Status of the machine studies

MSWG meeting, 28/08/09

1) Localization of SPS transverse impedance (R. Calaga)

- Only baseline measurements were done as in the previous years, because the first of the two days of MD (July 2nd and 3rd) was cancelled due to a major water leak in the CNGS extraction line.
- Reminder on the initial plan: The main goal of these experiments was to add 4-bumps (5, 7, 9) mm, vertical (and/or horizontal) and measure the corresponding impedance as a function of bump height. This was to be compared to the baseline SPS orbit to help localize the contribution of the local bumps, which were placed in locations determined from previous experiments as potential impedance contributors. The longitudinal emittance was quite small (full bunch length ~2.5 ns) compared to the past on the same SPS cycle (MD1). It was concluded that a scan of the baseline SPS and another scan with increased longitudinal emittance was to be performed. A detailed intensity scan of baseline orbit from 1e10 to 1.1e11 was performed and a similar scan was also accomplished with slightly larger longitudinal emittance. The orbit bumps were postponed to a later date.
- New requirement: Another session to perform the measurements with orbit bumps => It has already been planned for week 38 (https://ab-mgt-md-users.web.cern.ch/ab-mgt-md-users/2009/pmd38.htm).

2) Approaching the SPS working point close to the 1/2 or integer resonances (J. Wenninger)

- MD on July 23rd on the MD1/ 26 GeV cycle to understand the dynamics of the beams when the SPS main power converters trip and the beam is lost in an uncontrolled way.
- 12 bunches of ~ 10^10 p/b were used, the MD was successful and less than 1 hour was lost in total.
- We looked at the evolution of orbit and trajectories when approaching and later when crossing the integer (and half integer). When the tune is moving at the highest speed possible with the PCs we were able to get up to 1/2 (most of the time 1/3 to 1/4) of the beam through the integer resonance Qh/v=26. When the tune moves at a sufficient speed the trajectories pass through large (~10-15 mm) transients during the crossing, often resulting in (large) emittance blowup. Although the tune change during a real failure is even 10 times faster, this will provide very good data for X-checks with MADX. It also shows that in a real failure, a substantial amount of the beam could actually make it through at least one integer resonance, even when the intensities are much larger. We also compared the effect of the 26 and 24 resonance by tuning and injecting the beams with tunes of Q=24.xx, since this resonance is predicted to be very strong. The systematic Q=24 resonance proved to be really strong, and the beam would barely survive on the nominal 0.13/0.18 working point - no need to say that we did not manage to get through Q=24.
- The new HW and SW for a fast turn-by-turn position interlock is progressing well, but a few issue need to be resolved by BI related to false triggers on un-captured beam at injection. But it will take another month or two before the system could 'participate' in such an MD to demonstrate the ability to quickly and reliably dump the beam before it is too late…
- New requirement: Another session => It has already been planned for week 40 (https://ab-mgt-md-users.web.cern.ch/ab-mgt-md-users/2009/pmd40.htm).

3) BBLR => Compensation and excitation studies with the SPS wires (G. Sterbino)

- MD performed on July 7th and 8th.
- Some difficulties to obtain the required emittance. The emittance blow-up (using the transverse damper) took some time and we could not perform the excitation studies. We had problems in measuring the emittance (solved by Ana Guerrero).
- We had problem in inverting powering the BBLR5177M. After the request of SPS OP the electronic card of the power supply was changed and the problem was solved. We performed a new compensation scanning the vertical tune. The results show a compensation efficiency, which is smaller than expected (and observed in 2008 MDs).

4) BBLR => Excitation studies with the SPS wires (G. Sterbino)

- MD performed on July 9th.
- No specific problem.
- We performed excitation studies: a distance scan at 200 A (equivalent, for the measured SPS emittance, to 12 LHC parasitic encounters at the ultimate distance). We performed a current scan at a separation of 5 and 7 sigma. We observed that the time constant of the losses is much larger than the observed time (~5 s). The blow-up of the emittance worked well.

5) BBLR => Excitation studies with the SPS wires (G. Sterbino)

- MD performed on July 13th.
- Problem with the beam vertical emittance (we had 2 um rad instead of the required 3 um rad).
- We started with a delay 1.5 h (our cycle was not available). The vertical damper was not working properly so we could not increase the beam emittance. The PSB had a lot of problem so we had many MD cycle without current. In YASP we performed a pi+3pi bump: even if the bumps were activated on the flattop, we had large losses during the ramp (where the orbit corrector too started to ramp). We tried to solve that problem via the Trim Editor (shifting of 800ms the ramp of the orbit corrector) but this generated inconsistencies with YASP and we had to re-launch it.
- We tried to perform a current scan at 7 sigma but we managed to measure only at 250, 200 and 150 A.

