Proton-proton correlation functions using the upgraded FAUST array

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Proton-proton correlation functions have been predicted to be sensitive to the asymmetry energy in the nuclear equation of state using transport simulations [1]. As detailed in previous annual reports [2-4], position-sensitive Dual-Axis Dual-Lateral (DADL) Si detectors [5] were implemented as the dE detectors in the Forward Array Using Silicon Technology (FAUST) [6]. This setup was used to collect light-charged particle (LCP) data in four heavy-ion reactions: ^{40}Ca+^{58}Ni at 40 MeV/nucleon, ^{40}Ar+^{58}Fe at 40 and 30 MeV/nucleon, ^{40}Ar+^{70}Zn at 30 MeV/nucleon to extract proton-proton correlation functions and compare to Boltzmann-Uehling-Uhlenbeck transport simulations (pBUU).

Proton-proton correlation functions were extracted from experimentally measured proton pairs chosen to have been emitted early in the collision (momentum of the proton pair>250 MeV/c) and from central collisions (event transverse momentum>180 MeV/c). Both of the cuts are necessary in order to draw out the proton-proton interaction peak at 20 MeV/c. The proton-proton correlation functions are shown in Fig. 1. The resolution and efficiency at low q_{Rel} of FAUST achieved in this experiment is

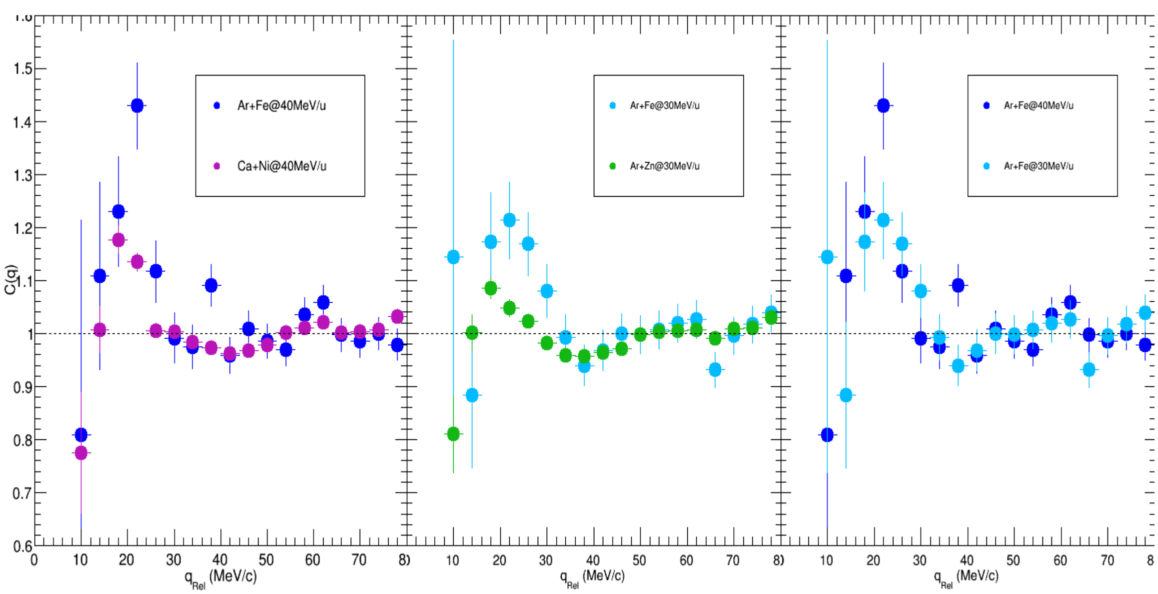

FIG. 1. Experimental proton-proton correlation functions extracted from, from left to right: the 30 MeV/nucleon systems (Ar+Zn green, Ar+Fe cyan), 40 MeV/nucleon systems (Ca+Ni purple, Ar+Fe blue), and the Ar+Fe systems at 40 MeV/nucleon (blue) and 30 MeV/nucleon (cyan). Figure from [7].

