Collisional Cooling of Negative Ions Using an RFQ Cooler: Application for RIB Generation.

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It has been recently demonstrated that gas-filled RF quadrupole ion-guide systems can be used to effectively cool low-energy positive ion beams.[1] In this device, ions are cooled by collisions with a light buffer gas. Ion energies can be reduced to thermal energies of the buffer gas in both longitudinal and transverse directions and, after collisional cooling, ion trajectories are confined near the axis of the device. Thus, ion beams with small emittances and energy spreads can be prepared with the device. We have investigated the feasibility of using this device to cool negative radioactive ion beams (RIB) for potential use at the Holifield Radioactive Ion Beam Facility (HRIBF). If this can be done, the cooled RIBs will significantly increase the isobaric purity of beams delivered to experiments without sacrificing beam intensity. Cooling and transporting negative ions through a collisional ion guide can be extremely challenging because negative ions are much more fragile than positive ions. Simulation studies have shown that losses due to electron detachment can be small if negative ions are injected into the cooler at energies below the threshold for collisional electron detachment. We have developed a RFQ cooler that consists of a deceleration stage, a gas-filled RF quadrupole, an acceleration stage, and an energy analysis system for measuring the energy spread in ion beams after cooling. The device has been used to cool both positive and negative ion beams injected at various energies. A detailed description of the RF cooler and energy analysis system and results derived from cooling experiments with both positive- and negative-ion beams will be given in this report.

* Managed by UT-Battelle, LLC, for the U.S. Department of Energy under contract DE-AC05-00OR22725.

1. D. J. Douglas and J. B. French, J. Am. Soc. Mass Spectrom. **3**, 398 (1992).