LISA Academic Day

CERN / June 2022

Asar AH Jaradat ESR 2

LISA
LASER IONISATION AND SPECTROSCOPY OF ACTINIDES

This Marie Sklodowska-Curie Action (MSCA) Innovative Training Networks (ITN) receives funding from the European Union's H2020 Framework Programme under grant agreement no. 861198

Agenda

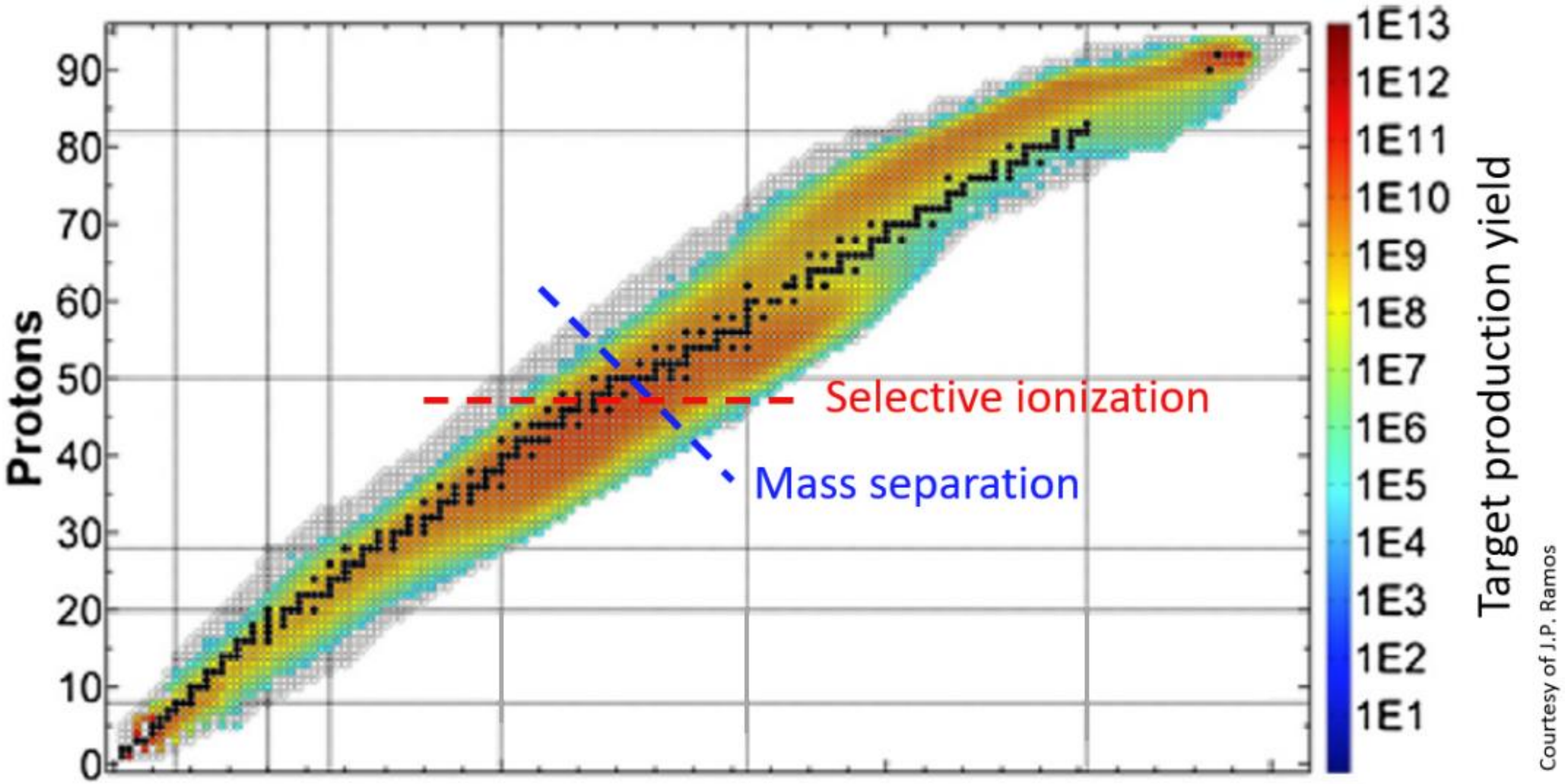
- Objectives
- Brief Literature Review
- Experimental Setup
- Future Plans

