

GANIL
Spiral2
laboratoire commun CEA/DSM CNRS/IN2P3

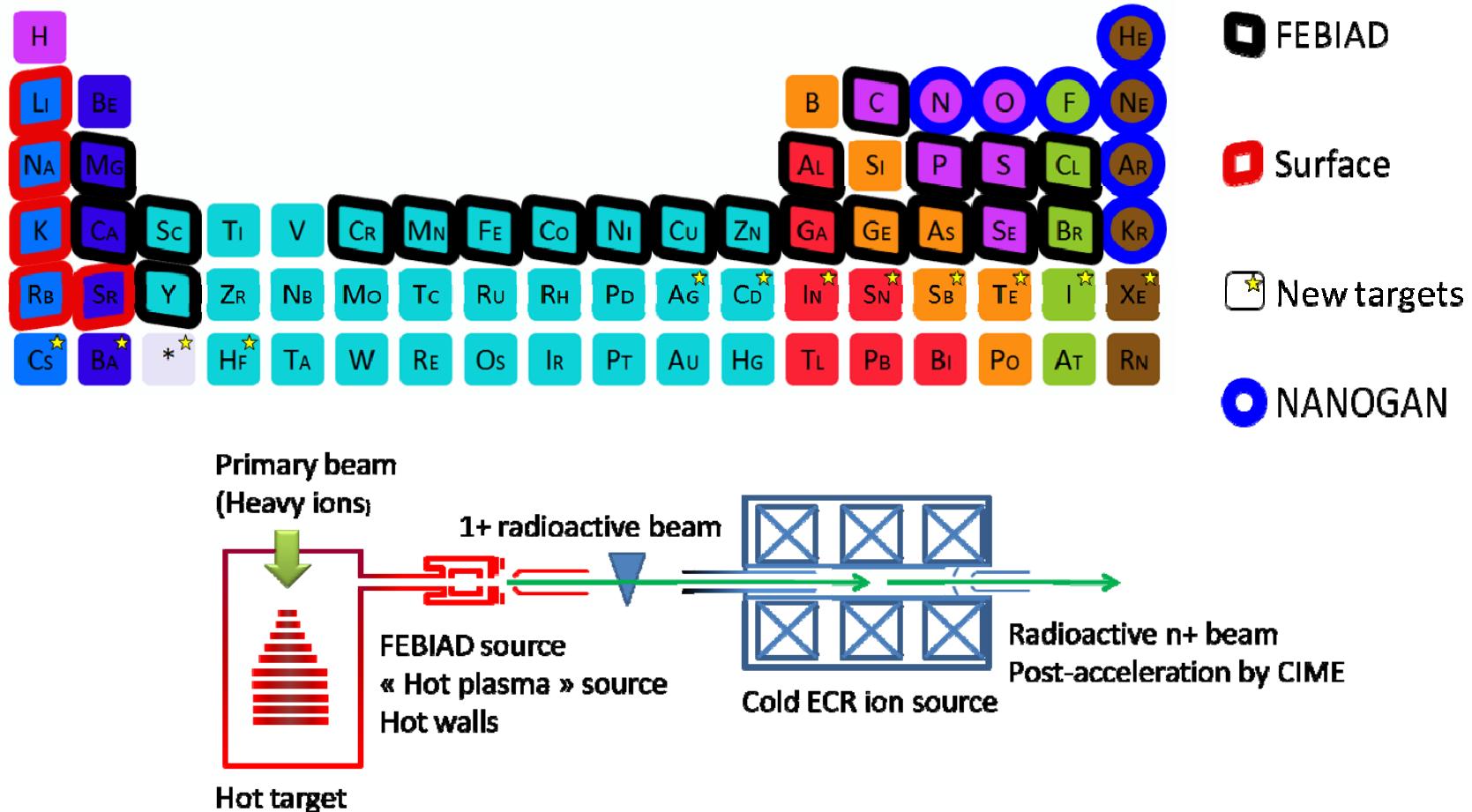
ENSAR2

Target and ion source development at SPIRAL

P. Delahaye and P. Ujic for the SPIRAL 1 Upgrade team
EURISOL Town meeting
2nd of July, 2018

SPIRAL upgrade in a nutshell

Extending the number of elements produced by the ISOL method at SPIRAL



1+ ionisation: VADIS from ISOLDE

- 1+ beams from metallic elements with $T_{\text{fusion}} < 2000^\circ\text{C}$

Conversion from 1+ to n+: Phoenix booster

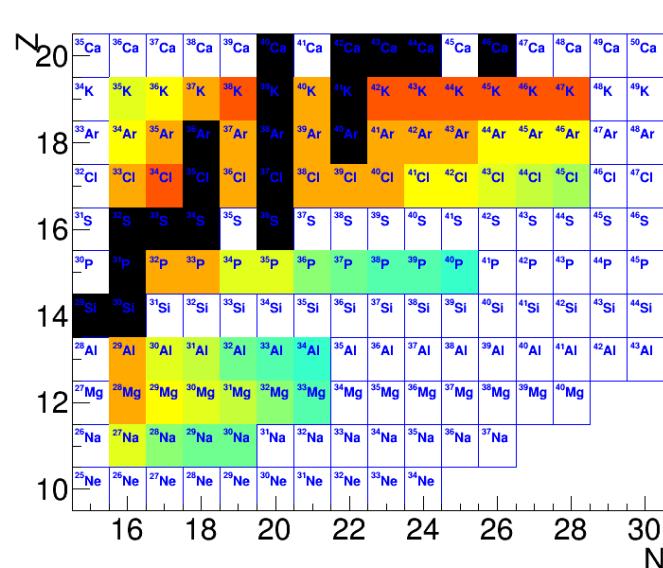
- Almost chemistry independant, charge breeding times from 10 to ~200ms

FEBIAD source

