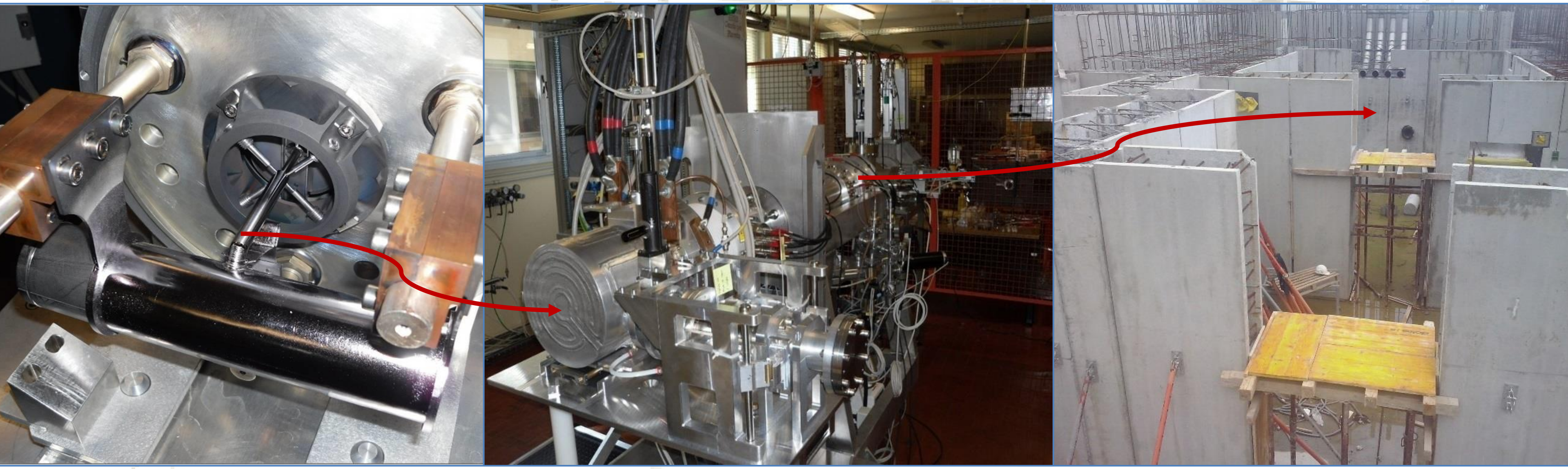
Recent results on the development for the SPES target-ion source complex



Alberto Andrighetto
INFN – Laboratori di Legnaro

Cathi Meeting
25 September 2014 ; Barcelona

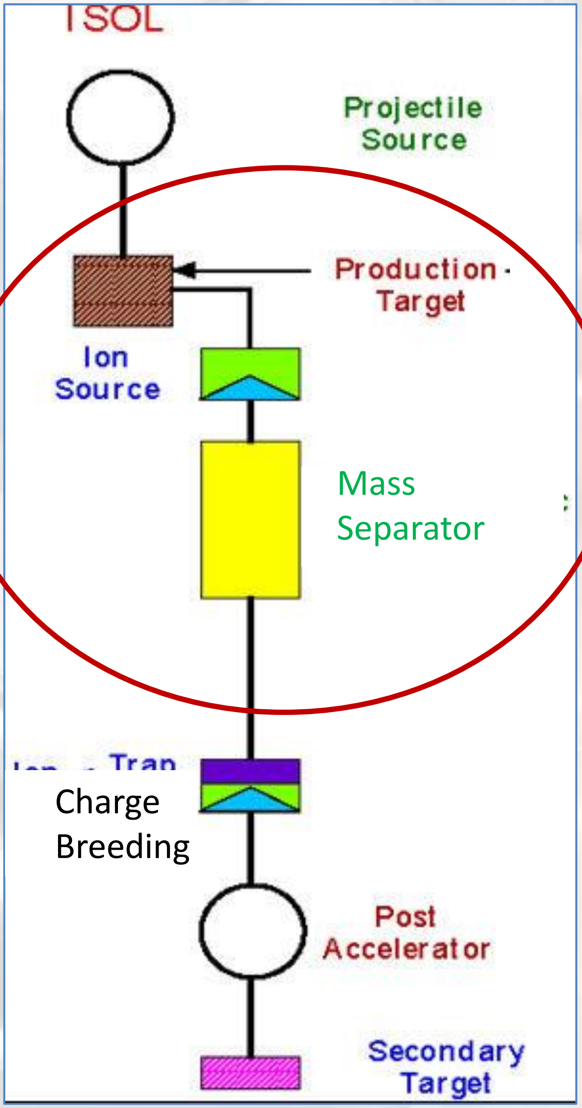
Outline

- The SPES RIB production station.

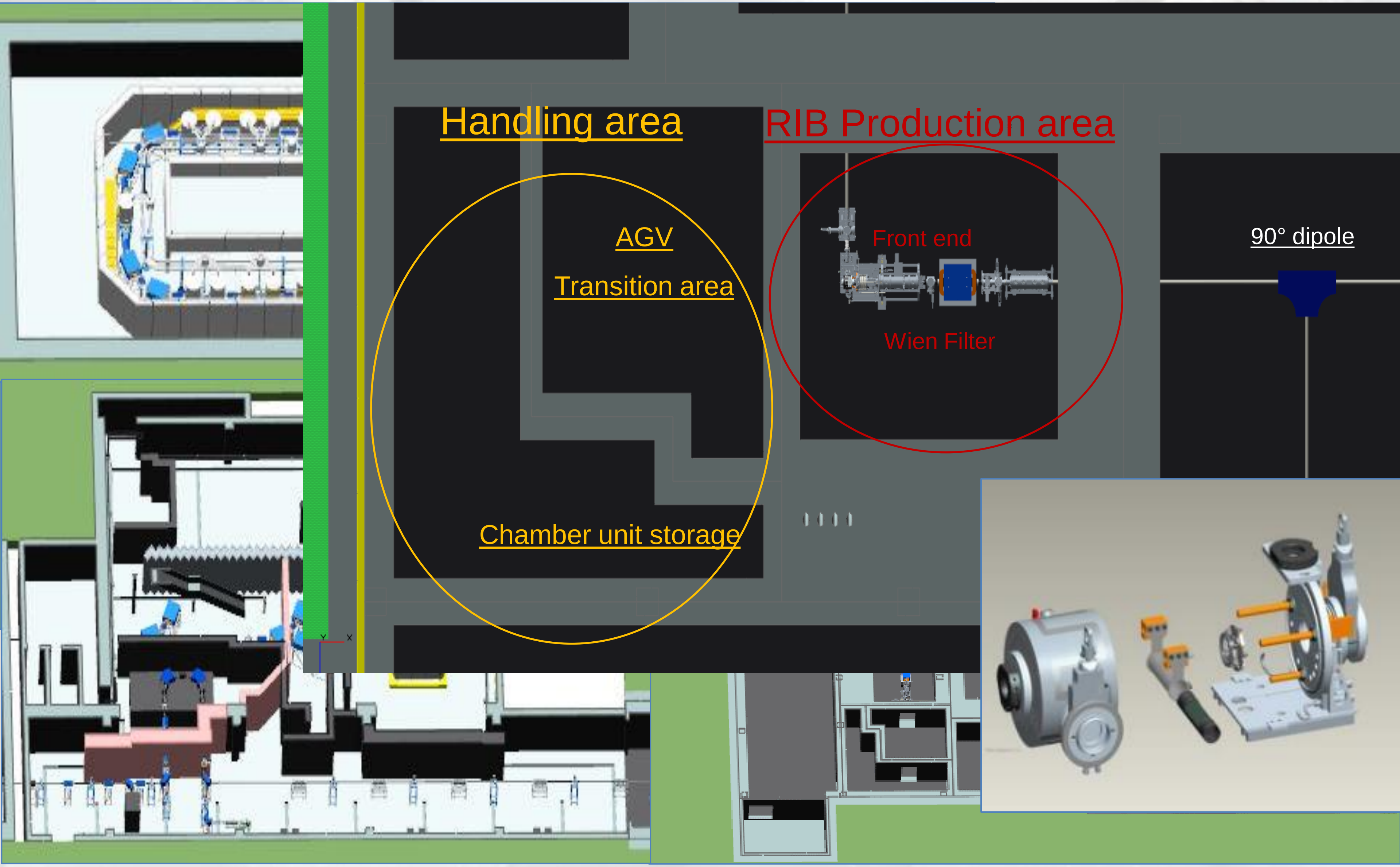
- Laboratories and organization.

- Working groups results.

- Conclusions.



The RIB production area overview



The TIS device

SPES Target :

Optimized for 8 kW power dissipation

(E= 40 MeV, I= 200 μA)

7 UCx coaxial disks:

thickness: 1.3 mm

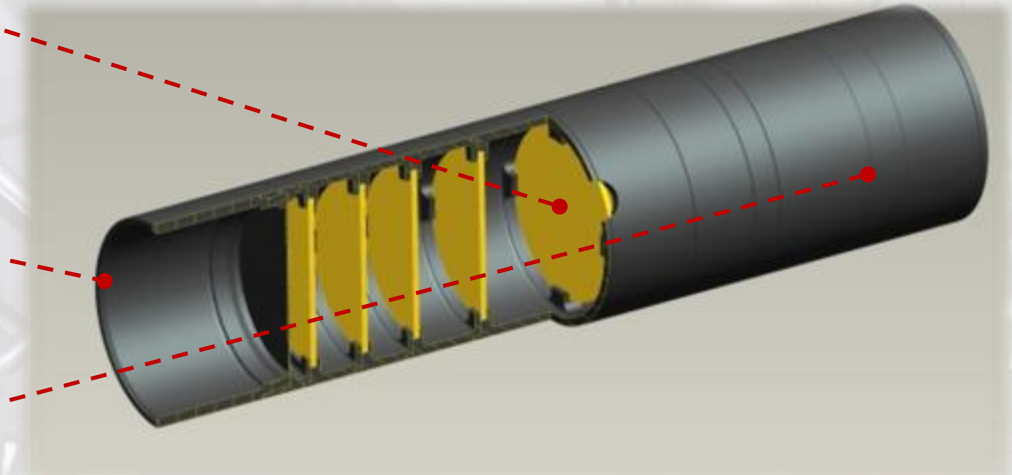
diameter: 40 mm

Graphite box:

external diameter: 49 mm

average length: 200 mm

3 graphite dump disks



SPES Heater, Ionizer & Chamber

Tantalum tube:

external diameter: 50 mm

thickness: 0.35 mm

length: 200 mm

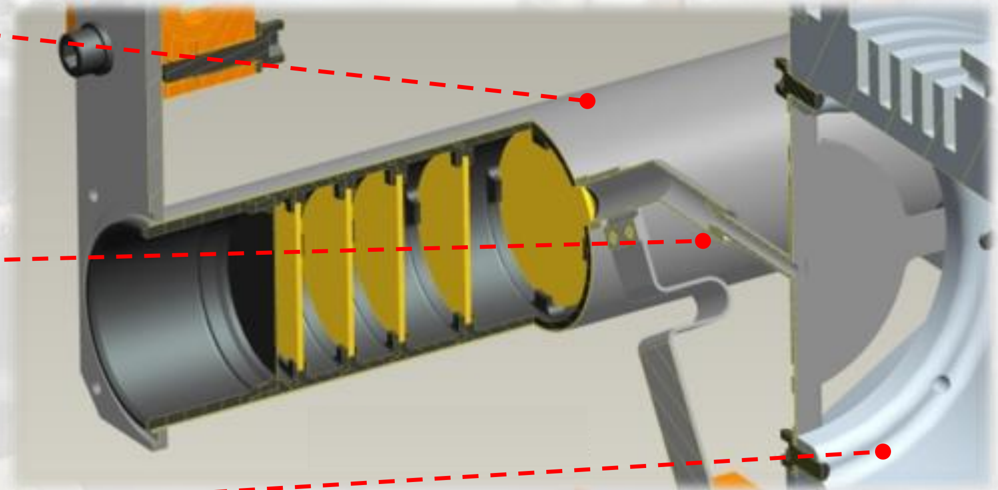
Ionizer & transfer tube:

thickness: 1 mm

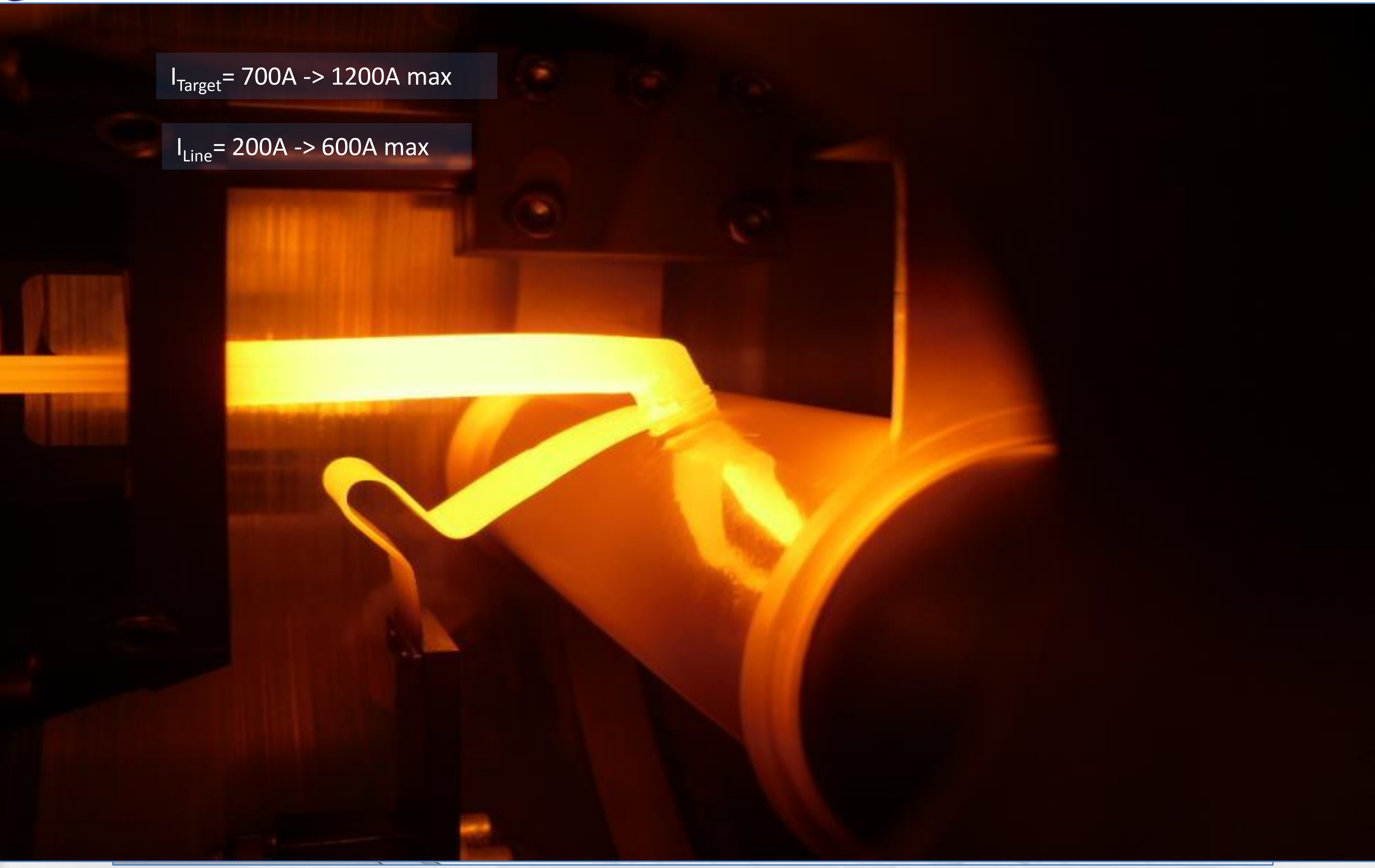
height: 34 mm

Inner diameter: 3 mm

Aluminum target unit



The TIS on operation



The SPES (off-line) RIB station

The TIS SPES (8) Laboratories

The TIS five Working Groups

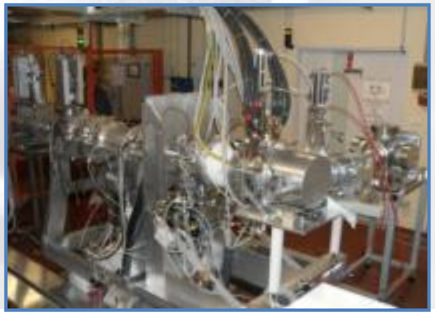
WG-1: Target and Ion Sources

WG-2: Target Materials

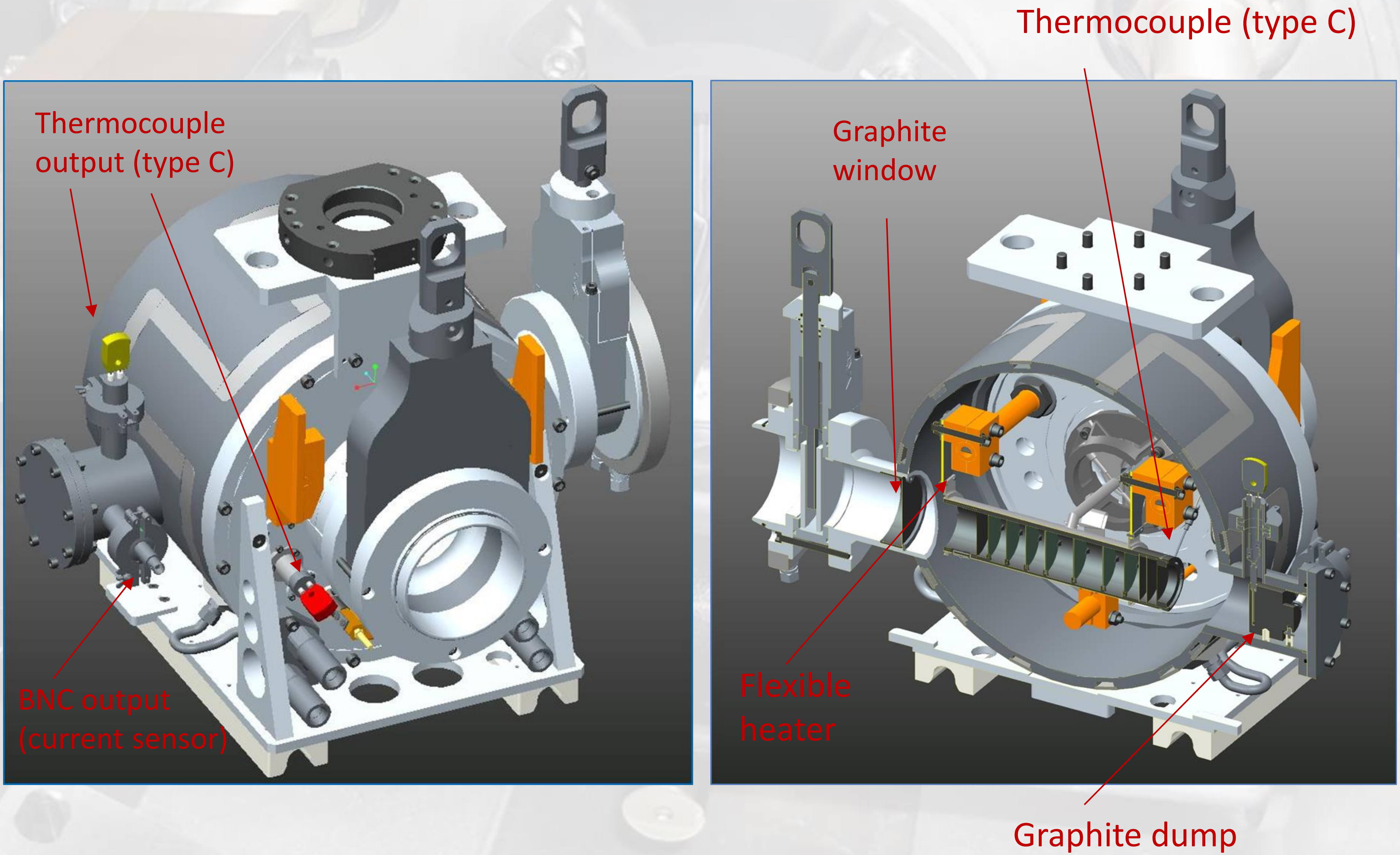
WG-3: Laser

WG-4: Handling

WG-5: Front End

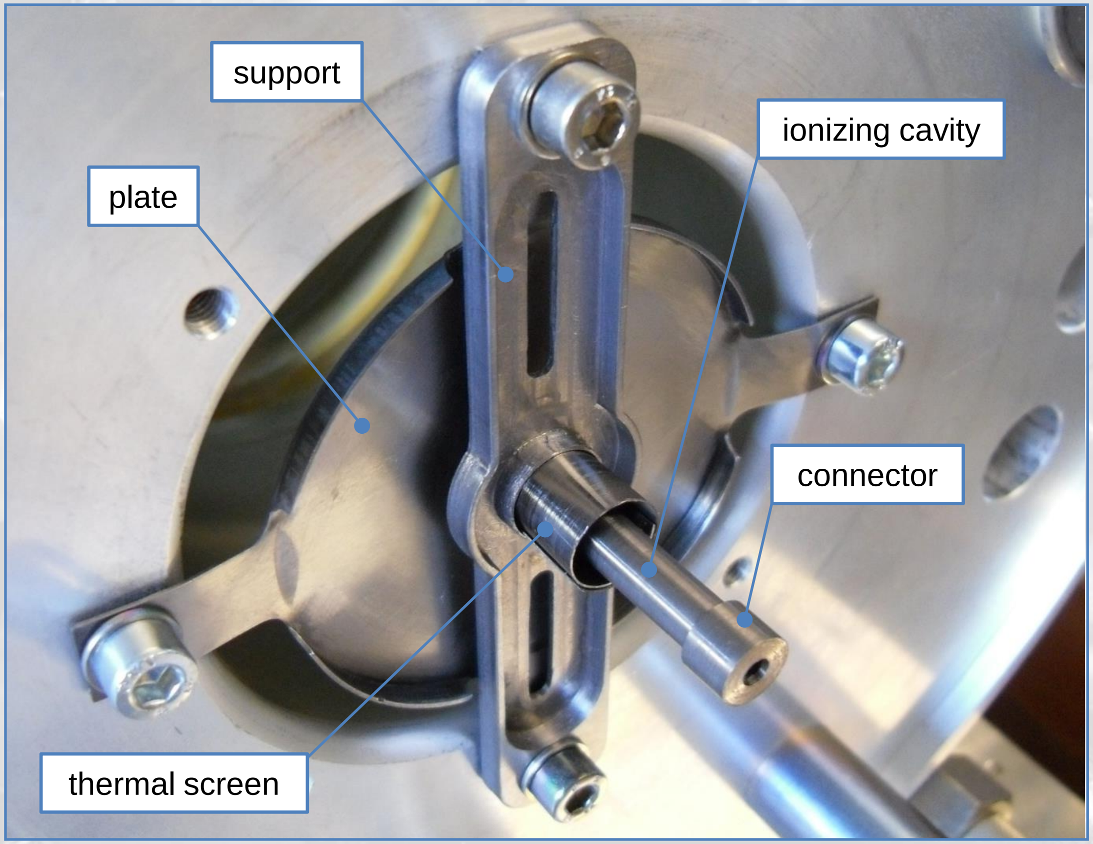


TIS: Definition of the unit device 1/6

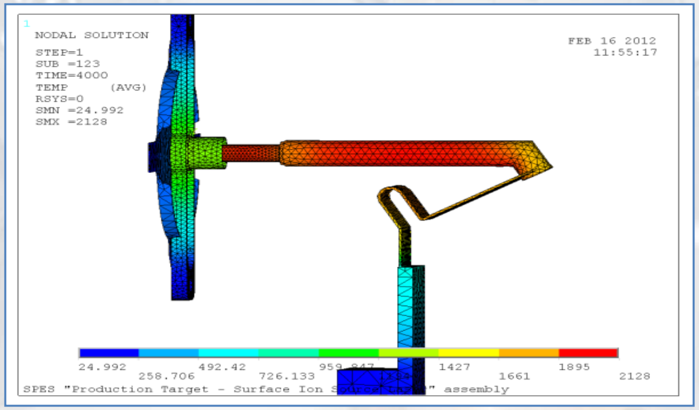


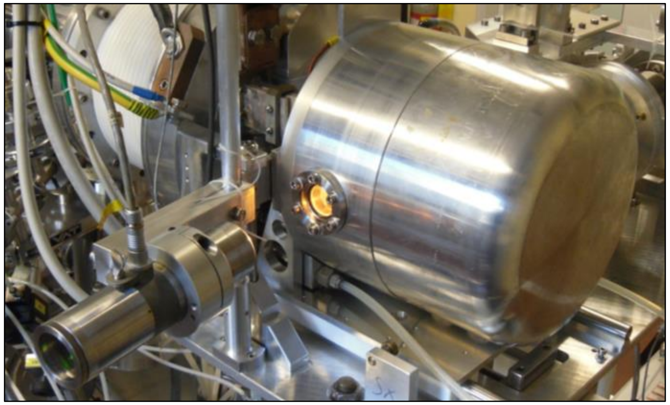
TIS: Ion Source Developments 2/6

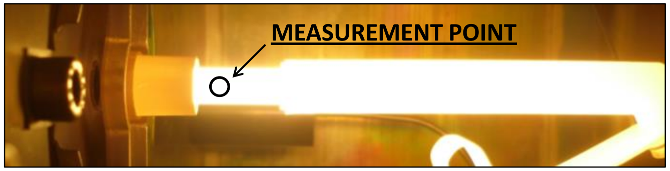
The SPES SIS Ion source



Re Ionizing Cavity and **Ta** Ionizing Cavity



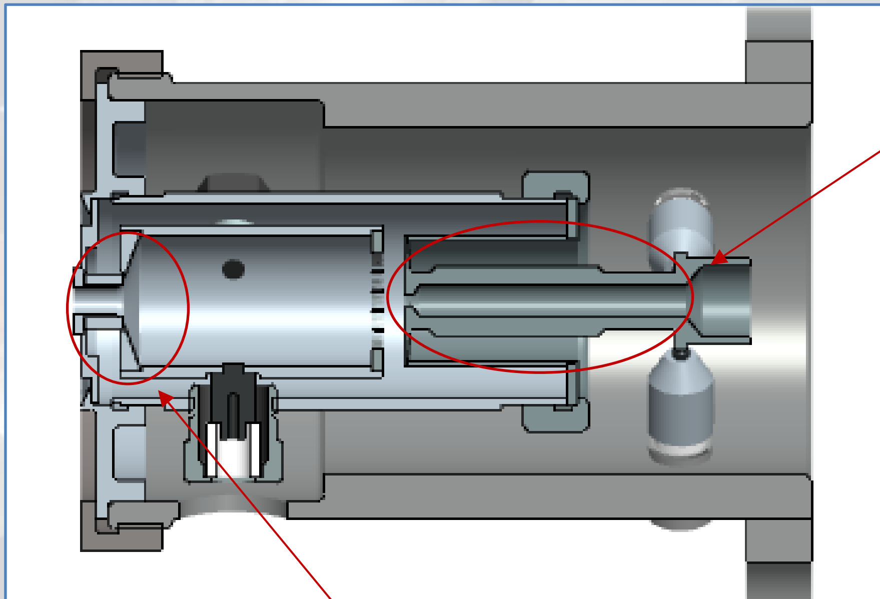




OFF-LINE TESTING
efficiency and emittance measurements
with accurate temperature monitoring

TIS: Ion Source Developments 3/6

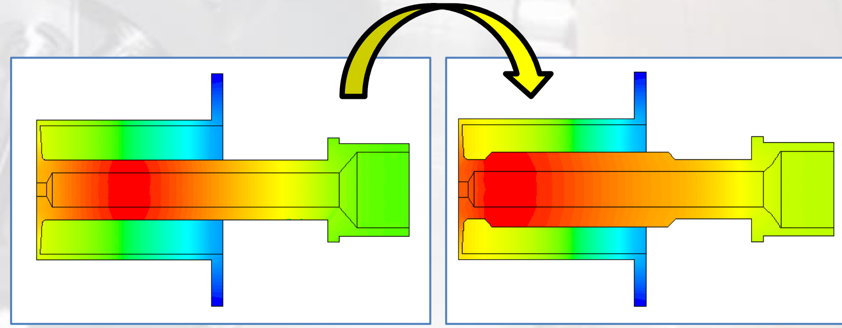
The SPES PIS Ion source



OPTIMIZED CATHODE GEOMETRY

hot spot close to the anode interface

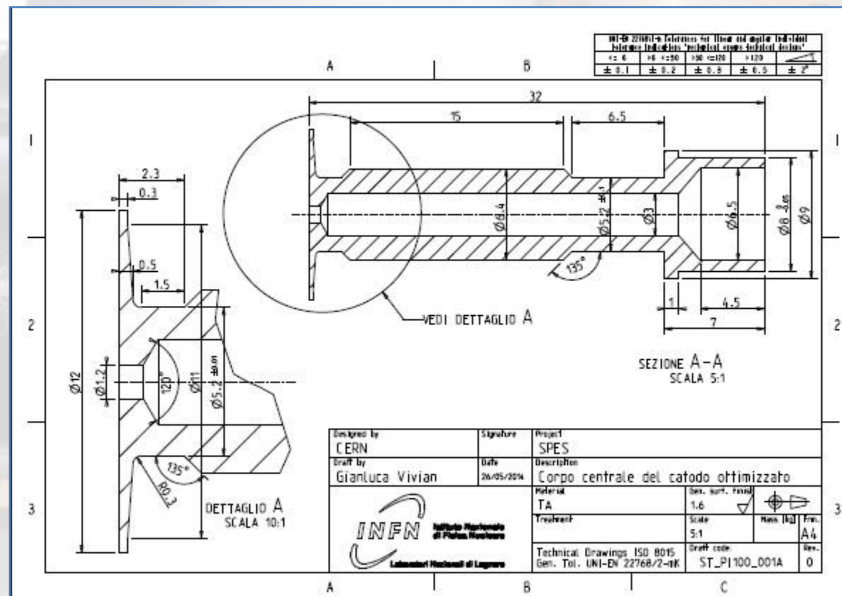
(thermionic electron production)



