

Infrastructure at CEA linked to HFM

E. Rochepault, J-M. Gheller, W. Abdel Maksoud, T. Genestier, S. Roux, M. Durante, T. Lécresse, R. Vallcorba, B. Baudouy

Current characterization platforms

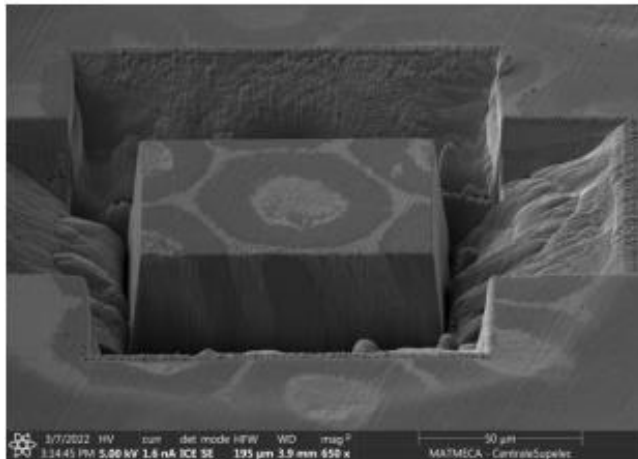
1. Tensile-compression tests: 300K, 77 K, 4 K
2. Heat treatment oven for Image Correlation (@ENS Paris-Saclay)
3. I_c measurements up to 17T, 4.2K and 1.9K)
4. Thermal conductivity at variable temperature
5. X-Ray Tomography (option for in situ tests)
6. SEM – FIB (@Centrale Paris-Saclay)
7. **Polisher and wire saw under procurement**



Thermal conductivity at variable temperature



Tensile test of a Nb3Sn strand at 77 K



In situ observation of the reaction of a RRP sub-element

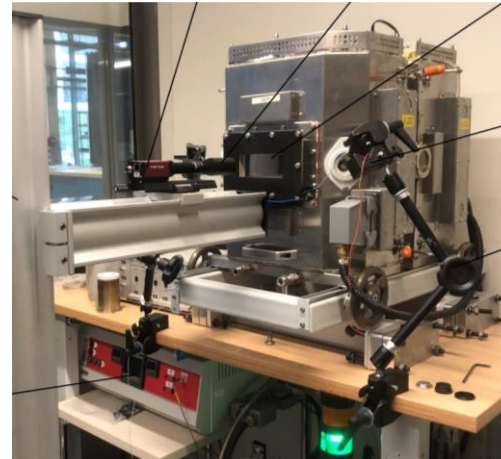
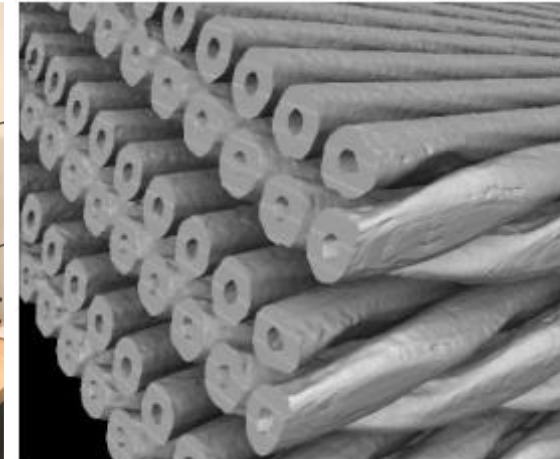


Image correlation on a Rutherford cable during heat treatment



X-ray tomography of a Nb3Sn Rutherford cable

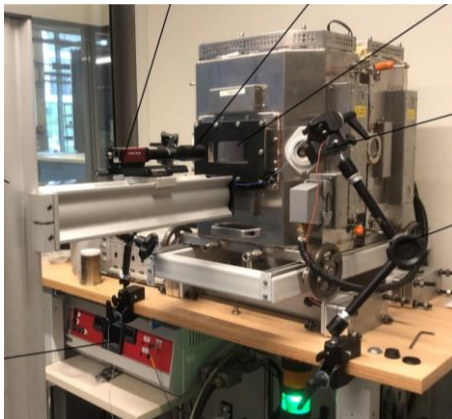
Future characterization platforms (PACIFICS)

