TISD activities in 2016/17

Sebastian ROTHE
EN-STI-RBS

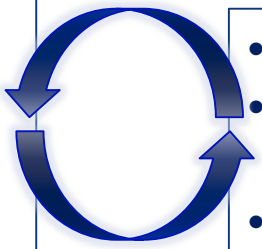
Target and ion Source Development (TISD) mandate

J.Ballof Y.Martinez T.Stora M.Delonca S.Rothe J.Ramos

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

Constant development 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

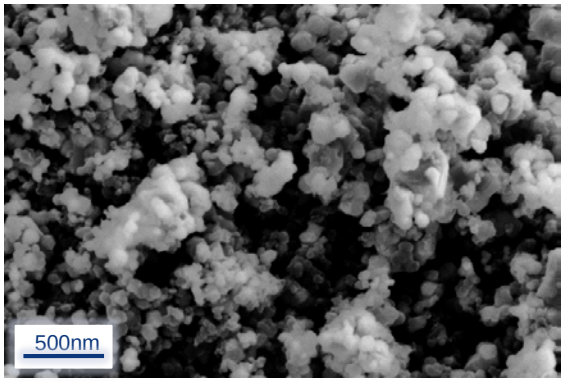
Sharing same resources as the ISOLDE physics program

- target unit production at WORKSHOP
- target quality control at OFFLINE
- beam time at ISOLDE

Nano Composites: Ti-Carbide

J.P. Ramos

TiC-Carbon black

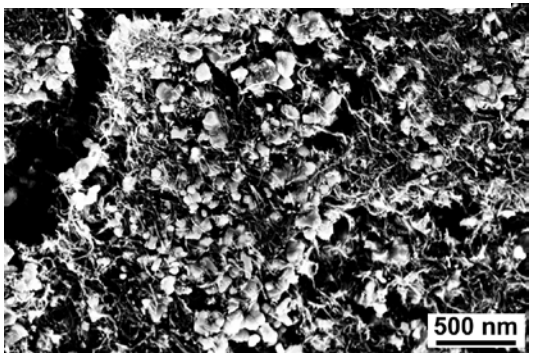


2016

Beams extracted:
- Li (high)
- Na (very high)
- K (similar)
- Ca (much lower)

Probable chemical reaction with carbon black

TiC-Carbon Nano Tubes



2017 ?

Short lived K and Ca beams

Si beams? Molecular?

INTC-I-176

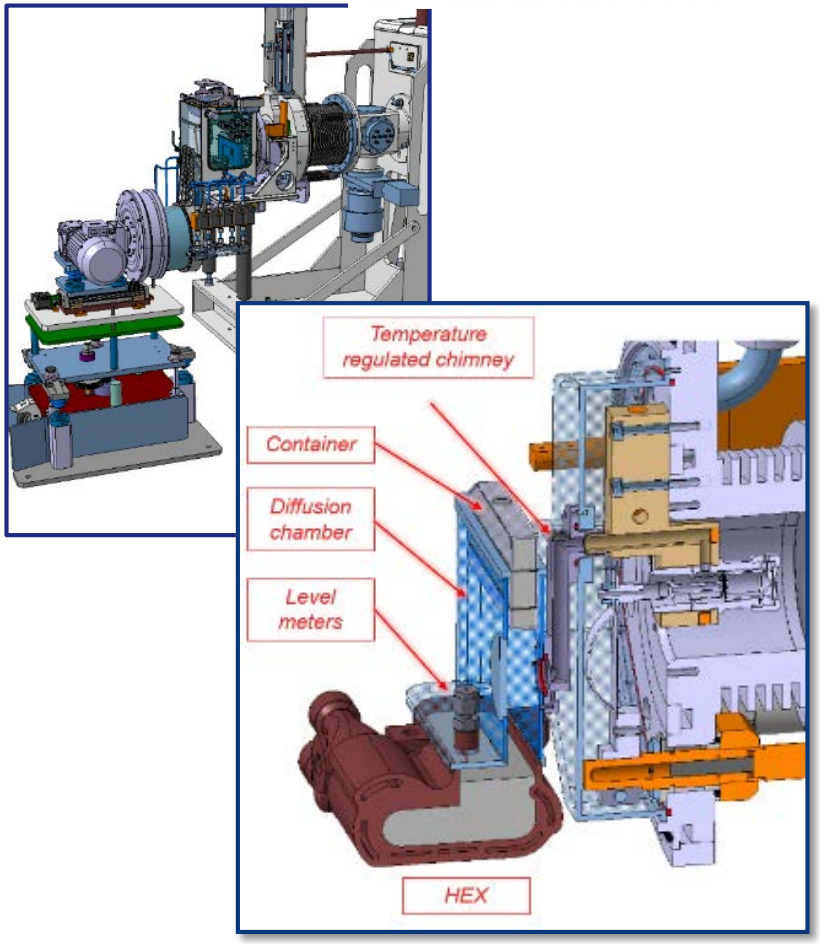
Nanomaterials research and operation is on hold until full risk analysis and clearance.

