

Recent results on development of the SPES production target



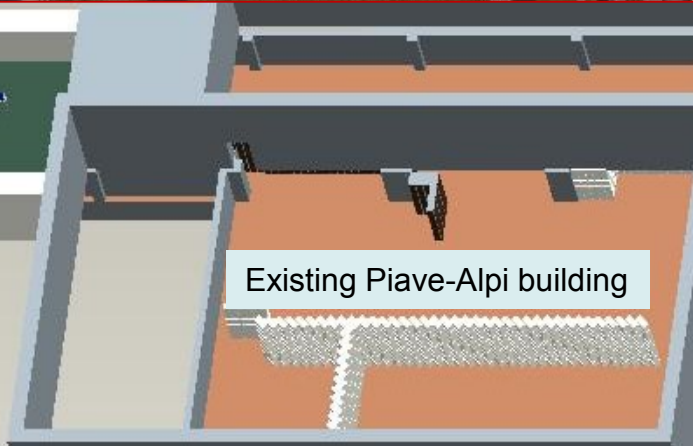
Alberto Andrichetto
LNL-INFN

The SPES project at LNL

Facility layout

INTERDISCIPLINARY
APPLICATIONS FACILITY

ISOL
FACILITY



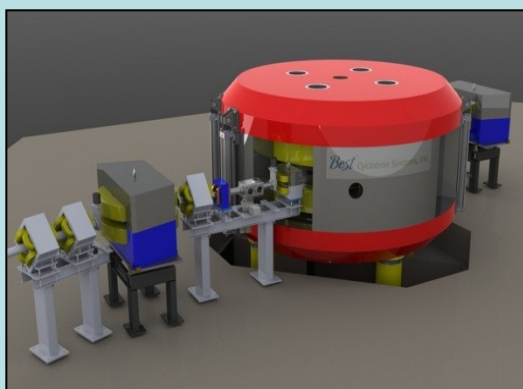
SPES is: 1) A second generation ISOL facility (for neutron-rich ion beams)
2) An interdisciplinary research center (for p,n applications)

On-Demand Simp Rep: TARGET3

3 main items...

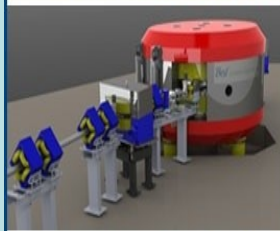
Driver:

'Commercial' cyclotron



Great News!

We are pleased to announce that Best Theratronics and Best Cyclotron Systems, members of TeamBest, won a bid from the Italian National Laboratory on May 4, 2010 for construction of a 70 MeV cyclotron.

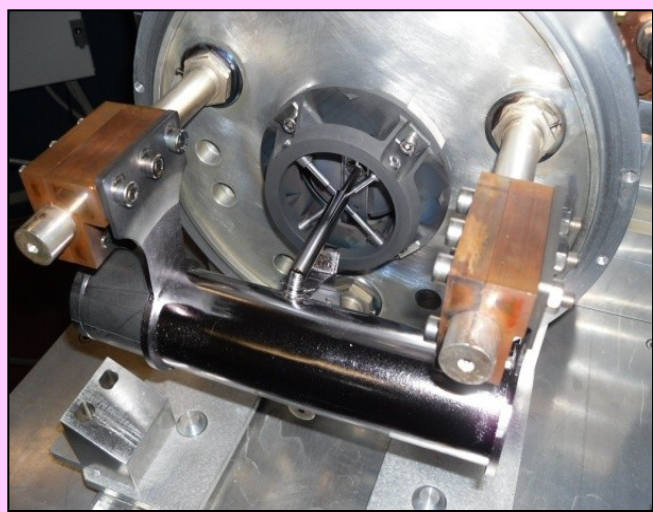


www.Theratronics.ca
www.BestCyclotron.com www.TeamBest.com



Production Target:

NEW CONCEPT!
(Multi-foil UCx target)

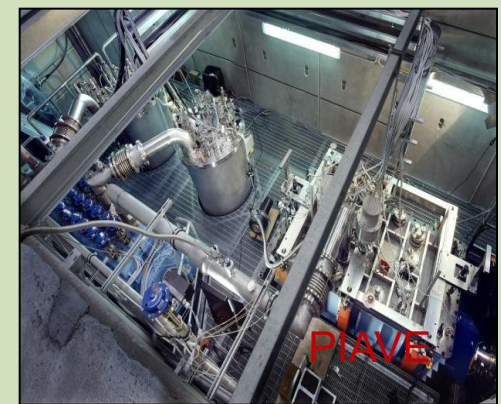


Target-Ion Source Complex:

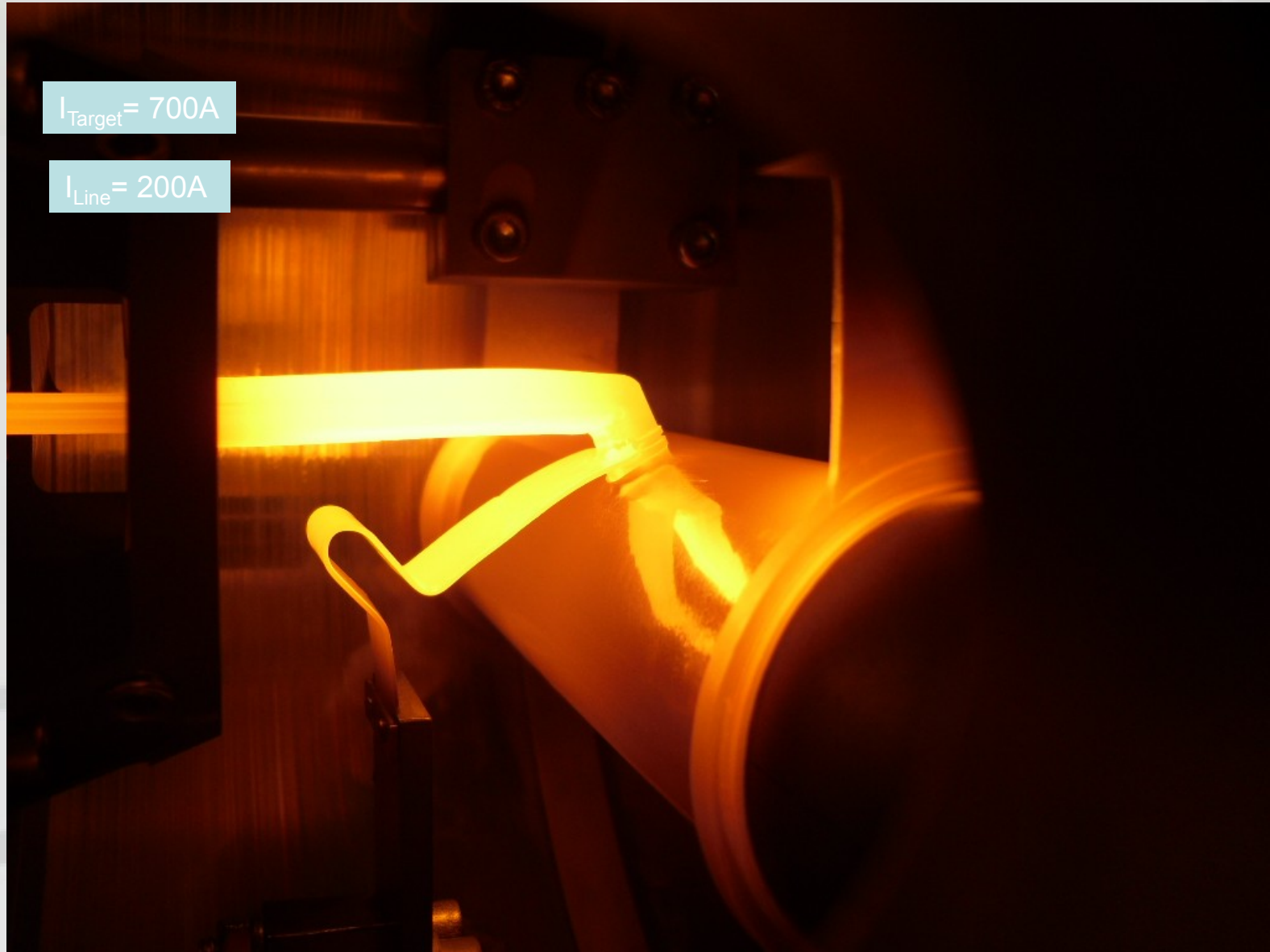
- 5 Working groups
- 5 Labs

Post Accelerator:

Piave- Alpi existing complex



The SPES TIS complex

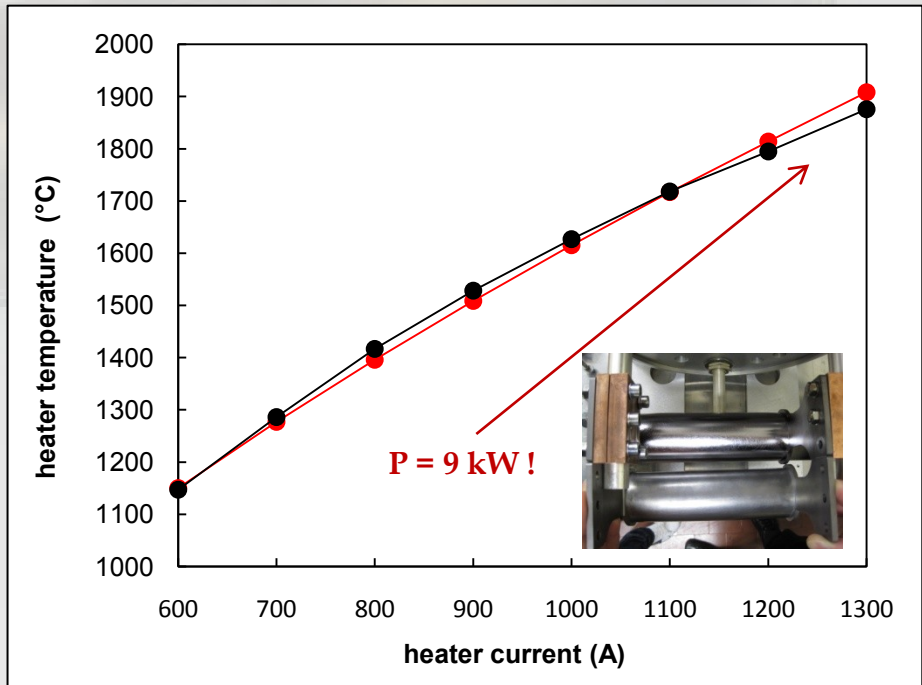
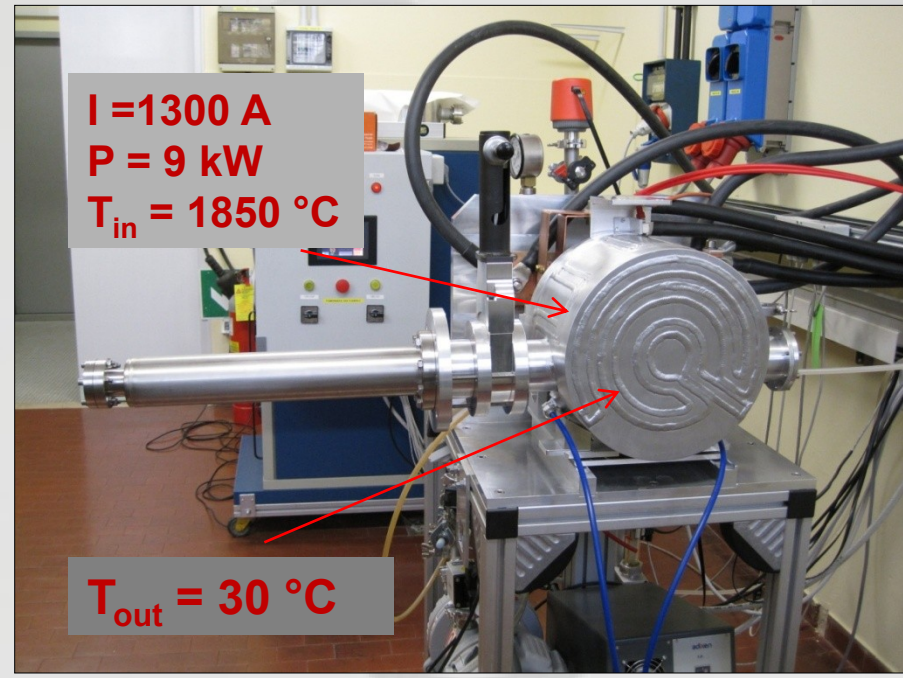
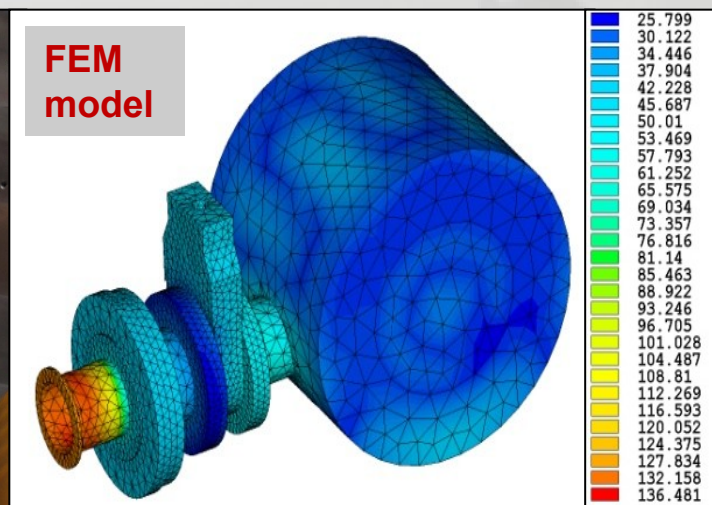
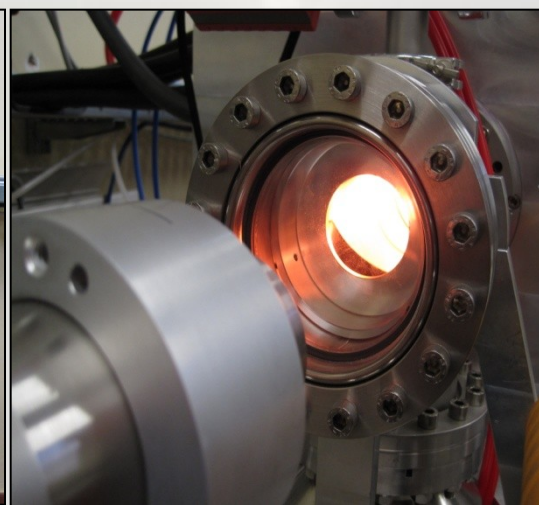
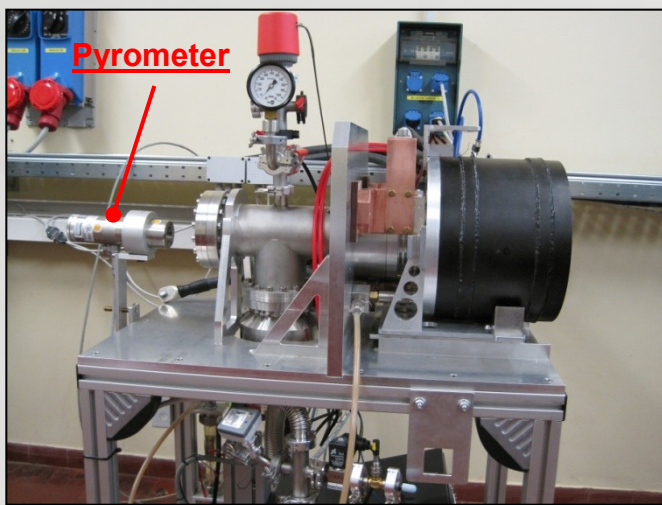


$I_{\text{Target}} = 700\text{A}$

$I_{\text{Line}} = 200\text{A}$

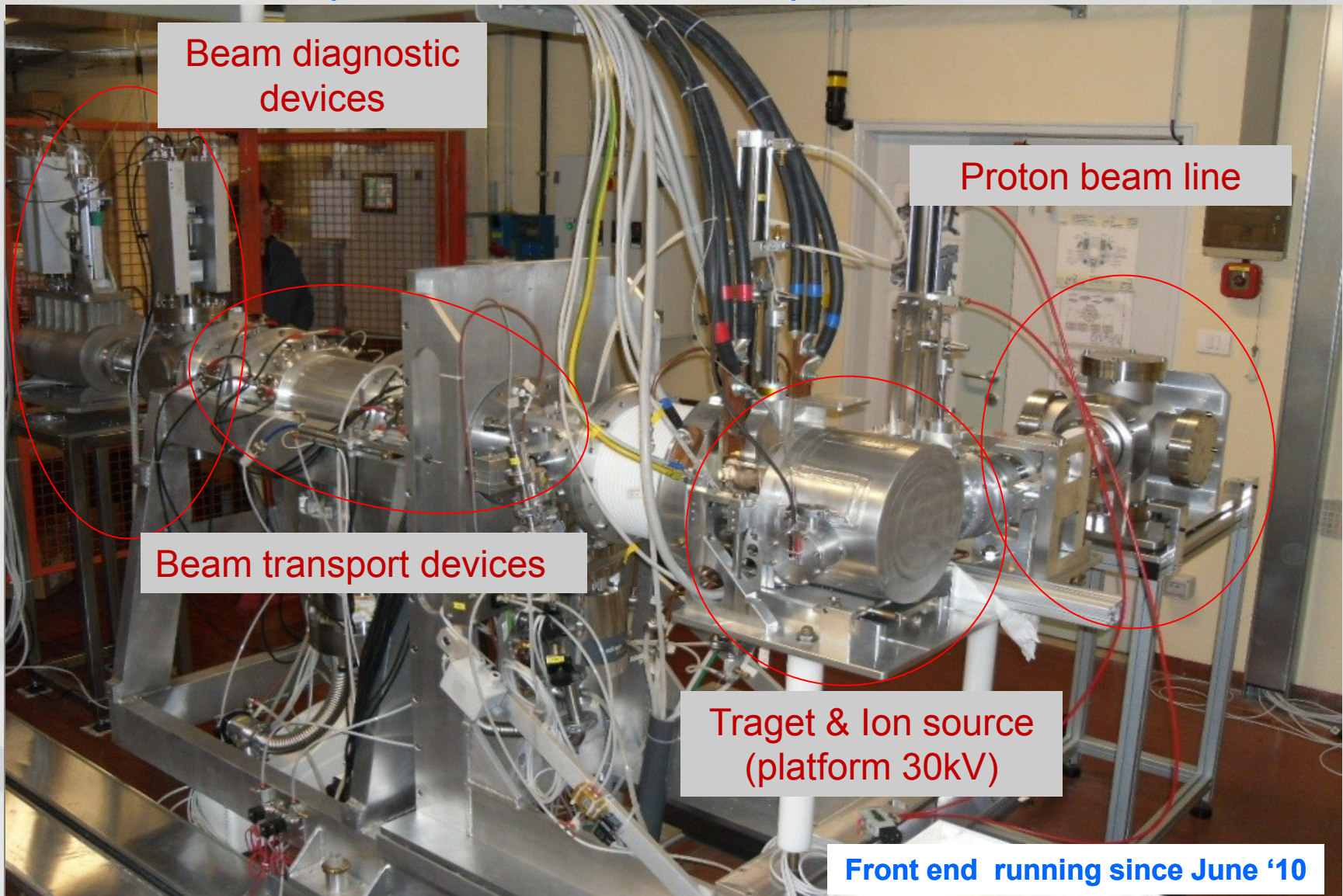
The SPES target chamber complex

On line test with 9kW imposed into the target -> successfully tested !



The SPES Front end complex

(evolution of Isolde FE6)



Beam diagnostic devices

Proton beam line

Beam transport devices

Traget & Ion source
(platform 30kV)

Front end running since June '10

WP01 Ion Source developments (M. Manzolaro)

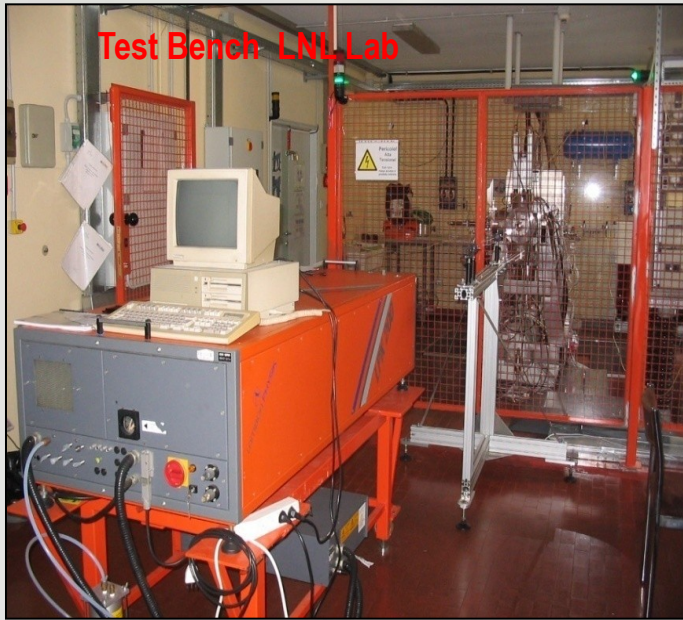
WP02 Material developments (L. Biassetto, S. Corradetti)

WP03 Laser developments (D. Scarpa, P. Benetti)