1. Characterizations at high temperature of superconducting materials
2. Cryogenic facility for studies of PHP
3. Cryogenic facility for studies of magnetic levitation of bubbles in very high fields
4. Test bench for mechanical characterization at cryogenic and variable temperature

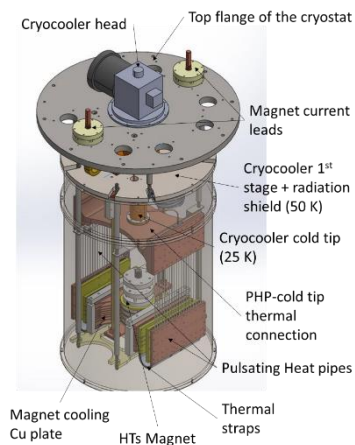
Courtesy T. Genestier, S. Roux

For illustration purpose :

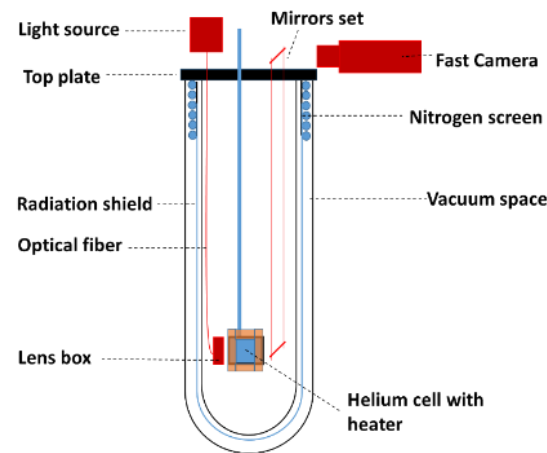
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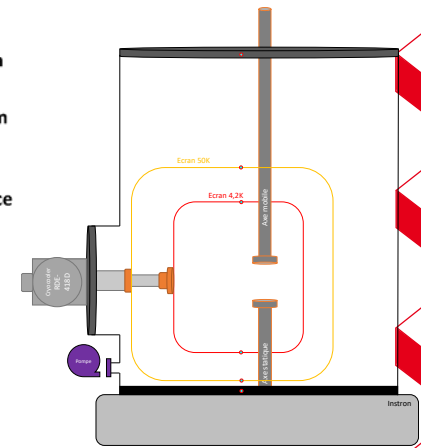
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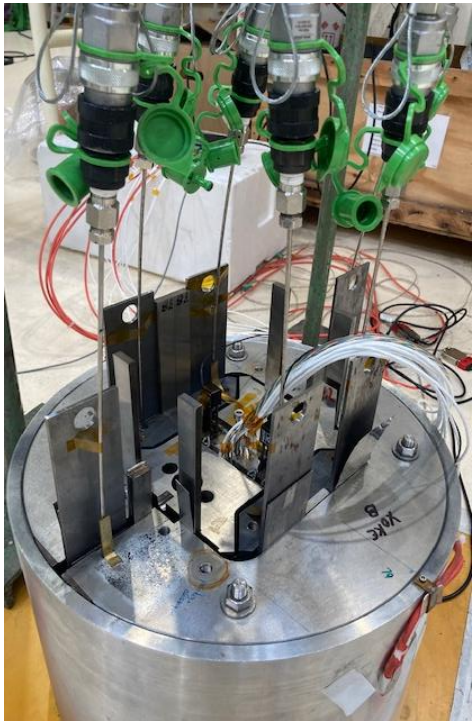
4.



