THE GERMAN MUSEUM OF TECHNOLOGY IN BERLIN – A CASE STORY OF ENERGY EFFICIENCY

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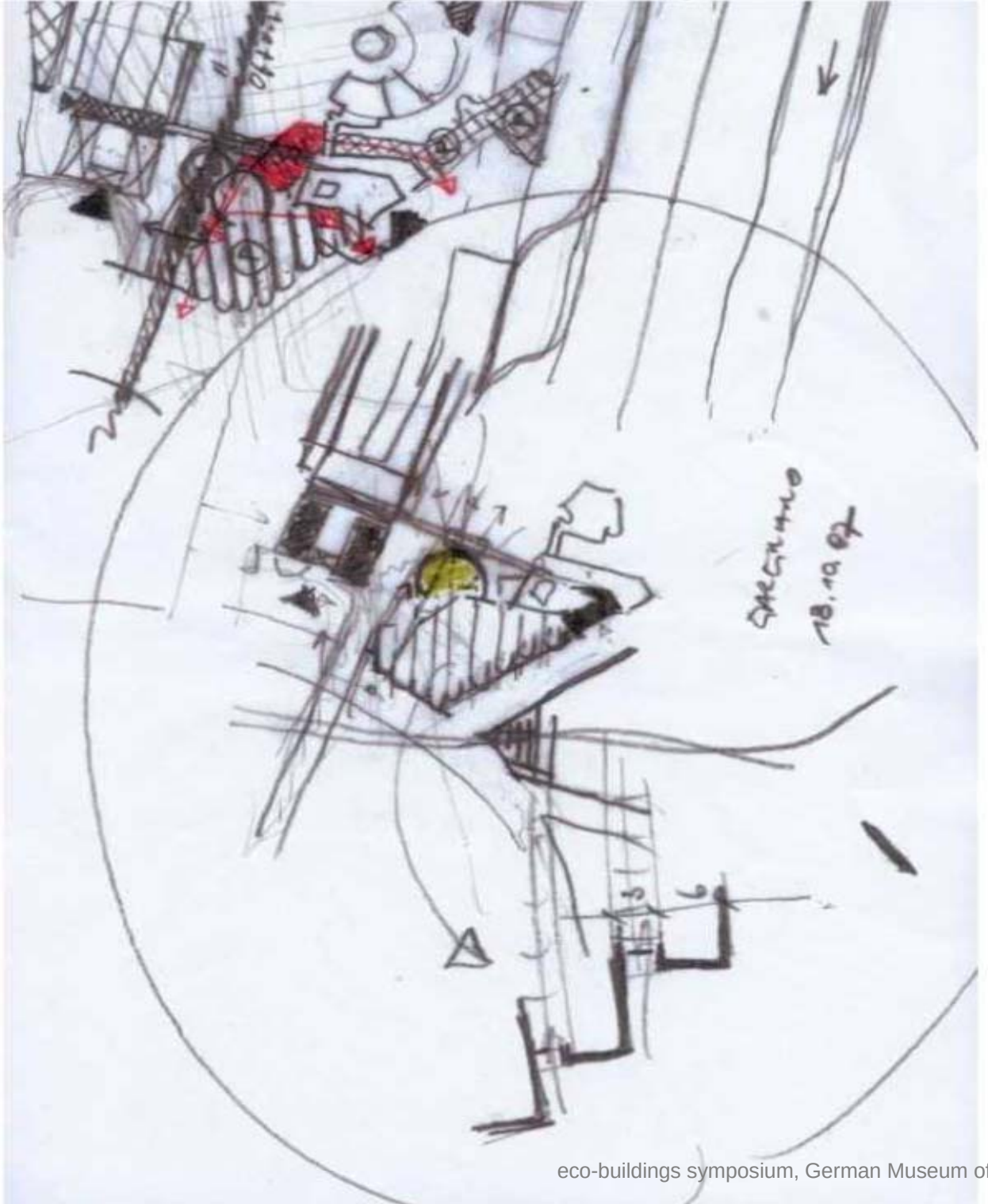
overall planning of German Museum of Technology

location plan showing the conception of the museum

design: Architect partnership MVT

birds eye view of urban context

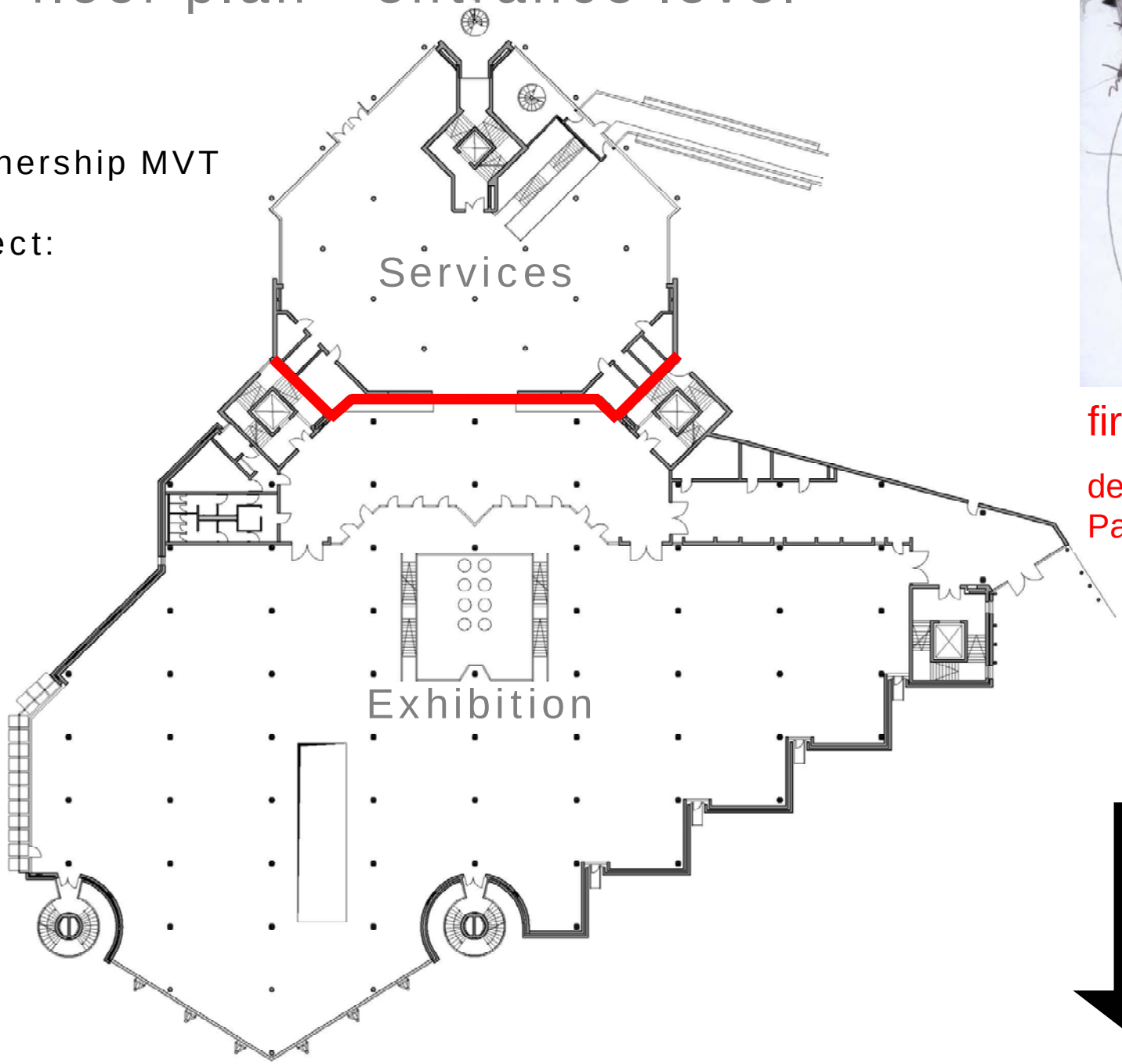
First sketch

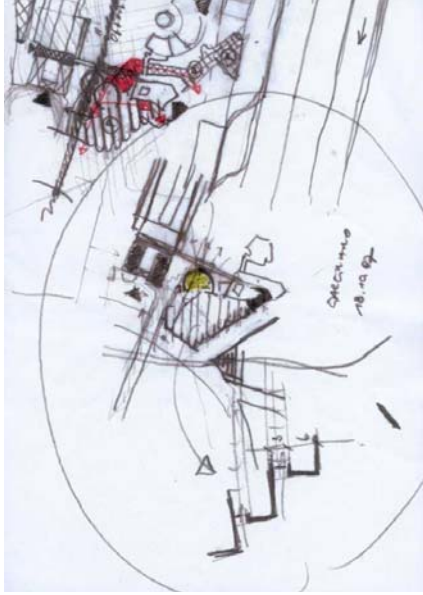


2nd story floor plan – entrance level

Architect:
Architect Partnership MVT

Project architect:
Regine Krause





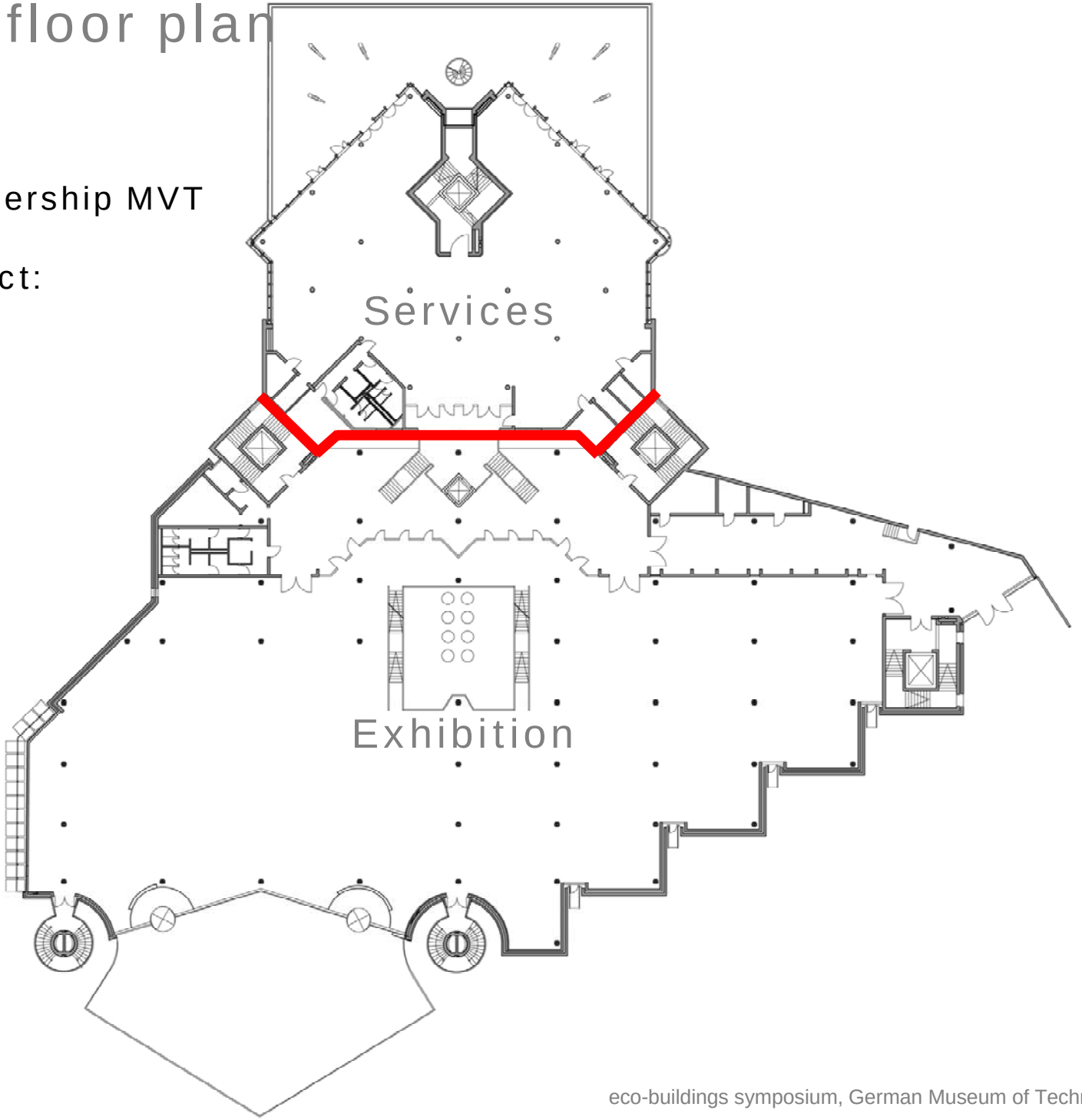
first sketch

design: Architect Partnership MVT

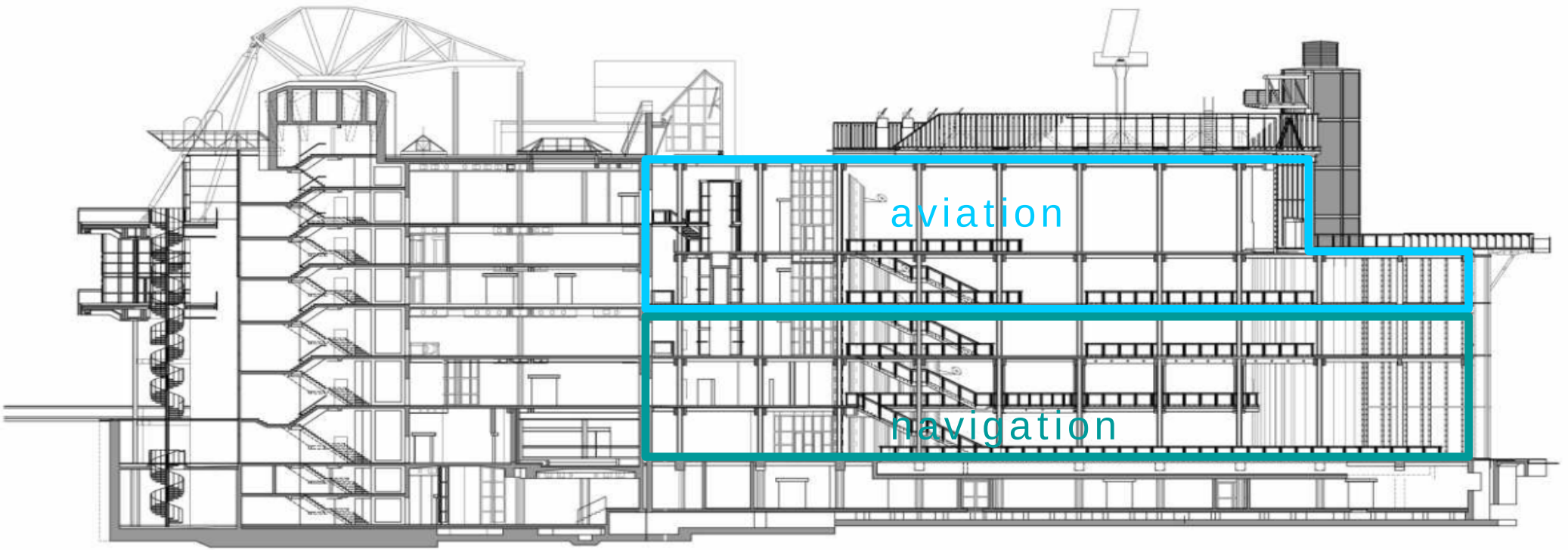
4th story floor plan

Architect:
Architect Partnership MVT

Project architect:
Regine Krause



cross section



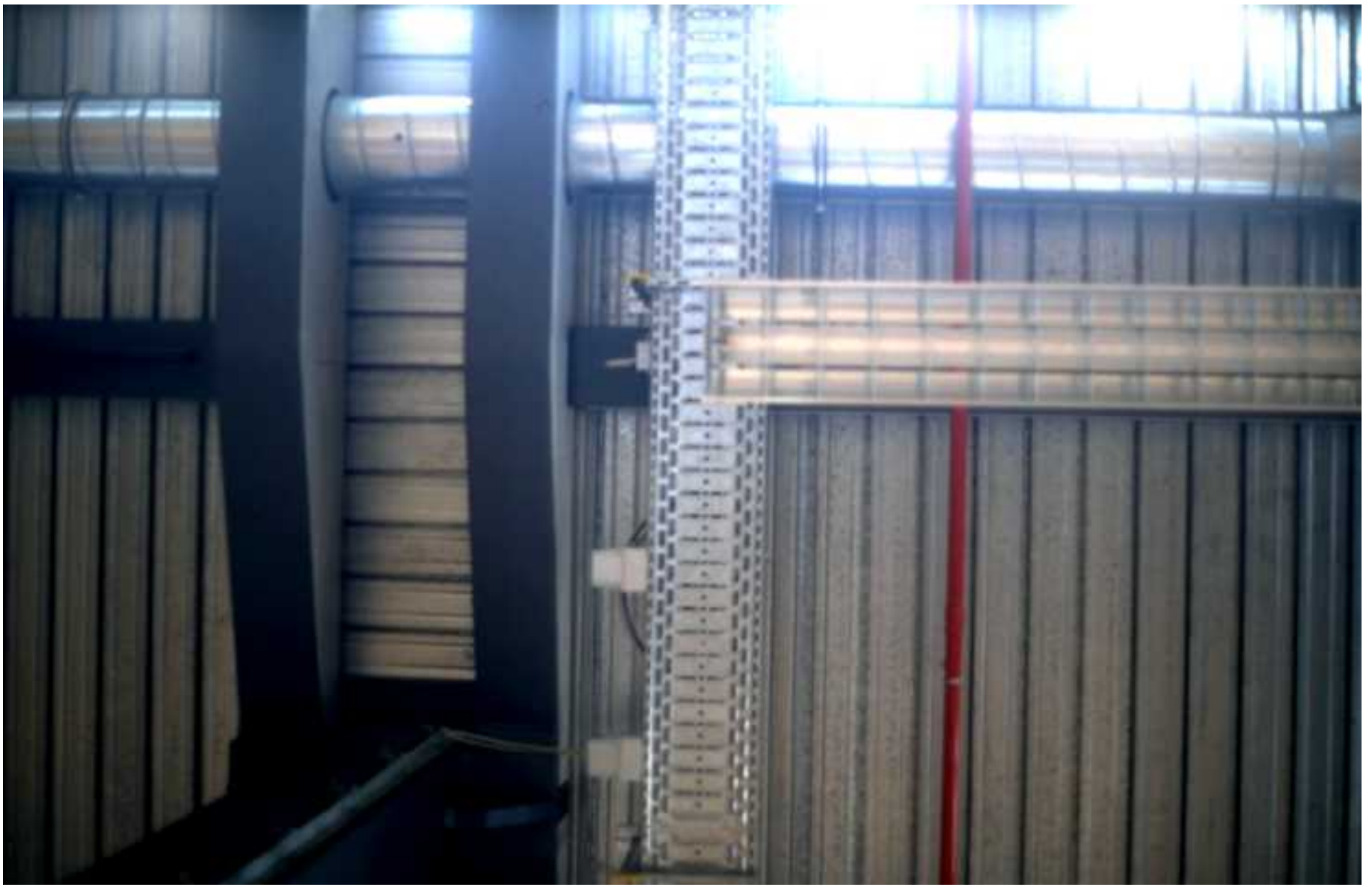
Design Principle: Architecture = Exhibit