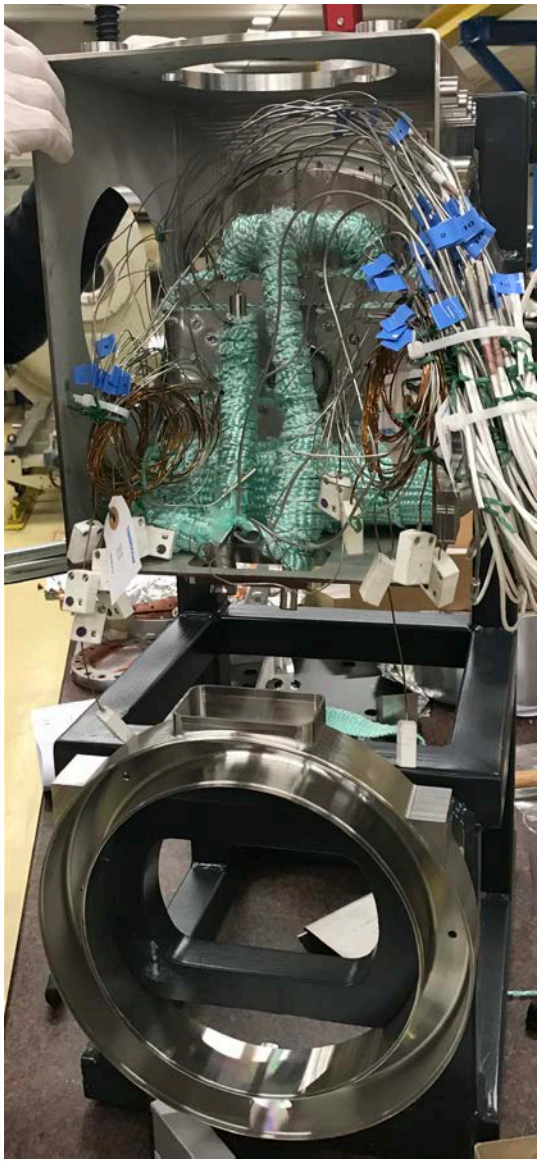
- New glove box for class A lab required
- Request permission to continue work with non-pyrophoric materials launched
- Asking for new and dedicated labs