Current LTS coil and magnet workshop

Courtesy M. Durante

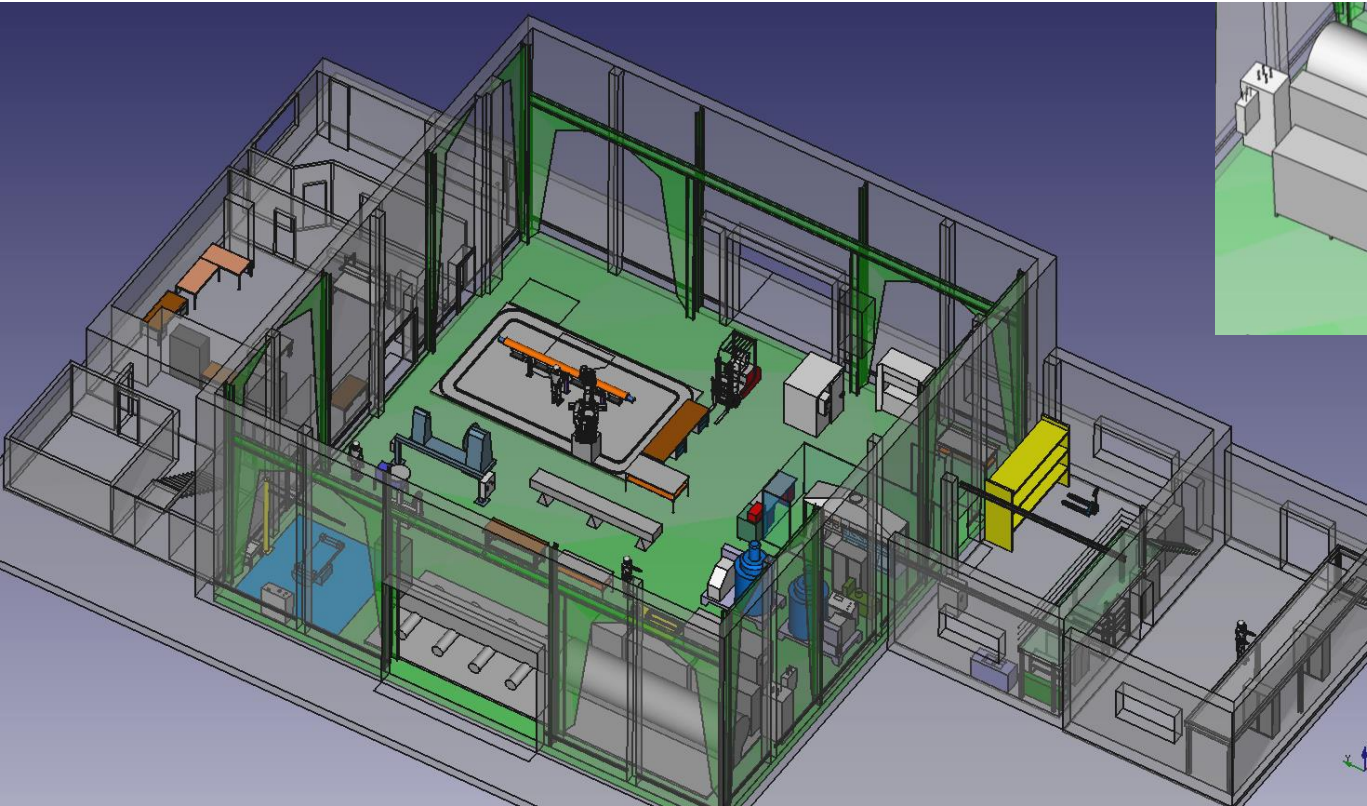
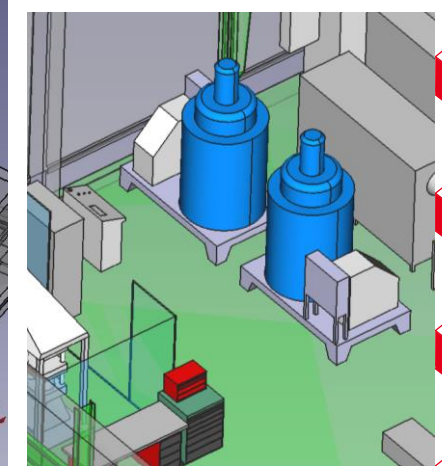
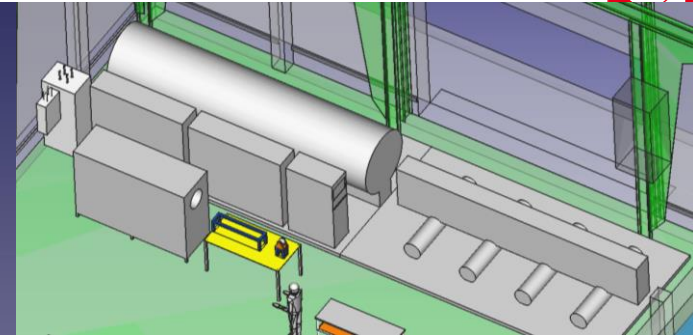
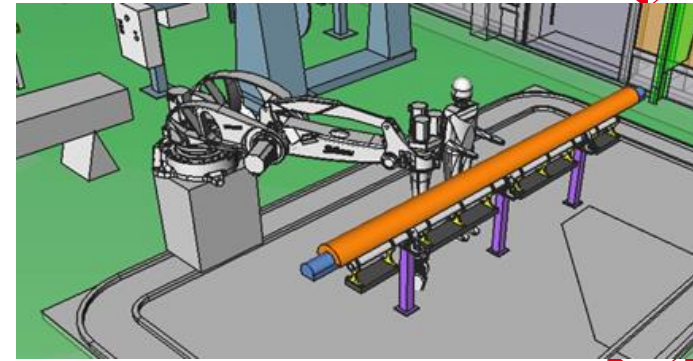
1. Winding table
2. Heat treatment oven
3. Impregnation bay
4. Qualification tests (electrical tests, Faro arm)
5. Structure assembly an pre-load



