Design and thermal simulations towards a high intensity radioactive ion source for ISOL@MYRRHA

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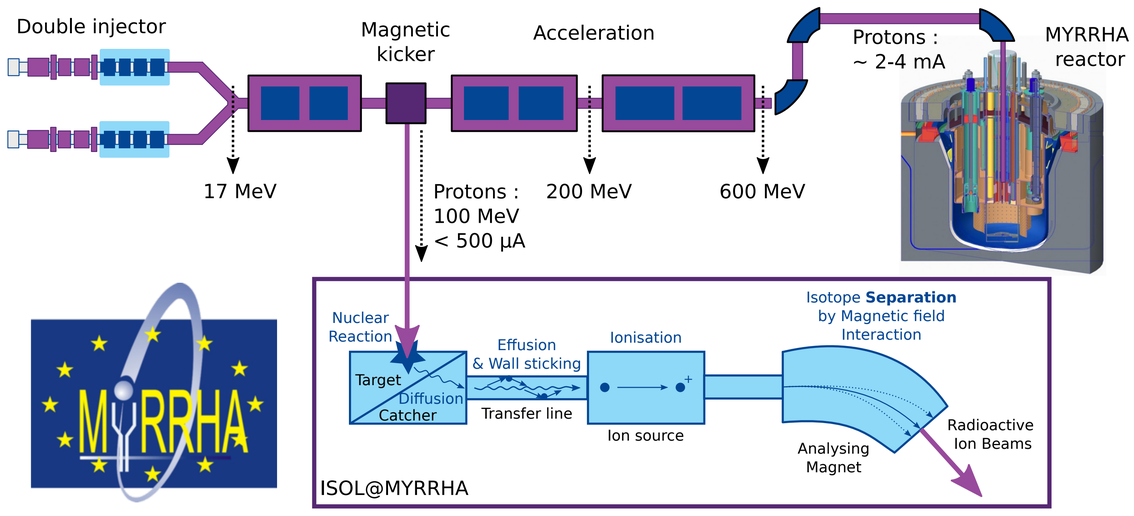
Introduction to ISOL@MYRRHA

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.

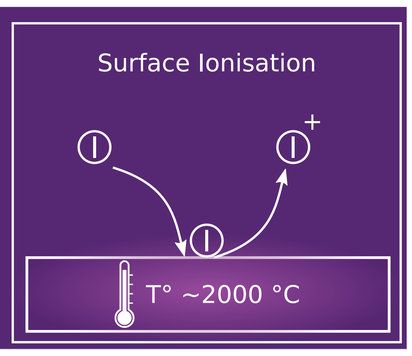
Increase the isotope production by:

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

Objectives

Surface Ion Source:
reliable & simple design

When an isotope interacts with a heated surface, it can lose or gain an electron before leaving the surface.

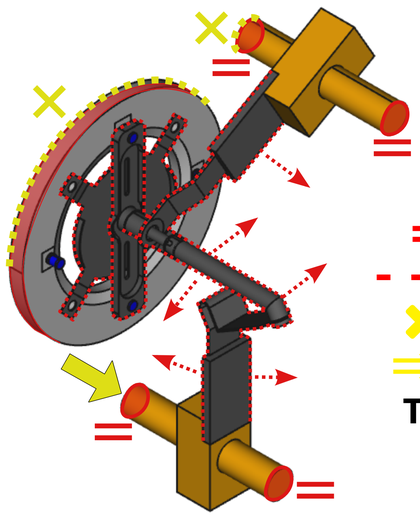


How an adapted ion source can be build to ISOL@MYRRHA conditions?

Improve the cavity temperature profile at **higher atom influx** with:

- **Similar or higher total efficiency**
- **Higher output intensity, beam quality.**
- **A robust design**

Simulation Setup



3D-Model & ANSYS thermal-electric simulation [1] **validation with existing data: coming** from a study [2] from the SPES project.

