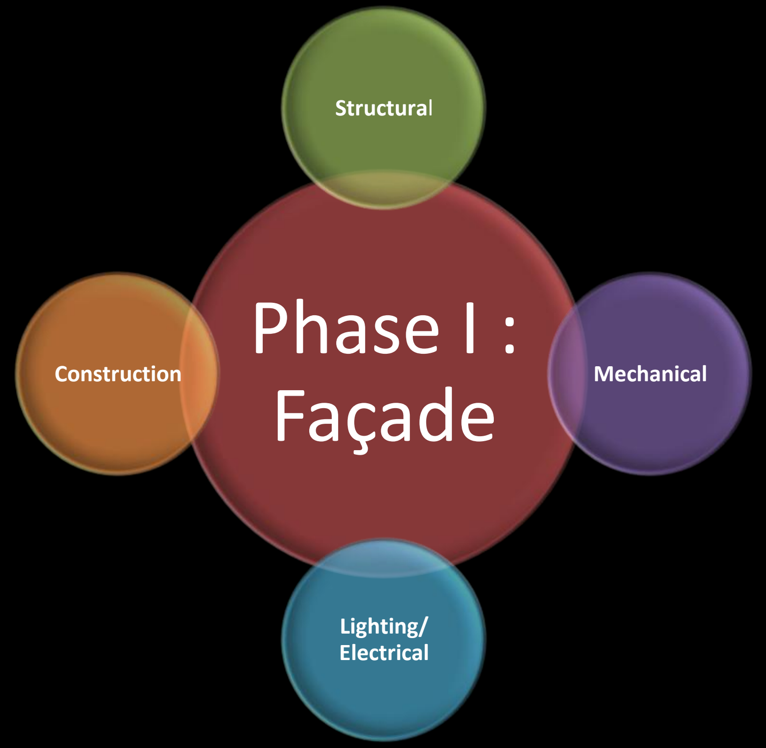


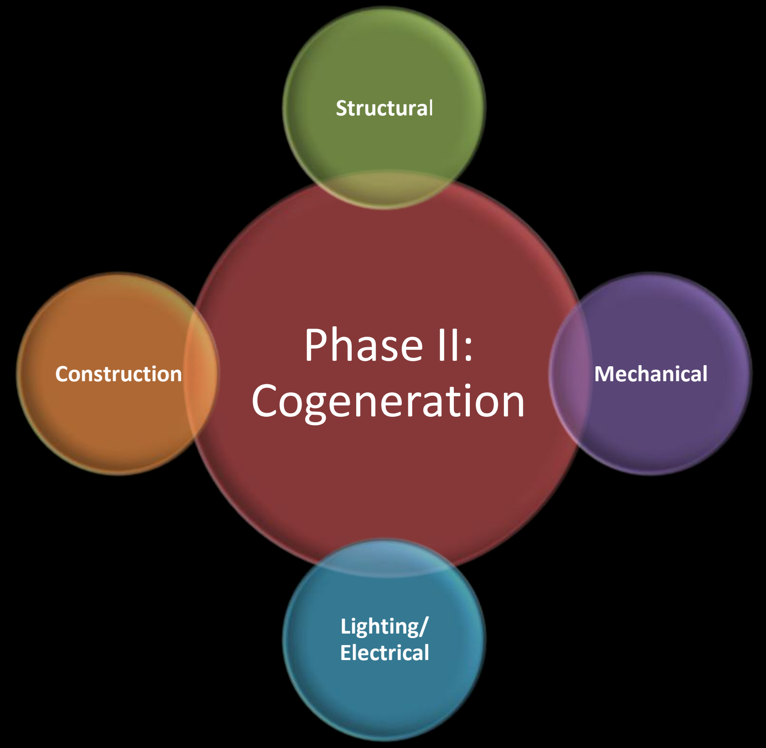
Building Overview

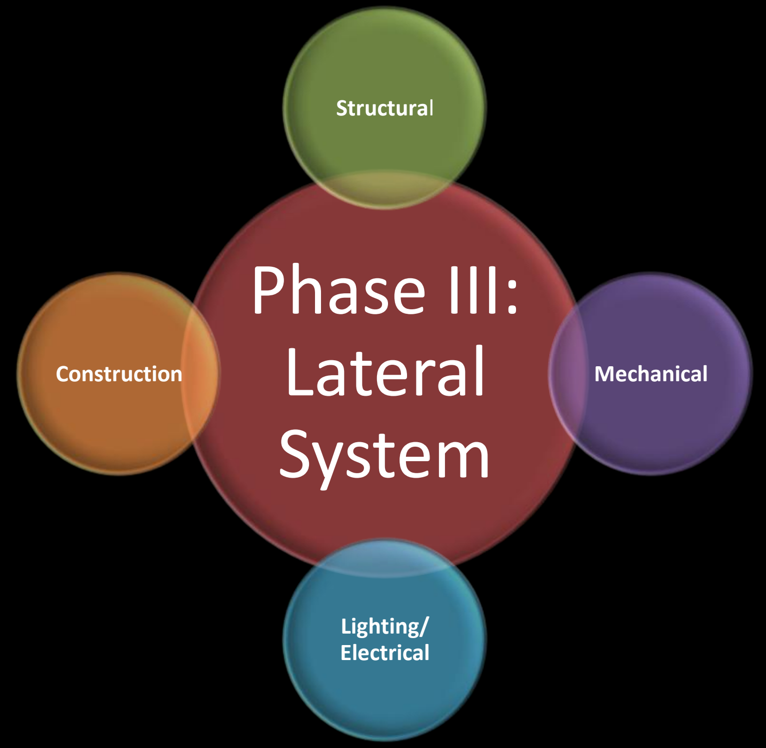
Team Workflow

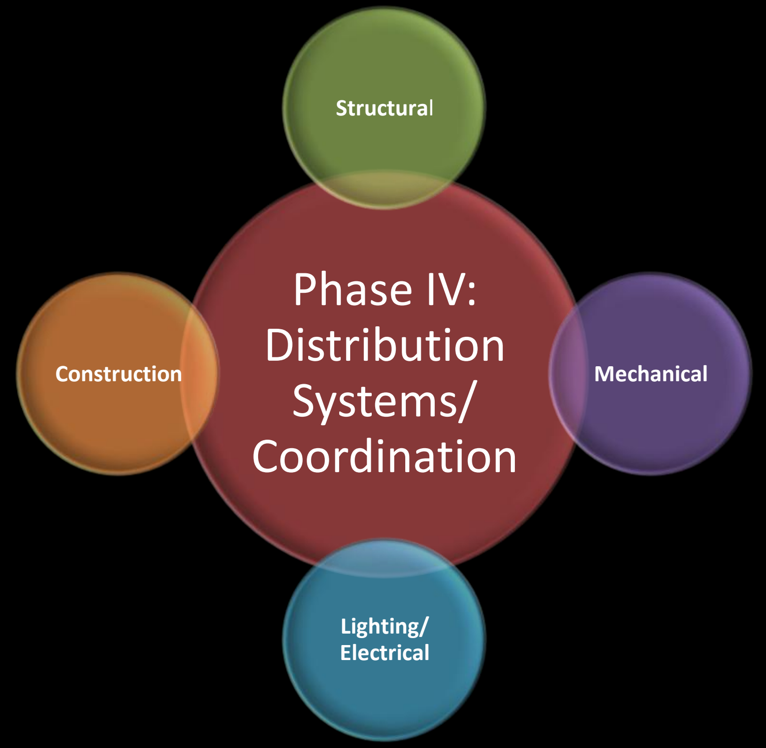
Phase I : Façade
Phase II: Cogeneration
Phase III: Lateral System
Phase IV: Distribution Systems and Coordination

Results and Conclusions









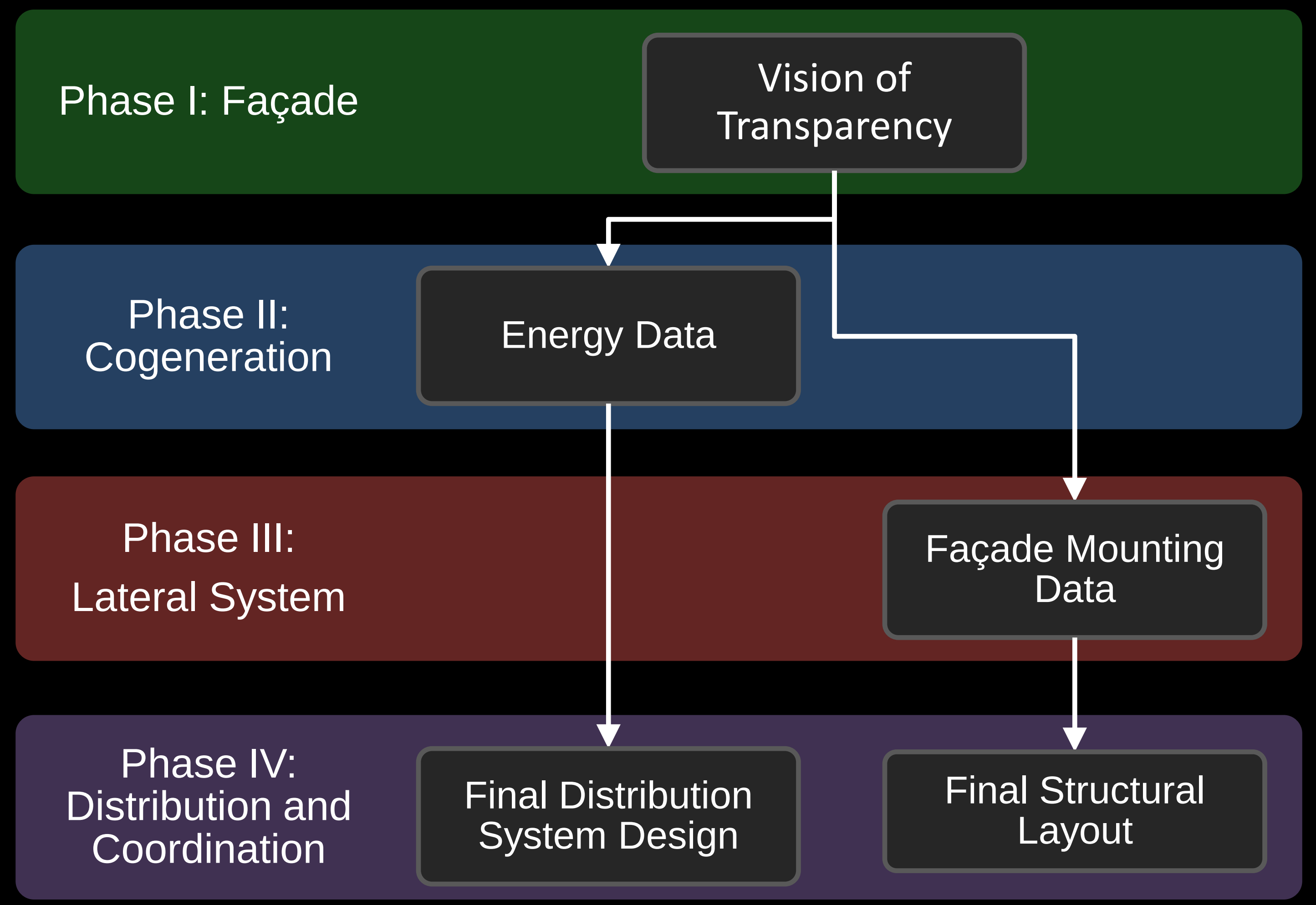
Team Workflow

Building Overview

Team Workflow

Phase I : Façade
Phase II: Cogeneration
Phase III: Lateral System
Phase IV: Distribution Systems and Coordination

Results and Conclusions

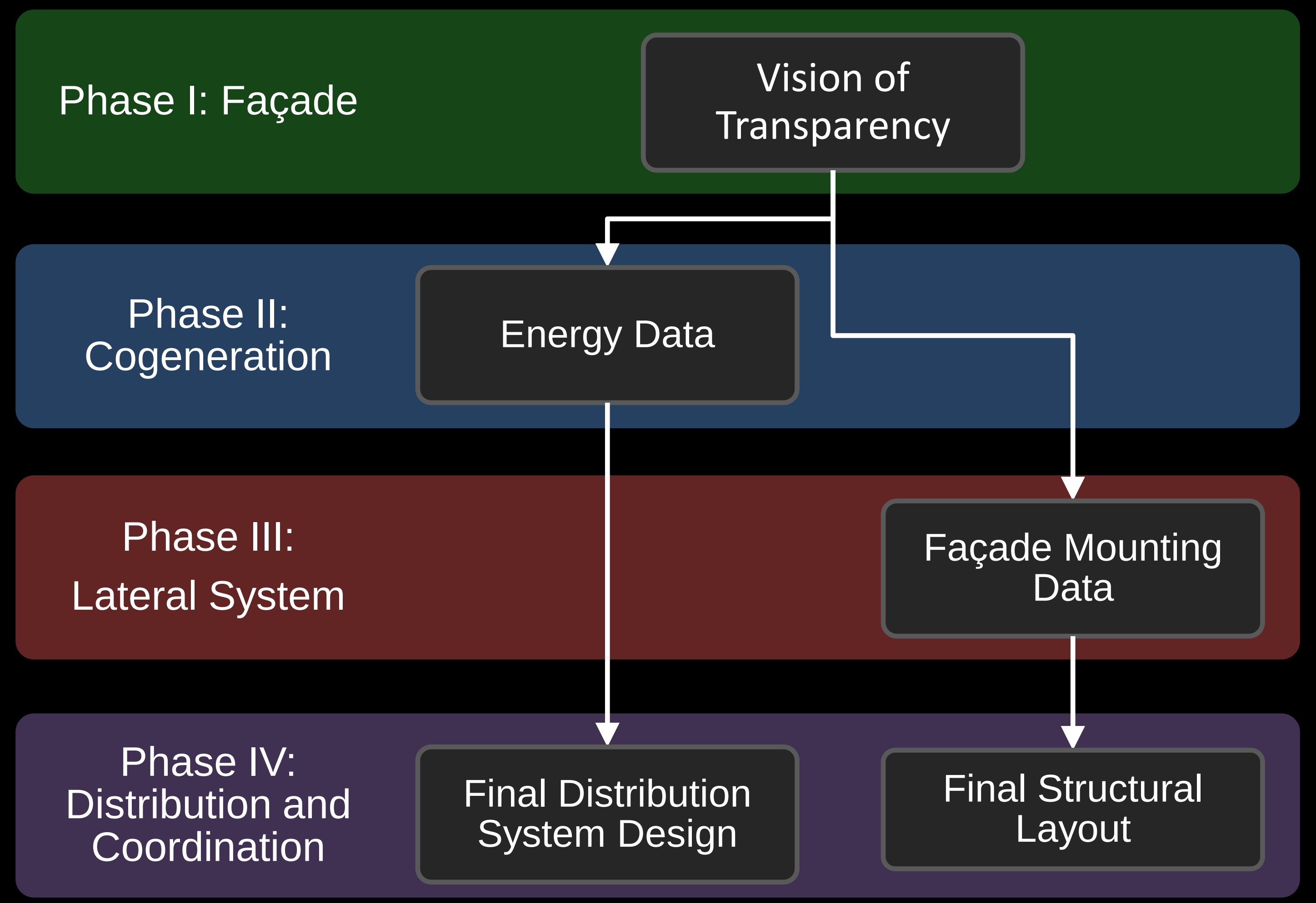


Building Overview

Team Workflow

Phase I : Façade
Phase II: Cogeneration
Phase III: Lateral System
Phase IV: Distribution Systems and Coordination

Results and Conclusions



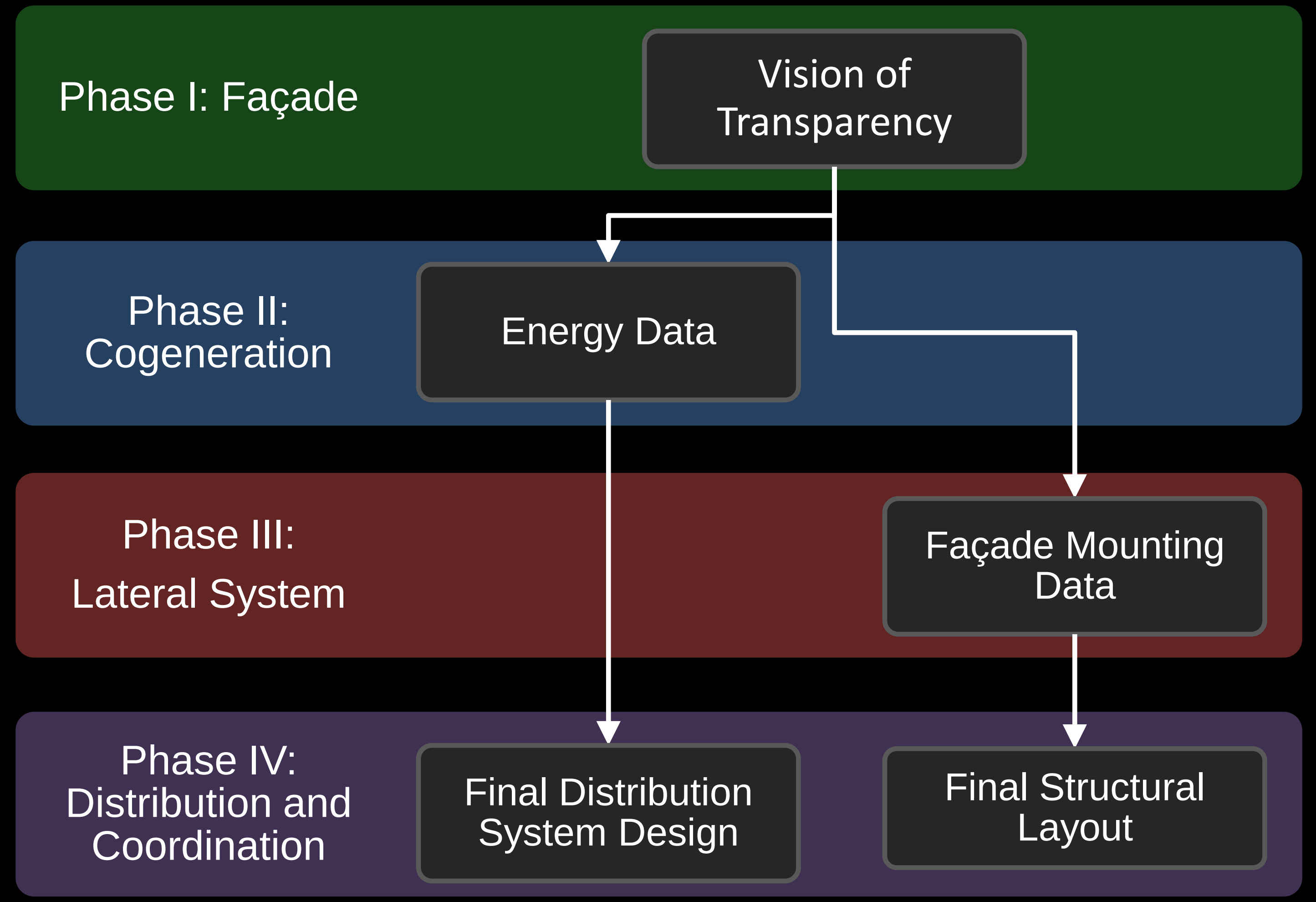
Similar to fast-tracked design build with bid packages

Building Overview

Team Workflow

Phase I : Façade
Phase II: Cogeneration
Phase III: Lateral System
Phase IV: Distribution Systems and Coordination

Results and Conclusions



Similar to fast-tracked design build with bid packages

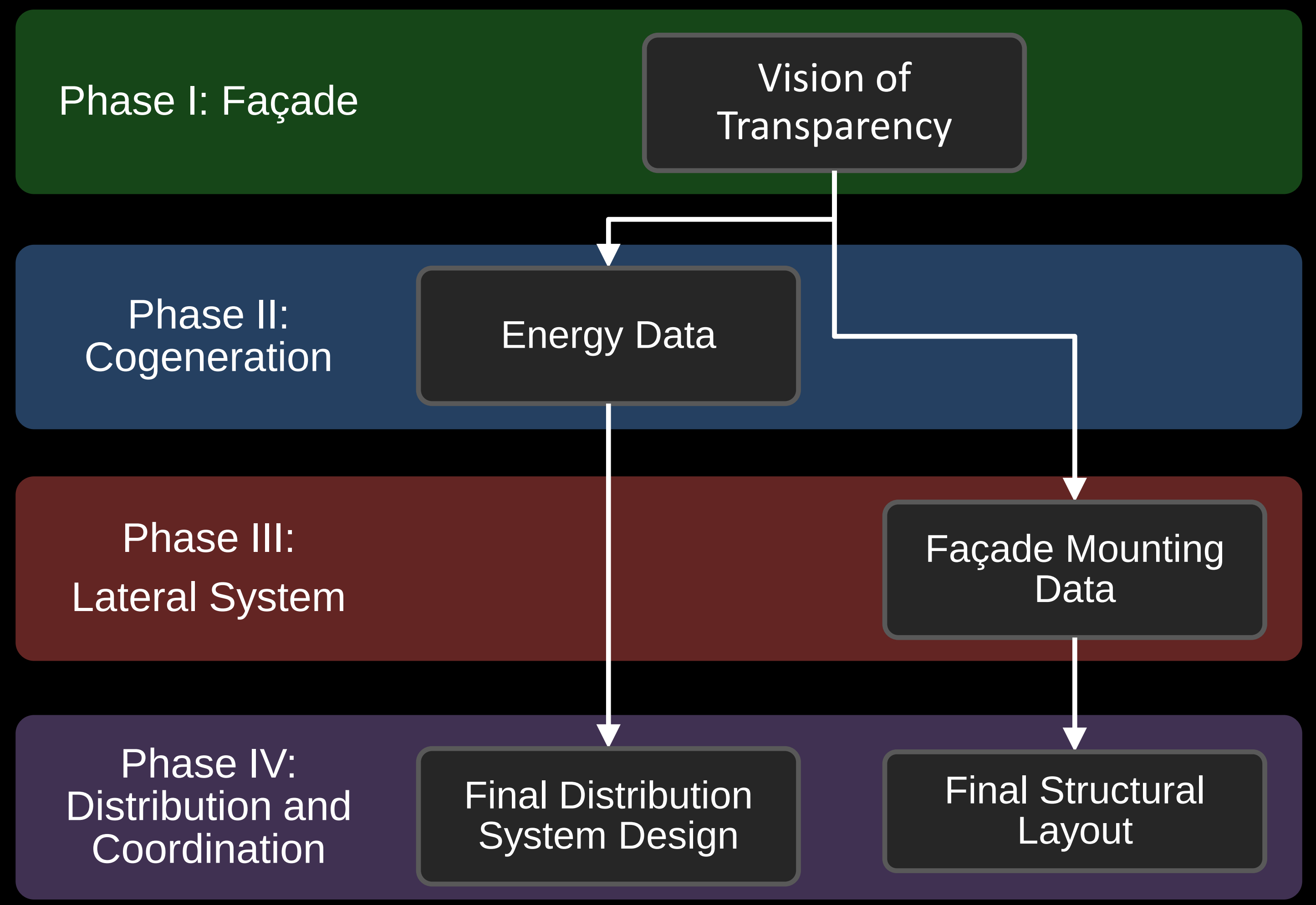
Allows for leadership roles to evolve naturally

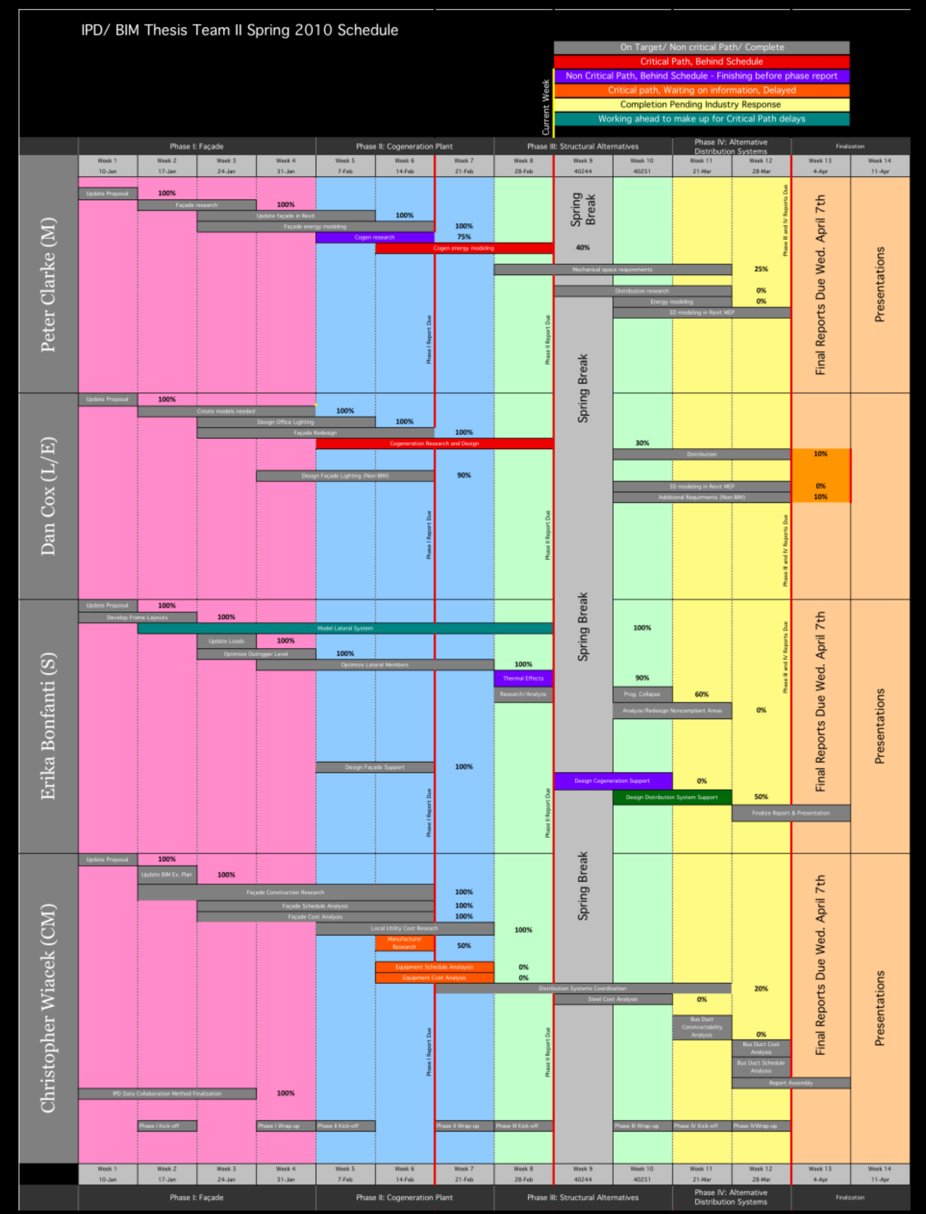
Building Overview

Team Workflow

Phase I : Façade
Phase II: Cogeneration
Phase III: Lateral System
Phase IV: Distribution Systems and Coordination

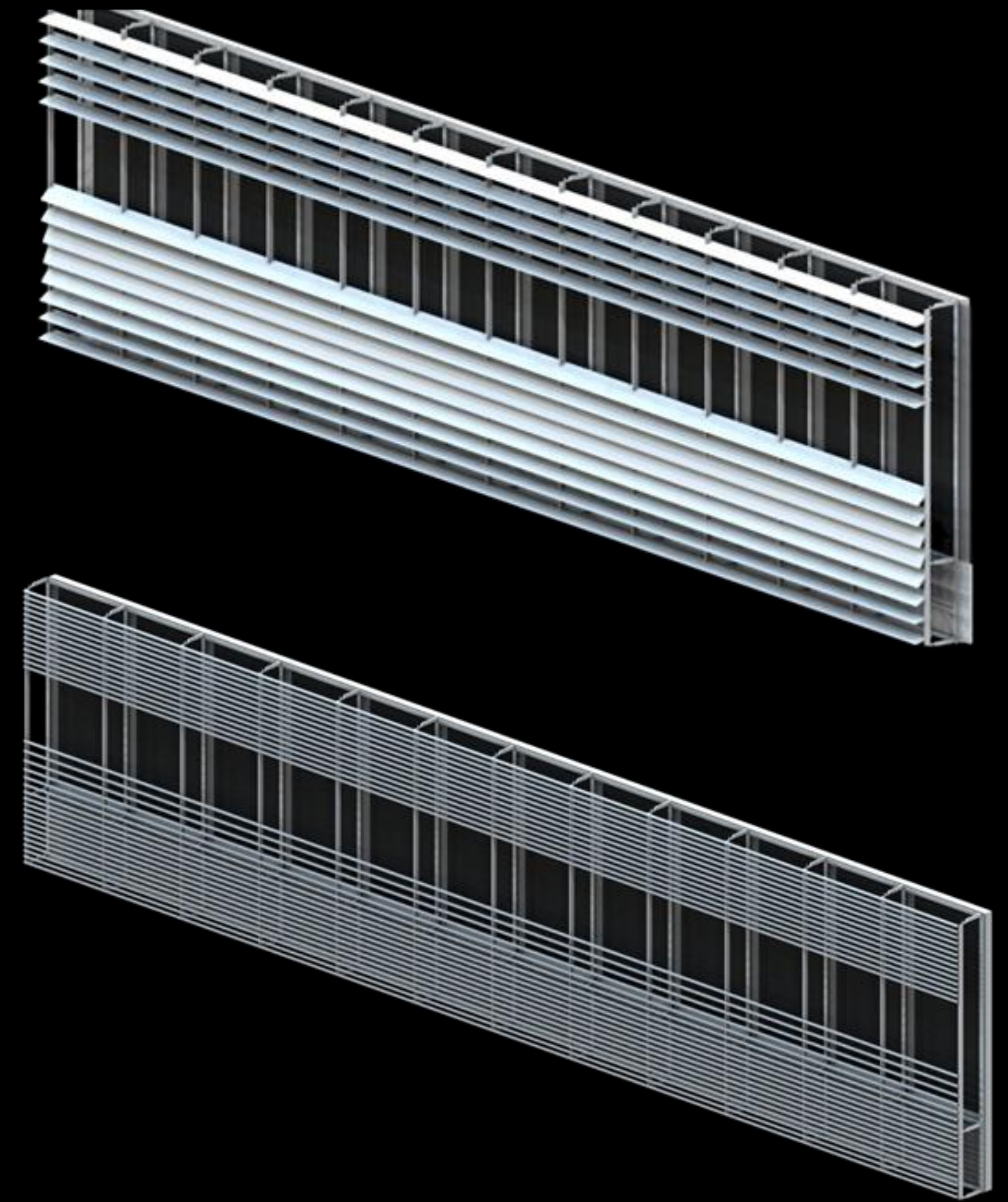
Results and Conclusions





Phase I:

Facade



Typical Floor

Key Aspects:

- Open office – 45 fc ave. + Task Lighting
- Private office – 35 fc ave. + Task Lighting
- Circulation areas – 30 fc ave.
- Brighter Interior Wall
  - Reducing contrast of a bright perimeter during the day

- 10’ spacing leaving room for:
  - Fire protection
  - Mechanical equipment
  - Lighting control equipment
- View out provided by façade redesign

Key Aspects:

- Open office lighting
- Brighter interior wall
- 10’ spacing
- Private office lighting
- View out

Daylight Analysis

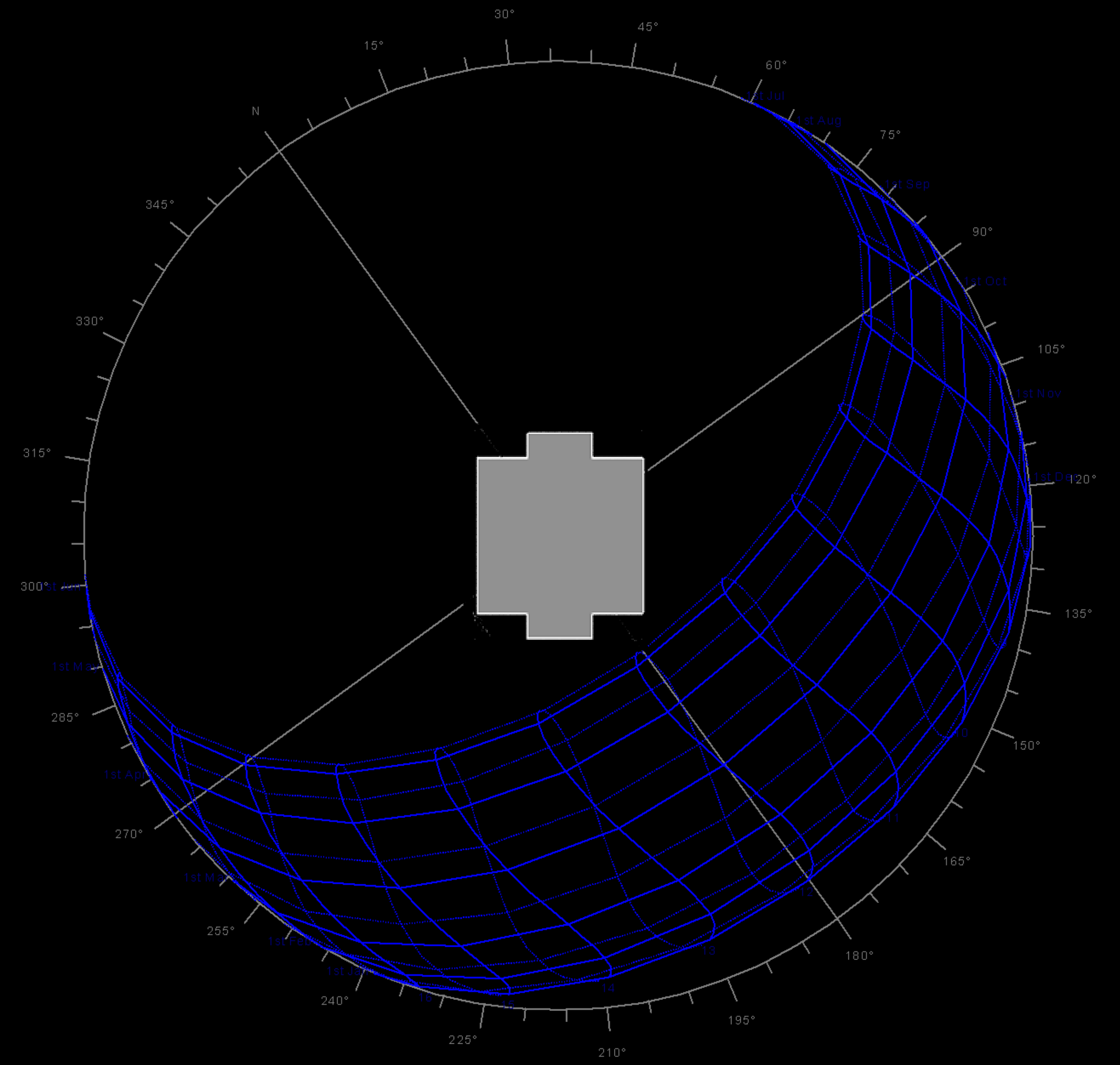
Building Overview

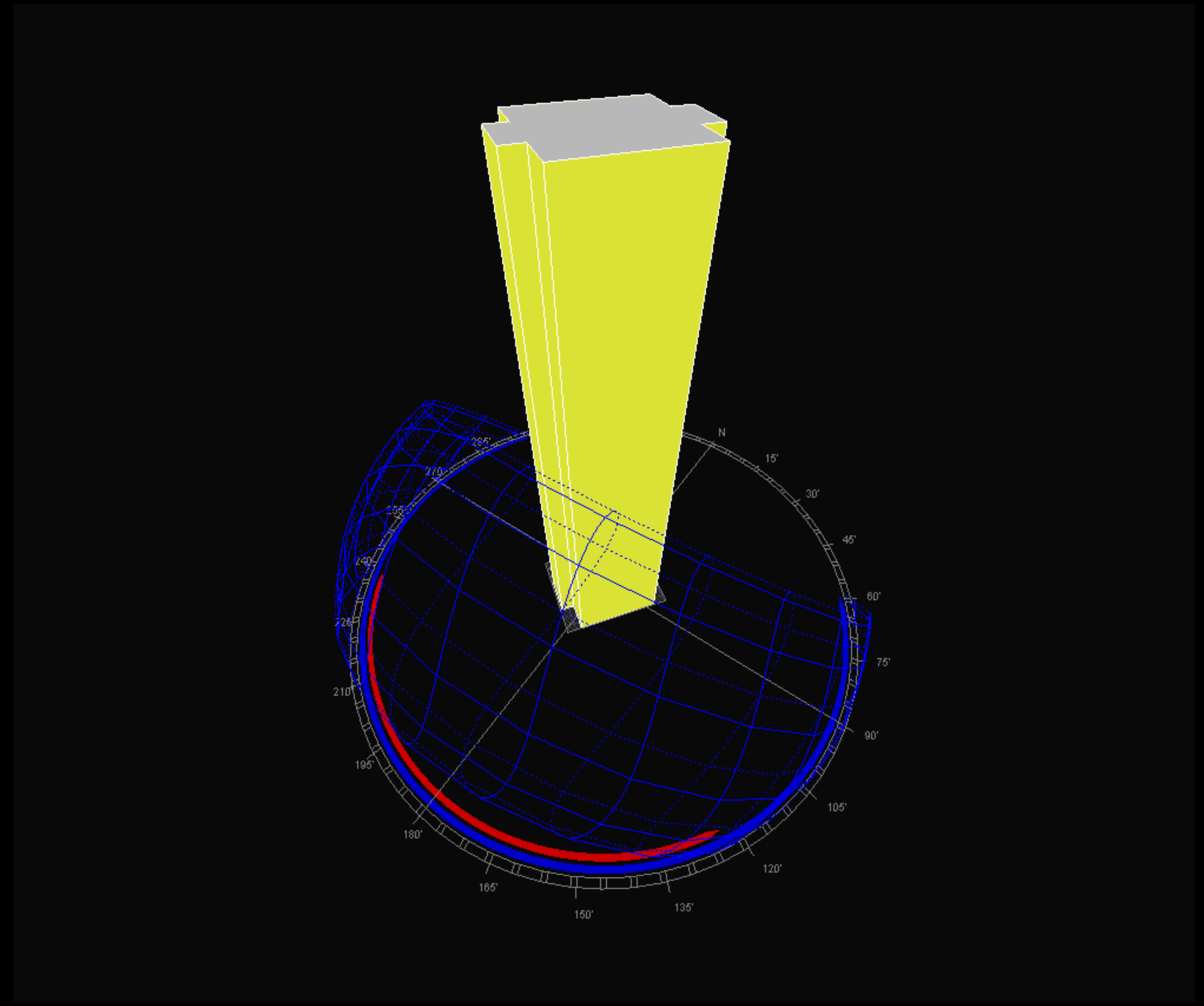
Team Workflow

Phase I : Façade
- Typical Floor
- Daylighting Analysis
- Energy Analysis
- Assembly and Cost

Phase II: Cogeneration
Phase III: Lateral System
Phase IV: Distribution Systems and Coordination

Results and Conclusions





Building Overview

Team Workflow

Phase I : Façade

Typical Floor

Daylighting Analysis

Energy Analysis

Assembly and Cost

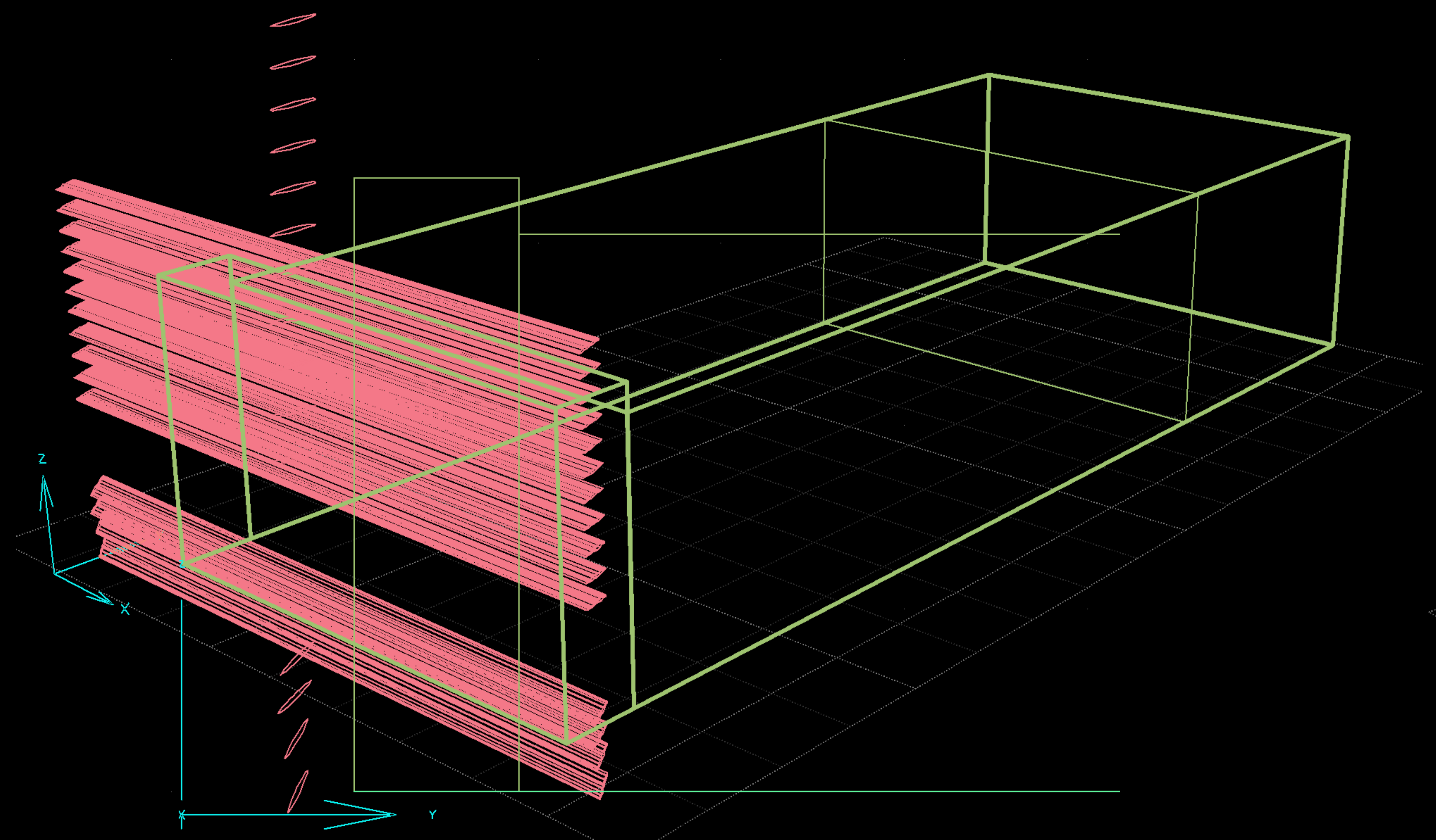
Phase II: Cogeneration

Phase III: Lateral System

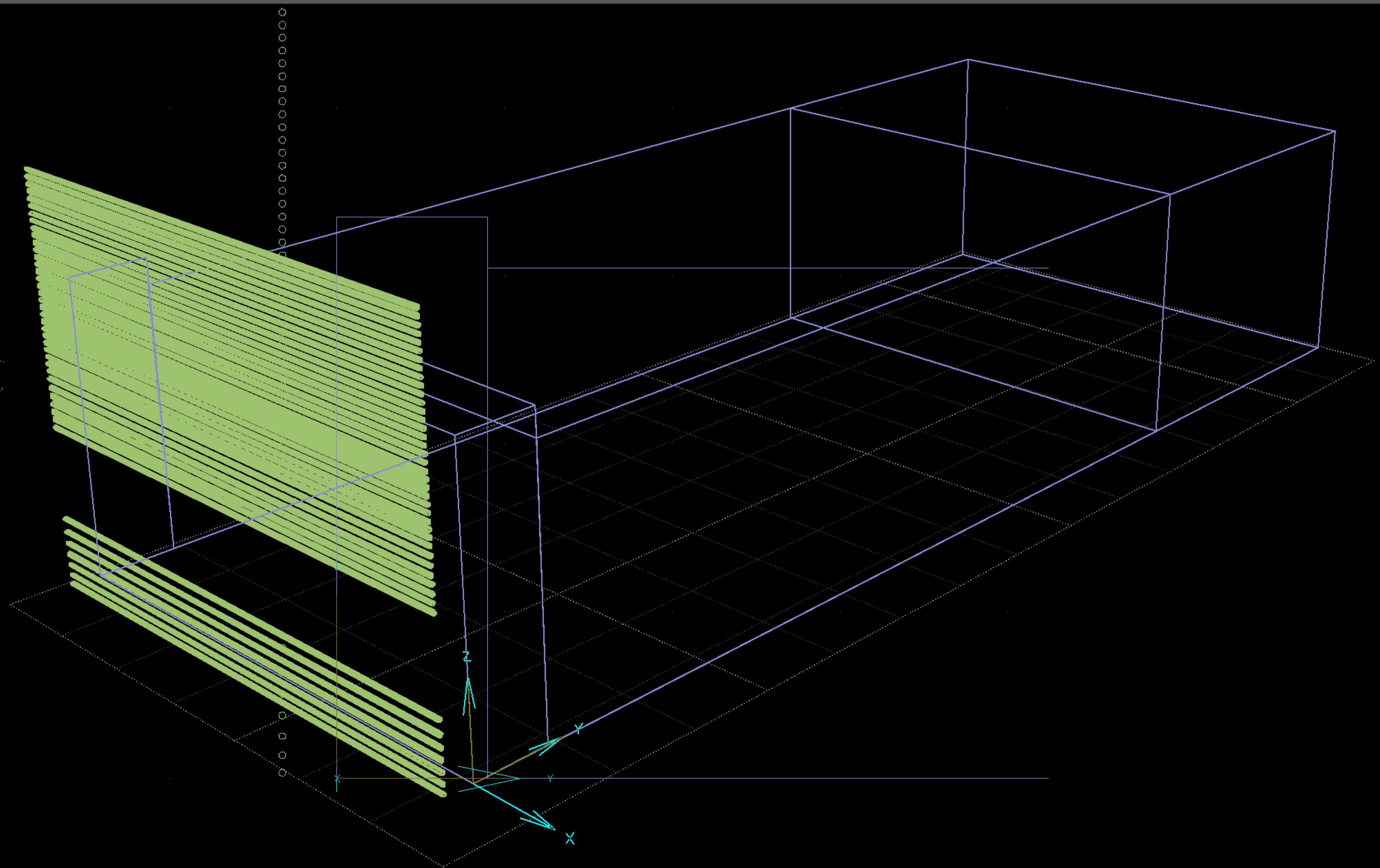
Phase IV: Distribution Systems and Coordination

Results and Conclusions

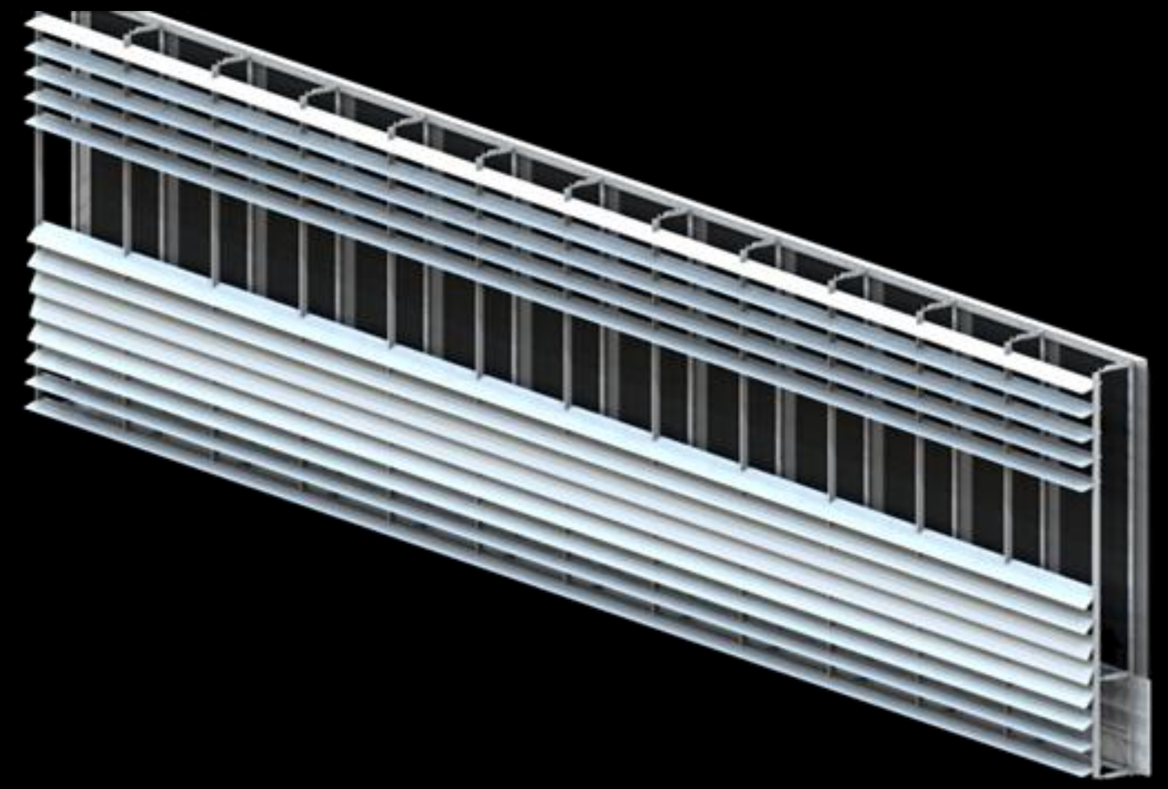
Redesign - Blades



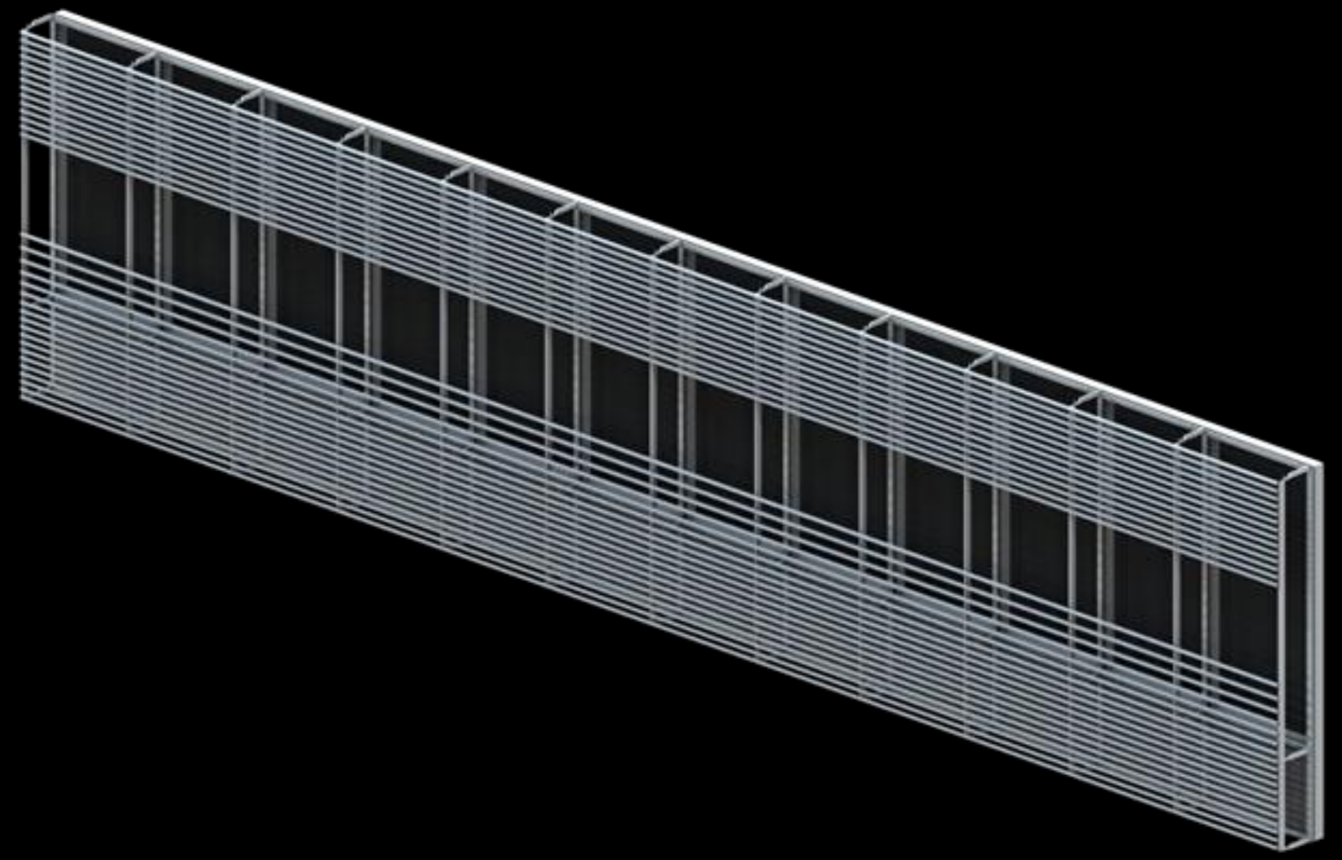
Existing - Rods

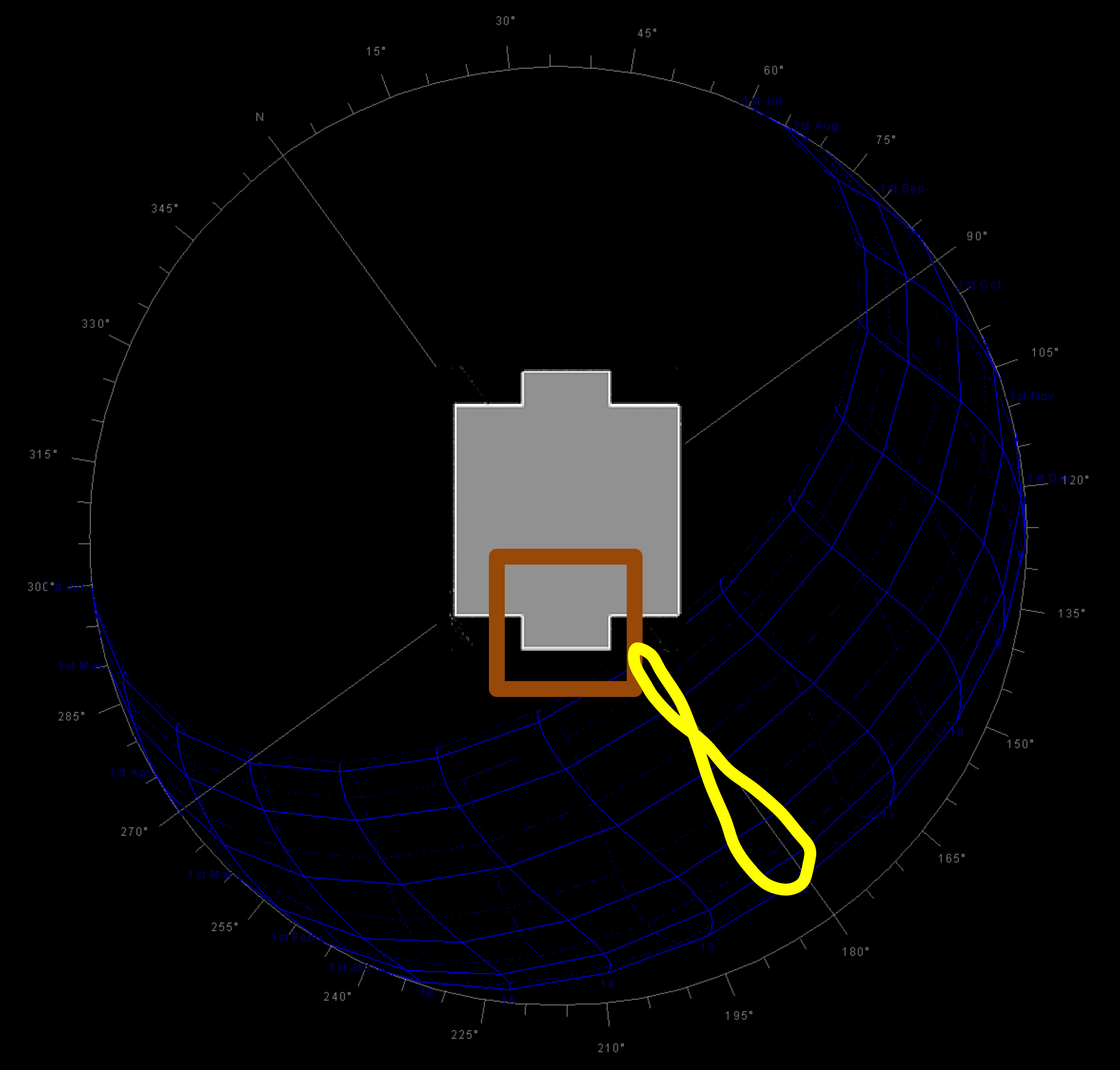


Redesign - Blades



Existing - Rods





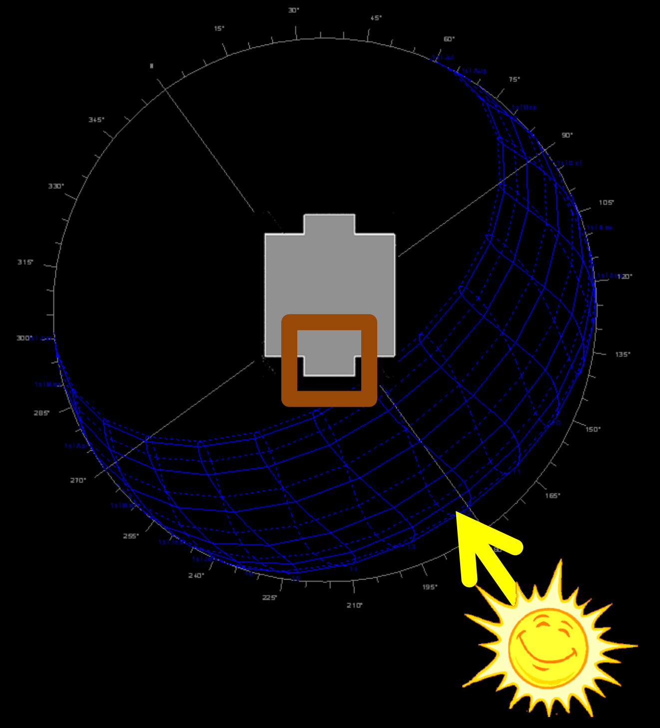
Noon

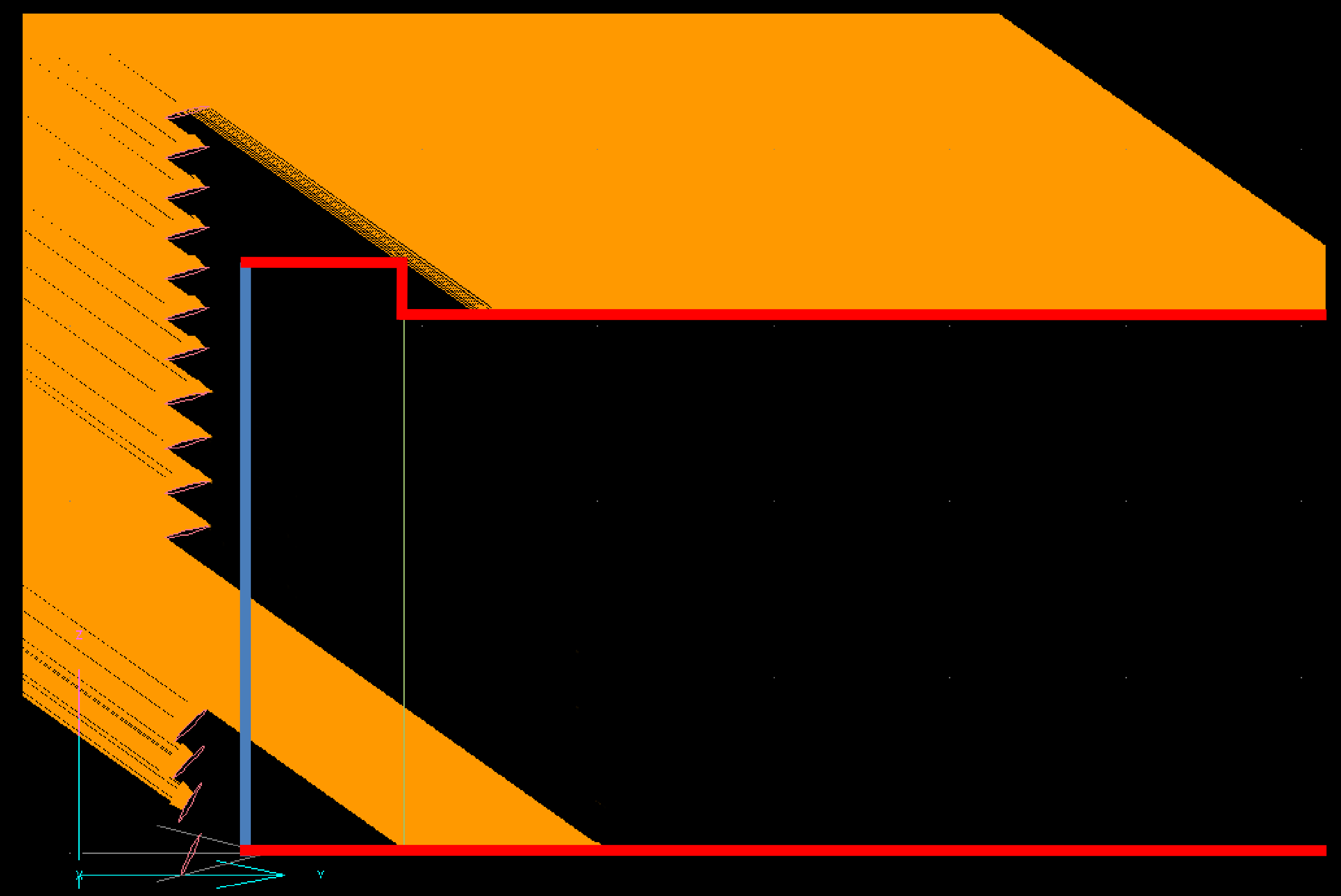
Looking For:
Direct sunlight penetration

