

Status of the machine studies

MSWG meeting, 09/10/09

1) Setting-up LHC50ns (PSB:LHC75A -> PS:LHC75) in the PS (H. Damerau) => Beam "almost" ready on 14/09/09

- The setting-up of the LHC50ns variant has advanced faster than expected and the beam is already almost within specifications: http://elogbook.cern.ch/eLogbook/event_viewer.jsp?eventId=1205778.
- Though we have not yet finished our adjustments in the PS, you could try to use it with somewhat compromised performance during the coming long MD.

2) PS coupled-bunch feedback with C11 on LHC25 (H. Damerau)

- Monday 14/09/09 (08:00 - 18:00).
- Good conditions only during about two hours.
- No problems related to the MD. Two unforeseen machine interventions (gap relay C56 and repair of C80-08) during the MD slot originally scheduled.
- A very quick test with the spare cavity 11 using it as a kicker cavity on the usual harmonics of the coupled-bunch feedback has been made successfully. No time to test any other harmonic numbers or to make systematic measurements.
- Next steps: Systematic measurements, operating the coupled-bunch damping loops (and C11 as a feedback kicker) on various harmonics.
- New requirements: LHC25 at full nominal intensity. As learned during the MD, no dedicated MD time will be required for those measurements anymore. The measurements can be done in PPM, accepting that it takes ~ 10 min to put C11 back to its normal state when needed.

3) Check of measurements with radial PUs on SFTPRO/CNGS-TOF-AD in the PS (H. Damerau)

- Wednesday 16/09/09, 0h00 - 6h00.
- No blocking problem. About 1h30 lost due to a problem with the sequence manager (super-cycle could not be changed).
- The full set of radial position measurements with SFTPRO (as a cross-check of the measurements from 14/07/2009) has been recorded.
- Next steps: Most probably, no further MD required until decision on which radial loop PU will be taken (-> MSWG). A dedicated MD session would be needed to try to adapt the operational beams to a new selection of radial PUs for the radial loop.

4) Investigation of radial loop receiver behavior on LHCION/EASTB in the PS (H. Damerau)

- Tuesday 15/09/09, 13h00 - 21h00.
- No blocking problem.
- The behaviour of the low-intensity radial loop (h16LI beam control) with different radial loop receiver modules (Δ/σ) has been studied. Both beams EASTB and LHCION were - for the MD - produced using spare radial loop receivers with a standard calibration (as used for the high-intensity radial PUs 22/51/96).
- Next steps: (i) Measurements in parallel to fully understand the calibrations of the two radial loops in the PS; (ii) An outstanding issue for the ion beams are still erroneous spikes observed on the radial position (measurement). Further tests will be done in parallel as far as possible on that subject, but the need for a couple of hours of LHCION without the SPS taking this beam is not excluded.
- On 28/09/09, Heiko informed Elias that this subject is closed.

5) Ecloud studies in the PS (Silke Federmann)

- Wednesday 23/09/09.
- The beam was the one we requested and it had very good quality. Also our request to have a few minutes without beam for calibration measurements was handled very quickly – we are very grateful for this!
- As for the obtained data: One part of our experiment showed good results (we could see ecloud signals very nicely). The RF measurement setup however still needs refining. With the microwave signal we could not resolve the expected signal caused by the ecloud (probably due to the high attenuation of the cables and/or noise – I will have to discuss this with Fritz). But overall it was a quite successful run for us.

6) UA9 in the SPS (E. Metral)

- Wednesday 23/09/09.

