Preliminary design study of the integration and remote handling processes for the Beam Dump Facility Target Complex

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Thanks to many people inside and outside CERN who have provided input and feedback on this work.

Beam Dump Facility (BDF)  
– other HPTW 2018 talks

• E. Lopez Sola, *Beam Dump Facility target: design status, beam tests in 2018 and material studies*, Mon 4/6

• H. Vincke, *Beam Dump Facility (BDF) at CERN radiological and environmental assessment*, Thu 7/6

• M. Lamont, *Physics Beyond Colliders at CERN*, Fri 8/6
Introduction

Physics view (SHiP)
See presentation by M. Lamont

Facility view
SPS beam

Part of technical feasibility studies in time for the 2020 European Strategy for Particle Physics (ESPP) update
BDF target – at the heart of the facility

355 kW average power
2.5 MW pulsed power
Water cooled

See presentation by E. Para Lopez

SPS beam

Outer tank  TZM blocks

Inner tank  W blocks
Target shielding and helium vessel

Target surrounded by iron shielding to stop hadrons

Target and shielding are underground to reduce radiation levels in the building and the surroundings ...

... and housed in a helium vessel to prevent air activation and corrosion

After 5 years of irradiation and 1 week of cooling time, residual dose rates are hundreds of Sv/h around the target and the proximity shielding

See RP presentation by H. Vincke

10m long, 8.5m wide at a depth ~12m from surface
Integration and remote handling study

Study aims

• Develop integration design of target complex
• Considering key handling and remote handling operations during the life of the facility

CERN + Oxford Technologies “Foreseen” and “unforeseen” handling operations (consider failures and damage)

Outputs: 3-D models, layout drawings, reports, animations
Two handling concepts studied

• **Crane concept** – all foreseen handling by overhead travelling crane.

• **Trolley concept** – target and its services mounted on trolley (as ISIS)

• I’ll go through common elements and then the differences…

Courtesy ISIS
Common elements for both concepts

The following are the basically the same (with some minor differences) for both concepts:

• Beam window and helium vessel
• Collimator
• Target internal design
• Magnetic coil and US1010 steel magnet core / shielding
• Most of the shielding in the helium vessel (away from the target)
• Cool-down area for temporary storage of items removed from helium vessel
• Cooling, ventilation and helium systems
• Overhead travelling crane
Helium vessel and beam window

Beam window attached to lower shielding plug (disconnect with MSMs)

Two pillow seals
Magnetic coil and US1010 shielding

Creates 1.4 T magnetic field downstream of the target to sweep muons produced in the target to reduce experimental backgrounds.

US1010 steel to guide magnetic field - minimize gaps.

Non magnetic stainless steel (black) not air – for shielding

Electrical and cooling connections above shielding to allow hands-on connection work

Coil integrated in shielding to allow handling by crane and restrain coil during operation
CV, helium systems, cool-down area

CV systems installed underground

Sump to collect any water leaks in helium vessel

Cool-down area (with remote handling area) below ground level
Crane concept – target and connections

Electrical Connector

Water Connectors (Grayloc® type)

Helium Connectors

Connector (un)locking tool

Connector recovery tool

Target Electrical Connector Retraction Motor

Target (Un)locking Tool (Crane)

Camera

Modular Bolting Tool

Target
Crane concept – target services

Water pipes and electrical connections

Target and proximity shielding services come up through pillars mounted on the helium vessel floor
Crane concept – proximity shielding

- Grayloc® type water connectors at every layer
- Spreader with tools to operate connector clamp screws
- Electrical connectors at every layer
Crane concept – target exchange

1) Open helium vessel and remove mobile shielding

2) Disconnect and remove proximity shielding

3) Disconnect target

4) Lift target into shielded flask and transfer to cool-down area
Trolley concept – the trolley

17m long trolley with target + shielding on cantilever beams that enter helium vessel
Trolley concept – target services and connections

Water + helium connections made as target is lowered onto support hooks. MSMs turn screws.

Electrical connections made by MSM

Trolley shown withdrawn – with target in hot cell
Trolley concept – proximity shielding

Proximity shielding uses service chimneys with lift attachments.

Water and electrical connections are above helium vessel shielding – hands-on access.
Trolley concept – target exchange

- Trolley withdrawn into hot cell
- MSMs disconnect target services
- Target transferred to cool-down area using hot cell crane and export trolley
“Unforeseen” operations

- **Trolley concept has hot cell** where damaged target and proximity shielding connections can be repaired.

- **Both concepts have remote handling area** as part of cool-down area.

- **Crane concept has crane-mounted tooling** to recover from seized connectors.

- **Crane concept needs additional mobile manipulator system** to repair damaged service connections in helium vessel.
Conclusions

- We have integrated designs for the two concepts

**Trolley concept:**
- simpler and faster target exchange + flexibility provided by the hot cell for repairs
- no fixed water connections in the helium vessel shielding

**Crane concept:**
- simpler facility design but complex tooling required to operate and recover from failure of the connections in the helium vessel
- an additional mobile remote handling manipulator system will be needed to repair damaged services installed in the helium vessel
Further work

Further design work is underway - including:

- Beam line,
- Target (including supports and connections),
- Helium vessel,
- Civil engineering,
- Cooling and ventilation, helium purification,
- Integration of the complete facility on the CERN site

Paper submitted to JINST available on ArXiV: http://arxiv.org/abs/1806.05920