A silicon vertex tracker for the ^{8}He$(p, p\alpha)4n$ reaction

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The SAMURAI19[1] experiment at the RIKEN RIBF aimed at producing $4n$ resonances with $(p, p\alpha)$ quasi-free scattering of a 156 AMeV ^{8}He beam at large momentum transfer. A 5 cm thick liquid-hydrogen target (MINOS) with a diameter of 4 cm was used. A luminosity of $\sim 10^{28}$ cm^{-2}s^{-1} was achieved. To obtain the $4n$ energy, the momenta of all outgoing particles were measured with high accuracy and the particle energy loss in the target was determined with essential vertex reconstruction. Reaction vertex positions in the target were determined by a newly developed silicon vertex tracker by TUM and RIKEN, which consists of six single sided silicon detector layers with an active area of $\sim$ 5 x 8 cm^2 and a thickness and pitch size of 100 µm each.[2] As shown in Fig. 1 the detectors are grouped in three units for X and Y determination at distances of 0.6, 12.6 and 24.6 cm with respect to the end of the target container in a vacuum chamber. The target container is thermally shielded from the first detector layer by a 2 um thick aluminized Mylar foil.

All 3708 detector segments are individually read out by the ASIC chip APV25S1.[3] The digital data are collected by a TRB3 board developed by GSI, which can handle trigger rates of up to 50 kHz, and they are time stamped for synchronization with the BABIRL-DAQ used for the other parts of the experiment.

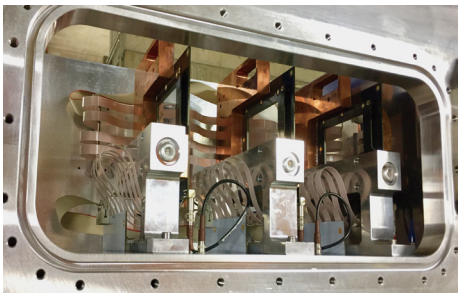

Fig. 1. Installed detectors in the reaction chamber.

With a typical equivalent noise charge of $\sim$ 7 keV, a single channel energy threshold of 38 keV was used to reduce event multiplicities. This is a critical parameter as the average energy loss of the proton from the reaction is $\sim$ 60 keV per detector only. As the ASIC's analogue range is $\sim$ 8 MIPs (Minimum ionizing particle), signals from α-particles may exceed the range. A sophisticated pulse-shape algorithm can separate α-particles from the reaction from the ^{8}He beam particles hitting the detectors at a high rate. From the redundant position measurement of 3 points per track we deduce an average transverse vertex resolution of $\sigma_{x,y} \sim 60$ µm. Owing to the small opening angle of charged reaction residues of interest the resolution along the beam line is $\sigma_z \sim 1$ mm without straggling. As next steps we will further investigate the detection efficiency, the tracking towards the SAMURAI detectors, hit multiplicities and transverse momenta.

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