5 - 3 Test of CSR External Target Facility using ^{40}Ar at 320 MeV/u

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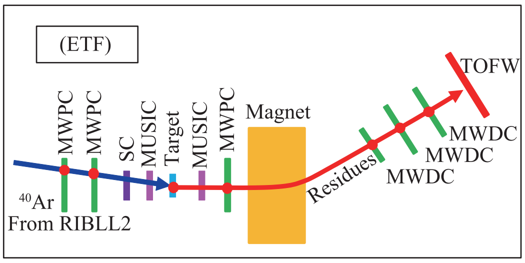

Fig. 1 (color online) Layout of the External target Facility.

The External Target Facility of CSRm[1−3], a magnetic spectrometer with a large angular and momentum acceptance, is a basic and critical device of the CSR experimental area. The device provides large opportunities for nuclear spectroscopic studies using high energy radioactive ion beams[4]. A schematic view of the ETF is shown in Fig. 1. To obtain an overall performance of the newly commissioned ETF, an ^{40}Ar beam with an energy of 320 MeV/u has been used to test the detectors on ETF.

The primary beam ^{40}Ar was accelerated to 320 MeV/u by the synchrotron CSRm and then extracted and delivered to the entrance of ETF. A 5 mm thick carbon reaction target was mounted at the entrance of ETF. Two multi-wire proportional chambers (MWPCs) located upstream of the target were used to determine the position and incident angle of the incident particles on the target. The outgoing charged particles were deflected by a dipole magnet, and their trajectories were determined from the positions measured using one MWPC before the magnet and three MWDCs behind the magnet. A plastic scintillator (SC) placed 15 cm upstream of the target and the time-of-flight wall (TOFW) with 30 plastic scintillator strips and an active area of 120 cm×120 cm placed about 10 m downstream from the target were used to measure the time of flight $TOF_{SC\to TOFW}$. The energy loss ΔE was measured by two Multiple Sampling Ionization Chambers (MUSICs) placed before and after the target. The charge number Z of the reaction residues that originate from ^{40}Ar projectiles were identified using the ΔE information.

In this test experiment, the performance and resolution of individual detectors on ETF have been obtained. The resolution of the time of flight $TOF_{SC\to TOFW}$ is measured to be about 140 ps (σ) as shown in Fig. 2(a). A charge number resolution of ∼0.12(σ) as shown in Fig. 2(b) was obtained. Such a resolution is adequate to distinguish different elements. The position resolution of the MWDCs is measured to be ∼85 μm (σ), see Fig. 2(c).

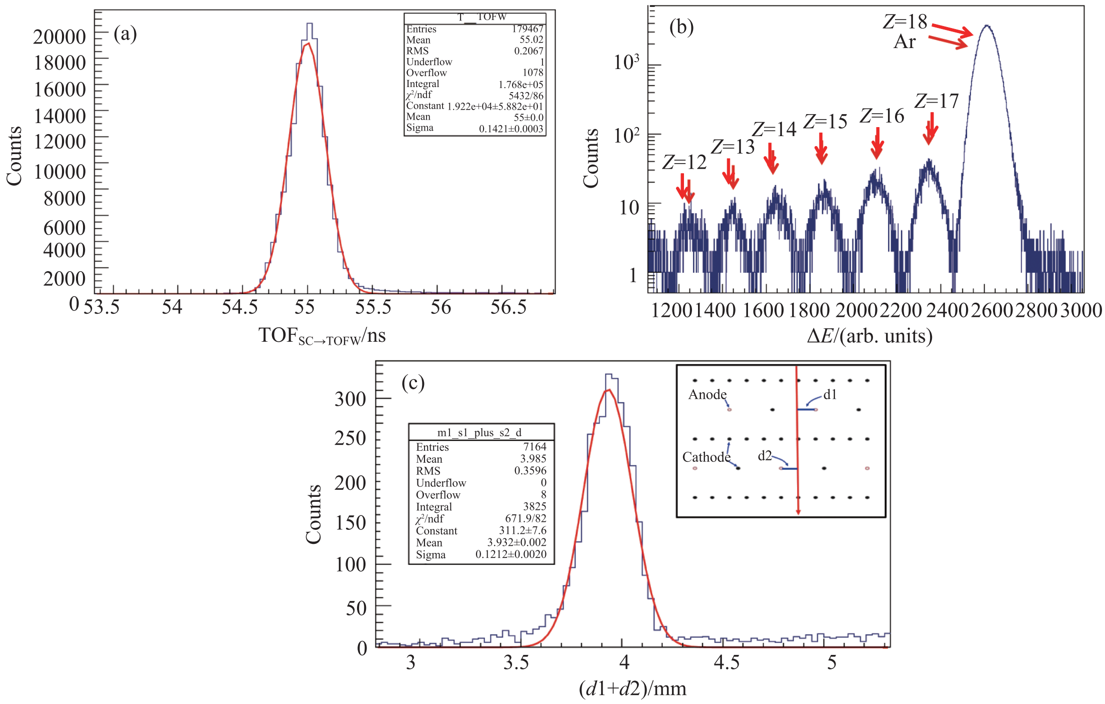

Fig. 2 (color online) Results of the resolution of (a) time of flight, (b) charge number and (c) position of ETF detectors.

