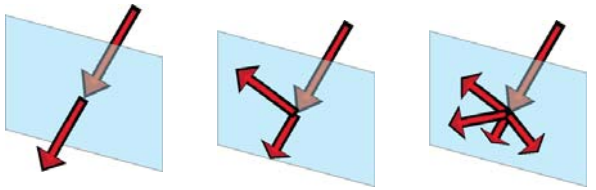
From research tools and instruments to lighting retrofit practice

Jérôme KAEMPF

Bernard PAULE

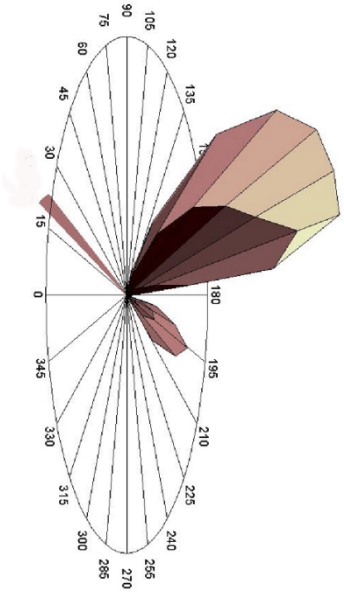
GERONIMO: BTDFs and Radiance

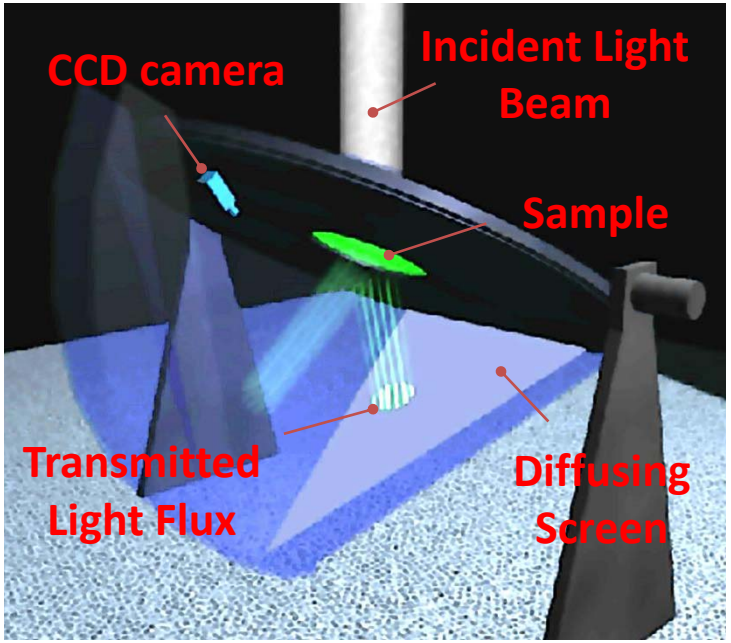
Introduction	Method	Examples	Conclusion



Complex Fenestration Systems (CFS) & LESO-PB's Goniophotometer

© Baumann-Hüppe





CFS → solar shading systems and light redirecting systems
May be used in building retrofit to improve the penetration of daylight
Reduction in electric consumption due to artificial lighting

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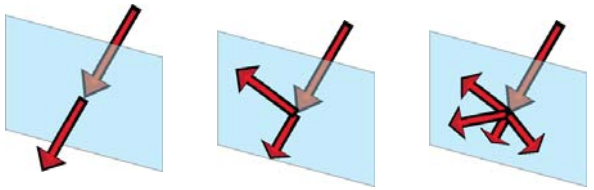
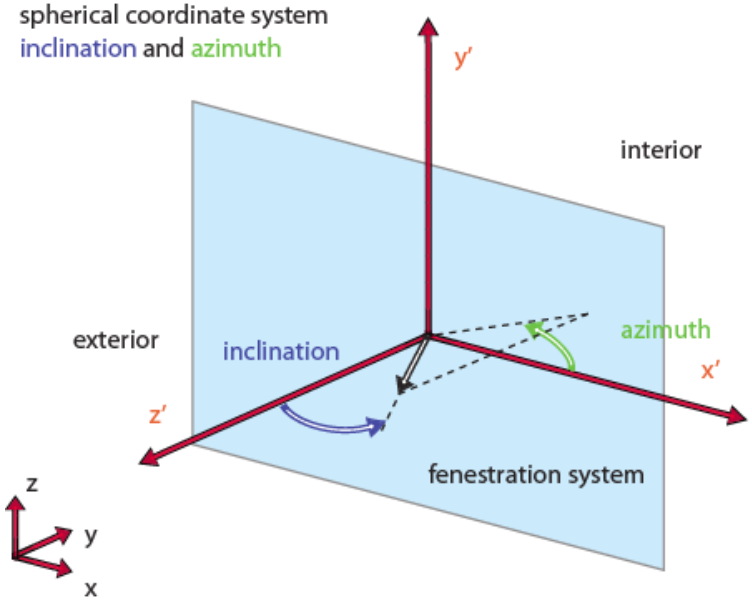
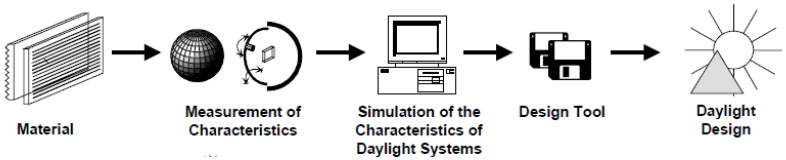


IEA Task 21 format (2000)






```
#material: sun directing glass (Lumitop)
#manufacturer: Vegla
#Isym=3 ! symmetry indicator: 0 no symmetry (phi_1 = 0°...360°)
#       1 rotary symmetry (only for one phi_1)
#       2 symmetry to phi=0°  and phi=180° (phi_1 = 0°...180°)
#       3 symmetry to phi=90° and phi=270° (phi_1 = -90°...90°)
#       4 symmetry to phi=0° & phi=180° and to phi=90° & phi=270°
(phi_1=0°...90°)
#measurements done at TU Berlin Fachgebiet Lichttechnik, TUB
#measurements and processing by Berit Herrmann, Sirri Aydinli
#date of measurement: 29. September 1998
#contact aydinli@ee.tu-berlin.de  for details
#light incidence:
#phi_1: 0° (azimuth)
#theta_1: 0° (altitude)
#light transmittance: 0.45
#data
#phi_2          theta_2          btdf
0.000000e+000    9.590000e+001    2.497359e-002
0.000000e+000    9.940000e+001    2.619607e-002
0.000000e+000    1.028000e+002    2.703650e-002
                    ...
0.000000e+000    1.437000e+002    6.901417e-002
END
```

Storage of the transmission properties (BTDF) of CFS in text files

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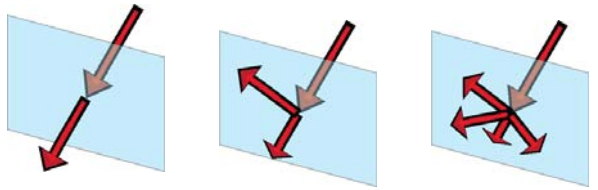
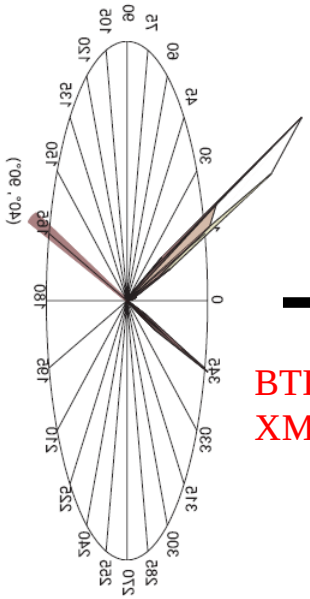


SFOE project (2010-11) to use BTDF data with Radiance in XML format

Laser Cut Panel

IEA21
Text format



BTDF2RADIANCE
XML format

2010: mkillum pre-process
2011: bsdf material

RADIANCE: open source, physically correct
Using an XML file format to describe the BTDF

