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The Laser Ion Source and Trap (LIST): Improving the Selectivity of the Resonance Ionization Laser Ion Source

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Highest ionization efficiency combined with effective isotope selectivity is of utmost importance for most on-line experiments on exotic, short-lived radionuclides, in particular for those with the lowest production rates. At ISOLDE, the ionization technique that most closely meets these requirements is the Resonance Ionization Laser Ion Source (RILIS), where the atoms of a chosen element are step-wise and thus, inherently selectively ionized by simultaneous irradiation with different laser beams, wavelength-tuned to strong optical resonances. Unfortunately, rare isotope beams produced with RILIS at ISOLDE are still often significantly contaminated with surface ionized isobars, which hinder or even prevent foreseen experiments.
In order to fully suppress these isobaric contaminants, the Laser Ion Source and Trap (LIST) has been developed at the University of Mainz and at CERN. An electrostatic electrode positioned at the exit of the isotope transfer line of the target unit stops surface ions from reaching the ion extraction region. Only neutral atoms may diffuse into the two-dimensional radio frequency quadrupole trap located immediately ahead. Resonant laser ionization of the atom of interest takes place within the LIST device, wherein the resulting ions are transversely confined and guided towards the subsequent extraction and acceleration field.
Various preparatory off-line measurements were performed to study the behavior of the LIST with several elements. Characteristics such as transmission, selectivity, and ionization efficiency were determined in full detail under realistic operating conditions.
In May 2011, the LIST was operated successfully at ISOLDE producing ion beams of stable and radioactive Mg isotopes. This is the first time that such a device has been tested in on-line (proton on target) condition at a radioactive ion beam facility. The primary goal was to study the long term behavior of the LIST in a radioactive environment and to study the LIST characteristics under realistic conditions.
A summary of the LIST technique and the results of the off-line and on-line studies will be presented, as well as the latest developments towards further improvements of the LIST performance.

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