



EDMS: 3202433

HL-LHC TDE Preliminary Design Review

Mandate and Charges

Date: Tuesday 11th March - Wednesday 12th March 2025

Venue: CERN (30/7-018 – 30/7-010)

Agenda: <https://indico.cern.ch/event/1487681/timetable/#20250311>

Glossary

HL: High Luminosity, or HiLumi

LHC: Large Hadron Collider

TDE: Target Dump External, or LHC Beam Dumps

CFD: Computational Fluid Dynamics

DR: Design Review

SE: Systems Engineering

FMEA: Failure Modes and Effects Analysis

WP14: (HiLumi) Work Package 14 – Beam Transfer & Kickers

SY-STI: Accelerator Systems department - Sources, Targets and Interactions group

Background

The High Luminosity (HL) upgrade to the Large Hadron Collider (LHC) will increase each beam's maximum stored energy from 540 MJ (current Run 3) to 710 MJ. The LHC has two Target Dumps External (TDEs), one for each counter-rotating beam. The purpose of a TDE is to safely and reliably absorb the LHC beam at any time, while not restricting the nominal minimum interval between dump events. Simulations and material studies proved that the current Target Dump External design would not be compatible with the more stringent operating conditions imposed by the HL upgrade.

A new TDE design, compatible with HL-LHC beam parameters, has been developed and is the subject of this review. Developments have been made in beam-matter interaction studies, thermomechanical simulation, CFD analysis, material studies and prototyping, design and integration studies together with hardware prototyping.

Basis of the Review

The LHC beam dump core can be summarised as consisting of four major subsystems, the purpose of each is explained here:



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- Core: absorb a majority of the incoming beam's stored energy.
- Vessel: contain the core and the inert atmosphere required to prevent the core material oxidising; facilitate heat transfer between the core materials and the outer atmosphere; allow the incoming beam to enter the core materials.
- Support structure: hold the vessel in place and maintain its alignment with the beam; mitigate and withstand the intense beam-induced vibrations of the vessel.
- Cooling system: cool the TDE sufficiently to prevent overheating in the case of repeated, high intensity beam impacts.

The fundamental requirements of the HL TDE system are stated in the Functional Specification ([EDMS 2694263](#)).

In this Design Review (DR), the design that has been developed to meet the requirements of HL will be presented in detail. The maturity of the design in each area is dependent on the subsequent timescales for procurement and implementation. In the areas of the core and vessel, the design will be fully defined, and this will act essentially as a manufacturing readiness review. In other areas, such as the cooling system, this will act as a preliminary design review as there may still be further refinements and detailed design aspects to develop.

The estimated lead times for the principal components of the TDE core and vessel are 12-18 months. Orders for these parts must be placed in summer 2025 to meet the installation deadlines for the HL TDEs.

A Systems Engineering (SE) approach has been adopted to structure the design process. The necessary functions of the system were derived from design requirements from several sources. A Failure Modes and Effects Analysis (FMEA) was used to identify the critical functions of the system and the key risks, enabling prioritisation of design studies and a thorough understanding of the system's vulnerabilities.

Reviewer's Mandate

The panel shall assess whether the proposed design and project schedule is compatible with the project requirements, so that the procurement and construction for the series units can continue as planned. The panel shall determine if additional studies or design modifications are needed to ensure that the TDEs for HL meet all design requirements and maintain an acceptable level of risk in view of the design failure cases.

The panel is requested to provide a summary of the review outcome in the form of a document to be submitted to the HL TDE project leader, WP14 leader, HL-LHC management and SY-STI management within ten working days from the end of the review.

Charge Questions

The Review Panel members are asked to answer the following questions:



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1. Assess and challenge the presented design requirements. Have they been correctly understood by the design team and have any design requirements been not appropriately considered or missed?
2. Does the design that has been presented fulfil all design requirements?
3. Is the design feasible to procure, manufacture, assemble, test and install in the time available and with the logistical constraints of HL?
4. Were the key technical, project and operational risks properly identified, and have they been adequately mitigated by the proposed design and the design studies performed? Are the residual risks acceptable?
5. Concerning the simulation package that contributes to the proposed design: are the assumptions, inputs and interpretation of the outputs valid? Are there any outstanding items that may have been overlooked?
6. Has an appropriate level of quality control been adopted throughout the design process?
7. Review the way that experimental or test results have been used to inform design decisions. Were the assumptions made appropriate and have the results been interpreted correctly?
8. Are there any obstacles that prevent the design that has been presented moving forward with the first steps of series production? If yes, make recommendations of further work that should be completed before these can commence.
9. For areas where the design is less mature and the production does not yet need to start, is the current design and R&D going in the right direction to be ready for procurement to commence?
10. Is the current proposed spare strategy adapted to the identified risks, long term degradation mechanisms and use of the allocated budget?

Composition of the Review Panel

1. Patrick Hurh, FNAL (Chair)
2. Michael Fitton, STFC
3. Drew Winder, ORNL
4. Stefano Sgobba, CERN
5. Michele Modena, CERN

Linkpersons: Gabriel Banks (SY-STI) & Nicola Solieri (SY-STI)

Proposed invitation list

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Other invitees / people to be informed

- HL-LHC WP Leaders & Deputies