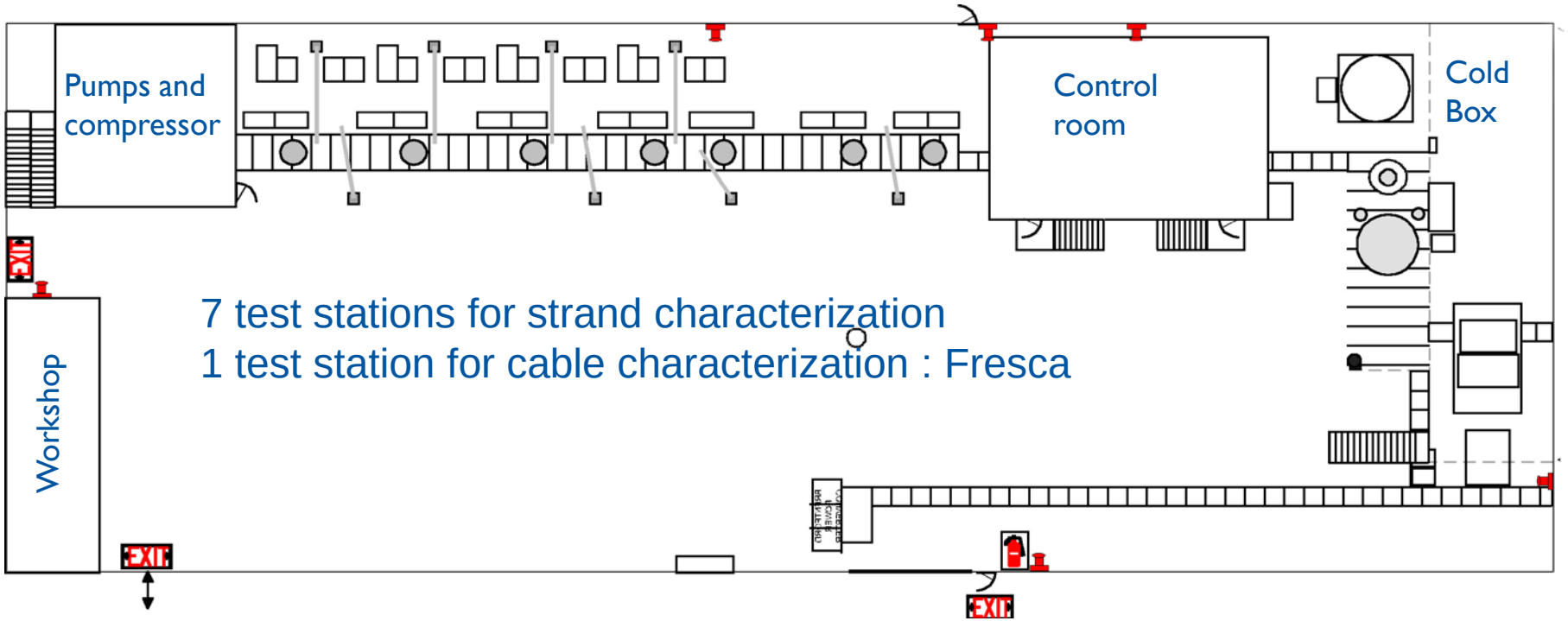

CERN

Superconductivity lab

MSC-CMI meeting, 16/12/2013

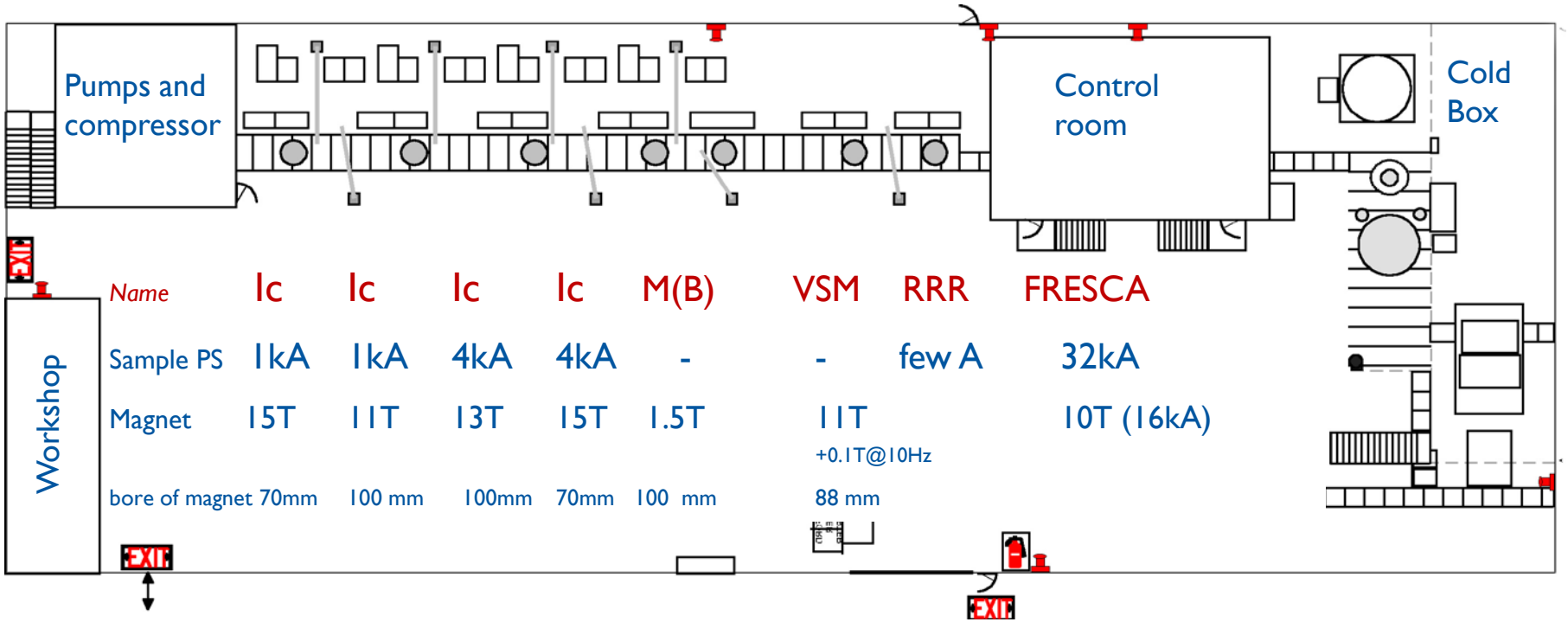
Sandrine Le Naour

Bat 163 : Superconductivity Lab



