RILIS: new advances and future prospects

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for

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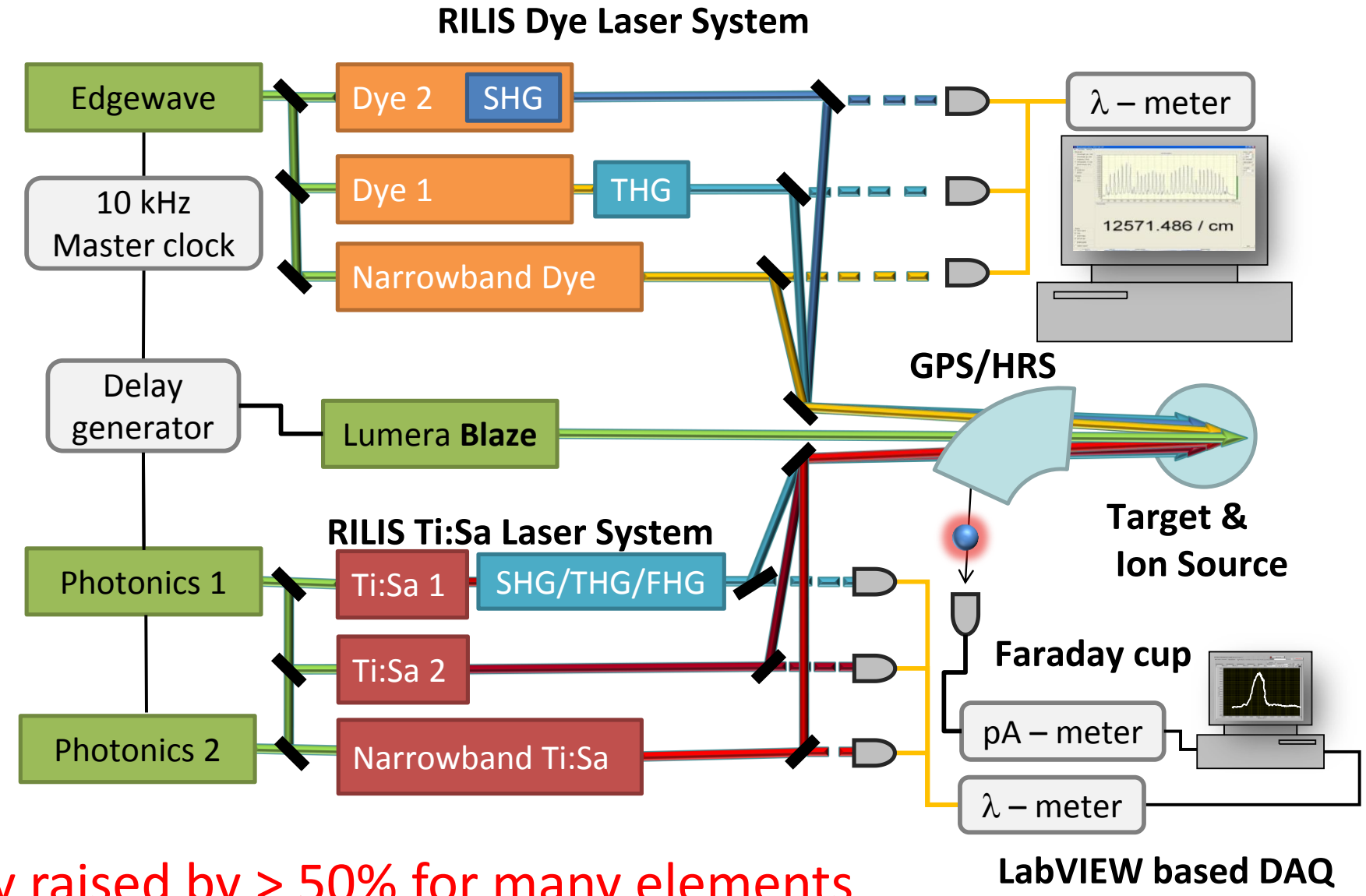
Branches of advancement and development

- RILIS infrastructure
  - Lasers
  - Beam control and diagnostics
  - Test benches
- Operation
  - Optimization of beam setting time
  - Stability
  - Remote control
- Ion source development
  - New beams
  - Selectivity
  - New modes of ionization

RILIS Lasers

Added in 2014:

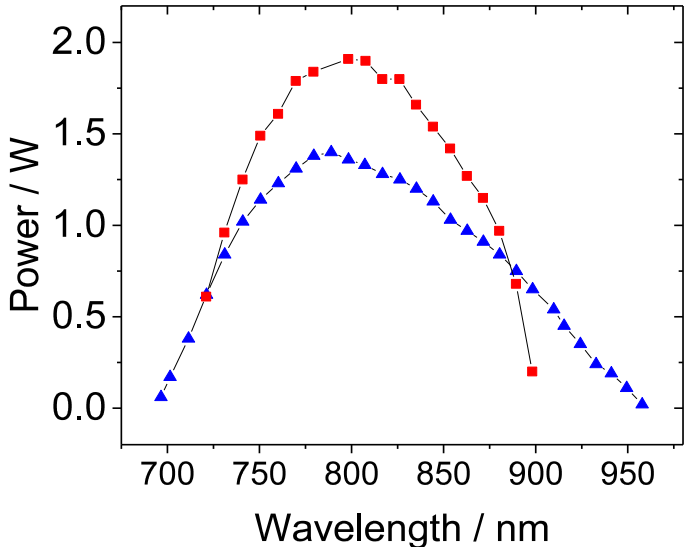
- 40W at 10 kHz
- 17ns Pulse
- Low Jitter: < 3 ns
- Gaussian beam M2 = 1.1
- Much better transmission to the source

