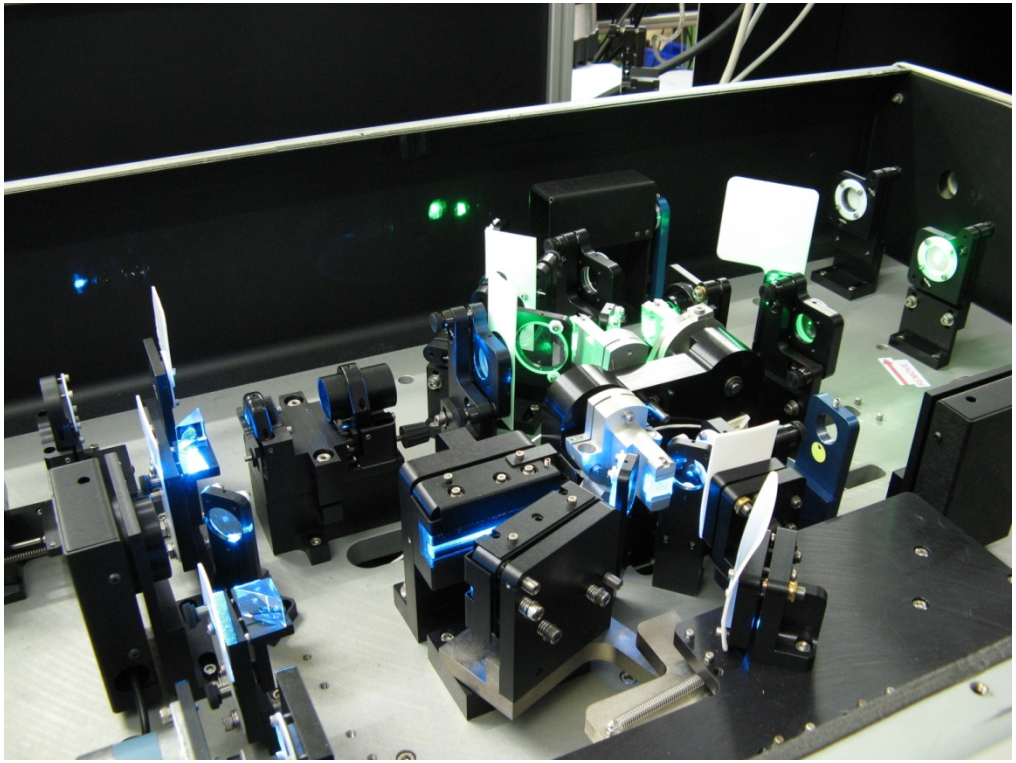
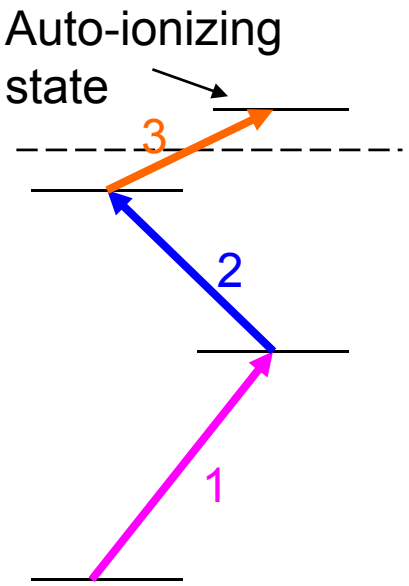
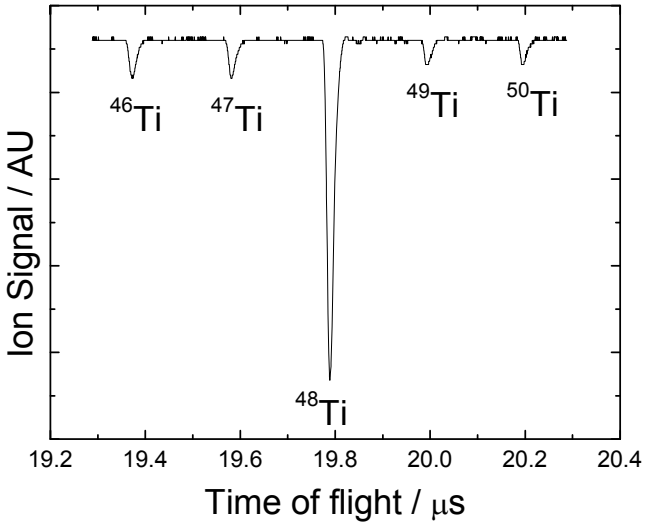
Update from the LARIS lab







Marica Sjödin

Isolde workshop, November 2008

The LARIS Laboratory

- Introduction

Primary objectives:

- **Investigate new ionization schemes (free from ISOLDE scheduling)**
- **Improve upon current schemes that rely on non-resonant ionization**
  - search for auto-ionizing states
- **Prepare for RILIS transition Solid State Laser system**
  - different wavelength range (532 nm and 355 nm pumped dye lasers)

Secondary objectives:

- **Investigate RILIS selectivity improvements**
  - HFS measurements (isomer selectivity)
  - Hot cavity optimization / material testing

Tertiary objectives:

- Questions related to fundamental atomic spectroscopy, e.g. accurate determination of atomic ionization potentials.

CERN/KTH collaboration

Funding: Knut and Alice Wallenberg Foundation

Laser ionisation not feasible with RILIS lasers

Ionisation scheme in use at ISOLDE

Good ionisation efficiency

Currently using non resonant final step - want improved efficiency

RILIS feasible - Atomic data known but ionisation scheme not tested

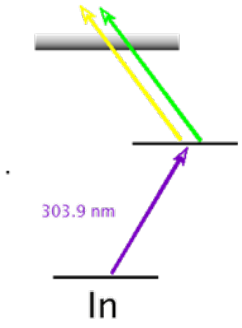
Element not released from ISOLDE target

1 H																	2 He
3 Li*	4 Be											5 B	6 C	7 N	8 O	9 F	10 Ne
11 Na*	12 Mg											13 Al	14 Si	15 P	16 S	17 Cl	18 Ar
19 K*	20 Ca	21 Sc	22 Ti	23 V	24 Cr	25 Mn	26 Fe	27 Co	28 Ni	29 Cu	30 Zn	31 Ga	32 Ge	33 As	34 Se	35 Br	36 Kr
37 Rb*	38 Sr*	39 Y	40 Zr	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd	49 In	50 Sn	51 Sb	52 Te	53 I	54 Xe
55 Cs*	56 Ba*	57 La	72 Hf	73 Ta	74 W	75 Re	76 Os	77 Ir	78 Pt	79 Au	80 Hg	81 Tl	82 Pb	83 Bi	84 Po	85 At	86 Rn
87 Fr*	88 Ra	89 Ac	104 Rf	105 Ha	106 Sg	107 Ns	108 Hs	109 Mt	110	111	112						

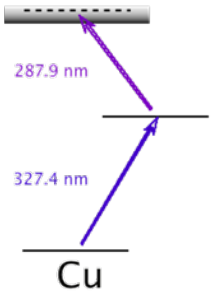
*Useful RILIS ionization would require SI suppression (new cavities or LIST)

58 Ce	59 Pr	60 Nd	61 Pm	62 Sm	63 Eu	64 Gd	65 Tb	66 Dy	67 Ho	68 Er	69 Tm	70 Yb	71 Lu
90 Th	91 Pa	92 U	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No	103 Lr

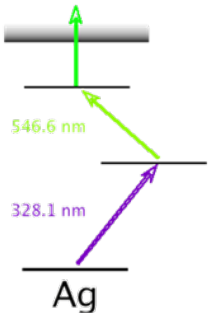
2-step:
(1 resonance)



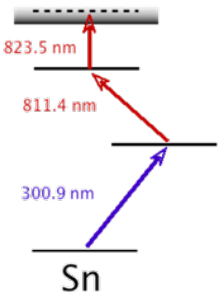
(2 resonance)



3-step:
2 resonance)



(3 resonance)



