Recent results on R&D of the SPES production target

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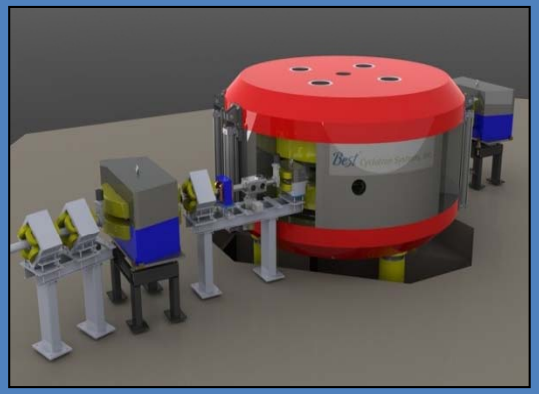
EURORIB'12 – Abano Terme

SPES mid-term ISOL facility

Driver:

'Commercial' cyclotron

from Best Cyclotron

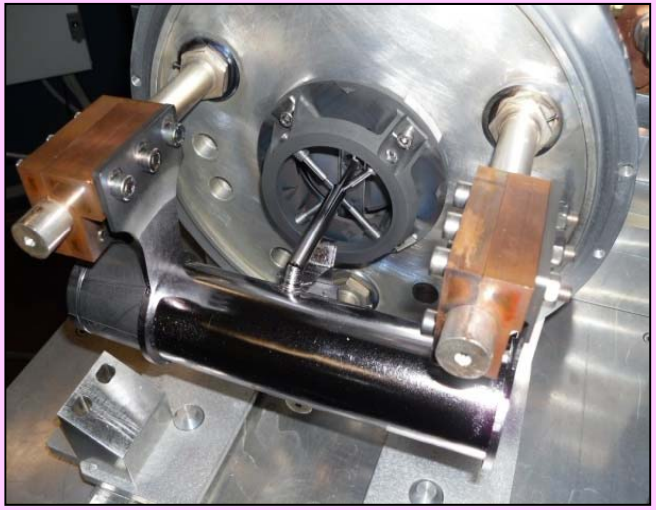


Beams	p
ENERGY	35-70 MeV
Current	750 μA
Extracted Beams	Dual Port Exit 300-500μA
Beam Loss	< 5%
Affidability	5000 hours/yea

Production Target:

NEW CONCEPT

(Multi-foil UCx target)



Target-Ion Source Complex:

- optimized for 8kW beam power
- E_{proton} = 40 MeV for RIB
- 10^13 fission/s.

Post Accelerator:

Piave- Alpi existing complex

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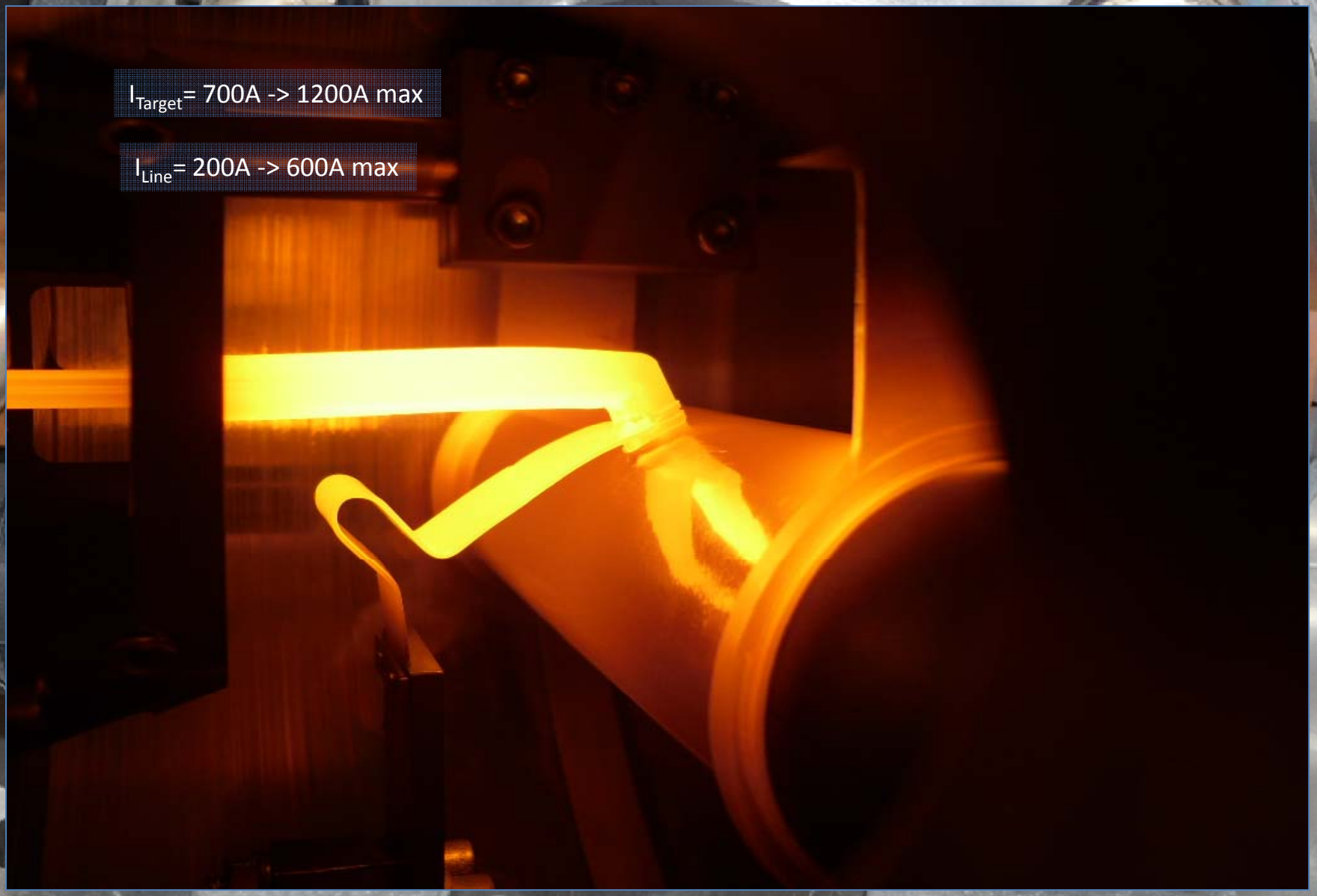
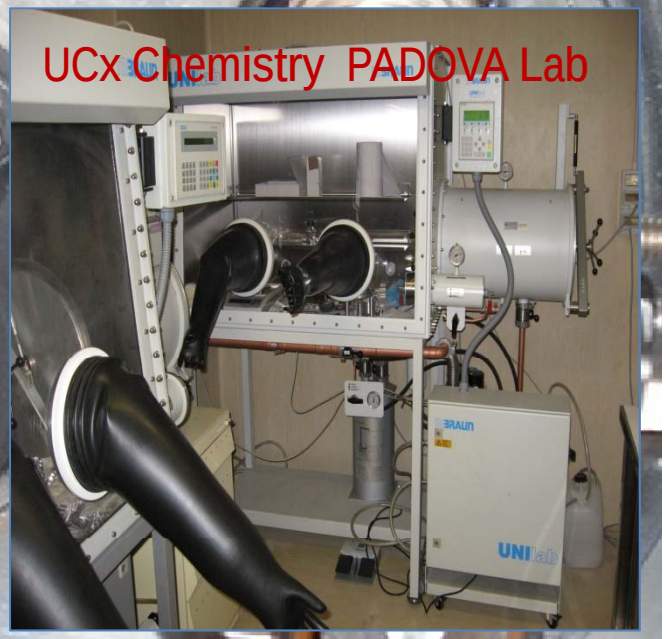
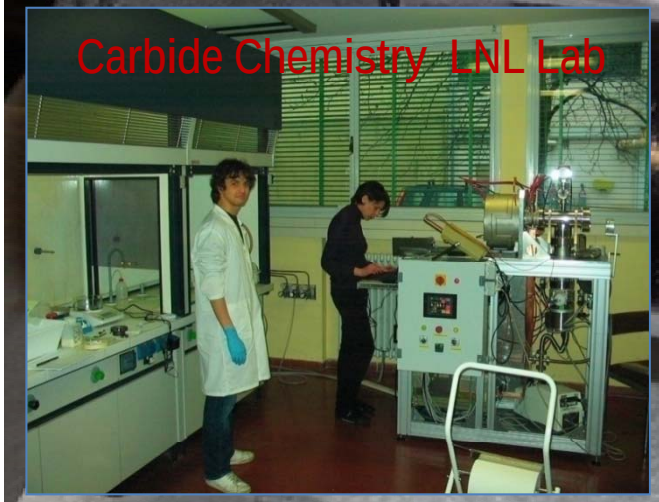
The SPES TIS complex



The TIS SPES Laboratories

Visit planned for this afternoon…





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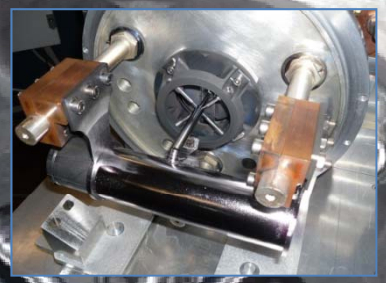
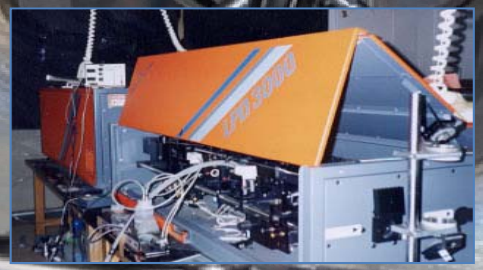
SPES TARGET Work Packages