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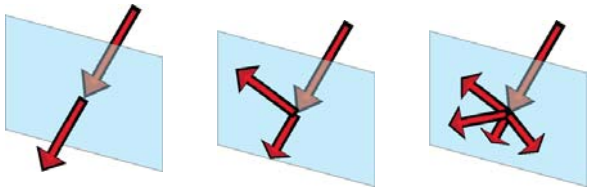
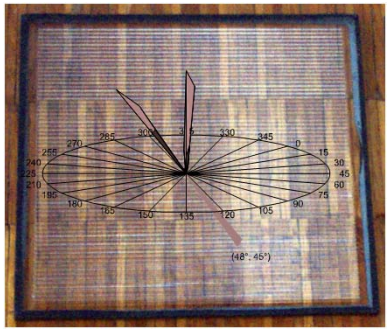
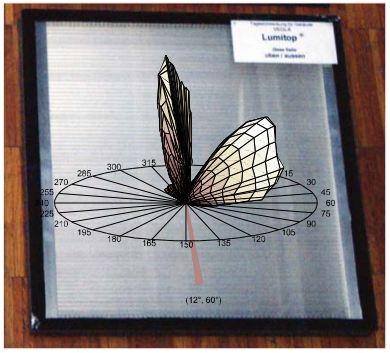


winter solstice | equinox | summer solstice

Laser Cut Panel



Lumitop



Renderings of fully measured CFS samples

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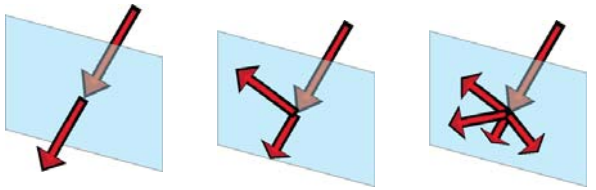
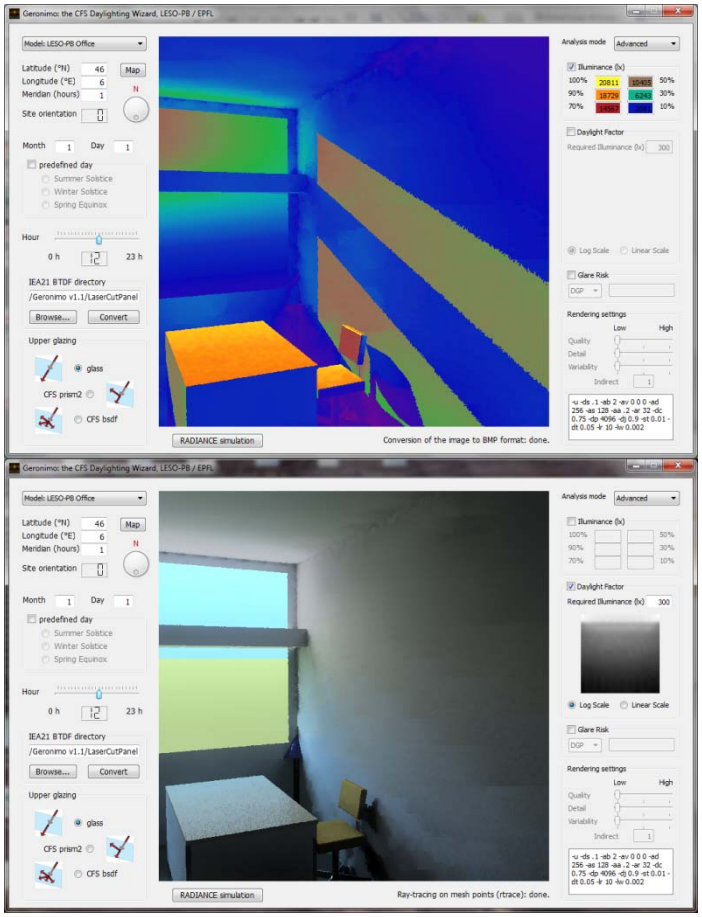
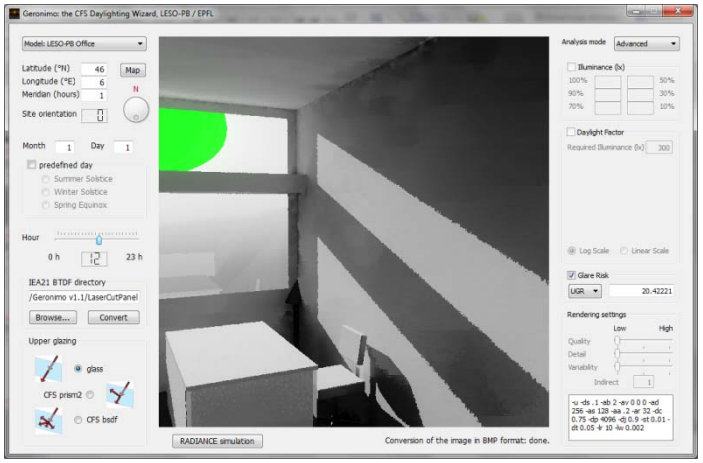


Set-up of a Graphical User Interface (GUI) for non-experts in Radiance





Easy daylight analysis
- Illuminance calculation
- Glare Indices determination
- Daylight Factor calculation

May be used for daylight retrofitting

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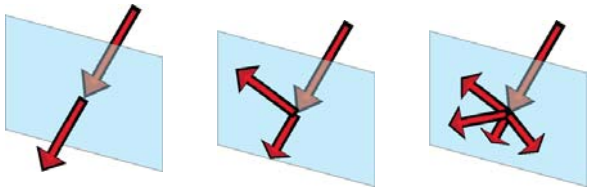
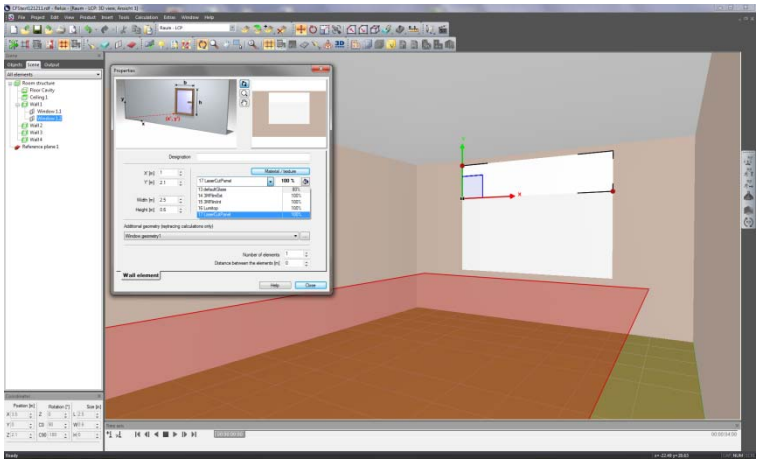
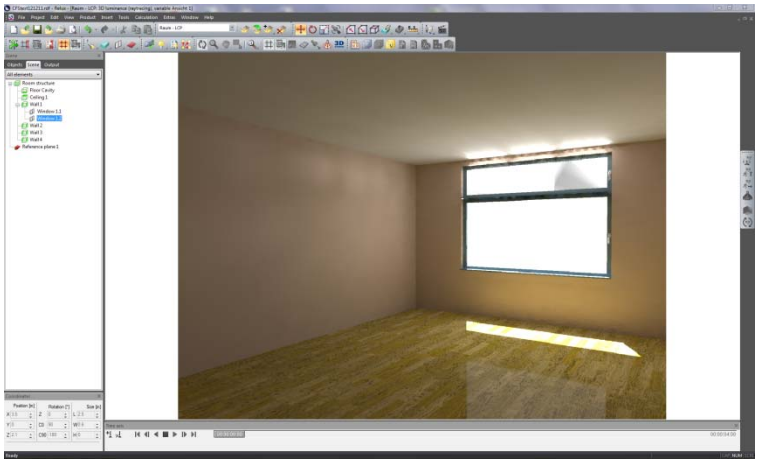