The LARIS Laboratory

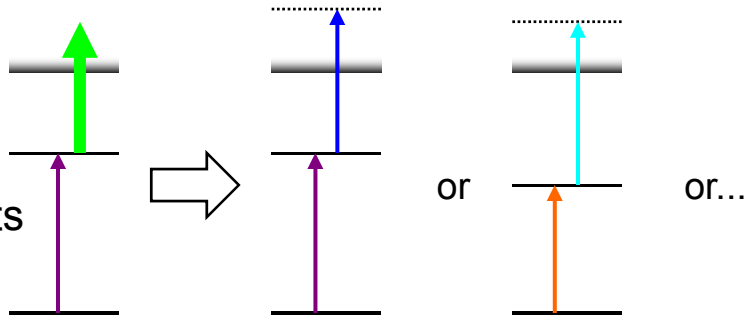
- Immediate tasks

Measure relative efficiecies of ionization schemes

Systematic study of auto-ionising states

New ionisation schemes for currently unavailable elements

Replace schemes that require CVL pumping @ 511 nm



LARIS is an offline development lab for RILIS ISOLDE

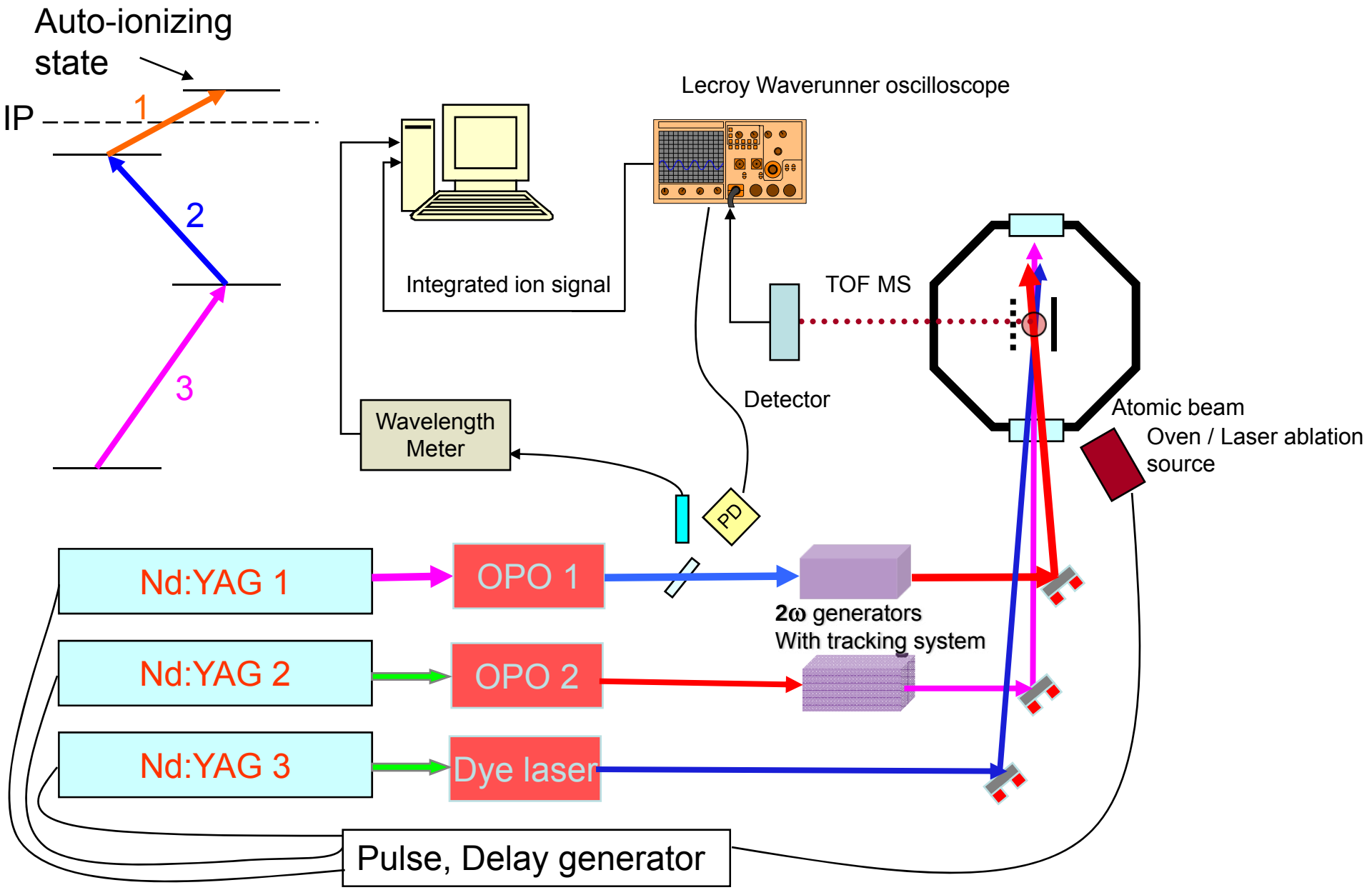
Separate laser system

Separate atomic scource

(only stable isotopes)

The LARIS Laboratory

- overview



The LARIS Laboratory

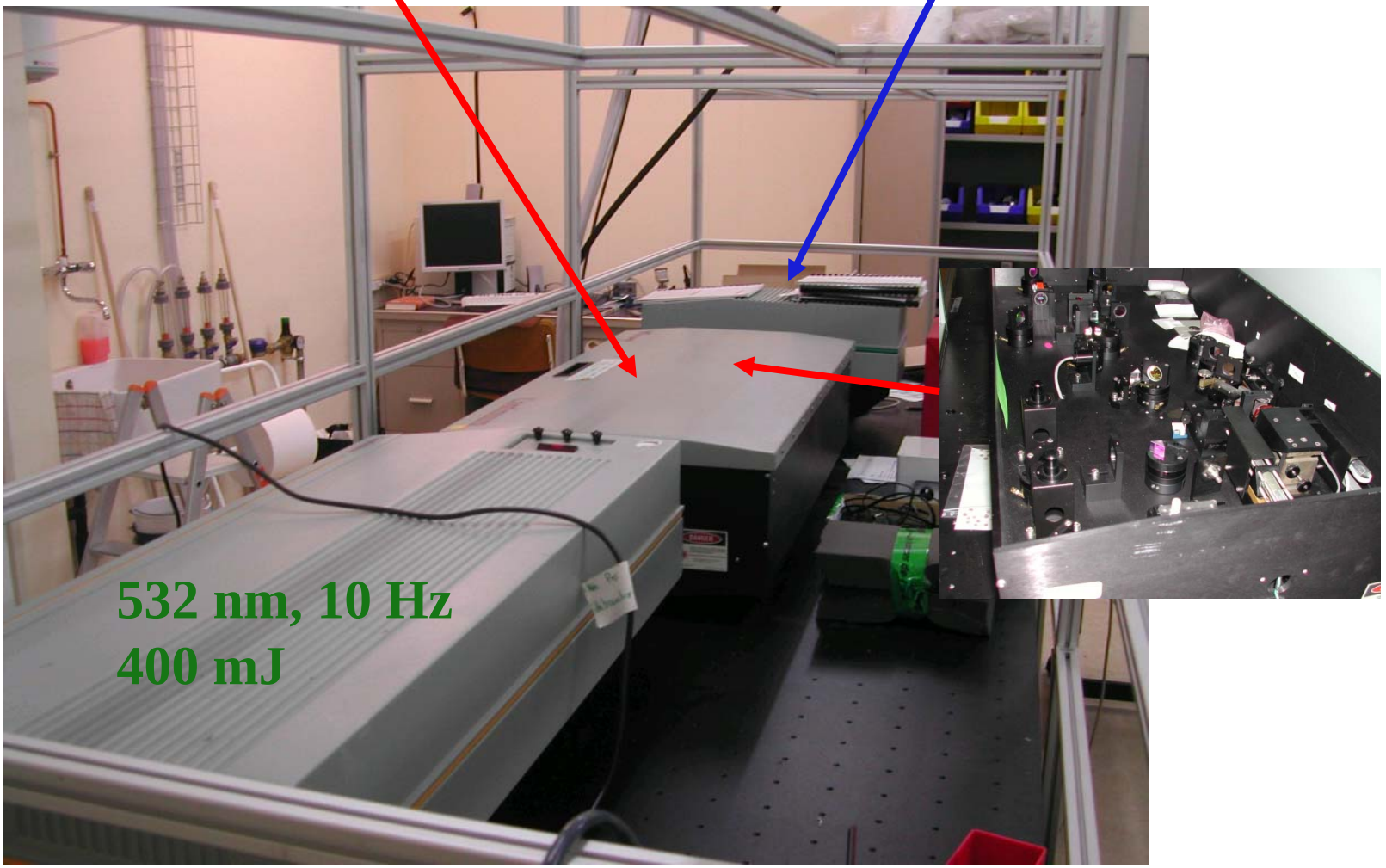
- Lasers

Continuum PowerLite 7010 + OPO Mirage + Continuum UVT

Tuning range: 720 - 920 nm (fund.), 360 - 460 nm (2ω)