WP01: Ion Source



WP02: Material developments

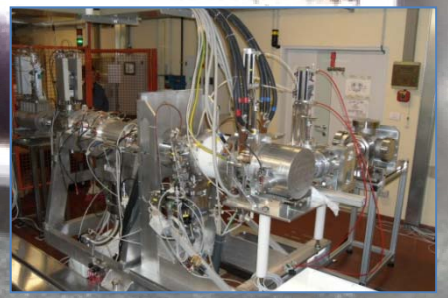
WP03: Laser



WP04: Handling

WP05: Controls

WP06: Mechanical developments



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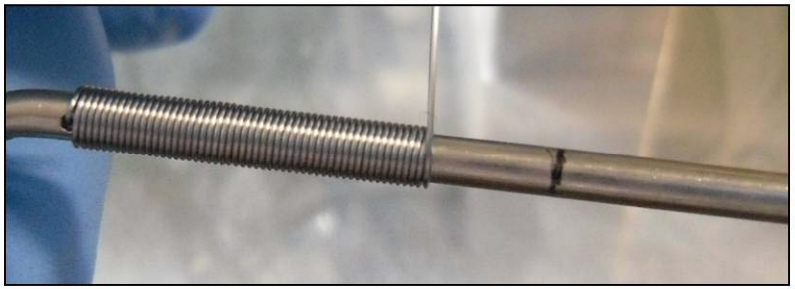
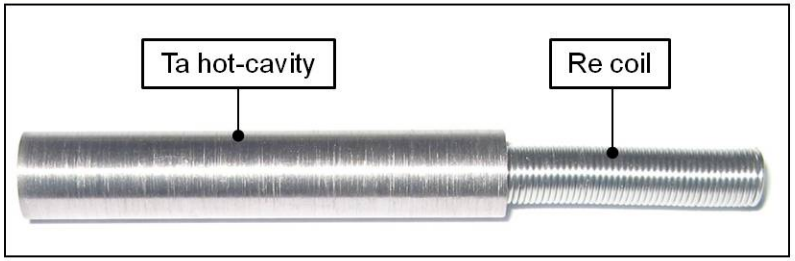
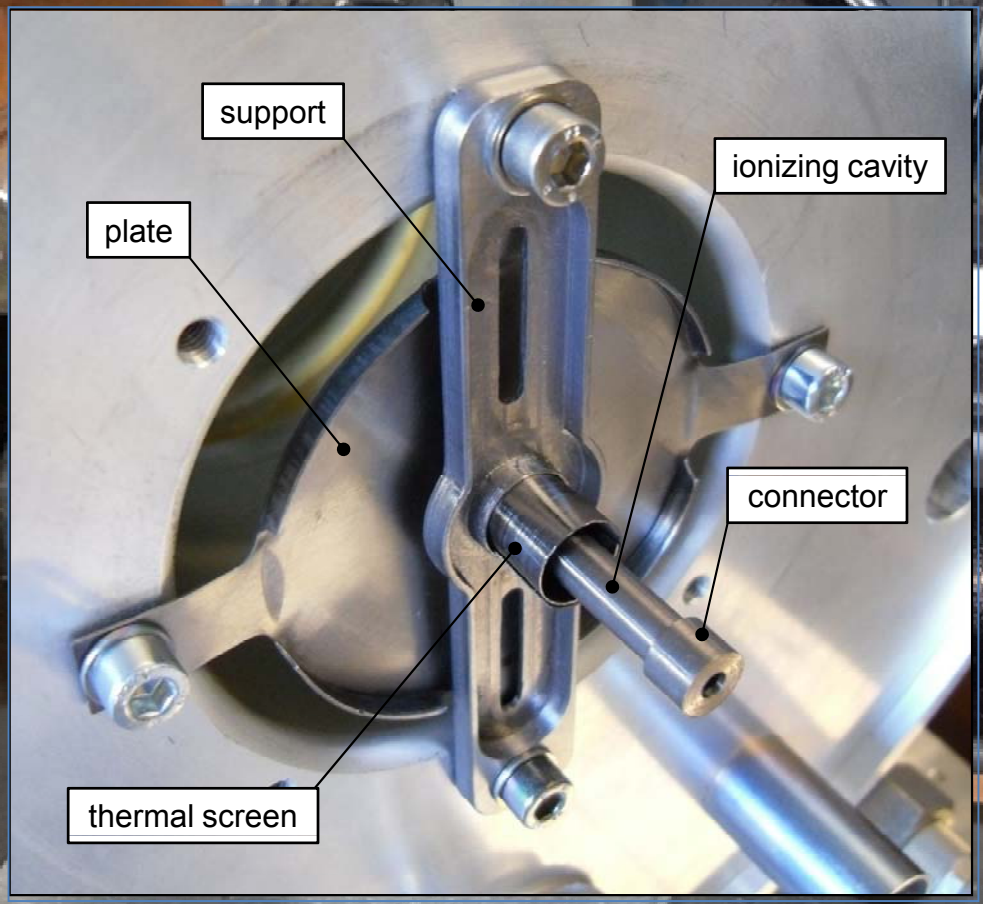
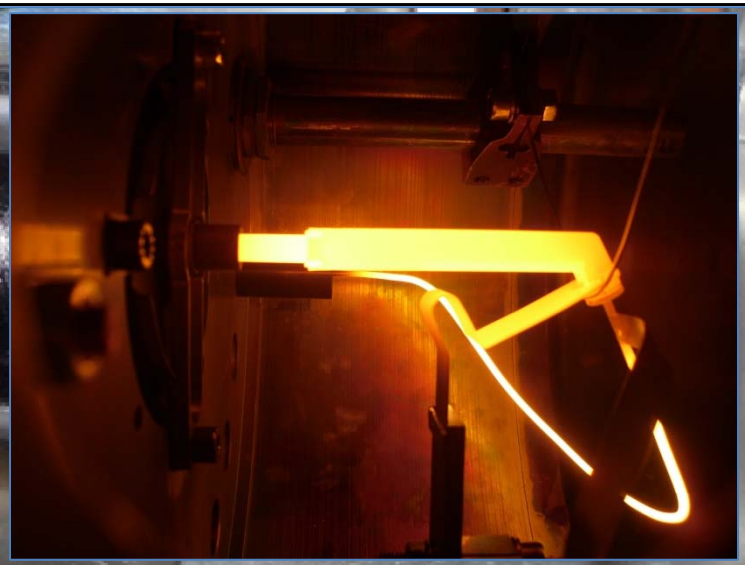
The new SPES Surface Ion Source (SIS)

Hot cavity inner surface
- Rhenium (inside Ta cavity) -> for SIS test
- Tantalum (naked) -> for LIS test









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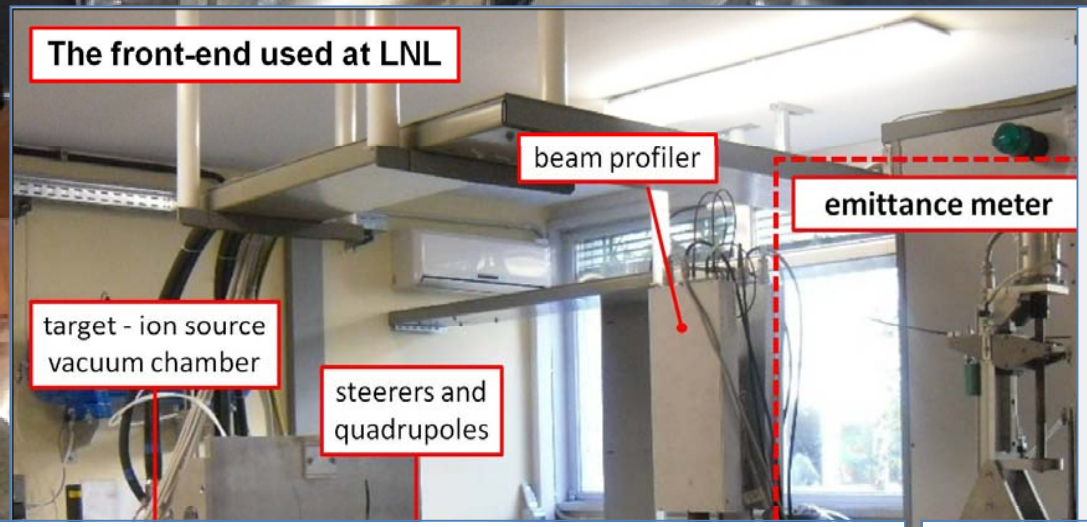
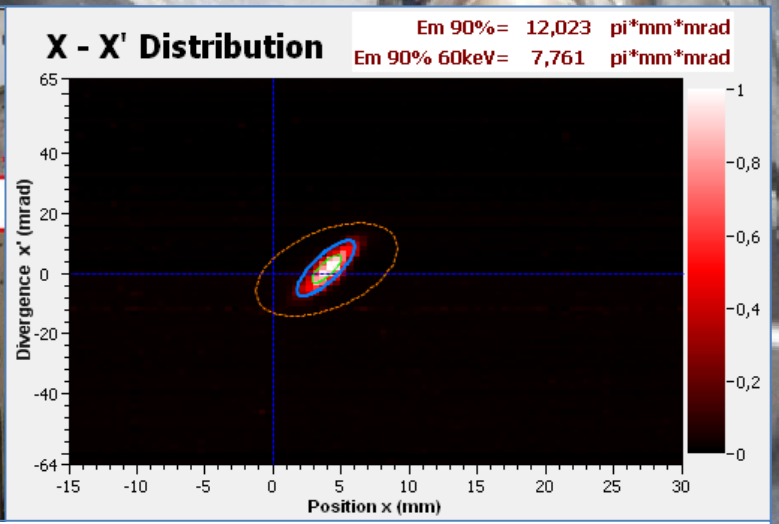
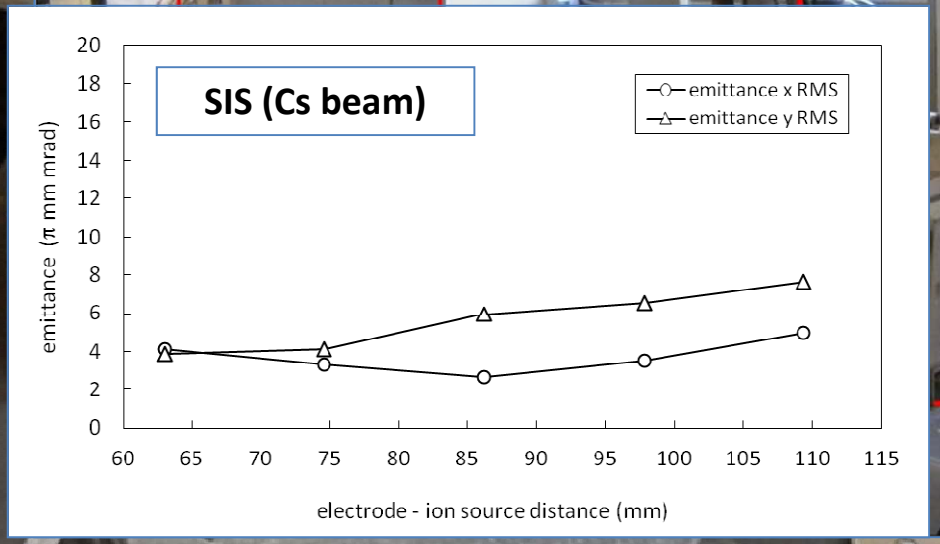
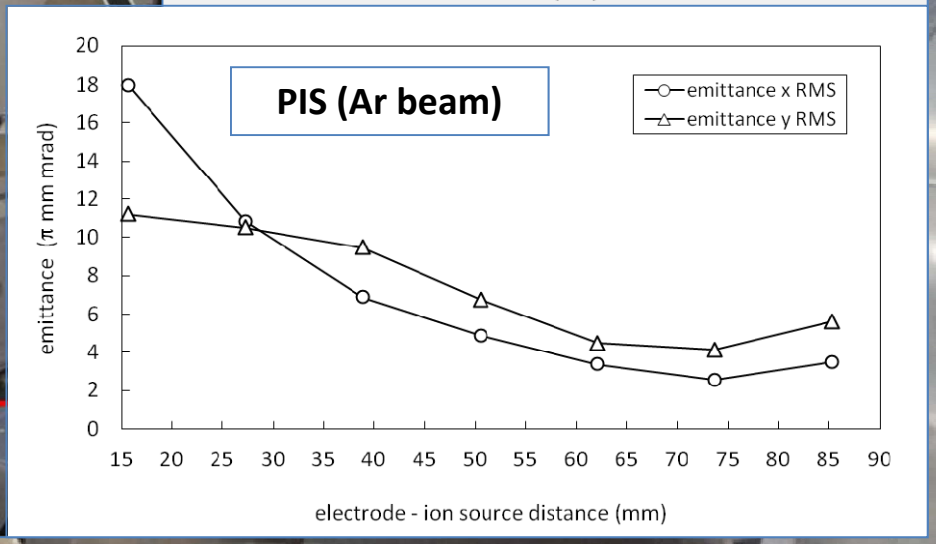
WP01

Emittance measurements for SIS and PIS









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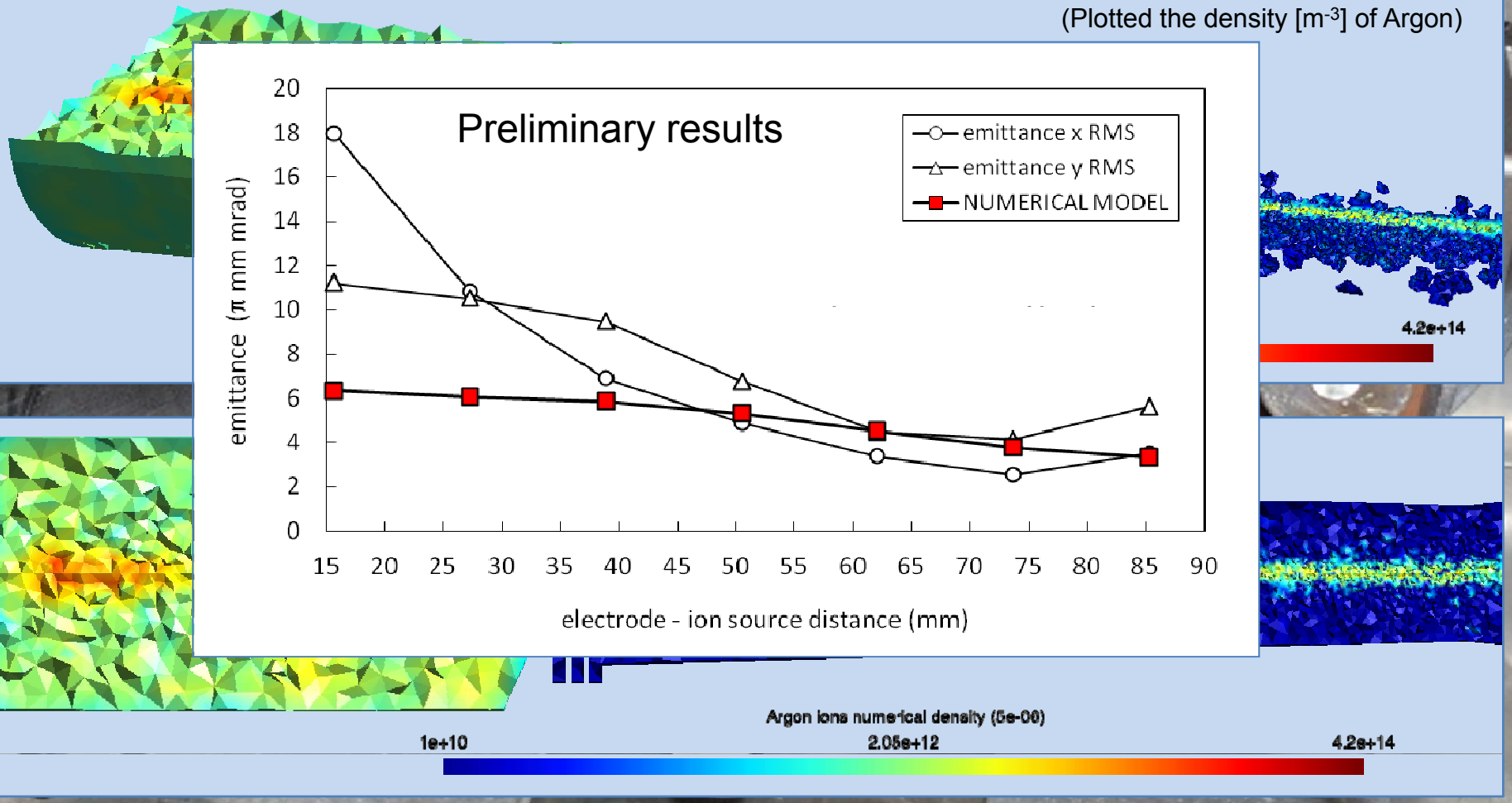
WP01

