Status of the machine studies

MSWG meeting, 02/07/10

1) InCA validation for PS deployment (S. Deghaye)

- 26 and 27 of April 2010.
- The SPS problem on Monday gave us even more time without other clients. For YASP, we were not able to perform all the tests because the machine wasn't available before Tuesday PM.
- Current results: We had some configuration problems in the beginning and also found a flaw in our system to support XMotif applications with InCA. The plans to deploy InCA in the PS end of June are kept.
- Next steps: Thanks to the MD work, we have a todo list that we'll have to empty before we can deploy.
- New requirements: // MD during the June block. Some exclusive periods might be needed for short periods (couple of hours). To be confirmed and discussed. As suggested by Rende, we might want to give it a try a week or two before the big bang.

2) Scrubbing run with nominal LHC beam and acceleration cycle (E. Shaposhnikova)

- 26-28 April (W17).
- The first day of MD was lost due to magnet exchange in the SPS.
- Problems: Intensity limitations due to MKDH3 (4 batches accelerated), MKP and MKE heating. E-cloud detection my microwave transmission method for 2 magnets (signal attenuation) plus lost of one power amplifier in the tunnel. Change of supercycle (with LHC filling) was completed when MD has not started yet (during the last day) - Time for setting-up should be foreseen in planning.
- Current results: Without long. damper beam losses for one batch were the same after the first night of scrubbing (27-28.04). Beam transmission was significantly improved with longitudinal damper on. Setting-up of the 800 MHz RF system (phase) has improved beam stability at 450 GeV/c. Conditioning was observed in ECMs for a-C coating and not for new StSt liner (saturation?). Presure rise for coated magnets was less than for new uncoated magnet but still higher than old (reference) uncoated magnets.
- Next steps: Increase of the LHC beam intensity above nominal (ultimate). Installation of two or four new coated magnets in the SPS ring.

3) ~ Ultimate intensity studies in the SPS for the 1st time! (E. Metral)

- Was already discussed in detail at the MSWG held on 18/06/2010. Only my (Elias) report for the transverse part in the SPS remains (as I could not participate to this meeting and then I was absent for some time). In short, this 1st MD was quite successful with respect to coherent instabilities but quite some high losses were observed as well as important transverse emittance blow-up (by a factor 2-3). Note that these blow-ups did not happen on the long injection flat-bottom but during the ramp. However, at first sight I think this was mainly due to tunes adjustments (the fine tuning remained to be done) than anything else, but this still has to be confirmed. Some additional info below (in addition to the results already mentioned by ElenaS):
- StephaneC modified the cycle (to have a plateau at the end at 13.5 GeV/c of 250 ms, i.e. the same as the others => Should be OK also when running with the LHCFAST in //), which is now called: LHC_4Inj_FB10860_FT835_2010_V1.
- Thibaut Lefevre had to disconnect the MOPOS of sextants 1-2-5 (as 3-4-6 already have some attenuators) to avoid burning them. Note that this had implications for the correction of the coherent oscillations at injection and for the chromaticity measurements.
- We injected 12 bunches with ~ ultimate intensity and the FBCT saturated around 1.4E11 p/b. This was solved by Lars Jensen and we could then see bunches of more than 1.8E11 p/b entering into the SPS!
- Next time we study higher intensities than nominal in SPS, we would like in fact to increase the intensity / bunch in steps as it is then easier for the adjustments (the nominal adjustments seem to be quite good at the moment and we should work in perturbation mode wrt these adjustments), but here it was a 1st exploratory MD.

4) PS injection tests with the LHCPROBE bunch and the kicker KFA45 in short-circuit mode (W. Bartmann)

- The aim of this MD was to evaluate the increase of the transverse emittance in case the KFA45 modules work in short circuit mode and thus increased flattop ripple, in view of the PSB energy upgrade.
- Date of the MD: 2nd June 2010, 07:00 - 11:15.
- Very good machine availability and no problems to change the kicker to short circuit mode.
- Current results: About 10% increase of the average emittance from terminated to short circuit kicker mode which agrees well with the expectations of 9% blowup in terminated and 20% blowup in short circuit mode for

the nominal 1 um emittance LHCPROBE beam type. These results look promising to use the short circuit mode not only for flat top lengthening for the ion injection but also 2 GeV proton injection.
- Next steps: Check implications of these results on other injection systems and overall feasibility of a 2 GeV proton injection into the PS.

