Field measurement of SCRIT electron spectrometer

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A large-acceptance magnetic spectrometer for electron scattering on unstable nuclei was constructed, and its magnetic field was measured. The analysis of the field distribution and the development of a program of track reconstruction are in progress.

The design[1] and construction[2), 3)] of the spectrometer have been reported elsewhere. The spectrometer is designed to have a reasonably good resolution of $\Delta p / p$: 10^{-3}, a large solid angle of about 100 msr, and a large scattering coverage of 30-60° .

The spectrometer consists of a single window-frame dipole magnet with an aperture of 29 cm in height (y), 1.4 m in length (z) and 1.71 m in width (x). As the spectrometer has no focal plane, the momentum and vertex position of scattered electrons are fixed through the track reconstruction using the information of drift chambers, as shown in Fig. 1. This implies that the knowledge of the precise distribution of the magnetic field is essential for analysis.

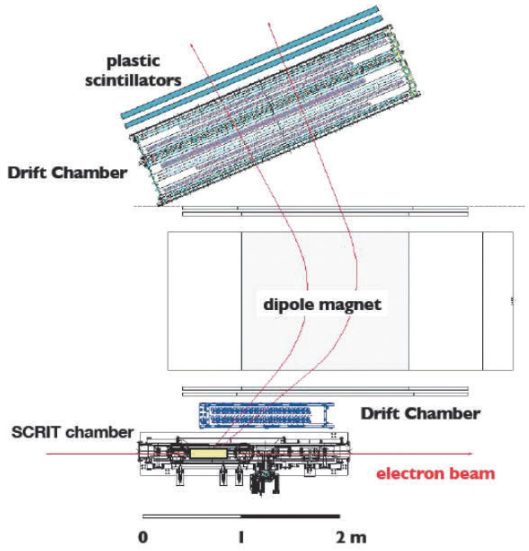

Fig. 1. Layout of the spectrometer, detectors, and SCRIT (Self-Confining Radioactive Isotope ion Target).

The magnetic field distribution was measured using a Hall probe at 37,118 points in 1/8 of the entire volume of the aperture and connecting regions. The absolute magnetic-field values were calibrated using an NMR set at a fixed position in the mid-plane. The field map was obtained at three strengths ((a) 4,096, (b) 7,628, and (c) 8,017 G at the NMR). The measured values were corrected for the drift of a Hall probe and for inaccuracy of the probe orientation. They were normalized to the NMR values.

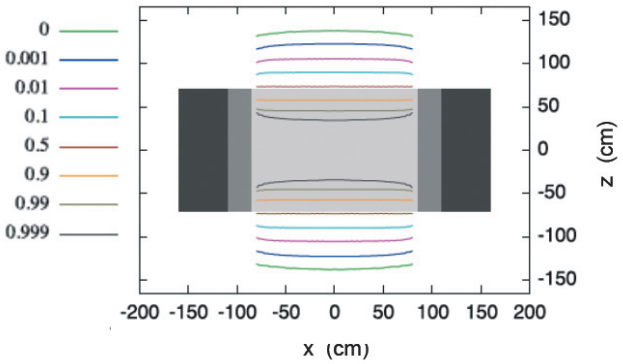

Fig. 2. Contour plot of field strength for a center field of 8,017 gauss. Numbers attached to lines show the ratio of the field strength to the central field strength. The order of lines in the figure is same as the order of lines in the legend. Light-grey region: aperture region of the magnet; dark-grey region: coil; black region: return yoke.

The field strength for case (c) is contoured in Fig. 2; numbers attached to lines show the ratio of the field strength to the central field strength. The figure shows that the field is almost uniform all the way to the coils, which is a unique merit of the window-frame magnet. The measured field along the electron beam at z = -155 cm is about -3 gauss; the leakage field of 3 G gives a closed orbit distortion (COD) of 0.1 mm at the SCRIT (max. 1.5 mm in the ring). These values are within acceptable levels for the ring operation.

The field strengths were also compared to calculations using the program OPERA-3D. The difference between the measured and calculated field strengths is much less than 10^{-3} in the aperture region, but it becomes larger at the fringe field region, especially at positions close to magnetic poles and field clamps. The estimation of errors for the electron momentum and vertex positions due to inaccuracy of the field distribution is in progress.

References

1) T. Adachi *et al.*: Accel. Prog. Rep. **45**, 144 (2012).
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3) T. Suda *et al.*: in this progress report.

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