



Design and manufacture of the large-bore 8T superconducting solenoid for the NAFASSY test facility

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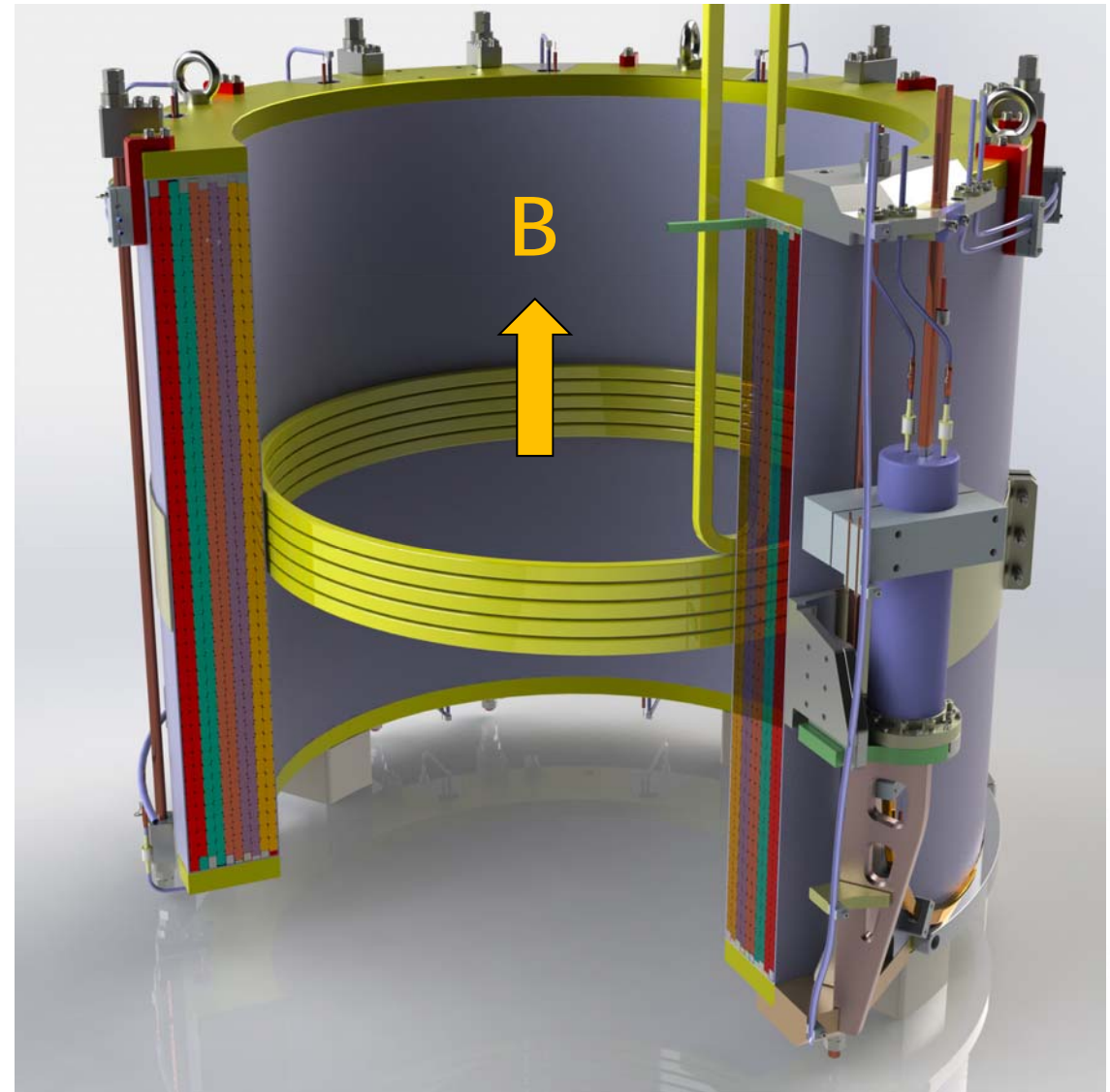
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Nafassy Magnet: 8T, 1150 mm bore

