Accelerator	LHC	LHC	LHC	LHC	LHC	LHC	LHC	LHC	LHC	LHC	LHC	LHC	LHC	LHC	LHC	LHC
MD title	Beam tail population measurements using collimator scans	Active halo control	Characterization of embedded-BPM collimators	Improved BLM-based collimator alignment	Off-momentum tail scraping for passive abort gap cleaning	Continuous loss maps during energy ramp and squeeze	Crystal collimation	Beta*-reach: IR7 collimation hierarchy limit and impedance	Beta*-reach: Collimation with tighter TCTs	Beta*-reach: IR aperture measurement at small beta	Exploration of collimators hierarchy for reduced impedance	Scans of physics debris collimators	Collimation quench test for protons at 6.5 TeV	Collimation quench tests for ions at 6.5 Z TeV	IR2 aperture measurements at 6.5 TeV	Improved off-momentum loss maps
MD Merit	Measurement of the tail population and beam diffusion speed at 6.5 TeV will provide valuable input for LHC collimation operation and future active halo control techniques. We propose to repeat the measurements successfully done in 2012 at 4 TeV.	This MD investigates possible mitigations for spurious beam dumps due to overpopulated beam tails being scraped instantaneously on the collimators in case of orbit jitter. The investigated techniques aim at providing an active halo control to deplete the tails in a safe and controlled manner. The results could, depending on the operational bottlenecks encountered, be beneficial both for Run II and HL-LHC (including machine protection aspects during fast crab-cavity failures).	Full validation of the embedded collimator BPMs with beam to ensure correct functionality for LHC operation. In addition to the main fast-alignment functionality, we will have to ensure that the BPM signal can be used for other purposes such as orbit interlocking and orbit feedback. This characterization is necessary to push forward the beta* reach.	New algorithms and hardware (bLM acquisition, motor controllers) will be tested to reduce the commissioning time required for beam-based alignment, as well as individual jaw corner alignment. Improvements of the alignment of collimators without BPM remains essential to improve the LHC time in physics, as more than 80 collimators, including 12 in IR1/5, do not feature the new BPM design.	Studies on off-momentum beam tails, through scraping with IR3 primary collimators, is proposed. This study aims at understanding the relative loss sharing between IR7 and IR3 and addressing the possibility to deploy a passive cleaning of the abort gap.	This study aims at determining if collimator settings ensure adequate protection in dynamics conditions where no standard loss maps can be done. After re-establish loss map technique for dynamic machine phases, continuous loss maps will be carried out at intermediate energy steps from injection up to 6.5 TeV (which were previously achieved only up to 4 TeV) and also during the beam squeeze for the first time.	Two bent crystals for beam collimation studies have been installed during LS1 in IR7, on beam 1. The min goals of beam tests in 2015 are to (1) demonstrate crystal channeling and collimation cleaning at 450 GeV and 6.5 TeV and to (2) verify with beam if the installed hardware (crystals and goniometers) are adequate and fulfill the required specs. It is critical to check the hardware before the end of 2015 to decide on potential upgrades at the end of 2015.	This MD is part of a series of collimation requests aimed at qualifying the collimation settings for beta* smaller than what's presently foreseen for the LHC startup. This MD will study the possibility to further reduce the operational limits of the IR7 hierarchy, taking into account constraints from operational tolerances and impedance. In particular, we want to understand if retractions between primary and secondary collimators can go below the start-up "mm-kept" settings. We also want to understand what is the IR7 hierarchy limit. The merit of this MD is increased if it can be performed several times over the year, to monitor the long-term stability.	This MD will explore the effect of tighter TCT settings on cleaning and experimental background, as well as investigate the protection during asynchronous dumps at small beta*. This MD is, together with "beta*-reach: IR aperture measurement at small beta" and "beta*-reach: collimation hierarchy and impedance", necessary for understanding the feasibility of reaching a small beta* (tentatively 40cm will be investigated) by pushing the collimation hierarchy.	This MD aims at checking the IR1/5 triplet aperture at a realistic low-beta* configuration including the crossing angle, as well as checking the protection during asynchronous dumps. This MD is, together with "beta*-reach: collimation with tighter TCTs" and "beta*-reach: collimation hierarchy and impedance", necessary for understanding the feasibility of reaching a small beta* (tentatively 40cm will be investigated) by pushing the collimation hierarchy.	Collimators are the dominant transverse impedance source. This MD verifies if retraction of individual secondary collimators helps reducing the impedance contribution, while still maintaining adequate cleaning efficiency and machine protection. Measurements on BLM data sensitivity to collimator setting changes will also be performed parasitically to benchmark analysis tools that identify settings errors from anomalous loss maps.	