Passivhaus Documentation

Office, 35150 Amanlis, FRANCE
(Passivhaus database 4254)

MIZU PORJECT – The smallest Passiv Haus in the World

Certified Passive House
Passive House Institute

PH Designer : Thomas Primault, Engineer and managing director of HINOKI, also architect of this project

This small project is the office of HINOKI, a engineering company, specialized in the passiv haus buildings since 2010. The architecture is a tribute to Japanese Tea Houses, and the principes of minimalism, simplicity and naturallity. Acheving in september 2014, it get the Passiv Haus Certification in November 2014, and will be presented at PASSIBAT 2015 during a conference.

Key features: Japanese architecture, wood construction, miniaturization, ecological materials

U-value external walls 0.157 W/ (m2.K)
U-value floor 0.087 W/ (m2.K)
U-value roof 0.105 W/ (m2.K)
U-value window 0.79 W/ (m2.K)

PHPP space heat demand 12 kWh/ (m2.a)
PHPP primary energy demand 82 kWh/ (m2.a)
Pressure test n50 0.44h-1

1. Project

The MIZU project, is a unique tiny house of 12 m², dedicated to be the office of HINOKI, a Engineering company specialized on Passiv Haus. I work alone in this company, as the creator and engineer, doing PHPP and physical calculations about fluids for my customers, architects. Needed an appropriate space to be more comfortable to work, to meet customers and to draw my projects, I started to think about a new building in 2011. At this period, our house was just achieving, a complete wood structure house.

Localized in the countryside, at 20 minutes From RENNES city, the house has no direct neighbors, and is built around lands and trees. Loving the countryside way of life, I wanted to keep this way, working here without travels. So when my business was booming, I decided to build a real office near my personal House.

I love the Japanese architecture, so the House was built with the codes and materials of this type of architecture, making garden a part of itself. The last part of the house was built as a Tea House, surrounded by the Garden. I finally use this place as an Office for the MIZU PROJECT, but I wanted to keep the spirit of tea house. The small place available, and the architecture, the natural beauty of raw materials, the view on garden, and the choice of naturals materials were all chosen to make a unique project. Eventually, the water boiling in the kettle will be the unique heater.

The challenge consisted to be conform to the standard passiv haus, and to resolve specifics problems of miniaturization:
- Many surfaces exposed to the outside air (meaning a bad compactness) that makes more loss.
- airtightness, also more difficult because of many surfaces exposed
- small thickness of walls, to adapt to the existent volume of house, in spite of will to use only natural materials (but natural insulation use more space than chemical, lambda is not so good)
- how to adapt balanced ventilation to a very small volume?
- how to enable natural thermal mass cooling in this structure 100% made by wood?

