



CERN TARGETRY ACTIVITIES

5/10/2012

A non-exhaustive review

Outline

2

□ CNGS

- Development, Design tools, Manufacturing, Installation, Operation

□ nTof

- Target history, Design tools, New cooling and moderator circuits, Operation

□ ISOLDE

- Target concepts and strengths, Installation & Operation, Storage
- Static molten Pb/Bi bath

□ Molten metal target activities

- MERIT free Hg jet target
- Offline molten Pb loop

3

CNGS

Development

Design tools

Manufacturing

Installation

Operation

Thanks to R. Losito, D. Grenier

□ Design development

- Target rod: C (2020PT), SC24 & CC Aerolor A035
- Vacuum / 0.5bar He

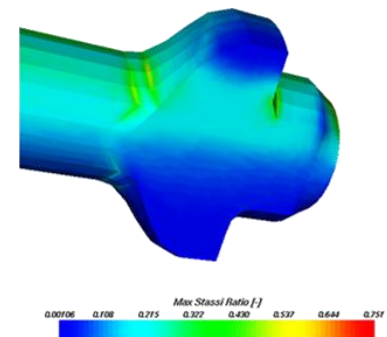
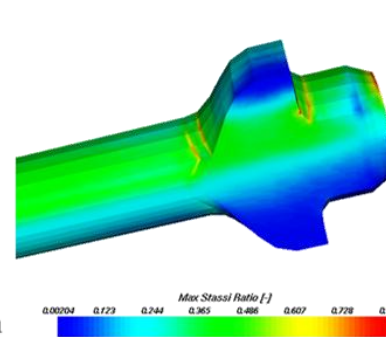
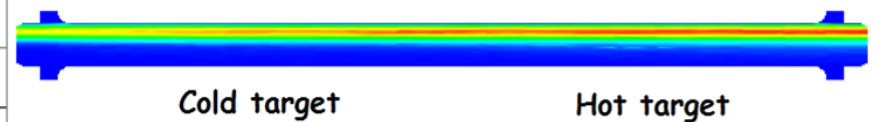
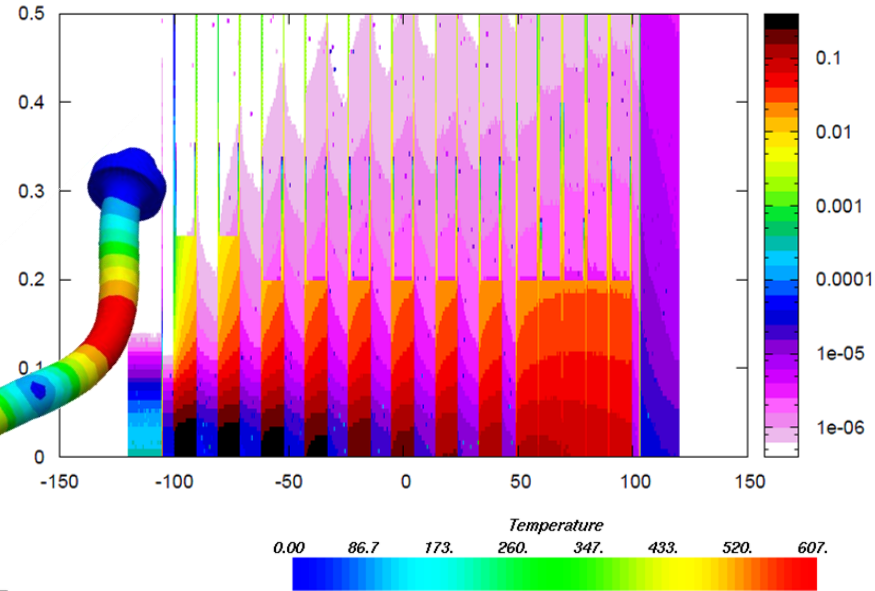
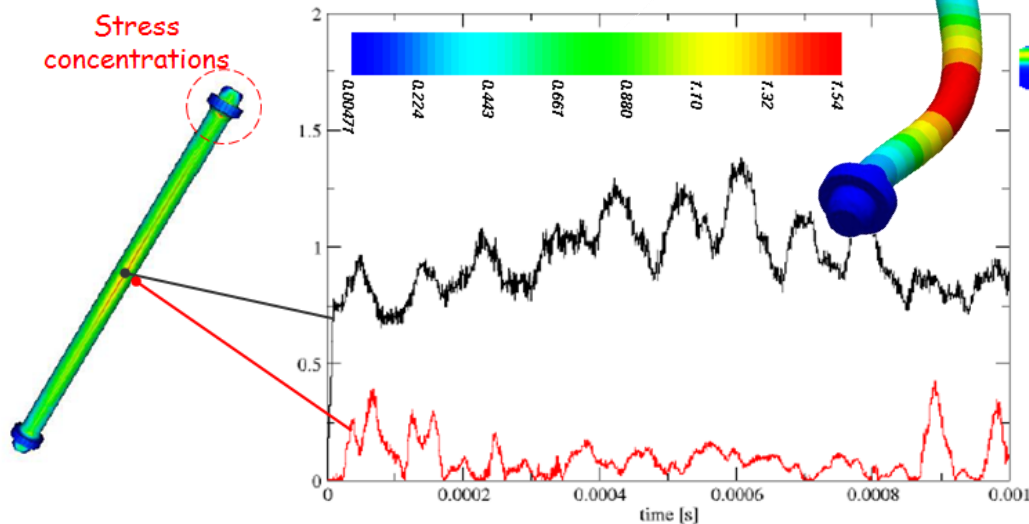


- 4.3kW avg / 750kW peak
 - Dedicated Target WG
 - Collaborations with several institutes
- Development 2001-2006

□ Design tools

- ▣ Monte-Carlo analysis (FLUKA)
- ▣ Modal and dynamic analyses (Spectral Element Method and explicit FEM)
- ▣ Thermo-structural analyses (implicit FEM)

Stress concentrations



CNGS

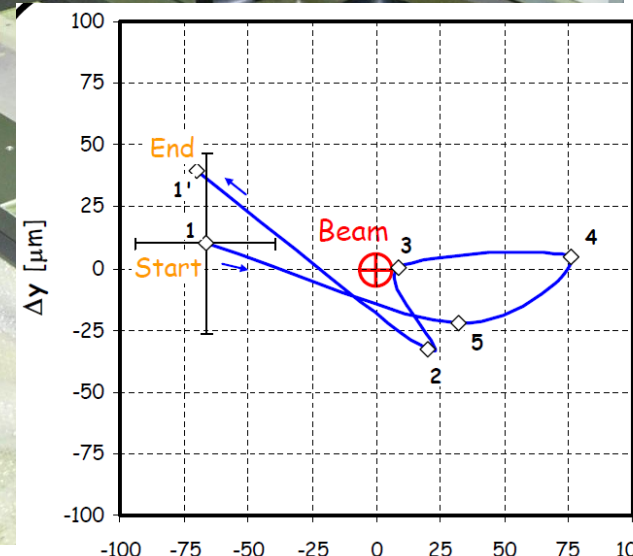
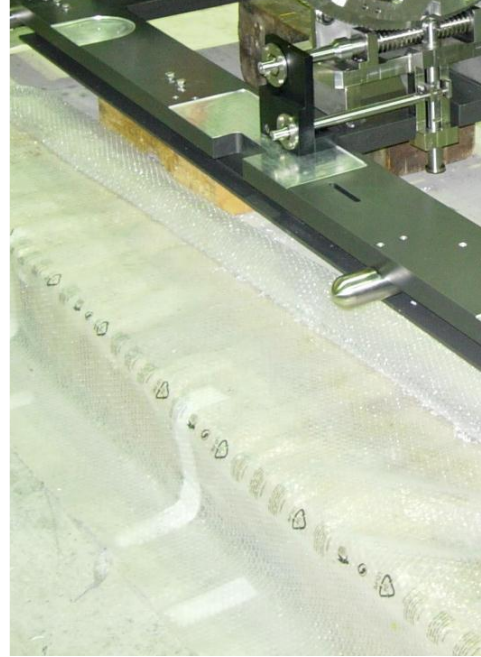
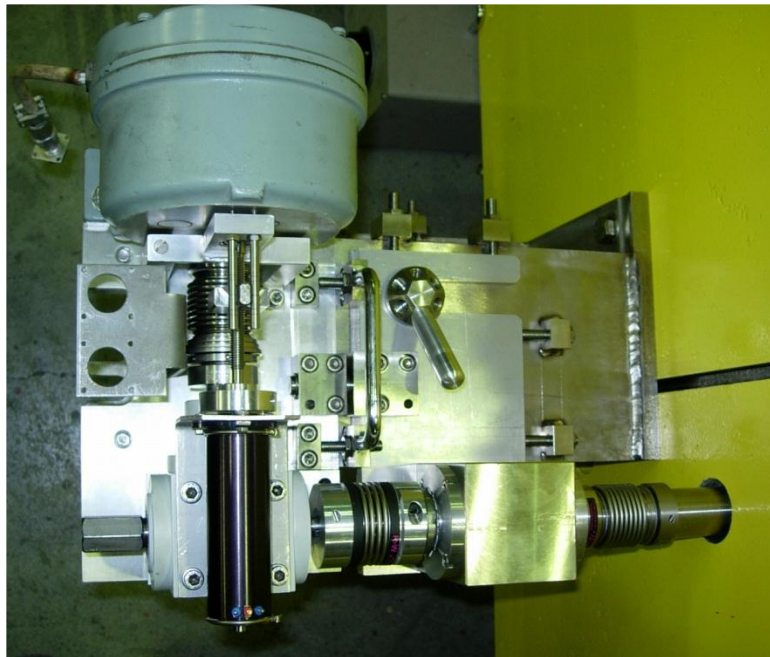
- In-house manufacturing and assembly



