Recent results on development of the SPES production target

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The SPES project at LNL

Facility layout

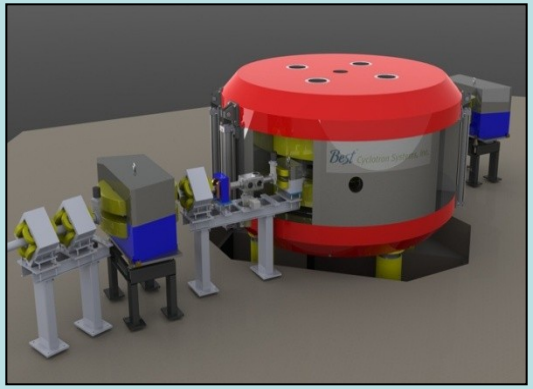
SPES is: 1) A second generation ISOL facility (for neutron-rich ion beams)
2) An interdisciplinary research center (for p,n applications)

SPES: a mid-term ISOL facility

3 main items…

Driver:

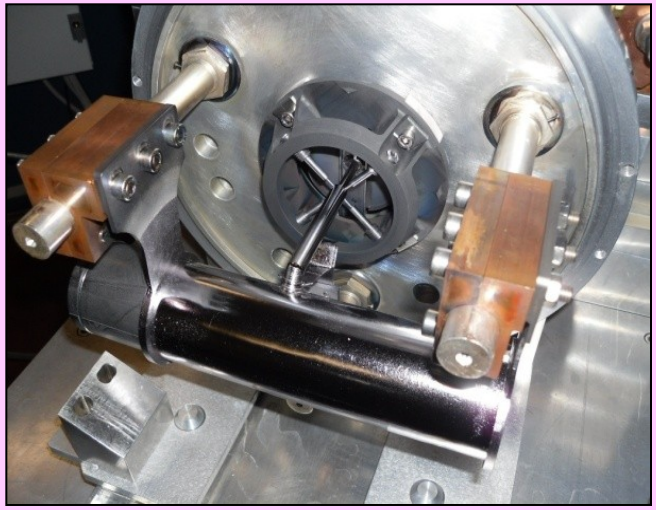
'Commercial' cyclotron



Production Target:

NEW CONCEPT !

(Multi-foil UCx target)



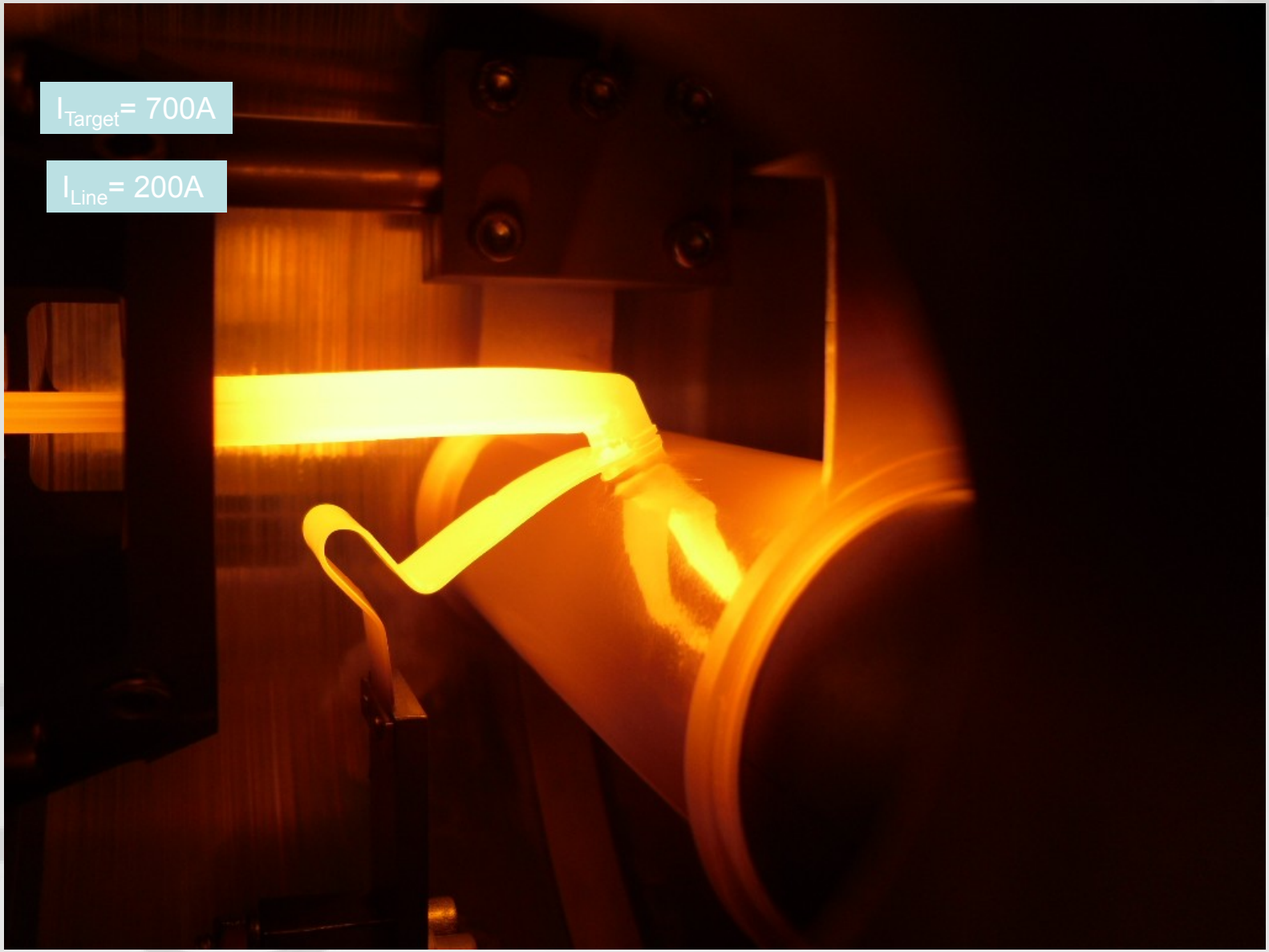
Target-Ion Source Complex:

- 5 Working groups
- 5 Labs

Post Accelerator:

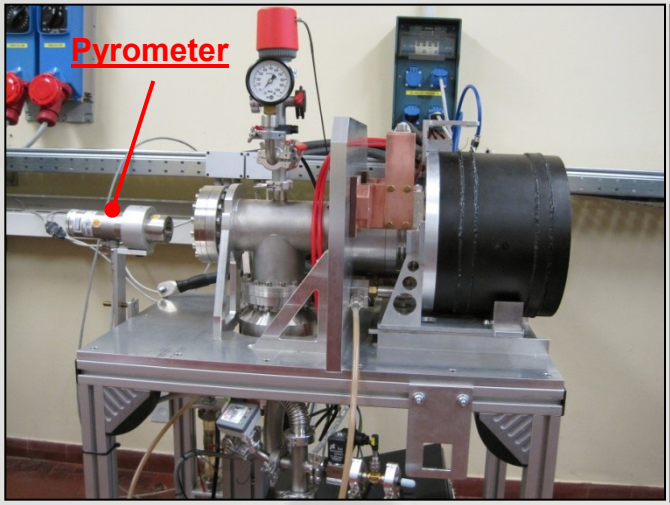
Piave- Alpi existing complex

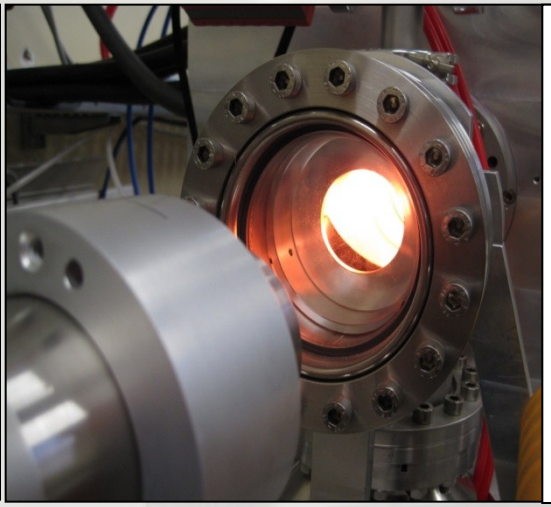
The SPES TIS complex

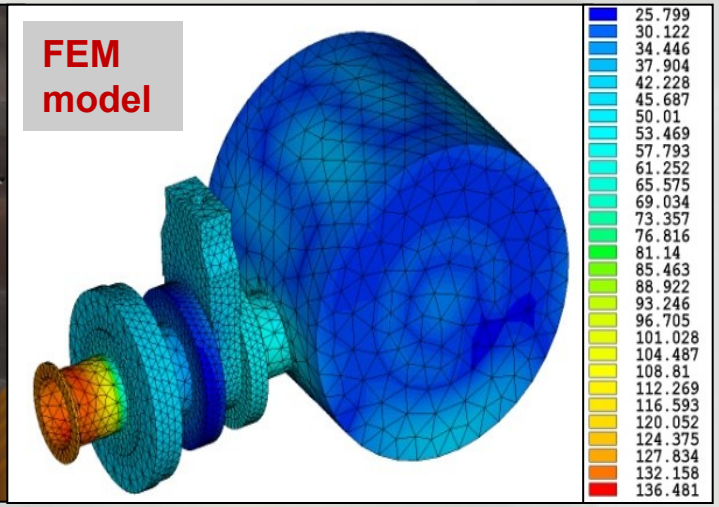


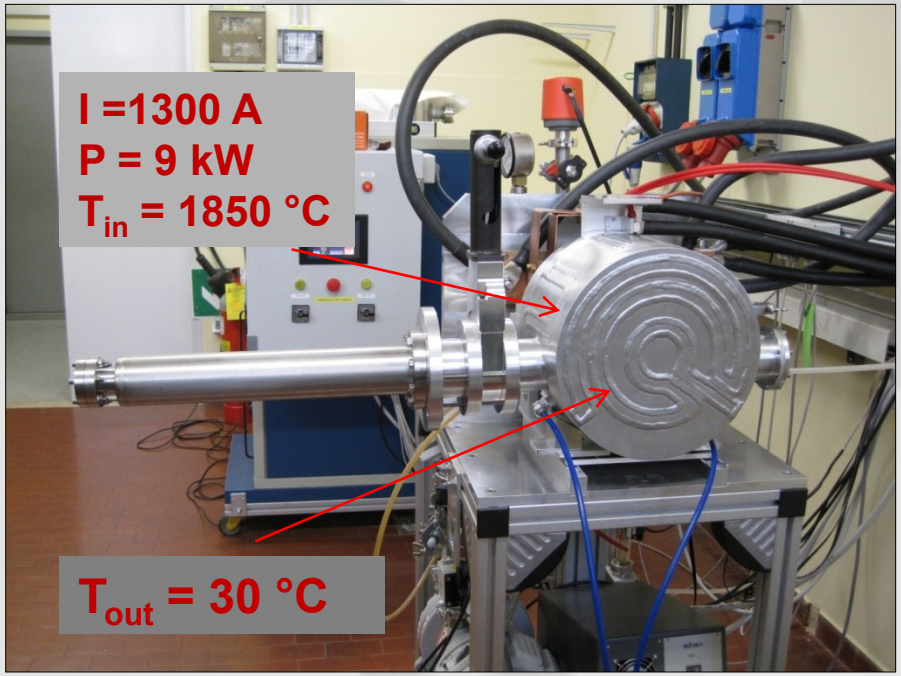
The SPES target chamber complex

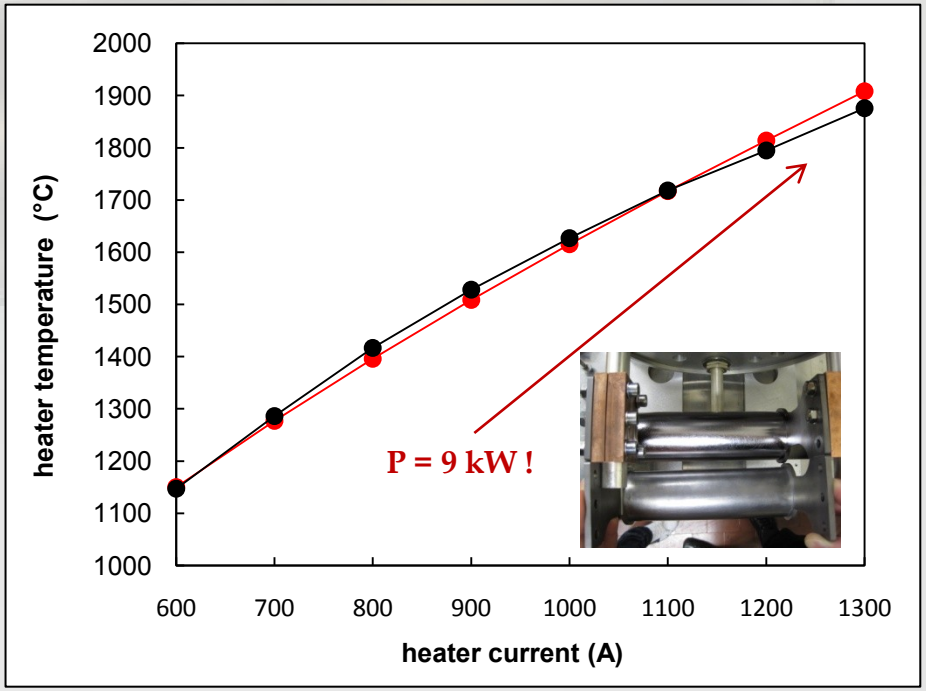
On line test with 9kW imposed into the target -> successfully tested !