J.P. Ramos, PhD Thesis, EPFL/CERN (2017), CERN-THESIS-2016-247

The LIEBE target – design & manufacturing

M. Delonca

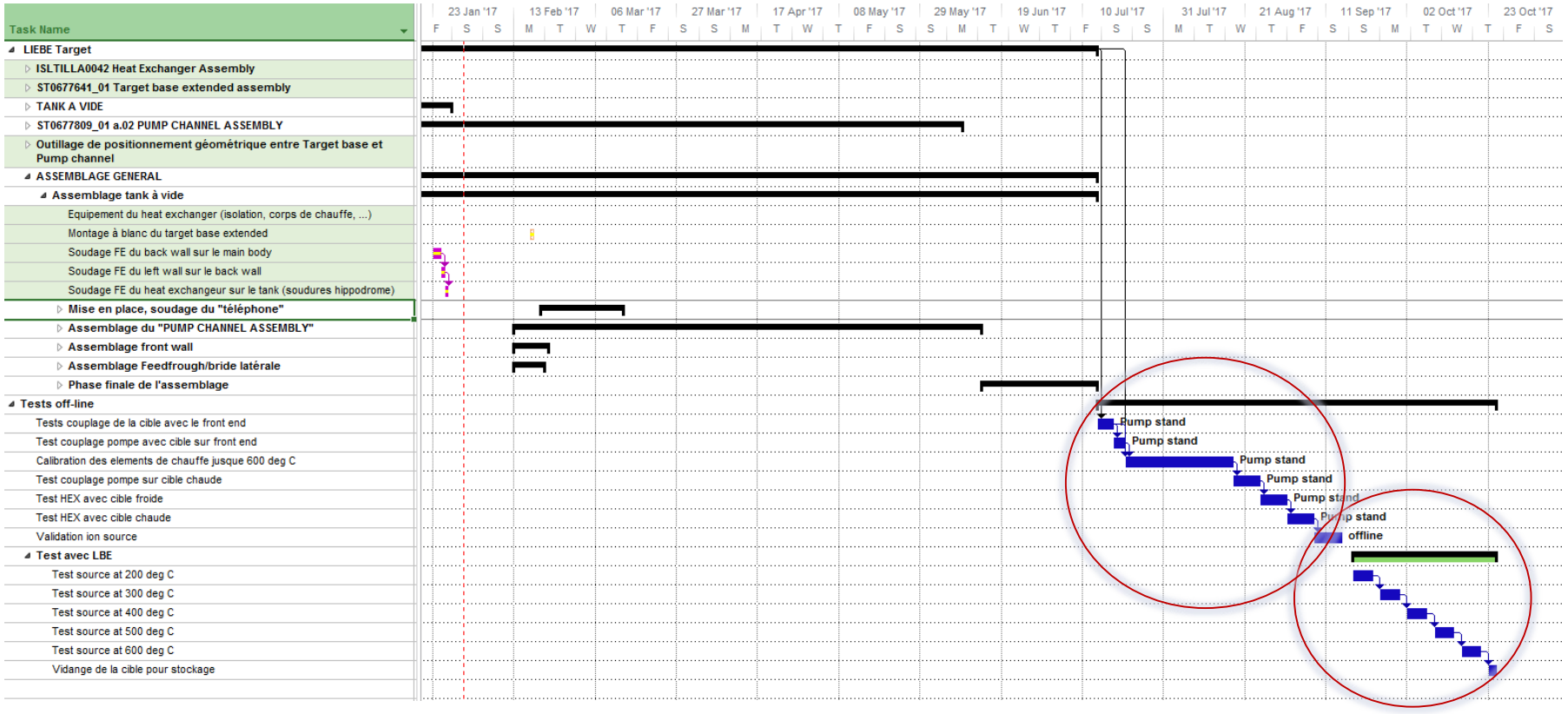




Assembly on-going

The LIEBE target - planning

M. Delonca



Pumpstand OFFLINE 1

- Fabrication and assembly on time
- Target final assembly & tests will depend upon pump results
- Large Pump Stand & Offline test campaign required from July

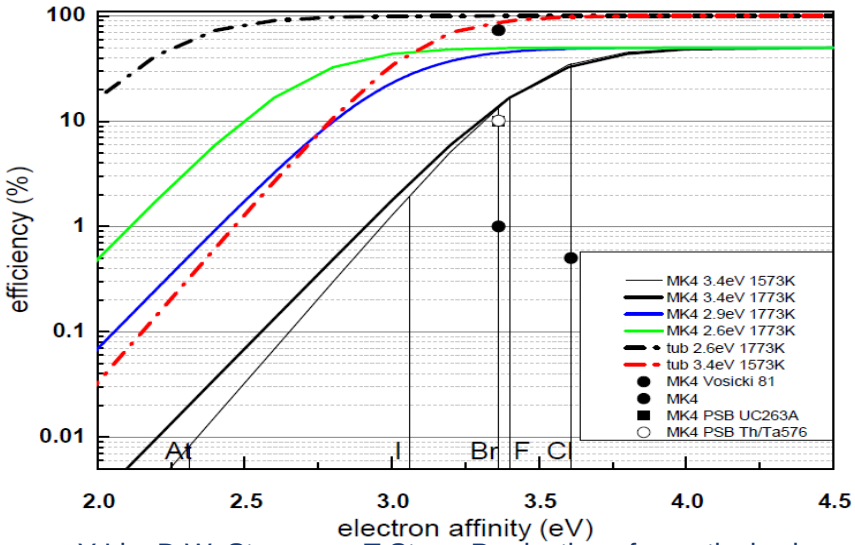
Negative ion source – 2015/2016

Measured ion yields from target with MK4 LaB6 surface source (UC target in 2005, Th/Ta in 2016)

