ABT MPS RECOMMISSIONING AFTER EYETS 16/17

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MPP, 31st March 2017

Outline

- SPS extraction, transfer, LHC injection

- LBDS
  - MKB coupling mitigation
  - Reliability run strategy

- Not covered here, but next week by Nicolas Magnin:
  - AGK modifications and validation
  - TSU firmware upgrade
  - Injection BIS input

MPS procedures

- Tests included there proved useful
- MPS procedure documents are up-to-date

https://edms.cern.ch/document/889343/4.0

https://edms.cern.ch/document/896392/3.0

Step-by-step procedures

- On dfs: \Departments\TE\Groups\ABT\Sections\BTP\LHC-Restart-2017\Procedures
- Procedures for real test execution with details on mechanics, interlock masking, etc.
- Will move on EDMS after this startup

LHC Restart 2017

Activity Summary

Activity:	MKI waveform measurements
Activity leader:	Linda
Support needed from:	Mike Barnes, Etienne Carlier
	Enrico Bravin/Stephane Burger in case of BTV issues
Measurements to perform without beam (detailed description):	Step 1: Synchronization without beam. For each beam: - Pulse the MKI in local mode - Overlap the TMR signals from all 4 modules, adjusted for the time of flight - Overlap the CPU signals from all 4 modules, adjusted for the time of flight
Measurements to perform with beam (detailed description):	Step 2: Fine synchronization of the MKI modules (only necessary if TMR & CPU signals are not in agreement). For each beam: - Slightly offset timing so that the pulse is late - Adjust the timing for each module so that the start of the rising edge is seen as a kick to the circulating bunch, observed as oscillations on the damper pickup. - Configure each module with the timing found Step 3: Verification of the start of the flattop. If P8 synchronization did not change, only for beam 1, otherwise for each beam: - Close the TDI and put the BTVST screen in - Inject pilots with varying MKI delay, noting down their position on the screen, to check whether the waveform is as expected. (We need a few shots without kick and a few shots at flattop to calibrate, and then measure a few delays to verify the start of the flattop.)
Prerequisites for performing the measurements (e.g. other systems which need to work):	Step 1: - Can be done during checkout Step 2: - Stable closed orbit - Damper pickups Step 3: - TL steering done - Screens BTVST.A4L2.B1 and BTVST.A4R8.B2
Required beam parameters:	Step 2: Pilot, circulating (perhaps to dump and reinject sometimes) Step 3: Pilot, Inject and dump, intensity reasonably stable (shot-to-shot)
Time estimate:	Step 1: To be done during checkout Step 2: 1 hour per beam Step 3: 2 hours per beam
Any other comment:	- Step 3 to be done after step 2. But if step 2 is not necessary, we could do step 3 without establishing the closed orbit if there is time in the schedule. - If step 2 is necessary we request machine setup (until MKI validation) to be done with a special delay (middle of the waveform instead of start). - Make sure the AGK changes are validated as well. (Failure cases tbd.)

- LHC_Restart_2017_Activity_Summary_asynch_dump_test.docx
- LHC_Restart_2017_Activity_Summary_Direct_BLM_test_procedure.docx
- LHC_Restart_2017_Activity_Summary_Inj_extr_protection_HW_and_interlock_checks.docx
- LHC_Restart_2017_Activity_Summary_Injection_Aperture_Measurements.docx
- LHC_Restart_2017_Activity_Summary_Interlock_BPM.docx
- LHC_Restart_2017_Activity_Summary_LBDS_aperture_measurements.docx
- LHC_Restart_2017_Activity_Summary_MKD_waveforms.docx
- LHC_Restart_2017_Activity_Summary_MKI_waveform.docx
- LHC_Restart_2017_Activity_Summary_SPS_extraction_setup.docx
- LHC_Restart_2017_Activity_Summary_TCDI_Alignment_And_Validation.docx
- LHC_Restart_2017_Activity_Summary_TCDQ_setup.docx
- LHC_Restart_2017_Activity_Summary_TDI_and_TCLI_setup.docx
- LHC_Restart_2017_Activity_Summary_TL_aperture_and_optics_measurements.docx
- LHC_Restart_2017_Activity_Summary_Transfer_Line_Steering_and_Injection_setup.docx

SPS extraction and transfer

- SPS extraction
  - Usual steps: https://edms.cern.ch/document/1750252/1
  - Flatten orbit in LSS4/6
  - Setup nominal bump
  - Aperture measurement at extraction – was performed last run after each TS with Coldex modifications
  - Can be done with upstream TED in ahead of LHC beam commissioning

- Transfer line
  - Notes from IEFC 03/03/17:
    TI 2 : Performed vertical smoothing of quads - 46% roll adjustment and 23% vertical adjustment. To note: the TI 2 vertical dipoles were also corrected at the top of the line (where the larger vertical excursions where measured)
  - Aperture measurement with dipole kicks of 30 deg phase shift along the lines
  - Consider also checking the optics with kick response

