Applied Superconductivity at CRPP-Villigen

ÉCOLE POLYTECHNIQUE
FÉDÉRALE DE LAUSANNE

Activities, Facilities, Expertise at CRPP - Villigen

- **Forced flow, large conductor testing**
- **Strand testing**
- **Current leads (HTS and normal)**
- **Joints for high current magnets**
- **Conductor samples preparation**
- **Conductor design**
- **Analyses and simulation**

Forced flow, large conductor testing

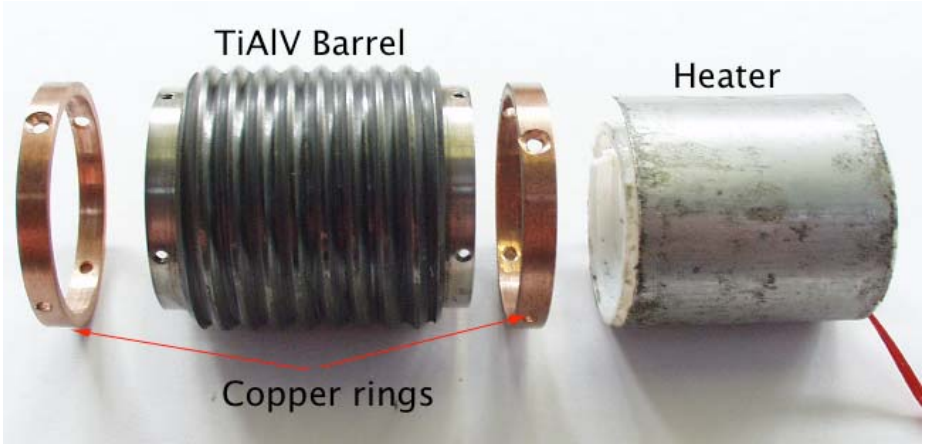
The SULTAN test facility is the largest worldwide device to test forced flow, high current superconductors. It offers

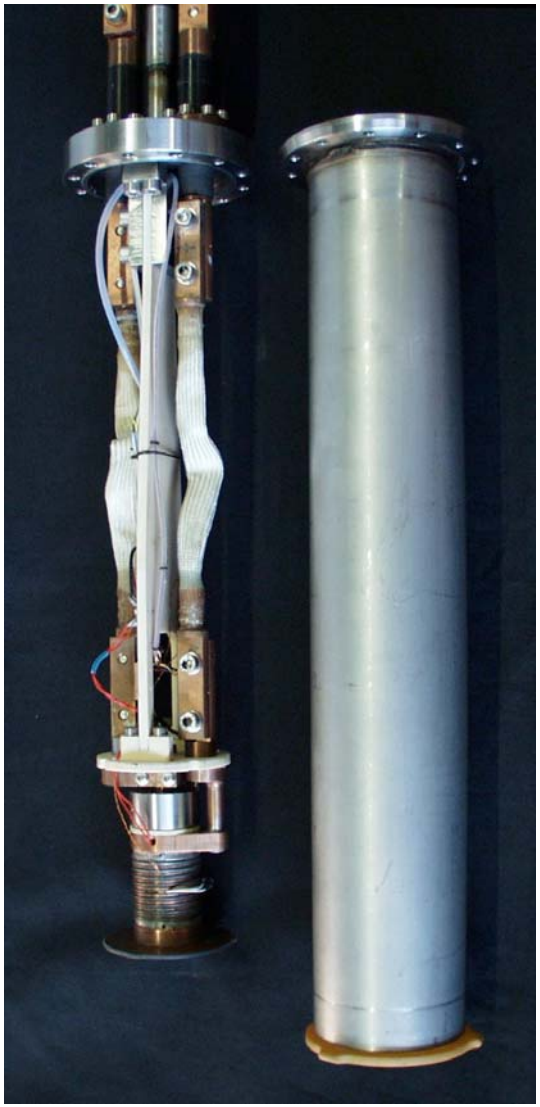
- DC background field up to 11 T in a split coil, 600 mm diameter
- DC current for test sample ± 100 kA
- Supercritical Helium at 10 bar, ≥ 4.5 K, up to 20 g/s
- Superimposed steady state ac field, up to ± 0.4 T, 0.01 to 6 Hz
- Superimposed pulsed field, up to 3 T amplitude, 140 ms period