Simulation of the Plasma Ion Source

F3MPIC-CISAS code for numerical simulation of an Argon beam: ions are extracted from the SPES Plasma Ion Source

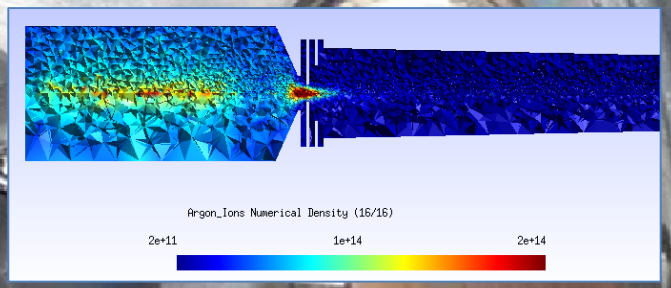
(Plotted the density [m^{-3}] of Argon)



PIS optimization with F3MPIC code

(preliminary results)

Starting configuration
(Hybrid from MK5/EBPIS)



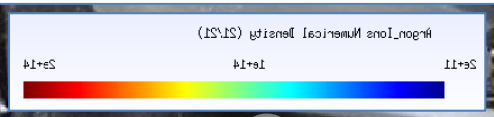
Goal: decrease emittance and increase beam current

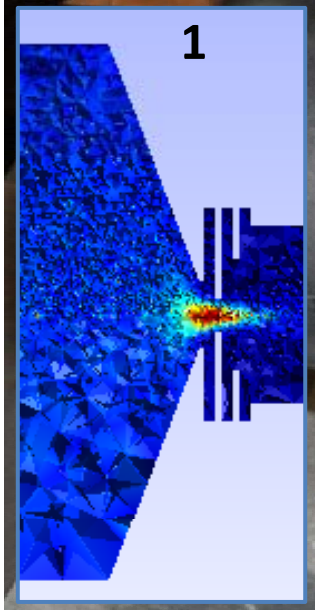
Don't change IS characteristics:

1. Anode chamber dimension
2. Presence of thermal screens

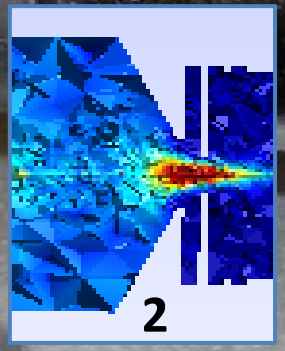
Change source characteristics:

3. Anode chamber shape
4. Anode diameter hole
5. Grid diameter hole

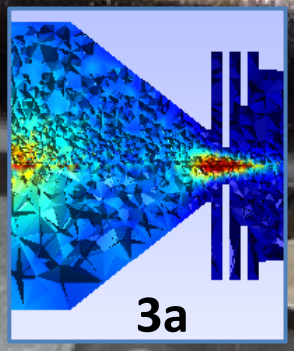




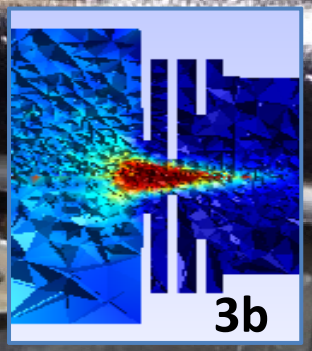
Emittance
Current



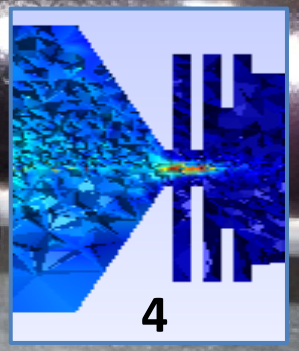
Emittance
Current



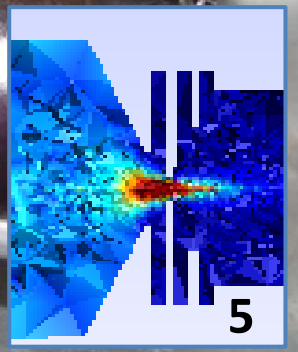
Emittance
Current



Emittance
Current



Emittance
Current



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WP01

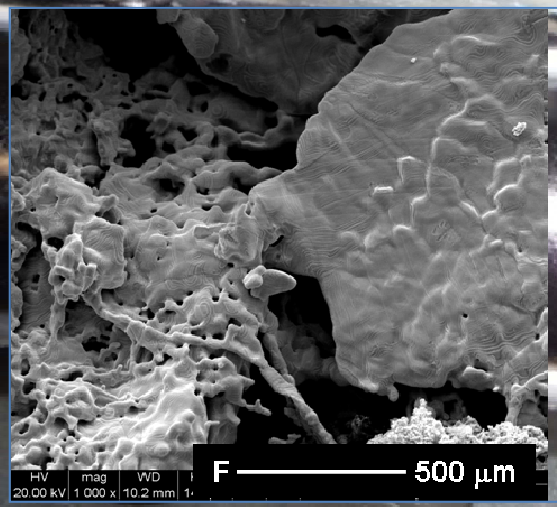
On line UC_X-CNT test at HRIBF

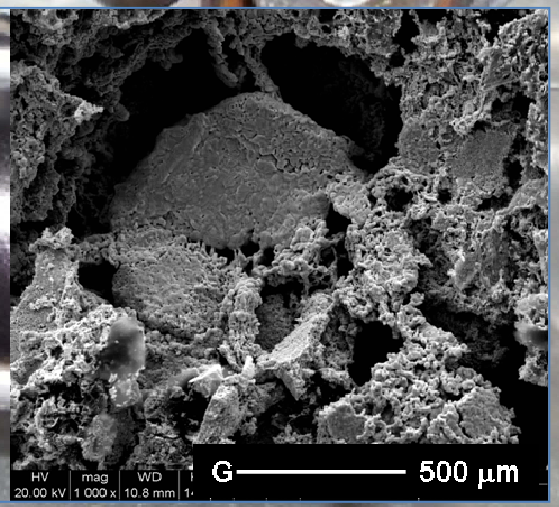
Second run: performed at ORNL on Oct '11

- Seven UC_X-CNT samples
- Densities in the range of 2.6 g/cm^3
- Used the SPES design where the targets are spaced out to allow for enhanced radiation to the walls of the container
- Heated to 2000° C for about two weeks with initial out-gassing (CO) and no obvious change in structure (samples observed after the on-line test)

$$UO_2 + 6C \longrightarrow UC_2 + 2C + 2CO$$

C comes 50% from graphite, 50% from MWCNTs





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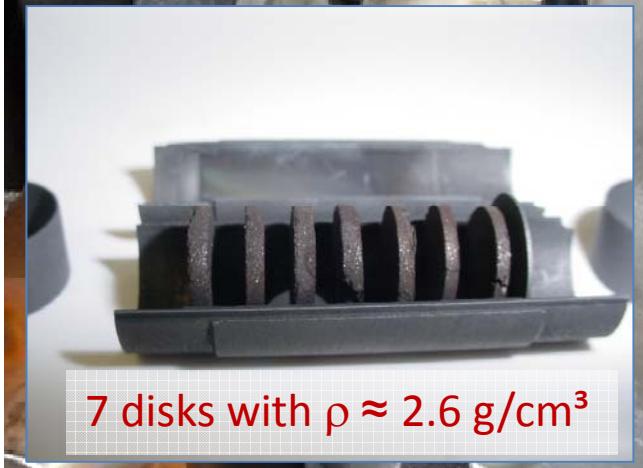
WP02

On line UC_X-CNT test at HRIBF

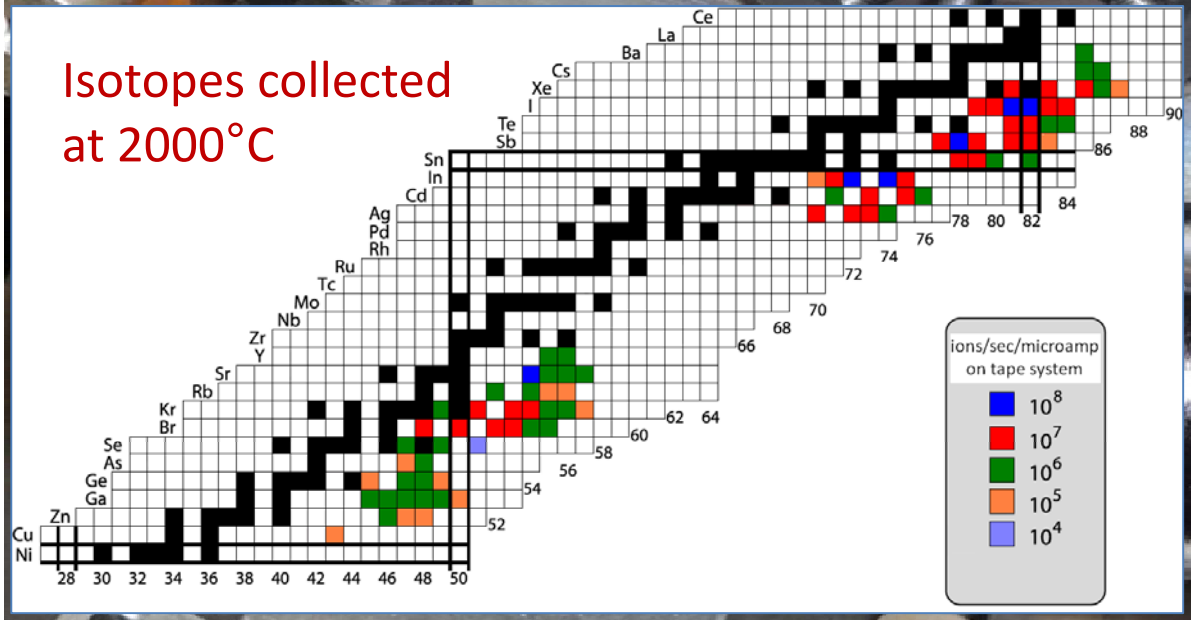


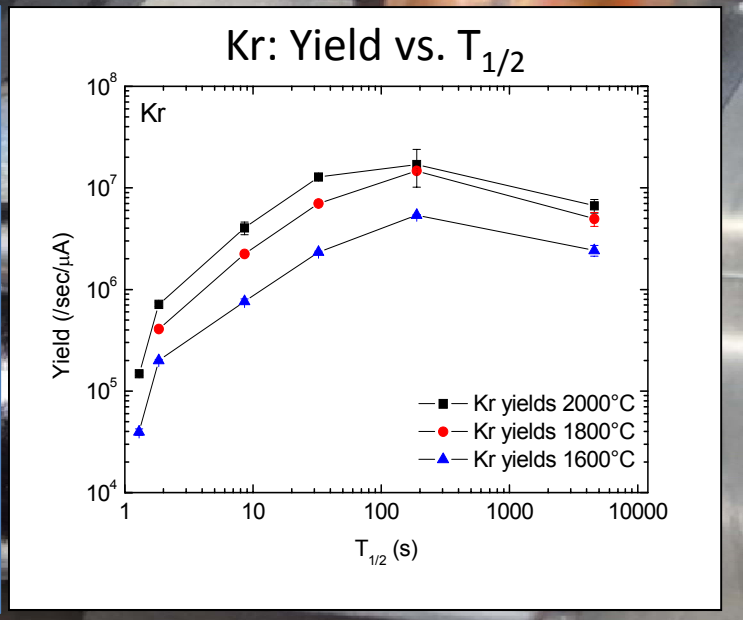
7 disks with $\rho \approx 2.6$ g/cm³

Graphite box

Standard OLTF TIS system

Isotopes collected at 2000°C





21 elements, 82 isotopes collected → Yield vs. $T_{1/2}$ and vs. temperature study

