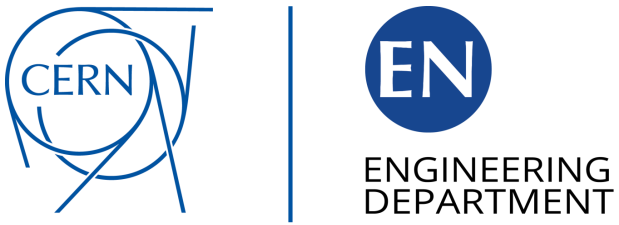
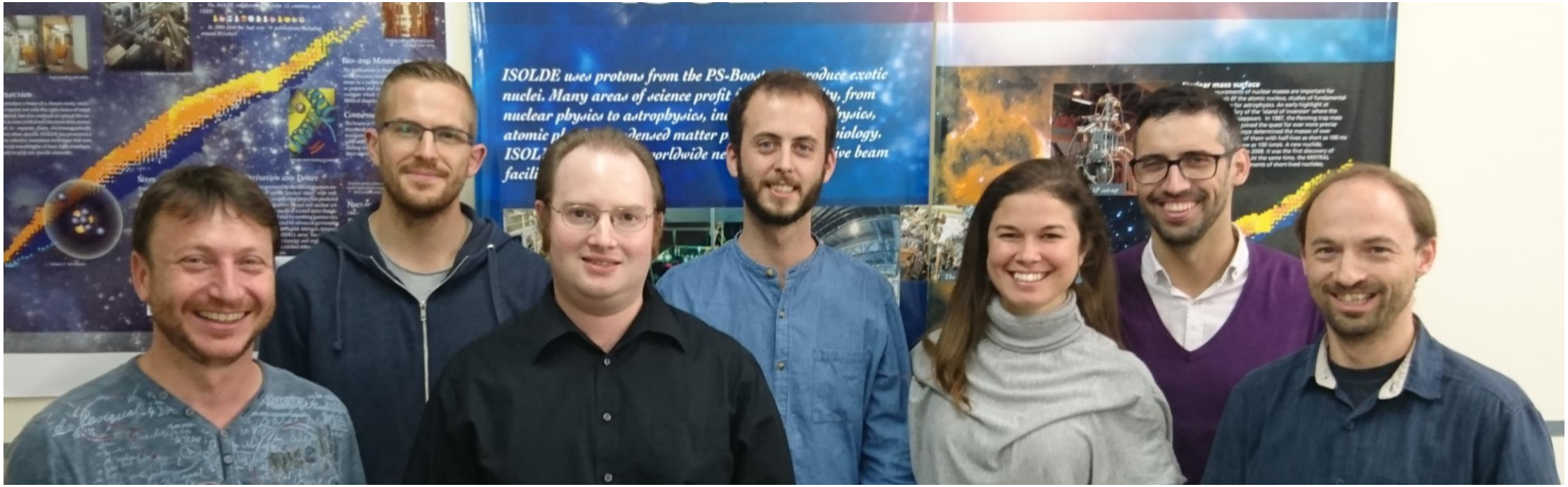
TISD activities in 2018

Sebastian ROTHE
EN-STI-RBS



The Target and ion Source Development (TISD) team



T. Stora D. Leimbach J. Ballof F. Boix Pamies Y.Martinez J.P.Ramos S.Rothe

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

Constant development is required to keep ISOLDE at the forefront of RIB facilities

Overview 2018

GPS

	April				May				June					July					August		
WK	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34
MO	2	9	16	#534/567 Sn VDS 23	30	7	MD: FTS 14	21	28	4	11	18	25	2	9	16	23	30	6	13	20
TU			TISD		May-01		MD:FTS			IS610		Tech Stop	Medical isotopes								
WE			TISD		#599 Ti foils	IS634					ISBM	#655 Ta - W		UC CP			ThC VD7				
TH		#513/ #650		IS611 IS640 IS647 IS652 IS653		Ascension					^{22}Mg to LA1		IS528 IS638	#659			#632		#650 M WCNT		(tbc)
FR							#663 UC - Ta n			#634 LIST										XT03	UC q n
SA										#660						IS644 + IS506					
SU			IS633					IS622			IS614	IS528			IS644			IS552		IS616	
			8B: IDS	111Cd		RILIS: Mg		RILIS: Cu		RILIS: In	RILIS: Mg	RILIS: Dy (night-time)	RILIS: Dy		96Kr / 212Rn			22x Rn		8B	

HRS

	April				May				June					#658 July					August		
WK	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34
MO	2	9	16	23	#651 ZrO HP 30	#652 ZrO HP 7	#618 UC - Ta/W 14	21	28	4	11	18	25	#652 UC Ta (+CF4) 2	9	16	23	30	6	13	20
TU					May-01					#626 Ta - W	#661 VD5	Tech Stop									
WE	#640 LaC - n				TISD								Machine development			UC W (+CF4)				#639		
TH						Ascension										#637		#631		LaC	
FR			#627 Ta - W					#654 UC - W				Machine development		IS650				LaC			
SA														IS637			IS552				
SU		IS639		IS532	IS623	IS642	IS645		IS620	IS649				IS608			IS553		IS562		IS613	
	HT tests	In RILIS		Sc RILIS	RILIS test	70Br	26Na		K beams	Sc RILIS				RILIS: Bi			22xRa/142Ba		Sn RILIS		Sn RILIS
				In RILIS	Ge 34S																

Overview APR-JUN 2018

12 targets retrieved from ISR

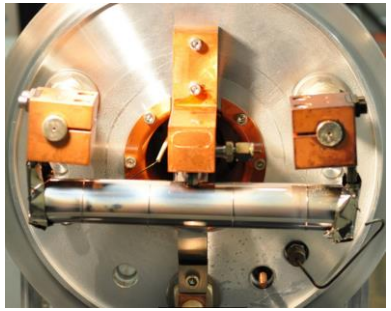
Cibles	Matériau	Operation 2018
#513	MWCNT-VD5	Tested in April
#534	Sn	used in April
#619	Pb-VD5	#577 backup
#620	LaC-Ta	#640 backup
#629M		Used at MEDICIS
#621M		Used at MEDICIS
#541	UC-VD7	#659 backup
#565	Ta-W	#655 backup
#577	Pb-VD5	#619 backup
#599	Ti-Foils	used in May
#618	Uc-n	used in May
#596	CaO-VD	Not scheduled

21 targets used / tested at offline
6 Units for development
11 Units irradiated at ISOLDE

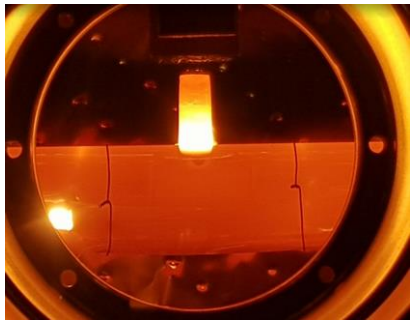
	#614	empty	VD5	Mn tests PSI , Se tests ILL
	#633	Nb foil	MK4 negative LaB6	Development, GANDALPH
	#640	LaC	RILIS	In -> CRIS
✸	#650	MWCNT	VD7	8B -> IDS
	#627	Ta	RILIS	Sc
	#567	Sn molten	VD7	backup for #534
	#657	No target	VD7	LIEBE test
	#651	ZrO	VD5	GeS /Ge -> COLLAPS
	#652	ZrO	VD5	70Br
	#653	UC (UC-2018-01)	MK1-Ta	Cu
	#654	UC (UC-2018-02)	MK1-W	K
	#626	Ta	RILIS	Sc
✸	#660	SiC	LIST - 90mm	22Mg
	#661	Empty	VD5	MD ISCOOL
	#655	Ta	RILIS	Tb /Dy
✸	#570	n.a.	GANDIS	Gandalph offline source
	#656	empty	VD5	Mn tests PSI
	#658	UC (UC-2018-04)	RILIS	Bi
	#502	empty	n.a.	n-Converter dev
	#628	empty	n.a.	nConverter / MEDICIS dev
✸	#634	empty	LIST - 34 mm	LIST development