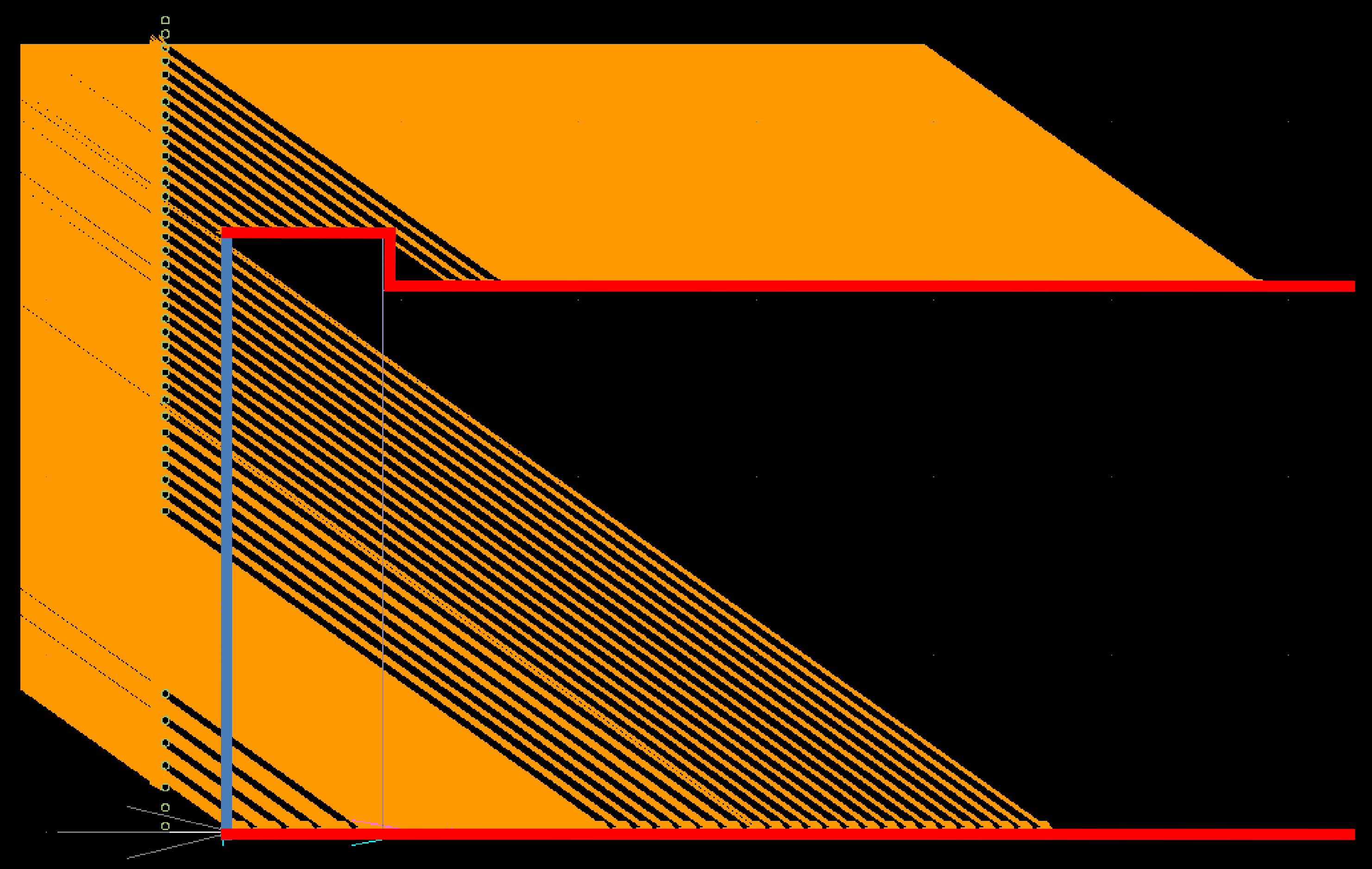
Redesign - Blades

Existing - Rods

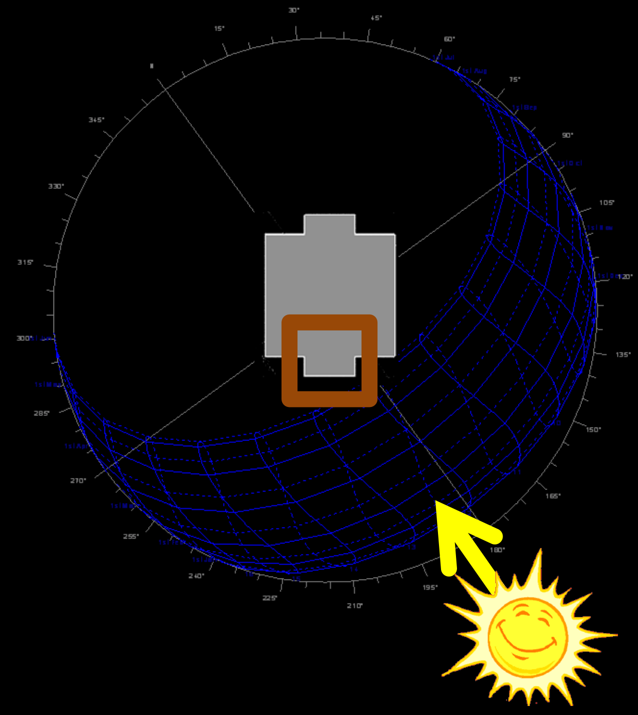
Solar Noon



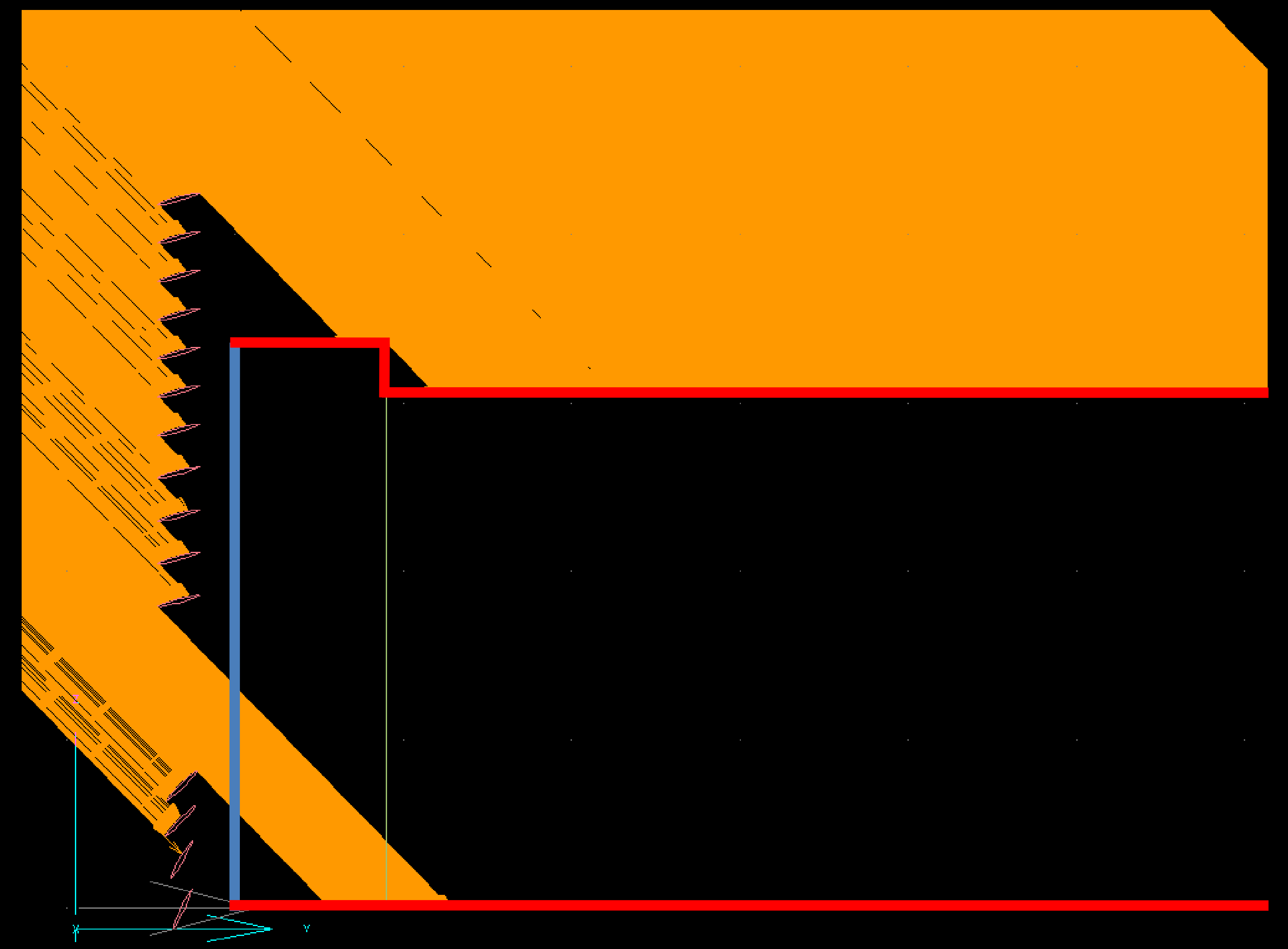




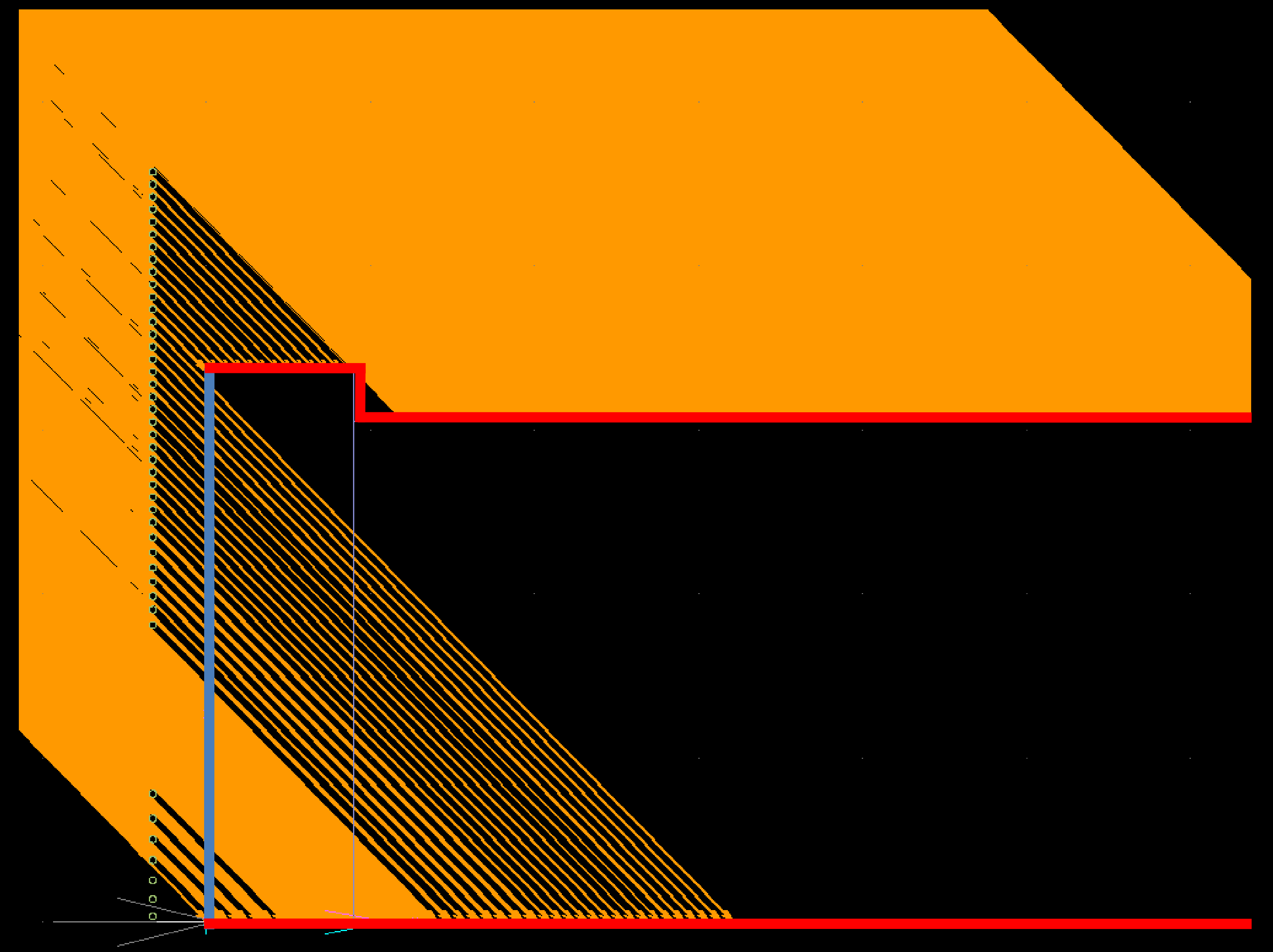
February 22nd
Noon



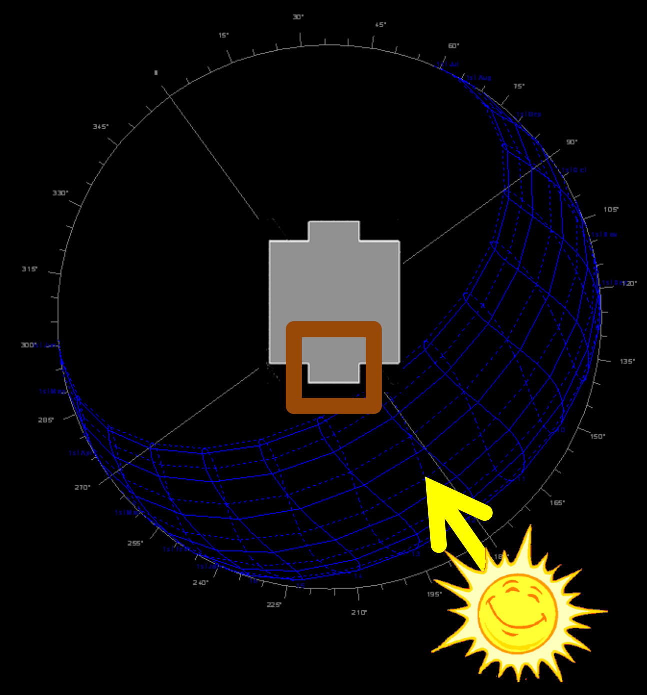
Redesign - Blades



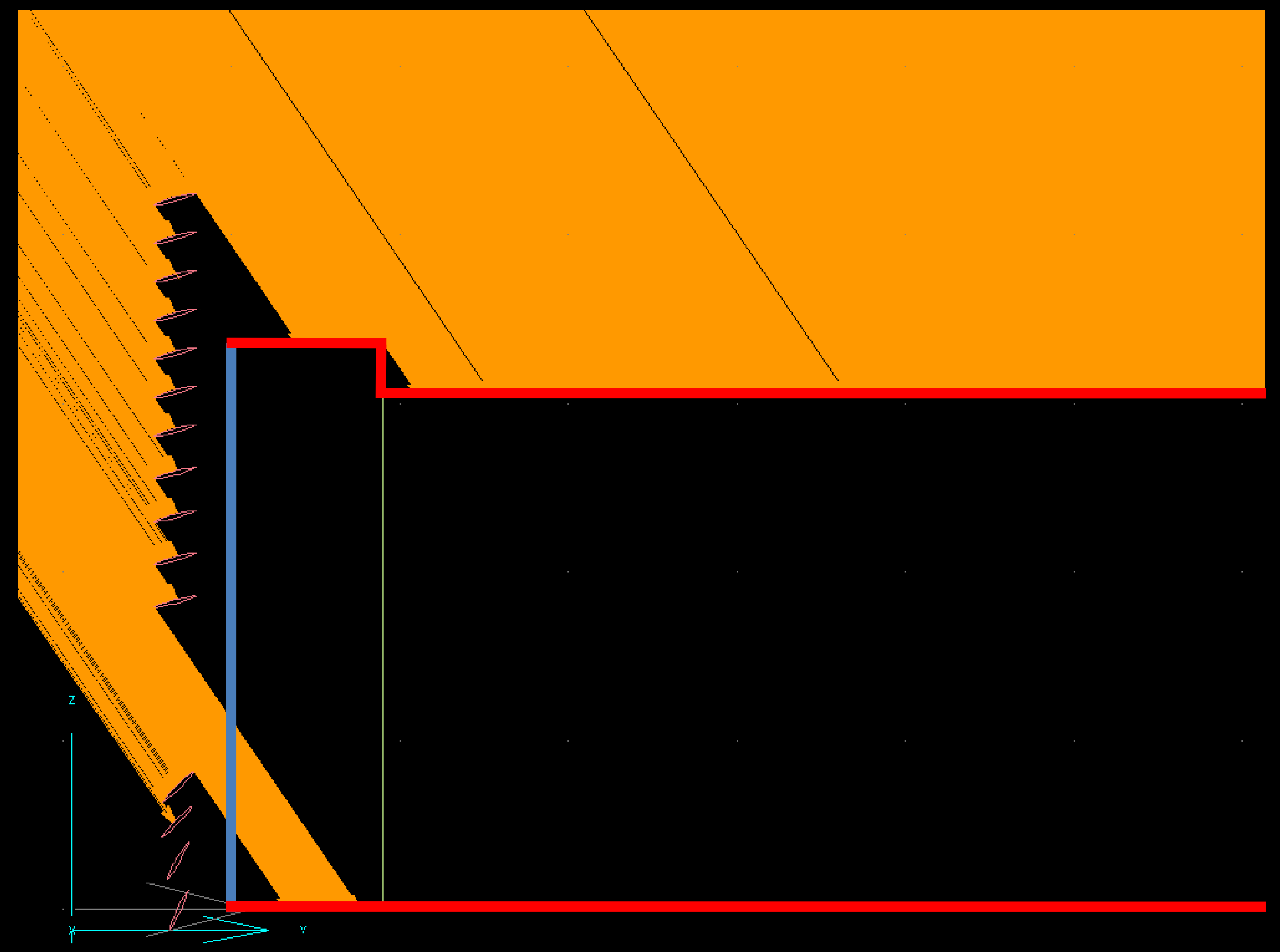
Existing - Rods



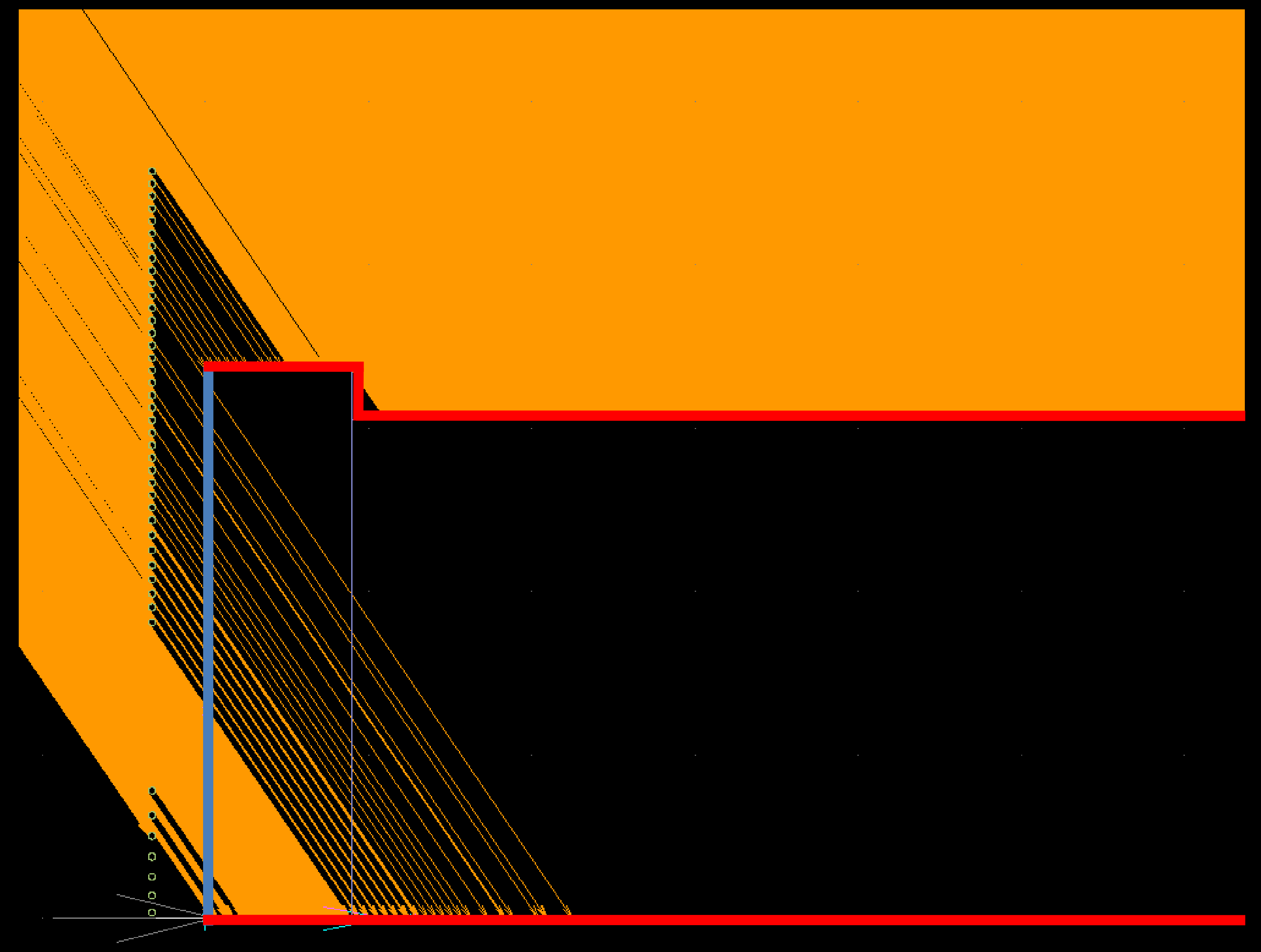
March 22nd
Noon



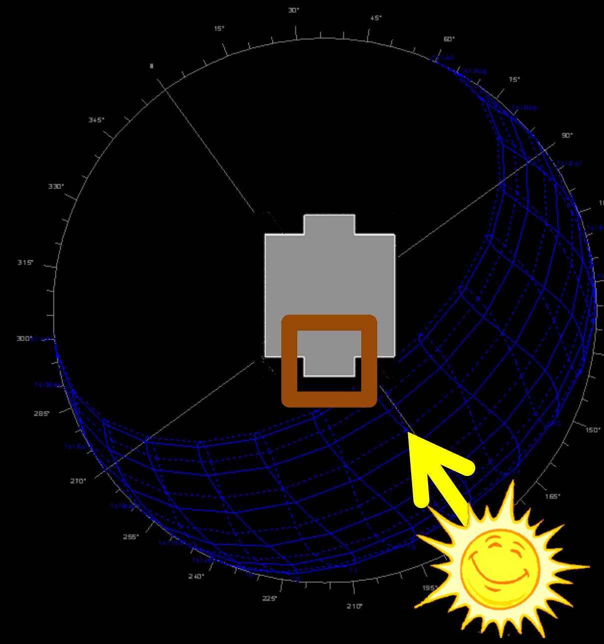
Redesign - Blades



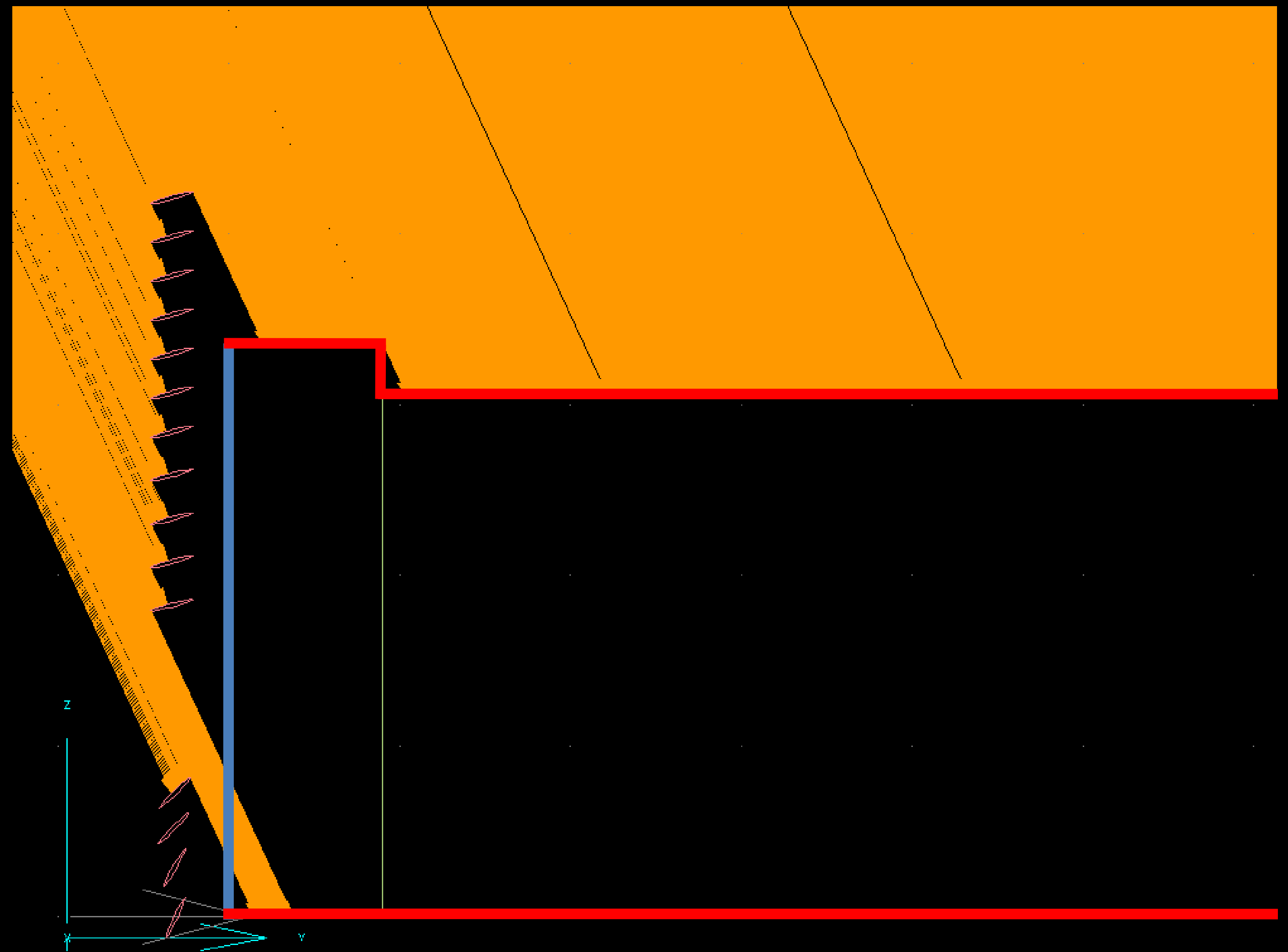
Existing - Rods



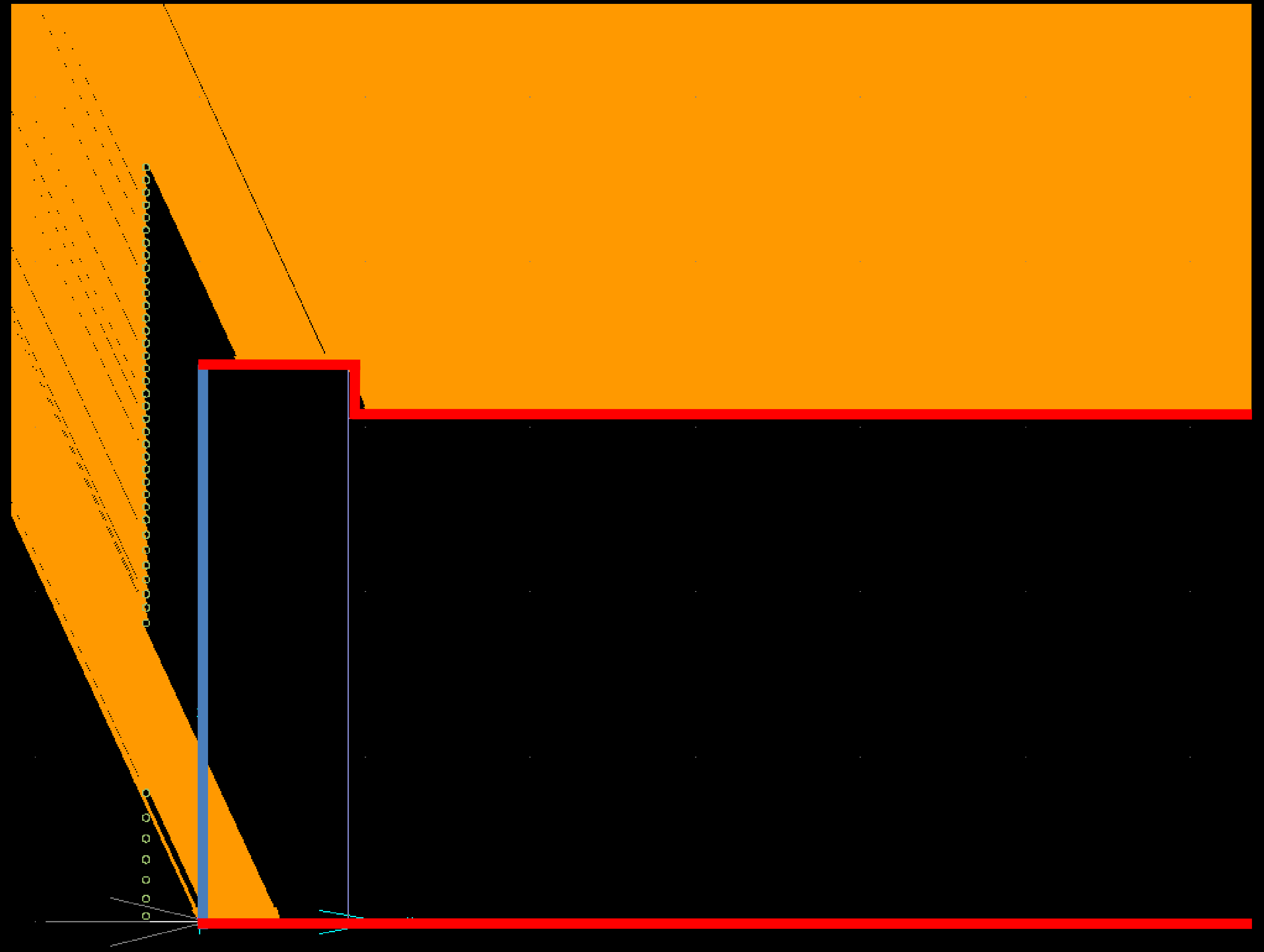
April 22nd
Noon



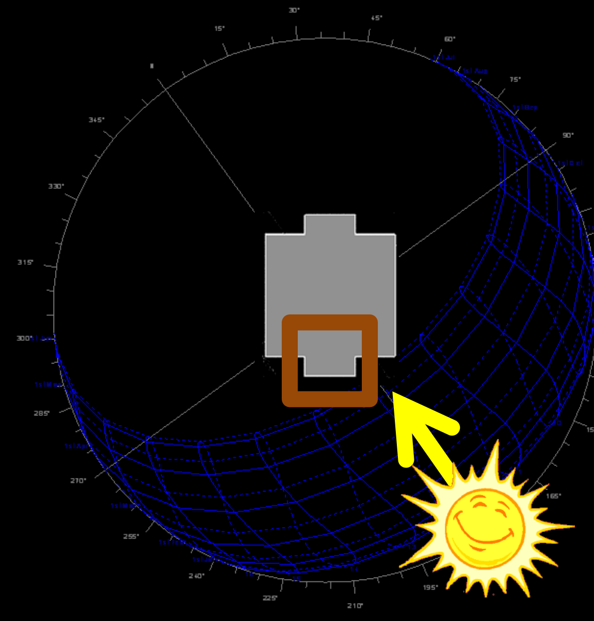
Redesign - Blades



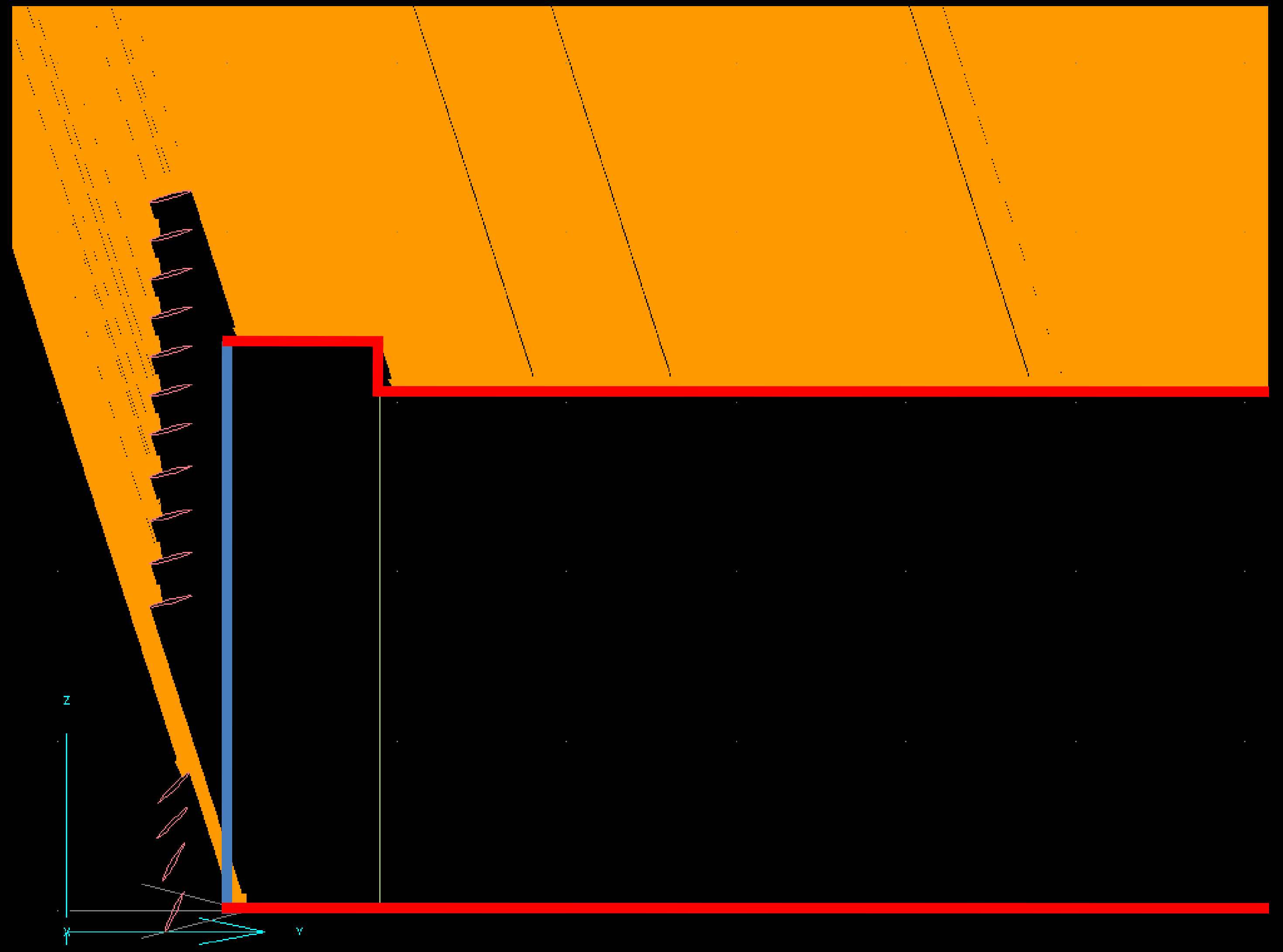
Existing - Rods



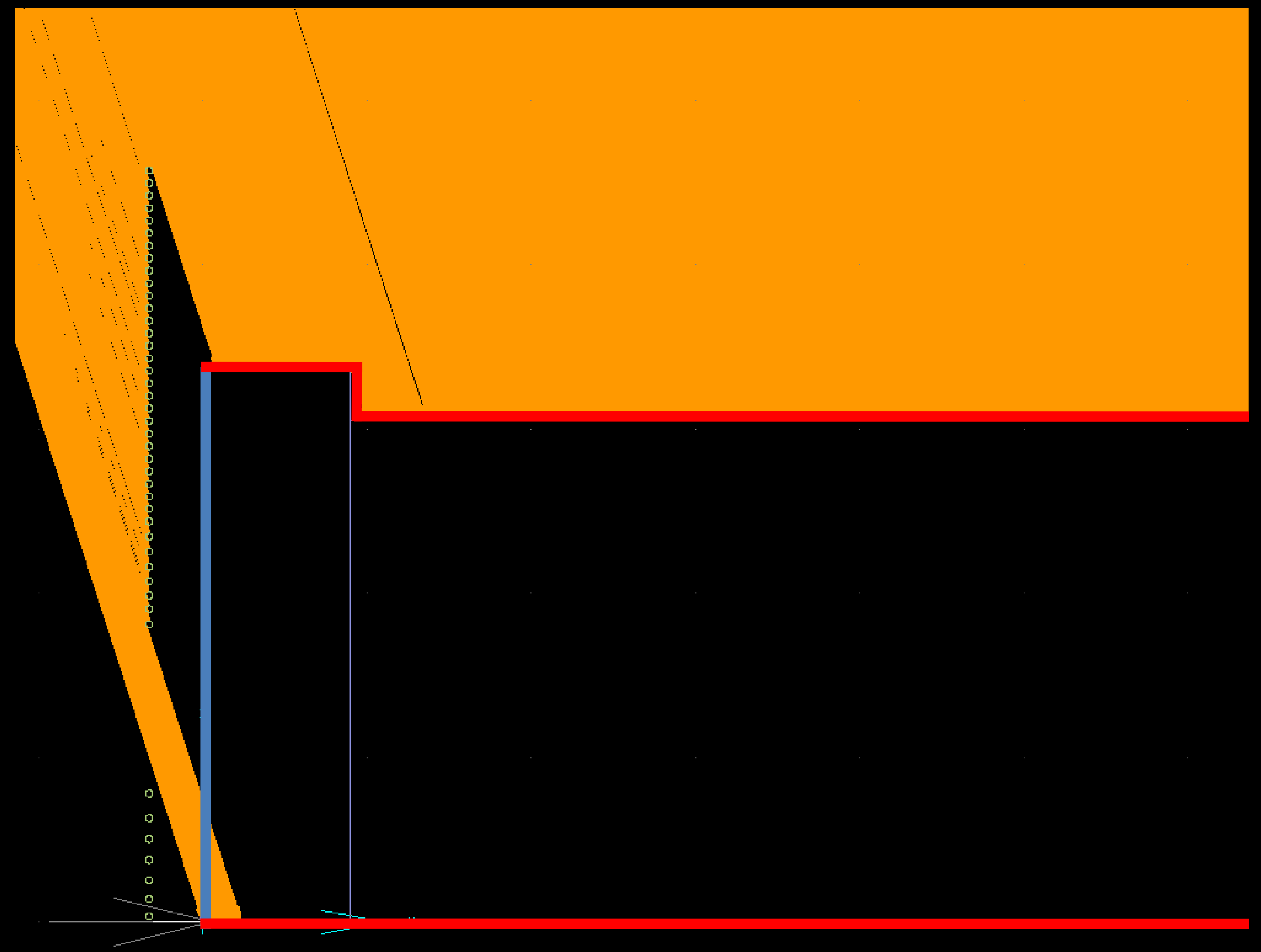
May 22nd
Noon



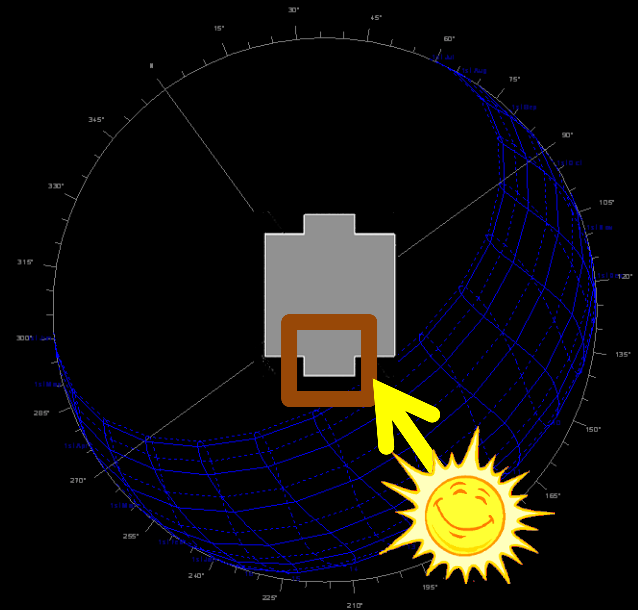
Redesign - Blades



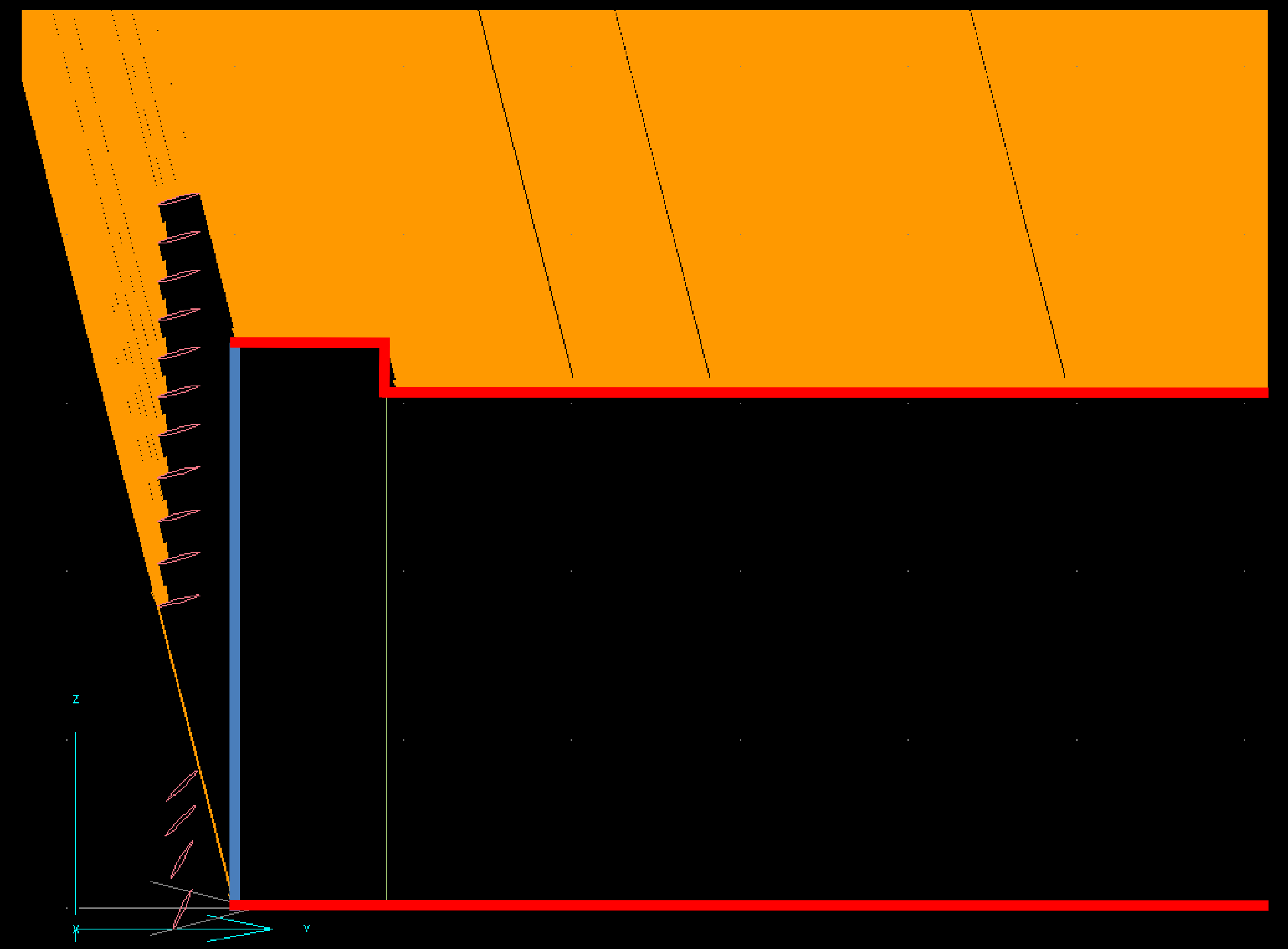
Existing - Rods



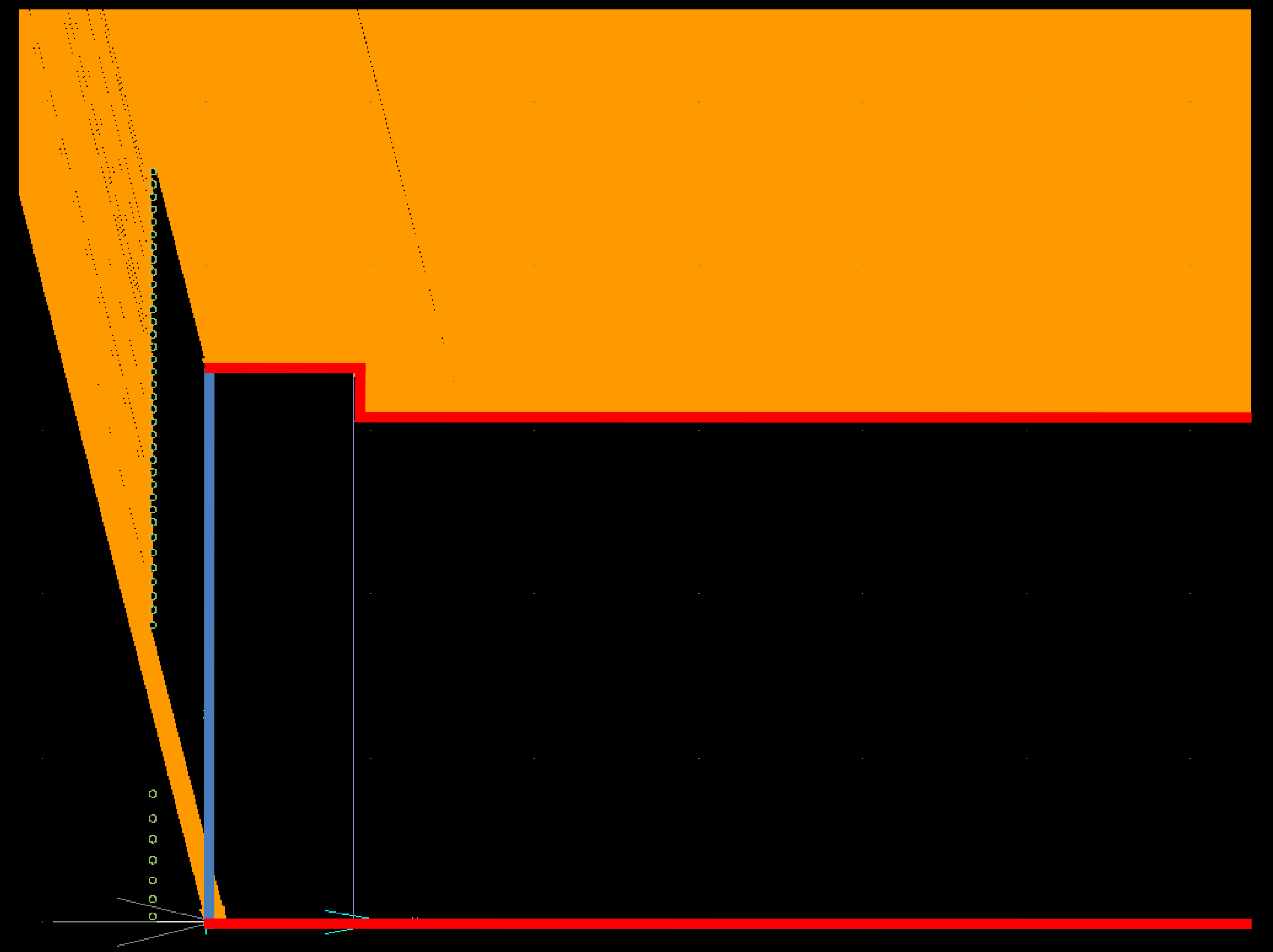
June 22nd
Noon



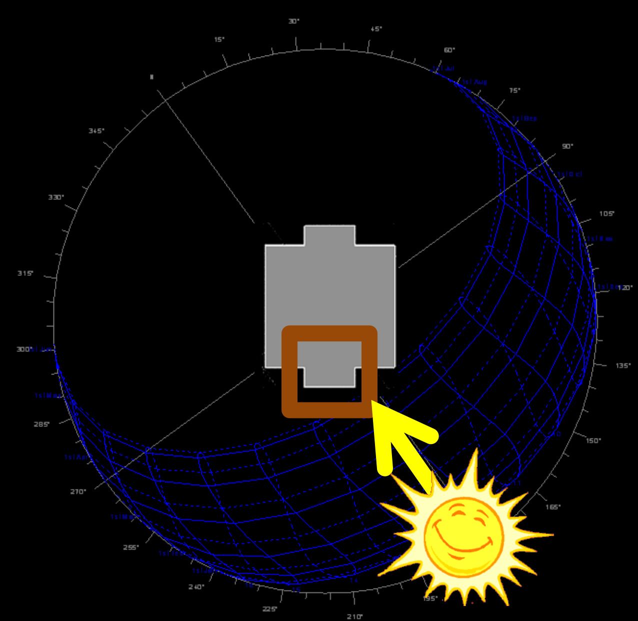
Redesign - Blades



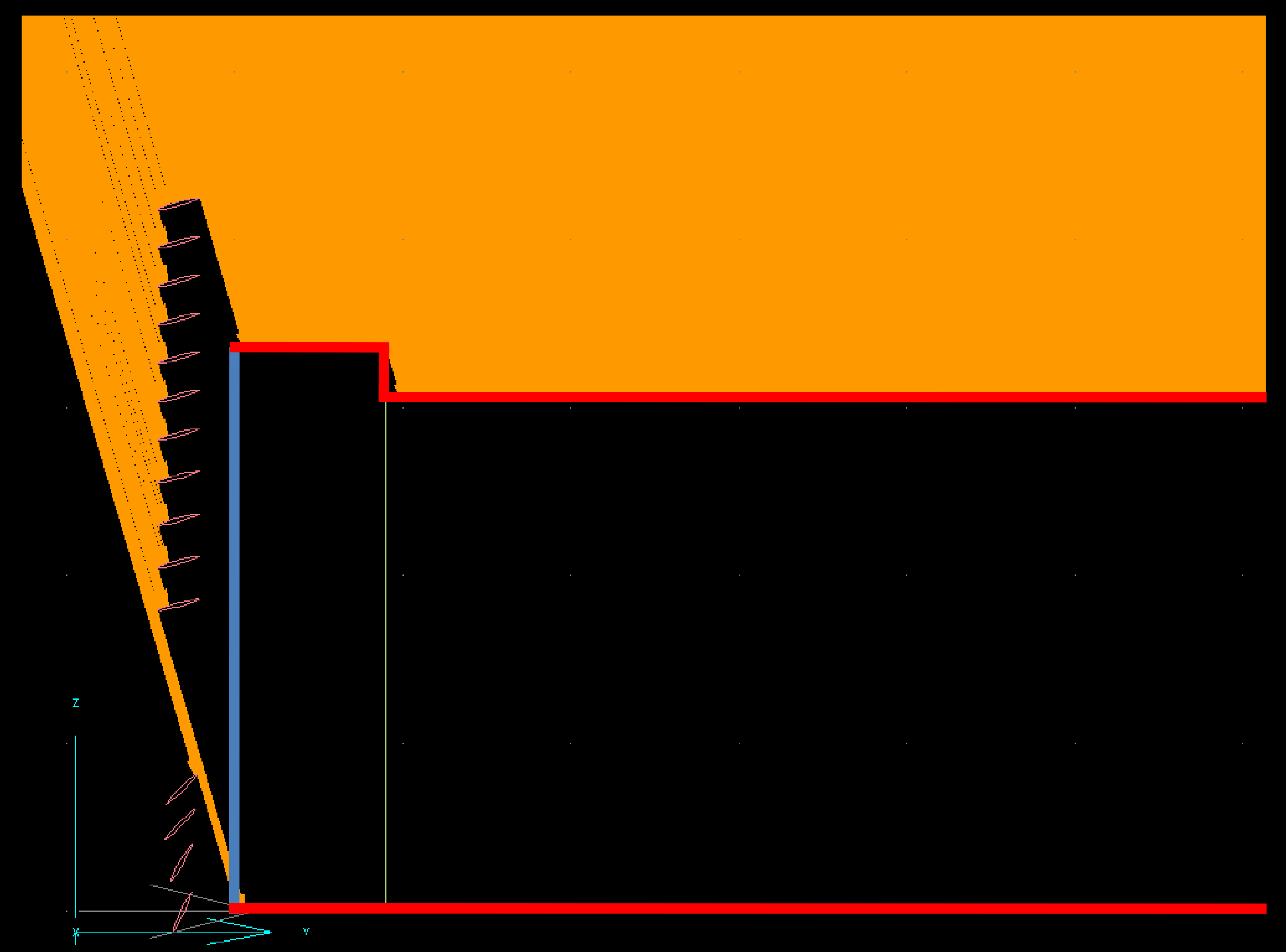
Existing - Rods



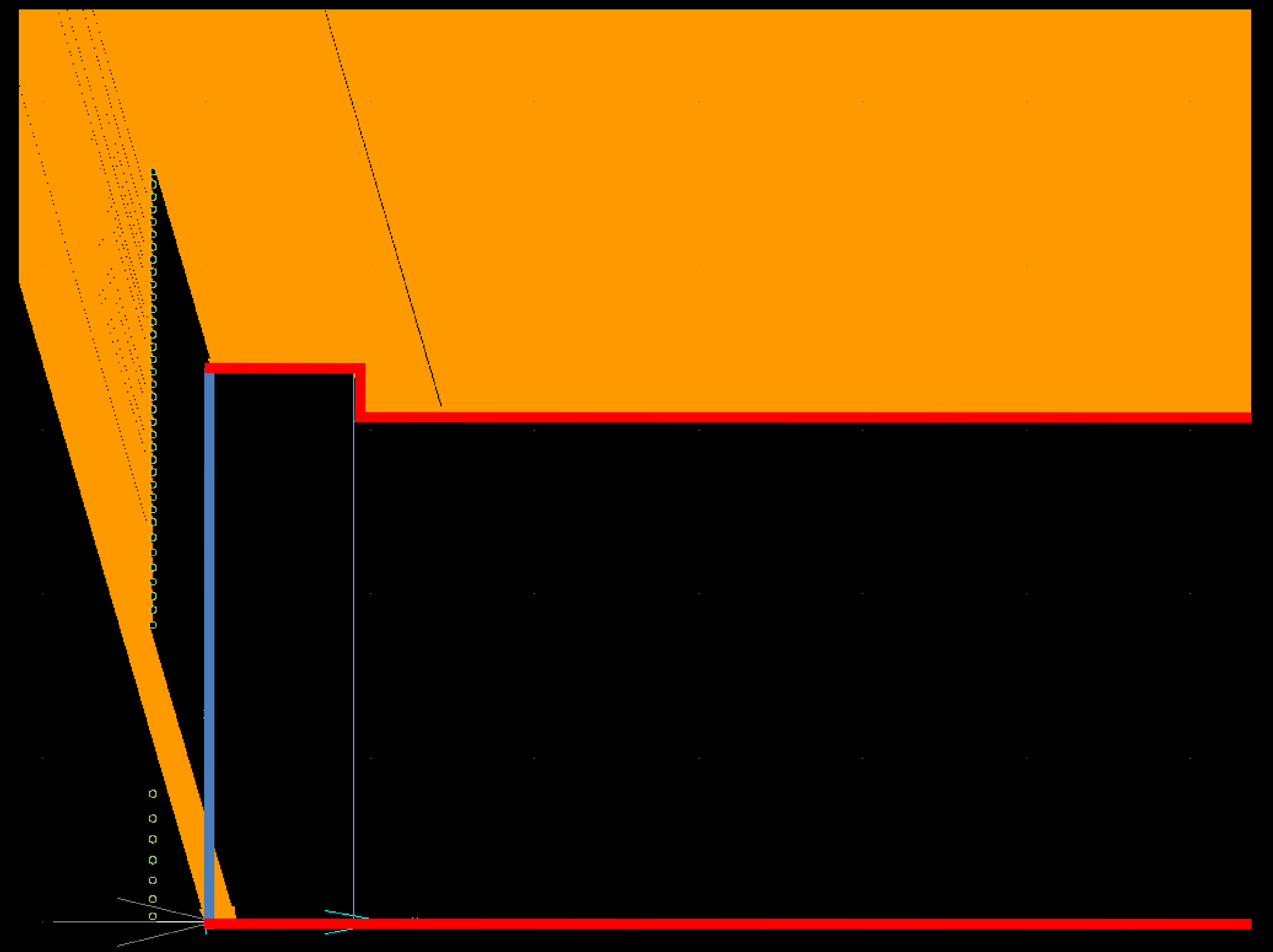
July 22nd
Noon



Redesign - Blades



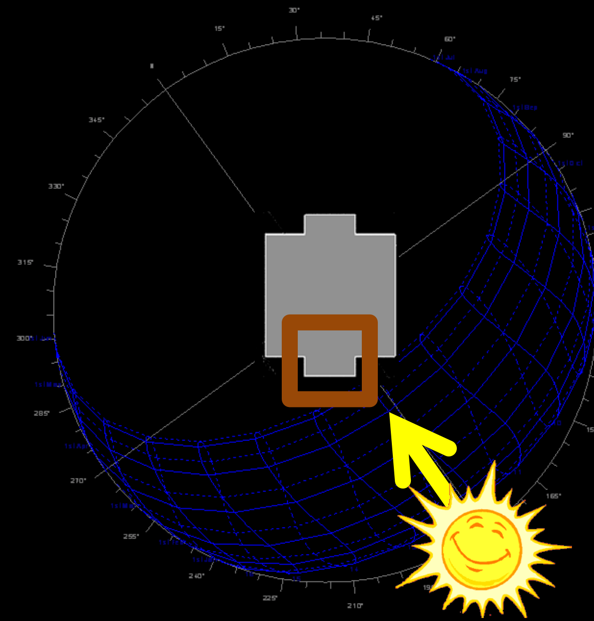
Existing - Rods

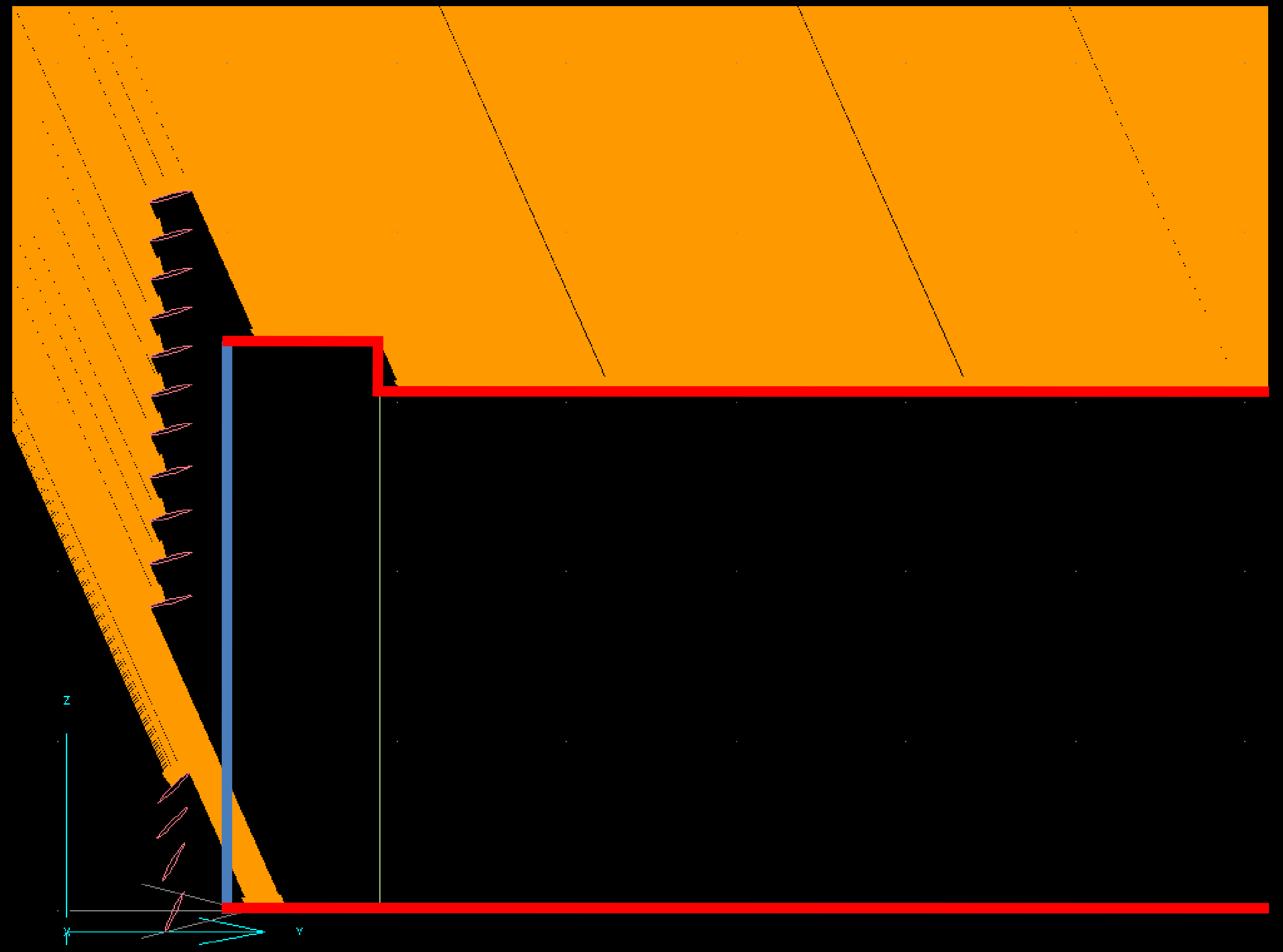


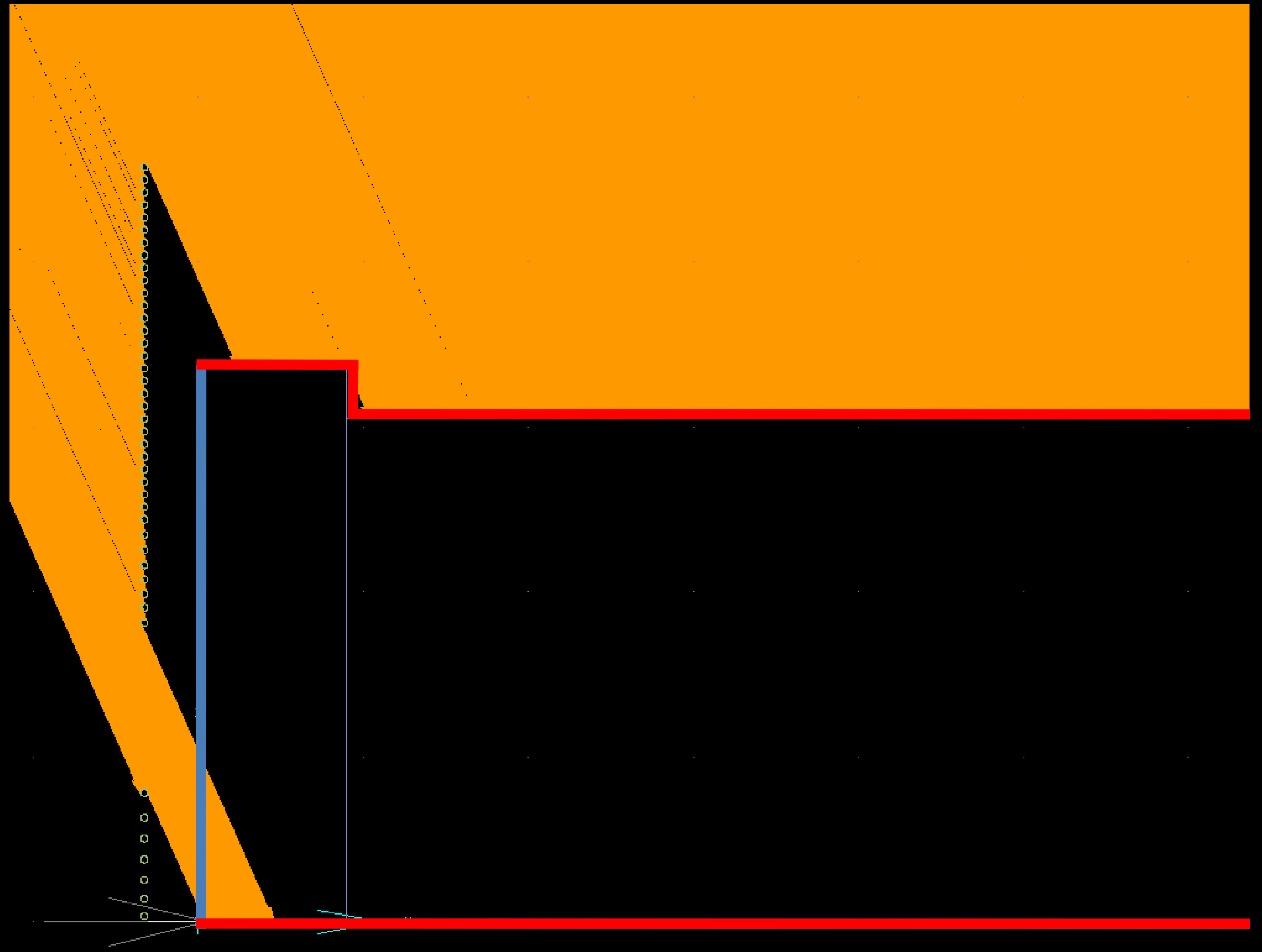
Redesign - Blades

Existing - Rods

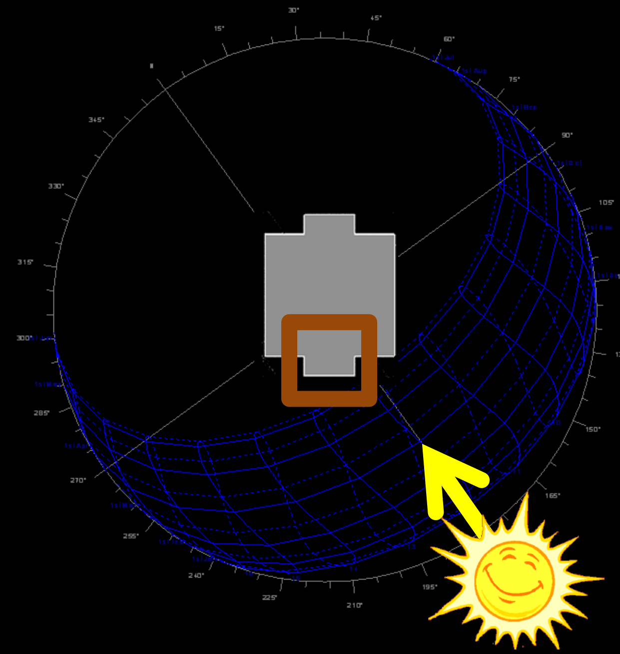
August 22nd
Noon



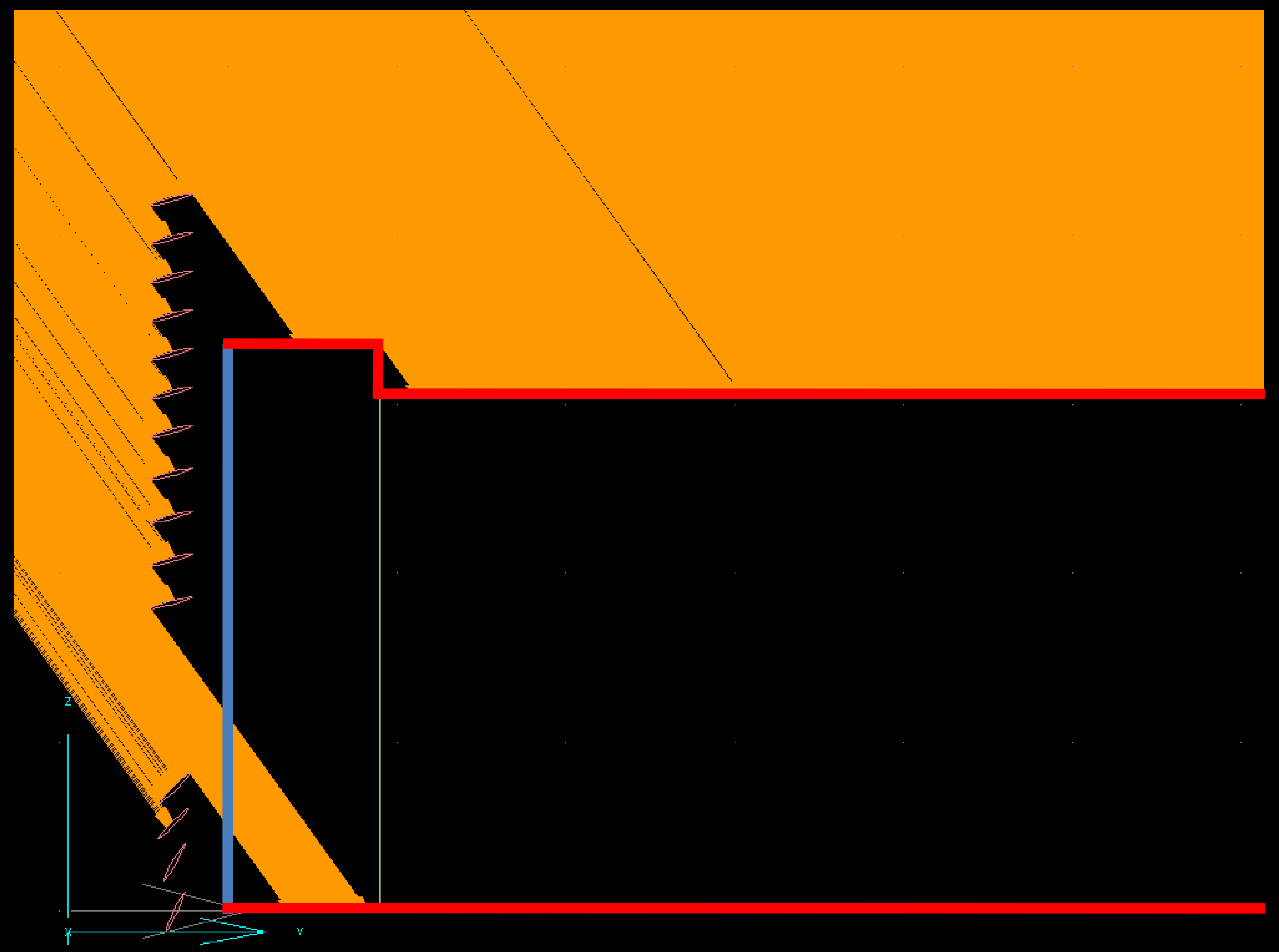




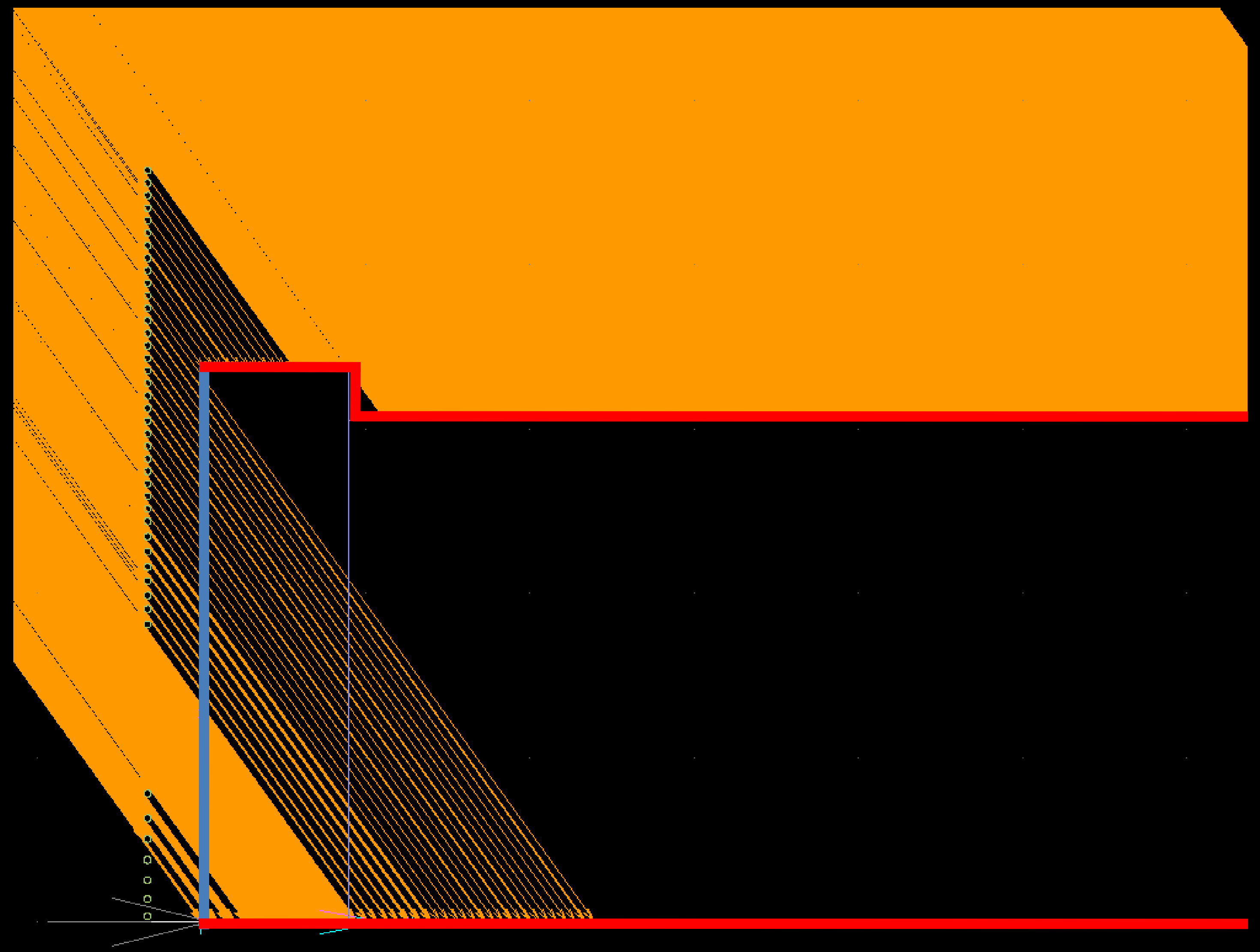
September 22nd
Noon



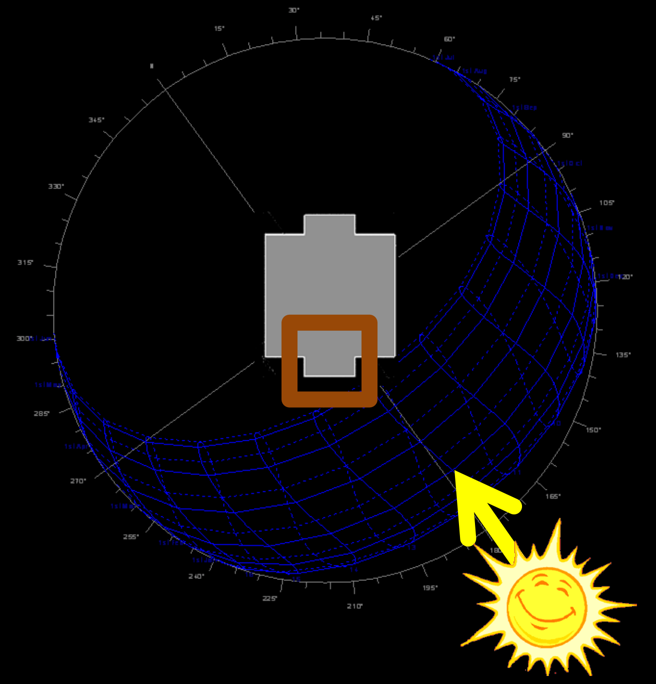
Redesign - Blades



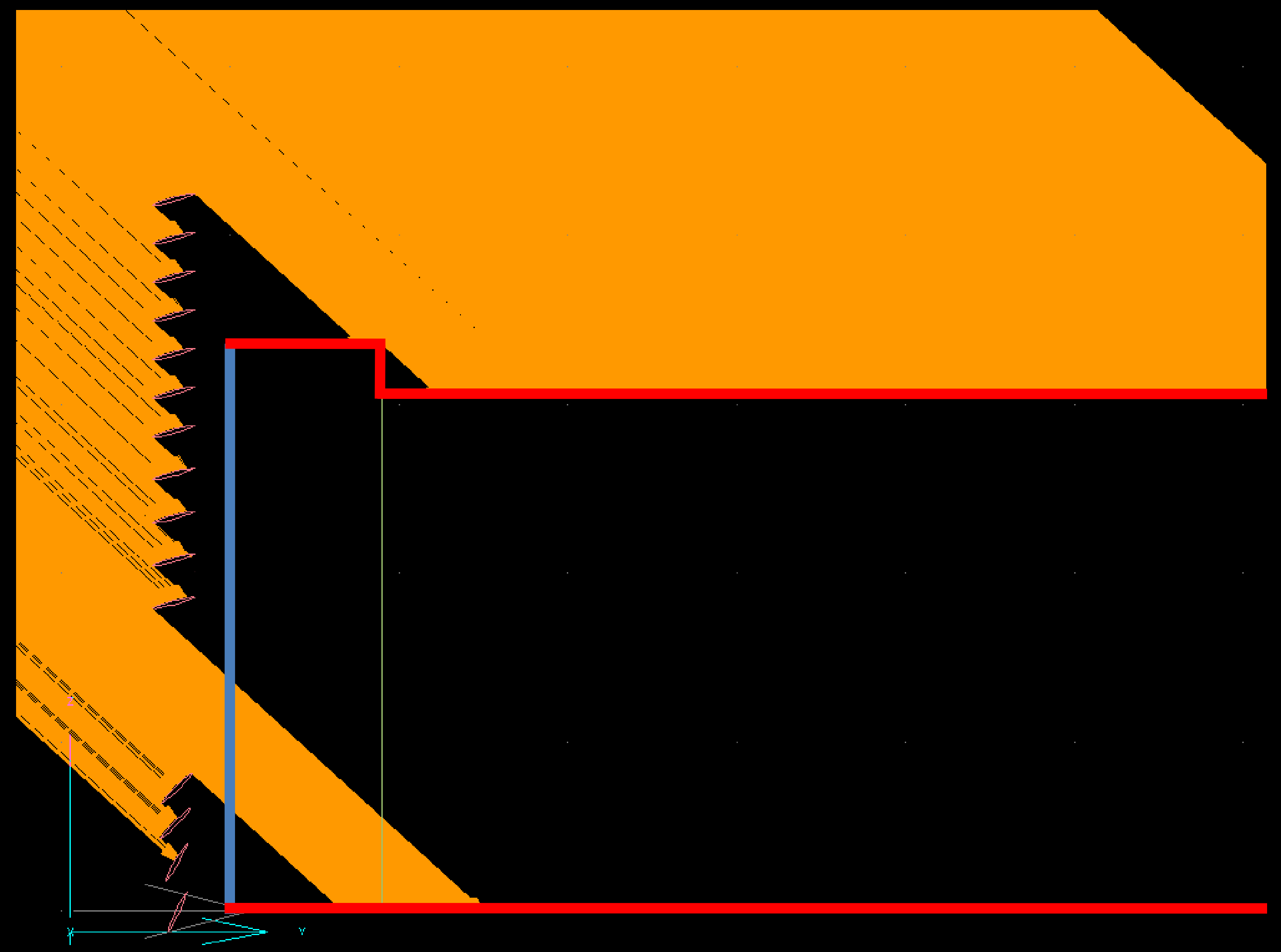
Existing - Rods



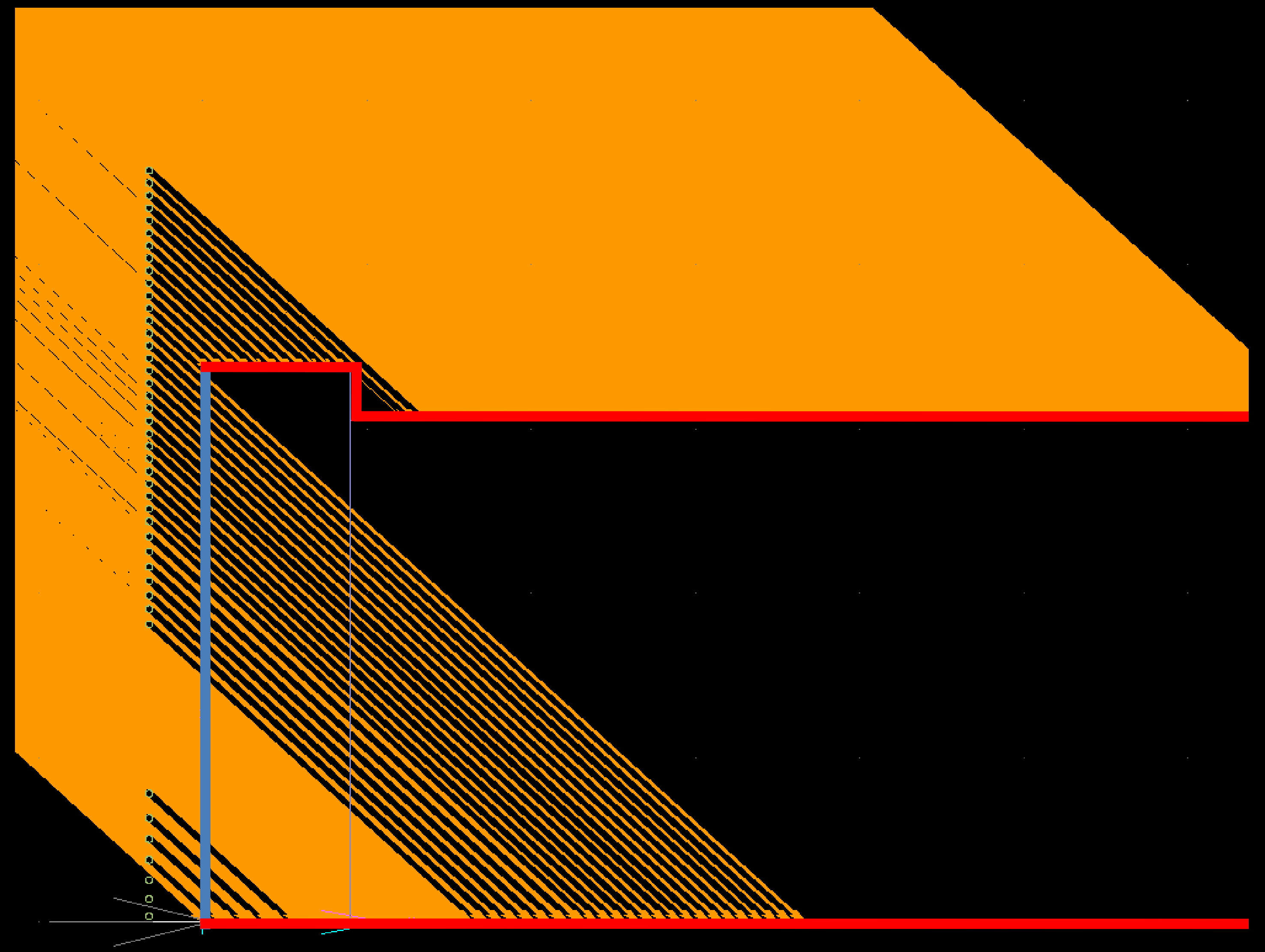
October 22nd
Noon



Redesign - Blades



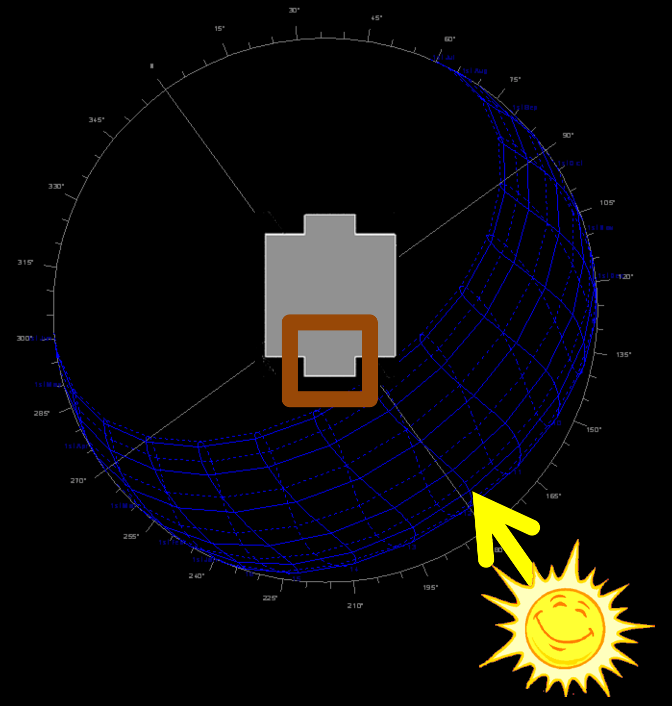
Existing - Rods

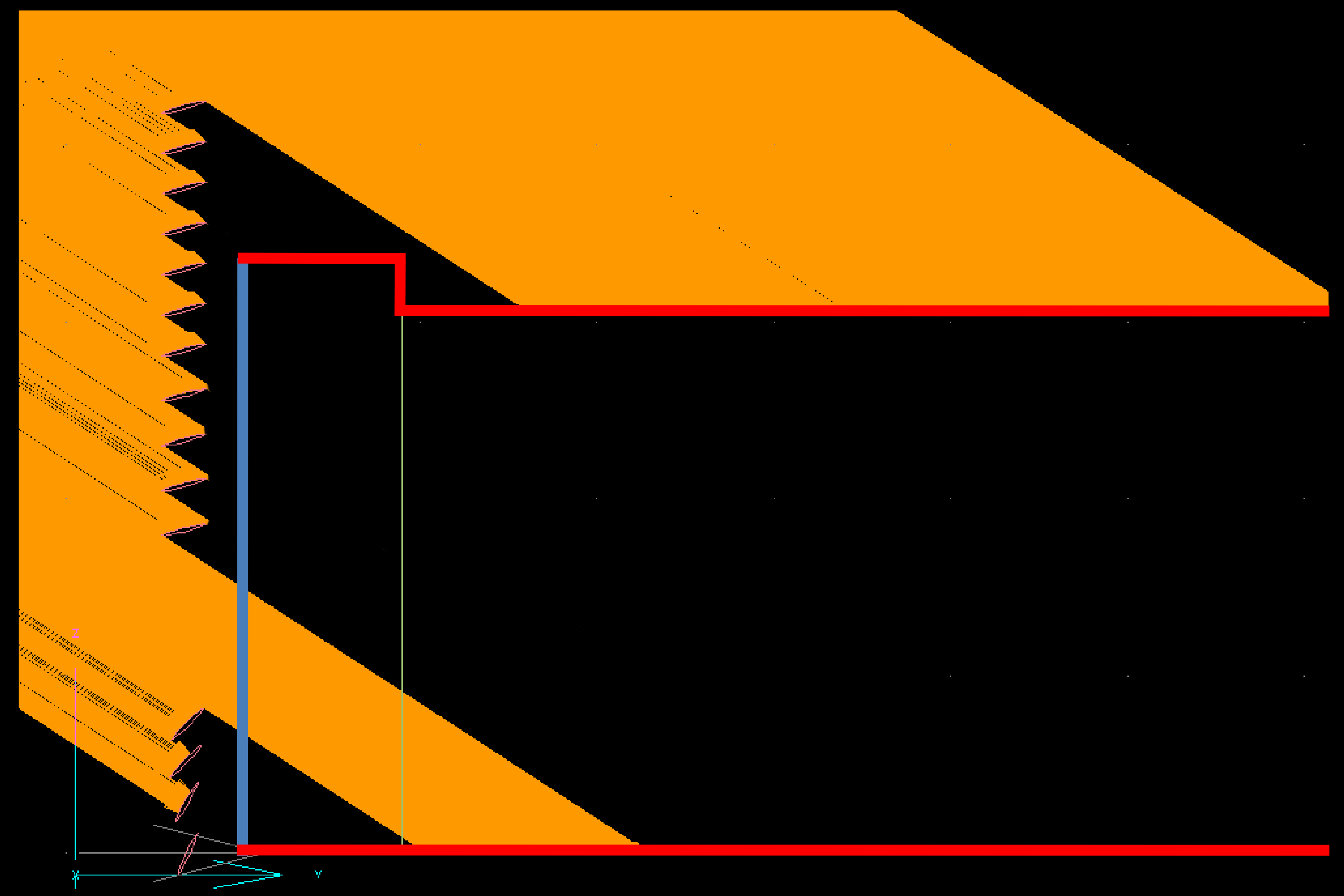


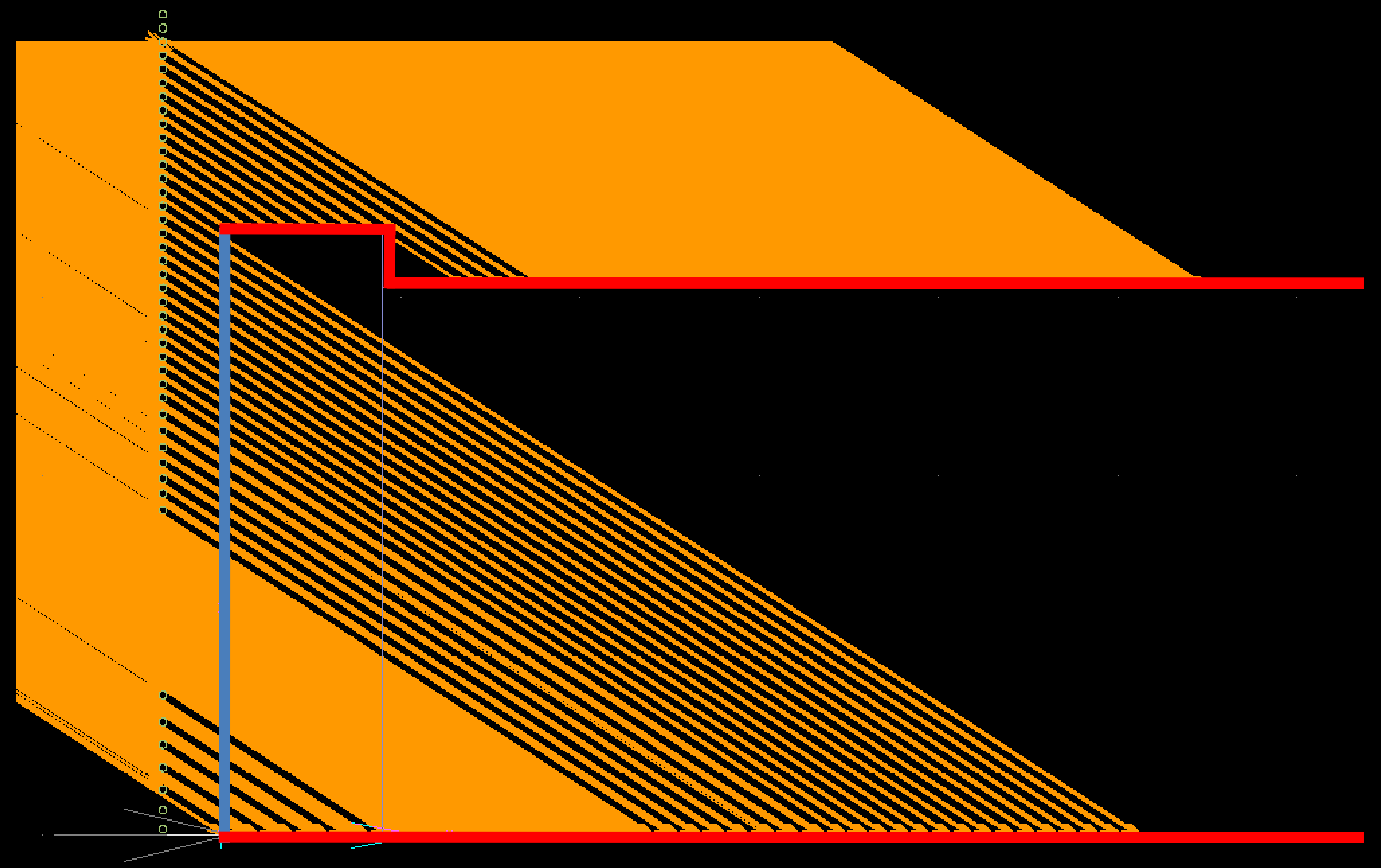
Redesign - Blades

Existing - Rods

November 22nd
Noon



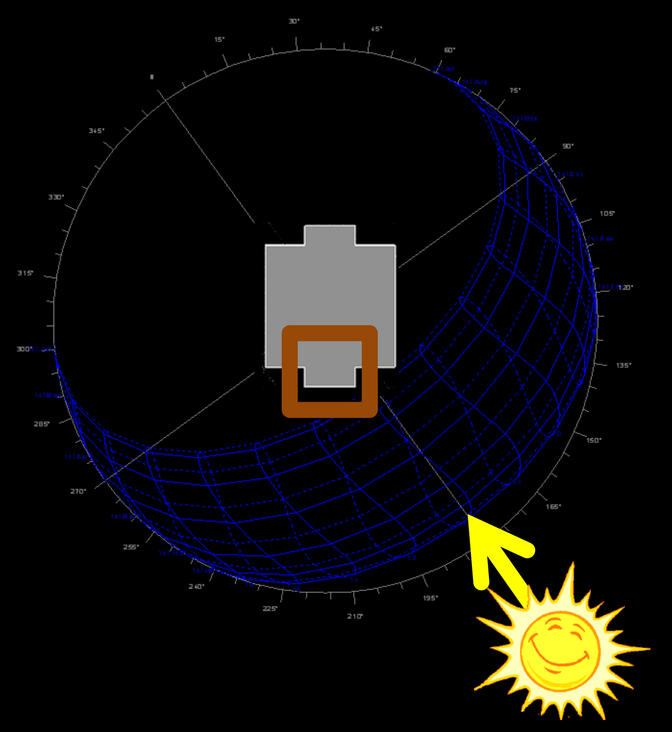


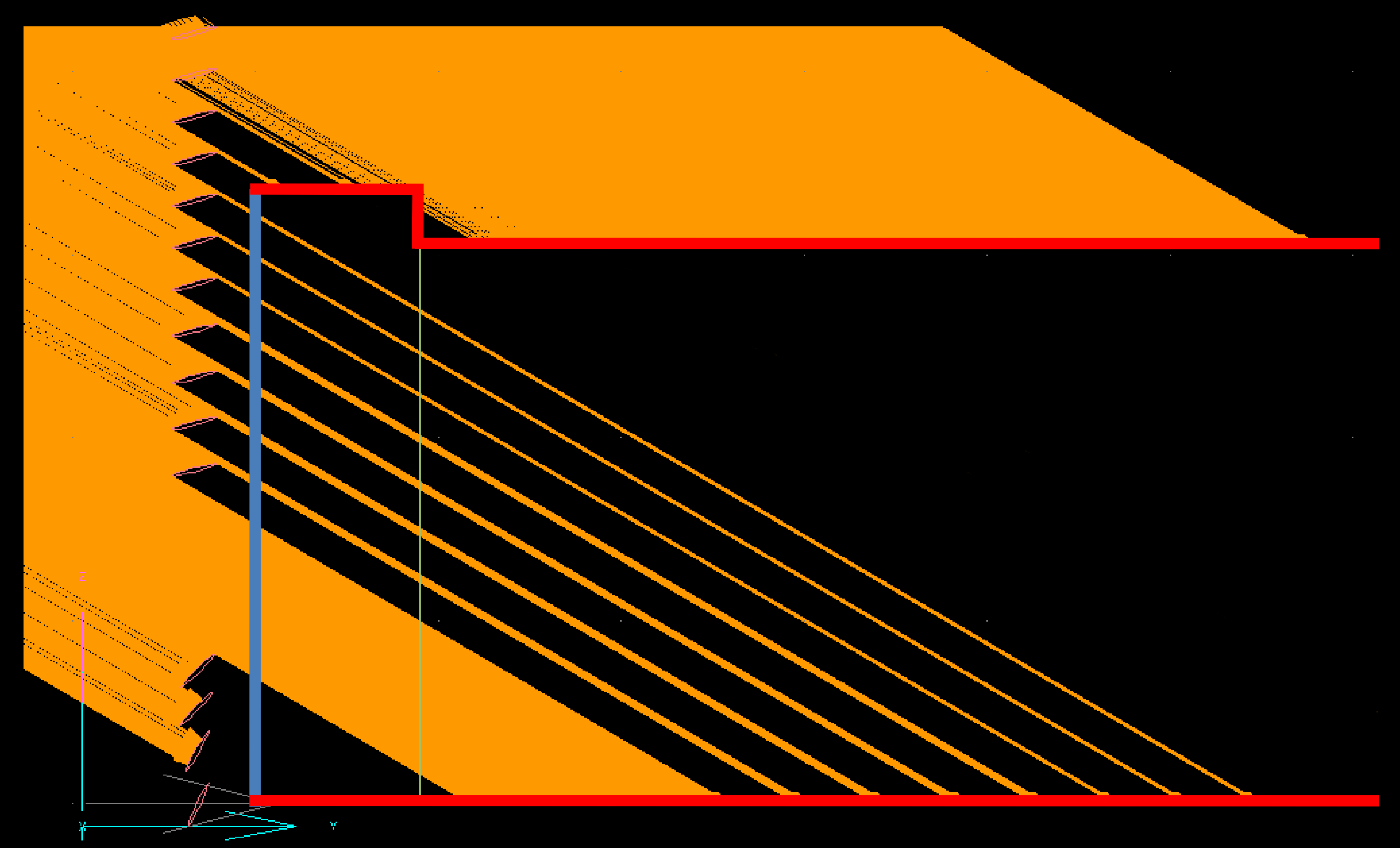


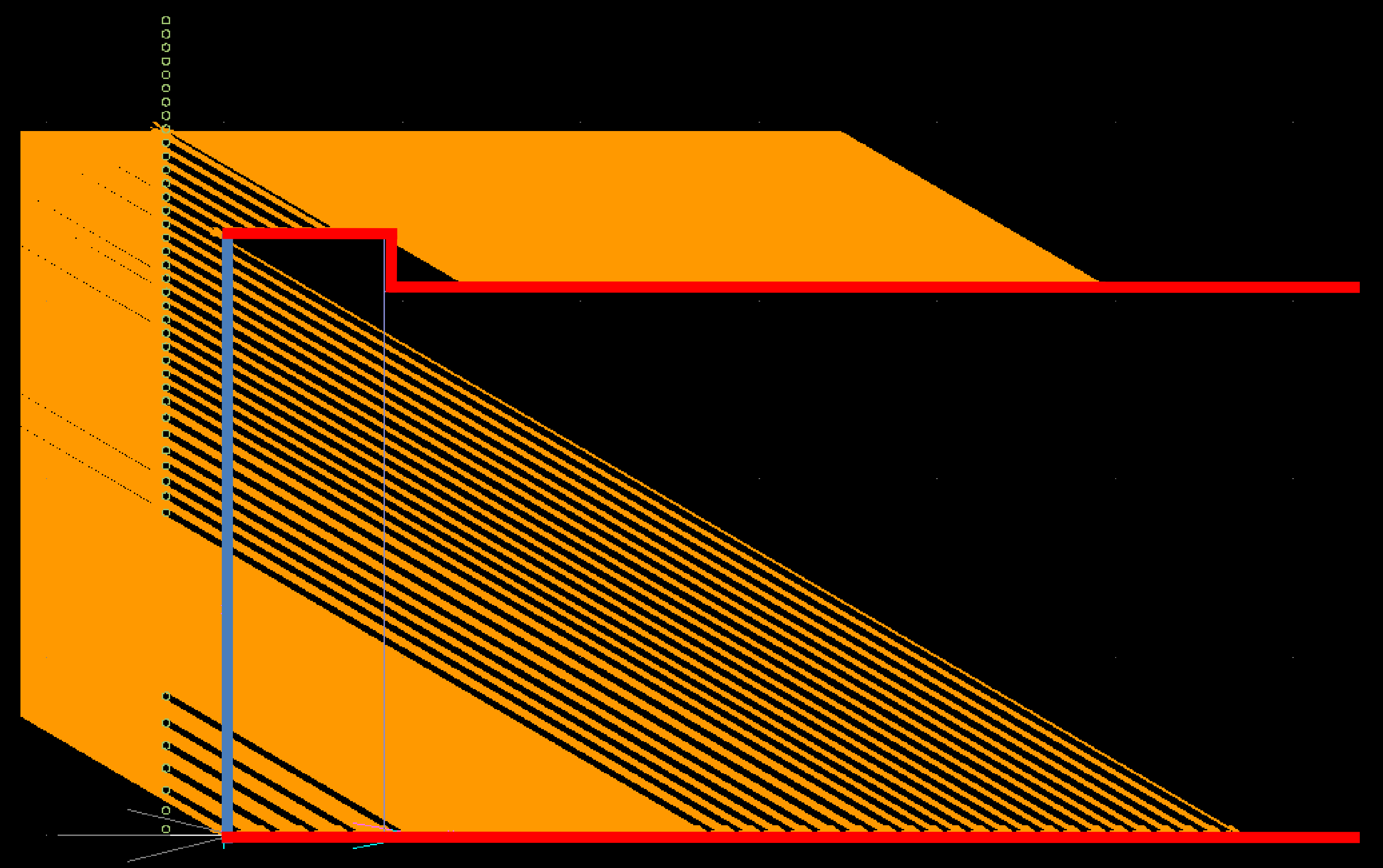
Redesign - Blades

Existing - Rods

December 22nd
Noon





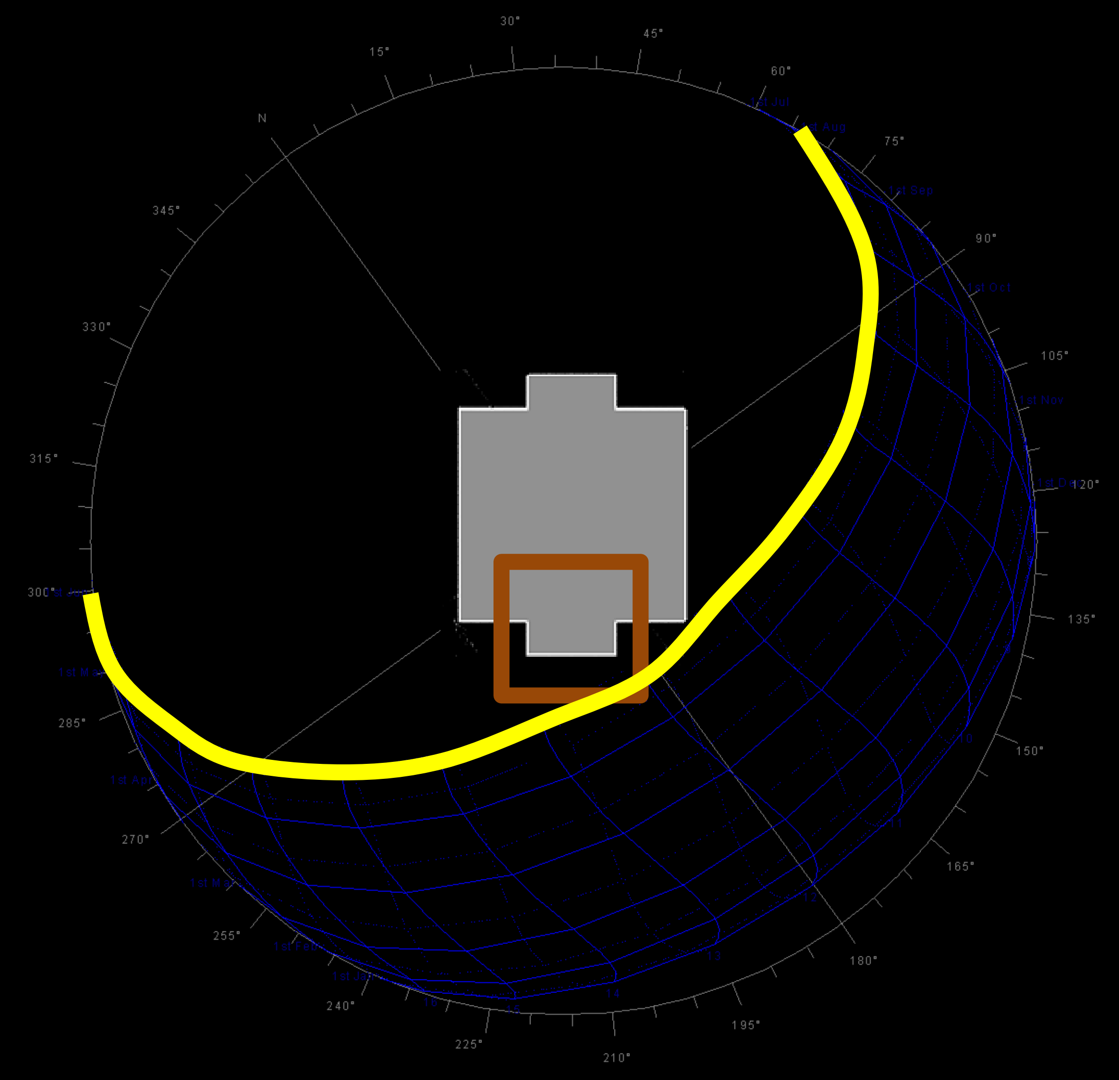


Building Overview

Team Workflow

Phase I : Façade
Typical Floor
Daylighting Analysis
Energy Analysis
Assembly and Cost
Phase II: Cogeneration
Phase III: Lateral System
Phase IV: Distribution Systems and Coordination

