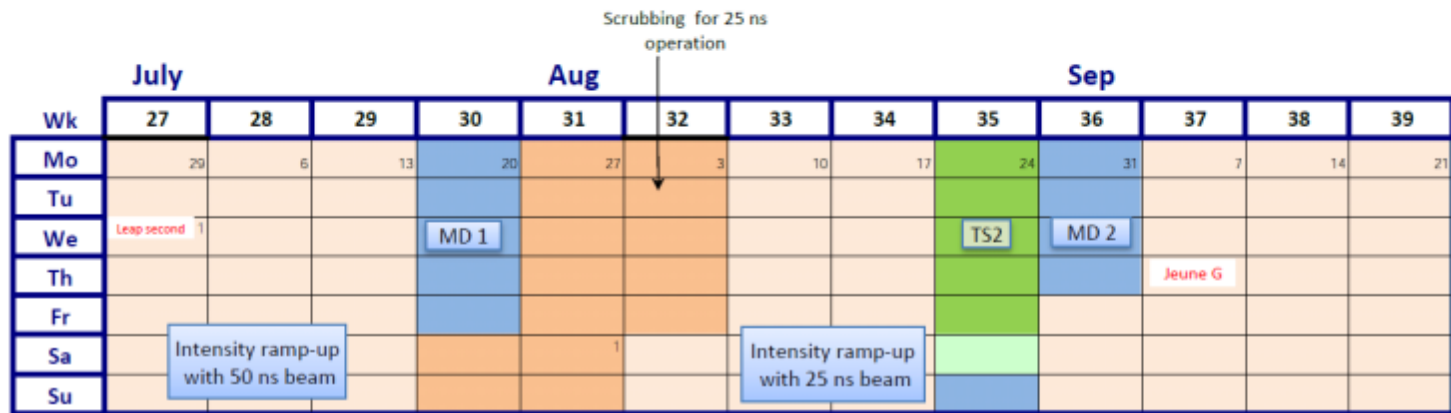


MPS commissioning status / preparation and issues

- Proposal for intensity increase
check list

D.Wollmann, M. Zerlauth, J.Wenninger, et al

2015 Q1/Q2



- 5th week into beam commissioning
- Using INDIV nom bunches at injection + ramp pilots
- First 50ns Scrubbing run after TS1

Courtesy M.Lamont @LMC

Status of (outstanding) MPS tests, preparations and issues 1/3

Item	Required for	Status	Item	Description/comments
1	nominal b	DONE	Completion of MKI waveform measurements	Done Friday / Saturday
2	nominal b	DONE	Connection of MKI BETS and AGK + subsequent check	Done, but needs additional adjustment of MKI delays for B1/B2 done + re-checked (confirmed by Etienne)
3	nominal b	DONE	Additional closing of TDI (to ~ 8 sigma) and rough alignment of TL COLL	Done, aligned to 8sigma, respectively 10 sigma, no major losses seen
4	nominal b	DONE	Aperture measurements in extraction region, 14/15 MKD tests, XPOC checks with beam	Done,
5	nominal b	DONE	SMP/BIS: B1/B2 mapping of SBF & BPF throughout all systems	Done with offline analysis
6	nominal b	Finalizing	Check LBDS/BIS arming sequence after fixes	Has been working after fix, but needs to be monitored and entirely reviewed, still want to add the BETS TCDQ arming command (ongoing this PM by N.Magin)
7	nominal b	Finalizing	XPOC: Connection to Sequencer + SIS	Still missing some data from time to time (BCT,..) Still manual checks but OK for ABT for time being
8	nominal b	DONE	Fix IQC – SIS connection problem and BQM	Done from CO side, Giulia/Verena adjusted/checked synchronisation and looks OK now.
9	unsafe beam	Finalizing	Define new reference orbit for nominal bunches	Fix issues with unreliable/noisy BPMs in IR1/5
10	unsafe beam	Finalizing	COLL alignment for unsafe beam (incl sep bumps in the IRs)	
11	unsafe beam	DONE	Soft start checks missing for injection systems (MKI conditioning)	Requires RBAC roles, ongoing by M.Barnes, might require change of a nominal value of voltage for MKI8, done and tested by amongst other inverting order of checks in sequencer
12	unsafe beam	ONGOING	EOF tests for FMCM with beam for RD1.LR1/5 and RD34.LR3/7 + others	Tbd with priority at injection (for unsafe beam), later at flat-top, DONE at 6.5TeV but to be repeated with PC abort
13	unsafe beam	Finalizing	Unmask all BIS channels and make sure there is no hidden/oscillating user input	Missing BPMs in IR6, BETS TCDQ remains masked until after setup at flattop
14	unsafe beam	Finalizing	Unmask all relevant SIS checks	Activate BPMS-TCDQ interlock (need to define functions at injection)
15	unsafe beam	Finalizing	Interlocked BPMs in IR6	Firmware upgrade done, commissioning some with ABT, UNMASKED in BIS, interlock set to +-3.5mm
16	unsafe beam	TBD (not blocking)	Noisy signal from DCBCT B into SMP which potentially toggles the SBF	Discussion ongoing with BI
17	unsafe beam	TBD (not blocking)	Test interlock for remaining 10% of BLM crates which did not yet trigger the beam dump after losses	List of 'missing' crates to be provided by Christos
18	unsafe beam	TBD (not blocking)	BLM system interlock Latency	Christos will look into this as of FRI 24/4