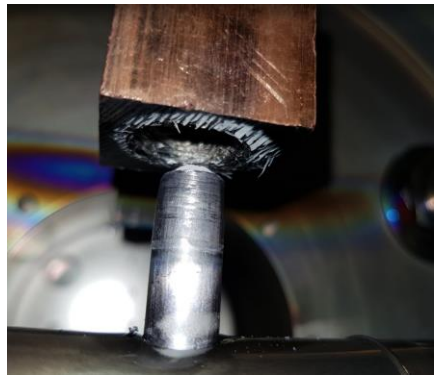
Target #606 -> #650

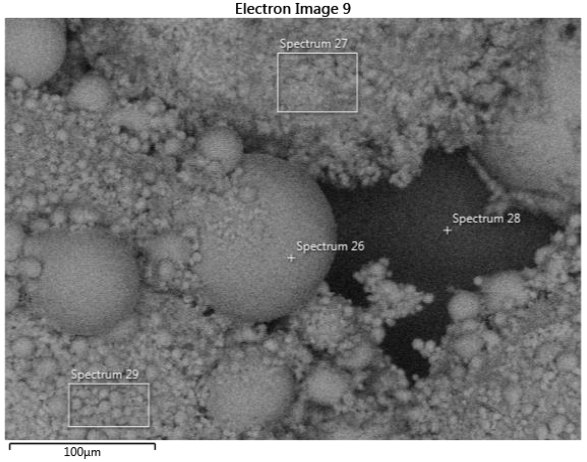
MWCNT for 8BF2 beams at IDS

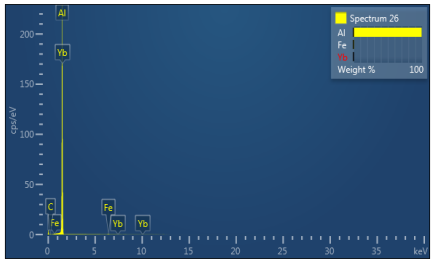


- 2017: #606 Target could not be delivered, #513 was used
- No infrastructure available to handle C nano tubes
- Decided to recuperate charge from #606 for #650
- Disassembly: transferline found clogged with AlF
- Target outgassed to remove contaminants
- Found macroscopic amount of Aluminum in transfer line







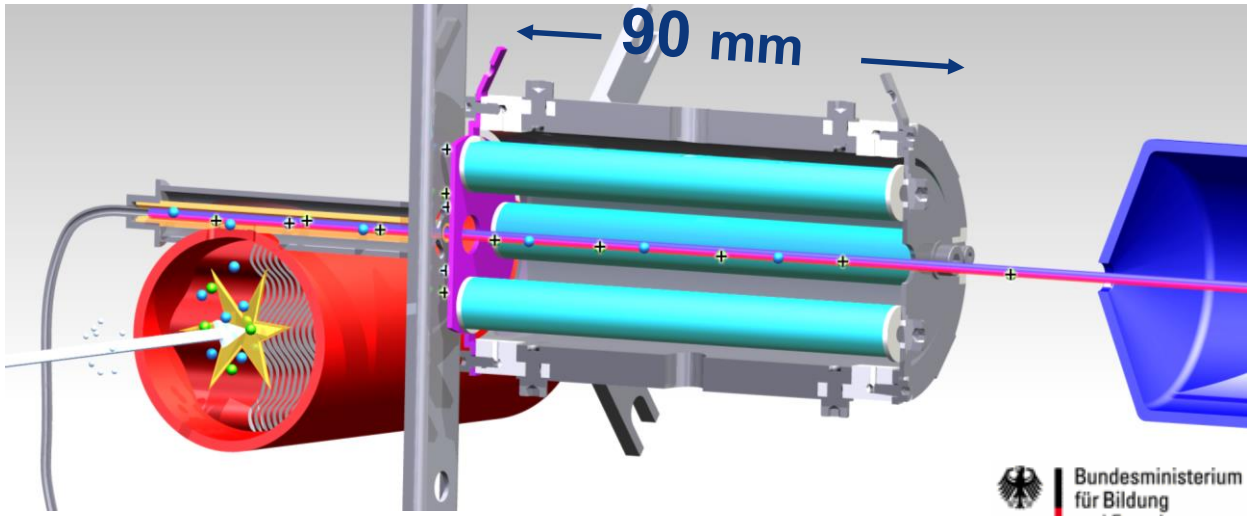


- Successfully used #650 for IDS run
- Factor 10 yield increase compared to #513

- > #650 rescheduled for HIE ISOLDE

LIST v 1.0

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)

In-Source Laser Spectroscopy with the Laser Ion Source and Trap: First Direct Study of the Ground-State Properties ^{217,219}*Po*, D. Fink et al., **PRX 5**, 011018 (2015)

LIST v 2.0

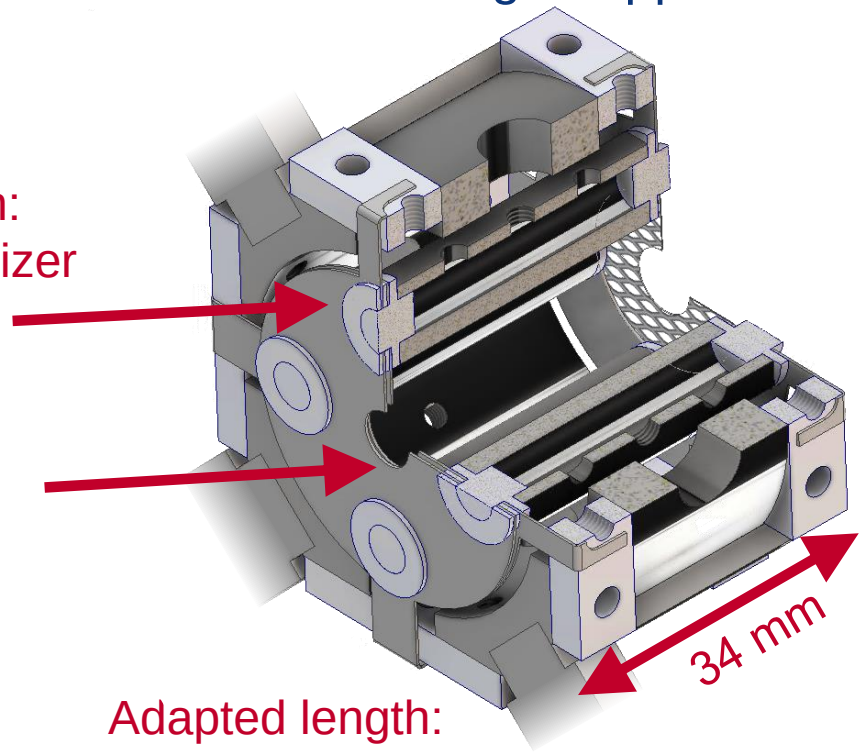
Upgraded 2018 **LIST** laser ion source for

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

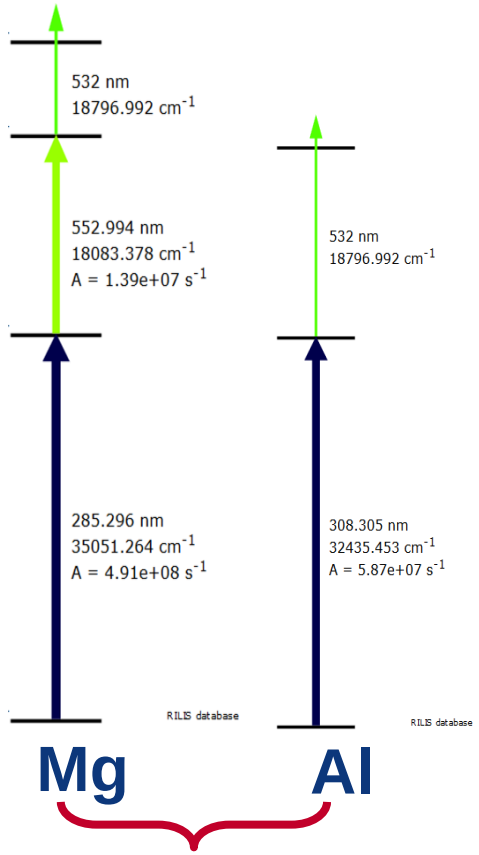
- Laser ionization of Mg - suppression of surface ionized Na contamination

