



# LMJ cryosystem

Overview of the cryosystem

Last results

New developments

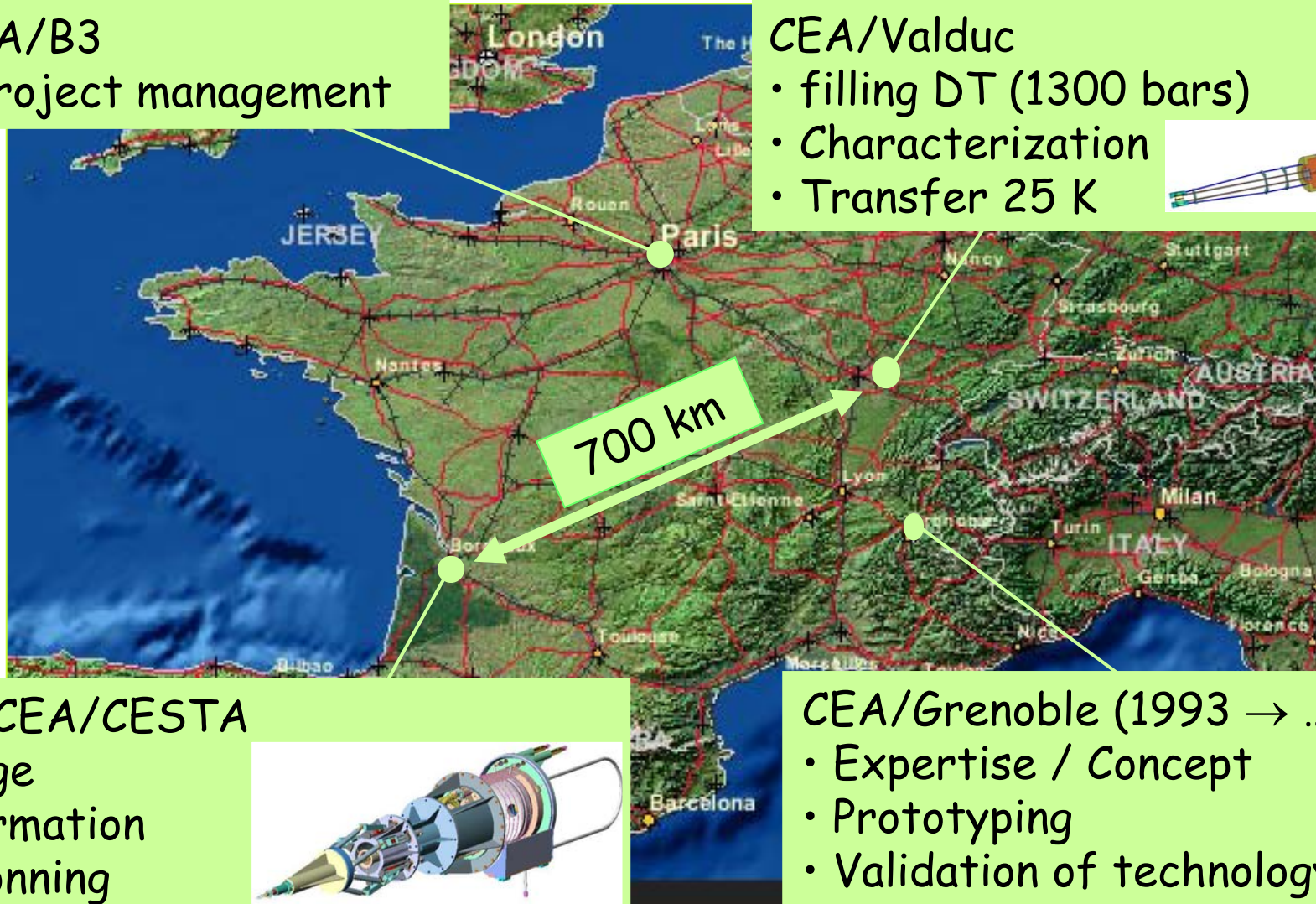
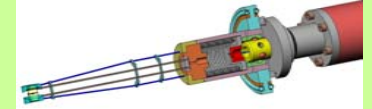
[jean-paul.perin@cea.fr](mailto:jean-paul.perin@cea.fr)

