

### 3.3 Johan Berte



Mr. Johan Berte is an industrial designer based in Belgium. He is currently Project Manager for the International Polar Foundation (IPF; Brussels, Belgium) Princess Elisabeth Antarctic Station project. He leads the IPF design team and is responsible for coordination of station construction.

Aware of the increasing impact of human activities on the Earth system, Belgian Science Policy Office (Belspo) launched in 1997 a research programme in support of a sustainable development policy. This umbrella programme included the Belgian Scientific Programme on Antarctic Research. The International Polar Foundation, an organization led by the civil engineer and explorer Alain Hubert, was commissioned by the Belgian Federal government in 2004 to design, construct and operate a new Belgian Antarctic Research Station as an element under this umbrella programme. The station was to be designed as a central location for investigating the characteristic sequence of Antarctic geographical regions (polynia, coast, ice shelf, ice sheet, marginal mountain area and dry valleys, inland plateau) within a radius of 200 kilometers (~124 miles) of a selected site. The station was also to be designed as ‘state of the art’ with respect to sustainable development, energy consumption, and waste disposal, with a minimum lifetime of 25 years.

Mr. Berte participated in the conceptual design studies leading to the selection of the IPF by the Belgian government to construct his team’s proposed station design. Since 2004, Mr. Berte has traveled in each of the subsequent Antarctic seasons to the proposed location for the new Princess Elisabeth Antarctic Station, assisting in the final site selection, preparing the site for construction, locating a surface route for the transport of supplies and heavy equipment from the coast to the site and, finally, completing the on-site assembly and checkout of the station. When not deployed to the Antarctic, he has been responsible for the engineering and overseeing construction of all of the systems that make up this station.

Mr. Berte has experience as a conceptual designer, system engineer, and project manager in innovative projects ranging from industrial automation, application of new technologies, and space instrumentation. Mr. Berte is a guest teacher and advisor on design methodology and technological innovation at various institutes in Belgium and other locations.

## **A10 – Presentation of Johan Berte**

### ***The Princess Elisabeth Station***

[Slide 1] The Princess Elisabeth Station, Johan Berte

[Slide 2] If you are going to build a station in Antarctica, the first decision is where. Most stations have been built near the coast on the ice and because of the winds are quickly buried in snow. We selected Utsteinen; it is a little further inland on solid rock.

[Slide 3] This is the area where our station is located. It is an 1100 km gap between a Japanese station to the east and a Russian station to the west. Our easiest access is through Cape Town, South Africa. A Belgian station was in the area until 1967 and a Japanese station until 1991, when they were abandoned.

[Slide 4] The red dot is the location of our station; the two green dots are the previous Belgian and Japanese stations. Our station is on the west side of the mountains to protect it from the adiabatic winds. The location gives us access within 200 km to three different areas of scientific interest – the coast area, the mountain range with dry valleys, and finally the high plateau.

[Slide 5] These are some pictures of the typical types of science that you can do in the 200 km area around the station location.

[Slide 6] The goal of the project was to build a station and enable science. So first we needed some basic requirements, which I have listed here; plus we had to finance the station ourselves. Our most important requirement was that we decided to make it a zero emissions station. This was both a philosophical choice as we thought it more consistent with Antarctic Treaty obligations and it was also a logistical advantage. If you are using renewable energy sources, you do not have to bring in all the fuel.

[Slide 7] When I came into the project in 2004, there had already been some work done by an architect; the design presented to me was mostly driven by aesthetics. The sponsors wanted a new approach and the diagram on this slide shows in a nutshell the methodology I used. We took a broad view to develop several concepts over a range of parameters. Building a zero emissions facility is not difficult; building one that also meets the science, human factor and lifetime requirements is more difficult.

I was working with people from the building community that were used to getting a set of architecture drawings, after which they would hire engineers and develop a technical solution that fit inside the aesthetics of the architecture drawings. What we did instead on this project was to remain in the trade space of the parameters without drawings and let the architecture be one of the results. Of course people get nervous if they do not have something to see, so we would create visualizations, crystallizations at points in time. Out of 11 potential building concepts, one was selected through a process of trade-offs to become the baseline for further development.

[Slide 8] This was the first crystallization (iteration) from our process and was the baseline that we evolved. We treated the Antarctic environment not as an enemy, but as an ally, so we were looking for features that could help us. This version consists of two modules. The first module is easy to see and sits on the rock, elevated by poles. The second module is lower, on the non-wind side in the ice next to the rock. The two modules are connected by stairs so that you do not need to go outside. Through measurements, we know that the ice is very stable.

The main module has a technical core containing systems such as water treatment. In the next layer out from this technical core are all the items that use core resources, so in this case for example the bathroom. This keeps everything compact and integrated with short piping. The next layer out are the living areas. Here on the wind side, where we can better control the wind flow and thus reduce noise, we have placed the sleeping rooms. On the non-wind side, we have storage and infirmary, less used areas. To the north (left), we have the offices because there is nothing to see in that direction. And finally, on the south side, we have the living room with a view of the mountains. You will also notice that we are basically circular, so you always have two ways to get to the same place.

[Slide 9] This was the level of drawings I allowed people to use as we worked on the concept of our station.

[Slide10] The station starts to evolve. The roof section has become bigger as we saw an increased storage need for our solar thermal heating systems. We also standardized the wall sections and angles between sections to ease the logistics of building the station. This geometry was combining requirements from ergonomics, construction, aerodynamic and solar passive gains

[Slide 11] This is one of the many small trade studies that we did in our parallel process. This is our light study in which we found out that good lighting conditions meant less energy for lights, but could also heat the station too much. Our first design had offices with temperatures of 40°C (104°F). The engineers of course had an immediate solution – add an air conditioner to the office space. To which I replied, “Are you crazy?” From a week at the Norwegian station, I had learned that people wanted to look out, but were always closing the blinds because of the low sun angle. So our solution to both these problems was to put in low windows on the side and indirect lighting from above. All window layouts were designed to control these solar passive gains but at the same time answered psychological needs. This is just one example showing how simple solutions can solve complex problems.

[Slide 12] And so the station evolved again – this is a drawing I made on the airplane to South Africa. You have lots of time to do this on 11-hour flights were no one is bothering you. [Slide 13] So this was then the third crystallization. The big change here is that the staircase has been replaced with a tower-like structure inside. This allow for gravity feed of water when needed. Also in the tower is a control room-like area for the manger to view what is going on outside on the wind protected side.

[Slide 14] The reason for the pretty pictures here is that it was time for a press conference. At this time, we thought we had a design, but still needed to finish our snow erosion models and testing, which were ongoing at that time.

[Slide 15] And this is what evolved in those studies.

[Slide 16] Why was that needed? We had good control over the forces on the building, which we had controlled from the beginning.

[Slide 17] We also controlled snow accumulation effect pretty well, but we were neglecting a little bit the snow erosion effects. Our model showed that we would dig out our garage (the module in the ice/snow) over time. We changed the corners to reduce the vortex and moved the station slightly. It was only 10 cm in one direction and 20 cm higher.

[Slide 18] This was then the design at the end of that period.

[Slide 19] We also looked at materials. Although we were always interested in high tech materials, we kept on coming to the conclusion that wood worked best. So, 90% of the building is wood construction. Wood use was however not well known to us, so we brought in some specialists to help us analyze water content and other factors. This was important because the wood starts out in Europe, goes through the tropics and ends up in the Antarctic all in fairly short time.

[Slide 20] We also need to work out how to work with the wood and how to package it. All 114 of the containers were worked out in 3D, so that we had good center of gravity and weight data for unloading under sea ice conditions.

[Slide 21] And we did a good amount of testing. This is the last model of the final design. You see a wall section. The outer section is a skin, not part of the mechanical design, which contains insulation. There are two ways to handle the typical problem of snow/water intrusion. One is to avoid and the other accept. We choose to accept. So the skin is designed such that water melt will come out the bottom.

[Slide 22] This is part of our production.

[Slide 23] After a study of what we should test and what we should not test, we decided it was easier to build the station in Belgium and use the opportunity to train the crew and test procedures. We even reproduced the rock environment.

[Slide 24] And of course, since we built it, we had to invite some people. We had it open for 3 days and more than 40,000 people went through it. This was quite a good vibration test.

[Slide 25] This was our parallel study on energy. The goal was not only to make the building zero emission, but also energy efficient within the constraints.

[Slide 26] One of the major factors in the Antarctic is that you are autonomous – no power grid. With renewable energy, grid stability is difficult to achieve. You need to balance the items listed here.

[Slide 27] We worked with standard stand-alone grid with a three-phase bus, which included generator backup, solar energy, wind energy, and batteries. Only surplus energy is stored in the batteries. Of course, you theoretical installed power (consumers) is far more than you can produce, so you need an energy management system. You could just go with a factor of 3, but we needed to do better.

[Slide 28] So we looked in detail at how the power was being used in different situations (attended, unattended, winter-over, etc...). We used two redundant controllers, similar to what you would find in a chemical plant. We have a system that prioritizes usage. For example, charging my MP3 player is not a high priority. We wanted people to be aware of the energy usage, so we installed a large status display in the living room. It was interesting to see how quickly people adapted to such a system. People coming in from outside would naturally look at the energy status.

[Slide 29] We had a number of issues integrating the electrical trays. The number and space needed tripled once we starting outfitting. Now these electrical units need constant temperature and humidity throughout the year; so that needed to remain in the technical core. Our solution was to put them on movable racks with cabling that allowed them to stay connected when moved. Thus, we could roll them out of the way when we needed to work in the area.

[Slide 30] This is the water treatment unit schematic. All water is treated and we have 70-75% recovery from secondary systems. Only drinking water is melted from the snow adjacent to the station.

[Slide 31] As you can see, the water treatment unit is a very compact system. These are pre-assembled as a unit and slip right into their location.

[Slide 32] The water treatment units have full access from the front, so they are easy to maintain in the tight area.

[Slide 33] Here is the water storage in the tower section. There is a reservoir for melt water and one for recycled water.

[Slide 34] This screen shot is from management system (SCADA); this one is for the solar thermal system. There are similar screens for all systems. We have access to such screens in both the base manager's office and the living room.

[Slide 35] To prepare, we constructed the entire technical core in Belgium; again, we did this for both testing and training.

[Slide 36] This is a list of the expeditions and corresponding goals leading to the creation of an operating station. Because our landing site is not accessible until December, we need to plan our deliveries for the following year.

[Slide 37] Scouting the site on the first expedition.

[Slide 38] This is how we got there, using the Novolazarevskaya runway at the Russian station.

[Slide 39] This is our target area. Originally 8 locations in the 300 square km area were under consideration and here you can see our final selection. The parameter list for selecting included requirements like accessibility, sun and wind conditions, access to fresh snow, stable bedrock etc....

[Slide 40] This first expedition went in by air and consisted of 7 people and 2 tons of equipment, including 2 snowmobiles. We only had a limited period of 1 month on the ice.

[Slide 41] Another view of our final selection; protected, but not so protected that wind turbines would not work; good access to the plateau; soft snow for water.

[Slide 42] During this visit, we installed an automatic weather station and did a topographic survey. These data were used for the engineering process.

[Slide 43] For the second expedition, we came in by Bessler (refurbished DC3).

[Slide 44] We needed to map a route from the coast to the station site. Of course, near the coast there are lots of crevasses.

[Slide 45] On the third expedition we came in by ship.

[Slide 46] And we were lucky and found a good offloading location with a natural ramp in a crack. Unfortunately, the wind picked up, pushing the ship back and the ship took the ice with it. So in the end it took us almost 10 days to get 12 containers on land.

[Slide 47] What worked very good was this logistics train. We have an agreement with Norwegians whereby we bought the same vehicles as they had and then we could share spare parts. We used for the first time this side loading mechanism and it worked very well.

[Slide 48] At the site, we tested the anchoring ability of the rock for the wind turbines. We assembled one turbine for testing.

[Slide 49] After the problem at the first ship unloading site, we needed a different unloading site for the fourth expedition. We found this new site, but it was much more to the west.

[Slide 50] So we had to re-map the access route.