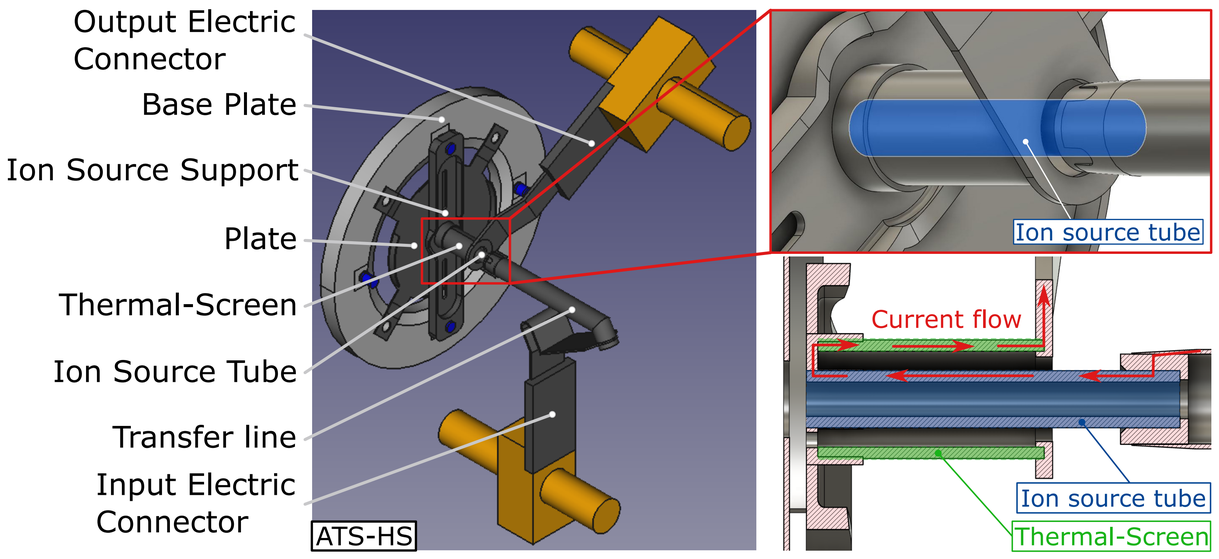
ANSYS boundary conditions:

- **Temperature** T_{constr} = 25°C,
- **Radiation emissivity** ϵ_{Ta}(T°) of tantalum,
- **Voltage constraint** at 0 V,
- **Current load** at 380, 350, 300 & 250 A,
- **Material** High work function (φ=4.19 eV), High melting point (~ 3000 °C).

References

[1] *ANSYS*. <www.ansys.com>.
[2] M. Manzolaro et al. In: *Rev. Sci. Instrum. 88, 093302* (Sept. 2017). <doi.org/10.1063/1.4998246>.
[3] *Starfish*. <www.particleincell.com/starfish>.