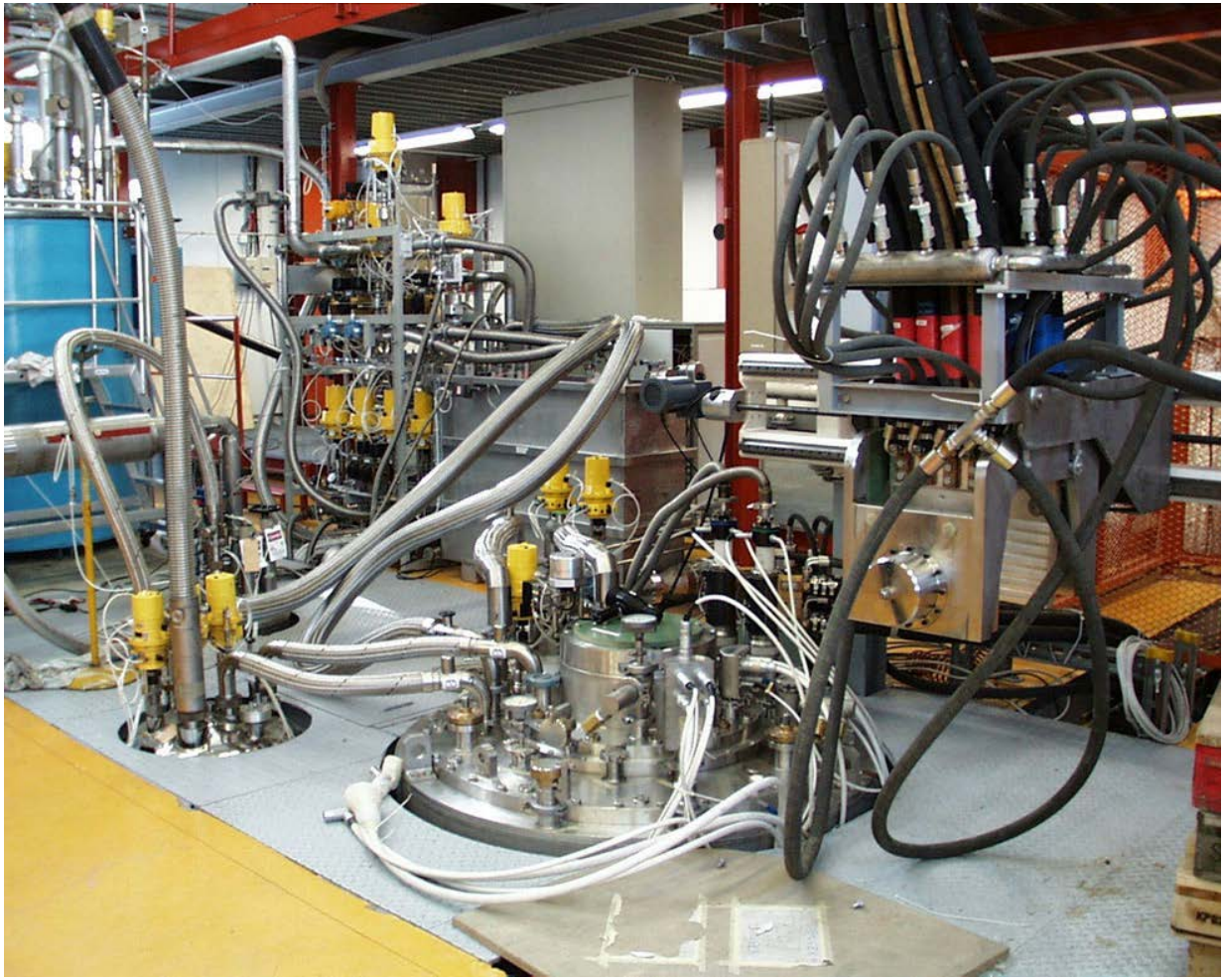
- Helium liquifier: (cold box + compressor) rate ~130l/h
- Station of demineralized water : 20m^3/h
- 6 pumps for characterisation at 1.9K
- 2 furnaces for Nb3Sn reaction (Vamas)

