In-gas cell laser spectroscopy tests for the S^3-LEB Commissioning

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OUTLINE

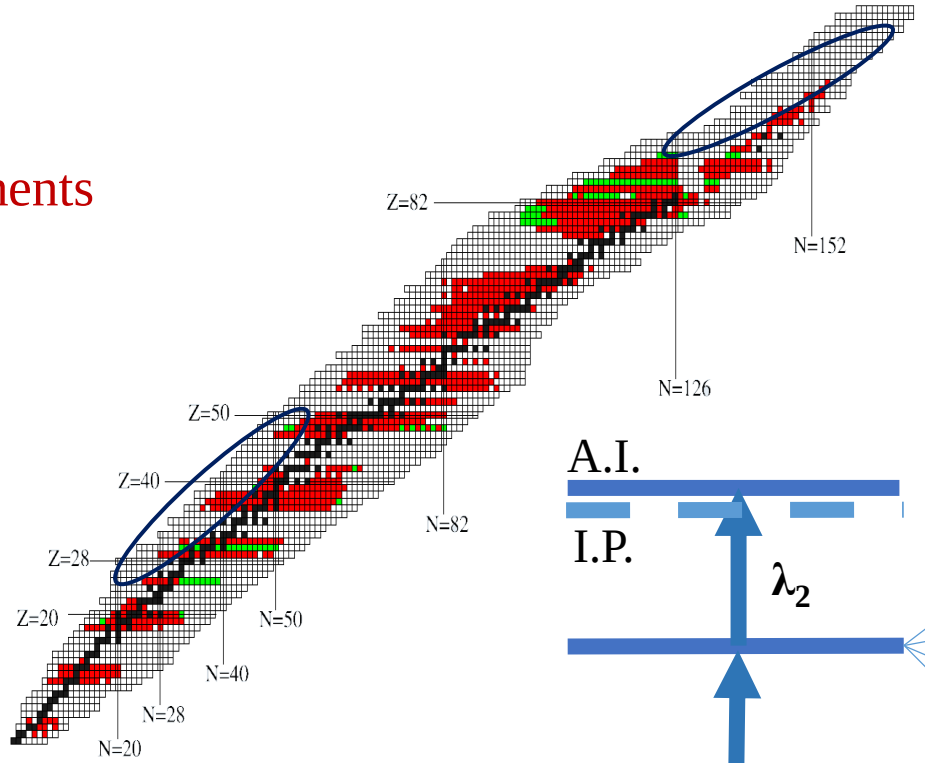
- S^3-LEB set up
- Gas cell/gas jet spectroscopy
- Commissioning tests
- Outlook

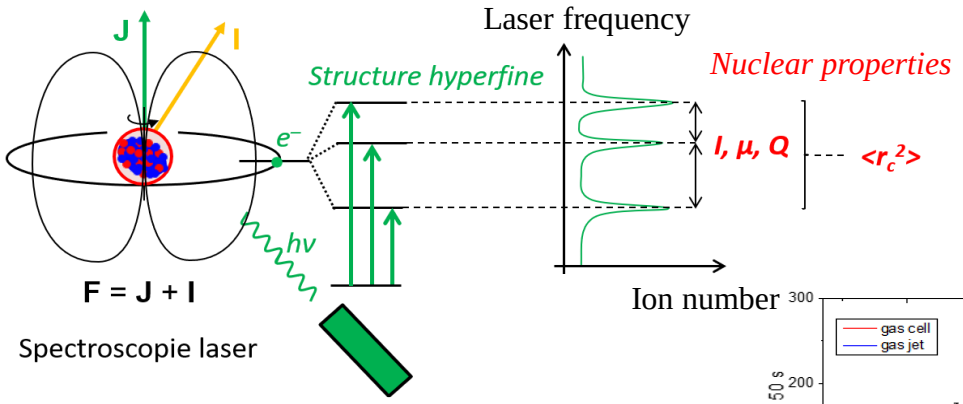
Physics

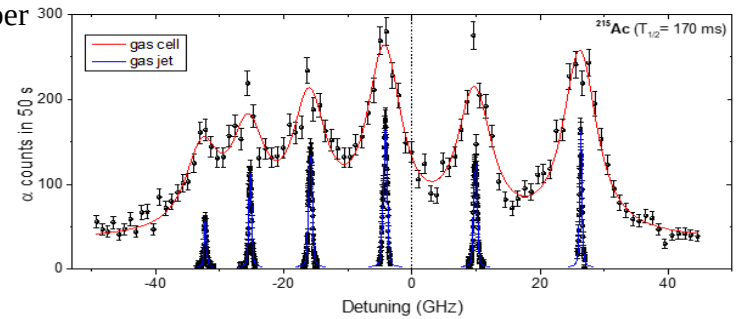
Goal

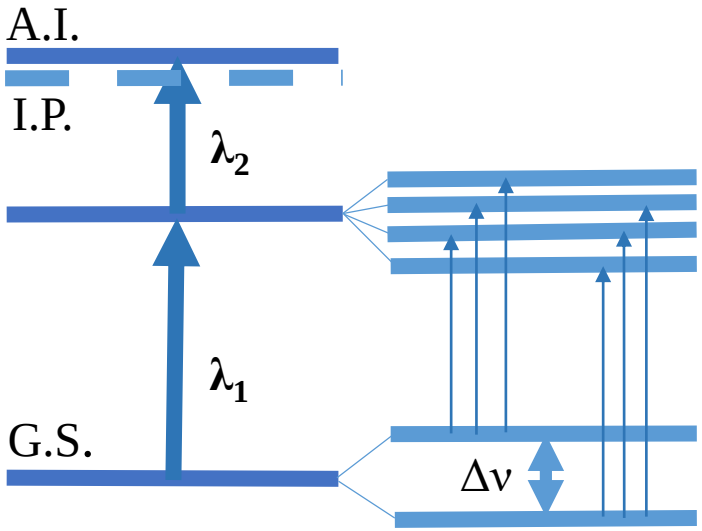
- Study atomic and nuclear properties

  N=Z nuclei & heavy and super heavy elements
- In gas cell/gas jet laser resonance ionization Spectroscopy
  - -Improved Spectral resolution
  - -Elemental selectivity



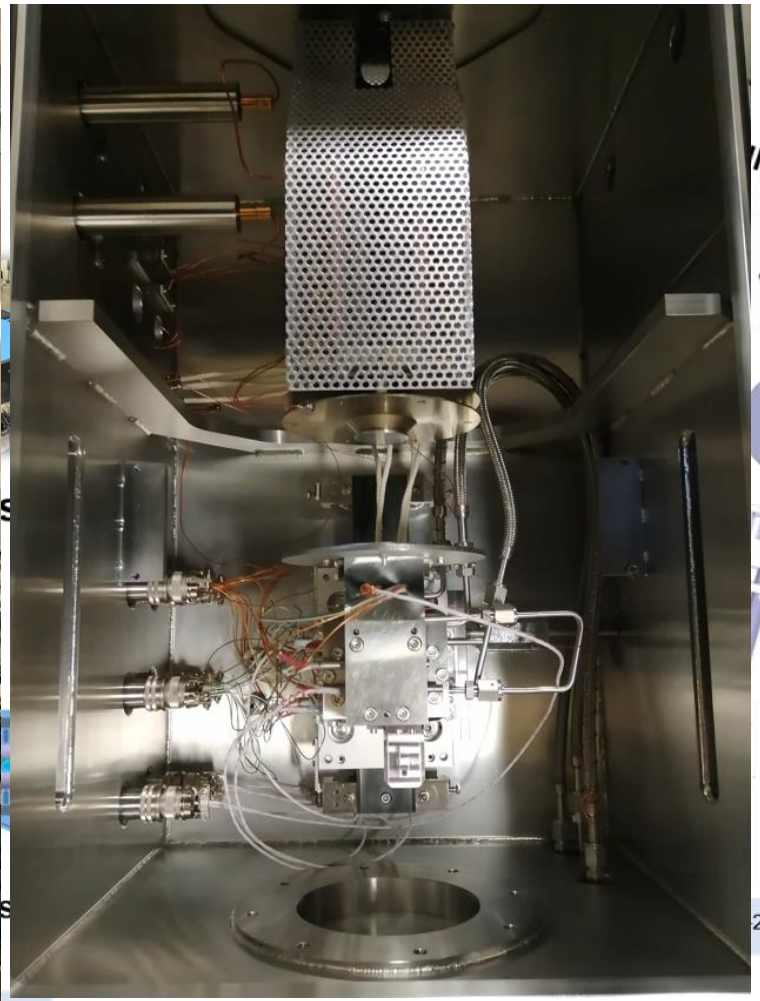




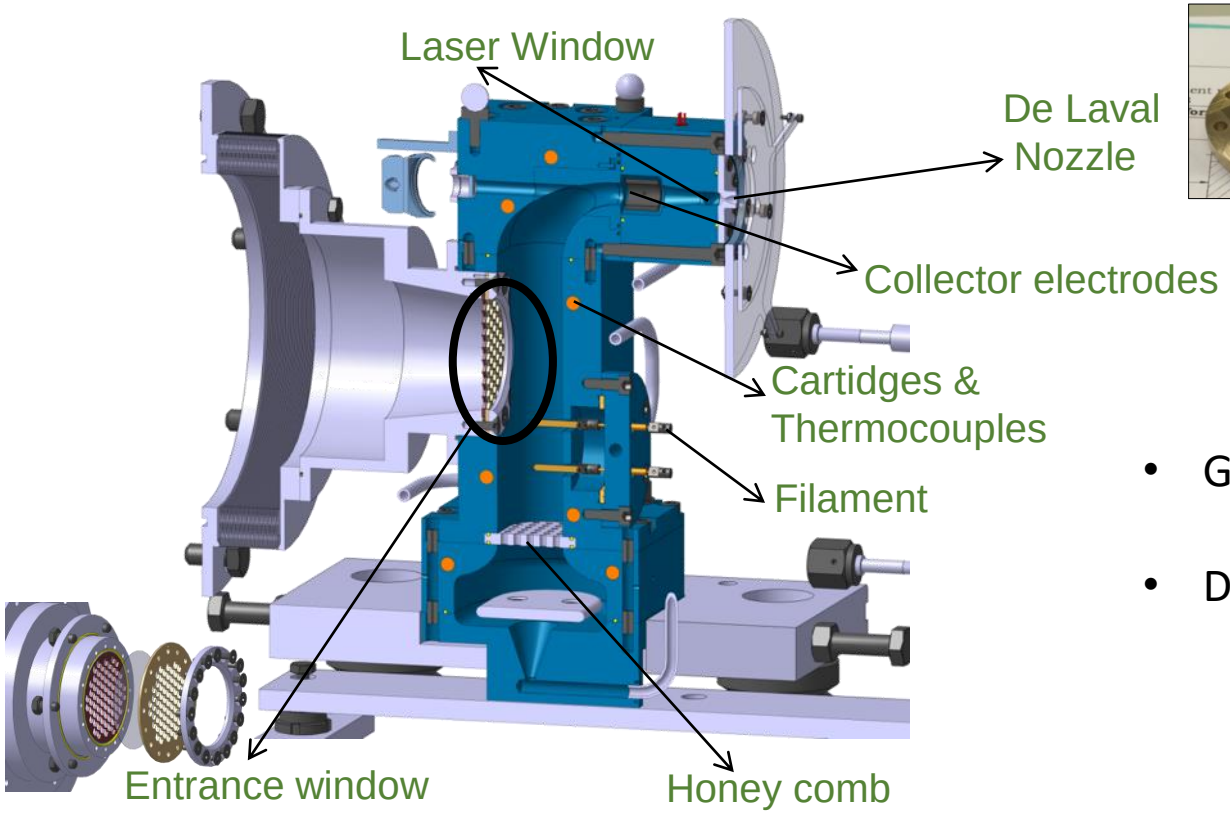


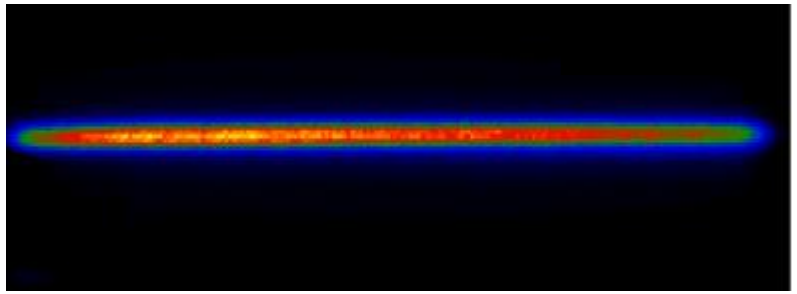
[1] R.Ferrer et al. Nature Communications.8.14520 .doi: 10.1038/ncomms14520