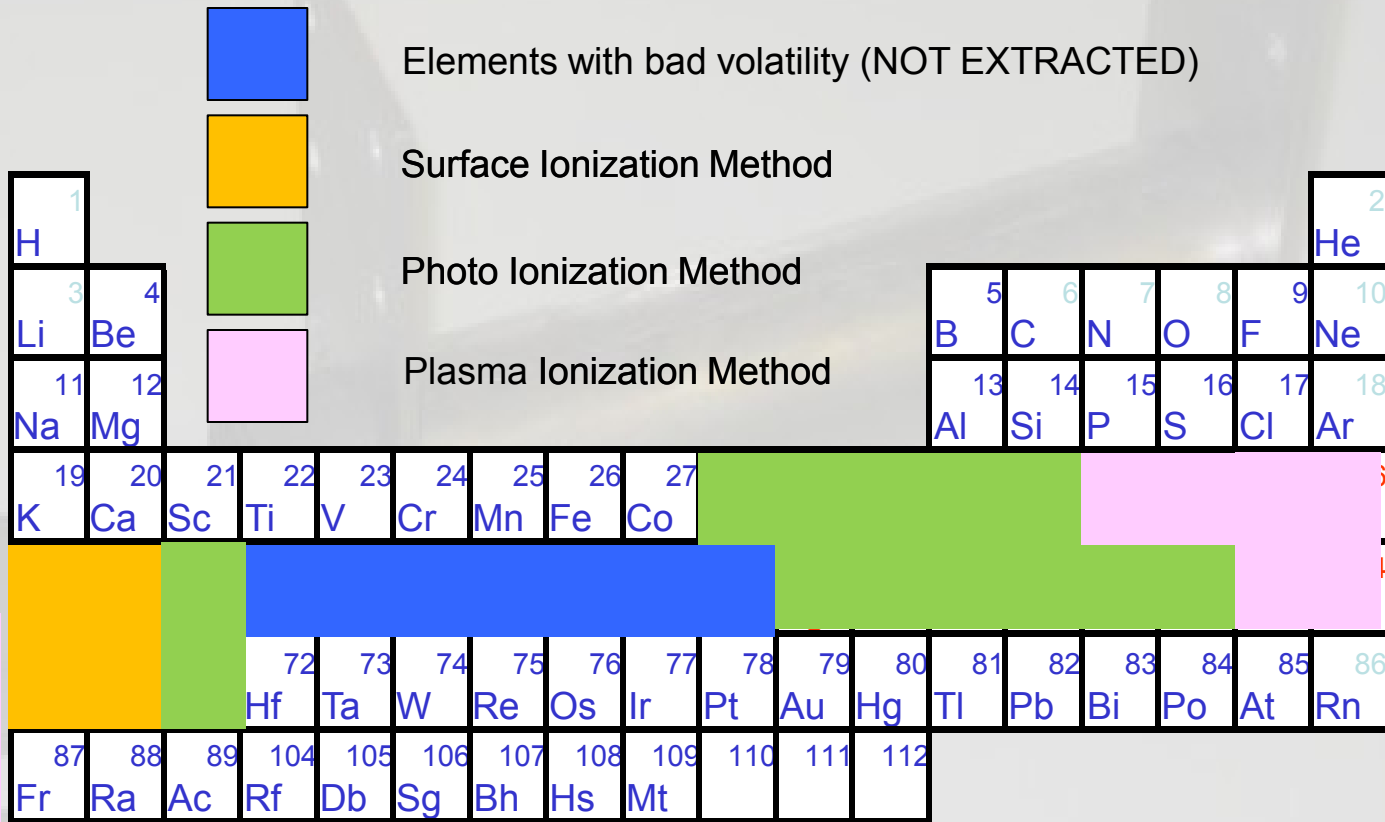
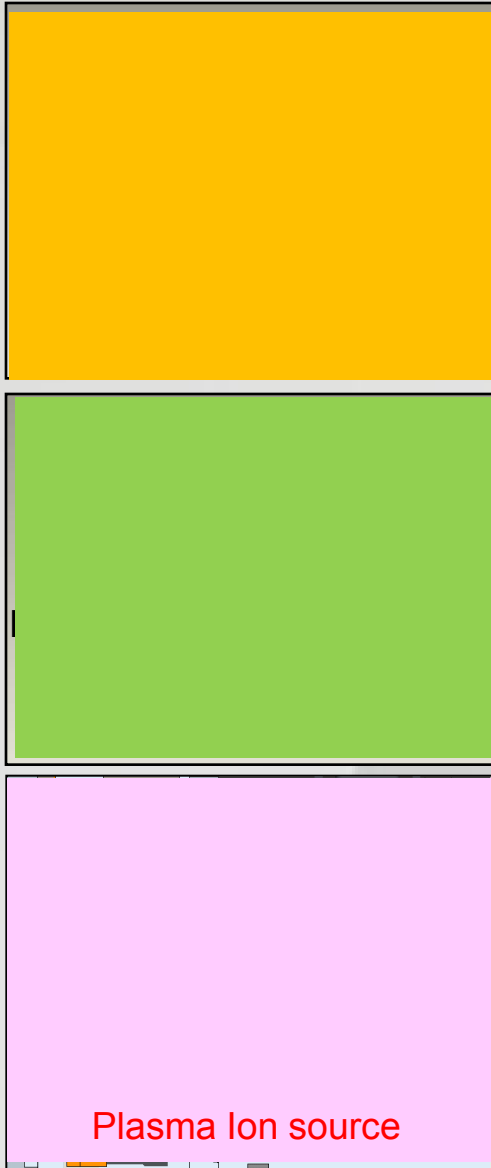
WP04 Target handling (M. Guerzoni, A. Cavazza)

WP05 Controls (J. Vasquez, J. Montano)

The TIS SPES Laboratories



(3 methods, 2 Ion sources)



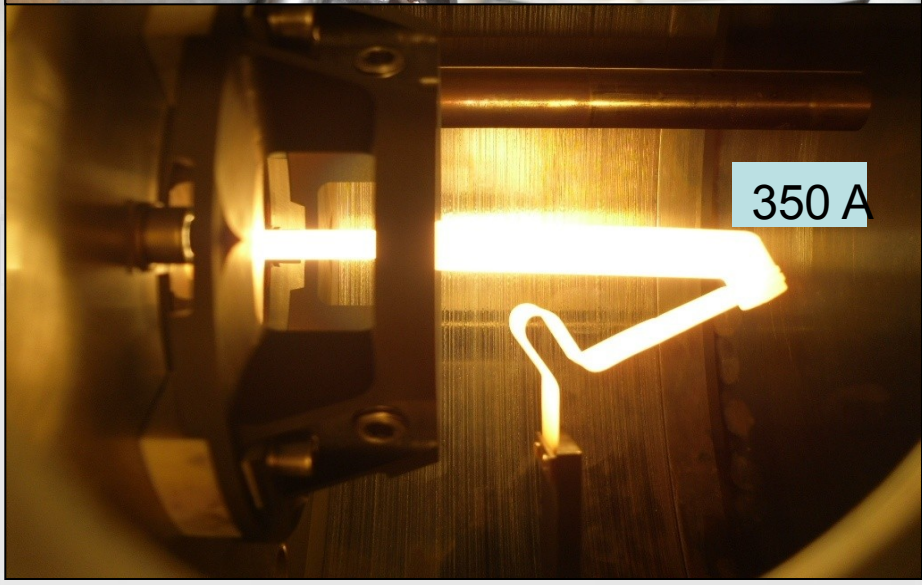
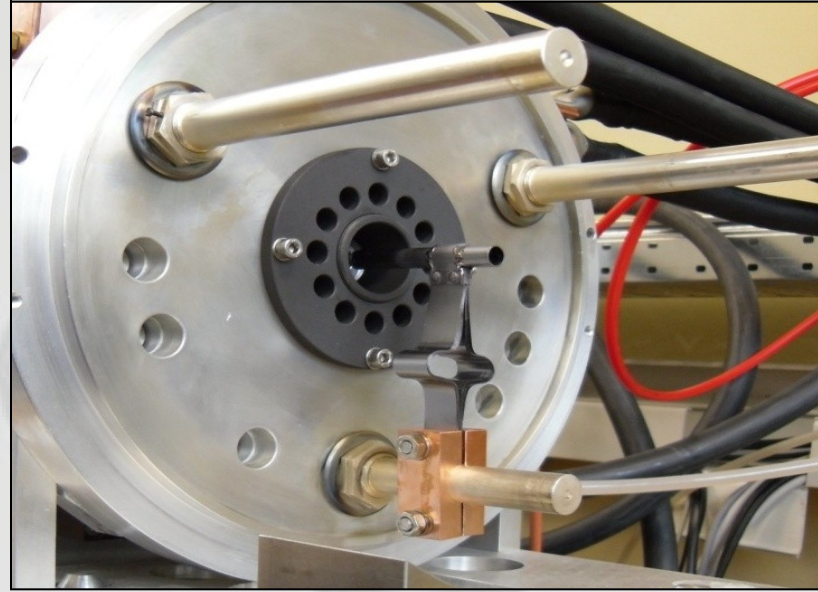
Main fission (p-> ²³⁸U) fragments

The SPES Ion Sources

Plasma Ion Source (PIS)

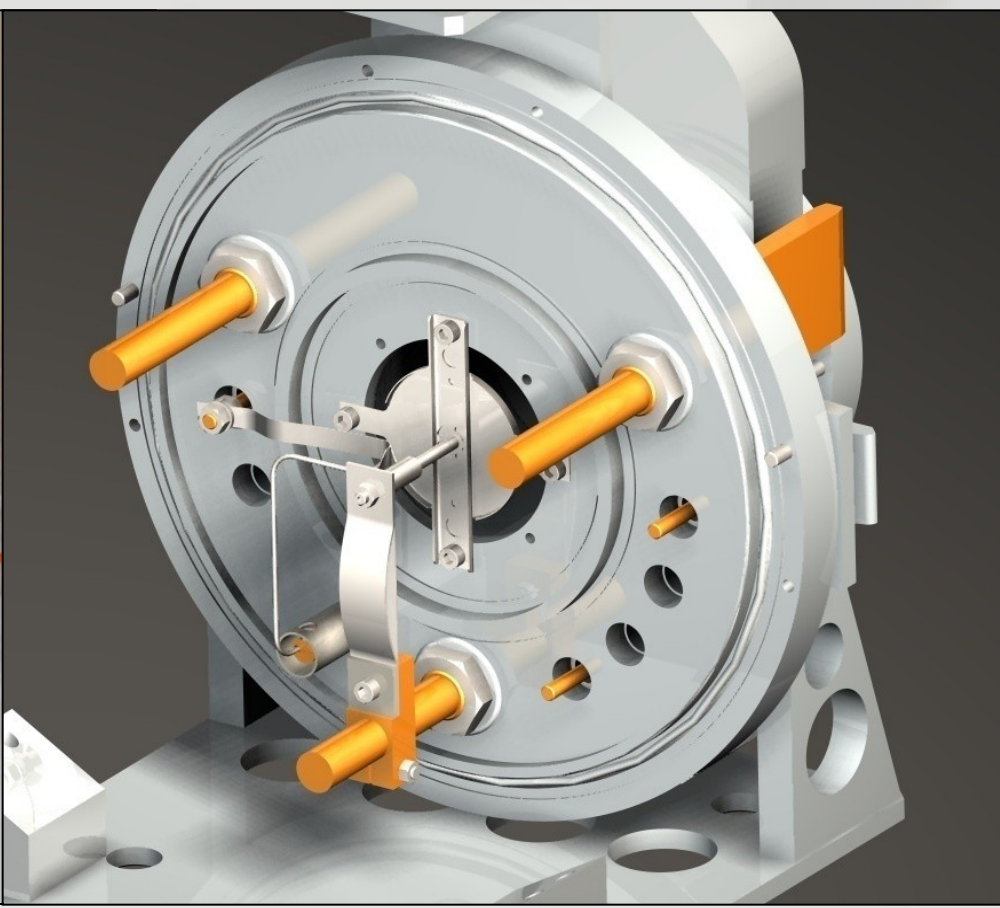
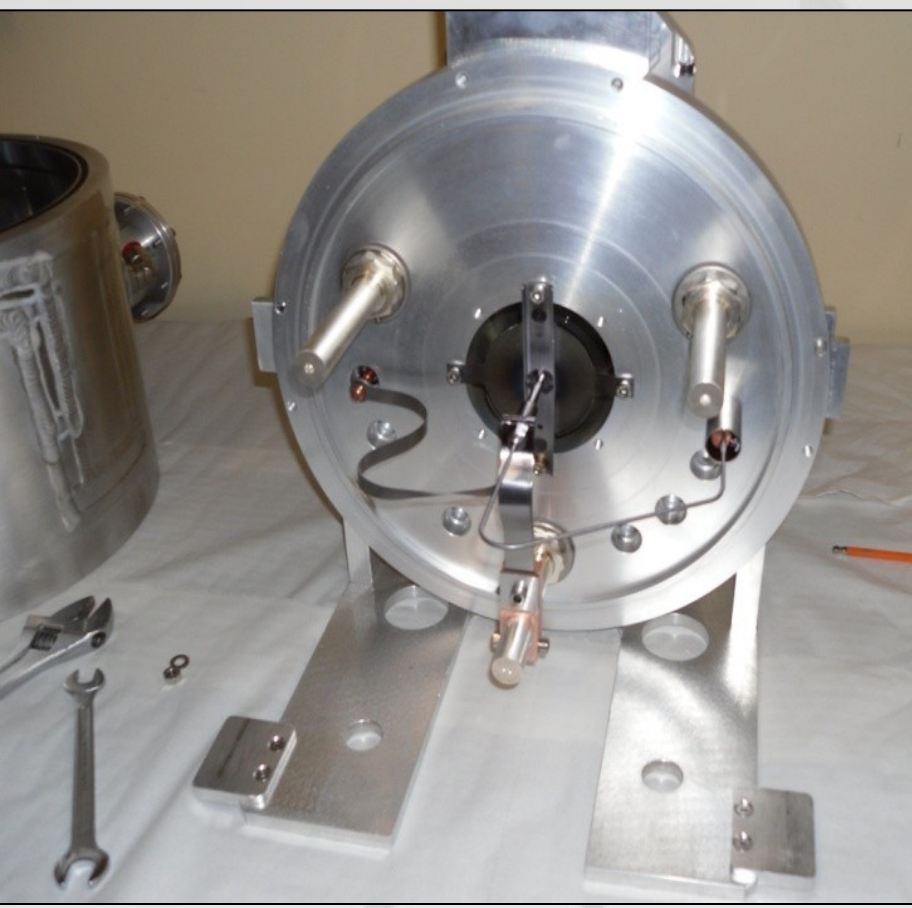


