EN Engineering Department

EN STI

PSB Upgrade
LIU Project

LIU Day 2014

NEW PSB BEAM DUMP

Antonio Perillo-Marcone (EN-STI)

Special thanks to: A. Sarrió-Martínez and F. Loprete, EN-STI, EN-HE, EN-MME, EN-CV, DGS-RP, GS-SE.

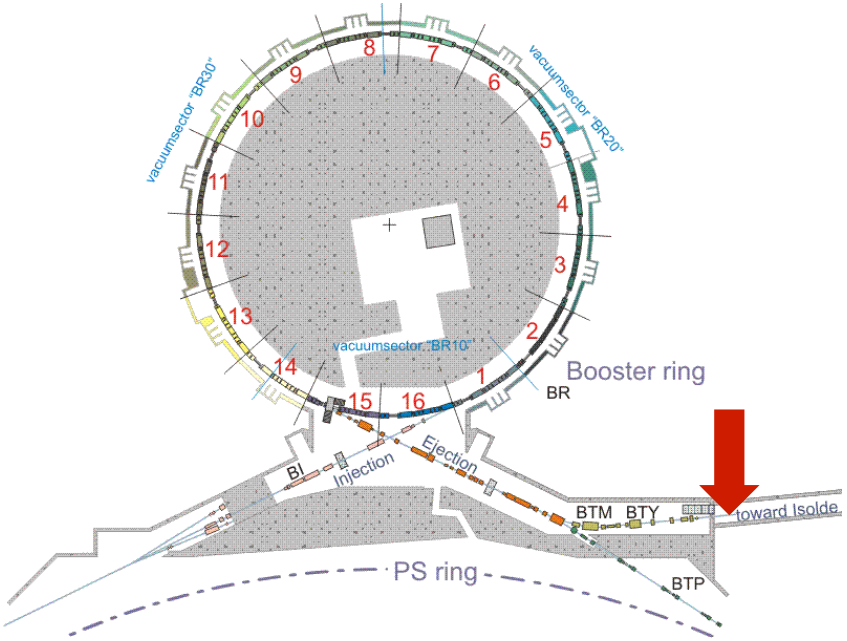
EN-STI

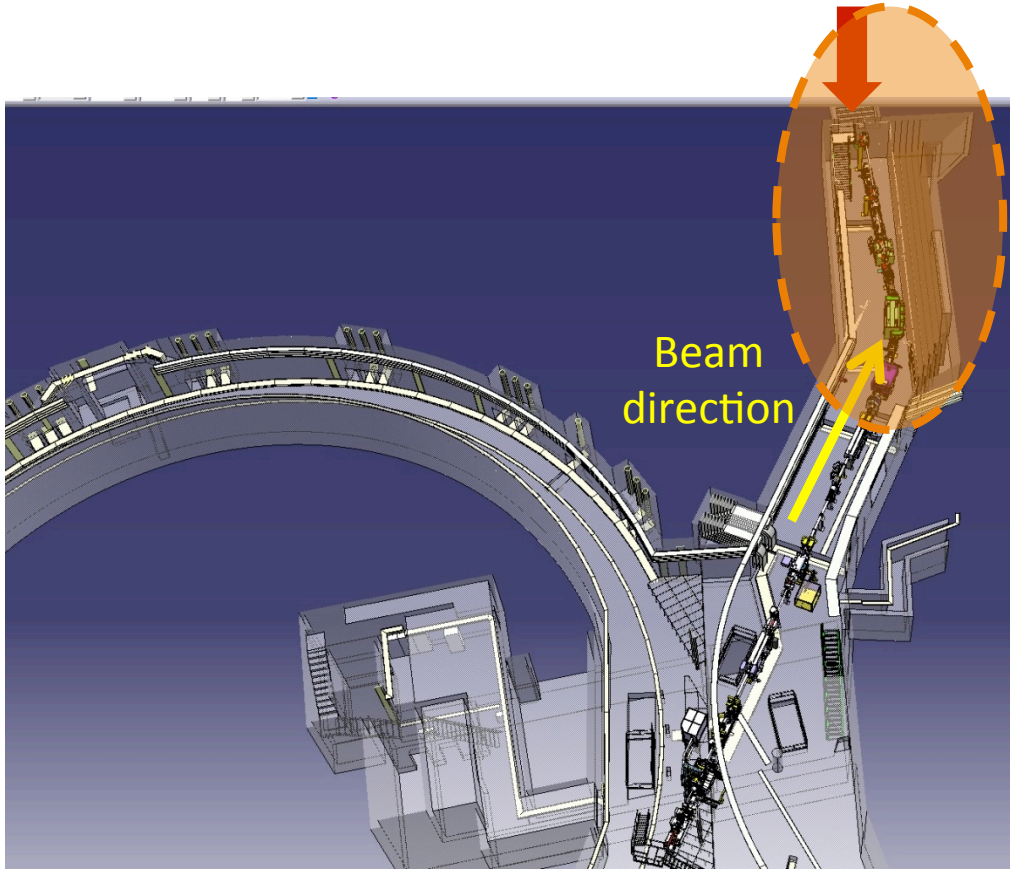