CEA/B3

- project management

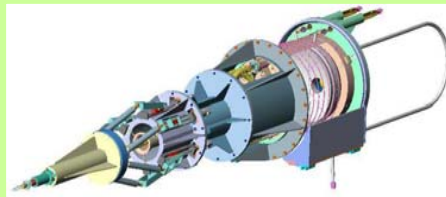
CEA/Valduc

- filling DT (1300 bars)
- Characterization
- Transfer 25 K



Pour le CEA/CESTA

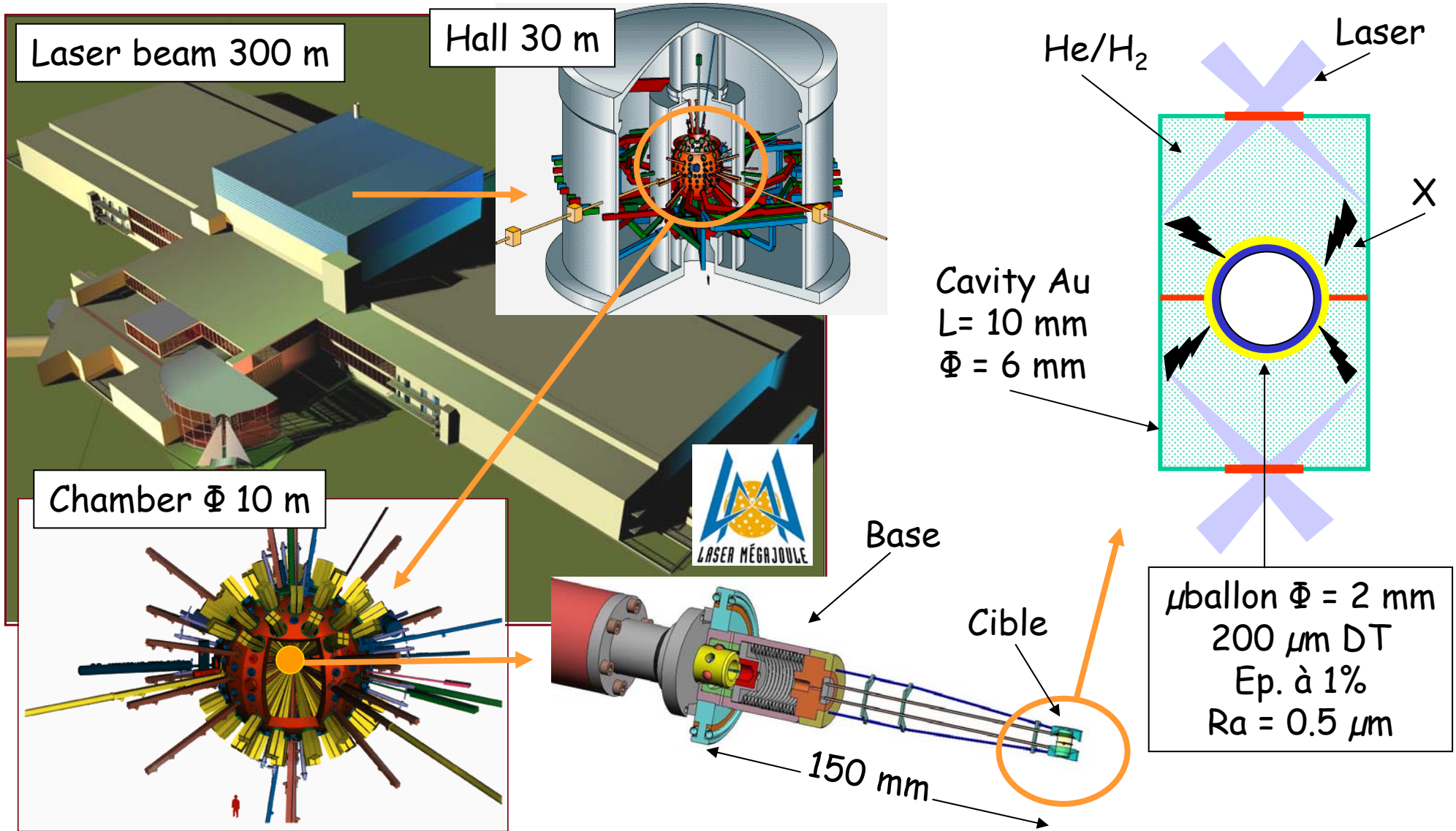
- Storage
- Conformation
- Positionning



CEA/Grenoble (1993 → ...)

- Expertise / Concept
- Prototyping
- Validation of technology

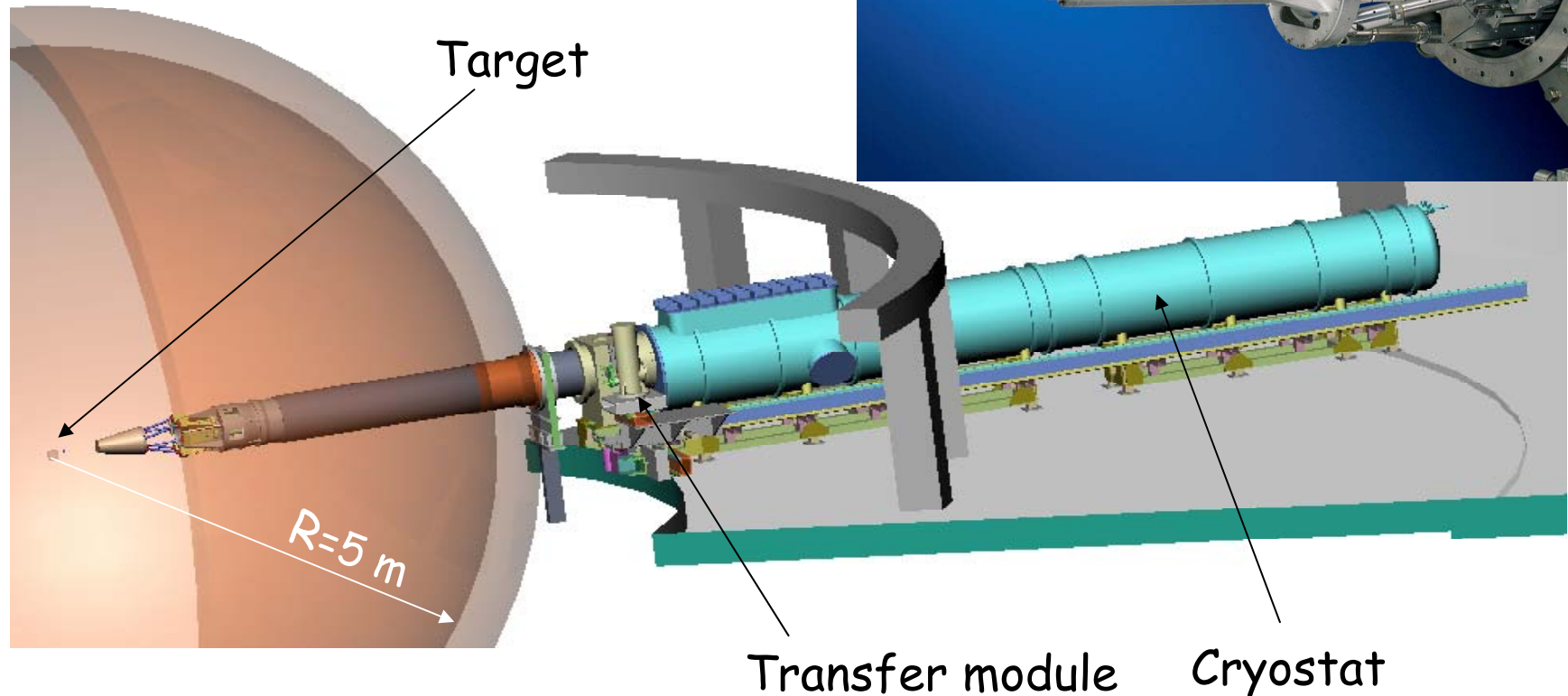
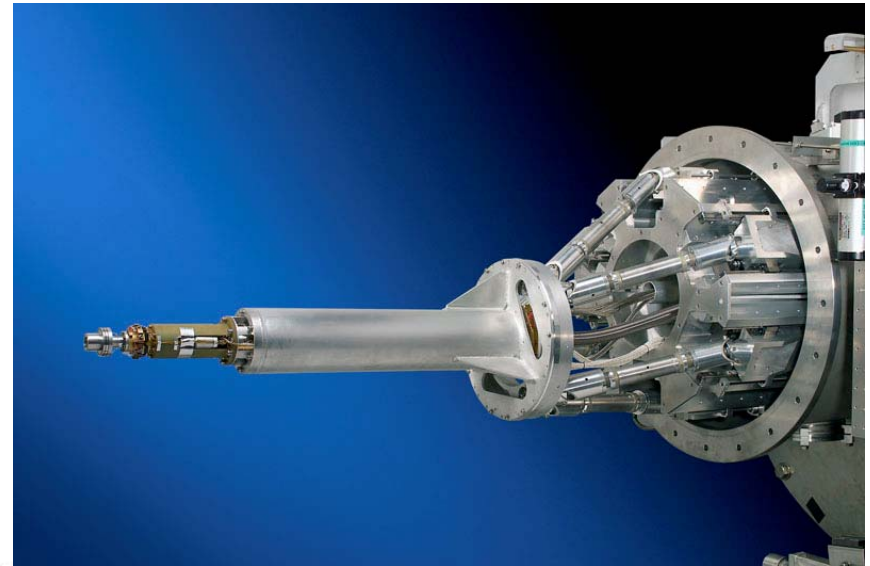
# Laser MegaJoule project

