Cooling Negative-Ion Beams

Y. Liu, J. F. Liang, G. D. Alton, J. R. Beene
Physics Division, Oak Ridge National Laboratory[•]
P. O. Box 2008, Oak Ridge, TN 37831, USA

Z. Zhou and H. Wollnik
Universität Giessen, 35392, Giessen, Germany

ABSTRACT

The Holifield Radioactive Ion Beam Facility (HRIBF) uses the Isotope Separator On-Line (ISOL) technique to provide accelerated radioactive ion beams (RIBs) for nuclear structure physics and nuclear astrophysics research. The radioactive ion beams produced are often mixed with isobaric contaminants that compromise experimental results. At the HRIBF, a magnetic mass separator, with a nominal mass resolving power of $M/\Delta M \sim 20{,}000$, is used for isobaric purification. However, in order to achieve this high resolving power, in practice, very high quality beams (i.e., beams with very small emittances and low energy spreads) are required. Cooling experiments have been conducted to determine the feasibility of using the gas-filled RF-quadrupole technique as a means of improving the qualities of sputter-generated negative-ion beams to the levels required for suppressing or drastically reducing isobaric contaminants necessary for research with radioactive ion beams, without sacrificing intensity. We have designed a RF-quadrupole ion cooler, equipped with provisions for retarding energetic negative-ion beams to low energies before injection and for re-acceleration to initial energies after the cooling process. The device has been used to cool negative-ion beams with initial energy spreads, $\Delta E > 10$ eV to final energy spreads, $\Delta E \sim 2$ eV FWHM. In this report, we provide detailed descriptions of the cooler and energy analysis systems and present energy spectra and transmission efficiency data for several negative- and positive-ion beams.

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