The Barrel's Cooling System Status

Unité mixte de recherche
CNRS-IN2P3
Université Paris-Sud 11

91406 Orsay cedex
Tél. : +33 1 69 15 73 40
Fax : +33 1 69 15 64 70
http://ipnweb.in2p3.fr

Introduction

I. The Slice cooling system (J. Xu and Christine)

1. The cooling system's principle
2. The upper cooling system's change
3. The front insulation system
4. The dew point problem

II. The cooling system for the Barrel (Y. Guarnelli, Philippe and Christine)

1. The principle
2. The pipes insulation
3. The installation in the Panda Hall
4. The pressure requirement (pressure drop study)

III. The cooling machine (M. Josselin, Tobias, C. Thaï and Philippe)

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2. Things done and things to do
3. Technical anomalies discovered
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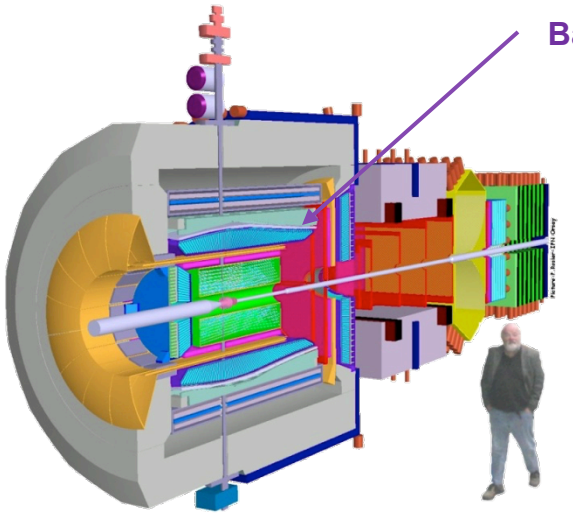
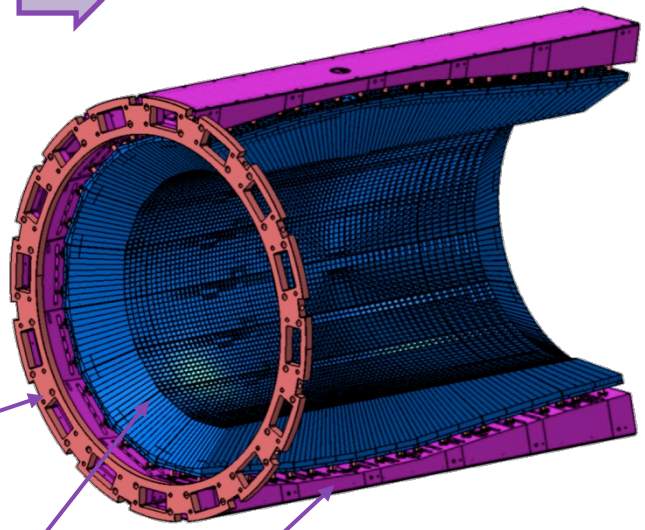
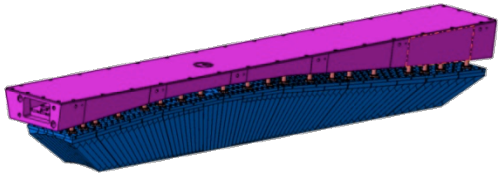
The cooling system principle



16 Slices



1 Slice

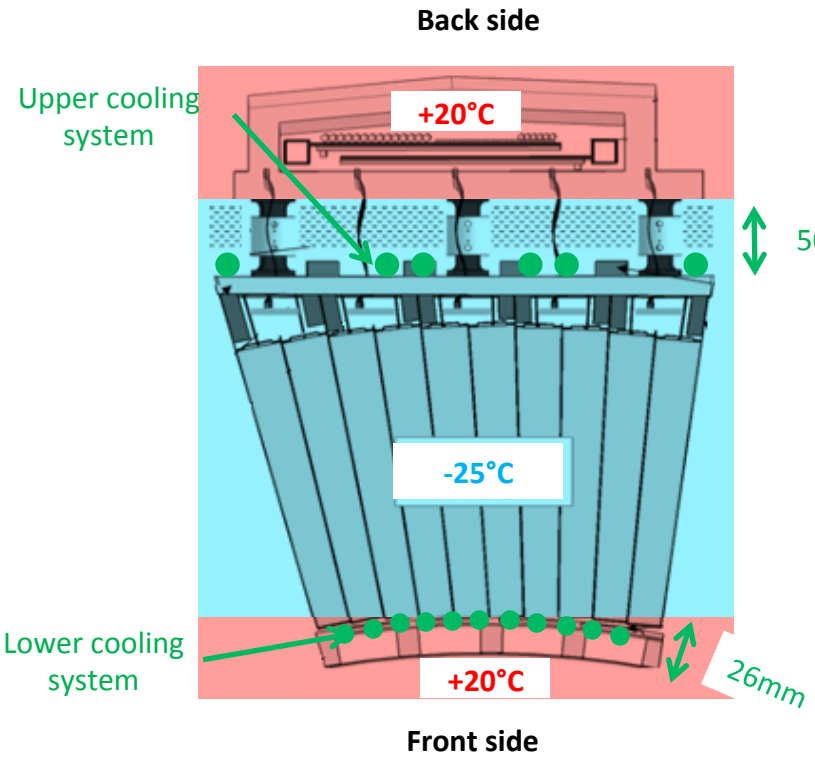


Crystals temperature = -25°C

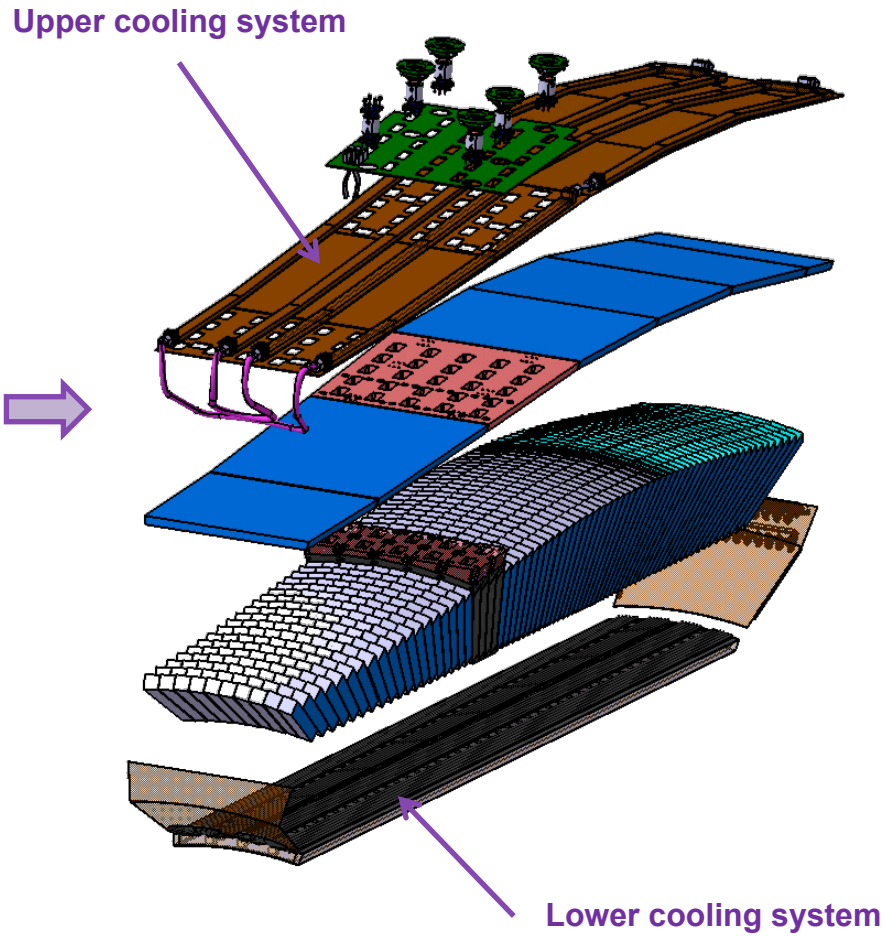
⇓

Each Slice need a cooling system and an insulation

The cooling system principle

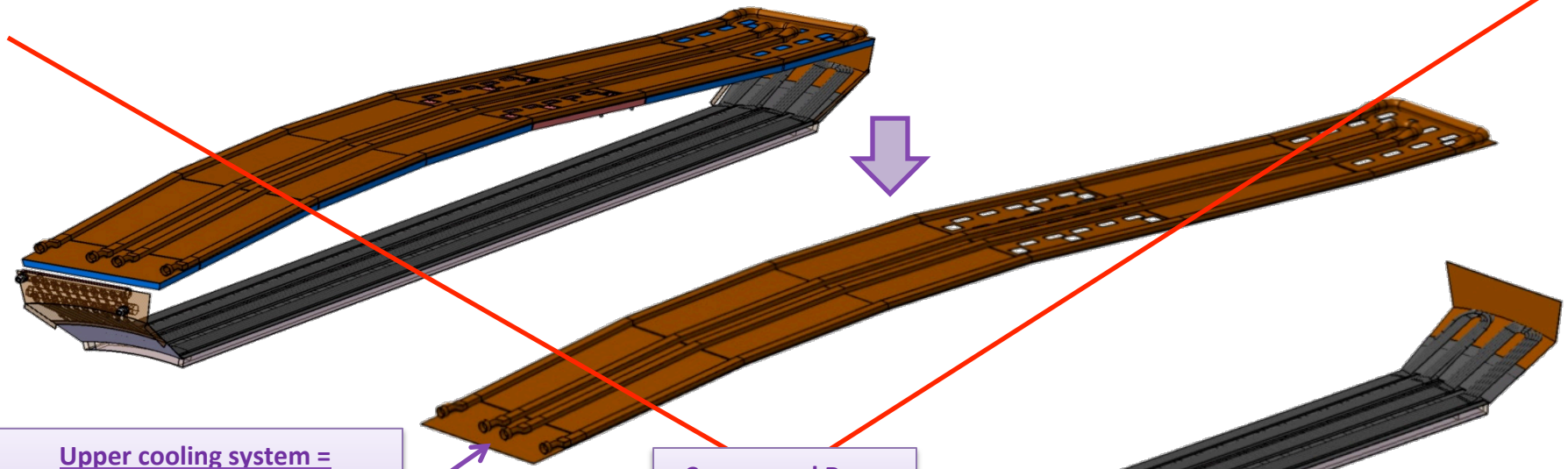


Old cooling system



The upper cooling system's change

Old cooling system for a working temperature of -25°C ± 0.1°C



Upper cooling system =
2 copper rectangular pipes (10x20mm²)+ 1 copper plate
D_v= 24 l/mn

