



Latest production and future beams at ALTO



Anahi Segovia Miranda

ISOL France 2024

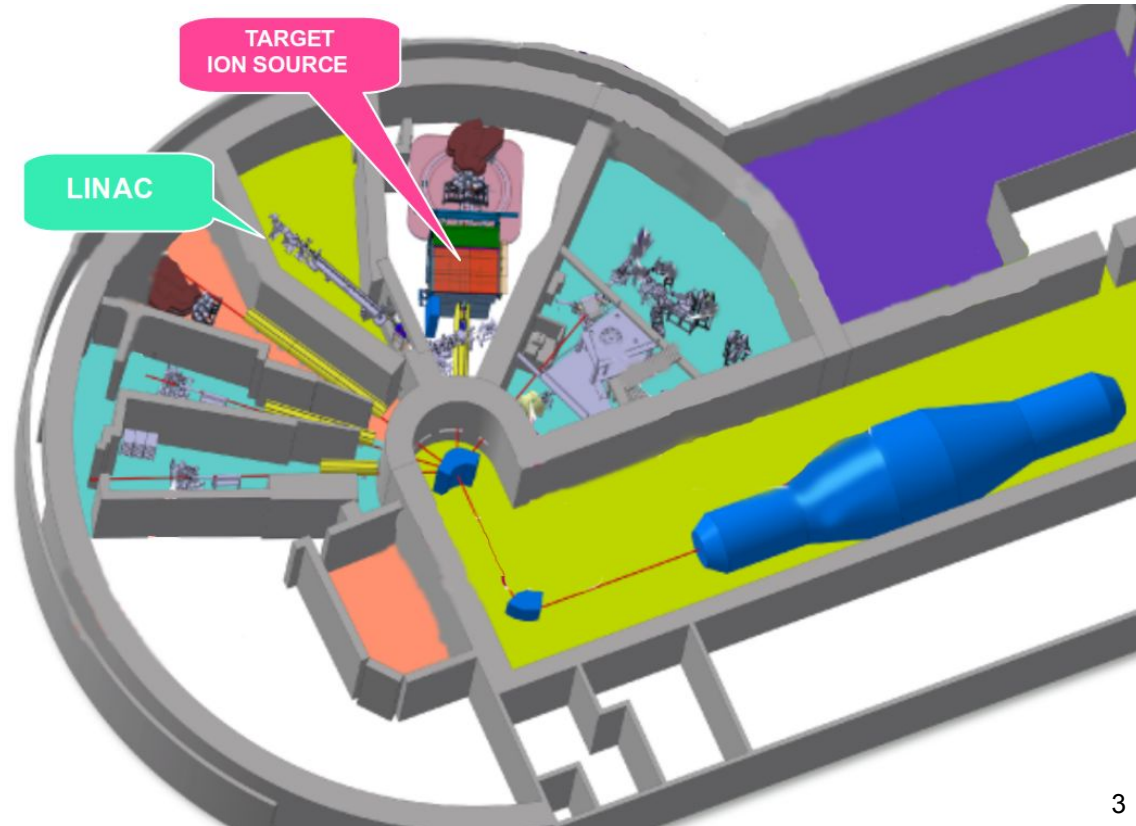
27/05/2024

Outline

- ✿ ALTO Facility
- ✿ TIS upgrade
- ✿ RIALTO upgrade
- ✿ Radioactive Ga and Ag production
- ✿ Future beams
 - * Zn beam development

ALTO Facility (Accélérateur Linéaire et Tandem d'Orsay)

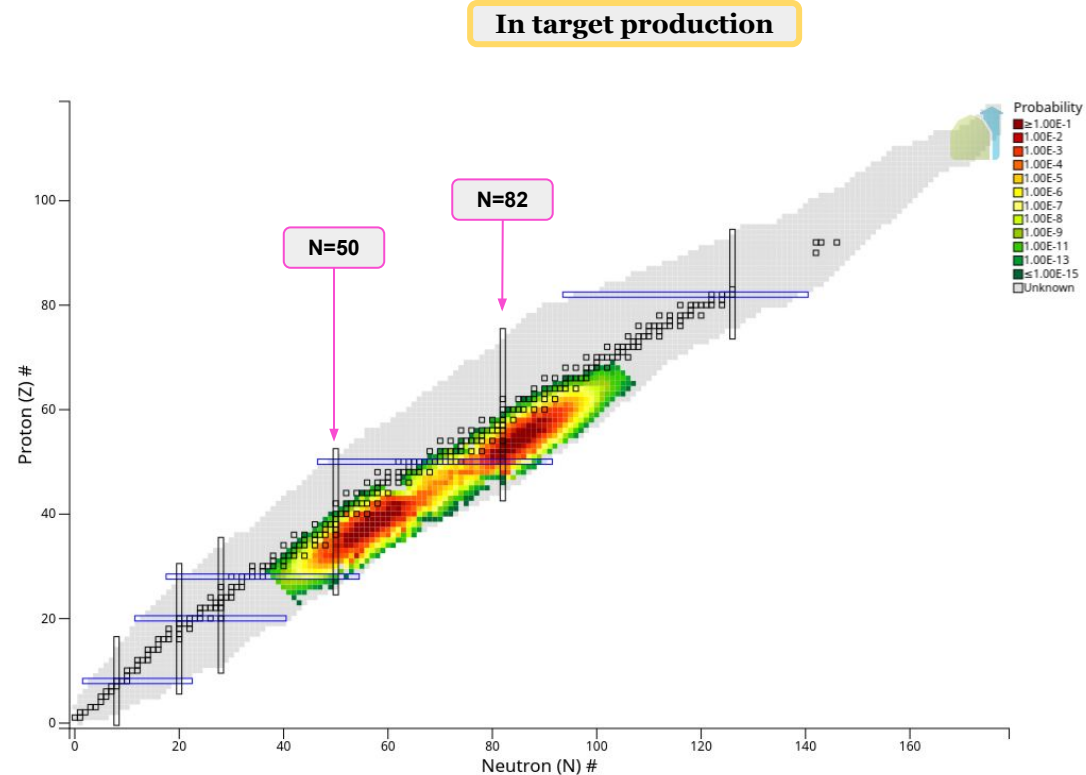
- ✿ 10 μA Electron beam accelerated at 50 MeV on a target of 70g of UCx to produce **neutron-rich** radioactive nuclei by **photofission** of uranium.



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 $N > 60$.



Photofission at ALTO

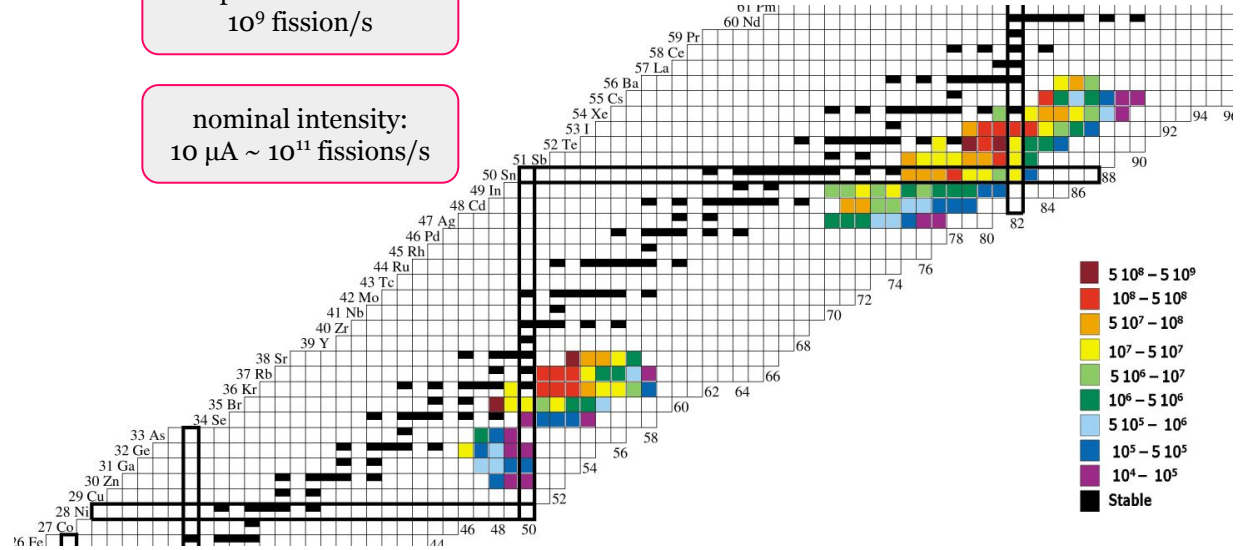
Interesting regions for fission fragments:

- ✿ 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:
 $10 \mu\text{A} \sim 10^{11}$ fissions/s

