Contribution ID: **545** Type: **Contributed Oral**

Sun-Mo-Or2-05: The HTS4 project: Energy-efficient FCC-ee operation using HTS nested magnets

Sunday 6 July 2025 09:00 (15 minutes)

We present our work on the HTS4 project, part of the CHART framework and the FCC Feasibility Study, on energy-efficient nested HTS magnets for FCC-ee. By replacing the normal conducting sextupole and quadrupole magnets in the 2900 short straight sections by HTS nested variants, significant amounts of energy can be saved. This follows from 1) avoiding ohmic dissipation in the sextupoles and quadrupoles and 2) a reduction in synchrotron radiation via increasing the dipole filling factor. We estimate that the combination of these two points will allow a reduction of the total FCC-ee energy consumption by 20%. As a bonus, the better filling factor results in a reduction of the total RF voltage needed, which results in an extra reduction of capital expense for the RF system.

The optimum operating temperature of such a nested HTS system is found by balancing the operational costs (dominated by electricity use for cooling) with capital costs (dominated by HTS conductor). As cooling options, both conduction cooling with (redundancy based) cryocoolers as well as cooling via a distribution line and centralized cooling plants are considered. We show that from a total cost point of view HTS-based FCC-ee operation is competitive to the normal-conducting baseline.

The end goal of the project, a sextupole-quadrupole nested prototype, is supported by demonstrators manufactured at CERN and PSI. Our first two demonstrators investigate the options of using a wax-impregnated canted-cosine-theta based on insulated tape, and a partial-insulation based cosine-theta configuration. We discuss winding techniques and results from tests in PSI's cryogen-free test stand and the status of the prototype.

This work was performed under the auspices of and with support from the Swiss Accelerator Research and Technology (CHART) program (www.chart.ch).

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Session Classification: Sun-Mo-Or2 - Fabrication and Testing of Magnets for Facilities