Isotope	Half-life	Yield / Production rate [ions/s/mA $^1H^+$]	
		2005	***2016***
^{38}Cl	37.2 m	1.6 10^5	1 10^5
^{40}Cl	81 s	4.3 10^4	9 10^4
^{41}Cl	38.4 s	1.4 10^4	3.5 10^2
^{42}Cl	6.9 s	1.1 10^3	1.4 10^1
^{85}Br	2.9 m	9.6 10^5	1.6 10^6
^{89}Br	4.4 s	8.4 10^4	3.6 10^3
^{122}I	3.6 m	4.4 10^4	6 10^5
^{137}I	24.2 s	1.3 10^5	9 10^4
^{138}I	6.4 s	7.3 10^5	9 10^4
^{204}At	9.2 m	-	9 10^3 (5 10^3 after 5 days)
^{206}At	29.4 m	-	6 10^3

M.Delonca, Isolde Workshop 2016

Theor. efficiencies (Materials/Geometries)



Y.Liu, D.W. Stracener, T.Stora, Production of negatively charged radioactive ion beams, 2016, New Journal of Physics, in press

MK4 (on-line 2016)

- Yields stable over time
- Slow release for Th/Ta foils (as expected)
  -> ThO fiber target required
- Good agreement between theory and experiment

Non-conformity of new batch ThO fibers

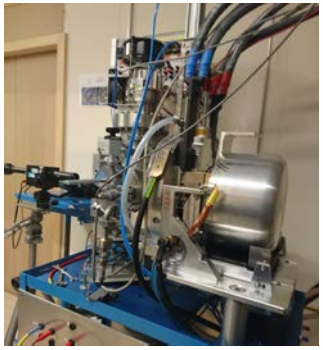
Tubular GdB6 (on-line 2015)

- Low yields due to poisoning
- unstable operation
- Requires further development

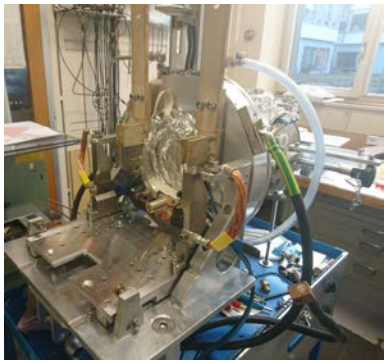
- Followed up with supplier
- Explore alternatives ?

Negative ion source developments

RILIS PISA



PumpStand 1



PumpStand 2

Scope: Test low work function materials

- robustness to thermal stress
- investigate poisoning and regeneration

Phase 1 (April)

- external heater + beam extraction system (~PISA)

Phase 2 (June)

- Put PS 2 in operation (requires power supplies, BUDGET)
- Upgrade PS with beam extraction system + RGA

Phase 3 (August)

- Negative ion tests at OFFLINE 1 (3x1 weeks)
- Select material and geometry

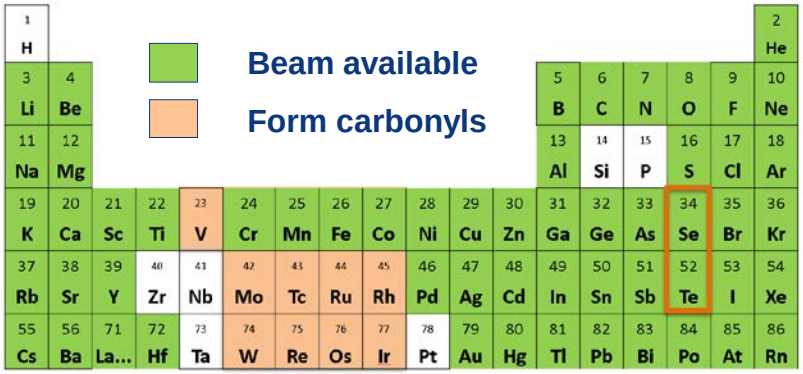
- 1 Master student (Gothenburg Univ.) starting April

Synergies

- ~ PISA-2 dev with RILIS
- Pumpstand-2 available later for LIEBE tests
- Ion detection: Long-term tests of ion-source performance

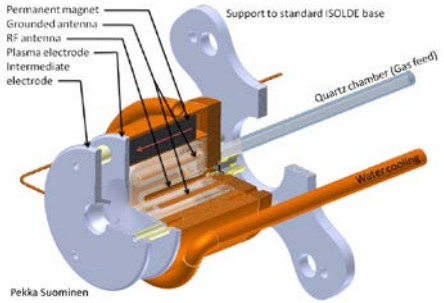
Molecular beams: Metal-Carbonyls

Motivation Potentially 9 new beams with the same method!

