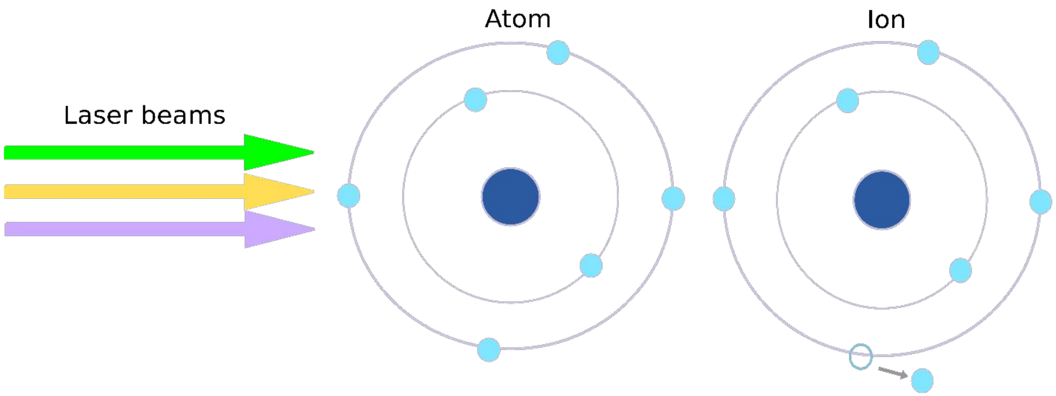
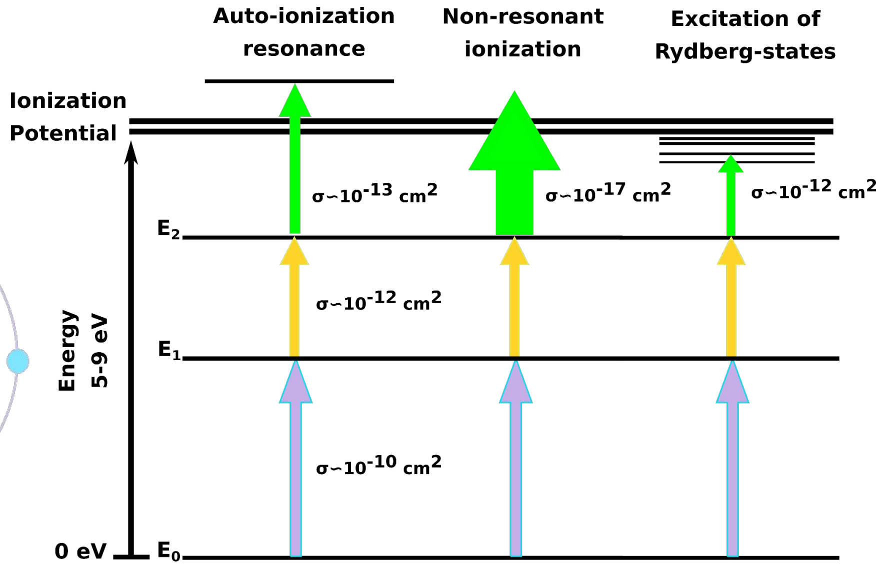
# RIALTO
# Laser ionized beams at ALTO

Anahi Segovia Miranda

Journées annuelles 2025 du GDR SCIPAC et du Réseau Instrumentation Faisceau.
16/12/2025

# Laser resonance ionization




Optical atomic excitation occurs when the laser radiation frequency matches the specific frequency of an atomic transition.

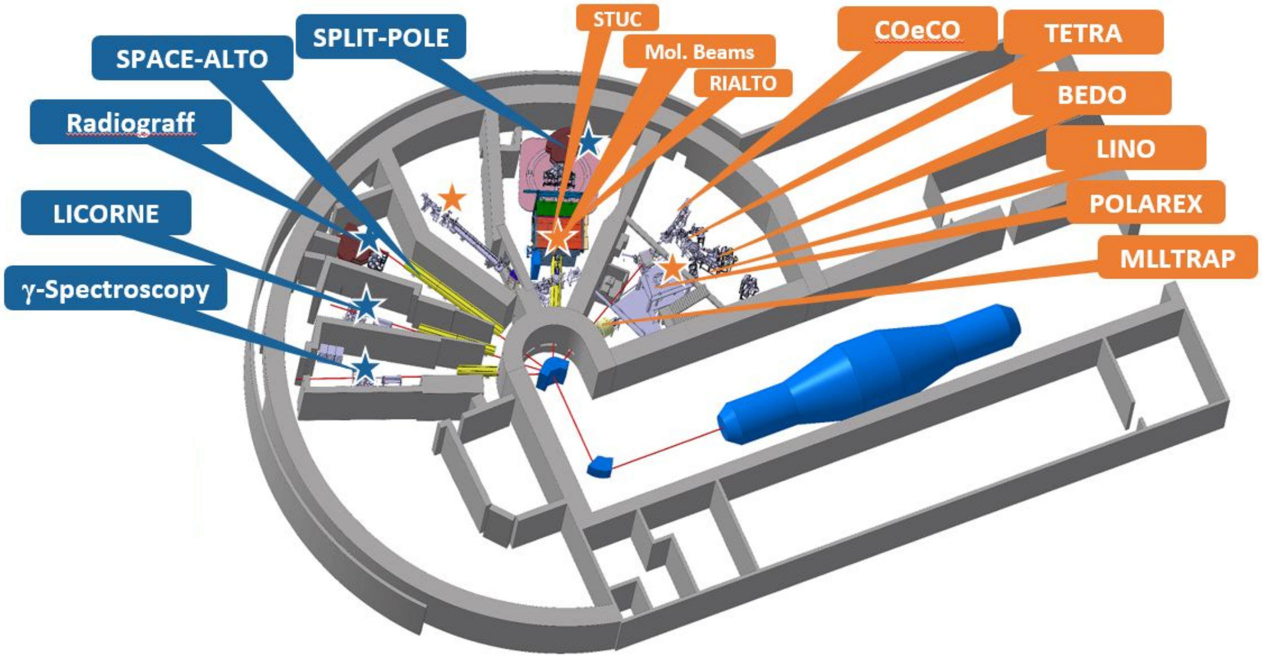
Probability of a single-step excitation process:

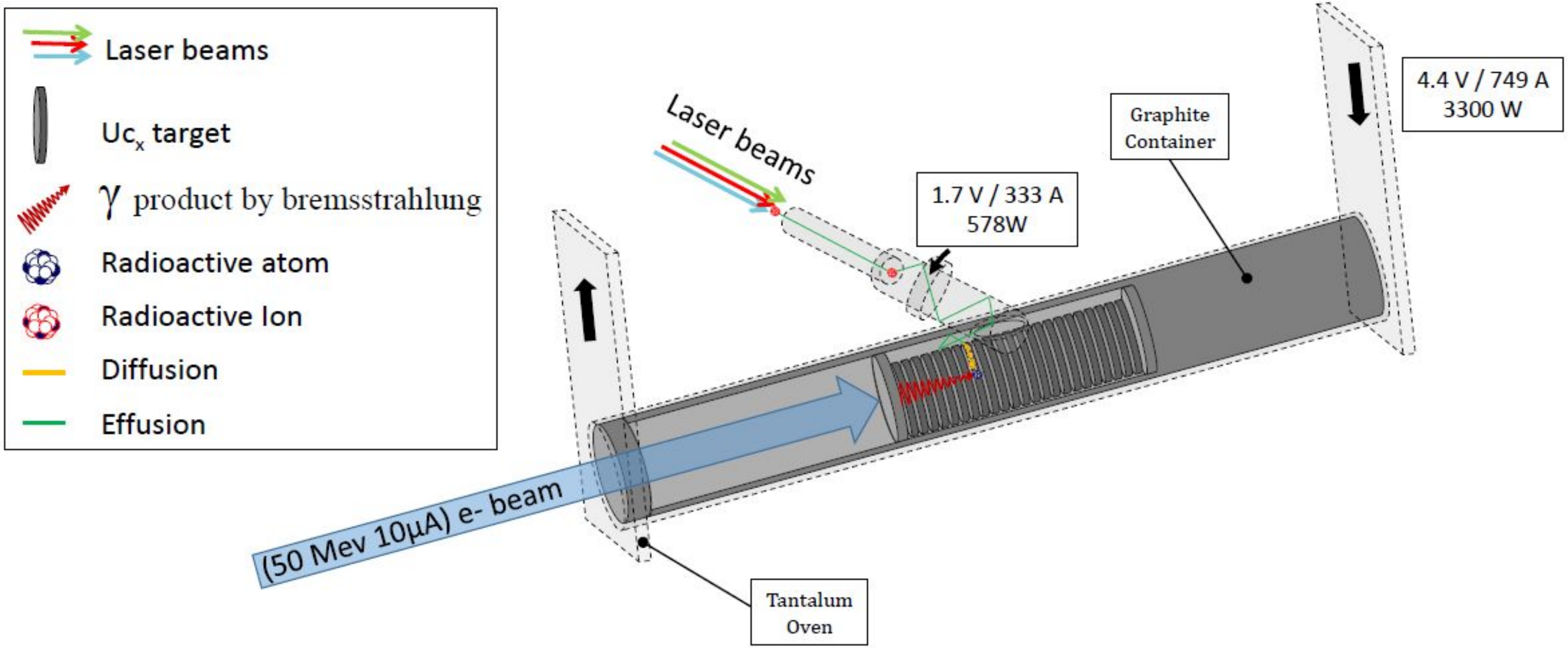
$$P = \sigma \phi_\gamma$$

P: ionization probability
$\phi_\gamma$: photon flux.

# ALTO Facility
# (Accélérateur Linéaire et Tandem d'Orsay)

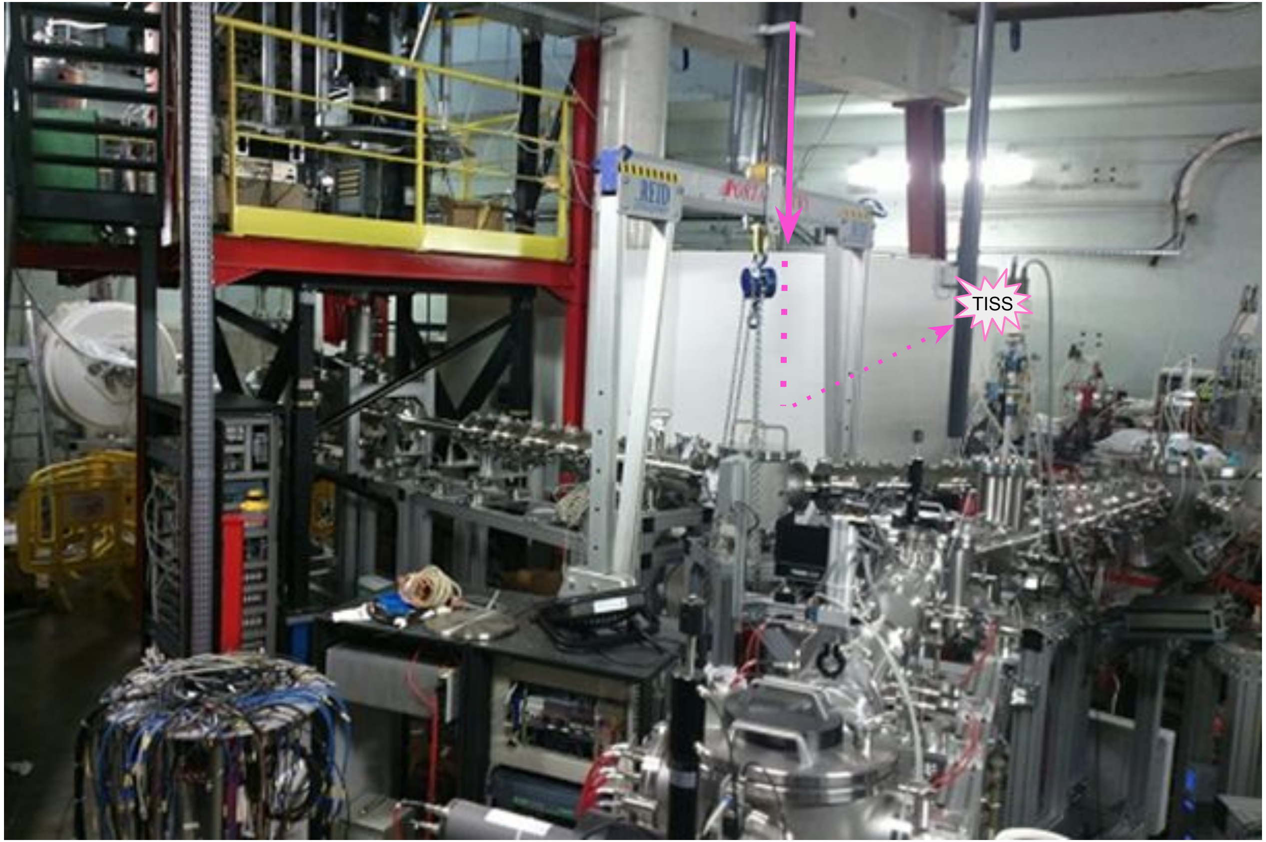
- 10 µA Electron beam accelerated at 50 MeV on a UCx target to produce **neutron-rich** radioactive nuclei by **photofission** of uranium.





