RILIS - Status and Developments 2017

ISOLDE Workshop and User's Meeting

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On behalf of the RILIS team

The RILIS team 2017

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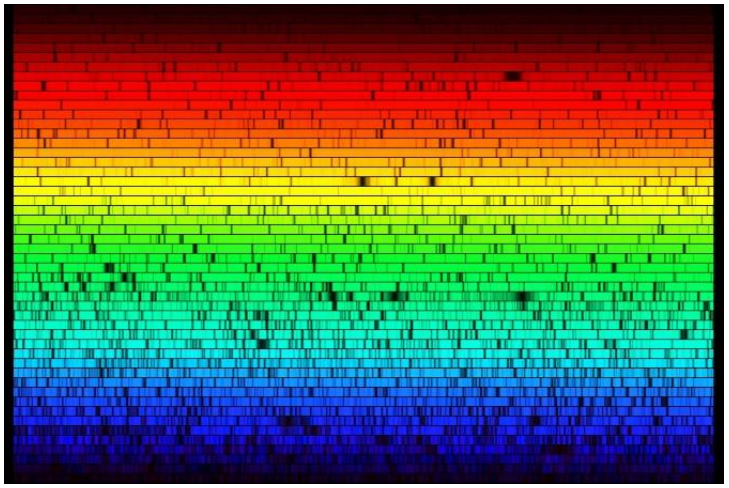
&

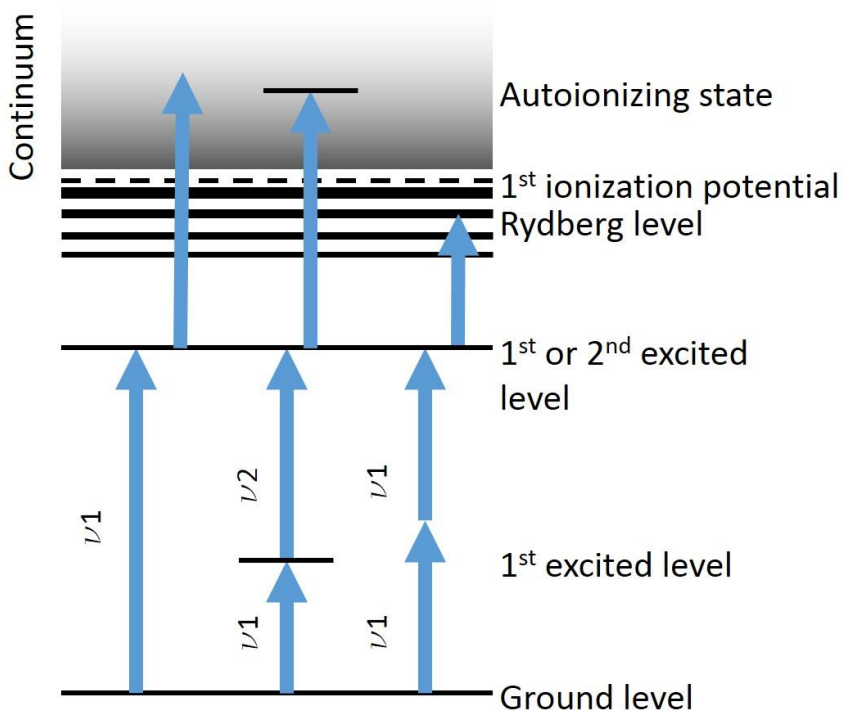
Support from PNPI: Dima Fedorov, Pavel Molkanov, Maxim Seliverstov