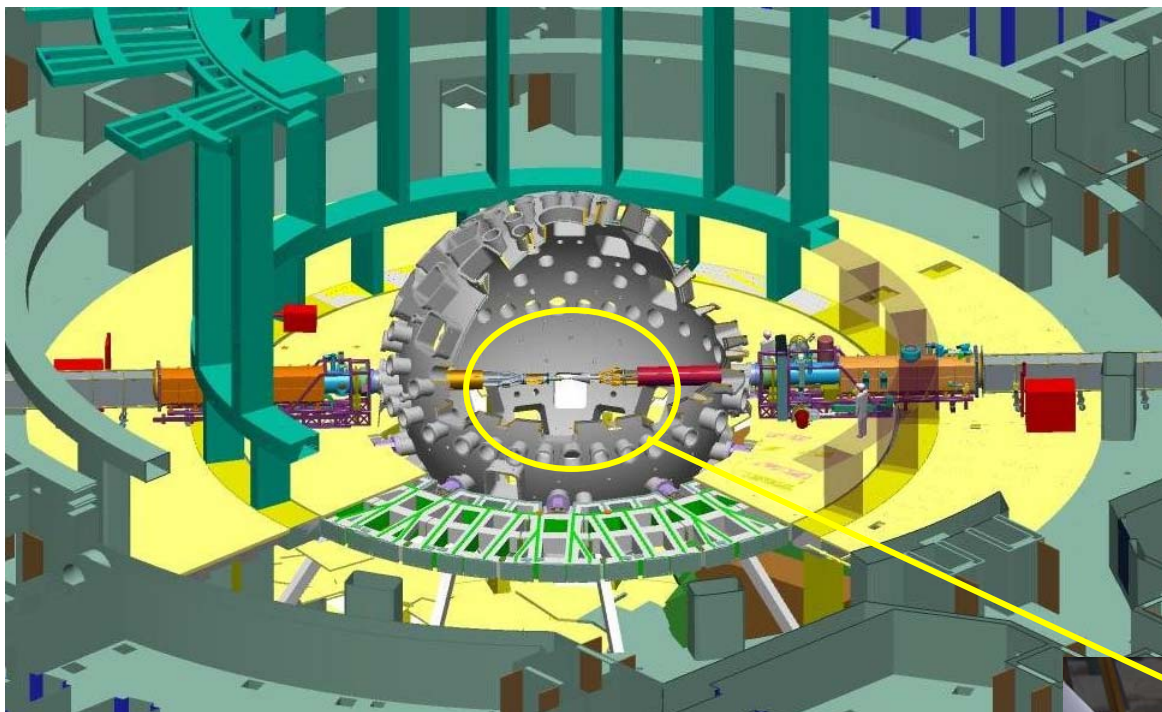




# Cryogenic target carrier (PCC)

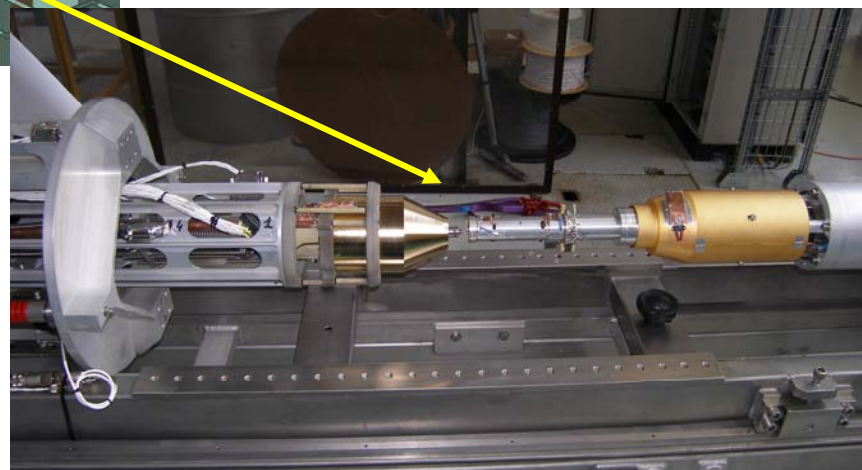
- Solidification ( $18.2-19.72 \text{ K} \pm 1\text{mK}$ )
- hexapode  $10 \mu\text{m}$  accuracy
- Thermal gradient  $< 75 \mu\text{K}$



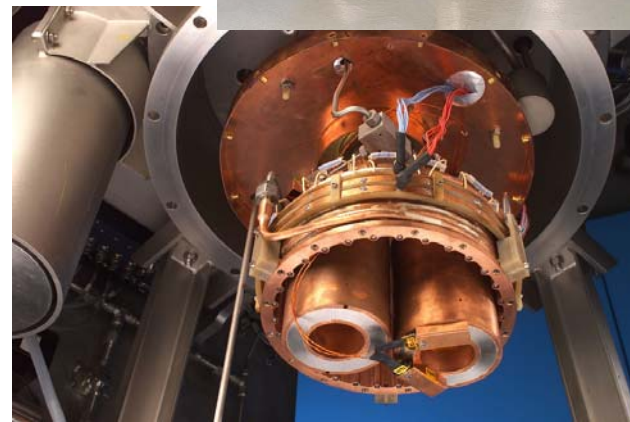
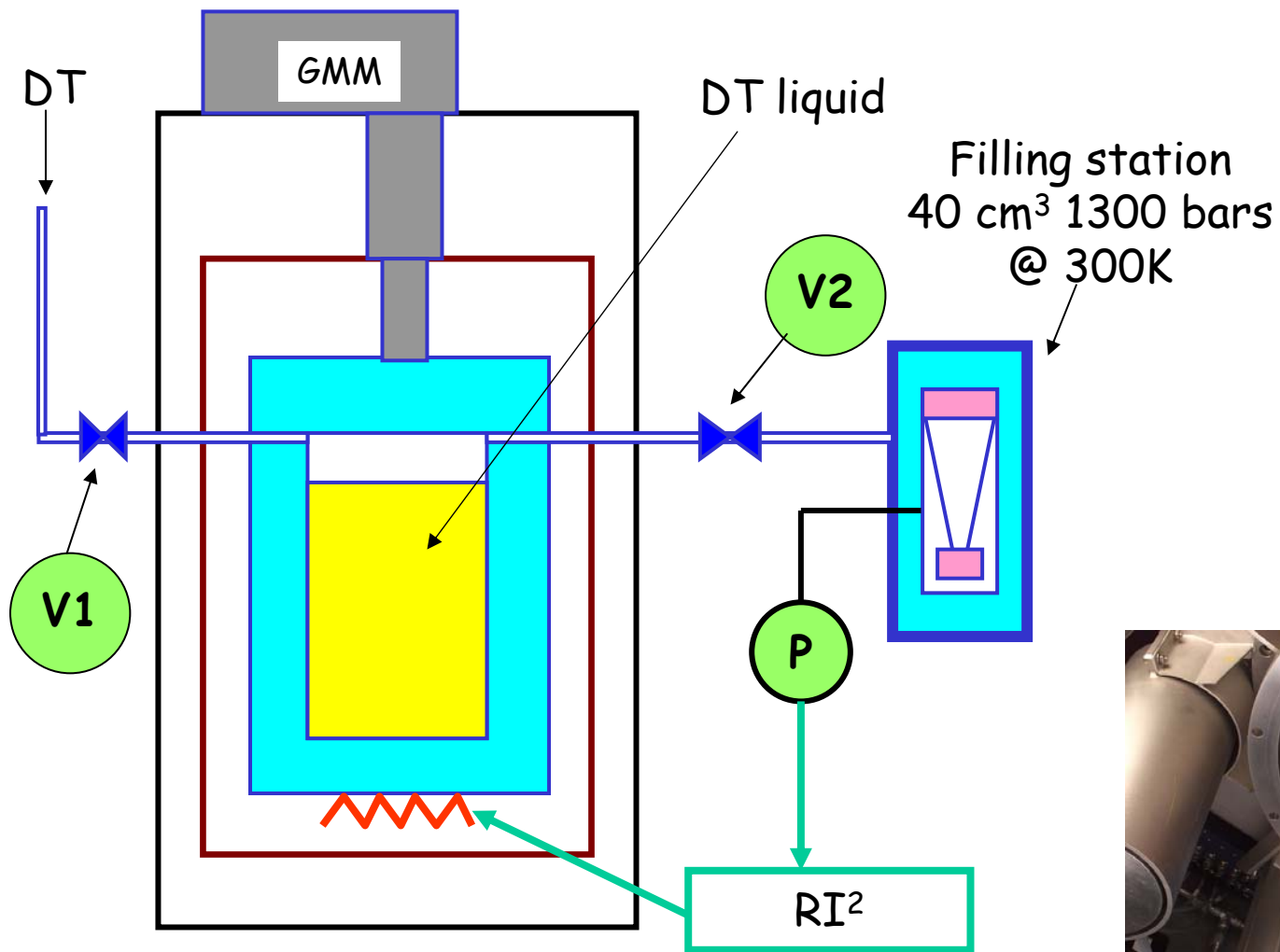


