Contribution ID: **825** Type: **Poster**

Fri-Af-Po.08-02: Preliminary Design of a Superconducting MgB_2 Feeding System for Fusion Applications

Friday 4 July 2025 14:00 (2 hours)

With the goal of generating net energy by 2040, fusion energy represents a cornerstone in the development of sustainable power generation technology, combining innovative approaches with advanced engineering solutions. Several programs aim to demonstrate the viability of fusion as a scalable energy source. However, the integration of remountable joints, the presence of large amounts of stored magnetic energy, and the spatial constraints imposed by magnetic geometries create significant technical challenges for the design and operation of magnet systems in fusion devices.

A key issue in this context is the development of a reliable and efficient current feeding system capable of meeting the demanding requirements of fusion magnets. To address this challenge, a preliminary design study has been conducted for a superconducting feeding system employing magnesium diboride (MgB_2) cables cooled by gaseous helium. MgB_2 offers a compelling balance between performance and cost-effectiveness, making it an ideal choice for high-current applications in fusion devices. The design process integrates considerations spanning electrical, thermal, magnetic, and mechanical domains to ensure compatibility with the unique operational environments of fusion systems.

From an electrical perspective, the supply current and voltage profiles, including transient behaviors during ramp-up, steady-state operation, and quench events, were analyzed. The discharge dynamics in the event of a quench were evaluated to ensure system safety, and the insulation requirements were defined based on the maximum voltage levels expected under normal and fault conditions. The configuration of the feeding system terminations, tailored to interface with magnet connections, was also optimized to facilitate efficient power transfer and minimize resistive losses.

Thermal management leverages the availability of gaseous helium as a coolant. Detailed analyses of helium flow rates, temperature gradients, and pressure drops along the feeding system were performed to ensure adequate cooling capacity and maintain the MgB_2 cables in their superconducting state.

The magnetic environment within fusion reactors imposes strict constraints on the design of the feeding system. The influence of stray fields and the maximum permissible magnetic flux density in various sections of the system were carefully evaluated to prevent flux jumps and ensure the stability of the superconducting state. The radiation environment, characterized by both intensity and type, was also considered to ensure the long-term performance and reliability of the materials and components employed.

Preliminary results from this study highlight the feasibility of a superconducting feeding system based on MgB_2 as a robust and scalable solution for delivering the high currents required by fusion magnet systems. By addressing the critical challenges associated with current delivery in fusion applications, this work represents a significant step toward realizing the goal of sustainable and commercially viable fusion energy and underscores the potential of MgB_2 as a key material in this class of applications.

Authors: SOLDATI, Luca (ASG Superconductors Spa); Dr MELACCIO, Umberto (ASG Superconductors Spa)

Co-authors: Dr BRUZEK, Christian Eric (ASG Superconductors Spa); Mr MAZZEI, Fabrizio (ASG Superconductors Spa); Mr GAMPER, Georg (ASG Superconductors Spa); Mr BULLERI, Giorgio (ASG Superconductors Spa); GRASSO, Giovanni; TROPEANO, Matteo (ASG Superconductors Spa); Dr CORSARO, Pietro (ASG Superconductors Spa); TEBANO, Riccardo (ASG Superconductors Spa); Dr SPINA, Tiziana (ASG Superconductors Spa)

Presenter: SOLDATI, Luca (ASG Superconductors Spa)

Session Classification: Fri-Af-Po.08 - Advances in Nb3Sn and MgB2 Conductors I