

Magnet and cable test facility at the Swiss Plasma Center (PSI, Villigen)

D. Uglietti, N. Bykovsky, B. Stepanov, K. Sedlak, R. Wesche, and P. Bruzzone

EPFL-SPC, 5232 Villigen PSI, Switzerland

- Background
- Facilities (SULTAN/EDIPO)
- Upgrades
- Summary

Background

EFPL - Swiss Plasma Center – Superconductivity Group

MAIN ACTIVITIES - Applied superconductivity for Nuclear Fusion magnets

- Testing of conductors for ITER (International Thermonuclear Experimental Reactor) -
- Testing of high current, high field HTS conductors for fusion magnets - *EuroFusion*
- R&D on LTS and HTS conductors for future reactors (DEMO) - *EuroFusion*

OTHERS ACTIVITIES

- LTS and HTS tests under bilateral agreements, worldwide
- R&D on HTS high field inserts - *Swiss national projects*
- R&D on HTS currents leads



Located in Paul Scherrer Institute (PSI)
Villigen, Switzerland

Facilities in Villigen

The SULTAN test facility has been used for 30 years in testing cable in conduit conductors for the fusion program.

It is the only facility for testing NbTi and Nb₃Sn conductors for ITER.

EDIPO – 12.5 T dipole magnet

- 92x142 mm² test well (1% homogeneity over 85 cm)

SULTAN – 11 T split coil solenoid

- 94x144 mm² test well (1% homogeneity over 300 mm)
- 580 mm Ø solenoid bore (1% in a 300 mm Ø sphere)

**DC current for testing
samples up to 100 kA**

- Supercritical Helium at 10 bar and 4.5 K~10 K, up to 10 g/s
- Superimposed steady state ac field: < 0.4 T, 0.01 to 6 Hz (100 Hz)
- Superimposed pulsed field: < 4 T amplitude, 40-120 ms period



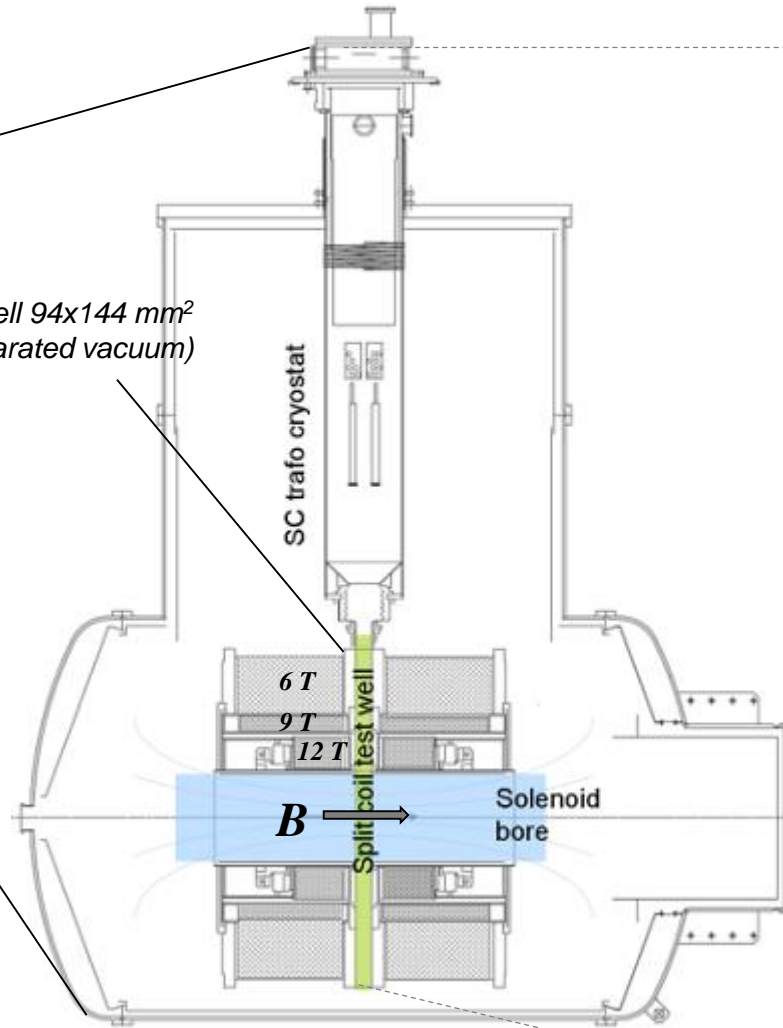
SU.L.T.A.N. (SUpraLeiter Test ANlage)