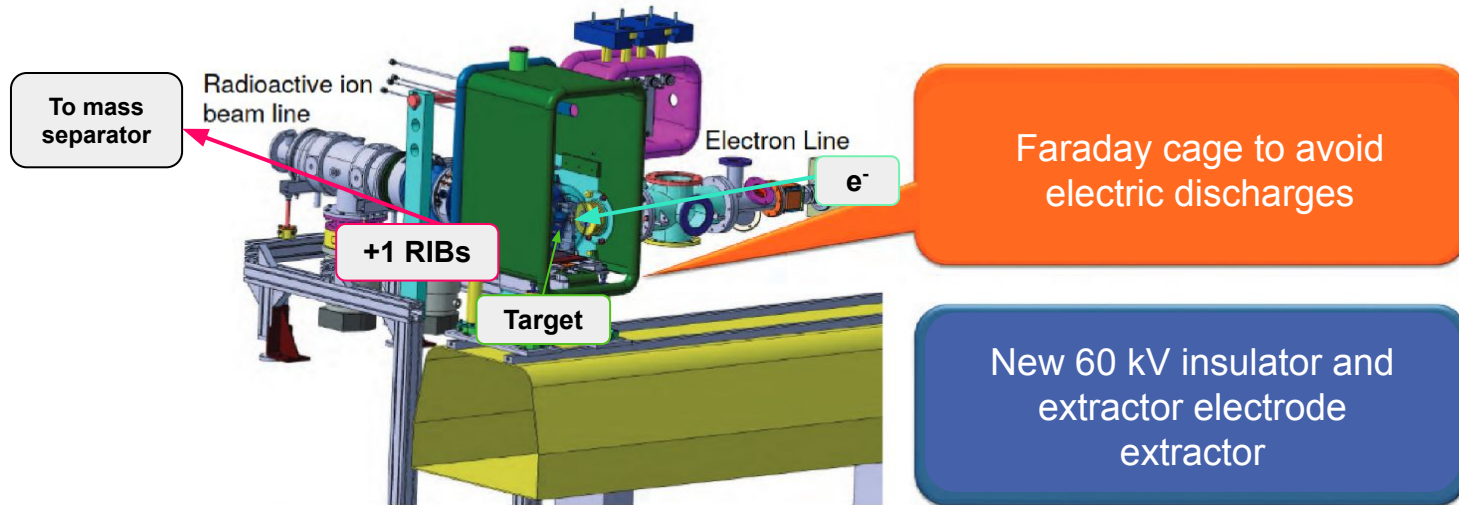
Measured yields



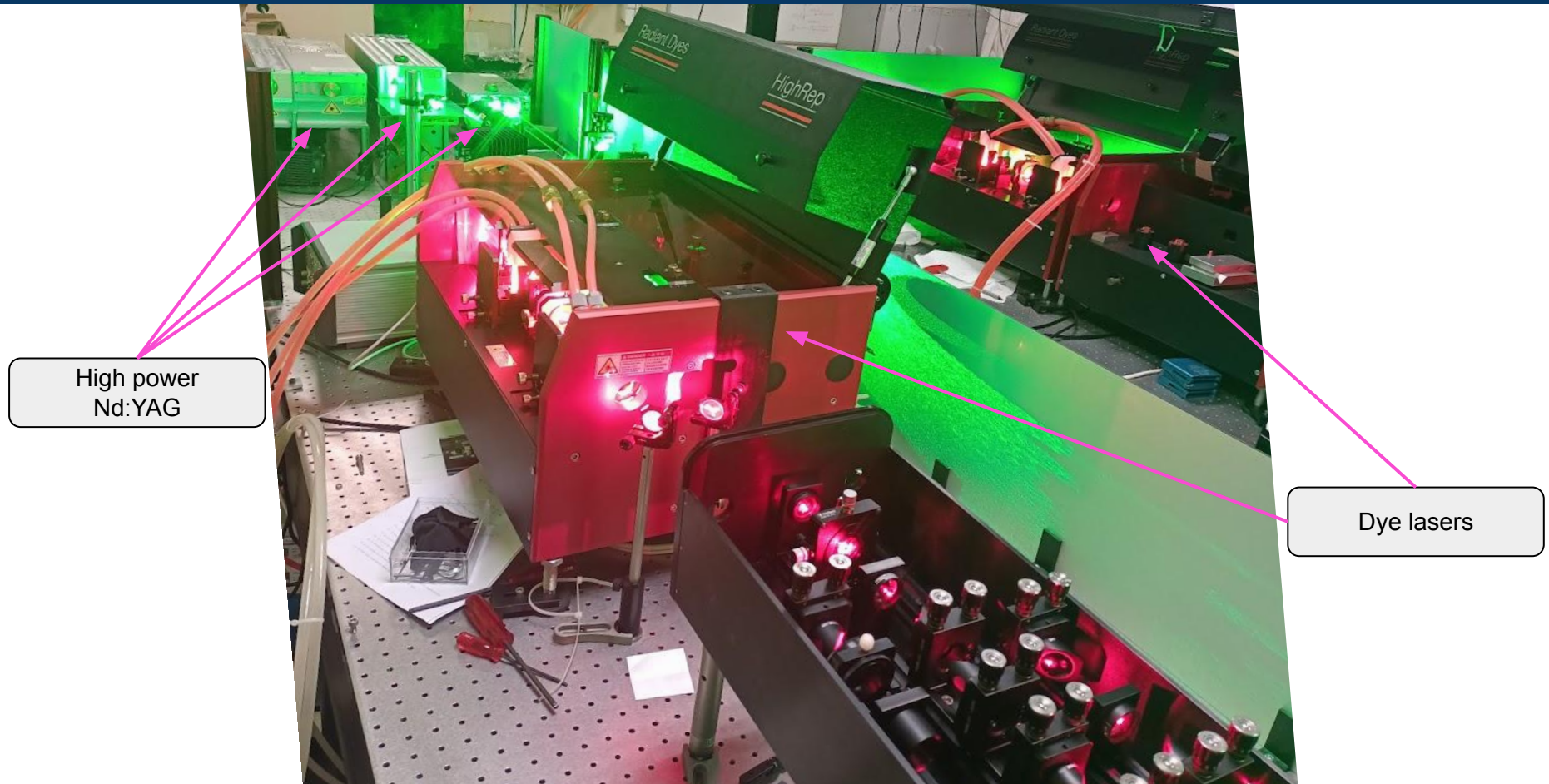
F. Ibrahim, D, Nuclear Physics A, 787(1):110–117, 200.

Front-end Robotisé pour ISOL ALTO (FRISAL)

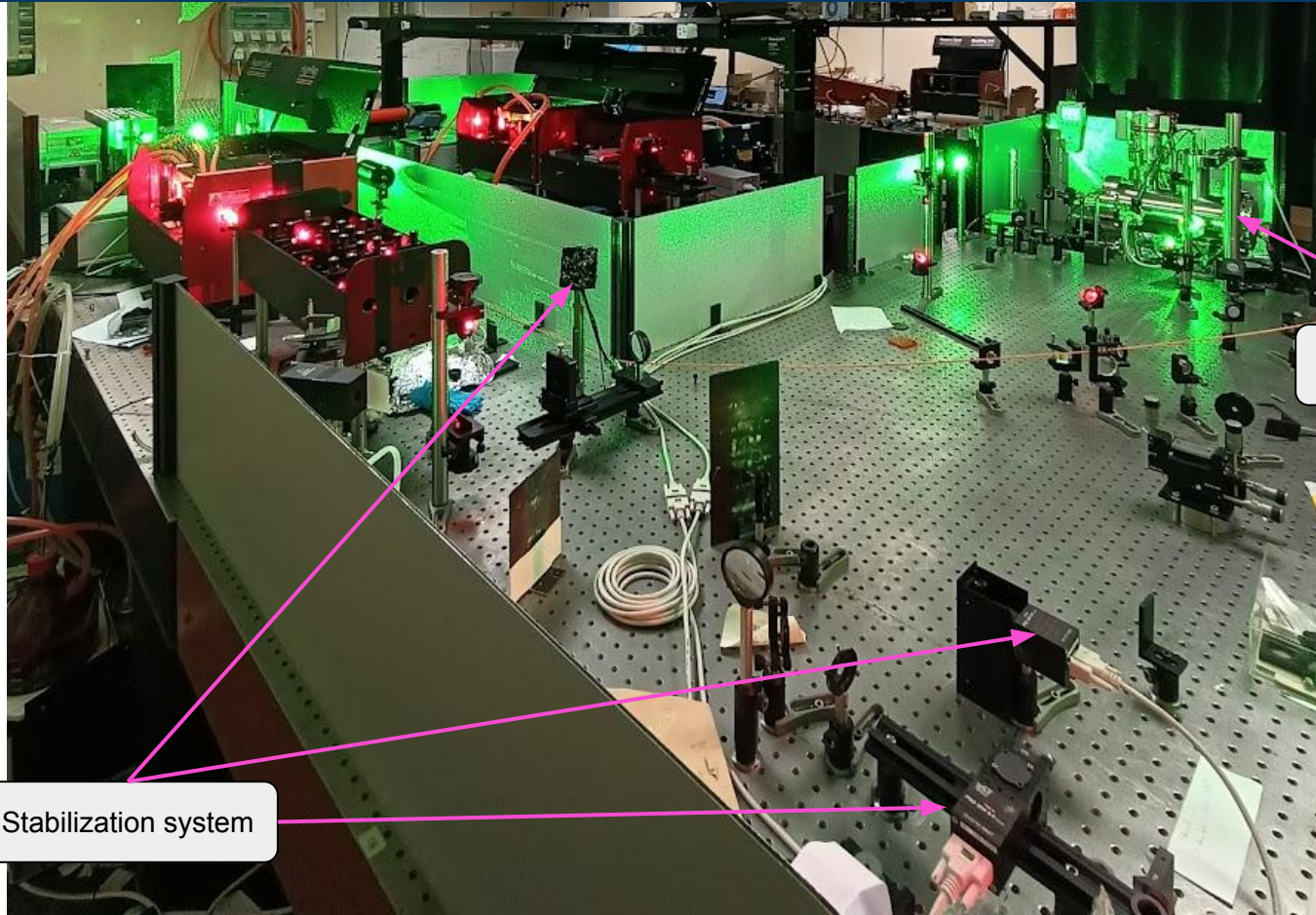
- * Refurbish (~20 years old)
- * Upgrade of front-end to increase extraction voltage from 30 kV to 60 kV
- * Robotic handling (in progress)



Resonance Ionization laser ion source at ALTO (RIALTO)



Resonance Ionization laser ion source at ALTO (RIALTO)

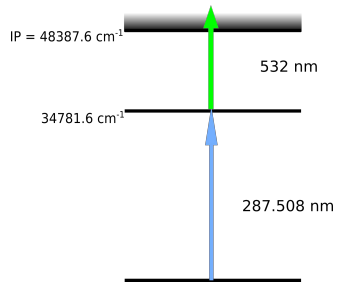


Stabilization system

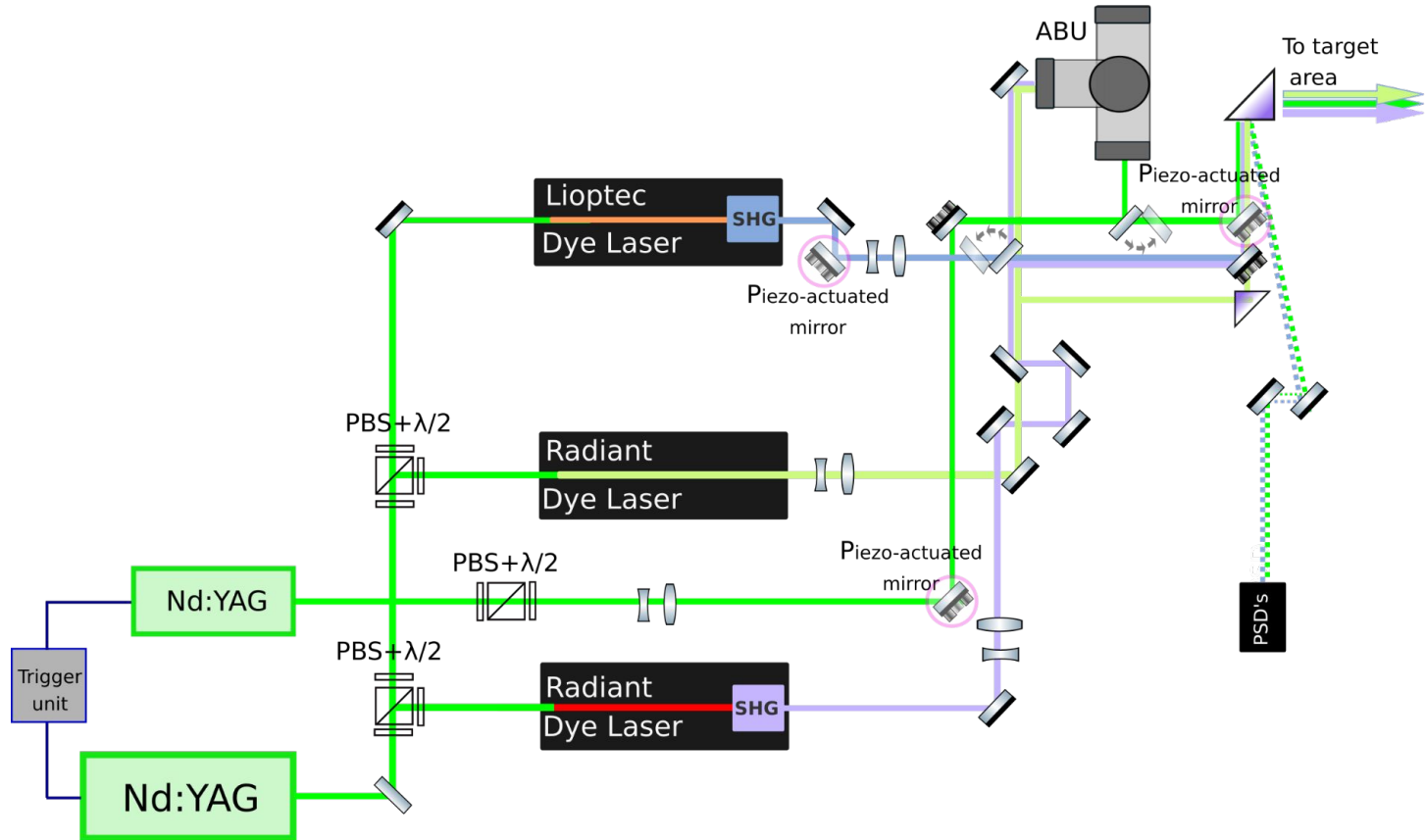
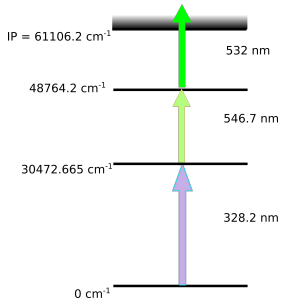
Atomic Beam Unit

