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Wed-Af-Or3-01: Design and Preliminary Tests of a Short, High-Temperature Superconducting Wiggler for Synchrotron Light Source

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The European Synchrotron Radiation Facility (ESRF) is currently working on the development of a new synchrotron light source for its beamline BM18. The proposed source is a short wiggler composed by three pairs of magnetic poles, delivering a peak magnetic field of 1.58 tesla. A crucial requirement is the possibility of performing scans of the magnetic field intensity, while keeping the overall installation footprint as small as possible, due to space constraints in the storage ring.

Second-generation, high-temperature superconducting (HTS) tapes based on rare-earth barium copper oxide compounds (ReBCO) offer an unprecedented current density which makes them suitable for high-field, compact applications. Moreover, the control of the source current offers a suitable alternative to bulky mechanical devices typically used in traditional permanent-magnet based phase-shifters for varying the magnetic field intensity.

This work presents the design, numerical optimization, and preliminary testing of a novel short superconducting wiggler. The magnet is composed by a set of racetrack coils and an iron yoke which optimizes the magnetic field shape and allows to meet field requirements while operating the HTS tapes at 65 K, in liquid nitrogen. Due to the simplified cooling system and cryostat, the footprint of the application is minimized. A no-insulation technique is applied to the coil winding for enhancing the robustness of the magnet against the consequences of quench events.

The electromagnetic design is carried out using COMSOL and RADIA, aiming for a magnet load line of 80% at nominal current. Subsequently, a numerical optimization approach is employed to refine the design parameters, in particular the shape of the iron yoke. Particular attention is given to minimizing the first and second integrals of the magnetic field along the particle beam path for the overall supply current range, ensuring stable operations in the synchrotron storage ring.

Preliminary tests are conducted on a prototype winding at 77K. The magnetic field characterized is compared with simulations, and the layer contact-resistance of the winding is determined, providing crucial information for the further coil winding, assembly and operation.

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