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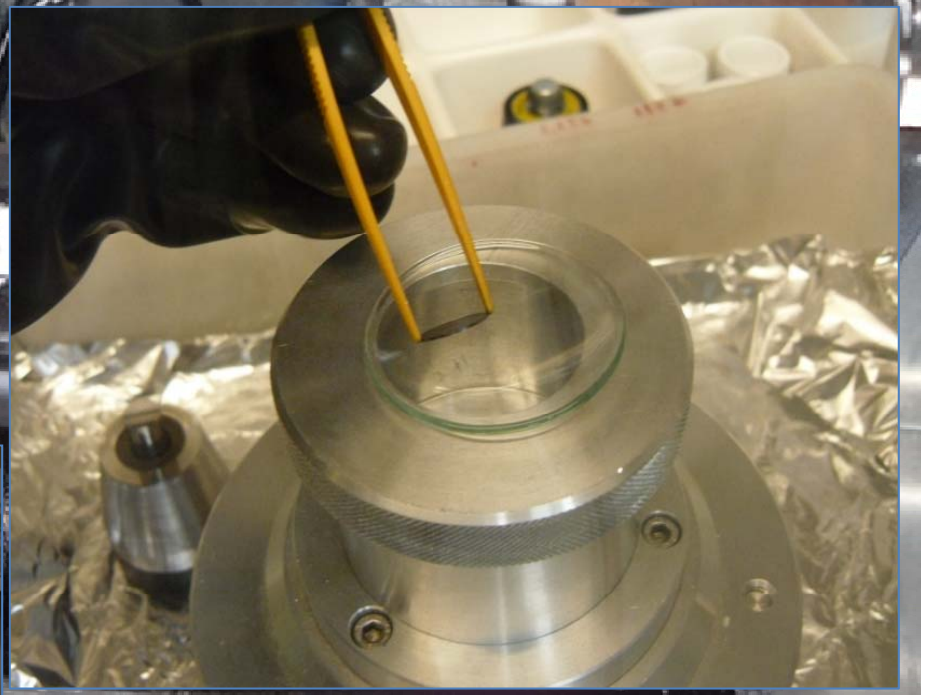
WP02

New target for medium density test

R&D of production process:

1) "Standard" carbothermal reduction synthesis → ~4 g/cm³
2) Grinding and re-pressing of the powders → 6 g/cm³
3) Re-sintering of the pellets → 6-7 g/cm³



Pressed and re-sintered sample

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WP02

B_4C for the production of Be

B_4C from boric acid – phenolic resin

RAW MATERIALS
- Boric acid as boron source ($B(OH)_3$)
- Phenolic resin as carbon source

SUSPENSION OF REAGENTS IN ETHYL ALCOHOL — T = 60°C

WET MIXING — T = 80°C

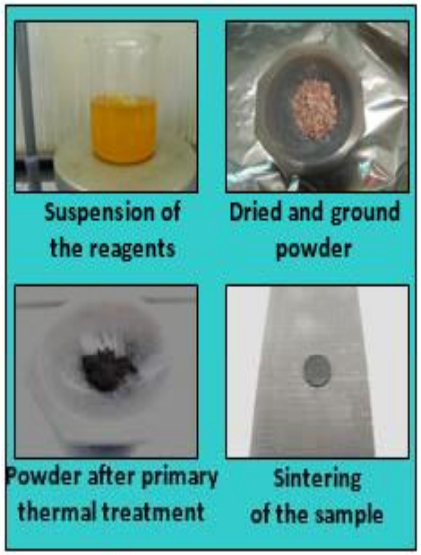
SOLVENT EVAPORATION

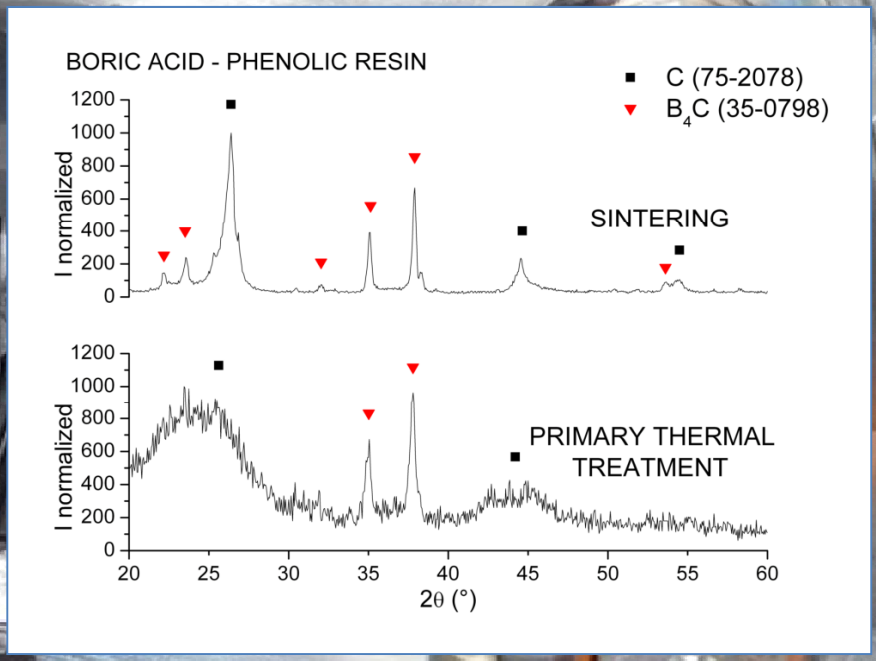
GROUNDING INTO POWDERS

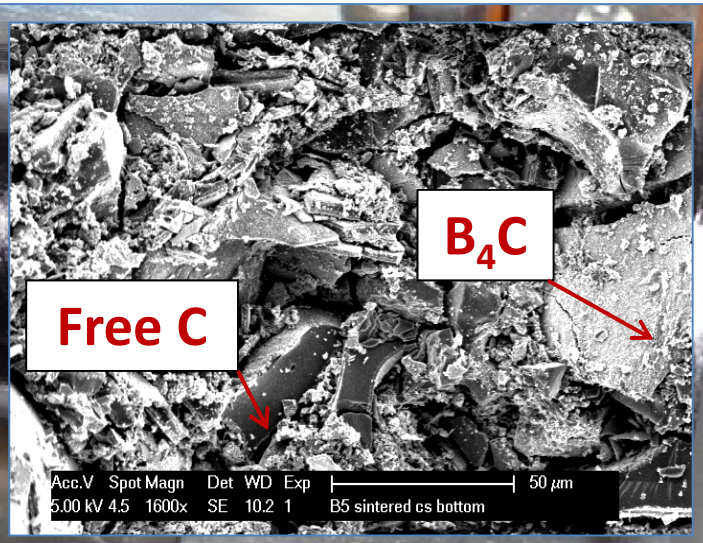
PRIMARY THERMAL TREATMENT
- DECOMPOSITION INTO BxOy/C MIXTURES — T up to 800°C (low vacuum)
- B_4C FORMATION — T up to 1500°C (1 mbar Ar)

COLD PRESSING

HIGH TEMPERATURE SINTERING — T ~ 2000°C (vacuum)







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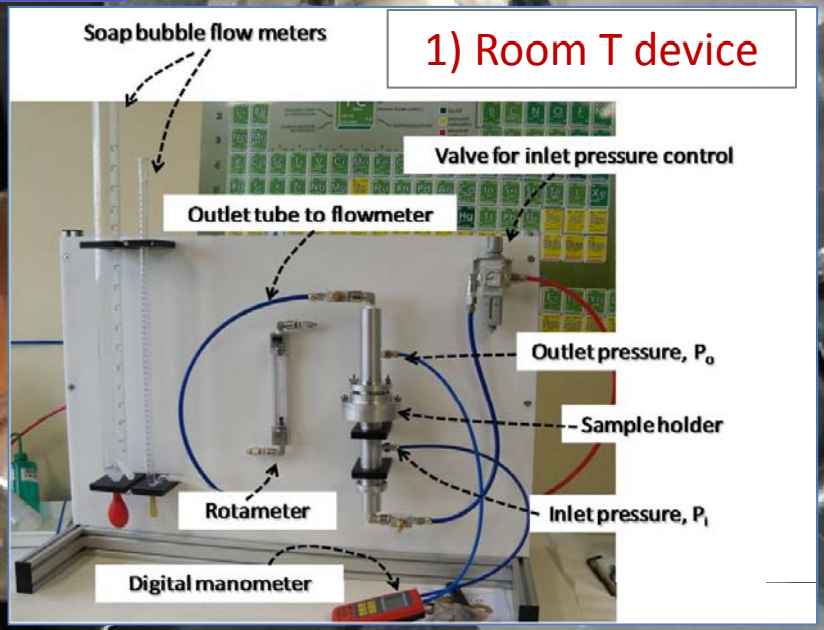
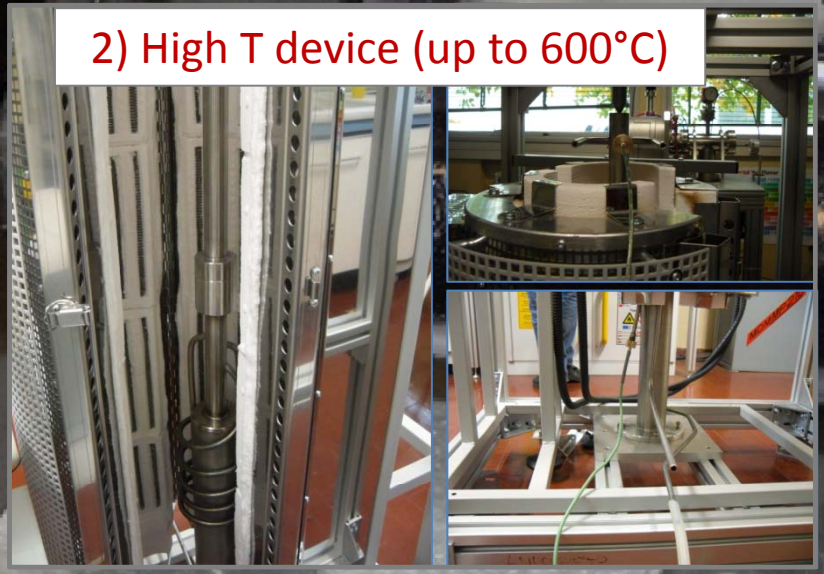
WP02

Permeability measurements

1) Room T device



2) High T device (up to 600°C)

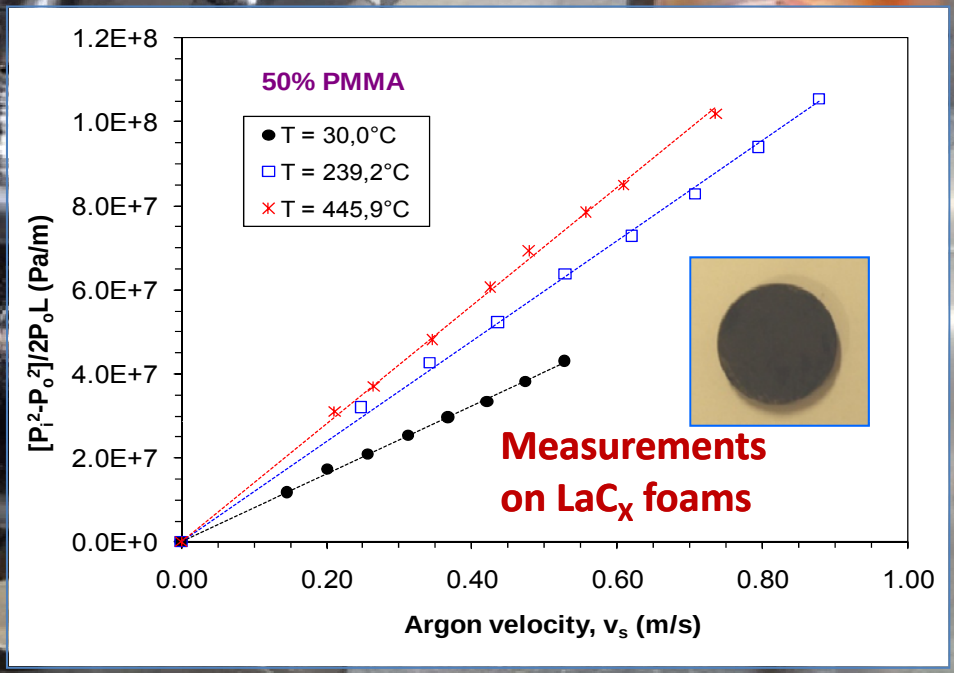


Forchheimer's equation:

$$\frac{\Delta P}{L} = \frac{\mu}{k_1} v_s + \frac{\rho}{k_2} v_s^2$$

Linear term (Darcy's law) → Pressure drop by viscous action inside the pores

Quadratic term → Pressure drop by turbulence and tortuosity

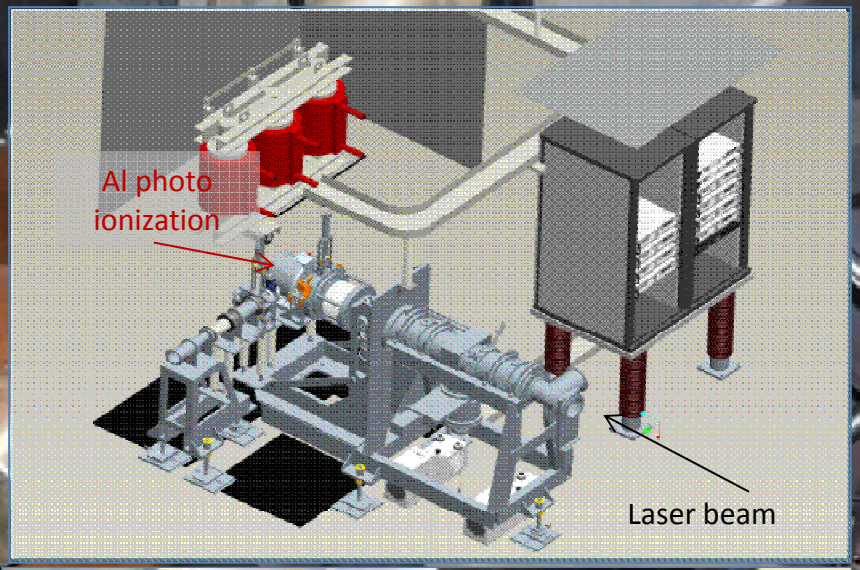


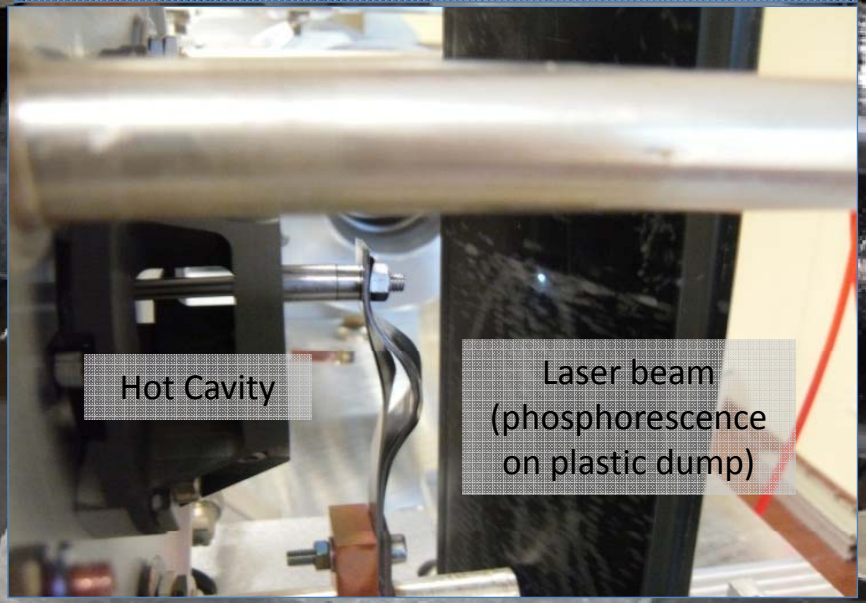
SPES Target Group

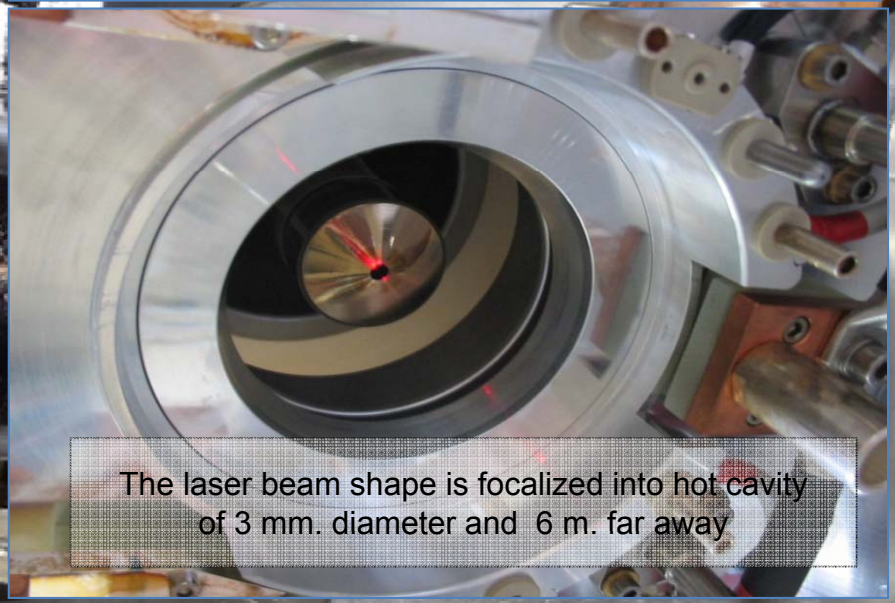
WP02

Laser test at LNL with excimer

Aluminum ionization with a single wavelength







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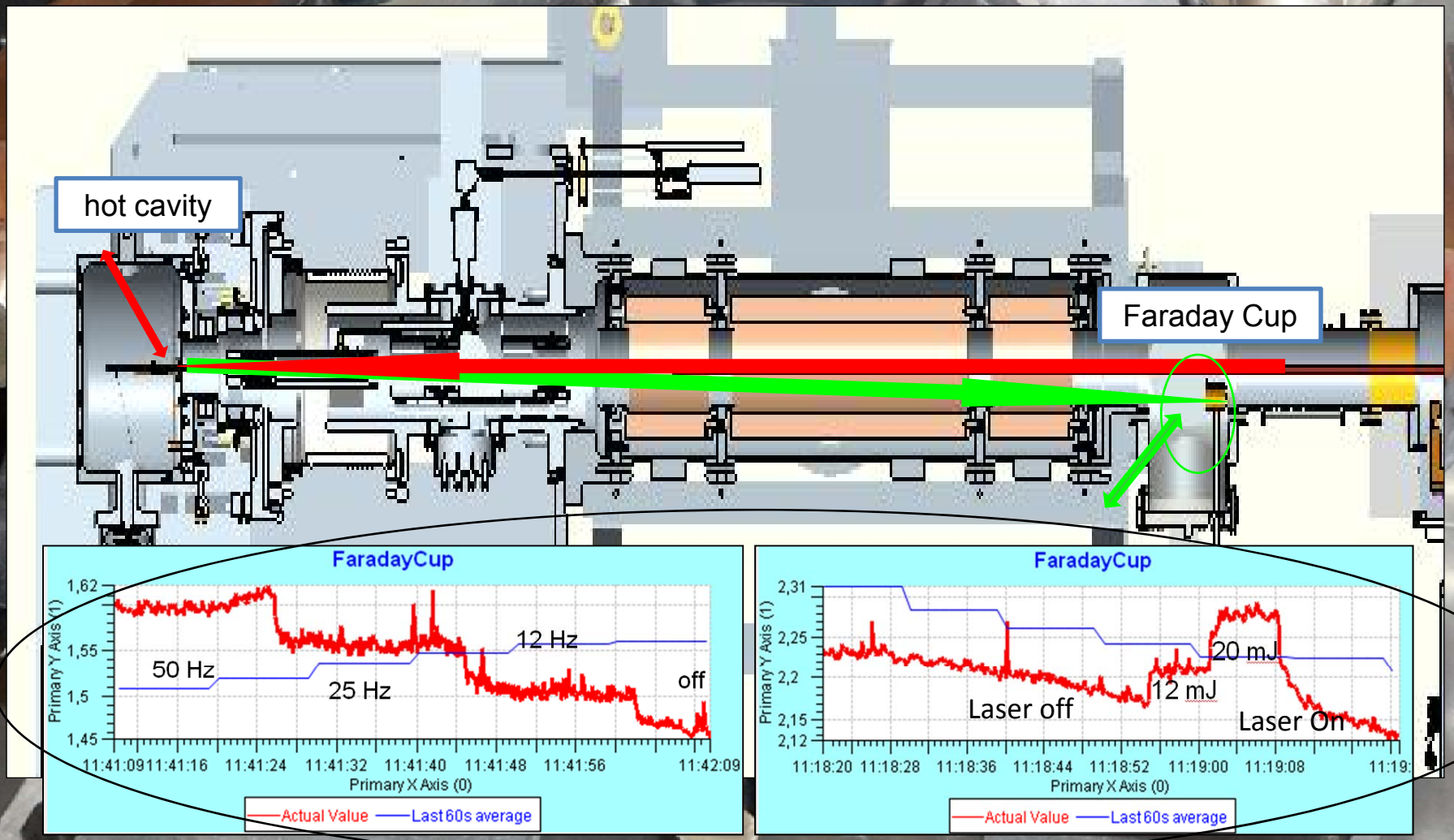
WP03

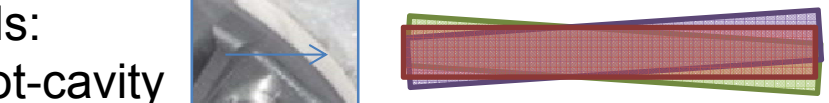
Aluminium photo-ionization

First ionization results (Current collected into the Faraday Cup)

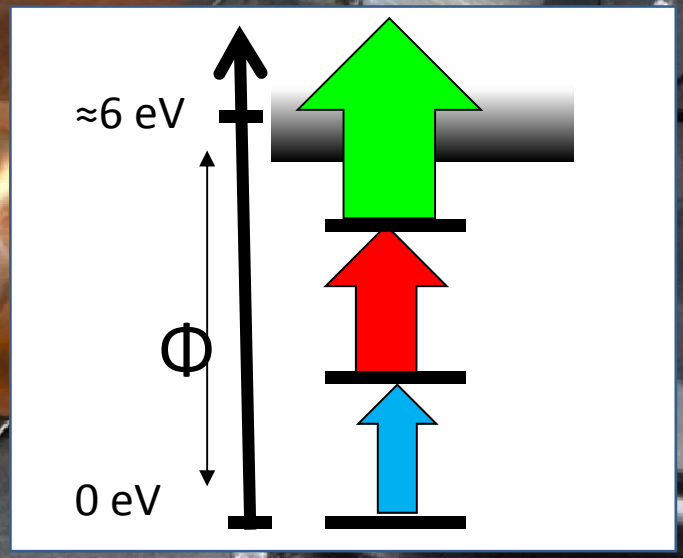


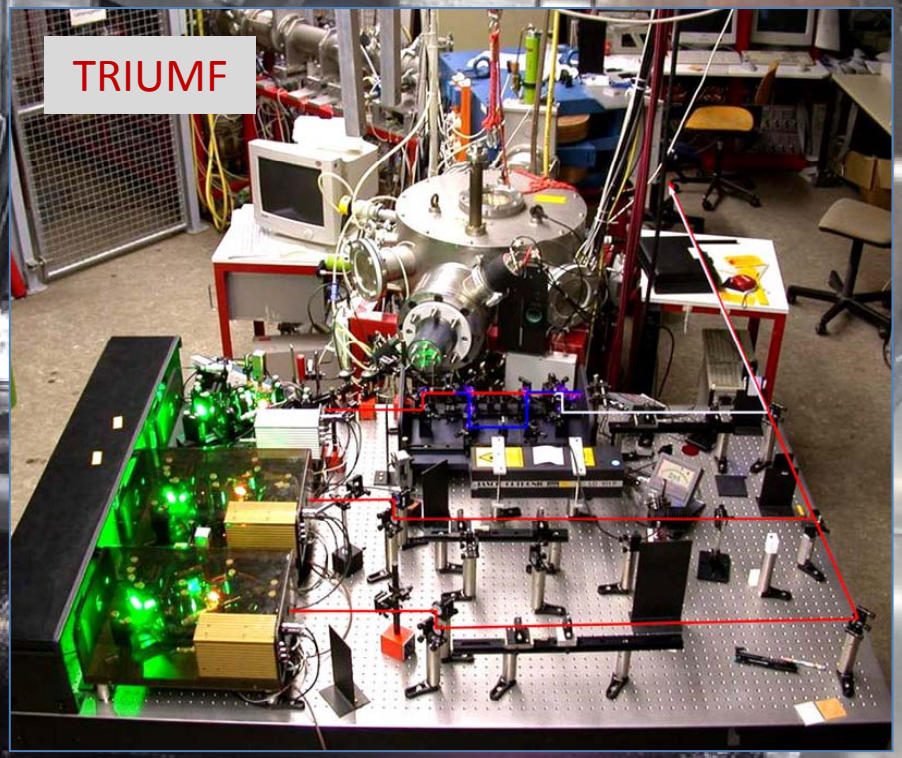
Combination of laser beam at Pavia

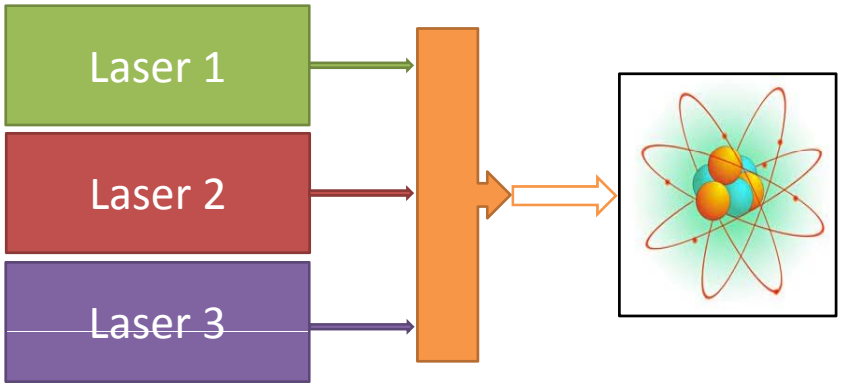
Multistep laser photoionization needs:
A spatial overlap of different laser beam in hot-cavity



Spatial overlapping region







Hot cavity distance on-line facilities is ≈ 20 m
Solutions: Mirror with tilt angle

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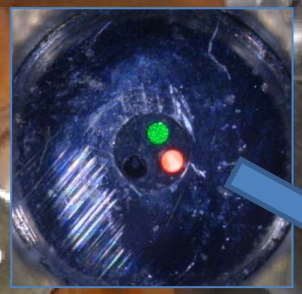
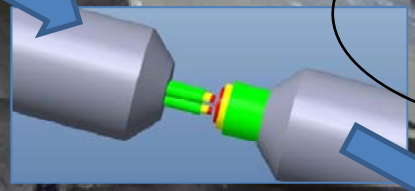
WP03

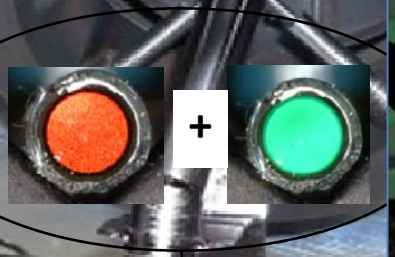
Combination of laser beam at Pavia lab.