Copper and Brass forbidden

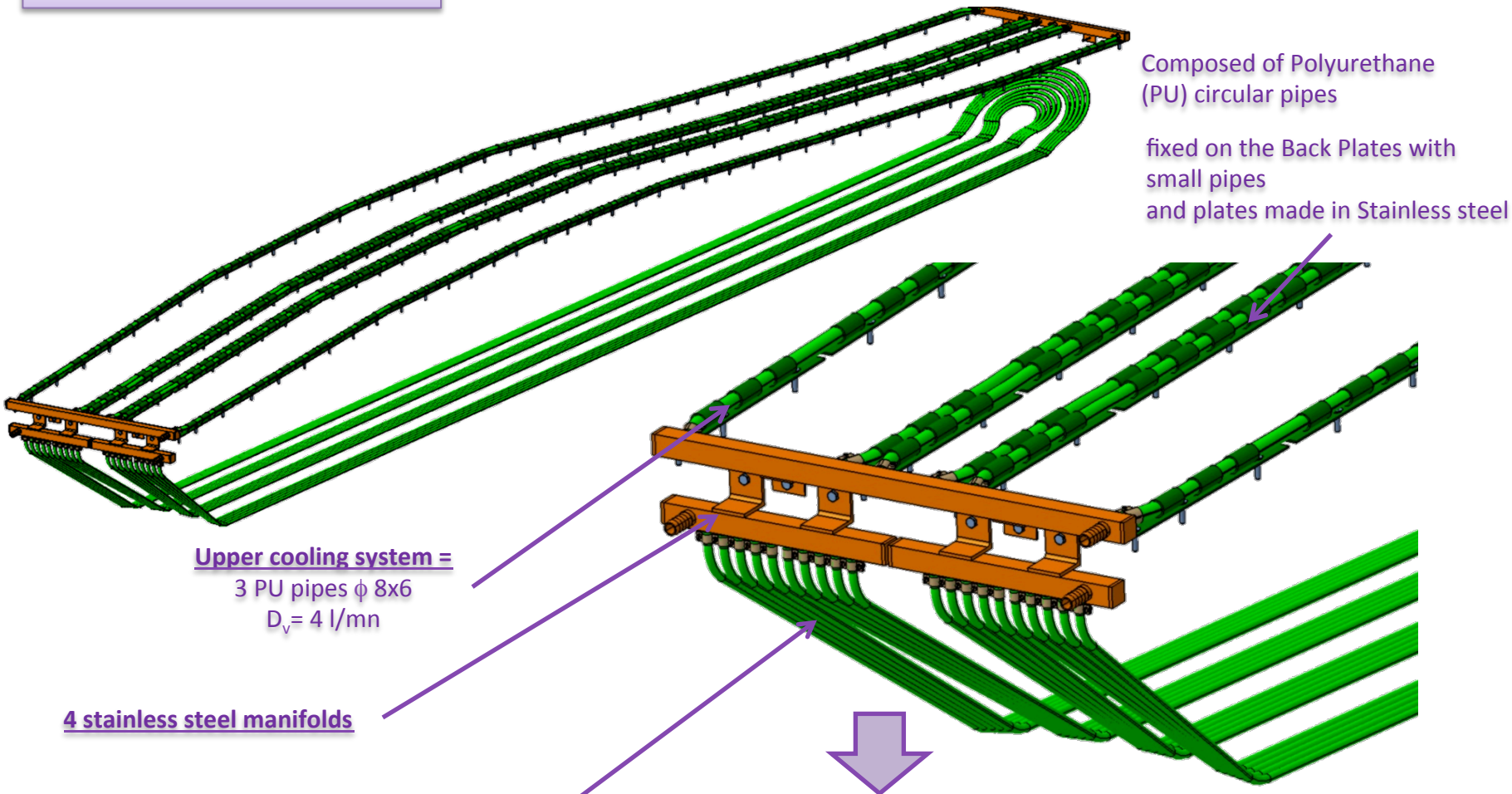
3 brass Manifolds

Lower cooling system =
10 Polyurethane circular pipes ϕ 6x4 + a composite sandwich
D_v= 3.5 l/mn

Total pressure drop with Water Methanol for 16 Slices =
~ 230 mbar for ± 0.1°C

The upper cooling system's change

New cooling system for a working temperature of -25°C ± 0.3°C



Composed of Polyurethane (PU) circular pipes

fixed on the Back Plates with small pipes and plates made in Stainless steel

Upper cooling system =
3 PU pipes ϕ 8x6
D_v= 4 l/mn

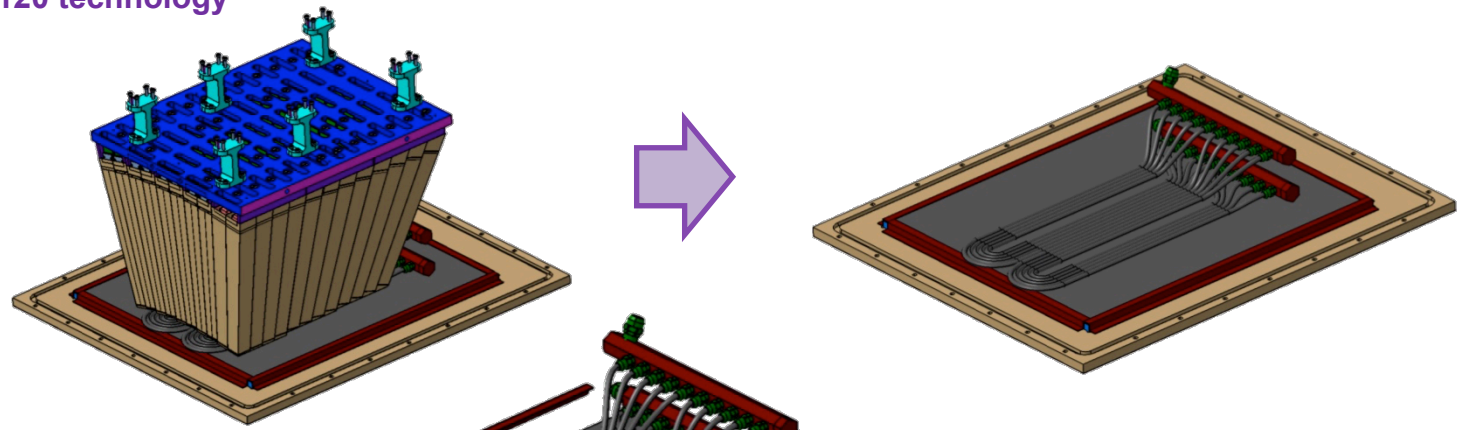
4 stainless steel manifolds

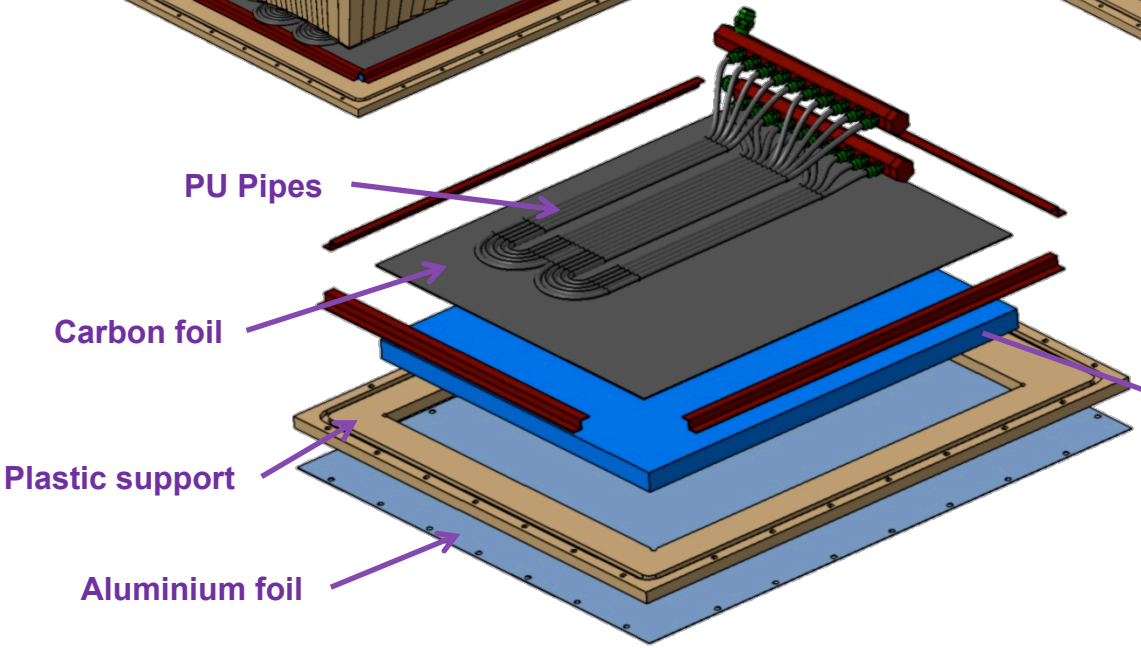
Lower cooling system =
10 PU pipes ϕ 5.5x3.5
D_v= 0.75 l/mn