Results and Conclusions



Summer Solstice

Both performed similar and will not be presented

Building Overview

Team Workflow

Phase I : Façade

Typical Floor

Daylighting Analysis

Energy Analysis

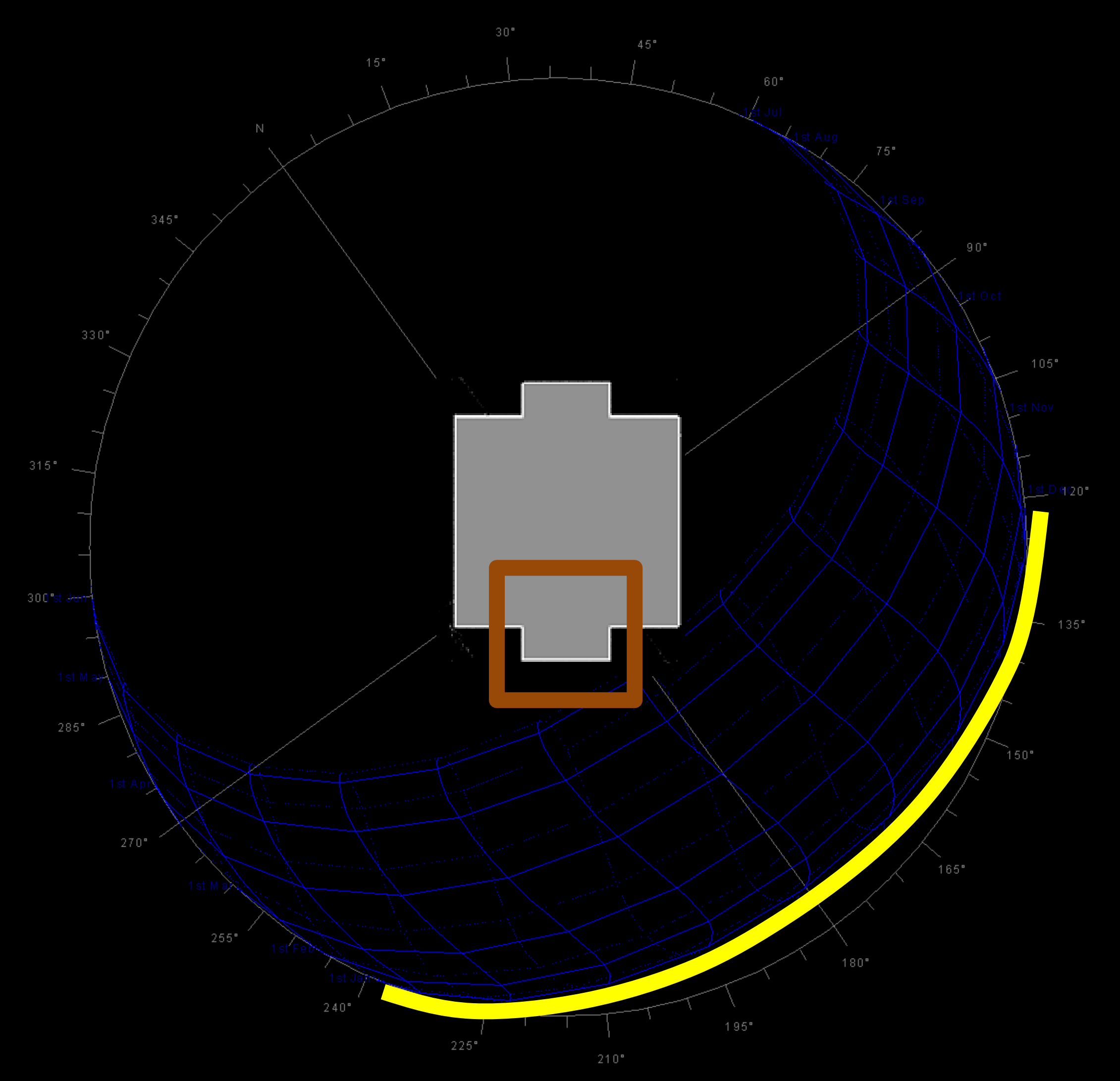
Assembly and Cost

Phase II: Cogeneration

Phase III: Lateral System

Phase IV: Distribution Systems and Coordination

Results and Conclusions

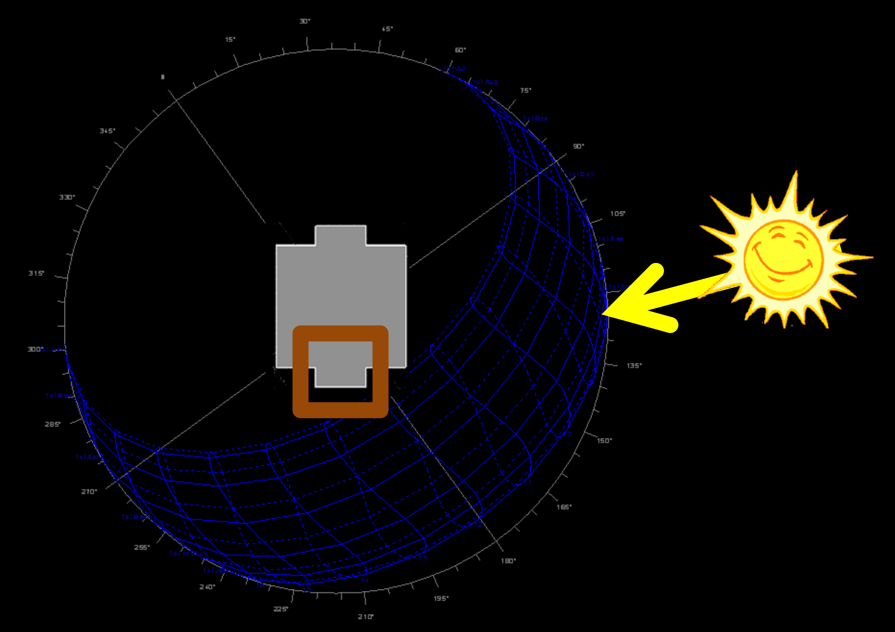


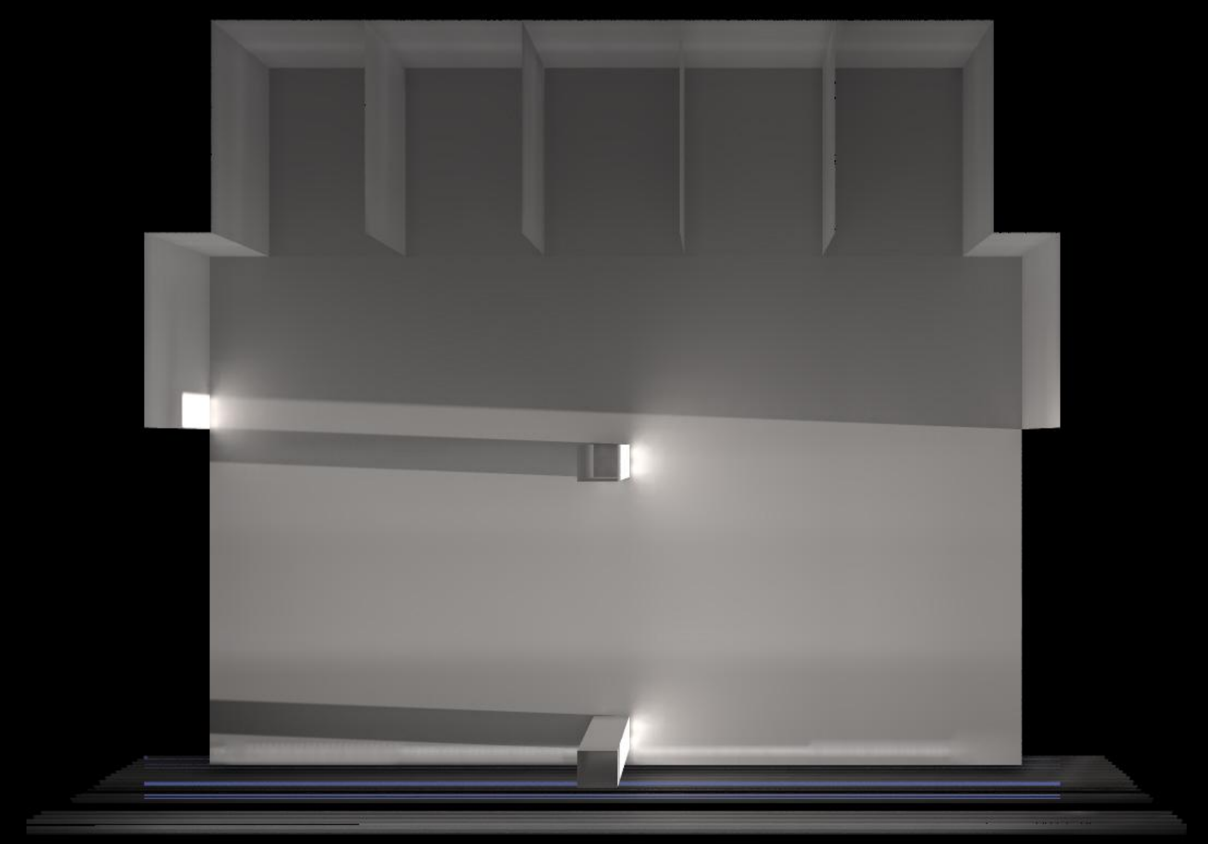
Winter Solstice

Redesign - Blades

Existing - Rods

Winter Solstice
8am

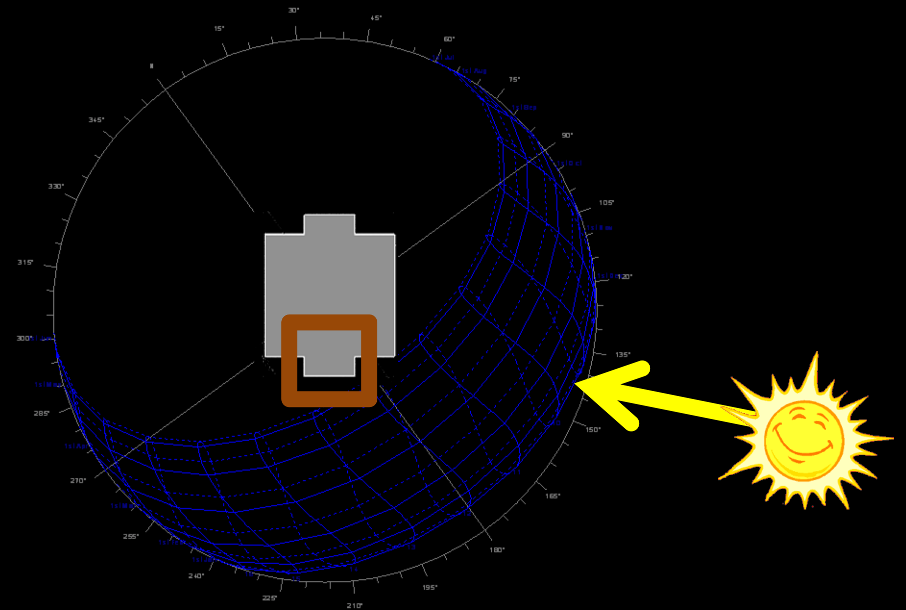


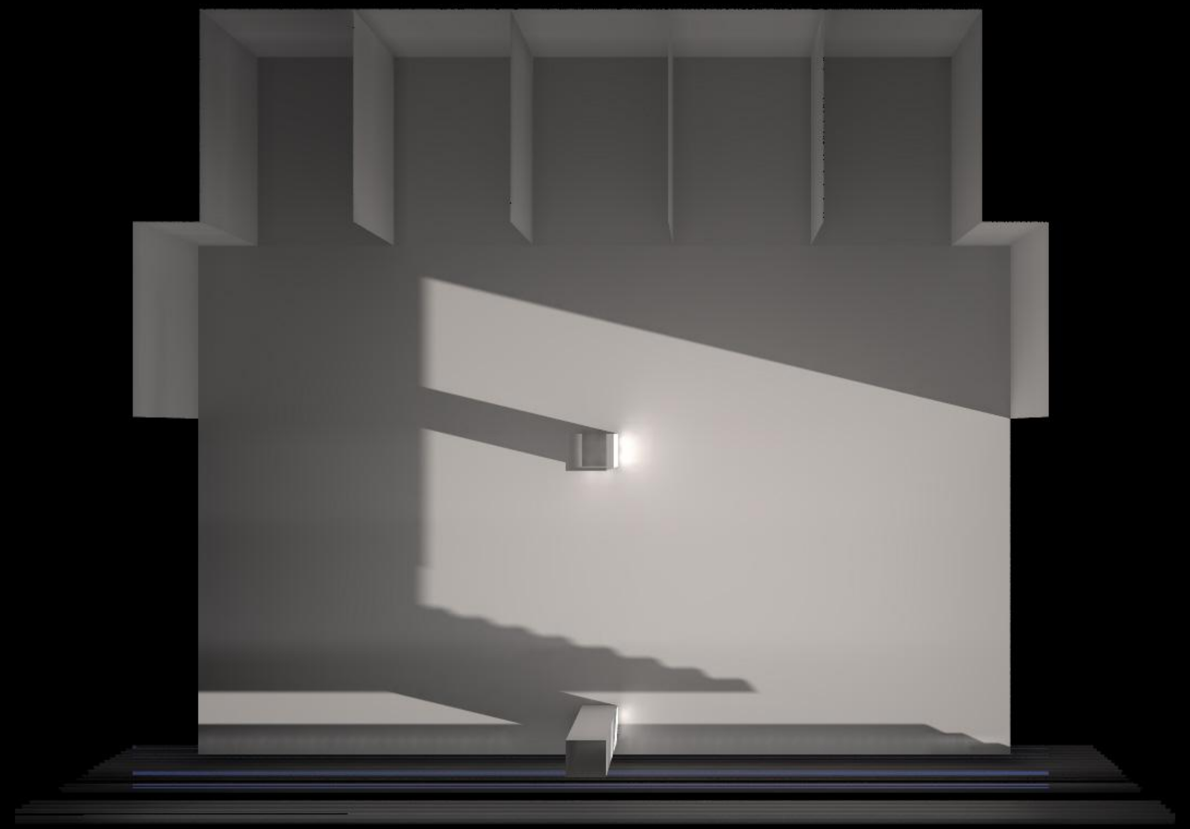


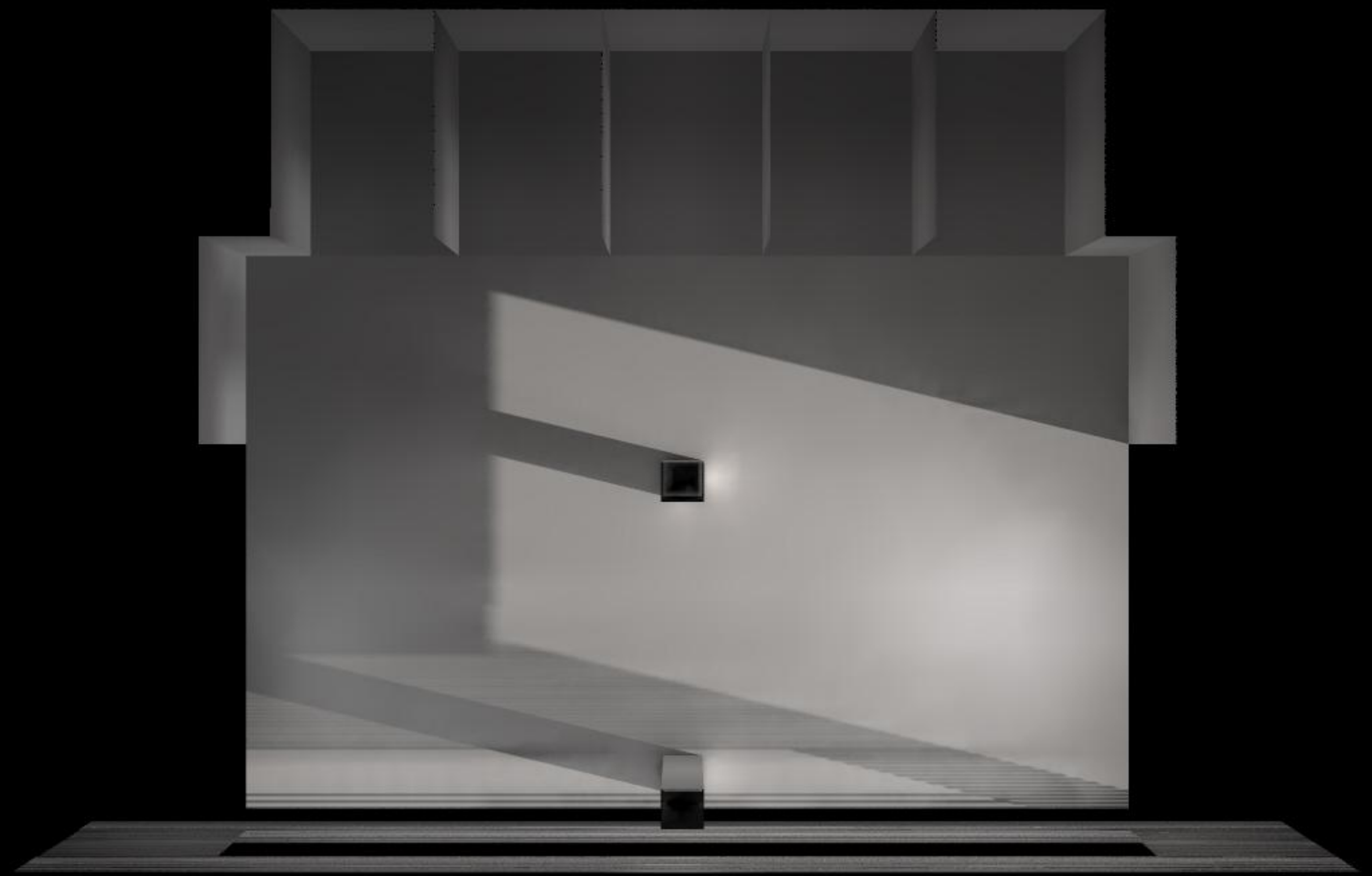
Redesign - Blades

Existing - Rods

Winter Solstice
9am



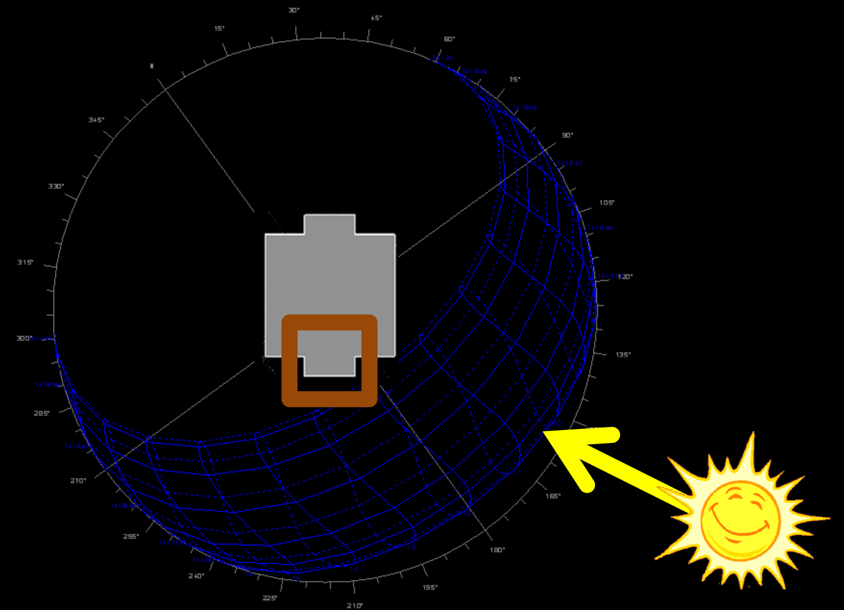




Redesign - Blades

Existing - Rods

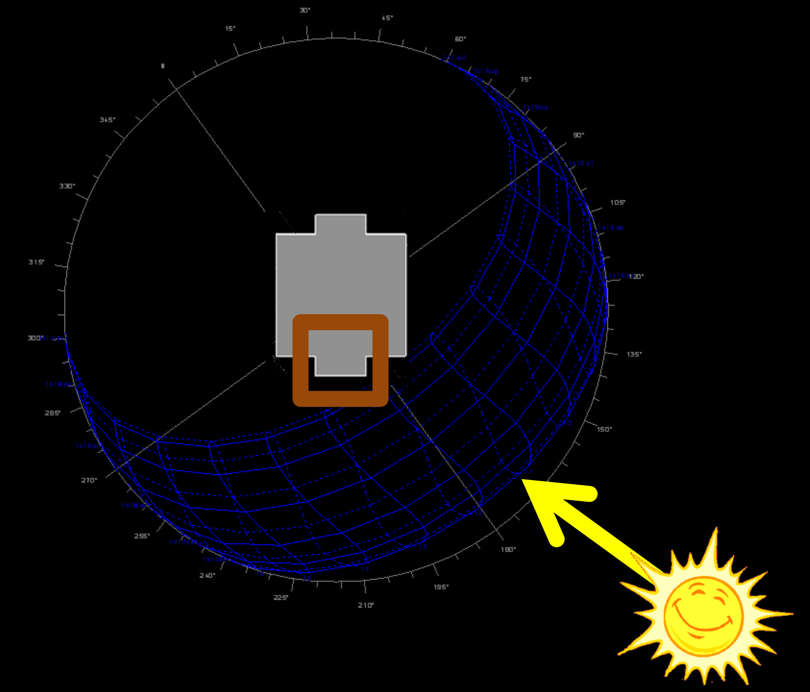
Winter Solstice
10am

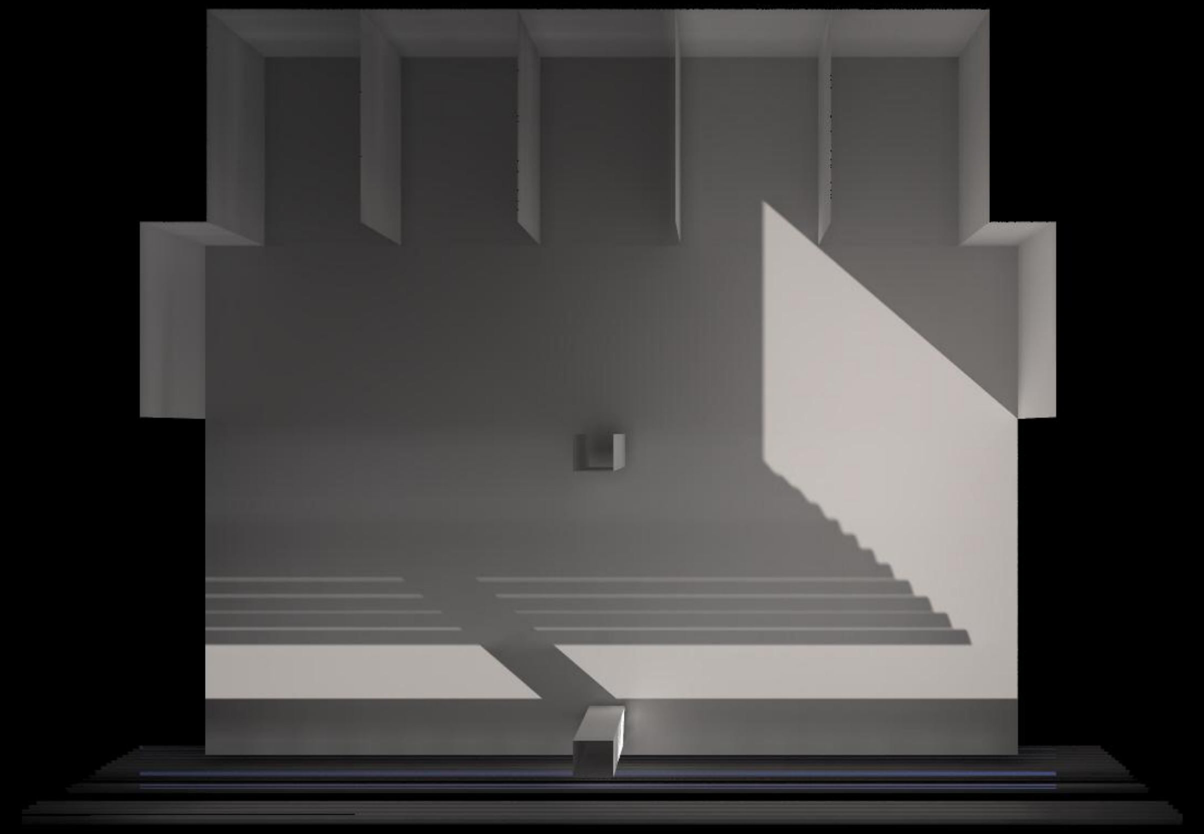


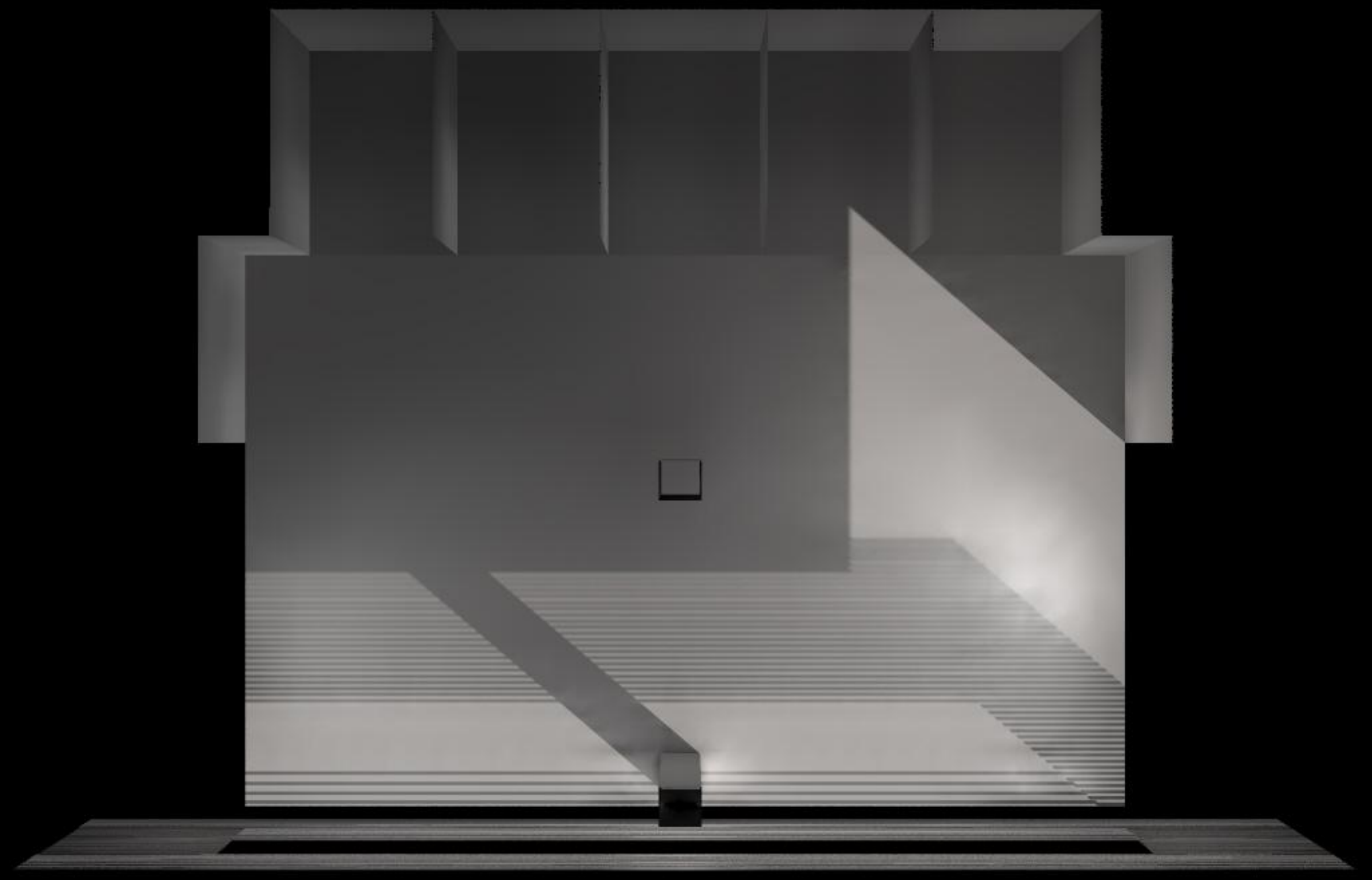
Redesign - Blades

Existing - Rods

Winter Solstice
11am



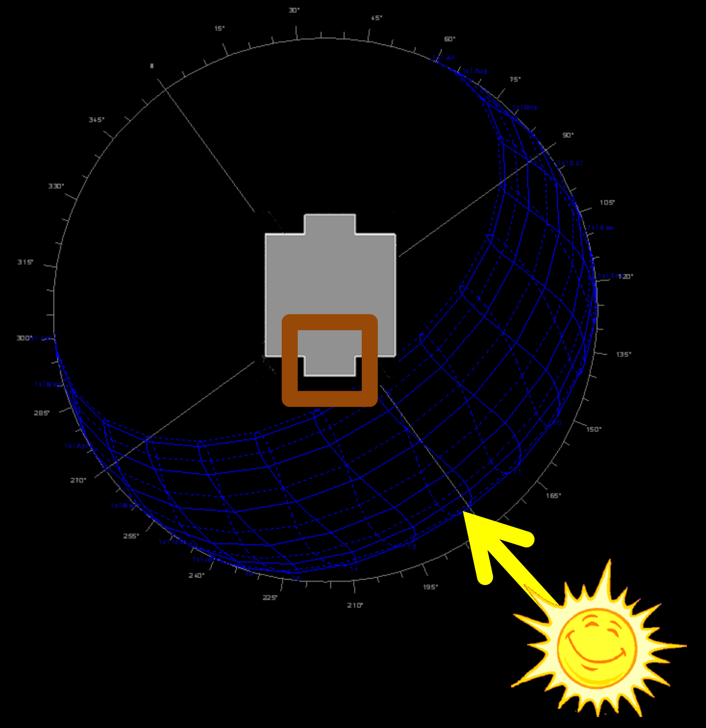


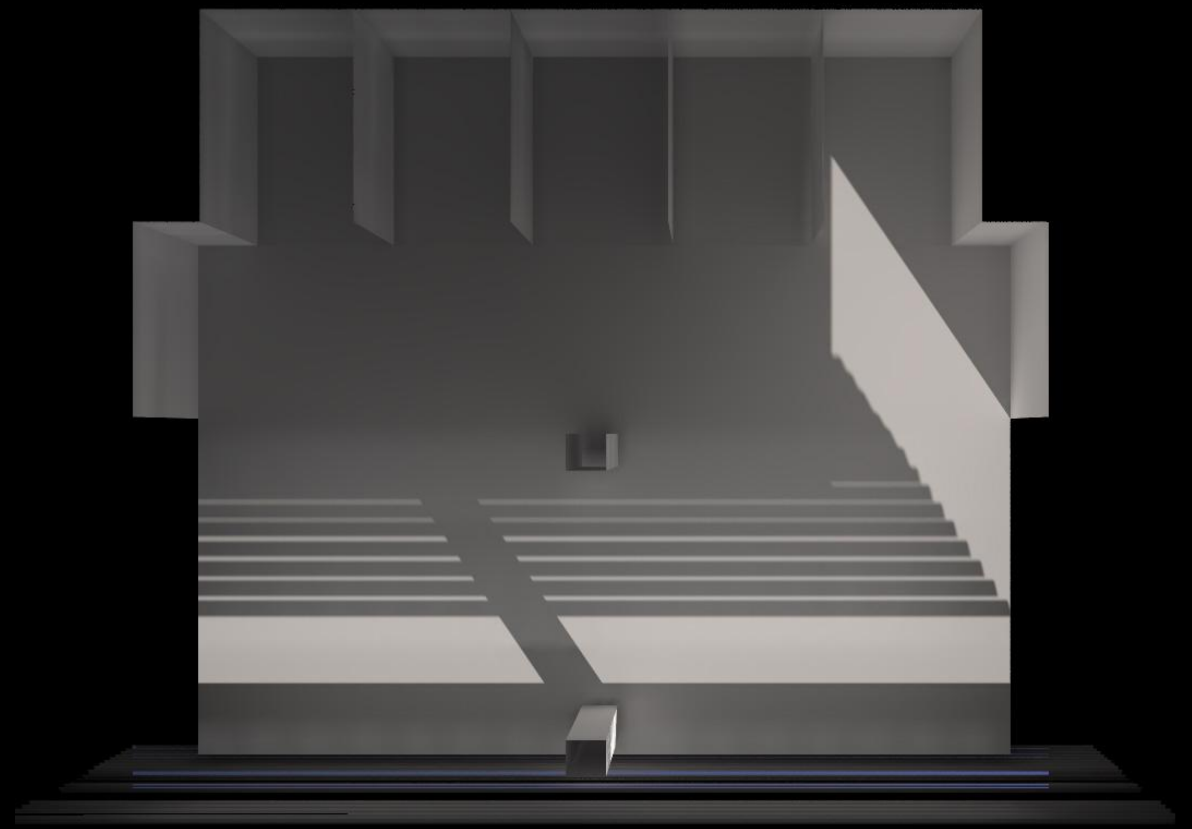


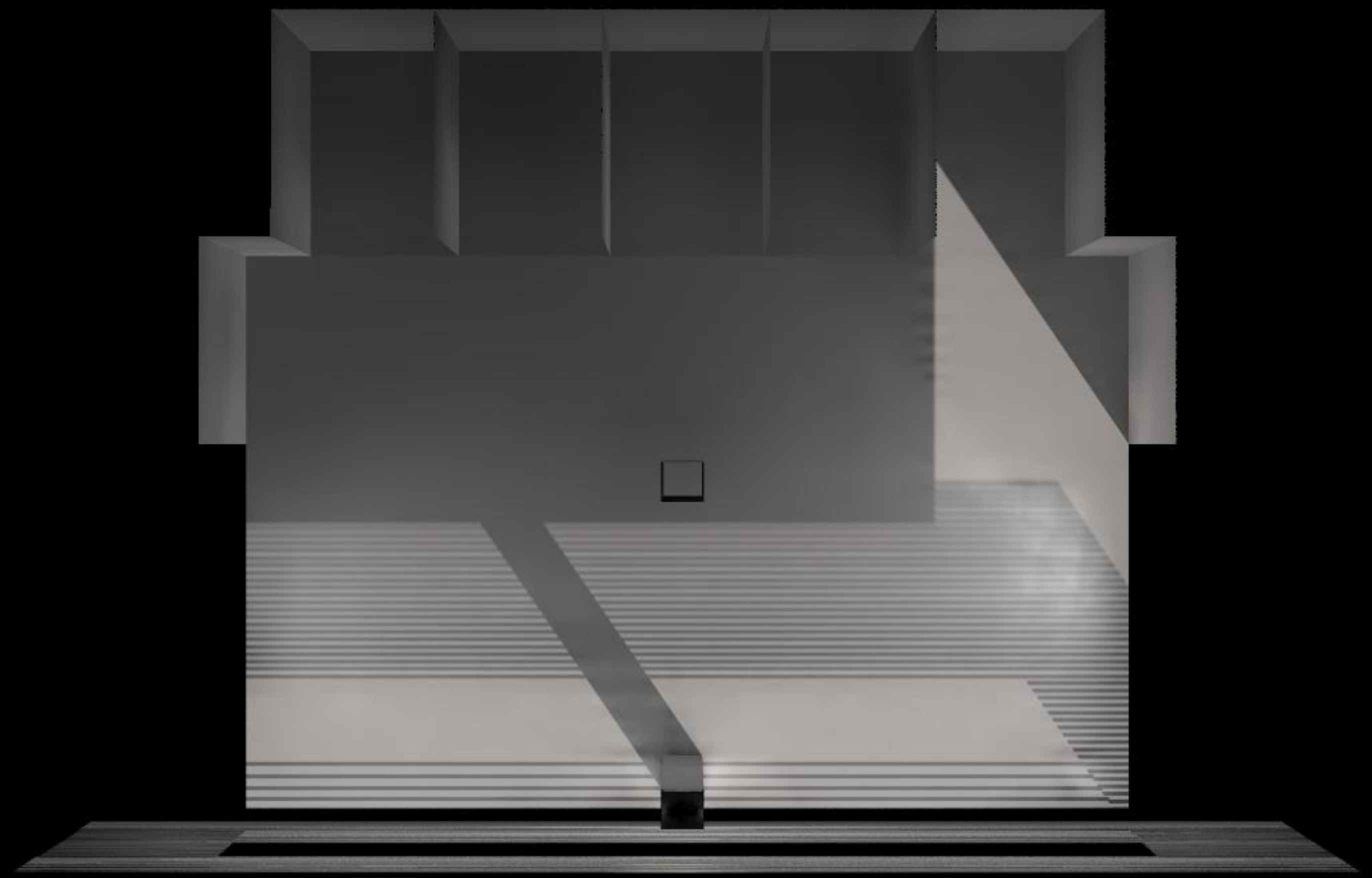
Redesign - Blades

Existing - Rods

Winter Solstice
12pm



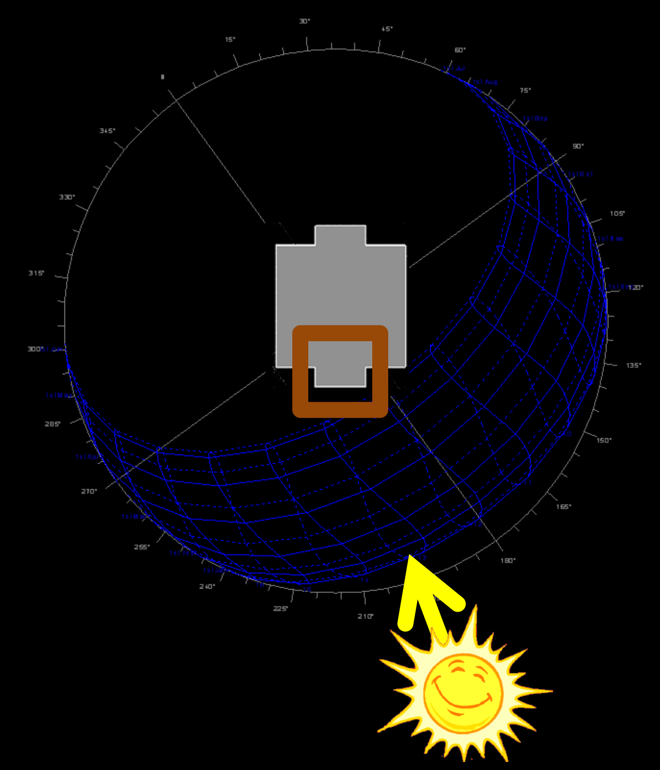


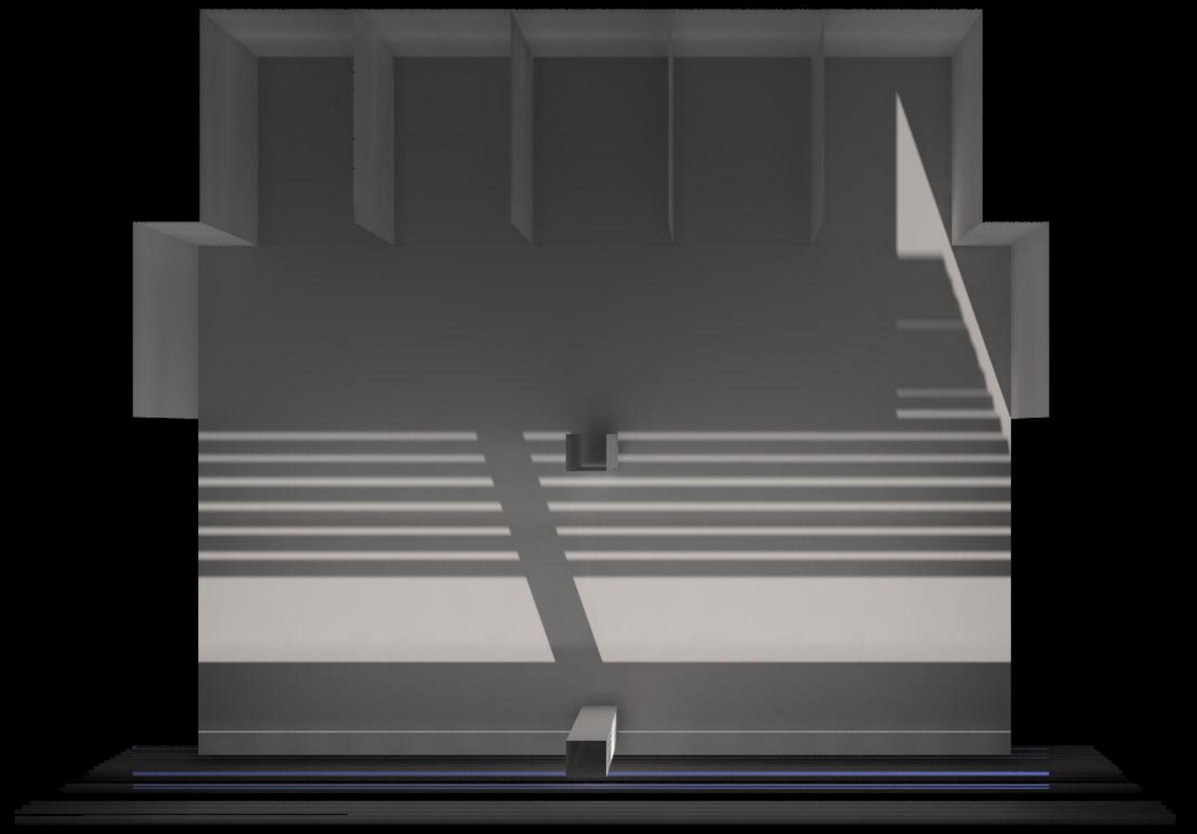


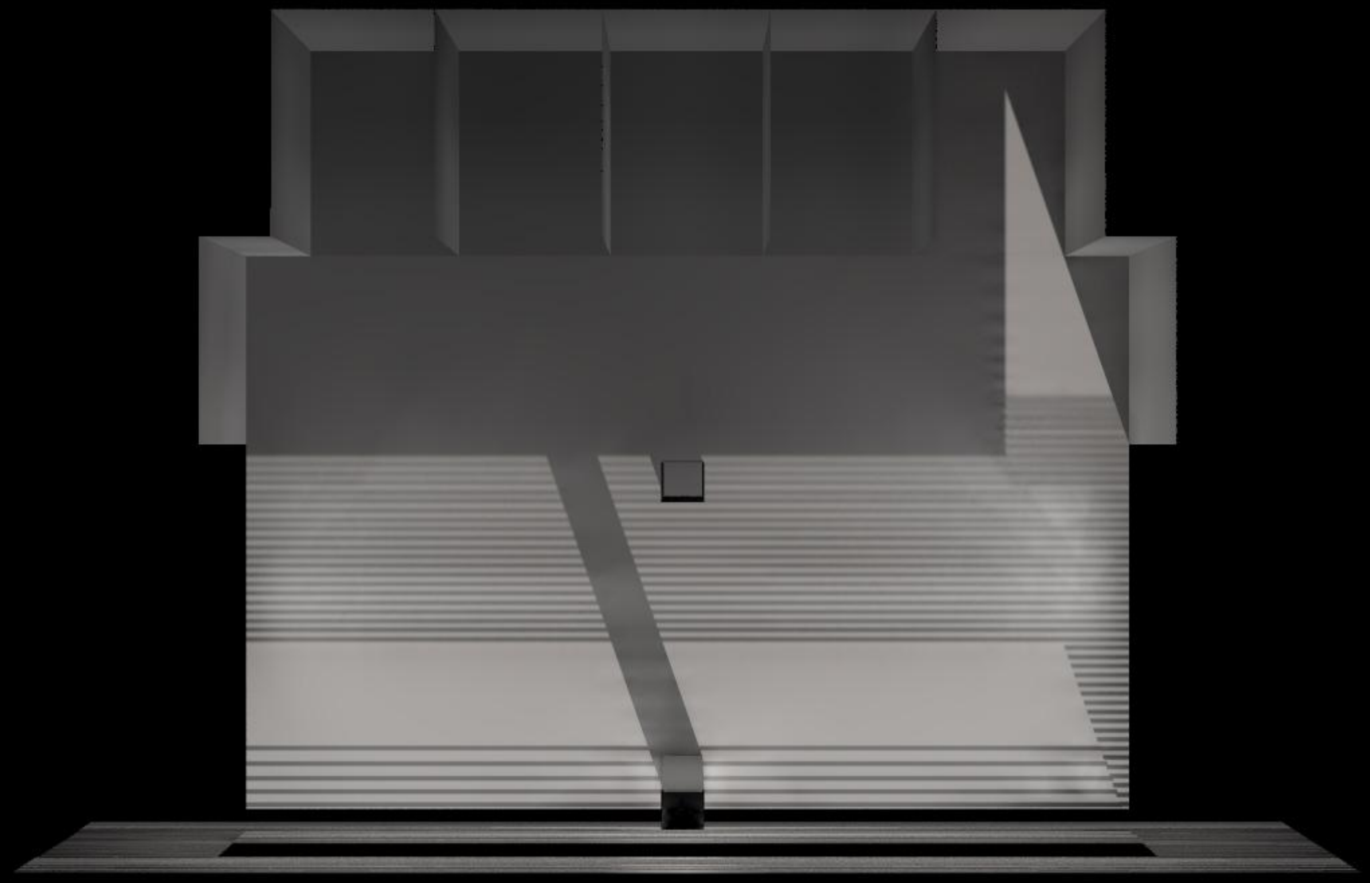
Redesign - Blades

Existing - Rods

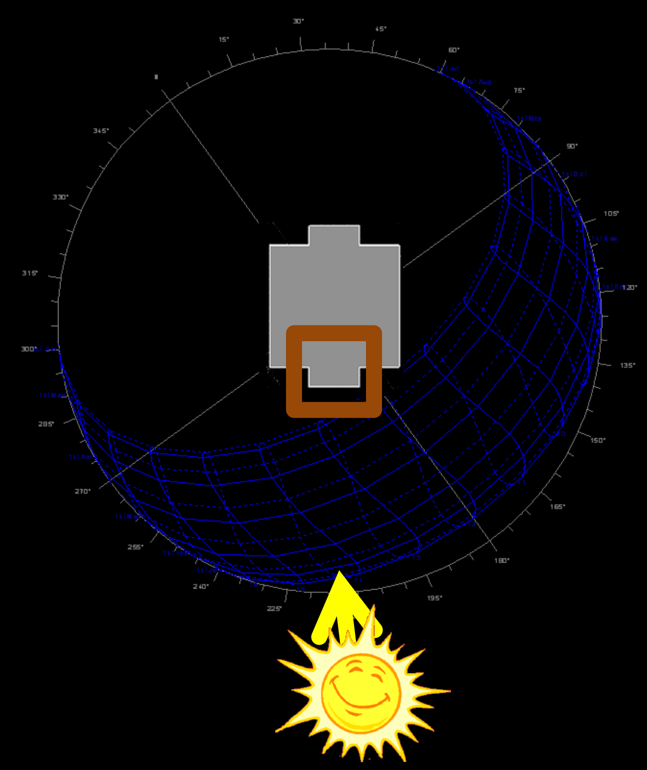
Winter Solstice
1pm



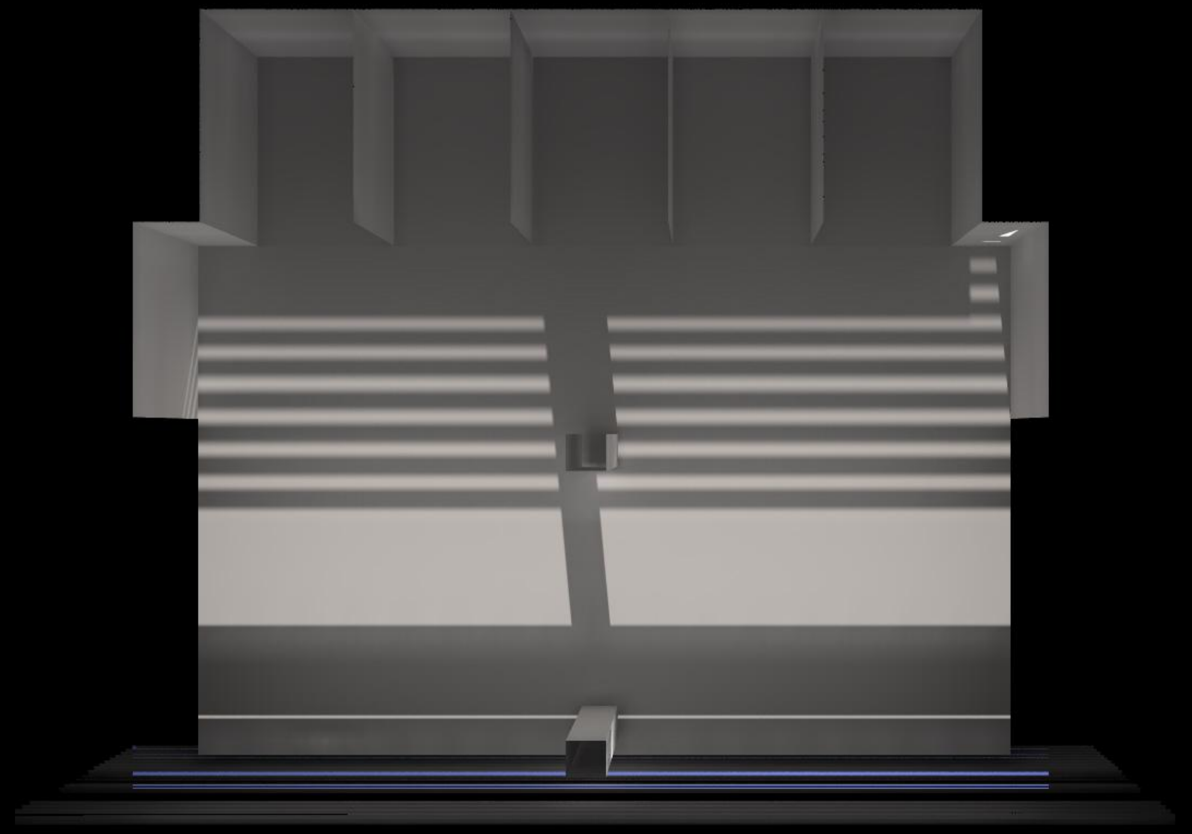




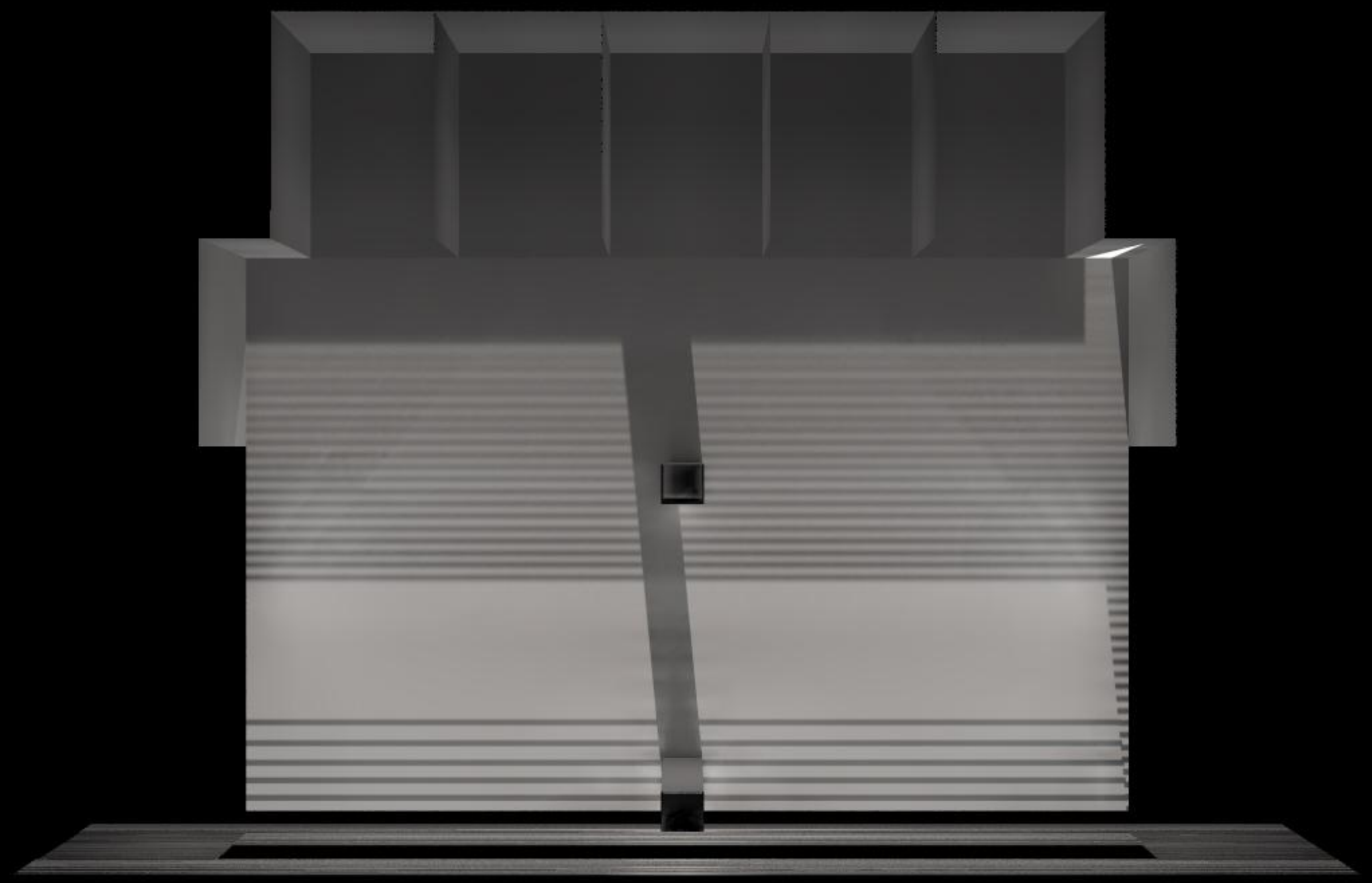
Winter Solstice
2pm



Redesign - Blades



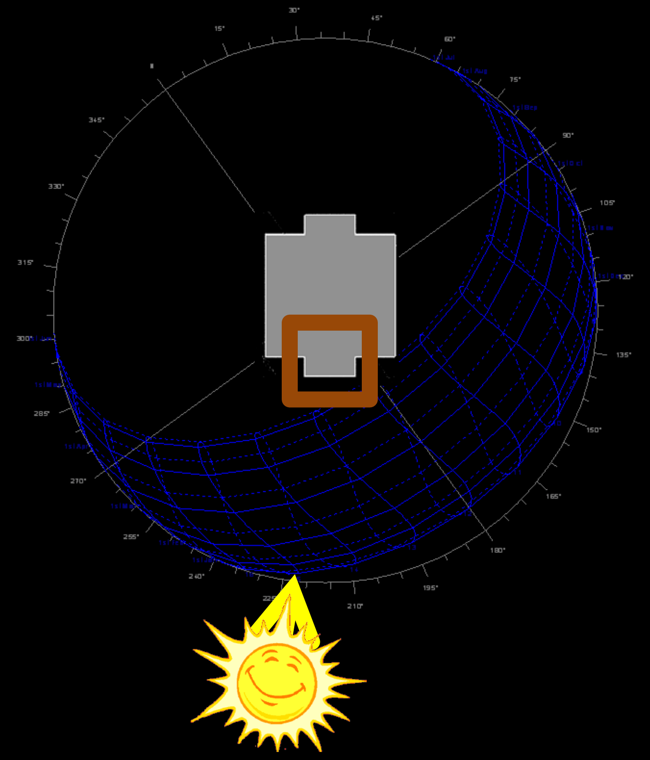
Existing - Rods

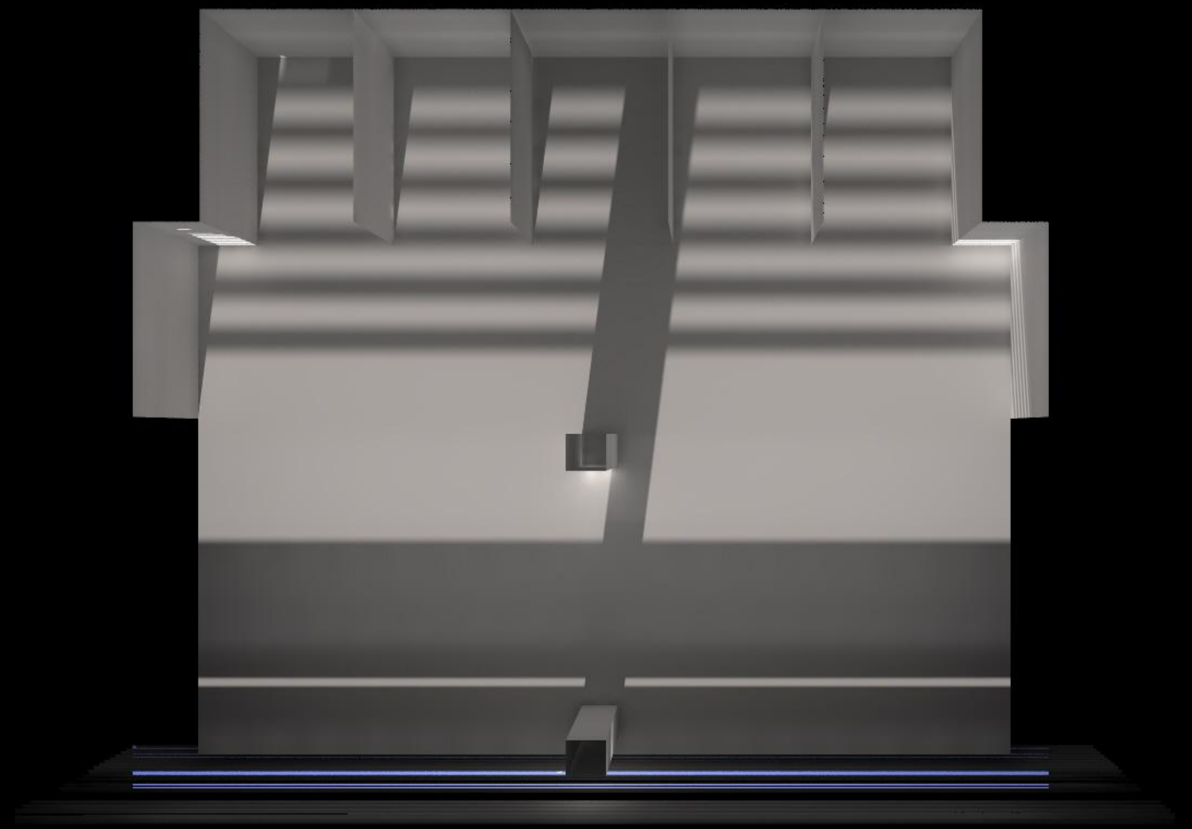


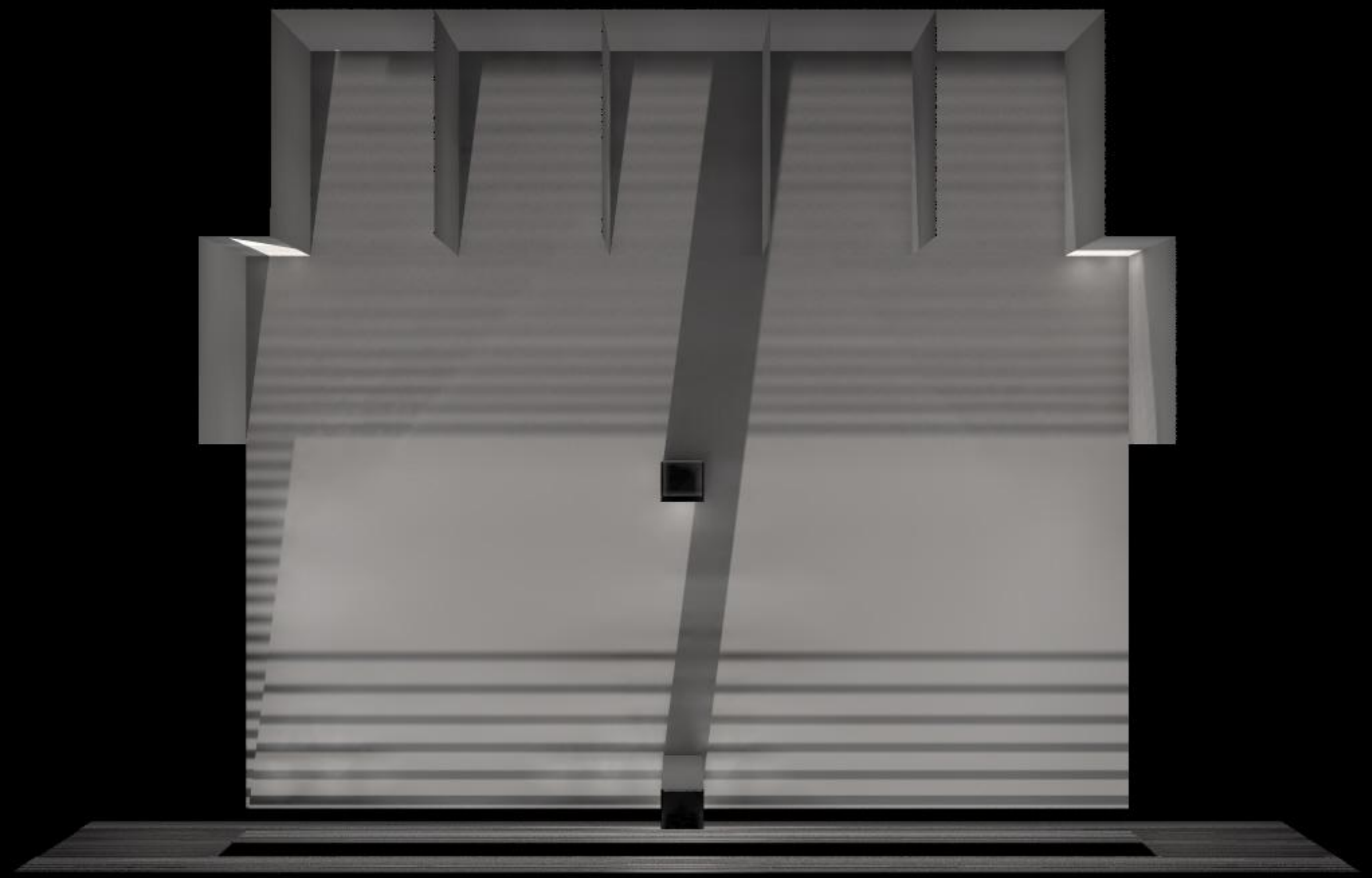
Redesign - Blades

Existing - Rods

Winter Solstice
3pm



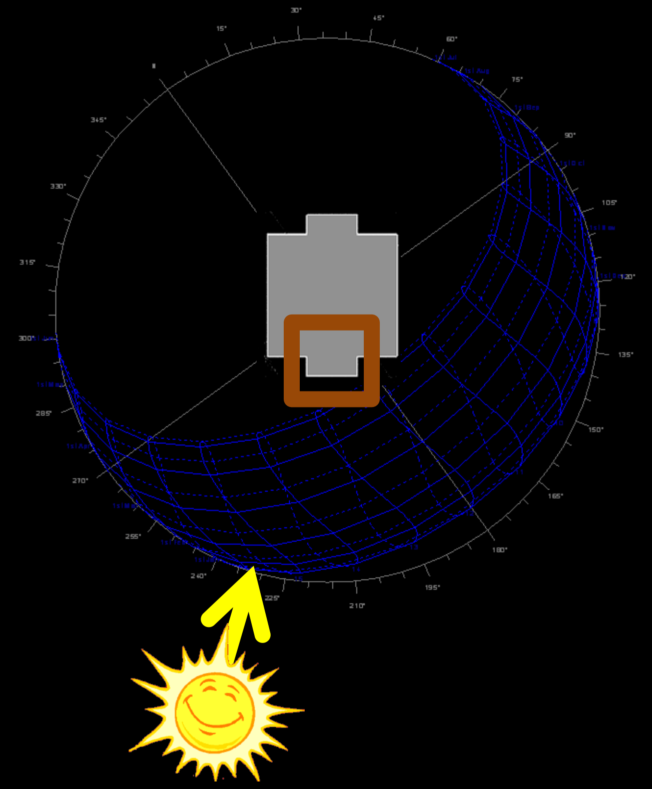


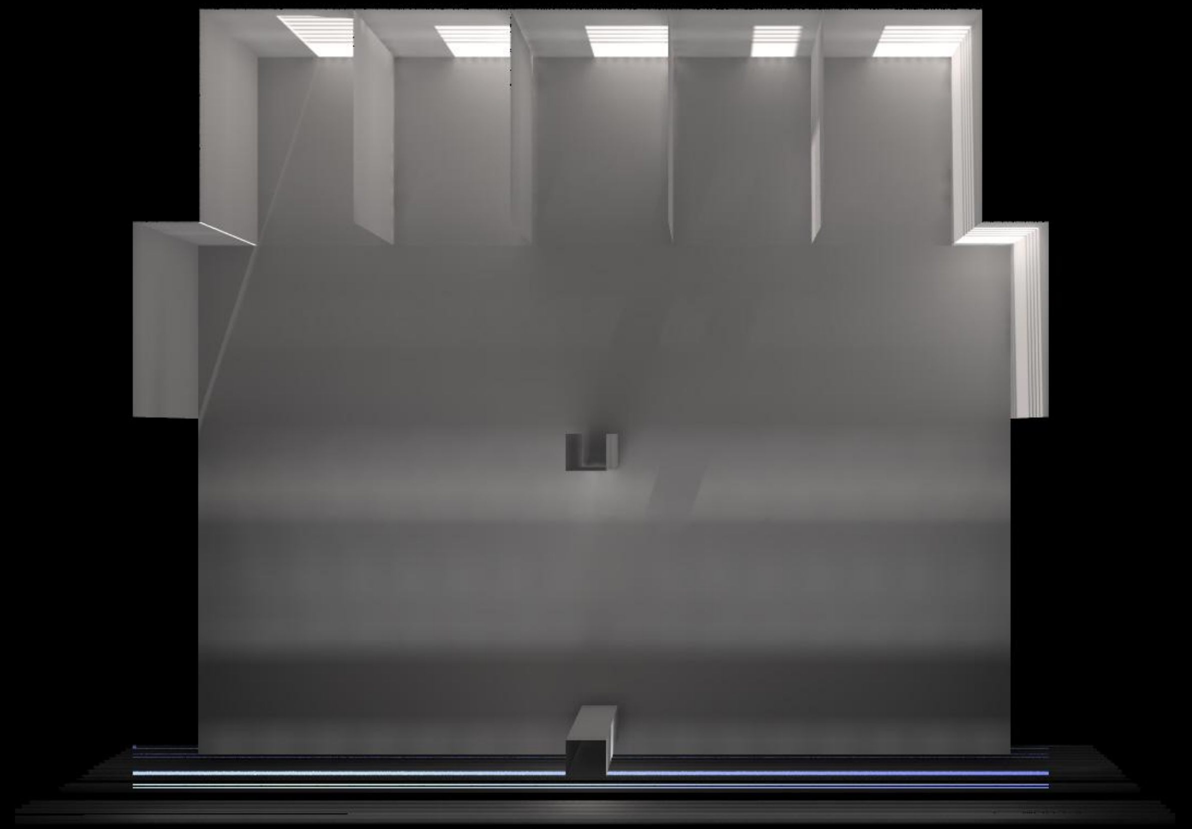


Redesign - Blades

Existing - Rods

Winter Solstice
4pm





Building Overview

Team Workflow

Phase I : Façade

Typical Floor

Daylighting Analysis

Energy Analysis

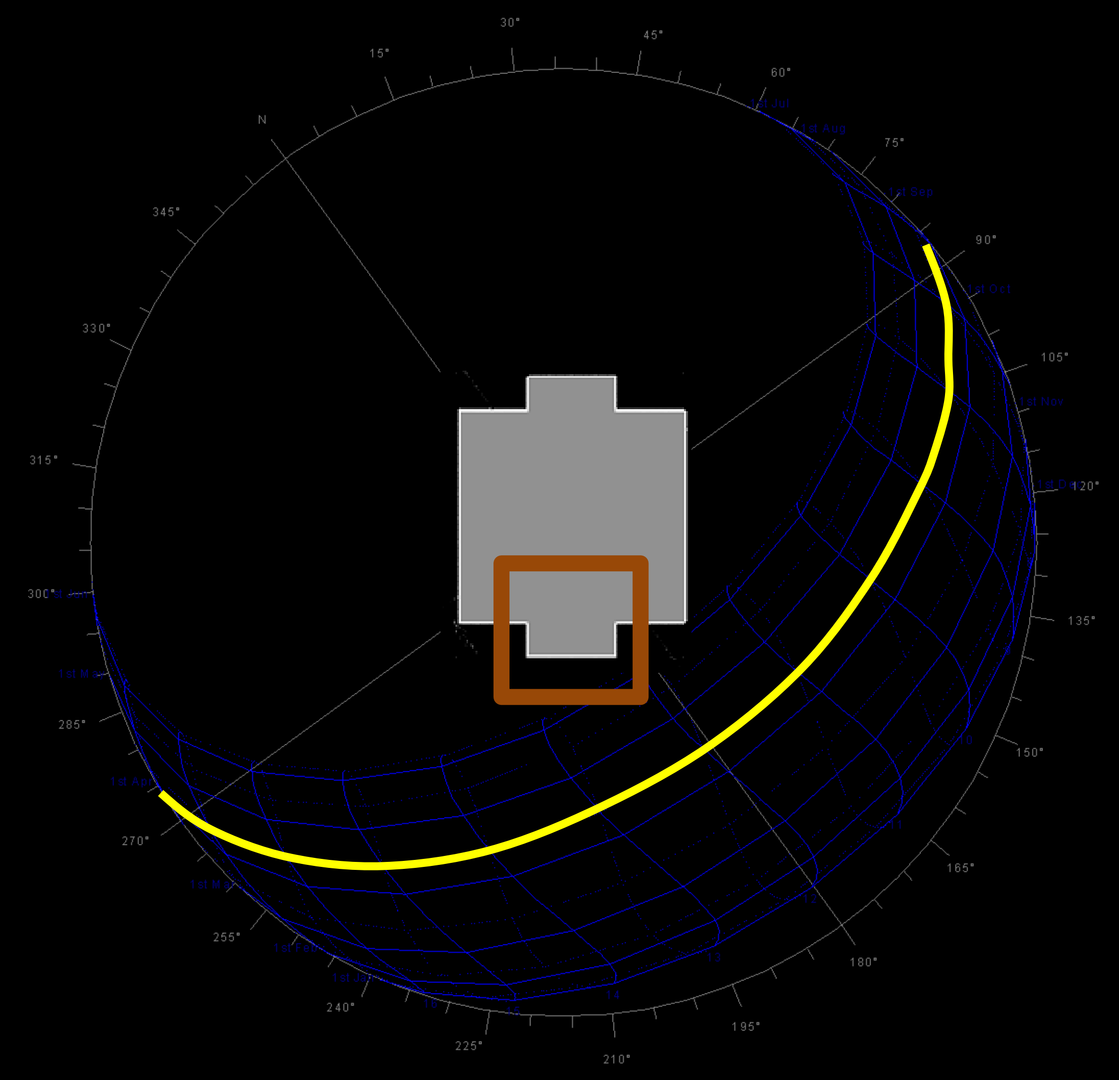
Assembly and Cost

Phase II: Cogeneration

Phase III: Lateral System

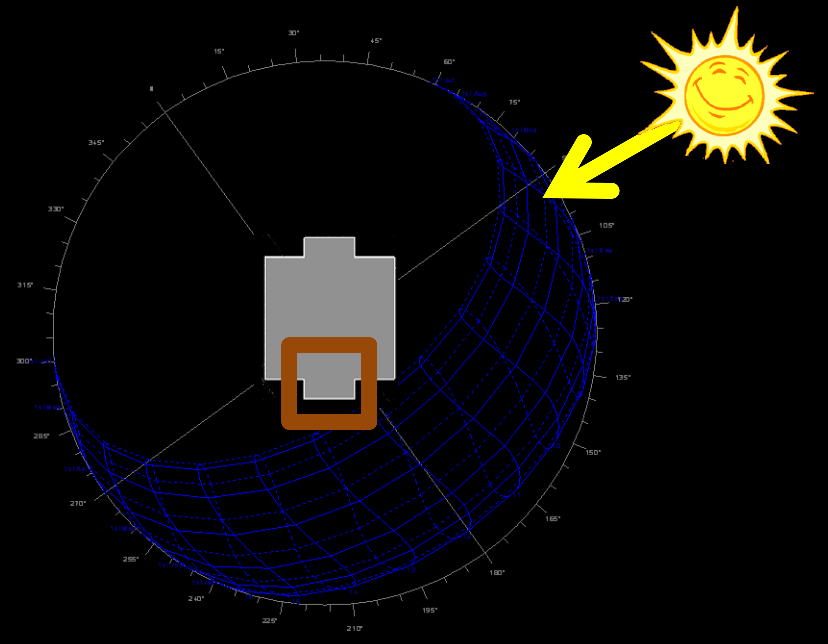
Phase IV: Distribution Systems and Coordination