Compact isolator design:
Narrow spacing to atomizer

Dual repeller:
Ion and electron suppression



Adapted length:
Reduced deposition and compatibility to additional purification techniques

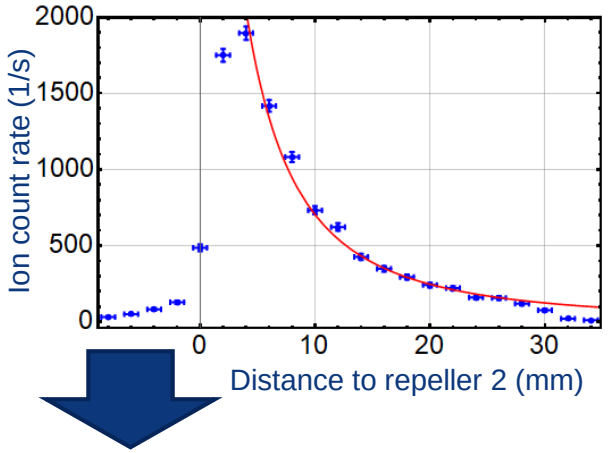


- Operation analog to 2012
- 1 unit available, 2 more machined at JGU workshop right now
- Robot handling tests with mock up unit in shutdown

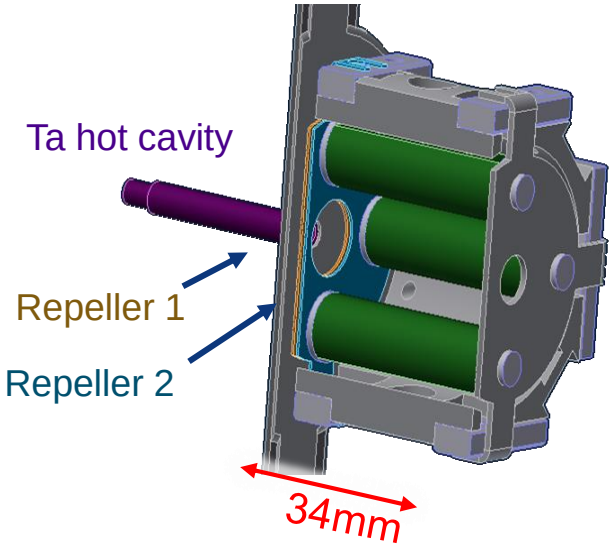
Ideal opportunity for Al yield checks

RESULTS 34mm „short“ LIST (LIST 2.0) – Off-line tests

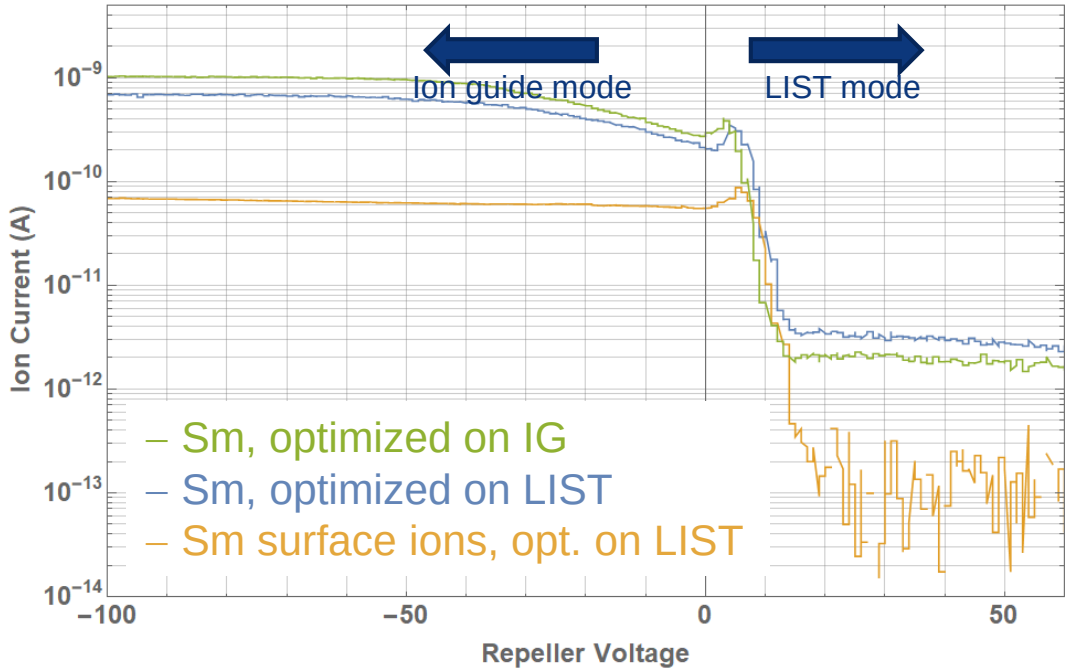
Measured *neutral particle density* on central axis in LIST volume:



Derived design (compatible to ToF-LIS)



Characterization at ISOLDE off-line separator on ^{152}Sm
With *1 laser 2 step resonant ionization scheme:*



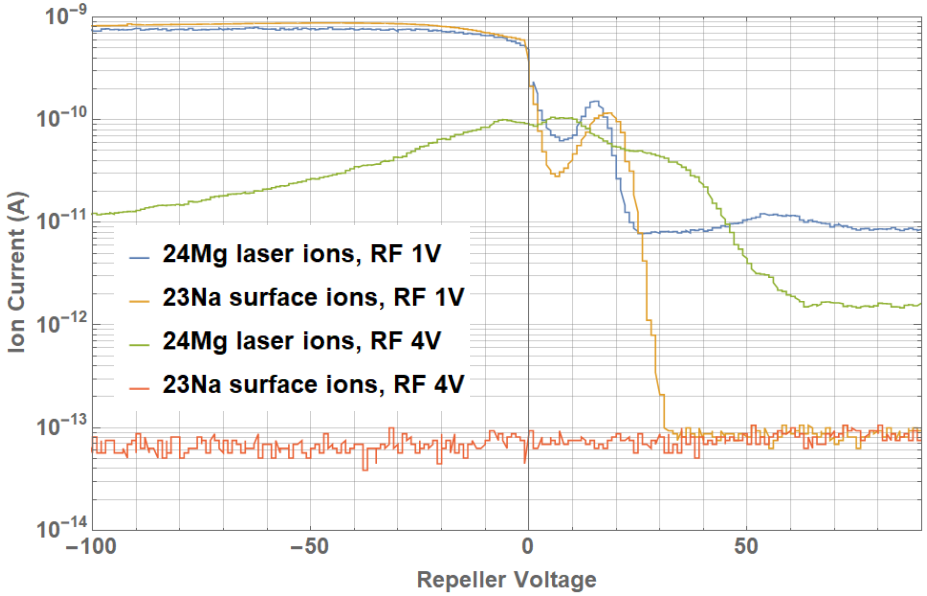
✓ Contaminant Suppression Factor > 1000

X Laser Ion Loss Factor 200 – 300

Reduced efficiency in LIST mode **or** enhanced transmission in ion guide mode? ➔ To be evaluated via absolute efficiency measurements

For IS614: Stay safe with “standard” 90mm LIST -> #660

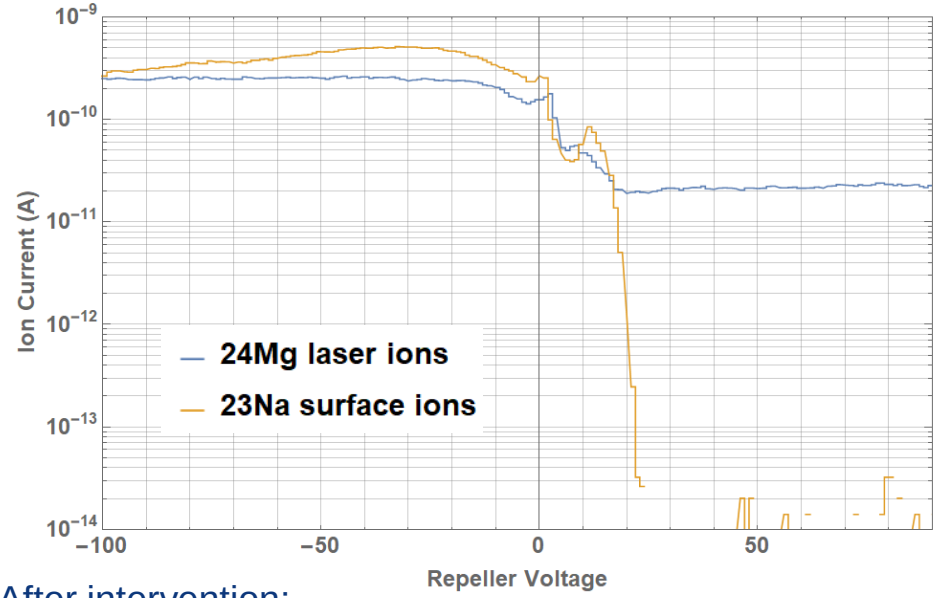
Results: 90mm „standard“ LIST /w 2 repeller electrodes @ ISOLDE



