

## Reference projects

**Example of projects with well integrated  
daylight strategies**

Falkonergården

Pajol sport center

Landskrona

Turnhalle Haiming

Siobhan davies studios

Ullern high school

Rovaniemi library

The Museum of Modern Art, Aalborg

Christianhavns Sports Center

Seconday school with hall in Klaus



Overlys i hallen

## Falkonergården

Location  
Copenhagen, Denmark

Year completed  
2015

Architect  
Falko Arkitekter Aps

Authors  
Tage Lyneborg (1946 Denmark); Carl Th. Lyneborg (1982 Denmark); Høgni T. Hansen (1971 Denmark)

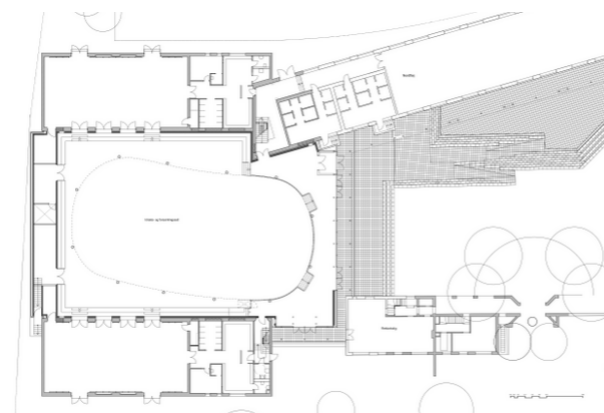
Collaborators  
Structural engineering: MOE A/S Acoustical: Gade & Mortensen A/S Technical architect: Halvorsen & Jensen

Program  
Education/School

Total area - 1.200 m<sup>2</sup>  
Size of hall surface - 975 m<sup>2</sup>  
Usable floor area - 1.400  
Number of seats - 1041  
Free height - 10.5 m



Borrowed light fra tilstøtende aktivitetsrum



Plantegning



Snitt fra vest til øst

### 1. Design and orientation of daylight openings

Daylight enter through skylights with a considerable depth and give for the most parts of the day a indirect daylight into the hall space. Electric lighting fixtures are implemented in the skylight openings like a lamella. An open facade towards/through the entrance hall give a view out and brings indirect light into the hall. It also give a depth to the space in addition to information about the outside wather and time of the day. The hall also receive indirect daylight from adjacent acticity spaces. The skylights are placed evenly and relatively close together which give good light modeling and uniformity in the light. Skylights are an efficient way of bringing light into the interior as the glass area of a skylight is up to 6 times more efficient than the equivalent glass area orientated vertically on a wall. A glass area efficiency are dependent on the available and visible part of the sky component.

### 2. The relation between the constuctive system, material and daylight openings

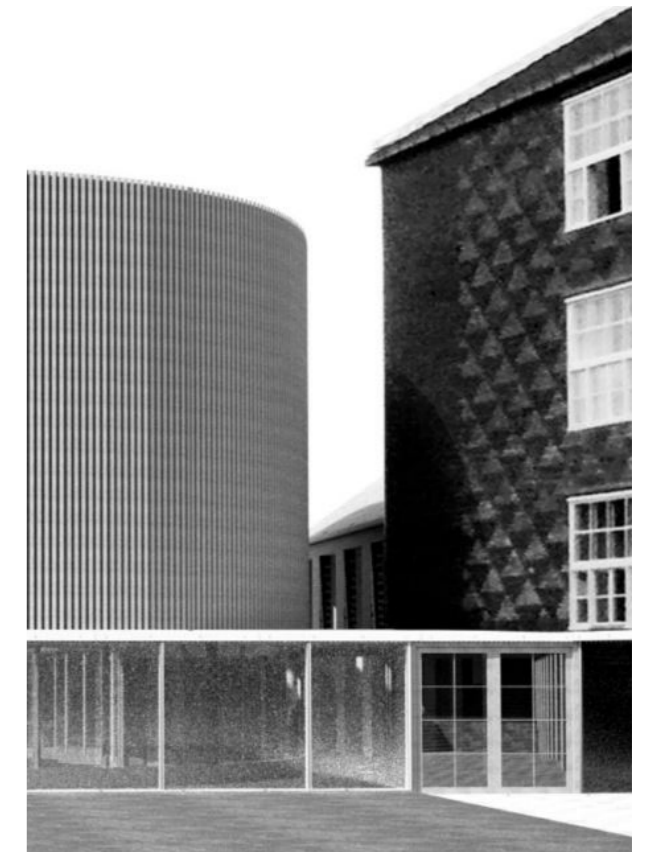
As a load carrying principle the wall uses its height as a beam that is supported by columns placed with even distance around the hall. The ceiling is a two way beam construcion rotated 45°, where the daylight enter through every second opening.

The brightness of vertical surfaces are important to balance the contrast in the visual field. As the main picture on the previous page show, the curved end of the space is darker. The contrast could have been reduced by giving the end wall more light.

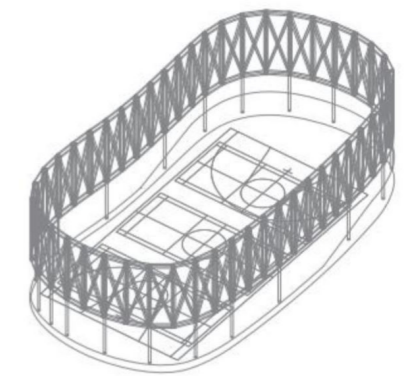
### 3. The buildings outer form, environment and orientation

The multi purpose hall is an addition to an existing school building. The hall is perceived as a separate volume with a skirt that binds it together with the existing building. The skylight form picks up the facade pattern on the existing brick building as a contextual reference to existing buildings. The entrance situation is orientated towards east and the morning sun. There are no outdoor obstructions.

