Reconstructed quasi-projectile source distributions as a probe of the nuclear equation of state

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Products from the reaction of 45 MeV/A beams of ^{32,36}S on targets of ^{112,124}Sn were measured with the Forward Array Using Silicon Technology (FAUST) [1]. Charged particle identification and energy calibration of the array have been completed [2]. The design of the FAUST Array selects heavily against particles emitted from a target like source. For peripheral reactions, this allows for relatively straightforward definition of projectile like sources based on the total charge collected during a given event. For the investigation discussed here, projectile-like sources have been defined by selecting for events where the sum collected charge is equal to that of the incident sulfur beam (Z=16). Accepted events also must also be composed only of particles identified in both charge and mass. Given this event selection, quasi-projectile distributions are presented in terms of ΔN_{app} as defined below.

$$\Delta N_{app} = A_{beam} - \sum_{i}^{CP_{mult}} A_{frag,\,i} \text{ for events where } Z_{beam} = \sum_{i}^{CP_{mult}} Z_{frag,\,i}$$

Calculations have suggested that the nuclear equation of state provides a measurable driving force, increasing the rate of isospin equilibration between peripheral interacting nuclei of differing N/Z [3]. This implies that equation-of-state information may be gleaned from comparison of these reconstructed quasi-projectile distributions by varying the relative isospin asymmetry between the target

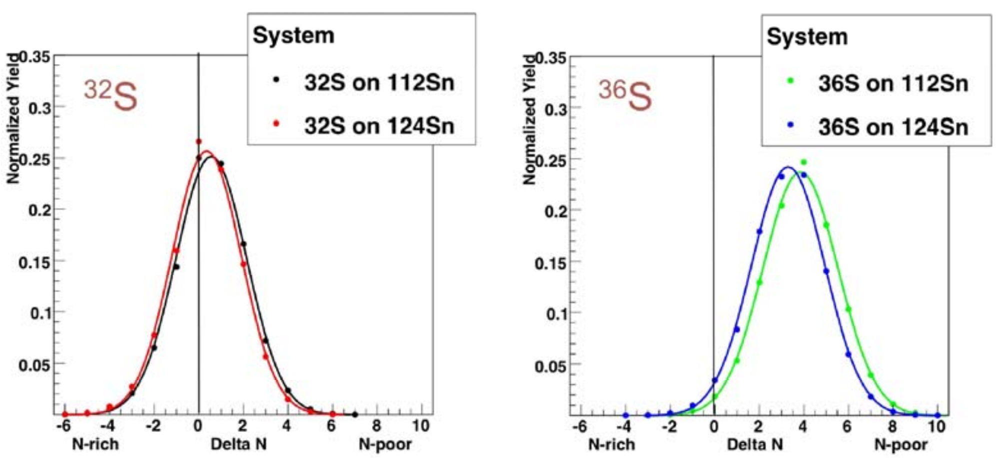

FIG. 1. ΔN distributions plotted to compare systems with a common beam. A Gaussian distribution has been fit to the data to increase readability. Notice that in both cases the distribution corresponding to the system with a larger isospin asymmetry between the target and projectile is more neutron rich. Statistical error bars are plotted.

and projectile. We would then expect the mean value of ΔN_{app} to decrease with increasing difference in asymmetry between the target and projectile. This is observed in the data when comparing between systems with the same incident beam (but different targets) as shown in Fig. 1. Table I shows the same trend numerically. In both plots, the system with the ^{124}Sn target has a larger difference in N/Z between target and projectile, and in both cases the mean value of the quasi-projectile distribution is reduced (meaning the distribution is on average more neutron rich). Comparison between systems with a common target (but different beam particles) should also show this dependence. However, the production of unbound neutrons from the quasi-projectile sources would be expected to differ greatly between systems with a ^{36}S beam versus a ^{32}S beam. Since the reconstructed quasi-projectile distributions would be unequally affected by this difference in production, any difference observed between two systems sharing a common beam (but differing targets) may not accurately represent the actual difference in neutron richness of the two quasi-projectile distributions.

TABLE I. Statistics for the Gaussian fits to the ΔN distributions in Figure 1. The error quoted after each value corresponds to the error in the fit of the Gaussian distribution to the experimental points.

System	Mean	SD
^{32}S + ^{112}Sn	0.559 (4.7e-4)	1.580 (3.74e-3)
^{32}S + ^{124}Sn	0.351 (4.27e-3)	1.545 (3.31e-3)
^{36}S + ^{112}Sn	3.845 (3.78e-3)	1.680 (2.84e-3)
^{36}S + ^{124}Sn	3.293 (4.52e-3)	1.640 (3.40e-3)

Currently work is under way to compare the above results with the Constrained Molecular Dynamics Model (CoMD) [4]. Multiple instances of the model utilizing different equations of state, specifically different values of the symmetry energy, are being analyzed to show a trend in the relative progress towards isospin equilibration for the pairs of systems discussed above. Once this trend is demonstrated, the experimental results will be used to constrain the range of symmetry potentials to those which best reproduce the experimental observable.

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