VADIS



1+ beams from metallic elements with $T_{\text{fusion}} < 2000^{\circ}\text{C}$



2011 -2013 - Different tests at SIRA and SPIRAL 1

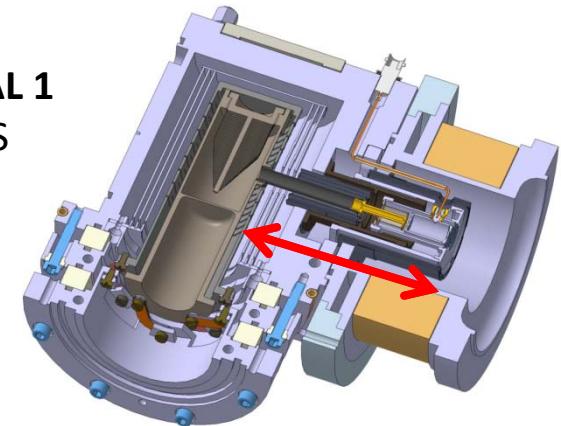
Coupling of the SPIRAL 1 targets with the VADIS

Dilatation problems are fixed

➤ Ion source sliding against its axis

➤ oven attached to container

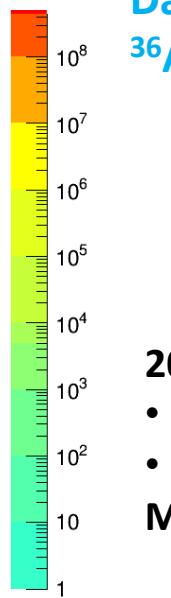
Record temperature of 2400°C attained



O. Bajeat et al, NIM B 317(2013)411

Dec. 2013: tests at nominal power at SPIRAL 1

P. Chauveau et al, NIM B 376(2016)35



Day 1 beams from FEBIAD TIS test results with ³⁶Ar@95AMeV at nominal power at SPIRAL 1

