Activities of EPFL-SPC

Kamil Sedlak

November 5, 2026



SWISS PLASMA CENTER

SPC – the Largest Laboratory of EPFL in Lausanne



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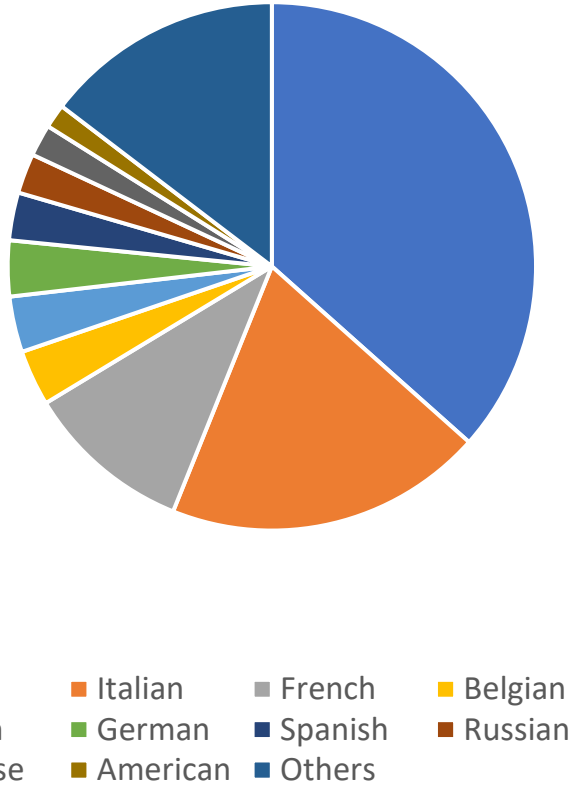
SPC Now Counts 200 Staff Members



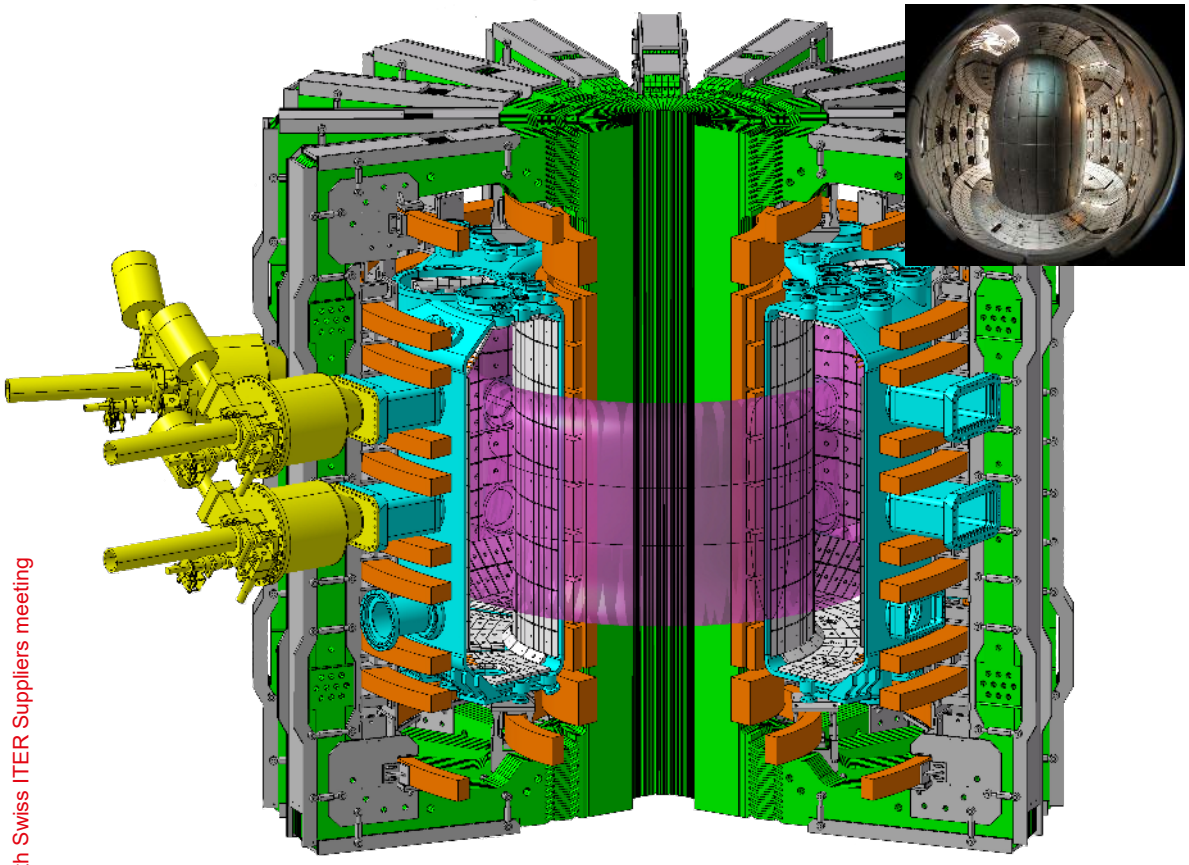
- Majority of SPC (180 people) works on plasma research in Lausanne.
- 20 people working on applied superconductivity is based at premises of PSI in Villigen.