S³-LEB gas cell set up



Gas cell and gas jet spectroscopy



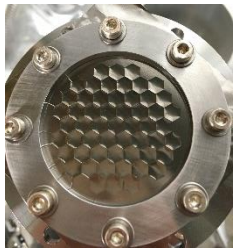


Fluorescence spectrum of gas jet

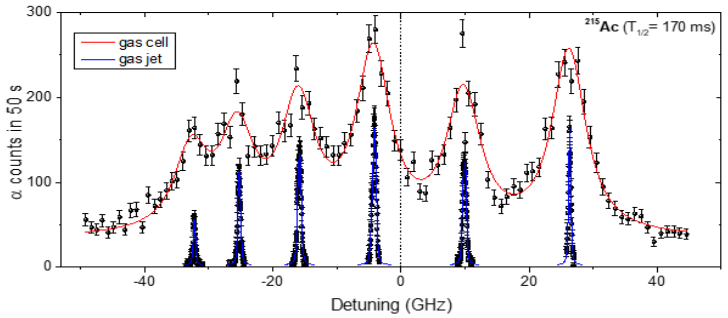
[1] A.Zadvornaya et al. Phy.Rev X 8.041008(2018) doi:10.1103/PhysRevX.8.041008

- Gas cell
  - ➢ broadening effects
- De Laval Nozzle
  - ➢ Hypersonic gas jet

    ρ ↓ T ↓

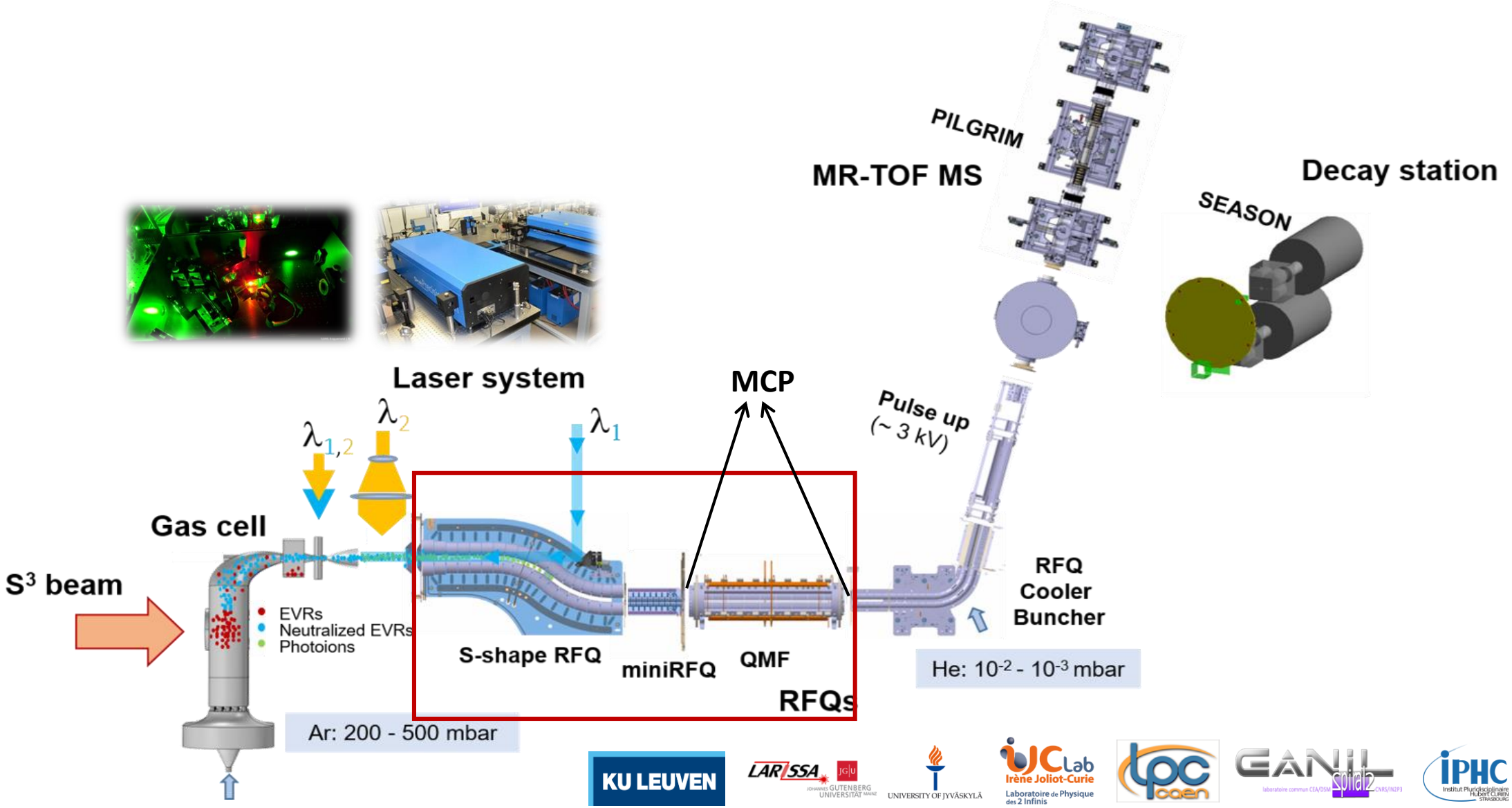


Ti or Mylar foils
5 – 1.5 µm

