

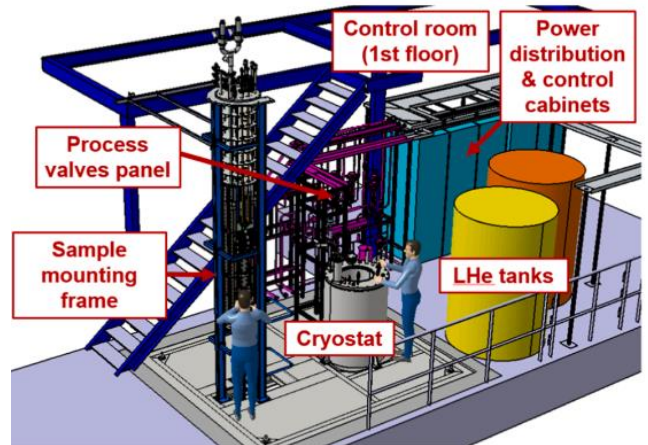
SELFIE : superconducting joint test facility

CEA designed and built a superconducting joint test facility called SELFIE. The test performed on SELFIE aims to measure the superconducting joints sample resistance (few nΩ) in cryogenic condition (liquid helium bath at 4.2 K) at 70kA in self-field. This system is designed to perform easily and in a more efficient way. This facility has already been declared ready for operation in January 2022. Furthermore, the SELFIE facility is also available for other superconductivity materials

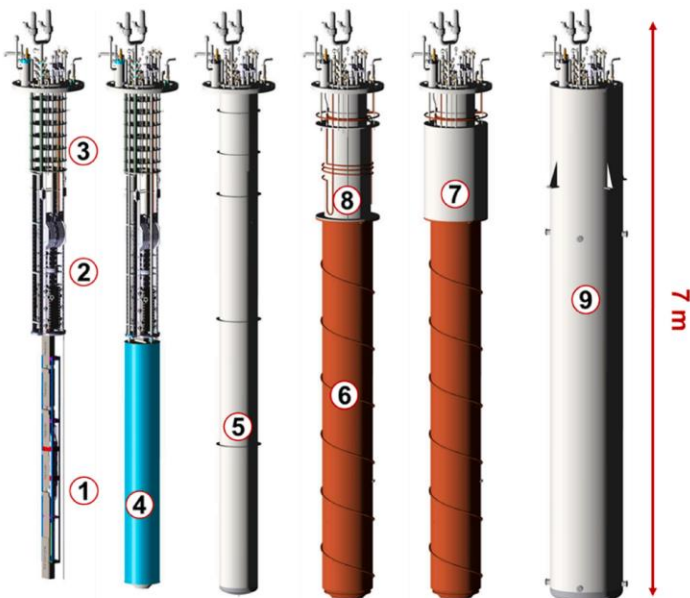
Description of the technology

SELFIE was designed for fast and simple operation in order to optimize the cost per test (helium consumption, manpower and test duration). The SELFIE tests are performed in a liquid helium (LHe) bath at 4.2 K and 70 kA, in self-field (no background magnetic field).

A dedicated superconducting transformer integrated in the same LHe bath as the sample, provides the sample current. It is able to provide up to 70 kA at the secondary in steady state during 10 min for a maximum resistive load of 12 nΩ . The primary current is provided by a standard bipolar power supply (8 V/ ±240 A).



Overview of SELFIE test facility layout.



Overview of the SELFIE cryostat.

The SELFIE cryostat hosts the whole Test Assembly composed by the test sample (1), The Sc transformer system (2) and the supporting system from the top flange (3). A foam filler is implemented around the sample in order to optimize the LHe useful volume (~350l).

The TA is inserted inside a central liquid Helium vessel. The Helium vessel is surrounded by an actively-cooled 80 K shield (6) coupled with a 200 litres liquid Nitrogen (LN2) guard (7).

A GHe subcooler (8) is implemented inside the LN2 guard for controlled cool-down and warm-up purposes.

The whole assembly is contained inside the 860 mm diameter cryostat vacuum vessel (9).

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■ Description of the technology

Two independent control systems have been developed: one for the cryogenic process control, and another one for both the Sc transformer operation control and the data acquisition. Each system is monitored remotely from the control room using dedicated Human-Machine Interfaces.