Research Lines of SPC

- Tokamak Physics - TCV
- Plasma Heating
  - FALCON: testing of ITER Gyrotron components
  - T-Rex: experiment to understand electron cloud formation
- Theory
  - Studies of core and boundary turbulences in plasma
  - Plasma control
  - Advanced modelling on powerful computing clusters
- Low Temperature Plasma and Application
- Applied Superconductivity



TCV: the Most Flexible Tokamak Worldwide



R_{major} = 0.9 m
R_{minor} = 0.25 m

I_p < 1 MA
B_T < 1.54 T
2.3 MW NBI heating
3.75 MW ECRH

Independently powered
16 shaping coils
2 OH coils
1 internal vertical control coil

$\kappa < 3$, $-0.6 < \delta < 0.9$

Graphite tiles
Internal divertor baffles

More than 40 international institutions participate in the TCV program

Applied Superconductivity group

Test Facilities

SULTAN Test Facility

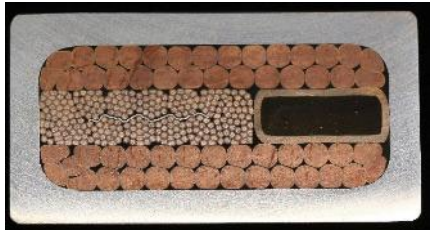
- **SULTAN test facility:**
  - B_{max} = 10.9 T in test well
  - Homogeneity (2%) along ~400 mm
- **SULTAN** has been pivotal in qualifying forced-flow conductors in the last three decades
  - LTS: ITER, DTT, EU-DEMO, JT60-SA, BEST, CFEDR
  - HTS: CFS, Proxima Fusion, STEP, EU-DEMO, CFEDR