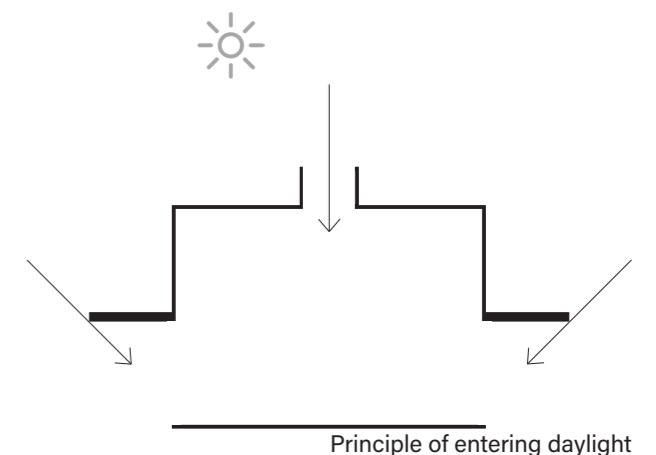
Picture references: <http://miesarch.com/work/3118>



The skylight shapes pick up existing facade pattern



Load carrying principle



Principle of entering daylight



Skylight from north facing clerestory windows

# Pajol sport center

Location  
Paris, France

Year completed  
2012

Architect  
Brisac Gonzalez

Program  
47 x 24m sportshall, martial arts and fitness center on ground level

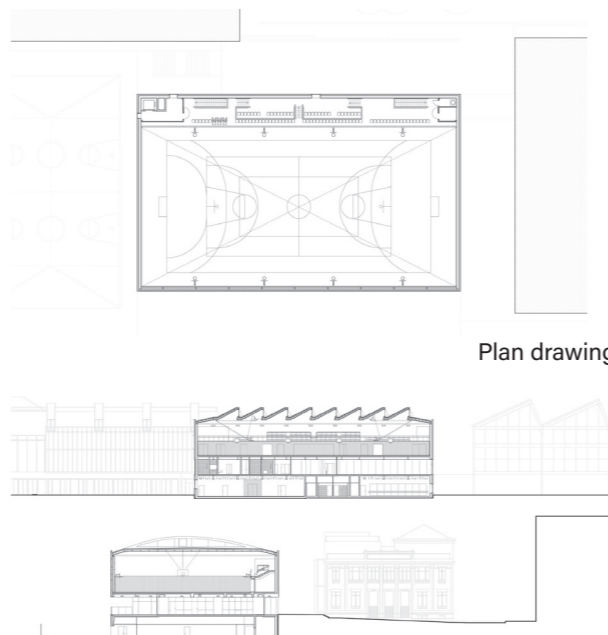
Total area  
4060.0 sqm

Number of seatings  
900

Free height - Assumed to be 9 m



Birds perspective - entrance



Plan drawing

Section

## 1. Design and orientation of daylight openings

The multi purpose hall utilize reflected light from north that enter through curved, sculptural clerestory windows. Light entering from the north works good seen from one direction, but lead to bigger contrasts in the opposite direction. Clerestory windows give a one sided direction of the light and the one short end of the space becomes darker.

## 2. The relation between the constuctive system, material and daylight openings

The load carrying principle is easy to read from the shape of the ceiling. The curved beam spans and works together with vertical steel posts. The lower beam is in tension from horizontal forces from the curved beam and prevents it from sliding to the sides. Wood abosbs a lot of light, at the same time as it has a texture in the surface that diffuse the light in a nice way that give a warm tone to the interior. The back wall could have been treated with a brighter surface or be given a separate skylight.

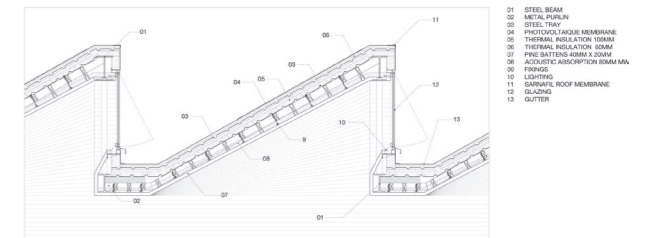
## 3. The buildings outer form, environment and orientation

The building hosts a sport and activity program in a total of three floors. The building is oriented north-south. The longitudinal facade towards east is oriented towards a railway track. The entrance situation is directly into the 2nd floor from ground level in west. A glass band separate the hall volume from the lower base. The offset inwards works as a sunscreen.

Picture references: <http://www.brisacgonzalez.com/pajol-sports-centre>



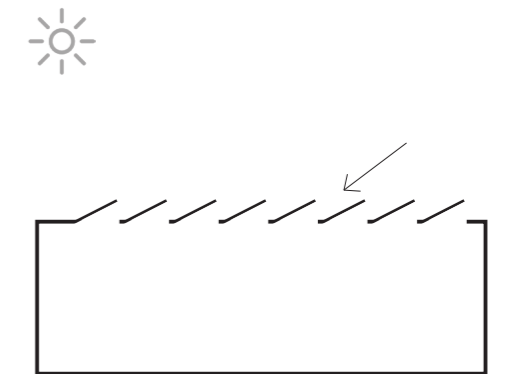
Massing of volumes - public zone in the recessed glass band



Window detail



Relation in contrast - seen in both directions



Principle of entering daylight



Sidelight from all four facades

## Landskrona

Location  
Landskrona, Sweden

Year completed  
1965

Architect  
Arne Jacobsen

Collaborators  
-

Program  
Bordtennis, handboll, skolidrott, friidrott,  
tyngdlyftning, kampsporter och innebandy.