Collaboration with RELUX – integration of the procedure in Relux Pro





Choice of CFS equivalent to a luminaire

- Database of products
- Assignation to a window
- Rendering & DF calculation

May be used for daylight retrofitting

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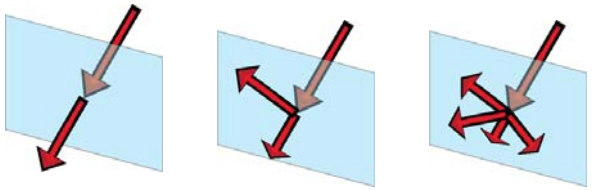
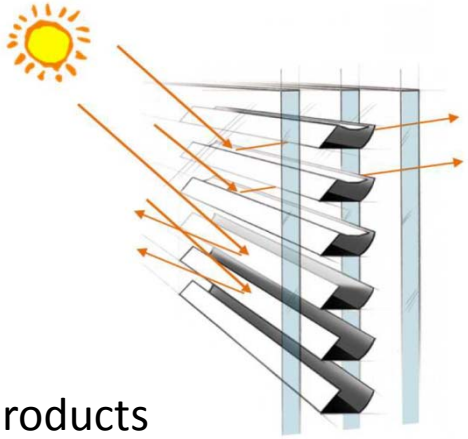


Industrial phase – measurement protocol

Facts

- Limited number of CFS available in the database (3) for Geronimo & RELUX
- Demands from manufacturers to be in the database



Okalux
Okasolar products

Solution

- A "production phase" measurement procedure for CFS with LESO-PB's goniophotometer
- Introduce the newly measured products in the existing database
- Promote the use of new CFS for retrofitting buildings & greenlighting

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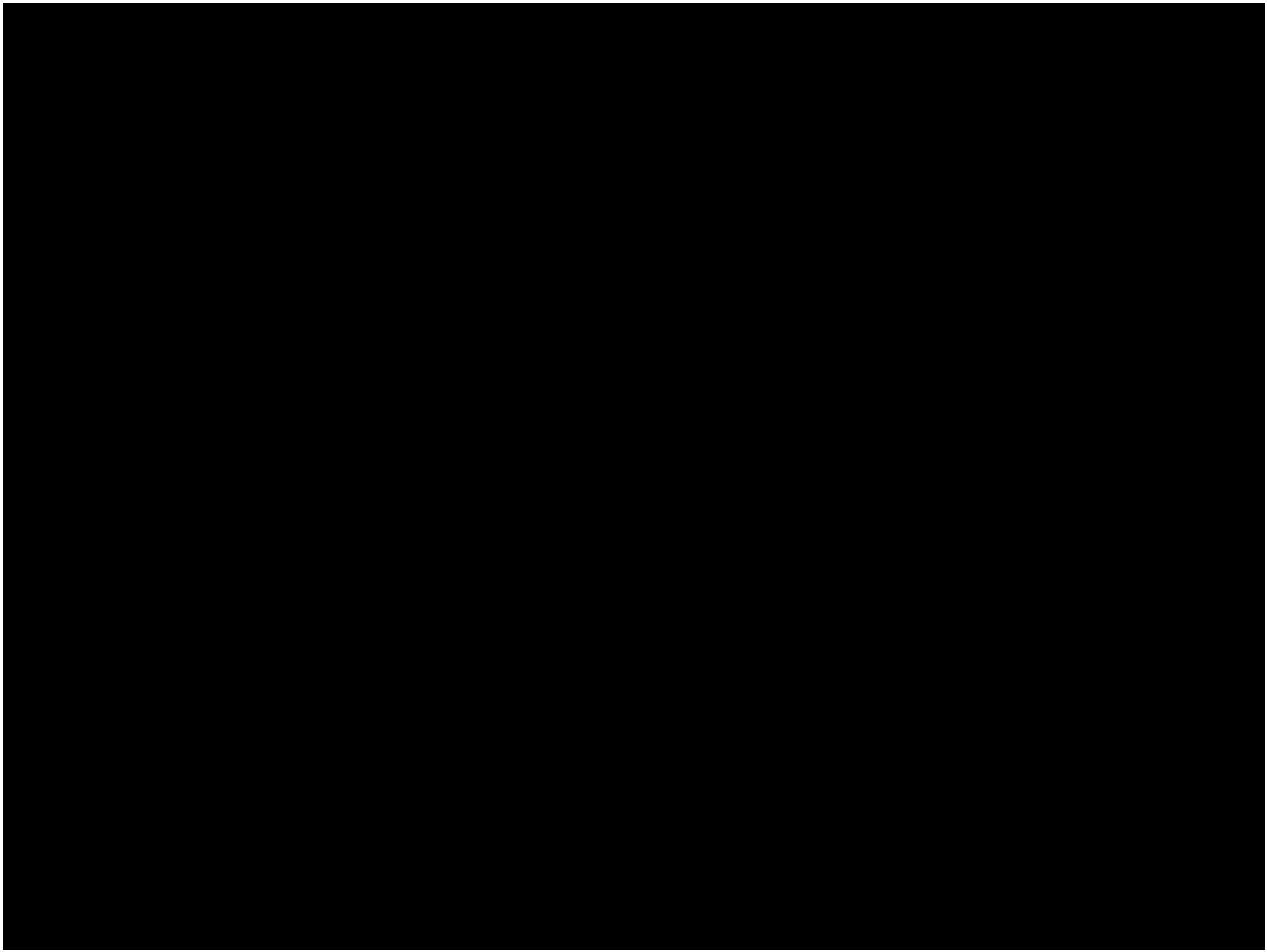
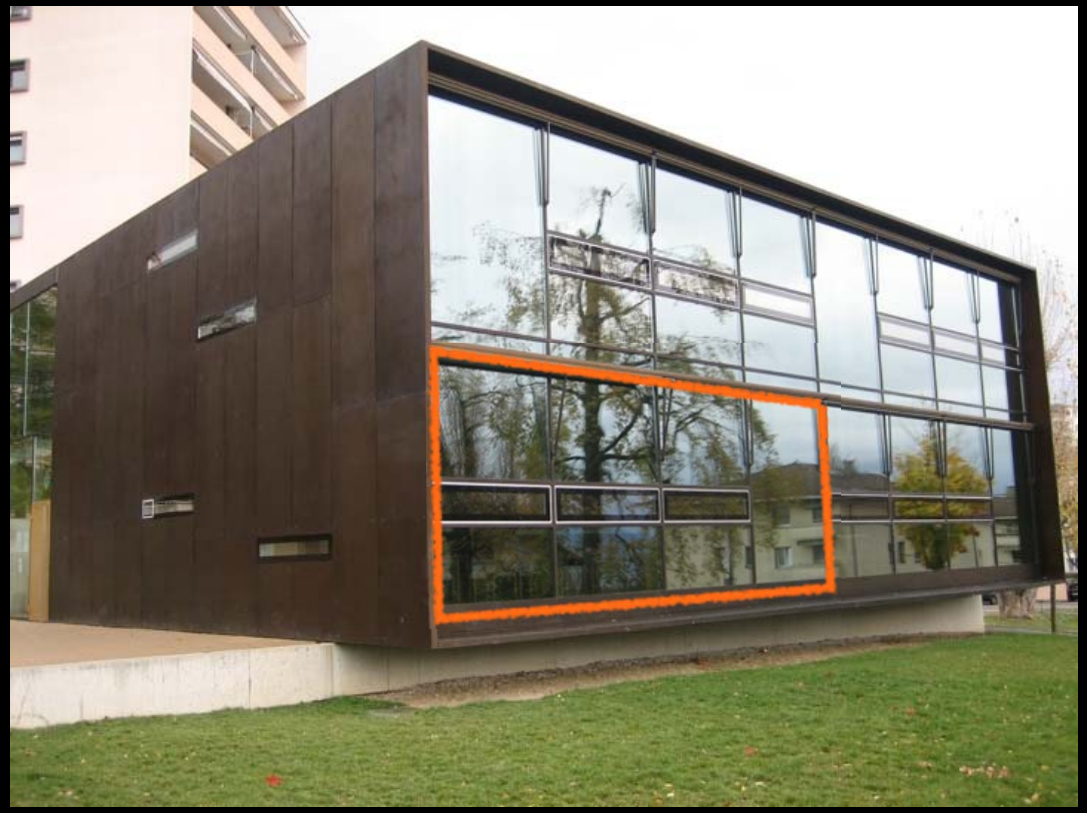