2. Elevations

View of all elevations, except West, who gives to the house

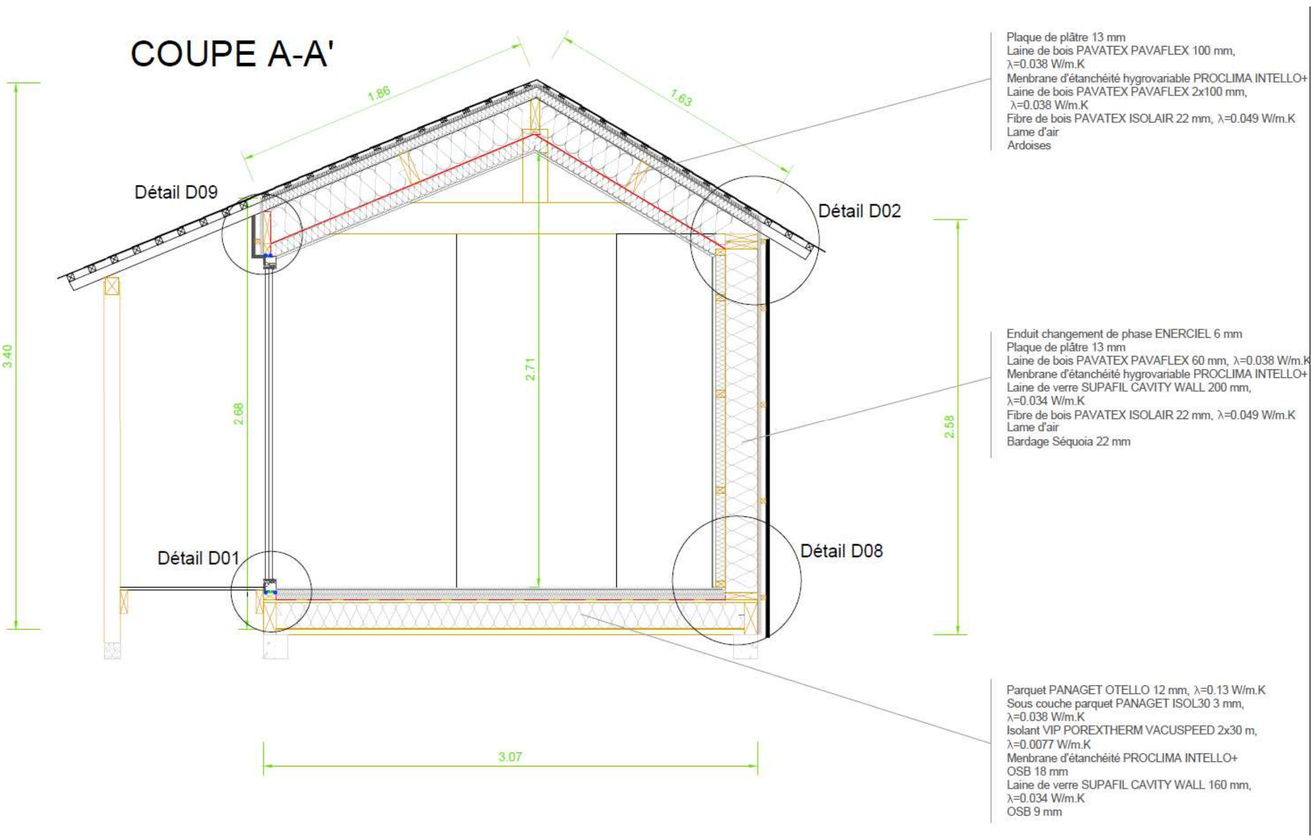
SOUTH

EST

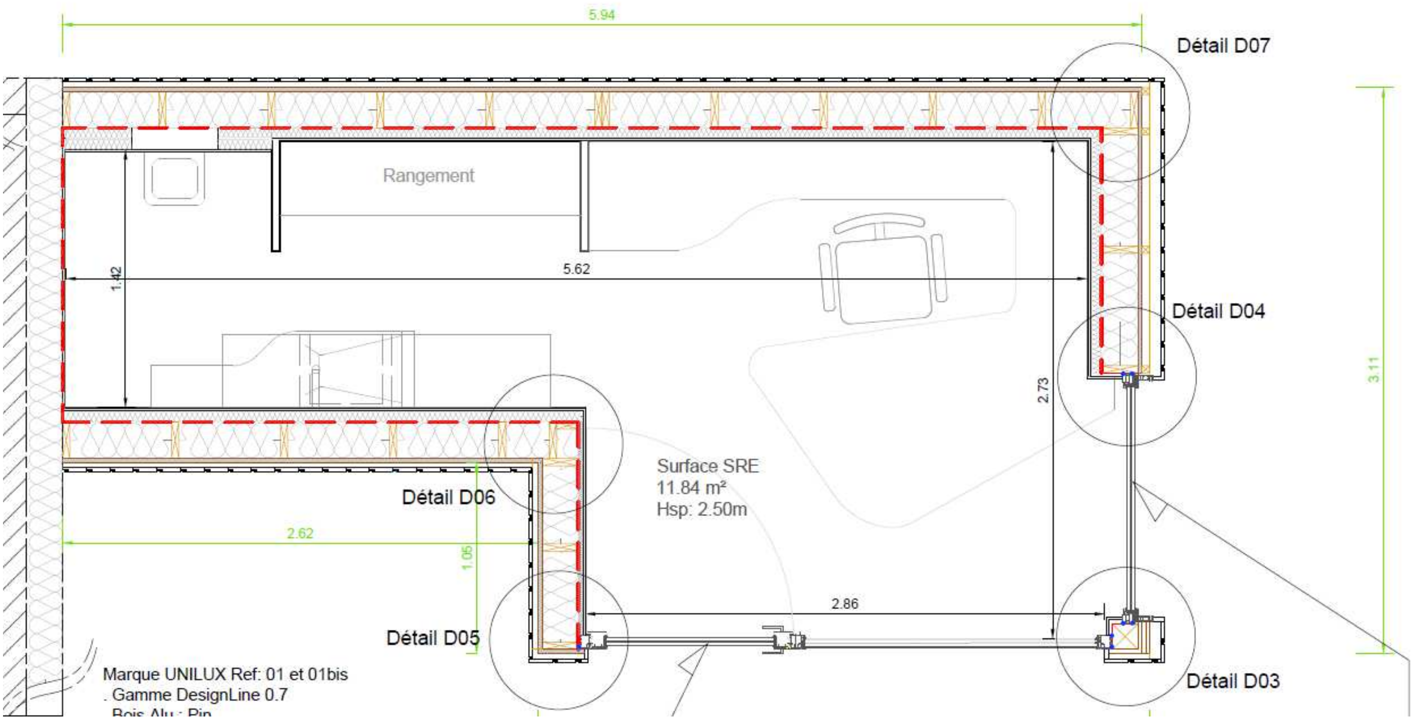
NORTH

3. Interior Views

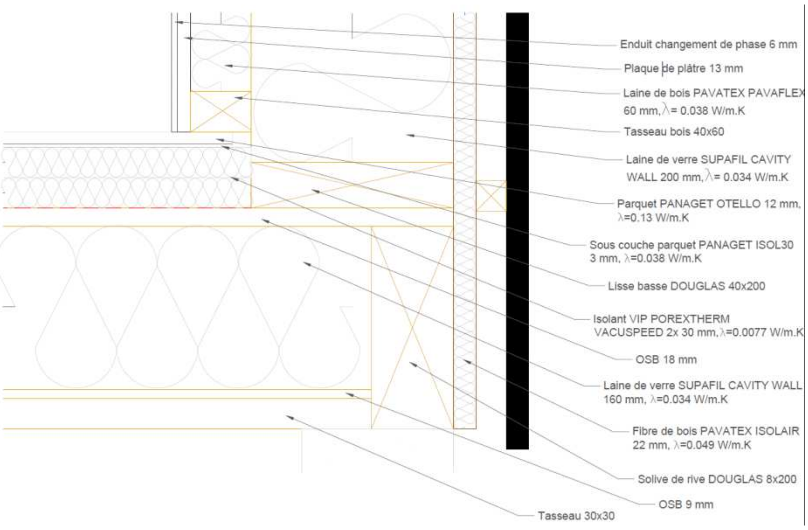
4. Cross section



5. Floor Plan



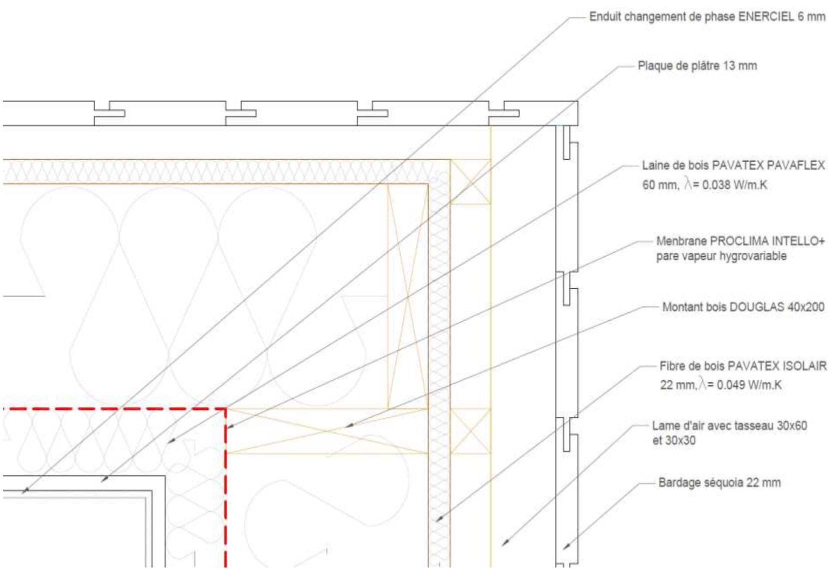
6. Construction details – floor



In the research of Japanese architecture, I choose for foundations some stones piles, the wood joist are fixed on it. It is also more easy to use natural insulation, between the joist with cellulose wadding of 160 mm. To complete insulation, I used VIP (vaccum insulation Pannel) because the ceiling height was already low. Those panels are really high insulation, with a lambda of 0.0077 W/m.K.

This wood system for the floor gives a real opportunity to resolve easily all thermal bridges. Indeed the floor's insulation and wall's insulation are completely imbricated.

