

Beam Development at ISOLDE

Towards a neutral barium beam and commissioning of an ion beam extraction system

Project by:

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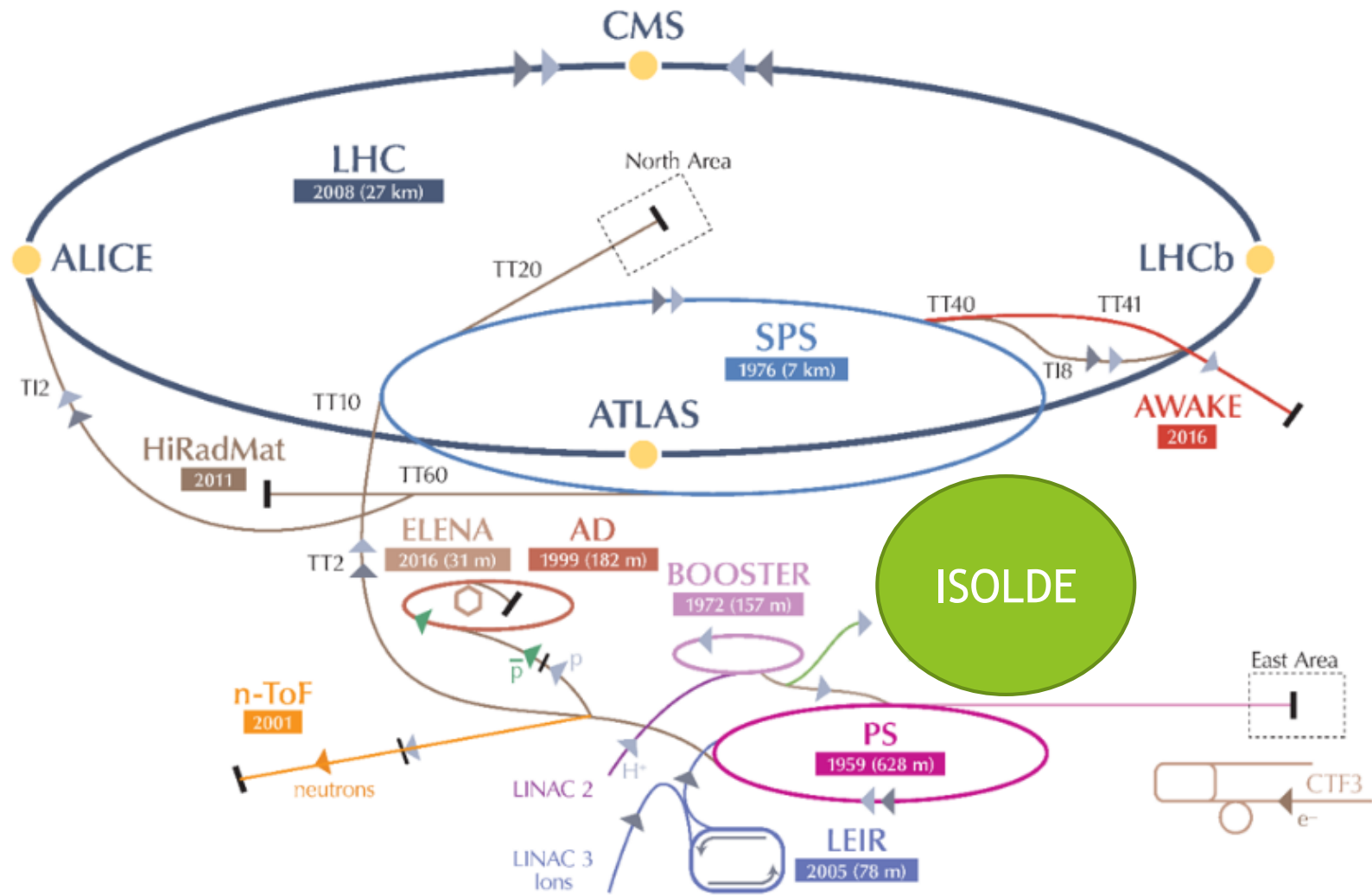
Diyar Hasso

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Supervisor:

David Leimbach





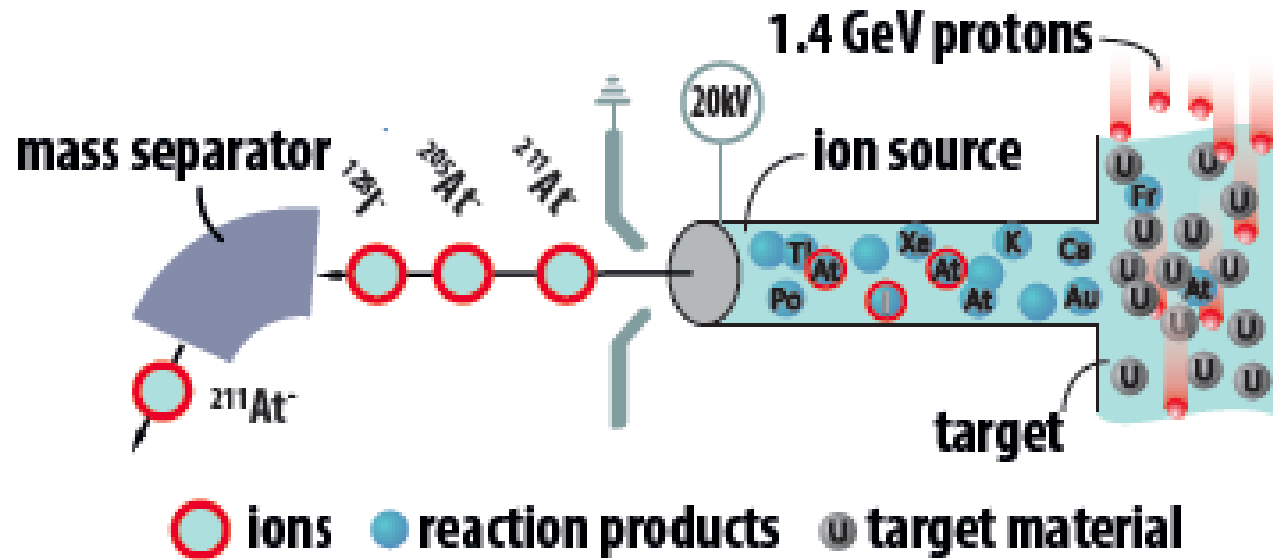
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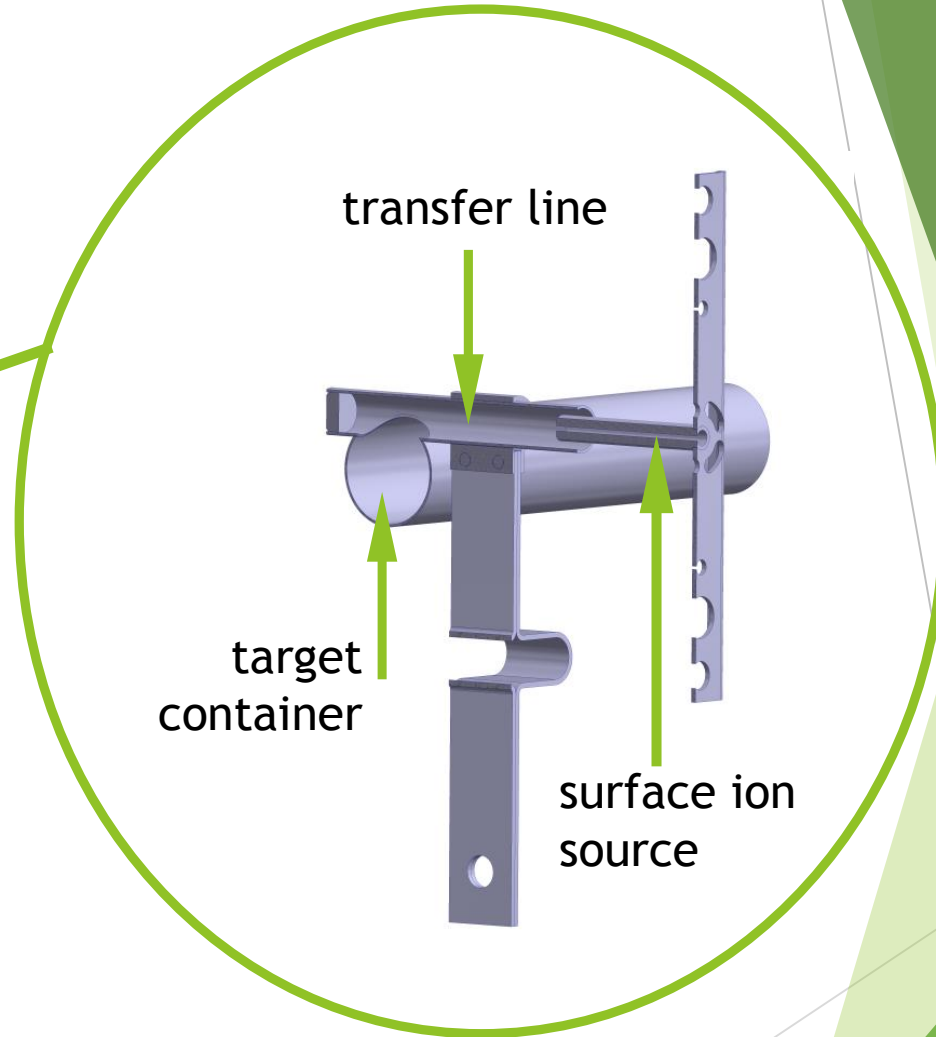
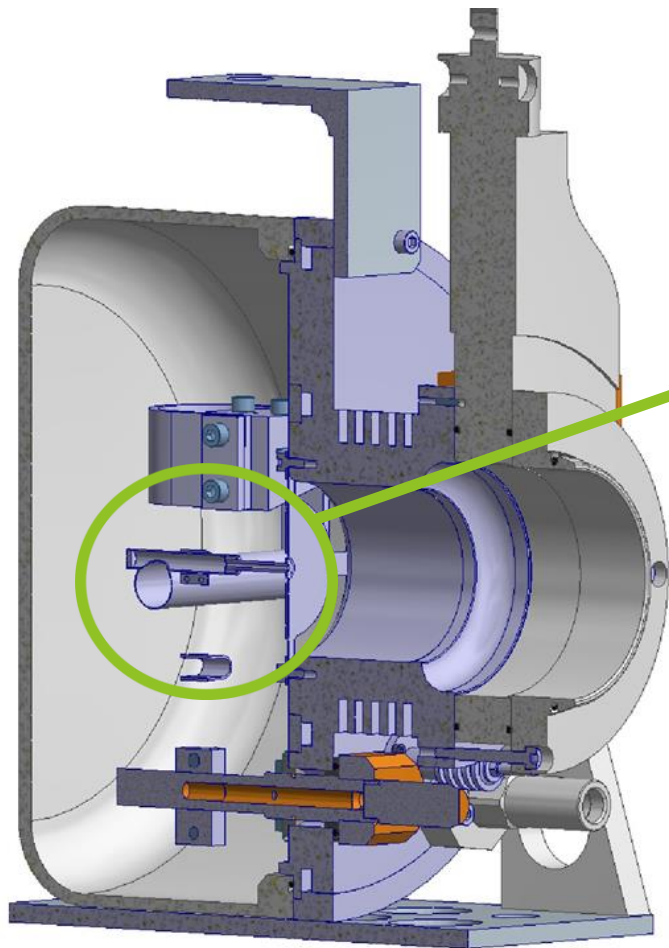
ISOLDE