OPTIMIZED EXTRACTION REGION

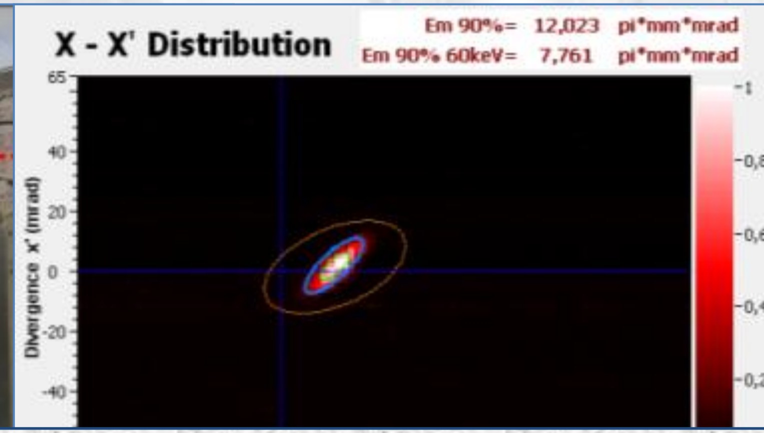
low transversal emittance values

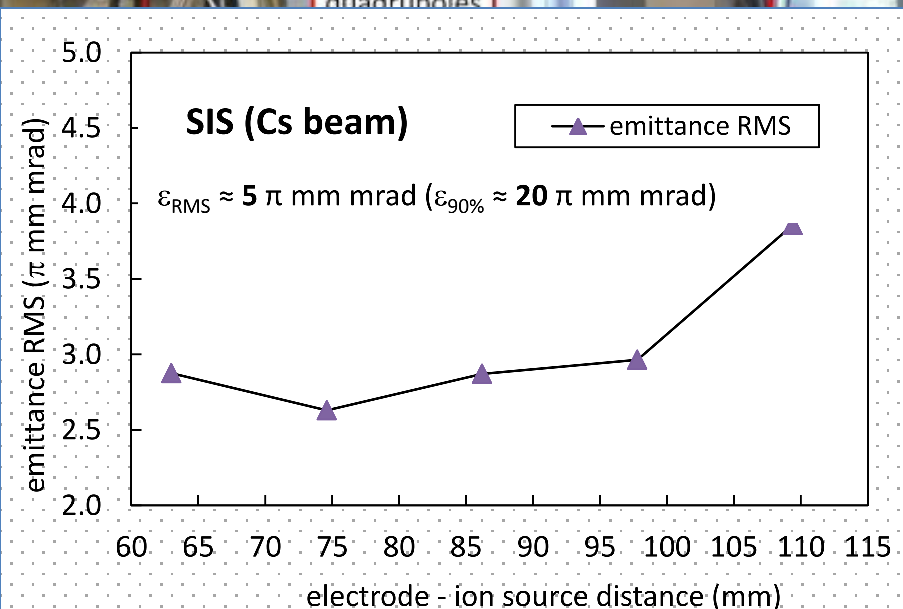
(now under testing at LNL)

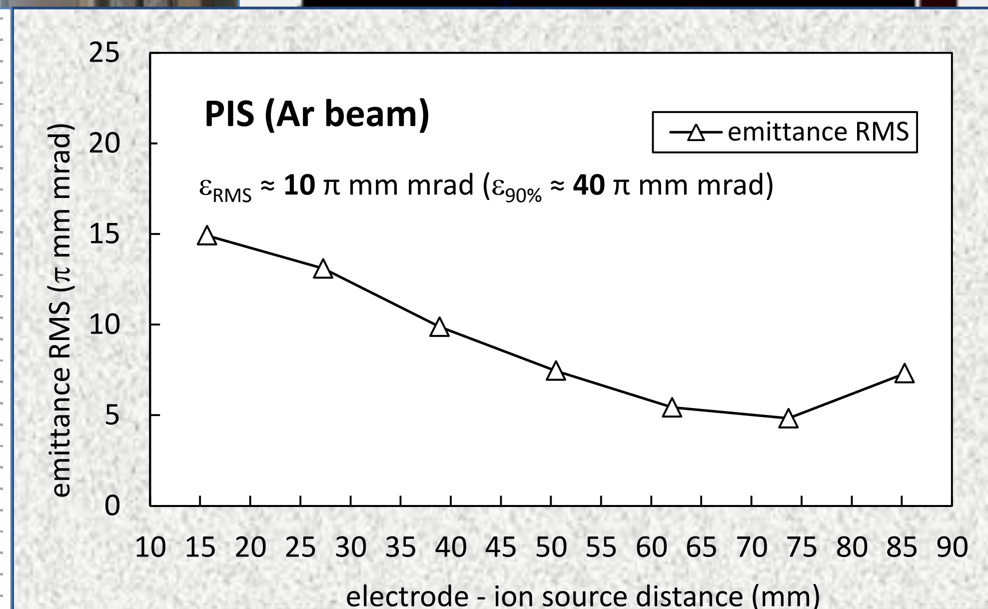


TIS: Ion Source Developments 4/6

> Emittance measurements for SIS and PIS (@ 25kV extraction voltage)





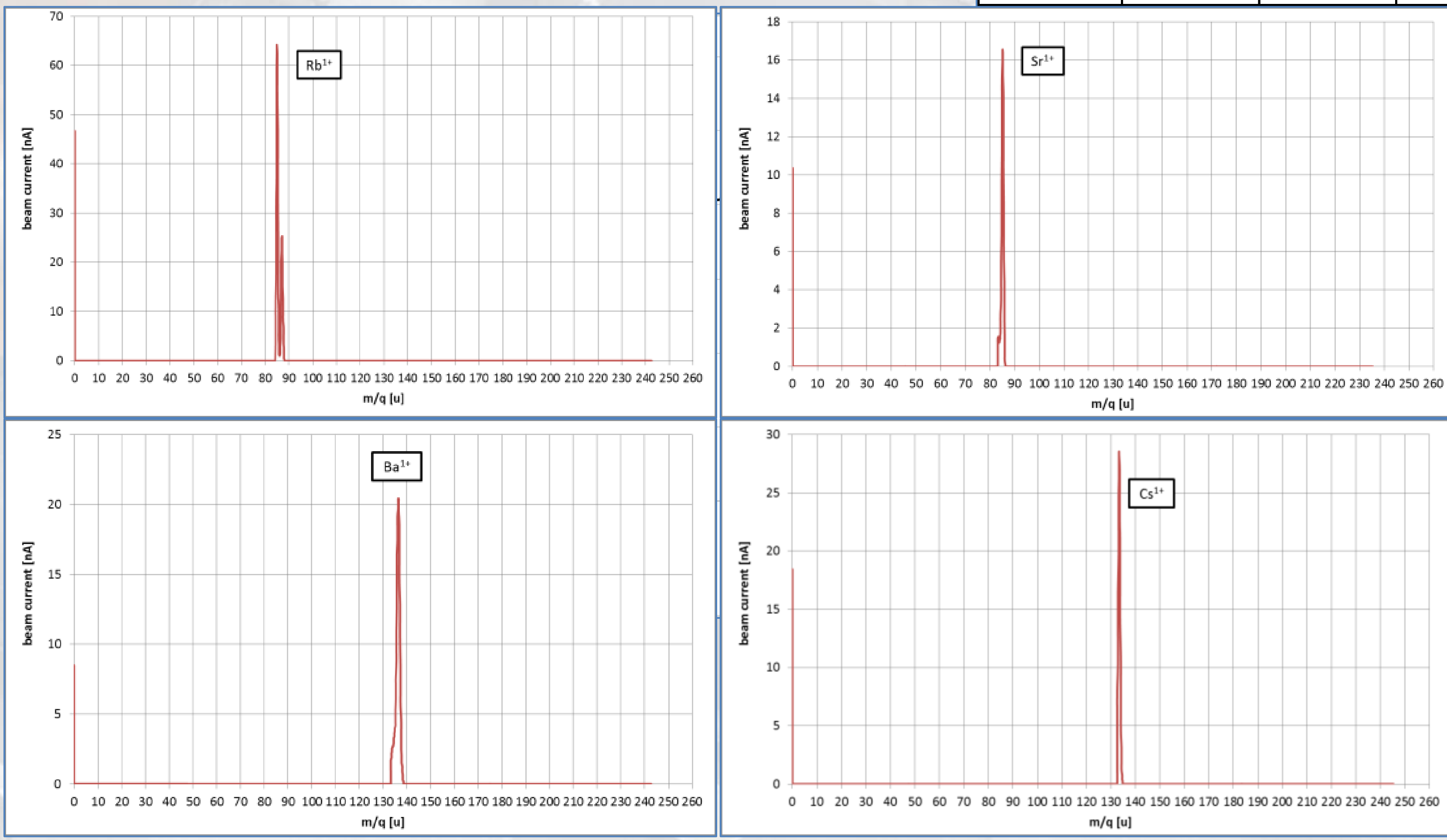


TIS: Ion Source Developments 5/6

> Efficiency measurements for SIS

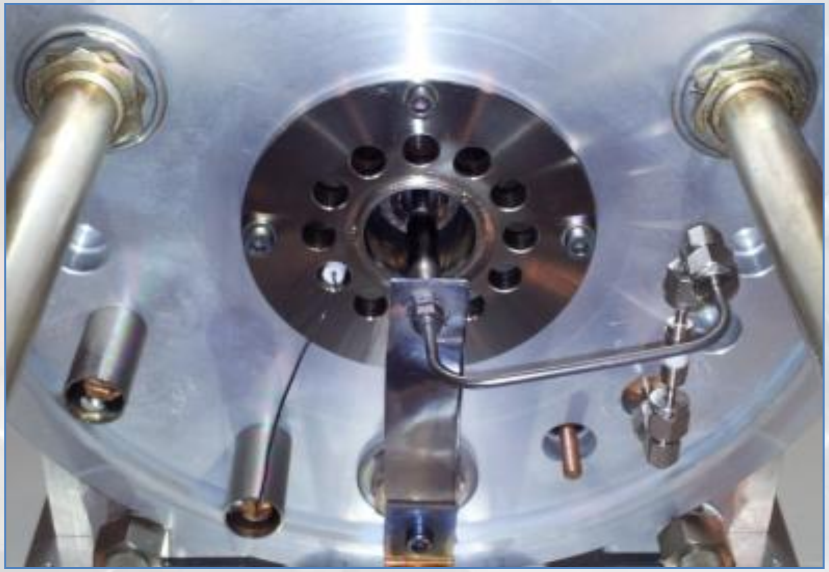
Element	Ta	T = 2200 °C	
(/)	(eV)	ε CLEAN [%]	Dev. St. [%]
			1.1
			3.1
			3.1
			1.3

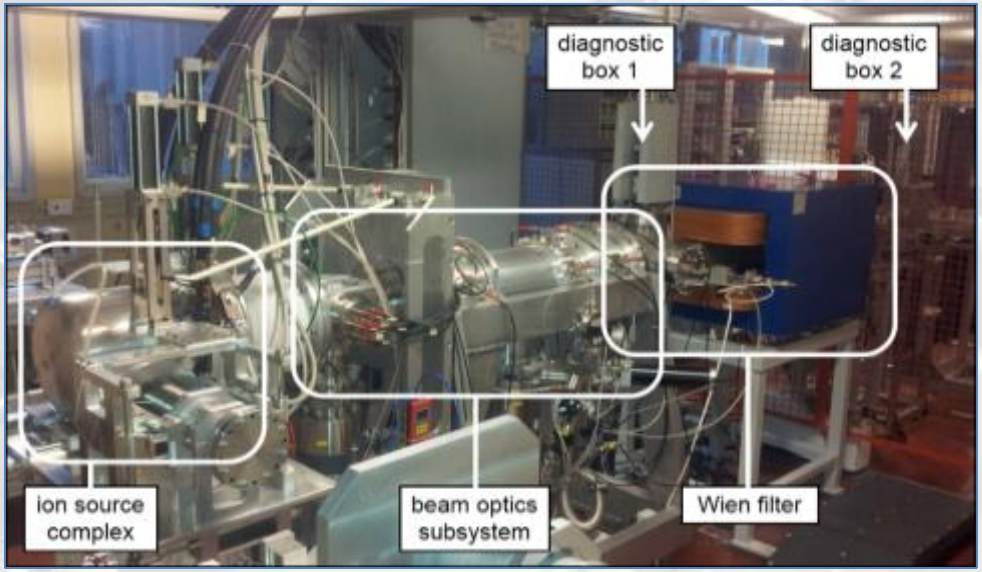
Ta - SIS efficiency data (off-line measurements)