ITER CS



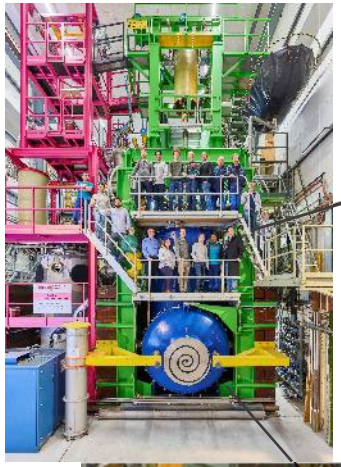
ITER TF



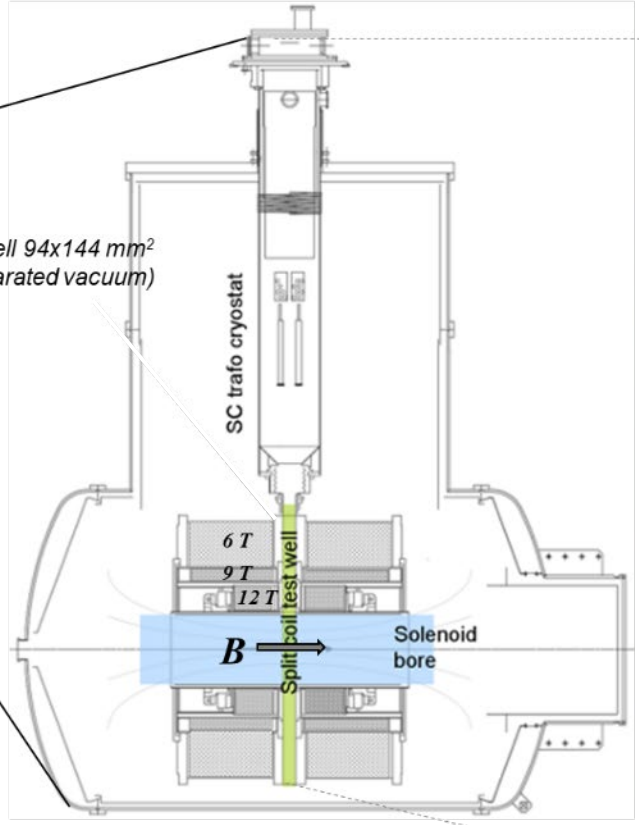
DEMO TF

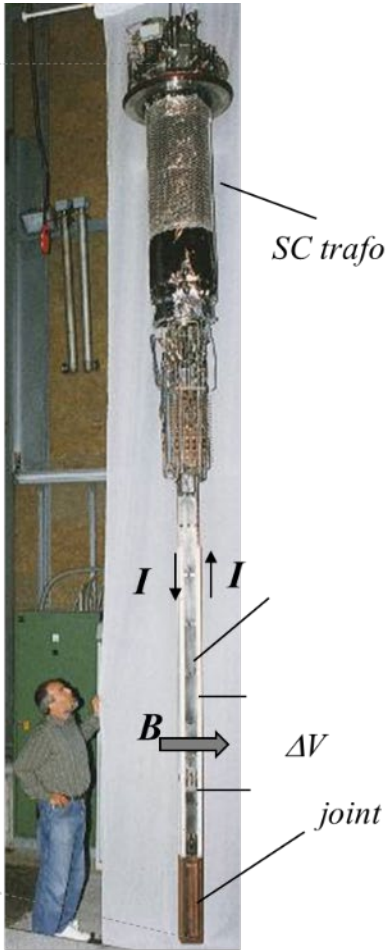


SULTAN Test Facility – DC Field up to 10.9 T







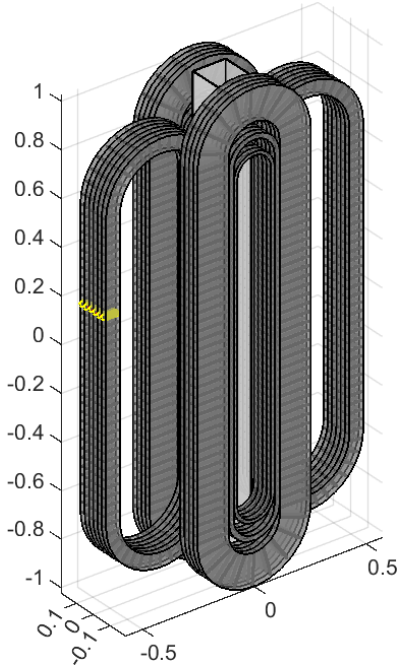


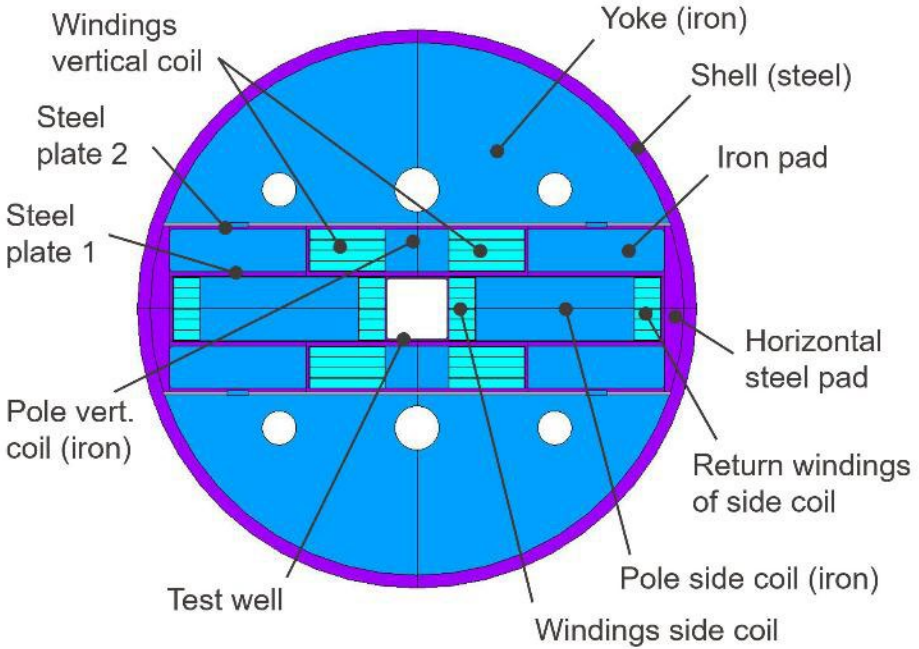
Magnet and sample cooled by forced flow of supercritical He (4.5 K- 20 K)