80 mJ @750nm

10 mJ @ 425nm



The LARIS Laboratory

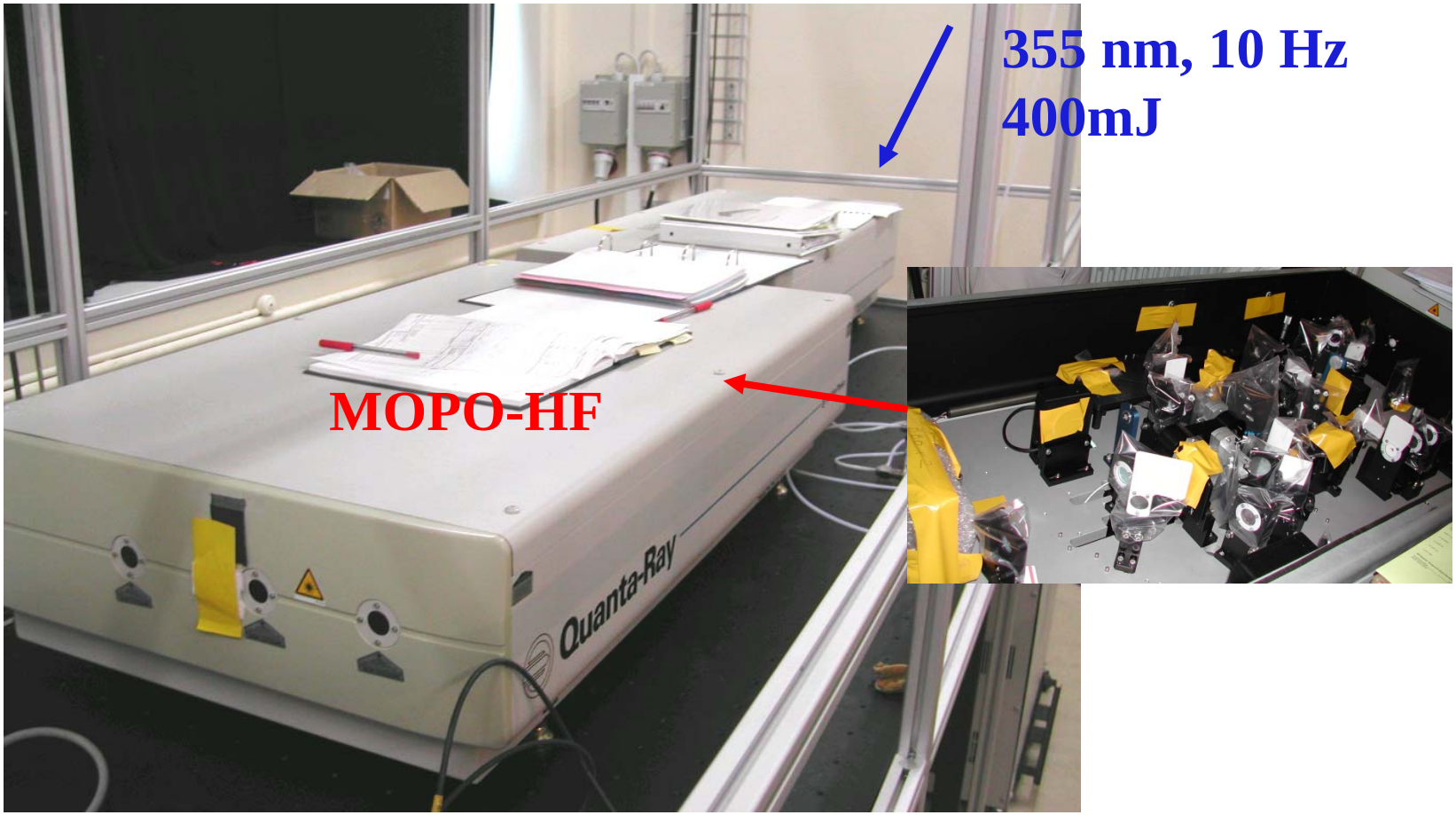
- Lasers

Spectra Physics Quanta-Ray PRO 230-10 + MOPO HF + FDO-970

Tuning range: 450 - 690 nm (signal), 735 - 1680 nm (idler), 220 – 440 (2ω)

70 mJ @500nm

7.5 mJ @250nm

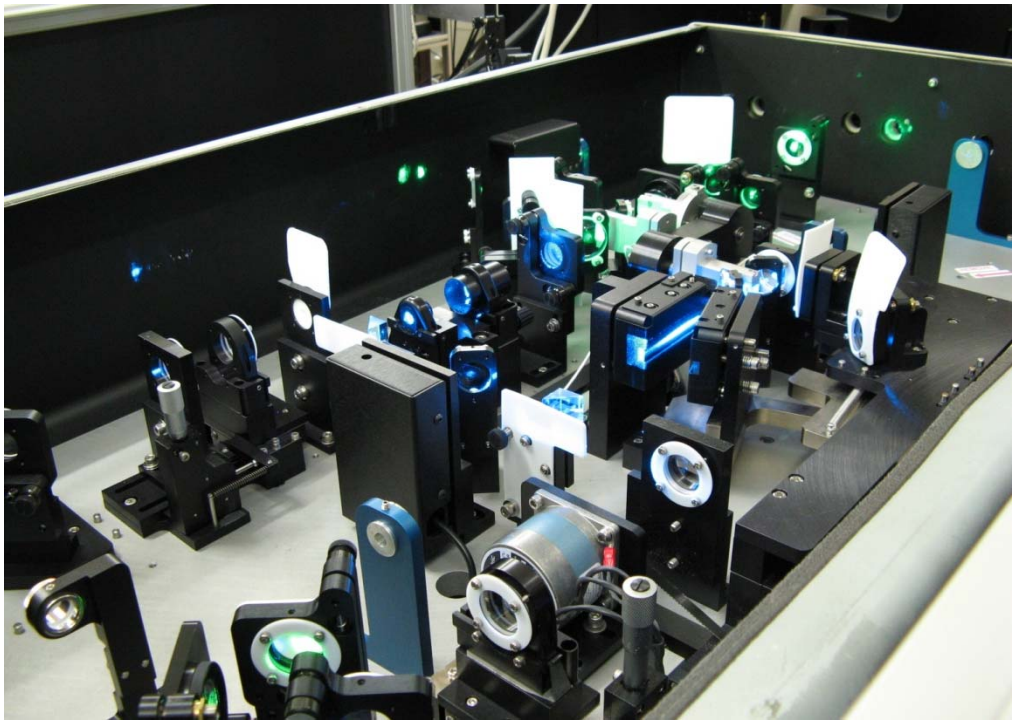


The LARIS Laboratory

- Lasers

Spectra Physics Quanta-Ray PRO 230-10 + MOPO HF + FDO-970

Tuning range: 450 - 690 nm (signal), 735 - 1680 nm (idler),
220 – 345, 365 - 440 (2ω)



”Easily” tuneable over a
very wide λ-region (with some gaps)