Results and Conclusions



Equinox

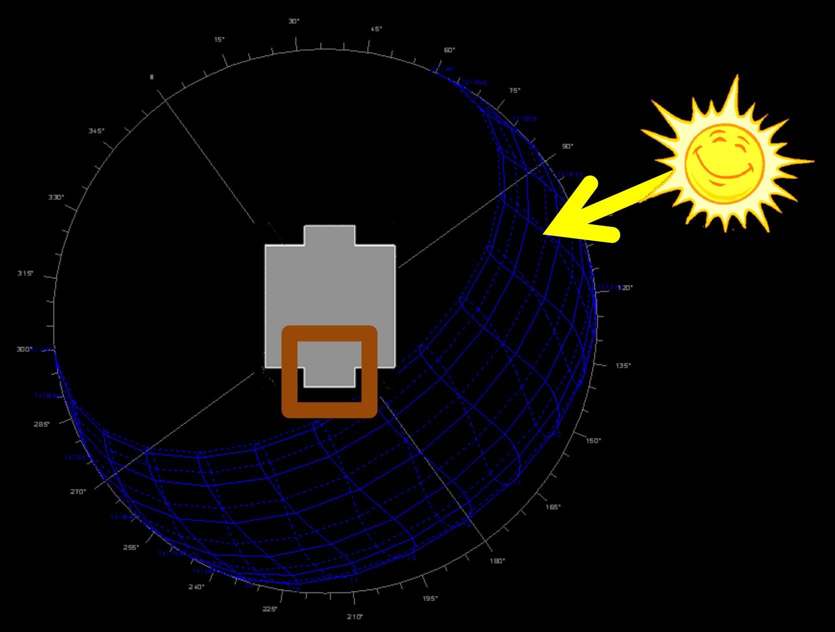
Equinox
7am



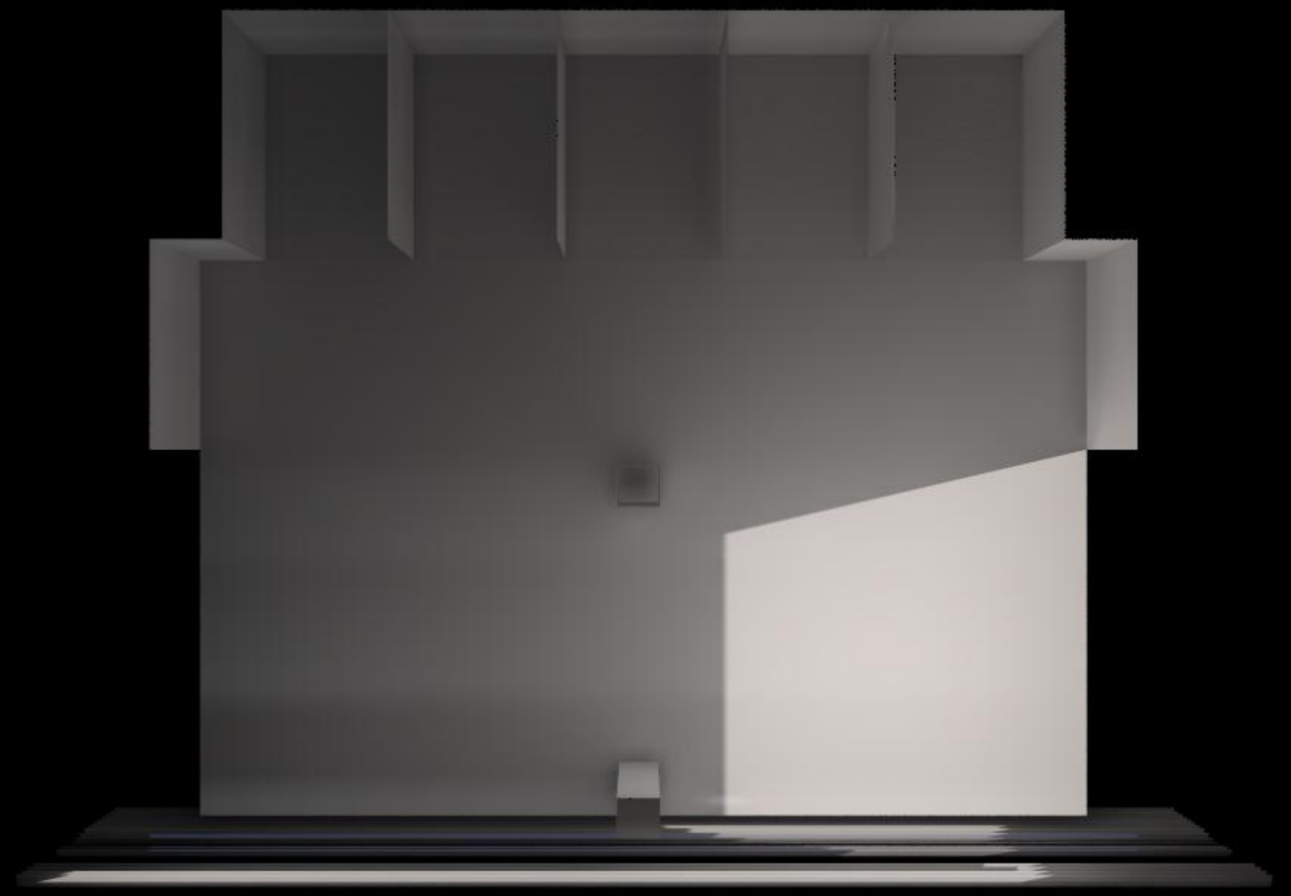
Redesign - Blades

Existing - Rods

Equinox
8am



Redesign - Blades

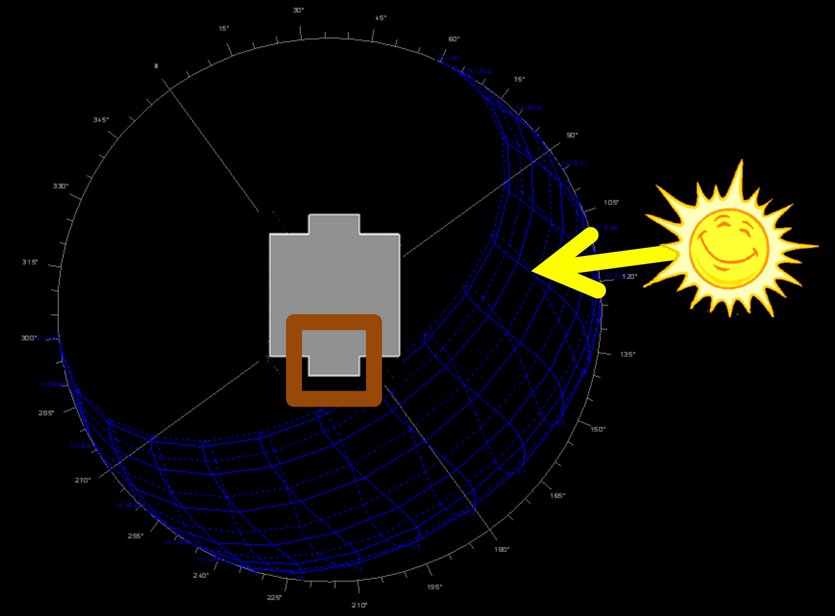


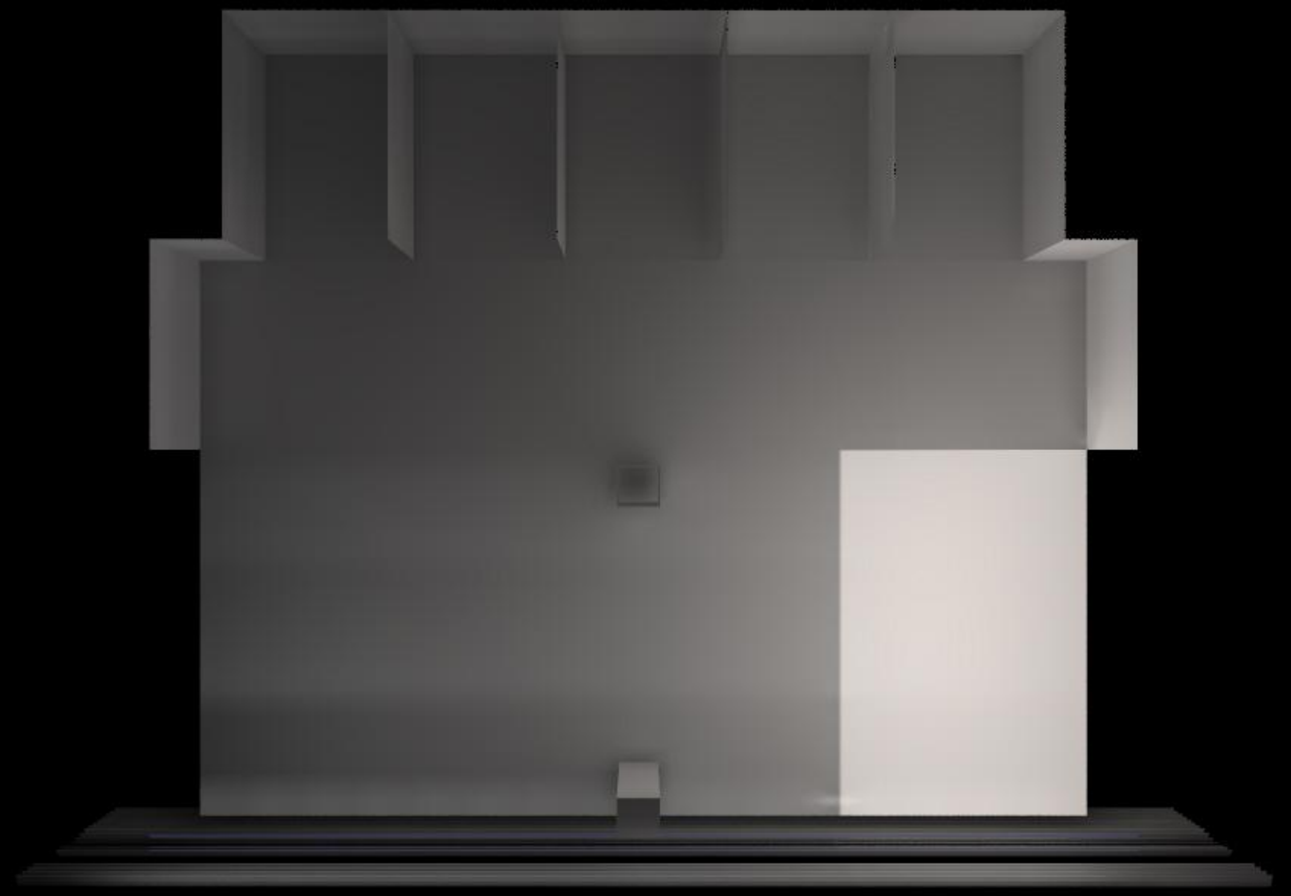
Existing - Rods

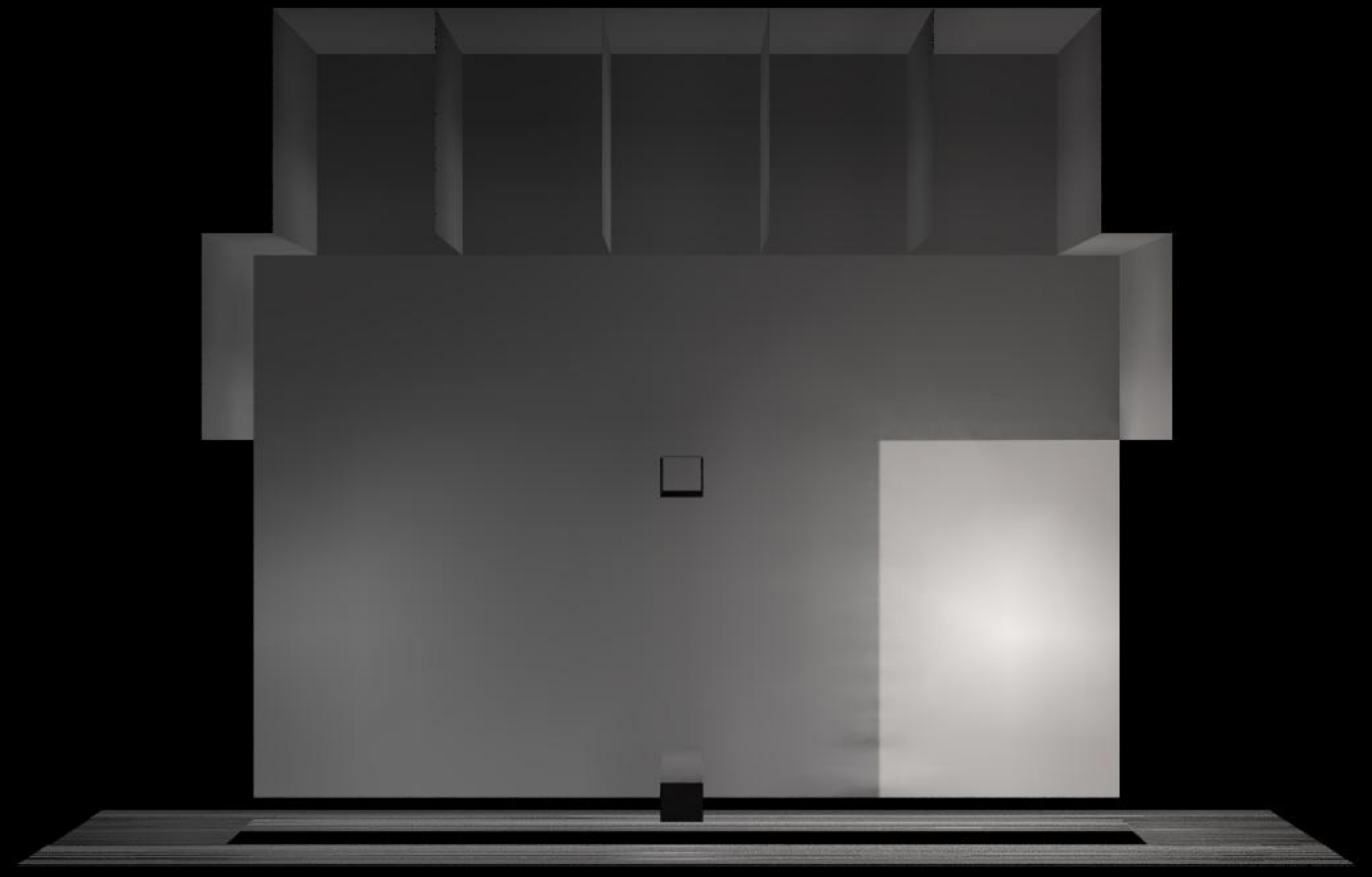
Redesign - Blades

Existing - Rods

Equinox
9am



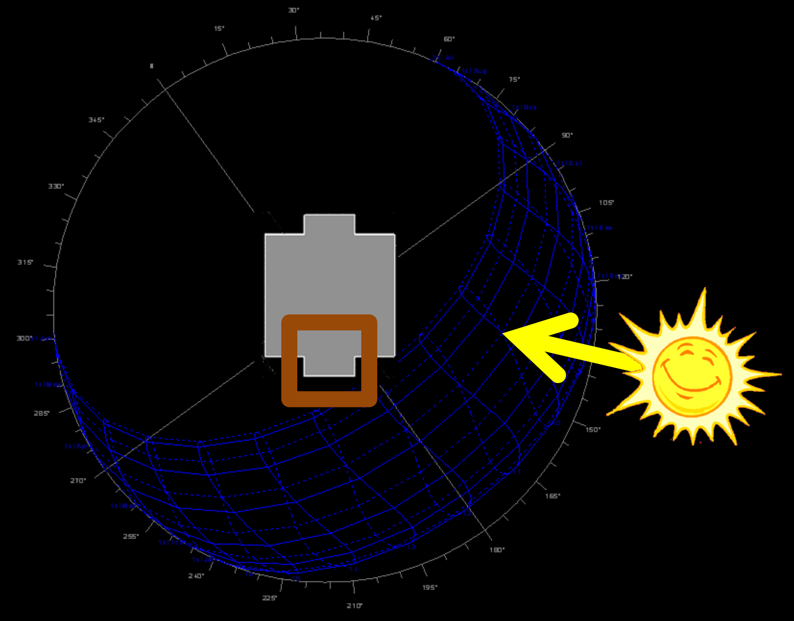


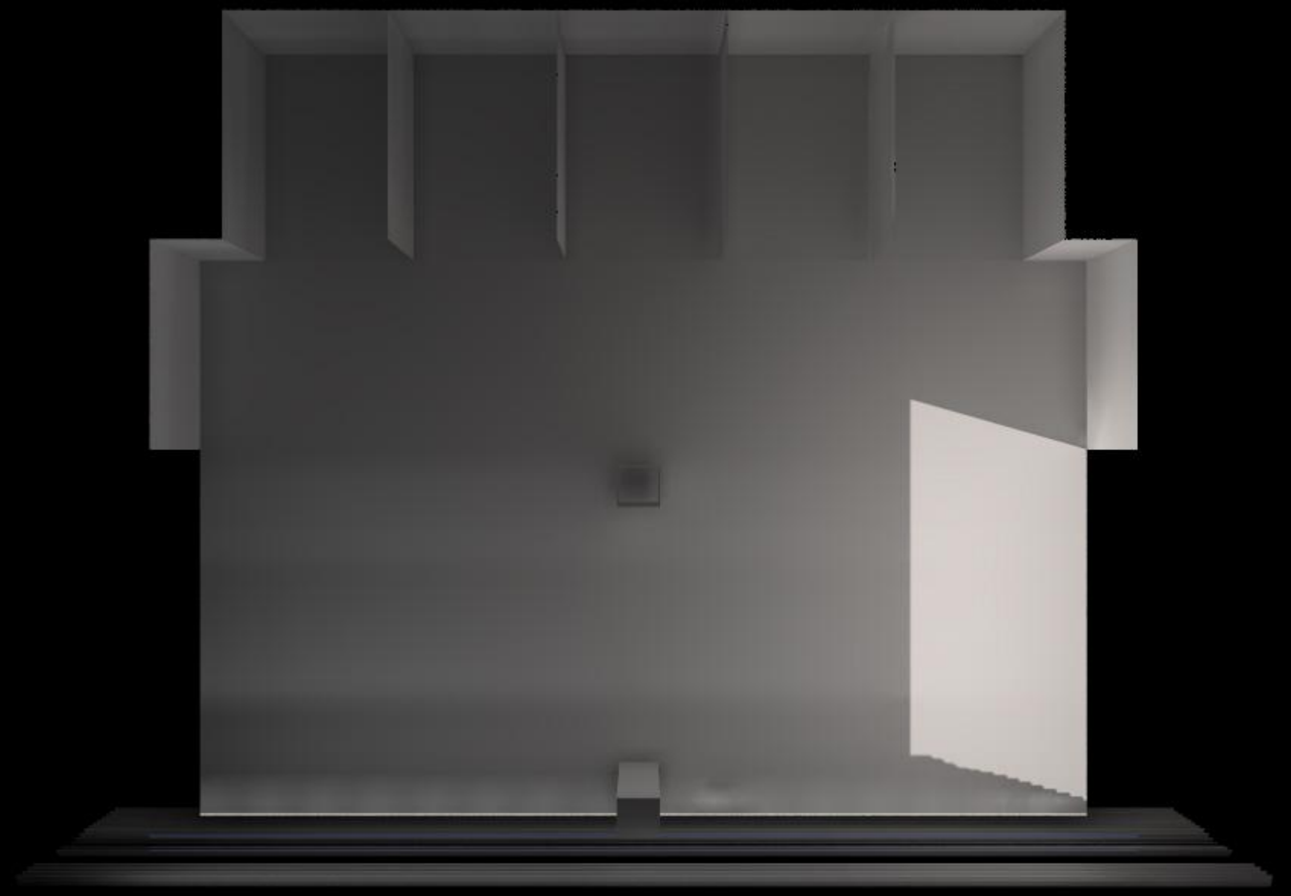


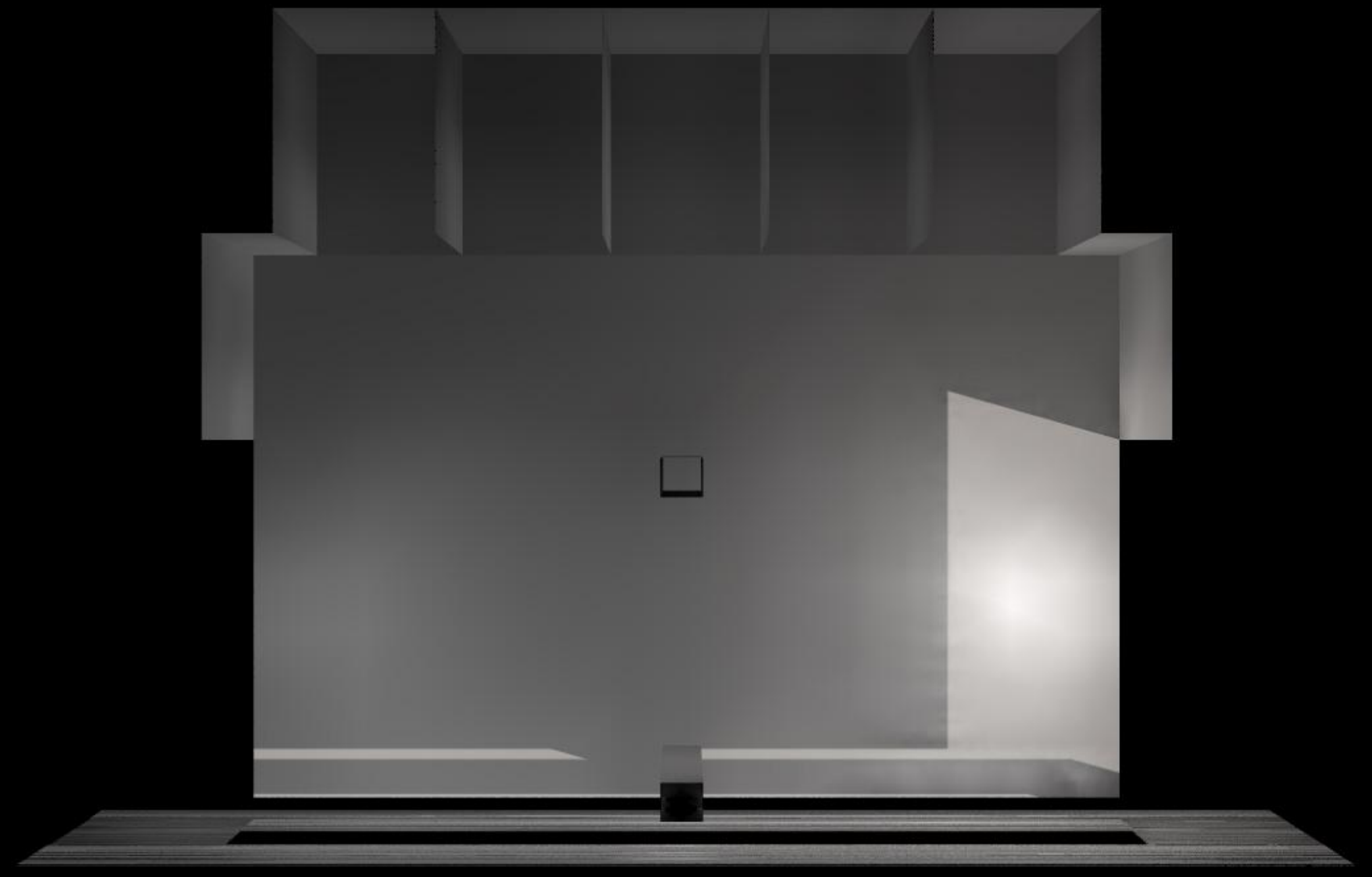
Redesign - Blades

Existing - Rods

Equinox
10am



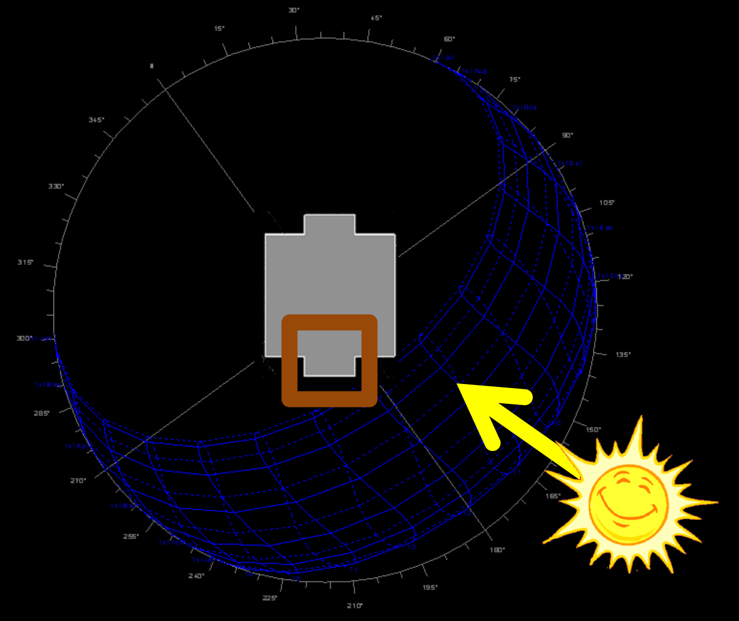


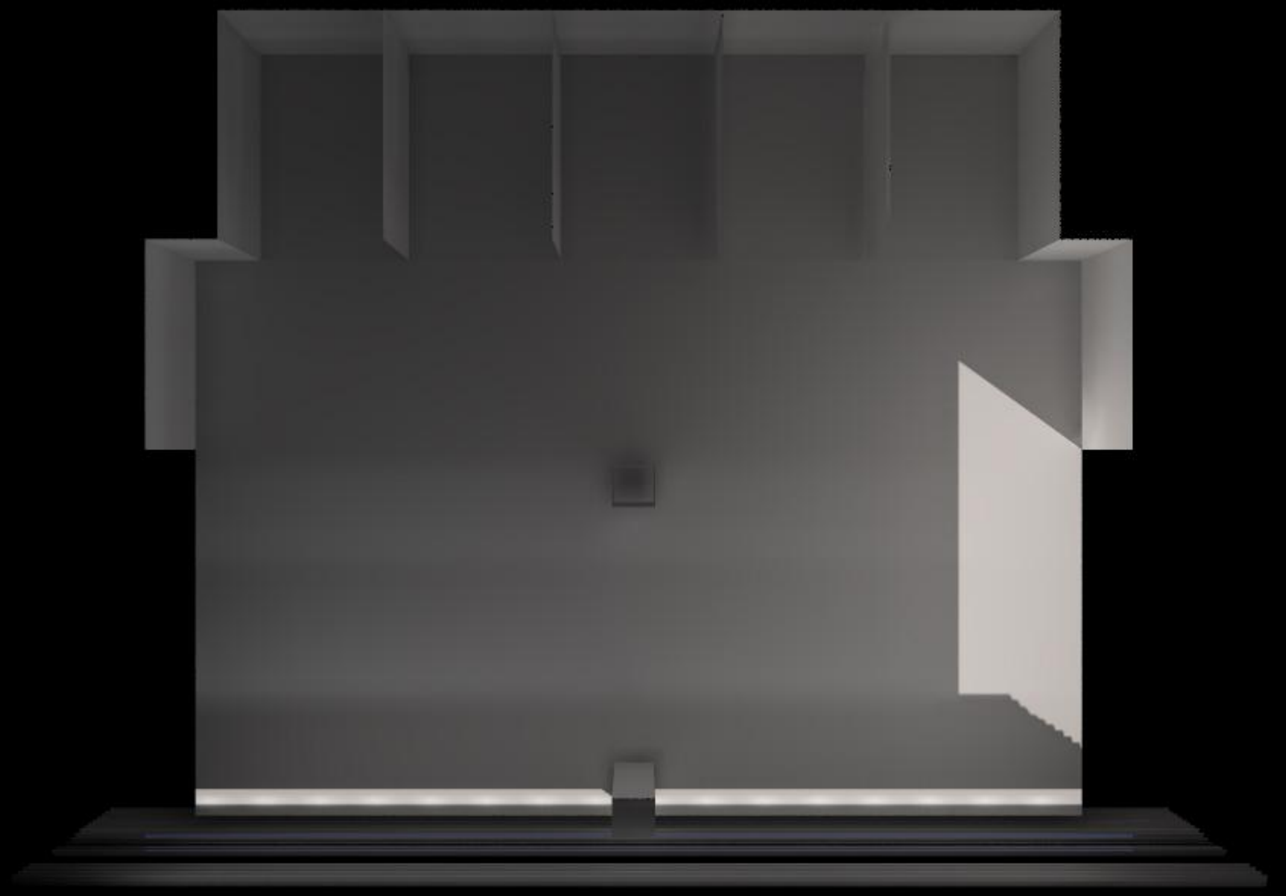


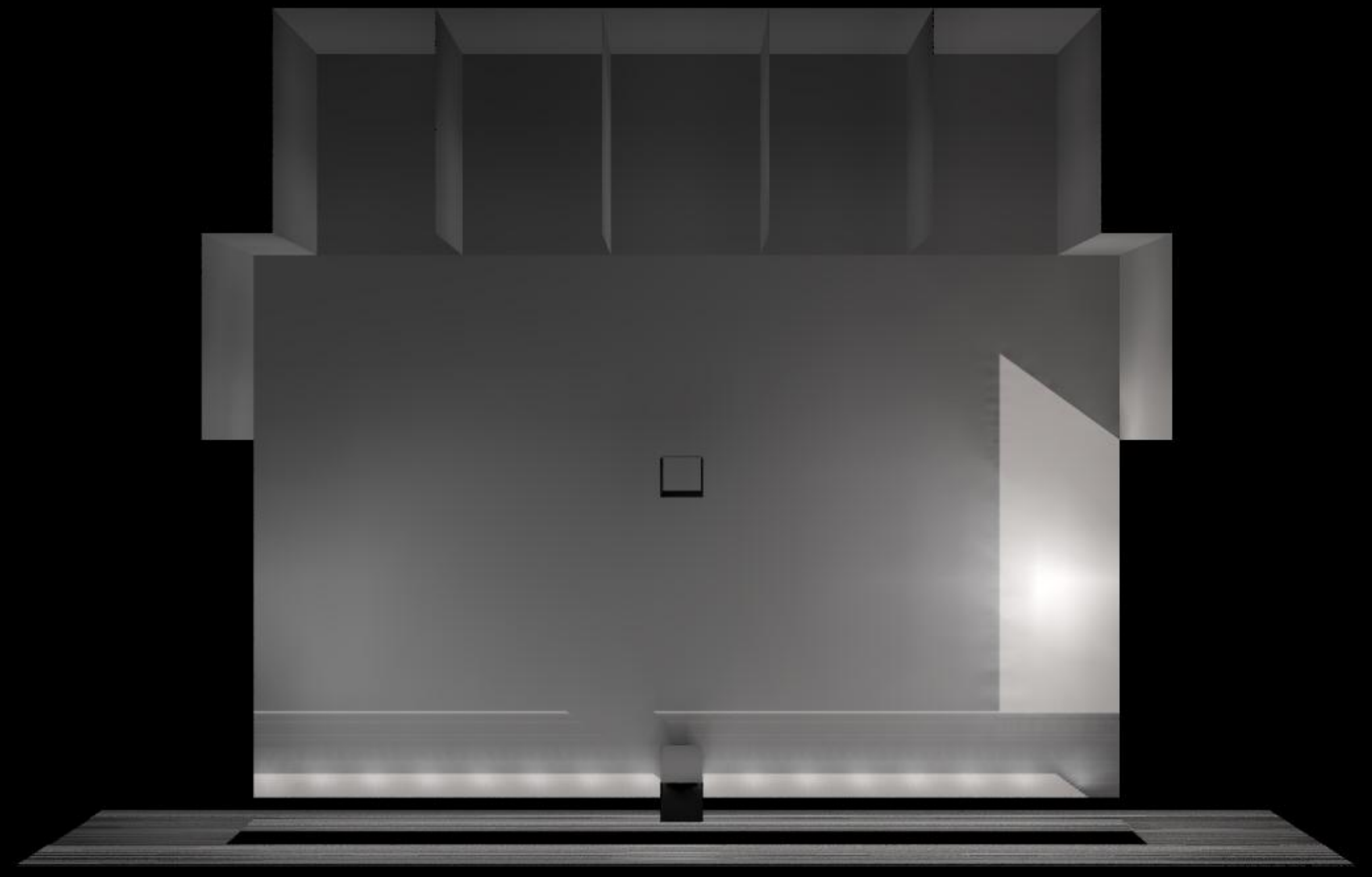
Redesign - Blades

Existing - Rods

Equinox
11am



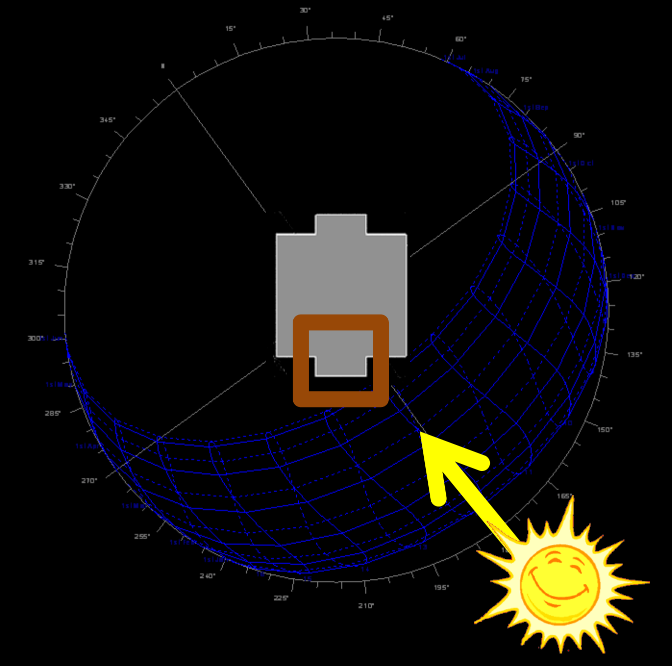


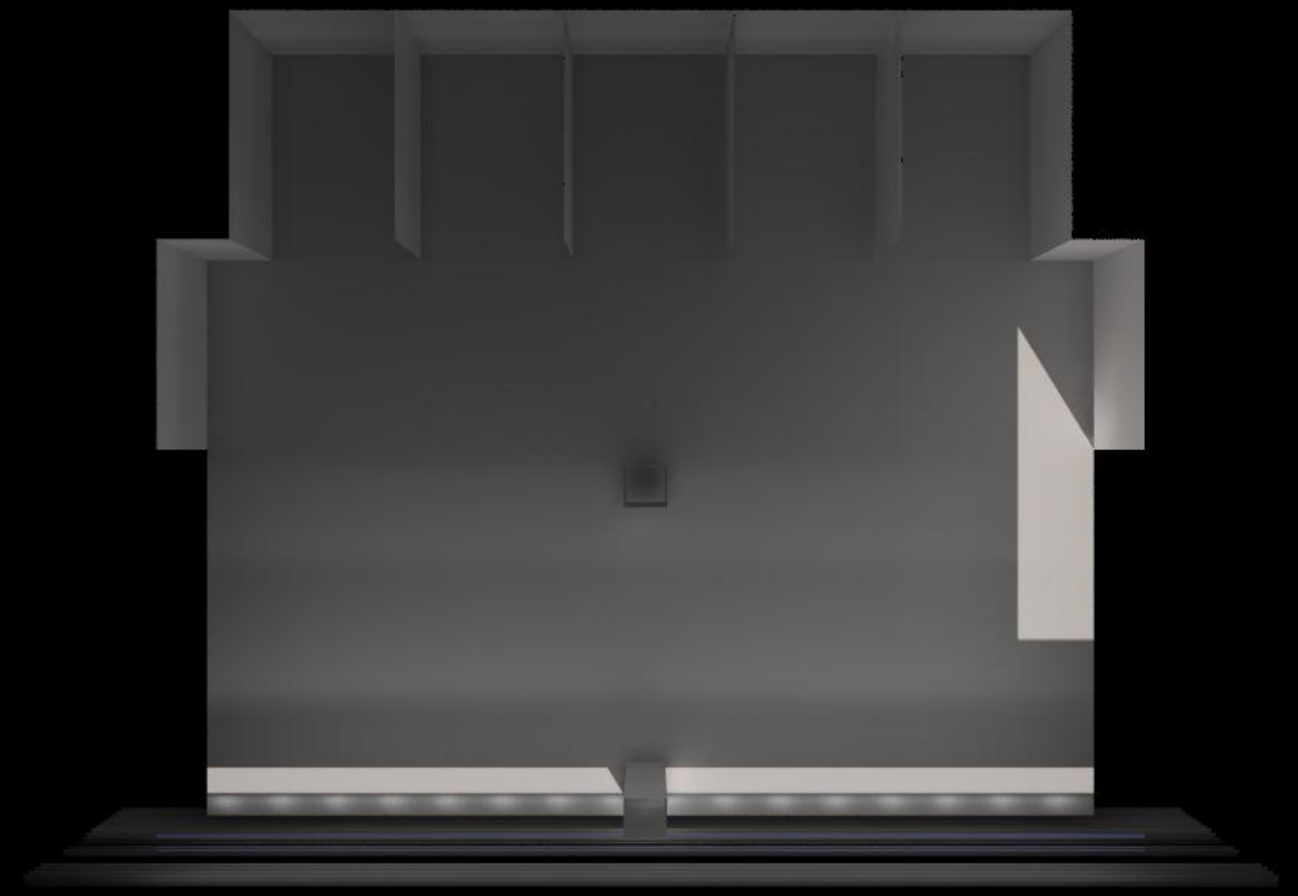


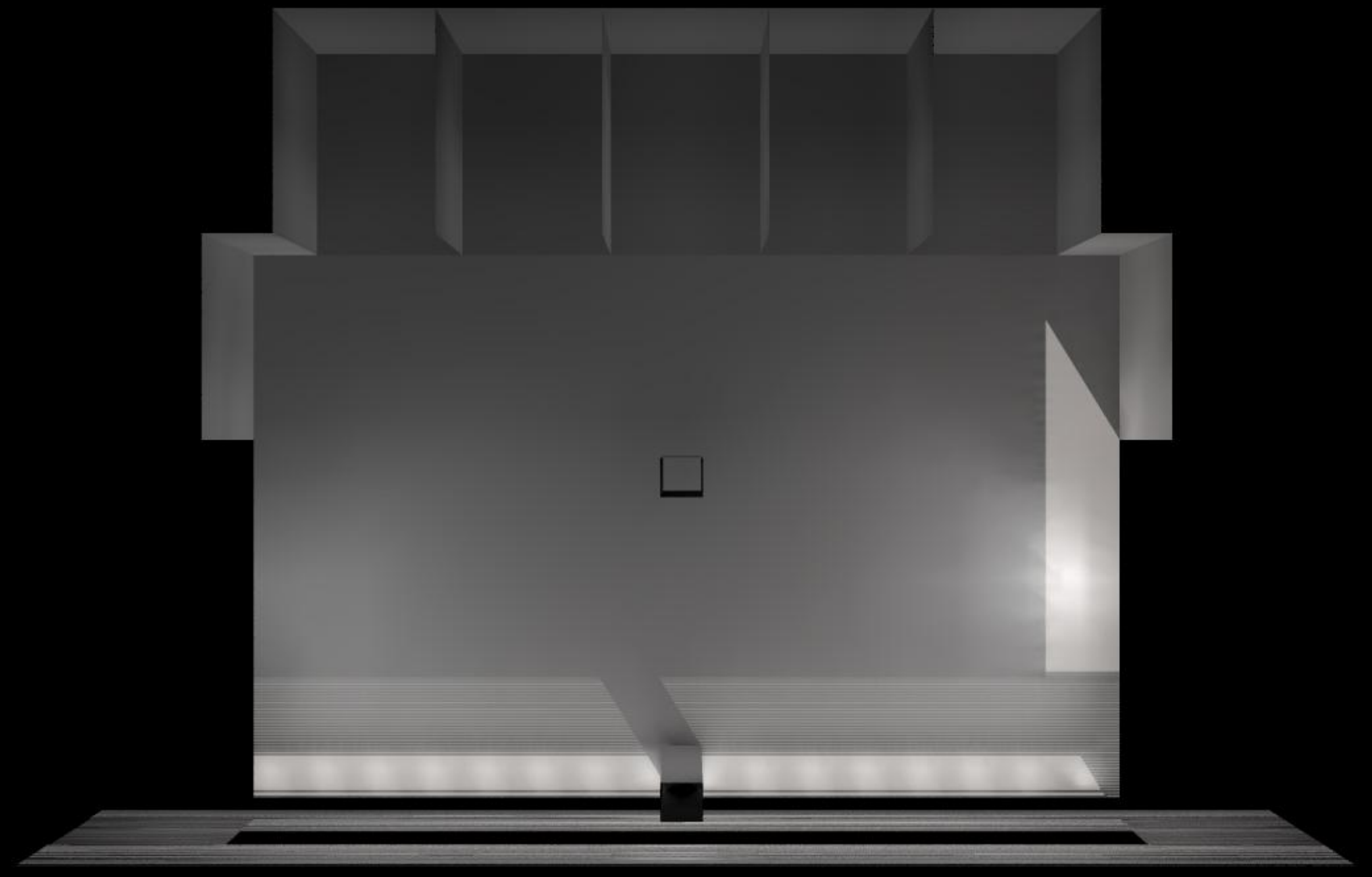
Redesign - Blades

Existing - Rods

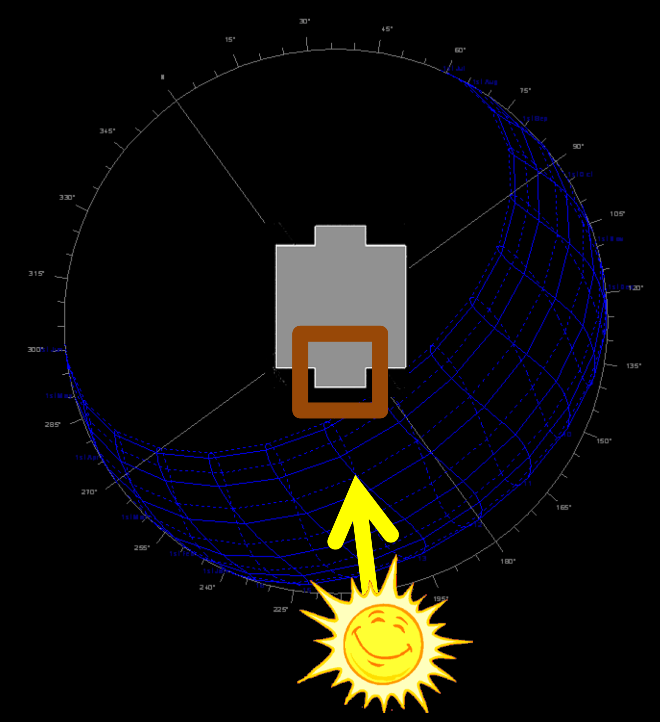
Equinox
12pm



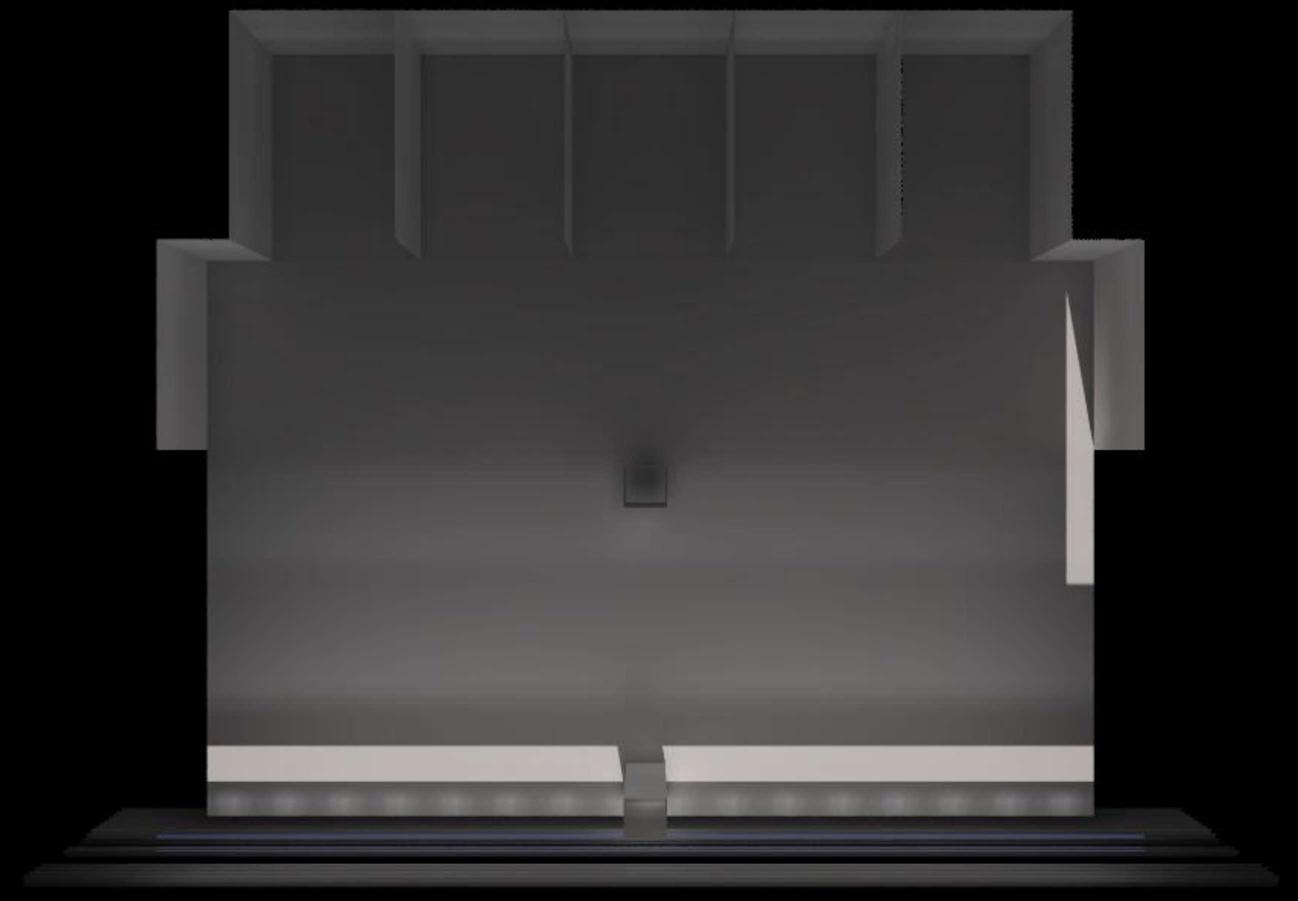




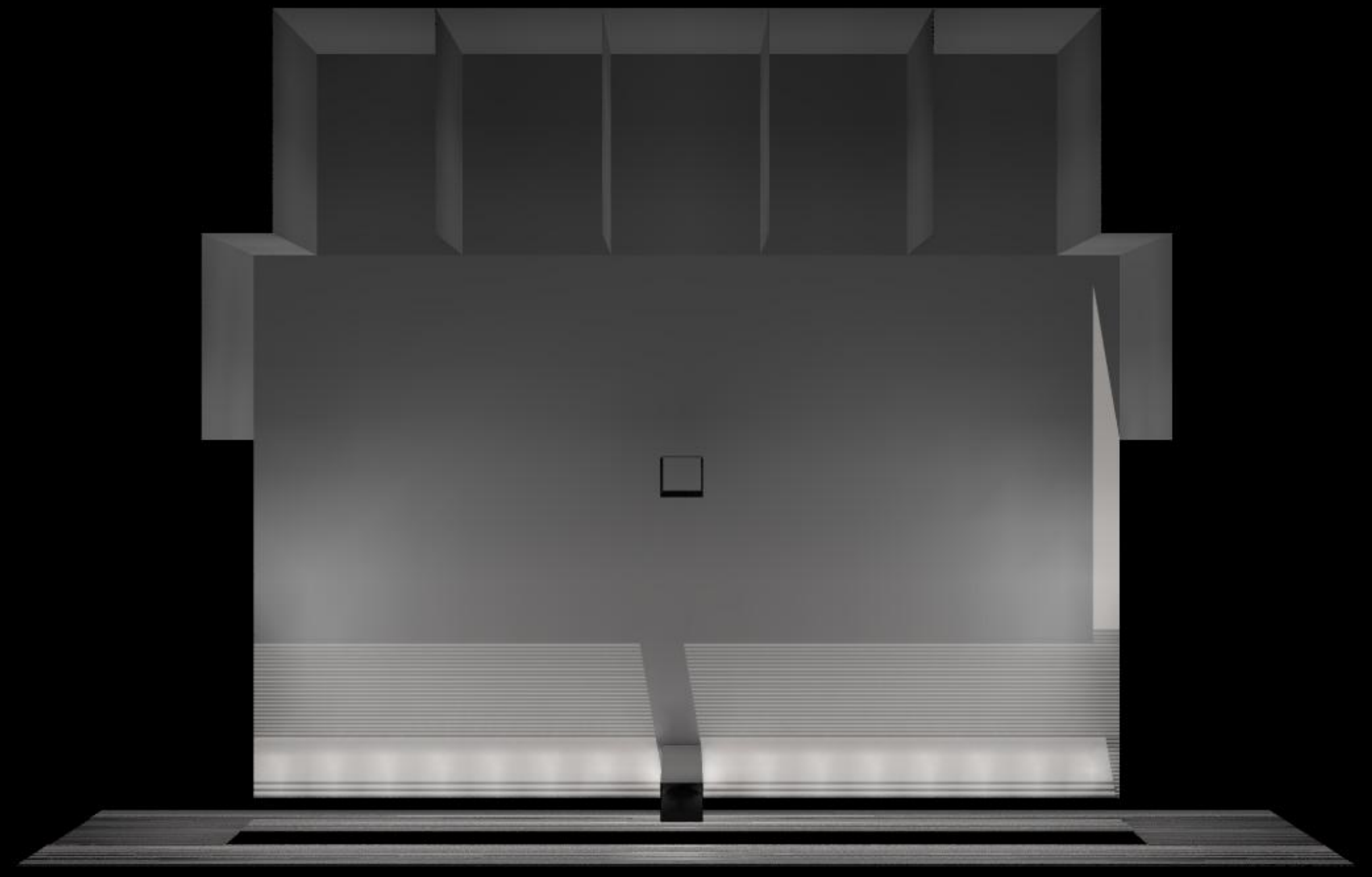
Equinox
1pm



Redesign - Blades



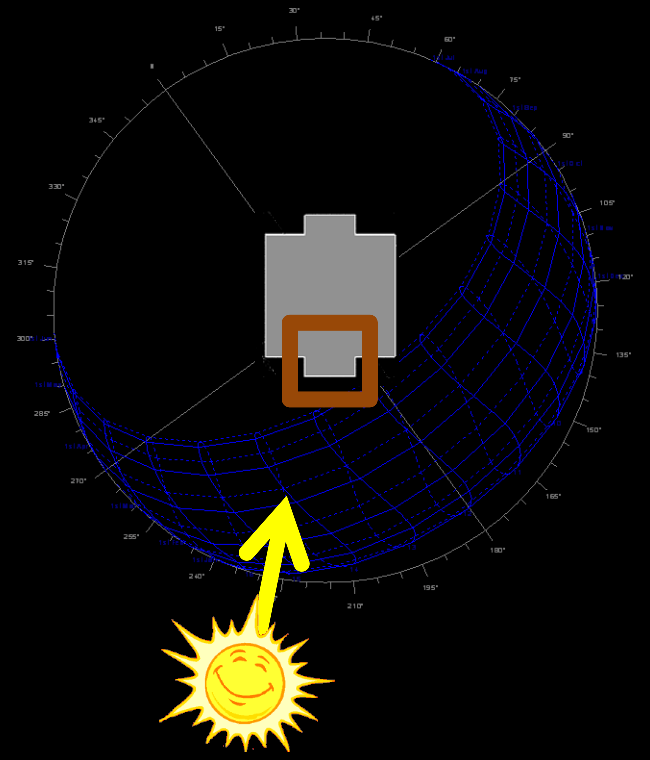
Existing - Rods

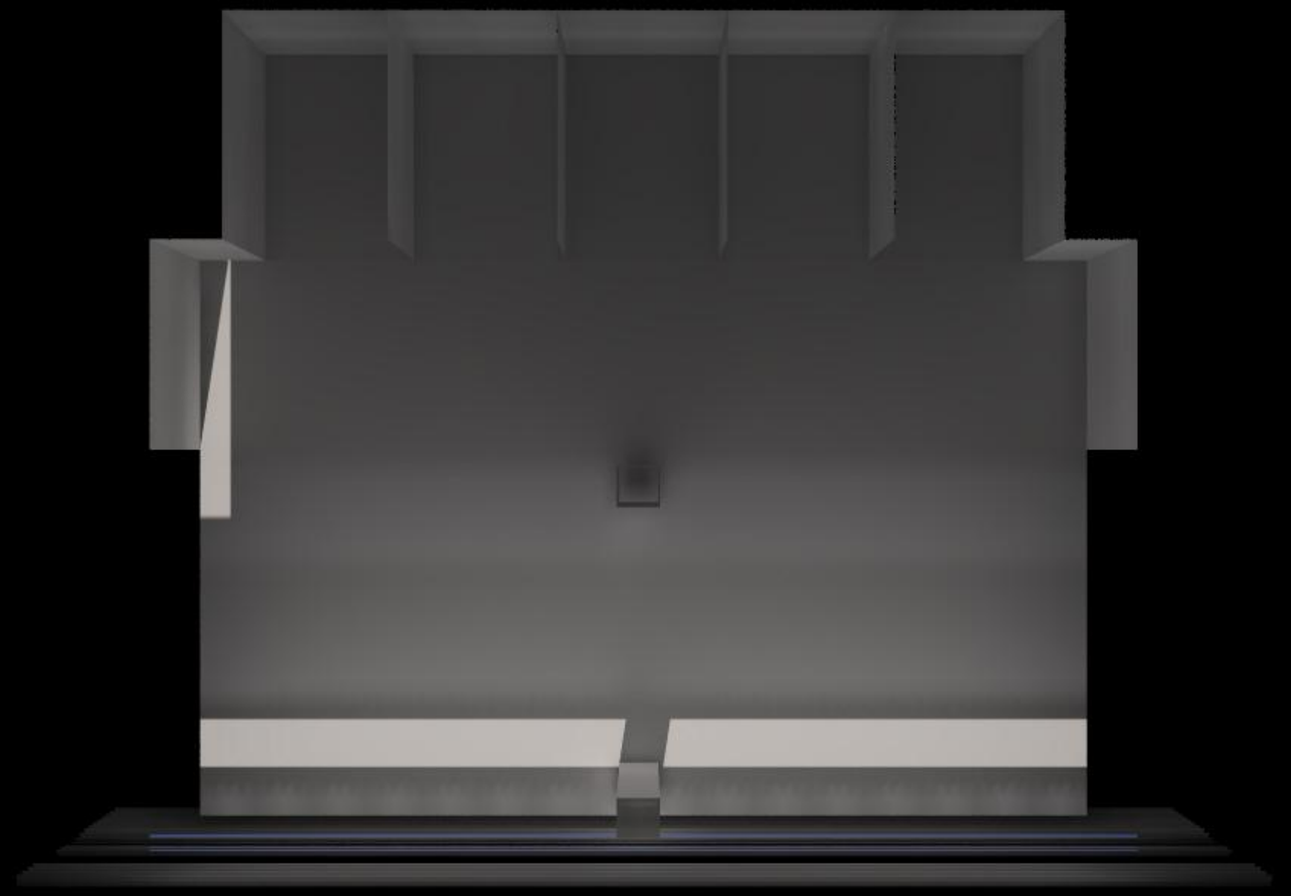


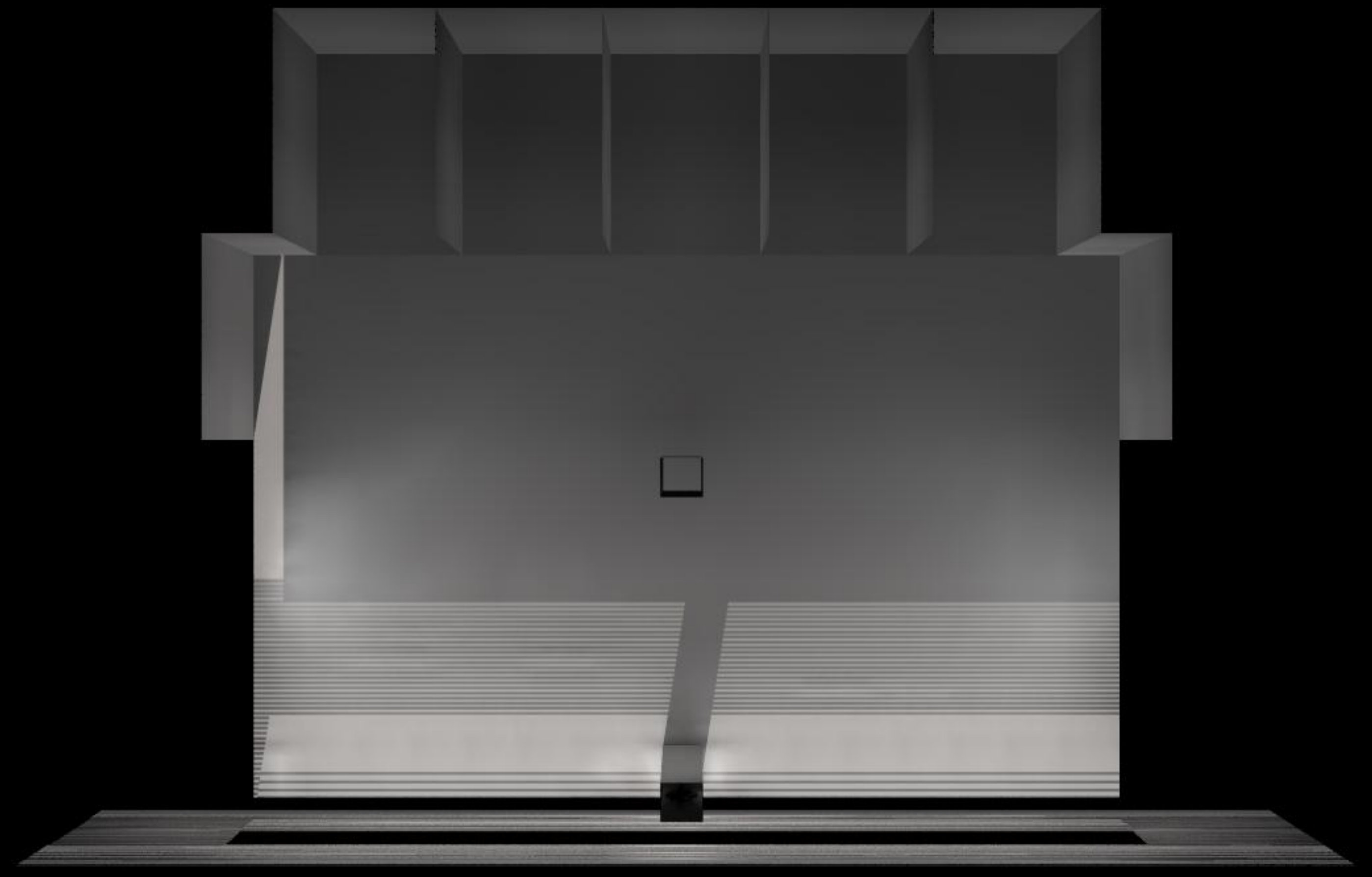
Redesign - Blades

Existing - Rods

Equinox
3pm



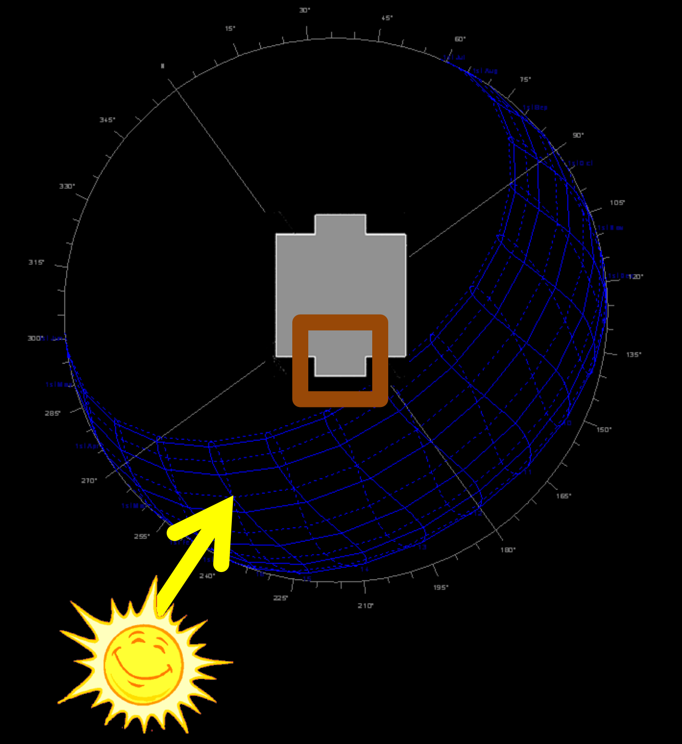


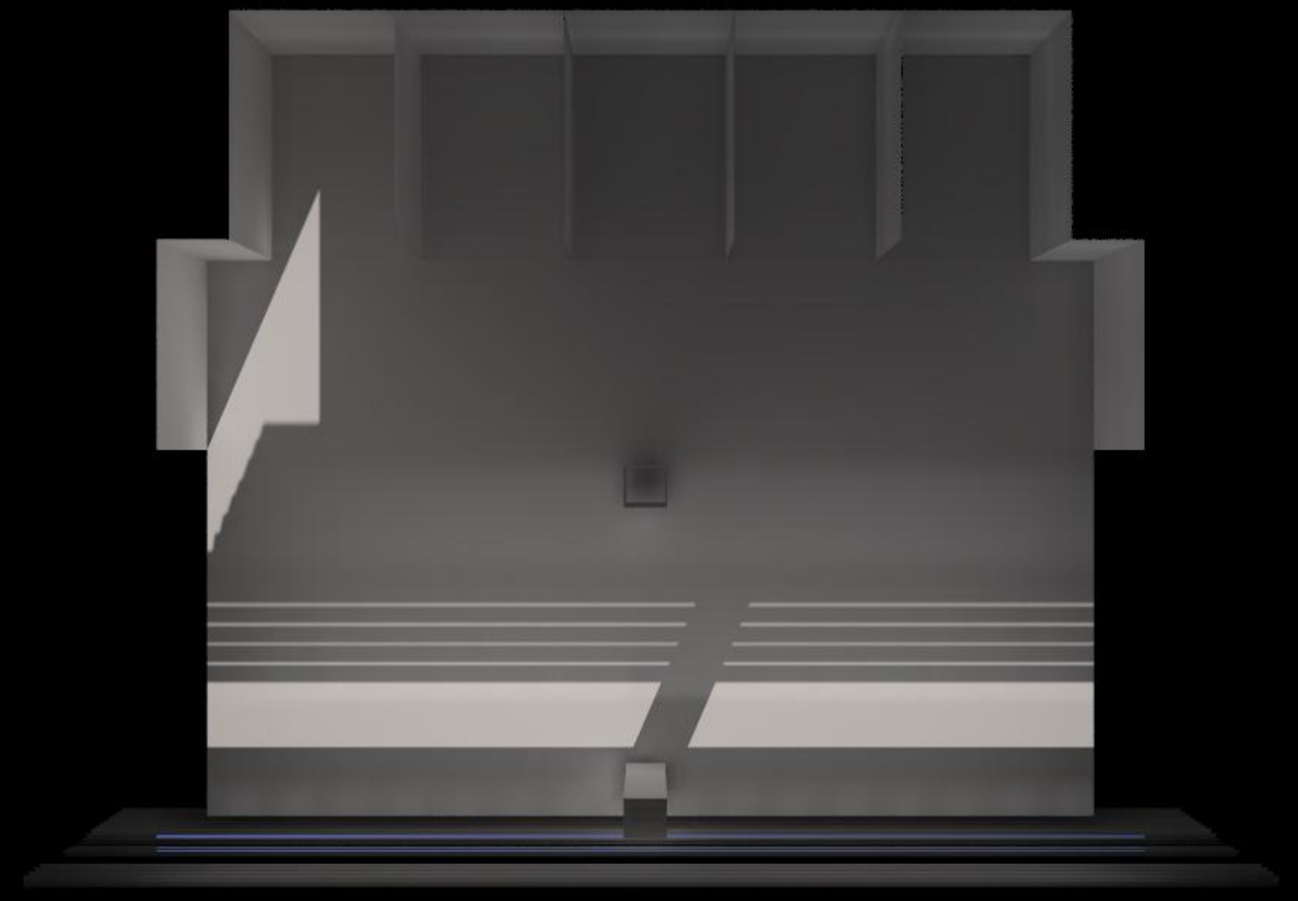


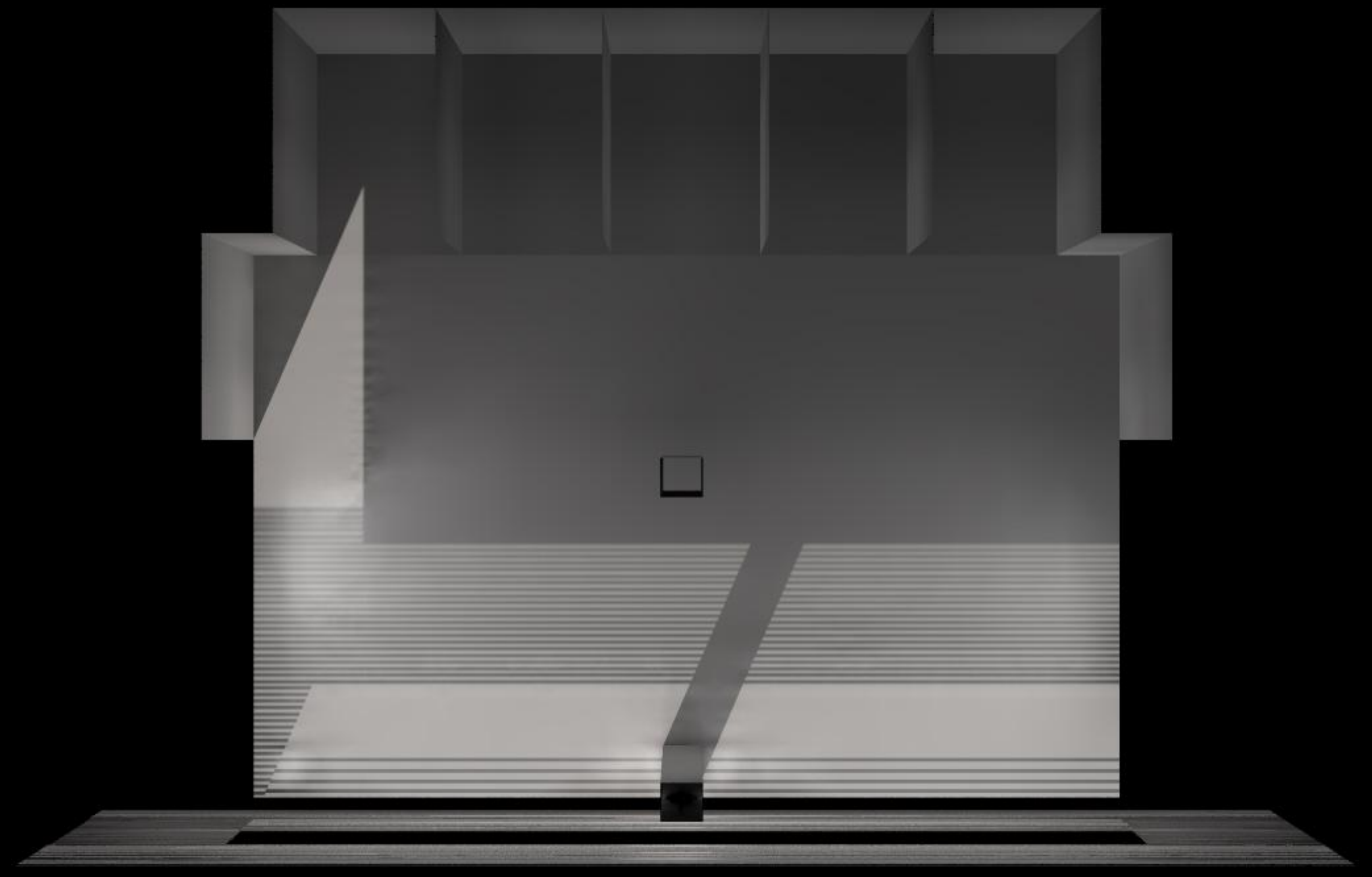
Redesign - Blades

Existing - Rods

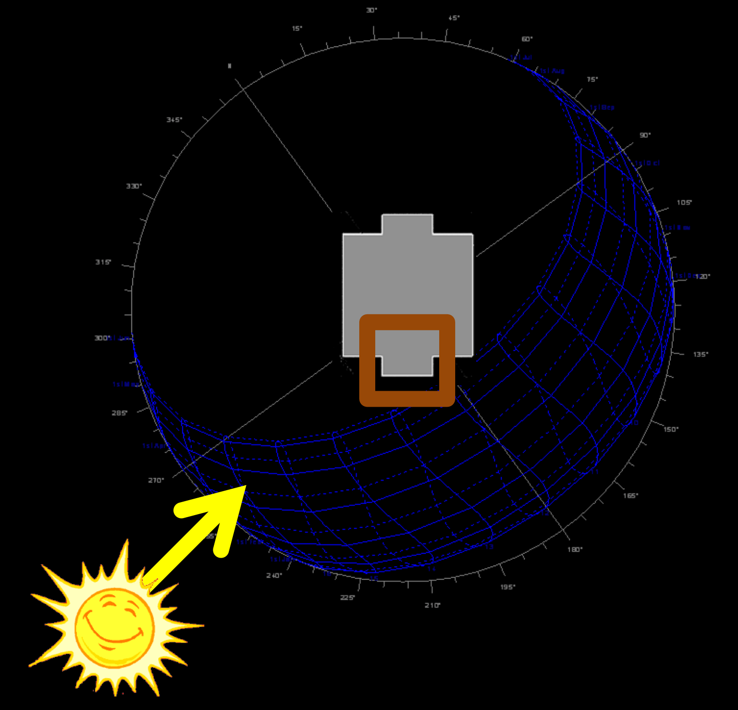
Equinox
4pm



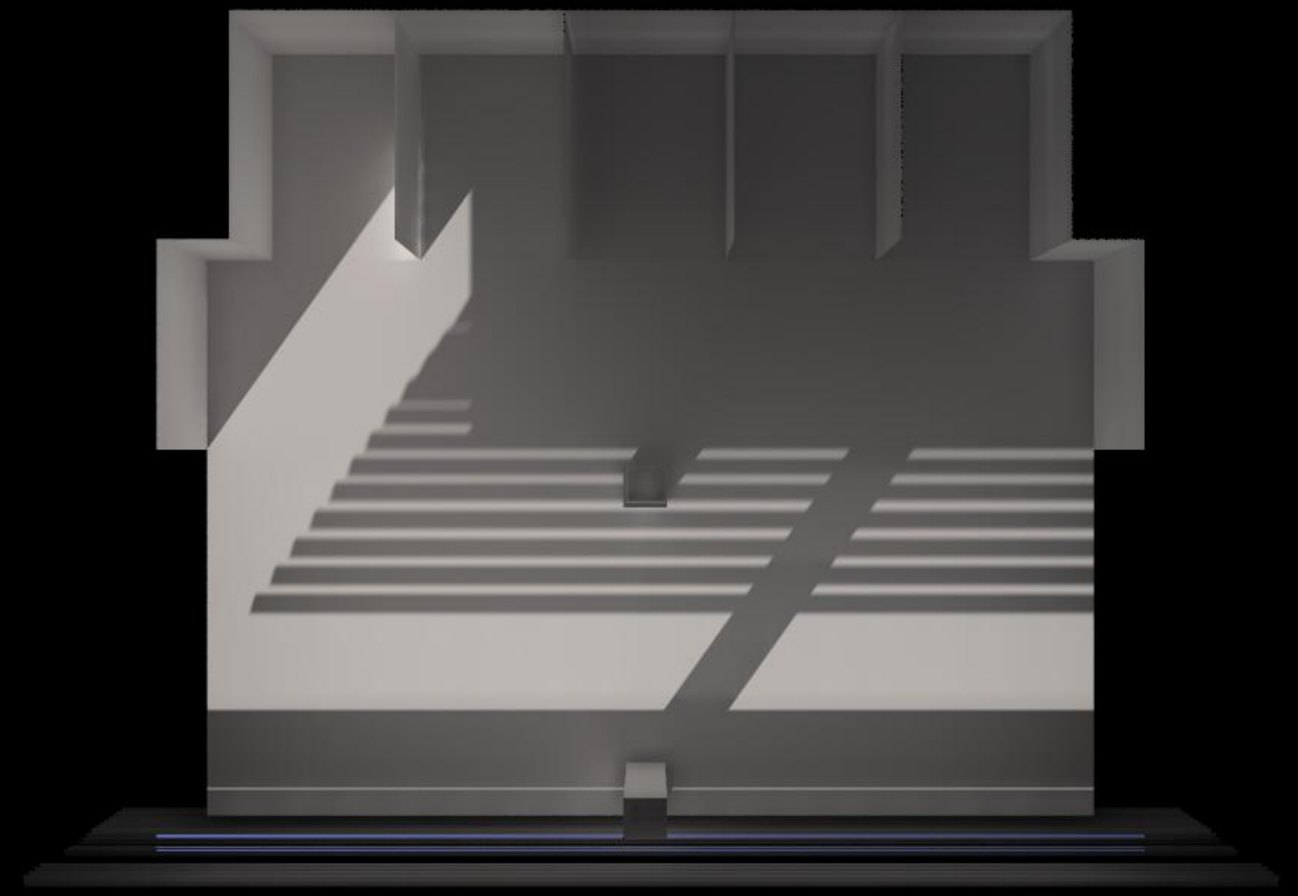




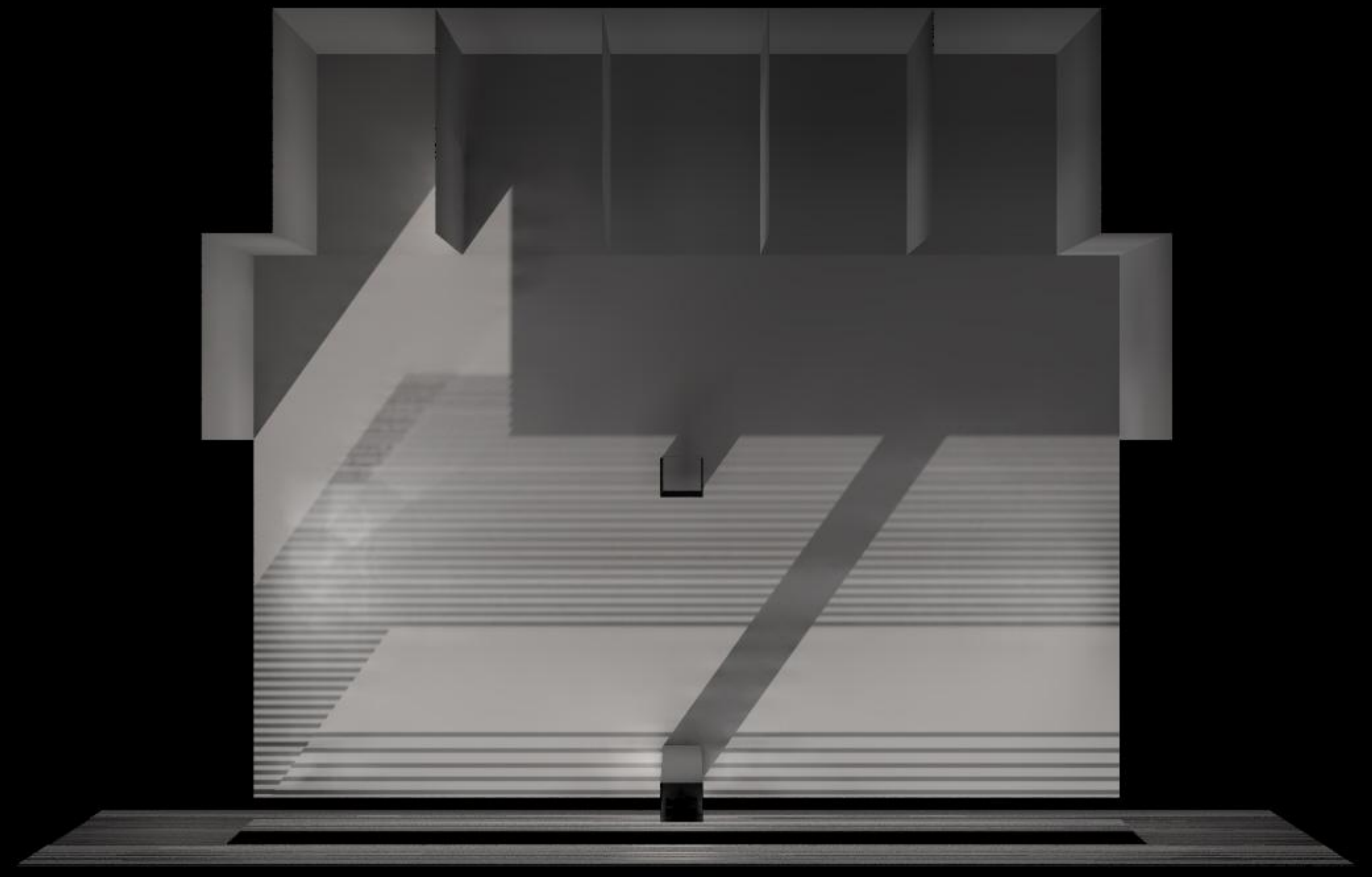
Equinox
5pm



Redesign - Blades



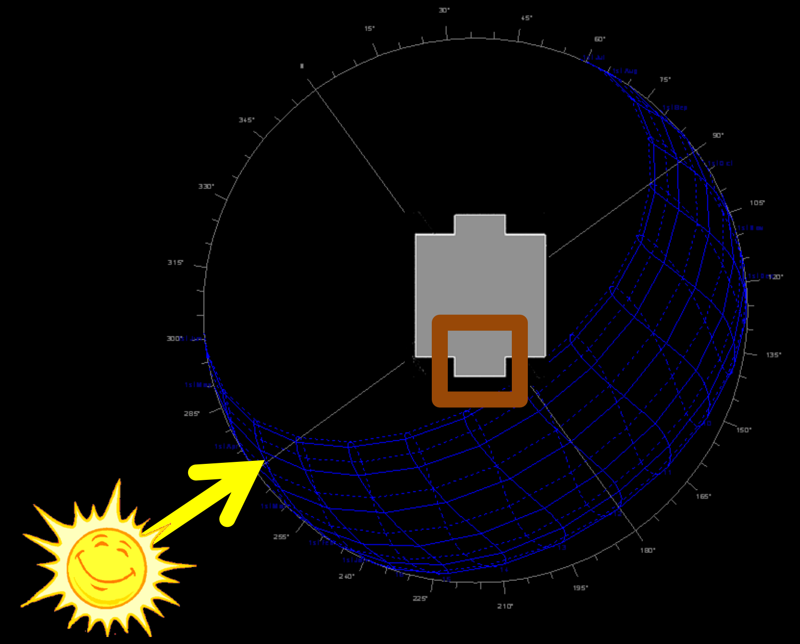
Existing - Rods

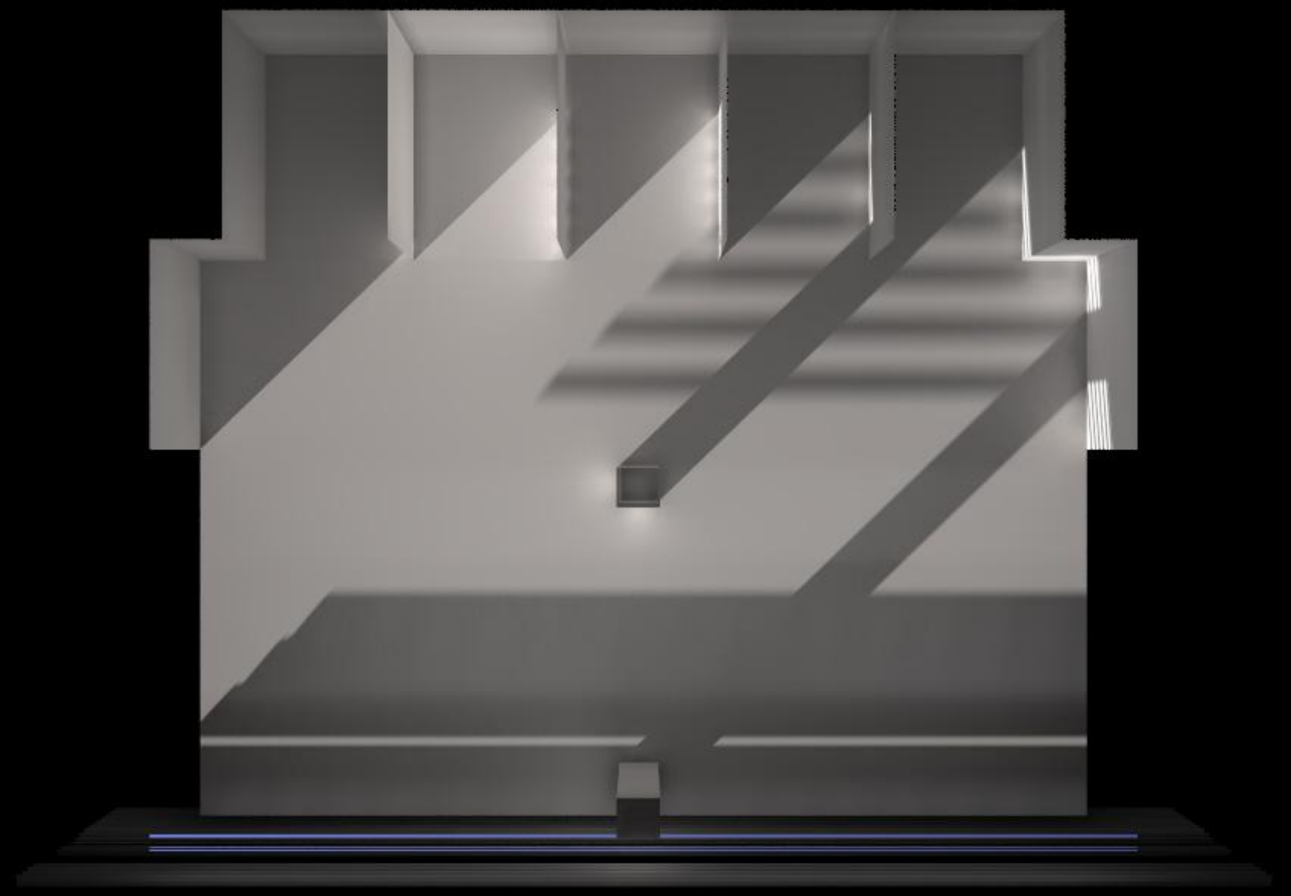


Redesign - Blades

Existing - Rods

Equinox
6pm





Building Overview

Team Workflow

Phase I : Façade

Typical Floor

Daylighting Analysis

Energy Analysis

Assembly and Cost

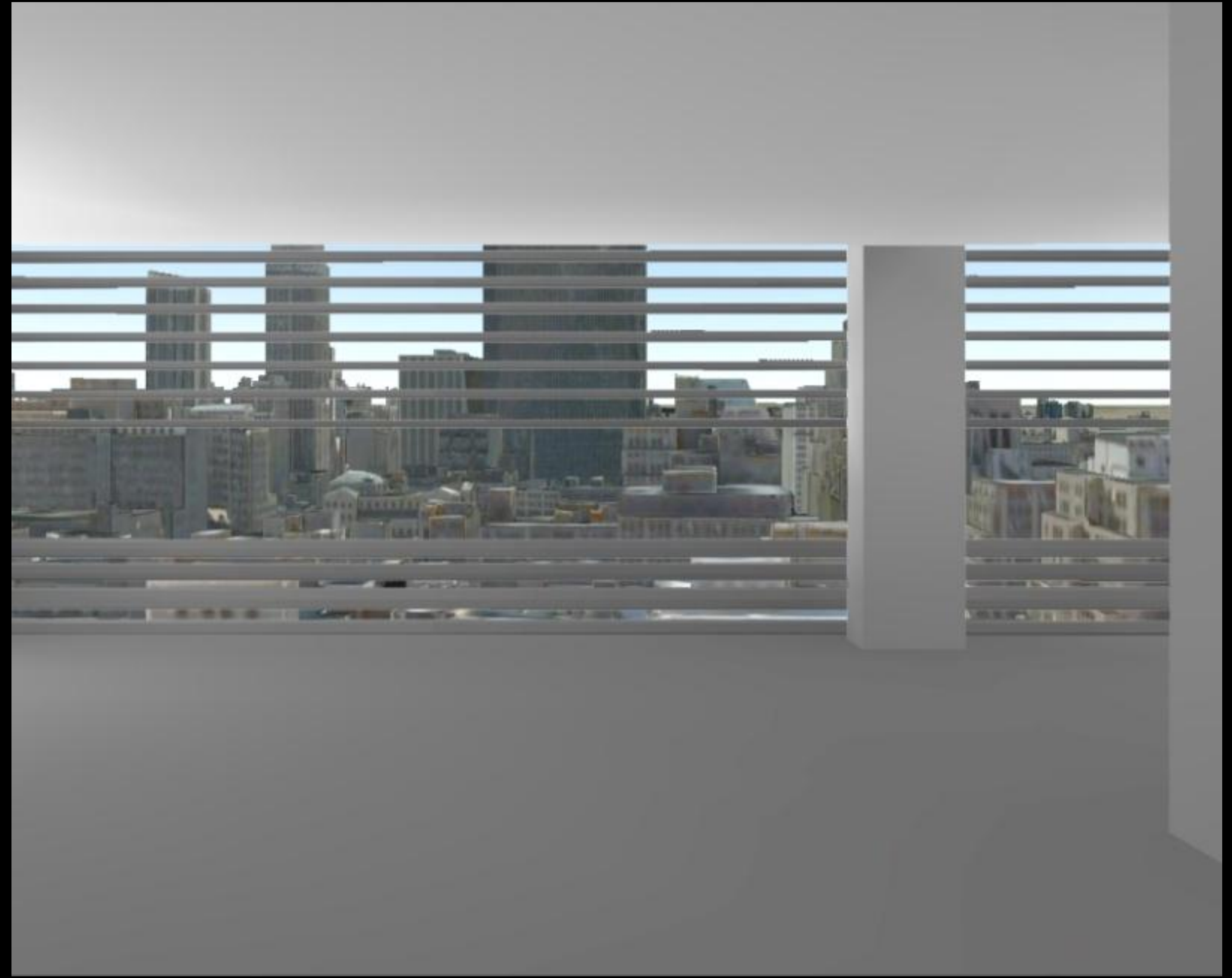
Phase II: Cogeneration

Phase III: Lateral System

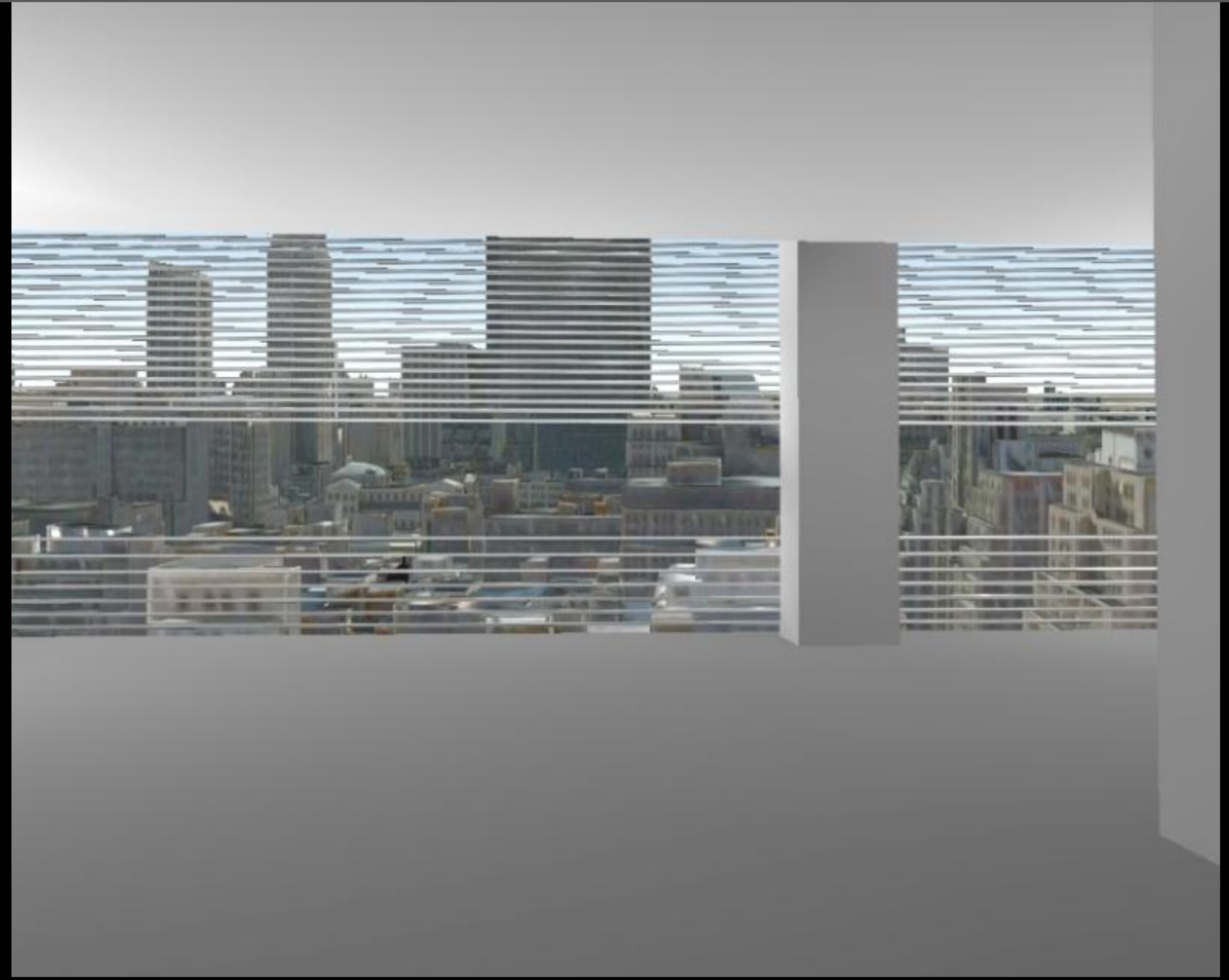
Phase IV: Distribution Systems and Coordination

Results and Conclusions

Redesign - Blades



Existing - Rods



Building Overview

Team Workflow

Phase I : Façade

Typical Floor

Daylighting Analysis

Energy Analysis

Assembly and Cost

Phase II: Cogeneration

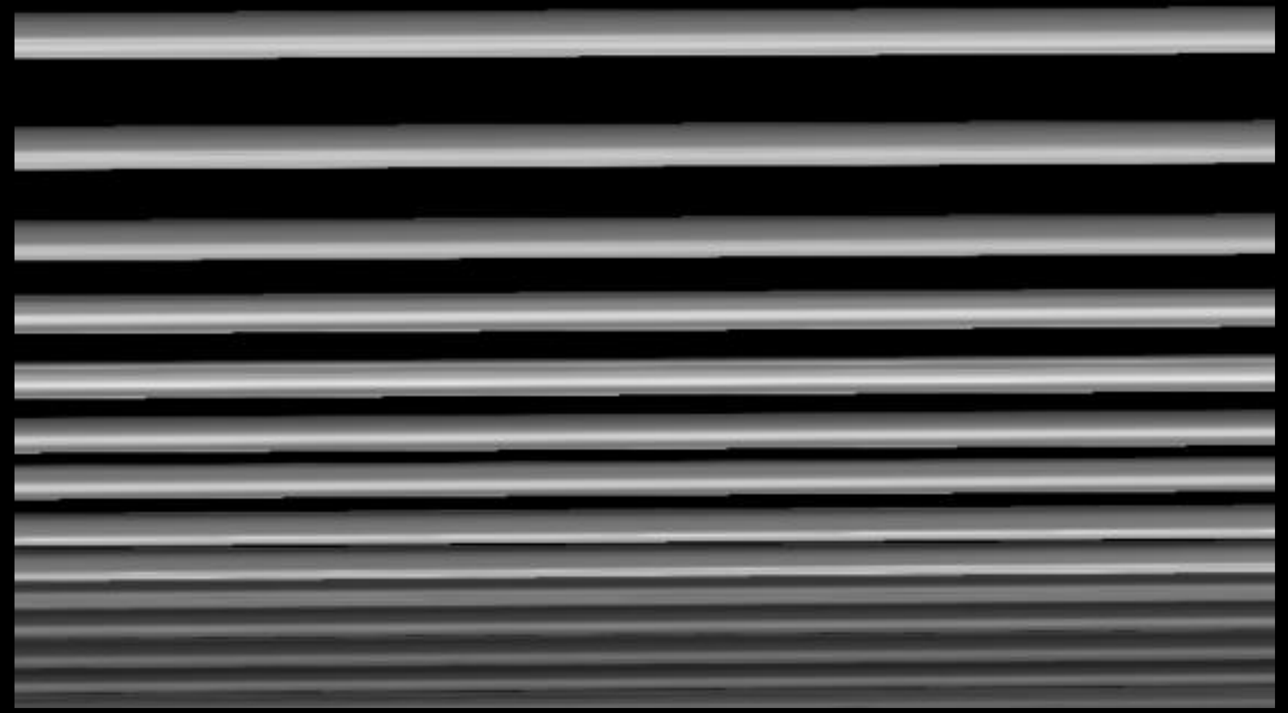
Phase III: Lateral System

Phase IV: Distribution Systems and Coordination

Results and Conclusions

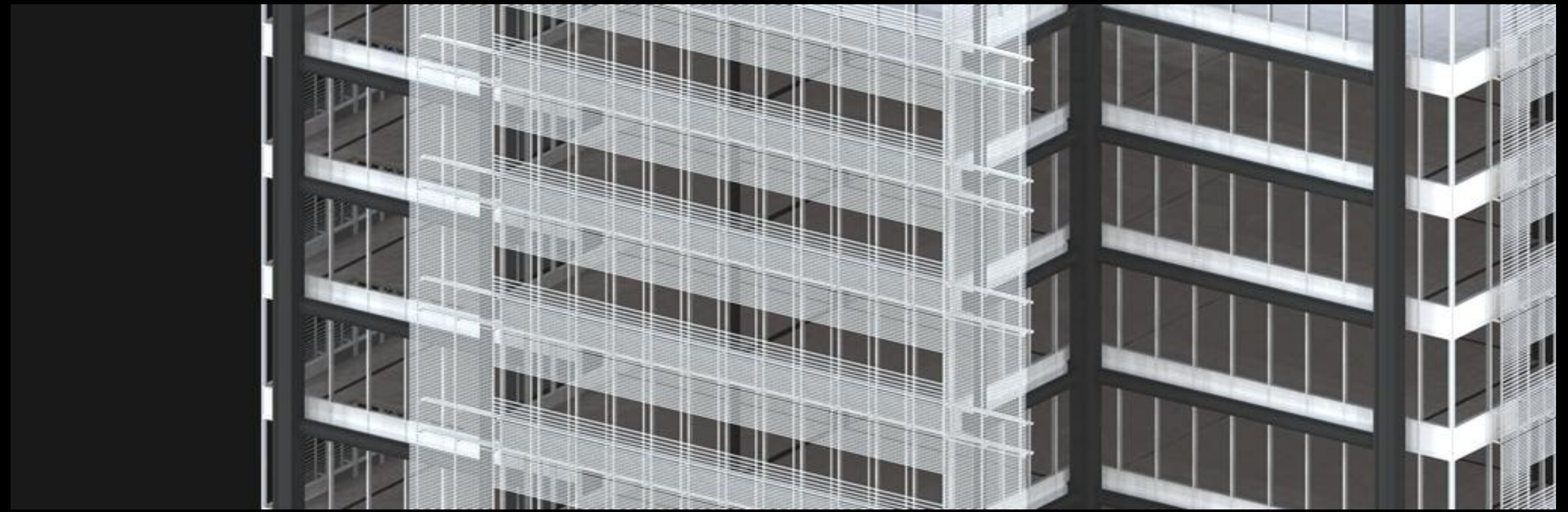
Redesign - Blades

Existing - Rods



Redesign - Blades

Existing - Rods

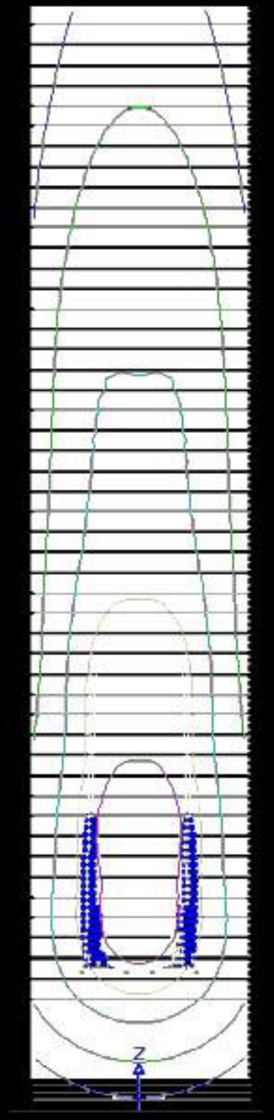


Sun View

Redesign - Blades

Existing - Rods

Pedestrian View



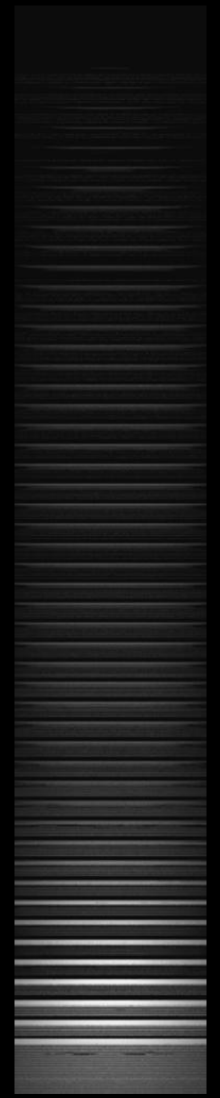
.1fc

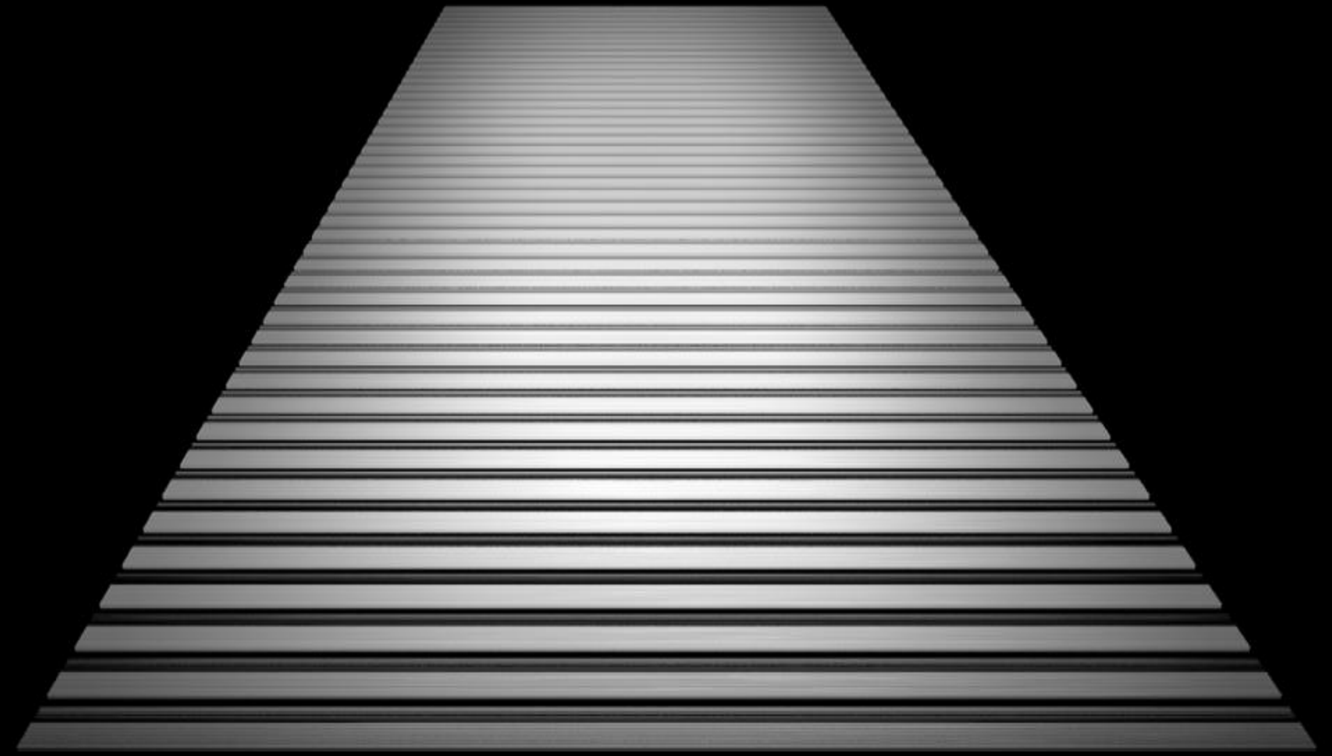
.5fc

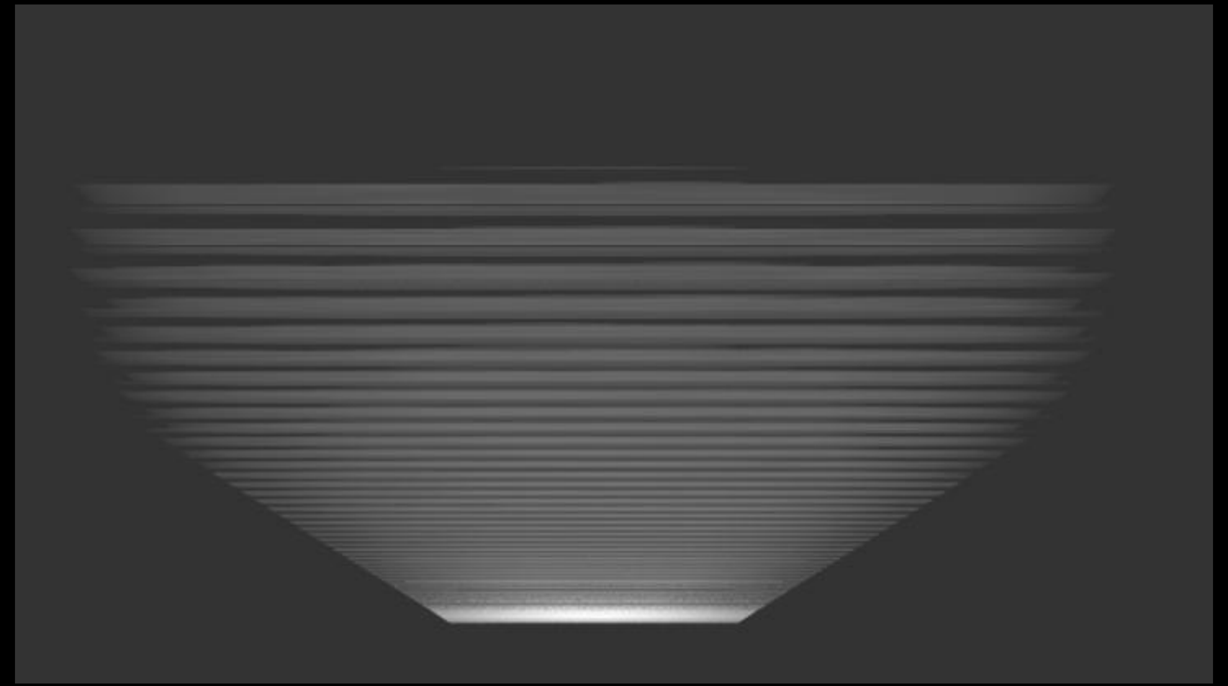
1fc

2.5fc

5fc







Glazing Properties

Redesigned Glazing

Manufacturer: Oldcastle Glass

Double-paned insulated glazing unit

Visual light transmittance: 74%

Overall U-value: 0.280 [Btu/ft^{2-} F]

Shading coefficient: 0.73

Existing Glazing

Manufacturer: Saint-Gobain Glass

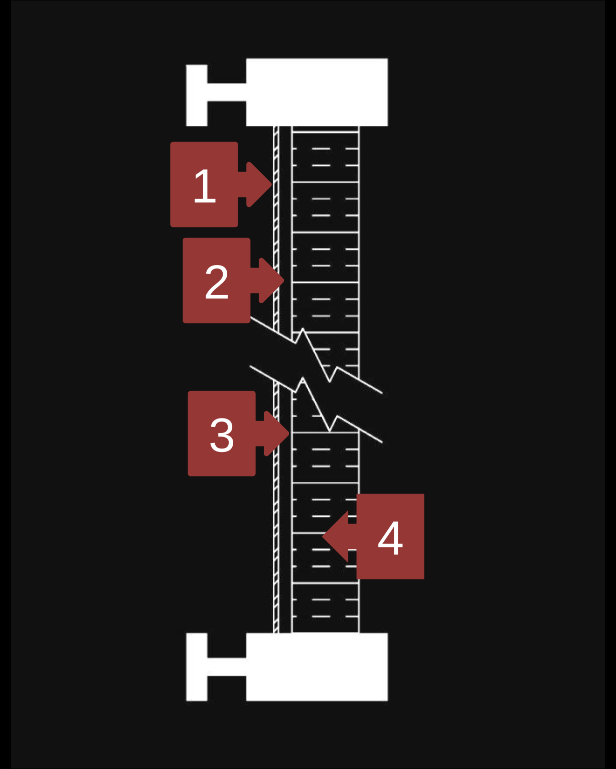
Double-paned insulated glazing unit

Visual light transmittance: 96%

Overall U-value: 0.625 [Btu/ft2- F]

Shading coefficient: 0.46

Spandrel Properties



Existing Spandrel

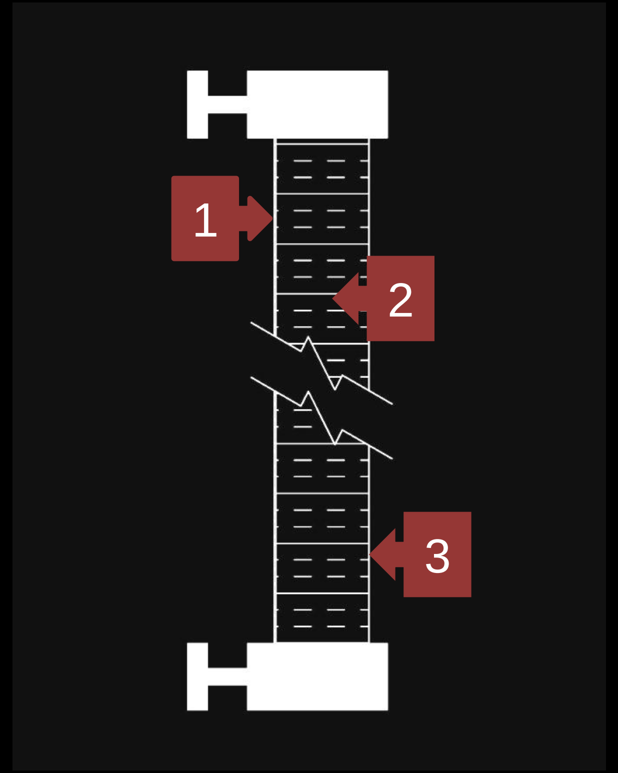
Cavity wall system

Overall U-value: 0.087 [Btu/ft2- F]

Condensation: 37 [grains H_2O/ft^2-day]

1. 3/16" aluminum panel
2. 1/2" air space
3. Vapor barrier
4. 2-1/2" rigid insulation

Spandrel Properties



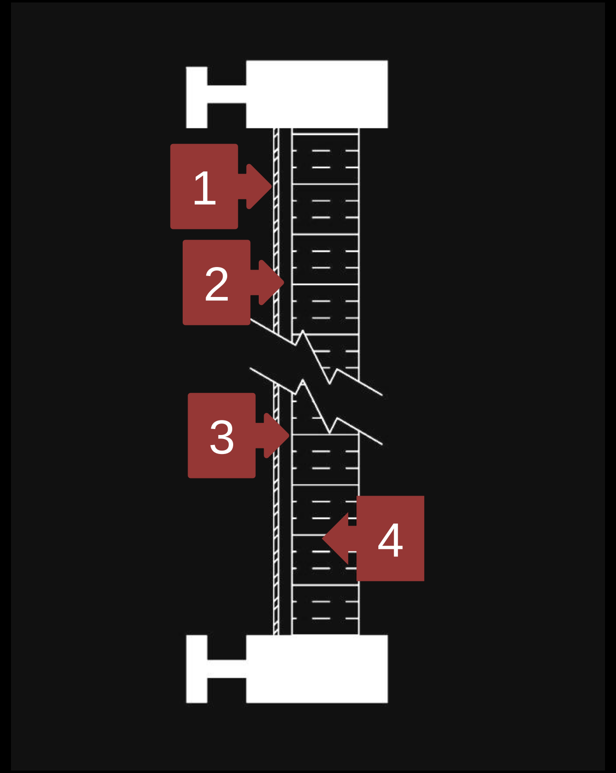
Redesigned Spandrel

Barrier wall system

Overall U-value: 0.067 [Btu/ft2- F]

Condensation: <2 [grains H_2O/ft^2-day]

1. 22 gauge aluminum panel
2. 3-1/2” rigid insulation
3. Vapor barrier



Existing Spandrel

Cavity wall system

Overall U-value: 0.087 [Btu/ft2- F]

Condensation: 37 [grains H_2O/ft^2-day]

1. 3/16” aluminum panel
2. 1/2” air space
3. Vapor barrier
