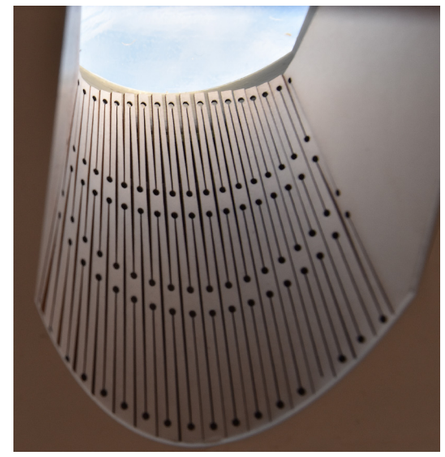
Adapting to daylight -

'A strategy for designing
a multi purpose hall'

Joar Tjetland

Index

Introduction
The site
Program
Process
Project



Introduction

This project investigates the use of daylight as a primary light source in a multi purpose hall. The aim has been to achieve a successful daylight design that brings spatial qualities to multiple levels of the project and makes the hall an attractive place to gather. Qualities beyond the ones that can be measured.

While daylight is a biological part of our body, the typical multipurpose halls are without utilizing daylight.
As a typology the multi purpose hall originated from an interest in sports as a leisure activity. The need for indoor facilities grew and from 1948 and on the building of multi purpose halls was financed through Norwegian gaming funds. From 1965-85 the gaming funds increased from 12 million NOK to 324 million NOK.[1]

A standardized hall was developed and adapted to the international standard requirements for the different ball games. The entrepreneurs could now deliver standardized buildings that were evaluated on technical parameters and price. In just in a few years the standardized hall was widely spread across local communities. It was no longer subject of an architectural approach in terms of design of space. [2] Daylight became a factor that made building on relatively small budgets more expensive.

Multipurpose halls have traditionally been

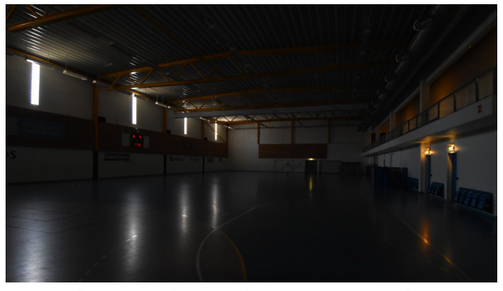
1 Ding 2017: 5
2 Lyngsgård 1990: 100

Adaptability to daylight - Definition:
"The ability a building has to modulate the available daylight outside, into the interior."

built as free standing building volumes near sport facilities and/or schools. As free standing structures they truly have a potential to make use of daylight.
In my opinion, the adaptation to daylight in architecture happens in the very early design process.

The adaptability of light is not just an add-on in terms of blinds, it is a mindset in designing architecture. In order for a building to be regarded as robust, valuable and worthy of care for future generations of users, daylighting design should be appropriated as a fundamental design approach. I simply believe that buildings that successfully utilize daylight as its main lightsource are the most preferred ones.

Interior of a gym in The Netherlands, around 1900



Sports hall Furuset Arena - mid day in September

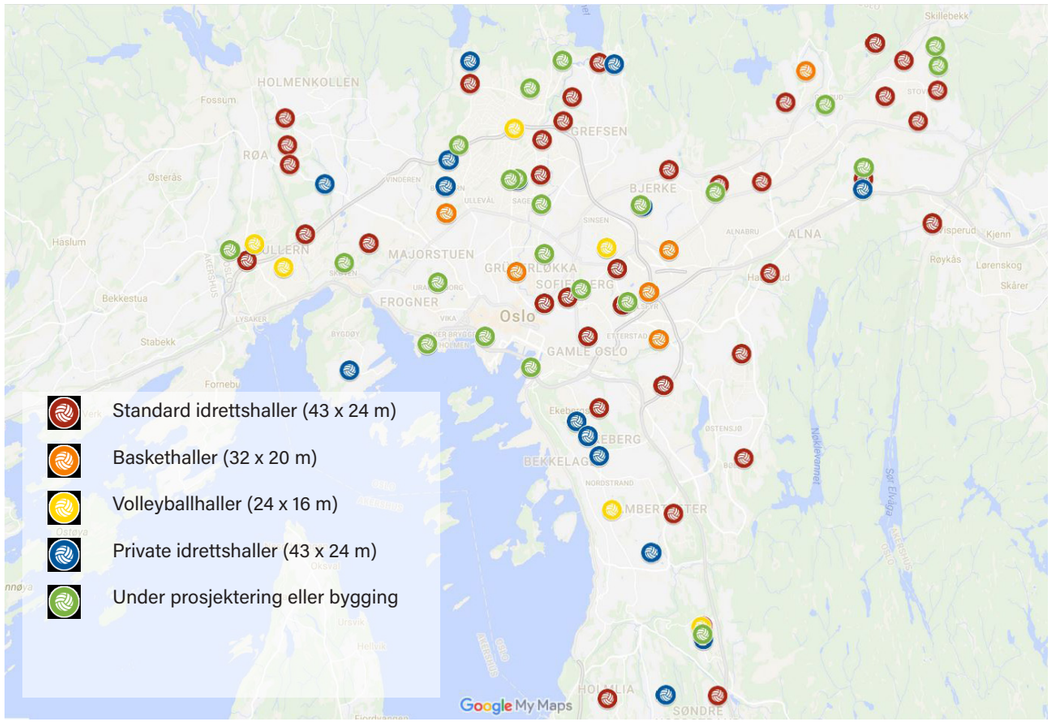
Ice hall Furuset arena - mid day in September

The site

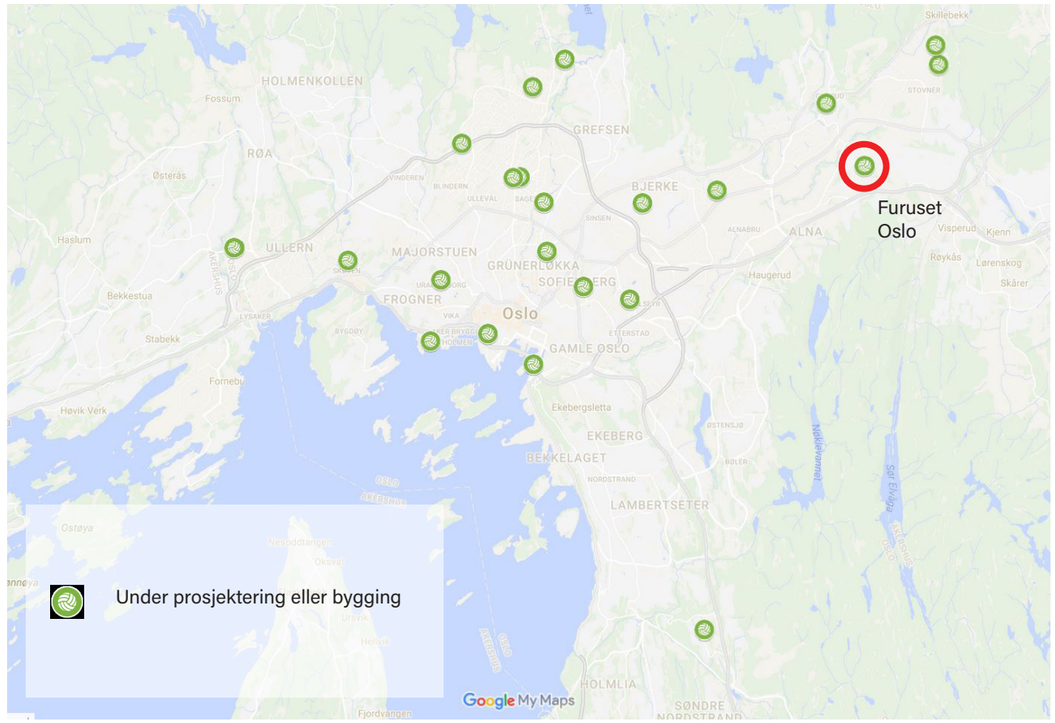
Site regulated for a multipurpose hall

The decision on choise of site is based on idrettsforbundets overview of planned and existing sports facilities in the municipality of Oslo.

In Furuset a new multi purpose hall are planned to support a new elementary school in Verdensparken.



idrettsforbundet.no



idrettsforbundet.no

Furuset

Furuset is a self sufficient suburb in the municipality of Alna. It was built in the 1970s and has got nice qualities in terms of car free environments, well connected to infrastructure, large green areas and nature.

The population in Furuset deviates from the norm, in that 90% of the residents between 0-20 years have a minority background.
I have learned that it is easier to engage youth in Furuset in individualized sports such as dance and parkour than in organized team sports. Especially for young girls, where dance is the most popular.

Furuset area is being rehabilitiated and redeveloped. A new proposal for an area plan was made by the city of Oslo in 2014. The plan focuses on climate efficiency and a strategy for densifying the area with an additional 1700-2500 new residences. In order to plan for a future scenario I use the new plan as a basis for my planning of a new multipurpose hall in Furuset.

Furuset was built as a suburb in the 1970s
(Historic map 1971 - www.finn.no)

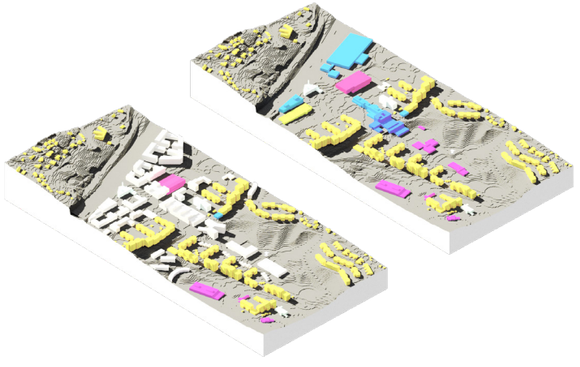
(Historic map 1971 - www.finn.no)

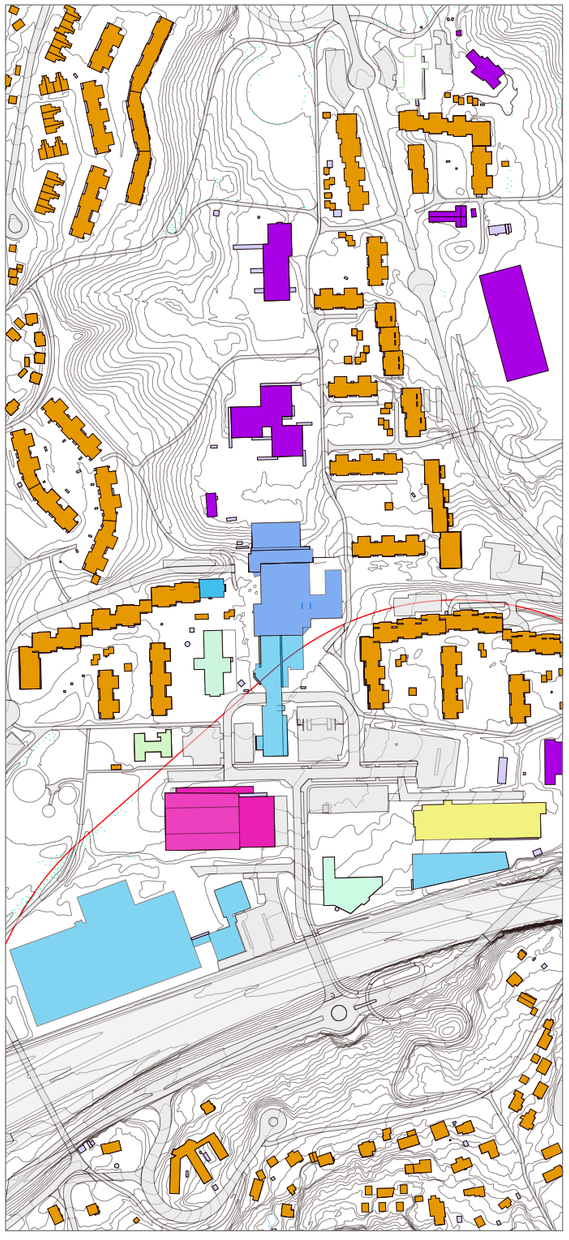
The most recent regulation proposal (2014)
Illustration: Plan- og bygningsetaten

Regulation plan

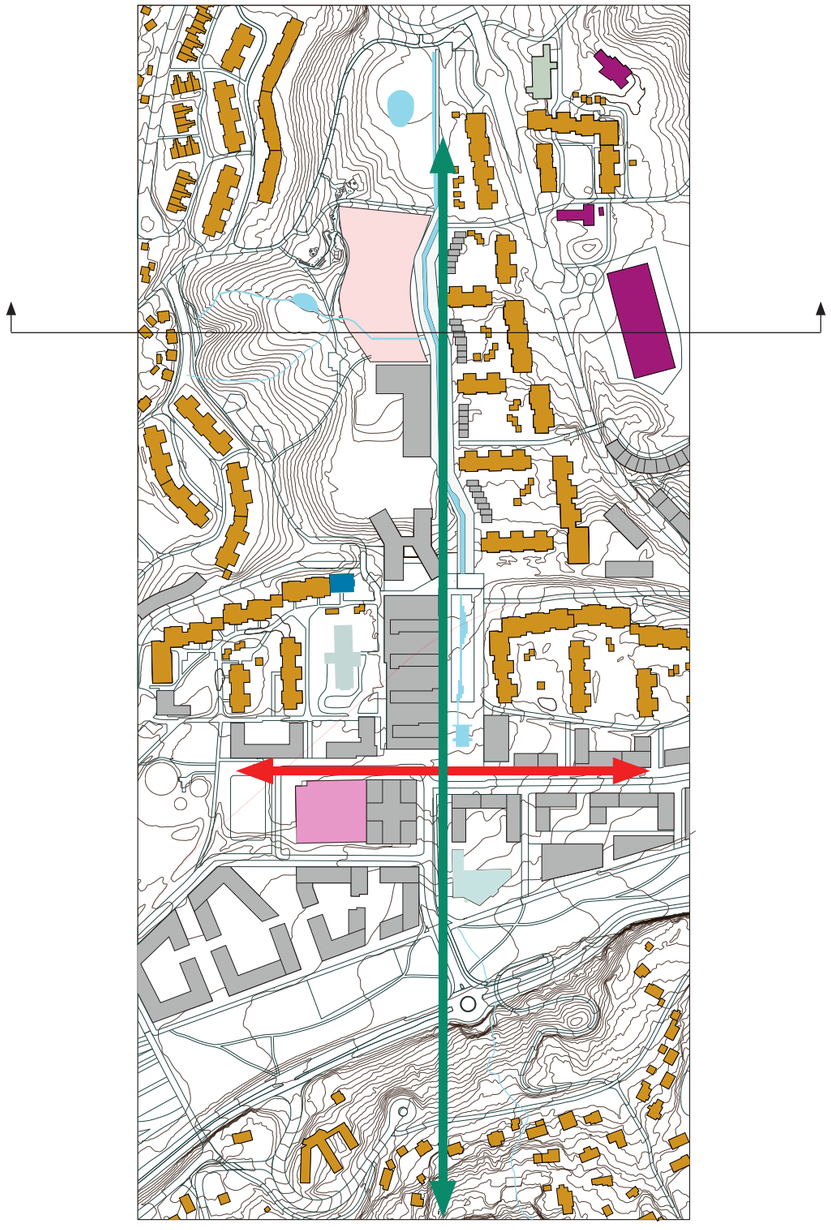
The north- south axis, marked with green arrow, connects the site to a car free axis to Furuset center with subway connection, 500m away. The red arrow in the transversal direction marks the city street axis.

