The target-ion source system for the SPES facility commissioning: design, development and online testing

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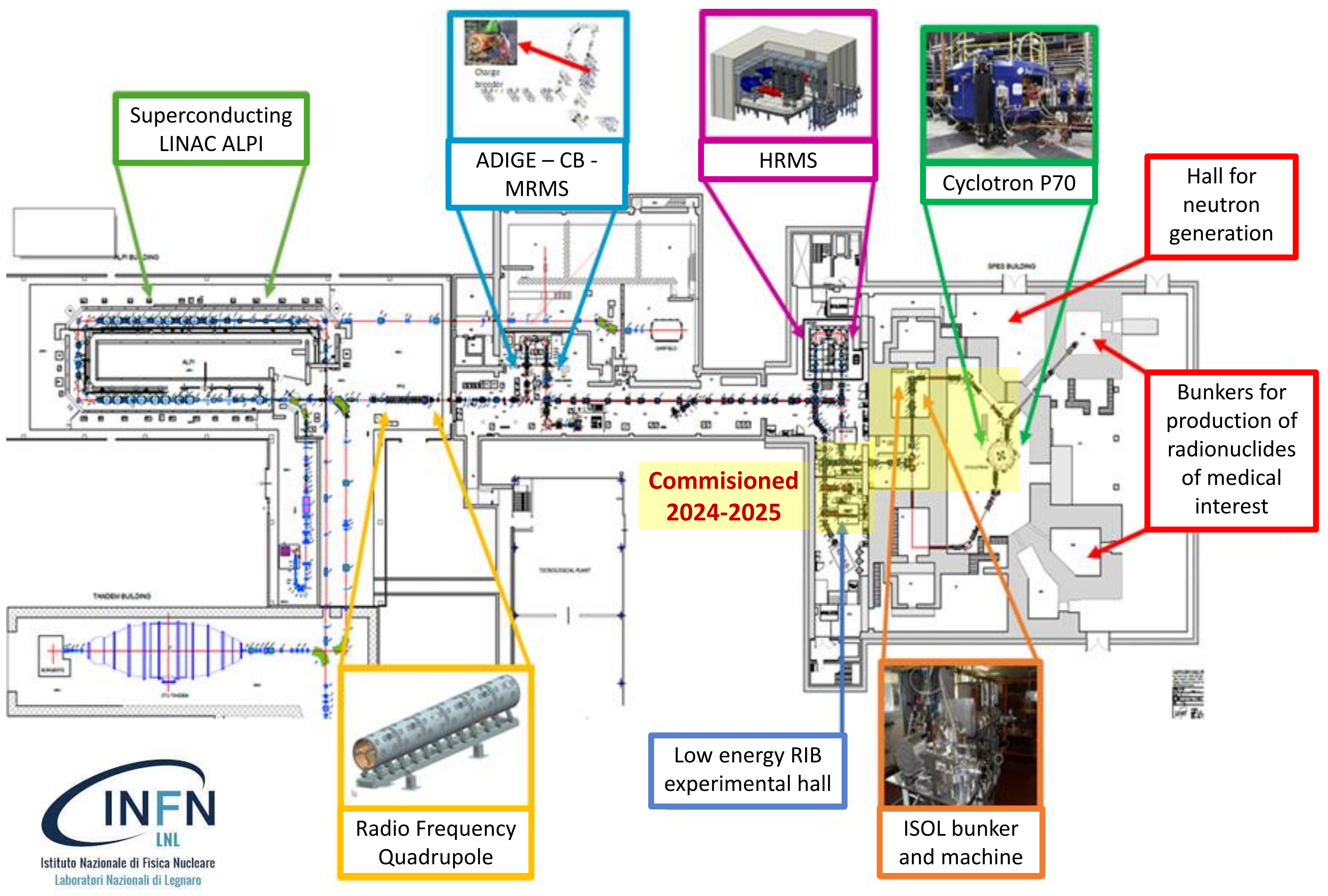
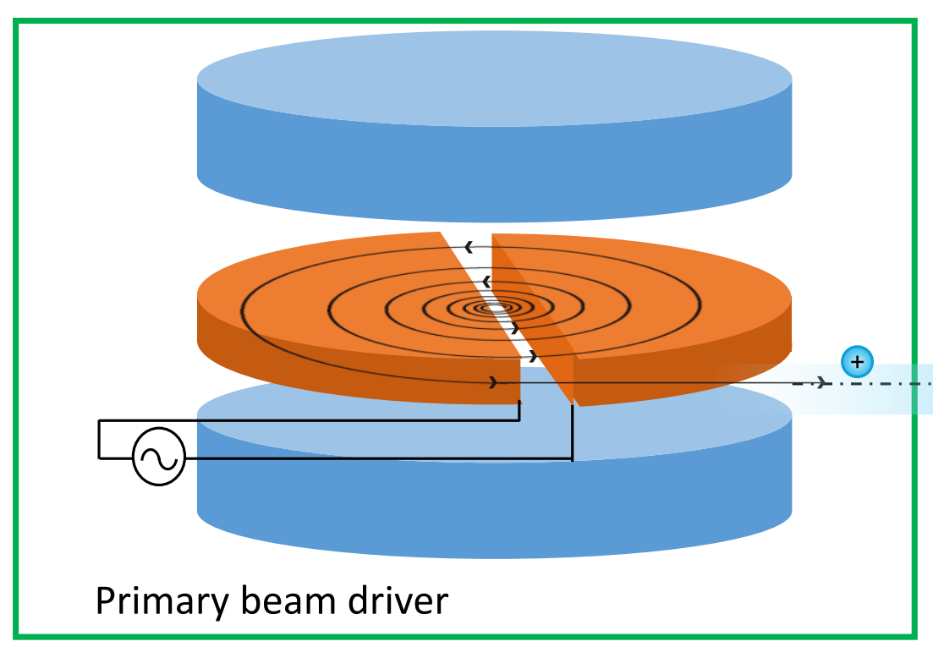
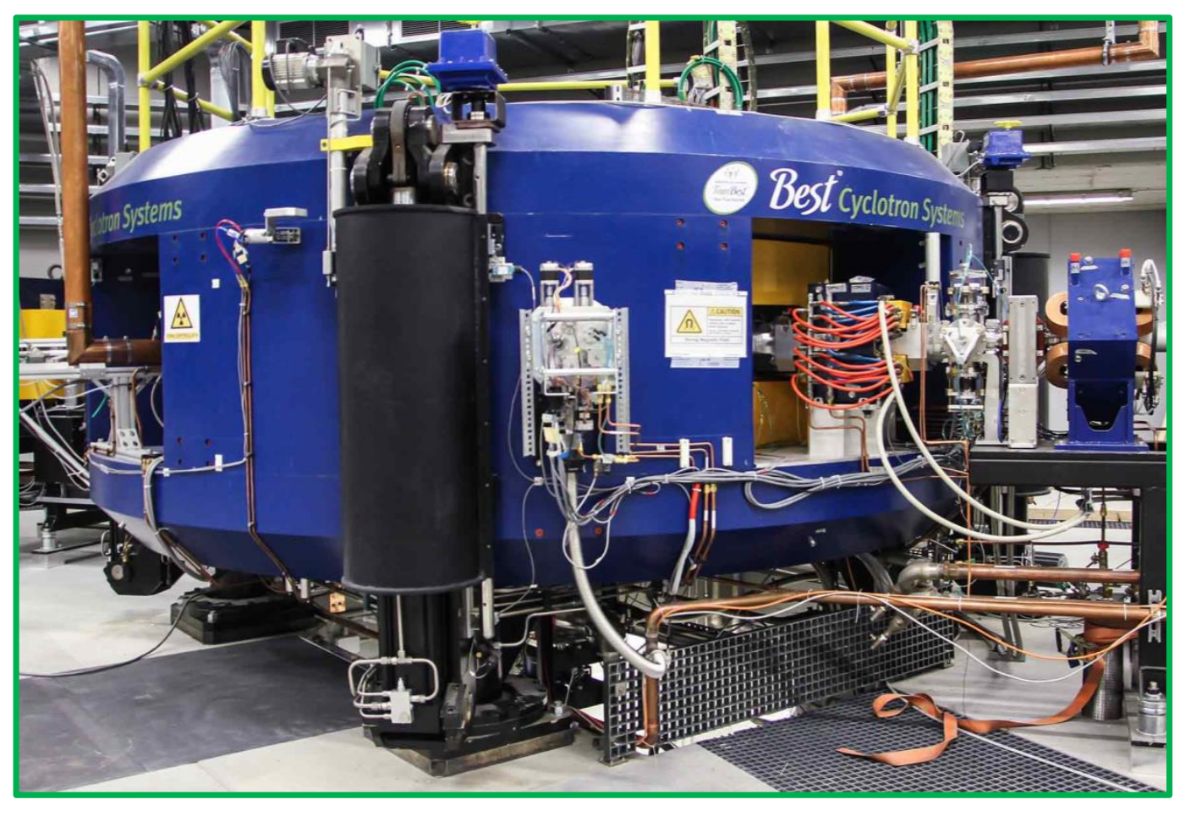
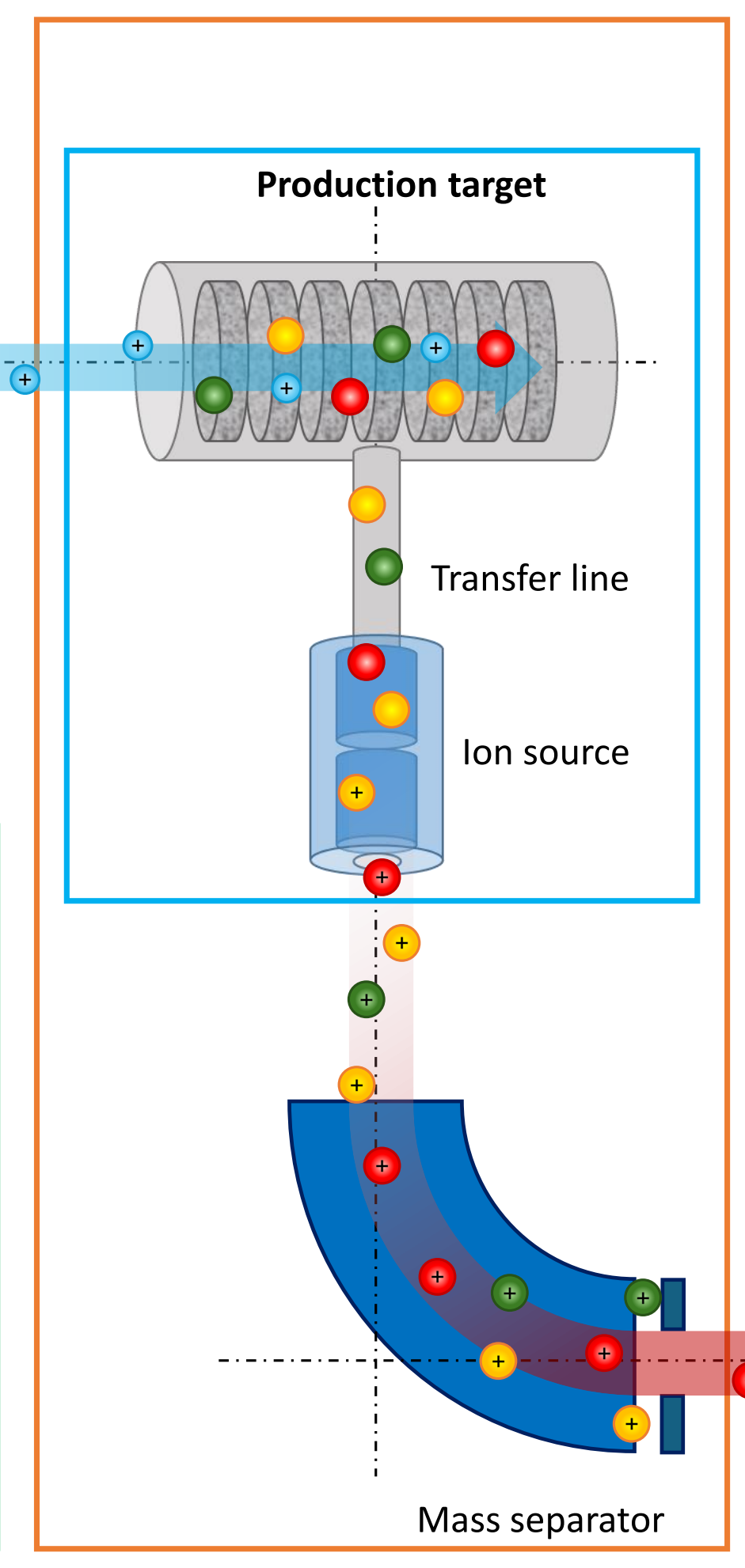
The SPES-ISOL facility

