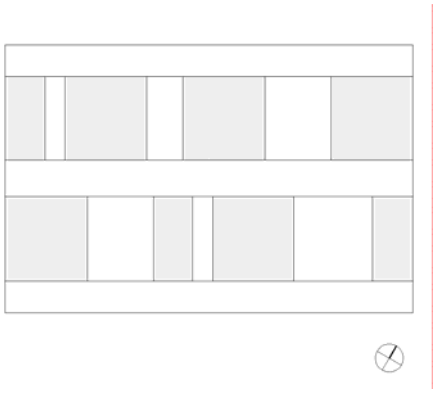
Research building for bio-chemical fundamental research at the University of Ulm:

Analysis of two different facade concepts

A: Laboratory facade with external solar control
B: Laboratory facade with solar control louvres in the glass cavity



Building orientation

General

Ulm is located in a sun-rich region. The assumption is taken as approx. 1640 sun hours per year. (Source German weather service: multi-year mean value, measured at the weather station Kuhberg *).

In addition to this, quite particular wind conditions occur: In 2003 wind speeds of over 10 m/s (= extreme speed for external raffstores louvers) were measured on over 250 work hours (*). It is therefore necessary to calculate a certain amount of down time for the solar control.

Energy costs
The addition of artificial light is necessary when the use of solar control hinders the transmittance of daylight. In a clear sky and high solar angle, 60 000-100 000 Lux (horizontal luminance) is available, with a cloudy sky and lower solar angle about 5000 Lux.

Visual comfort:
Occupational health analyses state that daylight, particularly the UV-portion, has positive effects. From improvement in comfort to protection against cancer illnesses - many influences have been given.

Glare types:
Apart from direct glare due to the suns rays, it is also possible to have indirect glare. On the one hand the wall behind the monitor may be too bright (ratio 1: 15 between monitor and background is the target). On the other hand, it is possible that a bright surface behind you may cause extreme reflections on the monitor. In addition to this,

on days where there is diffuse light, it may occur that there are extreme differences between light levels close to the window and in the depth of the room.

Daylight technology / Status
Since conventional louvres have disadvantages, apart from difficulties to keep out undesired heat and daylight, other systems have been developed over many years to bring optimisation to the desired end result formula:

- Summer heat protection with simultaneous highest possible transparency
- Use of daylight to save on energy costs and to improve comfort
- Stop glare
- Transportation of light to the depth of the room / optimising light conditions in the whole room
- Independence from wind

Facade Laboratory / general

Basic conditions according to dynamic building simulation (Büro SIG, Herrn Hollenbach dated 9.7.2004):
The analysis was carried out with differing glass types, external solar-control louvres as well as louvres in the cavity of an insulated unit. Generally it was planned to have mechanical ventilation during the day and night (4 times air change).

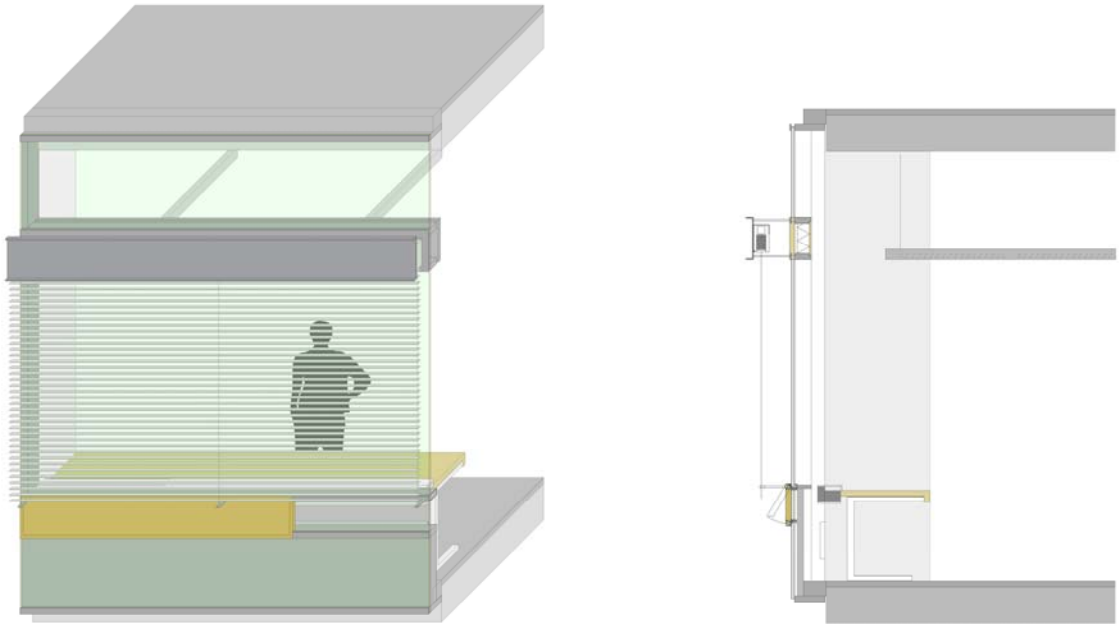
Reference values: According to DIN 1946-2 climatically controlled buildings with an external temperature of 26° may have a room temperature not exceeding 25°C. At higher external temperatures the internal temperature may exceed this. Simplified the basis used for calculation was DIN 4108-2 with the 10% guideline.

