A new resistive high temperature oven for metallic beams production

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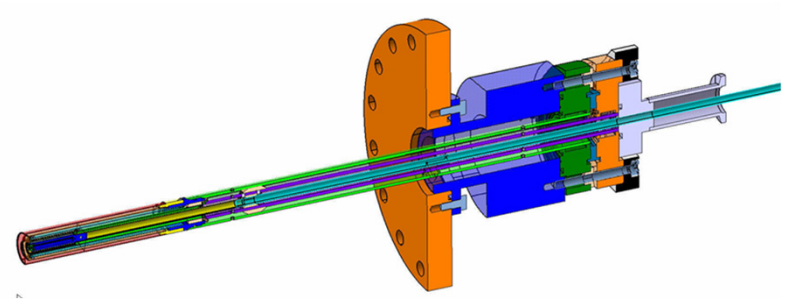


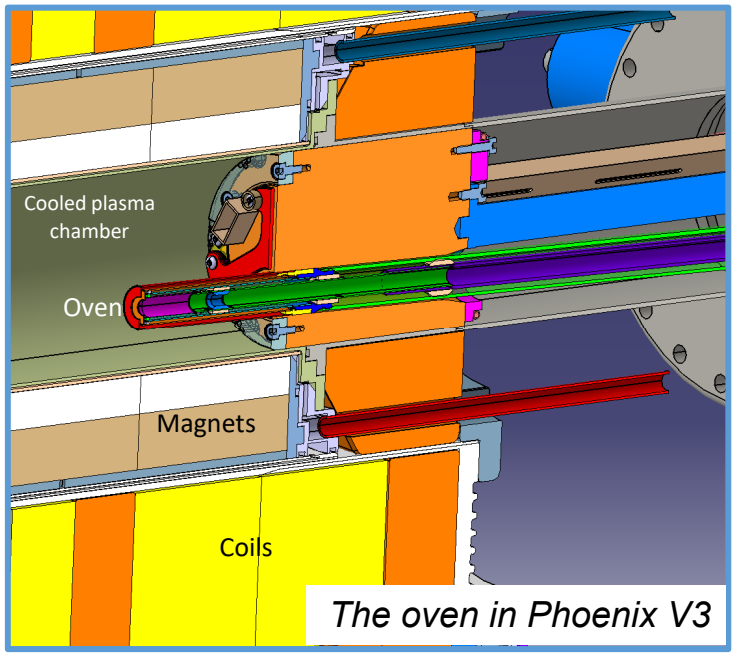
Specification

- ✓ For the Super Separator Spectrometer (S^3) on Spiral 2 in ***Phoenix V3**** ECR IS:
  - → ^{58}Ni, ^{50}Cr, ^{50}Ti or ^{50}V… ~ **$1.2\ 10^{13}$ pps**
- ✓ For Ganil-Cyclotrons in ECR4 source:
  - → increasing refractory metallic beams intensities included Uranium beams.

