Groupe Cible-Source

UNIVERSITÉ CAEN NORMANDIE

AGENCE NATIONALE DE LA RECHERCHE ANR

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SPIRAL1 RIBs : Ongoing developments and improvements

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SPIRAL1 ISOL facility

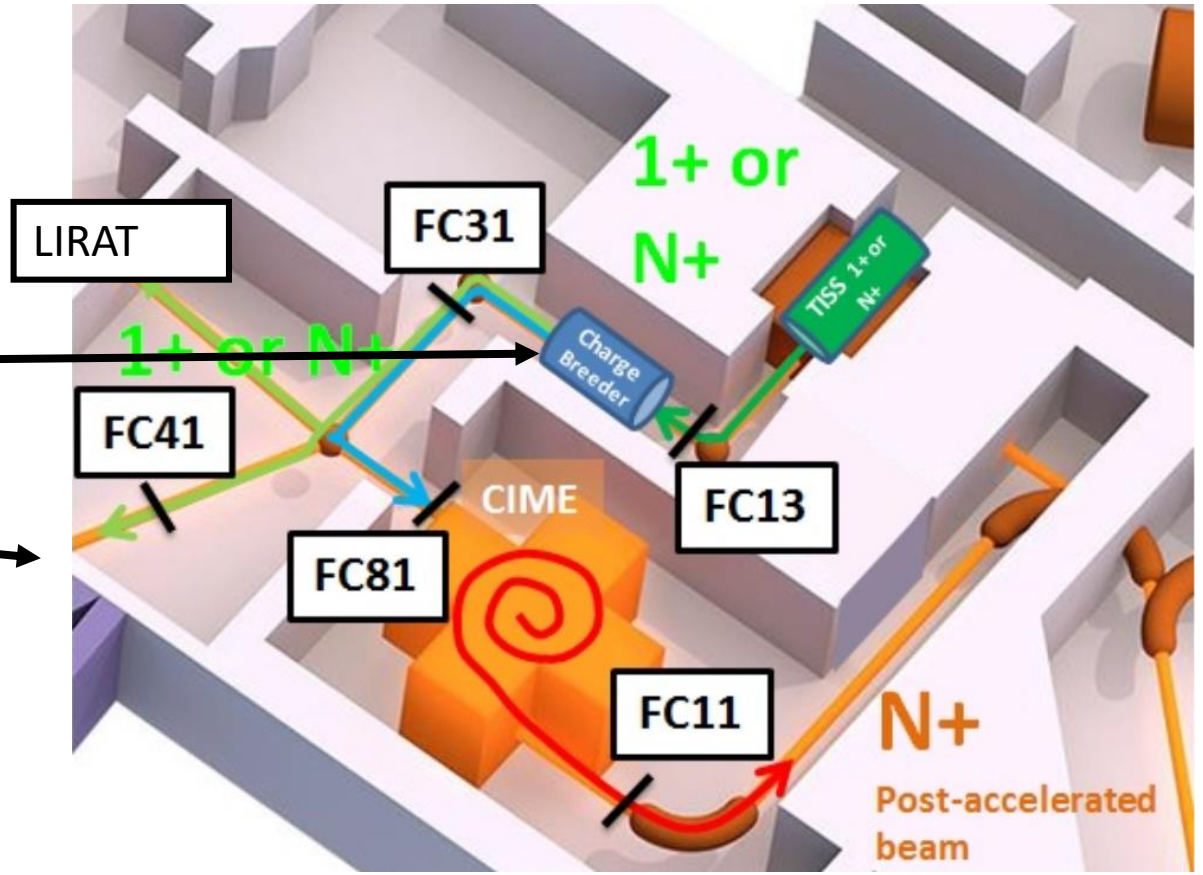
RIB Production using 2 different Target Ion Source System (TISS) :
- ECRIS + carbon targets (for gases)
- FEBIAD + carbon target (for metalic elements)
- Other target materials (for target fragmentation) and sources are being developed