This superconductors for fusion magnets (ITER, Wendelstein, HT7U) have been all tested in SULTAN

Strand testing

Nb_3Sn, NbTi and HTS wires are routinely tested in a 12.3 T solenoid in a temperature range 4.2 - 100 K, with test current up to 1000 A, as a straight section or coiled sample (ITER barrel)

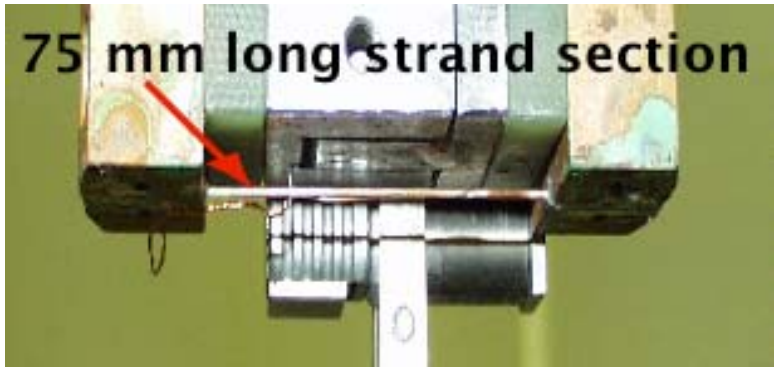


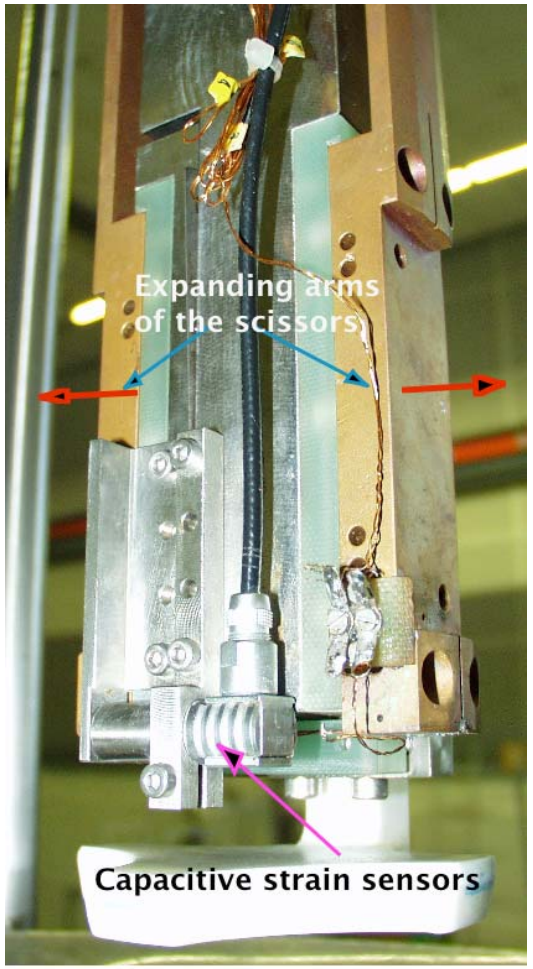


$I_c(\varepsilon)$ Strand Testing

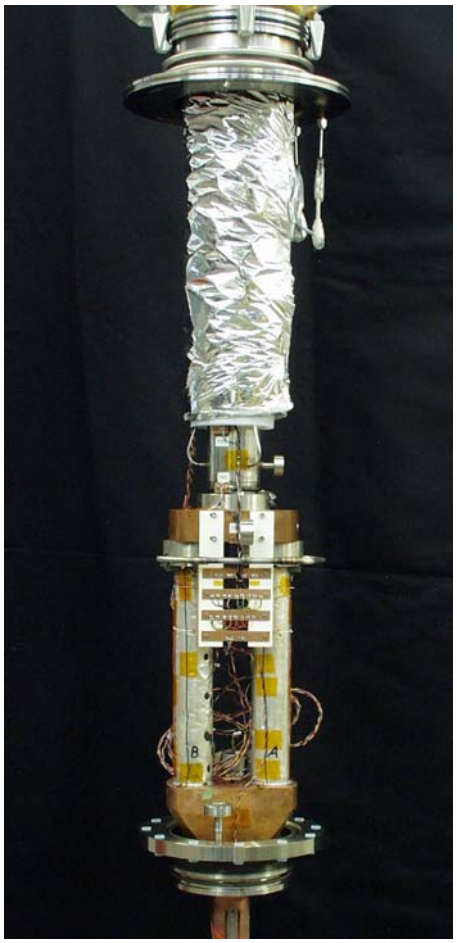
I_c test up to 1000 A under tensile load up to 700 N is done at liquid Helium up to 12 T for Nb_3Sn and HTS

The tensile strain is measured by capacitive sensors with an accuracy of 0.0012 %