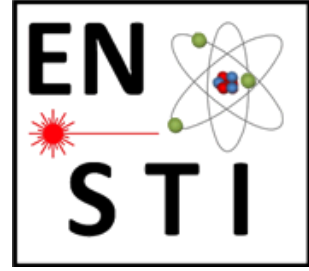
CNGS

7

- Alignment
- Motorization and Rotation precision

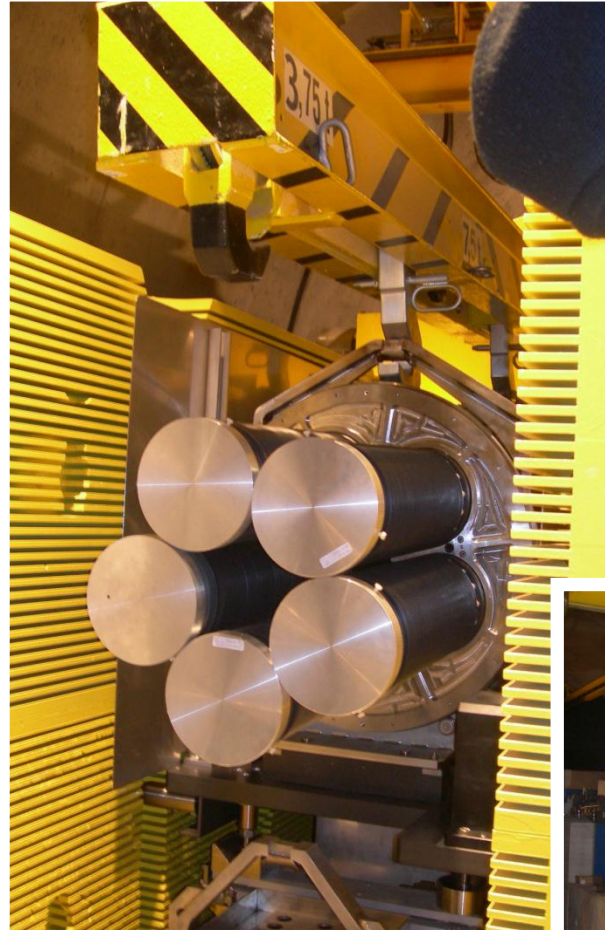


CNGS



8

- Installation in TT40

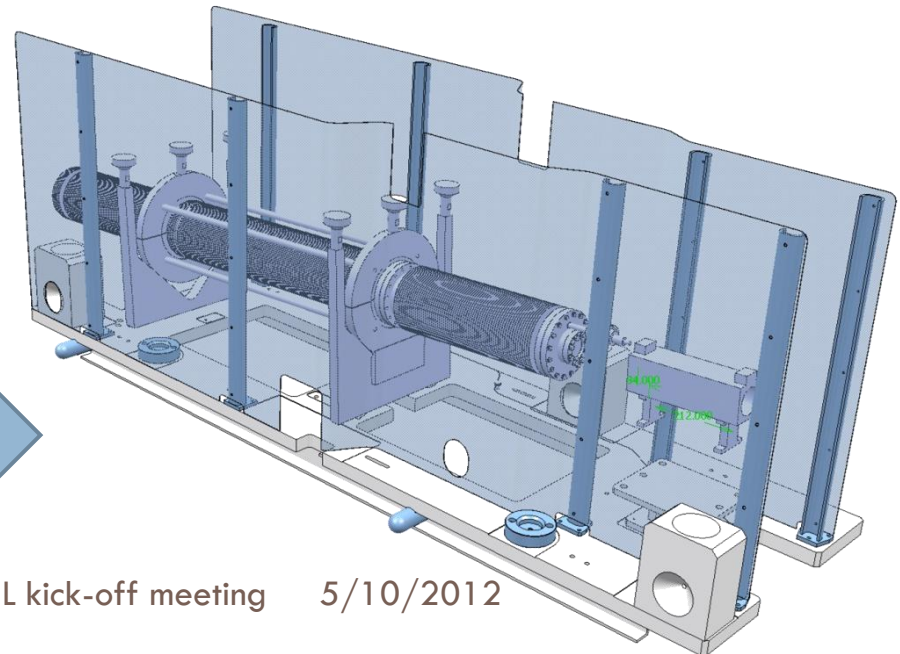
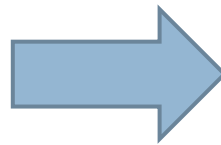


URISOL kick-off meeting



□ Operation

- 1st run 2007 – today
- Issues in rotating the target (ball bearing corrosion @ 450 MGray)
- Estimated production of H inside the target inert atmosphere
- Spare target modification ongoing to substitute the target in case of problems



