



Priority list for collimation installations in LS2

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Following also various discussions triggered by the HL-LHC project team



333rd meeting of the LHC Machine Committee (LMC)

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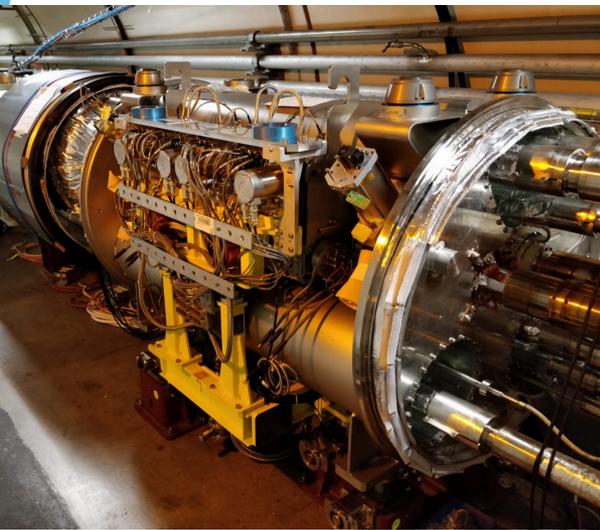
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Introduction

- Several important upgrades of the collimation system in LS2
 - LHC-TCAP-EC-0001, LHC-TC-EC-0013, LHC-TC-EC-0016, LHC-TCSPM-EC-0001, LHC-TC-EC-0019
- Main goals:
 - Upgrade of dispersion suppressor cleaning: IR2/IR7
 - First stage of low-impedance upgrade: prepare the LHC for LIU beams
 - Consolidation (and improvement) of primary collimators
 - Improved passive cleaning of warm IR7 magnets
- Additionally: re-shuffling of wire collimators (TCTW) in IR1/5
- With these upgrades / consolidation plans, no limitations are expected from the LHC collimation system in Run 3
 - With some uncertainty, as the detailed Run 3 configurations not known
 - Only a few items are very critical for the startup of Run 3.
- LMC and LS2C panels requested a priority list for collimation installations in LS2
 - Initially triggered because of some delays in the production
- Today: priorities schedule- and performance-oriented installation
 - Impact on installation plans to be reviewed for a new LS2 schedule

Details LS2 collimation deliverables

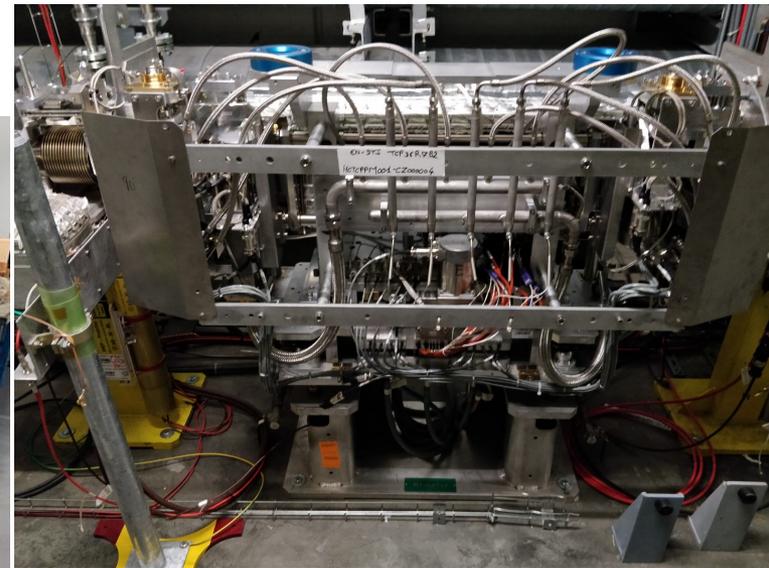
- **LS2 collimation upgrades:**
 - 4 (+1 spare) dispersion suppressor collimators (**TCLD**), around IR2/7 [HL]
 - 8 (+2) low-impedance secondary collimators (**TCSPM**), IR7 [HL]
 - 4 (+1) low-impedance primary collimators (**TCPPM**), IR7 [CONS+HL]
 - 2 passive absorbers for MQW protection (**TCAPM**), IR7 [CONS]
- Industrial production of 20 collimators; 2 passive absorbers in house.
 - All collimators with embedded BPMs; new advanced materials; coating.