Architecture + Construction = Exhibit

Fraunhofer Institut Bauphysik

Carcasse = Completion

Carcass = Completion, Installations = Exhibit



Objectives of R&D project

Demonstrate the energy saving potential of large public buildings

- Define and realise low energy strategy, optimise indoor comfort, decrease running costs
- Use integrated design process
- Develop innovative daylighting & solar energy systems, integrate systems in the building
- optimize operation
- Demonstrate energy concept / Systems
- Monitor and evaluate energy concept

Partners in the R&D project

German Museum of Technology Berlin
Project leader

Institut für Bau, Umwelt- und Solarforschung
Coordination, surveying construction, energy concept, realisation of daylighting systems

Fraunhofer Institut für Bauphysik
simulations, Energy concept, building physics

Technische Universität Berlin
Planning & simulation of daylighting strategies

The project is funded by the city of Berlin and by the Federal Ministry of Economics and Labour.
Project Management: PTJ
Project number: 0329084 A, B, C

Impact of decisions on energy savings

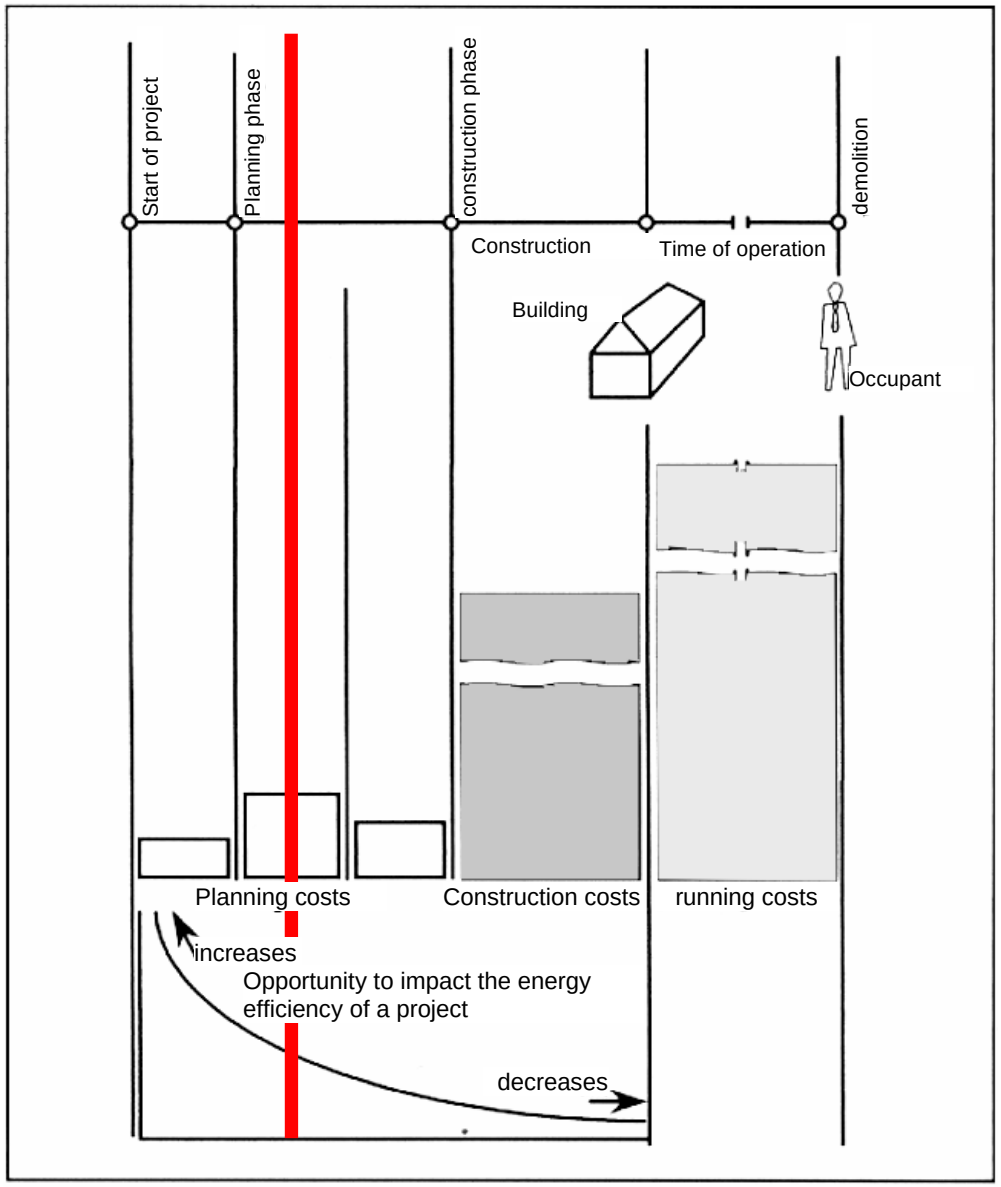
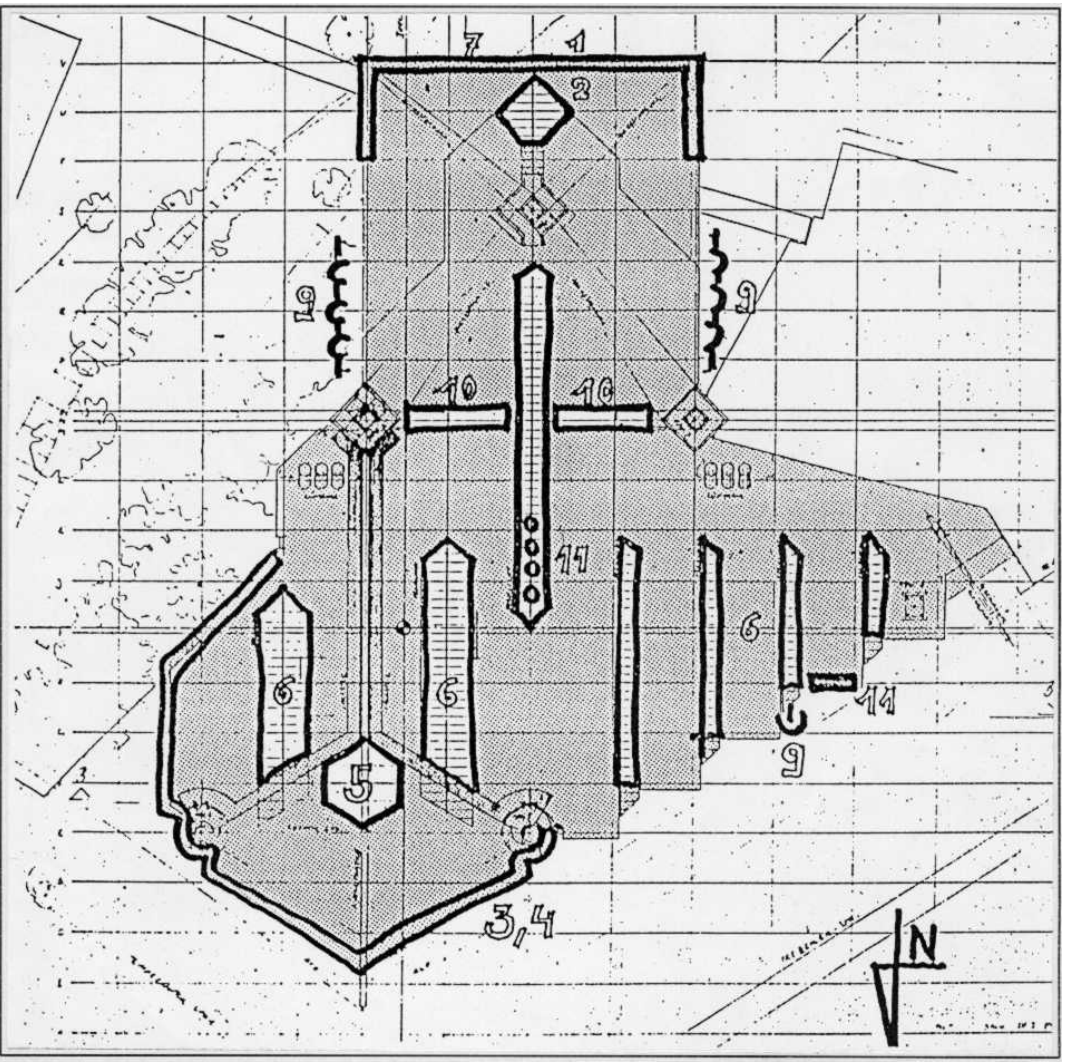


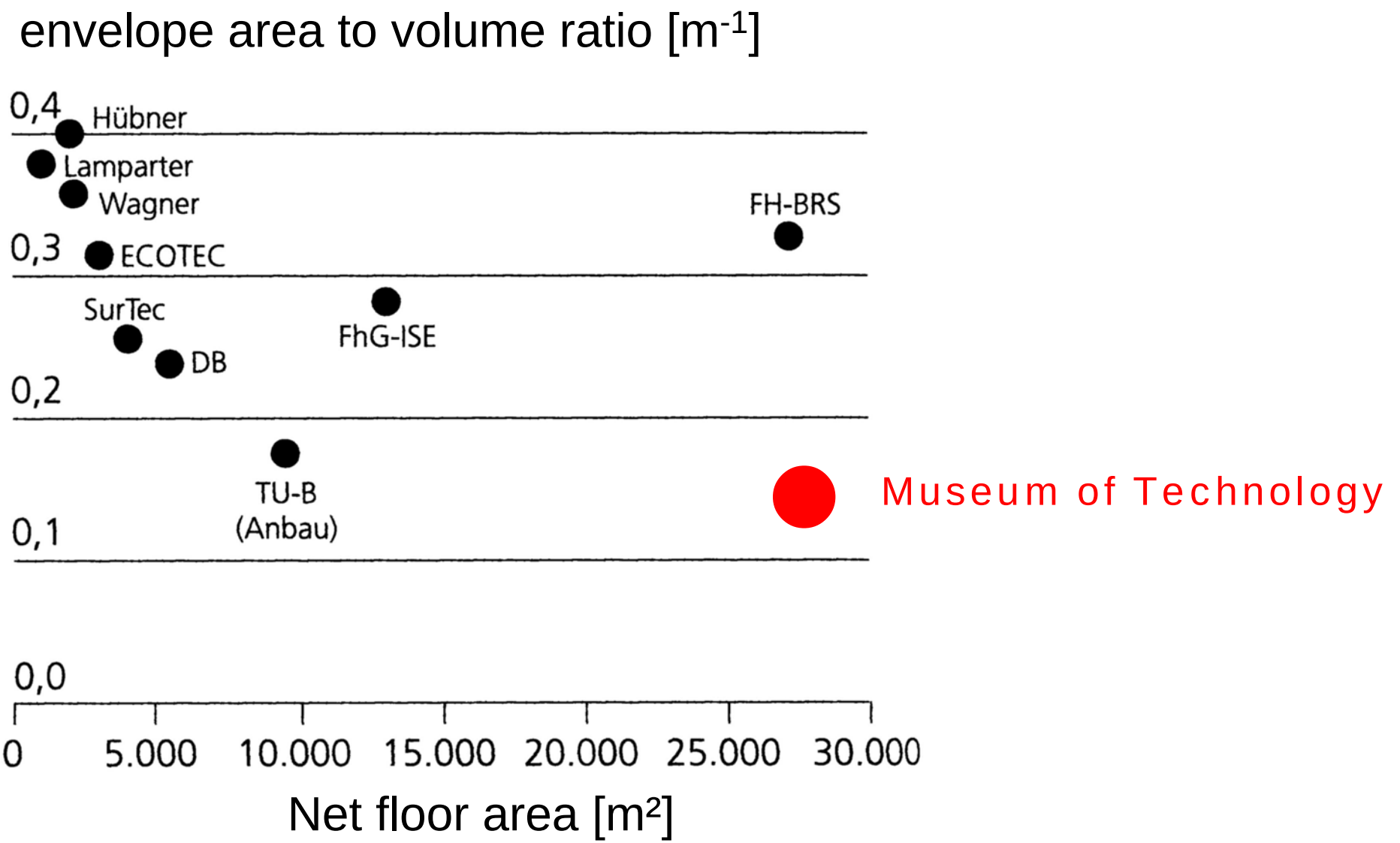
Figure: Pfarr K H: Handbuch der kostenbewussten Bauplanung, Wuppertal 1976

Analysis of initial design scheme



- compact shape
  - positive regarding the reduction of heat losses
  - negative regarding the penetration with daylight
- double layer foundation
  - possibility to precondition supply air
- exposure of structural elements penetrating the thermal envelope
  - negative regarding heat loss

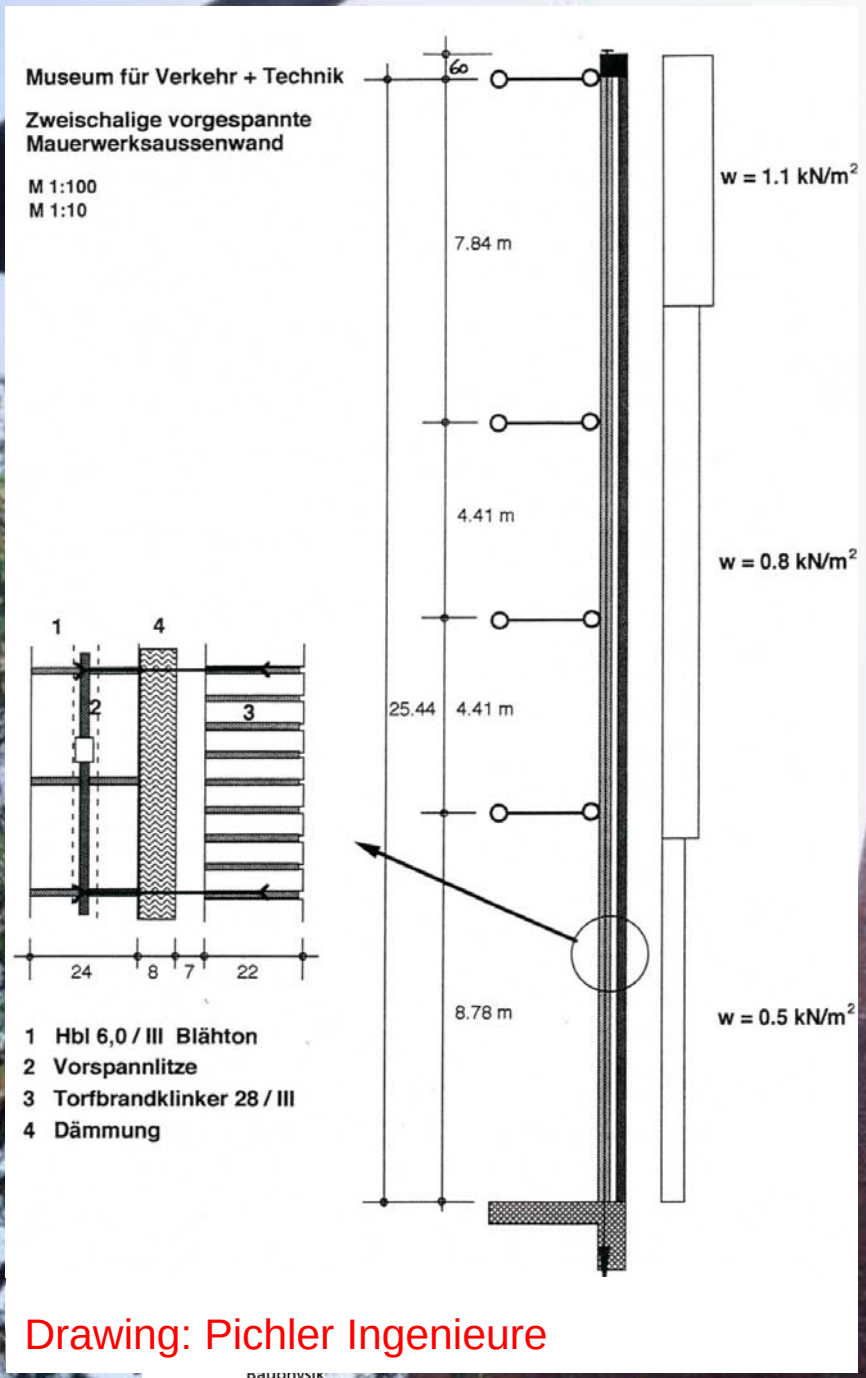
Building data compared to other energy efficient projects