[Slide 51] So this is our ship on the fourth expedition at our new landing site.

[Slide 52] We traveled about 5 km over the sea ice. This is our new ramp area. During this year we unload 117 containers, 1000 fuel drums and two new vehicles.

[Slide 53] Our logistics guys laid out all the unloaded containers; and if you look at the satellite photos, you can see them all nicely lined up.

[Slide 54] Then of course, you have the normal Antarctic issues – weather and breakdowns.

[Slide 55] At the site we had to deal with one more big issue – the anchoring of the building. The rock is not really solid bedrock, so we had to not only anchor the building to the rocks; we have to anchor the rocks to each other. This was one thing we could not test. And we finished just as the first vehicle was coming in from the coast.

[Slide 56] Here we are starting to build the station. The lessons learned from building it first at home really paid off.

[Slide 57] The assembly went much quicker than we expected.

[Slide 58] Soon the entire garage was complete and the frame for the upper building was complete.

[Slide 59] Then we came to a decision point. Do we close the building or not? You do not want to have a half-closed building during a storm. We decide to close it. With the skin you can see a combination of rounded forms and sharp edges. The sharp edges on the corners are vortex triggers.

[Slide 60] Here is a nice distance view of the station. During a storm, we left the crane unlocked and it just moved back and forth with the wind like a wind vane.

[Slide 61] Just after we closed, we had our first storm. This was actually good as it allowed us to immediately evaluate the wind interaction around our new station. There were no vibrations at 140 km/hr (87 mph). There was not enough snow to evaluate accumulation patterns.

[Slide 62] A good view of the station from the Utsteinen.

[Slide 63] A picture taken during the last days of the season.

[Slide 64] My office.

[Slide 65] The base camp.

[Slide 66] Another view of the station from the Utsteinen.

[Slide 67] During the fifth expedition, we were working to get all the active systems installed.

[Slide 68] Although I was attempting to hold off the scientists until we were a little more complete, we did start science operation last year. This is a list of those science projects.

[Slide 69] This is an important picture – after leaving the station for 8 months, the big news was that it was still there, including all the wind turbines.

[Slide 70] This is the mess tent to the east side of the station. Although you cannot see it, there was no snow accumulation or erosion around the station.

[Slide 71] This is an overview of our base camp organization.

[Slide 72] This is a shot from our ultralight airplane, which we can use in good conditions.

[Slide 73] This is our tent city. Everyone has their own.

[Slide 74] This is inside our mess. Good food equals good moral.

[Slide 75] This is overview of our active systems connections throughout the station.

[Slide 76] The bio-reactor installed.

[Slide 77] The water storage with local water treatment not quite installed. Recycled water on the left; snow melt on the right.

[Slide 78] One of the solar thermal systems installed on the roof.

[Slide 79] The corresponding part of the solar thermal systems installed on the in the roof.

[Slide 80] Here you have your typical picture of a site under construction.

[Slide 81] Here are two redundant ventilation systems.

[Slide 82] This is an important picture. With wood construction, there is no natural grounding, which is inconvenient for people and a real problem for electrical equipment. So we laid down a grid of copper strips. The strips are laid down in 3D, so they include the ceilings, basically creating a cage.

[Slide 83] This is a picture near completion of the station.

[Slide 84] Here you see that we also have solar panels on the sides of the station. This does not add to the overall production as much as it allows it to be more continuous as the sun progresses.

[Slide 85] This is the power electronics and the solar panels on the garage roof. Originally, these were to go on the rocks, but logistically it was easier to put them here. We are a little worried about the effect they will have on the snow accumulation – we will find out when we return this year.

[Slide 86] Eight of the nine wind turbines were installed; the ninth will be installed this coming year.

[Slide 87] Here are some additional details on the wind turbines.

[Slide 88] This is the effect I mentioned earlier where we decided to accept the water melt in the skin and handle it instead of trying to avoid it all together.

[Slide 99] The snow accumulation does not look too bad around the solar panels, but we will see the final answer when we get back.

[Slide 90] Here is a short description on one of our expedition related research projects.

[Slide 91] And here are the preliminary results.

[Slide 92] These are the locations of some additional scientific facilities that have been built to the north and south of the station along the ridge.

[Slide 93] In the coming year, we will finalize the technical build out of the station, including adding our satellite communications.

[Slide 94] And we will start adding site projects. Here we are looking at adding UAV support with a vehicle that can carry a 100 kg science payload.

[Slide 95] Finally, at the beginning of the winter season, the lights go on.



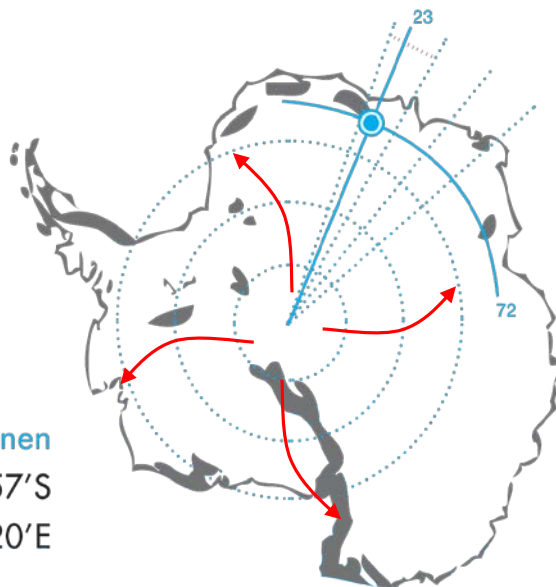
# The Princess Elisabeth Station NASA - Antarctic Traverse Workshop



04/07/2009  
Johan Berte

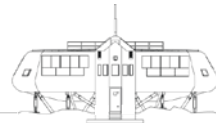
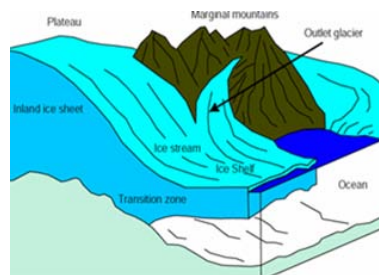
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## Terrain conditions



Utsteinen  
71°57'S  
23°20'E

Ice/compacted snow  
↓  
Plateau & coast  
&  
Rock/permafrost  
↓  
Mountains & coast

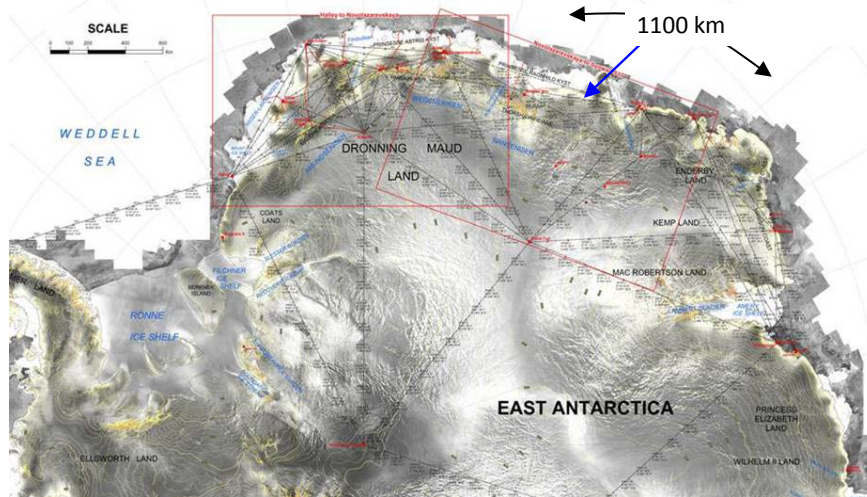


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## Closing the network



SOUTH AFRICA (CPT)



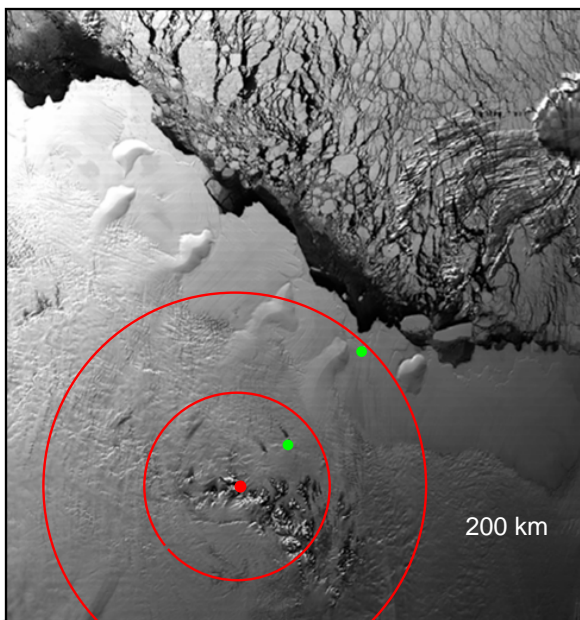
- Logistics
- Science
- SAR

INTERNATIONAL POLAR FOUNDATION



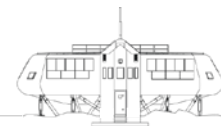
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## Operations range



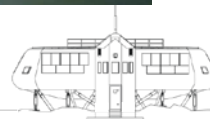
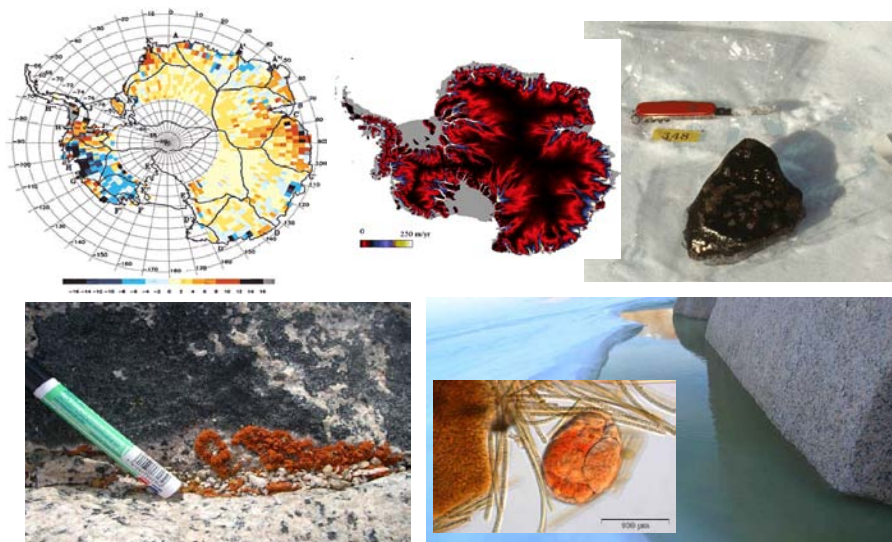
- Starting point for field expeditions up to 200 km
- Stand-alone facilities for observations : geomagnetic, ionosphere, gravimetric, GPS measurements, seismic ...
- Climatology, glaciology, microbiology ...