Already 7 new elements
Na, Mg, Al, P, Cl, Cu, Fe
+ many more to come

2014- 2015: reliability tests

- Failing BeO insulators exchanged
- High voltage discharges at extraction fixed

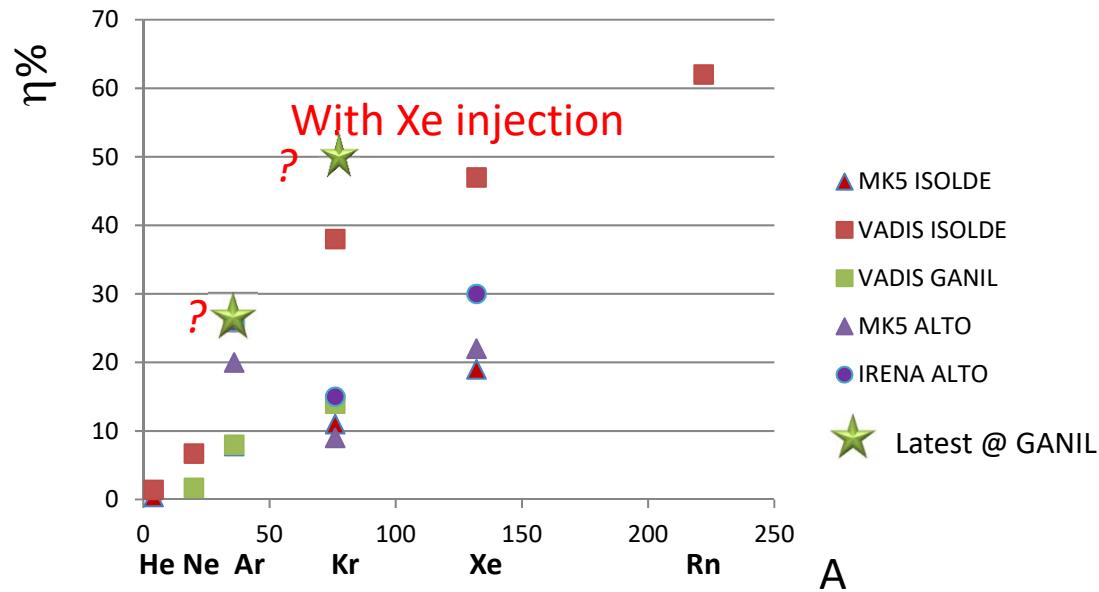
More than 3 weeks running with stable efficiencies

FEBIAD source - status - April

2 ion target ion sources

- 2 conditioned on the SPIRAL 1 test bench

Ionisation efficiency measurements



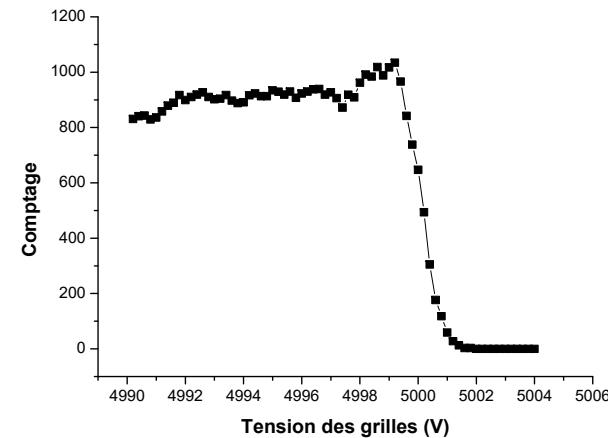
Ref: L. Penescu et al, Rev. Sci. Instrum. 81, P. Chauveau et al, NIM B 376, S. Essabaa et al NIM A 317

Using a calibrated leak with gas injection: $\eta = I_{1+}/I_{\text{gaz}}$

Intensity increase to be confirmed on long term

Yield estimates use conservative efficiencies

Energy profile measurement



Simulations: M. Herbane, LPC Caen



Charge breeding efficiency depends on δE
 $\sigma_E \sim 1.5 \text{ eV}$

FEBIAD source - status - May

2 ion target ion sources

- 1 failed during the beginning of the experiment!
 - Anode in shortcut, BN insulators were incriminated
- 1 broken on test bench, reconditionned and modified, back online
 - Rapid modifications to cool and protect new BeO insulators
 - ^{40}Ca 100-200W: tests show that the ionisation is ok, but slow release probably due to a too low primary beam power on target
 - ^{36}Ar 900W: yields are getting closer to nominal values thanks to the high power increase
 - New isotopes of $^{29-30}\text{Mg}$ seen
 - Alkali elements and noble gases are close to nominal yields
 - ^{25}Al , ^{33}Cl , yields are still a factor $\sim 10 - 20$ lower compared to 2013



