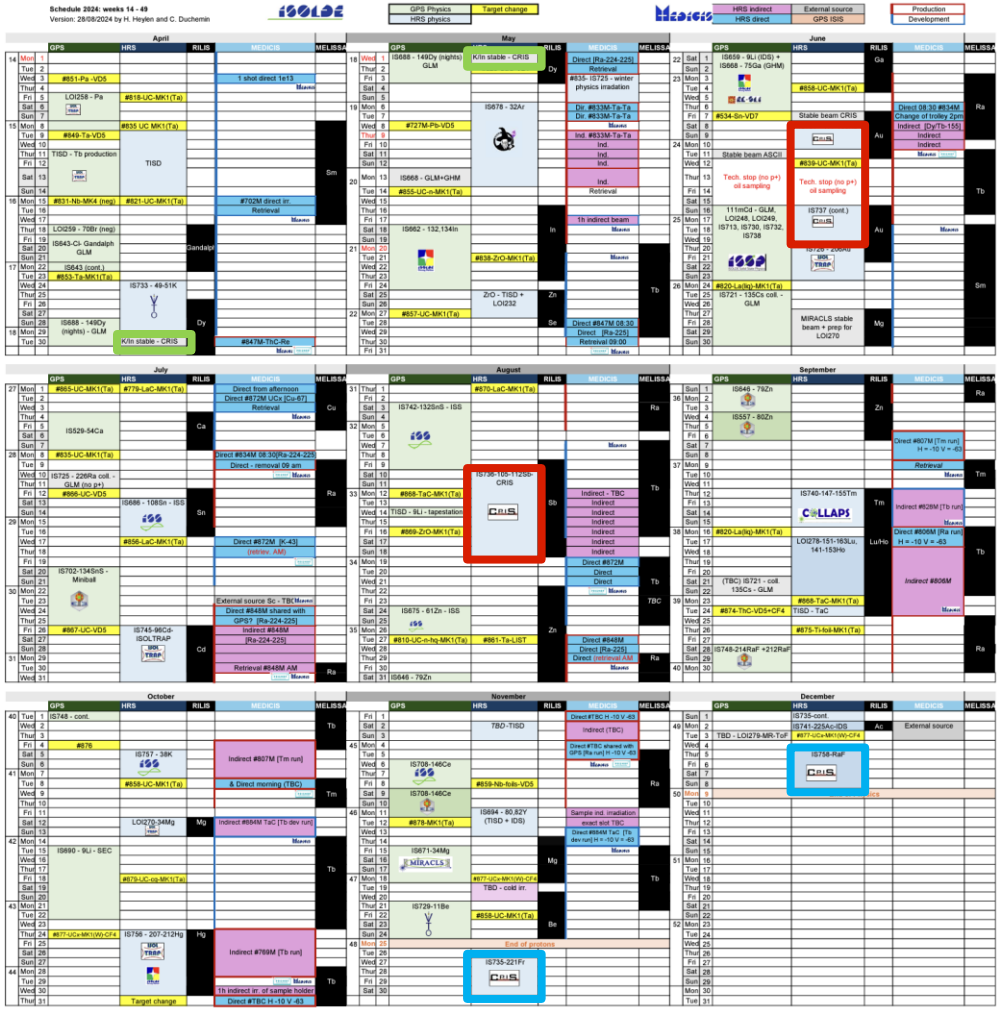
Status update of the CRIS experiment 2024