Laser beams
$Uc_x$ target
$\gamma$ product by bremsstrahlung
Radioactive atom
Radioactive Ion
Diffusion
Effusion
Laser beams
1.7 V / 333 A
578W
Graphite Container
4.4 V / 749 A
3300 W
(50 Mev 10µA) e- beam
Tantalum Oven

# ALTO LEB



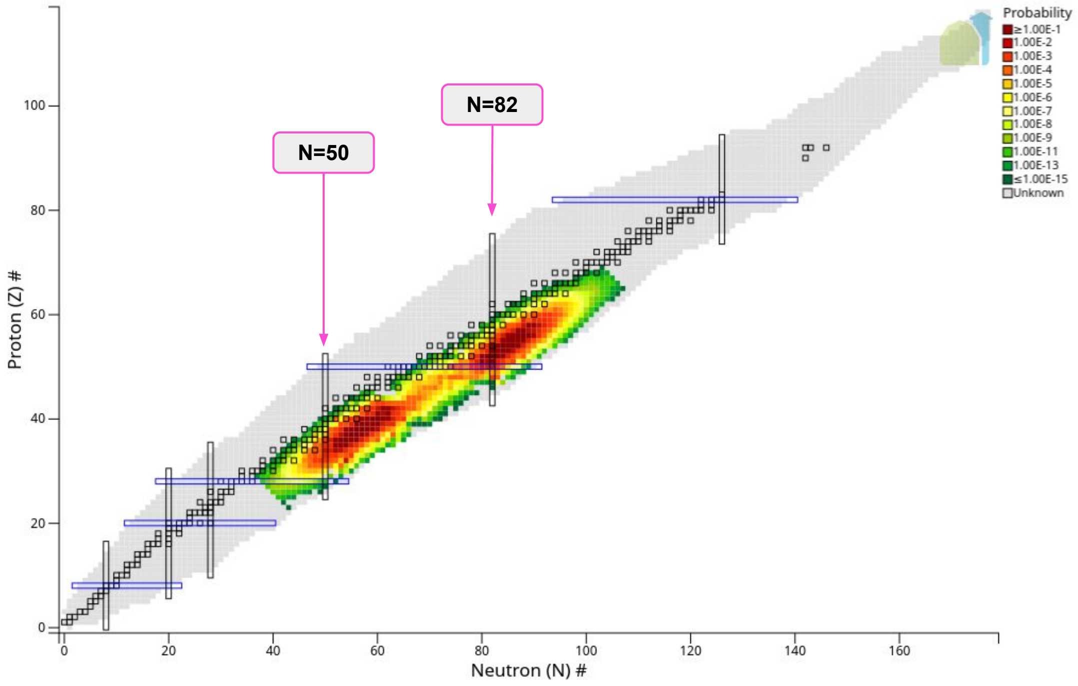
# Photofission

## Interesting regions for fission fragments:

- ❀ Nuclei near neutron shell closures: N = 50 and N = 82.

- ❀ Nuclei at the boundary of the deformation region with N > 60.

**In target production**



# Photofission at ALTO

## Interesting regions for fission fragments:

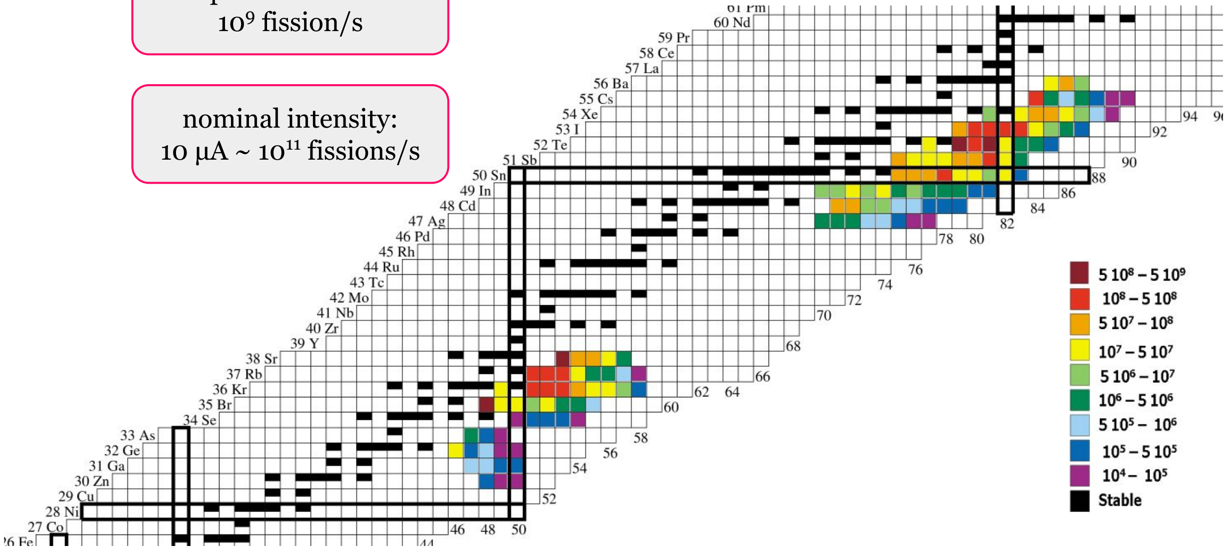
- Nuclei near neutron shell closures: N = 50 and N = 82.

- Nuclei at the boundary of the deformation region with N > 60.

Hot plasma ion source
$10^9$ fission/s

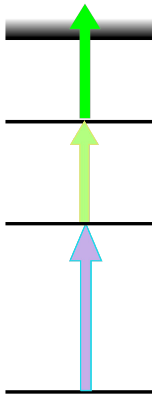
nominal intensity:
10 μA ~ $10^{11}$ fissions/s

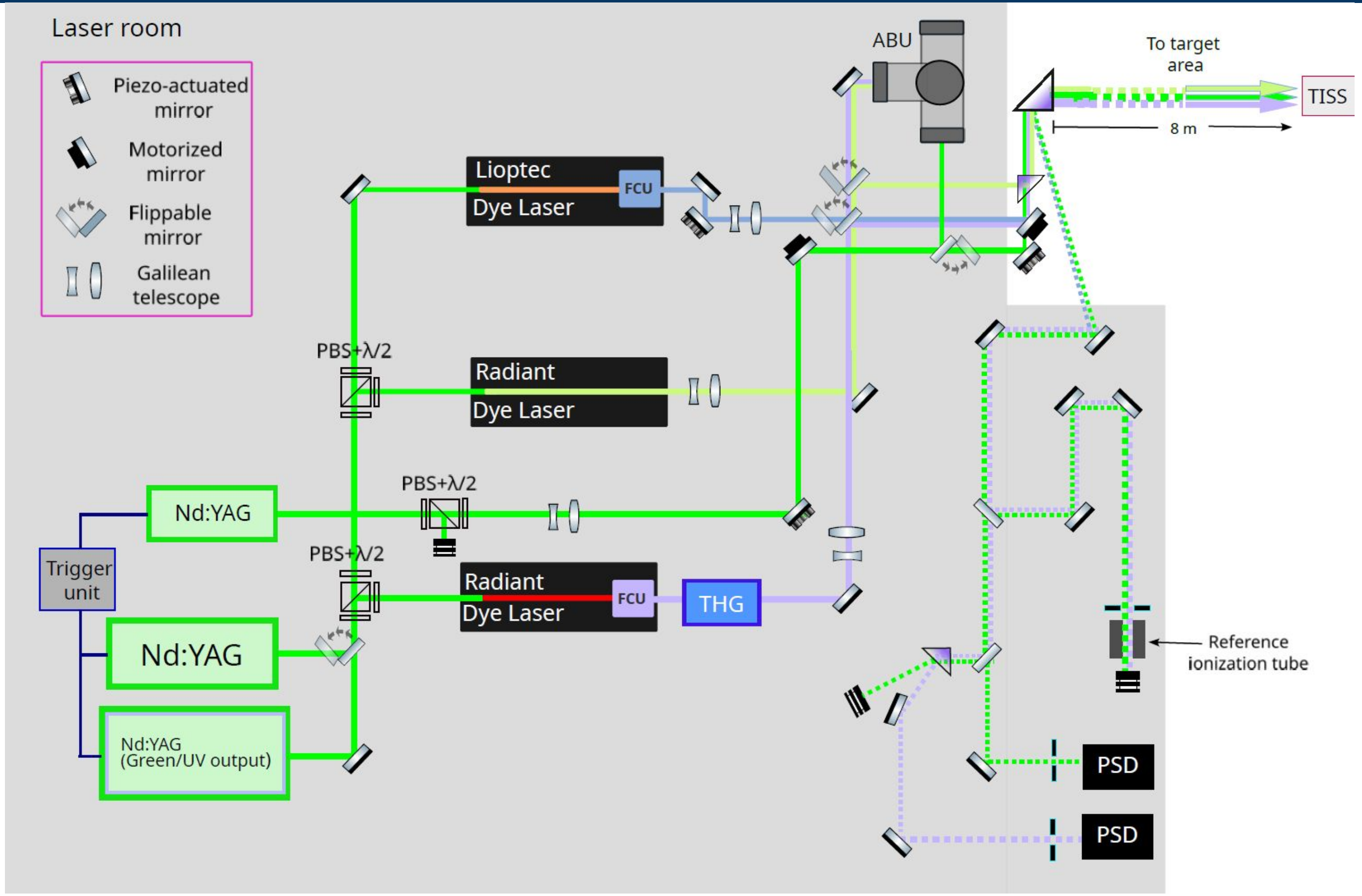
**Measured yields**




F. Ibrahim, et. al., Nuclear Physics A, 787(1):110–117, 2006.

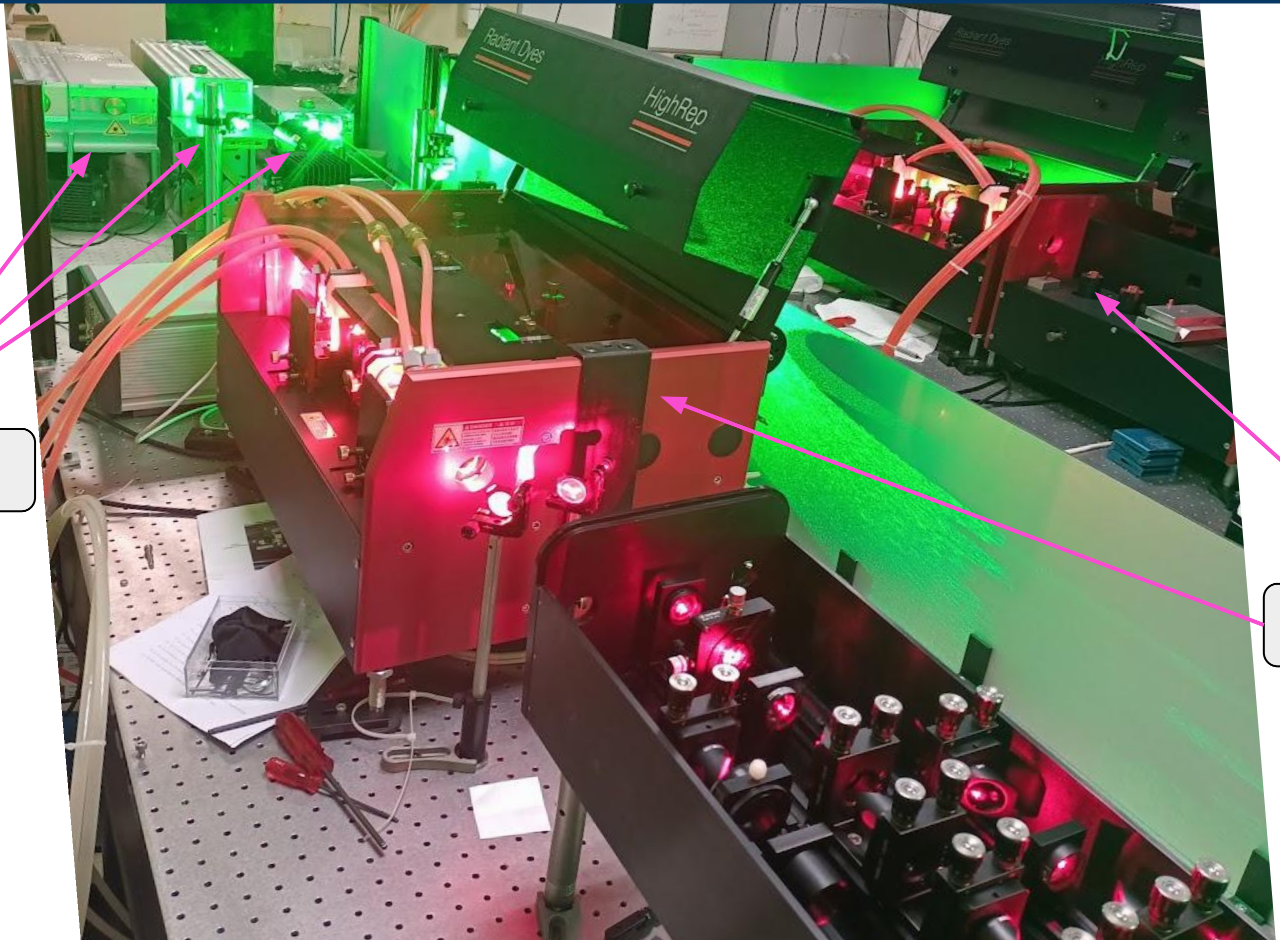
# Resonance Ionization laser ion source at ALTO (RIALTO)