End of May:

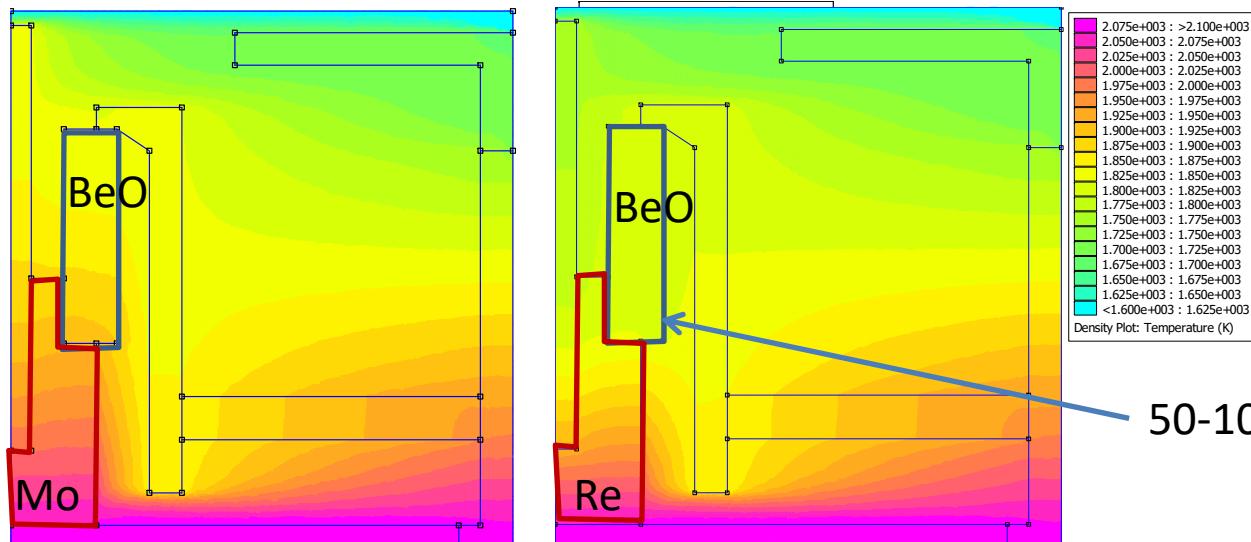
- ^{14}O beam from Nanogan
- Singling out a disfonctionnement of a position diagnostic for the primary beam:
 - More than a factor of 10 increase with the proper steering!