ECRIS Charge breeder

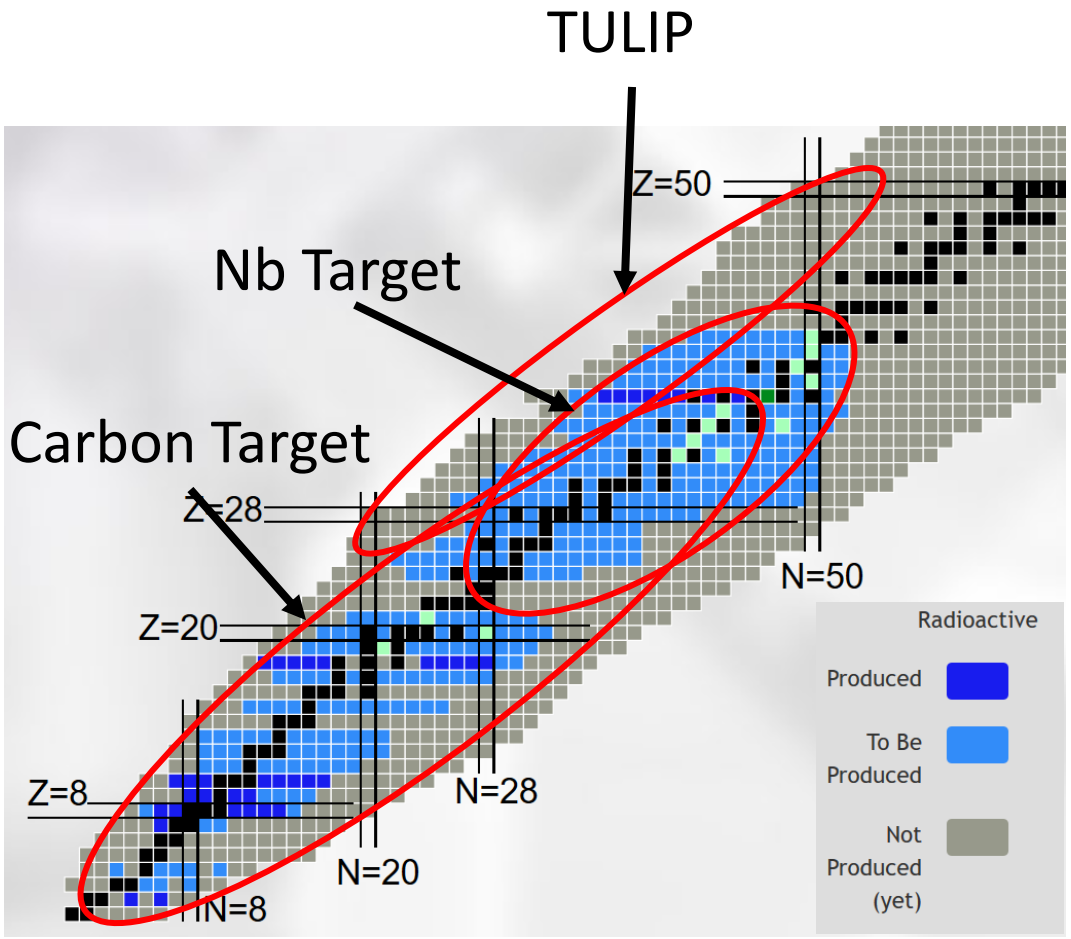
Identification system

LIRAT (low energy beam line for physics experiment)

CIME cyclotron for post-acceleration up to 25 MeV/A (depends on the A/Q ratio)



Available target and primary beam at SPIRAL 1



Large variety of beam-target combinations

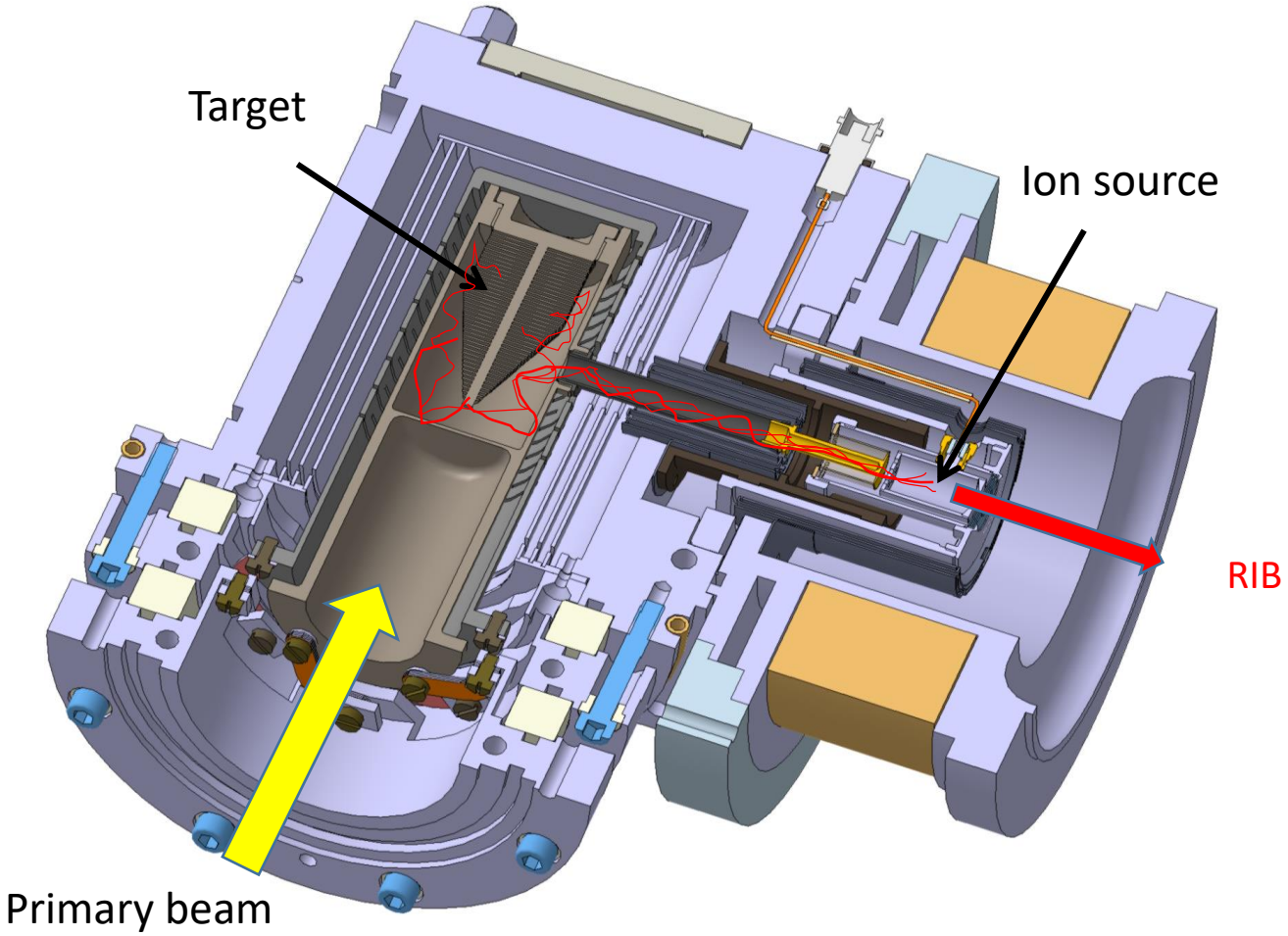
^{12}C up to ^{238}U (up to 95 MeV/A) → thick C target (currently used)

