Development of Beam-Profile Monitoring Methods in Secondary Hadron Beamline

(Report on T539)

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The high-intensity proton accelerator project at the Japan Proton Accelerator Research Complex (J-PARC) is in progress. The nuclear and particle physics facility to use the 50 GeV proton-synchrotron beam is under final-designing and the construction of the facility will start soon. The facility will provide us high-intensity secondary hadron beams, thanks to the high-power primary proton beam (0.75MW). Although the quality of the beam is basically determined by the design of the secondary beamline optics, some tunings of beamline elements are necessary to obtain the designed performance of the beamline. The tunings have been done by looking at the beam intensity, the purity of the beam particle species and the beam profile at the secondary target position. The beam status or beam profile between the primary and the secondary target positions have never been monitored due to technical difficulties, and beam focusings and effects of various slits in the secondary beamline have never been confirmed directly.

We are developing several beamline monitoring detectors optimized for the profile measurement of the secondary beam. The difficulties of the profile measurement in the secondary beamline mainly come from the intensity of the beam in the beamline. There are several detectors for the beam profile measurement of the primary beamline, at where typical beam intensity is 10^{12} particle/spill. In such high beam intensity, detector measures integrated signal of beam particles and signal levels are considerably high. Other types of detectors for the beam profile measurement are used in low beam intensity environment, say 10^6 particle/s, and the measurement is usually made by counting every beam particle. We will be faced with beam intensities from 10^8 to 10^{10} particle/spill in the secondary beamline at the new facility. Beam monitoring detectors in the intermediate beam intensity are not established yet.

We are testing following prototype detectors: (a) Segmented Parallel plate Ionization Chamber (SPIC) modified for a small-signal readout with an amplifier, (b) glass fiber profile detector based on Čerenkov radiation in the fiber with a PMT readout, and (c) plastic scintillation fiber detector with a PMT and amplifier readout. In the T539 experiment, we installed the prototype detectors near to the Intermediate Focus (IF) position in the PS/K6 secondary beamline, and typical beam intensities were a few 10M particle/spill and 4M particle/spill at IF and at the secondary target, respectively. We observed a clear image of the vertical acceptance slit of the K6 beam line by the modified SPIC detector as shown in Fig.1. Estimated beam intensity was about 2M particle/spill for each readout strip (2.5mm in width) of SPIC. This was the first time that a profile of a beam in such a low intensity was measured clearly with a position sensitive ionization chamber.

Stable operation of the fiber detectors (glass and scintillation fibers) in the secondary beam line was confirmed, at least, up to about 5M particle/spill/fiber. We noticed a proper shielding of PMT was necessary to avoid background from stray radiations in the secondary beam line for the glass fiber profile detector. This is a important point to be considered for designs of beam profile detectors in the secondary beamline. The integrated yield of the background radiations is almost same level as that from the secondary beam, so some insensitivity to the background particles is required for the monitoring detectors.

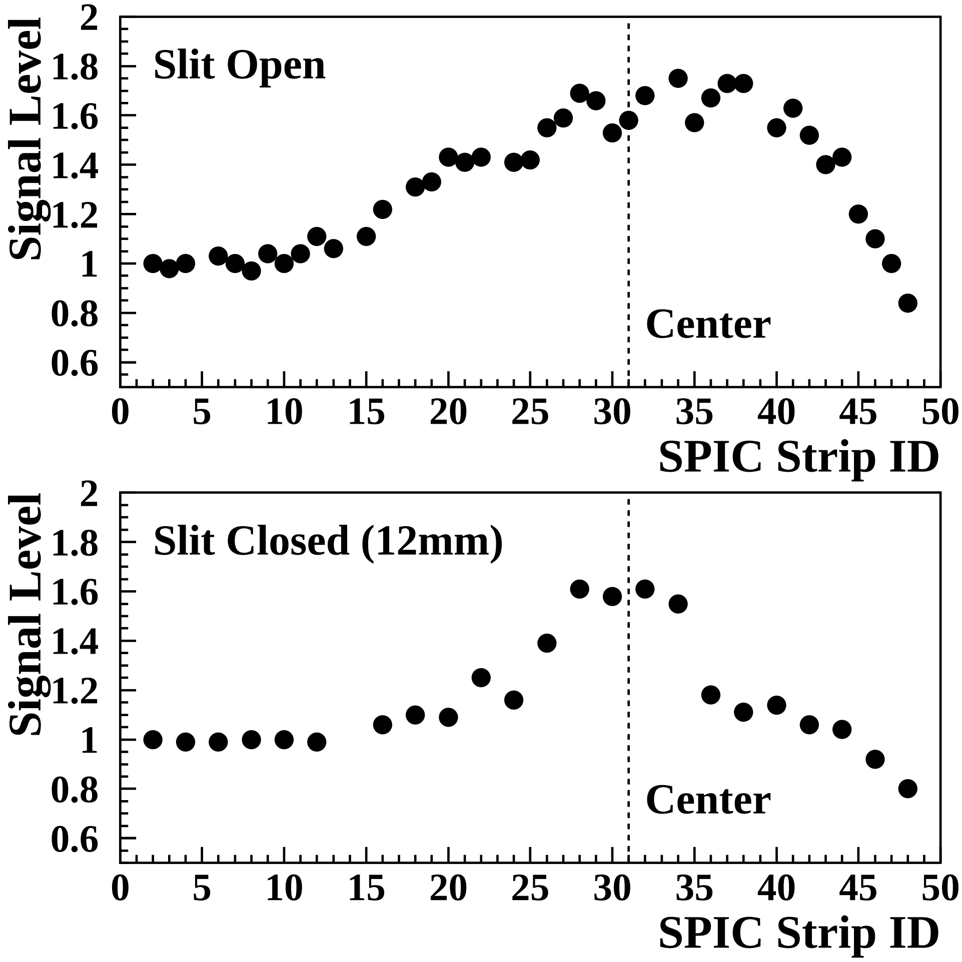

Figure 1: Signal level from every SPIC strip when the acceptance slit was open (top) and the slit was closed down to 12 mm (bottom). The shape of the secondary beam can be seen clearly in the bottom plot.