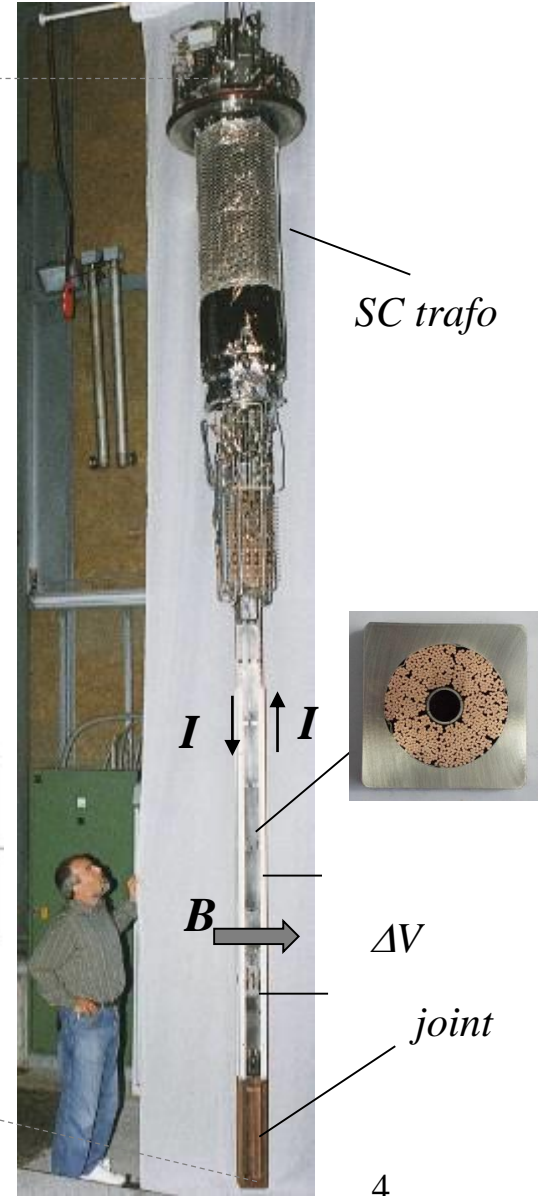
Vertical test well 94x144 mm²
 (separated vacuum)



Possibility of coil testing in the main bore (Ø600 mm)



Magnet and sample cooled by forced flow of supercritical He (4.5 K- 20 K)

