AMIS

AM I S

F

CERN

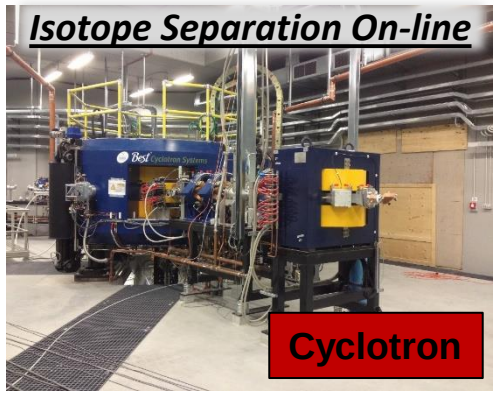
Introduction

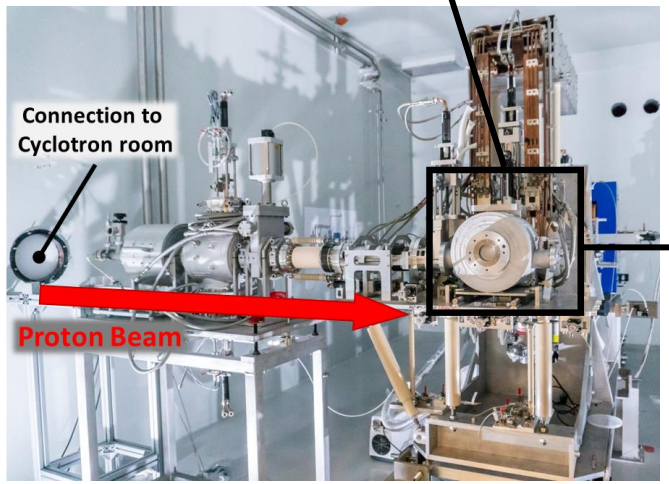
The ISOL technique and Project Context

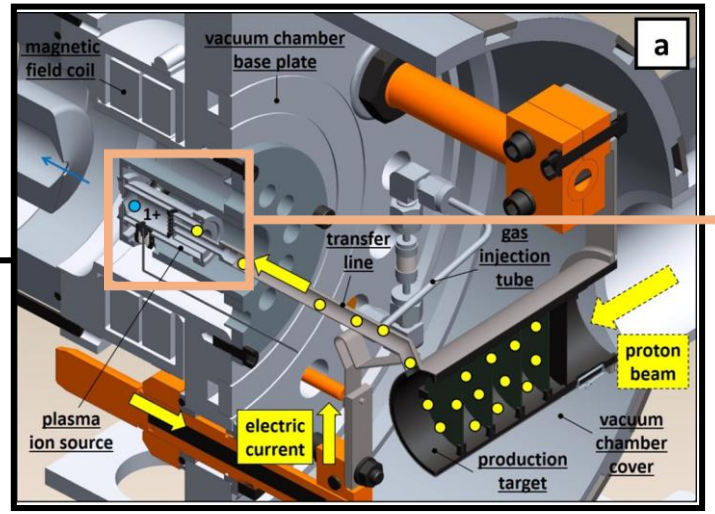
AMIS

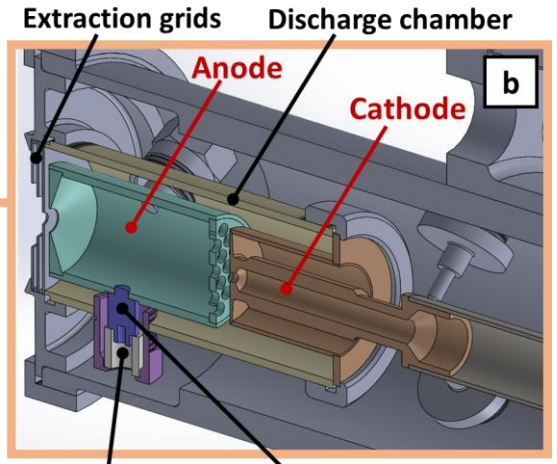
Proton beam → imping → **Target** (UC disks - **2000 °C**) → release → **Transfer Line** → migrate → **Ion source** (Ionization) → extract → **Radioactive beam** → deliver → **Experiment**

Isotope Separation On-line









Possible applications of RIBs:

- Nuclear Physics
- Nuclear Astrophysics
- Solid State Physics
- Nuclear Medicine