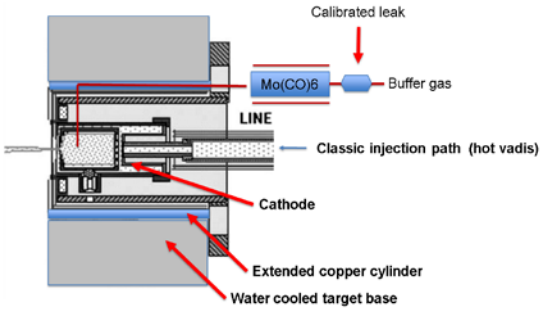


Letter of intent
INTC-I-178

RP-process study 86Nb
Medical isotopes 191Os
Laser spectroscopy W-Ir
…

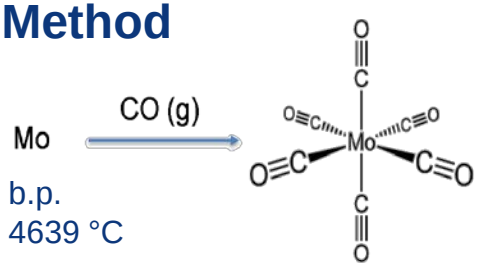


Q-COMIC (tested)



VADIS (tested)

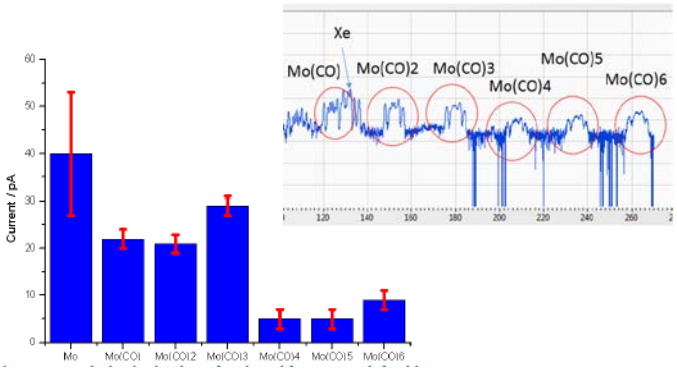
Method



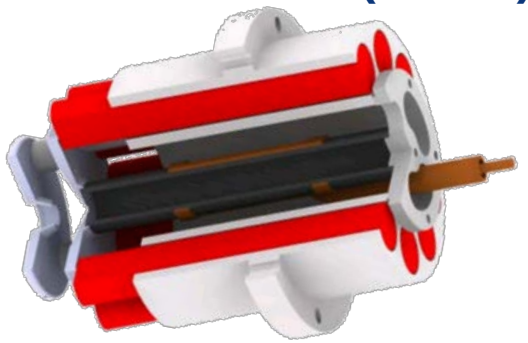
b.p.
4639 °C

volatile!

First results: OFFLINE



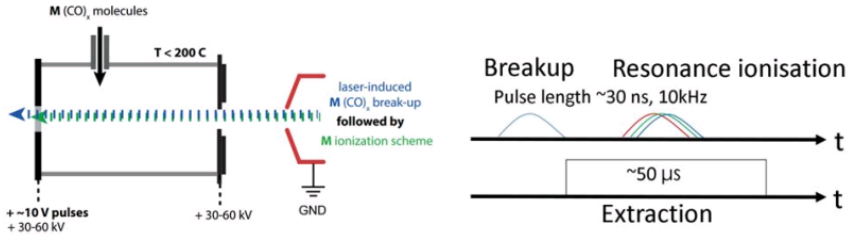
- ionization is feasible
- efficiency needs to be improved
- other plasma sources to be tested

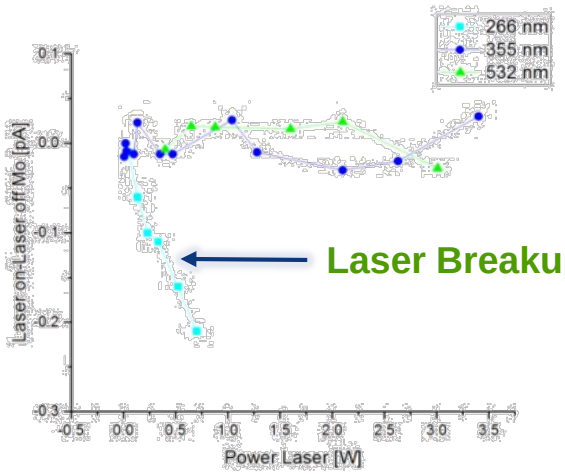


HELICON (ongoing)

Molecular beams: Metal-Carbonyls

Extended to ISBM project: Laser induced break up followed by Resonant laser ionization





