Influence of the magnetization features of the HTS tape on the magnetic field homogeneity inside the superconducting unclosed shield

Evgeny Kulikov1,2, Gennady Dorofeev1,2, Valery Drobin1, Kamil Kozlowski1, Henryk Malinowski1, Alexander Smirnov1

Abstract

Measurements of the magnetic field were performed in a copper solenoid with the high-temperature superconductor shield. The experiments were carried out under quasi-stationary conditions, magnetic fields up to 1 kG and 77K. The shield is a lengthwise winding made from YBCO tapes, 442 mm long each. Each layer is laid with the piece shift from layer to layer equal to one-half of the tape width, forming a “tile”. When the radial component of the magnetic field was being measured near the shield, the magnetic field irregularity was detected. It is related to the magnetization features of the 2G-HTS tape. It is shown that the absolute value of the field irregularity reaches some 6 near the inner surface of the shield and sharply decreases with the distance from it as well as r². The obtained results allow selecting the optimum radial shield size to get the required magnetic field homogeneity in the operating area for the electron cooling system of charge particle beams.

Electron Cooling System (ECS) for NICA

Electron cooling is an extremely useful method to obtain high intensity ion beams with a low momentum spread. Friction force equation:

\[ \Delta, \text{eff} \] is effective electron velocity spread depends on the magnetic field line position in the transverse direction! Full-size HTS shield was proposed to obtain the required magnetic field homogeneity [about 10⁻⁴] in the 6 meters length solenoid of the electron cooling section which will be installed in the heavy ion collider of the NICA project.

Material

- 2G-YBCO - HTS ceramic tape (Super Ox) Tape width: 12 mm

Experimental set-up

The unclosed shield screens only magnetic field perpendicular component at the centre and transmits the longitudinal component

Region (a) with B=0 inside the shield is defined by (in CGS)

\[ 2 \sin^{-1} \left( \frac{1}{2} a \right) \leq \phi_{\text{eff}} \leq \frac{3}{2} \pi \]

Results

Penetration of the radial magnetic field into the shield under different magnetic fields in the solenoid:

- 0 kG
- 2000 G
- 7000 G

Reference measurements were performed:


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Contact

Evgeny Kulikov, JINR (VBLHEP), 141980 Dubna, Russia
E-mail: kulikov_box_week@mail