Studies of spin-dependent interactions in hyperon-proton scattering with a newly developed track-detector SCITIC

KEK-PS E452

A series of experiments, E452A, B and C have been carried out aiming at studies of the spin-orbit(LS) interaction between hyperon and nucleon. We have published our first results (EPHJ A15 295-298) from analyses of data obtained in E452A, in which we reported a large Σ^+p LS-interaction in contrast to the case of Λp showing a small LS-splitting. The pilot experiment E452A was then followed by the E452B and C after major improvements of experimental setup to confirm the result with more statistics and better accuracy.

The main improvement from E452A setup to E452B and C was in the lens system for SCITIC. In the experiment E452A, a commercially available lens (Canon F1.2) was used, and the view field of SCITIC was ϕ100 mm at the target position. While the E452A was successful with this lens, the E452B and C were carried out using a special lens (with F0.66) which was designed to provide a larger view field (ϕ200 mm) sufficient to cover the picture of production and decay of a hyperon mostly. In addition, in order to improve the quality of images a new setup with three SCITICs was used. Accordingly, the shape of target container had to be redesigned to minimize the reflection of photons from other windows. Figure 1 shows the layout of three SCITICs and the active target. The hyperons were produced in the liquid-scintillator active target through the (π^+, K^+) reaction, Experimental setups (Fig3 a) for the pion-beam and kaon spectrometers were essentially the same as that for E452A, except for the modification of trigger system for E452C. A new trigger system with use of DC0, CH and FTOF (see Fig3 a) to select the particle momentum was introduced for E452C. Figure 3 (b) compares trigger-particle spectra to select the kaon-associated events before and after installation of the new trigger system.

Examples of data taken after the improvement are shown in (Fig2). Through the data taking run of E452B and C, the hyperon production and the hyperon-nucleon scattering images were accumulated about 10 times more than E452A, Scanning and pointing processes are under way, and a program for 3D track reconstruction from the 3 sets of SCITIC images have nearly been completed.

In parallel with the analysis of E452 data, we developed an analysis tool for hyperons produced from nucleons in nuclei by using the Λ production data from E289 experiment to determine polarization. Since the Λ is produced exclusively through the $n(\pi^+, K^+)\Lambda$ reaction from the neutron in a carbon nucleus, the effect of Fermi motion has to be taken into account to define the polarization axis. The Λ polarization and left-right asymmetry in Λp scattering were determined in the neutron-rest frame as shown in Fig4. The success of this procedure encourages us to apply also to the Σ case so that we can improve statistics by adding events of Σ hyperons produced from protons in nuclei to those from free protons.

