

SIS configuration and tests

J. Wenninger



- ❑ We currently have different 52 interlock types.
 - *Some of them are composed of more than one test ('leaf' in the SIS tree).*
- ❑ In the fall of 2011, 35 interlock types were used in SIS and documented (LHC-OP-MPS-0014, EDMS 1062498).
 - *The 17 other types were introduced later. They are not documented → to be completed.*
- ❑ LS1 is a good moment to go through all the types, think about changes, eradications...
- ❑ The tests procedures were never documented (but were listed on the share-point site for tracking) – **to be added.**



- For the majority of interlock types, the work consists in checking the device names, device properties/fields, reference and tolerance values...
 - *Lengthy but not special challenge.*
 - *Wherever there is no change, it should work right away.*
 - *But even unchanged interlocks will be re-tested.*



- ❑ **Collimator BPMs:** interlock on the beam offset wrt collimator center.
 - *To be prepared when readings become available.*
 - *Current strategy is to prepare interlocks to dump if the beam is too far off from the center, but to activate later – need some experience with the new BPMs.*
- ❑ **Abort gap monitoring:** activation of cleaning & dump.
- ❑ **Virtual beta* for TLs:** see MPP meetings from last summer.
 - *Generated by SIS → SMP → timing system → TL collimators.*
- ❑ Following the MPP workshop, I expect a few additional types.
 - *Need to plough through the workshop slides.*



- **Access-powering interlock**: simpler and more robust link from LASS to SIS.
 - *Reference: LHC-CIP-EC-0003 v.1.0, EDMS 1246780.*
 - *Not part of beam MP.*
 - *Must be ready for the start of the powering tests.*
- **TCDQ-beam interlocking**: incorporate the TCSG6 BPM – more accurate !
 - *Details to be worked out.*
- **Particle type interlock**: avoids that protons are sent into a ring setup for ions and vice-versa (injection).
 - *So far tricky identification of the particle type with the current of SPS injection line (TT10) dipoles.*
 - *To be replaced with information from the SPS telegram (coupled to the source machine) – much simpler implementation.*

Are they (still) needed?



- ❑ **Triplet alignment system motor state**: implemented but always masked (ok = motor off).
 - *Motors were condemned and the interlock gave some false triggers.*
- ❑ **SBF state**: injection interlock when the SBF not in 'normal' mode.
 - *Turned out not be really useful.*
- ❑ **E-cloud solenoids current (around MKI)**.
 - *it seems the solenoids will not be re-installed after LS1.*
- ❑ **TDI gap**: redundancy to the TDI position interlocks.
 - *Superseded by the gap surveillance of the TDI in the MKI BETS?*
- ❑ **BLM voltage interlock**.
 - *Will it be implemented in the BLM crate after LS1 (→ BIS) ?*
- ❑ **Beam position interlock at the Roman Pots**: implemented, tested... but never activated (mainly special runs).

Are they (still) needed?



- ❑ **QPS_OK**: injection interlock if some QPS_OK not present.
 - *is it still needed? I guess so, but would like confirmation.*
- ❑ **PC states**: all LHC PC states are interlocked in SIS (from the early period with initial reduced PIC configurations, sector tests...). Now that everything is in the PIC – obsolete.
 - *Proposal to remove all PC state interlocks except the 60 A CODs (that are not in PIC).*
 - *What about the simulation mode of the PCs?*



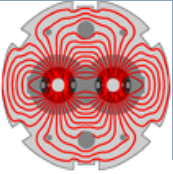
- ❑ **COD interlocks**: remained active in 2012 in parallel to the PC interlock server (K. Fuchsberger). Should be removed since the PC interlock server was shown to be fully operational and much more powerful.
- ❑ **PC current interlocks**: the current for a series of converters is surveyed (QD/QF at injection...) → can be done better in the PC interlock server.
 - *We could extend the COD current interlock to 'all' PCs, at least dipoles, quadrupoles [not RQTs], sextupoles).*
 - *We would profit from a new settings structure for the current interlock tolerances.*



- ❑ SIS is currently generating the beta* values for each IR from the currents of a pair of PCs.
 - *Based on a pre-calibrated table: current-ratio versus beta*.*
- ❑ This concept worked very well in standard operation, but failed for the ATS optics (for example).
 - *Table must be changed,*
 - *New PCs in neighboring IRs must be added (with another table).*
 - *The configuration must change automatically.*
- ❑ Before extending SIS directly, one could consider 'upgrading' the PC interlock server (\Leftrightarrow COD interlocks) to become the source of beta* since this server knows where in the cycle the machine is.
 - *Beta* is obtained from the LSA settings.*
 - *Could still transit through SIS.*
 - *This does not cover the TL virtual beta*.*



- ❑ The SIS server must be restarted around May to be ready for the powering tests (LASS-PIC).
 - *Operational ~ June.*
- ❑ The other beam related interlocks will be re-activated one by one starting in August-September.



List of SIS interlock types

L. Ponce @ MPP workshop

SIS Circulating Beam Interlocks

➤ Initial configuration in 2010

Test	Coverage	Comments
SMP energy	All RBs, SMP energy	0.2% to 2% (ramp or not)
SMP energy distribution	All BLM crates	Verify energy across all BLM crates
BETS	Q4 and MSD in IR6	
TCDQ – beam	Beam center in TCSG TCSG gap TCDQ-TCSG retraction	Achievable tolerances depend on orbit stability
COD integral	All arc Hor. CODs	$dp/p < 0.2\%$
Orbit	All ring BPMs	Achievable tolerances depend on orbit stability
COD settings	All CODs in STABLE BEAMS	Achievable tolerances depend on reproducibility and variation in ramp & squeeze
COD trips	60 A CODs (not in PIC)	Dump if COD(s) trips and missing kick > threshold.

SIS Circulating Beam Interlocks

- Several interlocks added during operation to fill the holes

Test	Coverage	Comments
RF voltage	Energy > 3.4 TeV	More strict for min limit than the internal interlock
BLM HV	All BLM crates	Dump if HV link lost, complement for sanity checks
FB masks	RAMP & SQUEEZE	Dump if >25% of BPM disabled
Ref orbit	RAMP & SQUEEZE	Dump if zeroed/wrong ref orbit
PC interlock	All 60A CODs	Dump if 2 CODs out of tolerance

SIS Injection Interlocks

➤ Initial configuration in 2010

Test	Coverage	Comments
PC states	All PCs	
PC currents	RB, RQ, RD, MCBX	Extended to IPQ
QPS_OK	All circuits with QPS	
RF	Synchronization Cryo maintain	
BTV position	Ring and dump line BTVs	
Injection bucket	Abort gap and over-injection protection	
Injection mode		Avoid injecting with wrong mode
Energy		
(Pre)-op checks	XPOC, PM, IQC, BIC, SMP	
Triplet alignment	WPS in all IRs	

SIS Injection Interlocks

➤ Quite long list of added interlocks:

Test	Coverage	Comments
ADT bunch intensity		Check SPS intensity compatible with ADT settings
Beam type	Telegram and TT10	Check ions/proton configuration
TL handshakes	IP2 and IP8	Allow extraction till TED
Injected intensity	SPS intensity vs circ.	Added for intermediate intensity concept
Injection orbit	All BPMs	Tighter than orbit too avoid large oscillation
Orbit in injection region	BPM around TDIs	
TDI Gap		
RF RT trims	Radial modulation OFF	
MKI vacuum	Magnets and interconnect	
MKI temperature	MKI magnets	Max values (MCS) per magnets
Ventilation doors	Non LASS interlocked doors	