The SPES High Power ISOL production target

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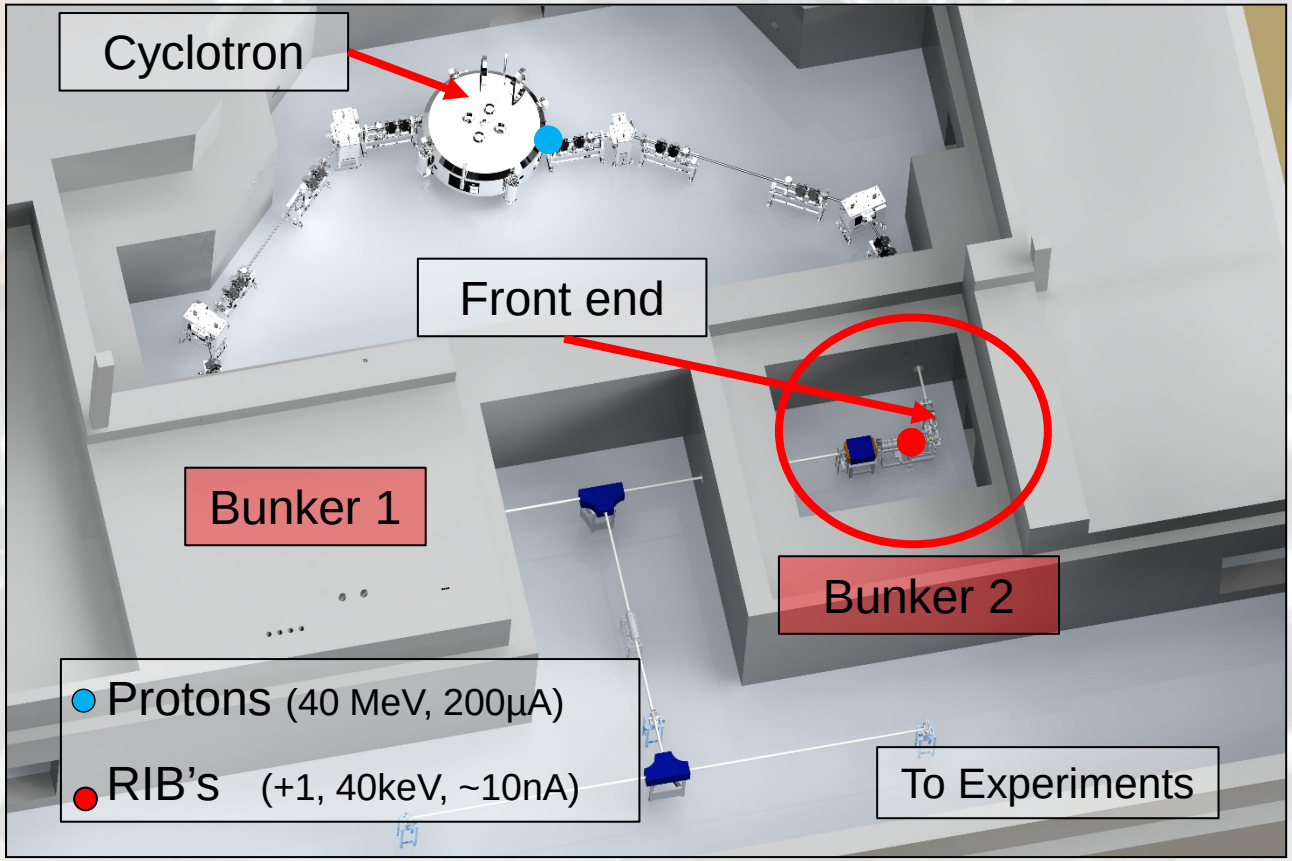
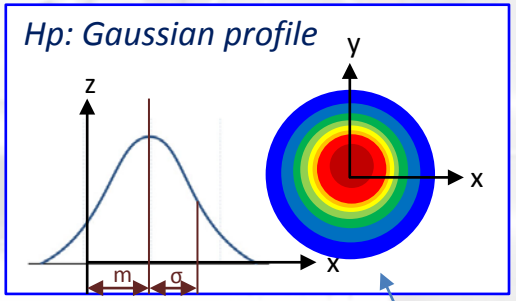
ISOL RIB from SPES

SPES is:

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

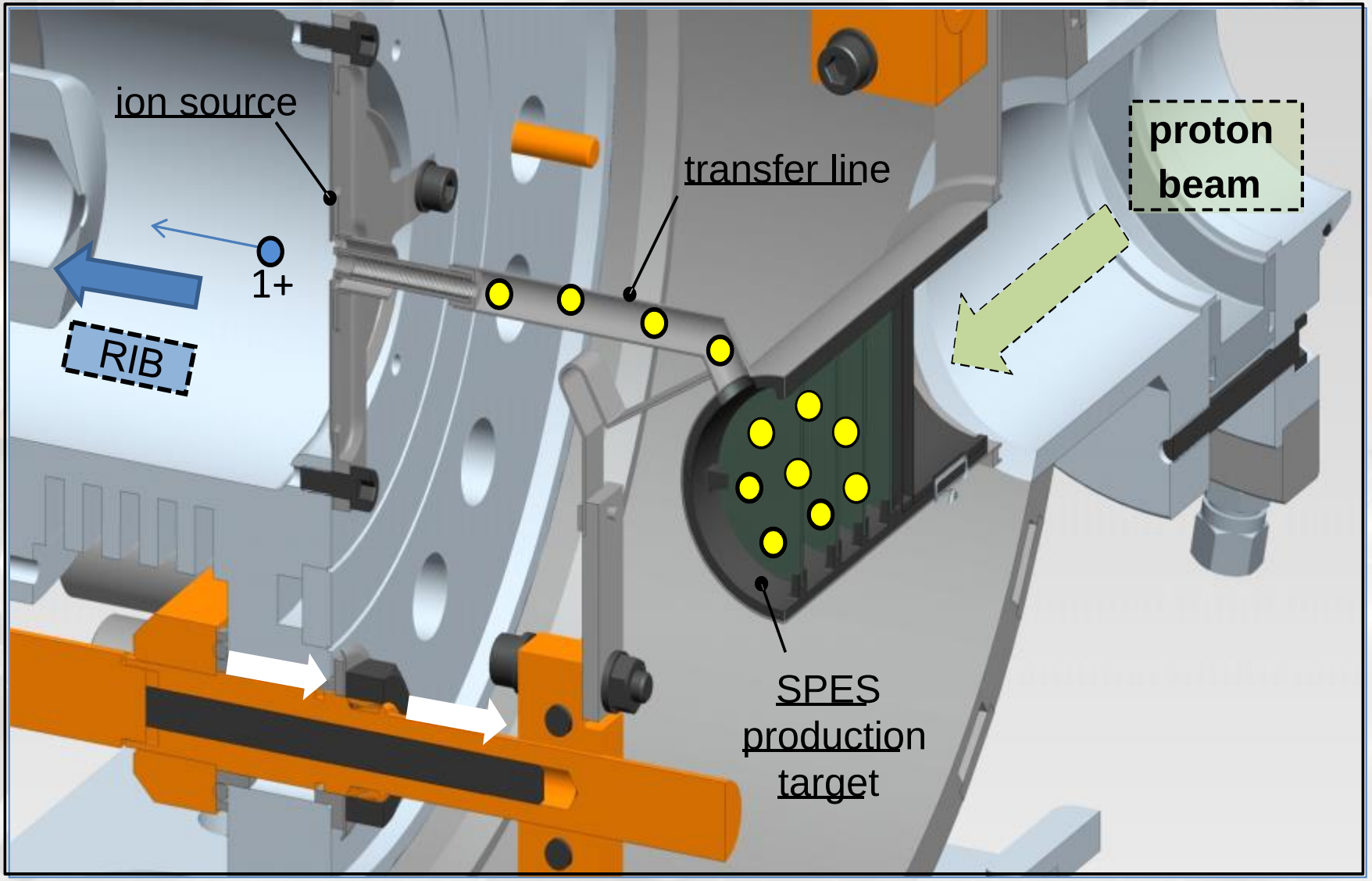


~100 Hz wobbler proton beam

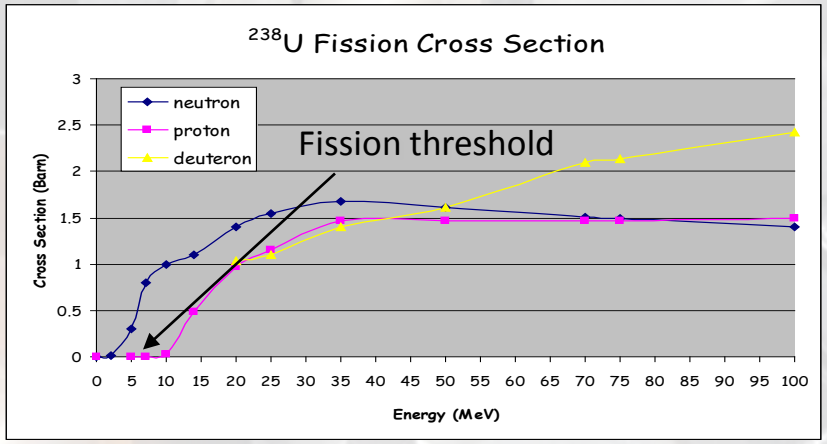


target diameter 4 cm.

The SPES TIS complex



p 40 MeV reaction on ^{238}U target



$$P_i = \Phi_d X_t \overline{\sigma}_i$$

Φ_d = driver beam flux

X_t = target thickness (atoms cm^{-2})

σ_i = production cross section for i

$$\overline{\sigma}_i X_t = \left[n_t \int_{E0}^{E1} \frac{\sigma_i(E)\,dE}{dE/dx} \right]$$

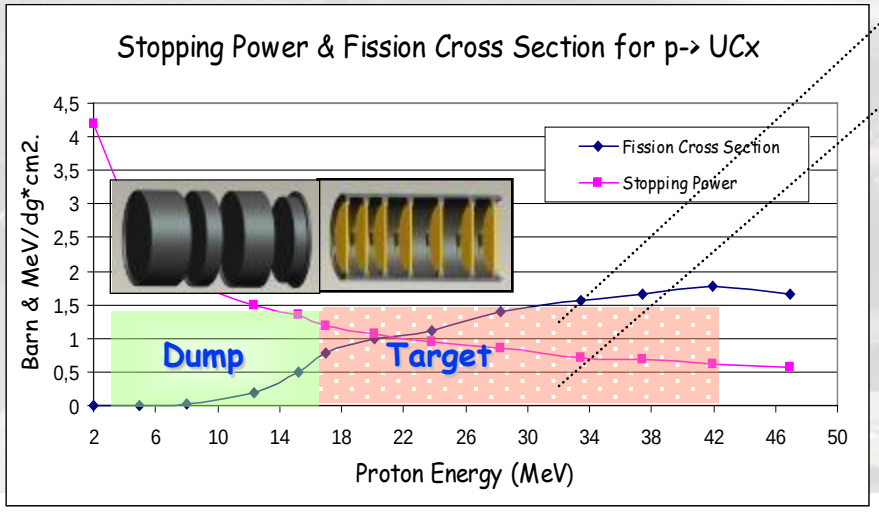
Cross Section

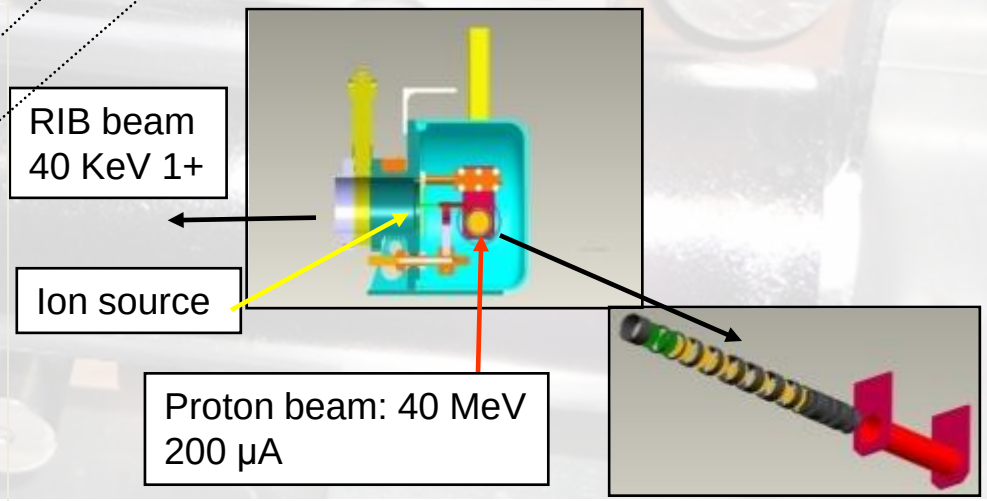
Stopping Power

10 ^{13} f/s are possible -> Question: how to dissipate the EM Power?