7. Construction details – wall

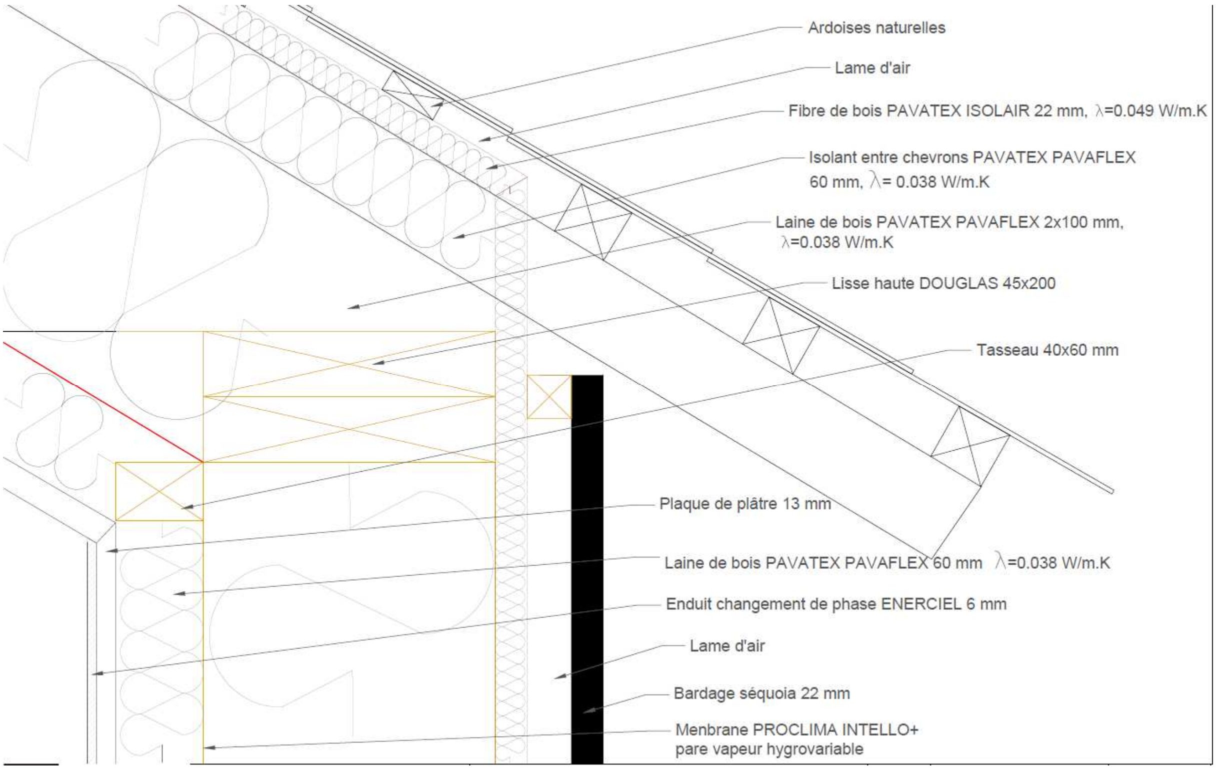


The walls are in continuation with the existing private house. So the structure is similar as for the wall framework, that's why this is the less isolated face. This wood complex is composed of external woodfiber of 22 mm, then 200 mm of cellulose wadding, and to complete, 60 mm of flexible woodfiber.

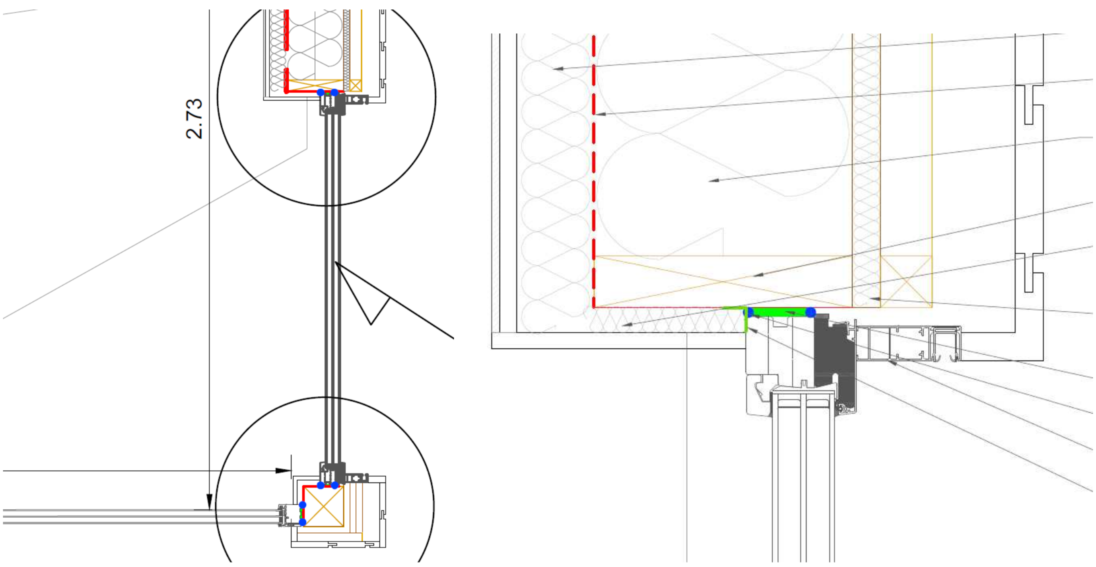
Those different insulation panels give a real guarantee to optimize space (electricity goes in the last insulation without risk of broken the airtightness), and to resolve any thermal bridge (there is everywhere insulation panel going in front of structure).