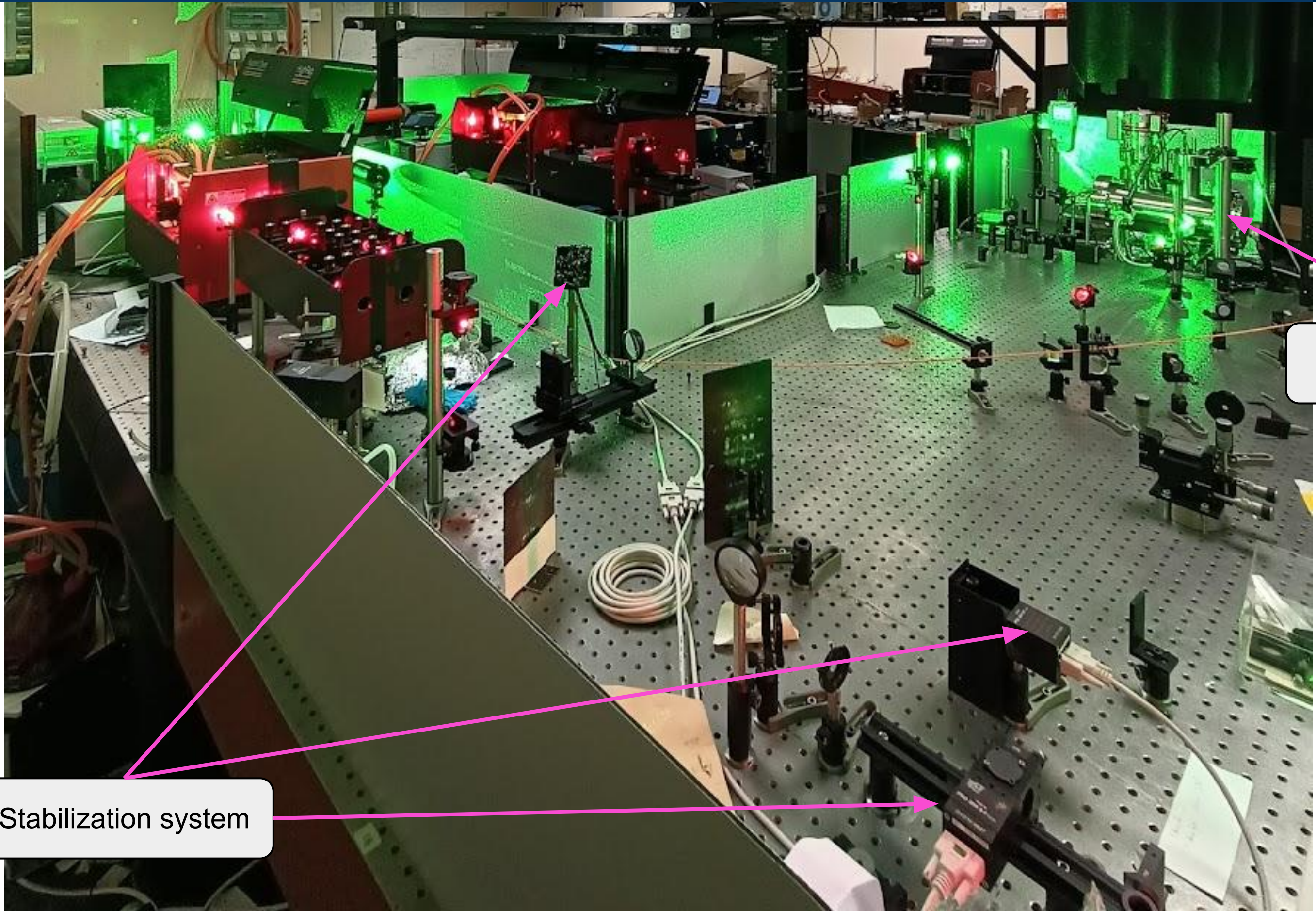
# Resonance Ionization laser ion source at ALTO (RIALTO)

High power
Nd:YAG

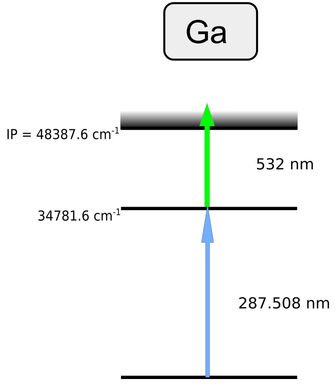


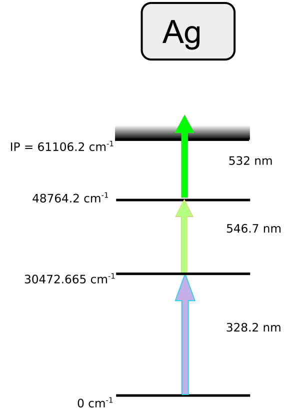

Dye lasers

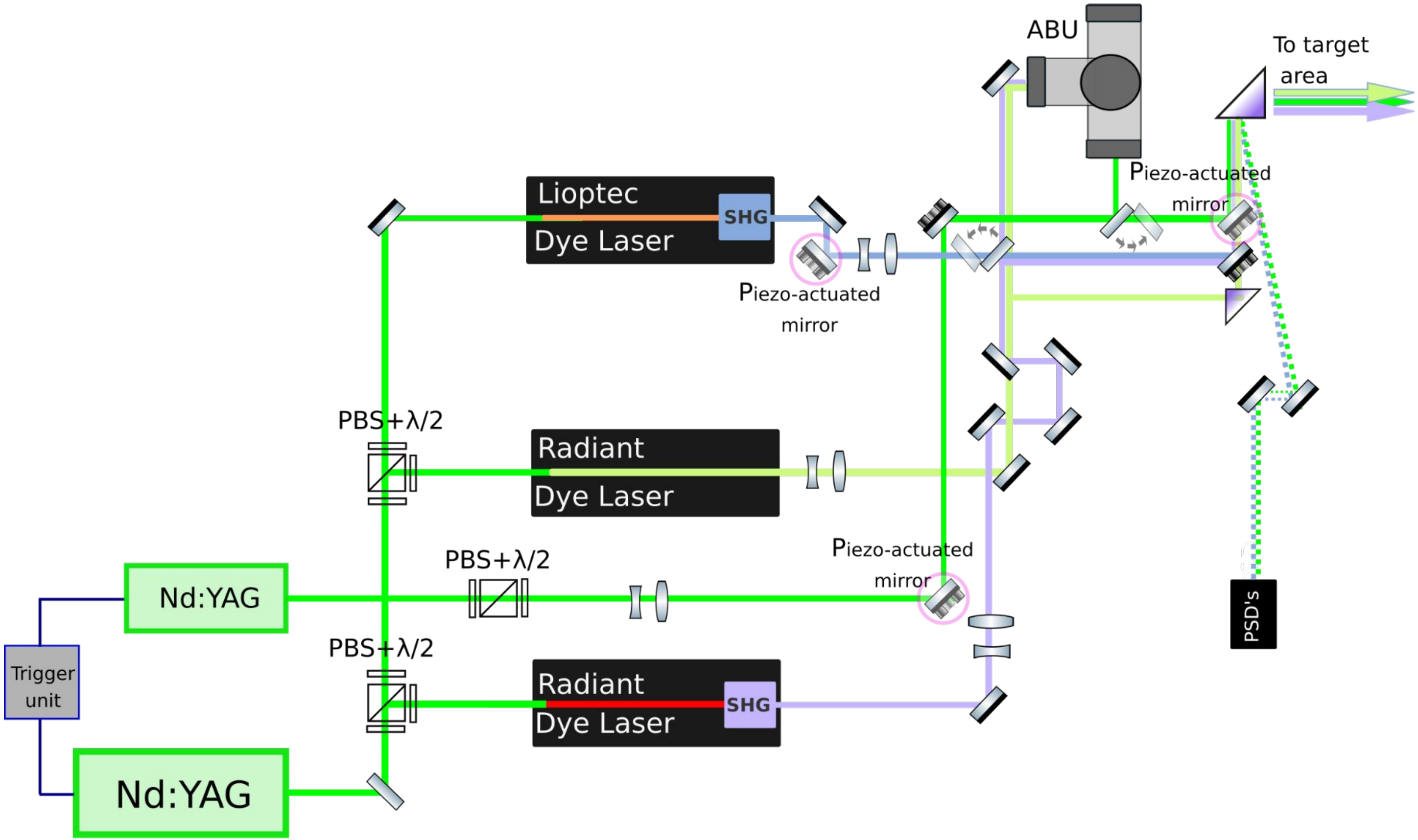
# Resonance Ionization laser ion source at ALTO (RIALTO)



