IPAC21

CONSTRUCTION AND INSTALLATION OF THE NEW CERN PROTON SYNCHROTRON INTERNAL BEAM DUMPS

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CERN SY STI LHC Injectors Upgrade

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Agenda

1. General Overview
2. Construction
3. Testing and Quality Control
4. Installation and Commissioning
5. Conclusion

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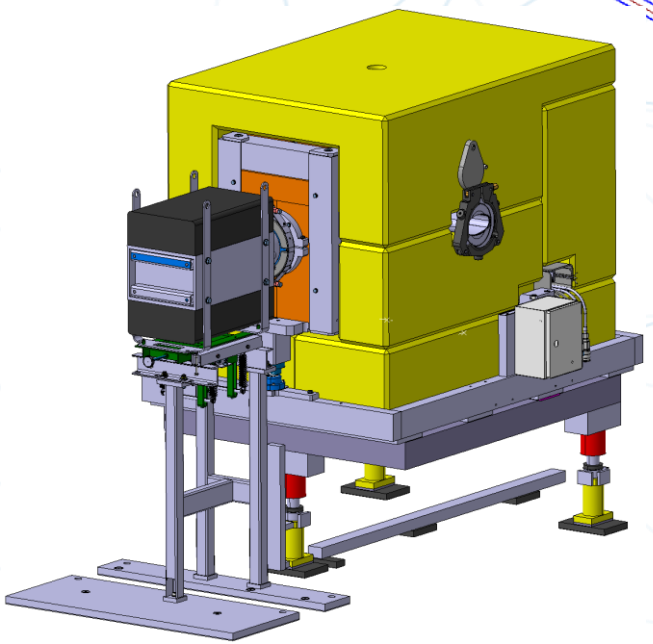
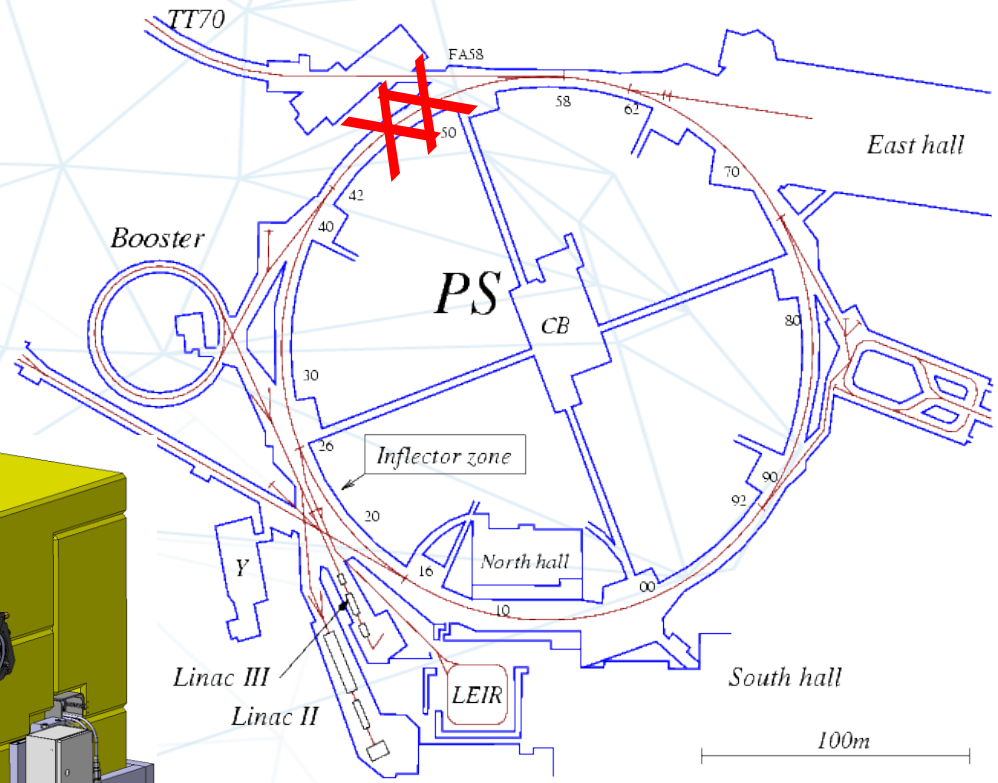
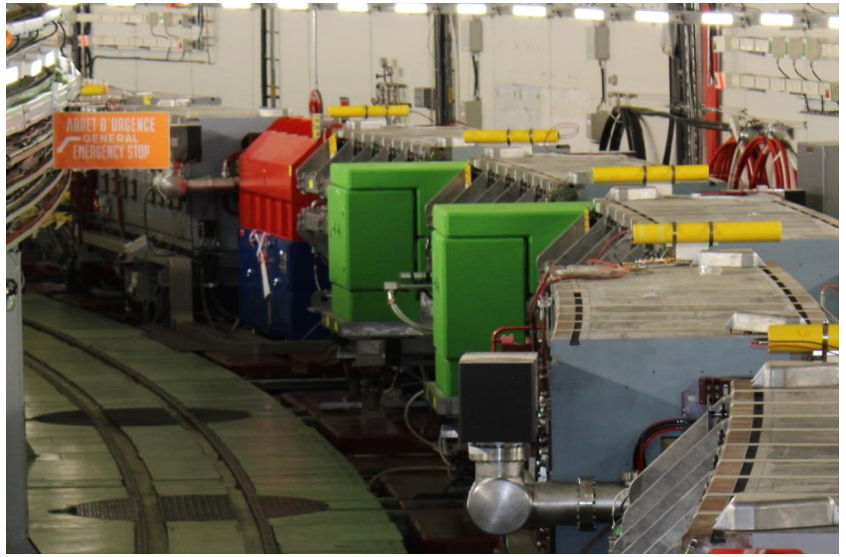
General Overview





