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Sat-Mo-Po.01-03: Development of a closed helium circuit cooled (CHiC) demonstrator magnet for carbon ion therapy

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Closed-circuit cooling of superconducting magnets unlocks new possibilities for advanced accelerator designs and applications. In hadron therapy, it has clear potential for compact rotating gantries, while for future accelerator cryogenic systems it could significantly reduce helium inventories. For this reason, a 1 m long Closed Helium Circuit Cooled (CHiC) straight demonstrator magnet is being constructed as the first stage in developing a curved cos-theta dipole for carbon ion therapy. A Stress-Managed-Like (SML) design is adopted, employing additively manufactured stainless steel formers as the primary supports for Nb-Ti coils. Integrated cooling channels supply supercritical helium at 3 bara and 4.5 K. To meet clinical requirements, the CHiC demonstrator aims to achieve a maximum bore field of 4 T, with continuous ramping up to ± 0.4 T/s. A central objective is to develop and verify accurate multiphysics numerical models for simulating the extraction of transient losses. Ultimately, these tools will be validated experimentally through magnet testing. This paper details the magnetic, thermal, and mechanical design optimisation of the CHiC demonstrator.

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