Expecting nominal beam intensities with the FEBIAD as of 2019

FEBIAD source - consolidation- Fall of 2018

1 consolidated target ion source to be tested on the test bench

- Cooling anode insulators with new support in Re

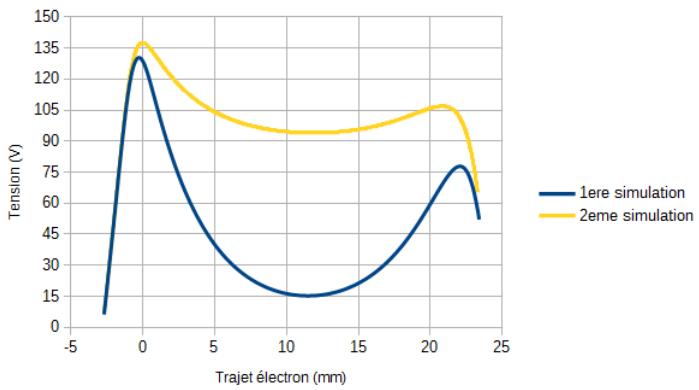
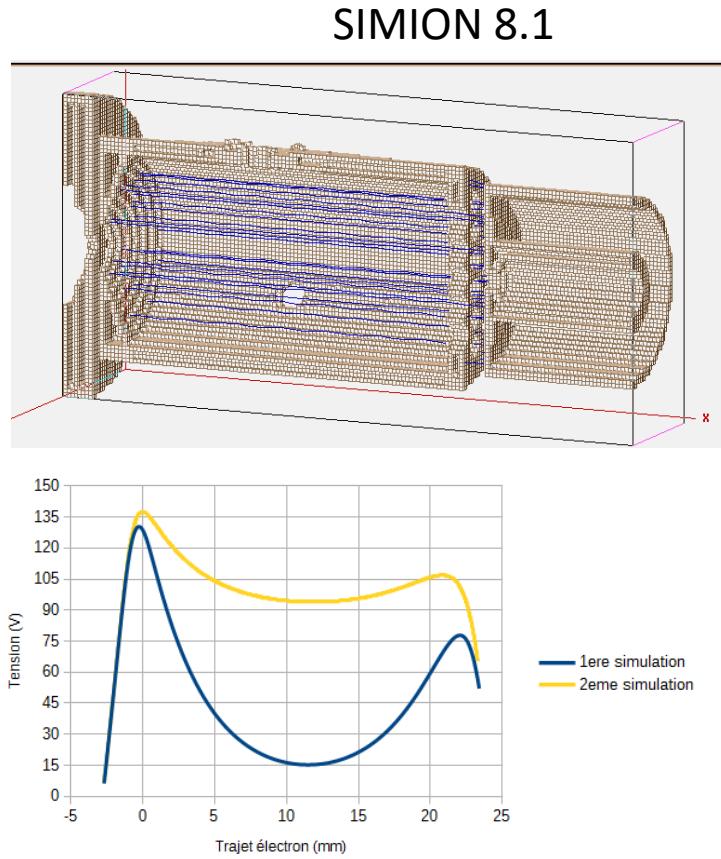


Thermal conductivity:
Mo~140 W/(mK)
Re~50 W/(mK)

- New flexible heat screen arrangement (1 – 2 layers easy to remove)
- Chicane in transfer tube for avoiding direct attacks from C vapors



FEBIAD source - Modeling fields



Organisation of the target and ion source R&D

Different developments

- Testing production with new primary beam on C target
- New Target or ... new ion source



		Delay (Month)	Number of TISS	GPI HR (supply, assembling, test) MM
Already exists		12	1	4
To be tested		18	1	6
To be improved and tested		24	1 to 2	12
To be designed and tested		36	1 to >2	12 + 36 (PhD student)
Difficult				

Ressources for 1 TISS	
Cost	25->50k€
Design	4 MM
Quotation	1 MM
Safety evaluation	1 MM

Evaluation in

GANISOL
ISOL beams for GANIL

reviews after each PAC meeting

Direction + TISS developpers + 4 external physicists (T. Stora, M. Assié, B. Blank, N. Orr)

List of priorities - from Review 2016/07 -**2019-2020?**

Test of new beams with C targets

- 1) ^{30}P and ^{25}Al from ^{36}Ar fragmentation
- 2) ^{56}Ni , ^{48}Cr from fragmentation of ^{58}Ni . For ^{56}Ni : ^{56}Co contamination to evaluate.
- 3) Beams (^{79}Se , ^{60}Fe , ^{67}As) from ^{86}Kr fragmentation.