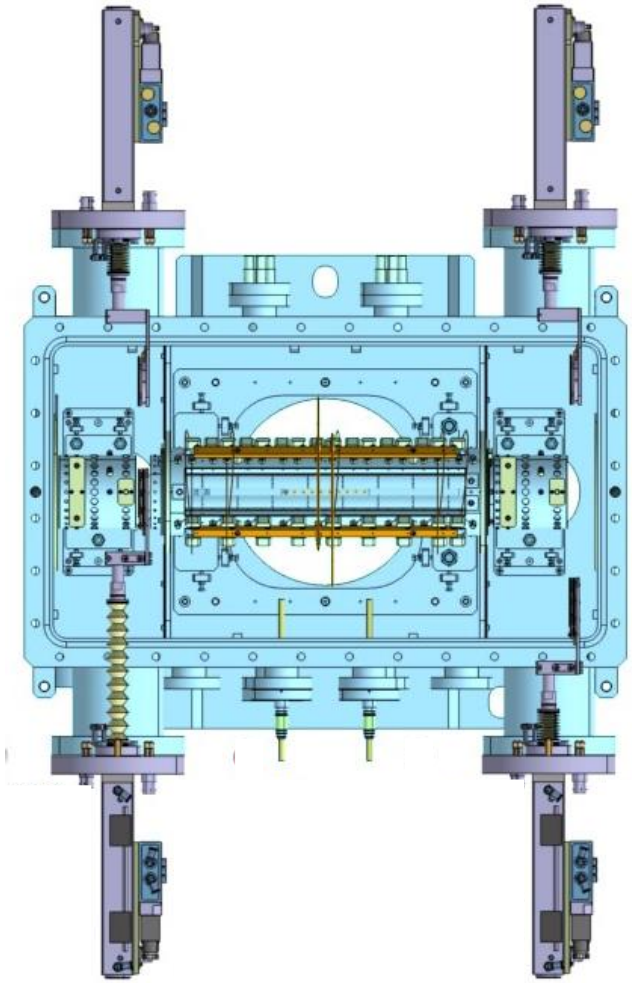


[2] R.Ferrer et al. Nature Communications.8.14520 .doi: 10.1038/ncomms14520

S³-LEB gas cell set up

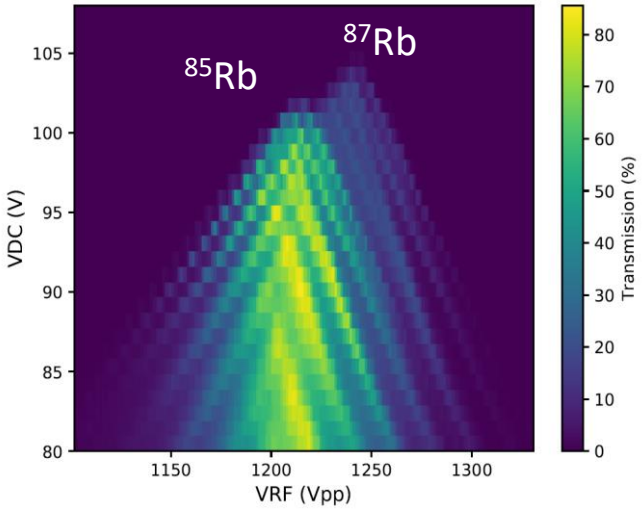


Quadrupole mass filter



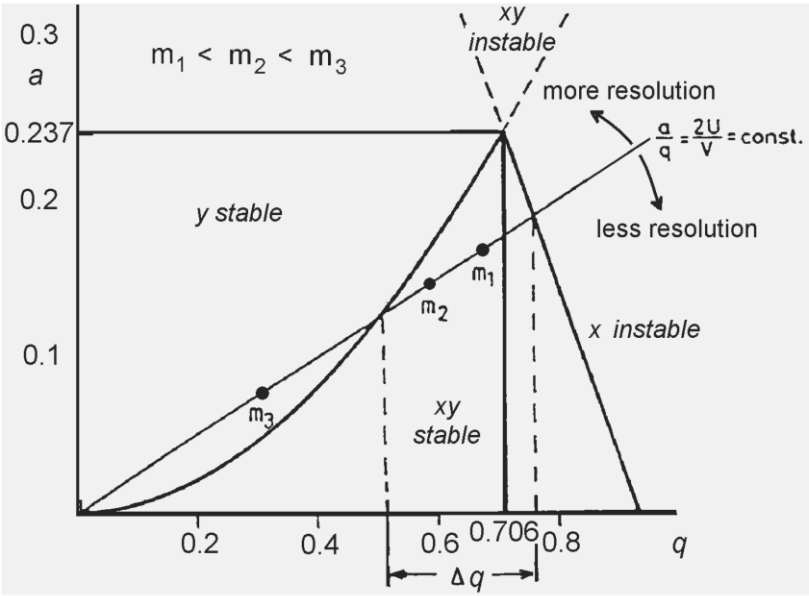
MCP1 MCP2

Thermionic Source

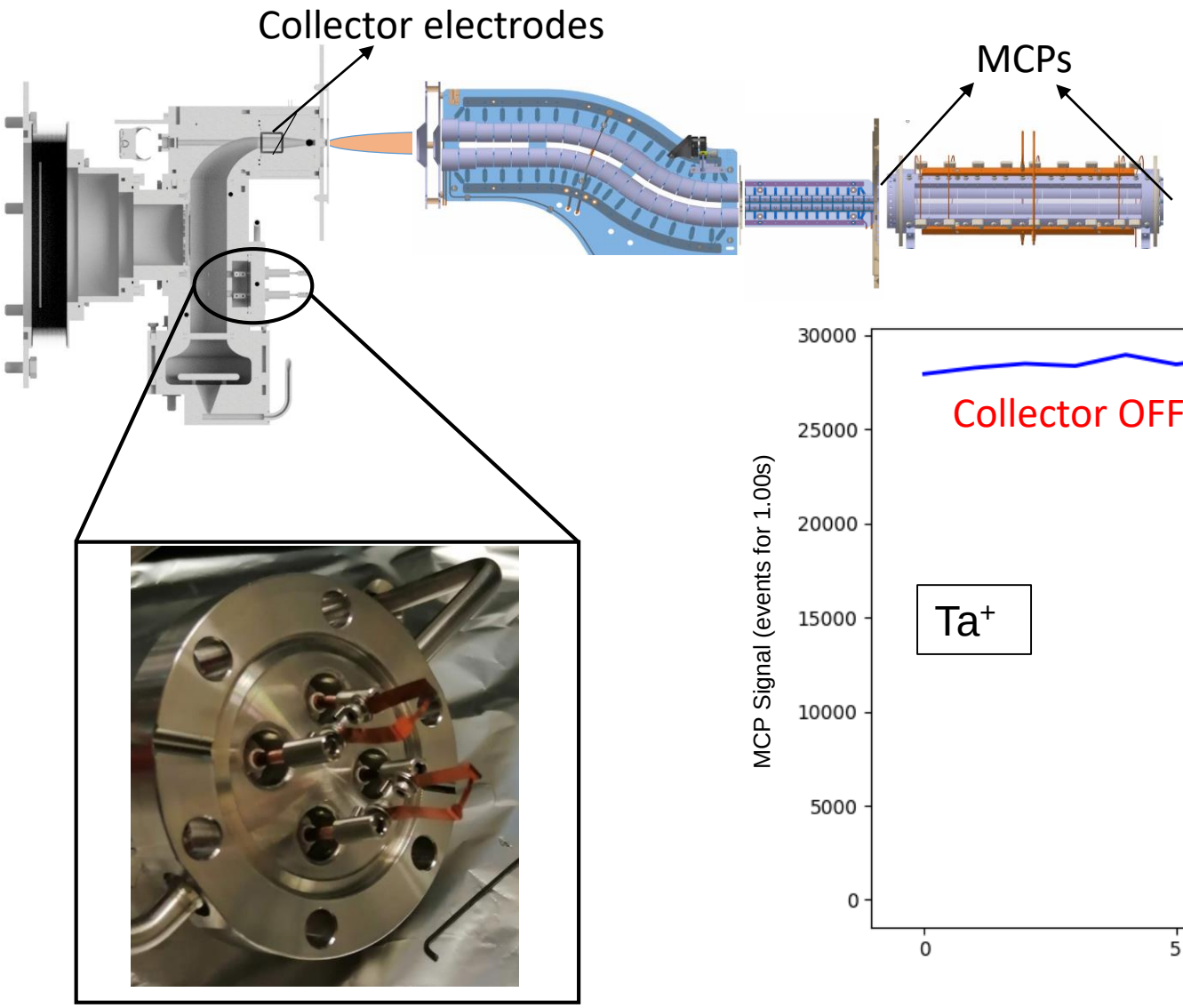


J.Romans

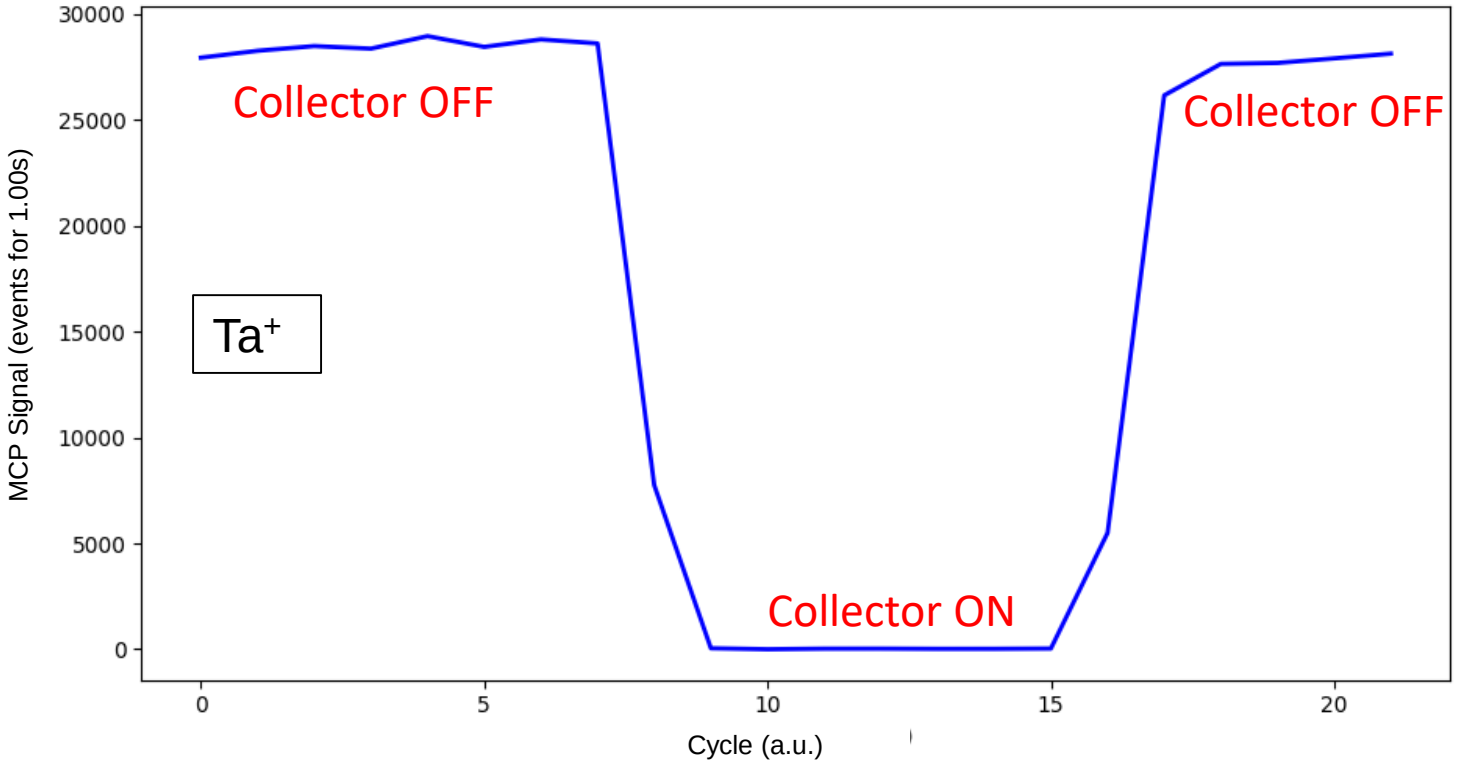
- 100% transmission
- Mass scans done at constant DC/RF ratios
- a↑, m/Δm ↑