Handy when probing for autoionising states

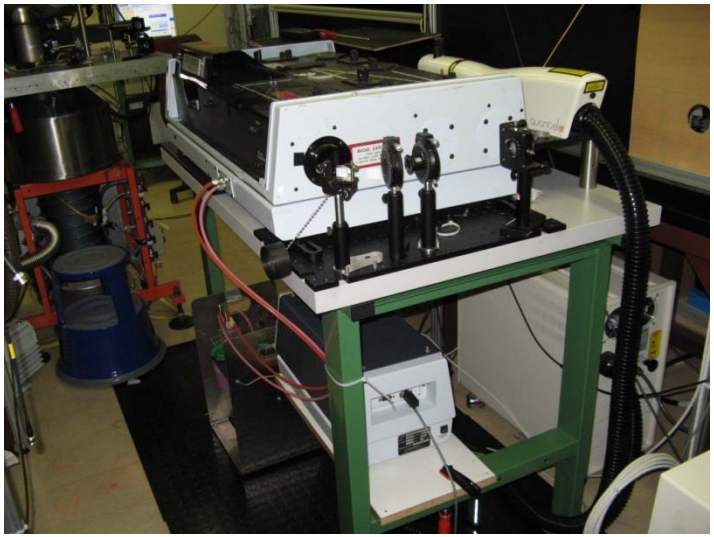
Complicated (and expensive!)
to set up

Need good tables

The LARIS Laboratory

- Lasers

Quantel Brilliant (“Banana laser”) Nd:YAG with 2ω and 3ω units
Lumonics HD-500 Dye laser
Dye tuning ranges: 390 - 850 nm (fund.), >200 nm(2ω)



Quantel YAG Pump laser

20 Hz

Pulse energy:

350 mJ (1064 nm)
160 mJ (532 nm)
60 mJ (355 nm)

Pulse duration @1064 nm: 4.4 ns

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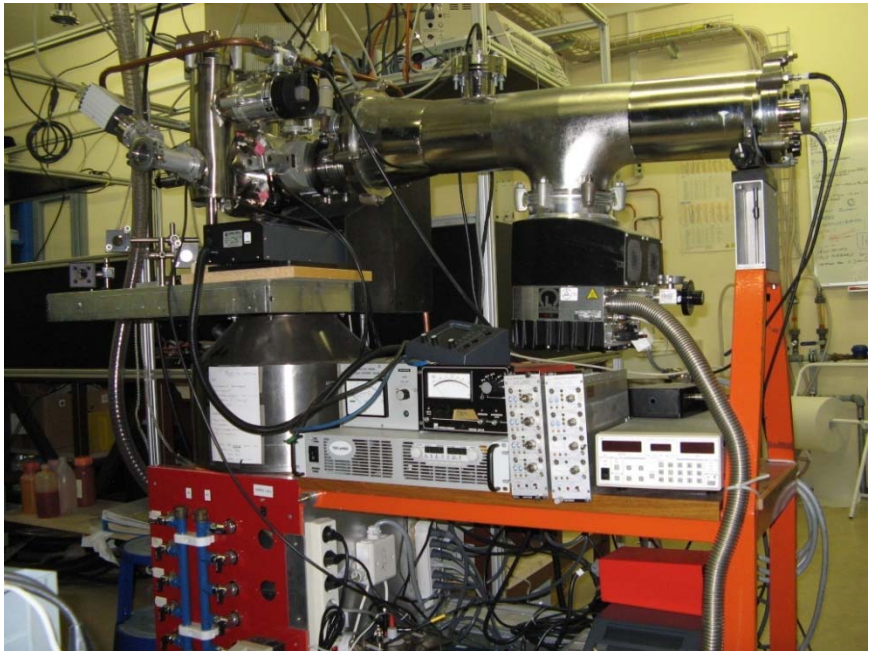
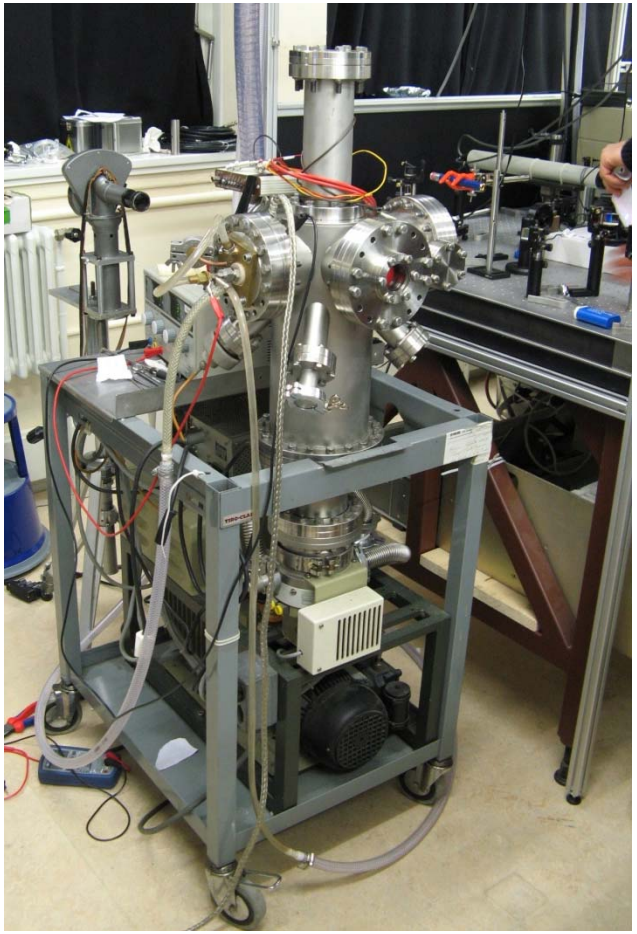
Two complementary units:

Laser ablation source
With Time Of Flight MS



Thermal atomic beam unit
TOF MS will be added



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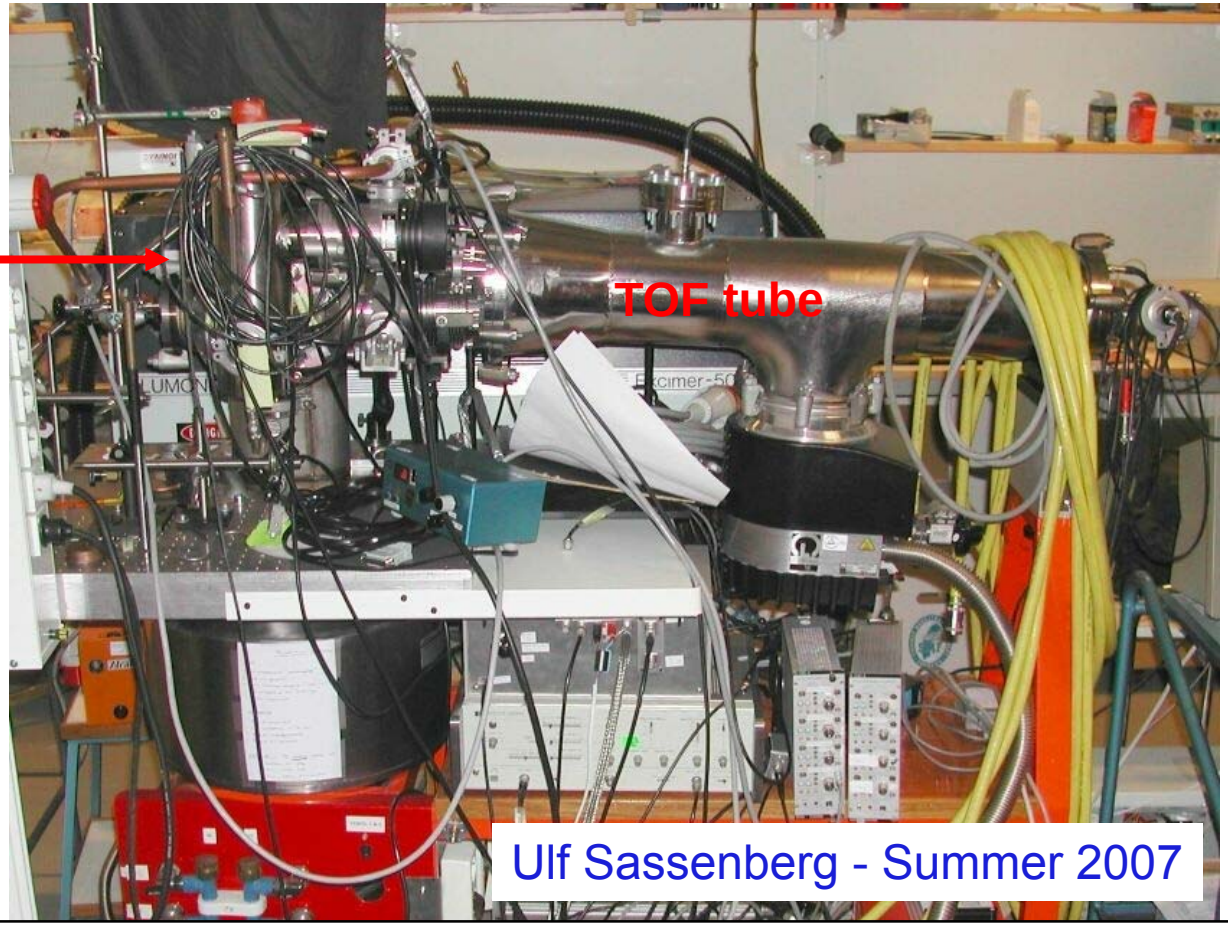
- Time of flight mass spectrometer

