ISOLDE Beam Dump Replacement Study (IBDRS) – Preparatory project

92nd ISOLDE Collaboration Committee meeting

05.11.2021

AP.Bernardes SY-STI on behalf of the IBDRS team

Acknowledgements:

SY-STI: M.Calviani, K.Kershaw, JM.Martin Ruiz, S.Marzari, J.Vollaire
SCE-DOD: E.Perez-Duenas, R. Cunningham
HSE-RP: E.Aubert, A.Dorsival, F.Pozzi, A.Formento
EN-HE: C.Bertone, JL.Grenard
EN-ACE: A.Pardons, M.Lazzaroni
SY-ABT: M.Fraser
BE-OP: S.Mataguez, E.Siesling

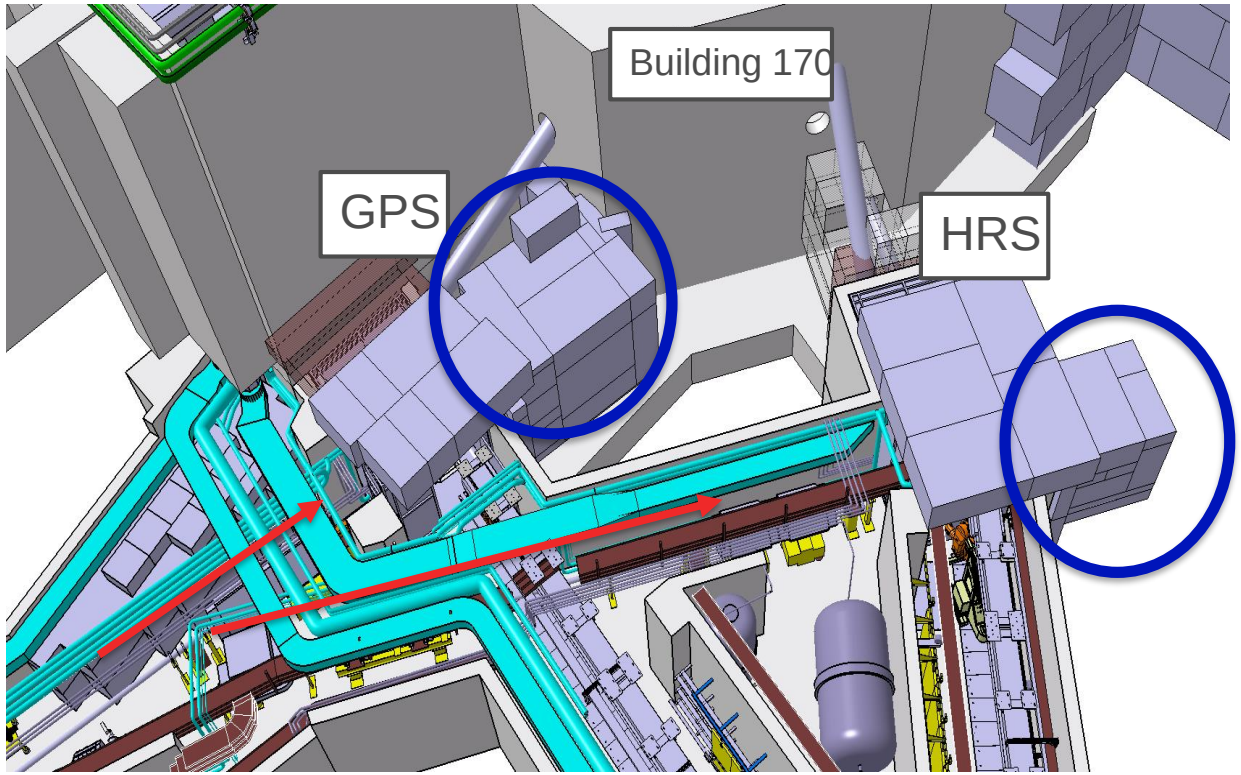
Agenda

1. Introduction
2. IBDRS organisation
3. IBDRS Status
4. Next steps
5. Conclusion

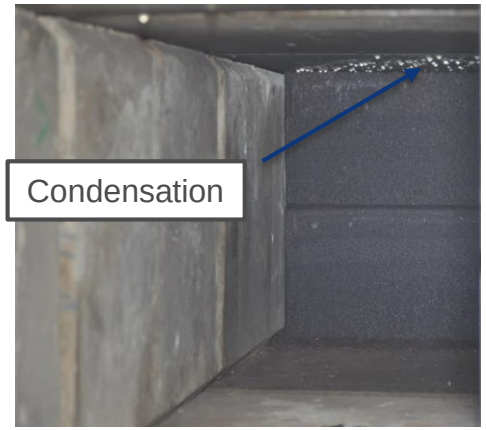
Introduction

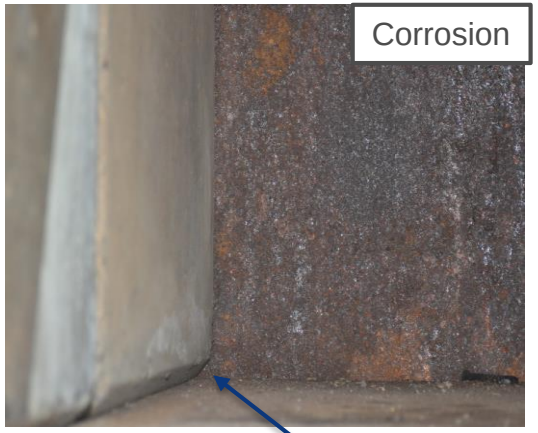
INTRODUCTION

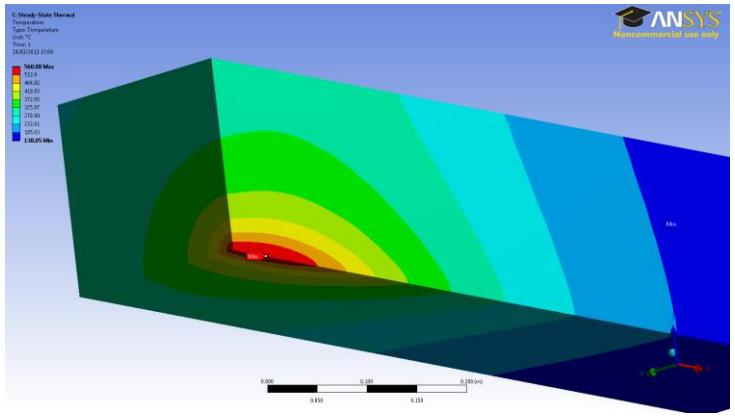
- Current ISOLDE configuration dates to 1991-1992 (ISOLDE 4)
- Beam dumps were designed for a proton beam of 1 GeV and lower (?) intensity
- Current max beam 1.4 GeV/c at 2.0 μA is **2.8 kW on dump**

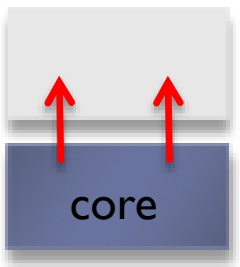


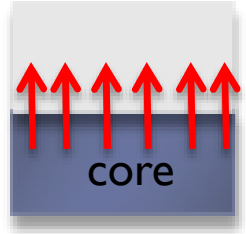
INTRODUCTION











Large uncertainty on the heat conduction coefficient

- Signs of corrosion, condensation and molten material on the visible face
- Unknown condition (neither access nor monitoring)
- **Dumps already operate at their limit in terms of temperature and mechanical stresses**
- Coupled FLUKA/thermo-mechanical analyses (EDMS 1277863, 1308217) are showing that the **dumps already operate at their limit in terms of temperature and mechanical stresses** → dangerous to go higher
- **Need for shielding improvements around the target areas and beam dumps** (EDMS 1142606)

INTRODUCTION

- PS Booster (PSB) beam upgraded during LS2 at 2 GeV (LIU Project)

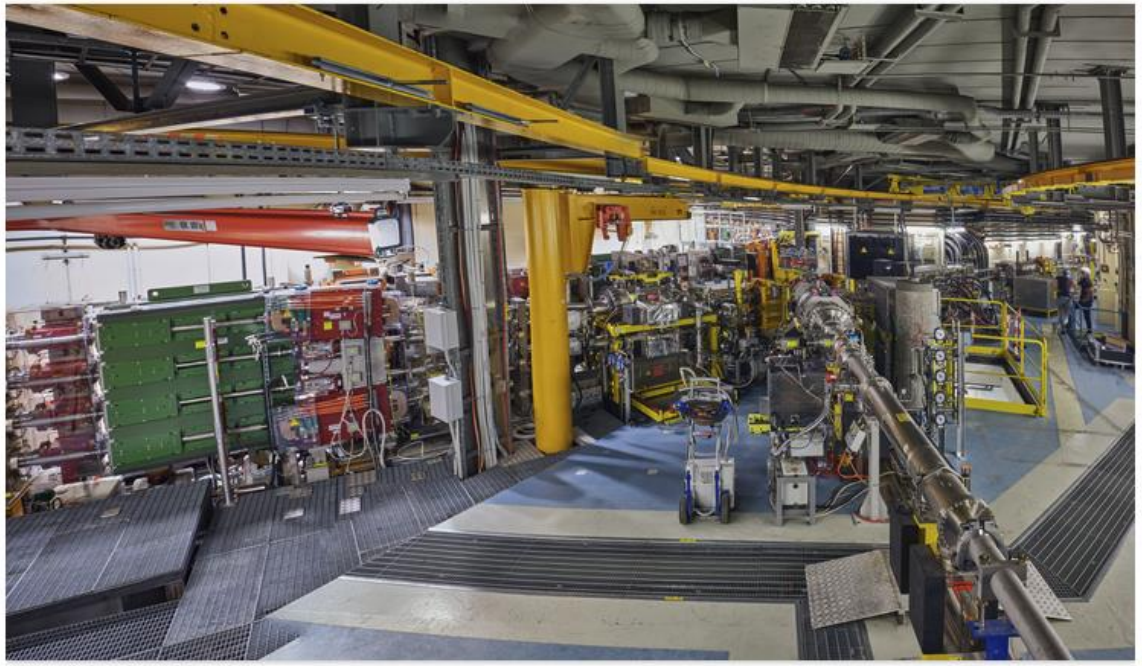
- ISOLDE is the only facility at CERN which cannot profit from PSB upgrade because of:
  - **Dump limitation** (Energy deposition → higher beam power dissipation requires air- or water-cooled dump)
  - BTY line upgrade