Bat 163 : Superconductivity Lab

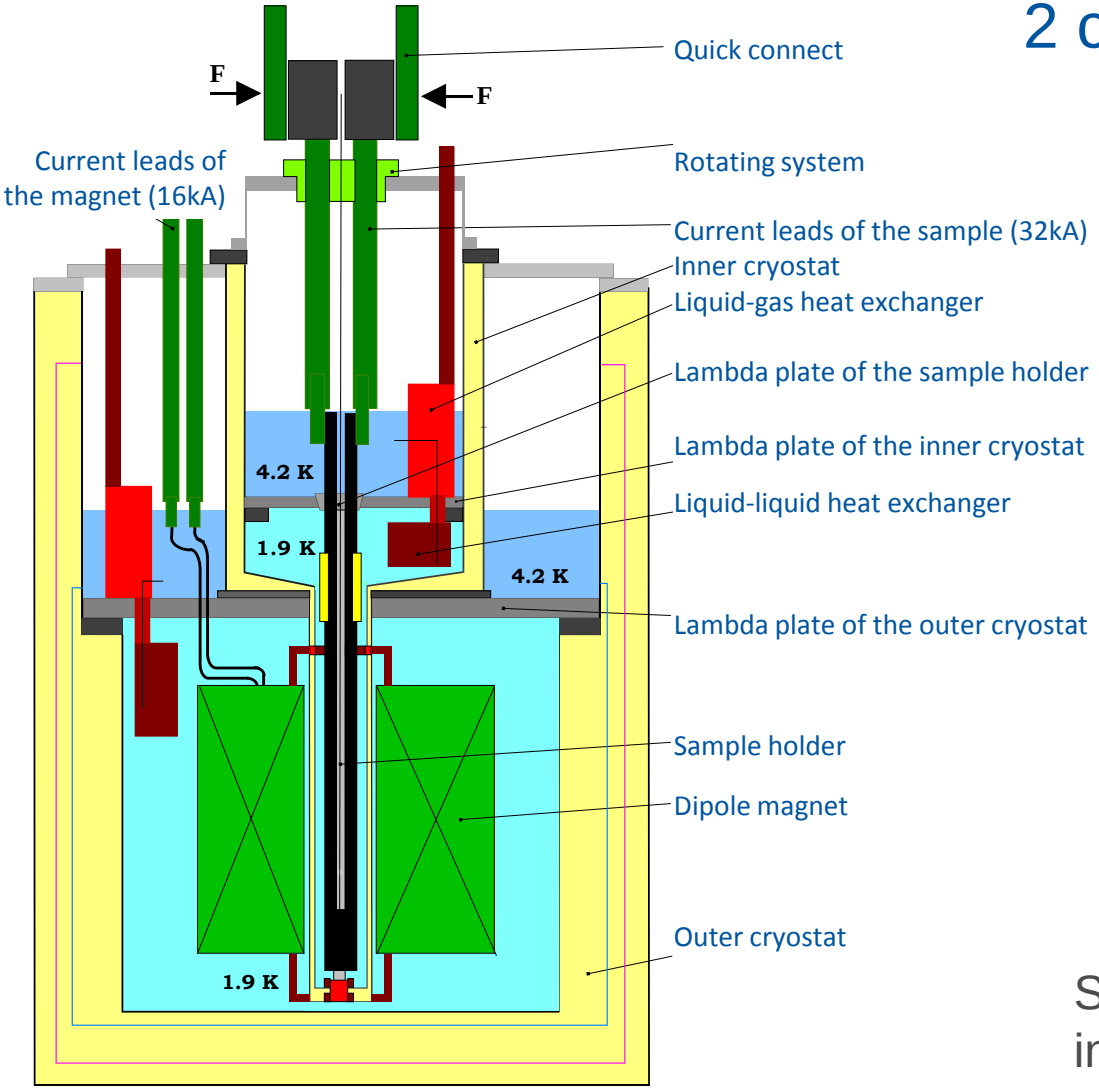


- 4 test stations for Ic on strands
- 2 test stations for Mg on strands
- 1 test station for RRR
- Fresca

Fresca



Fresca



2 cryostats :

Outer cryostat :

