Parametric Study of Daylighting Strategies with Consideration of Glare Problems

Case Study: IGES Research Center in Zushi

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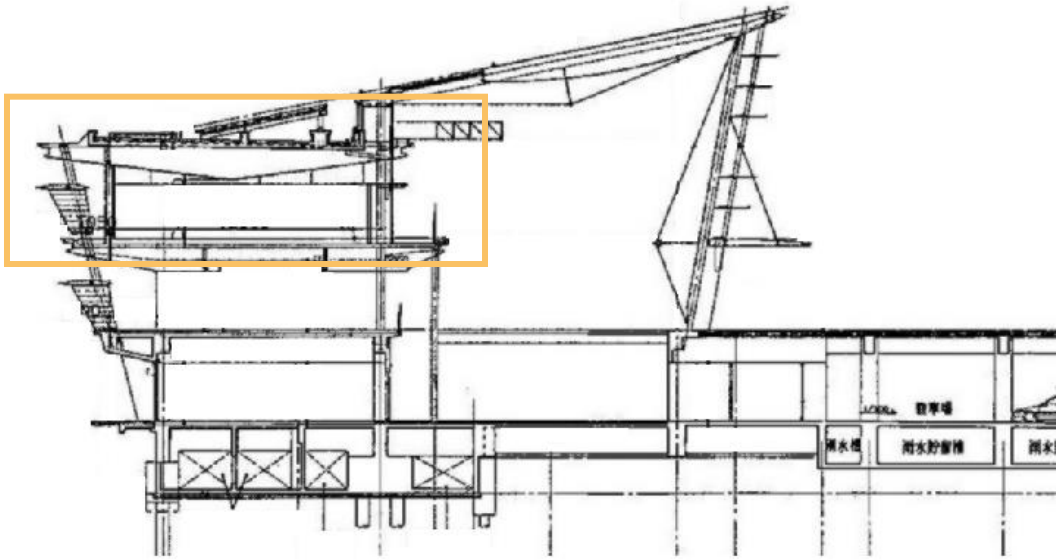
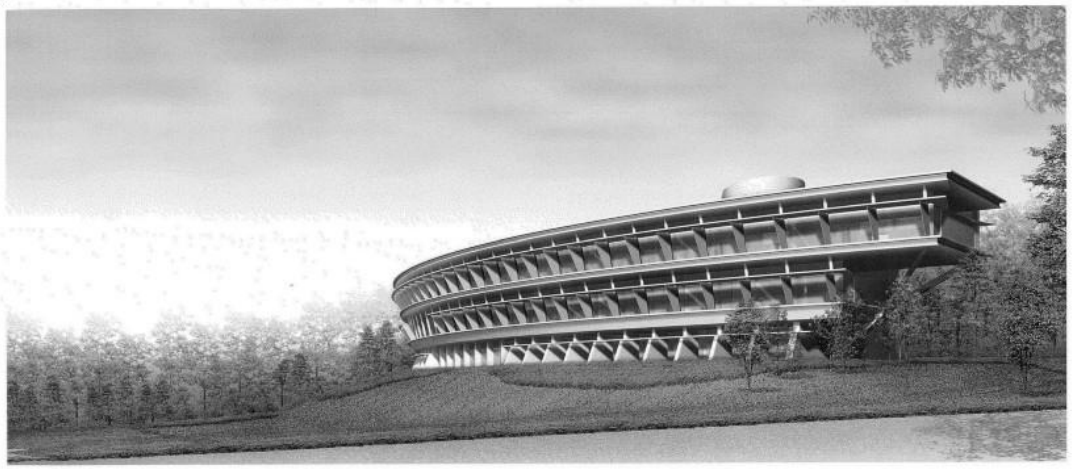
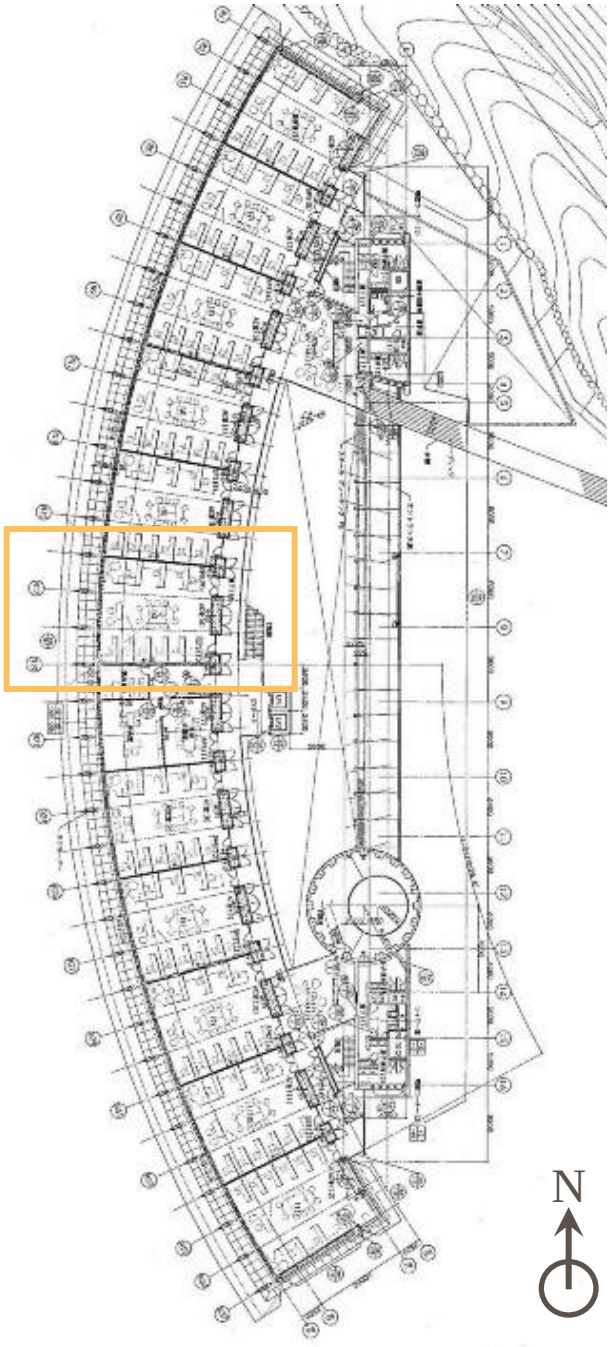
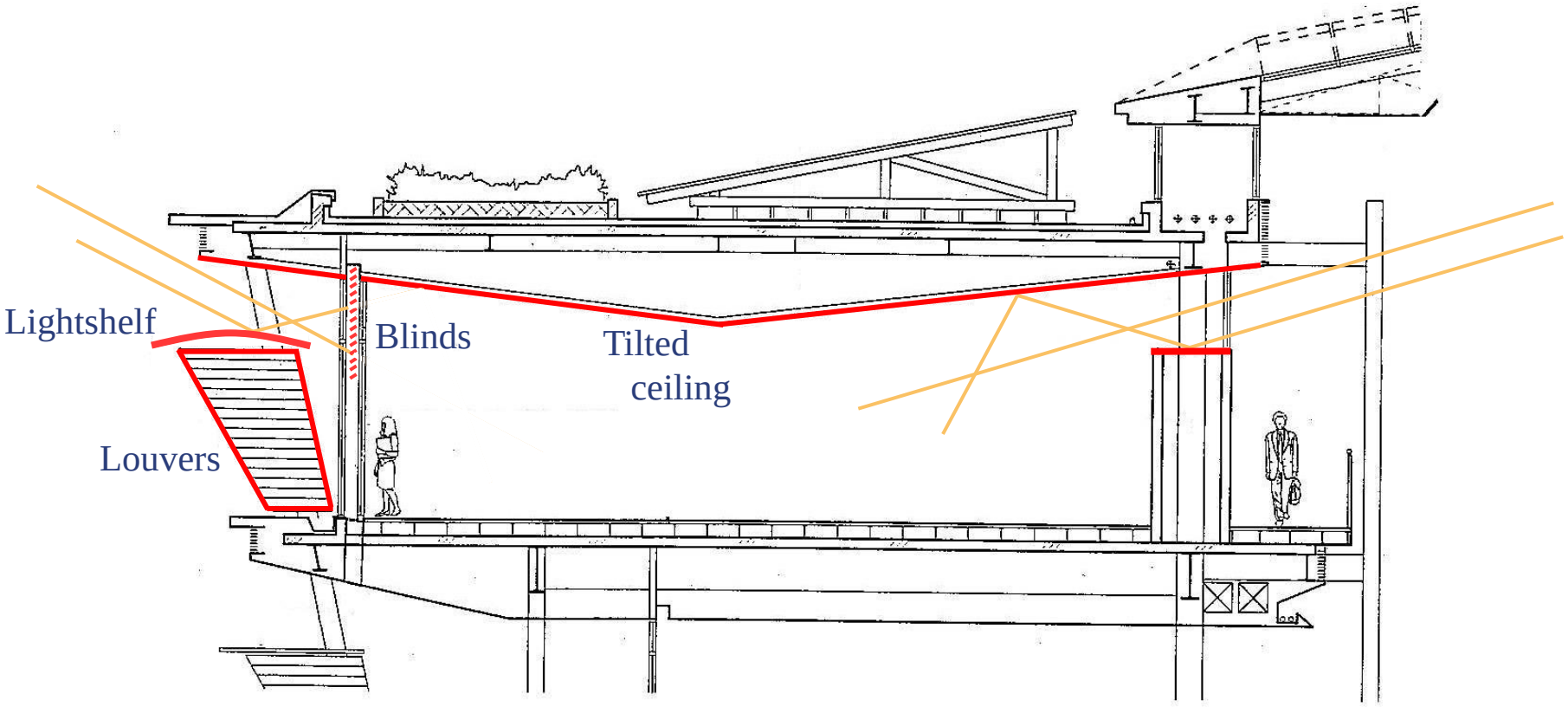