The site is located along the north- south activity axis where a stream that currently is buried will be exposed once again. The neighbouring site in the southern direction will hold a new elementary school which will be the main user of the multipurpose hall.

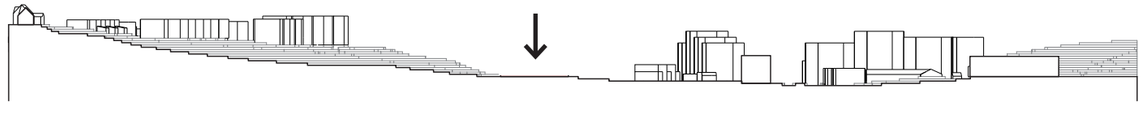




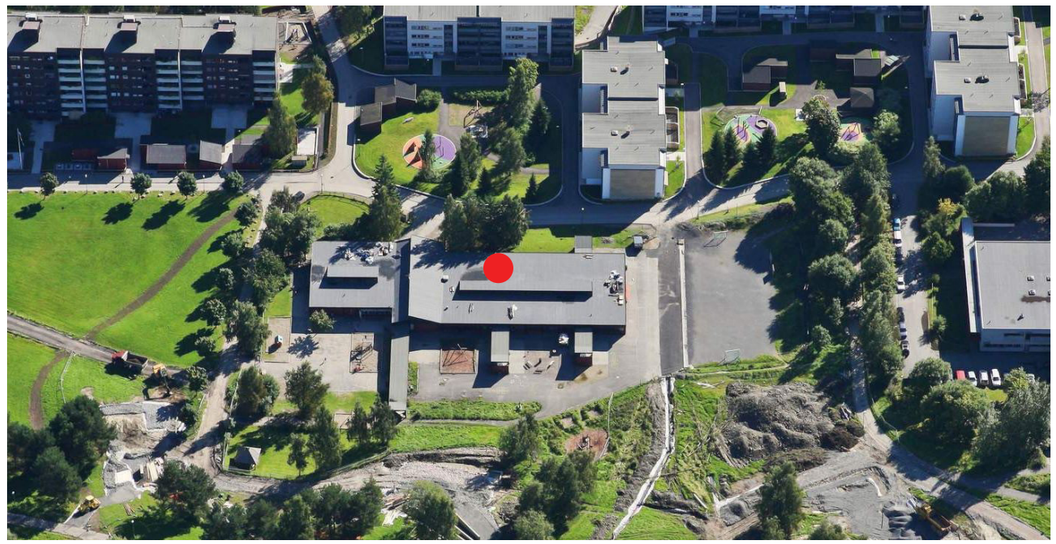
Existing situation



New regulation plan with site



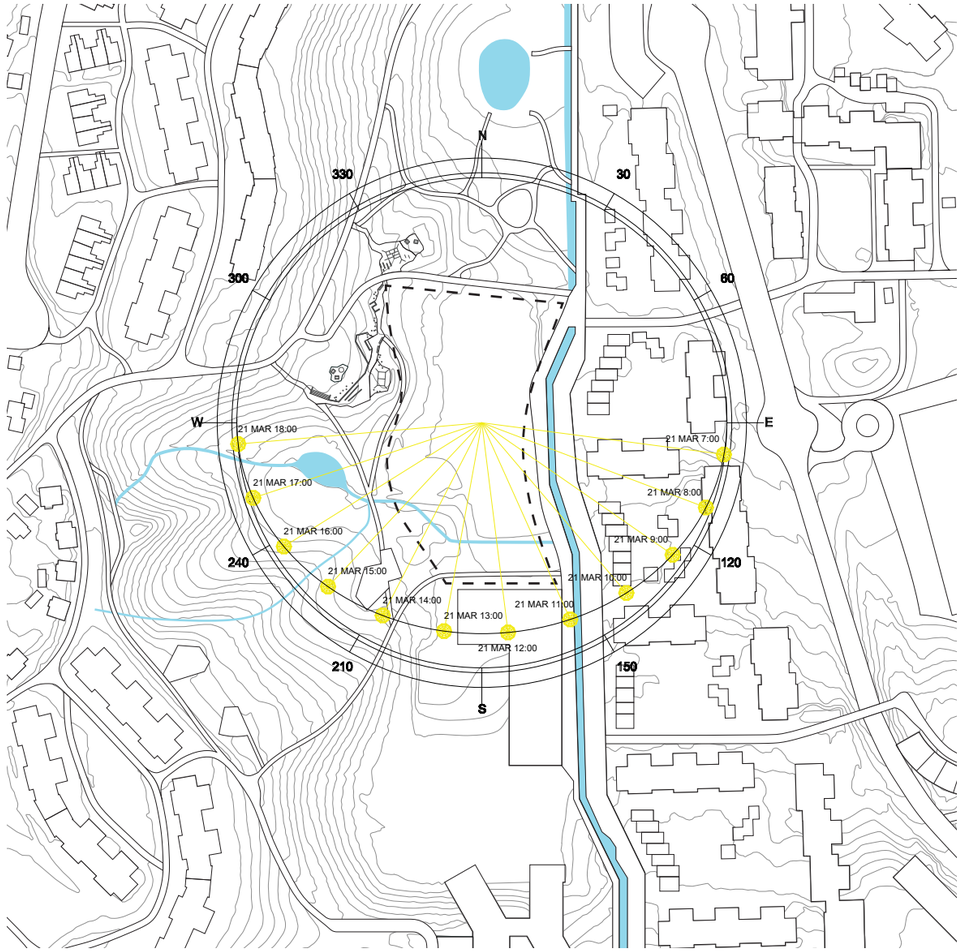
Aerial photo of site



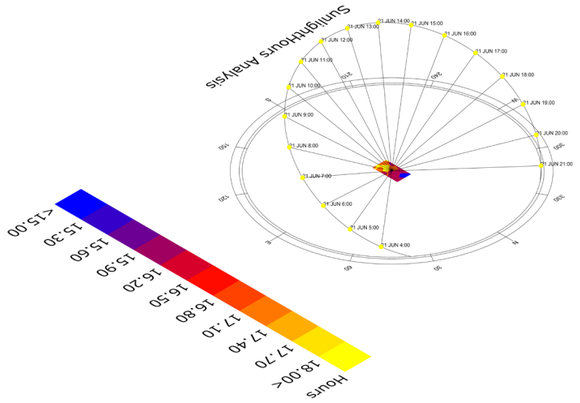
Aerial photo of site

Qualitative notes on the site:

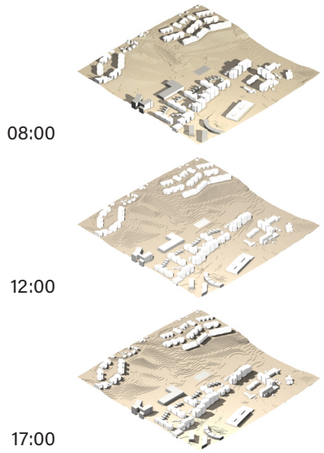
1. A clear north-south axis
2. Transverse axis towards the new Gran school.
3. Local qualities in Verdensparken:
   - parkour park
   - focus on edible plants
   - playground and water installation in the north end of the park.
   - gathering spots with bomfires
4. A close connection to a new elementary school
5. Park terrain slopes into a bowl
6. The park situation invite a visual and physical openness concerning the acitivity in the building.
7. The buidling negotiate a relationship between the park and the north-south axis

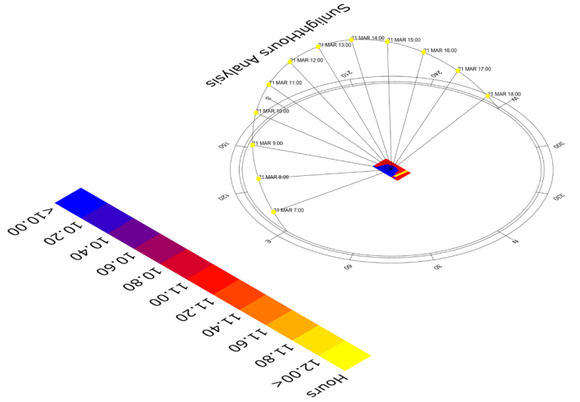


Sun path diagram 21st of march

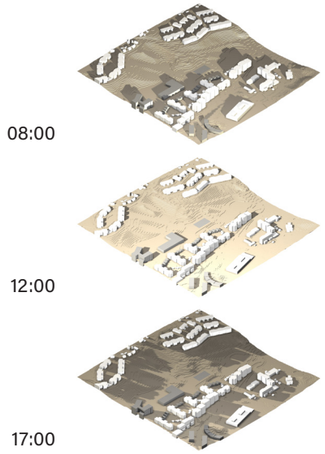


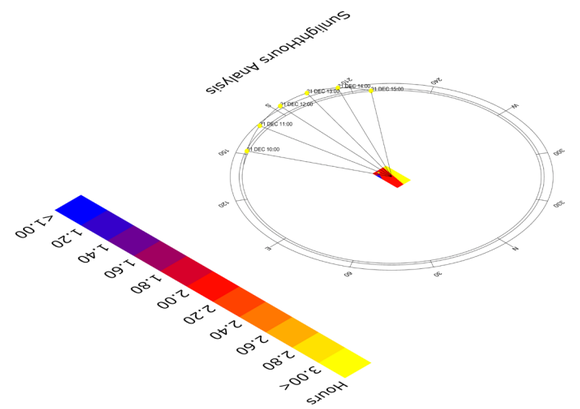
Sun path diagram - June 21st





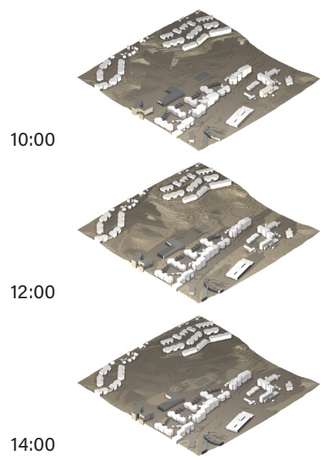
Sun path diagram - March 21st

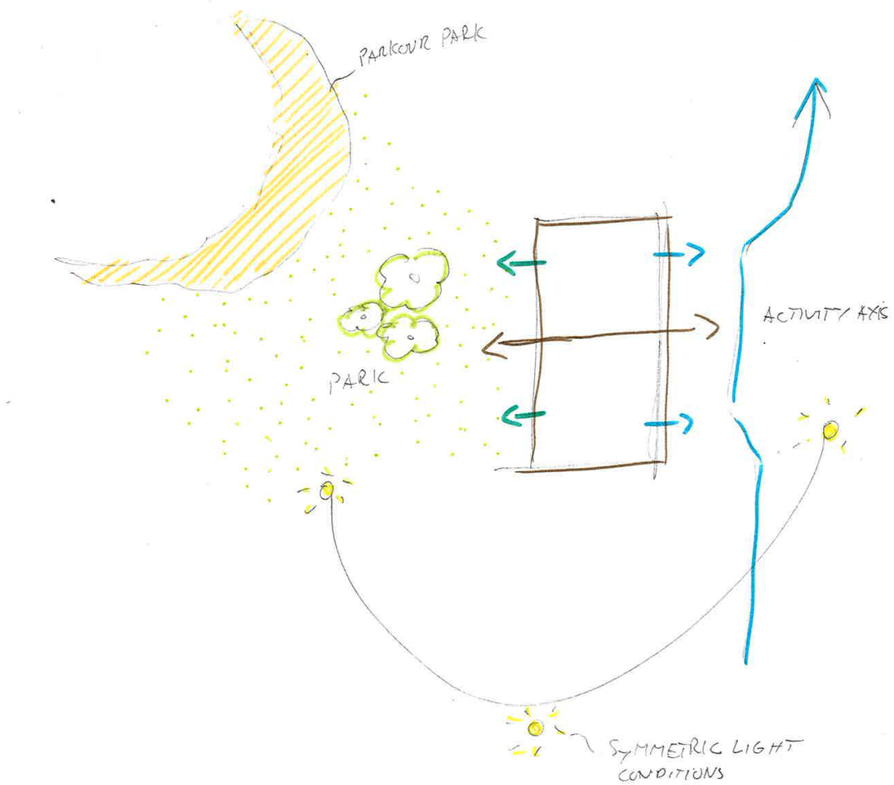




Sun path diagram - December 21st

Note: Sunlight hours include terrain and building obstructions on site





A north- south orientation:

- Preserves the most park area
- Follow the direction of the activity axis
- A narrow building volume is beneficial for sidelighting
- Connects well with the park and the north- south axis

Program

User meeting

In the initial process I asked for an interview with a representative from the municipality of Oslo and from the local sports club Furuset IL. The aim was to talk to a key group of users that would enable me to adjust my program to make it relevant to Furuset.

