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Application and further improvement of the Laser Ion Source and Trap (LIST) at ISOLDE/CERN

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The investigation of short-lived and exotic nuclides far off stability at on-line mass separators such as ISOLDE at CERN is a strong means to solve relevant problems in nuclear and astrophysics. To approach the regions far-off stability of the nuclear chart ion beams of highest purity are required. Today, the Resonance Ionization Laser Ion Source RILIS has become a worldwide established standard in the ion production due to its outstanding properties, regarding e.g. elemental selectivity, efficiency and temporal beam structure.
Nevertheless, in the RILIS hot cavity design significant isobaric contaminations are produced by the process of surface ionization. The Laser Ion Source and Trap LIST has been developed to entirely suppress these unwanted beam admixtures. Located immediately downstream the hot cavity, it consists of an electrostatic repelling electrode followed by a radio frequency ion guide quadrupole. Ions produced in the cavity are prevented from entering the RFQ, while only neutral atoms can pass to be ionized within the volume of the quadrupole structure by the RILIS laser radiation. Through the transversal confinement, they are guided towards the separator and subsequent experiments. In the past years, the LIST has been adapted for routine operation at ISOLDE [1] and used most recently for successful measurements on Po isotopes [2]. It has shown an impressive increase in the suppression of contaminations by more than a factor 1000, going along with only a slight loss in efficiency by a factor of 50 to 20 compared to conventional RILIS operation.
Further refinement of the LIST is presently carried out at Mainz University. A number of LIST design changes were driven by unexpected minor limitations and shortcomings, observed during operation at ISOLDE. A narrow rod LIST design is supposed to decrease a still remaining deposit area for contaminants inside the RFQ structure. In addition the use of the RFQ itself as initial mass filter is developed, leading to a new mass selective operation mode, which will also help to prevent space charge limitations. Efficiency improvement is addressed by avoiding the discrete repeller electrode and directly using the electric potential gradient of the cavity itself for suppression of unwanted isobars. These new design concepts and their performance during recent off-line tests are presented.

References

[1] Fink et al., NIMB 344, 83-95 (2015)
[2] Fink et al., PRX, in press

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