HL-LHC TDE Preliminary Design Review

Report of Contributions

https://indico.cern.ch/e/1487681

Contribution ID: **1** Type: **not specified**

Closed session

Contribution ID: **2** Type: **not specified**

Introduction the review and to the HL-LHC beam dumps project

Tuesday 11 March 2025 08:30 (20 minutes)

- High-level introduction of the TDE: key functions and location
- High-level introduction to the dump (shape, contents, key challenges)
- Objective of the review
- Recall Previous challenges and developments: o Original dump history o Challenges during Run 2 o LS2 upgrades
- Introduce reviewer's questions
- Introduce agenda and tie the reviewer's questions to contributions
- Acknowledgements

Presenter: SOLIERI, Nicola (CERN)

Contribution ID: **3** Type: **not specified**

Systems Engineering

Tuesday 11 March 2025 09:10 (30 minutes)

Description of the systems engineering approach taken in the design of the HL TDE.

- Sources of requirements
- Requirements gathering and processing
- Regulatory context
- Overview of requirements database (functional requirements and related performance requirements)
- FFMEA process overview, results and conclusions.
- Explain how requirements (and implicit DFMEA aspects) will be introduced in the remaining topics of the review.

Presenter: BANKS, Gabriel (CERN)

Contribution ID: **4** Type: **not specified**

LHC Beam Dumping System (LBDS)

Tuesday 11 March 2025 08:50 (20 minutes)

A description of the LHC Beam Dumping System, of which the beam dump block (TDE) is a key component.

- Introduction to LHC extraction system
- Components of LBDS
- Beam parameters and filling schemes expected for HL
- Failure modes

Presenter: BRACCO, Chiara (CERN)

Contribution ID: **5** Type: **not specified**

Energy deposition studies

Tuesday 11 March 2025 09:40 (25 minutes)

Description of beam-matter interaction studies performed as the basis for the HL TDE design.

- Setup of different models used
- Material properties
- Breakdown of total energy deposited by component
- Energy density profile for nominal, full intensity dump event
- LBDS failure scenarios results and conclusions
- Other conclusions

Presenters: LECHNER, Anton (CERN); GUERIN, Helene

Contribution ID: **6** Type: **not specified**

Detailed design studies

Tuesday 11 March 2025 17:15 (30 minutes)

A description of the detailed design studies performed to refine the HL TDE geometry

Presenters: TIMMINS, Marc (CERN); MAIRE, Vincent

Contribution ID: **7** Type: **not specified**

Carbon-based materials for TDE core

Tuesday 11 March 2025 10:25 (50 minutes)

A description of the design process followed to arrive at the current proposed design of the TDE core.

- General requirements for core materials
- Market Survey process (inputs and assumptions)
- Material testing
- HiRadMat-65 experiment approach, assumptions, analysis, QA + results
- Refinement of material distribution following HRMT results
- Describe validation checks and calculations
- Detailed geometry of IG and CFC parts and features introduced to mitigate possible failure modes
- CFC shrink fitting feasibility studies and simulations
- FMEA –residual risks in design following mitigation

Presenter: BANKS, Gabriel (CERN)

Contribution ID: **8** Type: **not specified**

Thermo-mechanical assessment of the dump core

Tuesday 11 March 2025 11:15 (1h 5m)

Overview of the thermo-mechanical calculations and simulations undertaken to substantiate the current proposed design for the TDE.

- Recall requirements of vessel and core
- Overview of Run 3 design, material properties, dynamic response load cases, stress analysis
- Description of the new proposed design, geometry, materials, response and stress analysis.
- Detailed description of simulation approaches, model setup, assumptions and simplifications, mesh and post processing.
- Studies of other operational scenarios
- Conclusions, appropriate mitigation of possible failure modes, residual risks.

Presenter: LUND, Asbjoern

Contribution ID: **9** Type: **not specified**

Thermo-mechanical simulations of the dump core (2/2)

Description of the design studies undertaken to analyse the core-vessel interface and arrive at the current proposed design.

- Requirements
- Reason for shrink fitting
- General challenges (tolerances, stress, assembly)
- Procedure for shrink fitting of isostatic graphite blocks and lessons learnt
- Impact of titanium vessel and conclusions from prototype
- Challenges of shrink fitting CFC, studies and simulations performed, conceptual CFC shrink fitting procedure and associated design features
- Why shrink fitting of CFC in 318LN is not feasible

Presenter: LUND, Asbjoern

Contribution ID: **10** Type: **not specified**

Vessel prototyping and material testing activities

Tuesday 11 March 2025 13:40 (40 minutes)

Description of prototyping activities and material testing completed, their conclusions and impact on the proposed design.

- Titanium procurement
- Manufacturing process used and material tests performed
- Shrink fitting procedure and results
- Welding
- Testing of 318 LN fatigue properties at elevated temperatures, fracture toughness and welding development

Presenter: LUND, Asbjoern

Contribution ID: **11** Type: **not specified**

Welding

Tuesday 11 March 2025 14:20 (30 minutes)

Overview of developments in welding approach and geometries informing proposed TDE design.

