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In-source laser spectroscopy for nuclear physics investigations at CERN-ISOLDE: Joining forces and new pathways

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The Resonance Ionization Laser Ion Source RILIS [1], employing laser radiation in a hot cavity ion source directly coupled to an isotope production target, has become a principal method for provision of radioactive ion beams at facilities world-wide, such as at CERN-ISOLDE [2], -MEDICIS [3], TRUMF-ISAC [4] or RAON [5]. Step-wise resonant excitation and subsequent detachment of an electron via element-unique atomic shell transitions allows for highly efficient and chemically selective provision of the desired nuclide in the mass-separated ion beam.
Besides its application as part of the production infrastructure, RILIS is proven to be a highly sensitive tool itself for laser spectroscopy nuclear structure investigations on isotopes with low production and extraction yields [6]. These capabilities are based on and can even be further enhanced by extensive integration with dedicated experimental setups present on site that usually serve for conducting research on the provided radionuclides themselves. E.g., the ISOLDE Decay Station (IDS) [7] offers a tailored array of radiation detection methods to tag the produced ions against contamination, or the high mass resolution power of ISOLTRAP' s Multi-Reflection Time-of-Flight mass spectrometer [8] provides isobaric and even isomeric separation of the produced species. Recent highlights of these joined experimental programmes and an outlook to planned work is given, and the collaboration is presented.
Alongside the scientific output in the field of nuclear physics, we report on ongoing technical developments regarding key aspects of the in-source spectroscopy technique:
The specialized high selectivity RILIS variant LIST [9], employing spatial separation of the hot cavity from a dedicated laser ionization volume in a directly adjacent RF quadrupole unit, has been augmented with perpendicular laser beam access [10]. It allows for reduction of the effective Doppler broadening in interaction with the hot atom vapor, thus enhancing spectral resolution from experimental linedwidths in the GHz regime down to a few 100 MHz. First results outline its potential for further high-resolution applications, and greatly enhanced capabilities for isomer-selective provision of nuclides for experiments demanding highest ion beam purity.

References

[1] V. Fedosseev et al., Journal of Physics G: Nuclear and Particle Physics, 44(8) (2017), p. 084006
[2] R Catherall et al., J. Phys. G: Nucl. Part. Phys. 44 (2017) p. 094002
[3] C. Duchemin et al., Frontiers in Medicine, 8 (2021), p. 693682
[4] R. Li et al., Nucl. Instrum. Methods Phys. Res. B, 308 (2013), p. 74–79
[5] S. J. Park et al., J. Korean Phys. Soc. (2024)
[6] B.A. Marsh et al., Nature Physics, 14(12) (2018), p. 1163–1167
[7] http://isolde-ids.web.cern.ch/
[8] http://isoltrap.web.cern.ch/
[9] D.A. Fink et al., Nucl. Instrum. Methods Phys. Res. A, 344 (2015), p. 83–95
[10] R. Heinke et al., Nucl. Instrum. Methods Phys. Res. B, 541 (2023), p. 8–12

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