Ionization of Ga and Ag

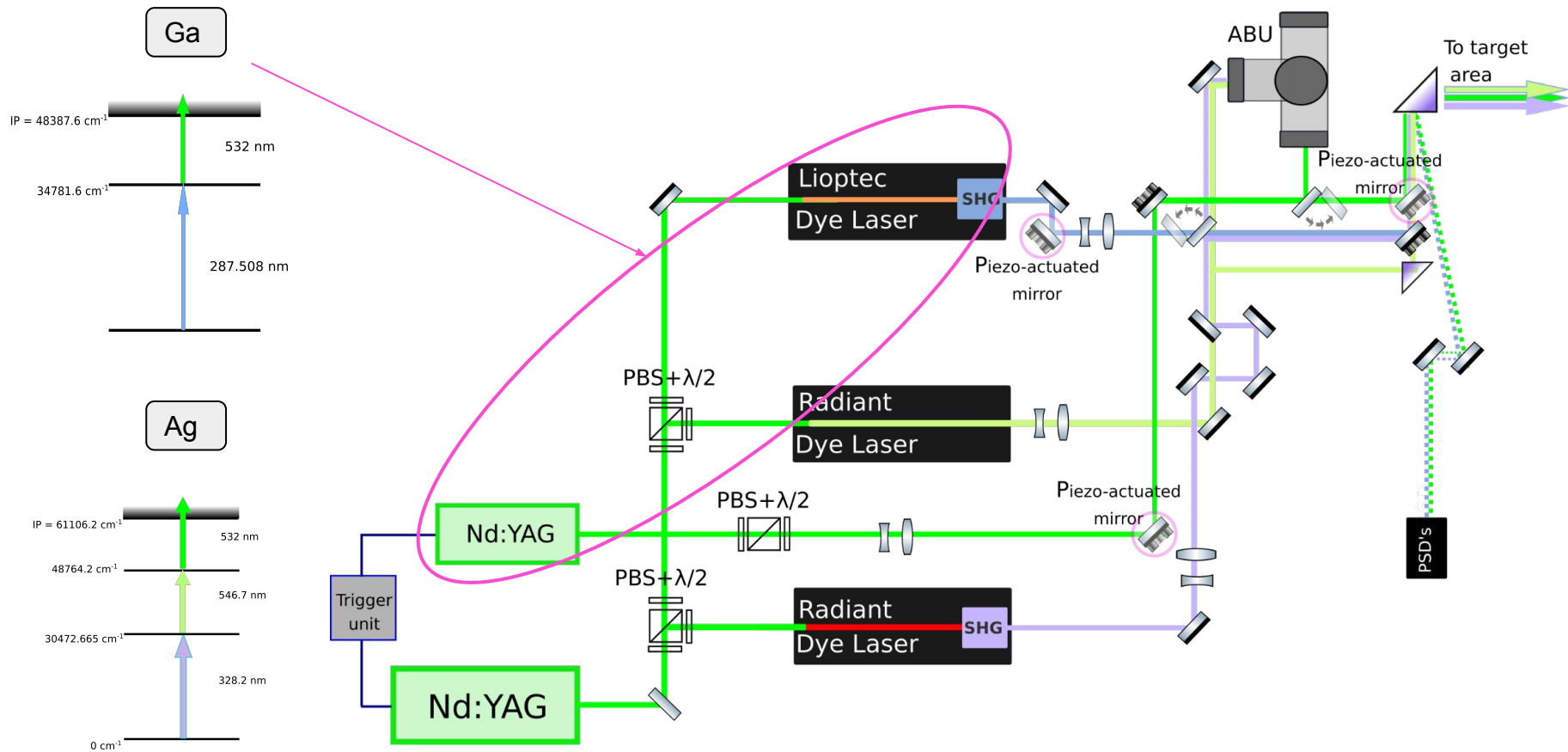
Ga



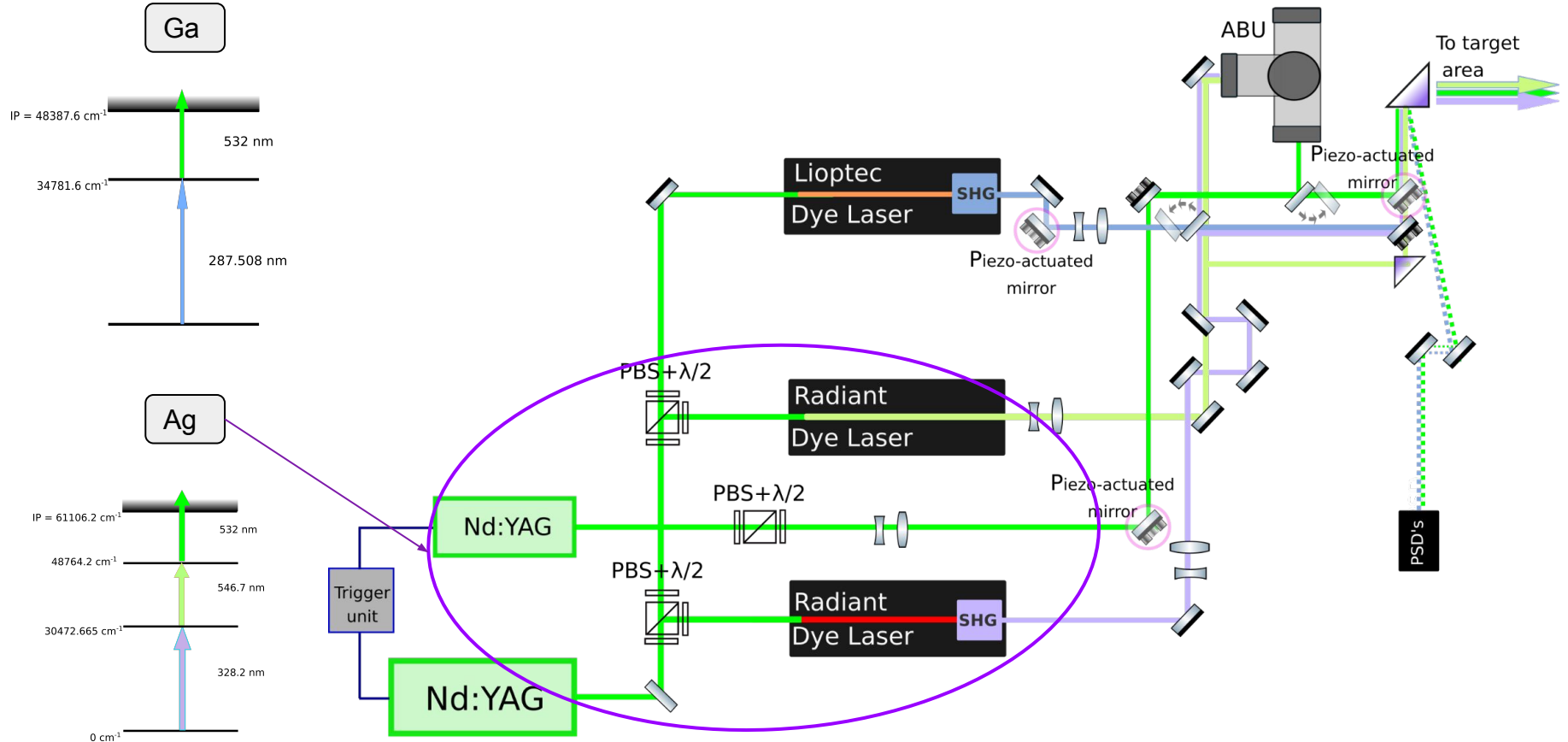
Ag



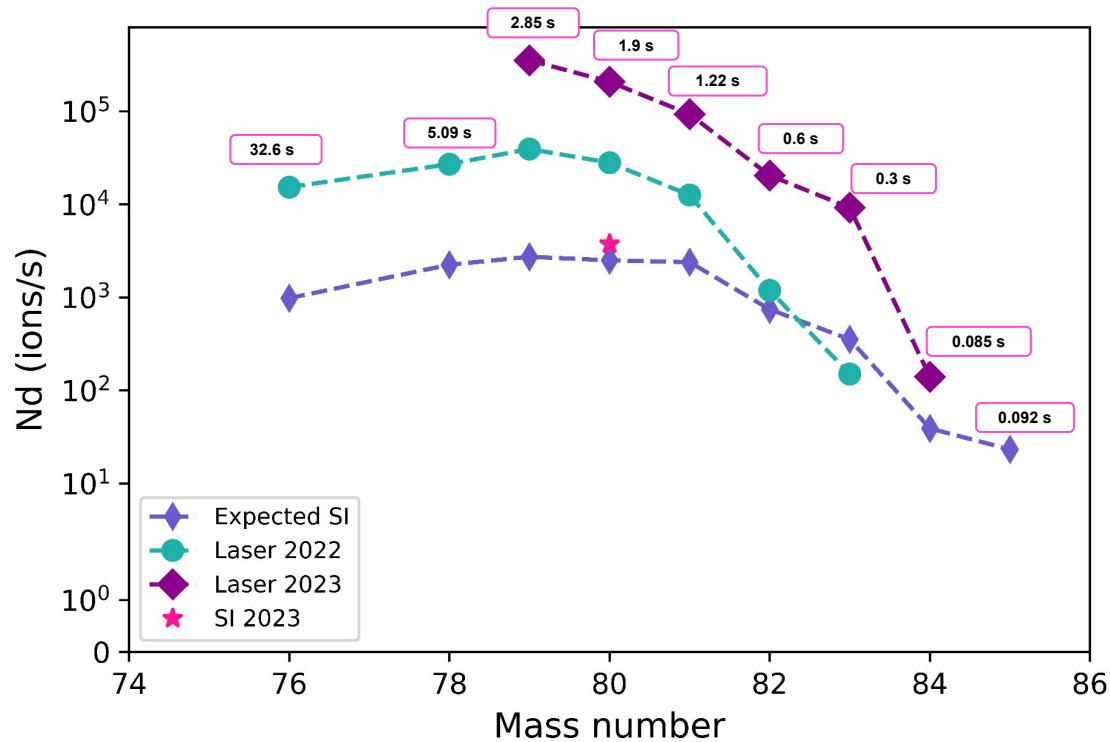
Ionization of Ga and Ag



Ionization of Ga and Ag



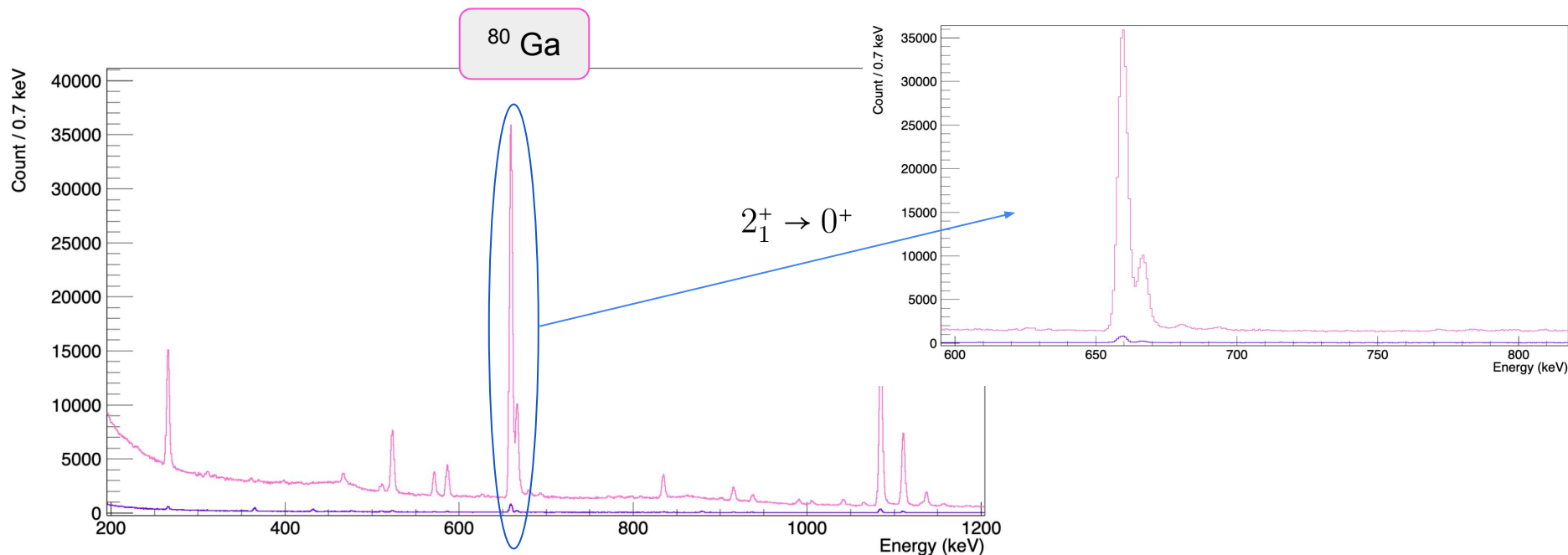
Ga yields at ALTO



*Expected values calculated by B. Roussière

*Yield measured by J. Guillot

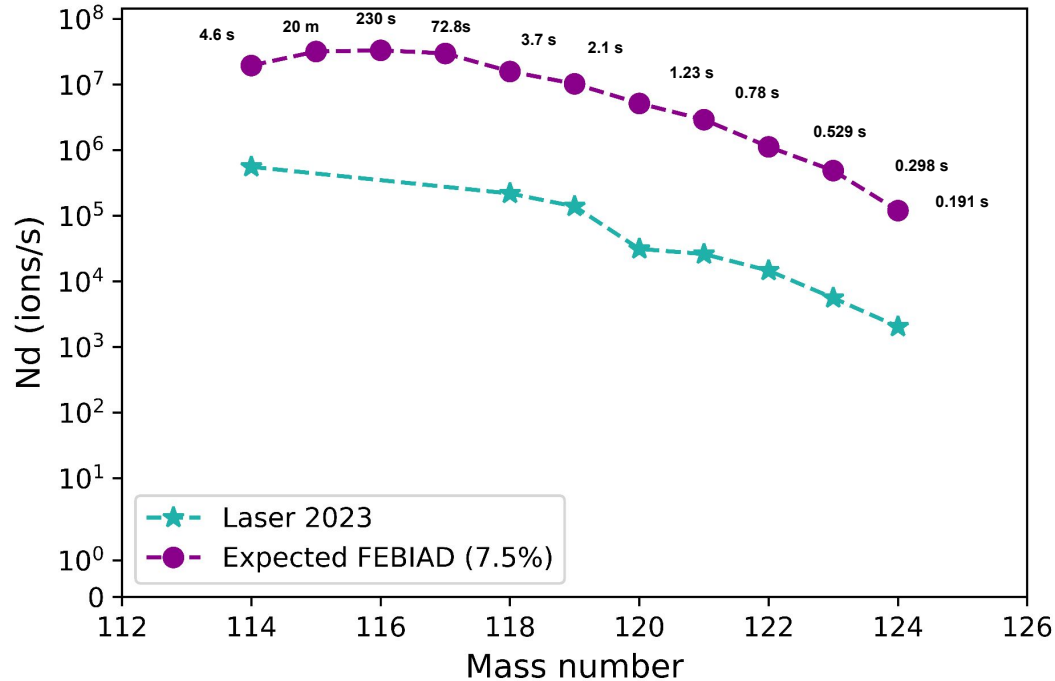
Radioactive Ga production 2023



Laser ON-OFF effect. Gamma-ray spectrum recorded with HPGe detectors at the TETRA station for ^{80}Ga with surface ionization ion