Furuset forum is the current center for sports in Furuset and are privately run by Furuset IL. From the user meeting I learned that there is a need for flexible spaces that can be used for a variety of individual sports such as dance, martial arts, parkour, table tennis, and more. Other practical issues were also emphasized such as adjustable tribunes, storage space, the need to avoid direct sunlight in the sports hall and that community areas are important gathering space for users in the evenings.

Program

Sports hall - 25x47x7m

Medium size hall for motoric play - 20x30x7m

Dance hall - 13x11m

Entrance hall

Room for social activities

4 team wardrobes

Judge and teachers changing rooms

+

Storage

Kitchen

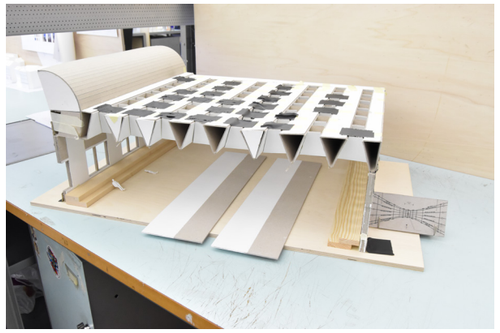
Toilets

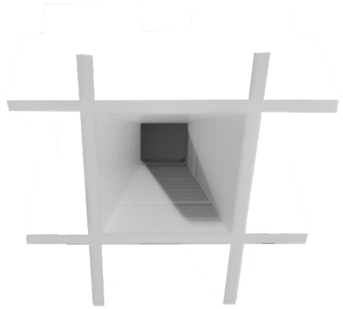
Technical room

Cleaning central

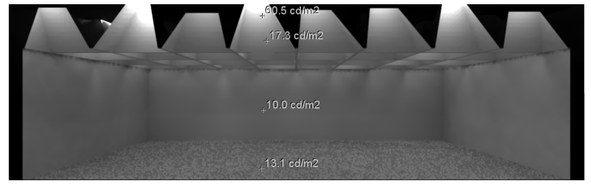
Administration and office

Process





Asymmetrically shaped coffers restricts direct sunlight



Initial light study in model

Casette ceiling with sun scoop on one wall.
Model scale 1:50

Camera settings:

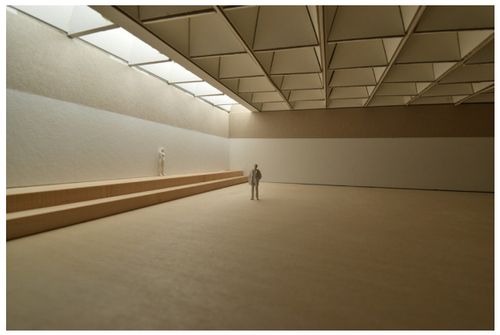
Shutter speed:	1/80
Aperature:	F11
ISO:	320
HDR:	Normal
White balance:	Direct sunlight
Camera lens:	Nikkor 12-24

Light conditions:
Outdoor photosession - clear blue sky.
Sunlight hitting the west oriented facade.

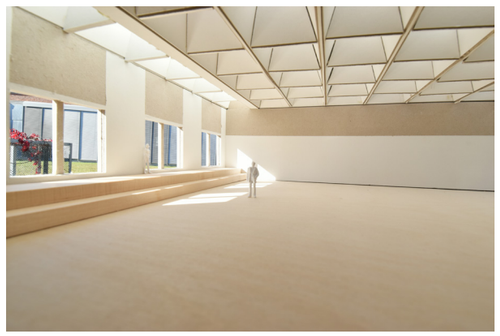
Show the importance of vertical windows that allow users contact with the outside. A flush meeting between skylight and walls prevents unwanted shadows in ceiling.

Barn doors can open or close the vertical apertures depending on the sun conditions outside.

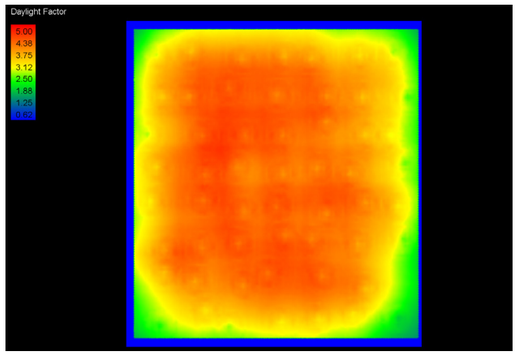
a) Skylights

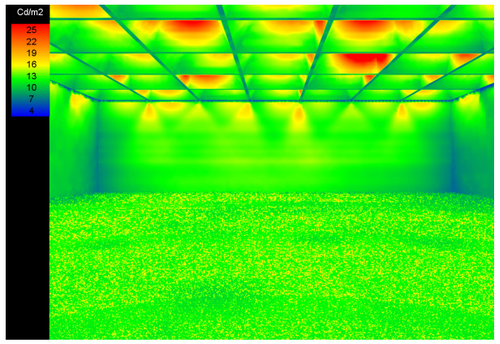


b) Sun scoop



c) Vertical window openings, sun scoop and skylights



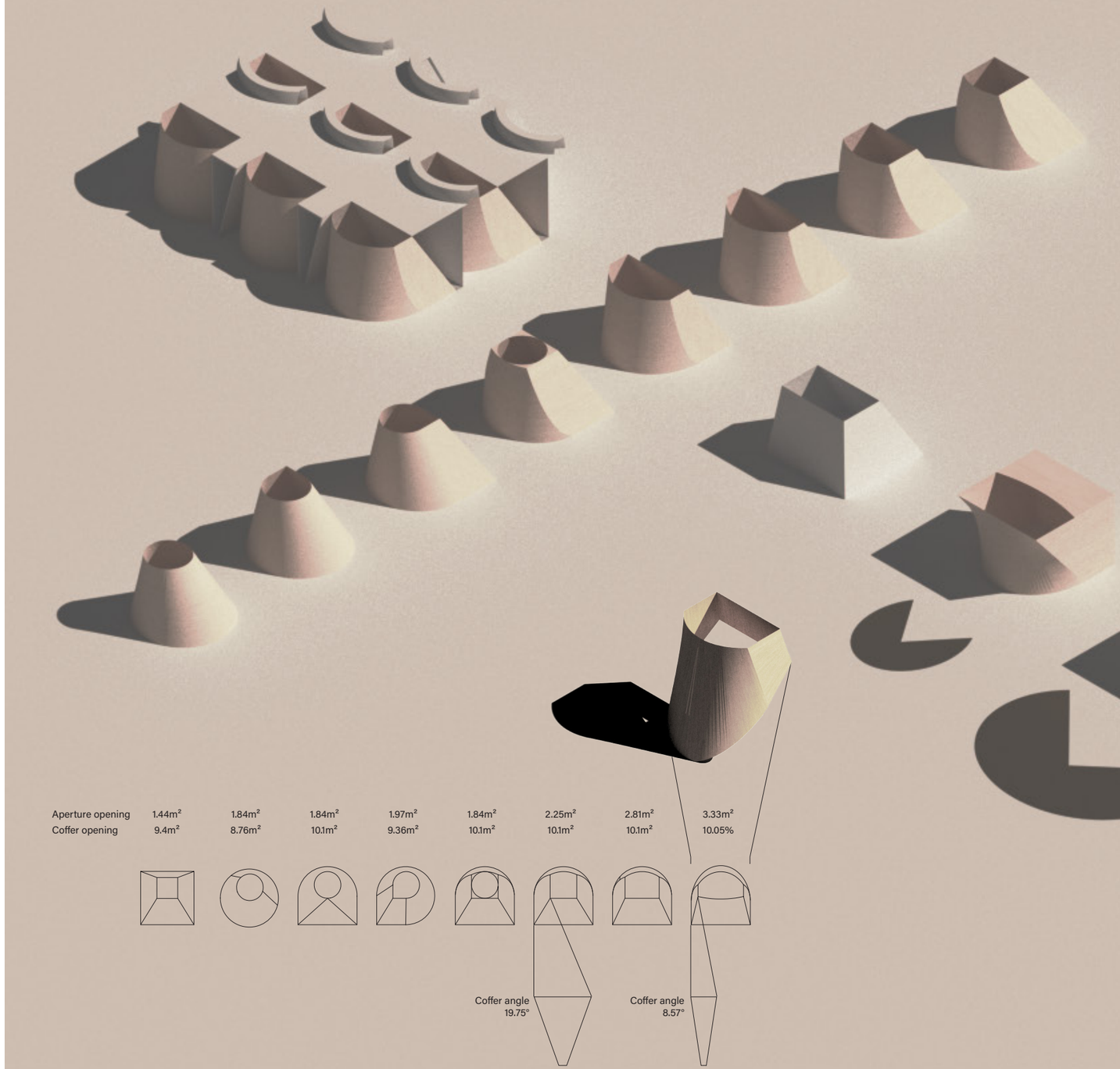


Daylight calculation/study of reference projects

DF% - Toplit room
School in Claus - Dietrich architecten

Mean	3.66
Median	3.84
Minimum	1.42
Maximum	4.56
Uniformity 1	0.39 (min/mean)
Uniformity 2	0.31 (min/max)
Room dimensions: (LxWxH)	27x29x7m
Window dimensions: (LxW)	1,44m2
Underkant vindu:	Skylights depth - 2.4m
Glass to Floor Area Ratio (GFAR):	20.3%
Light transmittance:	68% Opaque glass
Sky condition	CIE overcast sky

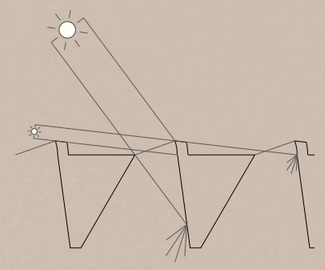
Annual visualisation of sunlight distribution at 21st each month at 12:00



Aperture opening	1.44m²	1.84m²	1.84m²	1.97m²	1.84m²	2.25m²	2.81m²	3.33m²
Coffer opening	9.4m²	8.76m²	10.1m²	9.36m²	10.1m²	10.1m²	10.1m²	10.05%

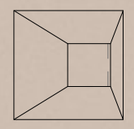
Summer solstice
Oslo 59.9°
Sun altitude 53.36°

Winter solstice
Oslo 59.9°
Sun altitude 6.6°



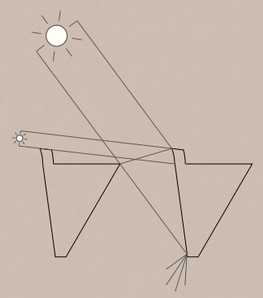
A square aperture does not use the full potential of the ceiling depth to cut off direct sunlight due to the square diagonal corners between coffer opening and aperture opening

Square shaped light opening
Aperture diameter 1.2x1.2m
Coffer opening 3.05m
Coffer angle 7.69°/30.24°
Glass area 1.44m²



Summer solstice
Oslo 59.9°
Sun altitude 53.36°

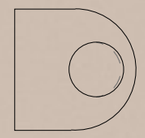
Winter solstice
Oslo 59.9°
Sun altitude 6.6°



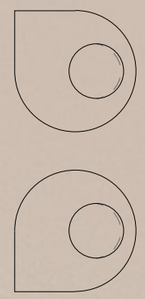
By rounding the north edge of the coffer opening and keeping with the previous angles, both the aperture and coffer opening can be increased

Circular shaped light opening
Aperture diameter 1.533m
Coffer opening 3.4m
Coffer angle 7.69°/30.24°
Glass area 1.84m²