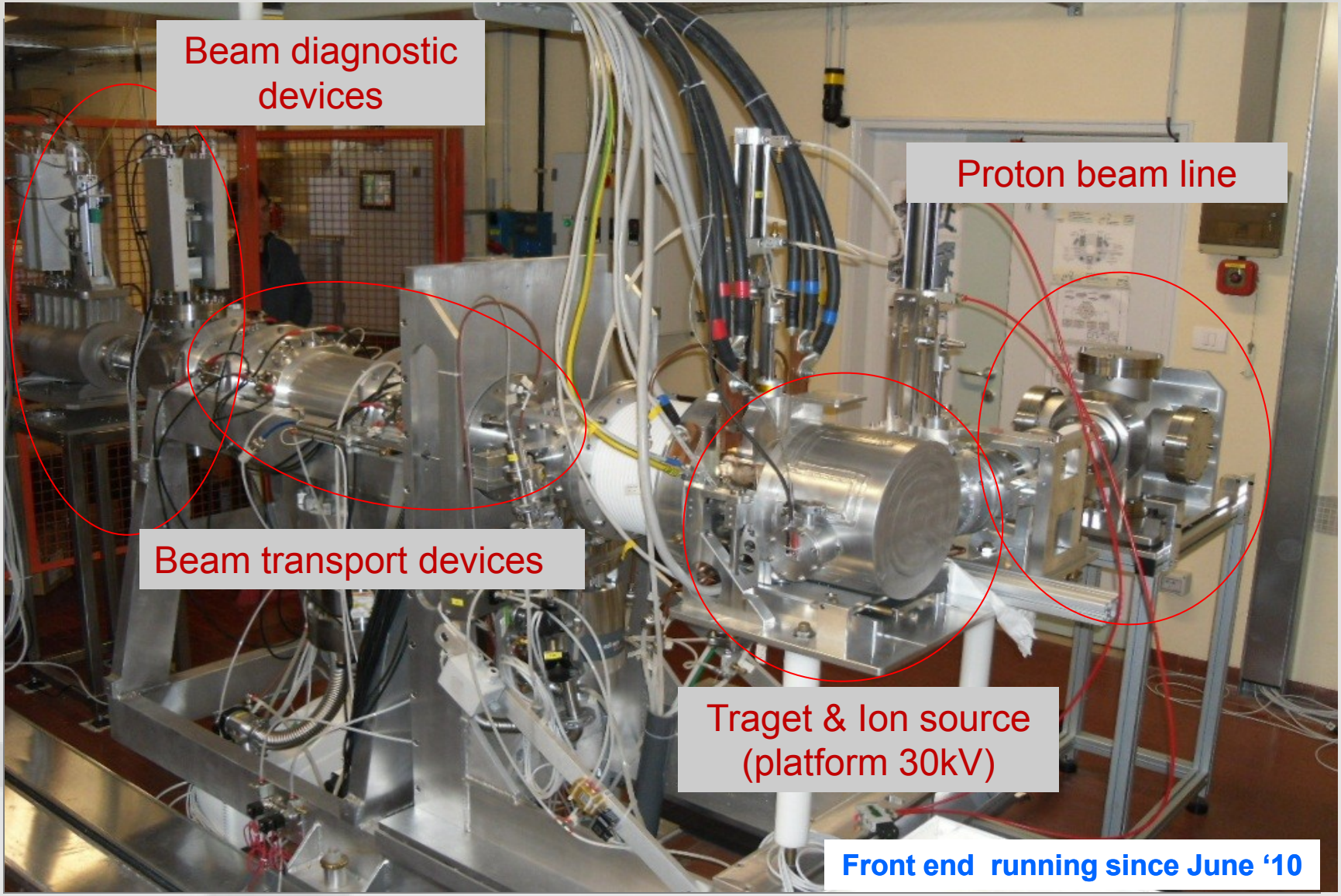






The SPES Front end complex

(evolution of Isolde FE6)



SPES TARGET Work Packages

WP01 Ion Source developments (M. Manzolaro)

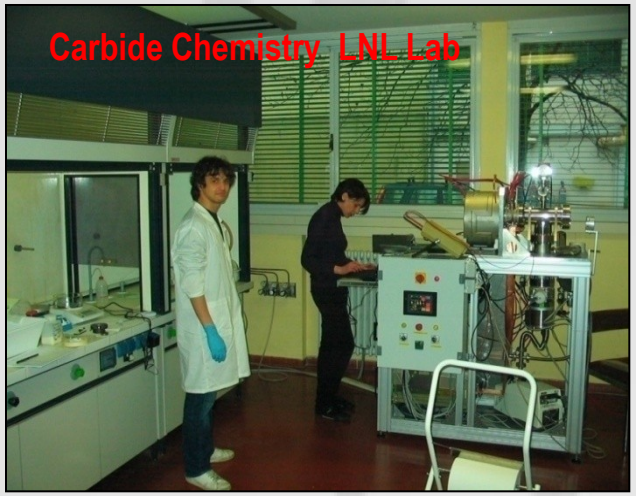
WP02 Material developments (L. Biasetto, S. Corradetti)

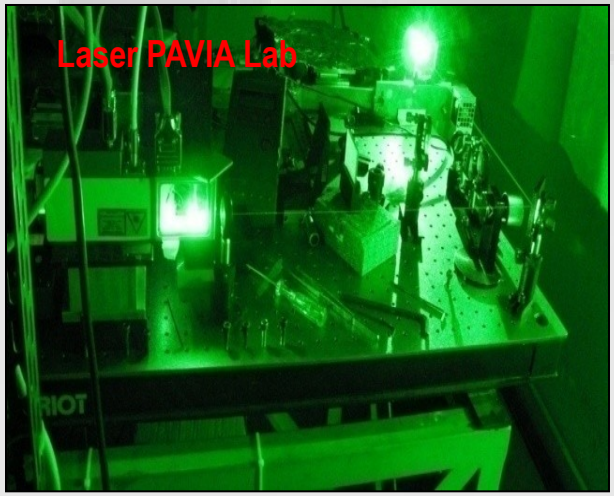
WP03 Laser developments (D. Scarpa, P. Benetti)

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

WP05 Controls (J. Vasquez, J. Montano)

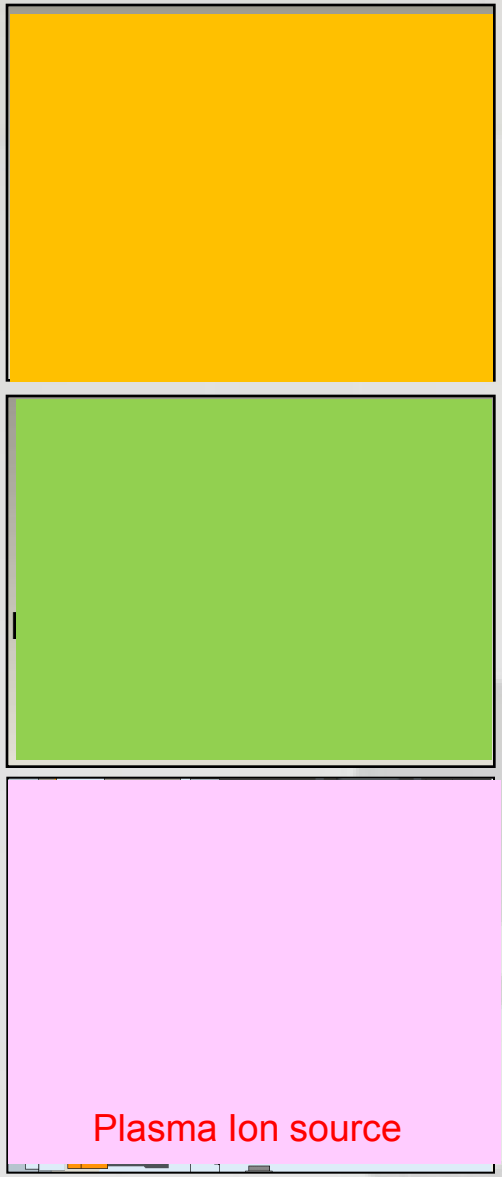
The TIS SPES Laboratories





WP1: IONIZATION methods for n-rich RIB's

(3 methods, 2 Ion sources)



Elements with bad volatility (NOT EXTRACTED)

Surface Ionization Method

Photo Ionization Method

Plasma Ionization Method

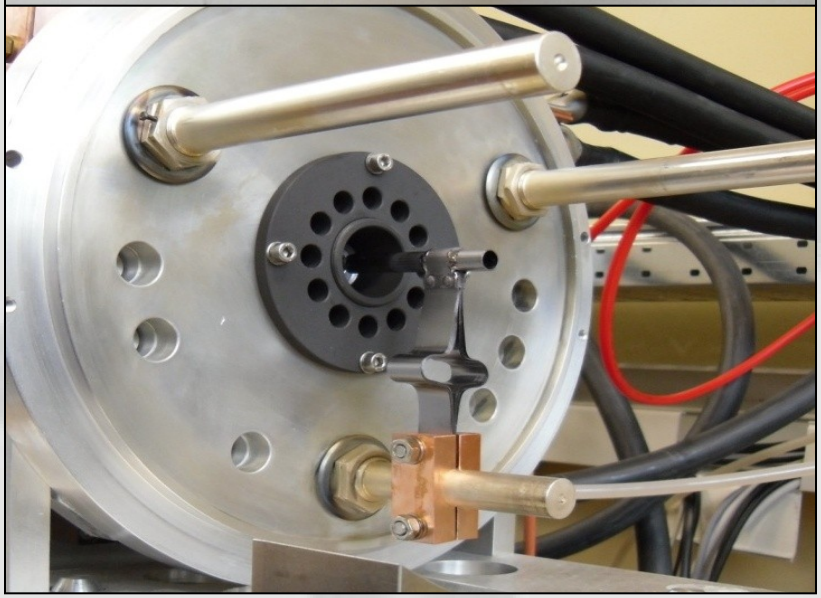
1 H																	2 He
3 Li	4 Be											5 B	6 C	7 N	8 O	9 F	10 Ne
11 Na	12 Mg											13 Al	14 Si	15 P	16 S	17 Cl	18 Ar
19 K	20 Ca	21 Sc	22 Ti	23 V	24 Cr	25 Mn	26 Fe	27 Co									
			72 Hf	73 Ta	74 W	75 Re	76 Os	77 Ir	78 Pt	79 Au	80 Hg	81 Tl	82 Pb	83 Bi	84 Po	85 At	86 Rn
87 Fr	88 Ra	89 Ac	104 Rf	105 Db	106 Sg	107 Bh	108 Hs	109 Mt	110	111	112						