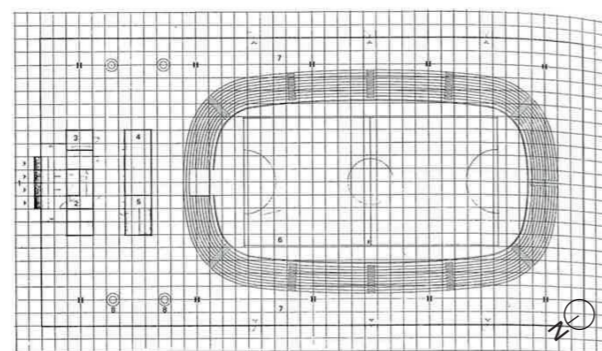
Total area  
- m<sup>2</sup>

Number of seatings  
1100 seats  
1000 standing

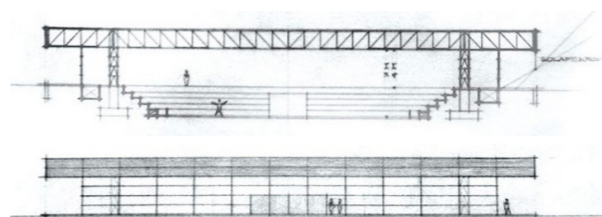
Free height - Assumed to be 7 m in center



View from outside at night



Plantegning



Cross section and elevation

### 1. Design and orientation of daylight openings

Daylight entering from four sides give a good light modeling, but will at the same time receive large periphery contrasts between ceiling and windows. The ceiling is glossy, and is in later refurbishments made matt white. The use of a spanning roof outside of the building in combination with the surrounding public area around the hall to screen of the sunlight are a very clear and legant move. (Although the low sun angles in Finland will enter). On all new photographs of the hall the curtains are closed. If there are issues concerned with heat gain/loss, visual disturbance og problems with low sun angles in winter is uncertain.

### 2. The relation between the constuctive system, material and daylight openings

The ceiling is a big two way beam construction, supported by 10 beams, 5 on each side. The walls are freed from carrying. The ceiling is glossy and reflects the outdoor inside.

### 3. The buildings outer form, environment and orientation

The building is a free standing structure and daylight is collected from the side of each facade. Big glass surfaces let light in from all four sides. Windows cover the whole walls. The transparency of the building is enhanced by that the sport hall is recessed under ground level. The ceiling is floating. The public enters on ground level with a overview of the hall where no walls meet the ceiling. The sport surface is lowered so that wardrobes and and storage is stored under ground in the short end of the hall.

Picture references:

Foto: <http://www.alamy.com/stock-photo-sports-hall-landskrona-1964-architect-arne-jacobsen-7889056.html>

<http://www.johannesreponen.com/journal/2016/3/30/landskrona-sports-hall-1965-in-sweden-designed-by-danish-architect-arne-jacobsen>

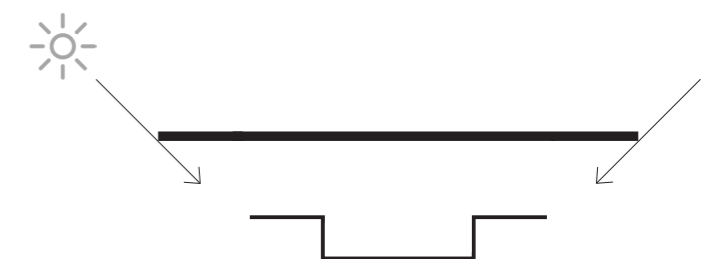
Tegninger: [http://hormaestudio.com/portfolio\\_page/arne-jacobsen/](http://hormaestudio.com/portfolio_page/arne-jacobsen/)  
[http://architecturalmetabolism.blogspot.no/2013/04/blog-post\\_4296.html](http://architecturalmetabolism.blogspot.no/2013/04/blog-post_4296.html)



Spanning roof screen from direct sunlight



Interior



Principle of entering daylight



Sidelight from two facades

## Turnhalle Haiming

Location  
Haiming, District Altötting, Upper Bavaria,  
Germany

Year completed  
2013-2016

Architect  
Almannai-Fischer

Collaborators  
Rolf Enzel, Florian Fischer, Harald Fuchshuber,  
Benjamin Jaschke, Antonia Sivjakov

Program  
2.5 size sports hall

Total area  
1800 m<sup>2</sup>

Number of seatings  
ukjent

Free height - Assumed to be 7 m



View from outside



Plan drawing



Cross section

### 1. Design and orientation of daylight openings

The sports hall is a free standing building and daylight enter from the two longitudinal sides. Opaque windows stretches from floor to ceiling towards north west. The windows emits a diffuse, indirect light that also give a brightness to the "ceiling". Windows on the opposite wall is lower and limited in area as they are placed on the south east wall. The windows are withdrawn behind the spectators area so that the direct sunlight is being screened off and reflected into the hall area.

Opaque skylights oriented south also give a brightness to the ceiling construction. Skylights also improve the uniformity of the illumination.

### 2. The relation between the constructive system, material and daylight openings

The architect describe the building to be based on standardized building elements such as standard dimensions of wood, beams and nail plates that create a repetitive pattern. The building is over dimensioned in the favour of visual repetition. White painted ceiling construction elements hide visual noise as the height, brightness and distance between them create a visual ceiling seen towards the longitudinal direction.

The choice of bright materials and a bright color palette helps the light reflect well inside the hall.