Ablation chamber and gas transport of atoms into interaction region:



To acquire higher resolution laser spectra for specific isotopes

Measure isotope shifts for stable isotopes

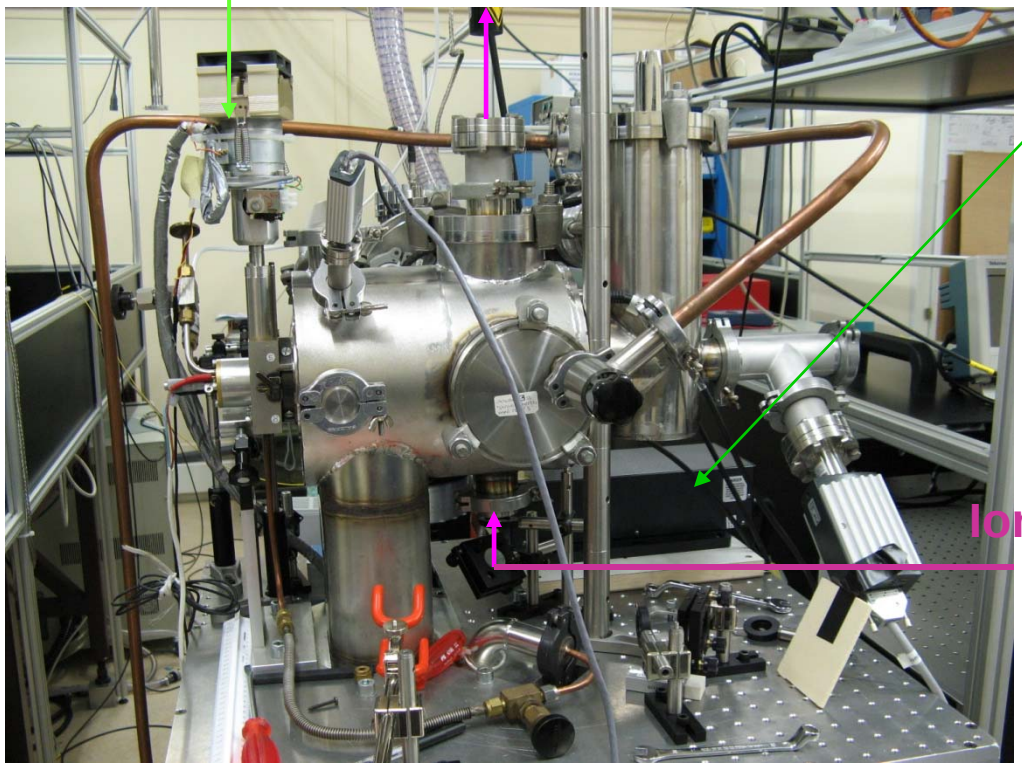
Measure HFS for different atomic transitions in various ionization schemes

(Feasibility study for ***isomer separation***)