Status of (outstanding) MPS tests, preparations and issues 2/3

Item	Required for	Status	Item	Description/comments
19	1 nom @ 6.5TeV	TBD (not blocking)	Verification of unmasking of BIS inputs with SBF changes in SMP	Check equations in SMP and correct unmasking in BIS
20	1 nom @ 6.5TeV	DONE	Coll setup, loss map and asynch dump at 6,5TeV	Done, COLL closed to 10sig (TCP), 15 sig (TCS) and 20 sig
21	1 nom @ 6.5TeV	TBD (not blocking)	Correct BETS window on TCDQ	Define TCDQ BETS functions after centre checked at flat top and asynch dump done at flat top
22	unsafe beam @ inj	ONGOING	Alignment of injection protection system for injection (TCDI, TDI,...) + Asynch dump	TCDI setup planned today; Access to update BETS tables required!!; TDI setup, verification and asynch dump done
23	unsafe beam @ inj	TBD	Correct BETS window on MSI	MSI also used for steering, needs to be corrected for unsafe beam (no masking anymore)
24	unsafe beam @ inj	TBD	Correct BETS window on TDI	As for MSI BETS tracking table not correct - needs confirmation of final current to generate and load new table
25	unsafe beam @ inj	To be observed	Check timing issue on extraction kicker in LSS6 of SPS	Delay card exchanged in MKE6 timing system, no further problem seen - 'old' card started to be tested in lab showing unexplained noise on sme outputs - tbc
26	(inj) trains	TBD	SIS injection interlock for QPS_OK	Validate at least for main circuits and activate, without beam, problem with QPS_OK flickering...
27	(inj) trains	DONE	Verify the SIS interlock for ring 1 / 2 injection	
28	(inj) trains	TBD	Verify the functionality of the new virtual beta * limits (optics IDs) in the TL	to be implemented in low level control (EN-STI), earliest by TS1
29	(inj) trains	TBD	SPS SMP: Issue with Intensity from BCT3 in SPS	

Status of (outstanding) MPS tests, preparations and issues 3/3

Status	Not blocking unsafe intensity but tbd:	Description/comments
	Item	
	Verify the installation of (correct) filter boxes on BLMs	HW correcton mostly done, need to validate with first beam CCR BIC as new refernce, 70us timing misalignment between SPS and LHC?!
	Correct BIC timing misalignment in IPOC	
	Verify relative timing of QPS triggers for 6.5TeV quench events (redundancy with BLMs)	
ONGOING	Diagnostic timing misalignment in Warm Magnet Interlock system Verification of beta* limits for collimators Direct BLMs in IR6 to be tested SIS for 13kA	Tbd when starting the commissioning of the squeeze,.. Requires definition of test procedure and access Validate and activate, tbd without beam
	SIS RQD/F current discrepancy interlock to be checked BCCM commissioning Verify BIS-LBDS arming squence for additional fields and imprvoed sequecne Linking of BPLs via the sequencer and in the BIS	Validate and activate, tbd without beam
DONE	Deploy new FMCM FESA class to fix diagnostic issue	fix requires modification of the BLM FESA server - pbm only exists if MSK channel is masked (as initial interlock then not considered by BIS_EVENT_SEQUENCE module
DONE	PM Data show interlock from beam 1 when beam 2 was injected [2015/04/12]	
	SMP: Check squeezing factors, beam modes, movable device flag,... during later cycle	
	Update IQC thresholds to run 2 limits	
ONGOING	Clean-up PMA data analysis Logging of orbit position	Many device name changes, modified sources,.. Not yet correctly configured, ongoing
	SIS interlock on bunch intensity for restricted SBF	Logic implemented, to be tested

Proposal for intensity increase checklist

D.Wollmann, M. Zerlauth, J.Wenninger, et al

Proposal 2015... (but the machine will tell...)

