Update on Front Ends, targets and laser systems Plans for 2020 and 2021

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87th ISCC Meeting, 20th of February 2020

CERN | EN ENGINEERING DEPARTMENT

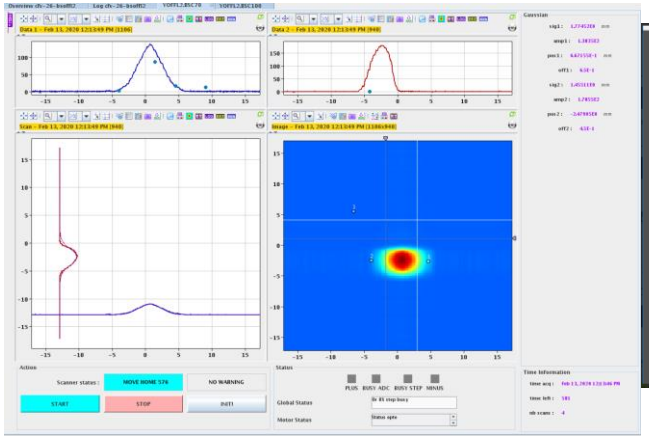
Outline

- Status of Frond Ends production and commissioning
- TISD activities and target lifecycle
- Update on laser systems
- MEDICIS status
- Upgrade studies
- Conclusions

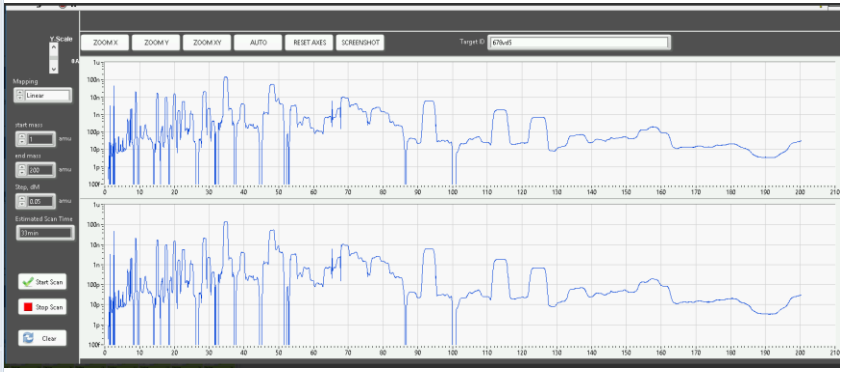
Front End 10 status (1)

- FE10 performances tested during the last weeks in offline2:
  - Check of controls
  - Extraction electrode movement and alignment for different ion sources and check of temperature effect…
  - Coupling/decoupling (different targets…)
  - Beam emittance and use the Front End optical elements…

Beam



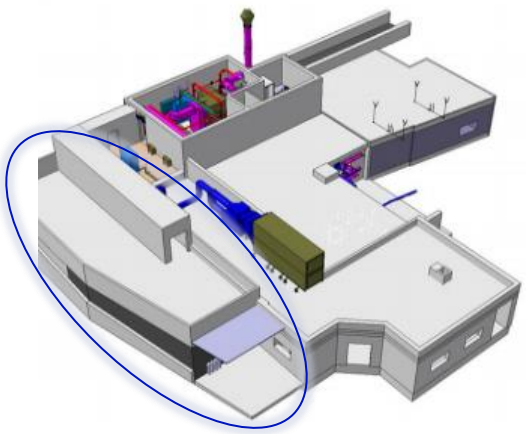
Mass Scan



Heating tests

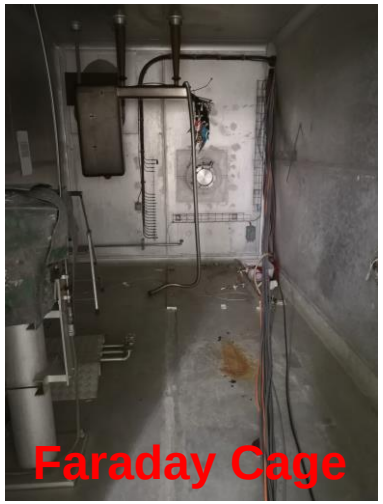
Front End 10 status (2)

- Construction of the Building 179 extension was originally planned for early January (nano-laboratory see further) but was delayed to 01/03
  - Decision to maximize the test period in offline2 (but running out of possible tests now)
  - FE10 will be transported from Build. 26 to Build. 179 next week
- Preparatory work in the target area to be finalized. Front End to be installed in March. Hardware and beam tests in April for handover to OP team end of April