We have to view the opening as a global system

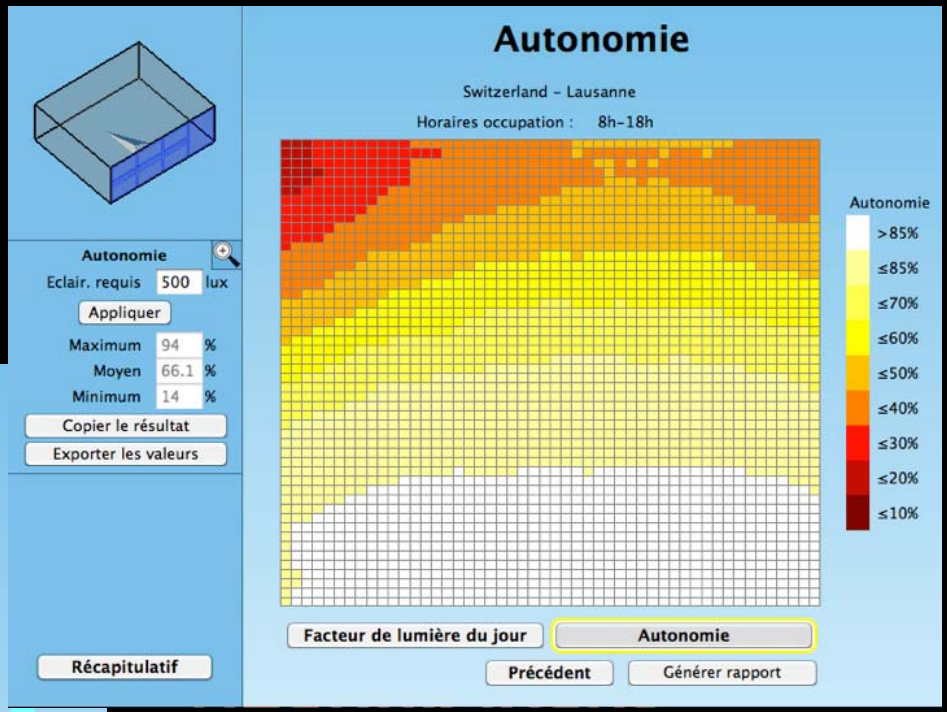
One unique tool to optimize the energy flows

