innoviris.brussels
empowering research

L.2.3.2 | Production et adaptation des métadonnées des sites démonstrateurs

Spécifications relatives au site Printemps

RUE DU PRINTEMPS, 49-51, IXELLES, 1050, BELGIUM

S. Hinque (UCL) – D. De Grave (UCL) - G. Masy (UCL)

02.03.18

Entreprises Jacques Delens
Avenue du Col-Vert, 1 B-1170 Bruxelles
T : + 32 2 566 96 96 | F : + 32 2 566 97 00
M : ejd@jacquesdelens.be | www.jacquesdelens.be
TVA : BE0400 471 428

UCL, Architecture et Climat
Rue Place du Levant, 1 bte L5.05.02 B-1348 Louvain-La-Neuve
T : + 32 10 47 21 42
M : climat@uclouvain.be | www.climat.arch.ucl.ac.be
TVA : BE0419 052 272

Table Of Contents

1. GENERAL INFORMATION

1.1. Introduction

The present document collects all the notes, information and steps concerning the experiment undertaken within the framework of the project *Cam(b)bridge*. Those specifications are presented with a dual purpose: sharing data sets enabling modellers to validate their simulation models and also describing the information and process of the experiment to make future measurement campaigns easier and more efficient.

This research project is leaded by *Architecture & Climat* from *UCL University* and *Jacques Delens s.a. Company*. The purpose of the initiative is to develop methods that can be applied on site during the construction phase to assess the actual performance of buildings at a moment when it can still be improved to reach the target without entailing over costs. The measurements are performed in summer, during 9 days without occupancy.

1.2. The Student Housings [SH]

The experiment was undertaken on students housing, located in Ixelles, a part of Brussels in Belgium. The construction, carried out by "*Jacques Delens s.a.*" [JD], includes 102 student housings.

This 3 storeys construction is composed of two major bars separated by a vegetated courtyard. The bar containing the tested SH's is South-West oriented, providing a sufficient amount of sun for the experiment.

Figure 1 : Site Printemps

Figure 2 : Student Housing Project, 3D visualization from interior yard

Figure 3 : View from unit AI balcony towards interior yard, during construction work

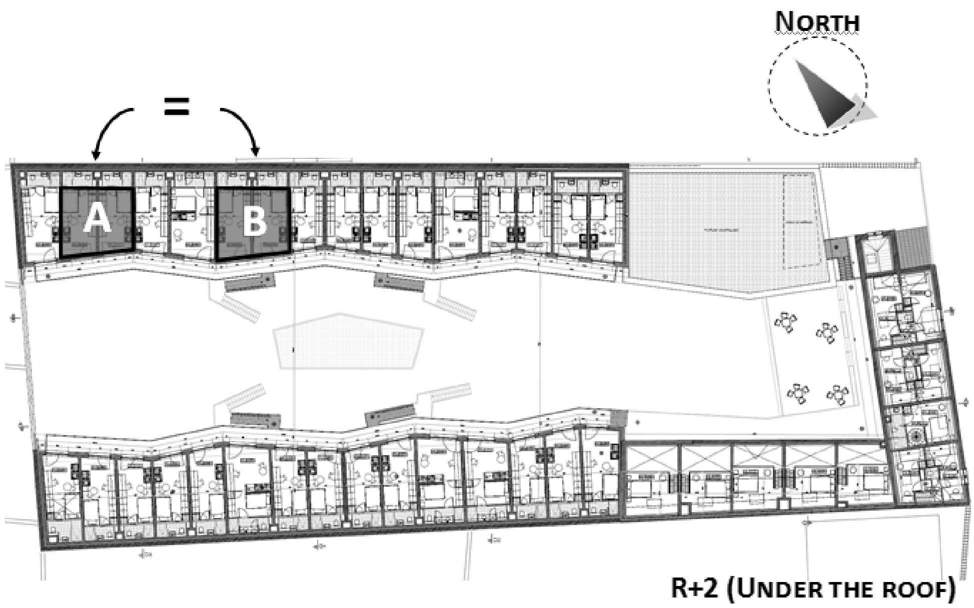


Figure 4 : Project layout with units A and B under study

The experiment has been undertaken in two pair of identical student houses, separated by a block of two units. The tested units are located on the third floor under the roof. Two units (AI and BI) have been covered by insulation panelson the indoor side of the shared party walls (party floor and vertical party walls, roof excluded). The 4 units are named “AI”, “AU”, “BI”, “BU” according to their location (A or B) and the presence “I” or the absence “U” of indoor insulation panels. AI and AU units are respectively identical to BI and BU units.

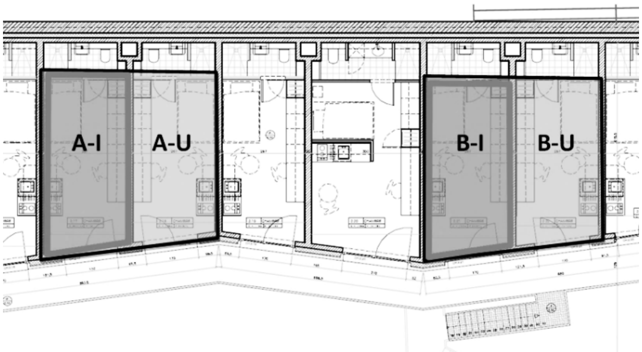


Figure 5 : Layout of tested units

Figure 6 : View from entrance of one tested unit (AI), interface sensor setup before the placement of insulation panels

2. EXPERIMENT

The conventional measurement procedure for the assessment of the Heat Loss Coefficient (HLC) is based on a coheating test. The coheating test is currently limited to winter month, as a significant internal-external temperature difference is needed. We intend to expand the time window allowable for the assessment of the Heat Loss Coefficient (HLC) by performing measurements in summer. Measurements on *Printemps* units were performed from 08/06/2017 to 21/06/2017.

The measurement have been realized in identical units in parallel, in order to compare a co-heating test to a method based on the observation of the floating indoor temperature. A reference value of the HLC can be obtained by comparing the input powers and the difference of internal temperatures measured in two parallel identical units, one submitted to coheating and the other being in floating temperature mode, as they are submitted to identical solar heat gains (Figure 7).

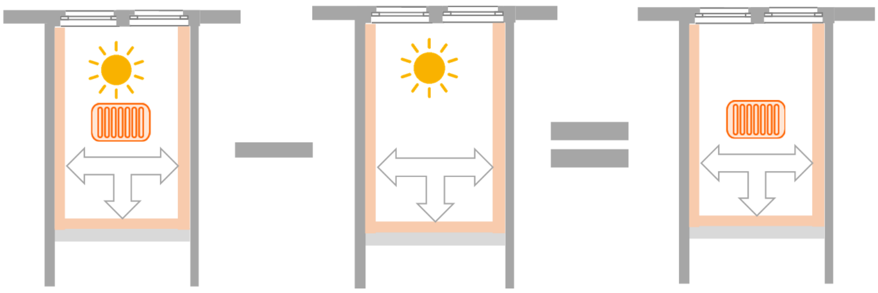


Figure 7 : Analysis process considering the temperature difference between two identical units provided with inside insulation panels: one of the unit is co-heated while both are submitted to identical solar heat gains

The heat loss by common walls and floor, shared with adjacent units, is hardly assessed as the surrounding spaces of the units are not accessible. The placement of internal insulation on party walls allows to focus on the determination of the heat loss coefficient of the external façade as it reduces the heat losses to neighbouring units and the thermal mass effect of party walls and floors. Moreover, the setup allows to reach higher values of internal temperatures in order to reach a sufficient internal-external temperature difference. Temperatures at the interfaces between inner insulation and original walls were monitored with temperature sensors, to assess the heat flow through the insulation layers.

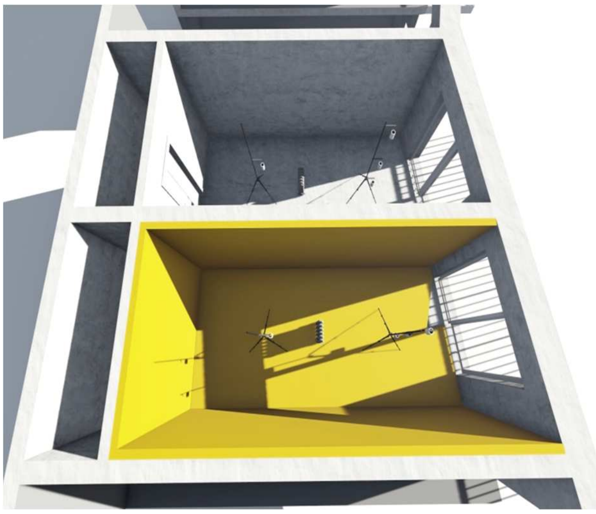


Figure 8 : Illustrative view from top of AI unit, with insulation panels

Four units, south oriented, have been requested (Figure 9 and Figure 10): two identical units with insulation panels and two other identical units without insulation panels. In both pairs, one unit is co-heated while the other is in floating temperature mode.