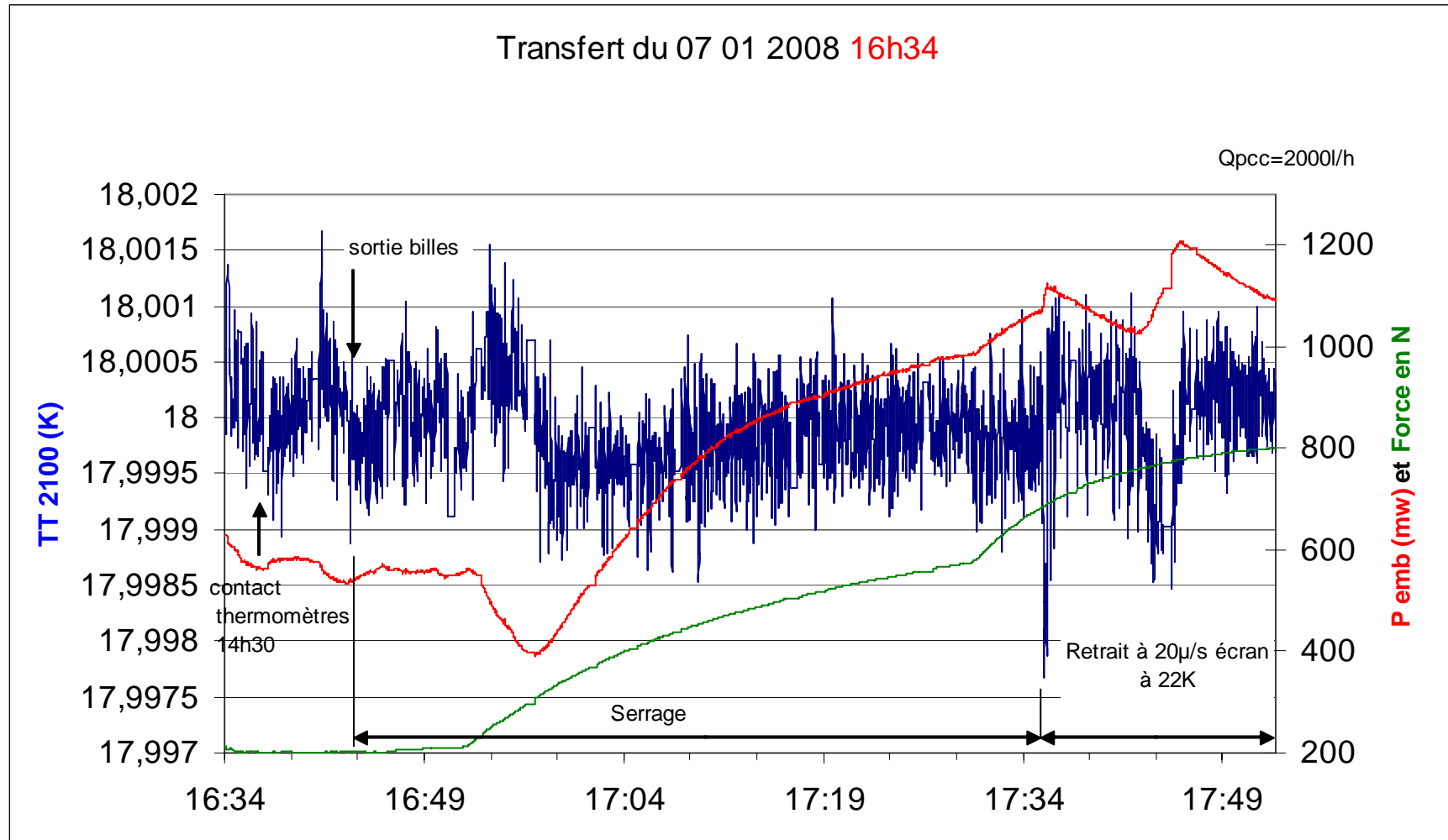
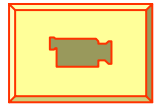
Target time life 180 ms  
(numerical calculations)

Remove the thermal shroud less than 100 ms  
and move away to a distance of 0.5 m  
Linear motor from 20 to 40 kW  
Acceleration 20 g