Support from Mainz: Reinhard Heinke, Dominik Studer

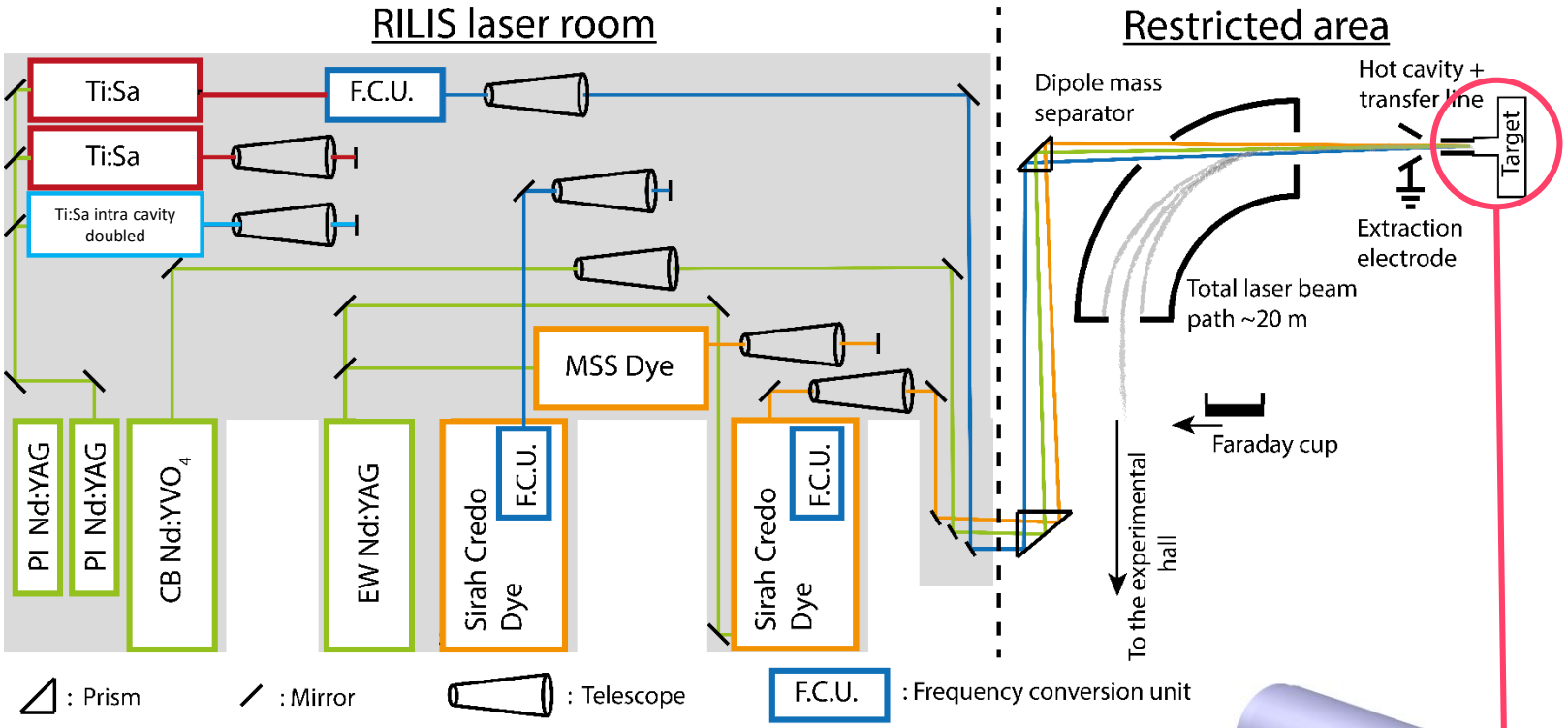
A quick reminder

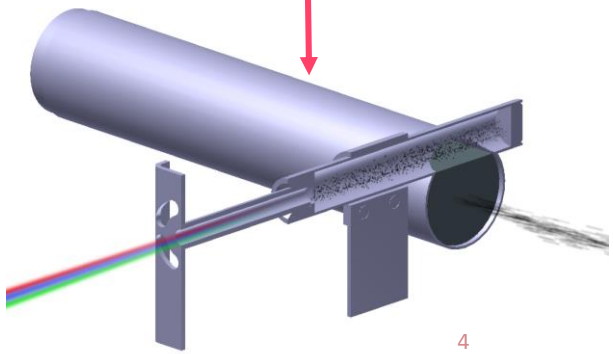
- RILIS: Resonance Ionization Laser Ion Source
- Coupled to surface ion source
- Use intrinsic properties (energy levels) of atom
- ‘Fingerprint’ specific for each element
- Ionization of elements with high (non surface ionizable) ionization potentials
- Enhancement of selectivity (laser ionization vs surface ionization)