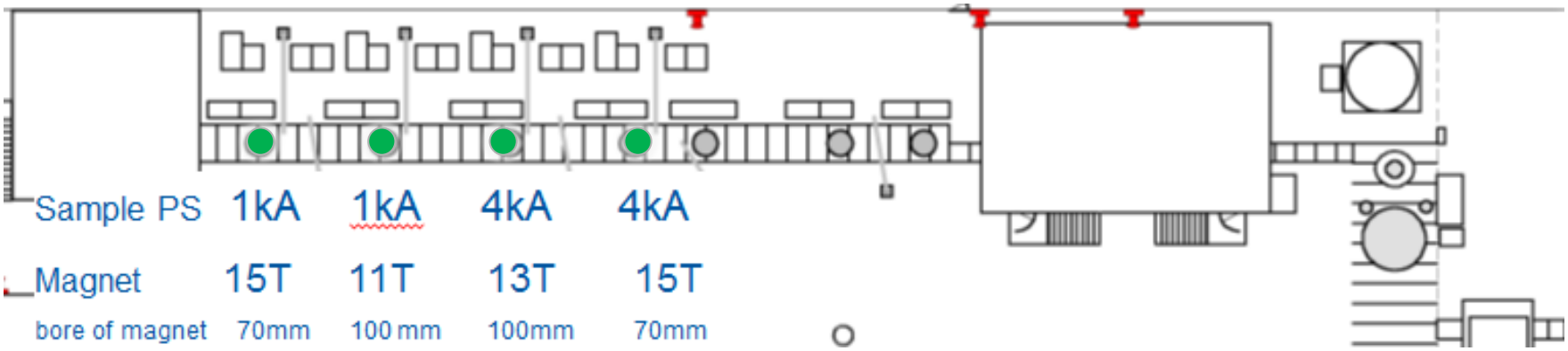
- NbTi dipole magnet of ~10T if operated at 1.8K.
- Uniform field on 600mm

Inner cryostat :

- Φint : 72mm, ~2m long
- Sample powered up to 32kA,
- The sample can be cooled down at 4.3K or 1.9K

Sample preparation to be seen in the preparation zone…

Critical current test stations



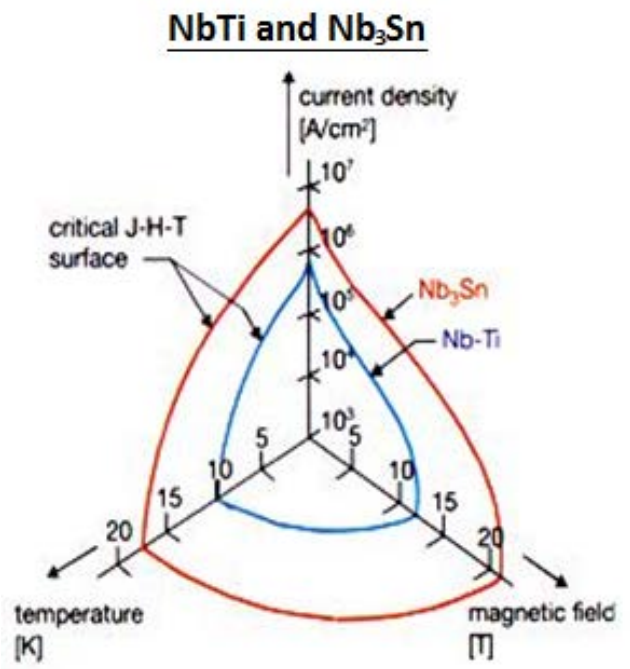
First dedicated to LHC strand qualification for NbTi strands (55000 samples measured over 5 years with Mg and RRR), now most of the measurements are done for Nb3Sn conductor.

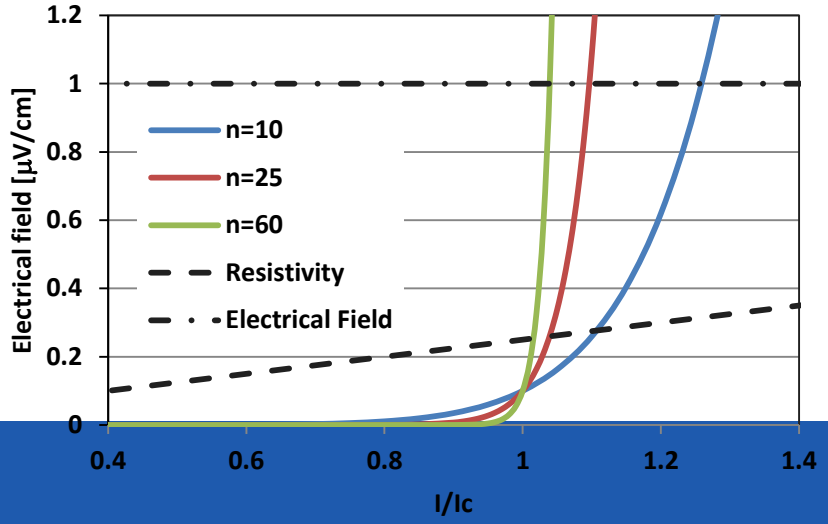
Standard ITER Ic barrel with periodic slots along two inner turns.