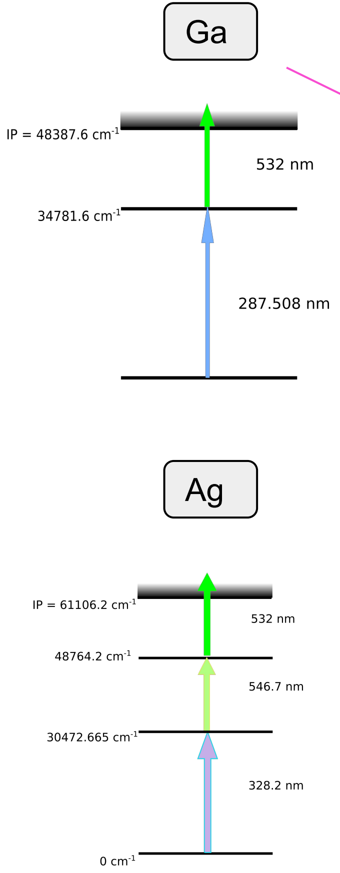
# Ionization of two elements

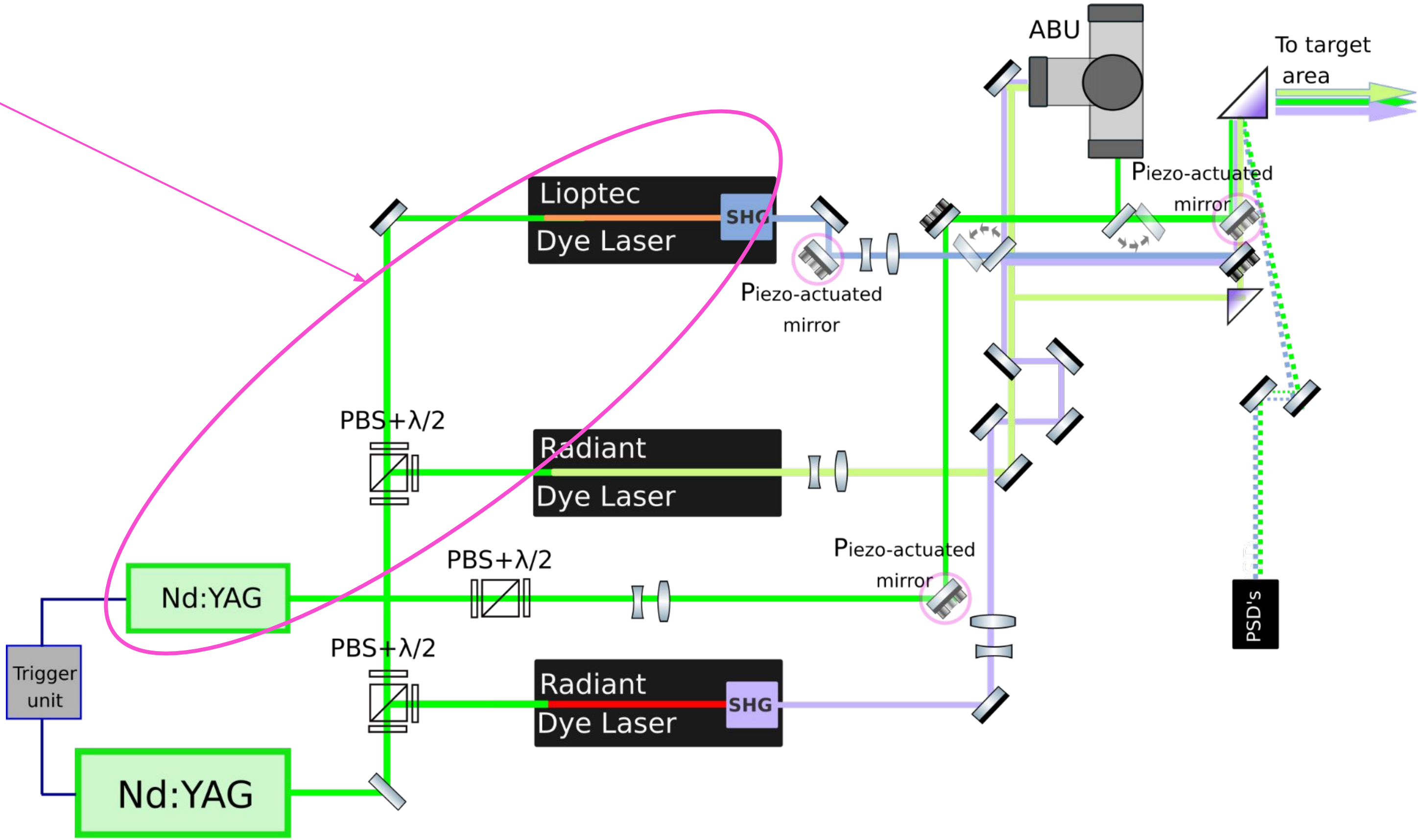


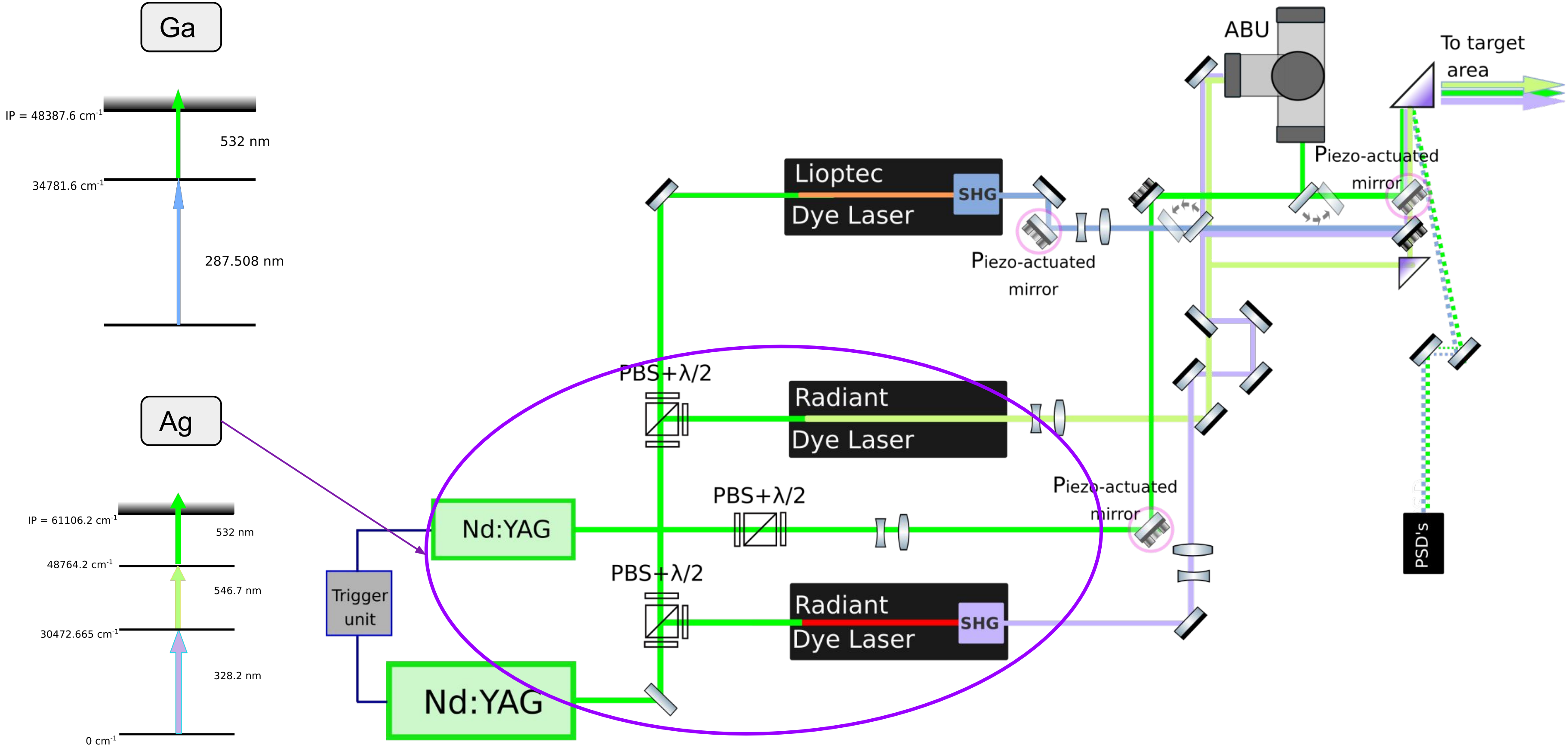



# Ionization of two elements

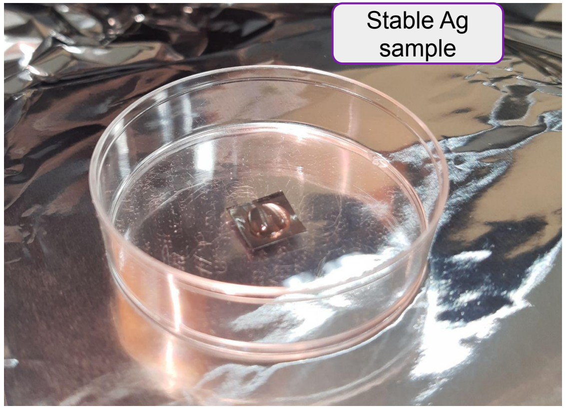


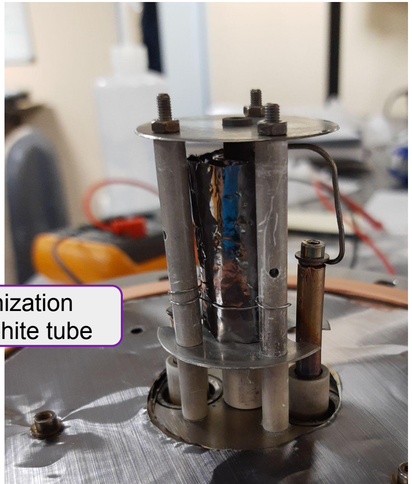



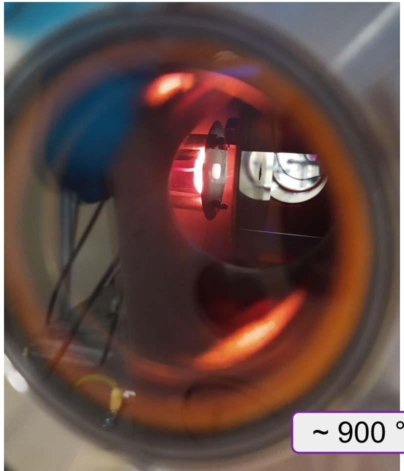
# Ionization of two elements

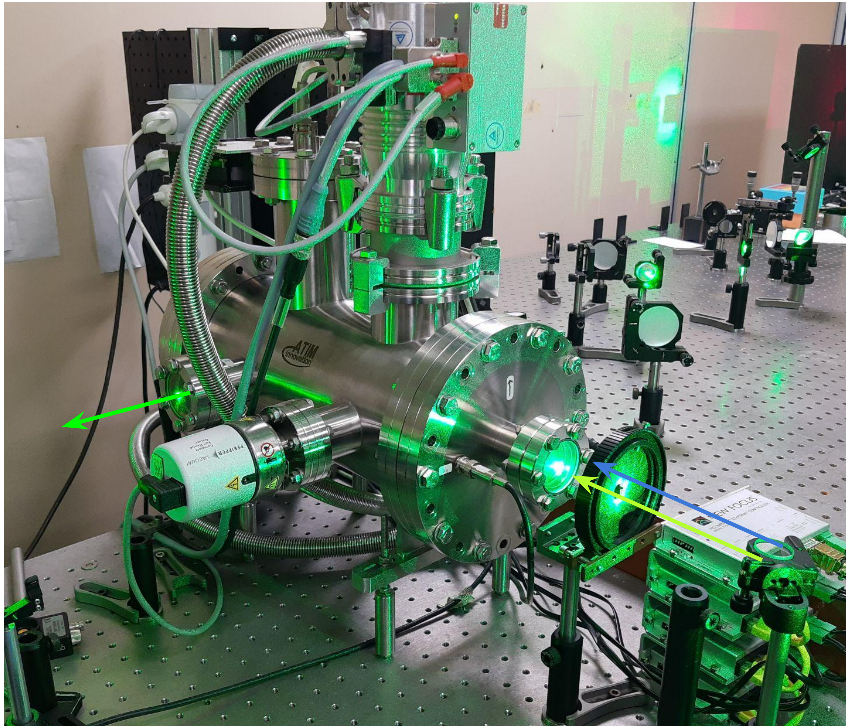


# Ag development

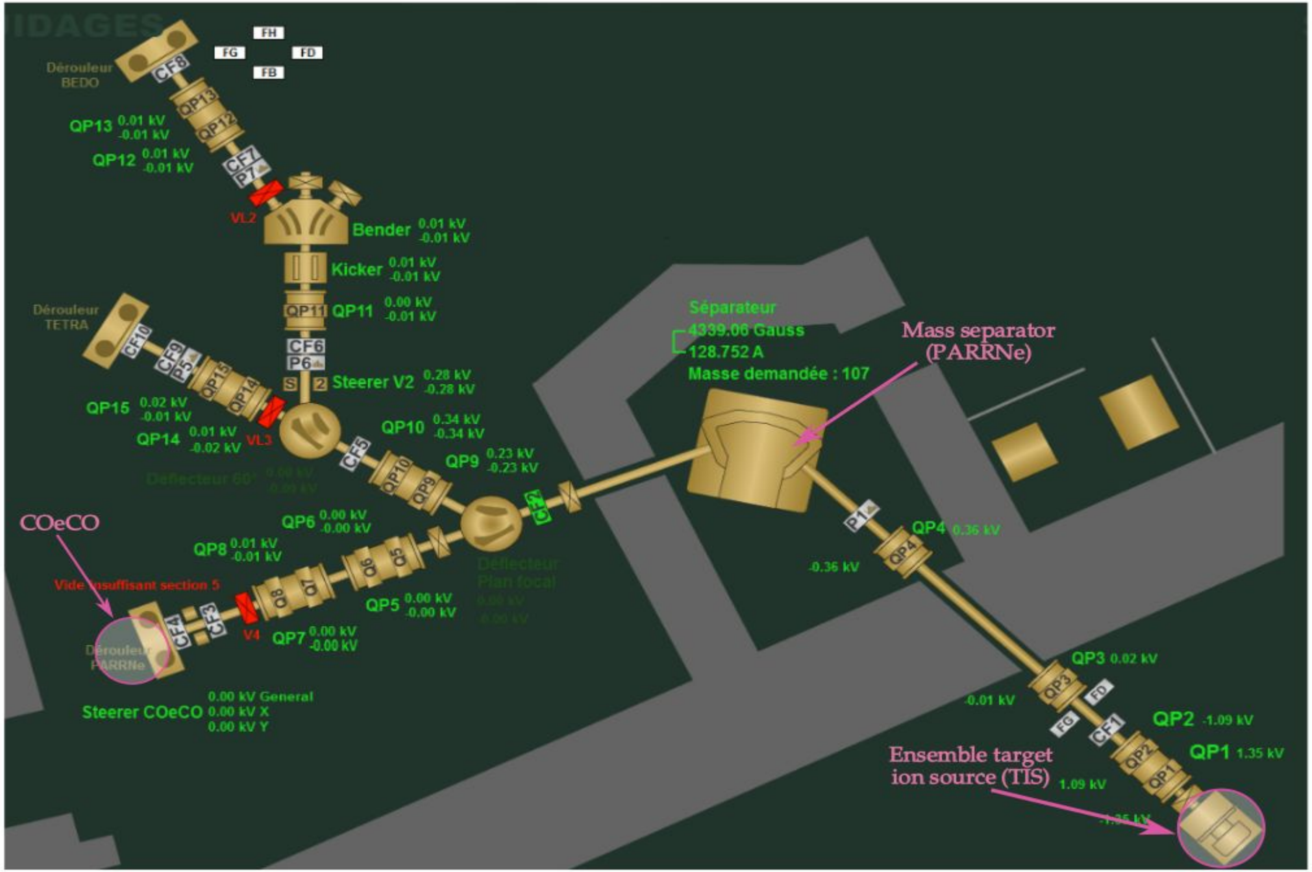