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4

## Science



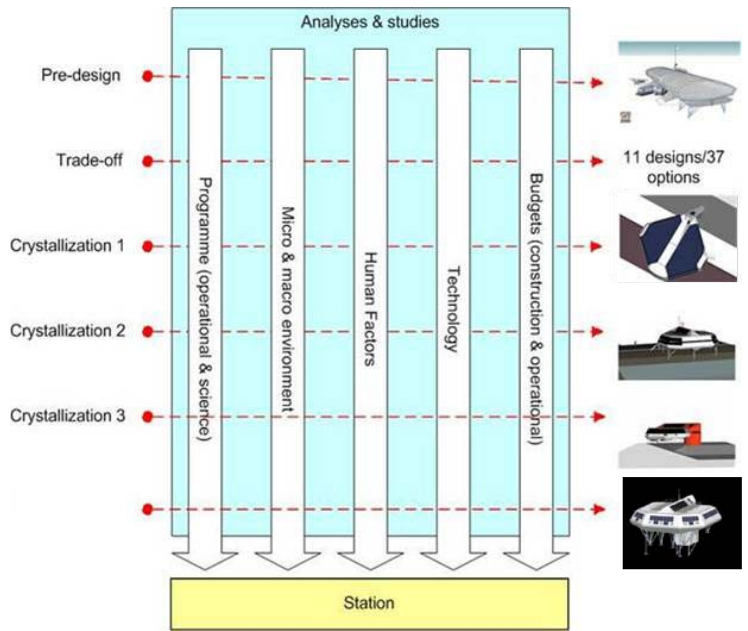
## Requirements



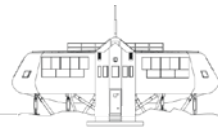
- Full year manned/unmanned
- Remote sensing
- Remote start-up (October)
- 16 Visitors (5 staff)
- Accommodation (living, technical, research, storage): 1500 m<sup>2</sup>
- +25 Years lifetime
- Zero emissions target



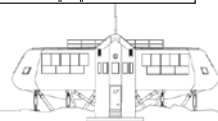
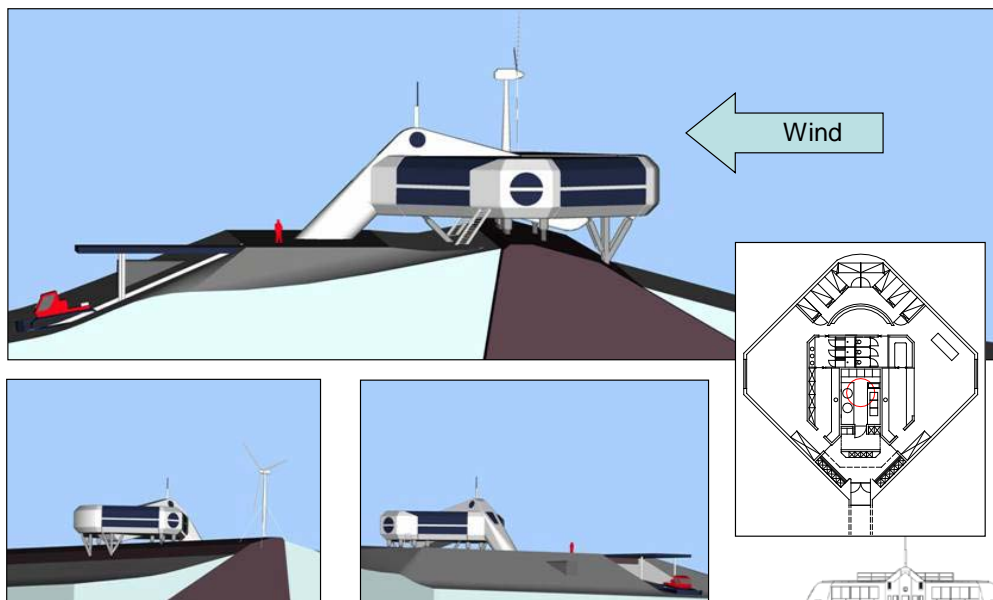
# Design process: methodology



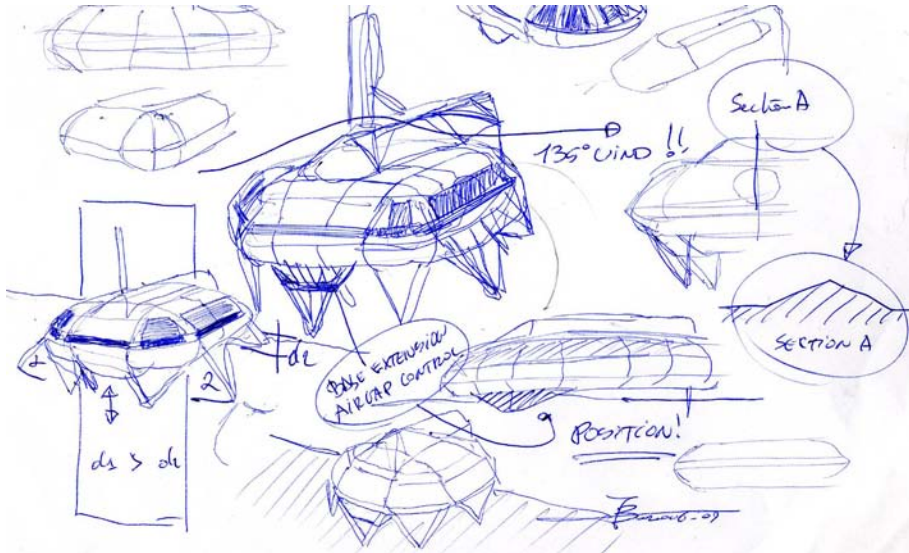
- Form follows function
- 11 designs
- 37 Integrations
- Trade-off process



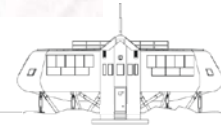
# A hybrid typology (C-1)



# Conceptual design

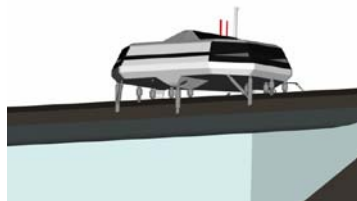
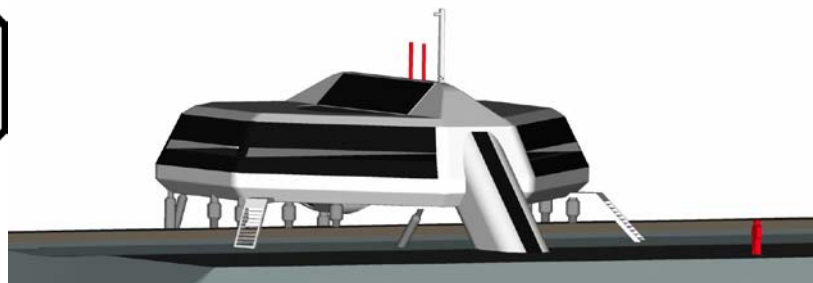
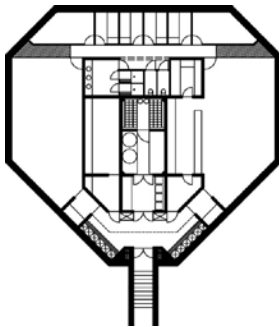


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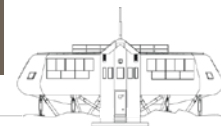


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# Main building (C-2)



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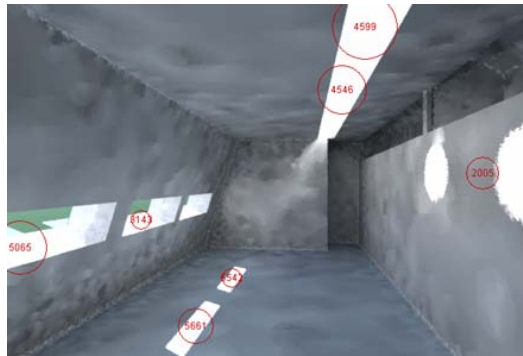


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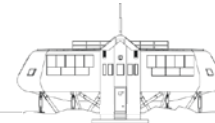
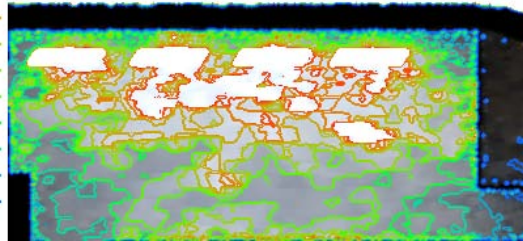
# Design process: key parameters



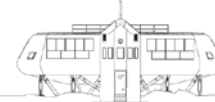
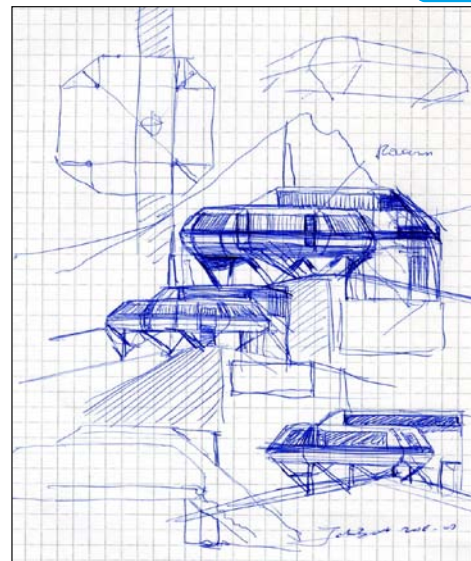
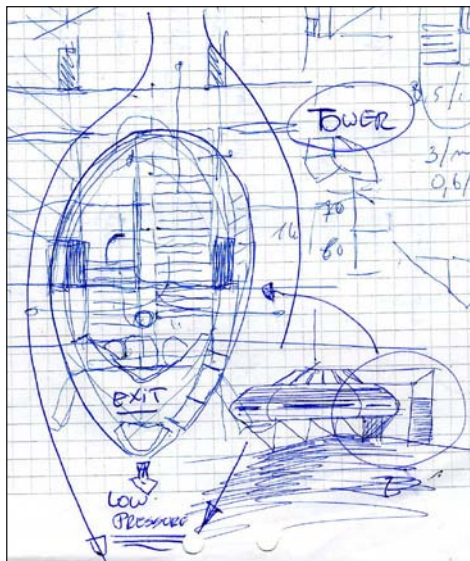
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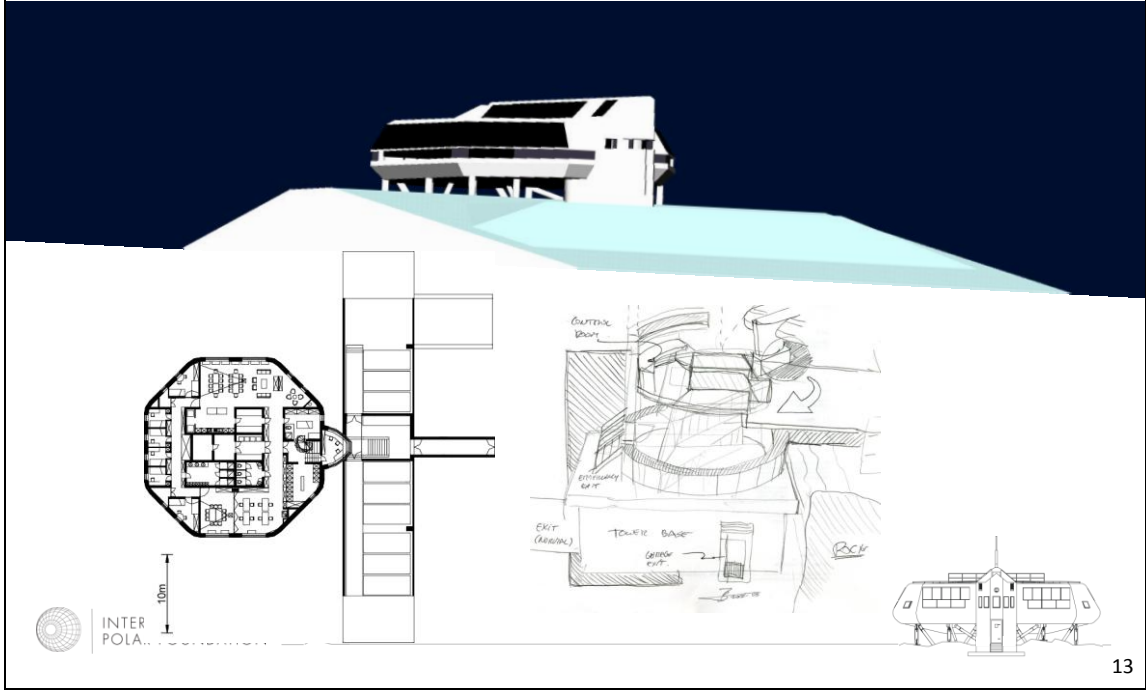
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# Conceptual design