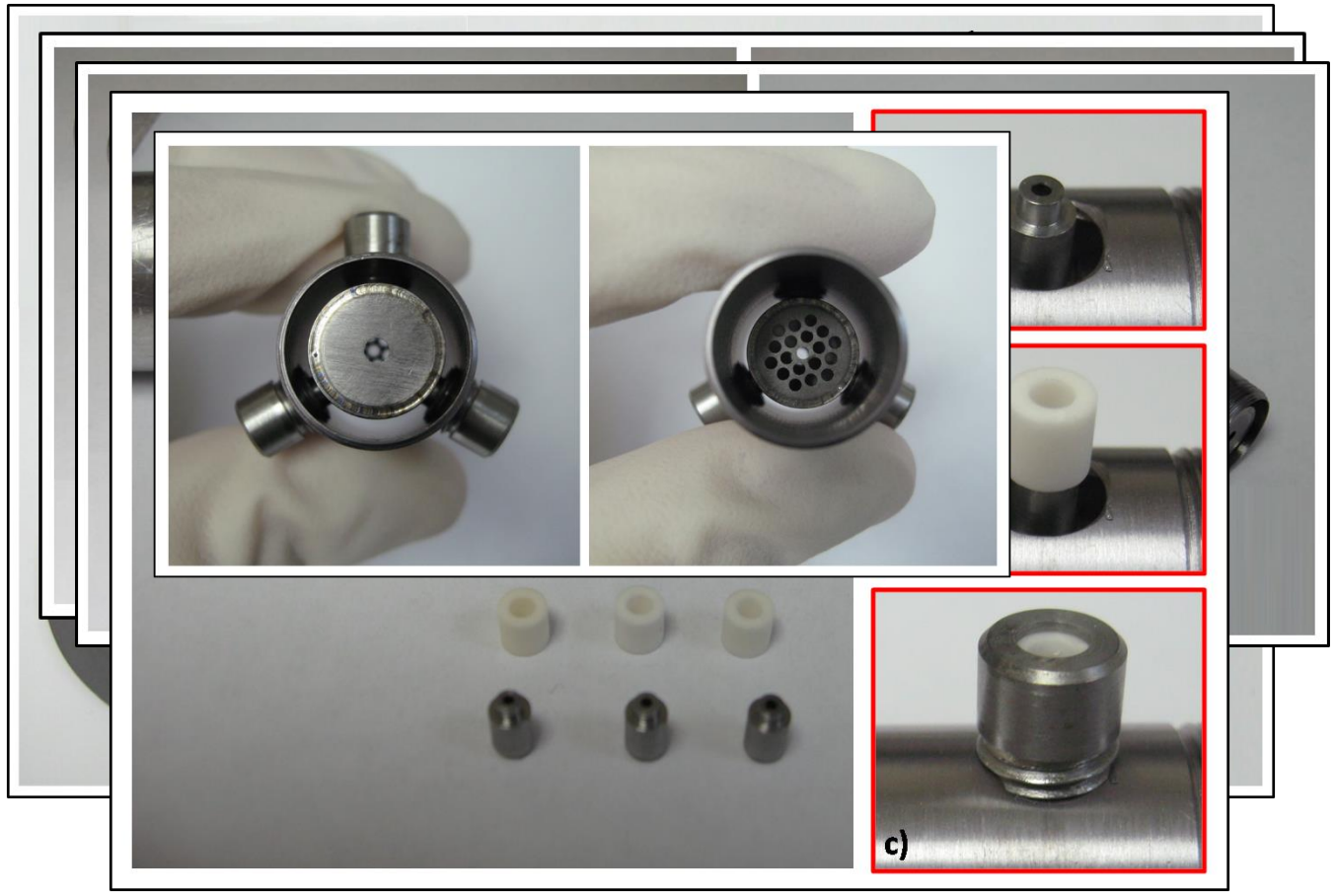
Example:

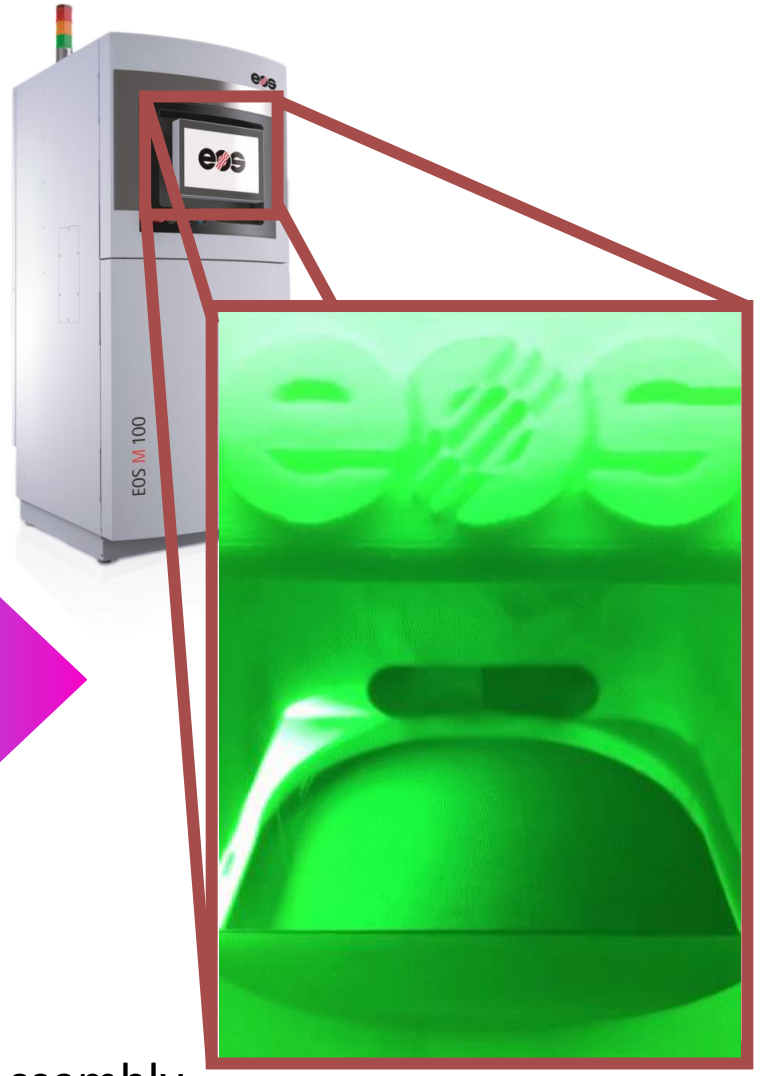
promising application of the ISOL technique:
the production of preclinical quantities of medical radionuclides

ISOLPHARM
SPES exotic beams for medicine

The Metal Additive Manufacturing solution

Courtesy of the SPES Target Group





Additively Manufactured Refractory Metals:

- High temperatures during the functioning
- Tight tolerances for guarantee high performance
- Need a new Design for Assembly
- Topology optimization to increase the performance

AMIS network - industrial partners and companies involved

Organizational Expertise

Material Characterization & Product Development	*Production & Supply of Refractory Metals*	*Product OFF-LINE and ON-LINE testing*	*Potential application project involved (Medical Radioisotope)*	*Market Analyses to evaluate potential Commercialization*	*Final component AM production*
INFN DIAM PADOVA INFN SPES project LNL EOS e-Manufacturing Solutions	TANIOBIS inspiring metal evolution	INFN SPES project LNL ISOLDE CERN TRIUMF	ISOLPHARM SPES exotic beams for medicine Medicis Promed *Supporting company* GE Healthcare	saes group	EOS e-Manufacturing Solutions

WP1. Development and Characterization of Innovative Refractory Metals and their Alloys by AM Technology

WP2. Development of Additively Manufactured Ion Source Components

WP3. High Temperature Tests and Beam Production with Additively Manufactured Ion Source Components