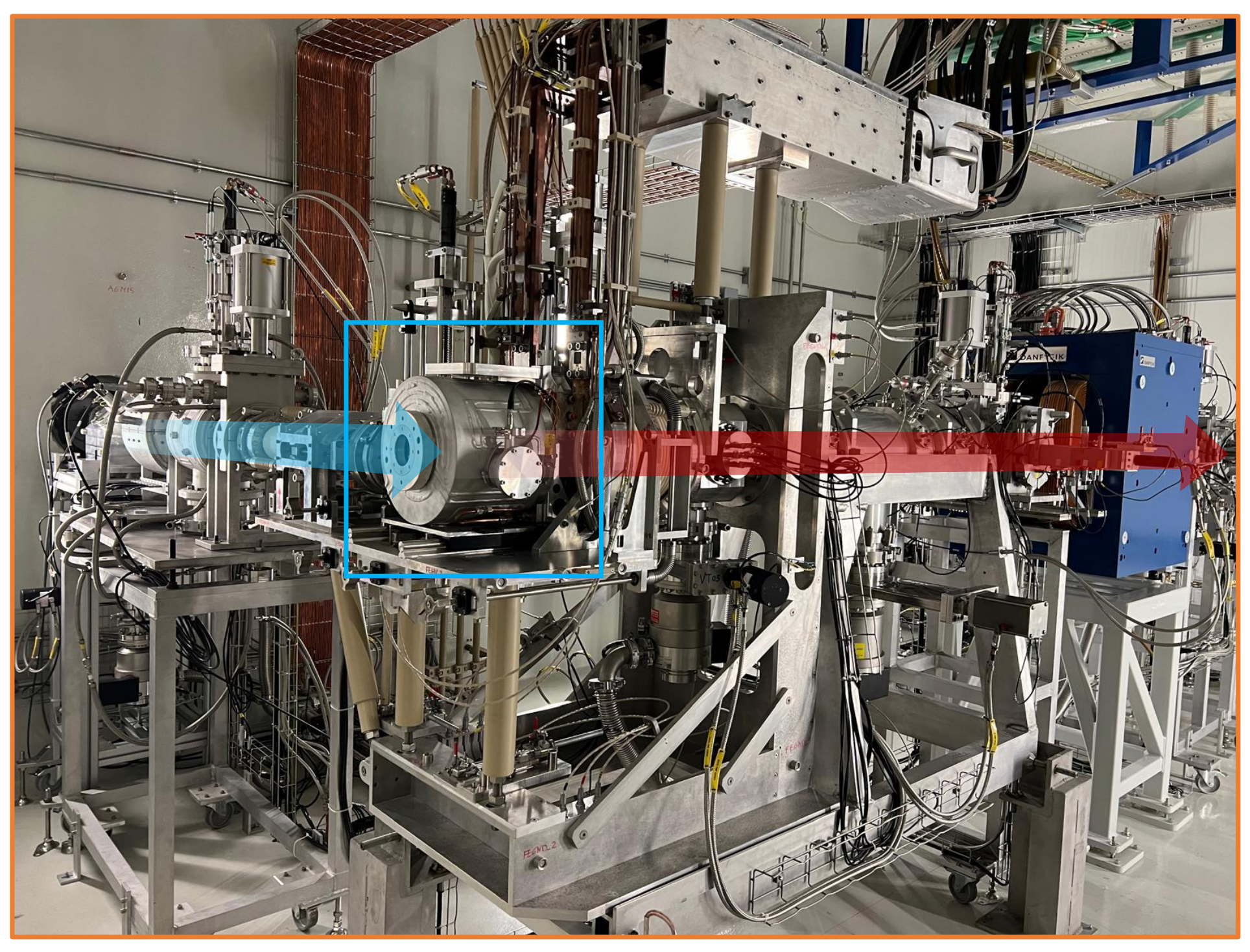




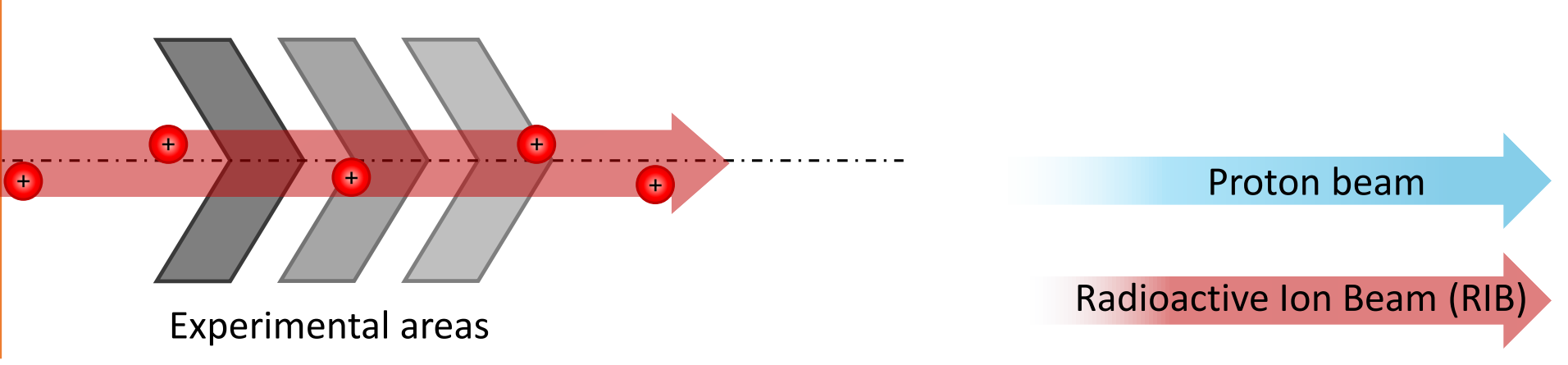
BEST® P70 cyclotron at INFN-LNL







The SPES ISOL machine

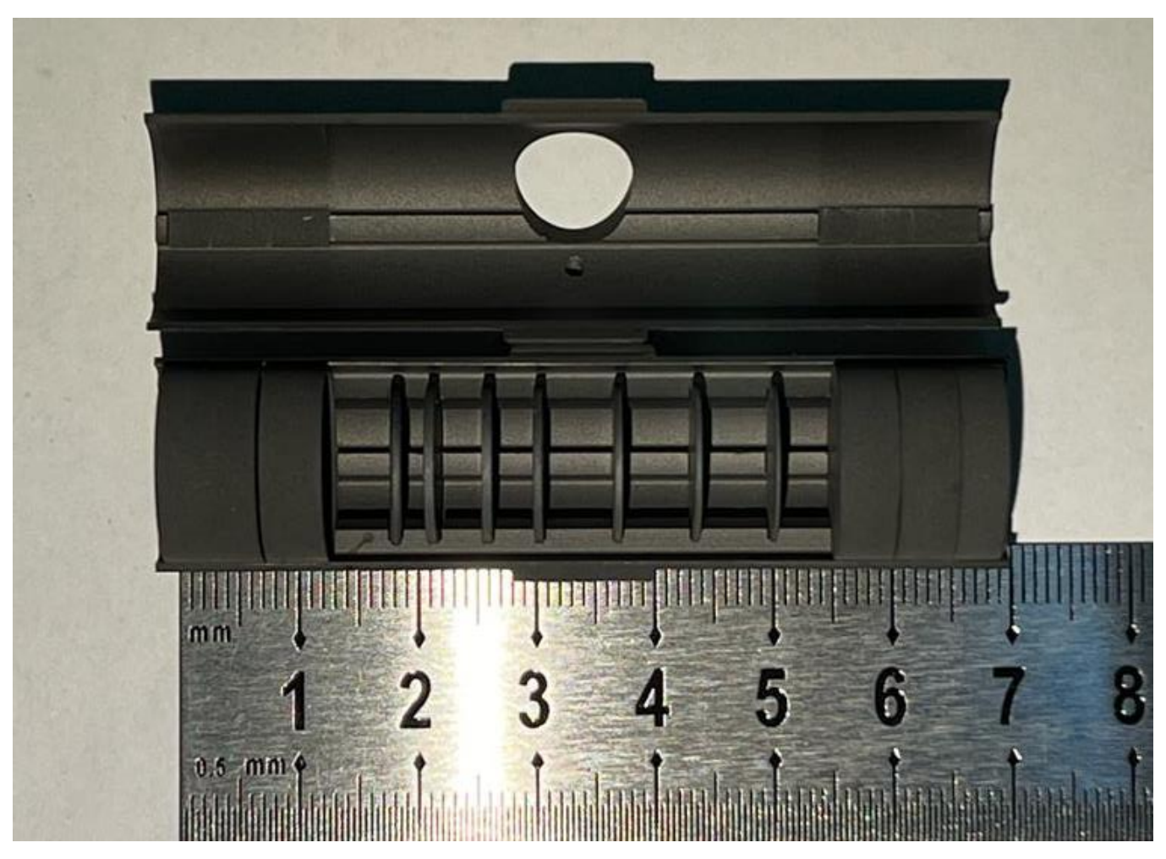


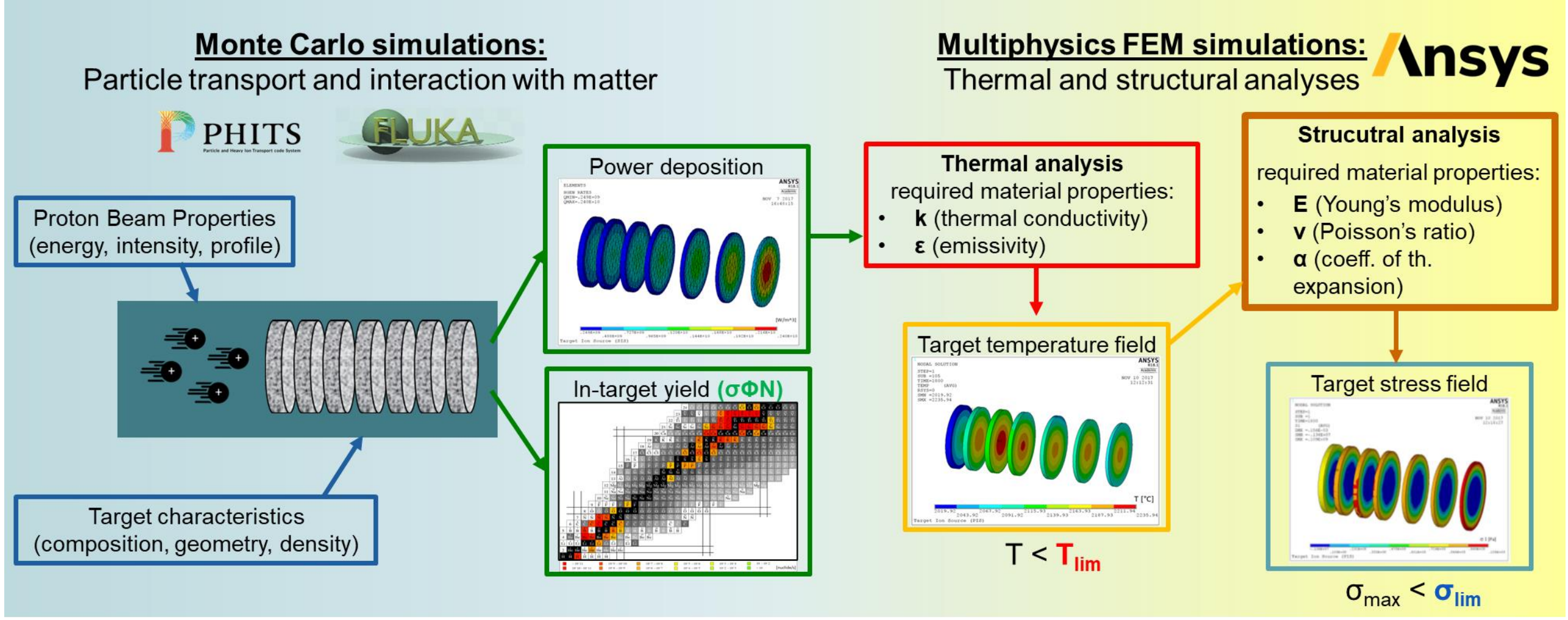
The Target-Ion Source system

Silicon Carbide (SiC) target

Hexoloy® **SiC SA:**

- Commercial high-performance Silicon Carbide crafted by SAINT-GOBAIN
- **High density:**
  - Good for **thermal and mechanical properties**
  - Not optimal for **isotope release** (low diffusion rates)
- Fully characterized for relevant **mechanical and thermal properties [1]**





Monte Carlo simulations:

Particle transport and interaction with matter

Multiphysics FEM simulations: Ansys

Thermal and structural analyses

Thermal analysis

required material properties:

- **k** (thermal conductivity)
- **ε** (emissivity)