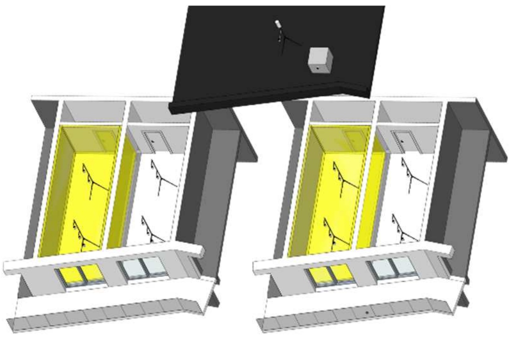


Figure 9 : Axonometry of the four measured units

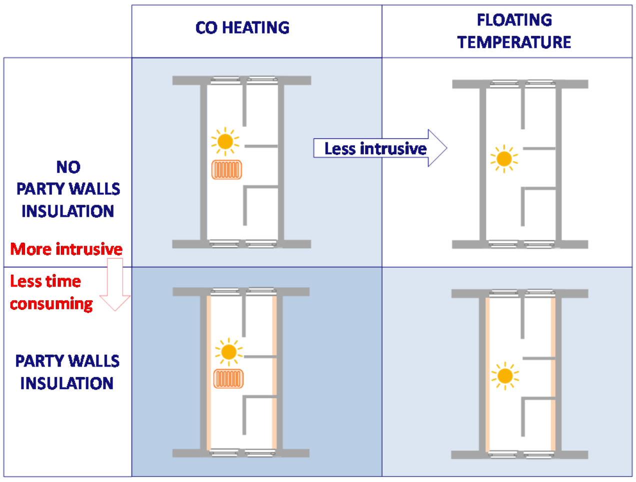


Figure 10 : Different boundary conditions and heat sources for the measurement of the Heat Loss Coefficient

The reduction of the thermal mass effect due to the placement of insulation enables to reduce the measurement time period until 9 days of monitoring without occupancy.

All the internal heat gains due to electric radiators have been monitored, as well as loggers and computer power consumptions. Access was denied during the monitoring, the door and the windows were closed during the whole process. Internal relative humidity has also been monitored in AU Unit.

Two periods of measurements of two week were planned to be done during one month. Technical problems occurred during the first two weeks, so that recorded data have not been recorded continuously for that period. The second period of measurement occurred as planned and provided continuously recorded data.

3. MODEL DETAILS

3.1. Location

The apartments are located in Ixelles, near Brussels in Belgium. The land lot is in town, very slightly shaded. The latitude of the buildings is 50.821N and the longitude is 4.389E. The elevation above sea level is approximatively 88m. The data were measured in Central European Summer Time (UTC/GMT+2h). Values were averaged every 10 minutes and recorded at the end of each 10 minutes time interval

Figure 11 : Site Printemps

Figure 12 : View of the land lot in google map, earlier building in yellow

The building is located at the periphery of the land lot and it is opened towards its centre, which limits the shading from the surrounding houses. However, the blind wall of unit B is in contact with an adjacent space whose internal temperature is unknown.

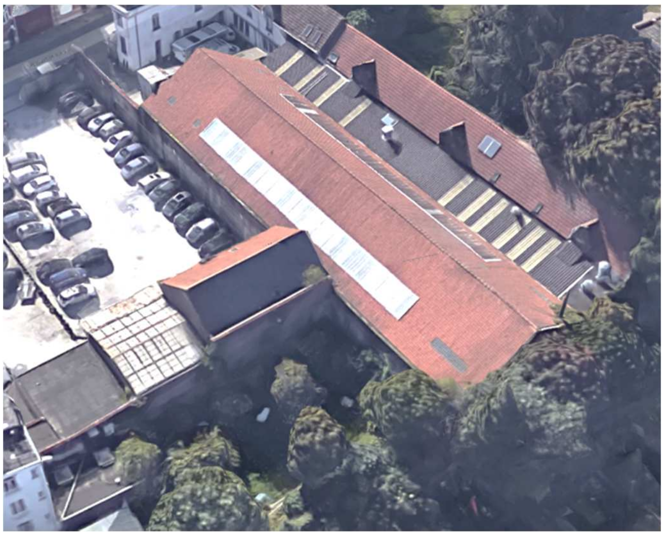


Figure 13 : View of the construction and land lot

As shown on the following picture, tall trees are shading the building during the late afternoon. Unit “A” housings are affected by this sunscreen earlier in the day than unit “B” housings.

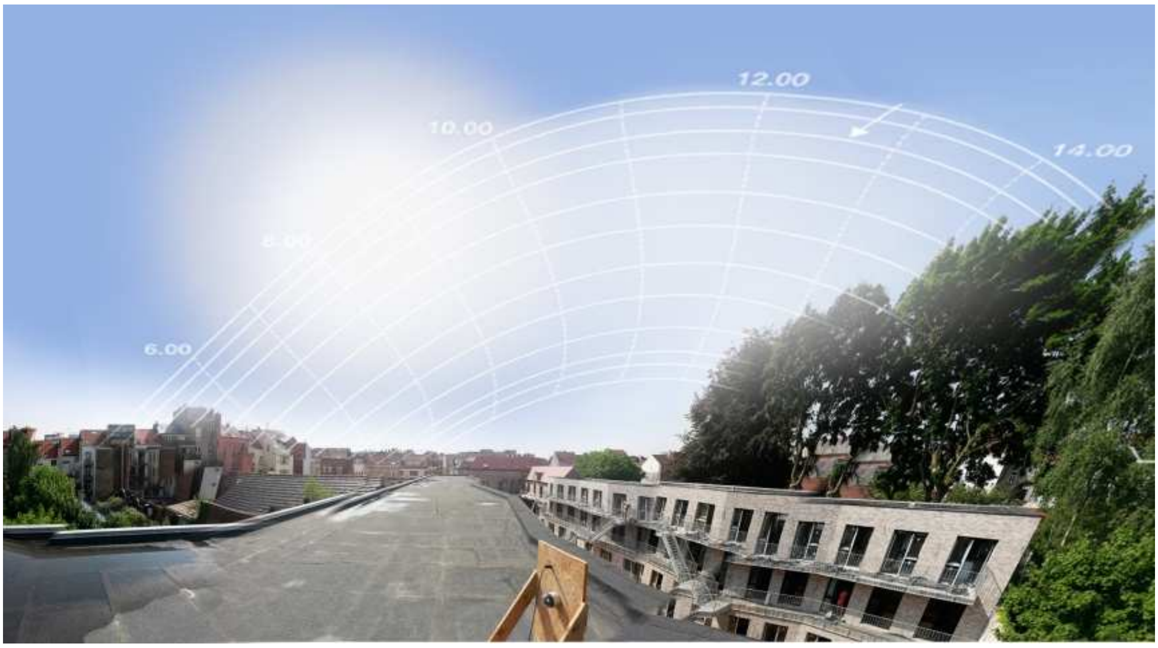


Figure 14 : Cylindrical view from roof and illustrative sun's path

3.2. Geometry

Figure 15 shows the internal layout of two units (AI and AU). The geometry is pretty simple and repetitive : a large glazed door window as façade (slightly not perpendicular) leading to the living room (2m67 wide) with adjacent sanitary zone. The internal ceiling height is 2.50m.

All the dimensions are specified in the annexes at the end of this document. The reference surface considered for the assessment of the wall dimensions is the layer of interior finishing. The thermal bridges heat losses are calculated according to this convention (chapter 3.6).