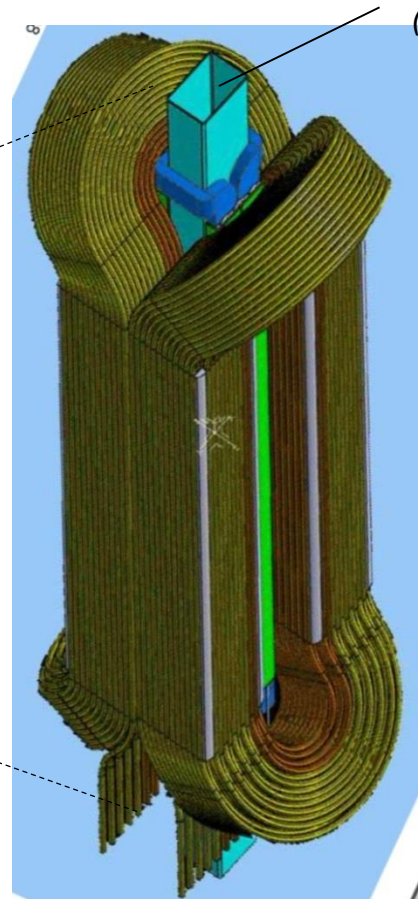
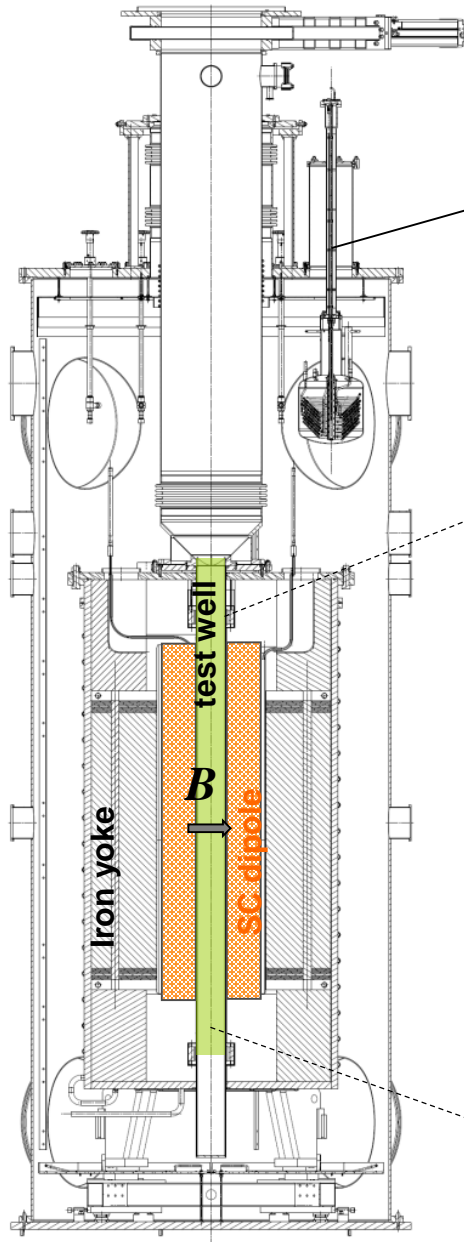


E.DIPO. (EuropeanDIPOle)

Race-rack tilted-ends dipole built with Nb₃Sn cable in conduit.

18 kA HTS current leads
(designed and built in
house)

Vertical test well 92x142 mm²
(separated vacuum)