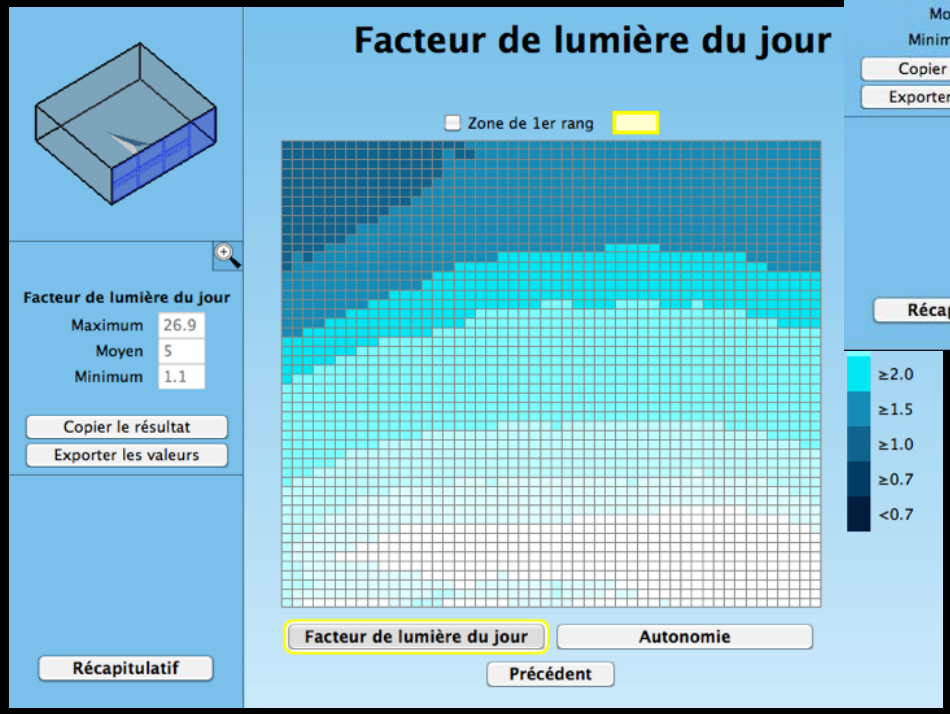
A global window approach



Daylighting

Daylighting
Reference case

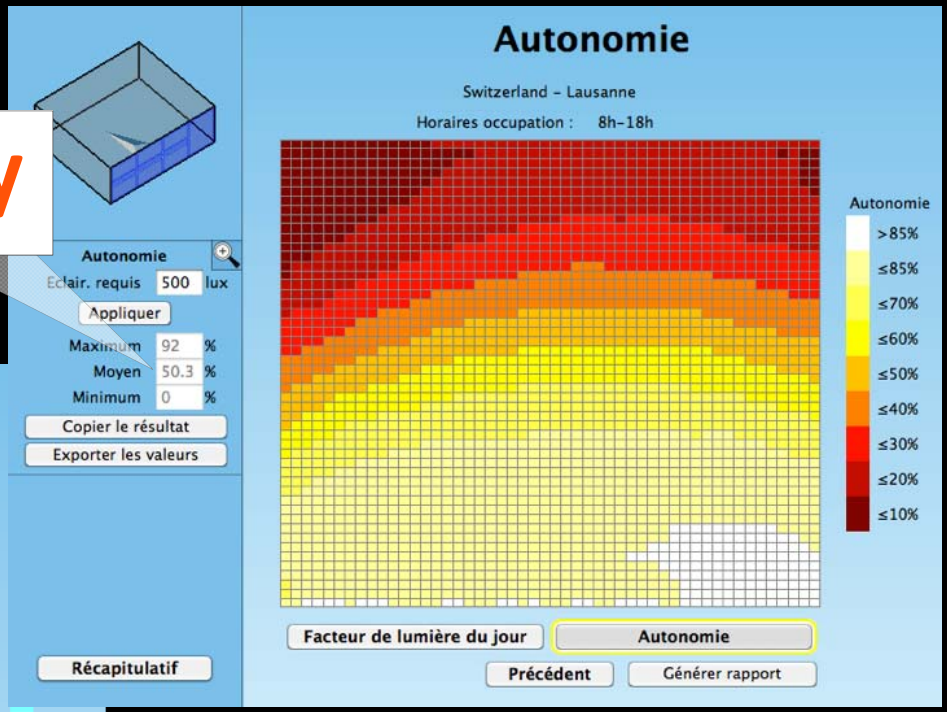


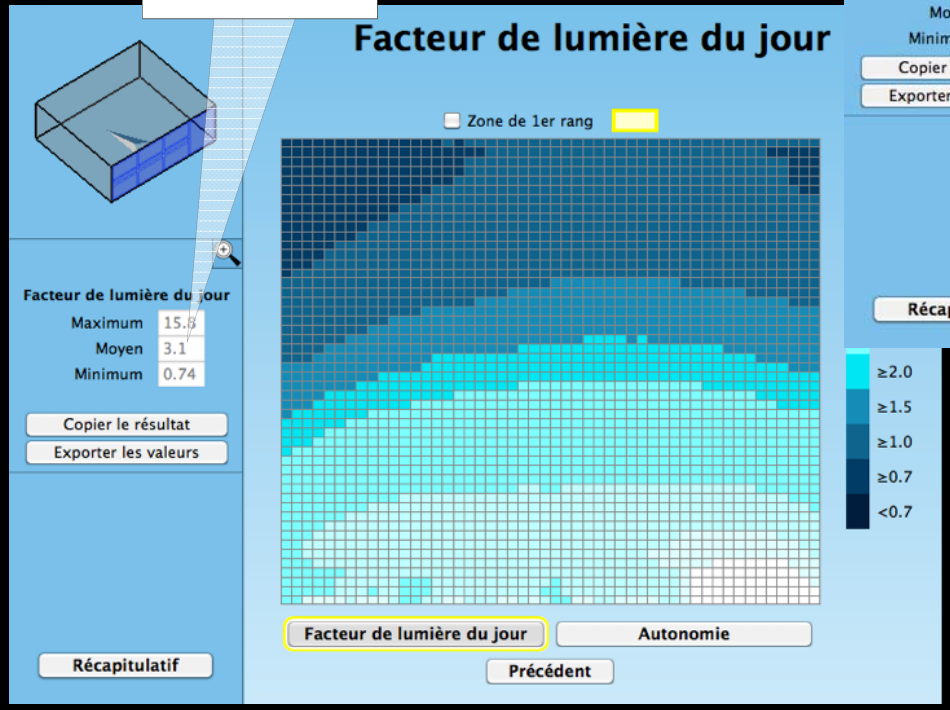


Daylighting
Reflective coating

+450h/y

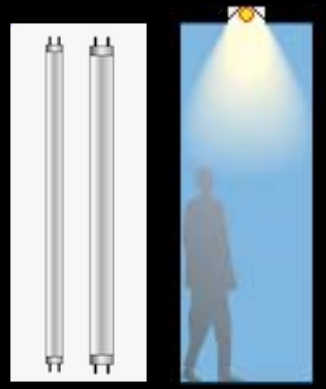
-38%





Artificial lighting

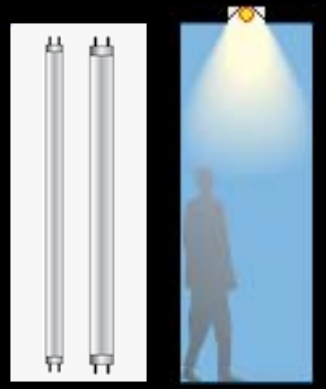
Artificial lighting
Reference case



RESULTATS

Puissance spécifique	12	W/m²	
Autonomie diurne	64	%	SIA 380/4
Heures à pleine charge	1844	h	
Consommation annuelle	**21.8**	**kWh/m²**	

Artificial lighting
Reflective coating



RESULTATS

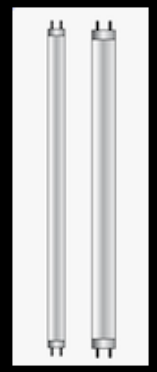
Puissance spécifique	12	W/m²
Autonomie diurne	43	% SIA 380/4
Heures à pleine charge	2607	h
Consommation annuelle	**30.8**	**kWh/m²**

30.8 >>

5.6 Valeur cible | 9.3 Minergie | 20.4 Valeur limite

+41%

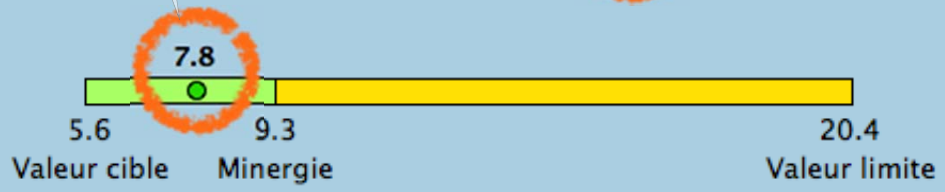
Artificial lighting
Auto Shut-off (ref. case)



-64%

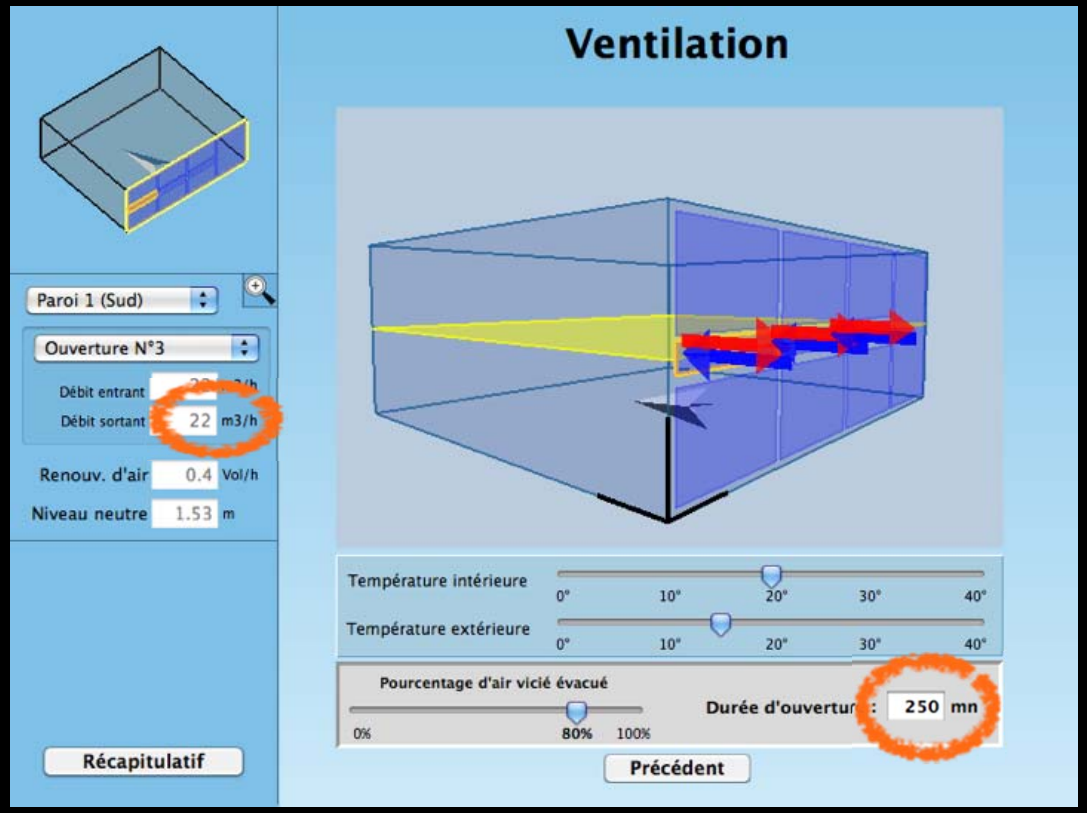
RESULTATS

Puissance spécifique	12	W/m²
Autonomie diurne	64	% SIA 380/4
Heures à pleine charge	663	h
Consommation annuelle	**7.8**	**kWh/m²**