- ❖ Lifetime : 2-3 weeks.
- ❖ Removable head

Technical challenges

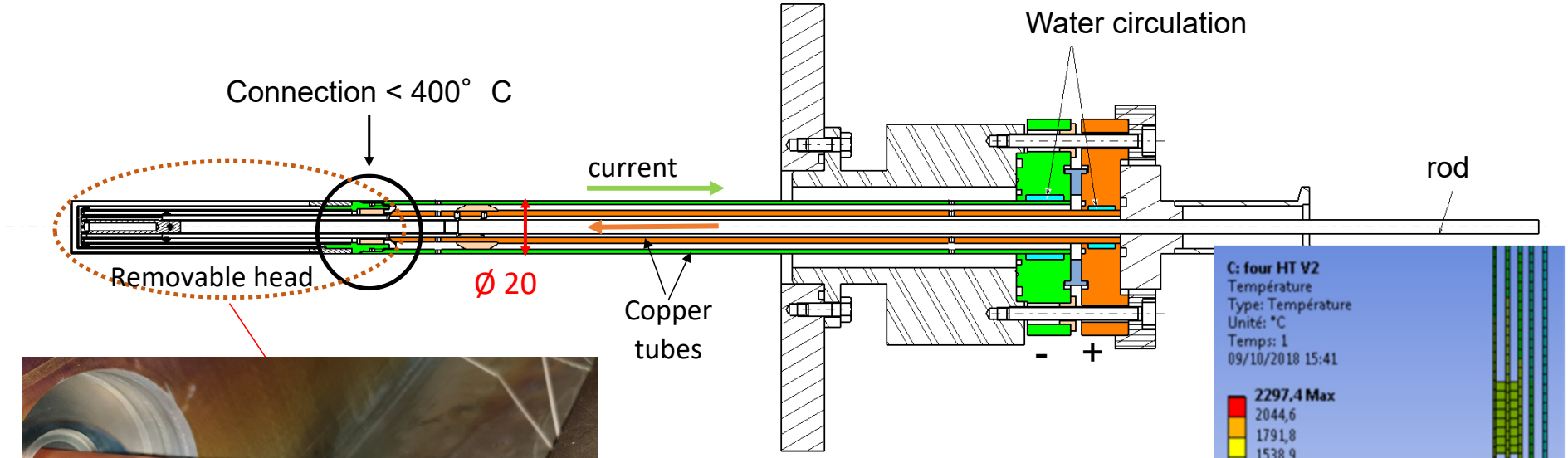
- Integration in sources (ϕ < 20mm)
- High temperatures (1500°C to 2000°C)
- Presence of a magnetic field (~1 Tesla)
- Crucible design and material for liquid metals