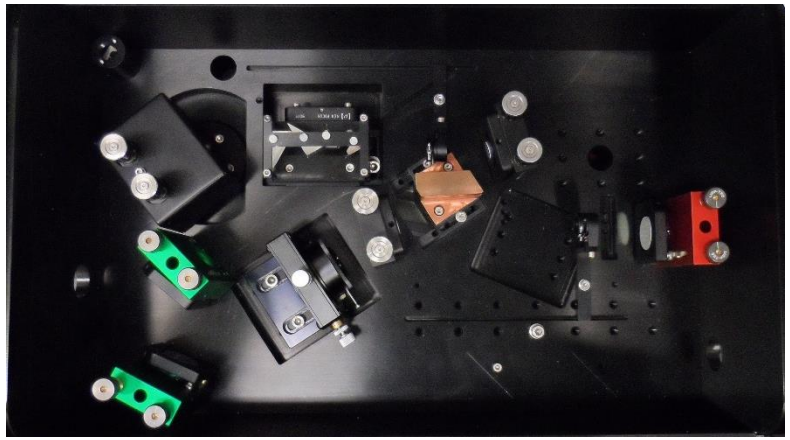


=> Ionization efficiency raised by > 50% for many elements

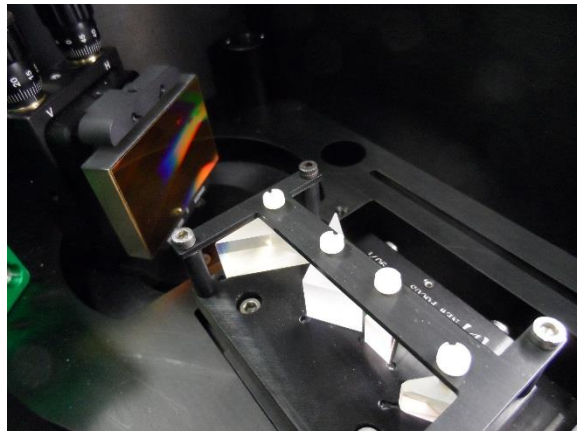
Upgrade of the Ti:Sa laser system: Grating tuned Ti:Sa

- Frequency selection via holographic grating
- Grating angle computer controlled
- High power mode
- Extended tuning mode
- Different linewidth options
- Made at Mainz University
- Tested last week at CERN, installation at RILIS scheduled for next week





