Existing and future techniques for the production of some specific metallic beams

We have to face two main issues

- *Improvement of the ECR performances*

➔ *We have to improve our knowledge of the plasma ability to transform more or more efficiently atoms (or ions) into multi-charged ions*

- *ENSAR3*

➔ *We have to prepare our proposal*

On-going technical contributions of GANIL to the improvement of the multi-charge metallic ion production

Techniques to inject metallic atoms in an ECRIS

- Evaporation of atoms from an oven
- Sputtering of atoms from an metallic sample in regard with the plasma
- Evaporation of high vapour pressure molecules containing metallic atoms
- 1+/N+

What has been done at GANIL?

On-going technical contributions of GANIL to the improvement of the multi-charge metallic ion production

Which method for which performances?

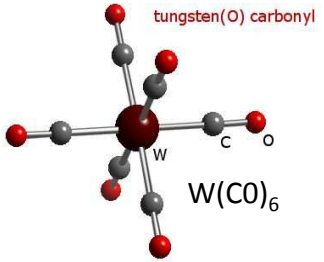
Example 1: W ion production.

By sputtering?

By molecule : Trioxyde (GSI?), carbonyl

Regarding expected performances, what are advantages and drawbacks of each method, considering that the chemistry of each method has a different impact on the performances?

Metallic carbonyls
(Mo, Ru, Rh, W, Re, Os, Ir…..)