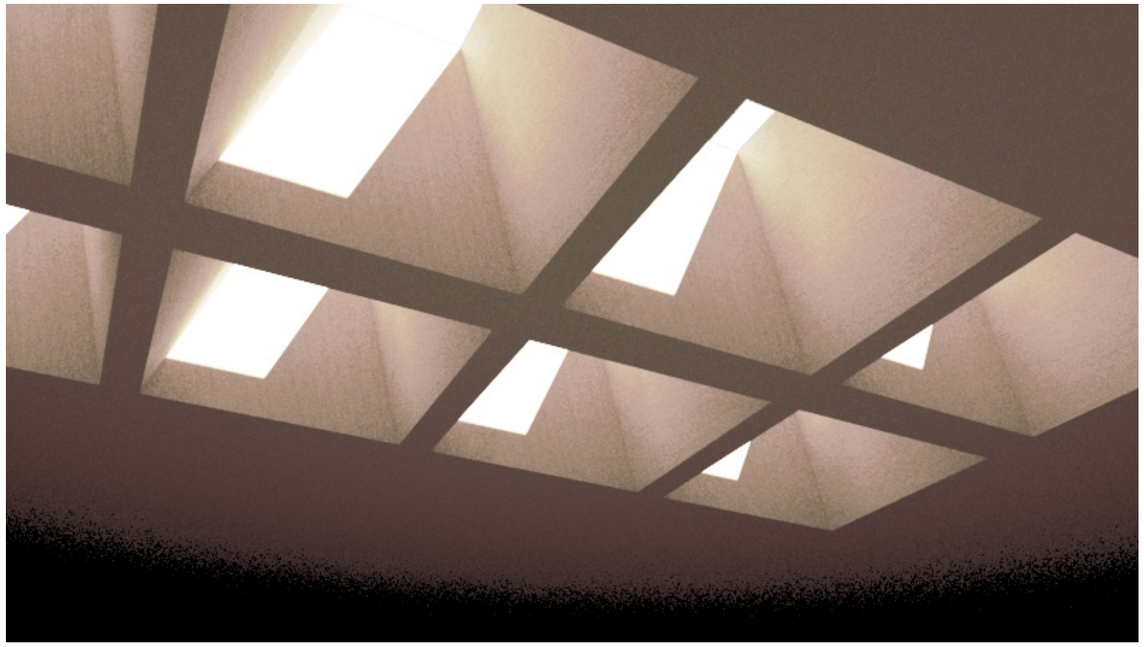
Sculptural coffer variation #2



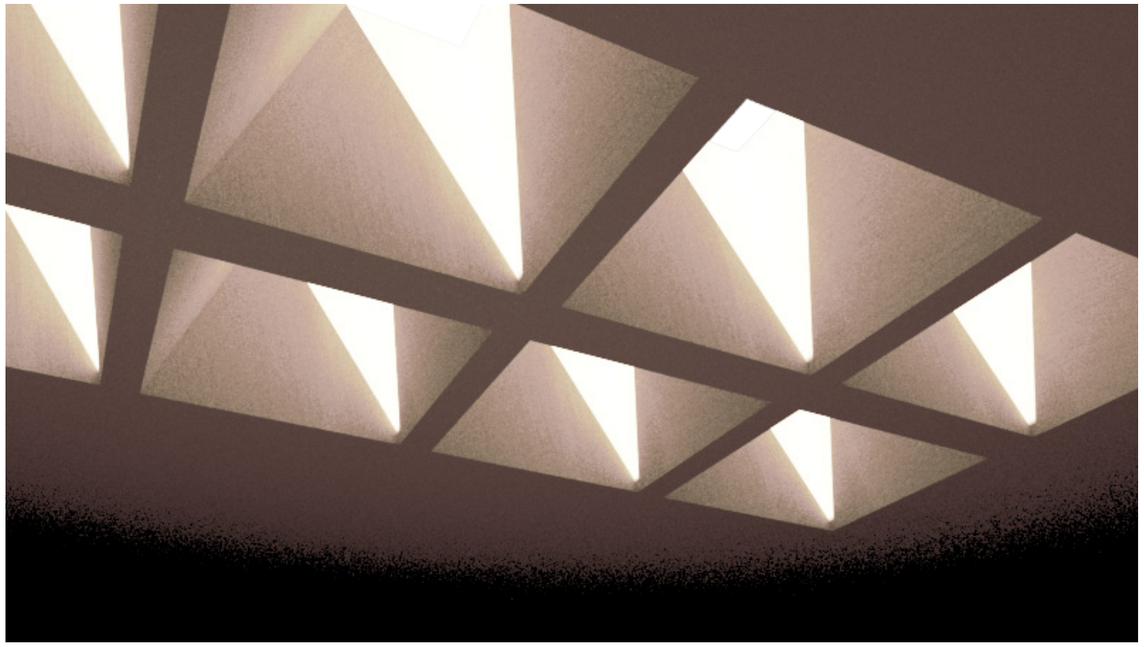
Sculptural coffer variation #3



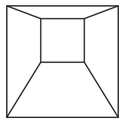
Sculptural coffer variation #3

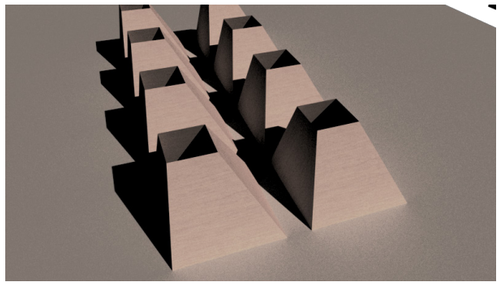


Time 12:00 - 21st of June



Time 16:00 - 21st of June



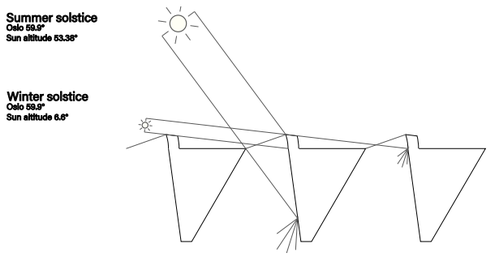


Square shaped light opening:

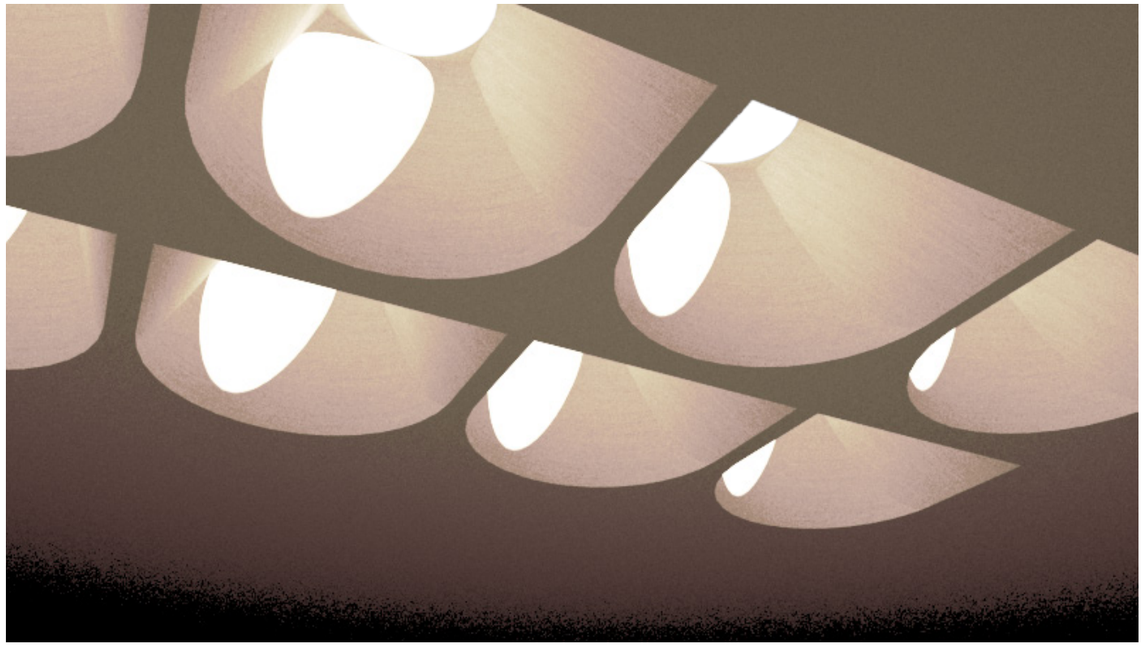
A square shaped aperture does not use the full potential of the ceiling depth to cut off direct sunlight due to the square diagonal corners between coffer opening and aperture opening.

Aperture size 1.2x1.2m
Coffer opening 3.05x3.05m
Angle 7.69°/30.24°
Glass area 1.44m²

Time 16:00 - 21st of June

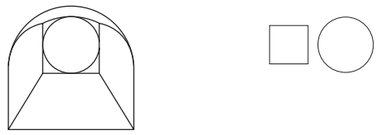


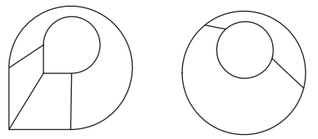
Transverse section diagram 1

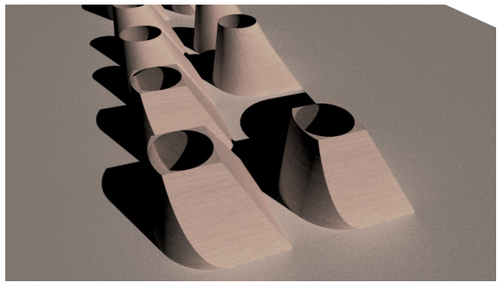


Time 12:00 - 21st of June

Time 16:00 - 21st of June





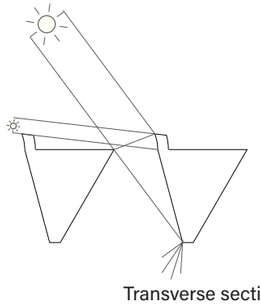


Oval shaped coffer:

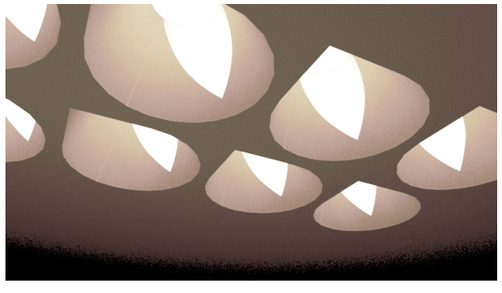
By rounding the north edge of the coffer, opening the aperture can be increased as the cut off angle is improved. It corresponds better to the movement of the sun throughout the day.

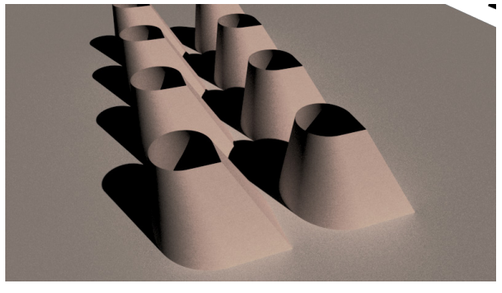
The light opening can also be centered more in the coffer, even with a larger coffer opening, as illustrated in section diagram 2.

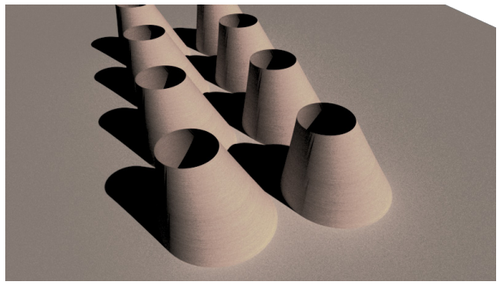
Aperture diameter 1.53m
Coffer opening 3.4x3.4m
Coffer angle 7.69°/30.24°
Glass area 1.84m²

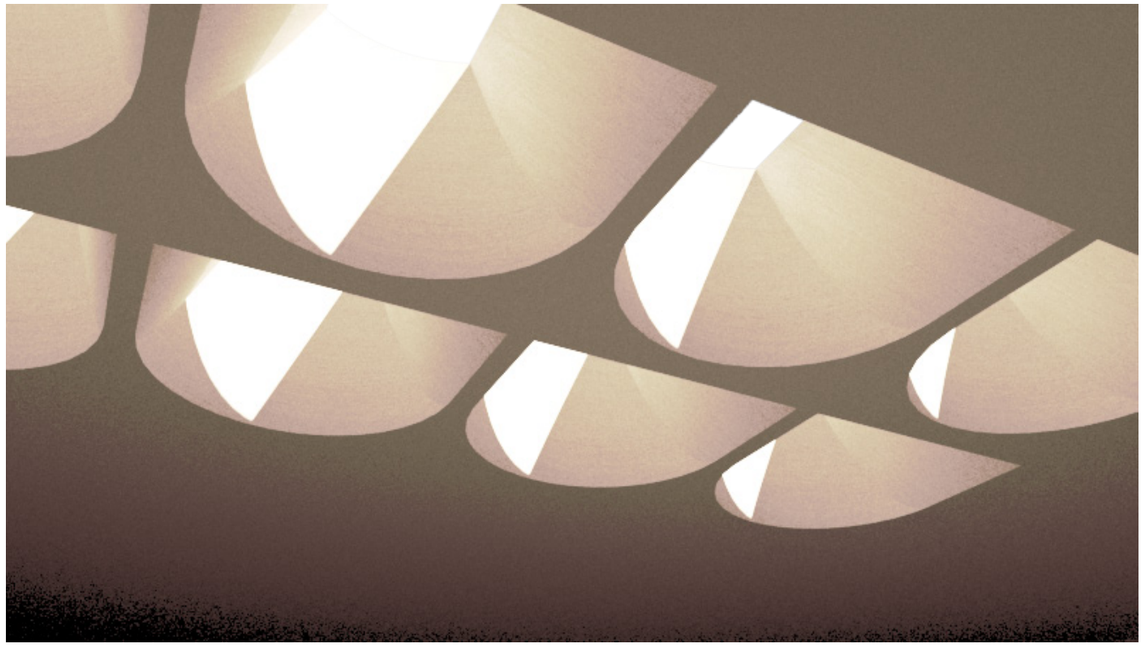


Transverse section diagram 2

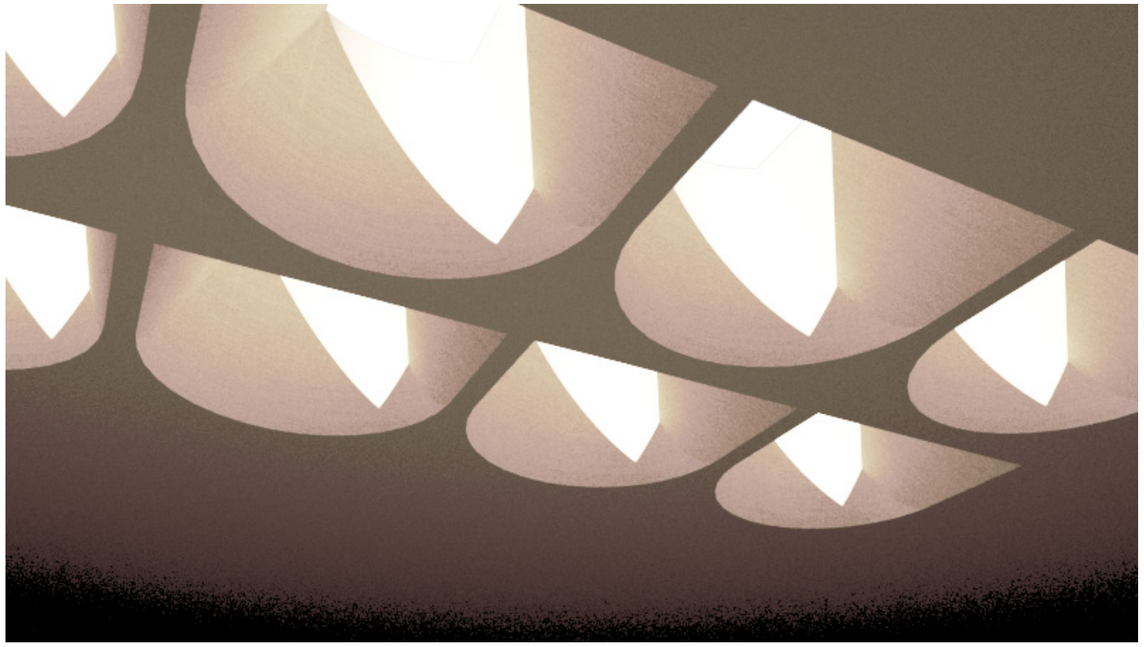




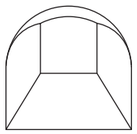




Time 12:00 - 21st of June



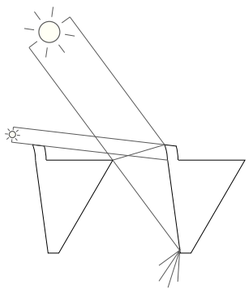
Time 16:00 - 21st of June



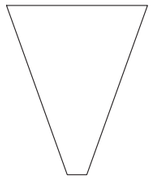
Oval shaped coffer:

Compared to the coffer angles used for the square light opening both the aperture and coffer opening can be increased.