10

nTof

Target history

Design tools

New cooling and moderator circuits

Operation

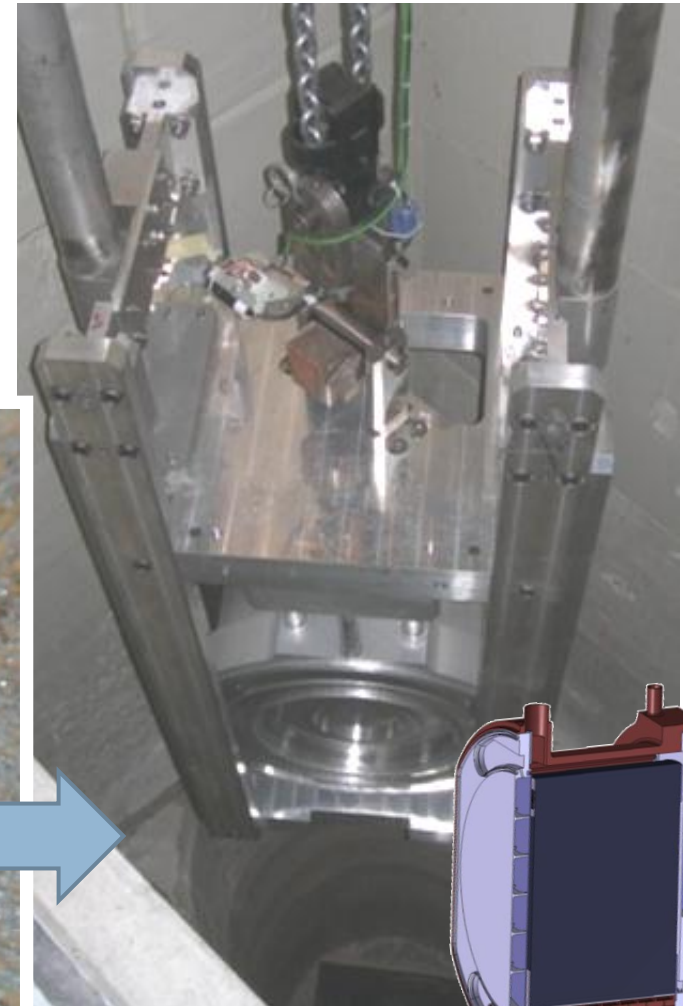
Thanks to M. Calviani

nTof

11

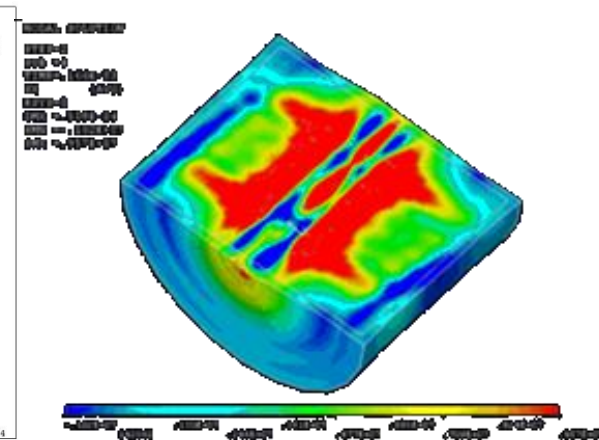
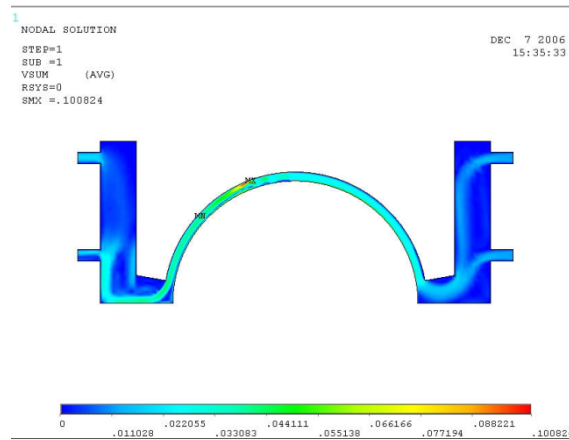
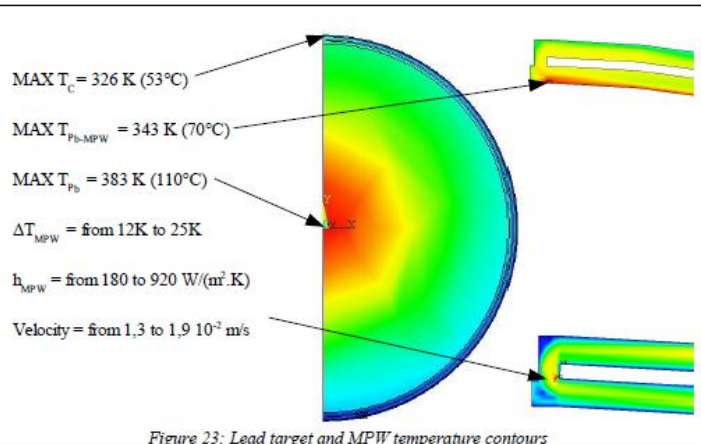
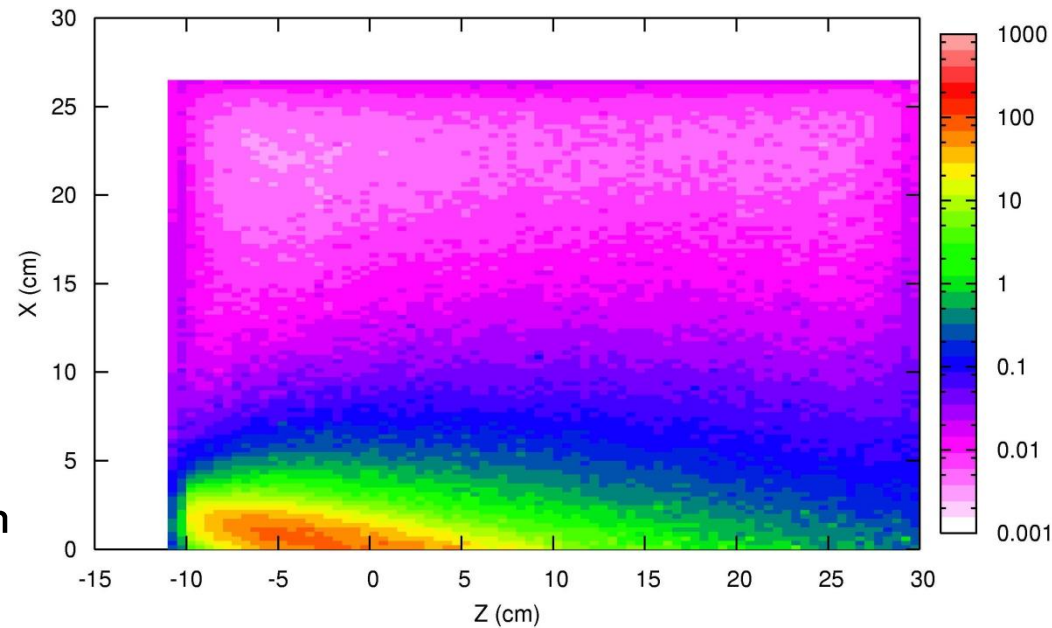
□ Target history

- ▣ 1st run 2000-2004
- ▣ Inspection 2007/08
- ▣ Update and restart (2nd run) in 2008
- ▣ Power: 6.5kW avg / 22kW max avg



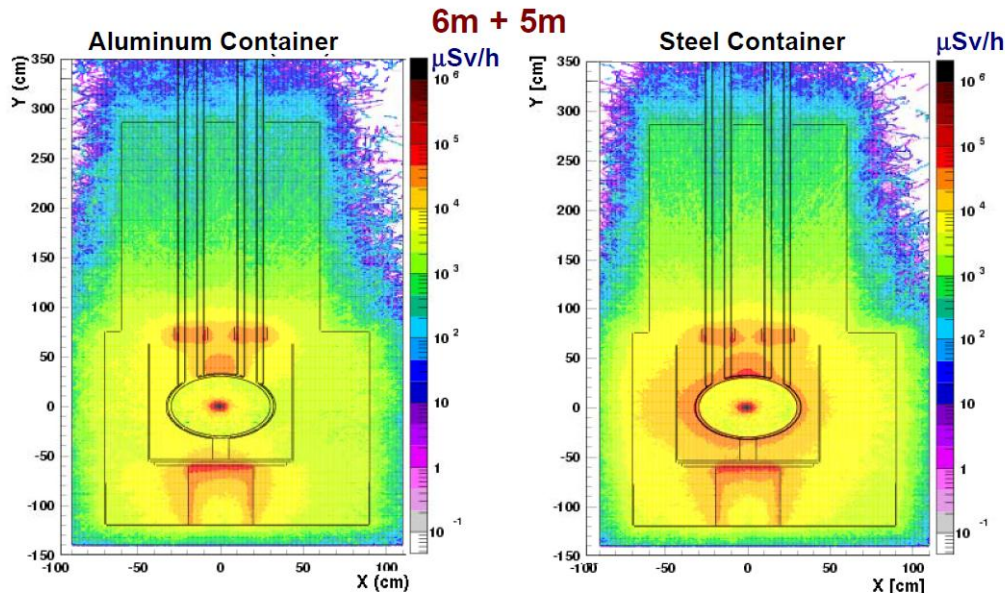
□ Design tools:

- ▣ External collaboration
- ▣ Monte Carlo (Fluka) analyses
- ▣ CFD analysis of cooling circuit
- ▣ Elastic wave propagation in Pb core (Explicit FEM)

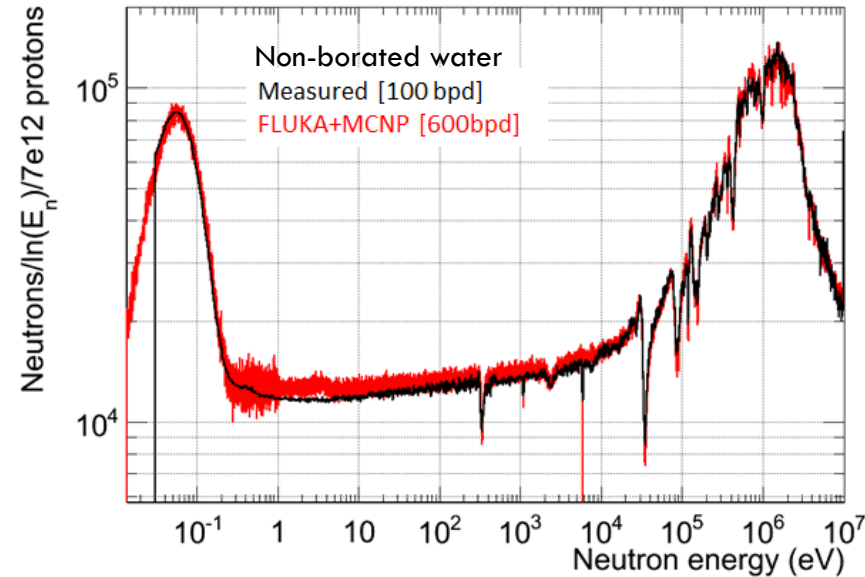


- Design tools:
 - Neutron fluence (FLUKA)
 - RP studies (FLUKA)

Target Support Material



n_TOF-Ph2 Evaluated Neutron Fluence (2009)

