CERN ISOLDE DUMPS
IBDRS* project / FLEXI building

* ISOLDE BEAM DUMP REPLACEMENT STUDY

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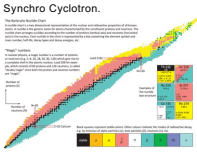
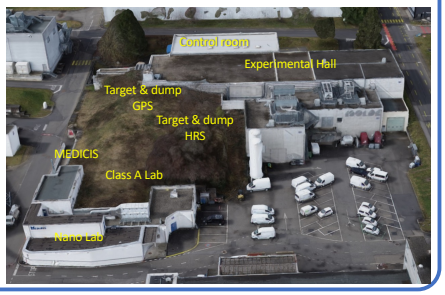
1. Introduction

- **ISOLDE at CERN** has been continuously upgraded **since 1967** to produce radioactive ion beams and radio-isotopes for physics and medicine.

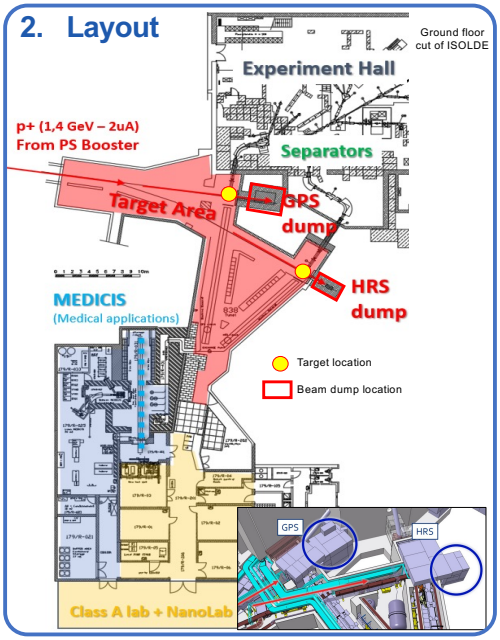
1967, the first test of the Isotope On-Line Separator (ISOLDE) installation at the 600 MeV CERN Synchro Cyclotron.



- **In 1991 ISOLDE was moved** to its current location and connected to the PS Booster (pulsed proton beam).



2. Layout

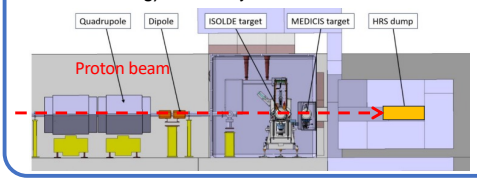


3. Background

- **The CERN PS Booster (PSB) has been upgraded during a Long Shut-down in 2020** to provide beam of higher energy and intensity for LHC. PSB upgrade opens new opportunities for ISOLDE as it delivers protons as well to GPS and HRS ISOLDE target stations (like other facilities).

Scenario	Energy [GeV]	Particles per ring [10^{12}]	Maximum particles /pulse (4 rings) [10^{12}]	Intensity [μA]	Shortest repetition period [s]	Average duty factor [%]	Power [kW]
Upgrade	2.0	25	100	13.4	1.2	100 (50)	26.6 (13.3)
Today (*)	1.4	~ 8	33	2.2*	1.2	50	3.1*

- At ISOLDE **about 85%** of the protons are absorbed by the beam dumps.
- The actual beam dumps don't permit to fully benefit from the new PS Booster parameters (thermal and mechanical stress)
- The actual beam dumps are made of **iron blocks (without active cooling)** shielded by concrete blocks.



4. Justification

- Actual beam dump **shows signs of corrosion and humidity.** Thermocouples have been added in 2023 to allow for the online temperature measurements and adjust simulations.

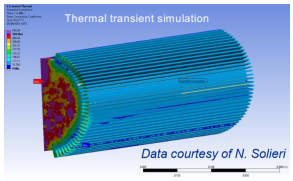
HRS dump face with thermocouples installed

- **The energy deposition heating was calculated in Ansys** for various proton beam energy and intensity:

Energy	Intensity	Max temperature in steady-state with lightest possible target inserted	Max VM stress
1.4 GeV	2 μA	135 ºC	51 MPa
1.4 GeV	3 μA	199 ºC	89 MPa
1.7 GeV	2 μA	160 ºC	63 MPa
1.7 GeV	3 μA	239 ºC	114 MPa
2.0 GeV	2 μA	187 ºC	77 MPa
2.0 GeV	3 μA	280 ºC	140 MPa
2.0 GeV	6 μA	612 ºC	-
2.0 GeV	13.4 μA	1257 ºC	Too high temperature !