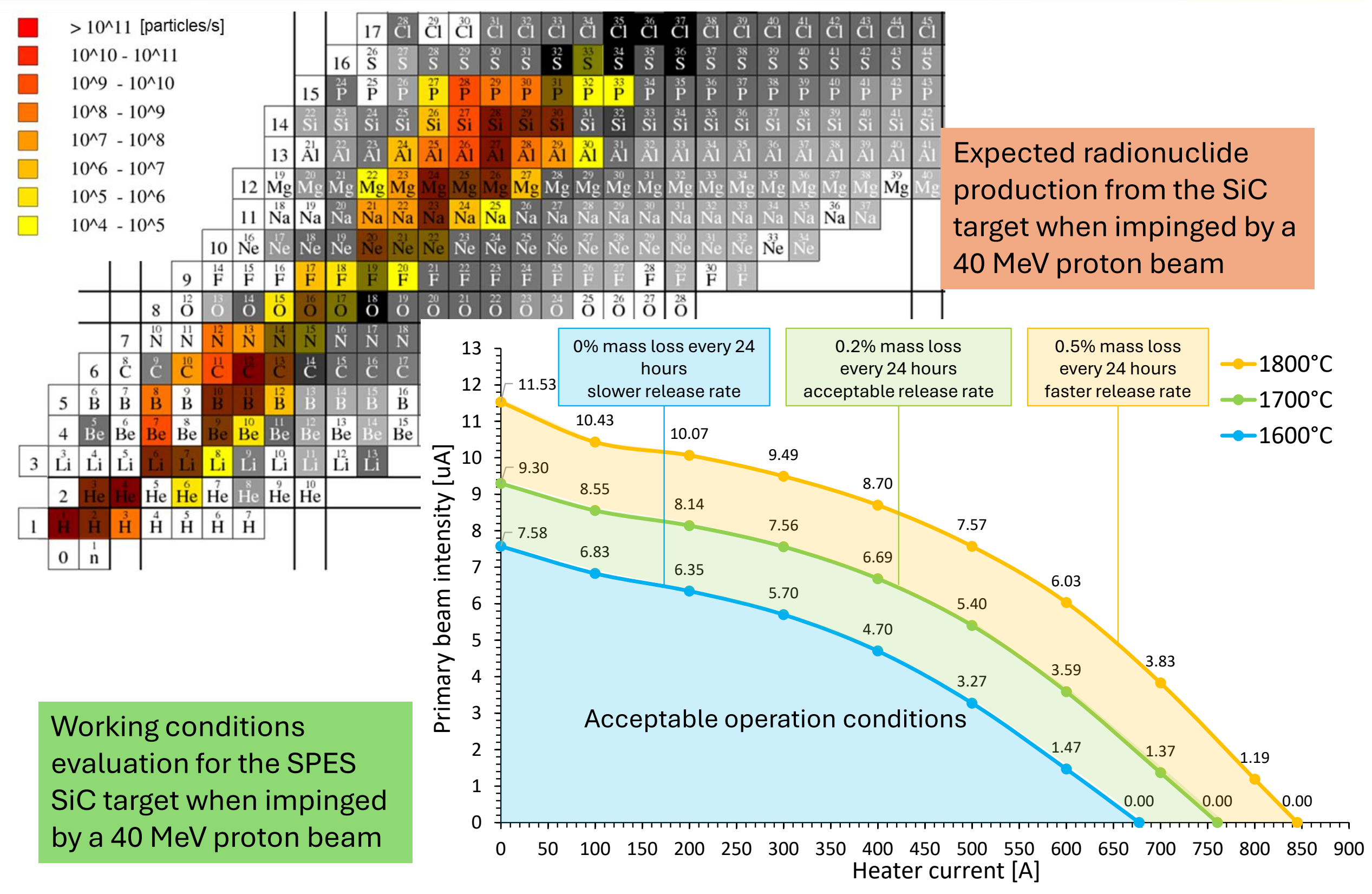
Strucutral analysis

required material properties:

- **E** (Young's modulus)
- **ν** (Poisson's ratio)
- **α** (coeff. of th. expansion)

