Installation of a Dipole Electromagnet *R*TAGX

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A dipole electromagnet *R*TAGX has been installed in the GeV-γ experimental hall. It sweeps out charged particles contaminated in the incident γ beam for meson photo-production experiments. It also supplies momentum-analyzed electrons or positrons in a newly constructed test beamline.

§1. *R*TAGX Magnet

A dipole electromagnet *R*TAGX was installed in the GeV-γ experimental hall from 13th to 15th December in 2005. This magnet was originally created as a 1/1.645 scale model for a sector focused cyclotron at Institution of Nuclear Study, University of Tokyo [1]. It had come to be used as a large acceptance spectrometer TAGX [2] for photon induced nuclear and hadron experiments, where the shims and pole tips were removed and the gap was expanded from 210 mm to 600 mm by inserting two iron blocks into vertical return yokes. It was moved to the second experimental hall in 2000 and was used as a Neutral Kaon Spectrometer (NKS). The NKS was replaced by a larger magnet, and it was preserved in a warehouse until SCISSORSII experiments finished.

The magnet was installed in the GeV-γ experimental hall. The inserted two iron blocks were removed and its gap became 210 mm again. We call it Return of the TAGX or Recycled TAGX (*R*TAGX). Figure 1 shows the installed *R*TAGX.

The pole faces are circle with a diameter of 1070 mm, and holes are drilled in the poles and yokes at the center of these with a diameter of 100 mm. The two hollow-conductor pancake-shaped coils are laid out, and the number of turns is 480 in total. It sweeps out charged particles contaminated in the incident γ beam for meson photo-production experiments. It also supplies momentum-analyzed electrons or positrons in a newly constructed test beamline.

§2. Magnetic Flux of *R*TAGX

The magnetic flux of *R*TAGX was calculated by a 3D magnetostatics computer code Radia [3], which is interfaced to Mathematica on Microsoft Windows XP. Figure 2 shows the magnetic flux B_y as a function of z position for the TAGX and *R*TAGX setups with a current of 500 A. The B_y at the center is 0.483 T and 1.183 T, and the $B\ell$ integration is 0.641 Tm and 1.549 Tm for the TAGX and *R*TAGX, respectively. The strong magnetic flux of about 1.2 T at maximum is achieved in the *R*TAGX by

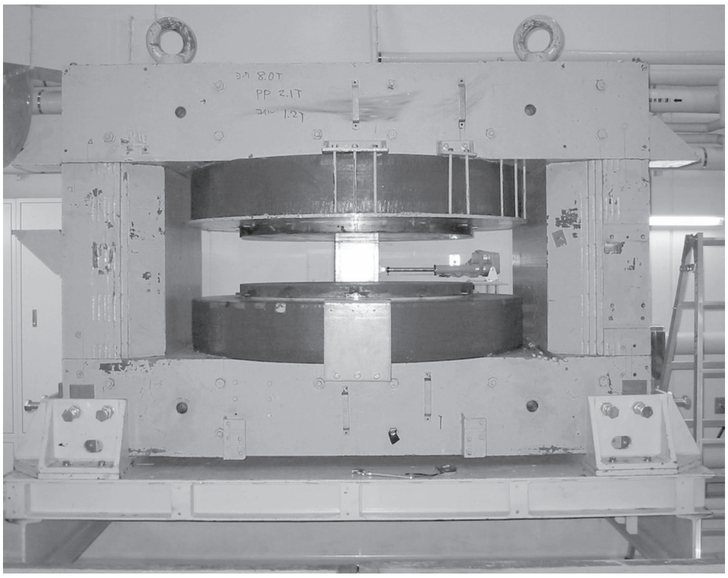

Fig.1. Installed *R*TAGX. The pole faces are circle with a diameter of 1070 mm, and the gap between them is 210 mm.

contracting the gap to 210 mm.

The magnetic fluxes at three points were measured by a calibrated Hall generator with different coil currents. Figure 3 shows the measured magnetic fluxes B_y at three points with various coil currents.

The realistic magnetic flux map was determined by normalizing calculated one for each coil current setup so that it reproduces the measured magnetic flux at the position (0,0,160) where the measured magnetic flux was not influenced by the precise position of the Hall generator.

§3. Electron and Positron Test Beamline

The *R*TAGX can be used to analyze momenta of charged particles with a high resolution since $B_x \simeq 0$ and $B_z \simeq 0$ in the horizontal plane. When the incident γ beam irradiates a target in front of the *R*TAGX, some photons convert into positron and electron pairs. The created positrons and electrons are bent by the magnetic flux, and a monochromatic electron or positron beam can be obtained at a specified angle [4]. Figure 4 shows the analyzed momentum as a function of *R*TAGX current at 30° with respect to *z* axis.