Laser Breakup demonstrated

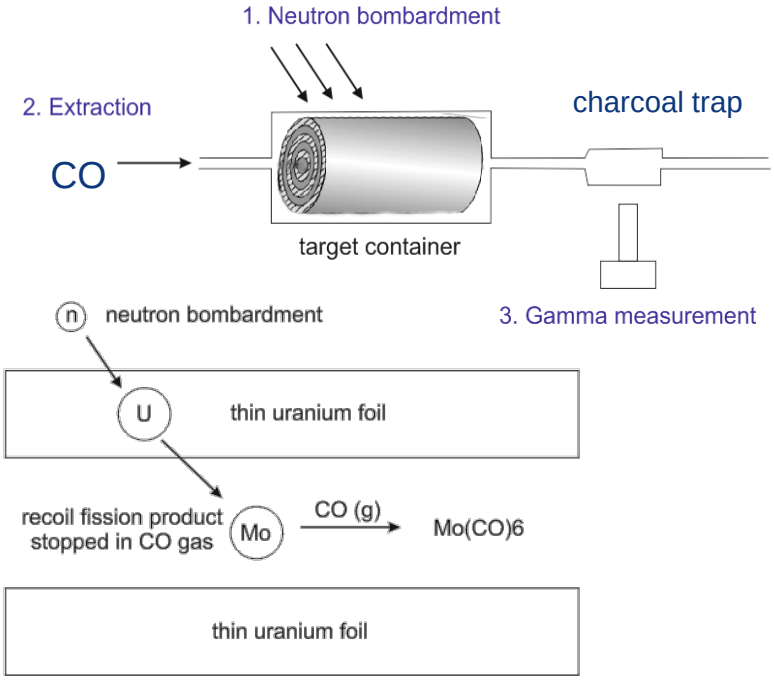
C. Seiffert, 2016

Laser ionization tested K. Chrysalidis, 2016

Combine breakup and ionization

INTC-I-178

Test: Carbonyl formation with protons using MEDICIS Montrac conveyor system



- Validate production and stopping simulations
- Carbonyl formation and survival
- Surface interactions

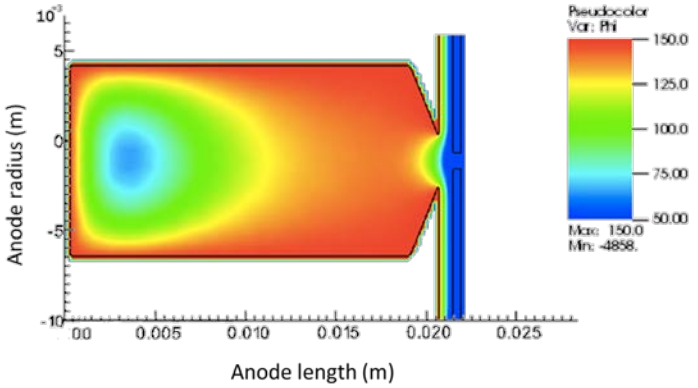
Ion source simulations: VSim

Y. Martinez

Is a flexible, multiplatform, multiphysics software tool for running computationally intensive electromagnetic, electrostatic, magnetostatic, and plasma simulations in the presence of complex dielectric, magnetic, and metallic shapes.
(https://www.txcorp.com/vsim)

1 kCHF per core / year
License purchased for 2016/17

Current: Full Simulation VADIS ion source



- 1st reproduction of electrostatic field distribution inside the VADIS using PIC code
- Optimize the anode geometry to reduce inactive volume for an increased efficiency/faster ion extraction
- Determine beam emittance and energy spread, compare with experimental results
- Better understanding of the processes taking place in the volume
- Precise description of the plasma properties

Future :