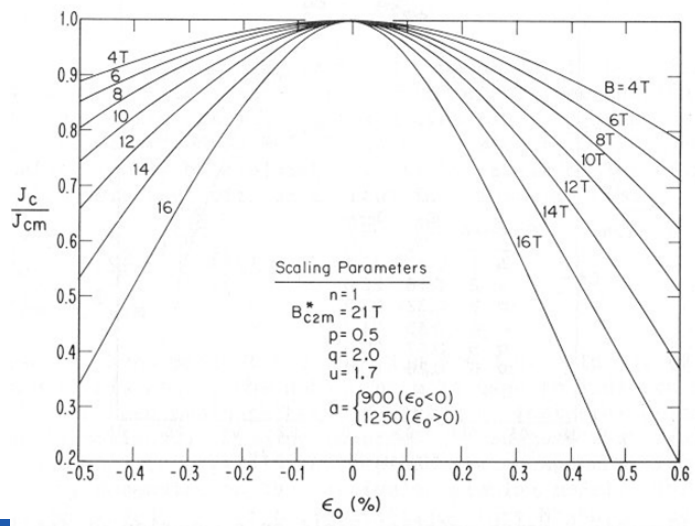
Critical current density values

For a critical current, different parameters must be given such as :

- Temperature
- Magnetic field (intensity, direction)
- Criteria (electric field or resistivity)
- Strain
- Specify if Ic over matrix or not



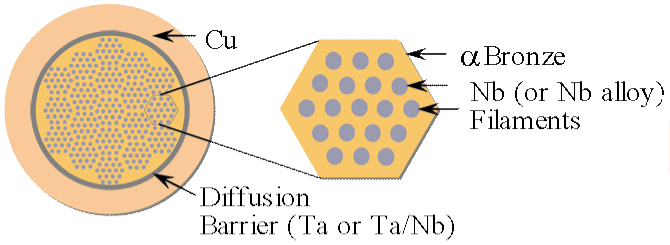




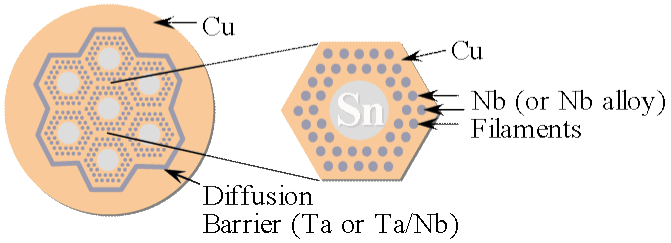
Relative critical-current density J_c/J_{cm} as a function of intrinsic strain $\varepsilon_o(\equiv\varepsilon-\varepsilon_m)$ for different magnetic fields, evaluated using Eq. (3) and the typical set of scaling parameters indicated in the figure.

Nb_3Sn wires: Different process

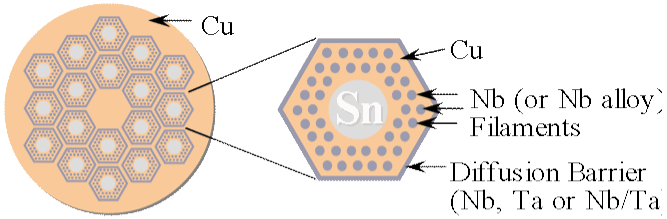
Bronze Process



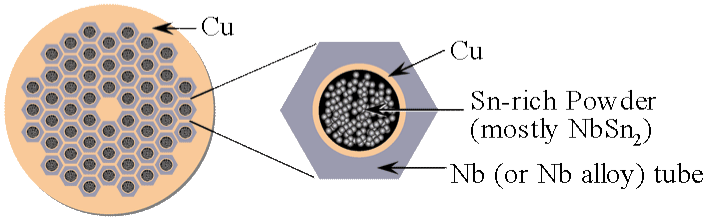
Internal Sn (Single Barrier)