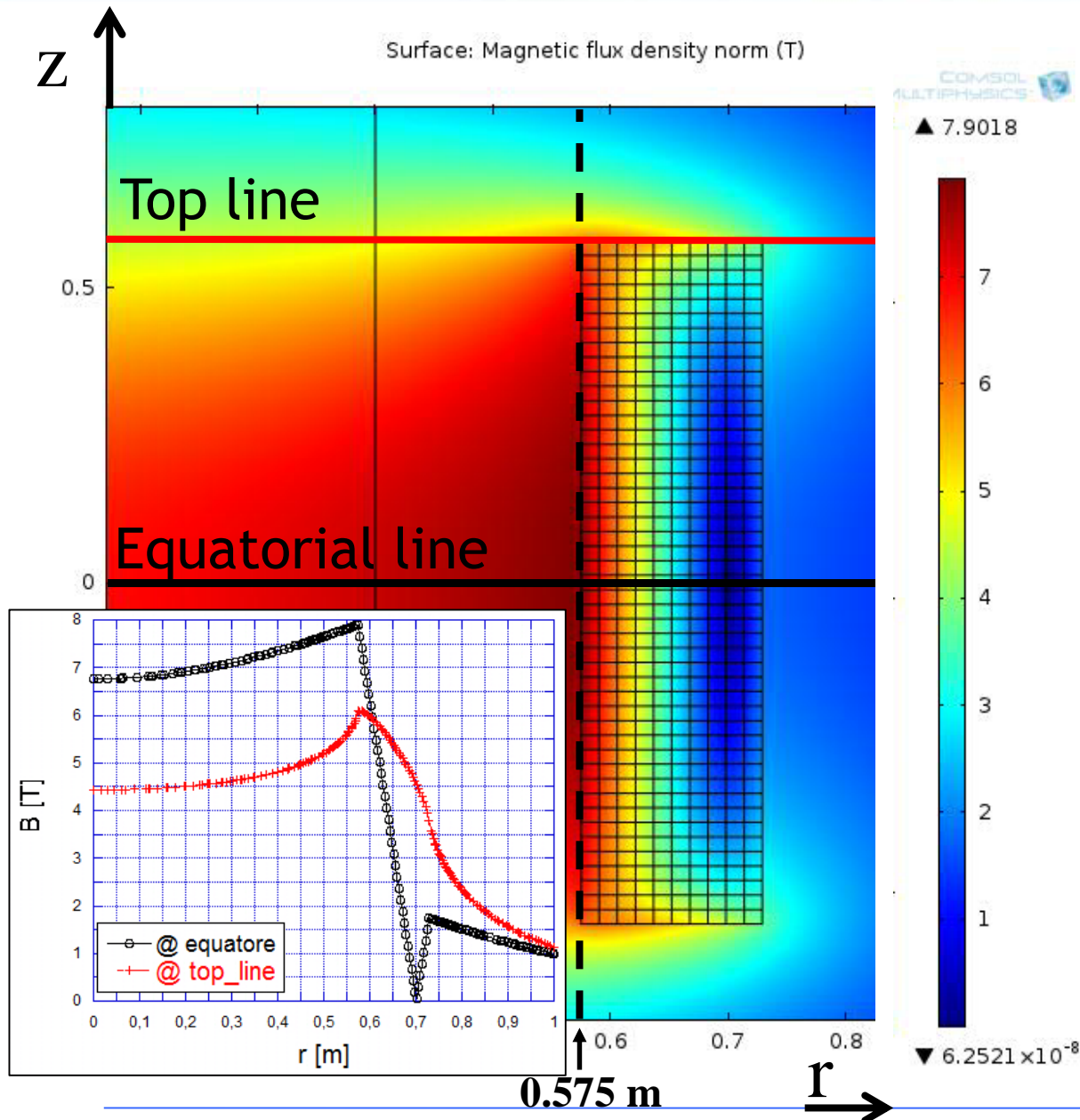
NAFASSY:

- Nb_3Sn 8 T magnet
- Large (1150 mm) and warm bore
- Variable temperature measurements (4.5-77K)

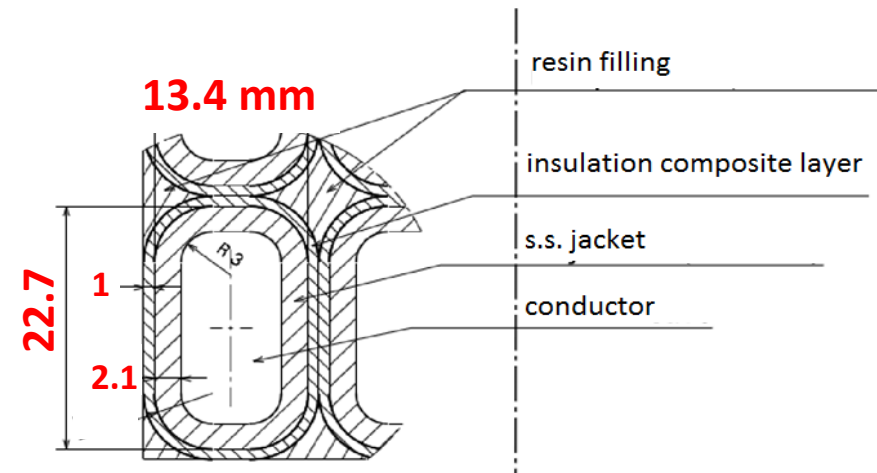
➔ To test HTS and LTS coiled samples



Magnet and conductor sizes

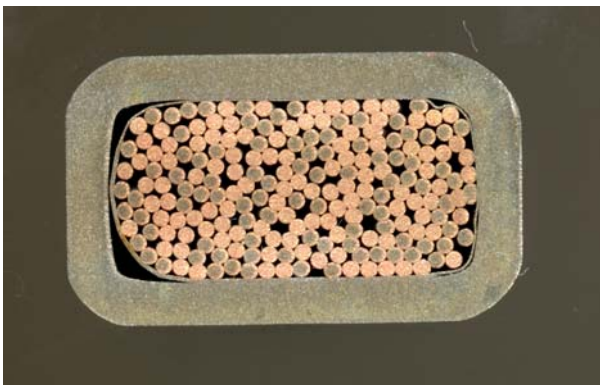


Strand	Nb ₃ Sn/Cu
Inner Radius [m]	0.575
Outer Radius [m]	0.729
height [m]	1.1609
# of layers	10
Turns/layer	47
Current [A]	20 000
Current Density [A/mm ²]	52.6
Stored Energy [MJ]	38