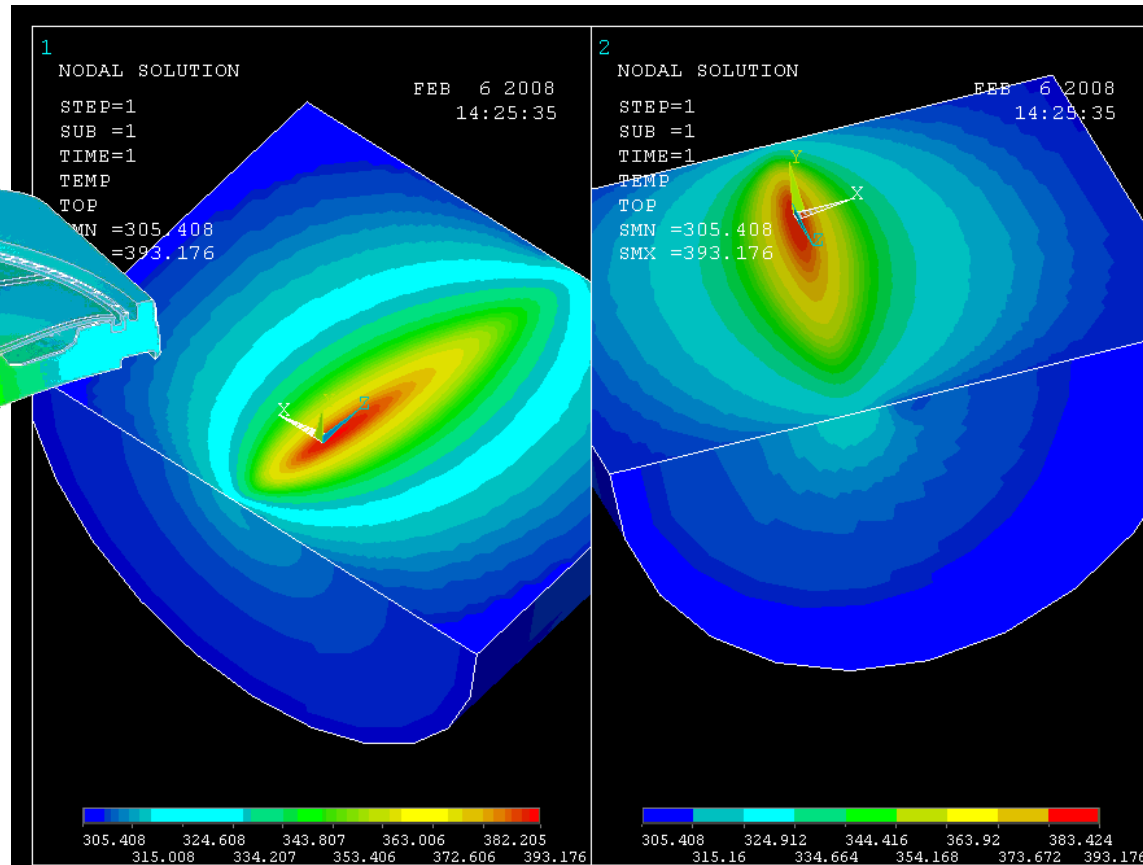
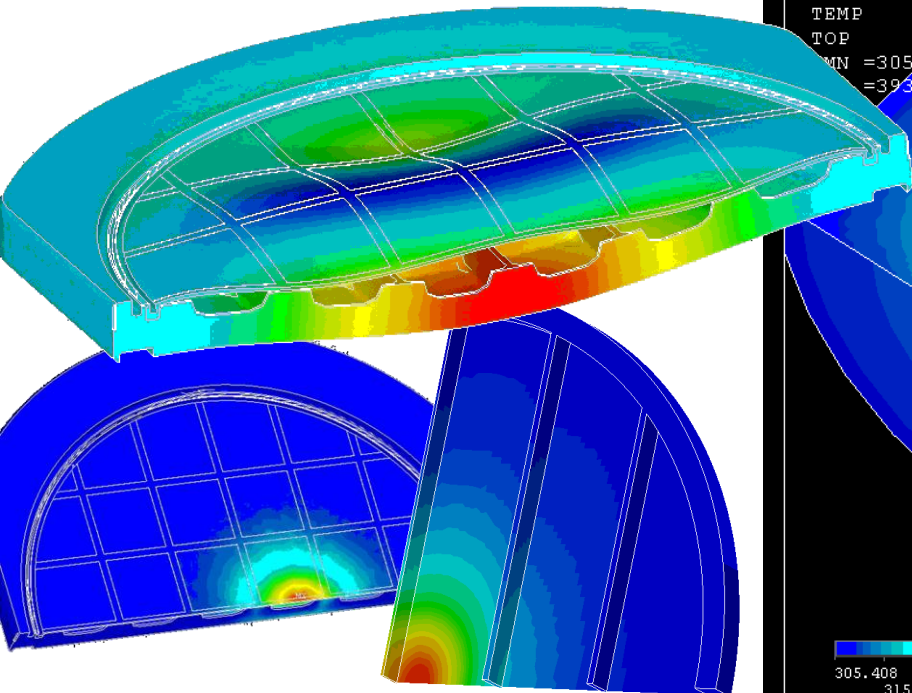


<http://pceet075.cern.ch/Meetings/TB2006/index.html>

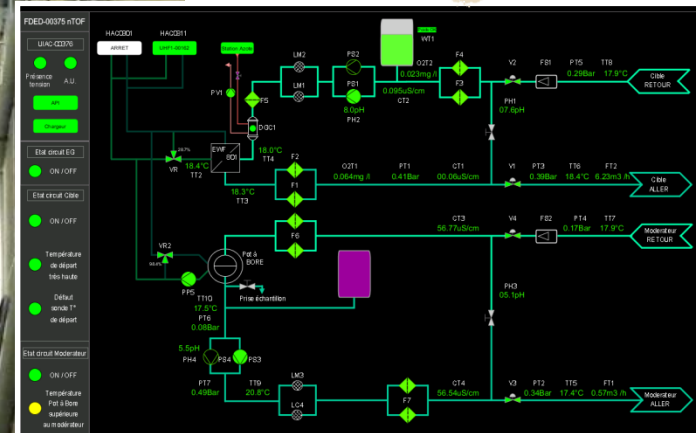
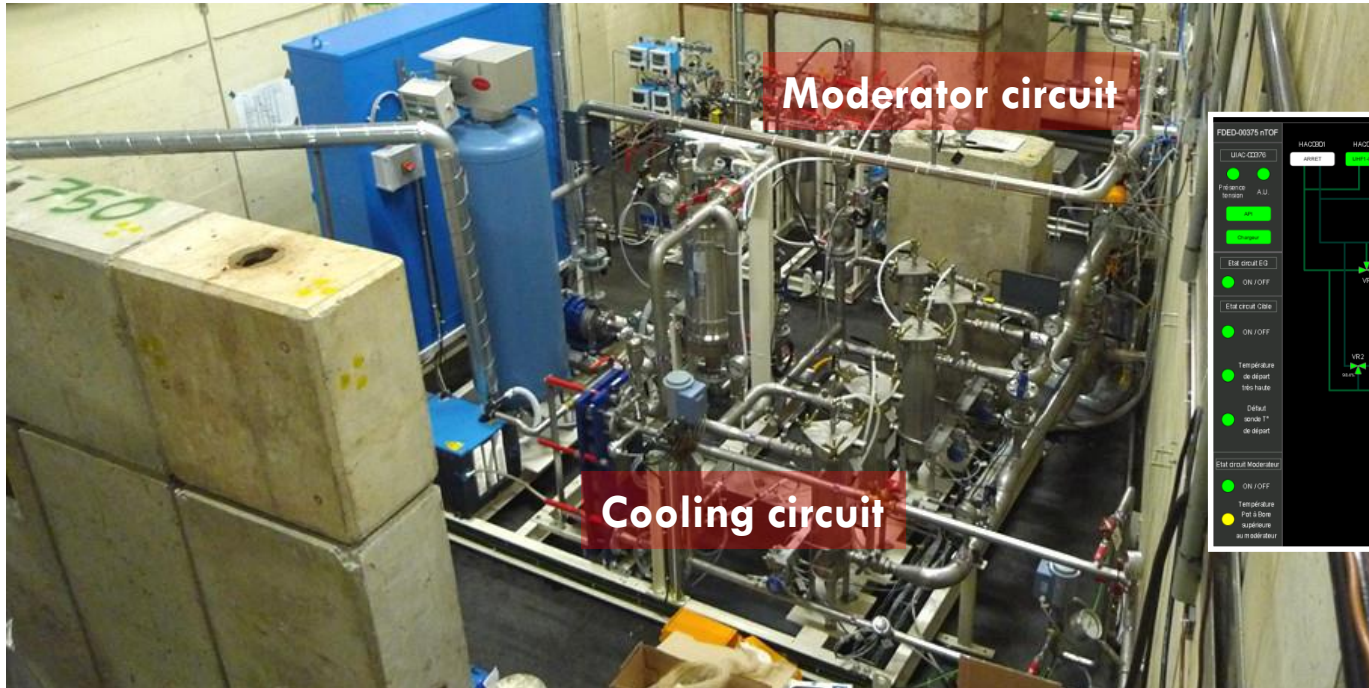
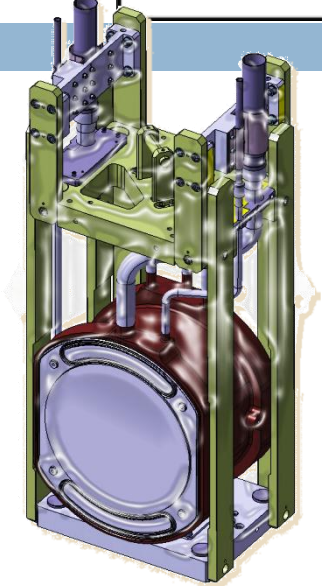
https://edms.cern.ch/cedar/plsql/project.info?cookie=10315092&proj_id=1064549944&p_tab=TAB3