### 3. The buildings outer form, environment and orientation

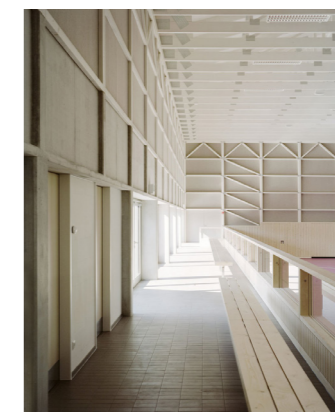
The building utilize the indirect light from the north by placing service functions and the entrance in a wing on the south side of the hall. The ceiling span outside the building, especially towards north west. A triangulated construction between ceiling and the bottom part of the facade screens the evening sun.

The hall is partly recessed in the ground and are surrounded by a solid, low wall with vertical wooden panels. Storage is hidden in the short ends of the hall.

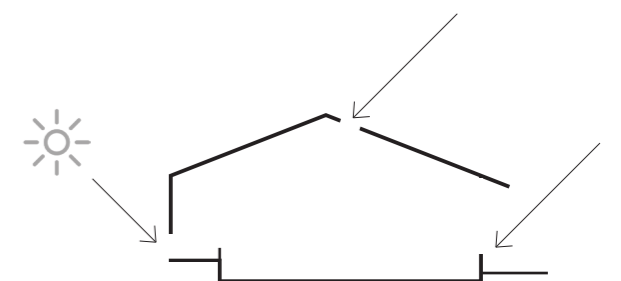
Picture references:  
<http://almannai-fischer.de/turnhalle-haiming/>



Diffuse glass



Interior from tribune



Principle of entering daylight



Borrowed light fra atrium

## Ullern high school

Location  
Ullern High School, Oslo

Year completed  
2015

Architect  
Dark

Program  
Norwegian Radium Hospital and the Institute for Cancer Research, as well as Ullern High School

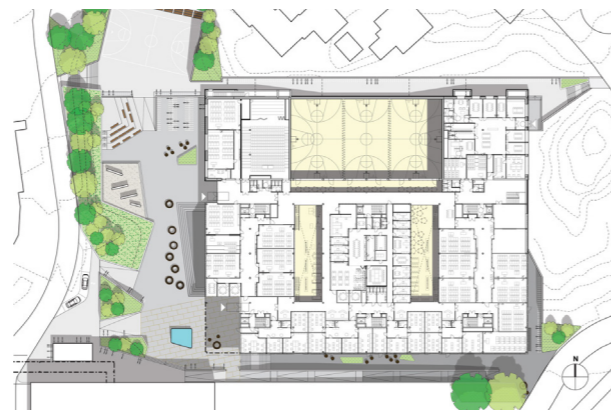
Total area  
35.300 GFA, of which 13.300 m2 is High school

Number of seatings  
900

Free height - Assumed to be 7 m



Telescope tribune



Plan drawing

### 1. Design and orientation of daylight openings

Daylight enter mainly from four skylights oriented in the cented axis. They are barely visible above the technical installations. The skylights help increase uniformity and modeling. There are two atriums that meet the hall in each corner. The atriums provide a borrowed light and a certain relation in intensity and variation throughout the day.

### 2. The relation between the constructive system, material and daylight openings

Truss beams span between beam and wall and carry a outdoor area on the top. Auditoriums and technical installations are placed in the hall end. The beams and technical installations are exposed and create a visual noise in the ceiling. Especially when daylight enter the skylights. A bright colour palette is used and a matt flooring limits shiny glare spots.

### 3. The buildings outer form, environment and orientation

The hall is a part of a bigger building and is attached to a cantina, library and a larger office. The hall is placed in the northern part of the building where three office lamellas shadow the skylights. The hall can become a large living room for the whole buidling complex when is opens up towards the cantina and the library. Telescope tribunes can gather up to 900 people.

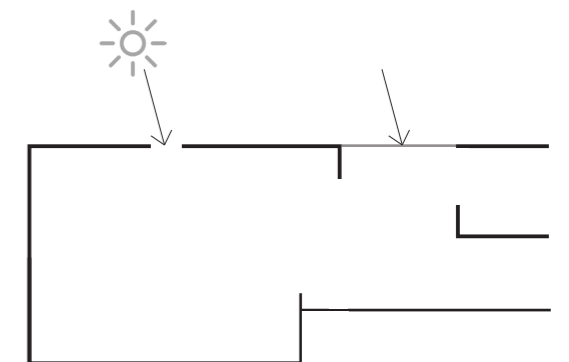
Picture references:  
<http://dark.no/projects/occi>



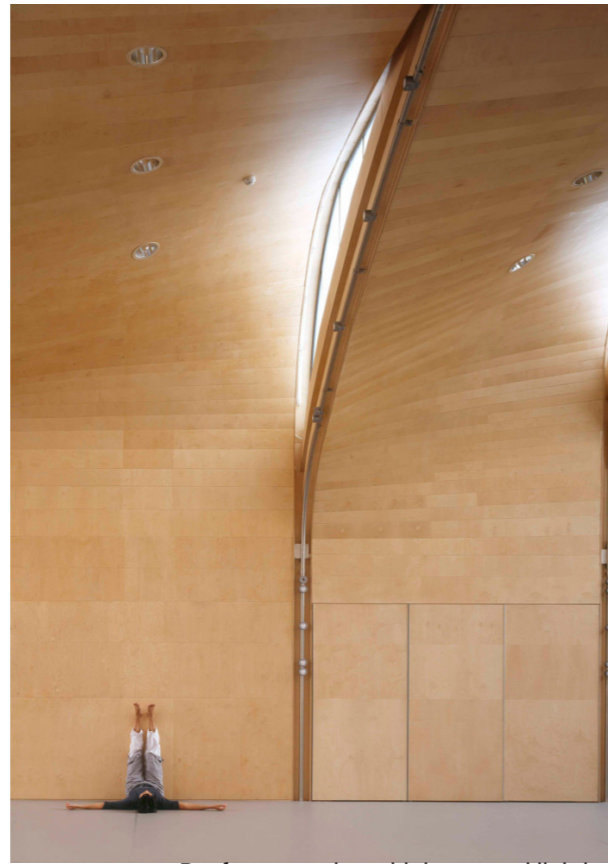
Visual contact between communal space and multi purpose hall



Atrium with multi purpose hall in the end axis



Principle of entering daylight



Roof construction with integrated lighting

## Siobhan davies studios

Location  
London, UK

Year completed  
2005

Architect  
Sarah Wigglesworth Architects

Program  
Dance studio, Utleie til bryllup, møter og kontor, private fester, foto location, film visning.