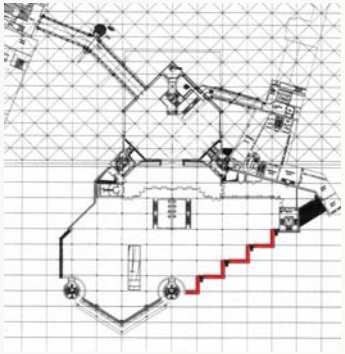


Measures

	Heating	Cooling	Lighting	mechanical ventilation
improved insulation	✓	✓		
direct gain	✓			
Floor heating adjacent to facades	✓			
double foundation to precondition supply air	✓	✓		
occupancy responsive ventilation rate	✓	✓		✓
Heat recovery	✓			
operable skylights		✓		✓
Daylighting	✓	✓	✓	
daylight responsive controls		✓	✓	
use of ‘white’ glass	✓		✓	
effective shading		✓		
use of hygroscopic construction materials		✓		✓
activation of thermal masses	✓	✓		
Photovoltaics				✓
Solar collectors	✓			

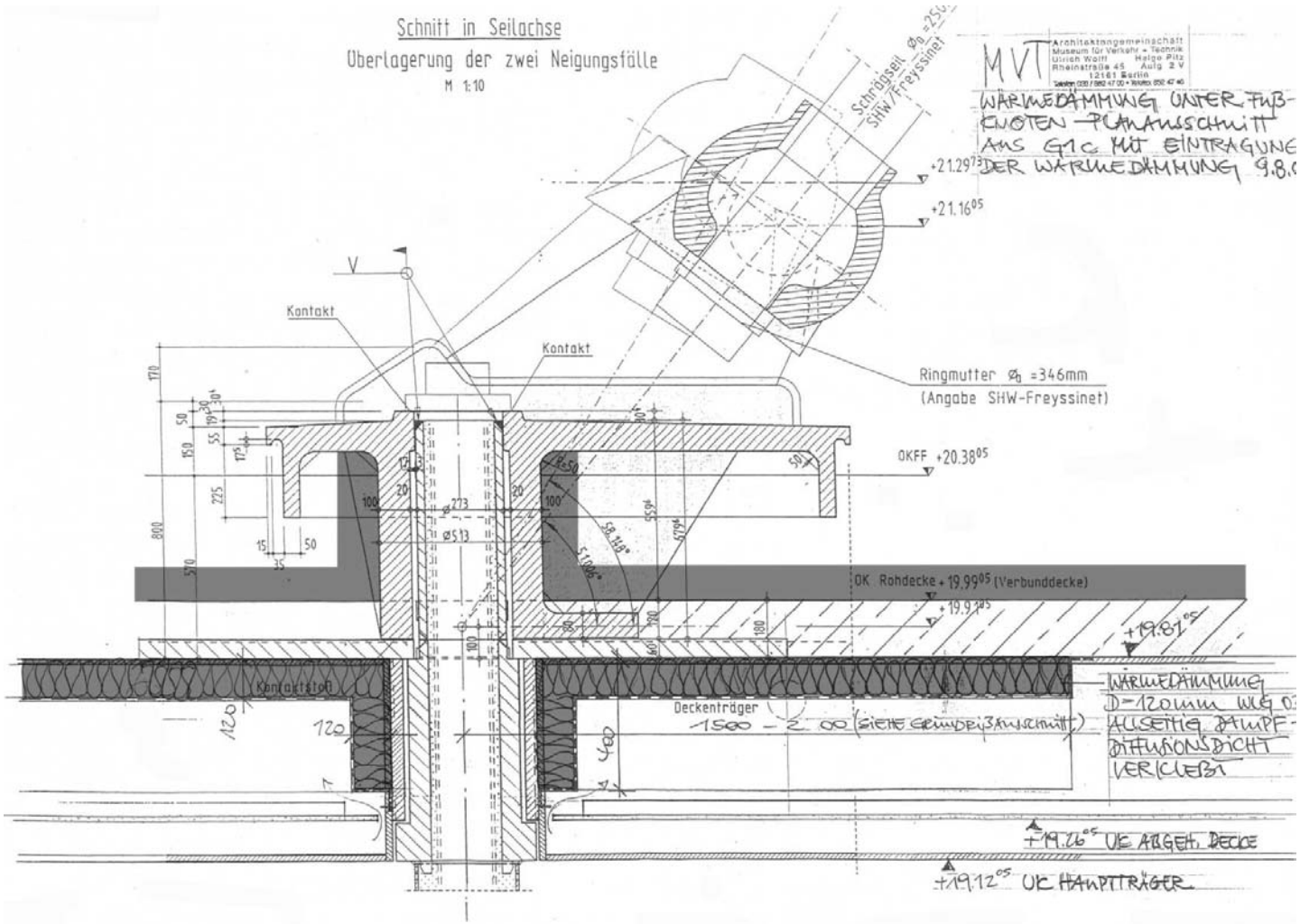
Improved insulation – cavity masonry walls





Drawing: Pichler Ingenieure

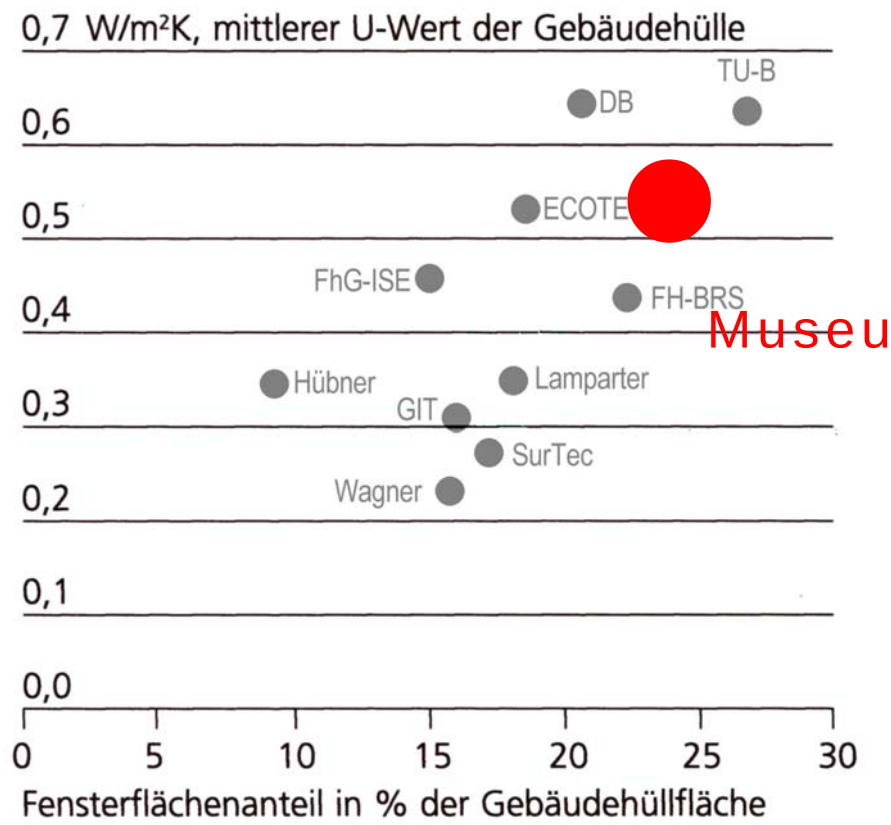
Improved insulation – anchorage of suspension cables



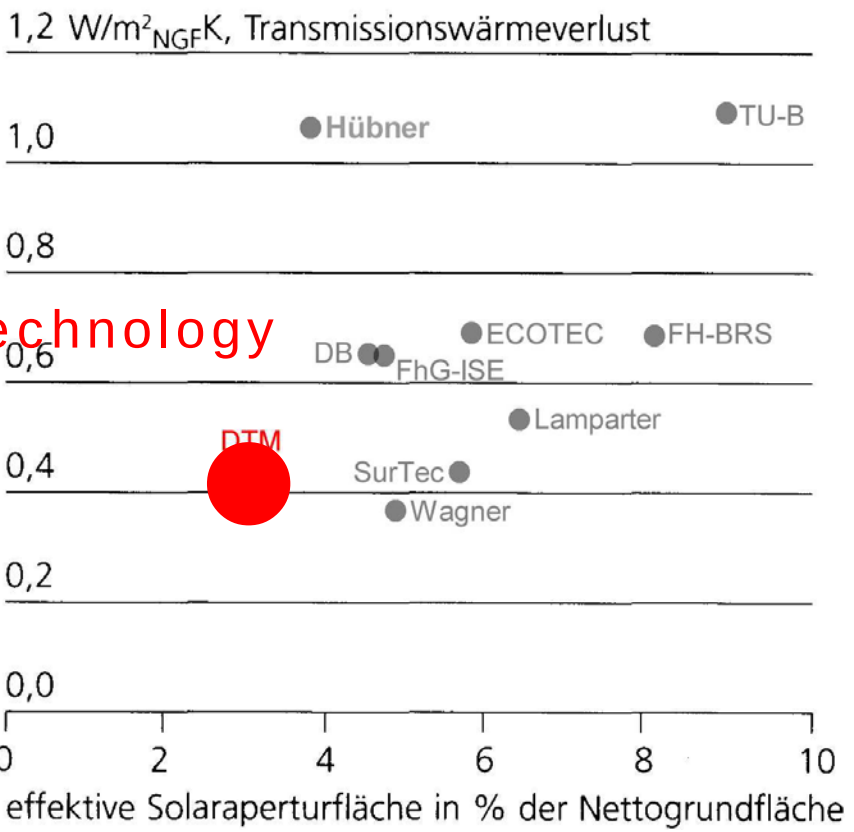
Improved insulation – stair case towers

Improved insulation

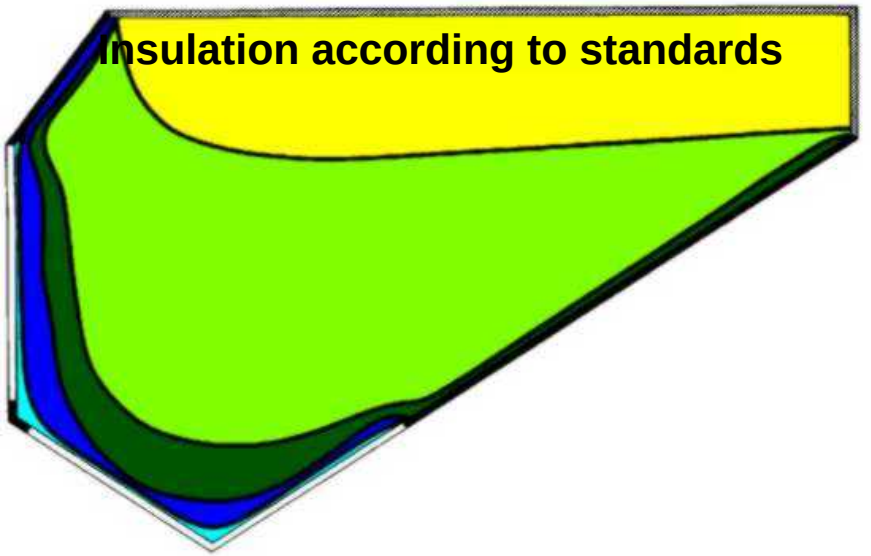
- Optimisation of constructions
- Fixing the level of insulation in all building parts
  - glazing: U ≤ 0,7 W/m²K, window frames of category 1
  - walls: U ≤ 0,3 W/m²K
  - roof: U ≤ 0,21 W/m²