Natural tungsten carbonyl has been tested in ECR4

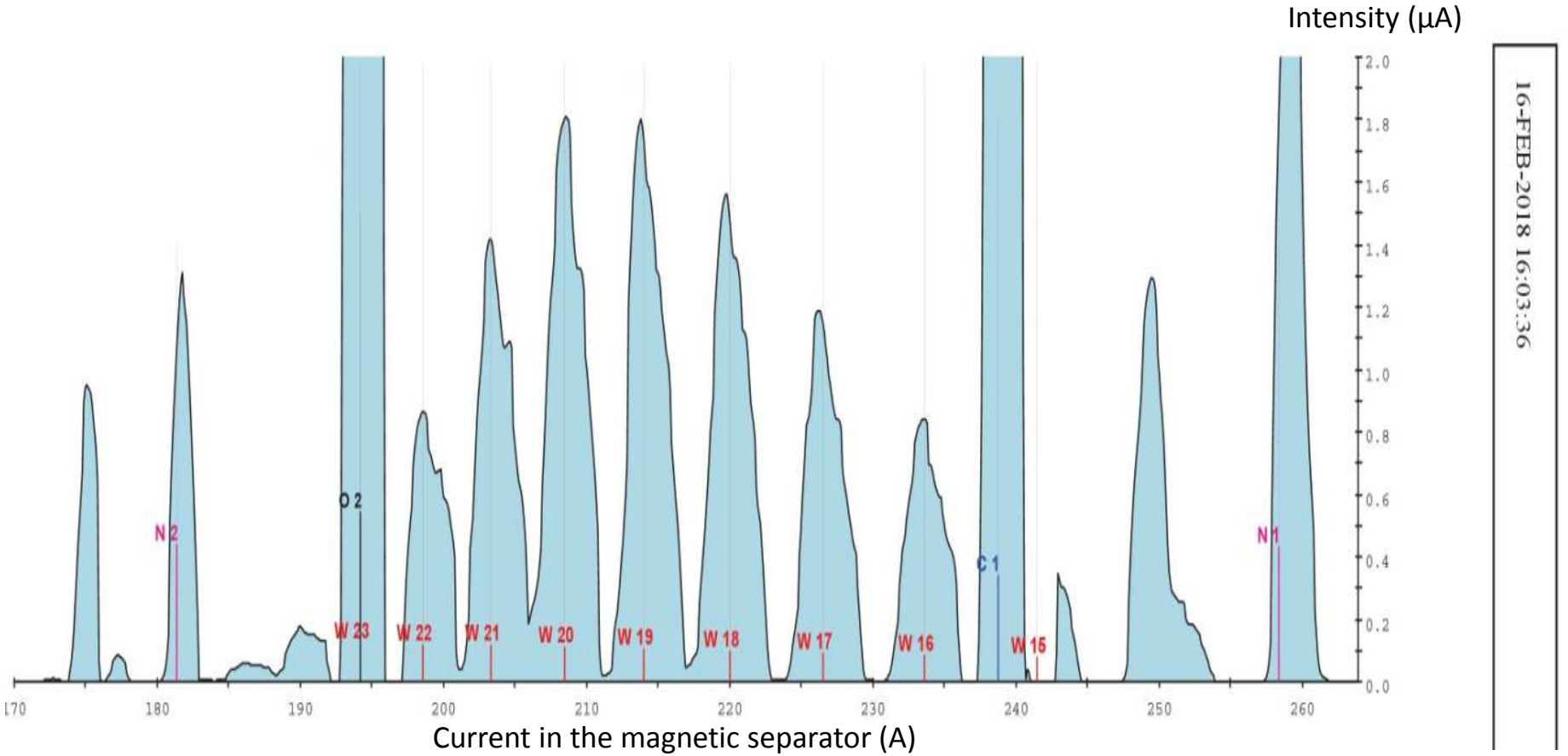
After 8 hours,

- I ($^{184}W^{20+}$) ~ 1,6 µA (=> ~5 µA for 90% enriched sample)

@ T_{MIVOC}=16°C, P_{HF}= 50 W, No support gas

White powder of $W(CO)_6$. To handle with care regarding the chemical risk

Is W of common interest? If yes, how could we work more closely on this subject?



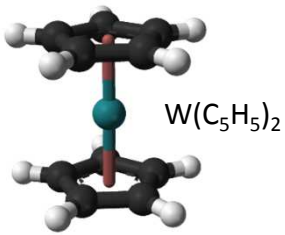
W ion intensity at the exit of ECR4, from tungsten carbonyl molecules

On-going technical contributions of GANIL to the improvement of the multi-charge metallic ion production

Which method for which performances?

Example 2: U ion production?

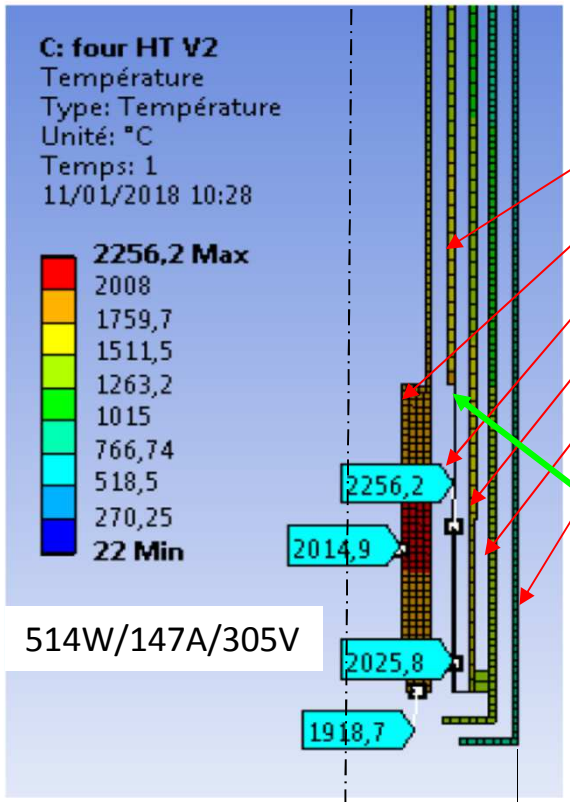
- Most performing method regarding the charge state : sputtering (Riken)
- Should be possible with an oven.
- « Tungstenocen » synthesis currently under development at IPHC in collaboration with Dubna.



What is the status of this development? Who is involved?

Recent and on-going technical contributions of GANIL to the improvement of the multi-charge ion production

- ***Developpement of a 2000°C oven, for U ion beam production***



ANSYS thermal simulation

514W/147A/305V

Oven axis

10mm

Current IN

Crucible

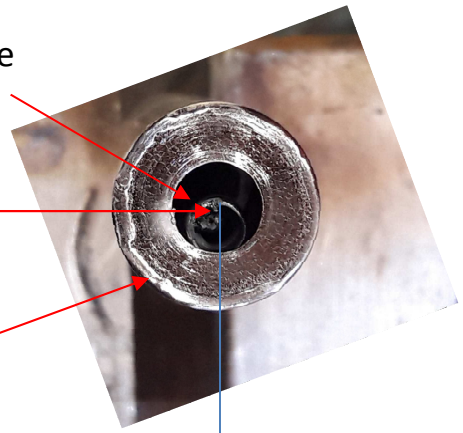
Tubular resistor (Ta 0,1mm thick, 9mm in diam.)

Current OUT

Screen 1

Screen 2 (20 mm in diam.)