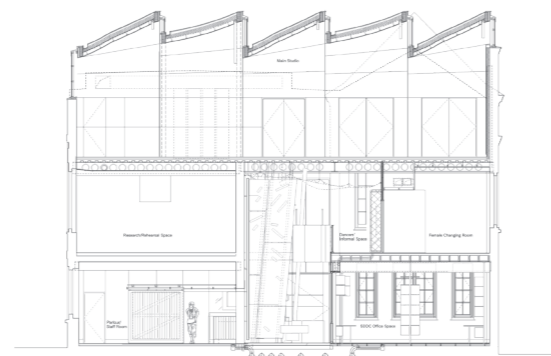
Total area  
Roof studio - 16.5m x 12.0m

Number of seatings  
-

Free height - Opp til 5.5m



Private rental



Section

### 1. Design and orientation of daylight openings

Daylight enter mainly from clerestory windows integrated in the roof construction. They "see" both towards north east and south west. All windows can be screened off.

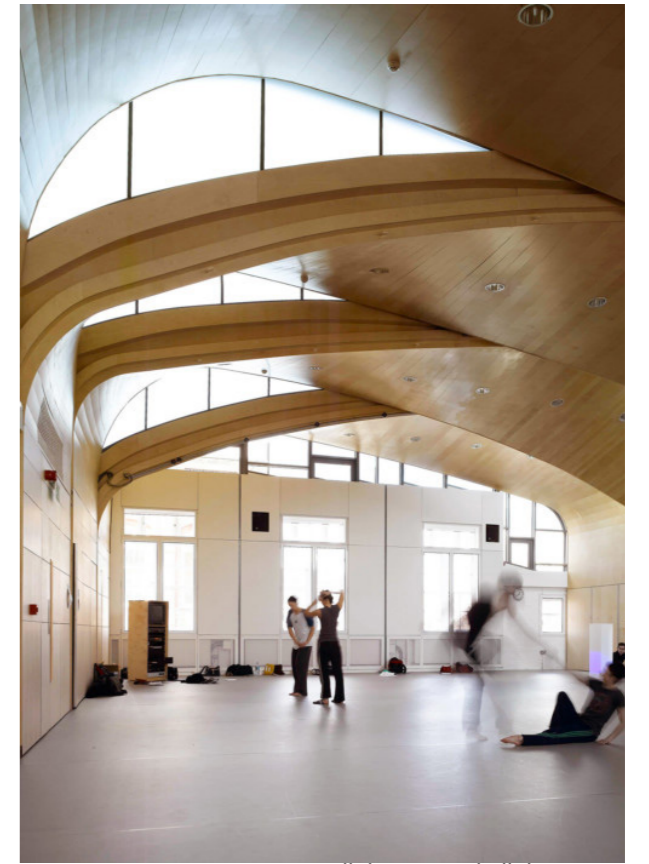
### 2. The relation between the constructive system, material and daylight openings

Beams span in the transverse direction. The movement of the beam refer to a dancers movements. A bright color palette and a matt floor surface limits shiny glare in flooring.

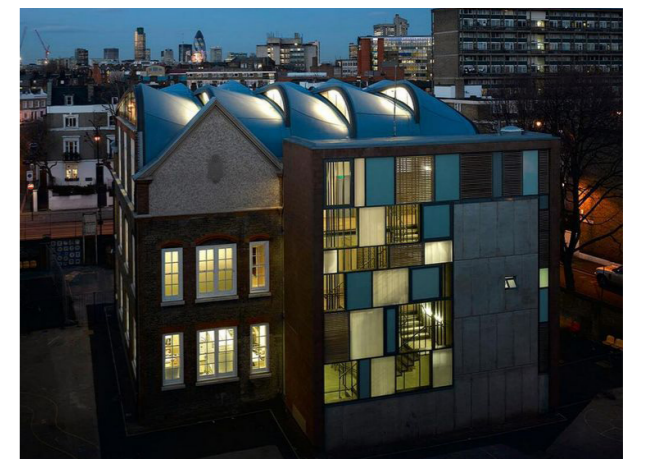
### 3. The buildings outer form, environment and orientation

The dance hall is a part of a larger renovation project from early 19th century and are attached to support functions and another hall on the floor below. The hall is placed on top of the building and is oriented northwest-southeast. When the hall is not used for dance, it is rented out for various private activities.