First Ions in the gas cell

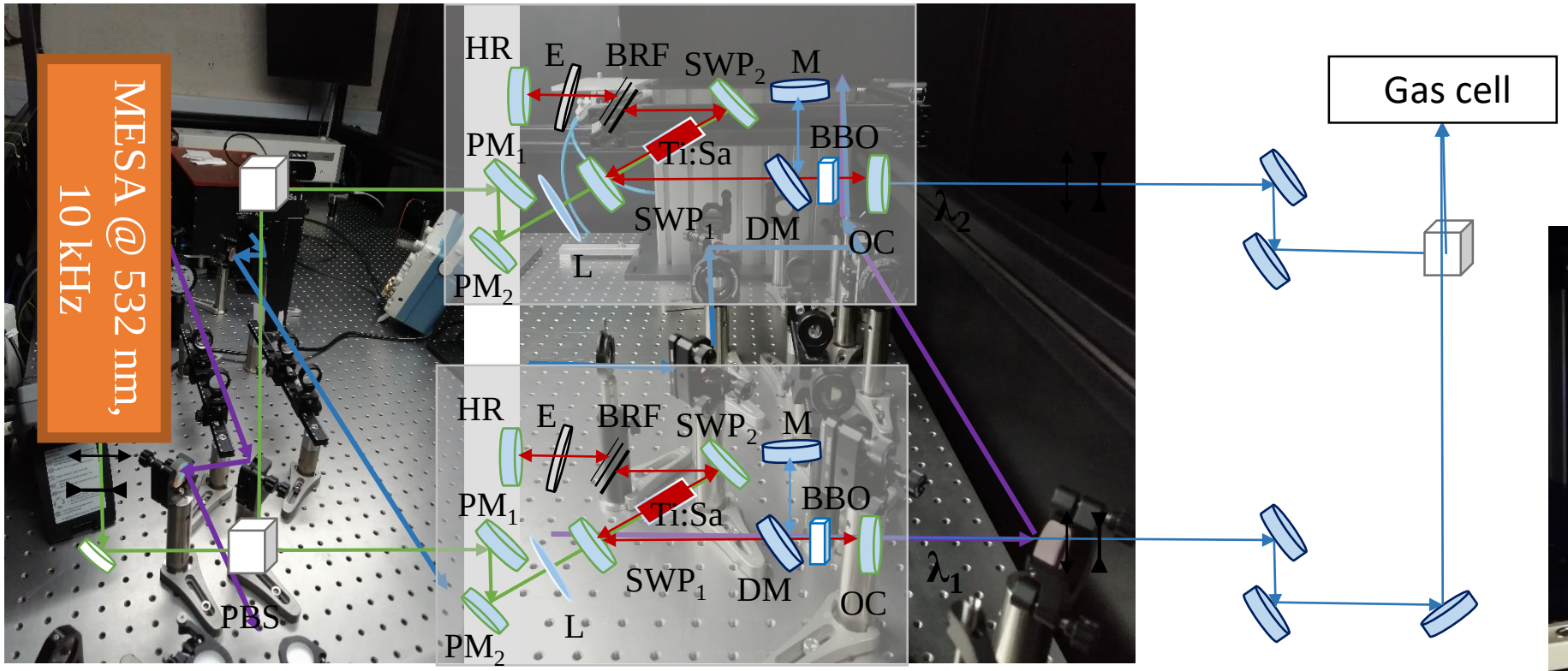


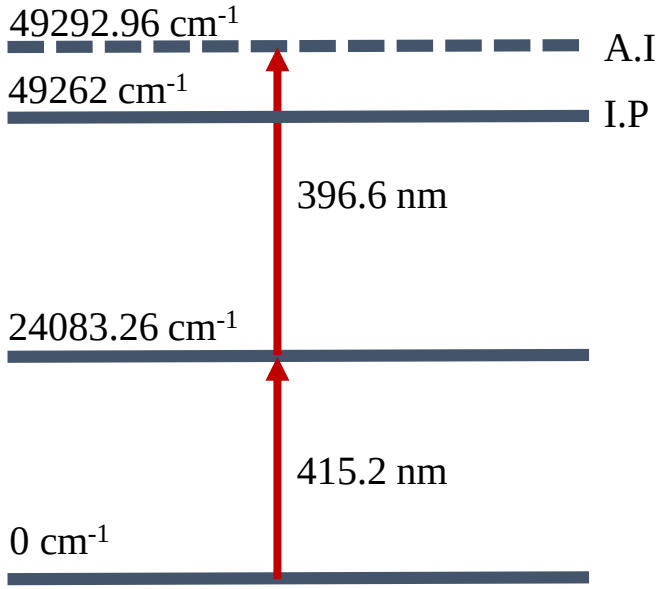
- Surface Ions
- Collector voltage -30 V

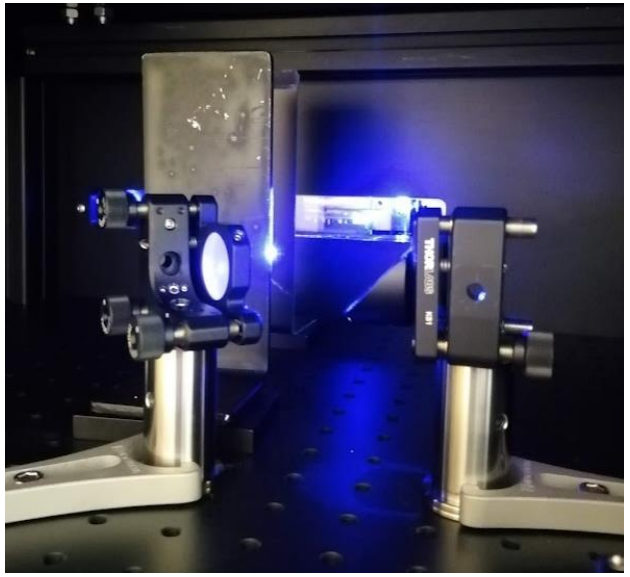


Towards Er Resonance Ionization Spectroscopy

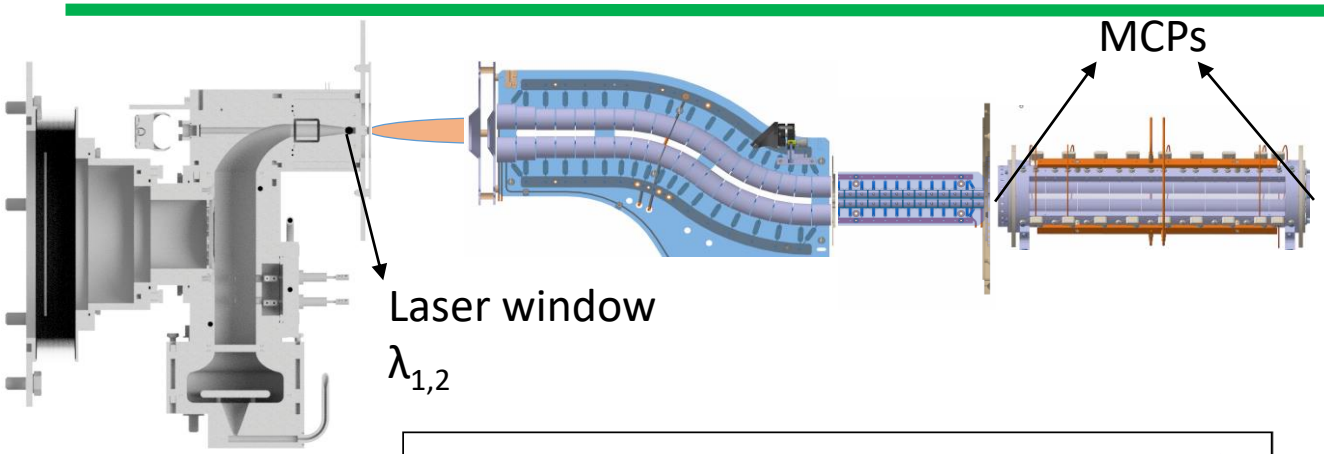
- Er I is used as commissioning element
- Excitation step: 12041.63*2 cm^{-1}/Ionization step: 12605.2*2 cm^{-1}
- Laser interaction in transverse geometry