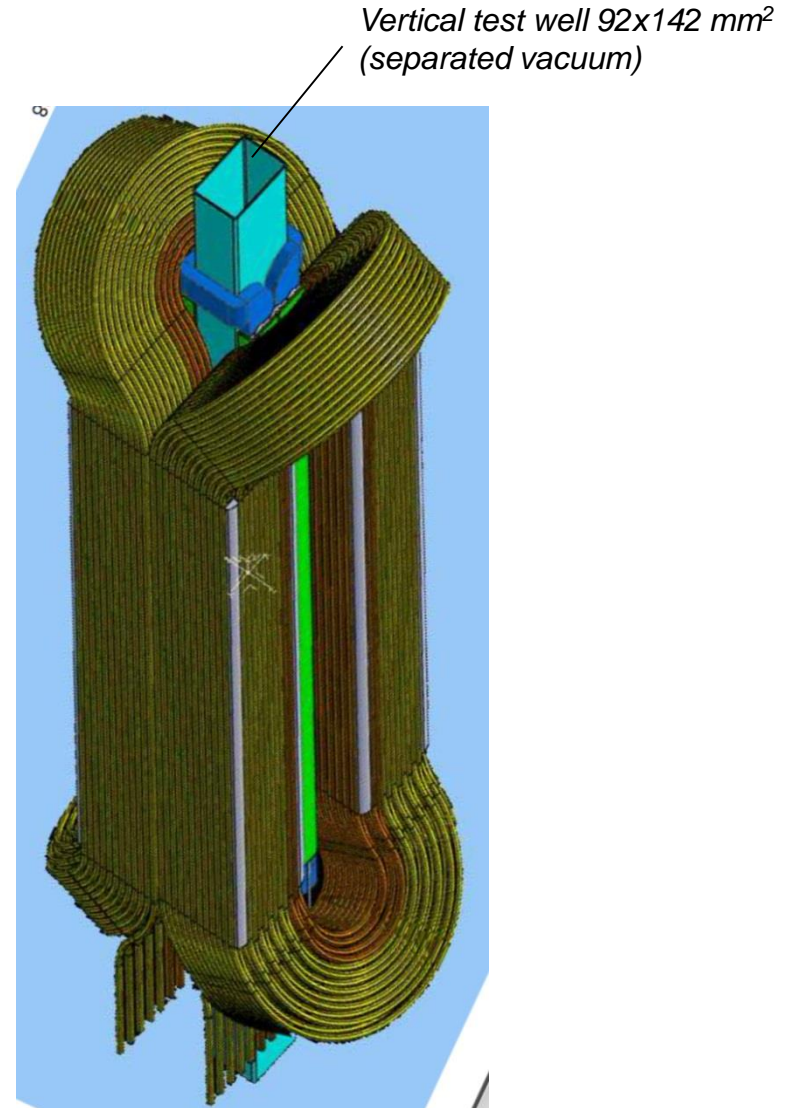
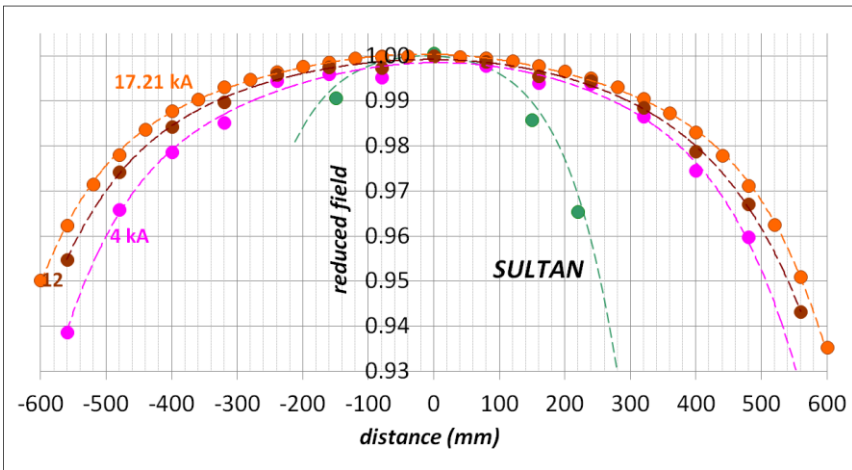
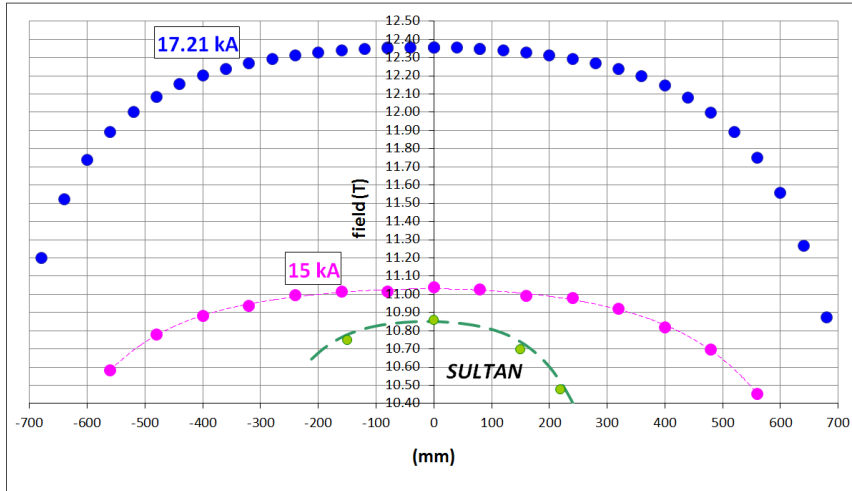


Magnet and sample cooled by forced flow
of supercritical He (10 bar, 4.5 K – 50 K)

DAQ: National instruments CompactDAQ
3x9205 (96 channels S.E. for voltage)
3x9208 (48 channels S.E. current, for cernox)

EDIPO (European DIPOle)

Field homogeneity: 3% over 1000 mm at 12.4 T.