First step to 2 GeV protons beam at ISOLDE is the ISOLDE Beam dump Replacement

LS2 Report: Beams circulate in the PS Booster

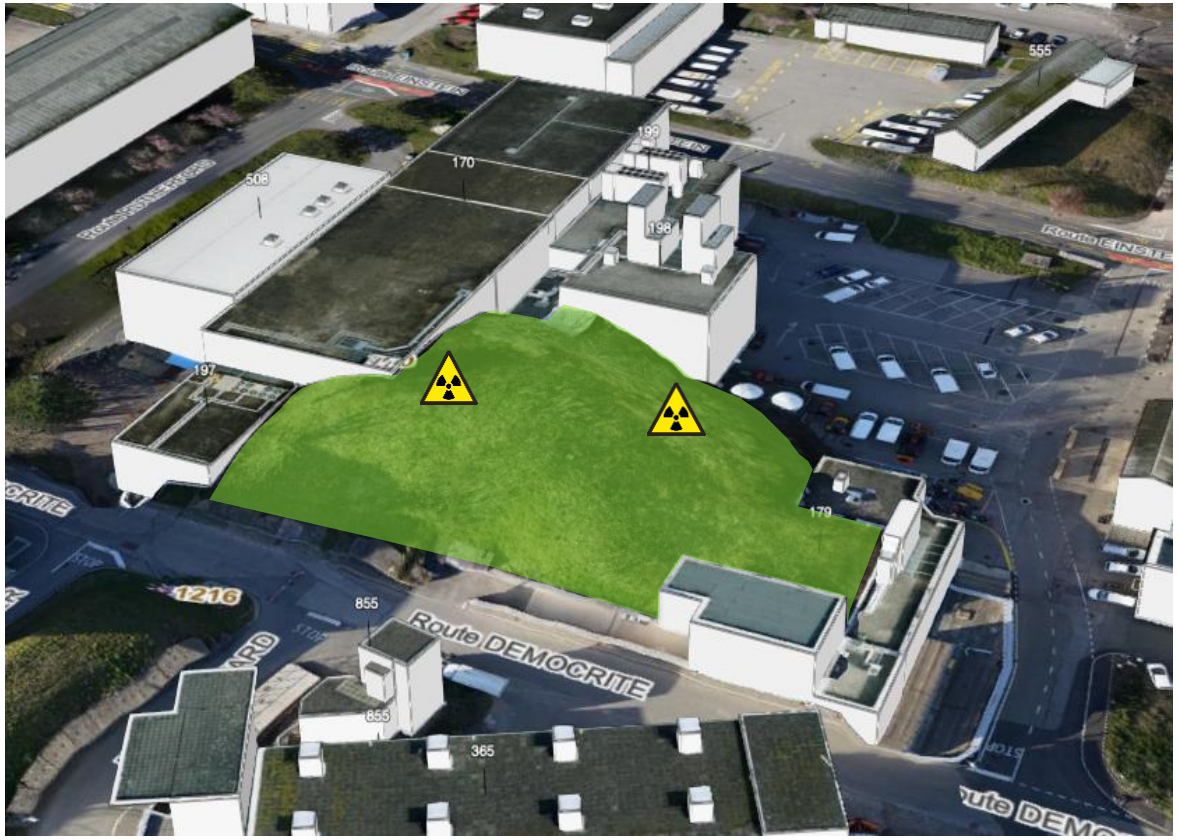
The PS Booster successfully received its first beams from Linac4 in December. The PSB team is now preparing the machine for acceleration

12 JANUARY, 2021 | By Anaïs Schaeffer



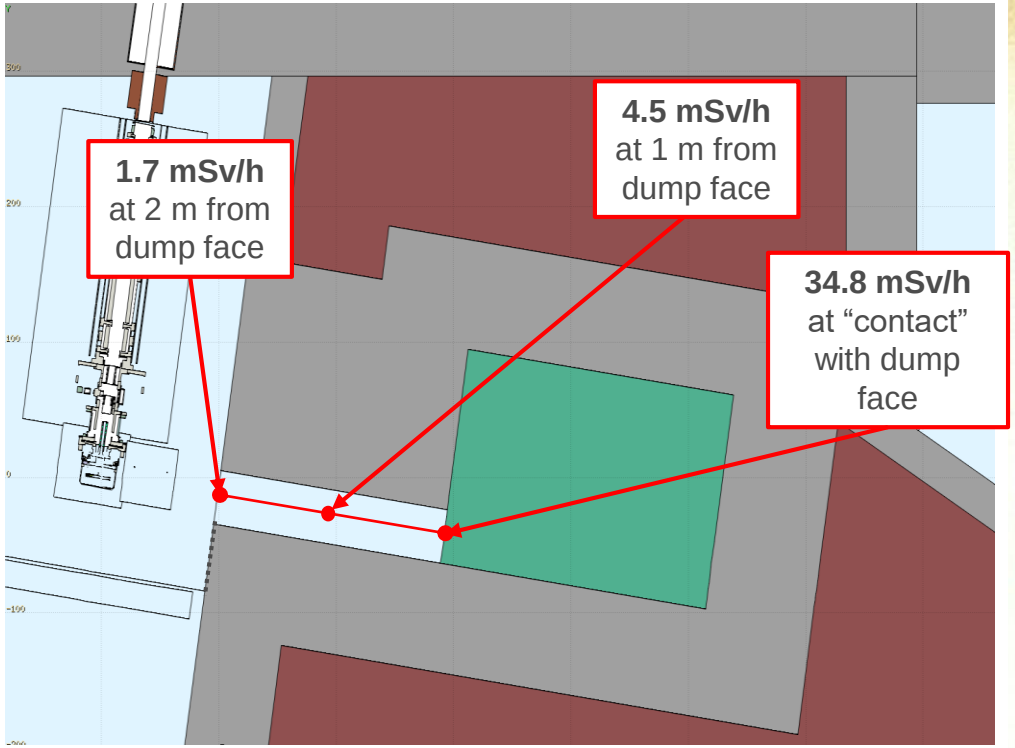
A view of the PS Booster after its metamorphosis. (Image: CERN)

INTRODUCTION



Beam dump exchange is challenging – Current design not planned to be dismantled (Buried in earth). Covered with activated earth

INTRODUCTION



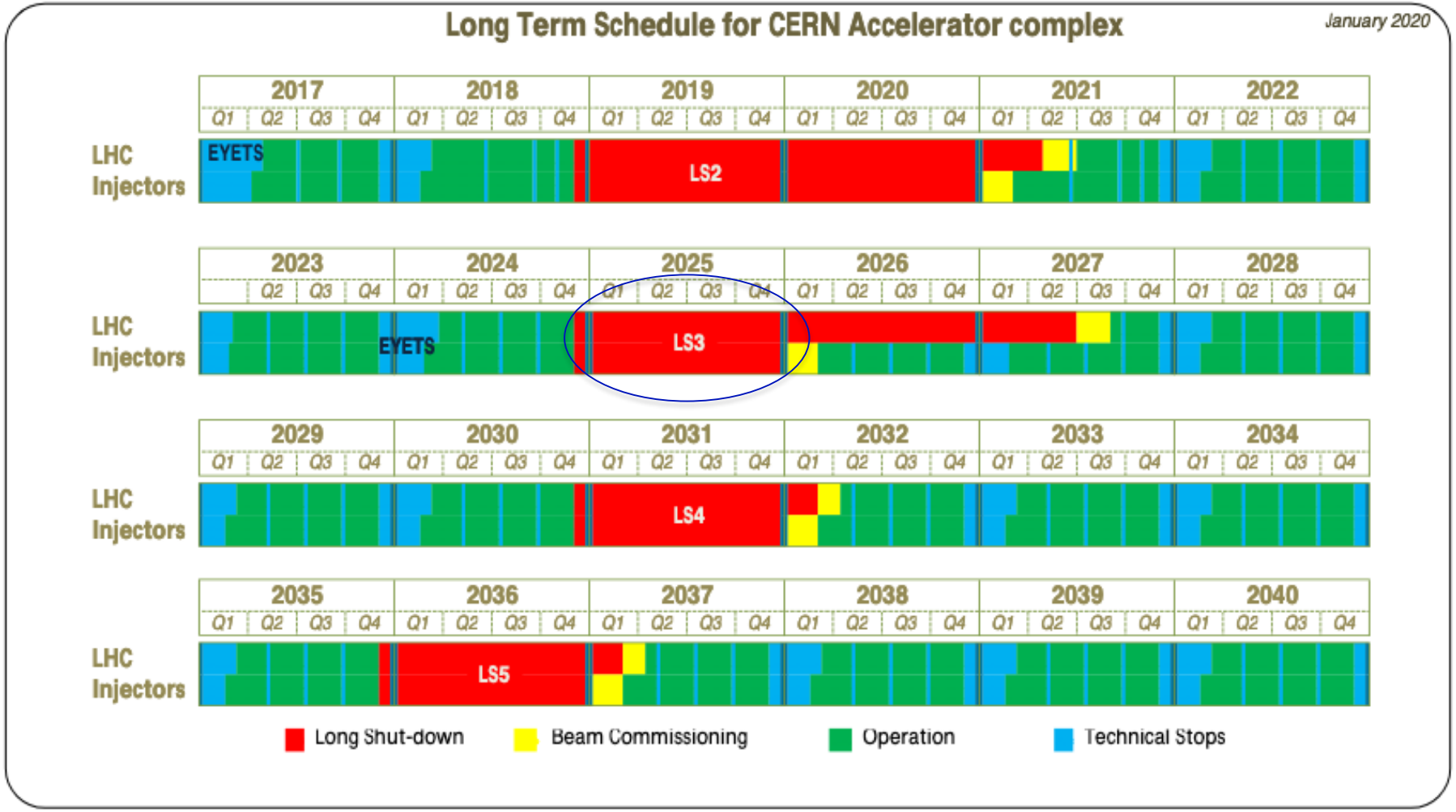
RP Survey – May 2021 after 2 years cooling

Acknowledgement A. Dorsival, F. Pozzi HSE-RP

(Manual handling)

INTRODUCTION

Dump Replacement is only possible during a LS (a long LS!)

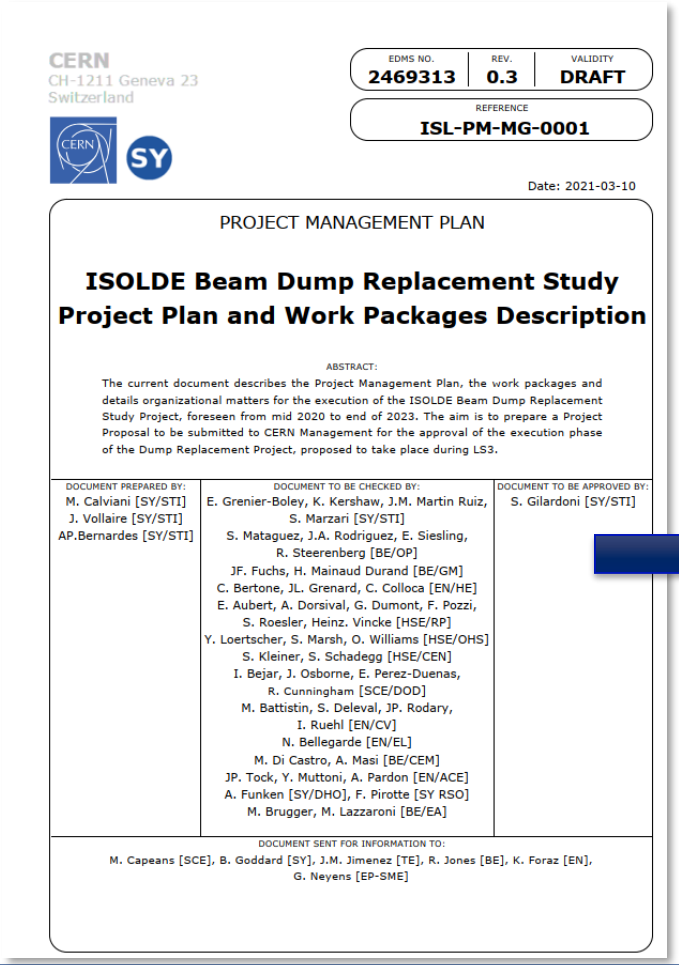


IBDRS Organisation

Organisation

Project Management Plan
[EDMS 2469313]

IBDRS Study funded by the ACC-CONS budget



CERN
CH-1211 Geneva 23
Switzerland

EDMS NO.	REV.	VALIDITY
2469313	0.3	DRAFT

REFERENCE: ISL-PM-MG-0001

Date: 2021-03-10

PROJECT MANAGEMENT PLAN

ISOLDE Beam Dump Replacement Study
Project Plan and Work Packages Description

ABSTRACT:

The current document describes the Project Management Plan, the work packages and details organizational matters for the execution of the ISOLDE Beam Dump Replacement Study Project, foreseen from mid 2020 to end of 2023. The aim is to prepare a Project Proposal to be submitted to CERN Management for the approval of the execution phase of the Dump Replacement Project, proposed to take place during LS3.