- Objective: Dumping of particle beams of an energy of up to 100 kJ in a section without any room for kicker magnets.
- Should be capable of dumping beams between one extraction and the following injection (around 300 ms)
- Location: PS Accelerator SS47 + SS48
- Project timeframe: 2015-2021



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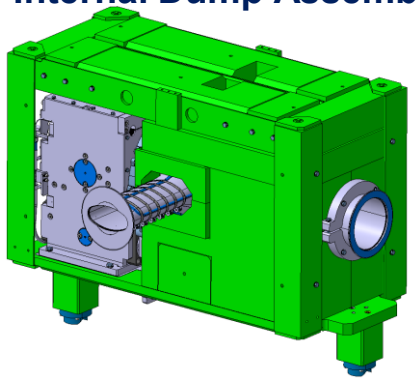
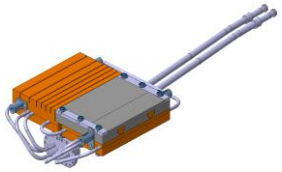
1. General Overview

The PS Internal Dump Assembly

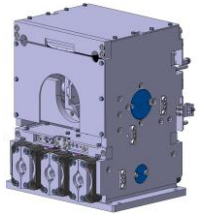
PS Internal Dump Assembly



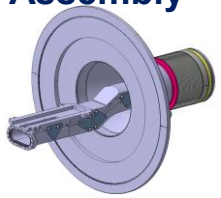
Dump Core Assembly (Graphite and CuCr1Zr)



