The SPES RIB production complex

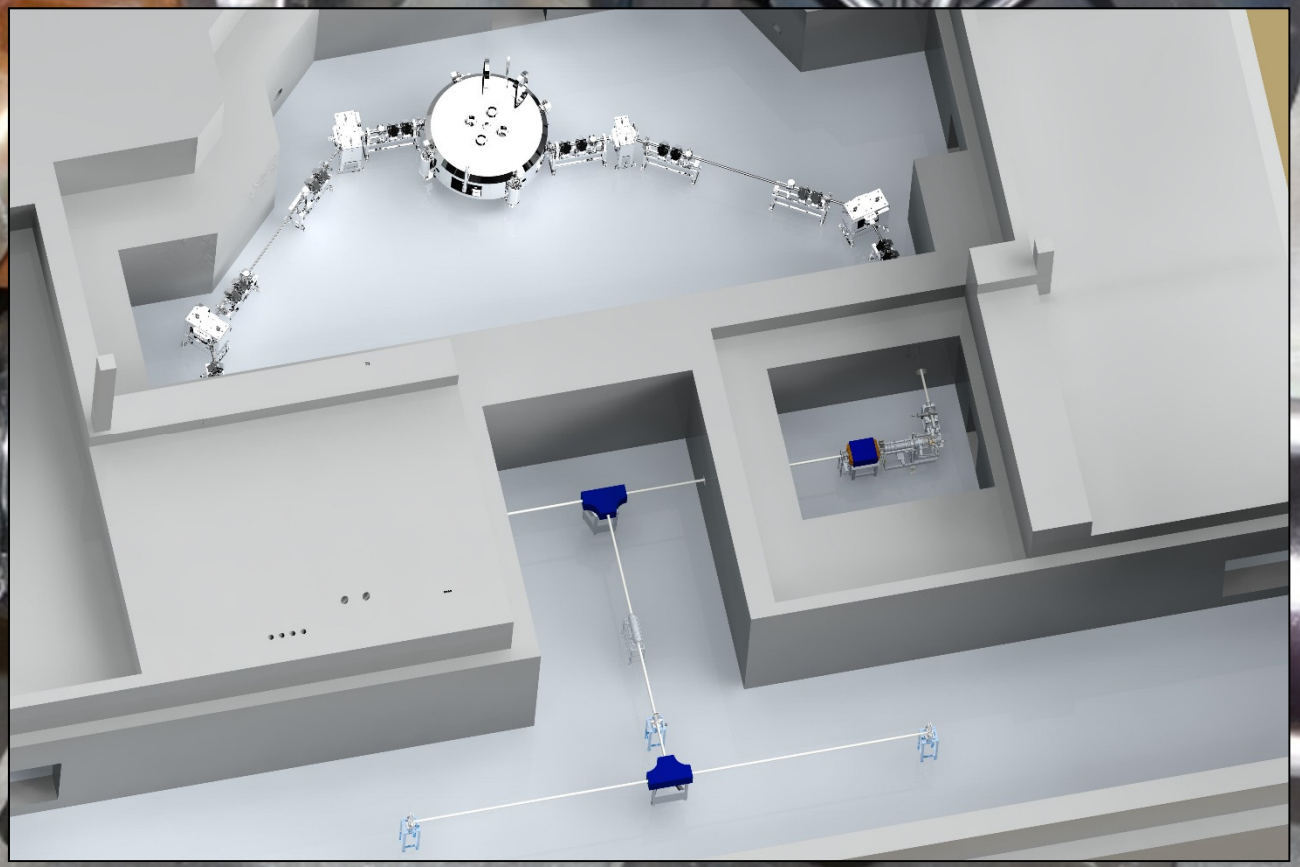
Alberto Andrighetto
LNL-INFN

HIAT 2015

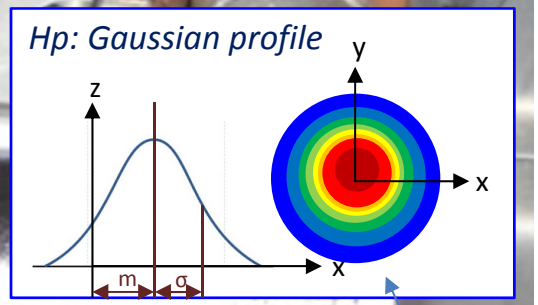
ISOL RIB from SPES

SPES is (just to remind..):

1) A second generation ISOL facility (for neutron-rich ion beams)
2) An interdisciplinary research center (for p,n applications)



~100 Hz wobbler proton beam
(Uniform power distribution)



target diameter 4 cm.

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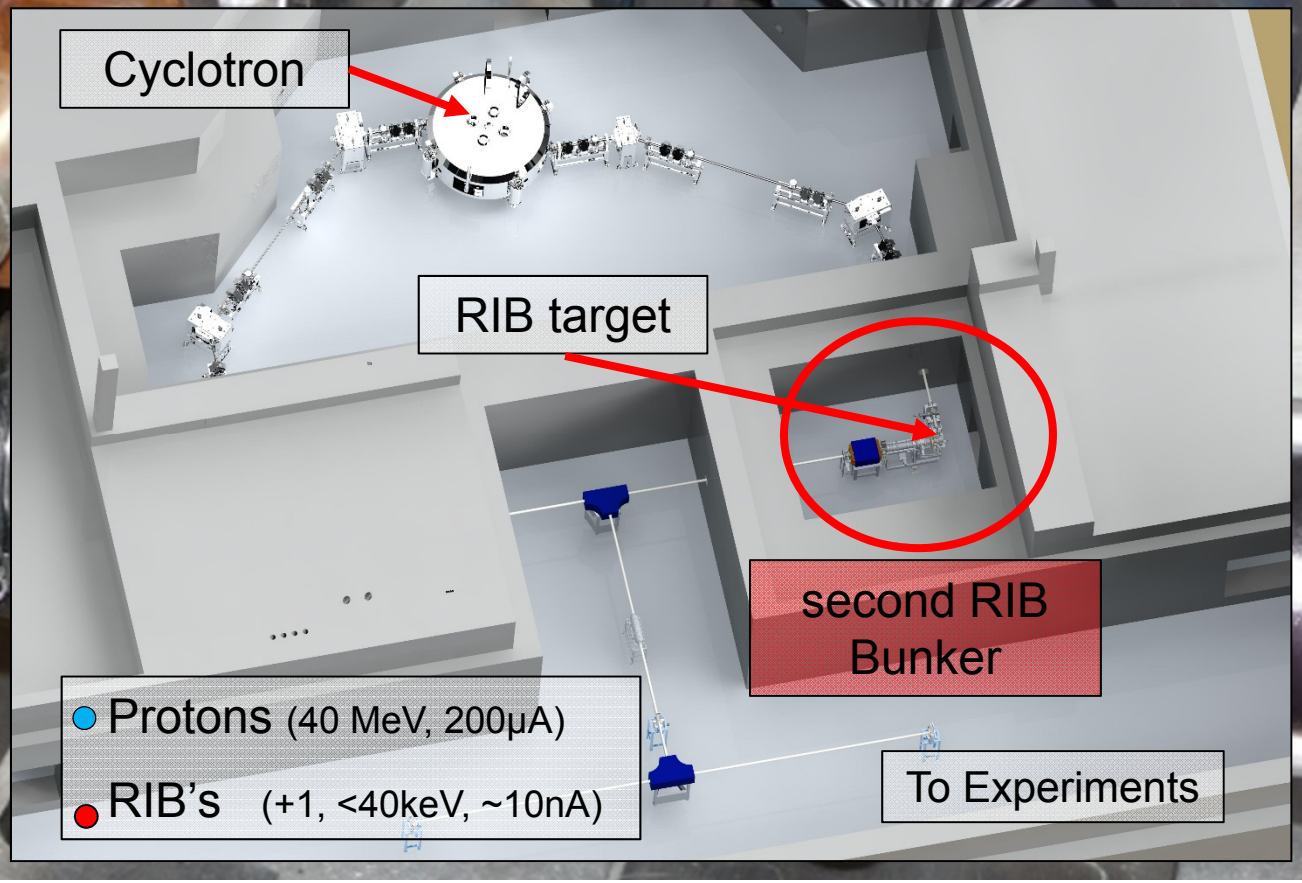

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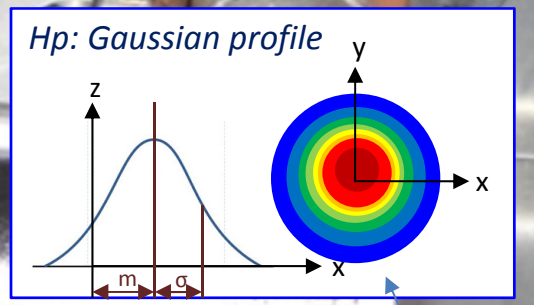

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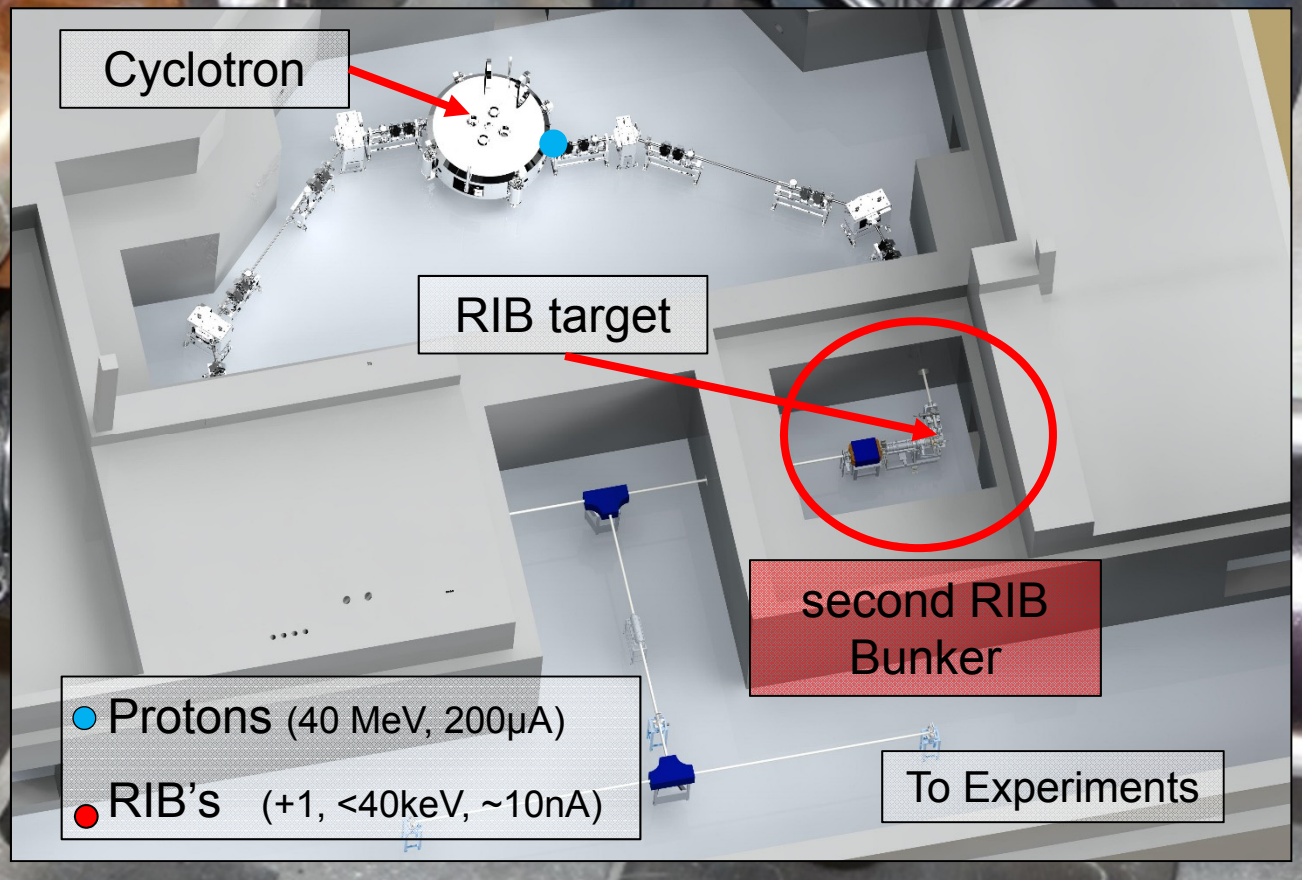

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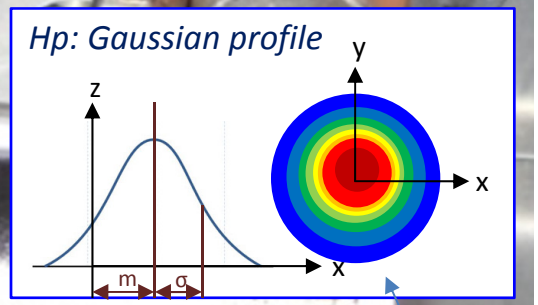

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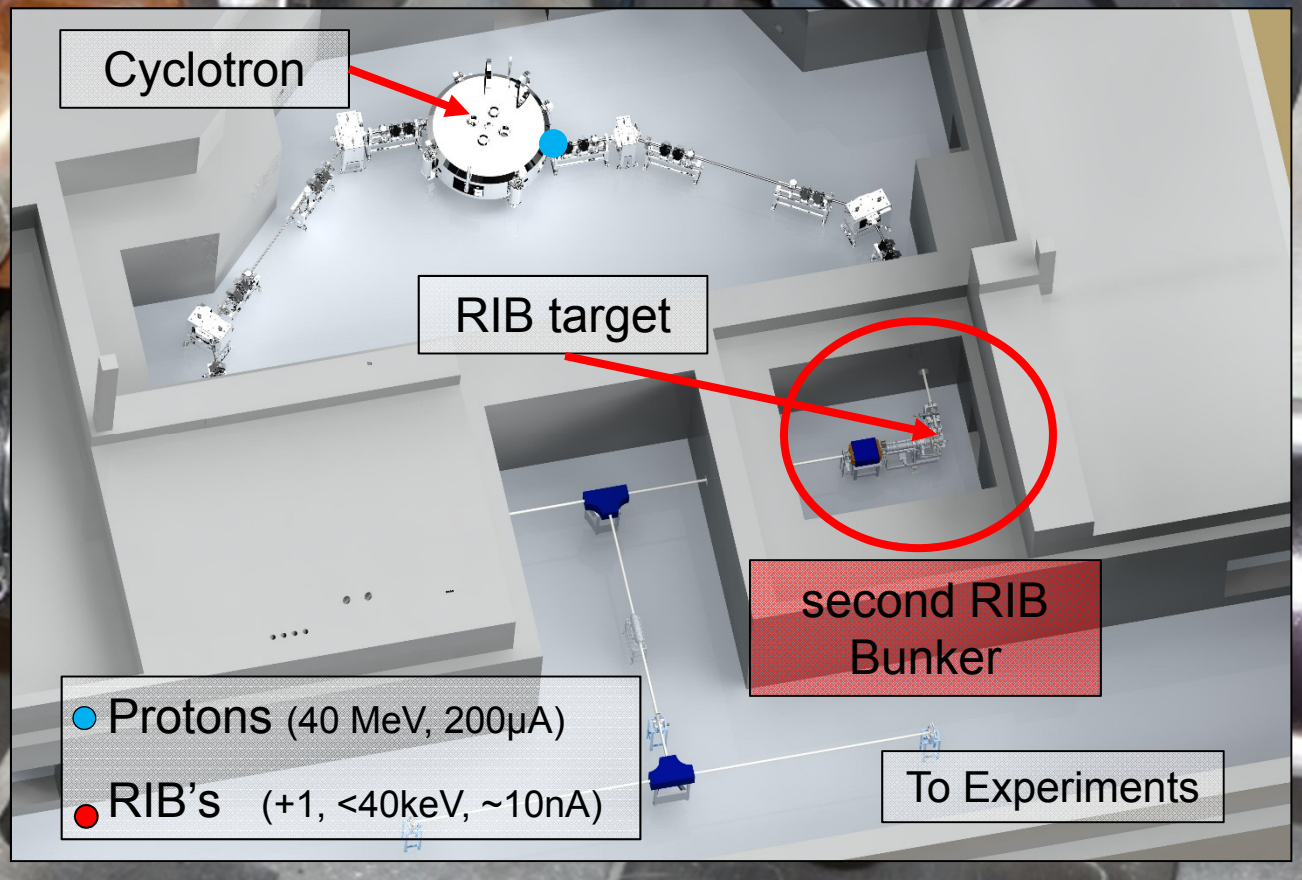

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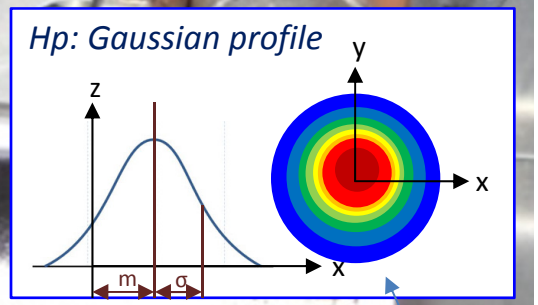