source (purple) and with the laser ionization (pink). Factor 50 enhancement with lasers.

Courtesy of Emile Cantacuzene

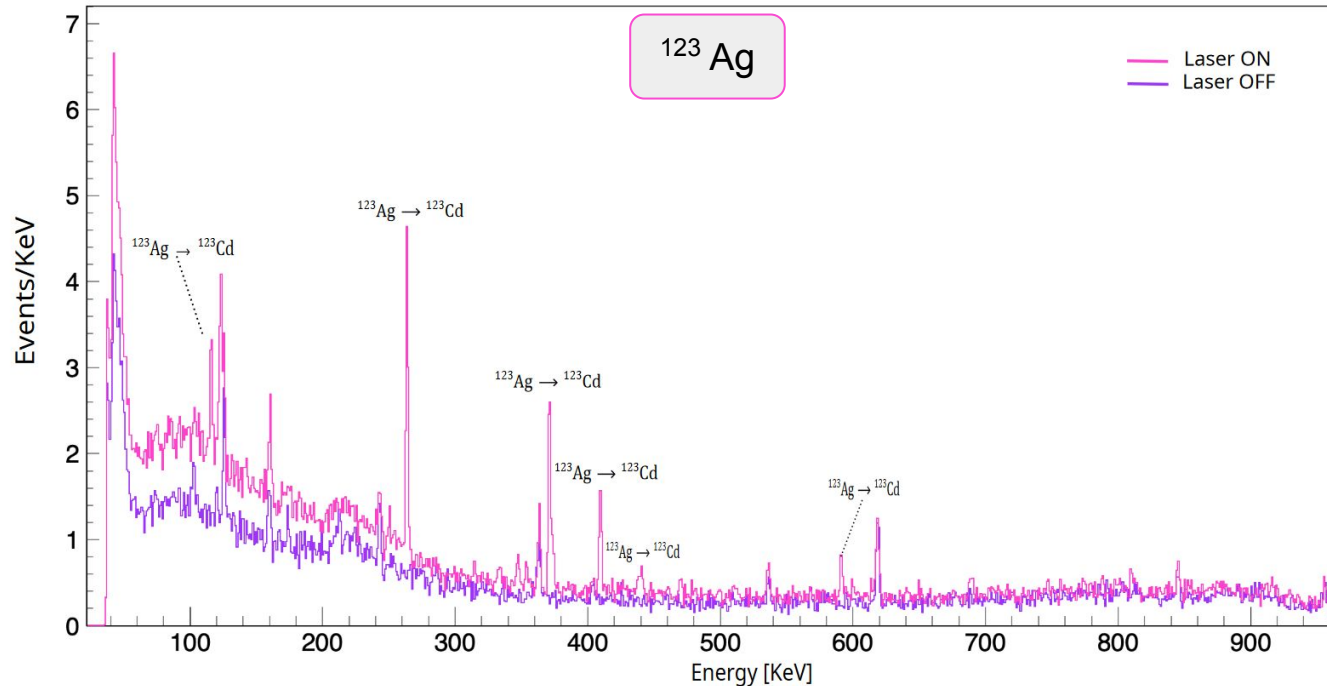
Ag yields at ALTO



*Expected values calculated by B. Roussi re

*Yield measured by J. Guillot

Radioactive Ag production

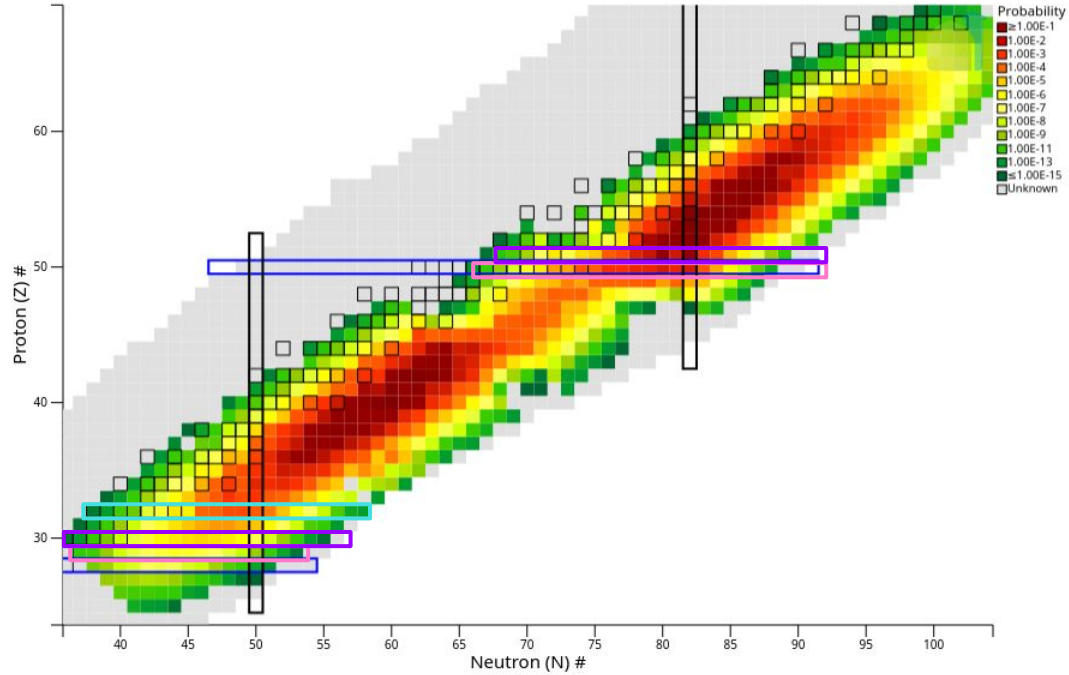
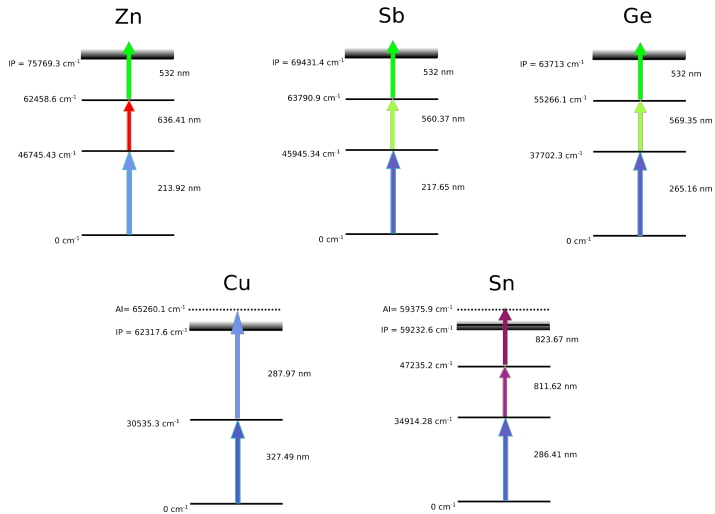


Laser ON-OFF effect. Gamma-ray spectrum recorded with HPGe detectors at the TETRA station for ^{123}Ag with surface ionization ion source (purple) and with the laser ionization (pink).