Taking into account the above measured resolution of the ETF detectors, particle identification on fragments with mass number $A < 20$ can be well achieved using ETF in the future experiments.

References

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5 - 4 Effect of Different Connection Modes of Multiple Silicon Photomultipliers on the Output Signal Shapes

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Silicon photomultipliers (SiPMs) have obtained a growing attention as an alternative to the traditional photomultiplier tubes in application on the fast detection of scintillation light thanks to their compactness, low cost, low operating voltage, high gain, high photon detection efficiency, excellent resolution for single photon detection, and insensitivity to magnetic fields[1]. In considering larger detector sizes, however, the main drawback of the SiPM readout is their small active area. Devices with an active area in the range between 1 and 36 mm^2 are now widely available. Usually, the small size of SiPMs can be compensated by using several SiPMs connected in parallel or in series, which is equivalent to a single large SiPM from the circuit viewpoint. In this report the effect of different connections on the shapes of output signals will be discussed.

The schematics of the setups for measuring the signals of plastic scintillators coupled with one SiPM, two SiPMs in parallel, and two SiPMs in series are shown in Fig.1(a), (b), and (c), respectively. The 50 mm×50 mm×3 mm EJ232Q-0.5% scintillator sheets wrapped in Tyvek were used in the test. The Hamamatsu S13360-3050PE SiPMs, each of which has an active area of 3 mm×3 mm, were optically coupled to the scintillator with optical grease. The output signals were sampled with a digital oscilloscope Tektronix MSO 5204B with a sampling rate up to 10 Gs/s. An Ortec 710 module was used to bias the SiPMs. The bias voltages shown in Fig. 1 correspond to an overvoltage of about 3 V for each of SiPMs.

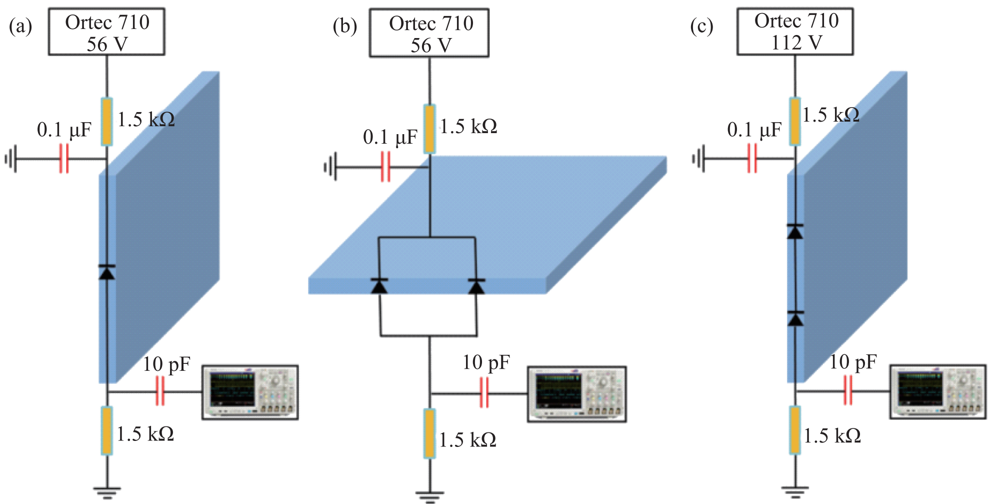

Fig. 1 (color online) Schematics of the setups for measuring the signals with different SiPM connections. (a) A single SiPM. (b) Two SiPMs connected in parallel. (c) Two SiPMs connected in series.

The scintillator was irradiated by cosmic rays under test, and the typical output signals with different SiPM connections are shown in Fig. 2(a). The rise times (10% to 90%) and the full width at half maximum (FWHM) of the output signals have been extracted and shown in Fig. 2(b) and (c), respectively. It can be seen that the signals from the series connection have faster rise times and narrower widths than that from a single SiPM. This is contrast to the case of parallel connection, where the signal rise times become slower and the widths become wider. This is due to the reduction of the total capacitance of the series circuit. The fast rise times and narrow widths