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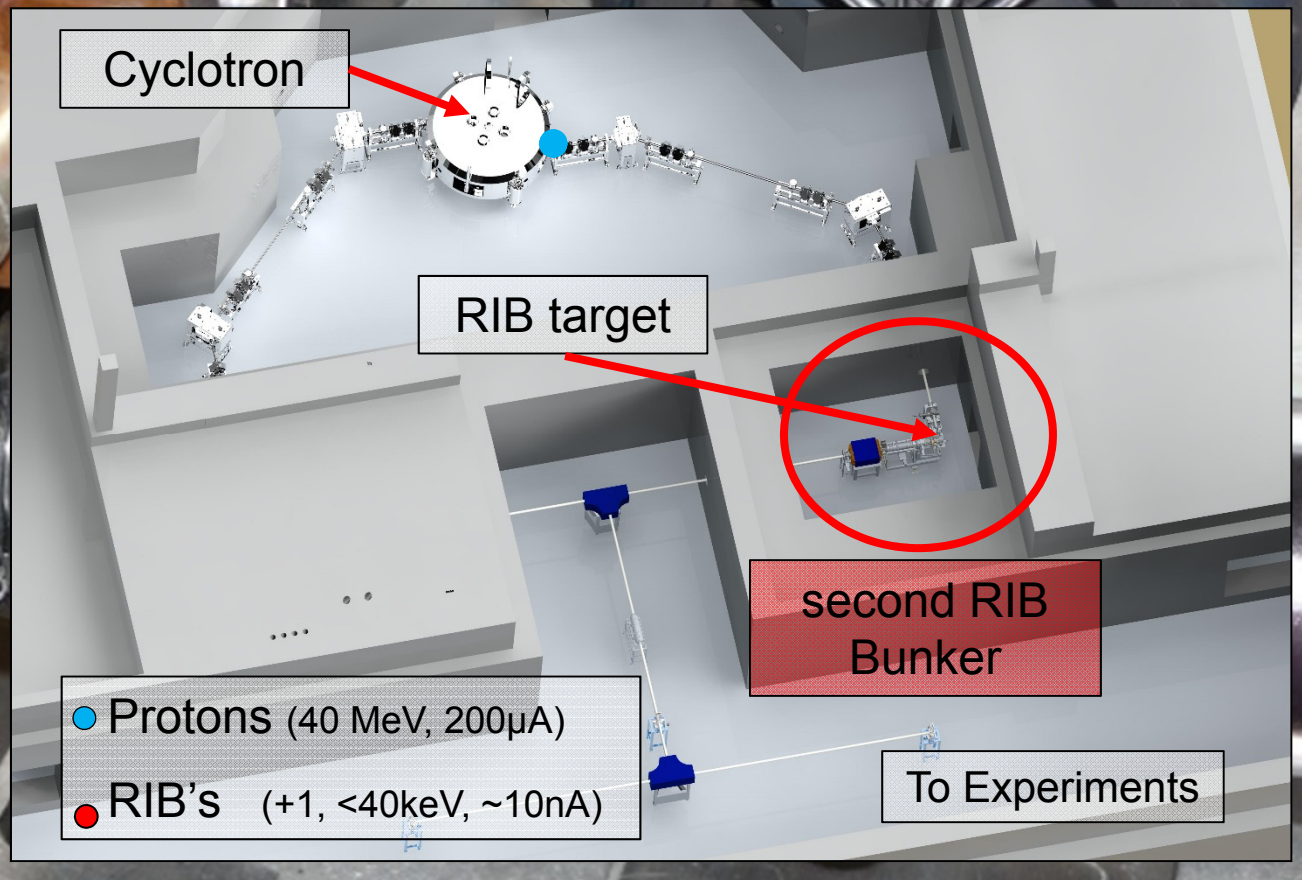

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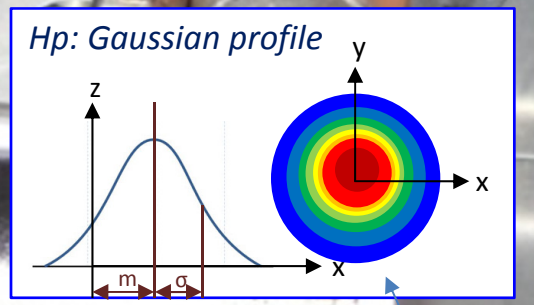

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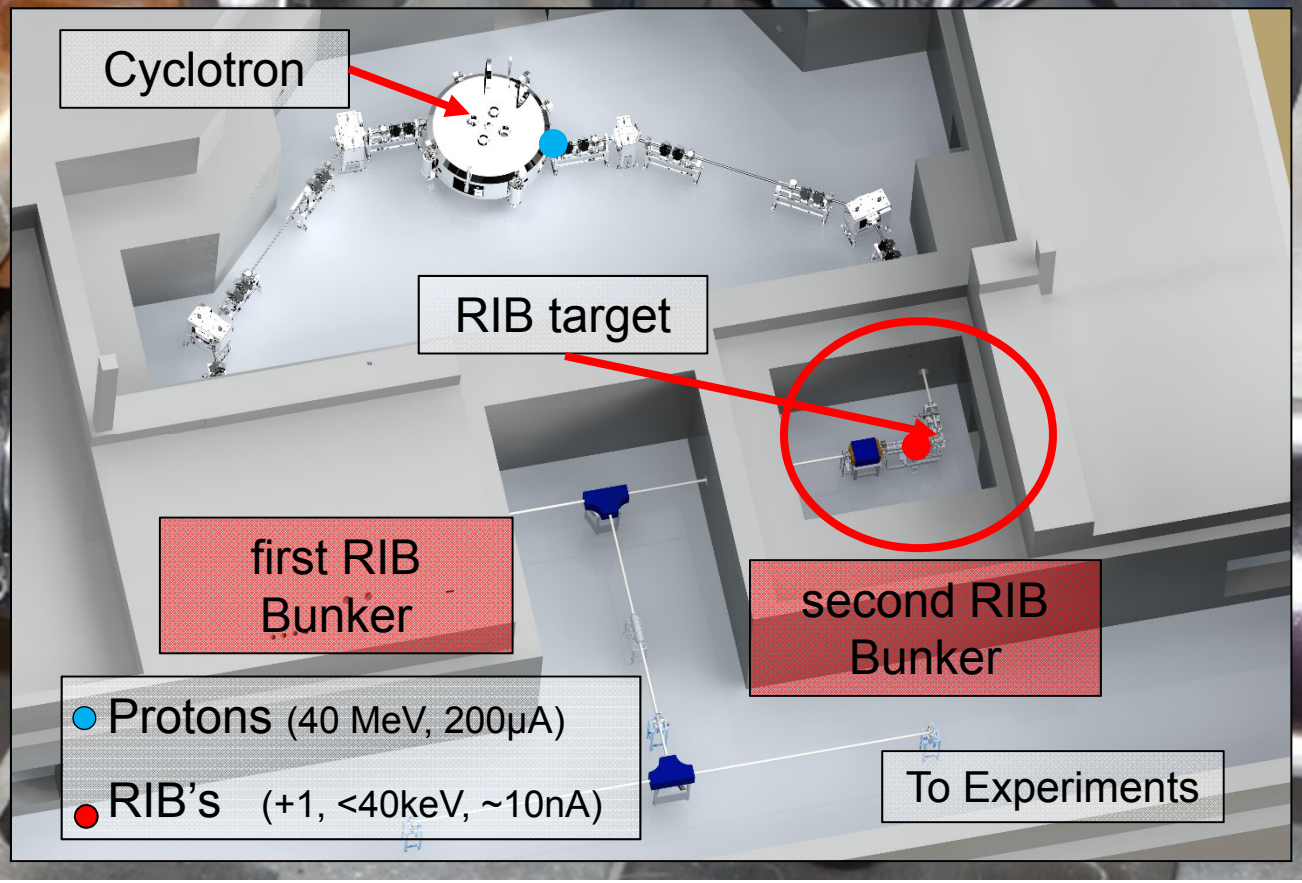

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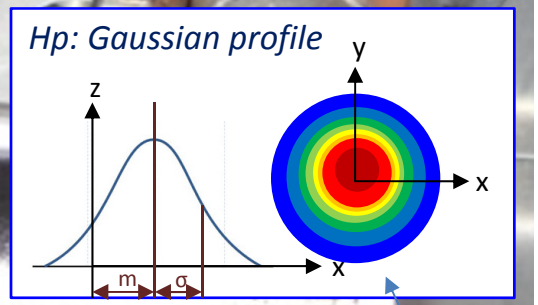
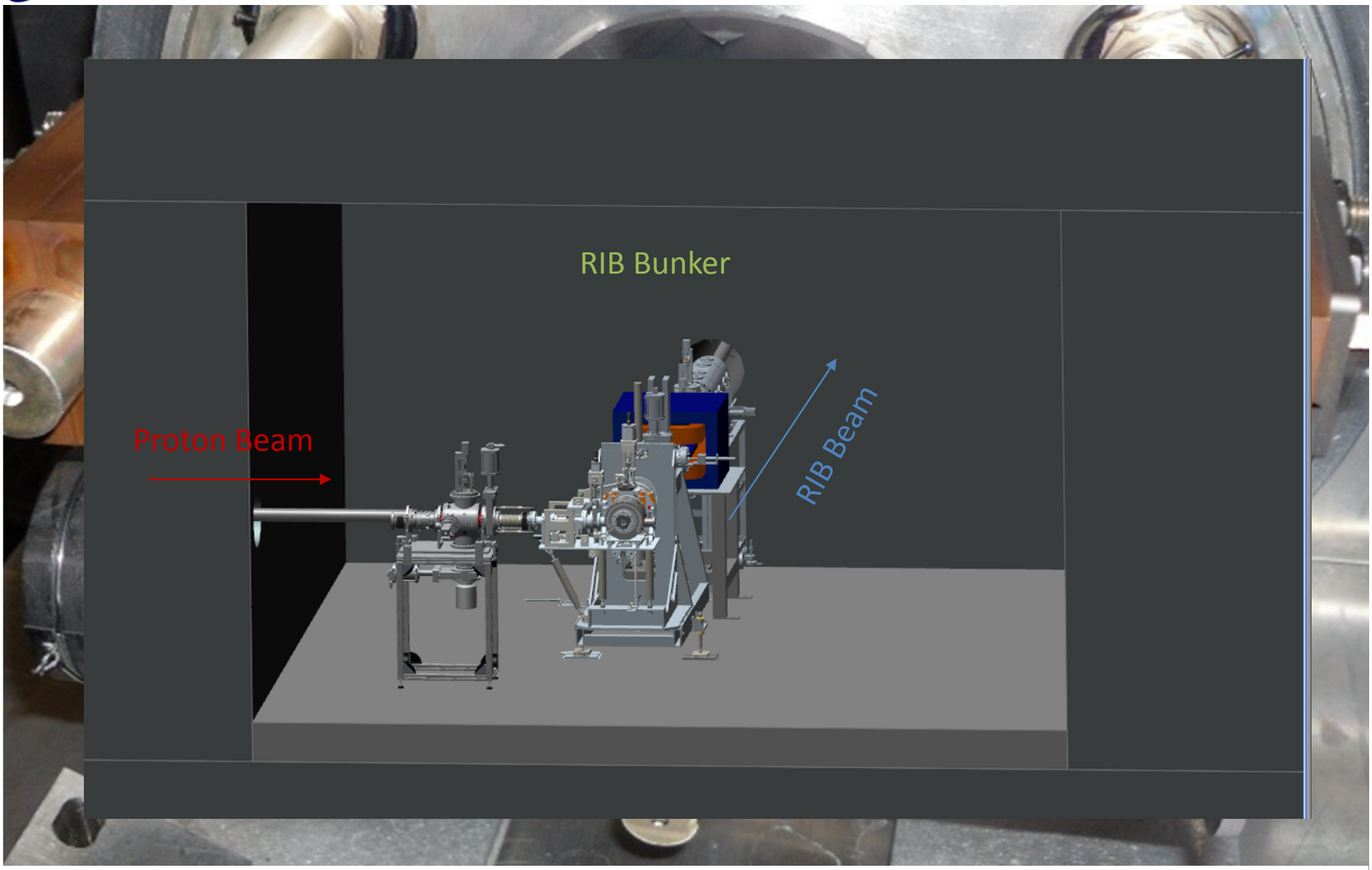
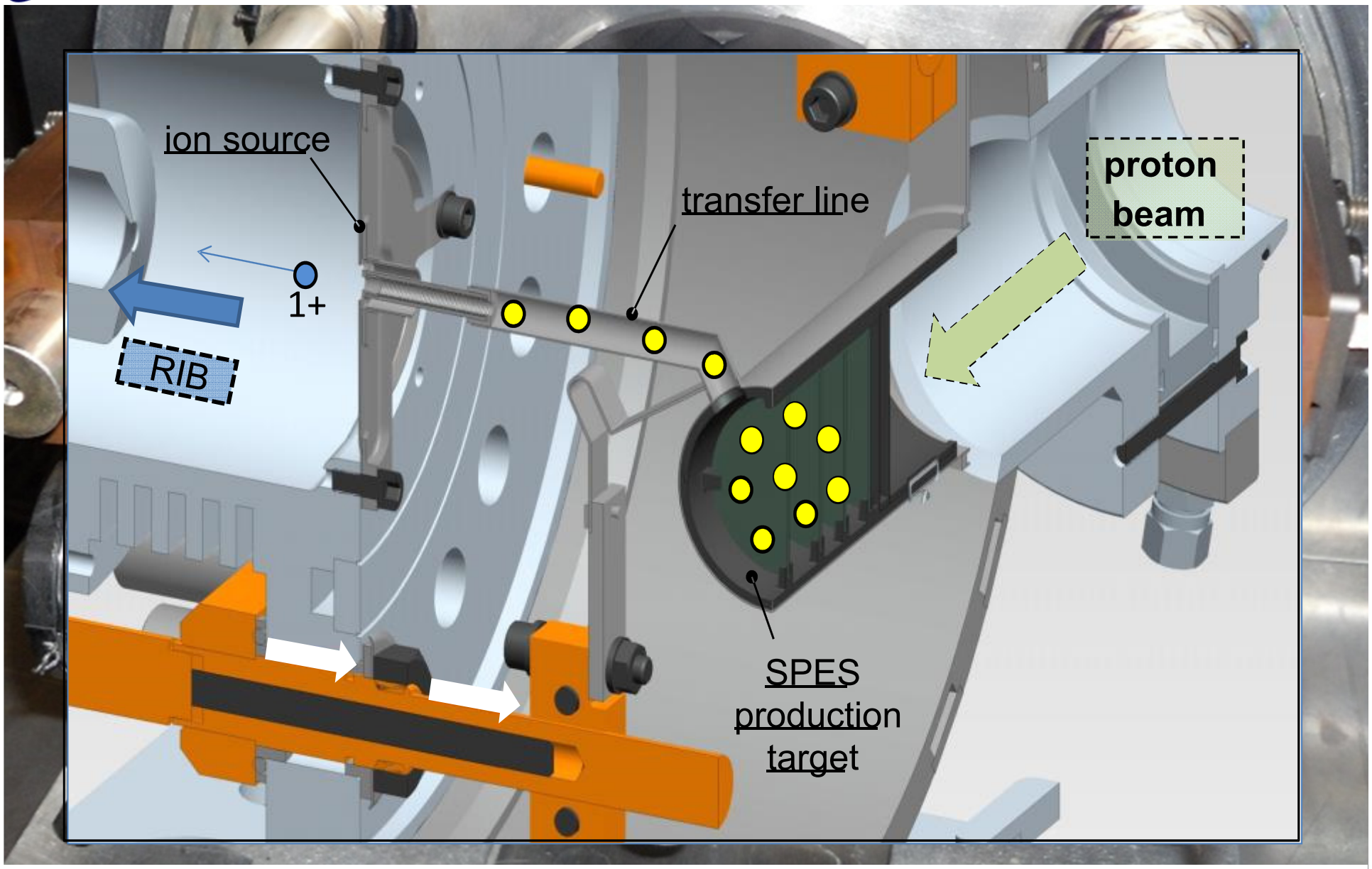


target diameter 4 cm.