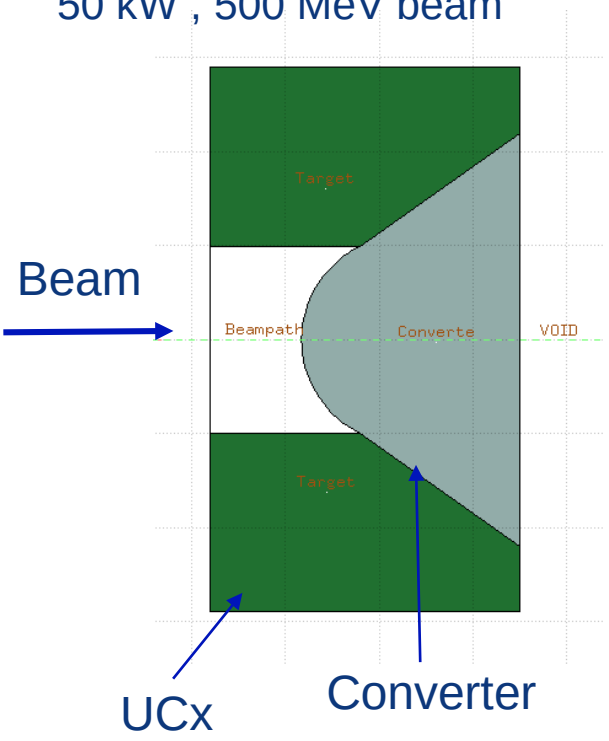
Establish collaboration with other facilities using VSim (e.g. SCK.CEN)
Extend studies to other ion sources:
ToF-LIS dynamics
Negative ion source geometries

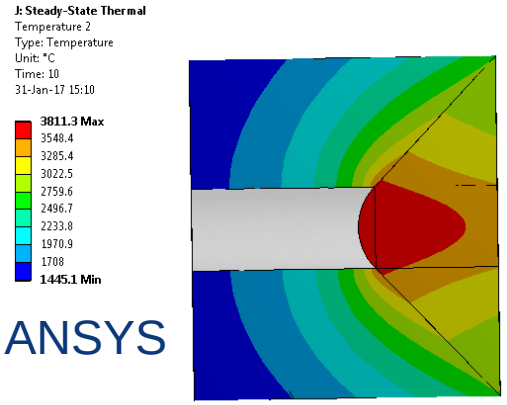
p2n-converter development

J.P. Ramos

Within CERN-TRIUMF MoU + SCK-CEN

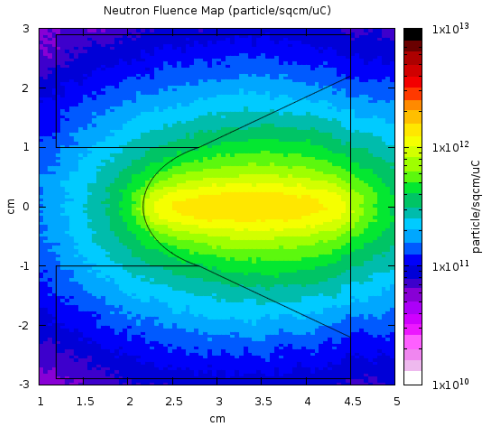
50 kW , 500 MeV beam

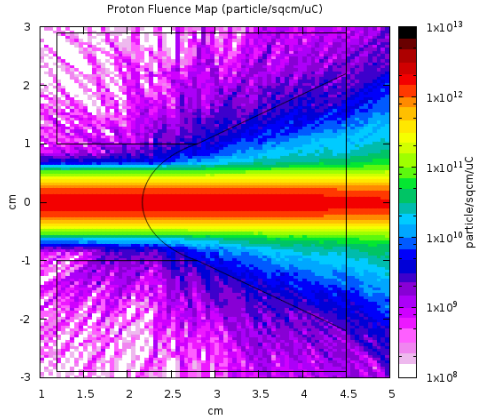




ANSYS

FLUKA



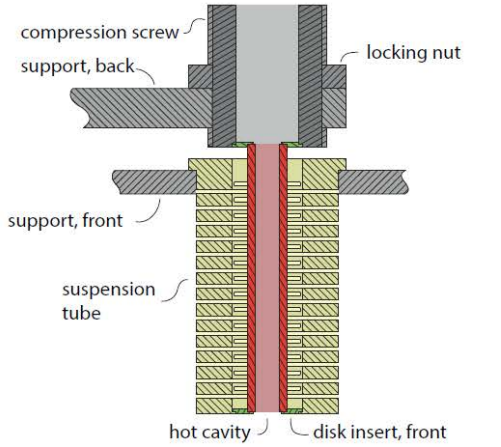


- Project Started in December
- Weekly meetings with CERN/TRIUMF/SCK

Preliminary time line:

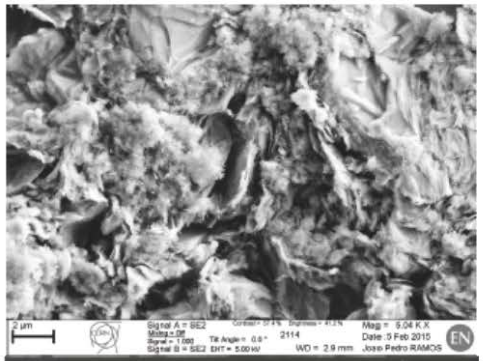
Apr-2017	Sep-2017	Jan->May-2018	?-2018	Aug->Dec-2018
Concept	Design + Offline Tests	Prototype ready	**ISOLDE test**	TRIUMF tests

