

SULTAN High-Field Superconducting Cable Test Facility

The SULTAN facility, operated by the Swiss Plasma Center (SPC) of EPFL and located at the Paul Scherrer Institute (PSI), Villigen, Switzerland, is a world-leading test facility for testing high-current superconducting cables and joints. It played a crucial role in testing conductors for ITER, which was coordinated and supervised by F4E. The collaboration of SULTAN team with F4E started during the initial R&D phase to validate the conductor design, and it continued during manufacturer qualification and finally for quality control. After testing ITER conductors, the testing continues on EUROfusion DEMO and various other public projects and private companies worldwide.

The technology

- **High Magnetic Field:** Provides a background magnetic field up to 10.9 Tesla in a large sample space (test well with inner cross section of 144 mm x 94 mm).
- **High Current Supply:** Delivers direct operating currents up to 100 kA using superconducting transformer or up to 15 kA using power supply (suitable for quench experiments).
- **Cryogenic Infrastructure:** Forced-flow supercritical helium across a variable temperature range (4.5 K to 50 K) and controlled helium mass flow rates of two times 10 g/s.
- **Comprehensive Testing:** Enables DC measurements like critical current, I_C , and current sharing temperature, T_{CS} , AC loss assessments, stability tests, and electromagnetic/thermal cyclic endurance tests (fatigue).

Advantages and Potential Applications

- **Full-Scale Testing of Superconductor Prototypes:** Accommodates high-current forced-flow superconducting cables, including the High-Temperature Superconductors (HTS), under realistic operating loads.
- **Nuclear Fusion:** Testing and qualification of conductors and joints for toroidal, poloidal, and central solenoid coils.
- **Studies of quench detection and quench evolution.** Studies of the performance degradation due to quench. (Quench studies are possible only up to current of 15 kA.)
- **High-Energy Physics:** Test of small-size coil prototypes in the background field.

Collaboration opportunities

- **Contract Testing Services:** Testing custom conductor samples, joints, and prototype cable setups.
- **R&D Partnerships:** Joint development and qualification of next-generation low- and high-temperature superconducting cables and joints.

Fusion for Energy Technology Transfer
Programme

Email: technologytransfer@f4e.europa.eu