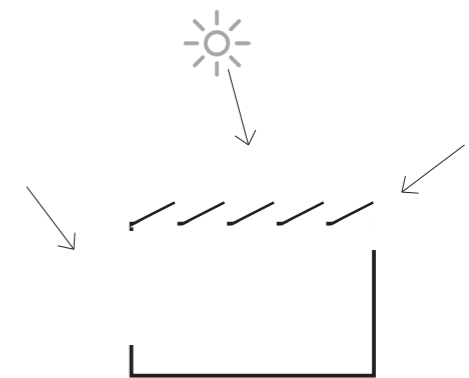
Picture references:  
<http://www.swarch.co.uk/>



Daylight as a main light source



Dance hall seen from the outside



Principle of entering daylight





Borrowed light from atrium

## Rovaniemi library

Location  
Rovaniemi, Finland

Year completed  
1965

Architect  
Alvar Aalto

Program  
Library

Total area

-

Number of seatings

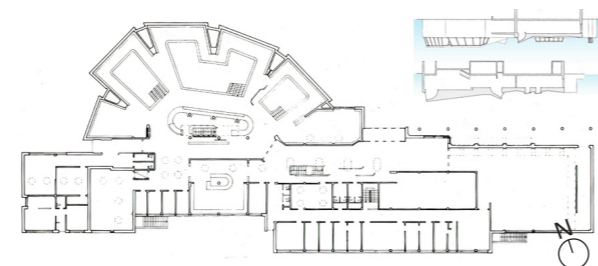
-

Free height

-



Interior



Plan drawing

### 1. Design and orientation of daylight openings

Daylight enter through north facing clerestory windows. Daylight is reflected back onto the window wall and preserves the books from direct sunlight. The architectural language is used to distribute the light. In the common room the daylight enter from south, providing a more dynamic light. Light is reflected in a concious and natural way into the interior. It is almost as if the distribution of daylight is detached from the glass surface.

### 2. The relation between the constuctive system, material and daylight openings

The ceiling shape seems to be hanging on a load carrying system. The system has first and most the function of being a reflector for daylight. White painted surfaces, assumed to be gipsum, reflect light efficiently.

### 3. The buildings outer form, environment and orientation

The building is free standing and has got no outdoor obstructions. The entrance is oriented towards south and the books to the north. In each part of the fan shape there are placed a reading space.

Picture references:

<https://medium.com/iamacamera/rovanie-mi-library-alvar-aalto-1966-ed17478d940a>

[https://encrypted-tbn0.gstatic.com/images?q=tbn:ANd9GcQpuGNdMdBsLfEpO-09rpjrkY-9T9O0xi-oVHB97tzoN\\_1iBzq3X](https://encrypted-tbn0.gstatic.com/images?q=tbn:ANd9GcQpuGNdMdBsLfEpO-09rpjrkY-9T9O0xi-oVHB97tzoN_1iBzq3X)

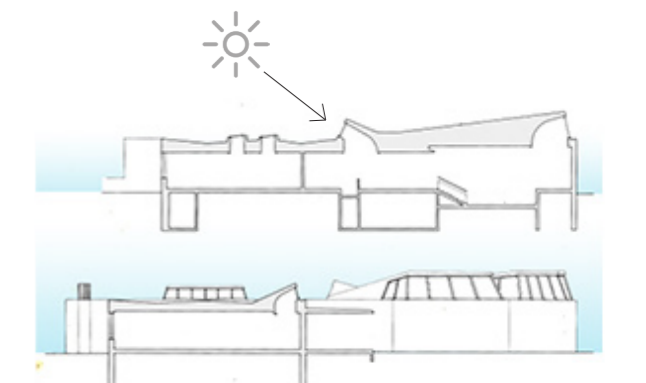
<https://i.pinimg.com/original-s/73/46/5c/73465c30c350fdcc650bb57d39cf-b9c5.jpg>



Exterior photo - north facing clerestory windows



Interior - recessed reading space



Principle of entering daylight



Interior - every daylight opening has its purpose

### 1. Design and orientation of daylight openings

Each daylight opening has its function and its connecting surface that are lit. Sculptural ceiling shapes work as reflectors that distribute light from skylights and clerestory windows into the interior. A conscious strategy in the use of architecture as a tool for using daylight as a light source.

"In his project description, Aalto argues that the quality of light is as important for an art museum as acoustics is for a concert hall. The main galleries are lit by two-sided, symmetrical, elongated clear-storey reflectors that prevent southern sunlight from entering the exhibition halls at an angle over 56 degrees (corresponding to Aalborg's latitude), whereas the northern side permits light up to a 90 degree angle. The music room next to the main entrance is lit by prism-shaped skylights"

### 2. The relation between the constructive system, material and daylight openings

Construction and ceiling shapes that reflect daylight is made out of white painted concrete.



Ceiling shapes reflect the light from clerestory windows, into the interior - Pallasmaa & Sato 2007: 191

## Kunsten

Formerly the Museum of Modern Art, Aalborg

Location  
Aalborg, Denmark

Year completed  
1972- renovated 2011-2013

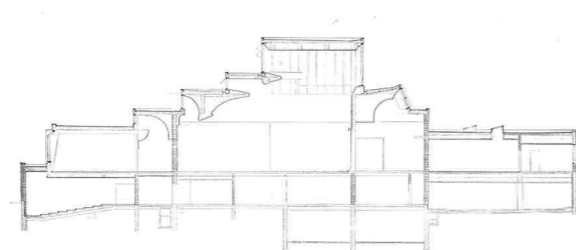
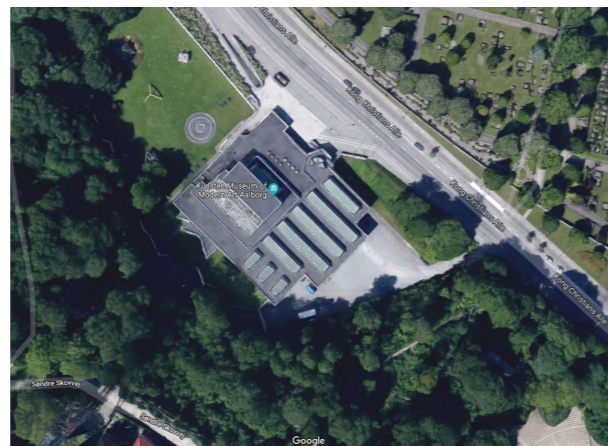
Architect  
Alvar Aalto

Program  
Museum for modern art

Total area  
6000 m<sup>2</sup> + 700 m<sup>2</sup> newbuilding

Number of seatings  
-

Free height  
-



Section - Pallasmaa & Sato 2007: 191

### 3. The buildings outer form, environment and orientation

The front of the building and the skylights are facing northeast and relate to the motor way that pass by. In the back of the building there is a small forest.

