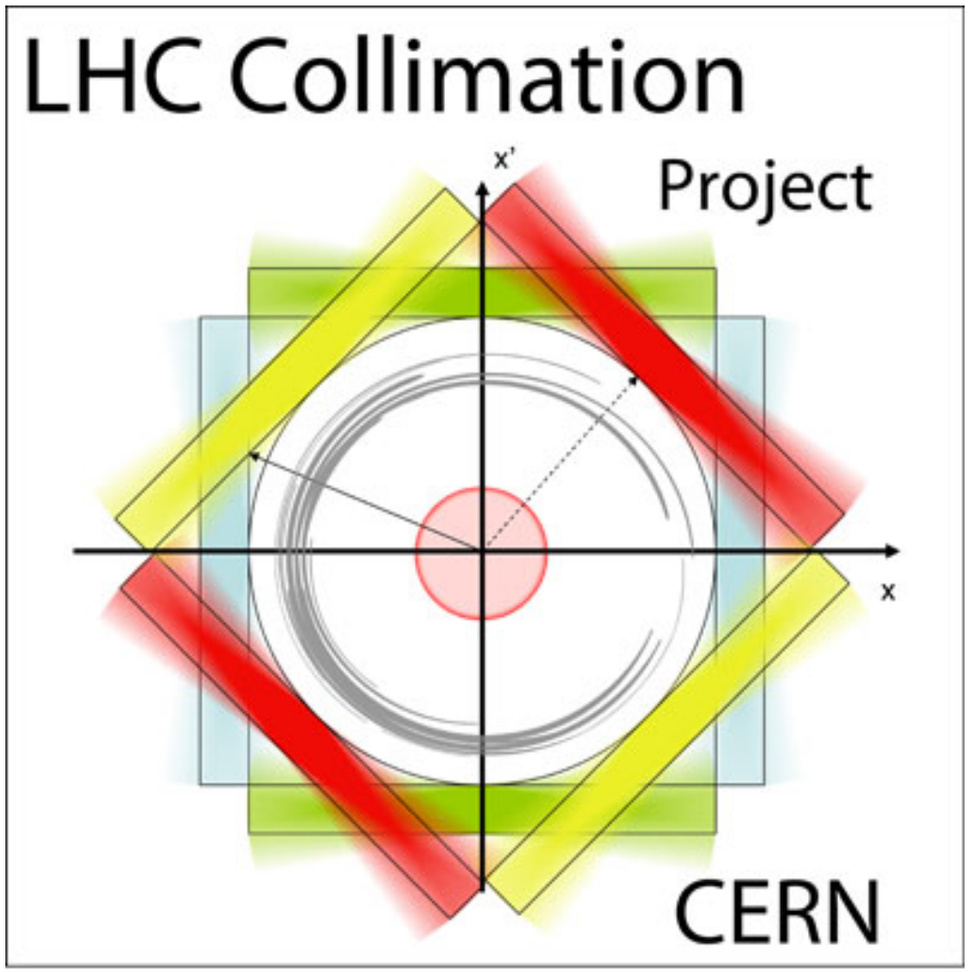
Review MPS Commissioning Procedures: LHC Collimators

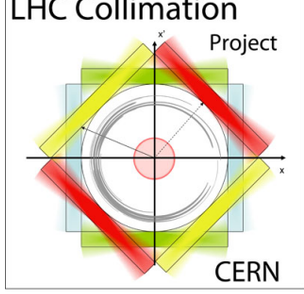


S.Redaelli, A.Rossi, **B.Salvachua** and G.Valentino

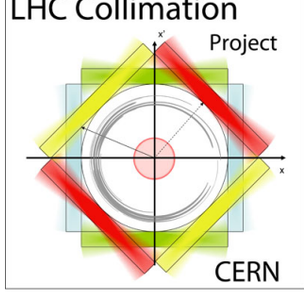
Machine Protection Panel Meeting

15th Aug 2014

Motivation



- **MP aspects for the commissioning of the Collimation System**
  - EDMS No. 889345 - LHC-OP-MPS-0002
- **Review and updated the document to include:**
  - Procedures used in 2009, 2011, 2012.
  - Correct or extend description of some tests and links to equipments.
  - Re-think about the MP tests with beams.