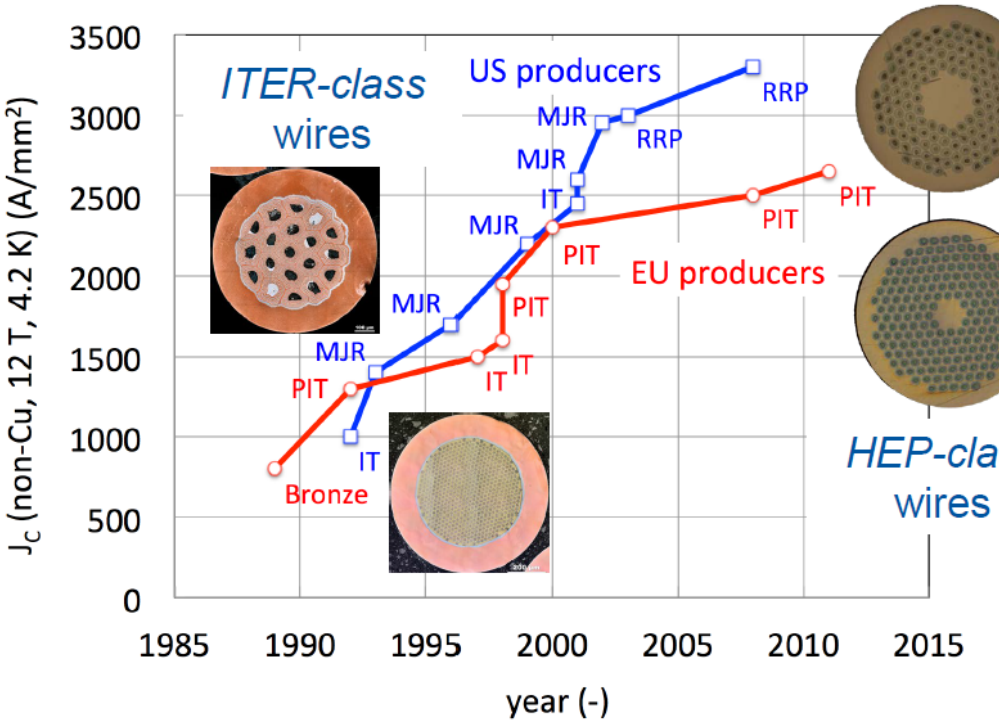
Internal Sn (Distributed Barrier)



Powder in Tube (PIT)

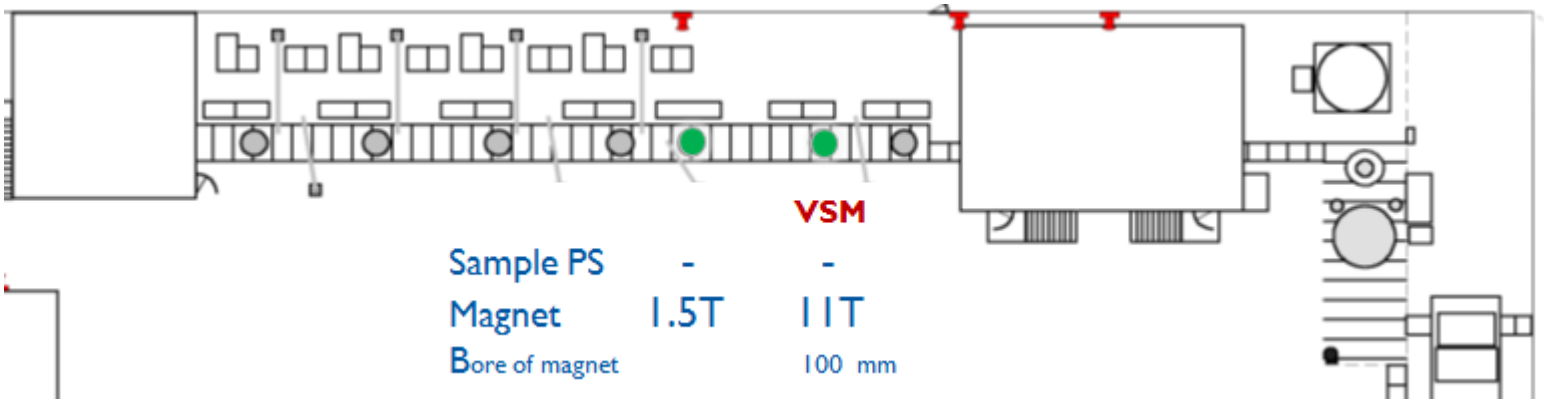


From ITER- to HEP-class Nb_3Sn



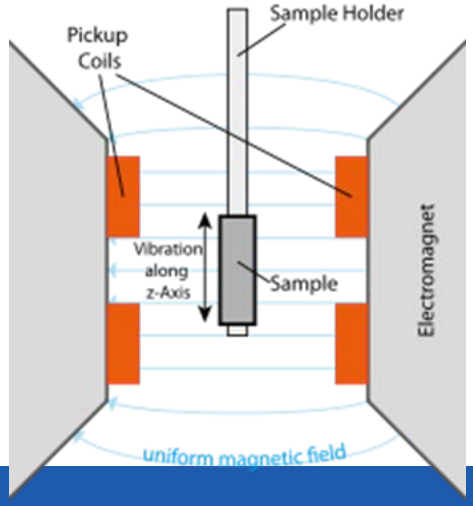
Graph from Luca's presentation at EUCAS 13