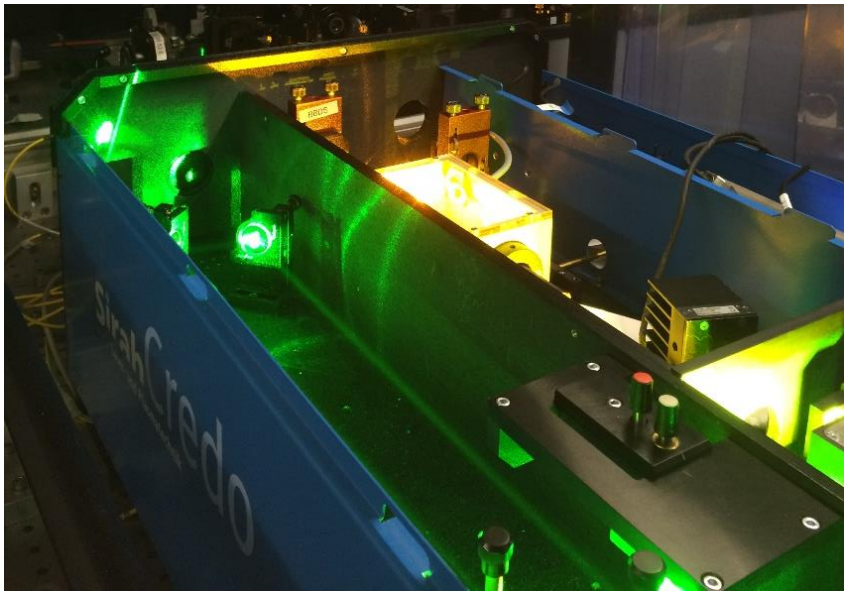
RILIS Layout

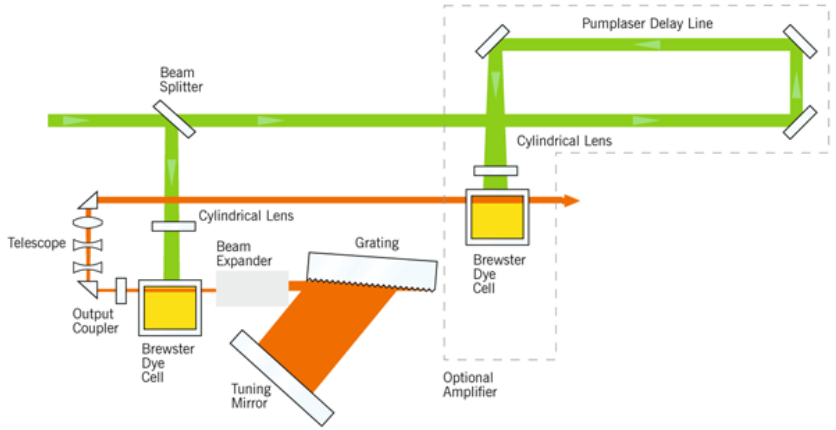


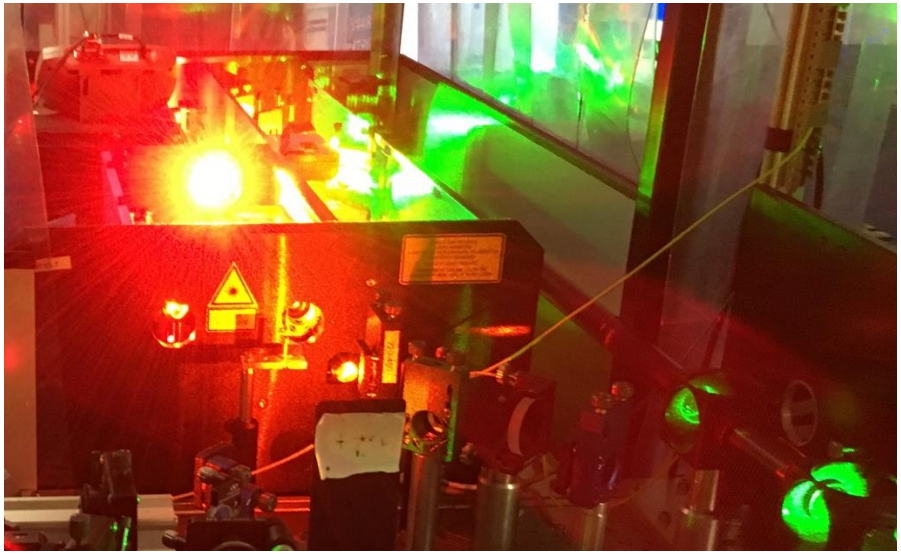


Lasers currently used at RILIS

- Dye lasers
  - 2x Credo from Sirah (linewidth ~8GHz)
  - MSS dye laser (linewidth up to 30GHz)

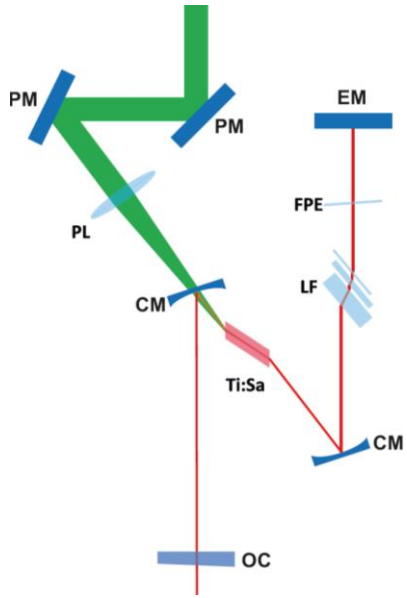


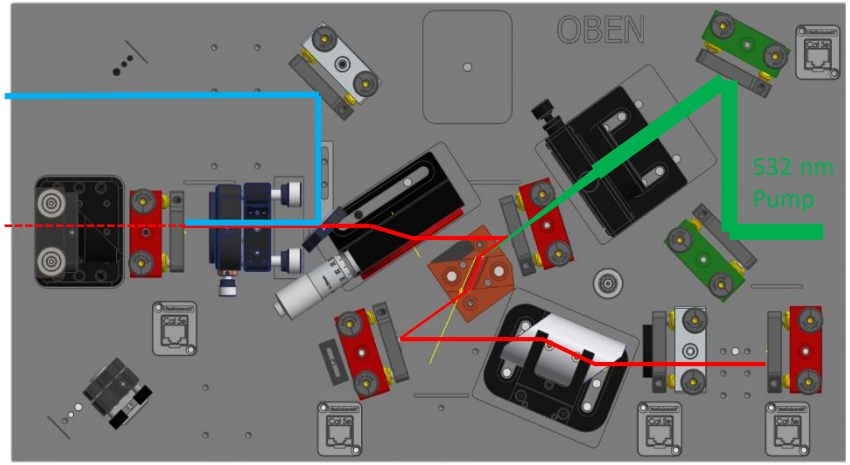




Lasers currently used at RILIS

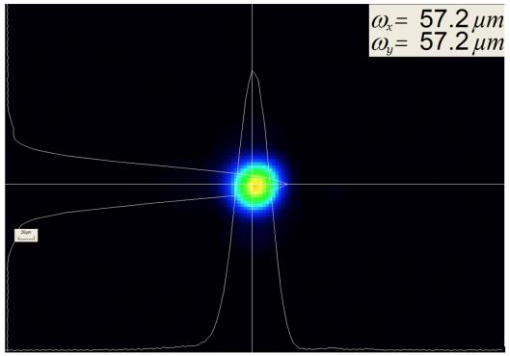
- Ti:Sa lasers
  - 2x **NEW** Z-cavities from Mainz → convenient for intra-cavity doubling (10W pump beam for up to 1.5W of blue with BIBO)
  - 1 standard Z-cavity, „old“ design
  - Linewidth ~5GHz
  - Possibility to exchange 1 cavity with grating Ti:Sa for spectroscopy (linewidth ~1-2GHz)





Lasers currently used at RILIS

- Frequency-doubled DPSS lasers (532nm)
  - 1x Blaze (40W) for non resonant ionization
    - New laser was supposed to be delivered April 2017 → will (hopefully) arrive February 2018
  - 2x Photonics (60W) for Ti:Sa pumping
    - Laser failure: overheating of 1 laser head due to stopped cooling (spare was used for continued operation)
    - Some issues with chillers: 1 pump replacement, 1 needs to be send for refurbishment
  - 1x Edgewave (100W) for dye laser pumping **NEW**



