Resonant Ionization Laser Ion Source

The purity of radioactive ion beams (RIB) is of crucial importance to many experiments. One of the laser based beam purification techniques being developed at HRIBF is resonant ionization laser ion source (RILIS). In a RILIS, ions of a selected isotope are produced by removing one electron, using laser radiation, via stepwise atomic resonant excitations and finally ionization in the last transition. Because each element has its own unique atomic energy levels, the resonant photo-ionization process can provide near 100% selectivity. Thus, RILISs promise significant improvement over conventional ion sources in generating pure RIBs. In FY2006 we made good progress in realizing a RILIS to extend the RIB beam capability at HRIBF.

- First prototype commercial Ti:Sapphire laser has been demonstrated to meet the specific requirements for a RILIS system. The commercial Ti:Sapphire laser is being jointly developed by HRIBF and Photonics Industries International, Inc, in Bohemia, New York. The final product is expected to be delivered in 2007.
- Mn and Fe ion beams are produced for the first time in a RILIS using Ti:Sapphire lasers.
- Simulation models for the measured temporal structures of laser generated ions have been developed. The simulation studies have revised our understanding of how the ions are confined and transported through the laser ions source, whish is very important in improving the design and performance of the RILIS.
- Measurements of the laser ion beam emittance demonstrate that RILIS provides the best beam quality (i.e., the smallest emittance) compared with the other ion sources used at HRIBF.

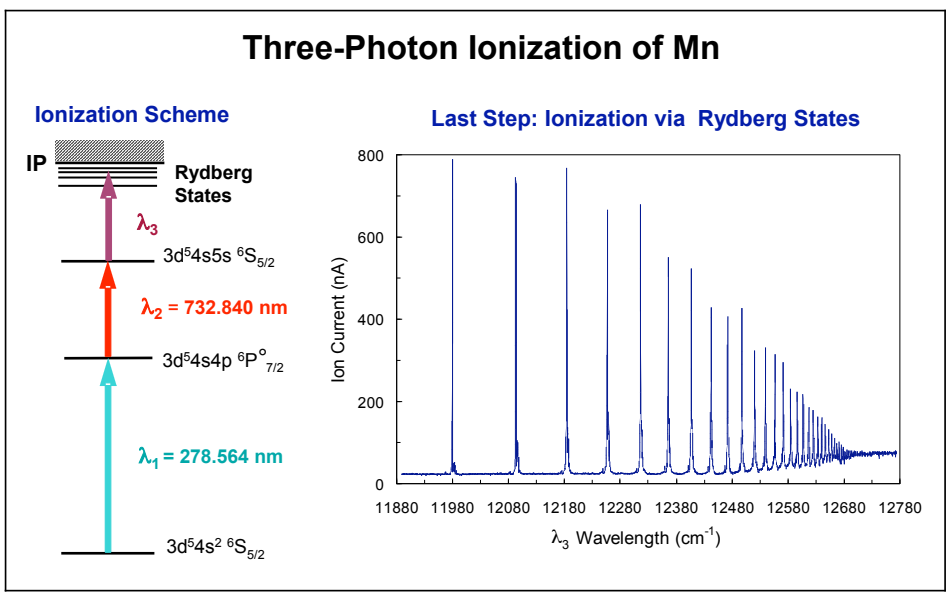

Figure 1. Generation of pure RIBs by resonant laser ionization. The three-photon ionization scheme used for Mn is shown on the left. Mn atoms can be ionized via Rydberg states. The observed Rydberg series is shown on the right.