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Update on Nb₃Sn Quadrupole Magnet Program

M. Durante

CEA Saclay - DSM Irfu SACM LEAS

The 2nd Saclay-KEK cooperation program workshop on superconducting magnets and cryogenics for accelerator frontier

Plan

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- Nb₃Sn Quadrupole Program Main Goals
- Pole components and Fabrication process
- Coil manufacturing and test
- Coil assembly and collaring
- First warm field measurements results
- Magnet and Cold mass assembly
- Cold tests

Nb₃Sn Quadrupole Program Main Goals

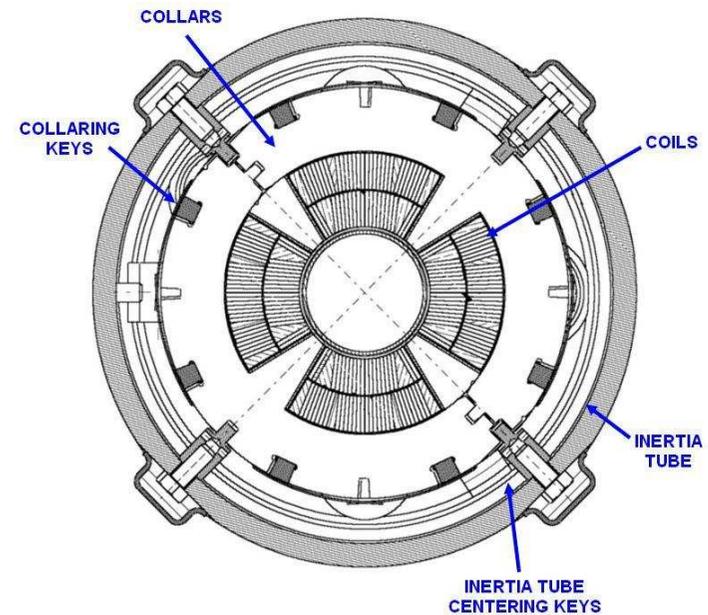
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- Get an experience in the Nb₃Sn technology keeping in mind the industrialization process
- Build a 1-m-long model, 56-mm single aperture with no magnetic yoke
- Model design based on the design of LHC arc quadrupole magnets

Gradient	211 T/m
Current	11870 A
B _{peak}	8.3 T
L	1 m



Cross sectional view of the assembly

Pole components

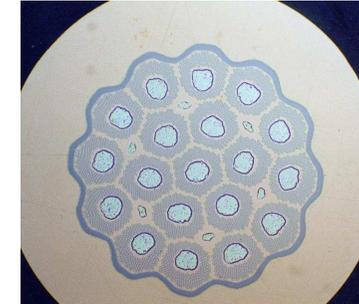
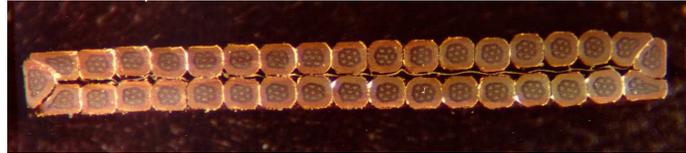
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- Rutherford-type cable developed by ALSTOM MSA

- 36 strands
- a 25- μm -thick stainless steel core



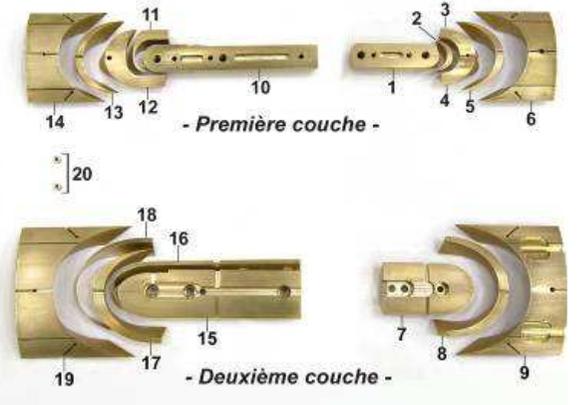
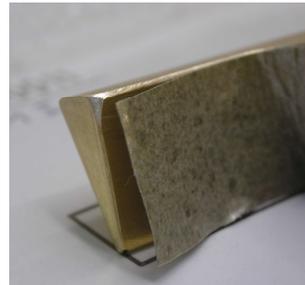
- Width : 15.1-mm
- Mid-thickness : 1.48 mm
- Keystone angle : 0.9°
- Strand \O : 0.825 mm
- Jc (4.2K, 7T) : 1850 A/mm²
- Effective filament \O : 19 μm