5) Evaluation of the effect of two gap relays in the PS 10 MHz cavities (H. Damerau)

- Tuesday 15/06/2010 (08:00 - 16:00) and Thursday 17/06/2010 (08:00 - 16:00).
- Current results: The influence of closing one or two relays per PS 10 MHz cavity on longitudinal beam stability has been measured during the first part of the MD. The beam seems to be significantly more unstable in case only one relay closes the cavity gaps. During the second part of the MD, the beam induced voltage was directly measured in both cavity halves with one or two gap relays closing. As expected from the previous result, the induced voltage rises with only one relay. Analysis of the recorded data will follow.
- Next steps: Depend on analysis results of recorded data.

6) The 120 GeV/c coast cycle is ready for the UA9 studies foreseen in week 29 (E. Metral)

- On 16/06/2010 we checked that the coast operation at 120 GeV/c worked with a single LHCINDIV bunch injected and we checked that all the required instrumentation is working (see info in the ElogBook).
- Then we stopped and moved to the other coast cycle (55 and 270 GeV/c).
- REMINDER:
    - 120 GeV/c coast cycle = MD_26_120_18000_2009_V1.
    - 55 and 270 GeV/c coast cycle = MD_25.92_55_270_2009_V1.
- However, we could not do the HW compensation (it was not possible to send the settings to the HW). There were also some issues with the RF voltage trim => Seems to be due to the manip from Stephen Page on the ROCS. We told him to come back. At 22:50 we stopped as we could not inject due to the Steering Program not working…

7) 150 ns bunch spacing LHC beam production in the PSB-PS (S. Hancock)

- Done in Week 23 (// MD).
- Current results: This beam requires very small longitudinal emittance from the Booster and profits from the single-batch transfer developed last year. At the outset there were concerns about splitting such small bunches, about crossing transition, and about keeping them stable. The single splitting at low energy was acceptable and transition crossing proved straightforward, but quadrupolar coupled-bunch instabilities developed during acceleration. We have no direct means to fight these. We have strong evidence to suspect they are driven by the 40 and 80MHz cavities, which explains why the "bricolage" one-turn-delay feedback around the 10MHz system had no effect. Nevertheless, the beam (12 bunches at ejection) is ok up to two-thirds nominal intensity. Thereafter it degrades due to the coupled-bunch instabilities. We did not go further than nominal intensity.
- Next step: Since the SPS anyway will need to blow up this beam, we should have a joint MD to see what level of beam quality degradation they can tolerate.

8) 150 ns bunch spacing LHC beam in the SPS (E. Metral)

- K. Cornelis already reported the “final result” at the last MSWG meeting held on 18/06/2010 (12 bunches with ~ 7-8E10 p/b can be provided by the SPS).
- This MD was performed on LHCFAST3.
- The BCT in the PS was ~ constant at ~ 100E10 p with 12 bunches => Should correspond to ~ 8.3E10 p/b.
- The BCT in the SPS was also ~ constant at ~ 100E10 p with 12 bunches (with 5 empty buckets in between) => Should also correspond to ~ 8.3E10 p/b.
- If we looked at the FBCT it seemed we had a lot of bunches in between and it gave lower values of ~ 7E10 p/b. It seems in fact that this was a FBCT problem (similar to this one in the past: https://emetral.web.cern.ch/emetral/SPSmachine/PossibleProblemsWithFBCT.htm) which needed to be re-adjusted (confirmed also by T. Bohl, who did not see satellite bunches in between the main bunches).
- The transverse emittances at top energy were ~ 1-1.5 microm (rms, norm).
- Preliminary results concerning the longitudinal parameters (from T. Bohl, 16/06/2010):
    - 2010-06-14
        - Nq(t=0): 100e10/12=8.3e10
        - bl(t=0): 3.5ns-3.8ns
        - bl(t=50ms): 2.8ns-3.0ns
    - 2010-06-15
        - Nq(t=0): 95e10/12=7.9e10

- Nq(t=4500ms): 90e10/12=7.5e10
- bl(t=4500ms): most reproducible conditions with TWC800 on and blow-up off/on
    a) blow-up off, TWC800 on: min: 1.2ns, max: 1.3ns-1.4ns
    b) blow-up on, TWC800 on: min: 1.55ns, max: 1.65ns-1.70ns

- The results of these MDs should be discussed at the next LMC meeting which will take place next week on July 7th and at the MSWG meeting which will take on July 30th.
- Next step (which is the one mentioned by S. Hancock in point 7)): Since the SPS anyway will need to blow up this beam, we should have a joint MD to see what level of beam quality degradation they can tolerate.

9) New (with the new control) SPS scraper tests (E. Veyrunes)

- Only control change:
    - Cables, Motors (collimator type) and FESA class
        - Old class : BOSCRA>SCR50S.
        - New class : SPSSCRAPER>BSHV.51659.
        - New Server : cfc-ba5-tscrap
- Application: SPS CONTROL>SPS Equipment Control>SPS Beam Obstacle>New-Scraper. In the same spirit as MKP and MKE kicker application.
- Delay: (V) 210ms - (H) 230ms.