EDIPO – cryostat (in preparation)

A variable temperature insert cryostat is in preparation.

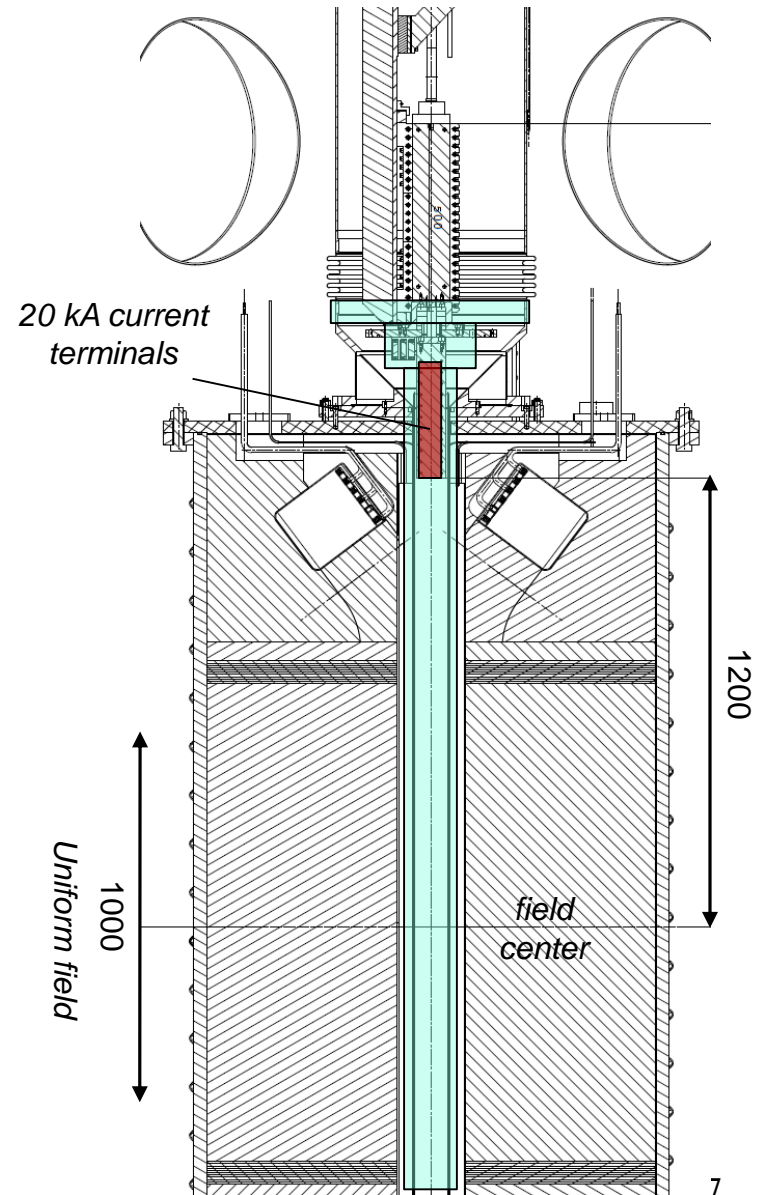
The work is carried out in collaboration with CERN in view of testing HTS dipoles.

The cryostat could be filled with LHe at 4.2 K, 1 bar.

Alternatively, a flow of supercritical He at 10 bar, with temperature between 4.5 K and 50 K could be established.

The cryostat allows testing of samples in bath; a conduit for cooling is not required.

Background field up to 12.4 T.



