Study on the impact parameter dependence on the trigger efficiency for the SπRIT experiment

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The main objective of the SAMURAI Pion-Reconstruction and Ion-Tracker (SπRIT) project is to place a constraint on the density dependence of the nuclear equation of state (EOS). In particular, the isospin asymmetric term of the EOS, which is called symmetry energy, plays an important role not only in unstable nuclei but also in neutron stars. Currently, the density dependence of symmetry energy is poorly constrained at around twice the saturation density.[1] It is proposed that charged π mesons from heavy-ion (HI) collisions at energies of several hundreds of MeV/nucleon could be a useful probe for the symmetry energy at supra-saturation densities.[2] At intermediate energies, π mesons are produced from the decay of Δ resonance states, which are excited from the nucleon-nucleon (NN) scattering in HI collisions. The π meson production cross-section depends on the NN scattering cross-section, which depends on the impact parameter. Therefore, central collisions will produce higher statistics of π mesons, and will be a region of interest in this experiment.

In the spring of 2016, we performed an experiment at RIBF with collisions between various Sn isotopes at 270 MeV/nucleon.[3] The SπRIT-TPC[4] inside the SAMURAI spectrometer was used to detect the charged particles. To provide a trigger signal focusing on the central collision, a combination of two kinds of detectors—KATANA veto[5] and Kyoto multiplicity array[6]—was utilized. It consisted of an array of plastic paddles and Multi-Pixel Photon Counter for use in the magnetic field of 0.5 T. The KATANA veto was placed downstream from the SπRIT-TPC, enabling us to veto peripheral collisions, which involve high-Z spectator particles. The Kyoto multiplicity array covered both sides of the SπRIT-TPC to detect central collisions by setting a threshold on the sideward-moving charged particle multiplicity. For regular data acquisition runs, the trigger condition required Z less than 20 in the KATANA veto and a multiplicity greater than four in the Kyoto multiplicity array.

The dependece of impact parameter on the trigger efficiency in regular runs has been studied by using Monte Carlo simulation with event generators. As a HI collision generator, JQMD-2.0 in PHITS[7] Ver. 2.880 and UrQMD[8] Ver. 3.4 were used to reproduce ^{132}Sn+^{124}Sn reactions at 270 MeV/nucleon. Figure 1 shows the trigger efficiency curve as a function of the impact parameter. For both models, about 100% trigger efficiency was obtained for central collisions with impact parameters of 0–2 fm. However, significant model dependence is found in semi-central collisions with impact parameters of 5–9 fm. For a more proper model parametrization, it would be necessary to compare the experimental observables with further simulations.

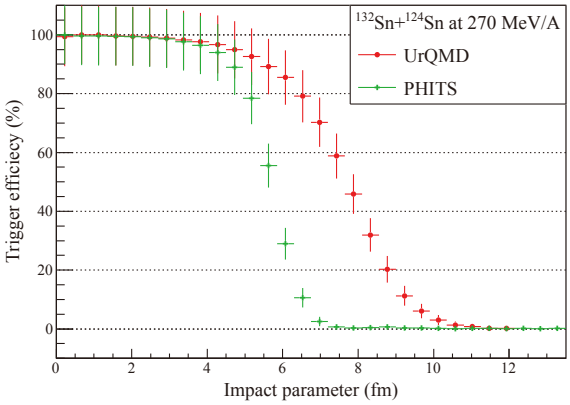

Fig. 1. Trigger efficiency curves as a function of impact parameter in the regular runs.

Further analysis on the impact parameter determination using the reconstructed track in SπRIT-TPC is now under way.

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