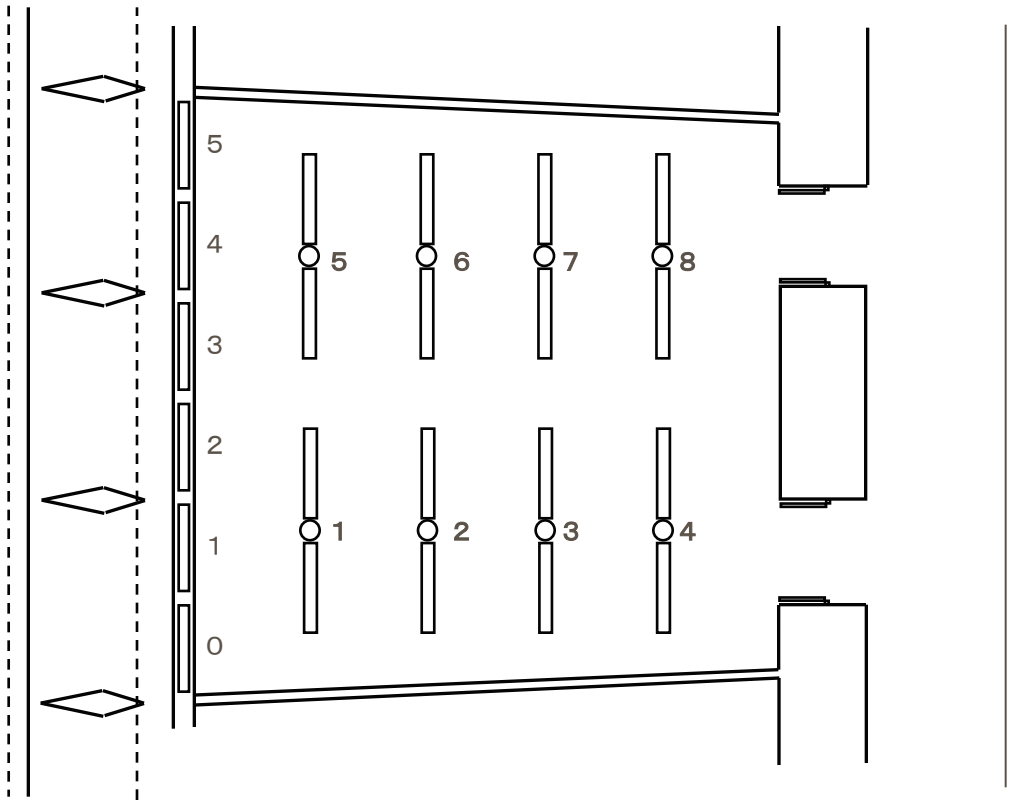
Daylight strategies



Reflectances:		
	70%	ceiling
	60%	walls
	40%	floor
	50%	louvers

Research room: plan diagram

- Sections in the main window and position of daylight sensors

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Daylight strategies and factors studied

- Light shelf
- Louvers
- Ceiling shape
- Orientation

Parametrical procedure

- Set of simulations repeated for different instances of the building
- Simulations calculated the electricity consumption for each operating hour in a year
- Results are obtained from the comparison of the different simulations
- Each yearly simulation took aprox. 36-40 hs.

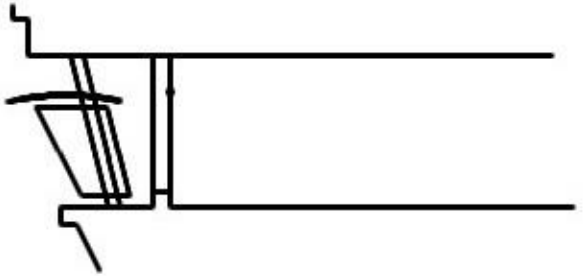
  (Pentium 3, 900MHz, 500Mb of RAM, under Windows)