Extension of B.179

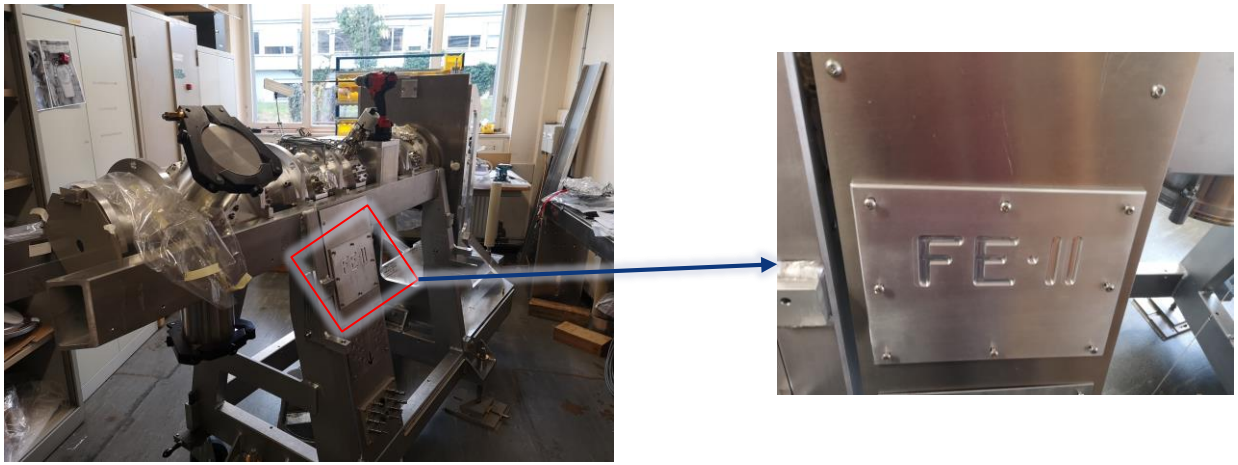
FE10 in offline2



Faraday Cage

Front End 11 status

- FE11 mechanical assembly progressing smoothly (benefit from FE10 experience)
- FE11 hardware tests on offline2 expected as of April
- FE11 to be installed in the target area in June (no possibility for access before due to civil engineering work for nano-lab)
- HW tests followed by commissioning during the summer



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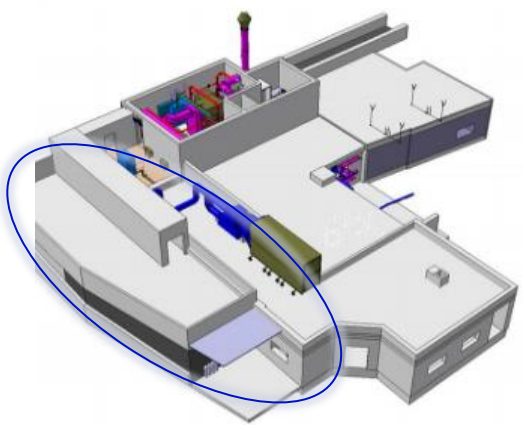
TISD activities

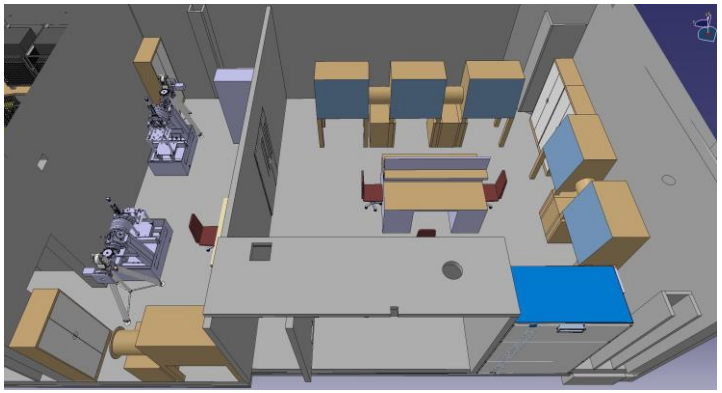
- Many studies:
  - LIST (Laser Ion Source and Trap): new Front End made compatible, work on compact quadrupole unit with repeller and transducer box
  - Optimized target heating (elimination of cold spot) and new target heating concepts
  - Negative ions at MIRACLS (Cl 35-37 shift)
  - Molecular beams
- Ion Source and Beam Manipulation (ISBM) working group re-established (concentrate on the work overlap areas between LP and RBS section). Monthly meeting planned.

Target Production (new laboratory)

- New laboratory dedicated to the production of actinide targets (civil engineering to start in March and last until spring 2021)
  - Compatible (glove boxes) with handling of nano size powders
  - Study ongoing for the integration of equipment and material workflow
  - Building will also include a storage area for radioactive material and waste.
  - Ventilation will be stopped for the connection to Build. 179 ventilation