Grating Ti:Sa resonator

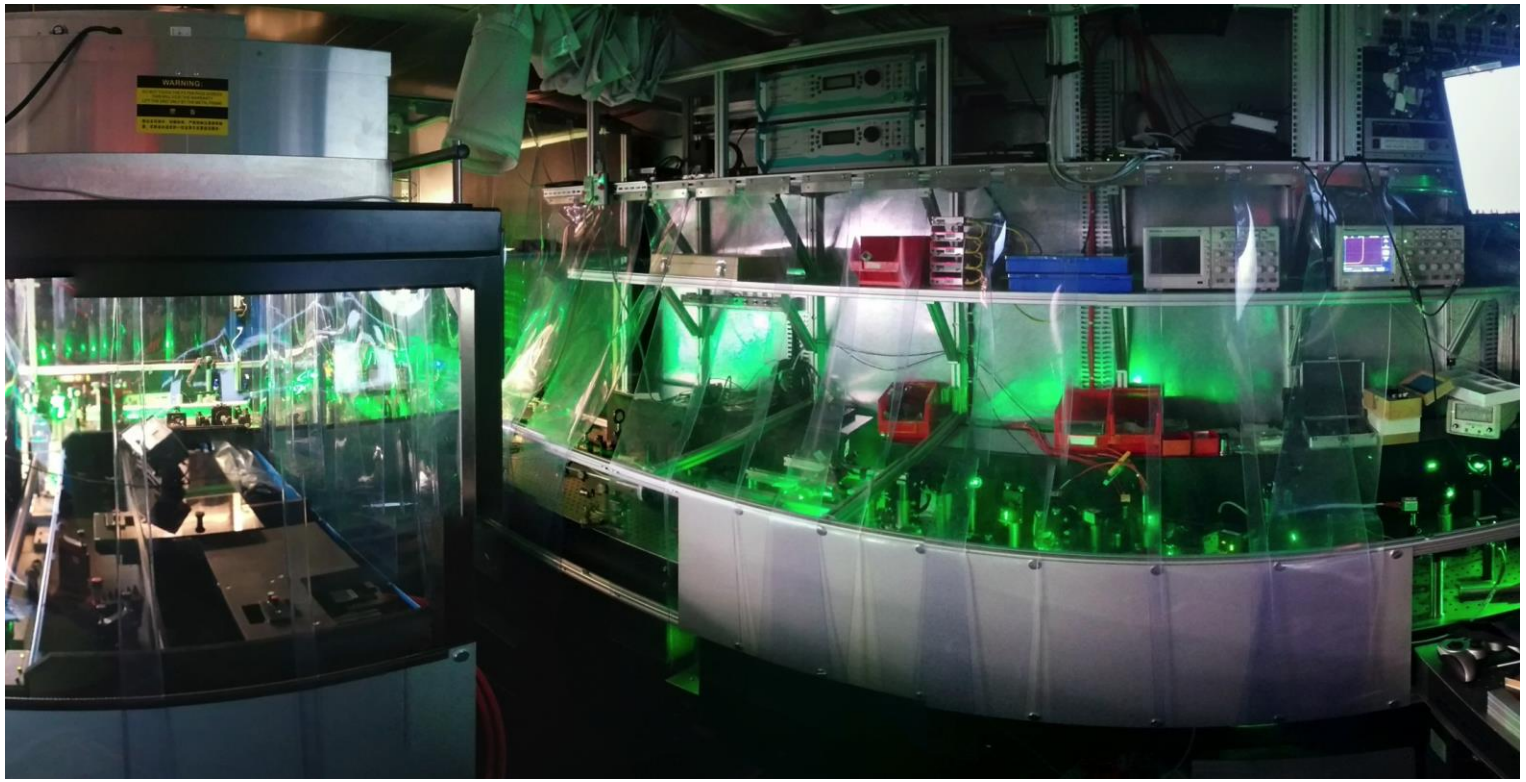


Grating and prism beam expander

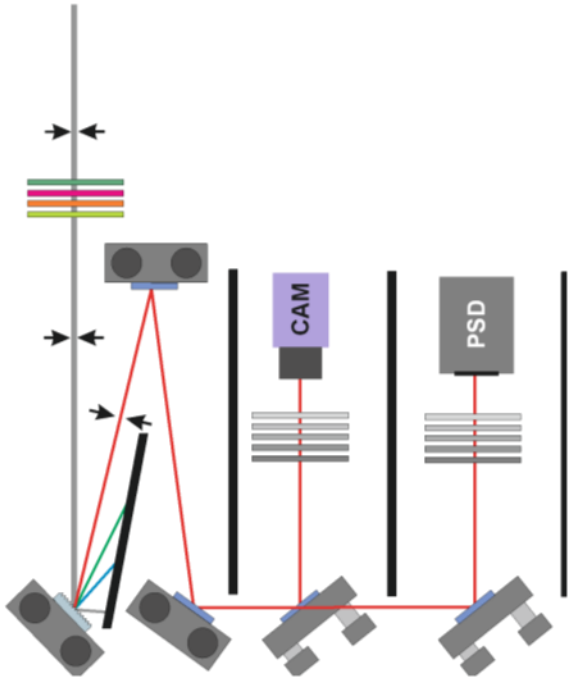
Will be a powerful tool for RILIS beam development

Beam control and diagnostics

Major upgrade performed due to RILIS cabin extension in LS1



4 beams to GRS
4 beams to HPS
1 beam to ISCOOL
Fewer power losses
Improved ergonomics

