TISD activities in 2018

Sebastian ROTHE
EN-STI-RBS
The Target and ion Source Development (TISD) team

Providing a large choice of **intense** and **pure** radioactive beams

Constant development is required to keep ISOLDE at the forefront of RIB facilities
RILIS team in 2018

Valentin Fedosseev
Section Leader
EN-STI-LP

Bruce Marsh
Staff Member
EN-STI-LP

Shane Wilkins
CERN Fellow
October 17 onwards

Camilo Buitrago
CERN Fellow
April 17 onwards

Katerina Chrysalidis
Doctoral student, 2nd year
Univ. Mainz

Support from PNPI:
Dima Fedorov
Pavel Molkov
Maxim Seliverstov

LARISSA group, Mainz:
Dominik Struder
Reinhard Heinke
ISBM working group

R&D for Ion Source & Beam Manipulation (ISBM)

- Scheme development
- Laser development
- RILIS operation
- Laser spectroscopy

Ongoing development projects:
- LIST
- FEBIAD optimization
- ISCOOL upgrades
- Fast beam gating
- Development of refractory metal beams
- VADLIS
- ToFLIS
- Ion beam multiplexing
- Optical pumping in ISCOOL
- Negative ion beams
- HRS upgrade
- Ion source selectivity

Technical coordination of ISOLDE

Target development
Target construction
Target operation

EN/STI LP

EN/STI RBS
Target and ion Source Development (TISD) mandate

Providing a large choice of intense and pure radioactive beams
Constant development is required to keep ISOLDE at the forefront of RIB facilities

- target and ion source units
- target materials
- beam interactions (p2n converter)
- ion source design / mode of operation shared with ISBM group

- yield & release study
- ion source efficiency measurements
- prototype tests

Sharing same resources as the ISOLDE physics program
- WORKSHOP: target unit production
- OFFLINE: target quality control
- ISOLDE: beamtime
The LIEBE target – Assembled

LIEBE fully assembled and coupled to offline 1
Vibration tests:
Good stability of the pump and no direct transmission to the target

<table>
<thead>
<tr>
<th></th>
<th>PUMP + X</th>
<th>PUMP + Y</th>
<th>PUMP + Z</th>
<th>LIEBE + X</th>
<th>LIEBE + Y</th>
<th>LIEBE + Z</th>
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<tr>
<td>Baseline</td>
<td>0.20</td>
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<td>0.19</td>
<td>0.06</td>
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<td>10Hz</td>
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<tr>
<td>20Hz</td>
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<td>1.76</td>
<td>1.41</td>
<td>0.73</td>
<td>0.27</td>
<td>0.25</td>
</tr>
</tbody>
</table>

Standardized model to evaluate the stability of the setup over time.

Ion source tests:
- Leak was found when heating the ion source to 1600 °C

Leak on vessel containing the ion source.
LIEBE: Offline Tests

Fixing the leak:

- Experimental tests and numerical analysis to understand the problem:
  - High temperature cathode inducing a thermal gradient on the vessel containing the ion source.
  - Deformation of the sealing path due to thermal dilatation.

- Manufacture of dedicated pieces to increase sealing pressure:
  - Experimental tests of the new pieces to be done.
LIEBE 2018

- Offline tests delayed until the leak is fixed.
- Test of LIEBE Online intervention procedure during 2018 shutdown:
  - Installation of new power supply cables
  - Robot tests
  - Alignment tests

KUKA robot handling the LIEBE mock up target

- Operational review to be scheduled
- Target to be installed on GPS end of October 2018
HFS studies of polonium / supression of francium (IS456, September 2012)

Isobaric suppression > 1000, efficiency loss ≈ 50

On-line implementation and first operation of the Laser Ion Source and Trap at ISOLDE/CERN, D. Fink et al., NIMB 344, 83-95 (2015)