TEM 00 , M^2 = 1.1

Circular, Gaussian beam

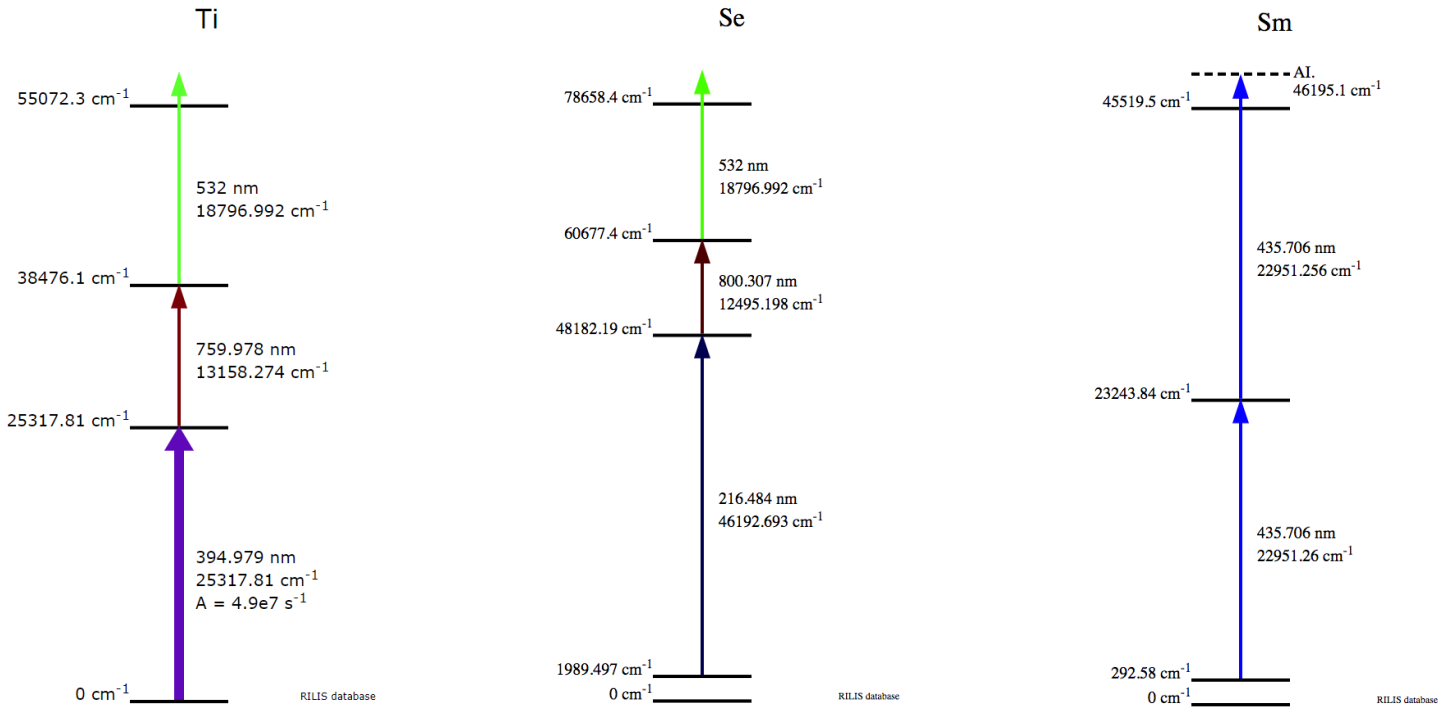
- Simple operation; better dye laser efficiency and beam quality
- Easy to transport to ion source (Blaze backup)
- Objective assessment of degradation of beam quality
- Better compatibility with commercial dye lasers

Some statistics from the on-line period

- **20** different elements (on-line operation, in-source spectr., TISD): In, Mg, Mn, Al, Bi, Cd, Se, Sm, Ni, Dy, Nd, Ga, Li, Hg, Cu, Mo, Sc, Ti, Si, Te
- **21** separate on-line runs (not included: development)
- **95** days of (on-call) operation (not included: set up & development time)