For off-line facilities or where
typical laser system – hot cavity distance is ≈ 1-5 m
a possible solution: Fiber optics

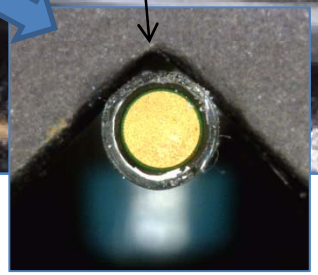


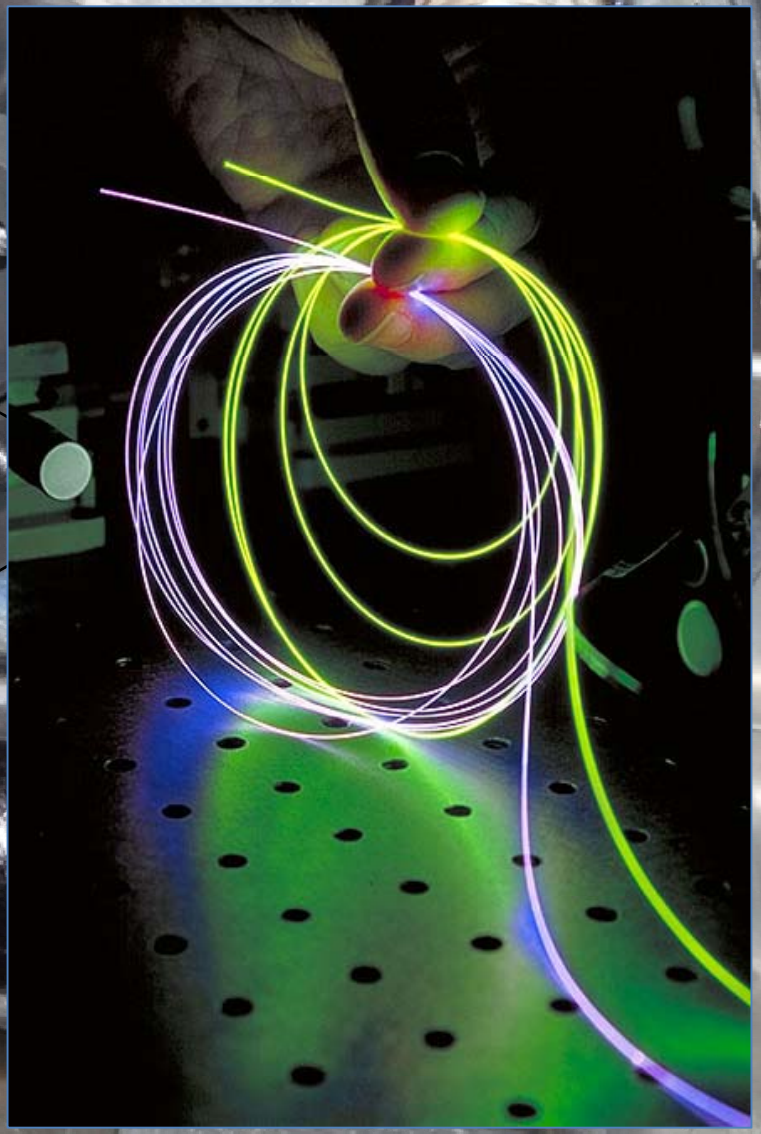
Each laser enter in 200 um core fiber





SMA-SMA connection:
3 x 200 um. into 1 x 1000 um.

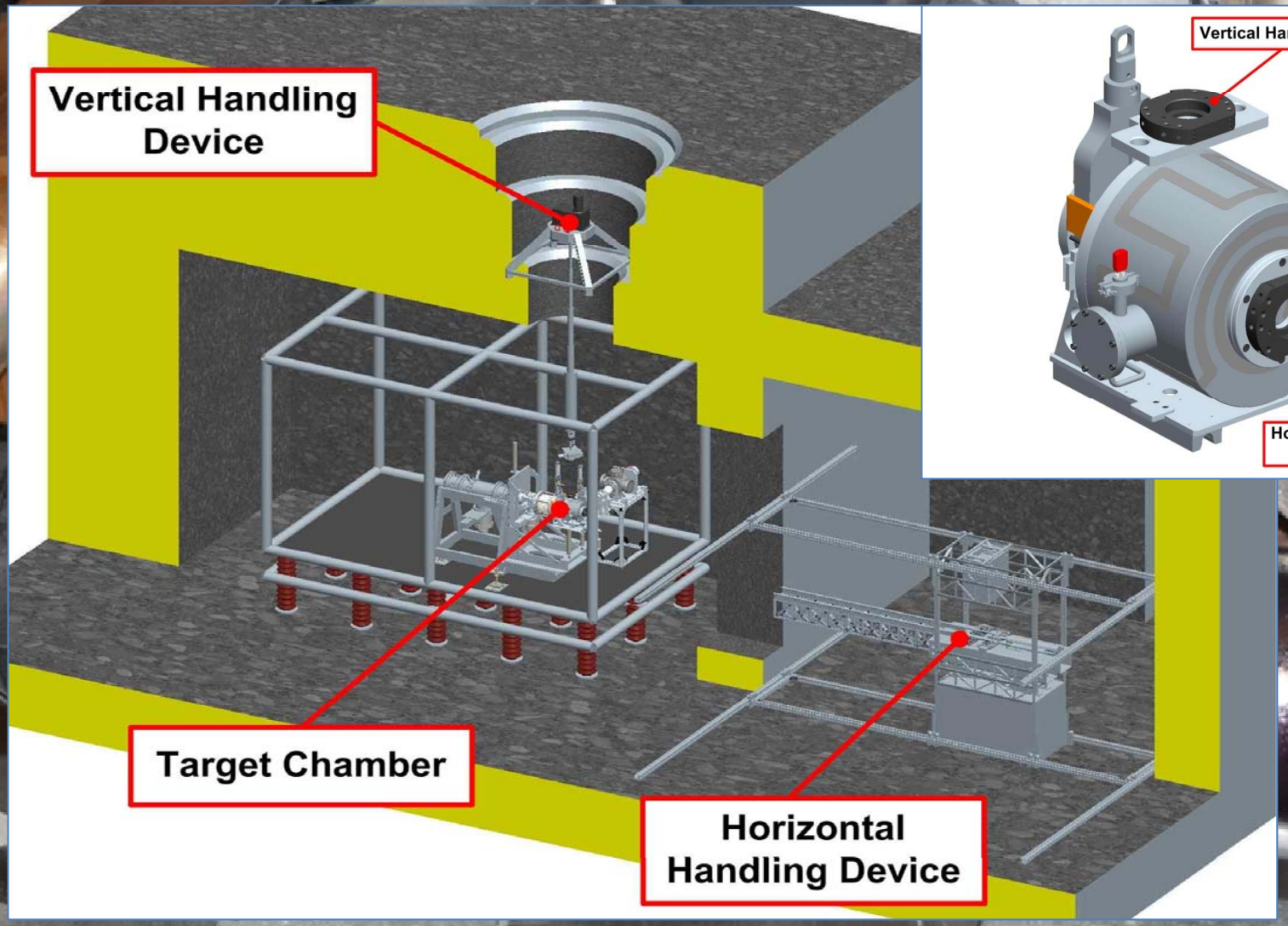




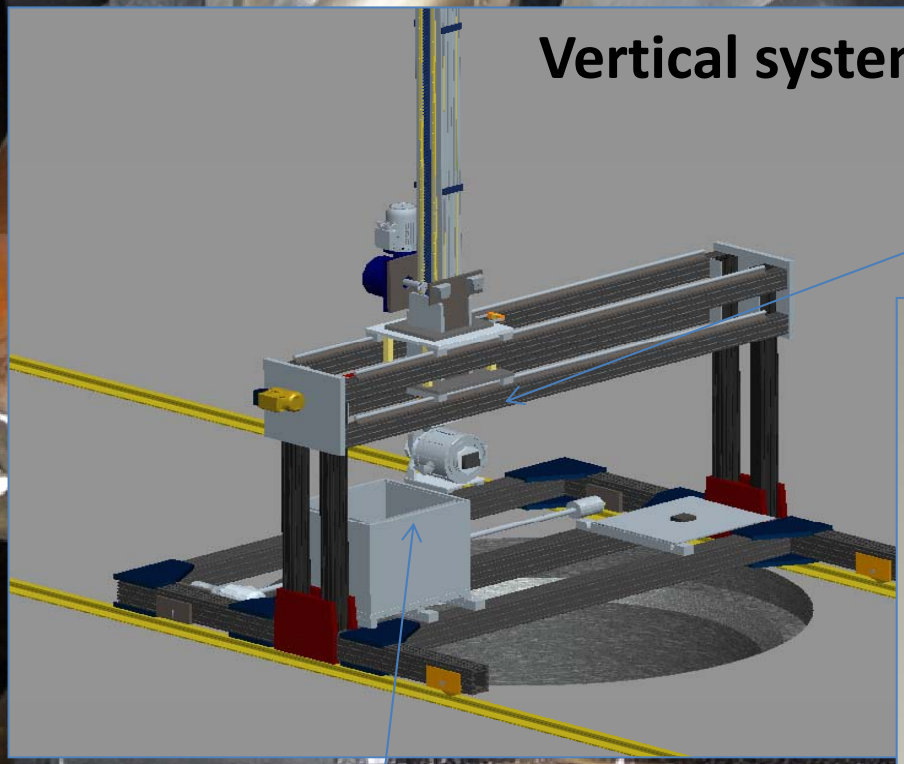
Optical fiber 3 in 1:
- Perfect spatial overlap
- Easy final alignment
- Up to 1mJ in each 200um. fiber (pulse 15 ns.)
- Bad final beam collimation (but ok for short distance)

The target handling

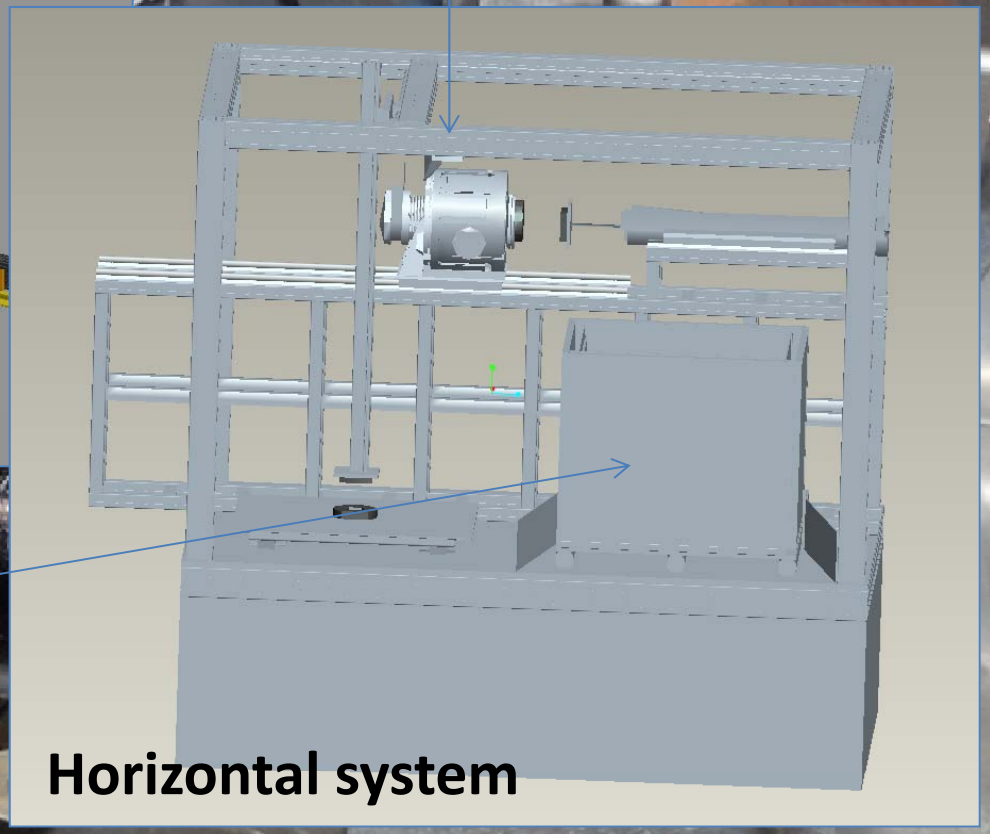
Two systems are foreseen in order to increase the handling security level