- Cable insulation relying on S2-glass fiber tape



- Angular and End wedges realized in Al-80%wt Cu

- End wedges insulation and inter-turn insulation made up of 0.1-mm-thick mica foils



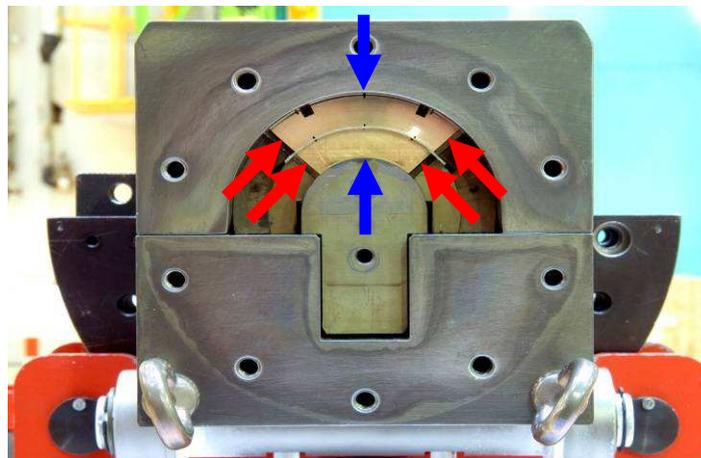
Fabrication process

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- Nb₃Sn coils will be fabricated by the « Wind, react & impregnate » technique :



Radial and azimuthal compression

Heat treatment :
240 hrs at 660°C
in argon flow

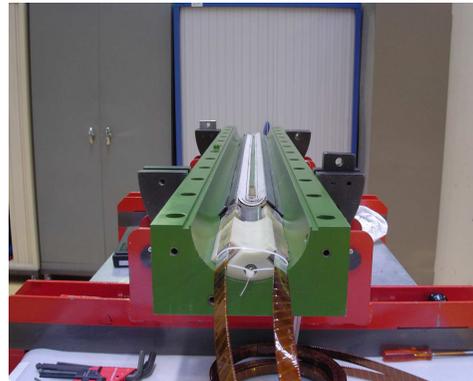
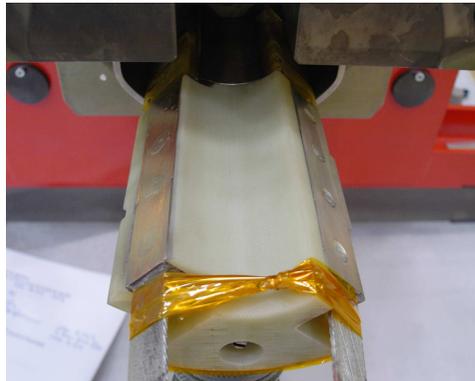
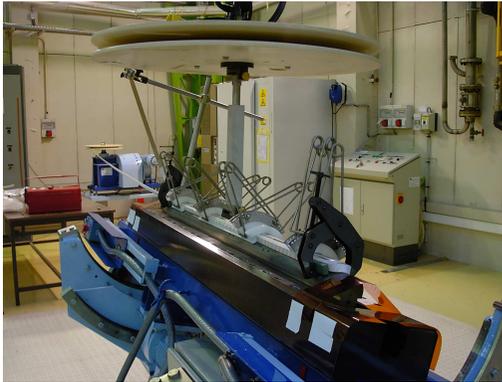
Fabrication process

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- Nb_3Sn coils will be fabricated by the « Wind, react & impregnate » technique :



- Each coil is equipped with 13 voltage taps
9 in the end parts, 4 in splice region
- The fabrication of one coil takes about 2 month