Main fission (p-> ^{238}U) fragments

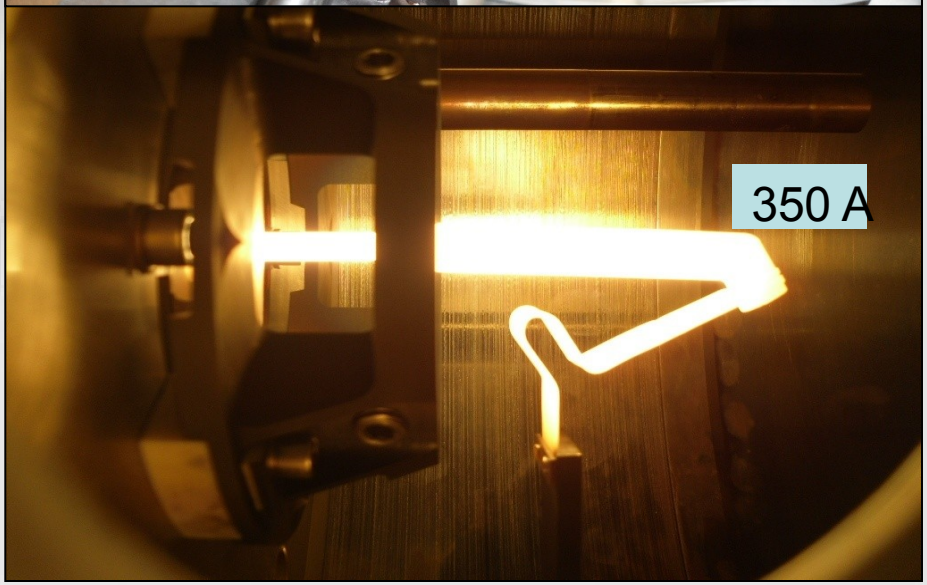
Alberto Andrighetto

The SPES Ion Sources

Plasma Ion Source (PIS)



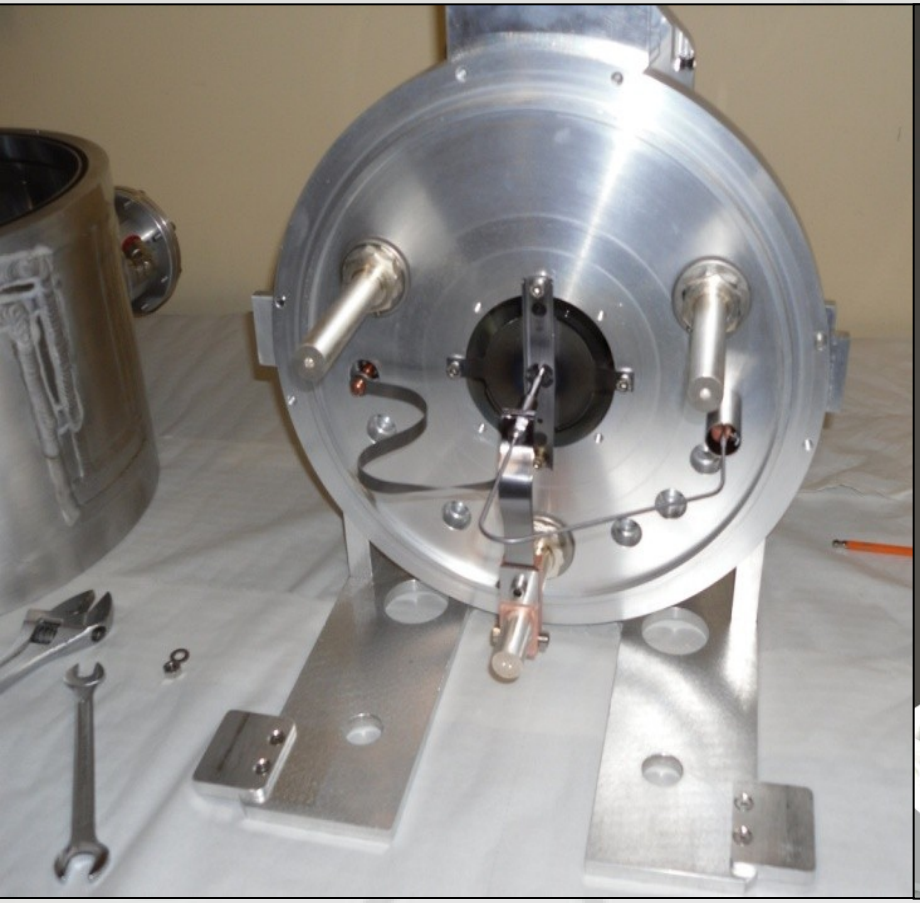
Surface Ion Source (SIS)

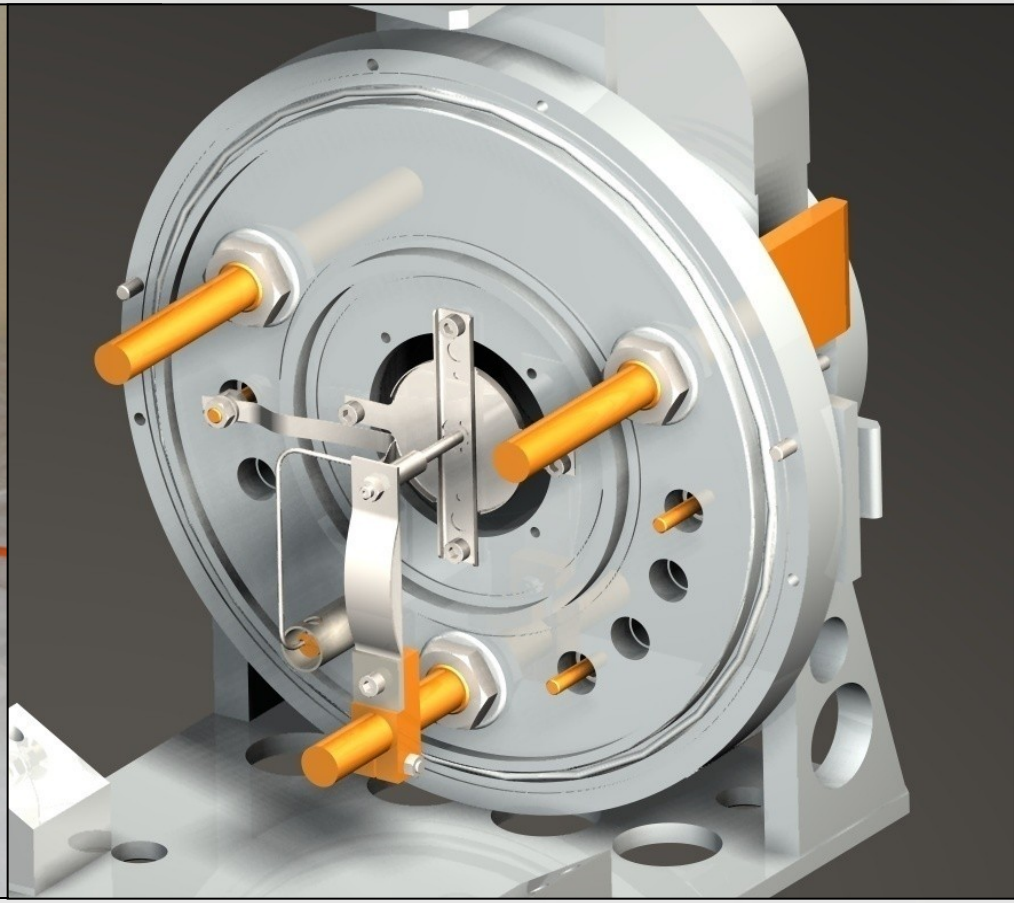


SPES Ion Sources

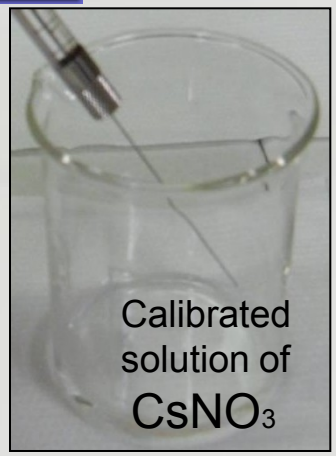
Surface Ion Source:

Mass marker capillarity technique



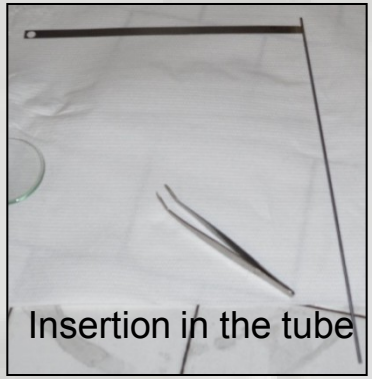


SPES SIS Ion Source

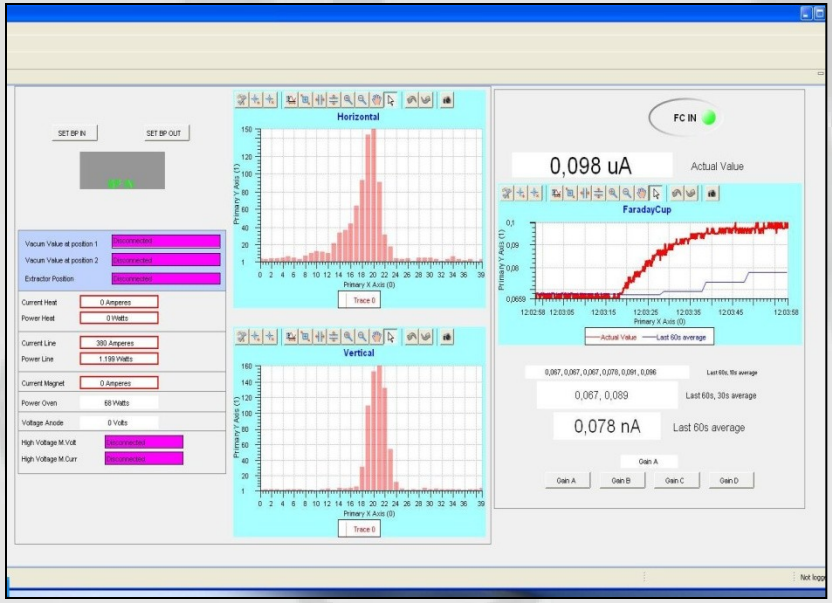


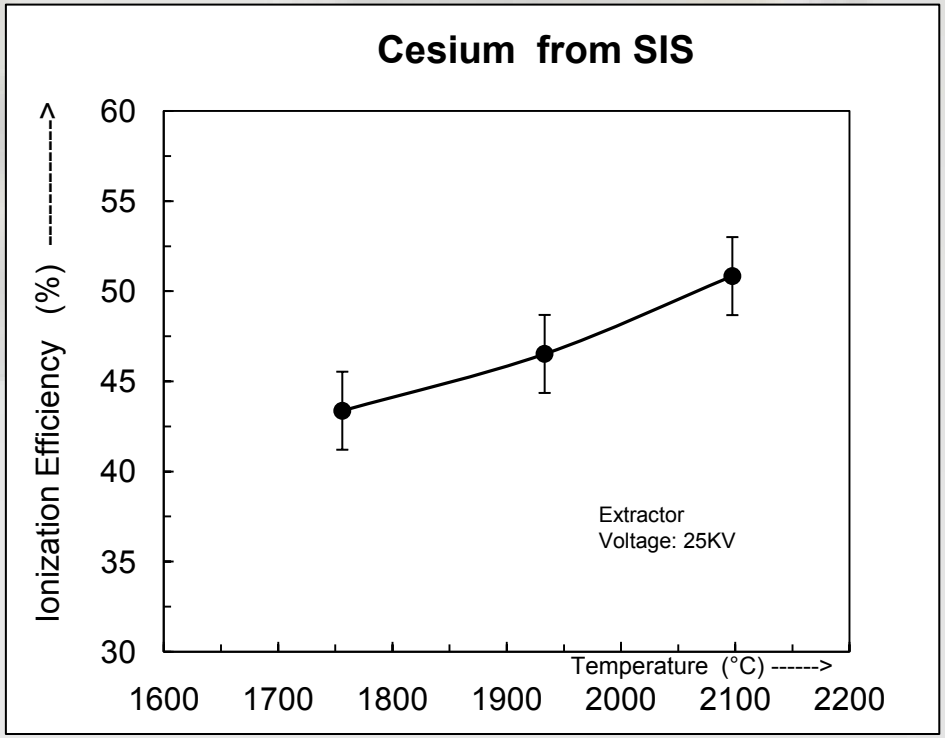
Tantalum substrate

Solution drying



Cesium Surface Ionization

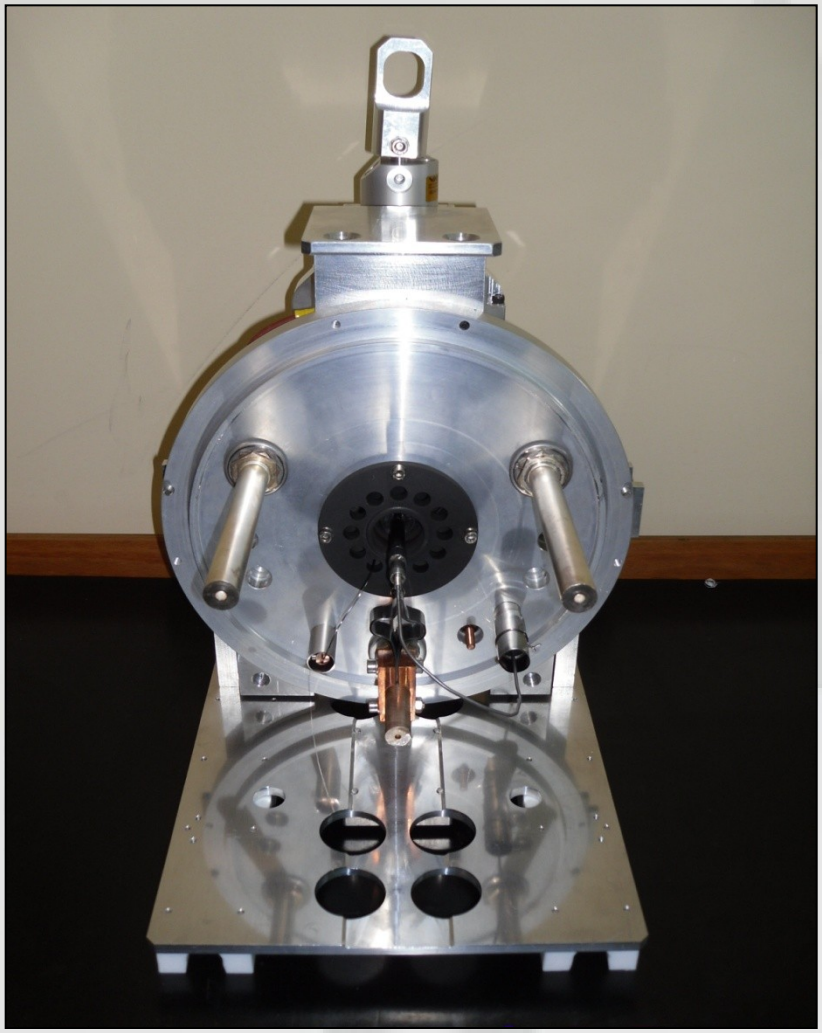


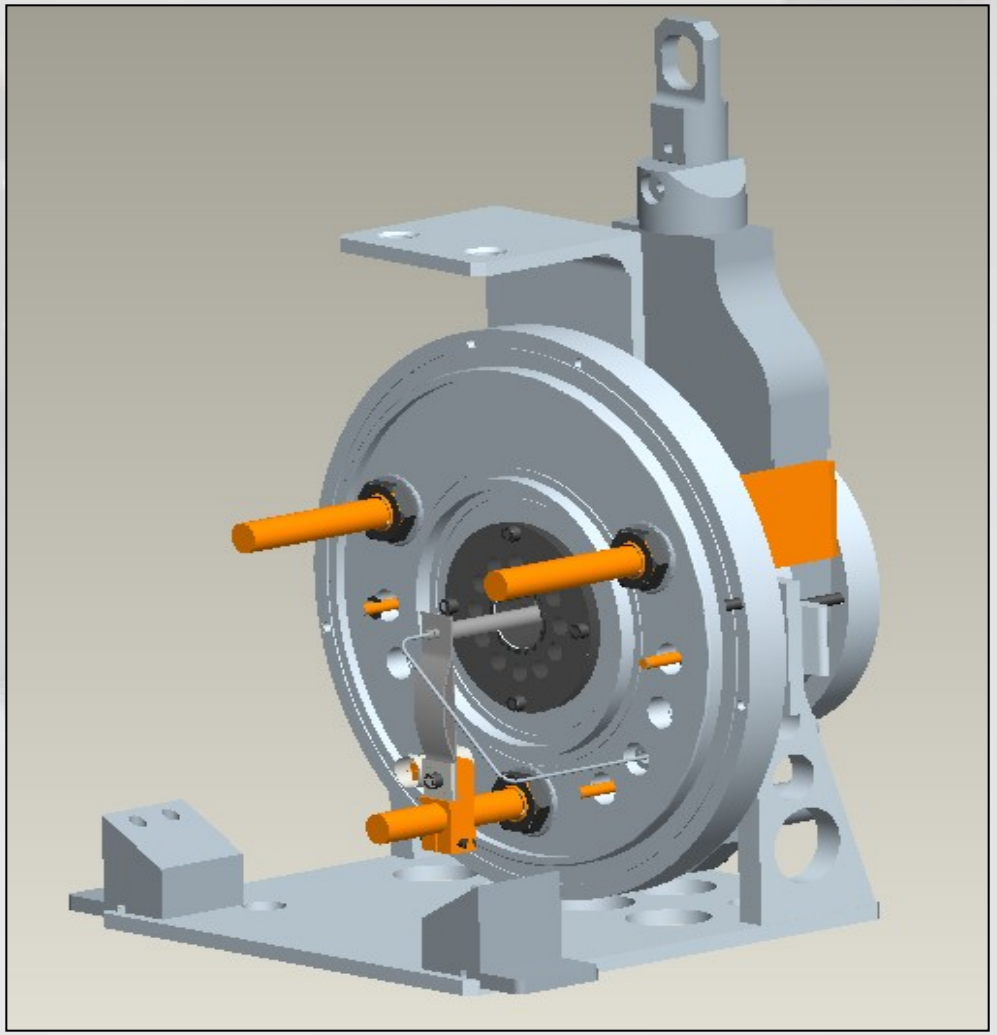


SPES Ion Sources

Plasma Ion Source:

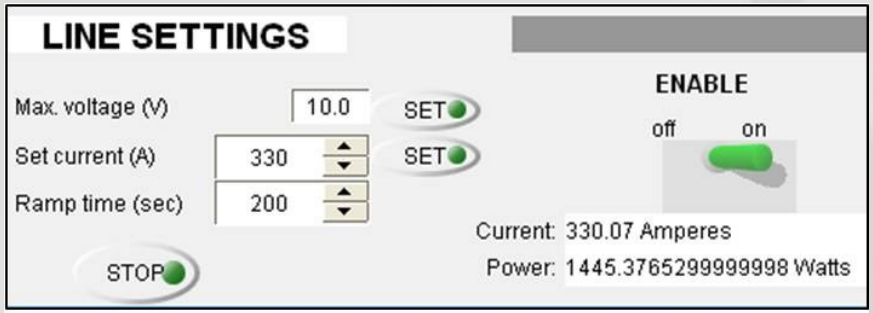
Calibrated leak gas inlet technique

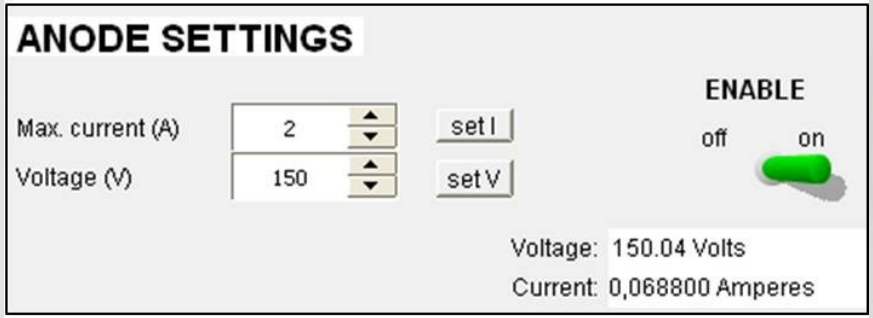


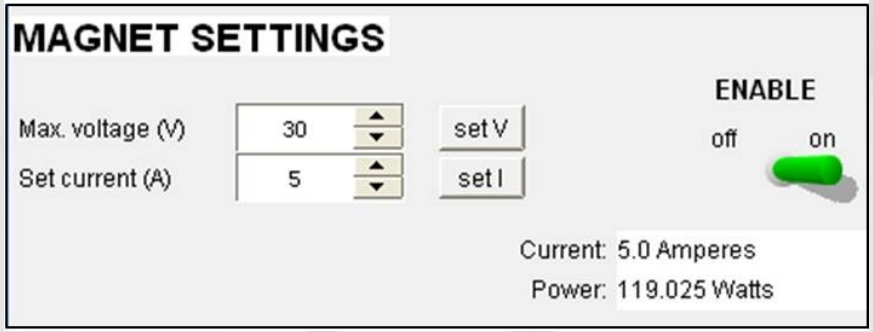


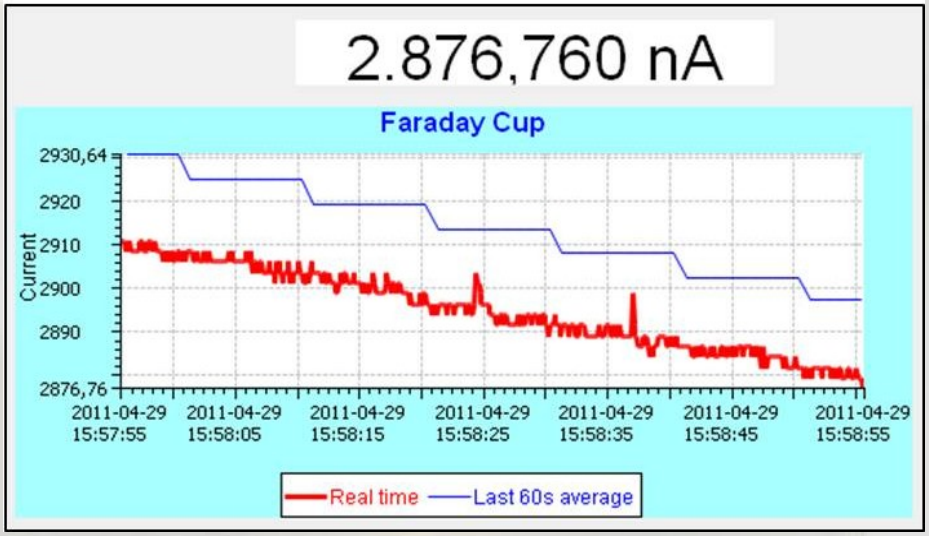
SPES PIS Ion Source

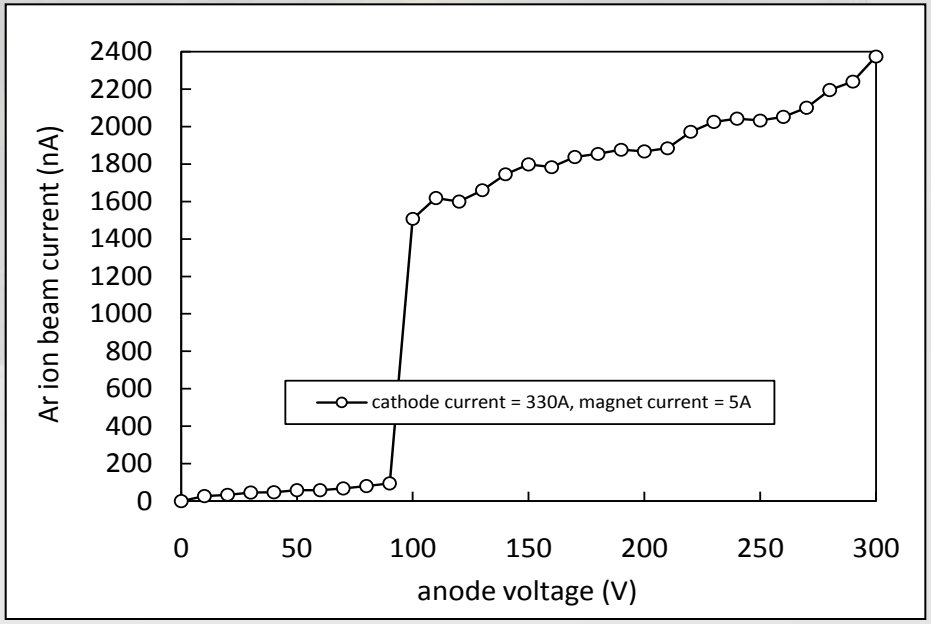
Argon Plasma Ionization







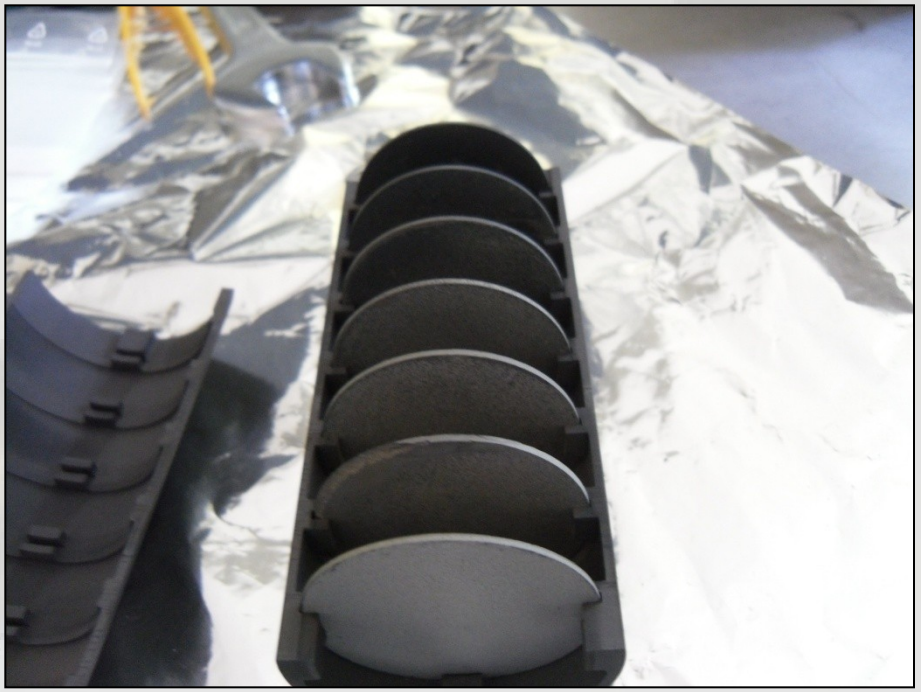




WP2: Lanthanum carbide synthesis

Vertical Carbothermic reduction (1600°C, high vacuum)

$$La_2O_3 + 11C \rightarrow 2LaC_2 + 4C + 3CO$$



OXIDE + GRAPHITE GREEN PELLETS → **CARBIDE/GRAPHITE (LaCx) PELLETS**

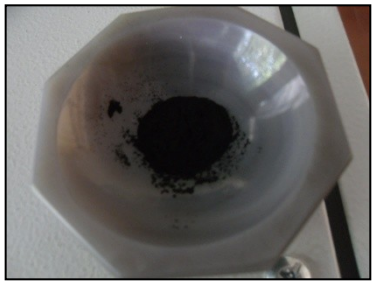
Boron carbide (B_4C) production

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

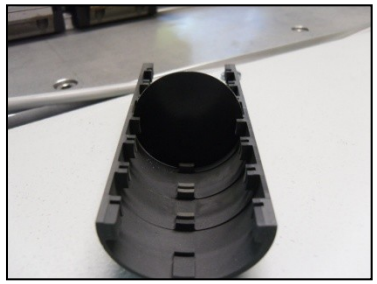
Solution of the acid

Gel formation

Grounding of the dried gel



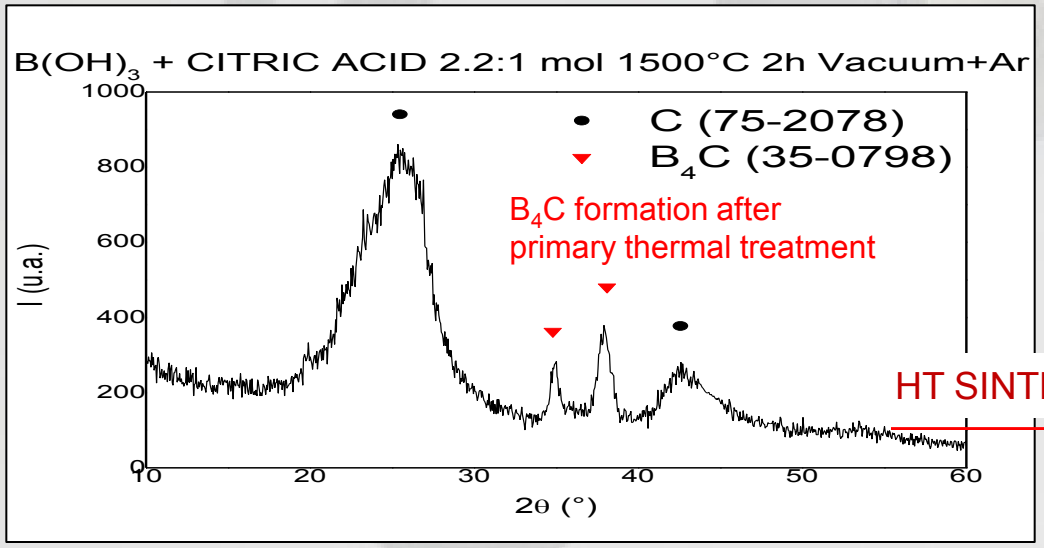
Thermal treated powder



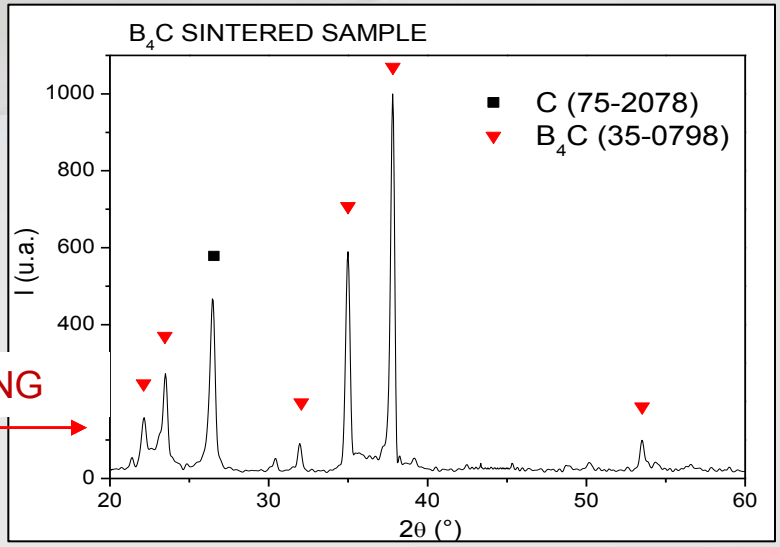
High temperature sintering

Thermal treatment :

- up to 800°C in low vacuum ($5*10^{-2}$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



HT SINTERING

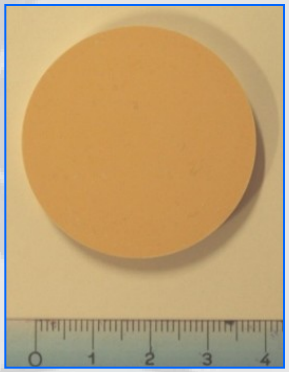


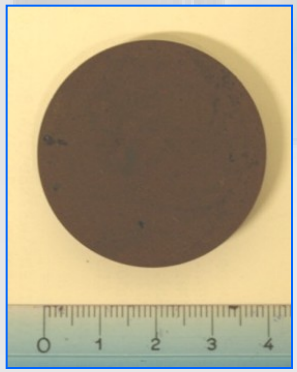
Transition metal carbides production

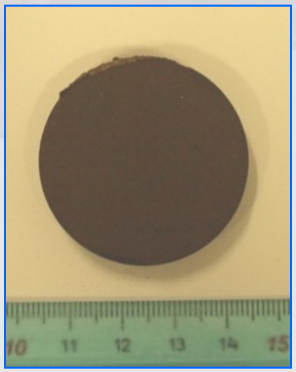
1. High melting point
2. High thermal and electrical conductivity
3. Chemical inertness up to very high temperatures

$$M_xO_y + (x+y+n)C \rightarrow xMC + yCO + nC,\ M=Zr,Ta,Hf$$

ZrC foams


As pressed


Post-cured

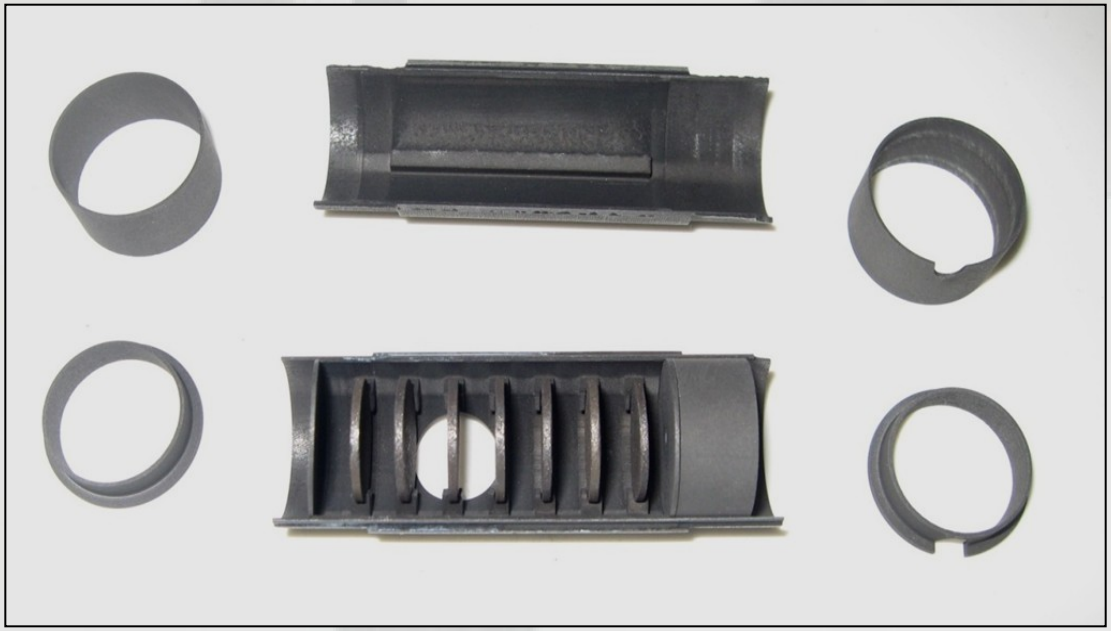

After burn-out

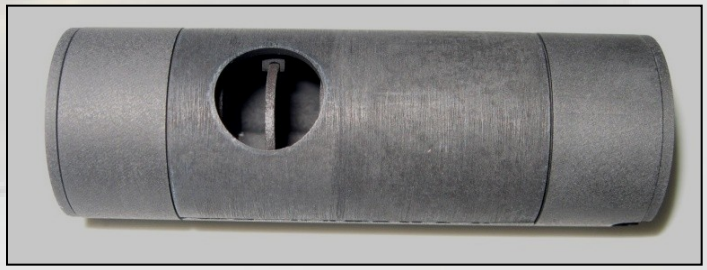

Final carbide

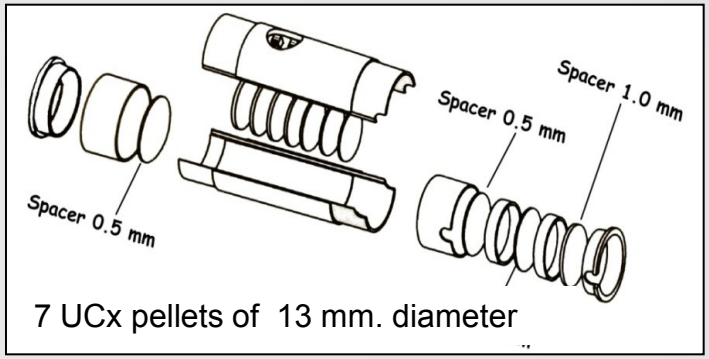
On line UCx test at HRIBF

Thanks to Dan Stracener and ORNL-TIS group

- Seven UC_2 samples SPES Target Group (in collaboration with HRIBF)
- Densities in the range of 4.2 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 without any out-gassing or obvious change in structure (samples observed after the on-line test)