- During this 24-hour MD, the idea was to devote the first shift of 8 hours (from 08:00 to 16:00 on Tuesday) to prepare the different beams which could be used during the next 2 shifts: the first part dedicated to measurements with low-intensity (for MEDIPIX etc.) and the second to measurements with "high intensity" (for the loss maps etc.). The planning for the machine setup was decided beforehand and was the following: On Tuesday 22/09/09, from 08:00 to 16:00, do the setup of the different beams which will (might) be used during this session (in each case the maximum intensity per bunch is $\sim 1E11$ p/b):

- 1) 4 bunches: LHCINDIV in PS and PSB (4 rings) in 1 batch.
- 2) $4 * 4 = 16$ bunches: LHCINDIV in PS and PSB (4 rings) in 4 batches.
- 3) $4 * 12 = 48$ bunches: TSTLHC25 in PS and LHCA in PSB (4 rings) in 1 batch.
- 4) $4 * 12 = 48$ bunches: TSTLHC25 in PS and LHCA in PSB (1 ring) in 4 batches.

- The 4 batches of 4 LHCINDIV bunches went well and was available in the morning. However, the beam had to be stopped from $\sim 11:00$ to $14:00$ (i.e. during ~ 3 hours) due to a fire of an RF amplifier of the Transmitter TRX8. The sequence was then changed and we tried to redo the same thing with 4 batches of 12 TSTLHC25 bunches. However, more difficulties were faced with this beam after the 3rd batch and some beam was lost at ~ 9200 ms. We did not have much time to study and understand the problem (due to the 3 h lost), since in addition we lost ~ 1 h of beam (between 16:00 and 17:00) due to a water pump problem in the source. After discussion with Walter it was agreed that the beam with 4 batches of 4 LHCINDIV bunches will be sufficient to make the high intensity tests. Therefore, we switched back to the previous sequence and could start the UA9 MD around 17:00.

7) Orbit acquisition in coast in the SPS (Stephen Jackson)

- It is now possible to acquire the SPS orbit in coast since Tuesday 22/09/09.
- In the past, the electronics configuration of the COAST1 user was incorrect. It was still set to trigger on the prepulse1 instead of the warning event... That has the effect of no starting of the acquisition and old data being returned on subsequent orbit requests. For some reason, rebooting all 6 crates seems to be necessary when passing in to COAST. Maybe the software or the electronics gets confused when triggering on pre-pulse or the MTG event. I have the feeling that in previous attempts to measure during coast, we either had bad configuration, or the MTG events needed were not being transmitted. Now it seems everything is working OK... With regard to the 'where' of the measurement, this should be visible in Jorg's application. If you request to read at 1200ms for example, I'm 100% certain you won't get an orbit at 1200ms due to the inaccuracy of the triggering. The actual time of the orbit however, should be displayed in Jorg's application (?). In previous years, YASP wasn't able to cope with this time mismatch as it requested the measurement in ms. Now Jorg asks for the orbit in turn offset from the start trigger, which means the front-ends don't complain and we get some data...

8) SPS BLR negative and positive offsets and MD (Jonathan Emery)

- Work done during the setting-up of the beam for the UA9 studies on Monday 21/09/09 => Latest news about the negative and positive offsets of the BLR of the SPS at high gain and amplification.
- Preceding the MD of this week we have recalculated the charge and current at gain=High(x200) and Amplification=32 (settings used for the MD). At this high amplification, the measurement of the output current of the ionisation chamber becomes a issue. One bit at 13s (STFLONG 1 cycle) is 59fA! and the full scale is 120pA! According to the designer of the system (FERIOLI Gianfranco) the only way to measure at this settings is to make differential measurement between a reference signal (Beam off or controlled initial conditions) and the measured event. This will remove the negative or positive offset (Pico ampere order!) due to various factors including the cable length (900m!). If one channel is saturating, the use of a lower amplification should be considered. The noise at this setting is in the range of 100 bits (as observed) corresponding to something like 1uGray. We are at the limit of what the system can do with 900m cable and the offsets and leakages of the electronics (the OpAmp used is already a very good one). Gianfranco advised to limit the use of BLR if going higher that gain=High(200x) and Amplification=2 (1bit=0.939pA, FS=1.92nA at 13s cycle). I proposed the people from the Crystal experiment on Tuesday to use a reference signal to be subtracted from they're measurements to remove the parasitic offsets.
- Next steps (information from Bernd Dehning): we would like to delay the cleaning of the remaining crates when LHC is started up and our colleagues have more time for this issue.