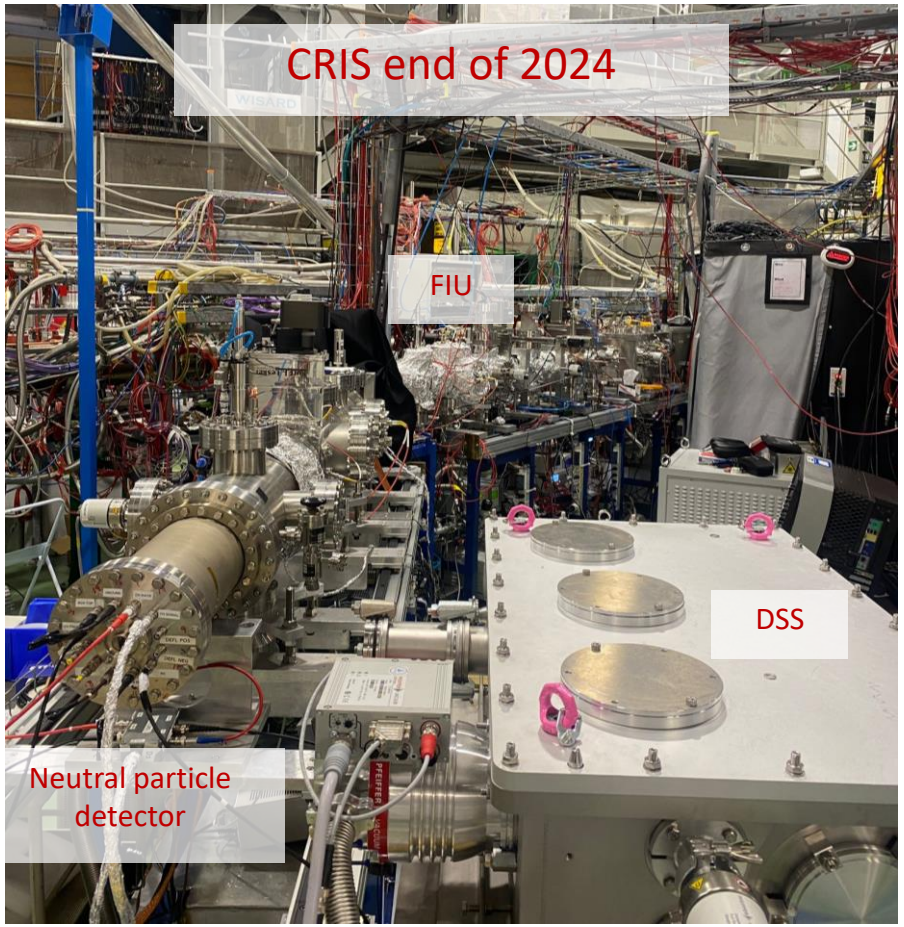
Jessica Warbinek

on behalf of the CRIS collaboration

CRIS collaboration meeting 2025, January 30

Experimental campaign 2024





Experimental campaign 2024

EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH

Proposal to the ISOLDE and Neutron Time-of-Flight Committee

Study of RaF^- anions at CRIS

April 9, 2024

R. F. Garcia Ruiz[1], O. Ahmad [3], M. Au [8], J. Berbalk [3] R. Berger [2], A. Brinson[1], T. E. Cocolios[3], R. P. de Groote[3], S. Ebadi[1], K. T. Flanagan[4] C. Fajardo[3], K. Gaul[2], D. Gonzalez[1], D. Hanstorp[5], P. Imgram[3], A. Jadbabaie[1], J. Karthein [1], Á. Koszorús[3], L. Lalanne[6], S. Moroch[1] J. M. Munoz[1] W. C. Mei[7] G. Neyens[3], M. Nichols[5] F. C. Pastrana Cruz[1], H. Perrett[4], S. Udrescu[1], J. Warbinek[6], S. G. Wilkins[1], X. F. Yang[7], C. Zülch[2],

EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH

Proposal to the ISOLDE and Neutron Time-of-Flight Committee

High-resolution laser spectroscopy of light gold isotopes: investigation of "island of deformation" and shape coexistence

April 19, 2023

X. F. Yang,[1] S. W. Bai,[1] G. Neyens,[2] A. N. Andreyev,[3] M. Athanasakis-Kaklamanakis,[2,4] Y. Balasmeh,[2] S. Bara,[2] T. E. Cocolios,[2] J. G. Cubiss,[3] J. Dobaczewski,[3] R. P. de Groote,[2] K. T. Flanagan,[5] S. Franchoo,[6] R. F. Garcia Ruiz,[7] D. Hanstorp,[8] M. Heines,[2] H. R. Hu,[1] J. D. Johnson,[2] Á. Koszorús,[2,9] L. Lalanne,[4] Y. C. Liu,[1] Y. S. Liu,[1] K. M. Lynch,[5] A. McGlone,[5] M. Nichols,[8] F. Pastrana, [7] C. Page,[3] H. Perrett,[5] J. R. Reilly,[5] J. Trujillo,[2] P. Van Duppen,[2] S. G. Wilkins,[7] Z. X. Yue,[3]

Y. Liu, O. Ahmad

EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH

Proposal to the ISOLDE and Neutron Time-of-Flight Committee

Collinear resonance ionization spectroscopy of neutron-deficient antimony isotopes, towards the proton drip line

January 11, 2023

K. M. Lynch[1], M. Athanasakis-Kaklamanakis[2,3], S. W. Bai[4], Y. Balasmeh[2], T. E. Cocolios[2], R. P. de Groote[2], C. Fajardo[2], K. T. Flanagan[1,5], S. Franchoo[6], R. F. Garcia Ruiz[7], S. Geldhof[8], G. Georgiev[6], D. Hanstorp[9], R. Heinke[10], A. Koszorús[2,11], L. Lalanne[3], Y. C. Liu[4], Y. S. Liu[4], A. McGlone[1], G. Neyens[2], M. Nichols[9], F. Pastrana[7], H. Perrett[1], J. R. Reilly[1], J. Trujillo[2], B. van den Borne[2], J. Wessolek[1], S. G. Wilkins[7] and X. F. Yang[4].

A. McGlone

EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH

Proposal to the ISOLDE and Neutron Time-of-Flight Committee

Characterization of the atomic 6D-states in neutral francium using collinear resonance ionization spectroscopy

May 17, 2023

R. P. de Groote,[1] P. Lassegues,[1] M. Athanasakis-Kaklamanakis,[1,2] Y. Balasmeh,[1] A. Dorne,[1] T.E. Cocolios,[1] K.T. Flanagan,[3] R.F. Garcia Ruiz,[4] S. Geldhof,[5] D. Hanstorp,[6] P. Imgram,[1,7] A. Kastberg,[8] Á. Koszorús,[1,9] K. König,[7] L. Lalanne,[2] K. M. Lynch,[3] A. McGlone,[3] G. Neyens,[1] W. Nörtershäuser,[7] F. C. Pastrana Cruz,[4] J. R. Reilly,[3] J. Trujillo,[1] B. Van Den Borne,[1] J. Warbinek,[10,11] S.G. Wilkins,[4] X.F. Yang,[12]