> 50% of ISOLDE beams in 2017

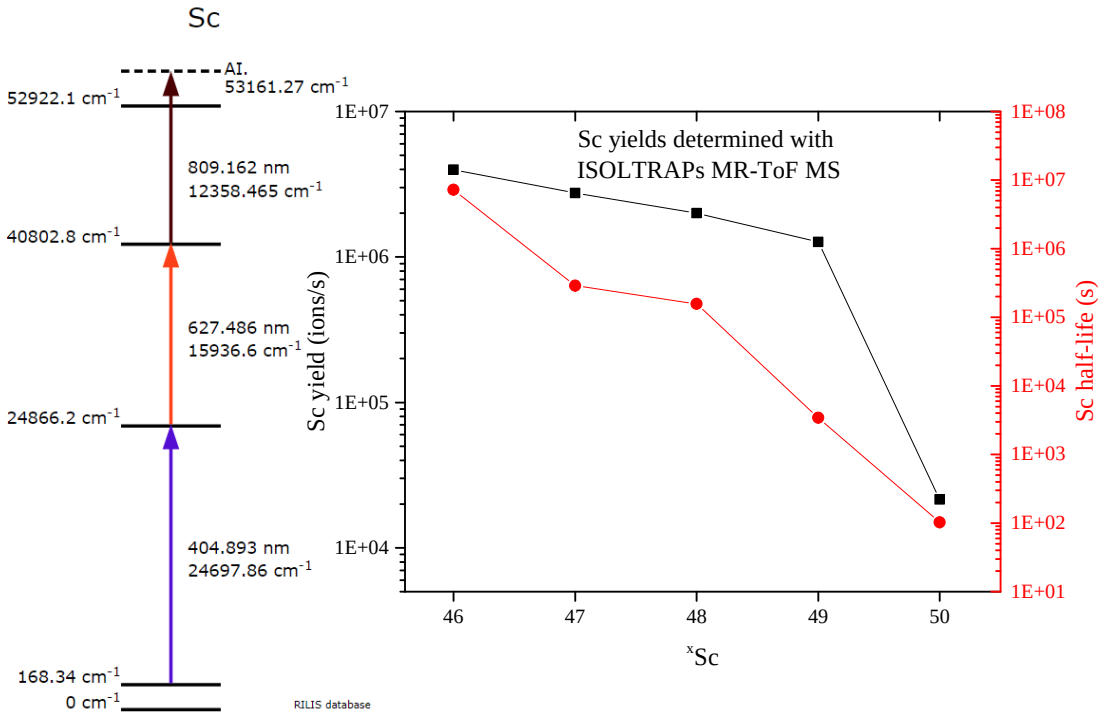
Laser ionization scheme development



→ Mostly „parasitic“ development in between or during runs

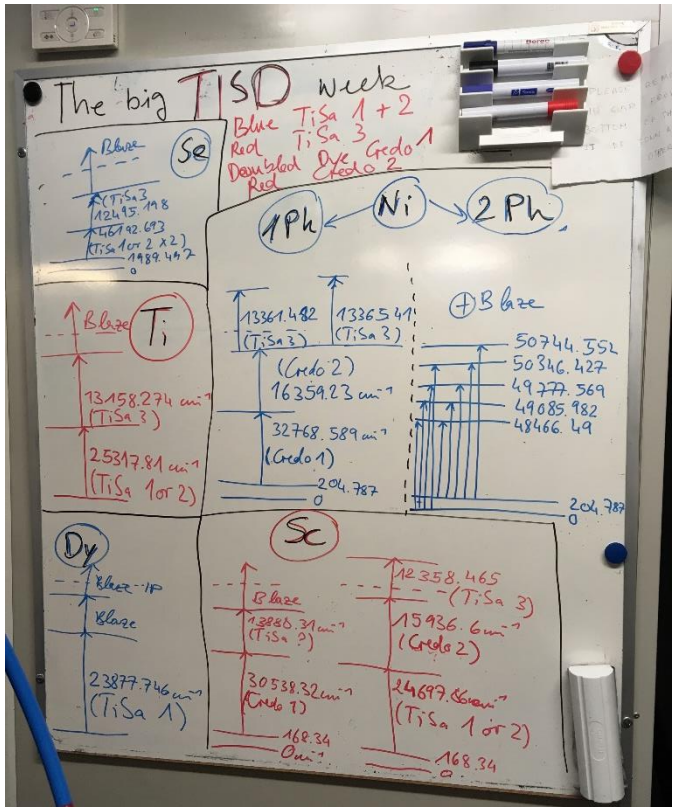
→ Effort towards more 2-step and Ti:Sa based schemes for reduced maintenance

Beam development



6 changes in 4 days!

Ti → Sc → Dy → Sc → Se → Dy → Ni



Scandium

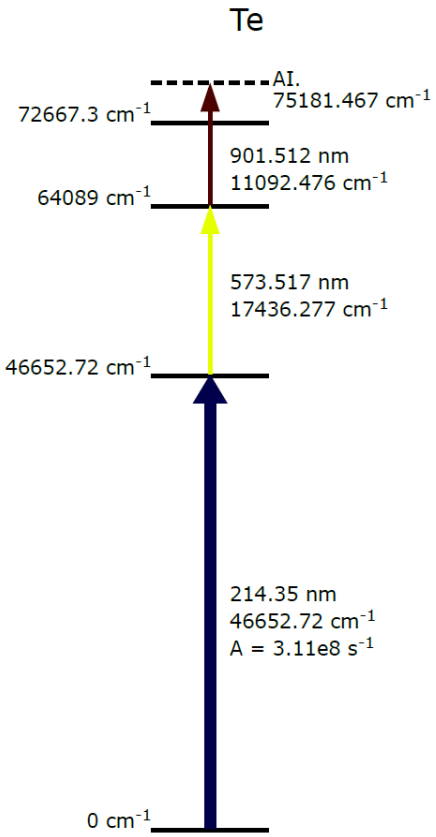
Ionization scheme developed in Mainz was tested

First, long-awaited, on-line yields of Sc measured

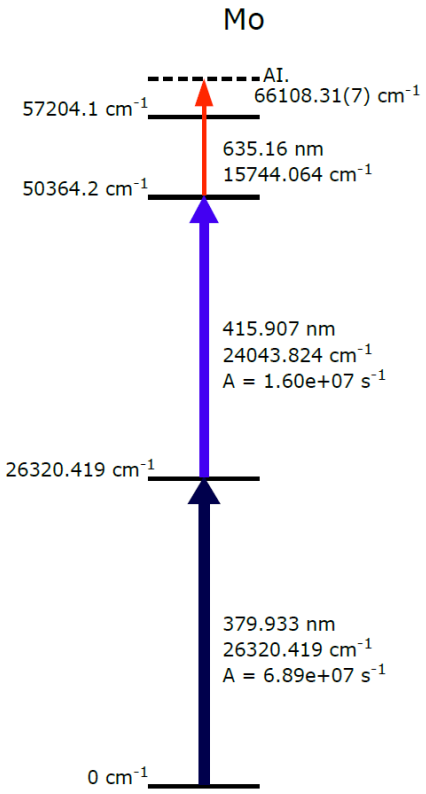
Sc beams now available at ISOLDE!

Beam development

Tellurium: Scheme used first time for yield tests → can now be provided for users