SPES handling devices

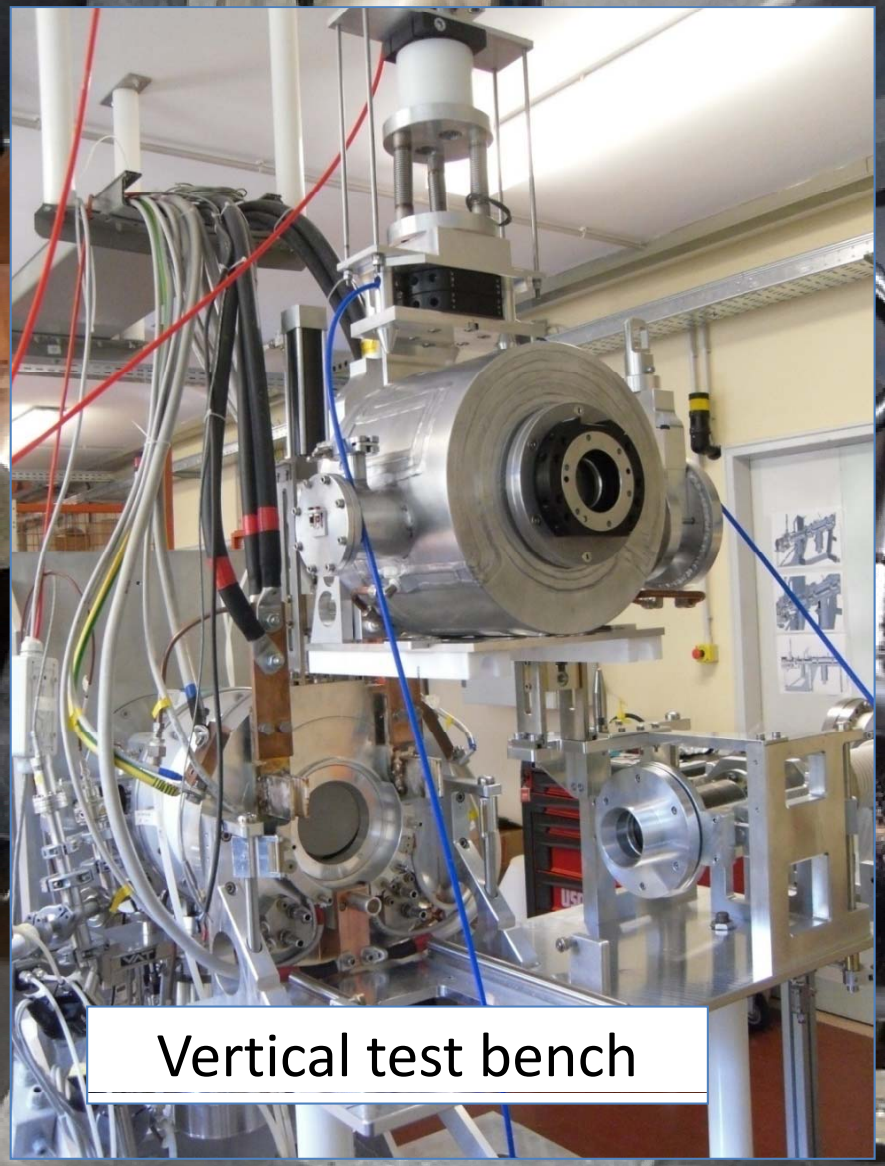


Target Chamber



Lead box

Handling system test bench at LNL

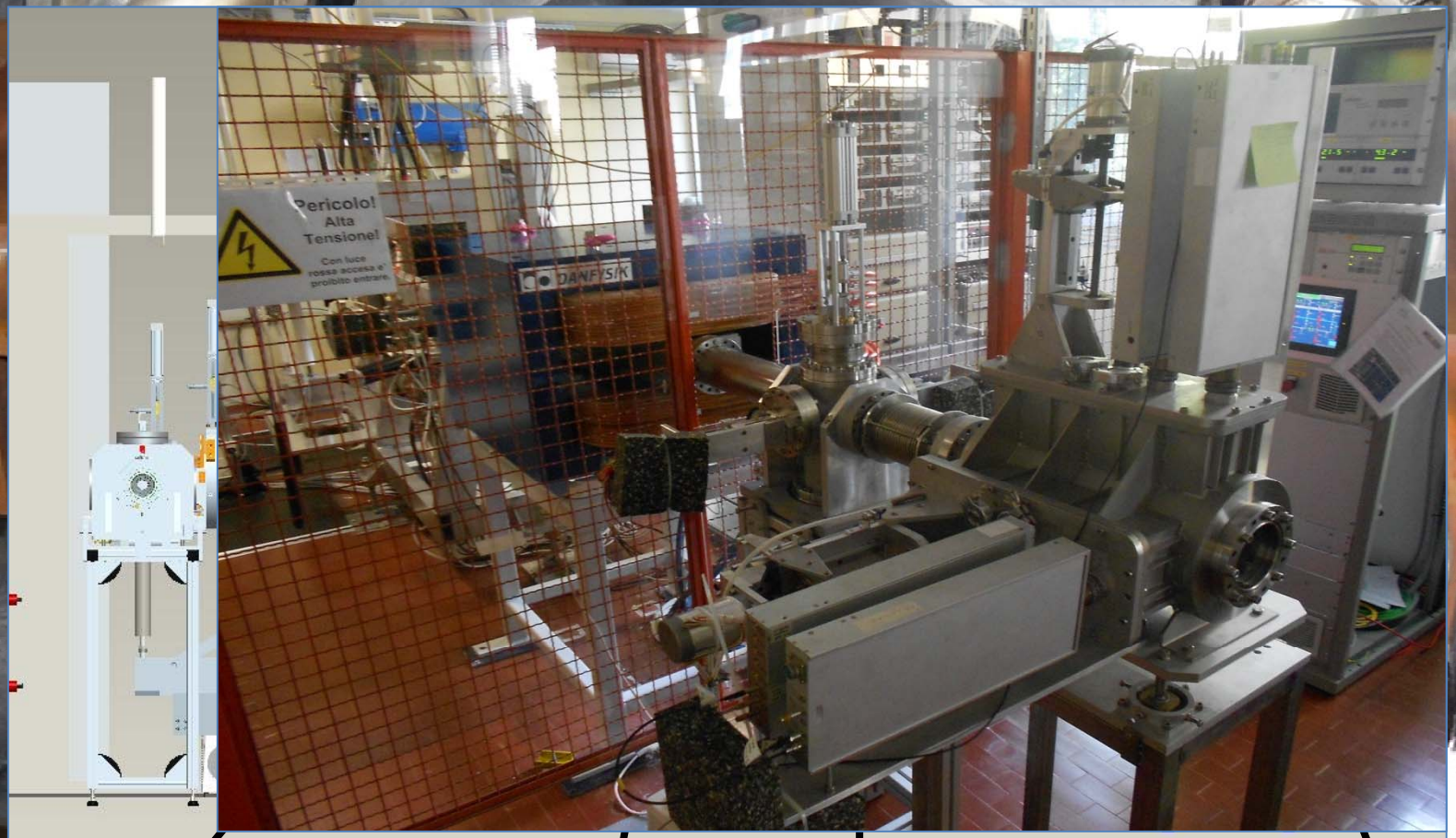


Vertical test bench

Horizontal test bench

Wien Filter on the FE Laboratory

(New set up with mass separator – May'12)