Happenings aside of physics in the lab

Successful PhD defenses

Dr. Reilly

New people at CRIS/ISOLDE:

- Theodoros Vafeiadis as ISOLDE DSO
- Handover of CRIS local coordination, new CRIS team, new people joining the CRIS

Celebration of successful runs

Recent CRIS publications:

- Athanasakis-Kaklamanakis, M., et al. "Radiative lifetime of the A Π 1/2 2 state in RaF with relevance to laser cooling." *Physical Review A* 110.1 (2024): L010802.
- Udrescu, S., et al. "Precision spectroscopy and laser-cooling scheme of a radium-containing molecule." *Nature Physics* 20.2 (2024): 202-207.

Almost there:

- *Wilkins, S. G., et al. "Observation of the distribution of nuclear magnetization in a molecule." arXiv preprint arXiv:2311.04121 (2023).*
- *Athanasakis-Kaklamanakis, M., et al. "Pinning down electron correlations in RaF via spectroscopy of excited states." arXiv preprint arXiv:2308.14862 (2023).*
- *Lalanne, L., et al. "$^{61} $ Cr as a Doorway to the N= 40 Island of Inversion." arXiv preprint arXiv:2409.07324 (2024).*

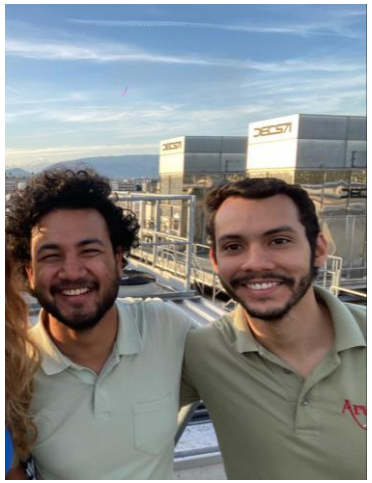
Collaboration meeting 2024

Local team 2024

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Louis												
Jessica												
Abi												
Carlos												
Osama												
Yinshen												

Pierre ☺

Local team 2025



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Jessica												
Carlos												
Osama												
Justus												
David												

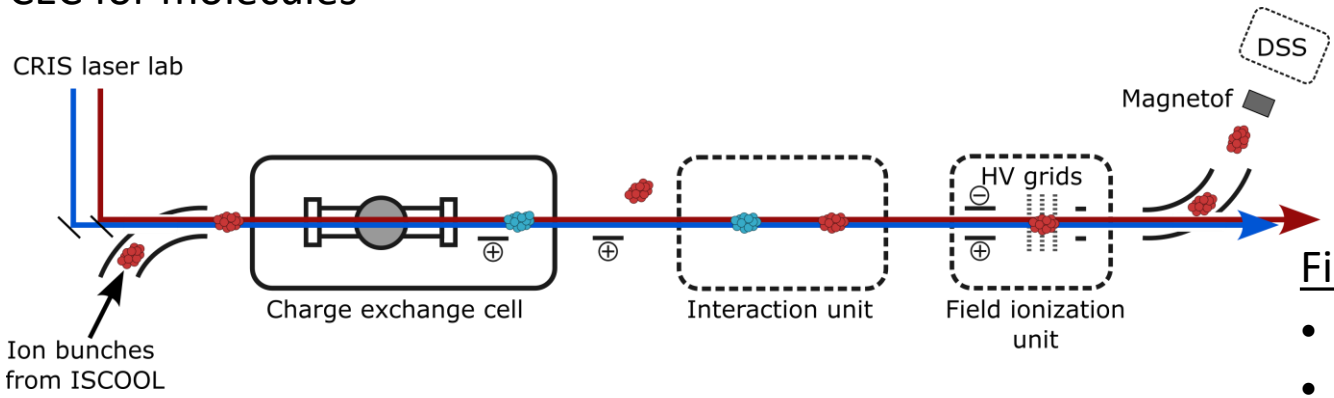
Lab status report – CRIS beamline

Charge exchange cell:

- Big contamination of RaF2023 resolved
- New replacement CECs: clean for short-lived, contaminated CEC for molecules

Detector systems:

- Main magnetof working flawless
- MiniTofs after CEC/Bender 2 to be investigated
- Upgrade of DSS ongoing, see talk tomorrow



ISCOOL:

- Marmot day all over
- Bunches 3us and even more
- Instabilities seen in all (CRIS) runs
- Investigations ongoing

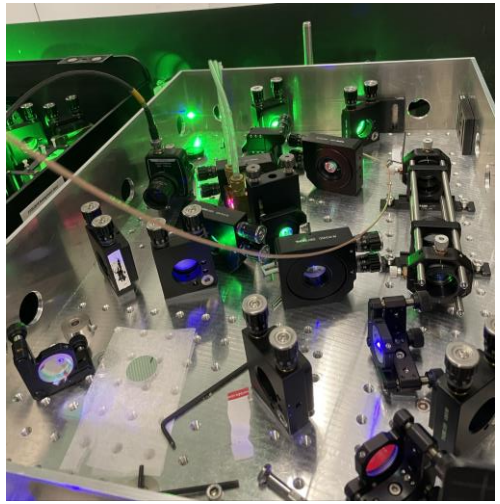
Vacuum system:

- Addition of two new Turbo pumps
- Low 10^{-10}mbar in IR with valves closed, 10^{-9} open
- Failure of Turbo controller in QT2: short term replacement gift from Miniball

Field ionization unit:

- Successfully commissioned with K
- First on-line application for Fr
- Vacuum tested, but limiting the IR
- New upgrades, see talk tomorrow

Lab status report – laser labs



Matisse and Jyvis:

- Working reliably and stable all year long
- Jyvis successfuly intra-cavity doubled/quadrupled and tripled
- Drifts/vibrations in ISOHALL there but limited

Z Cavity / Grating / Nd:YFL:

- Working but giving lower power
- Z: 180mW bb, Granting 60mW (halfed!)
- Nd:YLF crystal tuned, too long pulses, but didn't improve the Ti:Sa outputs
- Chiller unstable: new one?

Dual head / Trili:

- Repaired earlier this year, parts replaced
- Dualhead not operational, chiller failure
- Trili ceramics exchanged, holding up (so far), gave output closer to specs again

New laser on the way!

End of march: New Innolas Pump laser

Dye lasers:

- PDL working fine, burned resonator dye cell from OPO pumping to be replaced with new laser
- Cobra back to specs after repair, working reliable
- Picoscope died ☹

OPO:

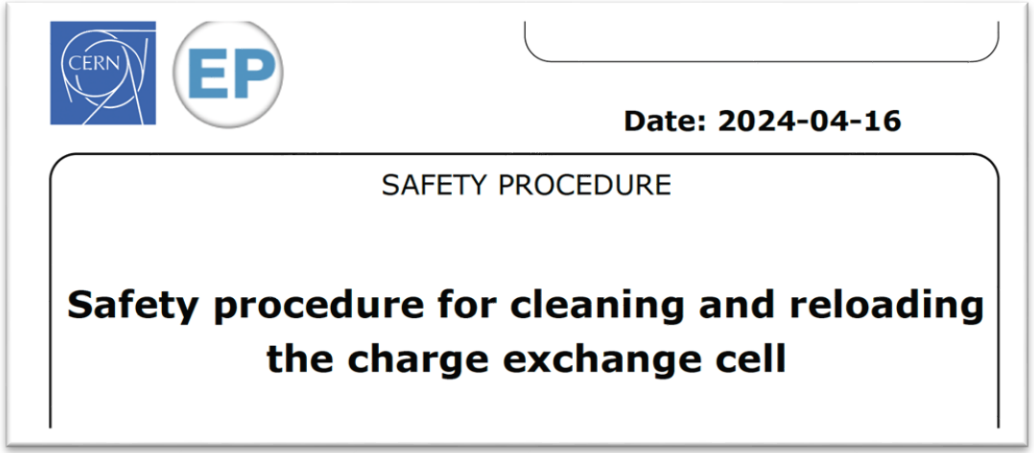
- Working reliable after temperature problem was solved in tent
- Beneficial addition for FIU work
- NEW temporary DLA for OPO at the end of the beamline

Safety

- 2024 year of new safety procedures
- Jan – Mar: Lab work partly disposed, slow start up
- Operation during year: not blocked but partly (potentially) hampered

Procedure for fitting the new Field Ionization Unit chamber into the CRIS beamline

For the upcoming CRIS activities, a new field ionization unit housed in a six-way cross piece (similar to (3) in Fig. 1) has to be fit in the CRIS beamline (in position (2). This document describes the procedure to be followed to safely open the beamline and prepare the setup to fit the new part.



CERN EP

Date: 2024-04-16

SAFETY PROCEDURE

Safety procedure for cleaning and reloading the charge exchange cell

- Status 2025: catching up on missing procedures
- Review of laser safety procedures necessary
- Chemical safety reviewed and chemicals disposed

Financial update 2024

Carry-Over from 2023	74,934 CHF	
Annual collaboration contributions	120,000 CHF	
Expenses in 2024: Pump purchases / repair Laser repairs Optics / Dye / Laser safety New Lauda chiller Other consumables, operation E-pool Transport costs	 -22,353 CHF -20,789 CHF -21,593 CHF -5,130 CHF. -5,613 CHF -3,214 CHF -2,109 CHF	~80,000 CHF
Account status today:	122,204 CHF	