9) Status of the SPS wire scanners on Wednesday 23/09/09 (A. Guerrero)

- Working WS: 416, 519, 521 and 414 V. They all move and measure reasonable values.
- Therefore, it was decided to launch a detailed campaign of measurements of transverse beam profiles in the SPS with all the BWS available (416, 519, 521 and 414V) starting in week 42 => Already planned in the MD planning: <https://ab-mgt-md-users.web.cern.ch/ab-mgt-md-users/2009/pmd42.htm>.

10) FBCT in TT2 (E. Metral and L. Jensen)

- On Wednesday 02/09/09, looking at the FBCT in TT10 it seemed there was more than a factor 10 between the core and the islands, while looking in TT2 it was closer to a factor 6. It was believed at that time that the FBCT in TT2 was the correct one (with a baseline below 0) and that there was a problem with the FBCT in TT10 (whose baseline might be below 0 but it was cut at 0). However, according to Lars Jensen this has been solved and the measurement in TT2 was in fact wrong and due to a PS timing problem.

11) 2 injector MDs proposed by M. Ferro-Luzzi (E. Metral and M. Ferro-Luzzi)

- M. Ferro-Luzzi proposed 2 injector MDs at LMC held on 16/09/09 and “The request for injector MDs was supported by the LMC” => https://espace.cern.ch/lhc-machine-committee/Minutes/1/lmc_28.pdf. The first for bunch spacings of >100 ns for special ALICE bunch trains (the best possible solution identified in the past was a 12x150 ns p bunch train to be inserted in an LHC fill), and the second for shifting PS to SPS transfer for producing the different suggested LHC filling patterns.

- Preliminary analysis after discussion with Massi and then Jorg and Delphine for the LHC Sequencer:

1) As concerns the time scale for Massi’s request => It is for next year in ~ March or April if feasible.

2) There are 2 requests from Massi:

2.1) Selection of the phase

- With for instance the scheme 156 * 156, there is no collision for ALICE if one does not displace symmetrically 8 bunches (minimum). If one could select the phase between PS and SPS then it would be better and fewer bunches would need to be displaced.

- With for instance the scheme 1404 bunches (i.e. 50 ns bunch spacing), the minimum one has to displace is 72 bunches. The idea is the following: If one could select the phase between PS and SPS (and not only SPS and LHC), all the batches could remain the same except one, which should be displaced.

=> For the moment a typical scheme in the SPS is: 36 bunches + 9 missing (25 ns) buckets + 36 bunches + 9 missing (25 ns) buckets + 36 bunches + 9 missing (25 ns) buckets + 36 bunches. The idea would be to have: 36 bunches + 12 missing (25 ns) buckets + 36 bunches + 9 missing (25 ns) buckets + 36 bunches + 9 missing (25 ns) buckets + 36 bunches. Therefore, for Massi’s request, only the first batch spacing should be modified from 9 to 12 missing (25ns) buckets, and only once in the LHC filling. In fact, in general it would be good to have the flexibility to choose the number of missing buckets between every batches (because this might be an important parameter to play with in case of ecloud pbs or multi-bunch instabilities etc.) => To be looked at in detail (In fact, Jorg told me that he has requested for some time now to have in the different LHC patterns, not only the number of bunches etc., but also the batch spacing). For Massi’s request, that this can be done with 2 different users in the RF MMI.