□ Design tools:

- Beam window modal analysis and fatigue life assessment (FEM)
- CFD analysis of the moderator circuit



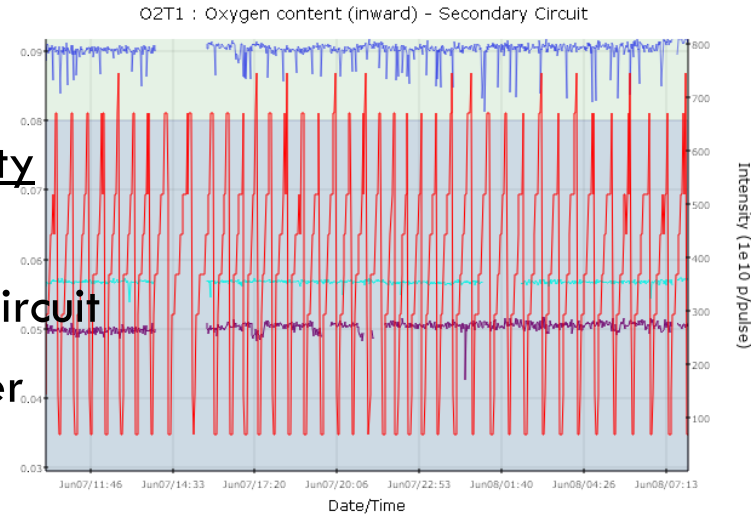
- New cooling circuit:
 - ▣ Water flow $\sim 5-6$ m³/h (0.5 m³/h at proton face)
- New (separated) moderator circuit:
 - ▣ B-water, reduction of in-beam γ -rays & thermal fluence



<https://ntofdaq.cern.ch/Cooling.php>

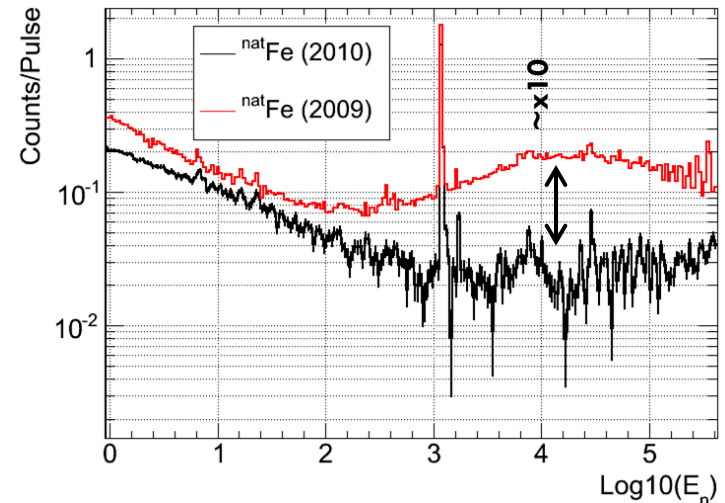
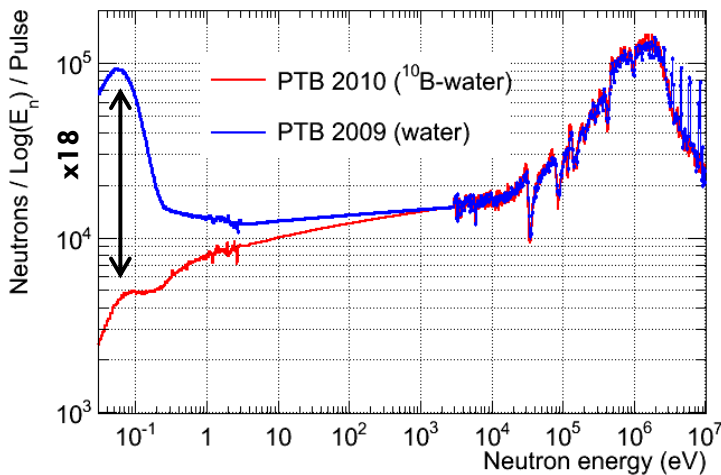
Operation

- Monitoring O₂ content, pH and conductivity (both circuits)
- Degassing device via N₂ flush in cooling circuit
- Moderator circuit with saturated ¹⁰B-water (~90 litres) at 20 °C
- ~constant boron concentration



<https://ntofdaq.cern.ch/Cooling.php>

<https://edms.cern.ch/document/1105710/6>



Target concepts and strengths

Solid target

Installation & operation

Storage

Static molten Pb/Bi bath

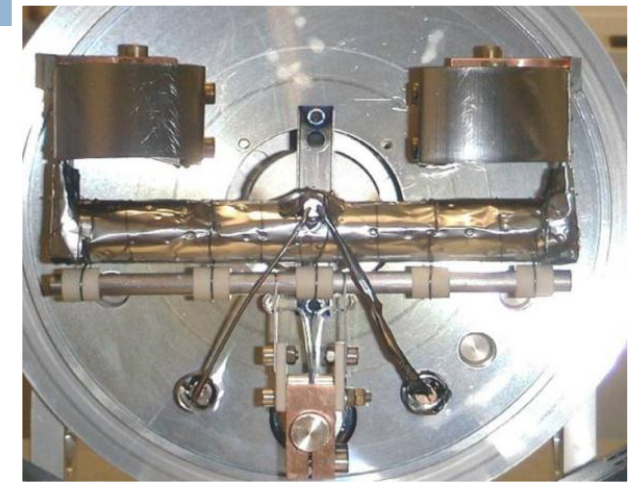
Thanks to T. Stora

ISOLDE

18

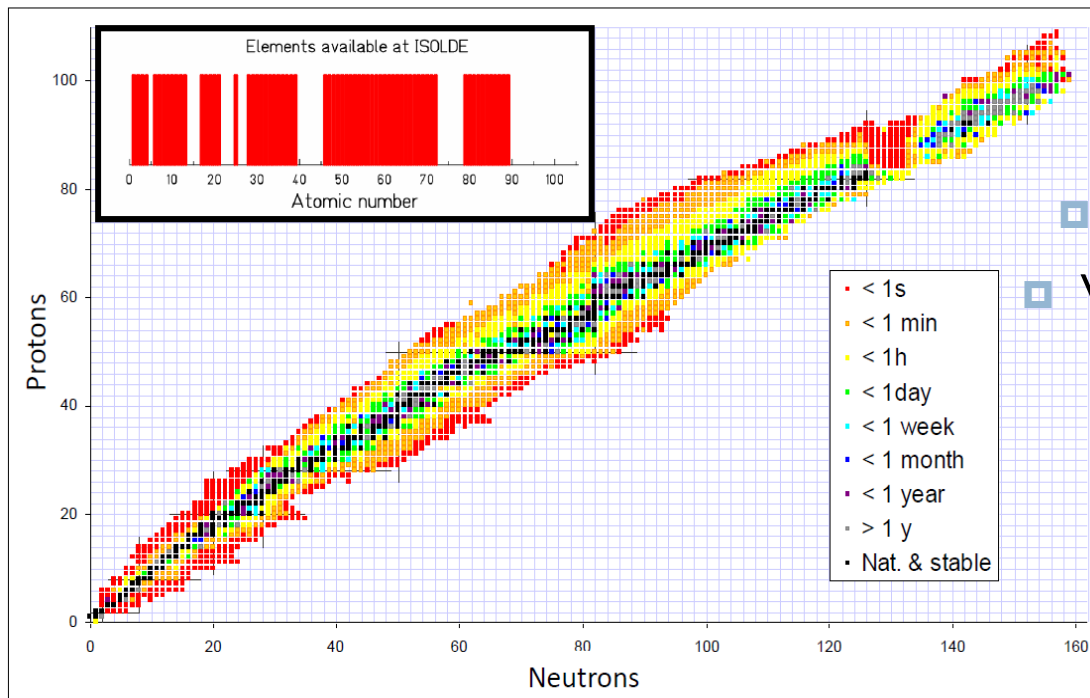
Established Solid target concept

- ▣ UCx but also CeO, SiC, Sn, Pb, Ta, Ti, MgO
- ▣ Also used Al₂O₃, Y₂O₃, hBN, ZrO₂, ...
- ▣ Power: 3kW avg/10 GW peak