The LARIS Laboratory

- Time of flight mass spectrometer

Ablation unit



Ablation laser

New wave POLARIS 3

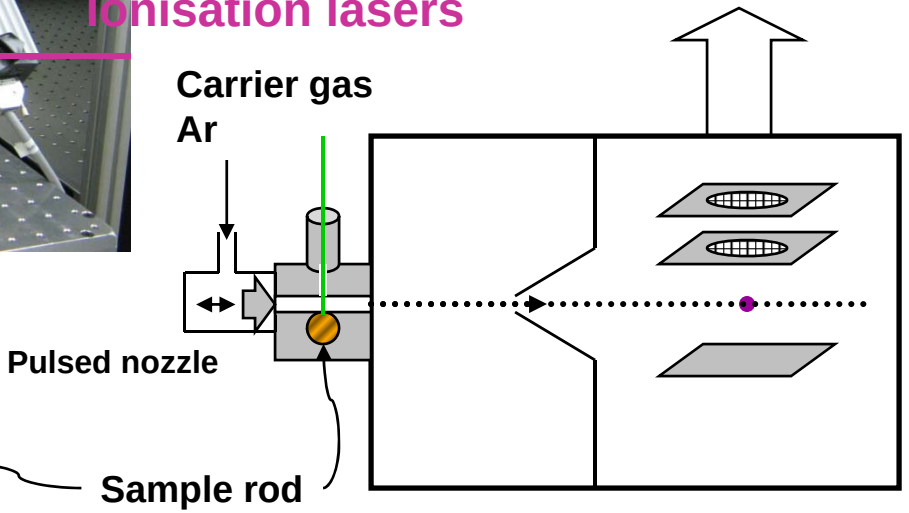
50mJ @ 532 nm

Ionisation lasers

To TOF tube

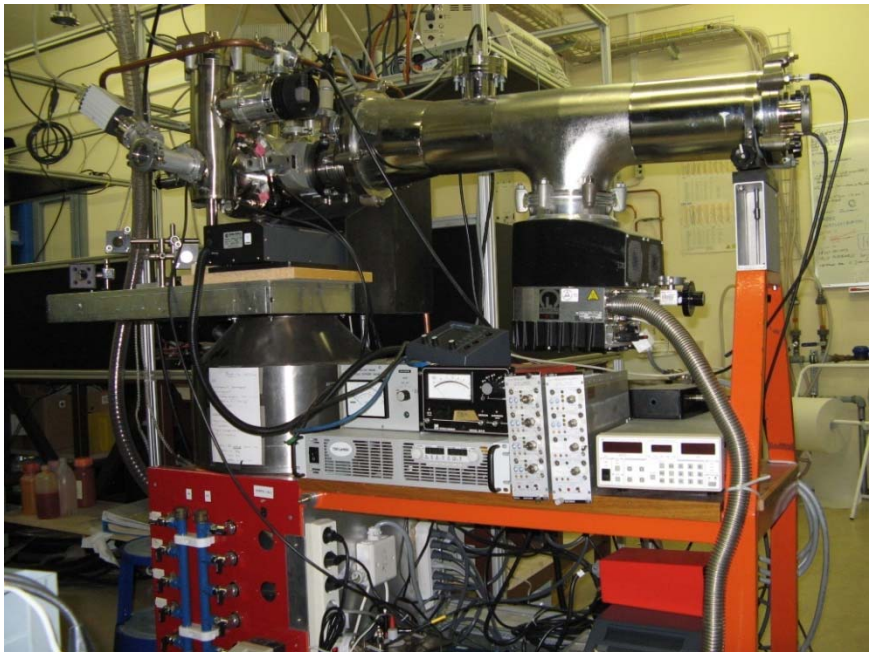
Carrier gas

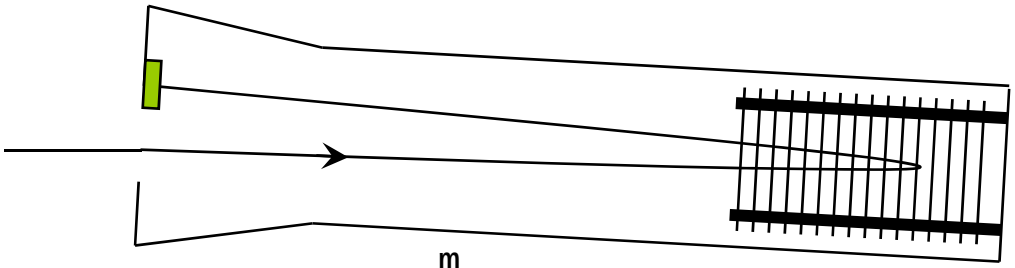
Ar



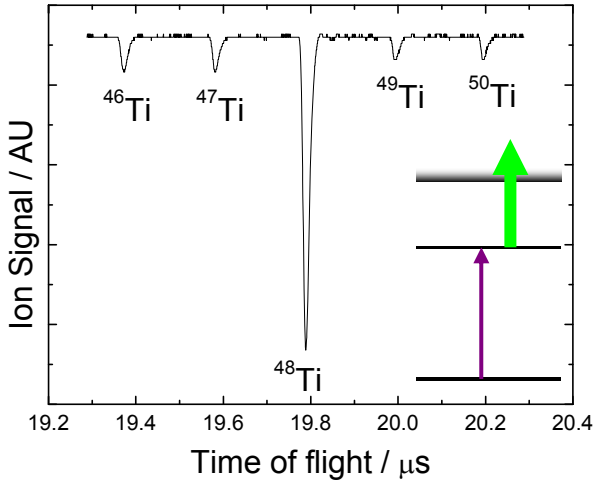
The LARIS Laboratory

- Time of flight mass spectrometer





$$R = \frac{m}{\Delta m} \sim 200$$

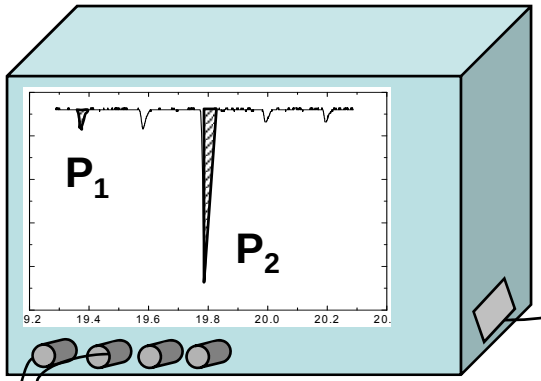


The LARIS Laboratory

- Data Acquisition system

Oscilloscope (Lecroy Waverunner 104Xi)

Define parameters



Signal from detector

Photodiode

powermeter

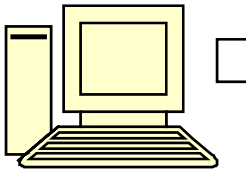
Wavemeter
LM 007

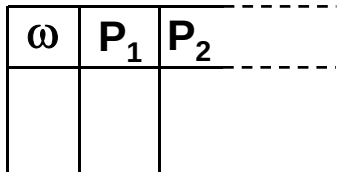
LABView interface

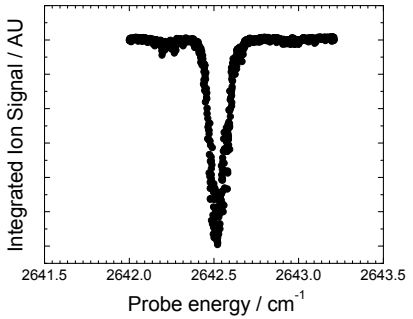
Select parameters to be recorded

Set tolerance levels for ω

Start program





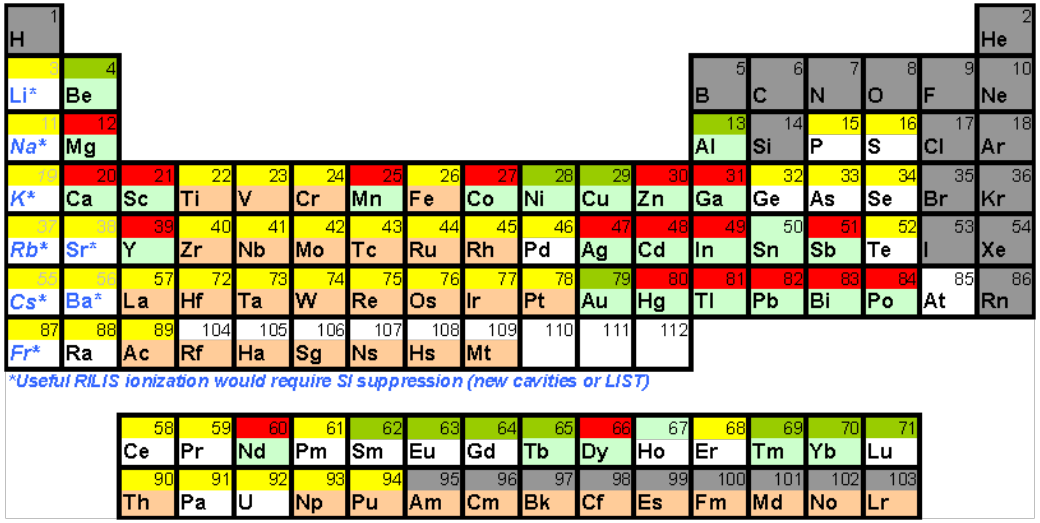


Wavelength measurement to computer

If the wavelenght is ”good” then
Get parameters from oscillator
And from powermeter(s)

The LARIS Laboratory

- First test of RILIS ISOLDE relevant element - Mn



Why Mn?

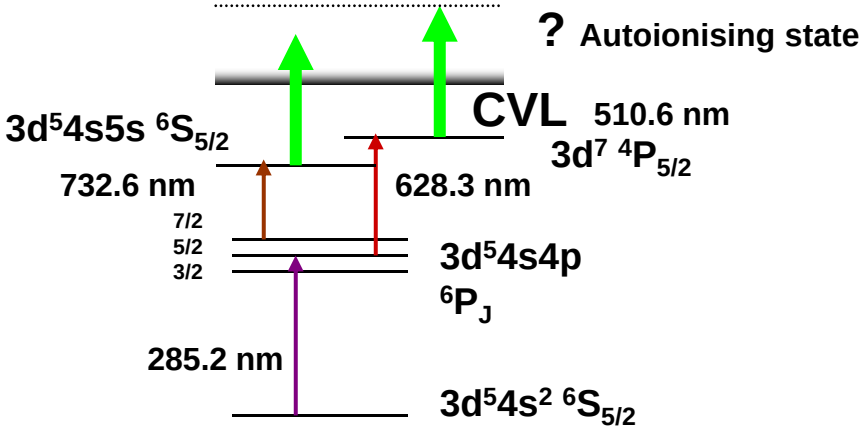
A new ionisation scheme was urgently needed

When the current Mn scheme was developed at RILIS the yield was found to be better when a weak transition was used in the second step –
Suspect an accidental resonance

Interesting – what is that accidental resonance?

What happens when we replace CVL with YAG?

