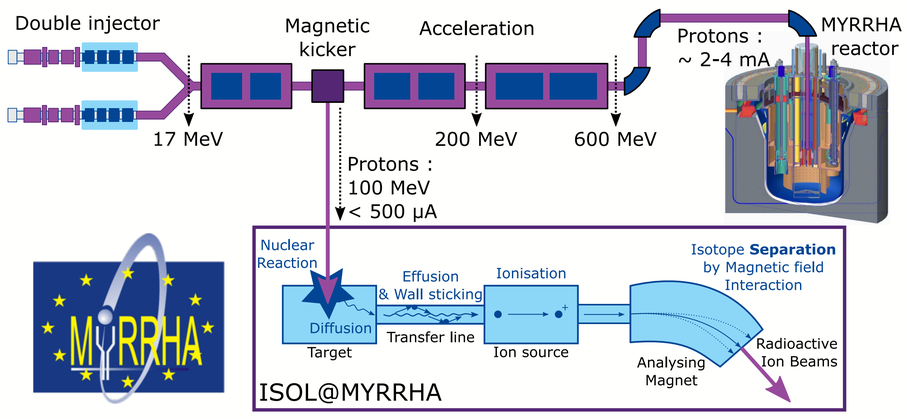
Radioactive ion source experimental study for ISOL@MYRRHA

Sophie Hurier[1,2],**Kim Rijpstra**[1], **João Pedro Ramos**[1], **Philip Creemers**[1], **Lucia Popescu**[1] & **Thomas Elias Cocolios**[2]
[1]Belgian Nuclear Research Centre, SCK CEN, Belgium
[2]KU Leuven, Institute for Nuclear and Radiation Physics (IKS), Belgium.
E-mail: sophie.hurier@sckcen.be

Introduction to ISOL@MYRRHA

MYRRHA: **M**ulti-purpose h**Y**brid **R**esearch **R**eactor for **H**igh-tech **A**pplications World's first large-scale **Accelerator Driven System** project at power levels scalable to industrial systems.

ISOL@MYRRHA: will **extract part of the proton beam** coming from the accelerator and use it to **produce** **R**adioactive **I**on **B**eams (**RIB**s) with the **I**sotope **S**eparation **O**n-**L**ine (**ISOL**) technique.



Increase the isotope production by:

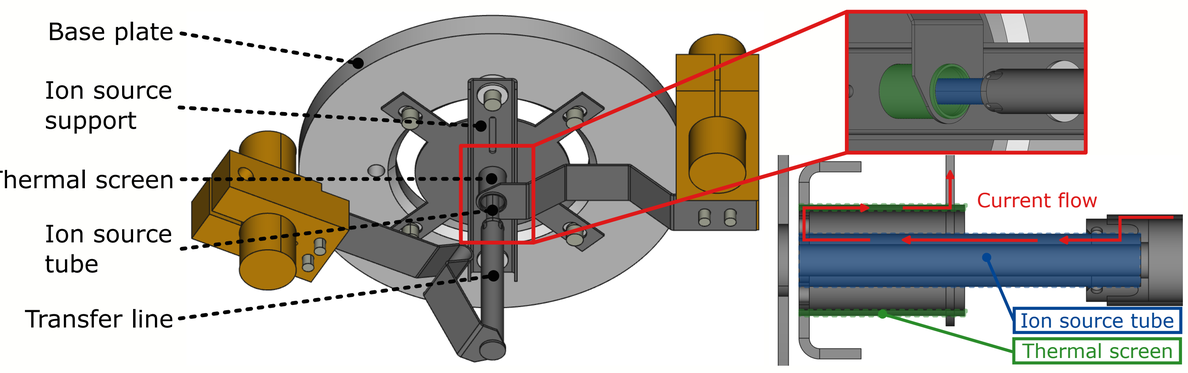
- Using high intensity primary beams
- For a longer period of time
- Maintain the radioactive ion beam quality

New surface ion source design

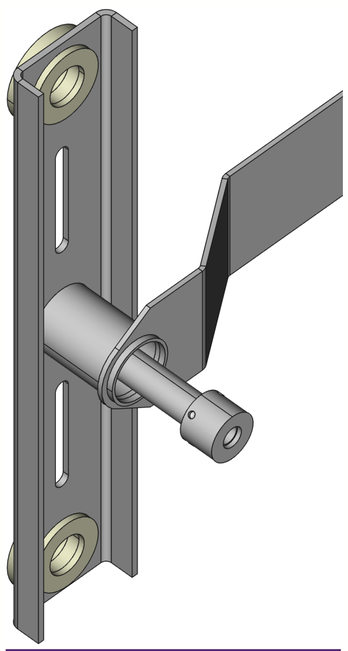
Improve surface ion source heating:

- **Add a second feedthrough** for the heating system electrical current: one input & one output
- **Insulate electrically (& Thermally)** the heating system from its base plate with washer
- **Transform a passive thermal-screen into an active part**