Total pressure drop with Water Methanol for 16 Slices =
~ 630 mbar ± 0.3°C

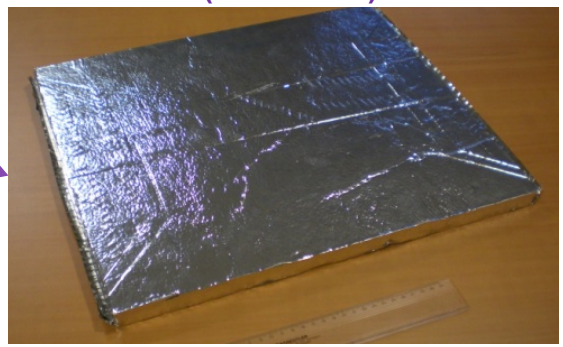
The front insulation system :
the principle = composite sandwich technology

Proto120 technology

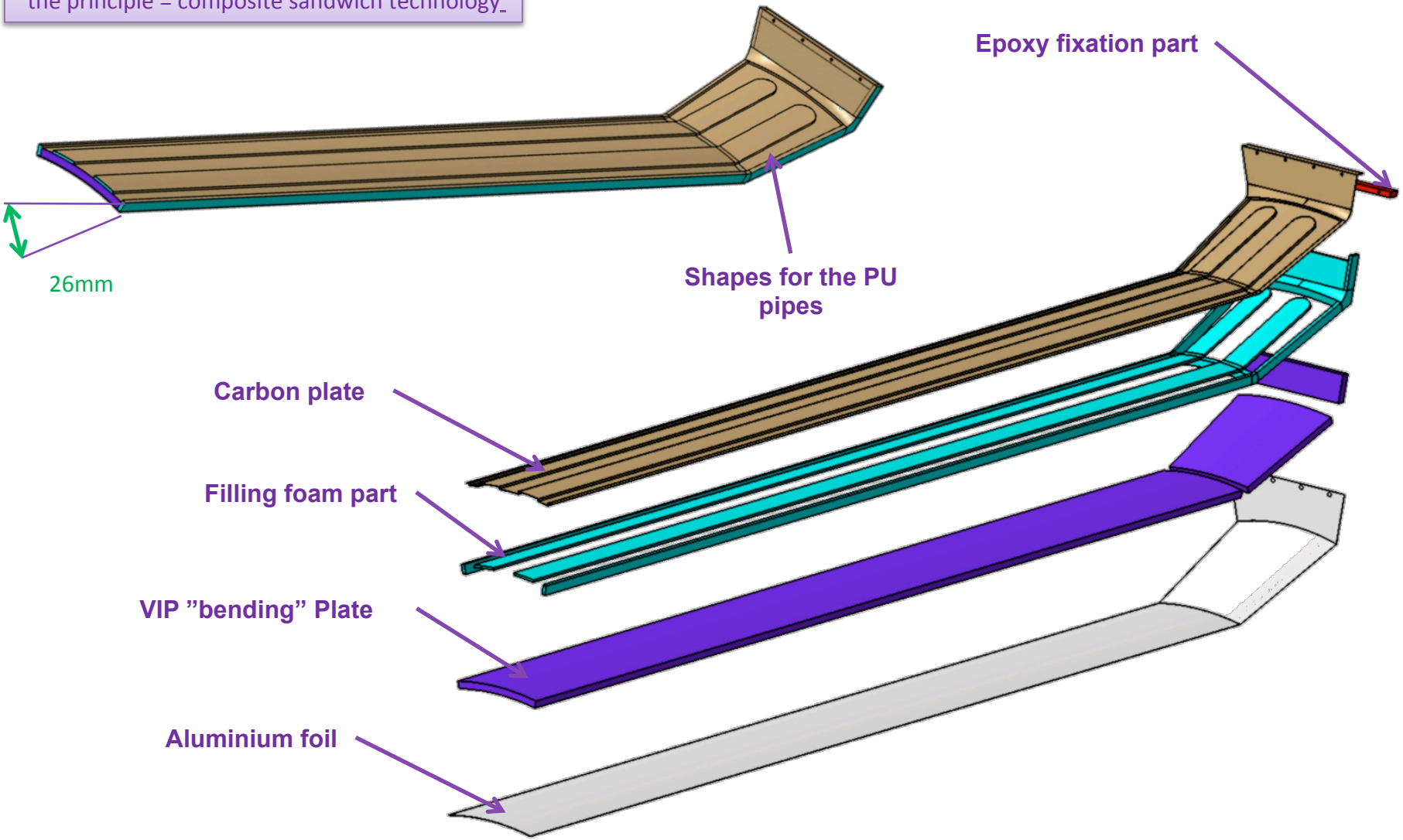




VIP (Vacuum Insulation Plate) Part (VAQTEC®)



The front Insulation system :
the principle = composite sandwich technology



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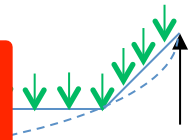
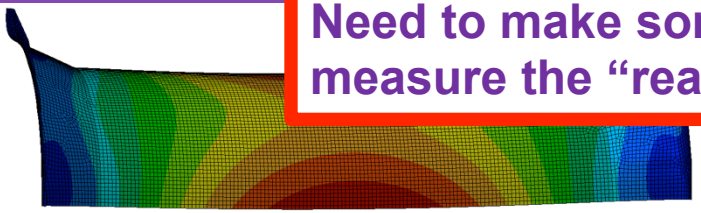
The front insulation system :
the calculations made with Ansys®

- Shell calculus
- Fixations on the edges
- q = total distributed load (water methanol + pipes + sandwich)
- Equivalent Young Modulus for the 4 materials



First calculus = 1 S

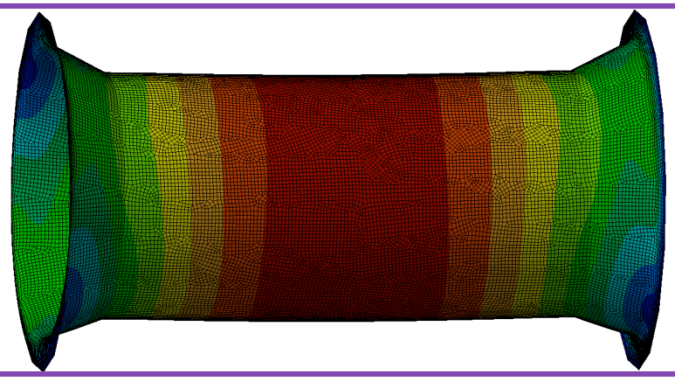
Second calculus =



All the calculi are based on an equivalent Young Modulus
Composite structure = Carbon + VIP + Foam + Aluminium glued together

Need to make some tests with this composite structure to measure the "real" Young Modulus

Third calculus = 16 Slices

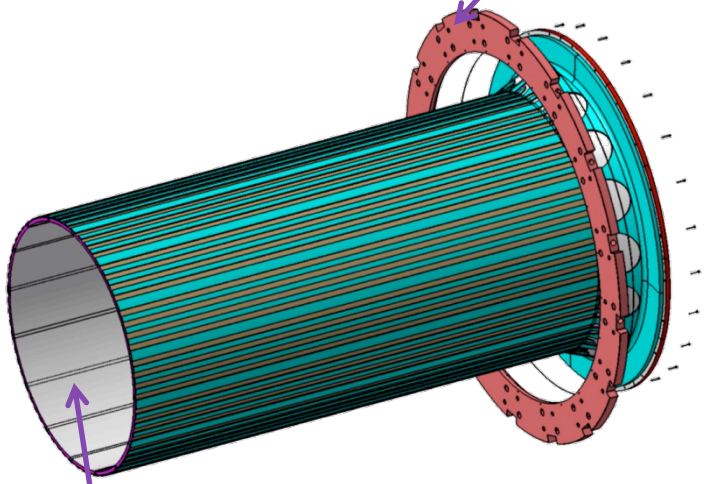


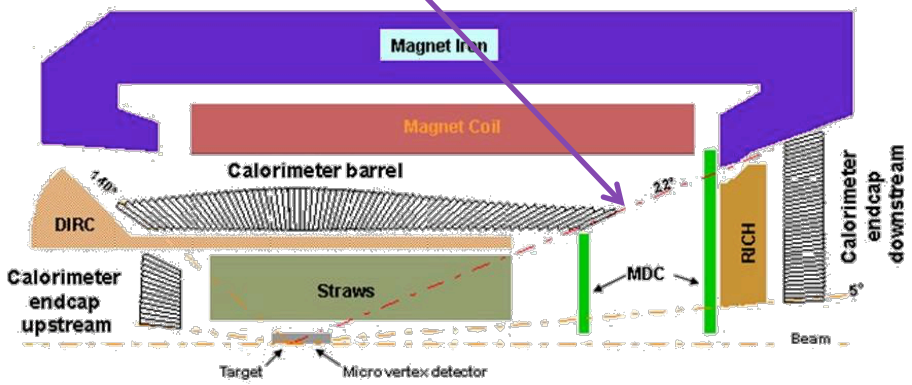
Δ=0.0013mm

- Best deflection
- Easier to seal the enclosure for the nitrogen

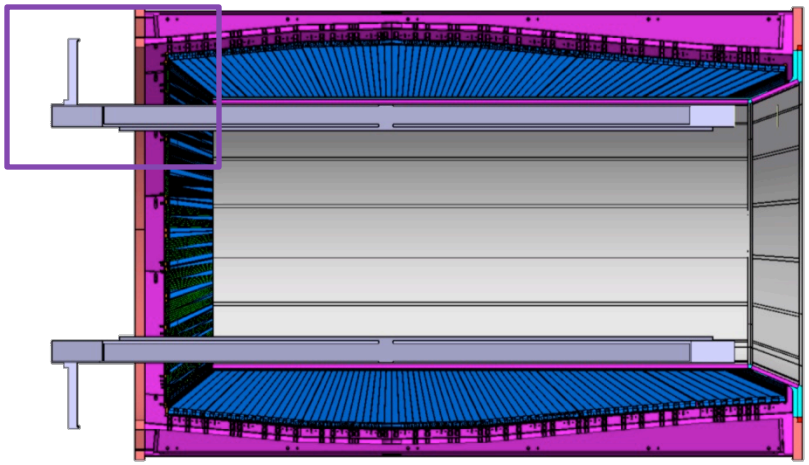
The front insulation system :
the last shape