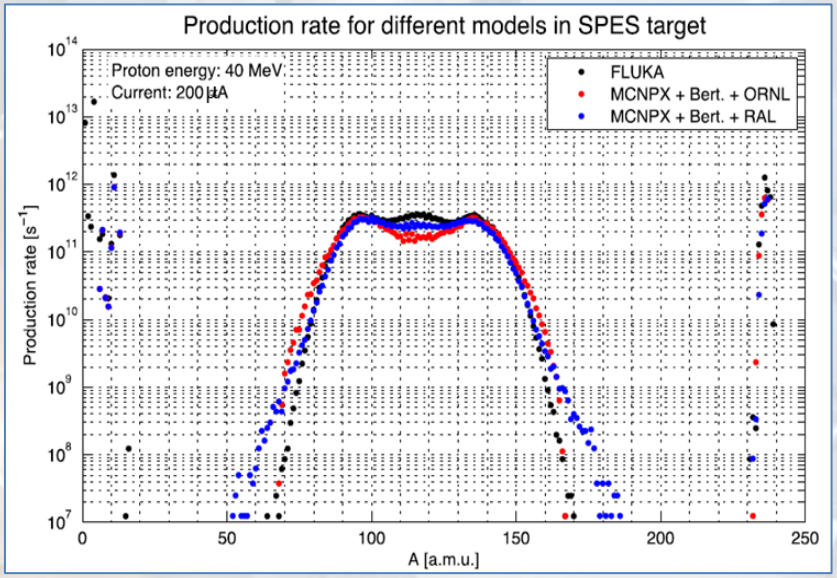
1) MULTIPLE SLICES (radiator) : increase the radiation surface area and high ε (P= ε·σ·S· T^4 Stefan-Boltzmann law)

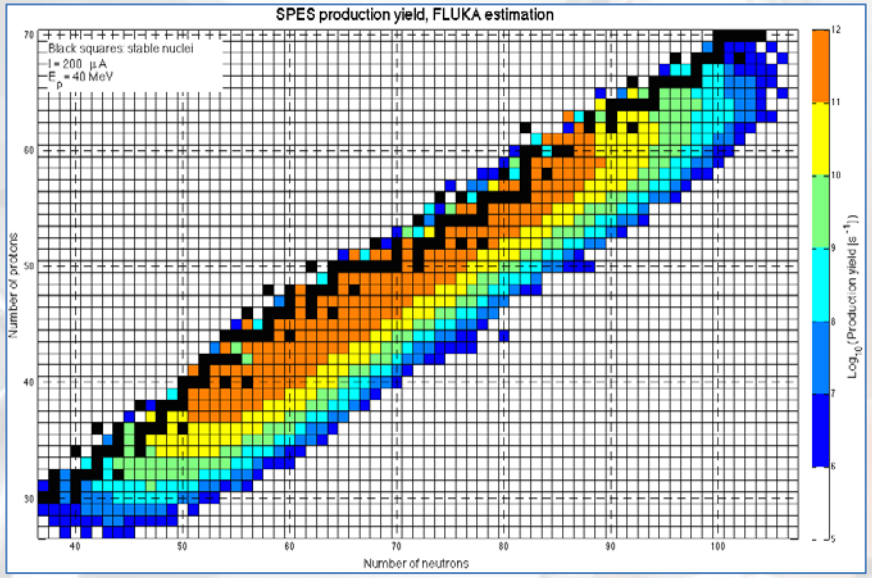
2) DUMP : send the proton with low fission rate & high stopping power value