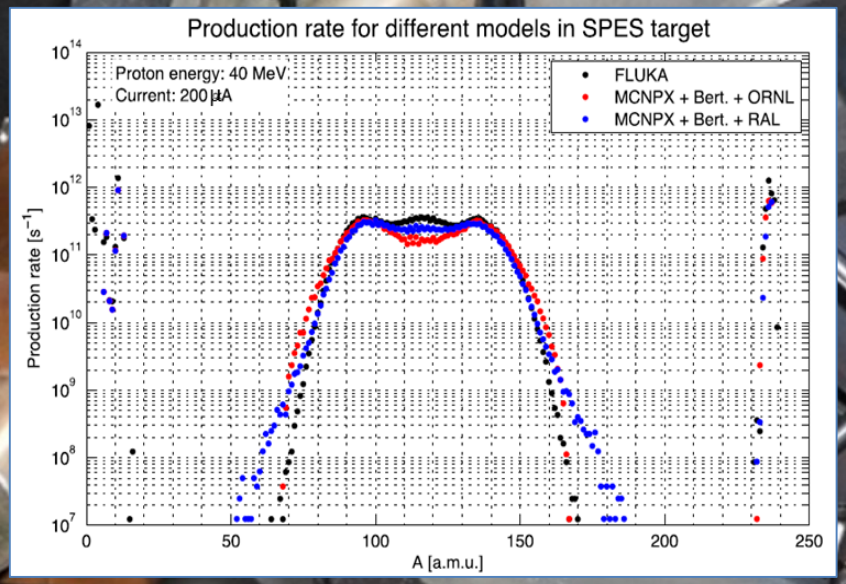
The SPES RIB production area

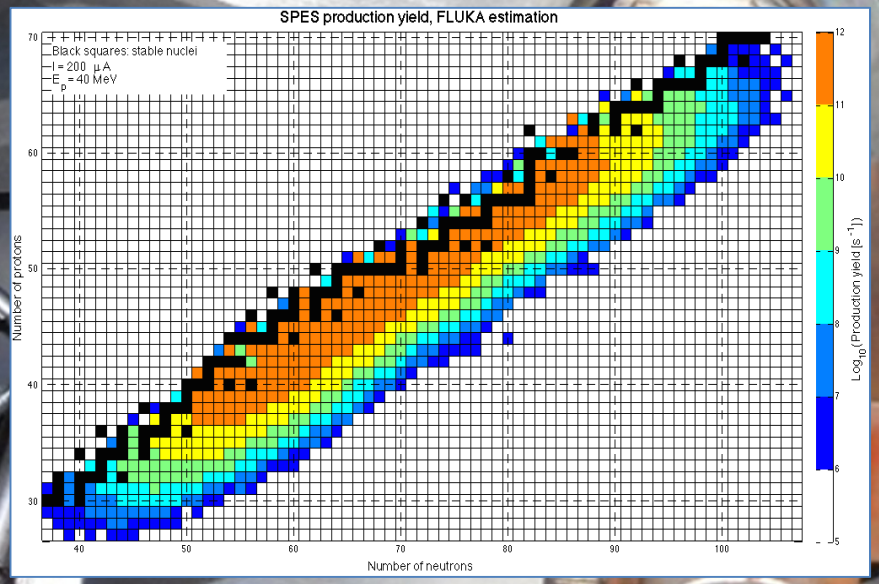


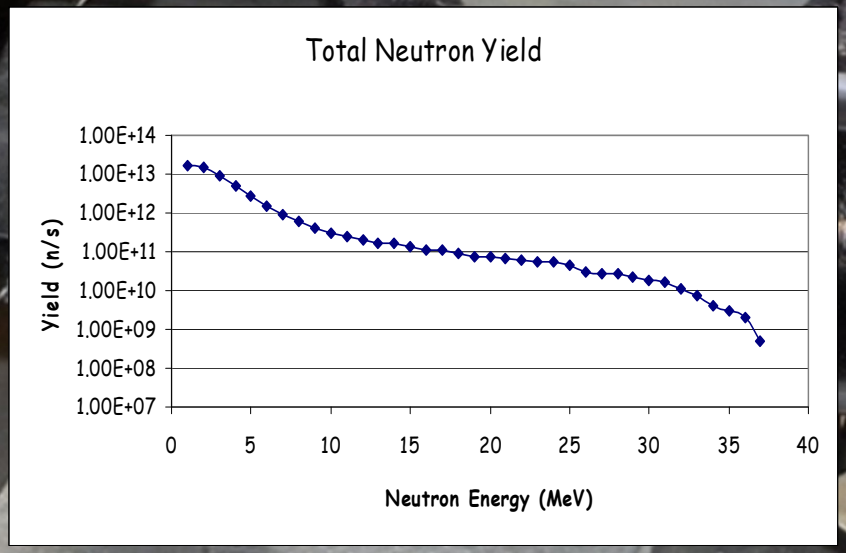
The SPES TIS complex

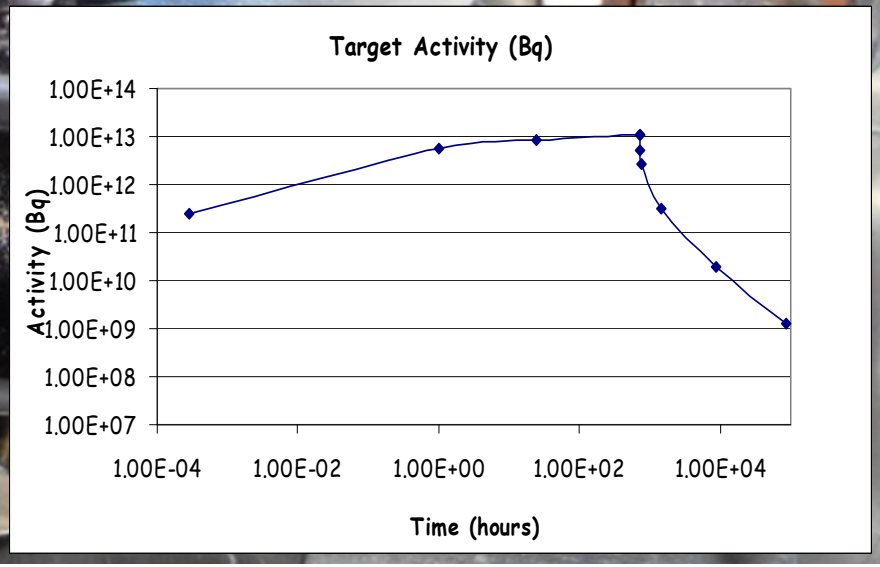


In target productions

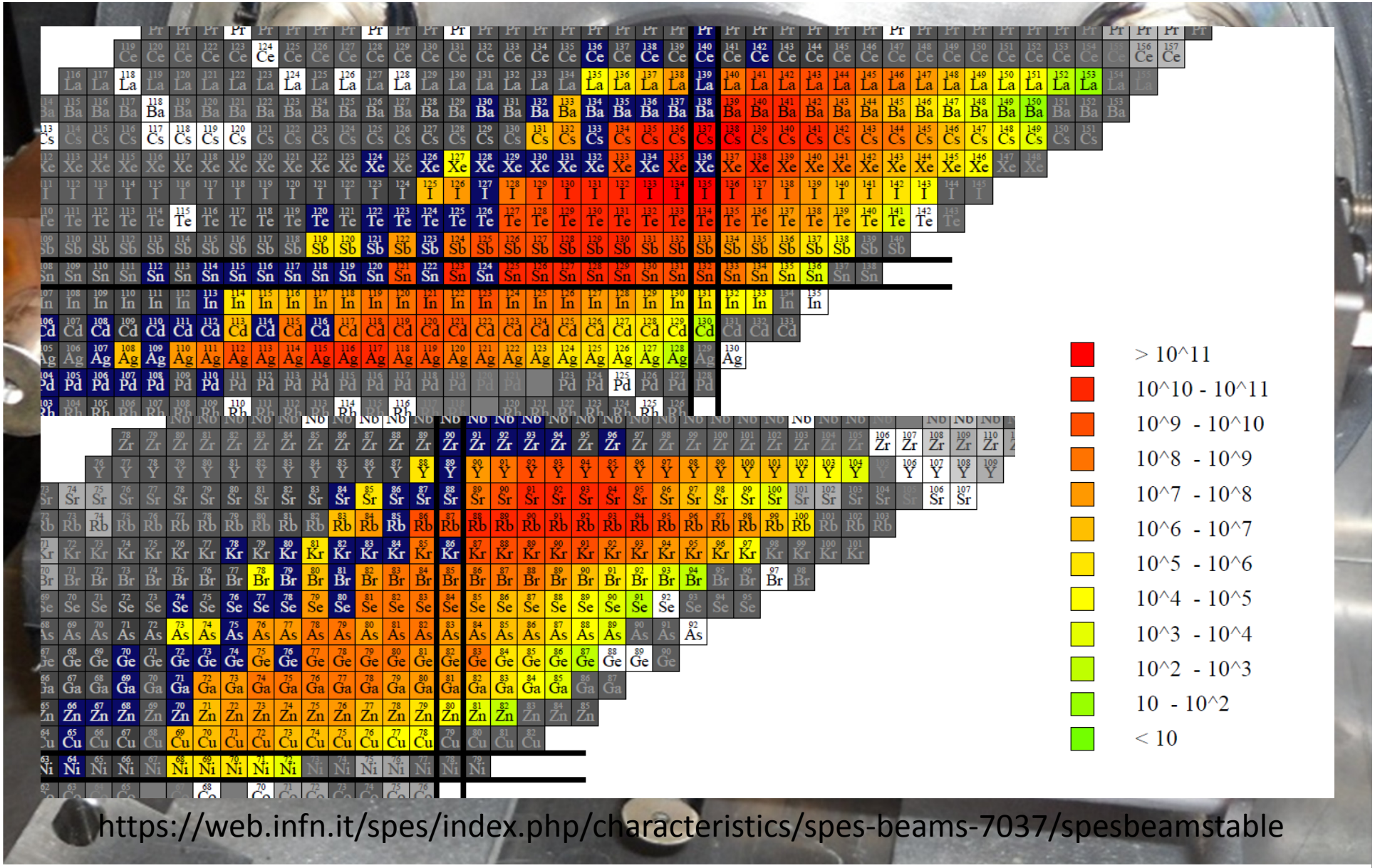






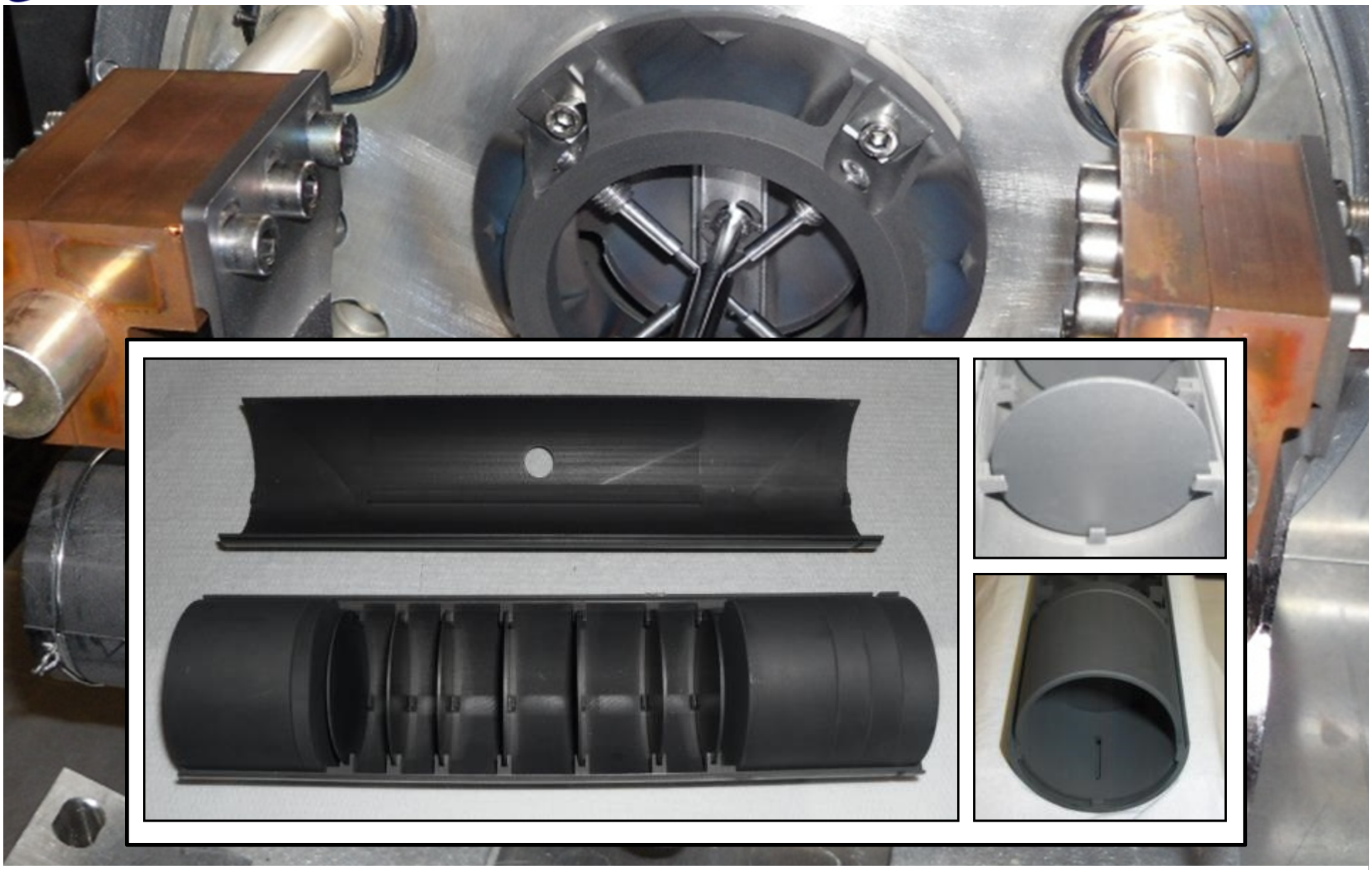


Beam at SPES



https://web.infn.it/spes/index.php/characteristics/spes-beams-7037/spesbeamstable

The target & ion source assembly



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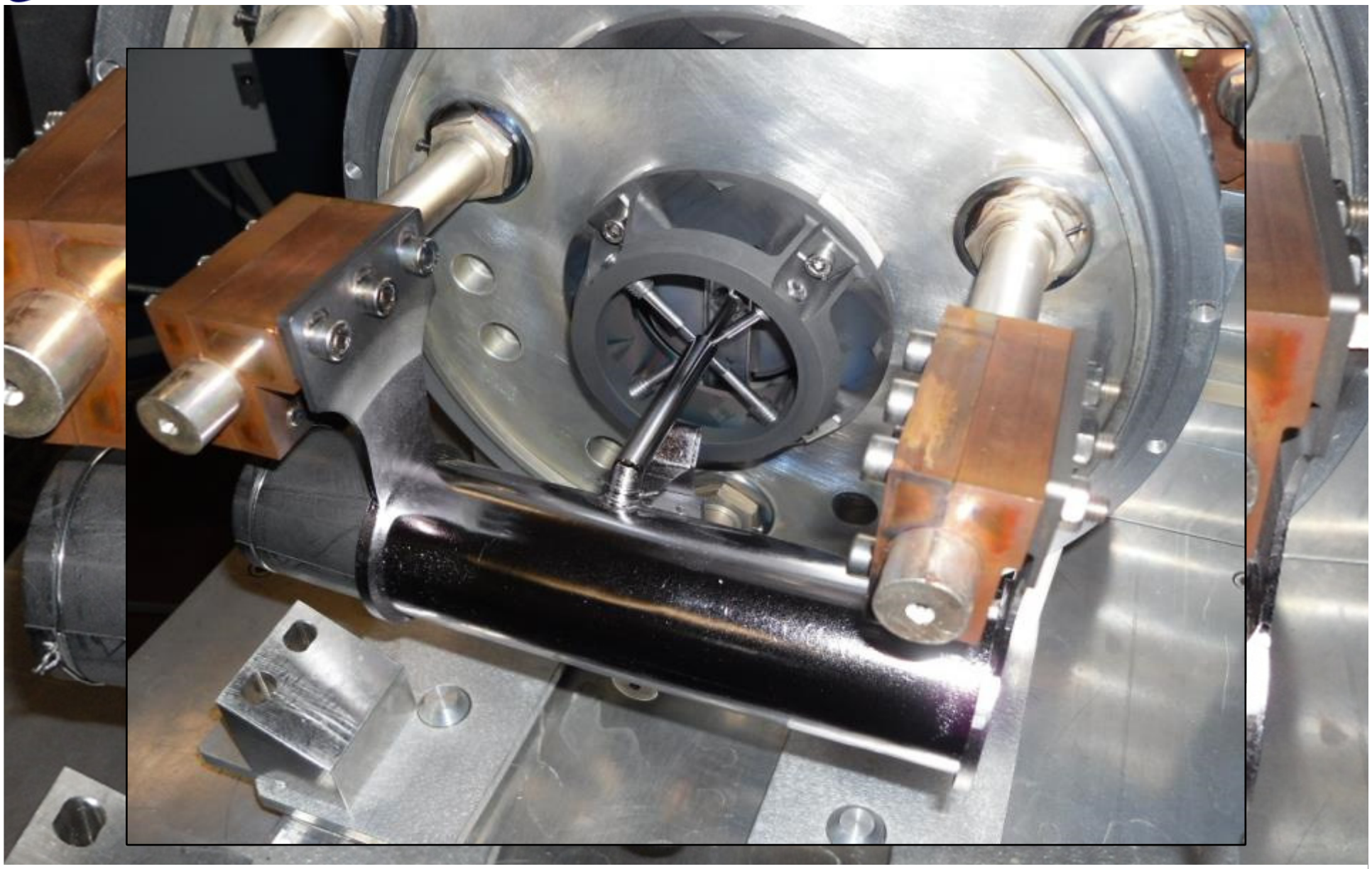