- 50ns (~9 steps to 1380b)
 - 3 – 12 – 48 – 144 – 288 - 480 –768 –1092 – 1236 – 1380
- 25ns (~11 steps to 2800b)
 - 3 – 12 - 48 – 72 - 144 – 288 – 432 - 588 –1164 –1740 – 2316 - 2748
- Scrubbing run(s)
 - 3 – 48 – 72 - 144 – 288 – 400 – 600 – 800 – 1000,..
- Note:
 - (If aligned) Roman pots could be inserted during each 2nd fill at each intensity step, after 2-3 hours (as part of beam process + TCL6,...). If beams dumped due to RPs no further insertion until reason fully understood.
 - EXP would like to collect data with reduced pile-up ($0.01 < \mu < 1$) early on (without delaying ramp-up or giving in too much int luminosity)
 - Either with separated beams (beam stability, what separation allowed) or with low(er) intensity bunches during commissioning

Intensity increase check lists -Motivation

- **Check and document each fill** with intensities, dump reasons and stable beams time during the intensity increase.
- Systematically check and document **readiness** for next intensity step of **protection critical systems/elements**.
- **Detect non-conformities**.
- **Delay intensity increase** in case of issues in MP critical system **until resolved** or satisfactory understood.
- Proposal 2015: 9x for 50ns; 11x for 25ns, 8x for scrubbing

Systems / categories

- Magnet powering (MP3)
- Beam and powering interlocks, post mortem
- RF
- Beam instrumentation
- Collimation
- Operation, orbit and feedbacks
- Beam Dump
- Injection
- Heating of Equipment

Proposal for Run2

- Using OneDrive (sociel.cern.ch) excel sheets, to ease exchange and filling.
- Documentation in EDMS after finalizing.
- LHCintensityincreaseRun2V1.xlsx

Daniel Wollmann > LHCintensityincreaseRun2V1.xlsx Microsoft Excel Web App Daniel Wollmann | ? x

FILE EDIT WORKBOOK ▾ SHARE ▾ DATA ▾ FIND

	A	B	C	D
1	Check list period			
2		Bunch pattern / intensity		
3		Start date		
4		End data		
5		Fill numbers		
6		Comment		
7		Next intensity		
8				
9		Non conform points in the following check lists: the intensity increase is put on hold pending a satisfactory understanding / resolution of th		
10				
11				
12				
13				
14				
15				

Check list period | Dump statistics | Fill overview | Magnet powering (MP3) | Beam, powering interlocks and p | ...

Check list period

Bunch pattern / intensity	
Start date	
End data	
Fill numbers	
Comment	
Next intensity	

Non conform points in the following check lists: the intensity increase is put on hold pending a satisfactory understanding / resolution of the issue

Dump statistics (from APEX or AFT?)

Dump caused by	# of dumps
Programmed dump (EOF)	
Fault of BPM IR6 (BPM IR6)	
Fault of LBDS (LBDS)	
Operator fault (OP)	
Controlles fault (CO)	
Orbit excursions (Orbit)	
Fault of Orbit feedback (FB1)	
Fault of Tune feedback (FB2)	
Beam losses (Beam loss)	
Fault of BPM system (BPM)	
Electrical network glitch (EL Net)	
Water fault (Water)	
Fault of BLM system (BLM)	
Fault of SIS (SIS)	
Machine Protection test (MPS test)	
Fault of Cryogenic system (Cryogenic)	
Fault of QPS (QPS)	
Fault of Collimation control (Coll Sys)	
Wrong collimator positions (Coll Ad)	
Fault of BCM (BCM)	
Experiments (EXP)	
Fault of vaccum system (VAC)	
Fault of BIS (BIC)	
Fault of PIC (PIC)	
Fault of FMCM (FMCM)	
Power converter fault (PC)	
RF fault (RF)	
Fault of access system (Access)	
Fault of tune kicker (MKQ)	
Transv. beam instability	
Long. beam instability	
Machine Development (MD)	
Fault of MKI or MKD (Inj./Extr. Kicker)	
UFO	
Magnet Quench	

Note: The dump cause indicates the system, which caused the dump due to a fault, not the first detection of the issue.

Fill overview (from APEX or AFT?)

Event Timestamp	Fill #	Intensity B1 [1e10]	Intensity B2 [1e10]	Stable Beams [hours]	Mps Expert Comment
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Magnet Powering

No magnet quench after beam dump in RQ4.R/L6.

No unexplained quench or powering event in a circuit.

No problems with loss of QPS_OK for main circuits following injection process.

No unexplained firing of quench heaters.

No unexplained abort of the fills by magnet powering system.

No un-validated change to the magnet circuit protection system

No un-validated configuration change detected in the QPS configuration management system

No magnet quench due to too high BLM thresholds

In case of quench: dump first triggered by QPS and not by BLMs e.g. in IP7

Beam, powering interlocks and post mortem

No unexplained IPOC failure in Post Mortem for FMCM.

No unexplained IPOC failure in Post Mortem for PIC.

No unexplained IPOC failure in Post Mortem for BIC.

No unexplained false beam dump from any of the MPS systems.