Future beams

Neutron-rich program at ALTO for:

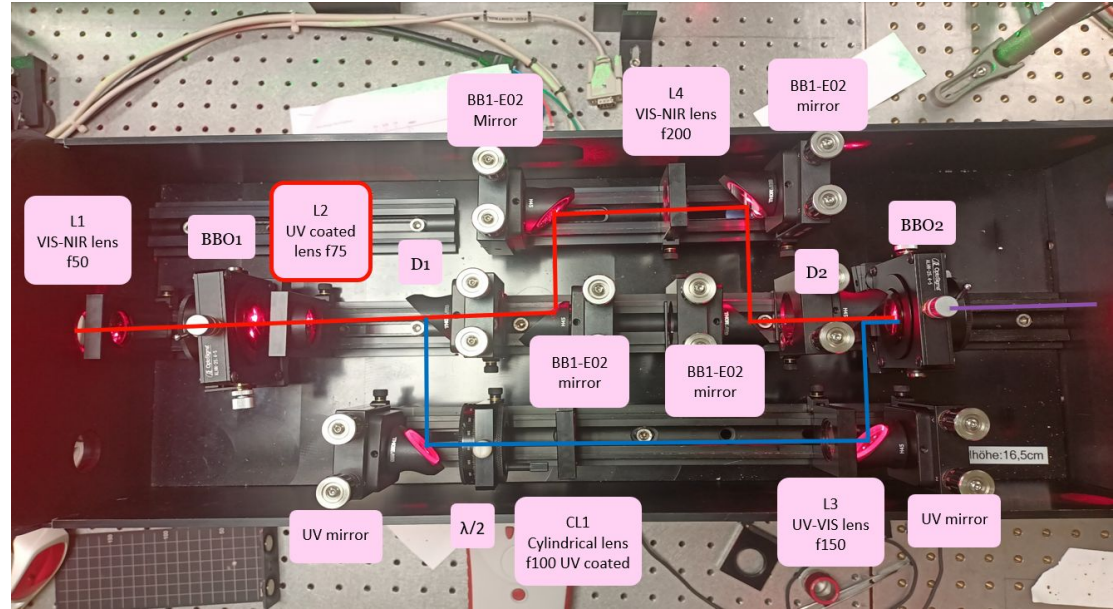
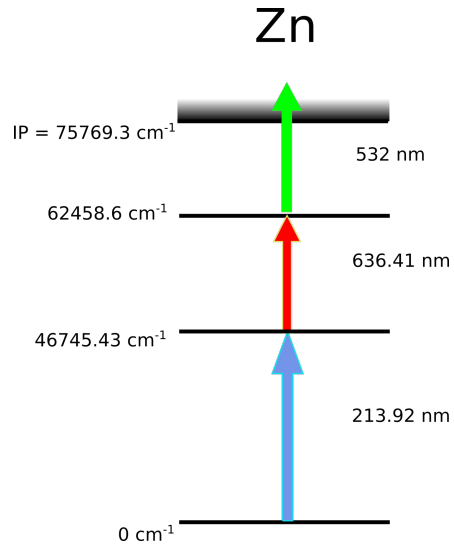
✿ Cu, Sn, Zn, Sb, Ge



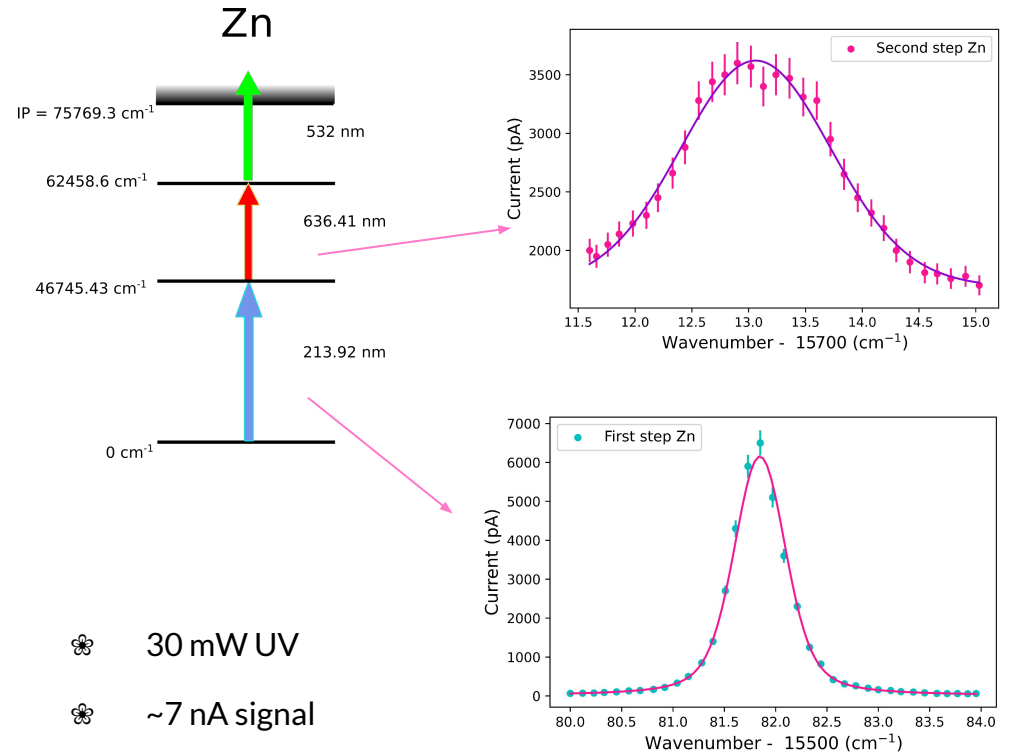
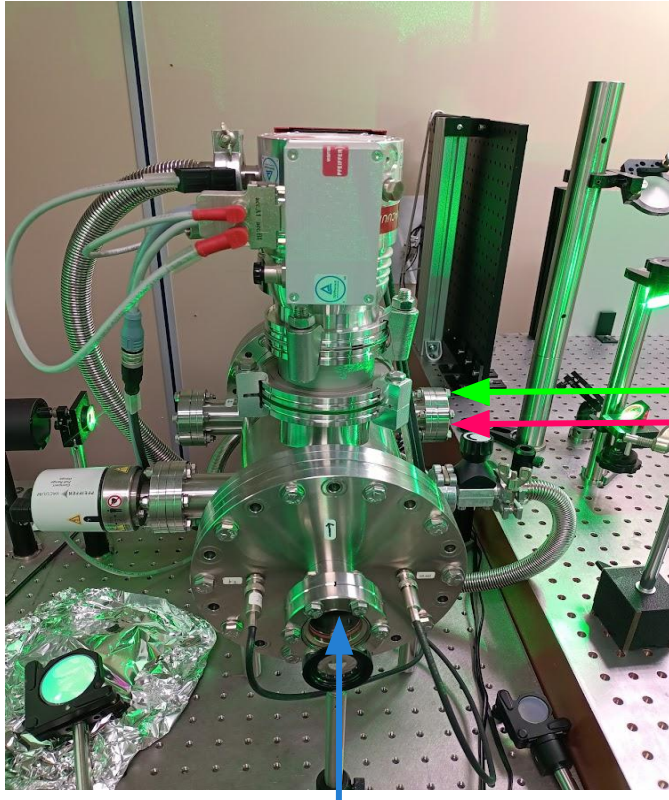
Zn development

✿ Neutron-rich Zn program

★ Monster (Autumn 2024)



Zn offline test



Conclusions

✿ **Radioactive Ga and Ag production**

- Production measurements for Ga and Ag
- Success of commissioning the new FRISAL Front-End and RIALTO upgrade

✿ **Neutron-rich Zn program**

- Monster (Autumn 2024)

Acknowledgments



Laboratoire de Physique
des 2 Infinis

ALTO
Accélérateur Linéaire et Tandem à Orsay



ALTO team



FIIRST team

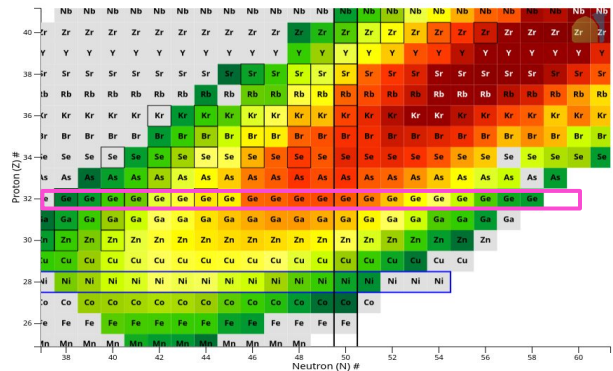
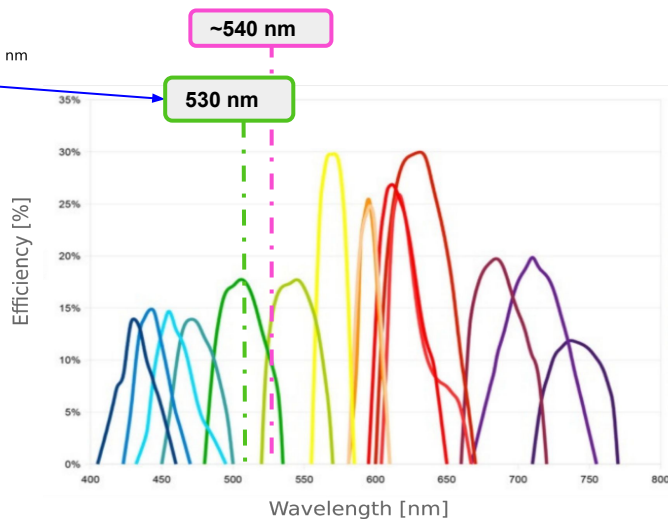
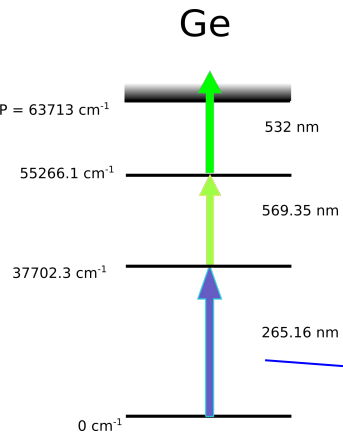