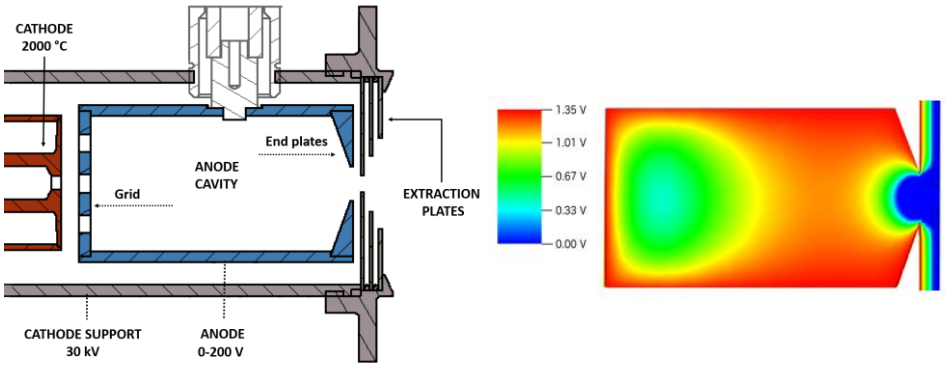


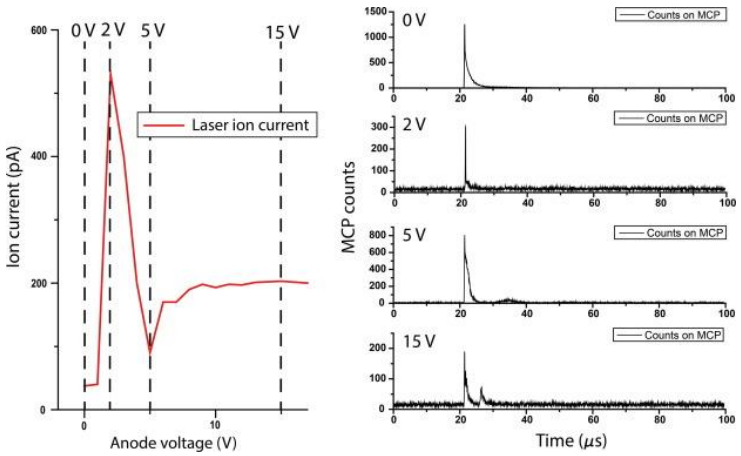
Molybdenum: Scheme used on-line for first time in combination with molecular break up (see talk by J. Balloff)



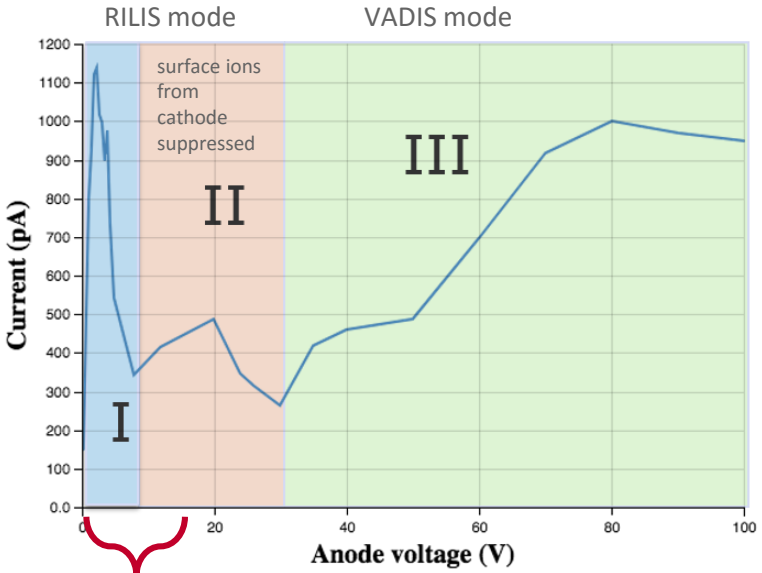
Other activities: work at ISOLDE Off-Line 1 – VAD(L)IS

Continued developments on VAD(L)IS ion source (off-line and on-line)





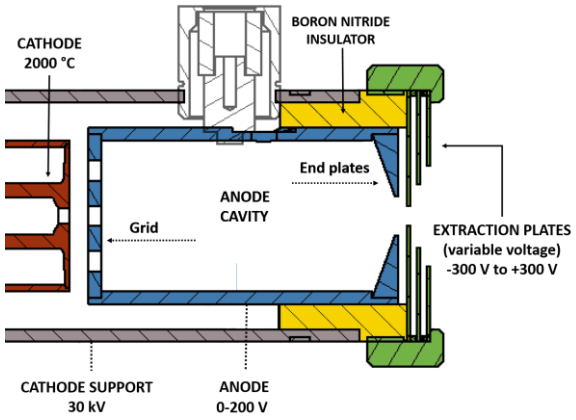
T. Day Goodacre et al., NIM B 376, 39 (2016)

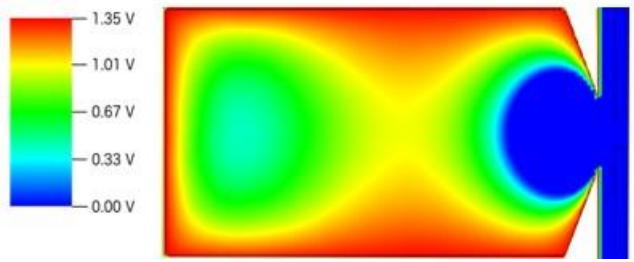


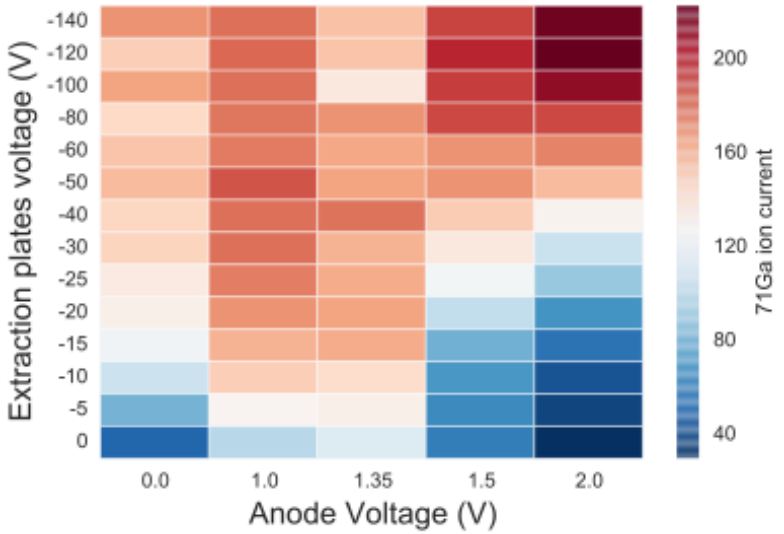
Credit: Y. Martinez Palenzuela

→ Simulations with VSim by Y. Martinez Palenzuela for better extraction of laser ionized particles