^{12}C up to 2.10^{13}pps (95 MeV/A) → thick targets, Mass up to Nb (under developement, O. Bajeat)

^{12}C up to ^{238}U, low energy → thin target, Mass up to U (explored through TULIP study)

Contents

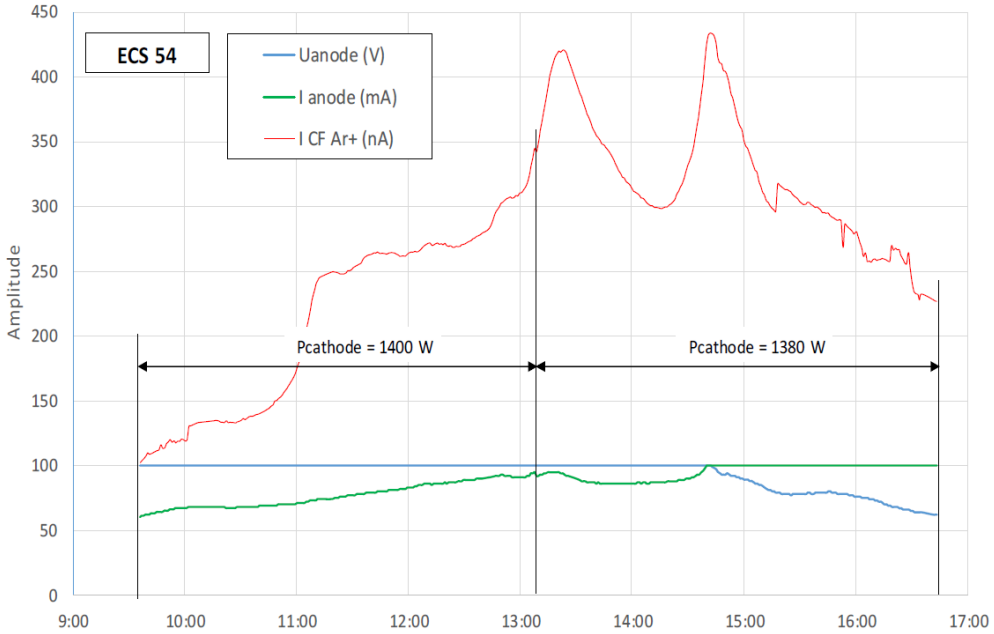
Improvement of the FEBIAD ion source



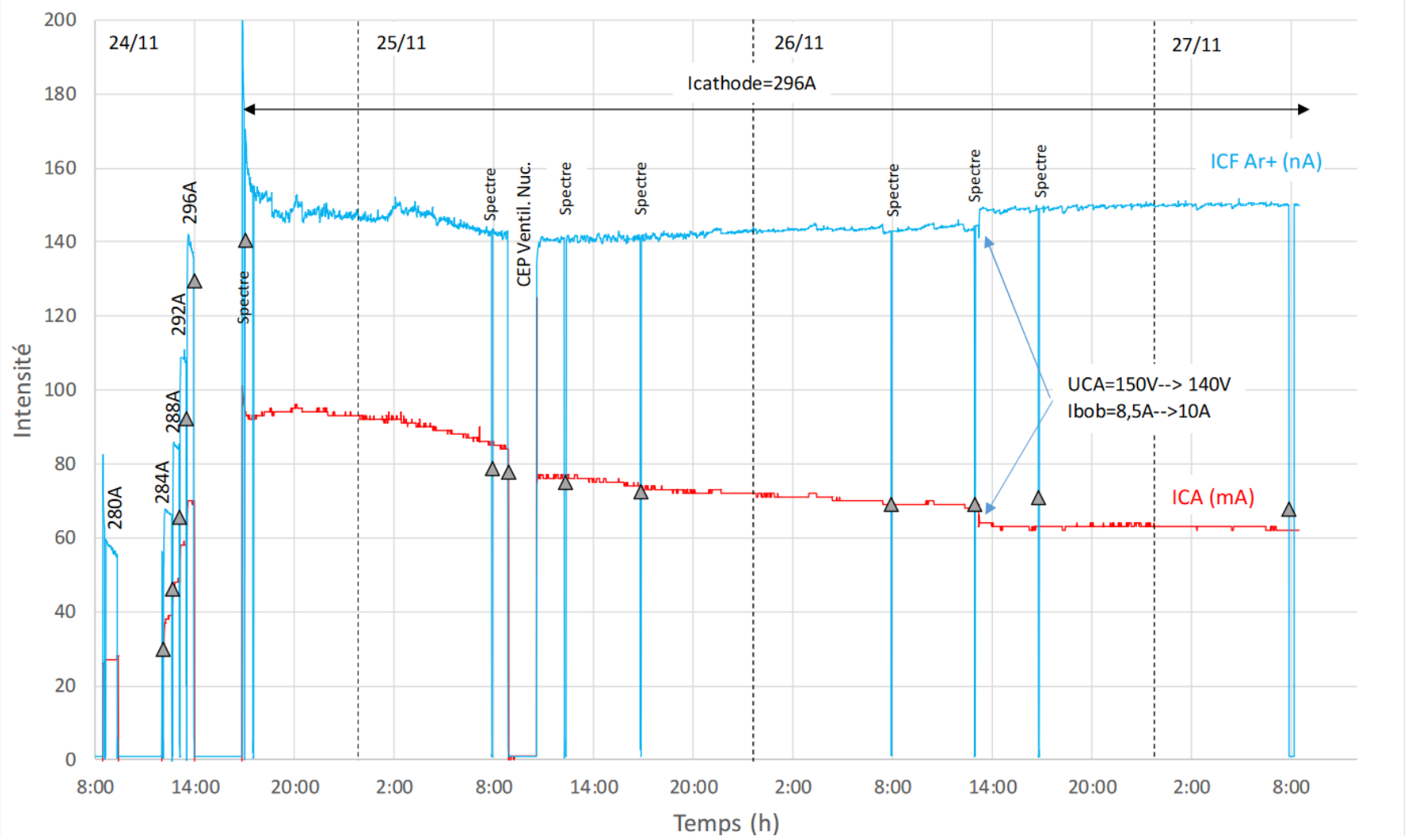
FEBIAD issues :