6) BBLR (compensation with full wires) with controlled transverse emittance blowup on the 120 GeV/c cycle (G. Sterbino)

- MD performed during the 2nd Long Injector MD block of week 29 with coasts.
- Very nice results could be obtained during the same coast, revealing the improvement of the beam lifetime with compensation etc.

7) Beta-beating and coupling in the SPS (R. Tomas)

- MD performed on July 21st.
- LHC25 beam with 12 bunches.
- Set-up went very well between 8 and 10 am and some baseline data was taken between 10 and 11 am. Between 11:00 and 4 pm there were major problems in the SPS and other problems in the PS concerning the beam preparation. Between 4 pm and 8 pm we took quite good data (off momentum beta-beating at Qx=26.47, coupling correction at different integer V tune, Qy=27.18).
- When restoring all the machine settings we found that the knob (based on vertical orbit bumps) we had just generated (system BETABEAT / name "again") and used to correct coupling could not be restored to zero. Jorg managed afterwards to get the knob out again with the trim.
- The study of the simultaneous coupling and vertical dispersion correction was not yet done. We achieved the coupling correction using orbit bumps but did not have time for combining with vertical dispersion.
- New requirement: Another session => It has already been planned for week 38 (https://ab-mgt-md-users.web.cern.ch/ab-mgt-md-users/2009/pmd38.htm).

8) Parallel MD LHC75 Single Batch Transfer PSB to PS (A. Findlay)

- MD performed on July 22nd and 24th.
- Confirmation of the longitudinal & transverse parameters for LHC75 (PSB:LHC75B-> CPS:TSTLHC75) nominal beam in the PSB, followed by adjustment of the extraction trajectories and injection into the PS. Capture, splitting and acceleration in the PS was successfully carried out, and the longitudinal parameters confirmed to be within specification. A scan of the C02 voltage at extraction (with 8kV on the C04) to obtain the correct bunch spacing in the PS was done, resulting in a CCV of 3kV being requested by the PS crew. A scan of the PSB kicker timing was undertaken to ensure the optimum extraction kick was used. The modification of Tomoscope was tested for this new mode of operation where we have H2+H1, and found to be fully satisfactory.
- Next steps: A check of the transverse emittances in the PSB and PS with 3kV on the C02 system must be carried out. The high energy splitting will need to be correctly set up in the PS. Use a copy of this beam on the PSB:LHC75A user to develop the single batch LHC50 ns variant, and send this to the CPS:LHC75 user to confirm that sufficient longitudinal blow-up can be done in the PS to perform triple splitting. Confirmation of all emittances for this beam in both machines. Finally, the injection plateaus of CPS:TSTLHC75 and CPS:LHC75 can be shortened to the minimum and a new common extraction time established (for all LHC-type users).
- New requirements: Further parallel MD sessions will be required in the PSB & PS to finish the 75ns version and develop and test the 50 ns variant.

9) Setup of the LSS6 TPSG (J. Wenninger and B. Goddard)

- MD performed on July 30th.
- The setup of the LSS6 TPSG (with the LHCFAST2 cycle) could not be completed.
- After about 2 weeks without 450 GeV LHC cycle in the SPS the beam could be quickly reestablished. Unfortunately problems with the PSB septum lead to frequent and lengthy downtime. In the 2-3 hours of useful beam time, we could establish that the position of the beam wrt to the TPSG absorber in front of the

MSE6 is correct (by scanning MKE voltage), but we could not start the actual measurements to confirm (or not) that the MST/MSE are properly shadowed by the TPSG.
- Next step: Scan of girder positions and check of protection settings.
- New requirement: Another session => It has already been planned for week 39 (https://ab-mgt-md-users.web.cern.ch/ab-mgt-md-users/2009/pmd39.htm).

10) PS injection studies (S. Aumon)

- MD performed on July 29th.
- We used the ring 1 and the transfer line to make optics measurements, check the recombination of the rings and test a new optics, which minimize the beam size at the septum 42.
- The polarity of the BTPQNO10 was not correct. However, we made a test and we compared with the MADX model. With this polarity, we expected a very large beam size in the vertical plane and this is what we observed.
- Next steps: Since the polarity of the BTPQNO10 was wrong, we could not check if the beam size is reduced at the end of the line. To correct it, Serge Pittet needs more time.
- New requirements: Another MD is needed with the correct polarity of the BTPQNO10 to check the validity of the new optics => This was planned and done during last Wednesday's MD (https://ab-mgt-md-users.web.cern.ch/ab-mgt-md-users/2009/wmd35.htm).