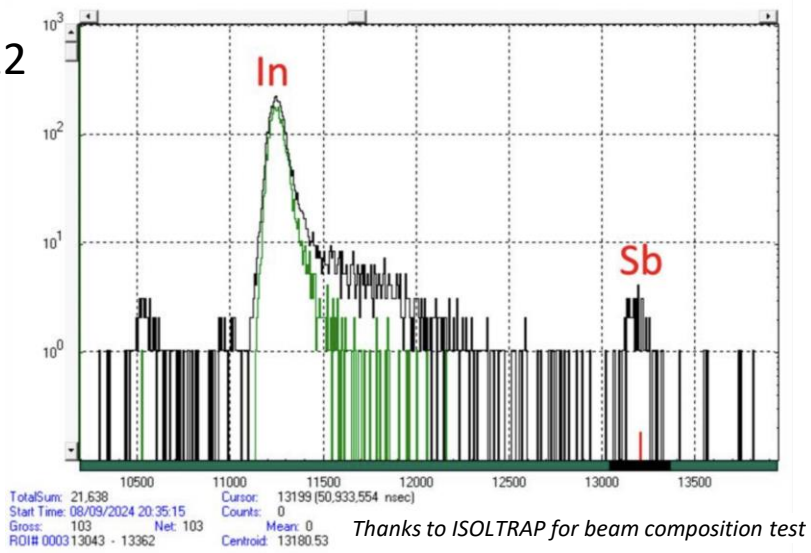
CRIS financial plan for 2025

New Innolas pump laser	85,000 CHF
New Grating laser	10,000-15,000 CHF
New chiller for TiSas upstairs?	3,000 CHF
Picoscope / cheaper alternative	6,000 CHF / < 1,000CHF
New spectrometer for OPO	3,000 CHF
Restgas analyzer	5,000 CHF
New pellet ion source	< 10,000CHF??
Operational costs	< 20,000 CHF
Safety	XXX
Total	= < -132,000 CHF
Contributions 2025 + carry-over 2024	120,000 + 122,000 CHF

Upgrades in 2024 and ongoing

Challenges: low yields and large contamination

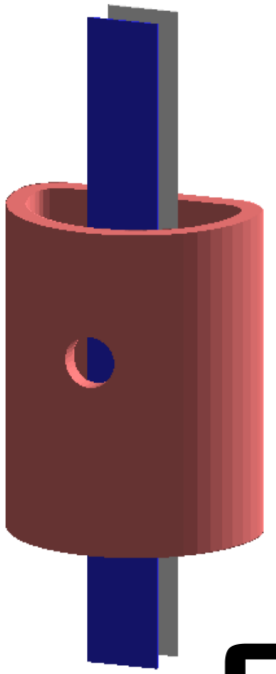
112

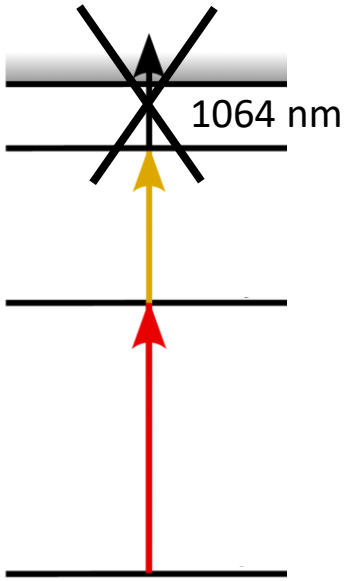


Thanks to ISOLTRAP for beam composition test

CRIS technique selective, previously handled 3 orders of magnitude and more of higher contamination, case specific