- unstable behavior
- unexplained drift of the source performances
- lower efficiency than expected

Goal : get more than 5 % Ar ionization efficiency and obtain steady working conditions



Improvement of the FEBIAD ion source



Obtained via in-depth diagnosis and consecutive thermal, mechanical and electrical modifications

Results :

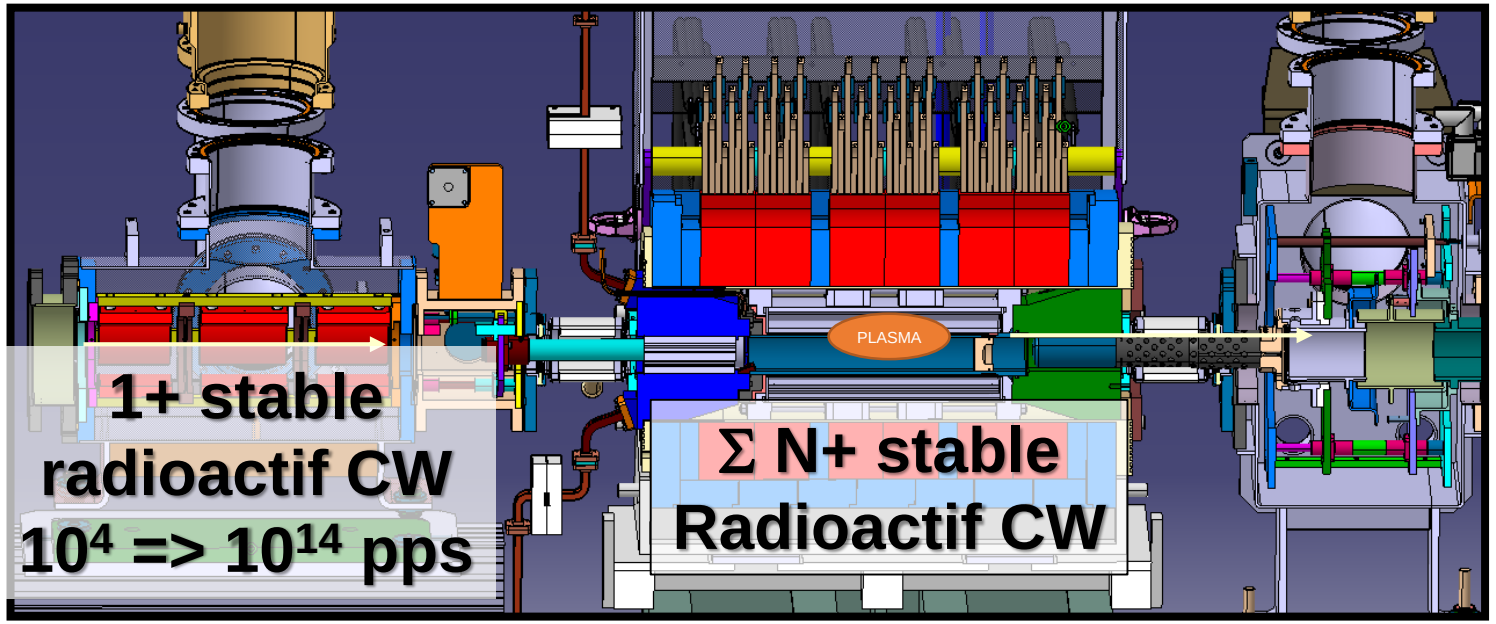
- 5-6% Ar efficiency
- Stable over 3 days
- Behavior consistent with our understanding of the system