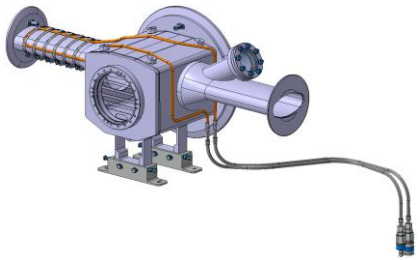
Mechanism



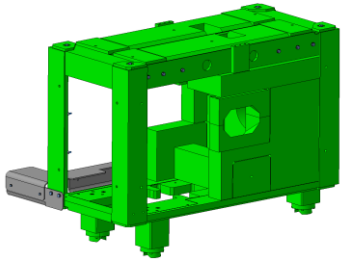
Cooling Shaft Assembly



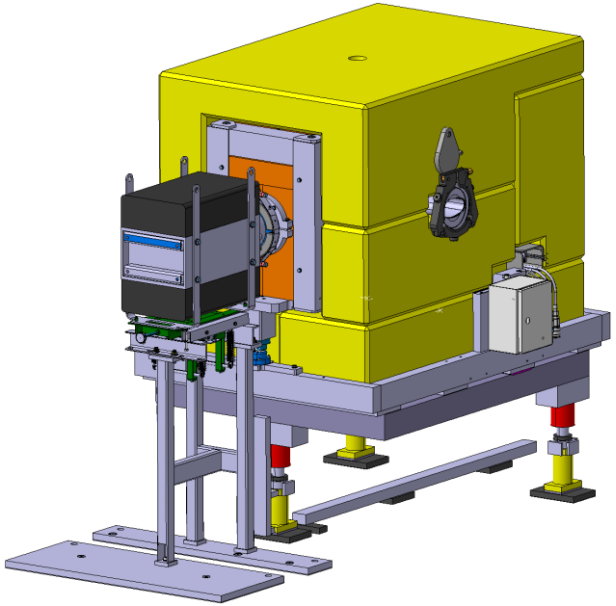
Vacuum Vessel Assembly



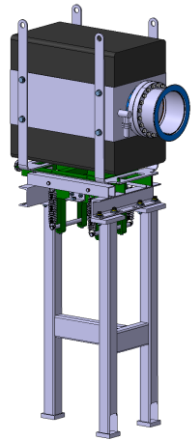
Steel Frame and Shielding



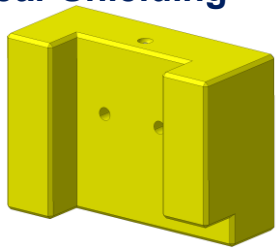
Full PS Dump Assembly



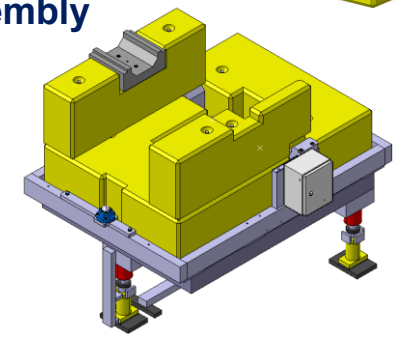
Ion Pump



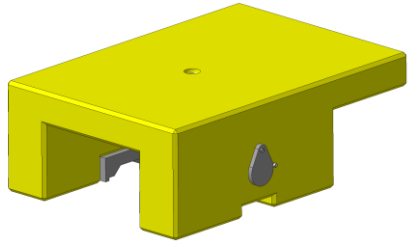
Rear Shielding



Support Structure Assembly

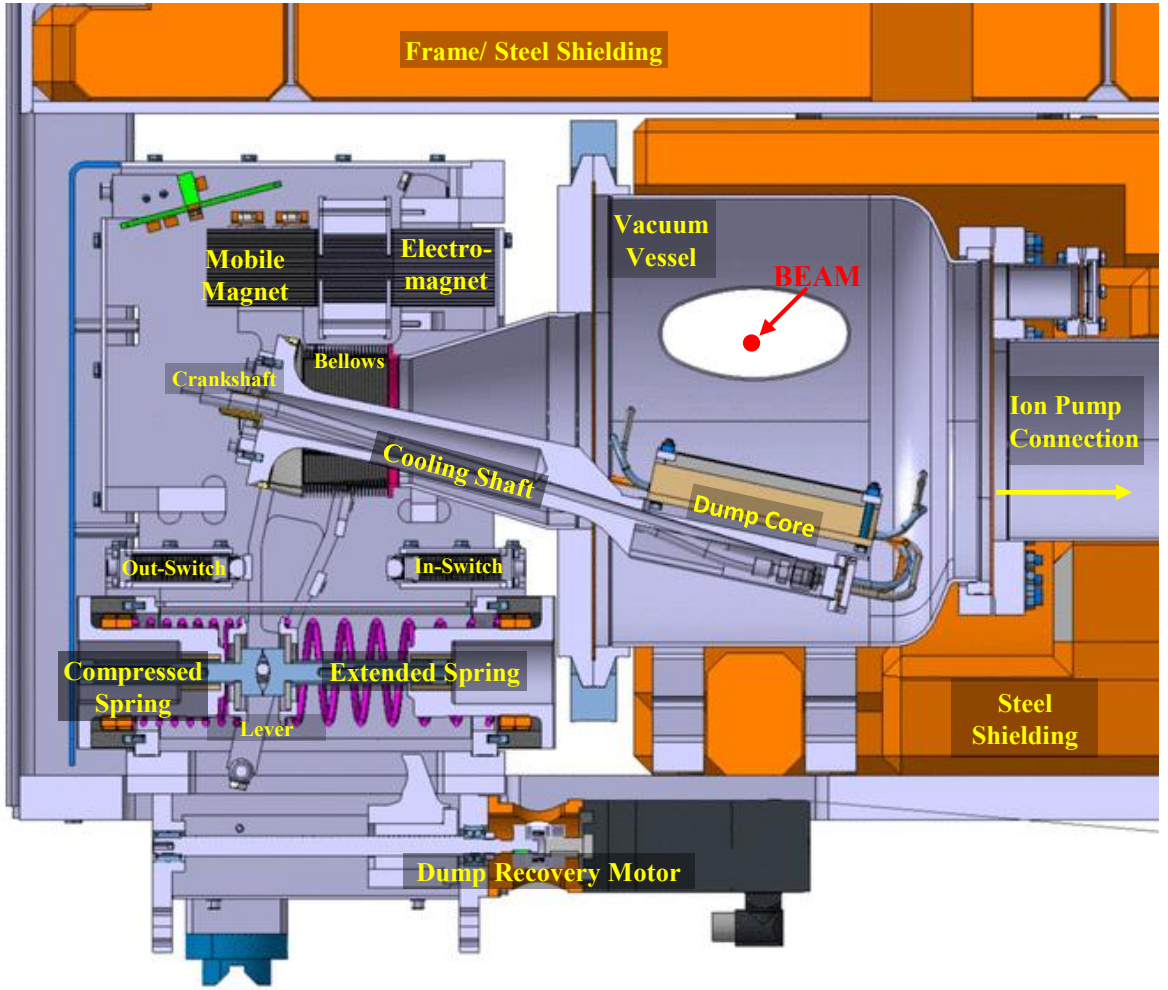


Top Shielding Block



2. Construction

Dump Actuation Animation (Cross-section)