Overview

- **Document covers MP tests during:**

Hardware Commissioning	Machine Check-out	MP functionality with beam

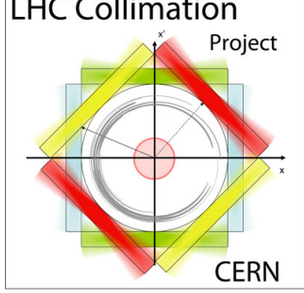
- **But does not cover:**

Beam commissioning of Collimation cleaning as this are operational settings and is independent of Machine Protection functionality of the system

- **Equipment SCOPE:**

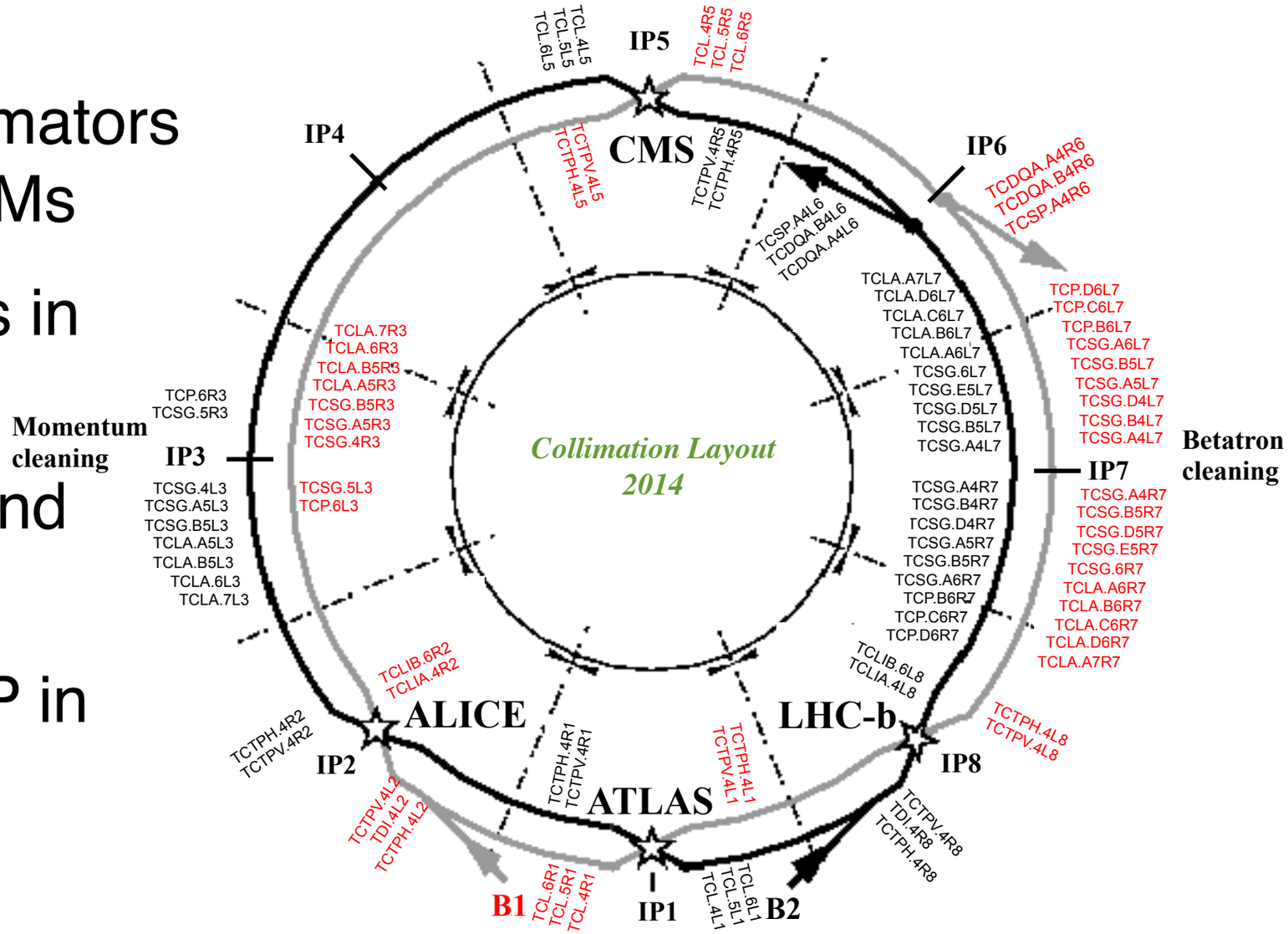
The part on movable devices that are not LHC collimators has been removed, this is TDI, TCDD, TCDQ and the TOTEM and ATLAS-ALFA Roman pots.