11th April 2014

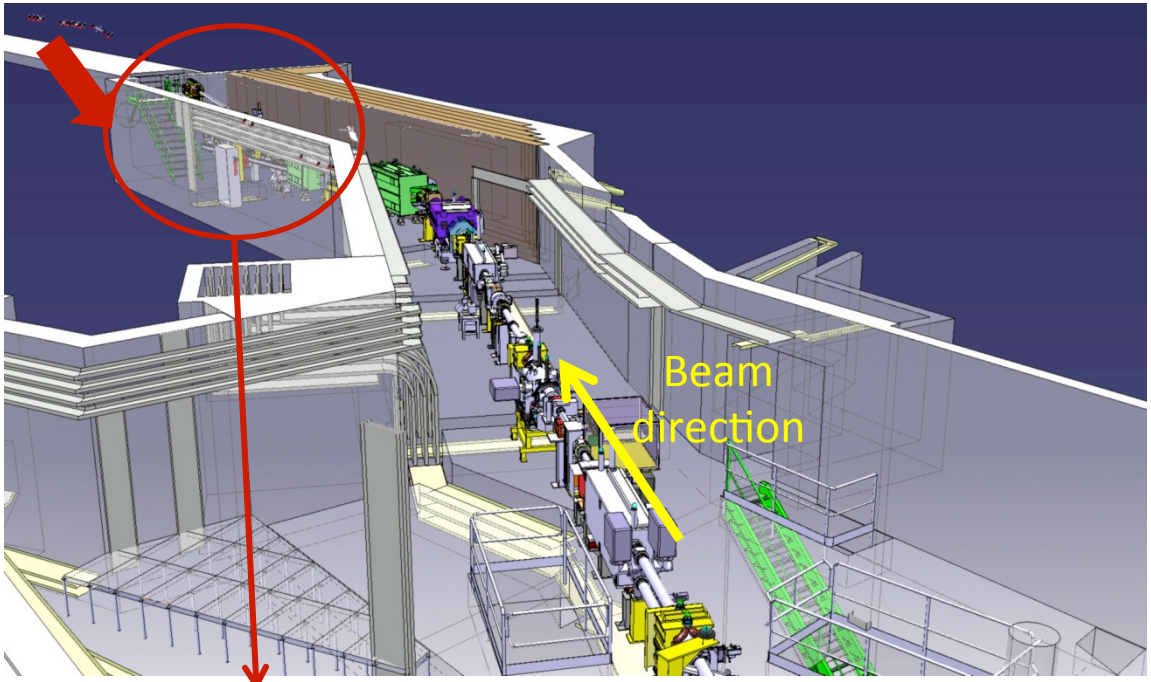
PRESENTATION OUTLINE

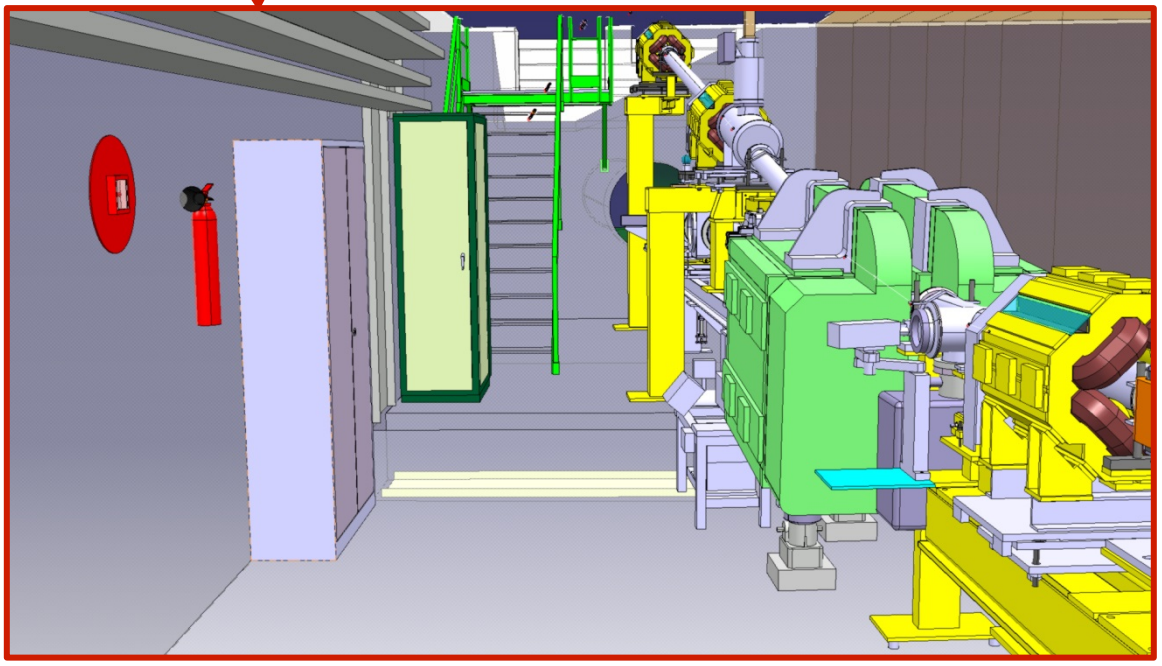
- Location of PSB main dump
- History (previous dump)
- Design parameters for new dump
- New design
- Simulations
- Installation (photos)
- Monitoring of dump performance