# Main building (C-3)



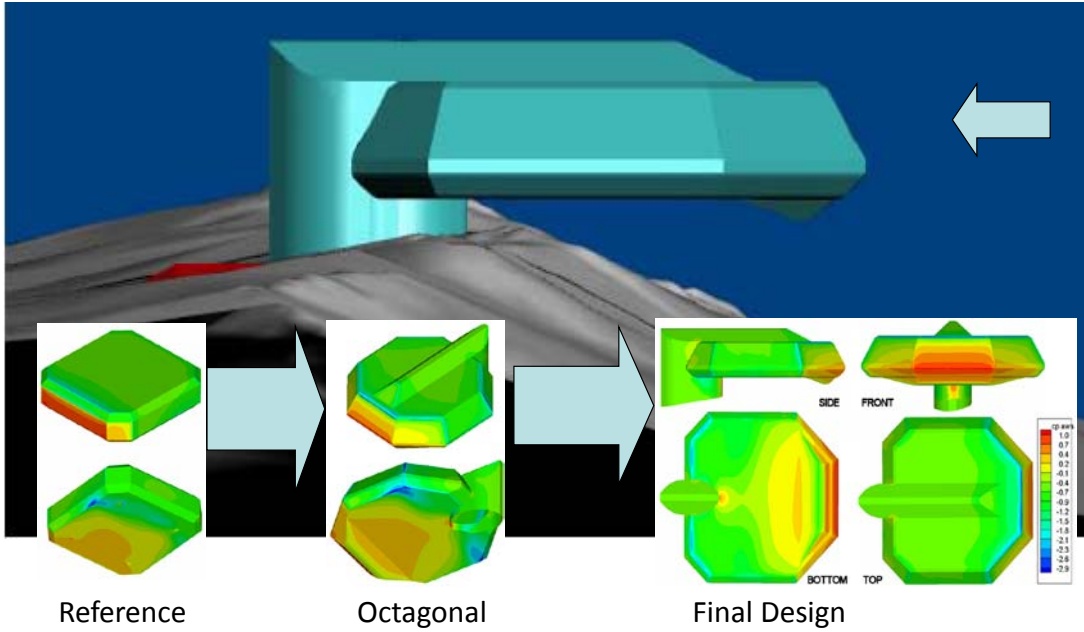
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# 2006: design freeze



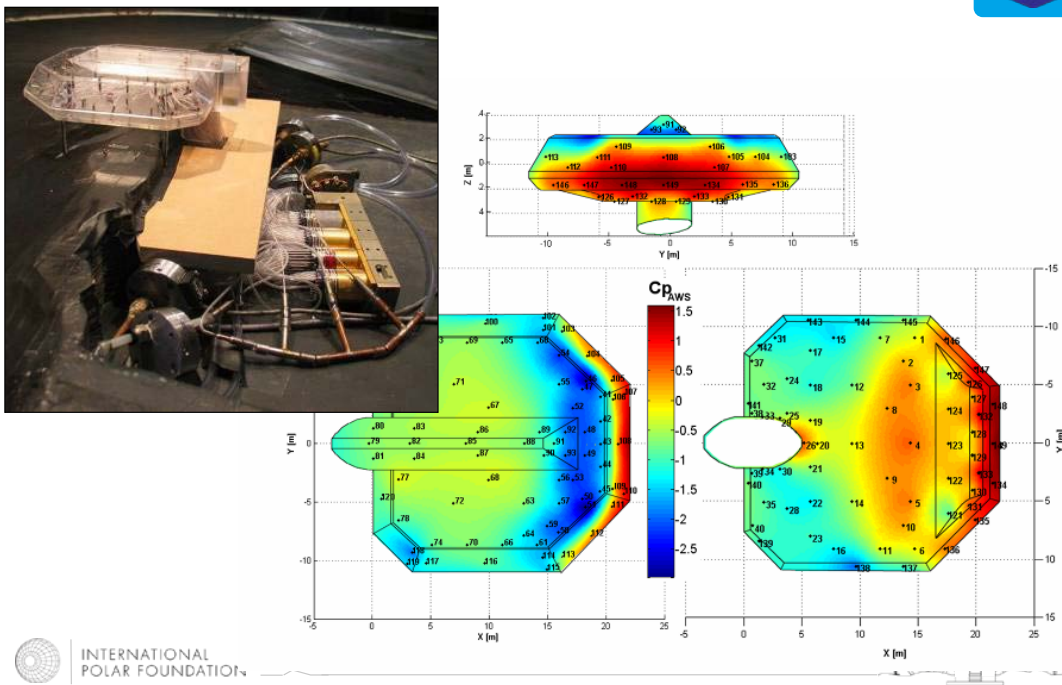
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# Aerodynamic CFD modeling



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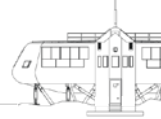
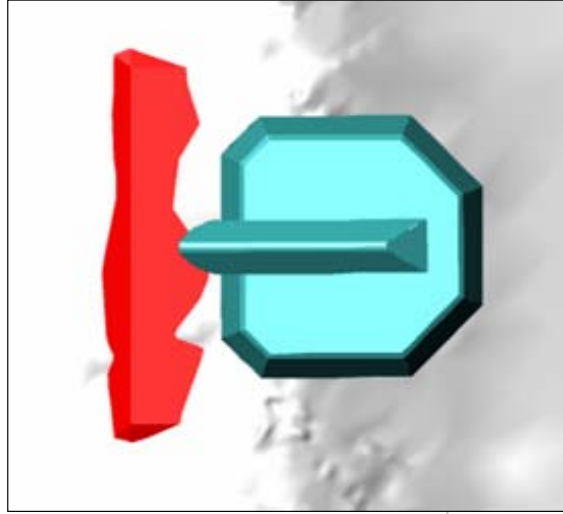
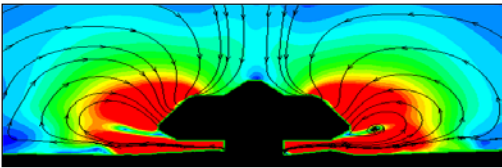
# Aerodynamic CFD modeling



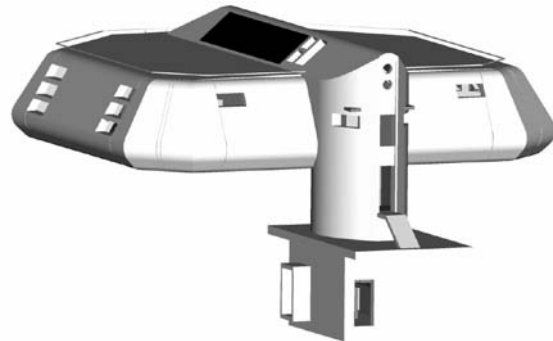
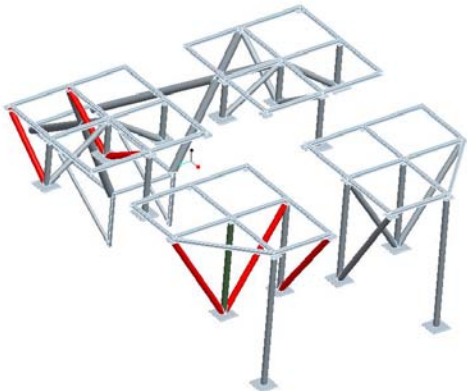
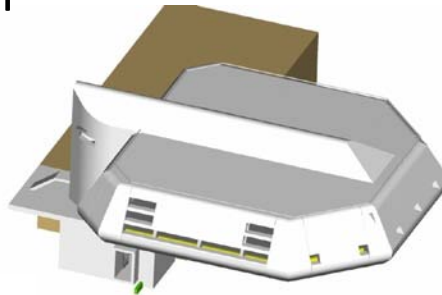
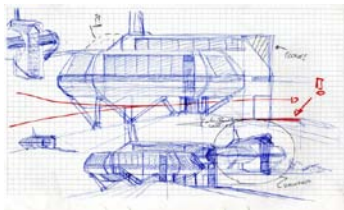
16



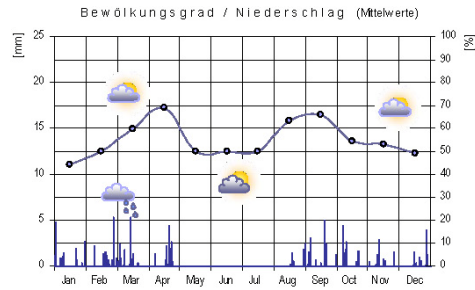
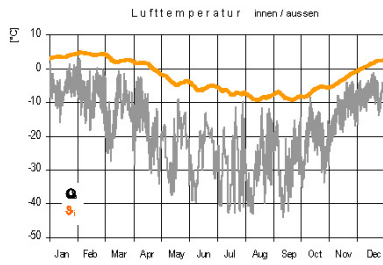
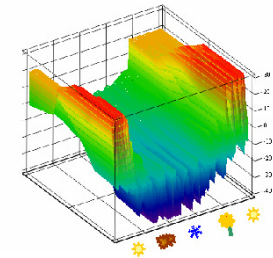
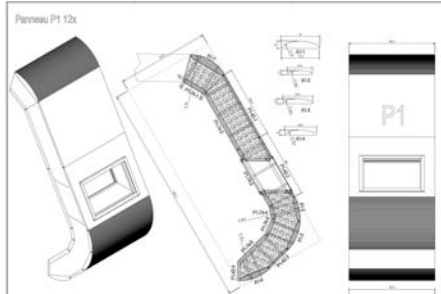
## Snow erosion/accumulation



## Conceptual design

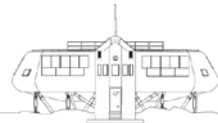
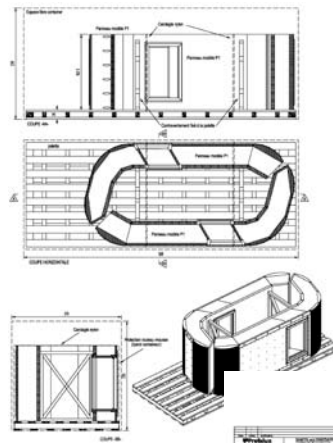
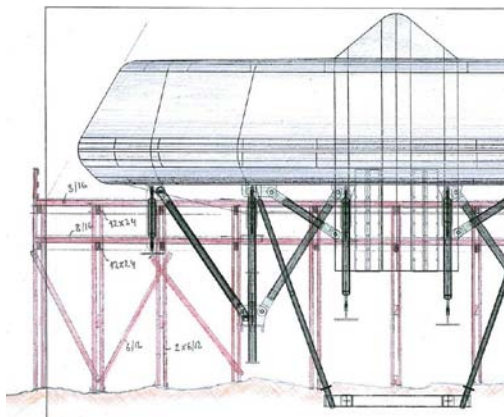


# Wood engineering



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# Construction/transport



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## Testing



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## Wood construction



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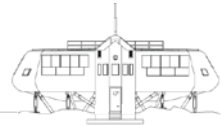


22

# Test assembly



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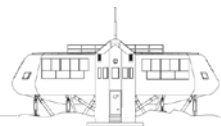


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# 09/2007



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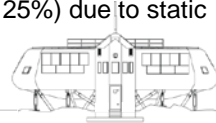


24

## Focus on micro-grid: Constraints?



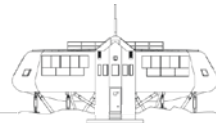
- Isolated environment: Security!
- Low temperatures down to -30 C
- No earthing is possible! Ice & granite are good isolators
- Low humidity <10% => static electricity => kiloVolts are possible!
- Imposed Energy resources by pre-study of 3E:
- Photovoltaic
- Wind
- Batteries
- Gensets for backup
- Low Short circuit power 300A during 100ms (equiv. to Ucc of 25%) due to static converters => adapted protective strategy