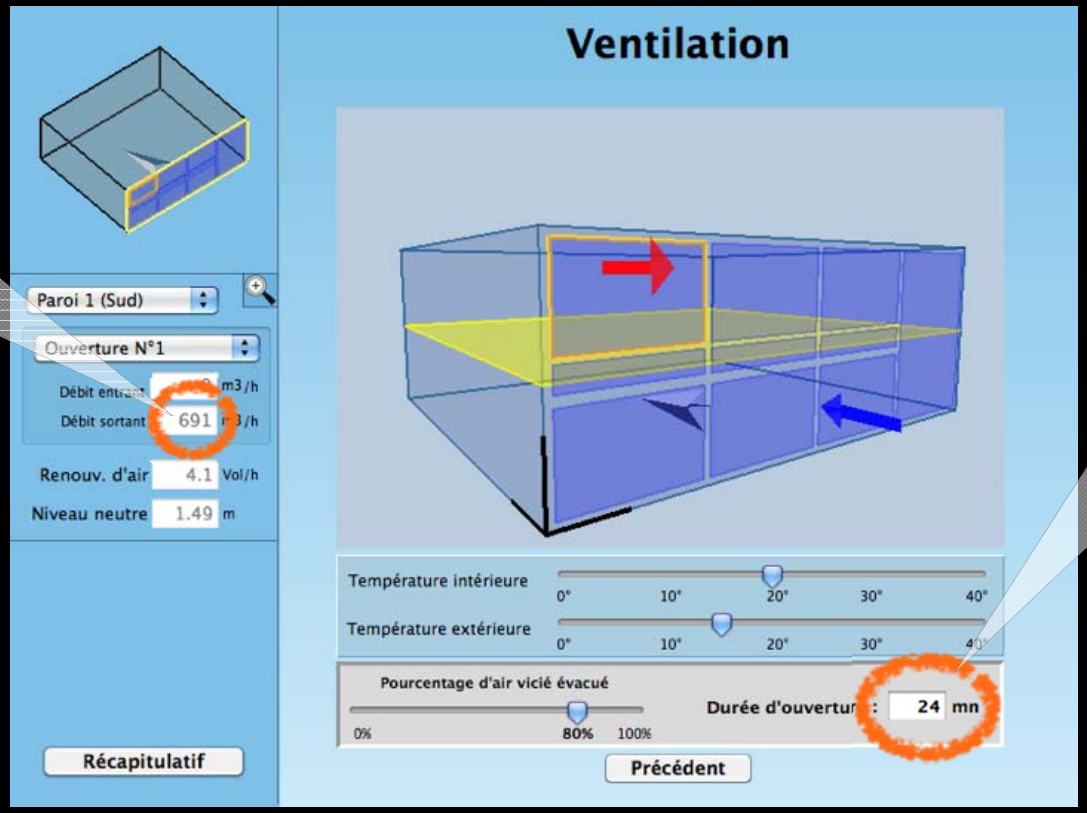
Natural Ventilation

Natural ventilation
Reference case



Natural ventilation
Up+ Down Openings

x 30



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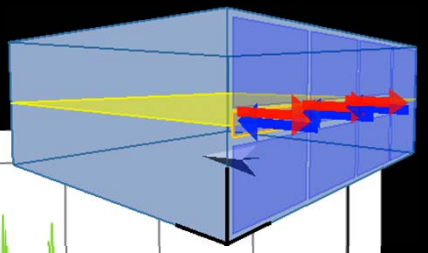
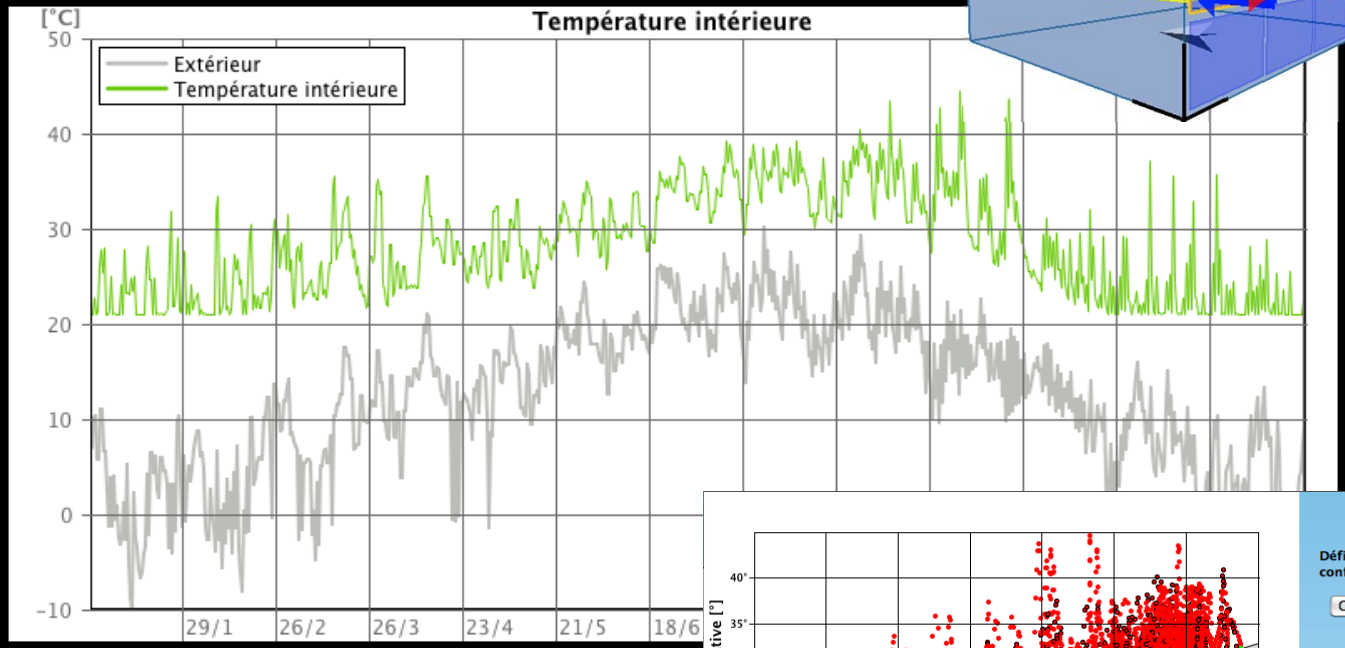
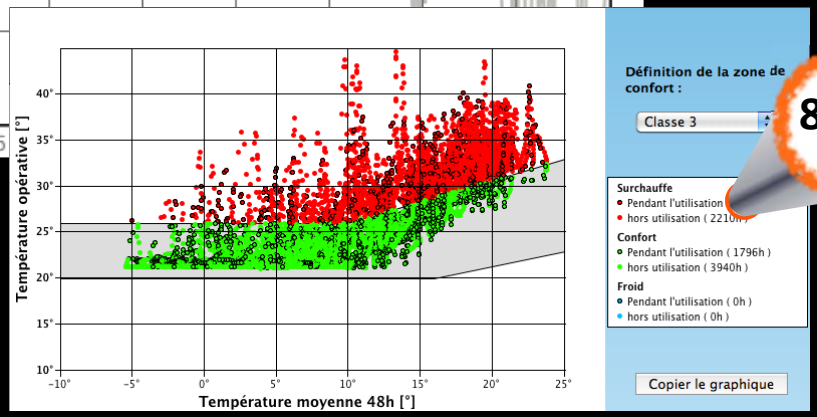
Overheating risks