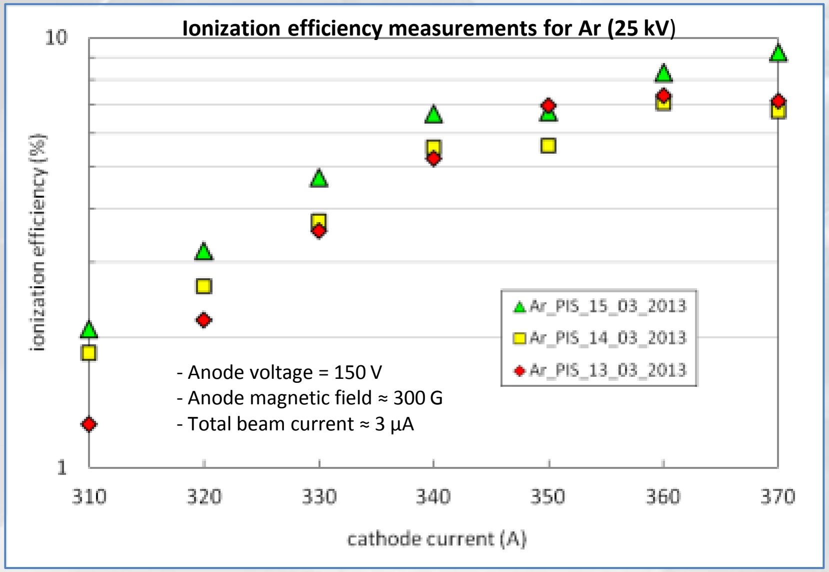


TIS: Ion Source Developments 6/6

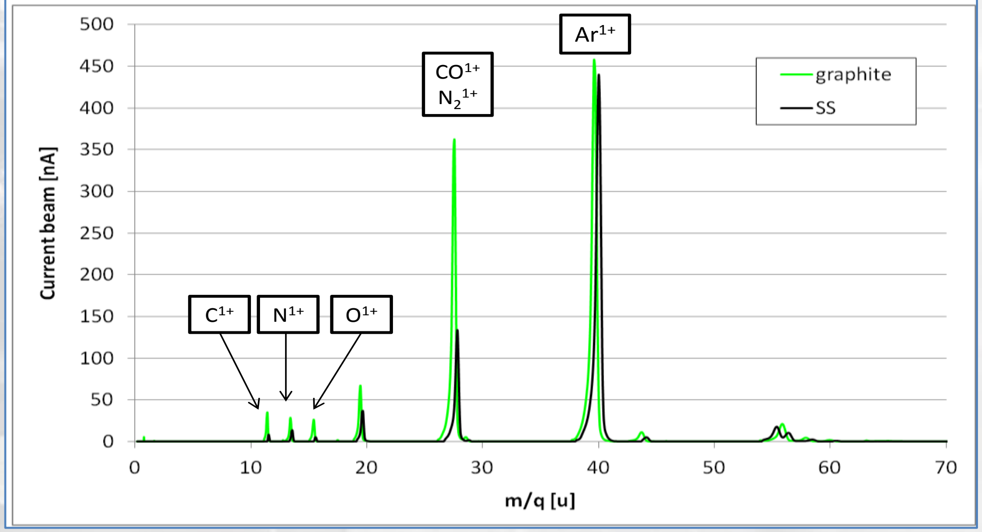
> Efficiency measurements for PIS





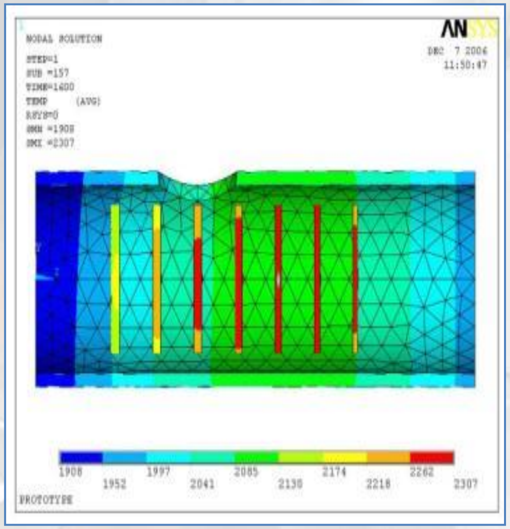


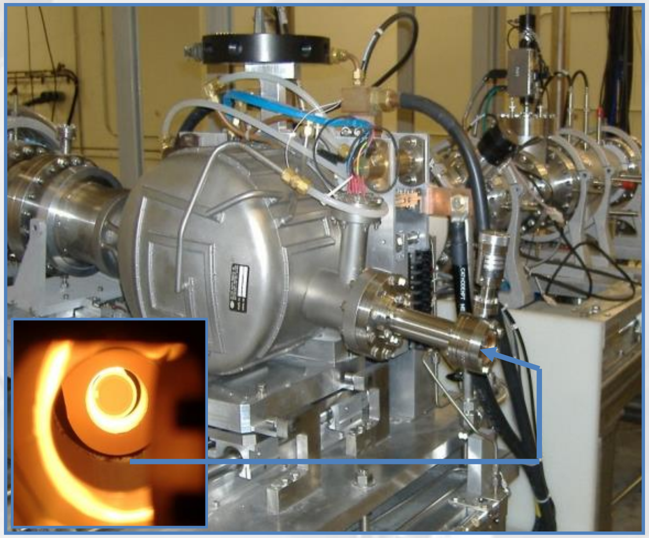
Reduction of contaminants: graphite support V.S. Stainless Steel support

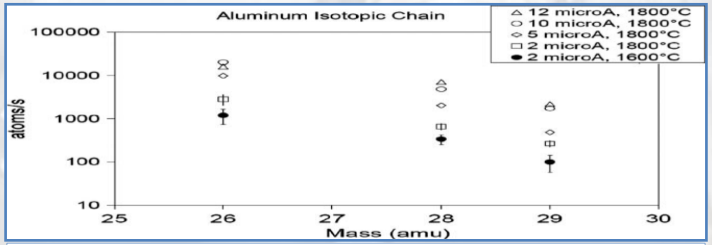


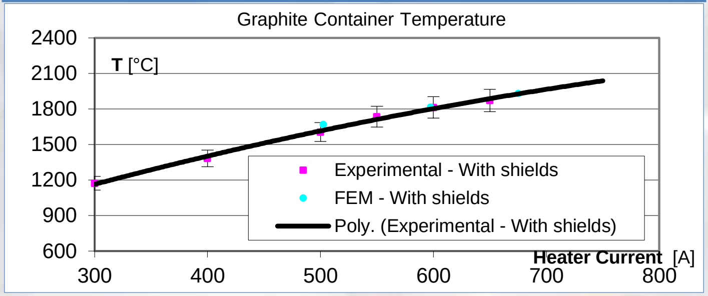
Target: Experimental test 1/4

1) scaled (d = 13 mm) SiC SPES tested @ ORNL (2007), – 40 MeV, 12 μA p beam, for thermal & release study



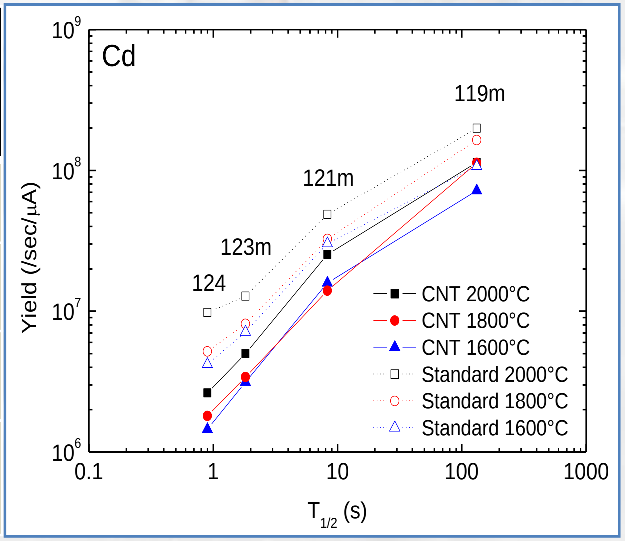






2) scaled (d = 13 mm) UC_x SPES tested @ ORNL (2010-2011) – 40 MeV, 50 nA p beam, for relase study

	2010 Standard UC_x	2011 Low density UC_x
Density (g/cm³)	4.25	2.59
Diameter (mm)	12.50	13.07
Thickness (g/cm²)	0.41	0.41
Calculated porosity (%)	58	75

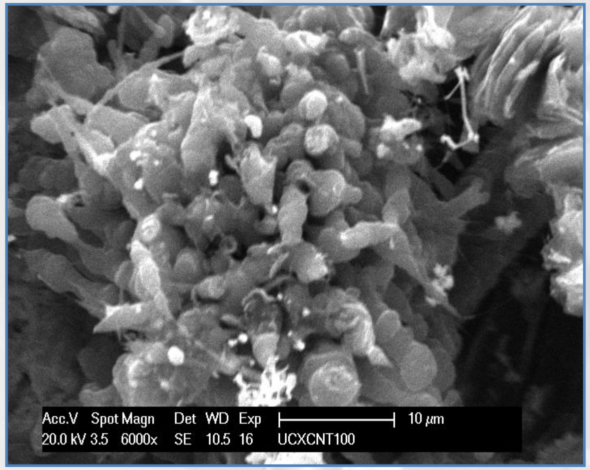


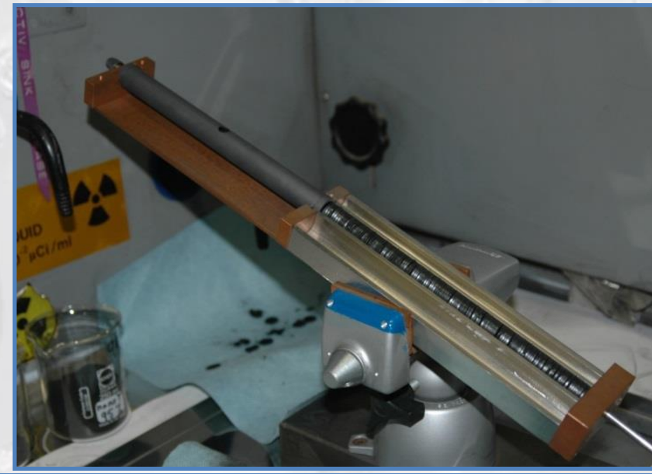
Target: Experimental test 2/4

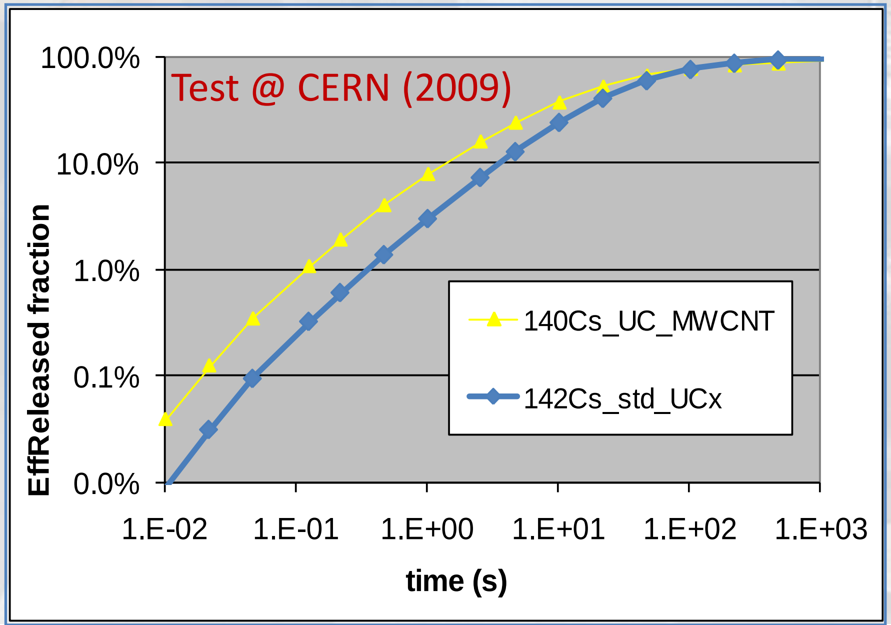
Actilab ENSAR JRA collaboration

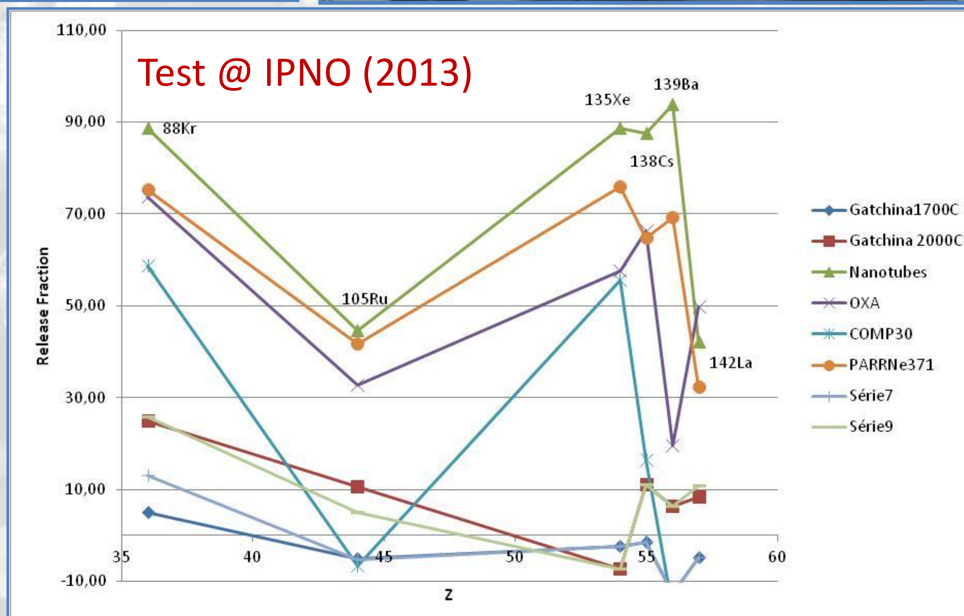
3) scaled (d = 14 mm) UC_X-CNT discs tested @ CERN (2009) and IPNO (2013) for release efficiency studies

	UC_X-CNT (synthesis at CERN, 2009)
Density (g/cm³)	1.30
Diameter (mm)	14.10
Thickness (mm)	1.30
Calculated porosity (%)	88







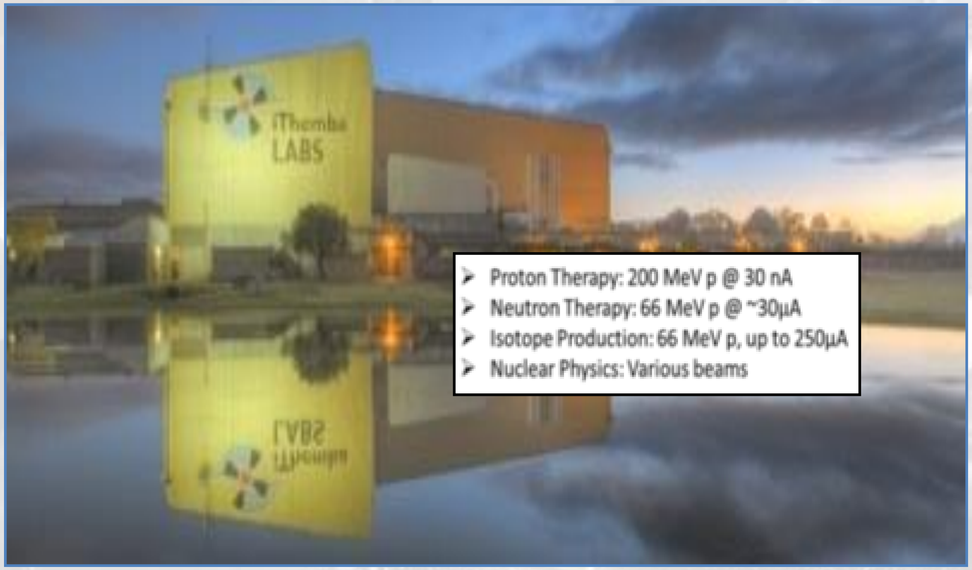


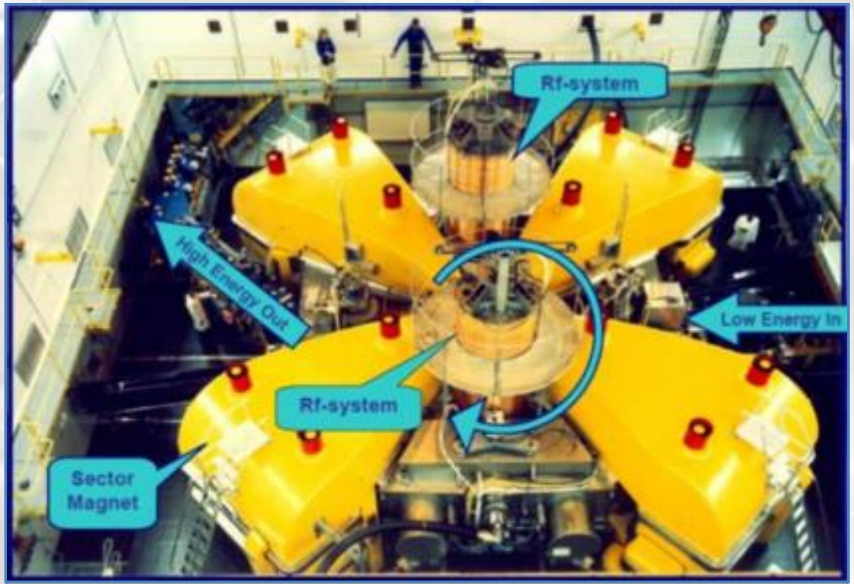
Target: Experimental test 3/4

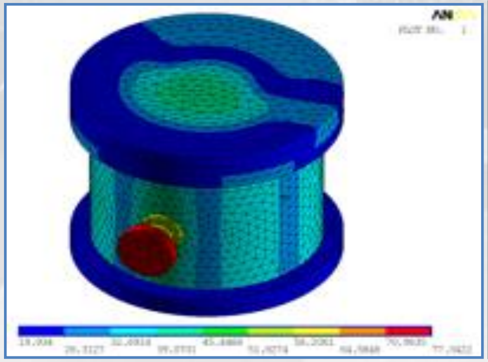
4) Full scale (40 mm.) SiC @ Ithemba, p=66 MeV, 60 microA for thermal dissipation studies