Objectives

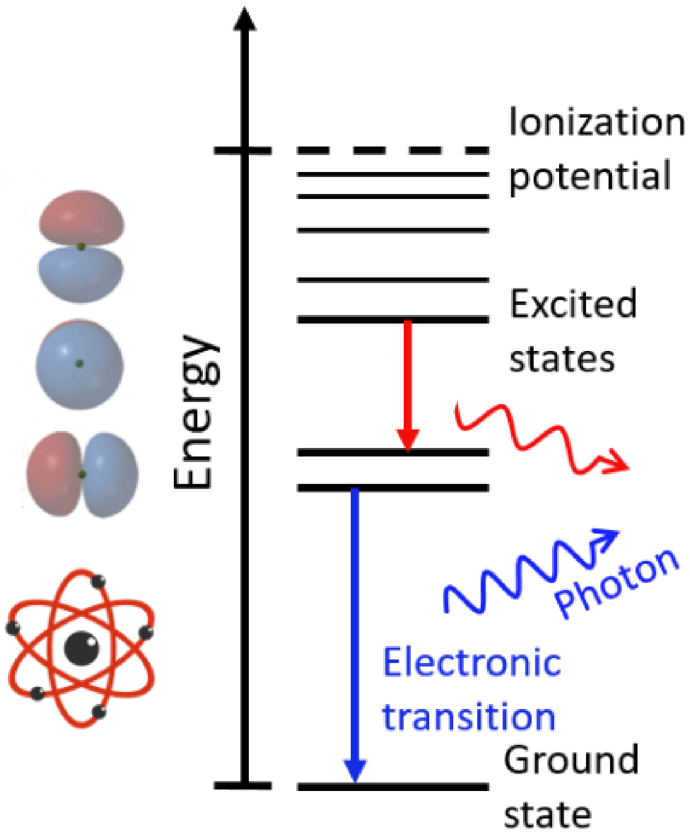
- Implementation of the PI-LIST device at ISOLDE
  - Design and setup of infrastructure
    - Characterization of its performance
      - High-resolution laser spectroscopy studies using the PI-LIST

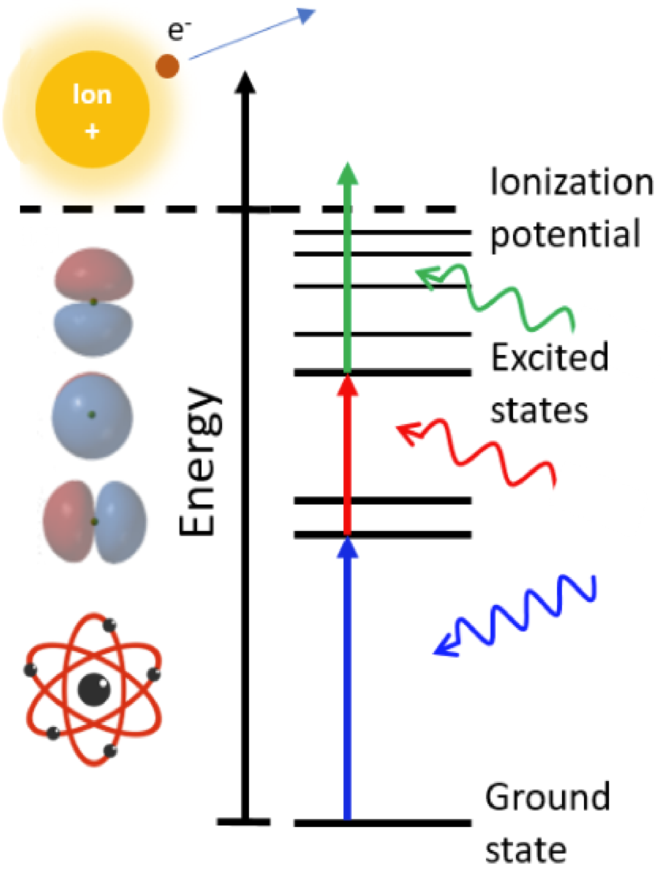
- Development of optimal ionization schemes of actinides for ISOLDE
  - Using laser spectroscopy of actinide elements
    - Collaborations with other ESRs