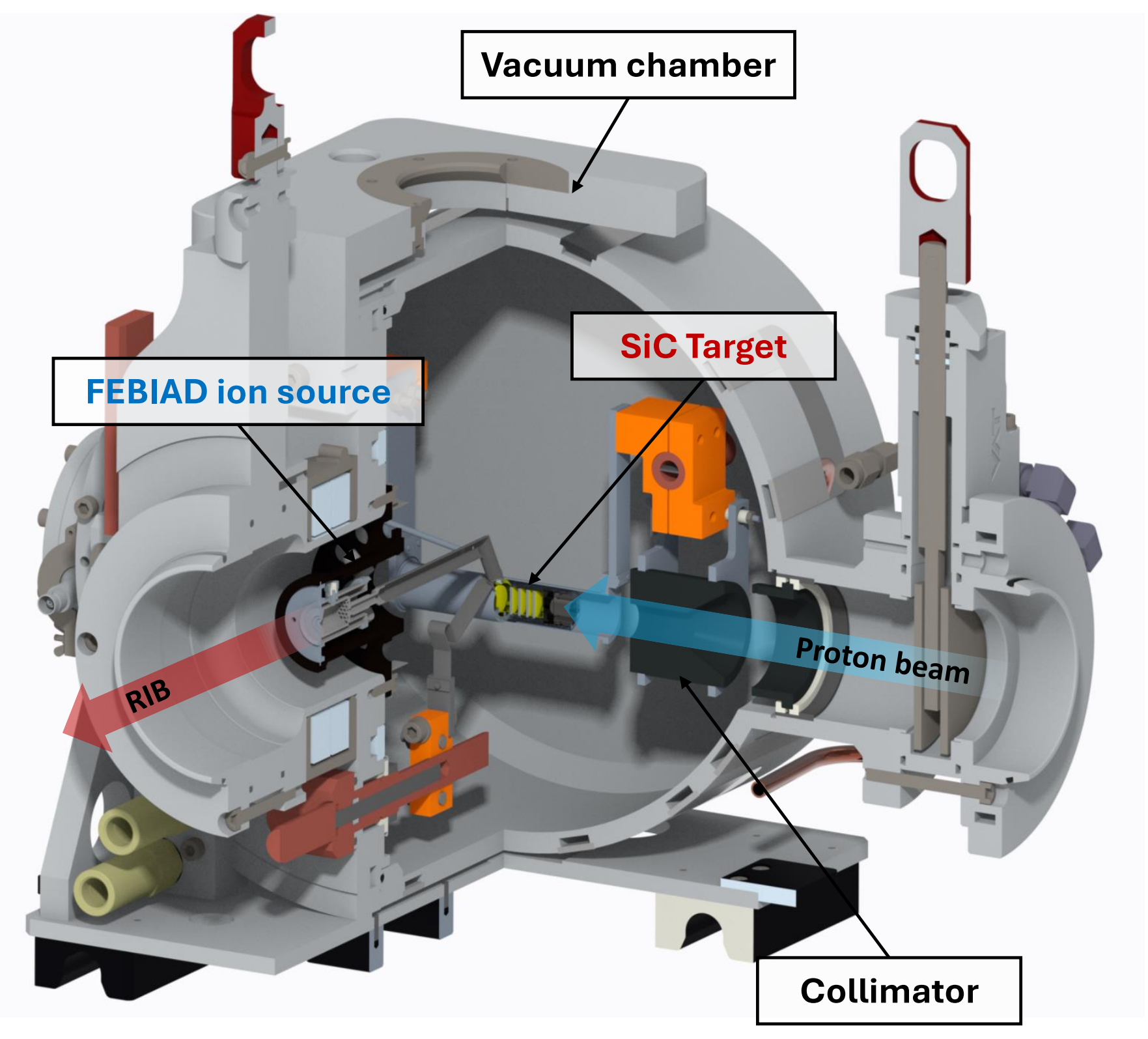
$T < T_{lim}$

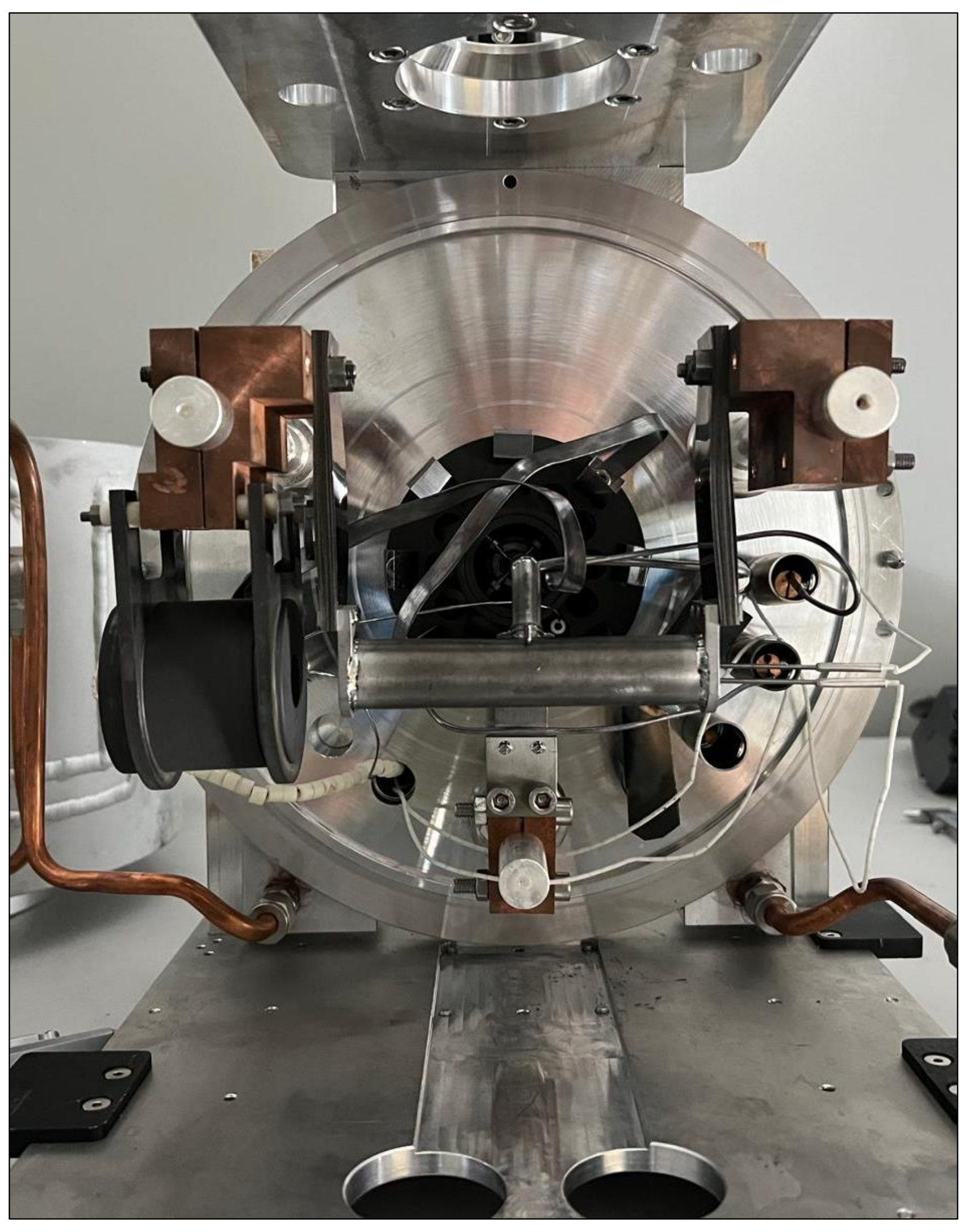
$\sigma_{max} < \sigma_{lim}$



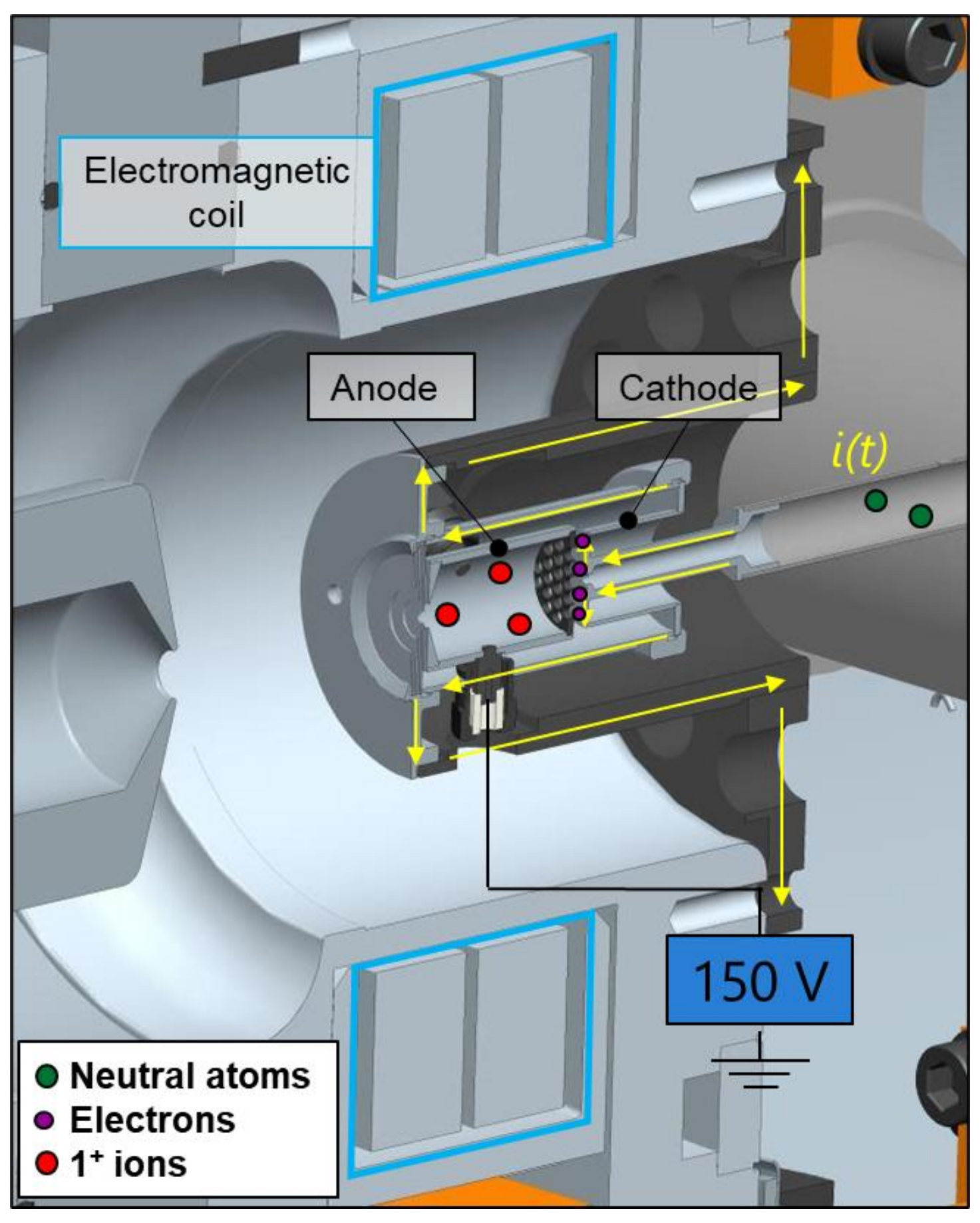
Expected radionuclide production from the SiC target when impinged by a 40 MeV proton beam