Isotope Separator OnLine Device

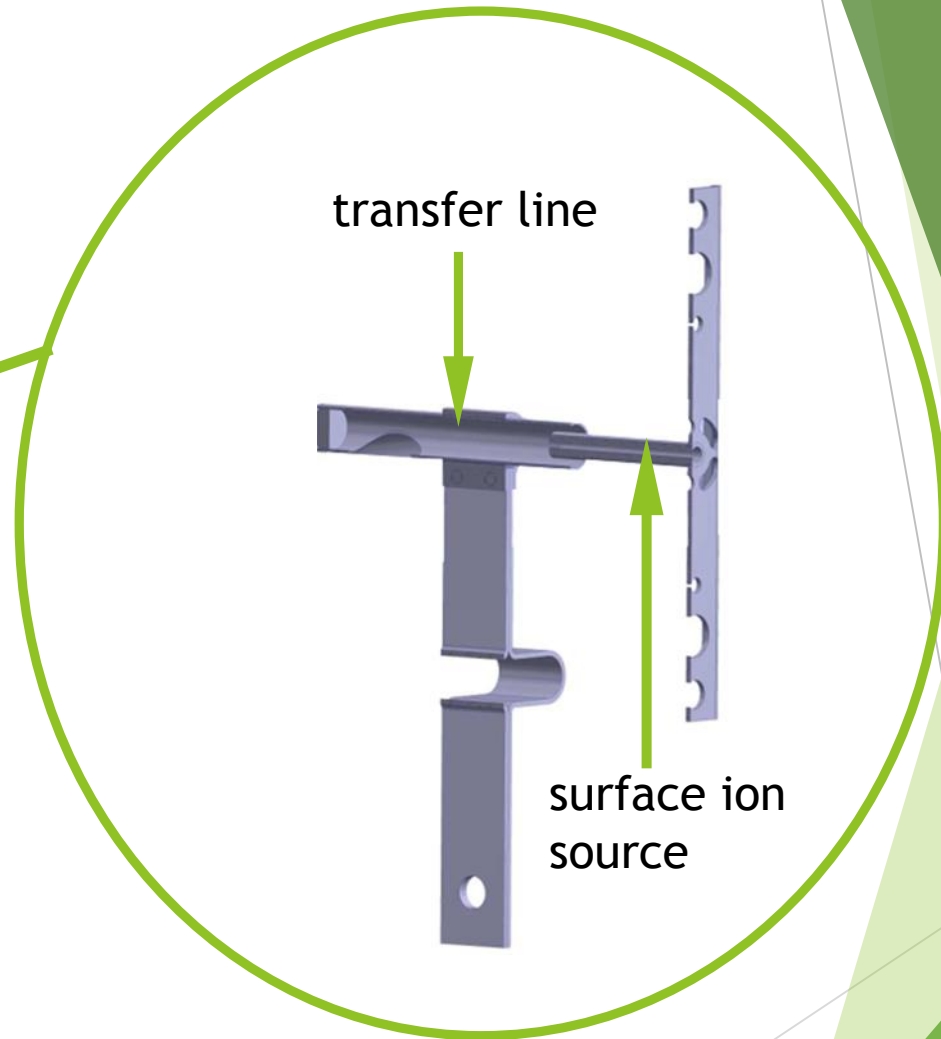
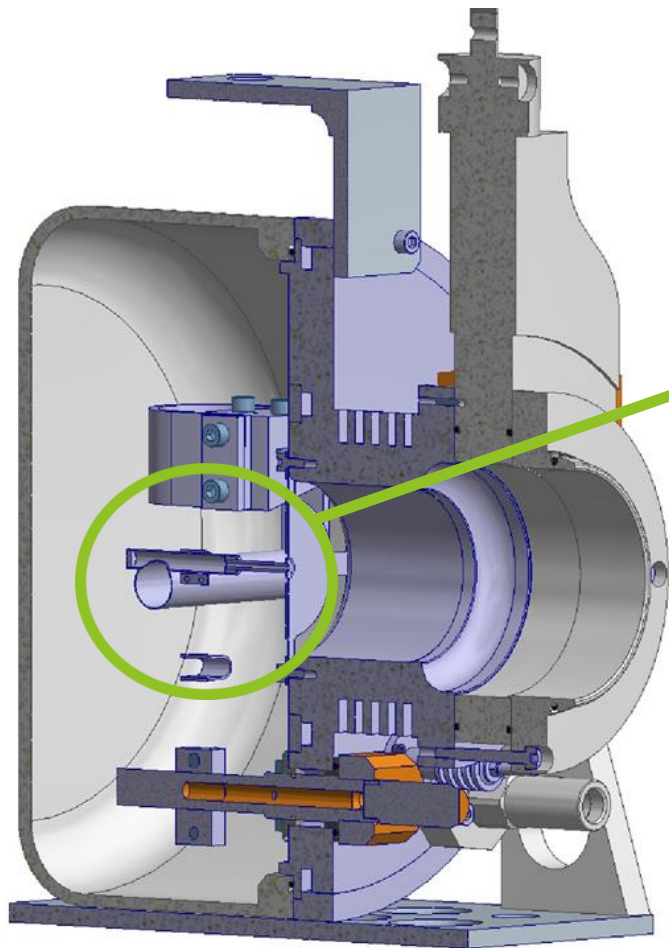
- ▶ produces radioactive ion beams for various experiments
- ▶ funfact: they use 50% of the protons at CERN