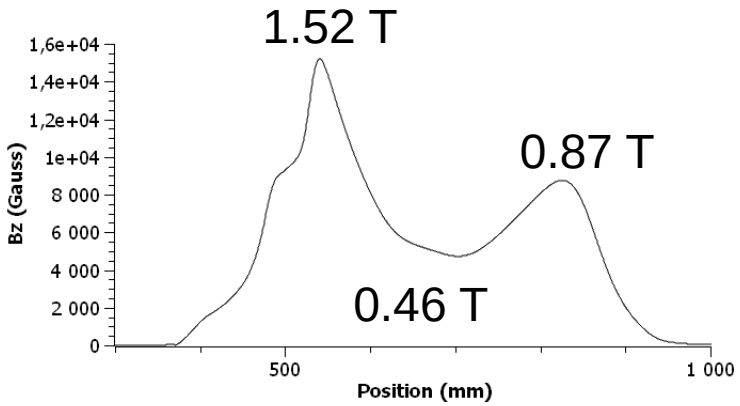
Upgraded version currently under construction (FEBIAD Evol)

Expected Argon ionization efficiency : over 10 %

Charge breeding improvements

SP1 booster de charge

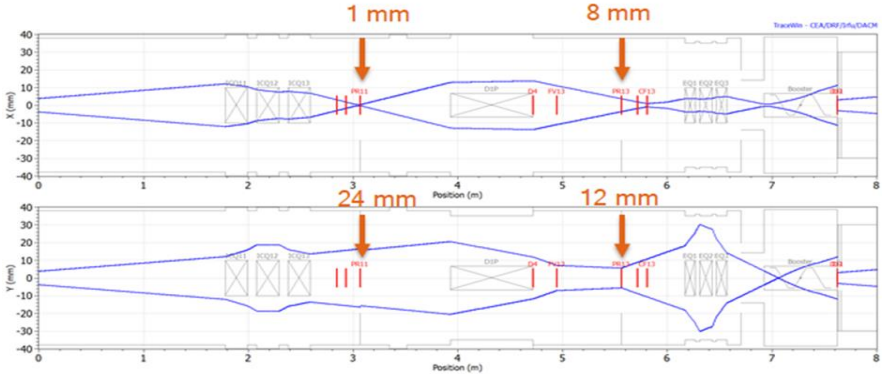




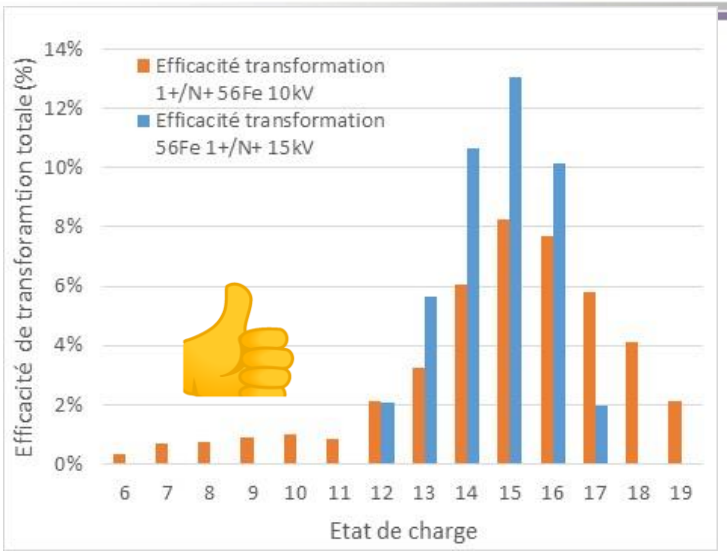
Axial magnetic field

Elements : Li => Cs
Efficiency : 5 – 15% (Q dependant)
Σ **Efficiency** : 40 – 70%
CB time: 5 – 20 ms/Q
Energy: 10 – 30 Q.keV