TCLD in IP2-L



TCAPM



TCPPM in IP7

Installation priorities

1. Installation of TCLD collimators following the availability of new connection cryostats around IR2 and 11T dipoles for IR7's DSs
 - *1 already installed in IP2-L, 3 more at CERN can cover LS2 needs!*
2. Installation of the passive absorbers replacing the MQW removed from the Q5 assembly
 - *Ready for installation, planned in March but postponed due to CERN closure*
3. Prioritised list of installation of new low-impedance primary and secondary collimators following their availability.
 - *Note that they replace existing collimators still functional, or replacement chambers, which are only removed when the new collimators are ready!*
 - *For several secondaries, we keep operational the present ones in CfC.*
 - *No blocking situations preventing startup with beam in the LHC if we decide to delay the installation of some of these collimators!*
4. Re-shuffling of TCTW collimators in IR1/5
 - *Activity successfully completed in 2019!*

Impedance-optimised installation strategy

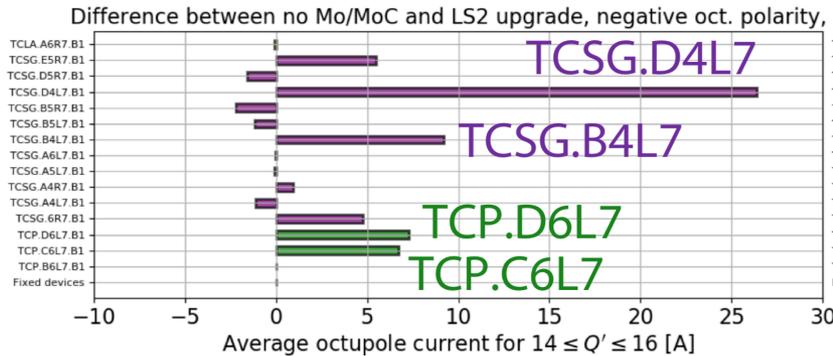
- Main goal: optimise run 3 impedance to enable pushing the bunch intensity and study other potential limitations
 - For secondary collimators, discussed in detail in CERN-ACC-2019-0001.
 - Impedance priorities revised recently including primary collimators, in light of issue with a TCPMM leaking below that caused delayed installations.
- 3 TCPMMs already at CERN, 2 of them installed in B2 (March 2020)

	Beam 1	Beam 2
Installed or available	TCP.D6L7.B1	TCP.D6R7.B2 TCP.C6R7.B2
Priority list for installation	TCSG.D4L7.B1 TCSG.B4L7.B1 TCP.C6L7.B1 TCSG.E5R7.B1 TCSG.6R7.B1	TCSG.D4R7.B2 TCSG.B4R7.B2 TCSG.E5L7.B2 TCSG.6L7.B2

Presented by R. Bruce at the 161st CoLUMM meeting and by S. Gilardoni to the 52nd LS2C, based on inputs from the impedance team and considerations on the wish to test as soon as possible both design (without and with coating).

Octupole-equivalent impedance contributions

Horizontal



Detailed work by the impedance team — see one example plot by N. Mounet for IR7 collimators only

Used here to assess the relative contributions

Note the important role of the TCPPMs

These estimates allowed establishing the presented priority list

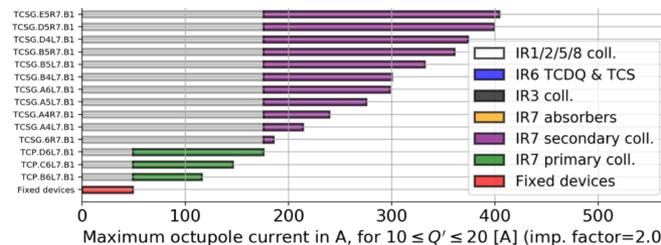
The two primaries contribute more than some of the secondaries.