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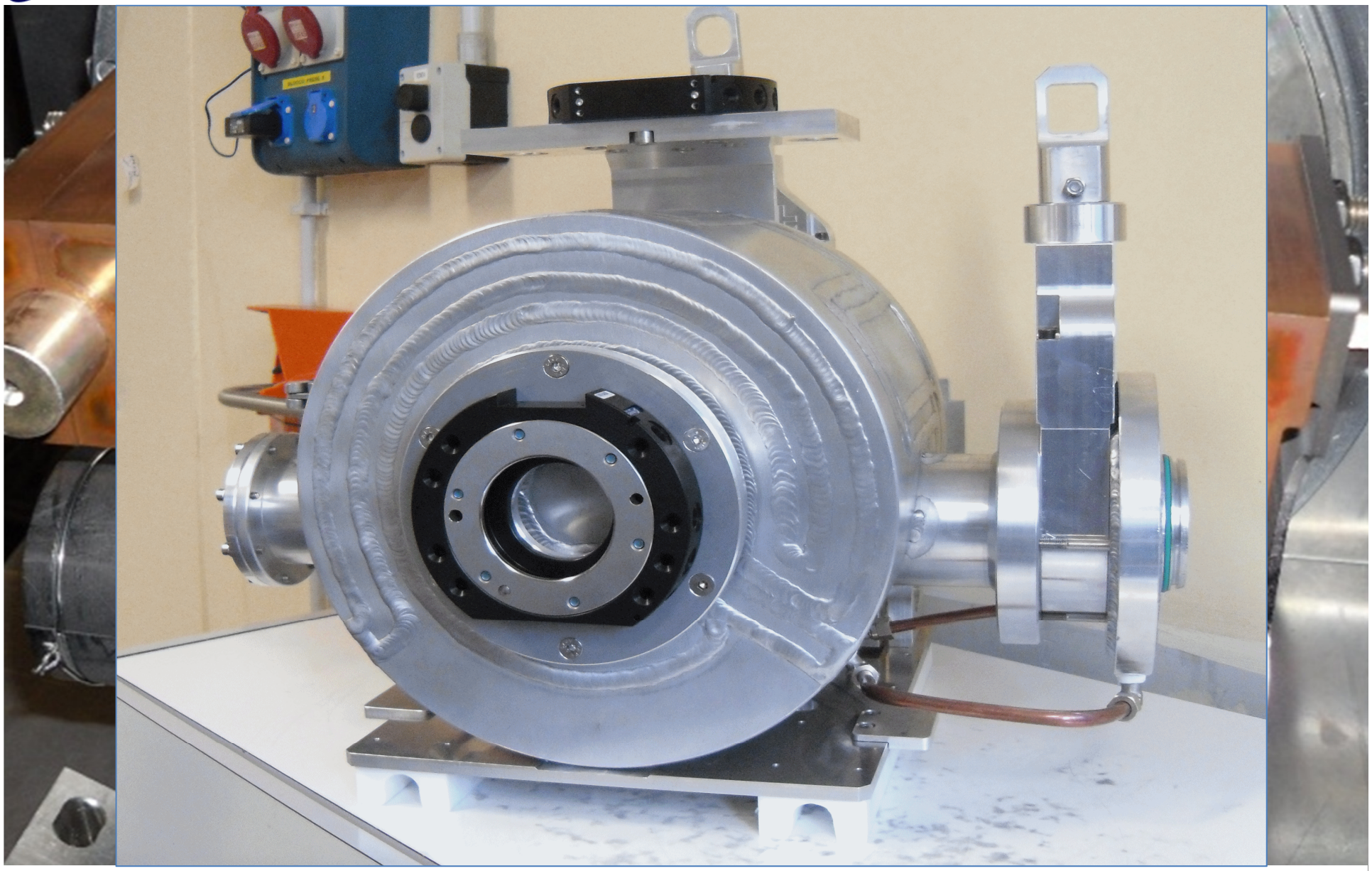

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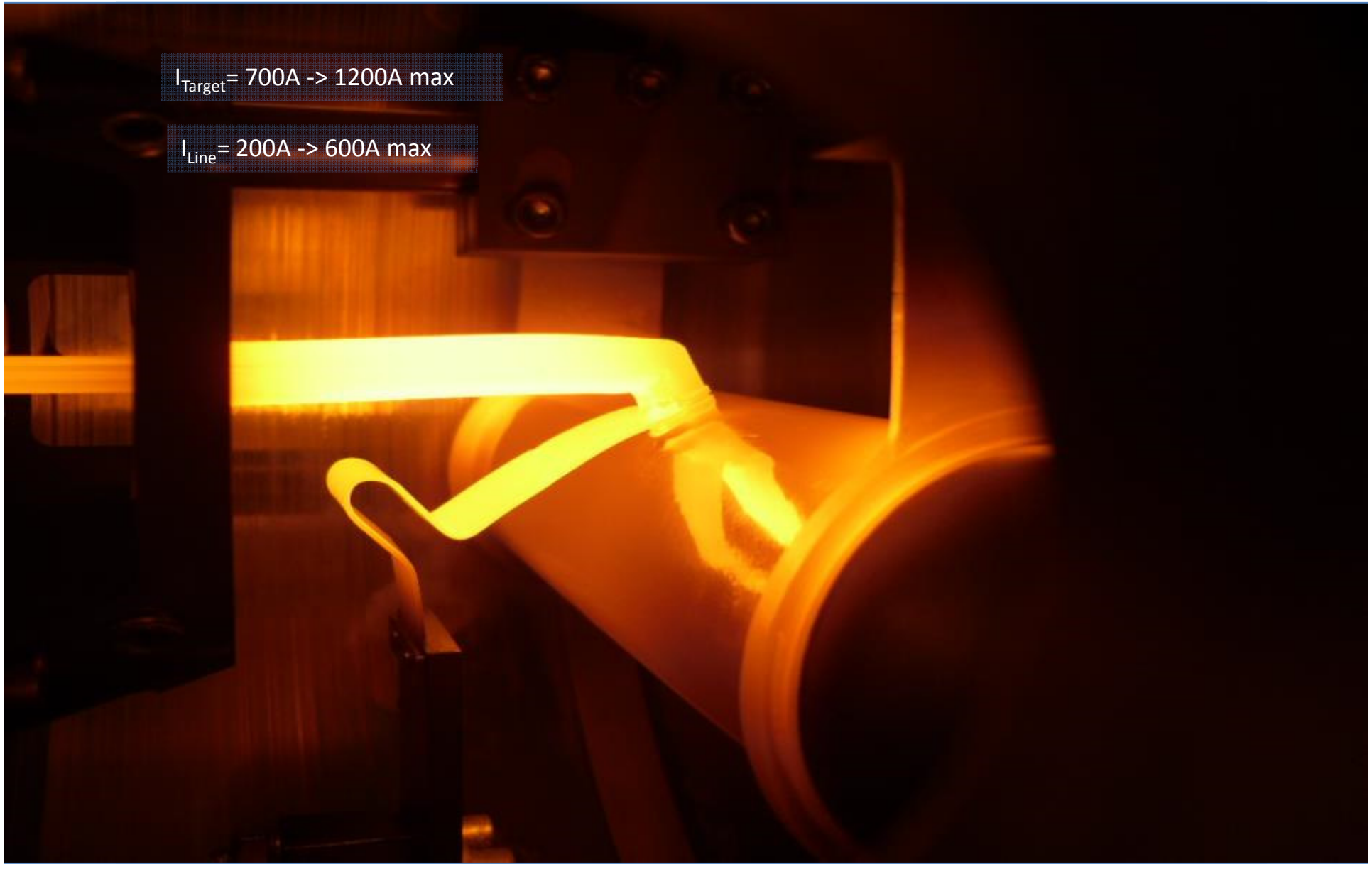
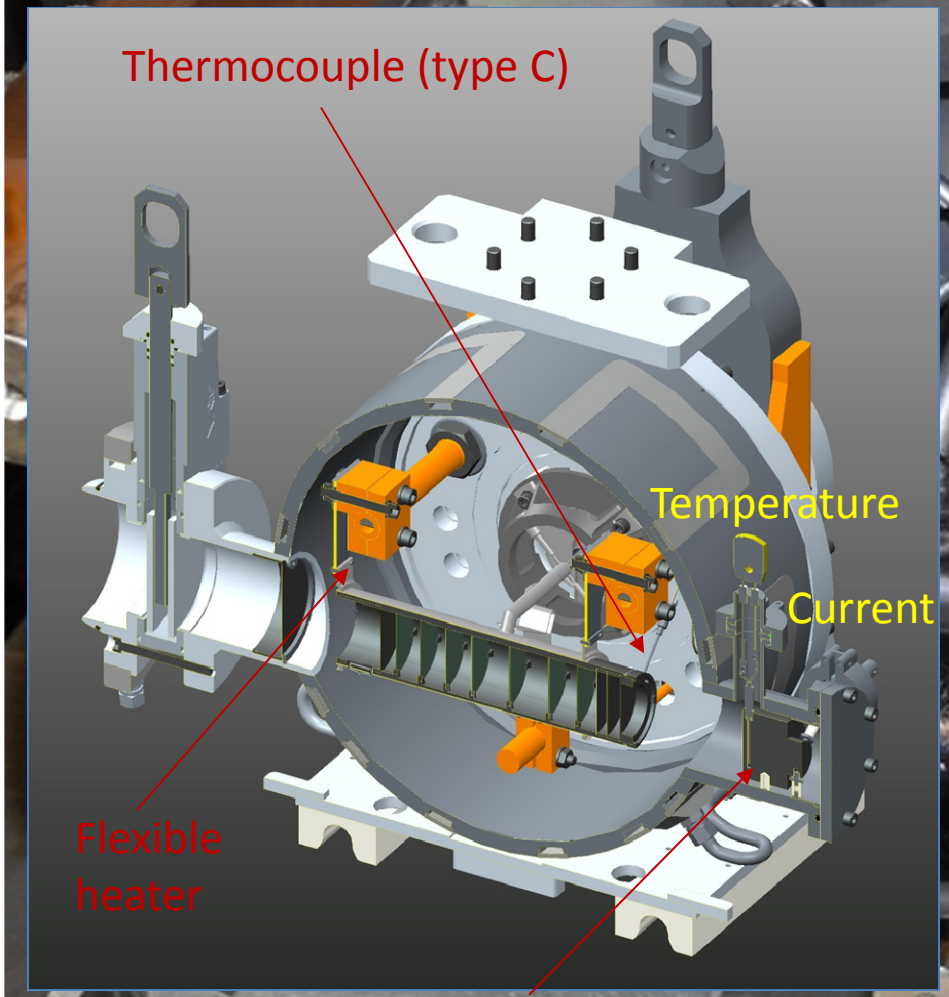
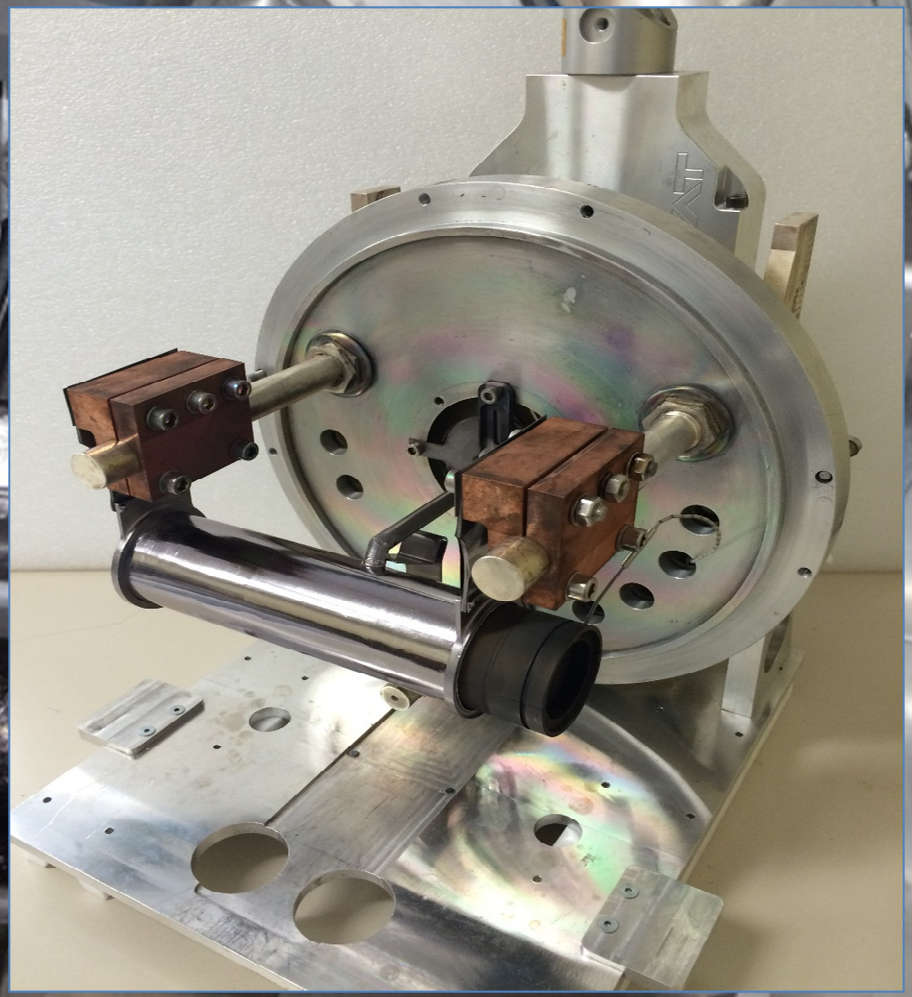


The Target Unit device

Taking into account the safety requirements: Monitoring target & dump temperatures





The SPES RIB LEBT (off-line lab)
Ion Source test area

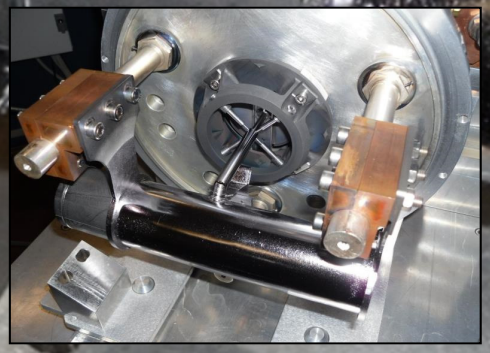
Steerers and triplet of quadrupoles

Diagnostic box (FC+BP)

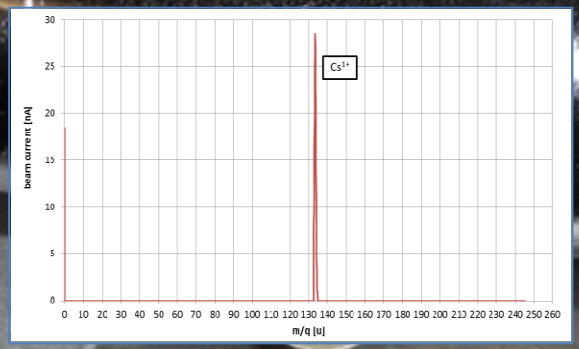
Slits and diagnostic box (BP+FC)