Fixation on the Downstream Ring

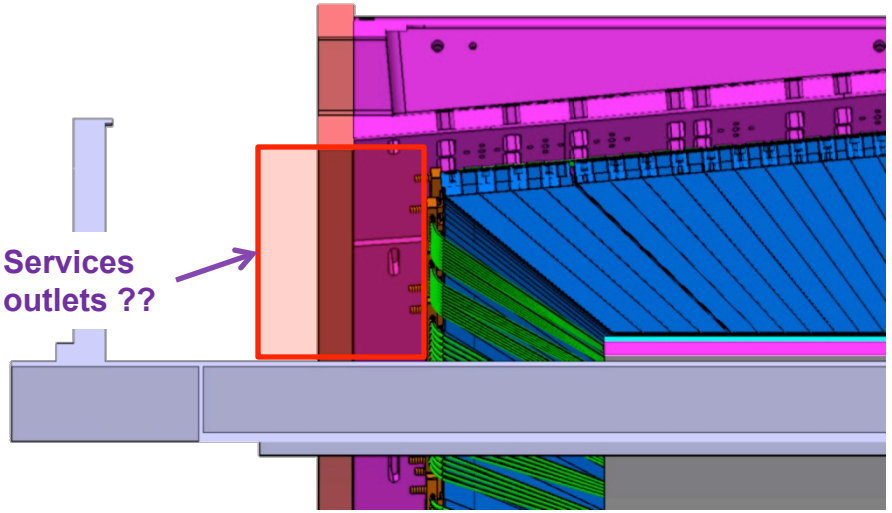




No design on the Upstream Side



Services outlets ??



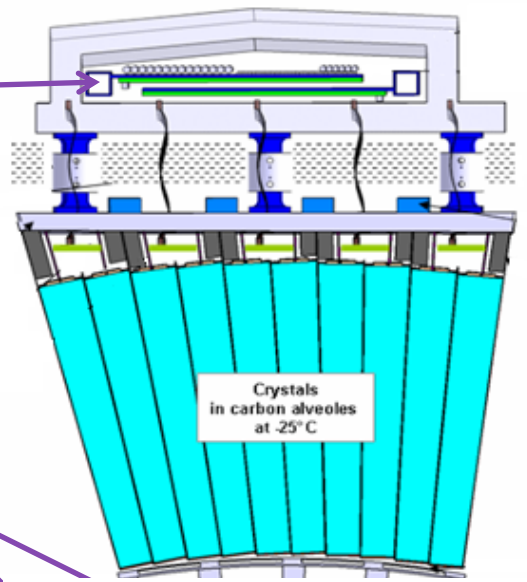
The upper cooling system's change

The dew point problem

Power in the Support Beam created by the electronic = 300 W

⇒ Need to have pipes with water ($D_V \approx$ 0.4 l/mn) in the Support Beam in order to :

- **have cool water to prevent the reheating of the Support Beam when its electronic is on**
- **Have hot water to prevent a big cooling in the Support beam when its electronic is off**



The Dirc and the Crystals = very closed

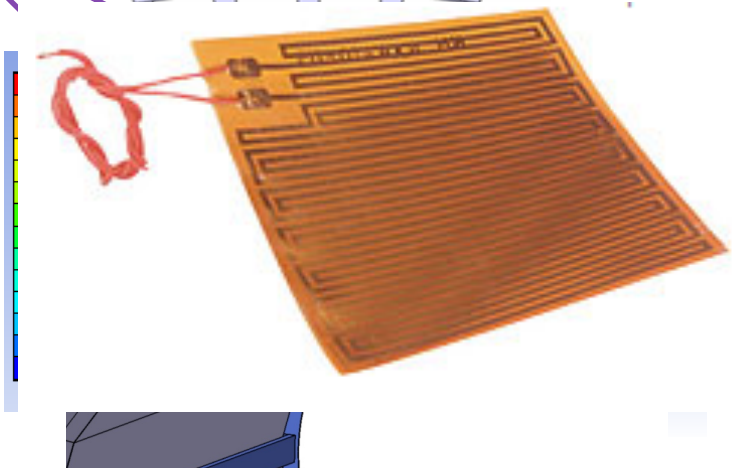
⇒ Need to have heating resistance in order to prevent the creation of ice between these two systems :

⇒Power of 11.25 W/m²

⇒Resistance = 51Ω

⇒Intensity = 470mA

Use kapton heating resistance with a thickness ≈ 0.15 mm



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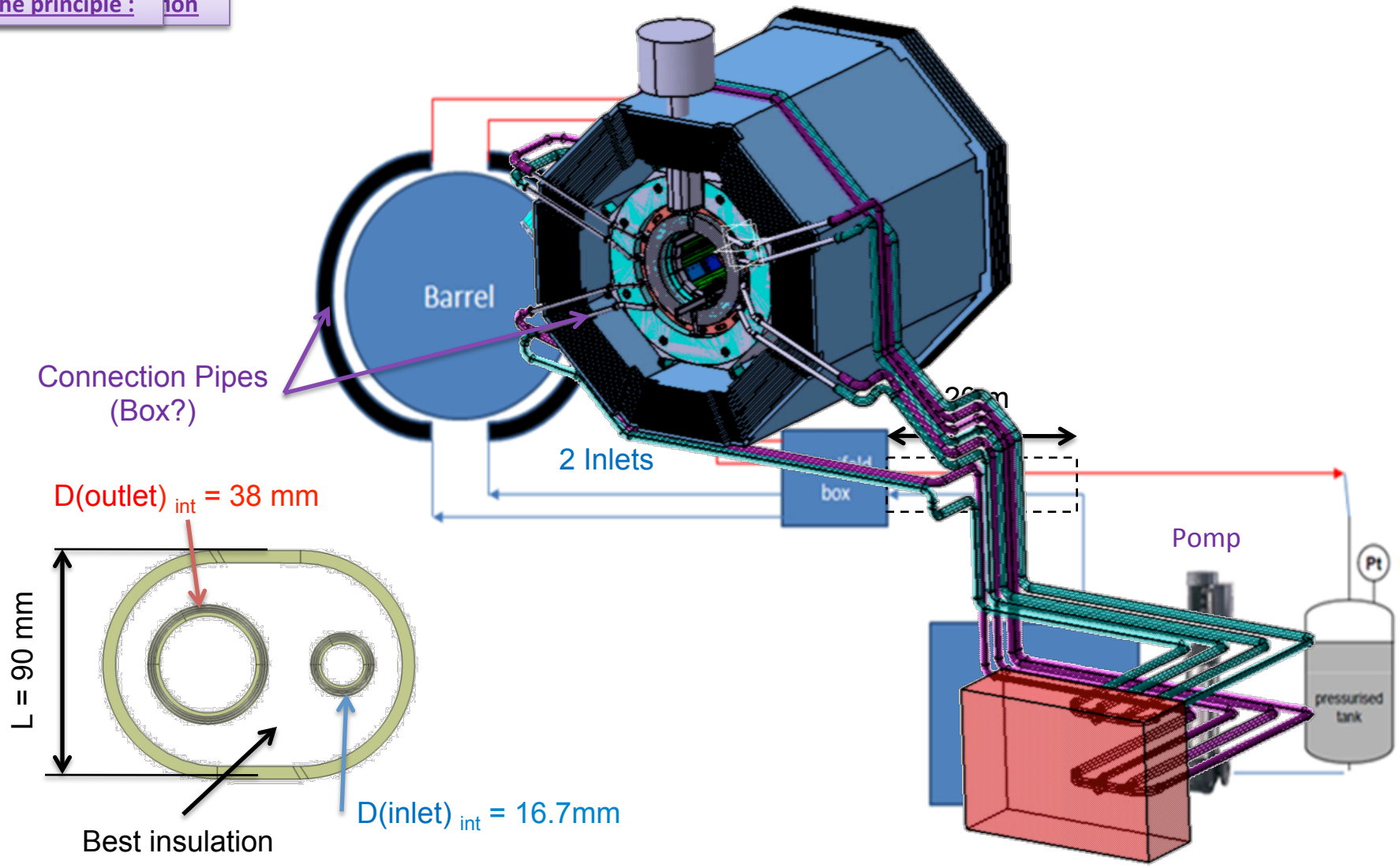
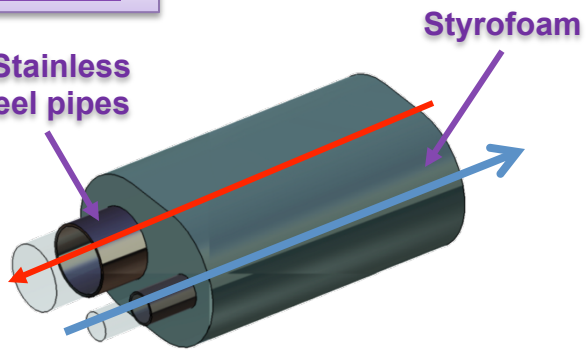
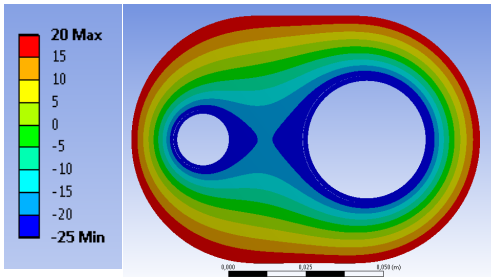
The principle : ion



The pipes insulation :

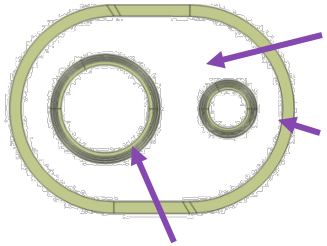
Solution 1 :

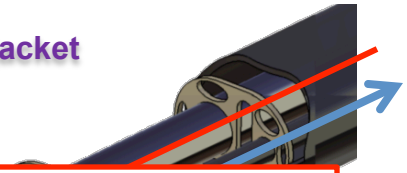




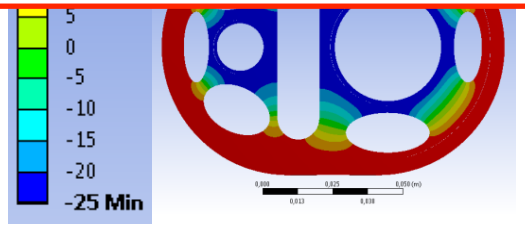
Total power drop = 16.6 W/m
For Water Methanol :
Total temperature drop = 0.001°C/m

