Upgrade of the Si-CsI array TiNA for transfer reactions at OEDO

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TiNA is an array of silicon strip detectors (SSDs) and CsI(Tl) crystals for measuring recoiling particles from transfer reactions.[1)] Initially, TiNA had six telescopes in a lamp-shade configuration. Each telescope had a YY1-type single-sided SSD of Micron and two CsI crystals behind the SSD, the total active area of which is 6×5 cm^2. The telescopes were placed 8 to 10 cm away from the reaction point and surrounded the beam axis. They covered a laboratory angle range of 100° to 150°. TiNA has been used in several transfer experiments at RIBF.[2,3)]

Upcoming experiments using transfer reactions, however, require a larger solid angle and better resolutions in angle and energy. For instance, for the ^{50}Ca(d,p) experiment at the OEDO beamline, an excitation energy resolution better than 200 keV in σ should be achieved. The upgrade project of TiNA has been launched to fulfill these requirements. In this report, we present the details of the improvements of TiNA and the results of the offline test.

Figure 1 shows the upgraded structure of TiNA. Four more telescopes are introduced to cover a larger solid angle, and they are located between the target and the YY1 telescopes. Each has a 0.3 mm-thick TTT2-type double-sided SSD (DSSD) of Micron and four 25 mm-thick CsI(Tl) crystals. The DSSD covers 97×97 mm^2. The CsI crystals placed behind can measure relatively high-energy charged particles (*e.g.*, protons with $E < 80$ MeV). The angular resolution is improved to be less than 0.5°. Three new trapezoidal CsI crystals are brought in to fully cover the active area of the original YY1 SSD.

A new electronic system for the TTT2 has been established. Since the additional detectors have more than a thousand channels, we employ the General Electronics for TPCs (GET), an integrated system for signal processing including analog to digital converters (ADCs), trigger logic, and amplifiers for detectors with many channels.[4)] For the connection between the DSSDs and GET, flexible-printed-circuit (FPC) connectors and circuits for the separation of signals from a DC bias are used. A new scattering chamber housing was prepared as well.

The performance of the GET system to readout the signal from the TTT2 was tested at RIKEN. The test bench consisted of one TTT2 and a standard ^{241}Am α-source installed inside the new TiNA chamber. The

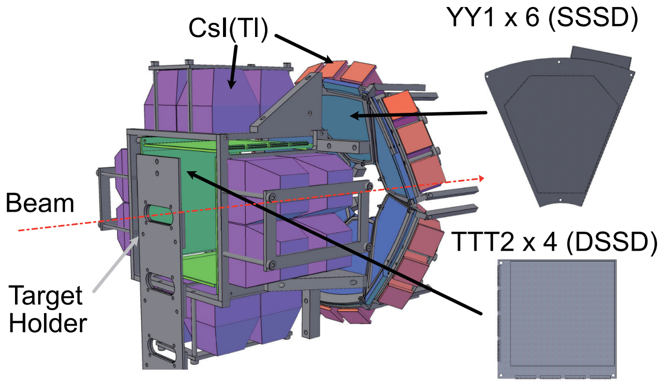

Fig. 1. Schematic drawing of TiNA after upgrade. The YY1-type SSDs and CsI(Tl) crystals of original TiNA are colored with blue and red, respectively. The new TTT2-type DSSDs and CsI(Tl) crystals are colored with green and purple, respectively.

detector was fully depleted at −55 V. The GET system consisted of an application-specific integrated circuit (ASIC) and ADC (AsAd) board connected to a total of 256 strips and a reduced version of the Concentration Board (rCoBo). The system was triggered by an internal multiplicity signal of rCoBo. A pulse-shape analysis is performed on the GET digitized signal to extract the energy of particle hits. The resolution obtained on the ^{241}Am α-spectrum is 28 keV (FWHM) for the 5.485 MeV peak. More tests have been performed with the full system using 4 AsAd boards connected to a normal CoBo. It yielded similar results.

In conclusion, the TiNA array was upgraded by integrating new DSSDs, CsI detectors, and the GET system. The performance was tested using a standard α-source. The results demonstrate the high resolution capabilities allowed by the new design and electronic circuit. This resolution was used to simulate the ^{50}Ca(d,p) reaction. The overall excitation energy resolution is less than 150 keV in σ, which is within the experiment specification. The full system of TiNA will be tested in-beam at the Tandem accelerator of the University of Kyushu in January 2021.

References
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