LHC injection

- Keep changes from 2015 on injection protection setup and validation
  - Automatic alignment application
  - Validation with *pycollimate*
  - X-measurement

- Additional tests
  - Kick response from line into ring to verify BPM capture is working
  - MKI module synchronisation and verification of flattop start for B1 after TS exchange
  - To be verified if injection protection needs to separately setup and validated for VdM scan optics

- No changes to interlocking strategy
  - All BETS modifications as introduced after LS1 kept (MSI, TDI, TCDQ)
  - Modifications related to variable AGK by Nicolas next week

- Test BLM inhibit with 288 b trains

LHC injection

- Standard optics for VdM scans
  - Setup for ATS but roll back to standard for VdM scans
  - Optics in injection region changes only at TCLIB
  - Keeping TCLIB settings in mm results in 7.2 sig (P2) and 8.3 sig (P8)
  - Until 2015 we had TCLIB at 8.3 sig during high intensity operation to minimize number of intercepted primary protons
  - For VdM scans will inject 4 nominal bunches at a time
  - Keeping these settings we consider safe

- Checks to be done for VdM scans
  - Check the orbit difference with nominal bunches
  - Perform alignment check with parallel jaws
  - Perform injection loss maps with/without injection protection

# LHC extraction modifications (more from Nicolas)

- Modifications during EYETS on dilution kickers to avoid MKB coupling
  - Retrigger box insulated from generator
  - Nano crystalline tores added on retrigger line to suppress common mode
  - After this modifications no coupling up to 7.1 TeV observed
  - Confidence for 6.5 TeV operation
  - Margin for 7 TeV operation not known, system will be different after LS2
  - Retriggering of MKBs seriously considered and studied for possible implementation in LS2

- Reliability run strategy
  - 2 weeks at 7 TeV - ongoing
  - 1 week at 6.5 TeV
  - Monitor rate of erratics and coupling
  - Keep MKBH voltage reduction as fall back option
  - LIBD with EN/STI input of 80% pattern being prepared – will report to MPP in due time

LHC extraction tests

In addition to standard procedure:

- MKD waveform check
  - Verify rising edge and rise time
  - Relevant for variable AGK

- MKB waveform check
  - Dump ~5 pilots distributed over the machine

- AG cleaning
  - Check if SIS triggered cleaning works
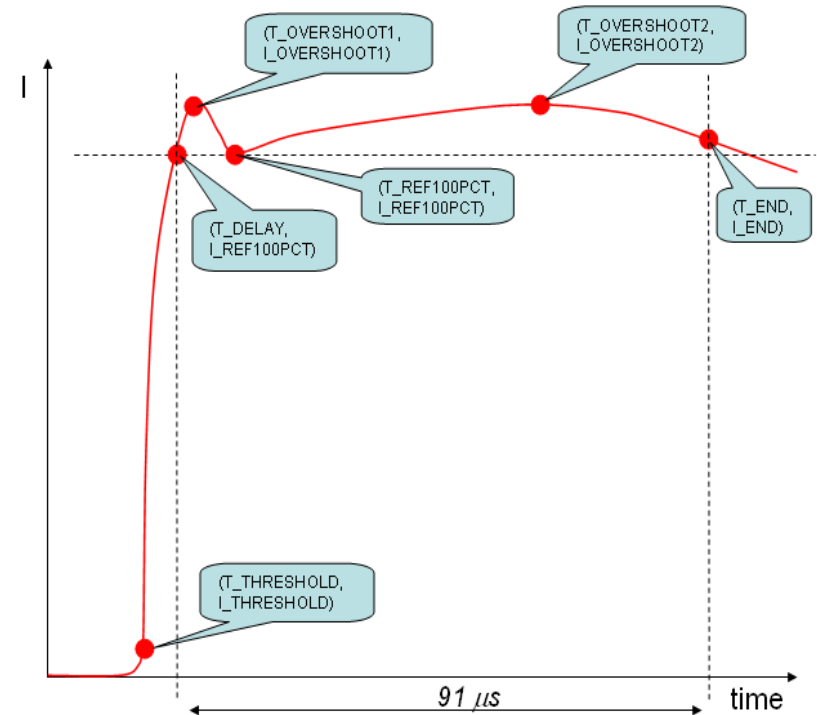
Summary

- Standard MPS revalidation procedure as in updated documents
  - Cannot rely on following all changes and their impact

- Certain interventions during EYETS require additional tests
  - TI 2 aperture/optics due to smoothing
  - MKIP2 rising edge to exchange in TS prior ion run – synchronisation for performance improvement
  - VdM standard optics requires alignment check and loss maps
  - BLM inhibit since 288 b trains couldn't be injected last year
  - MKD rise time as input for AGK modifications – and check if component ageing

- MKB coupling issue solved for 6.5 TeV operation
  - Synchronous retriggering considered for post LS2

- Reliability run ongoing
  - Baseline to keep MKB at 100% voltage for 6.5 TeV
  - Depending on erratic rate have fall back possibility
  - Approval of reduced MKB voltage being prepared in parallel