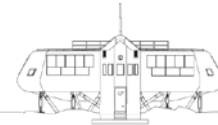
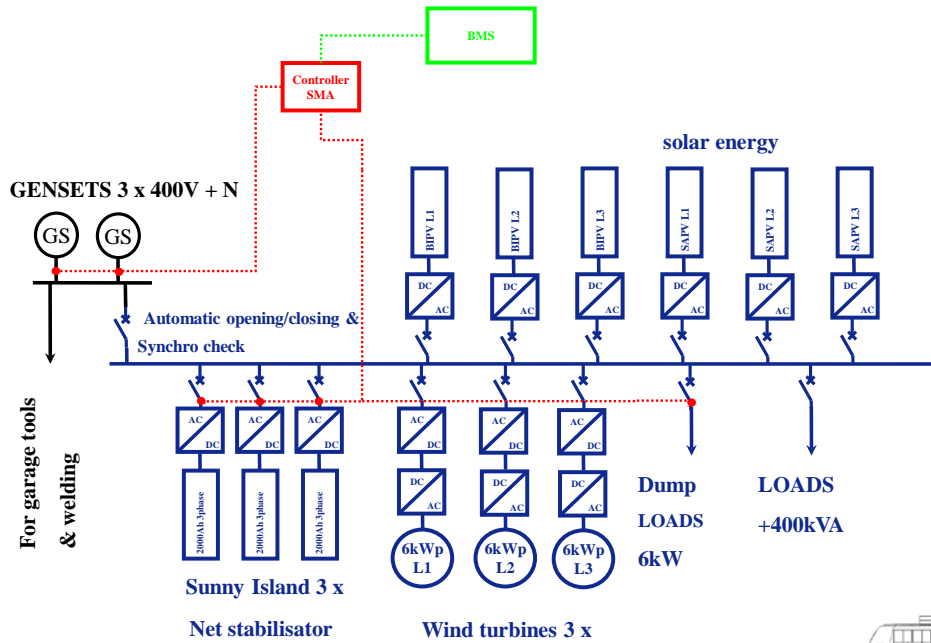
## Focus on micro-grid: Technical



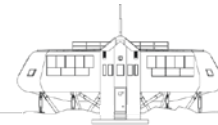
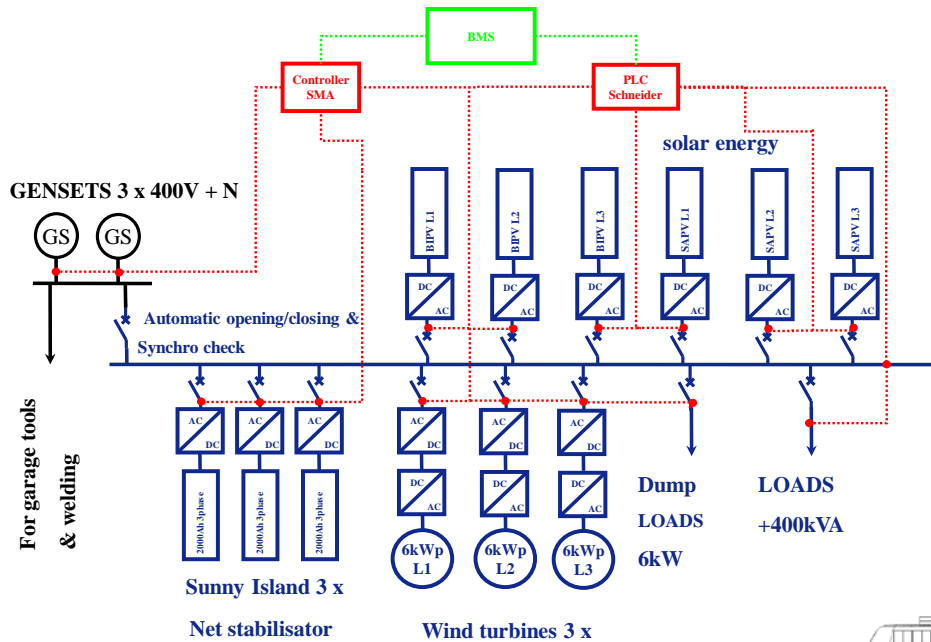
- 3 x 400V + N + “Global earthing” = connecting of all metallic parts together
- Discharging of persons when entering the base
- Main Busbar: In = 250A
- Photovoltaic: BIPV: 17.78kWp – SAPV: 44.94kWp => 58MWh
- Wind: 9 x 6kWp: 54kWp => 140MWh
- Batteries: 48V - 8000Ah C10
- Gensets: 2 x 40kVA @  $\cos \varphi 0.81$  => 6.5MWh /2200l of fuel
- Variable loads: installed power of +400kVA
- Insuring stability of the micro-grid: Sunny Island (SMA) 3 x (3 x 5kW) @ 25 C



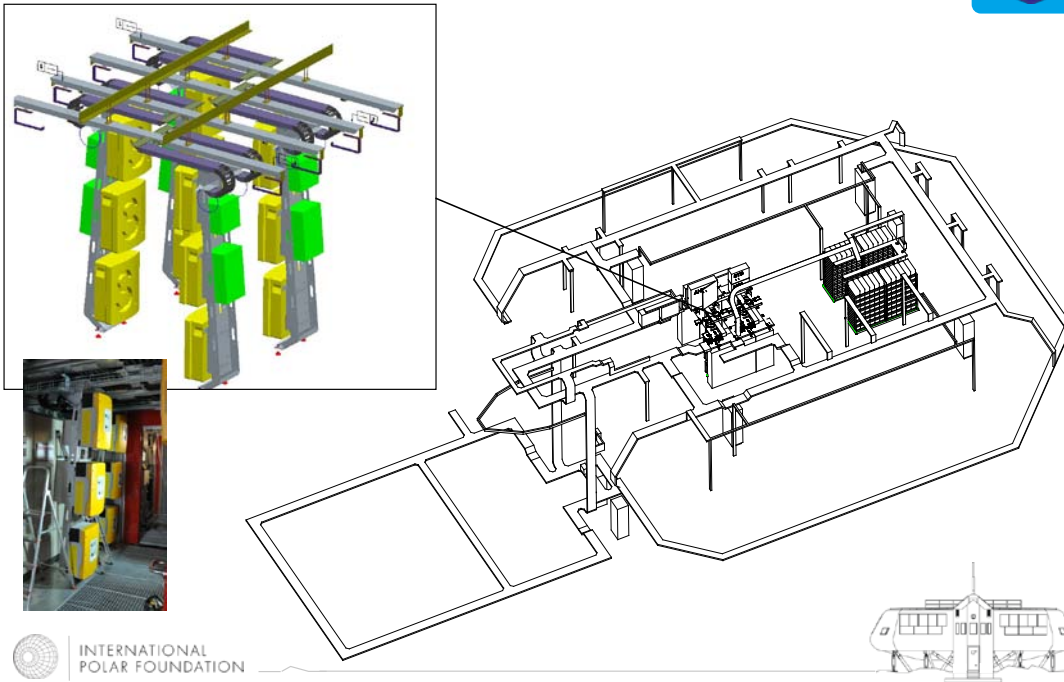
# Micro-grid P load > 3 x Pproduction



# Smart-grid P load > 10 x Pproduction

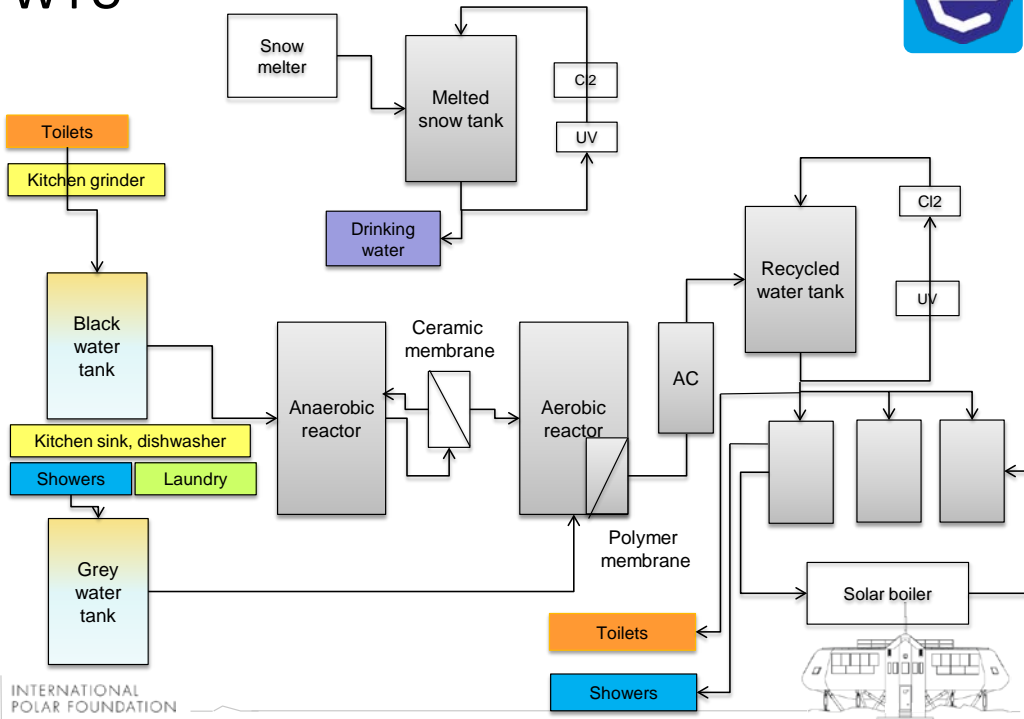


# Integration challenge



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# WTU

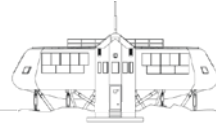


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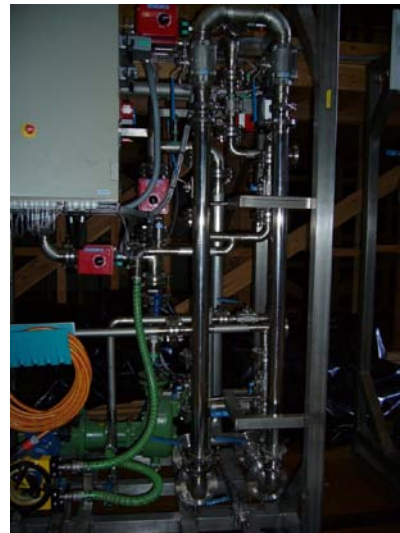
# WTU



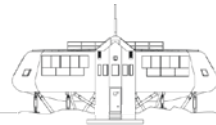
- Anaerobic & aerobic reactors



# WTU

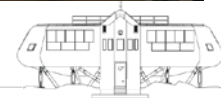
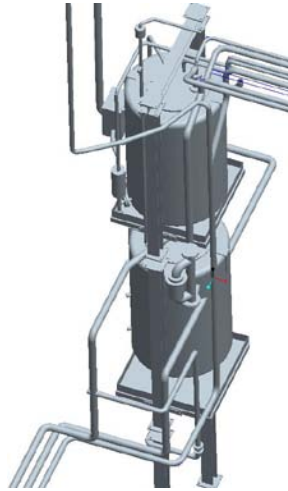
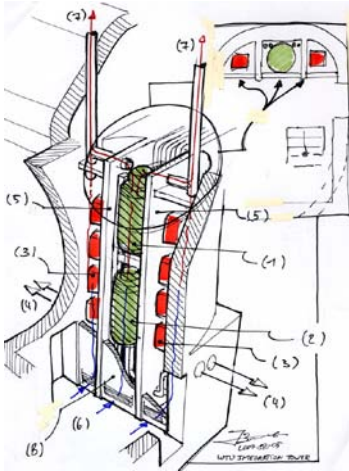


- Activated carbon column and cleaning devices

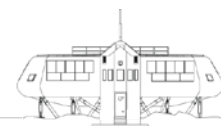
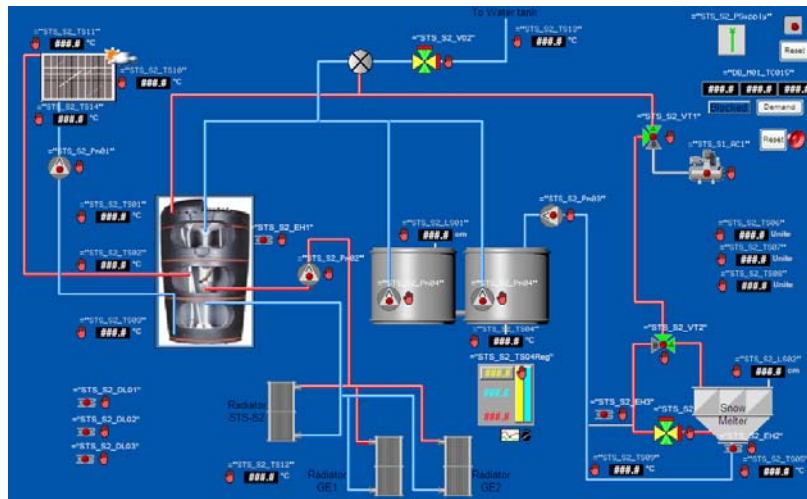