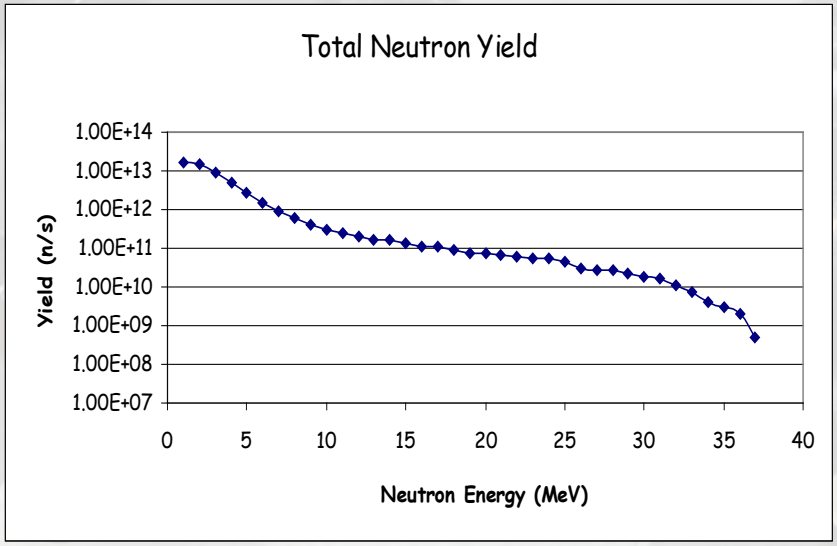


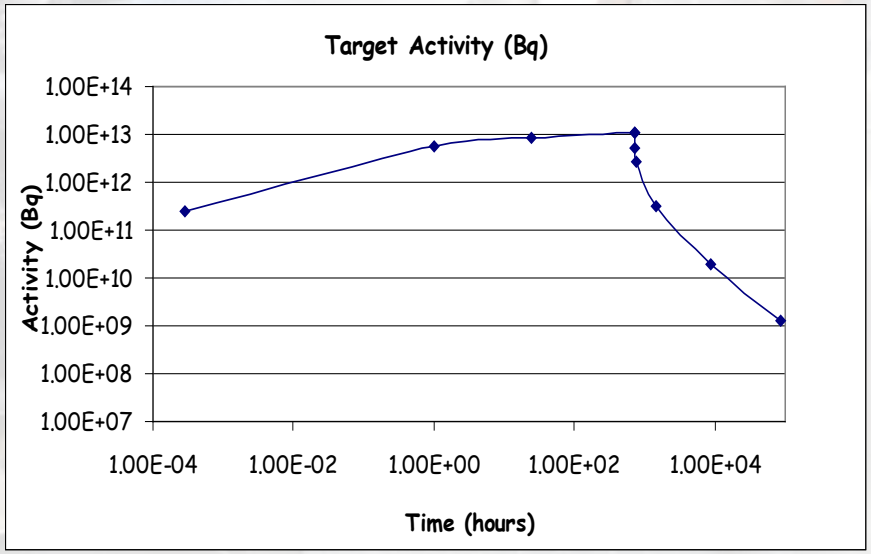


In target productions



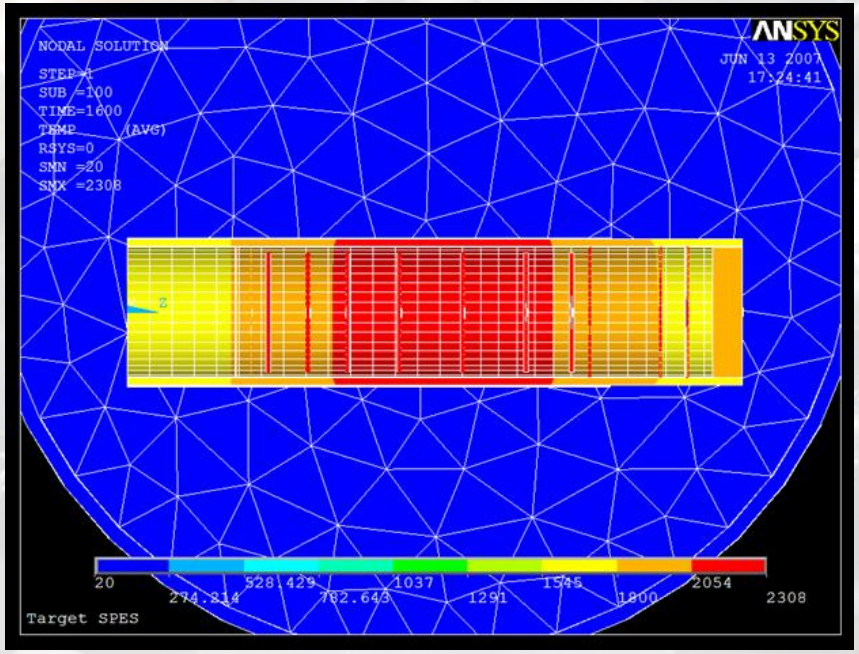




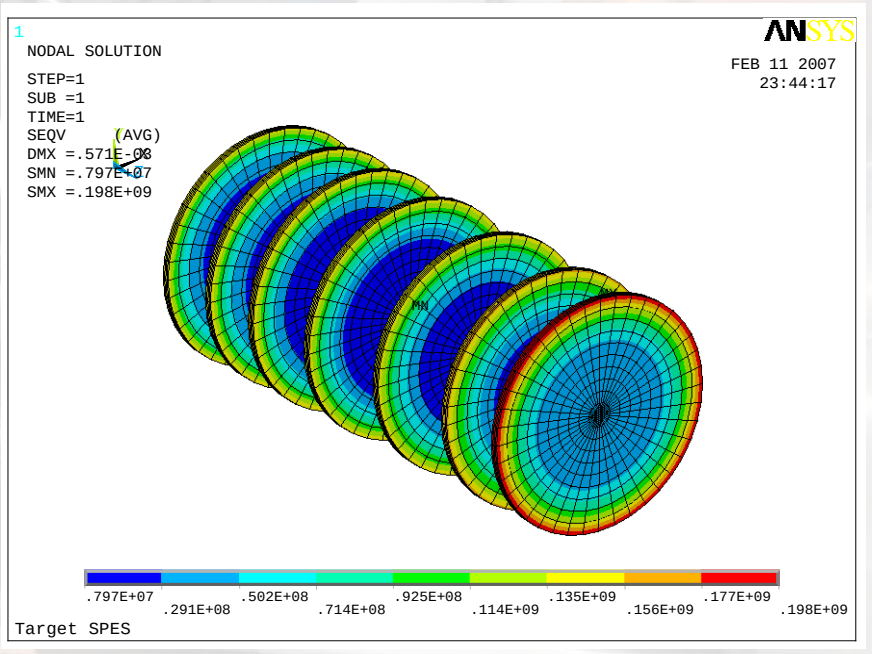


Thermo-mechanical calculations

Temperature distribution in the UCx discs -> uniform as possible

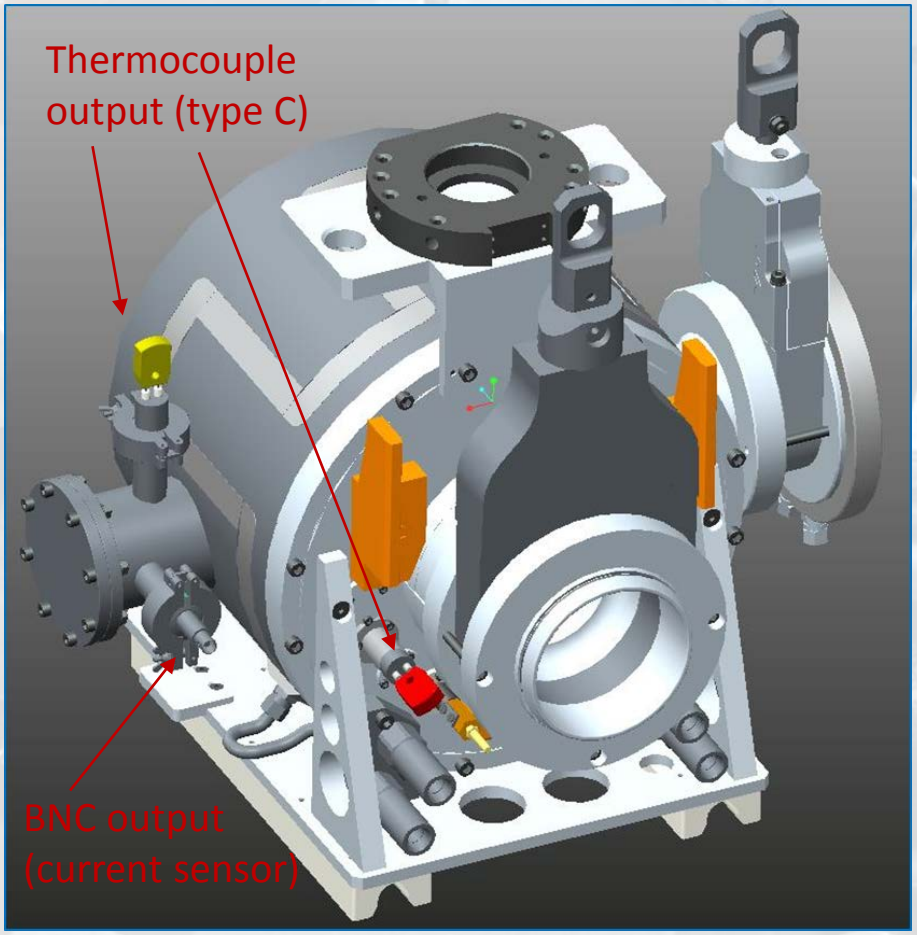


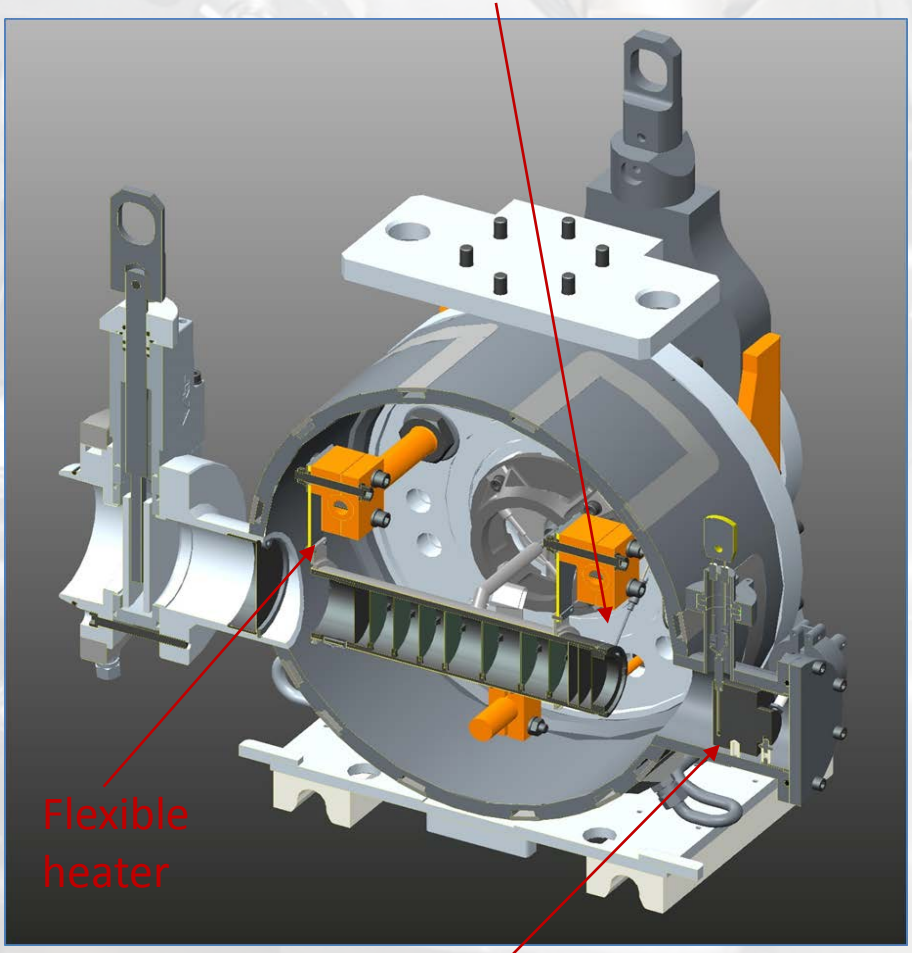
Discs thermal stress (equivalent stress) -> less than literature data



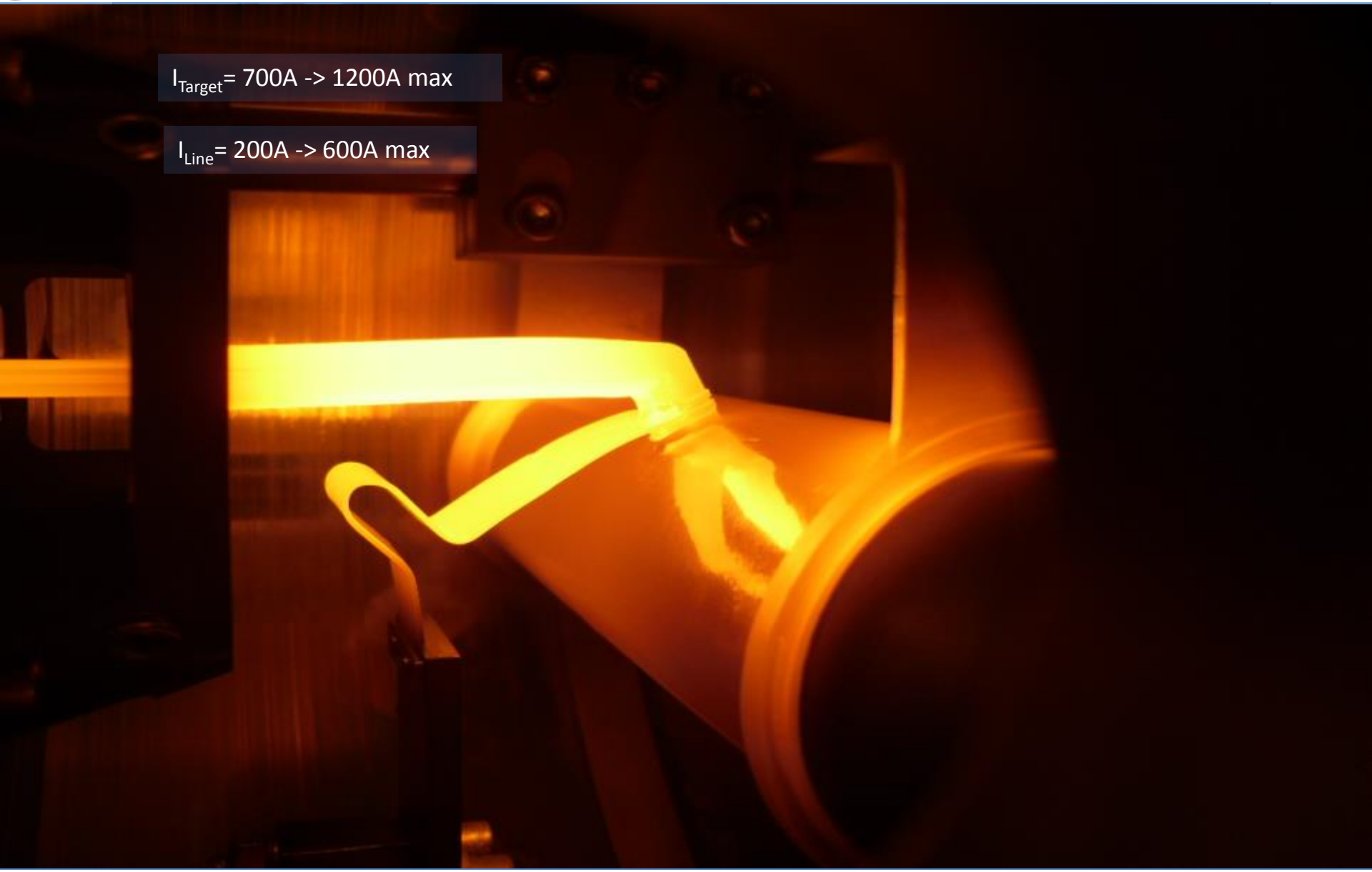
The Target Unit device

Taking into account the safety requirements

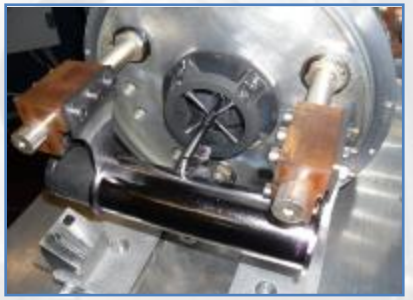




The target & ion source assembly



WP6: The organization & Labs

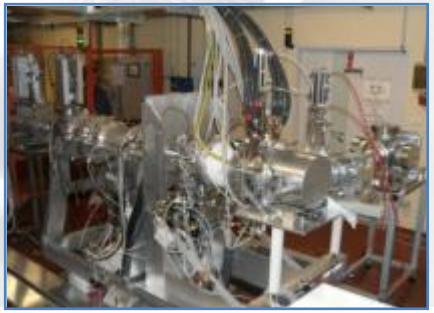


WG1:
Target and Ion Sources

WG2:
Target Materials

WG3:
Laser Ionization

WG4:
Handling



WG5:
Front End

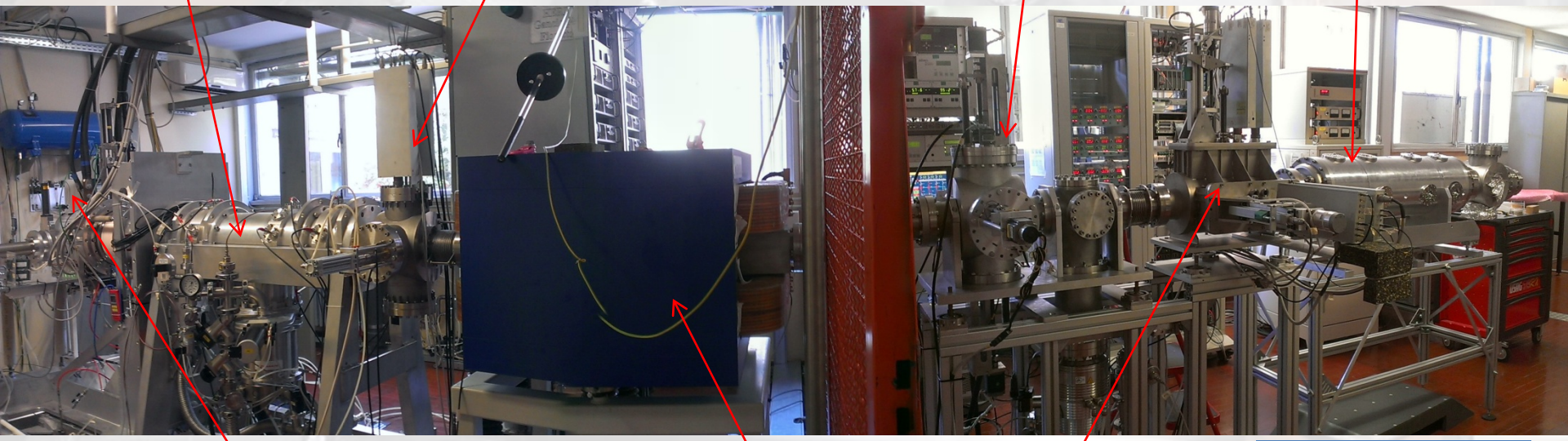
The SPES RIB LEBT (off-line lab)
Ion Source test area

Steerers and triplet of quadrupoles

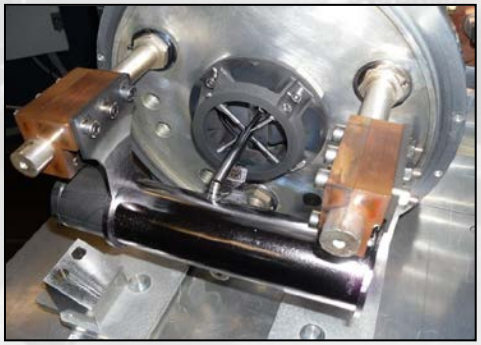
Diagnostic box (FC+BP)