Solution 2 :



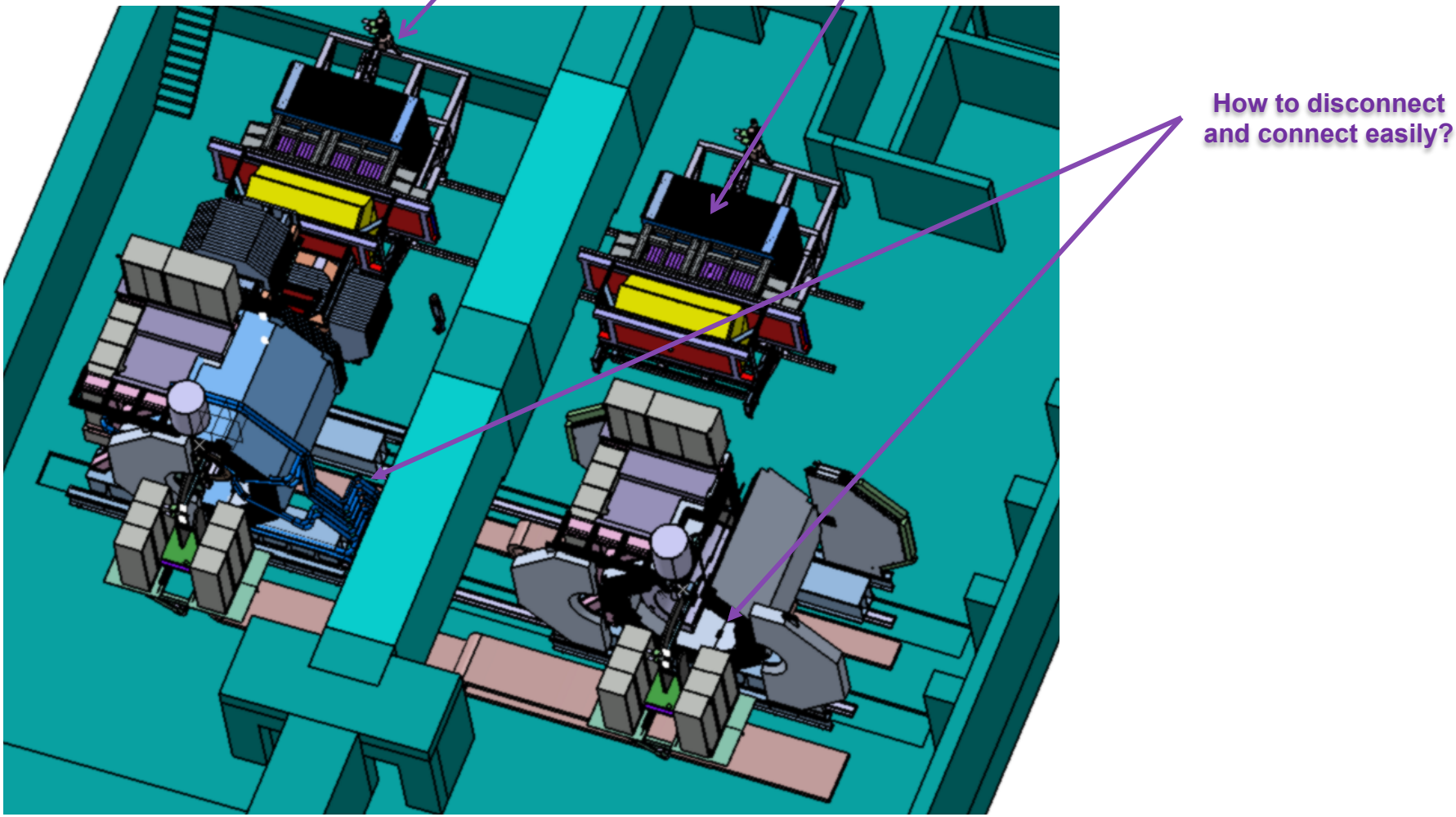


The best solution :
- Power drop for 20m ≈ 330 W
- Temperature drop for 20m ≈ 0.023°C
- Easier to do
- Cheaper



Total power drop = 1.93 W/m
For Water Methanol
Total temperature drop= 0.0001°C/m

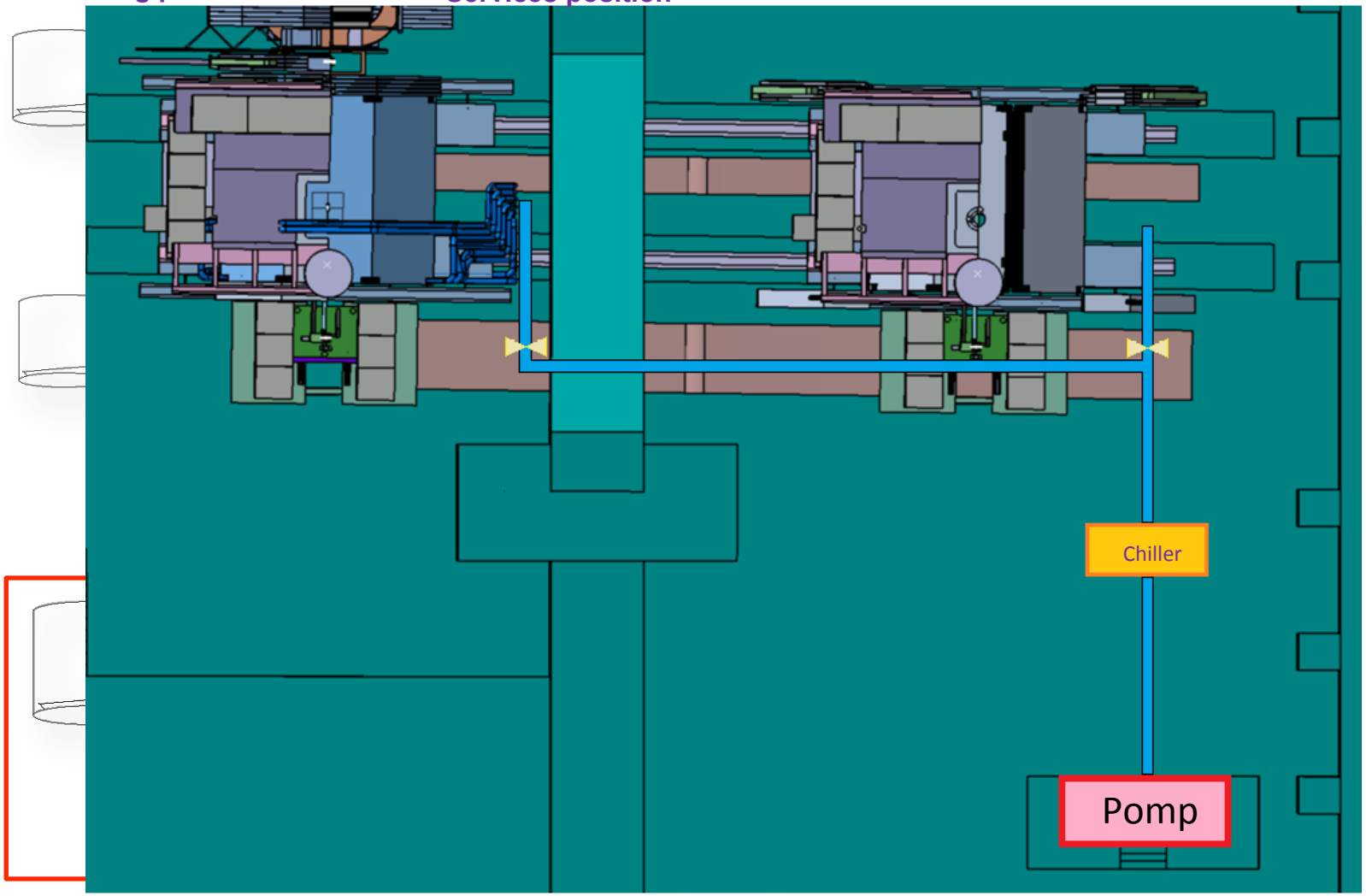
The installation in the Panda Hall :