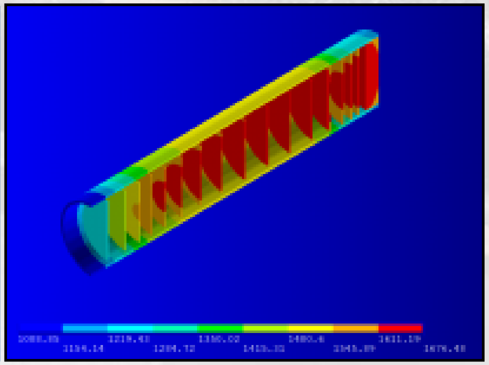
- On-line testing of the SPES target architecture @ iThemba (May 2014)

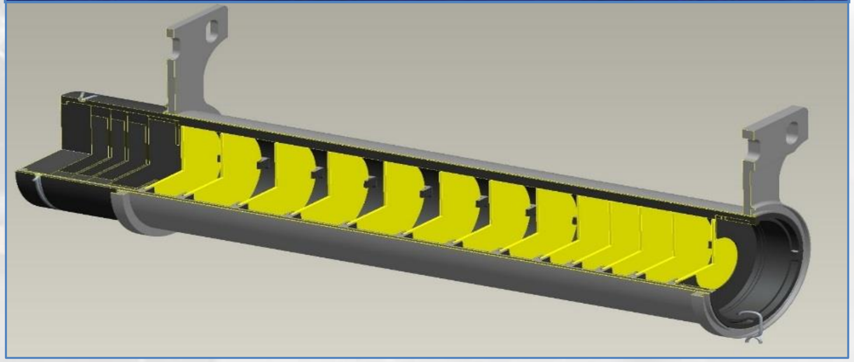
iThemba LABS: funded to build an RIB station like SPES (10 kW multi-foil target)





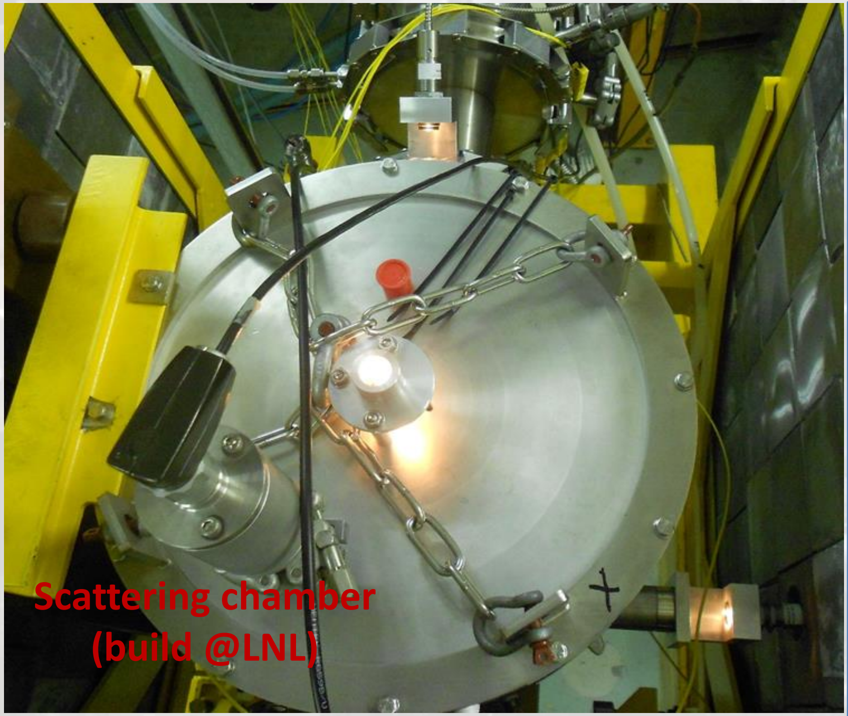


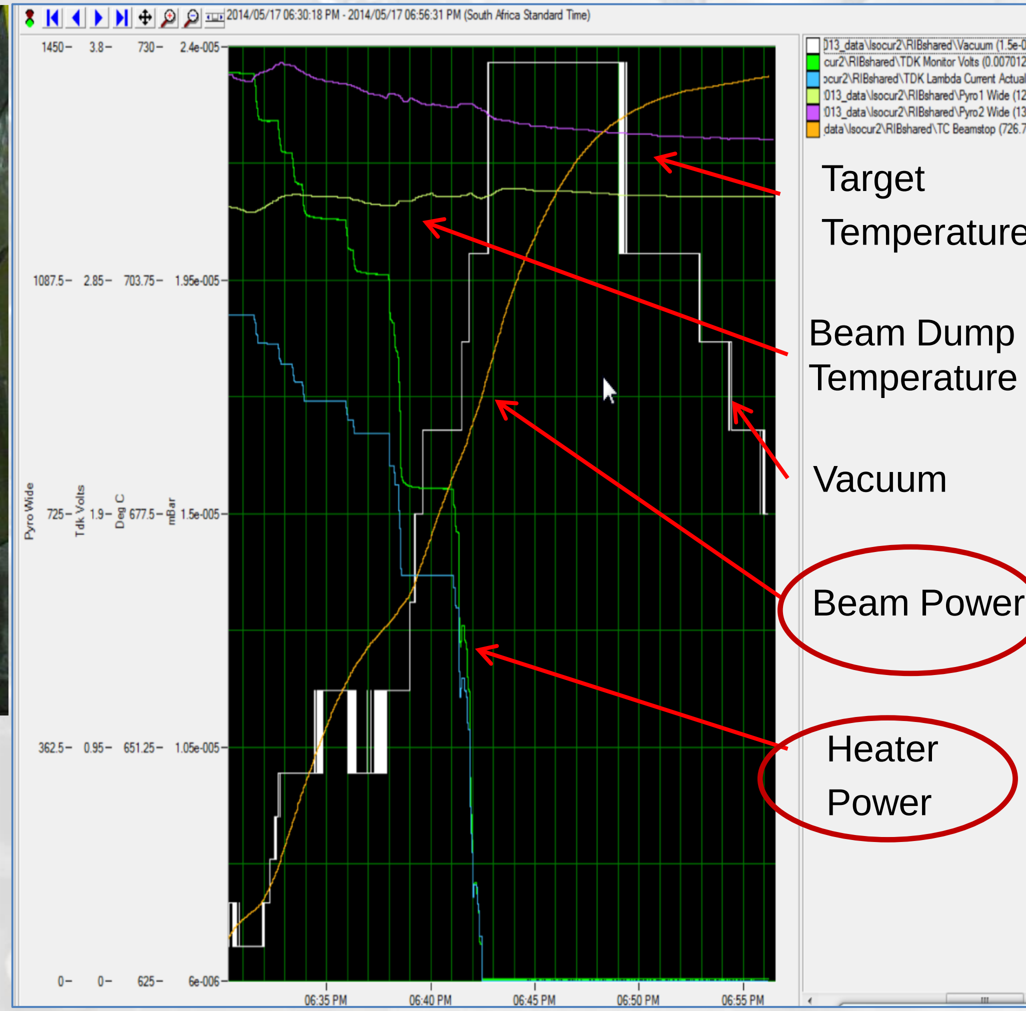




Target: Experimental test 4/4

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



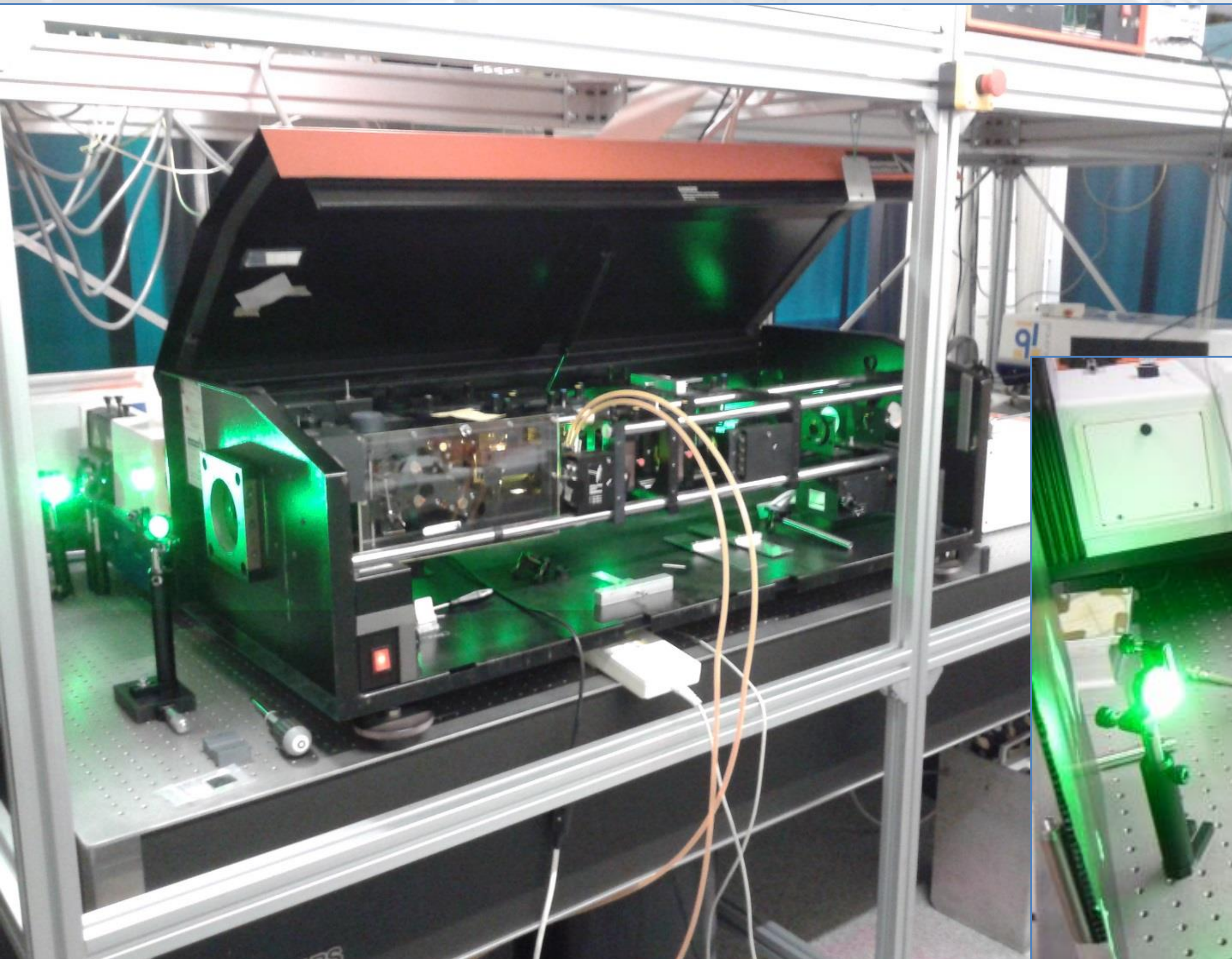


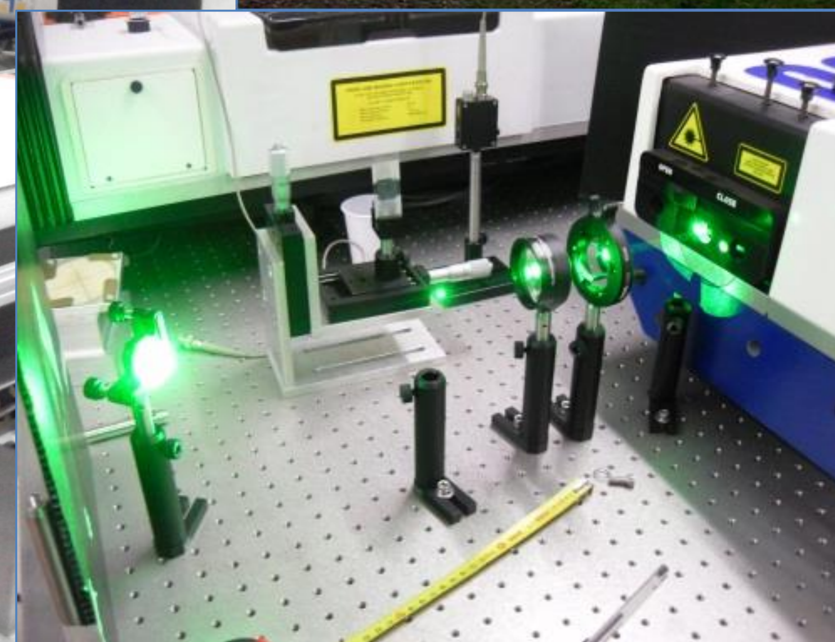
Measure [°C]	Estimated by FEM model [°C]
1° disk: 1365 ± 30°C	1390
Box: 1230 ± 25°C	1267
Dump on chamber: 728°C ± 10°C	750