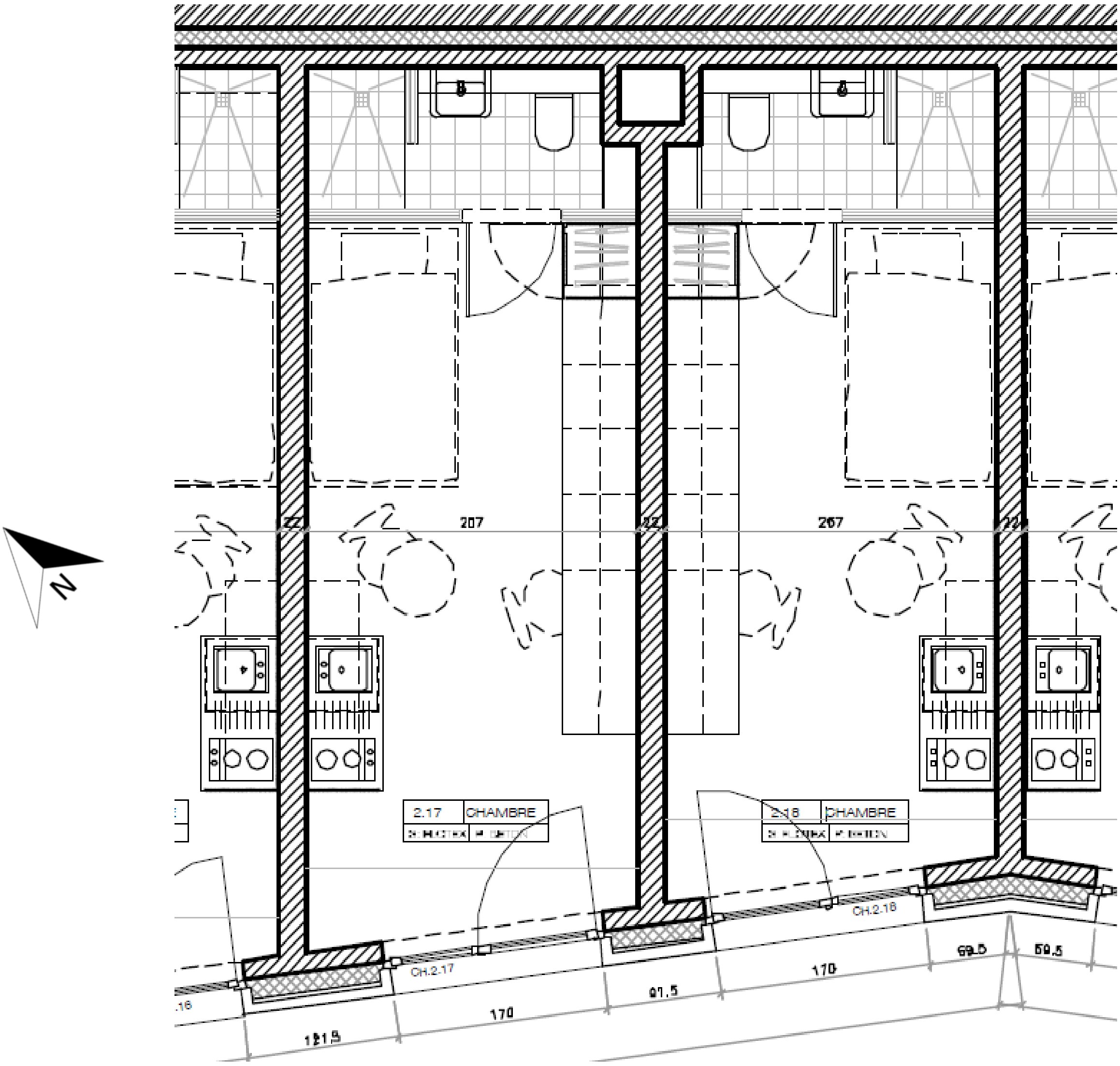


Figure 15 : Unit "A" housing layout [Furniture are not present in the apartment during the experiment]

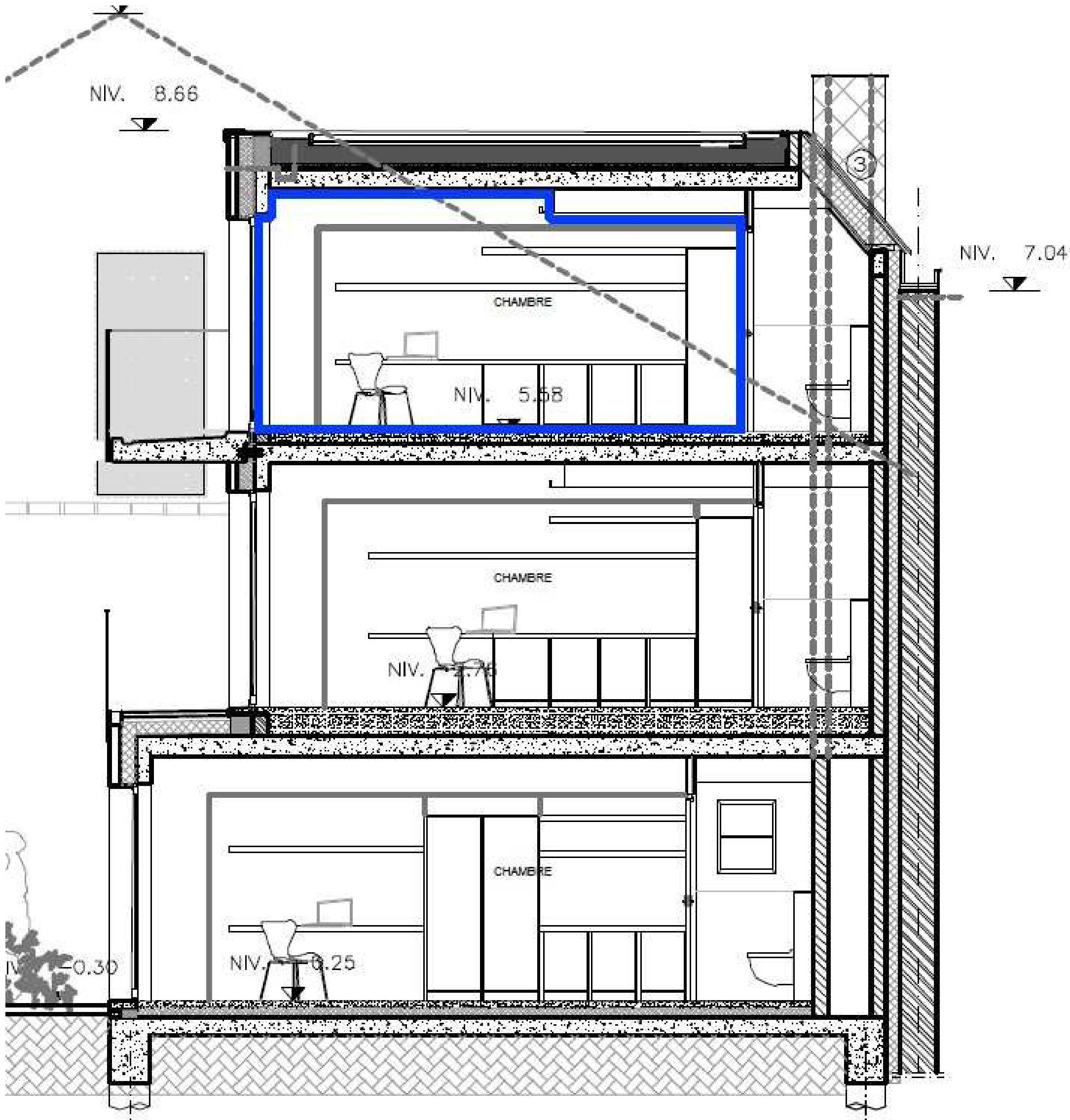


Figure 16 : Longitudinal section in "B" area

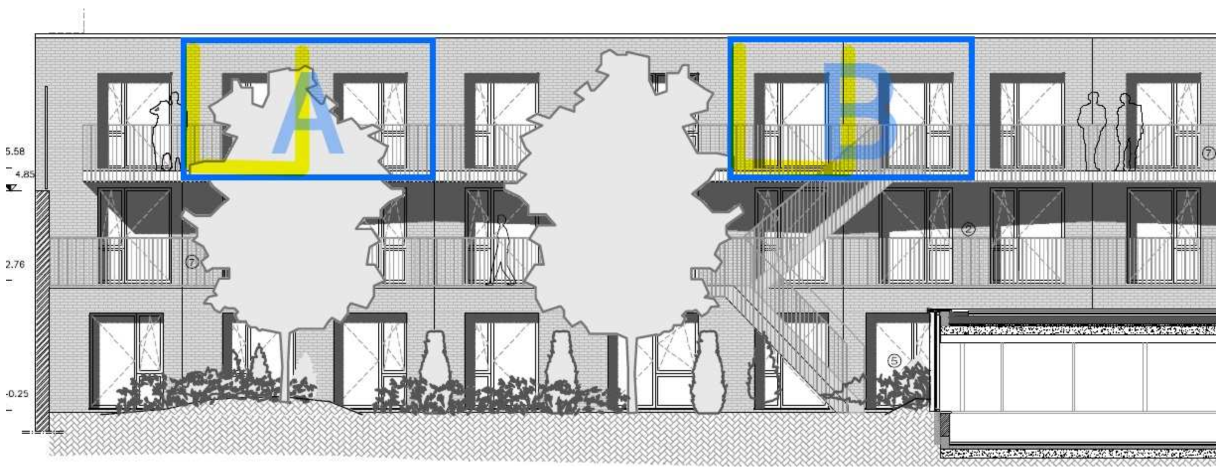


Figure 17 : Elevation from south west

Note that there are some differences between units A and B. Unit B is in contact with an adjacent construction (in red on Figure 18). The units covered with indoor insulation panels are larger the units that are not.

