TINA - a silicon tracker for transfer reactions

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Transfer reactions are powerful tools in nuclear physics to study the structure of atomic nuclei. In (d, p) transfer, for instance, one neutron is added to a nucleus populating a single-particle orbital. Respective measurements reveal important information about the shell structure, such as the appearance of closed shells (magic numbers) in exotic nuclear matter.[1)]

The recently commissioned OEDO beamline[2)] of CNS and RIKEN can provide beams with the necessary intensities at low energies (10–20 MeV/nucleon), offering experimental access to regions of the nuclear chart that were hitherto inaccessible for (d, p) studies.

To utilize OEDO for transfer reactions, the silicon detector setup called TINA has been developed and successfully used in two experiments. TINA is a joint project of CNS, RCNP Osaka, and RIKEN Nishina Center. It is designed for the position and energy measurements of recoiling light particles (protons) from transfer reactions in inverse kinematics.

The first (existing) version of TINA is shown in Fig. 1. It consists of six telescopes, each with a YY1-type silicon strip and CsI detectors. It has been used at Kyushu University Tandem Accelerator and at the OEDO facility. At Kyushu, a ^{12}C beam impinged on a deuterated Ti target.[3)] The obtained kinematics curve (energy of YY1 vs. lab angle) of the recoiling light particles is shown in Fig. 2. Deuterons from elastic scattering as well as protons from transfer to the ground state and some excited states were observed.

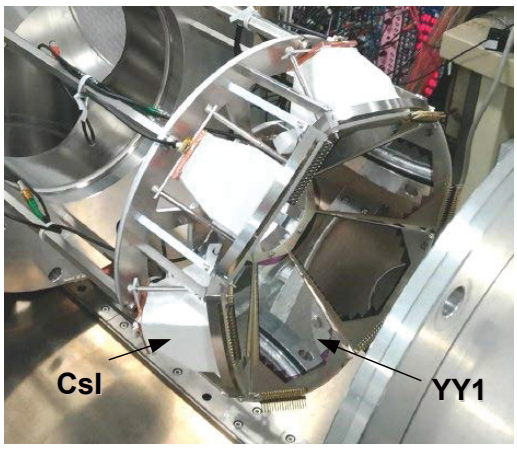

Fig. 1. Photograph of TINA during use in the OEDO Day 0 experiment.

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In the OEDO Day 0 experiment in November 2017, ^{77,79}Se beams were energy-degraded and irradiated onto a CD_2 target. The light recoiling particle identification (PID) plot obtained with TINA is shown in Fig. 3, where the energy loss measured with the silicon detectors are plotted against the remaining energy deposited in the CsI crystals. Protons, deuterons, and tritons can clearly be distiguished.

An upgrade to implement highly granular DSSD detectors with GET readout electronics[4)] is ongoing. The upgraded TINA will be well-suited for future transfer studies at OEDO. TINA is also compact enough to be coupled with 4π γ-ray detector arrays.

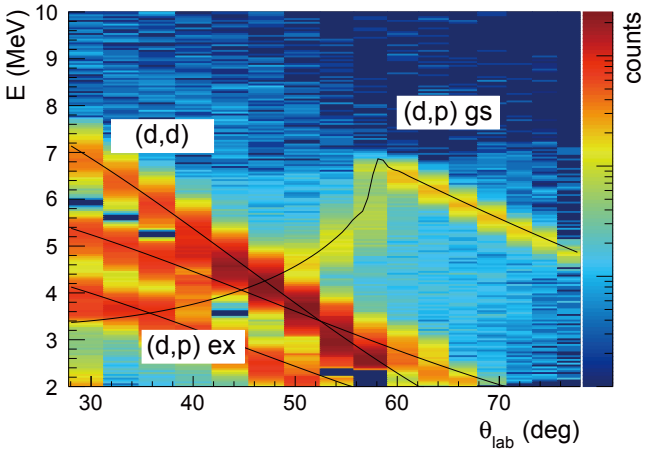

Fig. 2. Kinematics plot of light recoiling particles obtained with a ^{12}C beam on a deuterated target.

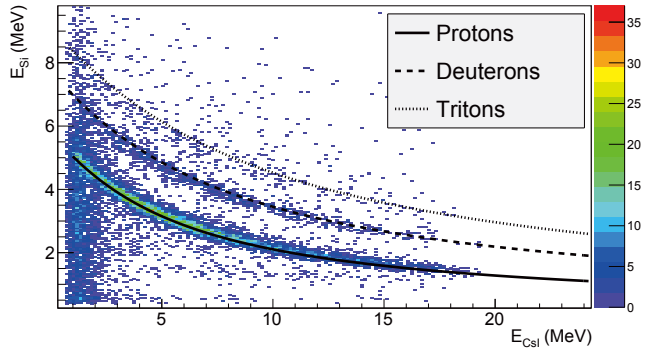

Fig. 3. PID plot for light reaction products obtained in the OEDO Day 0 experiment.

References

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