Laser: The LNL Laboratory 1/2

In 2013 a new SPES laser laboratory was build

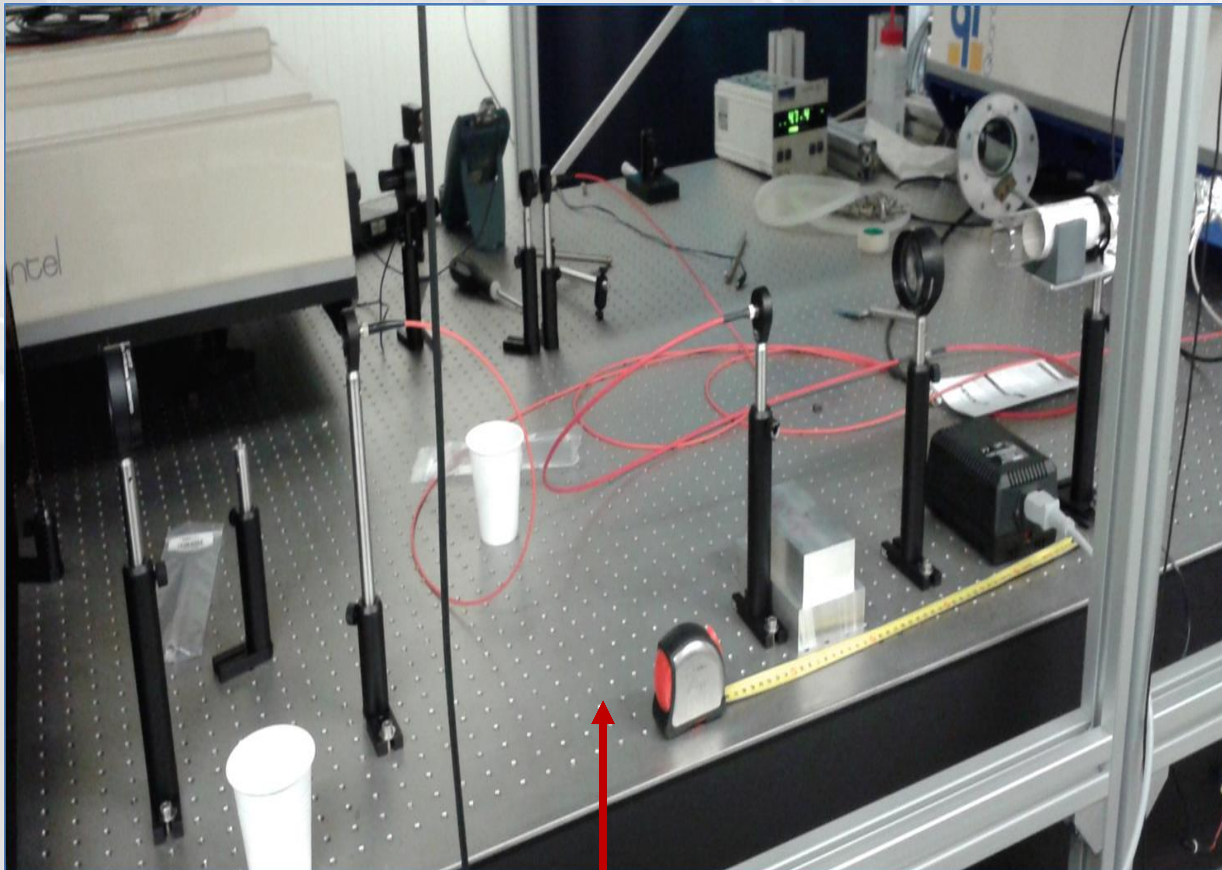
A tunable dye laser system ready for atomic spectroscopy study





Laser: Activities at LNL 2/2

Design/construction of new Time of Flight Spectrometer

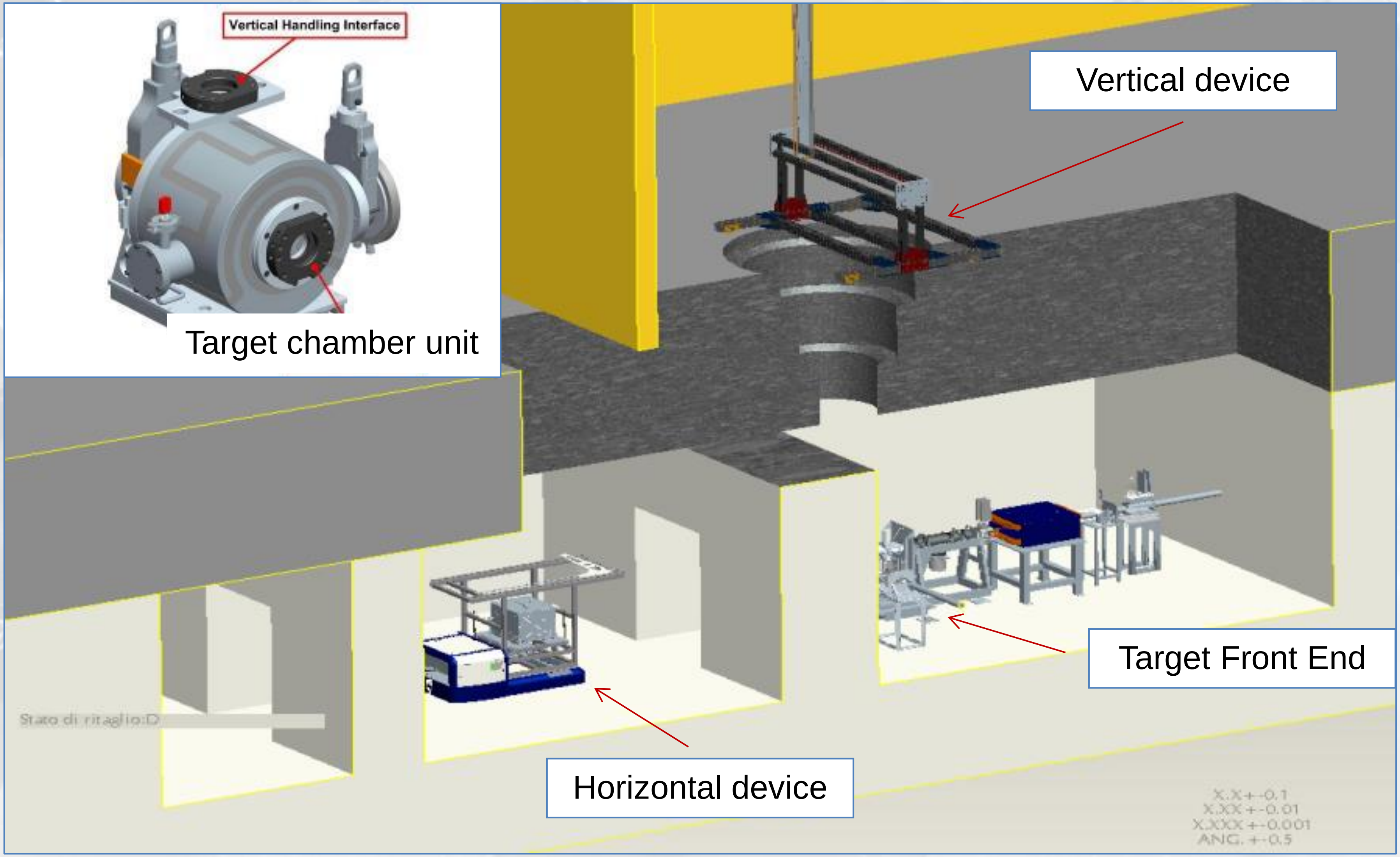


Fiber optic mixer (2 dyes to HCL)

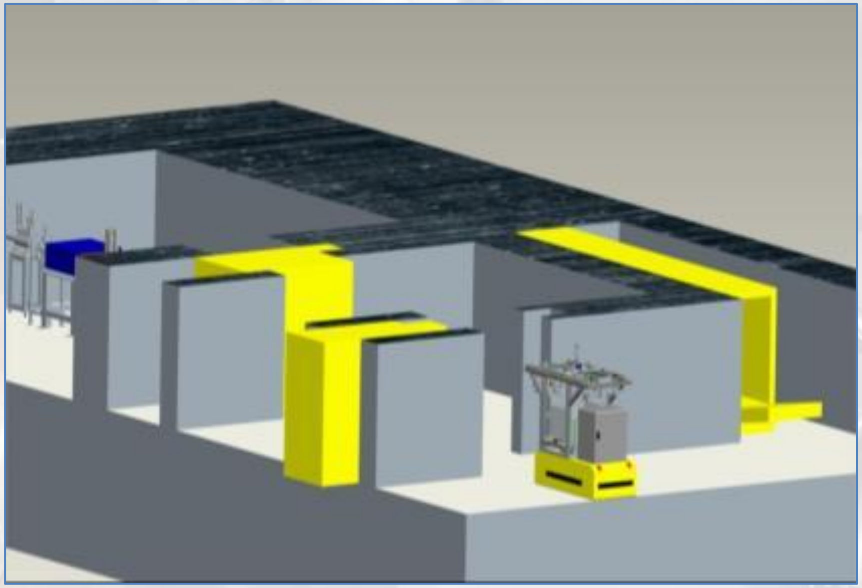
System ready for Ge spectroscopy study.. (Oct '14)

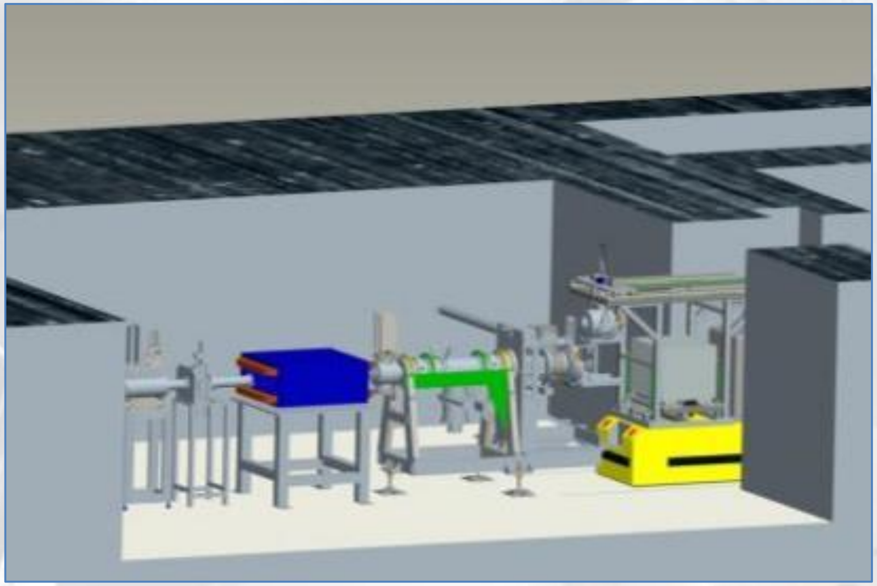
Handling: The SPES overview 1/4

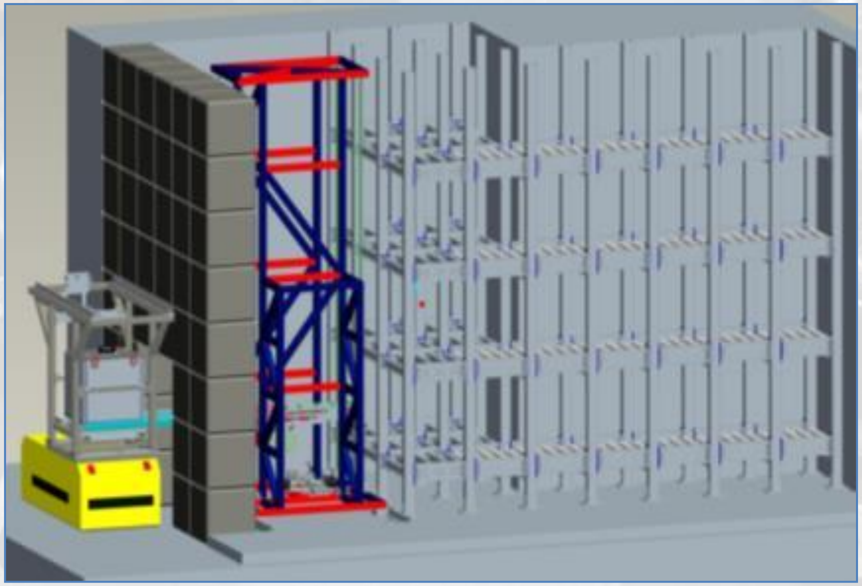
Two systems are foreseen in order to increase the handling security level