A new layout has been deployed for physics debris collimators (TCLs) in IR1/5. We propose to characterize the performance by performing scans of TCL settings with beams in collision. This work can be done during nominal physics fills in stable beam, as proved by similar tests performed in 2012. The understanding of physics debris collimation is essential to establish TCL settings for the operation at higher luminosity in 2016.	This study aims at evaluating the quench limits in dispersion suppressors due to collimation losses around the betatron cleaning insertion, at assessing maximum intensity reach for RunII, RunIII and HL. These tests also have the immediate outcome of allowing more optimized settings for the operational BLM thresholds.	This study aims at evaluating the quench limits in dispersion suppressor and arc magnets due to Pb ion collimation losses around the betatron cleaning insertion, at assessing maximum intensity reach for RunII, RunIII and HL. These tests also have the immediate outcome of allowing more optimized settings for the operational BLM thresholds. Specifically for ions, important upgrade choices like the production of 11T dipoles depend on the results of such tests.	For the upcoming LHC heavy-ion run it is intended to reduce the beta* in IR2 down to values as small as 0.5m. For this challenging task it is crucial to have knowledge about the dimensions of the available triplet aperture, as the transverse beam dimensions in collision mode are largest in the triplet magnets and increase with decreasing beta*. Thus, the measurements of the available aperture will give information about the achievable beta*.	Establish a new configuration of RF frequency changes to ensure sufficient losses in IR3 for off-momentum loss map qualification without dumping the beam. This aspect limited severely the duration of machine validation during RunI.
MD contact person	G. Valentino, S. Redaelli	R. Bruce	G. Valentino, S. Redaelli	G. Valentino, S. Redaelli	D. Mirarchi	E. Quaranta, D. Mirarchi	S. Redaelli, W. Scandale	A. Mereghetti	R. Bruce	R. Bruce	R. Kwee	S. Redaelli	B.Salvachua, P. Hermes, S. Redaelli	P. Hermes, B.Salvachua, S. Redaelli	P. Hermes	B. Salvachua, D. Mirarchi
MD procedure link	Similar procedure applied in previous studies: http://cds.cern.ch/record/1480603/files/CERN-ATS-Note-2012-074_MD.pdf	Some ideas at this link https://espace.cern.ch/lhc-machine-committee/Presentations/1/lmc_197/HL_LHC_halo_RBruce.pptx	Similar techniques have been already tested in the SPS with a BPM-collimator prototype.	Several similar studies were successfully carried out in 2011 and 2012, e.g. https://cds.cern.ch/record/1494126/files/md-note-nominalsettings.pdf?version=1 and http://cds.cern.ch/record/1369243/files/ATS_Note_Collimator_Setup.pdf	Similar studies performed already at 4 TeV with 25 ns beams, see https://cds.cern.ch/record/1751049/files/Daniele%20Mirarchi.pdf?	We plan to extend the methods applied in 2014 for loss maps during ramp, reported in http://accelconf.web.cern.ch/AccelConf/IPAC2013/papers/moodb202.pdf, to be applied for the first time during squeeze.	Detailed procedures and settings of the collimation system are being finalized in the scope of the PhD work by D. Mirarchi. Note that similar MDs are requested at the SPS with the same hardware installed in the LHC.	Similar tests performed in Run I, e.g. https://cds.cern.ch/record/1494126/files/md-note-nominalsettings.pdf?version=1	-	Follow similar procedures established in Run I, see ATS Md notes on aperture in http://lhc-collimation.web.cern.ch/lhc-collimation/library_paper.htm#LHC%20MD%20ATS%20Notes	-	See procedure followed during 2012 tests at https://cds.cern.ch/record/1756432/files/Note_TCL_scans.pdf?	Tests were successfully performed already in 2011 and 2012, see for example https://cds.cern.ch/record/1352756/files/CERN-ATS-Note-2011-042%20MD.pdf and https://cds.cern.ch/record/1708365/files/CERN-ACC-NOTE-2014-0036.pdf?. Corresponding MP notes are also available.	See procedure followed in the ion quench tests in 2011: https://espace.cern.ch/be-dep/Lists/IPAC13_new/Attachments/184/THPEA045.pdf and http://epaper.kek.jp/HB2012/papers/mop245.pdf. The corresponding MP note is also available.	The full procedure is explained at https://cds.cern.ch/record/1595801?ln=ca.	TBD
Category	Normal MD + E-of-F	Normal MD	Normal MD (if not OP development)	Normal MD	Preferably, E-of-F during ramp-up	Normal MD (if not done as OP development)	Normal MD	Normal MD	Normal MD	Normal MD	Normal MD + EofF	End of Fill	Normal MD	Normal MD	Normal MD	Normal MD (if not done as OP development)
Beam	Both	Both	Both	Both	Both	Both	B1	Both	Both	Both	Both (or one only?)	Both	One only	One only	Both	Both
Participants	Collimation team, Collaborators: G. Stancari (FNAL), G. Franchetti (GSI)	Collimation team, Collaborators: G. Stancari (FNAL), G. Franchetti (GSI)	Collimation and BI teams	Collimation team (potentially support from EN/STI and BE/BI)	Collimation team	Collimation team (support from the ADP team)		Collimation and impedance teams	Collimation team, ATLAS (M. Huhtinen), CMS (A. Dabrowski)	Collimation team + aperture team	Collimation team	Collimation team	Collimation team with BE/BI (BLM), ADT, magnet and MP teams.	Collimation team with BE/BI (BLM), ADT, magnet and MP teams.	Collimation team, J. Jowett, T. Mertens	Collimation Team, BLM team, RF team