ATS-HS: Active Thermal Screen Heating System

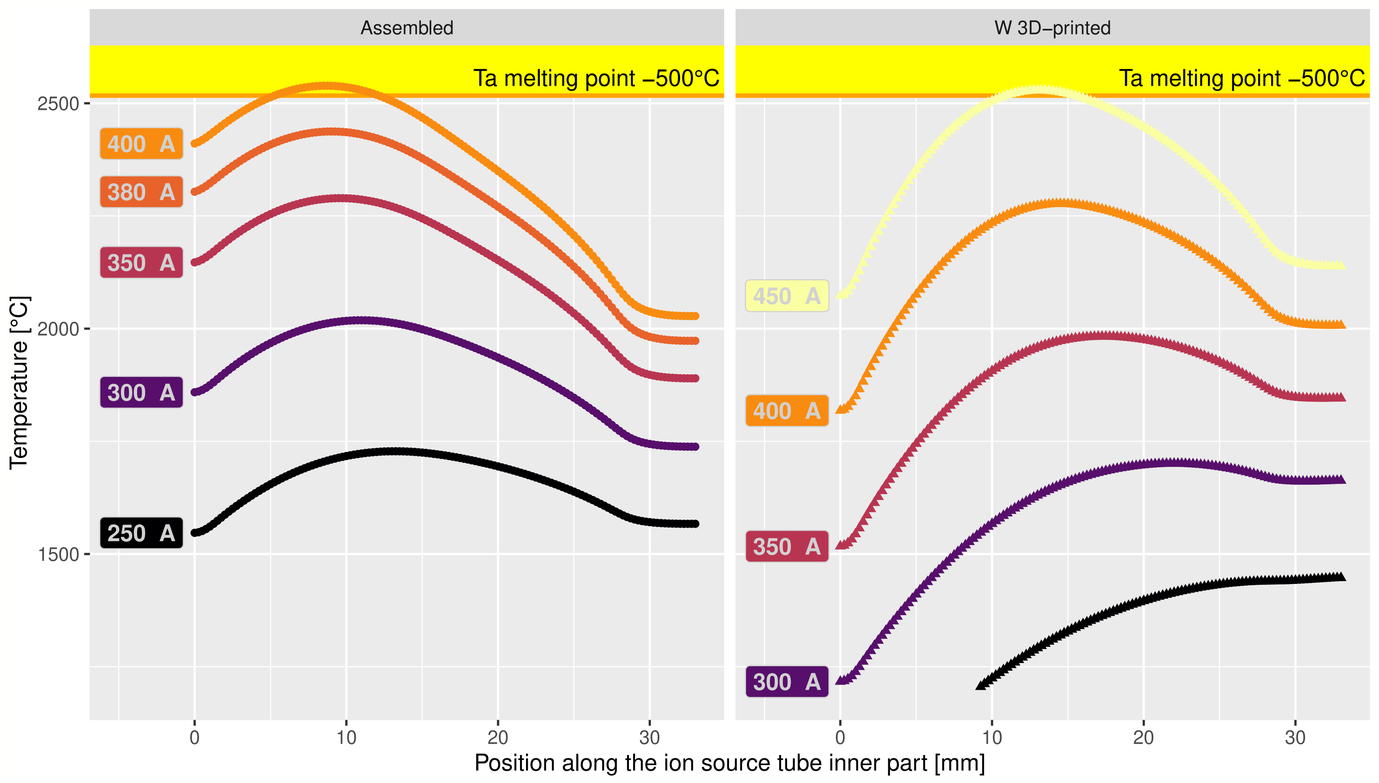


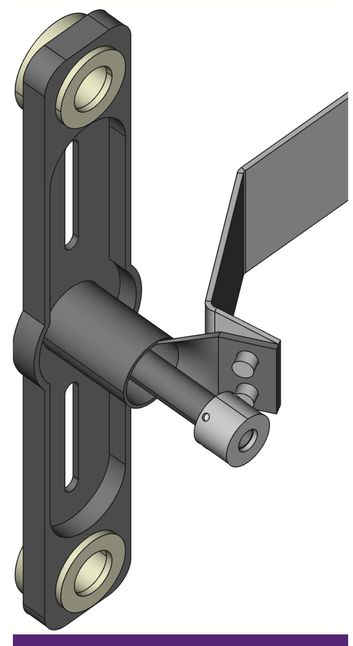
Tantalum vs Tungsten



Assembled

Made in **Tantalum**





3D-printed

Made in **Tungsten**

Use **conventional manufacturing process**

Ion source tube thickness: **1 mm**

Simple, good thermal-electric properties, well-known material (much experience)

Less reliable manufacturing due to many manual steps

Surface ionisation properties		
3017°C	Melting point	**3422°C**
4.25 eV	Work function	**4.55 eV**
Thermal-electric properties		
6.3 µm/(m·K)	Thermal expansion at 25°C	**4.5 µm/(m·K)**
57.5 W/(m·K)	Thermal conductivity	173 W/(m·K)
131 nΩ.m	Electrical resistivity at 20°C	52.8 nΩ.m

Material properties from [1]

3D-print by Volum-e:
A single piece in a single process:
Laser Beam Melting on Powder-Bed (LBM-PB)

Ion source tube thickness: **0.85 mm**

Good surface ion source properties, **printing opens new design possibilities**, reliability to be studied

Technology under development, tungsten can be a brittle material

Unknown material behavior:
3D-printed ≠ Bulk material properties?

Follow up

- **Measure 3D-printed material properties:** Thermal-electric properties as a function of the temperature
- **Test and compare** the design on the **SCK CEN thermal-test bench**
- **Validate** ANSYS [2] thermal-electric simulation [3] with experimental result
- **In situ ion source test** on the Leuven Isotope Separator [4] or CERN

References

[1] W. Haynes, *CRC Handbook of Chemistry and Physics*, CRC Press, **2016**.
[2] ANSYS, <www.ansys.com>.
[3] S. Hurier, K. Rijpstra, P. Creemers, J. P. Ramos, L. Popescu, T. E. Cocolios, *Journal of Physics: Conference Series* **2022**, *2244*, 012065.
[4] T. E. Cocolios, M. Huyse, A. Vantomme, *Nuclear Physics News* **2017**, *27*, 18–22.

Acknowledgements
This research received funding from the MYRRHA project of SCK CEN and Research Foundation Flanders FWO (Belgium) under contract FWO SBO Tb-IRMA-V No. S005019N. It is also part of the PRISMAP project funded within H2020 under grant agreement No. 101008571

Exploring a better tomorrow
www.sckcen.be