LIST v 2.0

Upgraded 2018 LIST laser ion source for

**INTC-P-459: Measurement of the super-allowed branching ratio of $^{22}$Mg**

- Laser ionization of Mg - suppression of surface ionized Na contamination

Compact isolator design:
Narrow spacing to atomizer

Dual repeller:
Ion and electron suppression

Adapted length:
Reduced deposition and compatibility to additional purification techniques

- Operation analog to 2012
- 1 unit available, 2 more machined at JGU workshop right now
- Robot handling tests with mock up unit in shutdown

Ideal opportunity for Al yield checks
Neutron deficient SeCO beams

Principle: \[ \text{Se} + \text{CO} \rightarrow \text{SeCO} \]

Shifting the mass to get pure beams
Beam available since many years.
but….

- SeCO gone after a few days
- Atomic Se still released after days

Why does SeCO disappear, even if we inject CO\(_2\)?

Injecting \(^{13}\text{CO}_2\)…
…extracting Se\(^{12}\text{CO}\)

Injected CO\(_2\) gas does not promote SeCO formation!

What’s the source of carbon?
Carbon from the ion source?
-> Placed graphite grid, but still depleting

Carbon from the target material?
-> EDS (preliminary) shows no carbon in ZrO fibers

Indications, that CF\(_4\) gas might serve as carbon source. Work in progress.

Target #605 and #612
Zirconia fibers, stabilized with ca. 10% Yttria
Studying molecular beam formation
Concept for a dedicated development unit for molecular beams

**Study chemical reactions**

- Injection of gases and vapor of solid samples into reaction volume
- Suppression by quartz and other materials

**Parameters**

- 2 gases, controllable flow rates
- 2 mass markers
- Controllable temperatures in reaction volume and chromatography column
- Materials for chromatography and
- Materials in reaction volume (target matrix)

- better understanding of molecule formation
- improve reliability of existing beams, tailor new beams
VADLIS Development

Tested at Online at ISOLDE for Hg, Mo, Mg (target #630)
Factor of >2 improvement in RILIS-mode efficiency for all cases

Standard VADIS
= FEBIAD MK5 (but with Mo anode)

PhD work: Yisel Martinez

Prototype tested for Ga at OFFLINE 1
At least 2 X efficiency improvement

Continued work of PhD student David Leimbach

V_{\text{extraction}} = 0 \text{ V}

V_{\text{extraction}} = -100 \text{ V}
1) two-photon spectroscopy of stable Si and Rb. **PhD project: Katerina Chrysalidis**

2) Samarium Efficiency measurement with alternative Blue-Blue scheme.

Tests planned in March
Collaboration started to design two p2n-converters:

- Improve the one of ISOLDE
- Design one for TRIUMF ISAC

Brings high purity neutron-induced fission fragments
Normal shielding – several metal foils stacked

New shielding: Sigratherm material – 1 cm thick

Converter will act as internal heat source

- 57.8 cc of lower density UCx (normally 30 cc – mass is the same to standard)
- 2.1 x more n-ind fissions
- 2.4x less %p-ind fissions

UCx
Graphite
p beam
Vacuum
Tungsten

NODAL SOLUTION
STEP=1
SUB =80
TIME=3000
TEMP (AVG)
RSYS=0
SMN =21.609
SMX =1359.63

57.8 cc of lower density UCx (normally 30 cc – mass is the same to standard)
2.1 x more n-ind fissions
2.4x less %p-ind fissions
TISD @ ISOLDE, 2018
(in order of appearance)

Dedicated TISD
• RILIS offline work Q1-Q2
• LIST 2.0 Q2
• M(CO)x formation @ MEDICIS irradiation point Q2-Q3
• p2n converter prototype test Q3-Q4
• LIEBE online Q4

Opportunistic TISD
• RILIS 2photon online Q1-Q4
• Si yields Q2-Q4
• VADLIS 1.5 online use Q2-Q4
Thanks to the TISD and RILIS teams