OP contact person	B. Salvachua	B. Salvachua	TBD (maybe someone on OFB?)	B. Salvachua	B. Salvachua	B. Salvachua	TBD	B. Salvachua	B. Salvachua	B. Salvachua	B. Salvachua	B. Salvachua	B. Salvachua	B. Salvachua	B. Salvachua	B. Salvachua
Description	With squeezed, separated beams, the IR7 primary collimators will be used to slowly scrape the beam down to ~2 sigmas. The jaws will then be retracted in steps to measure the halo repopulation rate and hence the diffusion speed. The procedure will be repeated with colliding beams. The beams will then be dumped by means of a fast jaw movement across the beam to determine the beam distribution in the core and tails. End-of-fill measurements are also proposed to measure diffusion speed with bunch trains in collision for comparisons with single bunches. ADT transverse excitations will be used to observe and calibrate the diffusion speed.	This MD aims at testing two techniques of halo depletion that uses the present hardware: tune modulation (using warm quadrupoles) and ADT narrow-band excitation. Reference: https://espace.cern.ch/lhc-machine-committee/Presentations/1/lmc_197/HL_LHC_halo_RBruce.pptx . these could be alternative (cheaper) methods to the electron lens, which is being studied for HL-LHC. The success of the MD relies heavily on the possibility to measure the halo population. Therefore, the first part of the MD is dedicated to exploring techniques for that.	Various aspects need to be addressed: BPM nonlinearities vs coll gap, effect of orbit shift in orthogonal BPM plane, signal stability, etc. As it was done in the SPS, measurements can be done by inducing controlled bumps at the new TCTP/TCSP collimators with BPMs. For example, one aim is to ensure that when the separation bumps are collapsed, the beam position measurement at the collimator in the other plane is not affected. The beam size measured using the standard BLM-based technique will be correlated to the interpolation of the BPM measurements from the adjacent horizontal and vertical TCTPs. In addition, the collimator BPMs will be used for the first time for orbit correction.	The collimators will be moved in steps towards the beam and aligned automatically based on feedback from the BLMs. The BLM data rate will be increased from the current 12.5 Hz to ~30 Hz and the resulting reduction in setup time will be measured. In addition, new algorithms for automatic recognition of BLM loss spikes will be tested. Faster BLM acquisitions are being discussed. In the past, orbit interpolations at the collimators were also used - this technique will be also investigated further.	The main aim is to study the population of the off-momentum beam tail and the effect on their population of the relative setting of IR3 and IR7 collimators. As done at 4 TeV in 2012, the jaw of the IR3 primary collimator at the negative off-momentum side is closed in steps, until off-momentum cuts equivalent to the RF bucket height and below are achieved. Ideally, this procedure should be repeated in different fills after several hours in stable beams, with different total beam intensities at 50 ns and 25 ns. Beam losses at the collimators, beam intensity measured by fast and standard BCT's and abort gap population are used to infer tail population and off-momentum tail diffusion speed. The latter is achieved with rapid steps of the collimator jaws out of the beam tails.	Beam loss maps will be performed using the ADT system, which allow to blow-up single bunches. After injecting several pilot bunches, maybe with one nominal for orbit measurements, the standard operational cycle is played. Two fills are needed for continuous loss maps during ramp and squeeze. Single pilot bunches are blown away at constant intervals of 500 GeV, or at intermediate times between matched optics in the squeeze, respectively. The main outcome of such test is the validation of the collimator hierarchy as well as to ensure the protection of the triplets in the experimental insertions for intermediate optics configurations where errors are the largest.	With IR7 nominal settings, H and/or V crystals are approached to the circulating beams until they become the primary machine restriction. In this conditions, angular scans are performed while monitoring beam losses close to the crystal and a collimators that intercept channeled particles. Once channeling is found, secondary collimators are opened one at a time until we achieve a reduced collimation system that, in presence of crystal collimation, is expected to provide improved cleaning than the present system that uses all secondary collimators. The test is ended with loss maps to measure the cleaning. Similar procedures are applied at injection and top energy.	At flat top, collimators in IR7 are re-aligned to the beam (to ensure optimum centring around the orbit) and loss maps are performed with reduced retractions between primary and secondary collimators. Analysis of collimator centres and loss maps with different settings are used to determine which hierarchy limit is achievable with and without repeating the IR7 collimator alignment. For different sets of tighter settings, the collimator impedance is evaluated through measurements of tune shift when moving in/out collimators between different settings (e.g., 2sigma- and 1sigma-retraction).	