Scattered proton detection system for Σp scattering experiment with the cylindrical scintillating fiber tracker and BGO calorimeters

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The proton detection system is under construction for the Σp scattering experiment at J-PARC (J-PARC E40) for the purpose of investigating Baryon-Baryon interaction, especially the origin of repulsive core. In the $\Sigma^+ p$ channel, strong repulsive force is expected to appear due to the Pauli effect among their constituent quarks (Σ^+: uus, p: uud). By measuring the differential cross section of this channel, we can access directly the repulsive force originated in the Pauli effect between quarks.

The E40 experiment is a double-scattering experiment, that is, $\pi^\pm + p \to K^+ + \Sigma^\pm$ followed by $\Sigma^\pm + p \to \Sigma^\pm + p$ in the liquid hydrogen (LH_2) target. Then, the Σp scattering events are identified by tagging the Σ production with spectrometer systems, and by measuring the scattered proton with the proton detection system. The momentum of produced Σ can be calculated from the momenta of π and K measured by the spectrometer systems. In addition, energy and trajectory of proton are measured by the scattered proton detection system. By using these information, we can reconstruct Σp scattering events using their kinematics.

The scattered proton detection system (CATCH: Cylindrical Active Tracker and Calorimeter system for Hyperon scattering) for this experiment is composed of cylindrical scintillating fiber tracker (CFT) and calorimeter of bismuth orthogermanate (BGO) crystals. CFT has 8 cylindrical layers and they consists of about 5000 scintillating fibers in total. Each layer is constructed from fibers arranged parallel or helix to the beam axis, Φ layers and UV layers respectively. The LH_2 target is closely surrounded by CFT, and 24 BGO crystals are put around CFT. The total energy and energy deposit in the fibers are measured by the BGO calorimeters and the scintillating fibers, respectively. In addition, their trajectories are reconstructed using the hit patterns on CFT layers. We distinguish scattered proton from π with the energy deposit in fibers and BGO calorimeter because the correlation between them is unique to particle. Thus enough energy resolution of CFT to separate protons and π is essential for good S/N.

The construction of the 2 layer of CFT (CFT-Φ2 and CFT-UV2) was completed. We performed a test experiment at the Cyclotron and Radioisotope Center in Tohoku University to evaluate its performance. 80 MeV proton beams were irradiated to polyethylene (CH_2) film target, and proton scattering data were acquired. Using the pp and pC scattering data, we evaluated proton detection efficiency of CFT-Φ2 and -UV2 and their energy resolution. In this contribution, I will report these results.

[1] K. Miwa, *et al.*, Proposal for an experiment at J-PARC, `http://j-parc.jp/NuclPart/pac1101/pdf/KEKJ-PARCPAC2010-12.pdf`