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
- 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 $\rightarrow$ 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 Anais Schaeffer
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

1.7 mSv/h at 2 m from dump face
4.5 mSv/h at 1 m from dump face
34.8 mSv/h at “contact” with dump face

(Manual handling)
Dump Replacement is only possible during a LS (a long LS!)
IBDRS Organisation
Project Management Plan
EDMS 2469313

IBDRS Study funded by the ACC-CONS budget

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 Work packages

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

<table>
<thead>
<tr>
<th>Date</th>
<th>Event Description</th>
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<tbody>
<tr>
<td>November 2021</td>
<td>17 Nov  ISOLDE Beam dump coordination meeting - WP1</td>
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<td>September 2021</td>
<td>22 Sep - 04 Nov  ISOLDE Beam dump coordination meeting - WP1</td>
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<tr>
<td>August 2021</td>
<td>04 Aug - 30 Sep  ISOLDE Beam dump coordination meeting - WP1</td>
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<td>June 2021</td>
<td>28 Jun  Price enquiry study for CE dismantling Study - RP aspects</td>
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<td>09 Jun - 01 Aug  ISOLDE Beam dump coordination meeting - WP1</td>
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Organisation

IBDRS Project

1st Project Management Board in May 2021 – Indico 1034928

IEFC (Injector and Experimental Facilities Committee)
Indico 13403

ITC (ISOLDE Technical Coordination meeting)
J.Vollaire (Chair), E.Siesling (Deputy)

On demand

Monthly

Every 3 to 6 months

Project Management Board
Indico 12446
EDMS CERN-0000213340

ISOLDE Beam dump coordination meeting
Indico 12446
AP.Bernardes (Chair), J.M.Martin Ruiz (Deputy)
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.

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Energy [GeV]</th>
<th>Particles per ring $[10^{12}]$</th>
<th>Maximum particles /pulse (4 rings) $[10^{12}]$</th>
<th>Intensity [$\mu$A]</th>
<th>Shortest repetition period [s]</th>
<th>Average duty factor [%]</th>
<th>Power [kW]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upgrade</td>
<td>2.0</td>
<td>25</td>
<td>100</td>
<td>13.4</td>
<td>1.2</td>
<td>100</td>
<td>26.6</td>
</tr>
<tr>
<td>Today</td>
<td>1.4</td>
<td>$\approx 8$</td>
<td>33</td>
<td>2.2</td>
<td>1.2</td>
<td>50</td>
<td>3.1</td>
</tr>
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</table>

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

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</thead>
<tbody>
<tr>
<td>Upgrade</td>
<td>2.0</td>
<td>100</td>
<td>1.2</td>
<td>50</td>
<td>6.7</td>
<td>4000</td>
<td>$3 \cdot 10^{20}$</td>
</tr>
</tbody>
</table>

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

In addition 8 to 10 meters of earth shielding

05.11.2021
Concepts

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

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

- CV room
- Pipes routed to the CV room
- Metallic covers
- New Boris tubes
- Boris tube to be replaced

Concrete shielding shown in green. Backfilled earth not shown.

Acknowledgement: JM. Martin Ruiz SY-STI

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 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
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

ISOLDE PHYSICS

Start Duration

W 26 21 W

Preliminary

Concept Basic Shafts

W 31 16 W

Limited physic in 2026

Option Bridge

W 34 7 W

No physic in 2026

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FLEXI concept

- New building on top of the target stations GPS and HRS
- Surface 350m², 12…15m high
- Full shielding, dump and Boris tube remain accessible
- Shielding modification is possible at anytime

Acknowledgement: S.Marzari SY-STI
FLEXI concept

- **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

Consolidation after LS3 could take place depending on resources and budget – Waiting for target consolidation upgrade feedback 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

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

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

Acknowledgement: S. Marzari SY-STI
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

No physic in 2026
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
Next steps

- Cost estimation of the shielding 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 shielding hill to be performed at ISOLDE after beam stop – December 2021 - Critical activity for the study

Not possible – ground too steep
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!