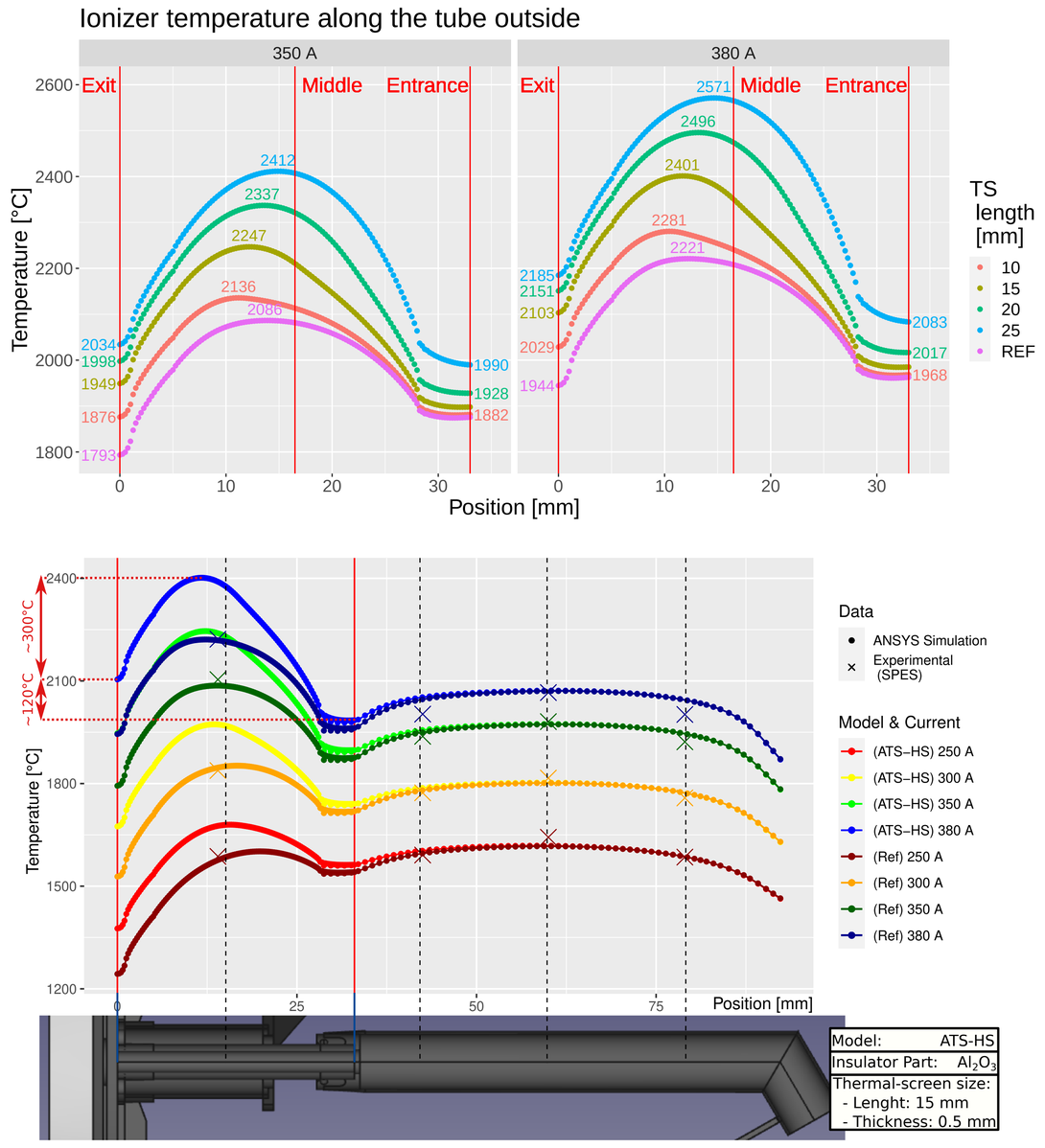
New ion Source Design



Improve surface ion source heating:

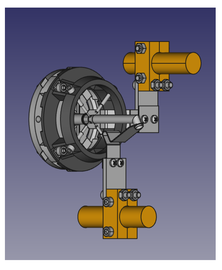
- **Add a second feedthrough** for the heating system electrical current : one input & one output.
- **Insulate electrically (& Thermally)** the heating system from its base plate with washer & with a 45° rotation of the plate
- **Transform a passive thermal-screen into an active part**

Thermal-screen Impact



To do Next

An **ion source with a higher temperatures at its output** was designed, the next steps are to:



- **Add alignment system** similar to SPES SIS to avoid the source displacement after the material thermal expansion
- **Manufacture** & **Construct** the different pieces
- **Test** on the SCK CEN **Thermal-Test Bench**
- **Estimate & Understand** the source physical mechanism with **Plasma simulation**: **Starfish** [3], an ElectroStatic Particle-in-Cell (ES-PIC) 2D code

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