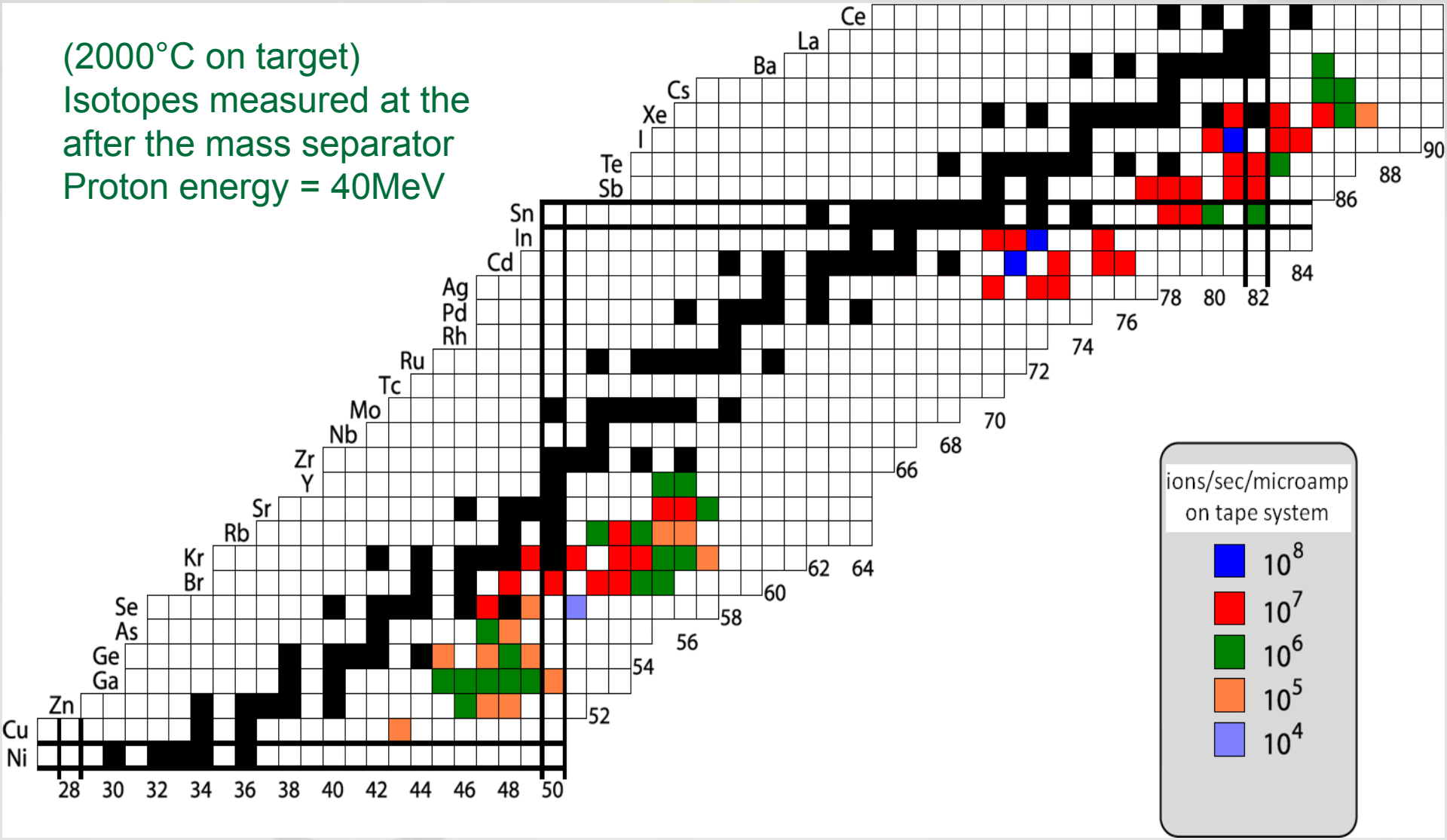


7 UCx pellets of 13 mm. diameter

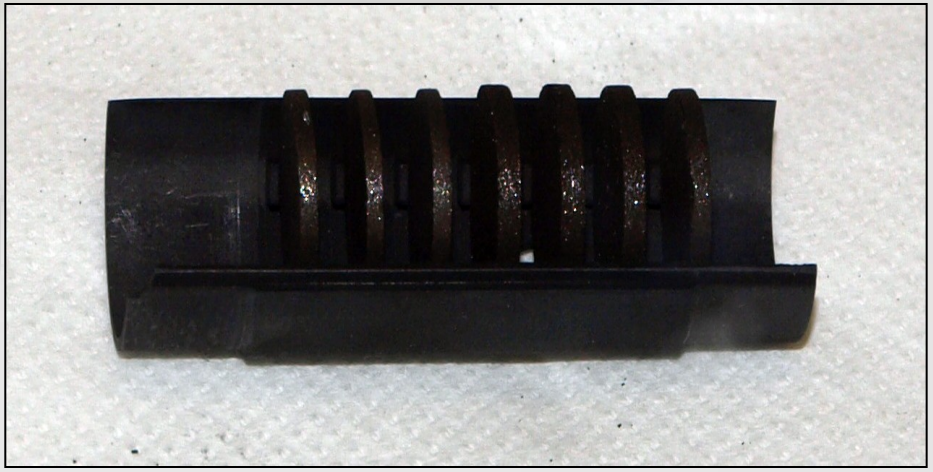
On line UCx test at HRIBF

N-Rich Isotopes yields

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



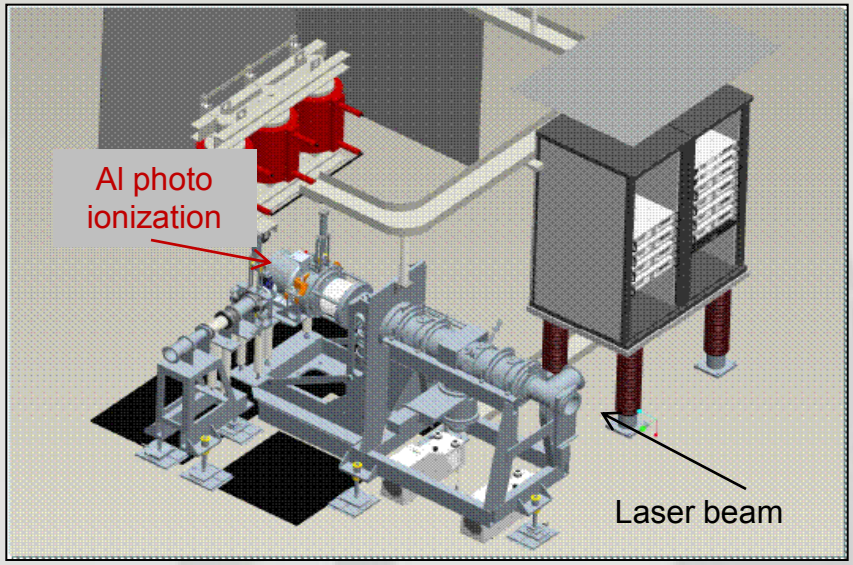
New target for next HRIBF test

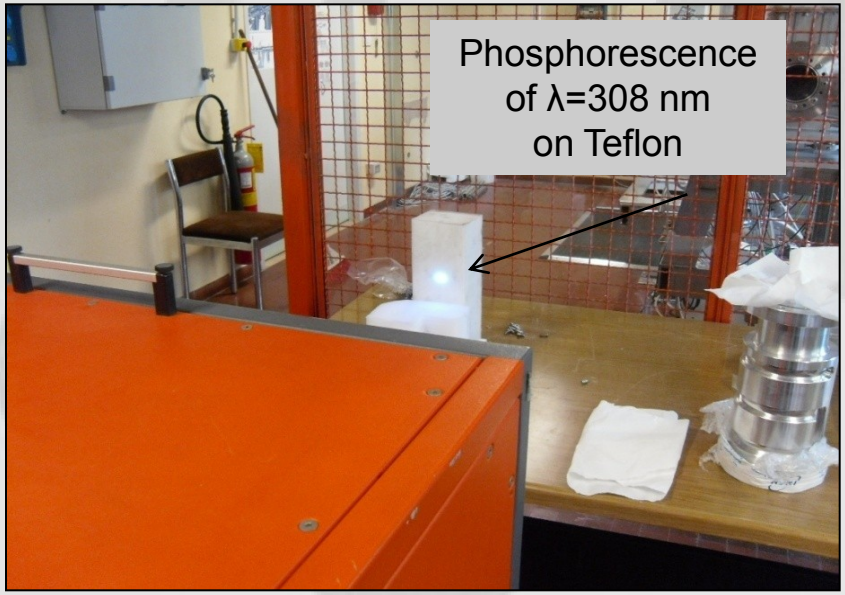


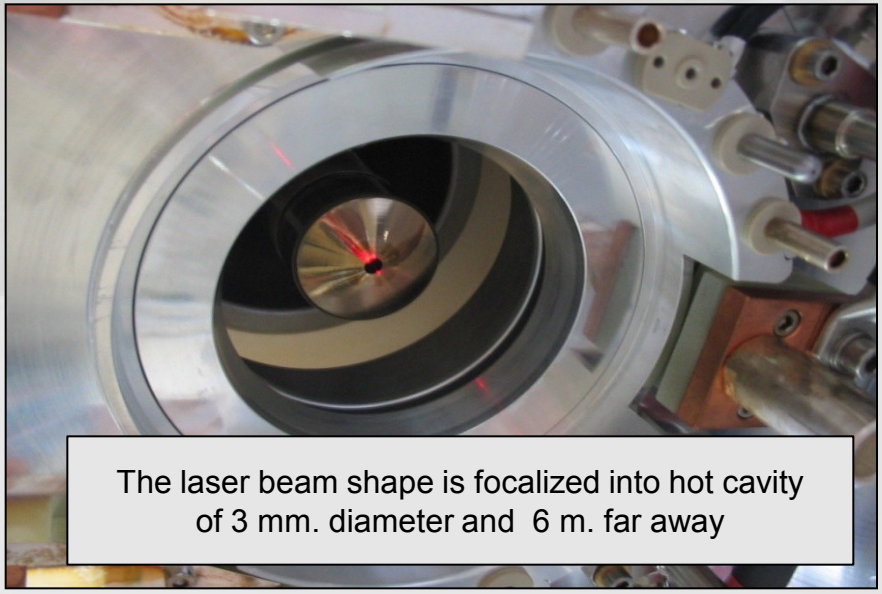
SPES UCx-CNT for ORNL : on line test planned for October '11