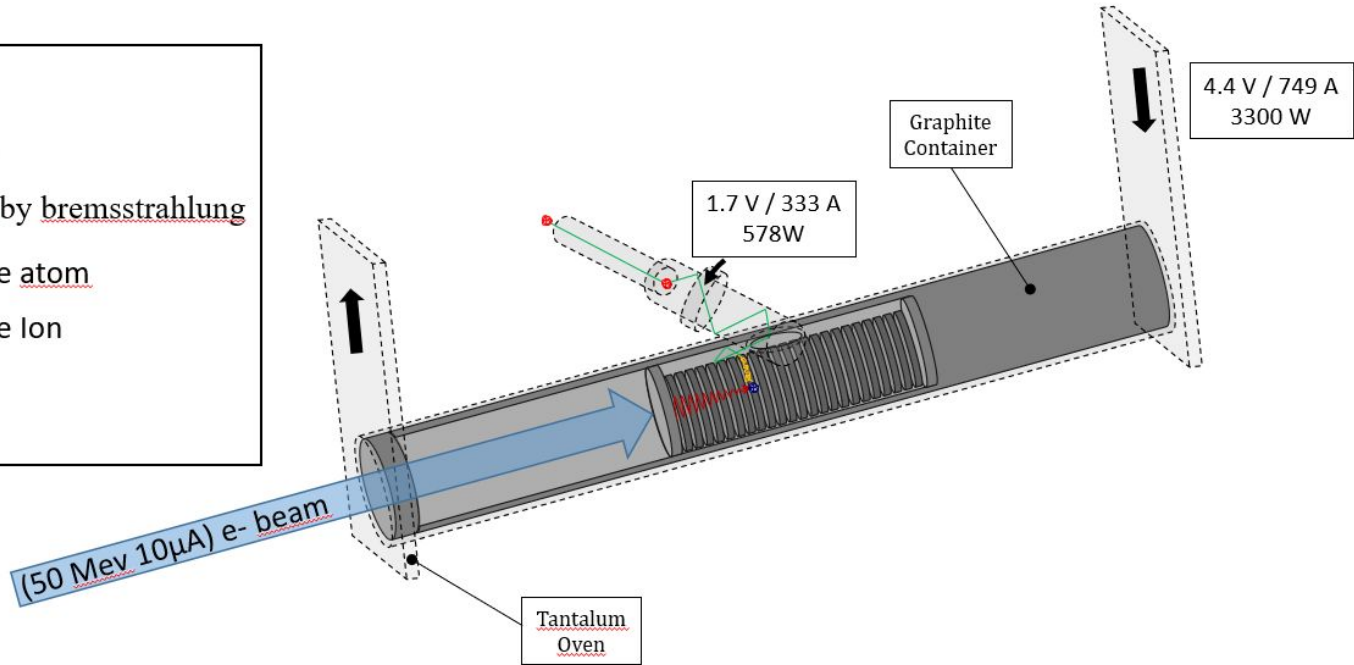
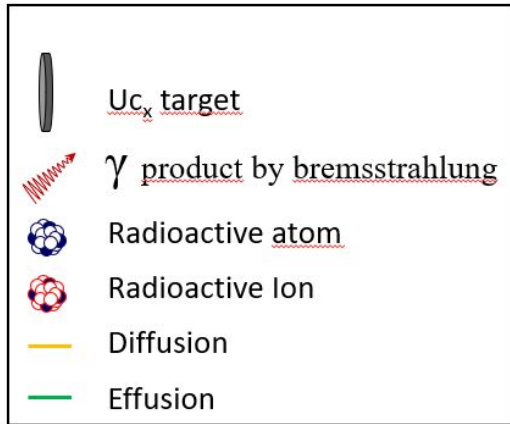
Thank you for your attention

Backup

Ge

✿ Neutron-rich Ge program





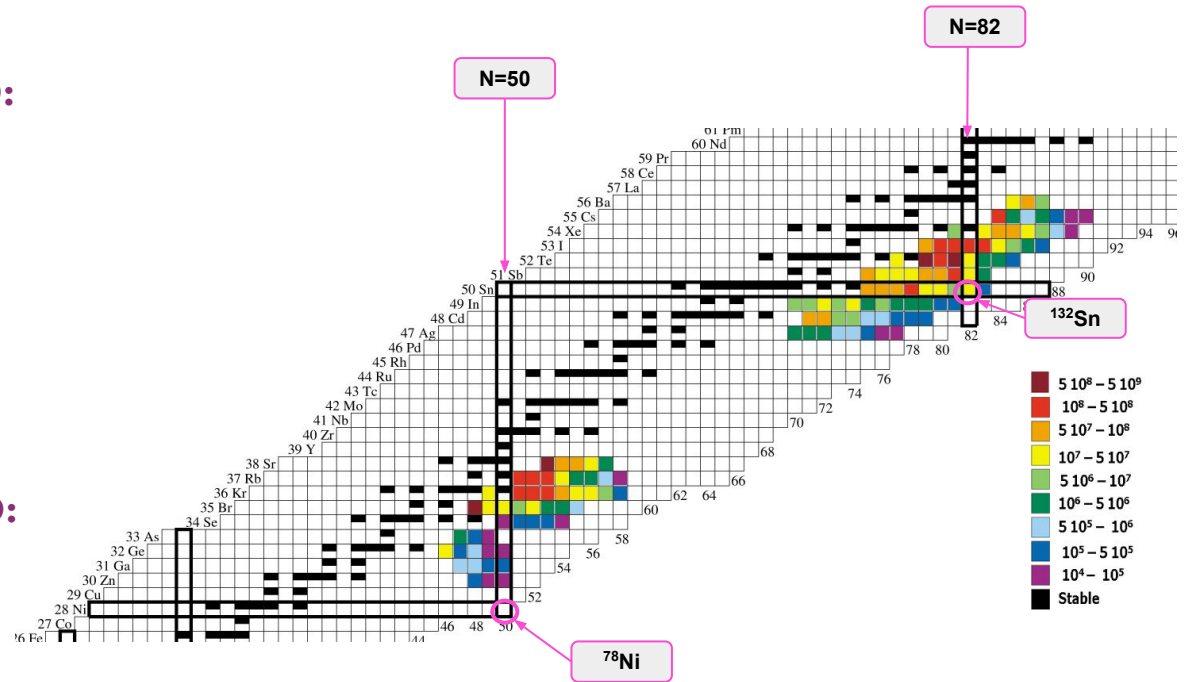
Ag and Ga neutron-rich program at ALTO

Neutron rich Ag program at ALTO:

- ✿ The region around ^{132}Sn , neutron shell closure $N = 82$

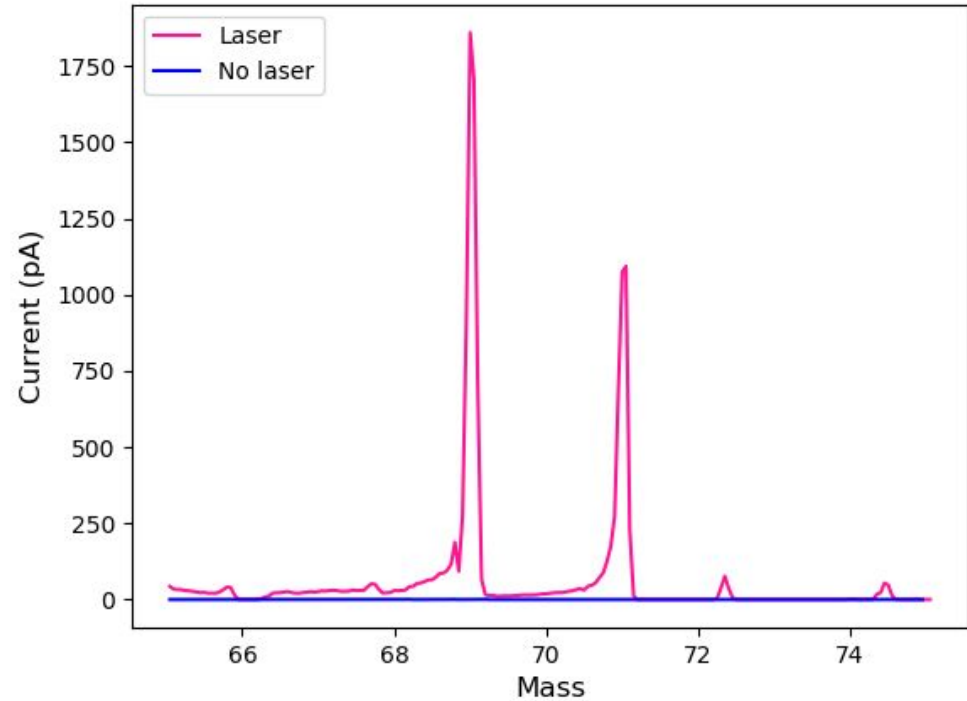
Neutron rich Ga program at ALTO:

- ✿ The region around ^{78}Ni , neutron shell closure $N = 50$



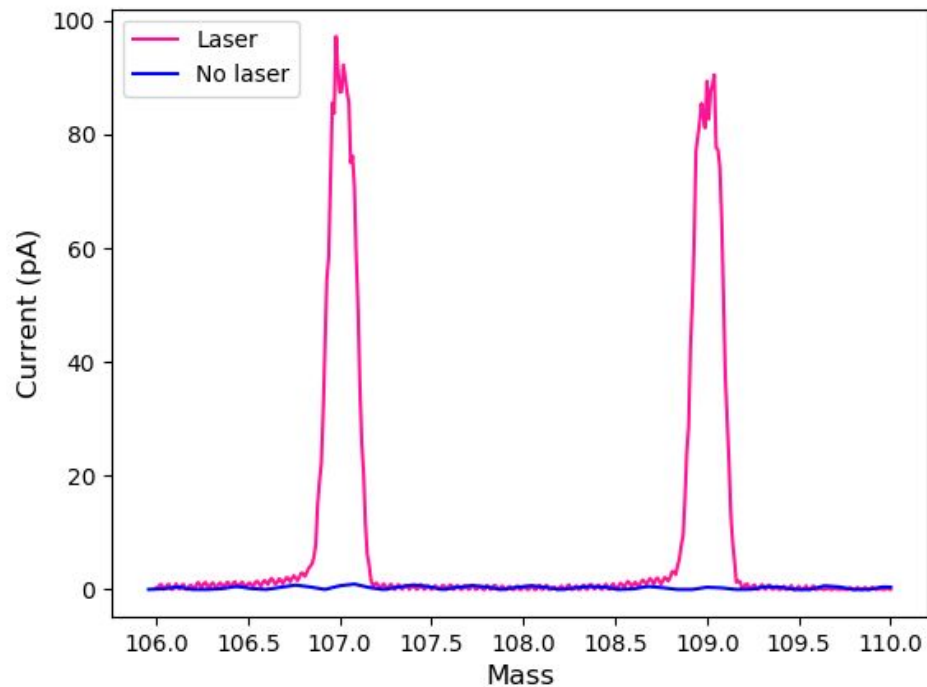
Stable Ga

69Ge 39.05 h $\epsilon = 100.00\%$	70Ge STABLE 20.57%	71Ge 11.43 d $\epsilon = 100.00\%$	72Ge STABLE 27.45%	73Ge STABLE 7.75%
68Ga 67.71 min $\epsilon = 100.00\%$	69Ga STABLE 60.108%	70Ga 21.14 min $\beta^- = 99.59\%$ $\epsilon = 0.41\%$	71Ga STABLE 39.892%	72Ga 14.10 h $\beta^- = 100.00\%$
67Zn STABLE 4.04%	68Zn STABLE 18.45%	69Zn 56.4 min $\beta^- = 100.00\%$	70Zn $\approx 2.3E+17$ y 0.61% $2\beta^-$	71Zn 2.45 min $\beta^- = 100.00\%$