Conductor Production by ICAS Consortium

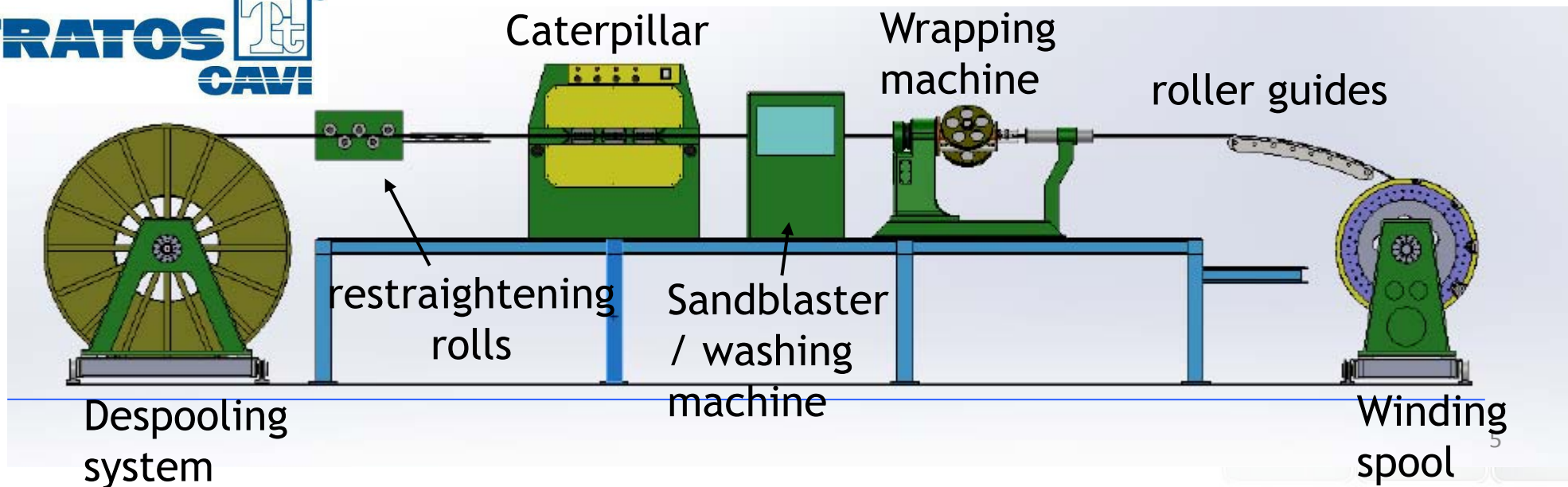
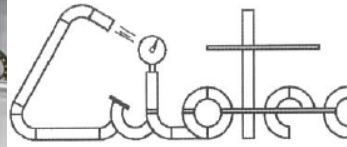
- 250 m of dummy conductor for setting the winding line
- 300 m of dummy conductor, for realizing the dummy magnet (10 layers, 6 turns/layer instead of 47)
- 2 Km of superconducting conductor, manufactured and leak tested



New Winding Line



Completely electronically controlled !



Shaking-hands joint



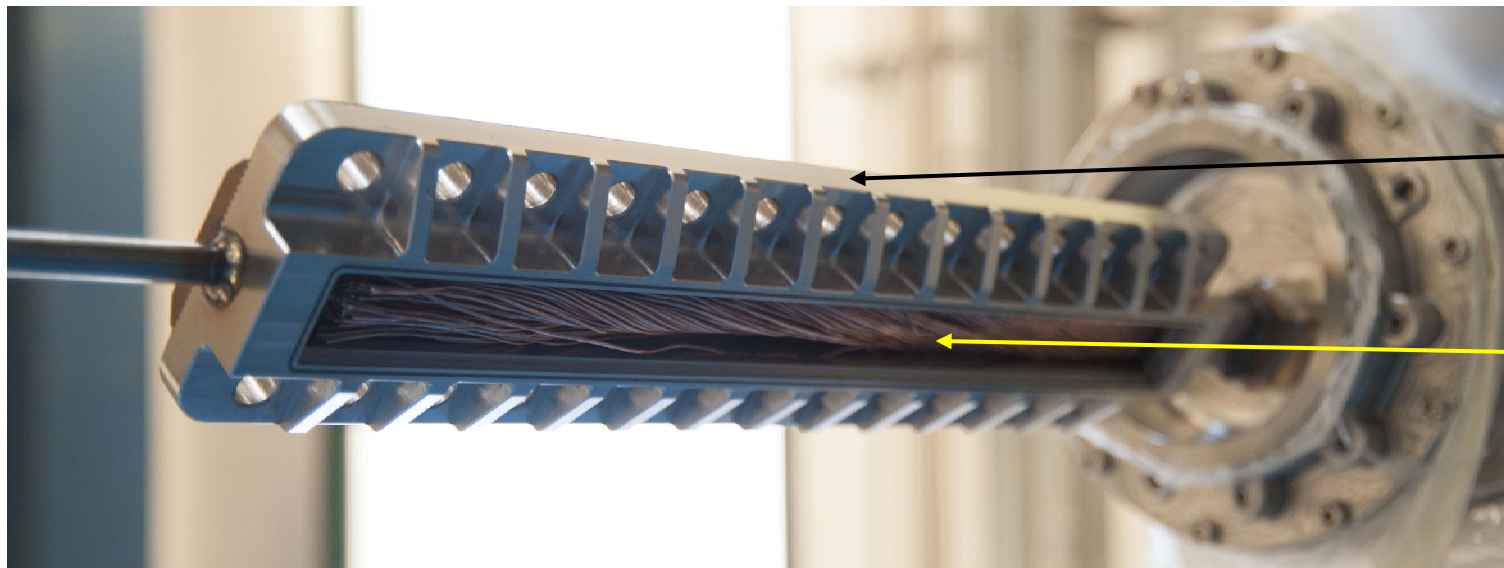
4 Joints in shaking-hands configuration, developed and patented by ENEA:

- 1) Cut and Chromium etching
- 2) Compaction into a 0.1mm thick Cu tube
- 3) Jacket reconstruction

Joints, having the same size of the conductor, are embedded into the winding.

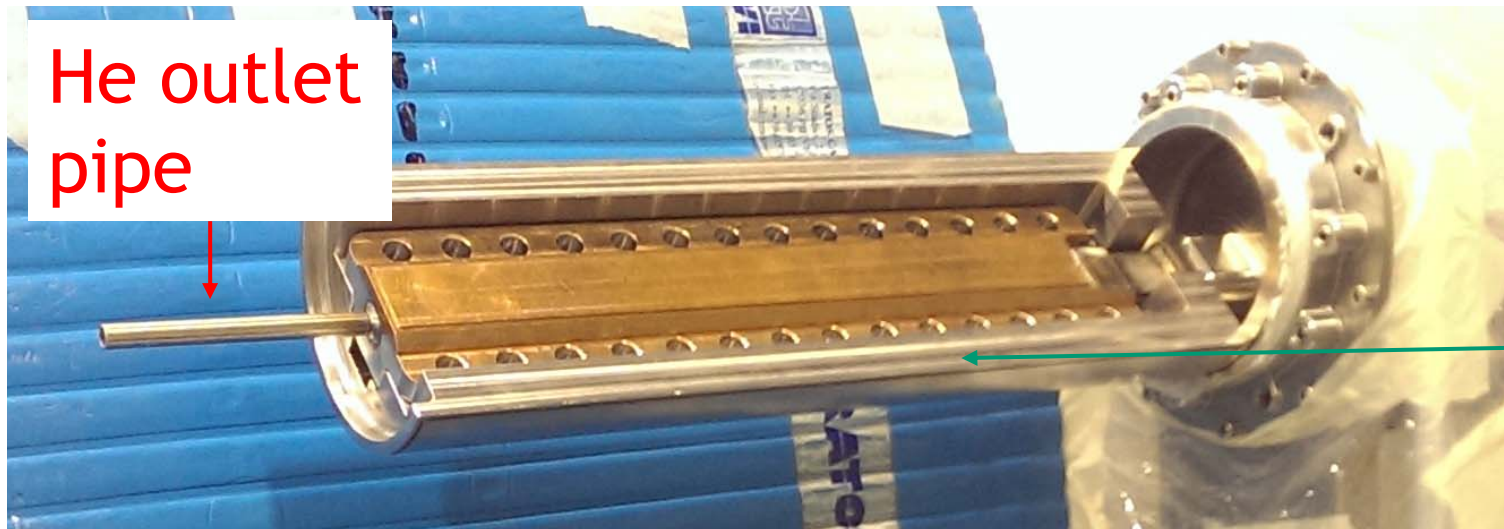


Terminations



Exploded
bonded plate

Nafassy
conductor



He outlet
pipe

SS cylinder for
mechanical
support during HT

Magnet after winding



Stainless steel structure
providing mechanical
support to terminations

Insulation:

- Fiber glass tape wrapped on the conductor, 1mm thick.
- The ground insulation thickness is 1mm.