Slits and diagnostic box (BP+FC)

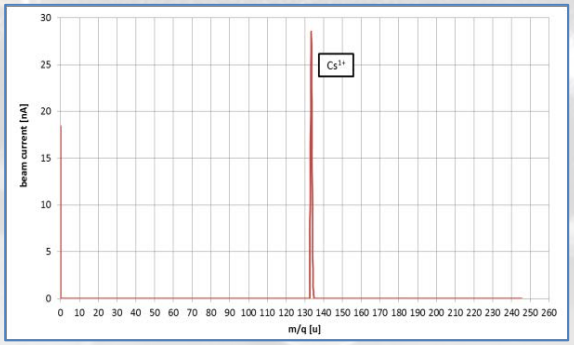
Second triplet of quadrupoles



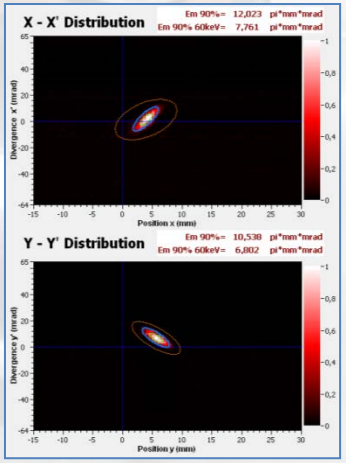
Target-ion source



Wien filter



Emittance meter



The ionization methods

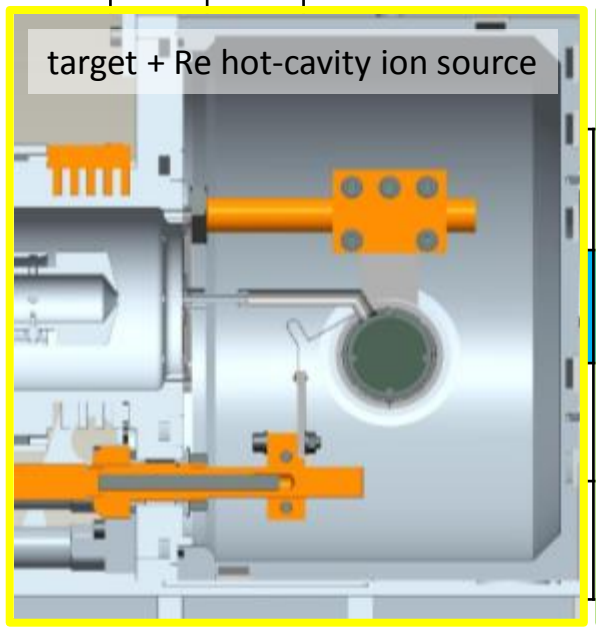
surface ionization mechanism

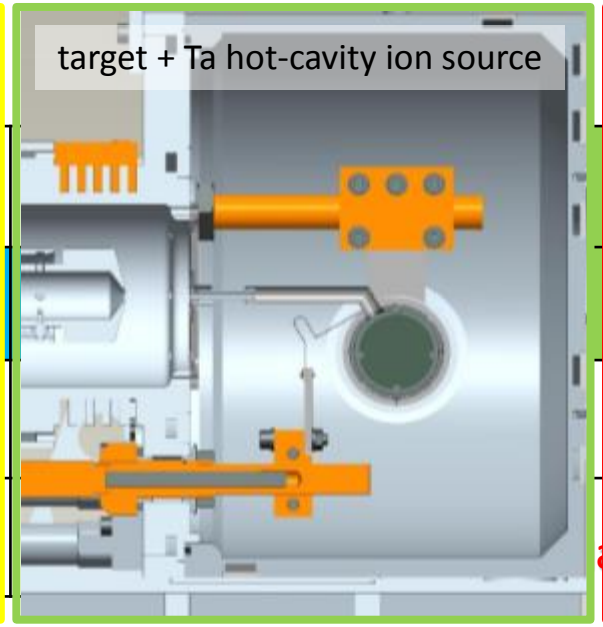
laser ionization mechanism

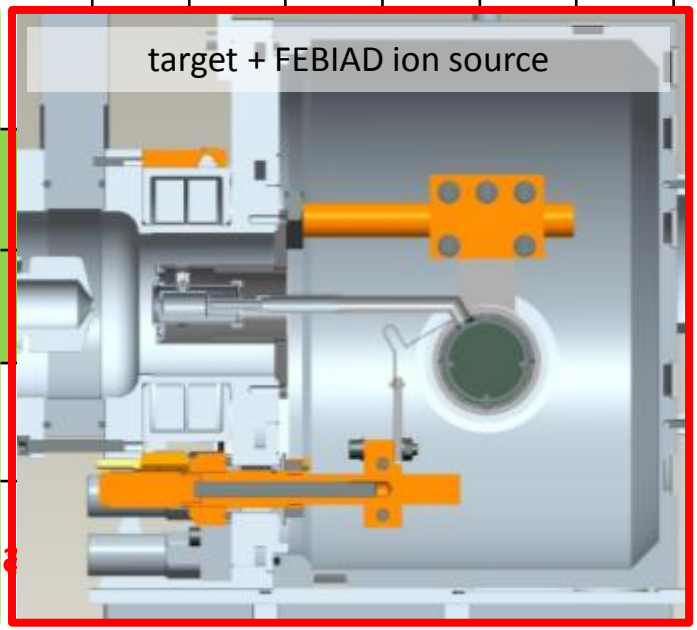
electron impact ionization mechanism

not extracted (bad volatility)

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



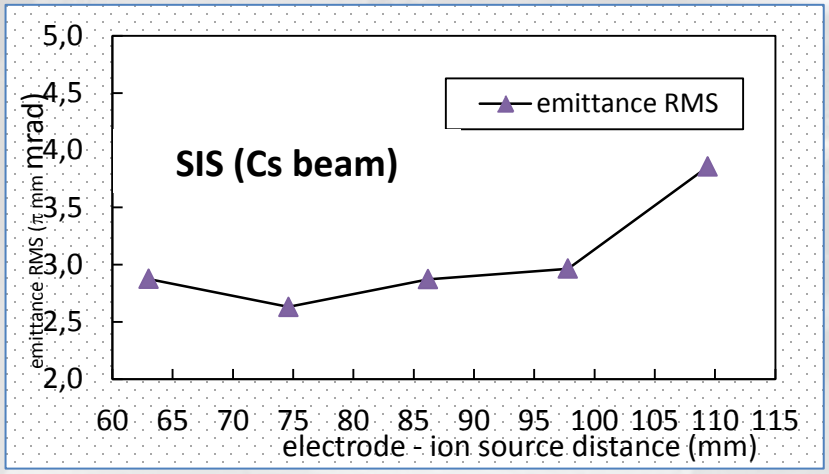




Ion Source Developments

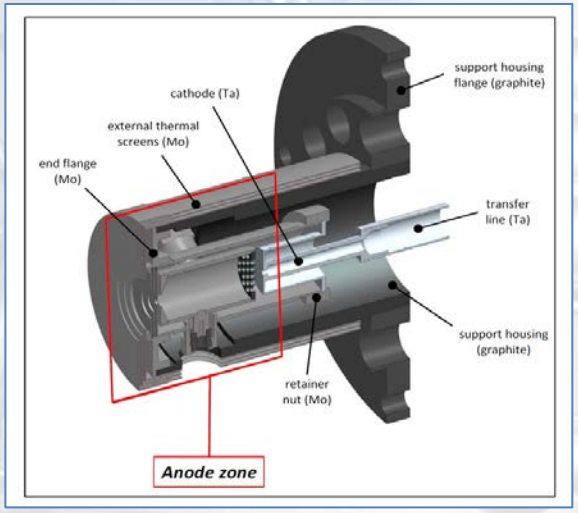
The SIS Ion source

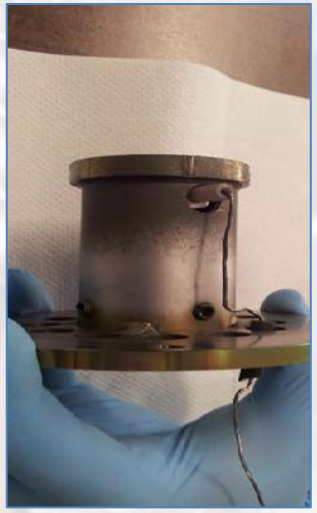
Efficiency measurements at different temperatures (1600°C, 1800°C, 2000°C, 2200°C) for Cs, Rb, Sr, Ba

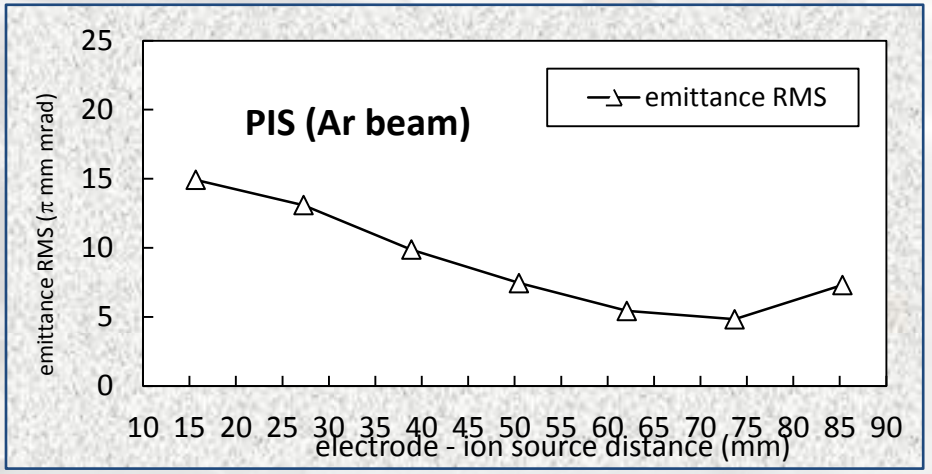


The PIS Ion source

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





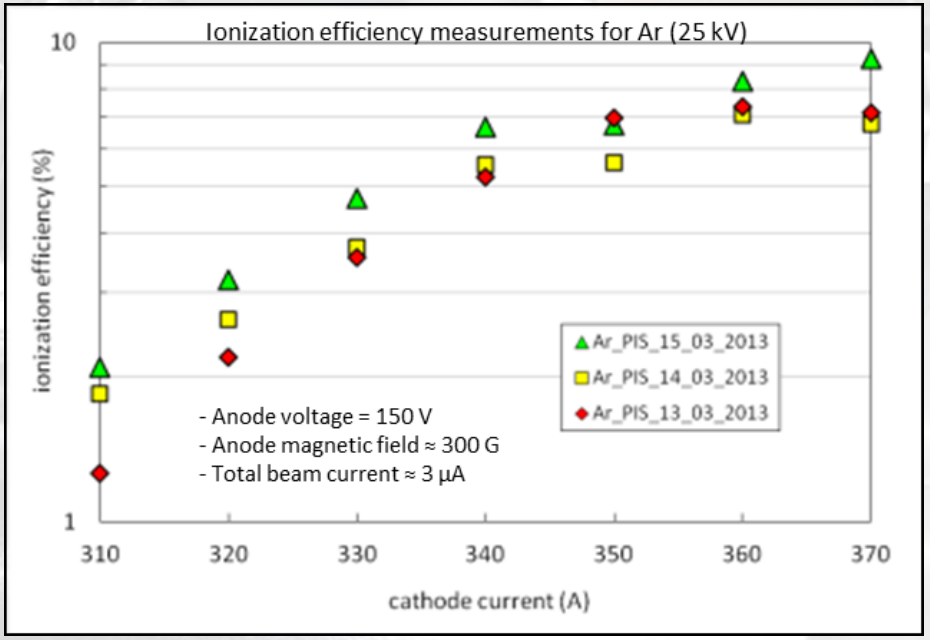


Ion Source Developments

> Efficiency measurements for SIS

Element	Ta	T = 2200 °C	
(/)	(eV)	ε_{CLEAN} [%]	Dev. St. [%]
Cs	3.90	41.6	1.1
Rb	4.20	49.6	3.1
Ba	5.20	19.6	3.1
Sr	5.70	6.0	1.3