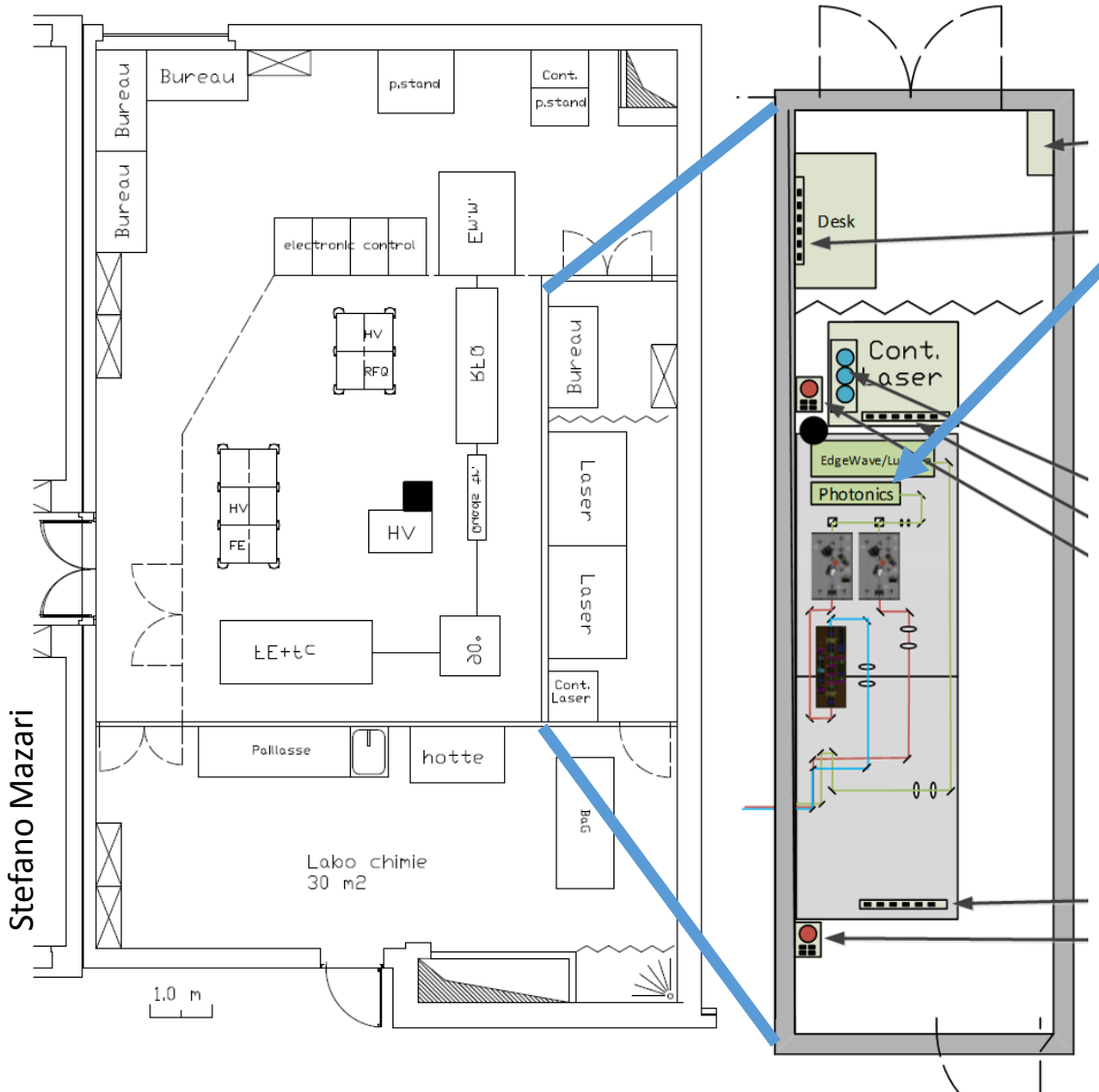


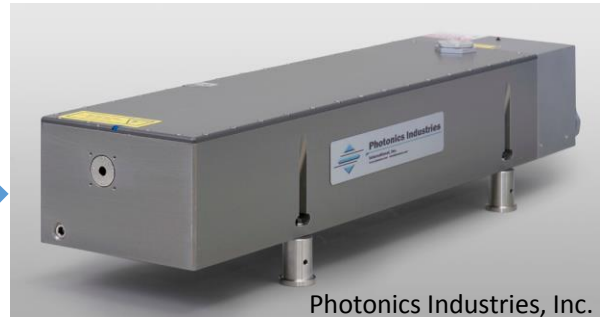
New beam stabilization system
Reference cell installation

Test benches

- LARIS:
  - 10 Hz repetition rate lasers
  - Laser ionization of volatile elements with thermal atomization + TOF MS
  - Laser ionization of refractory elements atomized by laser ablation + TOF MS
- Off-line mass separator:
  - Simplified 10 kHz laser setup (for 2 –step schemes only)
  - R&D on ion source cavity, ion detection by FC and MCP (time-resolved)
- New Off-line mass separator:
  - Laser setup based on RILIS spare lasers
  - Ionization of elements requiring 3-step ionization schemes will be feasible
  - More possibilities for ion source R&D

Plan for permanent Laser Installation at ISOLDE OFFLINE 2





- Laser Tables installed
- additional **Ti:Sa Pump laser (Photonics 3)** purchased 2014
- Hot-Spare Edgewave

= Dye and Ti:Sa capabilities

Operation

- Setting of lasers for element **B** while running RILIS on element **A** is now possible due to the dual Dye-Ti:Sa laser system

  => effective optimization of ISOLDE schedule:
  beams of 17 elements produced with RILIS in 2015

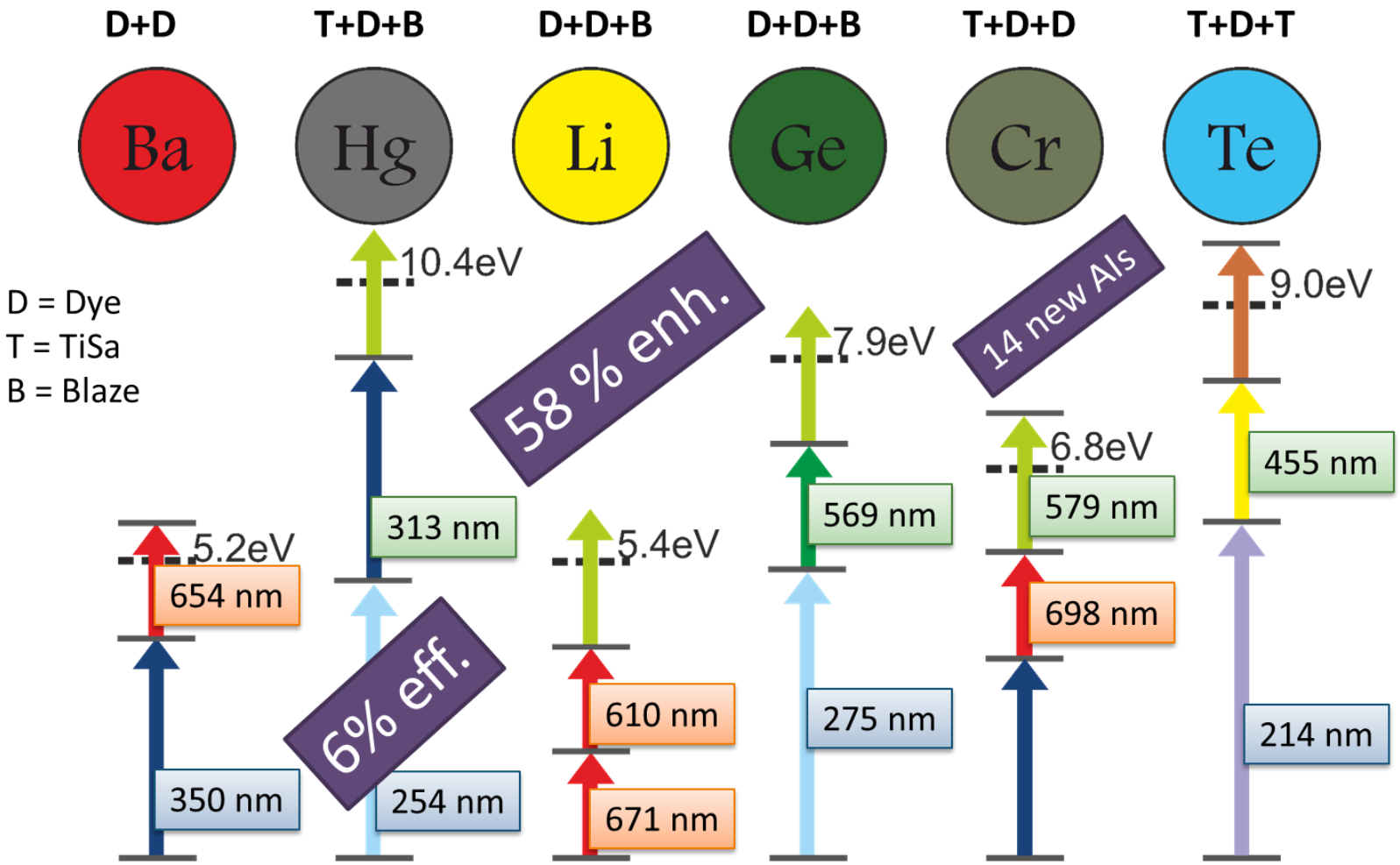
- System of active RILIS stabilization
  - Beam position in the ion source
  - Laser wavelength
  - Pulse timing