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EDIPO 2 Facility – under Construction

- **EDIPO 2** will **enhance** the **background B field and** the **aperture size** while keeping attractive features from SULTAN and EDIPO
- **Since January 2025,** a **SNF Infrastructures** grant funds the construction of **EDIPO 2** (as part of the *Swiss Fusion Hub*)







Tests in SULTAN

	SULTAN	EDIPO II
status	in operation	to be upgraded after accident
Matnetic field	11 T	15 T
Sample space	94x144 mm^2	144x144 mm^2
Temperature	4.5-50 K	4.5-50 K

Possible use of the SULTAN/EDIPO test facilities:

- Test of superconducting cables and joints (fusion and accelerator cables).
- Quench experiments (only up to 15 kA).
- Test of sub-size accelerator coils (e.g. Feather HTS magnets for CERN, SPC LASSO coil).

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R&D for Fusion Magnets

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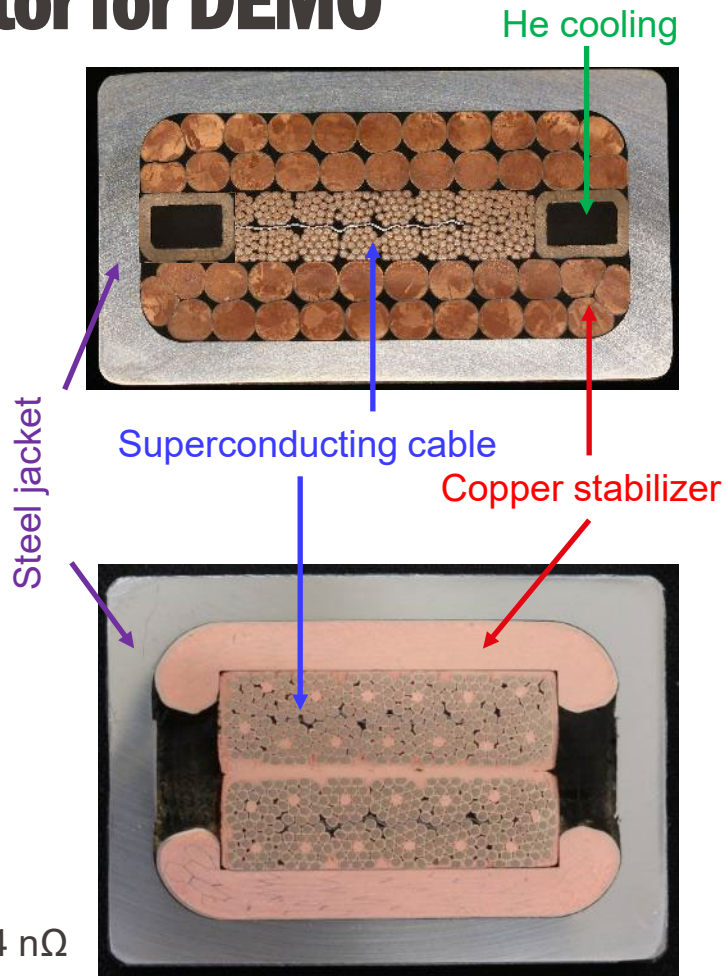
React & Wind Nb_3Sn Conductor for DEMO

Post-ITER LTS conductor development

- Cable assembled at room temperature from heat-treated Nb_3Sn cable. Steel jacket laser welded from two symmetric half-profiles.
- Increased superconducting performance due to low effective strain in Nb_3Sn:

➔ DEMO RW conductor reaches ITER TF cable performance with only 50% of Nb_3Sn.