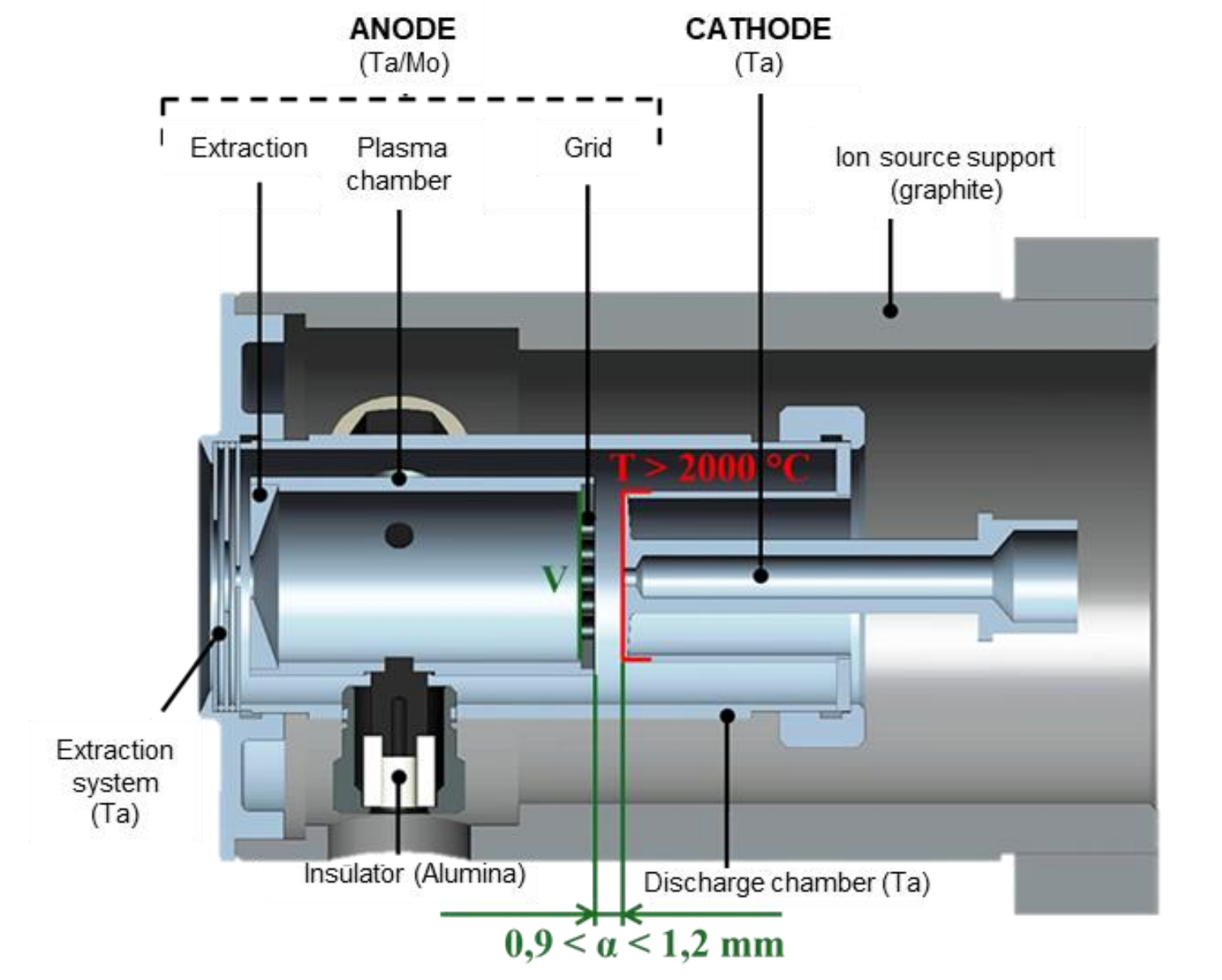
Working conditions evaluation for the SPES SiC target when impinged by a 40 MeV proton beam





FEBIAD Ion Source (based on ISOLDE MK5 source)

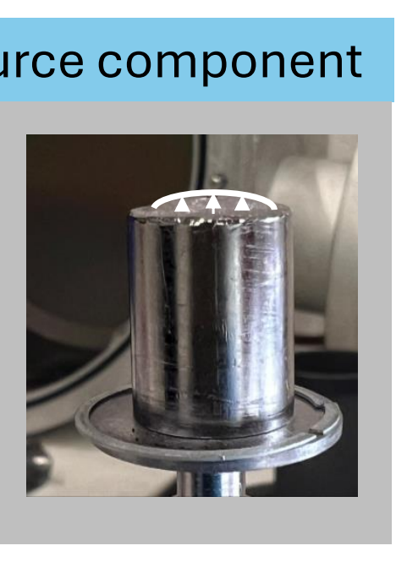




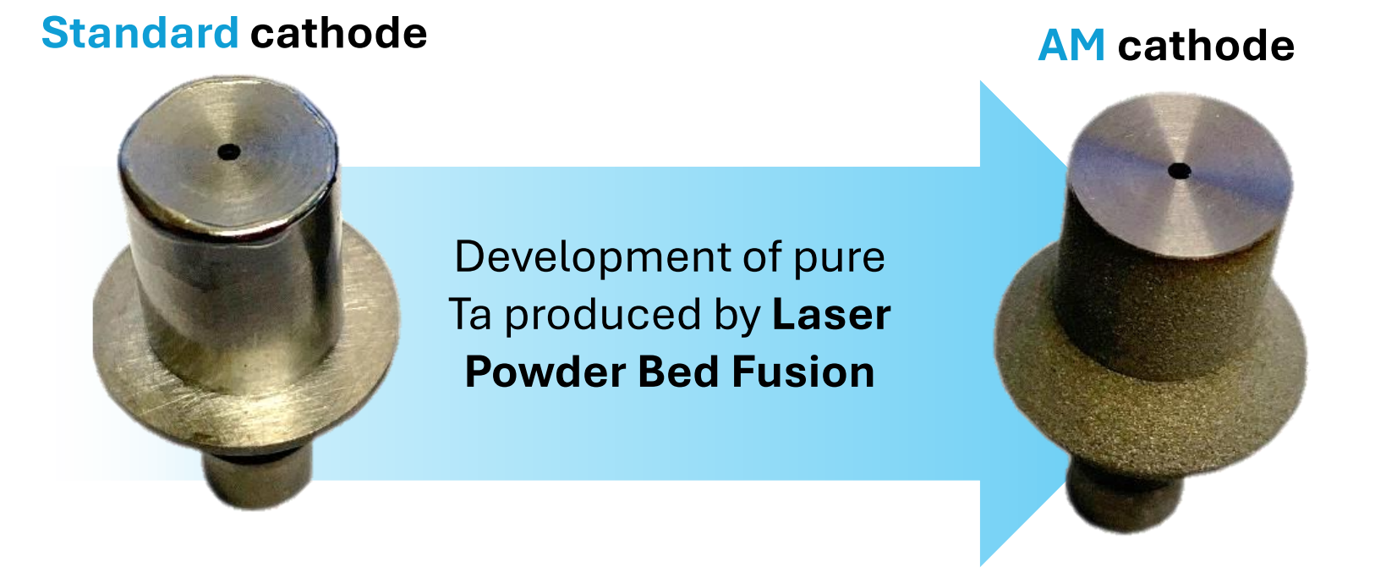
Cathode: most critical FEBIAD Ion Source component

Low geometrical accuracy due to difficult welding

Low reliability for deformation at high temperature



HISOL and HISOL_NEXT experiments

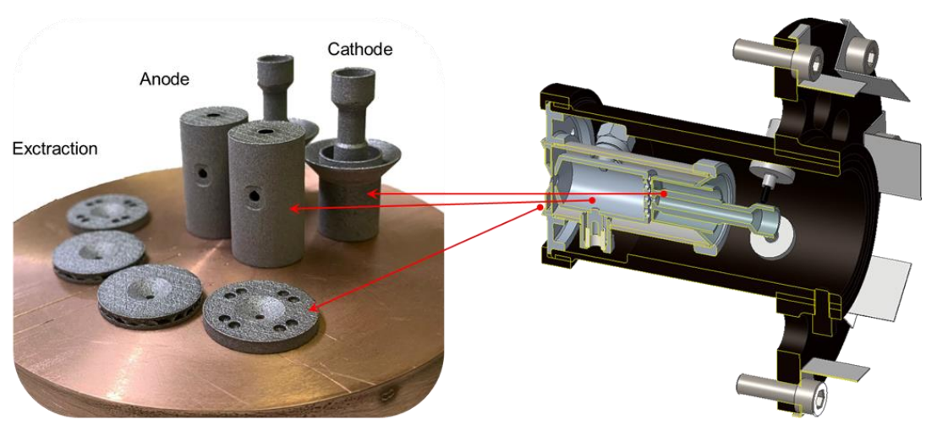


Development of pure Ta produced by **Laser Powder Bed Fusion**

No welding - Better geometrical accuracy [2]

Low deformation at high temperature [2]