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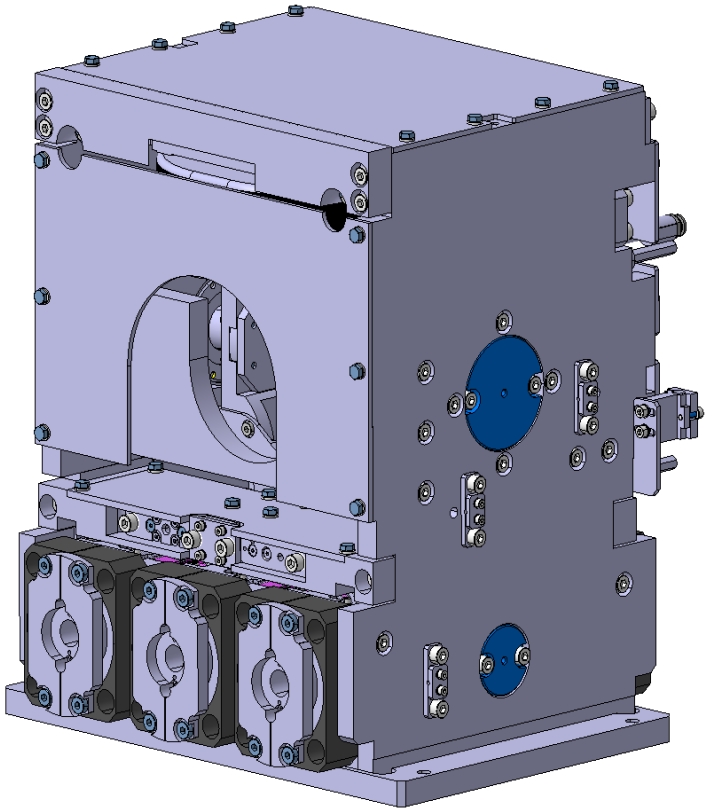
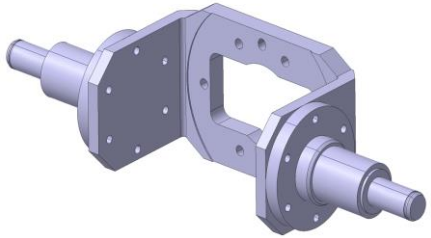
2. Construction

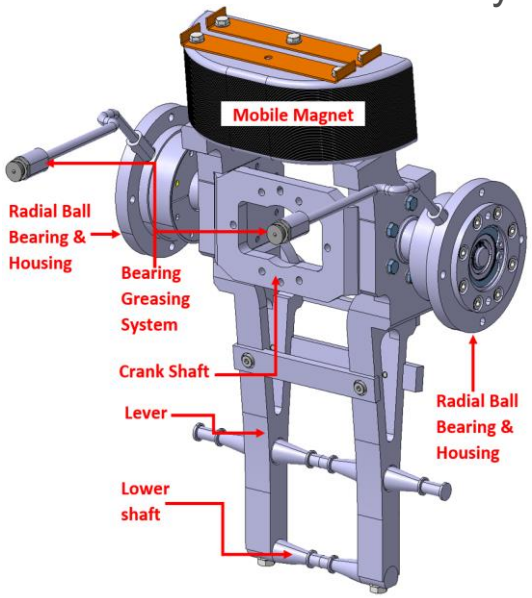
Mechanism

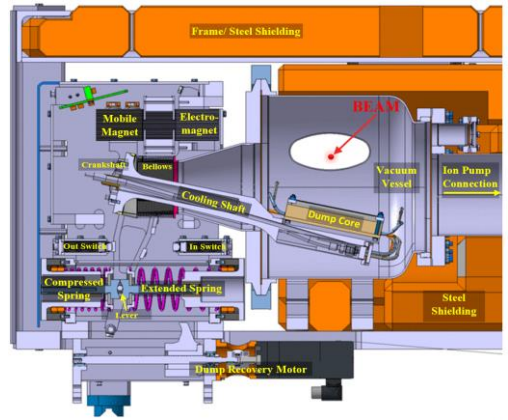


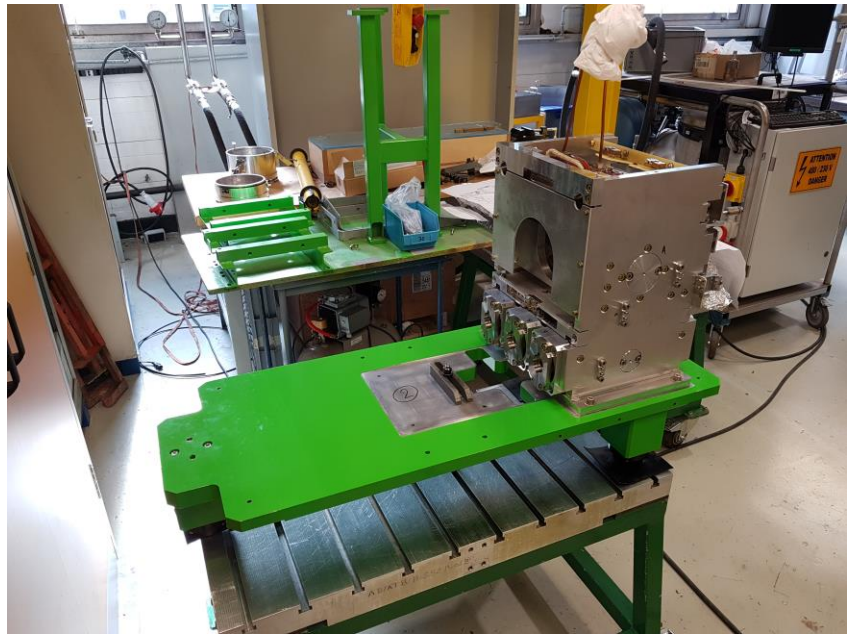
Crank Shaft (forged St. Steel 316L Machined from 1 block)