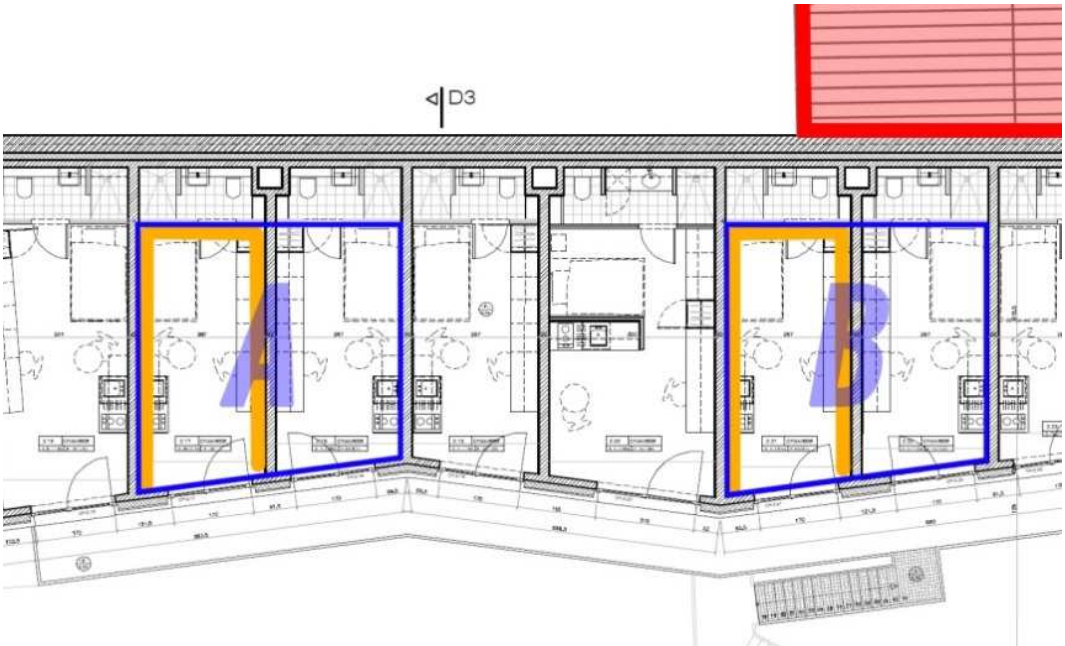


Figure 18 : Plan view from student housing

In insulated units, a piece of ground insulation has been removed behind each front door such that we could open the door to control the measuring instruments and load the data. However no presence was allowed during the measurement time periods.

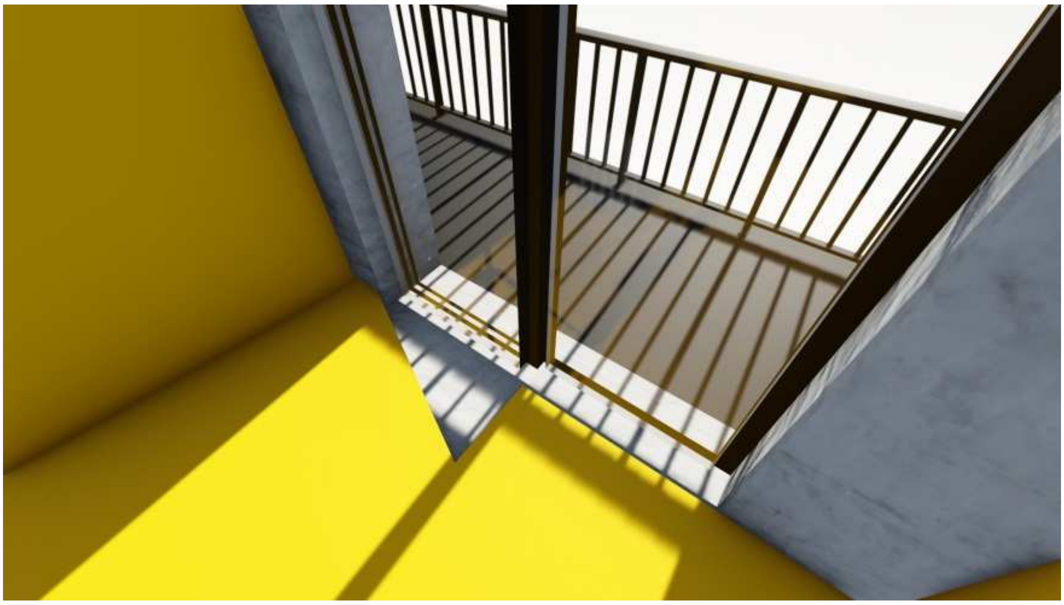


Figure 19 : Illustration of the removed insulation

3.3. Glazing and frame areas

All the windows are the same regardless of the size of the housing. They are composed of three main parts (Figure 20**Erreur ! Source du renvoi introuvable.**): a tilting and opening window (G1), a small fixe window (G2) and a glass door opening inwards (G3).

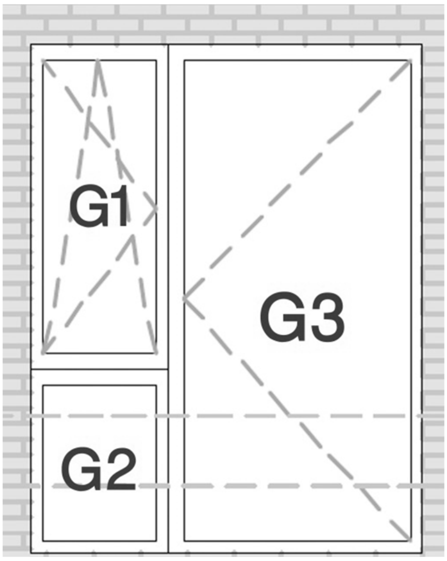


Figure 20 : Façade window

Table 1 : Dimensions of the windows

Glazing ID	Overall dimensions				Visible Glass area	Glass edge length	Frame area
	l [m]		h [m]	A [m²]	A [m²]	[m]	A [m²]
G1	0.74	x	1.25	0.91	0.554	3.15	0.35
G2	0.74	x	1.00	0.75	0.492	2.82	0.26
G3	0.91	x	2.25	2.05	1.484	5.37	0.57
Total				3.71	2.53	11.34	1.18

3.4. Constructions

The construction properties are presented in the Table *2***Erreur ! Source du renvoi introuvable.**. The following figures present the wall numers, as used in the table.

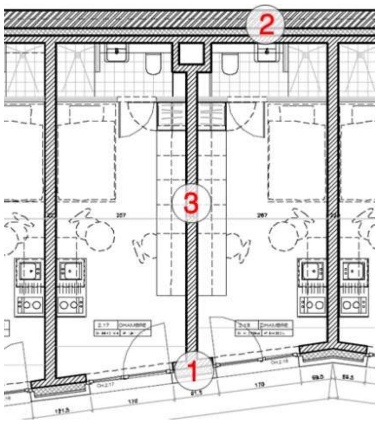


Figure 21 : Plan dialing

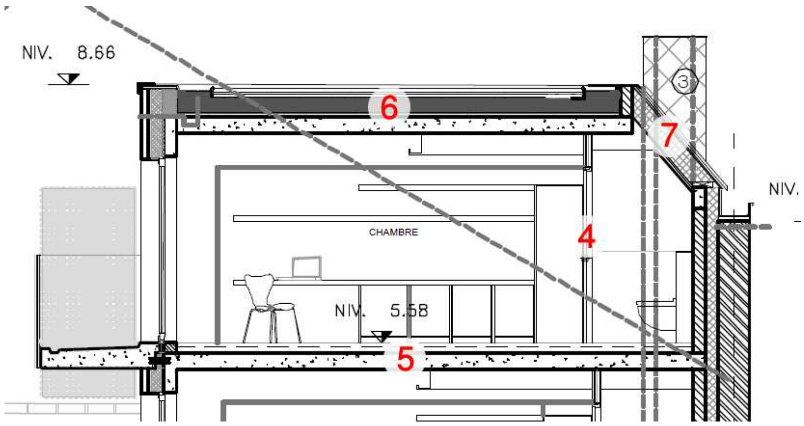


Figure 22 : Cut dialing

Table 2 : Construction thermophysical properties (green color: Manufacturer's data or as built documents, blue color: assumptions)