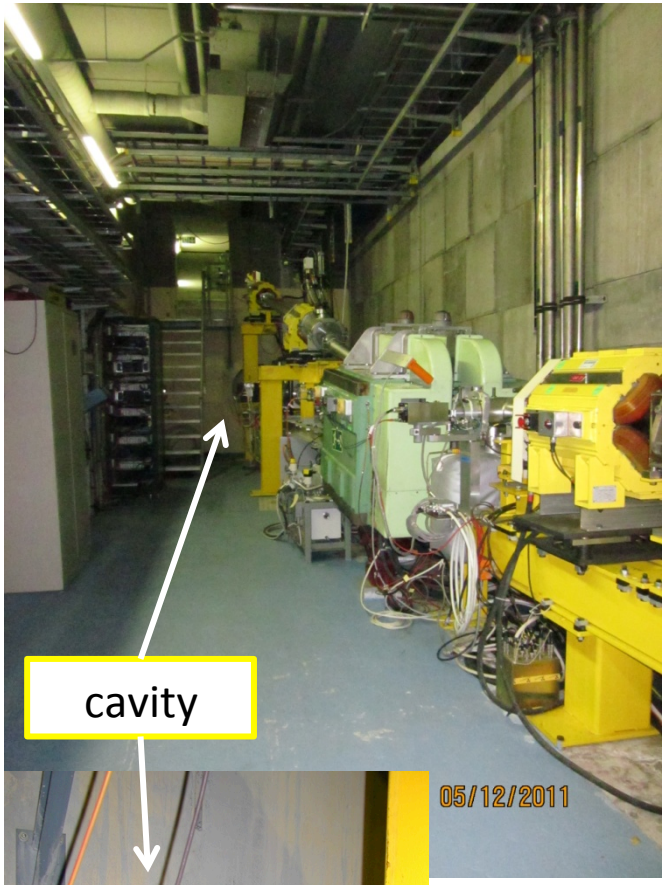
LOCATION OF EXTRACTION DUMP






Beam
direction

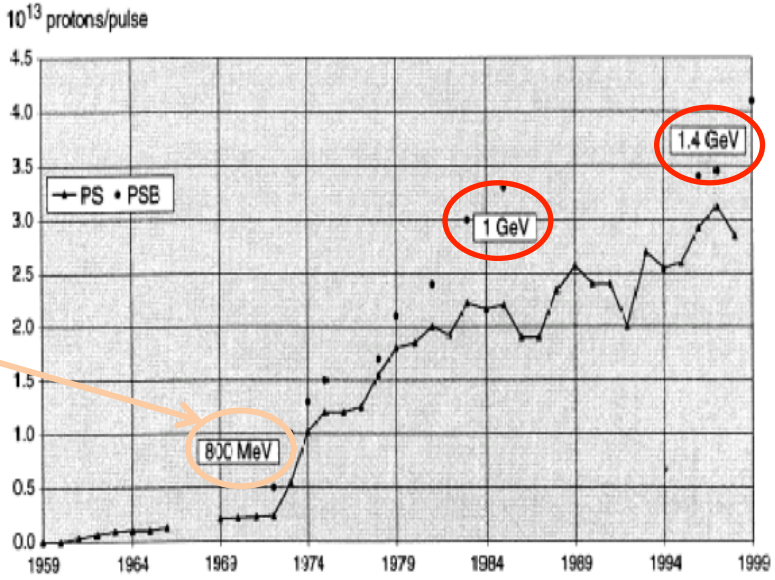



cavity
05/12/2011

HISTORY

1. The PSB dump was designed in the early 1970's to cope with beam energies reaching 800 MeV and intensities of 10^{13} protons per pulse in each ring*
2. Over the past years, the dump encountered some problems, i.e. vacuum and water leaks
3. Beam energy and intensity have been gradually increased during the last upgrades (1 GeV in 1988 and 1.4 GeV in 1999)

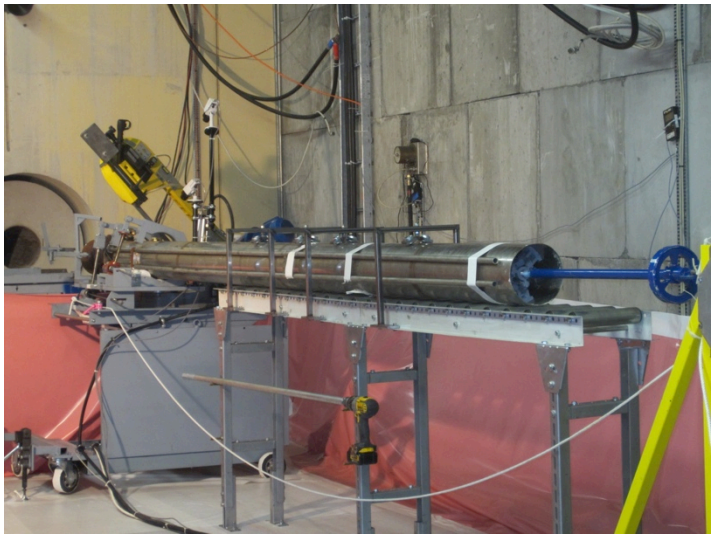
Historical diagram of peak beam intensities
(provided by Thomas Hermanns)