Literature Review

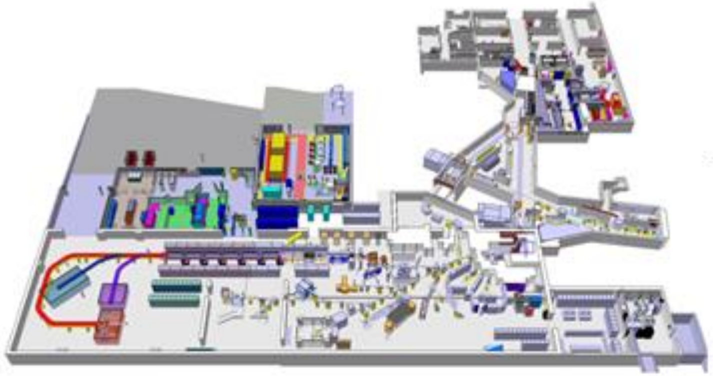


Literature Review



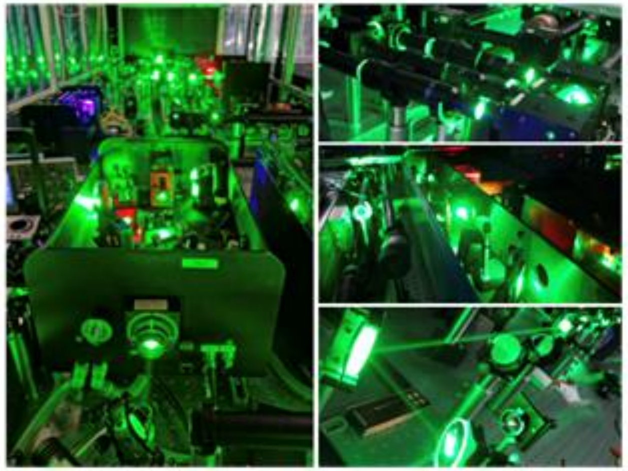


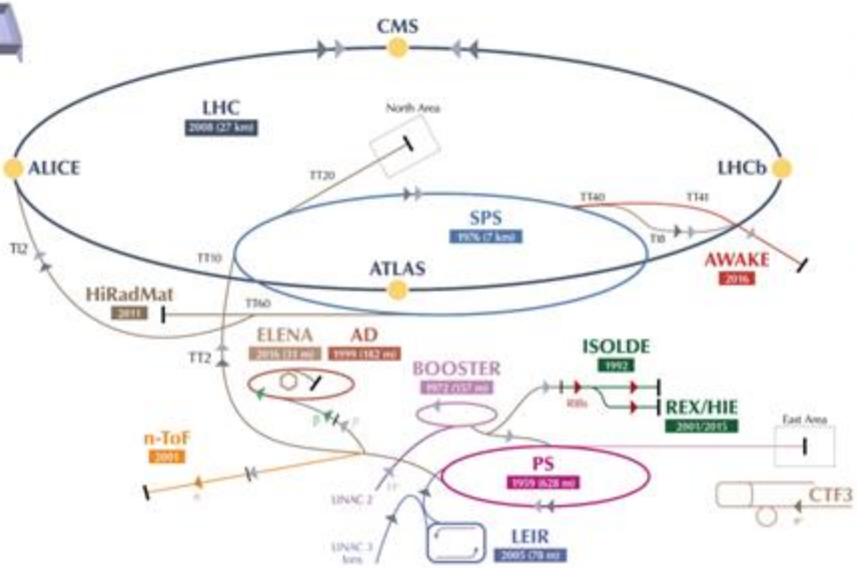
Setup- ISOLDE



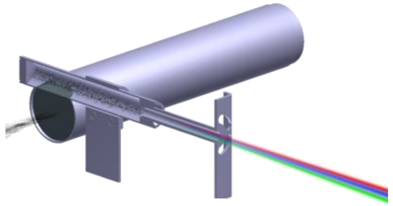
“Isotope Separator On-Line”