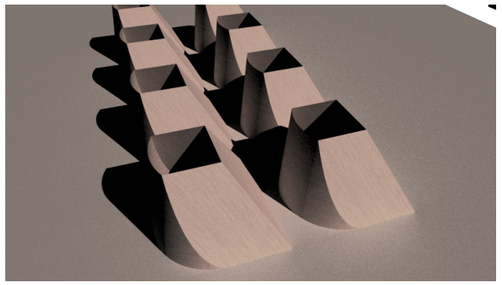
Aperture diameter 1.53m
Coffer opening 3.4x3.4m
Coffer angle 7.69°/30.24°
Glass area 2.25m²

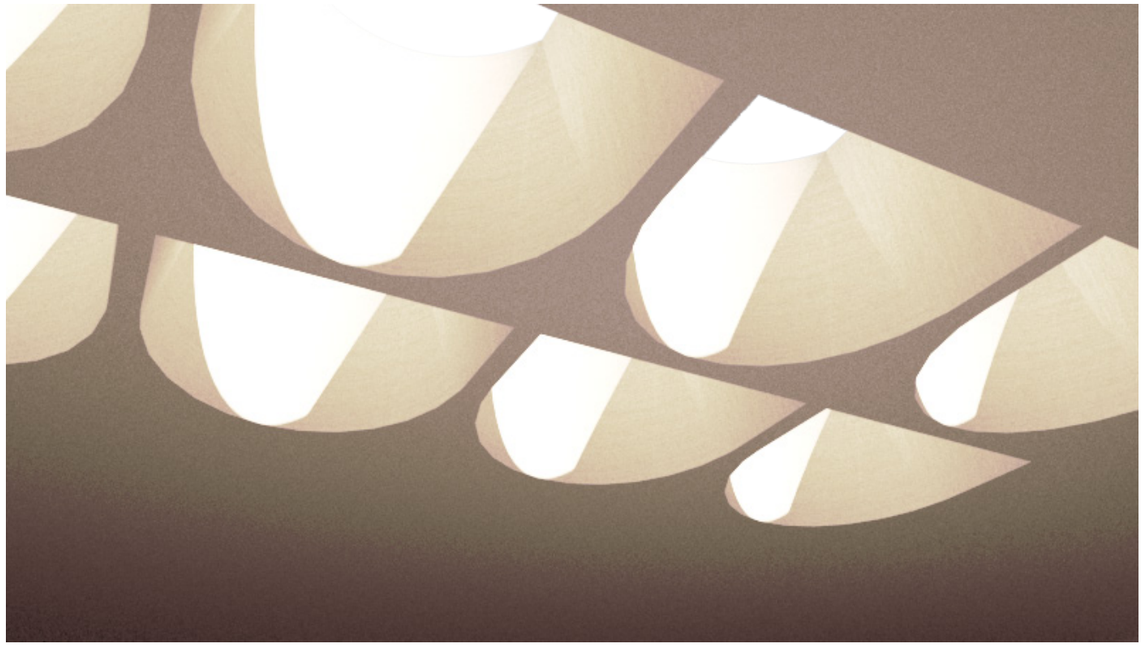


Transverse section diagram 3

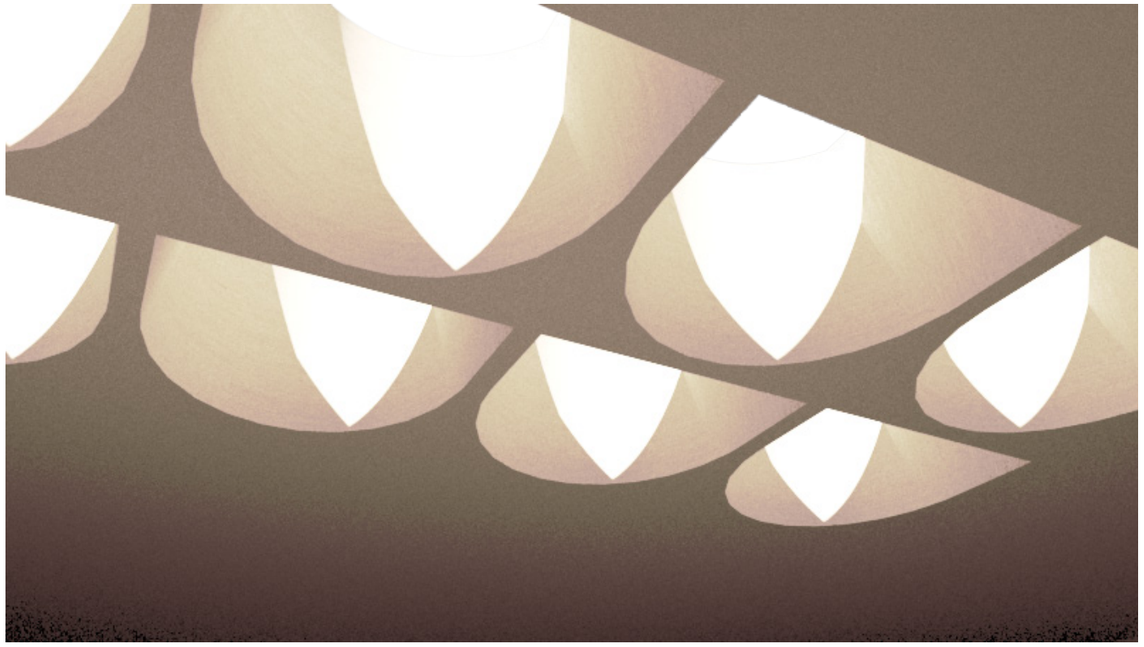


Longitudianal coffer angle

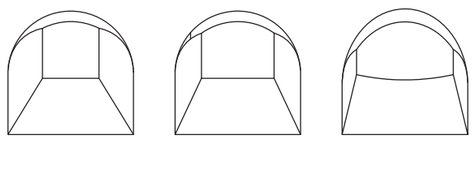


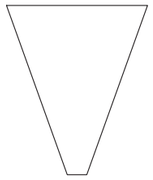


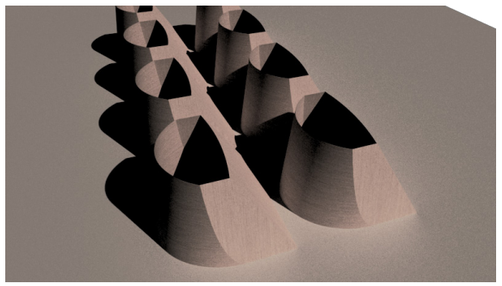
Time 12:00 - 21st of June



Time 16:00 - 21st of June



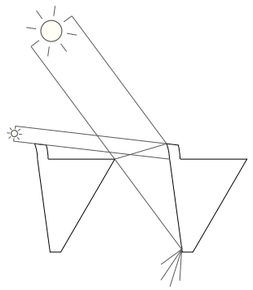




Oval shaped coffer:

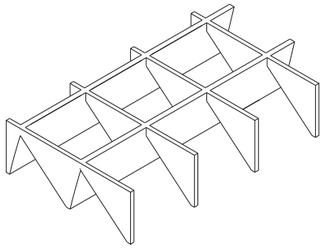
By further changing the longitudinal coffer angle from 19.75° to 8.57° the glass area can be increased to 3.4m2.

Aperture diameter 1.533m
Coffer opening 3.4x3.4m
Coffer angle 7.69°/30.24°
Glass area 3.4m²

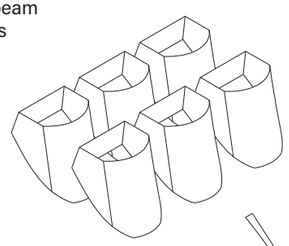


Transverse section diagram 3

Longitudianal coffer angle

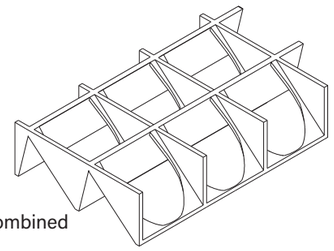


Tilted glulam beam
and CLT panels



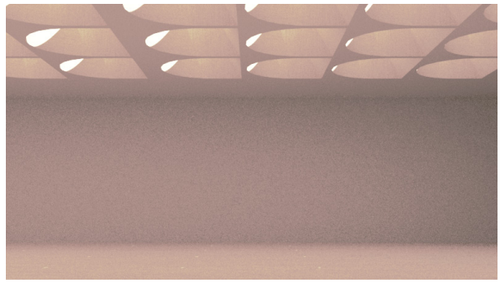
Kerf cnc- cut
wooden panels

Ceiling panel

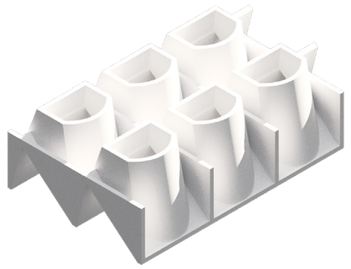


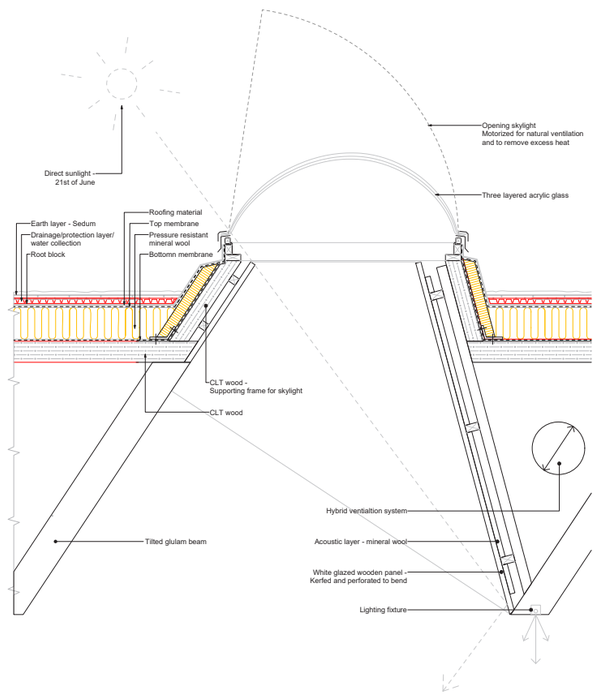
Elements combined

By removing the material of the skylight monitor that is not needed to shield from direct sunlight, the ceiling construction system can become a direct result of the sunlight analysis. The direction of the construction span can also be expressed more clearly.