Upgraded CRIS decay station available with new plastic scintillators



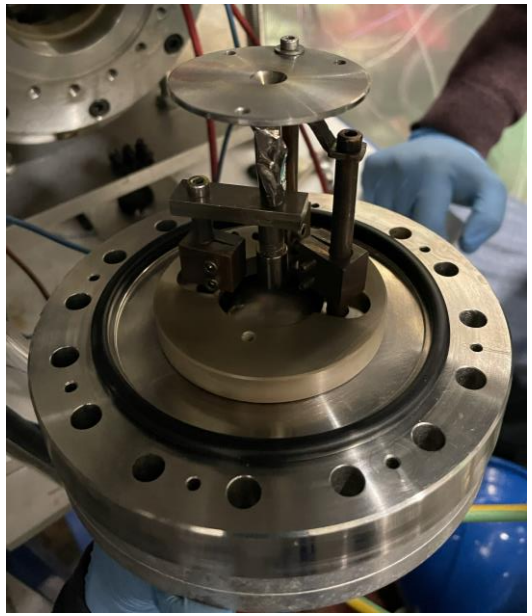


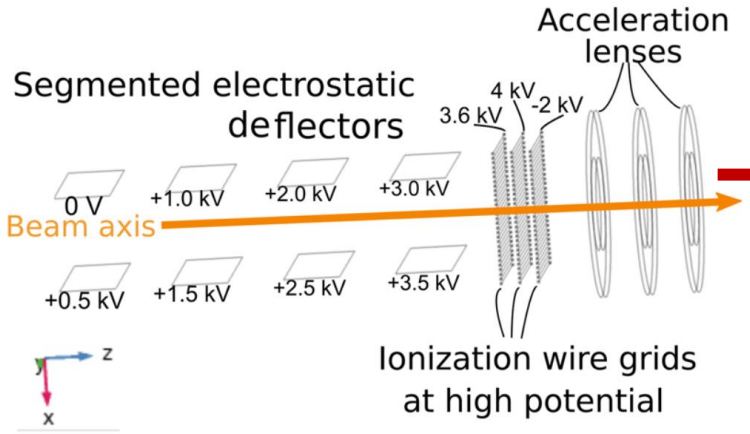
Background contributions from

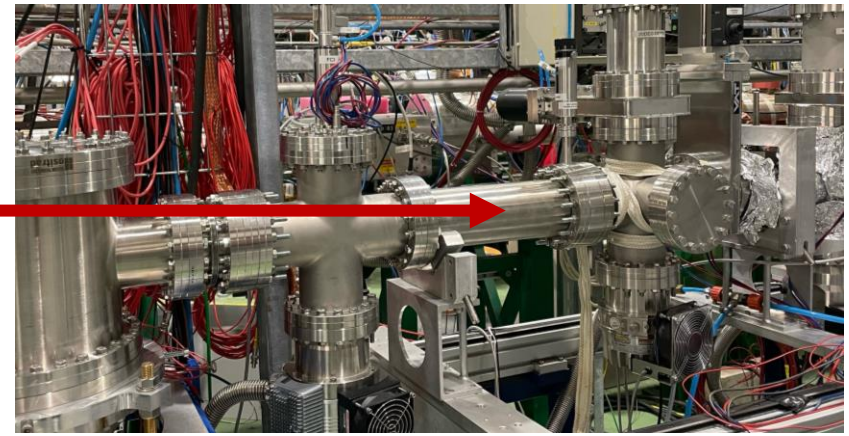
- Collisional ionization
- Laser related background, especially from high power non-resonant step