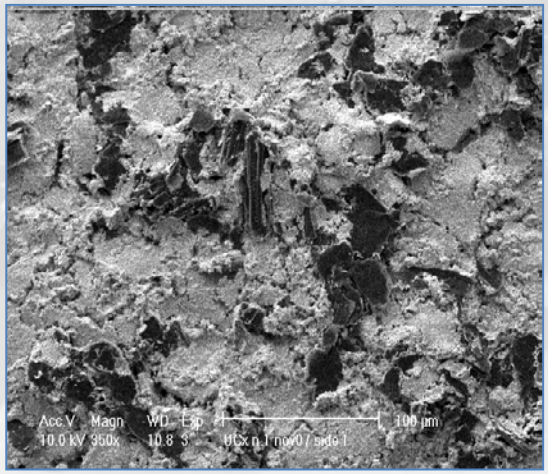
> Efficiency measurements for PIS



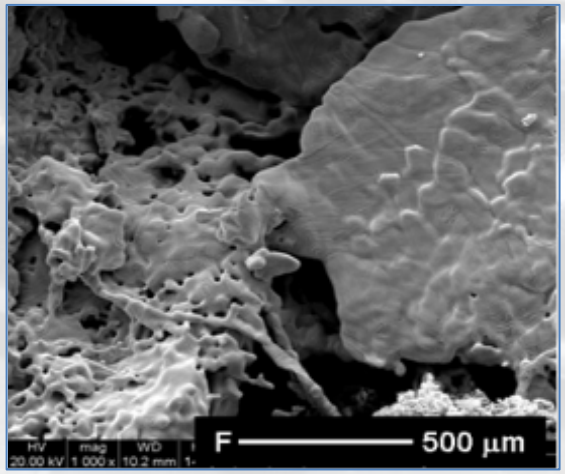
Target production

Study of the target porosimetry on the isotopes production yield

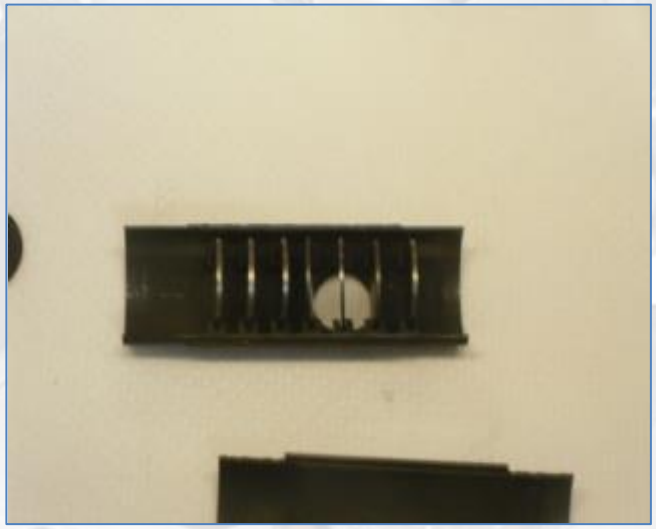
2010 Test
Standard UC_X



2011 Test
Low density UC_X



2012 Test
Medium density UC_X

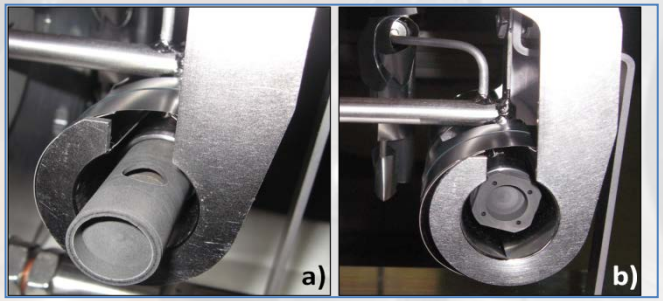


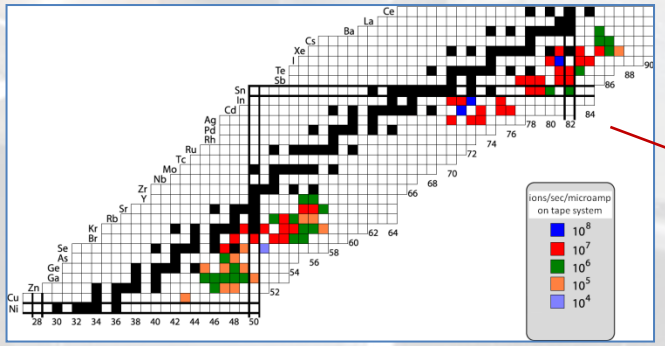
	2010	2011	2012
Density (g/cm^3)	4.25	2.59	6.38
Diameter (mm)	12.50	13.07	12.91
Thickness (g/cm^2)	0.41	0.41	0.41
Calculated porosity (%)	58	75	37

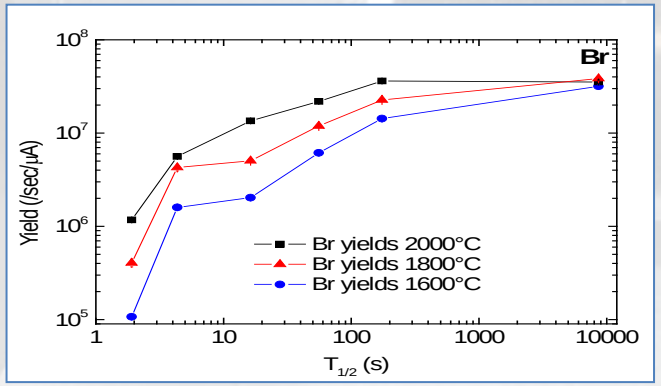
Experimental tests at HRIBF

Irradiation by 40 MeV, 50 nA proton beam, ionization with plasma ion source

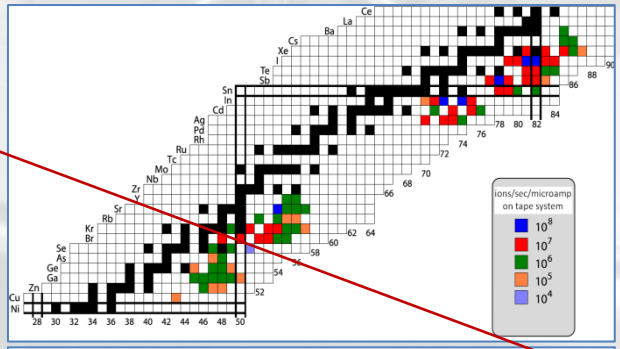
2010 Test
Standard UC_X

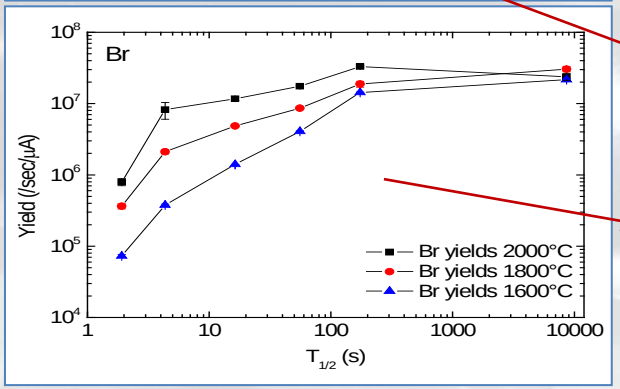






2011 Test
Low density UC_X





2012 Test
Medium density UC_X

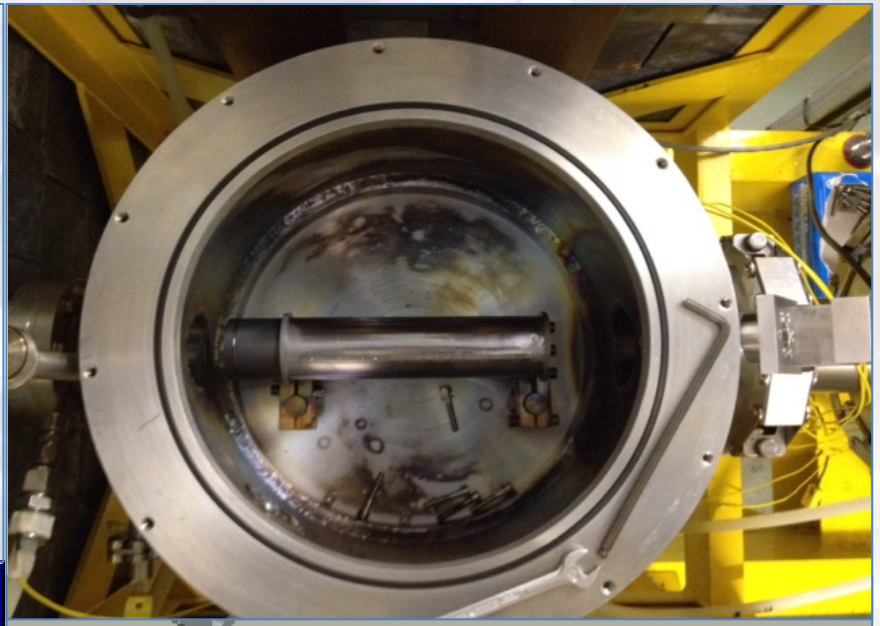
- Targets tested at 3 different T: 2000°C, 1800°C and 1600°C
- 20 elements, about 80 isotopes collected
- Yield vs. half-life characterization

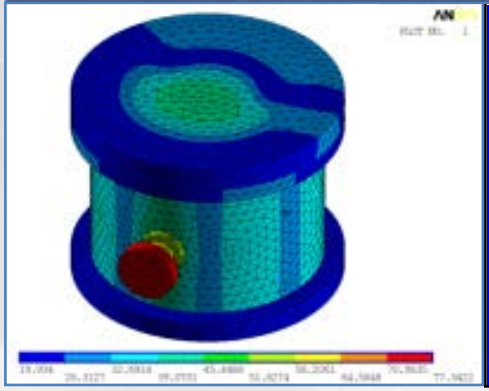
TM: Ithemba test

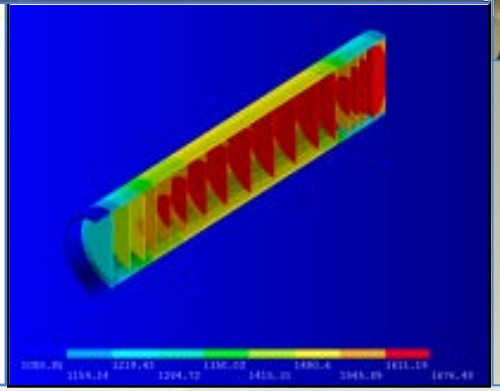
4) Full scale (40 mm.) SiC @ Ithemba, p=66 MeV, 60 microA for thermal dissipation studies

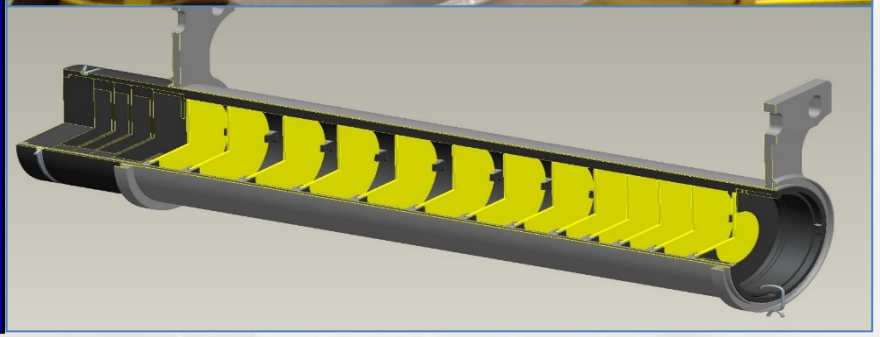
- On-line testing of the SPES target architecture @ iThemba (May 2014)