Strengths

- ▣ Remote handling and monitoring
- ▣ Well Defined beam-time schedule
 - ▣ Target unit tracking system
- ▣ In-house target unit production and assembly (few weeks)
 - ▣ PIE (@ PSI) and ALARA



ISOLDE

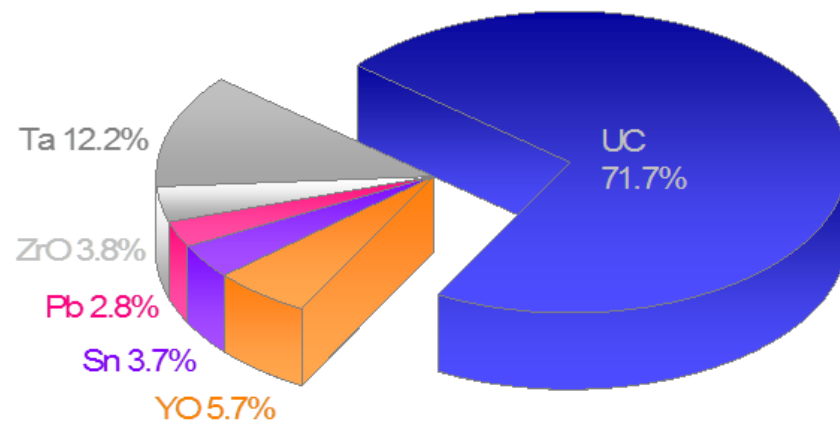
19

- Proven solid target design
 - ▣ Concept in use since the late 60's



Production targets in 2010

- 350 shifts of 8 hours


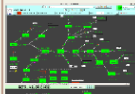


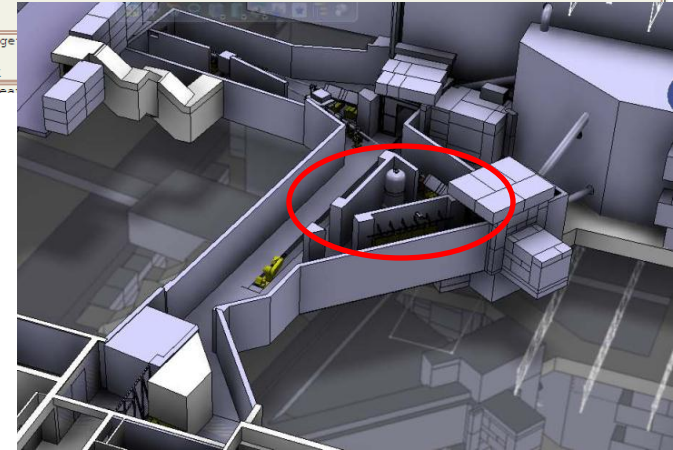
□ Operation

- Transfer to target station : trained operators
- Operation for 3 days- 4 weeks on target station
- Recuperation and short-term storage in primary area

<https://ab-dep-op-elogbook.web.cern.ch/ab-dep-op-elogbook/elogbook/eLogbook.php?shiftId=1039819>

CERN BE - OP eLogbook

Time	Comments
	Target change done. New target onto front end: #464 CaO Protons taken on target #463 Pb VD5 Mo: 3.5408337E17 Reset short and vistar counter done. New log file started: iso/isoilog/logFiles/GPS/CaO/gpslogfile.2011-10-26-target464.csv Source distance 46 mm Patch panel (ANODE and SRCMAG) and thermocouple connections done. /EP/MLB/FP/RC
17:20	 name: 20111026172800.png desc: name: 20111026175032.png desc:
17:31	Started pumping the front end. Line filled with gas mixture (Xe,Ar,Kr,He) up to 1.lbar. As soon as we'll reach 10E-6 vacuum we can open the shuttle valve. We are running in intervention mode...since usually it is not possible to pump with the valve closed. /EP/JPR/MLB/FP
17:45	Vacuum at 3.1E-6mbar /EP/JPR  name: 20111026174610.png desc:
18:29	Start heating target



C. Maglioni, CERN EN-STI-TCD, Pb/Bi

□ Storage

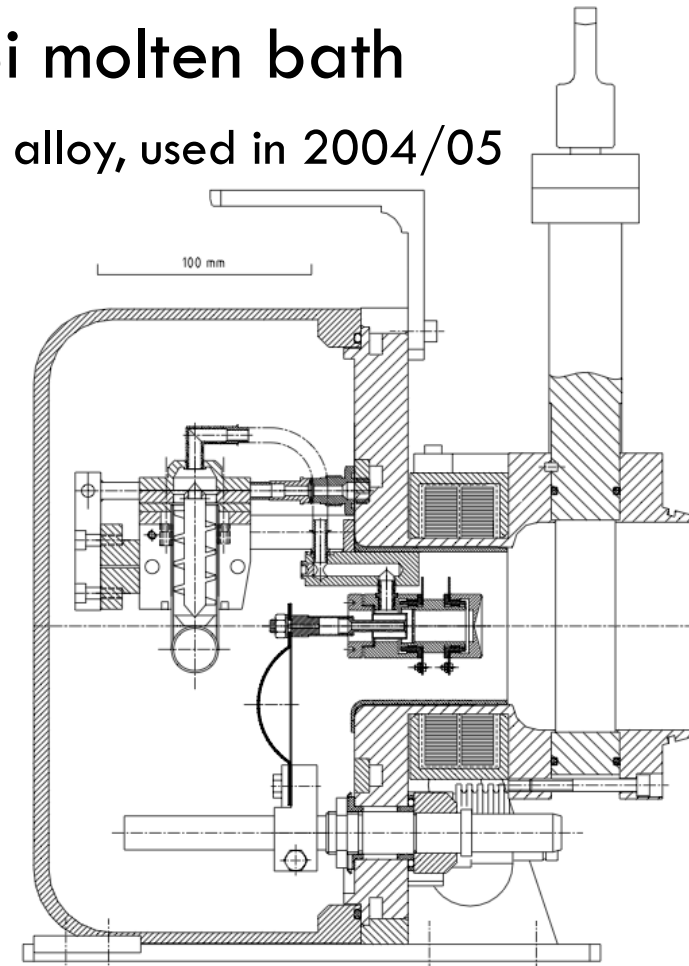
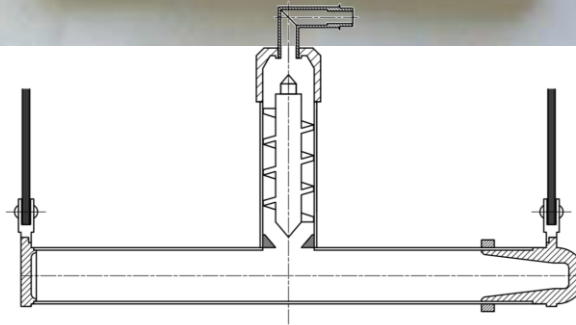
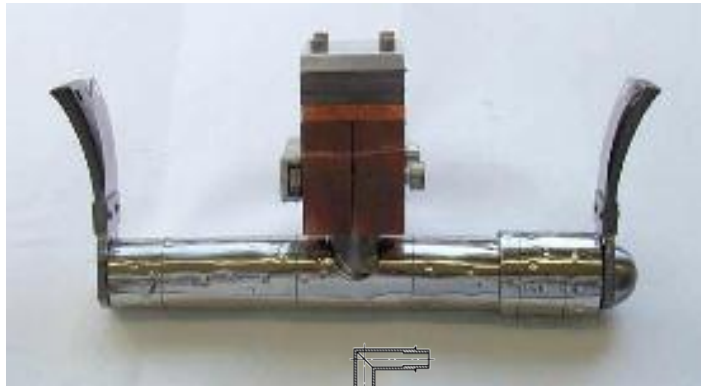
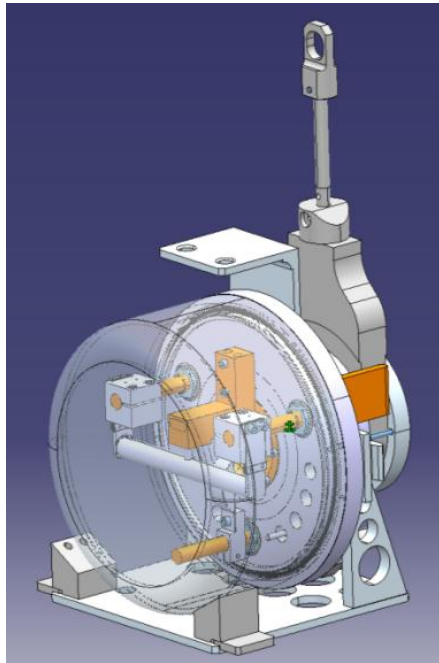
- Recuperation and short-term storage in primary area
- Intermediate storage at CERN (DIMR/ALARA procedure)
- Dismantling/shipping to PSI