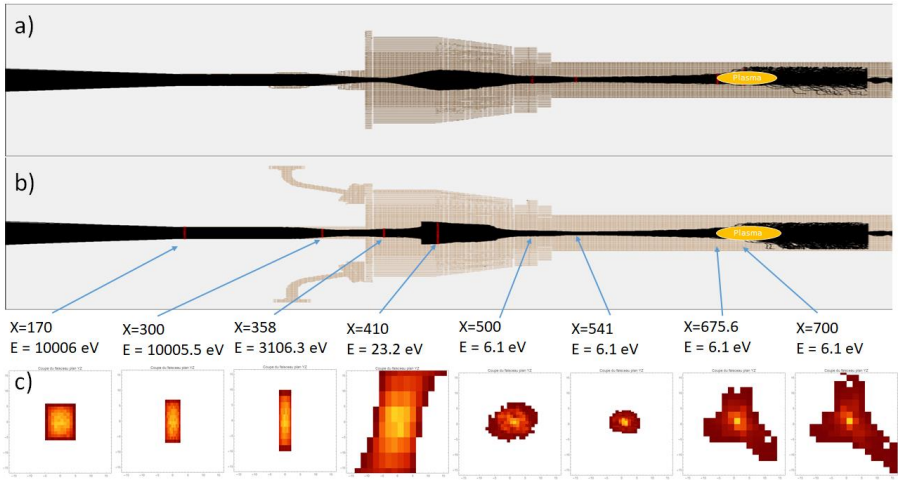
Charge breeding improvements



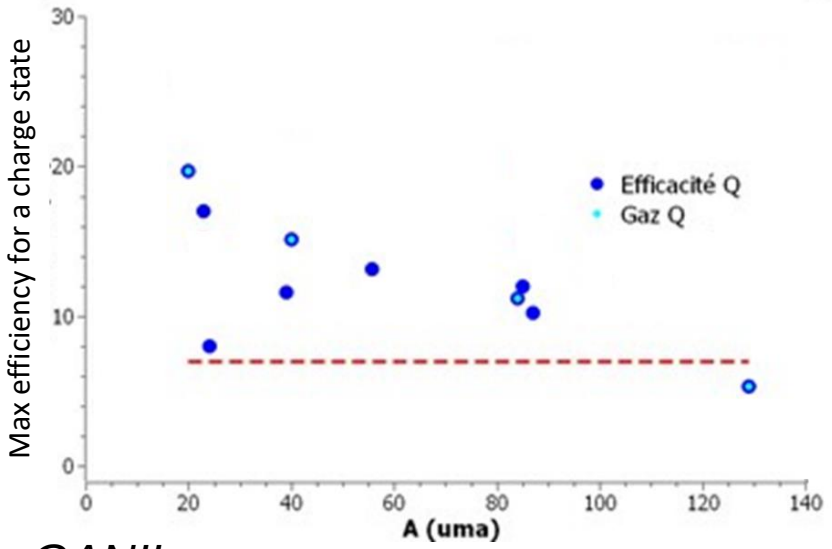
New 1+ beam optics 85Rb@27.5KV



ECS-FEBIAD + Charge Breeder



E + B needed to transport 1+



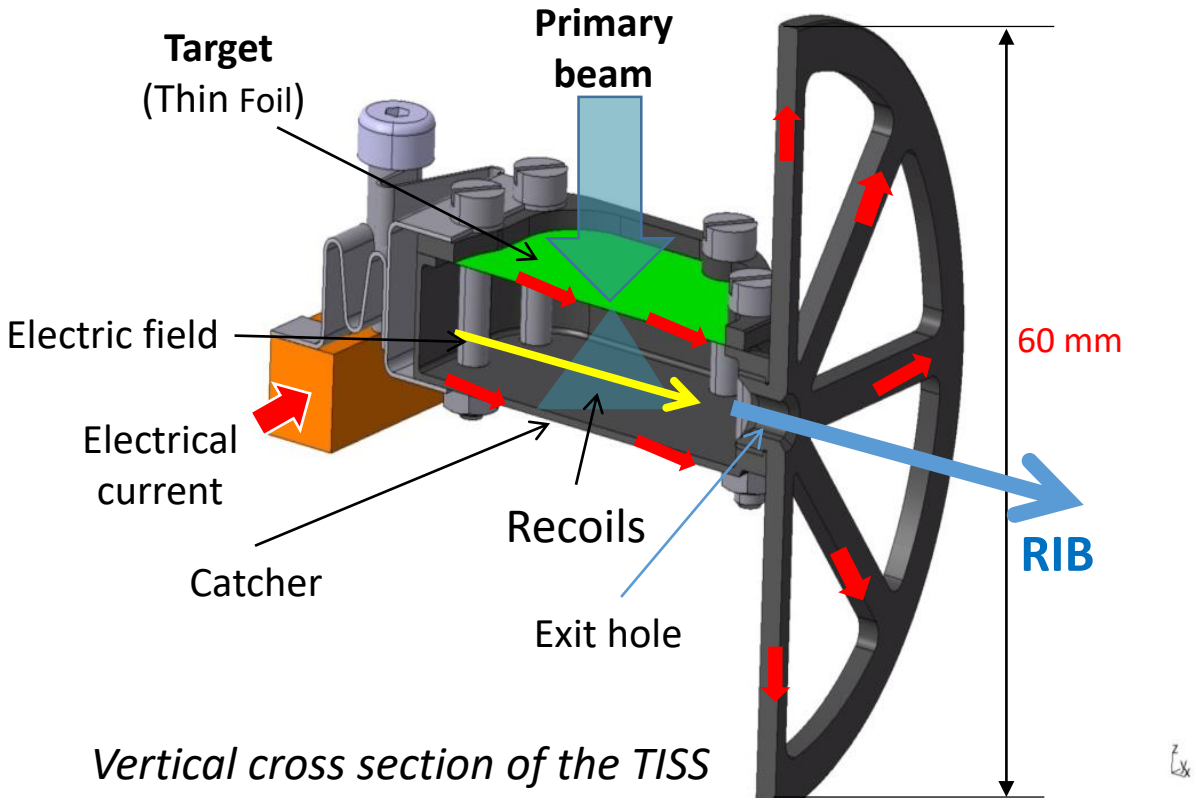
Courtesy of L. Maunoury GANIL

Innovative ion source : TULIP

Subject of my PHD

Goal of the ANR project : production of short-lived RIBs near 100Sn, with a 100Sn intensity > ten pps

First step : Surface ionization source for alkali



Vertical cross section of the TISS

Approach :

Minimising the time of each process involved in the atom to ion transformation: diffusion, effusion, ionization