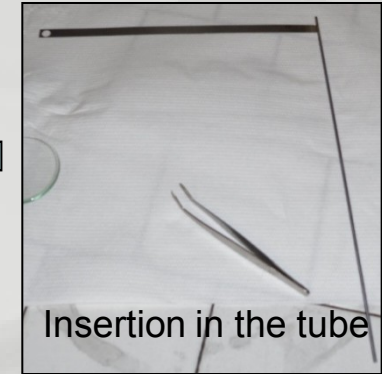
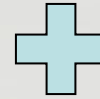
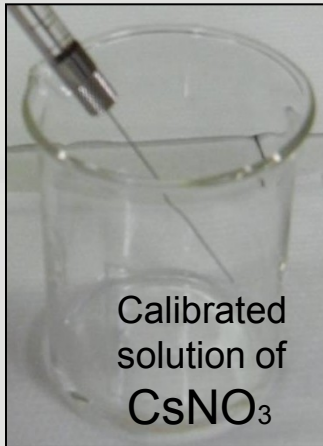
Surface Ion Source (SIS)



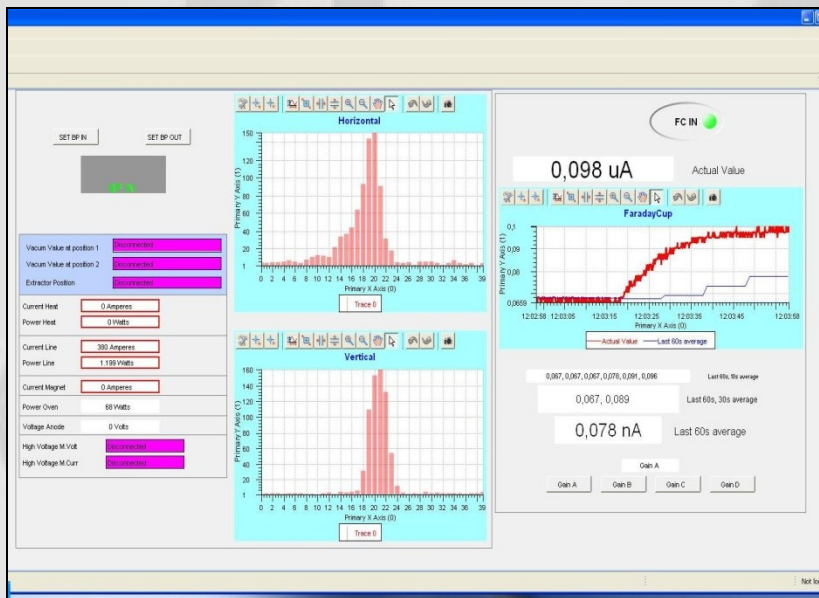
SPES Ion Sources

Surface Ion Source: Mass marker capillarity technique

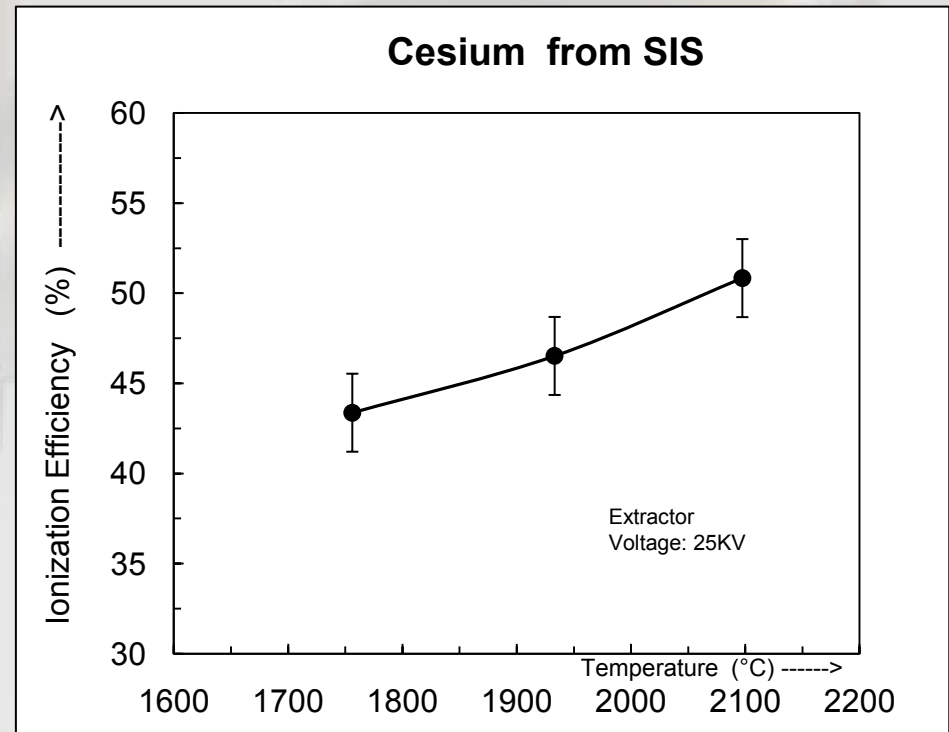




Cesium Surface Ionization

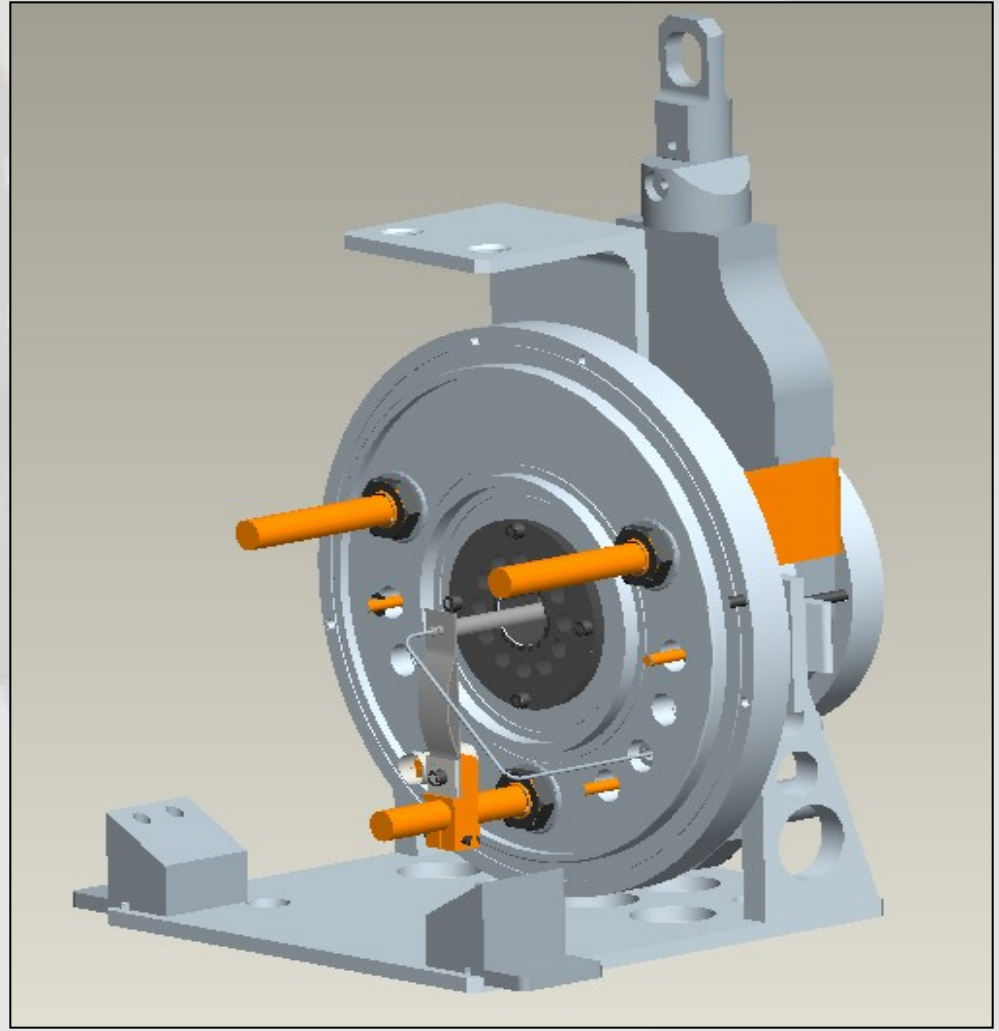
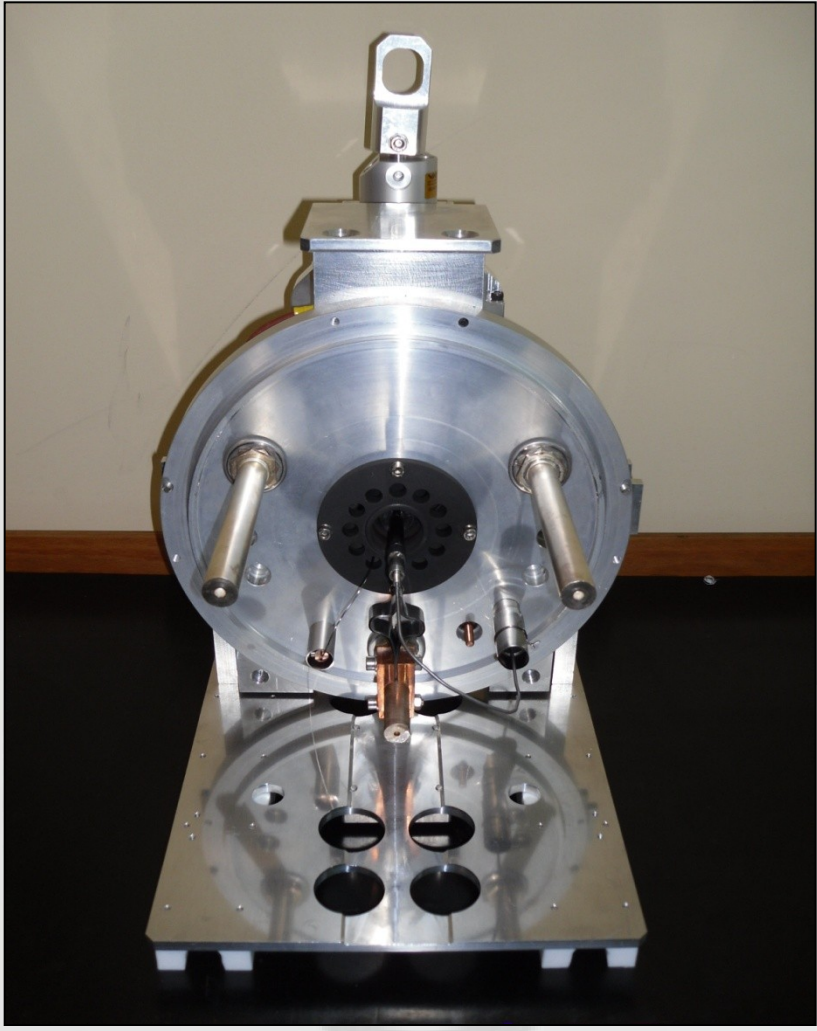