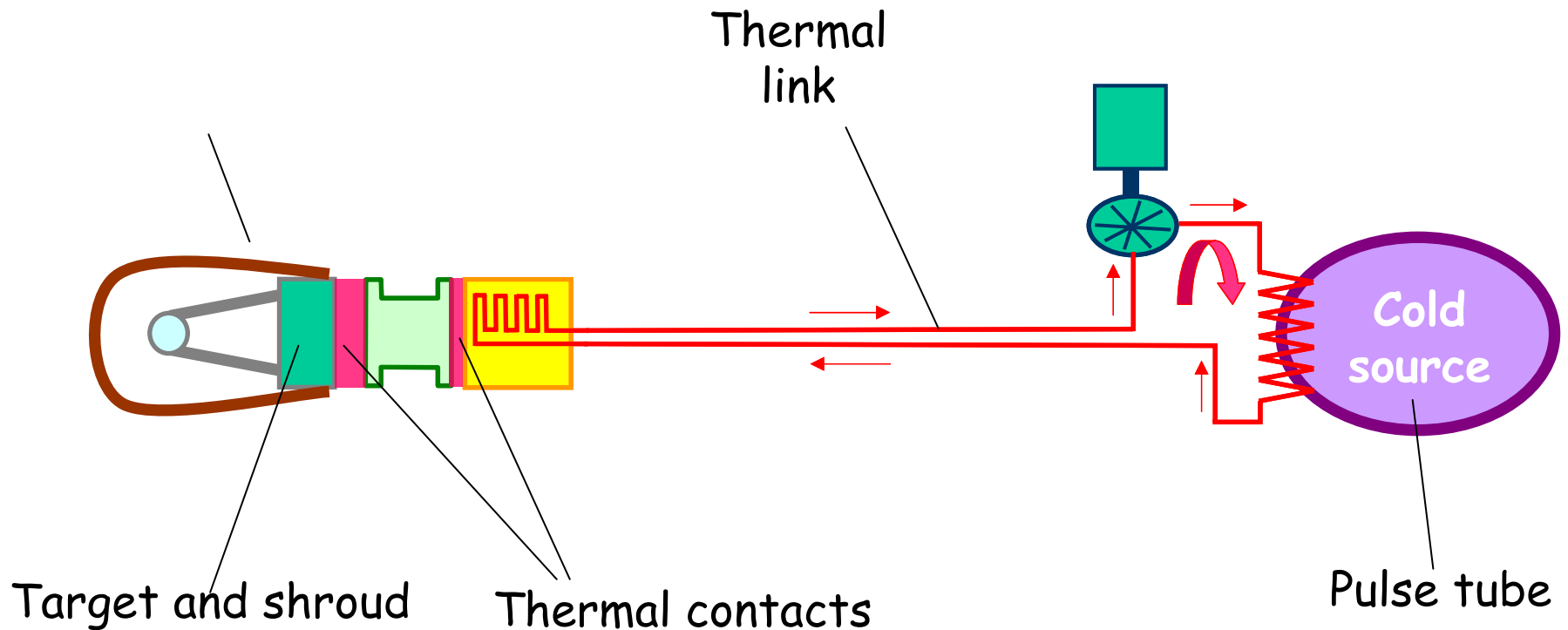


# cea Cryocompressor



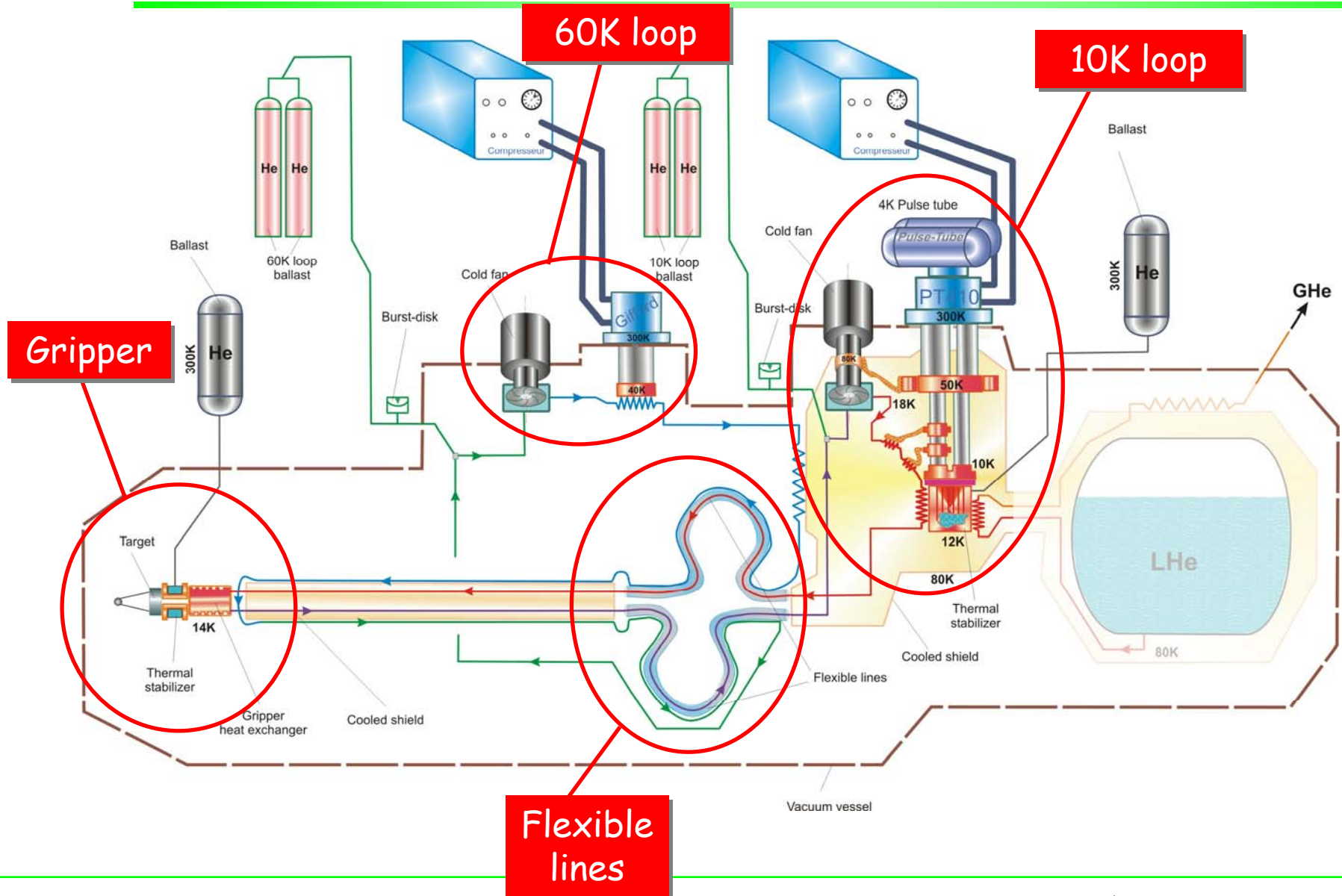


# Cooling of the gripper: principle