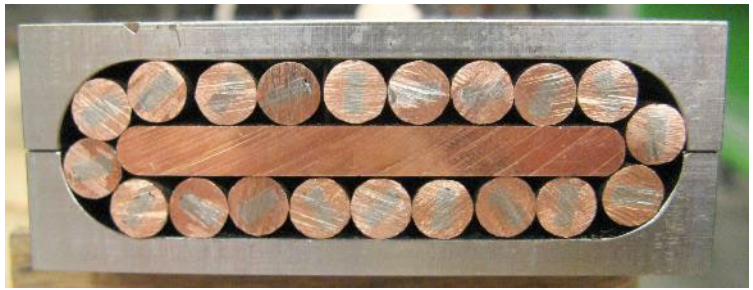
- Joint developed with the so-called “diffusion-bonding” of copper surfaces between two superconducting cables.
- We are now working on an industrial demonstration of 100m long conductor manufacture.



Joint Resistance (8 T, 63.3 kA) = 0.54 nΩ

R&D on HTS Conductors

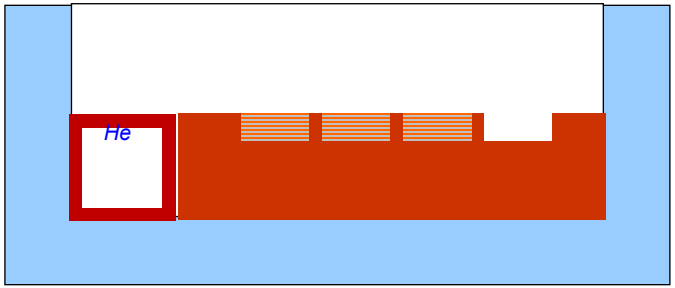
SPC: 60 kA, $B_{\perp}$ 12.5 T, 7.8 K, **2016**



The SPC conductor is transposed, scalable to 50-100 kA, designed for $B_{\perp} > 12$ T, AC tolerant, force flow.

(Nikolay Bykovskiy)

NTNT – Non-Twisted
Non-Transposed conductor, **2024**





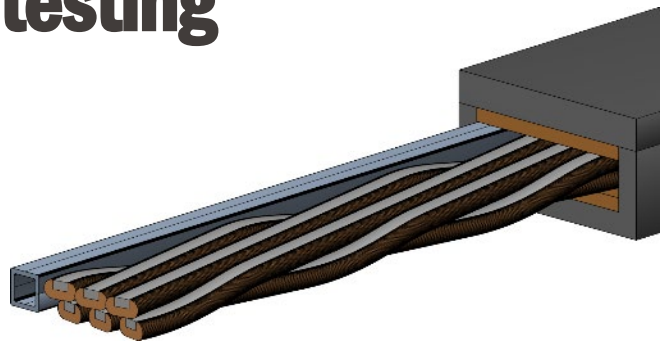
(Davide Uglietti)