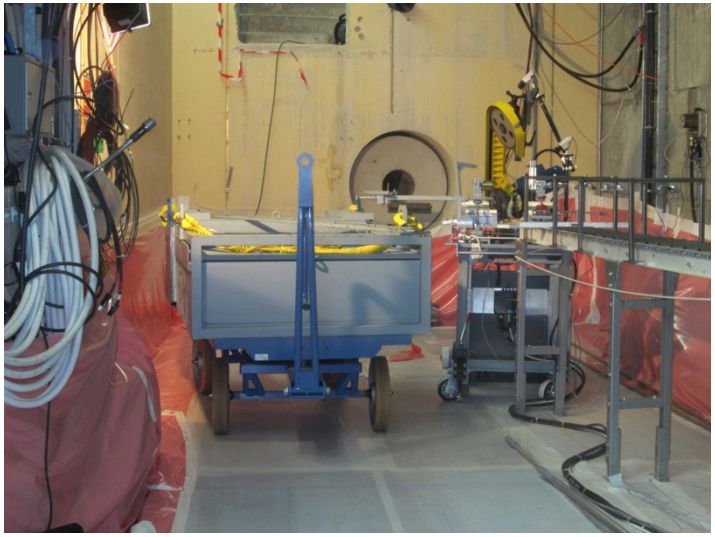


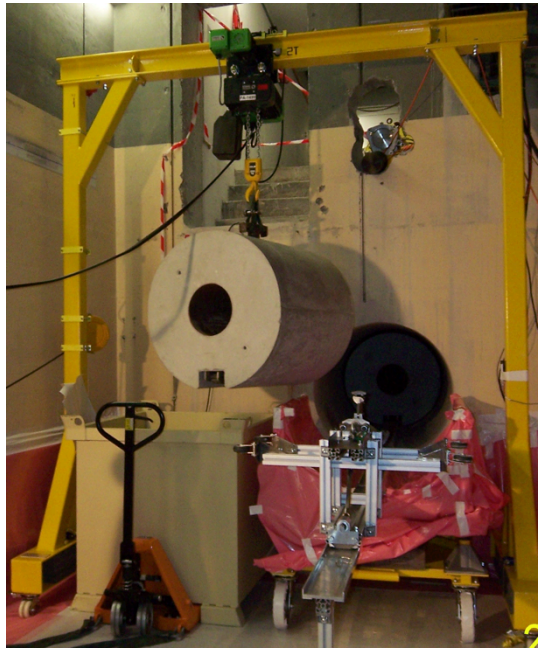
Design energy

* G. Gelato et al., IEEE Particle Accelerator Conference, Washington D.C. 1987

EXTRACTION OF OLD DUMP - ALARA







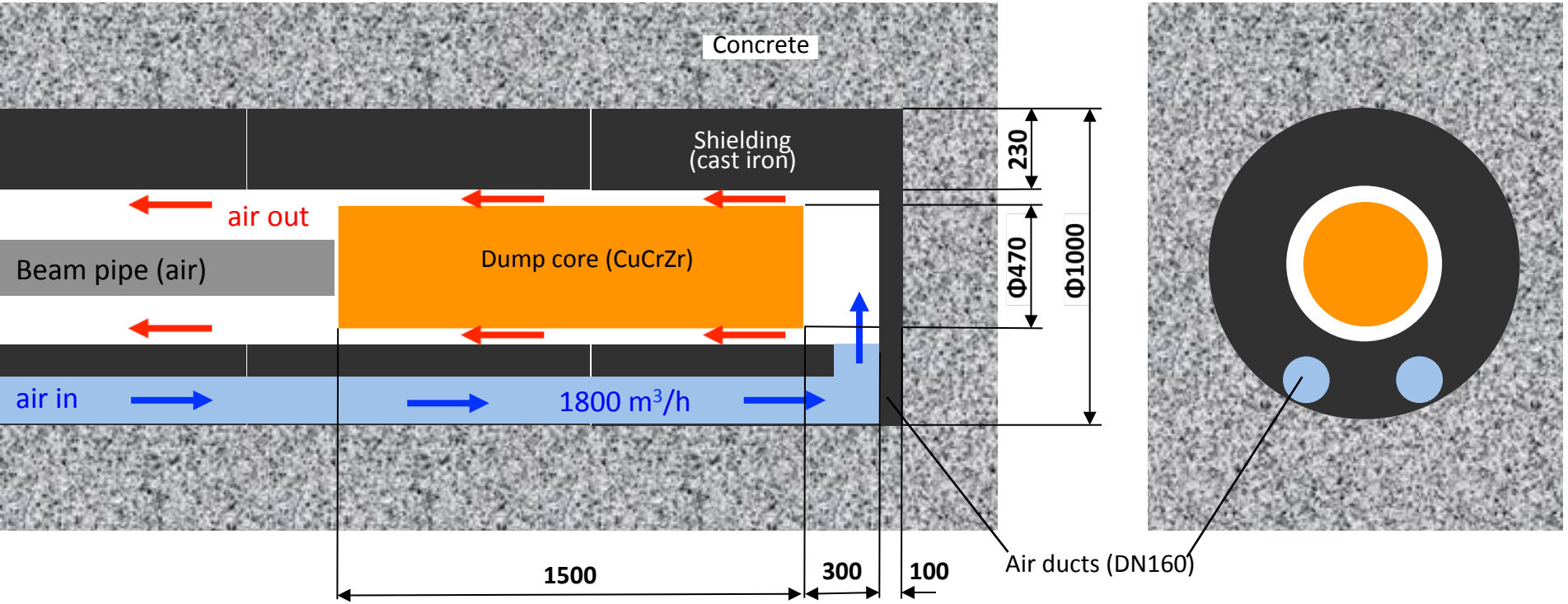
Thanks to G. Dumont (DGS-RP), EN-HE, EN-STI