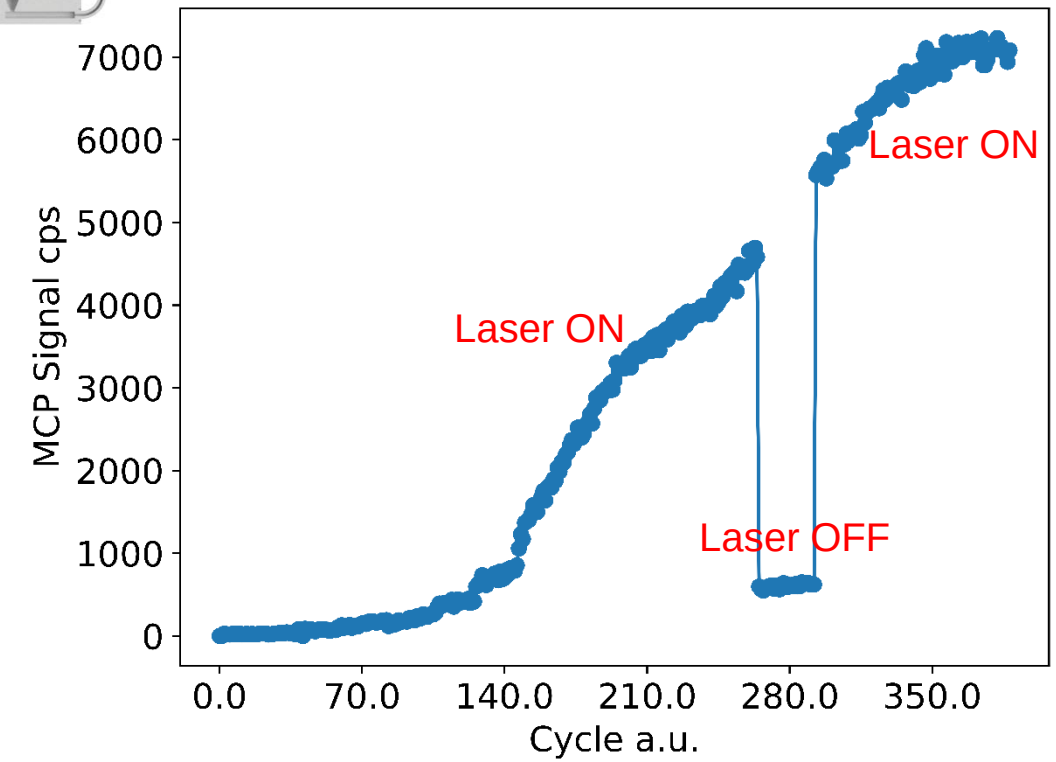


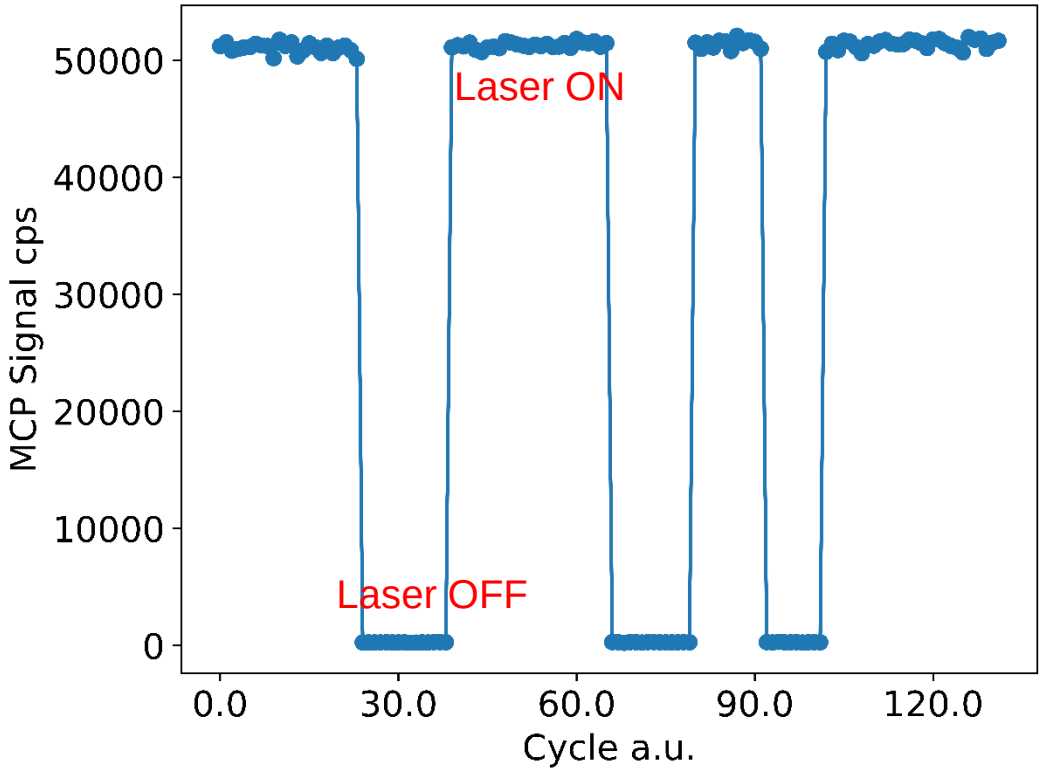


Towards Er Resonance Ionization Spectroscopy



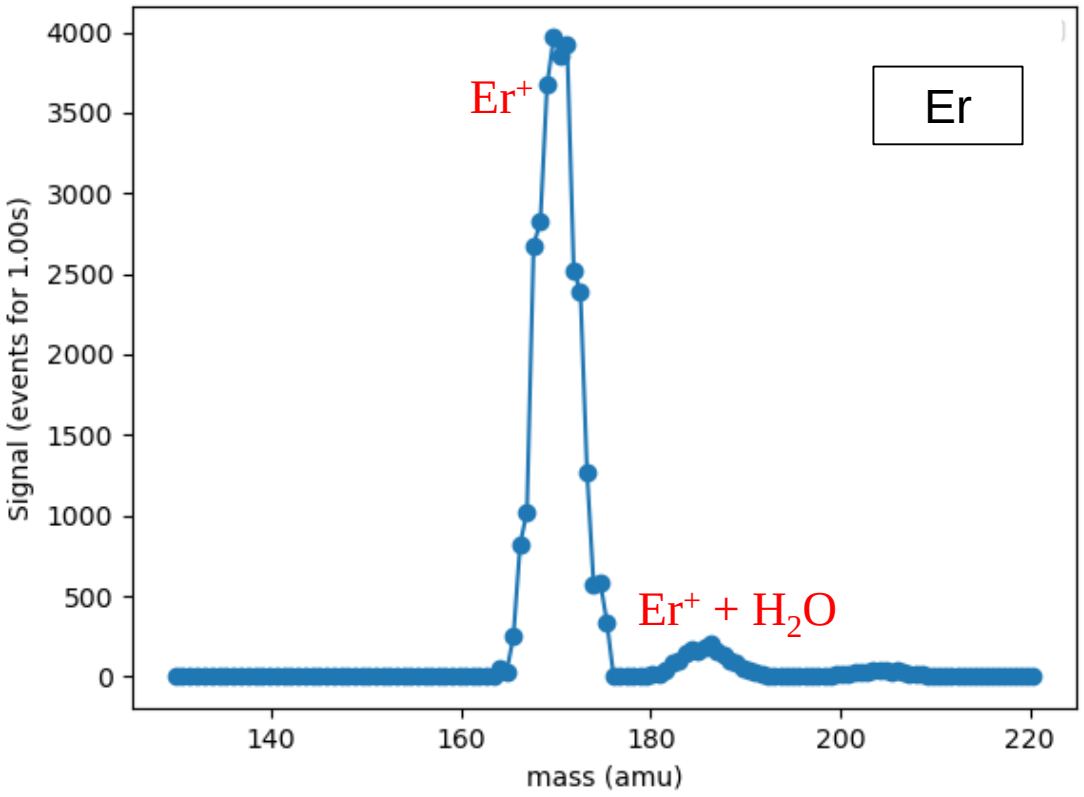
- First Er^+ ions in the gas cell
- Stable ion counts achieved
- Achieve almost 100% transmission through QMF

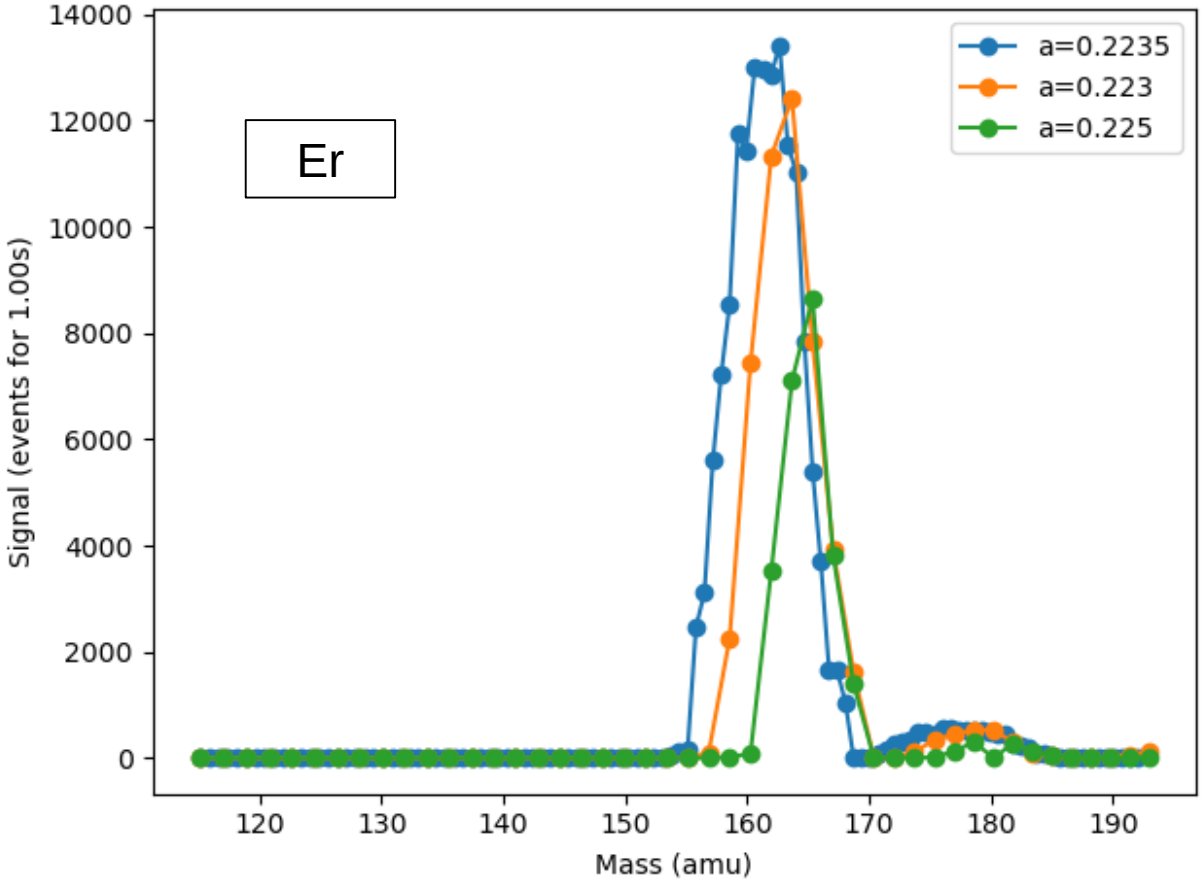




Er mass scan

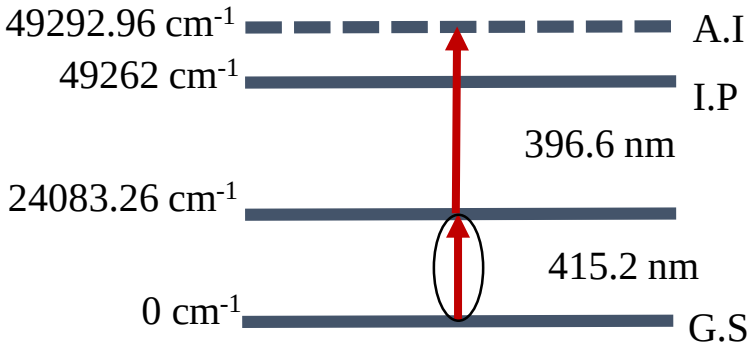
- Mass scans were performed
  - a-parameter increased to improve resolution
  - a-parameter : slope of the mass scan line