4. 2-1/2” rigid insulation

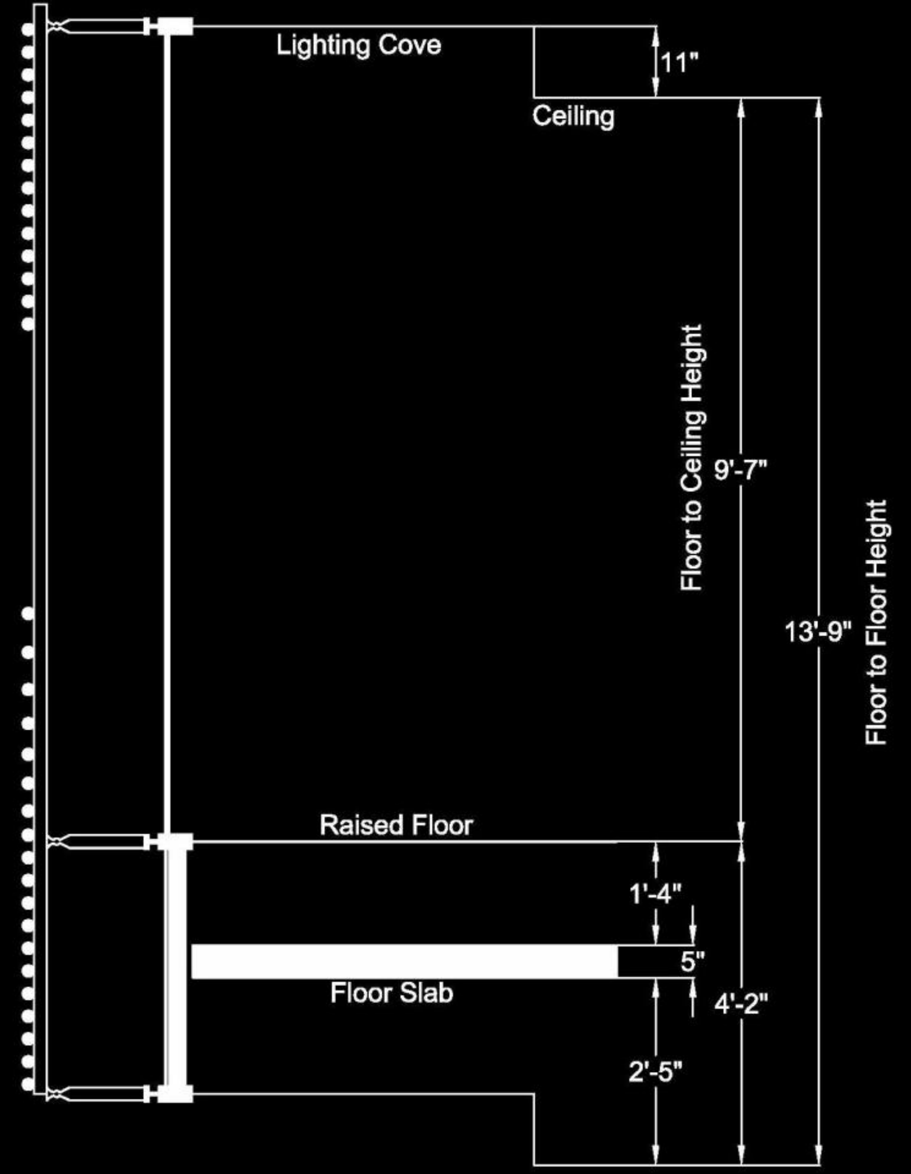
Wall Sections

Existing Wall

UFAD system requires large plenum

Lighting cove for improved daylighting

Floor-to-ceiling height: 9'-7"



Wall Sections

Building Overview

Team Workflow

Phase I : Façade
Typical Floor
Daylighting Analysis
Energy Analysis
Assembly and Cost
Phase II: Cogeneration
Phase III: Lateral System
Phase IV: Distribution Systems and Coordination

Results and Conclusions

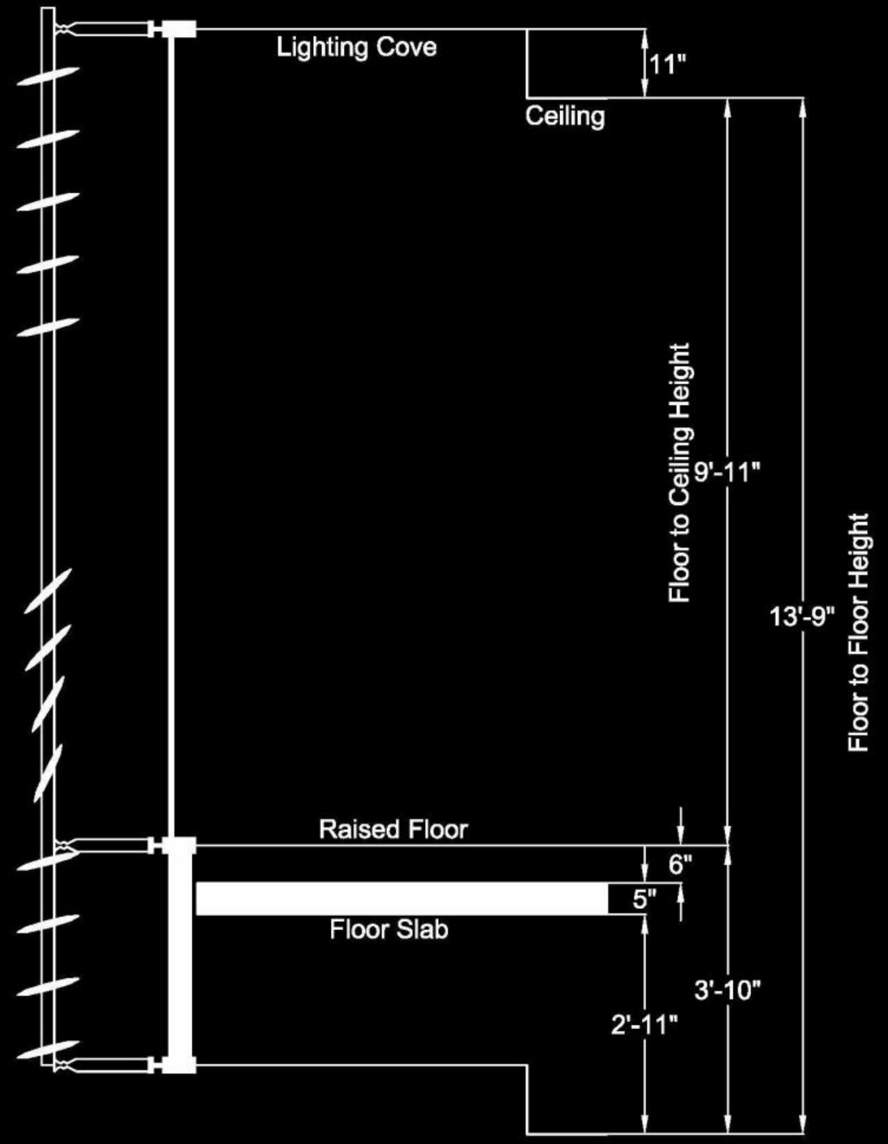
Redesigned Wall

Lower raised floor

- Elimination of UFAD

Floor-to-ceiling height: 9'-11"

Interstitial height decrease

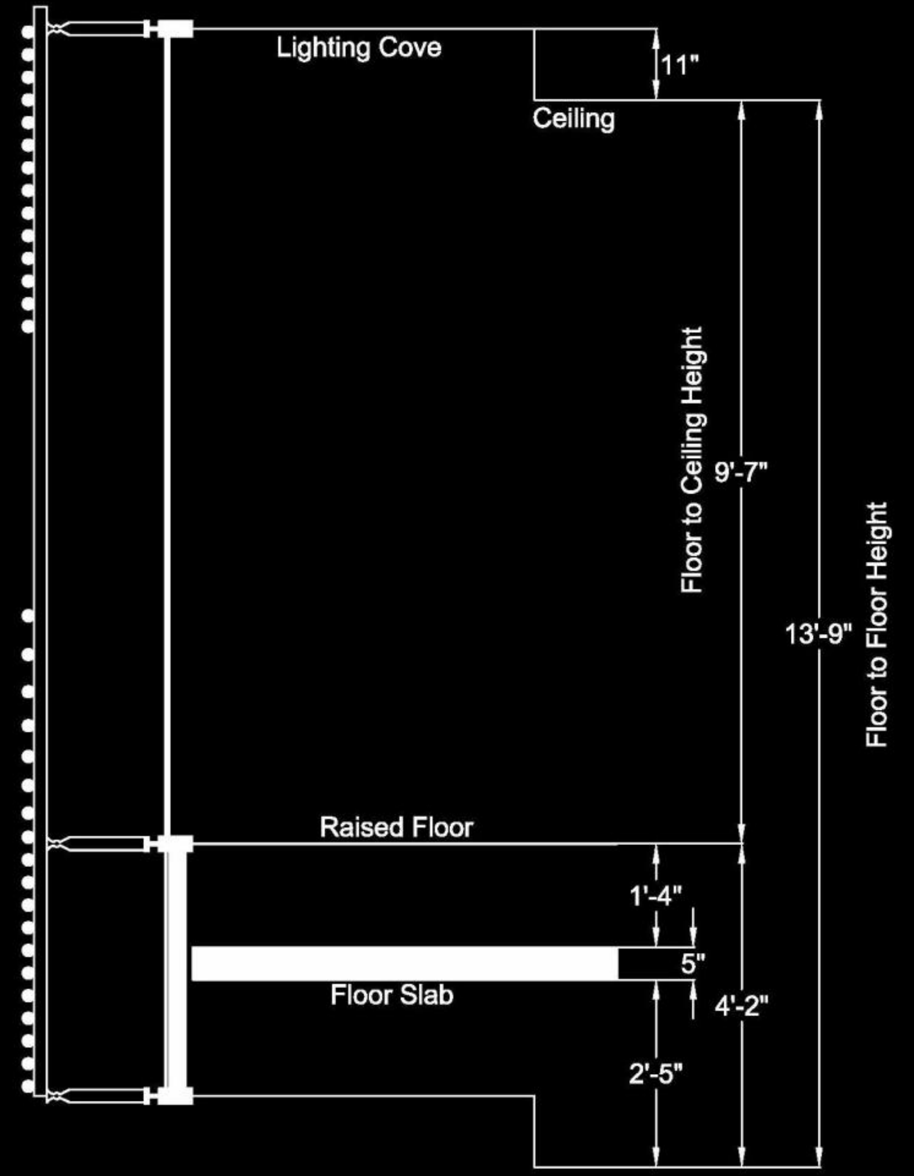


Existing Wall

UFAD system requires large plenum

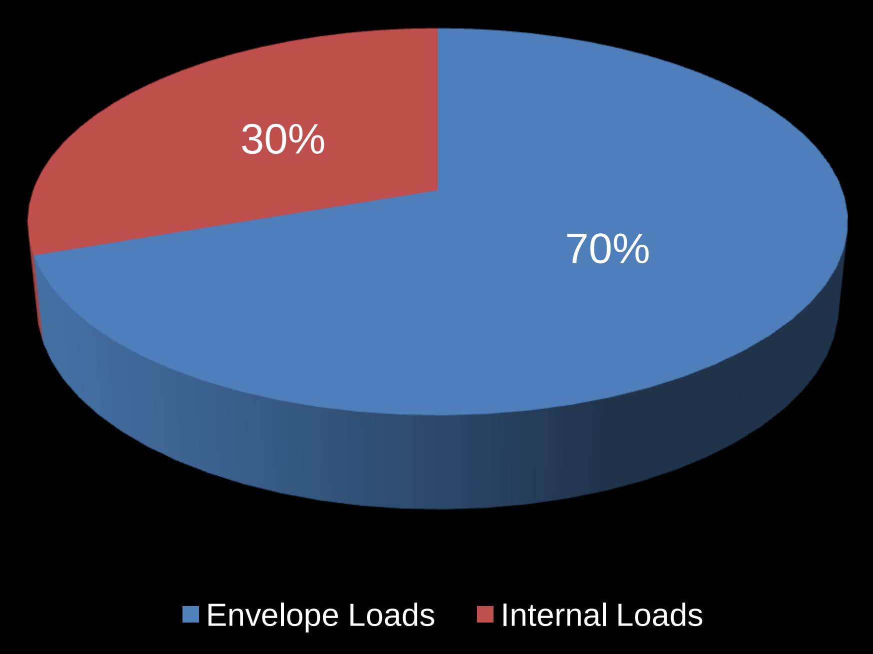
Lighting cove for improved daylighting

Floor-to-ceiling height: 9'-7"

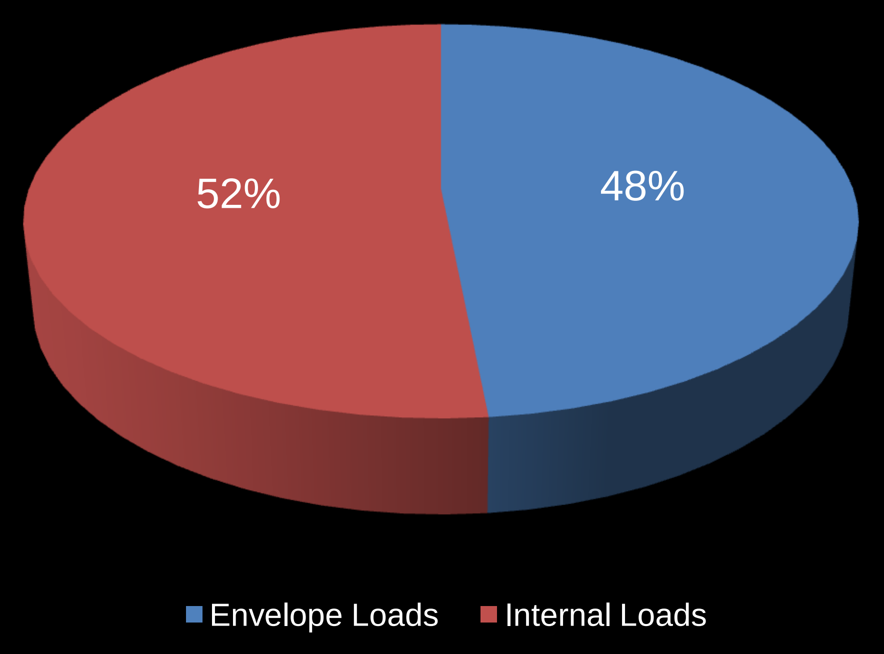


Façade Energy Analysis

Existing Facade: Cooling Load



Redesigned Facade: Cooling Load



Façade redesign reduced envelope loads due to:

- More effective shading scheme
- Improved U-value of glazing and spandrel
- Enhanced glazing transmittance and shading coefficient

Peak load reduction for typical floor:

- Cooling: 35%
- Heating: 21%

	Existing	Redesign
Cooling [Btu/hr-ft^2]	39.7	25.7
Heating [Btu/hr-ft^2]	51.9	30.6

Monthly Energy Requirements

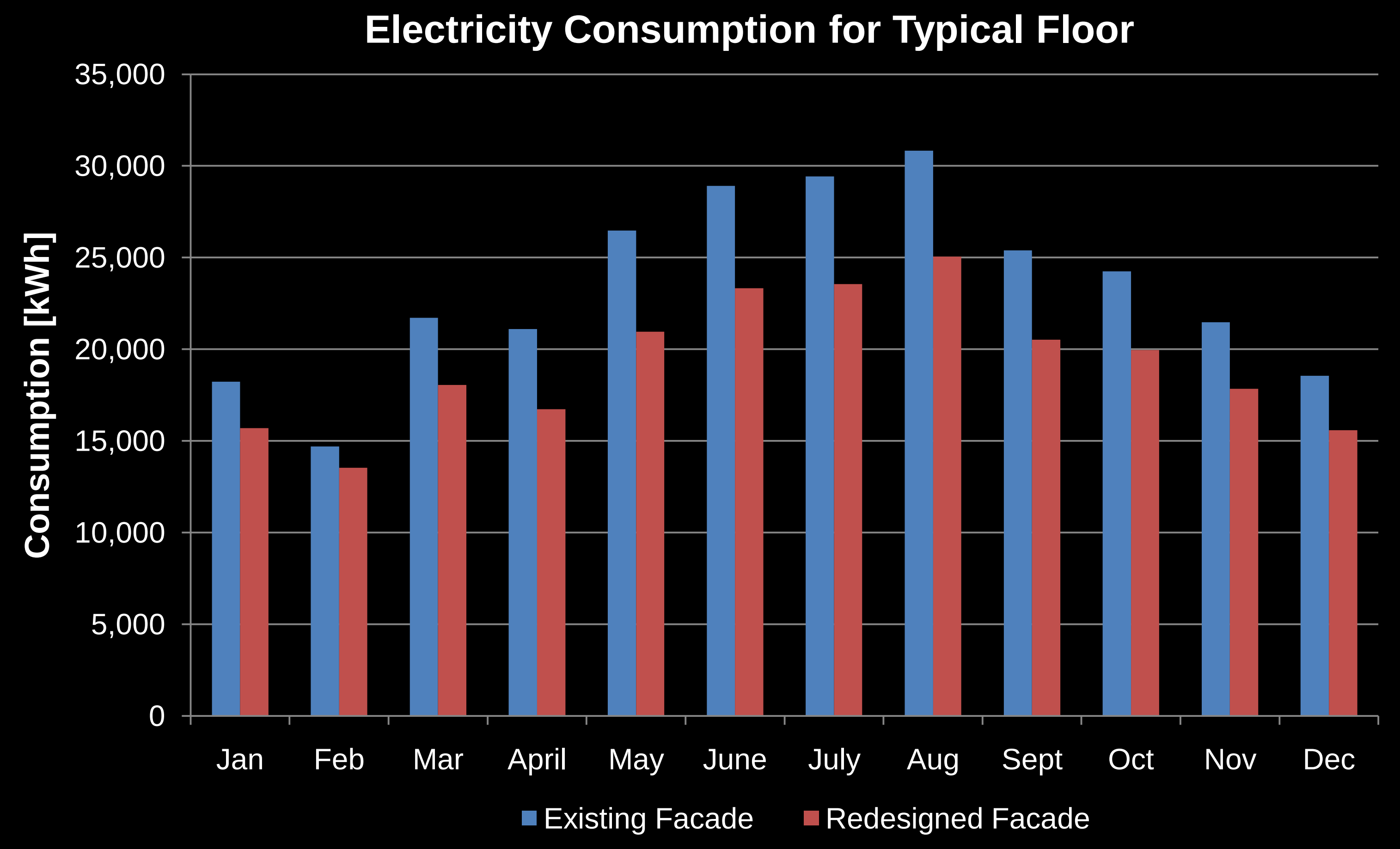
Building Overview

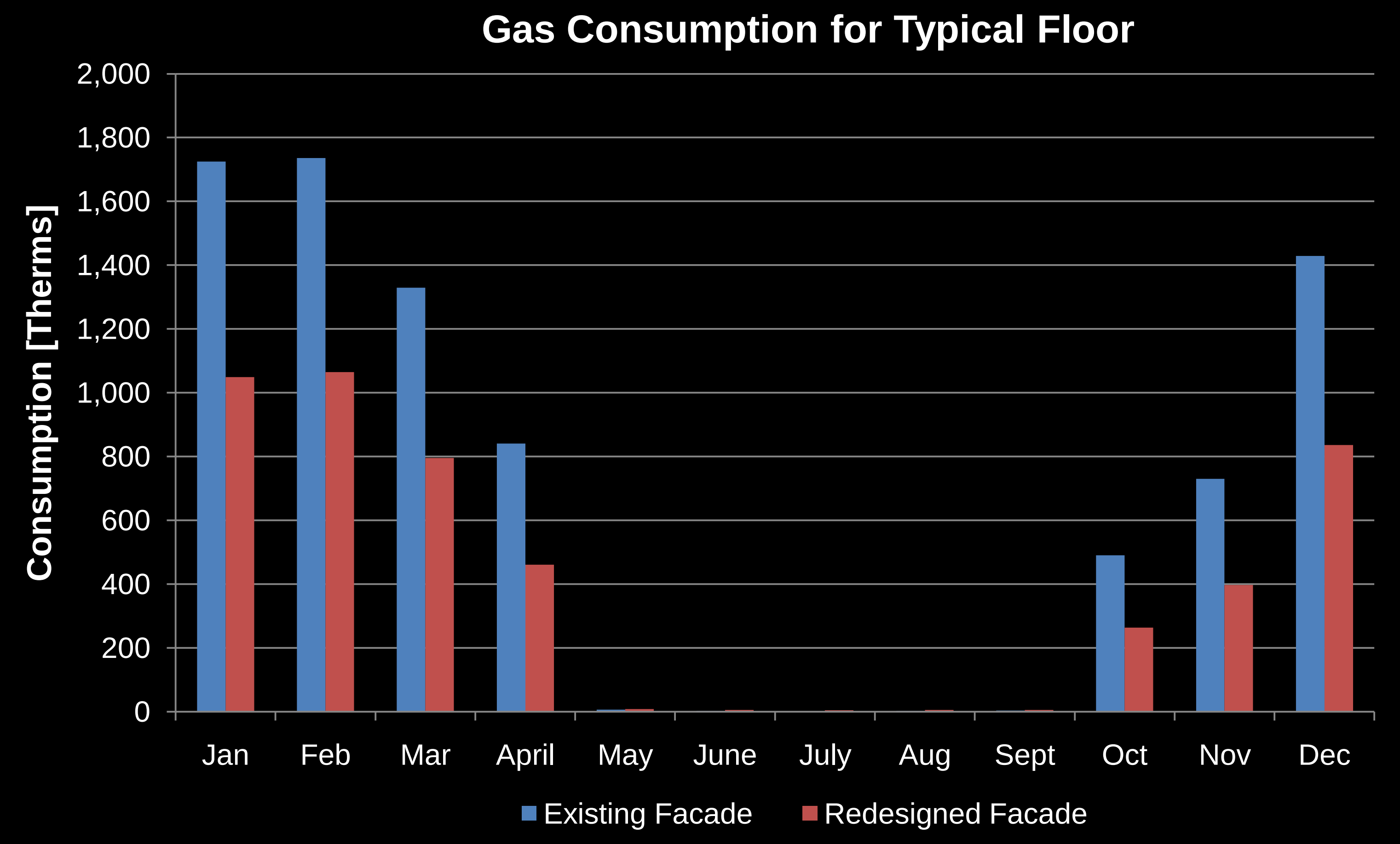
Team Workflow

Phase I : Façade
- Typical Floor
- Daylighting Analysis
- Energy Analysis
- Assembly and Cost

Phase II: Cogeneration
Phase III: Lateral System
Phase IV: Distribution Systems and Coordination

Results and Conclusions





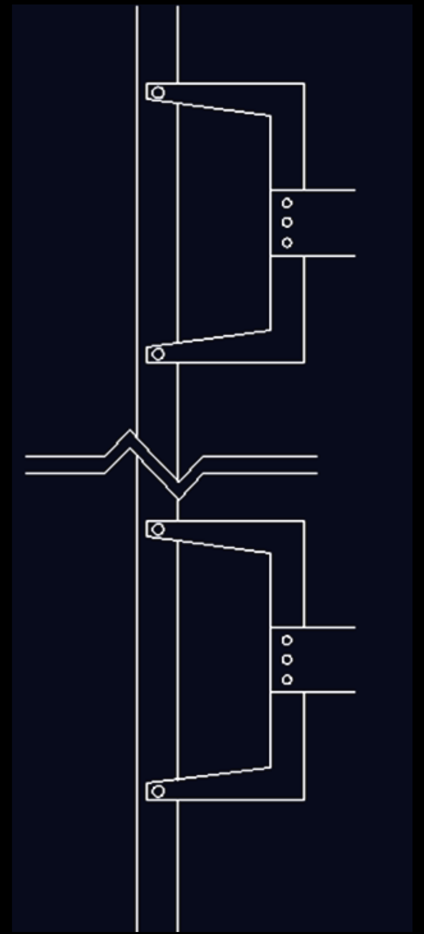
Façade support system

Existing shading system estimated at 25 psf
- Includes ice on rods
- New system weighs ~ 18 psf

C-shaped members allow unitized connection
- Bolted in 2 places per panel
- Same support used for new system

Thermal expansion calculated
- 120ºF temperature differential
- ¼" expansion per panel

Mullions and structural glazing redesigned



Double width façade panel was investigated for schedule savings

Double width façade panel was investigated for schedule savings

Not possible due to material hoist limitations

Additional information available in report

Cost of Existing Façade System

	Façade Area (SF)	Average Façade Unit Cost ($/ SF)	Rods (ea.)	Rod Unit Cost ($/ rod)	Total Cost ($)
Typical Tower Floor	10,678	$144	14510	$20	$1,606,290.00
Entire Building	555,236	$144	754,510	$20	$83,527,200.00

Cost of Existing Façade System

Building Overview

Team Workflow

Phase I : Façade
Typical Floor
Daylighting Analysis
Energy Analysis
Assembly and Cost
Phase II: Cogeneration
Phase III: Lateral System
Phase IV: Distribution Systems and Coordination

Results and Conclusions

	Façade Area (SF)	Average Façade Unit Cost ($/ SF)	Rods (ea.)	Rod Unit Cost ($/ rod)	Total Cost ($)
Typical Tower Floor	10,678	$144	14510	$20	$1,606,290.00
Entire Building	555,236	$144	754,510	$20	$83,527,200.00

Building Overview

Team Workflow

Phase I : Façade
Typical Floor
Daylighting Analysis
Energy Analysis
Assembly and Cost
Phase II: Cogeneration
Phase III: Lateral System
Phase IV: Distribution Systems and Coordination

Results and Conclusions

Cost of Existing Façade System

	Façade Area (SF)	Average Façade Unit Cost ($/ SF)	Rods (ea.)	Rod Unit Cost ($/ rod)	Total Cost ($)
Typical Tower Floor	10,678	$144	14510	$20	$1,606,290.00
Entire Building	555,236	$144	754,510	$20	$83,527,200.00

Cost of Redesigned Façade System

	Material ($)	Labor ($)	Total Cost ($)
Typical Tower Floor	$810,414	$1,343,285	$2,153,700
Entire Building	$45,383,218	$75,223,990	$120,607,208

Building Overview

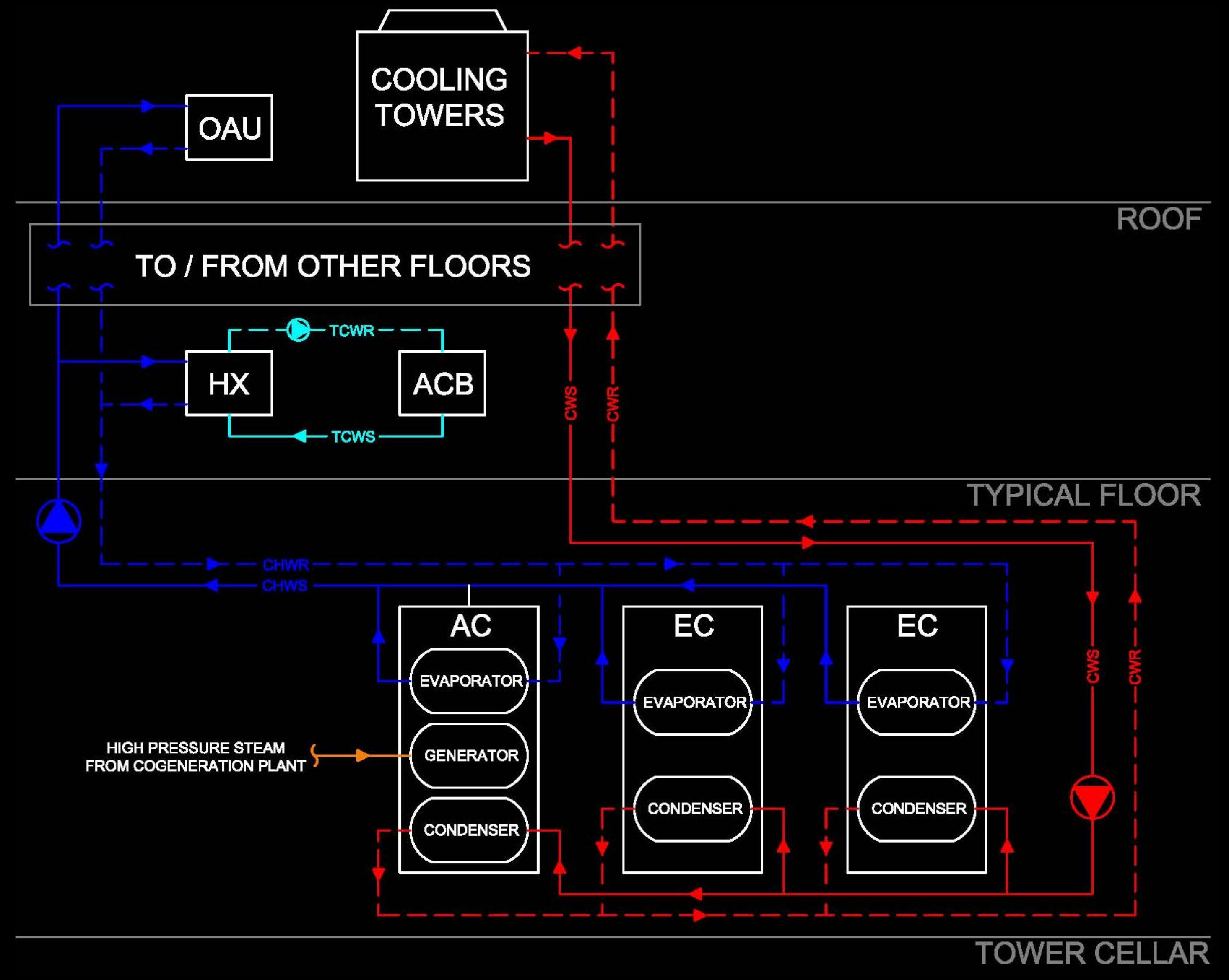
Team Workflow

Phase I : Façade
Phase II: Cogeneration
Plant Studies
System Operation
Interdisciplinary Coordination
Phase III: Lateral System
Phase IV: Distribution Systems and Coordination