DOCUMENT PREPARED BY:	DOCUMENT TO BE CHECKED BY:	DOCUMENT TO BE APPROVED BY:
M. Calviani [SY/STI] J. Vollaire [SY/STI] AP.Bernardes [SY/STI]	E. Grenier-Boley, K. Kershaw, J.M. Martin Ruiz, S. Marzari [SY/STI] S. Mataguez, J.A. Rodriguez, E. Siesling, R. Steerenberg [BE/OP] JF. Fuchs, H. Mainaud Durand [BE/GM] C. Bertone, JL. Grenard, C. Colloca [EN/HE] E. Aubert, A. Dorsival, G. Dumont, F. Pozzi, S. Roesler, Heinz. Vincke [HSE/RP] Y. Loertscher, S. Marsh, O. Williams [HSE/OHS] S. Kleiner, S. Schadegg [HSE/CEN] I. Bejar, J. Osborne, E. Perez-Duenas, R. Cunningham [SCE/DOD] M. Battistin, S. Deleval, JP. Rodary, I. Ruehl [EN/CV] N. Bellegarde [EN/EL] M. Di Castro, A. Masi [BE/CEM] JP. Tock, Y. Muttoni, A. Pardon [EN/ACE] A. Funken [SY/DHO], F. Pirotte [SY RSO] M. Brugger, M. Lazzaroni [BE/EA]	S. Gilardoni [SY/STI]

DOCUMENT SENT FOR INFORMATION TO:
M. Capeans [SCE], B. Goddard [SY], J.M. Jimenez [TE], R. Jones [BE], K. Foraz [EN], G. Neyens [EP-SME]

1.2.1 KEY REQUIREMENTS FOR REPLACEMENT DUMPS

The key requirements for replacement dumps can be summarised as follows:

- **Meet current as well as future operational needs**; this would allow reliable and safe operation with the current beam parameters at 1.4 GeV, but would also guarantee the possibility for ISOLDE to operate at 2 GeV with increased current;
- **Meet modern radiation protection standards**; this would include proper ground shielding around the dumps and soil and air activation minimization. In addition, the new dump works will allow reduction of the stray radiation on the

Meyrin site, resulting from the dump operation. Exchange of the dump would also potentially allow reduction of backscattered radiation into the ISOLDE Target area;

- The design shall consider **final decommissioning and disposal of the new dumps** – in particular their removal from the facility, transport to a suitable storage area and requirement for the elimination to the final repository.

1.2.2 DESIGN OPTIONS

The Study phase will allow the study of different design options: these are ranging from just an exchange of the HRS and GPS dump cores without changing the shielding design, to a broader scope that would also include the revision of the ISOLDE target area shielding.

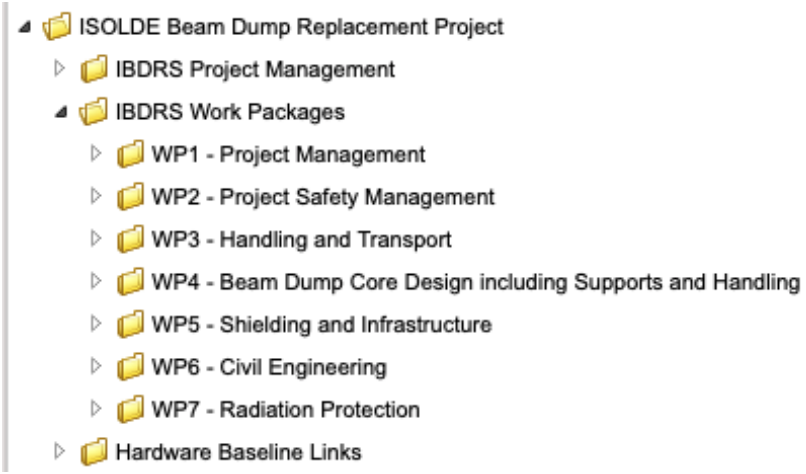
Organisation

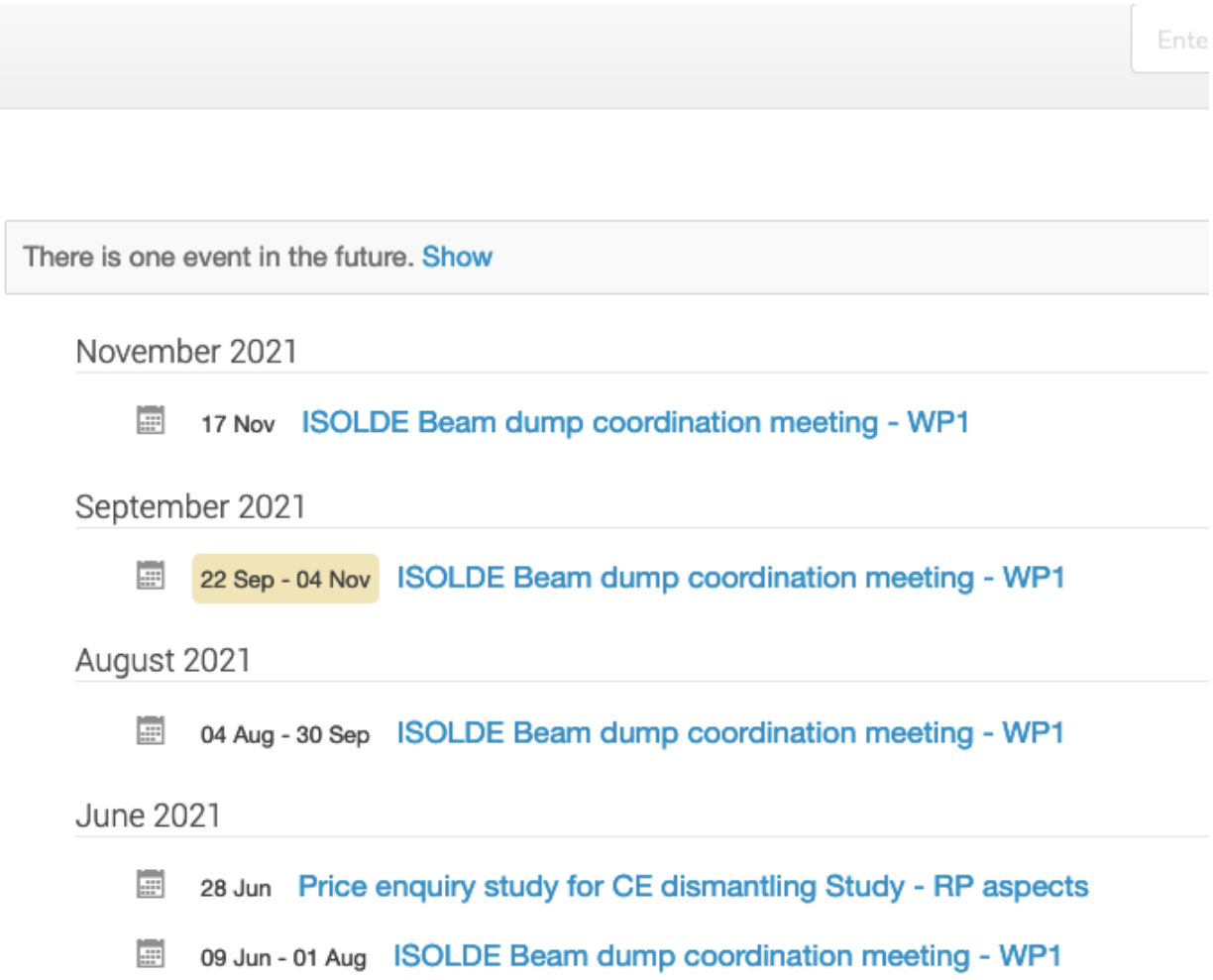
- 7 Work packages identified EDMS 2469313

WP1 – Project Management – A.P. Bernardes [SY-STI]
WP2 – Project Safety Management - S. Mataguez [BE-OP]
WP3 – Handling and transport - C. Bertone [EN-HE]
WP4 – Beam dump core design including supports – J.M. Martin Ruiz [SY-STI]
WP5 – Shielding and infrastructure: lifecycle handling and integration - S. Marzari [SY-STI]
WP6 – Civil Engineering Study– E. Perez-Duenas [SCE-DOD]
WP7 – Radiation Protection– F. Pozzi [HSE-RP]