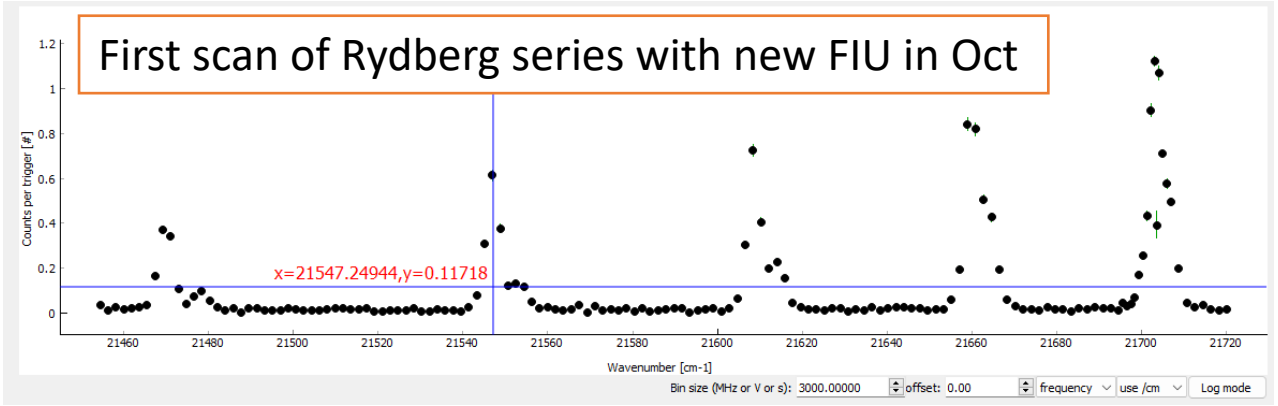
FIU off-line commissioning in 2024

Resurrection of surface ion source, large & “stable” beams for commissioning









Field ionization unit successfully implemented

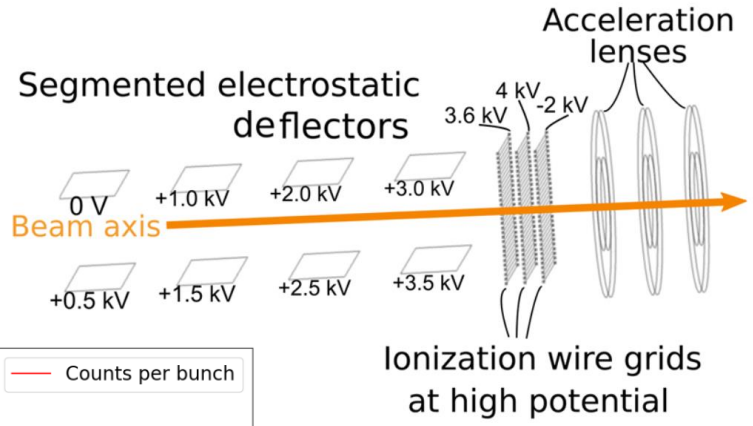
Principle shown with stable K beam

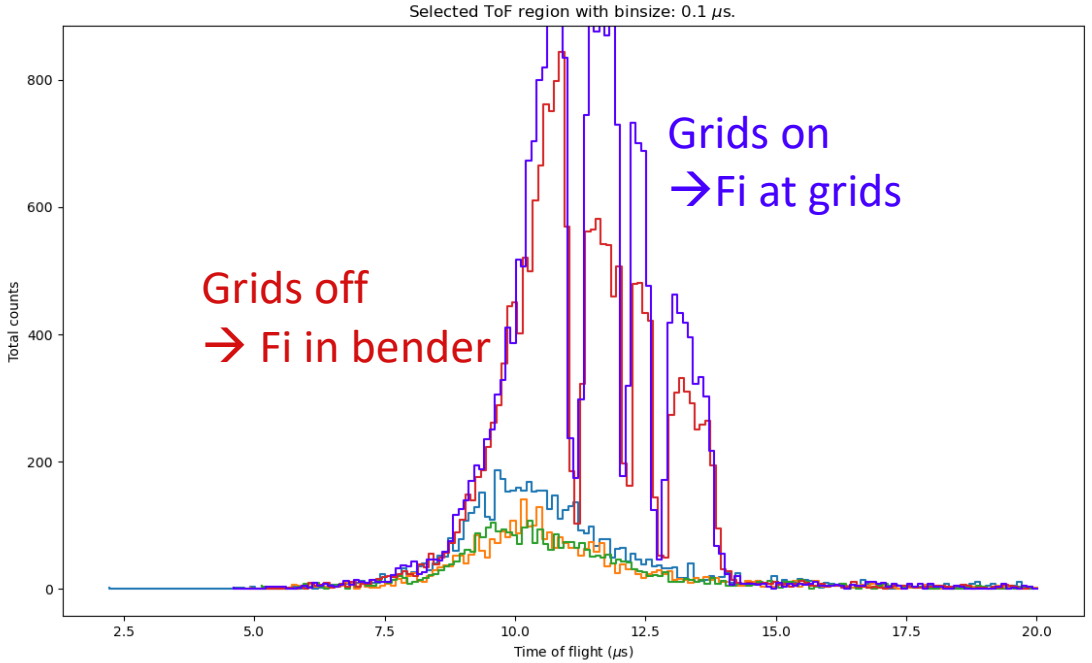
A. Vernon et al., Sci. Rep. 10, 12306 (2020).
C. Schulz et al., J. Phys. B 24, 4831, (1991).

On-line commissioning

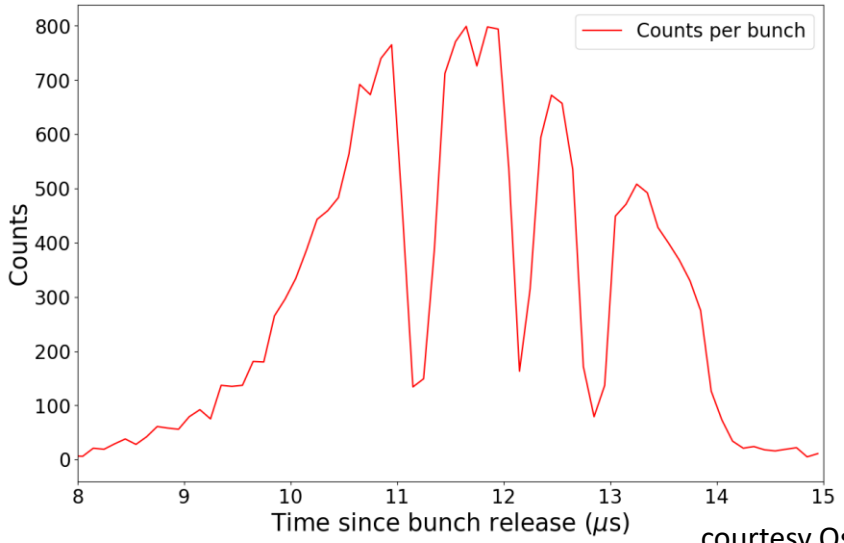
Field ionized K observed with beam from ISOLDE

See dips in ion bunch, not understood first





courtesy Pierre

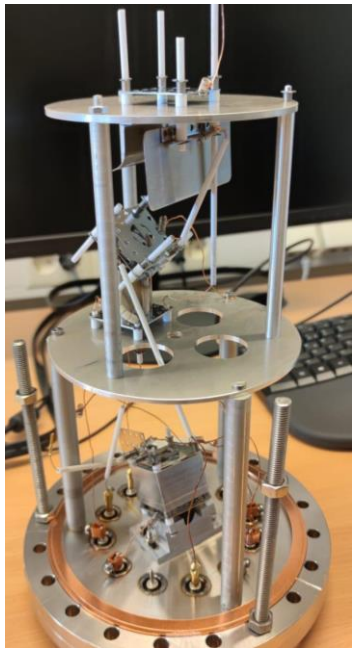


courtesy Osama

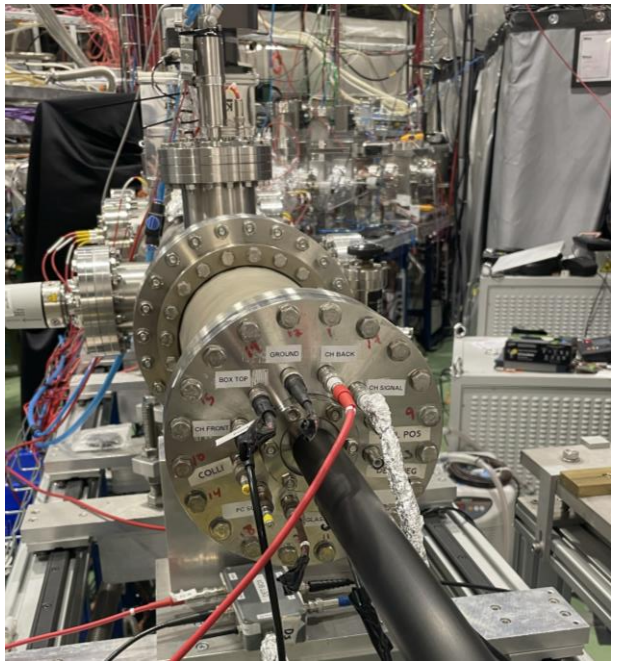
High-lying Rydbergs (n=24) affected strongly by Stark shift
Atoms at locations with strong field along beamline not Rydberg excited
→ field ionization not effectful