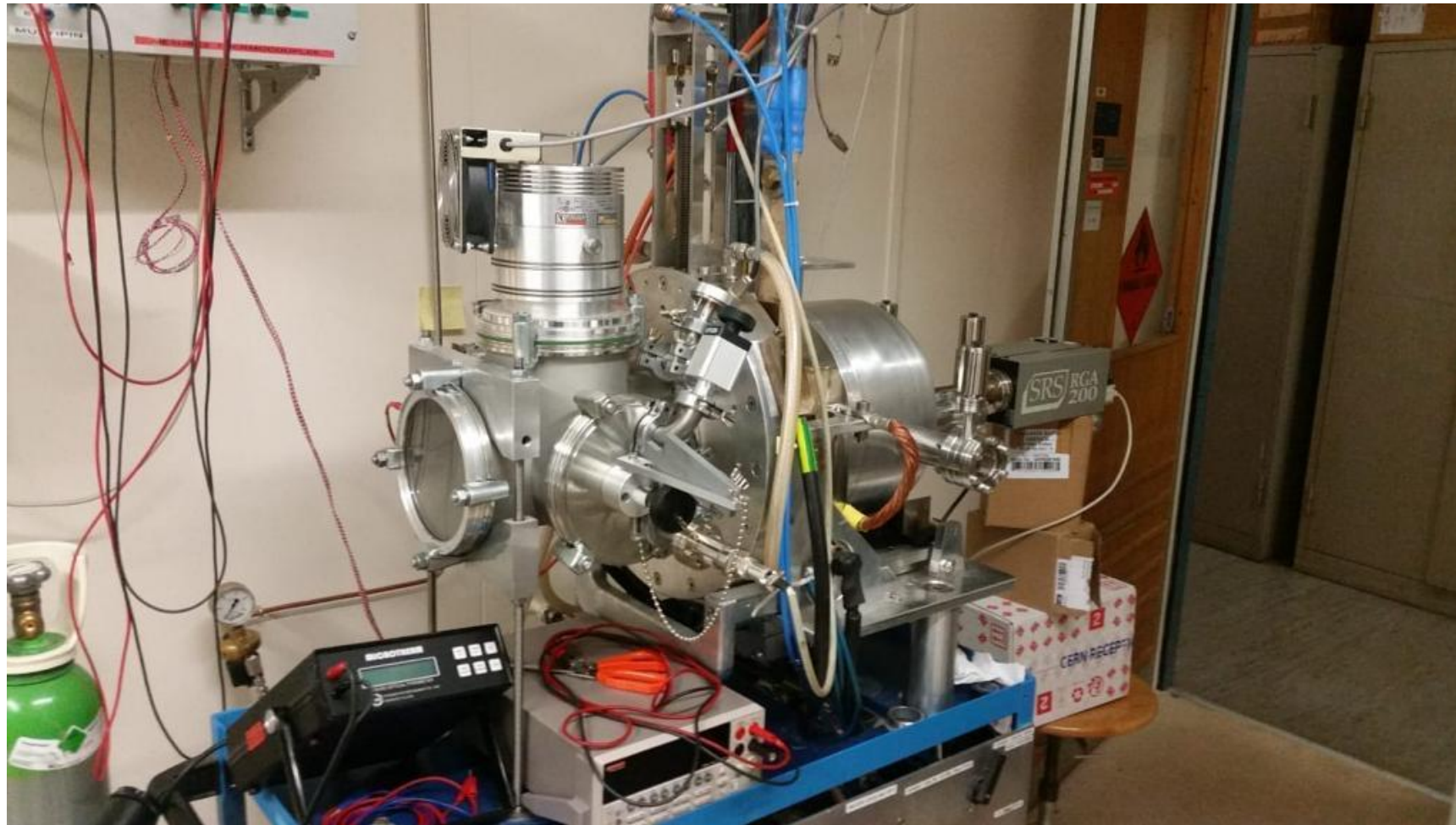
Target Unit



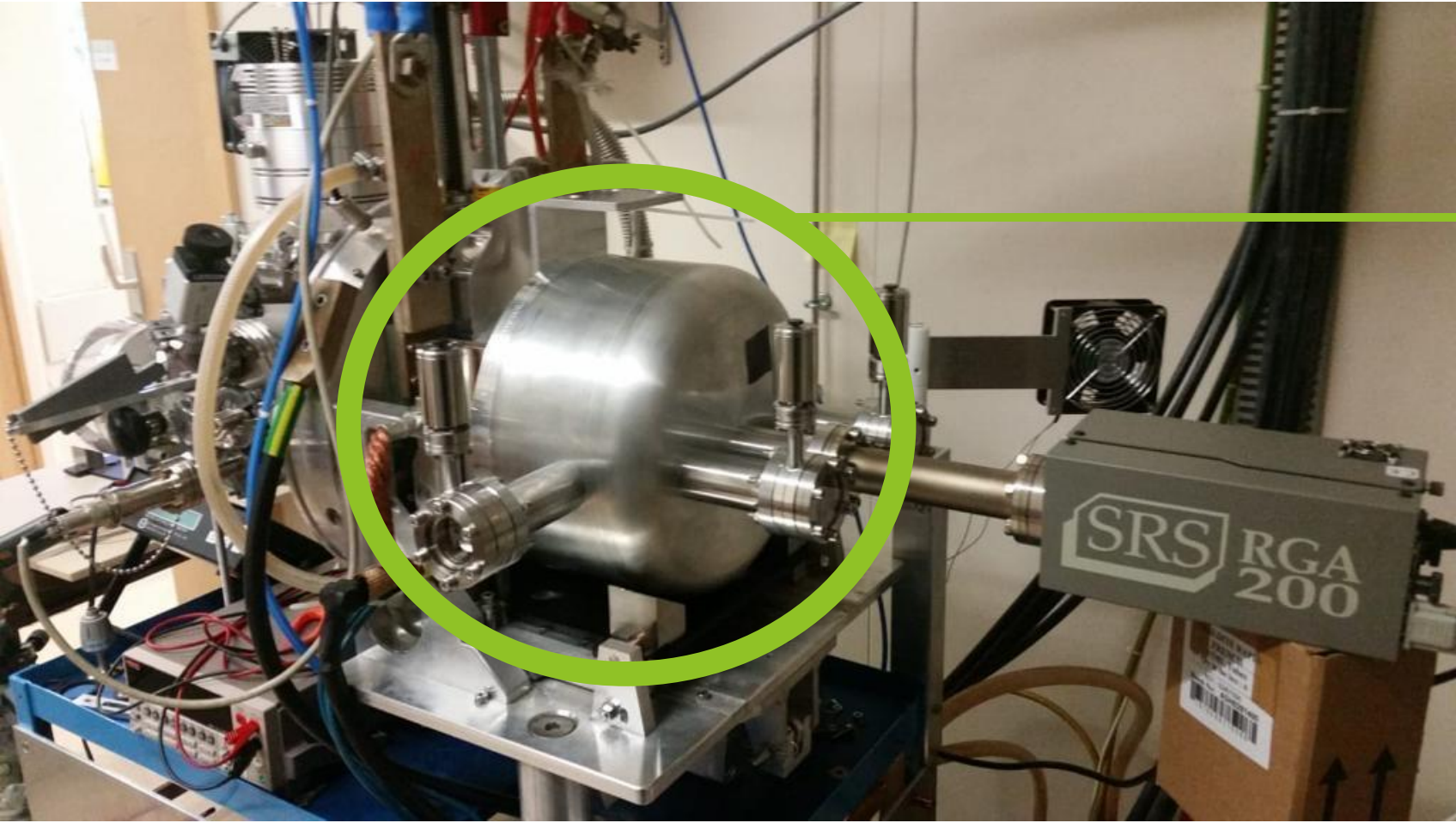
Target Unit



Pump stand - our main working place



Pump stand - our main working place



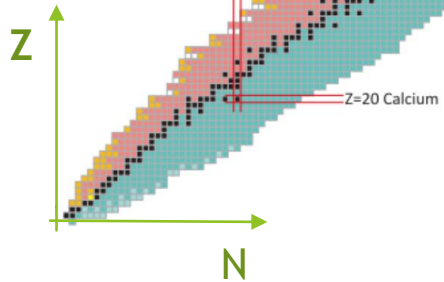
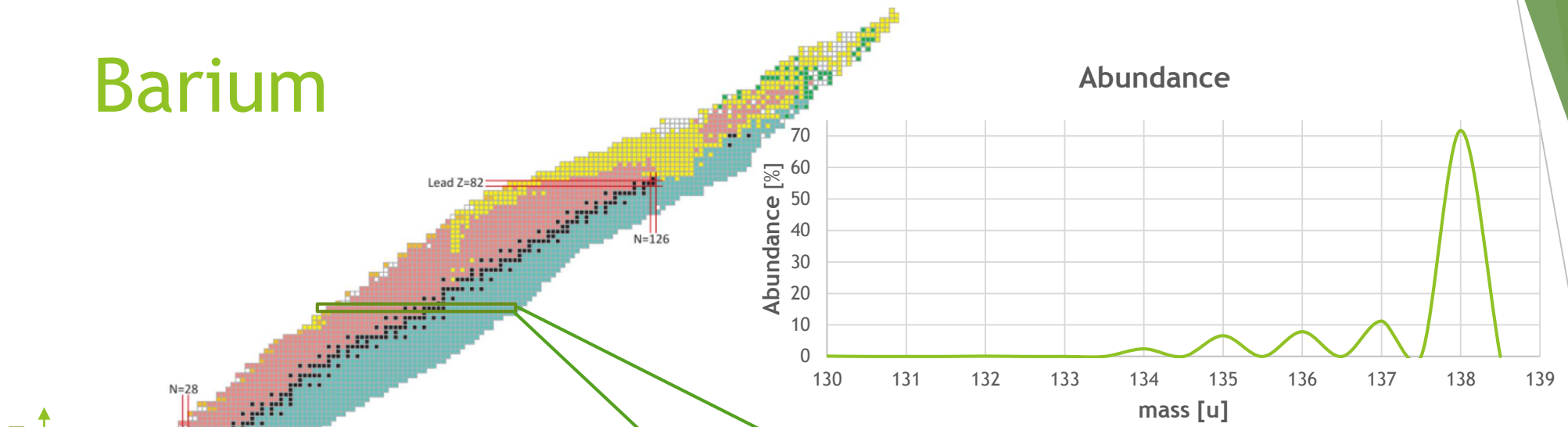
Target Unit