	Thickness	Thermal conduc.	Density	Sp Ht	Absorb	Emiss
Layer	m	W/mK	kg/m3	J/kgK	-	-
[1] External façade wall_SW - *from indoor to outdoor // Rse = 0.04 m²K/W , Rsi = 0.13 m²K/W*						
Plaster	0.015	0.57	1200	1000	0.25	0.9
Silica blocks	0.22	0.91	1800	1000		
PUR	0.2	0.025	40	1400		
Bricks	0.1	1.08	1650	1000	0.54	0.9
Total	0.535			U =	0.117	W/m²K
[2] External blind wall - *from indoor to outdoor // Rse = 0.04 m²K/W, Rsi = 0.13 m²K/W*						
Plaster	0.015	0.57	1200	1000	0.25	0.9
Silica blocks	0.15	0.91	1800	1000		
PUR	0.15	0.025	40	1400		
Bricks	0.32	1.08	1650	1000	0.54	0.9
Total	0.635			U =	0.15	W/m²K
[3] Party wall between student housings *// Rsi = 0.13 m²K/W*						
Plaster	0.015	0.57	1200	1000	0.25	0.9
Silica blocks	0.19	0.91	1800	1000		
Plaster	0.015	0.57	1200	1000	0.25	0.9
Total	0.22			U =	1.92	W/m²K

[4] Separative wall between room/bathroom - *from living to bedroom // Rsi = 0.13 m²K/W*						
YTONG concrete block + plaster	0.1	0.125	535			0.9
Total	0.1			U =	0.94	W/m²K
[5] Party floors - *top down // Rsi = 0.17 m²K/W*						
Carpet	0.01	0.06	200	1300	0.6	0.9
Screed	0.05	2.1	2500	880		
Acoustic insulation PE	0.01	0.45	1923	1030		
Screed	0.05	2.1	2500	880		
Hollow concrete slab	0.2	2.1	1600	880	0.25	0.9
Total	0.32			U =	1.49	W/m²K
[6] Concrete roof - *from indoor to outdoor // Rse = 0.04 m²K/W, Rsi = 0.10 m²K/W*						
Hollow concrete slab	0.2	2.100	1600	880	0.25	0.9
Screed	0.1	2.1	2500	880		
PIR	0.15	0.023	40	1400		
Bitumen	0.012	0.23	1150	1000	0.9	0.9
Total	0.462			U =	0.15	W/m²K
[7] Pitched roof - *from indoor to outdoor // Rse = 0.04 m²K/W , Rsi = 0.10 m²K/W*						
Fermacell	0.01	0.32	1150	1100	0.25	0.9
Air 90% - Wood 10%	0.03					
Rockwool	0.18	0.035	100	1030		
Air 90% - Wood 10%	0.06		2500			
Fiber cement slate	0.008	0.58	1800	1050	0.76	0.9
Total	0.288			U =	0.19	W/m²K

3.5. Glazing thermal and optical properties

The double glazing is filled with argon (16mm). The outer glazing consists of laminated glass (4mm) while the inner one consists of *Thermofloat Glass* (4mm, with low emission layer). The window frame is made of thermally broken aluminium.

The different thermal properties are specified in the Table 3**Erreur ! Source du renvoi introuvable.**.

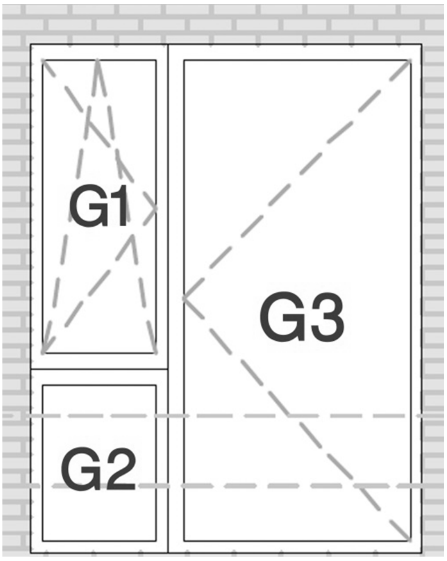


Figure 23 : Façade windows description

Table 3 : Windows thermal properties

Glazing ID	UGl	UFr	Ψ glass spacer	Uwd	SFgl	LT
	W/(m²K)	W/(m²K)	W/mK	W/(m²K)	%	%
G1	1.1	1.0	0.05	1.23	64	82
G2	1.1	1.0	0.05	1.26	64	82
G3	1.1	1.0	0.05	1.21	64	82
Total	1.1	1.0	0.05	1.22	64	82

Since the experiment was performed during the construction phase, windows weren't perfectly clean. Amount of dust, presence of stickers and stains are taken into account by a reduction factor, evaluated for each unit. The dust is evaluated by a default value of reduction of 4%. Each sticker (one per glazing) has an area of $0.0216m^2$. It has an approximate solar factor of 15%, leading to a corresponding value of an opaque glazing of $0.015\ m^2$. Stains are evaluated arbitrary (small/big; many/none;…) for each unit. Final values are summarized in the Table 4.

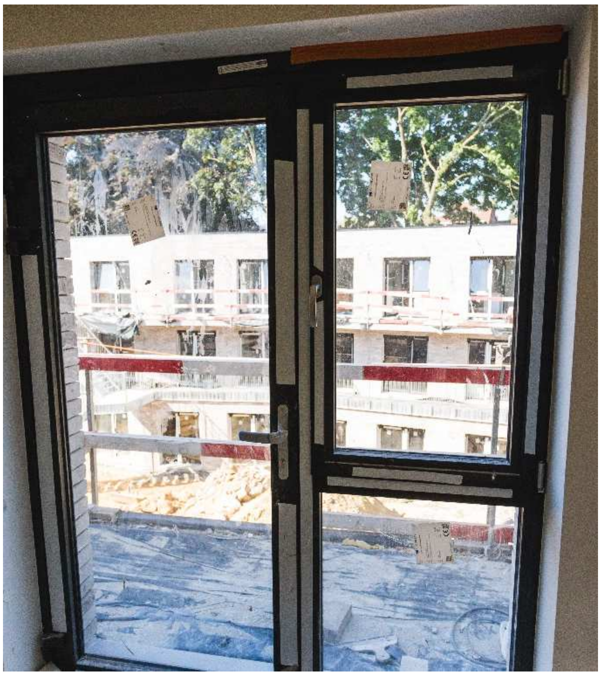


Figure 24 : State of one window during the experiment

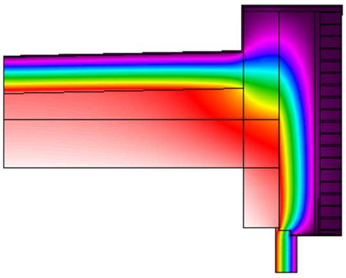
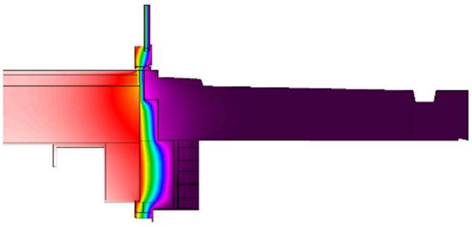
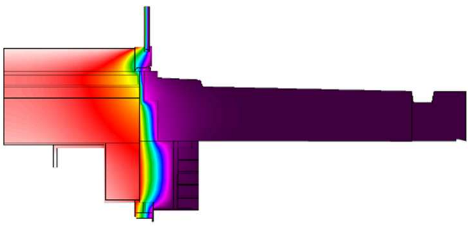
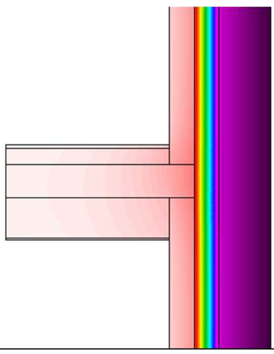
Table 4 : Reduction factors

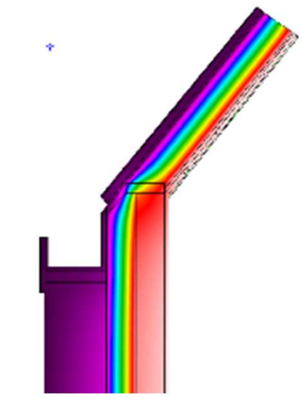
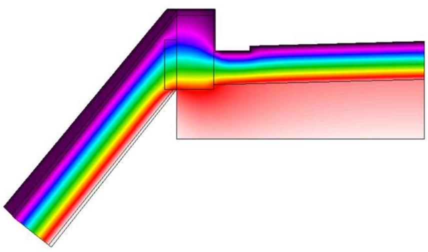
	AI	AU	BI	BU
LT while clean	82%	82%	82%	82%
SF while clean	64%	64%	64%	64%
Stickers reduction factor	-2.20%	-2.20%	-2.20%	-2.20%
Various stains reduction factor	-2.50%	-1.50%	-2.50%	-2%
Dust reduction factor	-4%	-4%	-4%	-4%
Total reduction	-8.70%	-7.70%	-8.70%	-8.20%
Estimated LT in real conditions	74.80%	75.60%	74.80%	75.30%
Estimated SF in real conditions	58.40%	59%	58.40%	58.70%

3.6. Thermal bridges

The thermal bridges Ψ values were assessed via the THERM software. The thermal loss calculation is performed on the basis of internal wall dimensions. Final results are presented in Table 5**Erreur ! Source du renvoi introuvable.**.