- Small implantation depth
- Small and simple source geometry
- Ionisation possible straight out of the catcher
- Extraction imediately after ionization

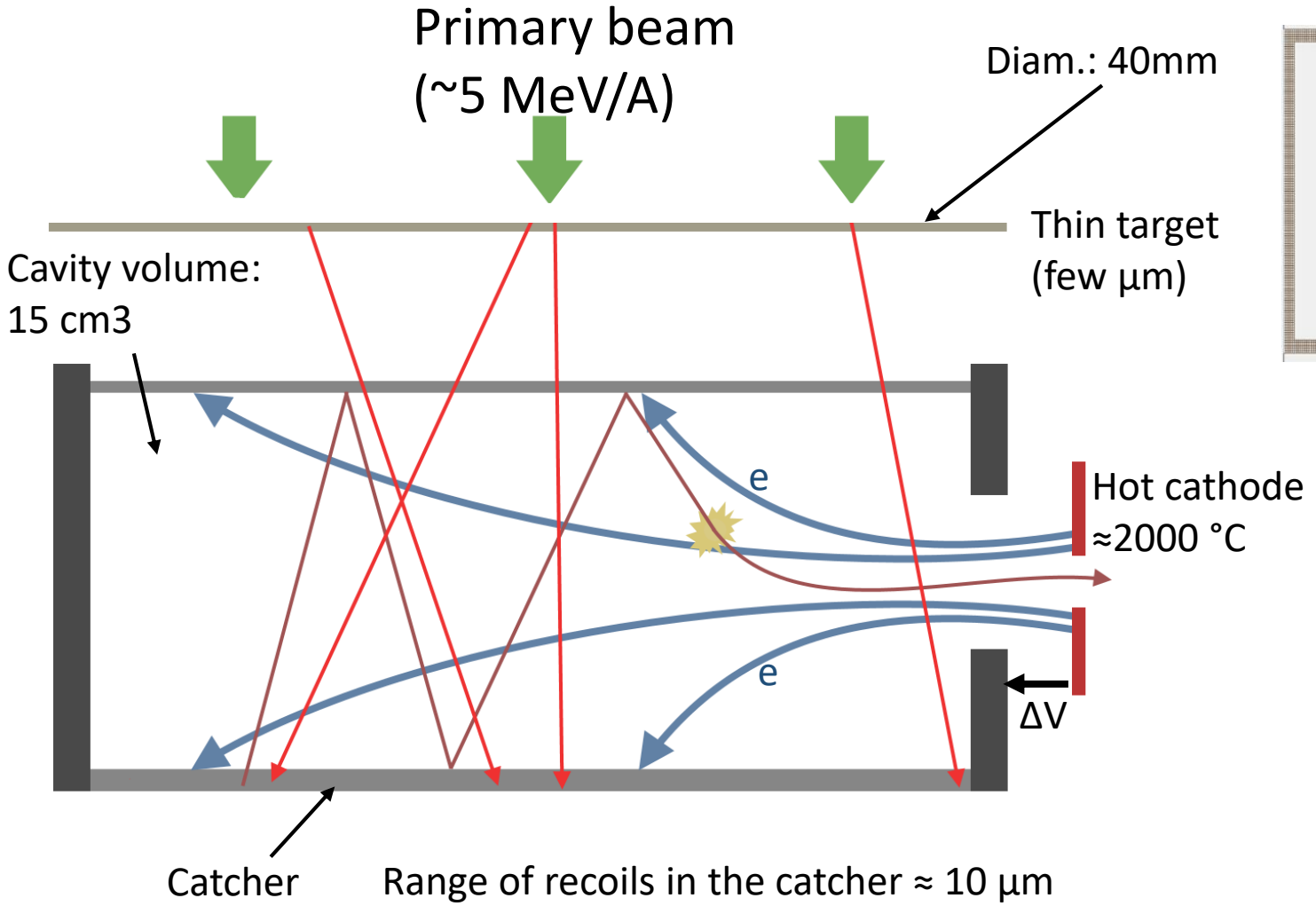
Experimental atom to ion transformation time :

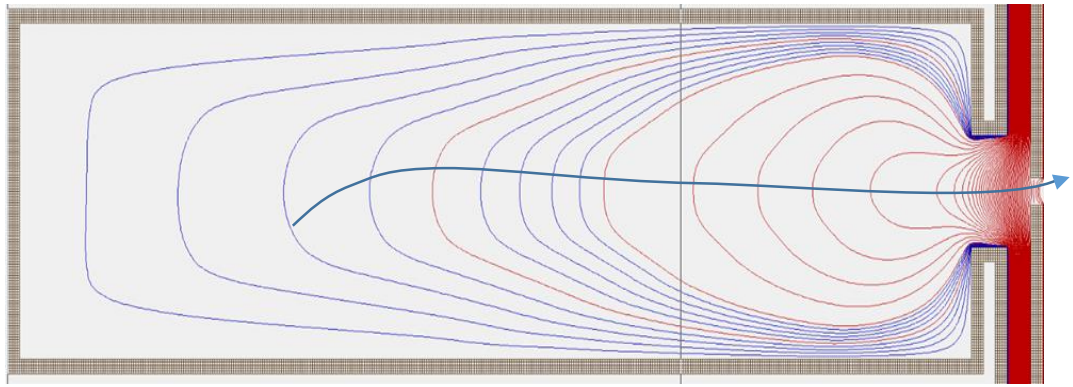
- Carbon target + MonoNaKe surface ionization source : 2,5s for K (Diff-Eff-Ioniz)
- TULIP surface ionization : 18ms for Rb (Eff-Ioniz)