2.2) Replace a usual train by a particular train

- The request from Massi is to have a train of bunches with bunches spaced by > 100 ns, multiple of 50 ns and the closest to 100 ns to have the maximum number of bunches. The number of protons / bunch should be between ~ [1 - 5]E10 p/b whereas the other batches will have bunches with ~ [5 - 10]E10 p/b. A possible solution could be (after the discussions I had with PS RF people in Spring) to have a train of 12 bunches in the PS spaced by 150 ns. It was said that it seems feasible but some work should be done => May be we could have a look to it before the shutdown if possible (recommendation of the MSWG?).

- Reminder: It is in the LHC Sequencer that we define the sequence one wants to play (i.e. 3 batches and then 4 batches and then etc.). It has therefore to have the SAME USER! If one wants to add particular PS bunch patterns, may be the best would be to define another user and add another sequence in the LHC Sequencer (or do it manually). If this particular batch is at the beginning: we do it manually in the LHC Sequencer and then we launch the sequence in the LHC sequencer. If this particular batch is at the end: we launch the sequence in the LHC sequencer and once it is done we do the particular batch manually in the LHC Sequencer. Finally, if this particular batch is neither at the beginning nor at the end, may be the best it to define 3 sequences: the 1st is the first part of the nominal sequence; the 2nd is the one for the particular batch and the 3rd is the 2nd part of the nominal sequence.

12) Performance and systematics assessment of the BI prototype Diode-BPM acquisition chain (R. Steinhagen)

- 2009-06-12, 2009-07-14.

- The acquisition system has been installed in BA2 and due to the distance to the available pick-up (BPCL.208) thus required very long cables. Due to the long cables, the signal was deteriorated by DC

current loops and EMC signals (main dipole powering cycle). Attempts were made to suppress these signals by various AC coupling techniques.

- Using small radial RF modulations, it could be shown that the resolution of the electronics can achieve a μm resolution at measurement bandwidth of about 50 Hz.
- Next steps: The systematic dependence on beam intensity and the verification of the accuracy (μm -level required) are pending and being further investigated. If possible, the operational system will be installed beneath the pick-up itself, thus minimising the systematic EMC contributions and enabling also μm -accuracies.

13) Prototyping and commissioning of the digital LHC-type FastBCT acquisition electronic and front-end software (R. Steinhagen)

- 2009-09-23.
- Some time was needed to recover the nominal SPS settings after the preceding machine development. Otherwise, no major problems and the MD's measurements programme could be completed with one coast.
- The resolution of the LHC-type acquisition chain was sufficient to resolve the coasting beam life-time in the SPS. The comparison between bunch (FastBCT) and total beam lifetime (DC-BCT) showed that while the absolute losses were small (life-time > 50 h), the bunch life-time of about 3.5 h at the end of the coast indicated that parts of the beam left the bucket and became part of the uncaptured beam circulating outside the RF buckets.
- Next steps: It was found that the calibration procedure and involved hard- and software need some further refinement for nominal LHC operation.
- New requirements: BI would require another MD with coasting beam to verify the modifications.

14) Instabilities measurements @ transition crossing in the PS (S. Aumon)

- From Thursday afternoon to Sunday in week 39.
- The bunch lengths measured with OASIS, the BSM and the tomoscope were different. It was a problem of "decimation" in OASIS, and Stephane Deghaye solved it. But some length measurements have to be redone. On Saturday, it was possible to measure neither the orbit nor the tune even by using the orbit specialist application.
- An instability was measured in the horizontal plane at low intensity ($30 \cdot 10^{10}$) with neither the Gammajump nor blowup. Time growing measurements. The frequency might be around 70MHz. It might be a problem with the chromaticity: we set up a chromaticity plateau close to zero. However the measurement of the chromaticity is delicate and we did not manage to determine the sign of the chromaticity. The threshold in the vertical is around $1 \cdot 10^{12}$.
- Next steps: Continue the scan in intensity for measurements in Horizontal and vertical.
- New requirements: The same as the last MDs.

