

Demountable Coil Technology for Improved Access and Cost Efficiency in Fusion Power Plants

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Abstract—The installation and maintenance of components within the vacuum vessel (VV) of fusion power plants (FPPs) are heavily constrained by access limitations. In current magnetic confinement fusion experiments, access is typically restricted to the space between magnetic coils, significantly limiting the size of components that can be installed or maintained. These constraints are even more pronounced in stellarator designs, which, while offering key advantages in terms of steady state operation and absence of disruptions, suffer from complex coil geometries that complicate the integration of the VV and its internal components. To address this challenge, Gauss Fusion GmbH (GFG) is developing a novel demountable coil technology. This approach features superconducting coils with separable connecting elements, enabling the opening of the coil structure and facilitating the use of large ports for better access to the VV. This innovation holds the potential to transform installation and maintenance strategies for FPPs by overcoming the inherent access limitations imposed by conventional coil construction.

In addition to enhancing accessibility, the demountable coil technology can offer several advantages for FPP development. The coil production can be drastically simplified by limiting the conductor's length to a few tens of meters rather than hundreds, facilitating the production process and reducing the costs. The coil would not require continuous winding, being instead laid out in sections, redefining the manufacturing process and facilitating the movement and transport of the coils. Moreover, effective conductor grading becomes feasible, reducing the amount of superconducting material in the low-field regions and reducing the material costs while optimizing the conductors.

This paper presents the development of this demountable coil technology, focusing on a 1:1 scale mock-up currently in the final design stages, to be manufactured during 2025. The mock-up is

equivalent to a sub-section of a GFG coil, featuring full-size superconducting Cable-in-Conduit Conductors (CICCs) and joints. Designed specifically to replicate the coil structure, the mock-up is constructed with multiple stainless steel (316LN) plates to encase and mechanically support the cables and joints. The mock-up measures approximately 3.0x0.65x0.55 meters and can house up to 16 conductors, each featuring two joints, for a total of 32.

The key enabling technology for this demountable coil concept is the development of robust connections between superconducting cables. GFG is exploring multiple joint configurations tailored to both low-temperature superconductors (LTS) and high-temperature superconductors (HTS). The target for joint resistance is in the $1\text{ n}\Omega$ range under operating conditions, a key metric for ensuring the effectiveness and reliability of the demountable coil. The mock-up will serve as a versatile test platform for a range of different experiments. Both LTS and HTS joints will be assembled and tested to develop and study the assembly process. Room-temperature (RT) tests include repeated opening and closing of joints to evaluate durability and mechanical stability under dynamic loading using a hydraulic table. At cryogenic temperatures, the platform will enable joint resistance measurements for HTS conductors at 77 K, leak tests before and after thermal cycling, and assessments of joint degradation over multiple warm-up and cool-down cycles. In addition, the mock-up will be used to explore remote handling options, an essential feature for future FPP operations. Finally, the mock-up is designed to include 2 SULTAN samples, which will be extracted and tested in relevant conditions (high-current and high background field) after the loading cycles at RT.

This comprehensive development effort marks a significant step toward overcoming the engineering challenges of magnetic confinement fusion and advancing the practicality of fusion energy.

Keywords (Index Terms)– Stellarator, Fusion, HTS magnet, HTS cable, LTS magnet

IEEE-CSC, ESAS and CSSJ SUPERCONDUCTIVITY NEWS FORUM (global edition), Issue No. 60, Sept. 2025.
Presentation given at MT29, Boston, MA, USA, July 2025.