Models of the building

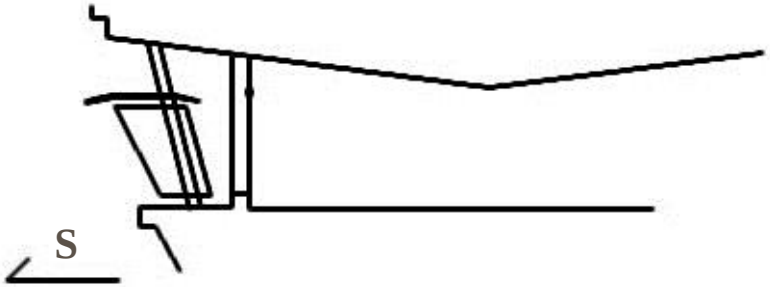
Base Case

Case 2 – without light shelf

Case 3 – without louvers



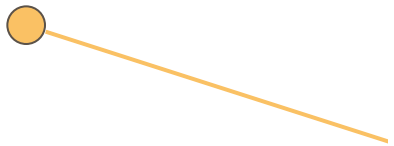
Case 4 – with horizontal ceiling



Case 5 – oriented towards south

Research room: plan diagram

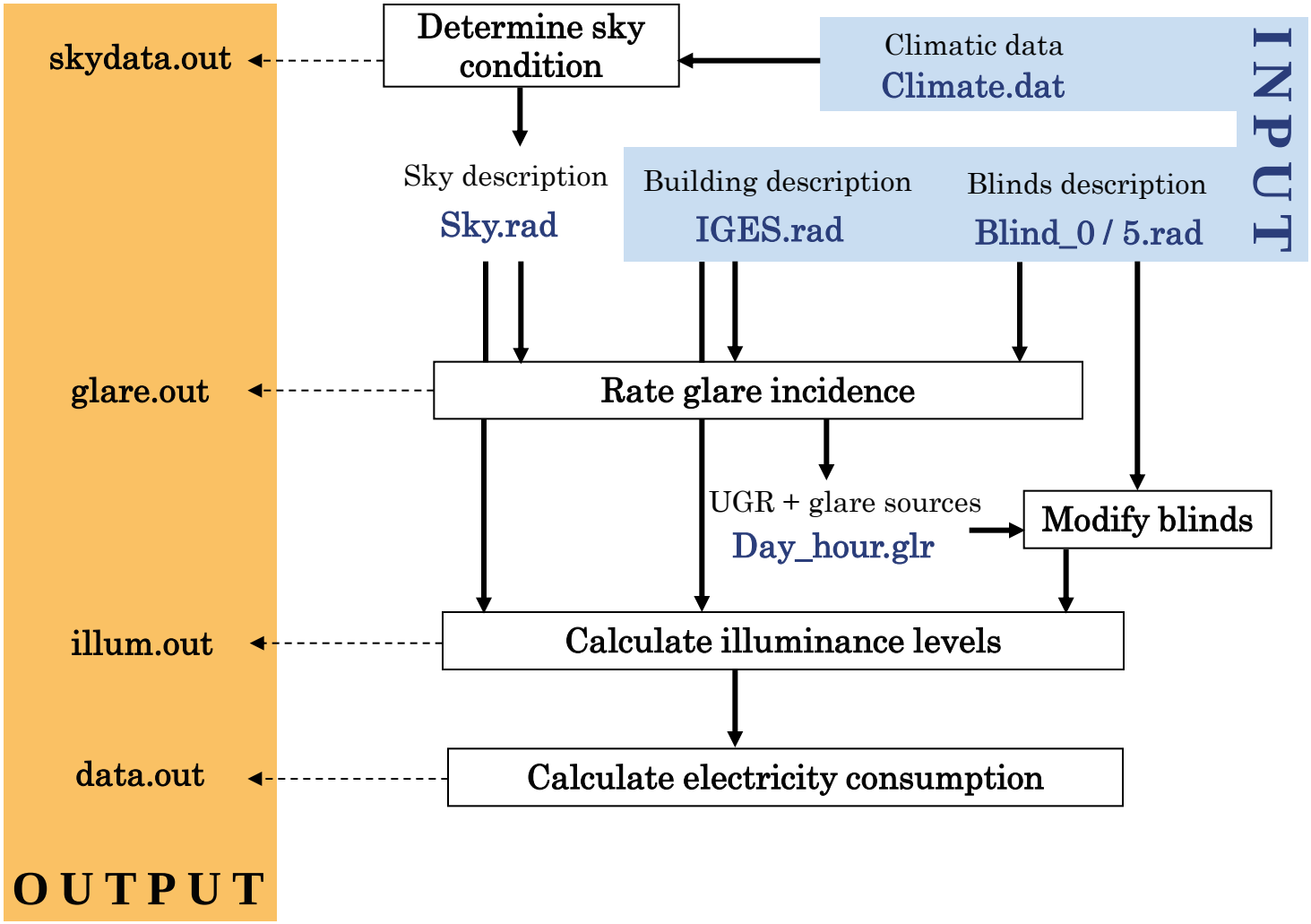
- Sequence in the simulation process (repeated for each hour)



- Glare assessment
- Verification of glare sources
- Modification of blinds position
- Calculation of illuminance values
- Calculation of electricity consump