11) New pick-up in SS76 for the beam control in the PS (S. Aumon)

- MD performed on July 13th.
- Several combinations of Pick-ups were tested including the new one in SS76. A good solution would be to leave the PUs 22-36-76-96 in the beam control. This new pick-up configuration for the PS radial loop reduces the orbit excursions at transition. This is the present status of the ongoing data analysis.
- Next step: It might be good to review the results and see whether this could be put in operation => Future presentation at the MSWG (This would require a dedicated MD and strong OP and RF support for taking references and restoring all the operational beams during the MD).

12) Double RF system and ecloud studies in the SPS (E. Chapochnikova)

- MDs performed during during the 2nd and 3rd Long Injector MD blocks of weeks 29 and 33.
- Double RF system:
  - 1st MD:
    - Measurements of longitudinal emittance blow-up in single and double RF system (bunch shortening and bunch lengthening mode) at 26 GeV for variable bunch intensity (LHCindiv).
    - Some problems to have low intensities (below 5E10). OP team suggested to take the probe beam.
  - 2nd MD:
    - Measurements of instability growth rates in double RF system after 800 MHz phase calibration with beam at low intensity.
    - Had probe beam at low intensities (2-5 E10).
    - Due to many different problems not much MD time was available for us.
- ecloud studies:
  - 1st MD:
    - Intensity limitation due to ZS (already for 3rd batch).
    - Measurements of pressure in coated and uncoated magnets for different conditions: transverse bump, RF voltage on flat bottom, batches with a hole.
  - 2nd MD:
    - Measurements of e-cloud signal (scanning) in liners for low B-field.
    - Pressure for different batch positions in the ring.
    - Intensity limitation due to ZS (we had 3 batches max).

13) Test of a new optics for the BT-BTP Line and PS injection and matching measurements with ions (LHCION in the PS) (S. Aumon)

- MD performed on August 26th.
- Problems with a injection quadrupole of the LEIR and the RF of the linac. Problems with SEMfils in SS48-52-54 for the ions. The measured profiles were negative, although those with the protons worked fine. We called Ana and she managed to find a solution.
- We managed to finish the measurements. However, the new optics does not reduce the injection losses because the BTPQNO40 cannot pulse below a current of 50 A. As a result, we put it to zero. But, even if this

quadrupole has a small current, it is enough, according to the MADX simulation, to reduce the beam size in vertical in a such a way that it should pass the septum 42 without touching the aperture. We run a simulation with this quad to zero and what we observed on the MTV screens in BTP looks like what we expected with the simulations.

14) InCA: validation of the latest developments (S. Deghaye)

- MD performed on July 29th.
- Many other MDs including some unplanned ones in the PSB made the number of available consoles limited which made difficult our scalability tests.
- Latest developments validated but as the number of hours we can work with the machine is still limited a test bench will be put in place.
- Next steps: Carry on the developments and prepare for the next MD that will be more critical as we plan to validate some important features such as the archives and references.

15) Further developments on the Beam Quality Monitor (G. Papotti)

- MD performed on August 5th and 7th.
- Any LHC-type beam was acceptable.
- I am at the final stages of the development of the BQM for LHC beams in the SPS. Until August 09 I could take advantage of other parallel MDs, and work parasitically, without the need to ask for dedicated MD time. During week 32 no other parallel MDs were scheduled with LHC beam, so I requested some for the BQM, in order not to stop the development completely. I worked in particular on setting up the new trigger units (two VTUs) and stability algorithm verification. To be noted that on Friday the MD mastership was taken over by the LHC EICs (which was absolutely no problem for me!).
- Next steps: Some checks on improvements on the stability algorithm will be needed soon, probably to be tested with a probe or pilot bunch. Additionally the time spent for the calculation will have to be checked with as many bunches/batches as possible (ideally 4x72, nominal, any intensity). When the module for the connection to the interlocks will be installed, also that will have to be tested.

16) Next dedicated MDs (E. Metral)

- A MD planning meeting already took place on August 14 to discuss the next MDs and in particular those of weeks 38 and 39. The current planning is the following: .
  - https://ab-mgt-md-users.web.cern.ch/ab-mgt-md-users/2009/InjectorLongMD38.htm.
  - https://ab-mgt-md-users.web.cern.ch/ab-mgt-md-users/2009/InjectorLongMD39.htm.
- The planning will be finalized during the next MD planning meeting on 07/09/09 at 16:30 in room 874-1-011.

