Status of the machine studies

APC meeting, 26/09/08

1) Achieving nominal longitudinal parameters at 450 GeV/c in the SPS + LHC beam at different intensities with constant longitudinal parameters in the SPS + Study of controlled emittance blow-up, reproducibility issue and dependence on 800 MHz settings = Continuation of what was started in week 28 (T. Bohl)

- Intensity of injected beam was about 8% less than nominal.
- Used up to 4 batches of 72 bunches of nearly nominal intensity - TWC 800 MHz phase offset scans and bunch tilt measurements - scan of noise parameters - beam quality data acquired, analysis ongoing.

2) PS-SPS transfer (capture/flat-bottom losses) + check LHC beams with 50/75 ns bunch spacings in the SPS (T. Bohl)

- Intensity of injected beam was about 8% less than nominal for 75ns bunch spacing and close to nominal for 50ns bunch spacing.
- Several hours lost due to MKD problems. Not sure about the cause why it was not possible to reset the MKD: controls problem, vacuum problem, ...?
- 75ns beam of nearly nominal intensity - bunch length growth along all batches - TWC 800 MHz phase offset scans and bunch tilt measurements - scan of noise parameters - beam quality data acquired, analysis ongoing 50ns bunch spacing - larger outgassing in MKD than with 25ns or 75ns bunch spacing - TWC 800 MHz phase offset scans and bunch tilt measurements - scan of noise parameters - beam quality data acquired, analysis ongoing
- Next steps: The bunch length growth and the outgassing issue will need some follow-up.

3) Setting-up of the beam to be used for BBLR in the SPS (this beam was only set-up and used in the SPS at 26 GeV/c until now) (T. Bohl)

- When beam was available (some time after 11:00, 25/08), problems with Freq. Program DSP on MD1 related to LHCFAST (rephasing). When trying to accelerate TX3 trips were provoked. Problem solved around 1330H. This problem also screwed up PS/SPS synchronisation. Beam ok since 13:30.

4) First test to produce TSTLHC25/LHC25 without SYNCDDSMHS (H. Damerau)

- One single ring from the booster at low intensity corresponding to about 20% of nominal per bunch to avoid losses while working on the beam control.
- The proof-of-principle to produce an LHC-type (25 ns) beam without switching from the Multi Harmonic System (MHS) to the DDS oscillator has been demonstrated. The high energy manipulations and the ejection synchronizations have been tested using a frequency multiplied MHS source.
- Next steps: Short tests of hardware (in parallel) might be required during this year's run to further advance.

5) Studies on beam-beam effect for the LHC upgrade: beam-beam compensation with a wire and Early Separation Scheme (F. Zimmermann)

- Work on the MD1 cycle on the flat top at 37 GeV/c with 12 bunches, 25 ns time separation, ~ 2e10 ppb.
- Problems encountered: 1. On the 29 August there for three times the beam was off for intervention on the machine: each stop lasts at least 30 min; 2. On the 3 September around 17:00 the main power supplies of SPS tripped for a thunderstorm; 3. The BBQ did not work properly (we tried to use it for measuring the chromaticity).
- Current results: 25-08: Experiment setup; 26-08:We performed a compensation tune scan and a compensation current scan: we confirmed that the optimum current on the second wire for having compensation is 210A for its nominal position and the compensation shows a significant tune dependence; 29-08: power loss scan (distance scan at three different tunes): there is a significant dependence of the losses from the tunes; 01-09: Current scan at LHC tunes at 5, 6,7, 9.5 sigma: the losses at 5 sigma are a significantly higher than the 6 sigma separation; considering the SPS case as calibration (but ignoring its single encounter at 3.5 sigma) it seems (preliminary result) that LHC could not work with more than 4 encounters at 5 sigma; 03-09: We performed a tune scan with 250A at 5 sigma losses can vary by more that one order of magnitude with changing the vertical tune; from the chromaticity scan at 250A and 50A we can conclude that chromaticity has not a significant impact on a time scale of a few seconds (.3125 .285) seems the best tune in SPS for the long range beam-beam effect: it seems quite far from the expected LHC optimum tune for the head-on beam-beam effect. We performed a distance scan at the optimum tunes and checked the noise level of the measurements.
- Next steps: The optimal compensation being obtained with a discrepancy by 20% on wire current, the transverse position of the (moving) compensator should be suspected. Compensation of an incorrect position by a weaker excitation current is liable to produce features such as the observed puzzling tune dependence of