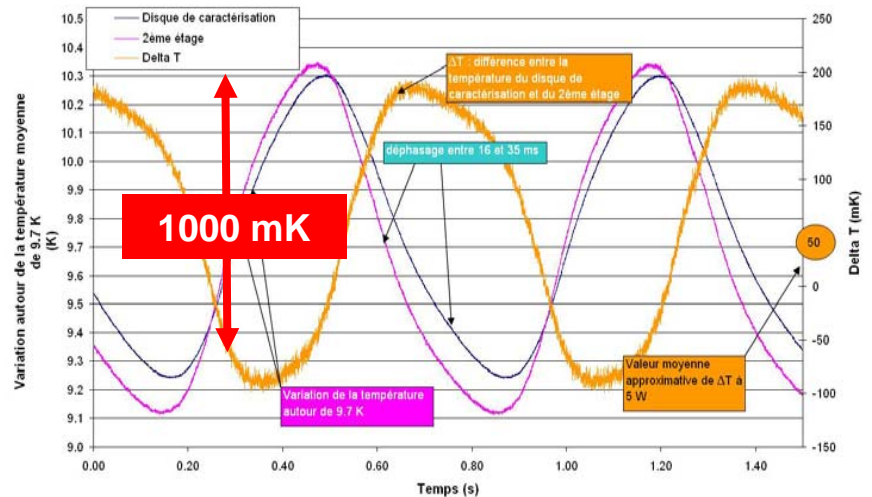


# Cryogenic circuits : principle

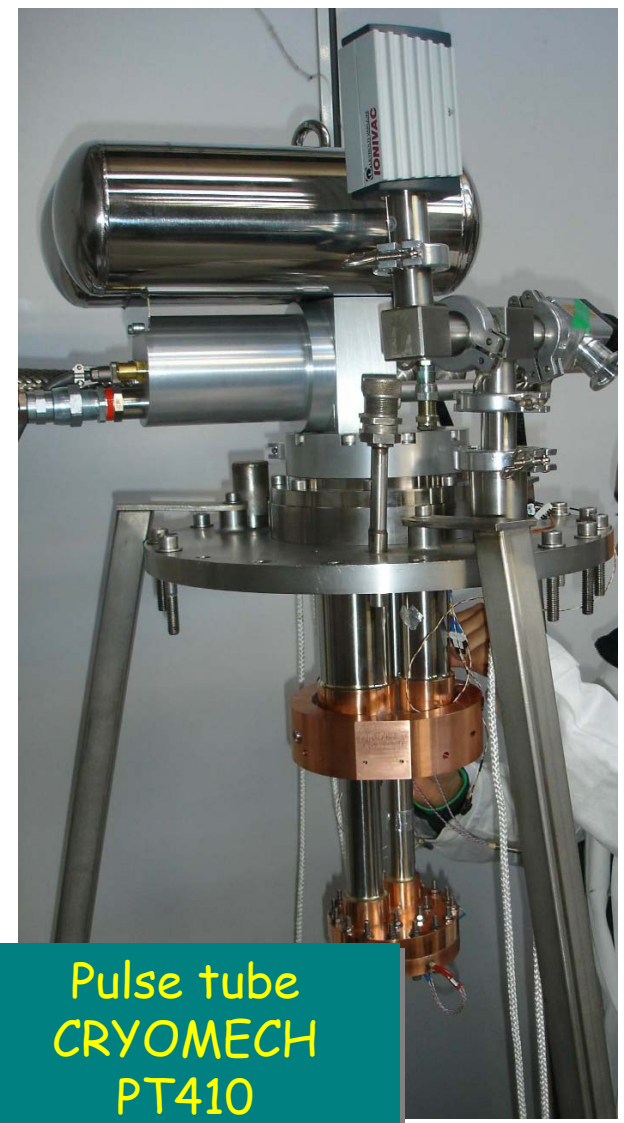
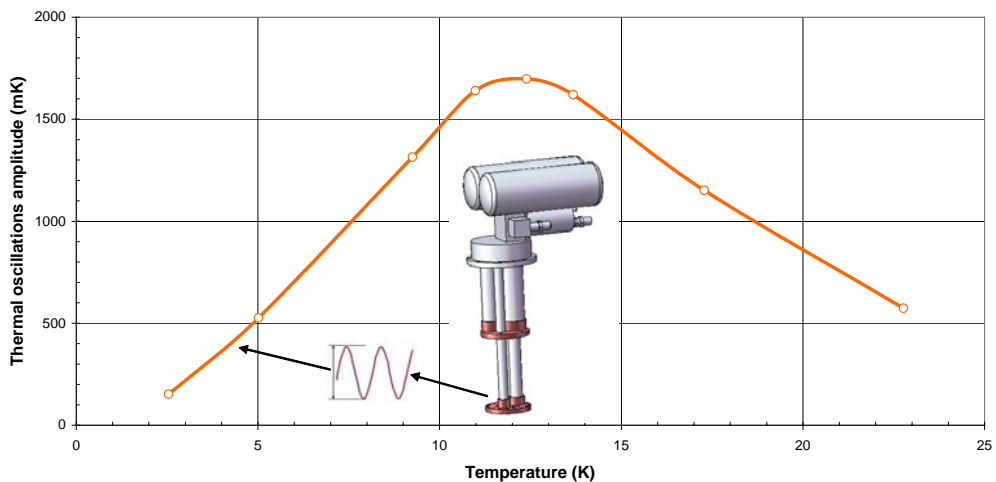