Initially enigmatic behavior @ ISOLDE:

- Complete suppression of all ^{23}Na ions at certain RF amplitude, while ^{24}Mg transmitted in both modes
- ^{24}Mg laser ion loss factor ~ 80
- Contaminant suppression requires unusually high repeller voltage
- *None of these features seen in off-line tests before*

Intervention:
decoupling target and retuning RF circuit box



After intervention:

- ^{24}Mg laser ion loss factor ~ 20-30 (as seen off-line)
- Required repeller voltage slighlty reduced
  Suppression factor > 50.000

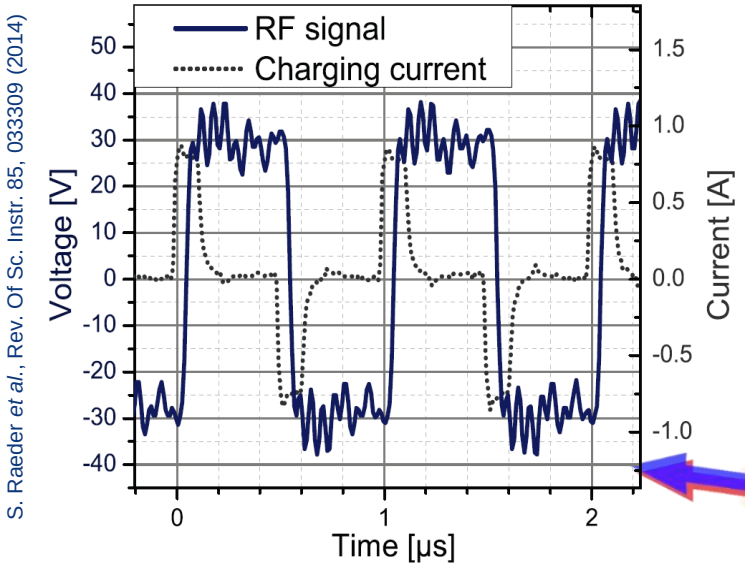
Final on-line characteristics with SiC target:

- Suppression factor 1E6 measured for ^{21}Na
- Laser ion loss factor of 27 on ^{22}Mg
- No ^{22}Na seen in IS614 detectors
- Factor ~20 less yield on ^{22}Mg compared to database

Ongoing developments

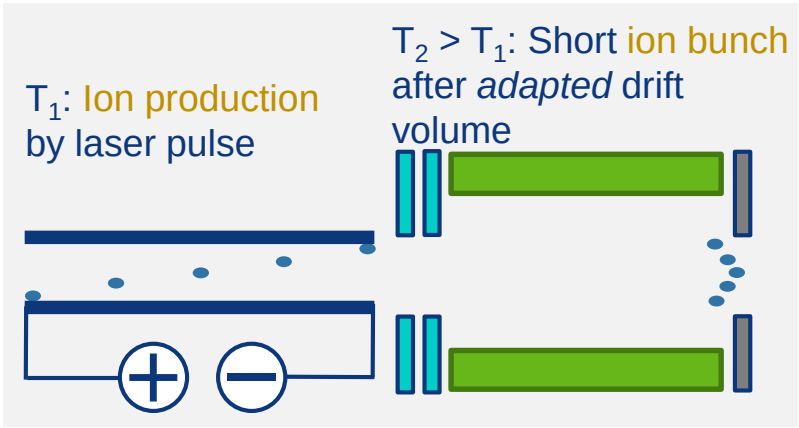
Square wave RF confinement by MHz switching:

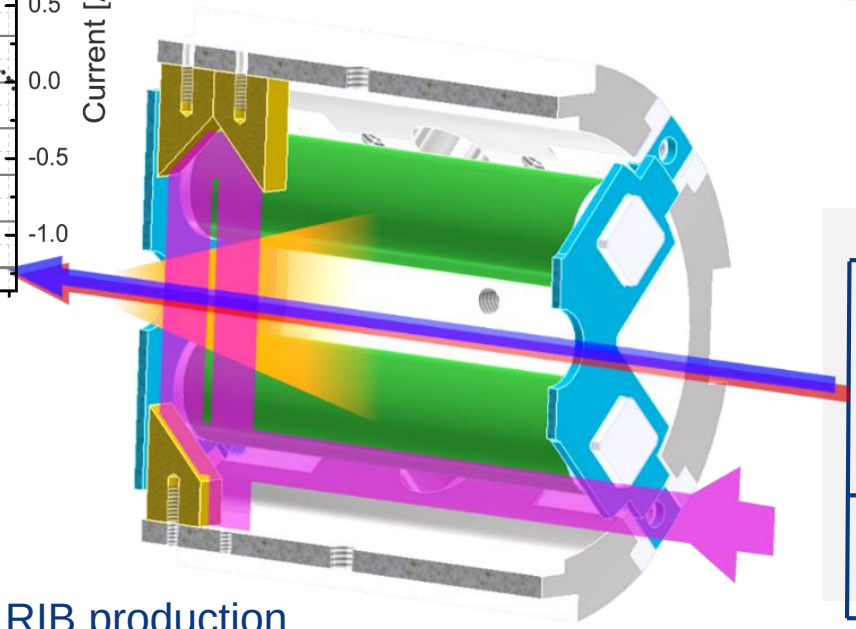
- Abolition of RF box attached to target unit
- Easy control of symmetricity, amplitude, offset
- Supply to source via multipin?



S. Raeder *et al.*, Rev. Of Sc. Instr. 85, 033309 (2014)

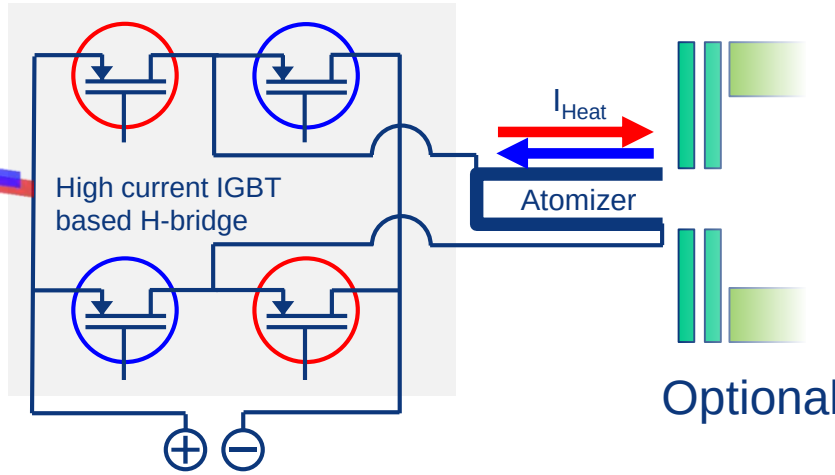
ToF-LIS: Field-free drift volume (= LIST)