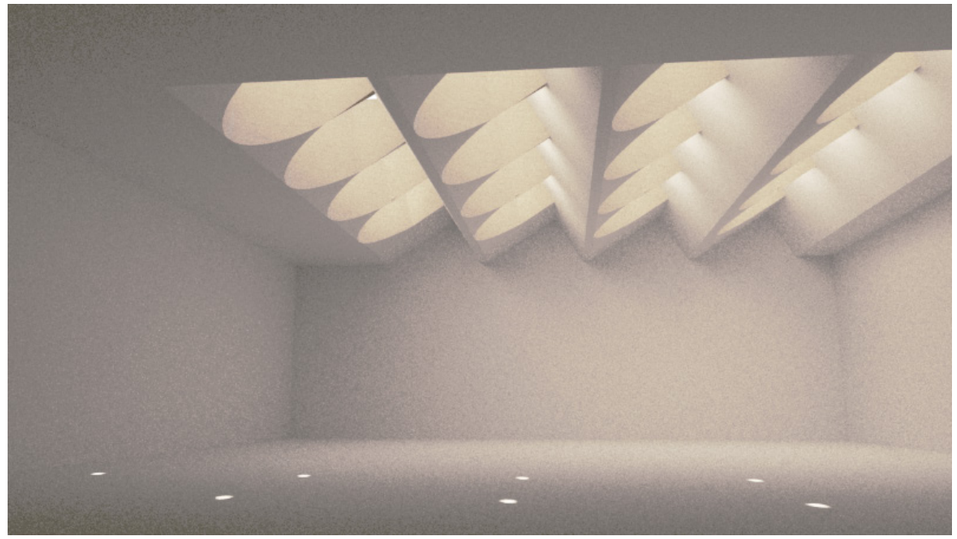


Time 12:00 - 21st of June

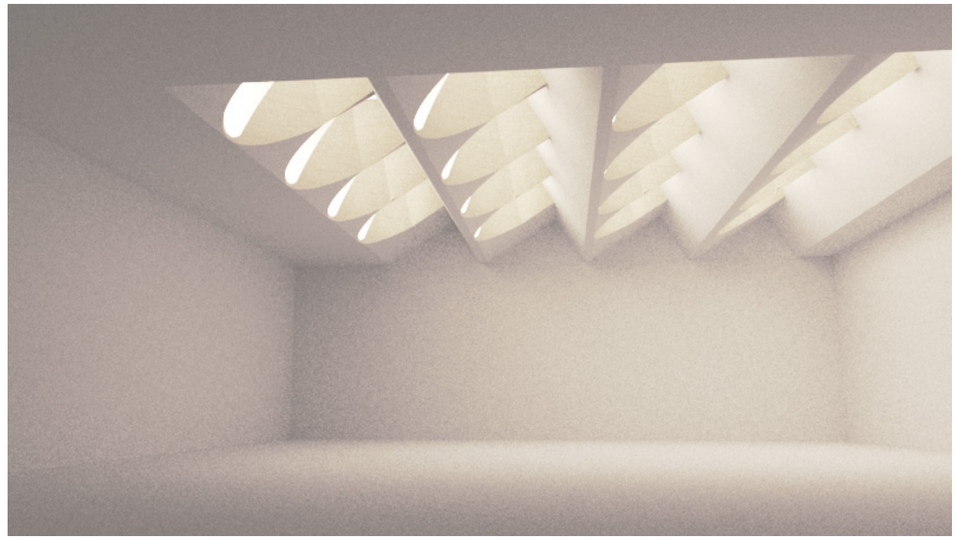




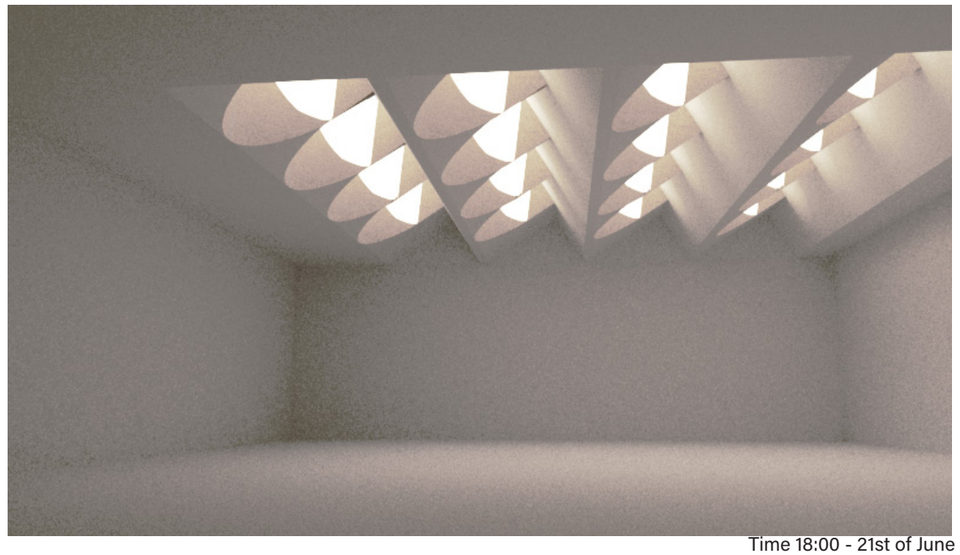
Skylight detail



Time 09:00 - 21st of June

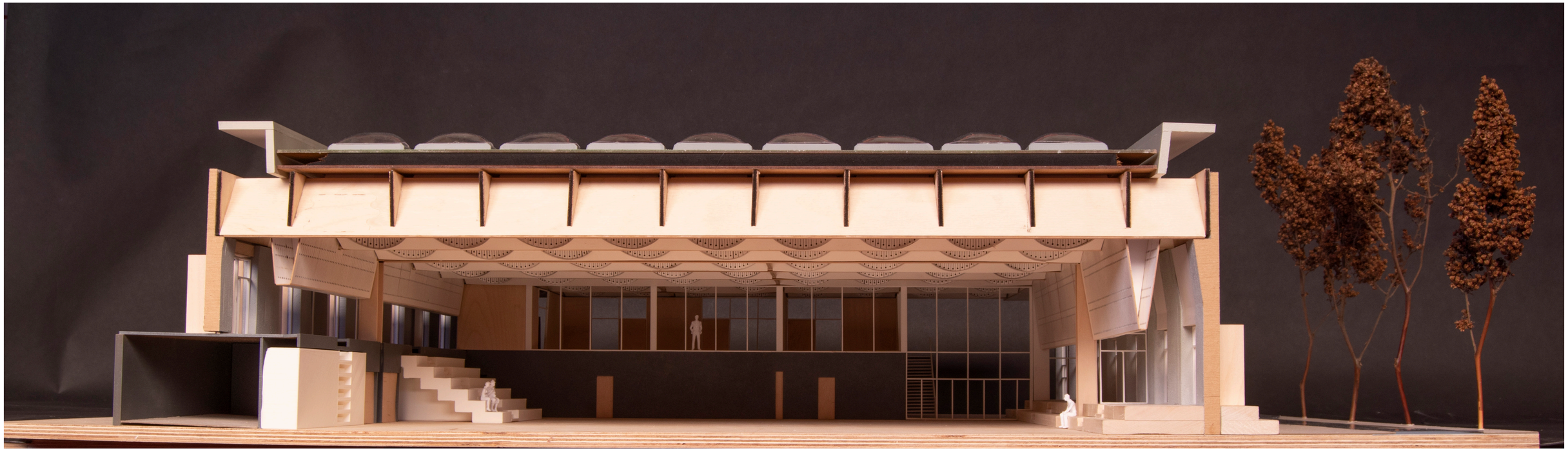


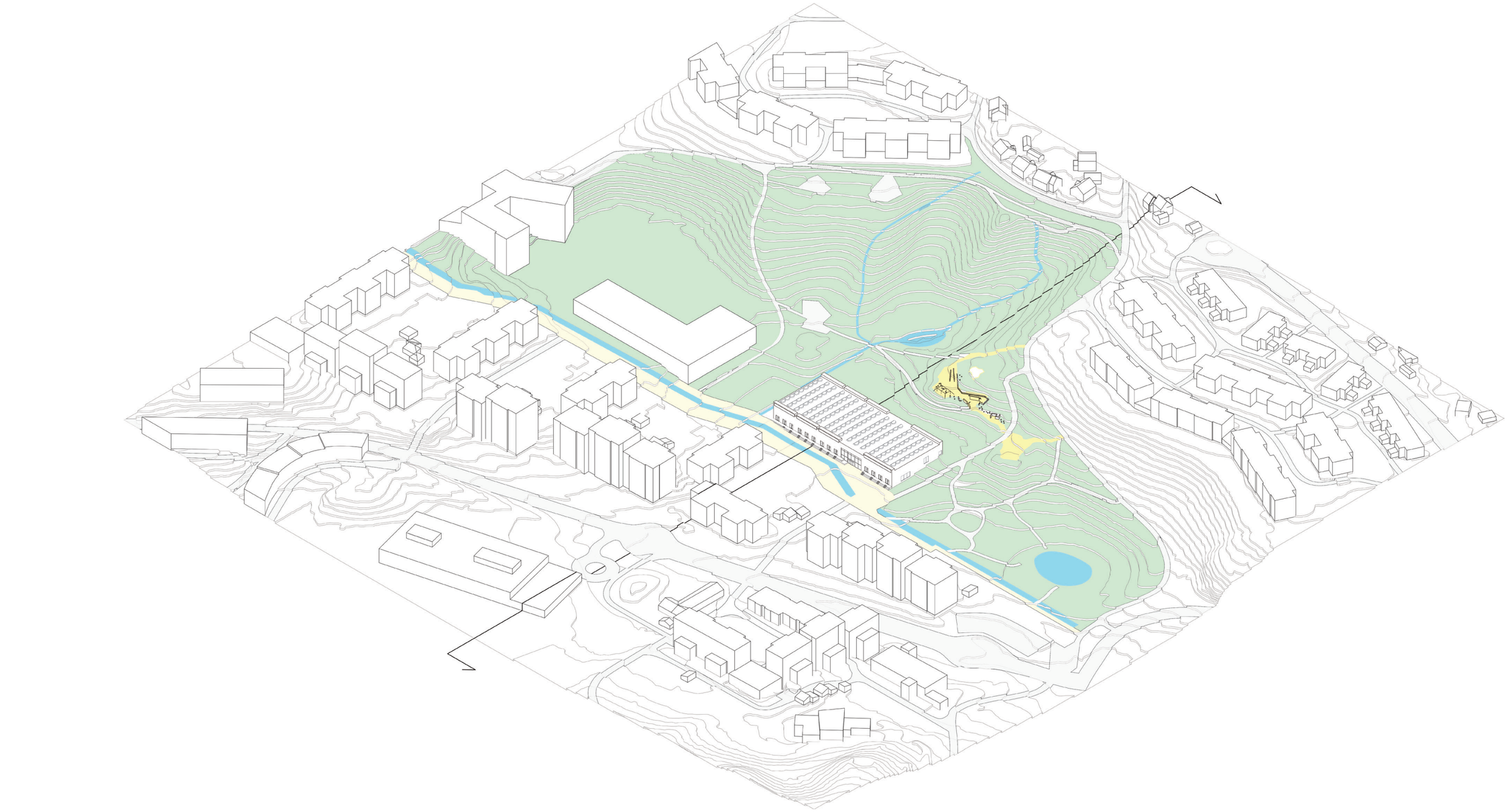
Time 12:00 - 21st of June



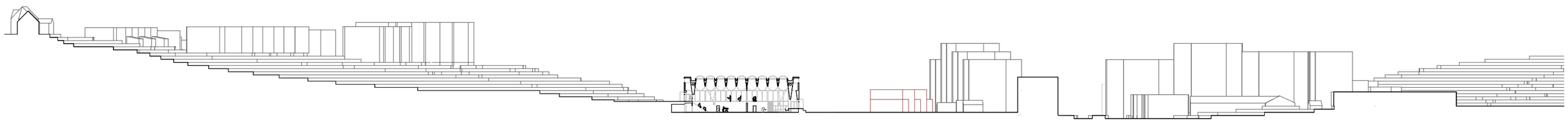
Time 18:00 - 21st of June

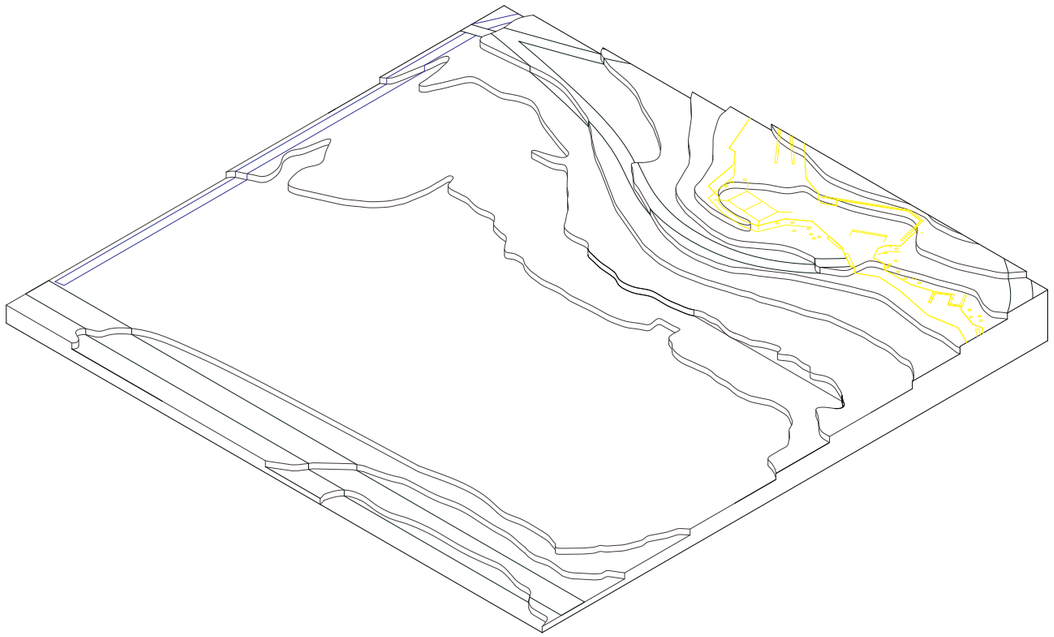
Final project



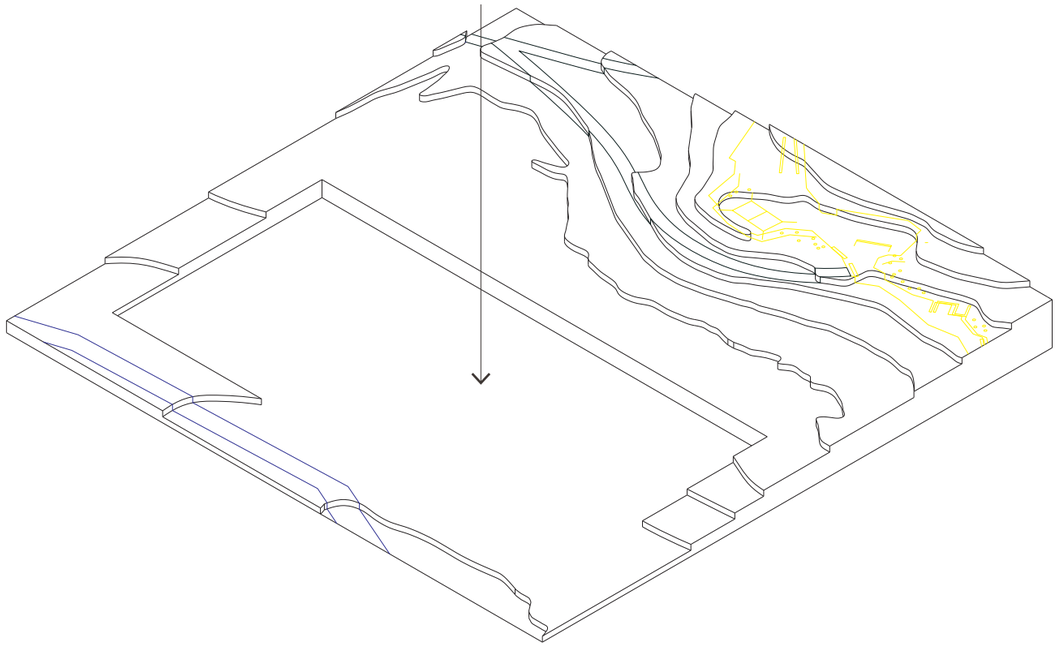


Axonometric site plan

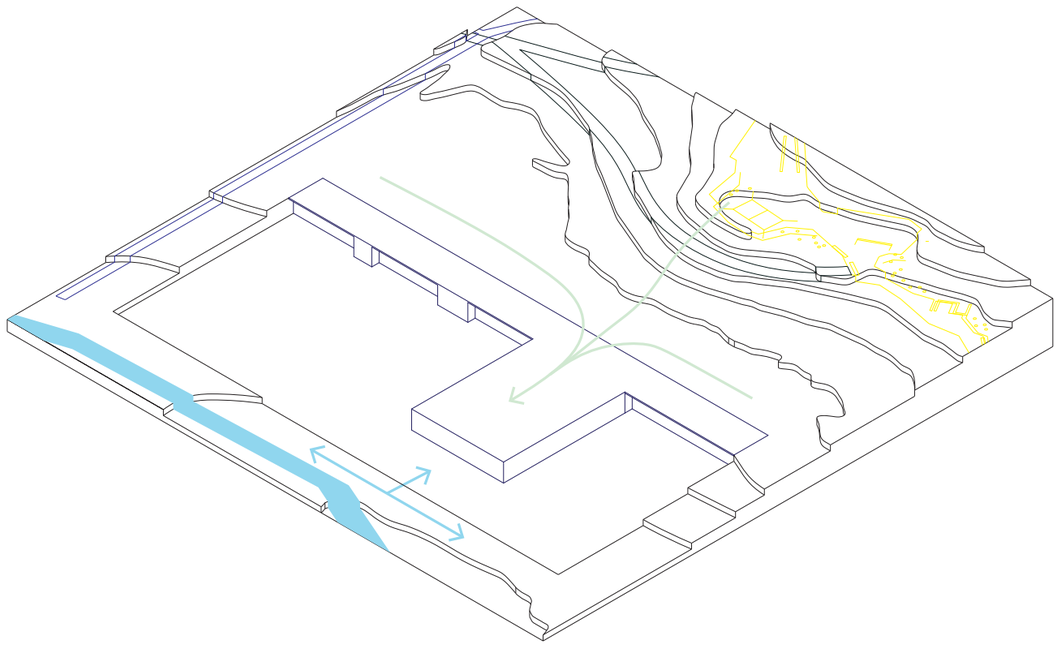




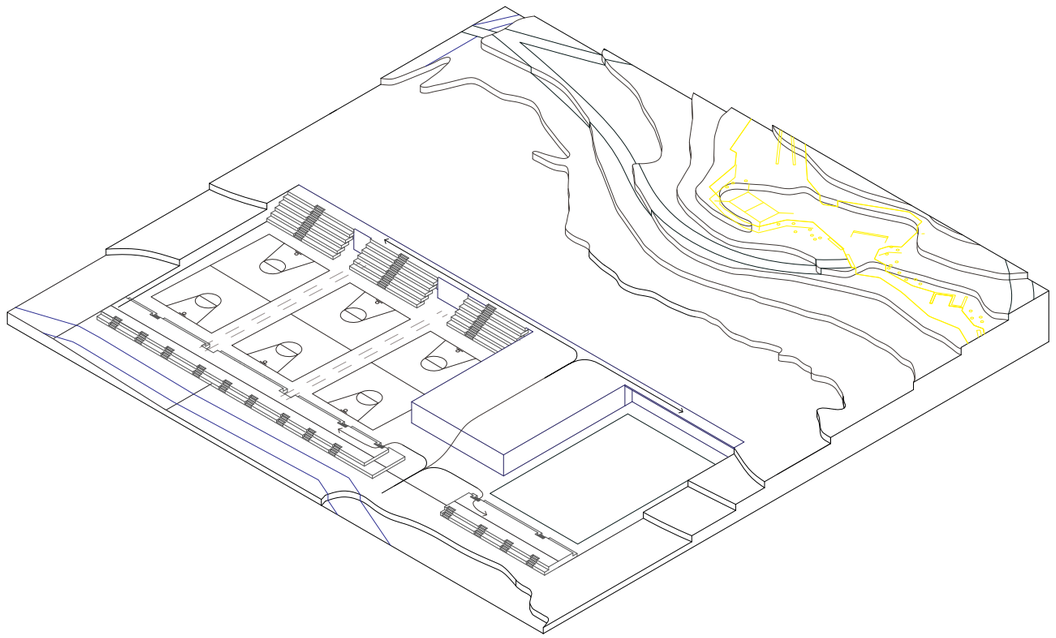
Existing site



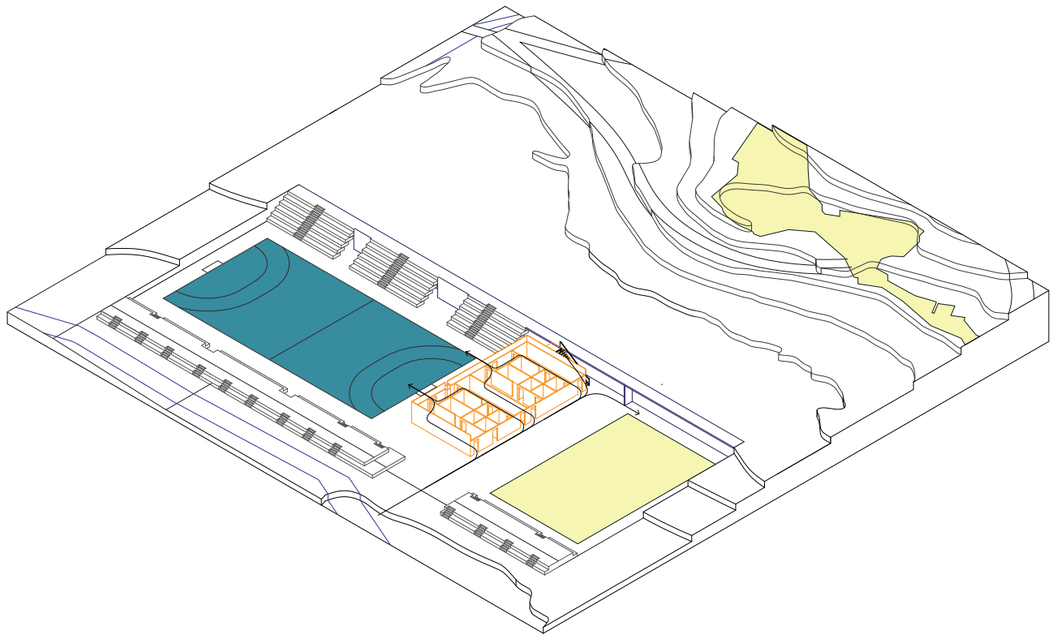
Adaption to terrain