WP4. Market Analysis to evaluate potential commercialization

WP 1 *main results*

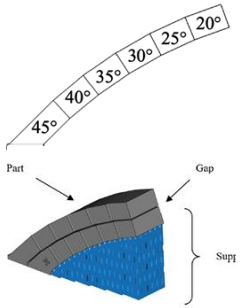
Characterization of refractory metals

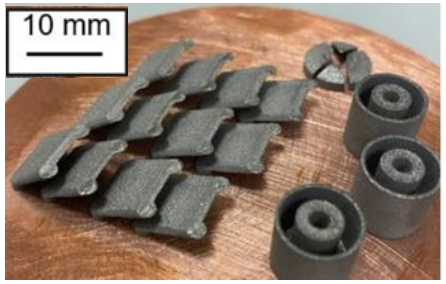
AMIS

Mechanical characterization of **pure Ta samples**

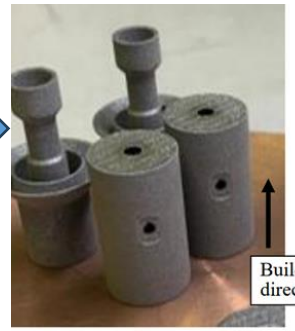
Mechanical Prop.	E [GPa]	UTS [MPa]	A [%]
Vertical AM	193.7 ± 3.2	512.2 ± 4.3	17.0 ± 1.0
Horizontal AM	181.6 ± 0.5	459.4 ± 1.2	23.8 ± 1.2
Standard	180.2 ± 2.6	337.6 ± 2.3	27.5 ± 0.6