A) Facade Laboratory with external sun protection

The analysis was carried out using solar control glass 50/27.

Control: In direct sun the louvre is lowered, with cloudy sky it is raised. Exception – with the West laboratories: in direct sun the louvres are closed. In direct sunlight the louvers close at sunrise because the morning heating from diffuse radiation is too high.

Results: Only the critical laboratories on the west side were analysed. Here, the most unfavourable locations with 250 hours at temperatures above 26°C were recorded (without taking local wind conditions into account).
The basis weather data (Test reference year Stötten / Schwäbische Alb) assumes 1305 work hours (from 2200 in the year) with direct sunlight radiating onto the lab cubes. This equates to 59 % of the working year. During this time it is not possible to look out of the windows.



Fassade Labor
Sonnenschutz aussenliegend, Brüstung geschlossen
Stand HU-BAU

Laboratory facade. Solar control external, spandrel solid

Functions:

1. Protection from heat transmittance (g-value)
2. Glare protection in closed position

Advantages:

Tested system

Very good total g-value of 0.1 in closed position, louvres vertical

Disadvantages:

High energy costs
In closed position it is necessary to use artificial light.
This is applicable for approx. 59 % of the working year in the West labs (1305 from 2200 hours in the year). For the East labs the proportion was about 23%

Restriction of view to the outside
During the 59 % of work time it is not possible to look out from the West labs.

Additional glare protection or longer closed periods are necessary

Even with a diffused sky it may be necessary for glare protection. As a result, the periods when the louvres had to be fully or almost fully closed were extended (Inner-lying louvers is not a practical solution for laboratories.)

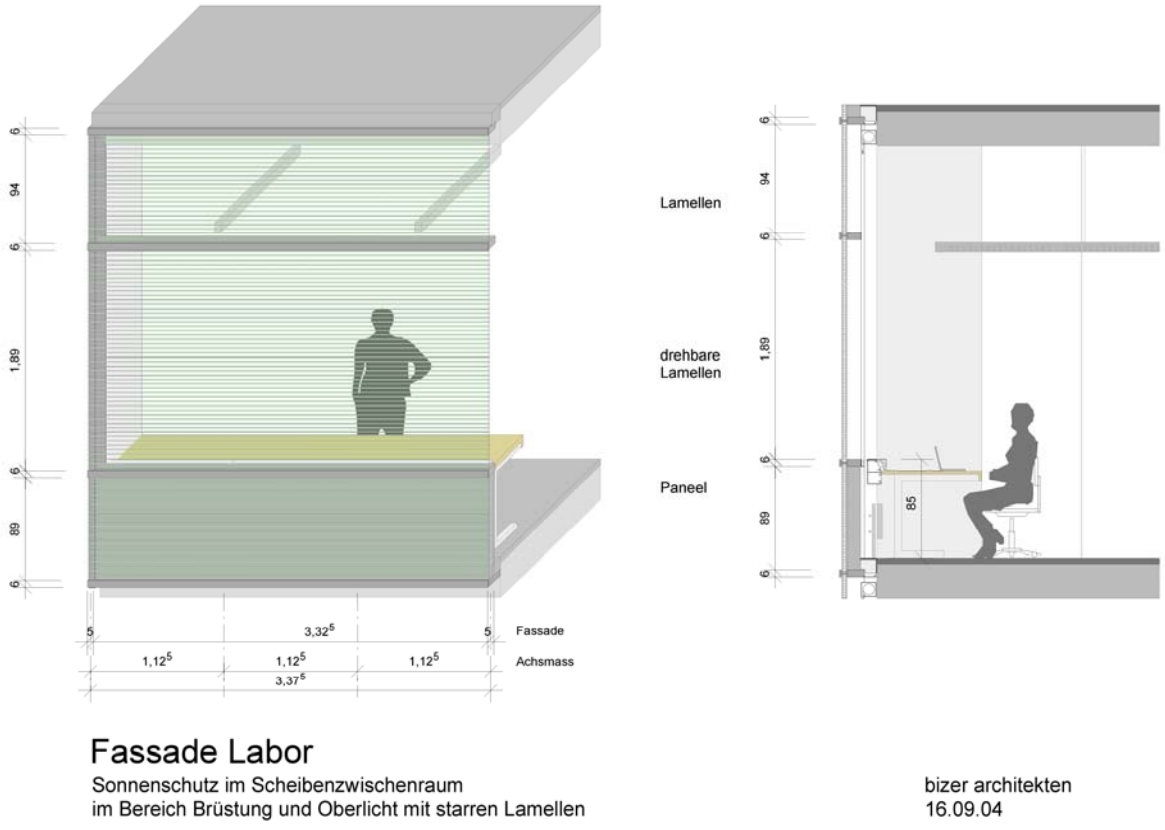
Discomfort and stress:
Often lifting and lowering of louvres causes disquiet – Motor noises.
Adjustment in eye concentration in differing light conditions is necessary – artificial light and natural light have different qualities.