JORDI - cryostat

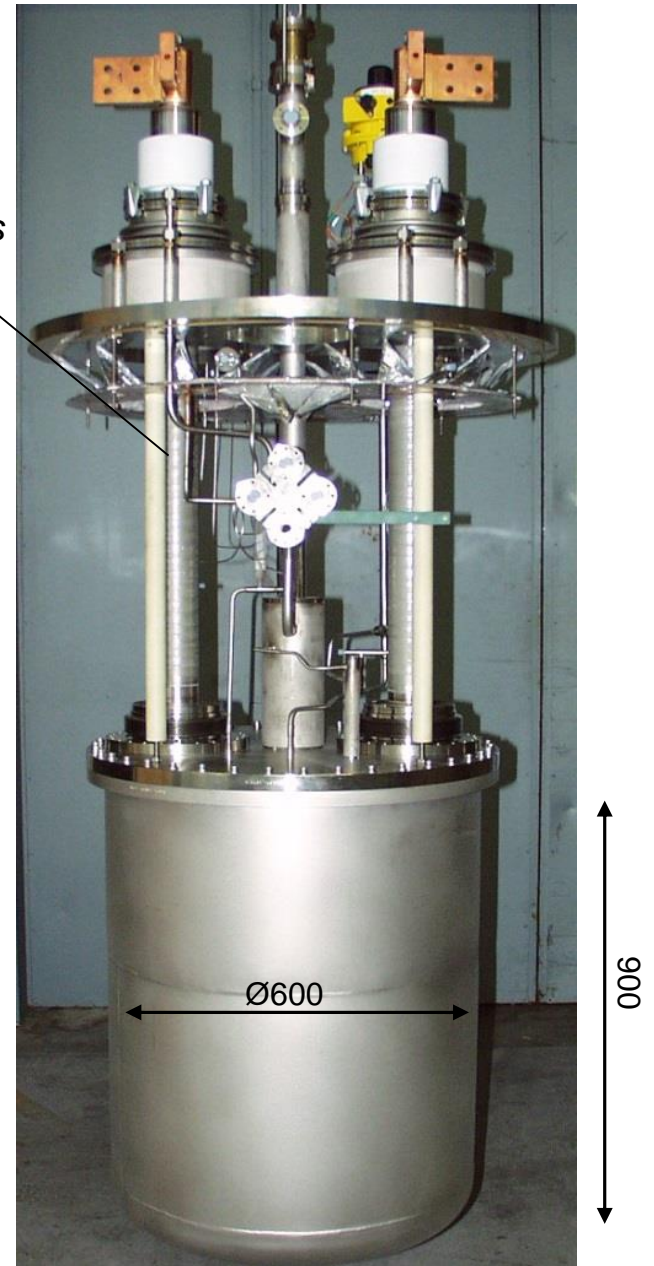
Large vacuum tank with two HTS current leads.

- 10 kA power supply
- DAQ: 64 channels (single ended)
- Supercritical He line (10 bar, 4.5 K)
- LHe container for 4.2 K operation in bath

It was used for testing 10 kA HTS current leads and joint resistance of cable in conduits.



10 kA HTS
current leads



TEST STANDS ID CARD

1 location	PSI (CH, Villigen)
2 surface of the test stand	aprox. 350 m ² on three levels
3 operating temperature and cooling techniques	4.2 K LHe, 4.5 K – 50 K supercritical He
4 cooling phases	300 - 4.2 K
5 cooling and pumping capacity	up to 10 g/s supercritical He at 10 bar
6 shared cryogenics? Or other equipment?	-
7 operating and mx. Current, max voltage	100 kA, 5 mV (in supercritical He); 20 kA, 5 mV (in LHe); 10 kA, 2 V (JORDI)
8 HVWL	unknown
9 nr of cryostats	2: EDIPO/SULTAN, JORDI
10 capacity of cryostats	EDIPO/SULTAN test well: 92 mm x 192 mm, 4000 mm long. JORDI: Ø600 h900
11 handling tools	1 x 20 t overhead crane
12 Interlock safety	yes
13 DAQ cards and used soft	NI CompactDAQ modules 3x9205 (96 ch SE) and 3x9208 (48 ch SE), Labview
14 Quality control tools	-
15 magnetic measurement capability	Hall sensors