Cesium from SIS



SPES Ion Sources

Plasma Ion Source: Calibrated leak gas inlet technique



Argon Plasma Ionization

LINE SETTINGS

Max. voltage (V) SET ENABLE
 Set current (A) SET off on
 Ramp time (sec)

Current: 330.07 Amperes
 Power: 1445.3765299999998 Watts

STOP

ANODE SETTINGS

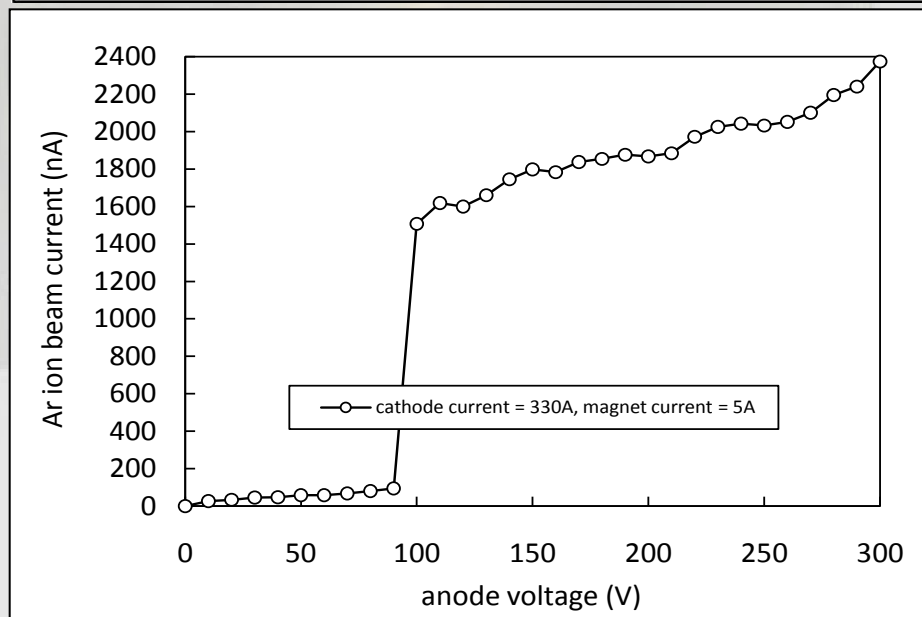
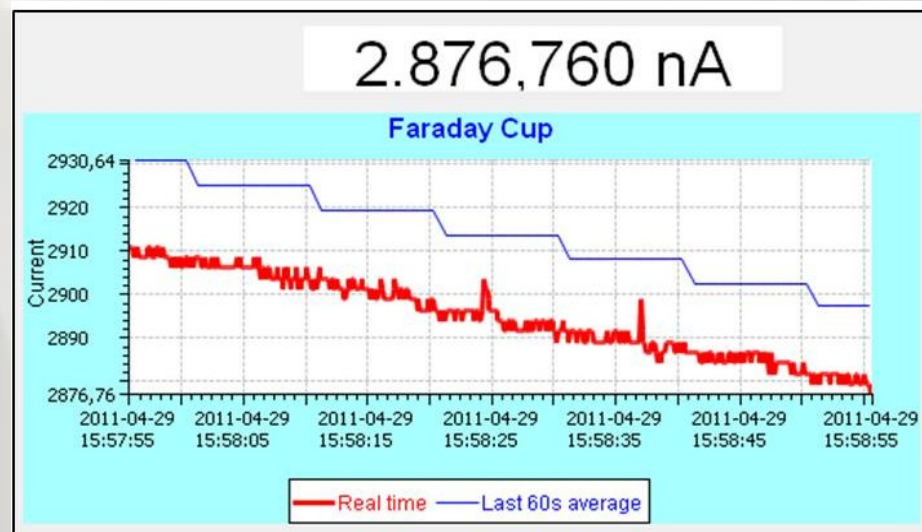
Max. current (A) set I ENABLE
 Voltage (V) set V off on

Voltage: 150.04 Volts
 Current: 0,068800 Amperes

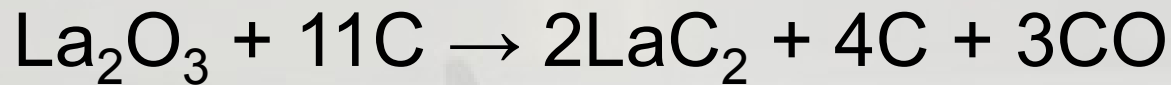
MAGNET SETTINGS

Max. voltage (V) set V ENABLE
 Set current (A) set I off on

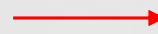
Current: 5.0 Amperes
 Power: 119.025 Watts



Vertical Carbothermic reduction (1600°C, high vacuum)



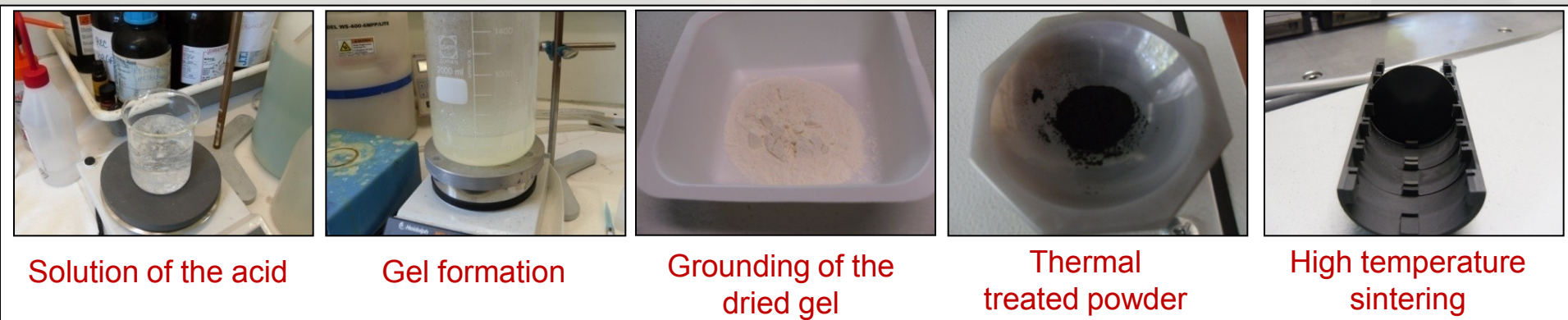
OXIDE + GRAPHITE GREEN PELLETS



CARBIDE/GRAPHITE (LaCx) PELLETS

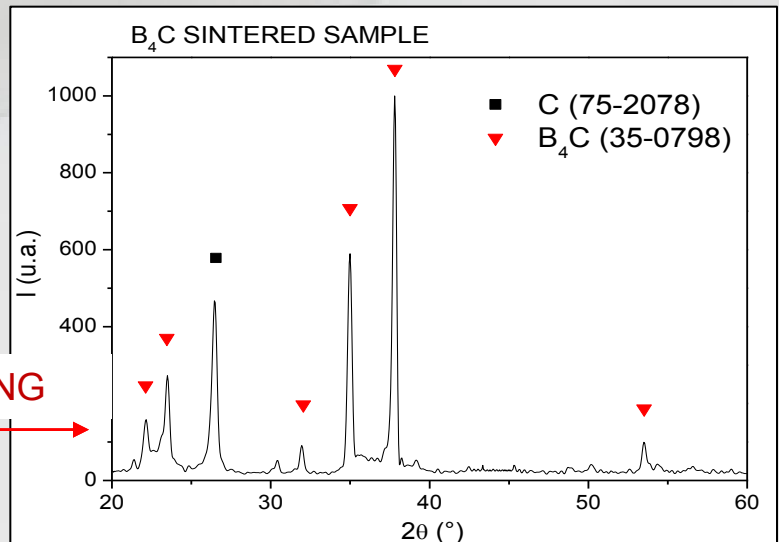
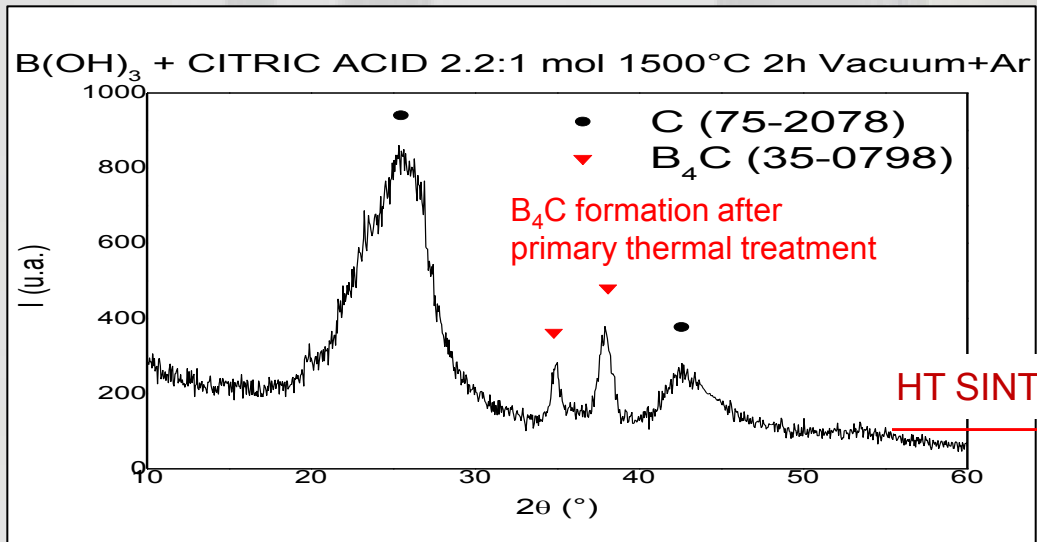
Boron carbide (B_4C) production

Boric acid $B(OH)_3$ + citric acid $C_6H_8O_7$

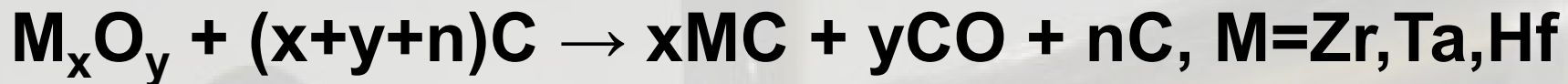


Thermal treatment :

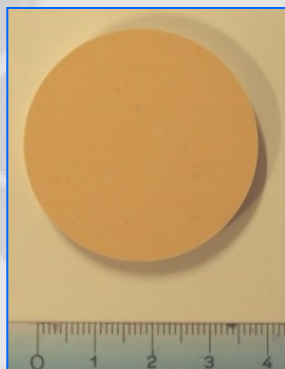
- up to 800°C in low vacuum ($5 \cdot 10^{-2}$ mbar), 0.5 °C/min
- up to 1500°C in vacuum with Ar flow (1 mbar), 1÷3°C/min
- 2 hours at 1500°C



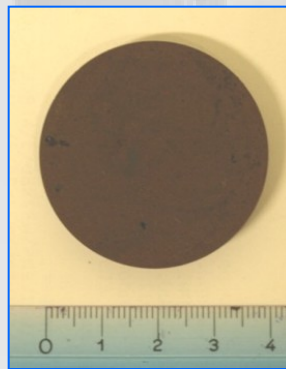
1. High melting point
2. High thermal and electrical conductivity
3. Chemical inertness up to very high temperatures