8. Construction details – roof

The roof structure is a traditional framework in local wood, covered by slate roof. From outside, the insulation is formed by external woodfiber 22 mm, then 360 mm of flexible woodfibre. This complex gives a really good thermal performance to the roof



9. Windows

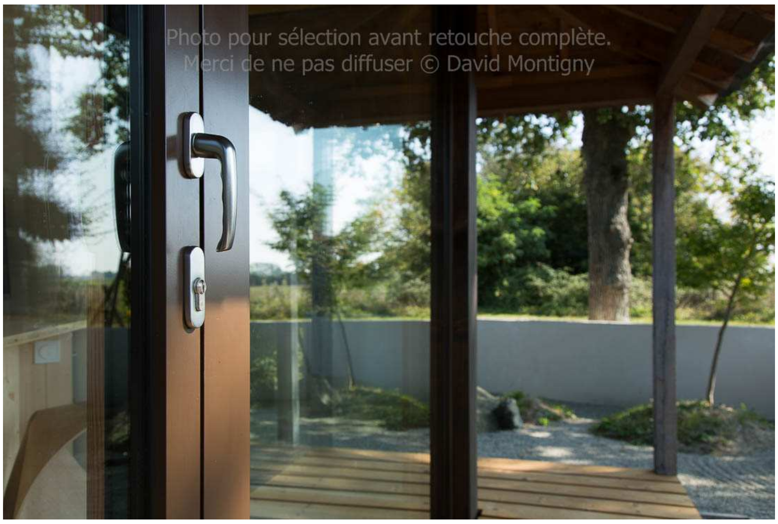


The windows are positioning closer to the exterior, to receive maximum sun light and heat, but also to be more performant as possible. I did a THERM calculation to

confirm this position. The Est windows is also equipped by an exterior mobile solar occultation, that I had to integrate into the insulation and the position of window.
2 different kinds of windows have been chosen, because of sponsoring by 2 different manufacturers: INTERNORM and UNILUX.
However, both of them are triple glazing wood/aluminum window.

Est window: INTERNORM HF200, wood and aluminum, Uf = 0.76 W/m².K
triple glazing 3N2 Solar, Ug = 0.62, g = 62%
Uw = 0.73 W/m².K

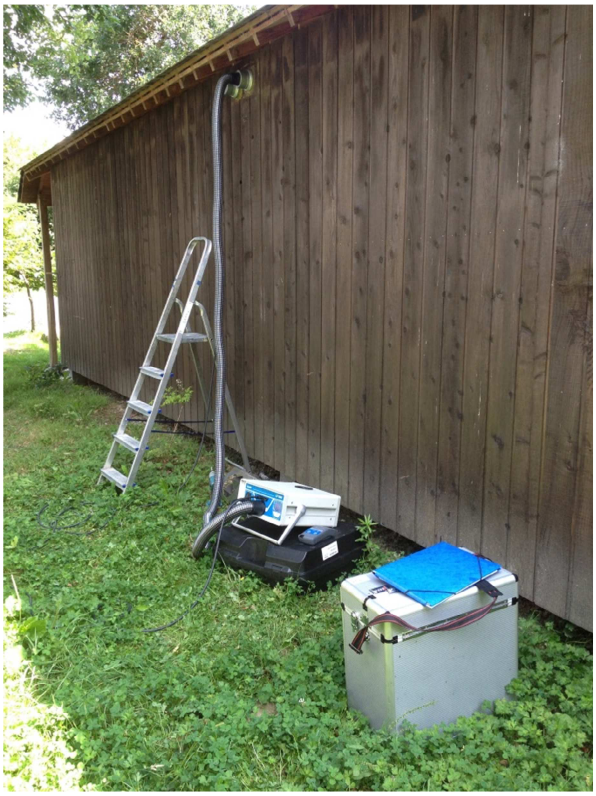
South Window: UNILUX Design line 0.7, wood and aluminum, Uf = 0.86 W/m².K
Triple glazing Thermowhite WSG 0.6, Ug = 0.60, g = 61%
Uw = 0.75 W/m².K



10. Airtightness strategy and results

We knew at the beginning that small means more expose to outside. As we seen before, tiny house include lots of surfaces between inside and outside air, so more loss, therefore more sources of air infiltrations everywhere.
So I planned when I drew the project, to use a very safe solution to reduce problems. So there is only one material who play the function of Airtightness, for floor, walls and roof. As the matter of fact it's a PROCLIMA INTELLO +, and the associate Tapes who make an entire skin.