Other activities: work at ISOLDE Off-Line 1 – VAD(L)IS





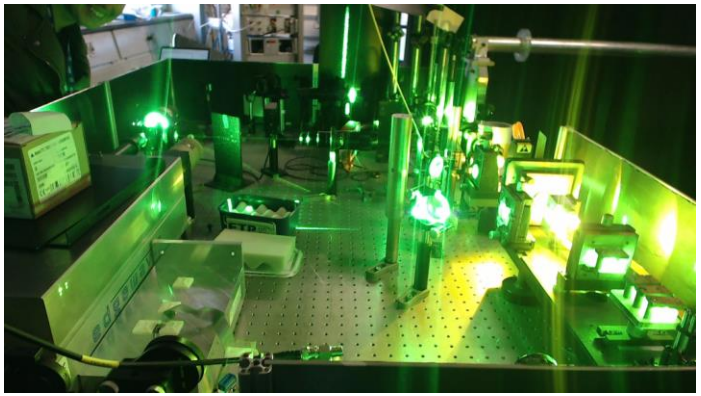


Credit: Y. Martinez Palenzuela

- New design with variable extaction voltage improves laser ion extraction
- Demonstrated off-line with Ga
- Demonstrated on-line (last week) with Mg: factor 3 extraction efficiency improvement when voltage was adjusted!

Other activities: work at ISOLDE Off-Line 1 – Laser installation

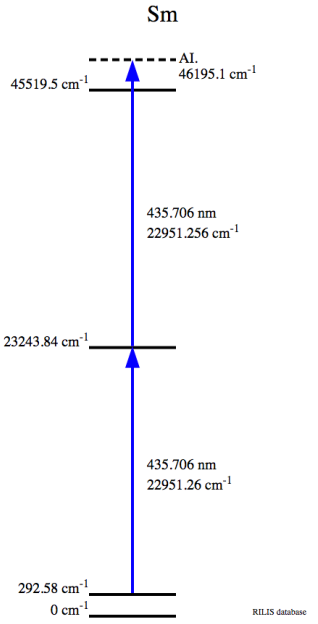
- Laser installation for Ga tests: Edgewave pump laser + dye laser (2-step scheme)
- Inconvenient: requires delay line for pump beam & set up of (very old) dye laser



- Laser installation in Off-Line 1 has been dismantled

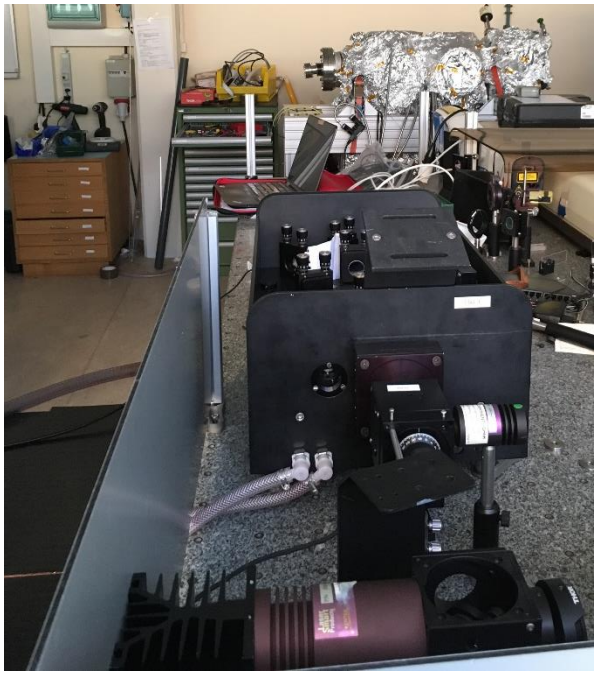
→ to be replaced with Ti:Sa laser set up for LIST development in 2018

→ Convenient scheme for Sm requires only 1 Ti:Sa laser + pump



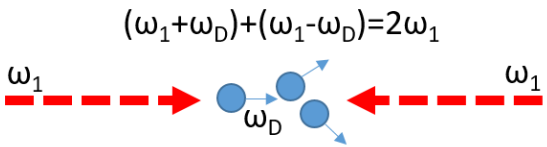
Other activities: Ti:Sa laser set up in LARIS lab

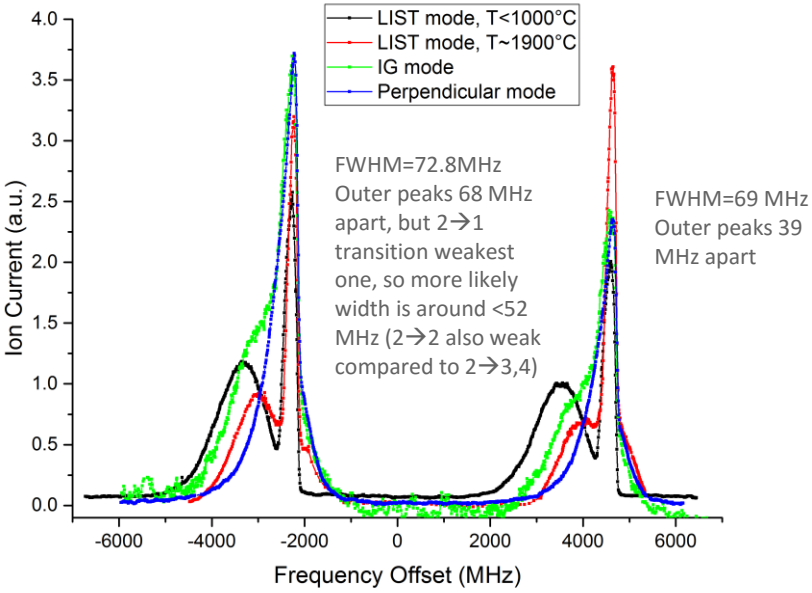
- LARIS converted temporarily into negative ion source test facility for target group
- Master thesis work of David Leimbach (poster yesterday)
- Ti:Sa laser set up for off-line photo detachment tests of iodine
- Set up & tests are happening this week