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



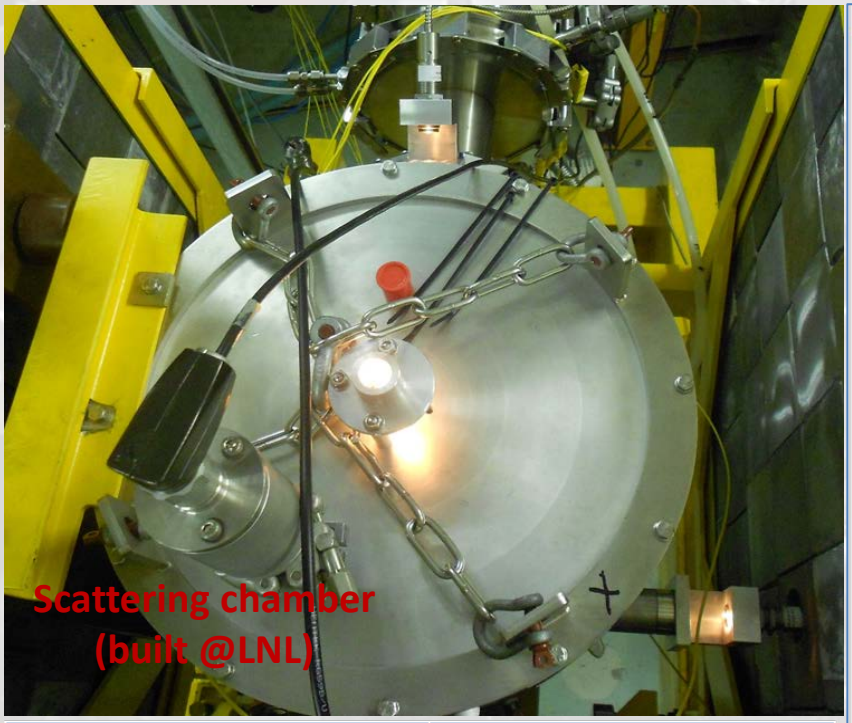




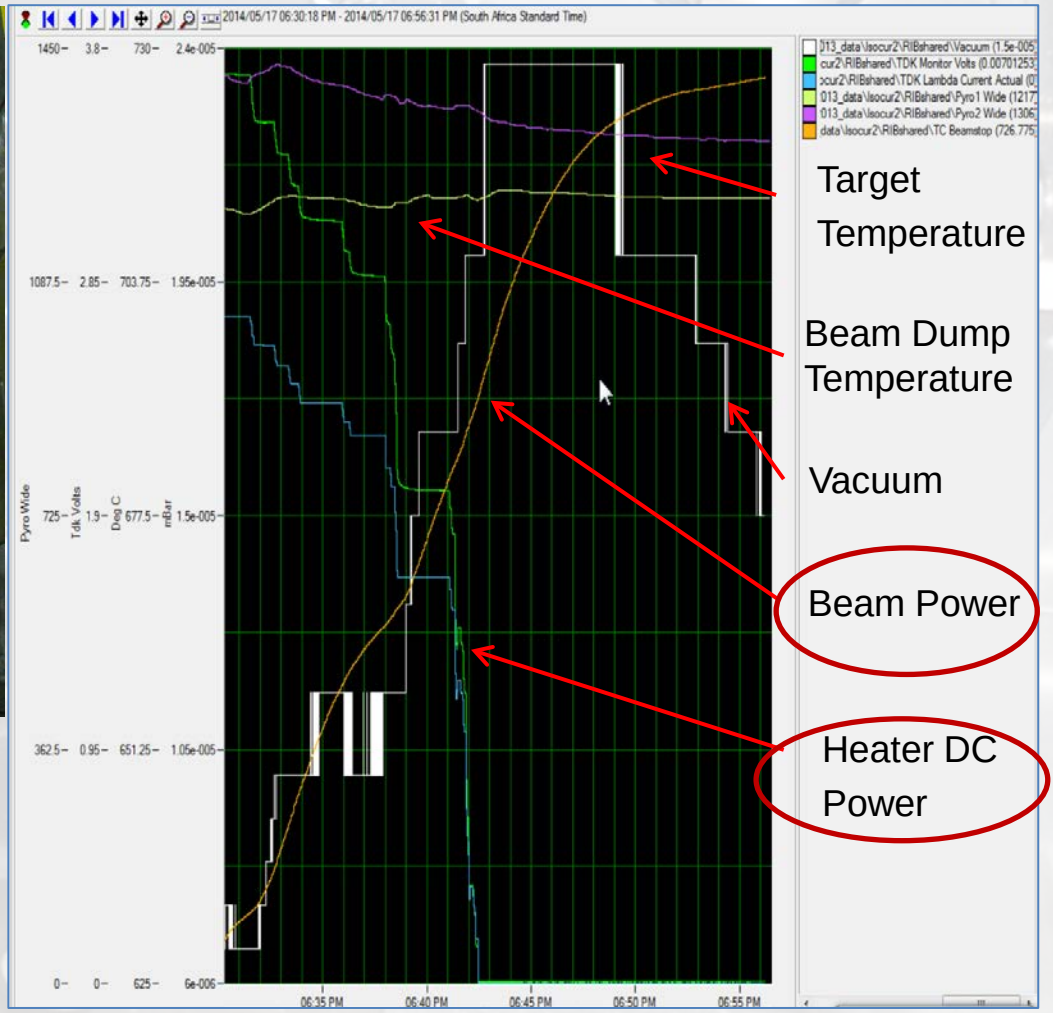


TM: Ithemba test

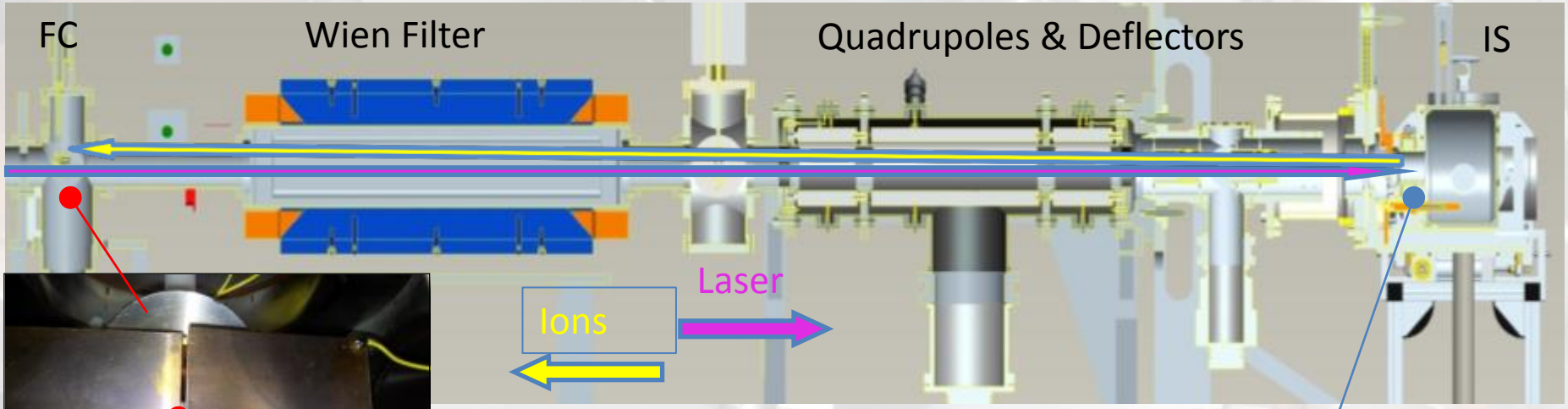
- On-line testing of the SPES target architecture @ iThemba (2013-2014)
- 66 MeV, up to 60 μA - proton beam on a SiC target (T_{max} on SiC =1600°C)

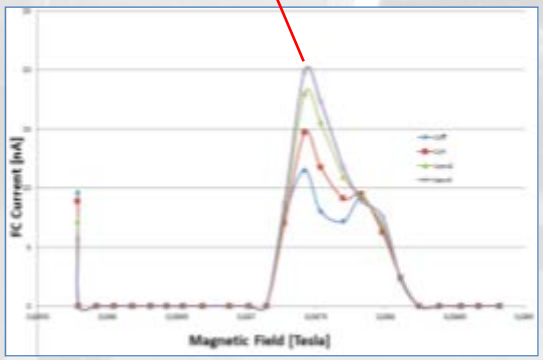


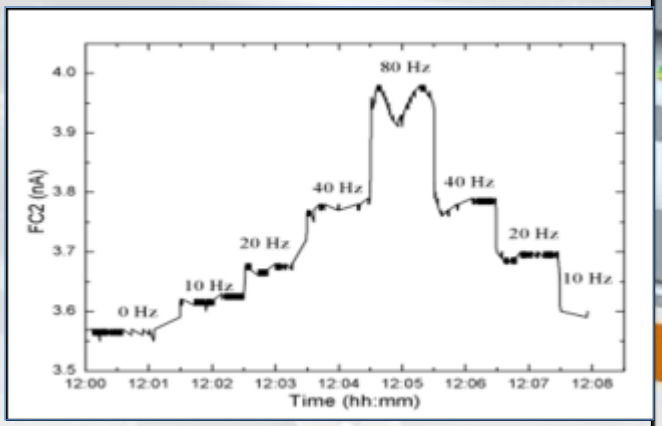
Measure [°C]	Estimated by FEM model [°C]
1° disk: 1365 ± 30°C	1390
Box: 1230 ± 25°C	1267
Dump on chamber: 728°C ± 10°C	750