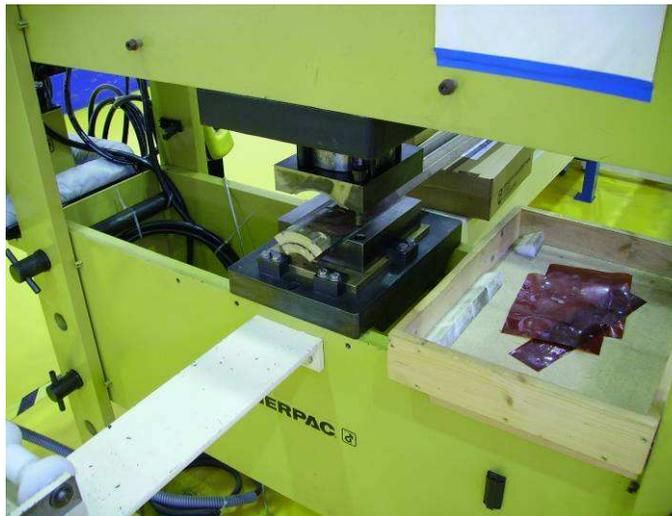
Coil manufacturing and test

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- 2 dummy coils have been manufactured to validate the fabrication process plans
- 6 coils relying on certificate cable have been manufactured between August 2004 and February 2007
- During electrical and mechanical tests, the whole length of the coils has been compressed azimuthally to avoid plastic behavior observed on short samples