Resolved with lower CEC deflector potentials and lower Rydbergs (n=18, K)

Upgrades for negative ions @ CRIS

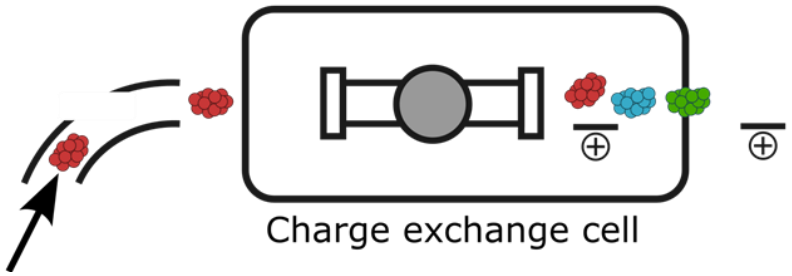


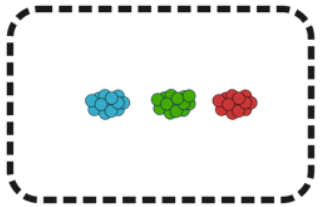
GANDALPH type neutral atom detector installed and commissioned at CRIS

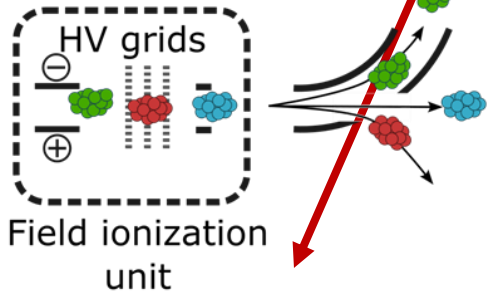


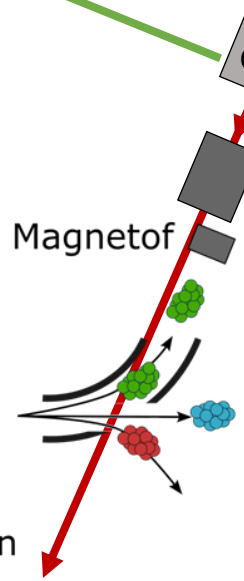
Upgrades for negative ions @ CRIS

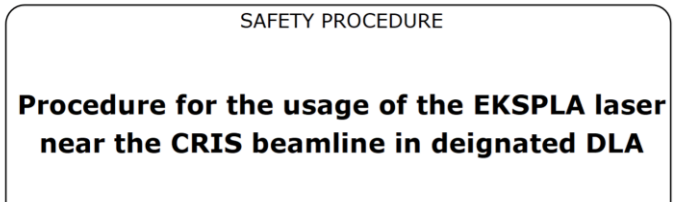
- Movable DLA created for laser operation at the end of the beamline
- Final arrangement not completed
- Safety paperwork done and approved











Spectrometers implemented to read OPO wavelength in crystal

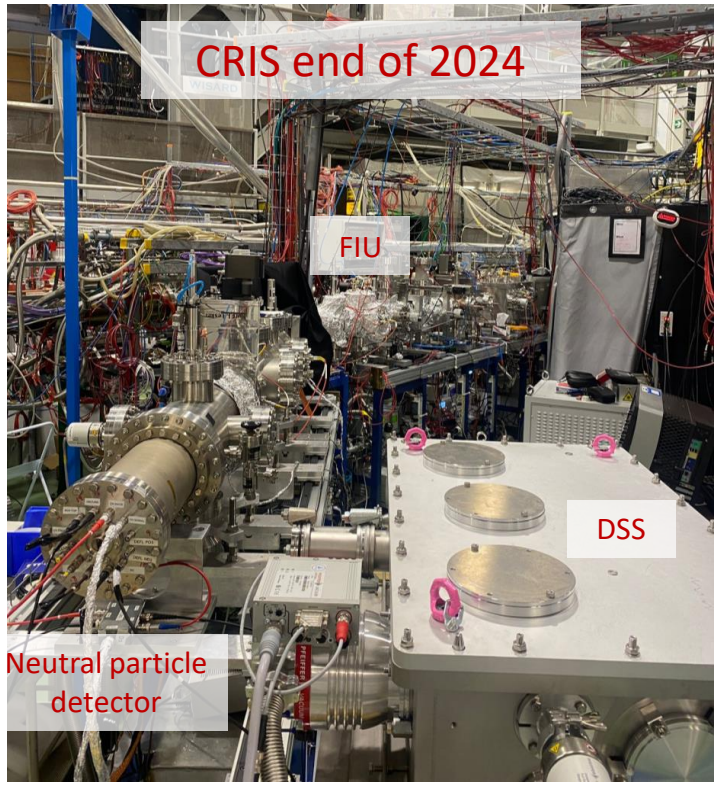
Conclusions & Outlook for 2025

✓Successful physics campaigns in 2024

✓New atomic levels and lifetimes identified in Fr

✓First online implementation of field ionization at CRIS

○ Production and laser photodetachment studies on RaF^-



Outlook for 2025

- Final implementation of new CRIS DSS
- Application of FIU and DSS for high sensitivity studies on challenging low yield cases

Acknowledgments

CRIS collaboration