radioisotope production, selection and transport to an experiment in one machine

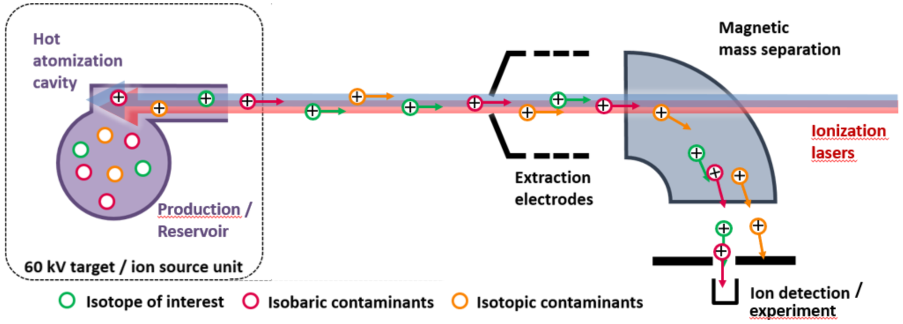




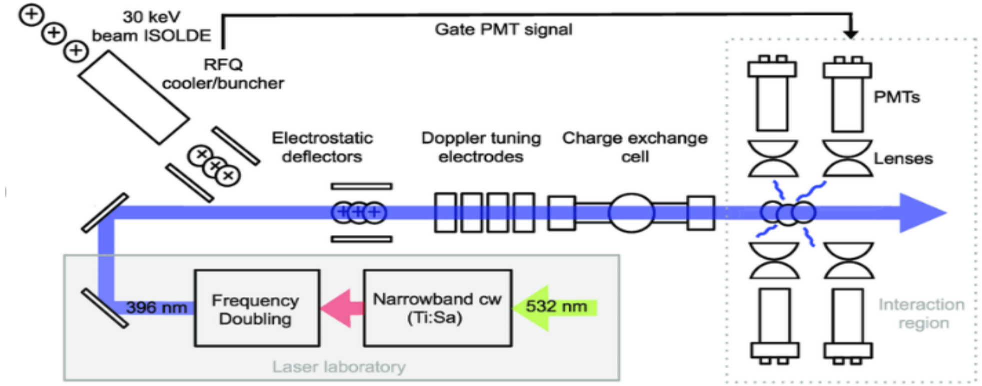
Setups in ISOLDE



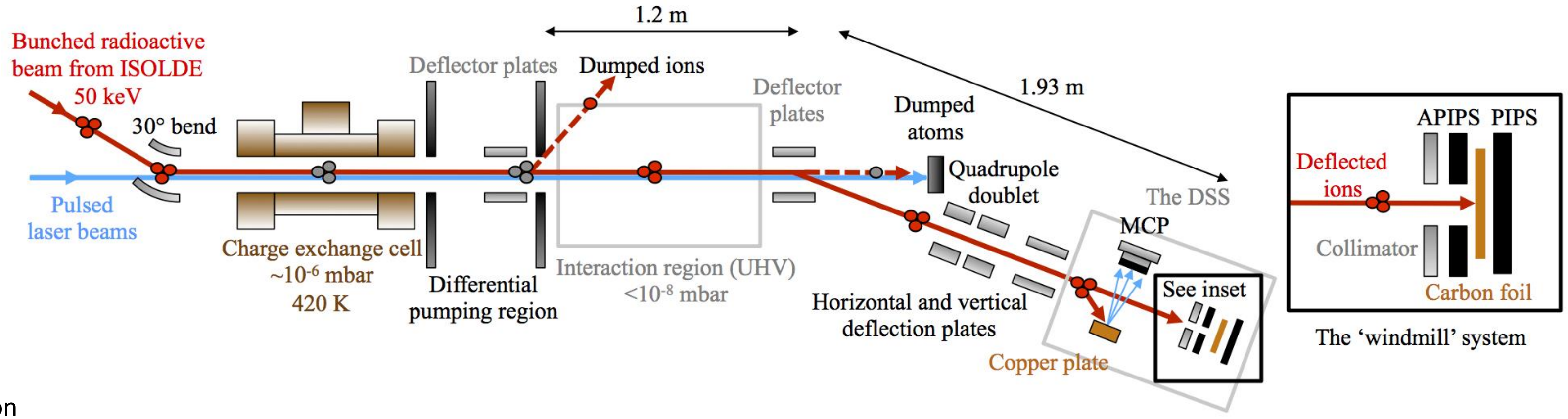
RILIS[1]



COLLAPS[2]

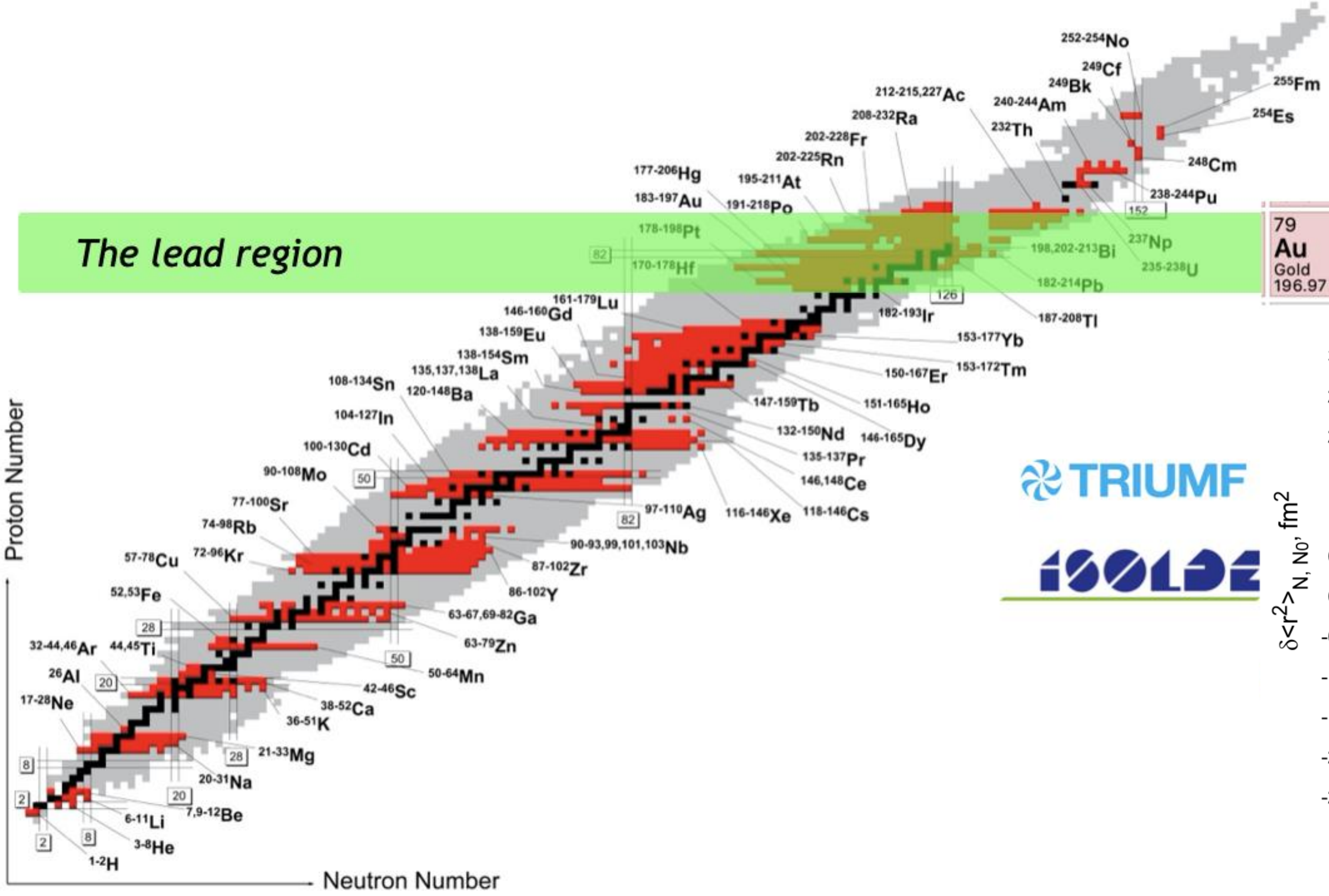


CRIS[3]