Overheating hours
Reference case

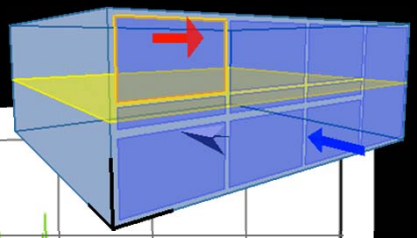


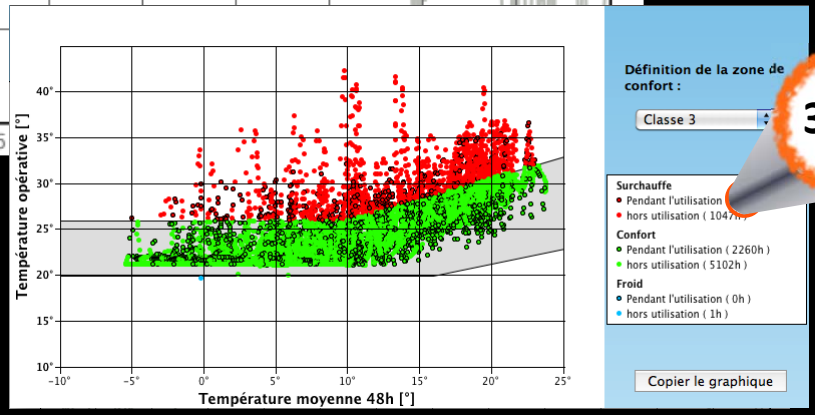




814h

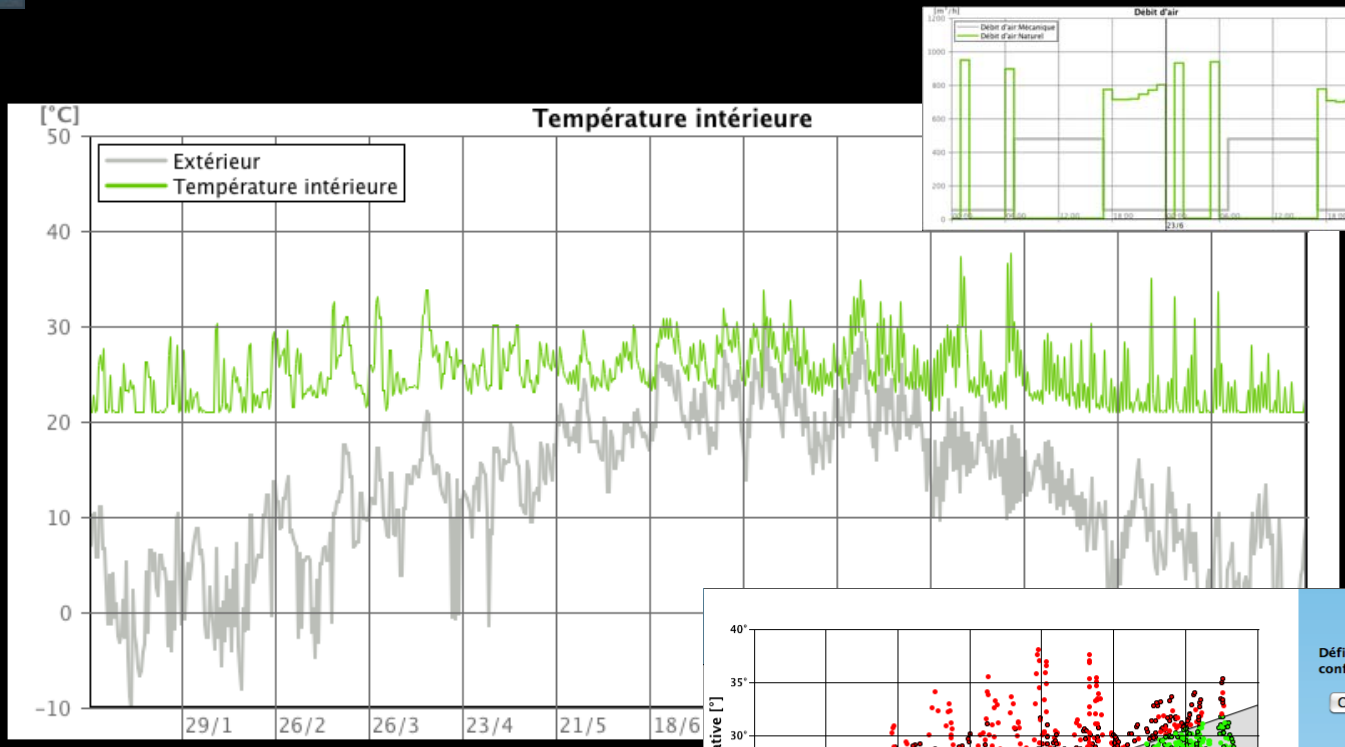
Overheating hours
Up + Down Openings

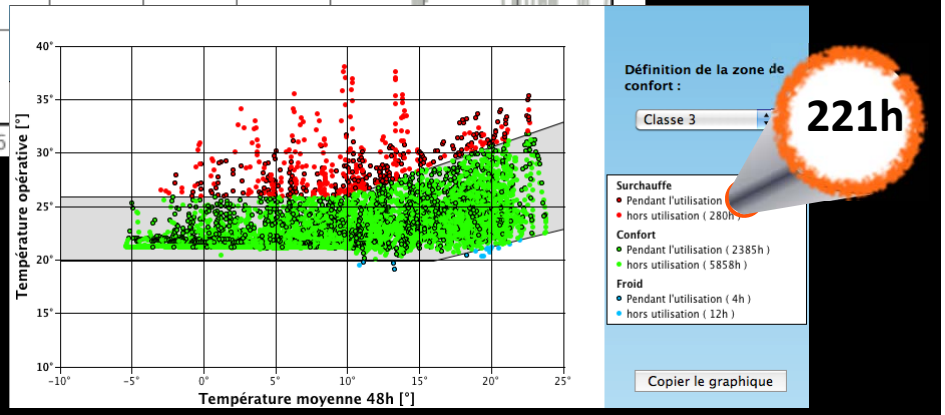




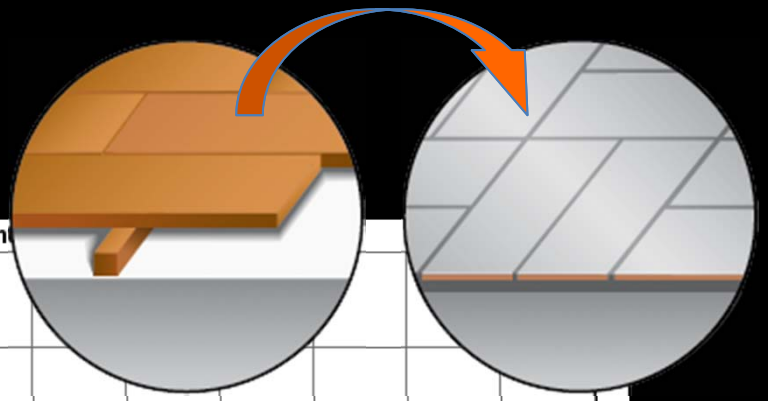
350h

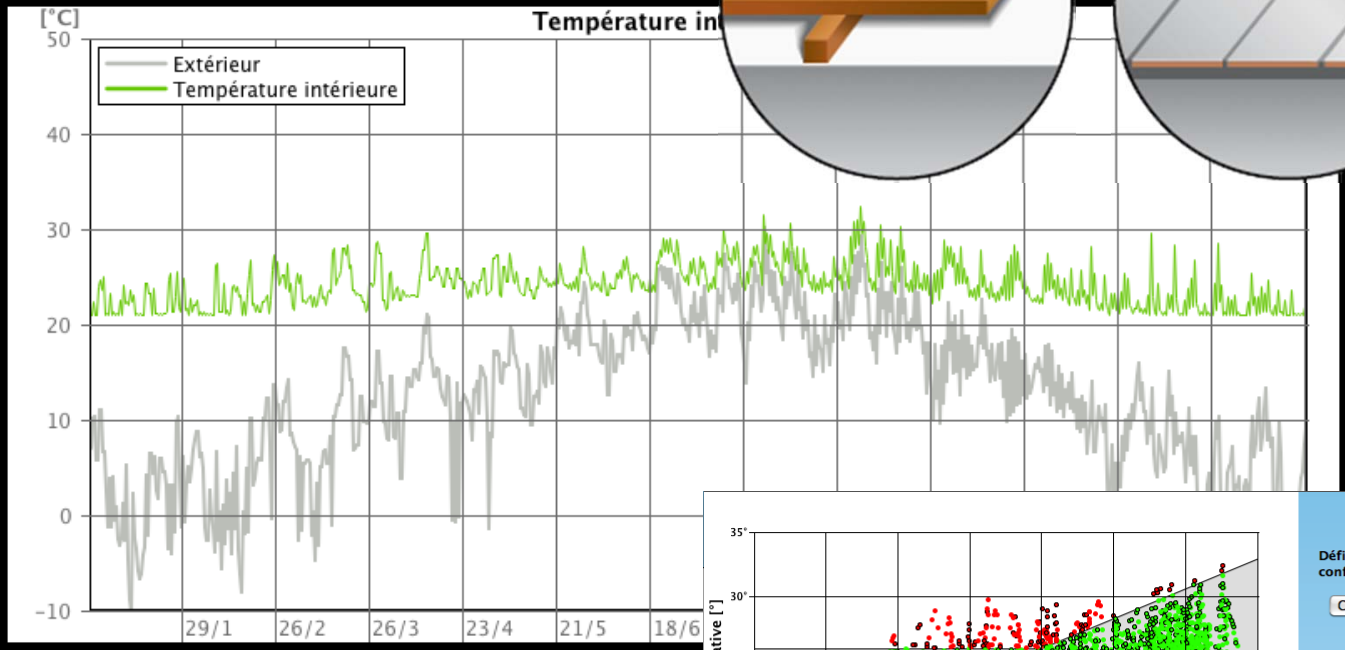
Overheating hours
Night Ventilation