The goal of the MD is to investigate the cleaning and background at a small beta*, tentatively beta*=40cm (https://indico.cern.ch/event/365220/). Another value of beta* could possibly be established if the long-range beam-beam MD has been carried out and analyzed beforehand. If the phase advance MKD-TCT is so far from 90 degrees that no MP margin is necessary, the TCT setting is limited inwards by experimental background and hierarchy considerations, and outwards by cleaning losses in the triplet. Therefore, the losses around the ring and on the TCTs in particular, and, if possible, experimental backgrounds in ATLAS and CMS, will be checked through a scan in TCT setting with loss maps at each step. It is assumed that the optics has been corrected down to the chosen beta* before the MD.	The goal of the MD is to check the available triplet aperture at a small beta*, tentatively beta*=40cm (https://indico.cern.ch/event/365220/). Another value of beta* could possibly be established if the long-range beam-beam MD has been carried out and analyzed beforehand. The beta*-reach is limited by the available triplet aperture. This MD therefore aims at verifying the triplet aperture at a realistic low-beta* configuration, in order to minimize uncertainties in the scaling of measured apertures at higher beta*. It is assumed that the optics has been corrected down to the chosen beta* before the MD.	Measure impedance, verify cleaning efficiency and machine protection for difference variation sets of IR7 collimator settings. Measurements can be done at flat top starting from the end-of-ramp settings in IR7. The tests foresee: (1) Retracting a selected subset of secondary collimators at 12 sigma while maintaining asynchronous beam dump protection; (2) Retracting a selected subset of single jaws, with the opposite jaws at nominal positions. For each type of setting, the cleaning will be checked through loss maps. The TCT/triplet protection during asynchronous beam dump will be checked for the most promising setting scenarios. Impedance is inferred through tune shift measurements. Note that asynchronous beam dumps could be performed as EoF of other MDs to check sensitivity to collimator settings.	The tests consist in measuring beam losses around IR1 and IR5 while changing the settings of TCL collimators in stable beams. Setting scans will be performed within the range of what has been validated by loss maps, without changing any critical interlock limit for the collimators concerned. The experience in 2012 proved that such tests can be carried out in stable beams without perturbing the physics data taking, as TCL collimators only affect the outgoing beams. We would like to repeat the same procedures several times during the run, ideally with different peak luminosity values.	Collimation quench tests are performed by inducing very large beam losses on the primary collimators of IR7 with collimation settings as in standard high-intensity fills for physics. This measuring the magnet behaviour in presence nominal loss distributions in the IR7 DS's that represent the limiting location for collimation losses. Large losses are achieved with special setting of the ADT whose excitation window is enlarged to affect several bunches. With this procedure, in 2012 we achieved peak loss rates up to 1kW. Fills with large losses follow a calibration fill when the ADT settings and loss map distributions are calibrated with a few nominal bunches. See details in https://cds.cern.ch/record/1708365/files/CERN-ACC-NOTE-2014-0036.pdf?	Collimation quench tests for ions are performed by inducing very large beam losses on the primary collimators of IR7 with collimation settings as in standard high-intensity fills for physics. The procedure for ion beams follows what has been already achieved for protons, as in https://cds.cern.ch/record/1708365/files/CERN-ACC-NOTE-2014-0036.pdf?. Note that in 2011, the ion quench test was performed by exciting the beams with the tune resonance method while we now propose to use the controlled ADT excitations instead.	It is proposed to measure the available triplet aperture in IR2 by applying local bumps on blown up beams with different TCT settings. The full procedure for this technique that combined orbit bumps and collimator scans, as tested in RunI, is given in https://cds.cern.ch/record/1595801?ln=ca. The available aperture shall be measured on both sides of the IP. The ADT system is going to be used to make sure the beam fills the space between to collimator jaws. As it was done in 2012, we propose to measure the aperture at lower beta* in IR2 so this MD might be coupled with other work from the optics team.	During qualification of collimator settings the main limitation in terms of machine time is the execution of off-momentum loss maps and asynchronous beam dump. The current off-momentum lossmaps are done by changing the RF frequency by a large amount (+/-500 Hz) in order to ensure that most of the beam is lost in IR3. This method dumps the beam after each off-momentum qualification loss map. We propose to change this frequency in smaller steps so that we can validate a method to perform the off-momentum loss maps without dumping the beam.