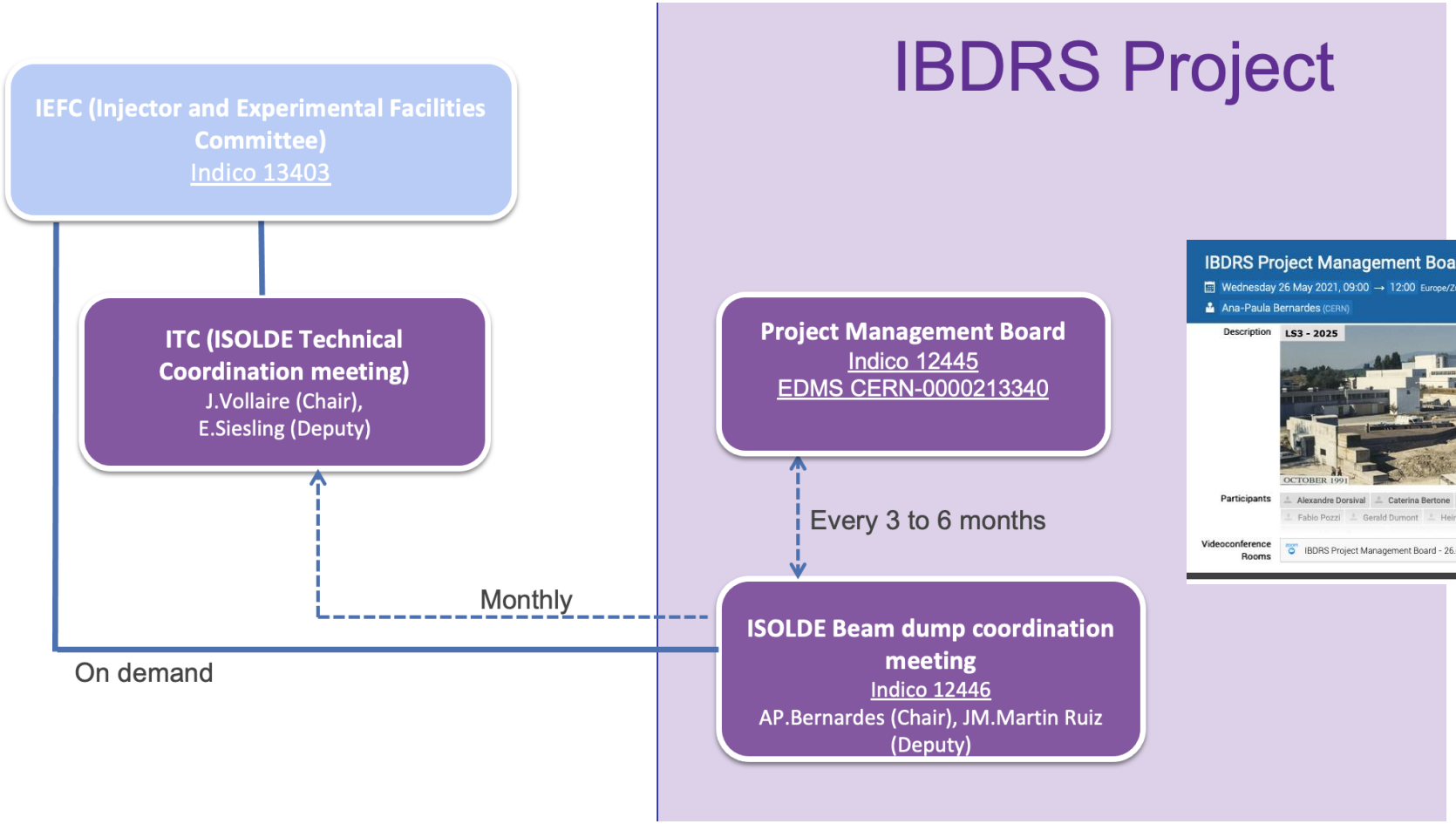
Introduction

- IBDRS coordination meetings every two weeks- [Indico 12446]
- EDMS structure

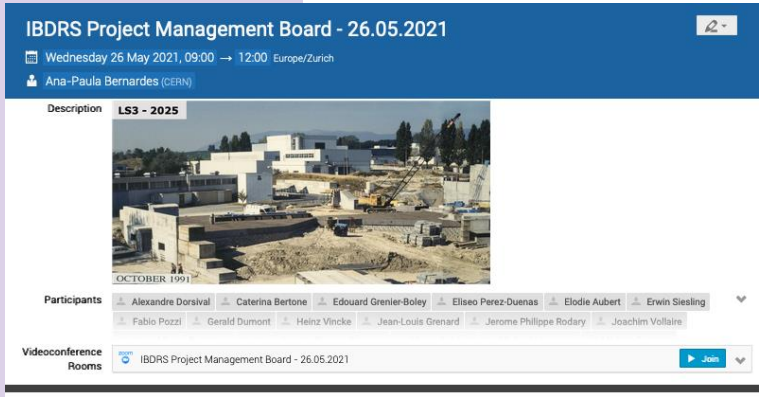




Organisation



1st Project Management Board in May 2021 – Indico 1034928



IBDRS Status

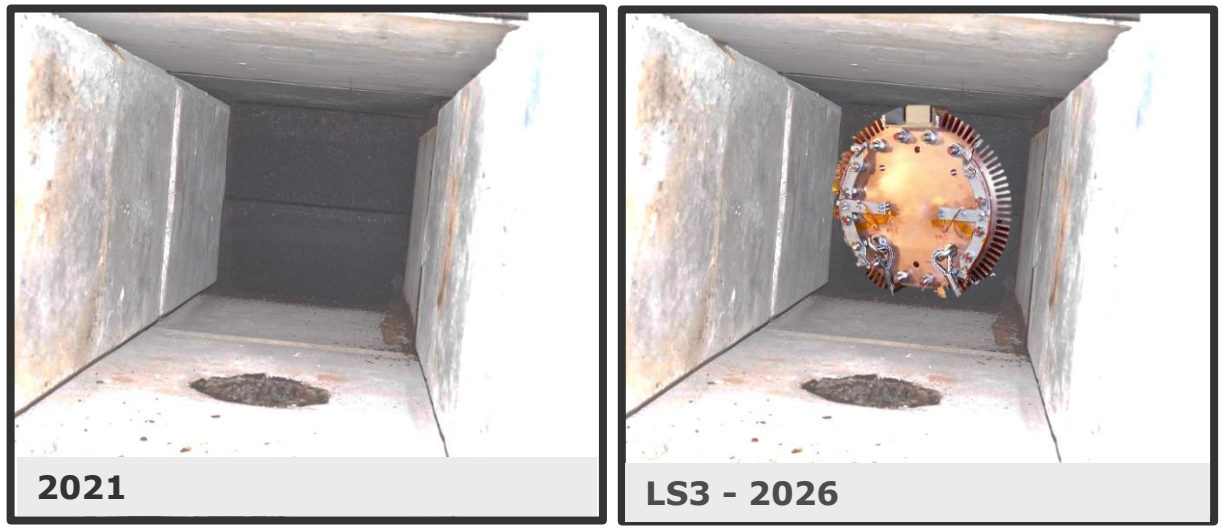
Dump design parameters

- **Requested to meet current as well as future operational needs**
  - Parameters to be considered for the **DUMP** design are under discussion

Table 1: Energy and intensity for the ISOLDE beam dump upgrade [1] compared to present day operation (maximum) receiving an average of 50% of available proton pulses from PSB.

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	26.6
Today	1.4	~ 8	33	2.2	1.2	50	3.1

Acknowledgement M.Fraser/SY-ABT (EDMS 2583793)



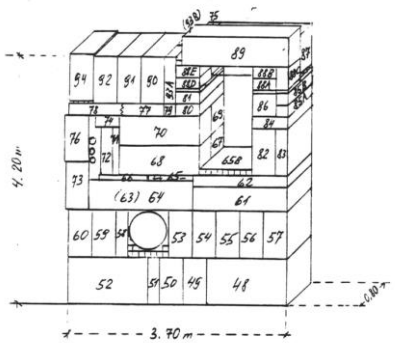
Shielding design parameters

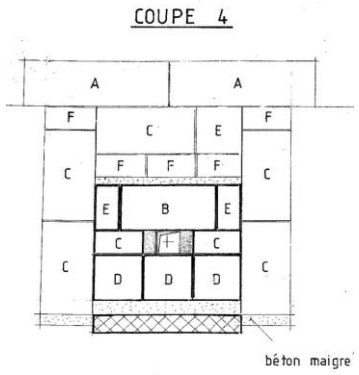
- **Meet current as well as future operational needs**
  - Parameters to be considered for the **SHIELDING** design under discussion

Table 6 – Beam parameters for shielding radiation studies

Scenario	Energy [GeV]	Maximum particles /pulse (4 rings) [10^{12}]	Shortest repetition period [s]	Average duty factor [%]	Intensity [μA]	Hours of ISOLDE operation per year [h]	Protons on each dump/year [p]
Upgrade	2.0	100	1.2	50	6.7	4000	$3 \cdot 10^{20}$

Acknowledgement J.Vollaire and J.M. Martin Ruiz (EDMS 2583793)





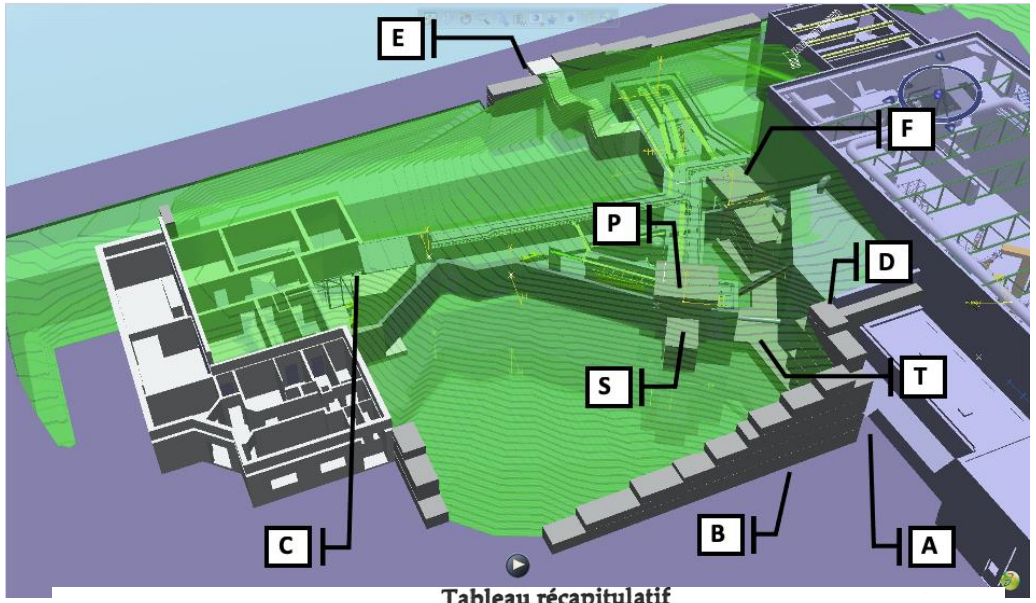


Tableau récapitulatif

Nature du blindage	Volume [m^3]	Masse [T]	Activité [GBq] *	Act. spécif. * moyenne [$Bq.g^{-1}$]
Béton	18,71	43,98	0,175	3,97
Acier	45,53	358,3	1462,2	$4,08 \cdot 10^3$

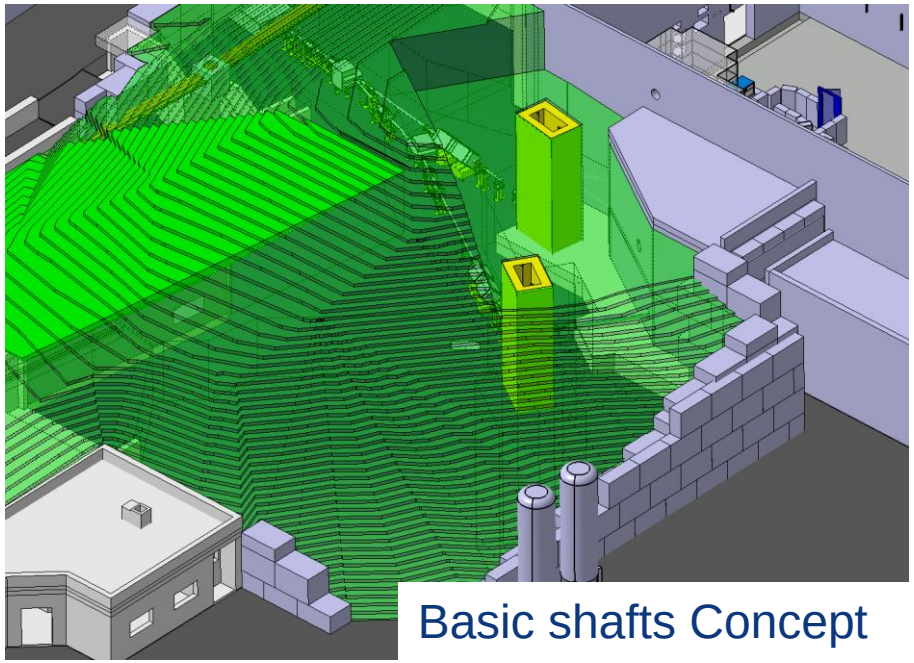
* Activité à la date du mois de juin 1991

In addition 8 to 10 meters of earth shieling

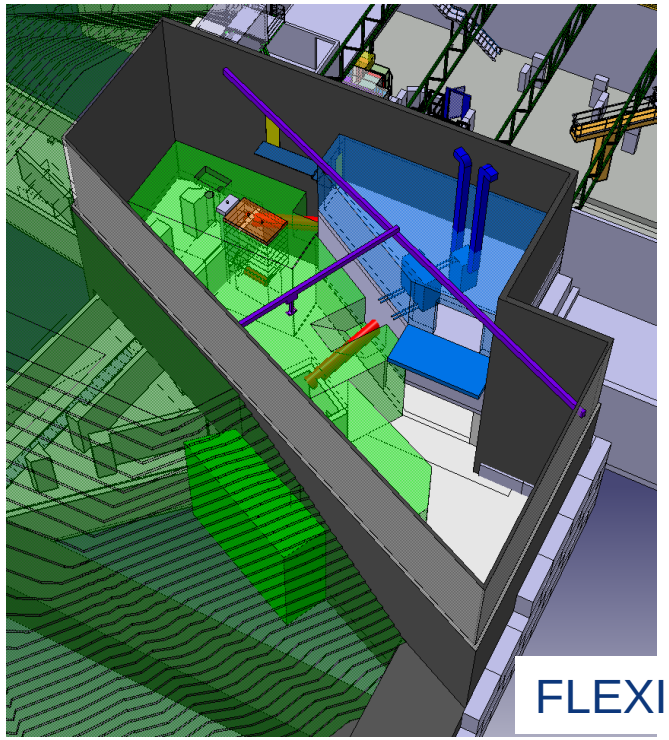
Concepts

Following 6 months brainstorming session – 2 concepts have been selected to be studied in parallel:

- BASIC concept (Reduced cost)
- FLEXI Concept (Higer CAPEX but would allow cheaper future ISOLDE upgrade)