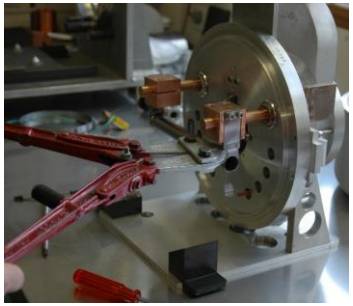
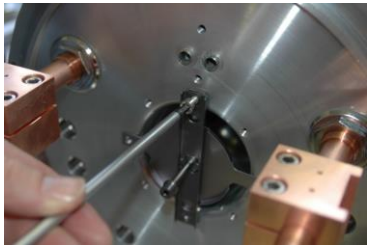
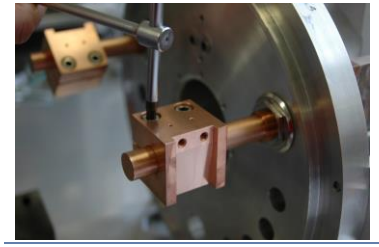
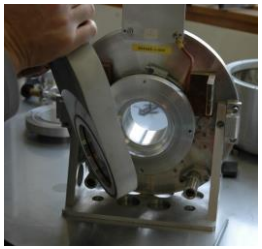
No actinide target production possible during the ventilation stop (need to anticipate 2021 needs)

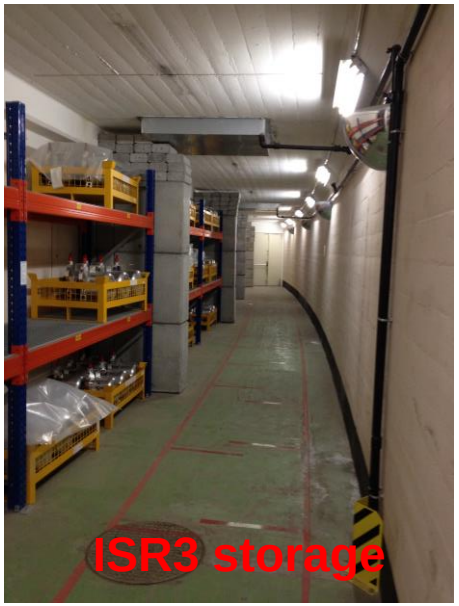


Target lifecycle (closing the loop)

- More than 300 targets stored in the ISR storage areas
- Last elimination campaign in 2007-2010 with the elimination of 114 targets (toward CH rad. waste repository)
  - Manual dismantling (need for a hot cell identified)
  - No actinide target eliminated

Manual dismantling

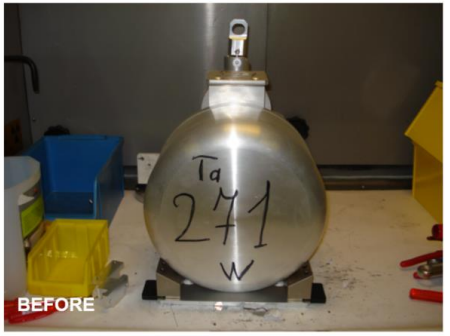





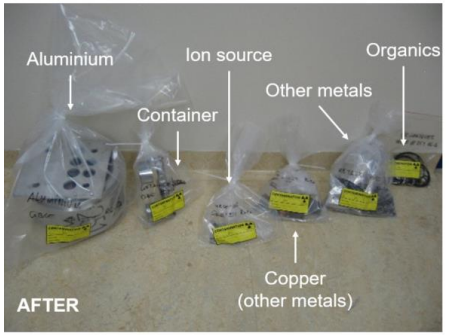


Dismantling of targets

- Need to separate different material categories
- Need to re-oxidize UCx (pyrophoric material)
- Need to declare radiological inventory and ensure traceability
- Need to transport to radioactive waste repository

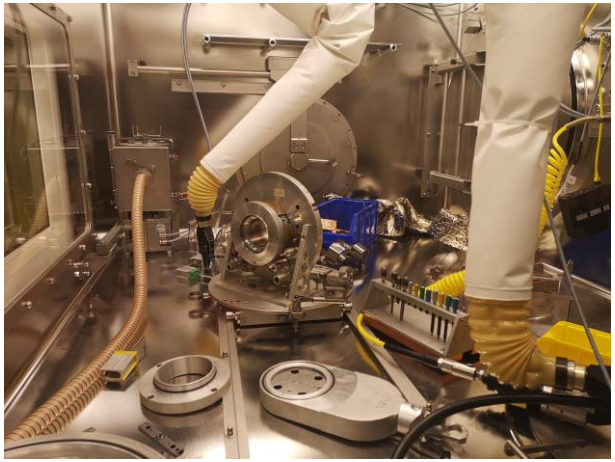
Type	Drum size	Waste type	α emitter?	Waste form & packaging	How will PSI handle the waste
1	20L	ThO_2 and U_3O_8 mixed with mortar	Yes	Mortar blocks in drum, no plastic bag	Take the blocks out of the drum, manually, probably with gripper
2	20L	Ion-sources, empty tantalum container + graphite tubes of ThC_2 and UC_2 targets	Yes	Pieces in drum, no plastic bag	Open the drum and pour mortar in it
3	20L	Non actinide powders/pills/fibres mixed with mortar		Mortar blocks in drum, no plastic bag	Take the blocks out of the drum, manually, probably with gripper
4	20L	Complete metal target containers Ion-sources, empty tantalum container + graphite tubes of the powders/pills/fibres targets		Pieces in drum, no plastic bag	Open the drum and pour mortar in it
5	200L	Aluminium		One plastic bag in drum	Open the drum, handle material by hand
6	20L	Steel		One plastic bag in drum	Open the drum, handle material by hand
7	20L	Copper		One plastic bag in drum	Open the drum, handle material by hand
8	20L	Non-metals (Organics and ceramics)		One plastic bag in drum	Open the drum, handle material by hand
9	20L	Mixed waste (anything that is left, cannot be separated)		One plastic bag in drum	Open the drum, handle material by hand