Development of new targets

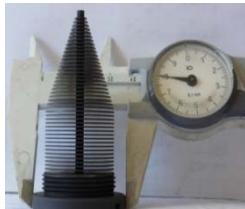
All science driven (LoIs)

- 1) Nb for production of high intensities for beams with $30 < Z < 40$
- 1) ex aequo Fusion evaporation targets ($N=Z$ nuclei)

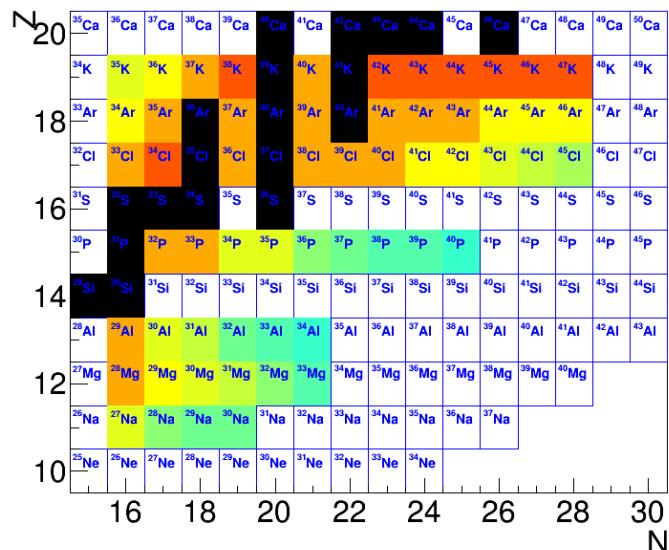
Beyond commissioning...



From day 1 beams...



ISOLDE FEBIAD + Graphite targets
1+ beam intensities (pps)



To longer term: 2020-...

New targets:

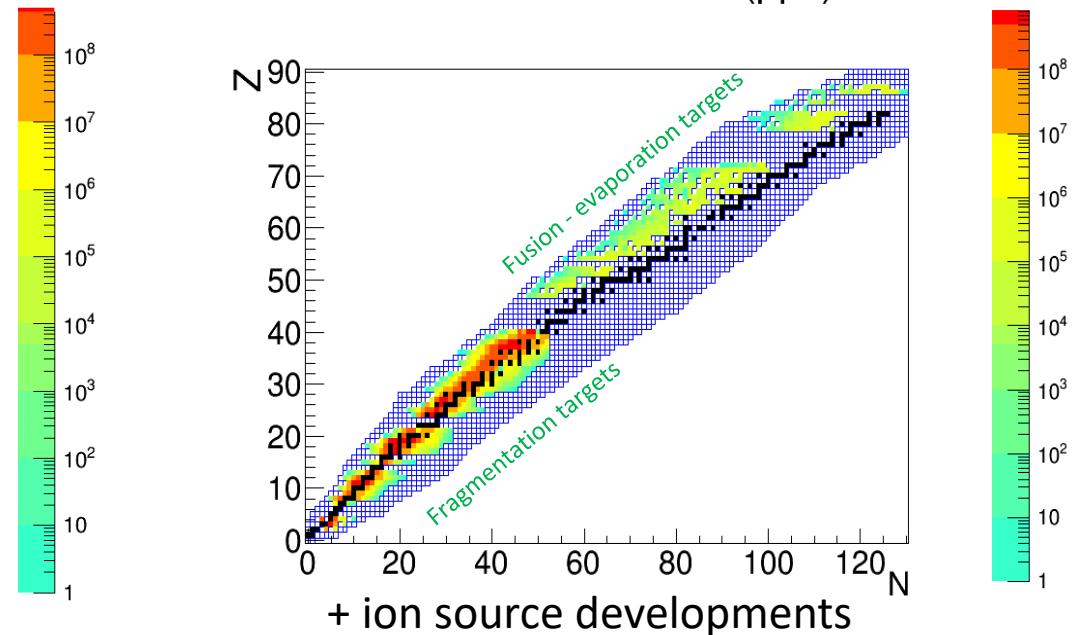
Fragmentation targets

- **Nb** target design is ongoing
- Others under study (**SiC, Al₂O₃, CaO...**)

Fusion evaporation targets

- thin **Ni** target (PhD thesis V. Kuchi)

1+ beam intensities (pps)