WP3: laser test at LNL with excimer

Aluminum ionization with a single wavelength





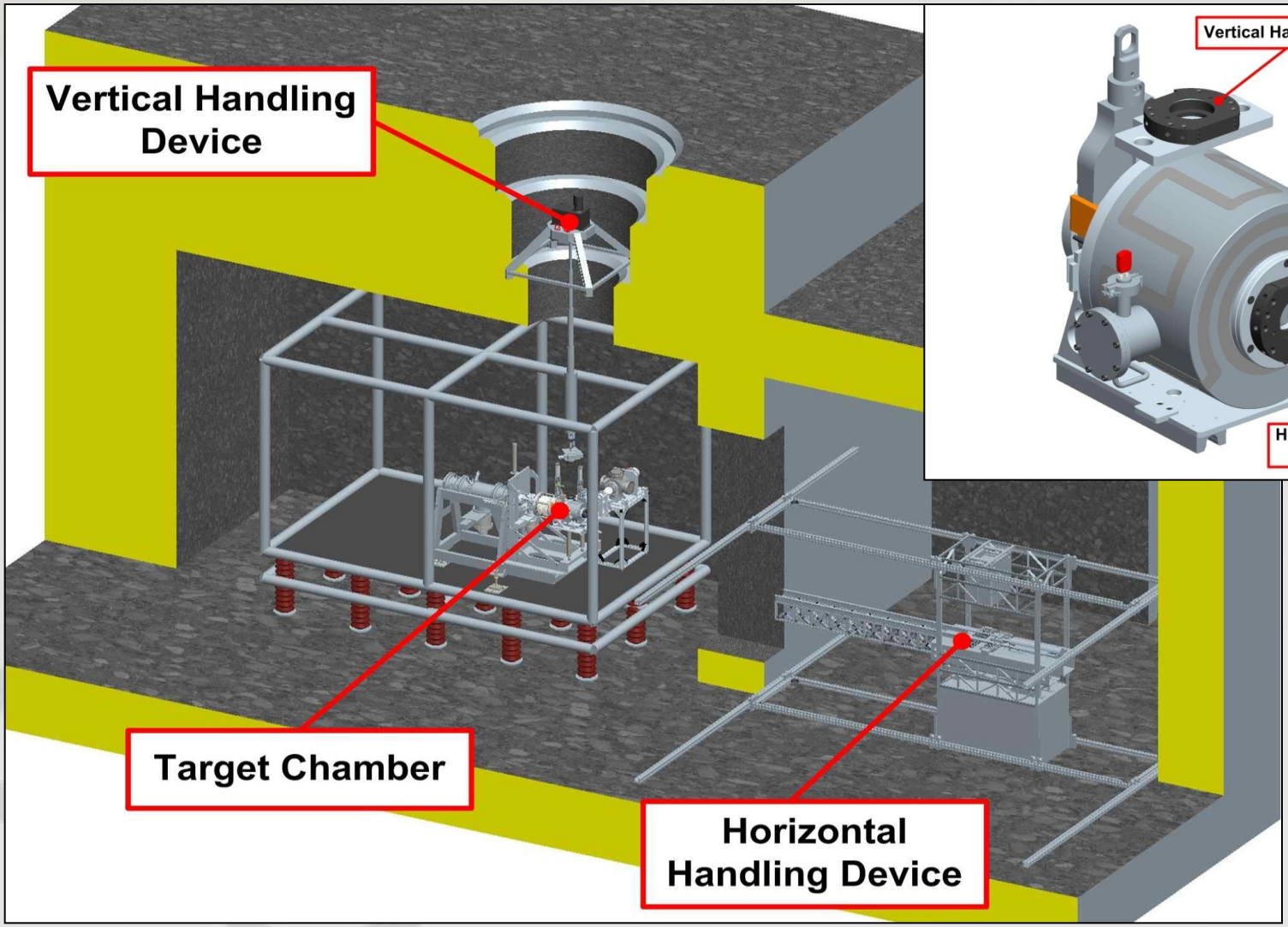


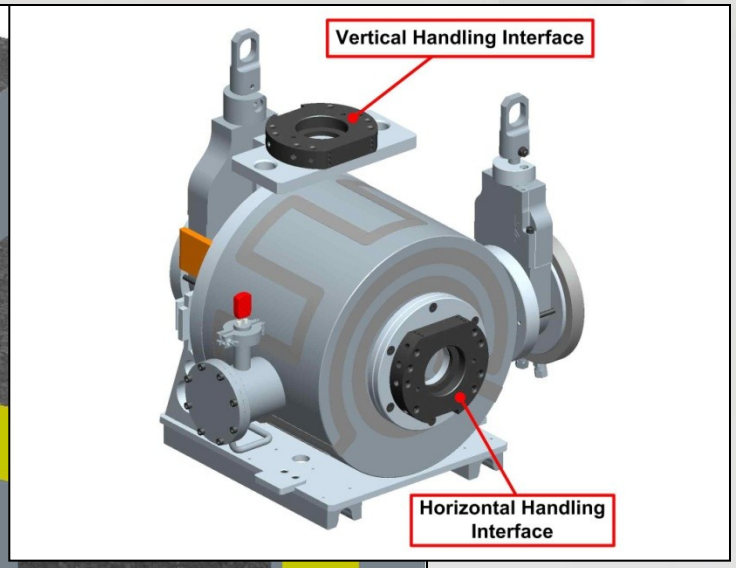
Aluminium photo-ionization

First ionization results (Current collected into the Faraday Cup)

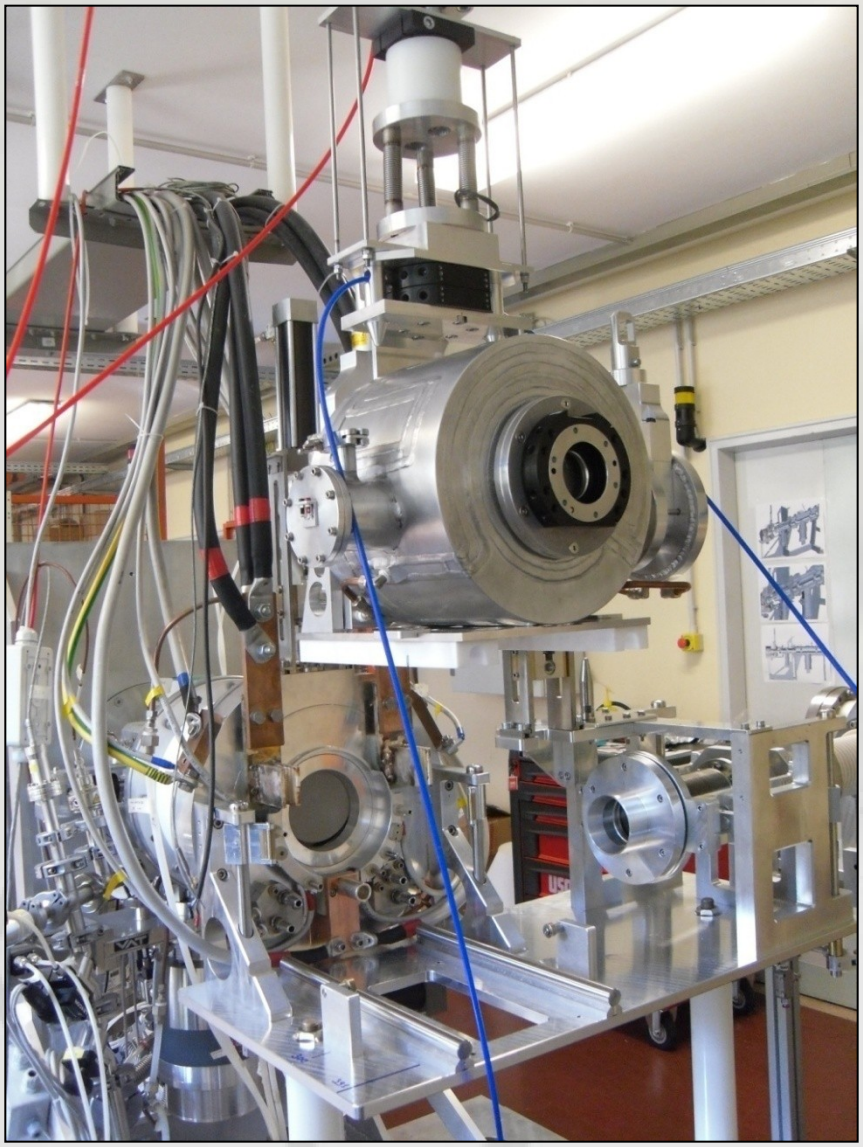
WP4: The target handling

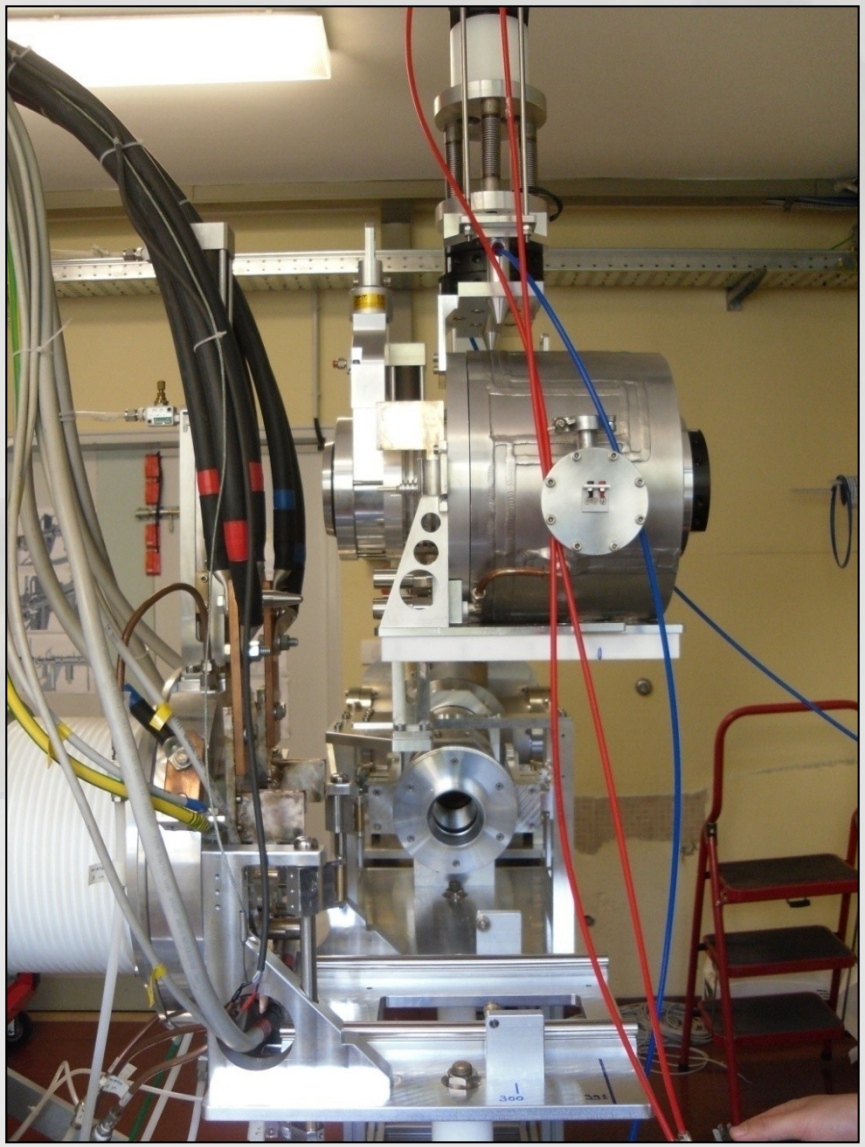
Two systems in order to increase the handling security level