- 2 coils with short circuit have been successfully repaired in April 2007

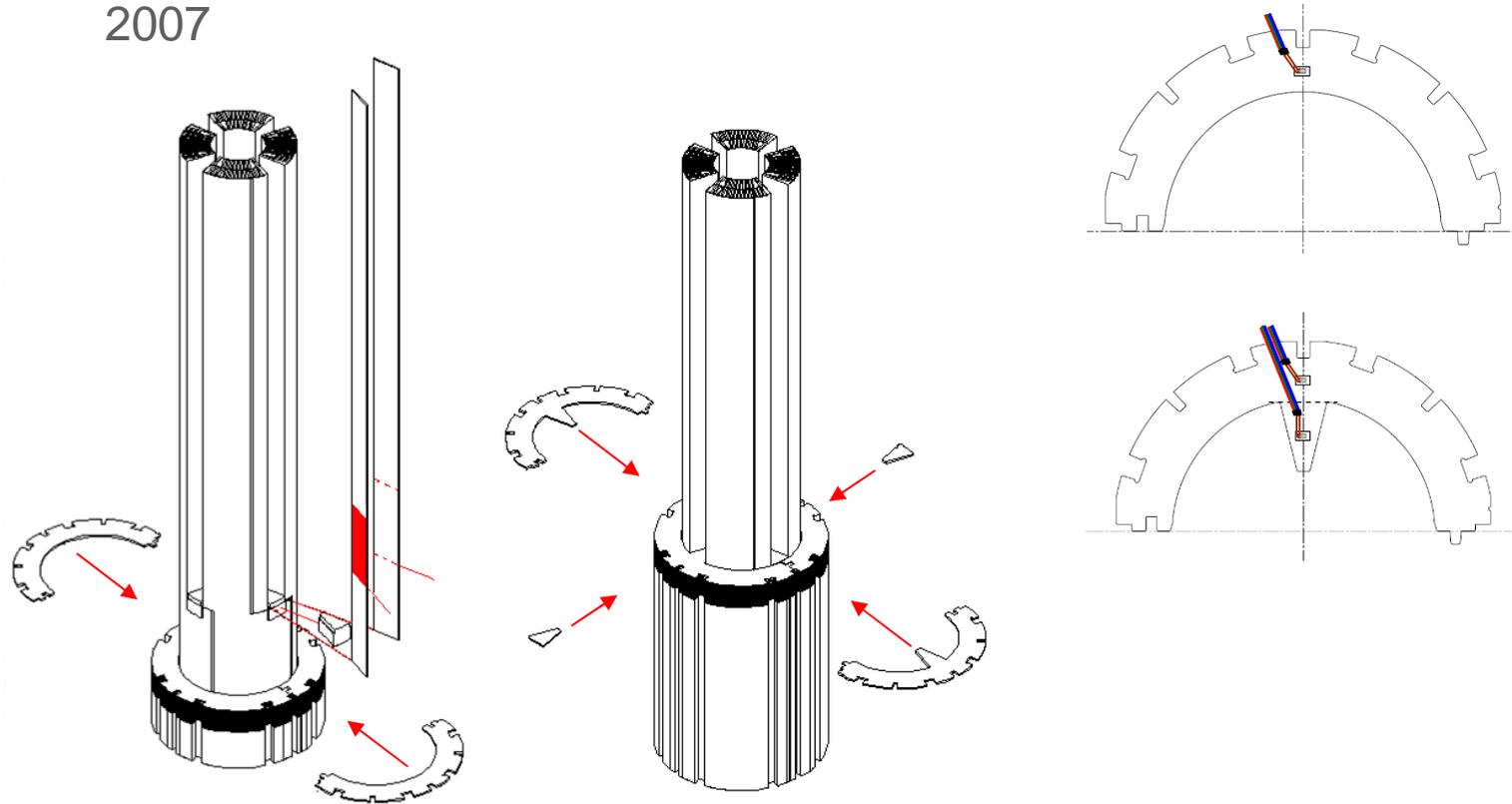
Coil assembly and collaring

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- The four best coils have been assembled and collared in November 2007



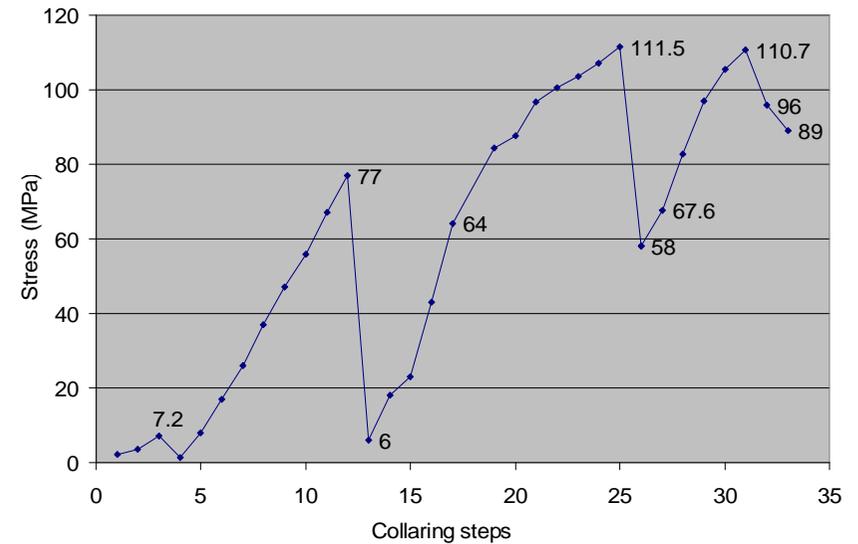
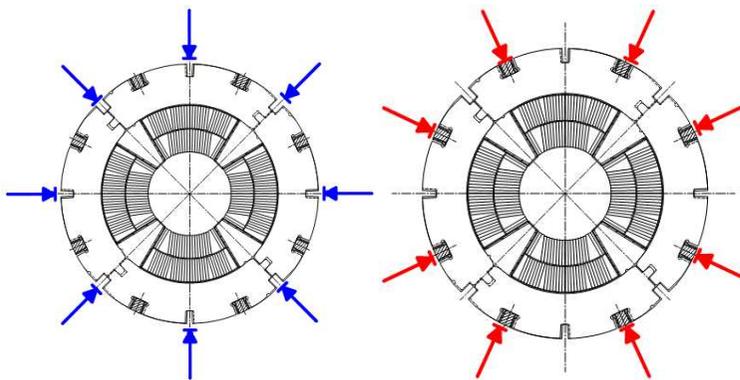
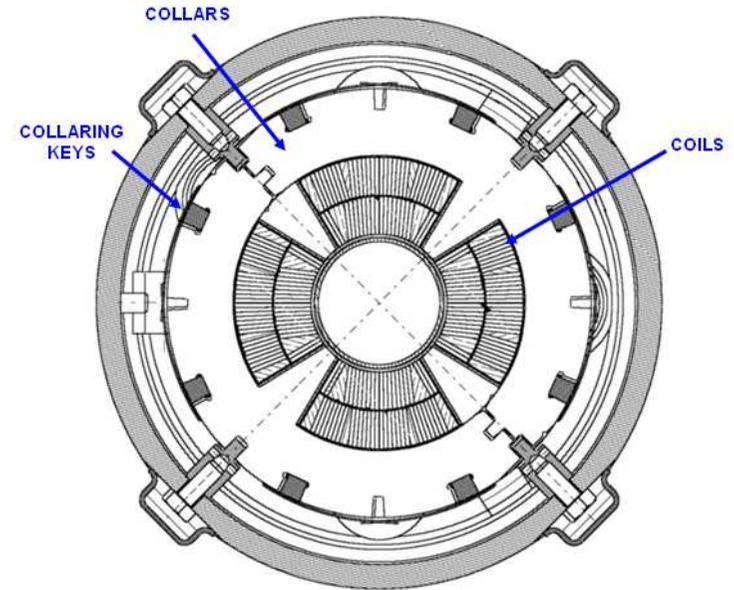
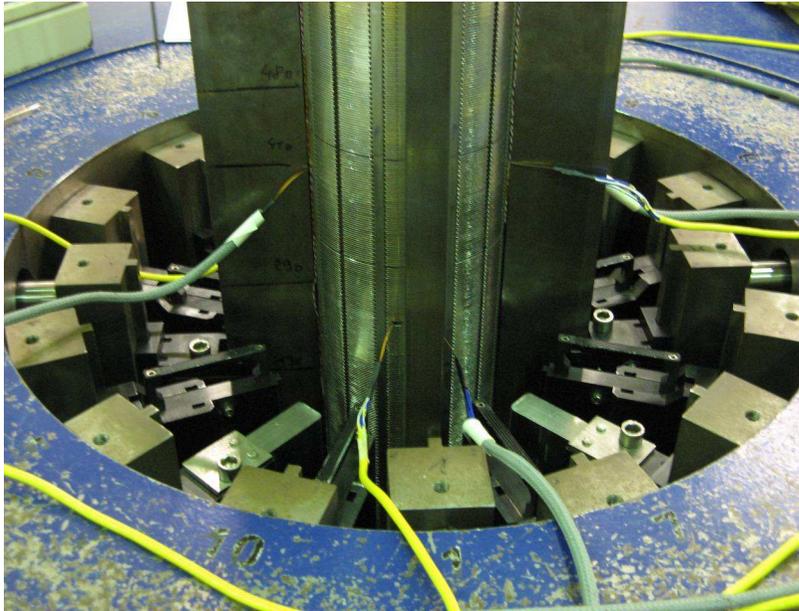
- In order to measure stress distribution in the coils, the assembly has been equipped with 8 double capacitive gauges, on the polar planes of the coils, and 12 strain gauges, glued on collars in the straight section and in one of the head sections