Results and Conclusions

Phase II :

Cogeneration



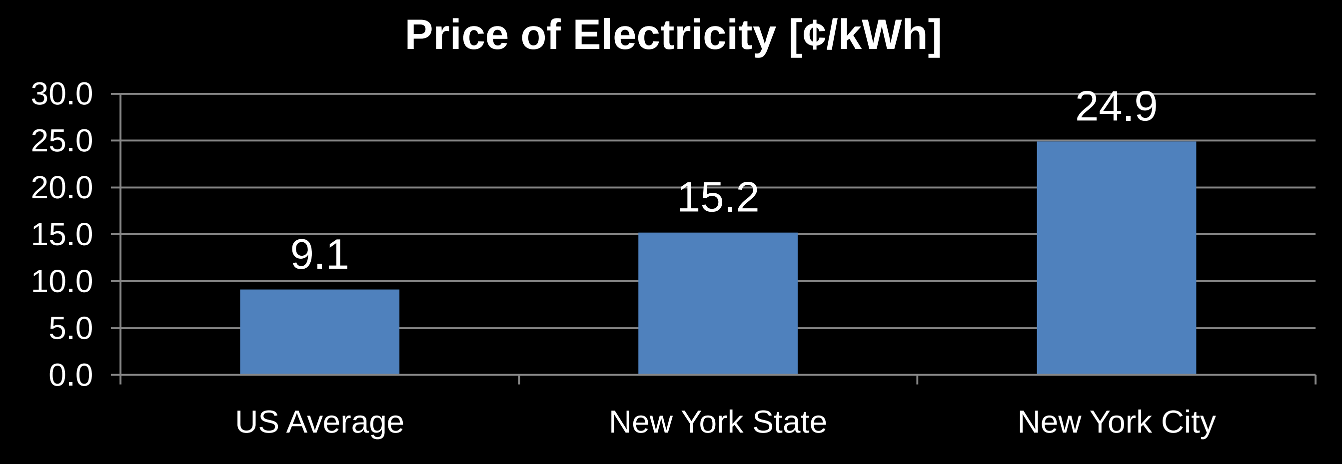
Price of Energy

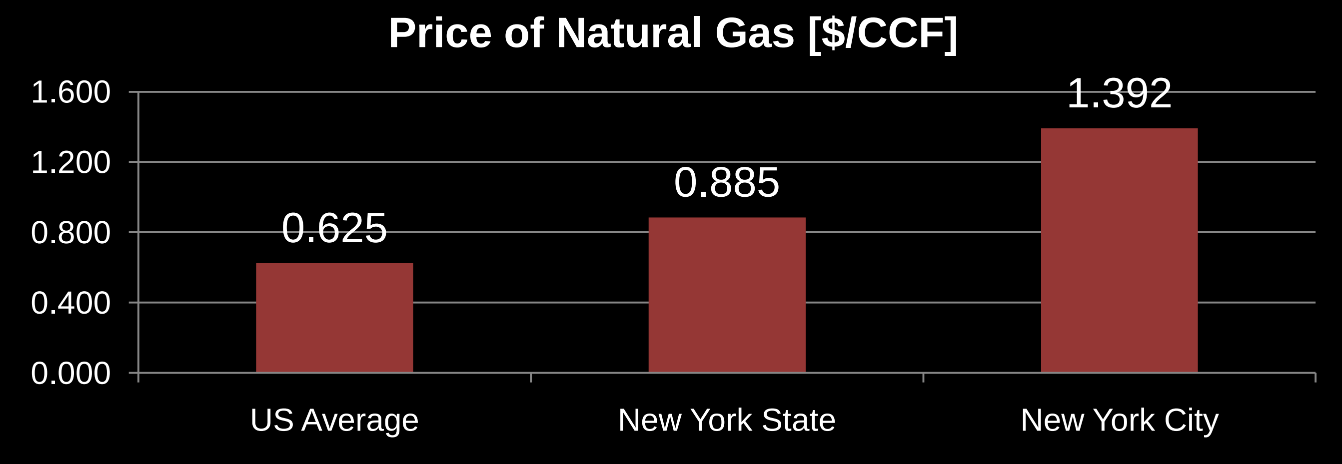
Building Overview

Team Workflow

Phase I : Façade
Phase II: Cogeneration
Plant Studies
System Operation
Interdisciplinary Coordination
Phase III: Lateral System
Phase IV: Distribution Systems and Coordination

Results and Conclusions





Electric and natural gas prices obtained from the EIA for 2007

Steam prices are difficult to compare because they are set by each utility

- Price of steam for large commercial customer in New York City:
  - 18.36 [$/1,000 lbs] - ConEd

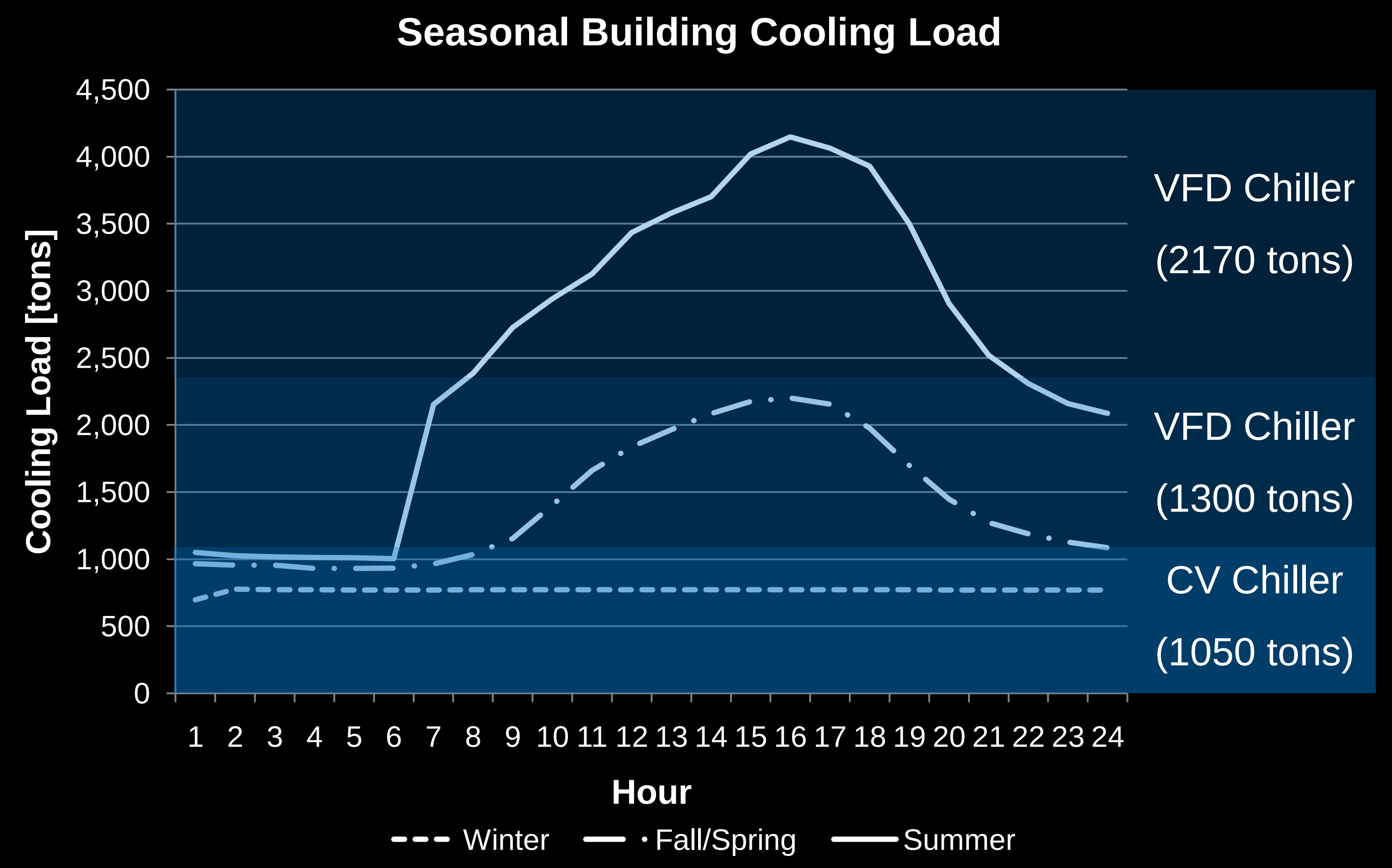
Plant Equipment Sizing Methodology

Building Overview

Team Workflow

Phase I : Façade
Phase II: Cogeneration
Plant Studies
System Operation
Interdisciplinary Coordination
Phase III: Lateral System
Phase IV: Distribution Systems and Coordination

Results and Conclusions



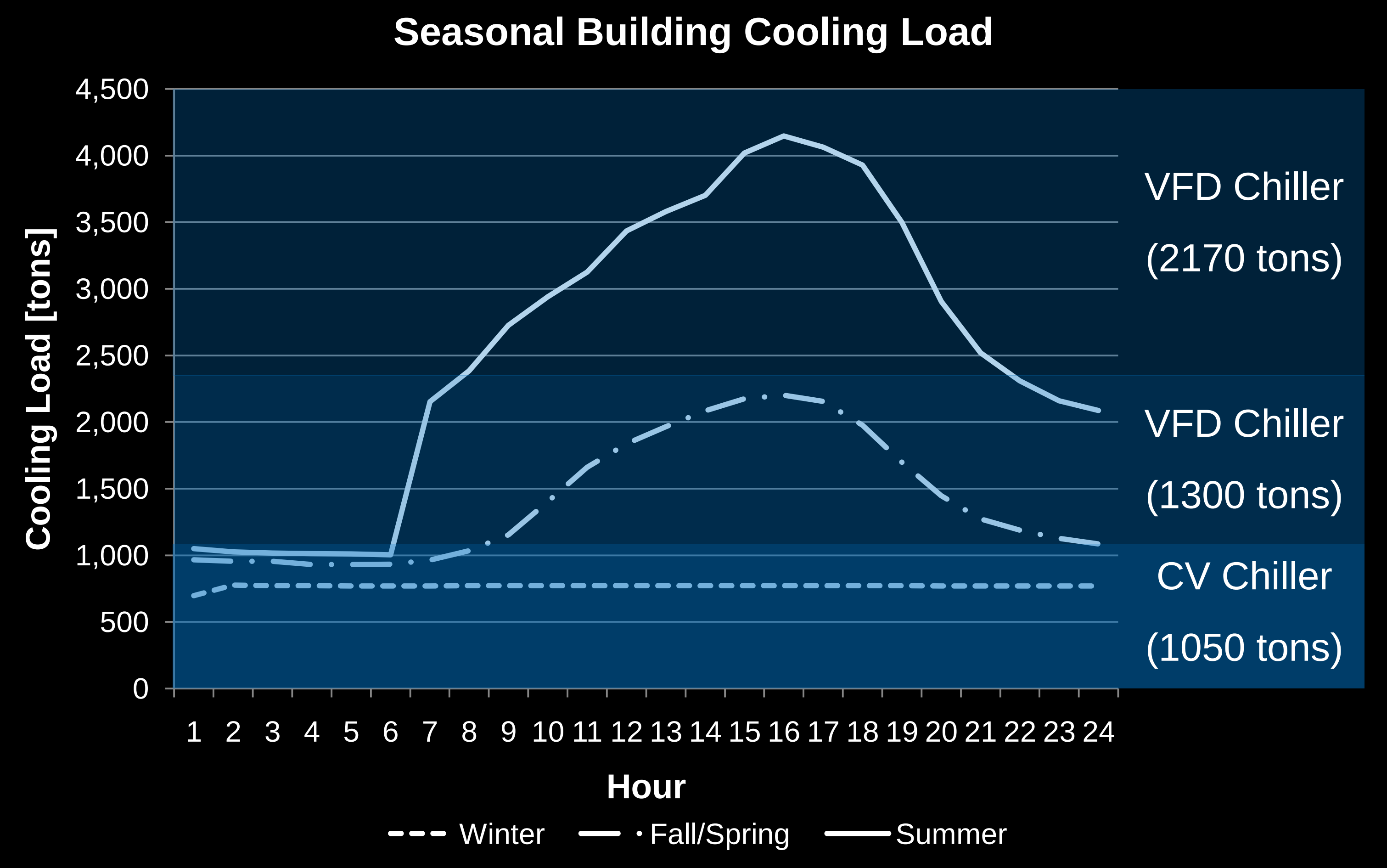
Plant Equipment Sizing Methodology

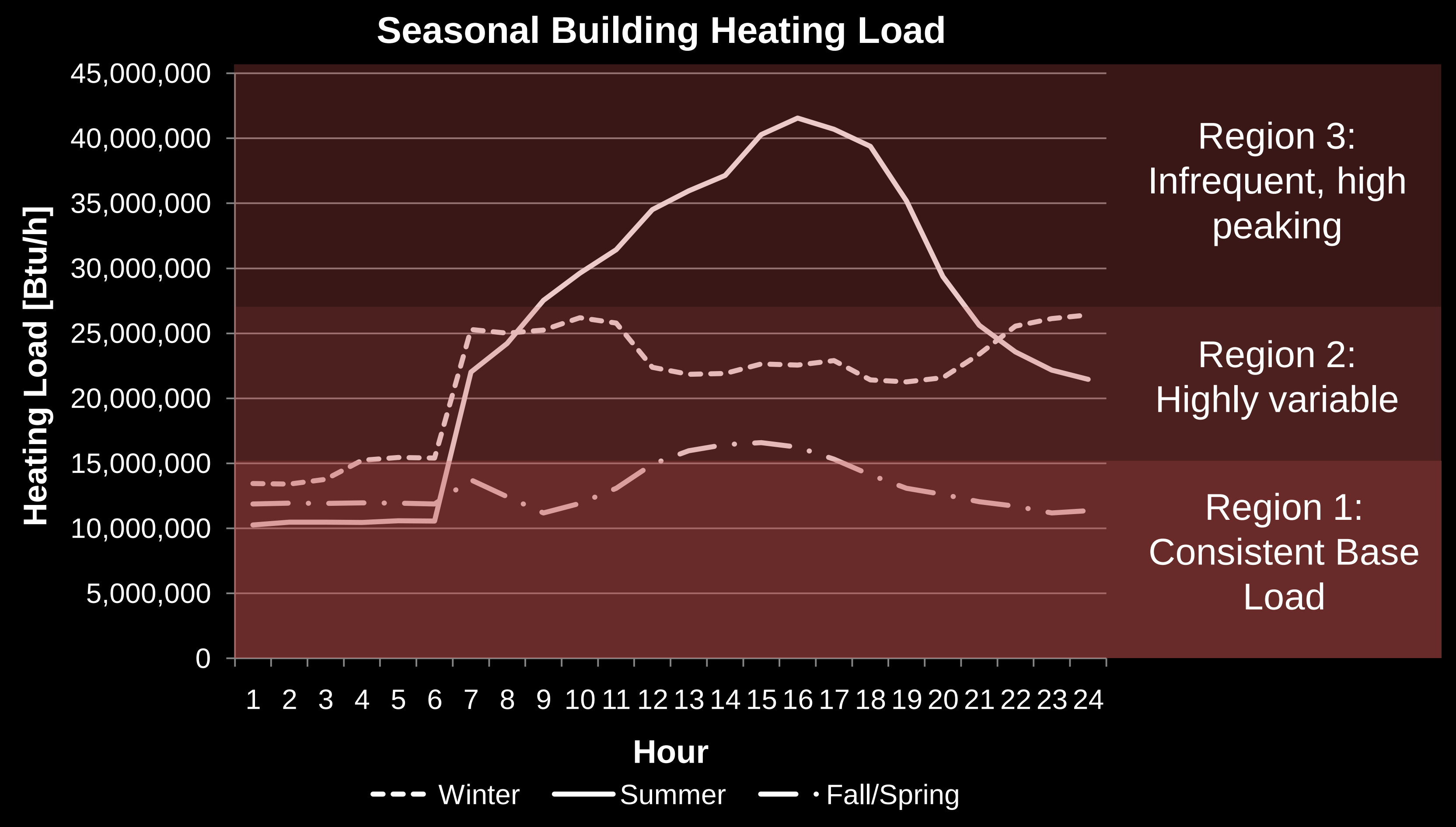
Building Overview

Team Workflow

Phase I : Façade
Phase II: Cogeneration
Plant Studies
System Operation
Interdisciplinary Coordination
Phase III: Lateral System
Phase IV: Distribution Systems
and Coordination

Results and Conclusions





Preliminary Plant Study

Building Overview

Team Workflow

Phase I : Façade
Phase II: Cogeneration
Plant Studies
System Operation
Interdisciplinary Coordination
Phase III: Lateral System
Phase IV: Distribution Systems
and Coordination

Results and Conclusions

		Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
Chiller Plant	**Low range CV**	Electric	Absorption (1-stage)	Absorption (2-stage)	Absorption (2-stage)	Absorption (2-stage)
	Mid range VFD	Electric	Absorption (1-stage)	Absorption (2-stage)	Steam Comp. (2-stage)	Electric
	High range VFD	Electric	Electric	Electric	Steam Comp. (2-stage)	Electric
Prime Movers	**Low range**	IC Engine (VFD)	Gas Turbine (CV)	Gas Turbine (CV)	Gas Turbine (CV)	IC Engine (VFD)
	Mid range	Gas Turbine (CV)	Steam Generator (VFD)	IC Engine (VFD)	Gas Turbine (CV)	Gas Turbine (CV)
	High range	IC Engine (VFD)		Steam Gen. (VFD)	Steam Gen. (VFD)	IC Engine (VFD)
Annual Operating Costs [$/yr]		10,133,170	8,155,927	7,459,702	7,704,658	7,794,157
Annual Primary Energy [MMBtu/yr]		444,224	546,834	446,416	516,813	424,050

Energy Modeling Assumptions

TRACE model from Phase I was adapted for the entire building

Used “average monthly hourly” TMY data for analysis

Electrical loads

- Lighting: 1.1 [W/ft^2]
- Plug loads: 0.5 [W/ft^2]
- Misc. loads: 1.0 [W/ft^2]
- Data center: 1,200,000 [W]
- Load profile was applied to all electrical loads (except data center)

Modeled part-load plant operating characteristics by weighting COP and heat rate for each hourly time-step

Preliminary Plant Study

		Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
Chiller Plant	Low range CV	Electric	Absorption (1-stage)	Absorption (2-stage)	Absorption (2-stage)	Absorption (2-stage)
	Mid range VFD	Electric	Absorption (1-stage)	Absorption (2-stage)	Steam Comp (2-stage)	Electric
	High range VFD	Electric	Electric	Electric	Steam Comp (2-stage)	Electric
Prime Movers	Low range	IC Engine (VFD)	Gas Turbine (CV)	Gas Turbine (CV)	Gas Turbine (CV)	IC Engine (VFD)
	Mid range	Gas Turbine (CV)	Steam Generator (VFD)	IC Engine (VFD)	Gas Turbine (CV)	Gas Turbine (CV)
	High range	IC Engine (VFD)		Steam Gen. (VFD)	Steam Gen. (VFD)	IC Engine (VFD)
Annual Operating Costs [$/yr]		10,133,170	8,155,927	7,459,702	7,704,658	7,794,157
Annual Primary Energy [MMBtu/yr]		444,224	546,834	446,416	516,813	424,050

Energy Modeling Assumptions

TRACE model from Phase I was adapted for the entire building

Used "average monthly hourly" TMY data for analysis

Electrical loads

- Lighting: 1.1 [W/ft^2]
- Plug loads: 0.5 [W/ft^2]
- Misc. loads: 1.0 [W/ft^2]
- Data center: 1,200,000 [W]
- Load profile was applied to all electrical loads (except data center)

Modeled part-load plant operating characteristics by weighting COP and heat rate for each hourly time-step

Final Equipment Selection

Building Overview

Team Workflow

Phase I : Façade
Phase II: Cogeneration
Plant Studies
System Operation
Interdisciplinary Coordination
Phase III: Lateral System
Phase IV: Distribution Systems
and Coordination

Results and Conclusions

Chiller Plant

(1) – 1,058 [ton] double-stage absorption chiller

- Trane ABTF-1050
- COP: 1.21
- Steam fired

(1) – 1,300 [ton] two-stage, single compressor electric chiller

- Trane CVHF-1300
- COP: ~ 6.1

(1) – 2,170 [ton] dual compressor electrical chillers

- Trane CDHF-2170
- COP: ~ 6.1
- (1) chiller for stand-by

Final Equipment Selection

Building Overview

Team Workflow

Phase I : Façade
Phase II: Cogeneration
Plant Studies
System Operation
Interdisciplinary Coordination
Phase III: Lateral System
Phase IV: Distribution Systems
and Coordination

Results and Conclusions

Chiller Plant

(1) – 1,058 [ton] double-stage absorption chiller

- Trane ABTF-1050
- COP: 1.21
- Steam fired

(1) – 1,300 [ton] two-stage, single compressor electric chiller

- Trane CVHF-1300
- COP: ~ 6.1

(1) – 2,170 [ton] dual compressor electrical chillers

- Trane CDHF-2170
- COP: ~ 6.1
- (1) chiller for stand-by

CHP Plant

(1) – 1,185 [kW] gas turbine

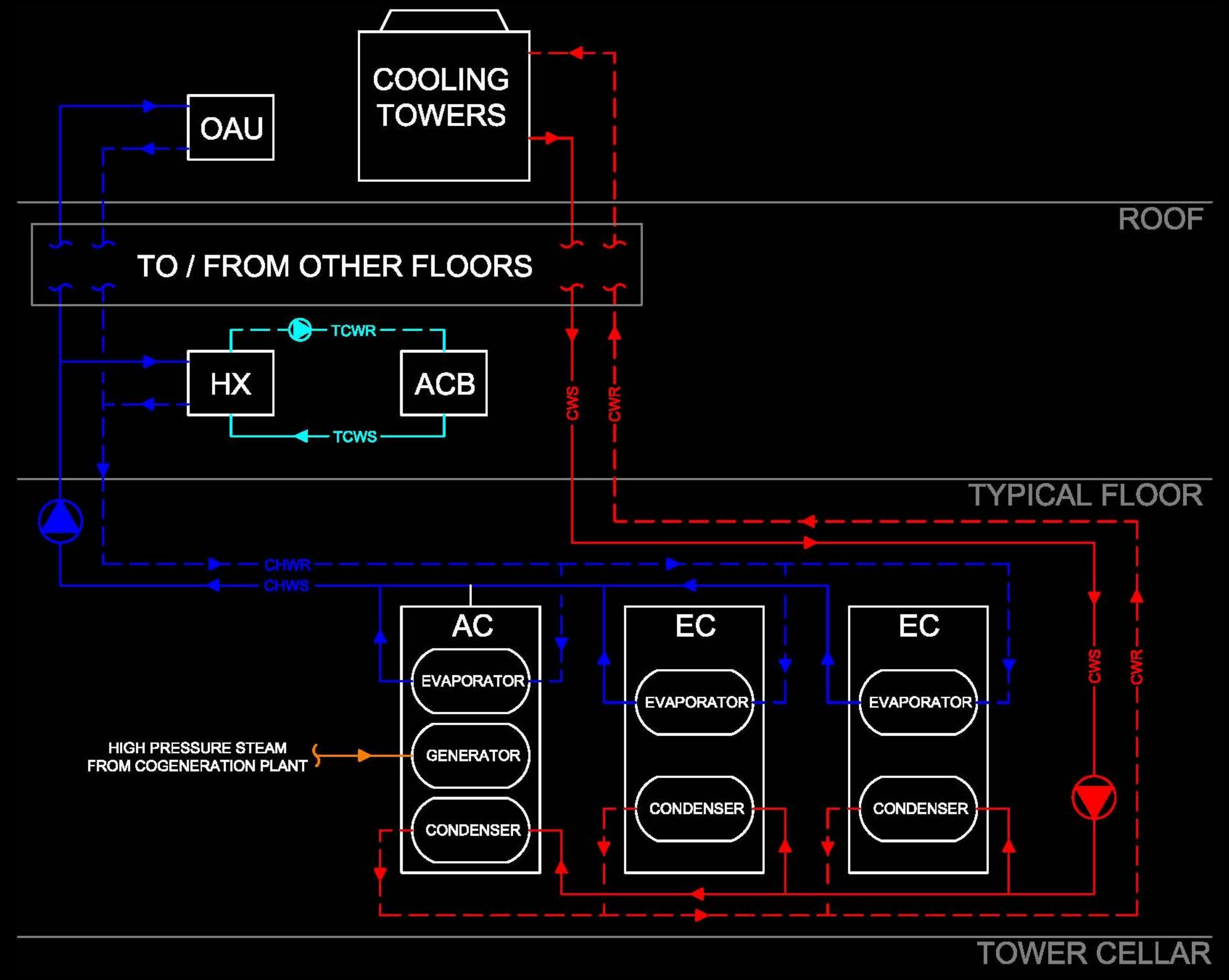
- Solar Saturn 20
- Heat rate: 13,906 [Btu/kWh]
- Recoverable heat rate: 8,975 [Btu/kWh]
- Electrical efficiency: 25%

(2) – 1,040 [kW] internal combustion engines

- Caterpillar G3516
- Heat rate: 10,593 [Btu/kWh]
- Recoverable heat rate: 5,234 [Btu/kWh]
- Electrical efficiency: 32%

Flow Diagrams

- Building Overview
- Team Workflow
- Phase I : Façade
- **Phase II: Cogeneration**
  - Plant Studies
  - **System Operation**
  - Interdisciplinary Coordination
- **Phase III:** Lateral System
- **Phase IV:** Distribution Systems and Coordination
- **Results and Conclusions**



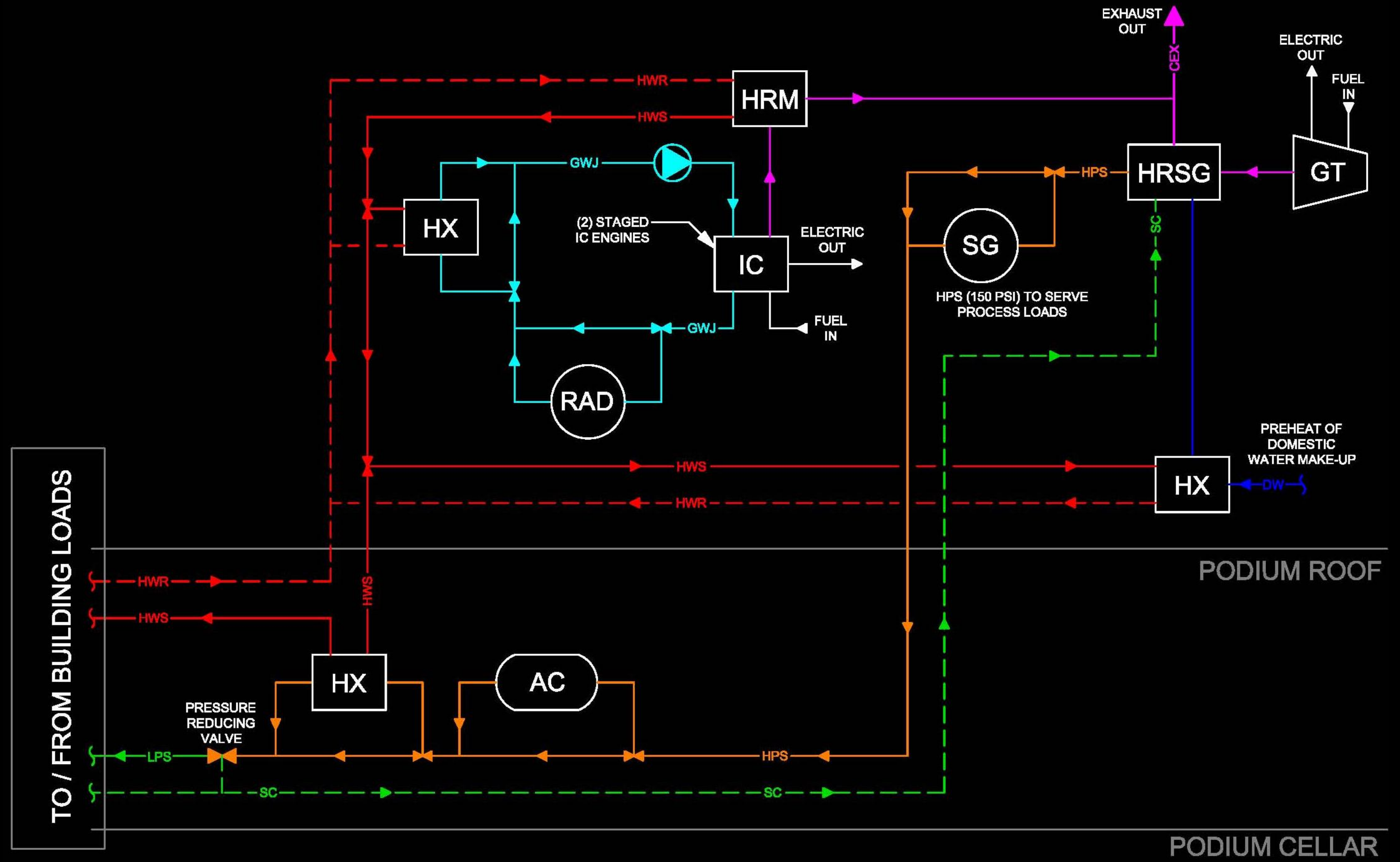
Flow Diagrams

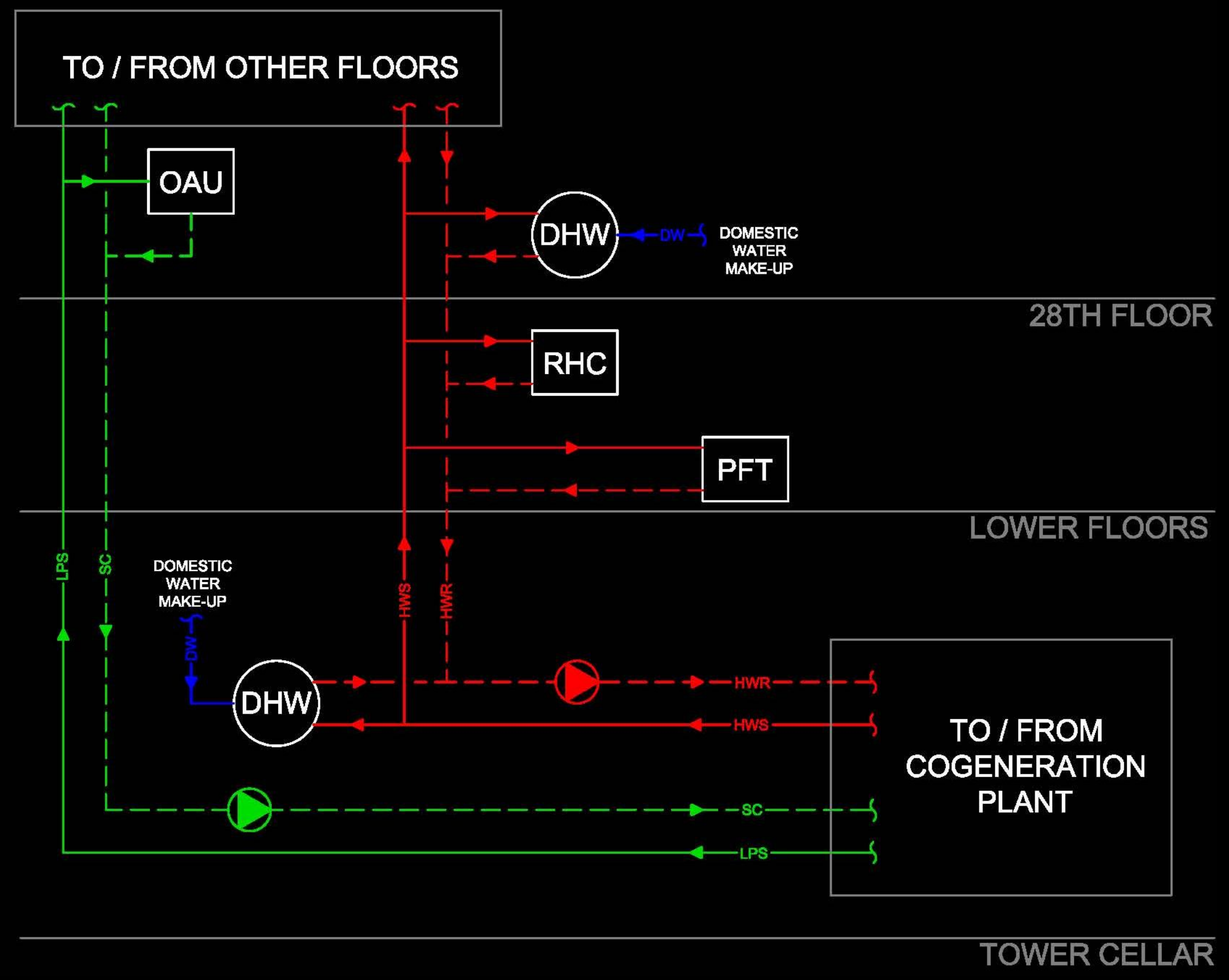
Building Overview

Team Workflow

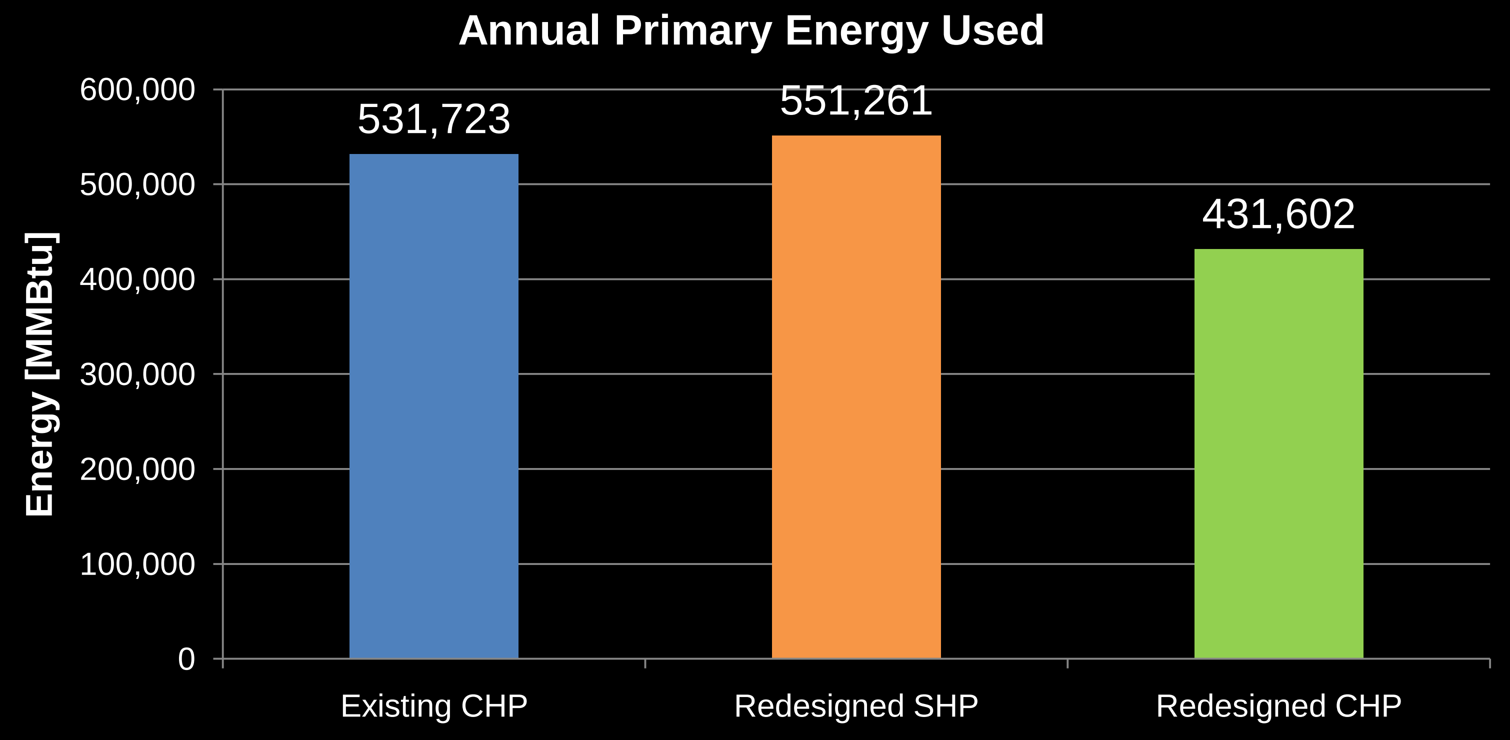
Phase I : Façade
Phase II: Cogeneration
Plant Studies
System Operation
Interdisciplinary Coordination
Phase III: Lateral System
Phase IV: Distribution Systems and Coordination

Results and Conclusions





Mechanical Systems Performance



Primary energy use reduction from existing building: 19%

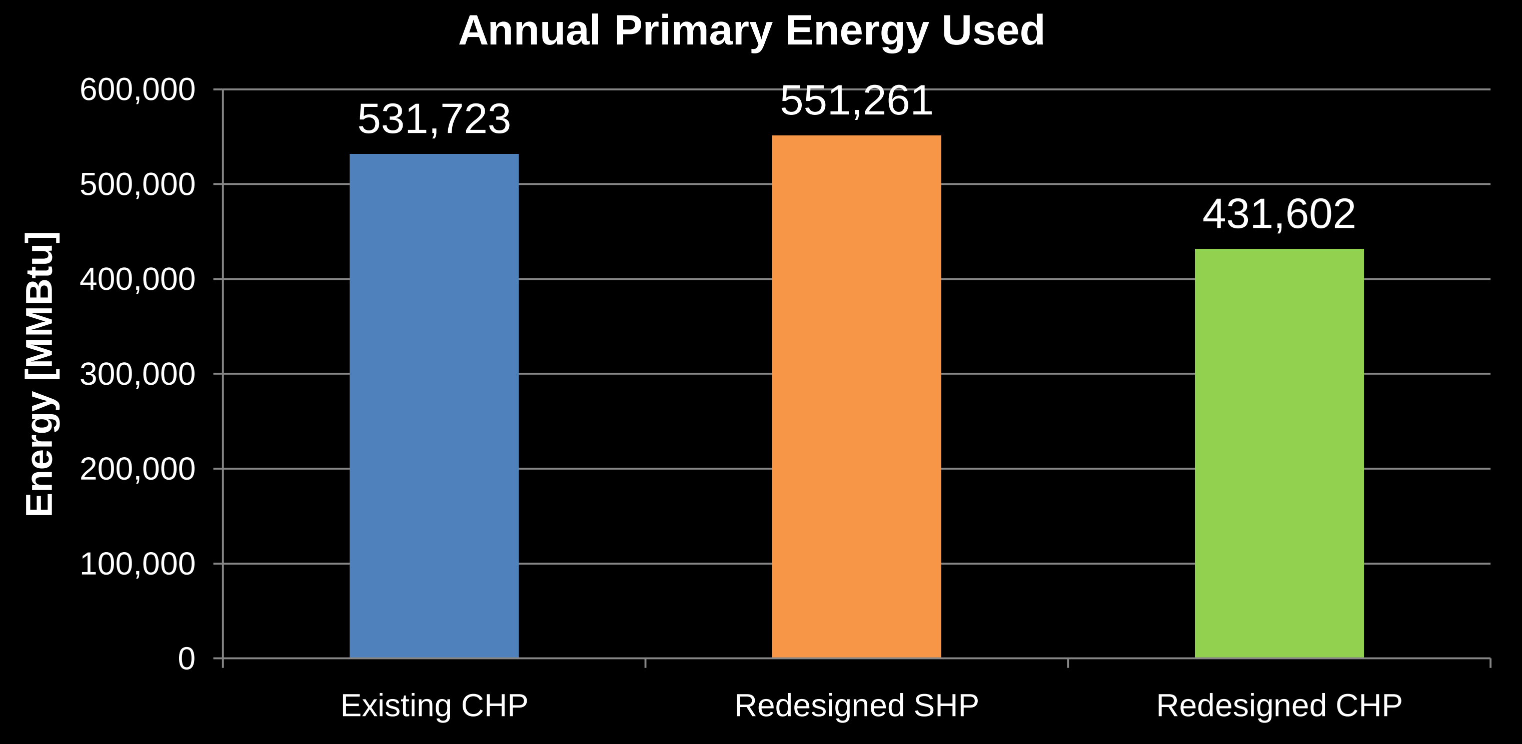
Mechanical Systems Performance

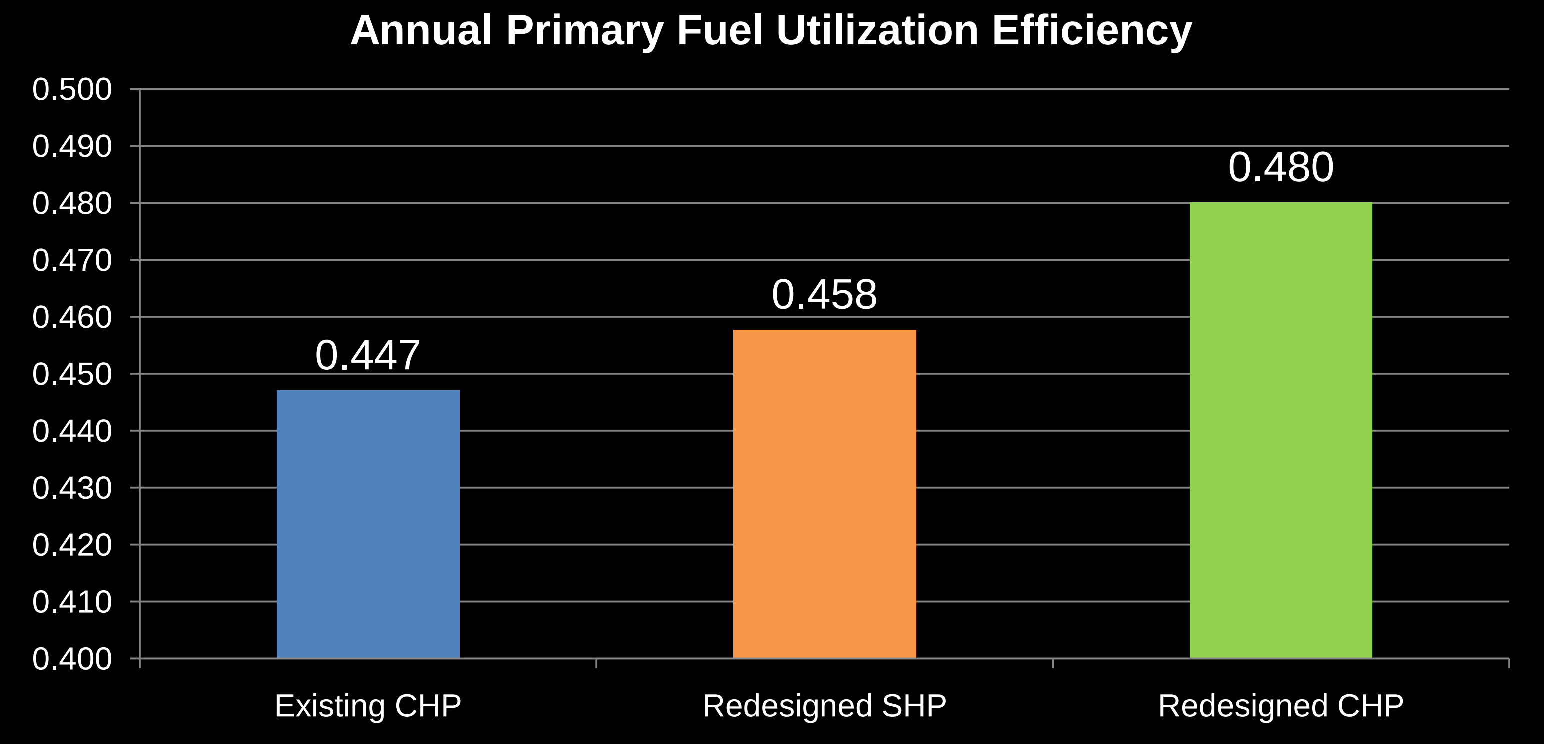
Building Overview

Team Workflow

Phase I : Façade
Phase II: Cogeneration
Plant Studies
System Operation
Interdisciplinary Coordination
Phase III: Lateral System
Phase IV: Distribution Systems and Coordination

Results and Conclusions





Primary energy use reduction from existing building: 19%

	CHP Existing	SHP Redesign	CHP Redesign
[lbs CO_2/yr]	67,562,895	84,787,465	63,443,589
[lbs NOx/yr]	497,038	135,807	292,978
[lbs SOx/yr]	285,510	333,528	210,681

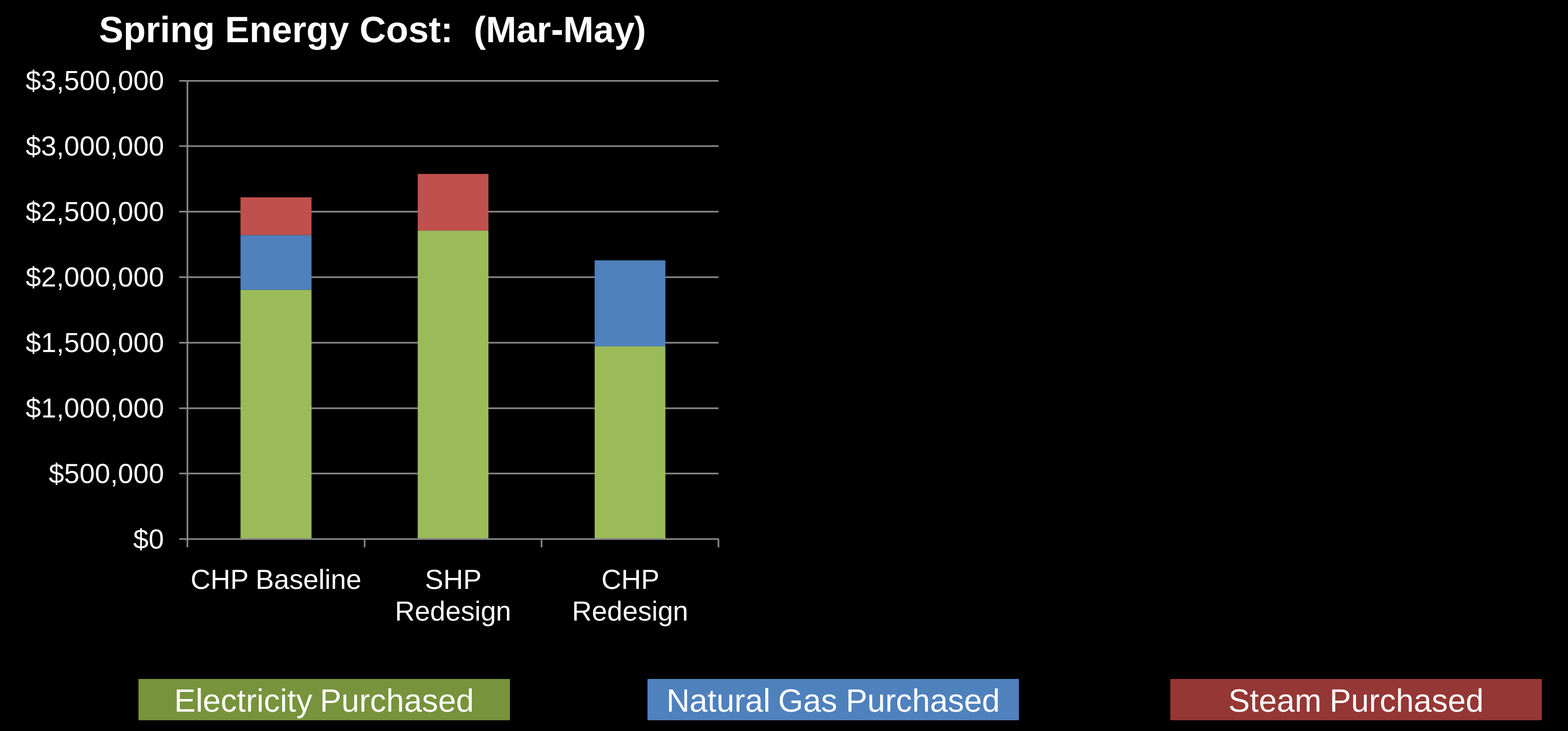
Normal Operating Costs

Building Overview

Team Workflow

Phase I : Façade
Phase II: Cogeneration
Plant Studies
System Operation
Interdisciplinary Coordination
Phase III: Lateral System
Phase IV: Distribution Systems and Coordination

Results and Conclusions



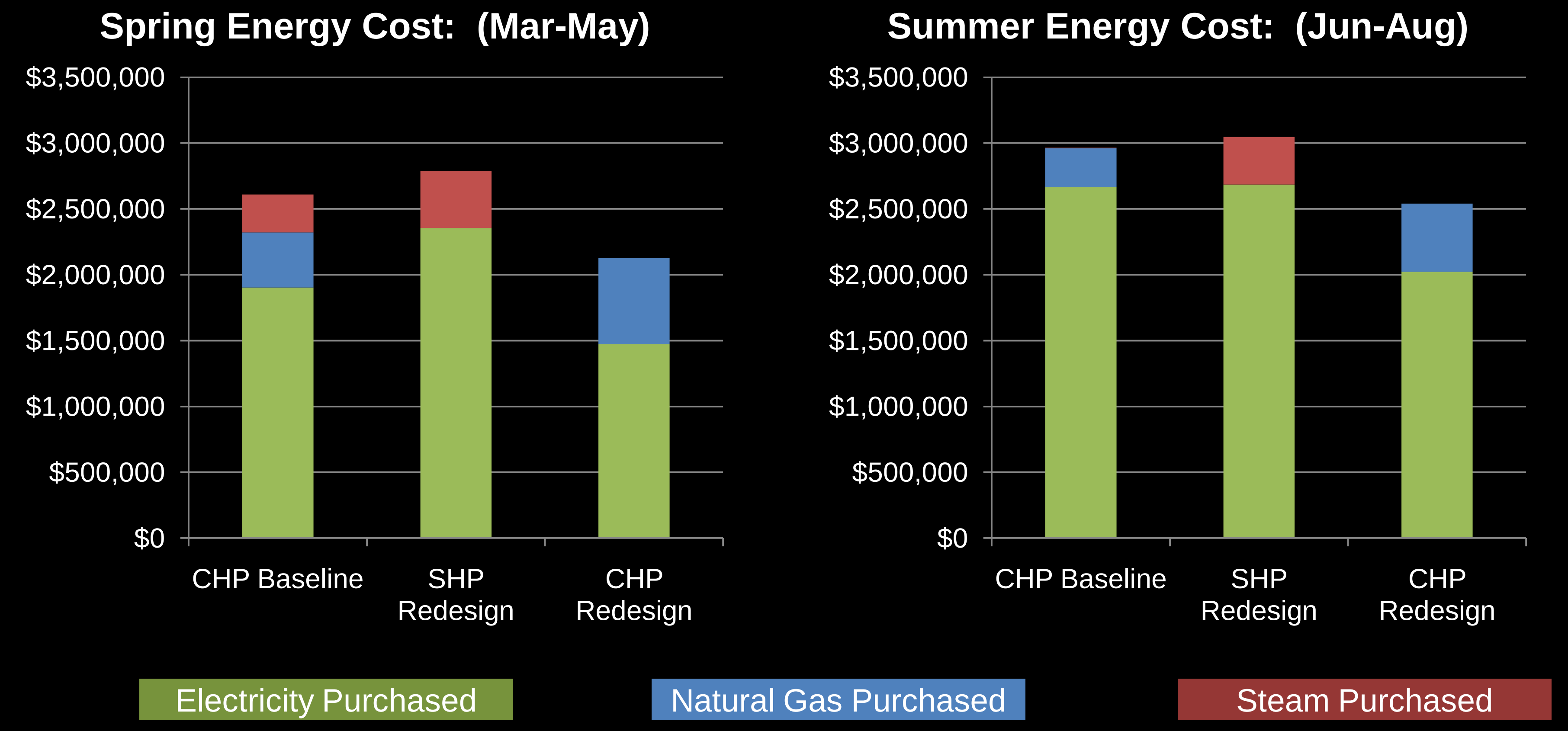
Normal Operating Costs

Building Overview

Team Workflow

Phase I : Façade
Phase II: Cogeneration
Plant Studies
System Operation
Interdisciplinary Coordination
Phase III: Lateral System
Phase IV: Distribution Systems and Coordination

Results and Conclusions



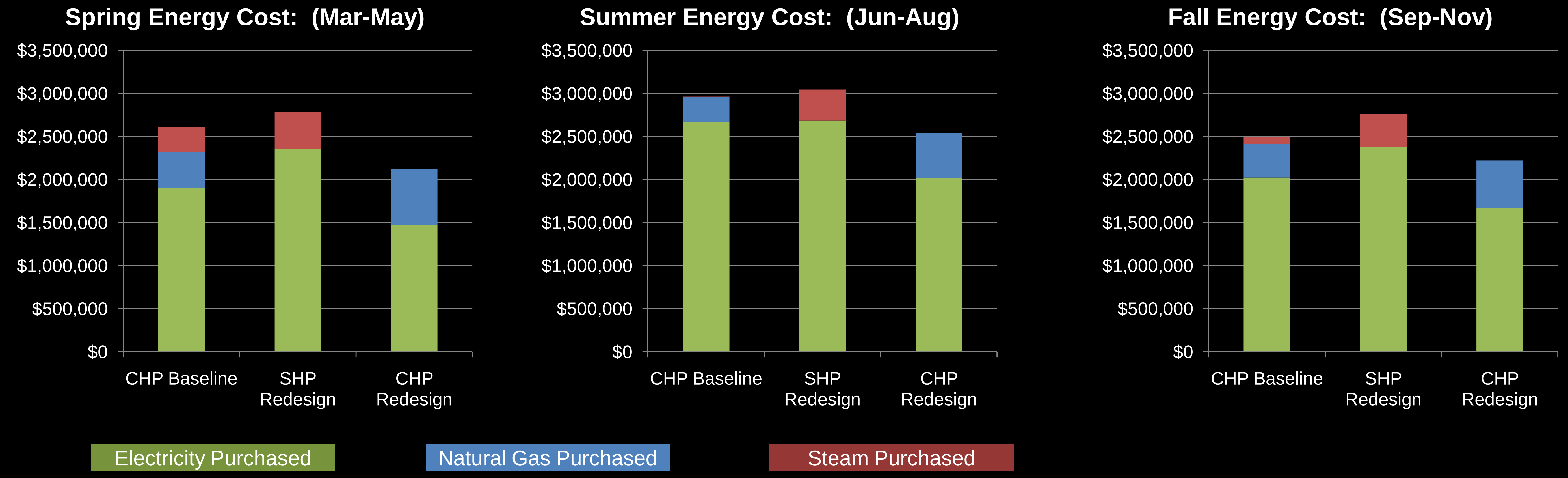
Normal Operating Costs

Building Overview

Team Workflow

Phase I : Façade
Phase II: Cogeneration
Plant Studies
System Operation
Interdisciplinary Coordination
Phase III: Lateral System
Phase IV: Distribution Systems and Coordination

Results and Conclusions



Normal Operating Costs

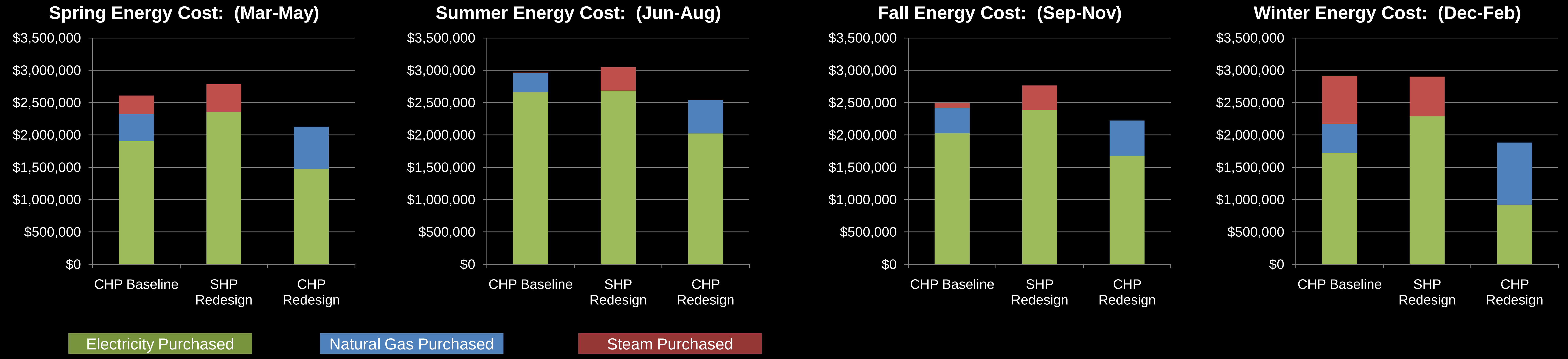
Building Overview

Team Workflow

Phase I : Façade
Phase II: Cogeneration
- Plant Studies
- **System Operation**
- Interdisciplinary Coordination

Phase III: Lateral System
Phase IV: Distribution Systems and Coordination

Results and Conclusions



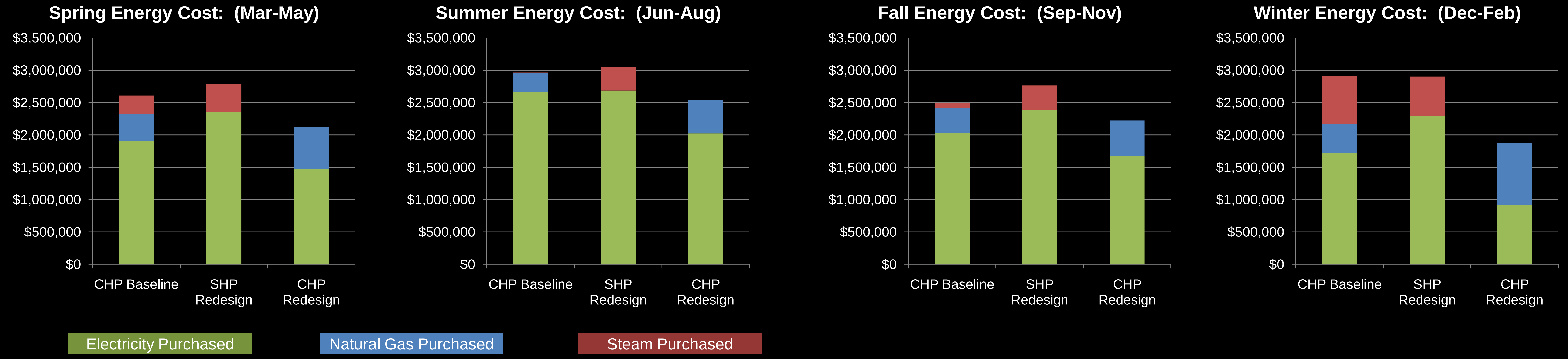
Normal Operating Costs

Building Overview

Team Workflow

Phase I : Façade
Phase II: Cogeneration
Plant Studies
System Operation
Interdisciplinary Coordination
Phase III: Lateral System
Phase IV: Distribution Systems and Coordination

Results and Conclusions



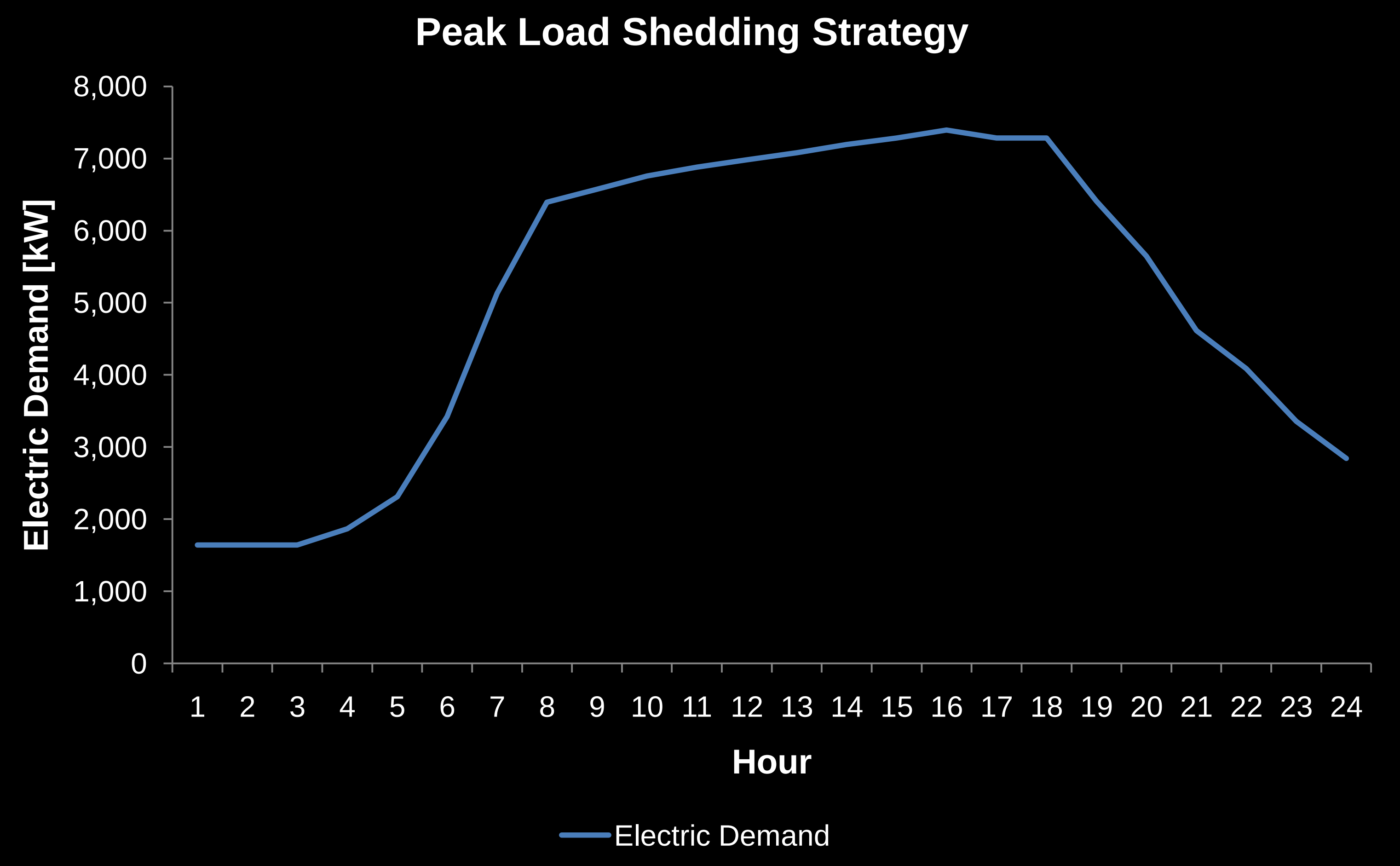
CHP Baseline: $ 10,983,700 / year

SHP Redesign: $ 12,081,500 / year

CHP Redesign: $ 8,773,200 / year

Energy cost reduction from existing building: 20%

Electric Load Control

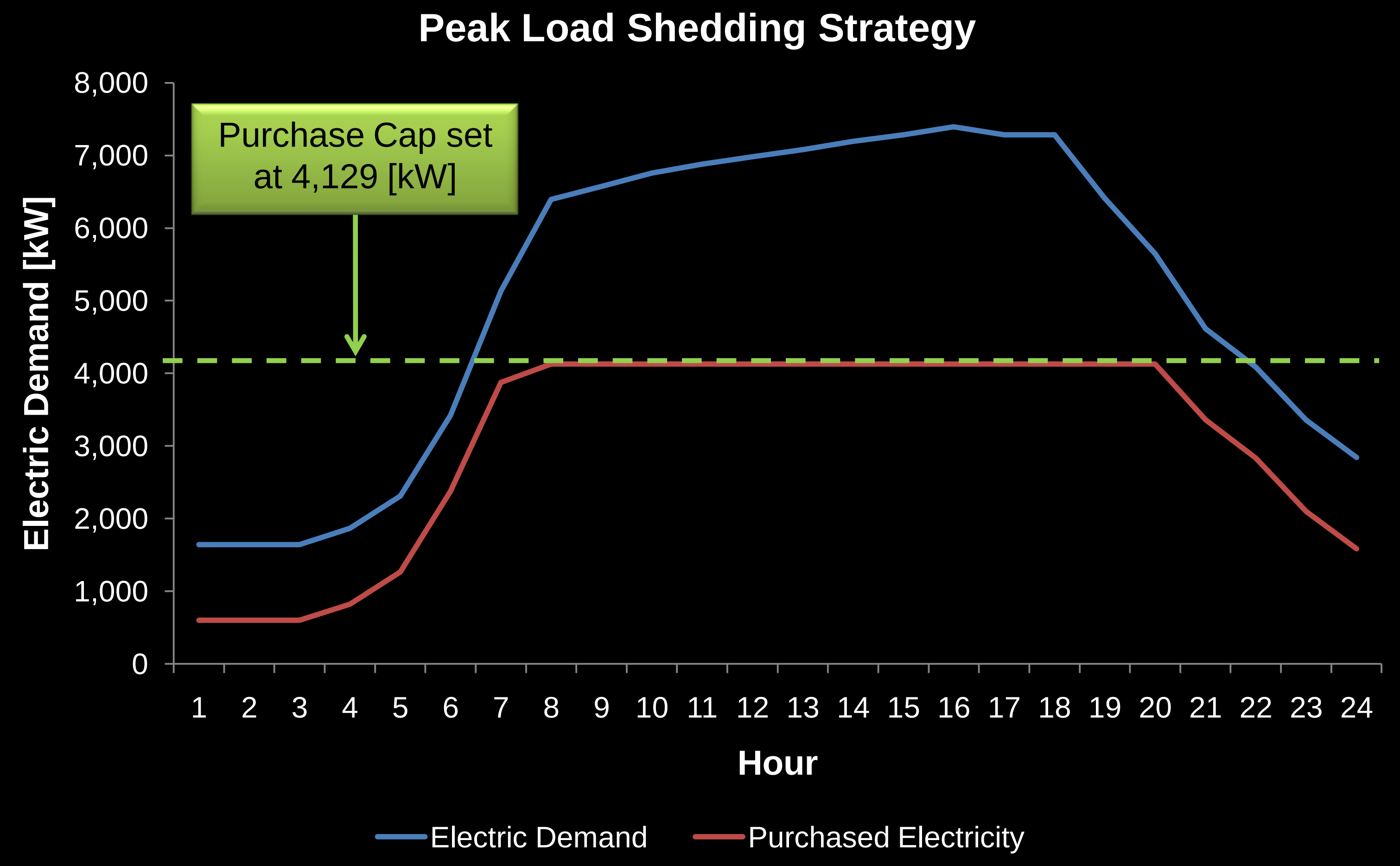


Building Overview

Team Workflow

Phase I : Façade
Phase II: Cogeneration
Plant Studies
System Operation
Interdisciplinary Coordination
Phase III: Lateral System
Phase IV: Distribution Systems and Coordination

Results and Conclusions



Electrical load shedding strategy

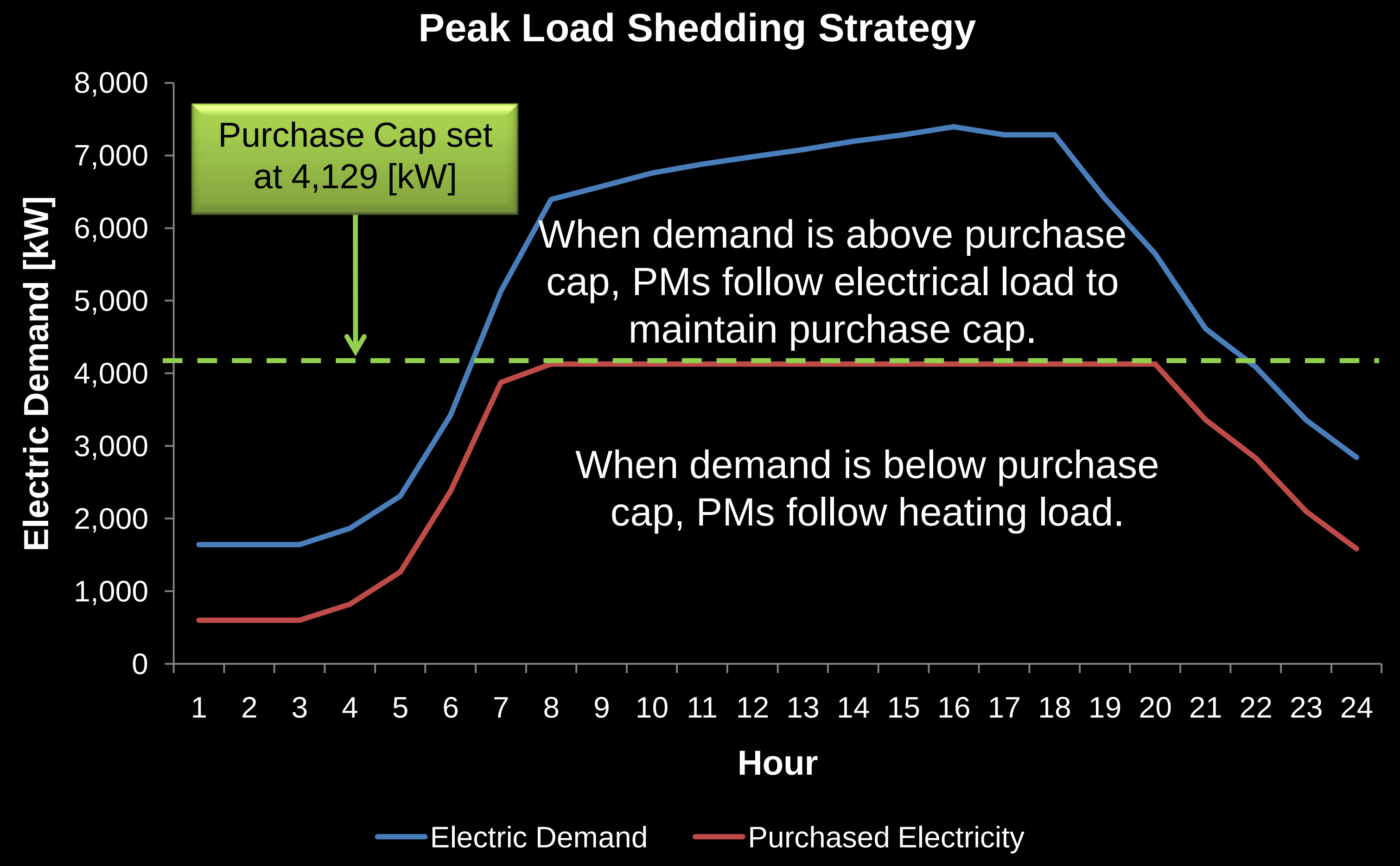
Building's peak electrical demand: 7,394 [kW]

Installed generation capacity: 3,265 [kW]

Recommended strategy: Peak purchase cap

- Guarantees no more that 4,129 [kW] be purchased from the utility

Electric Load Control



Electrical load shedding strategy

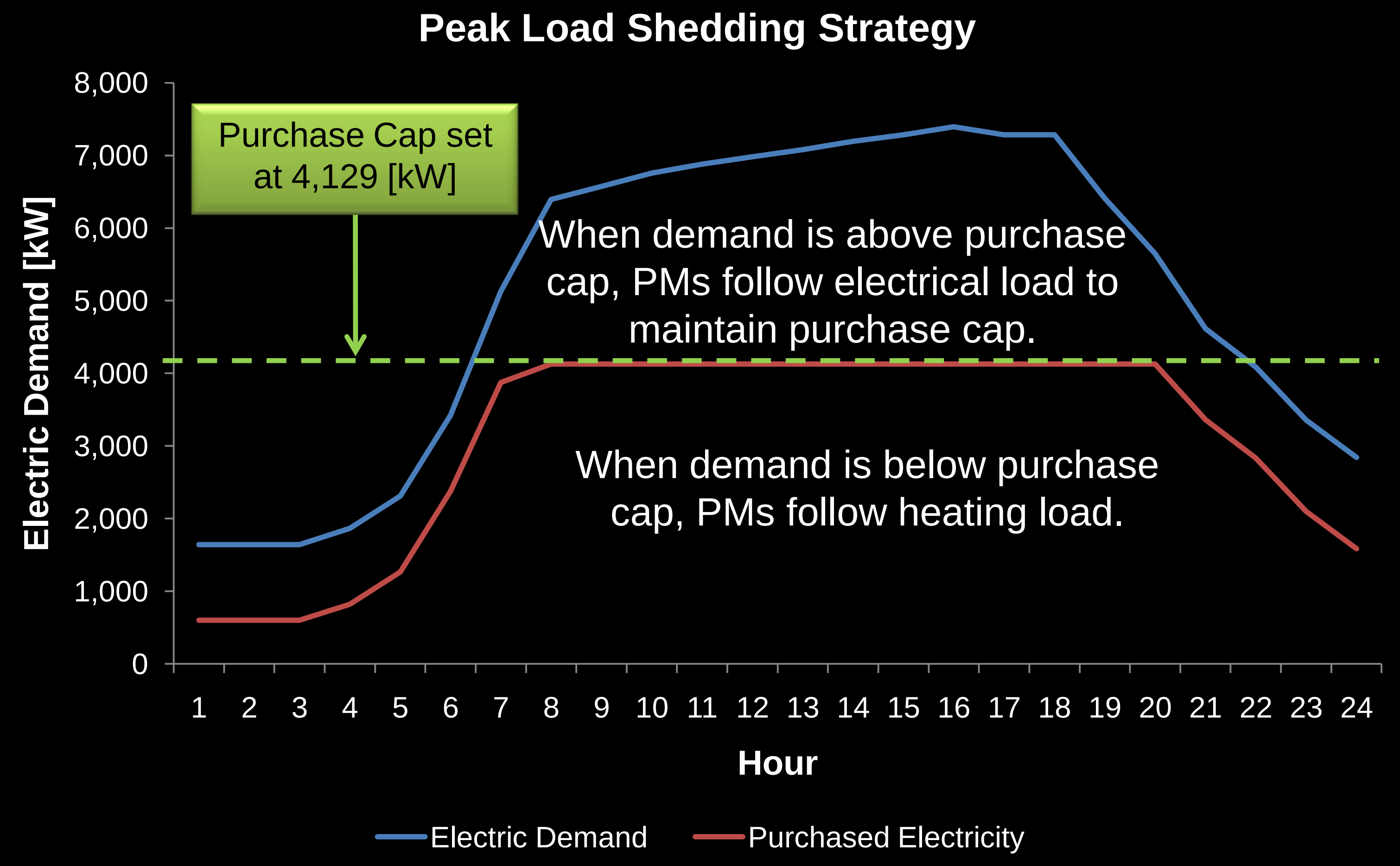
Building's peak electrical demand: 7,394 [kW]

Installed generation capacity: 3,265 [kW]

Recommended strategy: Peak purchase cap

- Guarantees no more that 4,129 [kW] be purchased from the utility

Electric Load Control



Electrical load shedding strategy

Building's peak electrical demand: 7,394 [kW]

Installed generation capacity: 3,265 [kW]

Recommended strategy: Peak purchase cap

- Guarantees no more that 4,129 [kW] be purchased from the utility

"Critical Peak Rebate Program"

NYT Building has lean burning generators which may act as localized emergency back-up for the utility

ConEd agrees to pay 1.50 [$/kW] in the case when the CHP plant has extra generating capacity and load relief is needed