DESIGN PARAMETERS

- **Design parameters:**
  - Max beam intensity: 1E14 p+/pulse
  - Beam energy: 2 GeV
  - Pulse period: 1.2 s
  - Max. Average power to dump : 9.44 kW

- **Operational requirements:**
  - Max. dump rate: 10% operation, 50% commissioning
  - Lifetime: 30years
  - No access to dump, i.e. zero maintenance design (apart from cooling)
  - Robust, reliable design

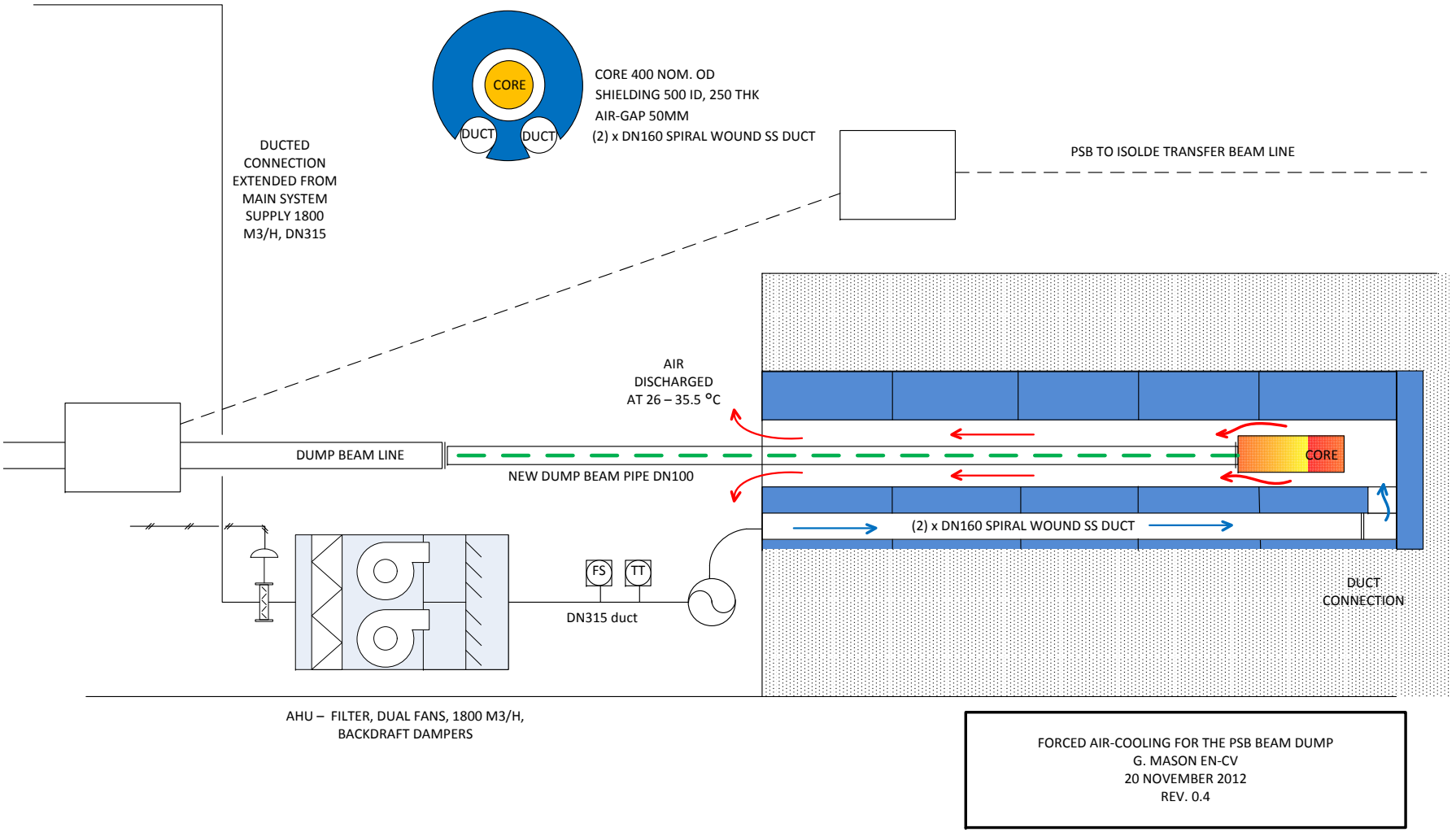
NEW DUMP DESIGN



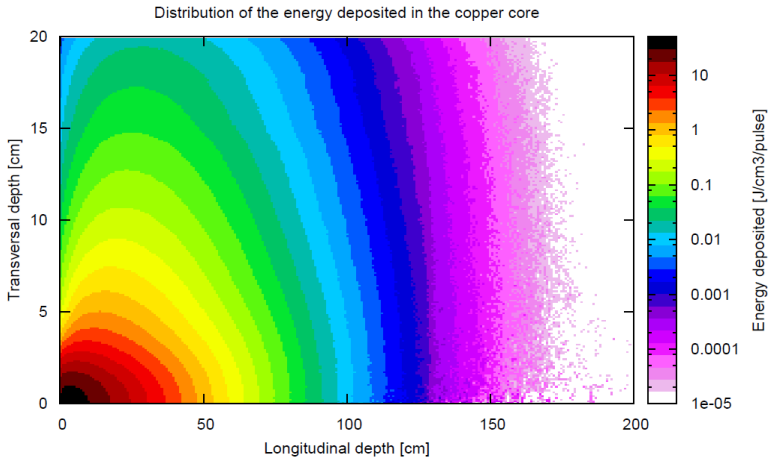
Materials

- Dump: Copper alloy (CuCrZr)
- Shielding: Cast iron (downstream) and concrete (upstream)
- Beam pipe: Aluminum

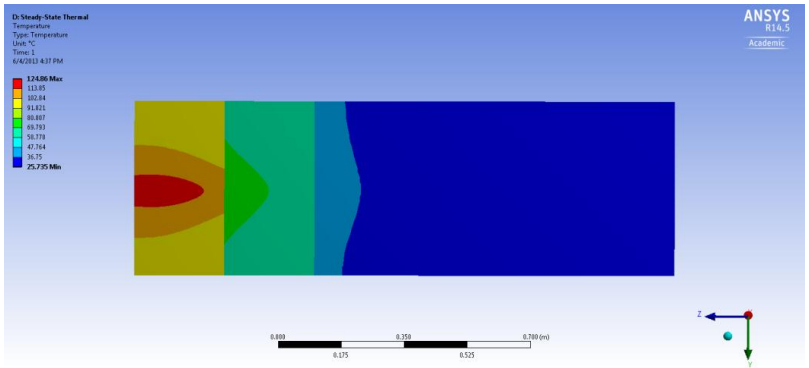
Cooling of new dump