15) Performance qualification of the APWL wall current monitor in view of its application as longitudinal profile monitor in the LHC (R. Steinhagen)

- The APWL shall provide expert beam diagnostics for cross-calibration and checks with other dedicated/specialised BI instrumentation systems. The target of this MD was to verify the systematics of the APWL pick-up and feasibility of a high-resolution measurement of bunch length, profile, intensity and potential for satellite or ghost-bunch detection.
- Date of the MD: 2009-08-11.
- While the analogue and subsequent digital acquisition chain proved to be sufficient for the intended purpose, thanks to this MD, we could explore and identify structural resonances and reflection signals in the pick-up setup that create spurious signals which uncompensated could otherwise be falsely interpreted as satellite or ghost-bunches. These reflections reach amplitudes of up to 2% w.r.t. to the preceding bunch signal, limiting the ghost bunch detection to the same value. Attempts were made to qualify and compensate these effects. However, it is believed that the observed systematic effects are specific to the SPS installation.
- Next steps: While the LHC installation has significantly shorter signal cable length, based on this MD, the accuracy is expected to be nevertheless limited by the reflections to about 2% w.r.t. the maximum signal level. A conclusive assessment requires beam measurements with the actual APWL installation in the LHC. The MD results and issues will be documented in a more detailed MD note.

16) Reference data measurement using the continuous beta-beat measurement system in the SPS (R. Steinhagen)

- Test of a beta-beat measurements method that uses two CODs that have a 90° phase-advance shift and that are being modulated with a sinusoidal oscillations in time. The phase advances of the latter methods are recovered using orbit data of the default SPS BPMs.
- Date of the MD: 2009-07-13.
- Using excitation amplitudes in the range of a few hundred μm , we could show that the 2-COD optics measurement method can resolve the SPS lattice with a resolution of about 10% and being essentially limited by the ratio between COD excitation amplitude and available BPM orbit measurement noise. Due to the very slow and off-tune resonance modulation, this measurement technique can achieve high resolutions with moderate excitation amplitudes, which make it safe with higher-intensity beams in the LHC. However, due to the necessity of using two CODs and the uncertainty on their 90° phase-advance, this measurement has some strong systematic on the absolute measurement of the beta-function value.
- Next steps: Regardless of its systematic dependence, this method is adequate to measure and control relative optics changes. Due to its simplicity and the fact that it intrinsically samples all longitudinal phases, it is proposed to use this method to verify the validity of the LHC-BPMs, optics and potentially available aperture, and could thus be executed prior to every nominal fill as machine-safety check if necessary. The same method is being implemented within YASP for the coming TI2/TI8 transfer line tests.

17) Beta-beat SPS MD (R. Tomas)

- 30 Sep. 2009.
- Focused on simultaneous coupling and dispersion correction using vertical orbit bumps in the sextupoles. The goal was accomplished and an on-line correction via knob generation of about a factor of 2 in coupling and vertical dispersion was achieved.
- The beam availability and the general conditions of the machine were very good.

18) Approaching the SPS working point close to the 1/2 or integer resonances (Tobias Baer)

- Date of the MD: Tuesday, 29/09/2009.
- The MD1-cycle was somehow changed to an ion cycle resulting in some problems at the beginning. We changed to the cycle MD2 to obtain appropriate conditions. This and some other problems (cp. elogbook) delayed the beginning of the MD by about one hour.
- The MD was very successful and provided valuable results, improving our understanding of the beam behaviour close to tune resonances in the SPS. As first focus of this MD the dispersion close to the systematic $Q=24$ resonance and the $Q=26$ resonance was measured. Prior madx-simulations predicted a broad dispersion explosion close to $Q=24$ that was also encountered during the MD. Also the beam losses due to the dispersion resonance were measured. Furthermore, the regions around the quadrupoles QD.209, QF.210, QD.321, QF.322, QD.323, which had conspicuously high beam losses in prior MDs on resonance-crossings were investigated. 3-corrector orbit bumps with a time dependent amplitude were set up at these positions and the influences on the beam losses and the beam current were recorded. Finally, the $Q_h=26$ resonance was approached with a 26GeV beam of 12 bunches with $\sim 4E10$ p/b and with a decreased intensity of $\sim 0.8E10$ p/b. The higher intensity beam was clearly less stable resulting in a beam loss in down to ~ 15 turns after reaching the resonances stop-band.
- Next steps: There are still some problems to be resolved by BI related to false triggers of the new fast turn-by-turn interlock BPMs. Nevertheless, it is intended to calibrate the interlock-thresholds and to test and determine the reliability of the new interlock-system in the next 1-2 months.
- New requirements: A further MD related to the tests and calibration of the new interlock system will be needed after the triggering problem of the interlock BPMs is solved.