Future LTS coil and magnet workshop (PACIFICS)

1. Winding machine → modular and versatile
2. Large heat treatment oven → up to 5 m
3. Impregnation Installation → up to 5 m
4. Diagnostic and data acquisition

Courtesy T. Genestier, S. Roux



Current HTS coil and magnet workshop

1. Winding machine installed in August 2023

- Up to 6 cowound tapes (later 10)
- Full parameters control and record
- Up to 230 N per tape
- Up to 1 m (diameter) 0.5 m (height)



2. Design test station ongoing

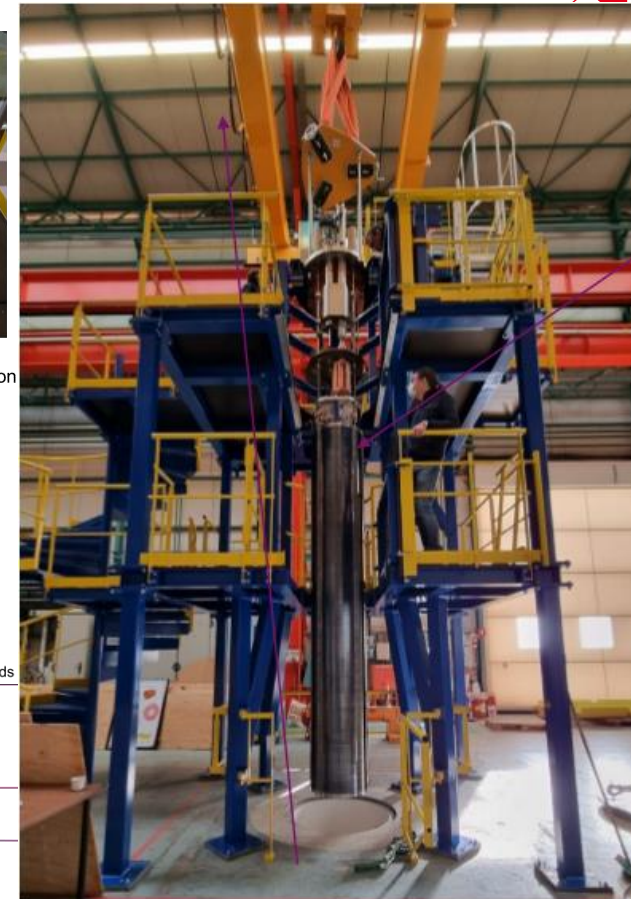
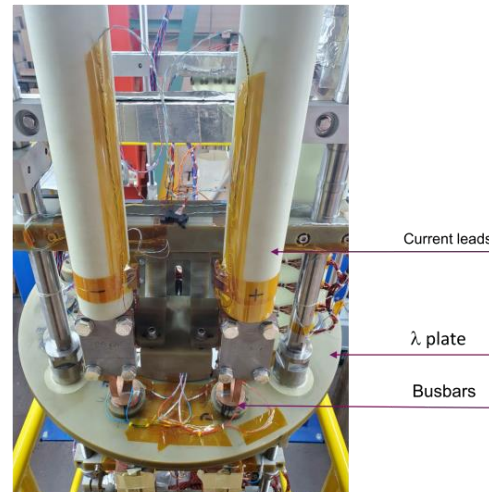
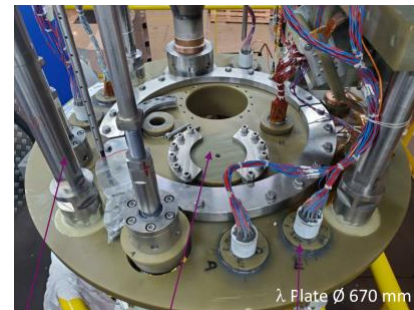
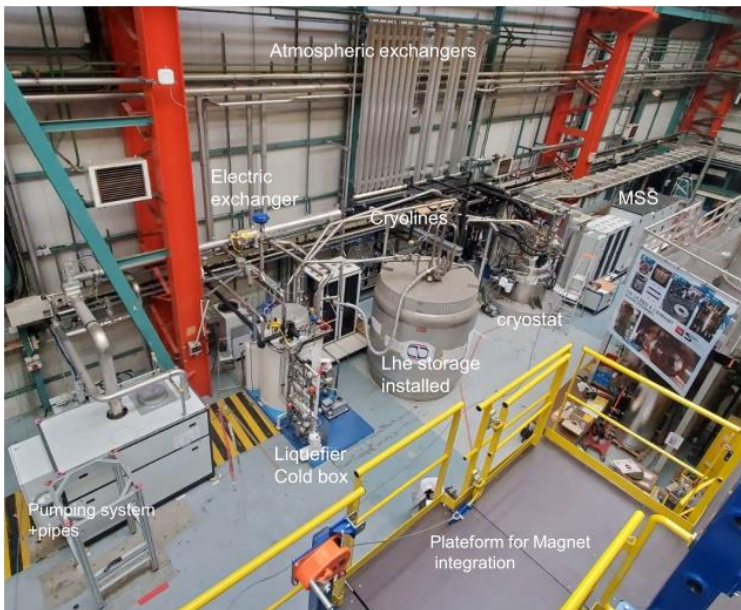
- no background field
- Planned max coil OD 600 mm
- Planned coil high 1000 mm
- Cooling : LN2 (77 K) or conduction (4.2 K – 30 K cryocooler)
- Up to 3 kA (400-1500 A in conduction)



Current LTS cryogenic test station (STAARQ)