Based on a Programmable Logic Controller (PLC), the cryogenic process is automatically controlled for safe and optimized operation 24 h/24, 7d/w.

For the SC transformer, the primary power supply control and the secondary current measurement are performed by the Sc transformer controller based on PLC. An independent quench detector module monitoring the primary voltages is able to trigger a fast discharge in case of quench event.

A first superconducting joint was realized and tested successfully in July 2022. Conclusion and perspectives The SELFIE test facility was commissioned successfully and declared ready for operation at the end of January 2022.

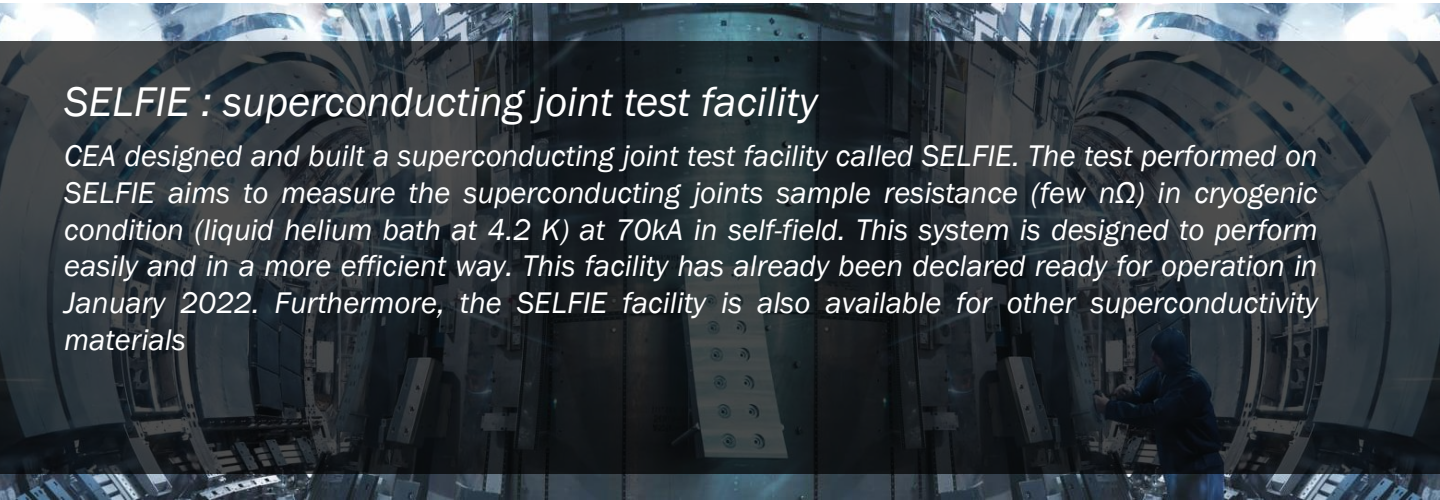
■ Innovation and advantages of the offer

The facility offered works presents several advantages, here are listed the main ones :

- Tests were commissioned successfully
- The process is automatically controlled for safe and optimized operation 24 h/24
- Tests can be performed at really low temperatures and high current
- The system is optimized to reduce the cost per operation

■ Non-fusion Applications

For non-fusion application, this facility can offer the possibility to verify the quality of superconducting materials. Such a solution could find applications in the health sector (for MRI for example), transport, electric motors, IT, power transmission, etc.



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EUROfusion Heritage

In the frame of a contract with ITER Organization (IO) on magnets assembly support, CEA designed and built a superconducting joint test facility called SELFIE (ITER SELf-FIEld joint test facility). This facility is installed at CEA Cadarache and started to operate in 2022.

This project was initiated by IO for quality control of critical assembly activities. Indeed, the magnet superconducting joints assembly is a special process, for which the performance cannot be verified until the full Tokamak is at cryogenic temperature and obviously repair cannot be envisaged once the machine is assembled.

Therefore, the quality control of these joints assembly relies on procedures and qualification of the workers in charge of their implementation. As the joints assemblies will span over three years of the ITER construction, the qualified workers will have to assemble periodically some Production Proof Samples (PPS) joints to train and keep their certification valid. The purpose of SELFIE is to test these PPS in a timely manner.



Test assembly insertion inside the cryostat