High-Temperature Superconducting Magnets for an Energy-Efficient FCC-ee

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The presented work concerns energy-efficient FCC-ee operation by employing high-temperature superconductor (HTS) magnets, and falls within CHART projects FCC-ee HTS4 (PSI) and CPES (ETHZ).

The baseline FCC-ee main ring magnet configuration consists chiefly of iron-dominated normal conducting dipoles, quadrupoles and sextupoles. The latter two form the short straight sections and consume a large amount of power (order of 50 MW).

Replacing the normal-conducting quadrupoles and sextupoles by HTS-based systems yields several benefits: significant power savings (from ~50 to less than 10 MW), an increase in dipole filling-factor, and optics flexibility. We demonstrate the feasibility of operating the magnet system with a high reliability by means of redundancy-focused cryocooler-based cooling.

The high-current leads that traditionally form a major heat load for cryogen-free superconducting systems can be avoided by converting (with a cryogenic power supply) a low-current, high-voltage signal to high-current, low-voltage. This is a key factor towards energy-efficient operation.