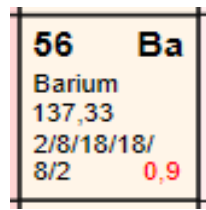
ISOLDE

Extraction of a neutral barium beam

Barium



Ba 130 0.106	Ba 131 0.106	Ba 132 0.101	Ba 133 0.106	Ba 134 2.417	Ba 135 6.862	Ba 136 7.854	Ba 137 11.232	Ba 138 71.698
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Legende

Ordnungszahl Symbol Ordnungszahl Serie
 Name Element schwarz = nicht radioaktiv
 Altemgewicht gmb = radioaktiv
 Elektronen Serie Symbol schwarz = Feststoff
 Elektronenkonfiguration Elektronegativität rot = Gas
 Elektronegativität blau = Flüssigkeit

1 H	2 He	3 Li	4 Be	5 B	6 C	7 N	8 O	9 F	10 Ne																										
11 Na	12 Mg	13 Al	14 Si	15 P	16 S	17 Cl	18 Ar	19 K	20 Ca	21 Sc	22 Ti	23 V	24 Cr	25 Mn	26 Fe	27 Co	28 Ni	29 Cu	30 Zn	31 Ga	32 Ge	33 As	34 Se	35 Br	36 Kr										
37 Rb	38 Sr	39 Y	40 Zr	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd	49 In	50 Sn	51 Sb	52 Te	53 I	54 Xe	55 Cs	56 Ba	57-71 La	72 Hf	73 Ta	74 W	75 Re	76 Os	77 Ir	78 Pt	79 Au	80 Hg	81 Tl	82 Pb	83 Bi	84 Po	85 At	86 Rn
87 Fr	88 Ra	89-103 Ac	104 Rf	105 Db	106 Sg	107 Bh	108 Hs	109 Mt	110 Ds	111 Rg	112 Cn	113 Nh	114 Fl	115 Mc	116 Lv	117 Ts	118 Og																		



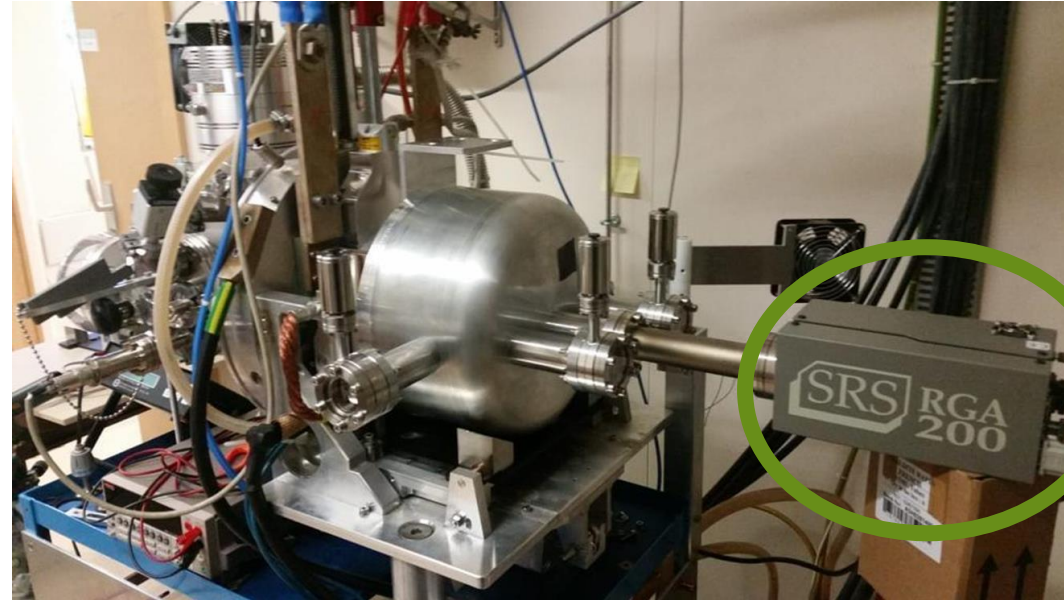
Extract a neutral barium beam

1st Step: Is it possible to extract barium?

- ▶ High melting point (1845 °C)
- ▶ Can't be manipulated by electromagnetic fields
- ▶ Expecting highly divergent beam and therefore low efficiency

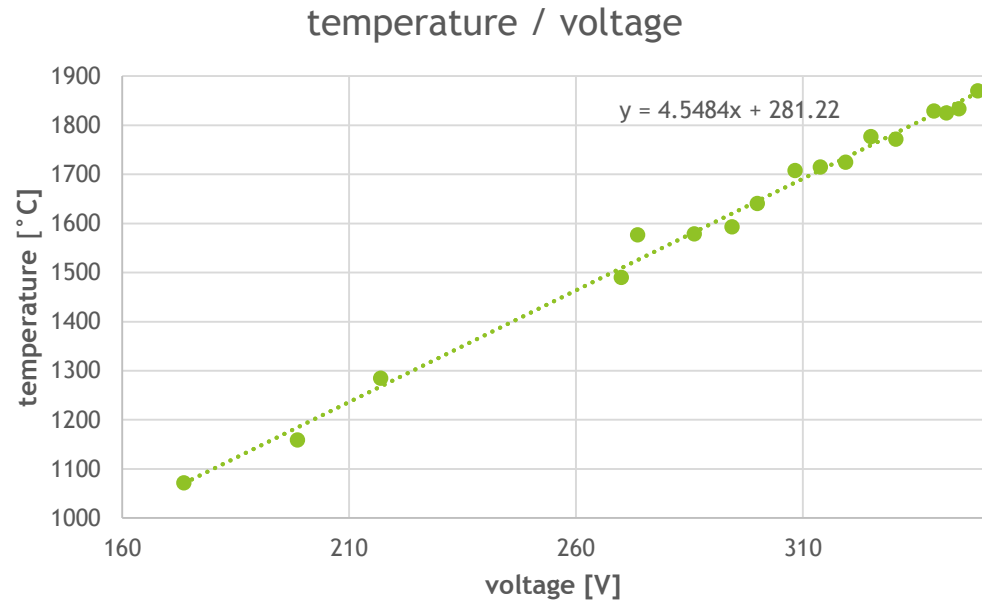
2nd Step: How efficient is it?

- ▶ Is it possible with standard ISOLDE target units?

