CONCEPTUAL SPECIFICATION

TCTPH/TCTPV – LHC TERTIARY COLLIMATORS WITH BPM

WP5

Equipment/system description

Tungsten-based tertiary collimators with pick-up buttons (TCTP, Target Collimator Tertiary with Pick-up) are used in the LHC to protect the superconducting triplets and the experiments in each experimental insertion against horizontal (TCTPH) and vertical (TCTPV) beam losses. A pair of TCTPH and TCTPV collimators is installed in front of each triplet, on the incoming beam, for a total of sixteen (16) collimators in the LHC. The new design with BPM-embedded jaws has been adopted in all IRs during 2015. 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 TCTP 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	WP Leader in charge of the equipment
O. Aberle	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 tertiary collimators with pick-up buttons (TCTP, Target Collimator Tertiary with Pick-up) are used in the LHC to protect the superconducting triplets and the experiments in each experimental insertion against horizontal (TCTPH) and vertical (TCTPV) beam losses. A pair of TCTPH and TCTPV collimators is installed in front of each triplet, on the incoming beam, for a total of sixteen (16) collimators in the LHC. The new design with BPM-embedded jaws has been adopted in all IRs during 2015. 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 TCTP 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

Tertiary collimators in all experimental regions have been upgraded in LS1 by adding new TCTP collimators with the BPM functionality [1, 2].

The present baseline for HL-LHC is that new tertiary collimators, TCTPM, based on advanced, more robust materials will be used in the experimental regions [3]. Existing TCTP's might be reused in the IRs as TCL collimators or as tertiary collimators if the present design/material prove to be adequate. Present collimators could also be used in other IRs where new materials are not needed, by adding the feature of the BPM (e.g., as TCLA collimators in IR3 or IR7).

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

1.3 Equipment performance objectives

The TCTP collimators are an important element of the LHC multi-stage collimation hierarchy and are required in all operational conditions with beam in the machine, in order to ensure that the triplet magnets and the experimental regions are protected against quenches and accidental beam losses. The collimation hierarchy and the retraction between TCT's and dump protection elements determines the minimum beta* that can be achieved in the high-luminosity points. Operation can not continue without these collimators. These are therefore high-reliability devices that must be compatible with operation in high radiation environments and withstand standard operational losses and relevant failure cases without permanent damage that can jeopardize their functionality.

An important design goal for HL-LHC is to find materials for tertiary collimators that can significantly improve the robustness against beam losses of individual bunches in case of asynchronous beam dumps at top energy.

It is important to note that the present tertiary collimation location is a critical area for equipment integration because of the tight longitudinal space and of the reduced intra-beam distance between the TAN's and the D2's. Upgrade designs of these collimators must therefore take these constraints into account to possibly improve the collimator integration.

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 at top energy;
- 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
Number of jaws	--	2
Orientation	--	Horizontal, vertical
Number of motors per jaw	--	2
Number of BPMs per jaw	--	2
RF damping	--	Ferrite tiles
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
Transverse jaw movement (5th axis)	mm	+/- 10 mm (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 tertiary collimators.

2.7 Radiation resistance

Same as the present system.

2.8 List of units to be installed and spares policy

Sixteen (16) TCTP collimators are installed in the LHC as of end of LS1. Adequate spare policy for HL-LHC to be defined (4 spares and 1 prototype are available for the moment).

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 TCTP collimators will have to be dismounted to allow the installation of upgraded ones.

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 new IR layouts foreseen by the HL project will be deployed in LS3. This sets the time line for the deployment on new IR collimation.

5.3 Schedule and cost dependencies

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6 TECHNICAL REFERENCE DOCUMENTS

[1] LHC-TC-EC-0003, "Replacement of TCT in IR1, IR2, IR5 and of TCSG Collimators in IR6 with Collimators with Embedded BPM Buttons", EDMS doc. 1251162.

[2] LHC-LJ-EC-0029, "Modification of the IR8 Layout and Installation of TCT Collimators with BPM Buttons", EDMS doc. 1251173.

[3] HL Conceptual Functional Specification, TCTPM in experimental regions, https://edms.cern.ch/document/1393893

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