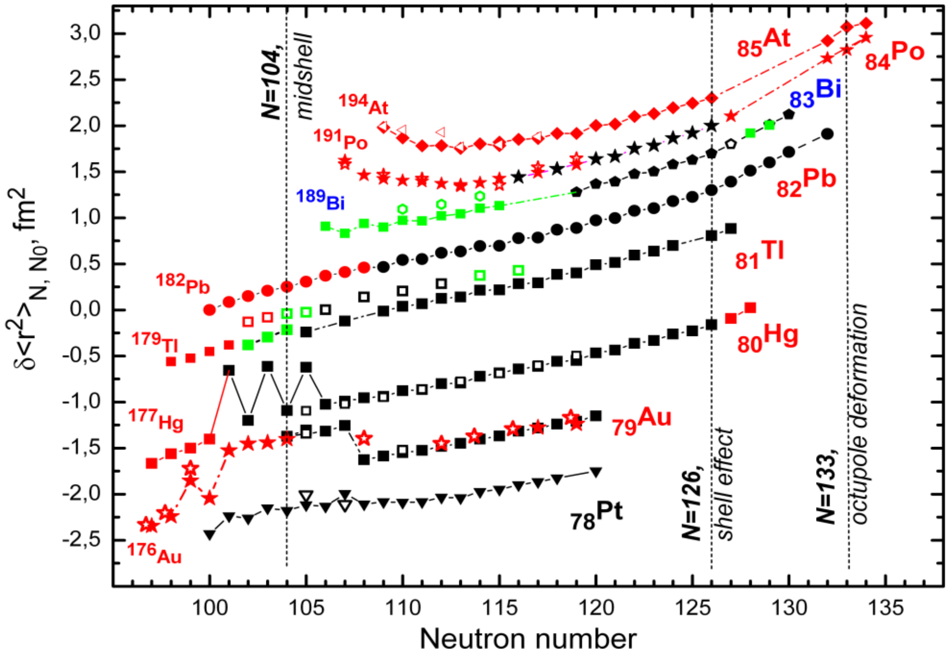
1) RILIS team documentation
2) High-resolution laser spectroscopy of Al 27 – 32 - Scientific Figure on ResearchGate. Available from: https://www.researchgate.net/figure/Schematic-depiction-of-the-COLLAPS-collinear-laser-spectroscopy-setup-at-ISOLDE-CERN_fig1_348767233 [accessed 15 Jun, 2022]
3) CRIS website

In-Source RIS so far at ISOLDE



TRIUMF

ISOLDE



How does ISOLDE fit in to LISA

Thick target ISOL method
Spallation of Th or U

ISOLDE
TRIUMF

Laser ionization and spectroscopy of Actiniides
Asar – ESR 2

Production / Extraction of Actinides
Mia Au – ESR 3

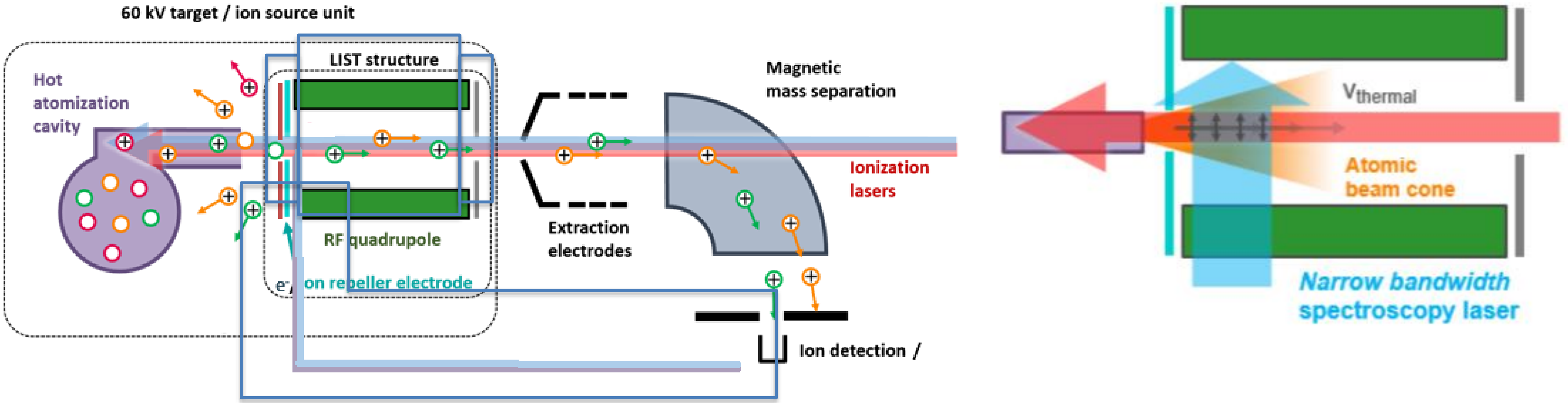
New ionization schemes (with M. Kaja, Mainz)