No unexplained abort of the previous fills by FMCM.

No failure of BIS pre-operational check.

No unexplained PM event with intensities > 8 nominal bunches

No unexplained PM event above 450 GeV.

UFO occurrences.

RF

Check klystron forward power during ramp, all klystrons. Report peak demanded power for each.

Check transient beam loading compensation and corresponding klystron power in physics (previous fill). Set Point module acquisition. All cavities.

Check Temperature and Power levels in all HOMs during the previous intensity fills (Timber or RF application).

Old tasks (intensity ramp up for scrubbing) - tbc

Check Temperature and Power levels in all HOMs during the previous intensity fills (Timber)

Check main coupler positions, all cavities

Make sure that NO RAMPING is intended in the next intensity period

Check for noise in the Cavity Field (Timber)

Measure during last fill (SR4): Phase Noise PSD (all cavities) + HOM spectra

Check for instabilities using BQM (ripples) via Timber

Beam Instrumentation

BLM Internal sanity checks results must be true.

Rise time (10 to 90%) of fast losses must be larger than 200 us.

No unexplained BLM check failures.

BLM system modification (ECRs) have to be agreed on, EDMS: notified persons signature is needed.

No nonconformities in the energy transmission to the BLM crates.

BSRA functioning and abort gap population always properly monitored

Change of BLM thresholds

No un-explained glitches of the Setup Beam Flag (SBF)

Collimation

Valid set of betatron loss maps (hor/ver at Inj., flat top, squeezed separated, colliding) done in last 3 months.

Valid set of off-momentum loss maps (pos./neg. at Inj., flat top, squeezed separated, colliding) done in last 3 months.

Loss maps for re-qualification after technical stop did not show unexpected losses distributions.

No observation of abnormal cleaning efficiency.

No observation of abnormal passive protection.

Collimators at agreed positions during cycle.

Correct LSA positions, thresholds, limits, warning levels.

No unexplained beam dumps due to collimators.

No beam dumps from collimator temperatures.

Operation, orbit, feedbacks

OFB operational status

QFB operational status

Global orbit in tolerance in stable beams (< 0.2 mm rms)

Orbit IR3/IR7 collimators within ± 0.2 mm in stable beams

Orbit at TCTs in tolerance in stable beams (≤ 1 sigma in IR1/5, ≤ 3 sigma in IR2/8)

Old tasks intensity ramp up for scrubbing 2011

Global orbit in tolerance at 450 GeV (< 0.2 mm rms)

Orbit IR3/IR7 collimators within ± 0.2 mm at 450 GeV

Beam dump

Asynchronous dumps understood? Protection worked correctly?

Parasitic asynchronous dump data show no loss of protection.

BPM IP6 (interlock BPM) during first beam with higher intensity and different bunch pattern.

No positioning errors on TCSG/TCDQ.

No settings or thresholds mistakes/wrong sequences/unexplained faults on TCSG/TCDQ.

Loss leakage to TCTs below 0.5% of losses at TCDQ during beam dumps.

No unexplained MKD, MKB kicker, TSU or BETS faults.

No potentially dangerous XPOC or IPOC failure on MKD or MKB.

No unexplained synchronization problem with TSU.

Pressure and temperature rise in TDE block within tolerances.

Requalification passed OK at 450 GeV and 6.5 TeV with pilot in case of any important component exchange.

Simulated asynchronous beam dumps by operator OK

Injection

Injection protection devices at agreed positions during cycle.

Correct LSA positions, thresholds, limits, warning levels.

Injection oscillations within tolerance for all injections.

No unexplained large beam loss on TCDIs.

Expected losses for the beam to be injected at least 30 % below threshold level.

Line has been re-steered successfully if losses have been too high.

No issues in injection procedure, settings or tolerances.

Orbit in injection region in tolerance wrt reference (tolerance <0.5 mm).

Resetting of TL trajectories, TCDIs and optics done when needed.

No increased rate of MKI flashovers.

No increased rate of MKI switch erratics or missing.

No unexplained MKI vacuum or temperature activity.

No machine-protection related injection system hardware failures.

Equipment heating

Heating of ALFA
Heating of BSRT
Heating of Collimators (TCP, TCS, TCTP, TCDQ, TCL)
Heating of BGV
Heating of MKI
Heating of TDI
Heating of beam screen
Heating of ALICE beam pipe (after TS1)
Heating of TOTEM and neighbouring vacuum
Heating of LHCb VELO
No unexplained heating of other equipment observed.
Variation of bunch length within the usual range.
Variation of beam spectrum within the usual range.
No additional non-conformities in vacuum observed (RF-fingers, etc.)

Summary / status

- Check lists will be run through rMPP before every increase in intensity.
- Assure readiness of all protection relevant systems for next intensity step.
- Iteration of check list content ongoing with system experts.