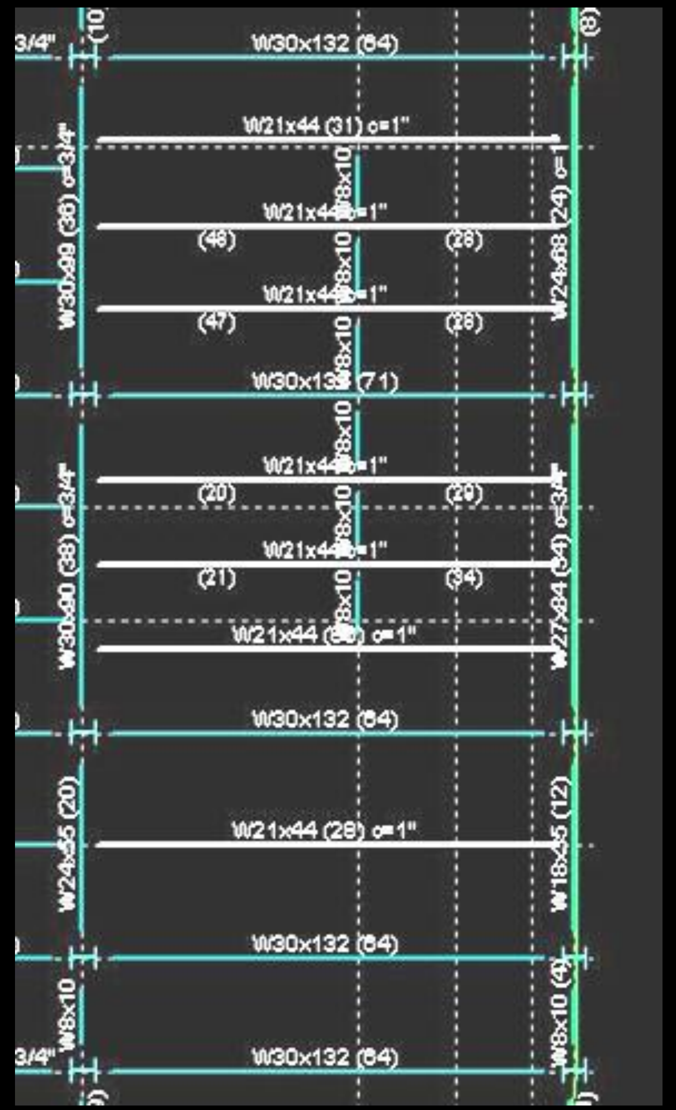
Podium framing

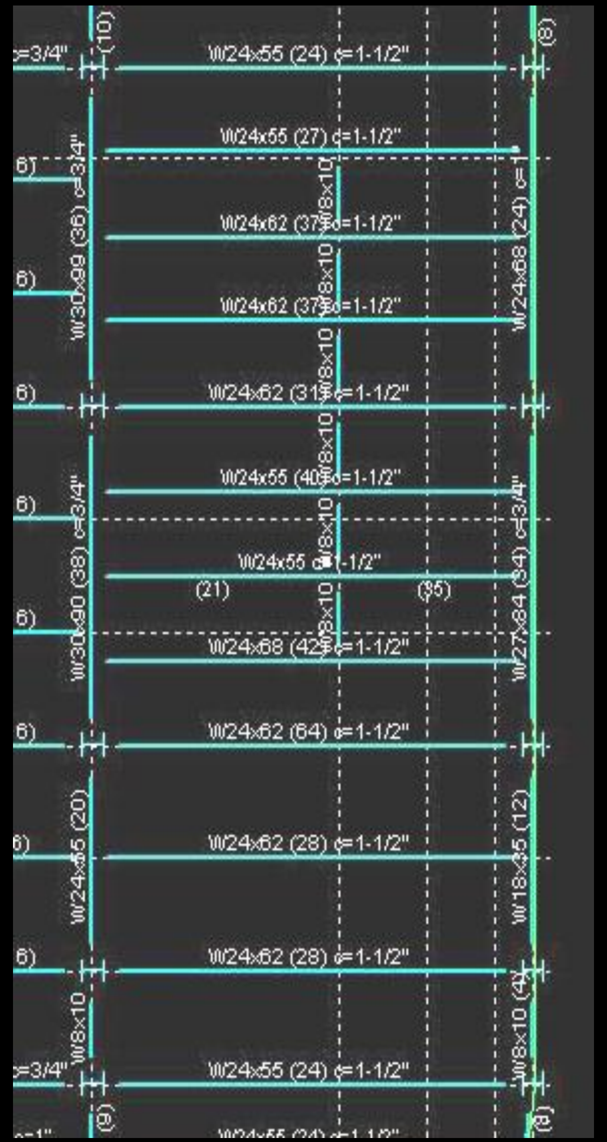
Larger area containing mechanical equipment

Located as far away from the tower as possible to prevent vibration effects

RAM Structural System used to analyze and redesign framing

- Existing W21x44 beam members not sufficient
- Increased to W24x62





Crane Selection

Item	Shipping Weight (lb)	Elevation (ft)	Horizontal Distance from Crane (ft)
Absorption Chiller	59,800	-16	40
Electric Chiller (Single Compressor)	37,701	-16	40
Electric Chiller (Dual Compressor)	78,890	-16	40
Internal Combustion Engine	20,560	80	180
Gas Turbine Engine	23,215	80	180

Crane Selection

Item	Shipping Weight (lb)	Elevation (ft)	Horizontal Distance from Crane (ft)
Absorption Chiller	59,800	-16	40
Electric Chiller (Single Compressor)	37,701	-16	40
Electric Chiller (Dual Compressor)	78,890	-16	40
Internal Combustion Engine	20,560	80	180
Gas Turbine Engine	**23,215**	**80**	**180**

440 ton Manitowoc 16000 crawler crane selected for controlling lift (by weight)

No increase to general conditions cost

Full data available in report

CHP Cost Comparison

	Equipment Cost ($)	Labor Cost ($)	Annual Operating Cost ($)
CHP Baseline	$3,673,500.00	$114,750.00	$10,983,700.00
CHP Redesign	$6,708,800.00	$255,000.00	$8,773,200.00
Difference	**($3,035,300.00)**	**($140,250.00)**	**$2,210,500.00**

Annual Savings	**$2,210,500.00**
Payback of Redesign	**3.15 Years**

CHP Cost Comparison

Building Overview

Team Workflow

Phase I : Façade
Phase II: Cogeneration
Plant Studies
System Operation
Interdisciplinary Coordination
Phase III: Lateral System
Phase IV: Distribution Systems and Coordination

Results and Conclusions

	Equipment Cost ($)	Labor Cost ($)	Annual Operating Cost ($)
CHP Baseline	$3,673,500.00	$114,750.00	$10,983,700.00
CHP Redesign	$6,708,800.00	$255,000.00	$8,773,200.00
Difference	**($3,035,300.00)**	**($140,250.00)**	**$2,210,500.00**

Annual Savings	**$2,210,500.00**
Payback of Redesign	**3.15 Years**

Loan Repayment Analysis

Interest Rate	Initial Annual PMT	FV of Loan at End Repayment Period	Annual Savings Applied to Payments	Potential PV w/ savings applied to payment	Potential NP w/ savings applied to payment
0.015	($50,242,255.52)	($1,256,056,387.88)	($2,210,500.00)	$1,086,800,700.55	23.74
0.02	($53,320,476.39)	($1,333,011,909.81)	($2,210,500.00)	$1,084,156,600.53	23.73
0.025	($56,501,233.81)	($1,412,530,845.22)	($2,210,500.00)	$1,081,727,084.08	23.72
0.03	($59,782,413.75)	($1,494,560,343.79)	($2,210,500.00)	$1,079,491,762.97	23.71
0.035	($63,161,670.86)	($1,579,041,771.57)	($2,210,500.00)	$1,077,432,388.01	23.69
0.04	($66,636,453.26)	($1,665,911,331.52)	($2,210,500.00)	$1,075,532,607.72	23.67
0.045	($70,204,028.19)	($1,755,100,704.71)	($2,210,500.00)	$1,073,777,755.91	23.65
0.05	($73,861,508.05)	($1,846,537,701.21)	($2,210,500.00)	$1,072,154,664.46	23.63

Given: $1.041 Billion initial loan (including redesign)

Assumed 25 year initial payback period

Loan Repayment Analysis

Interest Rate	Initial Annual PMT	FV of Loan at End Repayment Period	Annual Savings Applied to Payments	Potential PV w/ savings applied to payment	Potential NP w/ savings applied to payment
0.015	($50,242,255.52)	($1,256,056,387.88)	($2,210,500.00)	$1,086,800,700.55	23.74
0.02	($53,320,476.39)	($1,333,011,909.81)	($2,210,500.00)	$1,084,156,600.53	23.73
0.025	($56,501,233.81)	($1,412,530,845.22)	($2,210,500.00)	$1,081,727,084.08	23.72
0.03	**($59,782,413.75)**	**($1,494,560,343.79)**	**($2,210,500.00)**	**$1,079,491,762.97**	**23.71**
0.035	($63,161,670.86)	($1,579,041,771.57)	($2,210,500.00)	$1,077,432,388.01	23.69
0.04	($66,636,453.26)	($1,665,911,331.52)	($2,210,500.00)	$1,075,532,607.72	23.67
0.045	($70,204,028.19)	($1,755,100,704.71)	($2,210,500.00)	$1,073,777,755.91	23.65
0.05	($73,861,508.05)	($1,846,537,701.21)	($2,210,500.00)	$1,072,154,664.46	23.63

Given: $1.041 Billion initial loan (including redesign)

Assumed 25 year initial payback period

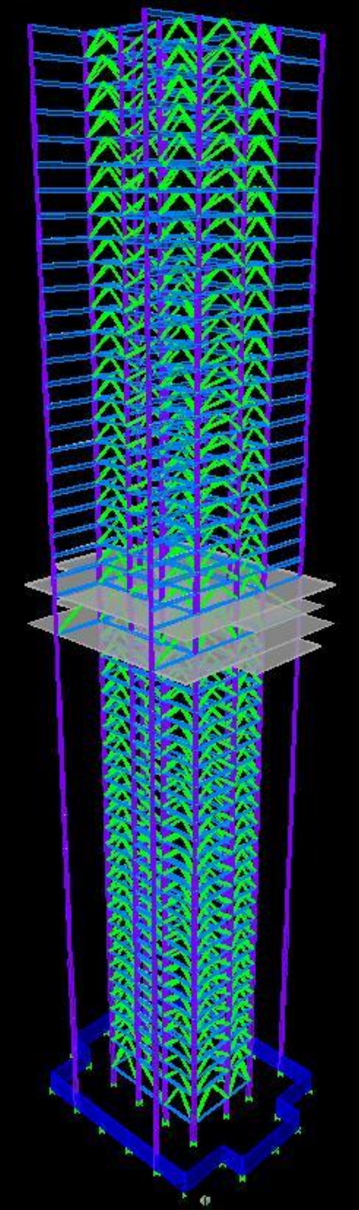
With monthly utility savings applied to loan payments:

Owner can borrow an **additional $38 Million**

Owner can pay back loan **1.3 years faster**

Phase III :

Lateral Systems

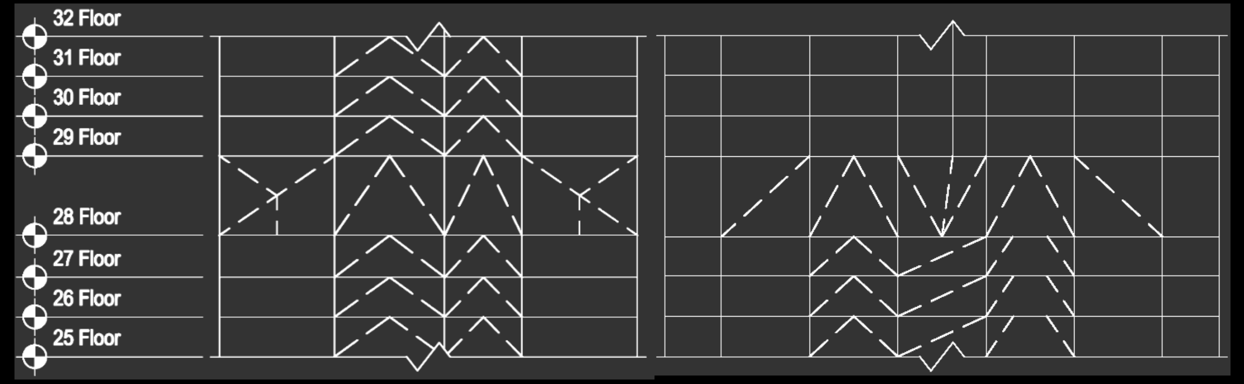


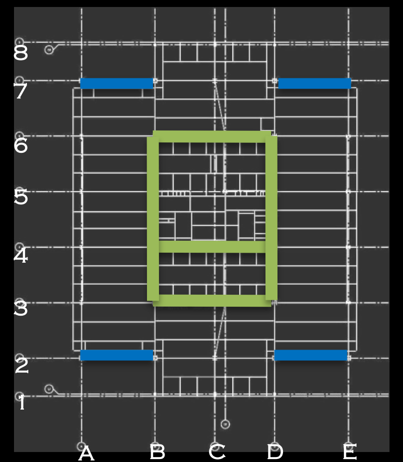
Structural Overview: Lateral system

Steel eccentric and concentric chevron braced frames

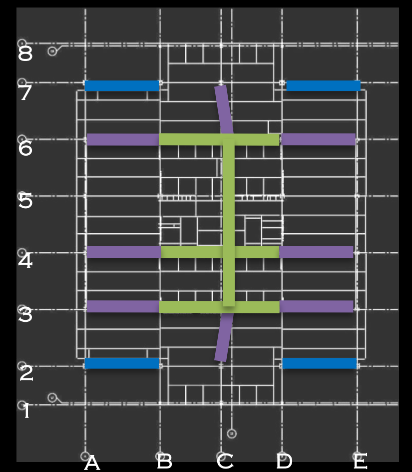
Exterior X-braces: pre-stressed rods

Outrigger level at 28th and 51st floors





below 28th floor



above 28th floor

N

Goals for Redesign

Create a penthouse level by removing the outrigger at the 51st level

- Bring in revenue with new space

Eliminate exterior X-braces for efficiency

Take advantage of extra structural depth with moment frames

Meet original design criteria

- Drift: H/450
- Periods of vibration: 6.25 seconds – 6.75 seconds

Option 1

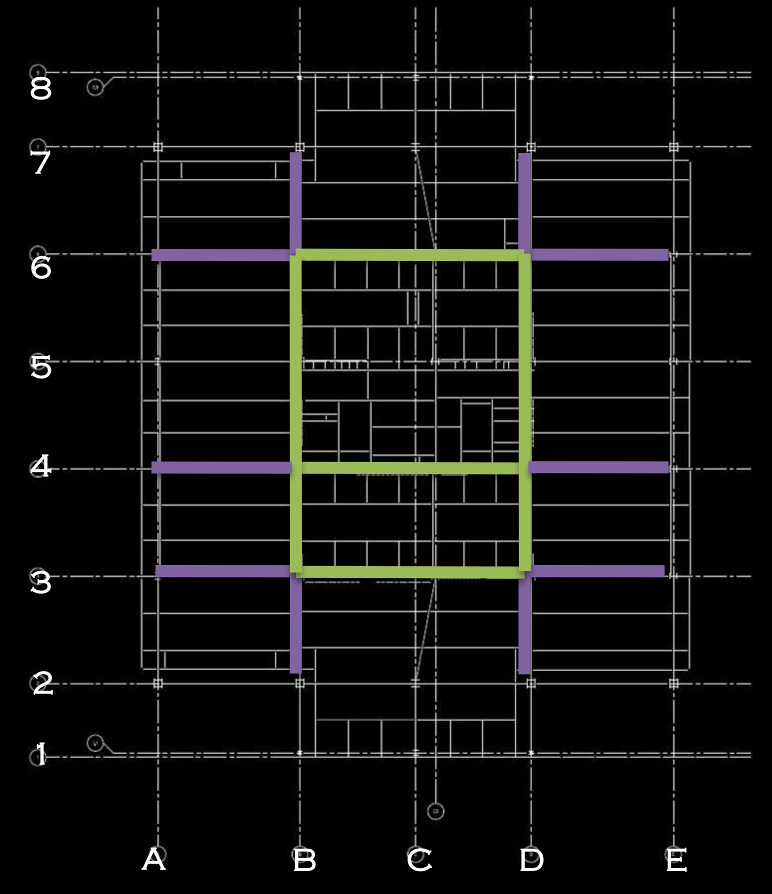
Moment frames in both the N-S and E-W directions provide stiffness in lieu of 51st outrigger

Concentric steel braces replace eccentric braces

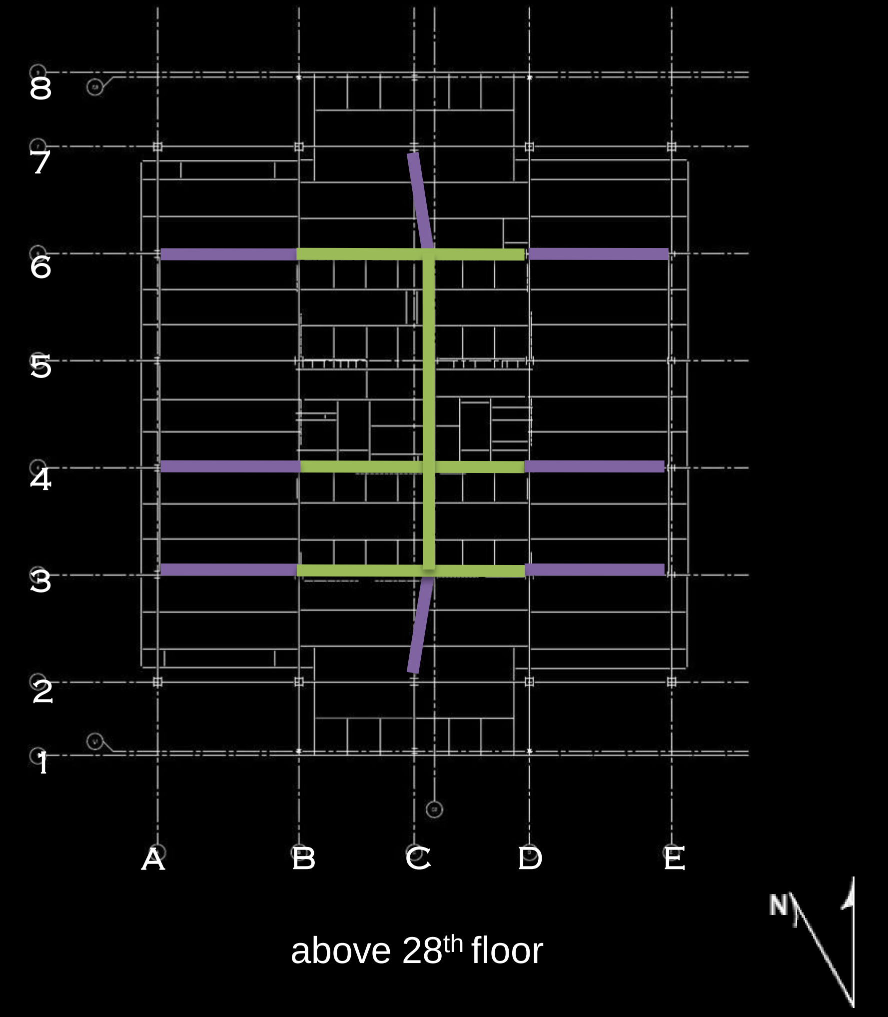
System is heavier due to amount of moment frames/added steel

N-S moment frames skewed along grid C

Not considered further



below 28th floor



above 28th floor

Option 2

Moment frames only in the E-W direction

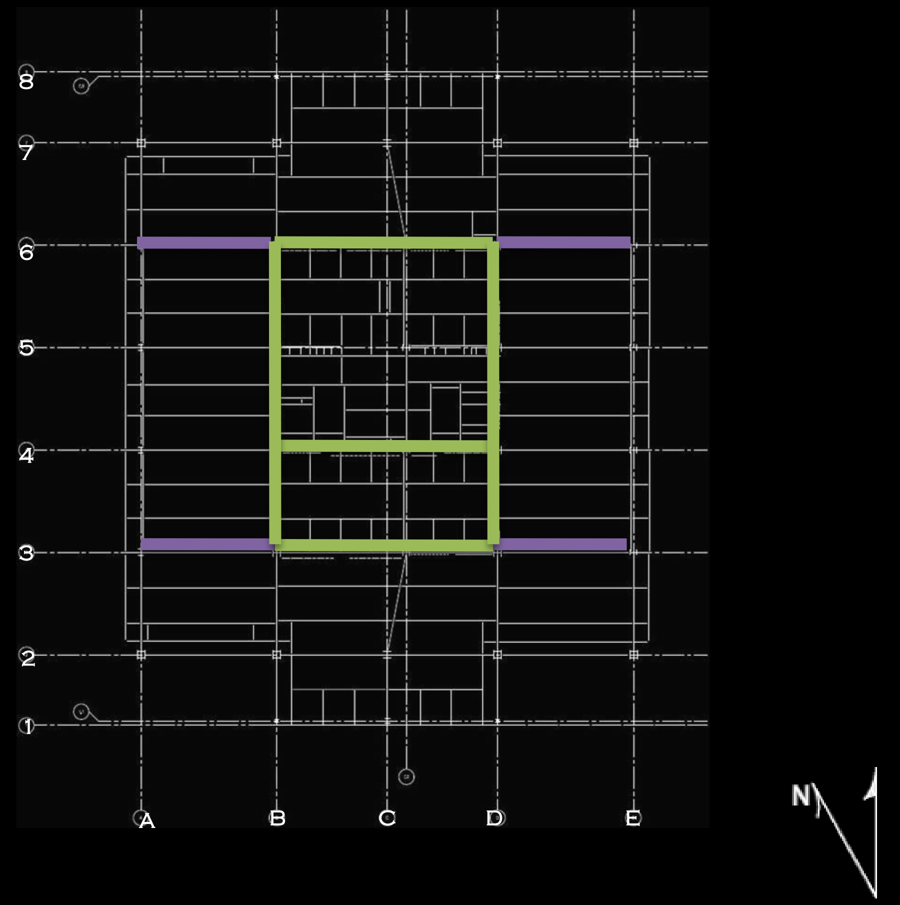
- Bracing members lighter due to contributing stiffness

E-W is much stiffer than N-S

Look into adding stiffness in N-S direction

Can eliminate some E-W members

Not considered further



Option 3

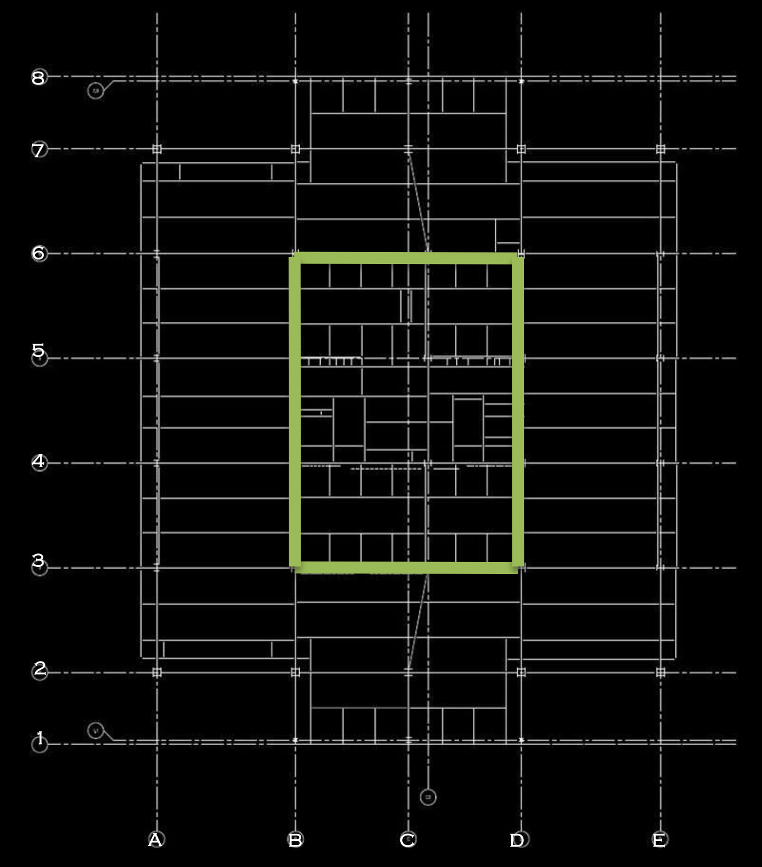
Moment frames only in the E-W direction

Symmetry in both directions

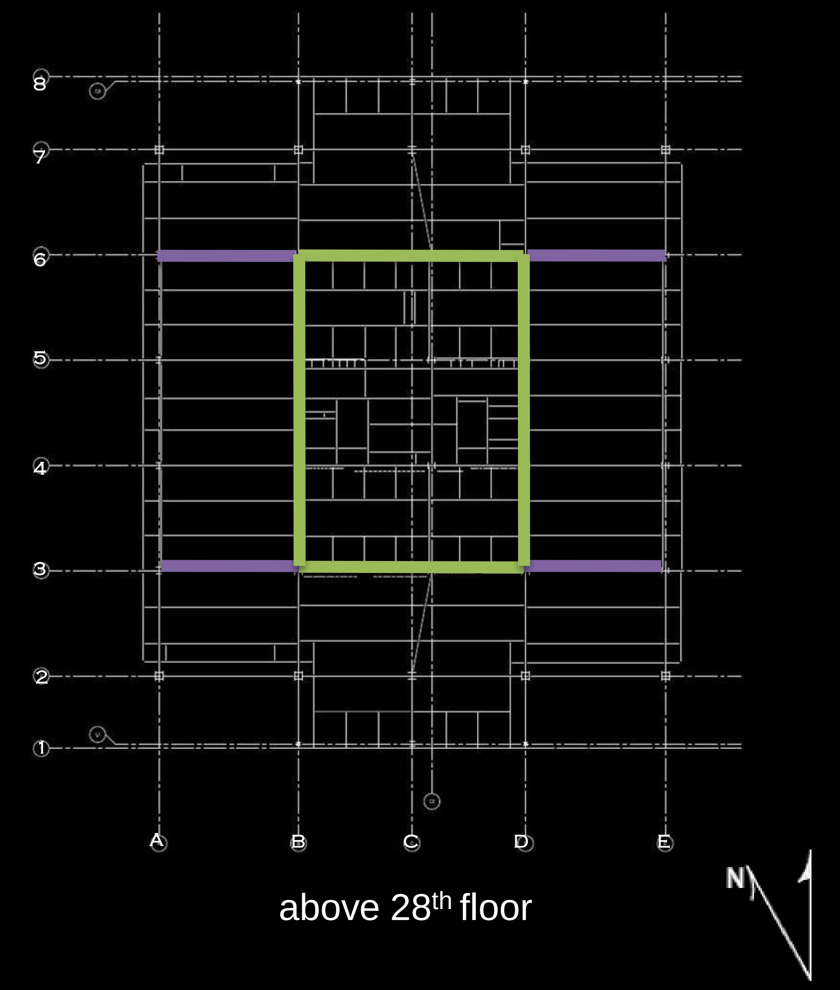
- E-W line of bracing removed
- N-S line of bracing added

Members in the N-S direction able to be lighter

System chosen for further analysis



below 28th floor



above 28th floor

Lateral system

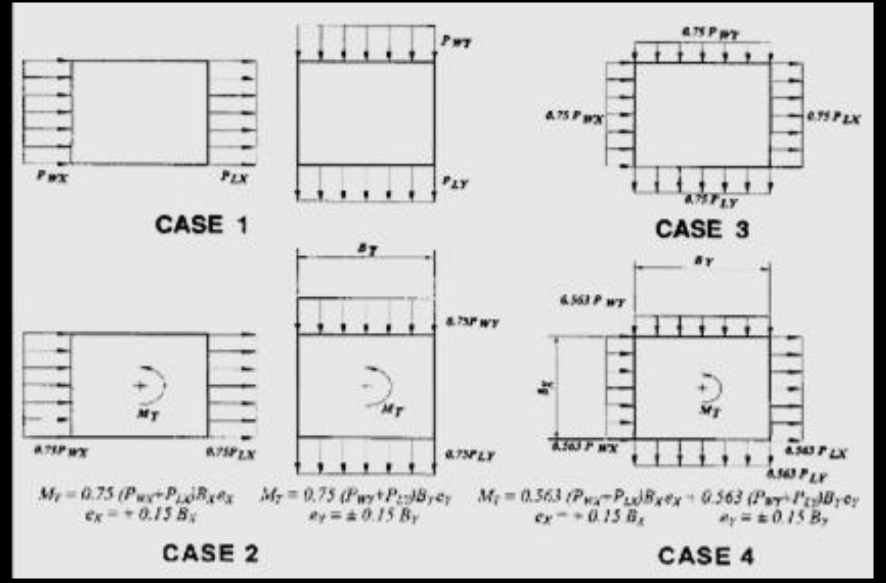
Used wind tunnel base shear

Approximately 2/3 that determined via ASCE 7-05

Cases 1-4 were considered

- Symmetrical system eliminates inherent torsion
- Case 1 controlled the design

Bracing sizes based on strength calculated in Excel spreadsheet



Lateral system

Modeled in 3D in ETABS using rigid and semi-rigid diaphragms

Dynamic analysis for periods of vibration

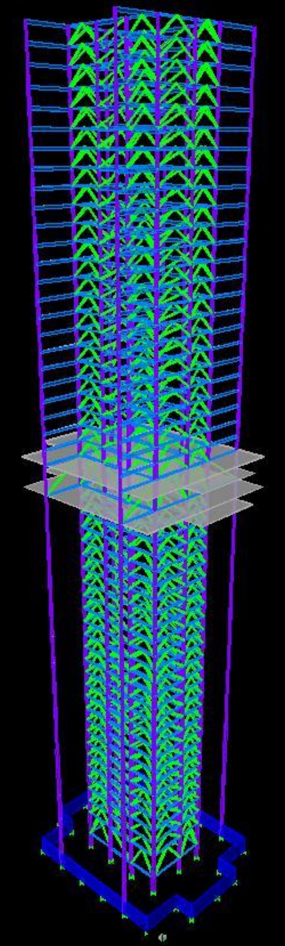
User-defined members - built-up and box columns

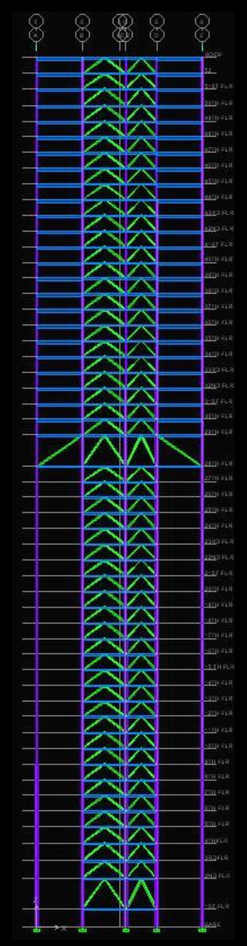
P-delta effects

Shear and axial deformations

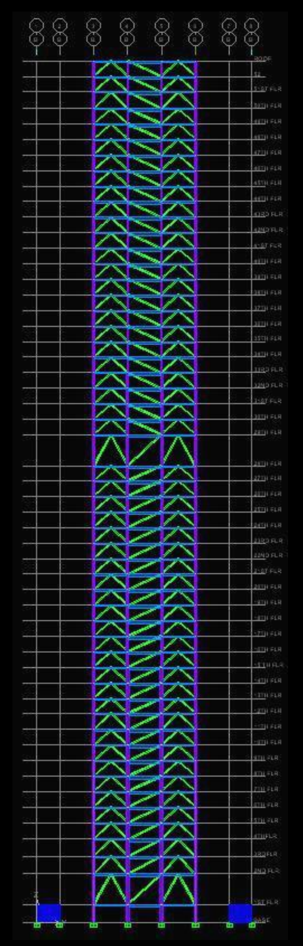
Panel zones explicitly modeled

Sizes grouped





E-W



N-S

Lateral system

Concentric braces used throughout due to newly ducted mechanical system

Bracing sizes increased to meet drift and period requirements

Original system: W14x68 to W14x455

New system: W14x53 to W14x176 (with additional N-S bracing line)

BRACING SIZES

	N/S Brace Existing			E/W Brace Existing		N/S Brace Proposed		E/W Brace Proposd	
Level	*Chevron Brace*	*Ecc. Brace*	*Single Diag.*	*Long Chevron*	*Short Chevron*	*Section*	*Weight*	*Section*	*Weight*
Roof	W14x159	W14x193	W14x159	W14x82	W14x68	W14	68	W14	53
52	W14x159	W14x193	W14x159	W14x82	W14x68	W14	68	W14	53
51	W14x159	W14x193	W14x159	W14x82	W14x68	W14	68	W14	53
50	W14x159	W14x193	W14x159	W14x82	W14x68	W14	68	W14	53
49	W14x257	W14x159	W14x398	W14x90	W14x68	W14	82	W14	61
48	W14x257	W14x159	W14x398	W14x90	W14x68	W14	82	W14	61
12	W14x283	W14x90	W14x283	W14x120	W14x90	W14	145	W14	159
11	W14x283	W14x90	W14x283	W14x120	W14x90	W14	145	W14	159
10	W14x283	W14x90	W14x283	W14x120	W14x90	W14	145	W14	159
9	W14x283	W14x90	W14x283	W14x120	W14x90	W14	145	W14	159
8	W14x283	W14x90	W14x283	W14x120	W14x90	W14	145	W14	159
7	W14x283	W14x159	W14x311	W14x132	W14x109	W14	159	W14	176
6	W14x283	W14x159	W14x311	W14x132	W14x109	W14	159	W14	176
5	W14x283	W14x159	W14x311	W14x132	W14x109	W14	159	W14	176
4	W14x283	W14x159	W14x311	W14x132	W14x109	W14	159	W14	176
3	W14x283	W14x159	W14x311	W14x132	W14x109	W14	159	W14	176
2	W14x283	W14x159	W14x311	W14x132	W14x109	W14	159	W14	176

Lateral system

3.5% structural weight savings
- 21.9 psf existing
- 21.1 psf new

Periods of vibration
- 6.7 seconds in E-W
- 6.3 seconds in N-S

Drift limit of 19.9” (H/450)
- E-W drift: 17.9”
- N-S drift: 13.4”

Lateral system

Thermal movement study

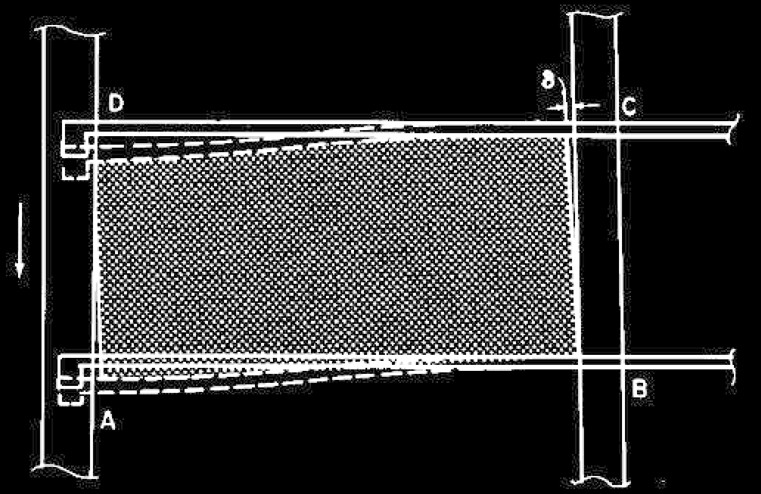
Outriggers controlled differential movement

Causes floor racking and partition separation

Δ_{28} = 6.45x10^{-6} in/in- F * (12in * 357.5') * 120 F = 3.32 inches

Allowable floor deflection L/180= 2.66"

Thermal movement of exterior exposed columns is an issue



Lateral system

Two options found

- Belt truss or outrigger
- Heat/cool columns

Controlling the temperature would likely increase costs

“Thermal” truss relocated to roof

Lateral system could be revisited utilizing truss for additional stiffness

- Bracing members could be optimized further

Mechanical Equipment Relocation

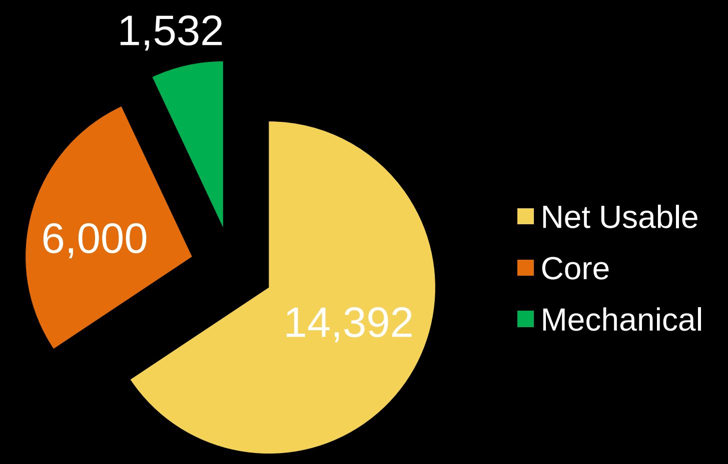
Building Overview

Phase I : Façade
Phase II: Cogeneration
Phase III: Lateral System
- Preliminary Study
- Redesign
- Mechanical Relocation
- Progressive Collapse

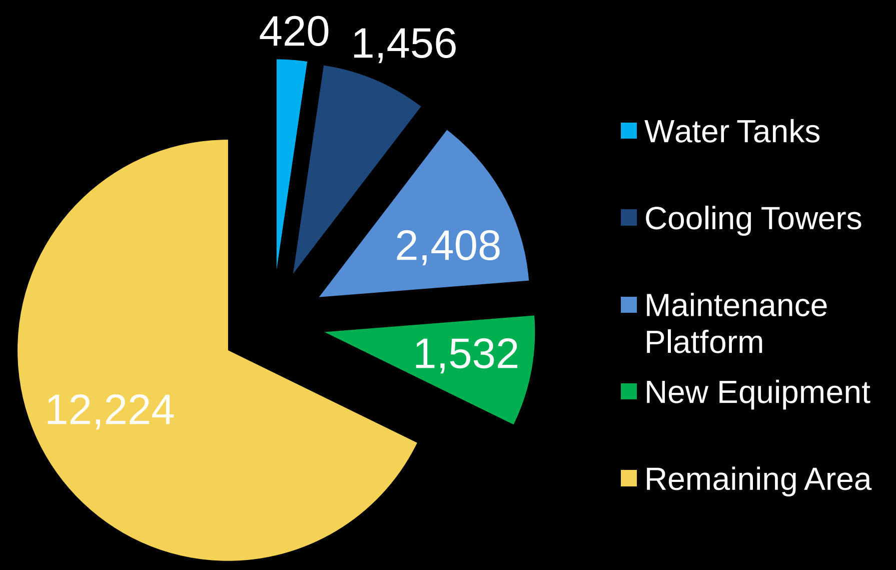
Phase IV: Distribution Systems and Coordination

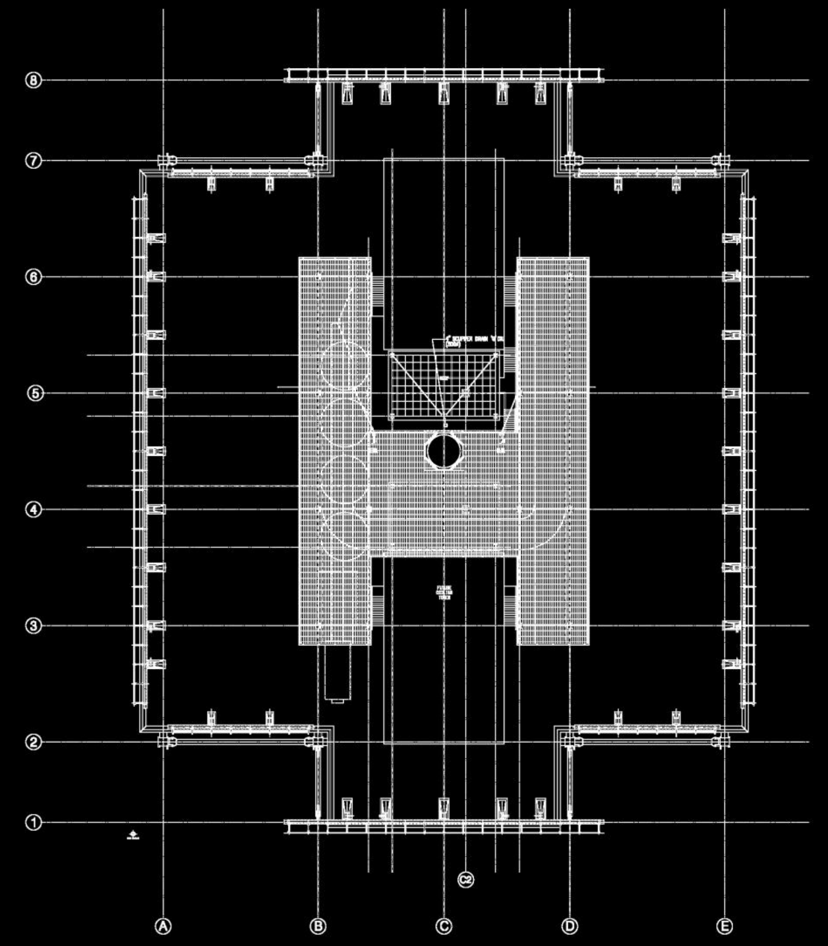
Results and Conclusions

Space Requirements for 51st Floor [ft^2]



Space Requirements for Roof [ft^2]





Mechanical Equipment Relocation

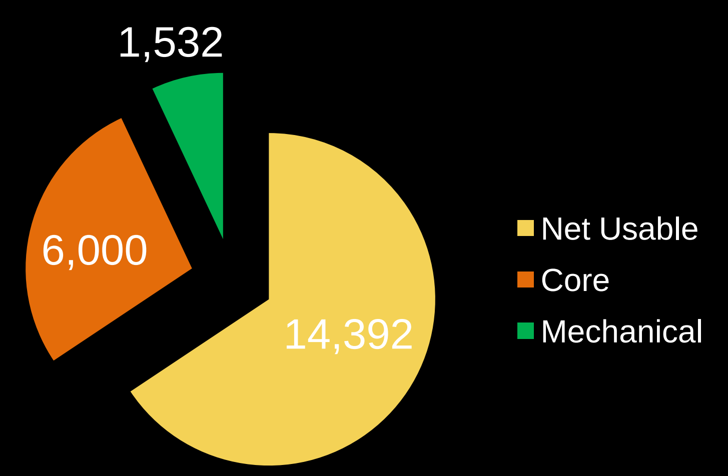
Building Overview

Phase I : Façade
Phase II: Cogeneration
Phase III: Lateral System
- Preliminary Study
- Redesign
- Mechanical Relocation
- Progressive Collapse

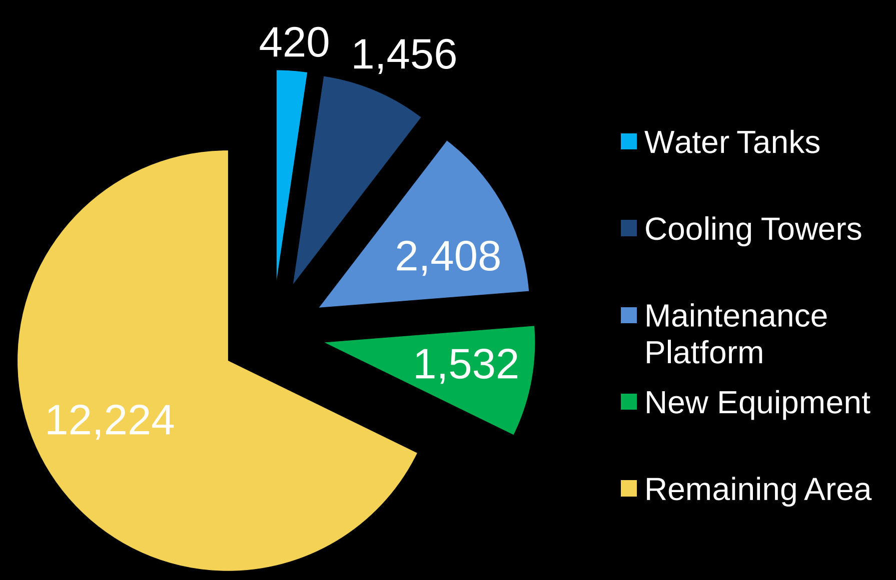
Phase IV: Distribution Systems and Coordination

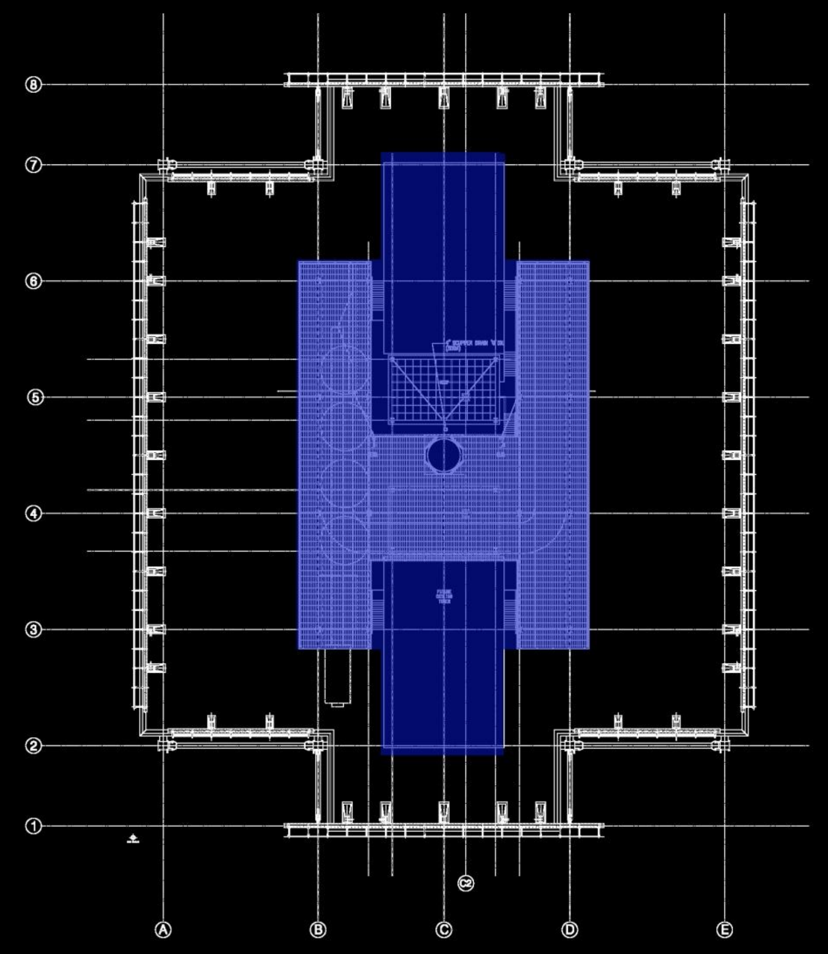
Results and Conclusions

Space Requirements for 51st Floor [ft²]



Space Requirements for Roof [ft²]





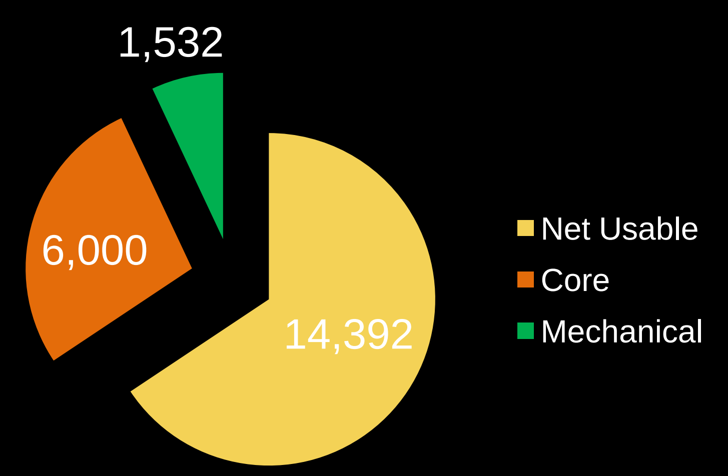
Mechanical Equipment Relocation

Building Overview

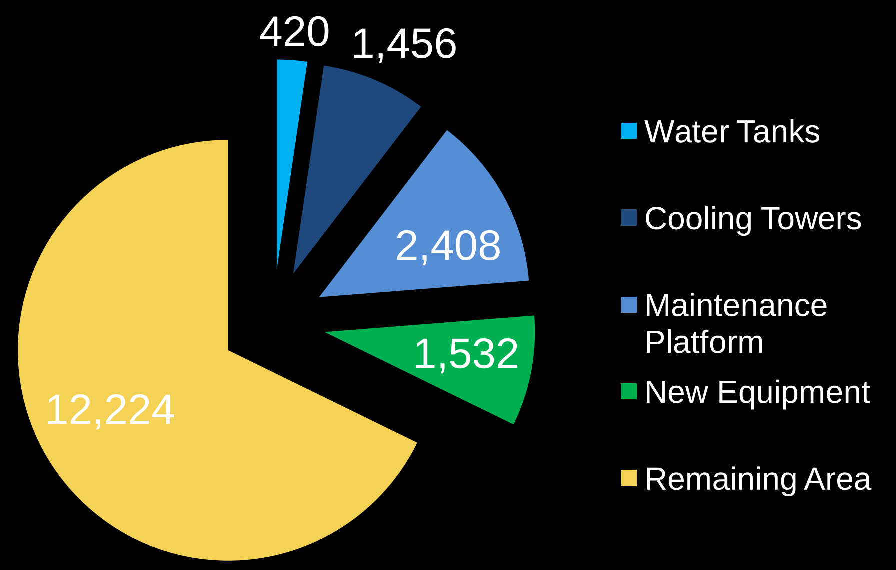
Phase I : Façade
Phase II: Cogeneration
Phase III: Lateral System
Preliminary Study
Redesign
Mechanical Relocation
Progressive Collapse
Phase IV: Distribution Systems and Coordination

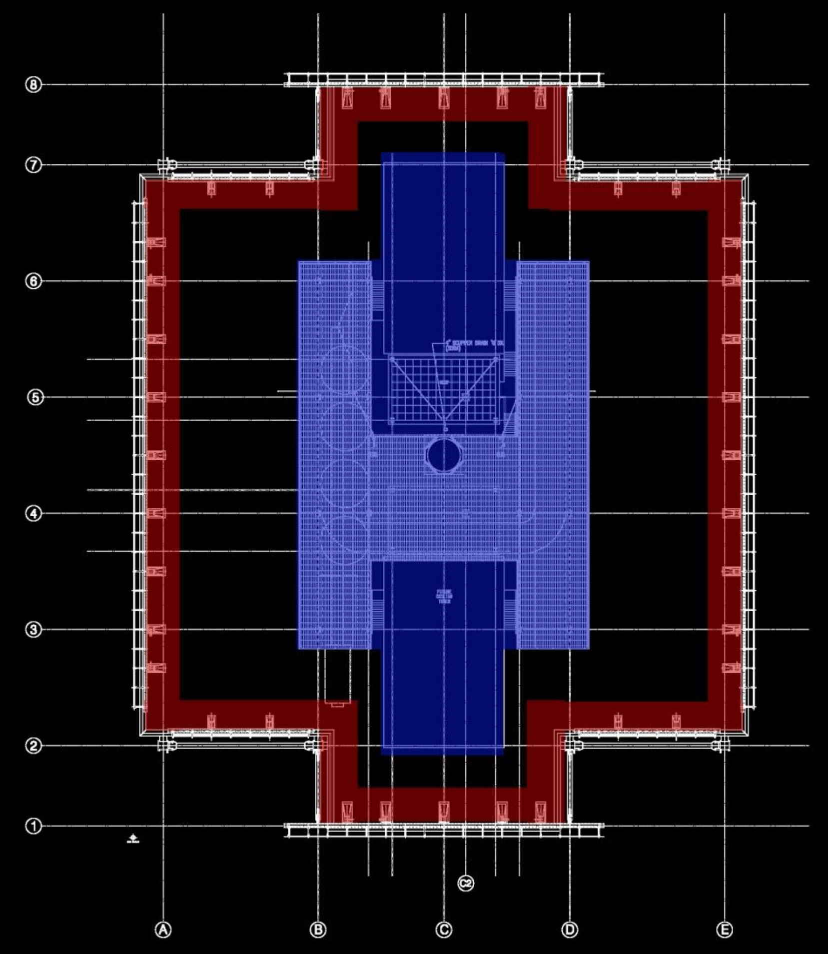
Results and Conclusions

Space Requirements for 51st Floor [ft^2]



Space Requirements for Roof [ft^2]





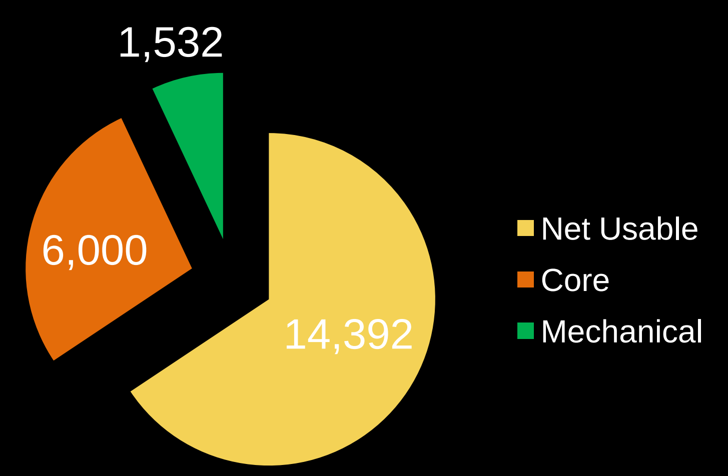
Mechanical Equipment Relocation

Building Overview

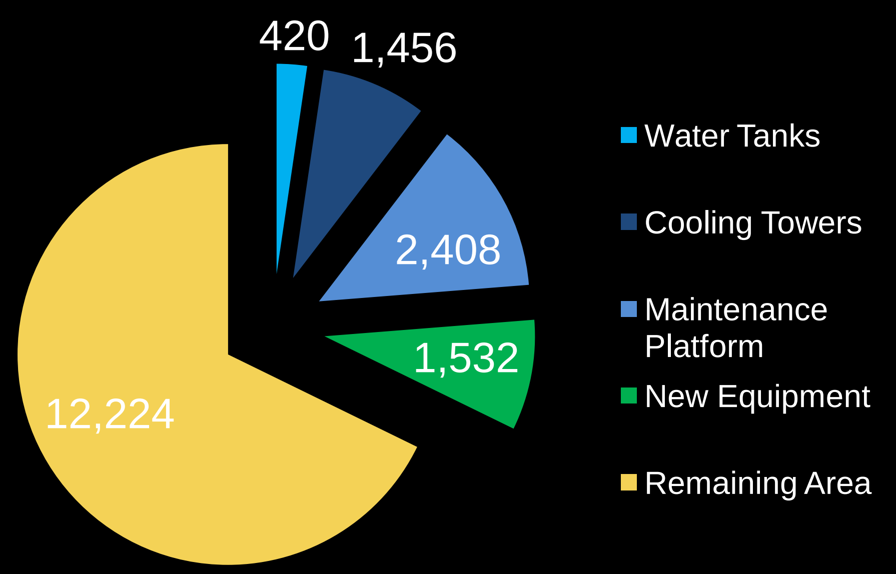
Phase I : Façade
Phase II: Cogeneration
Phase III: Lateral System
Preliminary Study
Redesign
Mechanical Relocation
Progressive Collapse
Phase IV: Distribution Systems and Coordination

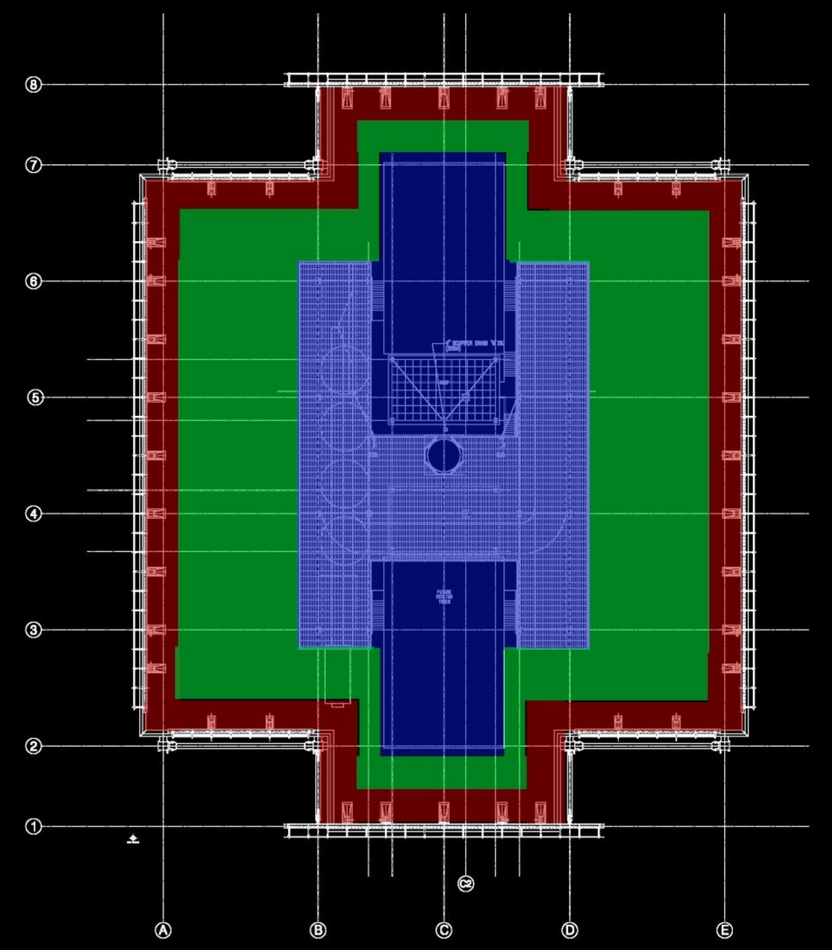
Results and Conclusions

Space Requirements for 51st Floor [ft²]



Space Requirements for Roof [ft²]





Progressive collapse

Building Overview

Phase I : Façade
Phase II: Cogeneration
Phase III: Lateral System
Preliminary Study
Redesign
Mechanical Relocation
Progressive Collapse
Phase IV: Distribution Systems and Coordination

Results and Conclusions

Linear-static method: GSA

Considers redistribution within frame of LC 2(1.0D + 0.25L)

Modeled and analyzed as a 2D frame in ETABS

Calculated DCR based on plastic moments

- All members failed: potential for progressive collapse

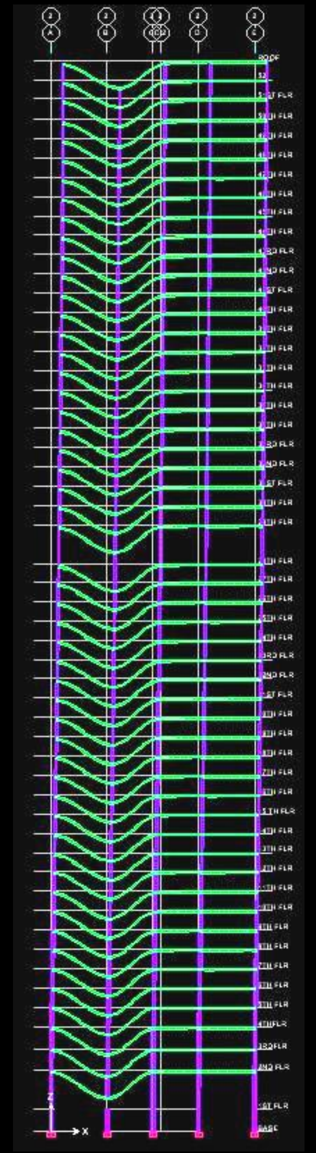
Nonlinear-static method: GSA

Virtual work used for analysis: does not consider redistribution

- All members failed: potential for progressive collapse

Should be modeled as a 3D frame in ETABS as DoD requires

- Considers redistribution of loads to other frames and bays



PROGRESSIVE COLLAPSE LINEAR STATIC ANALYSIS

	beam shear (k)		beam moment ('k)		allowable shear (k)				allowable moment (k)				required section			
	2, A&B	2, B&C	2, A&B	2, B&C	2, A&B	check	2, B&C	check	2, A&B	check	2, B&C	check	2, A&B	section	2, B&C	section
level	W18x50	W16x36	W18x50	W16x36	W18x50	DCR<2	W16x36	DCR<2	W18x50	DCR<3	W16x36	DCR<3	ΦMp		ΦMp	
2	190.90	198.40	3796.4	3214.1	192	OK	140	OK	379	NG!!	240	NG!!	1270	W30x108	1075	W30x99
3	189.82	199.01	3772.1	3222.4	192	OK	140	OK	379	NG!!	240	NG!!	1262	W30x108	1078	W30x99
4	188.73	199.65	3752.1	3234.2	192	OK	140	OK	379	NG!!	240	NG!!	1255	W30x108	1082	W30x99
5	187.62	199.99	3730.6	3239.9	192	OK	140	OK	379	NG!!	240	NG!!	1248	W30x108	1084	W30x99
6	186.67	200.16	3711.6	3242.6	192	OK	140	OK	379	NG!!	240	NG!!	1241	W30x108	1084	W30x99
7	185.85	200.23	3695.2	3243.7	192	OK	140	OK	379	NG!!	240	NG!!	1236	W30x108	1085	W30x99
8	185.11	200.19	3680.1	3237.4	192	OK	140	OK	379	NG!!	240	NG!!	1231	W30x108	1083	W30x99
9	184.43	200.02	3665.1	3240.3	192	OK	140	OK	379	NG!!	240	NG!!	1226	W30x108	1084	W30x99
10	183.29	199.82	3638.7	3237.0	192	OK	140	OK	379	NG!!	240	NG!!	1217	W30x108	1083	W30x99

Component/Action	Values for Linear Procedures DCR
Beams – flexure	
a. $\frac{b_f}{2t_f} \le \frac{52}{\sqrt{F_{ye}}}$ and $\frac{h}{t_w} \le \frac{418}{\sqrt{F_{ye}}}$	3
b. $\frac{b_f}{2t_f} \ge \frac{65}{\sqrt{F_{ye}}}$ or $\frac{h}{t_w} \ge \frac{640}{\sqrt{F_{ye}}}$	2
c. Other	Linear interpolation between the values on lines a and b for both flange slenderness (first term) and web slenderness (second term) shall be performed, and the lowest resulting value shall be used.

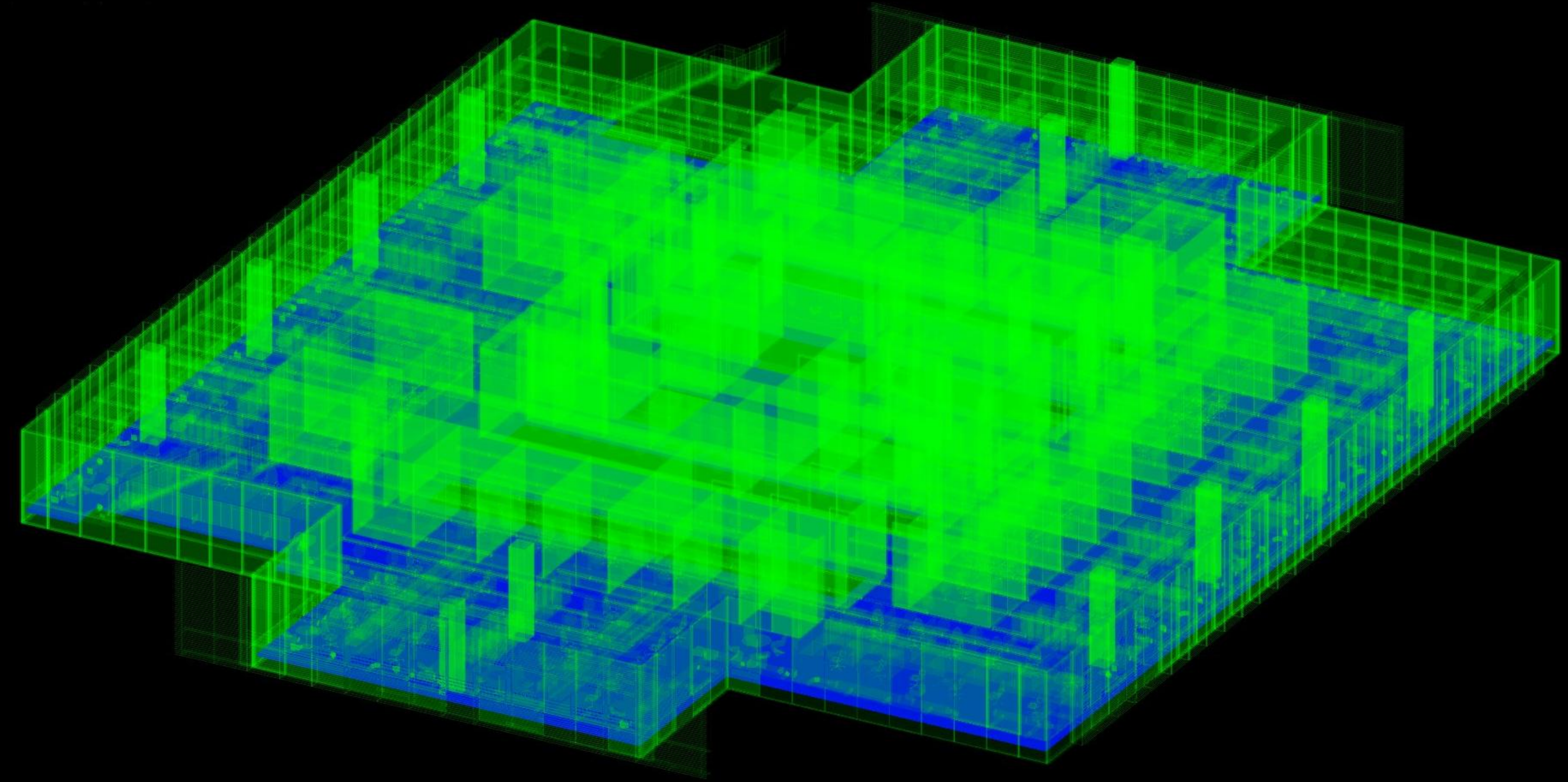
Building Overview

Phase I : Façade
Phase II: Cogeneration
Phase III: Lateral System
Phase IV: Distribution Systems and Coordination

Results and Conclusions

Phase IV :

Distribution Systems and Coordination



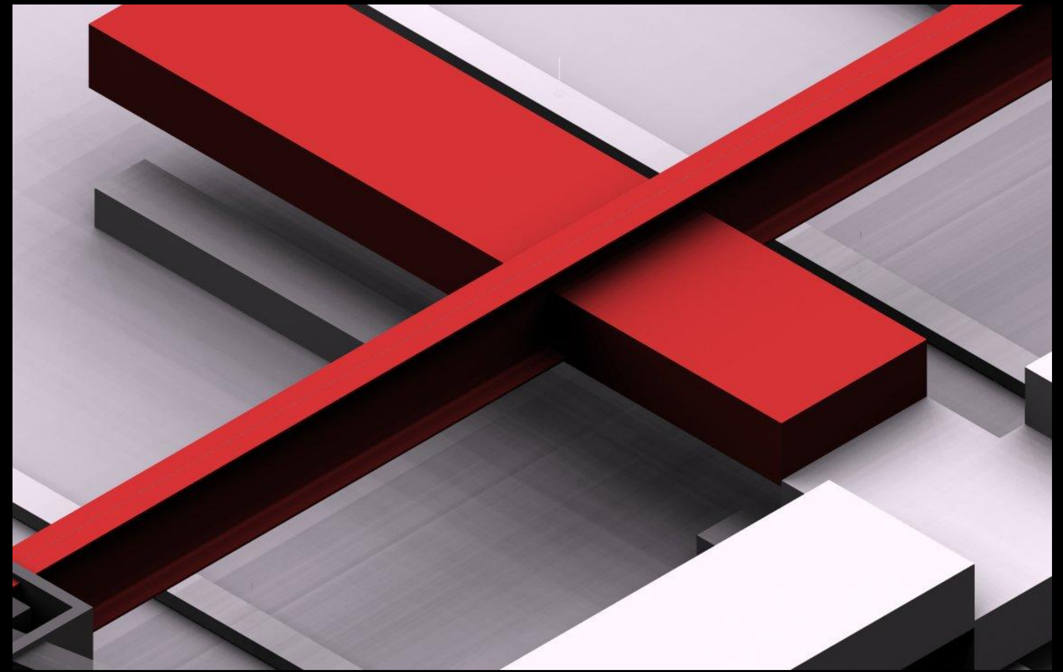
Proposed Mechanical Distribution

Removal of UFAD

Issues with long-term indoor air quality

Thermal comfort problems due to localized under/over pressurization

Proposed Mechanical Distribution



30 x 132 beam clashing with a 24” x 80” duct (recreated in Navisworks)

Removal of UFAD

Issues with long-term indoor air quality

Thermal comfort problems due to localized under/over pressurization

Elimination of VAV

Proposal included a comparison between an all-air variable air volume system (VAV) and a dedicated outdoor air system with active chilled beams

New structural space requirements eliminated the feasibility of a VAV system

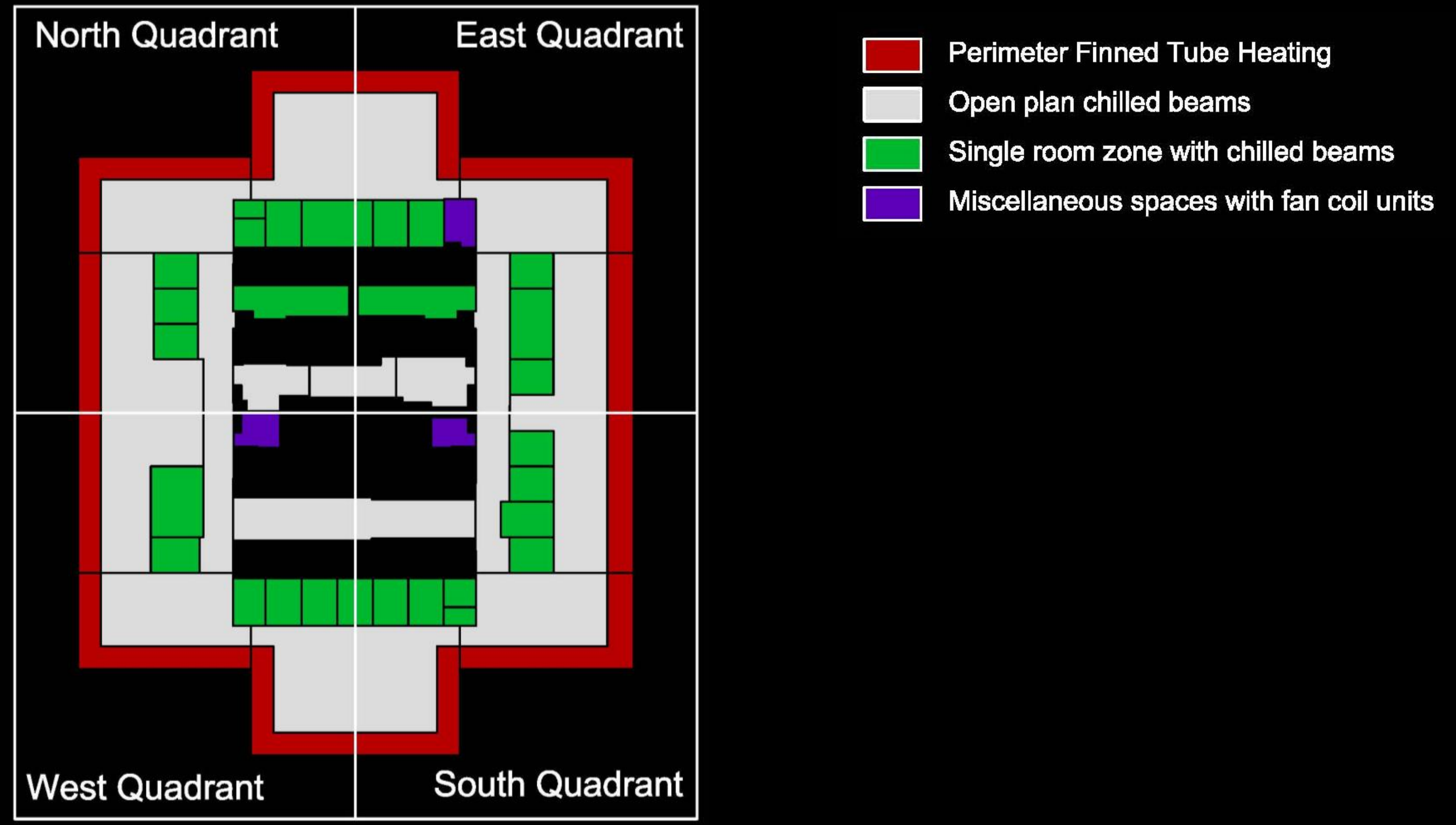
<u>Selected a dedicated outdoor air system (DOAS) with active chilled beams (ACB)</u>

System Selection

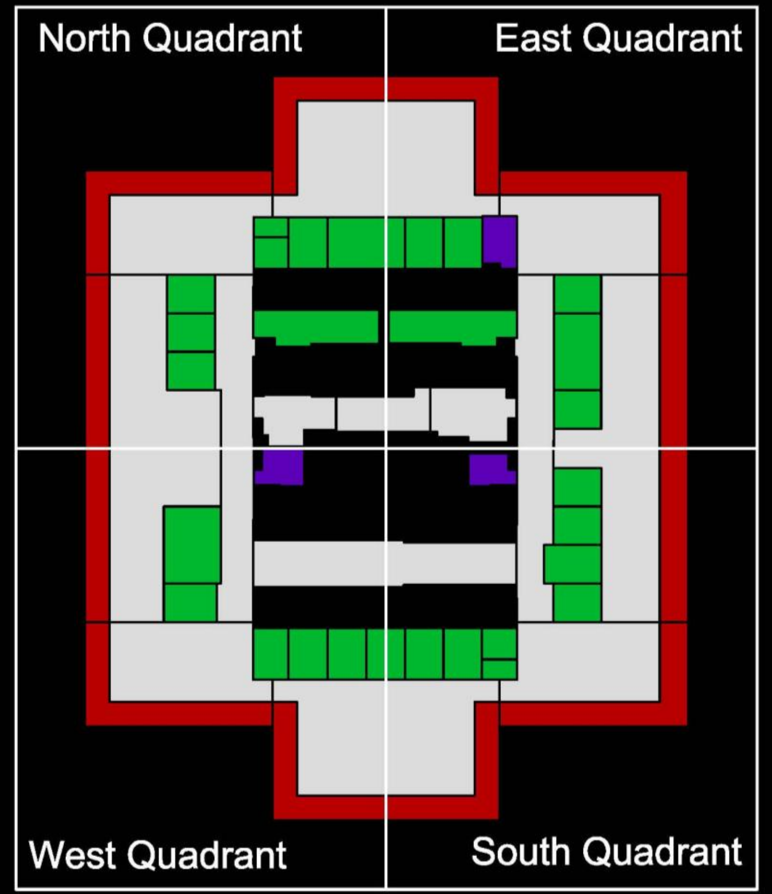
Building Overview

Phase I : Façade
Phase II: Cogeneration
Phase III: Lateral System
Phase IV: Distribution Systems and Coordination
- Mechanical
- Electrical
- Coordination
- SIPS Sequencing

Results and Conclusions

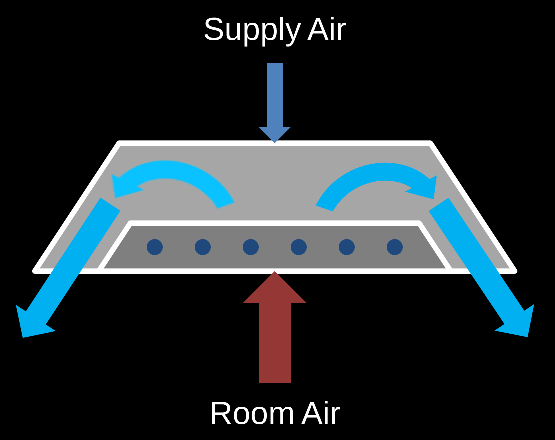


System Selection



- Perimeter Finned Tube Heating
- Open plan chilled beams
- Single room zone with chilled beams
- Miscellaneous spaces with fan coil units