Higher resolution in-source spectroscopy:

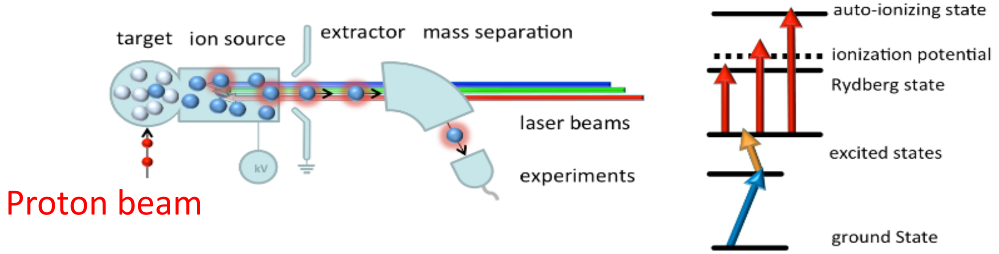
New high resolution in-source method (PI-LIST)

New laser technologies (with Mitzi@Hubner and Julius @ M^2)

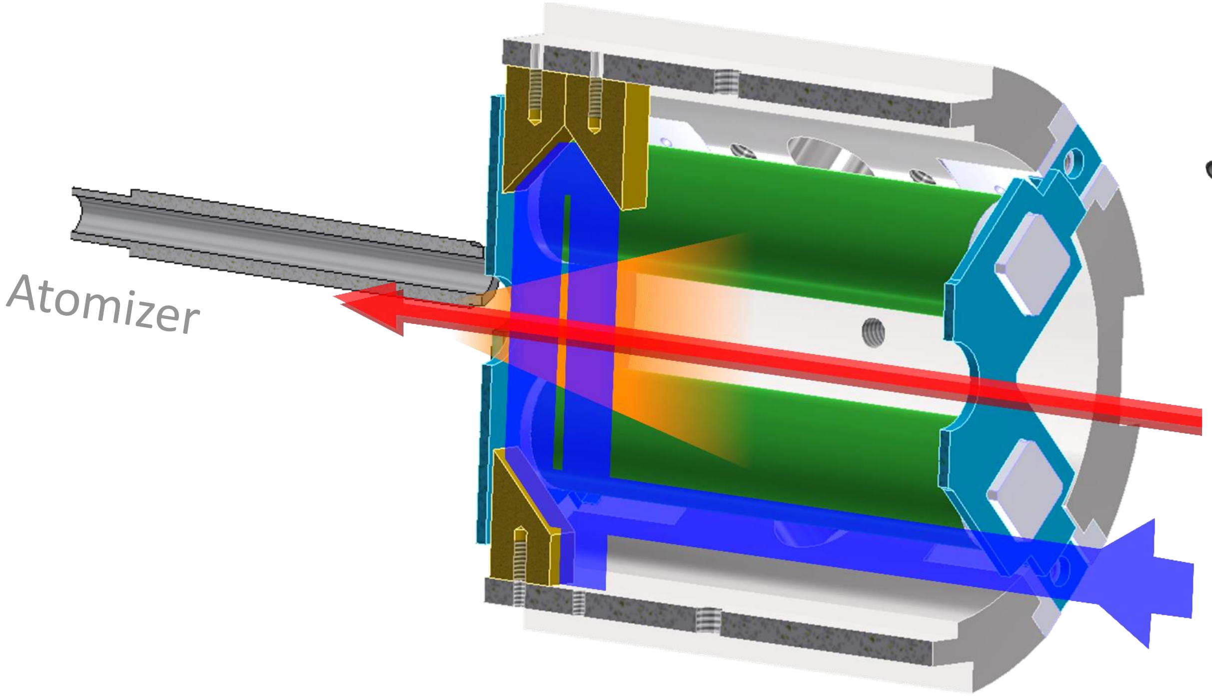
Setup: The Laser Ion Source and Trap LIST

