HRIBF: Facility and Physics

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The HRIBF is a first-generation ISOL radioactive ion beam (RIB) facility that was developed to make use of the existing HHIRF accelerator complex at ORNL. The characteristics of the facility are defined and limited by these accelerators. Radioactive species are produced by beams of hydrogen and helium isotopes from the k=100 Oak Ridge Isochronous Cyclotron. The comparatively short range of the production beam, and consequent high power density in production targets, is a significant challenge to target system designers. Our post-accelerator is the world's largest tandem electrostatic machine. This limits us to the acceleration of negative ions, effectively eliminating atomic species that have been staple beams at ISOL facilities because they are readily transported out of ISOL targets (e.g., noble gasses). On the other hand, the tandem has many advantages, e.g., high-beam quality and ease of energy variation, that make it particularly suited for our nuclear structure and nuclear astrophysics research programs. Experiments with radioactive beams are almost invariably extremely challenging. With this in mind, we have devoted a large part of our effort to the development of a world-class suite of experimental instruments, specifically optimized for RIB science. This set of tools is one of the great strengths of the HRIBF.

The HRIBF beam development philosophy has been physics-driven, accepting that we will be unable to produce high intensities of the "easy" ISOL beams, and trying to maximize our contribution to the field in selected areas. We have achieved some notable successes. Our initial focus was on fluorine beams, based on the overwhelming interest of our astrophysics community in ^{17,18}F. Toward this end we developed novel target systems for the ^{16}O(d,n)^{17}F production reaction, based on thin (<10 μm), refractory oxide fibers, and a completely new concept in ion sources, the kinetic-ejection negative-ion source, that is by far the most efficient source in existence for production of negative fluorine ions. This production system formed the basis for a remarkably productive yearlong campaign of ^{17,18}F experiments. Highlights included a study of ^{17}F(p,p) reaction that was able to locate and measure the properties of a long-sought and astrophysically important 3^+ resonance in ^{18}Ne. The ORNL astrophysics group and their collaborators have also collected an impressive data set on the ^{17}F(p,α) excitation function, spanning the entire range of astrophysical interest with data of unprecedented quality, and carried out equally productive and valuable studies of ^{18}F(p,p) and ^{18}F(p,α). A search for two-proton decay from states in ^{18}Ne populated by ^{17}F+p produced clear evidence for this long-sought and exotic decay mode. Finally, a study of projectile breakup of ^{17}F on a Pb target was undertaken as part of a systematic program to investigate the physics of fusion with weakly bound projectiles.

We have devoted considerable effort to the development of optimized beam production systems for neutron-rich RIBs. We have successfully produced a broad range of such beams. For a time, we will be the only facility in the world capable of both producing neutron-rich RIBs and accelerating them to energies above the Coulomb barrier. We have recently begun to do physics with these unique beams, but there is enormous scope for improving beam intensities, as we bring to bear the level of effort and ingenuity our staff has brought to earlier beam development efforts.

This talk will provide a brief overview of the status of HRIBF, with enough historical background to indicate why the facility has some of the characteristics it has. A sampling of the accomplishments of the target, ion source, and beam development program will be reviewed, along with some of the exciting physics done with radioactive beams at HRIBF over the last two years. Finally, a brief discussion of the prospects for improving HRIBF during the decade that separates us from first beams at RIA will be presented.

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