- Remote monitoring of RILIS performance
  - RILIS control room is established in b. 508
  - RILIS status is available at http://riliselements.web.cern.ch/riliselements/lasers/

- Switch from “Shift” to “On-call” operation mode due to development and implementation of RILIS Machine Protection System (RMPS)

Ion source development: New beams

Recently developed RILIS beams:



Beams of 37 elements have been produced with RILIS at ISOLDE

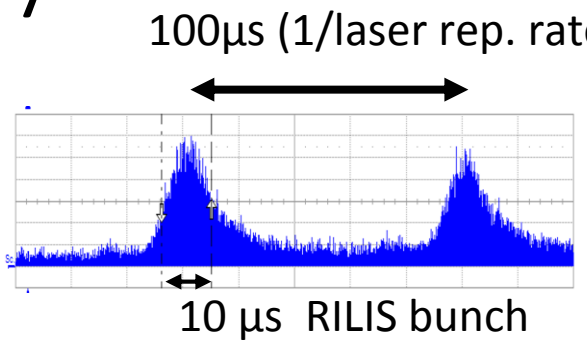
Development/tests under preparation for

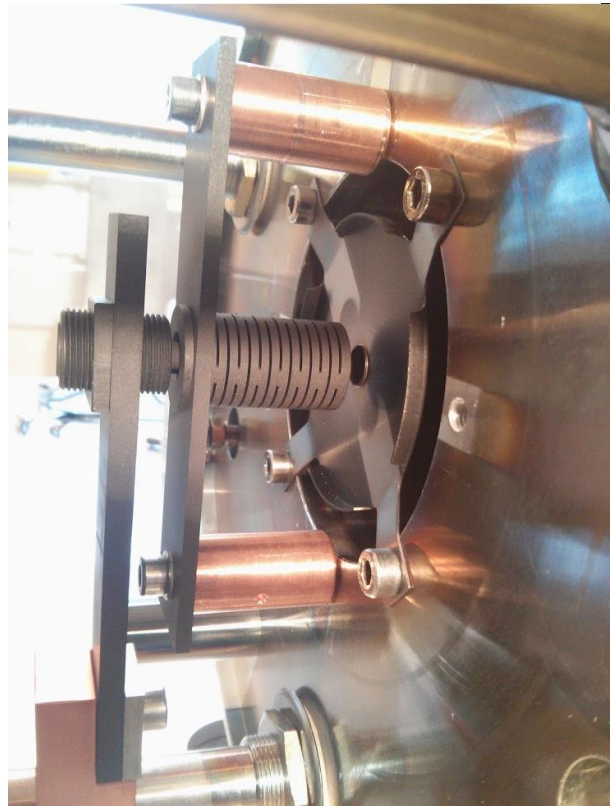
Rn, Er, Lu, Se

Ion source development: selectivity

- Bunch compression
  - Cavity prototype made of glassy graphite Sigradur successfully passed integrity test (20x power cycling)
  - Test with Lithium is being prepared

- Low work function material to reduce surface ionization:
  - Tests of ion source made of thoriated tungsten under preparation