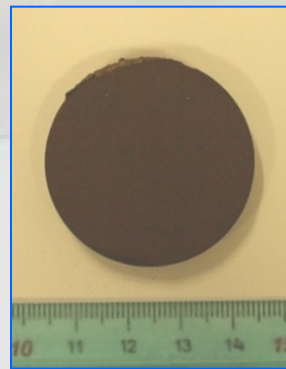
ZrC
foams



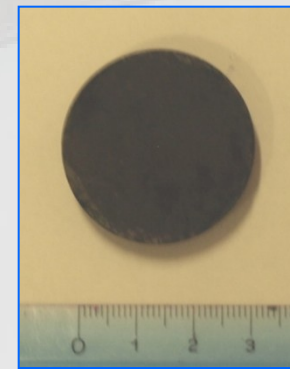
As pressed



Post-cured



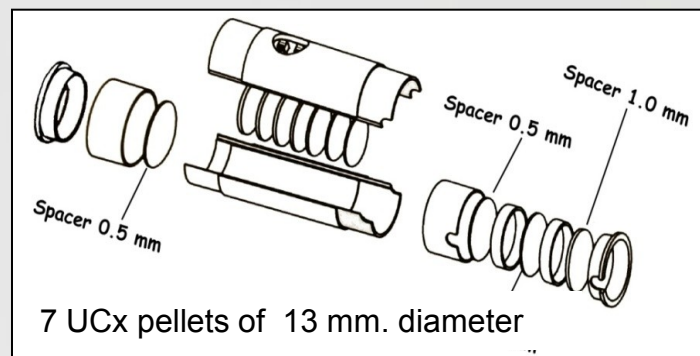
After
burn-out



Final carbide

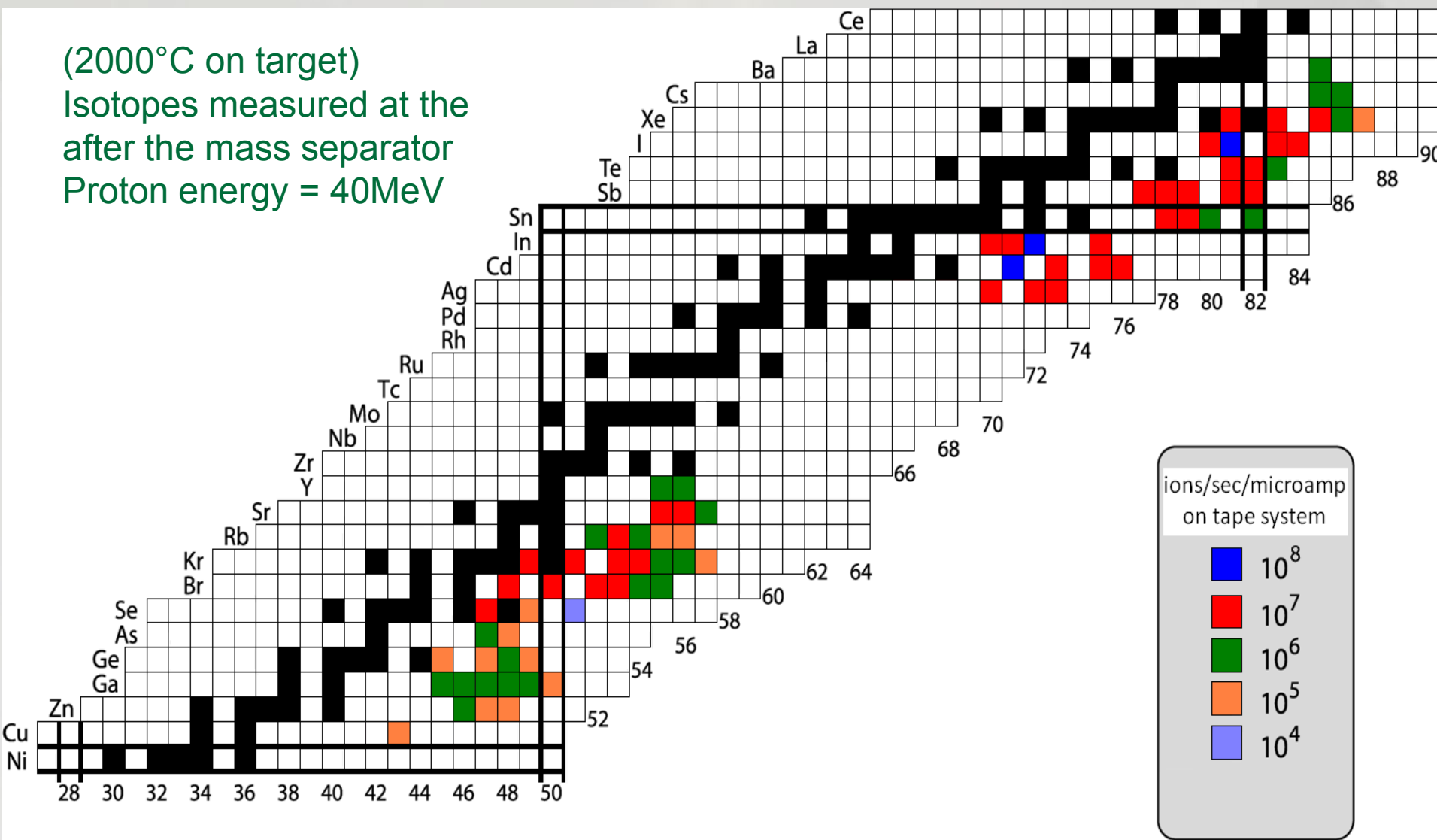
Thanks to Dan Stracener and ORNL-TIS group

- Seven UC₂ samples SPES Target Group (in collaboration with HRIBF)
- Densities in the range of 4.2 g/cm³
- 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 without any out-gassing or obvious change in structure (samples observed after the on-line test)

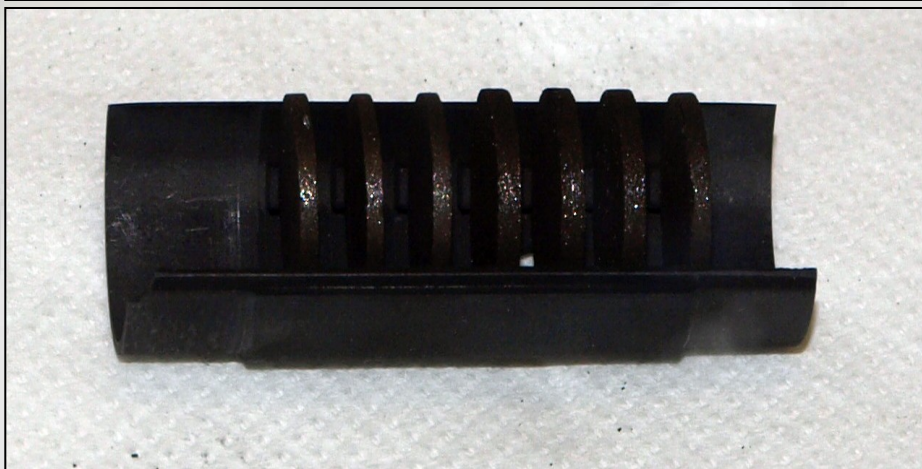


N-Rich Isotopes yields

(2000°C on target)
Isotopes measured at the
after the mass separator
Proton energy = 40MeV



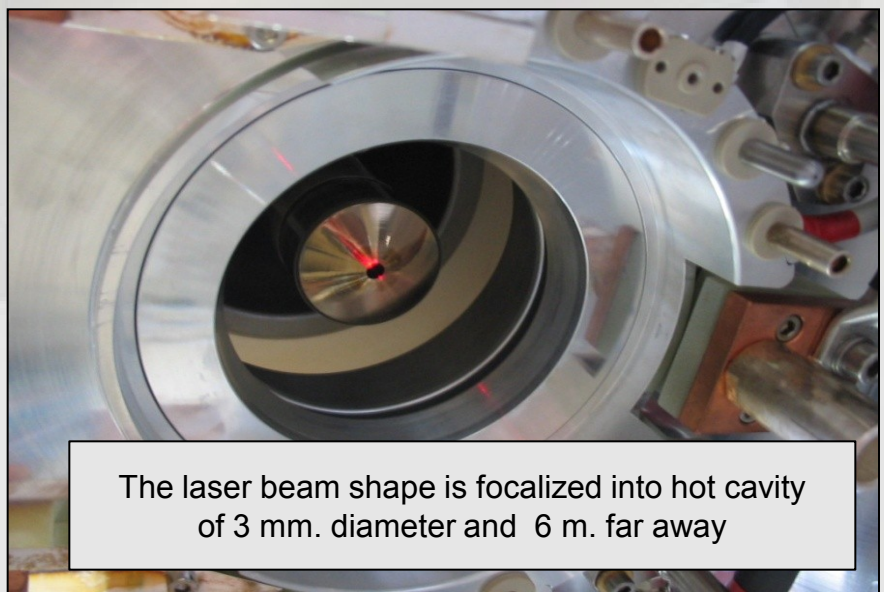
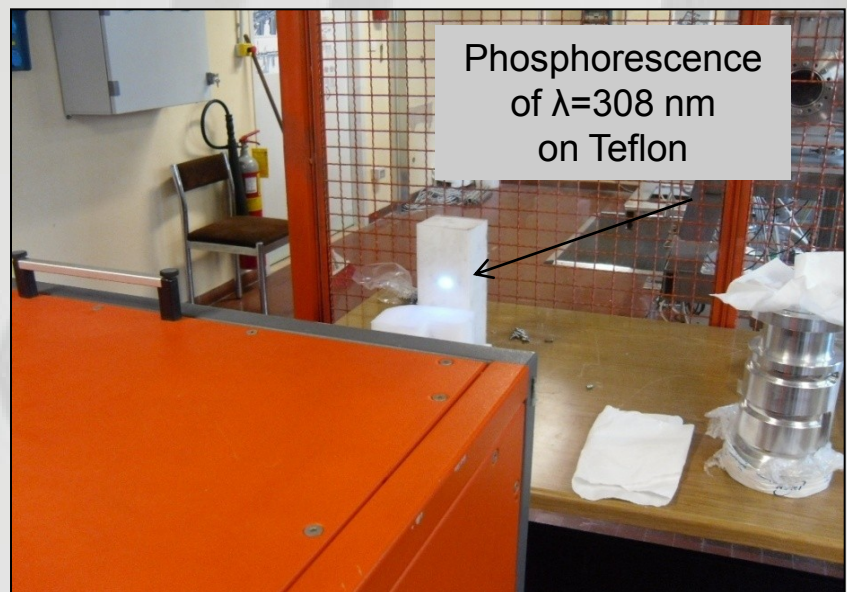
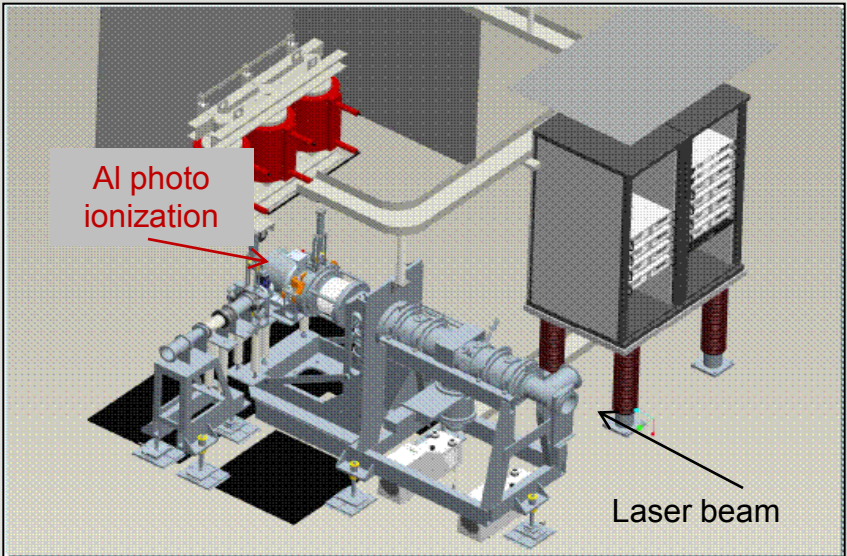
New target for next HRIBF test



