Experimental Equipment at RIA*

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The Rare Isotope Accelerator (RIA) will provide exciting new research opportunities in number of areas. These include the study of the nature of nucleonic matter, the origin of the elements and the tests of the standard model. To use the full capabilities of RIA beams, the experiments will face a number of new challenges. The beam intensity of RIA spans a much larger range compared to those of stable beams. The most intense beam will have an intensity of 10^{11} particle/sec, while the intensity of the most exotic beams, which can be studied, is about 1 particle/day. The beam energy will cover the range from near zero to 400 MeV/A. In addition, many of the reactions will be studied in "inverse kinematics", i.e. bombarding a lighter target with a heavier radioactive beam. In some cases the beams will have contaminants from other isobars, which are produced with higher yields and cannot be completely removed. The decay of the scattered radioactive beam particles will produce a high background counting rate in particle and gamma ray detectors.

For these reasons the experimental equipments at RIA has to fulfill additional requirements. For experiments with low-intensity beams, high efficiency detectors covering a large fraction of the full solid angle are needed. To handle high intensity beams and high background rate, segmented detector systems are required. The high beam energy and inverse kinematics in many of the experiments calls for detector with high position resolution to correct for the large kinematics or Doppler shifts. In order to select a particular reaction of interest in experiments with a large background, coincidence detection of several particles and gamma rays using different types of detector system is required.

Based on the physics requirements and broad discussions in the US research community, a preliminary list of experimental equipment has been developed [1,2]. For low energy experiments, the major equipment are a gamma-ray energy tracking array (GRETA), three recoil separators each optimized for studies of astrophysics, nuclei at drip lines, and heavy elements, a conventional and a large acceptance magnetic spectrograph. A number of large area detector arrays for charged particle and neutrons are also envisioned. Experiments using non-accelerated or stopped beams require atom and ion traps, a low temperature nuclear orientation facility, gamma-ray and particle detectors for decay spectroscopy. In addition, gas targets will be needed for many astrophysics experiments and the use of radioactive targets to extend the study of drip-line nuclei would be possible with a radioactive target facility. The essential equipment, for experiments using the fast fragmentation beams, includes a high-resolution fragment separator and a high-resolution magnetic spectrograph both with an 8 Tm bending power. A sweeper magnet and a large area neutron time-of-flight detector are needed for experiments involve weakly bound neutron-rich nuclei. For elastic, inelastic and transfer reactions, a large-area Silicon detector is needed for inverse kinematics studies. A number of experiments need a 4-pi charged-particle detector with broad dynamics range in particle energy and mass. A time projection chamber will be idea for these experiments.

A number of these equipments, such as GRETA and the large acceptance magnetic spectrograph with novel field configuration, require extensive research and development. Some of these experiments and developments have already started at the existing facilities. However, considerable efforts are needed to design and construct the detector systems required in order to fully exploit the opportunities available at RIA.

[1] Experimental Equipment for An Advanced ISOL Facility, ed. C. Baktash, I.Y. Lee and K.E. Rehm, LBNL-43460, March 1999.
[2] Scientific Opportunities with Fast Fragmentation Beams from the Rare Isotope Accelerator, NSCL MSU, March 2000.

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