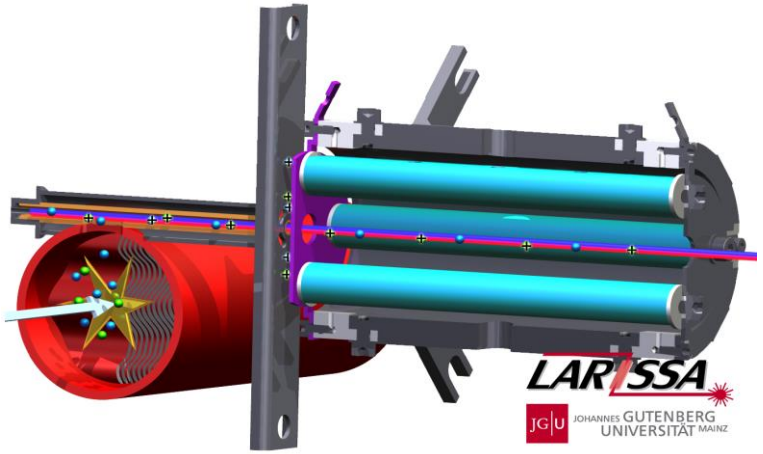


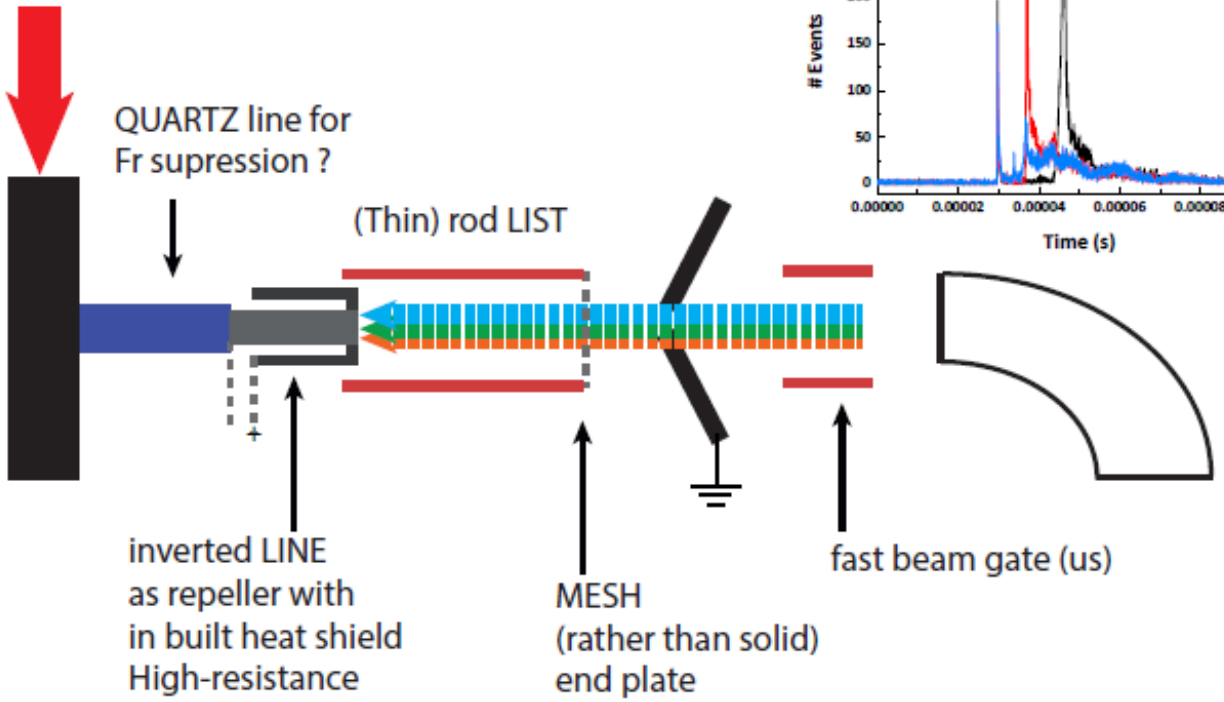


Ion source development: selectivity

LIST

New version is under construction in collaboration with Mainz University

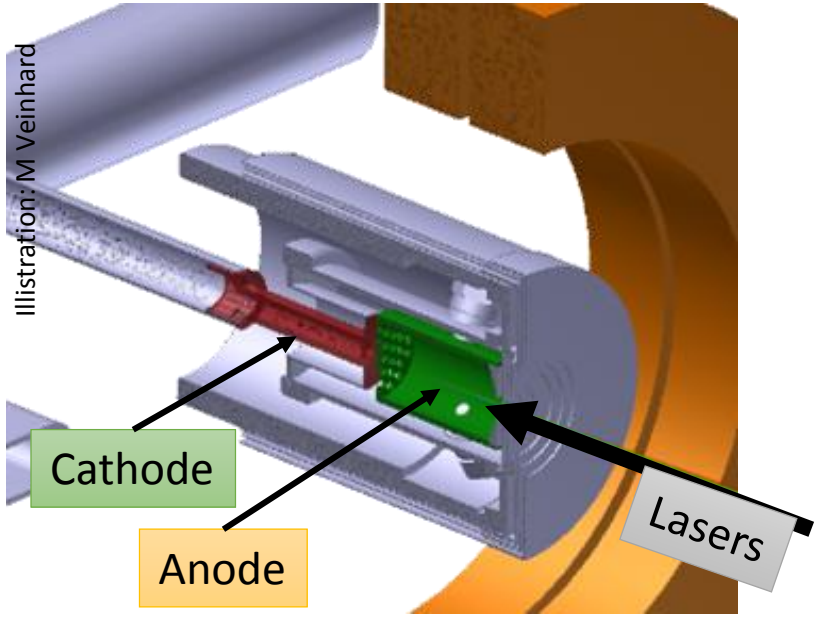




- Higher efficiency: better laser/atom overlap
- Combined quartz and LIST selectivity
- Address isotope specific selectivity issue