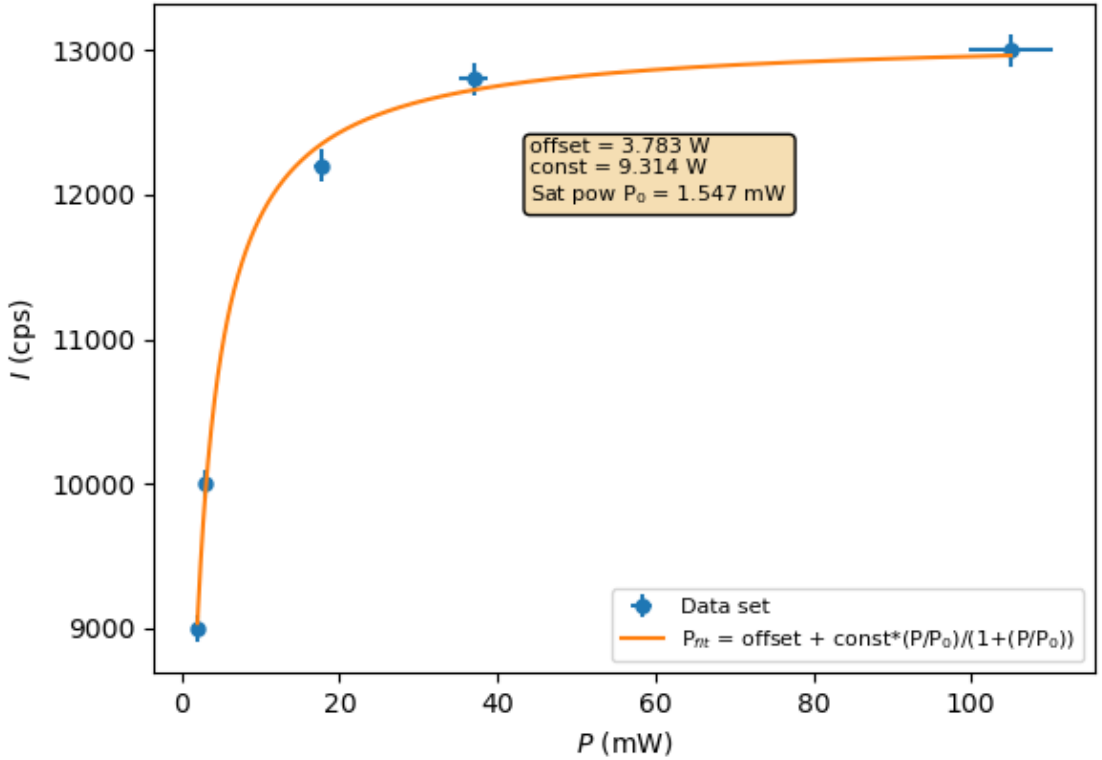


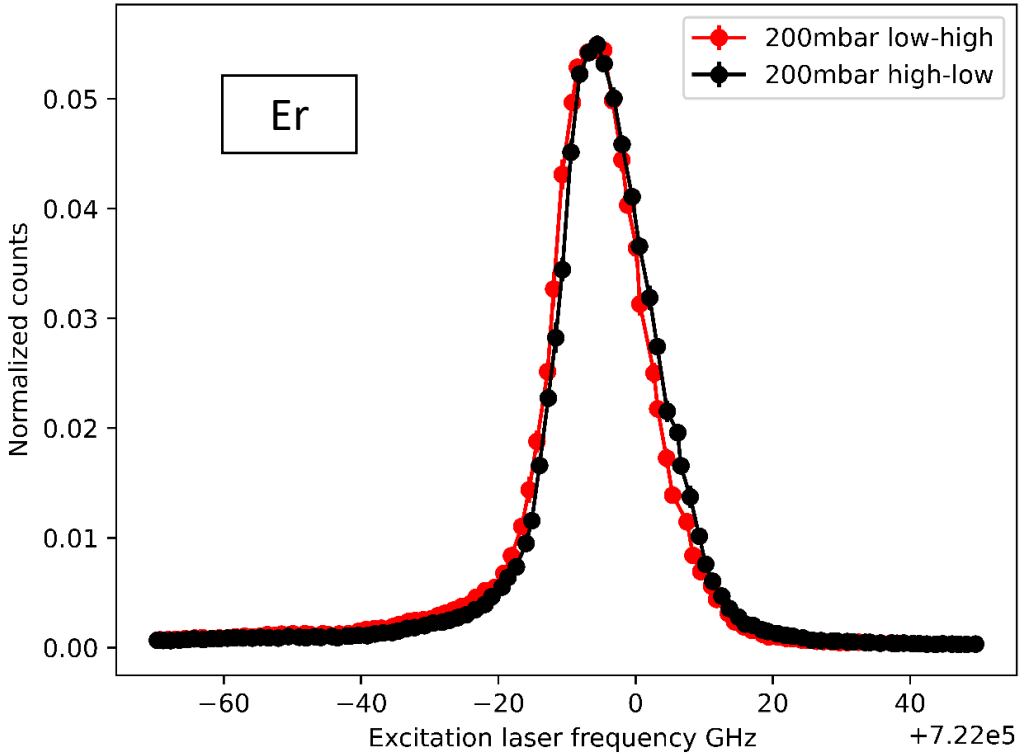


Behaviour of Er ions in the gas cell

- Saturation scan (1st step)
- First step scan
  -below saturation regime

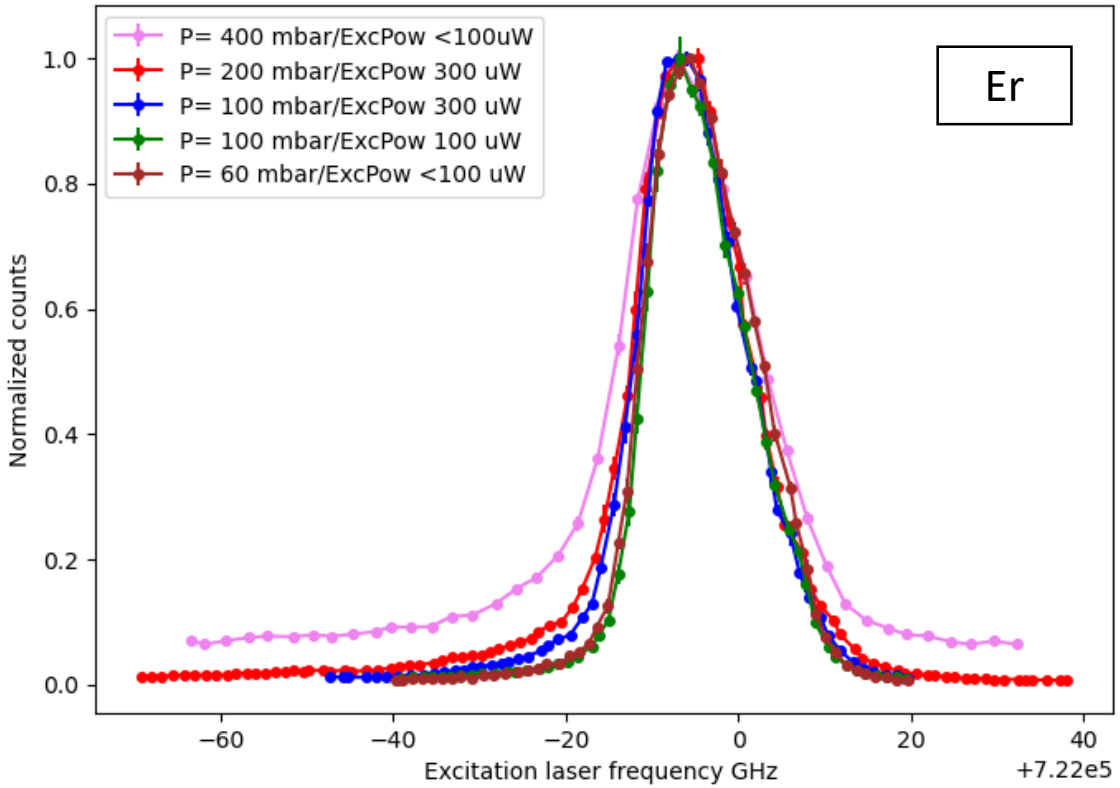


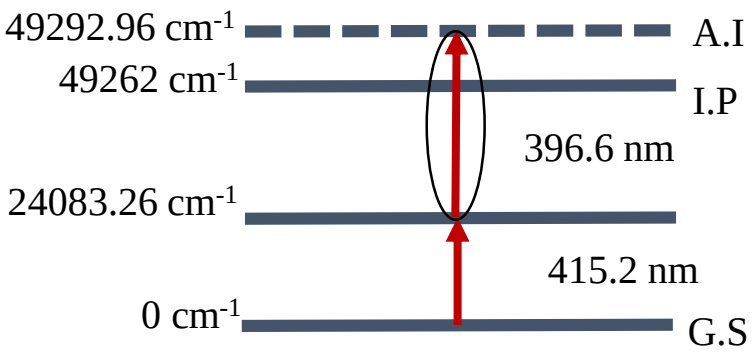




Tests on Er ions in the gas cell

Pressure broadening effects
- transition state dependent
- shift and collision broadening coefficient





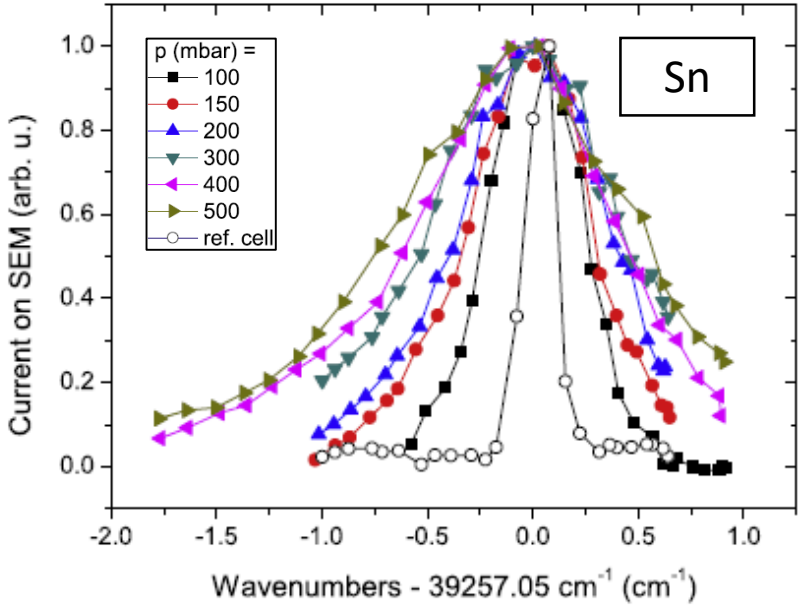
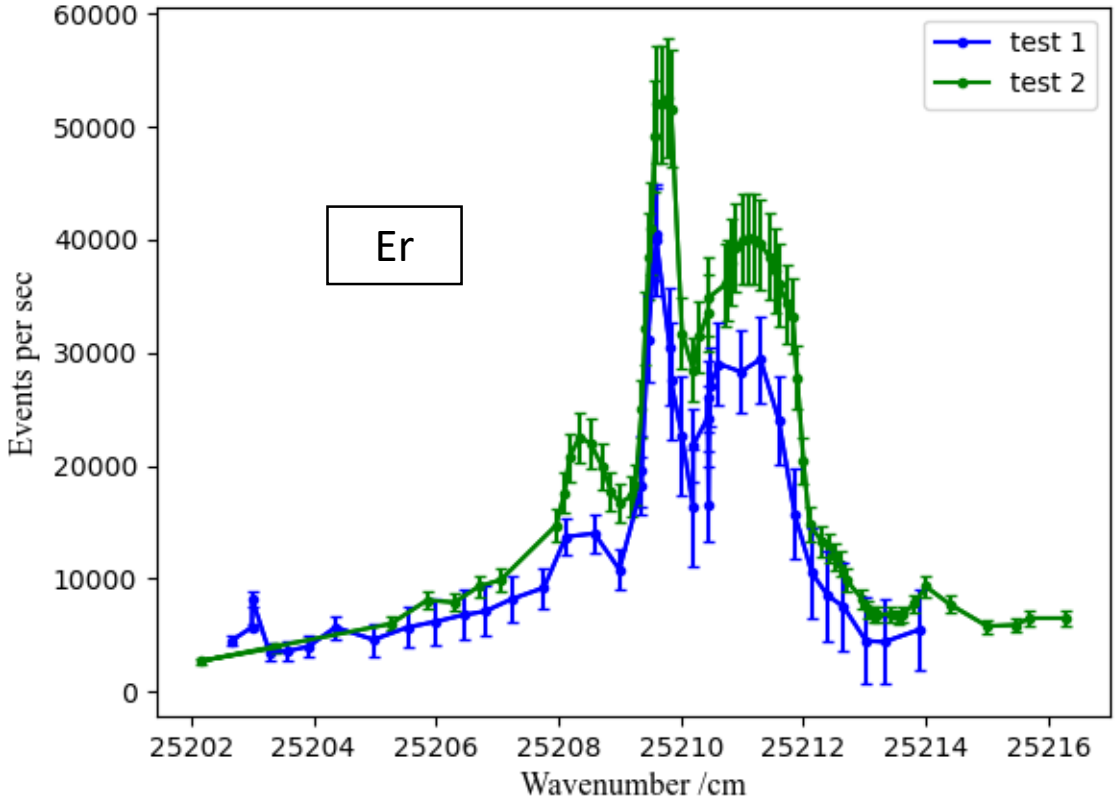


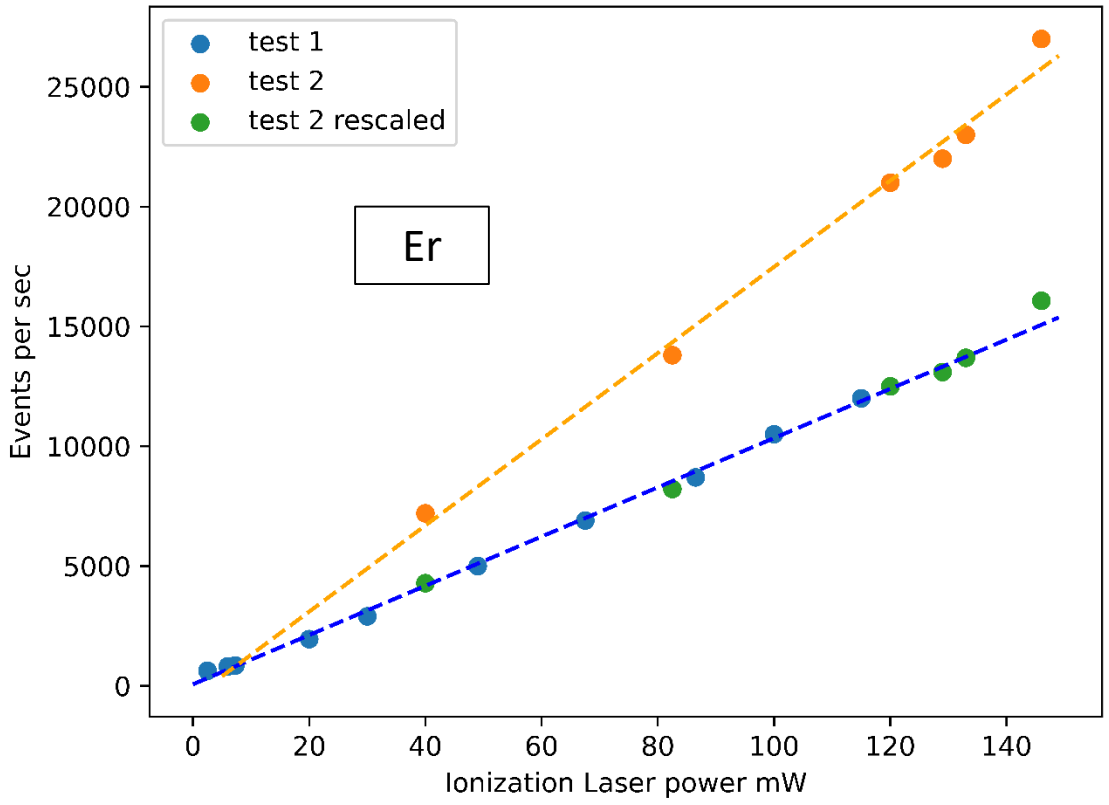
Fig. 3. Frequency dependence on the pressure for the first (bottom) and second (top) step transition in ^{120}Sn using the atomic scheme shown in Fig. 2b.