When we started the test of airtightness to get result, we soon have to accept that the traditional blowerdoor doesn't work for small space of 12 square meter. On the one hand, the flow we needed to calculate was too small for the machine, on the other hand the bad link between blowerdoor and window distorted reality. Finally, LINDAB who was also sponsor of this project, suggest to use à measuring equipment design for the air ducts systems, the LTEST. This machine was connected to the entrance and the exit of the air ducts built for the ventilation. So we finally get results with this machine, arrived at 0.44 h^{-1}.(0.428 h^{-1} negative pressure and 0.451 h^{-1} Over-pressure)
Tested by the company Tyeco2, Martial Chevalier.

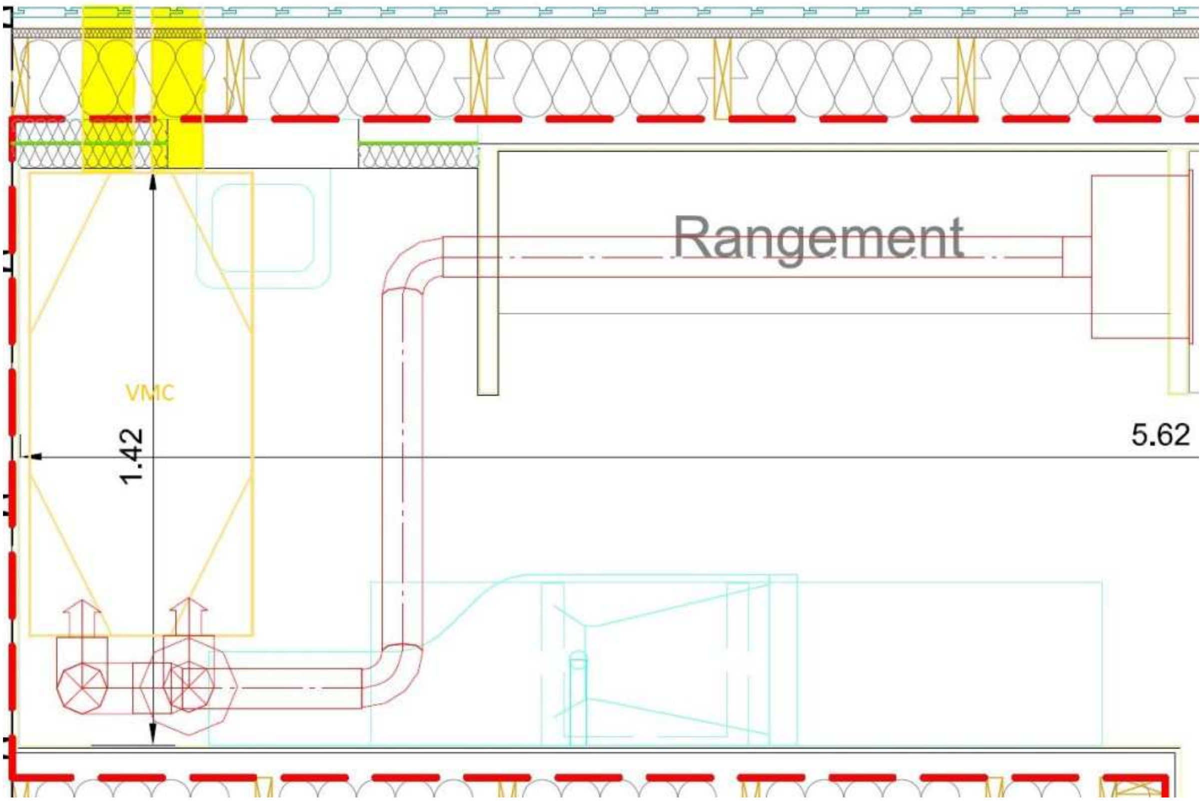


11. Ventilation Strategy

When I started to encode the PHPP, one on the most important question was “how to assure ventilation for 12 square meter, with a machine who have a Phi certified performance, and also without technical room!”. After many research, I finally let the solution of in-wall ventilation (small ventilation in a unique double duct inside the wall) because those machines have low and non-certified performance.

Next to Helios in the end I found a really good solution. They have a compact machine for small house, the KWL EC 220 PRO, who is designed for 60-160m3/h, and to be hang to the ceiling. With only 25 cm of thickness, it could be hang on a technical ceiling, at the opposite of the office, without technical room.

However, I had also to resolve the problem of air ducts, because the main part of the office has no technical ceiling. I firstly resolved the problem of main air duct (incoming and out coming) from outside. I found a grille from HELIOS (IPFKB) very useful, it is shape to have the entrance and the exit air in the same grille, and the space between both is the same than the ventilation KWL EC 220 PRO. So I had no cold duct inside the house!