Full Lever Assembly







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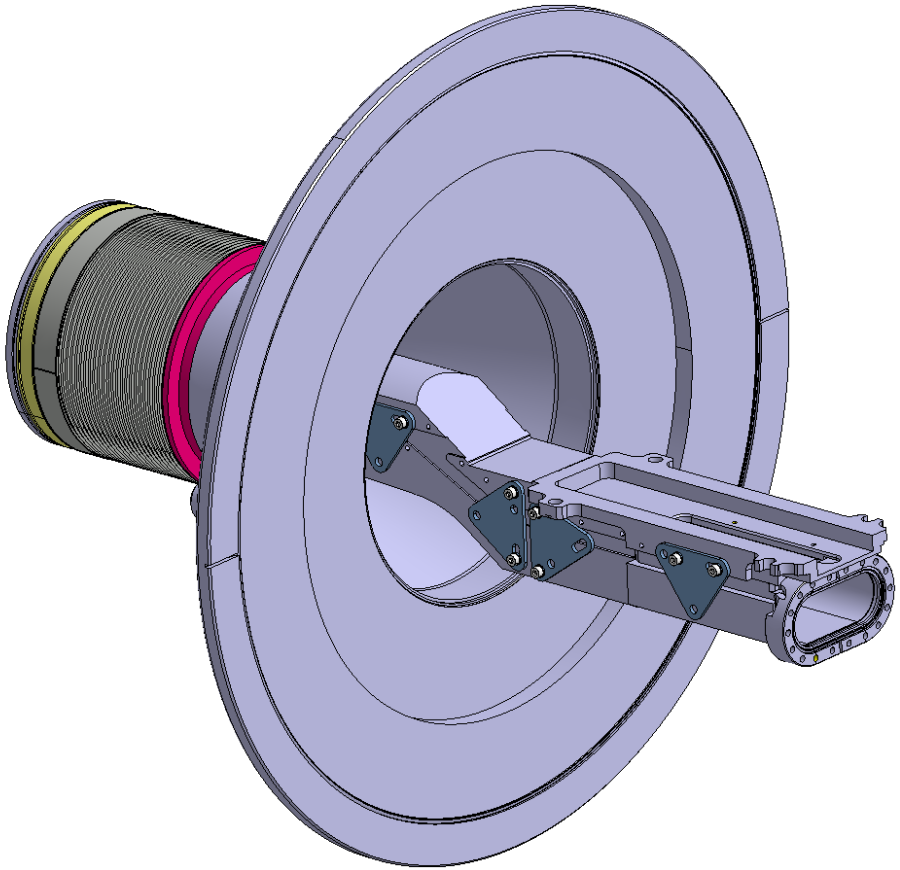
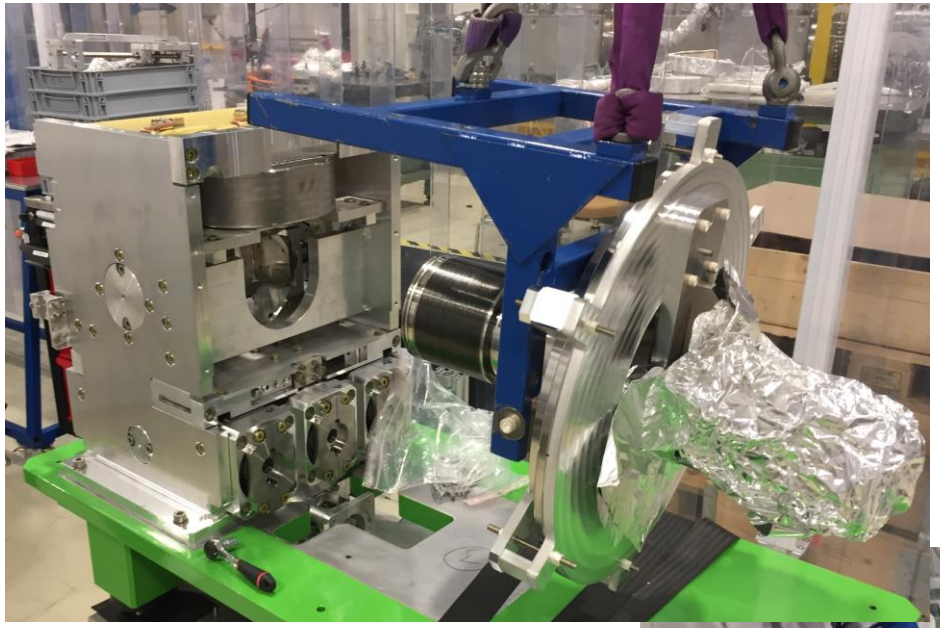
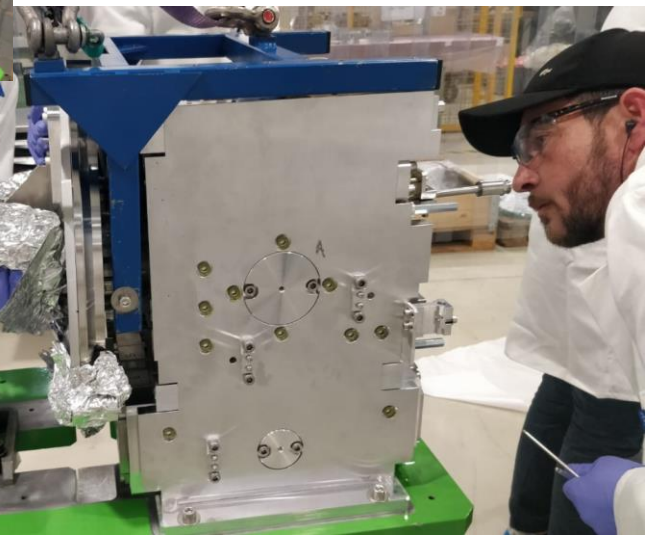
2. Construction