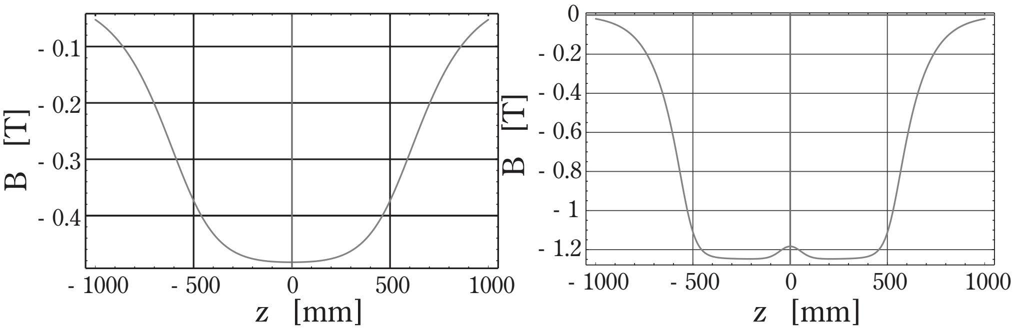

Fig.2. Magnetic flux B_y as a function of *z* position. The left panel shows that for the TAGX with a gap of 600 mm, and the right shows that for the *R*TAGX with a gap of 210 mm.

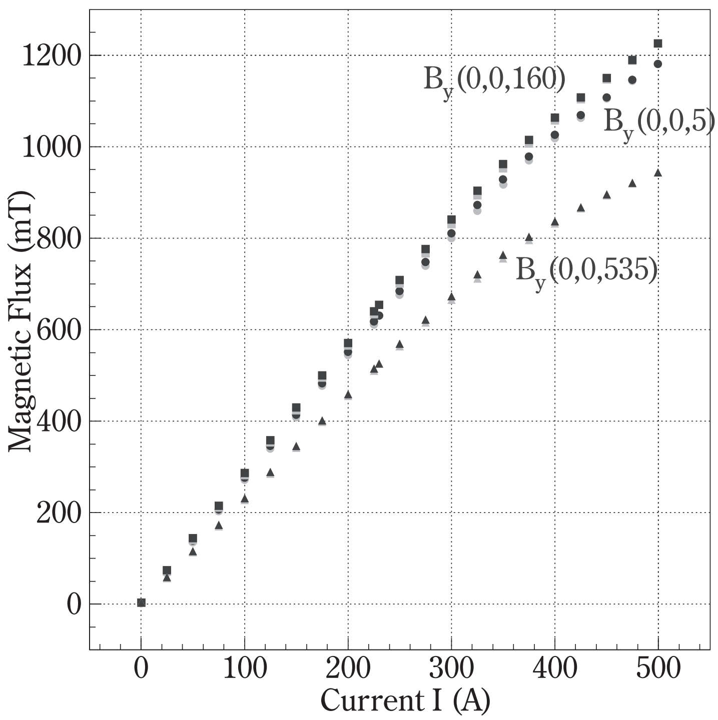

Fig.3. Measured magnetic fluxes B_y at three points with different coil currents. The deep gray circle, rectangle, and triangle markers show those at (0,0,0), at (0,0,160), and at (0,0,535), respectively, where the coil currents are set in the decreasing direction. The light gray circle, rectangle, and triangle ones show those at (0,0,0), at (0,0,160), and at (0,0,535), respectively, where the coil currents are set in the increasing direction.

A Au foil with a thickness of 20 μm is placed 878 mm upstream of the pole center, and a lead collimator with a diameter of 20 mm and with a thickness of 100 mm is laid out 2445 mm downstream at the $-30°$ with respect to z axis. The momentum resolution of the obtained beam depends mainly on the energy loss and multiple scattering of the positrons or electrons during penetrating the Au foil and

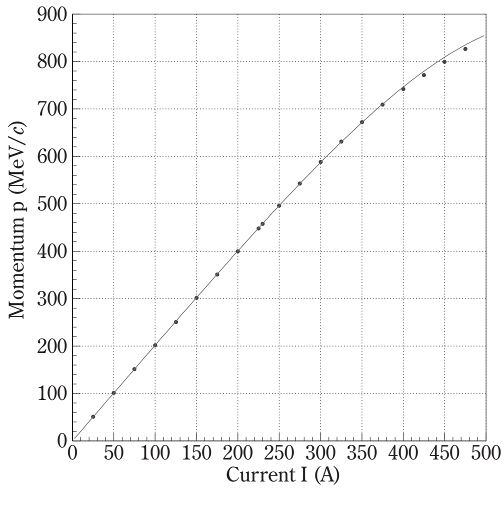

Fig.4. Analyzed momentum as a function of RTGX current at 30° with respect to z axis. The data points are compared with $p(I) = 2.0220\,I - 1.7947 \times 10^{-9}\,I^{4.0600}$ Mev/c.

the air on the way. It is roughly 2% although it should be estimated more precisely. The positron and electron beams are obtained with little contamination, and counting rates of these are about 3 kHz independently of the *R*TAGX current with a STB circulating current of 15 mA.

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