iFAST AMIS collaboration



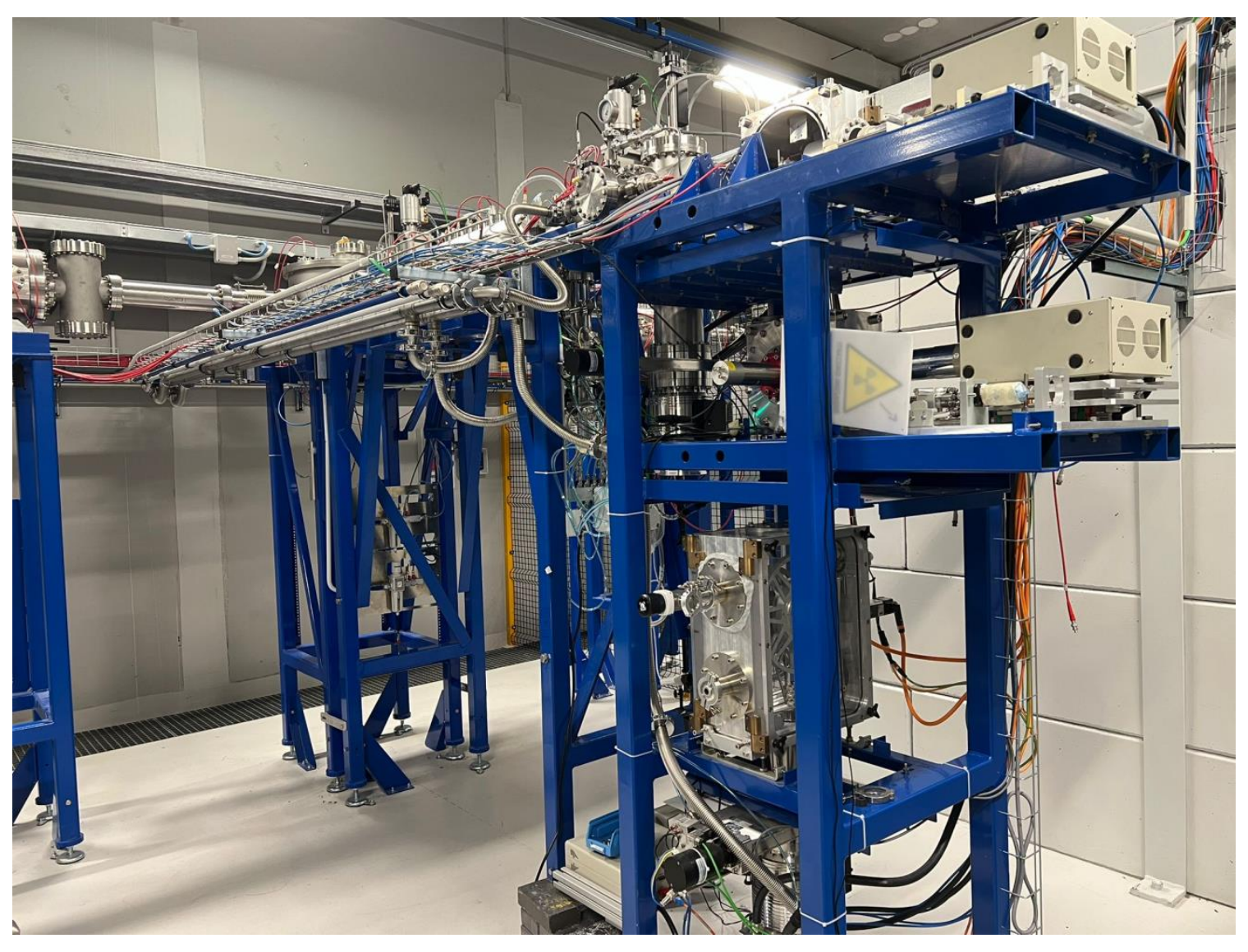
ISOLDE offline 1: ion source reference test facility

A **FEBIAD ion source** including **AM components** was **successfully tested** for the production of **stable ion beams at ISOLDE**

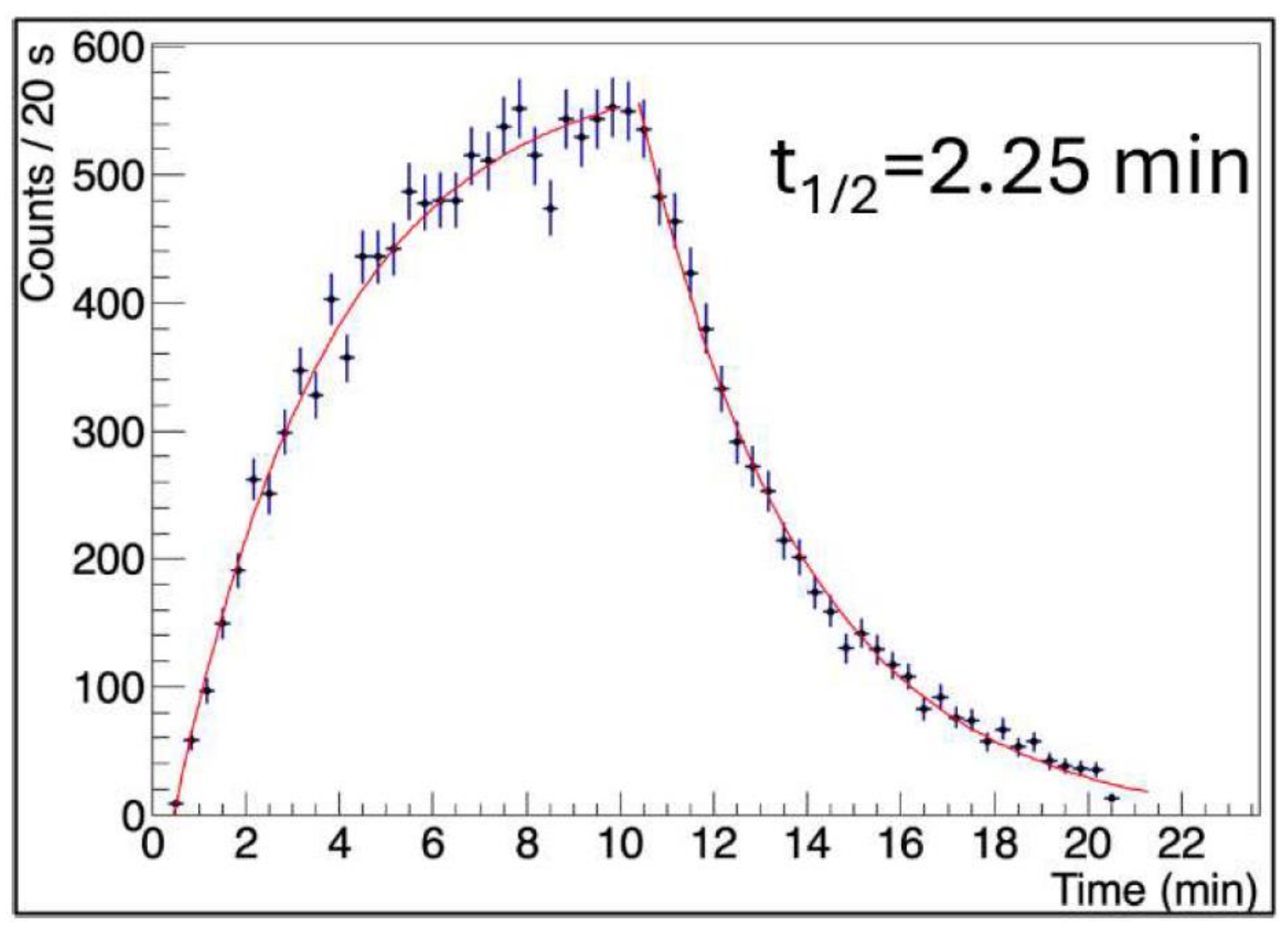
MAIN RESULT:

Suitability of **LPBF components** for the **operation** with **ISOL Ion Sources**

November 2024 – April 2025: RIBs at SPES!