the compensation. The position of the compensator should be investigated to obtain identical perturbation to the beam by the 2 wires excited at the same current level. The tune scan in compensation mode should then be reproduced. We have to post process the acquired data and plan a tracking campaign using this data to benchmark the simulations. A proposal for an implementation of the wire in LHC will be studied with parameters compatible with the observations in these MDs. For the D0 at 14 m, the minimum separation will be increased from 5 to 6 sigma. More refined analysis is needed to assess the possibility of reducing to 5.5 sigma or less.

- New requirements: It would be extremely useful to check the effect the compensation and the reduced encounter distance on a longer flat top to see if the loss that we observed are a steady state phenomenon or a transient. It would be interesting to do the next experiments with the same mechanical aperture limitation (now it is a function of the wire position): a collimator a 5 sigma. To obtain longer lifetimes, higher energy would be a great advantage. We shall investigate the availability of two stronger orbit correctors (those of the SppS) to work at higher energies. To implement a remote control system for the moveable wire would be useful too.

6) Testing a modified MHS with an additional serial input (H. Damerau)

- One single ring from the booster at low intensity corresponding to about 50% of nominal per bunch to avoid losses while working on the beam control.
- A modified type of Multi Harmonic Source (MHS) with an additional phase offset input has been successfully tested with beam. Triple splitting on the TSTLHC25 user has been demonstrated by correcting the phase errors between the different harmonics using the new phase offset input.
- Next step: No further MD time required this year.

7) Test of a possible transition crossing phase feed-forward on the MHS system (H. Damerau)

- One single ring from the booster at low intensity corresponding to about 50% of nominal per bunch to avoid losses while working on the beam control. Nominal AD beam has been taken at the end of the MD.
- The proof-of-principle of the benefit of a transition crossing feed-forward on the MHS system has been shown with a low intensity TSTLHC25 beam. The feed-forward significantly reduces phase oscillations after transition crossing the RF cavities have to follow when the phase loop is switched to the new synchronous phase. The measurements with the AD beam are not fully conclusive for time being.
- Next steps: Short tests of hardware (in parallel) on various beams might be required during this year's run to check if a feed-forward can be implemented in PPM.

8) Start of the PSB studies of the LHC beams in the LINAC4 era (A. Findlay)

- We managed to make a first attempt at an H=2 beam, where we split the beam and synchronise the beams with an uneven bunch spacing. This worked well, but we proved that we would have to develop a new method of synchronising, for an H2 beam with an H1 synchro. Until the present day, this has never been required.
- Next steps: The new synchronisation process will have to be investigated and tested, and fine tuning of the beam parameters to match specifications carried out.
- New requirements: Parasitic MD time on a regular basis on the TSTPS user in the PSB, when the specialists are available. This should, hopefully, not require dedicated MD time.

9) Synchronization studies on TSTLHC75 in the PS (H. Damerau)

- Used TSTLHC75, nominal intensity per bunch, 1-4 rings from the booster.
- The re-bucketing (h28 -> h84) of a TSTLHC75 beam (16 bunches) to an h84 bucket directly derived from the (simulated) SPS RF trains has been tested (instead of a re-bucketing to an h84 bucket being synchronized to the SPS trains). First measurements of bunch parameters at extraction indicate that the bunch position error is at least as small as with the nominal synchronization scheme. The fact that the beam is in open loop for a few ms does not seem to compromise longitudinal beam quality. To be verified together with the SPS.
- Next step: MD together with the SPS on Friday 03/10 (08:00 - 18:00).
- New requirements: If a three basic period cycle is available in the PS on 03/10/2008, tests should be done with LHC75 and with the 50 ns variant (PS user: TOF, PSB user: LHC25A/B with 50% intensity archive).