Post LS1 layout

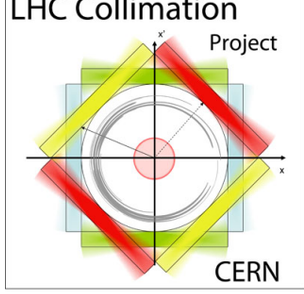


- **The changes on the Collimation system done during LS1 need to be propagated to the tests. These changes are summarized in the document.**

- Replacement of 18 Collimators with Collimators with BPMs
- 2 new passive absorbers in IR3
- TCL4 and TCL6 in IR5 and IR7
- Replacement of one TCP in IR7
- Moving of collimators

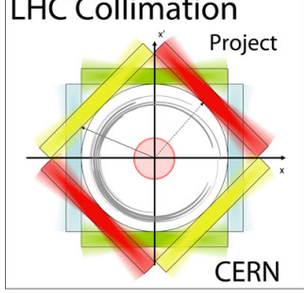


Link to other equipment



- Beam Interlock System: updated, including an appendix with BIC connections.
- LHC controls for safe machine parameters (beam energy and beta-star) and collimator configuration DB (metrology calibration and orientation): new section
- Beam loss monitors: minor update
- Other beam diagnostics, such as BPMs: minor update
- Alarms and **logging** and post-mortem: updated
- LHC software applications (LSA) for functions and limits: minor update, references on how the functions are generated, etc.

Handling of critical parameters



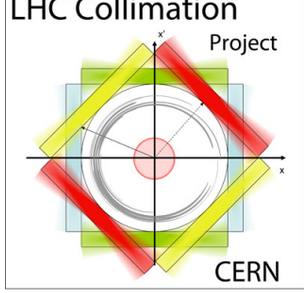
- **Human inputs:**

config. param. PVSS
- Interlocks and warning thresholds for jaw temperature
- Interlock and warning threshold for the jaw positions and gap values (discrete and functions)

MCS
- Interlock thresholds for collimator gaps as a function of beam energy
- Interlock thresholds for collimator gaps as a function of beta-star

- **Collimator sensor calibration: (more detailed now)**
  - Calibration of position and gap sensors (LVDTs) by experts EN/STI
  - Calibration stored as persistent variable in collimator front-end.
  - Periodicity specified.
- **Collimator beam-based parameters and functions: (minor updates)**

Individual collimator tests



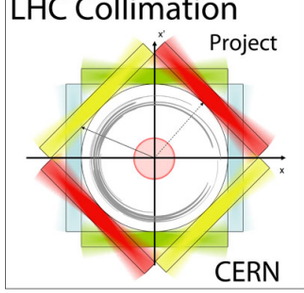
N	Not to be repeated. Executed only at the beginning of a Run i.e. after Long Shutdown.
S1, S2	To be repeated after every Shutdown. S1: to be repeated after every Xmas-like shutdown. S2: to be repeated after every technical stop.
P	Periodical repetition required, like 1 x per month; details to be defined in text
O	To be repeated when LHC optics is changed
X	To be repeated when crossing scheme is changed

Rep.		Rep.	Action	Group(s) Responsible
S	1	N	**Calibration of position and gap sensors (LVDT)**	EN/STI
S	2	N	**Verification of BIC connections of position interlocks**	EN/STI
S	3	N	**Verification of BIC connections of temperature interlocks**	EN/STI
N	4	N	**Verification of collimator orientation**	BE/ABP

We updated the frequency of the tests, this have to be done after a long shutdown. However, tests must be repeated in case of new collimators are installed to replace the existing one, or in case of changes that are considered critical (e.g., replacement of LVDTs).

After this tests the collimator should be released for remote operation

System tests during machine check-out



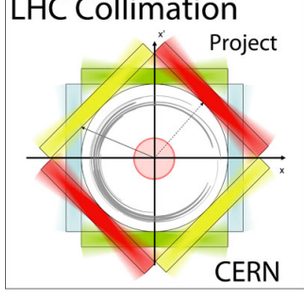
N	Not to be repeated. Executed only at the beginning of a Run i.e. after Long Shutdown.
S1, S2	To be repeated after every Shutdown. S1: to be repeated after every Xmas-like shutdown. S2: to be repeated after every technical stop.
P	Periodical repetition required, like 1 x per month; details to be defined in text
O	To be repeated when LHC optics is changed
X	To be repeated when crossing scheme is changed

These tests have to be performed to every collimator installed in the machine after a Xmas-like shutdown (S1). However during shorter shutdowns, like a technical stops it it is recommended to repeat the tests in a representative subset of collimators, for example one collimator per BIC.