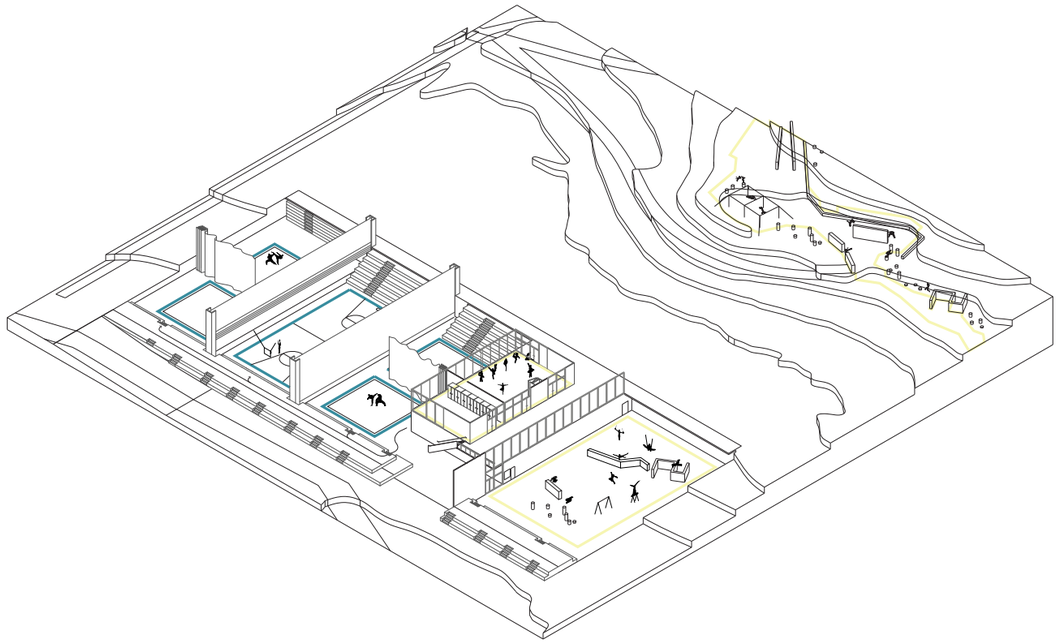
Relationship between park and axis



Movement as a spectator



Movement as user



Programmatic partition

- 1. Possibility for five sections of which three sections are sound isolated by liftable walls.
- 2. Play and individual sports - dance
- 3. Play and individual sports - parkour and gymnastics

Sedum roof

Skylights

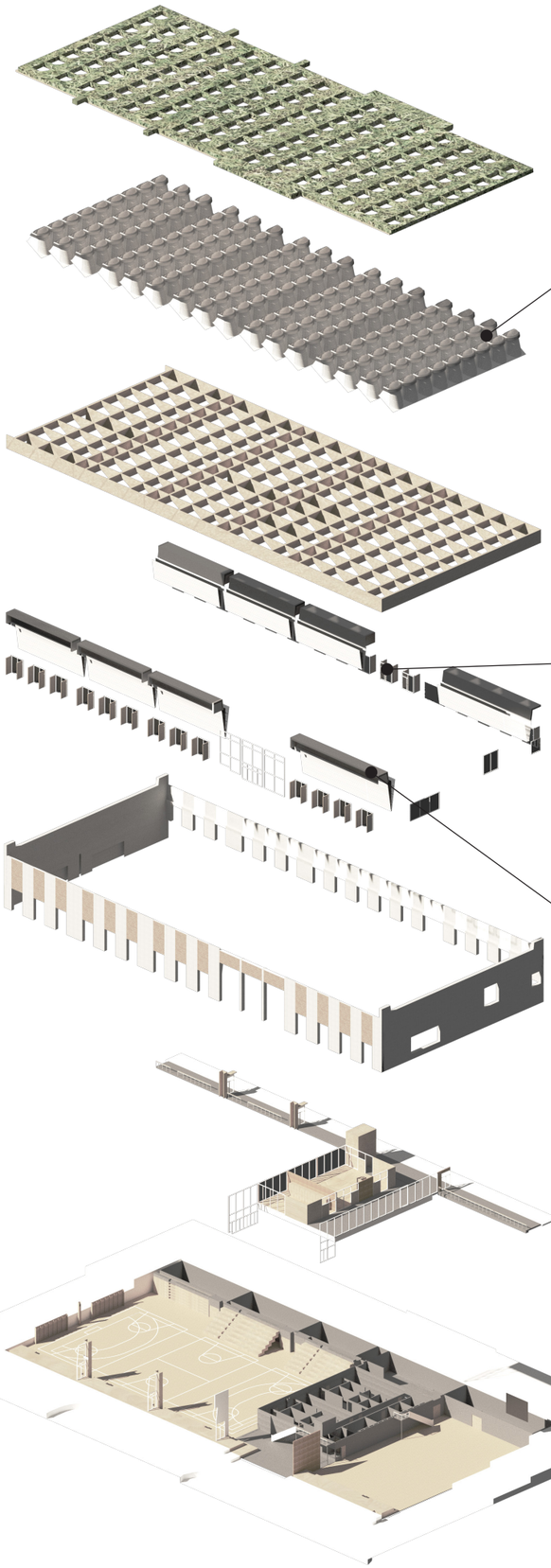
Roof construction

Daylight openings

Load carrying system

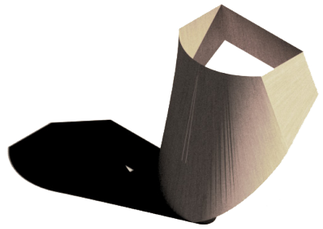
Podium

Ground floor

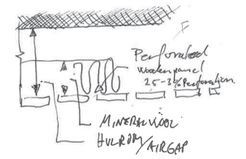


Skylight module

Limits direct sunlight from entering the interior and function as acoustic elements.