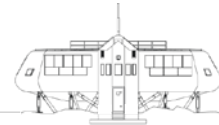
# WWB



# STS-S2 & SMU



## BELARE 2008/9 Preparations



## BELARE (BELgian Antarctic Research Expeditions)



### BELARE 2004/5: Site Survey expedition

- Selection of a construction site

### BELARE 2005/6: Logistic Survey Expedition

- Safe access routes

### BELARE 2006/7: Site Preparation Expedition

- Shipment heavy equipment

### BELARE 2007/8: Construction Phase 1 Expedition

- Construction of buildings

### BELARE 2008/9: Construction Phase 2 Expedition

- Active systems
- Start operational life of the Station

### BELARE 2009/10: Construction SATCOM

- Satellite communications
- Science



## BELARE 2004/5 : Building site



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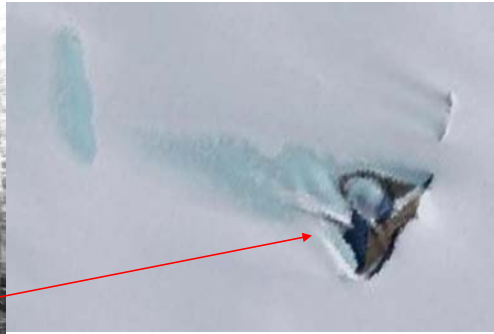
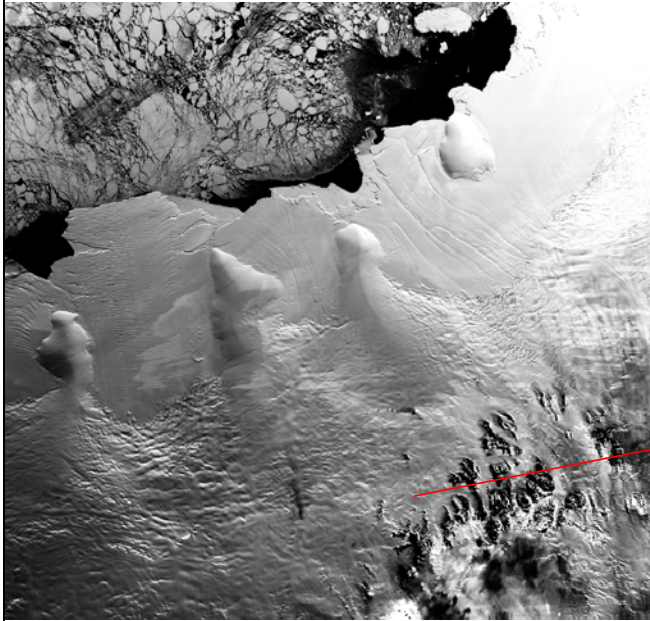
## BELARE 2004/5 : Building site



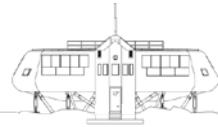
Novolazarevskaya blue ice  
runway

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# Queen Maud Land, Sør Rondane Mts



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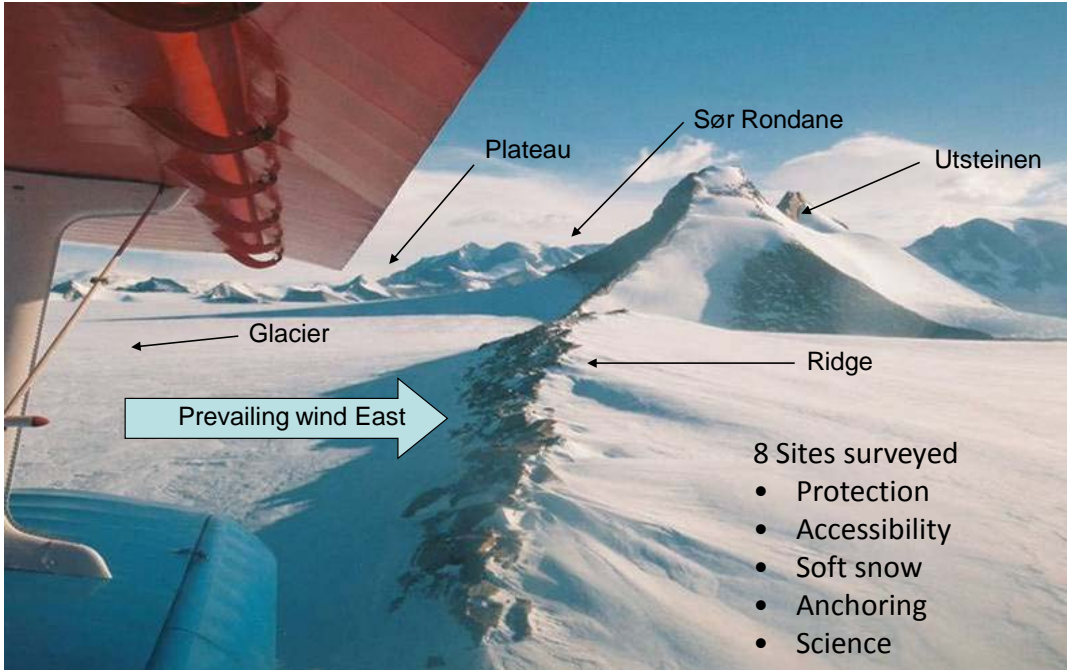
# BELARE 2004/5 : Building site



Gunestadbreen December 2004

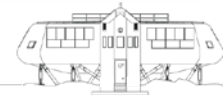
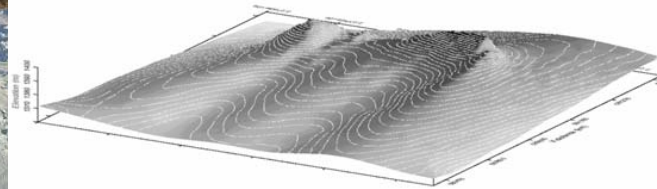
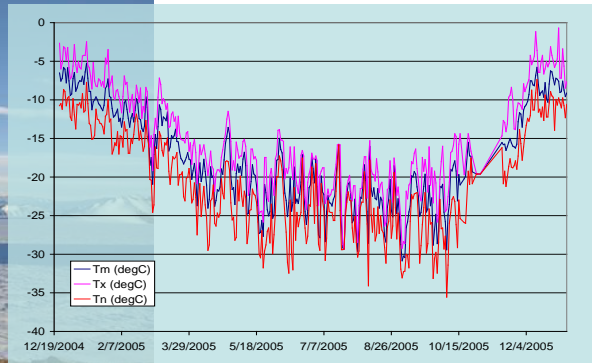
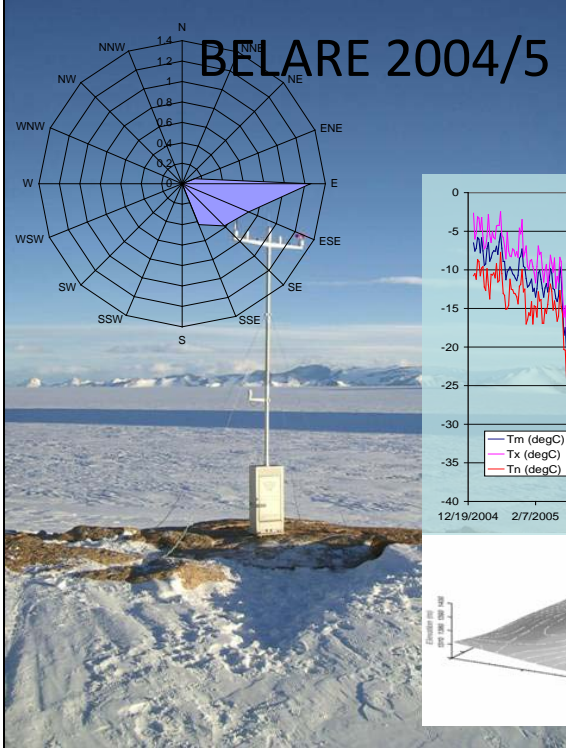
40

# BELARE 2004/5 : Building site



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# BELARE 2004/5 Building site



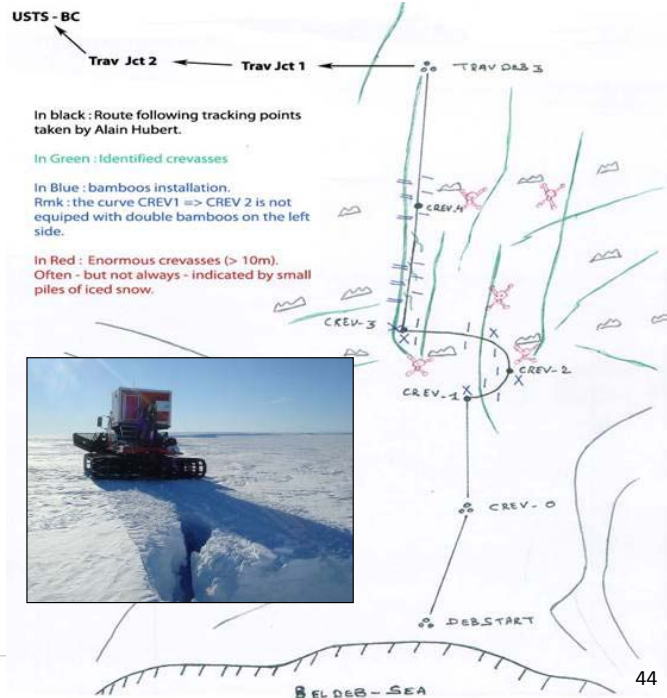
42

# BELARE 2005/6 : logistics

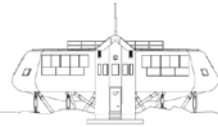


Breid Bay December 2005

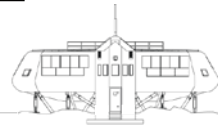
# BELARE 2005/6 : logistics



## BELARE 2006/7: general repetition



## BELARE 2006/7: ship unloading



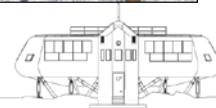
## BELARE 2006/7: overland traverse



## BELARE 2006/7: testing



- First ship unloading (200T)
- Vehicles, fuel, supplies
- Validation logistic chain
- Anchoring & position building
- Wind turbine test (9 x 6 kW)

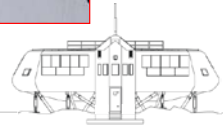




# BELARE 2007/8: Unloading site

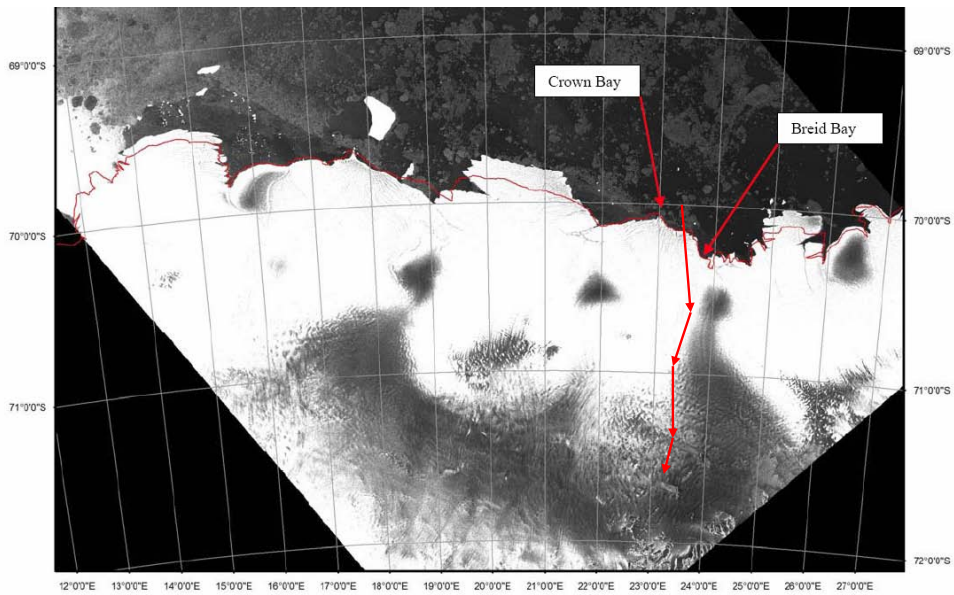


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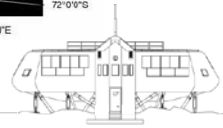