10) PS transition studies (S. Aumon and W. Bartmann)

- The transversal wide band PUs PR.WBUSU94 in particular, was not used because of noise. Trigger problem with the wall-current monitor signal PA.WCM03-AS, also noisy according to G. Metral. Unfortunately, we didn't measure bunch length at high intensity for cause of injection efficiency in the PS.
- Bunch length around the transition crossing at 3 intensities: 1.10^12, 3.7*10^12 and 1.5*10^11. On the very preliminary results, we can see clearly the bunch length mismatch around the transition time.

- Next steps: Observation of instabilities around the transition with the transverse wide band PUs and maybe a bunch shape measurements at high intensity.
- New requirements: The same.

11) Transverse feedback in the PS (F. Blas)

- The idea was to test the efficiency of the PS transverse damper by measuring the transverse decay time after excitation.
- We were not able to create a sufficient coherent perturbation on the 3.5 GeV/c plateau of an SFTPRO-like beam using a single tone excitation.
- New requirement: 2 times 8h in // MD, on a 1.4 GeV plateau, no chromaticity, no H/V coupling, 2 parasitic cycles per supercycle.

12) RF splitting h8/h16 at 14 GeV/c in the PS for MTE extraction (H. Damerau and S. Gilardoni)

- It seems this MD was not successful. Therefore, the new idea was to change the offset between the PS and SPS (as the MTE cycle is longer that SFTPRO by 75 ms, i.e. the PS extraction is at 845 ms instead of 770 ms): the PS team changed the timing on MTG to adjust the synchronisation between PS and SPS (SX.CZERO-CTM: initial value = 1870 ms, new value = 1945 ms). No change was required in the SPS side. This was done on TH 25/09/08 at ~ 18:00 and worked as expected. Note that some work still has to be done for the LHC cycles (as the injection time is 425 ms for protons and 525 ms for ions).

13) Controlled transverse emittance blow-up in the SPS with LHCPROBE (F. Arnold Malandain and E. Métral)

- We succeeded to blow up the LHCPROBE bunch in the vertical plane from ~ 1 μm to ~ 3.5 μm, without emittance blow-up in the horizontal plane, and inversely. We did not succeed to do it in both planes using only the transverse feedback (in excitation mode) with octupoles.
- The next step (short term) will consist to use linear coupling between the transverse planes to try and obtain a round beam of ~ 3.5 μm at SPS extraction.
- On the longer term, one should do the same thing with many bunches.
- Simulations should also be performed during the shutdown to guide the measurements as many parameters can be varied…

14) Study of the BSI of T6 in the SPS North area (E. Métral)

- Studies done with/by Stephane Cettour Cave (OP).
- After an MD performed on 12/06/08, to study the radiation levels in the TT20 transfer line (in particular close to the splitters), it was found that there might be a problem with the BSI (single foil in Titanium to measure the beam intensity) of T6: it is the BSI 251010 which is used for the intensity shown on page1, in fact the losses which are called "Loss T.L."). By moving the beam in the horizontal plane on T6 at -10 mm (on the BSGH.250611), the losses on the Transfer Line decreased by ~ 4% (from ~ 17% down to ~ 13%). A possible interpretation was that this measured intensity increase was due in fact to the foil degradation in the centre.
- To check this assumption, some measurements were performed by moving the beam horizontally (on the BSGH.250611) and vertically (on the BSGV.251009) by ± 10 mm. The initial "Loss T.L." was at 9.7 % whereas, when the beam was moved, it decreased by ~ 2 % (i.e. the "Loss T.L." became ~ 8% in all cases), which confirmed the suspicion.
- Next step: Discuss with BI people to see if one can change this foil to have more reliable intensity measurements.

15) Status of the SPS BWS on 22/09/08 (E. Métral)

- The 517 (linear wire scanner which should be used for the LHCPILOT and LHCPROBE beams, as it is at small horizontal dispersion) is still not working, even though it is on the same old server as the other ones which work! Jan and Ana changed several things but do not understand yet what happens: The server starts and then dies…
- In LSS4, the old electronics is in 414 and the new one in 416. The strategy is the following: Elias will send an email to Jan (done) to ask him to prepare the electronics for the SPS BWS416 (no answer yet). Once it is done Ana will then set the values for the 416 and she will come at the CCC to make some measurements with the new application. I will make some with the old application with the 414 to compare and hopefully found almost the same result...