Active Chilled Beam



Design considerations

Easy to implement demand controlled ventilation

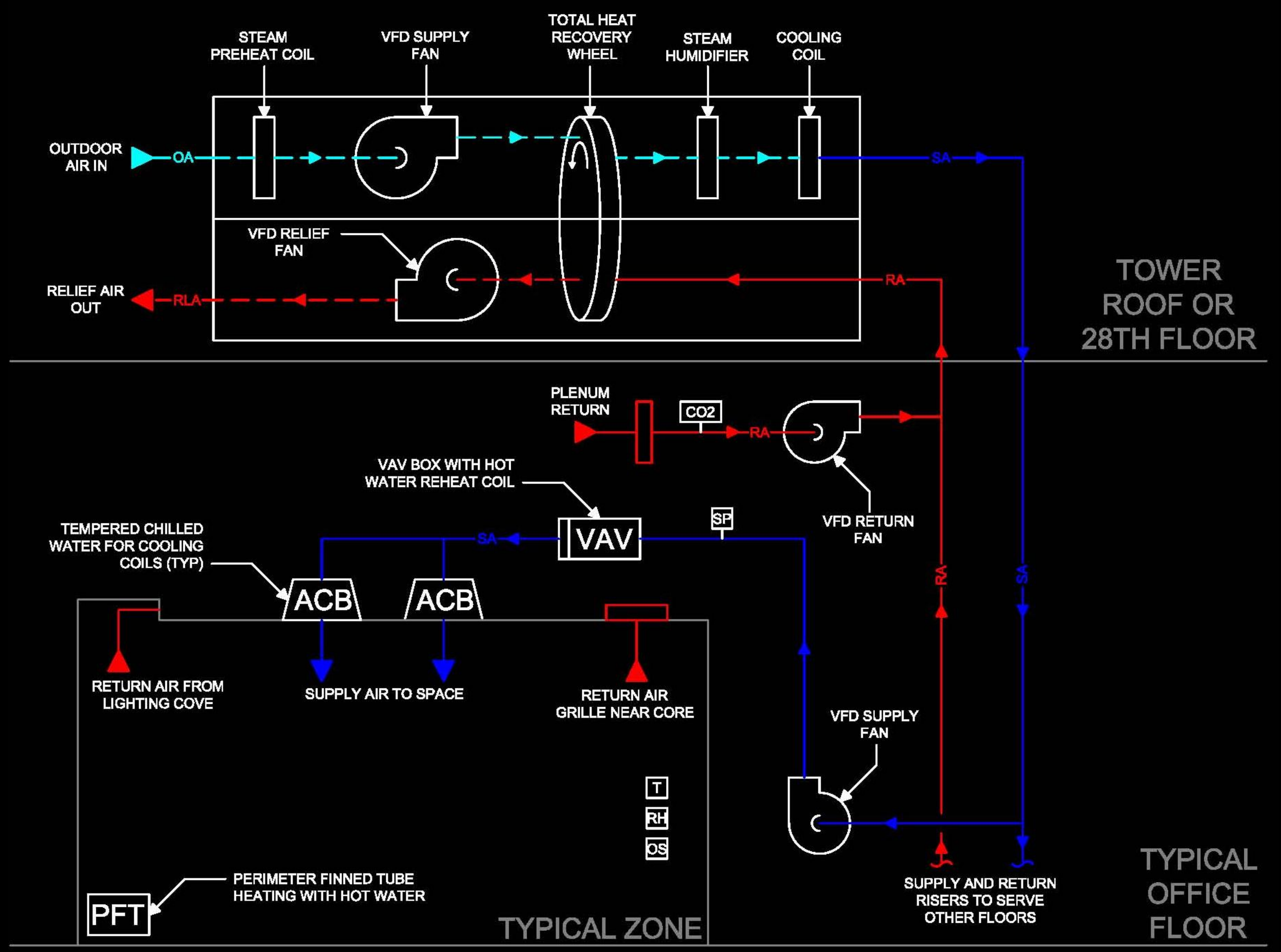
Ventilation and heating/cooling loads are decoupled

DOAS/ACB recommendations (Mumma et al):

- Space dewpoint: 45 F
- Supply air temperature: 55 F
- Discharge air temperature: 64-66 F
- 5:1 mixing ratio at terminal unit
- Chilled water supply temperature: 57-61 F

TROX 2-pipe active chilled beams as standard

System Operation



General operation

Outdoor air unit:

- Removes all latent loads
- Supply fan – 55,000 [CFM]
- Enthalpy wheel operates at around 64% effectiveness (unbalanced flow)
- Steam humidifier to maintain space minimum 0.006 [lb H_2O/lb DA]

Floor-by-floor

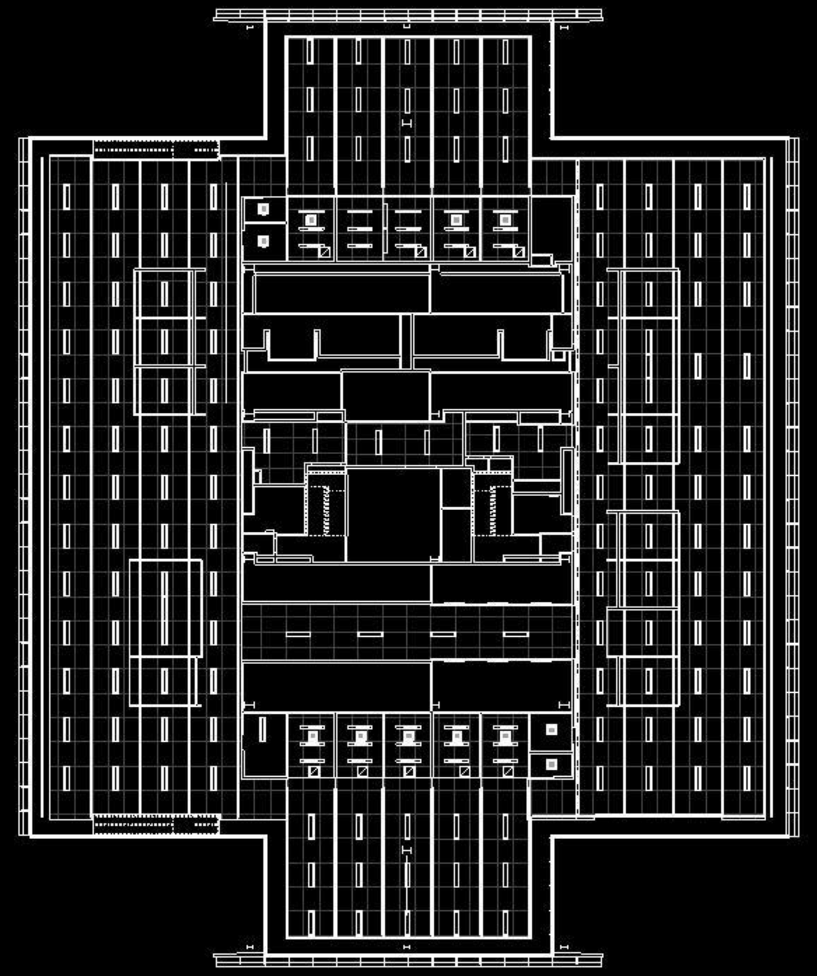
- Supply fan – 2,500 [CFM] (ASHRAE Std. 62.1 + 30%)
- Zone T-stat controls tempered chilled water in ACBs and perimeter finned tube
- Occupancy sensors in single-zone rooms allow for VAV box reset
- CO_2 sensor in return duct for each quadrant
- Relative humidity sensor in space for each quadrant

Ceiling Layout Coordination

Building Overview

Phase I : Façade
Phase II: Cogeneration
Phase III: Lateral System
Phase IV: Distribution Systems and Coordination
Mechanical
Electrical
Coordination
SIPS Sequencing

Results and Conclusions



Lighting and chilled beams

Selected linear devices

Oriented in the North-South direction

Mechanical Systems Cost

Material	Qty.		Unit Cost	Cost Per Floor	Cost for NYT Spaces
Ductwork and Connections	11,400	lb	$0.76	$8,664.00	$242,592.00
Chilled Beams	161	EA	$800.00	$128,800.00	$3,606,400.00
VAV Box and Connections	44	EA	$18.00	$792.00	$22,176.00
Outdoor Air Units	2	EA	$26,100.00	-	$52,200.00

Labor	Qty.	Unit	Unit Cost	Cost Per Floor	Cost for NYT Spaces
Ductwork and Connections	11,400	lb	$8.86	$101,004.00	$2,828,112.00
Chilled Beams	161	EA	$217.00	$34,937.00	$978,236.00
VAV Box and Connections	44	EA	$57.33	$2,522.00	$70,630.00
Outdoor Air Units	2	EA	8778	-	$17,556.00
			Total:	($276,719.00)	($7,800,346.00)

Conductor to Bus Duct Comparison

500mcm - Copper Conductors - Existing Conditions

From DP to Floor __	Price	Length	Length + 5'per termination (6)	Number	Total	3-1/2" - Conduit Price	Length	Total
4	$19.99	175	205	4	$16,421.79	$28.06	175	$4,921.02
7	$19.99	217	247	4	$19,750.12	$28.06	217	$6,089.02
10	$19.99	259	289	4	$23,078.46	$28.06	259	$7,257.02
13	$19.99	300	330	4	$26,406.79	$28.06	300	$8,425.02
16	$19.99	342	372	4	$29,735.13	$28.06	342	$9,593.01
19	$19.99	384	414	4	$33,063.46	$28.06	384	$10,761.01
22	$19.99	425	455	4	$36,391.80	$28.06	425	$11,929.01
25	$19.99	467	497	4	$39,720.13	$28.06	467	$13,097.01
28	$19.99	508	538	4	$43,048.47	$28.06	508	$14,265.00
				TOTALS:	$267,616.13			$86,337.11

Price per side	$353,953.24
Price Both sides	$707,906.48

Conductor to Bus Duct Comparison

750mcm - Aluminum Conductors

From DP to Floor __	Price	Length	Length + 5'per termination(6)	Number	Total	3-1/2" - Conduit Price	Length	Total
4	$10.18	175	205	4	$8,362.87	$31.61	175	$5,543.60
7	$10.18	217	247	4	$10,057.84	$31.61	217	$6,859.37
10	$10.18	259	289	4	$11,752.81	$31.61	259	$8,175.14
13	$10.18	300	330	4	$13,447.78	$31.61	300	$9,490.90
16	$10.18	342	372	4	$15,142.75	$31.61	342	$10,806.67
19	$10.18	384	414	4	$16,837.72	$31.61	384	$12,122.44
22	$10.18	425	455	4	$18,532.69	$31.61	425	$13,438.20
25	$10.18	467	497	4	$20,227.66	$31.61	467	$14,753.97
28	$10.18	508	538	4	$21,922.63	$31.61	508	$16,069.73
				TOTALS:	$136,284.75			$97,260.02

Price per side	$233,544.77
Price Both sides	$467,089.54

Conductor to Bus Duct Comparison

2500A - Copper Bus Duct

From DP to Floor

28		**Price**	**Units**	**Length**	**Number**	**Total**
	Bus	$980.79	LF	508	1	$498,609.12
	Elbows / Up / Downs	$4,054.37	EA	-	5	$20,271.85
	Taps	$6,279.75	EA	-	28	$175,833.00

Price per side	$694,713.97
Price Both sides	**$1,389,427.93**

Conductor to Bus Duct Comparison

2500A - Aluminum Bus Duct

From DP to Floor

		Price	Units	Length	Number	Total
28	Bus	$827.70	LF	508	1	$420,781.99
	Elbows / Up / Downs	$4,081.72	EA	-	5	$20,408.60
	Taps	$5,639.63	EA	-	28	$157,909.64

Price per side	**$599,100.23**
Price Both sides	**$1,198,200.46**

Conductor to Bus Duct Comparison

Building Overview

Phase I : Façade
Phase II: Cogeneration
Phase III: Lateral System
Phase IV: Distribution Systems and Coordination
Mechanical
Electrical
Coordination
SIPS Sequencing

Results and Conclusions

Results:

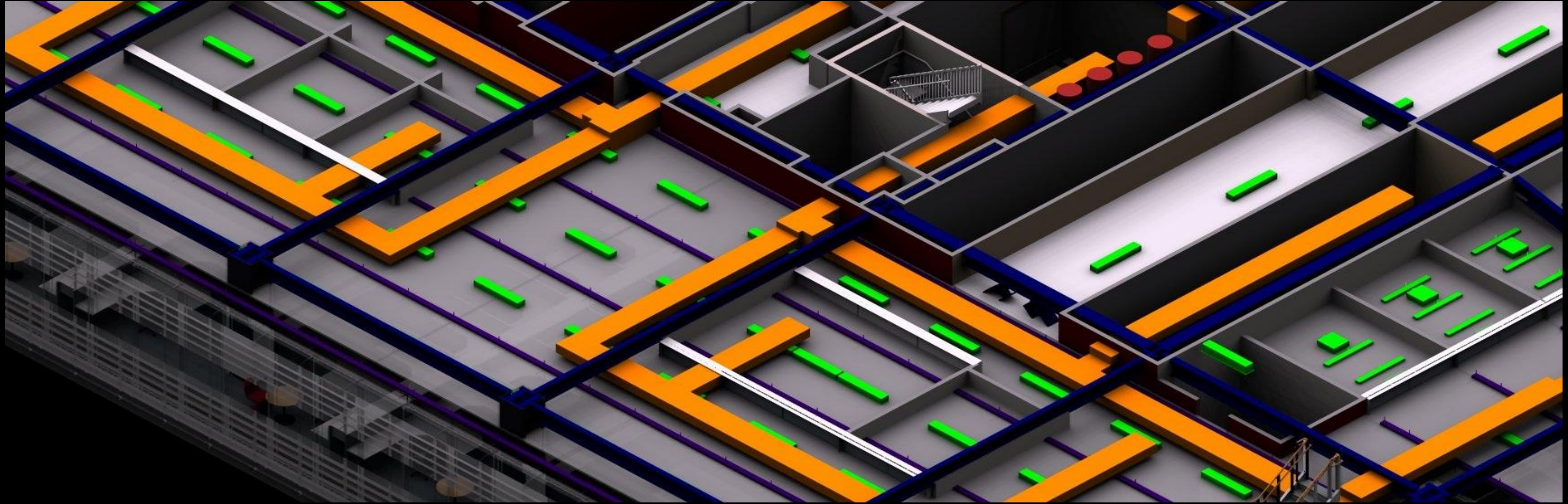
Existing:	**$707,906.48**
Aluminum Alternate:	**$467,089.54**
Copper Bus:	**$1,389,427.93**
Aluminum Bus:	**$1,198,200.46**

3D Coordination and Clash Detection

Building Overview

Phase I : Façade
Phase II: Cogeneration
Phase III: Lateral System
Phase IV: Distribution Systems and Coordination
- Mechanical
- Electrical
- Coordination
- SIPS Sequencing

Results and Conclusions

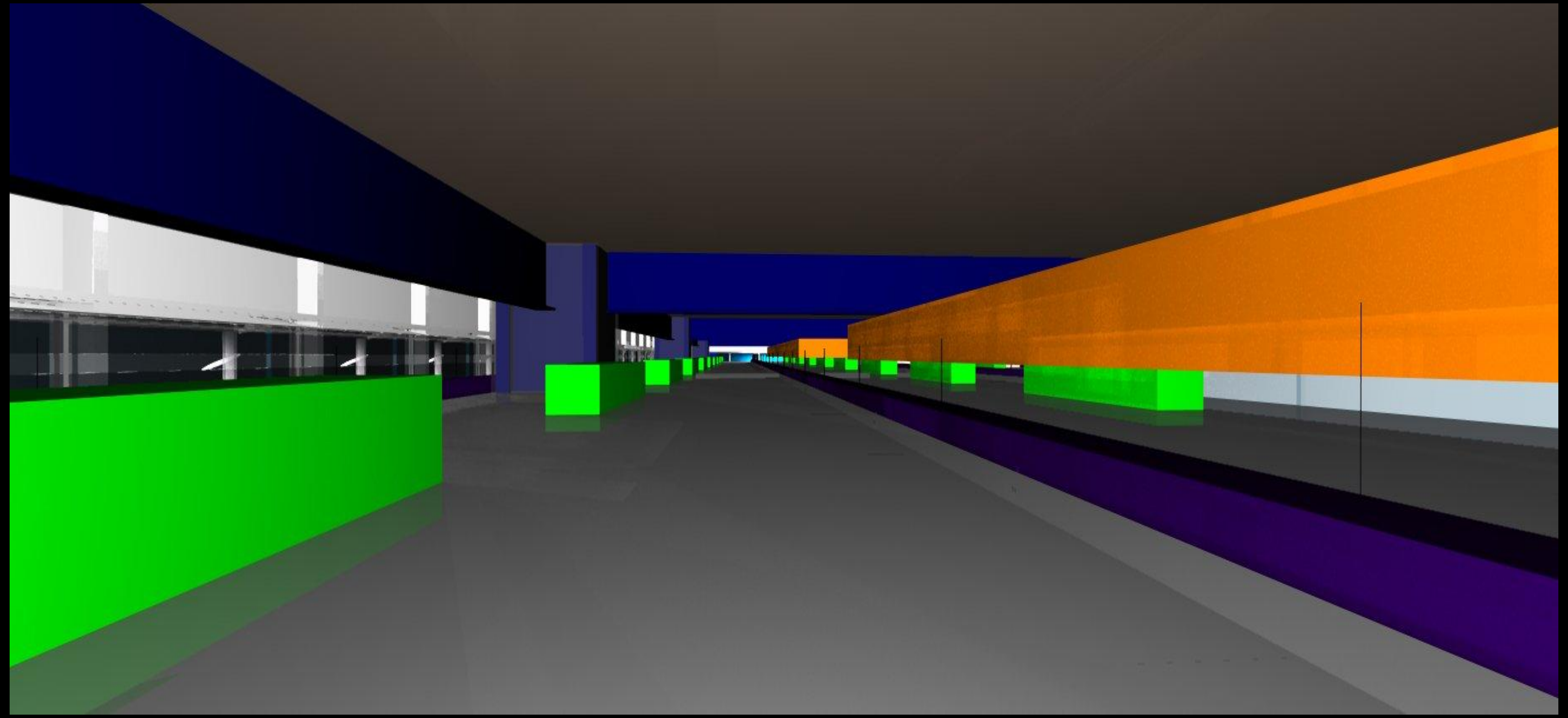


3D Coordination and Clash Detection

Building Overview

Phase I : Façade
Phase II: Cogeneration
Phase III: Lateral System
Phase IV: Distribution Systems and Coordination
- Mechanical
- Electrical
- **Coordination**
- SIPS Sequencing

Results and Conclusions



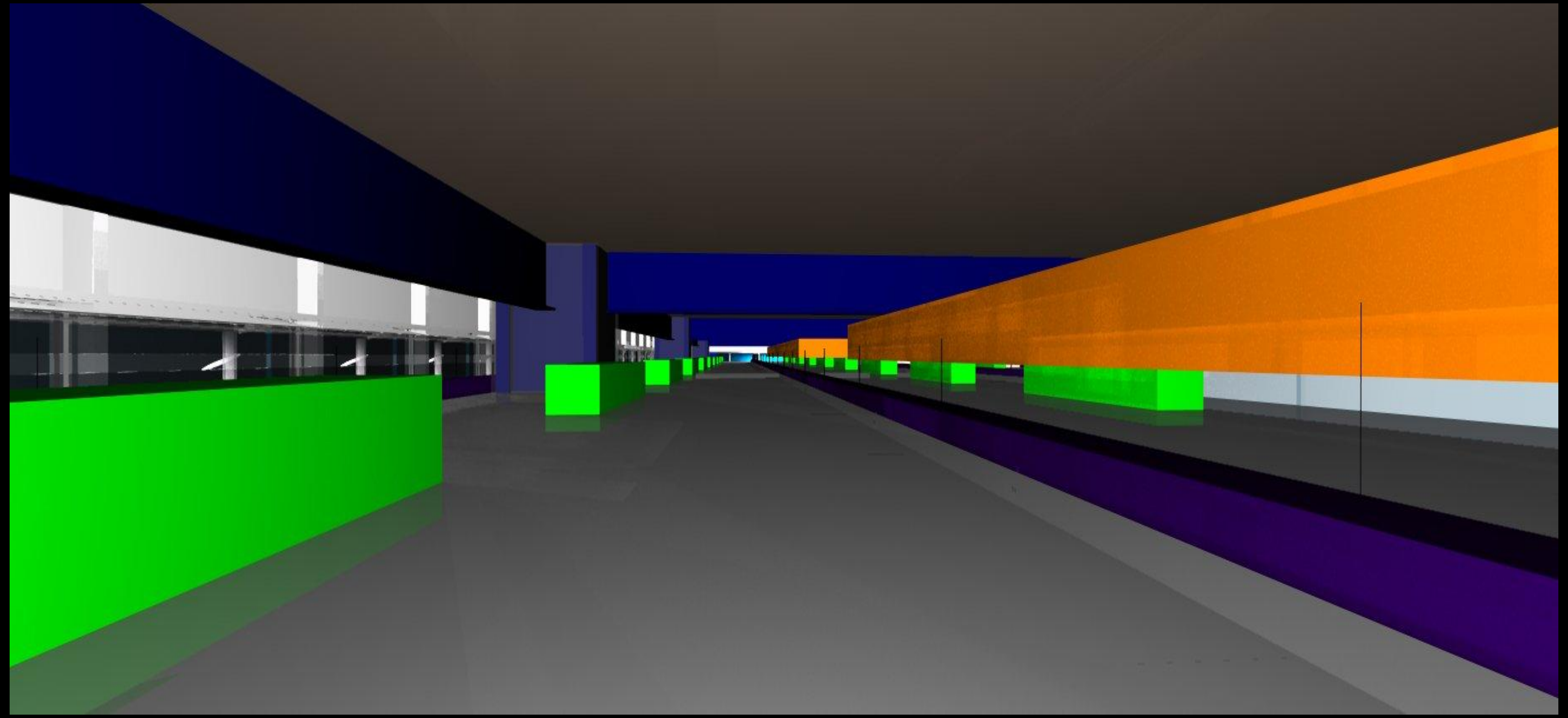
3D Coordination and Clash Detection

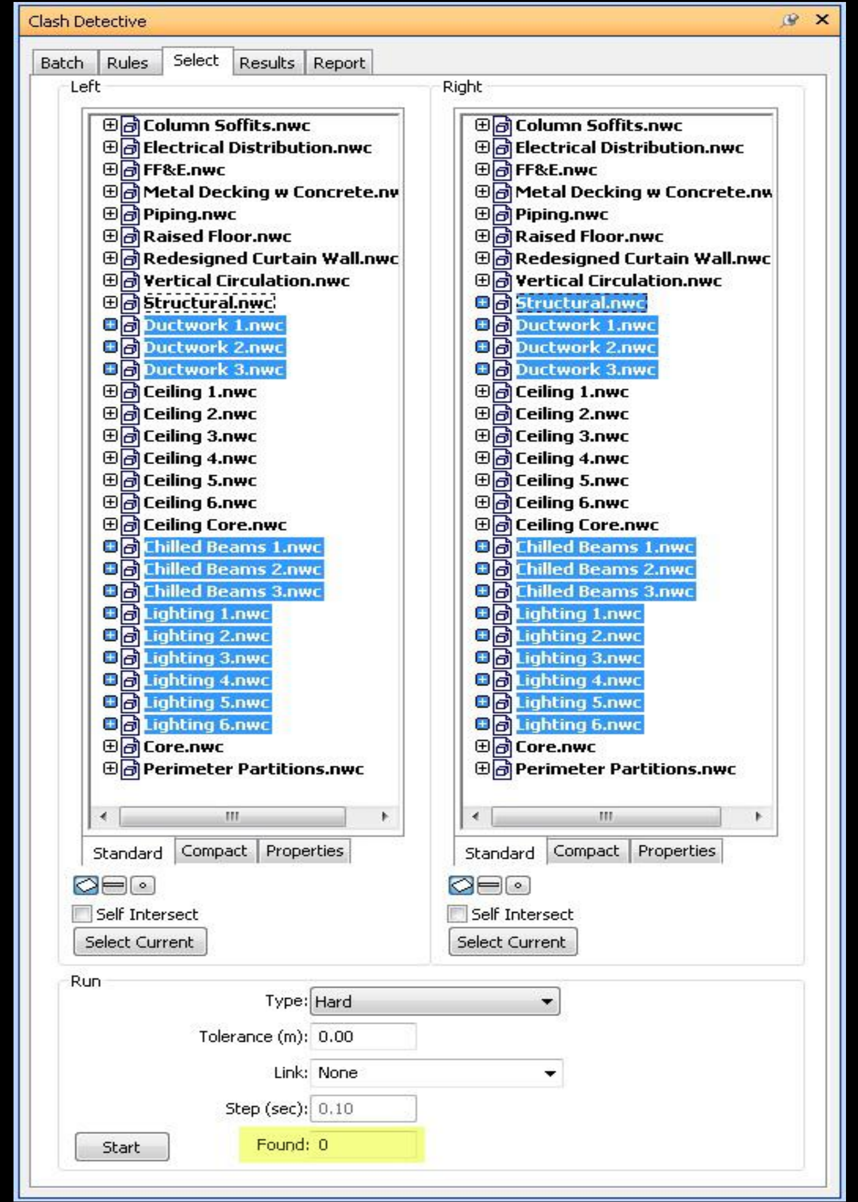
Building Overview

Phase I : Façade
Phase II: Cogeneration
Phase III: Lateral System
Phase IV: Distribution Systems and Coordination

- Mechanical
- Electrical
- Coordination
- SIPS Sequencing

Results and Conclusions





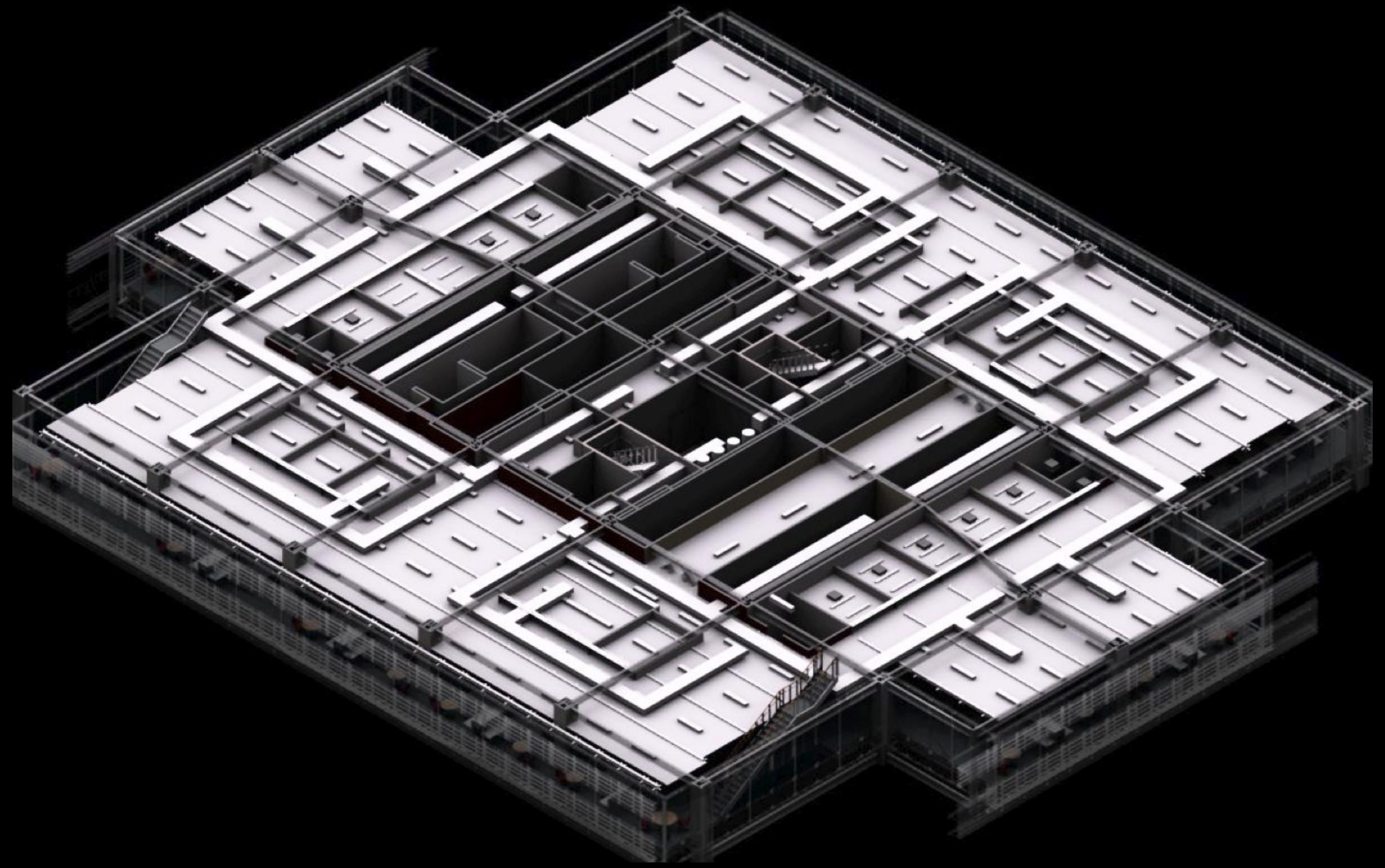
Zero clashes

SIPS Sequencing

Building Overview

Phase I : Façade
Phase II: Cogeneration
Phase III: Lateral System
Phase IV: Distribution Systems and Coordination
- Mechanical
- Electrical
- Coordination
- SIPS Sequencing

Results and Conclusions

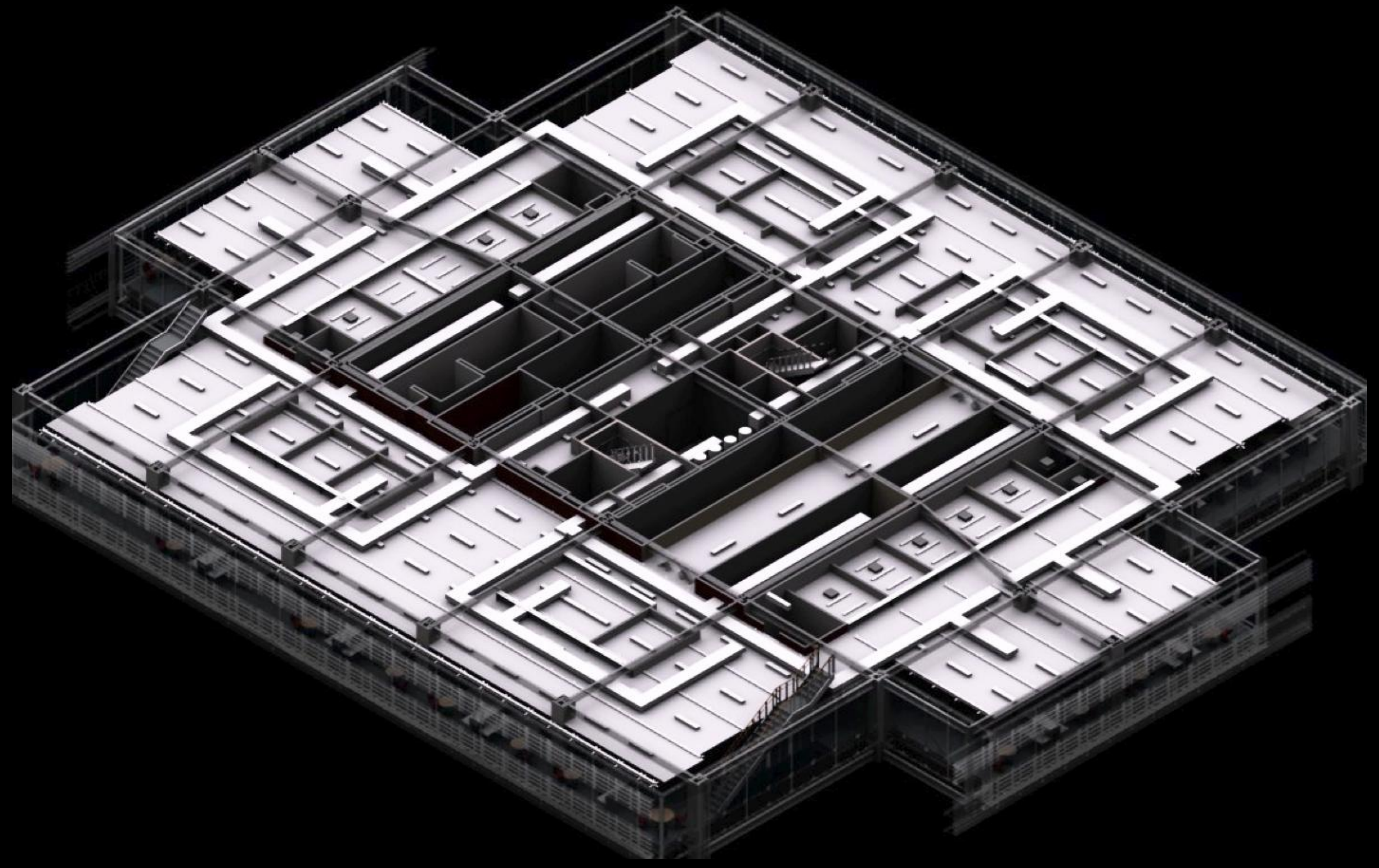


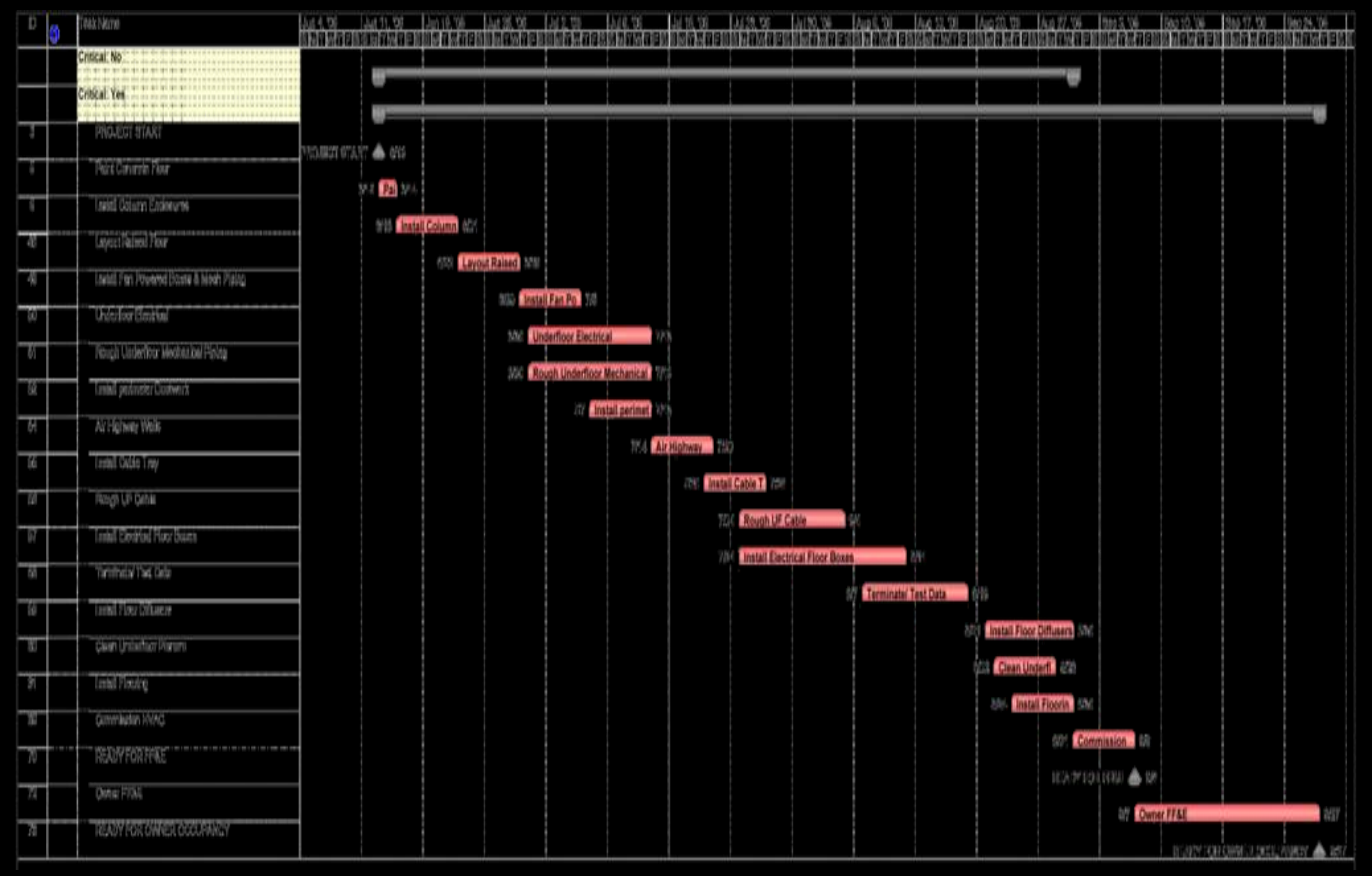
SIPS Sequencing

Building Overview

Phase I : Façade
Phase II: Cogeneration
Phase III: Lateral System
Phase IV: Distribution Systems and Coordination
- Mechanical
- Electrical
- Coordination
- SIPS Sequencing

Results and Conclusions



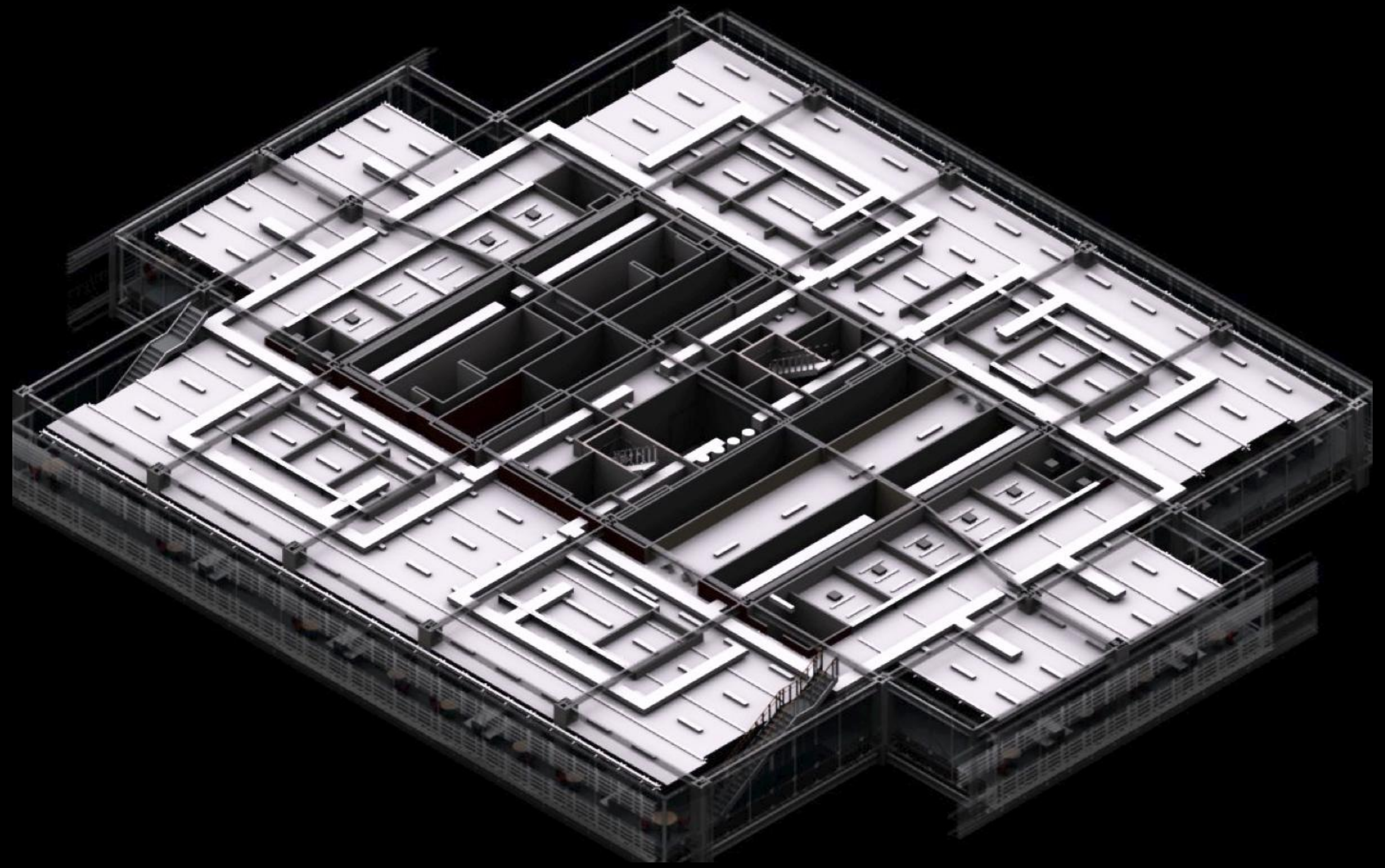


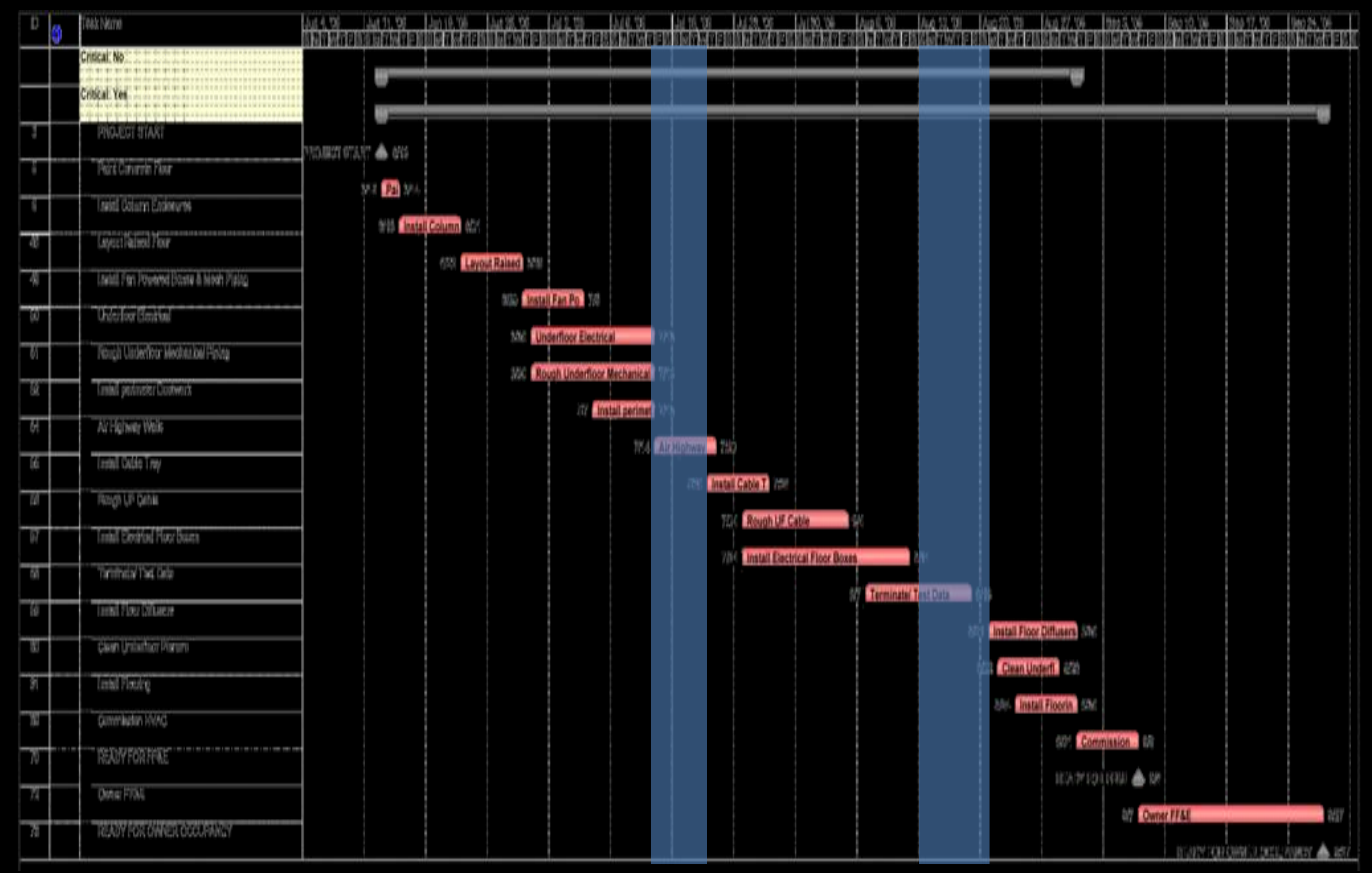
SIPS Sequencing

Building Overview

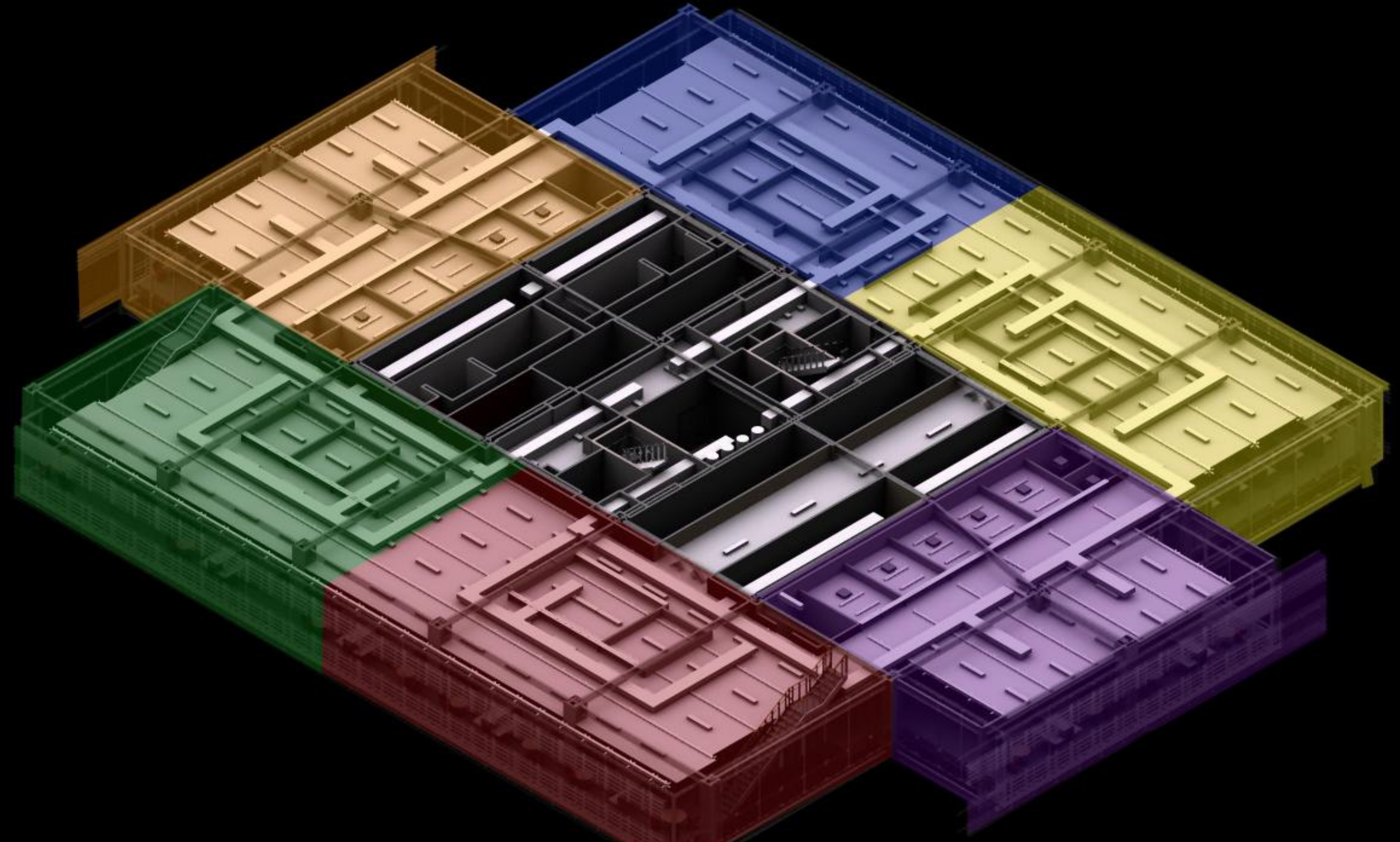
Phase I : Façade
Phase II: Cogeneration
Phase III: Lateral System
Phase IV: Distribution Systems and Coordination
- Mechanical
- Electrical
- Coordination
- SIPS Sequencing

Results and Conclusions





SIPS Sequencing

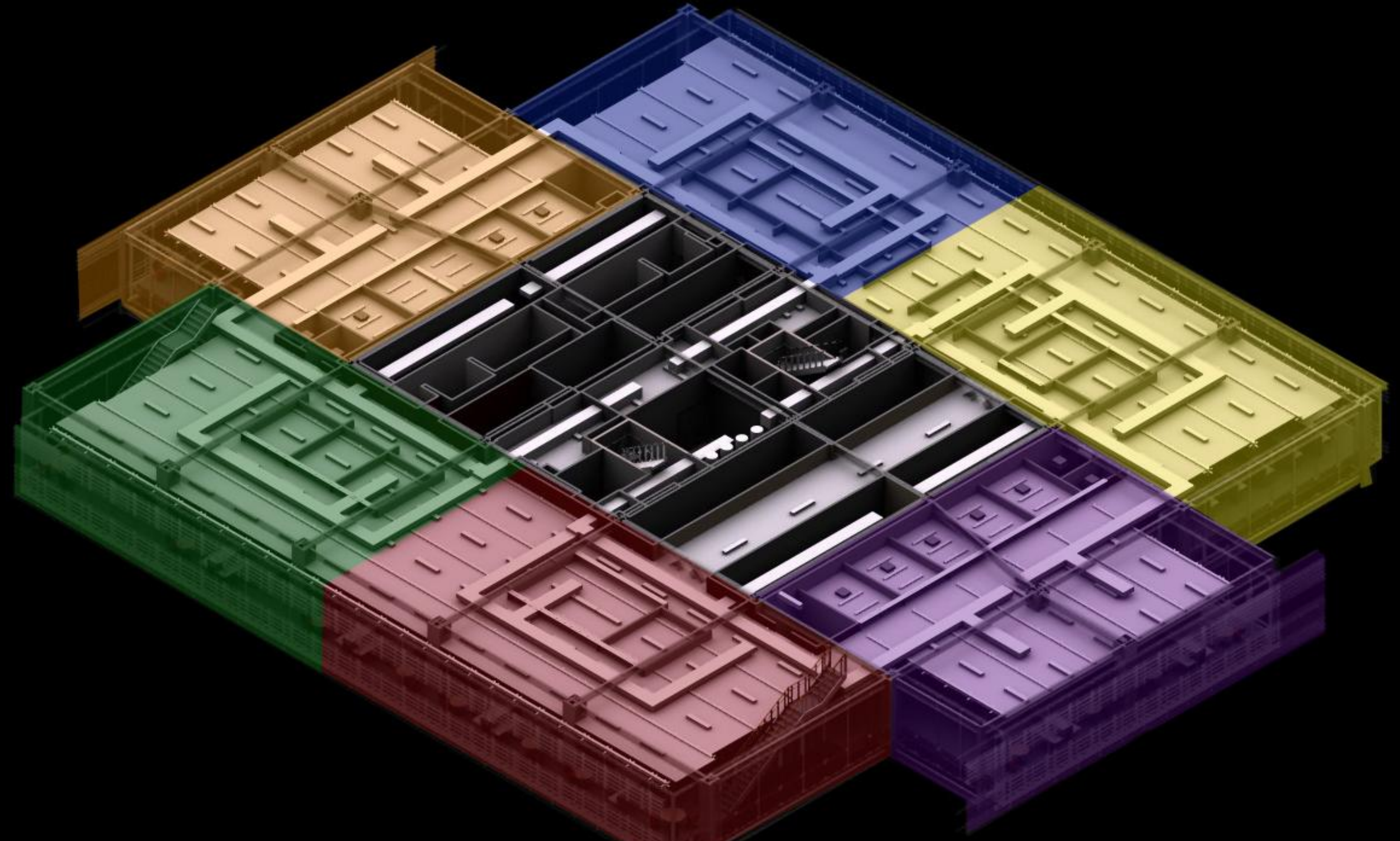


Interior fit out of each floor divided into six regions of equal work

Building Overview

Phase I : Façade
Phase II: Cogeneration
Phase III: Lateral System
Phase IV: Distribution Systems and Coordination
- Mechanical
- Electrical
- Coordination
- SIPS Sequencing

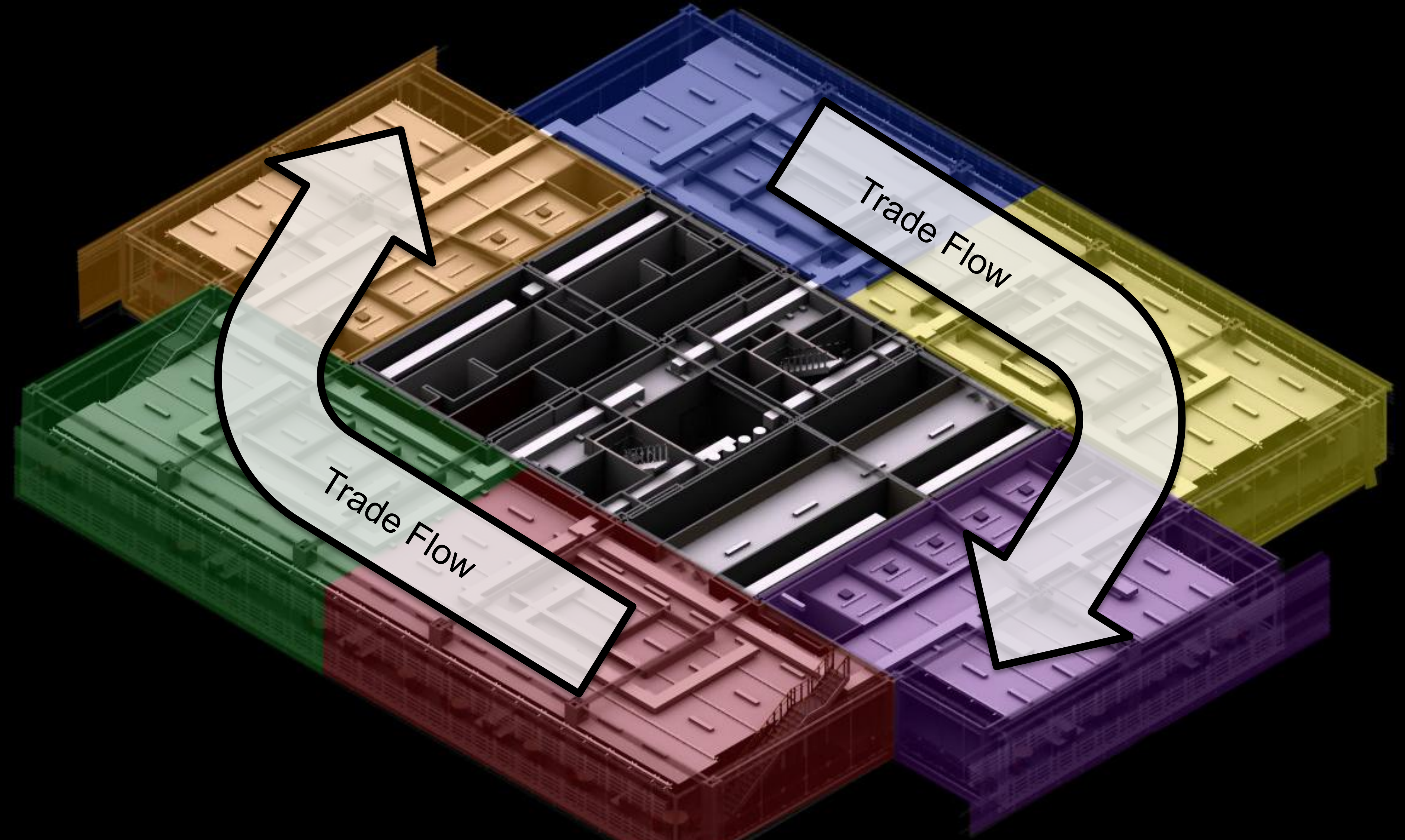
Results and Conclusions



Interior fit out of each floor divided into six regions of equal work

Allowed for tighter stacking of trades

SIPS Sequencing



Interior fit out of each floor divided into six regions of equal work

Allowed for tighter stacking of trades

- **SIPS** production method employed to reduce fit out time
- Trades move from one region to the next in succesion

SIPS Sequencing

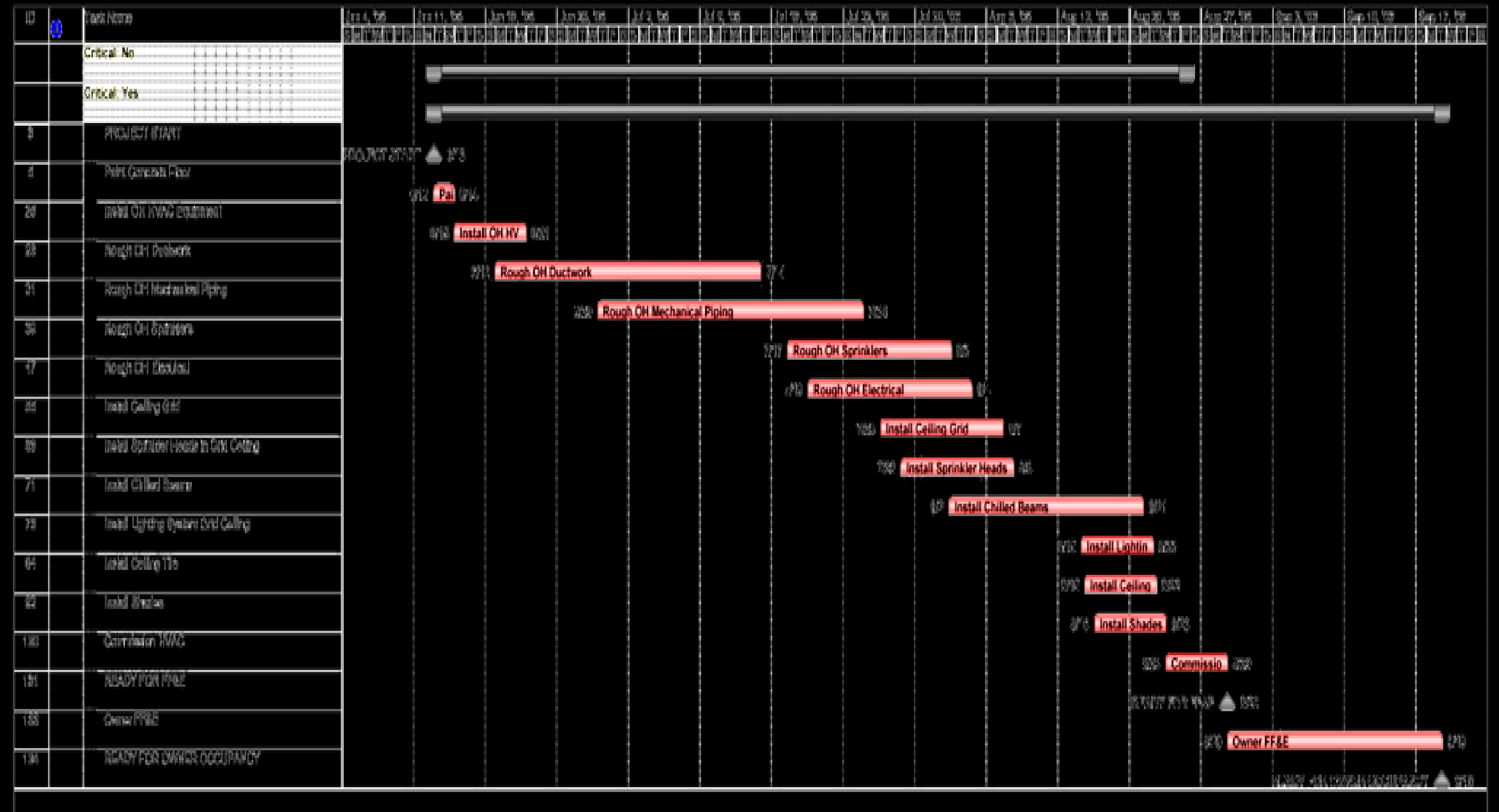
Building Overview

Phase I : Façade
Phase II: Cogeneration
Phase III: Lateral System
Phase IV: Distribution Systems and Coordination

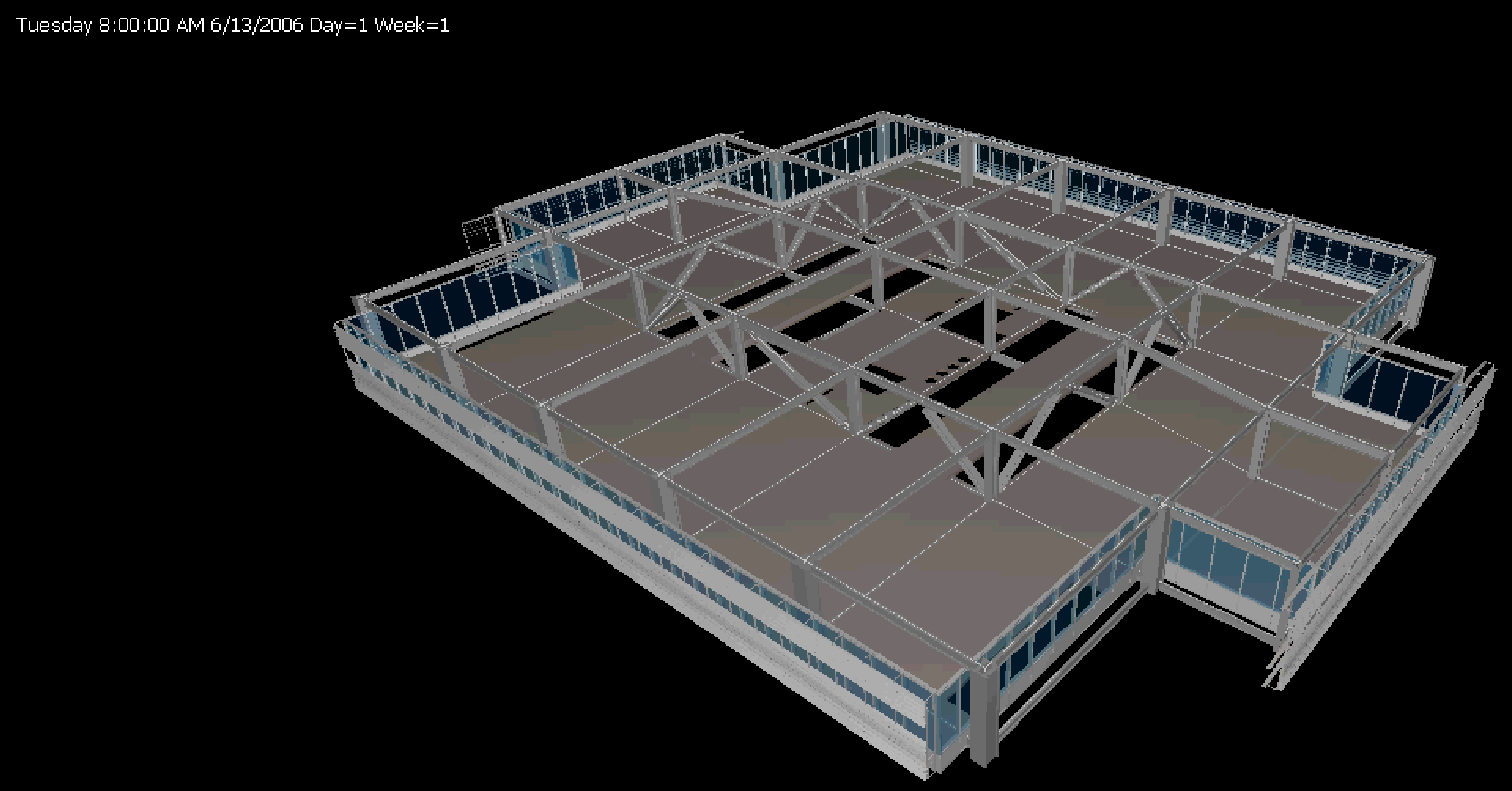
- Mechanical
- Electrical
- Coordination
- SIPS Sequencing

Results and Conclusions

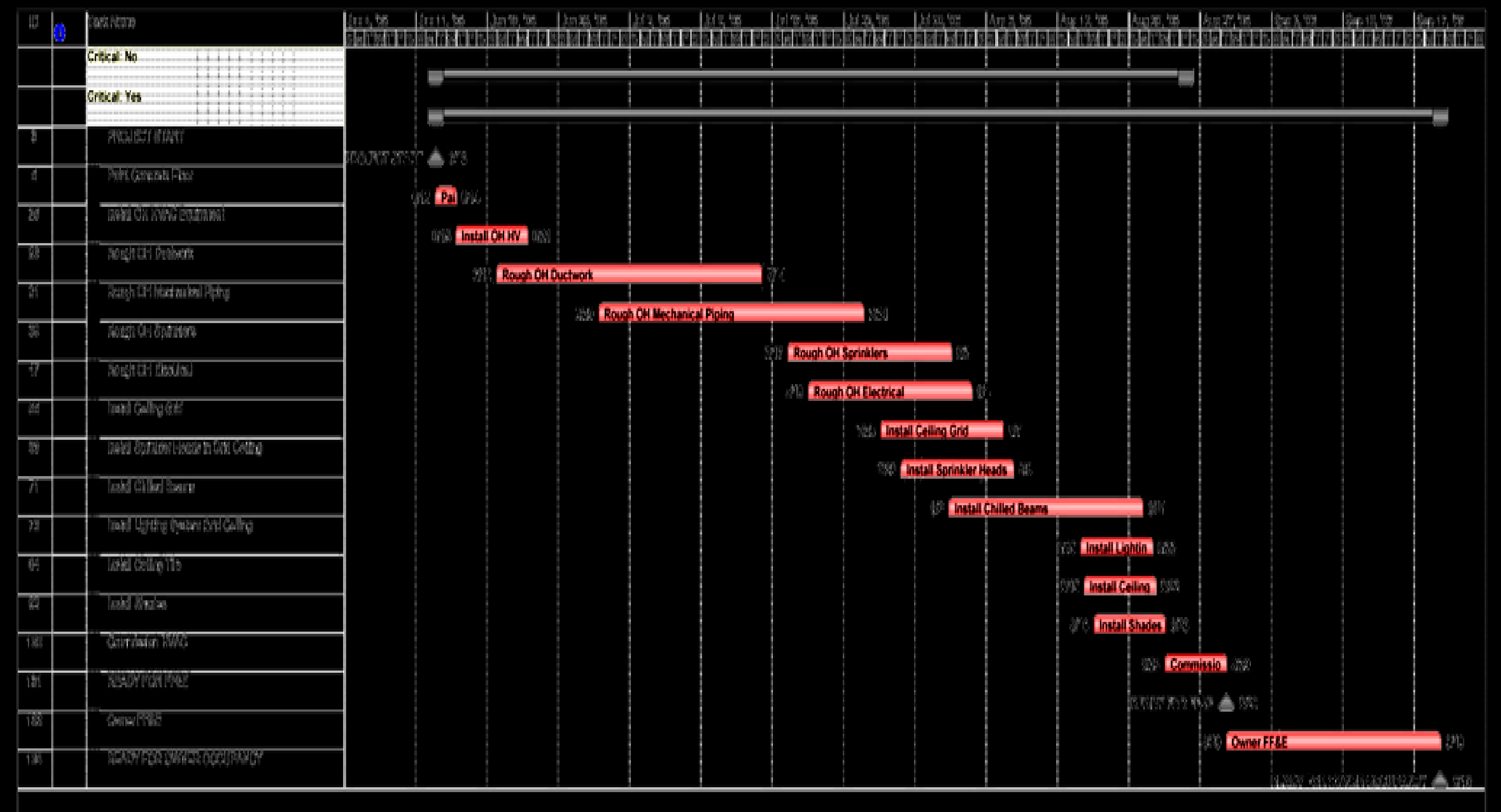
New schedule



SIPS Sequencing



New schedule



Building Overview

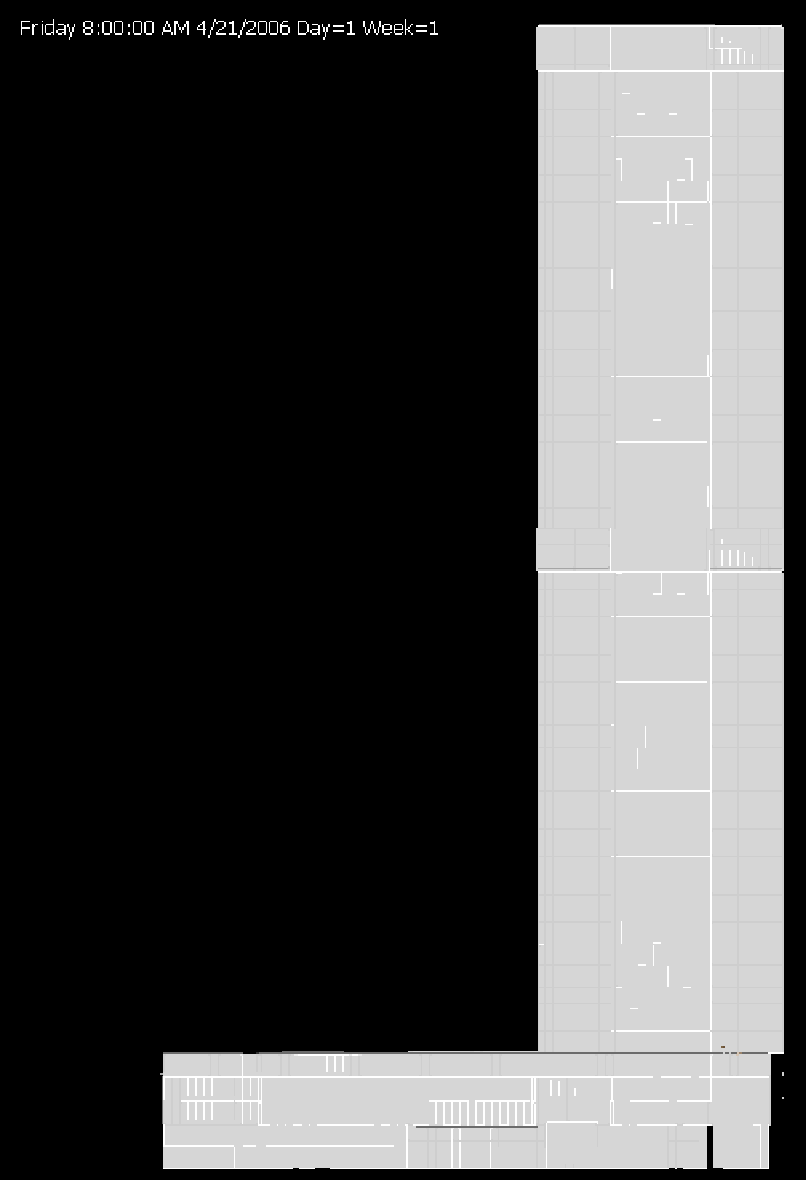
Phase I : Façade
Phase II: Cogeneration
Phase III: Lateral System
Phase IV: Distribution Systems and Coordination
- Mechanical
- Electrical
- Coordination
- SIPS Sequencing

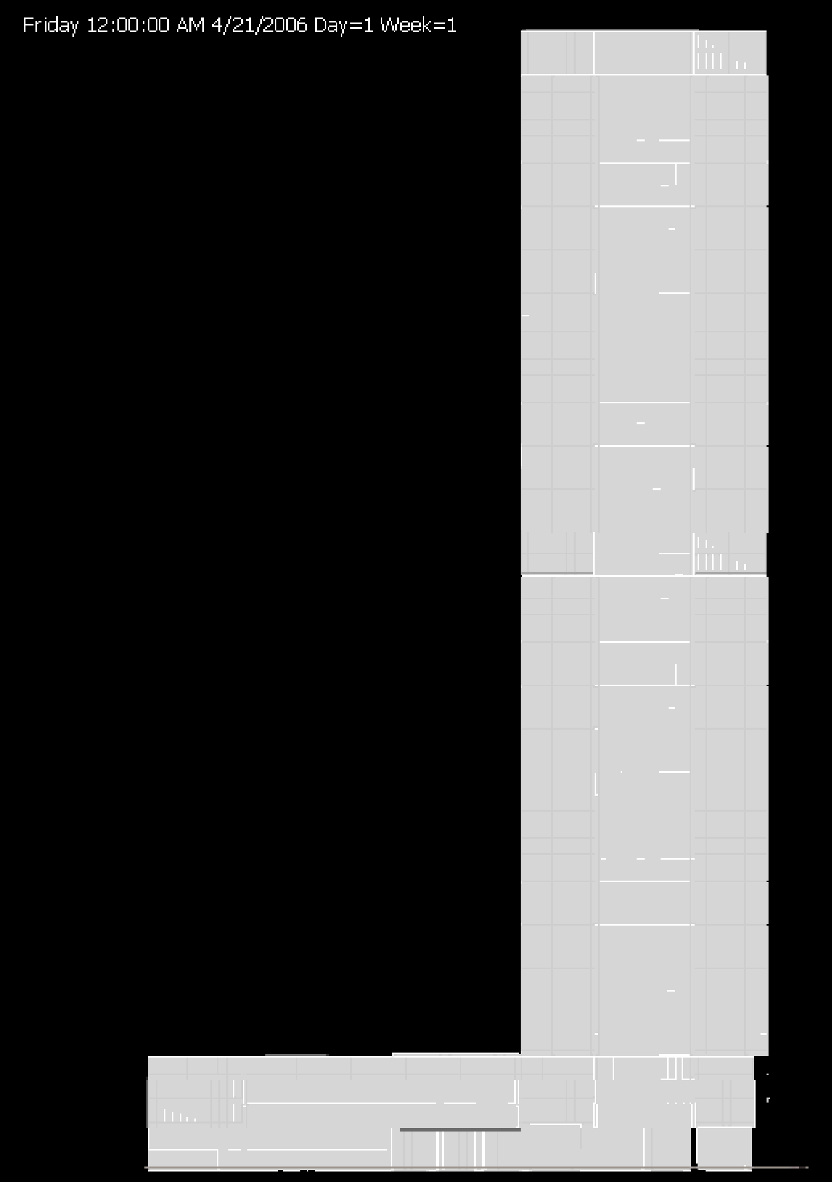
Results and Conclusions

Relation to entire building construction?

SIPS – Redesign Sequencing

Existing Sequencing





Conclusions

Phase I:

- Reduced number of fixtures by about 50%
- Dimming increased energy savings/decreased load
- Minimized direct solar glare
- Maintained building transparency
- Reduced the annual energy consumption by 23%

Phase II:

- Allowed for a cap to be placed on purchased peak electrical demand
- Increased the installed electric generating capacity from 1400 kW to 3265 KW
- Reduced the annual building operating costs by 20% compared to the existing CHP system

Phase III:

- Redesigned lateral system eliminates inherent torsion and reduces required steel by 3.5%
- Elimination of 51st floor outrigger creates two additional rentable floors to bring in revenue
- New York Times Building could be at risk for progressive collapse

Phase IV:

- Bus ducts not a cost effective option
- Replaced existing UFAD system
- Chose DOAS with ACBs because of reduced space requirements and superior thermal comfort
- Zero system clashes were found on the first clash detection analysis due to coordination process
- Achieved a 177 day schedule reduction for the interior fit out portion of the project

Financial Summary:

Phase I: Façade Redesign	Material	Labor	Typical Floor Cost	Total Building Cost
Existing Façade	$810,414	$45,383,218	$1,606,293	$83,527,260
Redesigned Façade	$1,343,285	$75,223,990	$2,153,700	$120,607,208
Difference	-$532,871	-$29,840,772	-$547,407	-$37,079,948

Phase II: Cogeneration Plant Redesign	Equipment Cost	Labor	Annual Operating Costs	Payback Period
Existing CHP Plant	$3,673,500.00	$114,750.00	$10,983,700.00	-
Redesigned CHP Plant	$6,708,800.00	$255,000.00	$8,773,200.00	3.15 Years
Difference	-$3,035,300.00	-$140,250.00	+$2,210,500.00	

Thank You

Industry Partners

Thornton Tomasetti
Amec
Flack + Kurtz
Turner Construction
The New York Times
PSU OPP

AE Faculty

Dr. Chimay Anumba
Dr. Andres Lepage
Dr. Jelena Srebric
Dr. Richard Mistrick
Dr. Jim Freihaut
Professor Robert Holland
Professor M. Kevin Parfitt
Dr. Kevin Houser
Dr. John Messner
Jim Faust

Family and Friends


The New York Times Building
IPD/ BIM Thesis Team II
Erika Bonfanti | Pete Clarke | Dan Cox | Chris Wiacek

Thank You