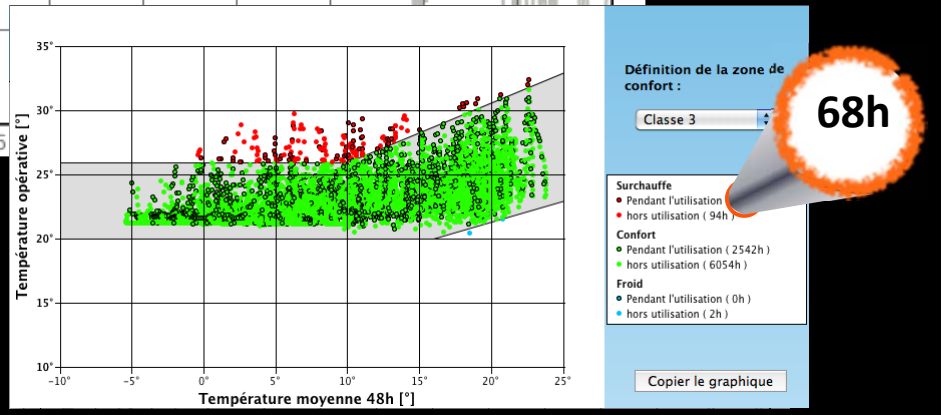




Overheating hours
Thermal mass

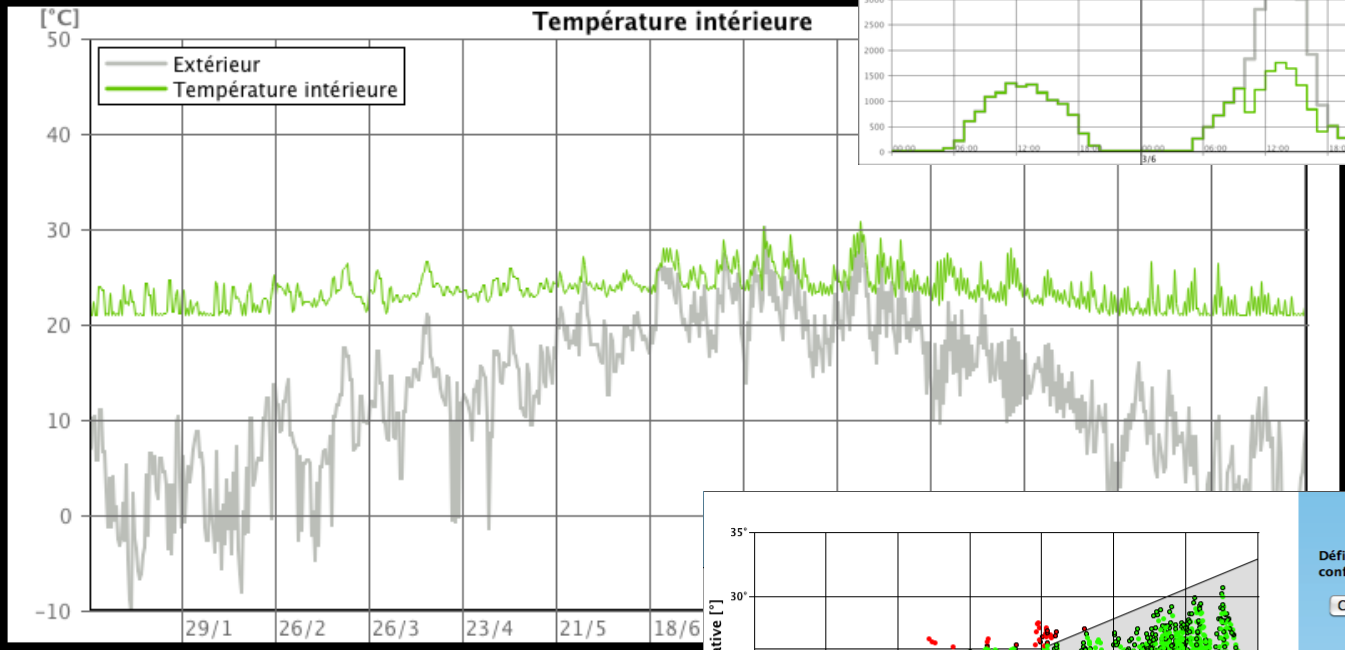


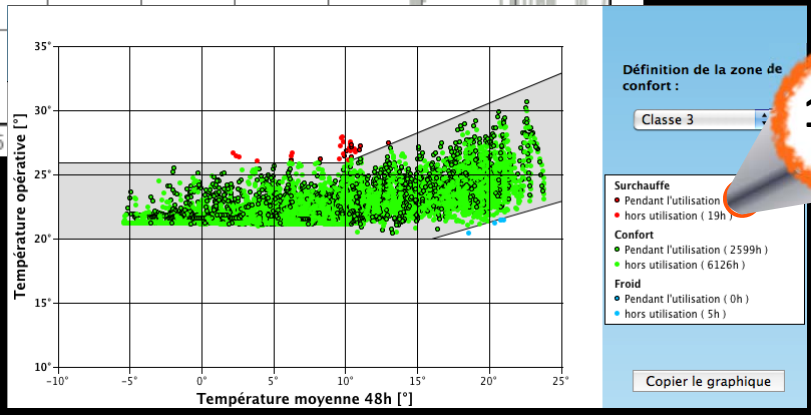




68h

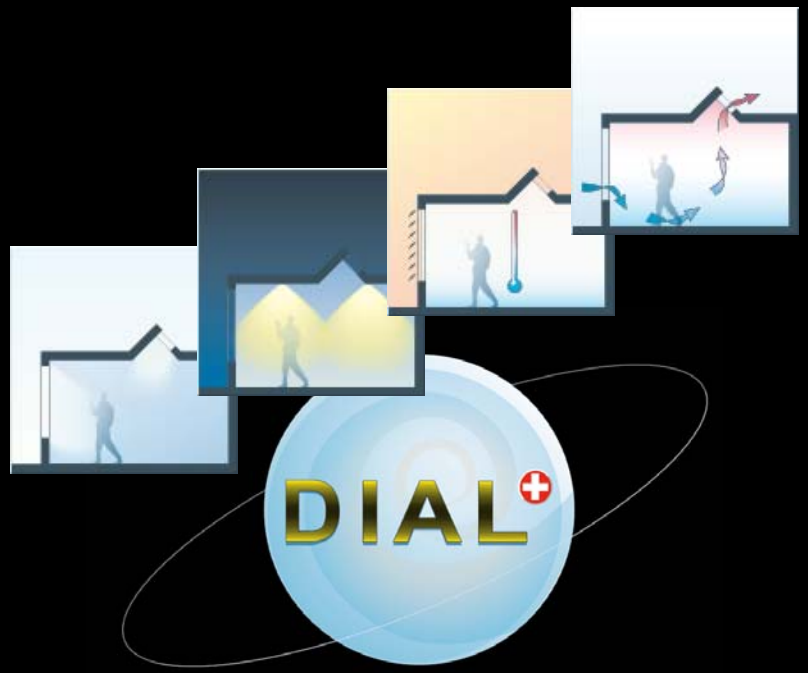
Overheating hours
Automated shading





11h

Complex simulation is now affordable for designers



It is well adapted for decision making in the retrofit process