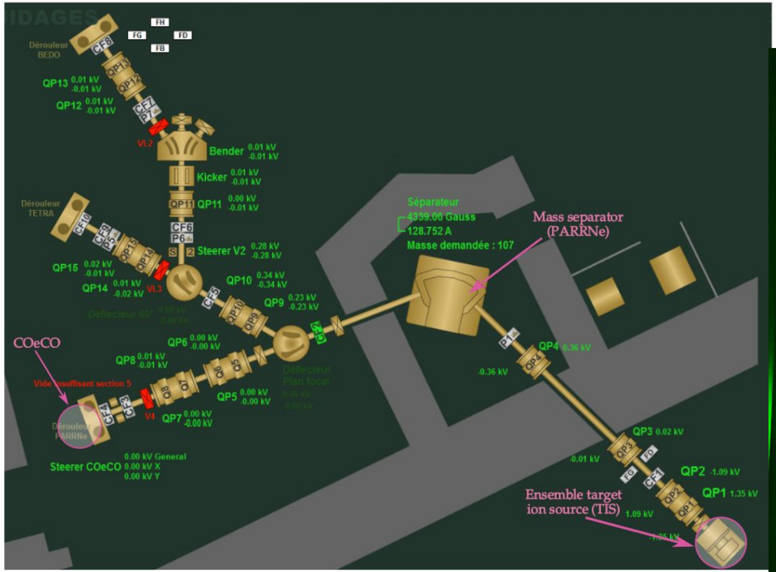



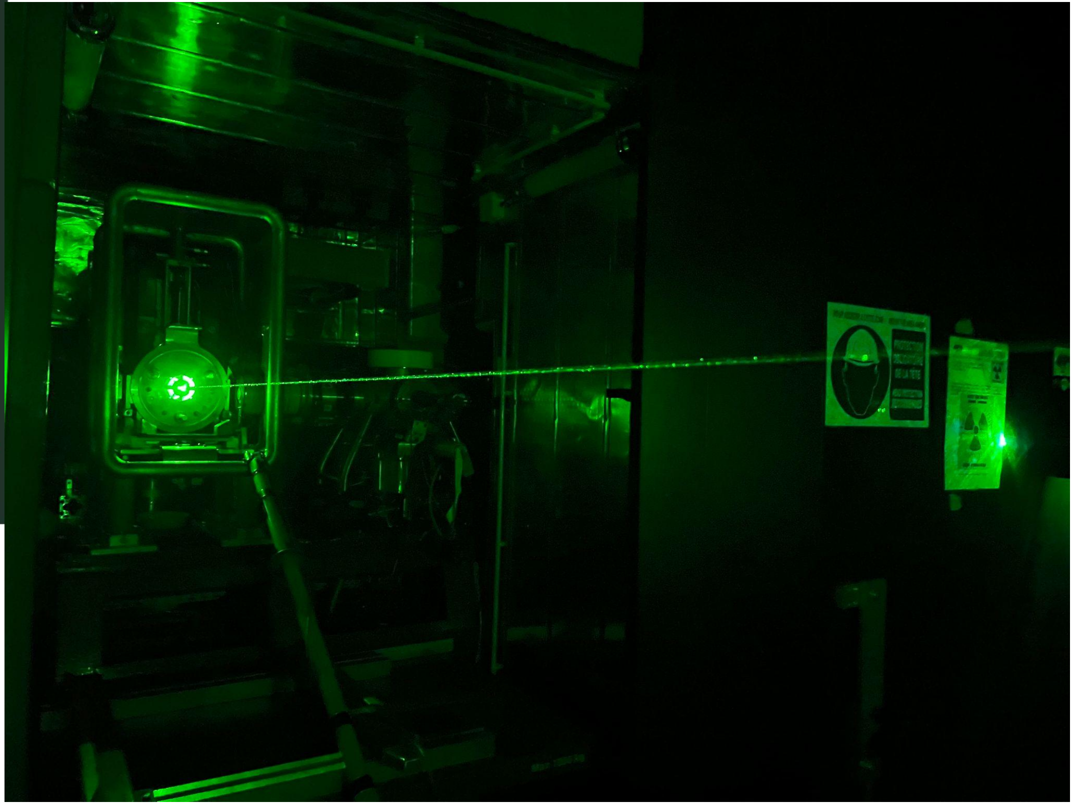



# Stable ionization "online"



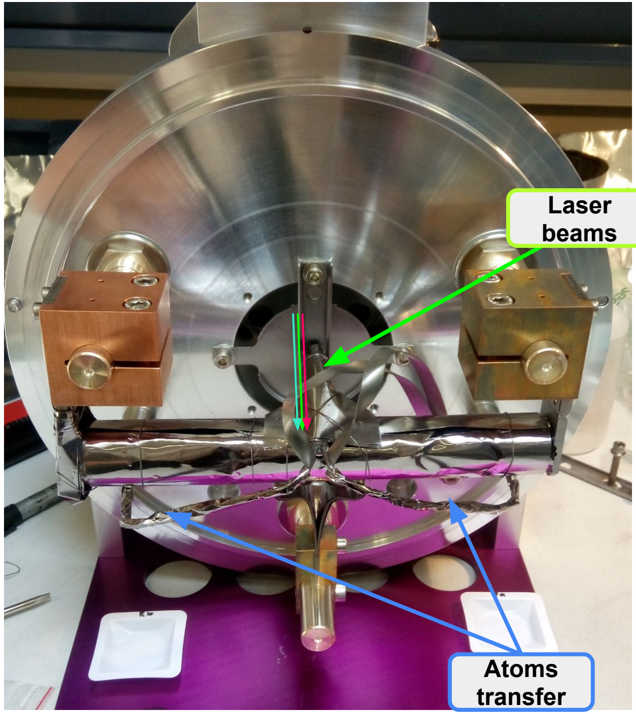
# Stable ionization “online”

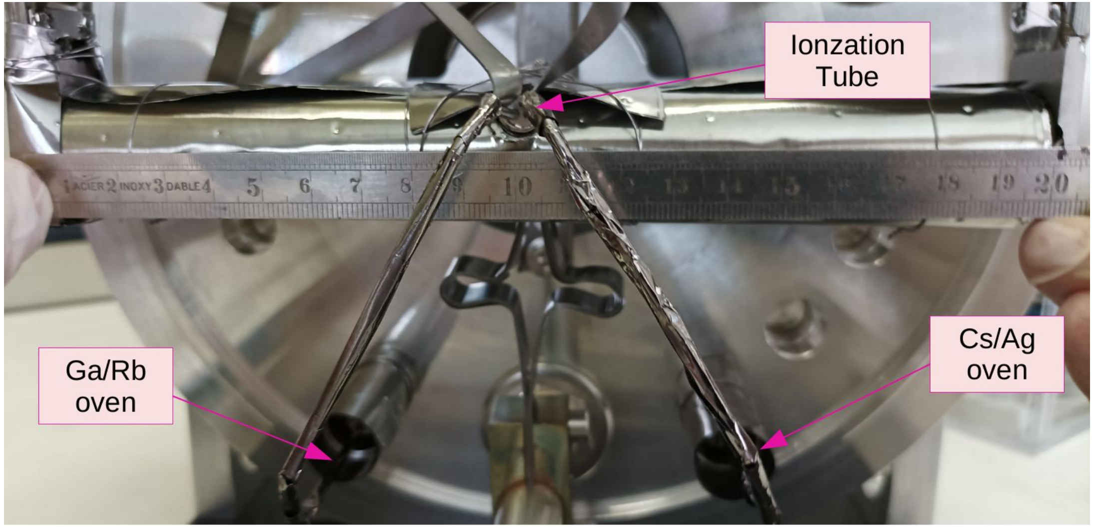


# Stable ionization online

Front-end (posterior view)

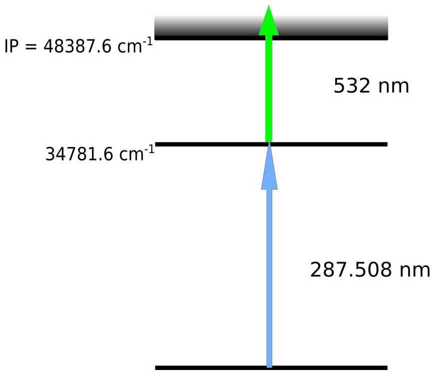


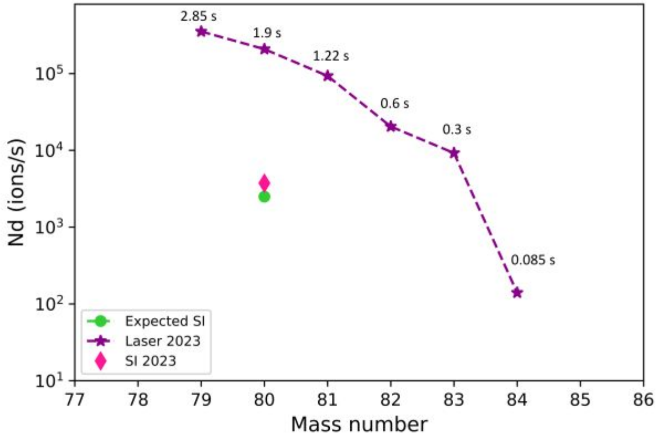




A sample is placed in a capillary oven container connected to the transfer line.