The ISOLDE hot cell

- Need to separate different material categories
- Need to re-oxidize UCx (pyrophoric material)
- Need to declare radiological inventory and ensure traceability
- Need to transport to radioactive waste repository
- Cold tests have just started. Aiming at dismantling hot targets in 2020 (non actinide) to pave the way for future routine elimination



EN-STI-RBS re-organization

Moved to TCD section on the 1st of February

- Loss of beam manipulation expertise with the departure of T. Giles (available for consultancy)
- Need to redistribute responsibilities within the RBS section:
  - S. Marzari responsible for the Front Ends replacement (support from S. Rothe)
  - S. Rothe takes overall responsibility for the new Tape Station (support from different groups)
- EN-STI finances a PJAS position (50%) in the framework of a collaboration agreement with the University of Manchester
- Expert already identified to start working on ISCOOL development and support other activities (Fast Tape Station and offline2 separator)

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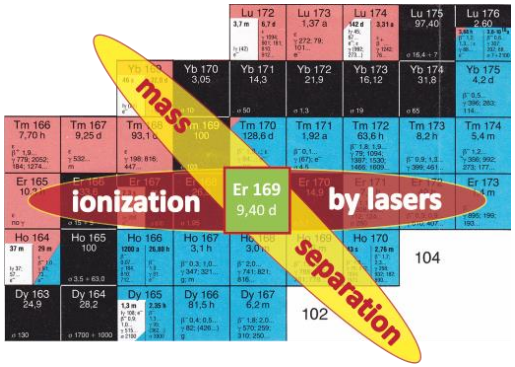
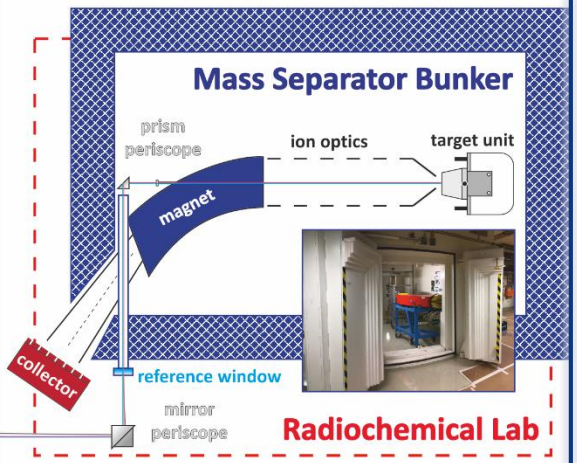
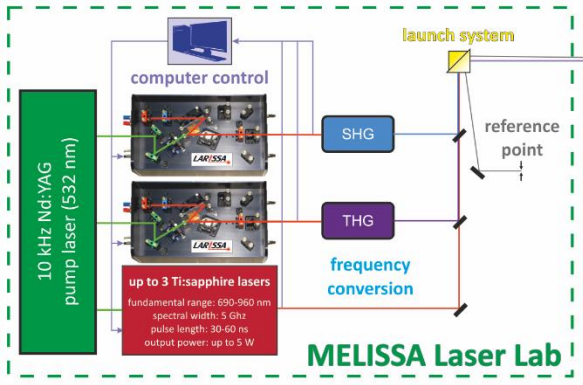
RILIS update

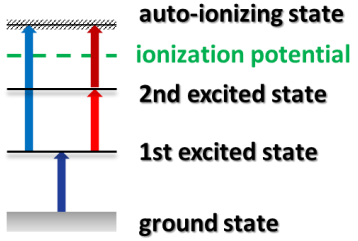
MELISSA: Laser ion source for MEDICIS

- Laser Lab became operational in 2019
- Laser-ionized beams of Tb, Er, and Yb produced
- First radioisotope collections performed