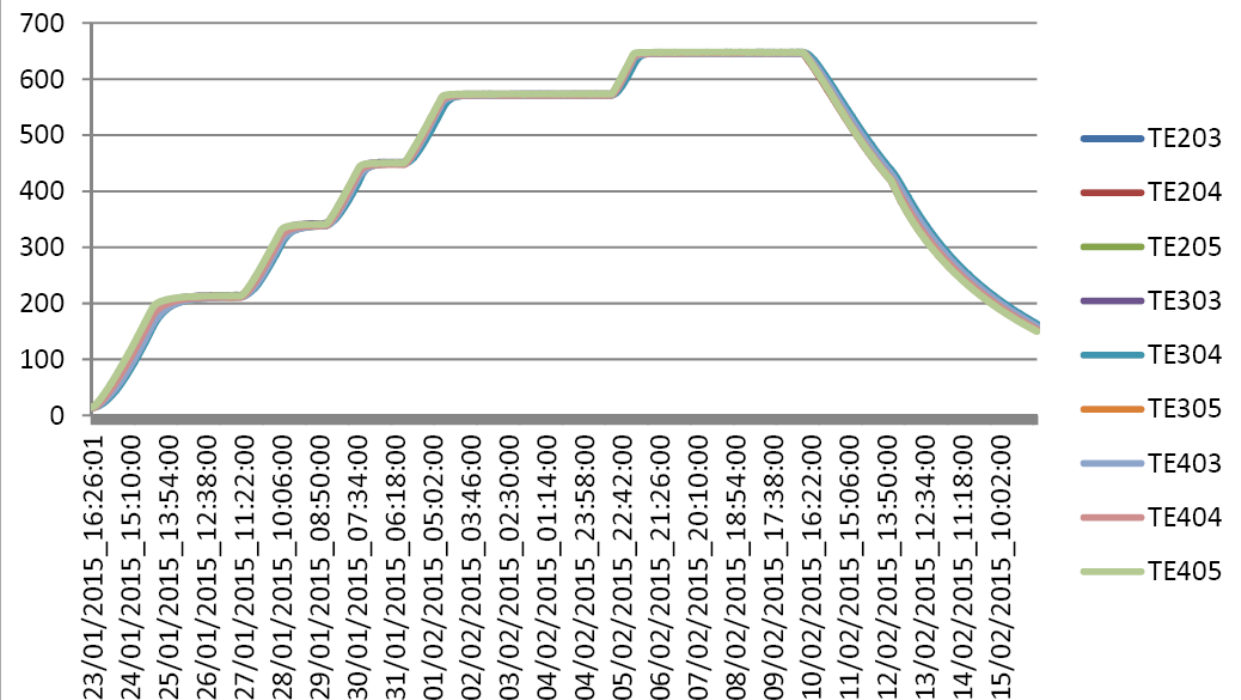
With $L=190\text{mH}$, $\tau_{\text{delay}}=1\text{s}$ and $\tau_{\text{discharge}}=3.5\text{s}$, the maximum tension at the discharge is $V_{\text{max}}=1100\text{V}$