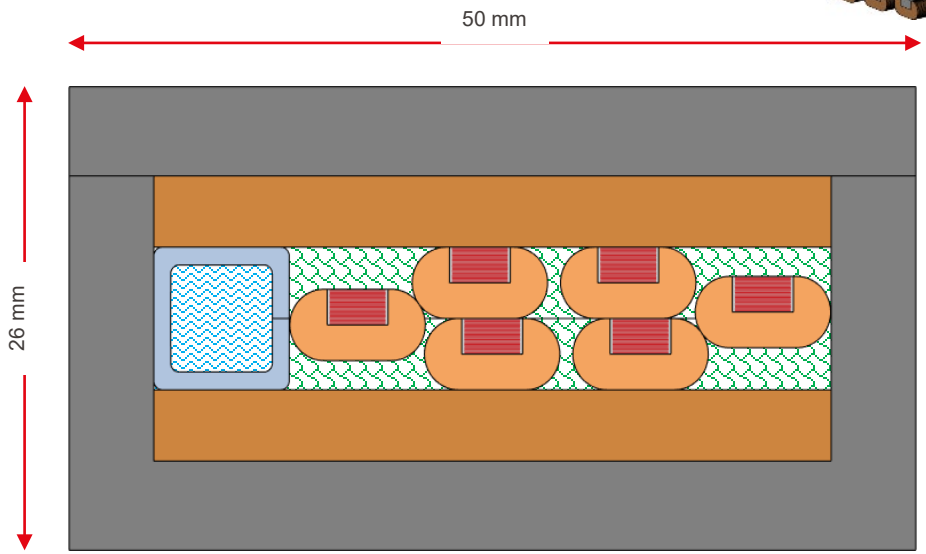
ASTRA prototype construction & testing





3.3 mm tapes
21 tapes in a stack
8 x 4 mm copper profile





Designed for 60 kA at 18 T

Impregnation with dimethyl sulfoxide (DMSO) – water solution

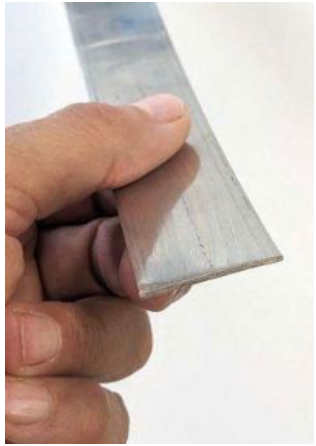
Nikolay Bykovskiy, SPC, 2023

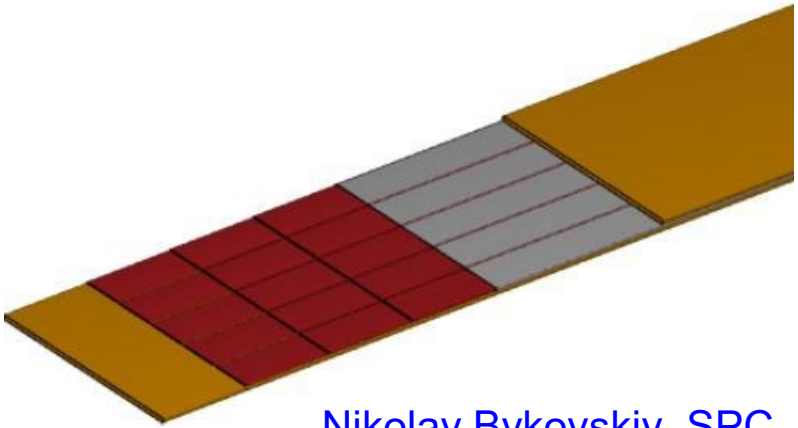
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HTS: LASSO (laminated stacked-tape soldered)

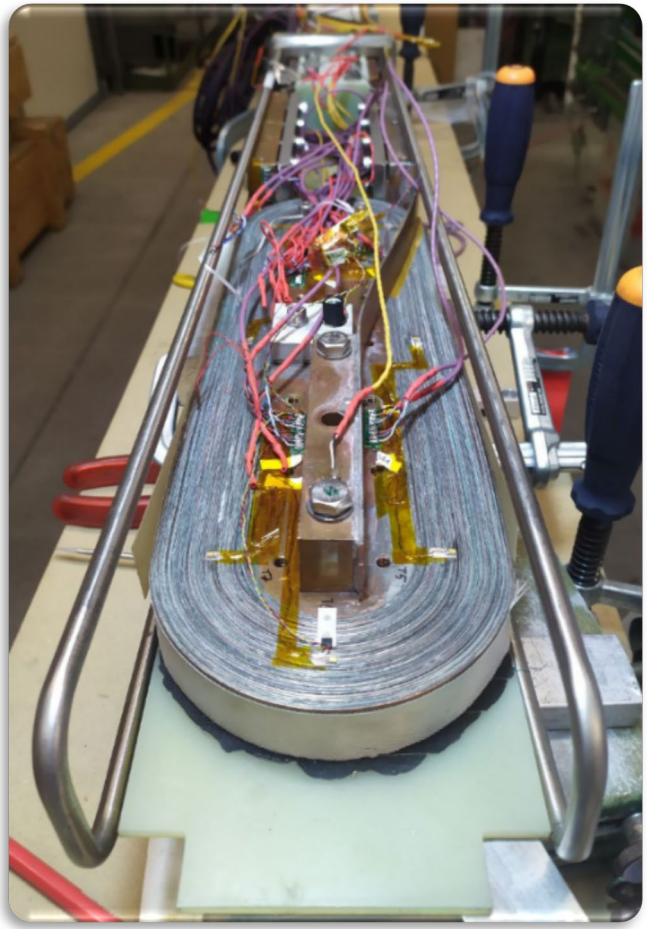
Potential advantages:

- Simplified and cheaper manufacturing
- Straightforward splicing and grading
- Industrial availability



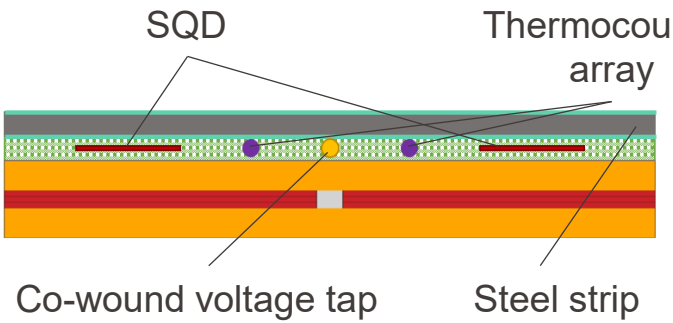


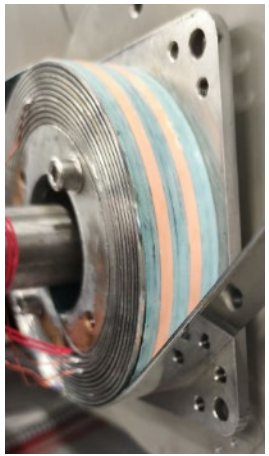
Nikolay Bykovskiy, SPC, 2025



LASSO Coil to be Tested in SULTAN Next Week

Superconducting-cowound-tape Quench Detection (SQD) based on REBCO Tapes









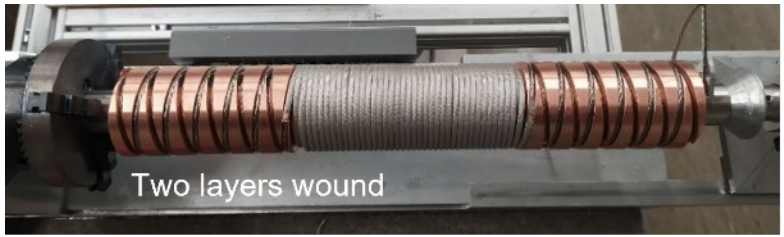
- Heat treatment of SQD ReBCO tapes for improved QD performance by decreasing Tc and Ic
- Various integration layouts being studied…

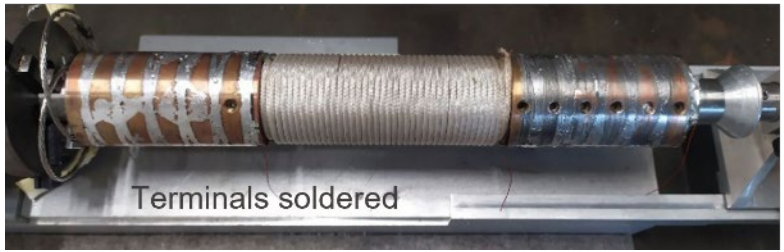
Nikolay Bykovskiy, SPC, 2026

R&D on Superconducting Switches

- In case of quench, superconducting magnet must be quickly disconnected from the power supply.
- The disconnection is done by “breakers” operating at room temperature.

Switch made of 12 Nb-Ti/Cu-Ni wires rated for 8 kA made at SPC







- Superconducting switches would do the same task at cryogenic temperatures, which simplifies the coil protection significantly.
- R&D on superconducting switches done by SPC and PSI is funded by Proxima Fusion.

Summary

- Superconducting group of SPC hosts unique test facilities for testing fusion-type superconducting cables, SULTAN and EDIPO.
- We have been testing ITER superconductors and joints for several years.
- The second largest activity is R&D on conductors & joints for fusion-size magnets, and related technologies (quench detection using optical fibers and SQD, superconducting switches, …)