Enhancement of beam purity due to the laser resonance ionization

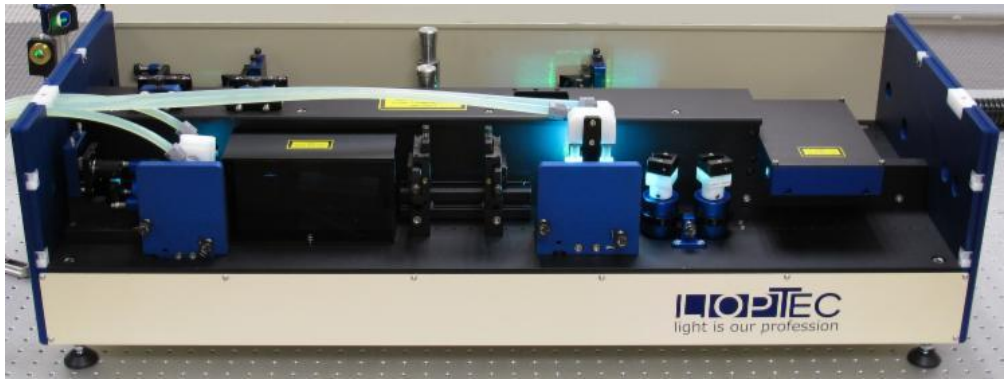
Slide courtesy of V. Fedosseev

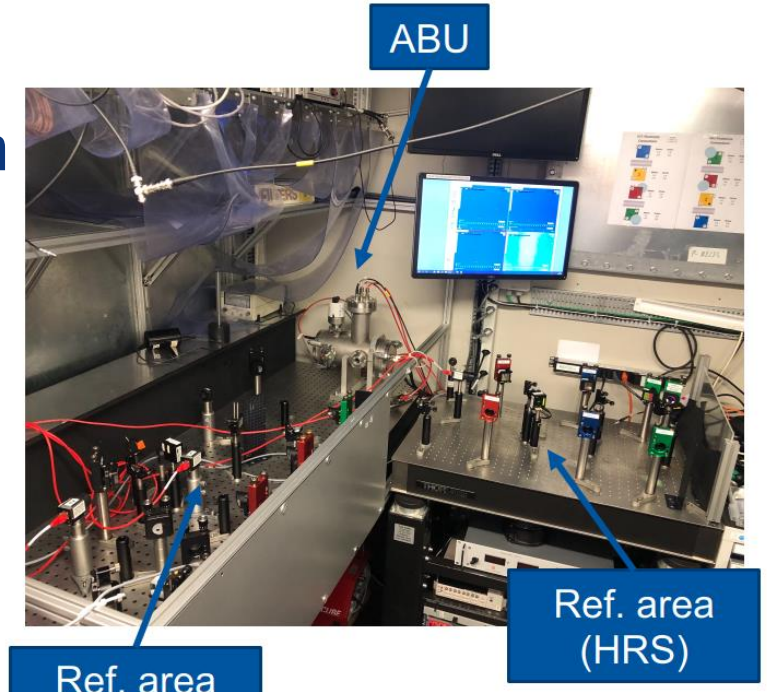
Offline Laser Ion Source R&D at **ISOLDE Offline 2 separator**

- Laser Lab is ready and will make use of spare laser equipment from ISOLDE-RILIS
- Aim to be operational from winter 2019-2020

Works at RILIS before restart

- Extension of the reference area for independent setup and stabilization of laser beams to both GPS and HRS ✓ Done
- Optimization of the optical layout ✓ In process
- Upgrade of dye lasers system
- Upgrade of the RILIS control system
- Exchange of magnet windows

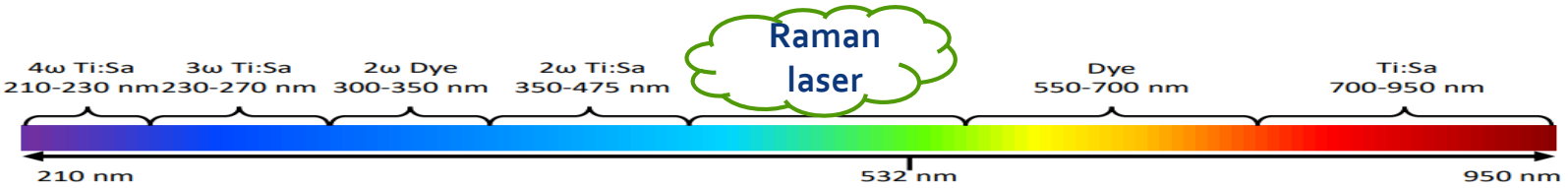




Slide courtesy of V. Fedosseev

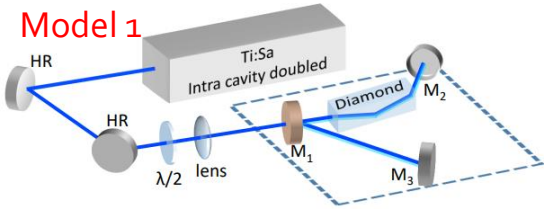
Solid-state Raman lasers for RILIS

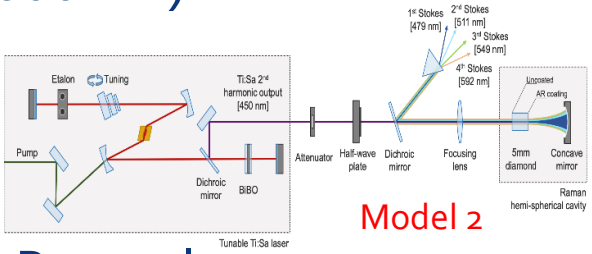
Closing the gap between Ti:Sapphire 2nd harmonic and dye laser tuning bands