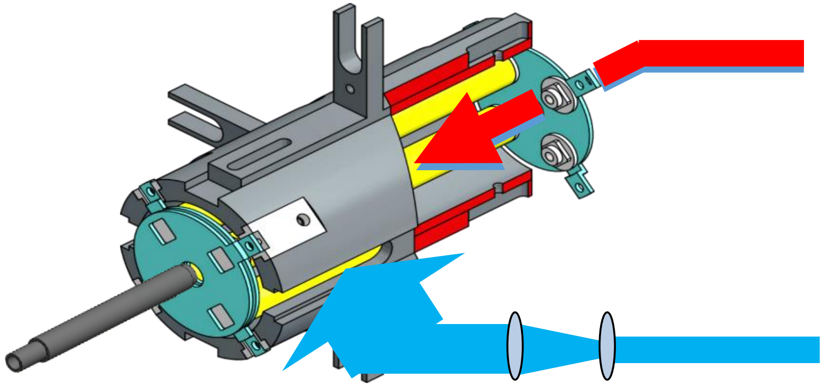


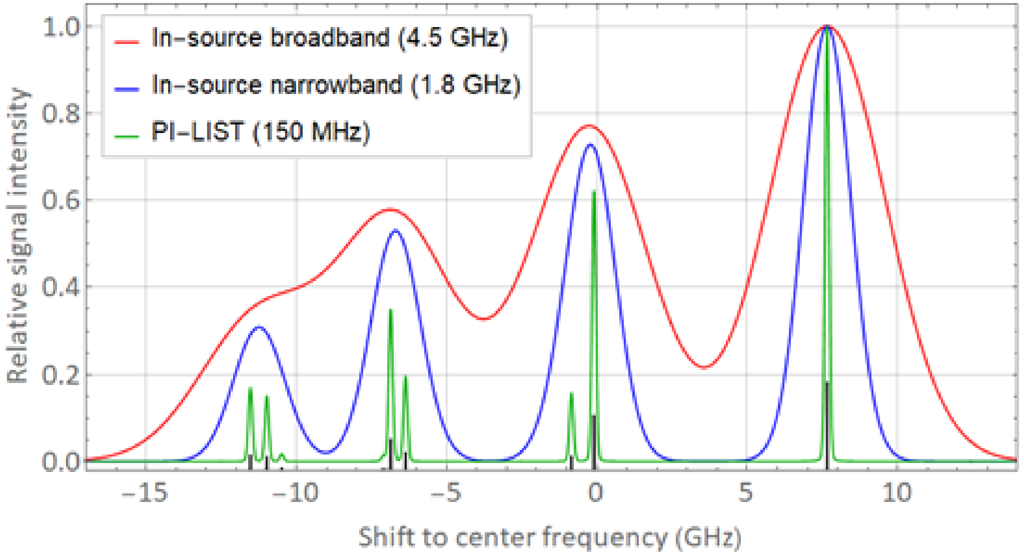
1) Supression of surface ionized species
2) Field-free laser ionization region
3) Confinement during the drift along the field-free region
4) High-resolution spectroscopy



Perpendicular Illuminated Laser Ion Source Trap



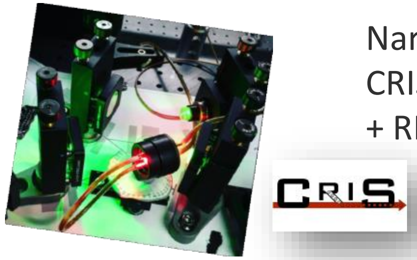




[1] Adapted from R. Heinke PhD thesis

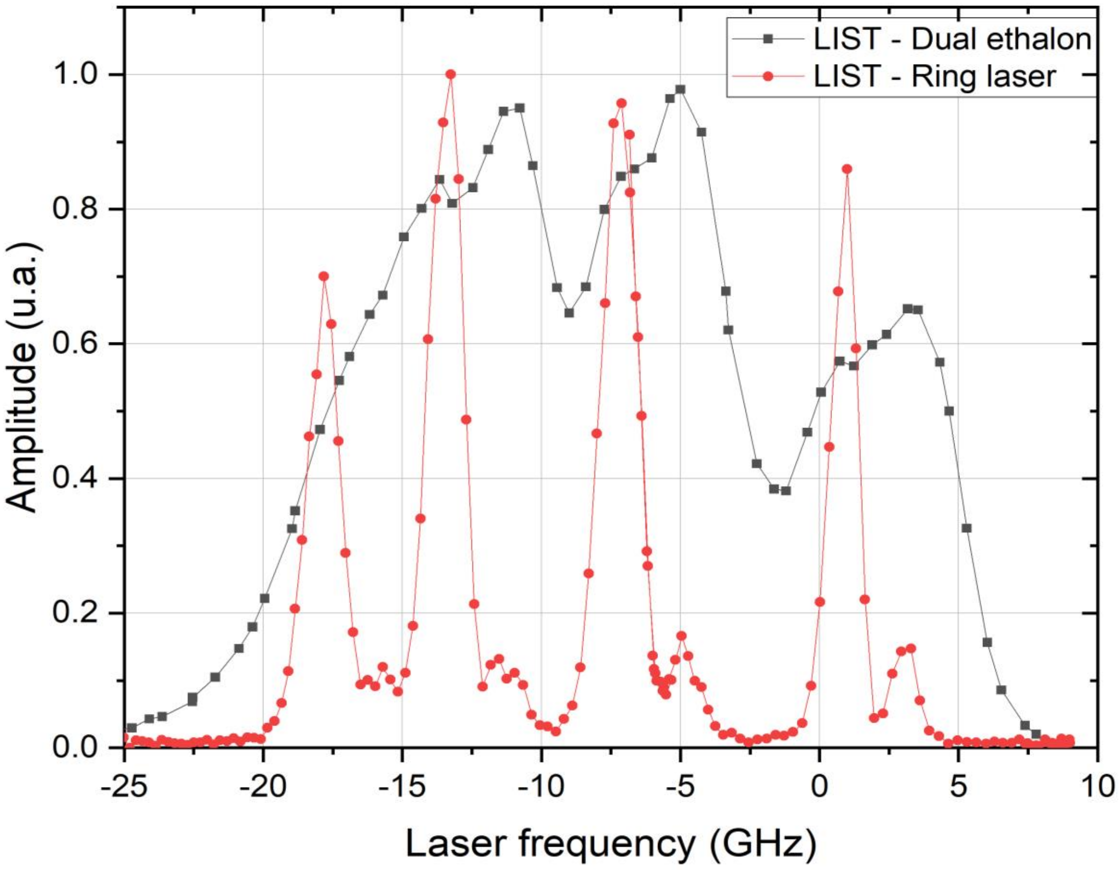
	Broadband (10 GHz)	Narrowband (1 GHz)	Fourier limited (< 100 MHz)
Ion guide	Maximum efficiency, low resolution, no isobar suppression (for general ion beam production when surface ionized isobars are not a concern)	High efficiency, intermediate resolution: for Isomer separation or laser spectroscopy of isotopes with large IS or HFS, and when isobar suppression isnt needed	Not applicable: high resolution laser would not improve experimentally observed linewidth
LIST (collinear)	20-50 x efficiency loss compared to ion guide, low resolution, good isobar suppression (for general ion beam production when surface ionized isobars are a major concern)	20-50 x efficiency loss compared to ion guide, intermediate resolution, good isobar suppression: for Isomer separation or laser spectroscopy of isotopes with large IS or HFS, and when isobar suppression isnt needed	Not applicable: high resolution laser would not improve experimentally observed linewidth
PI-LIST	Not applicable.	Improved resolution, but with slight efficiency loss. Experimental resolution will be limited only by the laser linewidth: for use when Doppler broadening is dominant in collinear mode (lighter isotopes or when a slight resolution improvement is needed).	High resolution, but with slight efficiency loss. Experimental resolution will be limited only by the atom beam divergence (~100-300 MHz): for use when resolution is of prime importance (small IS or HFS).

