Preliminary Results from the Reactions $^{20}\text{Ne}$, $^{20}\text{Na}$ + Au, Ag Using the FAUST Detector Array


The construction of the FAUST detector array was completed in the early part of 1996. FAUST was designed for studying projectile fragmentation reactions [1-3]. Utilizing the MARS beamline at the Cyclotron facility, it is possible to produce and separate nuclei that are unstable and use them as projectiles for a secondary reaction. Bringing together the capabilities of both FAUST and MARS, projectile fragmentation reactions of isobaric beams can be studied. This makes possible the study of the Coulomb interaction in the multifragmentation process.

The first experiment was performed with the FAUST detector array situated at the end of MARS. The two beams selected for the experiment were $^{20}\text{Ne}$ and $^{20}\text{Na}$ with energies of 32MeV/nucleon and 31MeV/nucleon, respectively.

Preliminary results of the experiment are shown in figures 1 and 2. The first figure shows the angular distribution of fragments. Statistical error bars are plotted and are in most cases smaller than the size of the data point. For the heavier fragments, the large error is due to the lack of statistics at these angles. The uppermost line shows that the proton cross section varies little over the given angular range. As the charge increases, the cross section becomes a steeper function of the angle, with the heavier fragments being very forward peaked.

Figure 2 shows the total charge distributions for multiplicity cuts of 1 to 5. For the cut on multiplicity of 1, the distribution peaks at charge equal to 10, corresponding to the charge of the Ne beam. Statistical error bars are shown and as in the previous plot are often smaller than the size of the data point.

The distributions cut on multiplicities of 1 and 2 are not significantly different. The main difference is at a total charge of ten. For a multiplicity of two the charge ten peak is suppressed. This is due to the exponential suppression of the elastically scattered beam. A charge higher than that of the beam can occur for two possible reasons. Although improbable,
two beam particles could have occurred within the event time of the electronics. A more likely scenario is that they come from a more central event where the target nucleus breaks up. There is a lower total efficiency for higher multiplicity events. Even though FAUST is approximately 90% efficient, it is only 59% efficient for a multiplicity of five. This can be corrected by using a filter that properly accounts for the acceptance of FAUST.

In order to compare with model calculations, a software filter was written to represent FAUST. This filter includes the exact geometry of FAUST, as well as energy thresholds. Spurious effects, such as energy thresholds, angular cutoff and also multiple hits can be studied and eliminated.

Figure 3 represents the angular coverage as obtained with a Monte Carlo distribution of particles projected onto FAUST. The five rings of Si-Csl telescopes can be clearly seen. The shaded area shows the active surface area of each detector. Each detector in FAUST is physically square, but once projected in polar coordinates they have curved edges. The plot shown was obtained for a uniform distribution of particles in the rest frame of the laboratory.

References


Reaction Mechanisms at 47A MeV

J. Cibor, B. Xiao, K. Hagel, R. Wada, Y. Zhao, R. Alfaro, N. Marie, Z. Majka, J. Li, and J.B. Natowitz

In December 1996 and February 1997 the CsI ball and neutron ball were used together to carry out a series of measurements designed to probe the dynamics of the reactions induced by 47A MeV projectiles. By varying the projectile mass over a wide range we hope to be able to separate different sources of particle and fragment emission and to follow the competition of the principal de-excitation modes to high excitation energies where multifragmentation becomes a dominant decay mode.

In this first group of measurements we have used $^4$He, $^{12}$C, $^{22}$Ne, $^{40}$Ar and $^{64}$Zn projectiles incident on a variety of targets. For one set of measurements the target was $^{197}$Au. In another set target nuclei of decreasing mass ($^{120}$Sn to $^{89}$Y) were matched to projectiles of increasing mass in an attempt to produce excited composite nuclei (after pre-equilibrium emission) with A~125 in the most central collisions. By selecting the most violent collisions for each projectile-target combination we expect to isolate composite nuclei with excitation energies ranging from ~1 to ~9A MeV. As an indication of our ability to select the most violent collisions we show, in Figure 1 on-line plots of detected charged particle multiplicity vs detected neutron multiplicity for a series of reactions studied. We note that, even though the neutron ball detection efficiency was lower than normal as a result of geometric limitations imposed by matching the two detectors, a clear evolution of response from low to high total excitation is apparent as is the steady progression toward higher excitation with increasing projectile mass.

Figure 1. Plots of detected charged particle multiplicity vs detected neutron multiplicity for 47A MeV projectiles incident on different targets. For central collisions composite nuclei with A~125 are expected.