

## CONCEPTUAL SPECIFICATION

### TCAP – LHC PASSIVE ABSORBER COLLIMATORS

#### WP5

##### Equipment/system description

Tungsten-based passive shower absorbers collimators (TCAP, Target Collimator Absorber Passive) are used in the LHC as fixed-aperture collimators in the momentum (IR3) and betatron (IR7) cleaning insertion to reduce radiation doses to the warm quadrupole and dipoles in these insertions. Two TCAP collimators per beam are used in IR3 whereas three collimators are used in IR7 for a total of 10 TCAP collimators in the LHC. Four variants of these collimators exist to match the dimensions and orientations of the aperture of the adjacent warm magnets: TCAPA, TCAPB, TCAPC, TCAPD. Operationally, these collimators are not supposed to intercept primary or secondary beam losses but rather to absorb shower products generated by halo particles impinging on primary and secondary collimators. They are built using a heavy tungsten alloy that maximises shower absorption, surrounded by copper. The need to improve the TCAP 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
<b>Final decision by PL</b>	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

## 1 CONCEPTUAL DESCRIPTION

### 1.1 Scope

Tungsten-based passive shower absorbers collimators (TCAP, Target Collimator Absorber Passive) are used in the LHC as fixed-aperture collimators in the momentum (IR3) and betatron (IR7) cleaning insertion to reduce radiation doses to the warm quadrupole and dipoles in these insertions. Two TCAP collimators per beam are used in IR3 whereas three collimators are used in IR7 for a total of 10 TCAP collimators in the LHC. Four variants of these collimators exist to match the dimensions and orientations of the aperture of the adjacent warm magnets: TCAPA, TCAPB, TCAPC, TCAPD. Operationally, these collimators are not supposed to intercept primary or secondary beam losses but rather to absorb shower products generated by halo particles impinging on primary and secondary collimators. They are built using a heavy tungsten alloy that maximises shower absorption, surrounded by copper. The need to improve the TCAP 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 passive absorber collimators might be needed for HL-LHC if the present design:

- proved not to be adequate for the standard operational losses at higher in HL-LHC;
- can be improved by increasing the lifetime of warm magnets due to radiation wear, e.g. thanks to improved materials or collimator improved layouts and designs.

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

### 1.3 Equipment performance objectives

The TCAP collimators ensure that doses on warm magnets in the cleaning insertions are minimized. Doses are determined by the integrated luminosity and therefore the possibility to improve the warm magnet protection must be envisaged for the HL-LHC luminosity goal.

## TECHNICAL ANNEXES

### 2 PRELIMINARY TECHNICAL PARAMETERS

#### 2.1 Assumptions

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

- yearly integrated luminosity;
- bunch intensity;
- bunch emittance (injected value and top-energy value);
- minimum allowed beam lifetime at top energy with maximum intensity in the machine (even if losses during operational cycle contribute to a small fraction of the total doses, driven by luminosity losses);
- relative settings between IR3 and IR7, determining the loss balance between the two cleaning insertions.

#### 2.2 Equipment Technical parameters

The key design parameters are given in the following tables. **OLIVER PLEASE ADD ONE TABLE FOR EACH TCAP DESIGN... Do you also have some references? Maybe drawing will suffice.**

**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
Transverse jaw movement (5 <sup>th</sup> 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 TCLA collimators.

## 2.7 Radiation resistance

Same as the present system.

## 2.8 List of units to be installed and spares policy

Ten (10) TCAP collimators are installed in the LHC, with 4 different designs. 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 TCAP collimators will have to be dismantled 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. These are passive collimators that feature only electrical connections for temperature monitoring.

## 5 COST & SCHEDULE

### 5.1 Cost evaluation

The indicative figure of 150 kCHF per collimator unit is assumed.

## 5.2 Approximated Schedule

The needs for upgrading the TCAP 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]??

## 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