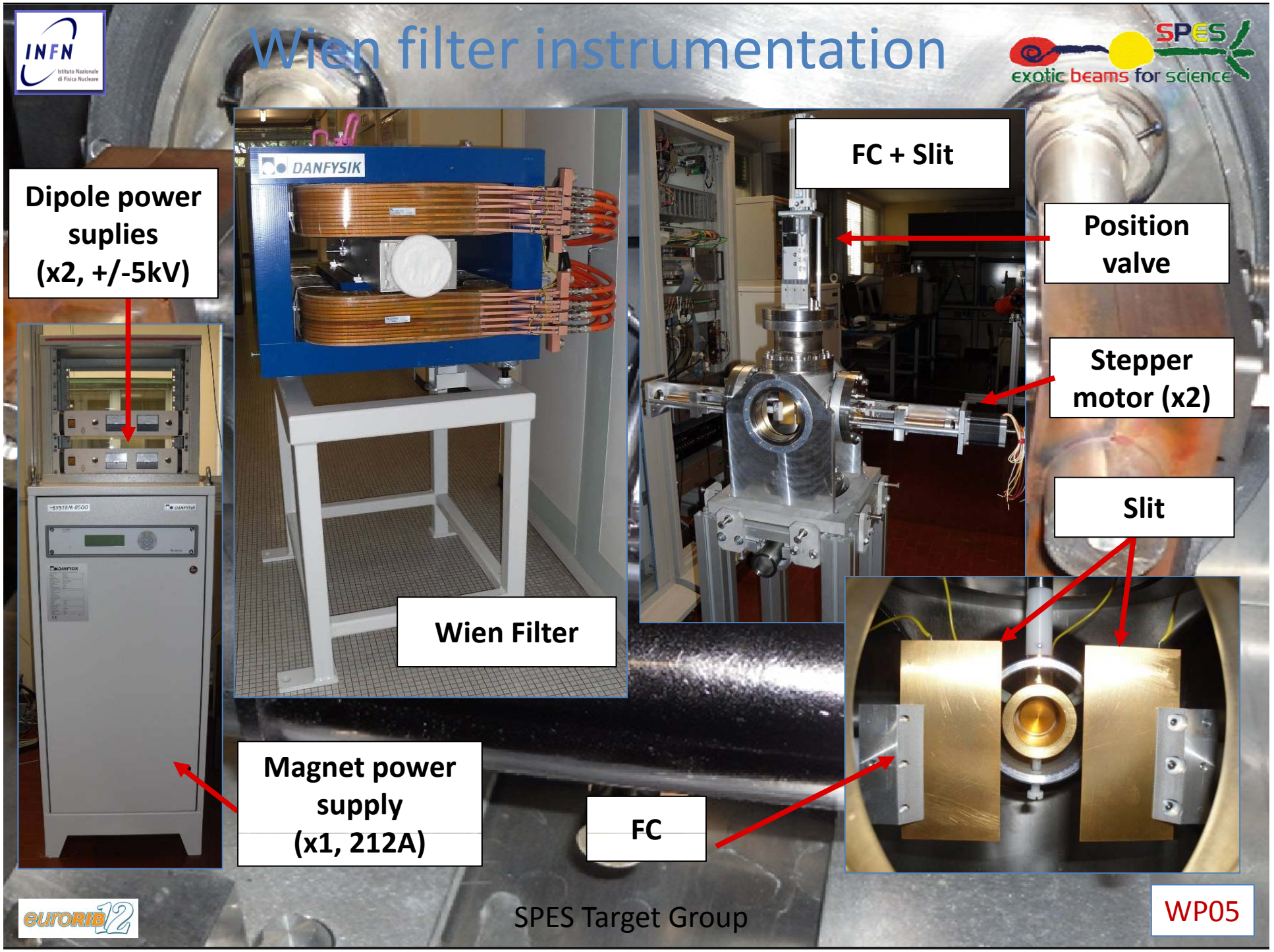


Front End	FC + Beam Profiler	WF	FC + Slit	EM

SPES Target Group

WP05

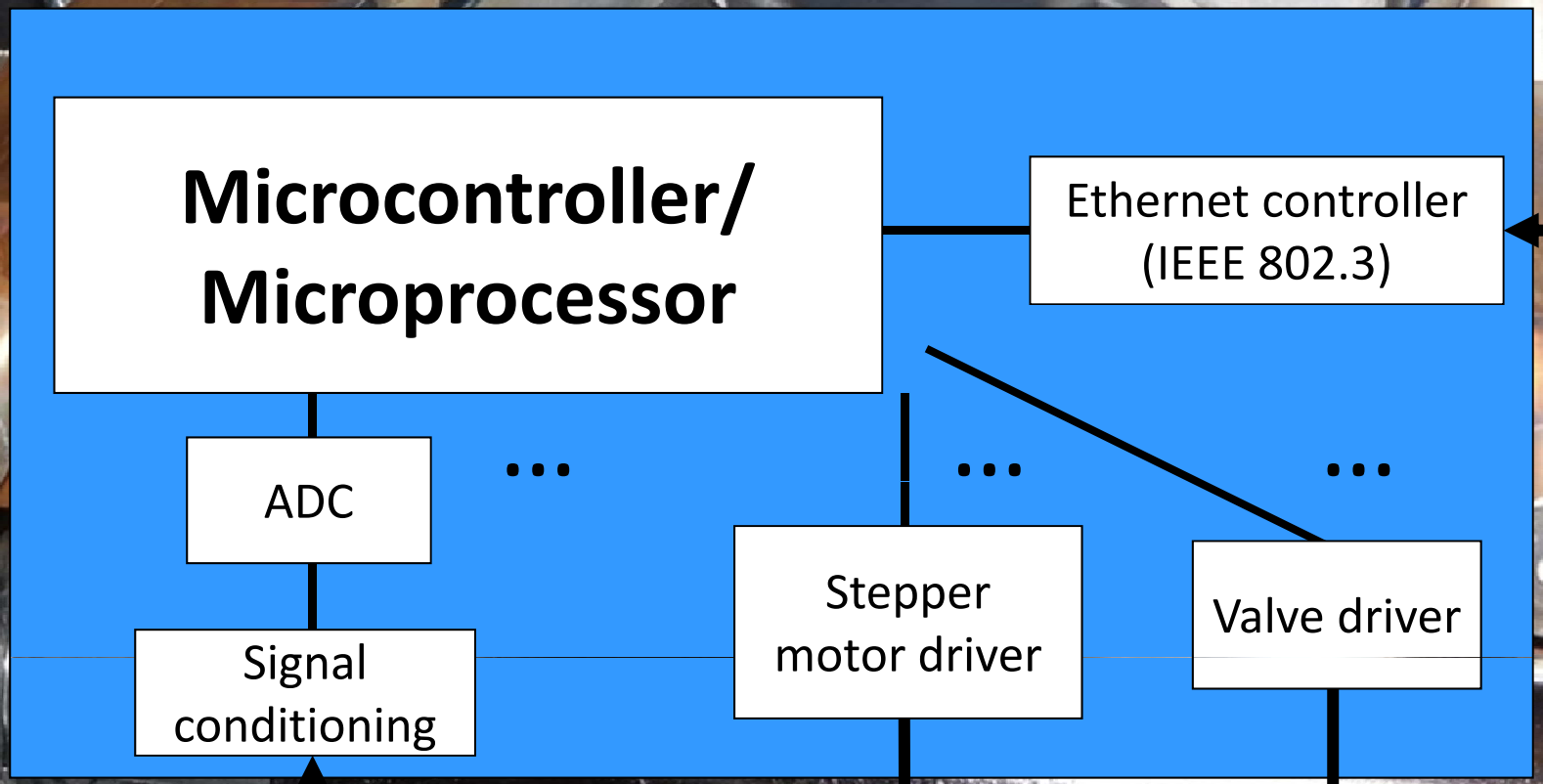
Wien filter instrumentation



SPES Target Group

WP05

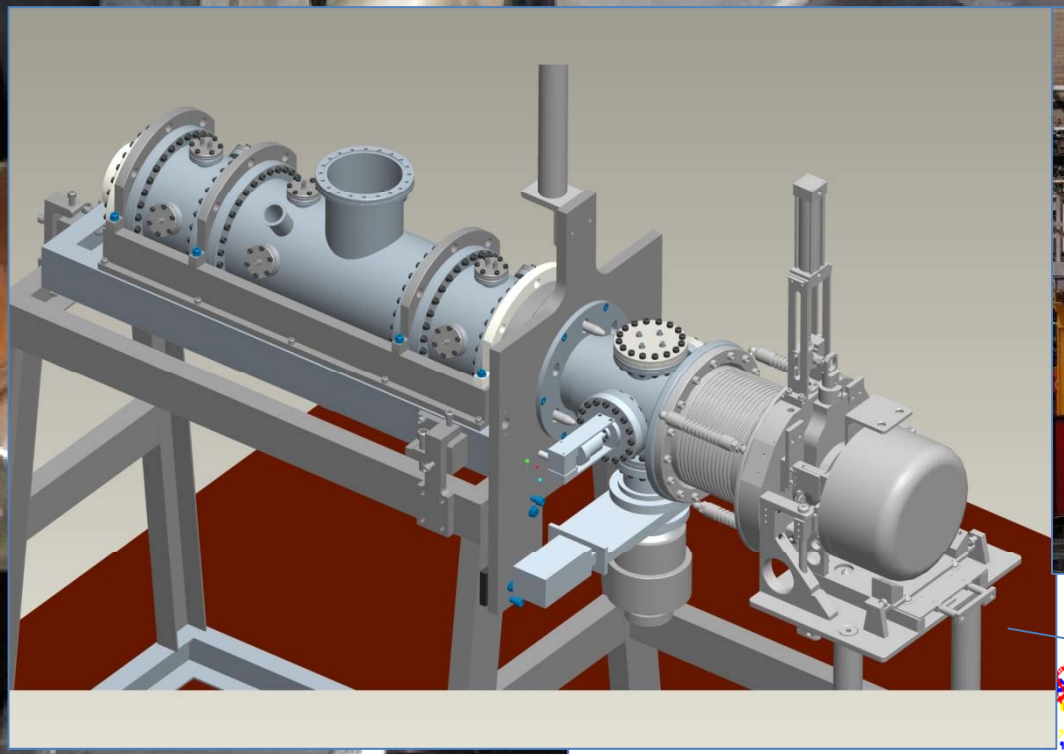
New data acquisition and control system for the off-line FE



Acquisition of Faraday cup, beam profiler and emittance meter signals

Control of slit and detectors positioning systems

The on-line Front end at LNS



For RIB production test using LNS Cyclotron

Proton; E= 40 MeV

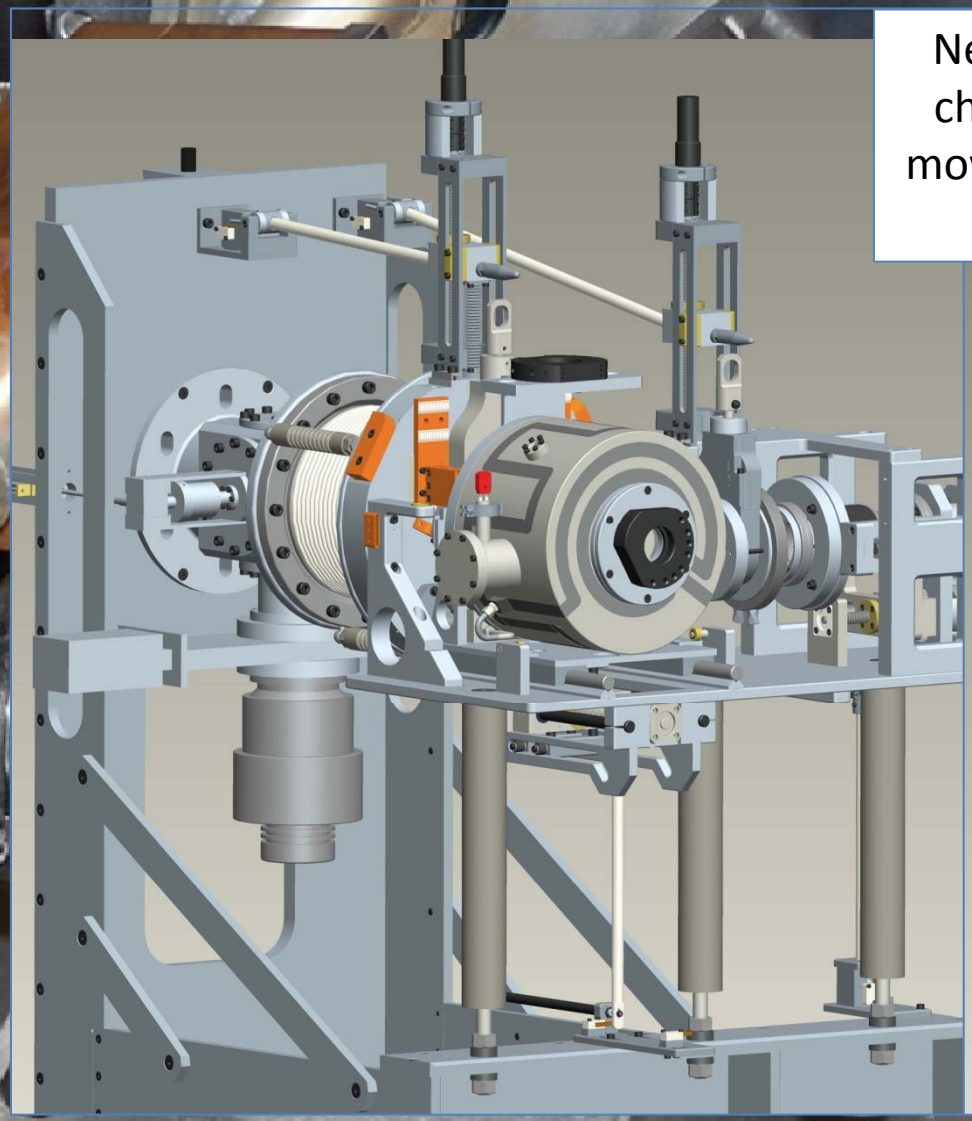
I = 50 nA

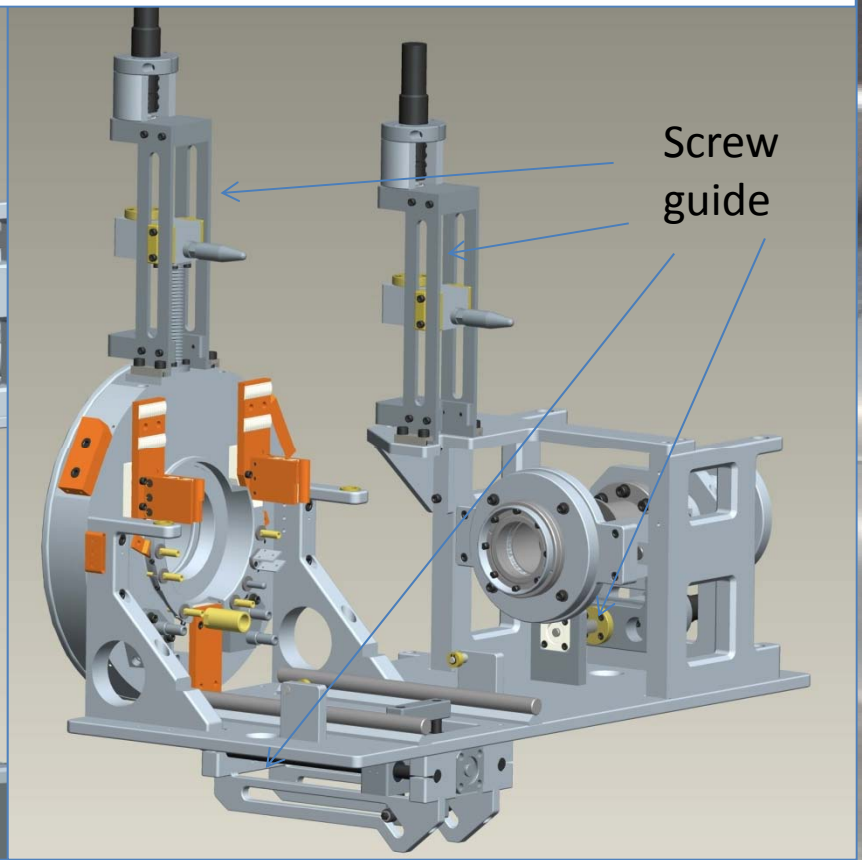
SPES Target Group

WP06

The new FE coupling table

New screw system for the handling of the chamber inside the Coupling Table, allows movements less impulsive in order to reduce the risk of jamming.





The SPES-TIS group

Since 2004: 45 thesis performed in the frame of target SPES activities

SPES Target Group

INFN Fellowship for young foreign PhD

INFN Istituto Nazionale di Fisica Nucleare

POST-DOCTORAL FELLOWSHIPS FOR NON ITALIAN CITIZENS
IN THE FOLLOWING RESEARCH AREAS

EXPERIMENTAL PHYSICS (N. 20)

Next call: December 2012…..

Please contact me for further information's

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