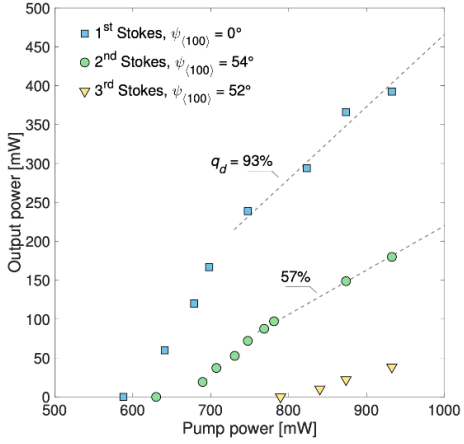
- Efficient cascaded broadband diamond Raman laser demonstrated (450-600 nm)

Model 1

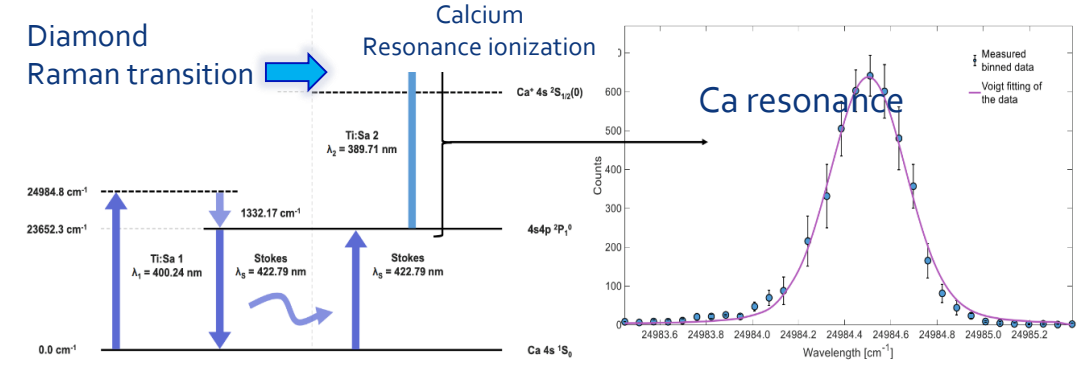


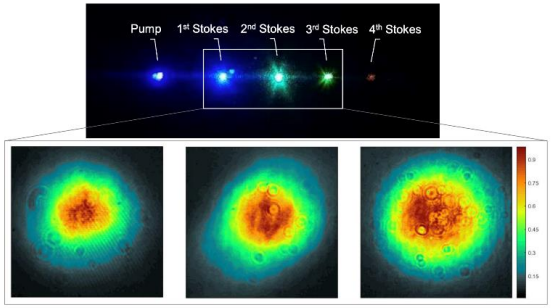


Model 2



- First time spectroscopy using Raman lasers

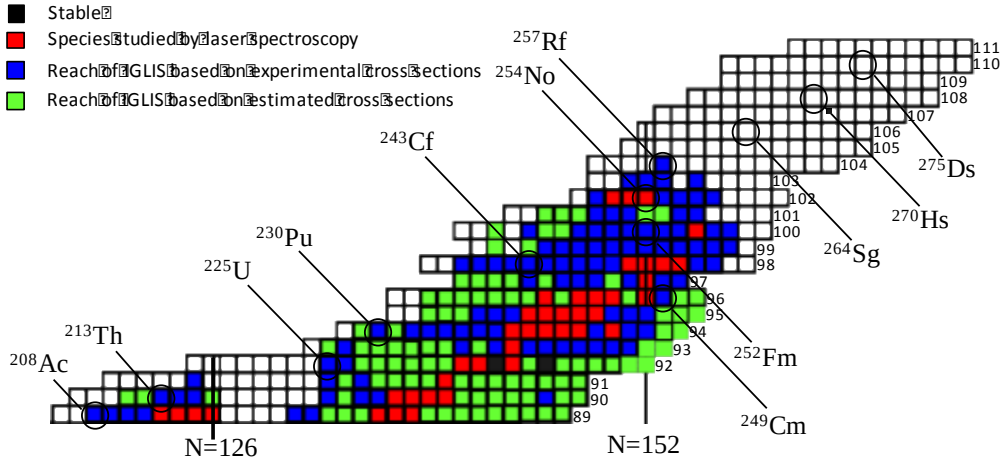




Slide courtesy of V. Fedosseev

Laser Ionization & Spectroscopy of Actinides

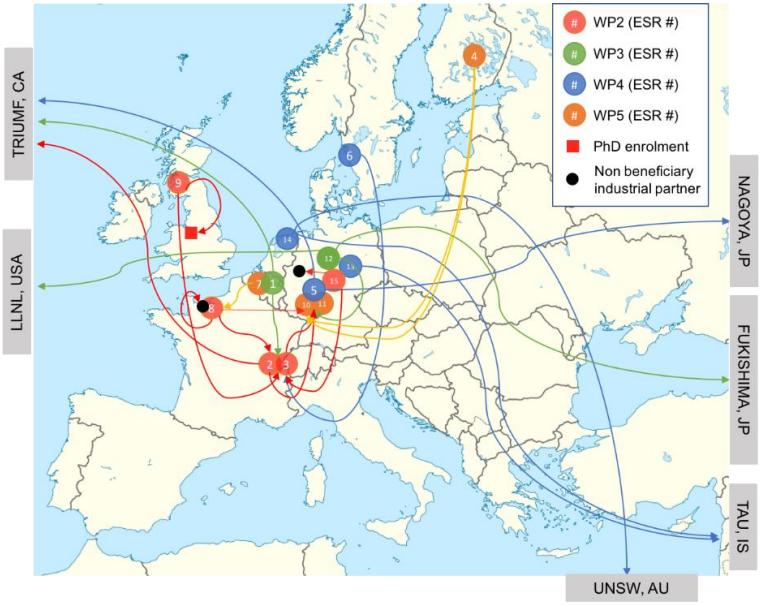
"LISA aims to train the next generation of atomic, nuclear and laser scientists by conducting research to increase our understanding of the atomic and nuclear properties of the chemical elements known as the actinides"



November 2019 - November 2023

15 36-month PhD positions, across **12** different locations.

Applications are open now



ESR #	Recruiting Participant	PhD awarding entity / Doctoral School
1	KUL	KUL Arenberg Doctoral School
2	CERN	JGU Institute of Physics
3	CERN	JGU Institute of Physics
4	JYU	JYU Doctoral School of the Faculty of Mathematics & Science
5	JGU	JGU Institute of Physics
6	UGOT	UGOT Department of Physics
7	KUL	KUL Arenberg Doctoral School
8	GANIL	Université de Caen PSIME Doctoral School
9	MSL	UNIMAN School of Physics & Astronomy
10	GSI	JGU Department of Chemistry
11	JGU	JGU Department of Chemistry
12	LUH IRS	LUH IRS Faculty of Mathematics & Physics
13	FSU	FSU & Helmholtz-Institute Graduate School
14	RUG	RUG Graduate School of Science & Engineering