THERMO-MECHANICAL SIMULATIONS



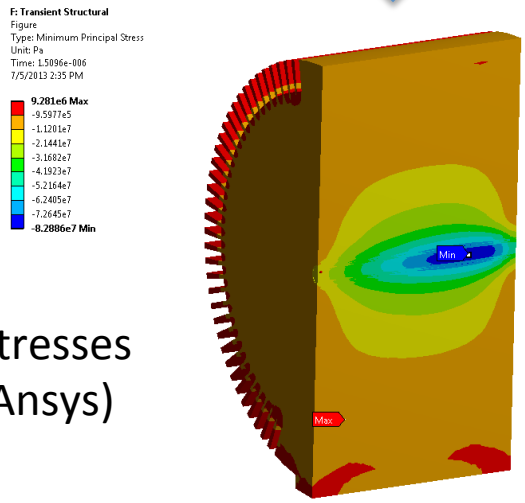
Energy deposition (Fluka)



Dump Temp. Steady state (Ansys)

Value	Case 1	Case 2	Limitations
Average heat transfer coefficient for the core [W/m^2K]	61	61	
Average air temperature [°C]	32	32	
Steady state temperature [°C]	124	144	Maximum service T = 300 - 350
Steady state + pulse temperature [°C]	134	153	
Steady state minimum principal stresses [MPa]	35	34	Compressive strength = 320
Dynamic minimum principal stresses [MPa]	93	85	
Fatigue: stress amplitude (σ_{min}-σ_{max})/2 [MPa]	29	25.5	Endurance limit = 83 - 106

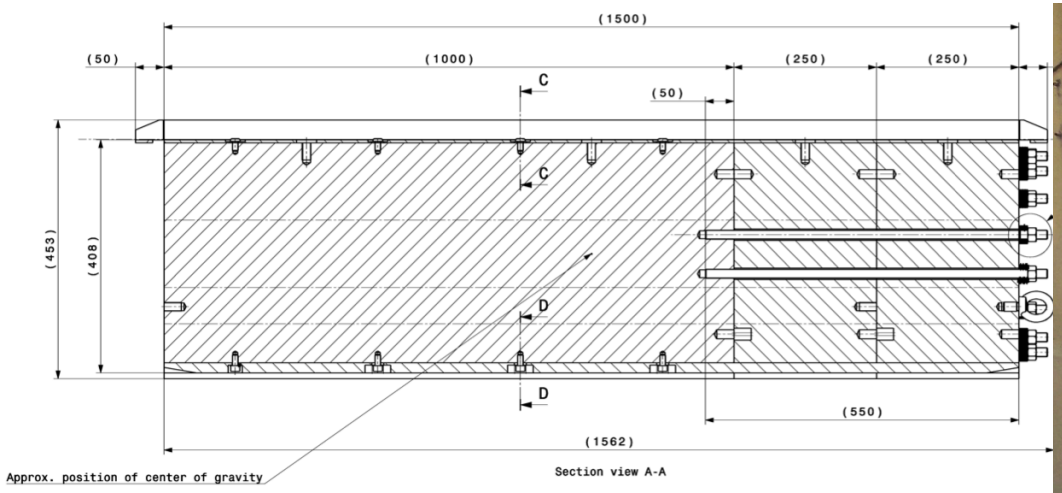
Main results from analyses (details in EDMS 1309632)