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# BELARE 2007/8: Unloading site

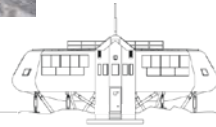


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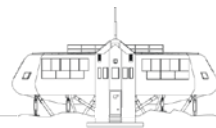


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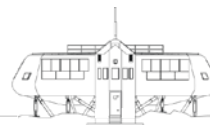
## BELARE 2007/8



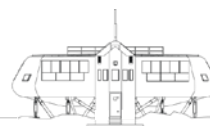
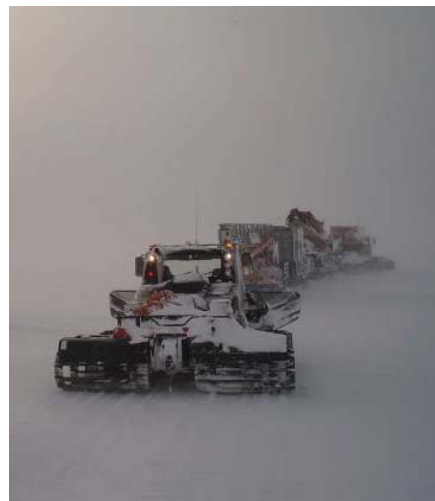
## Unloading on sea ice



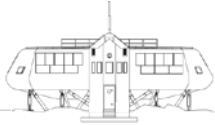
## Coast depot



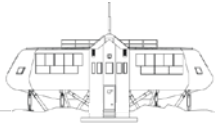
## Traverses: GPS guidance



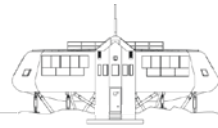
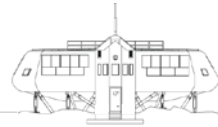
# Anchoring

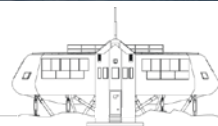
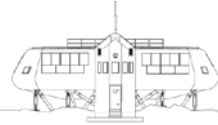


# Wood structure



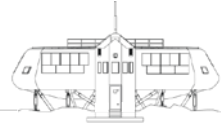
# Frame







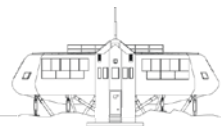
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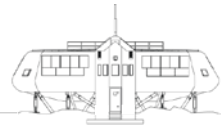
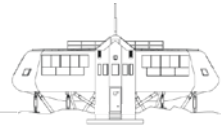
61



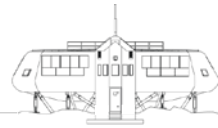
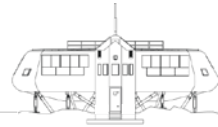
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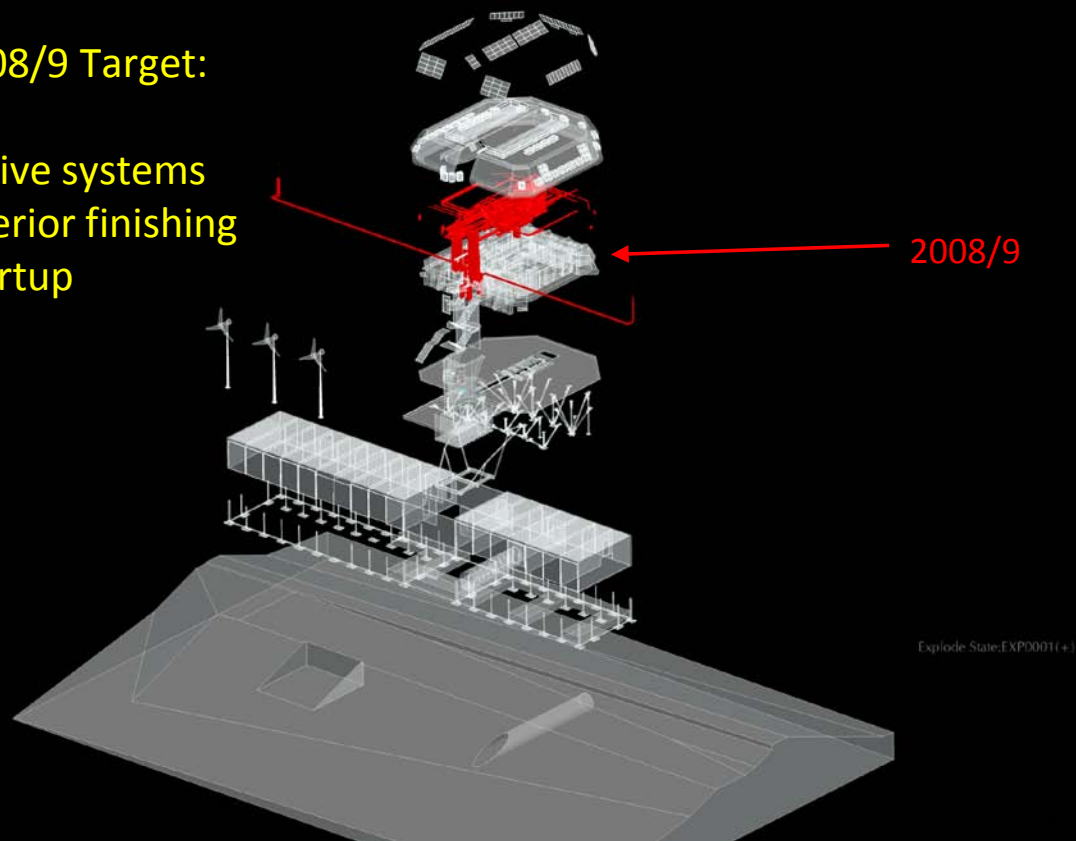






2008/9 Target:

Active systems  
Interior finishing  
Startup



## Science Belare 2008/9



**BELATMOS (RMI)** => BELgian monitoring of ozone and related trace gases, UV radiation, and aerosol particles in support of ATMOSpheric chemistry and climate research

**GIANT (ROB)** => Geodesy for Ice in ANTArctica (Evaluation of the ice mass around the Belgium station in Antarctica using GPS and Absolute Gravity observations)

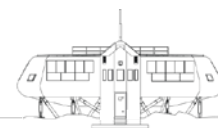
**LISSA (ROB)** => Lithospheric and Intraplate Structure and Seismicity in Antarctica

**BELISSIMA (ULB)** => Belgian Ice-Sheet Shelf-Ice Measurements in Antarctica

**BELDIVA (ULG)** => Belgian Microbial Diversity Project in Antarctica

**HYDRDRANT (KUL)** => Atmospheric branch of the HYDRological cycle in ANTArctica

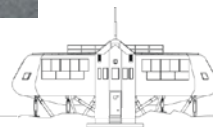
**NIPR NARE 51** => Logistic support



# BELARE 2008/9



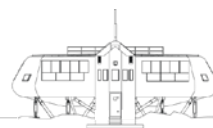
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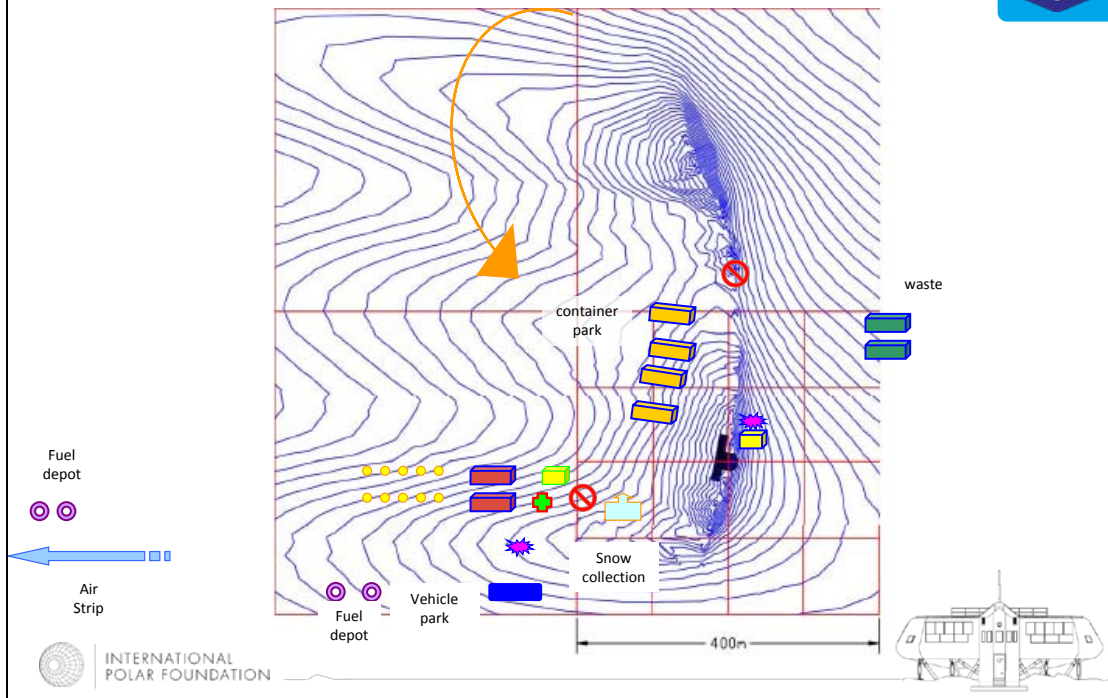


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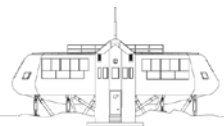
# Utsteinen Base Camp: organisation



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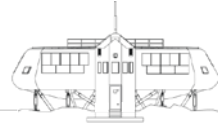


INTERNATIONAL POLAR FOUNDATION

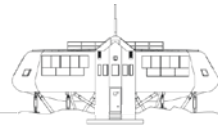


72

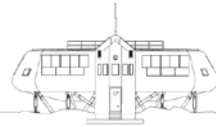
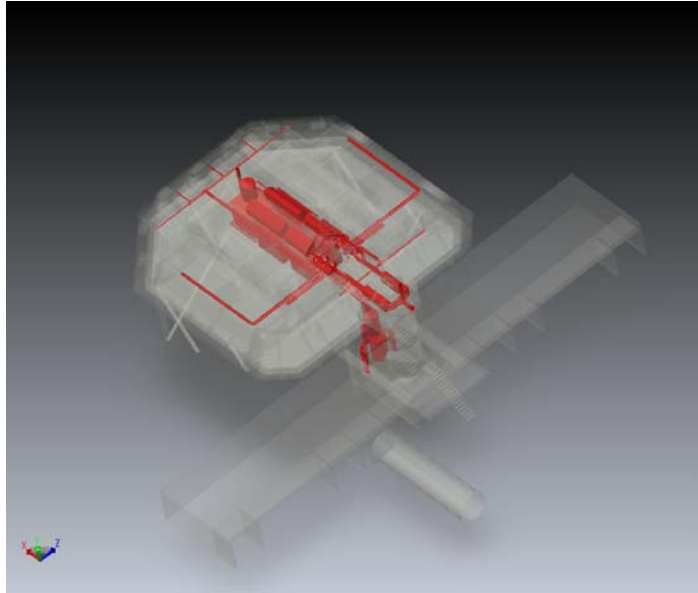
## Sleeping quarters



