NIMROD

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The NIMROD detector system described in several previous reports[1,2,3] has continued significant production in three major campaigns over the past year. The device itself was in production mode and most of the detectors performed very well. In addition we are beginning an upgrade of the system. In the following we first summarize the experiments and reference the different analyses occuring. We then describe the planned upgrade and present the status.

NIMROD Experiments

The three major NIMROD campaigns occurred in April, September and November of the past year. For one set of analyses we studied the systems shown in table 1. The excitation energies and masses shown in the table are those estimated of the composite system after the pre-equilibrium phase of the reaction. As shown in the table, we have studied a large number of reactions spanning a wide range of masses and excitation energies. The various projectile-target combinations allow us to separate dynamical effects from thermal effects. These systems extend a study in which we performed a coalescence analysis[4] to study the properties of hot nuclei. The analysis of this data is ongoing and the status of this analysis is presented elsewhere in this report [5].

The systems shown in Table 2 were also explored in a separate study. The aim of the study is to investigate in detail an interplay of isospin degrees of freedom with reaction dynamics. Isotopically resolved intermediate mass fragments detected in NIMROD carry information on the N/Z ratio of the emitting source and when combined with global event observables allow the study of evolution of isospin during the collision. First results of the analysis, focused on the description of IMF sources, are given in reference [6].

NIMROD Upgrade

We are in the process of beginning an upgrade of NIMROD. This upgrade has the purpose of increasing the isotope resolution through the use of silicon detectors. To accomplish this, all NIMROD modules at angles less than 45^o will be instrumented with silicon detectors. Two modules in each ring will remain as "super telescopes". This will provide gas-Si-CsI coverage from 3.5^o to 45^o. which will allow isotope separation to Z=5 or 6 on these telescopes while continuing to have isotope separation to Z=10-11 in the "super telescopes".

In addition, the backward hemisphere of the ISiS[7] system from Indiana has been acquired to be used as the backward hemisphere of NIMROD. This system provides gas-Si-CsI coverage from 93^o to 166^o. We are in the process of designing the proper mating flanges as well as a set of CsI detectors which would be used to fill the gap between 45^o and 90^o.

Table 1: Systems performed for coalescence model analysis.

Reaction	Beam energy (MeV/u)	ε^* MeV/u	mass (amu)
$^{40}Ar + ^{92}Mo$	26	3.4	135
$^{40}Ar + ^{112}Sn$	40	4.4	129
$^{40}Ar + ^{27}Al$	47	5.1	47
$^{40}Ar + ^{48}Ti$	47		62
$^{40}Ar + ^{58}Ni$	47		69
$^{64}Zn + ^{197}Au$	47	5.8	231
$^{64}Zn + ^{48}Ti$	47	6.4	80
$^{64}Zn + ^{159}Tb$	47	6.3	190
$^{27}Al + ^{124}Sn$	55	4.4	133
$^{64}Zn + ^{92}Mo$	26	3.4	135
$^{64}Zn + ^{92}Mo$	35	4.8	126
$^{64}Zn + ^{92}Mo$	47	7	117
$^{22}Ne + ^{117}Sn$	26	2.2	133
$^{22}Ne + ^{117}Sn$	35	2.7	130
$^{22}Ne + ^{117}Sn$	47	3.5	127
$^{64}Zn + ^{197}Au$	26	3.2	247
$^{64}Zn + ^{197}Au$	15	1.6	254
$^{64}Zn + ^{197}Au$	35	4.2	240
$^{64}Zn + ^{92}Mo$	15	1.9	145
$^{64}Zn + ^{58}Ni$	15	1.6	110
$^{64}Zn + ^{58}Ni$	26	3.3	100
$^{64}Zn + ^{58}Ni$	35	4.3	91
$^{64}Zn + ^{58}Ni$	47	6.6	84
$^{54}Fe + ^{100}Mo$	35	4.6	129

Table 2. Systems performed for IMF source analysis.

Reaction	Beam energy (MeV/u)
$^{124}Xe + ^{112,124}Sn$	28
$^{124}Sn + ^{112,124}Sn$	28
$^{124}Sn + ^{28}Si$	28

Once this upgrade is complete, we will have gas-Si-CsI coverage for all angles between 3.5 ^{o}-45^o and 93 ^{o}-166^o. This will significantly enhance our capability for completely characterizing intermediate heavy ion reactions with low thresholds and significant mass identification over a wide range of angles.

The current status of the upgrade is that all silicon detectors as well as CAMAC shapers for the forward hemisphere have been delivered and tested. A set of ADC's for the forward hemisphere is on order. The ISiS system has been acquired and the design for the mating is nearly complete.

In conclusion, a large body of data has been acquired using NIMROD. These data are in the process of being analyzed. In addition, an upgrade to significantly enhance the capabilities is underway.

References

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