Results

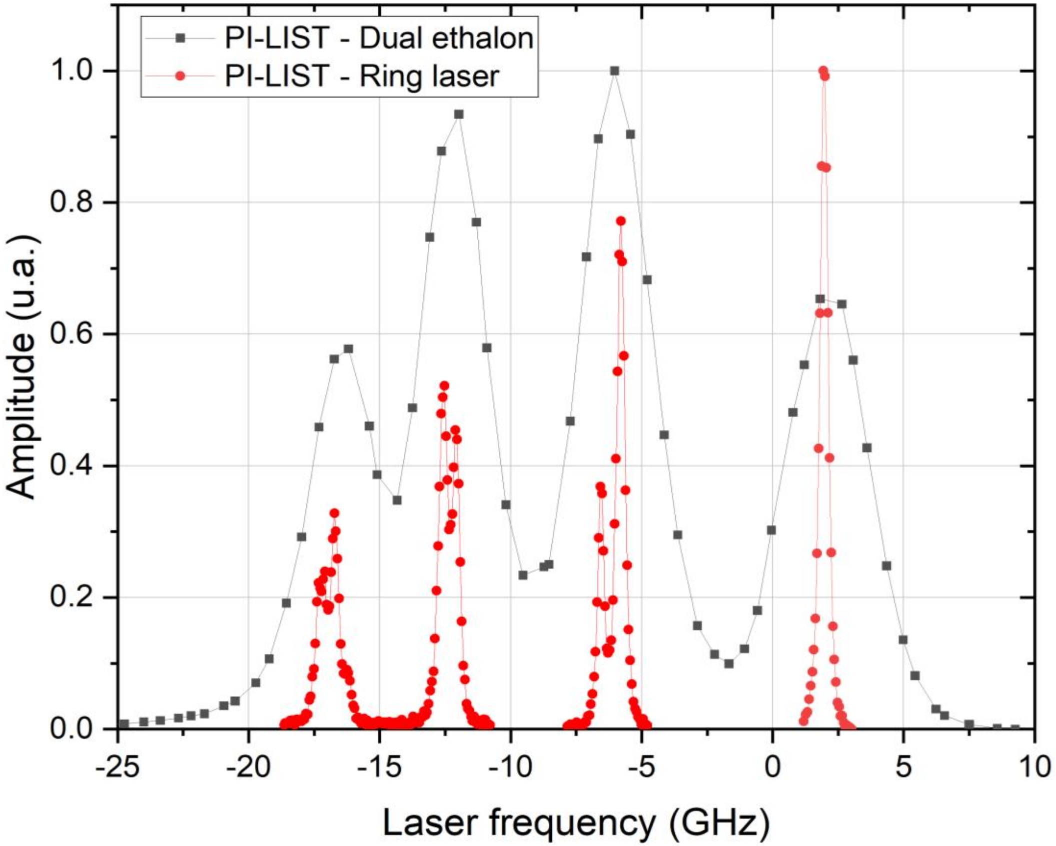


Narrow-band laser system:
CRIS Matisse cw-Tisa
+ RILIS seeded ring cavity

Ac 227



Ac 227



- First analysis by Michael Heines
- Taken from Cyril Bernerd

Conclusion

- Successful initial implementation of the PI-LIST in ISOLDE.

- PI-LIST proof of concept and first high-resolution in-source spectroscopy of Ac.

- Efficiency of perpendicular geometry setup was comparable to collinear setup.

Thank you For Listening ☺