Perpendicular laser irradiation:
Doppler-free spectroscopy and RIB production

In-situ heating current switching:
Fast polarity swapping and pulsing

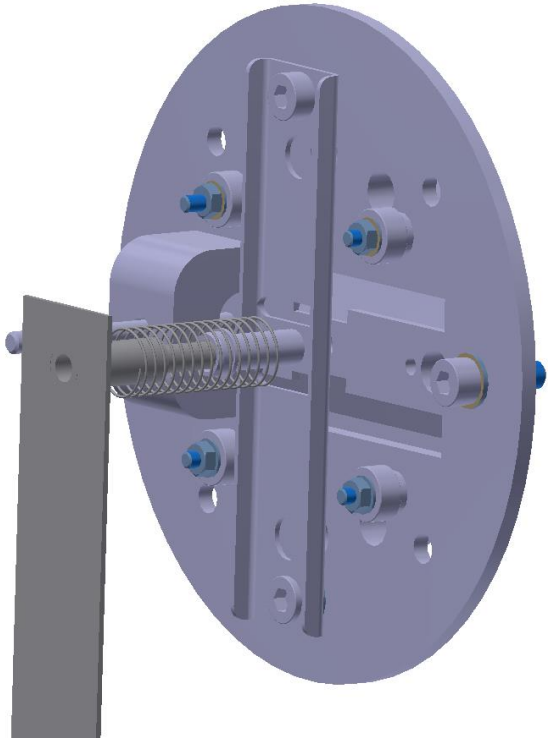


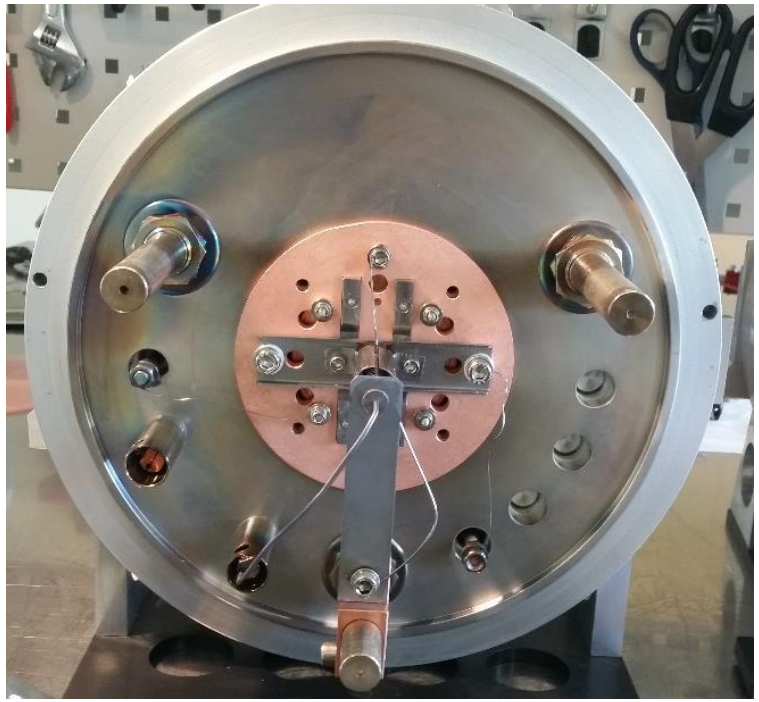
Optional LIST

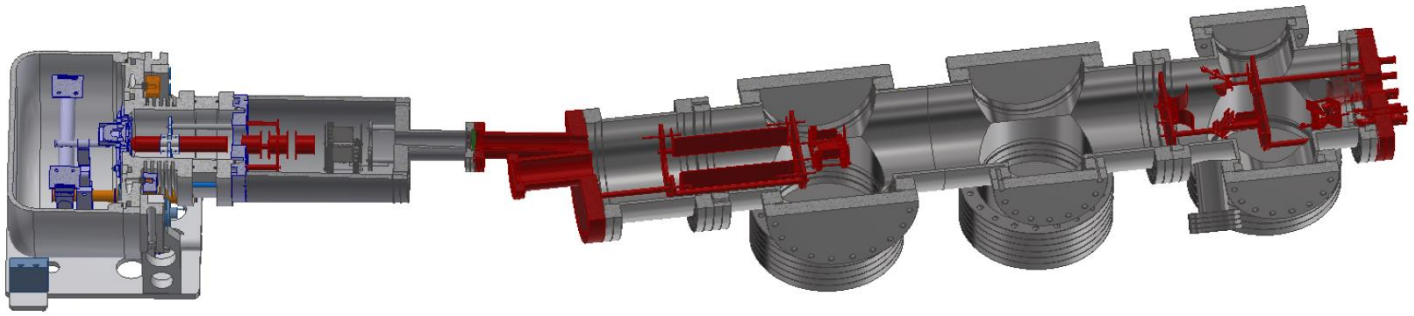
#570 GANDALPH negative Ion source (GANDIS)

- Goal: off-line testing of photodetachment setup

- Ion extraction via negative source potential
  - Electrical Isolation of the source from the base avoids faraday cage
  - external heating required





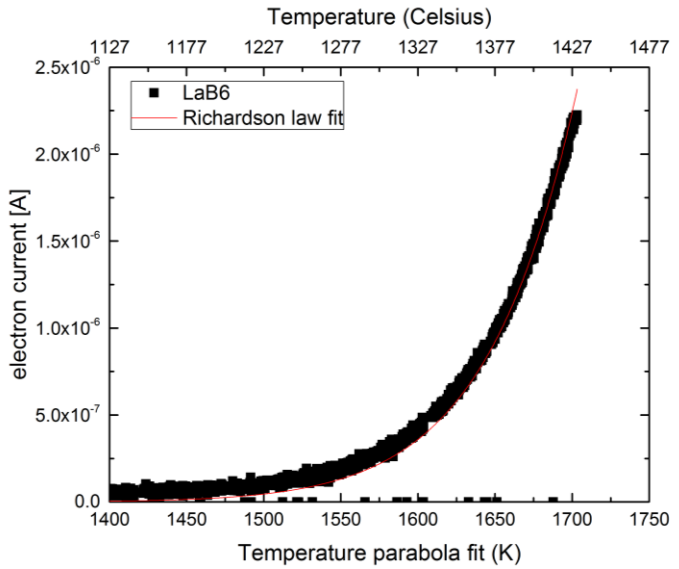


Ion source simulations:VSim software

- Simulation of kinetics and electromagnetic interaction of particles via PIC code

- Dedicated workstation and VSIM license has been purchased
  - 6 core @ 3.6GHz
  - 64GB RAM
  - NVIDIA Quadro K2200
  - 256GB SSD+ 3TB SATA

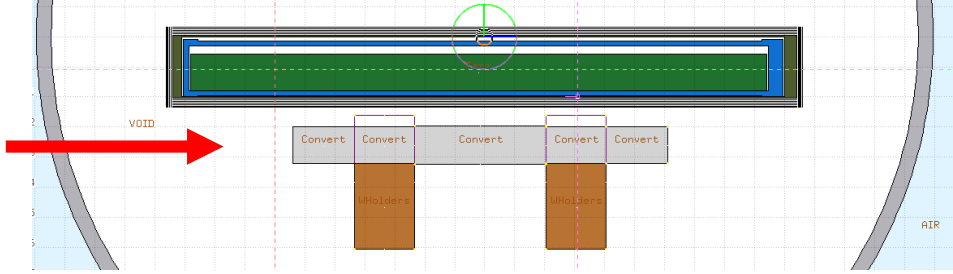
- 1st step: Validation of hot cavity ion source model
  - collaboration with SCK CEN
  - electron emission measurements performed at CERN-ISOLDE (ongoing)



Vsim workshop @ EMIS2018

P2n Converter

Converter very close to uranium carbide – high neutron flux!