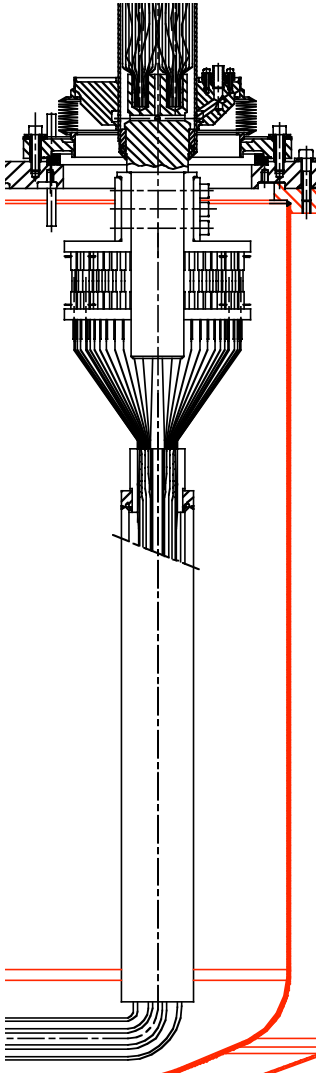
Design, manufacture and Test of Current Leads



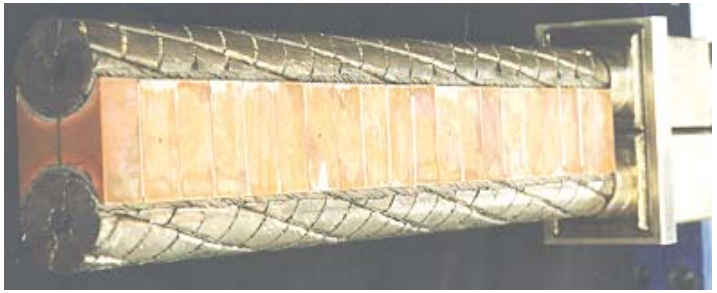
HTS current lead, tested up to 10 kA, made of 2 modules based on Bi-2212 ⇒

⇐ Manufacture of a 80 kA conventional current lead, made of 436 000 Ag coated copper wires

Joints for high current magnets



Joints are designed, manufactured and tested in SULTAN for dc and ac loss.

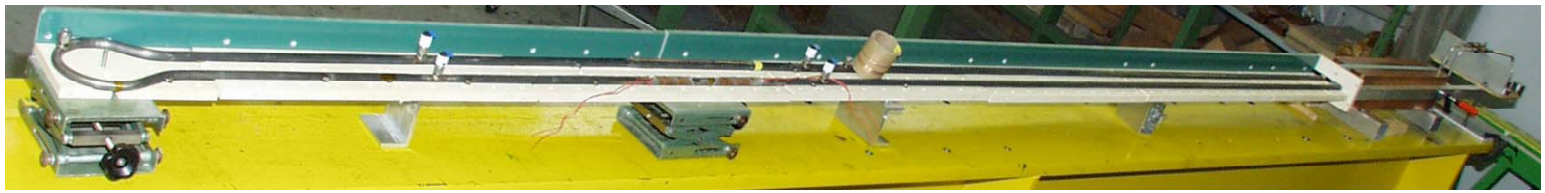


⇐The facility JORDI measures the resistance homogeneity at the joint, imposing balanced current distribution in the conductor subelements (up to 100 subelements) and sensing the voltage drop over each subelement

