Simulation study of a trigger scintillator array for the SPiRIT experiment

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The SPiRIT (SAMURAI Pion Reconstruction Ion Tracker) experiment was performed at RIBF using unstable heavy-ion beams with various N/Z ratios. The aim of the experiment was to determine the nuclear equation of state (EOS) by investigating the production ratio of π^- to π^+ in heavy-ion collisions. We designed a scintillator array to trigger central collision events by using a detailed detector simulation, which was performed using the GEANT4 toolkit with the Monte-Carlo transport code PHITS; the PHITS is used as an event generator of heavy-ion collisions.

First, we evaluated charged-particle multiplicity distribution in heavey-ion collisions to confirm the validity of the simulation by comparing the simulated distribution to the measured distribution in the H292 experiment. The H292 experiment was performed with 400 AMeV ^{132}Xe beam on CsI target at HIMAC in March 2013. In H292, a multiplicity counter, which consisted of 60 plastic scintillators, was used to trigger central collision events. By constructing the same setup of H292 in the simulation, we evaluated the charged-particle multiplicity distribution as shown in Fig. 1. The obtained distribution reproduces the experimental result well; in particular, the multiplicities of more than 6 show good agreement.

Then, we examined geometrical configuration of the trigger scintillator array for the SPiRIT experiment to maximize geometrical acceptance for the central collision events. In the experiment we used two sets of trigger arrays located just downstream of the SPiRIT TPC. Here, we assumed scintillator arrays with size 1200 mm (horizontal) × 400 mm (vertical) × 10 mm (thickness) segmented into eight units vertically. Figure 2 shows the obtained acceptance as a function of the centrality in 300 AMeV ^{124}Sn + ^{124}Sn collisions when the trigger scintillator arrays were installed to cover the polar angle ranges of $-40 < \theta < -20$ and $20 < \theta < 40$ degrees. In this configuration, the trigger array can accumulate the central events with more than 30% acceptance in the region of the 0 – 60% centrality, which satisfies the experimental requirement. We also evaluated the charged-particle multiplicity of the trigger array and found that we can precisely investigate the production ratio of π^- to π^+ with track information reconstructed by the SPiRIT TPC.

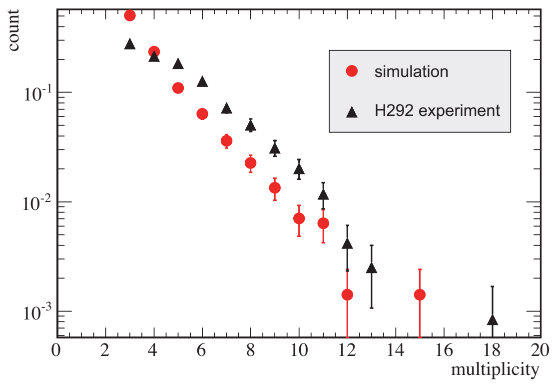

Fig. 1. Comparison of charged-particle multiplicity distribution between the simulation and the H292 experiment, with multiplicities of more than 2. The simulated distribution is normalized to the experimental yield.

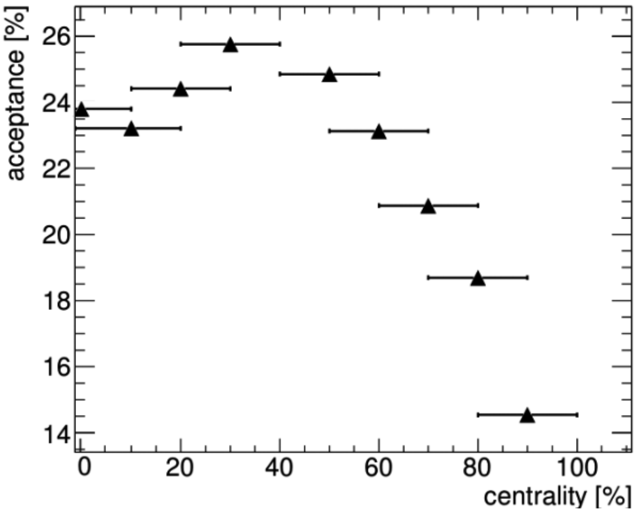

Fig. 2. Acceptance of the trigger scintillator array as a function of the centrality in 300 AMeV ^{124}Sn + ^{124}Sn collisions when the trigger scintillator arrays were installed to cover the polar angles ranges of $-40 < \theta < -20$ and $20 < \theta < 40$ degrees.

References
1) Bao-An Li, Nucl. Phys. A **708**, (2002) 365.
2) M. B. Tsang et al., Phys. Rev. C **86**, 015803 (2012).

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