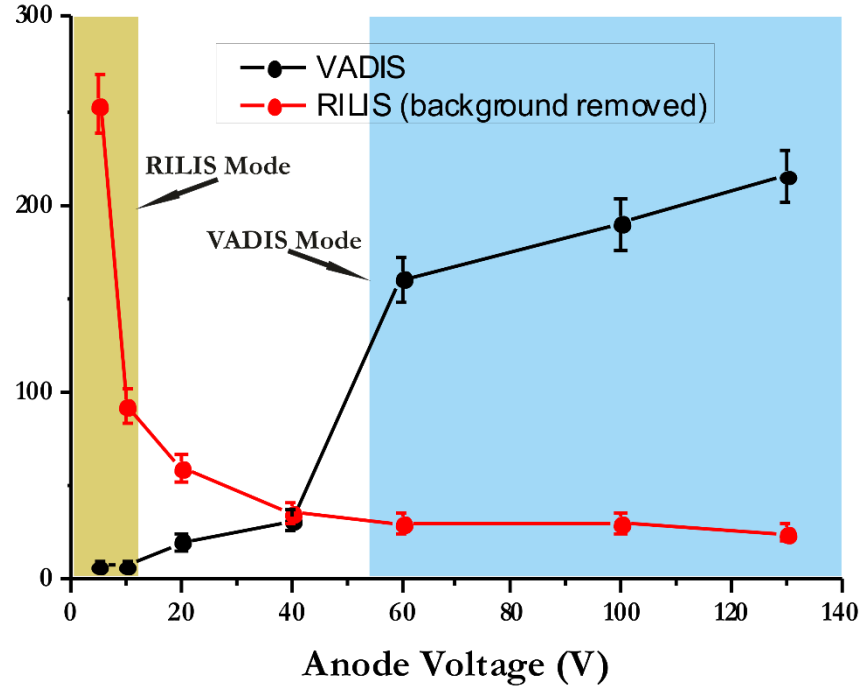
Ion source development: New modes of ionization