Cooling Shaft Assembly





Assembling Cooling Shaft onto Mechanism



The Cooling Shaft assembly consists of a rigid St. Steel shaft welded onto a flexible bellows of Ø120 x Ø90, and a DN350 flange. This assembly functions as the interface between the external actuation mechanism and the movement of the dump core, which is within the ultrahigh vacuum (UHV)
environment. It is fixed to the crank shaft from the bellow side.

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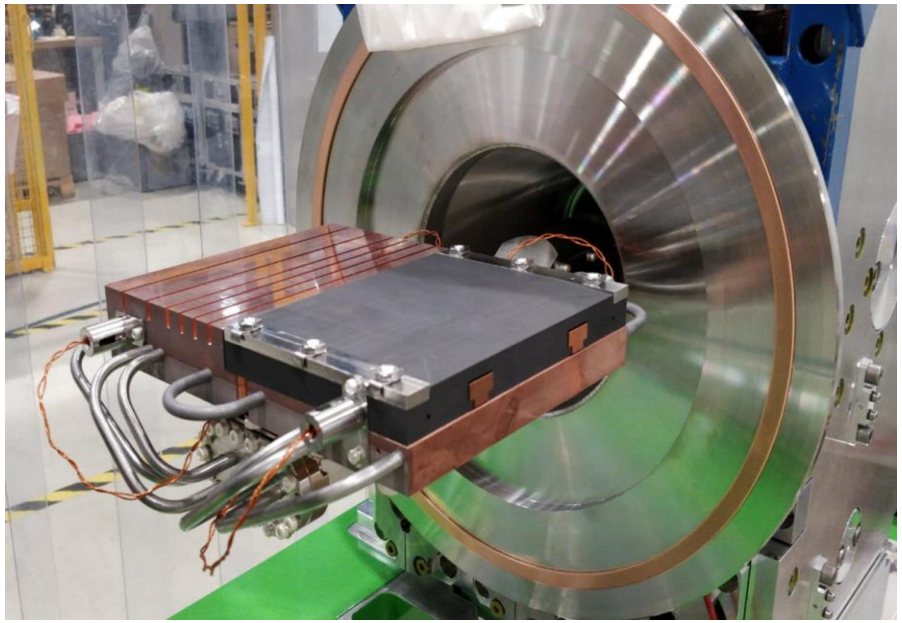
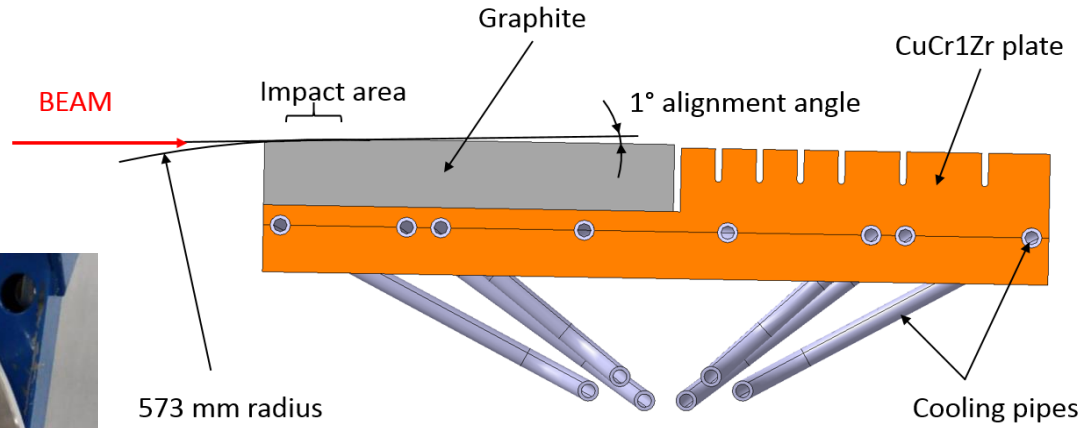
2. Construction

Dump Core Construction and Initial testing

- CuCr1Zr core body + Graphite core
- HIP- diffusion bonding between copper and st.steel cooling pipes;
- Graphite Core to withstand temperature rises of up to 1400°C on impact point;
- CuCR1Zr and Graphite cores are fixed together through mechanical contact with locking washers;
- Core is fixed on Cooling shaft with locking washers and screws with St.steel wire passing through their head to avoid them dropping if for any reason they loosen;