Collaborations within EURISOL/Beamlab within ENSAR2

Fusion evaporation targets



List of priorities from the GANISOL review 2016, July 4th

Ongoing developments

To be tested at SPIRAL at the earliest in 2020

Fusion evaporation target ion source development

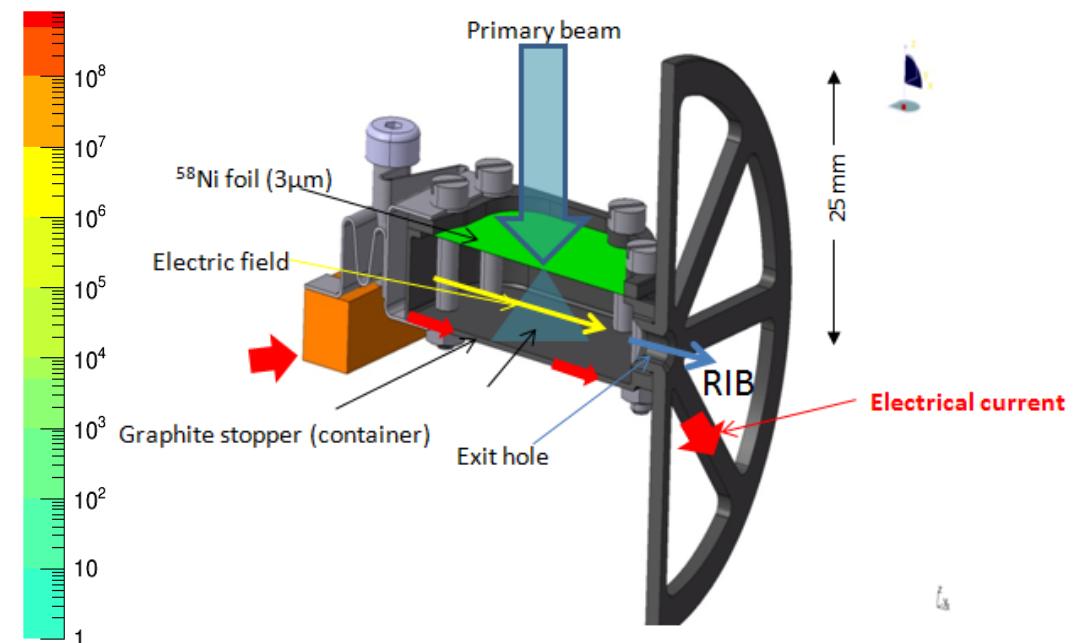
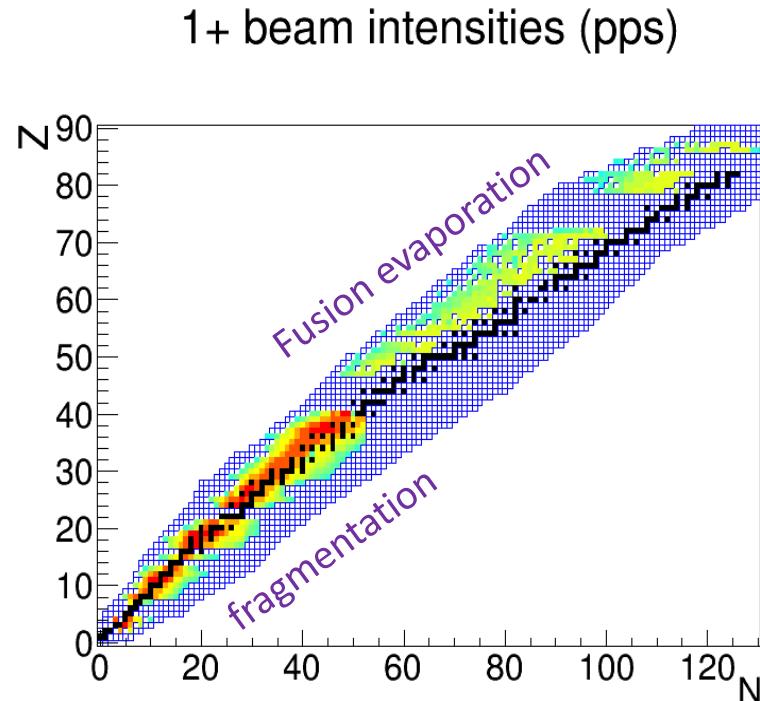
- neutron deficient isotopes such as ^{74}Rb , ^{114}Cs , N=Z for DESIR