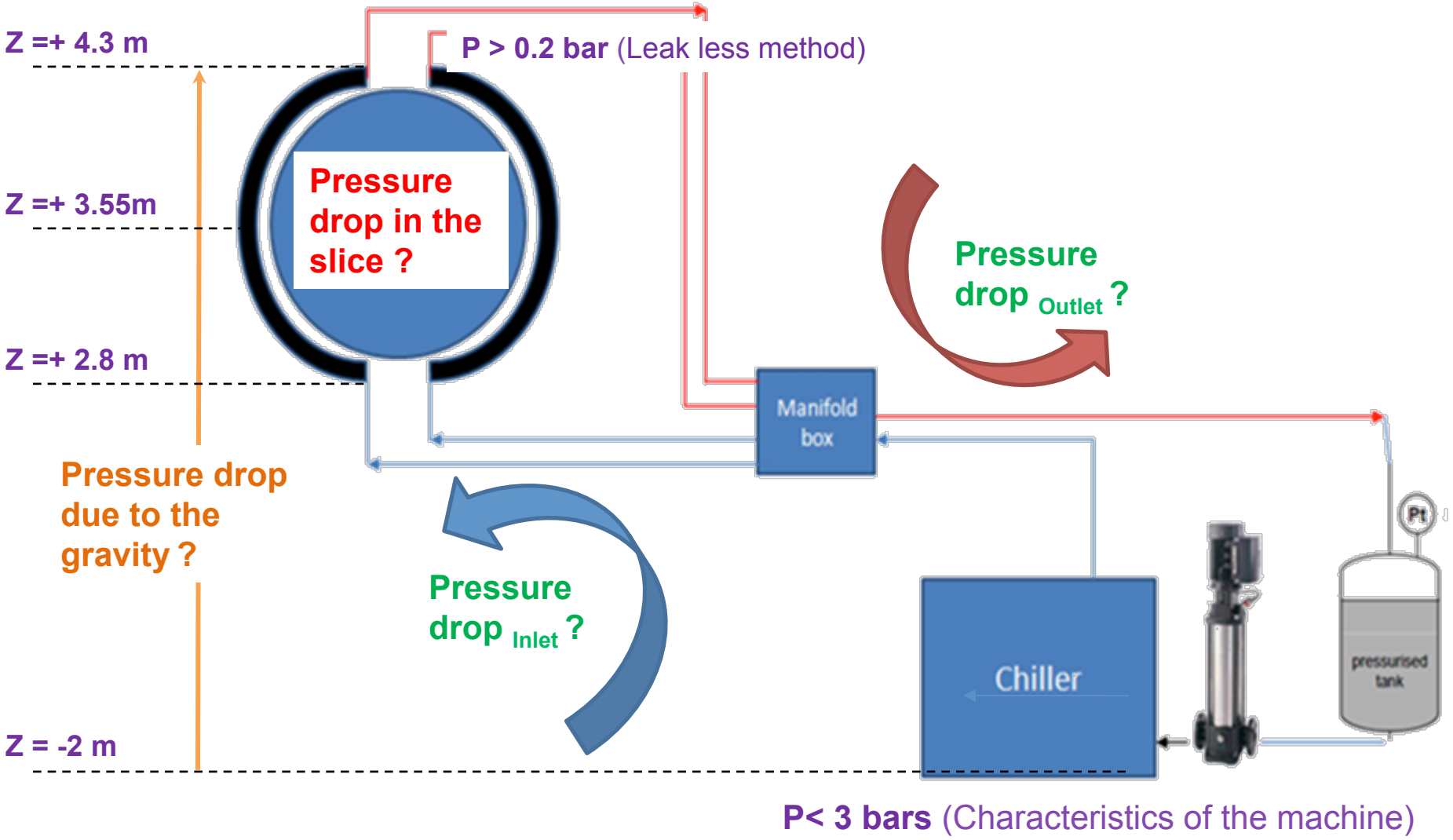
The installation in the Panda Hall :

Three solutions

Working position **Services position**



The pressure requirements :



The pressure requirements :

Bernoulli equation

Exchange energy between the coolant and the machine

Change in kinetic energy

$$\Delta W = \Delta E_p + \Delta E_k + \Delta E'_p + \Delta J$$

Change in potential pressure energy

Change in gravitational potential energy

Pressure drop

The Pomp-Slice way :

$$\Delta W_1 = p_{Slice} - p_{Pomp} + \frac{\rho}{2}(v^2_{Slice} - v^2_{Pomp}) + \rho g(z_{Slice} - z_{Pomp}) + \Delta J_{Pomp-Slice}$$

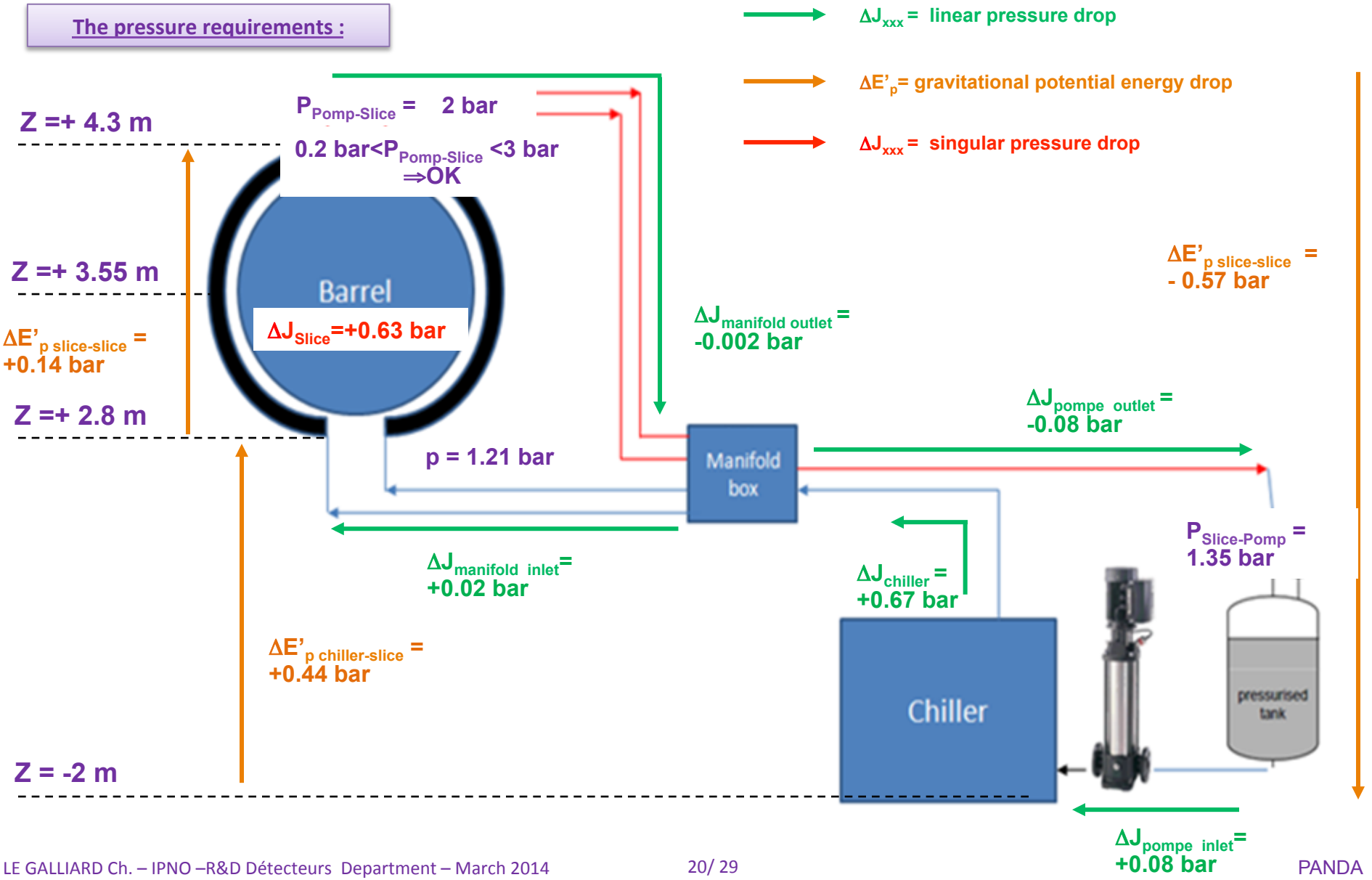
$$p_{Pomp} = \rho g z_{Slice} + \Delta J_{Pomp-Slice}$$

The Slice-Pomp way :

$$\Delta W_2 = p_{Pomp} - p_{Slice} + \frac{\rho}{2}(v^2_{Pomp} - v^2_{Slice}) + \rho g(z_{Pomp} - z_{Slice}) + \Delta J_{Slice-pomp}$$

$$p_{Pomp} = \rho g z_{Slice} - \Delta J_{Slice-Pomp}$$

The pressure requirements :



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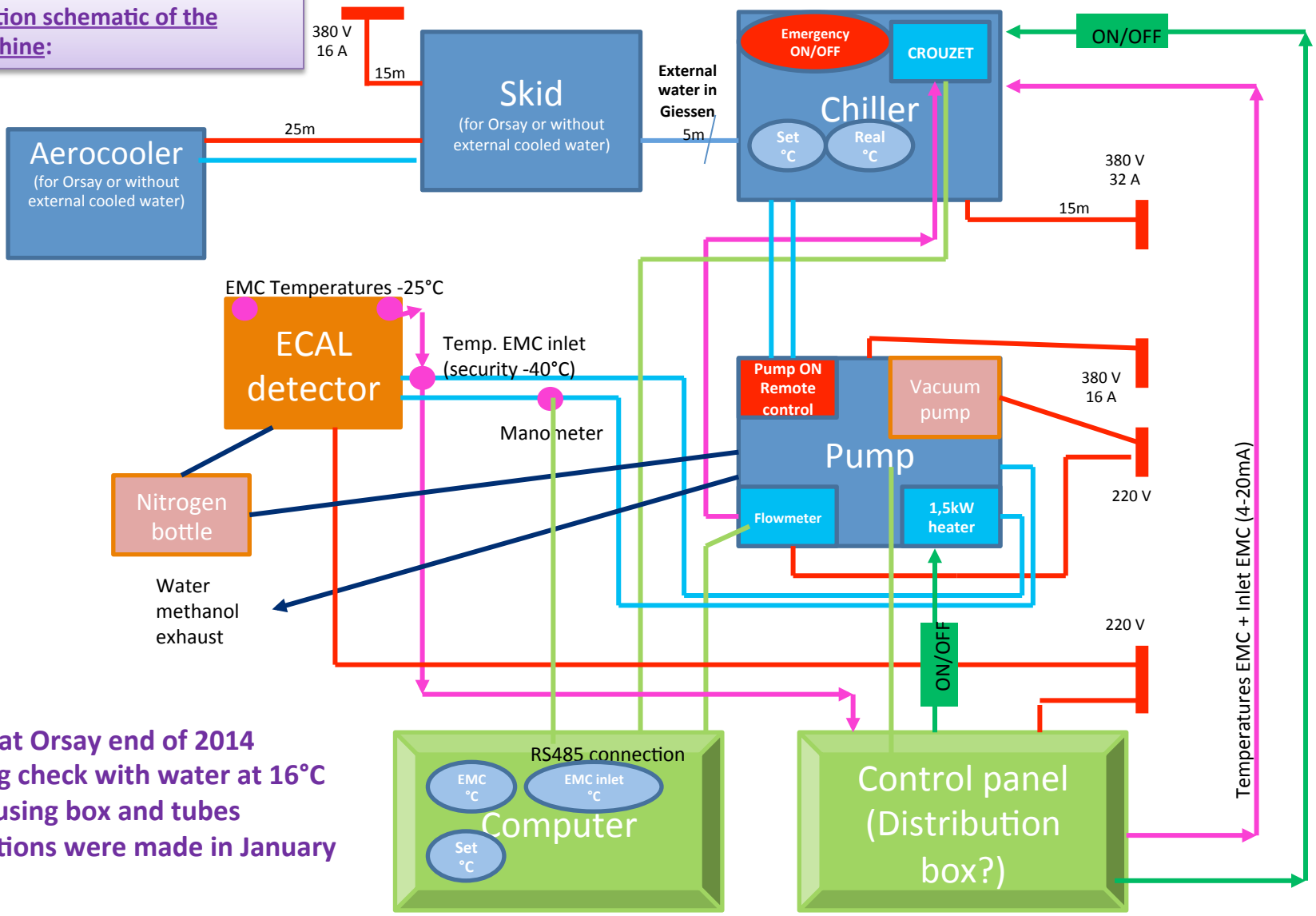
The Installation schematic of the cooling machine:



- **Arrival at Orsay end of 2014**
- **Running check with water at 16°C**
- **The housing box and tubes connections were made in January**

The Installation schematic of the cooling machine:

Aerocooler
(for Orsay or without external cooled water)

Skid
(for Orsay or without external cooled water)

Emergency ON/OFF

CROUZET

Chiller

Set °C

Real °C

Some pictures

Internal view

Internal view

Pump ON Remote control

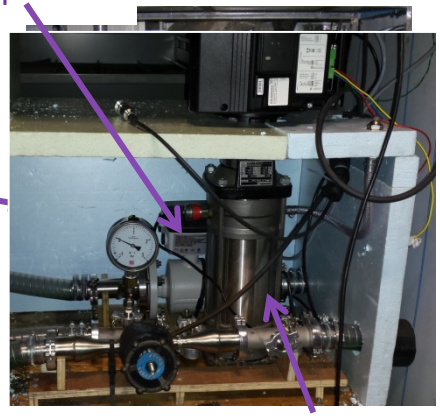
Vacuum pump

Pump

Flowmeter

1,5kW heater

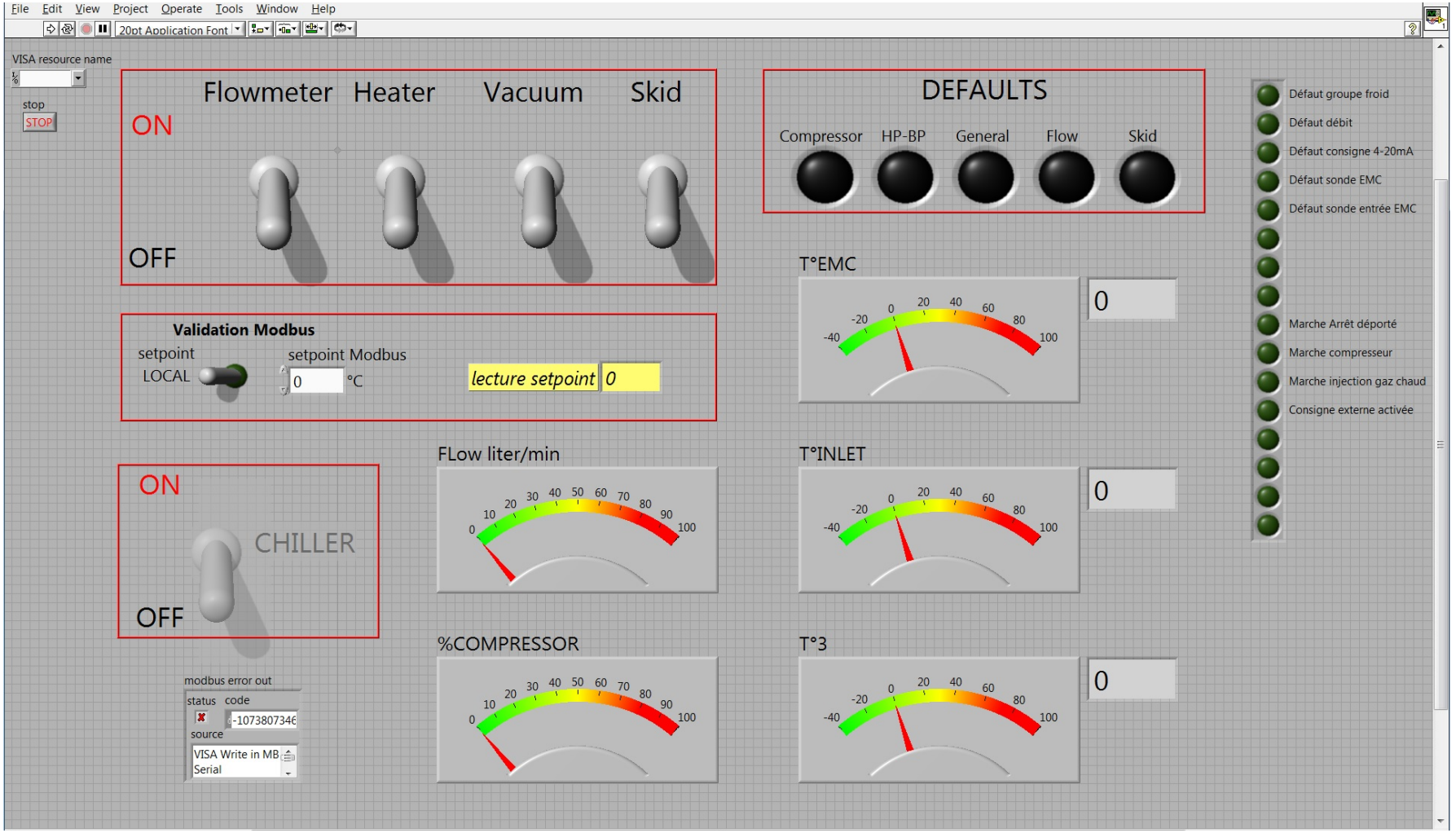
Electromagnetic flowmeter



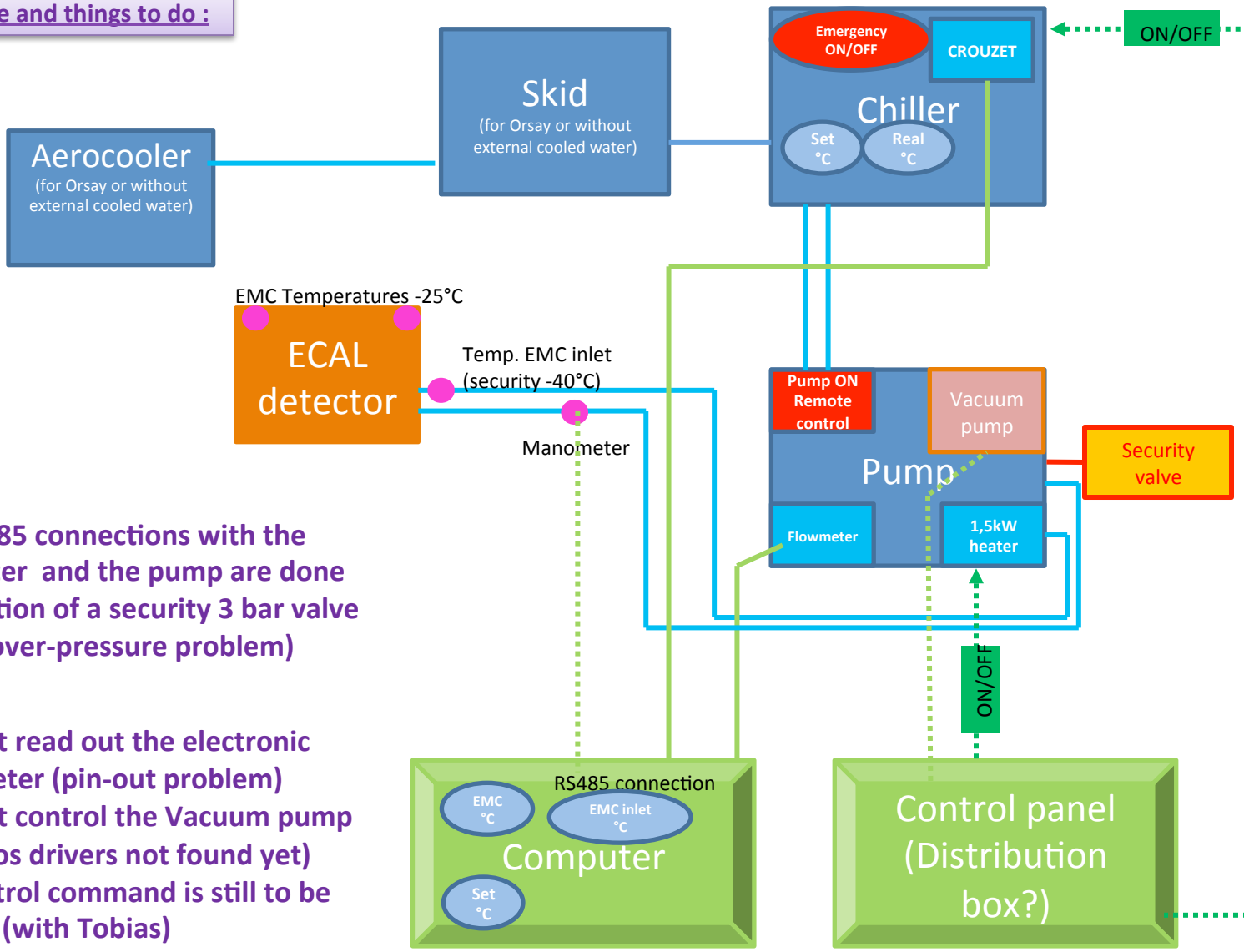
Pump circulator of the chiller

The Installation schematic of the cooling machine:

The control panel is done on a PC with Labview (compatible with EPICS used by Bochum)



Things done and things to do :