Heat Treatment



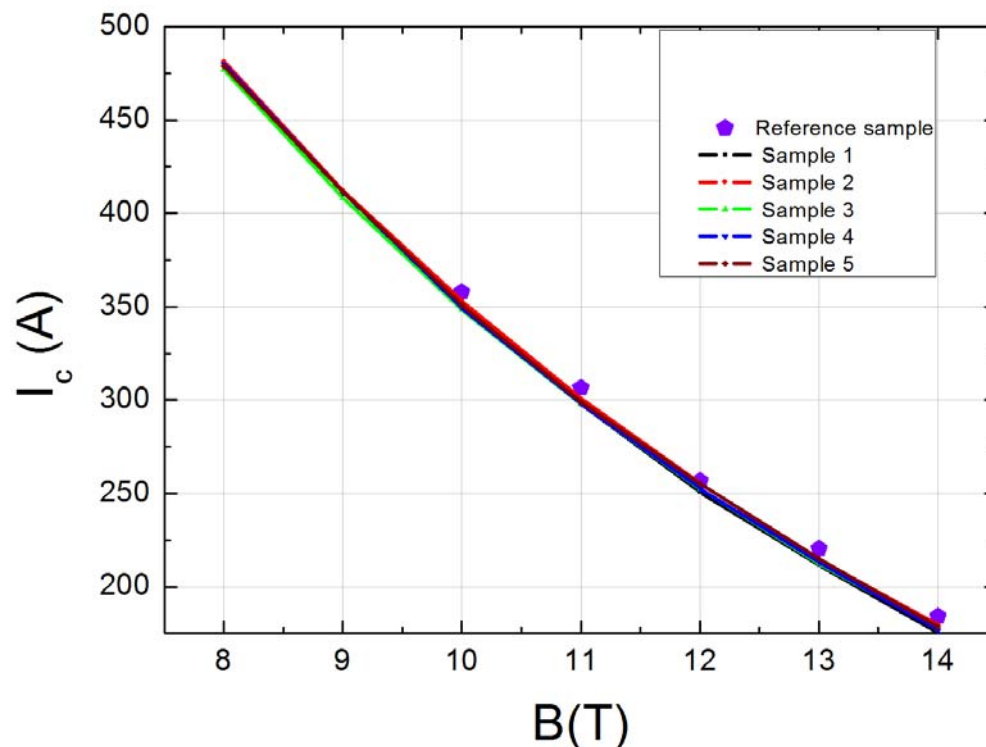
9 thermocouples
to monitor the
uniformity of the
temperature

Ramp at 5° C/h to 210 ° C and hold for 50h
Ramp at 5° C/h to 340 ° C and hold for 25 h
Ramp at 5° C/h to 450 ° C and hold for 25 h
Ramp at 5° C/h to 575 ° C and hold for 100 h
Ramp at 5° C/h to 650 ° C and hold for 100 h
Ramp at 5° C/h to 500 ° C cooled to room temperature inside the furnace



Heat Treatment of witness Samples

5 lengths of the strand used to cable the NAFASSY conductor have been employed as witness samples during the heat treatment. All samples have been heat treated, together with the 8T magnet, in the oven manufactured by Criotec for the NAFASSY project.



The values of critical current as a function of the magnetic field are reproducible among the different samples. In addition, the values are also very similar to the ones measured on a reference sample, that has been heat treated in a smaller oven in ENEA laboratories.

Impregnation and preliminary tests

Standard Vacuum Pressure Impregnation:

- 1) Epoxy temperature: 60°C
- 2) Gelification Step: 10h @ 110°C
- 3) Curing: 24h @ 135°C
- 4) Cool down: 5°C/h