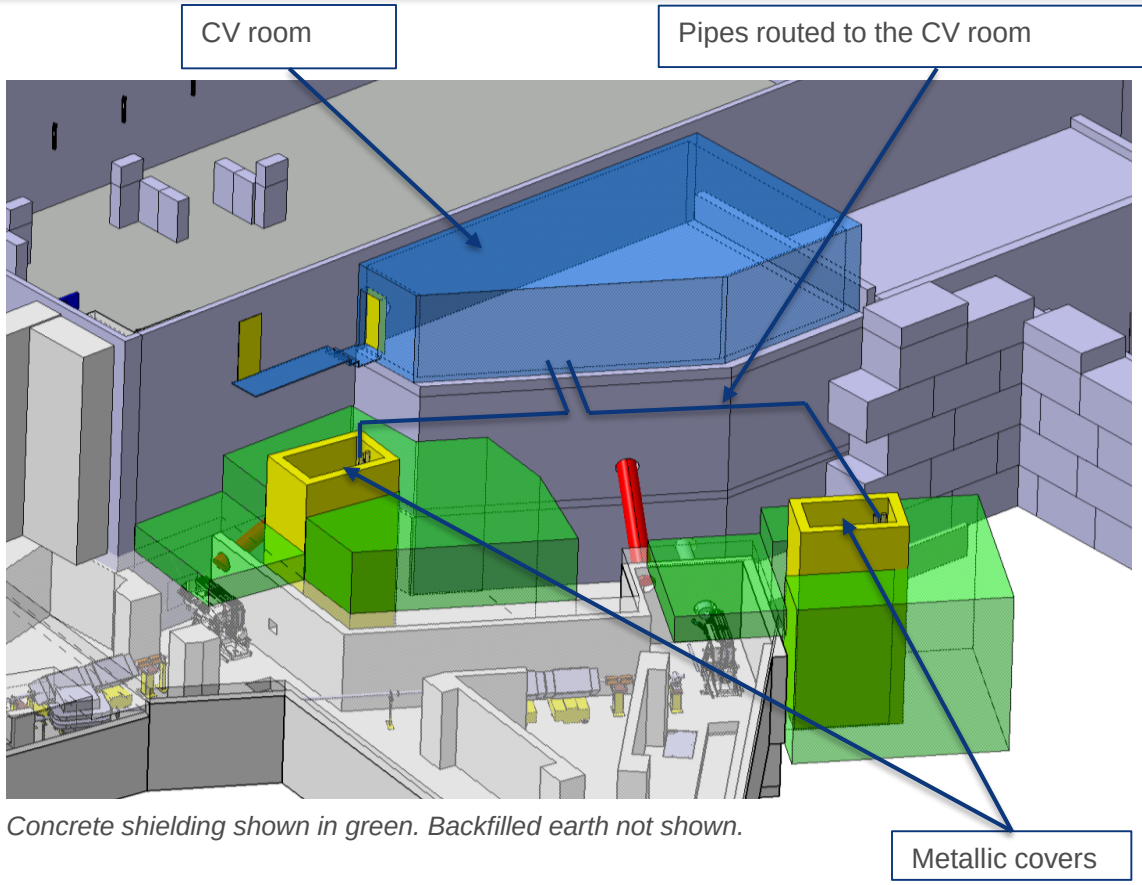
Basic shafts Concept



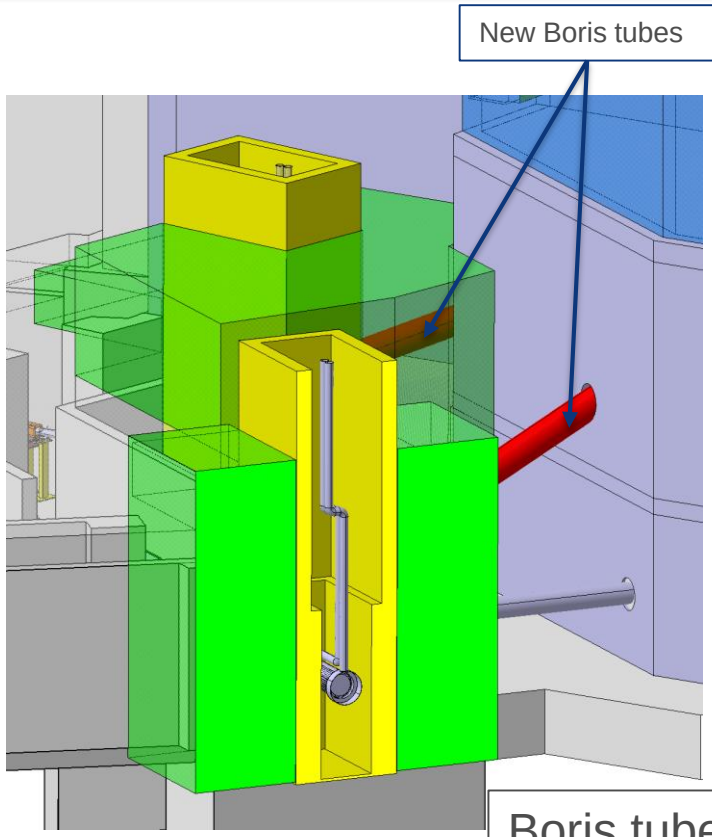
FLEXI Concept

BASIC concept

Acknowledgement: JM.Martin Ruiz SY-STI



Concrete shielding shown in green. Backfilled earth not shown.

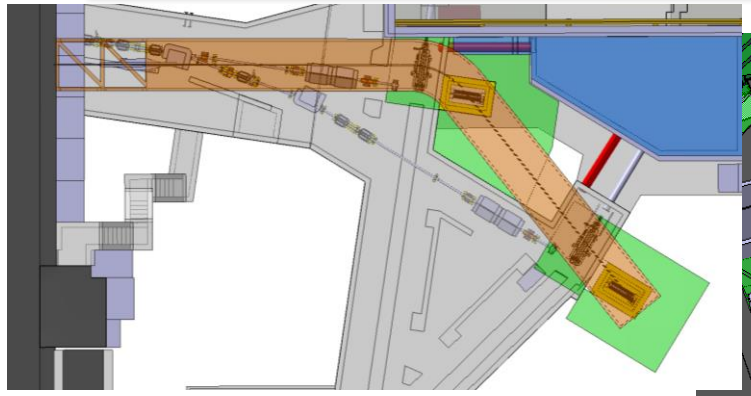


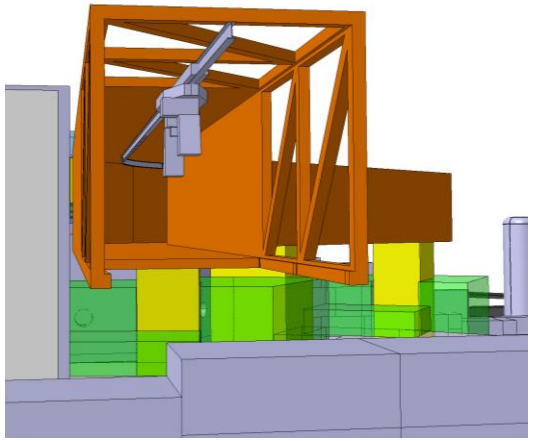
Boris tube to be replaced

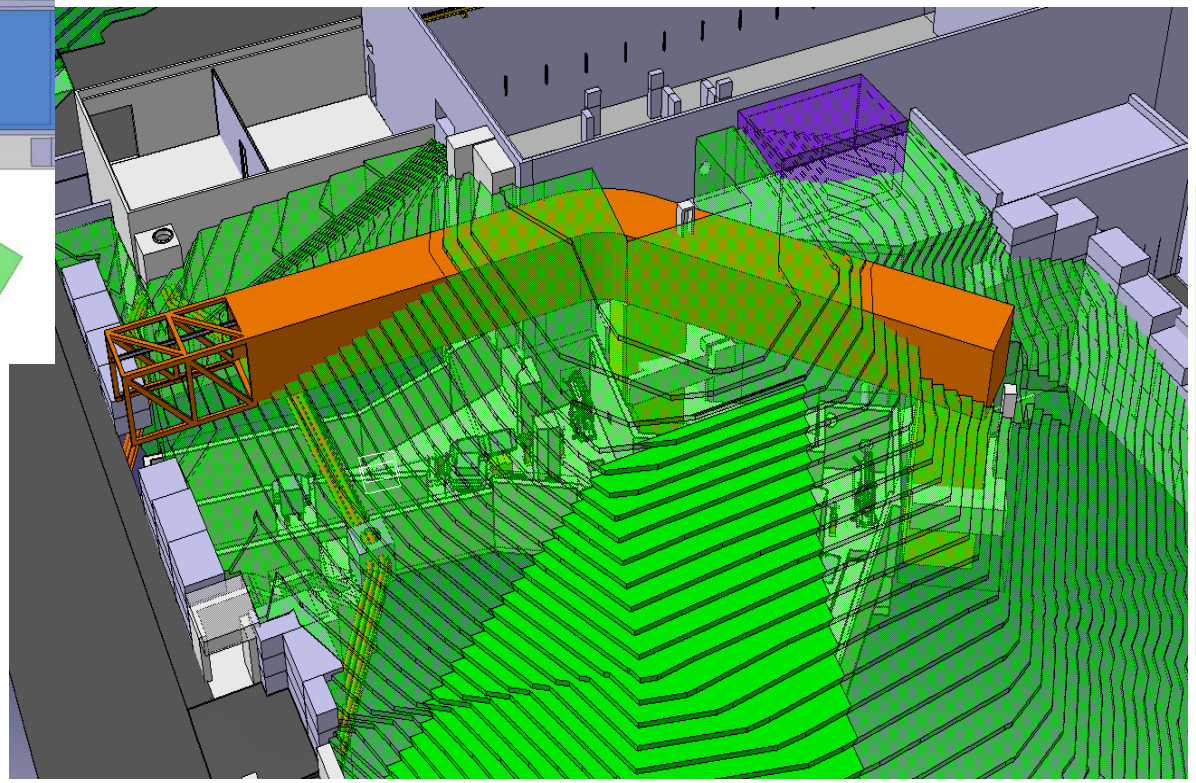
Dumps are not buried in earth. Removable shielding installed inside shafts – Outside the shafts, shielding will remain buried in earth. Boris tube to be replaced

BASIC concept – Bridge option

Acknowledgement: JM.Martin Ruiz SY-STI







Option Bridge: Permanent Handling access to dump

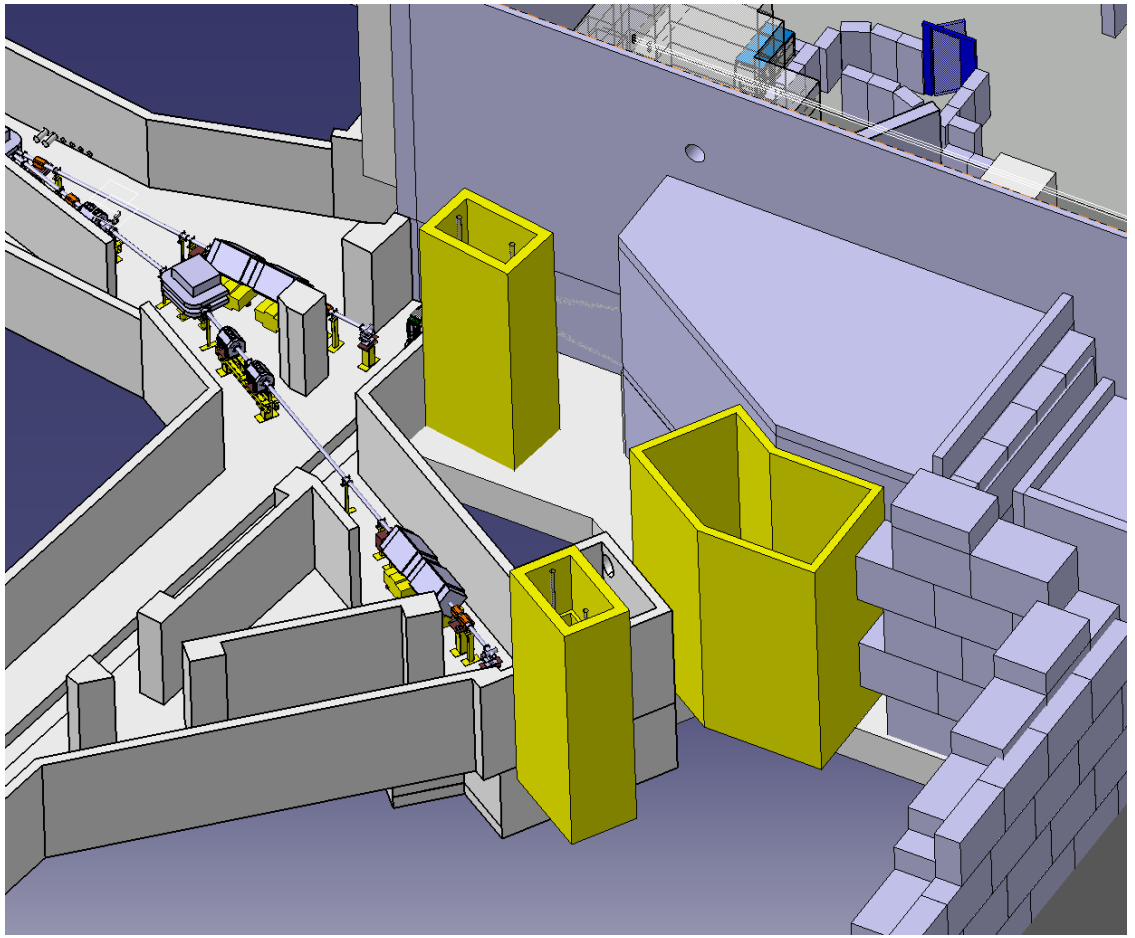
BASIC Concept with a “Bridge” Option to access the dumps in case of failure.
ALARA solution as it allows remote-handling operation

BASIC concept and HRS

HRS access not part of the BASIC concept. Not approved & not funded. Could be part of a future target area consolidation request.