## Mess: feeding up to 34 people



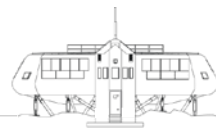
## Active systems integration



## WTU



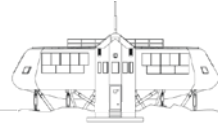
- Aerobic reactor and cleaning unit on site



# WSU



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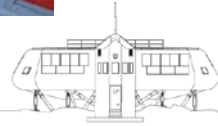


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# STS-S1

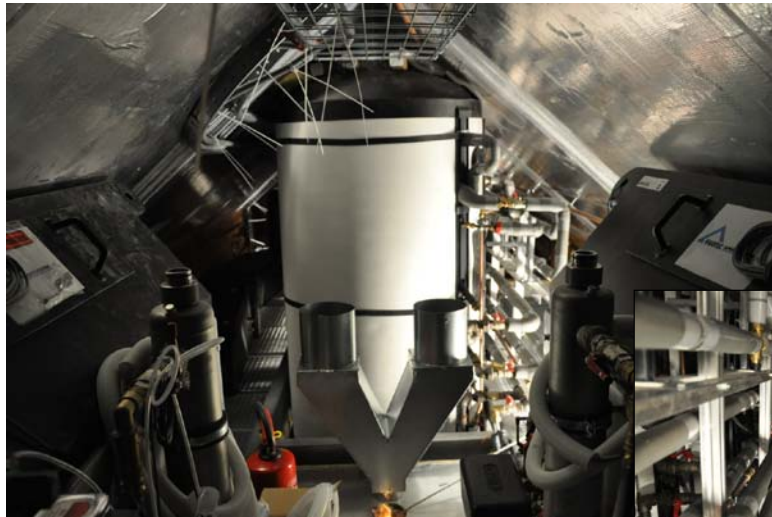


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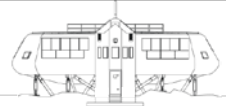


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# STS-S1



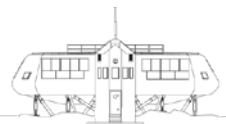
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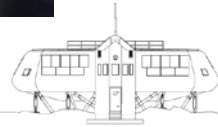
80



# HVAC



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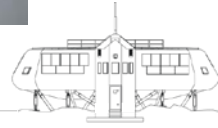


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# EMC



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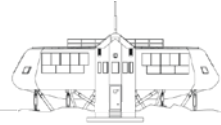


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# BELARE 2008/9



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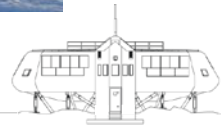


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# BI-PV

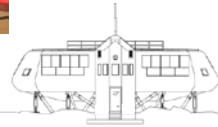
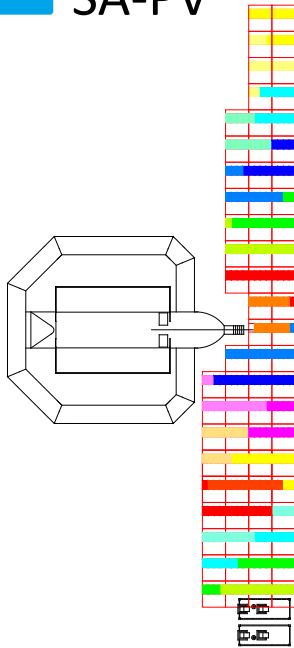


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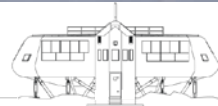


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# SA-PV



# Wind Turbines



# Wind Turbines

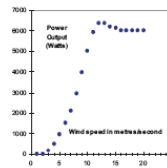


## Technical Specification Sheet

<b>MODEL</b>	Proven 6 (6kW)
Cut In (mph)	25
Cut Out (mph)	None
Survival (mph)	70
Rated (mph)	12
Rotor Type	Downwind, Self Regulating
No. of Blades	3
Blade Material	Glassfibre/epoxy Composite
Rotor Diameter(m)	5.5
Generator Type	Brushless, Direct Drive, Permanent Magnet
Battery charging	48V DC
Grid connect with	230Vac 50Hz or 240 Vac 60Hz ac
Windy Bay Inverter	300
Direct Heating	6000/12,000 kWh
Rated RPM	600
Annual Output	Tk up, tapered self-supporting, no guy wires (Tiller grade towers also available on request)
Hub Weight (kg)	9 or 15
Mast Type	2.5x2.5x1 or 3x3x1.2
Hub Height (m)	1x1x1 or 1.5x1.5x1
WT Found (m)	3x3 or 4x4
Tower Weight (kg)	Yes
Mechanical Brake	45 dBA
Noise @ 20m	65 dBA
Rotor Thrust (kN)	10
Sample of commercial customers	British Telecom Scottish Health Board Association Brexit Rail Irish Lighthouse Authority UK Lighthouse Authority Tireobha Orange Shell Exploration Saudi Aramco

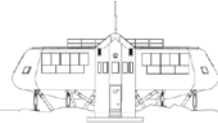
**Proven Patented Furling**  
In winds of above 12m/s or 25mph, the Proven's blades twist to limit power in response to high rpm

**Low Speed Equals Durability**

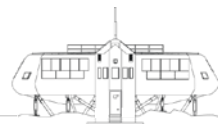


**Marine Build Quality**  
All machines are manufactured with galvanised steel, stainless steel & plastic components

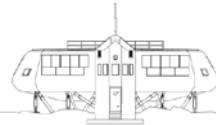
1. metres/second = 2.24 miles per hour x 0.447
2. Output graph is typical for the tower height range wind speeds (10m/s) lighter wind sites will require 40% less output tower will of range higher wind speed sites e.g. 10m/s range will produce approx 40% less
3. All machines have an ACP 25-25 dBA meter at the base of the tower at a height of 20m.
4. A 10m spacing 20m away @ approx 40 mph is 70dBA



# Ice



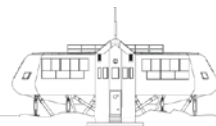
## Snow



## Expedition related research



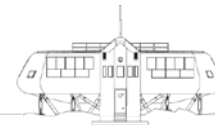
- Circadian rhythms, physical activity and their influence on sleep-wake regulation during an Antarctic summer expedition
- Dept of Behavioral Sciences - Royal Military Academy



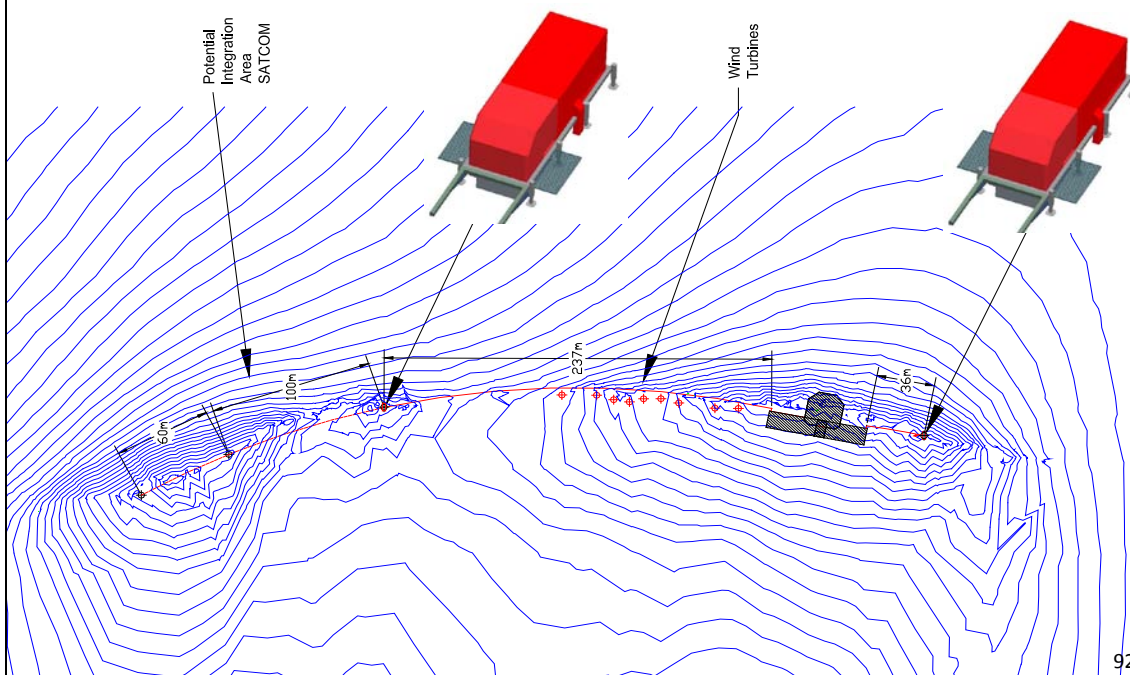
## Summary of results



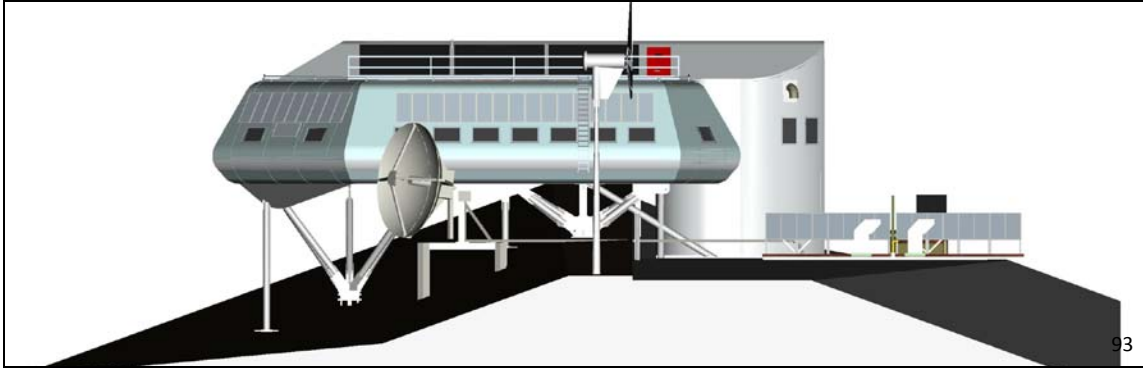
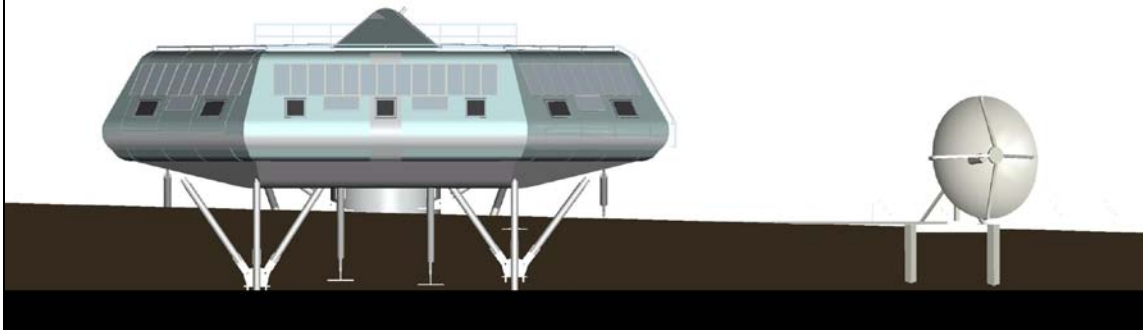
- Sleep
  - Non restorative sleep, high sleep fragmentation
  - Inversion in sleep architecture between light sleep and REM sleep
- Circadian desynchronisation by constant illumination?
  - Cortisol rhythms maintained: Behavioural cues sufficiently able to entrain?
  - Melatonin rhythms phase delayed (peaks in the early morning): accounts for the sleep disturbance?
- Link between sleep efficiency and physical activity
- Mood and vigilance
  - No mood disturbance, no effects of stress (POMS & cortisol)
  - Highly disrupted PVT (attention performance similar to subjects being sleep-deprived for 5 consecutive days).
- Potential countermeasures to be investigated: melatonin supplementation and exercise regimen => follow-up experiment.



## Outside facilities



# SATCOM



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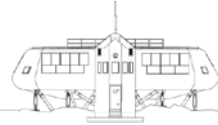
# UAV – instrumentation platform



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