Coil assembly and collaring

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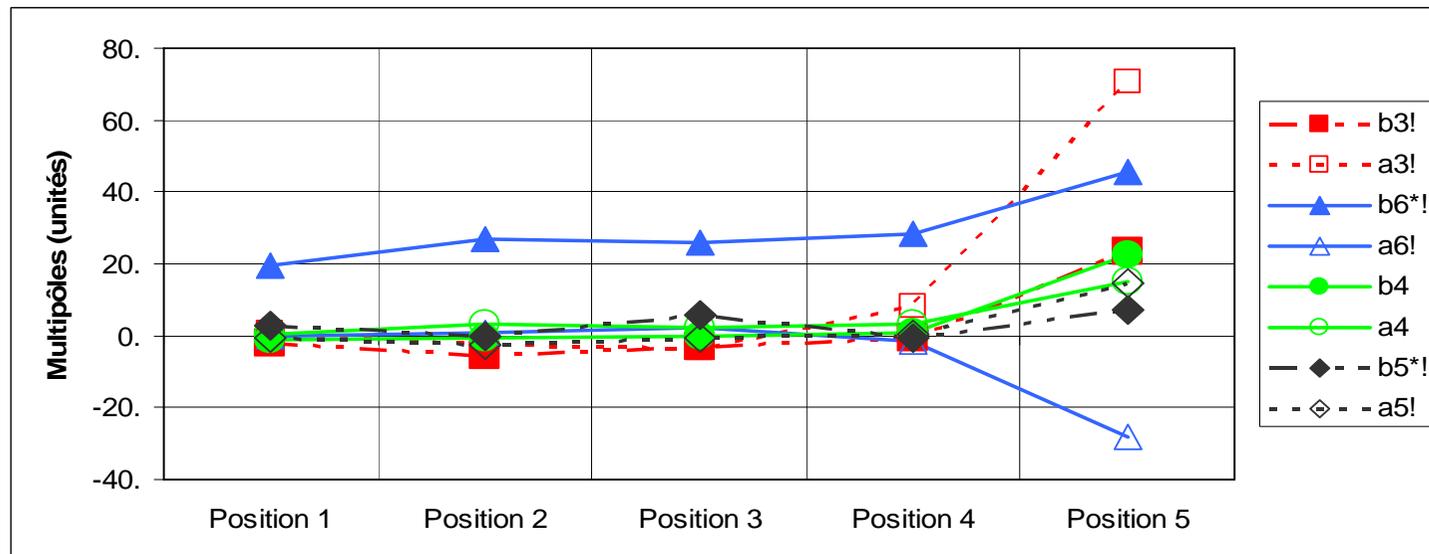
First warm field measurement results

