Track reconstruction of recoil particles in CAT-S at RIBF113: ^{132}Sn(d,d') measurement

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The equation of state (EoS) of nuclear matter not only governs the femto-scale quantum many-body system, namely nuclei, but also plays an important role in the structure of neutron stars and in supernova phenomena. In particular, the EoS of isospin asymmetric nuclear matter has attracted much interest from the viewpoint of the existence of heavy neutron stars. The asymmetric term of incompressibility, K_τ, can be a benchmark for various EoSs because it can be directly deduced from the energies of the isoscalar giant monopole resonance (ISGMR) measured along an isotopic chain, such as tin isotopes.[1)] The present value of K_τ is -550 ± 100 MeV and its error is larger than those of other parameters of the EoS. In order to improve the K_τ value, the measurement on the isotopic chain should be extended to unstable nuclei. A doubly magic tin isotope, ^{132}Sn, has been chosen as a flagship for the measurements of unstable tin isotopes because of its large isospin asymmetry and double magic nature. The measurement of deuterium inelastic scattering off ^{132}Sn was performed at RIBF in RIKEN. The typical intensities of the secondary beam at F3 and F7 were 8.5×10^5 and 3.2×10^5 particles per second, respectively. The main components of the secondary beam were ^{132}Sn, ^{133}Sb, and ^{134}Te with purities of 21%, 46%, and 25% at F7, respectively.

The excitation energy and scattering angle in the center-of-mass frame are extracted by means of missing-mass spectroscopy, for which the range and angle of the low-energy recoil deuteron must be measured. In order to measure such low-energy recoils, a gaseous active target system CAT-S[2)] with 0.4-atm deuterium gas has been employed as target and detector simultaneously. In this paper, we report the present status of track reconstruction for recoil particles stopping in CAT-S. Before the track reconstruction, a cluster of hits as a candidate track is searched for. The detailed procedure of track finding was reported by Tokieda *et al.*[3)] Here, we focus on the energy calibration of each pad and track reconstruction for the hit cluster found by the track-finding process.

CAT-S has an active are of approximately 10×10-cm^2. Primary electrons produced by energy deposition along the trajectory of the recoil particle drift toward the THGEM and readout pad. The drift velocity is currently assumed to be 1 cm/μs according to the simulation using Garfield for 0.4-atm deuterium gas with an electric field of 1 kV/cm/atm. The lateral diffusion coefficient is assumed to be 0.04 cm$^{1/2}$, which yields a charge spreading of 2 mm in one standard deviation for a drift length of 25 cm. In the procedure of track reconstruction, the charge spreading should be taken into account.

The track reconstruction is performed in a two-fold manner. First, the track in the plane defined by the drift direction (Y) and axis perpendicular to beam (X) is deduced by using a linear fit of position in this plane. The position along the drift direction is calculated from the leading-edge timing multiplied by the drift velocity. The position along the X-axis is the centroid of each pad. Second, the track in the plane defined by the beam axis (Z) and the X-axis is reconstracted by fitting the calculated charges to the measured charges by taking the diffusion and the resolution into account. The second part of track reconstruction requires energy calibration. A set of trial calibration parameters is used to deduce the realistic energy calibration parameter after comparing the measured charge with the one calculated from the best-fit track. The charge resolution can be estimated from the distribution of the difference between the measured and calculated charge. The typical charge resolution after correction is less than 10%. The analyses for particle identification, improvement of track reconstruction using iteration, merging beam particle identification and so on are in progress.

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