W converter

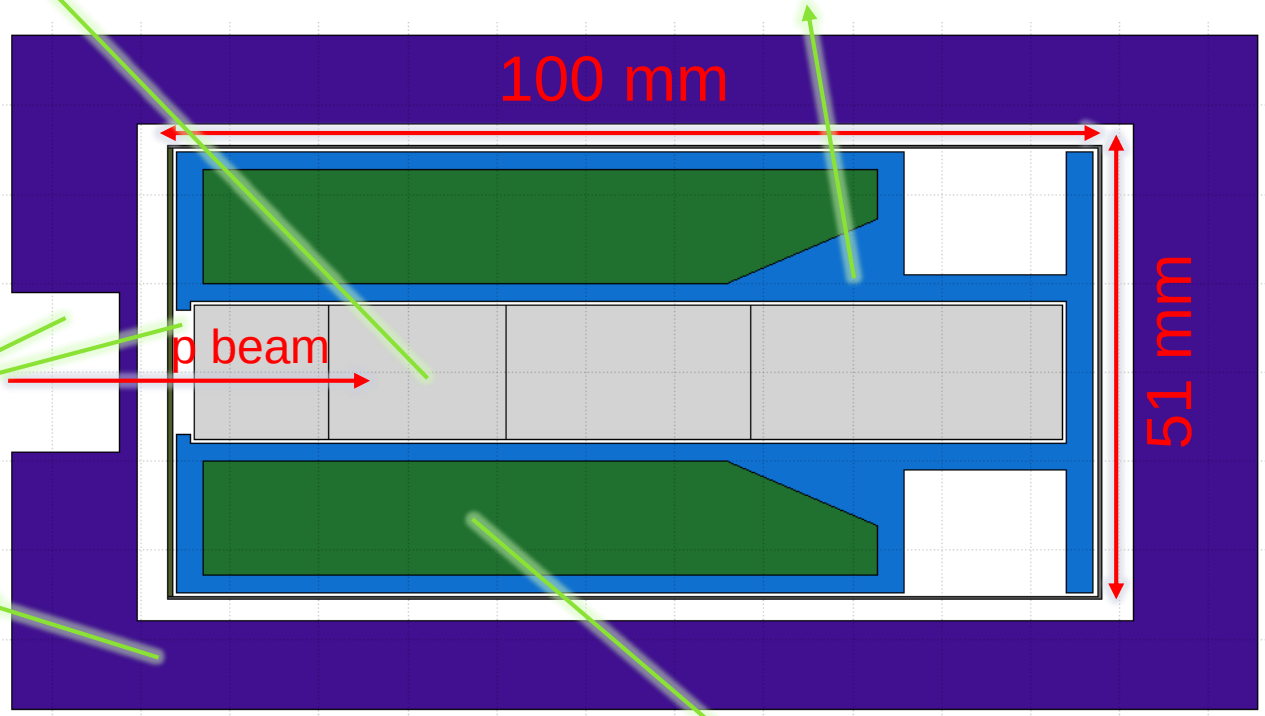
- Ø15 mm (12 mm - standard)
- Sliced to mitigate thermal shocks
- Operated at 2000 °C

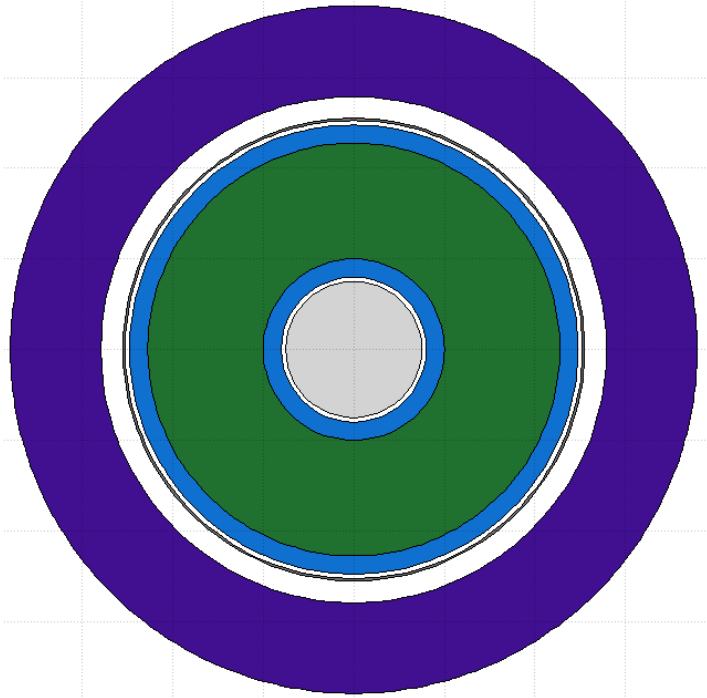
Avoid proton scattering

Thermal Shielding

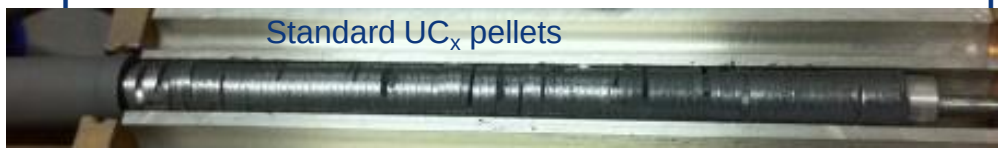
- Sigratherm® - “graphite foam”
- 0.2 g/cm^3
- Low thermal conductivity