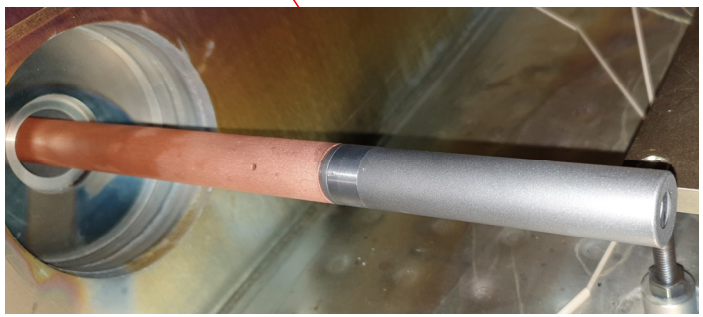


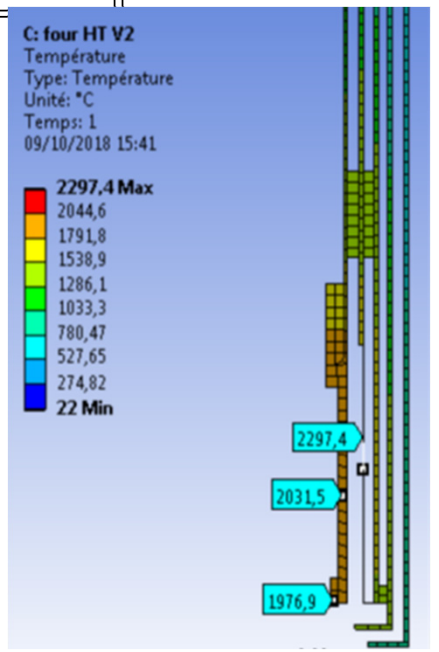
The oven in Phoenix V3

developed by **LPSC (Grenoble)*

The oven design



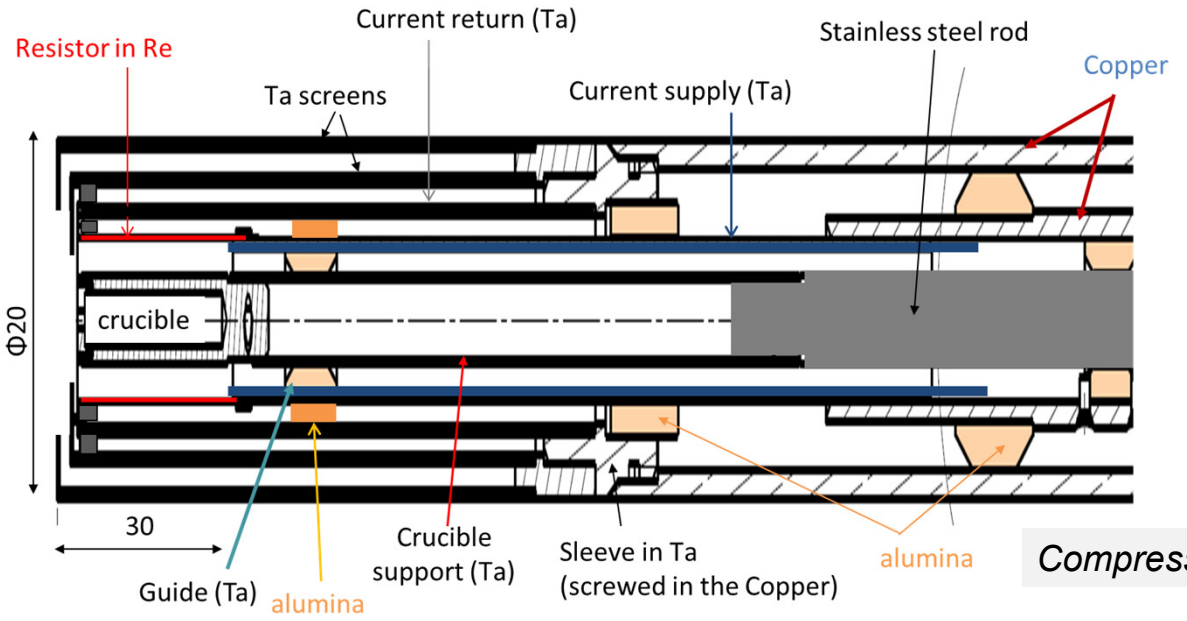




- Up to 2000° C in crucible
- < 400° C at junction head / cooled current supply

The head design

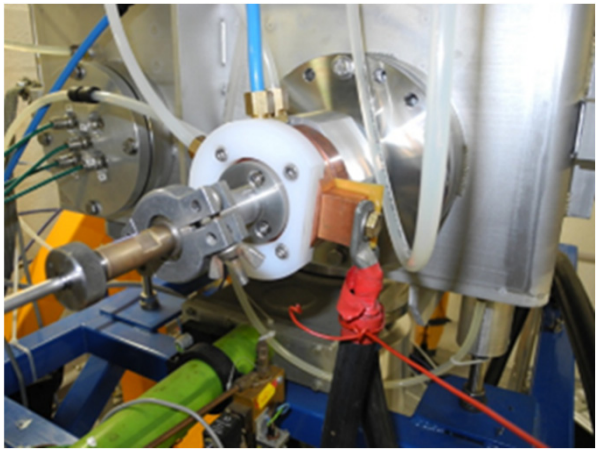
- The resistor is a tube → no Laplace force by the magnetic field
- **Rhenium.** Thickness 0.05 / ϕ 9 / L 35 mm
- Laser-welded