- Overview of current welding solution adopted in Run 3 beam spares
- Ti Gr 5 o Electron beam welding specification, joint geometry and parameter development o Qualification welding results o Production process for HL dumps o Other welding options
- 318LN requirements and process developments

Presenter: BAGNOLO, Umberto

Contribution ID: **12** Type: **not specified**

Support system

Tuesday 11 March 2025 14:50 (30 minutes)

Description of support system design, analysis and proposed upgrades

- Requirements, constraints
- Components of cradle and interfaces with shielding and dump
- Thermo-mechanical assessment of run 3 support system
- Stress mitigation proposals
- Detailed analysis of cables, lubrication and radiation hardness
- Critical failure modes and mitigations
- Summary of proposed HL design + remaining work required for detailed design

Presenter: LUND, Asbjoern

Contribution ID: **13** Type: **not specified**

Cooling system simulations

Tuesday 11 March 2025 16:10 (40 minutes)

Overview of cooling system studies completed and conclusions for HL design.

- Requirements
- Description of current operational cooling system and limitations
- Benchmarking of run 3 model
- Detailed simulation setup
- Performance comparison of different upgrades and implications for operation
- Feasibility of different options, comparison in terms of work needed, integration issues, cost, RP issues.
- Conclusion on proposed configuration

Presenter: BINDA NOTARIANNI, Giovanni (ETH Zurich (CH))

Contribution ID: **14** Type: **not specified**

Instrumentation package

Wednesday 12 March 2025 09:00 (30 minutes)

Details of instrumentation design proposed for HL

- Overview of past and operational instrumentation suites
- Return of experience, reliability, interpretation and usefulness
- Proposed instrumentation suite for HL and work required.

Presenter: BRAVIN, Enrico (CERN)

Contribution ID: **15** Type: **not specified**

Q&A

Tuesday 11 March 2025 17:45 (20 minutes)

Contribution ID: **16** Type: **not specified**

Opening of day 2

Wednesday 12 March 2025 08:40 (20 minutes)

Opening comments from panel for day 2. Reminder of any outstanding actions from day 1. Overview of day 2 agenda.

Contribution ID: **17** Type: **not specified**

Radiation protection

Wednesday 12 March 2025 09:30 (30 minutes)

Radiation protection assessments done for HL TDE upgrade.
- Radiation protection requirements
- Assessment of proposed design against requirements
- Residual dose rate for different intervention scenarios (cooling times)
- Air activation UD cavern (1 vs 2x flowrate)
- Waste disposal
- Argon content and spilling
- Ti vs SS comparison
- LS3 intervention scenario

Presenter: Dr INFANTINO, Angelo (CERN)

Contribution ID: **18** Type: **not specified**

Comparison of titanium grade 5 and stainless steel 318LN

Summary of comparison between the two considered vessel material options in terms of the key design requirements and feasibility

- Thermomechanical resistance
- Shrink fitting feasibility
- Cooling
- RP
- Cost
- Risk

Presenter: LUND, Asbjoern

Contribution ID: **19** Type: **not specified**

Conceptual design of the argon system

Wednesday 12 March 2025 10:00 (20 minutes)

Description of preliminary design of controlled argon atmosphere and related safety systems for HL TDE.

- Nitrogen system implementation in Run 3
- Consumption of nitrogen over runs - reasons and challenges
- RP requirements
- Design of new system and expansion vessel, integration

Presenter: BANKS, Gabriel (CERN)

Contribution ID: **20** Type: **not specified**

Procurement and production plan. Overall project plan.

Wednesday 12 March 2025 10:45 (25 minutes)

Description of procurement and production plan related to the proposed design.

- Components of dump design
- Production strategy and procurement path for each component

Presenter: SOLIERI, Nicola (CERN)

Contribution ID: **21** Type: **not specified**

Cost estimate and spares strategy

Wednesday 12 March 2025 11:15 (30 minutes)

Cost estimate for proposed design, sources and assumptions.

Available budget for HL TDEs and how it will be used

Spares strategy
- Why spares are required
- Reasons for proposed number of spares
- Strategy - how the spares would be produced, stored and used if needed.

Presenter: SOLIERI, Nicola (CERN)

Contribution ID: **22** Type: **not specified**

Overall project plan

Description of overall project plan and deadlines from now to HL operation.

Presenter: SOLIERI, Nicola (CERN)

Contribution ID: **23** Type: **not specified**

Closing remarks and final aspects required for full detailed design

Wednesday 12 March 2025 11:45 (15 minutes)

For those components where there are still some actions required to reach a detailed design, explanation of the steps required to arrive at the detailed design, assumed deadlines and any potential risks

Presenter: SOLIERI, Nicola (CERN)

Contribution ID: **24** Type: **not specified**

Closed session for panel

Wednesday 12 March 2025 13:50 (3h 10m)

Contribution ID: **25** Type: **not specified**

Closing and initial comments from panel

Wednesday 12 March 2025 17:00 (30 minutes)

Contribution ID: **26** Type: **not specified**

Preliminary implementation of cooling system upgrade

Tuesday 11 March 2025 16:50 (25 minutes)

Overview of cooling system studies completed and conclusions for HL design.

- Requirements
- Description of current operational cooling system and limitations
- Feasibility of different options, comparison in terms of work needed, integration issues, cost, RP issues.
- Conclusion on proposed configuration

Presenter: DRAGONI, Francesco (CERN)

Contribution ID: **27** Type: **not specified**

Buffer and ”homework” session

Contribution ID: **28** Type: **not specified**

Compliance with applicable CERN safety regulations

Tuesday 11 March 2025 15:50 (20 minutes)

Presenter: BANKS, Gabriel (CERN)

Contribution ID: **29** Type: **not specified**

Executive session

Tuesday 11 March 2025 18:05 (30 minutes)

Presenter: SOLIERI, Nicola (CERN)

Contribution ID: **30** Type: **not specified**

Q&A

Tuesday 11 March 2025 12:20 (20 minutes)