15	HUB	JGU Institute of Physics

Coordinated by CERN (B. Marsh, T. Cocolios)

Slide courtesy of V. Fedosseev

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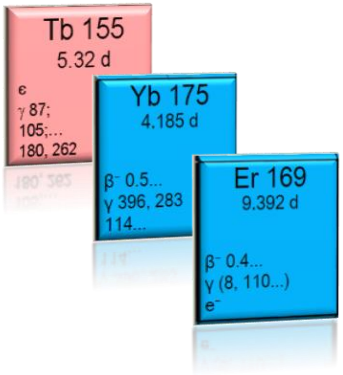
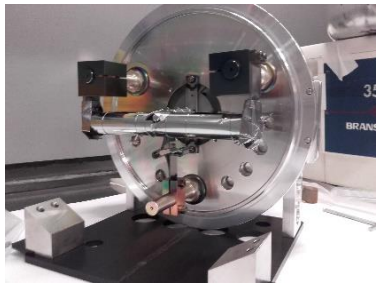
MEDICIS 2019 summary

- **Summary of 2019 achievements in term of collections from external sources at MEDICIS**
  - ✓ **15 sources** from two external suppliers (ILL (Grenoble) & Arronax (Nantes));
  - ✓ **3 radionuclides** of medical interest Tb-155, Yb-175 & Er-169;
  - ✓ **870 MBq** in total collected in 2019;
  - ✓ **4 institutes** part of the MEDICIS collaboration received activity;

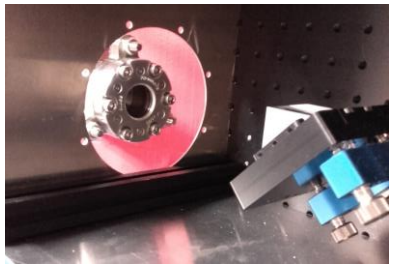


  - ✓ **8 targets** produced & re-used up to 3 times.



MEDICIS in 2020

- **From January to beginning of March 2020, MEDICIS is in technical stop for maintenance**
  - ✓ Maintenance of the ventilation, access and safety system
  - ✓ Replacement of the extraction electrode
  - ✓ Robot trajectories checks – **ONGOING**
  - ✓ Installation of a switch inside the collection chamber
  - ✓ Cleaning/replacement of the laser windows
  - ✓ Installation of the new gas system
  - ✓ Radiation monitor tests



One laser window

New electrode installed, aligned and calibrated

- **5th MEDICIS Collaboration Board Meeting**
  - ✓ Being held today (20/02/2020) !
- **Operation 2020**
  - ✓ Will re-start from middle of March 2020 with already 3 foreseen Tb-155 collections