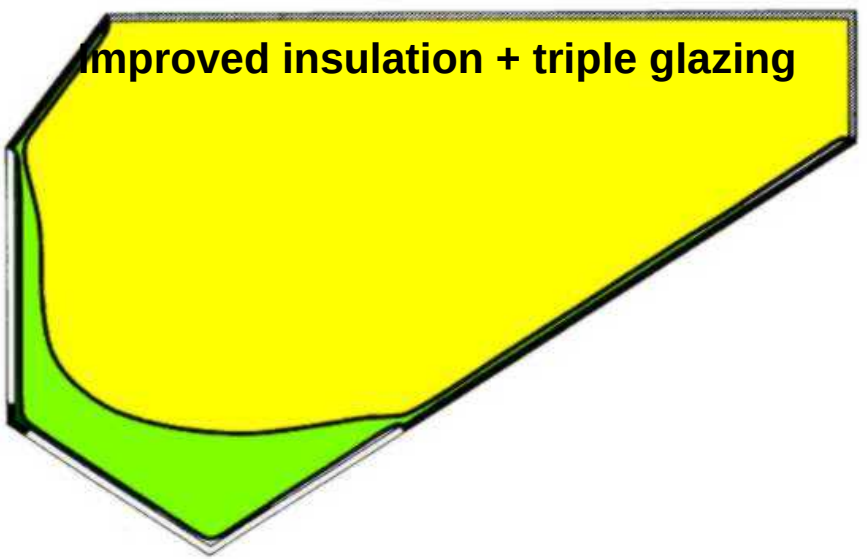


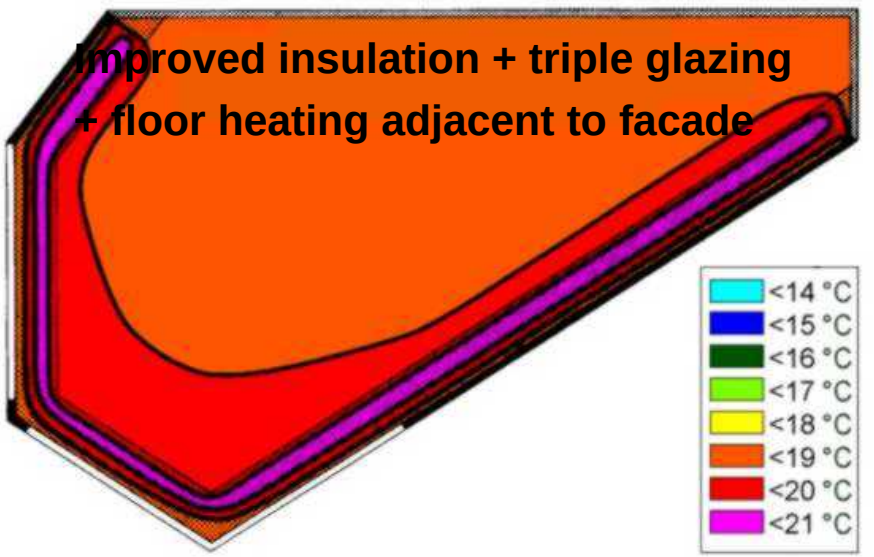
Museum of Technology



Perceived temperature

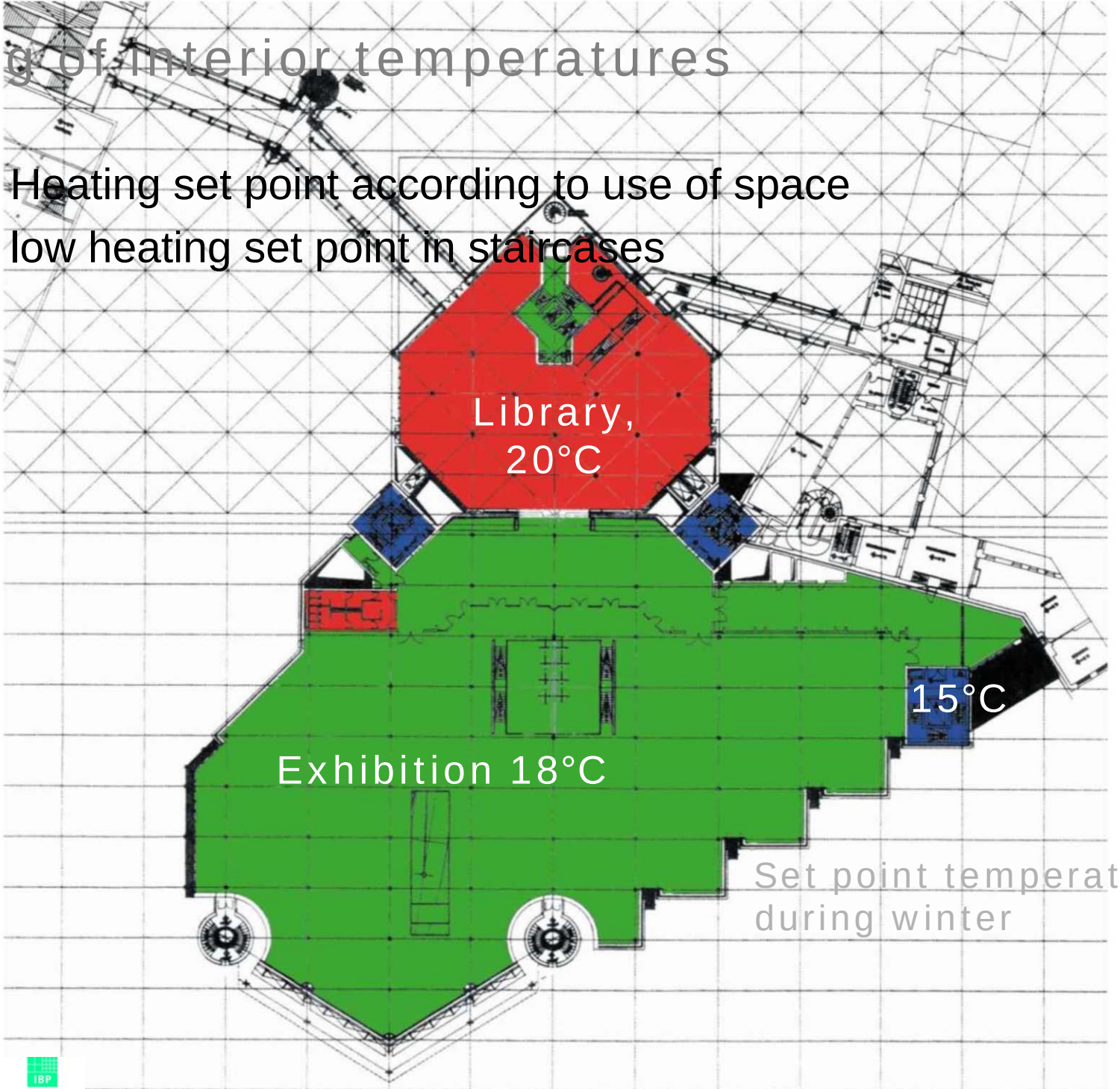






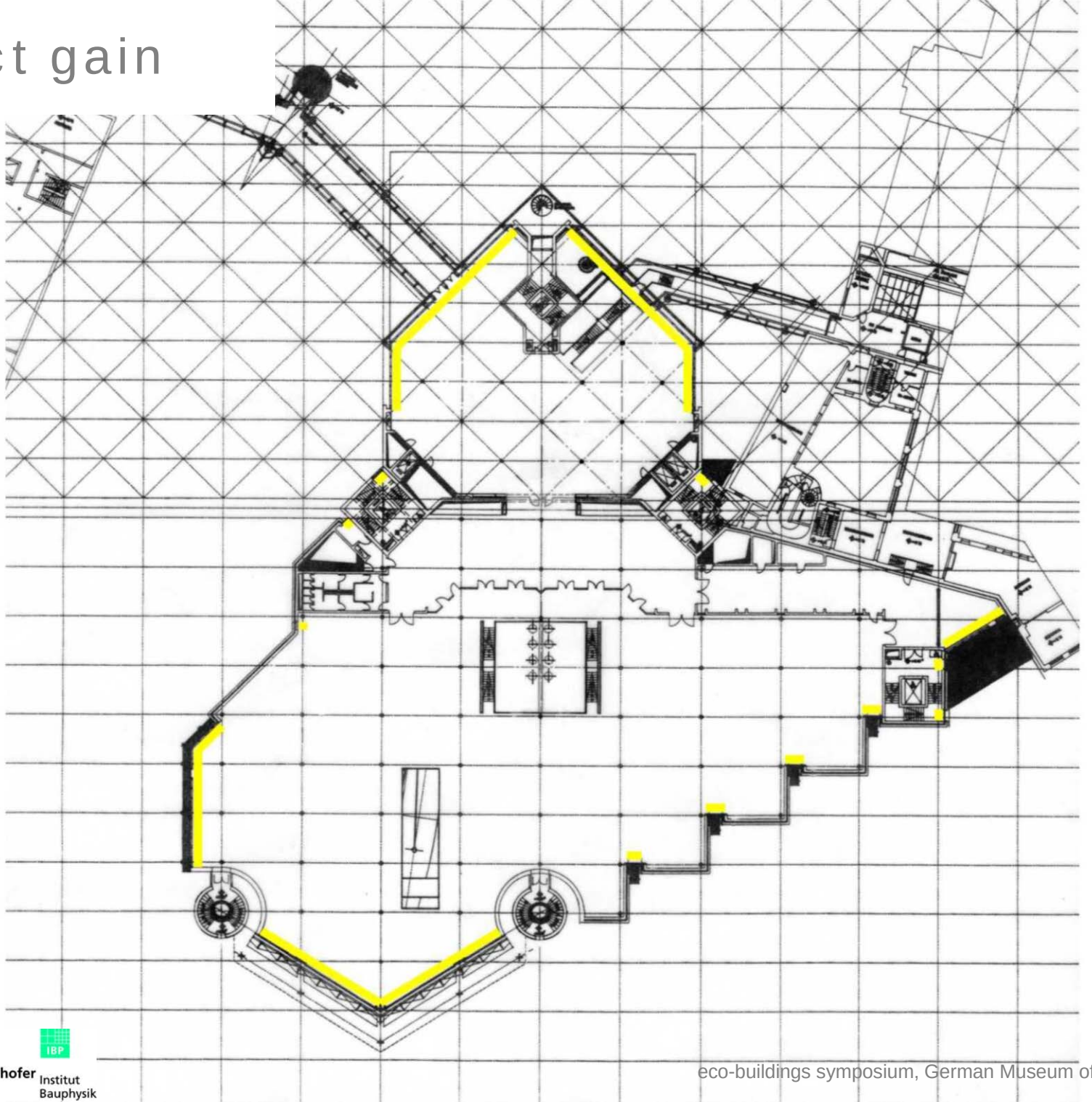
Zoning of interior temperatures

- Heating set point according to use of space
- low heating set point in staircases



Set point temperatures during winter

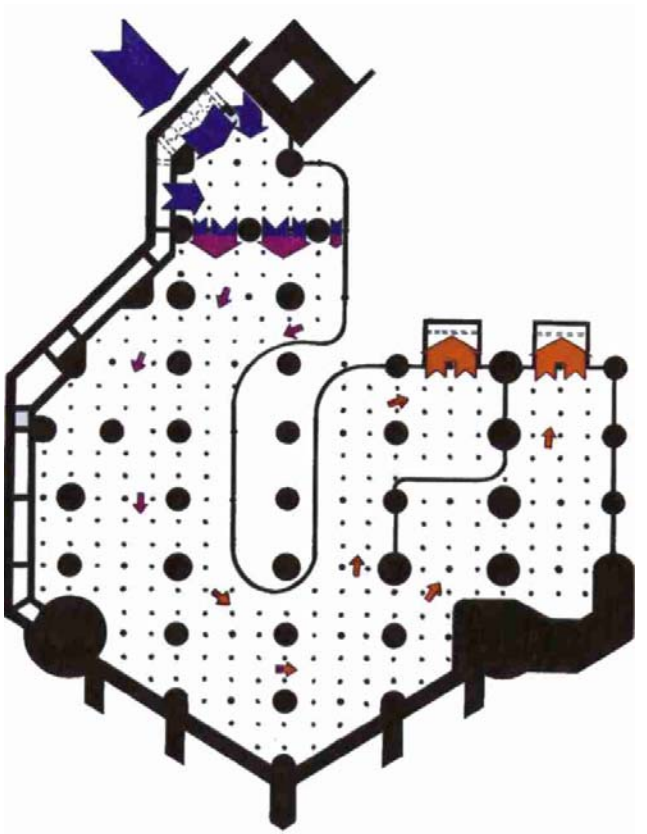
Direct gain



North

Ventilation strategy

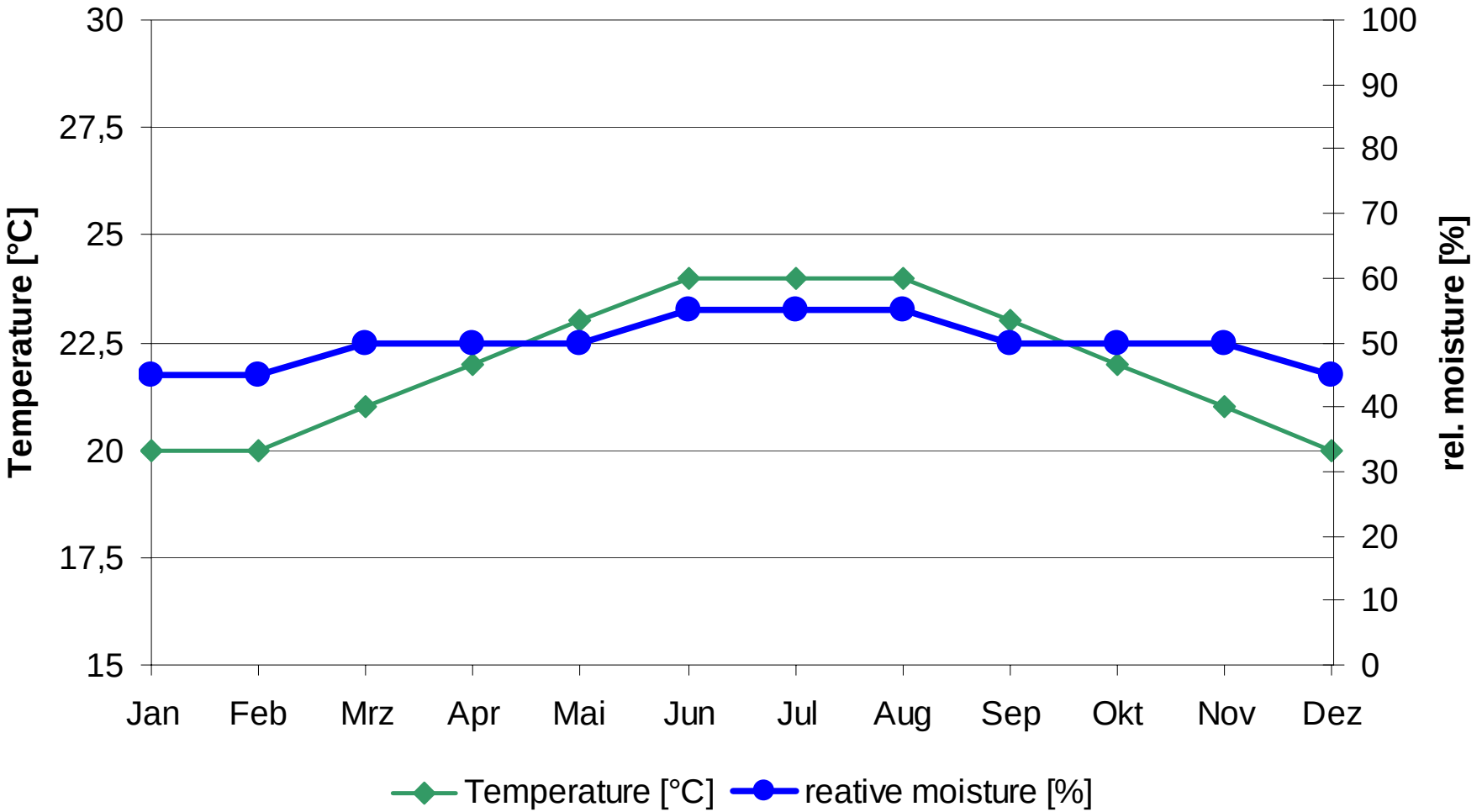
- Double layer foundation to precondition supply air
- Heat recovery
- occupancy responsive ventilation rate
- night ventilation
- operable skylights



Measures to maintain a balanced indoor climate in exhibition areas

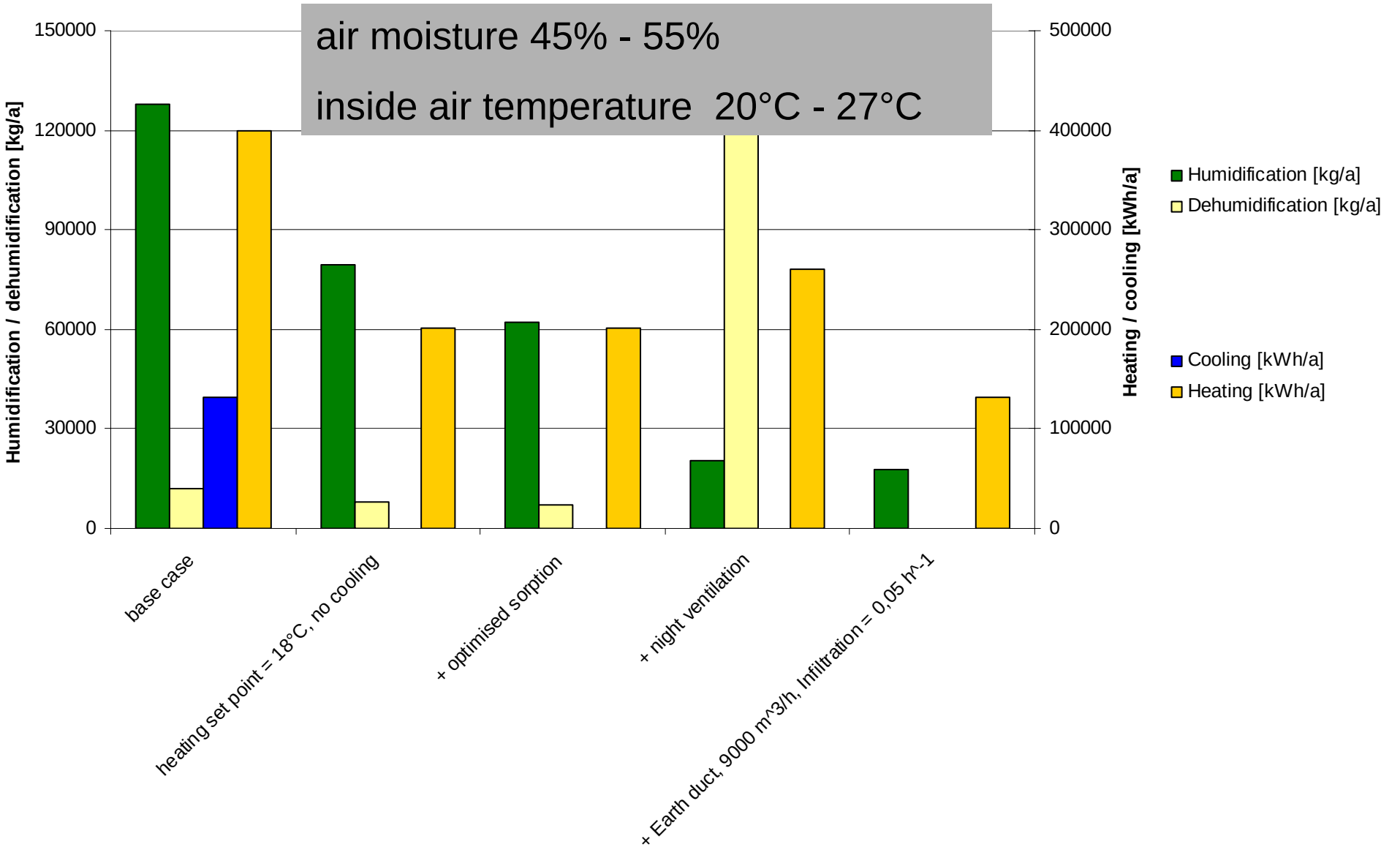
- Effective sun shading
- double layer foundation to precondition supply air
- use of hygroskopic materials
  - foamed slag concrete for interior masonry walls
  - wooden paving
- increased temperature on inner side of facades due to high level of insulation
- activation of thermal building masses
- optimised heating
- low heating set point
- low installed power density