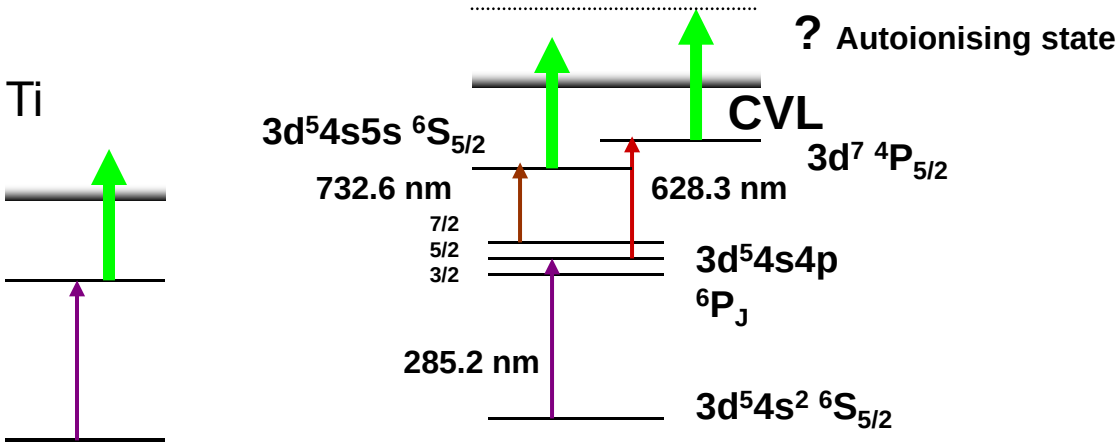
Full test of our entire system



One colour signal √

Two or three colour signal ×

The LARIS Laboratory



2-step:
(1 resonance) √

One colour signal √

Two or three colour signal ×

2-step:
(2 resonance) √

We can trust our method for overlapping the beams

But...

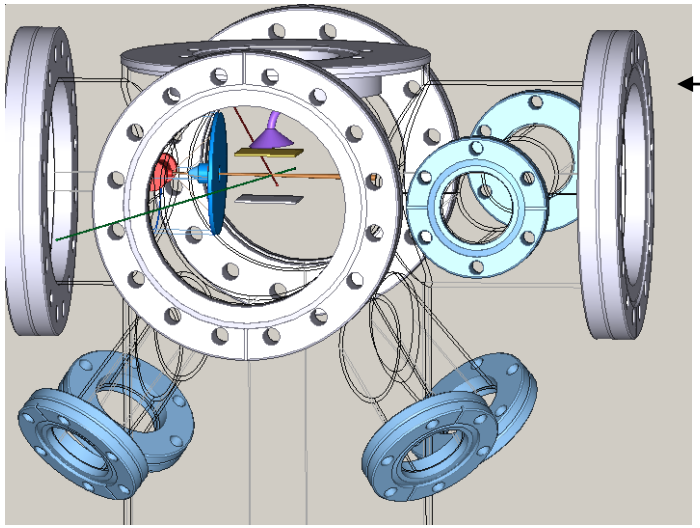
We recently found that we were not using optimal delays between gas pulse, ablation laser and ionisation lasers

And we found that our wavemeter can not be trusted in the UV region

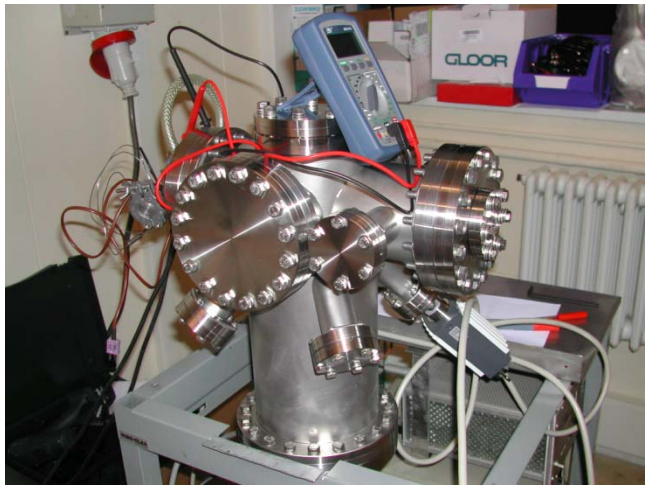
So we will try again

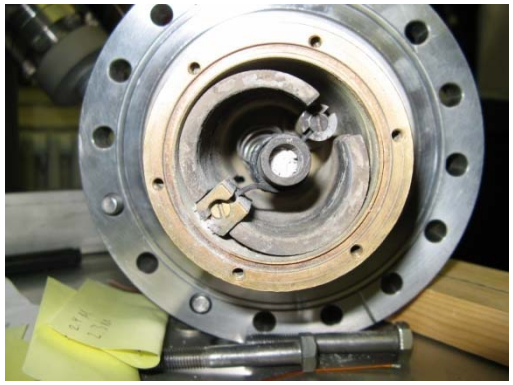
The LARIS Laboratory

- Thermal atomic beam unit



Plan of the first thermal atomic beam unit in LARIS built by Fabian Österdahl



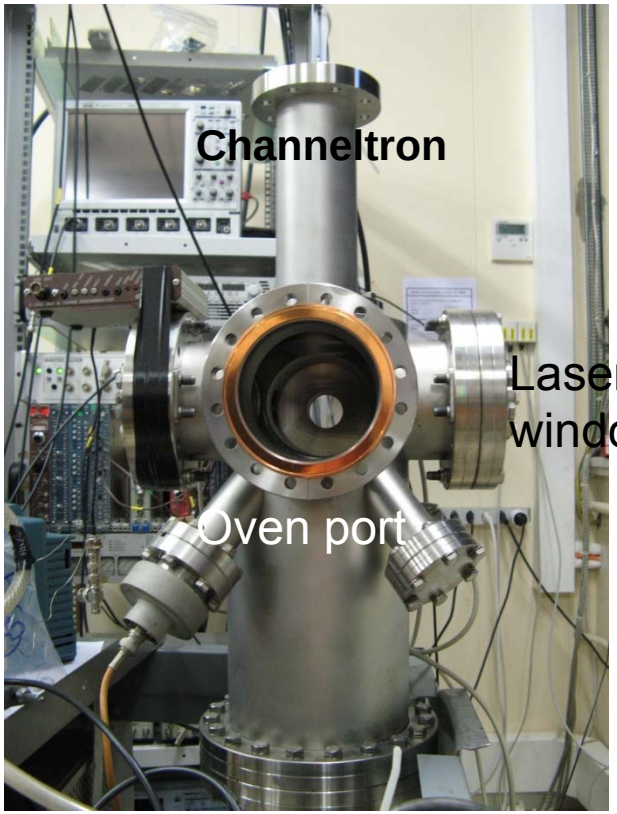


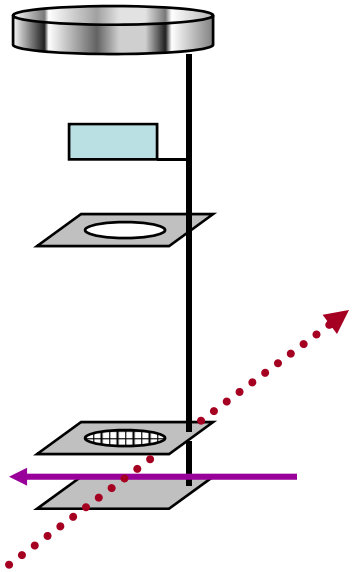
Ceramic oven
Watercooled flange
Channeltron detector close to the interaction region

We are now in the process of making some modifications to begin using it for spectroscopy

The LARIS Laboratory

- Thermal atomic beam unit





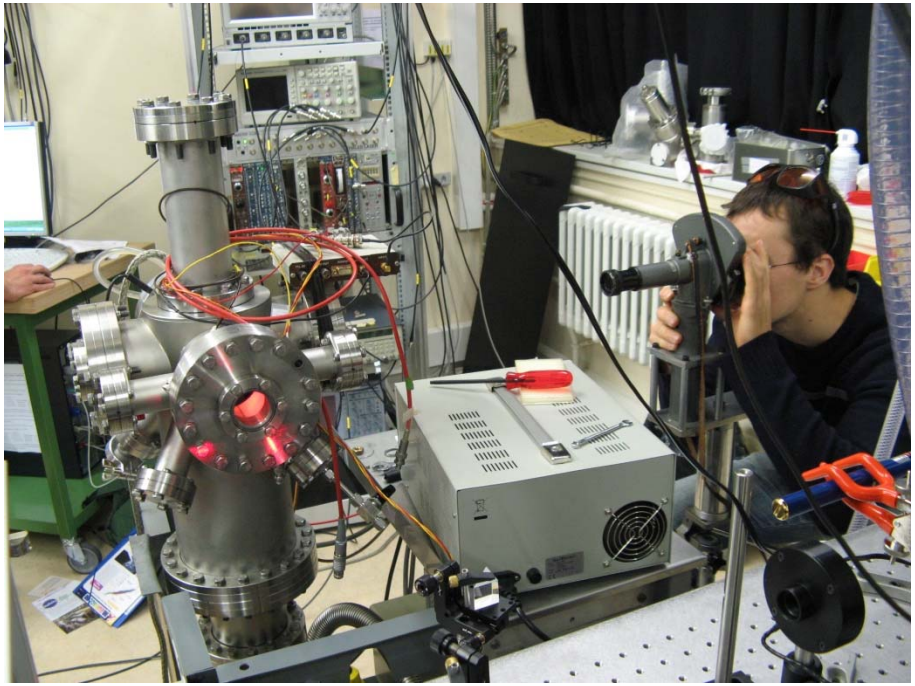
Ceramic oven replaced with Tantalum oven