Offline test 2018

Ionisation efficiency and rapidity measurement

Online test at ALTO earliest 2019

Online test at SPIRAL earliest 2020



Interest to test SnS formation at ALTO within Beamlab

Collaboration with IPN Orsay – first test possible in 2019 with the Tandem

Fusion evaporation targets



List of priorities from the GANISOL review 2016, July 4th

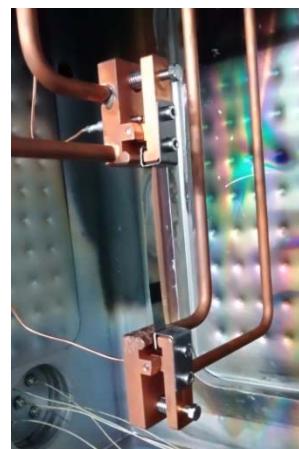
Ongoing developments

To be tested at SPIRAL at the earliest in 2020

Fusion evaporation target ion source development

- neutron deficient isotopes such as ^{74}Rb , ^{114}Cs , N=Z for DESIR

- Ongoing measurement of emissivity of target foils



Offline test 2017-2018

Ionisation efficiency and rapidity measurement

Online test at ALTO earliest 2019

Online test at SPIRAL earliest 2020

Test setup

Measurement of emissivity with a 2 wavelength pyrometer

- ANR ‘TULIP’ (Target Ion Source for Short-Lived Ion Production) has been submitted

Collaboration with IPN Orsay – first test possible in 2019 with the Tandem



GANISOL
ISOL beams for GANIL

SPIRAL upgrade team



O. Bajeat
M. Babo
P. Chauveau (*now CSNSM*)
C. Couratin (*now IKS leuven*)
M. Dubois (chef de projet)
P. Delahaye (resp. scientifique)
M. Fadil
R. Frigot
S. Hormigos
P. Jardin
P. Lecomte
N. Leceyne
L. Maunoury
B. Osmond
V. Toivanen ([postdoc](#))
E. Traykov (*now IPHC*)
J. C. Thomas
P. Ujic



T. Stora
C. Seiffert
F. Wenander
L. Penescu



J. Angot
T. Lamy



E. Lienard
G. Ban
X. Fléchard
D. Durand



R. Vondrasek

Acknowledgements to

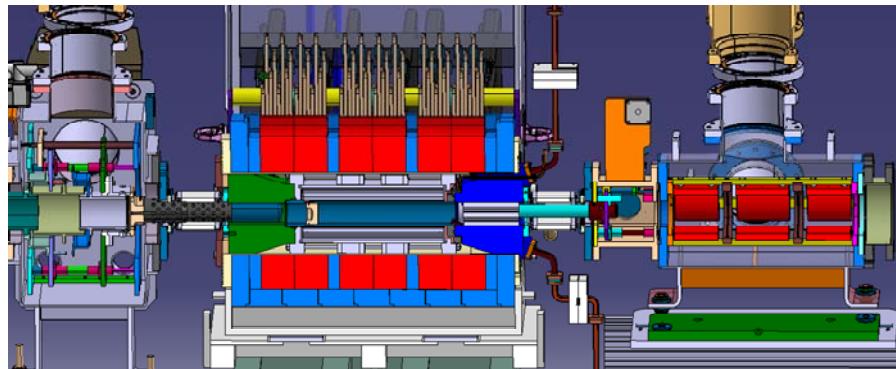




Phoenix ECR charge breeder

Former ISOLDE ECR charge breeder

- Upgraded with new Al plasma chamber, UHV vacuum, 2 RF ports and gas injection, injection triplet, mobile injection and puller electrodes



With contributions from



- Tested at LPSC in summer 2015



High efficiencies with stable beams
Rare gases and alkalis

L. Maunoury et al, Rev Sci Instrum.
87(2016)02B508