Sigradur hot cavity - status

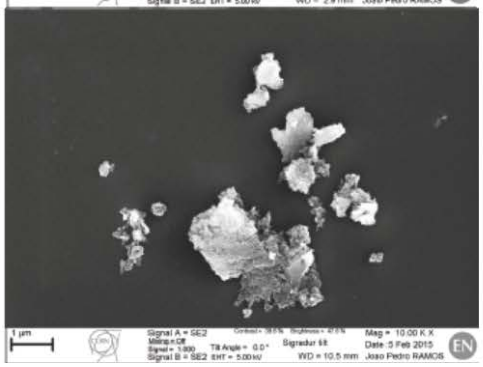


SEM surface analysis

graphite



Sigradur G



Li

Surface ionisation efficiency

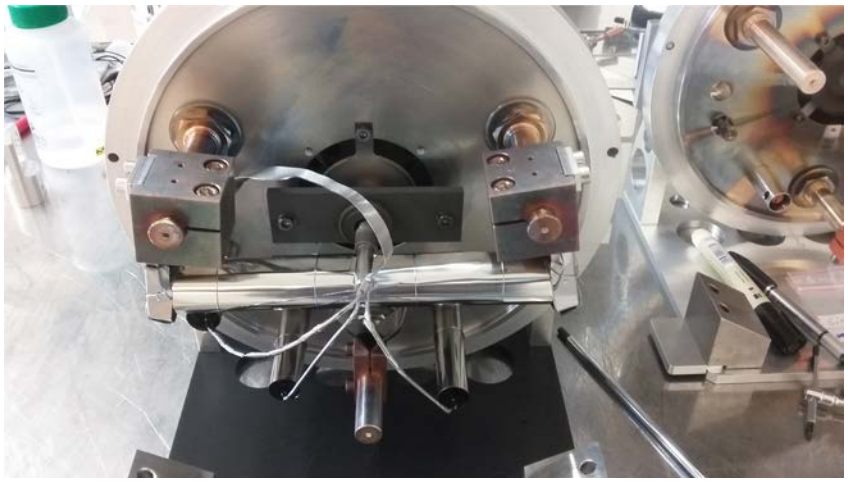
11 %

18 %

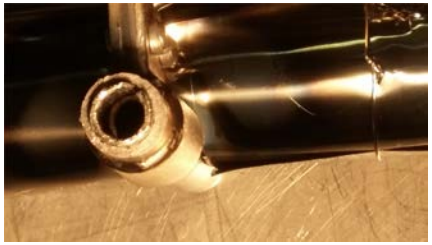
- Good efficiency for Li
- High work function comparable to Re
- Potential hot cavity for ToF-LIS project
- Potential material Ni beams

Sigradur hot cavity – Target Coupling

Coupling test 1 - FAILED



Coupling test 2 - FAILED



- Cause: Incompatibility of C to Mo
- Next: Re foil insert
- Requires Pumpstand 1 (heating cycles)

Infrastructure upgrades

Target production / dev. strongly depending on good working infra structure

- OFFLINE 1 – Quality control, Ion source dev. (+limited RILIS)
- Pump stand 1 – calibration, outgassing, development
- Pump stand 2 – Development (pending)
- OFFLINE 2 – Development (+extended RILIS, ISCOOL) (pending)
- Carburization Pumpstand (UCx production)
- Calibration Pumpstand

Bat. 3 "offline"

Bat. 179 "Class A lab"

Planned/Proposed upgrades:

- New, reliable control software for OFF1, and all pumpstands (ongoing, STI-ECE)
- Advance Pumpstand 2 operation
- Recording of pressure & logging to database (Timber) (STI-ECE)

  -> prerequisite for reliable/automatic UCx production
- Adding RGA to pump stands (monitor outgassing, UCx production)

Budget under evaluation

Expected TISD @ ISOLDE

- Sc: Ti foils (CF4, RILIS)
- Te: yields with RILIS
- M(CO)x formation @ MEDICIS irradiation point
- ThO felt + Negative ion source
- LIEBE @ GPS-online
- STAGISO beam test
- Si from UCx (pending INTC endorsement)
- TiC-CNT (pending safety clearance)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