# PT generates thermal oscillations

**2<sup>nd</sup> stage temperature oscillates at 1.4 Hz**



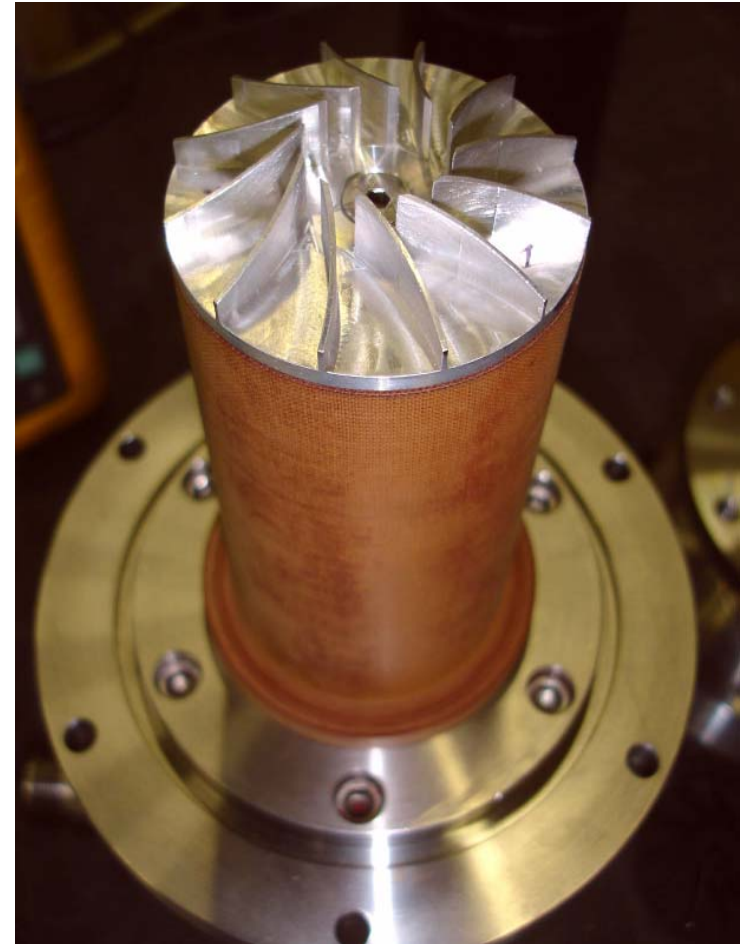
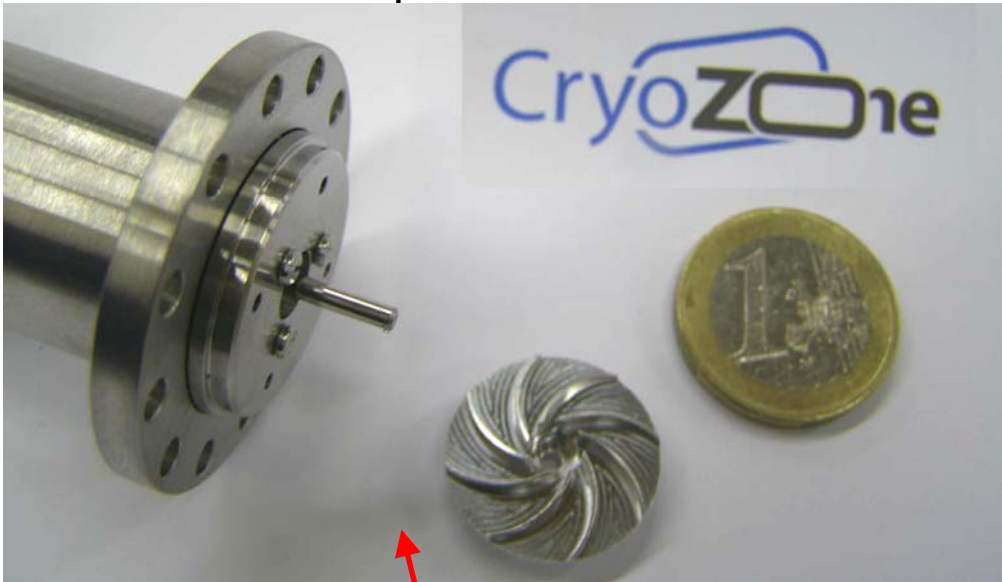
**Thermal oscillations at the pulse tube second stage as a function of the temperature**



**Pulse tube  
CRYOMECH  
PT410**

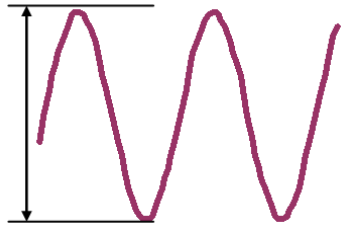
# Small Cryogenic Fans

- One fan for the 10K loop, another for the 60K loop
- Working pressure : 20 bars
- Mass flow : 0.1 to 0.5 g.s<sup>-1</sup>
- Delta P provided by the fan : up to 20 mbar
- The 10K fan has a thermal anchoring at 60K
- The critical point is the heat flow conducted

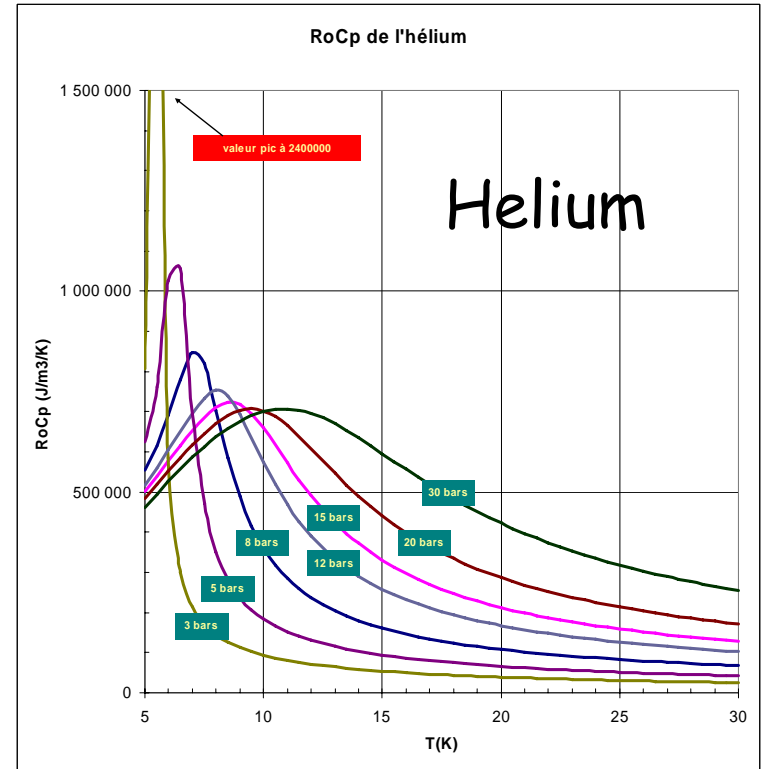
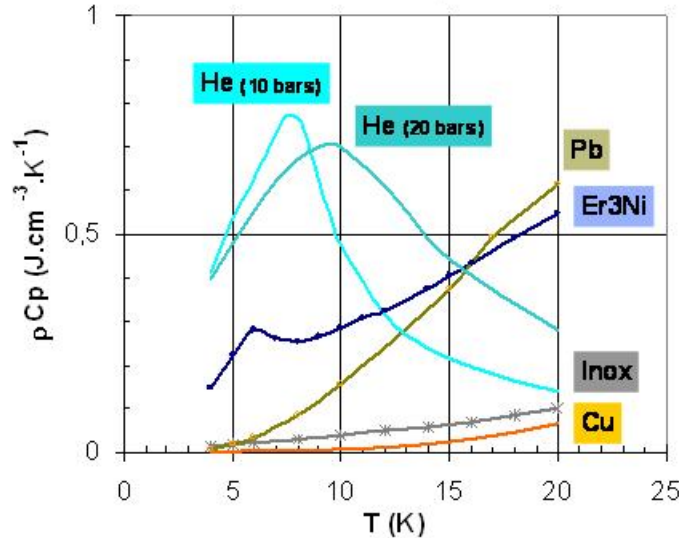


The fan "MISTRAL" : a brand new low heat input prototype designed and built by CRYOZONE