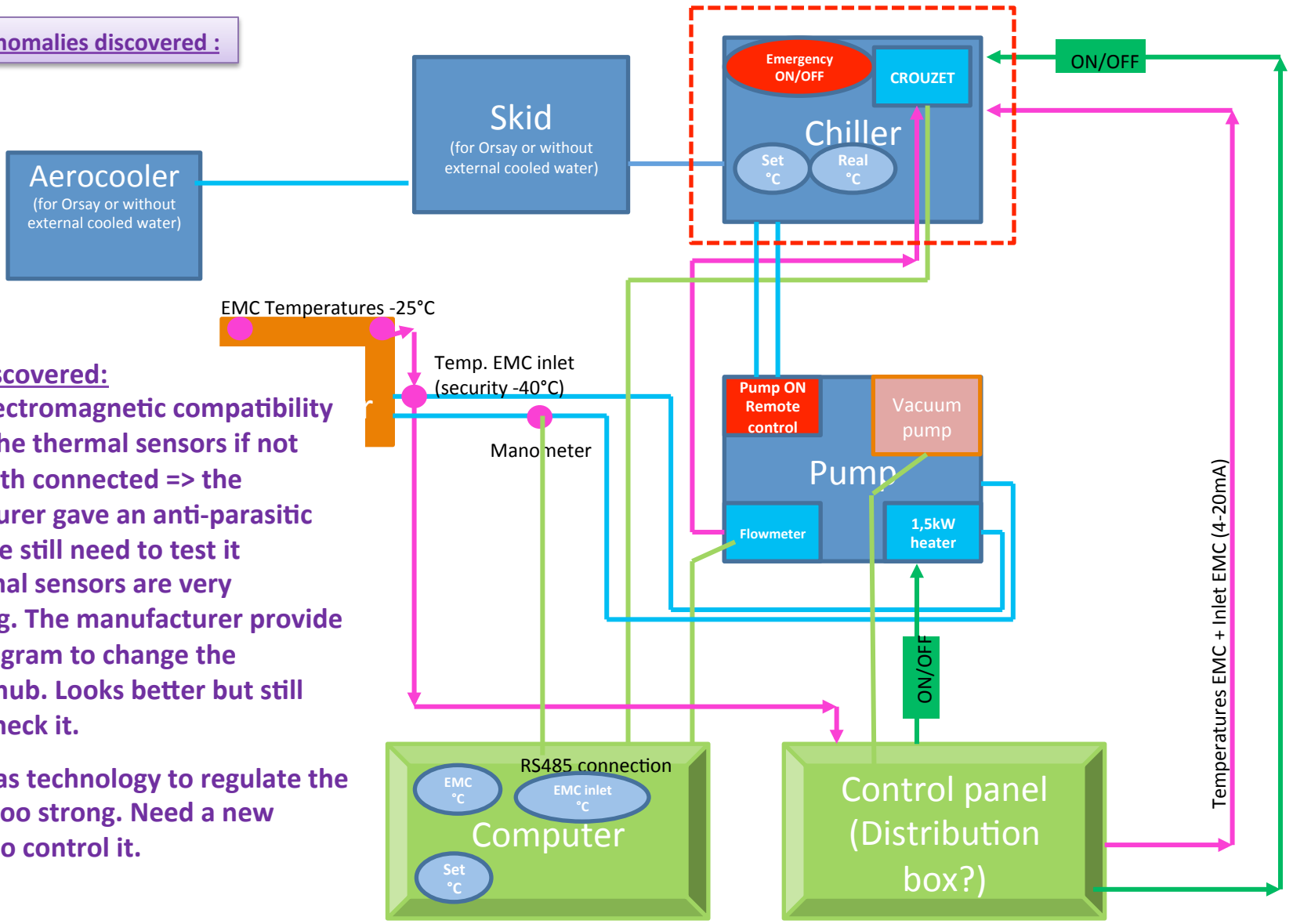


- The RS485 connections with the flowmeter and the pump are done
- Installation of a security 3 bar valve (chiller over-pressure problem)

But

- We can't read out the electronic manometer (pin-out problem)
- We can't control the Vacuum pump (Grundfos drivers not found yet)
- The control command is still to be finished (with Tobias)

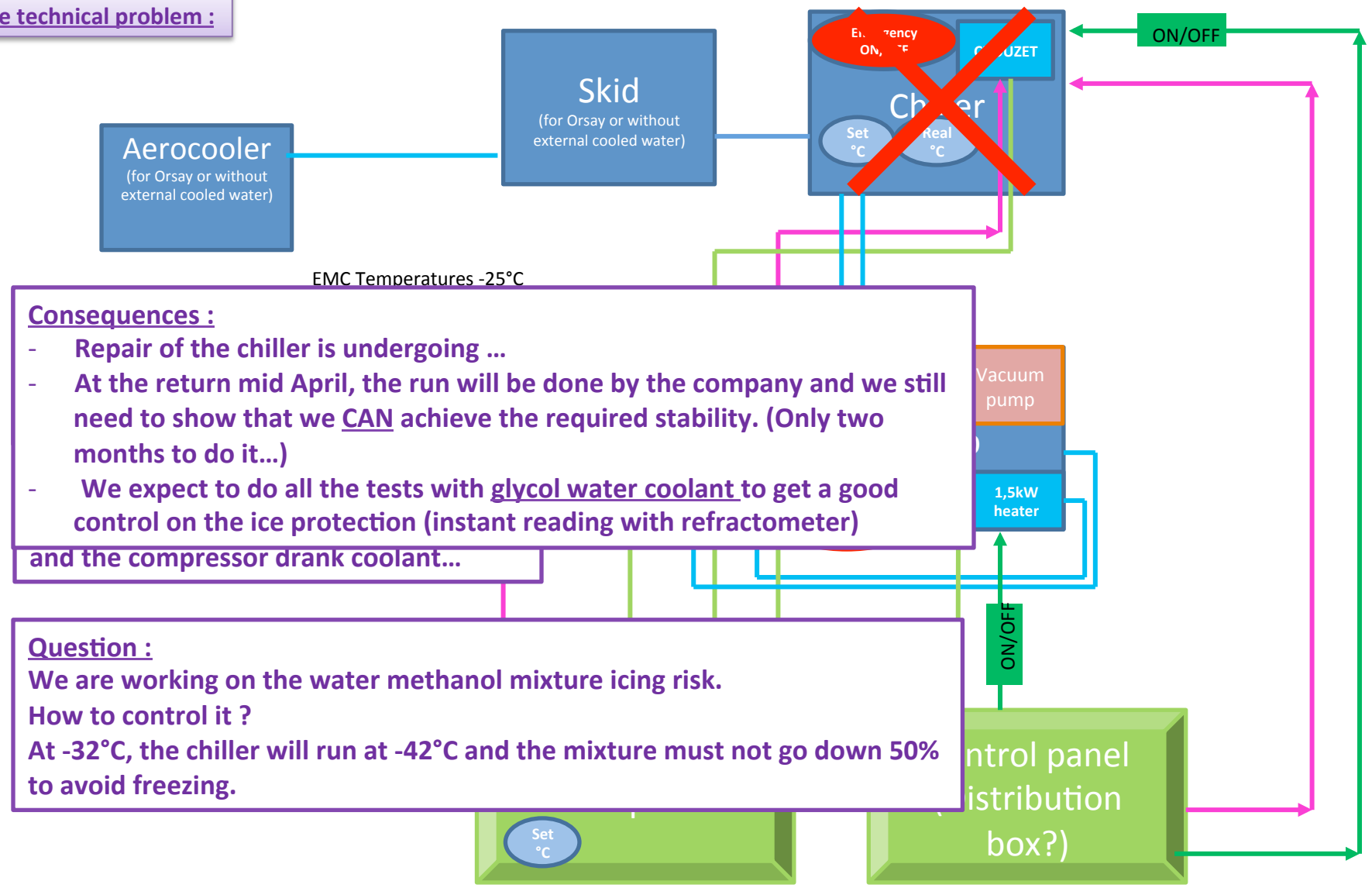
Technical anomalies discovered :



Anomalies discovered:

- **Severe electromagnetic compatibility affected the thermal sensors if not chiller earth connected => the manufacturer gave an anti-parasitic device. We still need to test it**
- **The thermal sensors are very fluctuating. The manufacturer provide a new program to change the channels hub. Looks better but still need to check it.**
- **The hot gas technology to regulate the power is too strong. Need a new program to control it.**

The technical problem :



EMC Temperatures -25°C

Consequences :

- **Repair of the chiller is undergoing …**
- **At the return mid April, the run will be done by the company and we still need to show that we CAN achieve the required stability. (Only two months to do it…)**
- **We expect to do all the tests with glycol water coolant to get a good control on the ice protection (instant reading with refractometer)**

and the compressor drank coolant…

Question :

We are working on the water methanol mixture icing risk.
How to control it ?
At -32°C, the chiller will run at -42°C and the mixture must not go down 50% to avoid freezing.

Conclusion

Reminder:

IPN Orsay has officially stopped its activities on Panda since last June.
At the end of August 2015, no more technical contribution from Orsay.

- **For the Slices :**
  - Test a sample sandwich to know the real Young Modulus of the Front insulation system
  - The Upstream front insulation and its fixation
  - Integration of the Front Heating resistances
  - Integration of the Support Beams cooling system
  - Integration of the other services (cables, pipes and optic fibers)

- **For the Barrel :**
  - The final design of the pipes, the Manifold box and the double circuit in the Panda Hall
  - The pipes connection between the Slices and the Manifold box(the distribution pipes for the Barrel)

??

- **For the Cooling machine :**
  - Test the anti-parasitic device and the new program to change the channels hub for the thermal sensors at Orsay
  - Read the electronic manometer and control the Vacuum pomp with the control command at Orsay
  - Be able to achieve the required stability at Orsay
  - Install the cooling machine and test it at Giessen
  - Finish the control command (Tobias)
  - ...

Orsay + Giessen + Bochum

Thank you for your attention

Unité mixte de recherche
CNRS-IN2P3
Université Paris-Sud 11

91406 Orsay cedex
Tél. : +33 1 69 15 73 40
Fax : +33 1 69 15 64 70
http://ipnweb.in2p3.fr