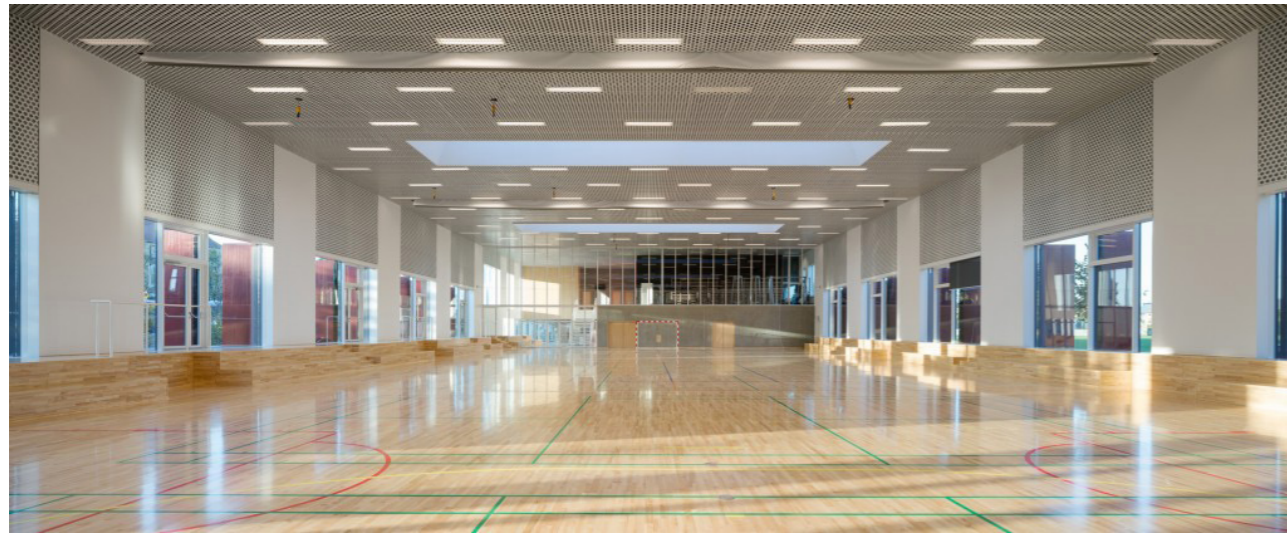
Picture references:

<https://ssl.c.photoshelter.com/img-get2/I000DbufQ8q7kSc/fit=1000x750/Kunsten-Soren-Jensen-2015-QJEL-20.jpg>

<http://denmark.dk/en/quick-facts/map-of-denmark/aalborg/kunsten/>

<https://www.cfmoller.com/p/-en/KUNST-EN-master-plan-for-restoration-and-revitalisation-i2825.html>





Oriented towards the canal

# Christianshavn Sports Centre

Location  
Christianshavn, Copenhagen

Year completed  
2013

Architect  
Christensen & Co

Program  
Sports centre for Christianshavn Gymnasium, sports clubs, schools and community associations in the local area.

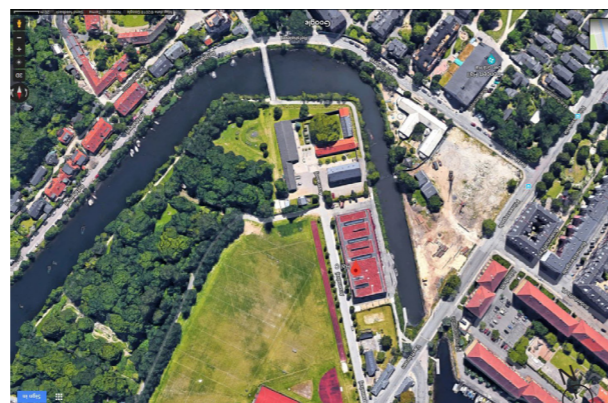
Total area  
2450 m<sup>2</sup>

Number of seatings  
-

Free height  
-



Environment



Situation

## 1. Design and orientation of daylight openings

Daylight enters through three wide skylight and from large windows on each side. Big vertical shutters can close off the vertical openings and shut out direct sunlight from entering the hall.

## 2. The relation between the constructive system, material and daylight openings

In the general areas of the building, such as changing rooms, fitness area and meeting rooms there are used a variety of materials. The different program resemble stacked boxes featuring different finishes such as raw concrete, plywood and black-painted wood. In the main hall features light materials and colors. The construction system can not be said to be articulated other than white painted sections on the side of the main hall, resembling load carrying walls.