sufficient to extract light charged particle correlation functions, particularly proton-proton correlation functions, which was the goal of this undertaking. Other light-charged particle correlation functions are shown in [7]. The four systems included in this analysis have sufficient data to consider the ordering of the strength of the proton-proton correlation functions when varying system (asymmetry and size) and beam energy. The four systems were compared in three sets: Varying the system at 40 MeV/nucleon, varying the system at an energy of 30 MeV/nucleon, and changing the beam energy for the same system. In the 40 MeV/nucleon case, the more neutron-rich system has a stronger correlation function, while in the 30 MeV/nucleon case, the less neutron-rich system has a stronger correlation function, which may be because it has fewer overall nucleons. The correlation functions extracted for the same system at two different beam energies are within error bars.

Correlation functions were also extracted from pBUU, using three different parametrizations of the asymmetry energy by varying the value of γ. The correlation functions from pBUU showed no dependence on the asymmetry energy (varied by varying γ) at low impact parameter selected for early emitted (last collision before 100 fm/c) protons. All three parametrizations are shown in Fig. 2 for the Ar+Zn at 30 MeV/nucleon reactions. The different parametrizations for the other three systems were also indistinguishable. The results from the transport simulations were therefore inconclusive when compared to the experimental correlation functions.

In order to extract this information, the angular resolution of the FAUST array was enhanced

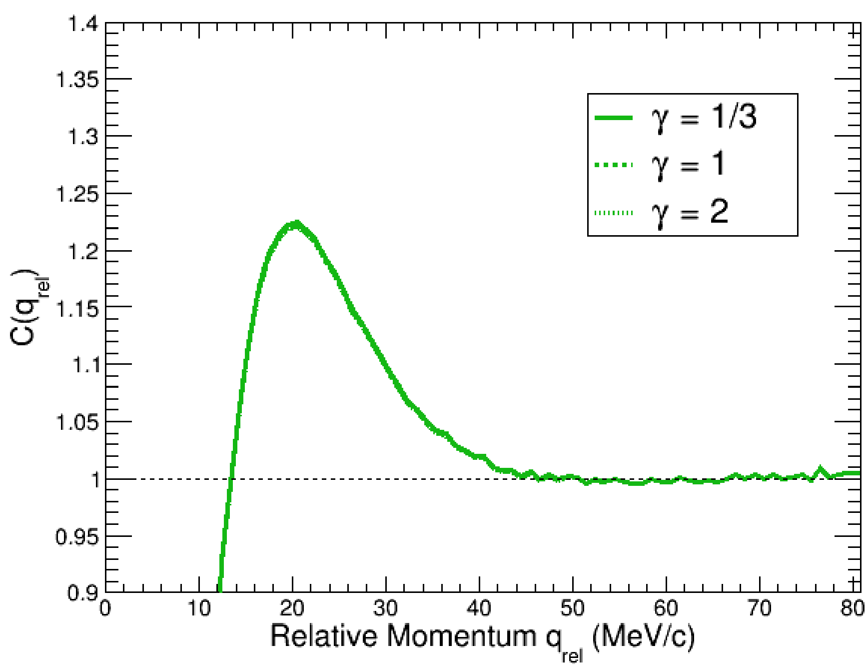

FIG. 2. Proton-proton correlation functions extracted from pBUU simulations using three different parametrizations of the asymmetry energy, denoted by γ. These three parametrizations result in indistinguishable proton-proton correlation functions for this system, Ar+Zn at 30 MeV/nucleon.

significantly by using a new style of position-sensitive DADL silicon detectors in every Si-CsI telescope. The new position-sensitive configuration along with the infrastructure established in this project for running in this mode was used for the first time in this campaign. The slotted mask, designed for use with the FAUST, has appropriately sized slits to verify the position calibration. The upgraded configuration has already been used in a subsequent experiment.

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