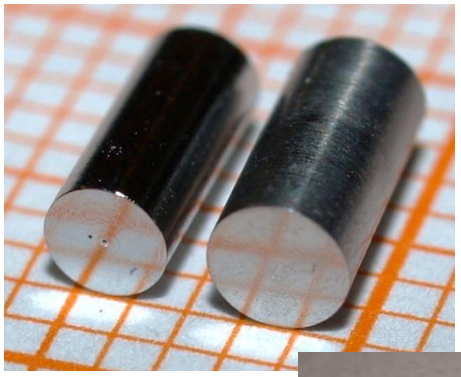


Other activities: Towards (really) narrow band RILIS operation

- Efforts towards high resolution spectroscopy
- Aim: Doppler-free two-photon excitation in-source
- Demonstrated succesfully at RISIKO Mainz off-line separator for Rb







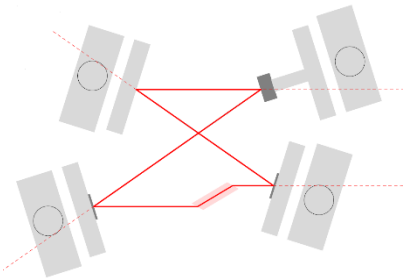
Other activities: Towards (really) narrow band RILIS operation

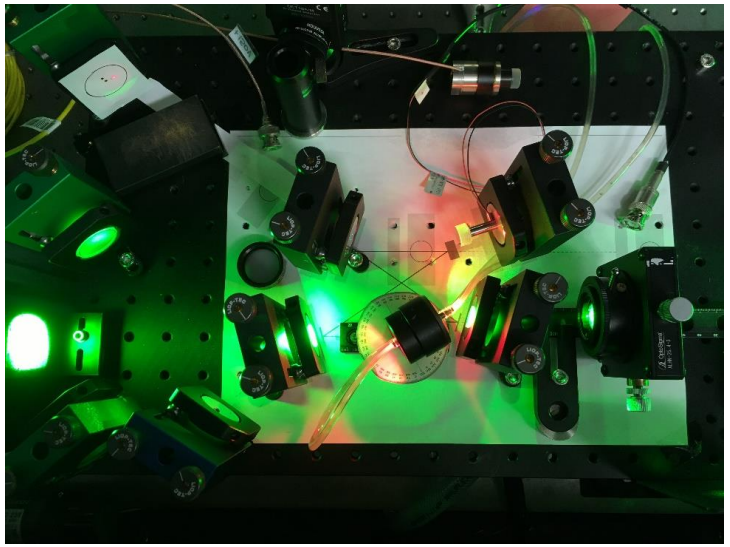
- Efforts towards high resolution spectroscopy
- Aim: Doppler-free two-photon excitation in-source
- **Problem:** Current laser set up does not allow for linewidths < 800MHz

Solution 1:

Use seeded Ti:Sa ring cavity

- New fiber has been put in place between RILIS and CRIS labs
- Minituarized design of ring cavity, developed in Jyväskylä and Mainz
- Use M^2-laser for seeding ring cavity in RILIS





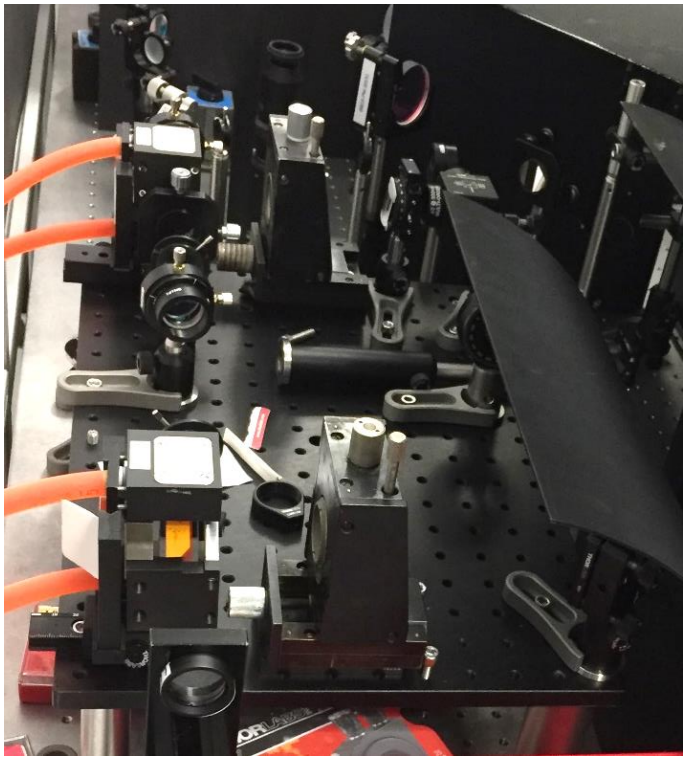
Other activities: Towards (really) narrow band RILIS operation

- Efforts towards high resolution spectroscopy
- Aim: Doppler-free two-photon excitation in-source
- **Problem:** Current laser set up does not allow for linewidths < 800MHz

Solution 2:

Use Pulsed Dye Amplifier (PDA)

- Two dye cells for amplification
- Test set up in CRIS lab
- Old Edgewave laser for pumping
- Amplification of Matisse CW laser



Other activities: Off-Line2 & MEDICIS

- New laser installations

→ Off-line 2:
  - Testbench for laser scheme ionization development
  - Tests for molecular break up in the cooler
  - Continued tests for VAD(L)IS & LIST

→ MEDICIS:
  - Beginning of installation of Laser Ion Source
  - First things first: Transform the available room into a lab
  - Start purchase of lasers and optics for equipping the lab

Conclusion

- 4 new schemes (Mo, Se, Ti, Sm)
- 2 new beams (Sc, Te)
- On-going ion source developments for better RILIS efficiency and suppression of contaminants (VADLIS & LIST)
- New approaches to in-source high-resolution spectroscopy
  → first tests done in Mainz
  → new lasers for RILIS in collaboration with CRIS & Mainz
- New laser installations planned for Off-Line 2 and MEDICIS

Thank you for your attention!