<https://edms.cern.ch/file/857363/1/ISL-T-ES-003-00-10.pdf>

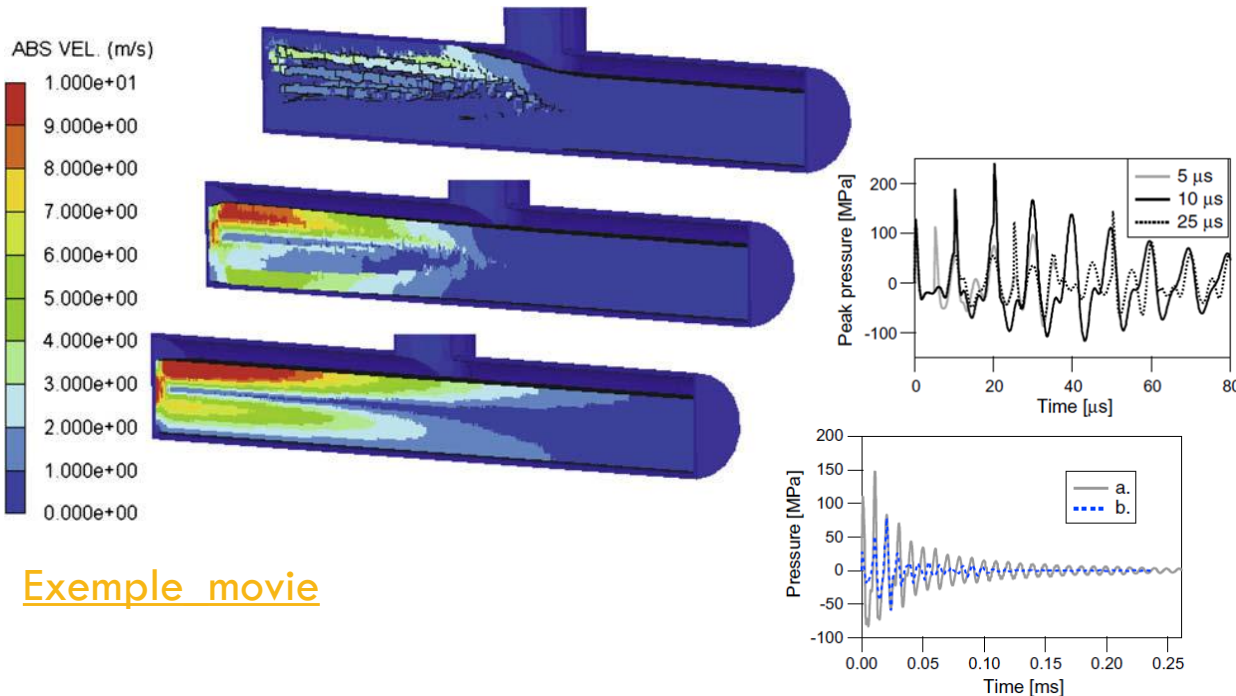


Work and dose planning - Transfert cibles														
Transfert cibles irradiées des tunnels GPS et HRS jusqu'aux ISR.														
							Working time [man.hours]	Effective avg. dose rate [µSv/h]	Collective dose [man.µSv]	Collective dose [man.µSv]	Working time real [man.hours]	Collective real dose [man.µSv]	Collective real dose [man.µSv]	
Totals:							1.5	387	584	584	0	0	0	
Prior intervention To be completed and checked by work coordinator(s) and experts							Prior intervention To be checked and completed by RP			Posterior intervention To be completed by work coordinator or/and RP				
1	2	3	4	5	6	7	8	9	10	11	12	13	14	
No.	Work description (Task)	Responsible person	Dep/Grp (executing)	Location (check table 'DoseRates')	Persons [No.]	Time [min]	Dose rate [µSv/h]	Estimated dose [µSv]	Estimated total dose [µSv]	Real time [min]	Real dose [µSv]	Real total dose [µSv]	Remarks	
1 PHASE 1 : libération de positions vacantes dans la galerie ISRS									50	0				
1.1	Manutention mécanique puis manuelle de 23 cibles à faible débit de dose pour entreposage devant le blindage en attente achèvement de la galerie ISR3 (liste de cibles)	B. Crepieux	EN-STI	1 - ISR5	2	30	50	50			0			
2 PHASE 2 : despose des cibles sur les palettes									407	0				
2.1	Recensement des personnes en fonction de la dose reçue préalablement	B. Crepieux	EN-STI	3/R-034	1		0	0			0			
2.2	Aller chercher les 4 palettes aluminium aux ISR	B. Crepieux	EN-STI	1 - ISR5	2	1	50	2			0			
2.3	Rentrer les palettes aux bat 179	B. Crepieux	EN-STI	2 - Tunnels	1	1	30	1			0			

- Proven design of the static Pb/Bi molten bath
 - ▣ High purity Pb(44.5%) / Bi(55.5%) eutectic alloy, used in 2004/05
 - ▣ Molten Pb used for 1 week/year



- Proven design of the static Pb/Bi molten bath
 - ▣ Thermal shock enhance the release of radioisotopes
 - ▣ Thermal shock weaken the target container (pitting corrosion on window)



Available online at www.sciencedirect.com

SCIENCE @ DIRECT[®]

Nuclear Instruments and Methods in Physics Research B 204 (2003) 251–256

NIM B
Beam Interactions
with Materials & Atoms
www.elsevier.com/locate/nimb

Effects of thermal shocks on the release of radioisotopes and on molten metal target vessels²²

J. Lettry^{a,*}, G. Arnau^a, M. Benedikt^a, S. Gilardoni^a, R. Catherall^a, U. Georg^a, G. Cyvoct^a, A. Fabich^a, O. Jonsson^a, H. Ravn^a, S. Sgobba^a, G. Bauer^b, H. Brucherstölter^b, T. Graber^b, C. Güdermann^b, L. Ni^c, R. Rastani^b

^a CERN, CH-1211 Geneva 23, Switzerland
^b Paul Scherrer Institut, Villigen CH-522, Switzerland

Nuclear Instruments and Methods in Physics Research B 126 (1997) 170–175

NIM B
Beam Interactions
with Materials & Atoms

Release from ISOLDE molten metal targets under pulsed proton beam conditions

J. Lettry^{a,*}, R. Catherall^a, G. Cyvoct^a, P. Drumm^b, A.H.M. Evensen^a, M. Lindroos^a, O.C. Jonsson^a, E. Kugler^a, J. Obert^c, J.C. Pataux^c, J. Sauvage^c, K. Schindl^a, H. Ravn^a, E. Wildner^a

^a CERN, CH-1211 Geneva 23, Switzerland
^b RAL, Chilton Didcot, Oxon OX11 0QX, UK
^c IPN, F-91486 Orsay, France

Abstract

By moving the ISOLDE mass separators from the 600 MeV Synchrocyclotron (SC) to the 1 GeV Proton-Synchrotron-Booster (PS) [1] the instantaneous energy density of the proton beam went up by 3 orders of magnitude. The developments of the molten metal target units and the optimization of the PS proton beam to cope with the effects of the thermal shocks induced by the proton beam are described. The energy density of the PS proton beam was reduced by spatial defocusing and time staggered extraction of the four PS-accelerators. The release from lanthanum, lead and tin targets is discussed for different settings of the proton beam and compared to the release observed at ISOLDE-SC. The yields of Hg isotopes are presented.