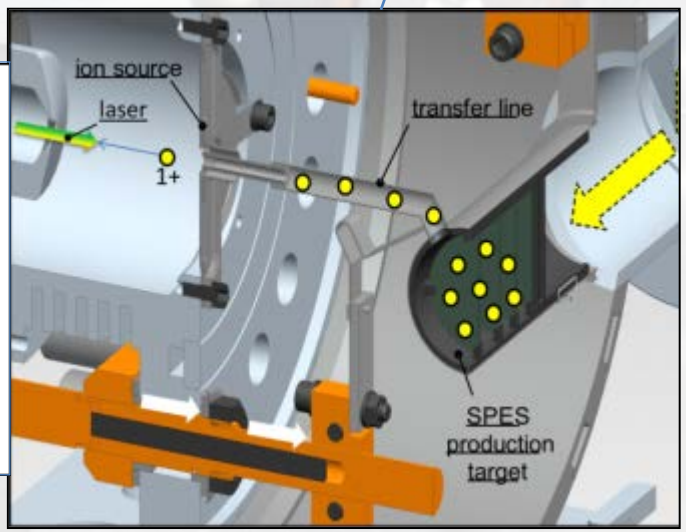


TL: photo-ionization of Al in hot cavity



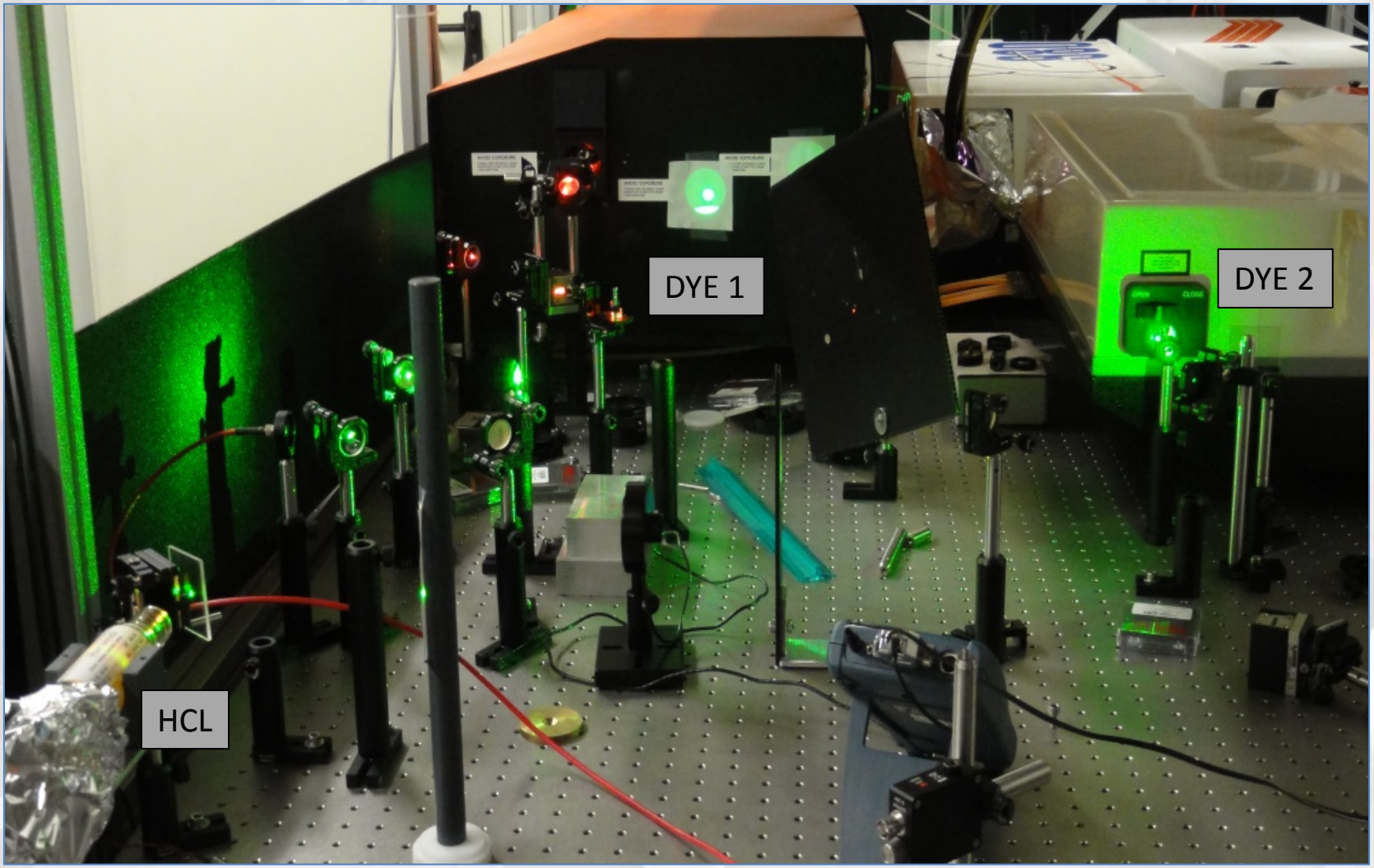






TL: Germanium spectroscopy study

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

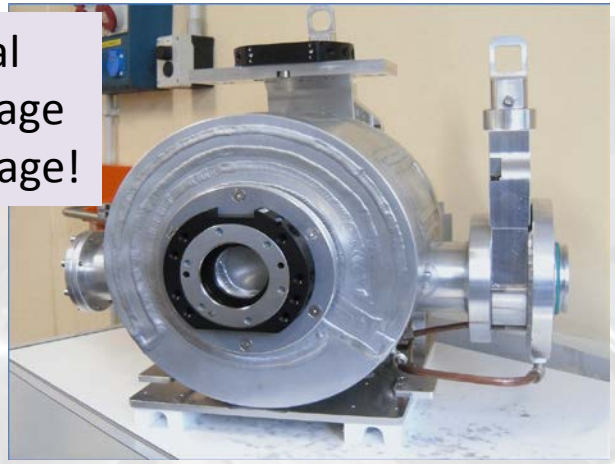


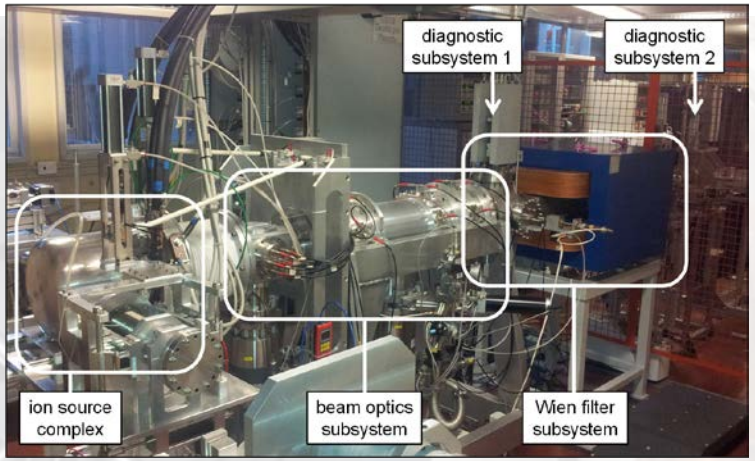
5 first step transitions and 7 second transitions were tested successfully

Radioactivity: The critical points

1) Neutron activation

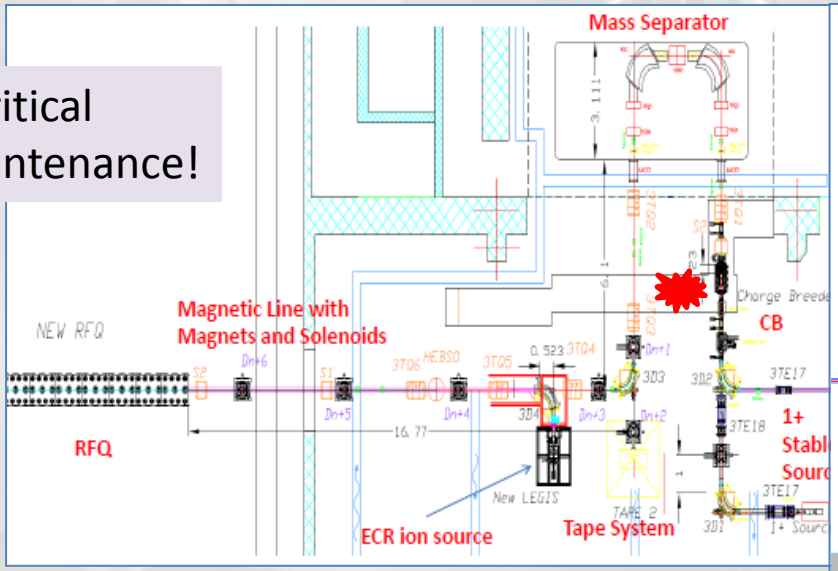
Critical for damage and storage!

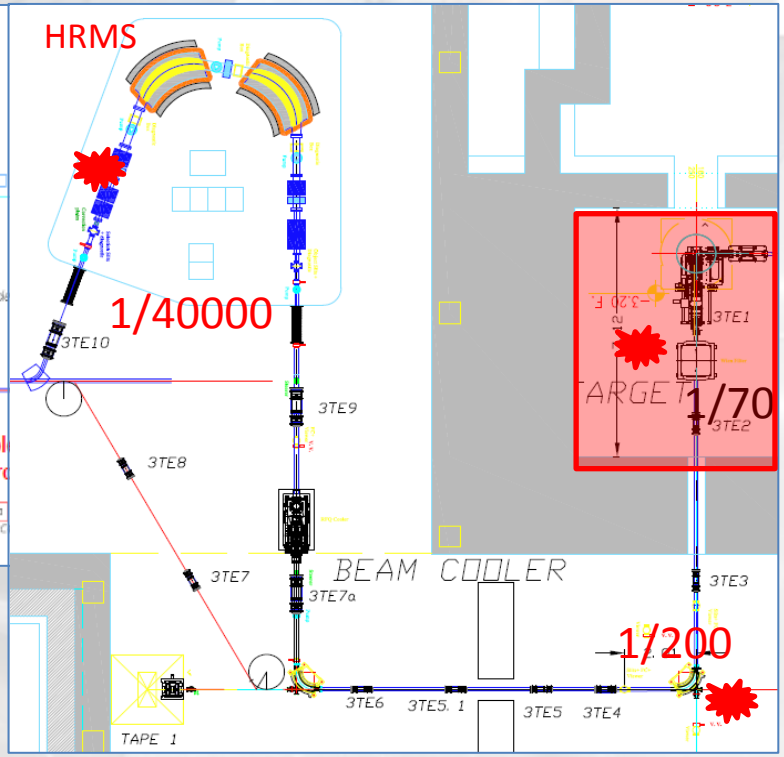


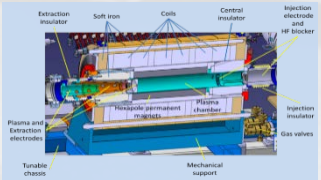


2) Radioactive beam hot-spot

Critical for maintenance!