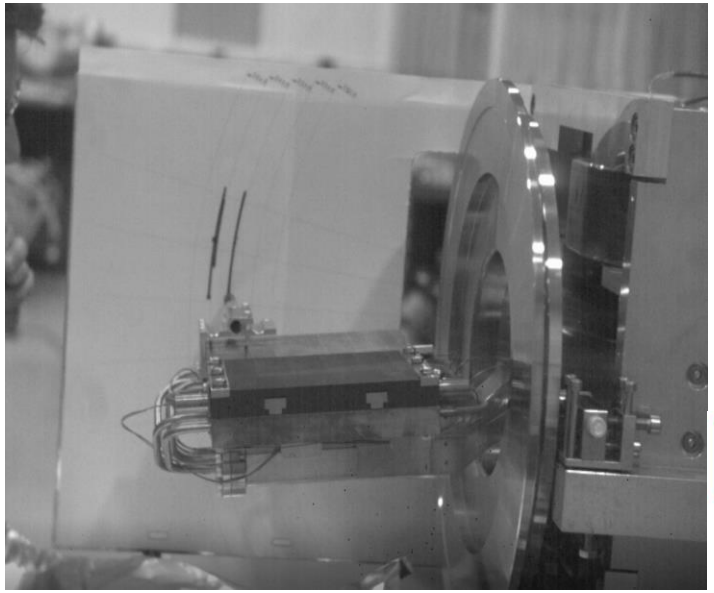


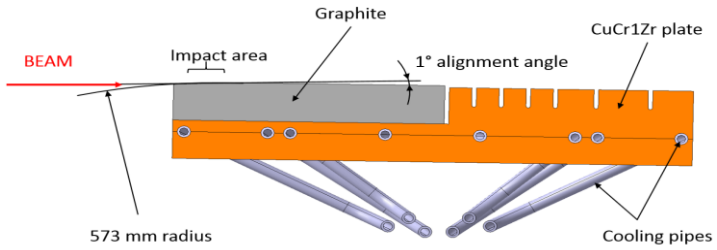


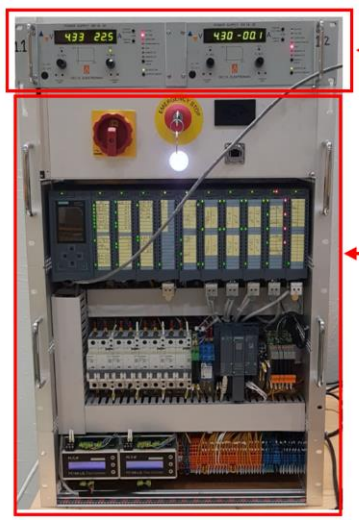
Testing and Quality Control

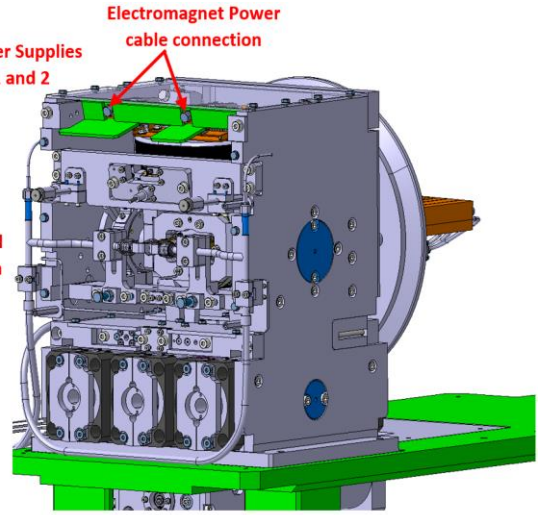
Angle, Cycle stroke and Parameter Checks and Adjustments

- Checking cycle stroke of -6° to +6° degrees angle (Adjustment of springs and Magnet position)
- Checking switches and sensors
- Adjusting parameters for smooth Cycling (voltage, current and magnet off-time)
- Confirming a cycle time of 300ms using a high-speed camera.
- Confirming reliability with some thousand cycles.









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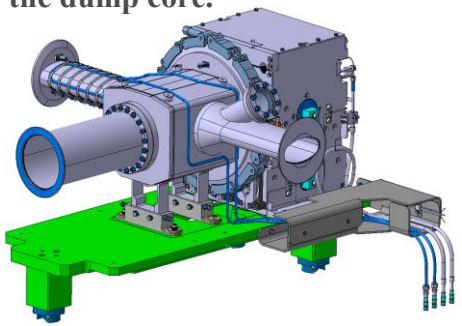
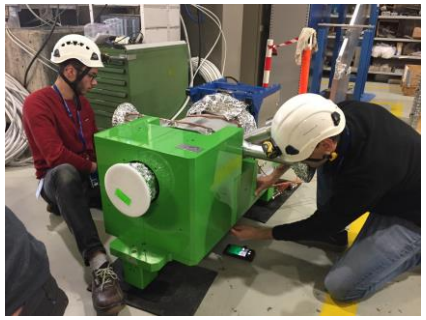
Testing and Quality Control

Vacuum Vessel, Steel Shielding, Metrology Test and UHV Acceptance

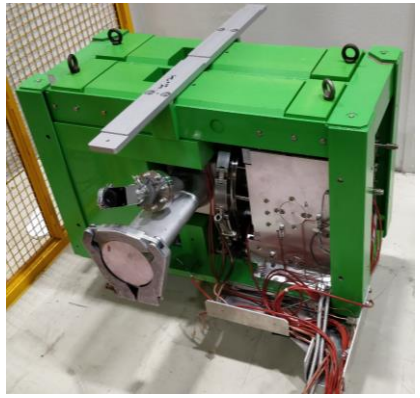
To close the dump, the vacuum vessel is installed onto the base plate, covering the dump core.