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Before inter-pole connection soldering, warm field measurements have been carried out on the collared coils



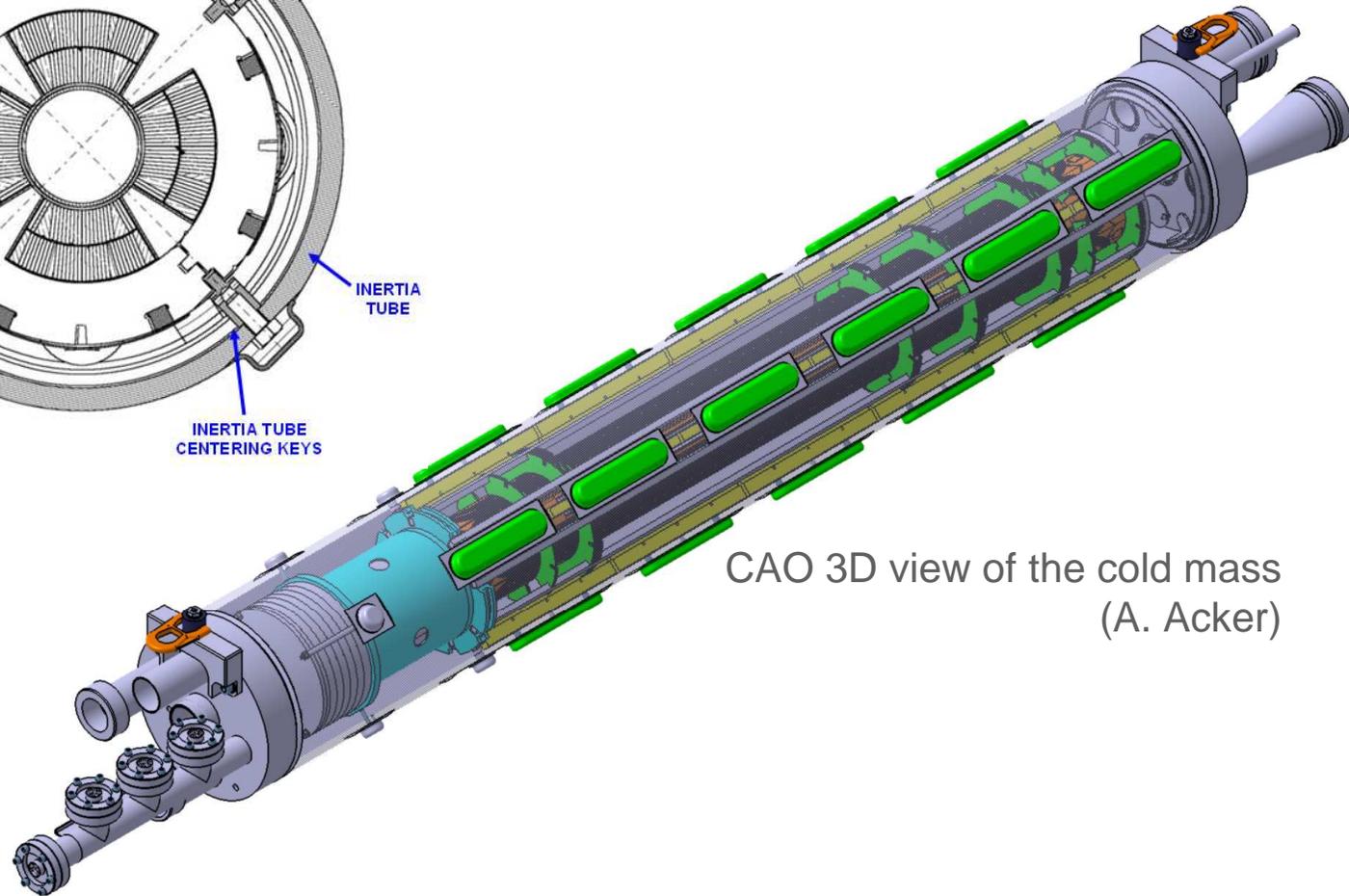
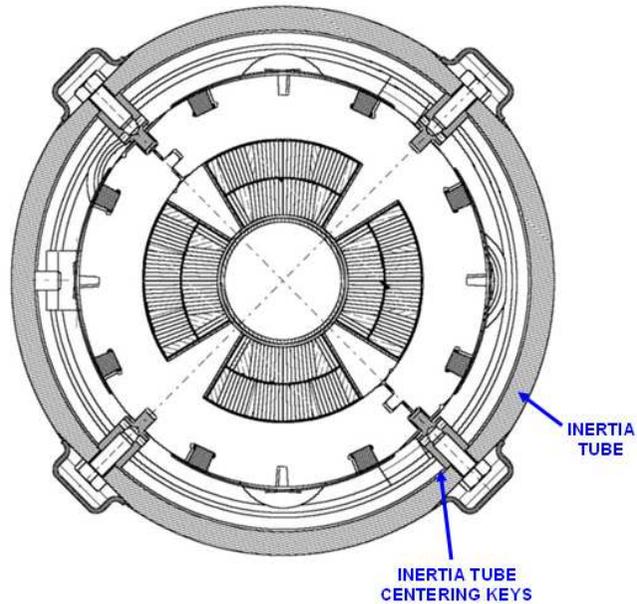
Cold mass assembly