Did not perform detailed simulations of intensity reach for each intermediate configuration, which also depend significantly on details of machine setup (still under discussion), but preliminary we expect:

- Full LS2 upgrade compatible with $1.8e11p$ per bunch (emittance 1.8 microns)
- Scenario with 2 TCPPMs and 2 TCSPMs per beam compatible with $\sim 1.4e11p/b$

Conclude that there are no significant risks for the first year of Run 3 and assume that additional collimators can be installed during a YETS

- Could perform more studies if needed, e.g. intensity limit with only 1 TCSPM.



Status at CERN closure

- Collimators for installation in the tunnel:
 - 2 TCPPMs installed. One TCPPM ready for installation;
 - 1 TCLD installed in IP2's DS! 3 more TCLDs at CERN.
 - 2 TCLDs at the company (could not be shipped).
 - 2 TCAPM at CERN, planned for installation in March.
- Note: 5 TCLDs produced (1 spare). A prototype built at CERN is conform for installation → can cover tunnel requirements.
- Global assessment on collimation activities in LS2:
 - With TCLDs already at CERN (with prototype) can cover both installations around P2 and P7, even if 4 11T dipoles ready.
 - 3 TCPPM already at CERN, two already installed!
 - Prospect to build 3-5 TCSPM until June, if global CERN activities can be unblocked soon (shipment is urgent).
 - 2 TCAPMs ready on surface for installation in IR7.
- Globally, LS2 installation can remain very successful for collimation, to be assessed with the new LS2 schedule.

Summary table

	Total to build	Already produced	Planned LS2 installation	Ready for tunnel	Installed
TCLD	5	5	4	4†	1
TCPPM	5	3	4	3††	2
TCSPM	10	0	8	0	0
TCAPM	2	2	2	2	0

†: including prototype that is conform for installation. A few validation steps for 2 TCLD, including bake out, to be done.

††: One TCPPM with a leaking bellow to be repaired.

Update on production status

- The main production company for the moment has restarted the activities (at a reduced pace), after a short stop < 2 weeks.
 - They have components for **3 TCSPM. More components ready at CERN.**
 - They plan to produce 2 TCSPM collimators by the end of April.
 - Last 2 TCLDs ready for shipment to CERN.
- Urgent steps upon re-opening of CERN:
 - Ship 16 bent BPM cables (= 4 TCSPM), ready at CERN.
 - Ship coated MoGr batches for 1 TCSPM + 1 for TCPMP, ready at CERN.
 - Resume the CERN activities: collimator acceptance, preparation of components and activities for tunnel installations
 - Possibly, 4 collimators could be shipped (2 TCLD, 2 TCSPM) by April;
 - Various important activities to prepare other TCLDs for installation
 - Preparation of components: BI, materials, metrology, ...
- Clearly, there is the prospect to complete the full production and the final possibility for LS2 installation depends on the final schedule.

Conclusions

- Main milestones for Run 3 start up are within reach
 - Enough DS collimators at CERN to cover all installation scenarios
 - New passive absorbers are ready for installation
 - 3 new primary collimators available, 2 already installed
 - Prospect to continue with the TCSPM production
- This would make a very successful startup scenario for the new collimation system for Run 3!
 - We are monitoring the present situation and prepare the re-start of CERN activities
- Detailed impact clearly to be reviewed once an updated LS2 schedule will be released
 - Still possible to install all collimators initially planned for LS2
 - Collimation priorities to be assessed globally in the CERN context, and potential re-scheduling of installation at subsequent YETS(s) can certainly be considered.
 - Impacts for various scenarios to be assessed.