Table 5 : Thermal bridges dimensions and heat losses,

	Dimension per SH	Ψ	TB heat loss
Roof parapet 	2.7 m	0.177 W/Km	0.48 W/K
Balcony Edge 	2.7 m	0.467 W/Km	1.26 W/K
Balcony Edge + insulation 	2.7 m	0.345 W/Km	0.93 W/K
Lower Edge, sanitary 	2.7 m	0.04 W/Km	0.11 W/K

Pitched roof, lower edge 	2.7 m	0.087 W/Km	0.23 W/K
Pitched roof, upper edge 	2.7 m	0.218 W/Km	0.59 W/K
Total thermal bridges			3.6 W/K

3.7. Ventilation

Fresh air is naturally supplied through inlet grids located on top of the windows. Air is extracted mechanically through outlets located in the living zone and in the bathroom zone. Mechanical ventilation was shut off during the whole measurement period, but ventilation inlets/outlets were unobstructed. Aeration openings in window/door frames are unobstructed and left in their initial position which may vary from one unit to another.

Figure 25 : Ventilation outlet unobstructed during experiment

Figure 26 : Aeration openings

3.8. Heating

Co-heating was performed with an electric radiator, with the configuration shown in Figure 27**Erreur ! Source du renvoi introuvable.**. The power of the radiator is determined by the position of a rotating thermostat with levels ranging from 0 to 6.

Figure 27 : Electric radiator in the insulated unit

Two periods of measurements of two week were planned to be done during one month, according to the schedule illustrated on Figure 29. Technical problems occurred during the first two weeks, so that recorded data have not been recorded continuously for that period. The second period of measurement occurred as planned and provided continuously recorded data.

Hence the heating were performed following those two phases:

- 7 days from 2017/06/08 to 2017/06/15: all units in floating temperature mode.
- 6 days from 2017/06/16 to 2017/06/21: units BI and BU heated with thermostat level 3 while units AI and AU in floating temperature mode.

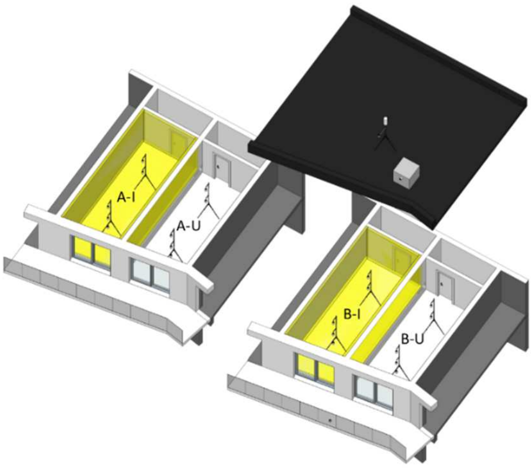


Figure 28 : Axonometric perspective of different units in Printemps

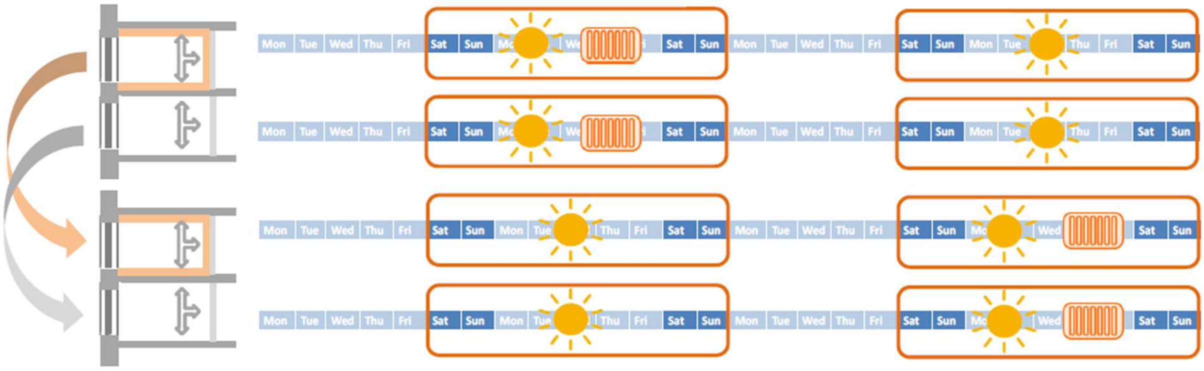


Figure 29 : Theoretical co-heating and floating temperature measurement schedule

3.9. Air leakages

Pressurisation tests (blowerdoor) were carried out on the four tested units on the 22/06/2017. Air infiltration air flows are gathered in the following table:

Table 6 : Air infiltration test results

Blowerdoor test 50 Pa	AI	AU	BI	BU
V50 [m³/h]	697	1029	250	1127

The blower door was installed in the exterior window-door frame for the four tested units.

The difference of results is explained by the different boundary condition regarding air infiltration:

- The windows ventilation grid was closed for the BI unit and open for the three other units, explaining the lower value of air infiltration air flow for unit BI.
- The internal door separating the living zone from the bathroom was not yet installed at the moment of the coheating test and blower door test. In the units AI and BI covered with inside insulation panels, the internal door opening was sealed by insulation panels (two layers of 5cm each). In the units AU and BU not covered by insulation panels, a plastic sheet was installed to reduce air infiltration between the living zone and the bathroom (which has a ventilation outlet connected directly with exterior) (Figure 30).

Figure 30 : Sealed bathroom door

During the blower door test, the main air infiltration air flows occurred through:

- Windows ventilation grids: the manufacturer data indicate an air flow of 436 m^3/h. This value has been adopted for the three units whose windows grids were open.
- Air infiltration flowing from the living zone to the bathroom and then through the ventilation outlet. This air flows is assumed to be zero in units AI and BI as the connection between the living zone and the bathroom is supposed to be totally sealed by the presence of the insulation panels.
- Air infiltration through the ventilation outlet of the living zone: the pressure drop losses have been calculated on basis of the dimensions of the air duct, which lead to a maximal air leakage value of 238 m^3/h.
- Two holes (2cm diameter) were made in the party wall separating the insulated and uninsulated units in order to pass the sensor cables to the data logger: the air flow through both holes is estimated at 23m^3/h.