# Laser ionized beams at ALTO

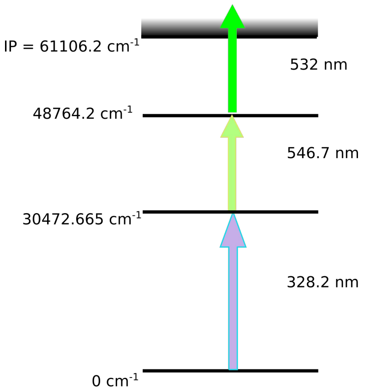
Ga

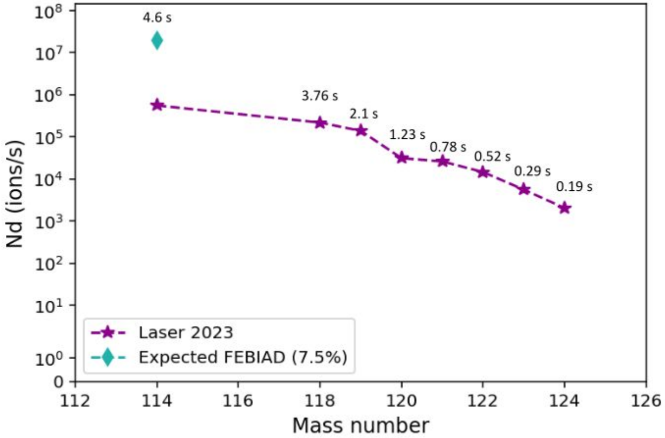



Ionization efficiency 0.5%

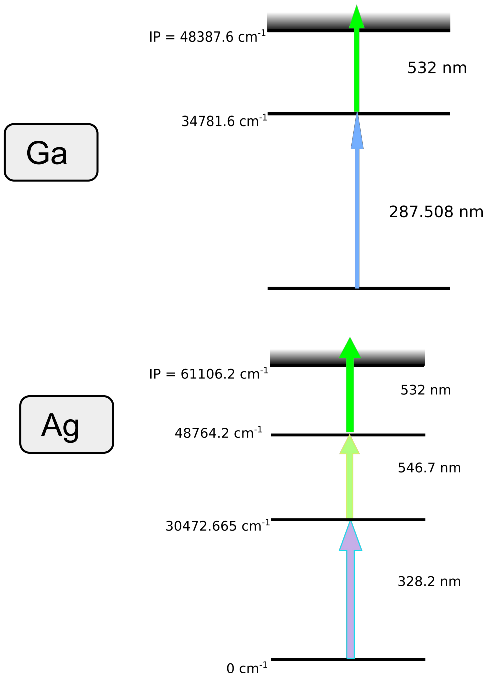
Ag

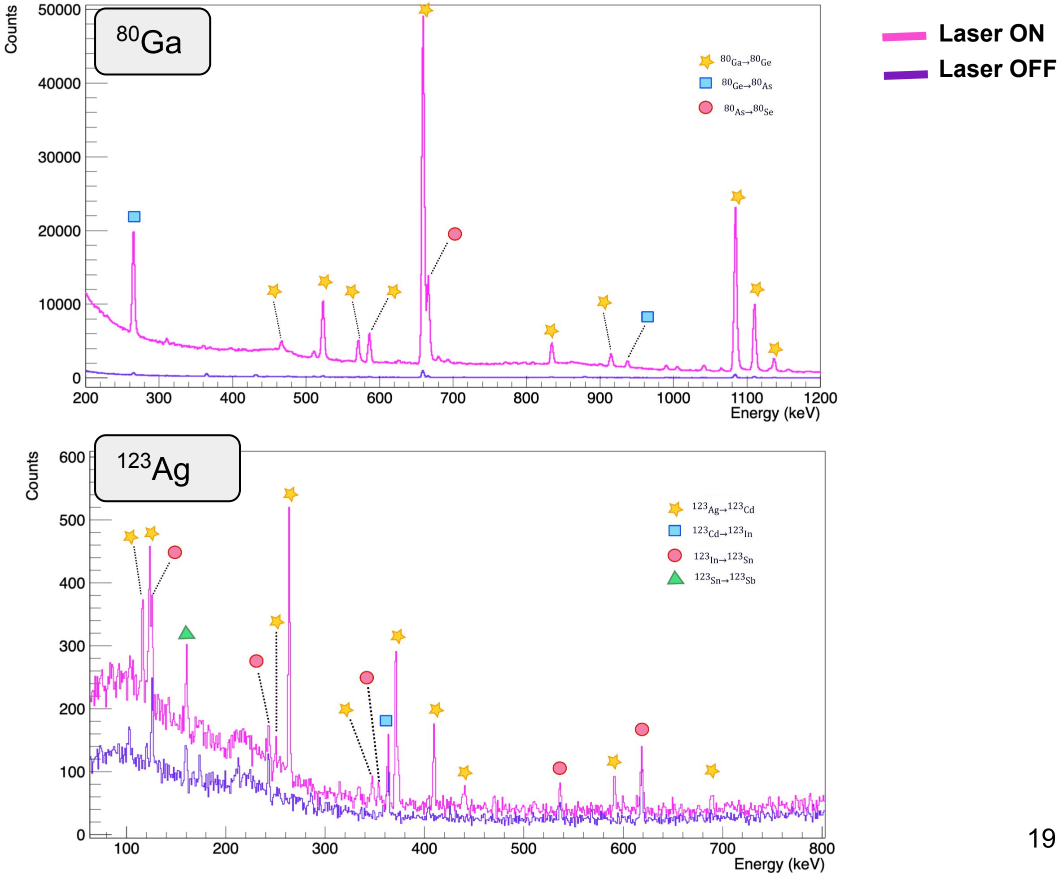



Ionization efficiency 0.21%

# Laser ionized beams at ALTO



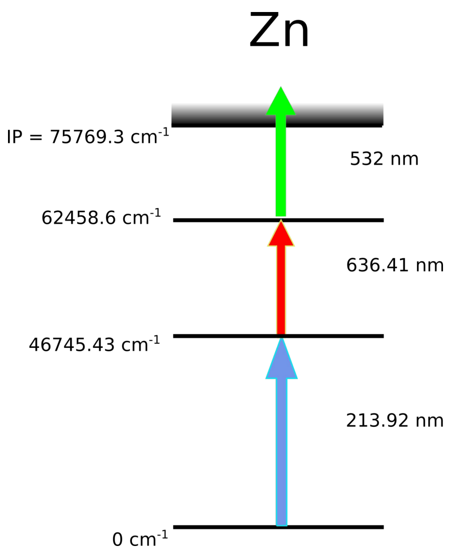



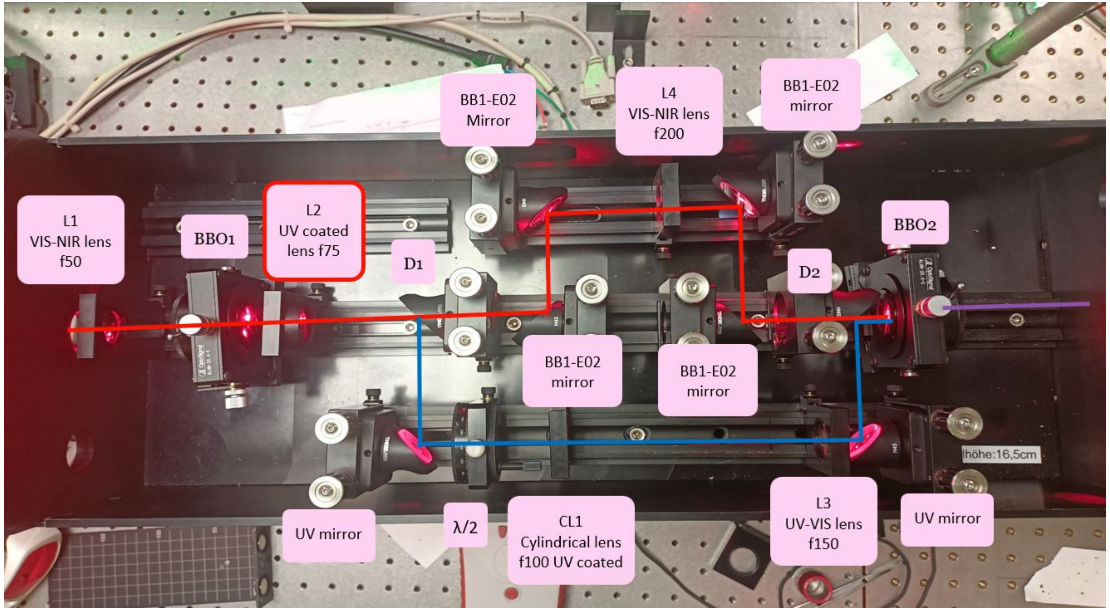

A. Segovia-Miranda et al., "Upgrades of the RIALTO facility and recent laser-ionized beams of radioactive gallium and silver isotopes", Nuclear Instruments and Methods in Physics Research A 1080 (2025) 170785

# Zn development

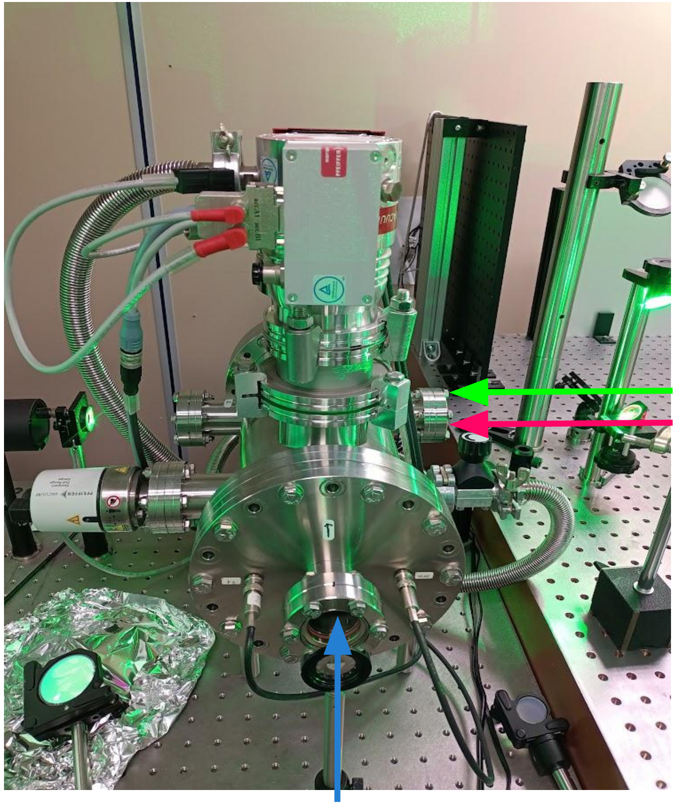
## ❀ Neutron-rich Zn program

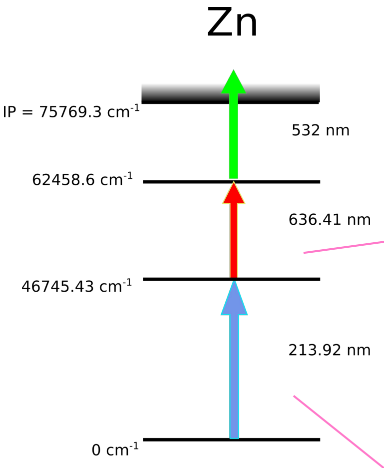
- ⋆ Monster (February 2025)