Geometrical characterization of **pure Ta samples**





In order to be able to produce the **final parts** with **pure Ta**



***2024* Focus on:**

Development of new Refractory Metals Alloys specifically DfAM

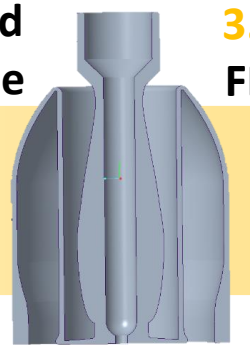
WP 2 *main results*

Development of a New ION source DfAM

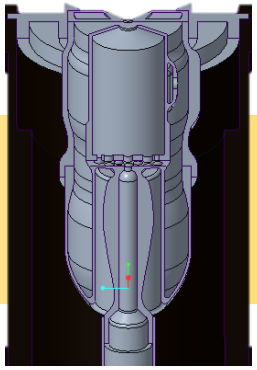
0. Standard cathode

1. first AM cathode

2. improved AM cathode

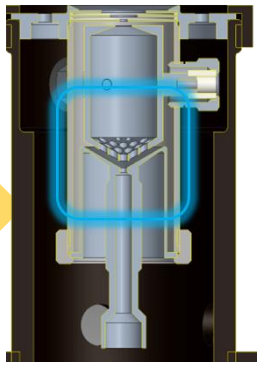


3. Fully AM FEBIAD ion source



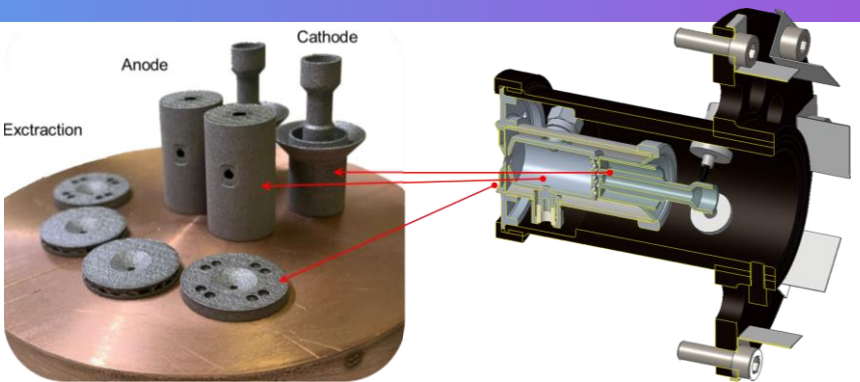
4. ***2024* Focus on:**

AM FEBIAD ion source with AM «free-form» geometries

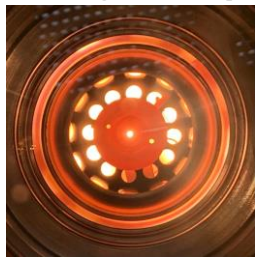


WP 3 *main results*

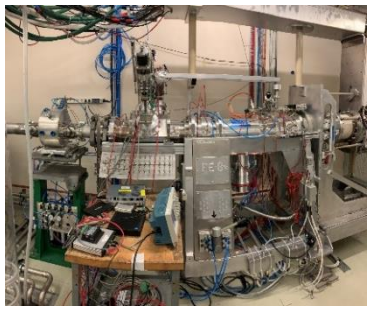
tests of New ION sources

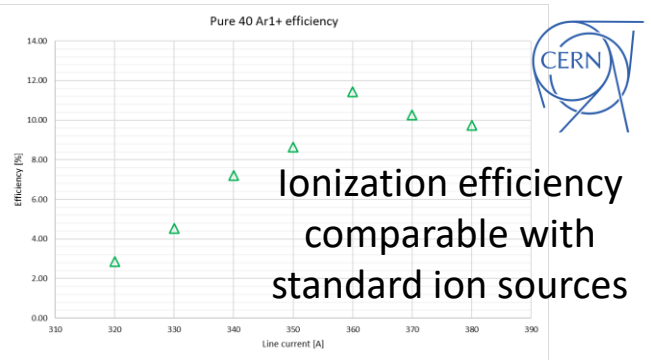


High temperature test



Successfully operated at HT (2000 °C) for **3 weeks**





Ionization efficiency comparable with standard ion sources

update on the progress made towards the deliverables and milestones

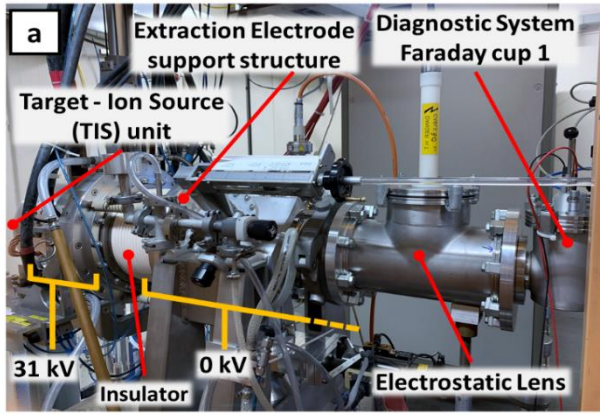
Main goal of AMIS Project: Development of a **new generation of High Performance ISOL Ion Sources** with cutting edge technologies available within INFN and its collaboration network.

WP1. Development and Characterization of Innovative Refractory Metals and their Alloys by AM Technology	year 1				year 2				End
	M3	M6	M9	M12	M15	M18	M21	M22	M26
T1.1. Production and characterization of Additively Manufactured Ta and/or Ta-based alloys.									MS.1
T1.2. Production and characterization of Additively Manufactured Nb and/or Nb-based alloys.									
T1.3. Identification and Development of refractory metal alloys and/or composite powders specifically designed for LPBF process.									
T1.4. Production and characterization of samples with innovative refractory metal alloys and/or composite powders.									
WP2. Development of Additively Manufactured Ion Source Components	**year 1**				**year 2**				**End**
	M3	**M6**	**M9**	**M12**	**M15**	**M18**	**M21**	**M22**	**M26**
T2.1. Multiphysics Simulation of Ion Sources with dedicated numerical models.									MS.2
T2.2. Redesign of specific Ion Source components for an improved assembly repeatability considering hybrid AM-traditional techniques.									
T2.3. Development of innovative AM free-form geometries to improve the performance of specific Ion Source components.									
T2.4. Development of a fully AM Ion Source prototype for off-line / on-line tests.									
WP3. High Temperature Tests and Beam Production with Additively Manufactured Ion Source Components	**year 1**				**year 2**				**End**
	M3	**M6**	**M9**	**M12**	**M15**	**M18**	**M21**	**M22**	**M26**
T3.1. High temperature tests of AM Ion Source components.									MS.3
T3.2. Thermionic emission tests of AM FEBIAD cathodes and anodes.									
T3.3. Stable ion beam production (off-line) with FEBIAD Ion Sources containing AM components at CERN and/or INFN-LNL.									
T3.4. Radioactive ion beam production (on-line) with FEBIAD Ion Sources containing AM components at CERN and/or TRIUMF.									
WP4. Commercialization and Market Analysis	**year 1**				**year 2**				**End**
	M3	**M6**	**M9**	**M12**	**M15**	**M18**	**M21**	**M22**	**M26**
T4.1. Evaluation of expected impact of the project in term of: addressable and obtainable market									
T4.2. Intellectual Properties evaluation									