The air flow balance gives the following results:

AI

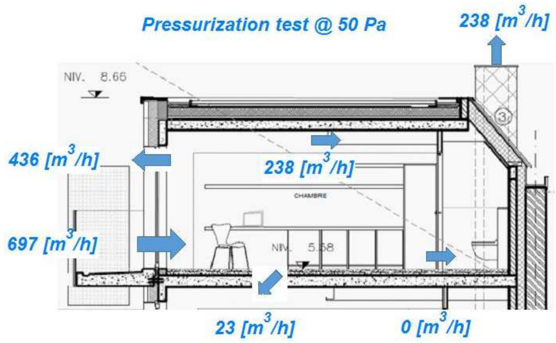


Figure 31 : Partition of air leakage for AI unit

AU

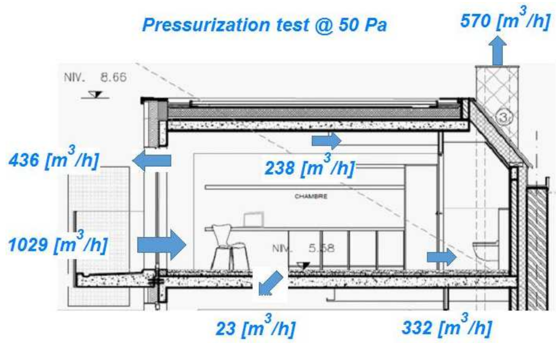


Figure 32 : Partition of air leakage for AU unit

BI

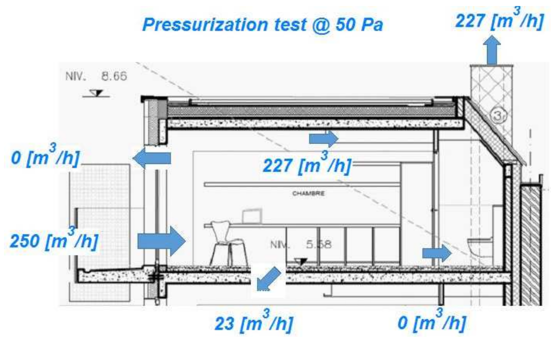


Figure 33 : Partition of air leakage for BI unit

BU

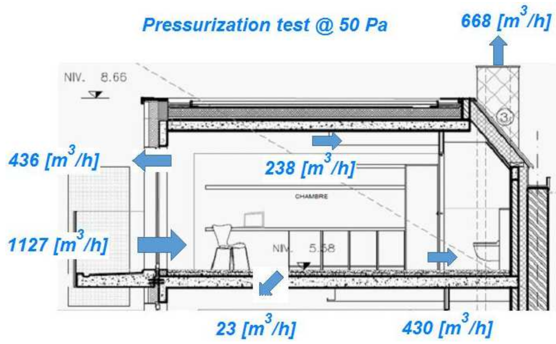


Figure 34 : Partition of air leakage for BU unit

Table 7 : Balance of air flow values during the blower door test

Blowerdoor test 50 Pa	Units	AI	AU	BI	BU
V50	[m³/h]	697	1029	250	1127
Envelope area	[m²]	34.76	33.61	35.06	33.91
v50	[m³/h/m²]	20.05	30.62	7.13	33.24
Internal volume	[m³]	37.37	34.72	38.07	35.41
n50	[ac/h]	18.65	29.64	6.57	31.83

3.10. Weather

The weather data during the experiment were collected on site with a weather station placed on roof. This station collected data related to wind speed and direction (at approximatively 10 m above the ground), atmospheric pressure, air temperature, relative humidity, rain fall and intensity, global and direct solar radiation on a horizontal plane. The data were recorded as average values every 10 minutes. Wooden equerries were placed on the roof near the weather station to collect the global and diffused solar irradiation on a vertical plane with a 10 min time interval.

Figure 35 : Weather station on the roof

Figure 36 : Solar radiation sensor on the roof

3.11. Ground reflectivity

The ground reflectivity wasn't measured. The windows give access to a balcony, overlooking an internal courtyard.

Figure 37 : View on the inside yard from the AI unit

3.12. Predicted HLC

The calculation of the predicted heat loss coefficient is summarized in the following table. It takes into account:

- External wall heat loss coefficient: depending on the U-values of the South oriented windows, external South and North oriented walls and roof.
- Thermal bridges heat loss coefficient: the values were described in chapter 3.6
- Infiltration heat loss coefficient: the blower door test shows air leakages resulting from a wind pressure of 50 Pa. In real conditions, a mean value of 2 Pa is assumed.

	AI			AU			BI			BU		
Wall loss												
	Dimension	U	TB loss [W/K]	Dimension	U	TB loss [W/K]	Dimension	U	TB loss [W/K]	Dimension	U	TB loss [W/K]
External wall	3.10 m^2	0.12 W/Km^2	0.36	3.05 m^2	0.12 W/Km^2	0.36	3.05 m^2	0.12 W/Km^2	0.36	3.10 m^2	0.12 W/Km^2	0.36
Roof	14.93 m^2	0.15 W/Km^2	2.18	13.86 m^2	0.15 W/Km^2	2.02	15.20 m^2	0.15 W/Km^2	2.22	14.14 m^2	0.15 W/Km^2	2.06
Window	3.71 m^2			3.71 m^2			3.71 m^2			3.71 m^2		
Window - glass	2.53 m^2	1.10 W/Km^2	2.78	2.53 m^2	1.10 W/Km^2	2.78	2.53 m^2	1.10 W/Km^2	2.78	2.53 m^2	1.10 W/Km^2	2.78
Window - frame 1	1.18 m^2	1.00 W/Km^2	1.18	1.18 m^2	1.00 W/Km^2	1.18	1.18 m^2	1.00 W/Km^2	1.18	1.18 m^2	1.00 W/Km^2	1.18
Window - glass edge	11.34 m	0.05 W/Km	0.57	11.34 m	0.05 W/Km	0.57	11.34 m	0.05 W/Km	0.57	11.34 m	0.05 W/Km	0.57
Total wall loss		[W/K]	7.07		[W/K]	6.91		[W/K]	7.10		[W/K]	6.96

Thermal Bridge loss												
	Dimension	Ψ	TB loss [W/K]	Dimension	Ψ	TB loss [W/K]	Dimension	Ψ	TB loss [W/K]	Dimension	Ψ	TB loss [W/K]
Parapet	2.70 m	0.18 W/Km	0.48	2.70 m	0.18 W/Km	0.48	2.70 m	0.18 W/Km	0.48	2.70 m	0.18 W/Km	0.48
Balcony Edge				2.70 m	0.47 W/Km	1.26				2.70 m	0.47 W/Km	1.26
Balcony Edge + insulation	2.70 m	0.35 W/Km	0.93				2.70 m	0.35 W/Km	0.93			
Lower sanitary	2.70 m	0.04 W/Km	0.11	2.70 m	0.04 W/Km	0.11	2.70 m	0.04 W/Km	0.11	2.70 m	0.04 W/Km	0.11
Pitched roof, lower edge	2.70 m	0.09 W/Km	0.23	2.70 m	0.09 W/Km	0.23	2.70 m	0.09 W/Km	0.23	2.70 m	0.09 W/Km	0.23
Pitched roof, upper edge	2.70 m	0.22 W/Km	0.59	2.70 m	0.22 W/Km	0.59	2.70 m	0.22 W/Km	0.59	2.70 m	0.22 W/Km	0.59
Total thermal bridges		[W/K]	2.34		[W/K]	2.67		[W/K]	2.34		[W/K]	2.67

Infiltration loss												
	V50 value [m^3/h]	ACH conversion [m^3/h]	TB loss [W/K]	V50 value [m^3/h]	ACH conversion [m^3/h]	TB loss [W/K]	V50 value [m^3/h]	ACH conversion [m^3/h]	TB loss [W/K]	V50 value [m^3/h]	ACH conversion [m^3/h]	TB loss [W/K]
	697.00	34.85	11.62	1029	51.45	17.15	250.00	12.50	4.17	1127	56.35	18.78
Total infiltration loss		[W/K]	11.62		[W/K]	17.15		[W/K]	4.17		[W/K]	18.78

Total heat loss	**[W/K]**	**21.03**	**[W/K]**	**26.73**	**[W/K]**	**13.61**	**[W/K]**	**28.41**

4. EXPERIMENTAL SCHEDULE

The experiment was undertaken in parallel in 4 similar units so that all units were submitted to the same weather conditions. The time schedule of the experiment is shown in Table 8:

Table 8 : Experimental schedule

	AI	AU	BI	BU
Days 1-8 06/08 to 06/15	Floating temperature	Floating temperature	Floating temperature	Floating temperature
Days 9-14 06/16 to 06/21	Floating temperature	Floating temperature	Coheating : Thermostat 3	Coheating : Thermostat 3

5. INSTRUMENTATION

5.1. Internal sensors

- Sensors are named with 5 letters, to identify in which apartment they are located and where precisely. The following table summarizes the meaning of letters composing the name of the sensors

Logger zone	Unit	Sensor type	Sensor location - 1	Sensor location - 2
A *Area A* B *Area B*	I *Insulated* U *Uninsulated*	T *Temperature* R *Radiation*	B *Back* F *Front* M *Middle* I *Interface* S *Sanitary*	E *East* W *West* G *Ground* L *Low* M *Medium* H *High*

Notes:

Sensor location 1:

- (B, F, M): according to the depth from the façade (B: back of the room, F: next to the façade, M: middle of the room)
- (I) : interface between wall and insulation
- (S) : neighbor sanitary zone

Sensor location 2:

- (M,H,L): If air temperature sensor: at medium height (M) or near the ceiling (H) or near the floor (L)