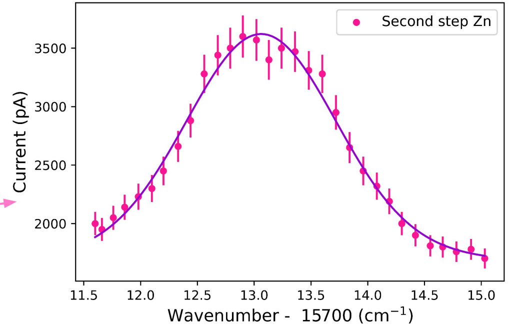


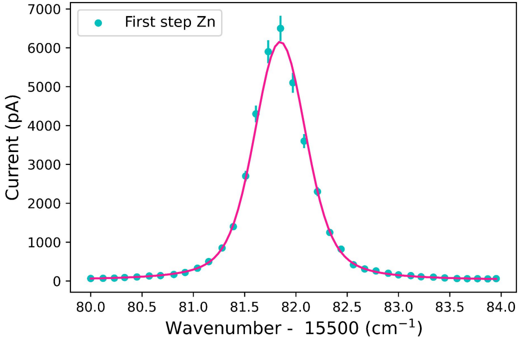



# Zn offline test



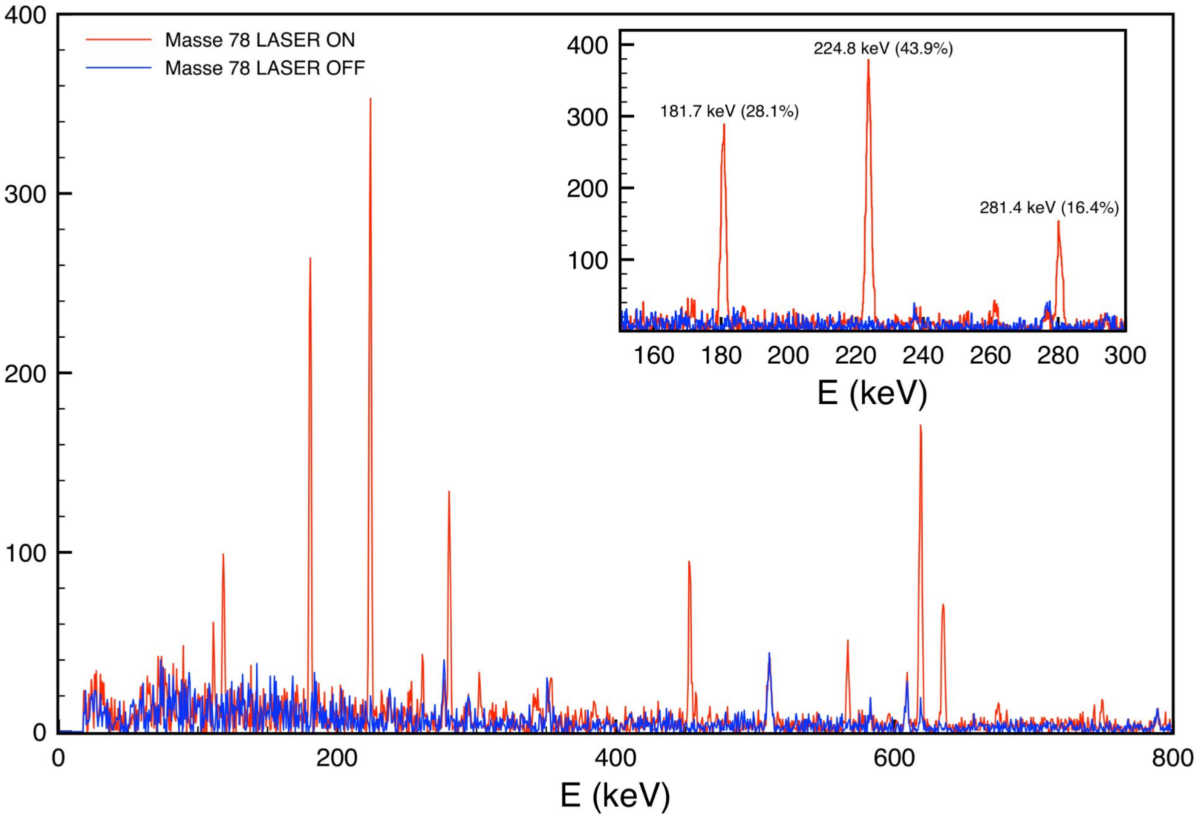


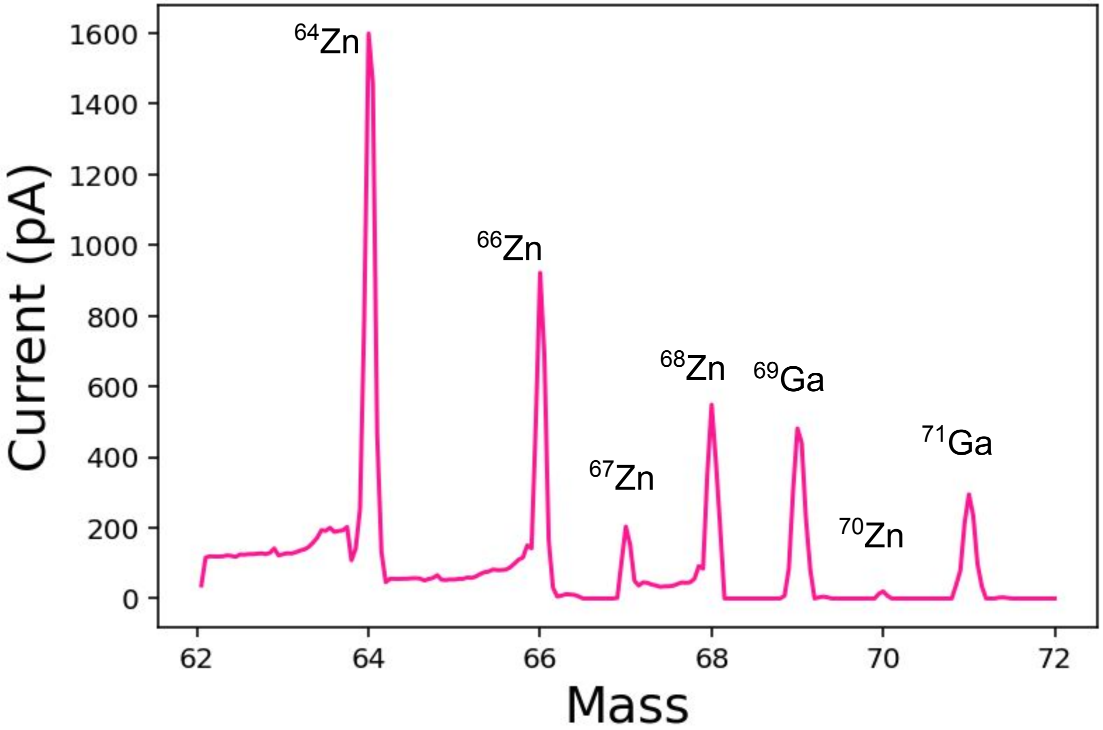




- 60 mW UV

# Radioactive Zn production 2025

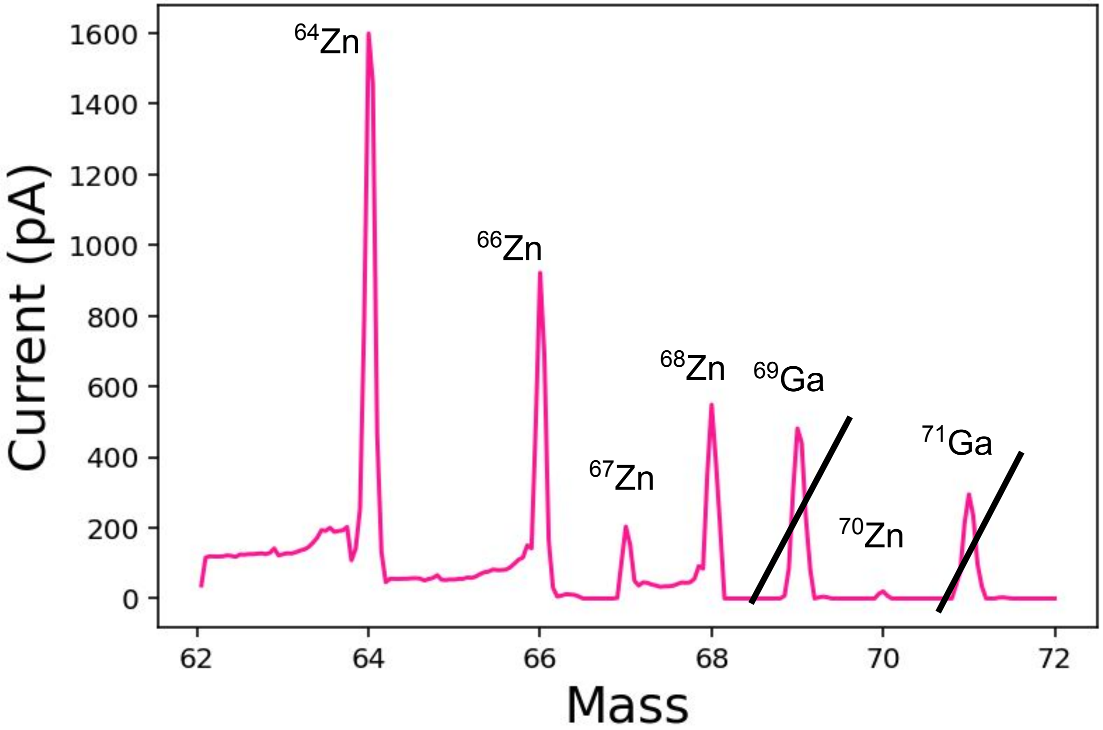


# Perspectives




- Ta ionization tube

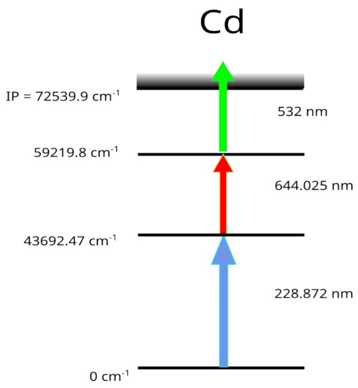
# Perspectives




- Quartz ionization tube

# Perspectives

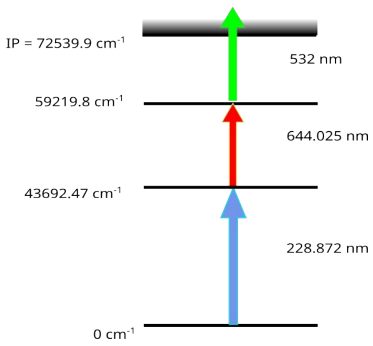
- Future beams
  - 2026 BEDO/COeCO



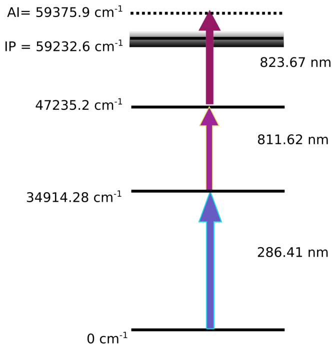
# Perspectives

- Future beams

Cd

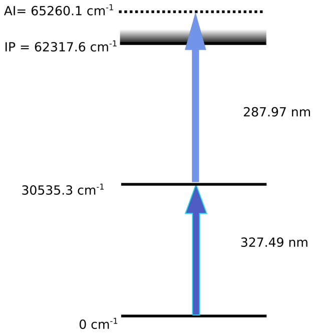



Sn

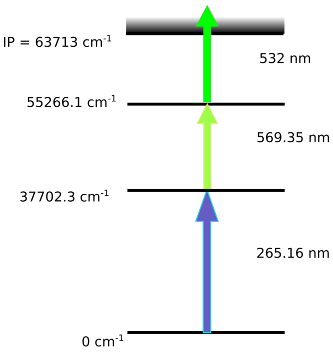



COeCO

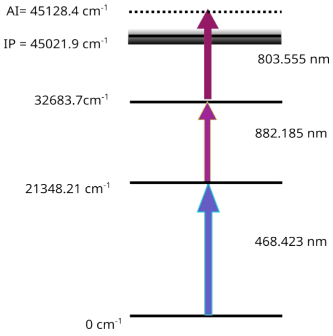
Cu




Ge




Pm

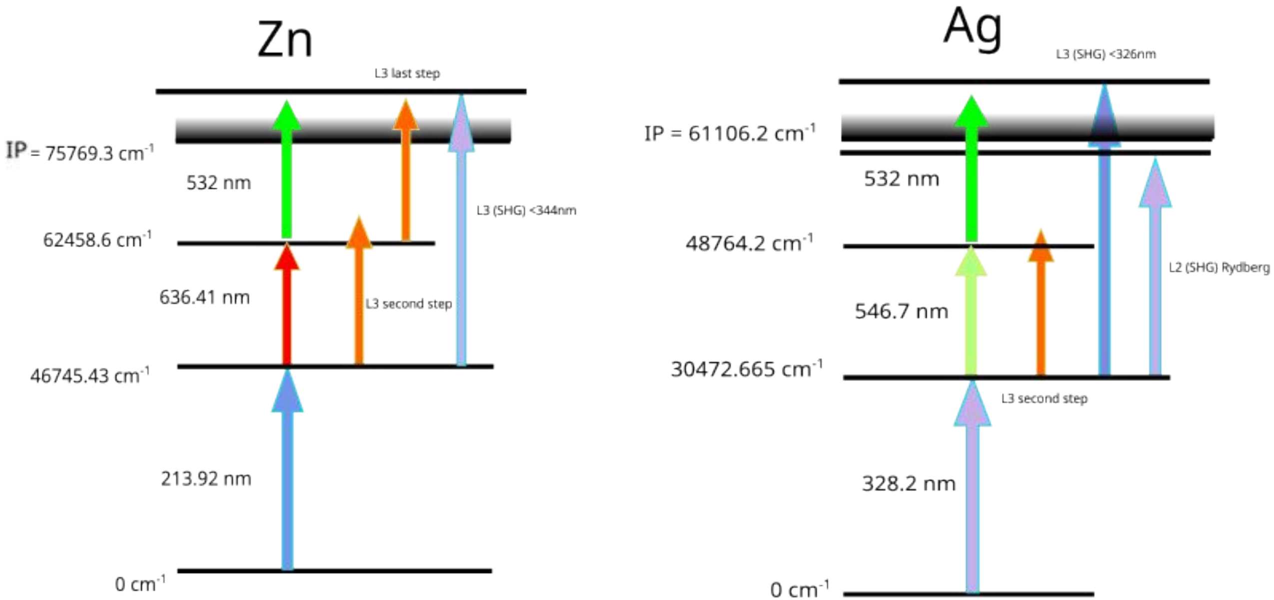



BEDO

POLAREX

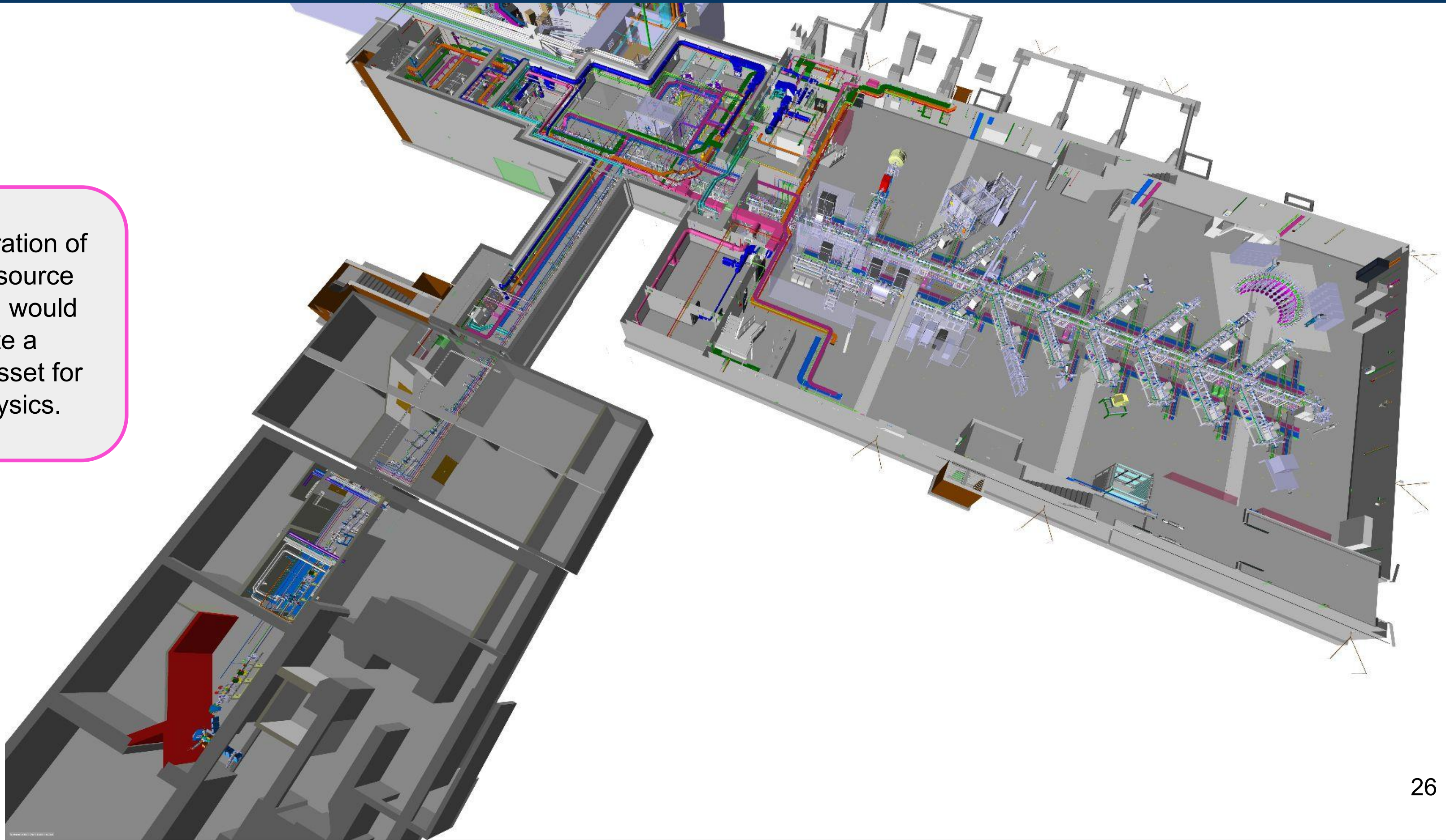
# Scheme development with RIALTO (phase 2)

- Autoionizing States



