Purification of Radioactive Ion Beams by Photodetachment in a RF Quadrupole Ion Beam Cooler*

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The availability of exotic nuclei far from stability offers unique and exciting opportunities to study the structure of the nucleus, the stellar processes which power the universe, and the fundamental laws of physics. The Holifield Radioactive Ion Beam Facility (HRIBF) at the Oak Ridge National Laboratory (ORNL) is an Isotope Separator On-Line (ISOL) facility providing high-quality radioactive ion beams (RIBs) for research in nuclear structure and nuclear astrophysics. The RIBs produced using the ISOL technique are often mixtures of the radioactive isotope of interest and isobaric contaminants that complicate and sometimes compromise the experiments. As the HRIBF tandem post-accelerator requires negatively charged ions as input, a highly efficient method for selectively suppressing contaminants in negative RIBs by photodetachment has been developed [1]. In this method, a laser beam having the appropriate photon energy is used to selectively neutralize the contaminant if the electron affinity of the contaminant is lower than the electron affinity of the desired radioactive ions. The photodetachment efficiency can be dramatically increased when the laser-ion interaction is made inside a RF quadrupole ion beam cooler where the ion residence time can be a few milliseconds. In off-line experiments with ion beams of stable isotopes, more than 99.9% suppression of Co^-, S^-, and O^- ions by photodetachment has been demonstrated while under the identical conditions only 20% reduction in Ni^- and no reduction in Cl^- and F^- ions were observed. This technique is being developed for on-line purification of a number of interesting radioactive beams, such as ^{56}Ni, $^{17, 18}$F, and $^{33, 36}$Cl.

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References

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