10) Single-batch (LHC25) intensity limit at PS injection: joint PSB/PS MD (S. Hancock)

- This // MD has been completed:http://elogbook.cern.ch/eLogbook/event_viewer.jsp?eventId=1295184 (=> Single-batch LHC 25ns injected on a 3.6s cycle. One bunch was provided from the Booster with nominal intensity, but the single-batch style meant that it was crammed into 0.9eVs. This gave more than 1.6E12 in 135ns (matched at 40kV rf) compared with the usual 180ns (matched at 24kV rf) when the Booster delivers a pure h=1 beam in the double-batch case. Despite the increase in longitudinal density, transverse blow-up is only ~10% in both planes by the end of the long flat bottom. There was no discernible longitudinal emittance growth. The injection plateau will be 1.2s shorter for single-batch operation of course, so any concerns about transverse emittance dilution now get pushed upstream to the Booster which must produce two of these bunches per ring and not just one).
- This beam was initially unstable in the PS due to electronic rather than accelerator physics reasons. Once this was understood and fixed the MD could proceed, but, without opening the can of worms that is the cross-calibration of the Booster and PS flying-wire scanners, any fast emittance dilution at the start of the flat-bottom remains hidden. The conclusions are:
    1) The follow-up of this topic shifts to the Booster since it is there that the single-batch 25ns intensity limit will be defined.
    2) The modified PSB:LHC50 user which provided the single-batch single bunch has been archived, so this user is free for Alan to begin preparing for the 50ns single-batch high-intensity studies of next week.

11) LHC50 1-batch high-intensity studies

- LHC50 was produced in the PSB with ~ 240E10 p in 2 bunches (h2) within 0.9 eVs and with transverse emittances smaller than 3.5 microm => Reported by J. Tan at the last FOM.

12) LHCINDIV with maximum intensity in the PSB

- LHCINDIV was produced in the PSB with ~ 2.4E11 p/b, 0.3 eVs and transverse emittances smaller than 1 microm => Reported by J. Tan at the last FOM.

13) PSB Ring 4 Instabilities (G. Rumolo)

- From yesterday's PSB logbook: Ring4 MD on losses at C640 and extraction on NORMGPS. There were a couple of problems noted with high intensity on the isolde users: 1) Losses around C640 and C675, 2) Our old friend the loss during the last ms in the machine. The first problem was solved by reducing the gain of the phase loop between the cavities (non-ppm hardware change), and increasing the gain of the TFB. Once we had done this, the beam was accelerated up until the last few ms, when the "old" losses re-appeared. The losses at extraction we now believe we have a solution, based around a change of the vertical tune at extraction, a modification of the function for the TRIM1+4 supply, and a modification of the radial position before synchro. a) The TRIM function was reduced to 90% of its original value, and we could deposit the beam a bit closer to the preferred orbit. The MRP was modified to remove a transient seen when the syncro process started. b) A check by modifying the horizontal Q Strip function so that it was active from C780 until extraction, proved that moving the tunes closer together seemed to solve the problem of losses in the last ms. After various tests,

we modified the tune at extraction via the cycle editor, so that the vertical tune approached the horizontal tune, and we could get 13 turns or 9.5E12 accelerated and extracted without any losses. The vertical tune value was 4.21 and is now 4.18, while the horizontal remains at 4.17. Since we have introduced these changes on NORMGPS, we have not seen one loss on R4 at extraction. The Easy Wirescanner application proved to be VERY useful in helping to diagnose the problem we had, as did the orbit measurement application DODO (well, once we'd rebooted the work station!). We think we can now consider this problem solved at least up to 9.5E12. Due to a lack of available cycles these changes HAVE NOT been copied to NORMHRS yet, but this will be done tomorrow.

- Update from today: When pushing the intensity to 1.05E13 on R4 NORMGPS (as no space in cycle for HRS), we can still see losses from 1E13 up. After some more fine tuning of the working point at extraction, we managed to accelerate 1.05E13 without triggering the BLM (only occasionally).

14) General news (E. Metral)

- We planned to extend the Technical Stop of week 29 from 12 h to ~ 24 h (minimum time estimated in the past for the ecloud liner exchange). The idea would be to keep the 12 h Technical Stop in the PS and use the other 12 h to perform PS dedicated MDs.

- The 24h Injector MDs of weeks 32 and 39 will have to be floating, as these stops are not required anymore by the LHC (the cryo is working well!).