After this tests the we can be sure that the interlock triggers for all the scenarios designed.

Rep.		Rep.	Action	Group(s) Responsible
S	1	S1	**Verification of position interlocks (discrete) by violating limits**	BE/ABP, BE/OP
S	2	S1	**Verification of position interlocks (functions) by violating limits**	BE/ABP, BE/OP
S	3	S1	**Verification of energy interlock by violating limits**	BE/ABP, BE/OP
S	4	S1	**Verification of temperature interlocks by violating limits**	BE/ABP, BE/OP, EN/STI
S	5	S1	**Verification of interlocks from status faults**	BE/ABP, BE/OP, EN/STI
S	6	S1	**Ensure safe system performance during and after power cut**	BE/ABP, BE/OP, EN/STI
S	7	S1	**Test safe update of collimator sensor calibration table, using RBAC**	BE/ABP, BE/OP, EN/STI
S	8	S1	**Test safe update of time-dependent warning and interlock values, using MCS and RBAC functionality**	BE/ABP, BE/OP
S	9	S1	**Test safe update of energy-dependent interlock values, using MCS and RBAC functionality**	BE/ABP, BE/OP

Tests with beams I



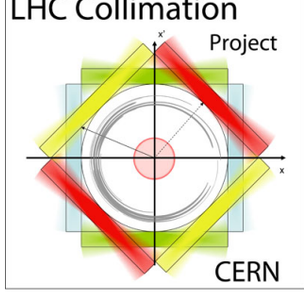
When the machine changes (orbit, beam energy, aperture etc.) the collimators need to be aligned to the beam orbit and later the settings in the sequence validated with dedicated loss maps at low intensity.

Table 1: Minimum qualification loss maps required to validate the MP functionality of the system after collimation alignments.

	Betatron loss map				Off-momentum loss map (B1 + B2)		Asynchronous beam dump (B1+B2)
	B1H	B1V	B2H	B2V	Negative	Positive	
Injection	X	X	X	X	X	X	X
During Ramp	-	-	-	-	-	-	-
Flat top	X	X	X	X	X	X	X
During Squeeze	-	-	-	-	-	-	-
Squeezed	X	X	X	X	X	X	X
Stable Beams	X	X	X	X	X	X	X

These loss maps must be repeated after any update of collimator parameters, for the particular machine mode.

Tests with beam II



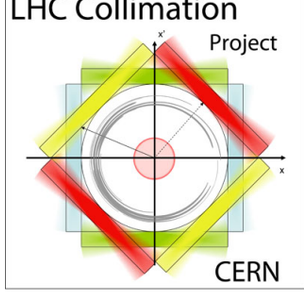
Provided that the **orbit is stable** and that there are no changes **no additional tests** are required for the **intensity ramp up.**

However, a minimum validation of the cleaning must be guaranteed through un-frequently loss maps.
In 2012 was 3 months : In 2015 will have to be re-assessed

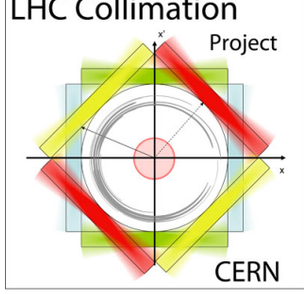
Table 2: Minimum regular qualification to validate the MP functionality of the system.

	Betatron loss map				Off-momentum loss map (B1 + B2)		Asynchronous beam dump (B1+B2)
	B1H	B1V	B2H	B2V	Negative	Positive	
Injection	X	X	X	X	X	X	X
Flat top	-	-	-	-	-	-	X
Squeezed	X	X	X	X	-	-	X
Stable Beams	X	X	X	X	X	X	X

Appendix I, II, III



- **Updated connection to the BIS**
- **Updated description of the Machine check-out tests of position and gap interlock**
- **Updated description of the Machine check-out tests of temperature interlocks**



Summary

- **The MPS commissioning procedure for collimators have been reviewed.**
- **Extended description of link to other equipment and individual tests**
- **Modified the tests with beam to include the loss map procedure.**
- **The new document will be circulated after the meeting for comments**