Stable Ag

107Cd 6.50 h $\epsilon = 100.00\%$	108Cd > 1.9E+18 y 0.89% 2 ϵ	109Cd 461.4 d $\epsilon = 100.00\%$	110Cd STABLE 12.49%	111Cd STABLE 12.80%
106Ag 23.96 min $\epsilon = 99.50\%$ $\beta^- < 1.00\%$	107Ag STABLE 51.839%	108Ag 2.382 min $\beta^- = 97.15\%$ $\epsilon = 2.85\%$	109Ag STABLE 48.161%	110Ag 24.6 s $\beta^- = 99.70\%$ $\epsilon = 0.30\%$
105Pd STABLE 22.33%	106Pd STABLE 27.33%	107Pd 6.5E+6 y $\beta^- = 100.00\%$	108Pd STABLE 26.46%	109Pd 13.7012 h $\beta^- = 100.00\%$

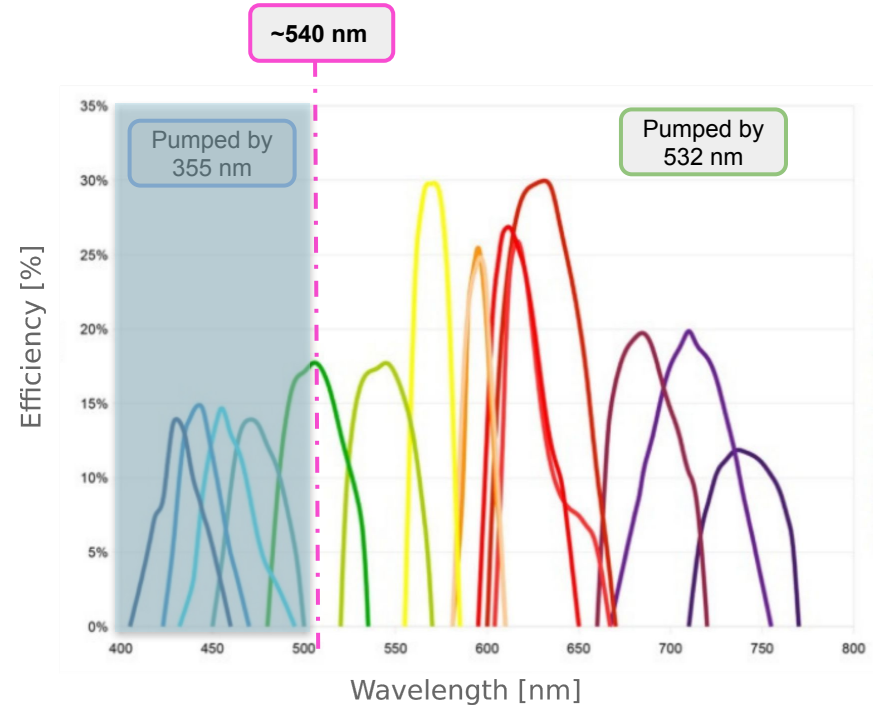
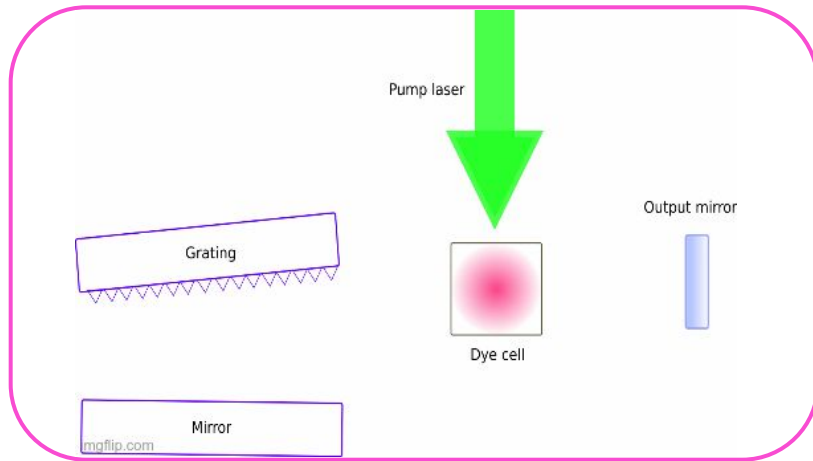


Python Turtle Graphics

H																	He																												
Li	Be											B	C	N	O	F	Ne																												
Na	Mg											Al	Si	P	S	Cl	Ar																												
K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr																												
Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe																												
Cs	Ba	La	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn																												
Fr	Ra	Ac	Rf	Db	Sg	Bh	Hs	Mt	Ds	Rg	Cp	Nh	Fl	Mc	Lv	Ts	Og																												
<table border="1"> <tr> <td>Ce</td> <td>Pr</td> <td>Nd</td> <td>Pm</td> <td>Sm</td> <td>Eu</td> <td>Gd</td> <td>Tb</td> <td>Dy</td> <td>Ho</td> <td>Er</td> <td>Tm</td> <td>Yb</td> <td>Lu</td> </tr> <tr> <td>Th</td> <td>Pa</td> <td>U</td> <td>Np</td> <td>Pu</td> <td>Am</td> <td>Cm</td> <td>Bk</td> <td>Cf</td> <td>Es</td> <td>Fm</td> <td>Md</td> <td>No</td> <td>Lr</td> </tr> </table>																		Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu	Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lr
Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu																																
Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lr																																

Dye lasers

A type of laser that uses an organic dye solution as the gain medium, allowing it to emit laser light across a wide range of wavelengths by selecting different dye materials.

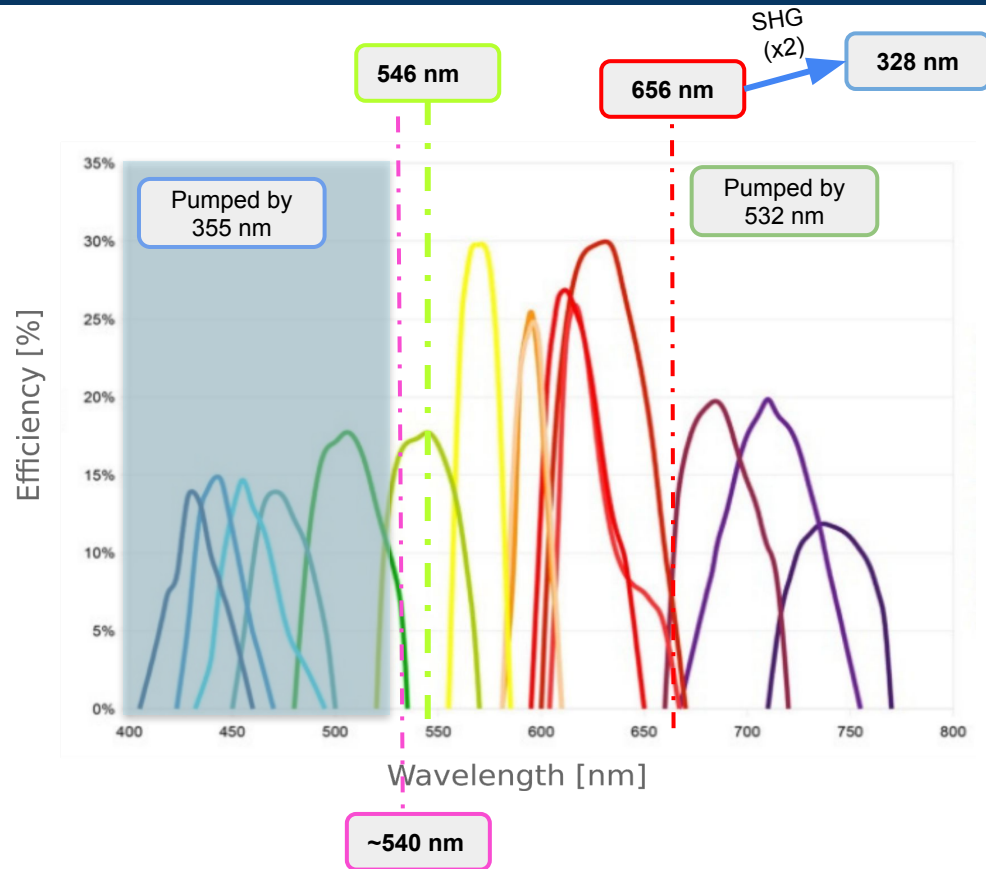
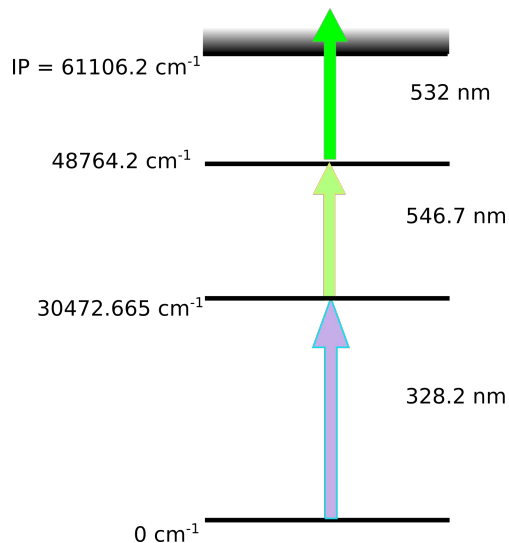


Dye tuning and dye efficiency curve of a laser pumped by Nd:YAG laser at 355 nm and 532 nm

Silver ionization

Ag ionization scheme:

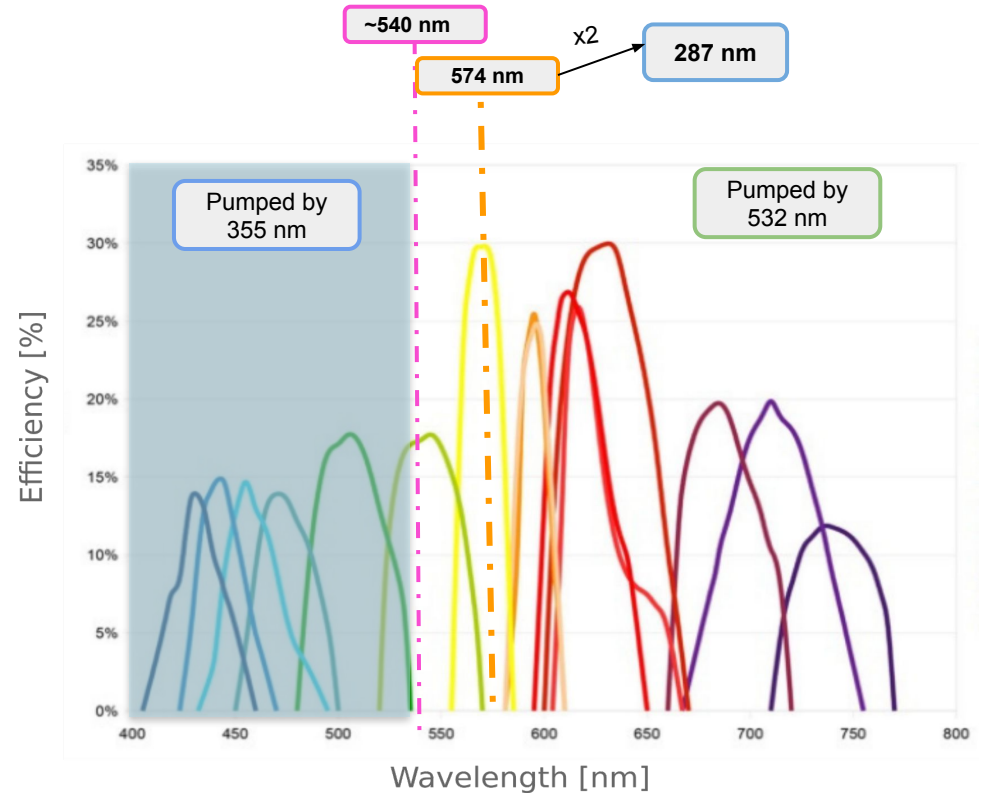
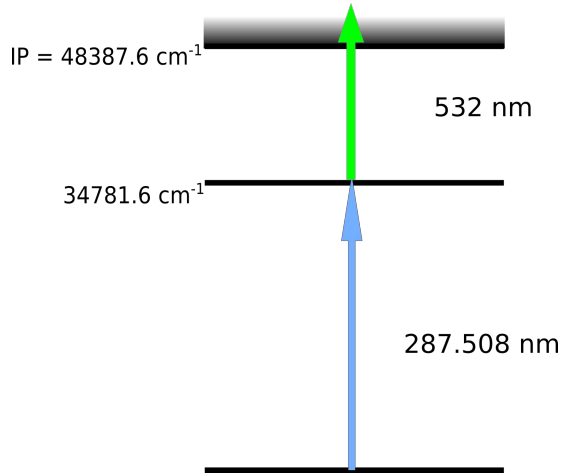
- ✿ 3 step-3 color scheme.
- ✿ Challenging second step.



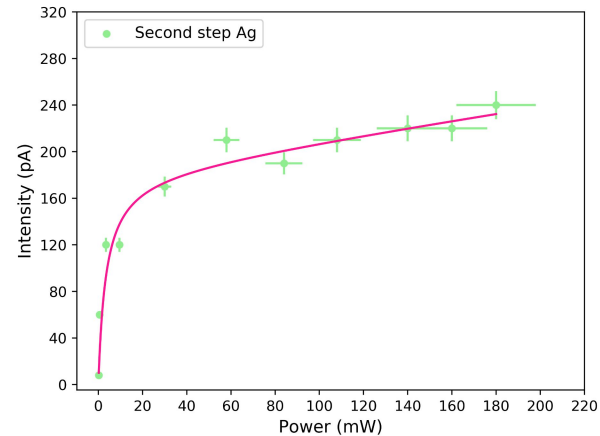
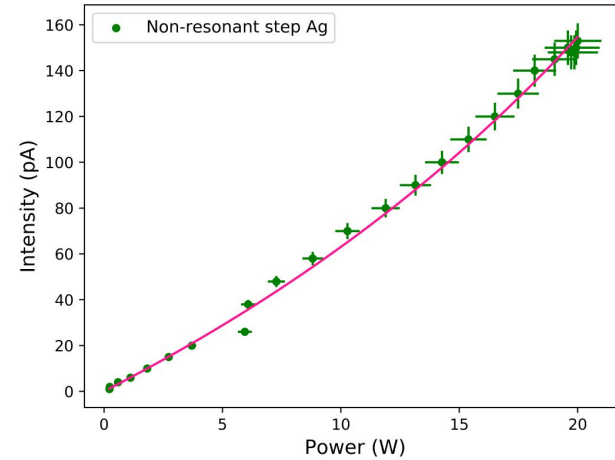
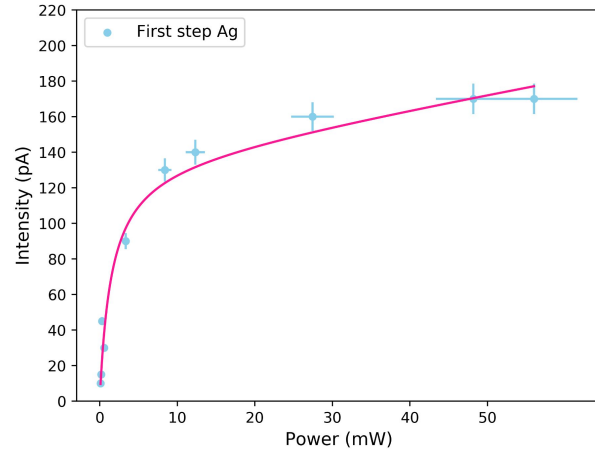
Ga ionization

Ga ionization scheme:

- ✿ 2 step-2 color scheme.
- ✿ First step SHG and non-resonant ionization.



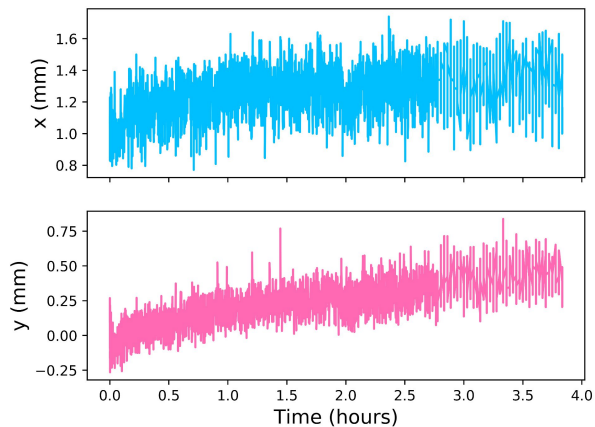
Saturation curves online



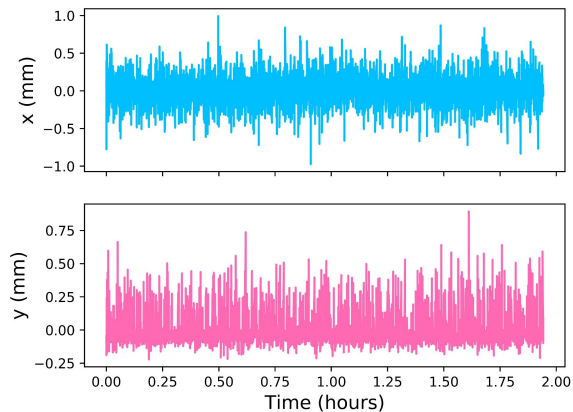
	P_{Sat} [mW]	$P_{Max Available}$ [mW]
First step	1.5	73
Second step	3.5	100
Non-resonant step	n/a	20000

Stabilization for UV and Nd:YAG beams

UV stabilization OFF

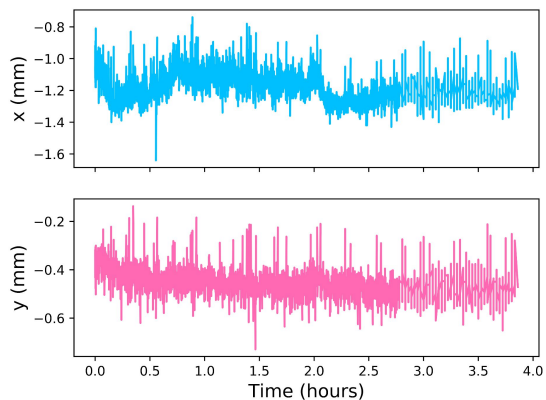


UV stabilization ON

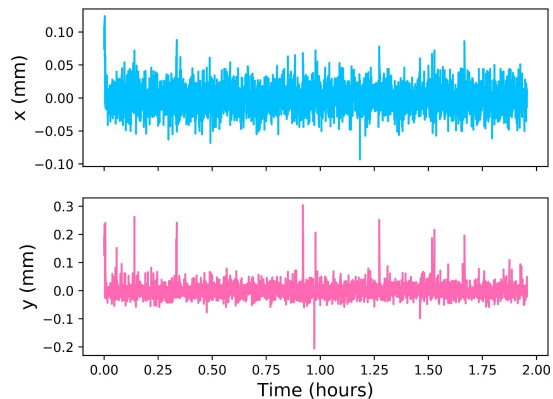


Complete
correction of
long-term drifts

Nd:YAG stabilization OFF

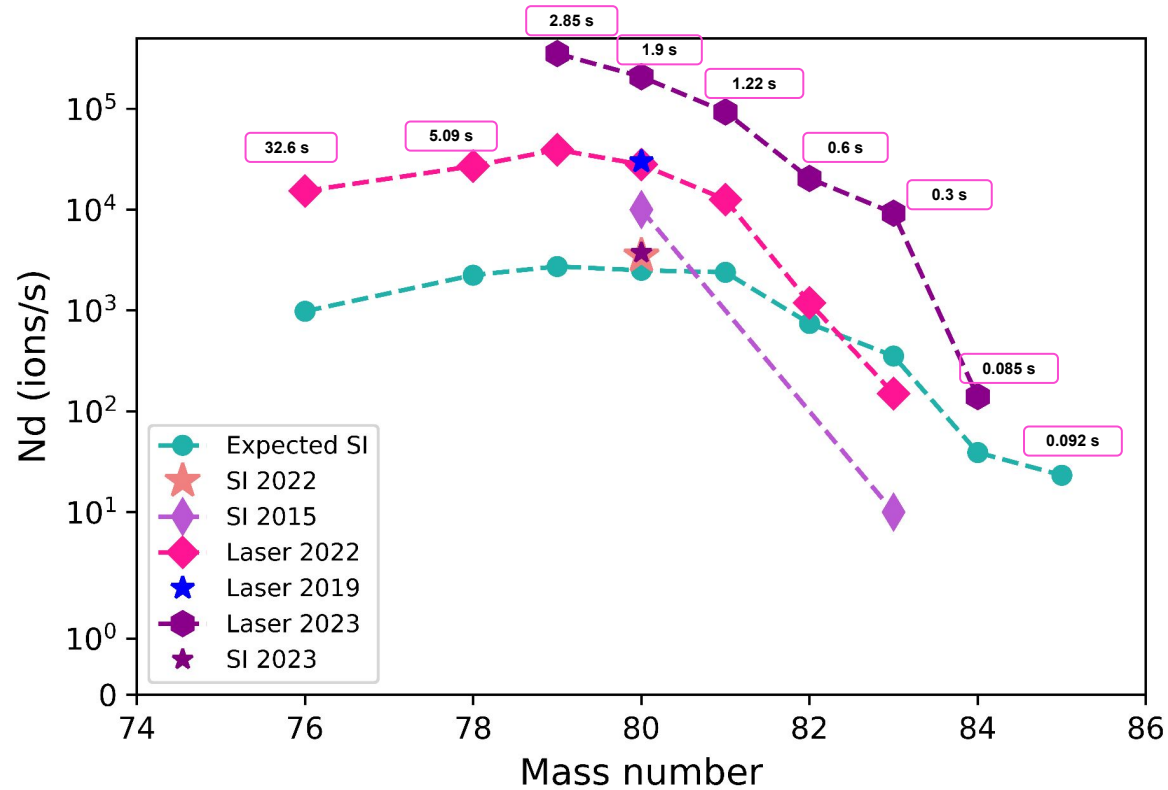


Nd:YAG stabilization ON



Partial correction of
short-term
fluctuations

Ga yields at ALTO



*Expected values calculated by B. Roussière

Zn