Model photo show skylight kerfing pattern



Acoustics: Perforated membrane absorbant

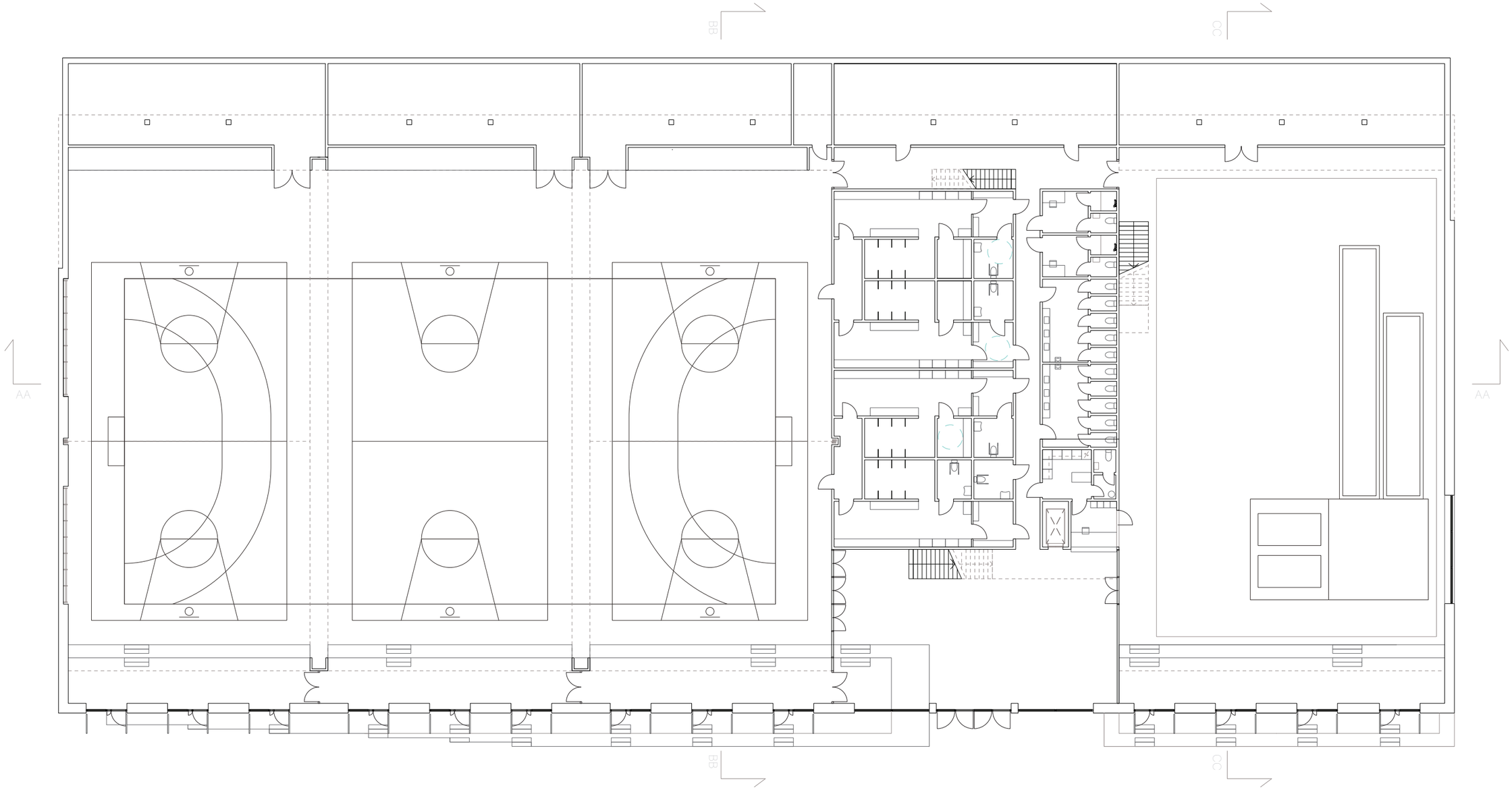
External shutters:

Large, wooden shutters can block view and direct sunlight. Or they can stay open for transparency, shield direct sunlight, and allow for the play of variations in direct sunlight.

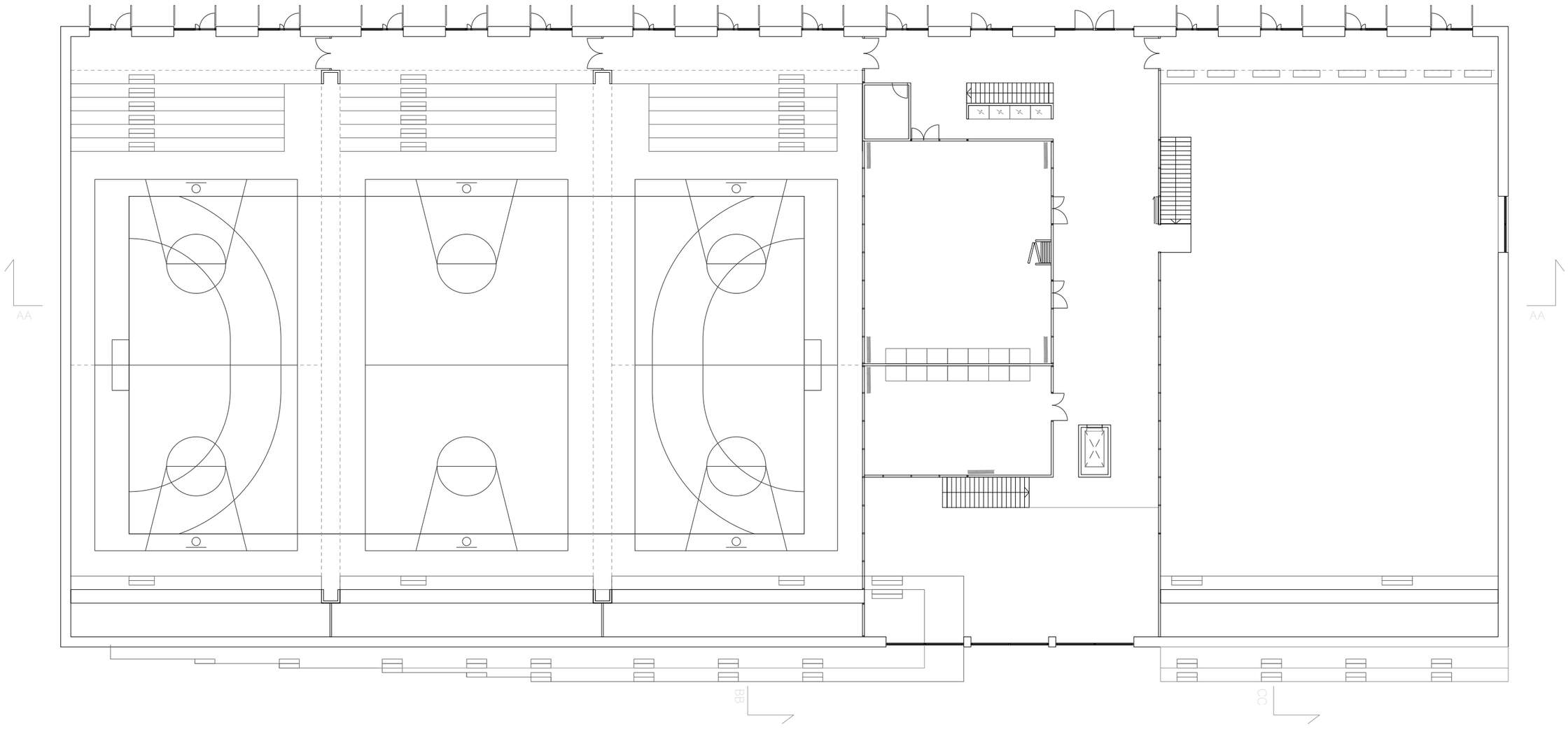
Clerestory light and ceiling shape:

Clerestory windows turn the room into a sun dial by letting in the morning sun on one side, and the evening sun on the other. A prominent effect in winter time, when sunlight does not fall into the skylight coffers and if the barn doors are shut.

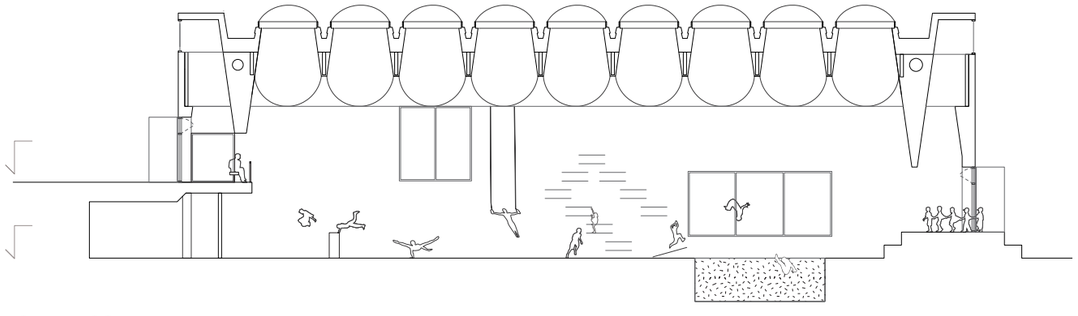
The ceiling drops down alongside the gallery to shield off direct sunlight.



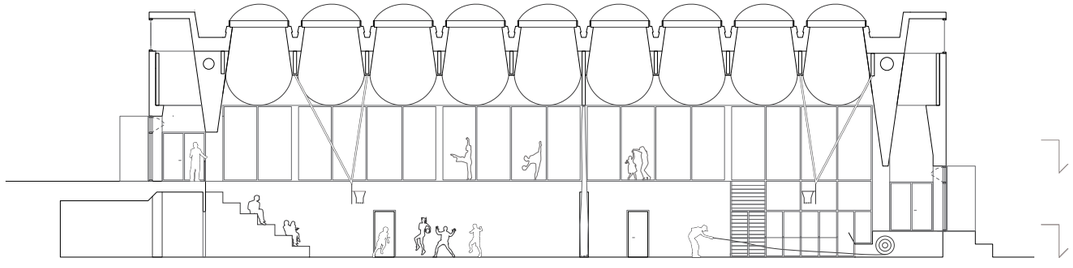
Ground floor



Second floor

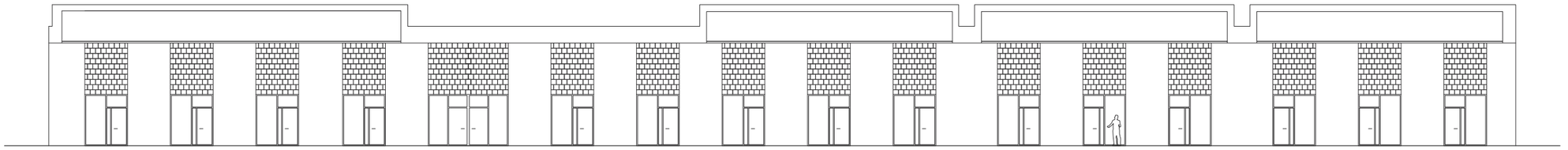


Section CC

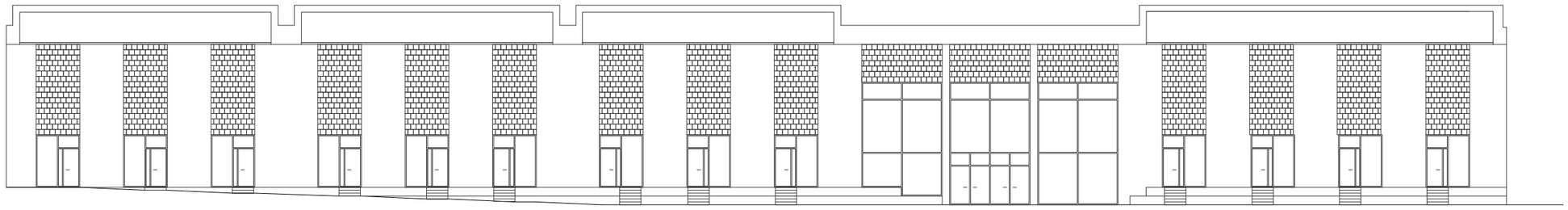


Section BB

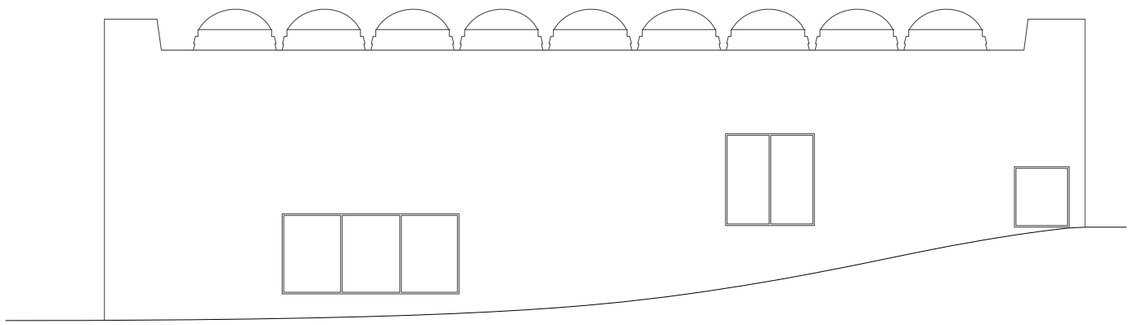
Section AA



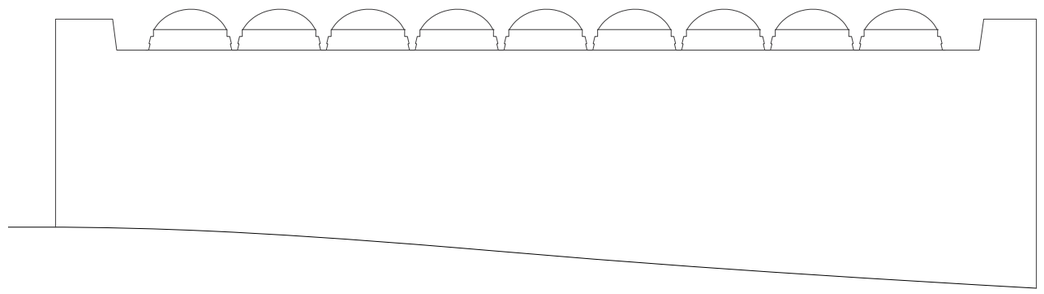
Elevation west facade



Elevation east facade



Elevation north facade



Elevation south facade