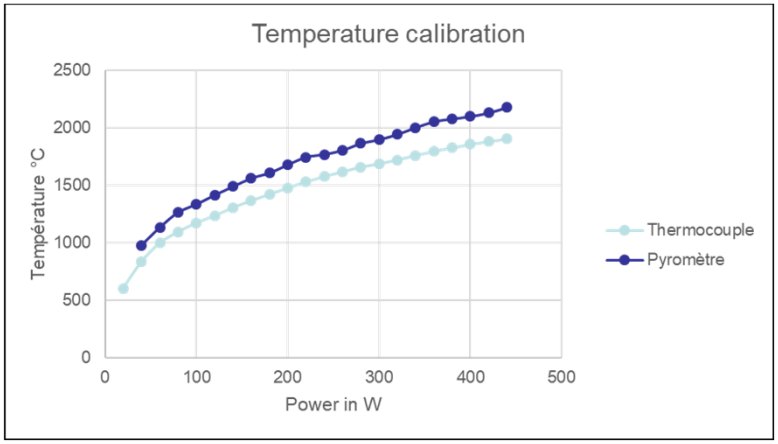


Tantalum tube and rings are embedded

Compressed scale

Off-line test





First test in heating test bench

- A thermocouple type C (W/W-Re) is inserted in the place of the crucible
- The temperature of the resistor is measured by pyrometer

➢ During 8 days **T > 1900°C** in crucible and **~2100°C** on the resistor **P ~ 400 W** (107 A / 3.4 V)

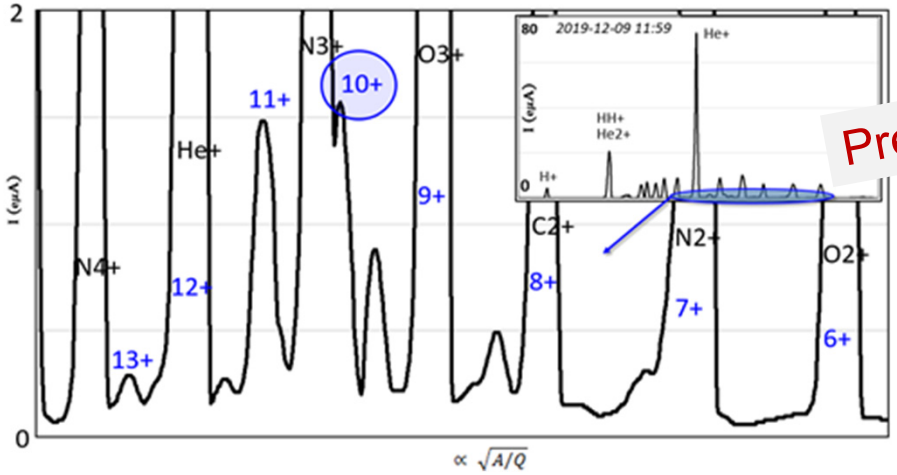
→ **No degradation was observed.**

Validation of the oven in ECR4

Oven integrated in ECR4M on Ganil cyclotrons injector

- ✓ Oven at 1800°C (~90 A) with magnetic field but without plasma → oven OK.
- ✓ Oven OFF and source optimized in Ar^{9+} to check source performances with the oven → OK
- ✓ Titanium beam produced from 173 to **214 W** (1550°C in crucible according off-line calibration) but melting point (**1660°C**) has been reached due to plasma contribution.

Titanium beam

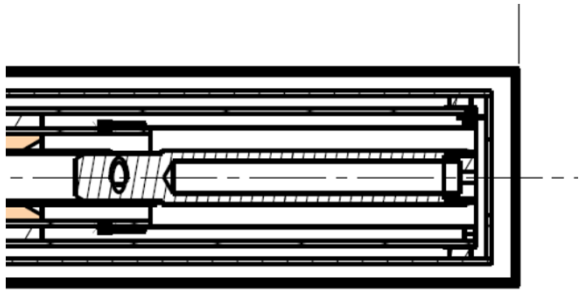


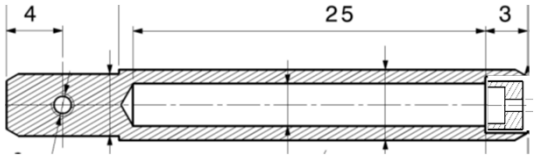
Preliminary test

Oven 214W/78A
RF 167W/10W
Support gas : Helium

- ✓ **O_2** as support gas → Nitrogen due to Boron Nitride isolators**.** Will be replaced by **Al_2O_3**