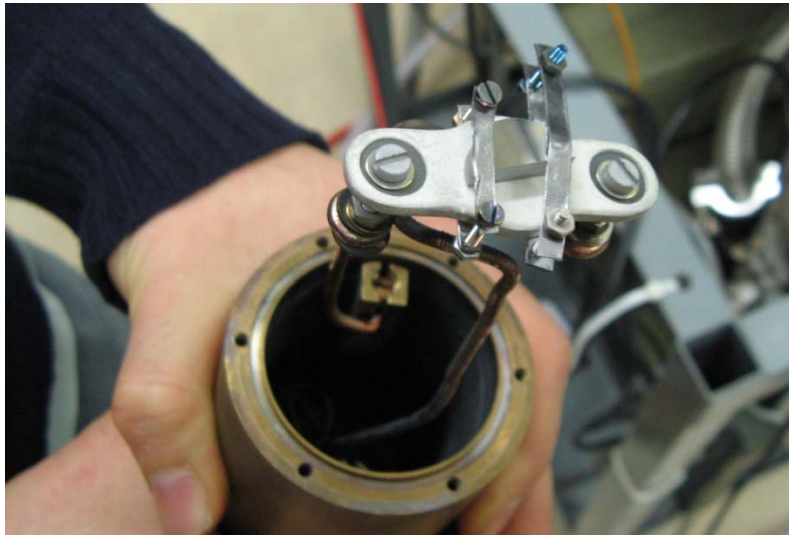
Same flange – Replace insulator and make full use of water cooling

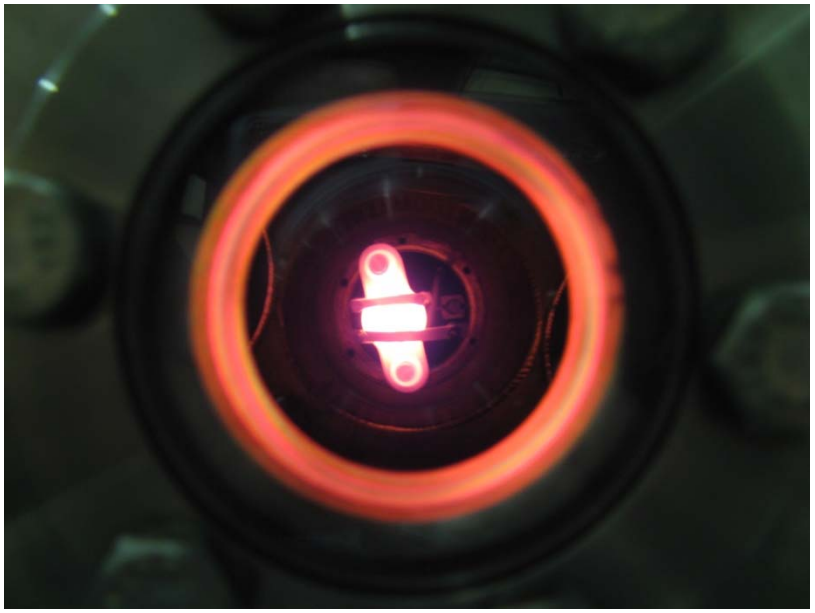
20 cm extension to increase the distance to channeltron

The LARIS Laboratory

- Testing Reflectivity of Molybdenum mirror at higher temperatures







Heated mirror up to 1000 C

No change in reflectivity has been detected

The LARIS Laboratory

- SUMMARY

- Working Lasers
- Timing system
- Working Laser ablation TOF MS
- Laser Ions – Ti, Cu, Mn, Ca 1 and/or 2 coulour signals
- Data Aquisition: ω, Oscilloscope can function as 8 Boxcar modules, laser power measurement.

FUTURE plans

- Reassemble oven unit
- Measurements from thermal ABU to complement laser ablation scource
- TOF for oven ABU
- Continue with Mn and other elements...

The LARIS Laboratory

- PEOPLE

FEDOSSEEV, Valentine (CERN)
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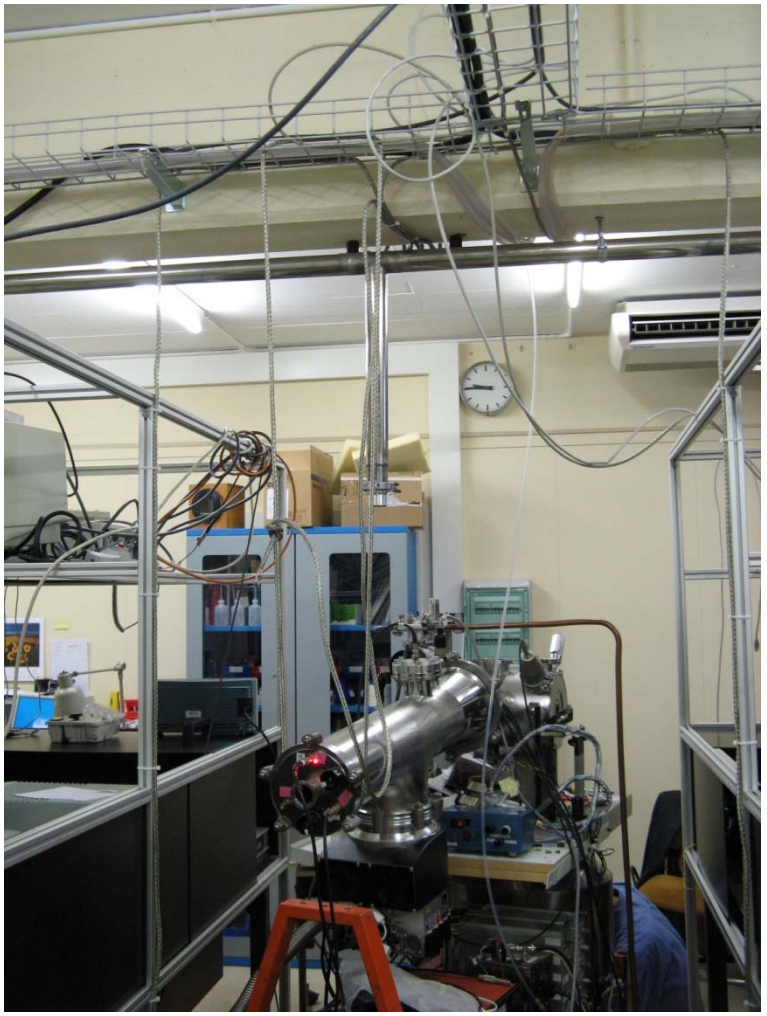
LOSITO, Roberto (CERN)
MARSH, Bruce (CERN)

POHJALAINEN, Ilkka (Helsinki University)

SASSENBERG, Ulf (Stockholm University)

BERG, Lars-Erik (Royal Institute of Technology)
LAUNILA, Olli (Royal Institute of Technology)
PAUCHARD, Thomas (Royal Institute of Technology)
RAFIEE, Mohammad (Royal Institute of Technology)
SJÖDIN, Marica (Royal Institute of Technology)
TRANSTRÖMER, Göran (Royal Institute of Technology)
VANNESJÖ, Johanna (Royal Institute of Technology)
ÖSTERDAHL, Fabian (Royal Institute of Technology)



Funding: Knut and Alice Wallenberg Foundation