Time	10h (dedicated) + 4h (end-of-fill)	3 x 8h	4h+4h	6h	A few to several 2-4h slots as E-of-F	2 fills (one for ramp, one for squeeze)	2 x 8h	8h	8h	12h	1 fill (4h at flat top)	1-2h during stable physics	16h (3-4 ramps)	16h (3-4 ramps)	1 fill	2-3 fills
Beam energy	Flat top	Injection	Injection and flat top	Flat top	Flat top	Full cycle	Injection and flat top	Flat top	Flat top	Flat top	Flat top	Collision	Flat top	Flat top	Flat top followed by suqeeze in IR2	Top energy, squeezed
Optics change	Standard squeeze, separated +colliding	NO	NO	NO	No	No	No	No	No	No	No	No	No	No	Yes	No
Orbit change	No	No	Yes	NO	No	No	No	No	No	Yes: bumps in the IRs	No	No	No	No	Yes	No
Collimation change	Yes: closing H/V primary collimators	Yes	Yes, only TCTP/TCSP	Yes: IR3/7 collimators	Yes: IR3/7 collimators	No	Yes: in IR7	Yes: in IR7	Yes	Yes	Yes: IR7 secondaries	Yes: TCL settings in IR1/5	No	No	Yes: IR7 TCPs + IR2 TCTs	No
RF system change	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Feedback change	No	No	No (to be kept OFF)	No	No	No	No	No	No	No	No	No	No	No	No	No
What else should be changed?	Nothing	Need to introduce periodic time variation of the current of warm trim quadrupoles. Need to use the ADT for narrow-band excitation. Need to change gain of wire scanner. Need to change octupole current.	Nothing	Nothing	Nothing	Nothing	Position an angular scans of new crystals in IR7	Nothing	Nothing	Need to use ADT white-noise excitation.	Nothing	Nothing	Special ADT configurations to generate high losses.	Special ADT configurations to generate high losses.	Nothing	Trims of the RF frequency
Are parallel studies possible?	No	No	Possibly (one beam at a time?)	Yes: collimator hierarchy limit+impedance and potentially other.	No	No, but fills could be re-used after out tests.	Yes: B2 could be potentially used in parallel.	Yes	No	No	Potentially, can work on one beam.	No	No	No	No	No
More information on parallel studies	-	-	-	Improved alignment of collimator is the pre-requisite of several Md studies.	--	We do not plan to lose the entire beams that could therefore be re-used after ramp and squeeze.	The other beam must not cause spurious dumps and loss spike that could compromise the B1 tests.	-	-	-	-	-	-	-	-	-
MD requester is ready?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
MD readiness	Ok	Ok	Ok	Ok	Ok	Ok	Ok	Ok	Ok	Ok	Ok	Ok	Ok	Ok	Ok	Ok
Bunch intensity [10^11 ppb]	1.2	1.2 and 0.5	1.2	1.2	Nominal	1.2 and 0.5	Below safe intensity at any energy	1.2 and 0.5	1.2 and 0.5	1.2 and 0.5	1.2 and 0.5	Nominal filling patterns	1.2-1.3	Nominal	1.2 and 0.5	1.2
Number of bunches	1 or 2	1/2 plus several pilots	1	1	Up to several trains	1/2 plus several pilots	Several pilots	1 nominal + several pilots	1 nominal + several pilots	1 nominal + several pilots	1 nominal + several pilots	Up to nominal filling	Many nominal bunches	Up to ~100 bunches	1 nominal + several pilots	Feb 03, 2015
Transverse emittance [um]	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5 or smaller	3.5 or smaller	3.5 or smaller	3.5 or smaller	Nominal	Nominal	Nominal	3.5 or smaller, to be blown-up	3.5
Bunch length (4 sigma, ns)	Nominal	Nominal	Nominal	Nominal	Nominal	Nominal	Nominal	Nominal	Nominal	Nominal	Nominal	Nominal	Nominal	Nominal	Nominal	Nominal