The crucibles



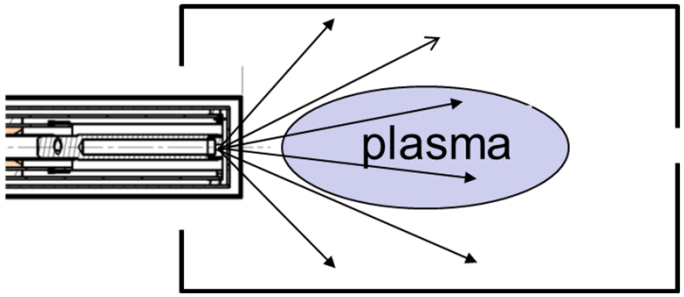


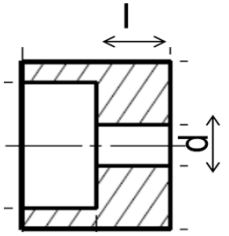
Volume: 175 mm^3

- For Ni, Cr, Ti, V… → crucible in WL20 (W alloy 2% La_2O_3)
- For liquid Uranium → crucible in Y_2O_3

Flux and angular distribution measurement

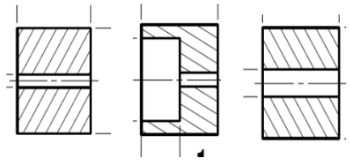
Goal: reduction of angular dispersion to increase efficiency





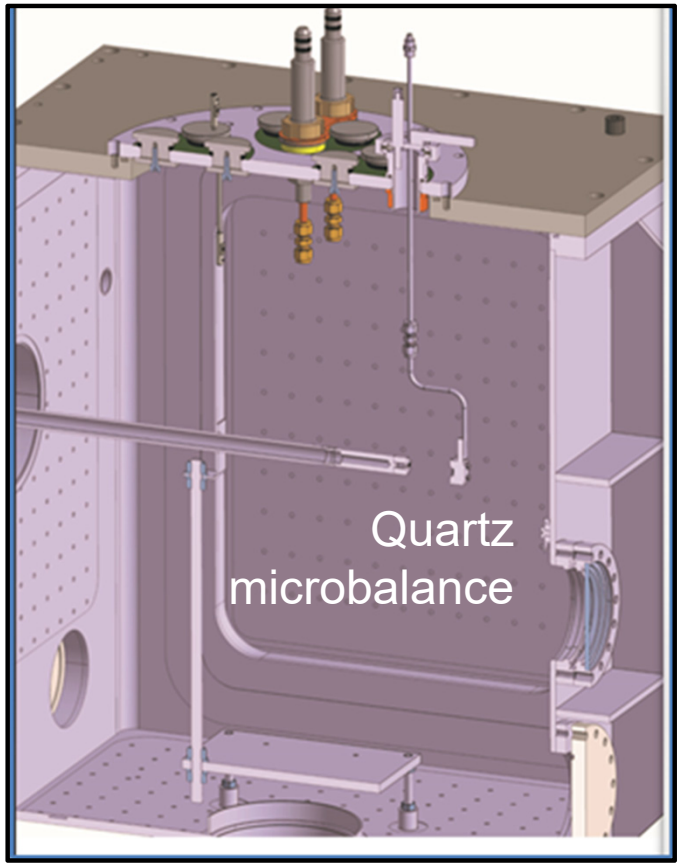
Crucible cap

Angular distribution narrower if $\frac{d}{l}$ $lower$.



Tests with different caps geometries (hole diameter and length)

- Limitation: risk of plugging the exit hole.



Conclusion

- ✓ Operation of the oven off-line satisfactory
- ✓ ECR4 + oven on-line : OK but boron nitride to be replaced

- ➢ New test on-line in ECR4 planned this year
- ➢ Crucible geometries to be optimized by off-line flux measurement
- ➢ Integration in Phoenix V3 underway

Thank you for your attention.