For the secondary ducts inside the project, I used a LINDAB ducts spiral tubes. Those strong and jointed tubes are only 5 meters. Most of them are hidden near the ventilation, but a small part going to the desk is keeping viewed

The ventilation hidden in a small technical ceiling :
HELIOS KWL EC 220 PRO
Phi certified : 88%
0.4 Wh/m3

12. Heating strategy

At first, we chose the Iron kettle to boil water and heat the office. This choice was a volunteer concept to show what the heating demand is in passiv haus (to communicate). Though the power of the kettle is finally higher than loss, it was a problem during first winter. Indeed, during night time and week end, nobody was in the office and the kettle stay off. So we had some Monday’s morning when we arrived, the temperature was under 17°C. So it was an uncomfortable solution. In addition to kettle, I installed à heating diffuser HELIOS ECO2 placed near the desk, and connect to the balanced ventilation HELIOS. Tempered to 19°C it gives a real comfort anytime.

13. Verification

Vérification du bâtiment passif

Bâtiment:	PROJET MIZU - Bureau société Hinoki
Localité et zone climatique:	Rennes / F - Rennes
Adresse:	La delée
Code postal / localité:	35150 Amanlis
Pays:	France
Type de bâtiment:	BUREAU
Maître de l'ouvrage:	Thomas Primault
Adresse:	La delée
Code postal / localité:	35150 Amanlis
Architecte:	HINOKI
Adresse:	La Delée
Code postal / localité:	35150 AMANLIS
Bureau d'étude fluides:	HINOKI
Adresse:	La Delée
Code postal / localité:	35150 AMANLIS

Année de construction:	2014				
Nombre de logements:	1		Température interne:	20,0	°C
Volume extérieur du bâtiment V_e:	45,0	m^3	Apports internes:	3,5	W/m²
Nombre d'occupants:	0,3				

Valeurs rapportées à la surface de référence énergétique

Surface de référence énergétique:	11,8	m^2			
	Méthode utilisée:	**Méthode mensuelle**		**Certification standard passif:**	**Accompli?**
Besoin de chaleur de chauffage annuel:	**12**	**kWh/(m²a)**		**15 kWh/(m²a)**	**oui**
Résultat du test de perméabilité:	**0,4**	**h^{-1}**		0,6 h^{-1}	**oui**
Besoin en énergie primaire (eau chaude sanitaire, chauffage, électricité auxiliaire et domestique):	**94**	**kWh/(m²a)**		120 kWh/(m²a)	**oui**
Besoin en énergie primaire (eau chaude sanitaire, chauffage et électricité auxiliaire):	73	**kWh/(m²a)**			
Besoin en énergie primaire économisée par la production d'électricité photovoltaique:		**kWh/(m²a)**			
Puissance de chauffage:	20	**W/m²**			
Surchauffe estivale:	3	**%**	sup. à	25 °C	
Besoin de refroidissement annuel:		**kWh/(m²a)**		15 kWh/(m²a)	
Puissance de refroidissement:	14	**W/m²**			

14. Construction Cost

It is difficult to give a construction cost, owning to sponsoring and a part of auto construction. If we try to calculate, without sponsoring, **the cost is around 2000 €/m²**
This project required an expensive budget, because it uses lots of technologic systems (VIP, PCM...) costly materials, and small surface that mean high price per m². In opposition, the cost of the total project is really fair with 25 000 €.

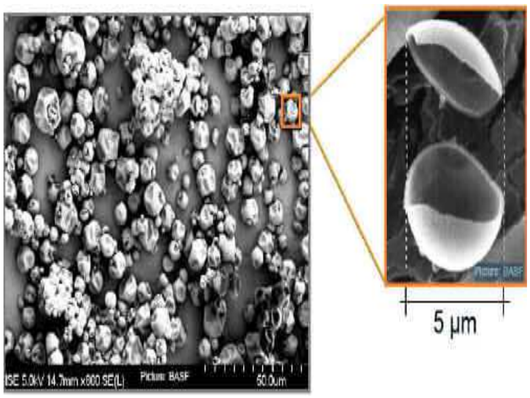
15. Year of construction

2014

16. Architectural intentions

This project needed to be completely integrate in the global project (private house and garden) So his office function had to be integrated in this living place. Using the vocabulary of Japanese architecture, the building is surrounding by an ENGAWA, who is a deep patio, covered by roof, his function is to protect from rain and to stay dry walking around the house or sitting. In the Britanny climate, this function is really comfortable, and during summer it gives a really good solar protection. Indeed, the larges windows, open to the garden, give lots of sun during winter but need to be protected in summer.
The Japanese architecture let an important place for Nature in construction, completely open to the outside, this small office look larger than it is, making the limit of inside out of focus.
Garden is a part of it, inside materials are naturals (wood flooring, furniture) or just white to forget their existence. That's a smashing experience to work here, surrounding by nature, and always in hot climate (given by passiv haus).