Second triplet of quadrupoles

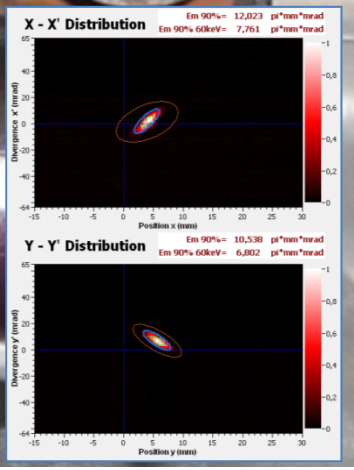
Target-ion source



Wien filter

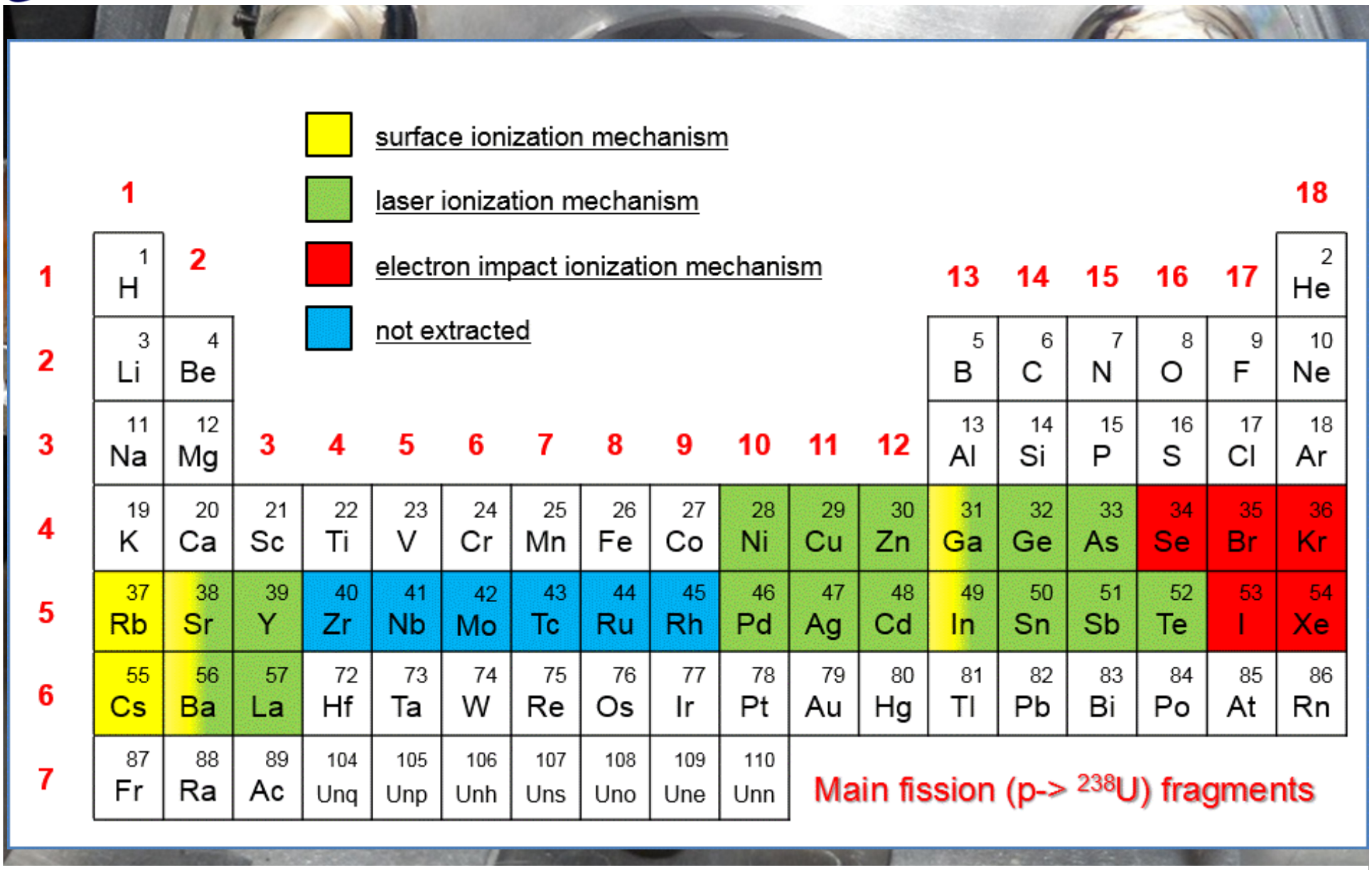


Emittance meter



WP6: The organization & Labs

The ionization methods



The ionization methods

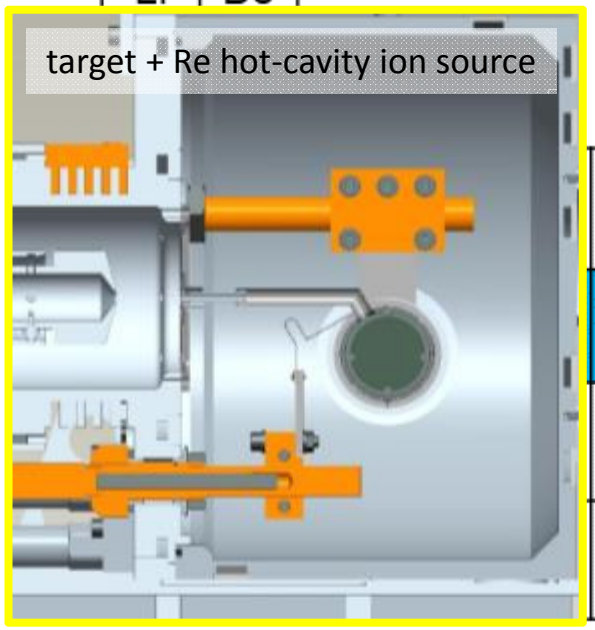
surface ionization mechanism

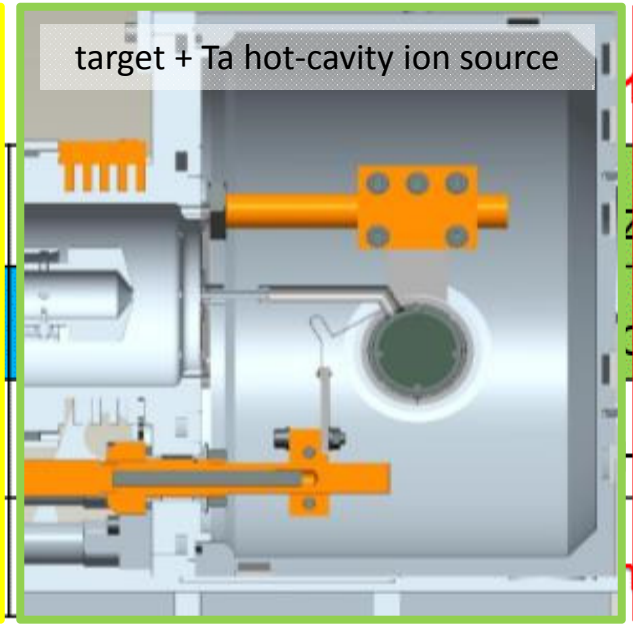
laser ionization mechanism

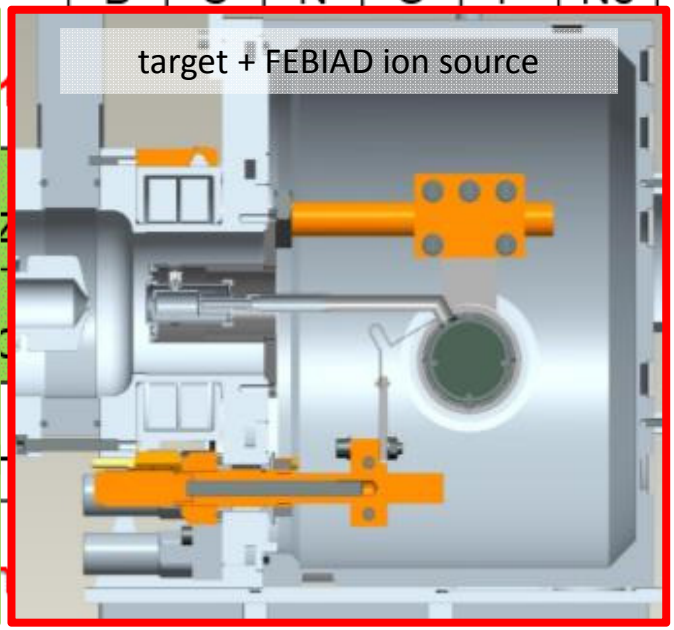
electron impact ionization mechanism

not extracted

	1																	18
1	1 H	2											13	14	15	16	17	2 He
2	3 Li	4 Be											5 B	6 C	7 N	8 O	9 F	10 Ne

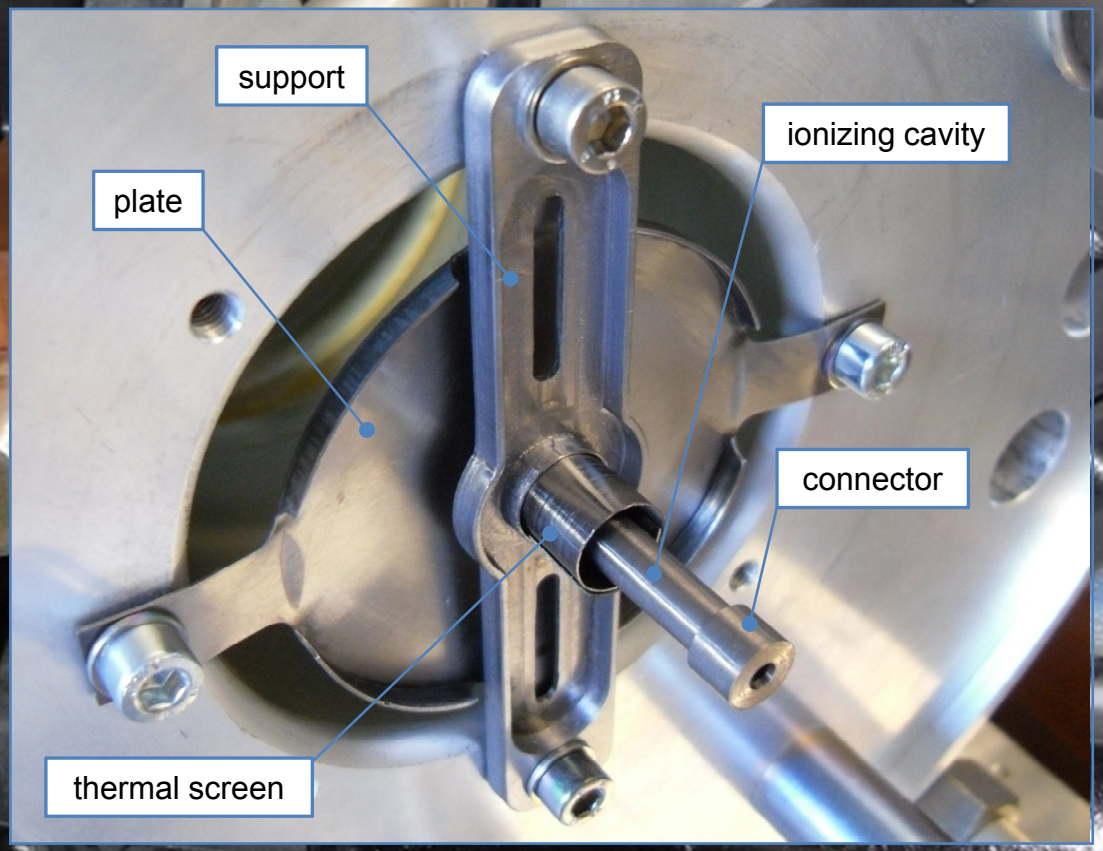






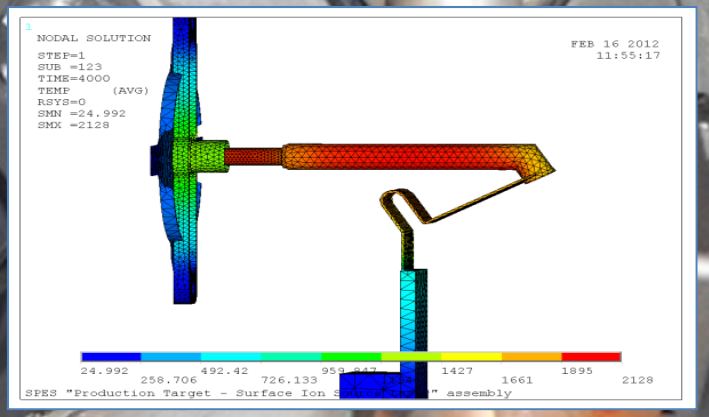
Ion Source Developments

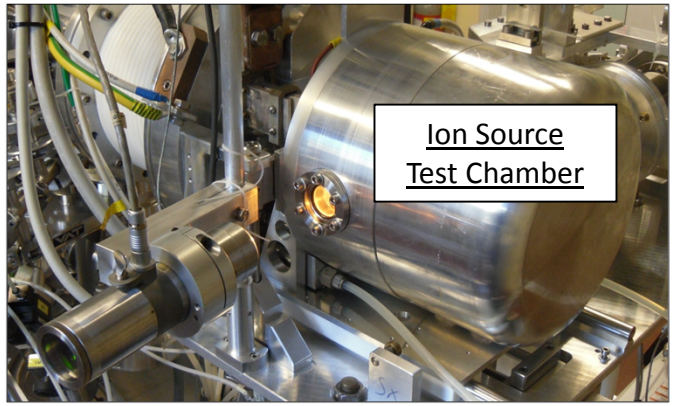
The SIS Ion source

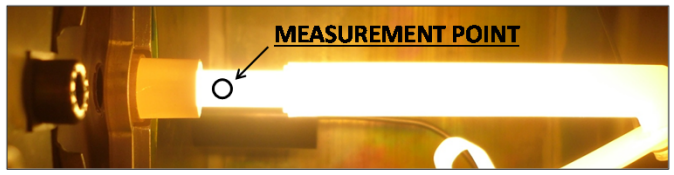


OFF-LINE TESTING
efficiency and emittance measurements
with accurate temperature monitoring

Re Ionizing Cavit and **Ta** Ionizing Cavity

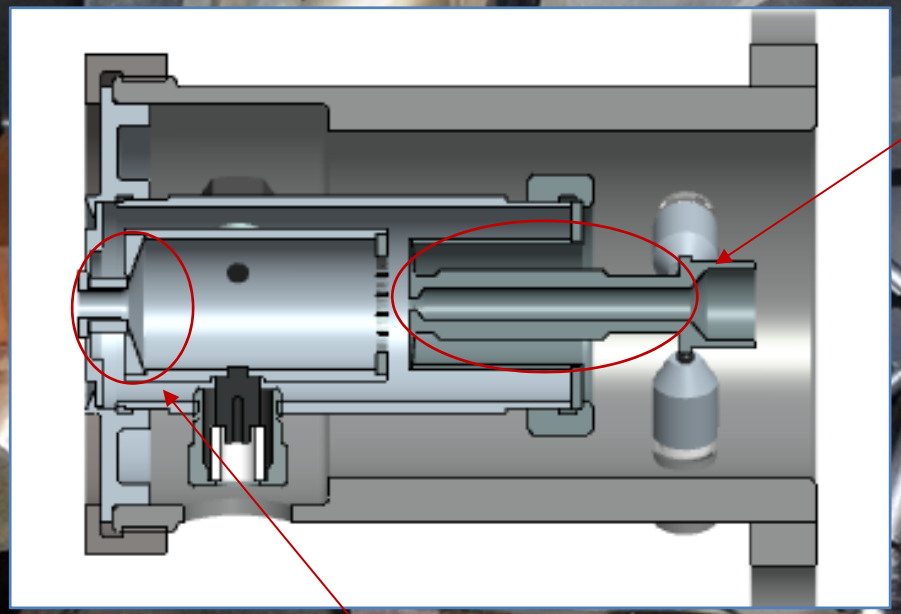






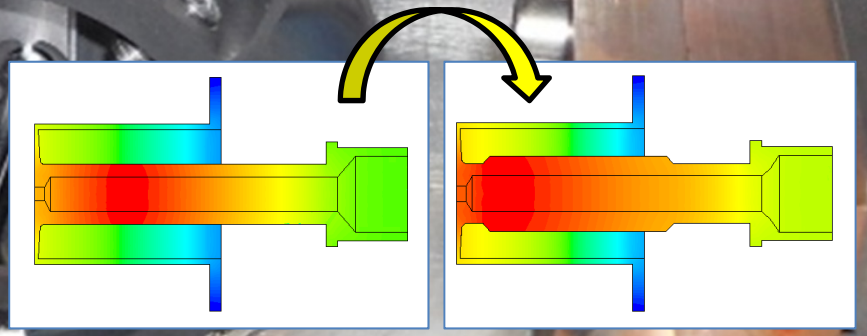
Ion Source Developments

The PIS Ion source



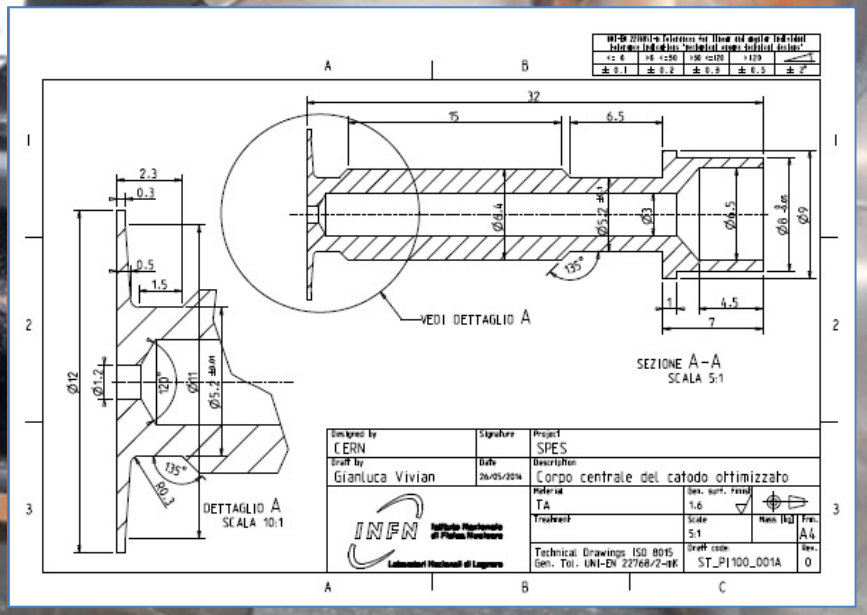
OPTIMIZED CATHODE GEOMETRY

hot spot close to the anode interface
(thermionic electron production)



OPTIMIZED EXTRACTION REGION

low transversal emittance values

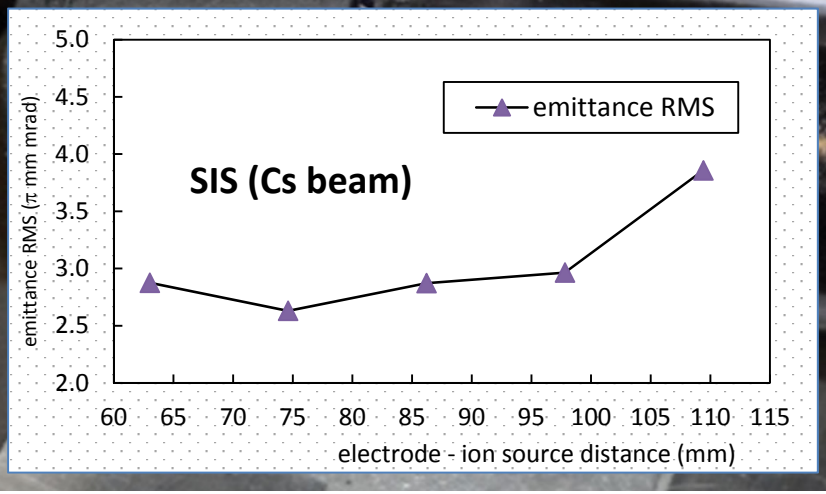


Ion Source Developments

The SIS Ion source

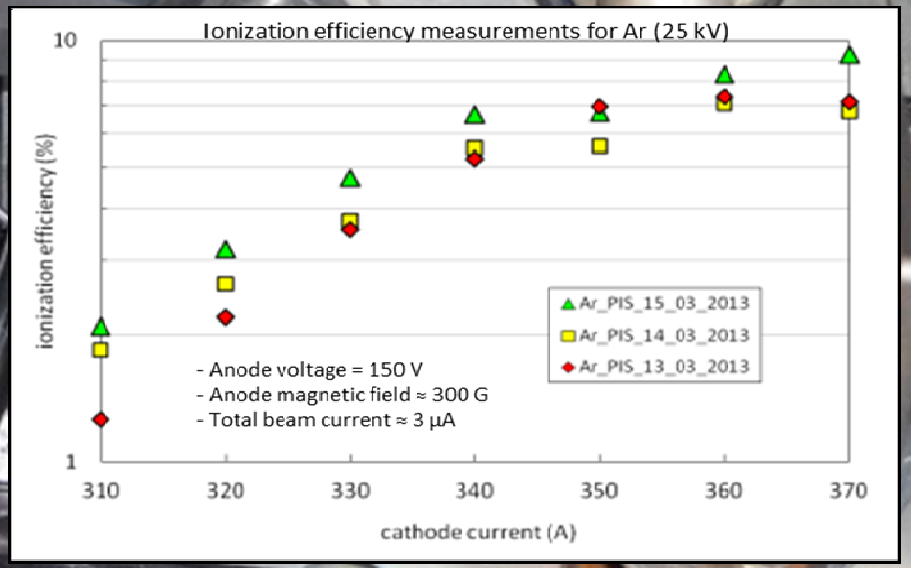
Efficiency measurements at different temperatures (1600°C, 1800°C, 2000°C, 2200°C) for Cs, Rb, Sr, Ba