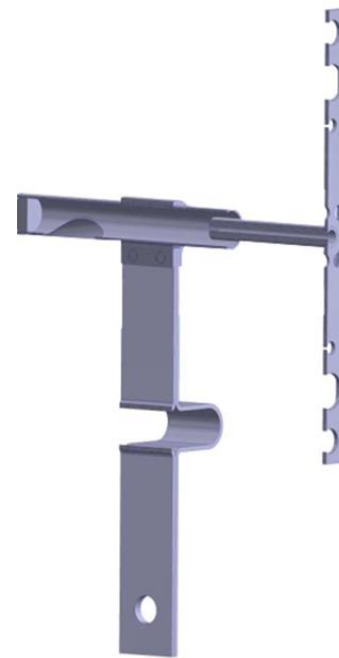
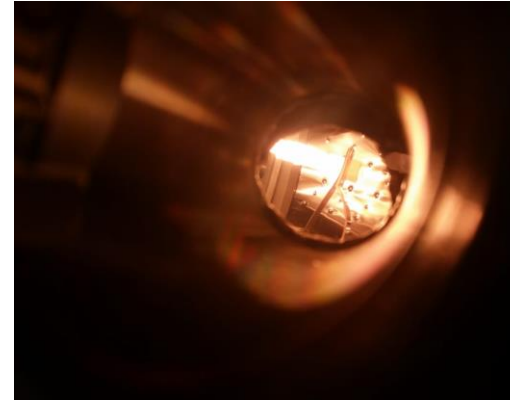


Final goal: neutral beam of ^{133}Ba

Temperature calibration

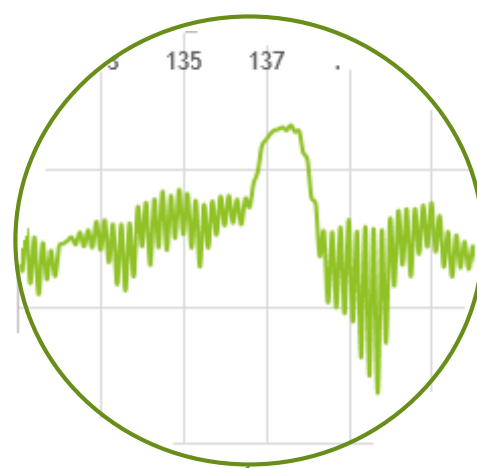


- ▶ Ion source used as an oven
- ▶ Temperature calibration necessary

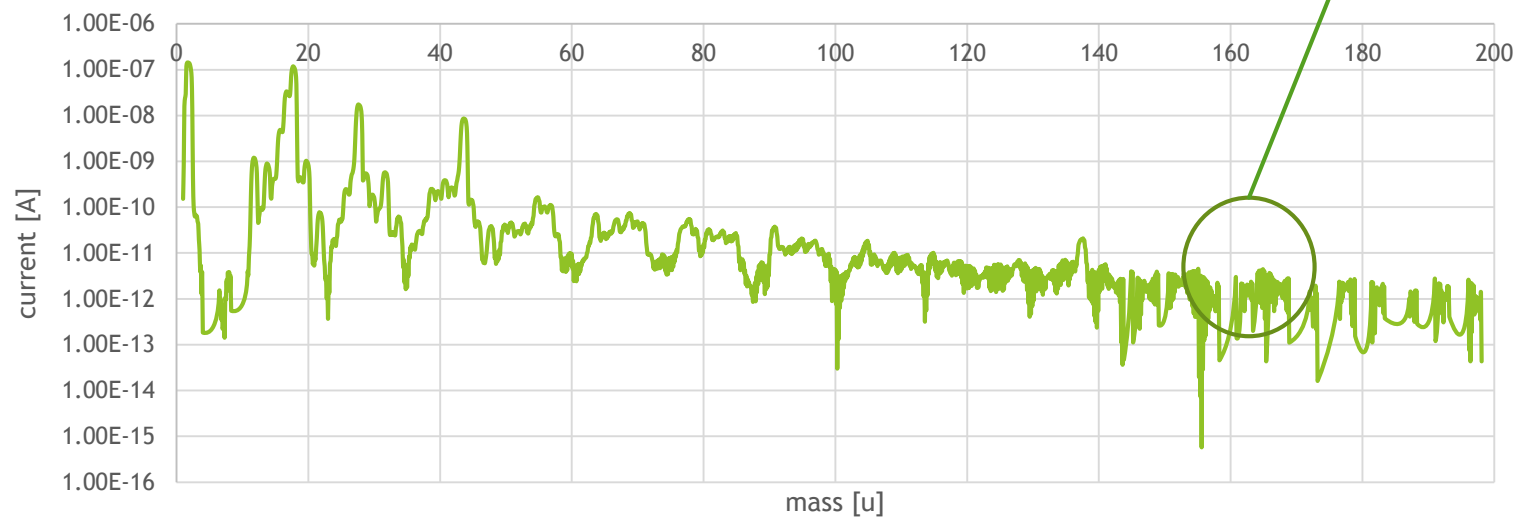


Second measurement (250 μ l)

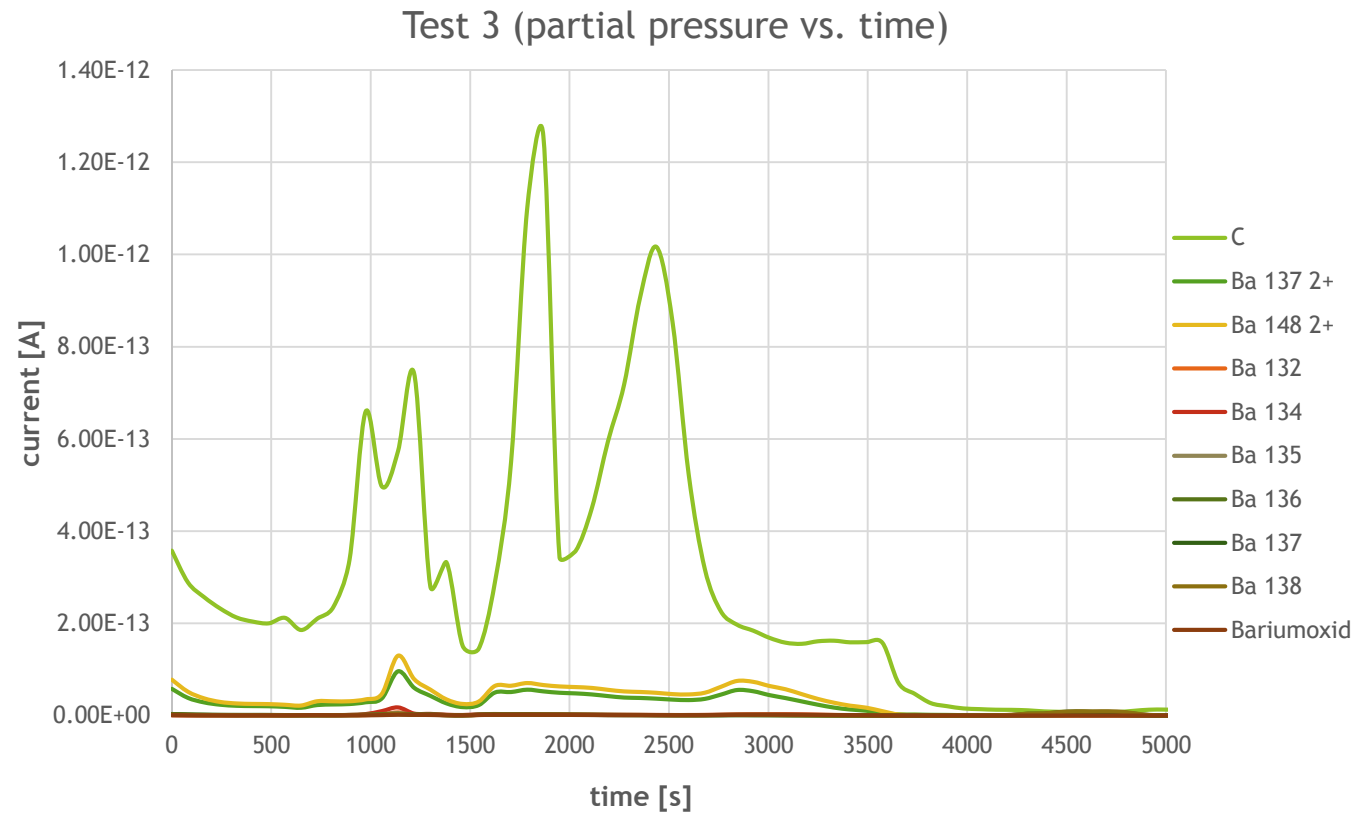
- ▶ First measurement (10 μ l unsuccessful)
 - ▶ Increased amount of barium by 25 times