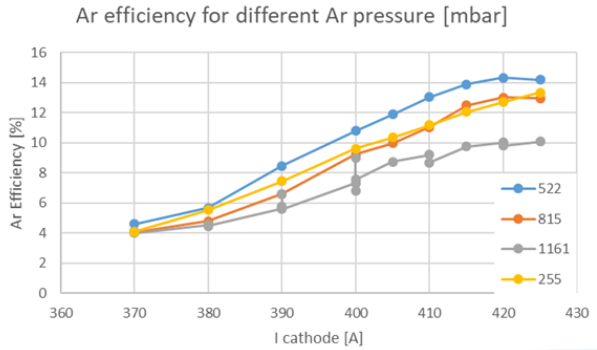
AMIS TRL status

2022 (end)

→ ***TRL 4***



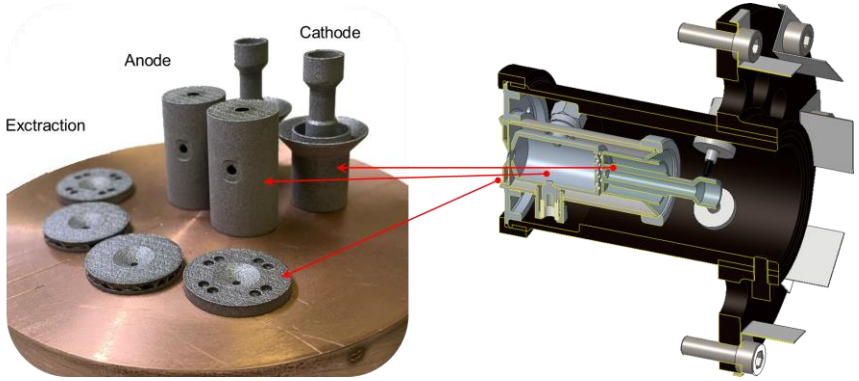
Ionization efficiency using AM Mo Anode comparable to STD Ta Anode

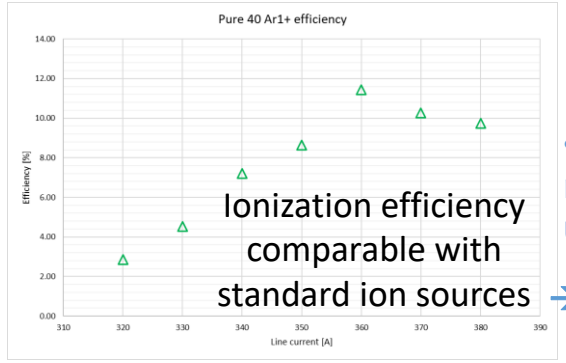


- **Proof of Concept Test of the AM ION Source and Prototype production**
- **Off-line Test of the AM Mo Anode with the traditional geometry**

2024

→ ***Transition TRL 4 to 5***





- **Production and characterization of samples with refractory metal alloys**
- **Development of a fully refractory metals Ion Source with traditional design using AM parts for off-line/on-line tests.**

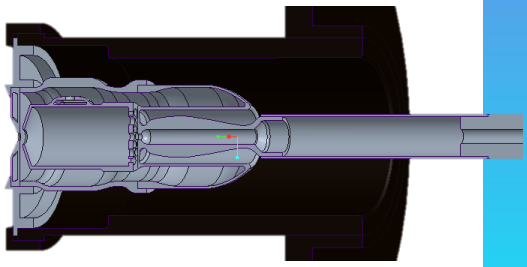
→ **Validation of the production process using the traditional design of the ion source.**

Future 2024/2026

Estimated time for TRL 6

"Technology demonstrated in relevant environment (industrially relevant environment in the case of key enabling technologies)"

- **Development of a fully refractory metals Ion Source with new Design for AM for off-line tests at CERN and/or TRIUMF and/or SPES.**