- Pressurized LHe bath at 1,9 K
 - Current leads 13 kA, power supply 20 kA
 - Liquefier: 50 l/h
 - MSS Numeric // Analogic
 - Weight max magnet: 12 t
 - Useful diameter: 640 mm
 - Useful Length : 5,2 m
- **Ongoing commissioning**

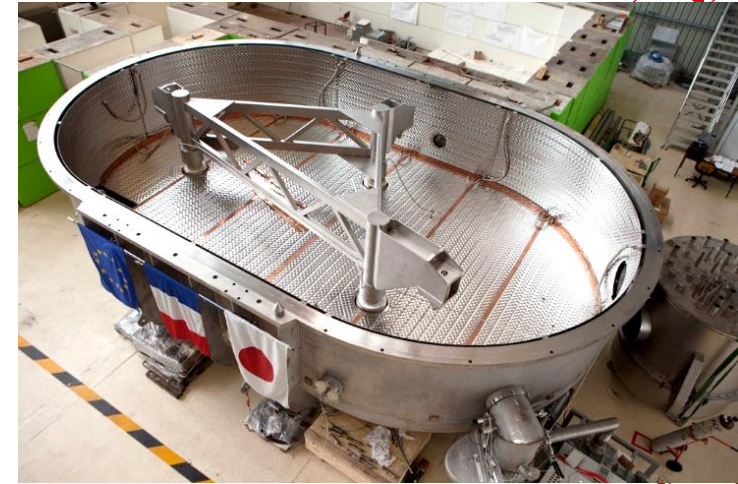
Courtesy J.M. Gheller



Current large cryogenic test station (JT60)

- Cryostat for **large magnets**: $L < 10$ m, $W < 6.5$ m, $H < 2$ m (previously JT-60SA)
- 500 W @ 4.5 K, +3.6 g/s from 50 K to 300 K
- Supercritical forced helium flow 5 K - 7.5 K
→ upgrade with a tank possible for tests in a bath
- **High current: $I < 26$ kA**

Courtesy W. Abdel Maksoud, R. Vallcorba



Helium refrigerator Cryogenic line Nitrogen warmer Copper busbars Dump resistor and main breaker Safety System cabinets



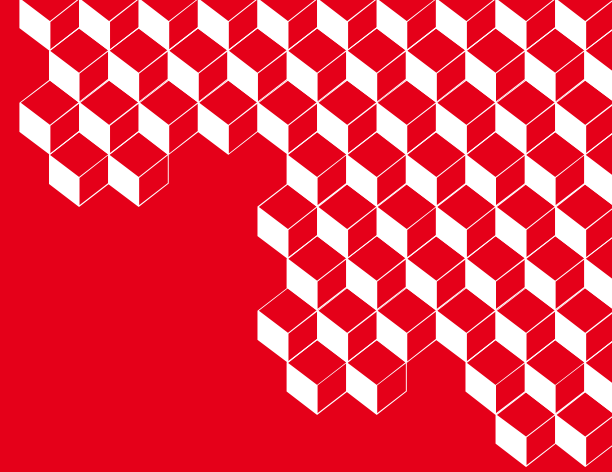
Process and control cabinets Warm valves HTS current lead Valve box Cryostat Power supply Test frame

Various platforms for HFM activities

- **Material and conductor characterizations:**
 - Many possibilities : mechanical, thermal, in situ tests during the heat treatment, metallography...
 - Strong partnership with Université Paris-Saclay
 - Investments in future platforms for other characterization
- **LTS coil and magnet workshop:**
 - NbTi and Nb₃Sn short coils fabrication and magnet assembly
 - Investments for large coils, long coils
- **HTS coil and magnet workshop:**
 - ReBCo short coils fabrication
 - Test station for magnets under design
- **Cryogenic test stations:**
 - STAARQ: long vertical station, 14 kA
 - JT60: large adaptable “horizontal” station, 26 kA



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Merci !

Thank you !