Fall of the crucible and short circuit



Bottom

Breaking point after 100h of heating

Recent and on-going technical contributions of GANIL to the improvement of the multi-charge metallic ion production

Developpement of a 2000°C oven, for U ion beam production

- Important difference between thermal and electrical simulations (ANSYS) and measurements (~+250°C for exp. 2000°C, ~+30A for exp. 150A). Theoretical inputs must be improved.

➔ Systematic measurements of resistivity and emissivity in identical conditions are under progress at GANIL for « high » temperature materials (Ni, Co, W, Re, Ta, Mo, Nb, Ir, V, Ti, Cr, Sc, Fe, Ru, Rh, Hf, stainless steel)

- 0,1 mm Ta oven needs a high current (150A), which could be reduced to 100A by using a Re resistor 0,05mm thick, and so reducing the heating of the upstream and downstream current connections

- Ta crucible support and its mechanical connection are too flexible at high temperature. Must be fixed

Is a high temperature oven of common interest? If yes, what could be the organisation to lead it?

On-going technical contributions of GANIL to the improvement of the multi-charge metallic ion production

Evaporation of atoms from an oven :

Need to deal with the chemical interaction of the element of interest with its surrounding (solid, gas, plasma) at a temperature which depends on the flux of atoms expected

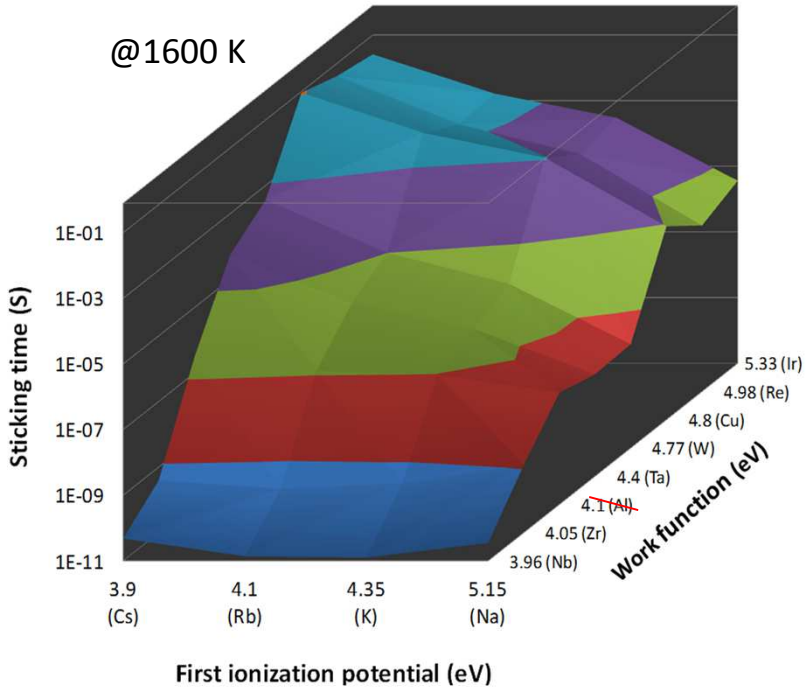
On-going study: sticking of atoms on solid surface: are there clear trends which can be easily deduced from atom and surface characteristics?

For alkali atoms, clear dependance of the sticking time with the first ionisation potential of atoms and the work function of the surface material (to be published)

➔ *Easier optimisation of the surrounding materials*

What about atoms other than alkali?