Graphite container

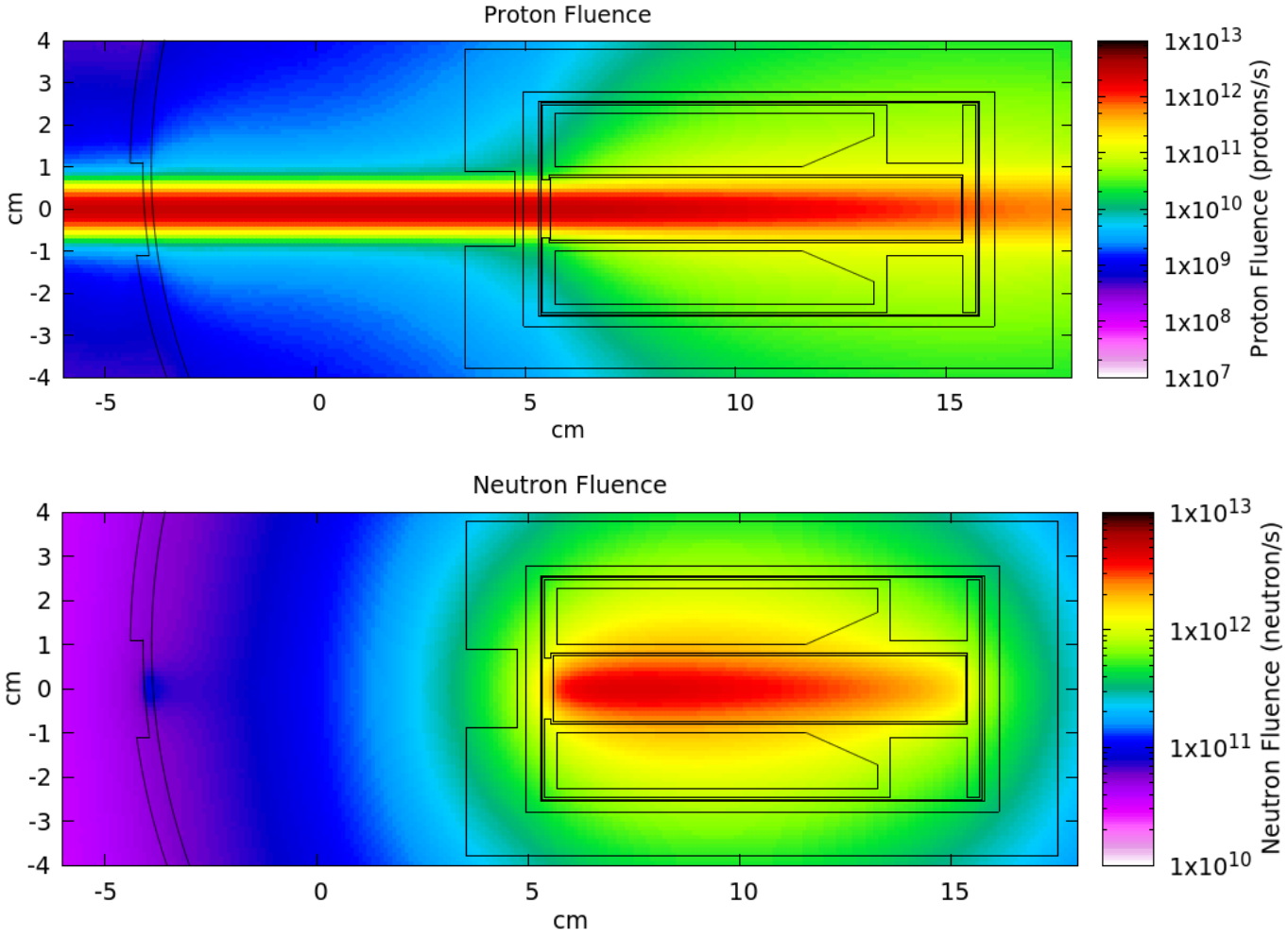




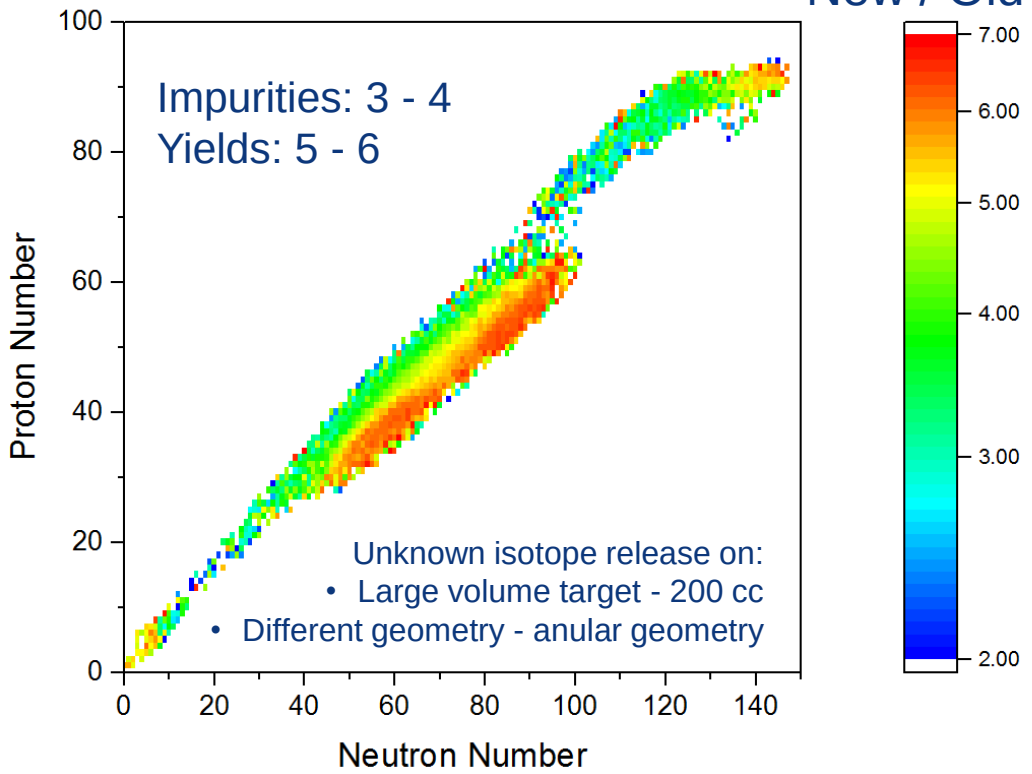
UC$_x$: new procedure has to be made for annular shape