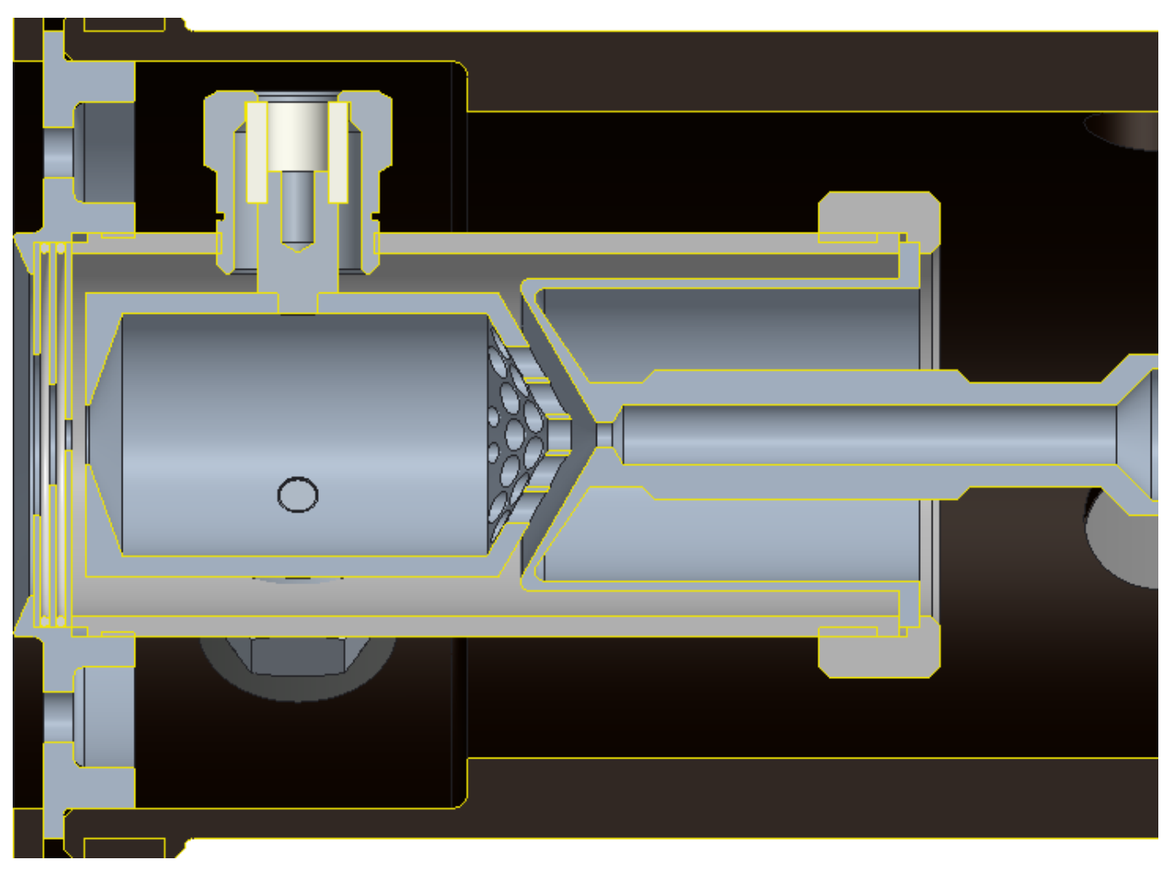
SPES tape station

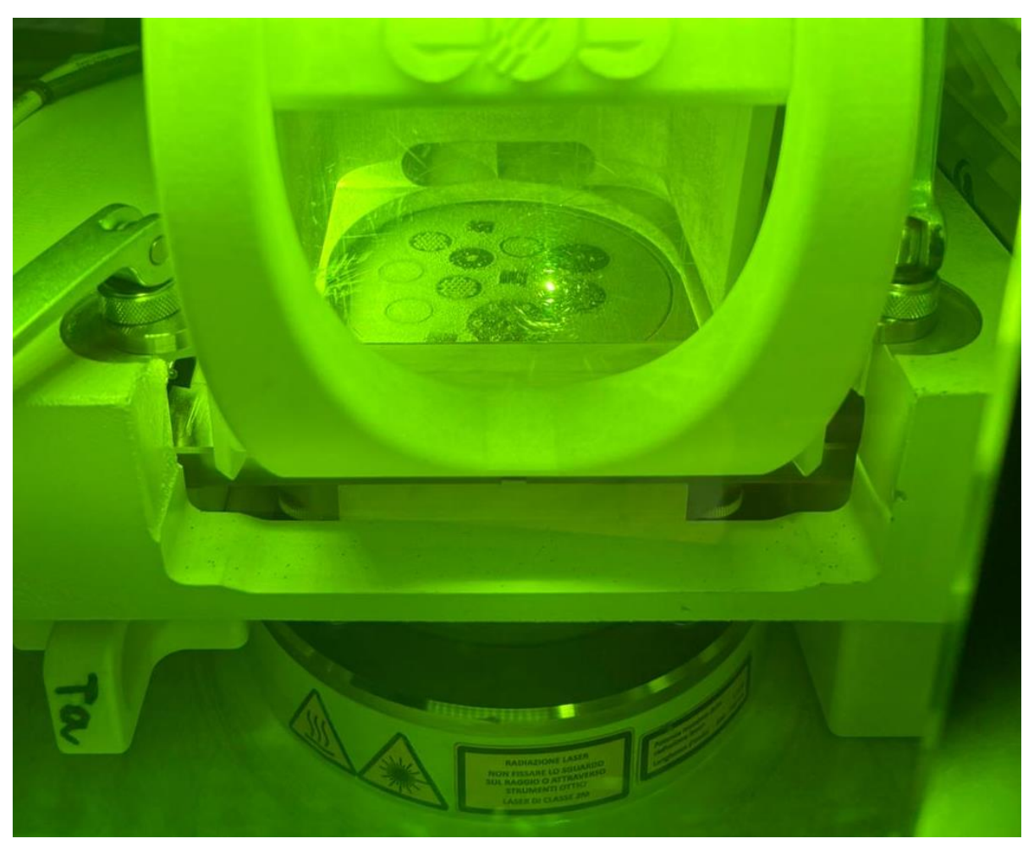


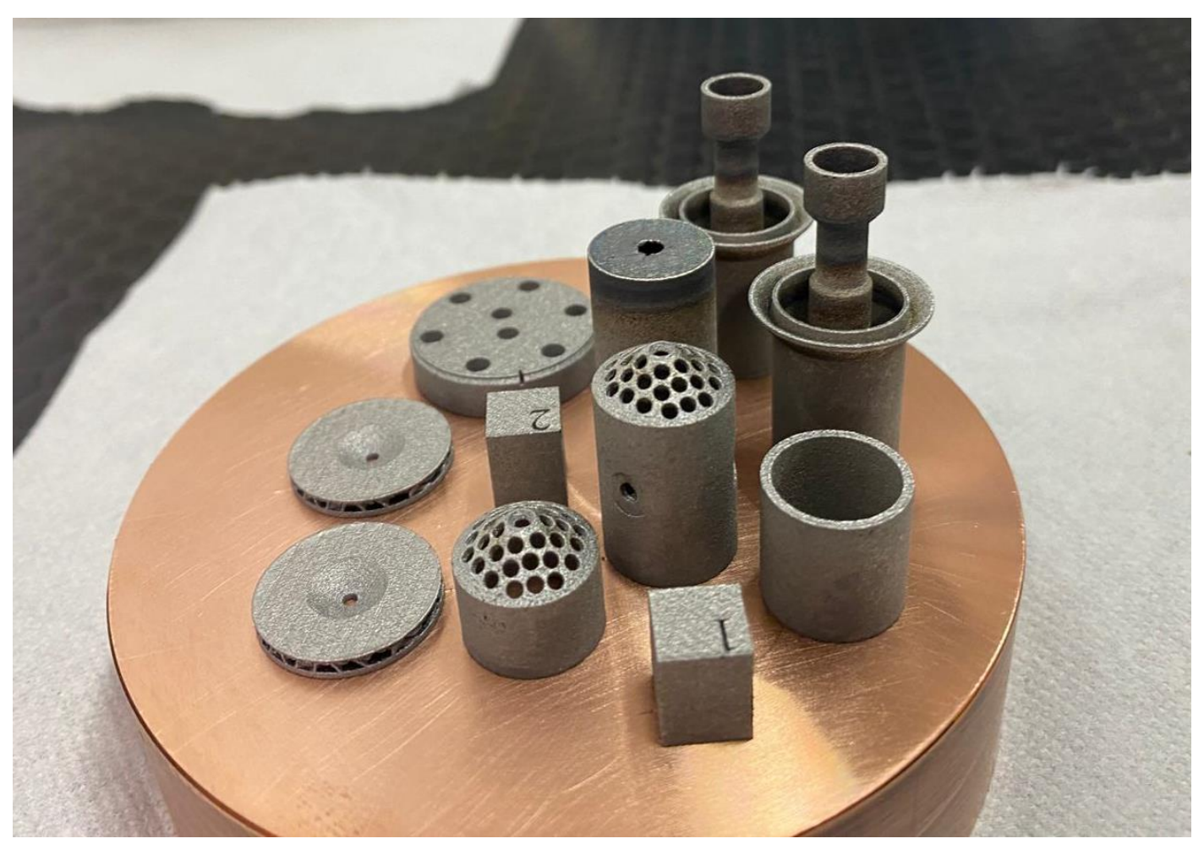
Counts for ^{28}Al β^- decay [3]

Future developments

Study of innovative anode-cathode interfaces for an increased electron emission by thermionic effect







Conclusions

- The capability of delivering RIBs at the SPES ISOL facility was successfully demonstrated
- The first RIB was ionized with a FEBIAD ion source including a tantalum cathode produced by LPBF
- Ongoing activities at SPES are currently aiming at the consolidation of the achieved results by planning experiments at higher proton beam intensity and at the completion of other parts of the facility.

References

[1] Manzolaro, M. et al.; *Materials* **2021**, https://doi.org/10.3390/ma14102689

[2] Girotto, A. et al.; *Journal of Physics: Conference Series* **2024,** https://doi.org/10.1088/1742-6596/2687/8/082047

[3] Fagotti, E. et al.; 16th *International Conference on Heavy Ion Accelerator Technology* (HIAT'25) **2025,** https://doi.org/10.18429/JACoW-HIAT2025-MOB01

21st International Conference on Ion Sources
8th - 12th of September 2025, Oxford, UK