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Muon Collider Magnet Programme: Test and Measurement Requirements

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Oral presentation (20 min) + Q&A (10 min)

The muon collider requires advanced magnet systems to meet the demands of muon production, acceleration, and storage. The key targets for magnet R&D include achieving field levels up to 20 T in dipoles, quadrupoles and combined function accelerator magnets, up to 40 T in solenoids, and very fast ramping, up to 3 kT/s, in resistive accelerator magnets. R&D presently focuses on integrating high-temperature superconductors (HTS), developing efficient cooling systems, required to manage heat loads from muon production and decay at the level of kW, ensuring radiation resistance at the level of tens of MGy, and developing efficient MJ-scale energy storage and GW-scale power management for the pulsed accelerators.
These exceptional challenges will require intense test and measurements with tailored and advanced techniques, from materials, to magnets, to systems. In this presentation we will outline the magnet challenges, the proposed R&D program and the time scale of the development, prototyping and series production towards a muon collider. Based on the proposed R&D and production programme, we have identified some specific challenges for test and measurements that will need dedicated new methods, sensors and infrastructure. Examples are:

- Characterization of HTS material performance at cryogenic temperatures and ultra high field (up to 40 T), including in relevant radiation environment;
- High current conductor testing with capabilities up to 20 T, currents up to 60 kA and variable temperature in the range of 4.2 to 100 K;
- Characterization of magnet performance, quench detection and protection of NI HTS magnets, including at temperatures above liquid helium (e.g. 10 to 20 K);
- Measurement of field quality, stability and reproducibility of NI HTS dipoles and quadrupoles, which can rely on the standard methods of harmonic expansion, as well as combined function accelerator magnets and solenoids, for which a non-standard field representation is required.

The presentation will provide a first evaluation of the measurement needs and tentative range of operation, useful to guide future developments and investments in test methods and infrastructure.

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