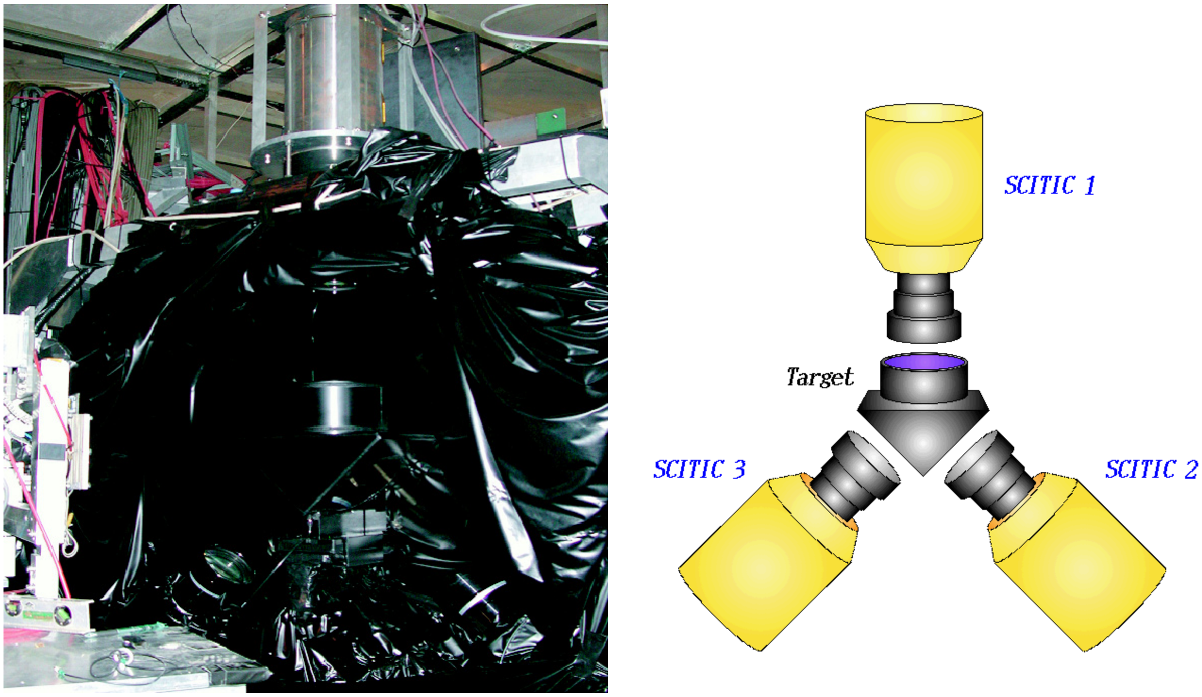

Figure 1: Active target with 3 SCITICs for E452B and C

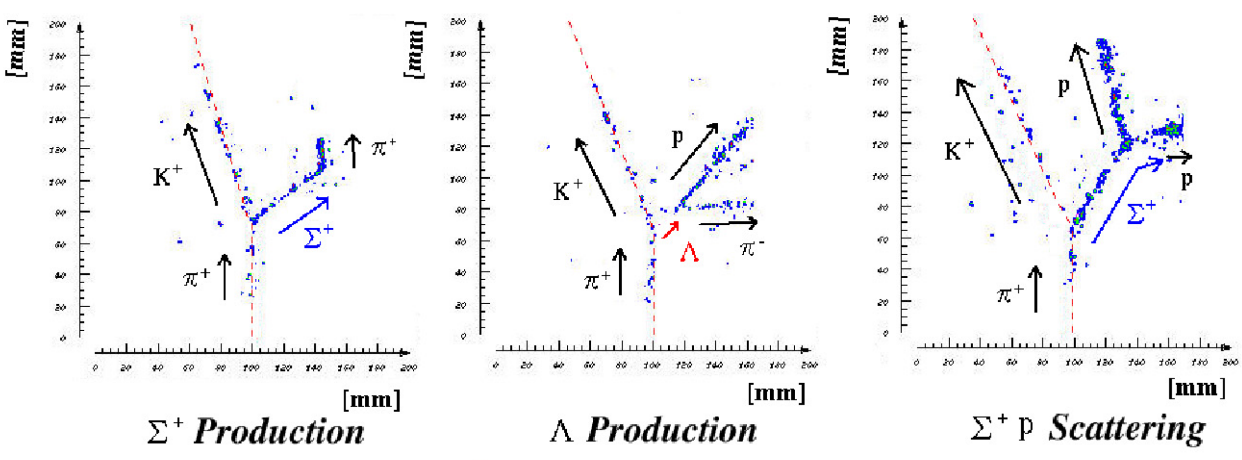

Figure 2: Examples of hyperon production and scattering events

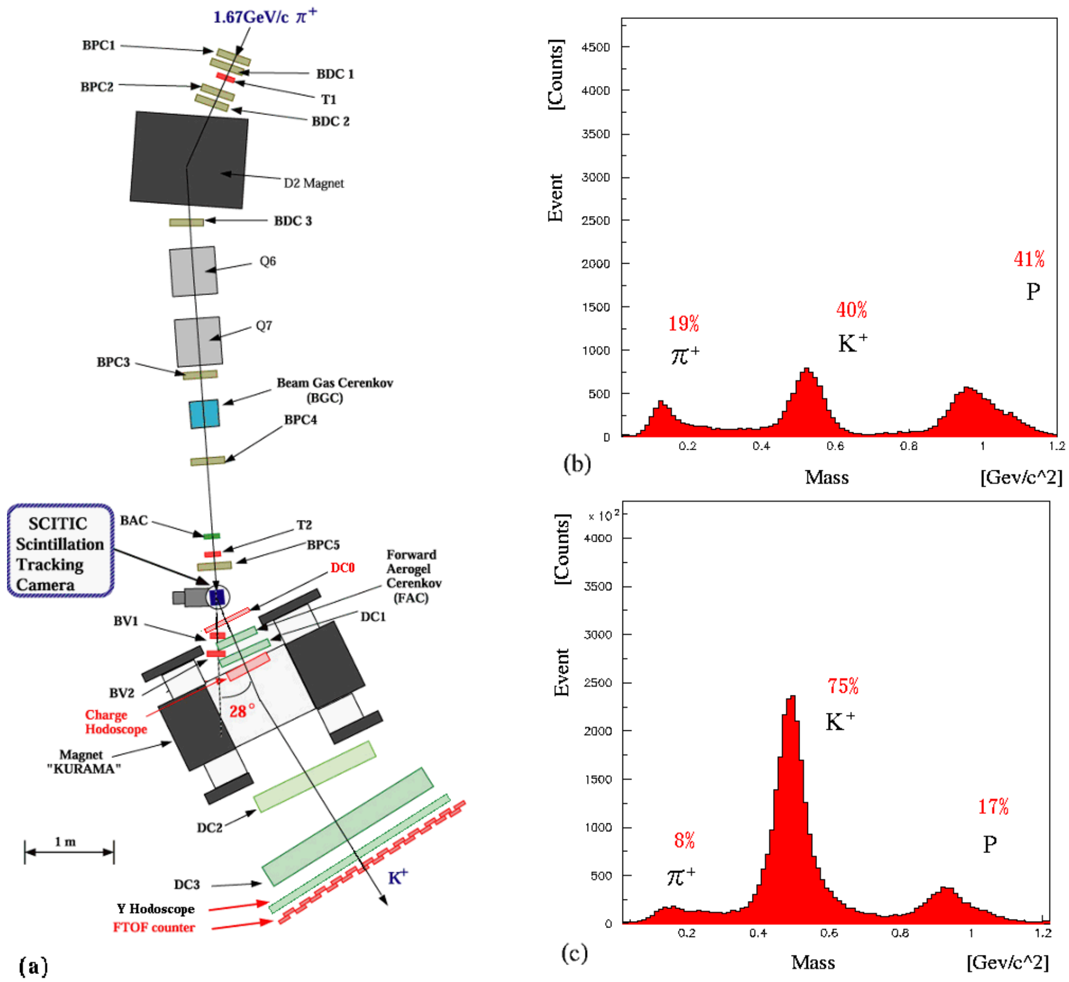

