Experimental correlation function using FAUST upgrade

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The proton-proton correlation function has been shown to be sensitive to the proton-neutron asymmetry of an excited quasi-projectile [1]. In the past, correlation functions have been examined in transport models such as the iBUU model[1]. In this work, Constrained Molecular Dynamics (CoMD) [2] is used to simulate nucleus-nucleus reactions, and construct pp correlation functions for 30 MeV/nucleon ^{48}Ca+^{64}Ni and ^{40}Ca+^{58}Ni reactions.

Proton-proton correlation functions from CoMD using two asymmetry energy implementations each for both systems (^{48}Ca+^{64}Ni and ^{40}Ca+^{58}Ni events), were examined. The basic shape of the correlation functions extracted is similar, because all impact parameters and total momenta of proton pairs were used. All have a ratio of correlated-to-uncorrelated around one at q_{Rel} above 60 MeV/c. The bump in the correlation function at a relative momentum of about 20 MeV/c is characteristic of attractive final-state pp interactions [3,4]. However, the softer equation of state for both the n-rich and n-poor systems exhibits a larger bump around 20 MeV/c, indicating more correlated proton pairs, overall. This effect will need to be disentangled from the density in the future, perhaps by more stringent source cuts on the violence of the collision. The correlation functions extracted from the super-stiff equation of state exhibit more anticorrelation at the lowest relative momenta.

Characteristic features of known correlation functions (the bump from pp interactions and the dip from Pauli blocking) can be reproduced by CoMD. Some difference exists in the shape of the correlation functions between those obtained from different formulations of the density-dependences of the asymmetry energy in CoMD

Further investigation into the correlation function extracted from the ^{40}Ca+^{58}Ni reaction with different density- dependences of the asymmetry energy in CoMD, at 45 MeV/A, is planned, along with an analysis on iBUU code. For comparison of experimental with simulated results, a software representation of the geometric and energy acceptance of the Forward Array Using Silicon Technology (FAUST) [5] will be used. The same data analysis performed upon the experimental results can then be compared to the molecular dynamics and transport model simulations.

Proton-proton correlation functions for ^{40}Ca+^{58}Ni will be measured experimentally at the Texas A&M Cyclotron Institute to be compared to CoMD and iBUU results. FAUST will be used to detect the free protons and other charged particles for this project. FAUST currently consists of sixty-eight 2x2cm 300 μm thick Si backed by CsI(Tl)/PD detectors, arranged to geometrically accept the particles originating from the QP [5] . The array has 89.7 % geometric coverage from 2.3º to 33.6º [5] .

In interferometry, a precise knowledge of the point of detection of the particles is essential, so improved angular resolution is of paramount importance when measuring a correlation function for a reaction [6]. In order to increase the angular resolution of charged-particle detection in the upcoming experiment, an upgrade of the array is planned using Dual-Axis Dual-Lateral (DADL) Si detectors. The

DADLs have uniform resistance across the front and back of the detectors and use charge-splitting to determine the position of a detected particle to within 200 μm [7].

Fig. 1 schematically shows the equipotential lines on the surface of a DADL detector. Both electrons and “holes” set in motion by incident radiation generate signal. The uniform potential and resistance over the face of the detector, along with the reverse bias on the p-n diode, allow the holes or electrons to be collected at the opposite edges of the face of the detector. The holes on the back of the detector split proportionally to the Back 1 and Back 2 signals, while the electrons go to the front, split proportional to the relative left-right position of the detected ion. These four signals allow the position of a fragment to be determined. Guard rings help to keep the potential uniform across the entire surface of the detector [7].

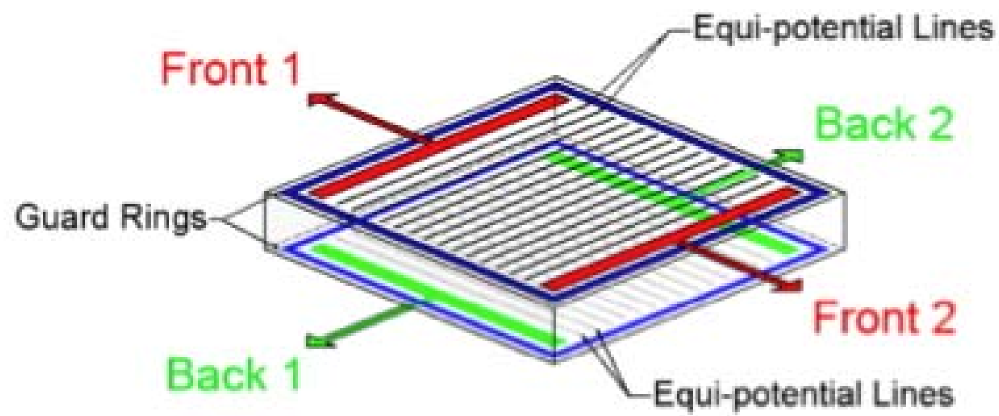

FIG. 1. Schematic of DADL, showing the equipotential lines on the uniformly resistive surface, which allows position to be determined by charge splitting.

The additional signals on each Si-CsI telescope will result in an 150% increase in the number of channels processed, so Application-Specific Integrated Circuit (ASIC) Heavy Ion Nuclear Physic (HINP) chip electronics will be used in order to deal with the increased number of signals. The addition of the two signals from the fronts or backs allows the energy of the incident particle to be determined. After experimentally gain-matching the signals generated by the uniform resistance of the detector, the ^{228}Th α spectrum in Fig. 2 was obtained. The energy resolution of the 8.785 MeV alpha peak is 1.4%. The FAUST array in its current configuration with the Quadrupole Triplet will be tested and run in-beam in spring and summer 2013, the upgrade to DADL detectors will follow this campaign.

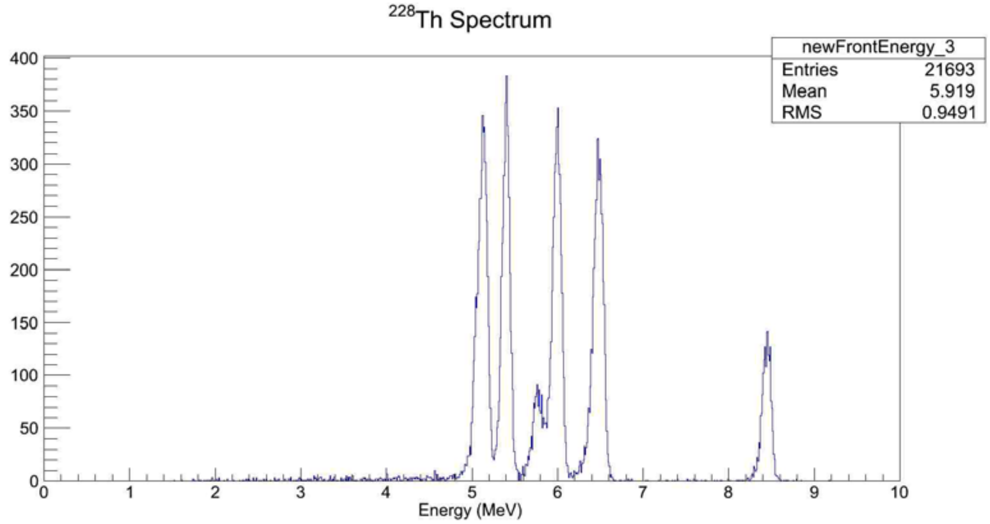

FIG. 2. Thorium-228 spectrum obtained from gain-matching process of a representative DADL detector.

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