➔ *Under study*

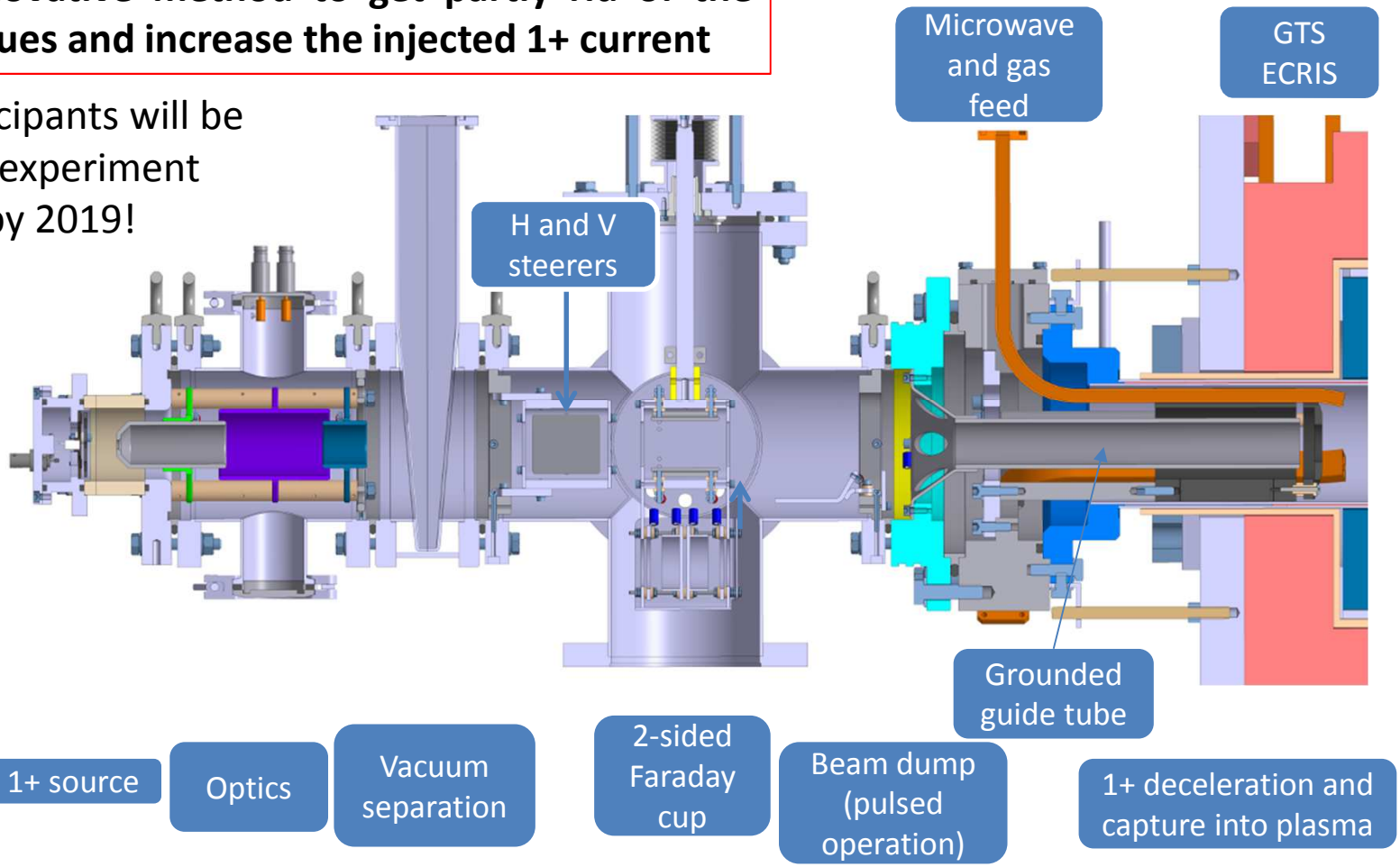


Common data base could be useful

On-going technical contributions of GANIL to the improvement of the multi-charge metallic ion production

1+/N+ : Innovative method to get partly rid of the chemical issues and increase the injected 1+ current

MIDAS participants will be welcome to experiment the system by 2019!



What could be our collaboration within ENSAR3?

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Recall

ENSAR2 *is the integrating* ***activity for European nuclear scientists*** *who are performing research in three of these major subfields:* ***Nuclear Structure, Nuclear Reactions and Applications of Nuclear Science****.*

➔ **Our objective must serve this goal**

But

- How to determine which beams and thus associated instruments we have to develop in priority regarding the numerous demands of physicists at the european level?
- Who, or which organisation, has a sufficient overview to extract the priorities from the fundamental and applied physics needs?
- If we have no clear direction given by an european Physics Advisory Comittee and by a committee of industrial experts, the R&D orientation are given by
  - The local PACs (which ask for beams, not for specific instruments)
  - The local issues or ideas (of instruments, which do not answer a specific beam demand)
- Why collaborating on a topic specific to a local need ?
  - when demands, issues or ideas are the same in different facilities or laboratories

What could be our collaboration within ENSAR3?

- **Where are listed the demands at the european level?** (And even at the world level to know how competitive we can be)?
- **What are the issues (one of the major concern of MIDAS)?**
- **What are the new ideas?**

Once subjects of common interest identified, how can we work on them together in a more efficient way?

By building a development program around a given topic, sharing the work among interested laboratories, asking for money for material and travels, delivering new results and performing instruments

i.e. ➔ Submitting a JRA collaboration within the ENSAR3

➔ Using TNA funds to perform common experiments

Rq: according to the PCC meeting report of Groeningen (19th of April, 2018), for the moment, everything seems to be possible.

Thank you for your attention