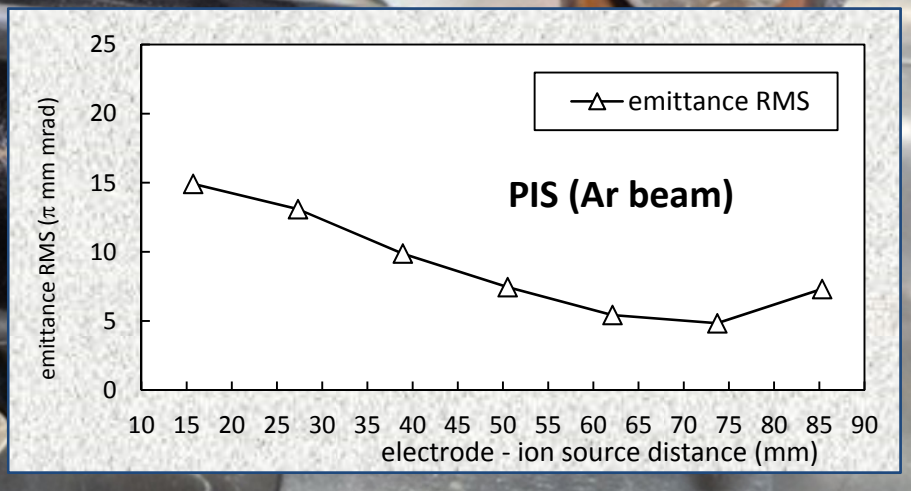
Element	Ta	T=2200°C	
(/)	(eV)	ε_{CLEAN} [%]	max. error
Cs	3,9	43,0	1,1
Rb	4,2	54,6	3,1
Ba	5,2	19,6	3,1
Sr	5,7	6,0	1,3



The PIS Ion source

Ionization efficiency measured for Ar; Kr, Y and Xe beams has been produced

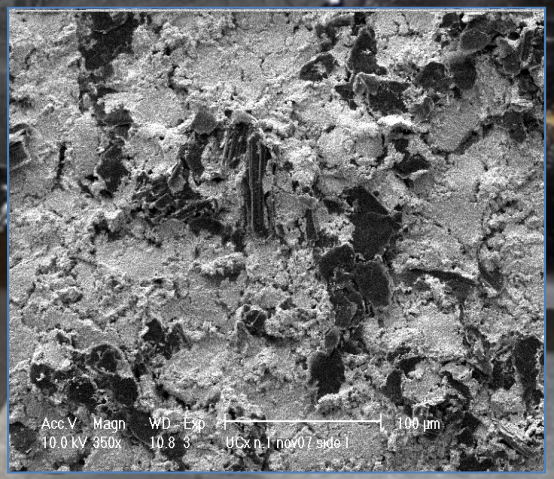




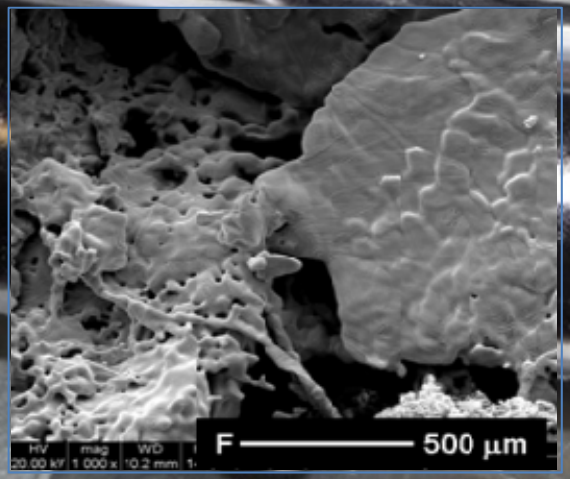
Target production

Study of the target porosimetry on the isotopes production yield

First Bunch
Standard UC_x



Second Bunch
Low density UC_x



Third Bunch
Medium density UC_x

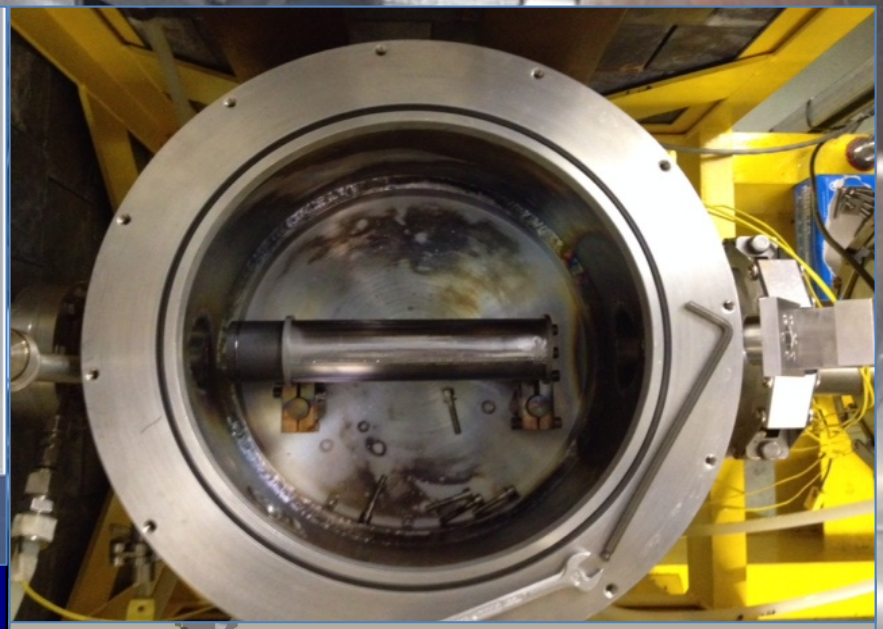
	Standard	Low	Medium
Density (g/cm^3)	4.25	2.59	6.38
Diameter (mm)	12.50	13.07	12.91
Thickness (g/cm^2)	0.41	0.41	0.41
Calculated porosity (%)	58	75	37

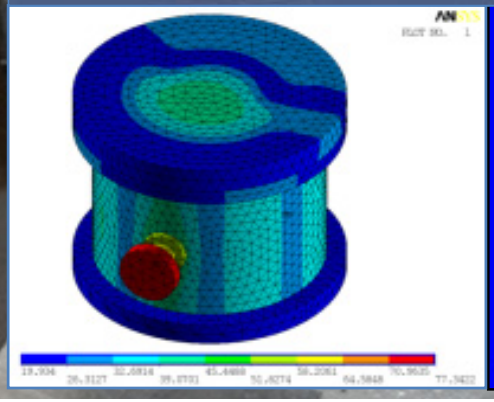
TM: Ithemba test

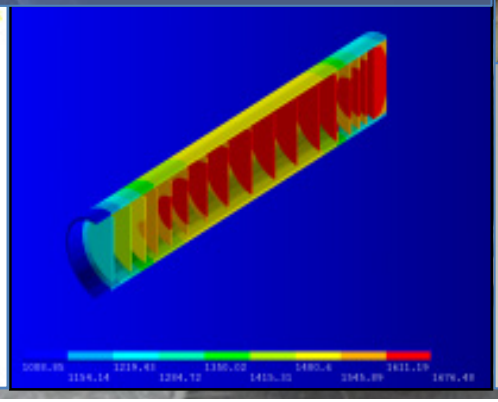
4) Full scale (40 mm.) SiC @ Ithemba, p=66 MeV, 60 microA for thermal dissipation studies

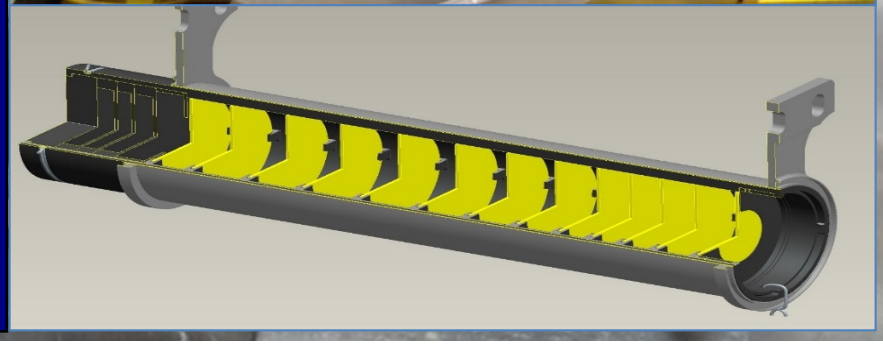
- On-line testing of the SPES target architecture @ iThemba (May 2014)

iThemba LABS: funded to build an RIB station like SPES (10 kW multi-foil target)



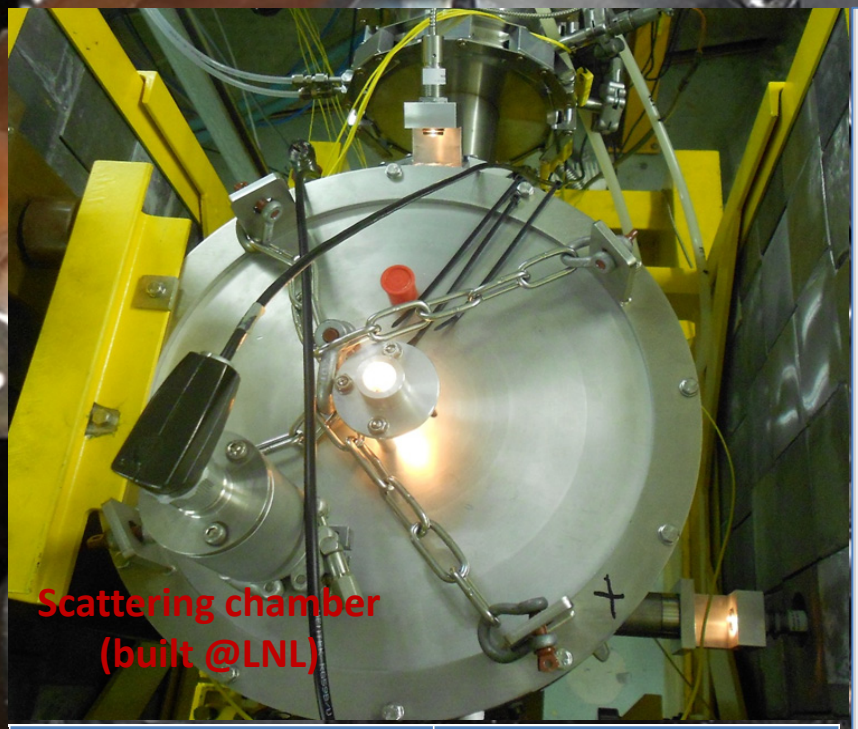




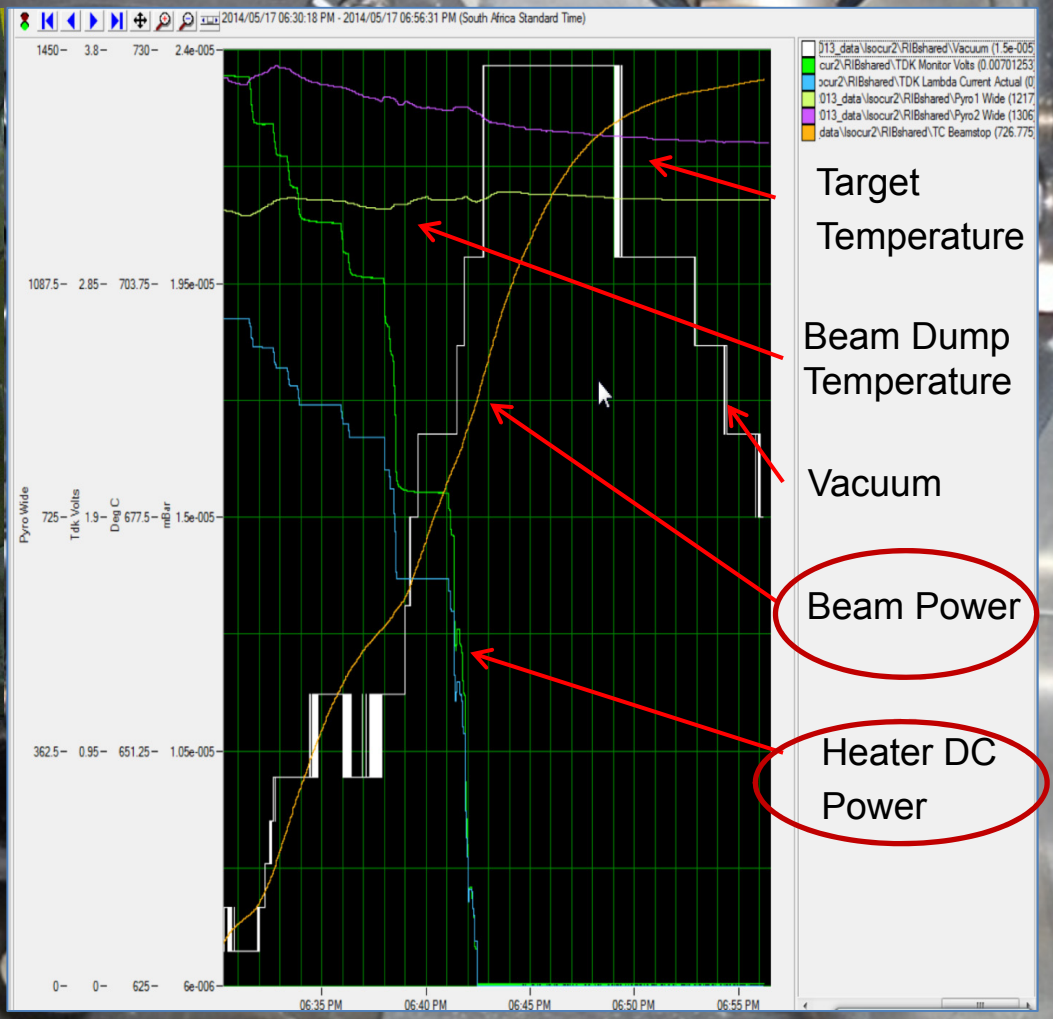


TM: Ithemba test

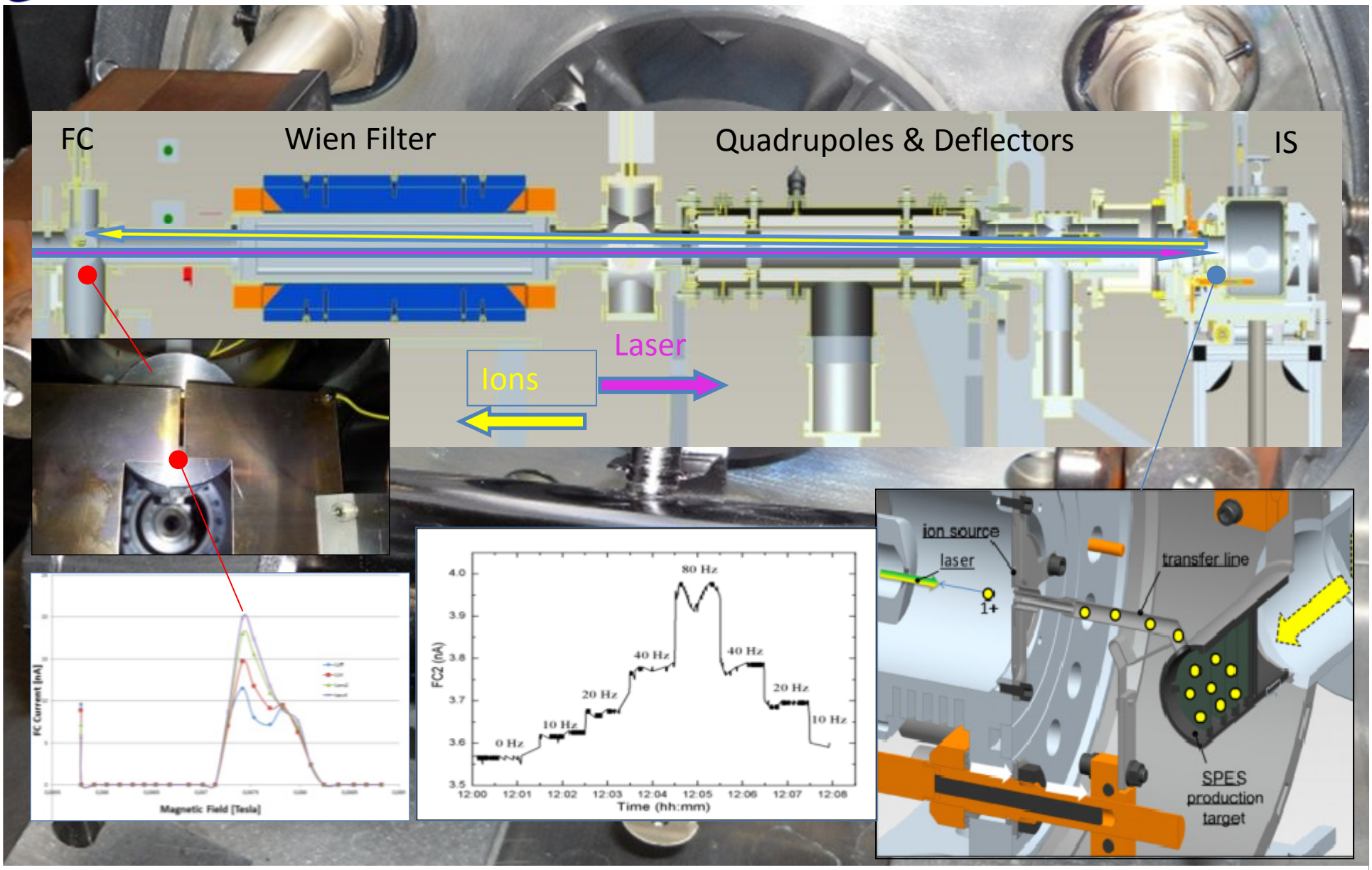
- On-line testing of the SPES target architecture @ iThemba (2013-2014)
- 66 MeV, up to 60 μA - proton beam on a SiC target (T_{max} on SiC =1600°C)