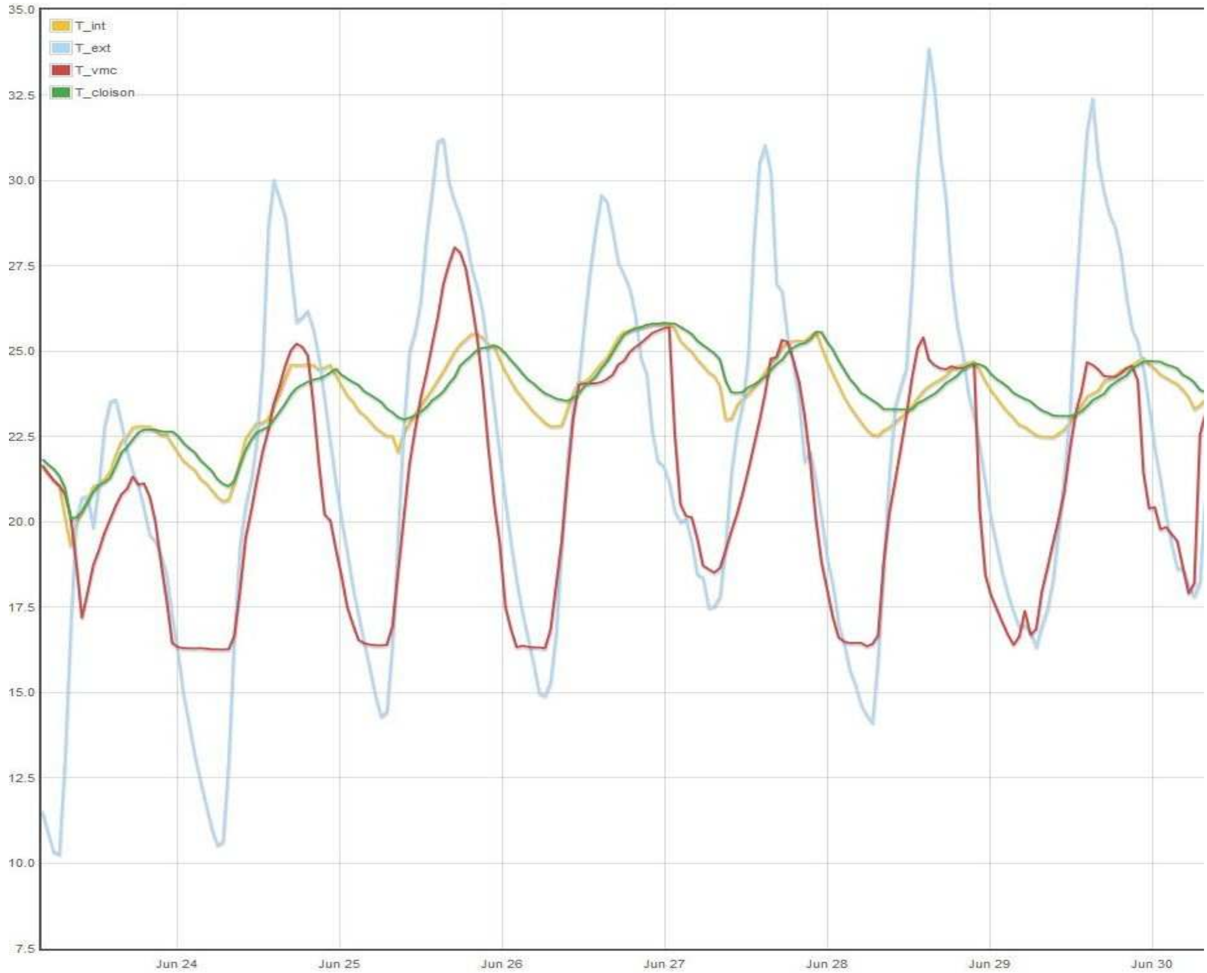
17. Physical research : thermal mass cooling



As telling in the first part, one of the problem in this building was the light thermal mass cooling, because of the 100% wood construction. The structure and space available, did not permit to use clay, concrete, or other heavy materials. So I had to find a thin material, who can give more mass than the other one. My research makes me meet a company specialized in PCM (phase change material). Based in Britany they have just created a plaster who integrate PCM. Selling as ENERCIEL, this plaster has a great capacity to absorb energy. We found an accord and they sponsored the project. This plaster was applied on every wall in 6 mm

18. Experiences

The office has now been occupied for one year, the feedback is really positive, given by the architecture, and the comfort of Passiv Haus. All the temperatures are monitored, and we had now a return of what happens during winter and summer. Eventually, the summer conditions are quite good, in spite of really hot summer this year, due to ENGAWA and solar protections:



During winter, the temperature is good, but the difference between night and day is sensible. I think the PCM are not enough efficient than calculate, and natural thermal mass cooling are to light.