CONCEPTUAL SPECIFICATION

TCSP – LHC SECONDARY COLLIMATORS WITH PICK-UP

WP5

Equipment/system description

Carbon-based secondary collimators with pick-up buttons (TCSP, Target Collimator Secondary with Pick-up) are used in the LHC IR6 insertion as a part of the LHC protection system. Two collimators are used in the LHC, one per beam, as auxiliary dump protection device in the horizontal plane. In LS1, the TCSG design without integrated beam position monitors (BPMs) was replaced with the new one with BPMs for improved alignment and local orbit monitoring. Since these collimators are among the closest ones to the circulating beams, and are expected to be heavily exposed to beam losses in case of asynchronous dumps, their jaws are built with a robust Carbon-Fibre Composite (CFC) that is designed to withstand the design LHC failure scenarios at injection (full injection train of 288 bunches impacting on one jaw) and at 7 TeV (up to 8 bunches impacting on one jaw in case of an asynchronous dump). The need to improve the IR6 TCSP 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

Carbon-based secondary collimators with pick-up buttons (TCSP, Target Collimator Secondary with Pick-up) are used in the LHC IR6 insertion as a part of the LHC protection system. Two collimators are used in the LHC, one per beam, as auxiliary dump protection device in the horizontal plane. In LS1, the TCSG design without integrated beam position monitors (BPMs) was replaced with the new one with BPMs for improved alignment and local orbit monitoring. Since these collimators are among the closest ones to the circulating beams, and are expected to be heavily exposed to beam losses in case of asynchronous dumps, their jaws are built with a robust Carbon-Fibre Composite (CFC) that is designed to withstand the design LHC failure scenarios at injection (full injection train of 288 bunches impacting on one jaw) and at 7 TeV (up to 8 bunches impacting on one jaw in case of an asynchronous dump). The need to improve the IR6 TCSP 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 secondary collimators in IR6 have been upgraded during LS1: new TCSP collimators with the BPM functionality replaced the previous collimators without BPMs [1]. A further upgrade of the LHC secondary collimators in IR6 might be needed for HL-LHC if the present TCSP design:

- proved not to be adequate to cope with the design LHC failure scenarios updated for the upgraded HL-LHC beam parameters (larger bunch intensity and smaller emittances); in particular, the effect on robustness from the BPM in the jaws is being studies;
- 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. by improving the jaw materials.

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

1.3 Equipment performance objectives

The TCSP collimators in IR6 are a fundamental element for the LHC passive protection are therefore required in all operational conditions with unsafe beams in the machine. 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. In particular, the present is designed to be robust against [1]:

- injection failure scenario: 1 injected train of up to 288 bunches at 450 GeV impacting on one jaw;
- asynchronous beam dump at top energy: up to 8-10 bunches at 7 Tev impacting on one jaw;
- 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.

The impact on collimator robustness from the BPM integrated in the jaw is presently being assessed also experimentally (HiRadMat beam tests), like it has been done in the past for the design without BPMs (2004 and 2006 tests at TT40).

TECHNICAL ANNEXES

2 PRELIMINARY TECHNICAL PARAMETERS

2.1 Assumptions

We are assuming for the moment the same failure scenarios 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);
- maximum number of bunches per injection train;
- 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	--	CFC
Flange-to-flange distance	mm	1480
Number of jaws	--	2
Orientation	--	Horizontal
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 (5^{th} axis)	mm	+/- 10 mm

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 secondary collimators.

2.7 Radiation resistance

Same as the present system.

2.8 List of units to be installed and spares policy

Two (2) TCSP secondary collimators are installed in the LHC IR6 as of LS1. Adequate spare policy for HL-LHC to be defined.

3 PRELIMINARY CONFIGURATION AND INSTALLATION CONSTRAINTS

3.1 Longitudinal range

Same as the present system.

3.2 Volume

Same as the present system.

3.3 Installation/Dismantling

Present secondary collimators will have to be dismounted to allow the installation of upgraded TCSGs.

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 TCSP secondary 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] 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] HL Conceptual Functional Specification, "Target secondary collimator with pick-up metallic", 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