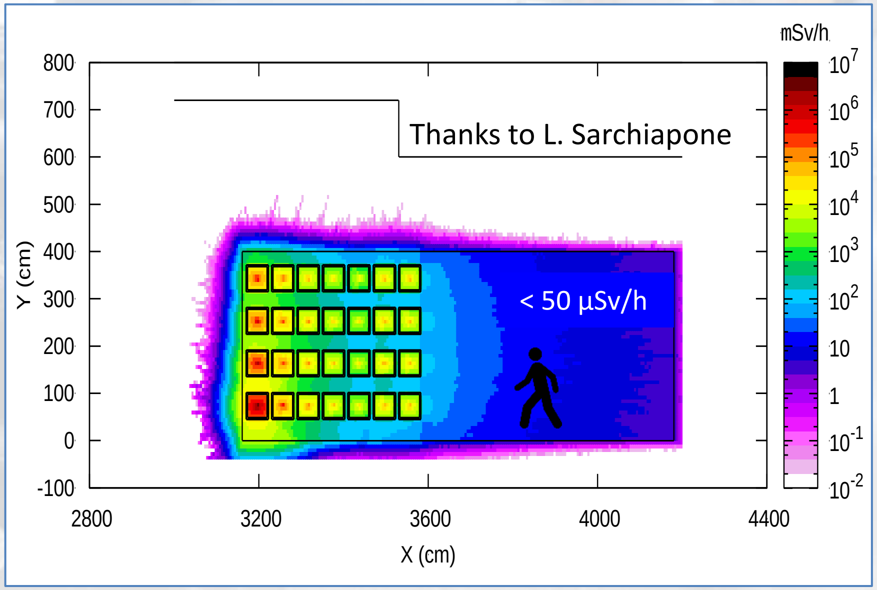


Handling: The Horizontal system 2/4



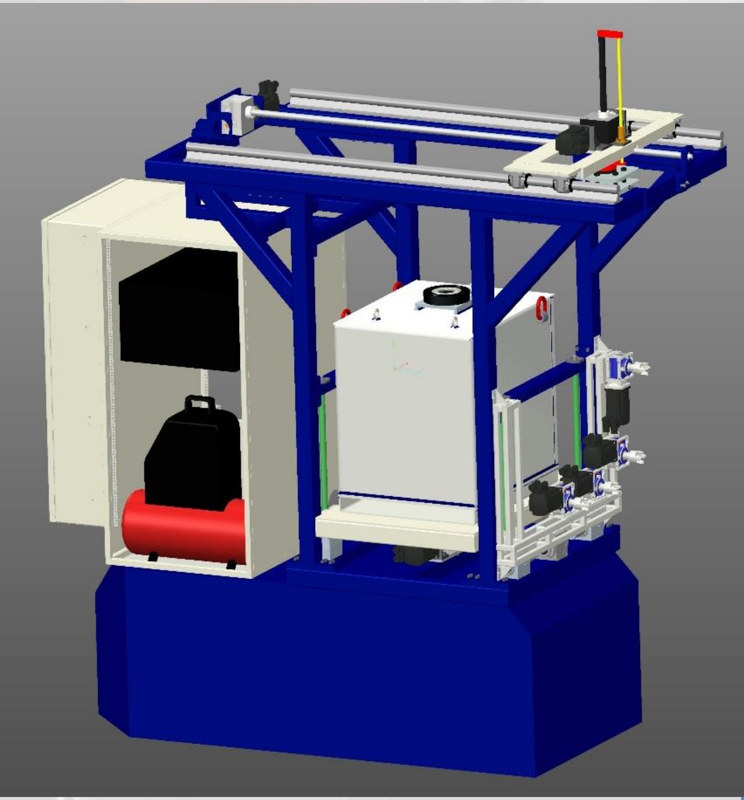


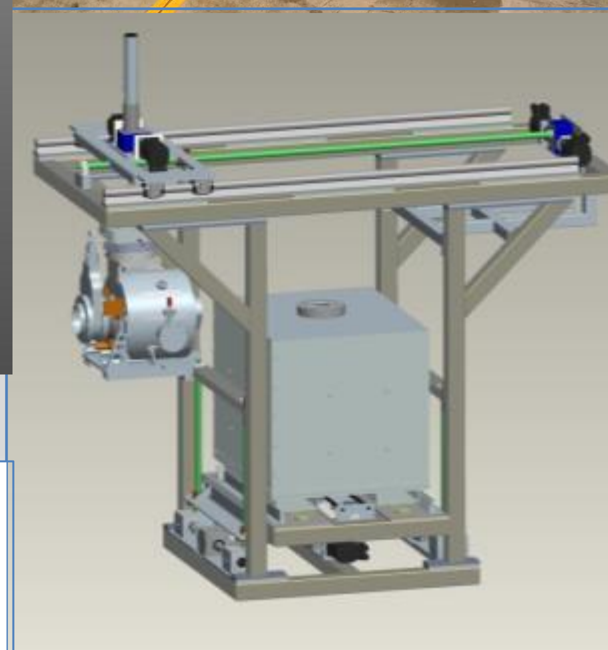




Handling: The vehicle AGV based 3/4

Devices under construction at the LNL mechanical workshop



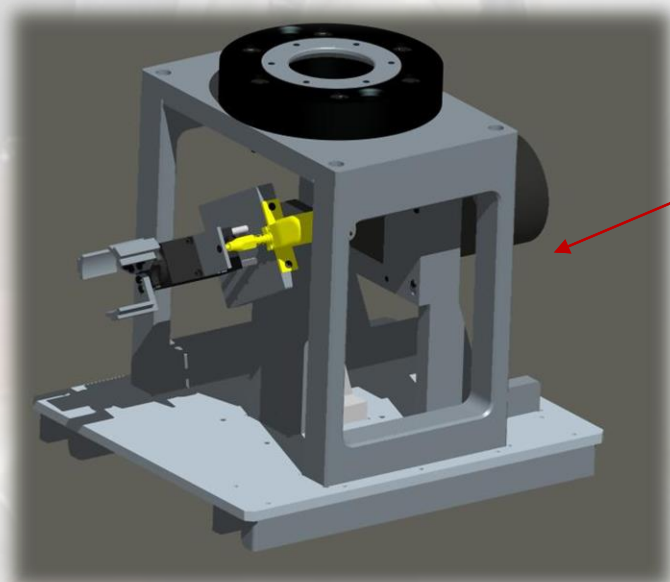


ICM 2013

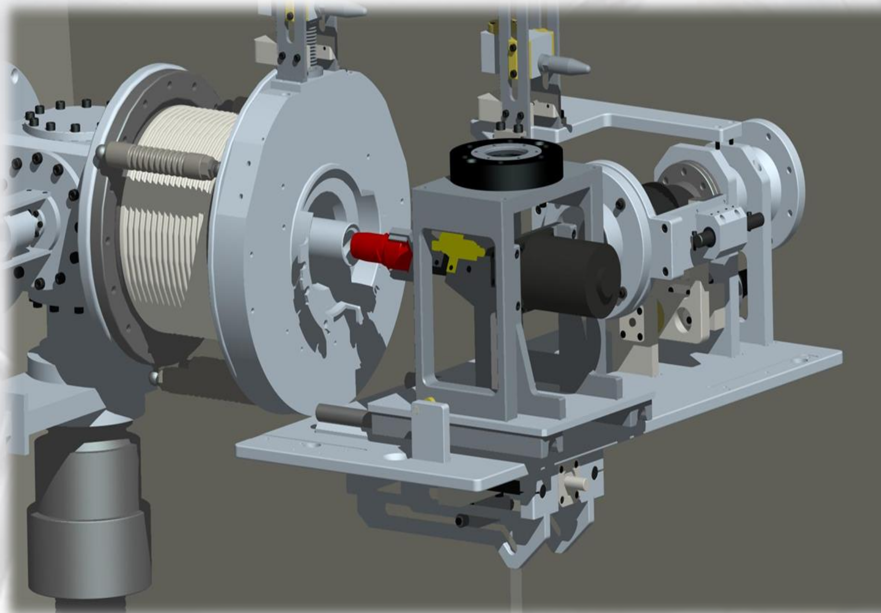
IEEE International Conference on Mechatronics

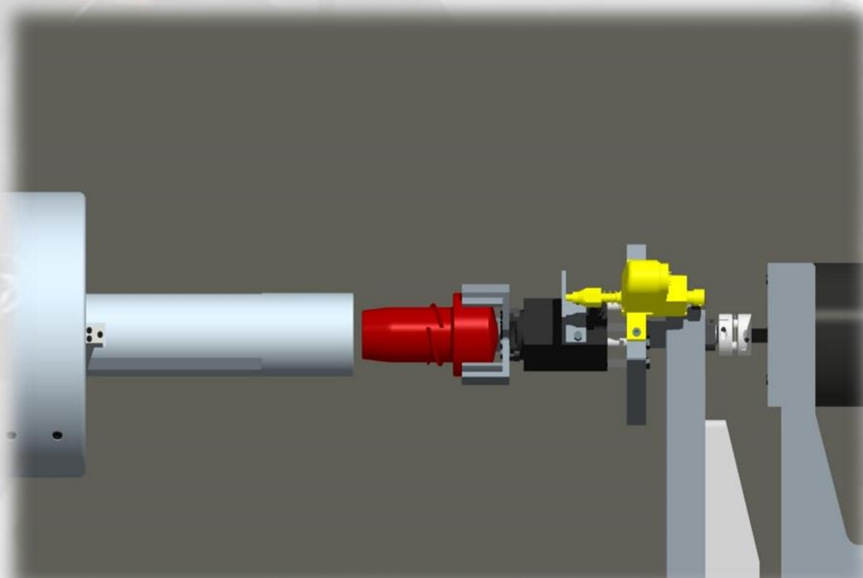
Vicenza (ITALY) - February 27-28 , March 1 2013

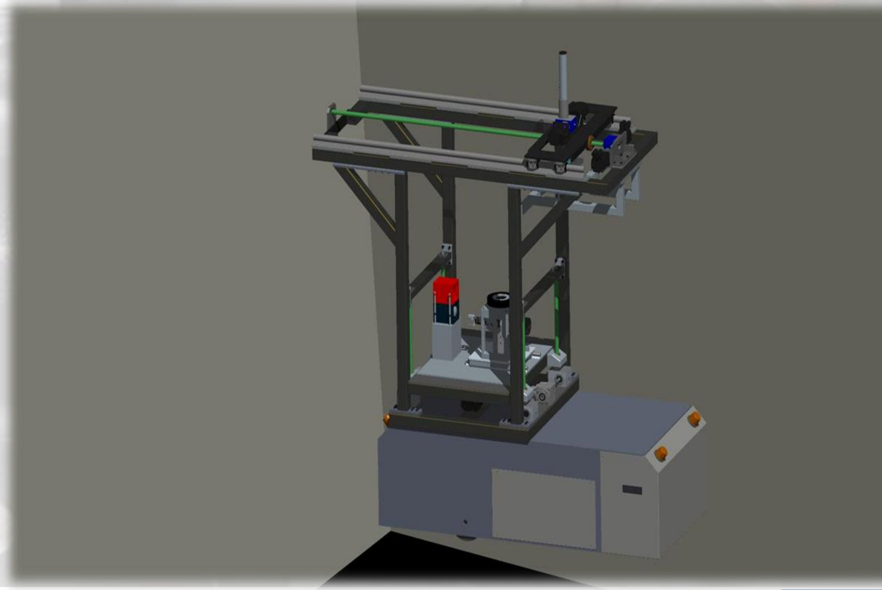
Handling: R6D for Puller Handling 4/4



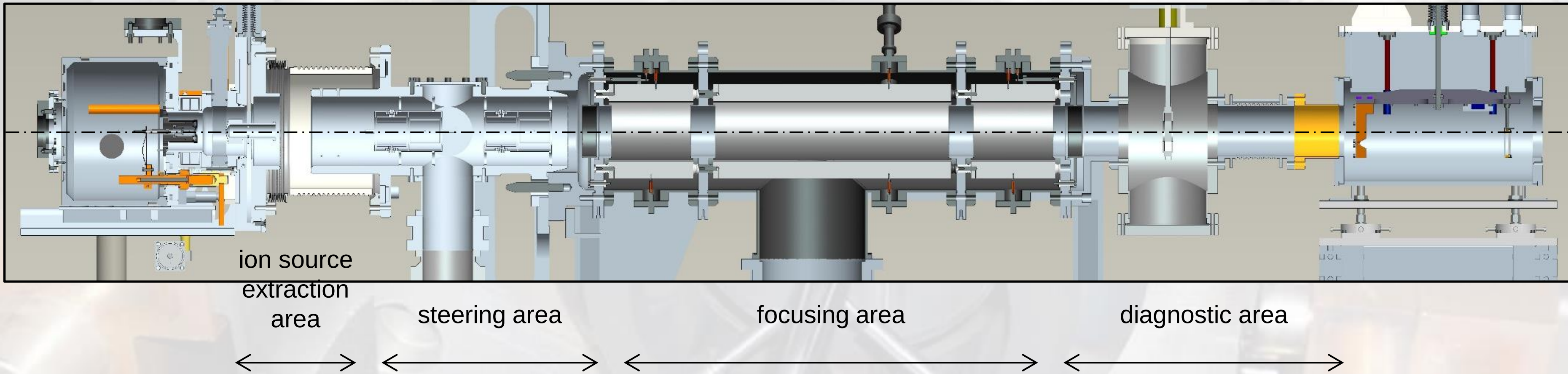
Puller toy

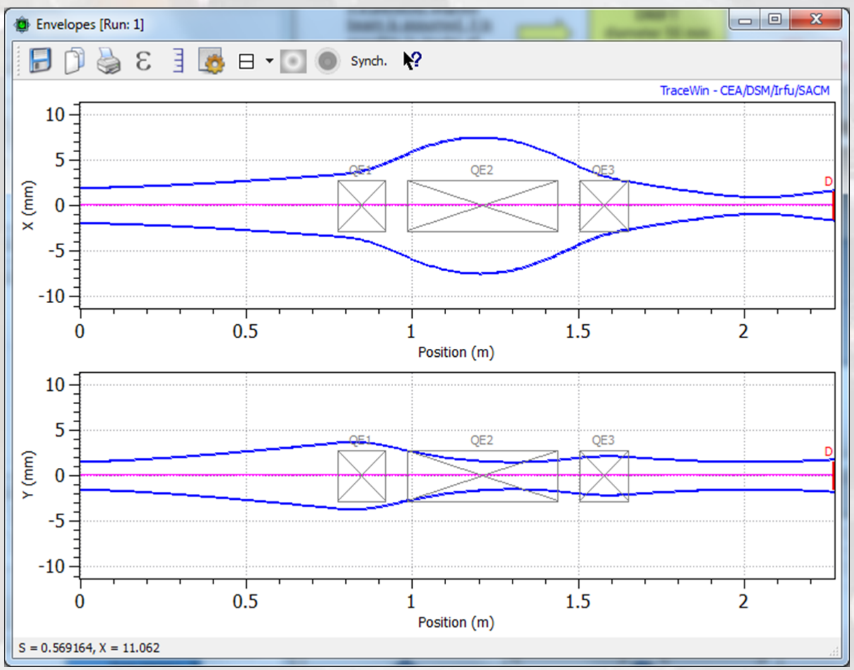


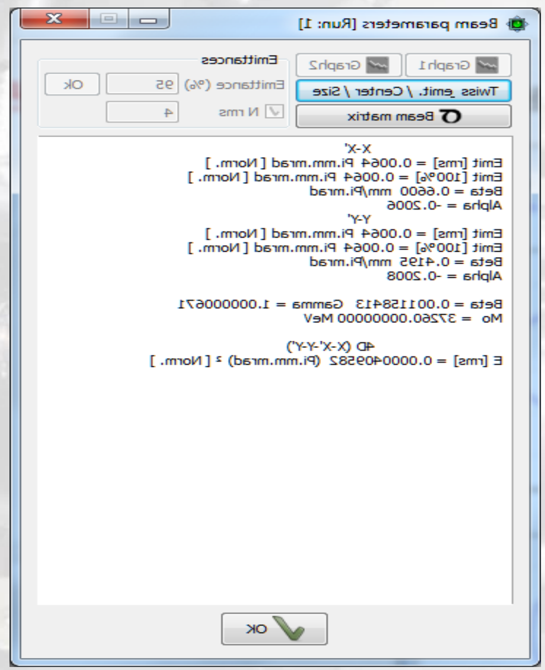


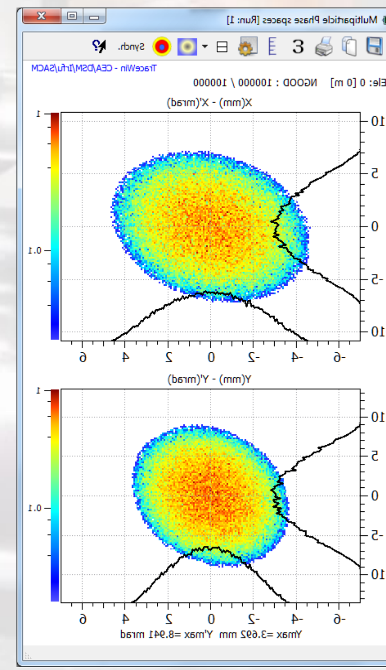


Front End: Beam transport trace-back 1/5



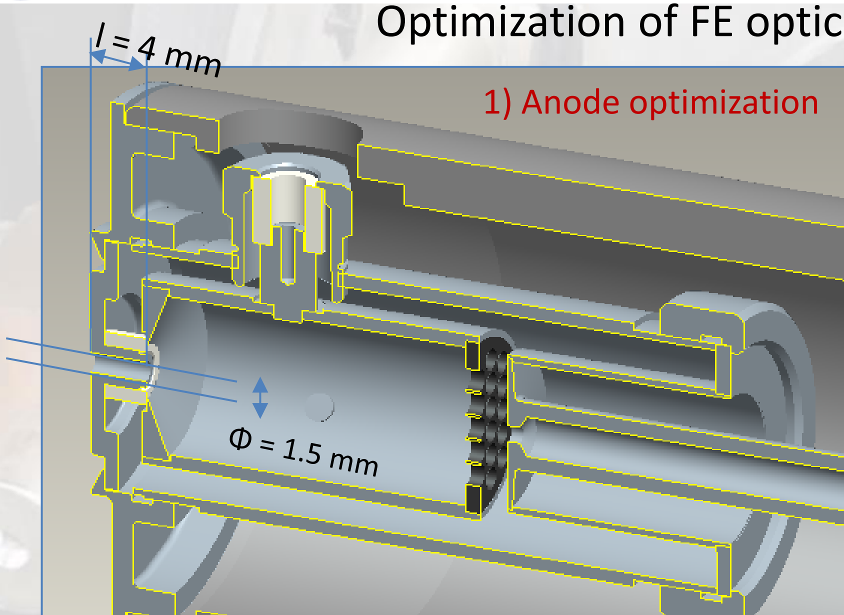




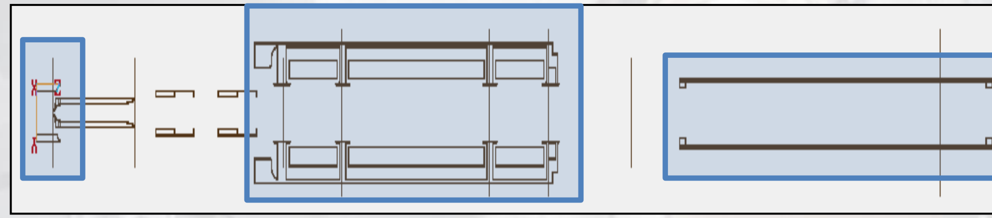


Front End: extraction optimization 2/5

Optimization of FE optics in order increase the RIB transport



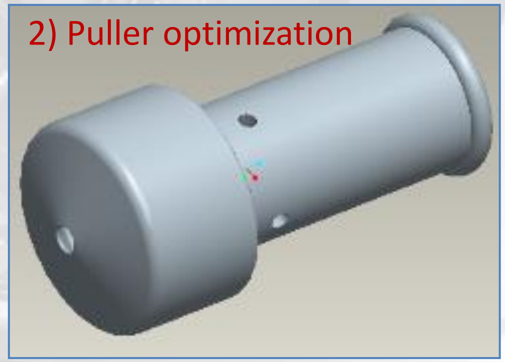
Tested with a reduction of 40% of emittance
(ε = 6 π mm mrad @ 25 kV)