Conductor samples preparation

Short length conductor samples are prepared for test in SULTAN. The design includes joints, termination, clamps, instrumentation, wiring

ITER full size conductor sample, Nb_3Sn-CICC, Ø = 43 mm, with bottom joint and continuous, thick clamp structure



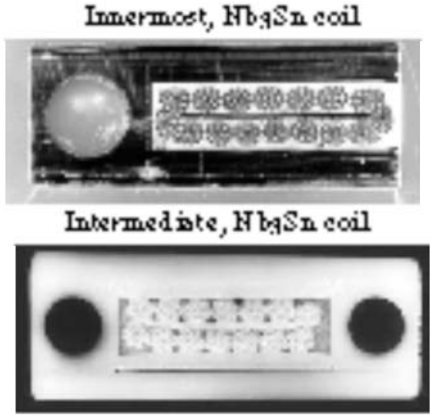
"Small" conductor sample, with U-bend replacing the bottom joint (NbTi-CICC, Ø = 18.5 mm)

Conductor design

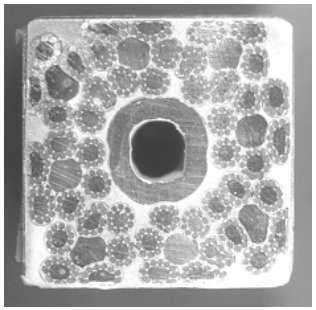
SULEIKA, from Bi-2223 tapes

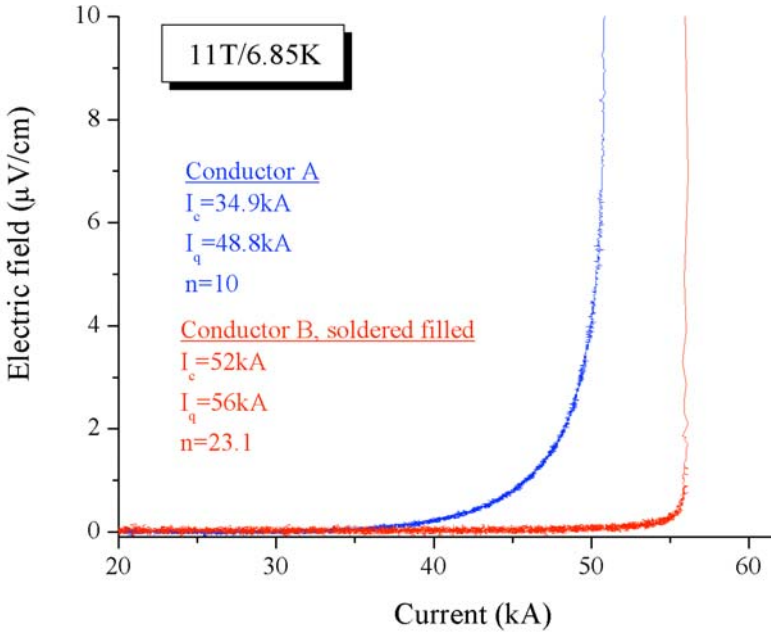
Conductor and coil design activity at CRPP dates back 25 years, from the NbTi LCT coil to the Nb_3Sn SULTAN coils and ITER. A HTS power cable (project SULEIKA) was designed, manufactured and tested in 2000.

SULTAN conductors



Swiss LCT, NbTi





Comparison of CICC vs. solder filled conductors

Analyses and simulations

The behavior of large superconductors is modeled and simulated to analyze the experimental results. Among the recent activities on this subject,

- **Self field induced take-off in high current NbTi conductors**
- **Current voltage characteristics in multistrand conductors**
- **Interstrand current re-distribution upon local disturbances**
- **Thermo-hydraulic assessment of large scale experiment for ITER**