…but money could be saved if the HRS shaft is approved and founded at the same time as the IBDRS project

HRS magnet and beam line will remain non accessible if nothing is done



Option HRS: Access to HRS magnet and line

BASIC concept

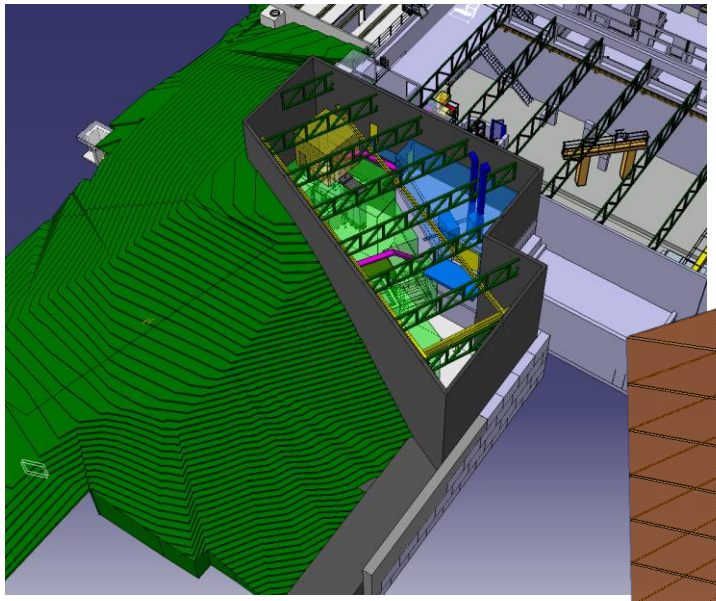
All the work should be achieved during LS3

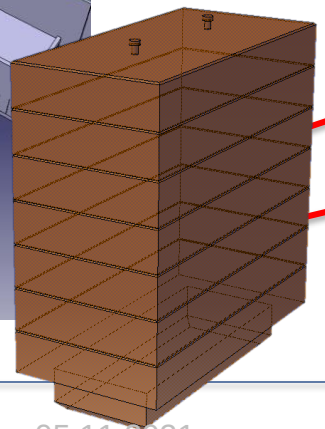
- New dump and cooling
- New technical cooling station
- New shielding
- New Boris tubes (large impact on HV room)
- If ‘Bridge option’ chosen, new permanent handling access to the dump and ALARA solution as it allows remote-handling operation

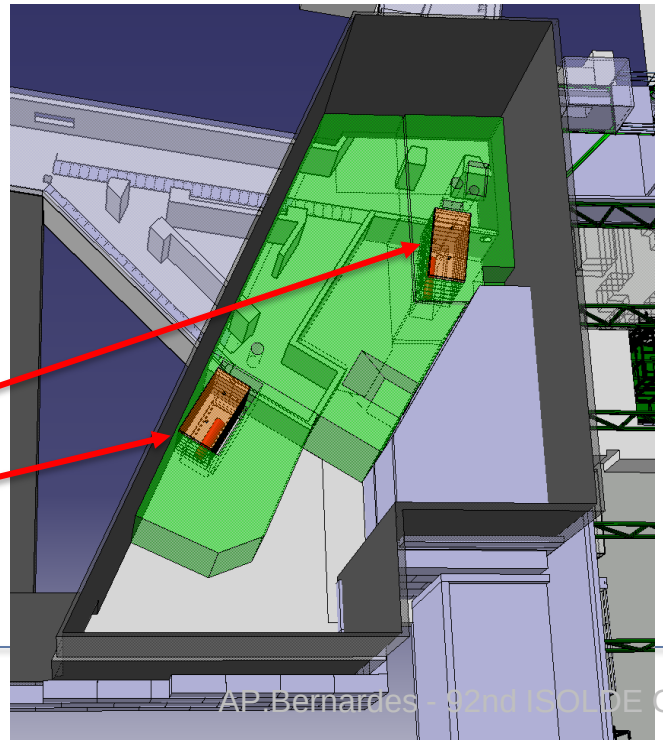
FLEXI concept

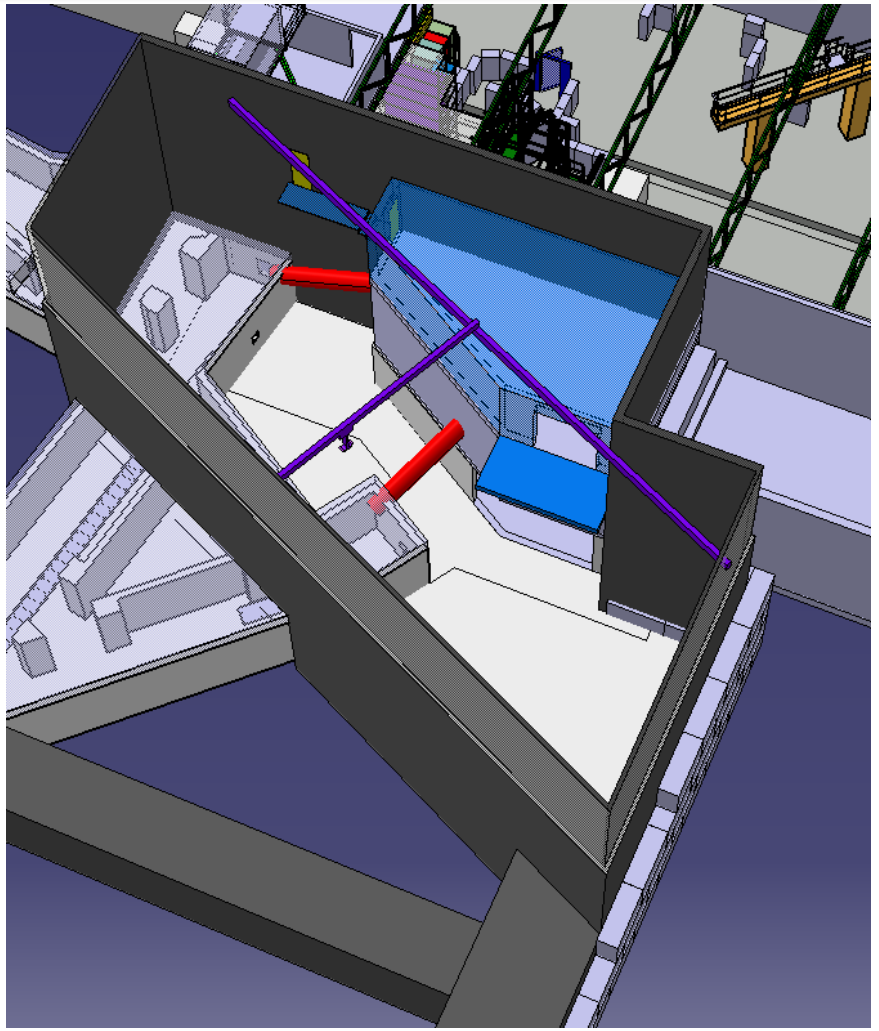
Acknowledgement: S.Marzari SY-STI

- New building on top of the target stations GPS and HRS
- Surface 350m^2, 12…15m high
- Full shielding, dump and Boris tube remain accessible
- Shielding modification is possible at anytime





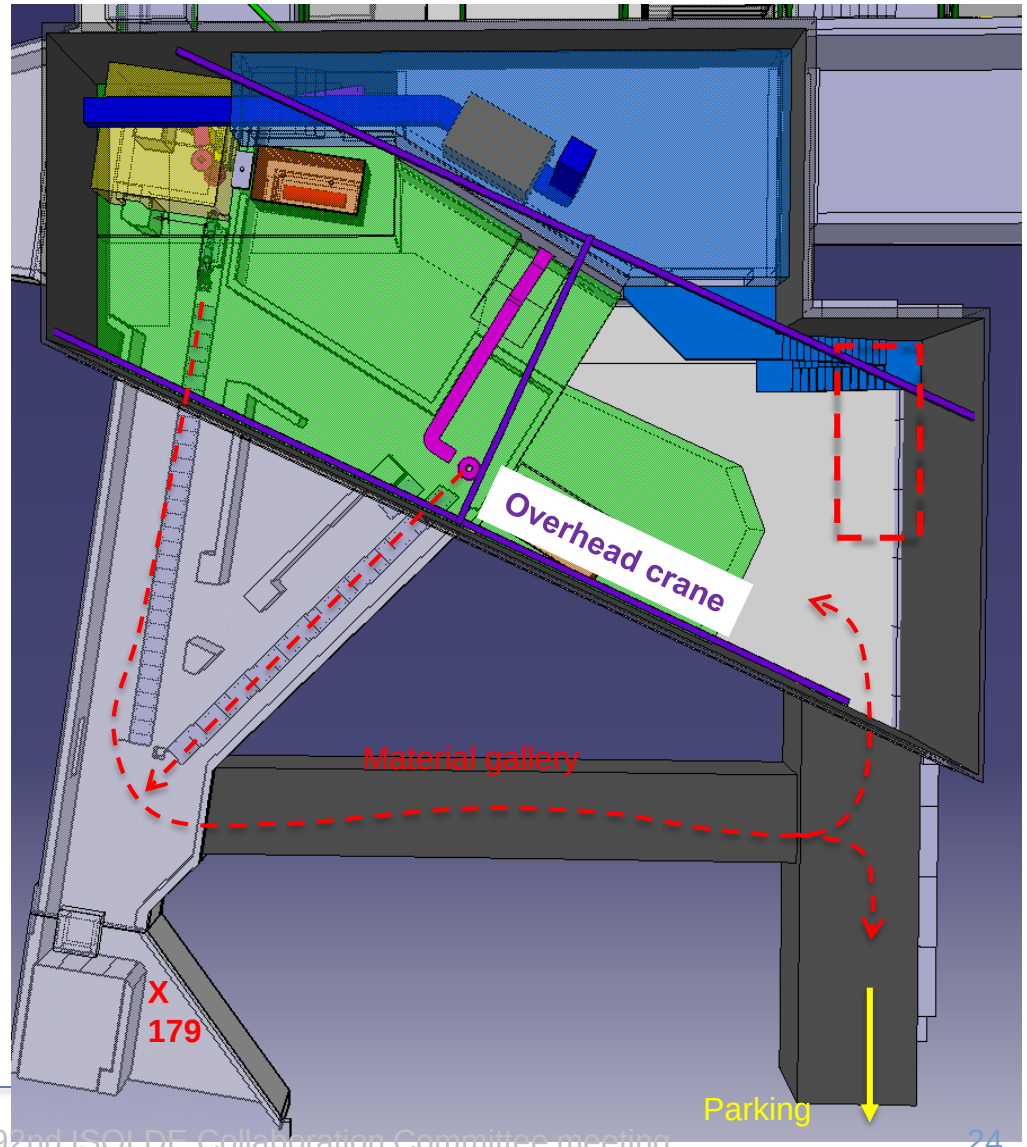




FLEXI concept

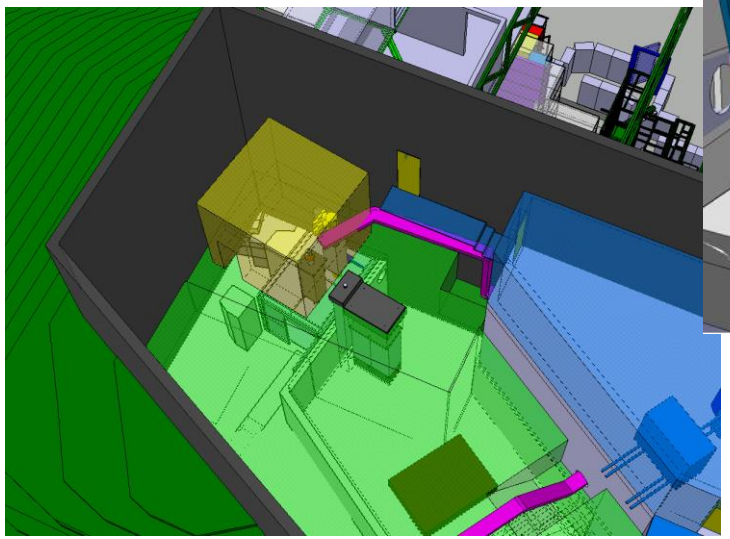
Acknowledgement: S.Marzari SY-STI

- **New maintenance philosophy:** Replace -> Repair -> Reuse
- Reduce **radioactive waste**
- Move FE to new building through the material gallery
- FE handling with overhead crane
- **Intermediate FE storage** for decay