## 3. The buildings outer form, environment and orientation

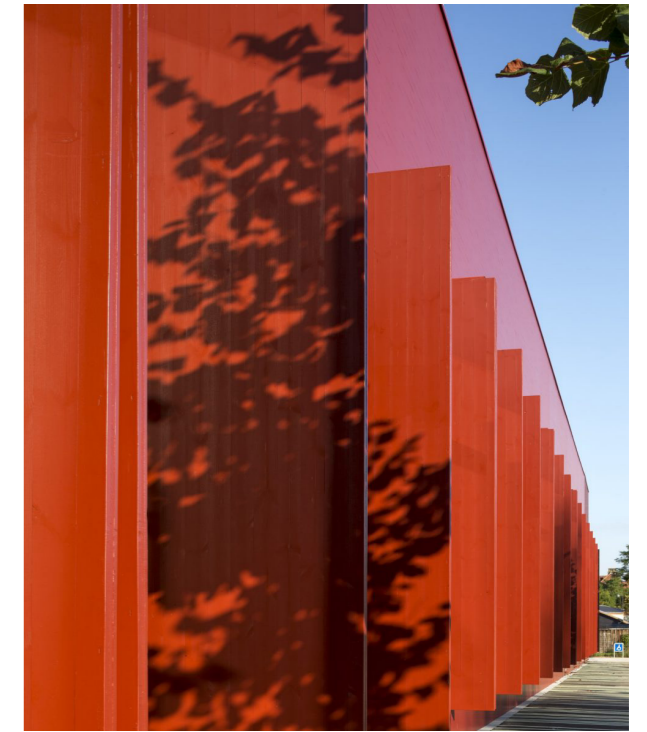
The building are oriented along a canal. Giving it an extra dimension in regards to being a social meeting place. Especially in the summer. The tribune seats is also a stair leading up and then down again to the outdoor environment. The building is oriented north-south.

Bildereferanser:

<https://www.mimoo.eu/projects/Denmark/Copenhagen/Sports%20Centre%20Christianshavn/>

<http://christensenco.dk/projects/christianshavn-sports-centre/>

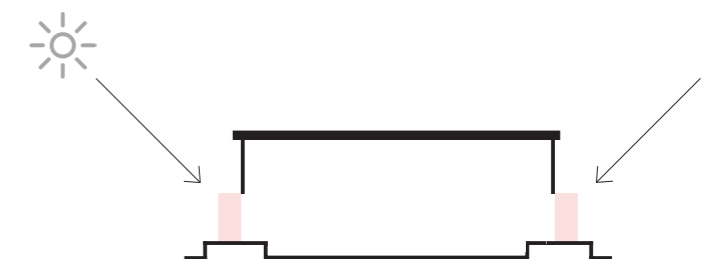
[https://halc.kk.dk/sites/halc.kk.dk/files/styles/flexslider\\_full/public/uploaded-images/Haandbold.jpg?itok=t-u3v98V](https://halc.kk.dk/sites/halc.kk.dk/files/styles/flexslider_full/public/uploaded-images/Haandbold.jpg?itok=t-u3v98V)



Exterior show west oriented shutters



Interior



Principle of entering daylight



Direct sunlight enter the space

## Secondary School with Hall

Location  
Klaus, Austria

Year completed  
2014

Architect  
Dietrich | Untertrifaller

Program  
Secondary School with sportshall

Total area  
Multi purpose hall: 790 m<sup>2</sup>  
The whole project: 6,940 m<sup>2</sup>

Number of seatings  
Telescope tribune

Free height  
7m



Skylight - interior



N  
Situation

### 1. Design and orientation of daylight openings

The daylight enters the space from the skylights. All the skylights are oriented differently which lead to direct sunlight entering at different times of the day from different skylights. A vertical window in the west also give direct sunlight into the hall.

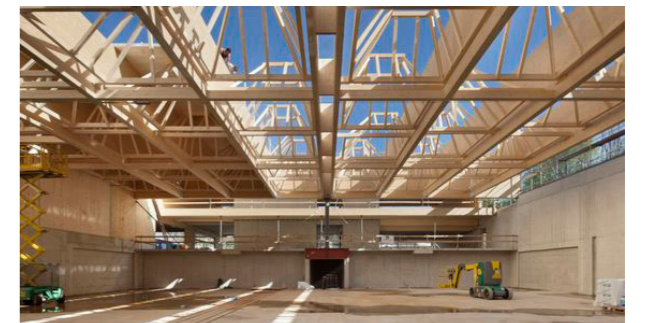
### 2. The relation between the constructive system, material and daylight openings

The construction span in one direction and the skylights fill in the void. The angled inside of the skylights give a homogenous bright ceiling. The flush contact with the walls eliminates unwanted shadows on the walls.

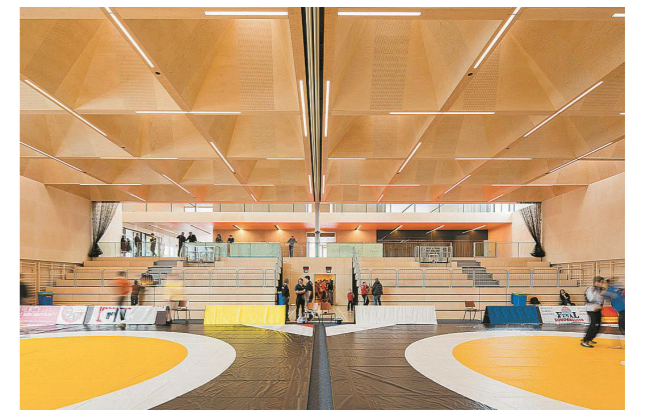
### 3. The buildings outer form, environment and orientation

The hall is lowered to be mostly under ground. The atrium is oriented in the halls northern part which reflects the entering sunlight. There are no outdoor obstructions.

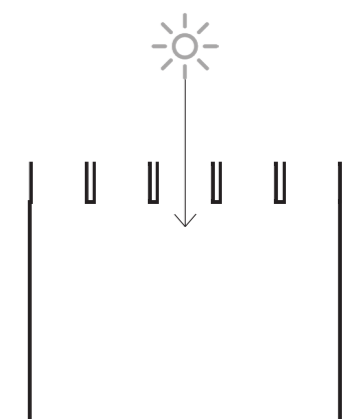
Bildreferanser:  
<http://www.dietrich.untertrifaller.com/en/projekt/schule-und-sporthalle>



Construcion site



Interior



Principle of entering daylight