Seasonal sliding of moisture and temperature in a narrow band



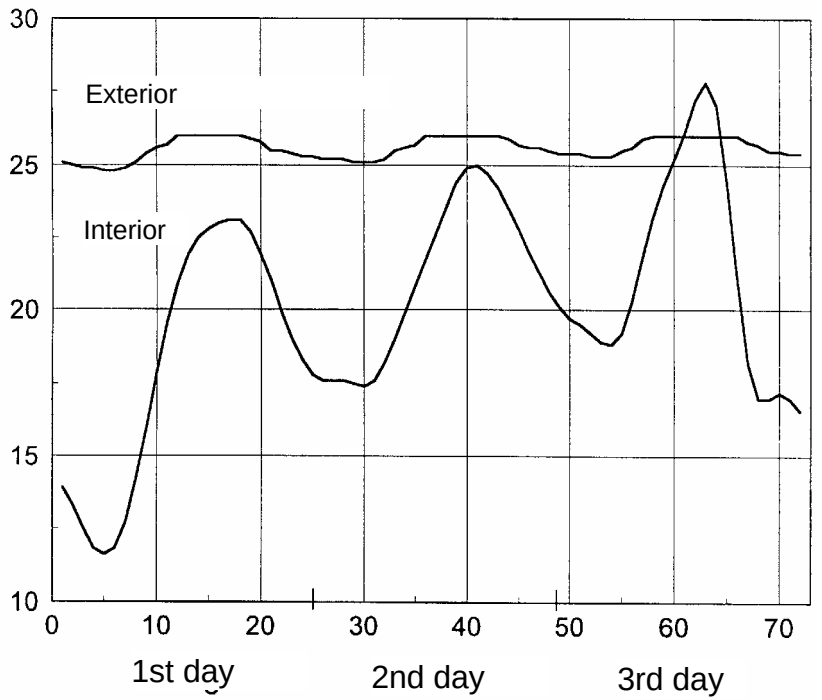
Source: Hilbert, Restauro ,93

Evaluation of measures

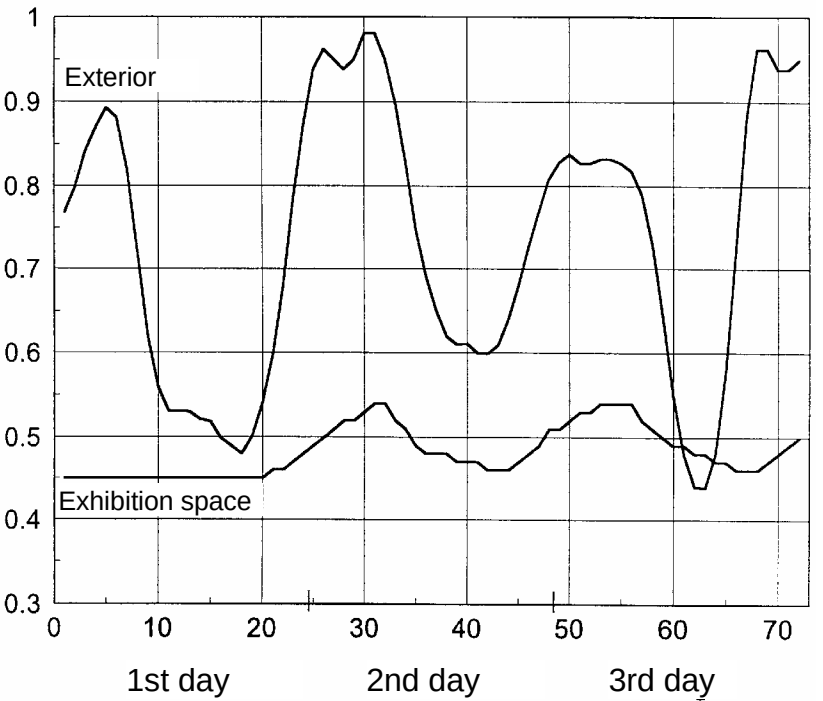


Temperature and moisture in summer

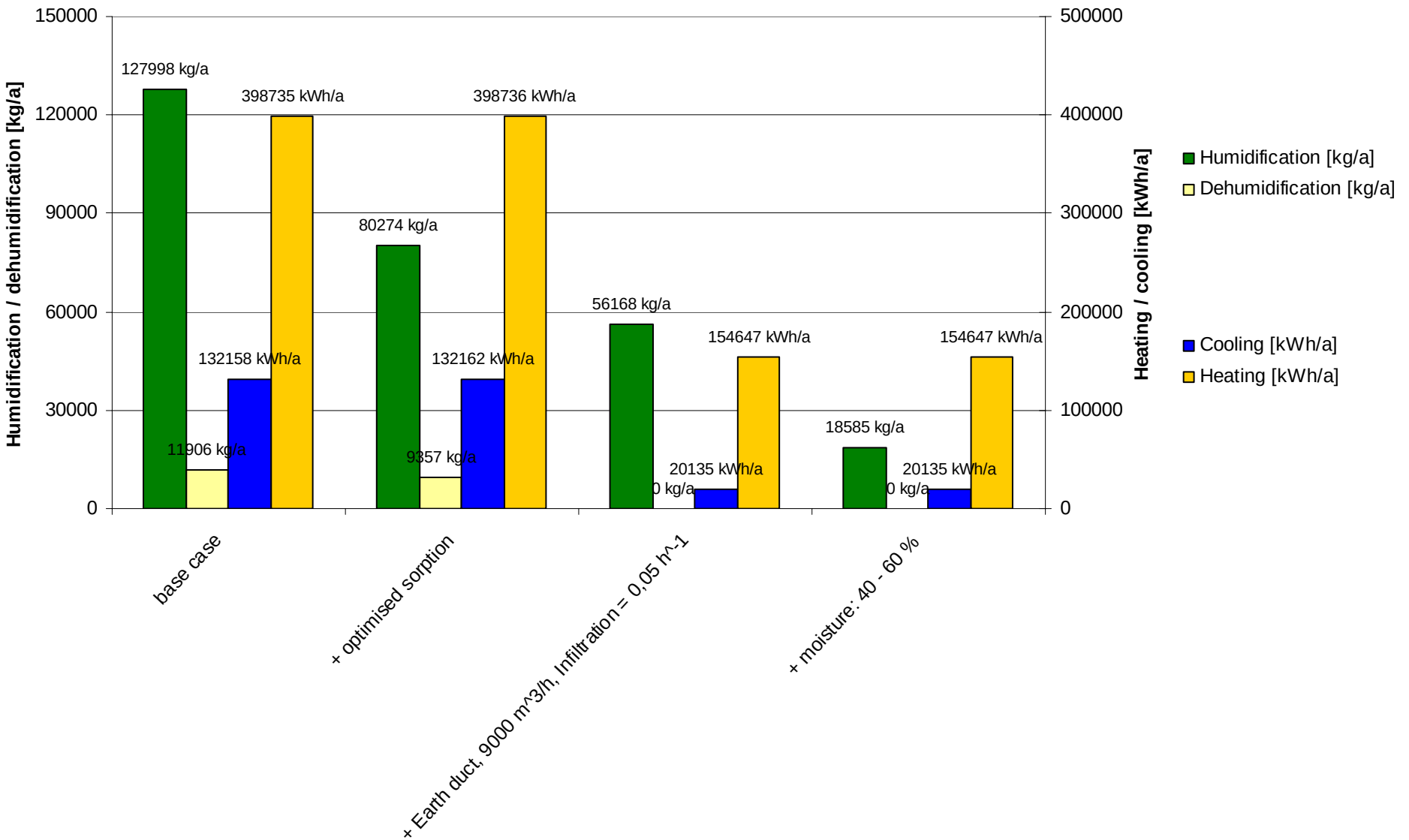
Temperature [°C]



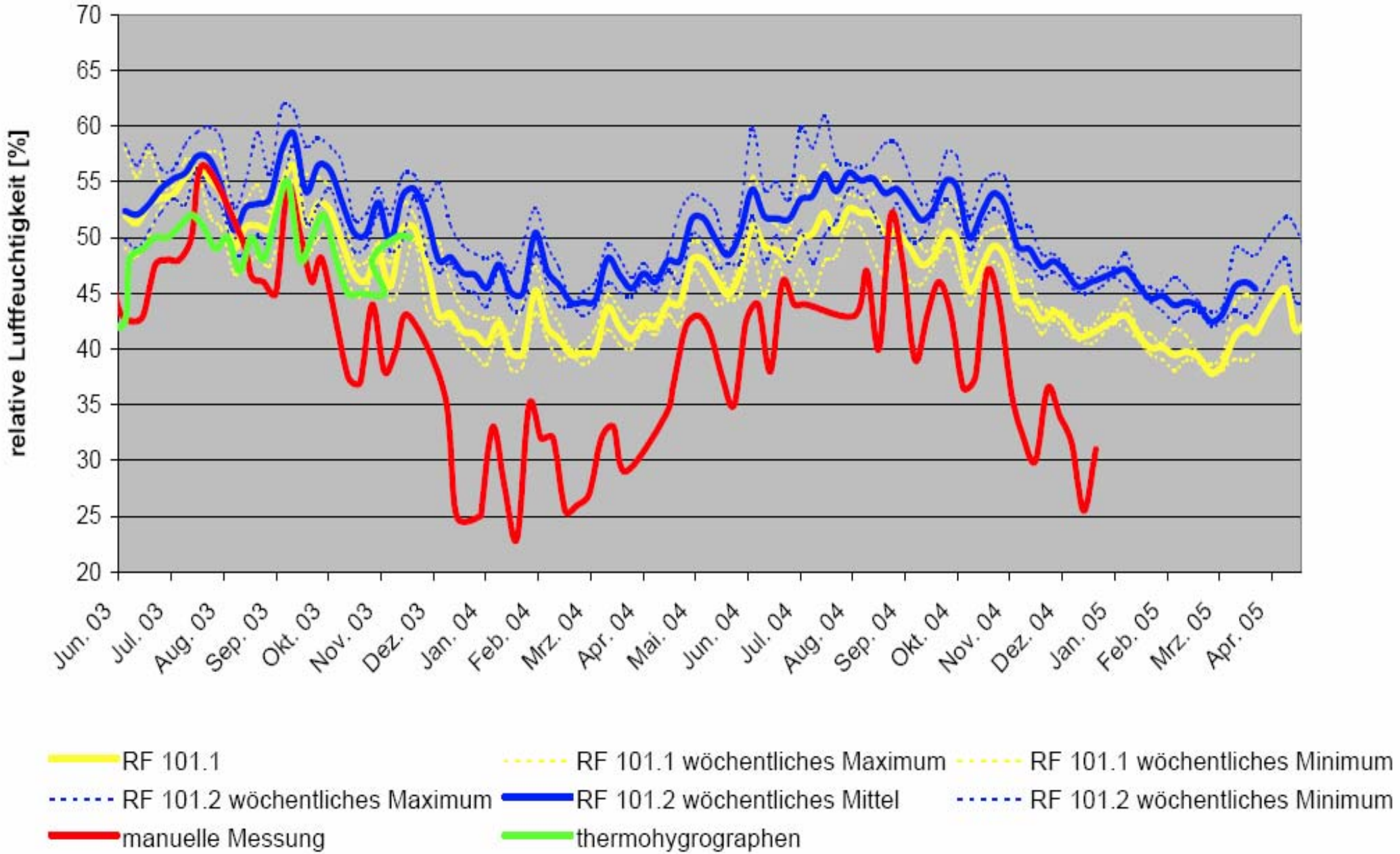
Relative moisture



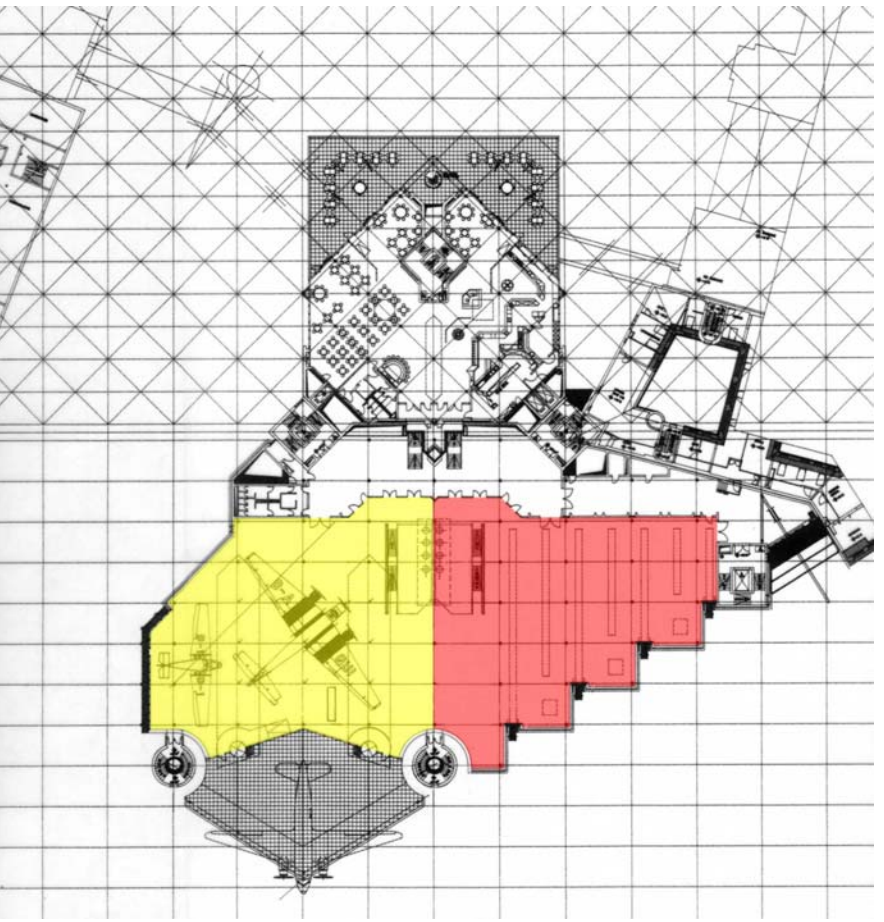
Evaluation of measures



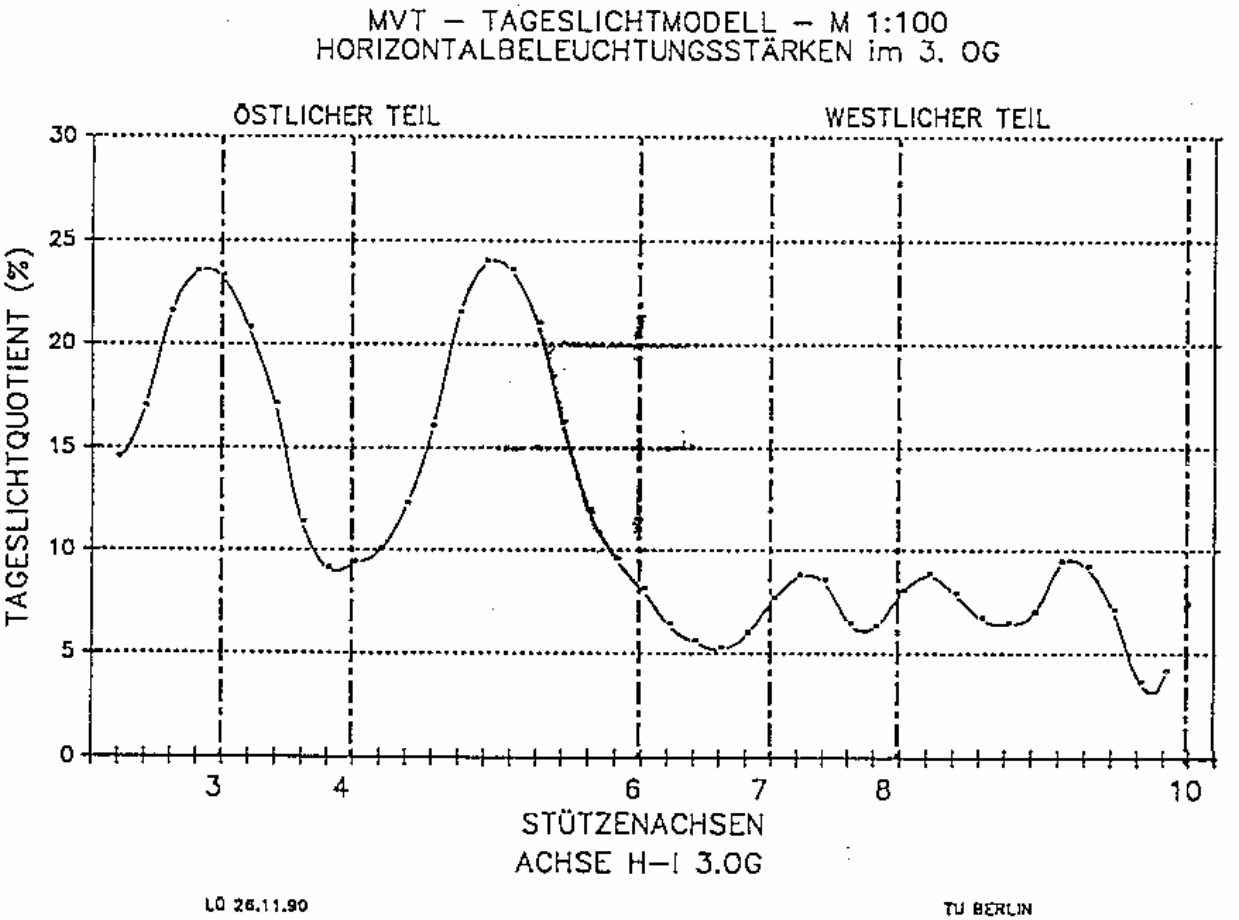
relative Luftfeuchtigkeit im 2.OG des Ausstellungstraktes



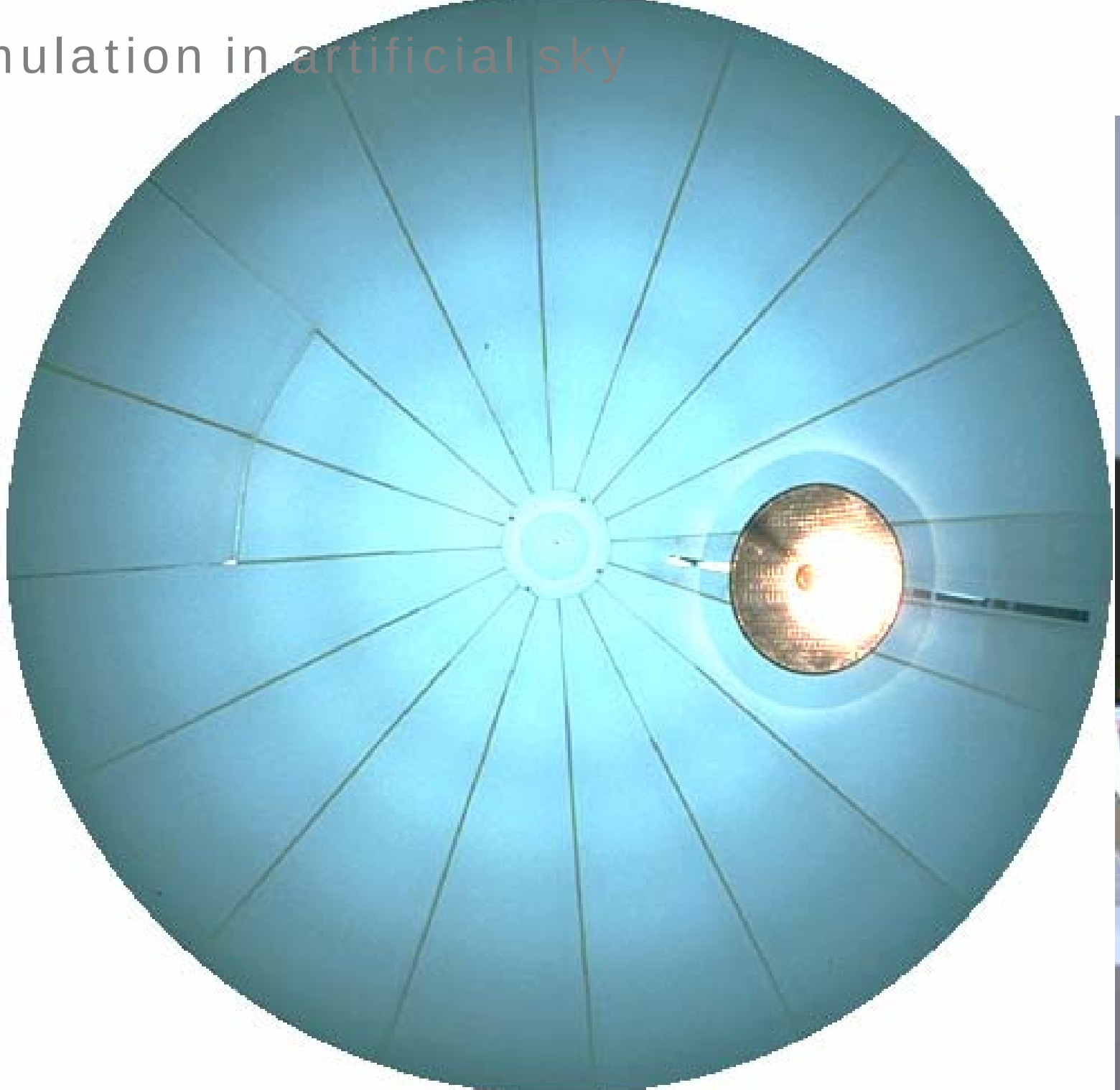
Daylighting - varying demands in different floor areas