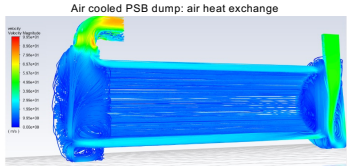
5. New dump design choice

- Future **water-cooled** beam dump similar to PS Booster dump (air cooled)*
- Graphite + CuCr1Zr absorber

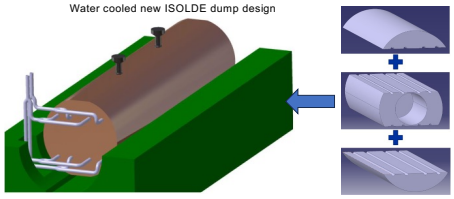


* Design and operation of the air-cooled beam dump for the extraction line of CERN's proton synchrotron booster, Phys. Rev. Accel. Beams 23, 063001 – Published 11 June 2020, A.Perillo-Marcone&All CERN https://journals.aps.org/prab/abstract/10.1103/PhysRevAccelBeams.23.063001

Air cooled PSB dump: air heat exchange

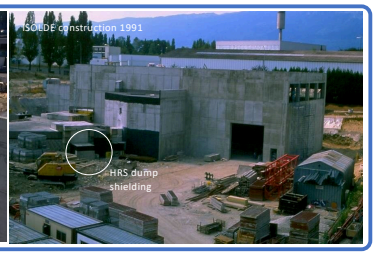


Water cooled new ISOLDE dump design



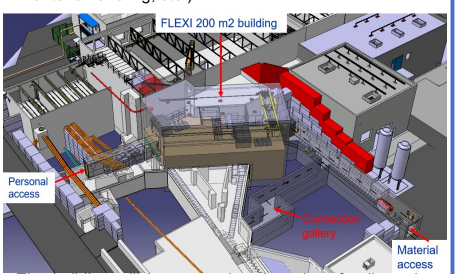
6. Challenges

- **Actual dumps are buried below 10 meters of soil (partially radioactive).**
- Dose rate at contact is around **300mSv/h.**
- **Not compatible with remote handling**
- Need to remove 7000 m^3 of to reach the beam dump shielding (1500m3 radioactive)



8. The FLEXI concept

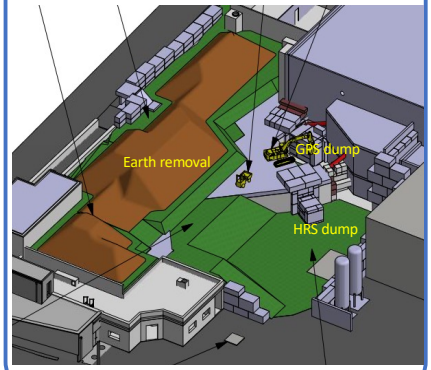
- **Around 7000m^3 of soil needs to be removed** for the dump replacement. It's a unique opportunity **to upgrade the target area** for a medium and long-term development
- **Increase space by adding a new building** on top of the target area (FLEXI building).
- **Main advantages of the FLEX building:** rationalization of equipment location to improve safety and facilitate maintenance (Vacuum pumps, radioactive gas storage, handling of vertical modules with a crane, possibility to develop an Automatic Guided Vehicle (AGV) for the Frontend handling, etc.)



- The building will be covered under ~4m of soil used as shielding.

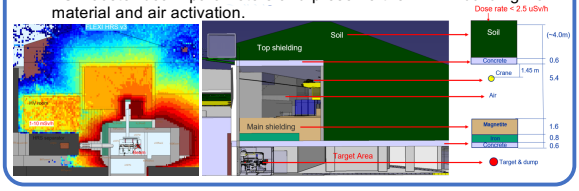
7. Dismantling of old dumps

- An accurate study was performed to optimize the dismantling due to management of the **radiological risk.**

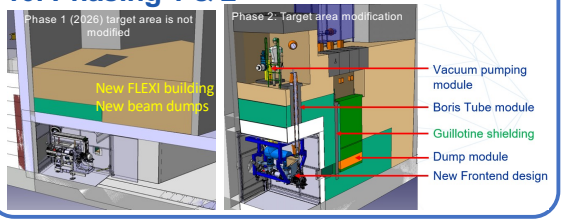


9. Shielding optimization

- **FLUKA simulation** have been performed to to cope with the new PS Booster beam parameters and preserve the FLEXI building from material and air activation.



10. Phasing 1 & 2



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