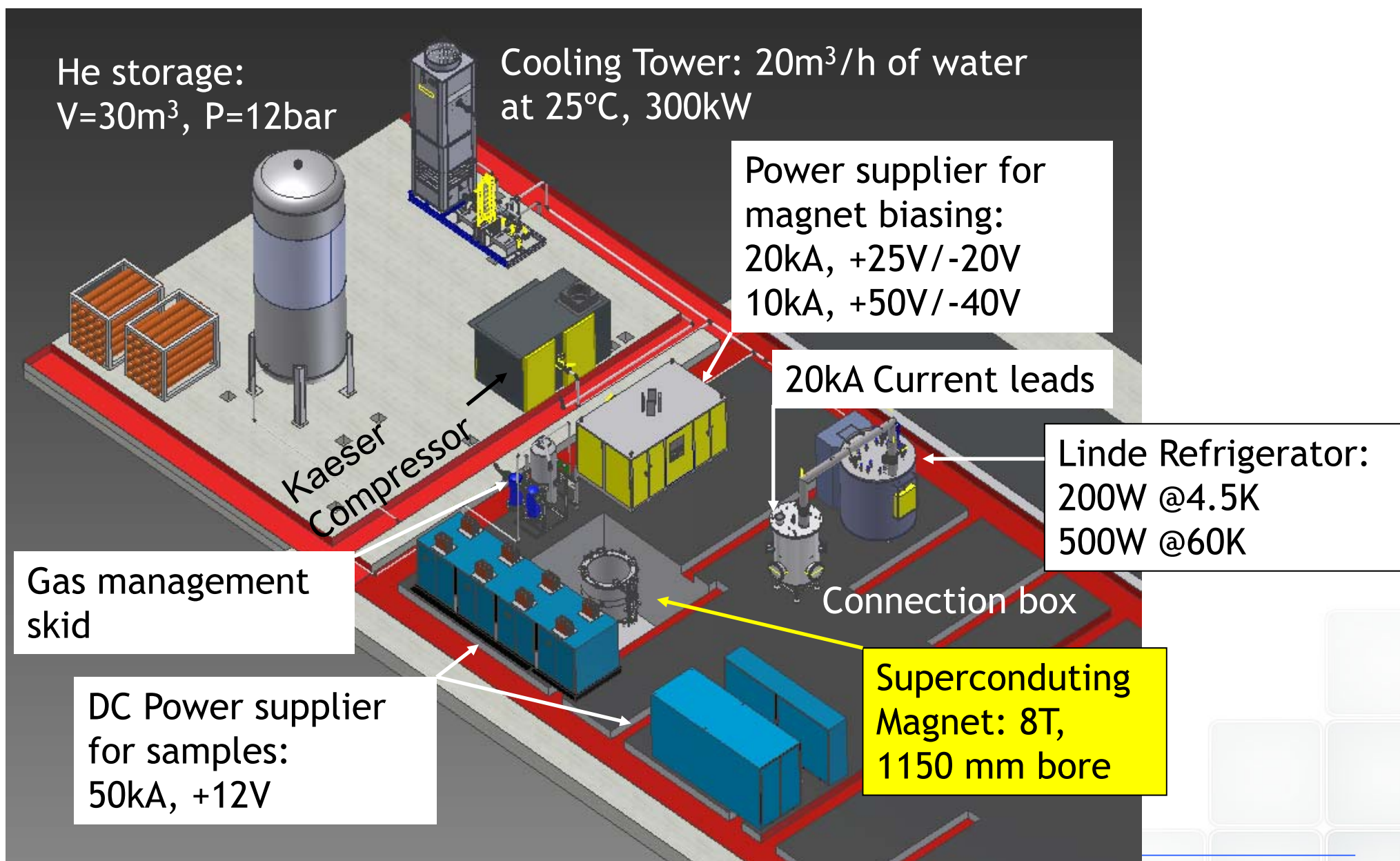
Paschen test under different
vacuum pressures: 120s @ 1000V

Results: $R=1.4-1.7G\Omega$



20 kA HTS Current Leads (Re-BCO based)





- A new winding line and ovens for heat treatment and impregnation of large solenoids have been realized
- The Nafassy Magnet has been manufactured
- Preliminary tests have been successful

... Next steps

- Final tests are in progress
- Assembling of the Nafassy magnet at the University of Salerno
- Commissioning of the Nafassy facility

Thanks for your attention !