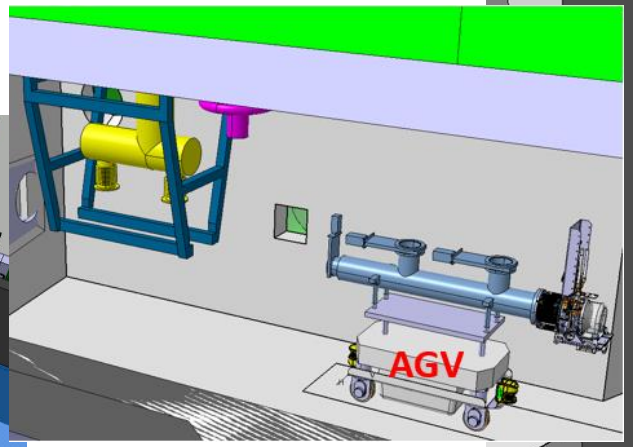


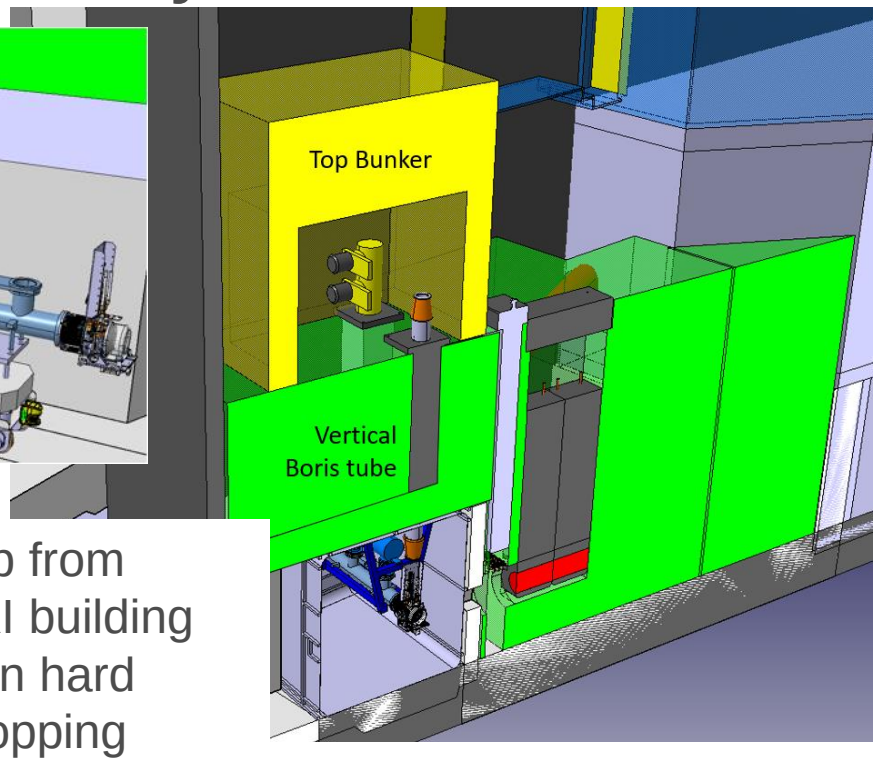
FLEXI concept

<u>Consolidation after LS3</u> could take place depending resources and budget – Waiting from target consolidation upgrade feed-back and Front-end upgrade study in 2022 – Not part of the IBDRS study



Consolidated Boris tube possibility



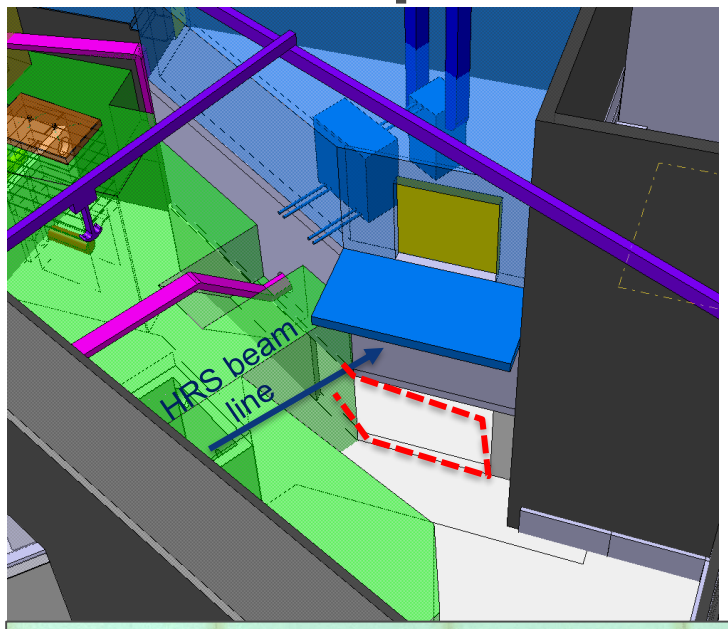


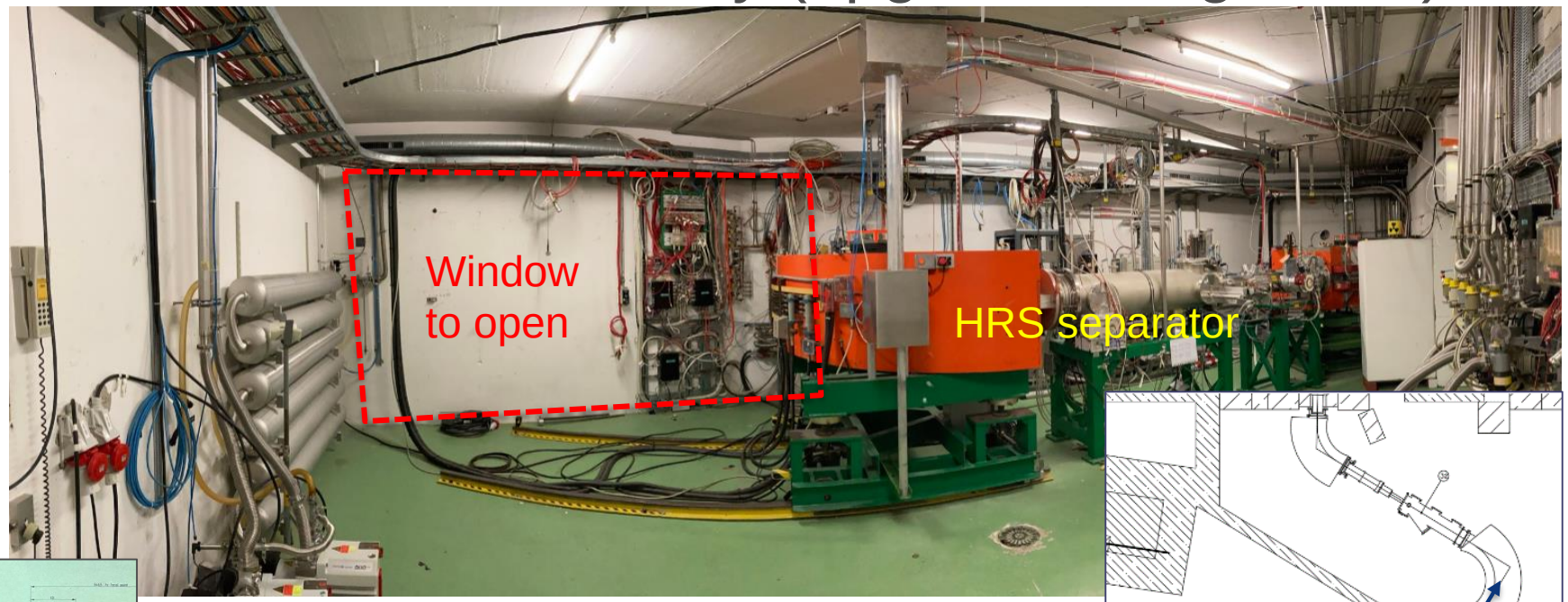
Move vacuum pump from target area to FLEXI building (Supplier of radiation hard vacuum pump is stopping production)

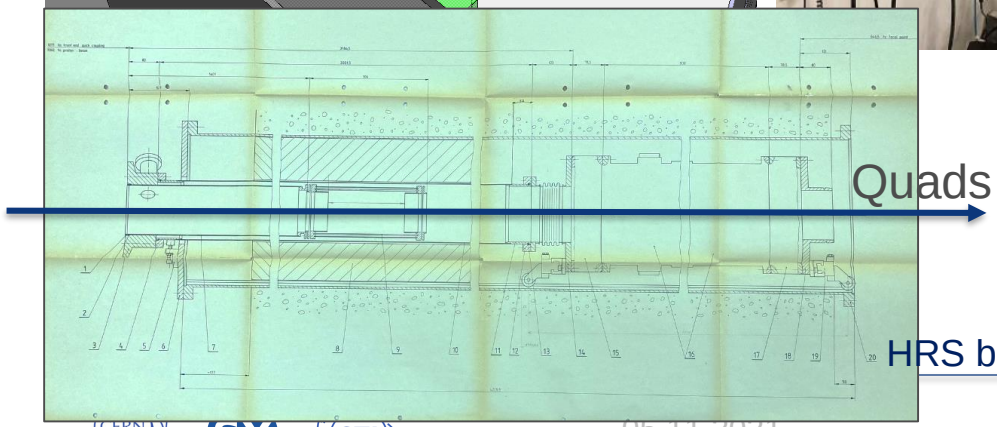
FLEXI concept and HRS

Acknowledgement: S.Marzari SY-STI

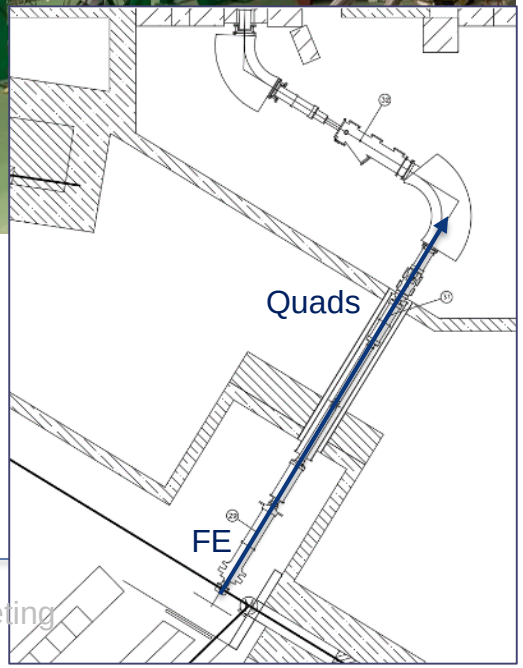
- HRS **separator** and **beam line** accessibility (upgrade – alignment)