Magnetization test station

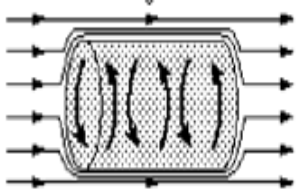


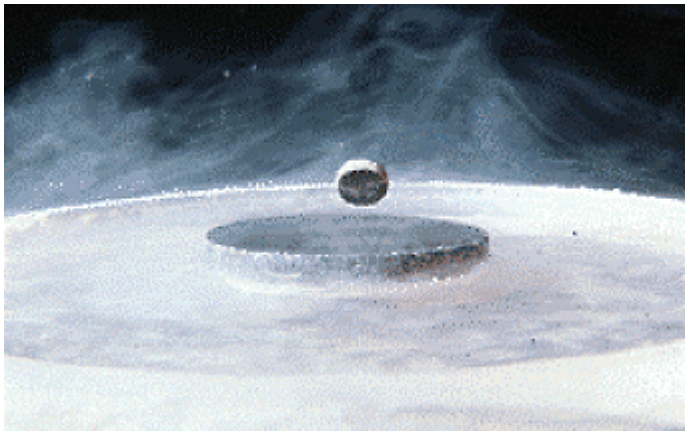
VSM (Vibrating Sample Magnetometer)

- With a VTI (variable temperature insert) : 1.9K -> 300K
- Magnetic field : 10.5 T
- Sample vibration : 20Hz

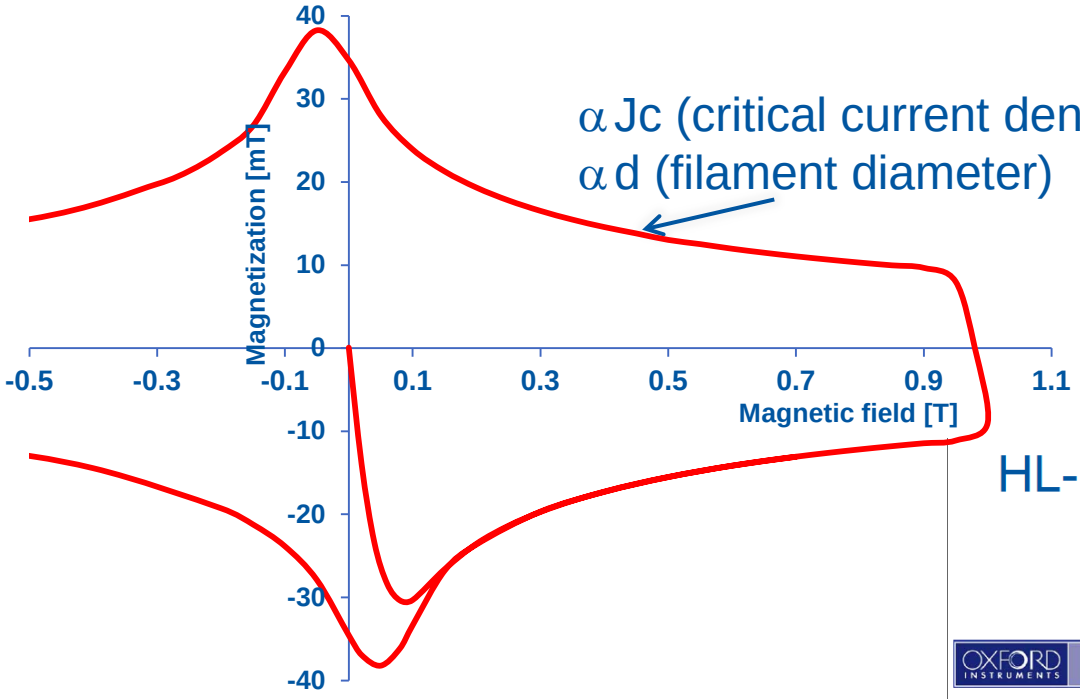


Magnetization

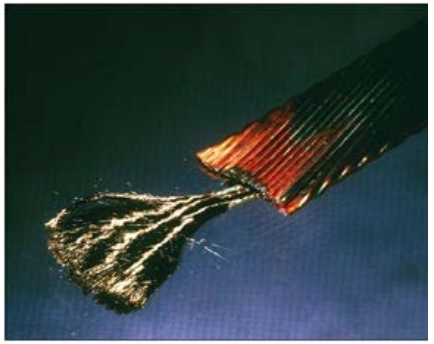




Superconductor : diamagnetic propriety

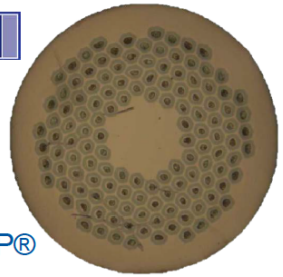


α Jc (critical current density)
α d (filament diameter)



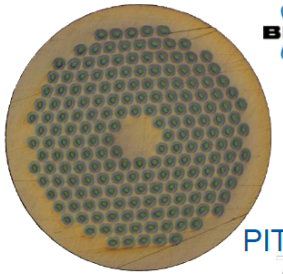
HL-LHC Nb_3Sn wires (CERN view)