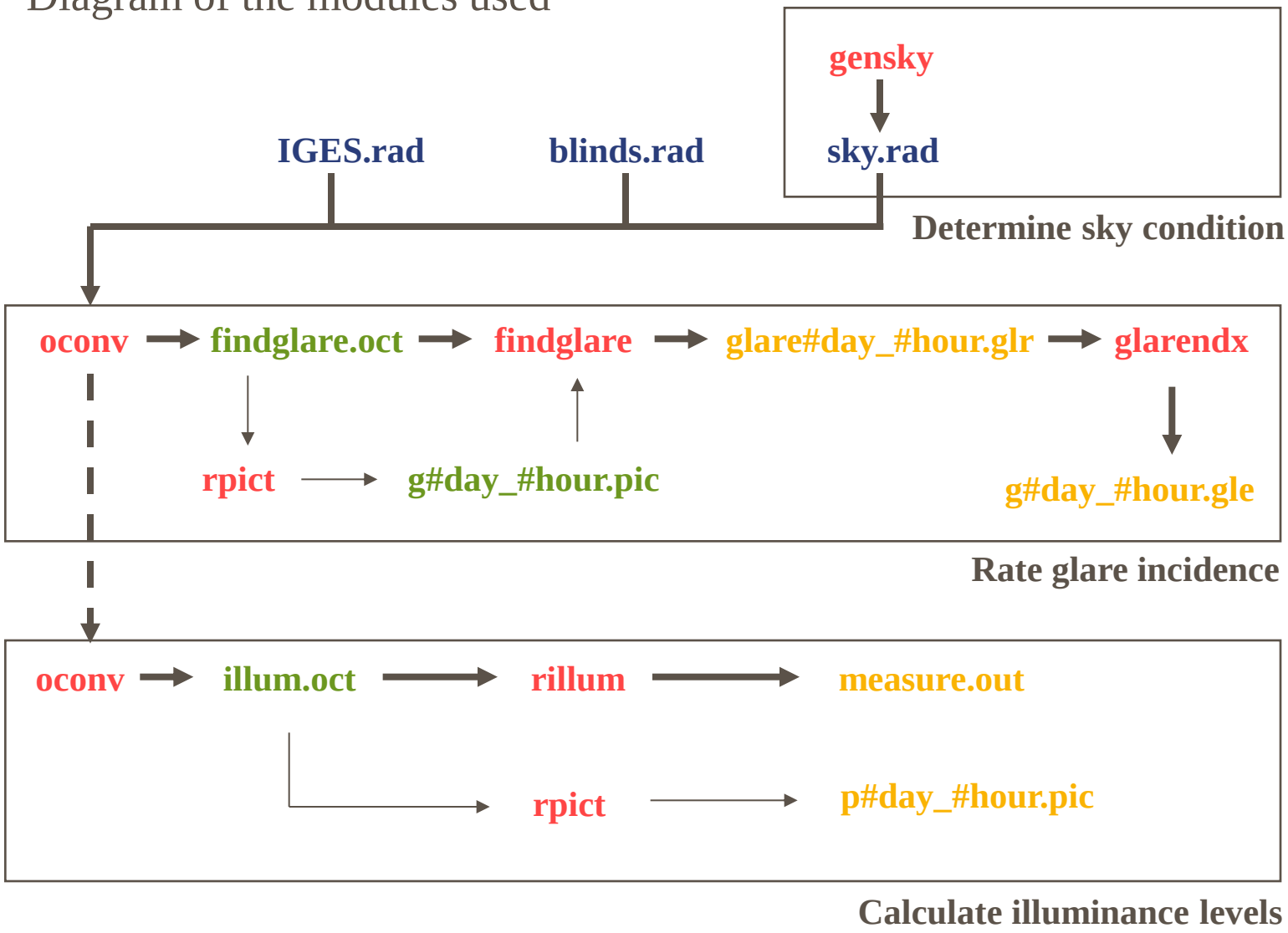
```
#?RADIANCE
findglare -vp 2 5.8 1.5 -vd -1 0 0 -t 6000 -ga 10-70:10 -av .1 .1 .1 findglare.oct
VIEW= -vth -vp 2 5.8 1.5 -vd -1 0 0 -vu 0 0 1 -vh 180 -vv 180 -vo 0 -va 0 -vs 0 -vl 0
FORMAT=ascii

BEGIN glare source
        -0.999111 -0.013333 0.040000  0.146333      8758.838079
        -0.751899 -0.658737 0.026714  0.052349      8017.280019
        -0.784885 0.617347 0.053269   0.033143      6741.591044
        -0.947418 0.000000 0.320000   0.117585      9812.825088
        -0.662042 -0.649863 0.373333  0.013426      14175.594810
        -0.848399 0.249883 0.466667   0.027712      13902.406172
        -0.840480 -0.275346 0.466667  0.025820      14099.565250
END glare source
BEGIN indirect illuminance
        70      2516.027533
        60      2741.833632
        50      2963.398747
        40      3200.358899
        30      3439.329770
        20      3653.850107
        10      3815.299138
        0       3892.450187
        -10     3878.283673
        -20     3776.563295
        -30     3617.793440
        -40     3419.675381
        -50     3204.818327
        -60     2989.049532
        -70     2764.193109
END indirect illuminance
```

