



Contribution ID: 10

Type: Invited (In person)

ISOLDE's new high-resolution laser ion source PI-LIST: Nuclear structure investigations and isomer-pure beams

Thursday 1 December 2022 11:00 (25 minutes)

On-line in-source laser resonance ionization has been proven to be a highly sensitive tool for nuclear structure investigations on isotopes with low production and extraction yields [1]. While the efficiency of this technique is unrivalled, the spectral resolution is ultimately limited by Doppler broadening in the hot cavity required to ensure atom volatilization. At typical operation temperatures around 2000 °C, this leads to a 1-10 GHz experimental resolution limit, whereas precise measurements of nuclear magnetic and quadrupole moments often require resolving hyperfine structure splittings below the GHz regime.

A new laser ion source design has been implemented at ISOLDE this year to provide in-source spectroscopy capabilities down to experimental linewidths of 100–200 MHz, an order of magnitude below usual limitations. It is based on the high beam purity Laser Ion Source and Trap (LIST) [2, 3]: laser ionization takes place in a quadrupole structure directly downstream the hot cavity, while potential contamination from non-laser related ionization mechanisms in the latter is electrostatically blocked. In the new so-called Perpendicularly Illumination LIST (PI-LIST) mode [4], a crossed laser / atom beam geometry reduces the effective Doppler broadening by addressing only the transversal velocity components of the effusing atom ensemble – a method that was employed very successfully at off-line experiments at Mainz University [5, 6].

We present the first-time on-line application of the PI-LIST at ISOLDE for nuclear structure investigations. Neutron-rich actinium isotopes $^{224-231}\text{Ac}$ in the region of assumed octupole deformation were probed (IS664), pinning down predictions of recent Energy Density Functional nuclear theories that incorporate reflection symmetry breaking [7]. Additionally, enhanced Fr suppression capabilities of standard LIST operation and utilizing particle identification at the ISOLDE Decay Station enabled extension of measurements on the Po isotope chain around and above $N=126$ (IS456).

Besides results of this experimental campaign, the general scope of using the new PI-LIST at ISOLDE also outside in-source laser spectroscopy applications, e.g. for production of isomer-pure RIBs, is explored. Its limits especially in terms of efficiency and spectral resolution are discussed, and on-going developments are presented.

References

- [1] V. Fedosseev et al., J. Phys. G: Nucl. Part. Phys. 44 084006 (2017)
- [2] D. Fink et al., Nucl. Instr. Meth. B, 317 B, 417-421 (2013)
- [3] D. Fink et al., Phys. Rev. X 5, 011018 (2015)
- [4] R. Heinke et al., Hyperfine Interact 238, 6 (2017)
- [5] D. Studer et al., Eur. Phys. J. A 56, 69 (2020)
- [6] T. Kron et al., Phys. Rev. C 102, 034307 (2020)
- [7] E. Verstraelen et al., Phys. Rev. C 100, 044321 (2019)

Primary author: HEINKE, Reinhard (CERN)

Co-author: FOR THE IS664 AND IS456 COLLABORATIONS

Presenter: HEINKE, Reinhard (CERN)

Session Classification: News from the ISOLDE Technical Team