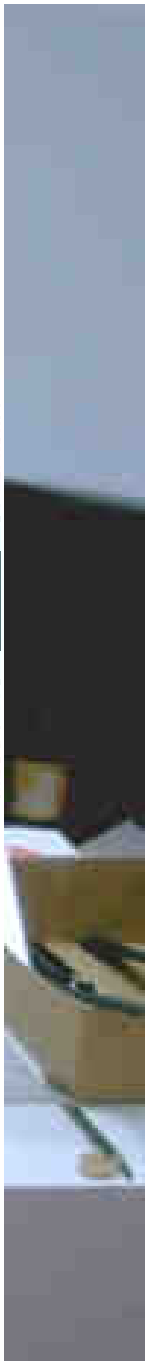


4th floor

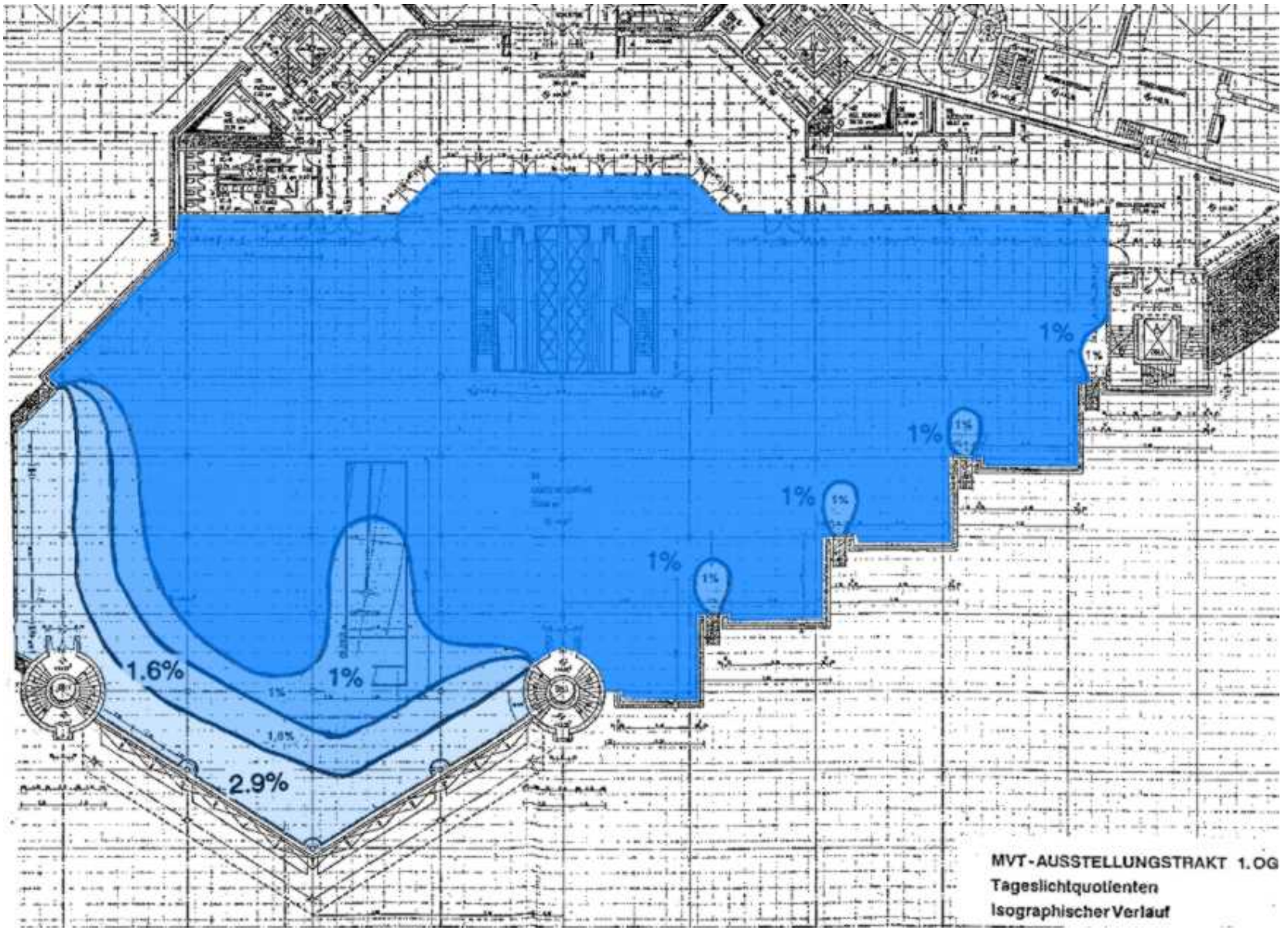


Daylight simulation in artificial sky



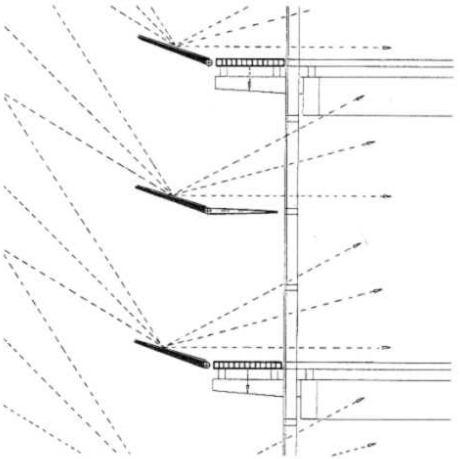


Daylighting

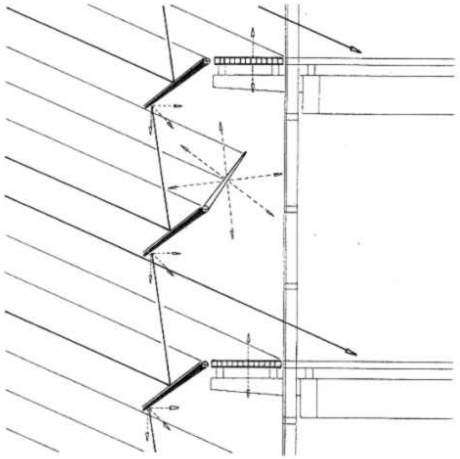


Design of East facade

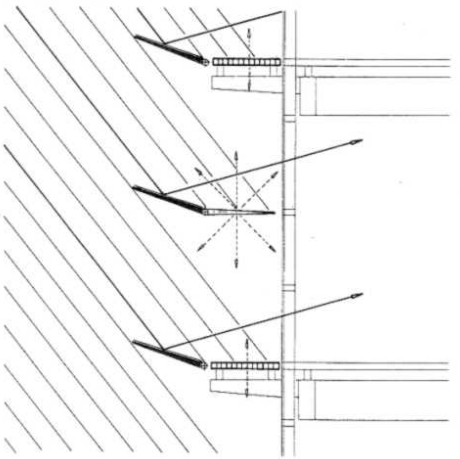
overcast sky



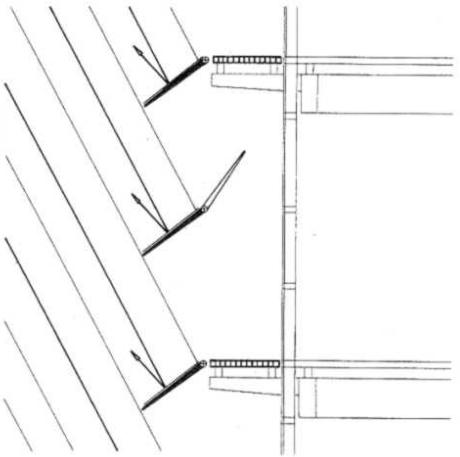
low sun position



high sun position
- daylighting

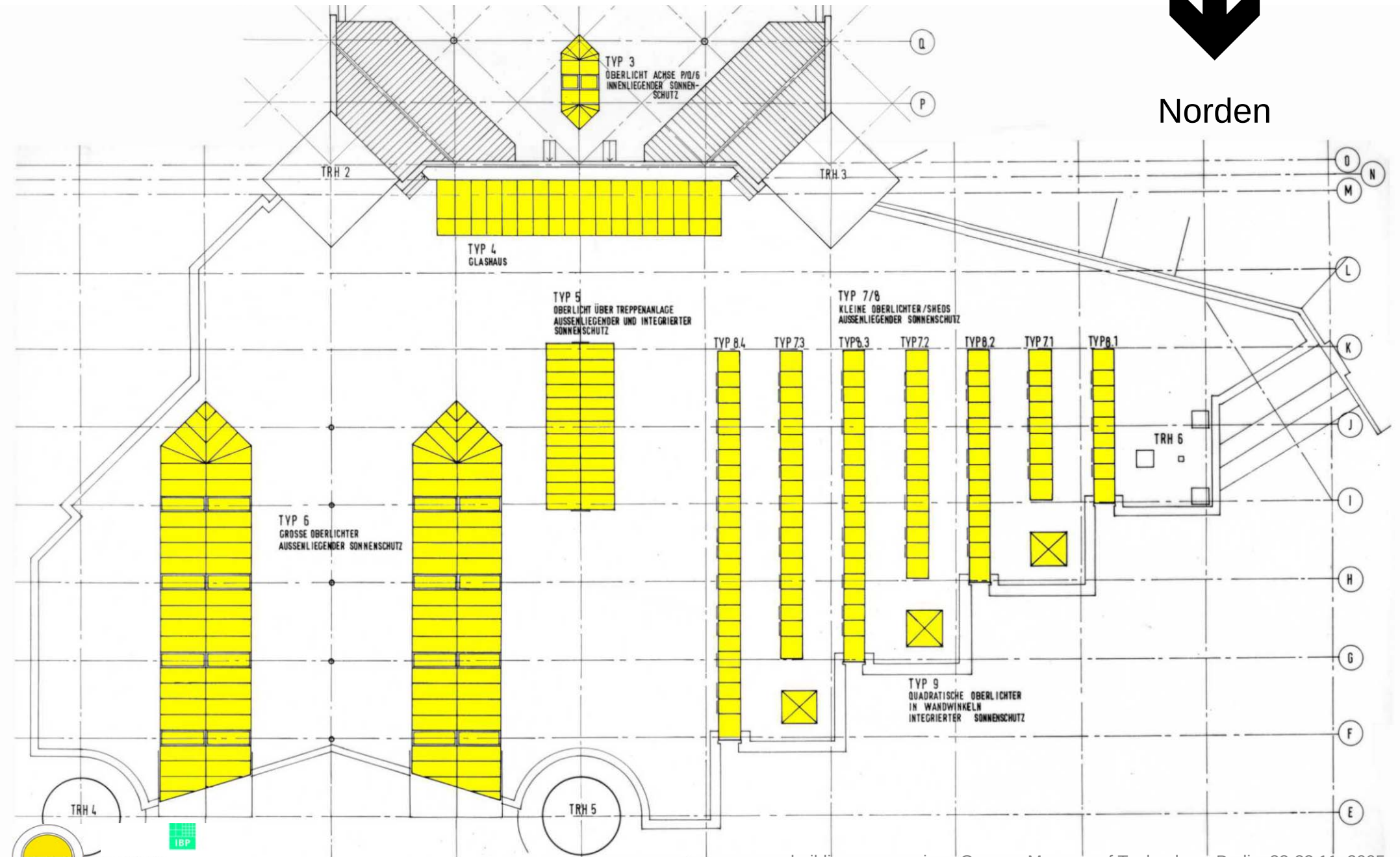


high sun position
- shading

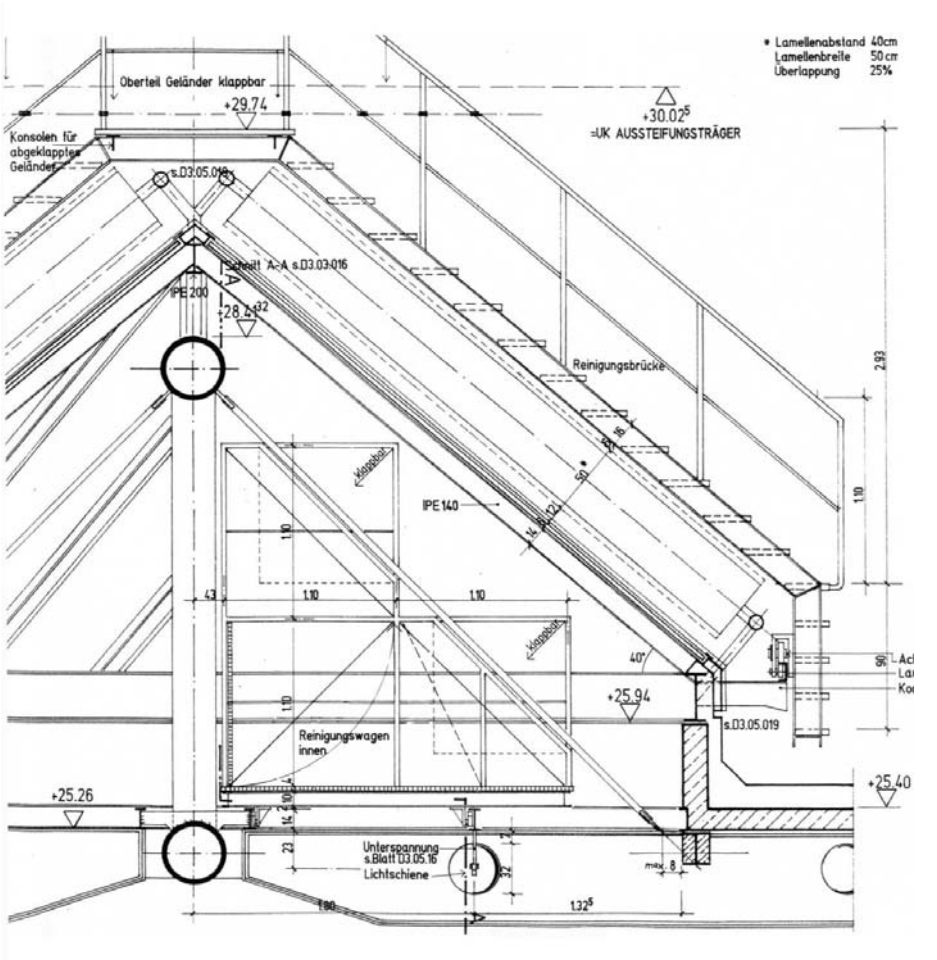


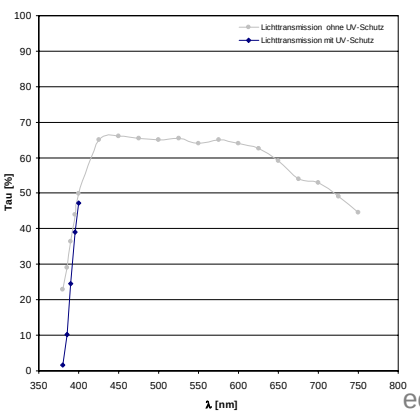
Daylight responsive control of louvers

rooflights in exhibition area

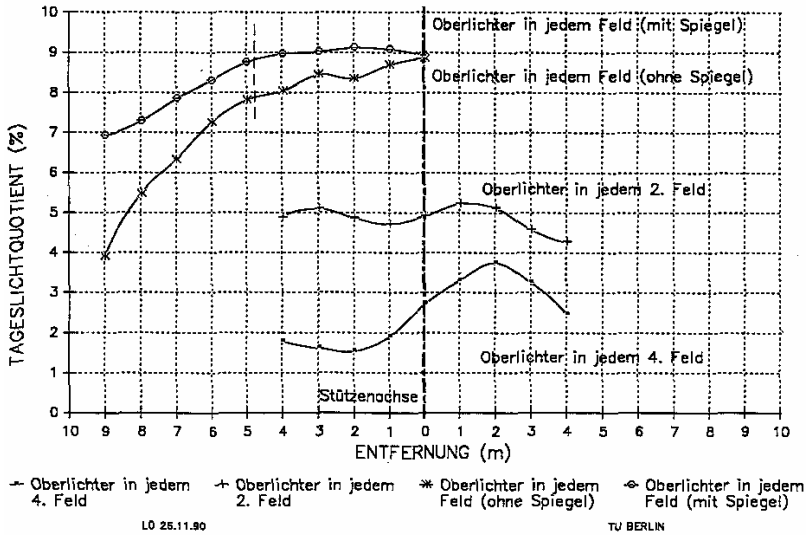


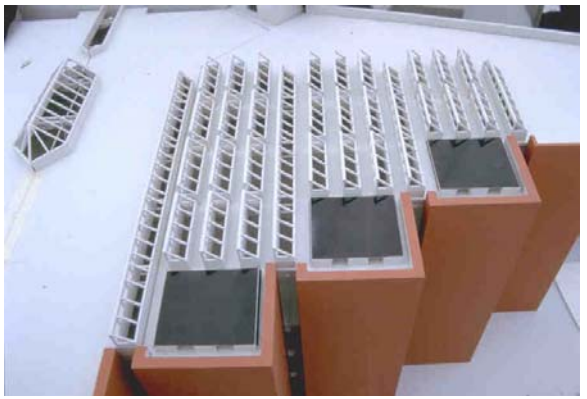
Large rooflights in eastern part



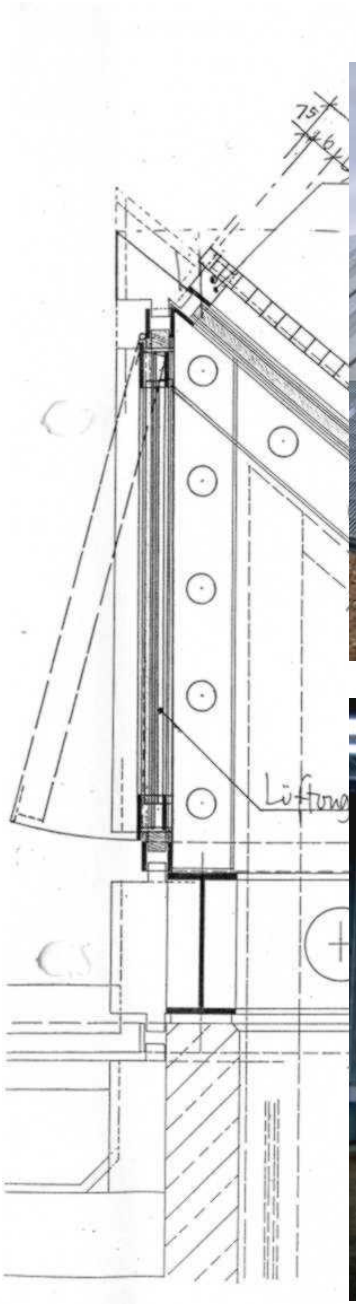


Design of rooflights in western part

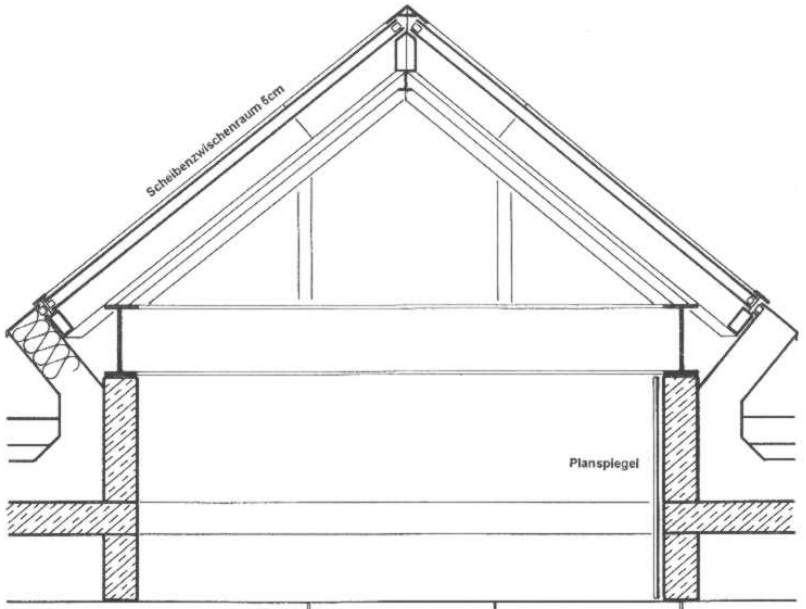