[3] R.Ferrer et al. Nucl. Instrum. Methods Phys. Res. B,317 doi:https://doi.org/10.1016/j.nimb.2013.07.028

Tests on Er ions in the gas cell

- Ionization step power in linear regime
- May limit the ionization efficiency for in-gas jet laser spectroscopy





[3] D.Studer, Resonanzionisationsspektroskopie hochliegender Zustände in Dysprosium und Erbium zur Entwicklung effizienter Anregungsschemata und Bestimmung des ersten Ionisationspotentials,Thesis(2015)

Outlook

Summary:

- Laser ions were detected in the gas cell
- Transmission till QMF has been tested
- Mass scans were performed
- Characterisation of laser ions in the gas cell

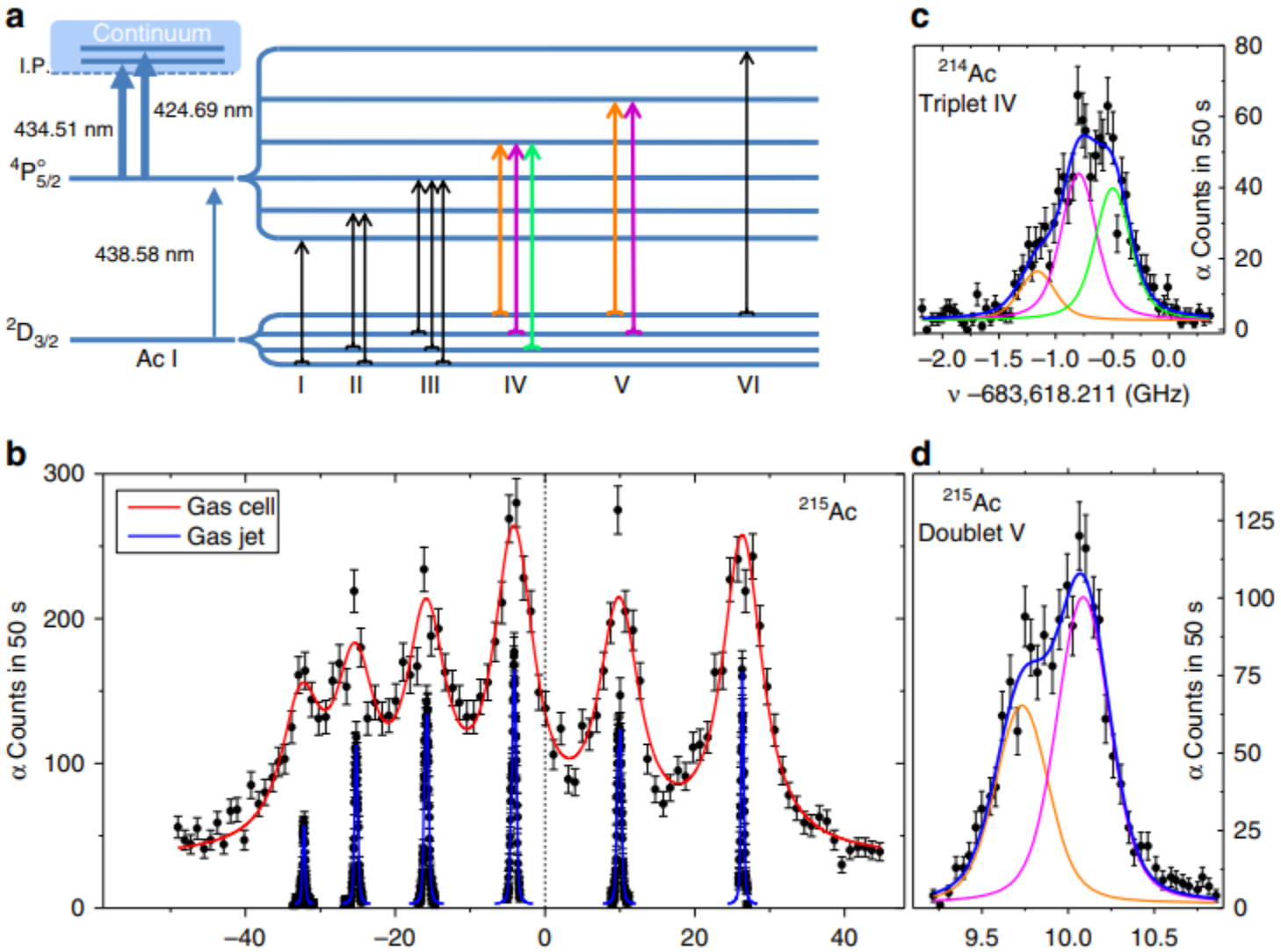
Future Steps:

- Continue with the gas cell tests

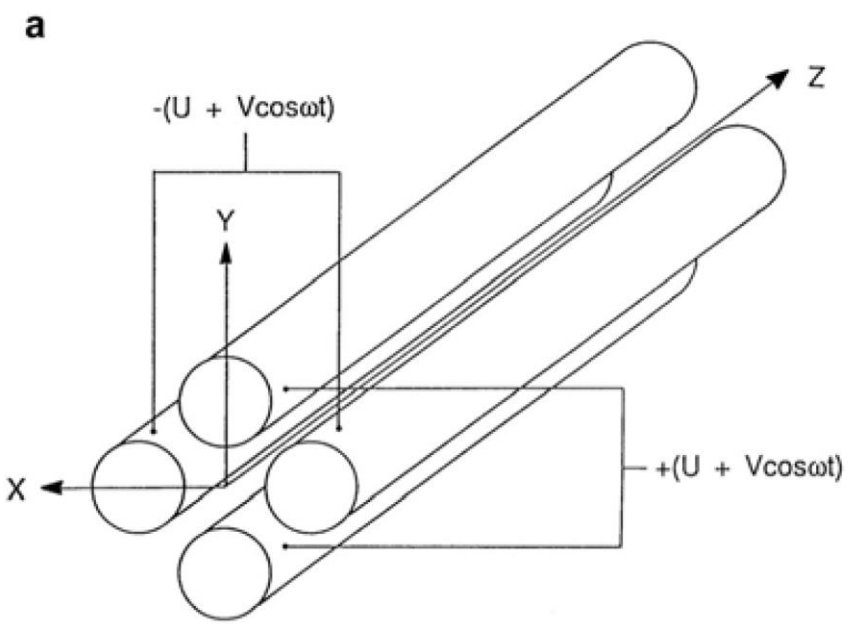
  - Influence of pressure broadening in first and second step transition

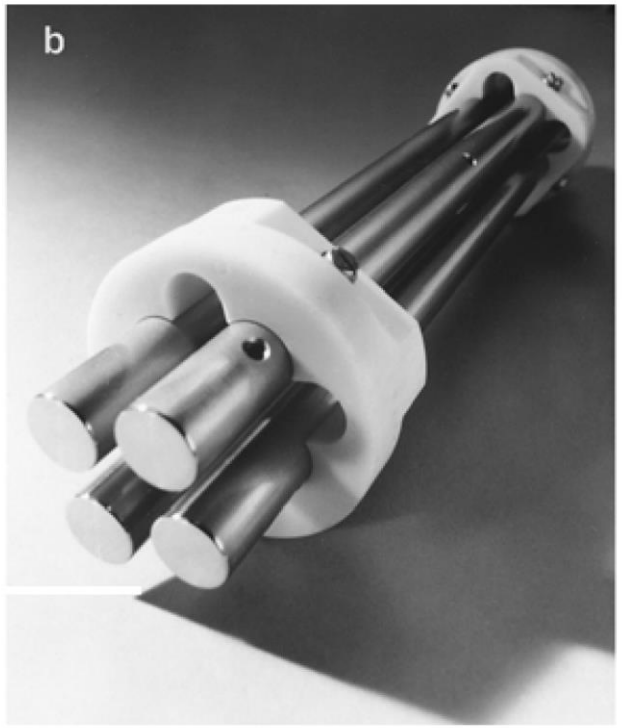
- Preparation for In- gas jet spectroscopy tests

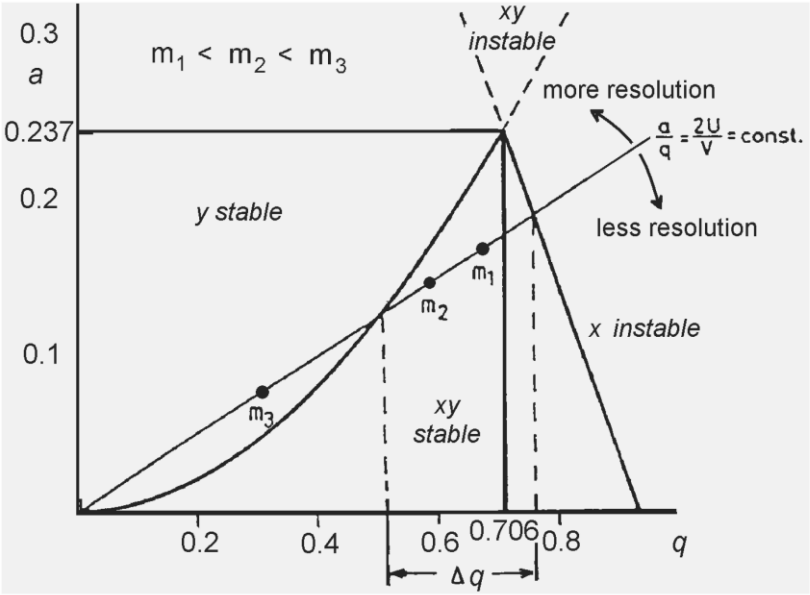
Thank you

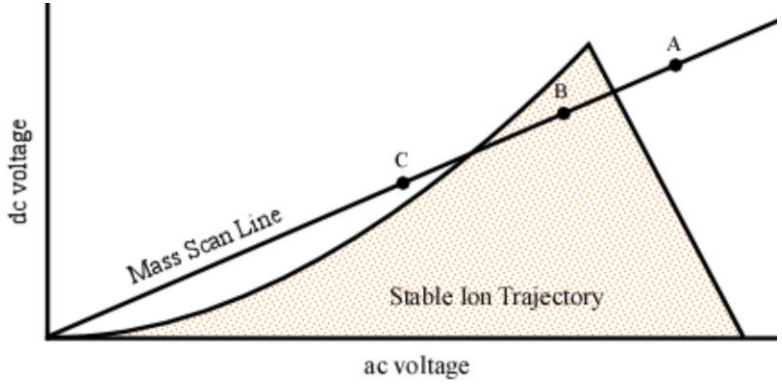

a
Continuum
I.P.
434.51 nm
424.69 nm
$^4P^o_{5/2}$
438.58 nm
$^2D_{3/2}$
Ac I
I
II
III
IV
V
VI
c
^{214}Ac
Triplet IV
α Counts in 50 s
ν −683,618.211 (GHz)
b
Gas cell
Gas jet
^{215}Ac
α Counts in 50 s
d
^{215}Ac
Doublet V
α Counts in 50 s