# SPIRAL 1 / DESIR

The incorporation of a laser ion source into Spiral 1 would constitute a significant asset for DESIR physics.



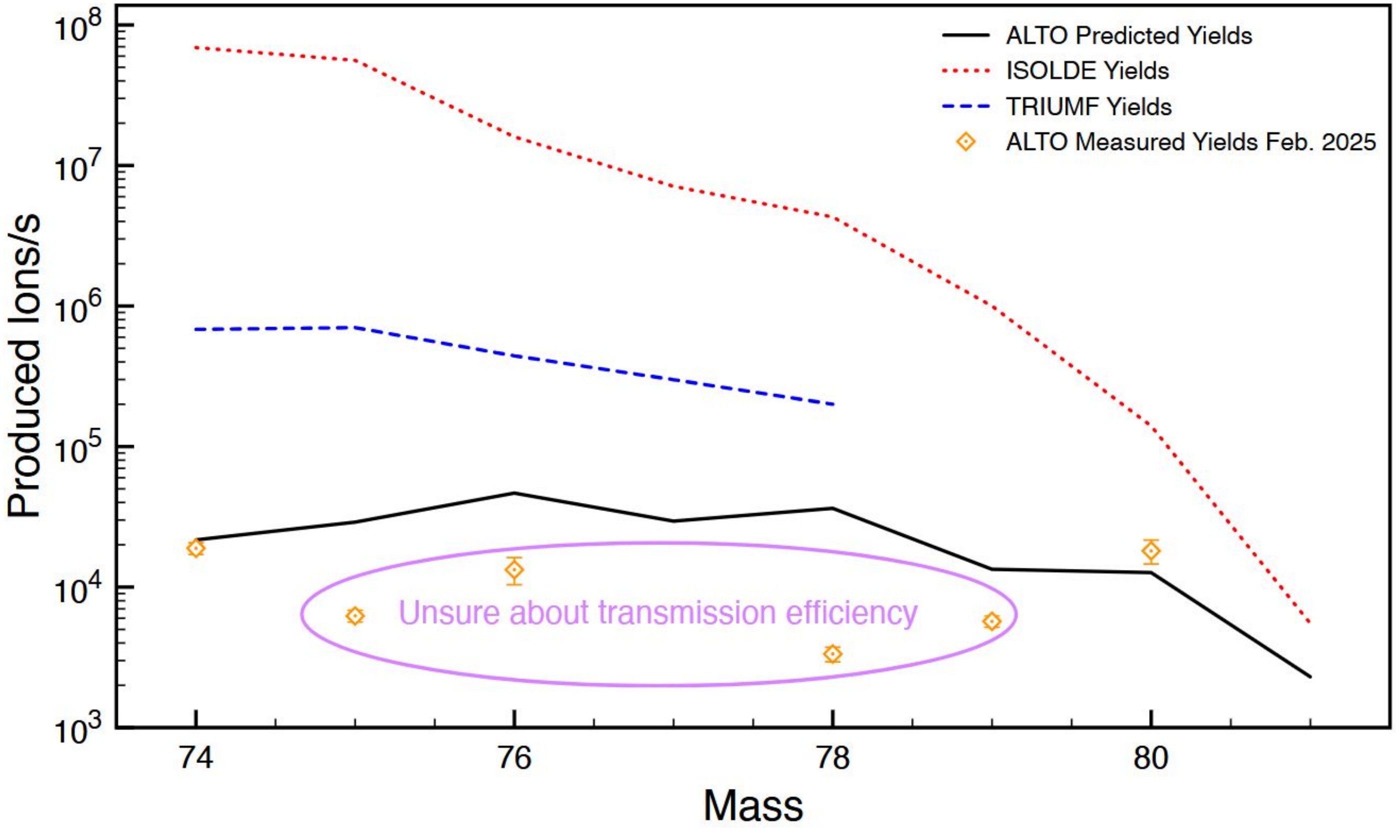
# Acknowledgments

IJCLab
Irène Joliot-Curie
Laboratoire de Physique des 2 Infinis

ALTO
Accélérateur Linéaire et Tandem à Orsay

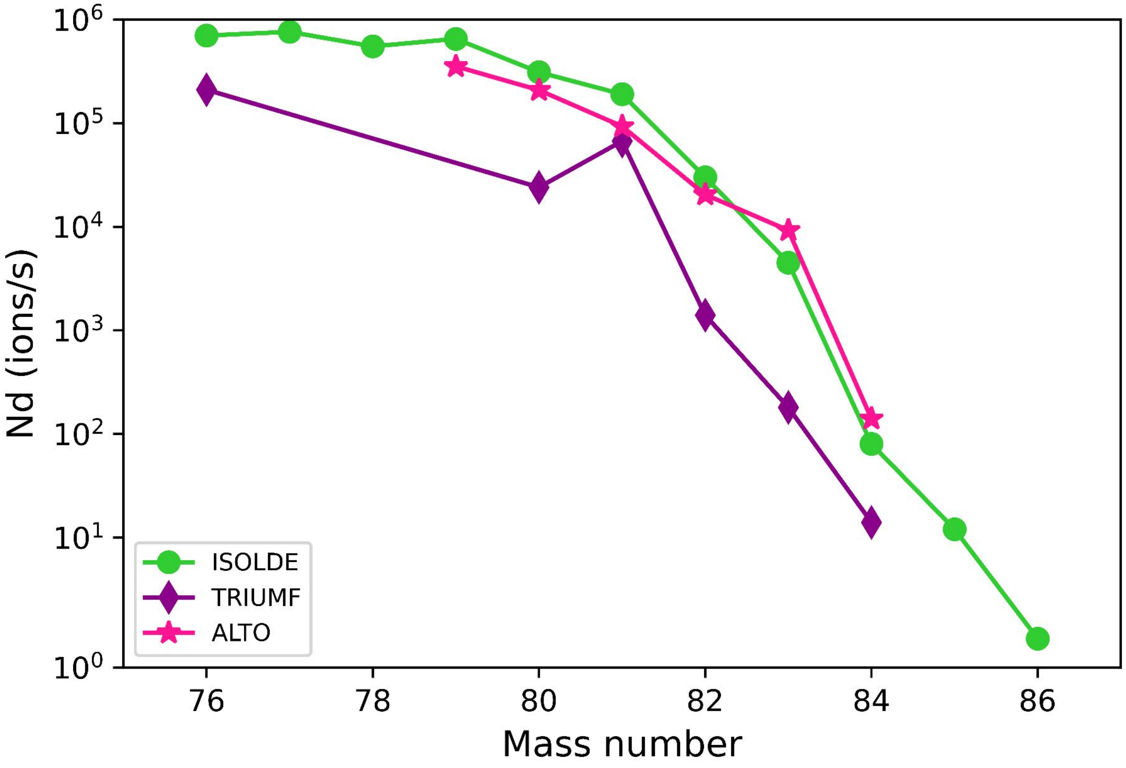
Thank you for your attention

# Zn yields



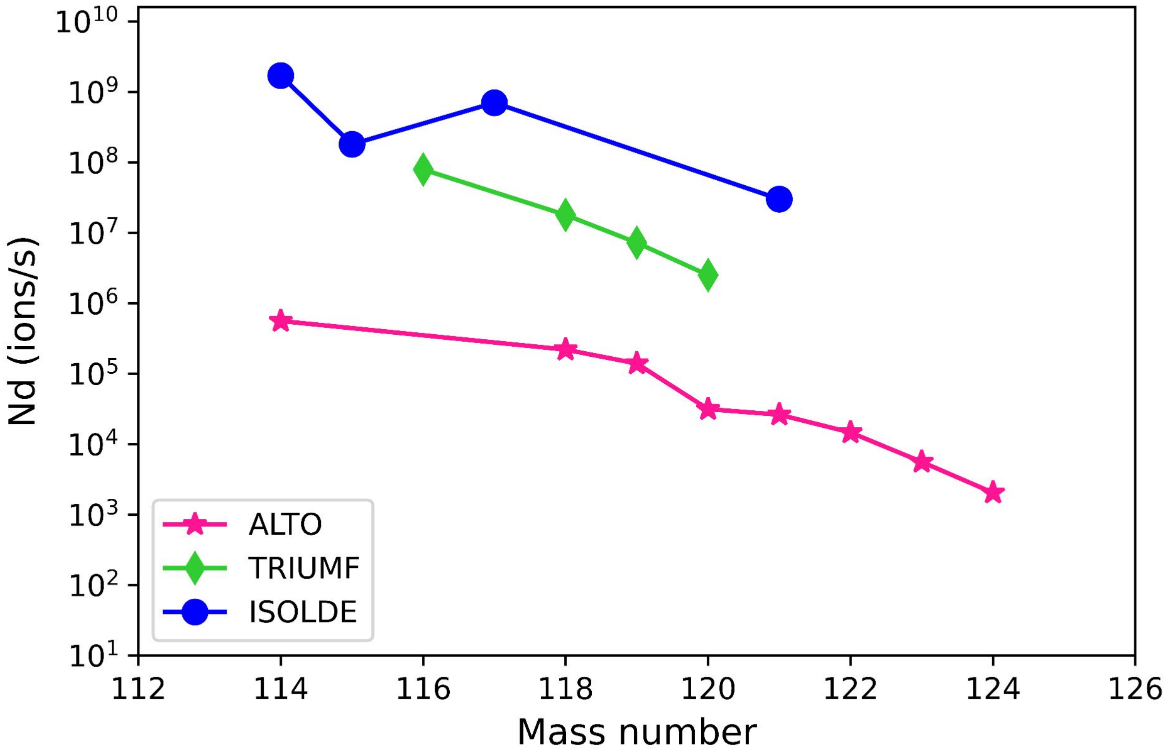
ALTO Predicted Yields
ISOLDE Yields
TRIUMF Yields
ALTO Measured Yields Feb. 2025
Unsure about transmission efficiency
Produced Ions/s
Mass
$10^8$
$10^7$
$10^6$
$10^5$
$10^4$
$10^3$
74
76
78
80

# Ga yields



$10^6$
$10^5$
$10^4$
$10^3$
$10^2$
$10^1$
$10^0$
Nd (ions/s)
76
78
80
82
84
86
Mass number
ISOLDE
TRIUMF
ALTO

# Ag yields



$10^{10}$
$10^{9}$
$10^{8}$
$10^{7}$
$10^{6}$
$10^{5}$
$10^{4}$
$10^{3}$
$10^{2}$
$10^{1}$
Nd (ions/s)
112
114
116
118
120
122
124
126
Mass number
ALTO
TRIUMF
ISOLDE