3 ionization methods :

- Surface ionization for alkali
- Laser ionization (not explored yet)
- Electron-impact

SPEED : Electron-impact ionization source for metallic ion production





Electric isopotential lines

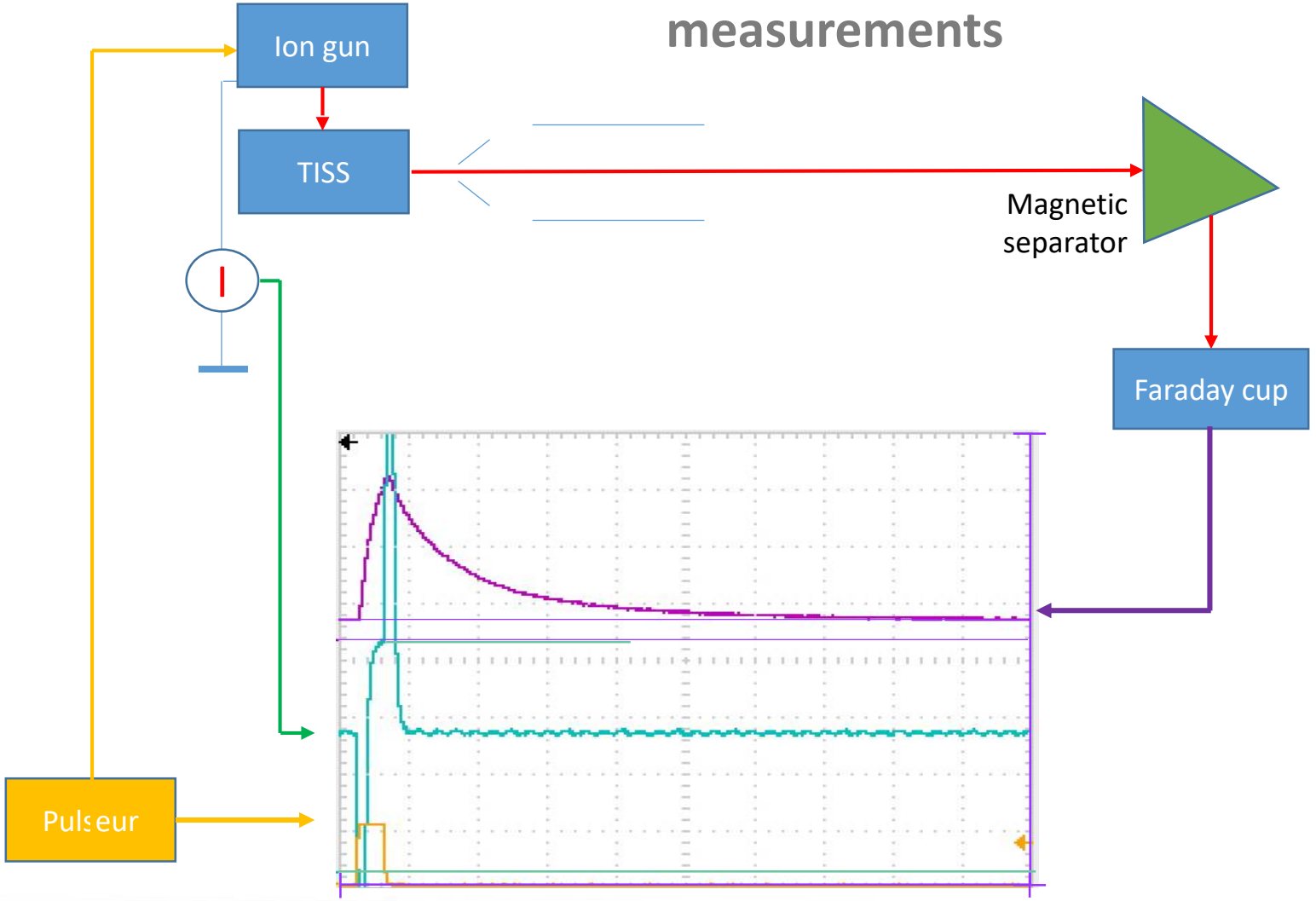
Target characteristic requirements :

- Self supporting
- Thick enough for a sufficient in-target reaction rate and recoils at target exit
- Temperature resistant (over 1400 °C)
- Long lifespan (2 weeks)

Ready for on line tests by 2023-2024

Instrumentation for TISS caracterisation before on-line use

Effusion time and Ionization time measurements



Measurement of TISS time response is crucial to predict production efficiency of radioactive ions

Development of a metallic ion gun:

- Pulsed
- Known ion intensity
- Able to deliver different metals

If succesful, the method could be used to systematically determine the sticking times of metallic elements on different surfaces.

Construction is almost complete

- New production techniques should be tested on line in 2021 (TULIP at ALTO)
- Instrumentation for off-line characterization will be available by june 2021
- The FEBIAD TISS is currently producing RIBs at GANIL
- Important performance improvements and progress in tuning of the charge breeder have been made

➔ New beams and enhanced intensities should be soon available at SPIRAL1

Thank you for your attention !