- (E,W,G): If interface temperature sensor: at the East (E) or West (W) wall surface or at the floor (G) surface

Description of different sensors:

- 8 Temperature sensors per insulated units: 3 sensors located on the floor and party walls at the interface between walls and insulation panels, 4 air temperature sensors in the tested unit (3 near the façade, 1 in the center of the room), 1 temperature sensor in the adjacent bathroom.
- 5 Temperature sensors per uninsulated units: 4 air temperature sensors in the tested unit (3 near the façade, 1 in the center of the room), 1 temperature sensor in the adjacent bathroom.
- 1 temperature sensor located on top of the electric radiator, at 2 m height in BU unit (BUTMH)
- 1 pyranometer in units AU and BU: located at the lower edge of the facade fixed window in order to collect the total amount of solar irradiance.
- Co-heating consumptions were monitored in kWh. NOTE: The recorded powers are computed from the differences of the recorded consumptions. As data were recorded with a 10 minutes interval, recorded power must be multiplied by 6 to be expressed in Watt.
- 1 temperature, relative humidity, dew point and atmospheric pressure sensor In BU uninsulated unit, located at the middle of the zone at 2 m height. (AUTMH, AU_RH, AUT_DP, AU_P_ATM):
- In the BU-unit, data logger electricity consumption and power have been measured too as loggers were inside the tested zone. The recorded powers and consumptions are negligible.

The following figure show the location of internal sensors used.

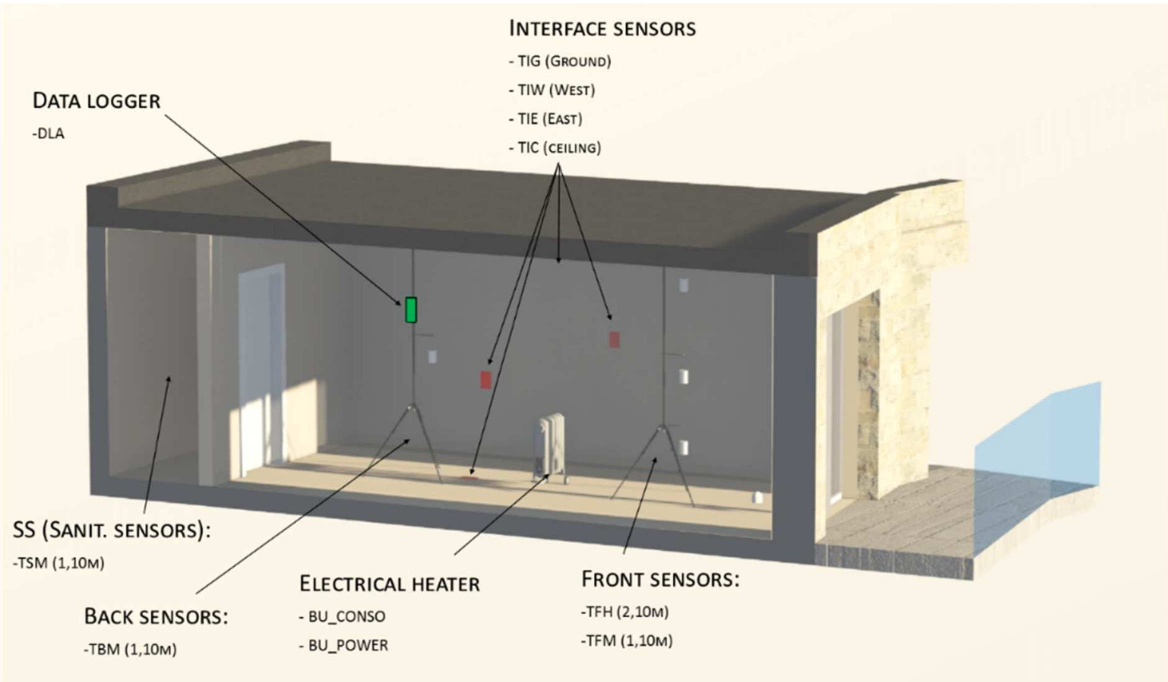


Figure 38 : Location of different internal sensors

5.2. Weather sensors

A weather station located on the roof collected:

- Solar radiation data: direct and global on a horizontal plane + calculation of the difference for diffuse radiation in W/m2 ;
- Wind: speed in m/s / orientation and maximal speed in degree from North ;
- Temperature in °C ;
- Relative humidity in % ;
- Atmospheric pressure in Pa;

On the roof, two pyranometers measured the solar irradiation on vertical plane parallel to the façade (SW) and parallel to the back blind wall (NE).

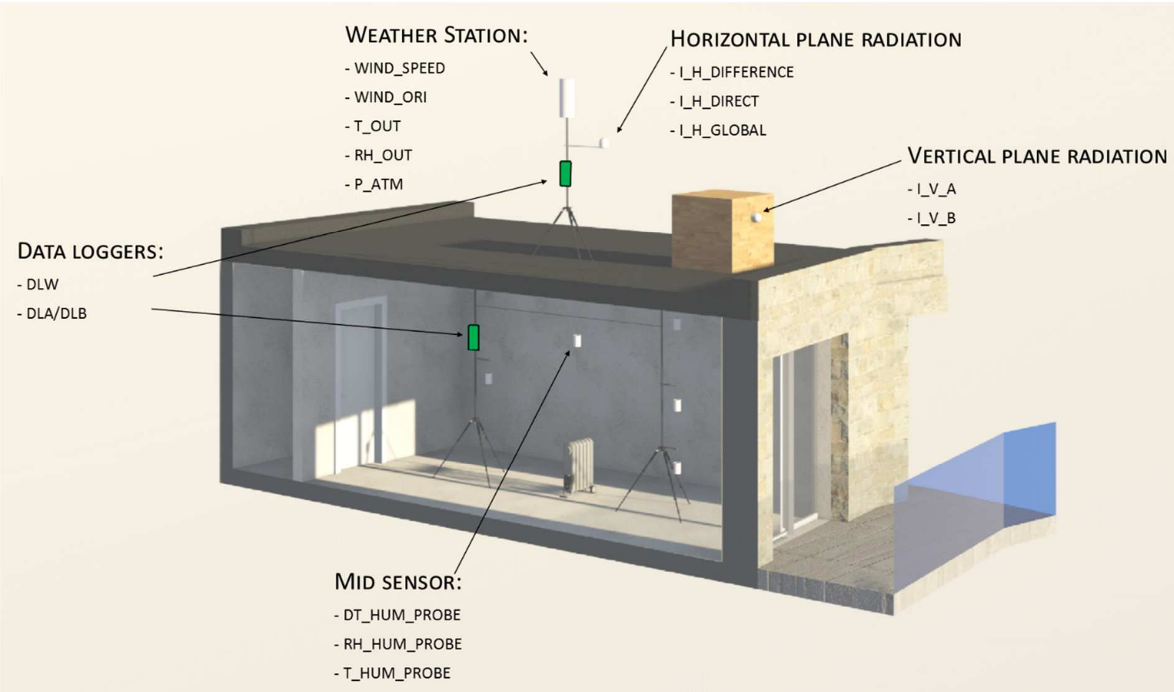


Figure 39 : Configuration of sensors emplacement for weather datas

6. PROVIDED MEASURED DATA

All the data are provided in three Excel files, with a 10 minutes time step:

- A_170608_170622.xlsx : for data in units AI and AU
- B_170608_170622.xlsx for data in units BI and BU
- W_170602_170622.xlsx for weather datas.

INTERNAL DIMENSIONS

Printemps		Room			
		AI	AU	BI	BU
Floor area	m²	14.93	13.86	15.20	14.14
Interior ceiling height	m	2.50	2.50	2.50	2.50
Volume	m³	37.37	34.72	38.07	35.41
[1] External façade wall_SW	m²	3.10	3.05	3.05	3.10
[2] External blind wall_NE	m²	6.76	6.71	6.71	6.76
[1] Windows	m²	3.71	3.71	3.71	3.71
Glass	m²	2.53	2.53	2.53	2.53
Frame	m²	1.18	1.18	1.18	1.18
Glass percentage	%	68%	68%	68%	68%
Glass edge	m	11.34	11.34	11.34	11.34
[3] Party walls between student housings_O	m²	14.29	13.31	14.55	13.56
[3] Party walls between student housings_E	m²	13.39	12.41	13.65	12.67
[4] Separative wall between room/bathroom	m²	6.09	6.09	6.09	6.09
[5] Party floors	m²	14.93	13.86	15.20	14.14
[6] Concrete roof	m²	14.93	13.86	15.20	14.14

LIST OF FIGURES

LIST OF TABLES