Figure 3: (a) Schematic view of the E452 setup, and mass spectra of trigger particles for (b) E452A and B, and (c) E452C

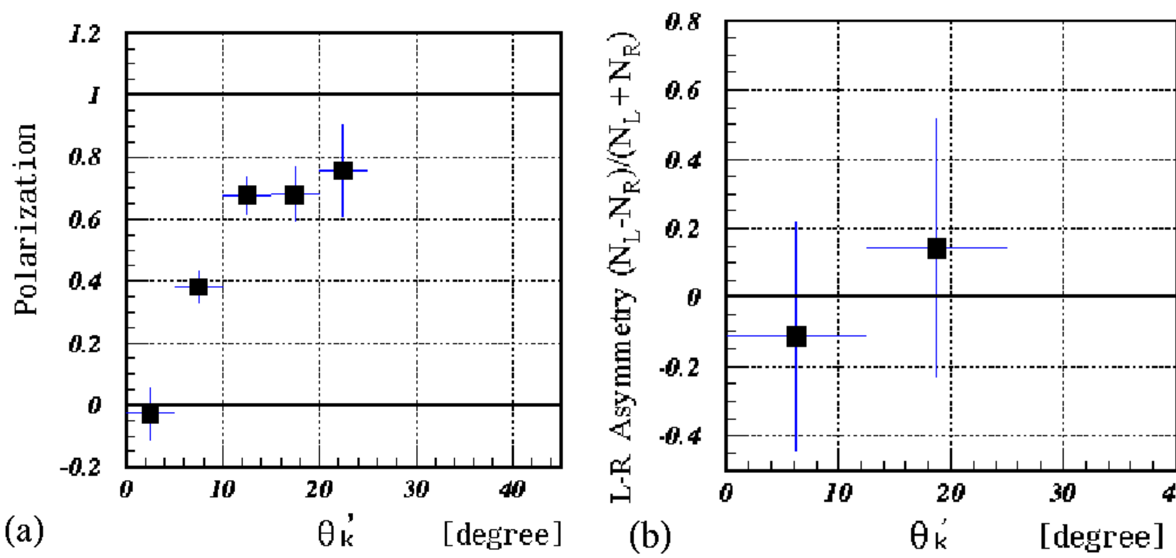

Figure 4: (a) The Λ polarization as a function of emitted angle of K^+ in the neutron rest system. (b) Left-Right asymmetry $\frac{N_L-N_R}{N_L+N_R}$ of Λp scattering.