# Damping the oscillations with a thermal mass

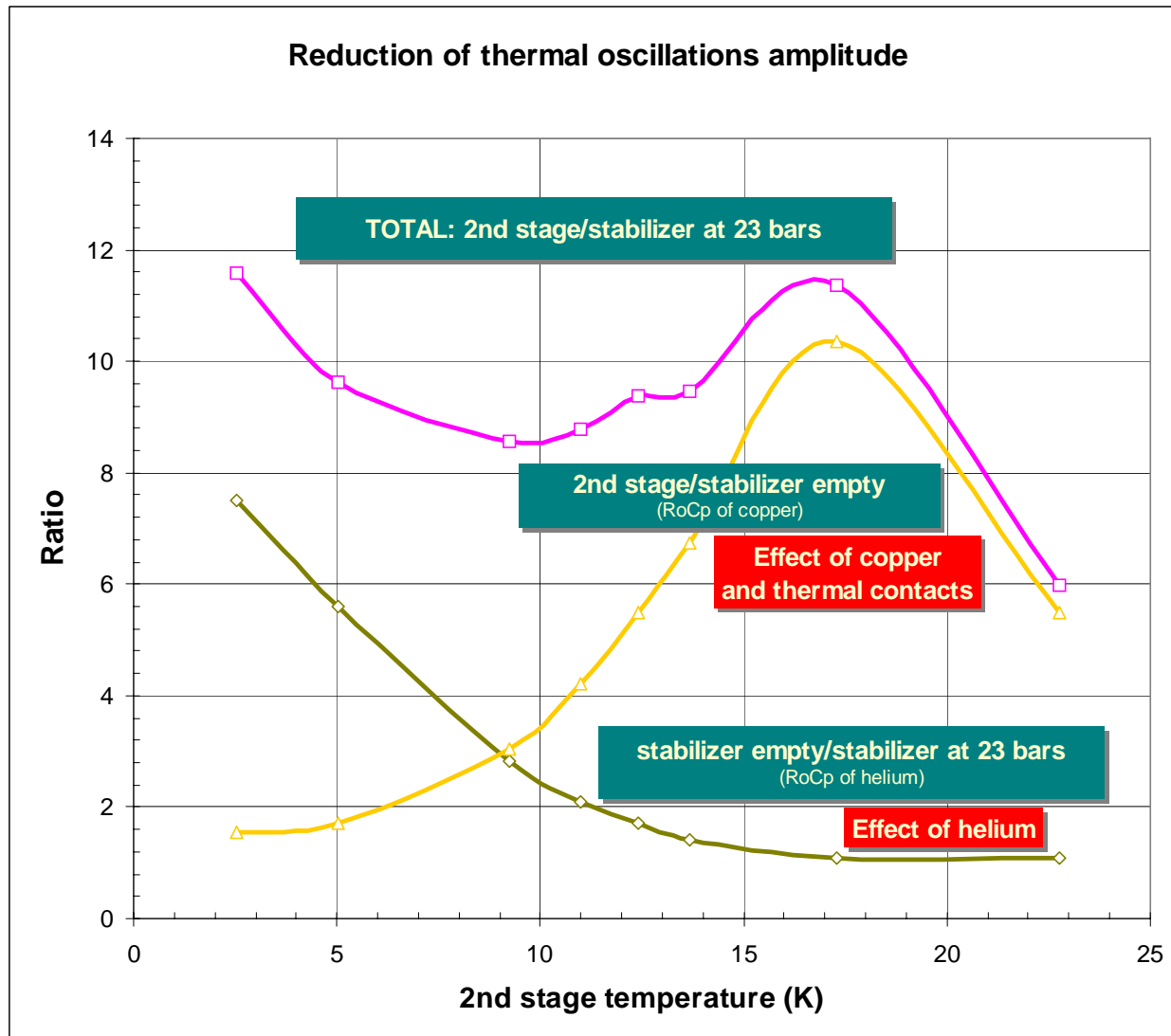


Oscillations have to be reduced by a factor 1000



With its high Cp Helium is a good candidate





It is expected from passive stabilizers to obtain a high damping.

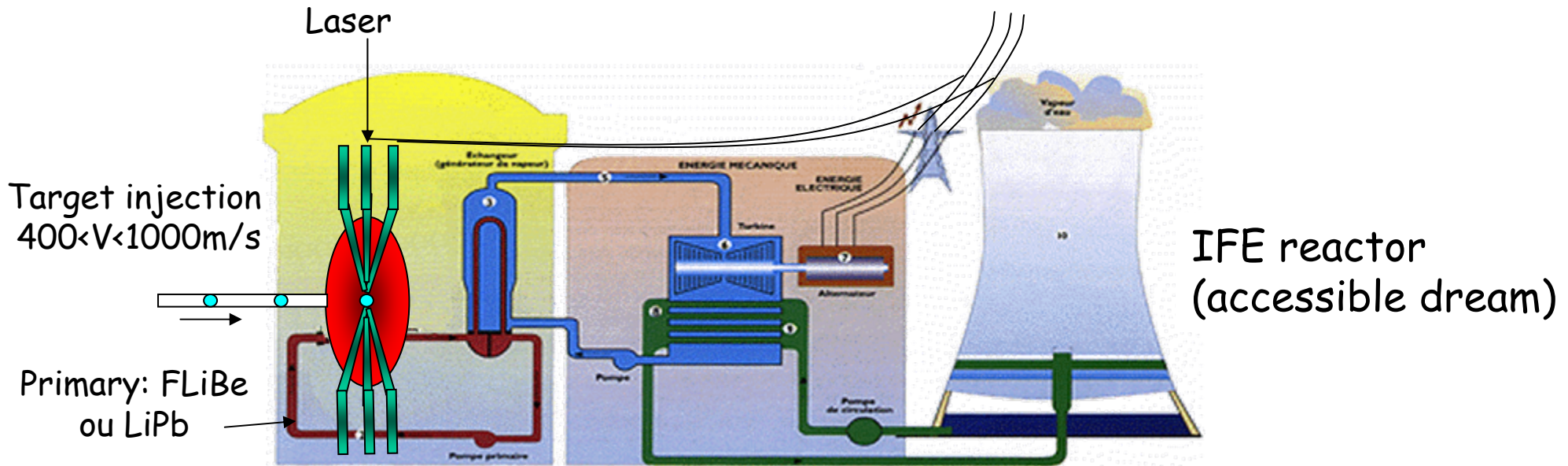
Many technologies are now available for cryotargets  
(direct or indirect drive)

Regulation within a margin of 1 mK (LHe + GHe loop)

cold robotics with accuracy 10-15 microns,

With cryorefrigerator the margin is 20 mK.

# Thanks for your attention



*Do not ask yourselves what Hiper can do for you, ask yourselves what you can do for Hiper.*

*JFK*

# Copper and helium : a passive stabilizer

- Passive thermalizer : a cold helium volume (a few cc) connected to a ballast at 300K.
- A bulk copper part with numerous slots is used as thermal link.
- Copper helps the stabilization at 15K or above.
- The cold volume is thermally linked to the pulse tube.

