

CONCEPTUAL SPECIFICATION

TCLA – LHC SHOWER ABSORBER COLLIMATORS

WP5

Equipment/system description

Tungsten-based shower absorbers collimators (TCLA, Target Collimator Long Absorber) are used in the LHC as third or fourth stage of cleaning of beam halos in the momentum (IR3) and betatron (IR7) cleaning insertion. Four TCLA collimators per beam are used in IR3 whereas five collimators are used in IR7 for a total of 18 TCLA collimators in the LHC. Horizontal and vertical orientations are used depending on the location. Operationally, these collimators are not supposed to intercept primary or secondary beam losses. They are therefore built using a heavy tungsten alloy that maximises efficiency in cleaning but that it is not robust. The need to improve the TCLA collimator design in view of the updated beam parameters for the HL-LHC design is being assessed.

| Layout Versions | LHC sectors concerned | CDD Drawings root names (drawing storage): |
|-----------------|-----------------------|--|
| V 1.1 | IR7 | to be created by S. Chemli |

TRACEABILITY

| Project Engineer in charge of the equipment O. Aberle | WP Leader in charge of the equipment S. Redaelli | |
|--|---|------------|
| Committee/Verification Role | Decision | Date |
| PLC-HLTC/ Performance and technical parameters | Rejected/Accepted | 2014-07-01 |
| Configuration-Integration / Configuration, installation and interface parameters | Rejected/Accepted | 20YY-MM-DD |
| TC / Cost and schedule | Rejected/Accepted | 20YY-MM-DD |
| Final decision by PL | Rejected/Accepted/Accepted pending (integration studies, ...) | 20YY-MM-DD |

Distribution: HL-TC

| Rev. No. | Date | Description of Changes (major changes only, minor changes in EDMS) |
|----------|------------|--|
| X.0 | 20YY-MM-DD | Description of changes |
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1 CONCEPTUAL DESCRIPTION

1.1 Scope

Tungsten-based shower absorbers collimators (TCLA, Target Collimator Long Absorber) are used in the LHC as third or fourth stage of cleaning of beam halos in the momentum (IR3) and betatron (IR7) cleaning insertion. Four TCLA collimators per beam are used in IR3 whereas five collimators are used in IR7 for a total of 18 TCLA collimators in the LHC. Horizontal and vertical orientations are used depending on the location. Operationally, these collimators are not supposed to intercept primary or secondary beam losses. They are therefore built using a heavy tungsten alloy that maximises efficiency in cleaning but that it is not robust. The need to improve the TCLA collimator design in view of the updated beam parameters for the HL-LHC design is being assessed.

1.2 Benefit or objective for the HL-LHC machine performance

The upgrade of the LHC shower absorber collimators might be needed for HL-LHC if the present design:

- proved not to be adequate for the standard operational losses with a larger stored beam energy in HL-LHC: for the same assumed minimum beam lifetime in operation, the total loss rates expected on the collimators might be up to a factor 2 larger for HL-LHC than for LHC;
- can be improved in a way that HL-LHC could profit from; e.g. improved materials or improved alignment features (integrated BPMs) for a more efficient operation.

Present work is on-going to understand if the present design is adequate for the HL-LHC parameters.

1.3 Equipment performance objectives

The TCLA collimators are an important element of the LHC multi-stage collimation hierarchy and are required in all operational conditions with beam in the machine. Operation can continue temporarily in case of isolated TCLA failures but, since they are an essential ingredient for the collimation cleaning performance, we assumed here that HL operation for physics without TCLA collimators will not be possible. These are therefore high-reliability devices that must be compatible with operation in very high radiation environments and withstand standard operational losses and relevant failure cases without permanent damage that can jeopardize their functionality. In particular, the present design is robust against continuous loss rates during standard operation: 0.2 h beam lifetime at 7 TeV during up to 10 s (equivalent to peak losses of 500 kW during 10 s for the LHC nominal case) and 1 h beam lifetime for an indefinite amount of time.