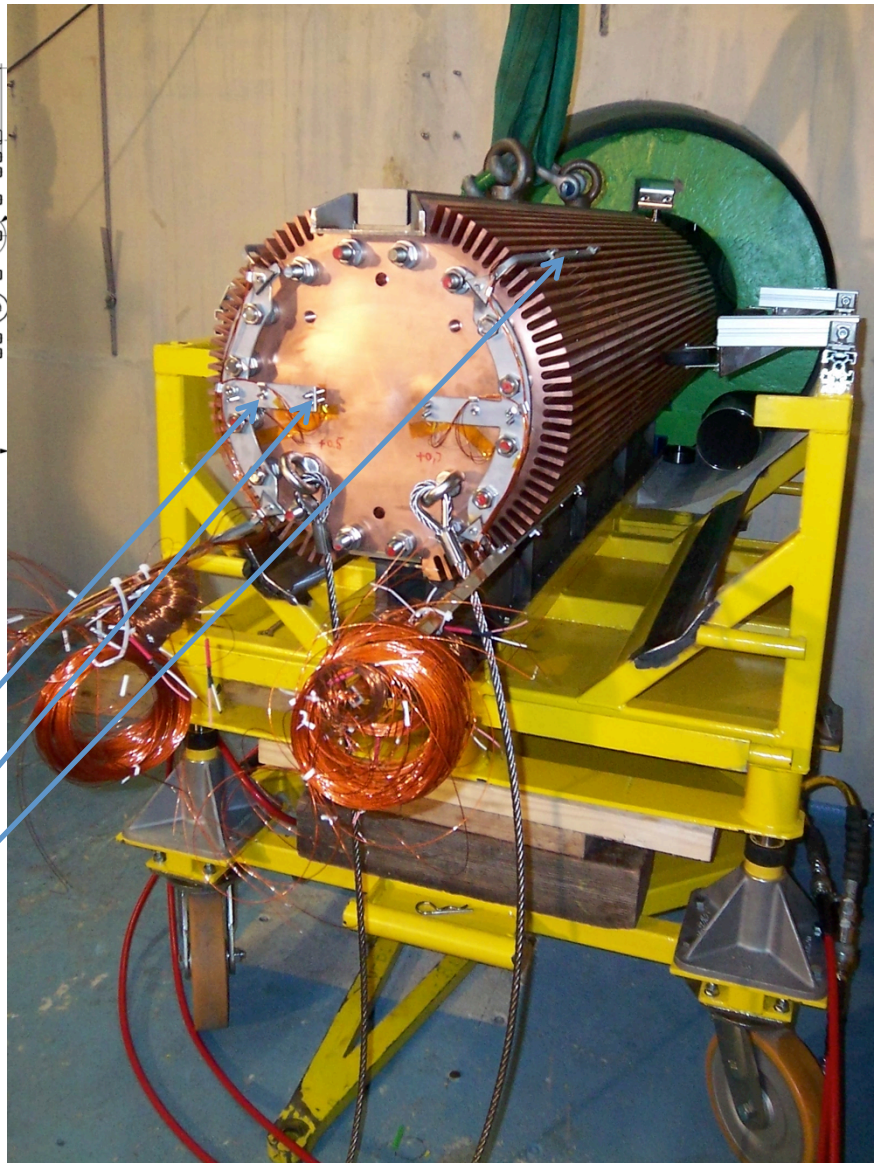


Stresses (Ansys)

Thanks to V. Venturi, E. Novak, A. Manousos (EN-STI)