Danger of damage by wind possible refurbishment necessary

Interference of the summer thermal insulation / glare protection due to wind

Cleaning costs
Higher costs for building maintenance; typical cleaning regime every 2 years

B Facade Laboratory with solar control in the cavity



Laboratory facade. Solar control in cavity, spandrel and over-light with fixed louvres

Functions:

1. Protection from energy transmittance (g-value)
2. Complete glare control with movable, controllable louvres
3. Daylight use

The evaluation was carried out using a louvre in the cavity in combination with thermal insulating glass 76/52.

To 2.: Control: The louvre is generally lowered and adjusted to suit the angle of the sun (maximum 82 % visibility).
High wind speeds have no influence on the function of solar control.

Result: In the West laboratories, it was calculated that about 290 hours with temperatures above 26°C occur (worst case Lab ZOP 2 floor in entrance area).
By adapting the louvre angle to the prevailing sun angle it was possible to reduce this further.

Advantages:

Very good total g-value of 0.13 to 0.16 at sun angles above 30°, at louvre angle of 15° from horizontal

Saving of energy costs by using daylight sensors
In almost horizontal position, the louvres provide a very bright level of daylight throughout the year for laboratory-suitable light. Since daylight is available in sufficient amounts, the use of artificial light can be reduced significantly.

Visual comfort
The eye finds constant, light-technical optimised conditions.
Through control of the louvers it is possible to achieve uniform lighting conditions throughout the room.

No incorrect operation possible
Since the louvre is designed not to be raised, it is not possible to operate incorrectly and disturb the calculated, optimised energy protection.

No additional interior glare protection necessary
The solar conttrol simultaneously fulfils the function of glare protection

No interference of the summer thermal insulation / glare protection due to wind

No new investment required in solar control caused by wind damage

Cleaning costs are not incurred

Calculation trials

Part of the façade type (a closed, b glass without solar control, c glass with solar control) x Proportion time factor x Factor visibility x Light transmissions factor of glass = possible daylight use in %

A facade laboratory with external solar control
31 % closed, 14% glass without solar control, 55% glass with solar control
a) 0,31 x 1,0 x 0 x 0 = 0 (Spandrel, panel)
b) 0,14 x 1,0 x 1,0 x 0,5 = 7 % (Over-light)
c) 0,55 x 0,41 x 1,0 x 0,5 = 11,3 % (Glass with solar control, opened)
0,55 x 0,59 x 0 x 0,5 = 0 (Glass with solar control, closed, no vision)
Sum 18,3 % daylight use possible

B facade laboratory with solar control in cavity
23 % closed, 77% glass with solar control
a) 0,23 x 1,0 x 0 x 0 = 0 (Spandrel)
c) 0,77 x 1,0 x 0,69 (mid-position) x 0,76 = 40,4 % (Glass with solar control, always closed, with vision)
Sum 40,4% daylight use possible

K.Bizer / bizer architekten / 4.02.2008