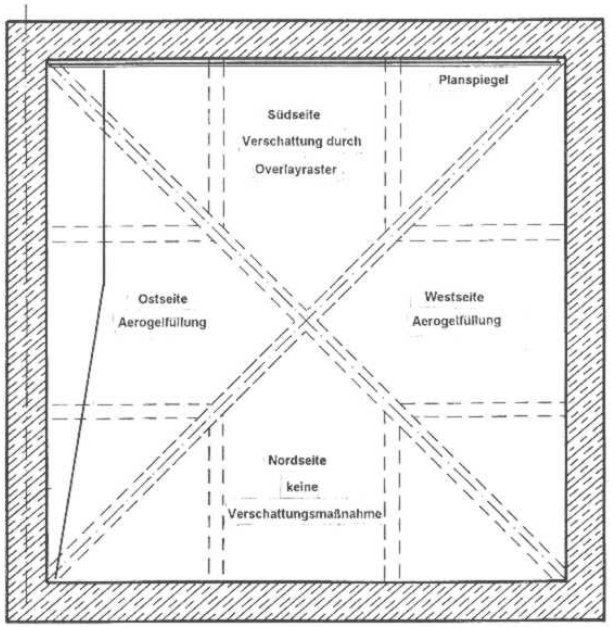
rooflights in western part



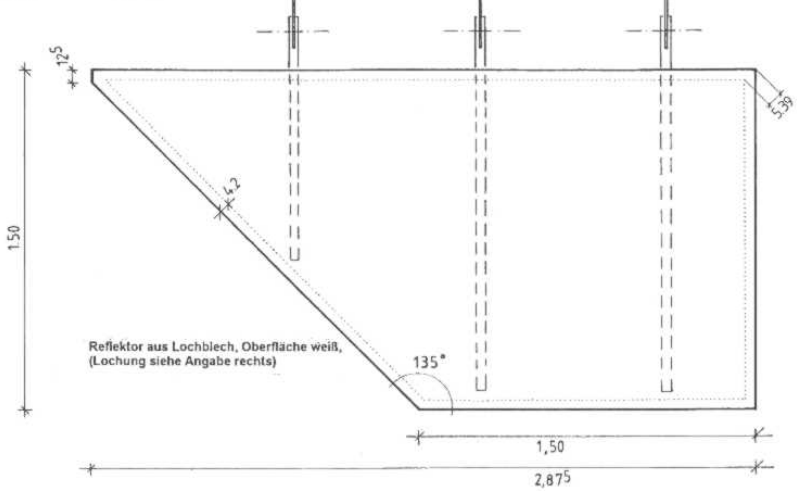
Design of rooflights above instructional corners

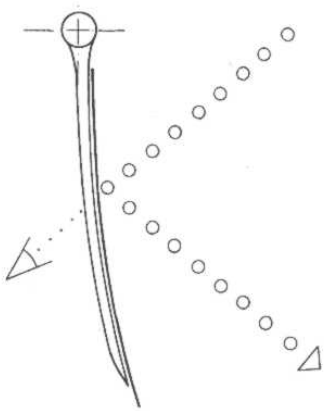


Schnitt Oberlicht

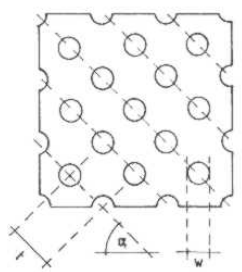


Grundriß Oberlichtschacht





Schnitt Reflektor



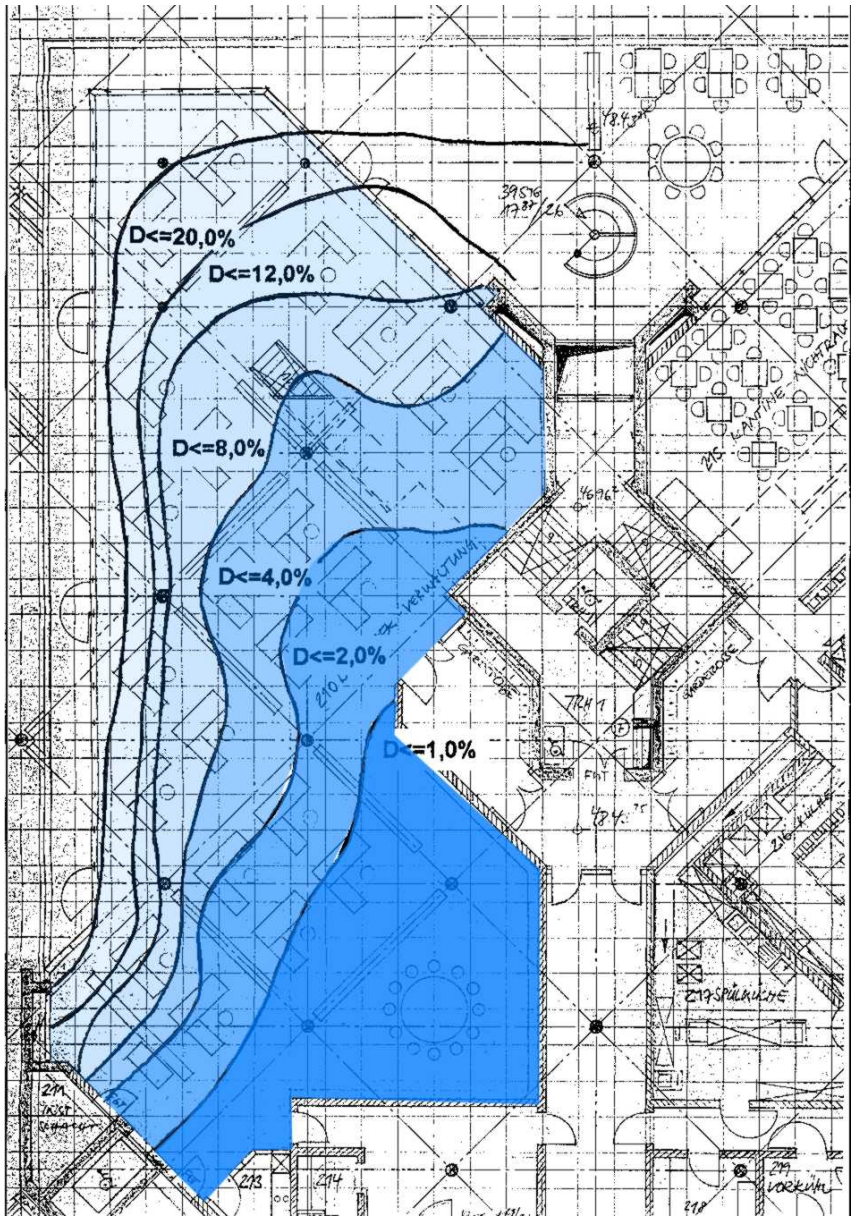
Lochung:

Rundlochung, diagonal versetzt, 102 Streifen mit t=20mm (konst.) W beginnend mit 2,5mm je 6 Streifen konstant, dann 6 Streifen um 0,5mm größer..., beginnend von rechts oben, W=2,5mm, 3mm, ..., 10,5mm

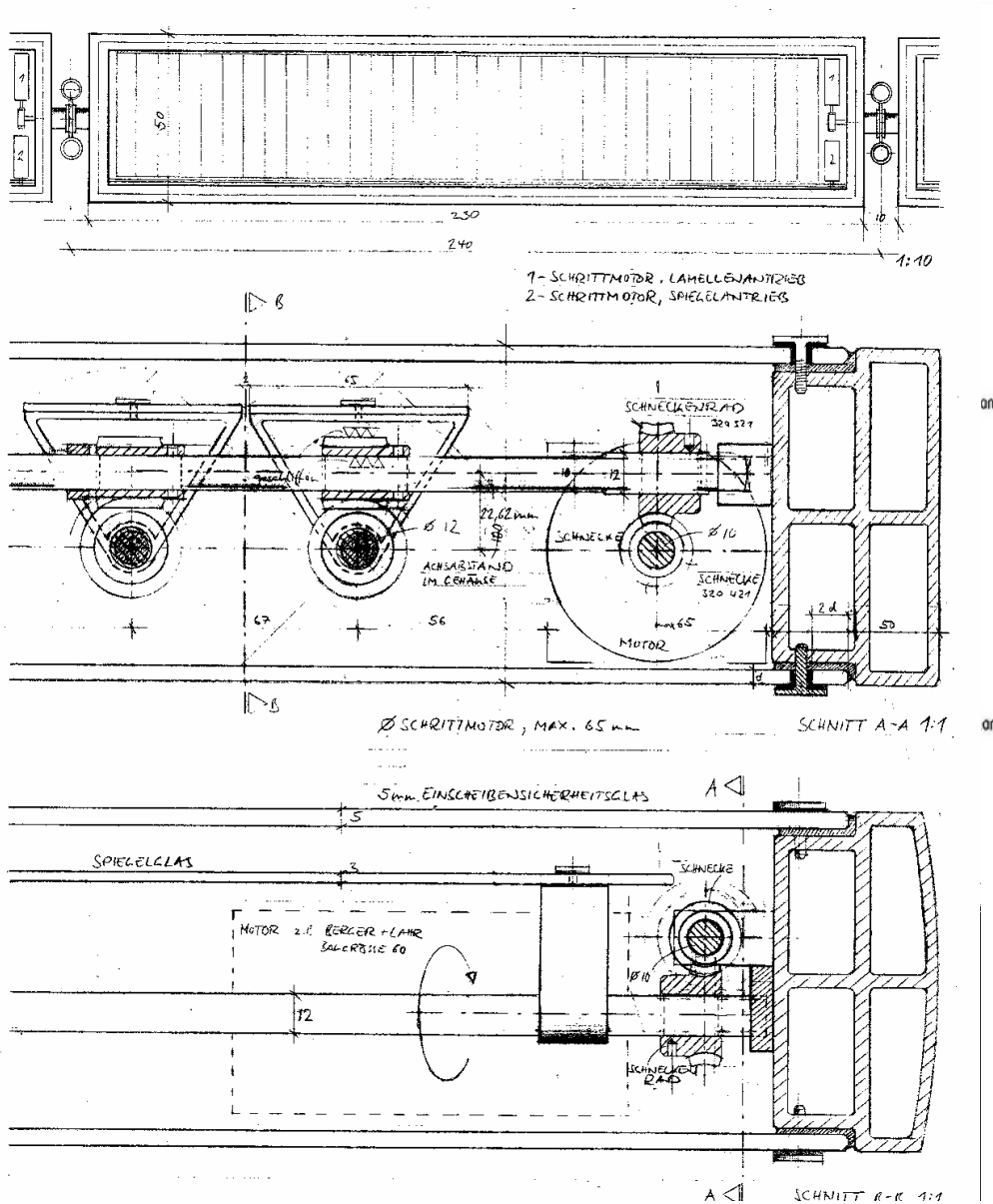
rooflights above instructional corners

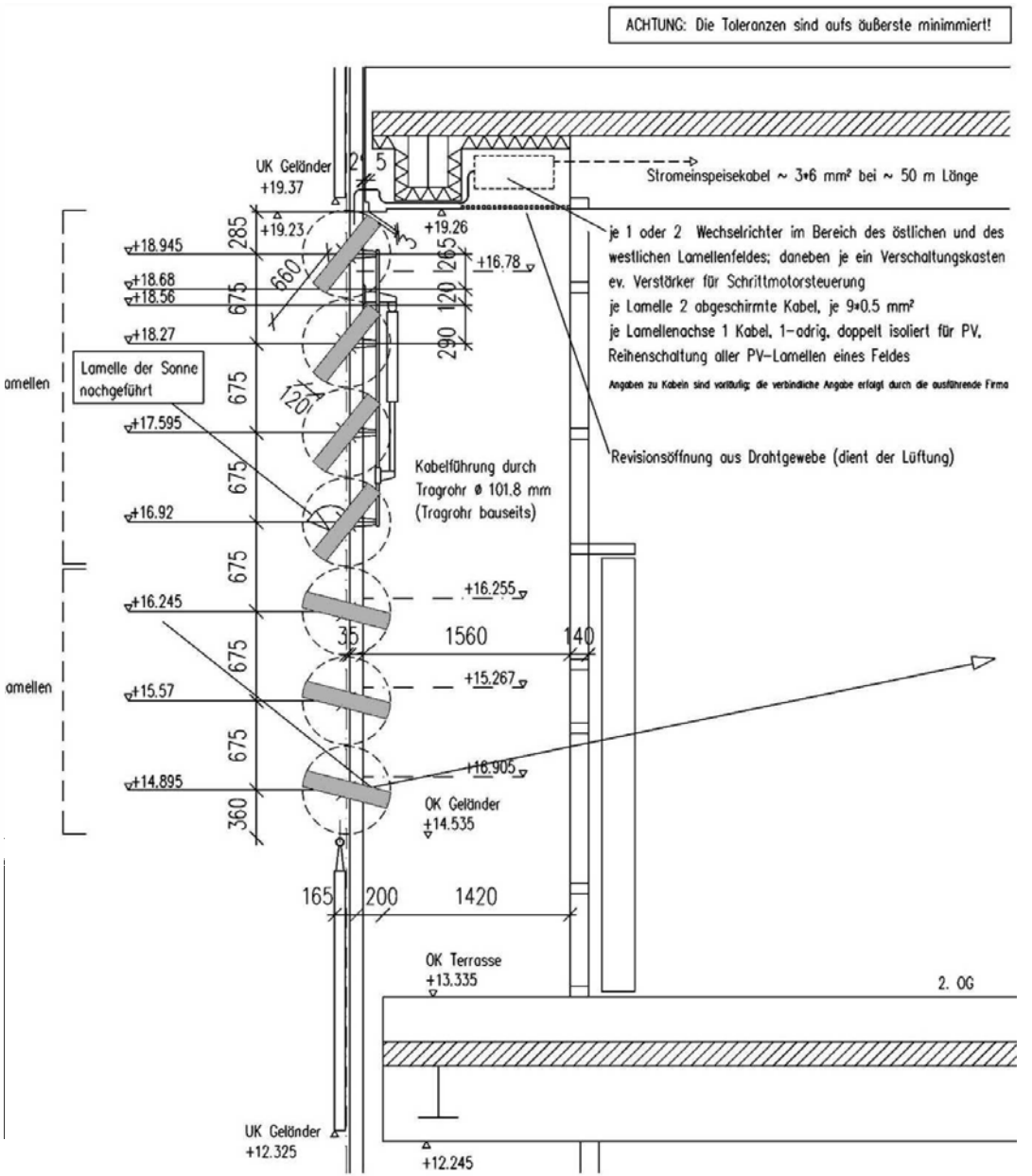
rooflights above instructional corners

Design of daylighting systems in library

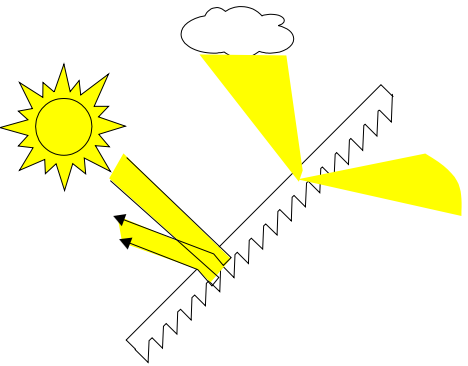


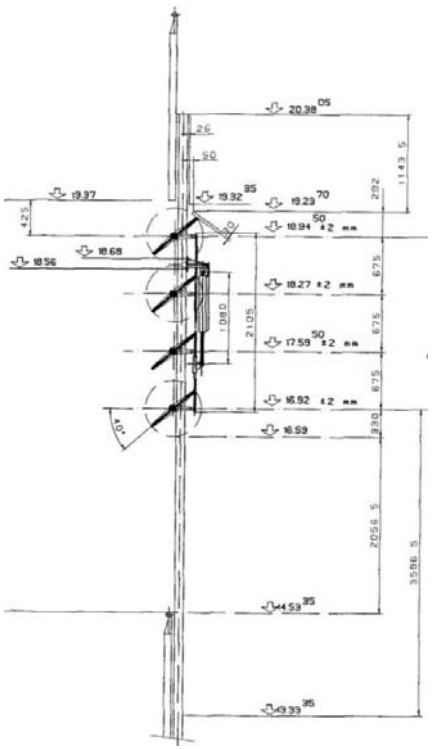
Design of daylighting systems in library