Measure [°C]	Estimated by FEM model [°C]
1° disk: 1365 ± 30°C	1390
Box: 1230 ± 25°C	1267
Dump on chamber: 728°C ± 10°C	750

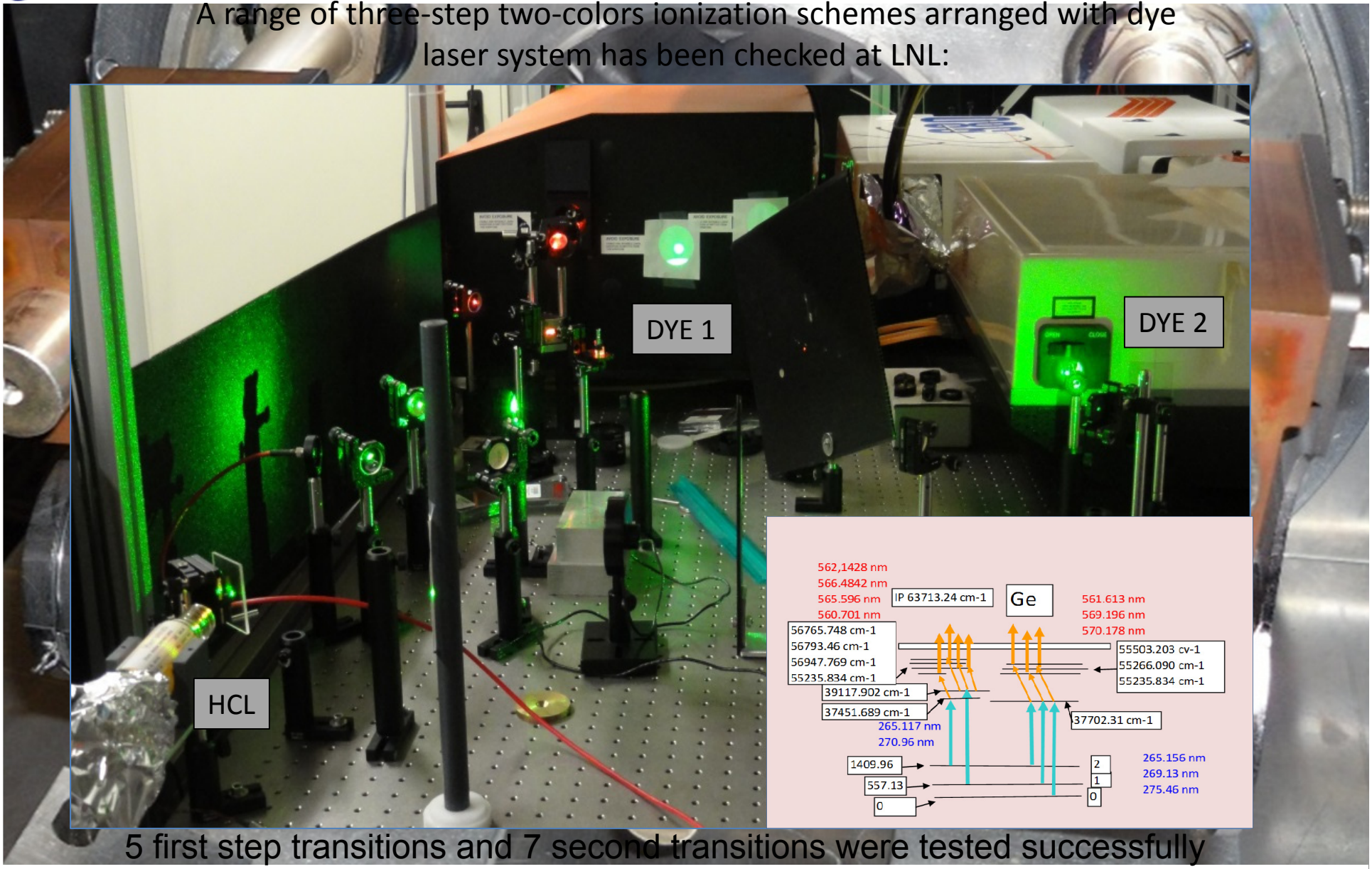


TL: photo-ionization of Al in hot cavity



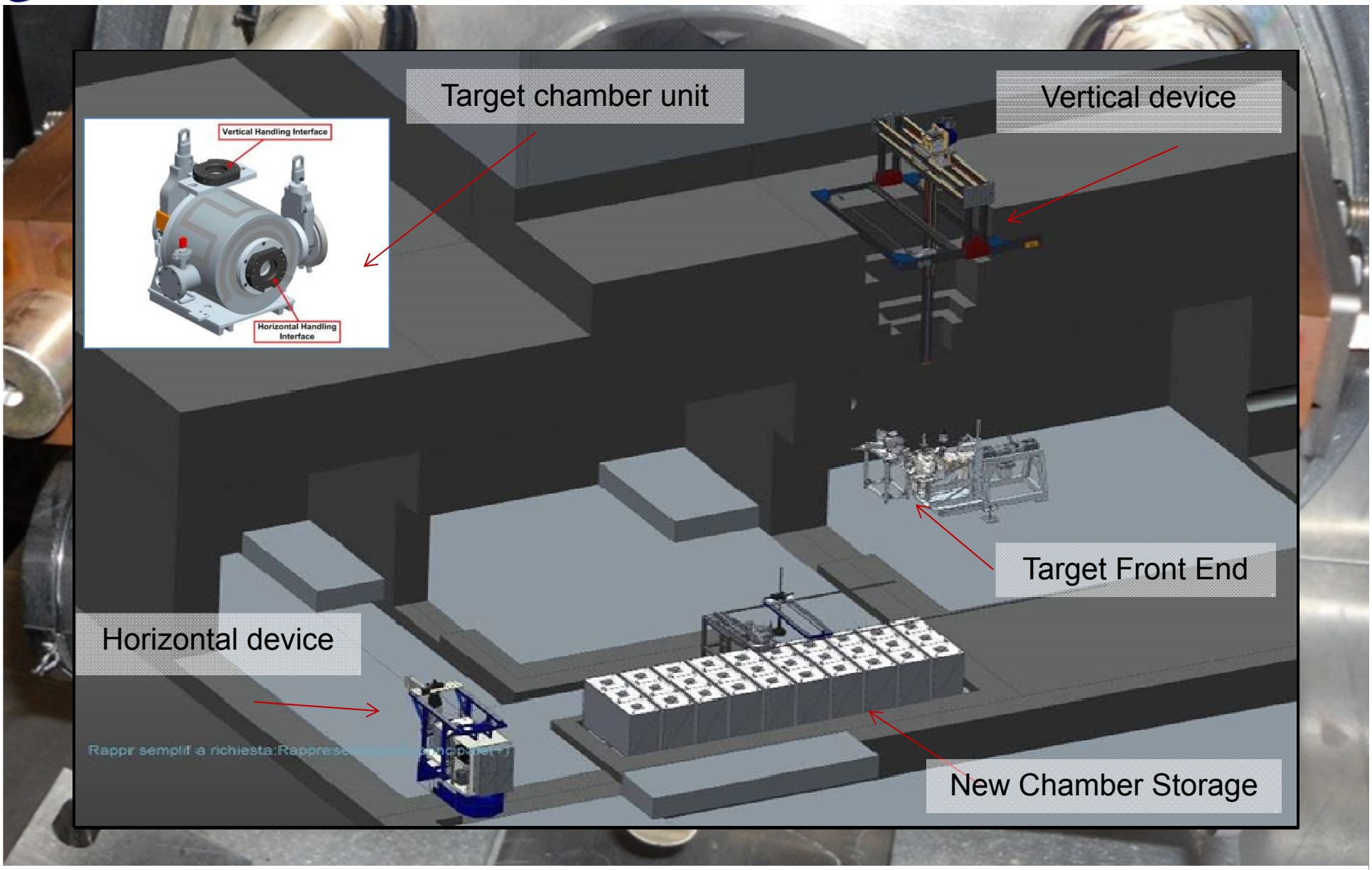
TL: Germanium spectroscopy study

A range of three-step two-colors ionization schemes arranged with dye laser system has been checked at LNL:

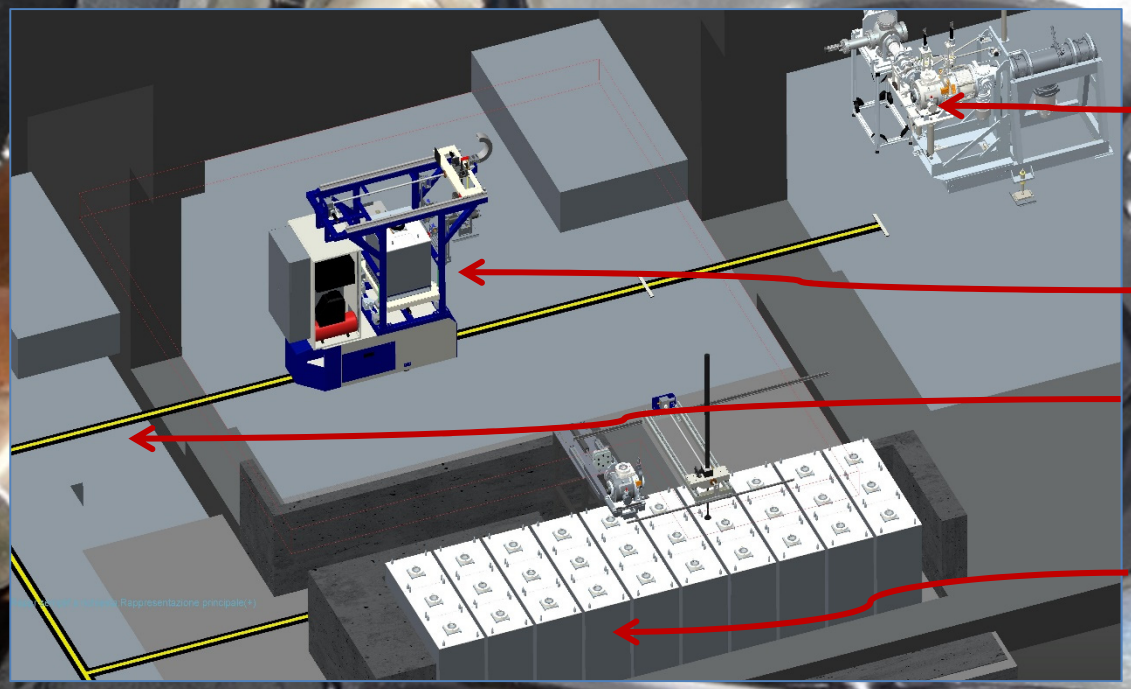


5 first step transitions and 7 second transitions were tested successfully

TH: The handling overview



The Horizontal system: 4 phases



1) Coupling table handling

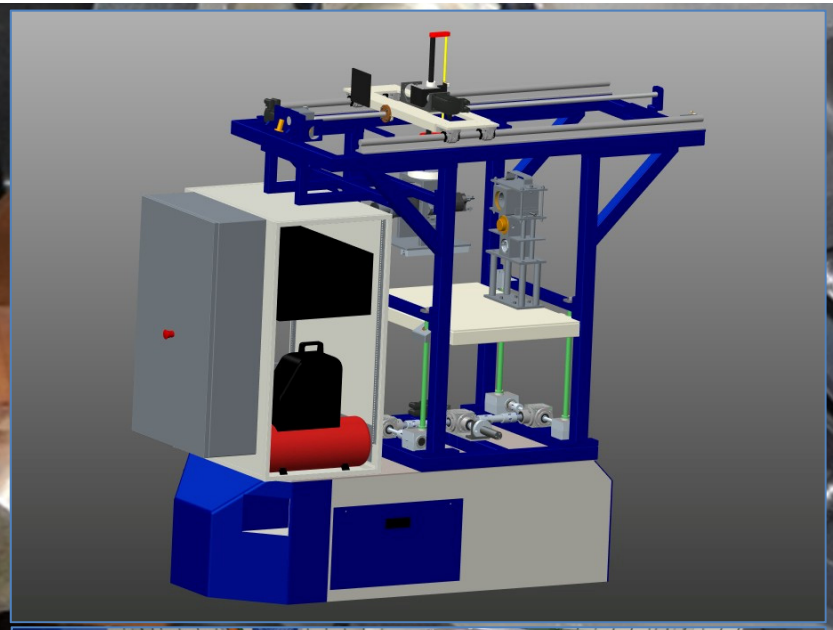
2) Cartesian handling

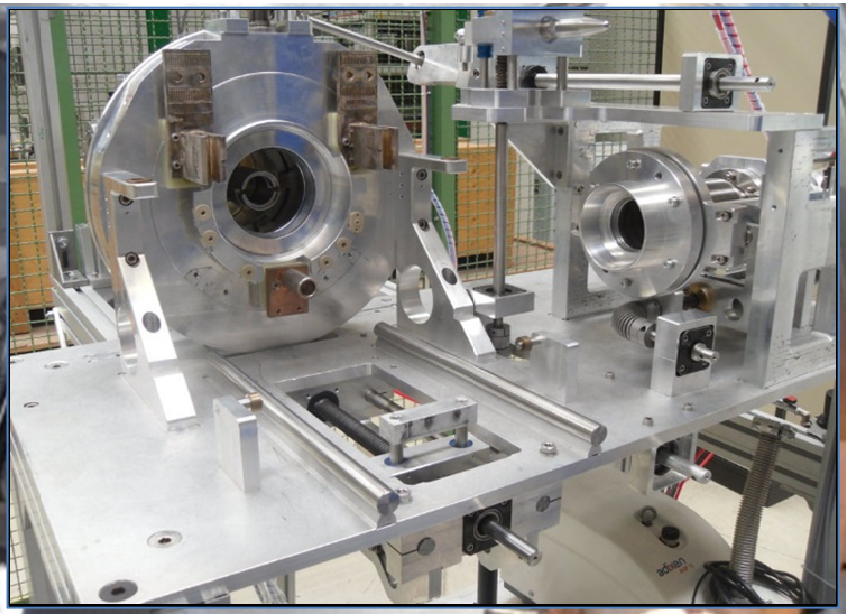
3) AGV trip

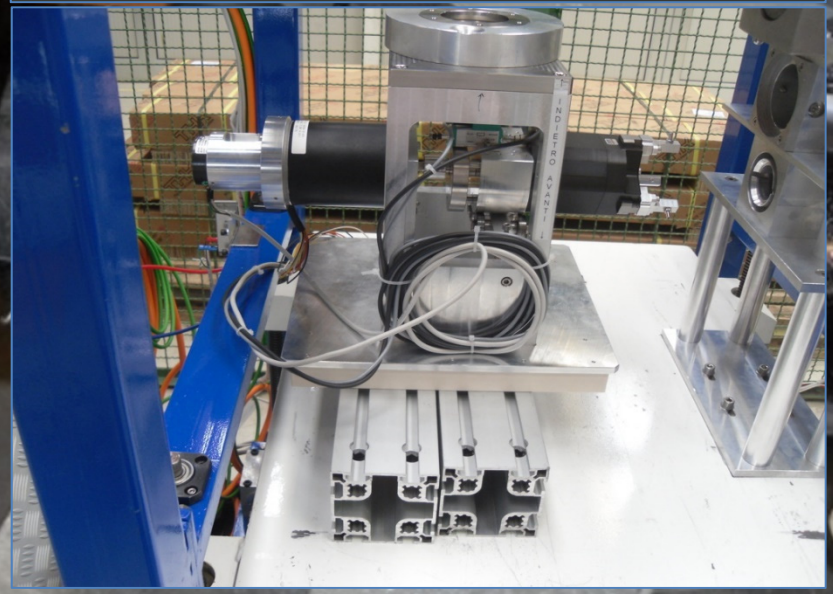
4) Storage handling

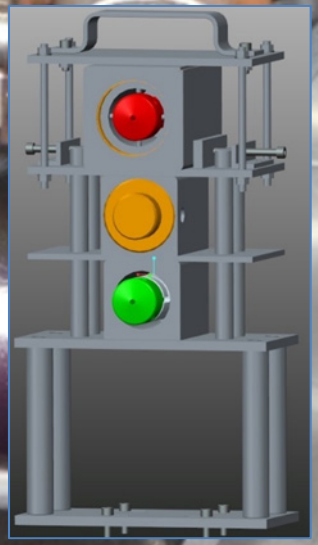
Temporary test lab (from Sept '14)