19) Further developments on the SPS BQM (G. Papotti)

- Date of the MD => always only in parasitic mode, no dedicated time used: 2009-09-15 (during ecloud studies); 2009-09-26/28 (during TL studies); 2009-10-01 (during Brennan's MD).
- Current results:
 - 1) runtime measurements of the last (critical) algorithm with 4×72 bunches (result: below 20 ms, in spec).
 - 2) reliability studies: the software was running for up to ~ 24 hours continuously during the long MD (until stopped).
 - 3) first connection to the beam dump tested (even though masked in the beam interlock software most of the time)

- 4) stability measurements done (for deducing thresholds, accuracy...).
- 5) GUI improvements from Fabio Follin.
- Next steps: more statistics to be acquired in the next long MD.

20) SPS ion commissioning: upgrade of LSA for ions (T. Bohl)

- Date of the MD: Thursday 01/10.
- Usual problems with debugging software.
- Time on Thursday 2009-10-01 was not sufficient to finish the programme. We continued on Friday 2009-10-02 and used an I-LHC cycle without beam at the end of the morning. As far as we can say the LSA upgrade for ions went fine. This concerns mainly the RF functions like bucket area, total and individual cavity voltages, counter-phasing, synchrotron freq. and period, and cavity calibration factor.

21) Long Injector MD of week 41 (E. Metral)

- It was first reduced from 3 days to 2 days due to a replacement of the PS bus-bar and advancement of the Injector Technical stop of week 45.
- Finally, it was cancelled due to a problem with the PS injection septum 42.
- There was no beam during the whole week and therefore no MD (both dedicated and parasitic).

22) Preliminary 2010 schedule and MD blocks (E. Metral)

- Mike Lamont presented a first draft of the 2010 schedule and the MD blocks at the FOM held on 06/10/09.
- It was said that we will have a similar situation as this year for the MDs, but 2 blocks are missing on this preliminary version. Discussions ongoing.

23) MDs request for validation tests of YASP on high energy orbit corrections in PS with beam (M. Gourber-Pace)

- This is already planned:
 - In week 43 => <https://ab-mgt-md-users.web.cern.ch/ab-mgt-md-users/2009/pmd43.htm>.
 - In week 44 => <https://ab-mgt-md-users.web.cern.ch/ab-mgt-md-users/2009/pmd44.htm>.

24) MD request for a study of a double extraction to ISOLDE (K. Hanke)

- This is a long-term study to evaluate the possibility to have two injections/extractions within a 1.2 s BP on ISOLDE cycles. While we believe that this will not be possible with Linac2, at least we are exploring if there is a possibility for the Linac4 era.
- Participant: J.-L. Sanchez Alvarez.
- Beam: MD2 in the PSB, not coupled to any machine.
- Date: 19 November 2009, agreed with ISOLDE.
- Requirements: Standard instrumentation (pick ups and transformers)
- This is already planned => <https://ab-mgt-md-users.web.cern.ch/ab-mgt-md-users/2009/pmd46.htm>.

25) Next (8th) MD planning meeting: Thursday 15/10/09, between 09:30 and 11:00 (maximum) in room 874/1-011.