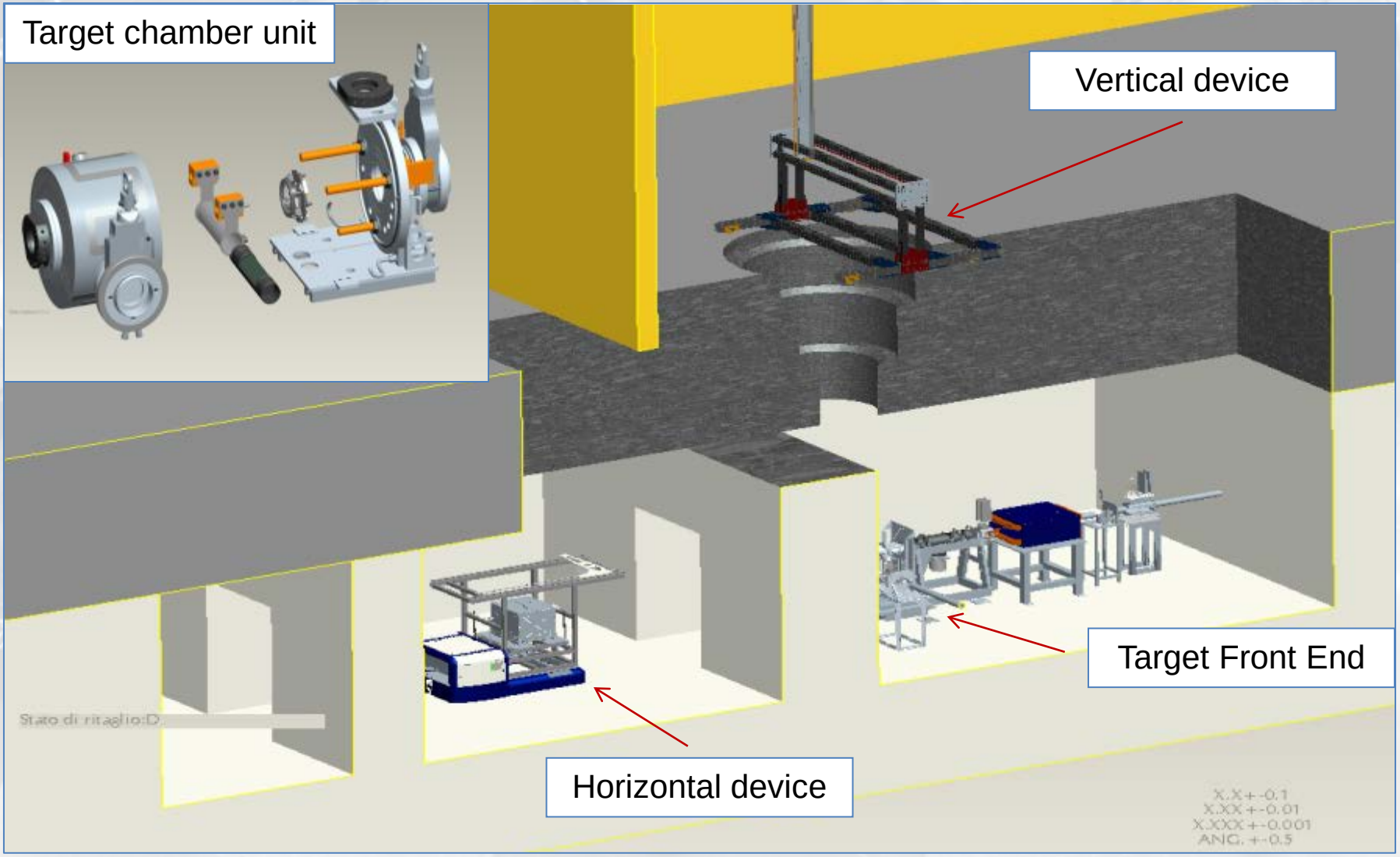




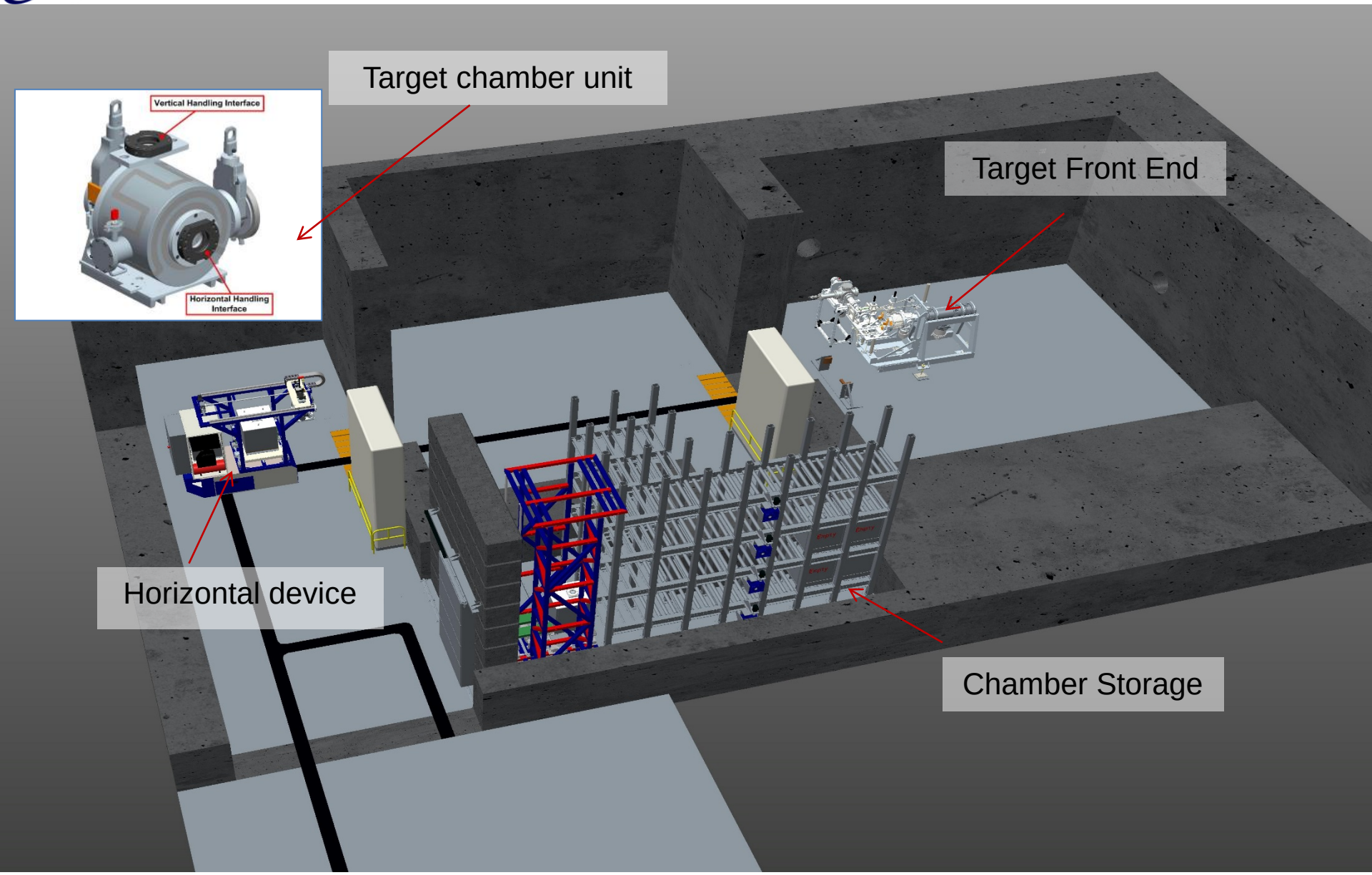
Charge Breeder: Loss of 90% of radioactive beam

The target chamber handling

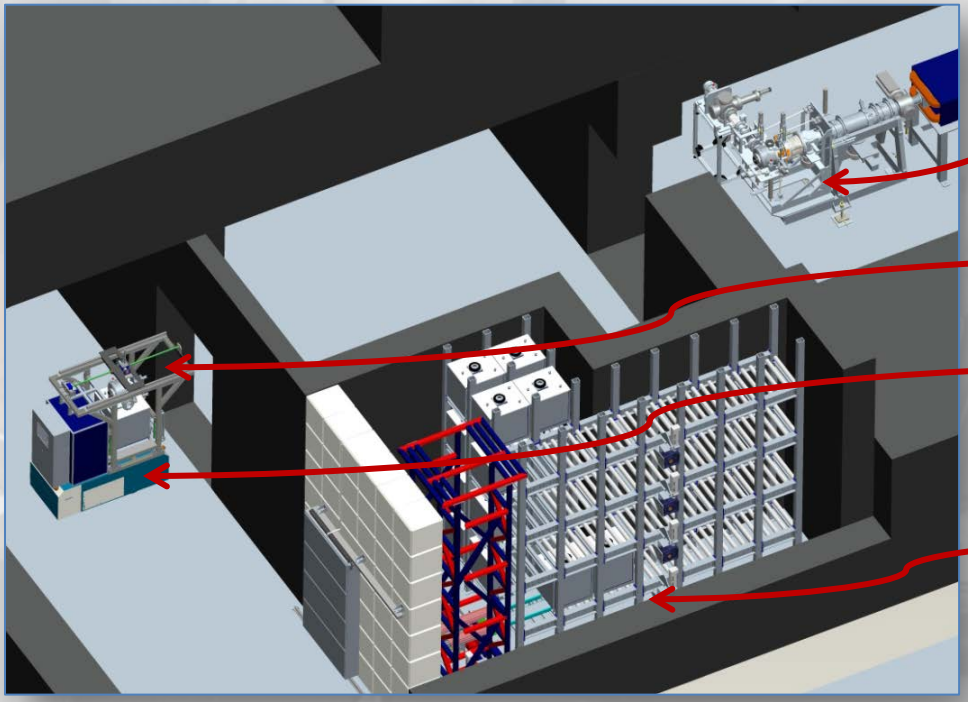
Two systems are foreseen in order to increase the handling security level



TH: The handling overview



The Horizontal system: 4 phases



1) Coupling table handling

2) Cartesian handling

3) AGV trip

4) Storage handling

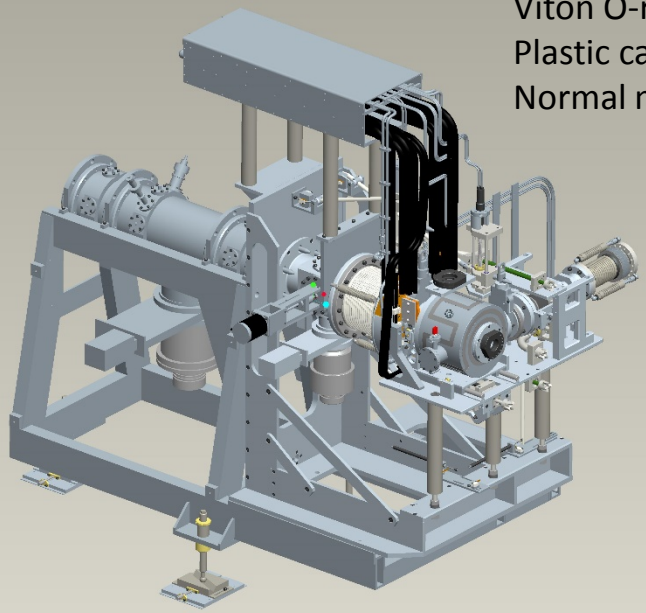
Temporary test lab (from Sept '14)

TFE: On- Line FE

RAD-HARD version

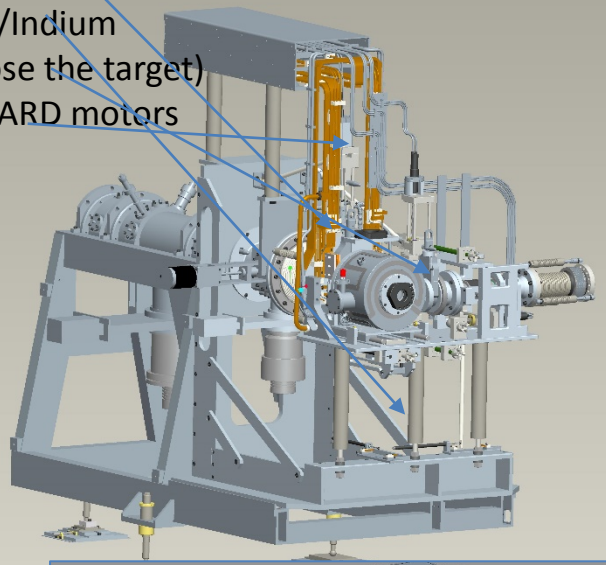
Critical materials

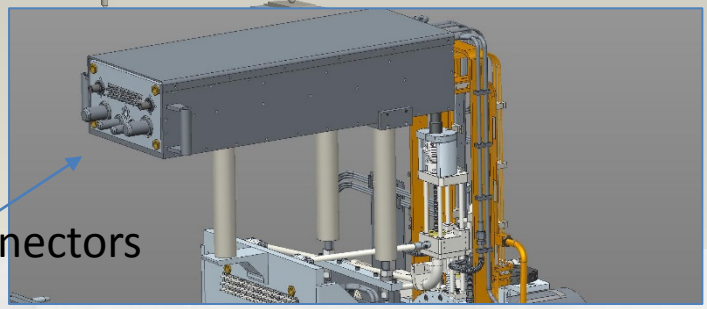
Off-line FE



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





fast connectors

TFE: Critical components

Platform Insulator:

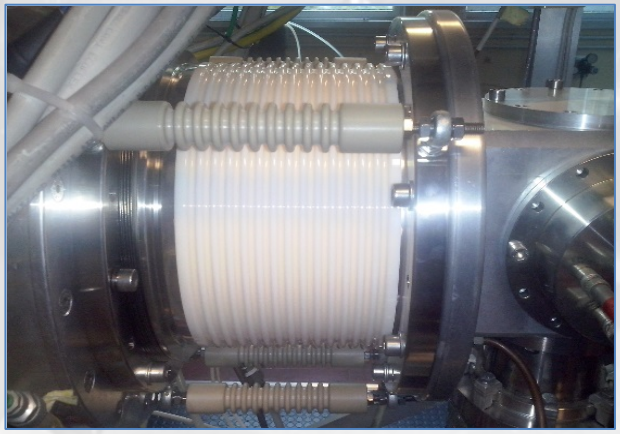
Teflon with glass fibres

Plastic support Insulator:

Polyethylene

ITALBRAS Part of umicore

Ensinger

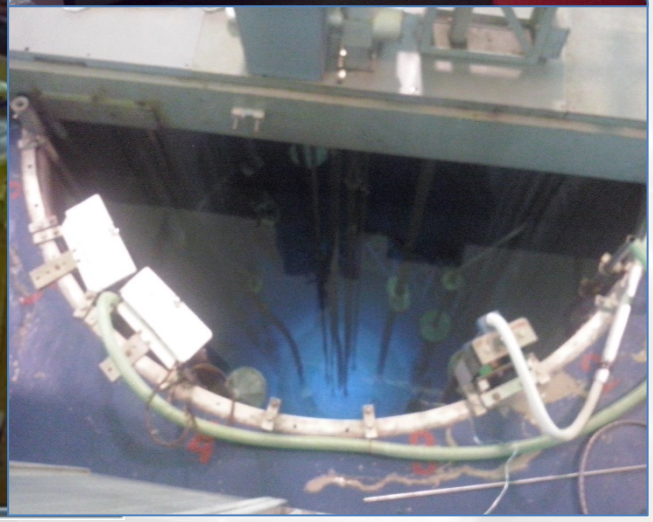


Alumina insulator brazed with SS bellow

Peek

TFE: Measurement of neutron damage (9/11)

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

SPES EB : a large collaboration network…

ITHEMBA
RISP-KOREA
ORNL- HRIBF

CERN- ISOLDE
GANIL-SPIRAL 2
ORSAY-ALTO

SPES
Exotic Beam

INFN- Pavia
INFN- Milano
INFN- Bologna
INFN- LNS
INFN- Padova

UNISI
UNIPV
UNIPD
UNITN
UNIBS

DSF
DEI
DIM
DSC
DEI
DTG
DIM
DIM

CONTROLS

LASER
ION SOURCES
MATERIALS
HANDLING
FRONTEND

33 Master Thesis
34 Bachelor Thesis
3 PhD Thesis
15 Foreign Scientist (FAI)

The SPES-TIS group