Strand diameter: 0.7…1.0 mm
Cu:non-Cu: 1.15…1.25
UL > 400 m … 800 m



RRP®

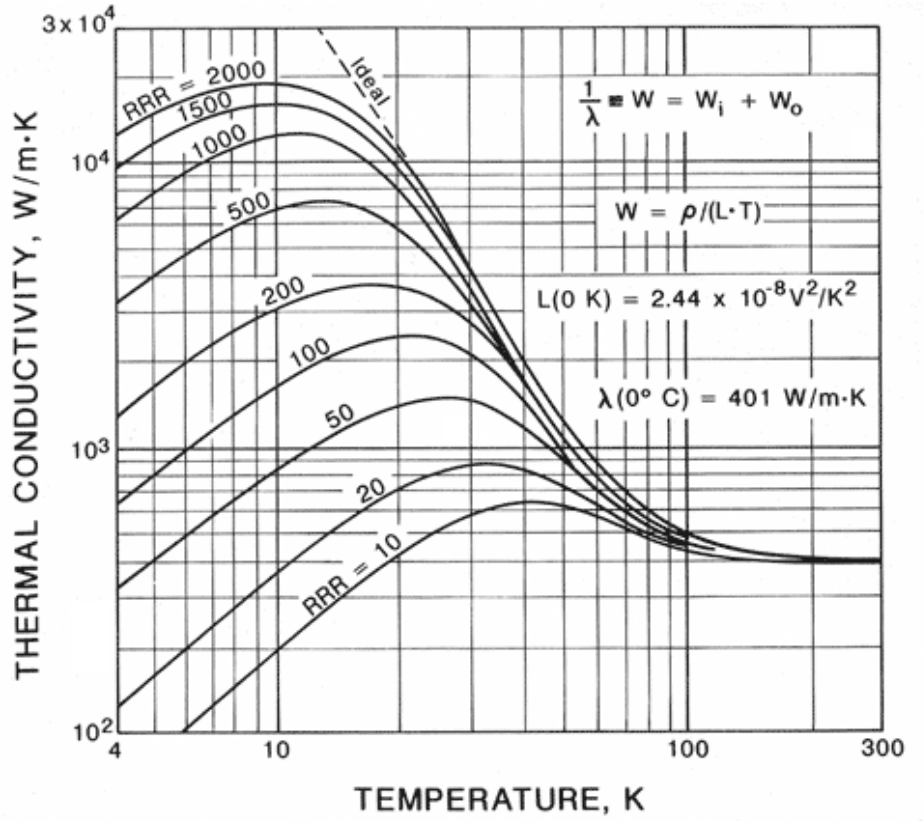
Filament diameter: **40…60 µm**
Number of sub-elements: 108…132
J_c (15 T. 4.2 K) > **1575 A/mm²**
RRR > 150



PIT

Filament diameter: **35…50 µm**
Number of sub-elements: 114…192
J_c (15 T. 4.2 K) > **1350 A/mm²**
RRR > 150

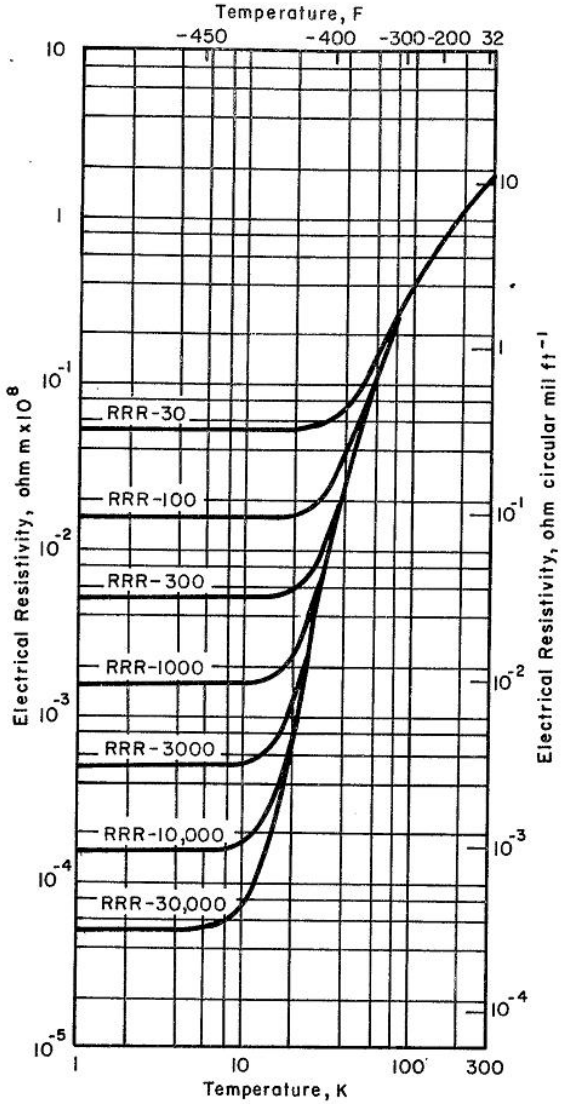
RRR = $\rho_{300\ K}/\rho_{>Tc}$



$$\frac{\kappa}{\sigma} = LT \quad or \quad L = \frac{\kappa}{\sigma T}$$ Wiedemann-Franz Law

κ = thermal conductivity σ = electrical conductivity

L = Lorenz number



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Super conductor Tyranno

Critical current measurement comparison