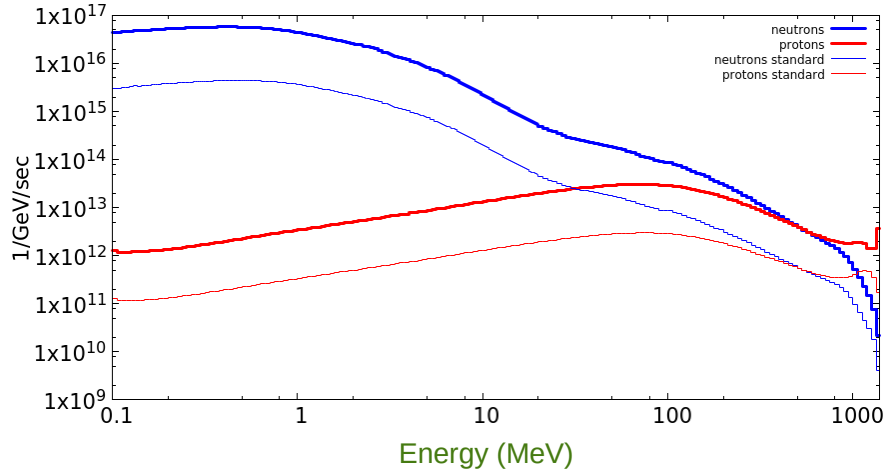


P2n Converter

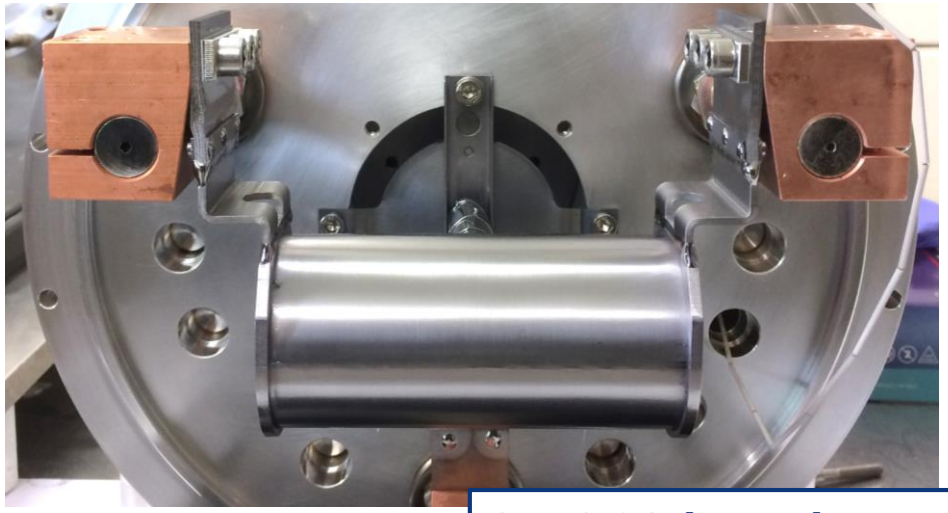


New / Old

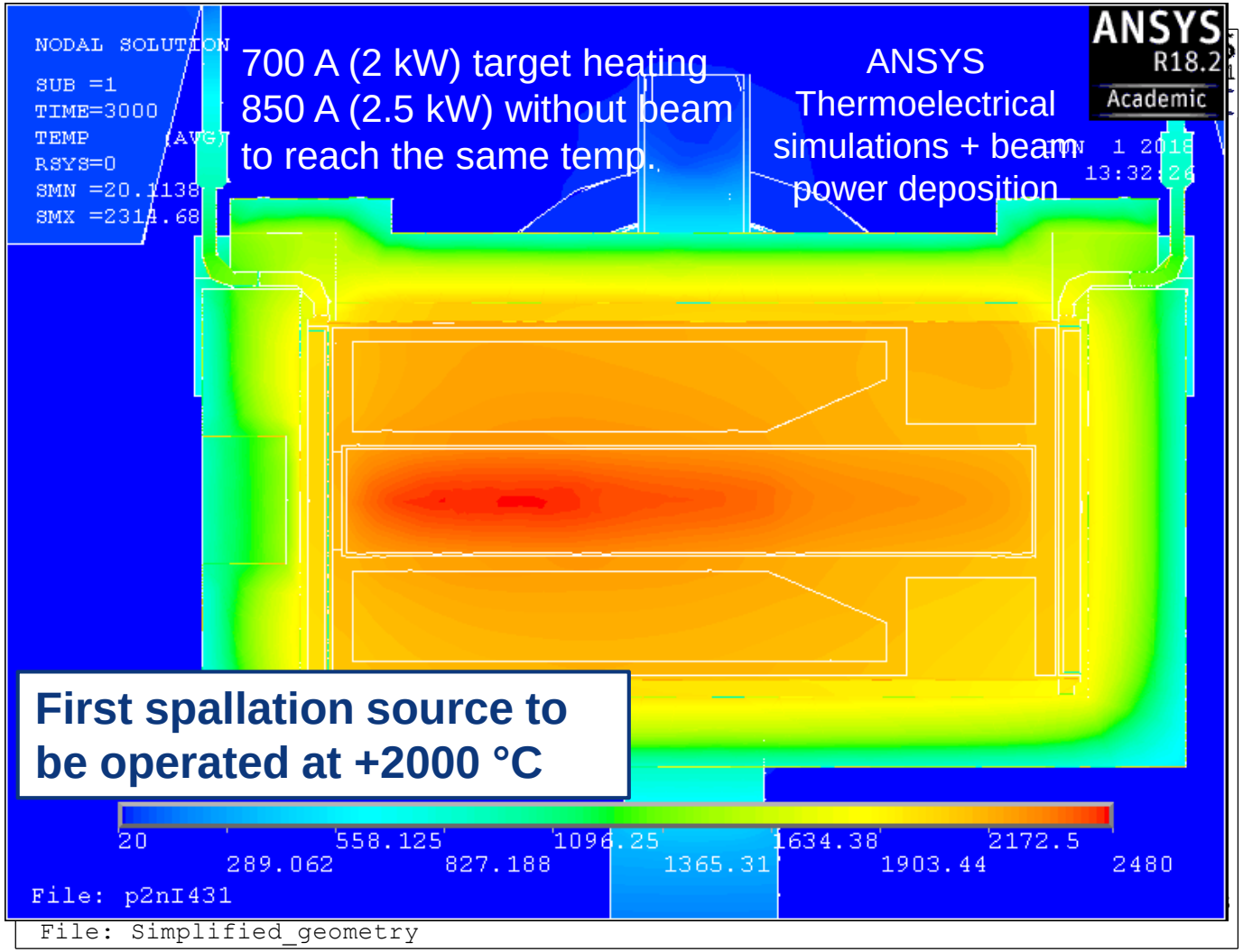




p2n Challenges: beam heating



2150 °C have been reached in the target



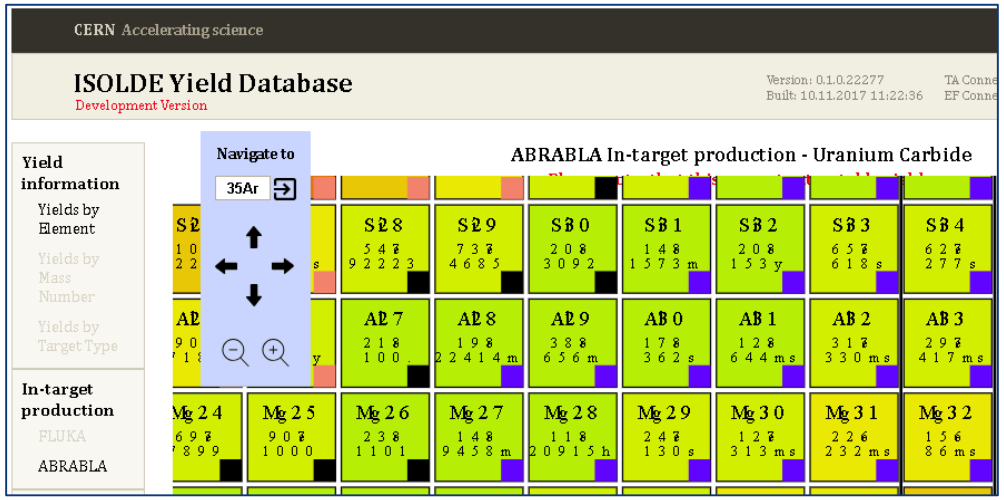
First spallation source to be operated at +2000 °C

Yield Database

Status and new developments

Summer student (Andreas Molander) working on:

- Presentation of in-target yields for all ISOLDE target materials
- Extended search functions in the database
- Yield predictions / extrapolations
- Integration of Infor-Data
- …

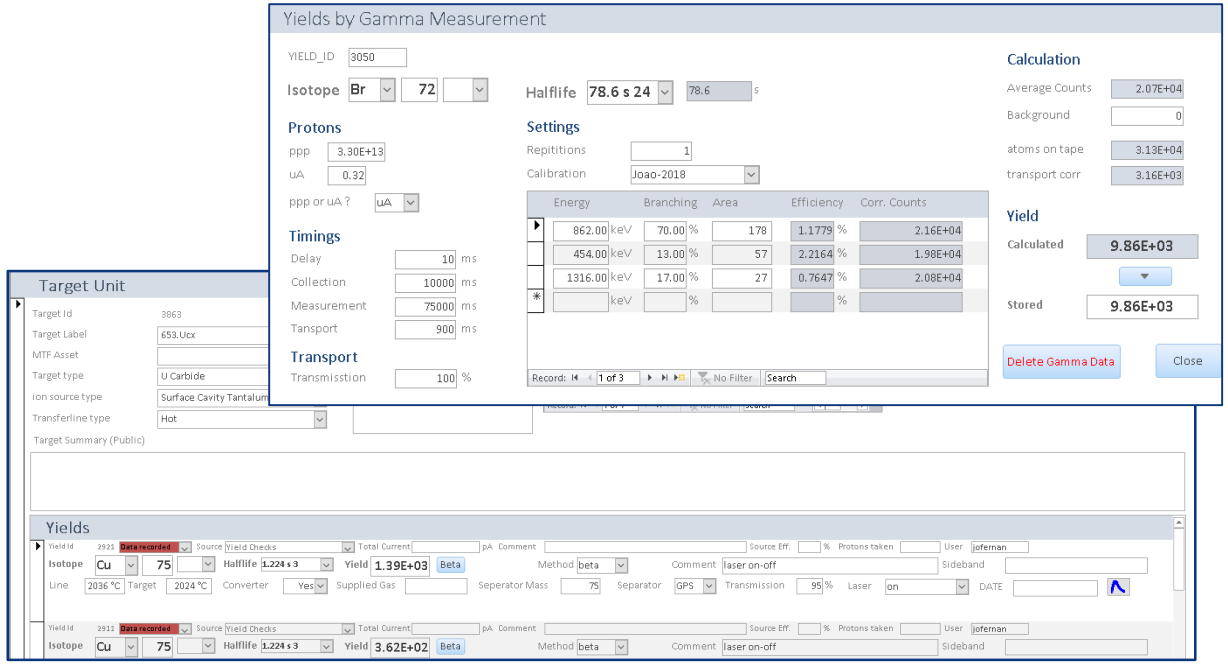


A new application for fast yield insertion

- Yields of this year all entered in database
- Web interface needs minor adjustments to avoid confusion

Issues to tackle

- Reliability of CERN webserver not yet fully satisfactory



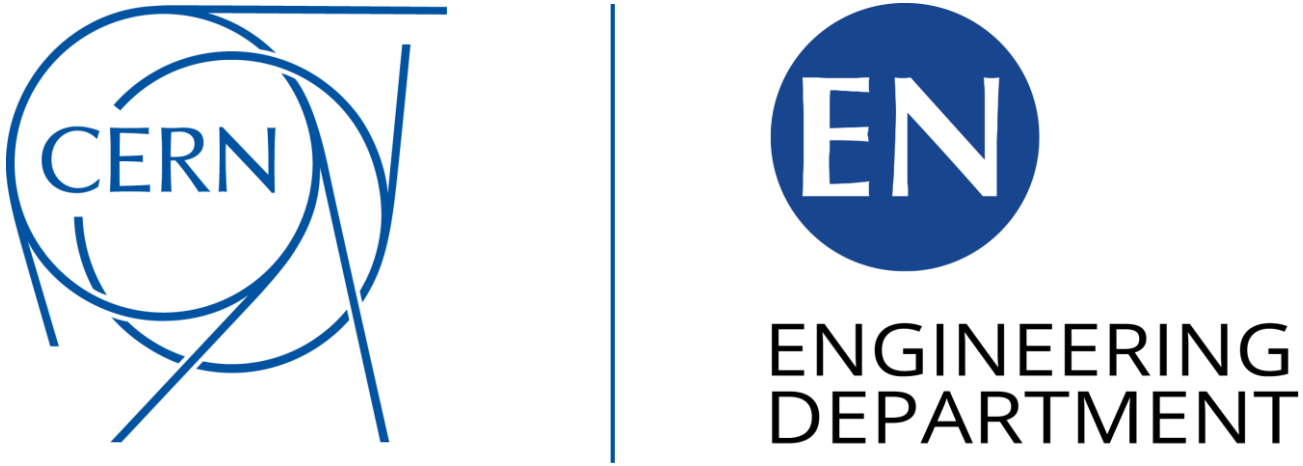
TISD @ ISOLDE, 2018
(in order of appearance)

Dedicated TISD

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

Opportunistic TISD

- Si yields Q2-Q4 — Planned for #658
- RILIS 2photon online Q1-Q4 — Offline tests required, ongoing
- VADLIS 1.5 online use Q2-Q4 — Offline tests required, ongoing



Thanks to the TISD and RILIS teams