Handling of the extractor







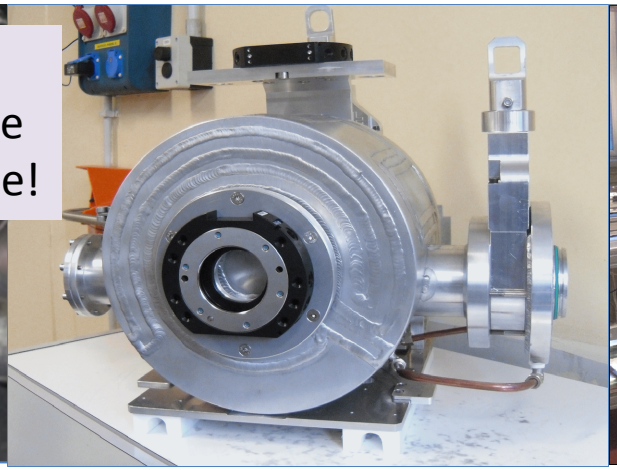


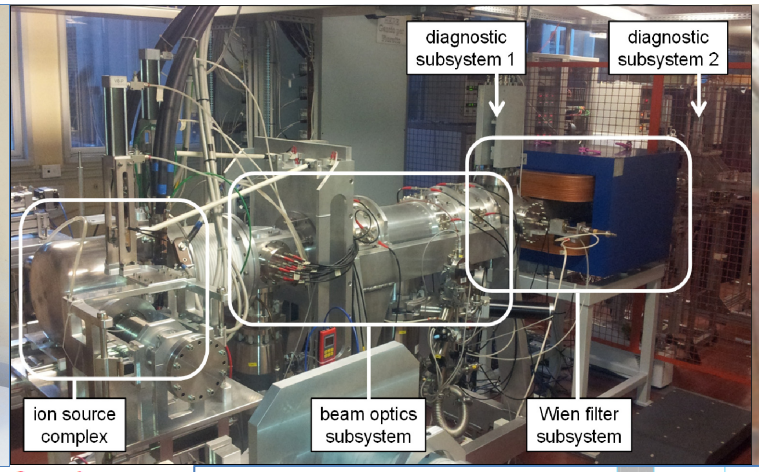
High contamination:
To remove remotely

Radioactivity: The critical spots

1) Neutron activation

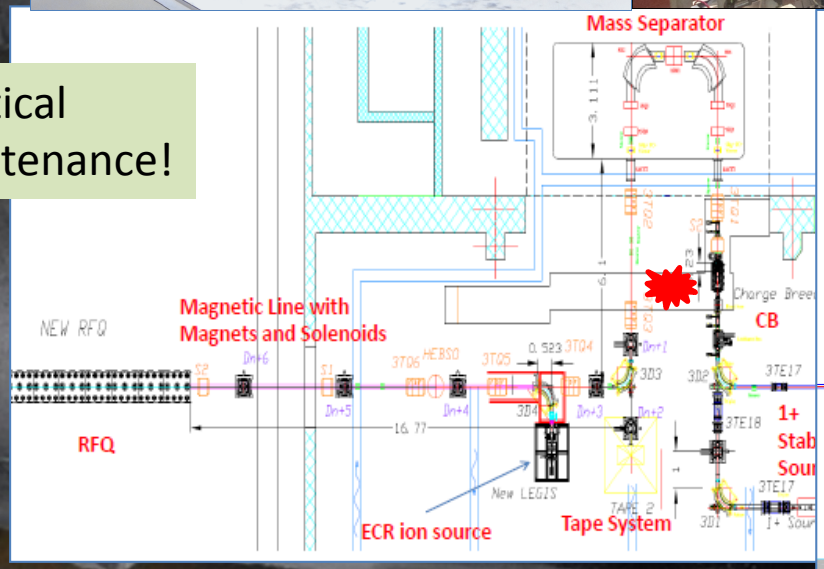
Critical for damage and storage!

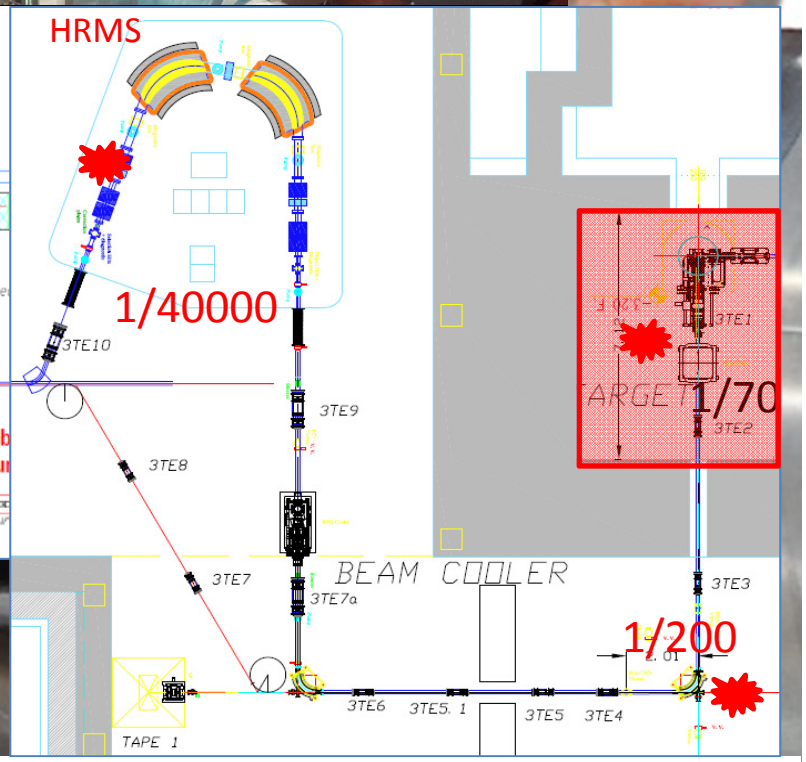


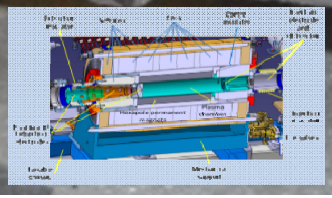


2) Radioactive beam hot-spot

Critical for maintenance!







Charge Breeder: Loss of 90% of radioactive beam

TFE: On- Line FE

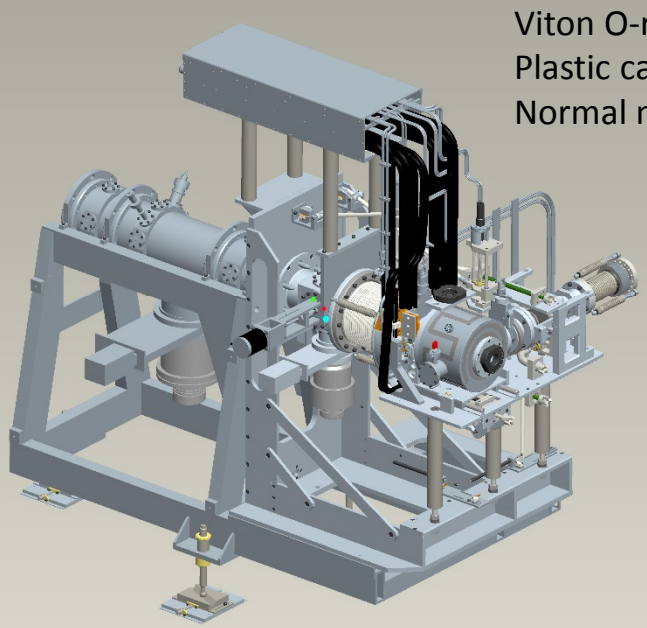
RAD-HARD version

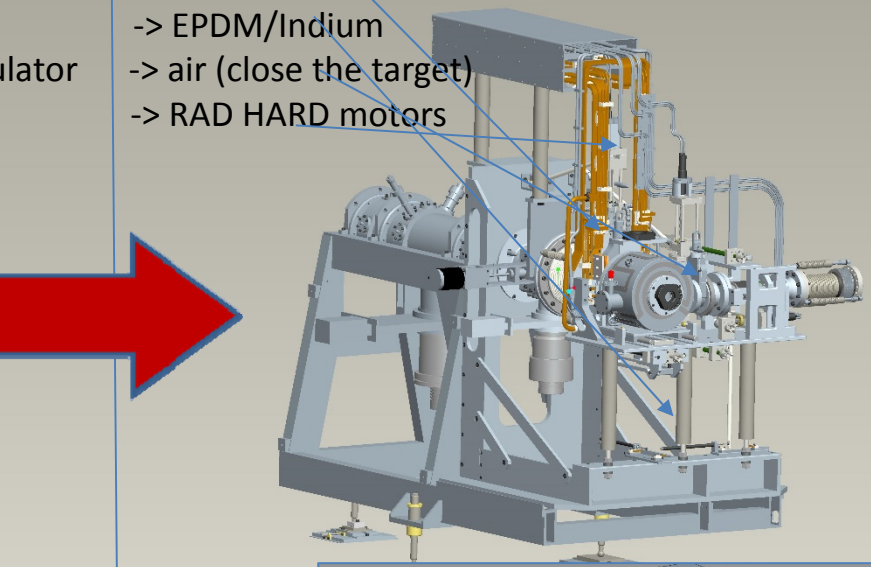
Critical materials

Off-line FE

Teflon with glass fibres	-> alumina
Polyethylene	-> peek
Viton O-rings	-> EPDM/Indium
Plastic cable insulator	-> air (close the target)
Normal motors	-> RAD HARD motors

On-line FE





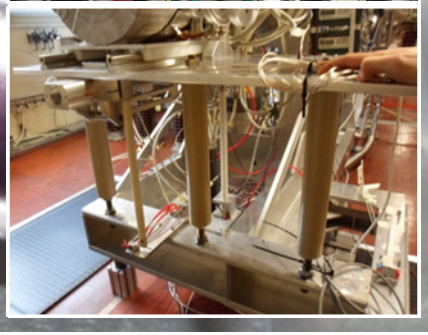
New giraffe:
fast connectors & plastic free

TFE: Measurement of neutron damage

Use of the LENA (PV) reactor for material testing (collaboration started on June 2014)

Reactor for research TRIGA Mark II (250 kW) – LENA since 1965

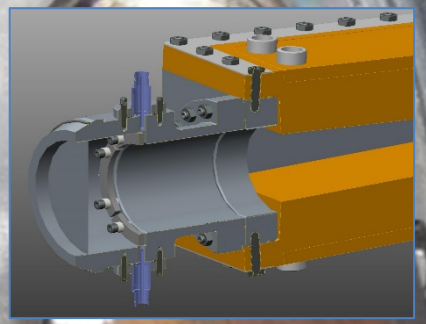
Critical materials on test list



Planning of the production area

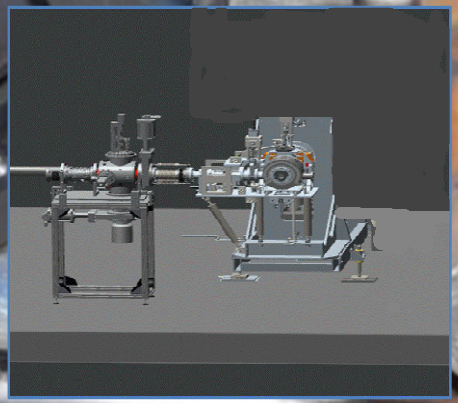
1) Driver Commissioning

- **2015:** Delivery of infrastructure
- **2016:** First subsystems (B.D.)



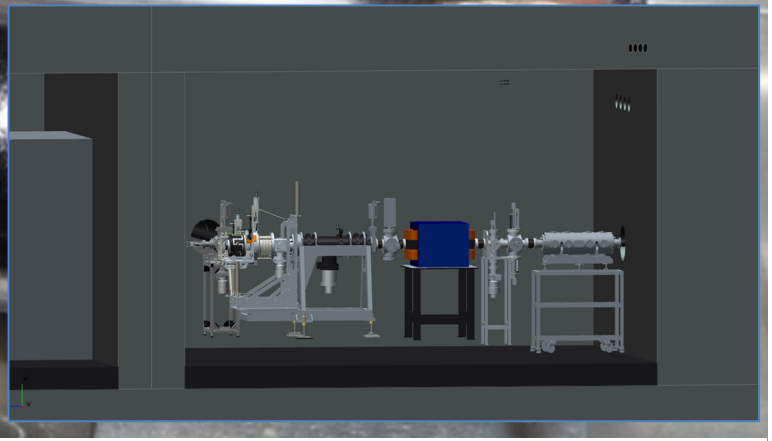
2) Production Target Commissioning

- **2016 -17:** 8kW, SiC (40 mm);

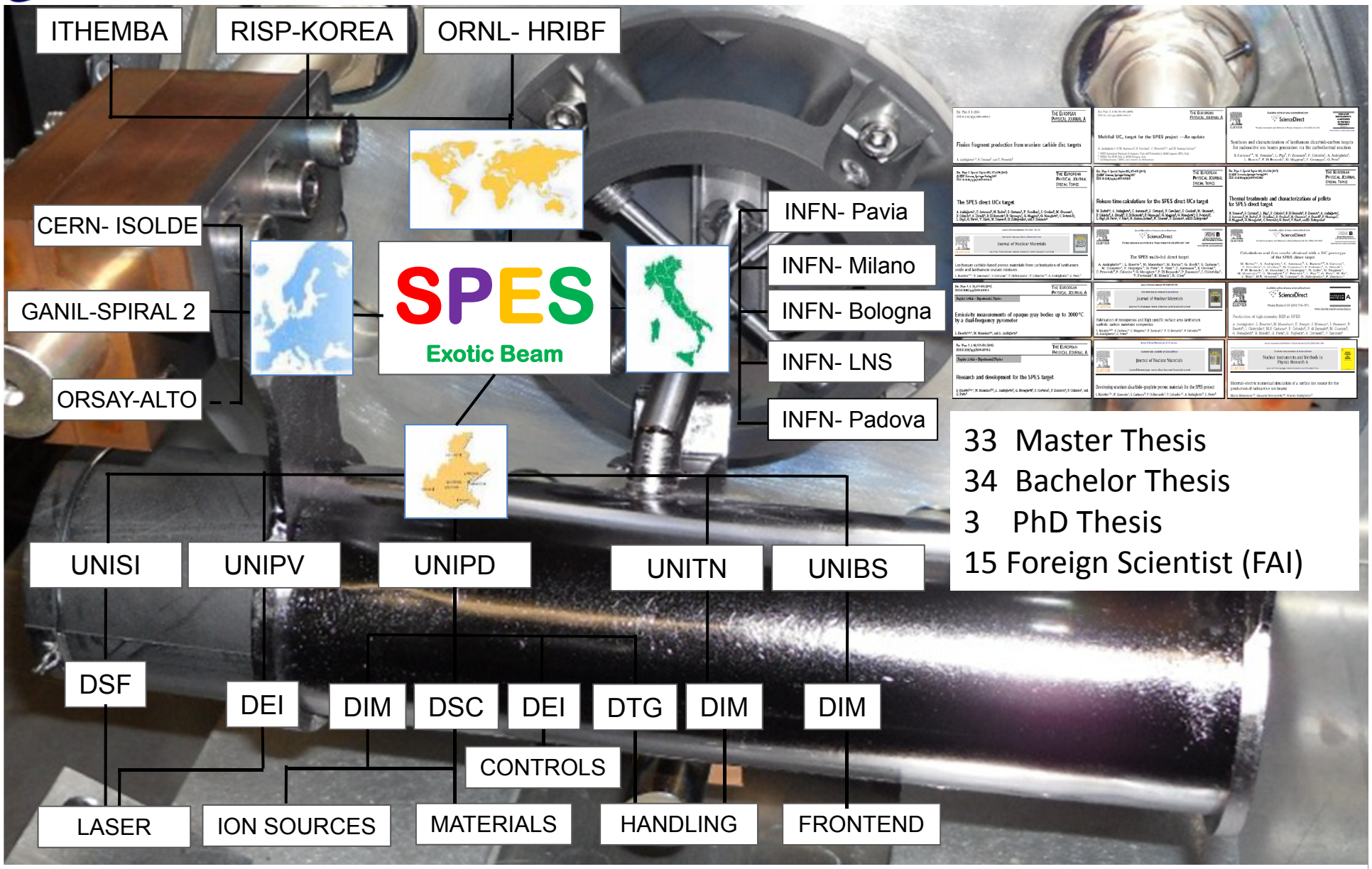


3) RIB Operational-> : 40 MeV on target

- **2017 -18** I = 5 µA, UCx-SiC (13 mm);
- **2018 -19** I > 5 µ A, UCx – SiC (40 mm);
- **2019 -20** I= 150 µ A, UCx (40 mm)



SPES EB : a large collaboration network…



The SPES-TIS group