No opening is foreseen in the FLEXI concept anymore but possible later

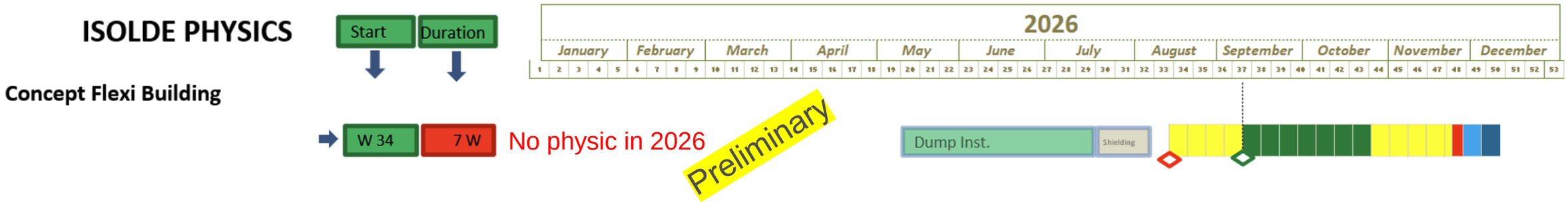


FLEXI concept

Phasing is possible – All the work is not performed during LS3
FLEXI final status at end of LS3:

- New building
- New dump and cooling
- New shielding
- New technical cooling station

BORIS tube and target area are not modified during LS3 allowing an easier restart

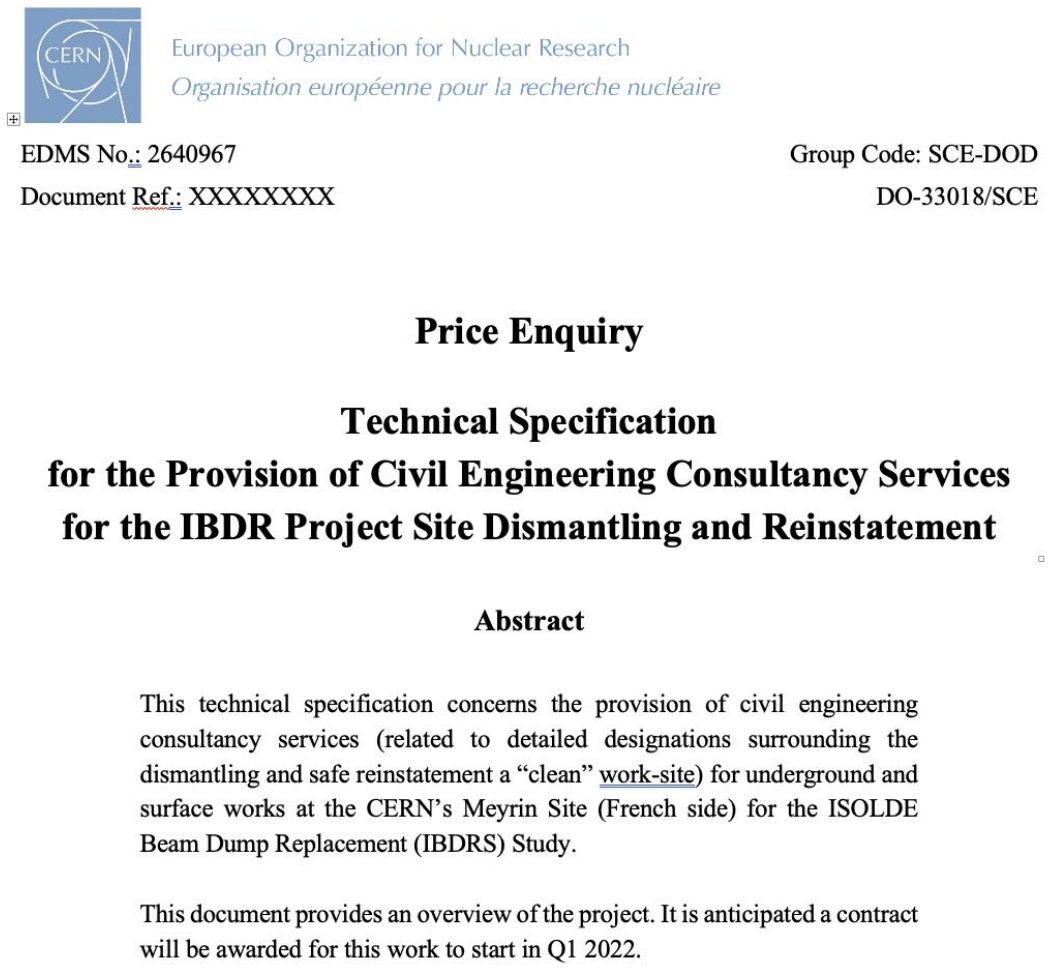


Next steps

Next steps

- Dismantling phase is the more critical part of the project
- Consultancy technical specification under circulation

First feed-back from consultant interviews is that we are underestimating the time needed for the dismantling phase



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Price Enquiry

Technical Specification
for the Provision of Civil Engineering Consultancy Services
for the IBDR Project Site Dismantling and Reinstatement

Abstract

This technical specification concerns the provision of civil engineering consultancy services (related to detailed designations surrounding the dismantling and safe reinstatement a "clean" work-site) for underground and surface works at the CERN's Meyrin Site (French side) for the ISOLDE Beam Dump Replacement (IBDRS) Study.

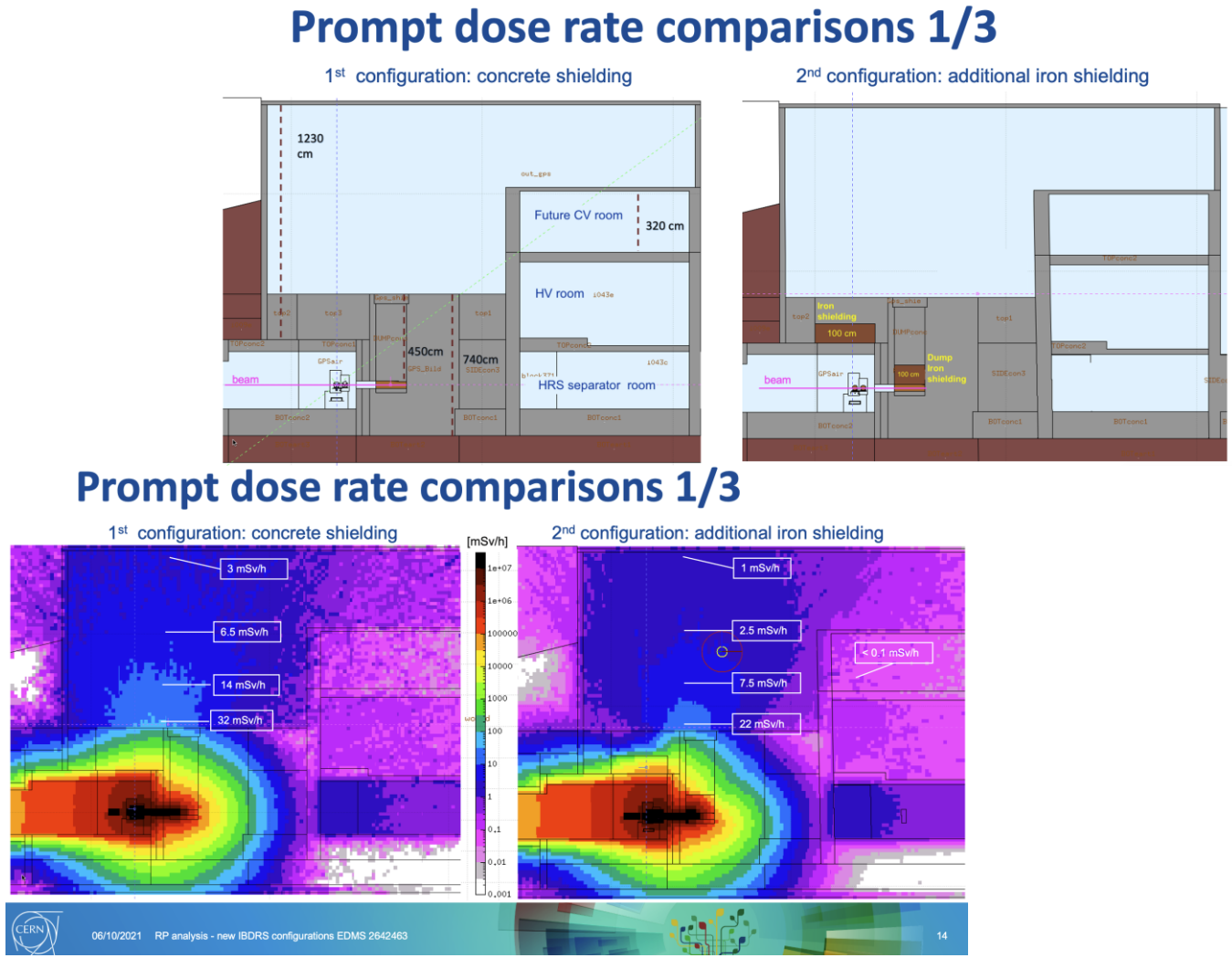
This document provides an overview of the project. It is anticipated a contract will be awarded for this work to start in Q1 2022.

Next steps

Acknowledgement: A.Formento HSE-RP

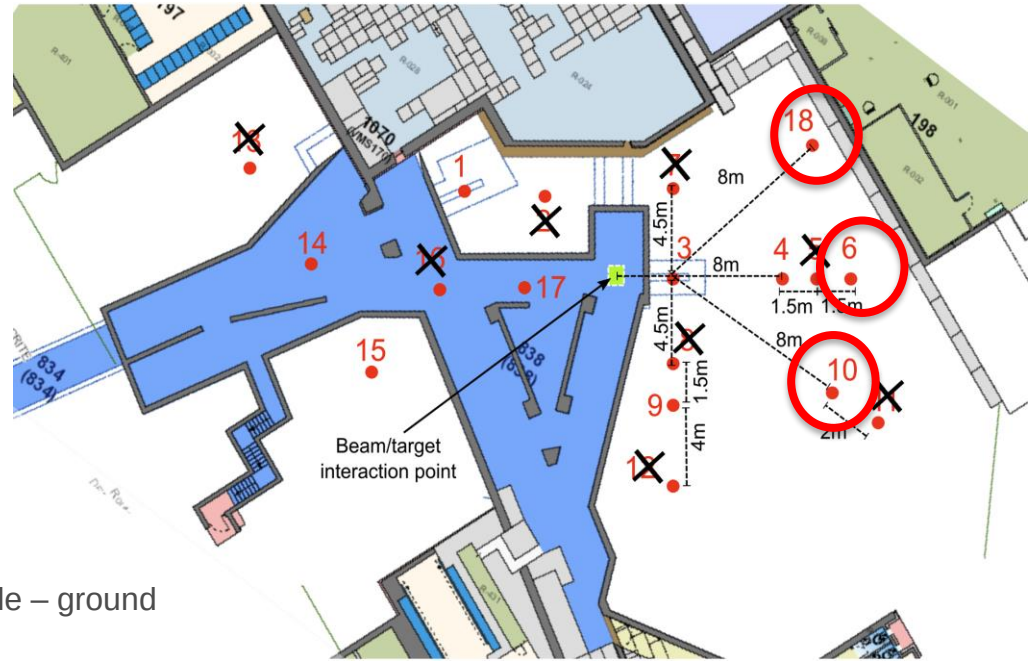
- Cost estimation of the shiedling layout for BASIC and FLEXI options after Fluka simulation from HSE-RP
- Cost estimation of waste disposal to be finalised by HSE-RP

Project management Board beginning 2022 to be foreseen



Next steps

Coring campaign on top of the shieding hill to be performed at ISOLDE after beam stop – December 2021 - Critical activity for the study



Conclusion

Conclusion

- First step to 2 GeV protons beam at ISOLDE is the ISOLDE Beam dump replacement
- IBDRS can be done only during an LS
- 2 Concepts BASIC and FLEXI have been identified to be further studied
- Preliminary planning estimation shows that **2 years** are needed for this project – Physics will be impacted by the IBDRS project if approved (LS3 duration may not be enough) but changing the dumps is an investment for ISOLDE.
- Dismantling consultancy technical specification should be circulated soon
- Shielding sizing and cost for waste disposal should be available soon
- Corings campaign results will be an asset for the progress of the IBDRS study

Thank you for
your attention!