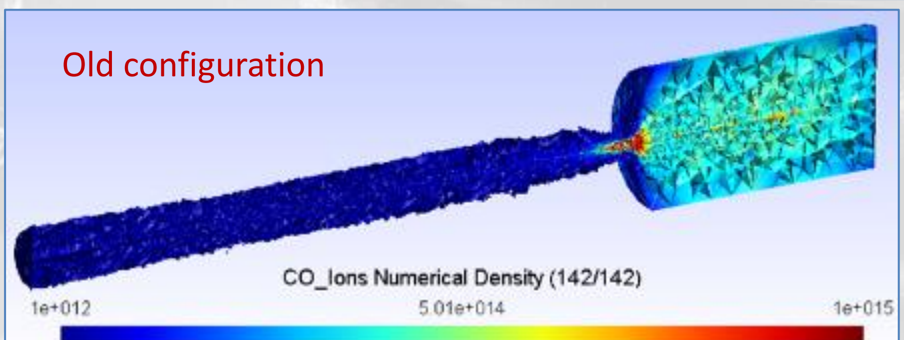


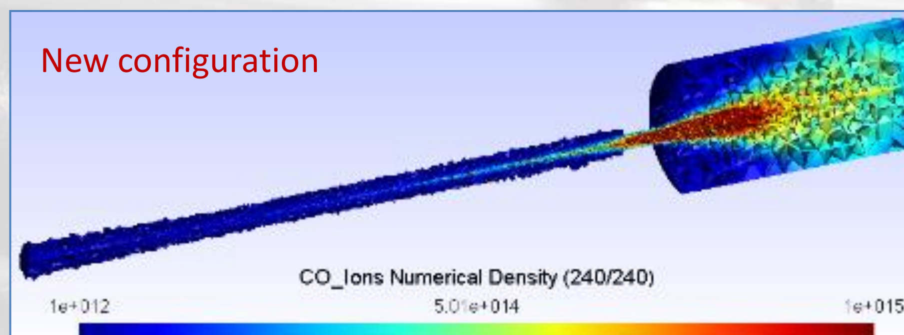
Source:
PIS
SIS (and LIS)

Quadrupoles:
SIS (and LIS)
PIS (presence of non-linear effects)

Wien Filter:
Mass resolution Transport efficiency





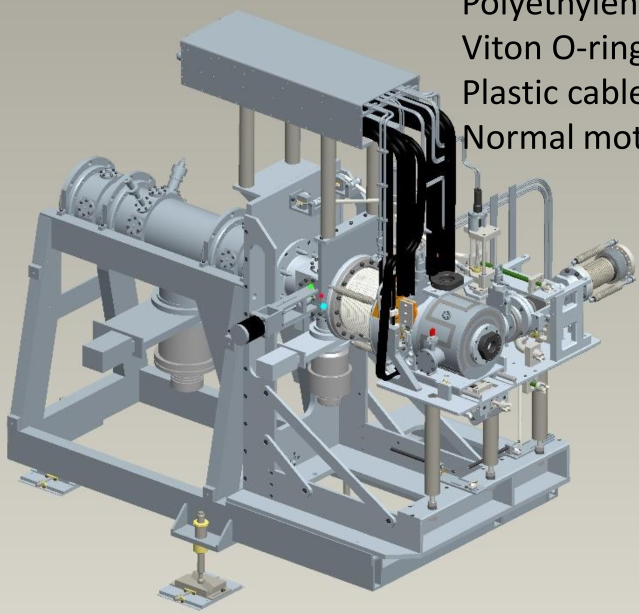


Main goal: PIS emittance comparable with SIS without losing in efficiency

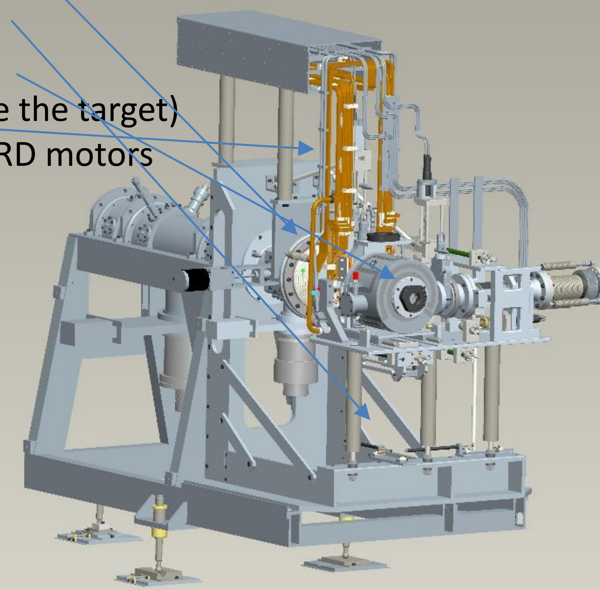
Front End: design for On-line version 3/5

Critical material List

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



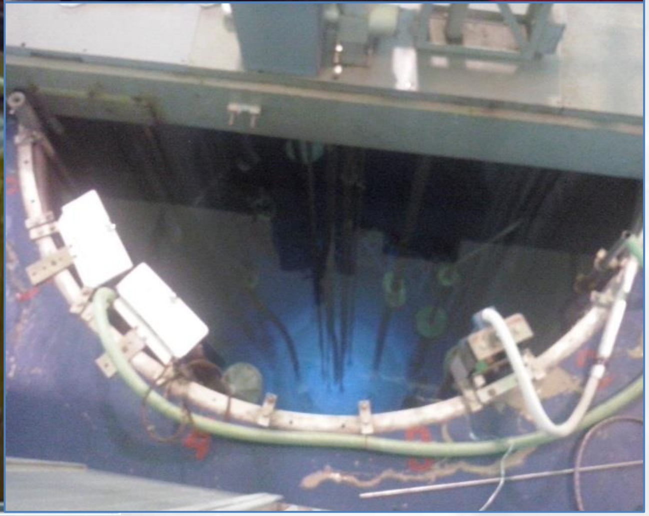
Off-line FE



On-line FE

Front End: Study on damage 4/5

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

Front End: Planning for damage test 5/5

Preliminary program of Italian collaboration: SPES, LENA, INFNPV, UNIBS

1. Compilation of materials of interest for the SPES project to be rad-hard tested;

   -> working in progress

2. Evaluation by MCNPX, FLUKA codes of the radiation fields and cumulated dose expected on the critical components inside the ISOL bunker -> working in progress

3. Characterization of the obtainable radiation fields in the TRIGA Mark II in order to reproduce as close as possible the expected inside the SPES bunker. -> early 2015

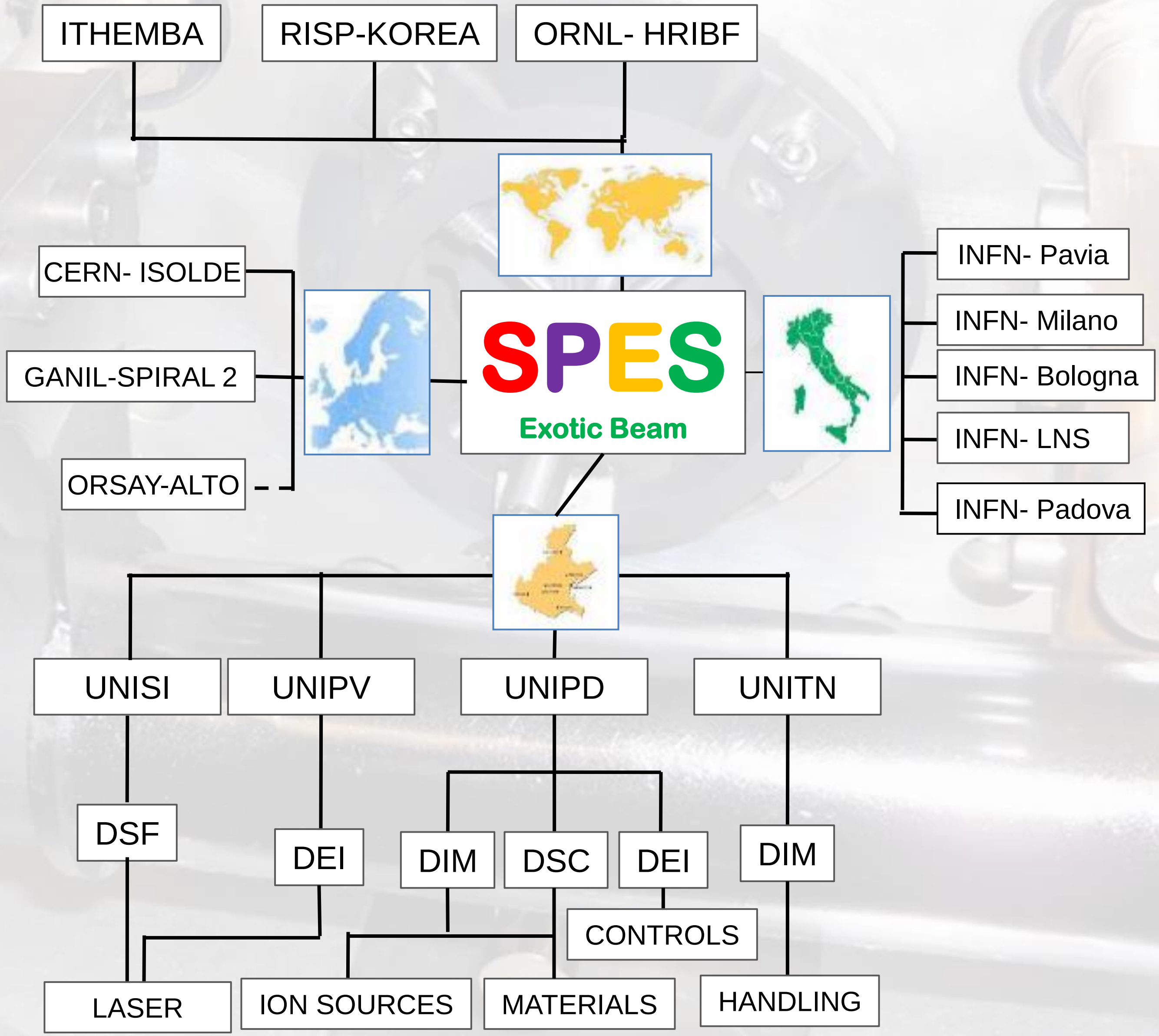
4. Planning of irradiation campaigns at L.E.N.A. reactor on sample of SPES critical materials. . -> early 2015

5. Tests on irradiated samples physical and operational properties of materials corresponding to different levels of irradiated dose; . -> late 2015

6. Post-irradiation study of irradiated samples in order to evaluate the radiation damage (mainly for polymers). . -> late 2015

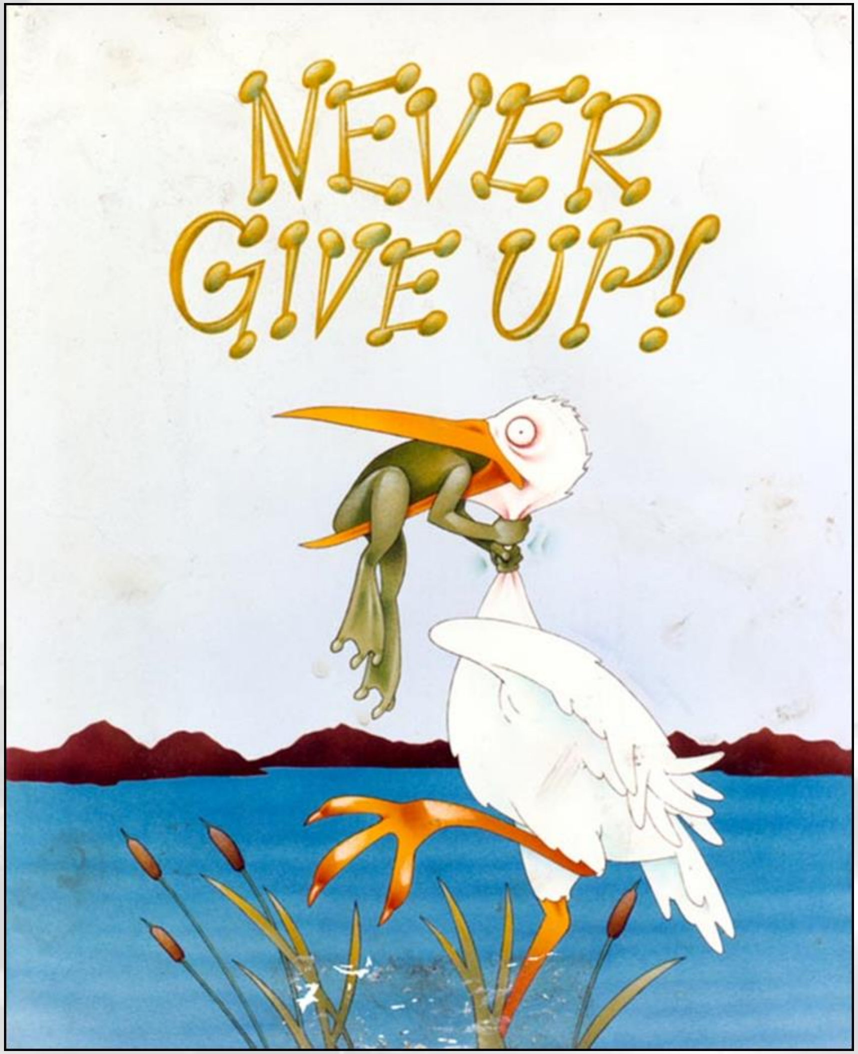
Possibility to extend the collaboration with external partners (Is fully welcome!)

Conclusions: the collaboration network…



Conclusions: the group…

and finally..



Thanks for your attention!