Vertical handling system

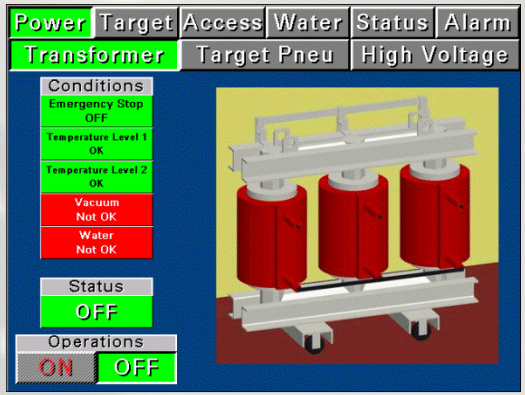


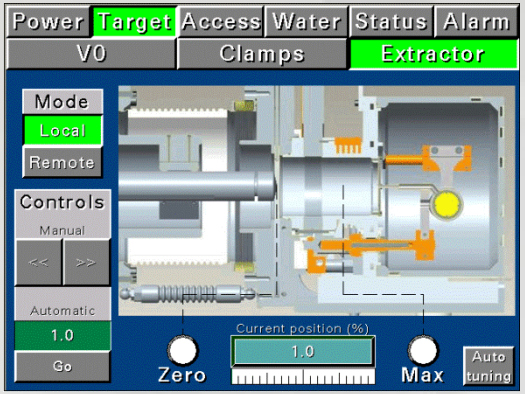


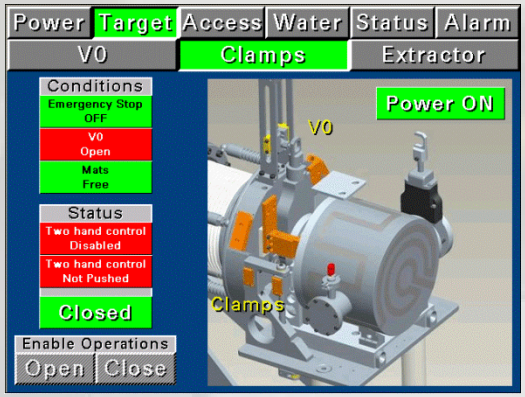
WP5: Safety Control System

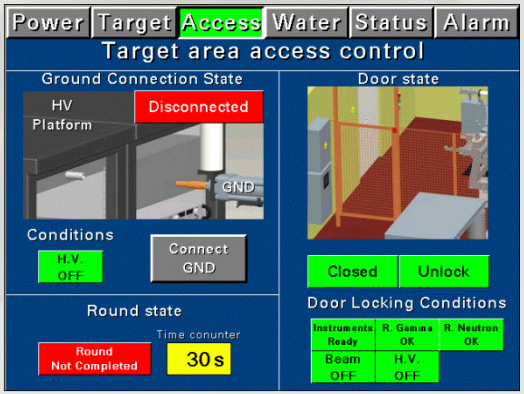
Touch Screen Interface

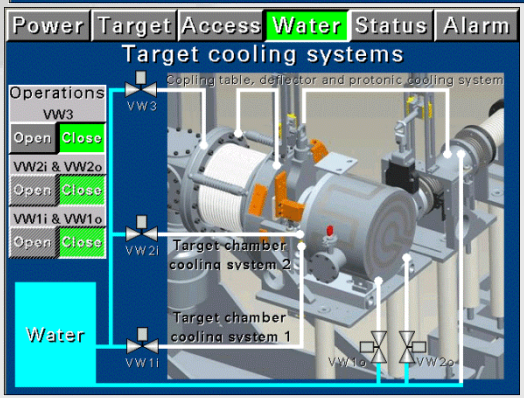
PLC

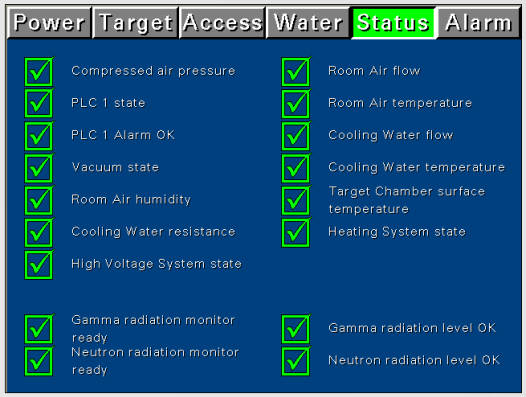










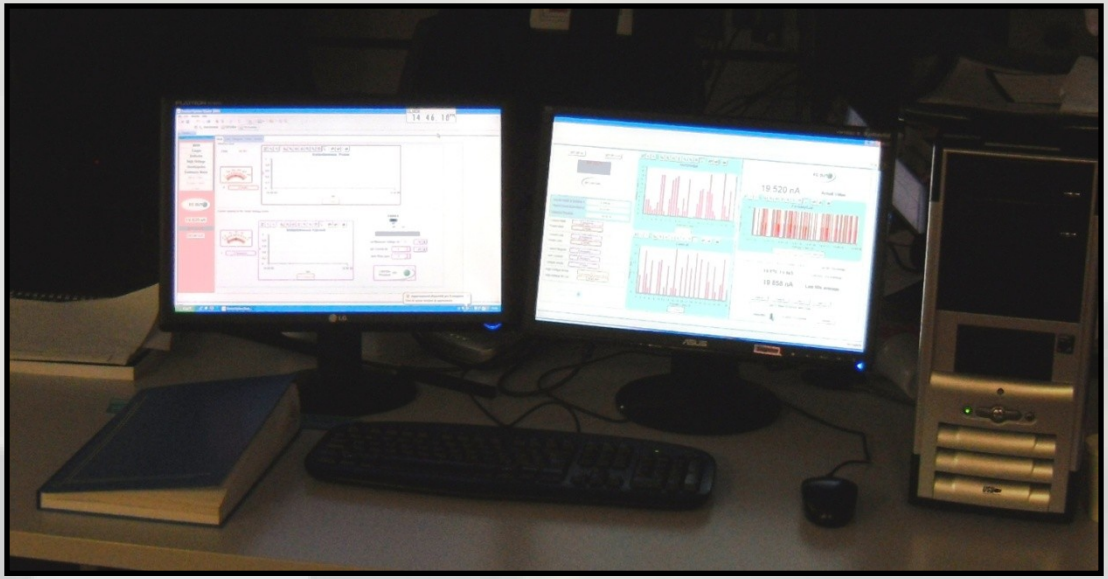


Alberto Andrighetto

The Front End Console

Two Monitor:

Control



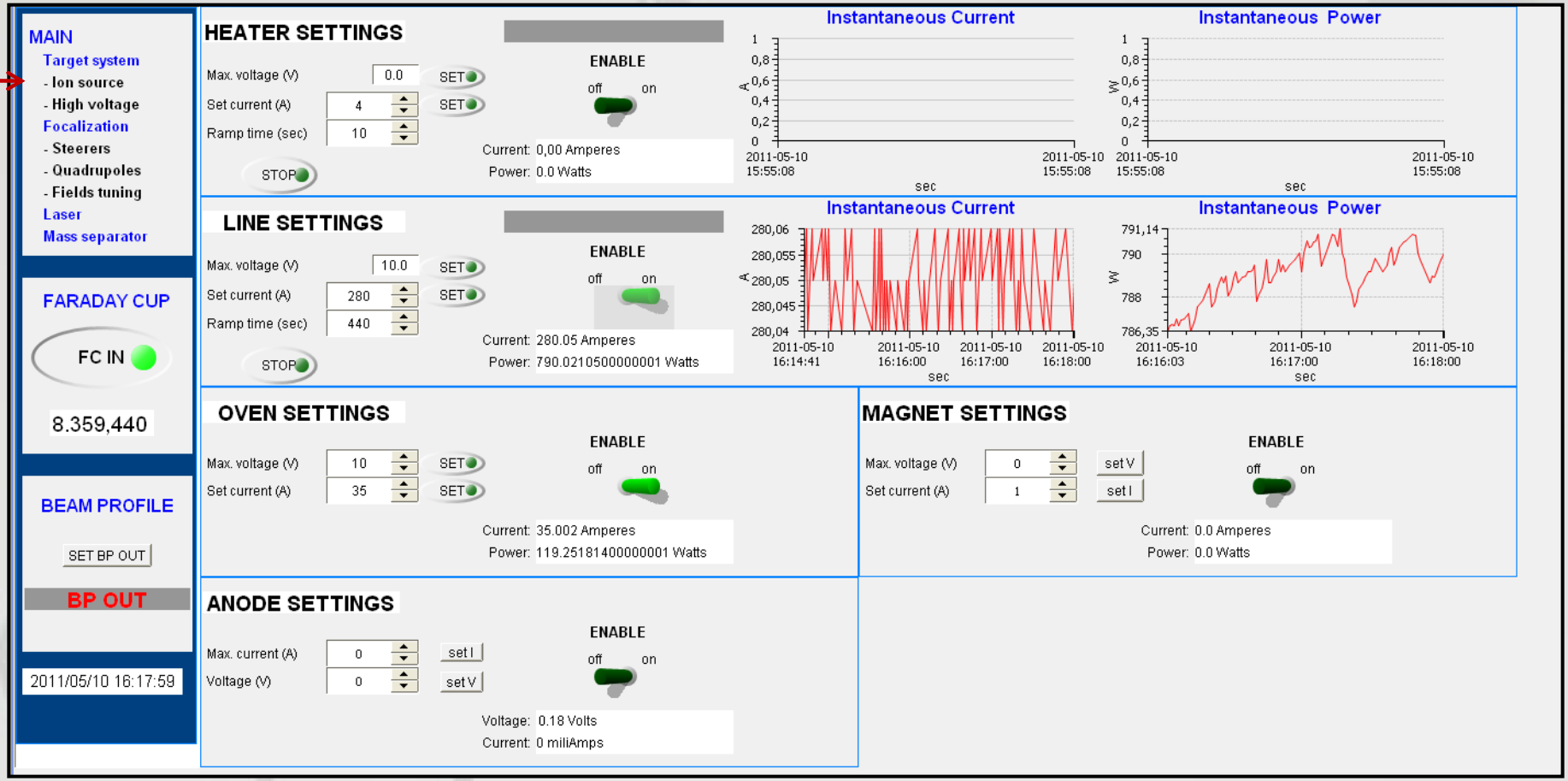
Diagnostic

-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

The Front End Console

control side

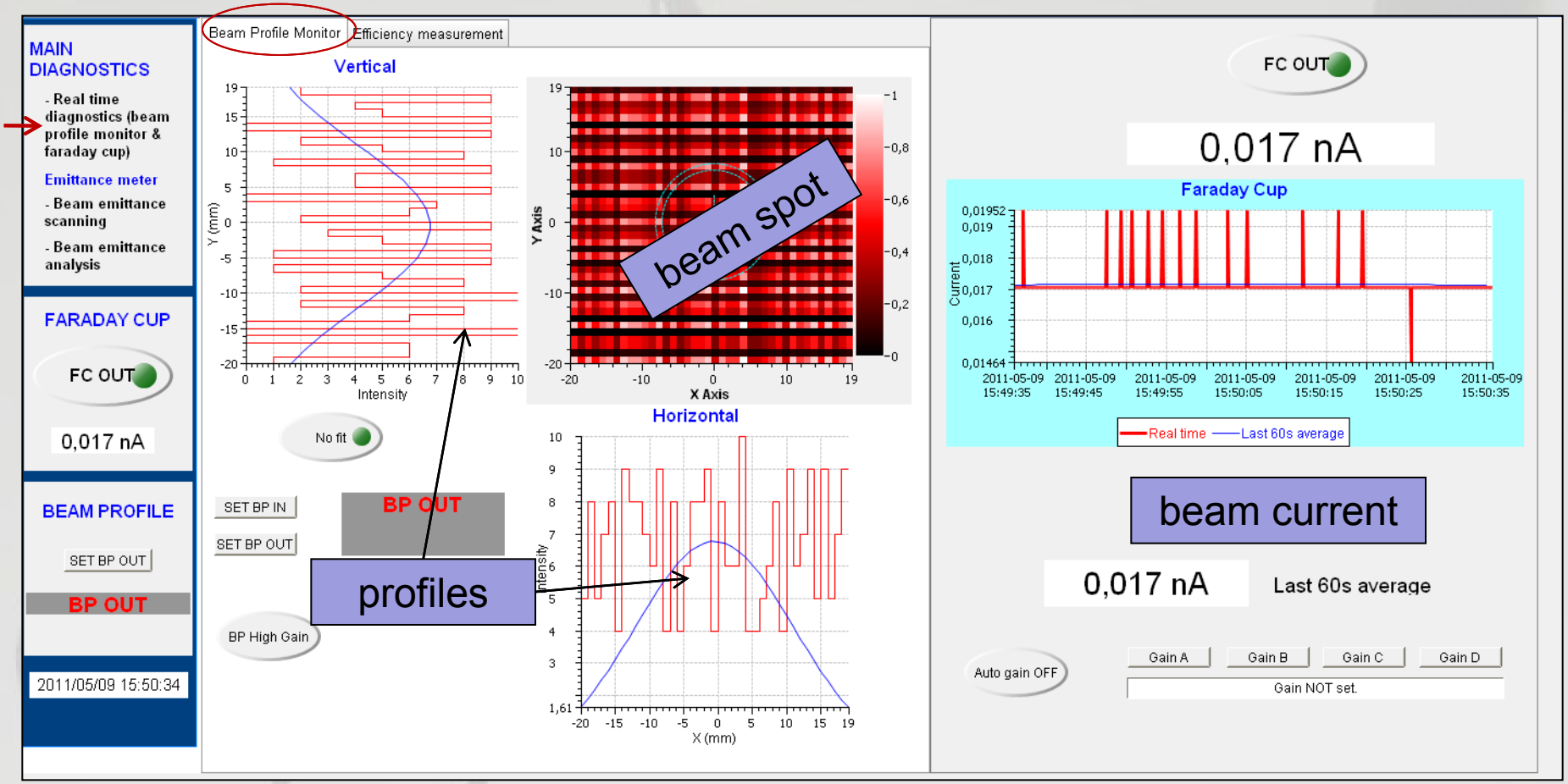
Controls of ion source complex power supplies



The Front End Console

diagnostic side

Beam profile monitor and Faraday cup



The SPES Target: collaborations network

TRIUMF- ISAC

KEK- TRIAC

KoRIA-KOREA

ORNL- HRIBF

CERN- ISOLDE

GANIL-SPIRAL 2

ORSAY-ALTO

SPES

TARGET

INFN- Pavia

INFN- Milano

INFN- Bologna

INFN- LNS

INFN- Padova

UNIPV

UNIPD

UNITN

DSC

DIM

DSC

DEI

DIM

CONTROLS

LASER

ION SOURCES

MATERIALS

HANDLING

Since 2004:

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

The SPES-TIS tree…