Powering Test Results of HTS Undulator Prototype Coils for Compact FELs at 4.2 K

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***Abstract*—Short-period and high-field undulators are crucial for the production of coherent light up to X-rays in compact free-electron lasers (FELs). Besides, future colliders like CLIC or FCC-ee demand high-field damping wigglers to reach a low beam emittance. Both applications may benefit from the use of high-temperature superconductors (HTS), e.g., by providing high magnetic field amplitudes or higher operating temperatures. This paper presents and summarizes our HTS undulator prototype coils, designed and manufactured at CERN, made from coated REBCO tape superconductor. The coil design, described and already powered at 77 K in previous works, is based on no-insulation (NI) vertical racetracks with a period length of 13 mm, assembled with iron poles. Powering tests of several HTS undulator prototype coils at 4.2 K, performed at KIT, revealed safe operations at high engineering current densities of 2.3 kA/mm^2 with produced magnetic fields of up to 1.5 T at 3.5 mm distance from the magnetic iron poles. Reasonable effective time constants of around 100 s were obtained and further powering tests in regions beyond Je,c with 3.6 kA/mm^2 showed the stability of our NI design and created magnetic fields in the region of 2 T.**

***Keywords (Index Terms)*—Free electron lasers, high-temperature superconductors, superconducting devices, undulators**

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