PACS: 41.75.Ak; 41.85.Qg; 28.60.+s; 47.40.Nm; 61.25.Mv

Keywords: Release; Molten metal; Target; Ion beam; Lead; Mercury

24

Molten metal target activities

MERIT free Hg jet target

Offline molten Pb loop

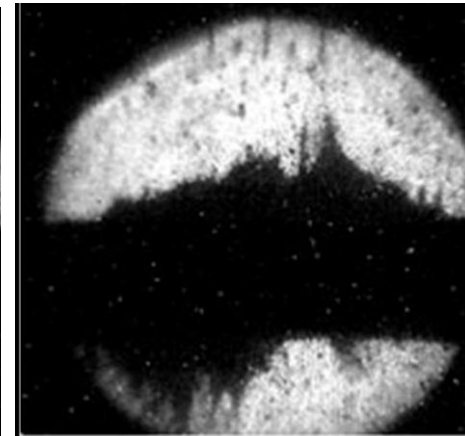
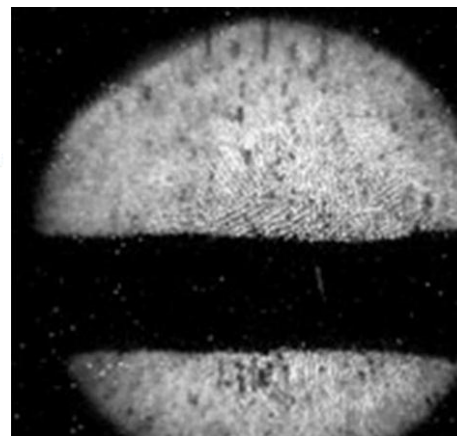
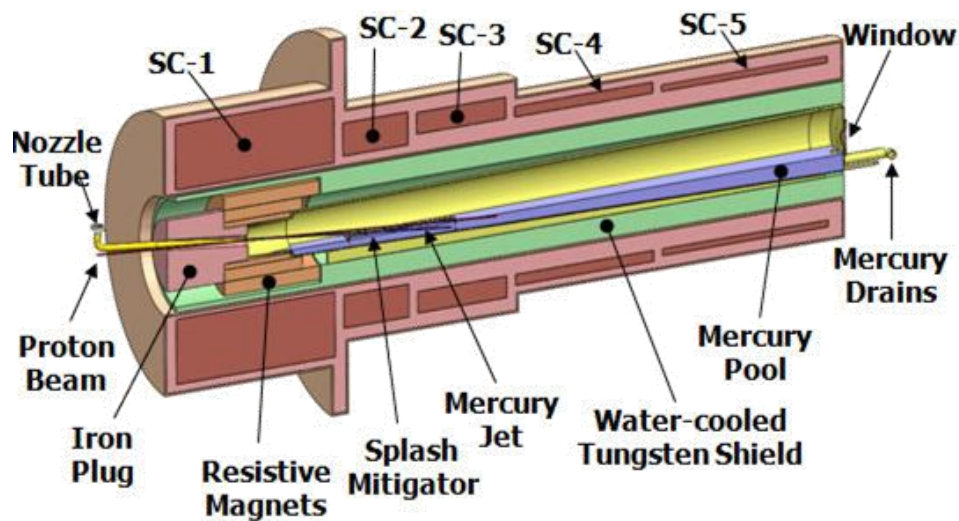
Thanks to T. Stora, E. Noah

Molten metal target activities

25

□ MERIT free Hg jet target

- International collaboration
- 2001/02 small-scale validating experiments
- 2007 experiment with full-scale target in TT2A gallery (nTof)
- 14 and 24 GeV. 1cm-dia, 20m/s Hg jet
- **Proof of principle** of Hg jet in 0-15T solenoid field

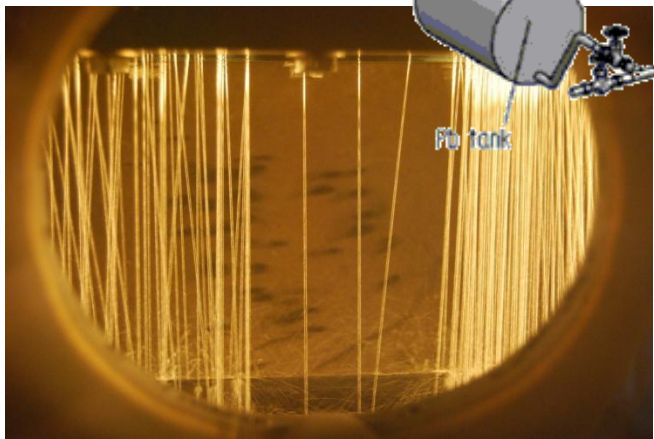
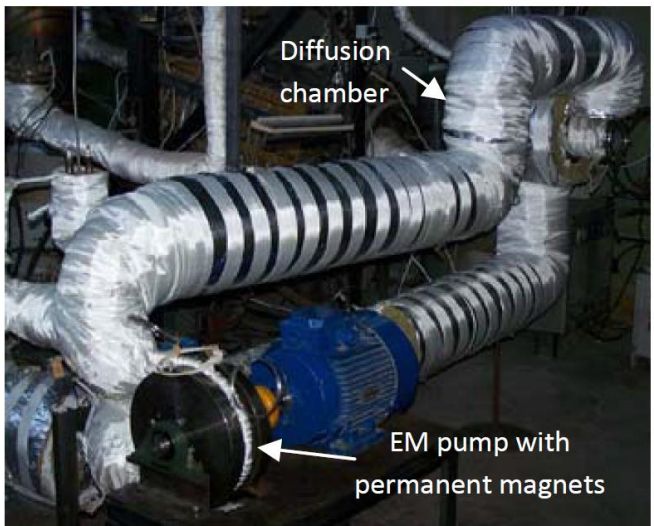
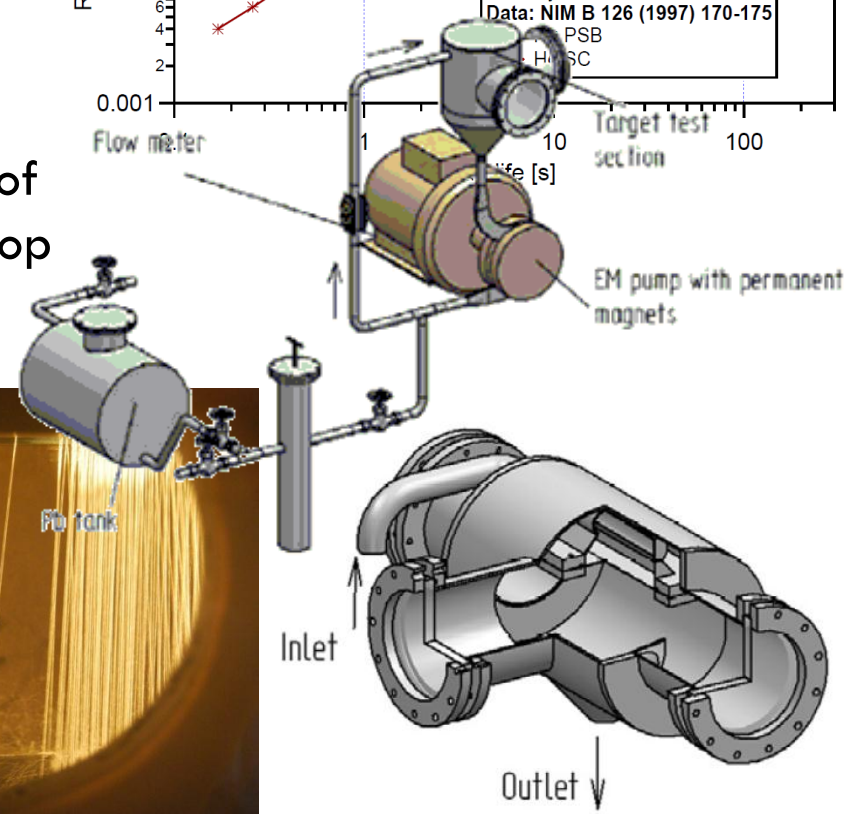
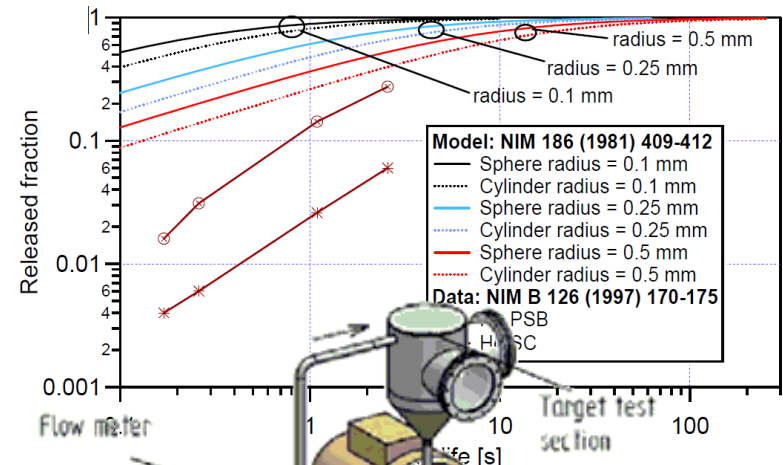


Molten metal target activities

26

Offline molten Pb loop

- 600 °C pressurized Pb droplets trough diffusion chamber (DC)
- Tests at IPUL during EURISOL Design Study by E. Noah (CERN-ISOLDE)
- **Proof of principle** for the feasibility of film/droplets and operation of the loop





Thank You

C. Maglioni, CERN EN-STI-TCD

Spare slides

28

□ NA

- 4 targets (T2,T4,T6,T10) built in the 70s & running since then – consolidation in LS1
- Forced air cooled 2mm-thickness Be plates
- Forced air cooled 2mm-dia Be rods

□ AD <https://edms.cern.ch/document/1146356/>

- Same configuration as from the 80's
- 8-100W avg power on target