Quadrupole mass filter



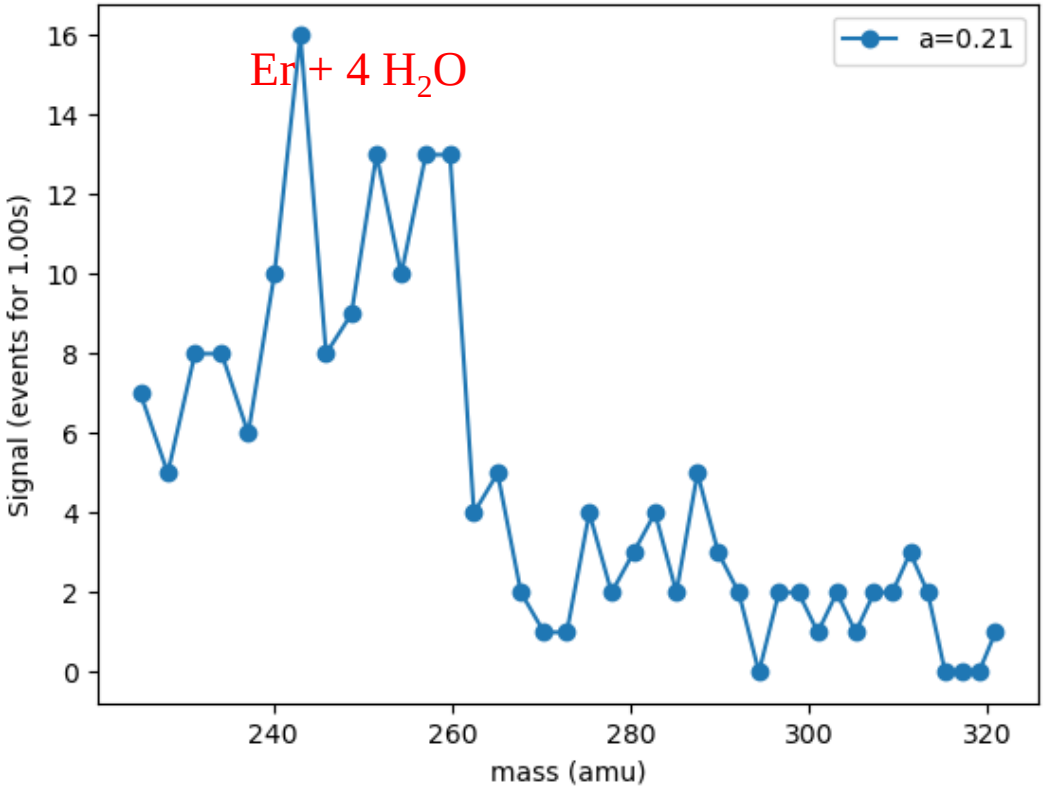


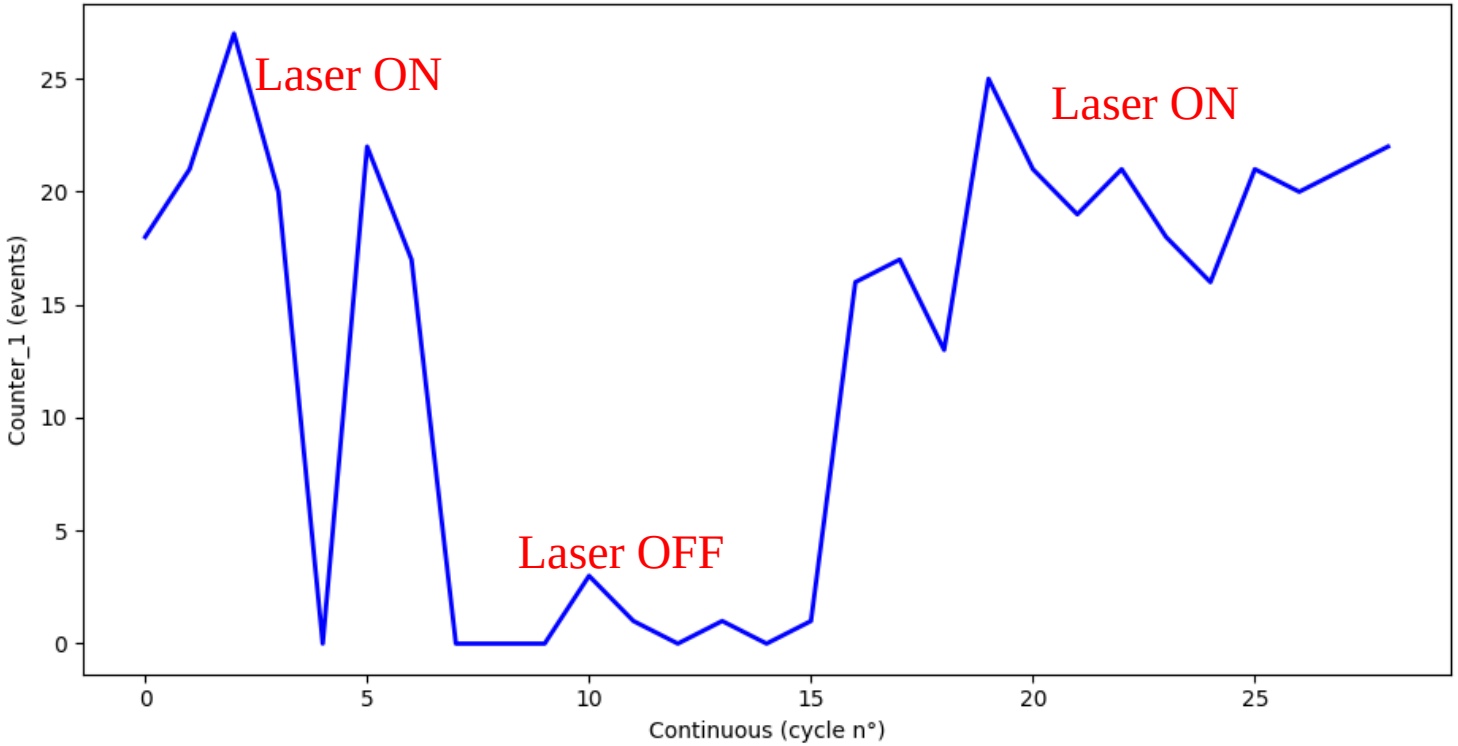




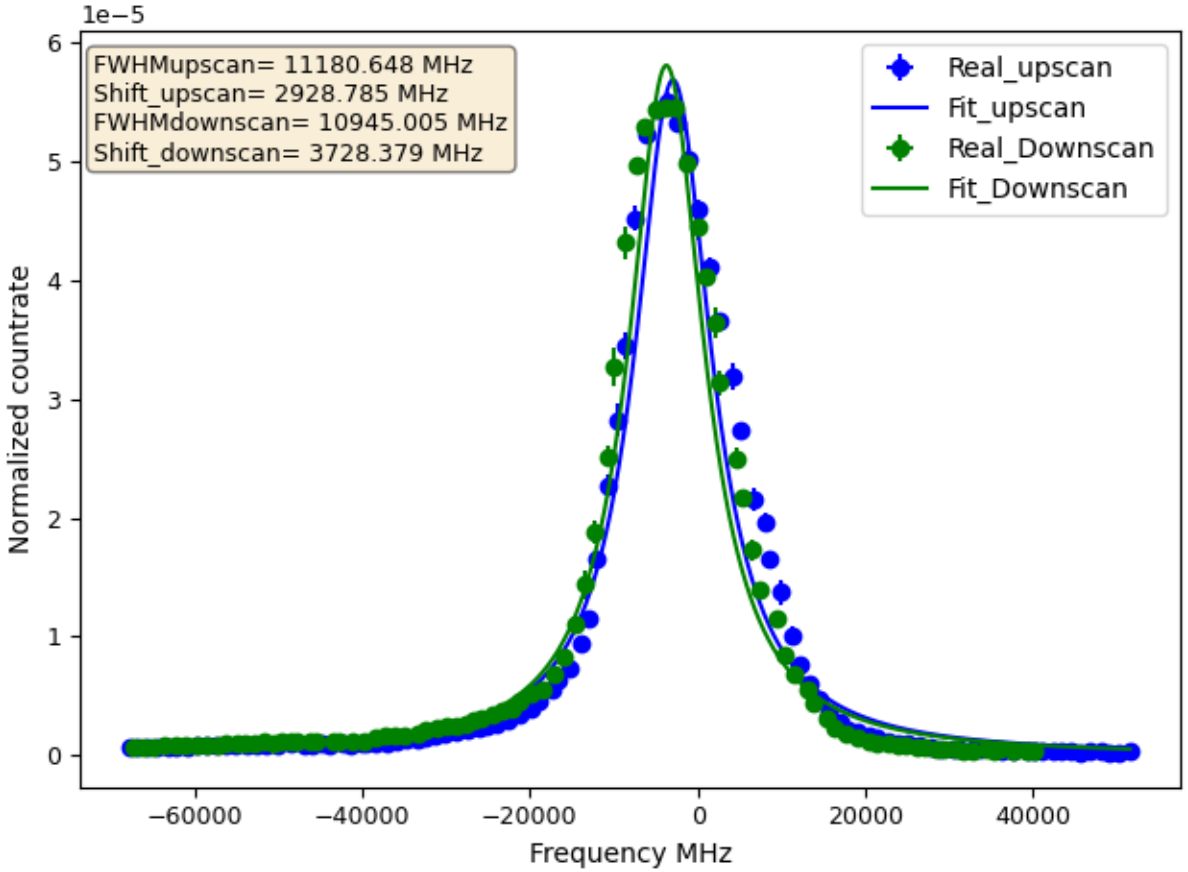
Er mass scan

- Mass scans were performed
  - a-parameter varied to get higher resolution





Laser Scan

- Asi=9.60e+07s^{-1}
- [Xe]. $4f^{12}(^3H_6)\ 6s^2$ -------- $4f^{12}(^3H)6s6p$
- $\Gamma_{nat}=A_{01}/\ 2\pi$ =15.278MHz
- $\Gamma_{coll}=\gamma_{coll}\cdot\ \rho$

$$\Gamma = \Gamma_{nat} + \Gamma_{sh} + \Gamma_{coll}$$