Diagram of the Control program

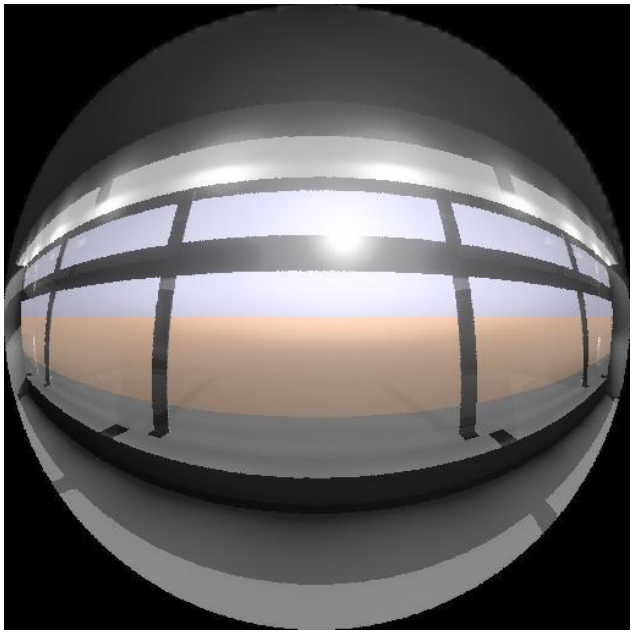


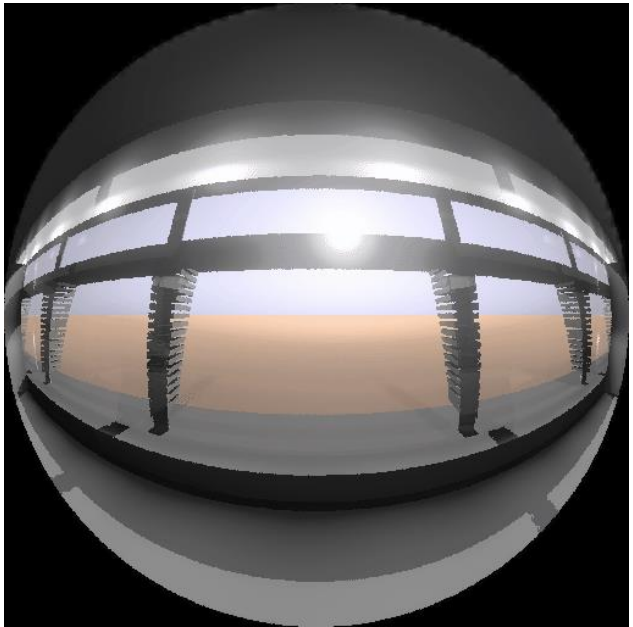
Radiance

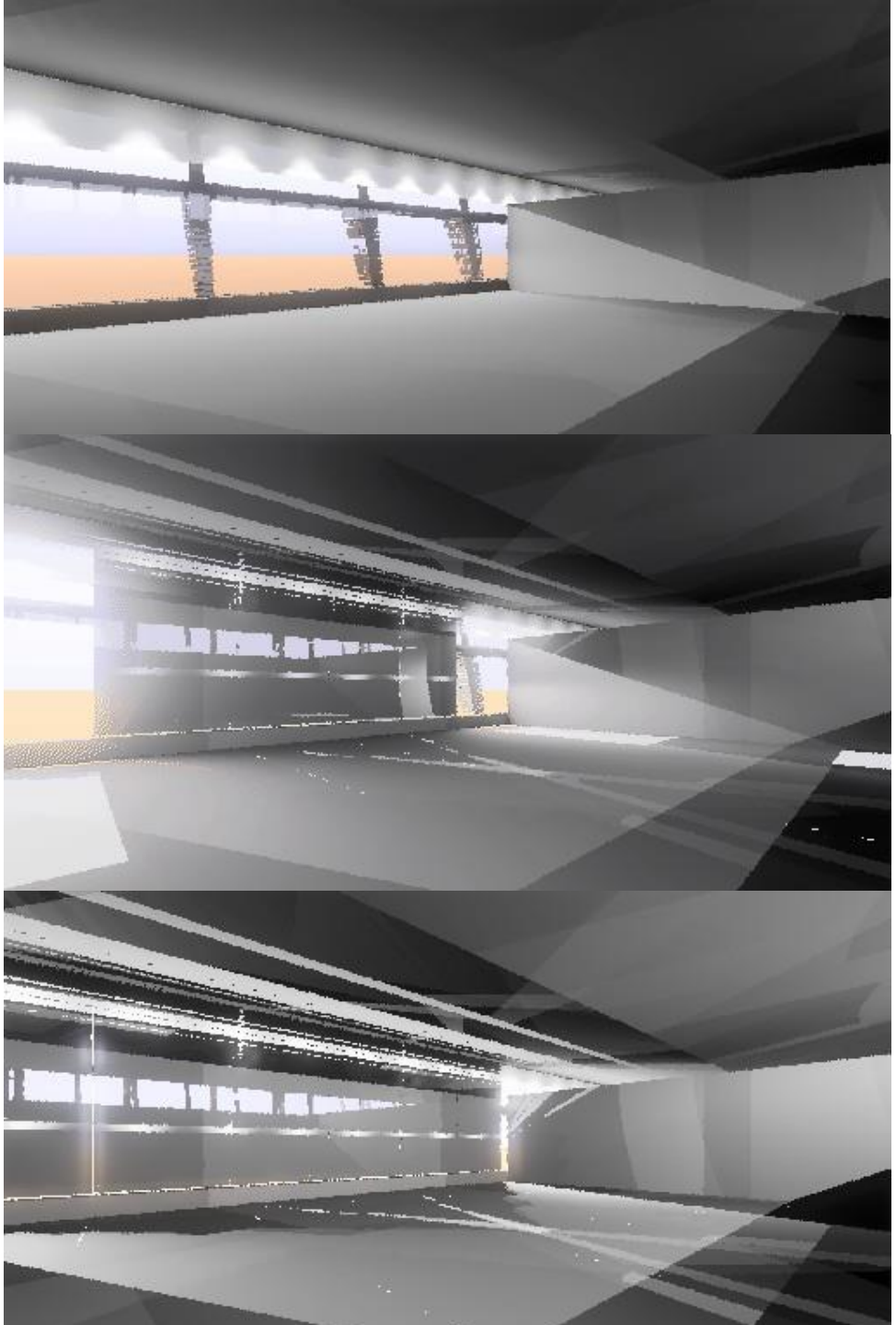
- Diagram of the modules used



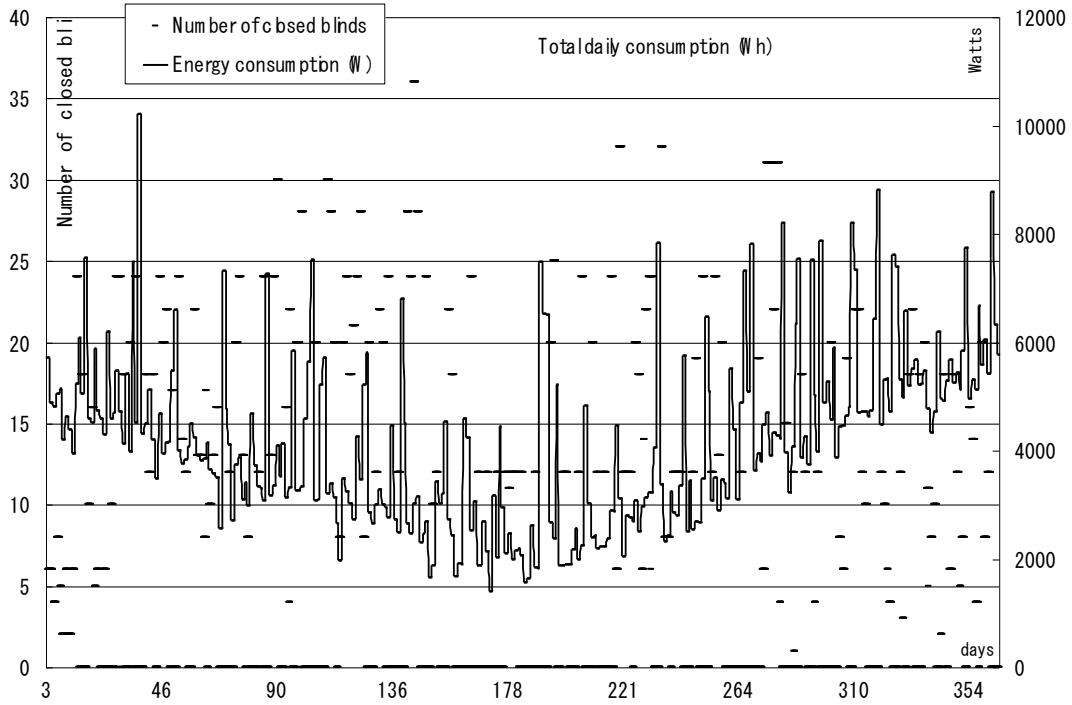
Radiance images



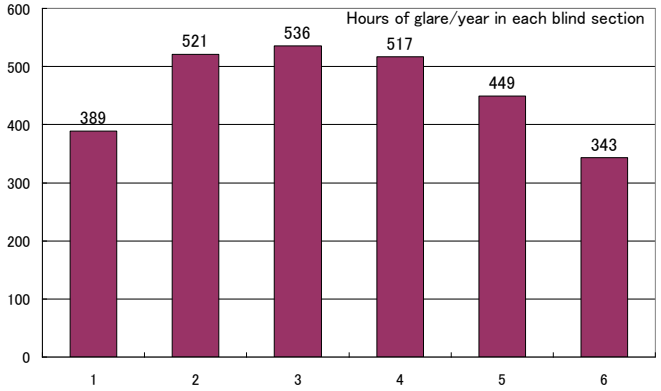




Base case

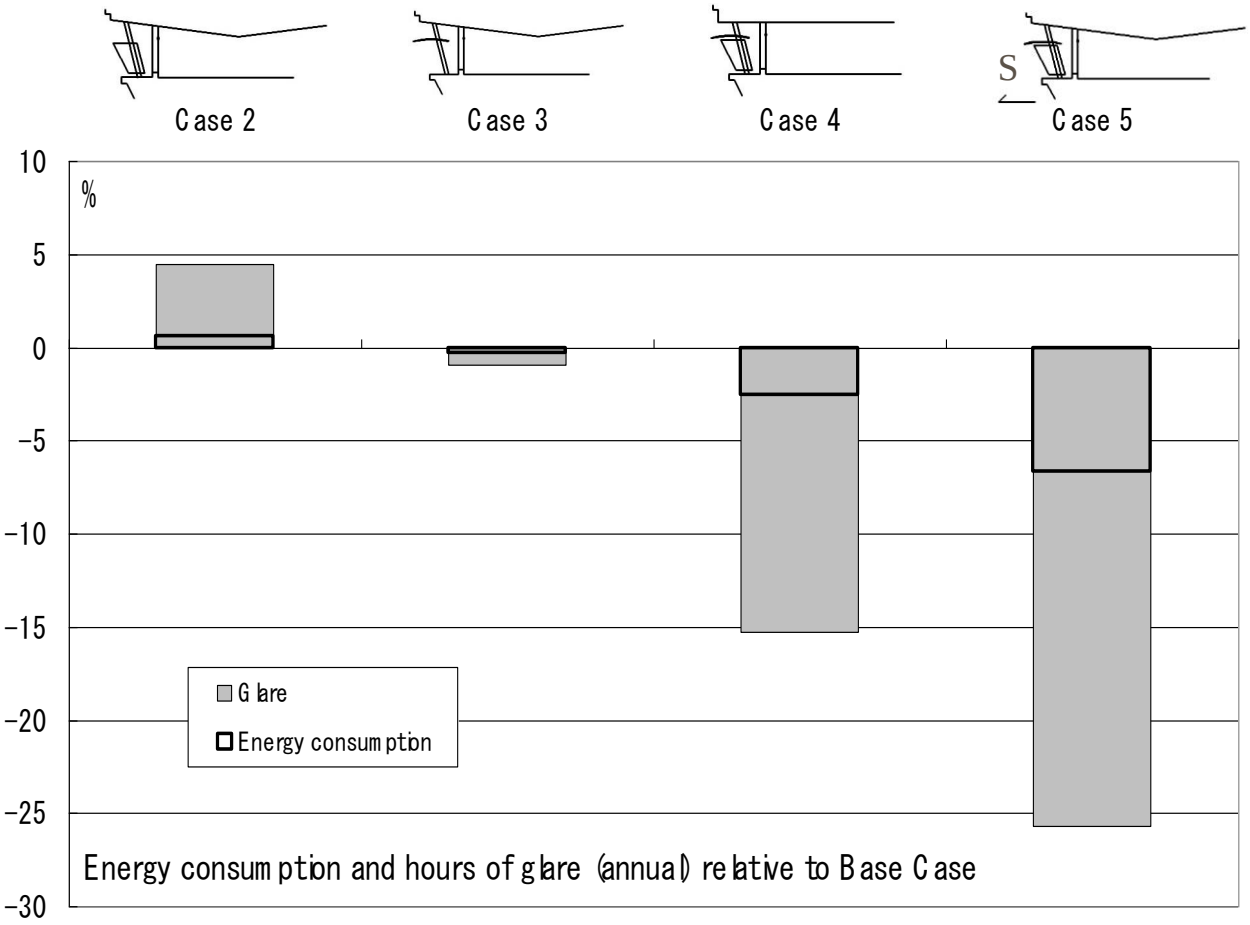


Daily consumption and glare incidence



Annual glare rates

Annual total energy consumption and glare variation with respect to base case



Known problems

- The use of only one observer to assess glare conditions
- The use of UGR, not specific for daylight
- Low quality renderings (computing time)
- Impossibility to determine the sky condition for low solar altitudes
- Differences between the modeled building and the real building
  - All blinds in each room open or close together
  - Daylight sensors are placed every three or four sets of lamps
  - The reflectance of the louvers is much lower
- Differences between simulated behavior of occupants and real occupants (unknown)

Conclusions

- The variation of the glare rates was always related to a variation of the energy consumption.
- The light shelf showed a protective effect without reducing the daylight levels inside the room.
- The horizontal ceiling redirected the light from the light shelf further into the rear part of the room.
- Changing the orientation of the main facade proved to be more effective than other measures.
- Some results were counterintuitive, indicating that glare rates should be considered in energy consumption assessments.
- Further research should include the comparison of this methodology with real operating conditions, especially regarding the behavior of real occupants.