Assembly of Steel Shielding Blocks coated with anticorrosion primer and two layers of radiation resistant Polyurethane paint.



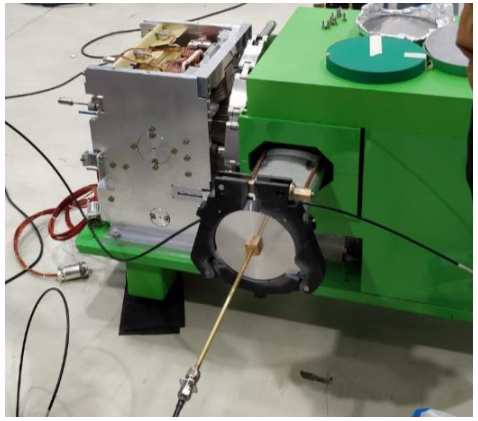
Assembly of Target Bar for Metrology checks. Total Dump mass now is 1600kg.



Metrology checks: Aligning the vacuum vessel with respect to the theoretical beam axis and checking 1° angle of graphite core w/ respect to beam axis.

Final checks:

- **Impedance test**
- **UHV Acceptance test:**
  - ***Helium Leak rate***
  - ***Total Outgassing***
  - ***Residual Gas Analysis (RGA)***
- **Final cycling checks (~20 000 cycles)**



Installation and Commissioning

Installation

Base support installation and pre-alignment of lower jacks

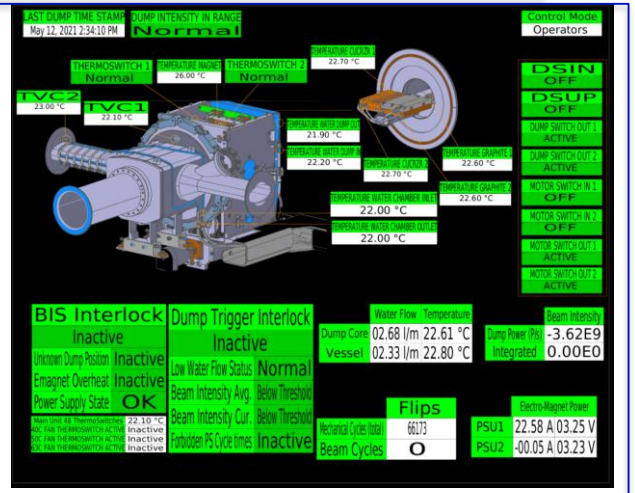
Installation of Ion Pump

Dump Installation and alignment with regards to Beam Axis. Water cooling and electrical connections

Vacuum closing and pumping

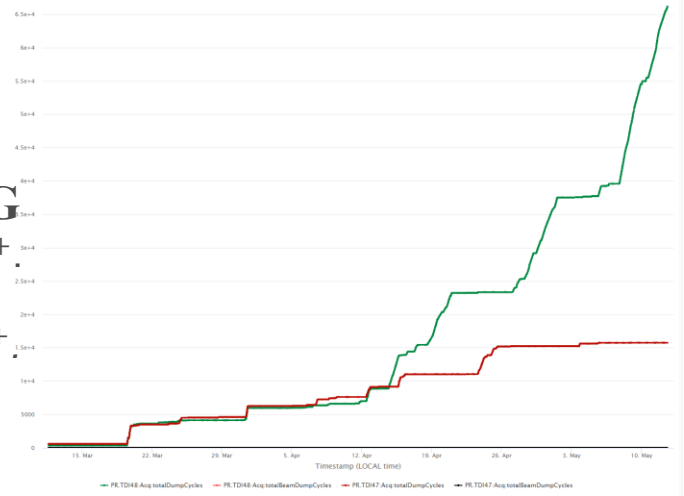
Commissioning

- Sensor Checks
  - *Temperature*
  - *Water flowrate*
  - *Pressure*
  - *Switches*
- Commissioning of water cooling



- Cycling checks
- Interlock checks

- BEAM COMMISSIONING
  - *Starting around* $2.0 \cdot 10^{10}\ P^{+}$.
  - *Intensity up to* $2.45 \cdot 10^{13}\ P^{+}$.



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Conclusion

The installation and commissioning of these Dumps conclude five years of engineering, development and production activities involving high precision machining, quality control, sheet metal forming, welding, HIP diffusion bonding, assemblies in UHV clean environments and the dedication of several professionals through multiple disciplines.

Some of the successful challenges completed

- *Successful design and machining of the forged 316L crank shaft in one single piece*
- *Development and manufacturing of the vacuum vessel*
- *R&D and studies leading to the successful production of HIP components*
- *High reliability and low maintenance of the actuation system.*

All the tests to this point have been successfull including Beam Tests up to intensities of up to $1.2 \cdot 10^{13}$ P+, temperature levels stability, functionality of cooling system and vacuum levels.

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Thank you for your attention!

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