TECHNICAL ANNEXES

2 PRELIMINARY TECHNICAL PARAMETERS

2.1 Assumptions

Assuming for the moment the same loss assumptions as for the LHC design [1], to be updated with the HL-LHC parameters. Relevant parameters are

- bunch intensity;
- bunch emittance (injected value and top-energy value);
- minimum allowed beam lifetime at top energy with maximum intensity in the machine.

2.2 Equipment Technical parameters

The key design parameters are given in the following table.

Table 1: Equipment parameters

| Characteristics | Units | Value |
|--|-----------|---------------------------|
| Jaw active length | Mm | 1000 |
| Jaw material | -- | Heavy tungsten alloy |
| Flange-to-flange distance | Mm | 1480 (to be reviewed) |
| Number of jaws | -- | 2 |
| Orientation | -- | Horiz., vert. |
| Number of motors per jaw | -- | 2 |
| Number of BPMs per jaw | -- | 2 |
| RF damping | -- | Fingers |
| Cooling of the jaw | -- | Yes |
| Cooling of the vacuum tank | -- | Yes |
| Minimum gap | mm | < 1 |
| Maximum gap | mm | > 60 (to be reviewed) |
| Stroke across zero | mm | > 5 |
| Angular adjustment | -- | Yes |
| Jaw coating | -- | No |
| <u>Transverse jaw movement (5th axis)</u> | <u>mm</u> | <u>+/- 10 mm</u> (manual) |

2.3 Operational parameters and conditions

Same as the present system.

2.4 Technical and Installation services required

Same as the present system.

2.5 P & I Diagrams

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2.6 Reliability, availability, maintainability

The LHC cannot operate above safe intensities without TCLA collimators.

2.7 Radiation resistance

Same as the present system.

2.8 List of units to be installed and spares policy

Eighteen (18) TCLA collimators are installed in the LHC. Adequate spare policy for HL-LHC to be defined.

3 PRELIMINARY CONFIGURATION AND INSTALLATION CONSTRAINTS

3.1 Longitudinal range

Same as the present system, see [1].

3.2 Volume

Same as the present system, see [1].

3.3 Installation/Dismantling

Present TCLA collimators will have to be dismantled to allow the installation of upgraded TCPs.

4 PRELIMINARY INTERFACE PARAMETERS

4.1 Interfaces with equipment

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4.2 Electrical interfaces

No changes for the powering.

5 COST & SCHEDULE

5.1 Cost evaluation

The indicative figure of 500 kCHF per collimator unit is assumed.

5.2 Approximated Schedule

The needs for upgrading the TCLA collimators must be addressed in time for an upgrade in LS3.

5.3 Schedule and cost dependencies

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6 TECHNICAL REFERENCE DOCUMENTS

- [1] [R. Assmann *et al.*, Collimation chapter of the LHC Design Report, edited by O. Brüning *et al.*, <http://ab-div.web.cern.ch/ab-div/Publications/LHC-DesignReport.html>](http://ab-div.web.cern.ch/ab-div/Publications/LHC-DesignReport.html)
- [2] [HL Conceptual Functional Specification, TCSPM in IR3/7, <https://edms.cern.ch/document/1393878>](https://edms.cern.ch/document/1393878)

7 APPROVAL PROCESS COMMENTS FOR VERSION X.0 OF THE CONCEPTUAL SPECIFICATION

7.1 PLC-HLTC / Performance and technical parameters Verification

Comments or references to approval notes. In case of rejection detailed reasoning

7.2 Configuration-Integration / Configuration, installation and interface parameters Verification

Comments or references to approval notes. In case of rejection detailed reasoning

7.3 TC / Cost and schedule Verification

Comments or references to approval notes. In case of rejection detailed reasoning

7.4 Final decision by PL

Comments or references to approval notes. In case of rejection detailed reasoning