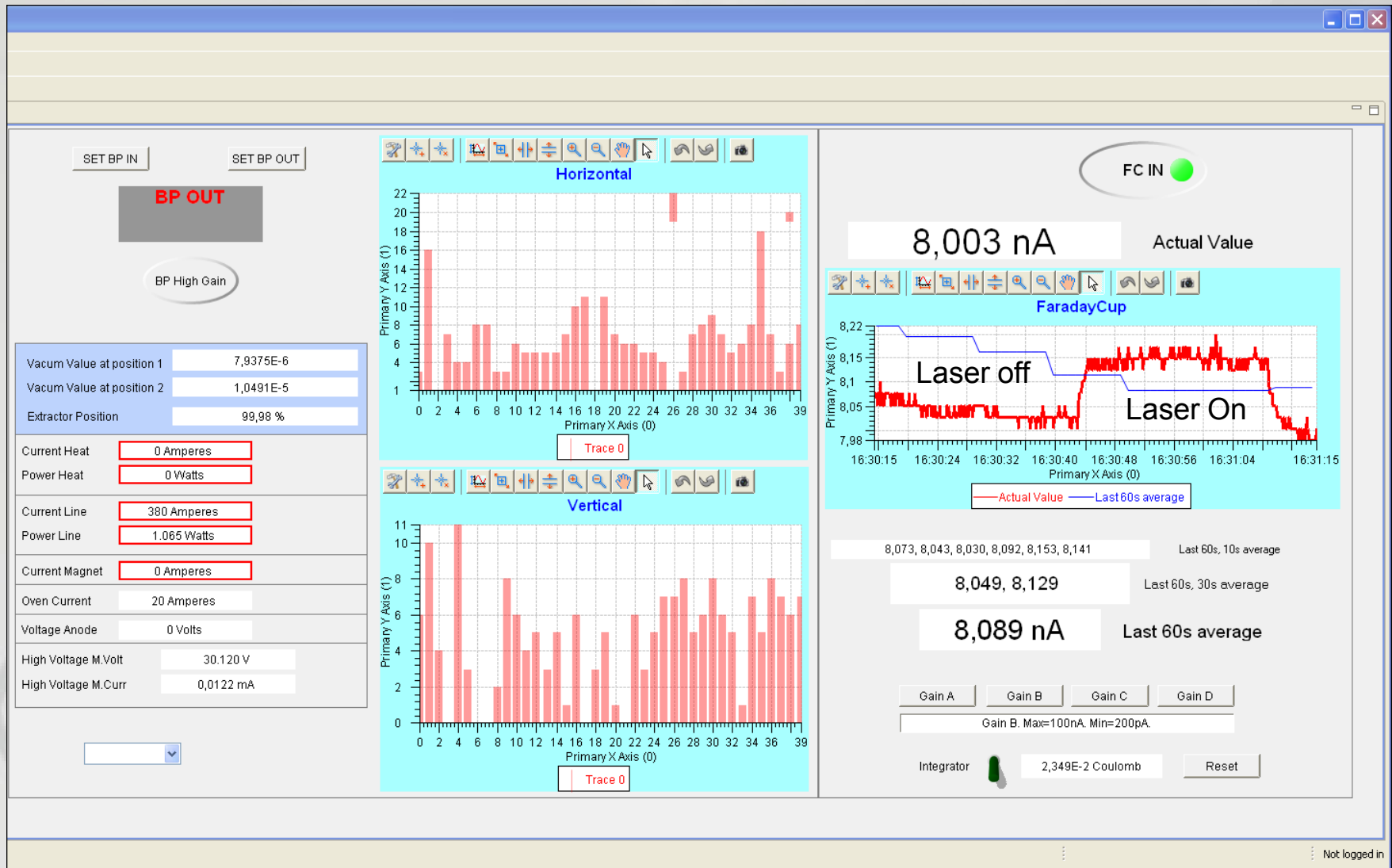
SPES UCx-CNT for ORNL : on line test planned for October '11

WP3: laser test at LNL with excimer

Aluminum ionization with a single wavelength

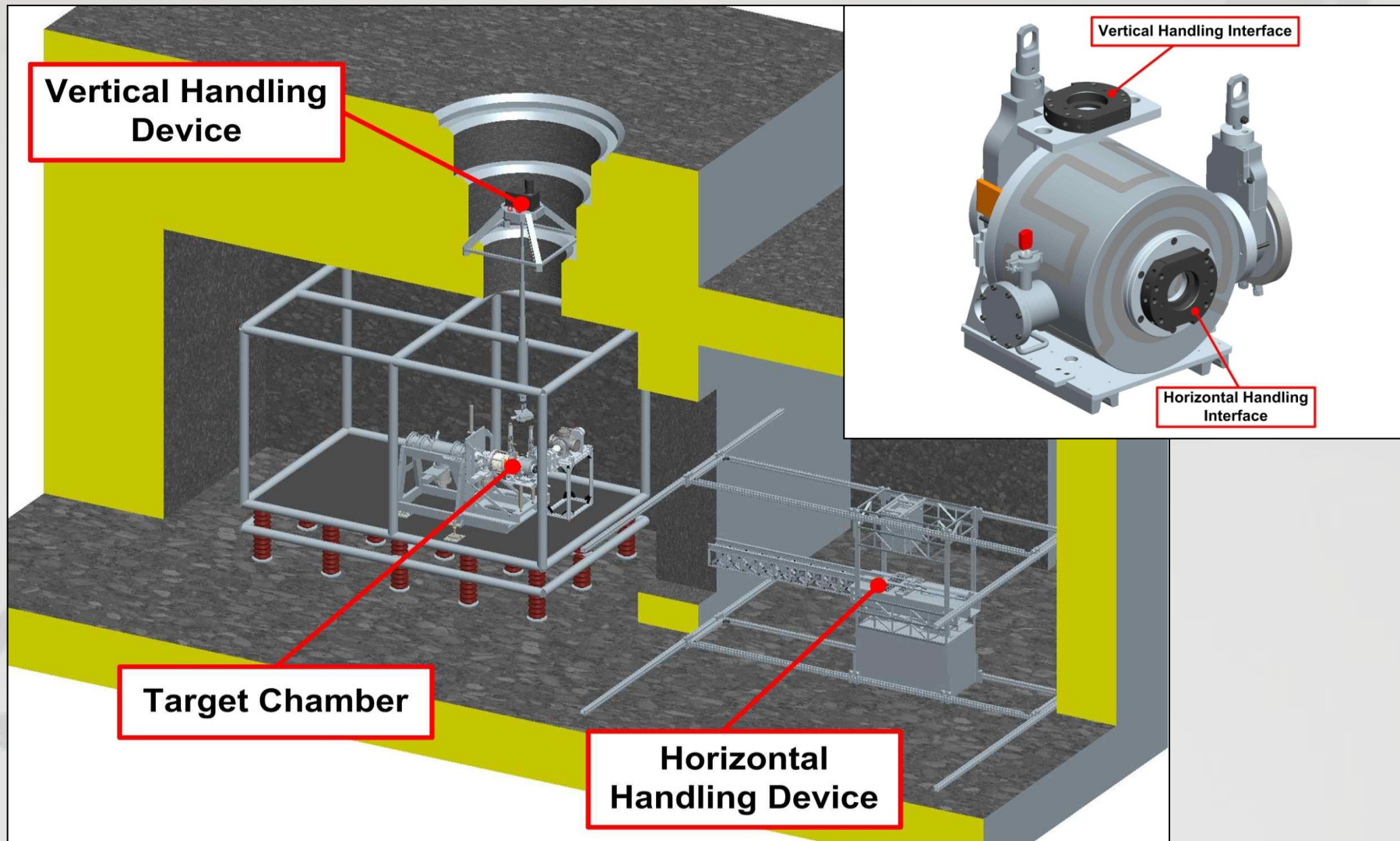


First ionization results (Current collected into the Faraday Cup)

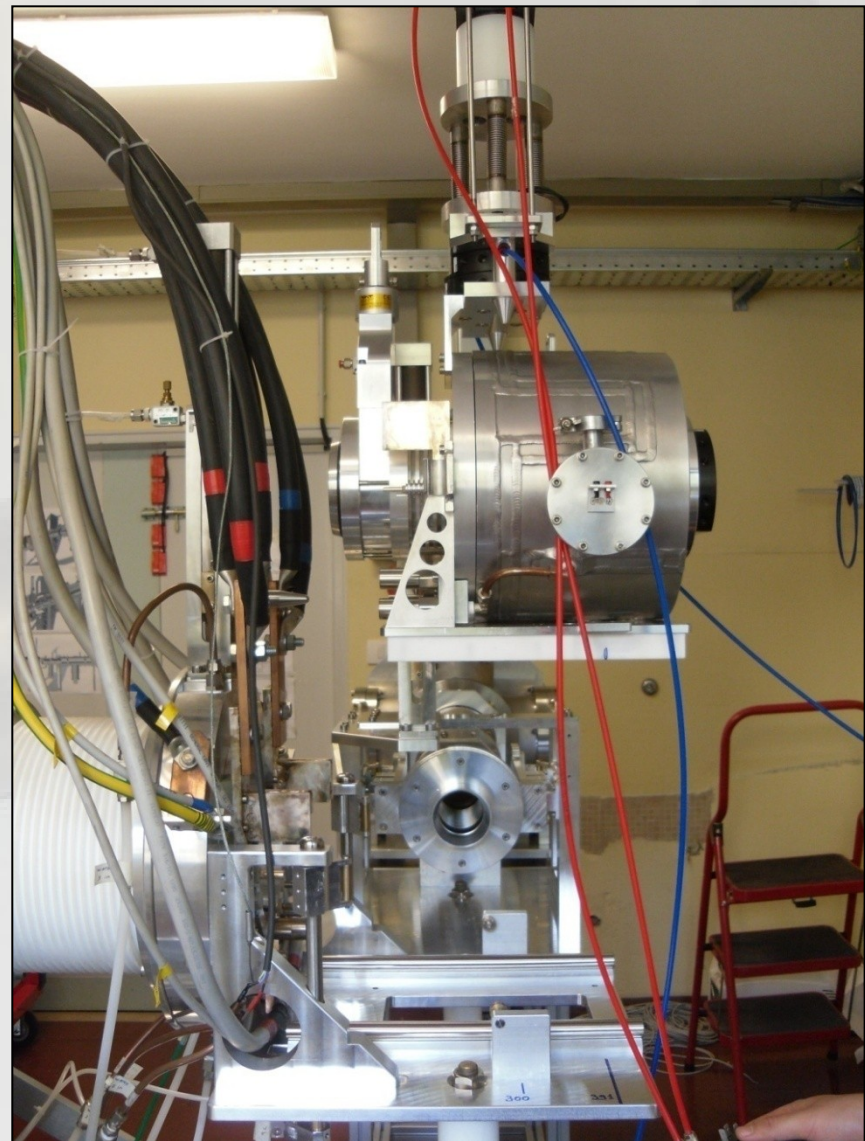
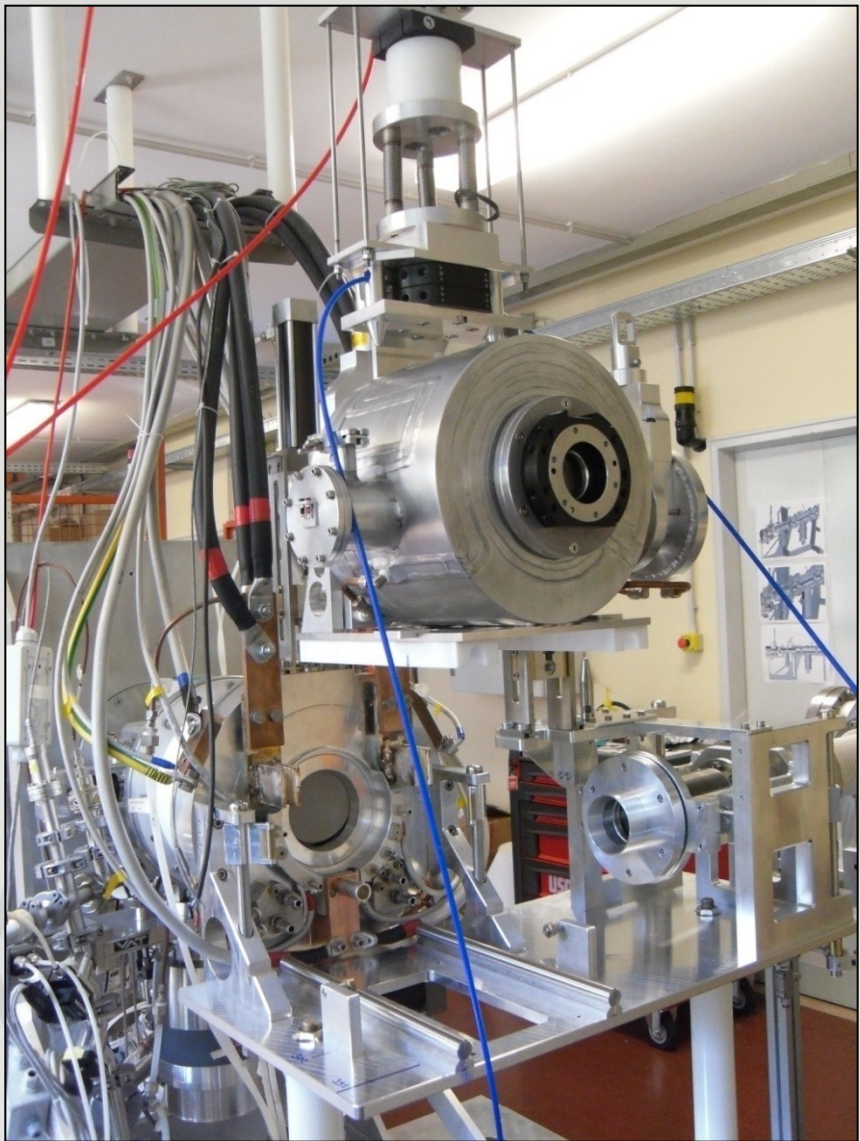