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- Cols mass assembling will be realized at Saclay next month



CAO 3D view of the cold mass
(A. Acker)

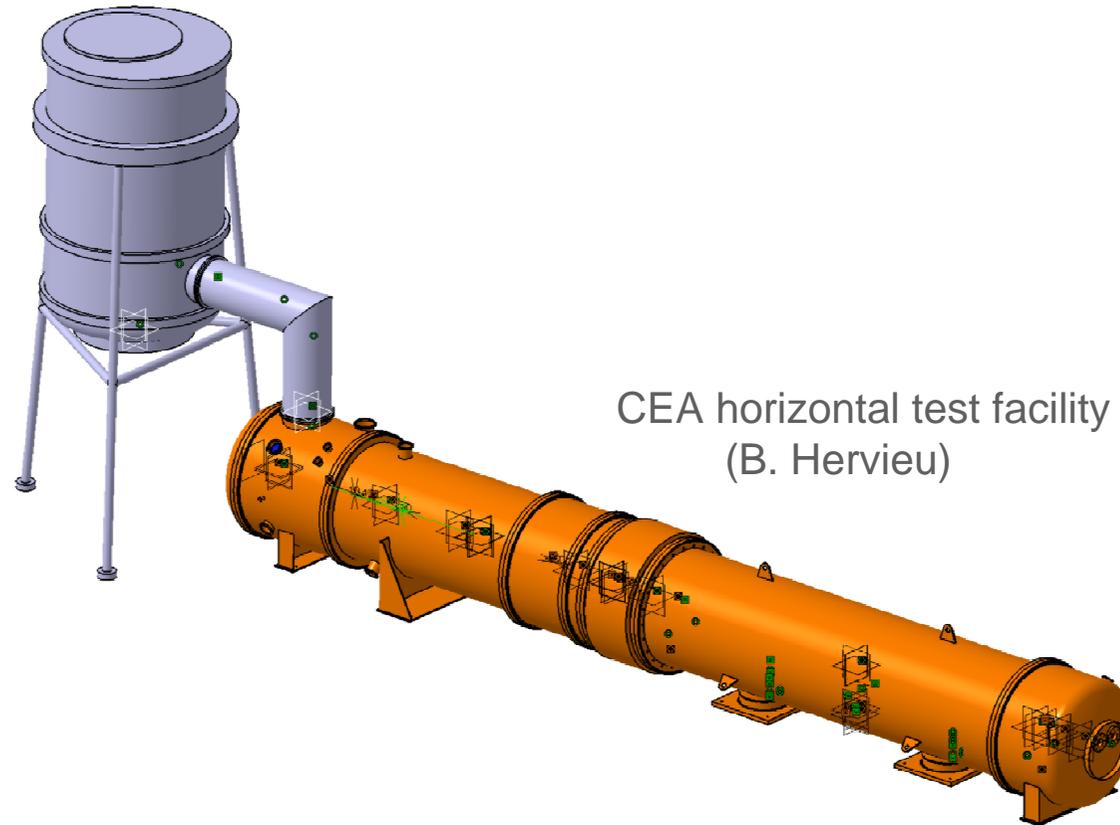
Cold tests

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- The magnet model will be tested in CEA horizontal cryostat SCHEMa