… potentiality for TRL 7

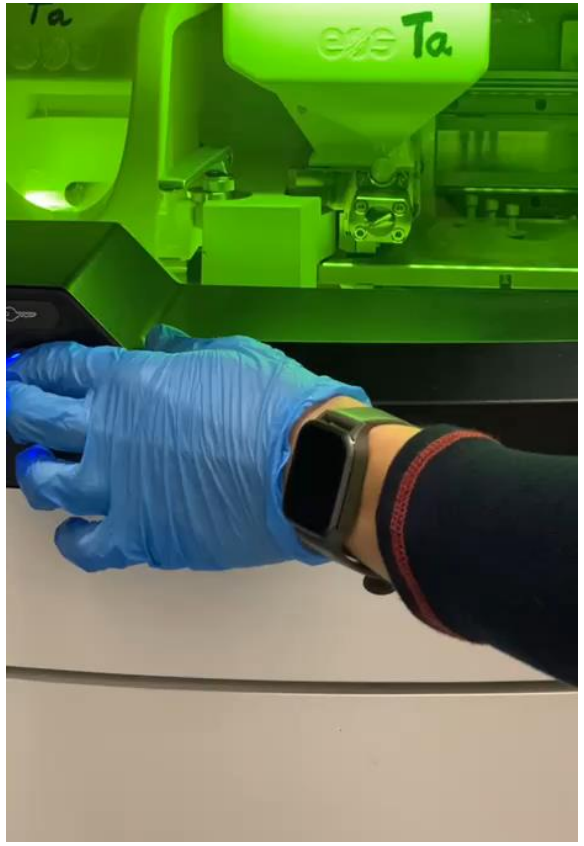
"System prototype demonstration in operational environment"

- **on-line test with FEBIAD Ion Sources containing AM components at CERN and/or TRIUMF and/or SPES.**

AMIS contribution to improve sustainability and to reduce the environmental impact

1. ADDITIVE MANUFACTURING PROCESS

- *Build the final part in only one step*
  - → *Production time reduction*
  - → *Reduce the amount of wasted material*
  - → *Post-processing phase time & cost reduction*
- *Recycling of the un-melted powder*



2. LOWER COSTS

→ *cathode example*

Standard cathode
(Cost ~ 1100 €)

First AM cathode
(Cost ~ 300 ÷ 500€)

3. Potential application environmental impact

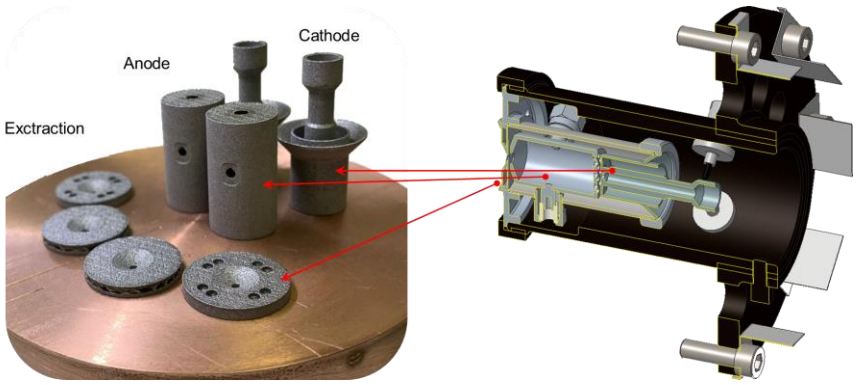
- *ISOL technologies for production of medical radionuclides can become a green alternative to nuclear fission reactors.*

Conclusion

AM applications of refractory metals for Ion Sources

AMIS

WP 1 AMIS



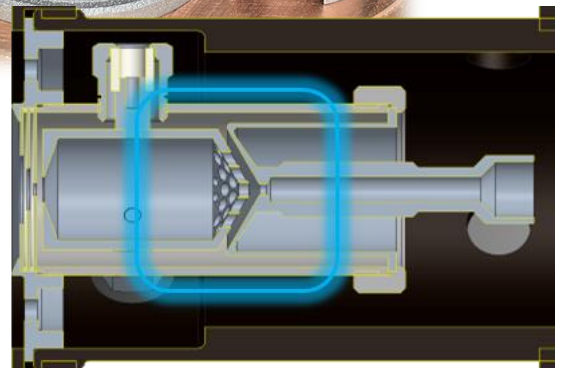
2023 → *Pure Ta/Nb characterization*

2024 → *Ta alloys characterization*

WP 2 AMIS

2023 → *DfAM & production of specific Ion Source components (Hybrid & full AM Ion Source)*

2024 → *Development of innovative AM "free-form" geometries*



WP 3 AMIS

2023 → *High temperature and off-line tests of redesigned ion source*

2024 → *off-line tests of innovative AM free-form geometries ion source*

saes group

WP 4 AMIS

2024 → *Evaluation of expected impact of the project*

→ *IP evaluation and Market Analysis*

iFAST

Thank you for your attention!

This project has received funding from the European Union's Horizon 2020 Research and Innovation programme under GA No 101004730.

The FEBIAD type ION Source