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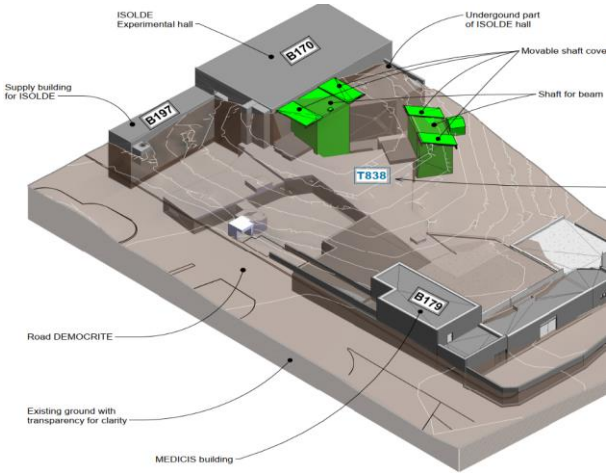
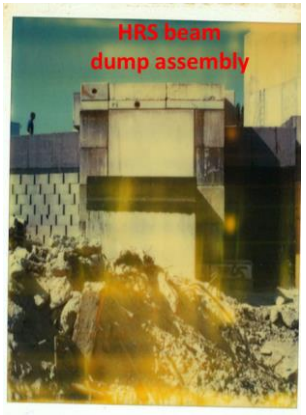
Beam power upgrade (intensity/energy)

- Feasibility study:
  - Replacement of beam dumps (new cores) and shielding consolidation to cope with higher beam power (PSB performances)
  - Study to be conducted in 2020-2023 to deliver a consolidated cost estimate and an execution plan for a possible implementation during LS3
  - Study does not foresee additional target stations



Option with partial soil removal (complete removal also considered)

Past soil sampling (MEDICIS)



Beam sharing capabilities

- Study and cost estimate to overcome the CA0 bottleneck
  - Principle tested a few years ago
  - Need bi-polar power supplies and integration in CERN control and data logging environment
  - Possibility to obtain a grant from the Swedish Science Council is being investigated

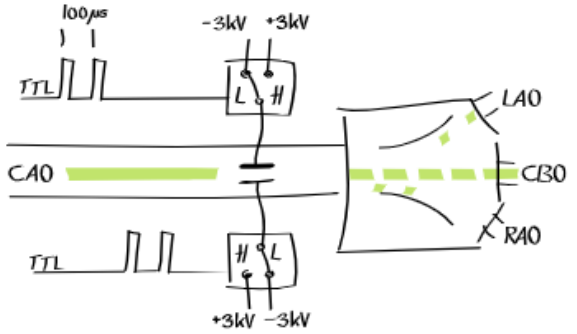


Fig. 7. Two fast high voltage switches control the voltage of the kicker plates of a switch-yard. Depending on the on-time the beam is fed into the three possible beam lines.

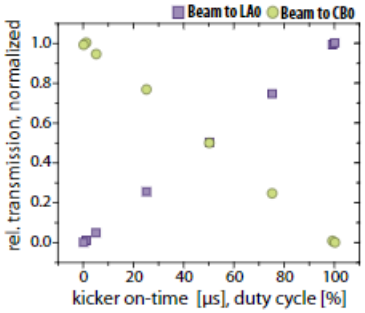
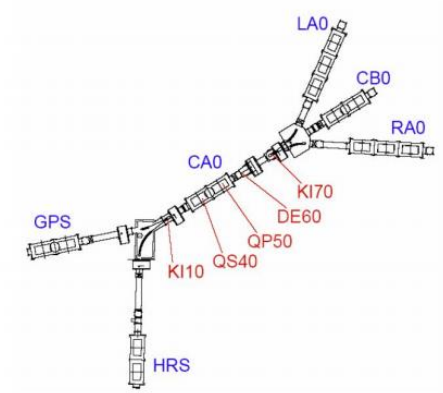


Fig. 8. Demonstration of beam line multiplexing or μ-switching at 10 kHz for the ISOLDE LA0 and CB0 beam lines.



Cf: S. Rothe: "Introducing Fast Beam Multiplexing at ISOLDE", EDMS 1509964, 2016.

"Advances in surface ion suppression from RILIS: Towardsthe Time-of-Flight Laser Ion Source (ToF-LIS)",

Conclusions

- 2020 priority is to finalize, install and tests the two new Front Ends (beam delivered to the hall)
- Construction of the Building 179 extension leads to operational constraints and risks (to be mitigated):
  - Access restrictions for FE installation
  - Laboratory ventilation not operational first semester of 2021 (anticipate actinide target production for 2021 operation)
  - New nanolaboratory for the production of actinide targets to commission (enclosed process using glove boxes). Keep current laboratory operational
- Many development being done by the TISD team. Successful target disposal is mandatory for the long term sustainability of the facility.
- Laser systems greatly enhanced during LS2 (new infrastructure and upgrade of RILIS for ISOLDE operation)
- Investigating future infrastructure upgrades (parallel operation and dumps)