RILIS + VADIS compatibility is demonstrated off-line and on-line



VADIS MODE :
Anode >100V

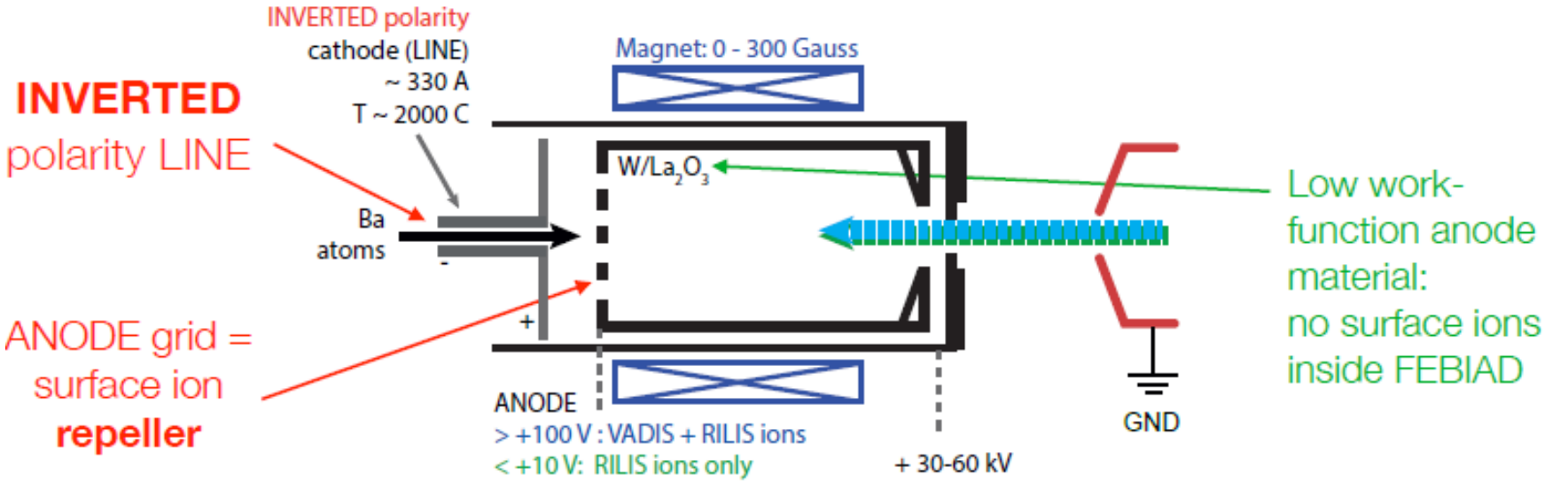
RILIS Mode:
Anode ~5V

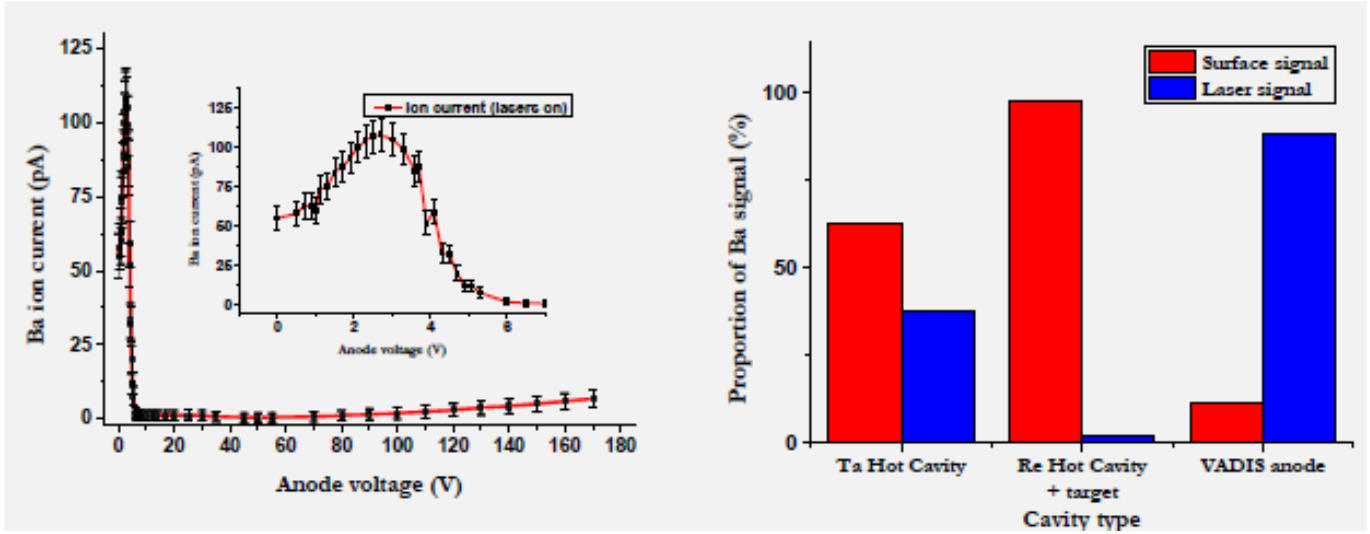


- VADLIS: demonstrated for Ga, Ba, Ba^{2+}, Hg, Cd
- Improved flexibility for USERS: - Fast switching between VADIS and RILIS mode
- RILIS compatibility with molten targets.

=> R&D is continuing at ISOLDE off-line separator

Ion source development:
Surface ion reduction with VADLIS

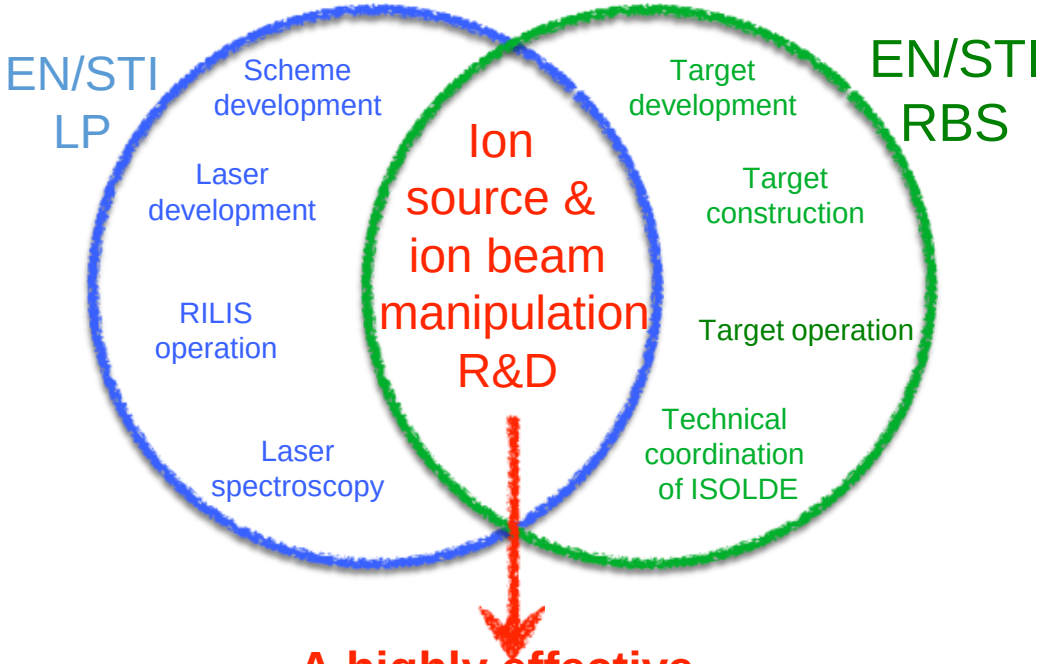




Demonstrated for Ba with normal FEBIAD

Low work function FEBIAD to be built

ISBM development team



A highly effective
means of improving ISOLDE performance

There is room for improvement of

Efficiency Selectivity Beam quality Reliability

With ***reduced radioactive waste inventory***
(essential for HIE ISOLDE)

Established in July 2015

- Regular monthly meetings
- Concentrates on the work overlap areas between LP and RBS section
- Discussion of all aspects of ion source development and beam manipulation

- Members:
  - EN-STI-RBS (TISD team)
  - EN-STI-LP (RILIS team)
  - F. Wenander

To tackle
subjects such as

HRS upgrade

ToFLIS

FEBIAD optimzation

VADLIS

LIST

ISCOOL upgrades

Fast beam gating

Ion source selectivity

Ion beam multiplexing

Optical pumping in ISCOOL

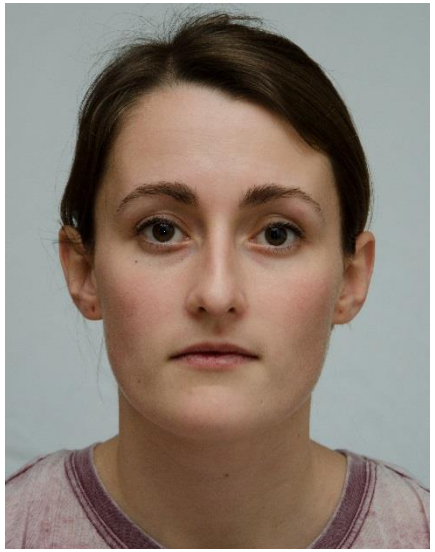
RILIS team today

Bruce Marsh
CERN staff member

Sebastian Rothe
Visiting scientist
Manchester University

Tom Day Goodacre
PhD student
Manchester University

Christoph Sieffert
CERN fellow



Katerina Chrysalidis
Technical student
Mainz University

+ visiting collaborators from PNPI Gatchina: Dima Fedorov, Maxim Seliverstov, Pavel Molkanov, Anatoly Barzakh