Breakup of ^{9}C studied at SAMURAI

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During the NP1412-SAMURAI29R1 experiment, the ^{9}C breakup reaction into ^8B+p was studied by Coulomb dissociation and nuclear breakup. By using the invariant mass technique and the detailed balance theorem,[1)] it is possible to determine the reaction cross section for the astrophysical process ^{8}B(p, γ)^{9}C using two alternative indirect methods: Coulomb dissociation[1)] and by applying the ANC technique for nuclear breakup (NB).[2)]

The radiative proton capture ^{8}B(p, γ)^{9}C is being investigated due to its astrophysical importance as a possible bypass of the 3α-process leading to the CNO cycle in low metallicity massive stars, by a sequence of protons and alpha capture reactions on nuclei close to the proton drip line.[3)] From the previous experiments, a large spread of results was obtained for the determined astrophysical S_{18} factor (see Ref. 4)), and hence a new set of accurate measurements is necessary.

The experiment was performed in RIKEN at the RIBF facility during the SAMURAI Oxygen18 campaign in the spring of 2018, as part of the HI-p program. The primary beam ^{18}O at 230 AMeV hit a Be production target. The ^{9}C secondary beam, having intensities up to $4.7 \cdot 10^4$ pps, was separated by using the two-stage separator BigRIPS and delivered to the SAMURAI area. Fig. 1 shows the PID of the beam at the entrance of the SAMURAI area. The aim of the experiment is to perform inclusive and exclusive measurements of the ^{9}C breakup reaction products using a dedicated detection system set at the superconducting magnetic spectrometer SAMURAI. For the study of ^{9}C breakup in a nuclear field, a natural carbon target (425 μm thick) was used, and for the Coulomb dissociation measurement, we set a Pb target (150 μm thick). The detection system used during the experiment comprised two scintillator detectors (SBT1&2) for beam PID (in combination with the BigRIPS scintillators) and for triggering the data acquisition system. Two drift chambers (BDC1&2) were used to measure the position and angle of the beam. The target was followed by 4 Si detectors to track the reaction products along with another drift chamber (FDC0). Two plastic scintillators (HODF&HODP) were placed behind the SAMURAI exit window to measure the energy loss and the time of flight for particle identification. Finally, two proton drift chambers (PDC1&2) were used for magnetic rigidity analysis of the emitted protons.

The tracking system mentioned above is made of 4 position sensitive Si detectors (GLAST) with a large active area (87.5×87.5 mm^2) and high granularity (each silicon detector has 128 strips), which were arranged in two pairs, an placed downstream of the reaction target.

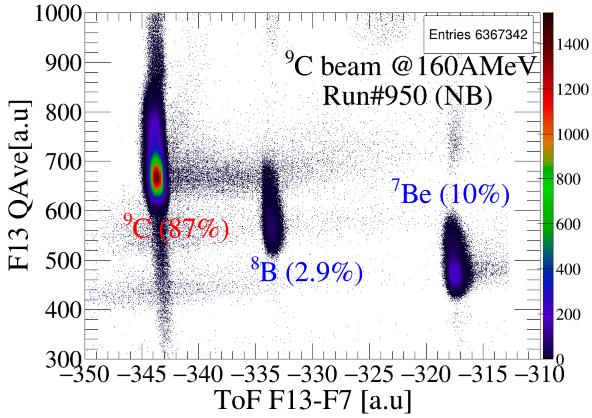

Fig. 1. The purity and PID of the secondary beam.

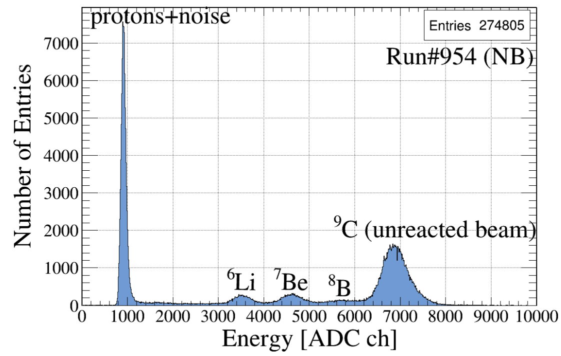

Fig. 2. Signals of the reaction products in the Si system.

This system was newly introduced for all 4 HI-p experiments. In order to simultaneously track the protons and heavy fragments, the signals from the Si detectors were processed with new Dual Gain Preamplifiers (DGP) designed at RIKEN and packed at ATOMKI. A high dynamic range was assured for the entire system. Thus, the system could measure the energy loss of the protons (around 200 keV) in coincidence with the heavy fragments (up to 600 MeV). The signals from the DGP were fed into the ASIC system based on HINP16 chips.[5)] Two Motherboards (MB) with 16 slots each for connecting 16 HINP boards, each of them having 2 ASIC chips, processed a total of 1024 output signals from the silicon detectors. The PID of the reaction products in the Si detectors can be seen in Fig. 2.

The Si system was used in the beam for the first time. It worked well, and in combination with the existing detection systems, assured the experimental goals presented in the submitted proposal. The data analysis is in progress.

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