WP4: The target handling

Two systems in order to increase the handling security level



Vertical handling system



Touch Screen Interface



PLC



Power	Target	Access	Water	Status	Alarm
Transformer	Target Pneu			High Voltage	

Conditions

Emergency Stop OFF

Temperature Level 1 OK

Temperature Level 2 OK

Vacuum Not OK

Water Not OK

Status

OFF

Operations

ON OFF

Power	Target	Access	Water	Status	Alarm
V0	Clamps	Extractor			

Conditions

Emergency Stop OFF

V0 Open

Mats Free

Status

Two hand control Disabled

Two hand control Not Pushed

Closed

Enable Operations

Open Close

Power ON

Clamps

Power	Target	Access	Water	Status	Alarm
	Target cooling systems				

Operations

VW3

Open Close

VW2i & VW2o

Open Close

VW1i & VW1o

Open Close

Water

VW11

Coil table, deflector and protonic cooling system

Target chamber cooling system 2

Target chamber cooling system 1

Power	Target	Access	Water	Status	Alarm
V0	Clamps	Extractor			

Mode

Local

Remote

Controls

Manual

<< >>

Automatic

1.0

Go

Current position (%)

Zero 1.0 Max

Auto tuning

Power	Target	Access	Water	Status	Alarm
	Target area access control				

Ground Connection State

HV Platform Disconnected

Connect GND

Conditions

H.V. OFF

Round state

Time counter

Round Not Completed 30s

Door state

Closed Unlock

Door Locking Conditions

Instruments Ready	R. Gamma OK	R. Neutron OK
Beam OFF	H.V. OFF	

Power	Target	Access	Water	Status	Alarm

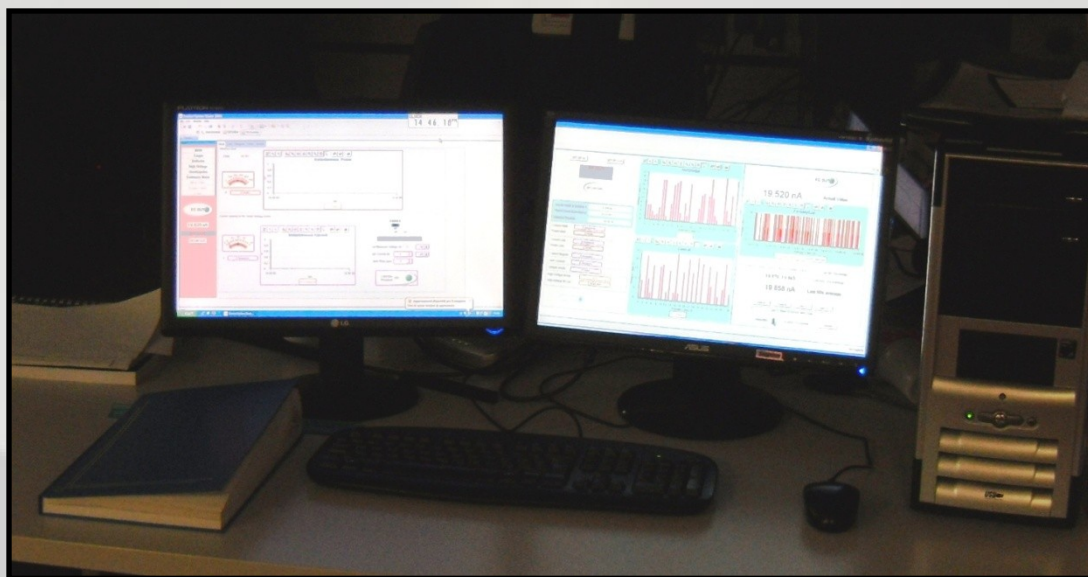
- Compressed air pressure
- PLC 1 state
- PLC 1 Alarm OK
- Vacuum state
- Room Air humidity
- Cooling Water resistance
- High Voltage System state
- Gamma radiation monitor ready
- Neutron radiation monitor ready

- Room Air flow
- Room Air temperature
- Cooling Water flow
- Cooling Water temperature
- Target Chamber surface temperature
- Heating System state
- Gamma radiation level OK
- Neutron radiation level OK

The Front End Console

Two Monitor:

Control



Diagnostic

-Power supplies:

- Ion source complex
- High voltage
- Deflectors
- Quadrupoles

-Beam matching calculation

-Target chamber temperature measuring

-Real time diagnostics:

- Faraday cup
- Beam profile monitor

-Efficiency measurements:

-Surface and/or laser ion source (integrative)

-Plasma ion source (instantaneous)

-Emittance measurement

control side

Controls of ion source complex power supplies

MAIN

Target system

- Ion source
- High voltage
- Focalization
- Steerers
- Quadrupoles
- Fields tuning
- Laser
- Mass separator

FARADAY CUP

FC IN ●

8.359,440

BEAM PROFILE

SET BP OUT

BP OUT

2011/05/10 16:17:59

HEATER SETTINGS

Max. voltage (V) SET

Set current (A) SET

Ramp time (sec)

ENABLE

off on

Current: 0,00 Amperes

Power: 0.0 Watts

Instantaneous Current

Instantaneous Power

LINE SETTINGS

Max. voltage (V) SET

Set current (A) SET

Ramp time (sec)

ENABLE

off on

Current: 280.05 Amperes

Power: 790.02105000000001 Watts

Instantaneous Current

Instantaneous Power

OVEN SETTINGS

Max. voltage (V) SET

Set current (A) SET

ENABLE

off on

Current: 35.002 Amperes

Power: 119.251814000000001 Watts

MAGNET SETTINGS

Max. voltage (V) set V

Set current (A) set I

ENABLE

off on

Current: 0.0 Amperes

Power: 0.0 Watts

ANODE SETTINGS

Max. current (A) set I

Voltage (V) set V

ENABLE

off on

Voltage: 0.18 Volts

Current: 0 millAmps

EURISOL-NET 27 June 2011

Alberto Andrichetto

diagnostic side

Beam profile monitor and Faraday cup

MAIN DIAGNOSTICS

- Real time diagnostics (beam profile monitor & faraday cup)
- Emittance meter**
- Beam emittance scanning
- Beam emittance analysis

FARADAY CUP

FC OUT ●

0,017 nA

BEAM PROFILE

SET BP IN

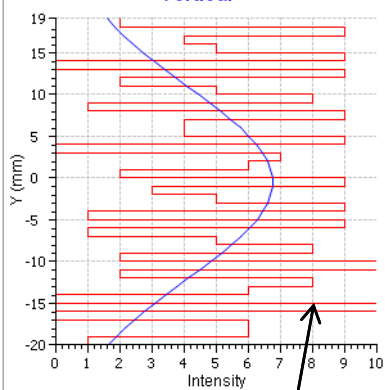
SET BP OUT

BP OUT

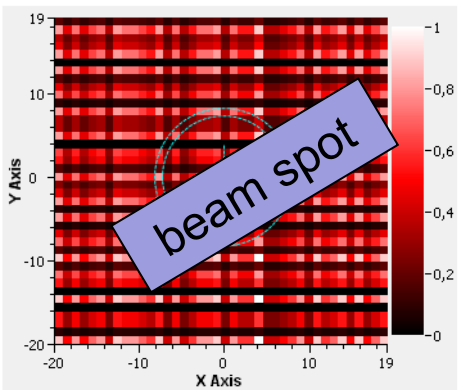
2011/05/09 15:50:34

Beam Profile Monitor
Efficiency measurement

Vertical

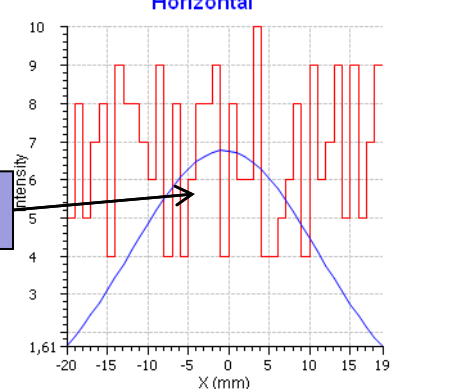


Intensity



beam spot

Horizontal



Intensity

No fit ●

SET BP IN

SET BP OUT

BP OUT

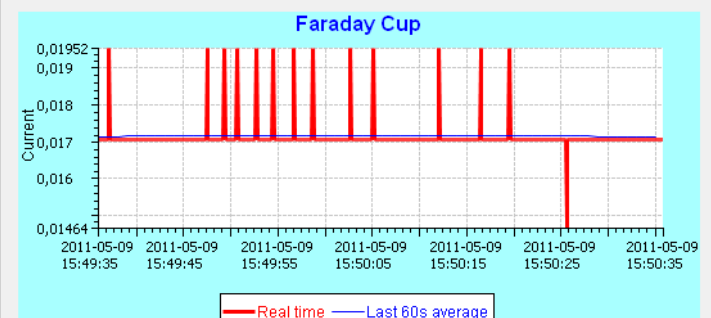
profiles

BP High Gain ●

FC OUT ●

0,017 nA

Faraday Cup



Current

— Real time — Last 60s average

beam current

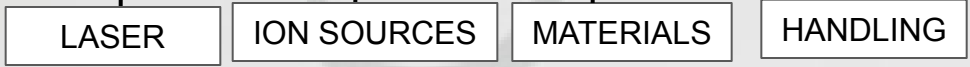
0,017 nA Last 60s average

Auto gain OFF

Gain A Gain B Gain C Gain D

Gain NOT set.

The SPES Target: collaborations network



Since 2004:
35(!) thesis performed in the frame of target SPES activities

The SPES-TIS tree...