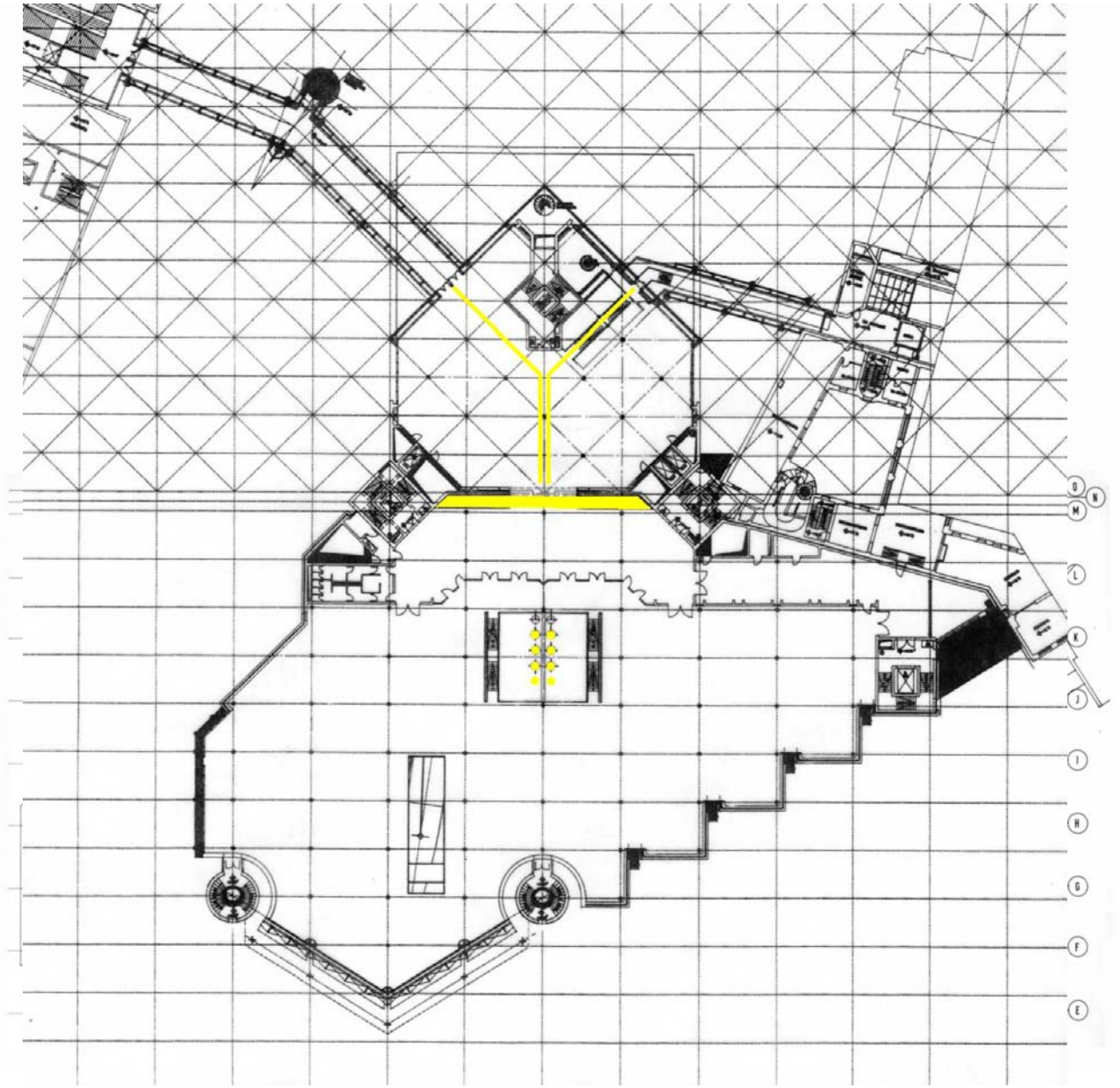


Design of daylighting systems in library

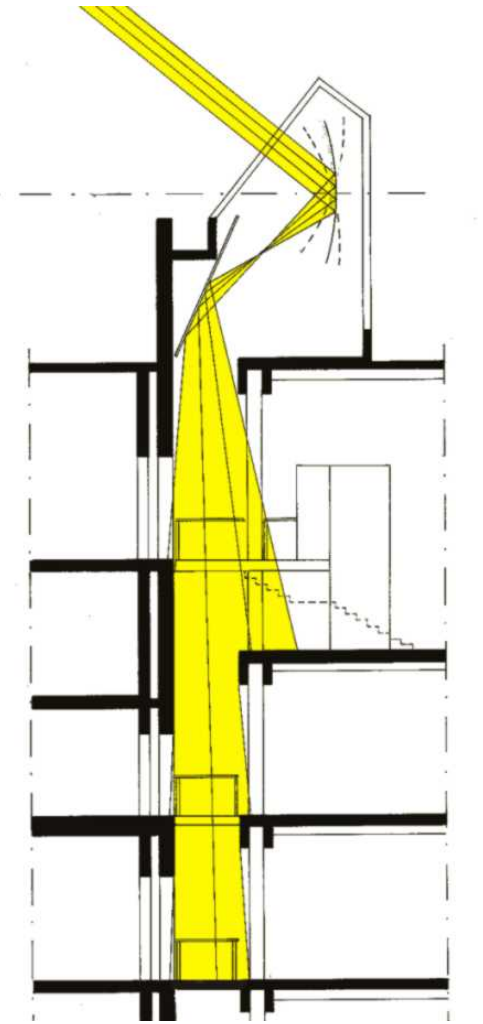




Lightguiding systems



Sun-duct



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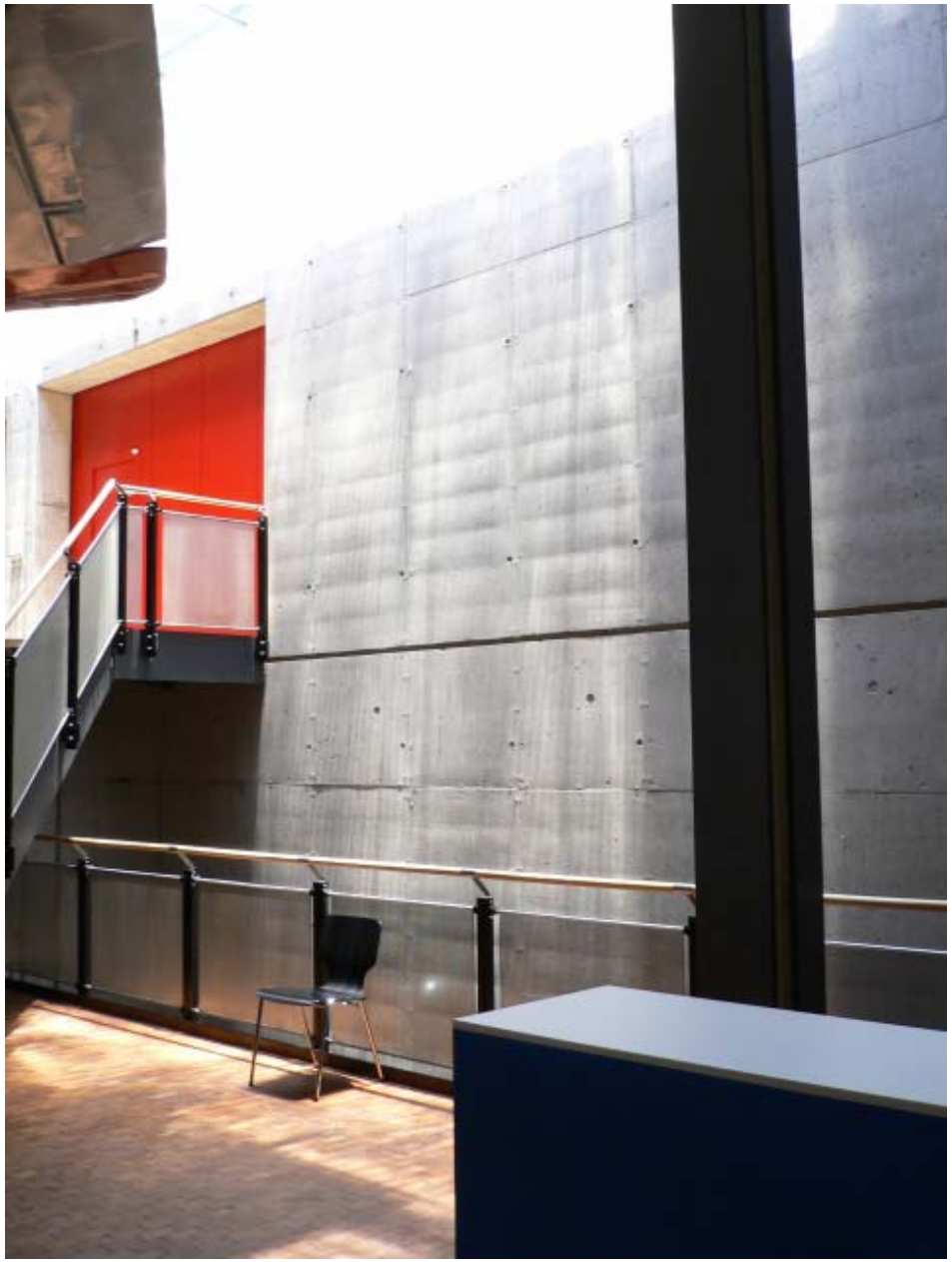
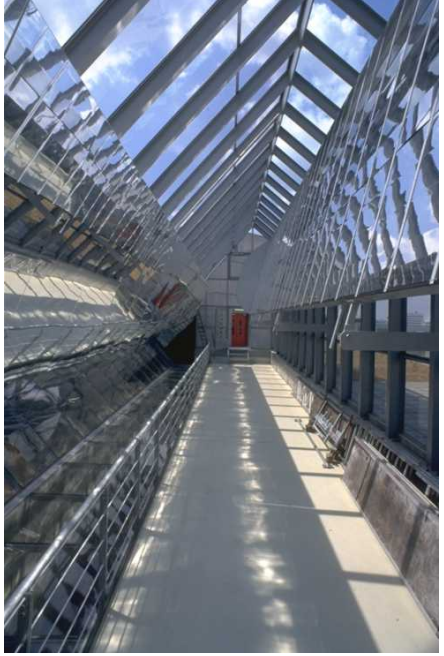
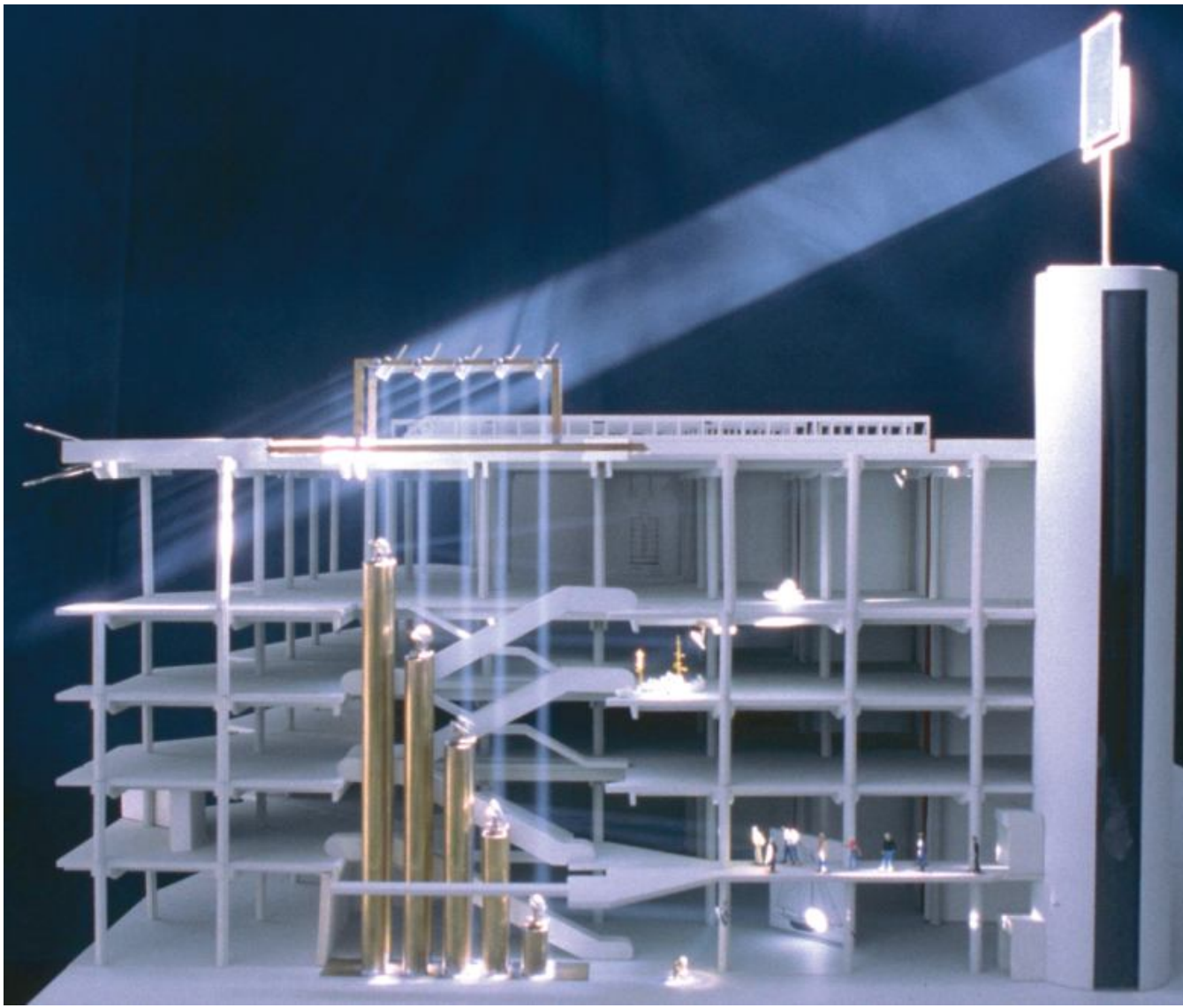
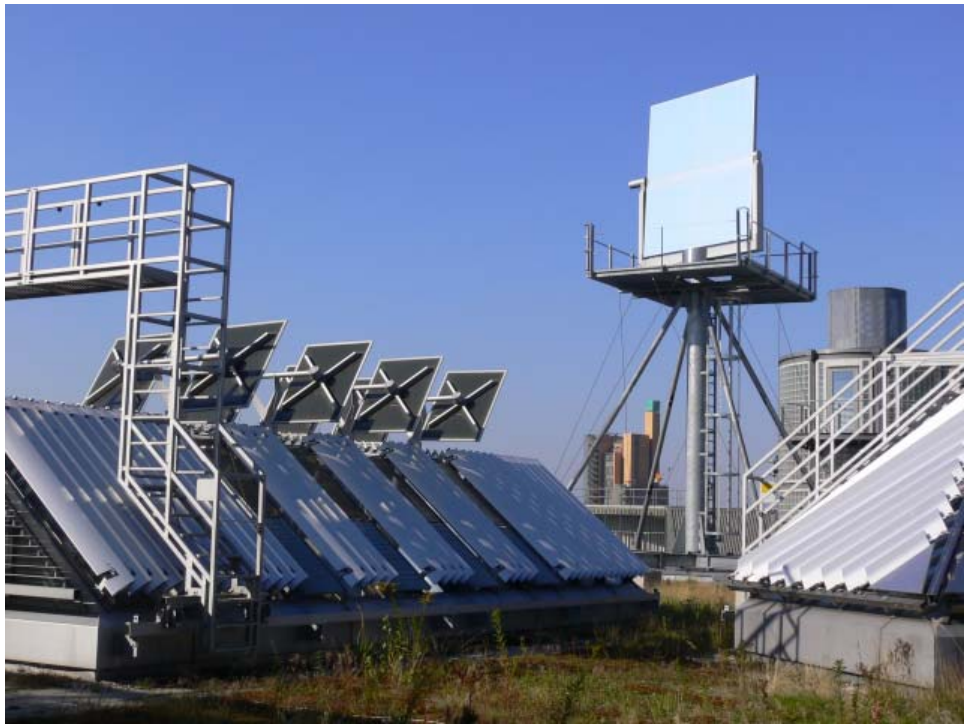




Sun tracking mirrors

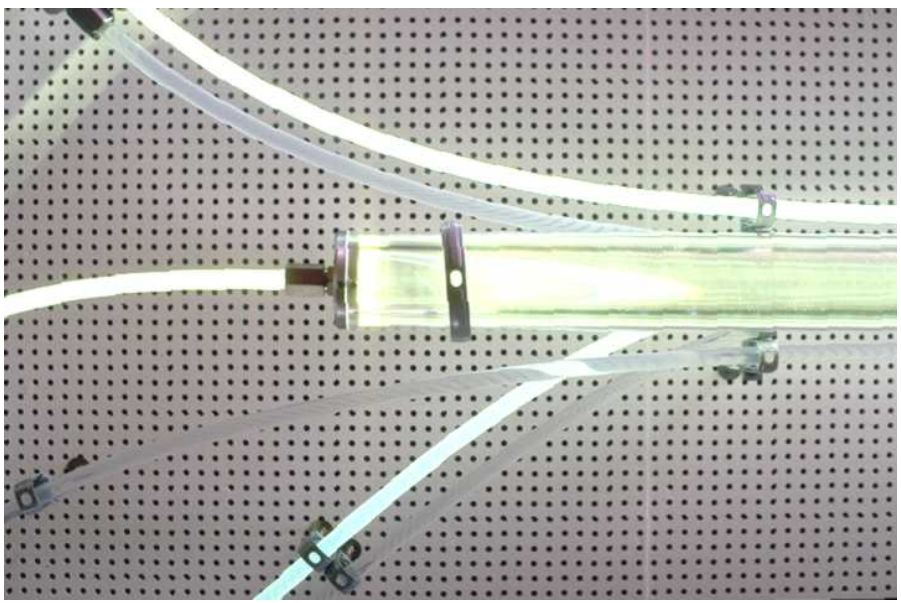


Sun tracking mirrors



Sun tracking mirrors

Daylight luminaries



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Comparison of light guiding systems

system	size of daylight collecting area (gross)	(corrected)
daylight luminaries	4,71m²	3,82m²
sun duct	75,80m²	66,15m²
sun tracking mirrors	14,18m²	14,02m²

monitoring...

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THE GERMAN MUSEUM OF TECHNOLOGY IN BERLIN – A CASE STORY OF ENERGY EFFICIENCY

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