NEW DUMP

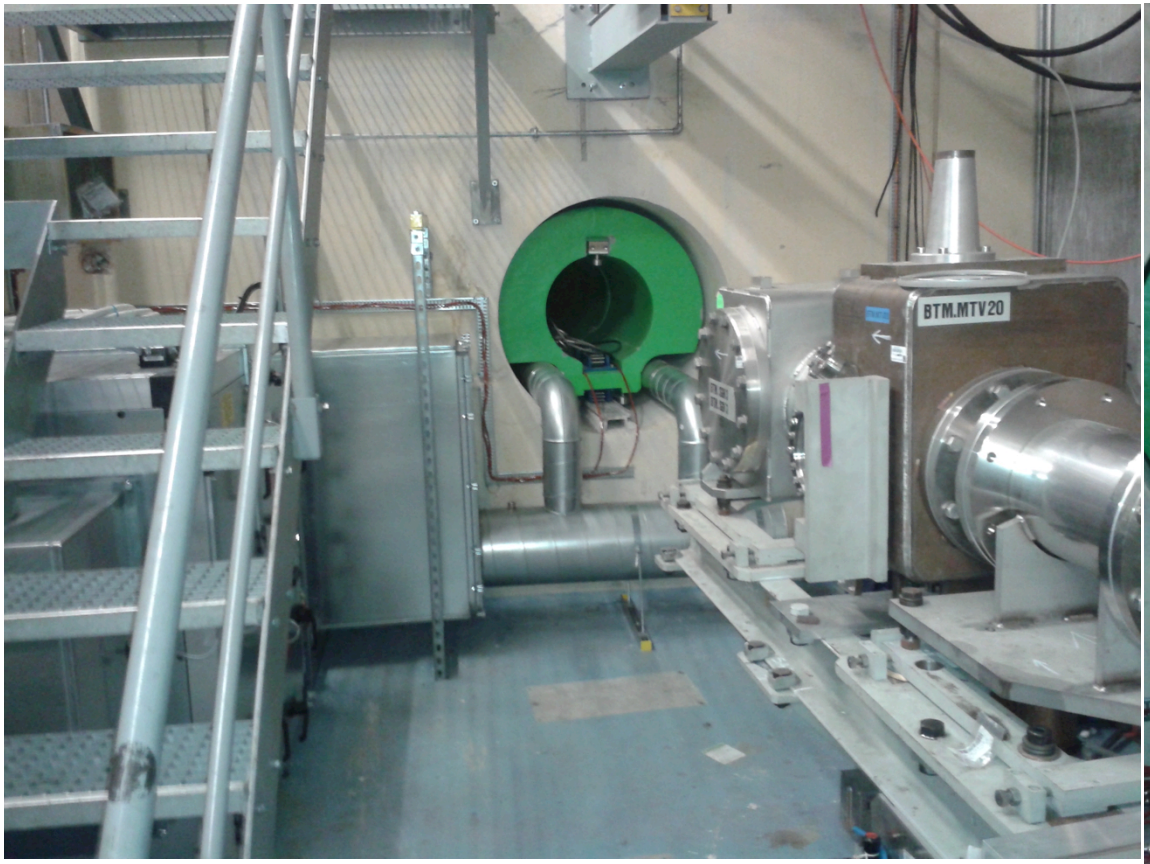


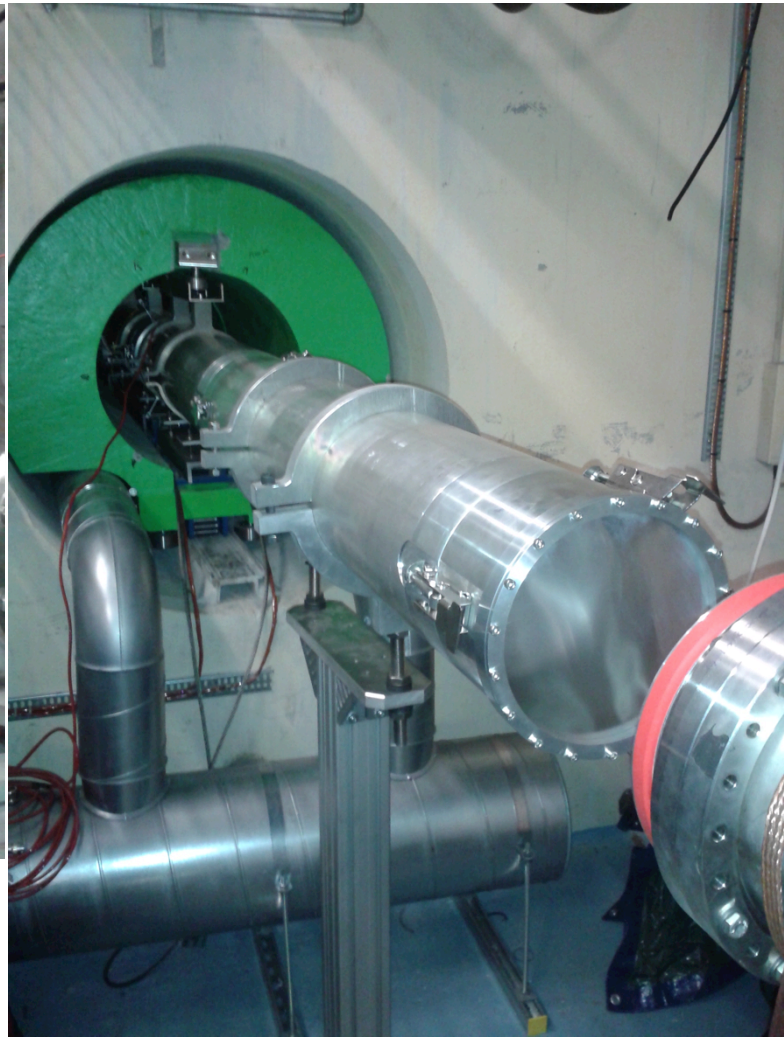


Thermocouples
and PT100

Insertion of Dump and Shielding

Air Handling Unit and Beam Pipe





Monitoring – Validation of simulations

As soon as the dumps starts being used, its performance will be carefully assessed by means of the following measurements:

- 12 temperature points on dump (1 PT100 and 1 thermo-couple at each point)
- Temperature and flow rate of air at inlet
- 6 temperature measurements of air at outlet

Thanks to J. Lendaro and M. Donze (EN-STI)

References

- EDMS 1229493 – Beam parameters
- EDMS 1309632 – Thermo-mechanical studies
- EDMS 1250483 – Cooling Engineering Specification
- EDMS 1263715 – CFD Study by EN-CV
- EDMS 1243621 – RP study on new dump
- CDD – PSBTDE__XXXX – Technical drawings
- EDMS 1302713 – Structural analysis of rail
- EDMS 1265118 – ALARA for old dump dismantling