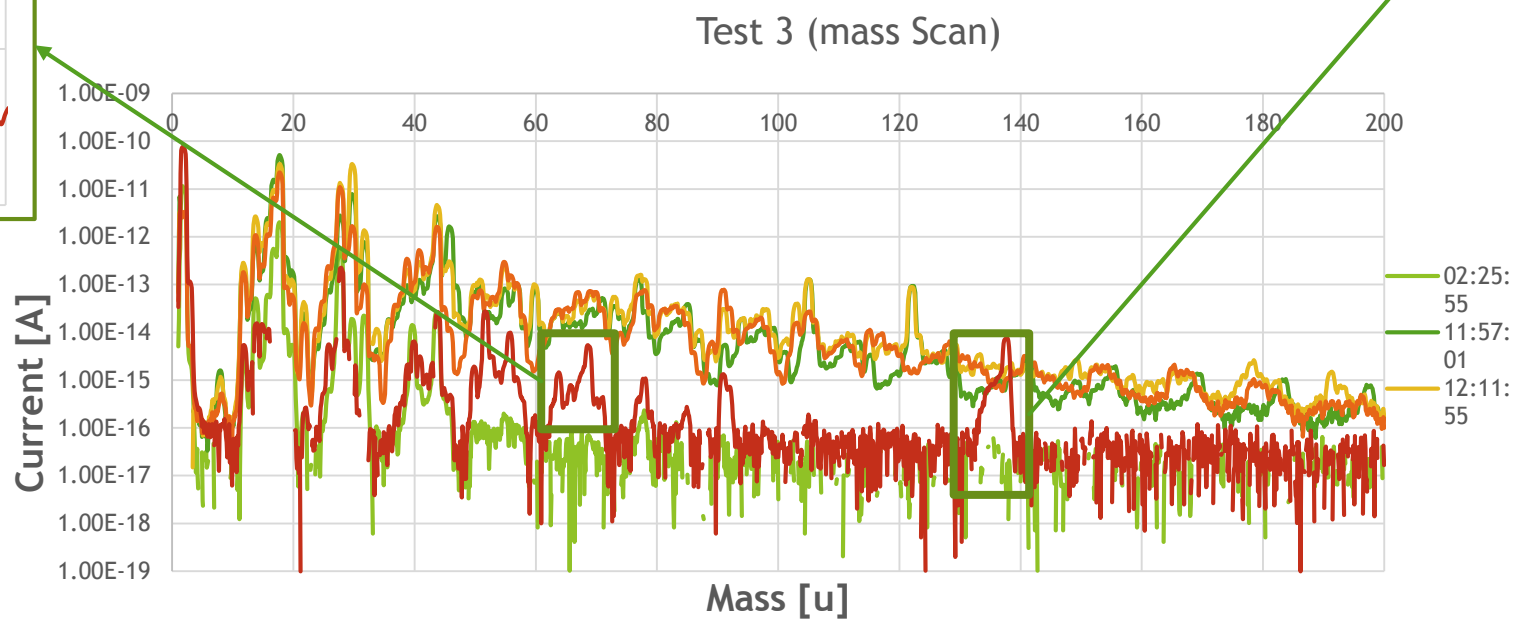
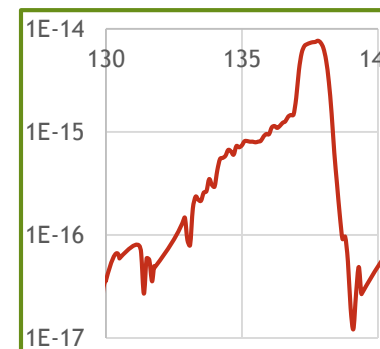
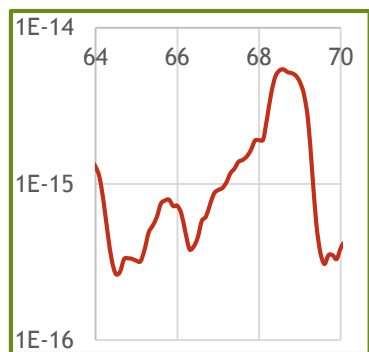
Test 2 (mass scan)



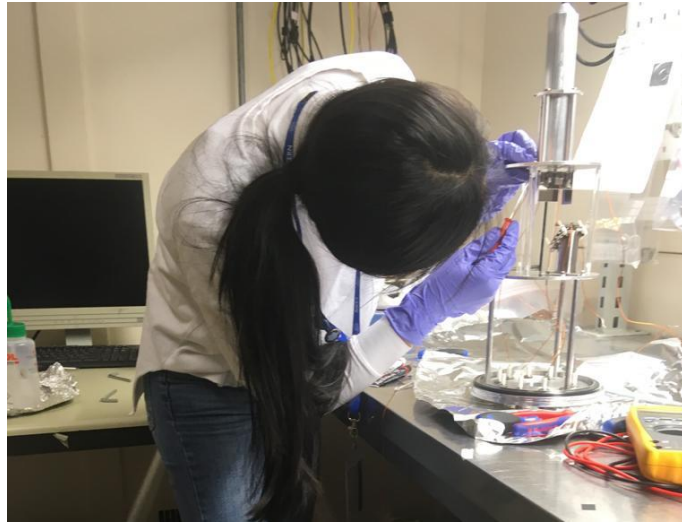
Third measurement (10ml)



Third measurement (10ml)



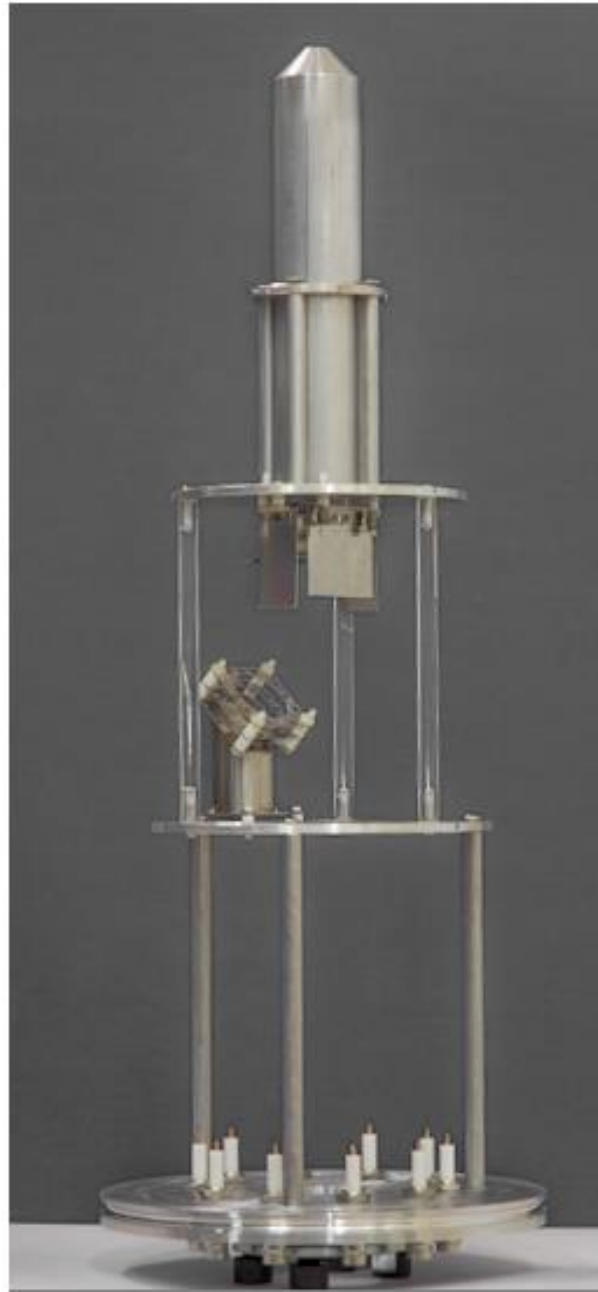
Design and simulation of the extraction flange

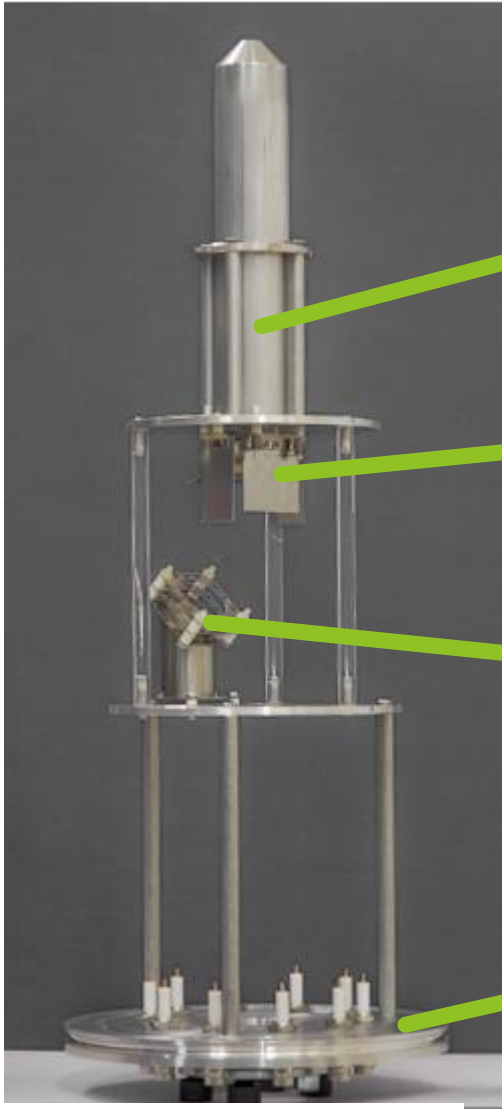


An extraction flange

Motivation:

- long- term tests and performance studies
- laser ionisation
- destructive tests, operational limits and failure mode analysis (thermal stress)