CEA horizontal test facility SCHEMa
(B. Hervieu)

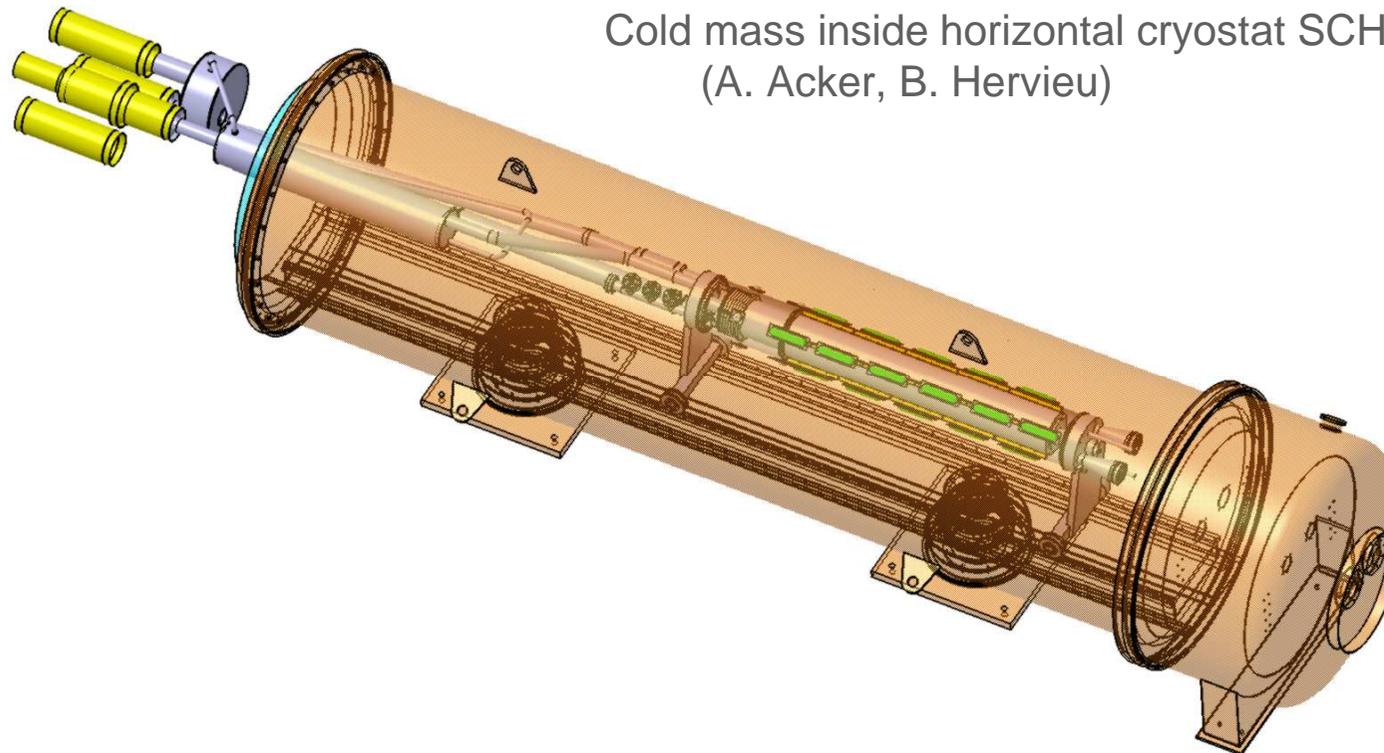
Cold tests

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- ▶ The magnet model will be tested in CEA horizontal cryostat SCHEMa



Cold mass inside horizontal cryostat SCHEMa
(A. Acker, B. Hervieu)

- ▶ Cold tests of the magnet , at 4.2K and 1.8K, are foreseen for July - September of this year