17) Next TI2 & 8 tests (E. Metral)

- During the week-end of week 39, only protons will be taken. Ions will be taken on Monday => https://ab-mgt-md-users.web.cern.ch/ab-mgt-md-users/2009/TI2and8testsWeekend39.htm.
- These beams will checked in the injector chain on Thursday and Friday just before the week-end: https://ab-mgt-md-users.web.cern.ch/ab-mgt-md-users/2009/pmd39.htm.

18) Strategy for setting-up of single-batch LHC beams in PS (R. Steerenberg and S. Hancock)

- **Rende (18/08/09)**:
  - After several discussions and a decision in the MD meeting of August 17th, we agreed on a change of strategy for setting up of the single batch 75 and 50 ns beams in the PS. Initially we would set up the 50 ns single batch injection beam, and adjust the low energy blow up time until the correct longitudinal beam characteristics were obtained, which would then learn us what the extraction timing would need to be. The PS RF team is confident that the additional time required for the blow up at low energy for the single batch 50 ns beam is 25 ms, which means that the extraction timing will be 1220 instead of 1195. In order for the SPS to be able to use these single batch beams, they will need to change the delay in all their LHC type cycles accordingly, but this also means that we have to put this same extraction timing of 1220 on all 2 bp LHC type users (LHCPILOT, LHCPROBE, LHCINDIV, TSTLHC25,....) 2420 on our 3 bp LHC users (LHC25).
  - Strategy:
    - All PS LHC type beams should be archived under the present conditions.
    - The PS can then start changing, adding 25 ms to the flat bottom, all the user that are not required by the SPS until wk37. The only beams required are LHCPROBE (wk34, wk37) and the MD4 (wk36). This means that we can start to change the following users:

1) LHCPILOT
2) LHCINDIV
3) TSTLHC25
4) LHC25

- The users TSTLHC75 (75 ns version) is ready with the new extraction timing and the LHC75 (50 ns version) will be set up with this new timing for use in week 38.
- This is also the occasion to ensure that the magnetic cycles, PFW settings and extraction settings are identical for all the LHC type users.
- The SPS should prepare the changes for implementation and tests in wk36 or 37. At the same time the PS will adapt the remaining cycles LHCPROBE and MD4. During that week we should test each of the cycles in combination with the SPS for validation.

- **Steve (20/08/09)**:

- There are a couple of preconditions that should be satisfied in order to proceed described above.

1) Firstly, since the 75ns single-batch variant is the only one that has seen beam, it is important to validate the transverse aspects of this user. We don't anticipate any problems, but this must done so that TSTLHC75 can be declared the template for all 2bp LHC-type cycles.

2) Then we need to recover the 50ns variant (which was introduced barely a year ago as an MD user on TOF - in extremis! - and which has not been executed since) from archive and modify this in the single-batch style.

- As point out, normally we would have performed these tasks in parallel with each other in order to be sure about the blow-up requirements and hence about the extra cycle length. Lack of users simply means that we have had to decide to add 25ms and get on with it. However, point 1 cannot be bypassed.
- Finally, in view of the "natural order" of these modifications which must be carefully implemented with the proper consultation of all specialists in order no to break existing beams, I should like to make it clear that there is no guarantee that the 50ns single-batch variant will be available in time for MDs.

19) Repositioning of LHC BLMs and scintillators in the SPS during last Wednesday's access:

- The main purpose was to try and get a good picture of the losses at least in Sextant 5.
- Displacement of the LHC BLMs:
  - LHC BLM 7 to QD23.
  - LHC BLM 2 to QF22.
  - LHC BLM 5 to QD21.

20) Ions in the SPS (E. Metral)

- See Django's report for the main achievements.
- The // cycle is used almost everyday in a supercycle composed of 1 SFTPRO and 4 CNGS (and the // ion cycle).
- During the dedicated MD of week 33, we were not sure about the correct coupling of the different machines (LEIR, PS and SPS). To understand it better we wanted to read the C0 of the SPS machine (called Phase.c = 1735 ms) with the Passerelle. This had the unexpected consequence to change its value and the MPS tripped. It was then not possible to modify it again afterwards. Finally, after several hours, it was possible to send the correct value to the HW with the Passerelle, which is still a mystery.
- A simple worksheet is now available to enter the correct coupling between the different machines in the CBCM:
https://ab-mgt-md-users.web.cern.ch/ab-mgt-md-users/CouplingBetweenTheDifferentMachines/ComputationOfTheMachineCouplingOffsetsForTheCBCMProgrammation.xlsx