Extraction electrode

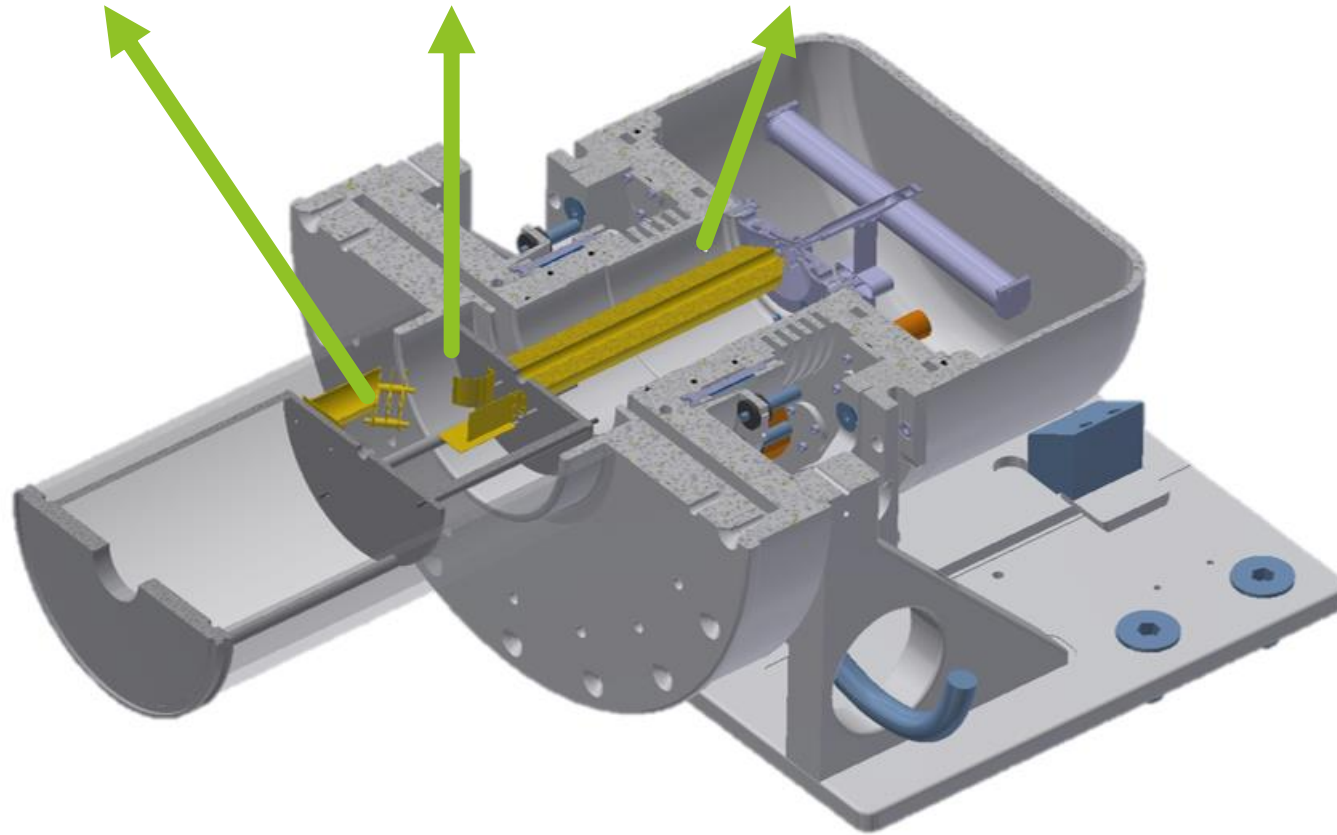
Deflector

Faraday cup

Vacuum feedthrough

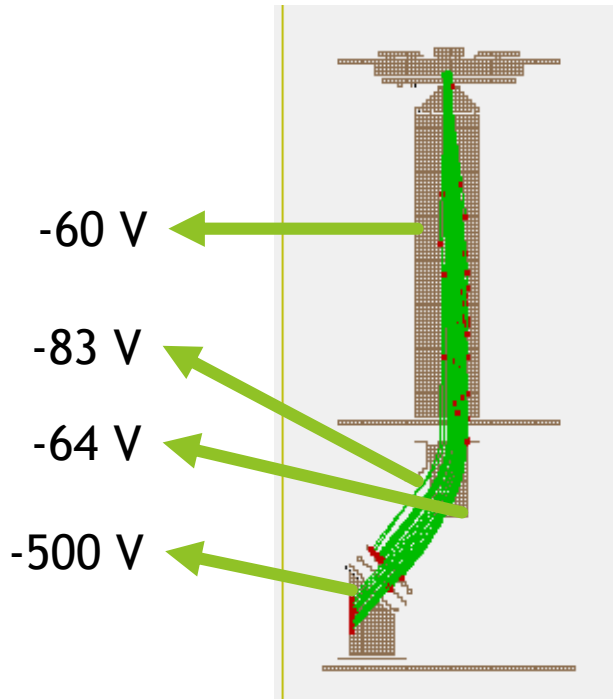
This is how it looks inside

Farady cup Deflector Extraction electrode



SIMION

Simulated ion beam trajectories



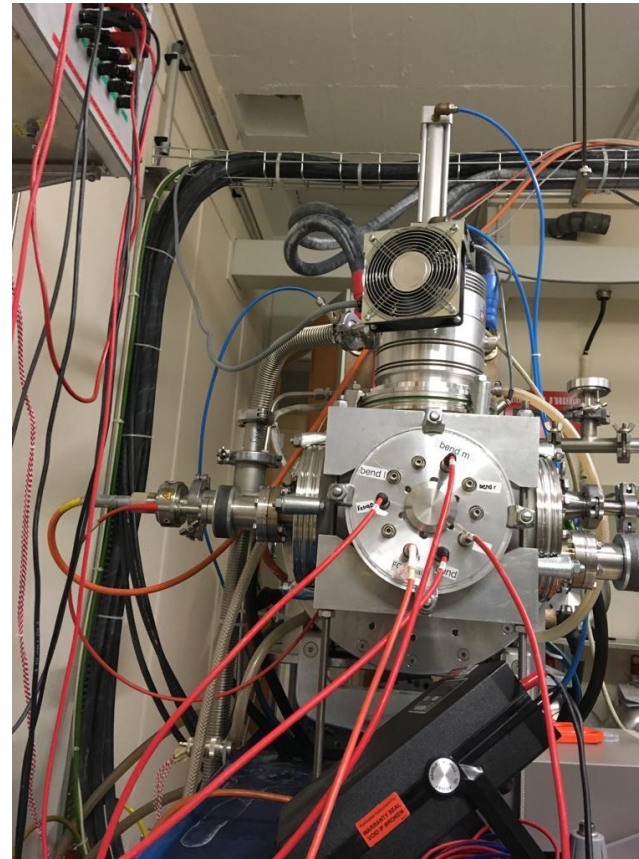
Particle definition

Selected particle group:

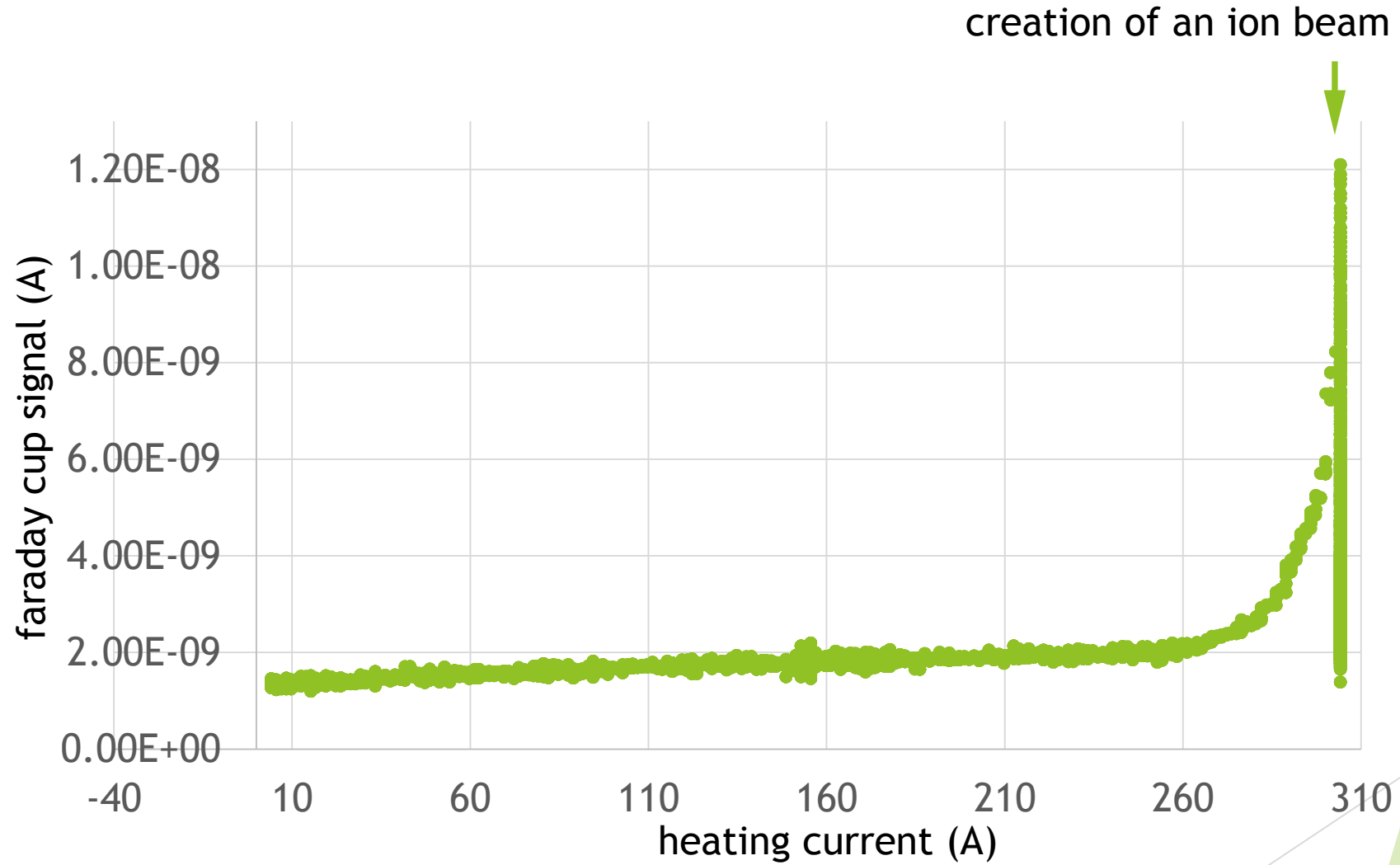
Use:

Num particles:	<input checked="" type="checkbox"/> 100		
Mass:	single value	138	u
Charge:	single value	1	e
Source position:	gaussian3d distribution	Mean: { x: 89 y: 482 z: 89 } Stdev: { x: 1 y: 1 z: 1 }	mm or gu
Velocity format:	direction+KE		
Direction:	single vector	{ x: 0 y: -1 z: 0 }	unitless
KE:	single value	0.17	eV
TOB:	single value	0	usec
CWF:	single value	1	unitless
Color:	single value	2	index

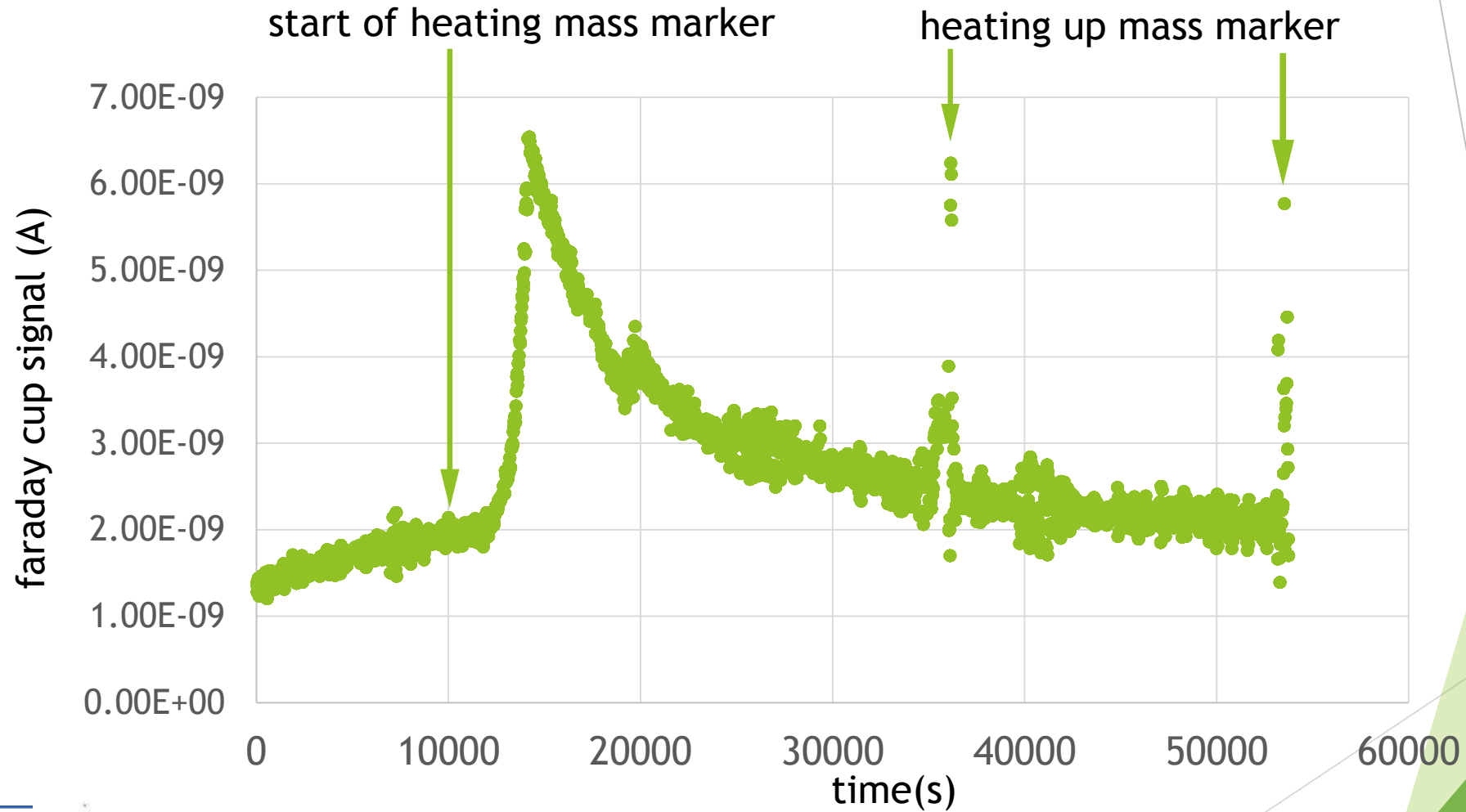
Results of the ion beam extraction



Results



Results



Conclusion

Barium experiment

- ▶ Successfully extracted a neutral barium beam
- ▶ Efficiency needs to be improved upon
 - ▶ Source geometry
 - ▶ longer pump down and bake out of vacuum system to reduce background

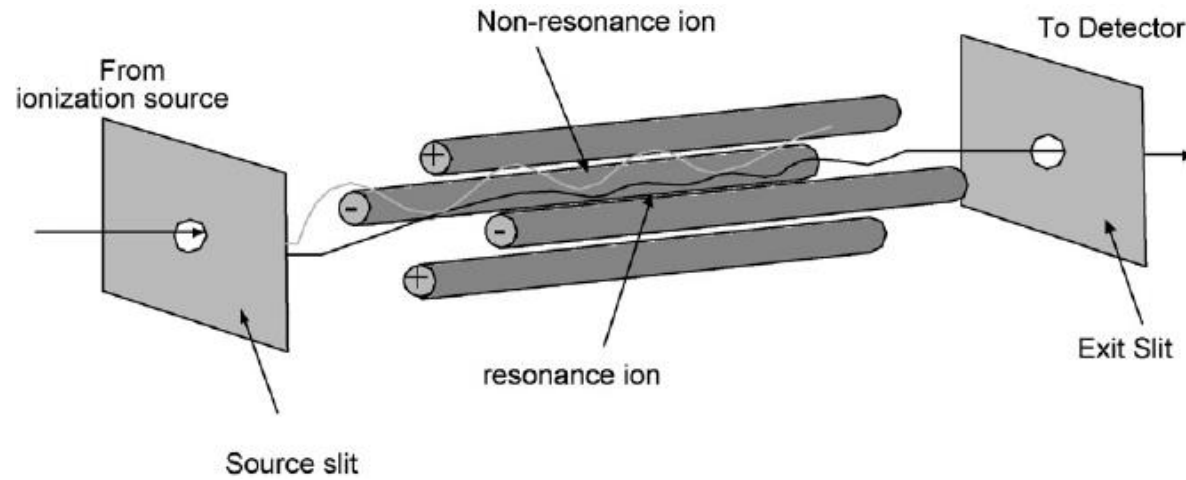
Ion Beam extraction

- ▶ 1st Ion beam extraction achieved
- ▶ Optimization of electrical setup



RGA (Residual gas analyzer)

- ▶ Ion source
- ▶ Quadropole mass filter



https://www.researchgate.net/figure/A-schematic-of-a-quadrupole-mass-filter-Resonant-ions-will-travel-down-through-the-poles_fig6_6699273