MSWG Meeting #8, 29-June-2018

Present: S. Albright, F. Antoniou, F. Asvesta, H. Bartosik, M. Barnes, J.F. Comblin, H. Damerau, G.P. Di Giovanni, G. Favia, V. Forte, M. Fraser, S. Hirlander, V. Kain, E. Koukovini-Platia, A. Lasheen, T. Lefevre, B. Mikulec, G. Papotti, F. Velotti.

The minutes of the last meeting were approved. The proposal for the recabling of the SPS octupoles was presented to the IEFC meeting made and ECR's to be written.

Agenda:

Link to the Indico Event:

- Approval of minutes – Hannes Bartosik
- Status of operational Beams – Machine supervisors
- Main presentations:
    - Status update: high intensity LHC beams in the PS – Heiko Damerau
    - PSB / PS optics measurements – Piotr Skowronski

Status of operational Beams

PSB – Jean-Francois Comblin

OP beams OK and good beam availability at 98.8%. Restart from TS went well after fixing TFB issue on R2 and a timing problem on the distributor on R1. The White Rabbit B-train distribution has been restarted after a change of a LLRF card on R4 and the new TFB is progressing with new HW and FESA class. Beams for LHC special runs (W25/26) have been checked and a request has been made to re-check parameters of the cycles for the BSRT, BGI vs WS calibration next week.

H. Bartosik pointed out that the SPS took the beam but the beam quality was not sufficient for LHC (intensity fluctuations too large).

PS: No representative present.

SPS – Hannes Bartosik

During the TS the hotspot in 519 was attributed to a large misalignment of the Fast BCT (12 mm H / 5 mm V). It is thought not to have been realigned even during the TS and its status should be checked. MBB30490 was exchanged (had inter-turn short). Issues of transfer of LHC beam on Wednesday was reported and new tune corrections implemented on SFTPRO to recover spill quality after SC changes to fill LHC.

High intensity MD's progressed, focusing on emittance preservation and stability and the details reported. In particular, no impact was seen on the ZS at high intensity. A dedicated MD on partially

stripped ions in the SPS included deployment of new TT2/TT10 optics for Pb^{80+} and Pb^{81+} with the lifetime of Pb^{81+} being preferable for injection into LHC during MD2.

H. Bartosik requested the high intensity 12 bunch BCMS beam for next Thursday, with **H. Damerau** stating that it still needs to be set-up in the PS.

Main presentations:

Status update: high intensity LHC beams in the PS – Heiko Damerau

The LHC 25ns Standard and BCMS production cycles in the PS were introduced before older results presented at the Injector MD Days 2017 were reviewed. These first tests pushing towards intensities of 2.6E11 ppb in 2016 encountered severe problems in the longitudinal beam stability. To achieve the extracted beam intensity large blow-ups were needed leading to very large longitudinal emittances at extraction, outside of the specification for acceptance by the SPS.

This year the longitudinal beam stability appears better compared to 2016/17.

Multi-bunch tomography was introduced, allowing to reconstruct the longitudinal distributions of all bunches with more detailed analysis on bunch-by-bunch emittances. The foot-tangent technique is no longer employed due to variations in the bunch-by-bunch distributions and instead a statistical emittance definition (at 90%) was introduced.

For the LHC 25ns Standard beam about 15% higher intensity could be accelerated this year. The growth in the bunch length along the batch is far less significant and the impact of 2 or 3 open 80 MHz cavities is less important and significantly smaller emittance growth is observed along the batch for comparable intensities.

For BCSM, the LIU intensity with 48 bunches and 2.6E11 ppb is potentially within reach. The triple splitting is sensitive to transient beam loading and uncontrolled emittance growth is still observed for tail bunches at flat-top.

A review of the changes made during the YET17-18 was made but none explain the performance improvement. For the RF system changes it was postulated that maybe detected signals for the feedback systems around the cavities were saturating last year and went unnoticed, the same again for the saturation of drive power for the Finemet cavity amplifiers that were replaced. Other vacuum interventions were considered but no significant effect on the longitudinal impedance is expected.

New measurements in 2018 of the 80 MHz cavity impedance were presented without any significant change since 2017. The measurements will be complemented with the 40 MHz cavities and new measurement of the modified C80-89 after the TS.

Recent work on the multi-harmonic feedback demonstrated a large reduction in beam induced voltage. In the 80 MHz cavity, with feedback on, the beam performance was as good as if the cavity was invisible to the beam (same as cavity gap was mechanically closed). It will be interesting to see the results with the feedback applied to multiple cavities at the same time.

The talk was concluded and future studies planned for 2018 were outlined.

Discussion:

H. Bartosik sought clarification that nothing is presently foreseen to tackle the triple-splitting sensitivity to beam loading (intensity). This is indeed the case but can be investigated.

H. Damerau explained that the PS has no hard parameters to understand if the situation is sufficient for the SPS and that the beam should be taken and issues checked. **H. Bartosik** agreed that there are many issues that need careful attention in the SPS and encouraged as many complementary studies as possible this year, like the post-acceleration studies, to give independent information. It is not clear how many bunches at 2.6E11 the SPS can take with the available RF power. **H. Bartosik** stated that we will already start to accelerate 12 bunches to flat-top and see from there.

T. Lefevre asked if there is an impedance model that exists to predict the impact of the changes made since last year. **A. Lasheen** explained that the answer is no, but it is being built. A good model exists for 10 MHz cavities but for the 40 and 80 MHz cavities, which are driving most of the relevant instabilities, it does not exist. So far only design report values were used and put into model. A discrepancy from measurement and simulation of factor of 2 in impedance is not understood and development of the model is on-going. In addition, there are still differences between RF and beam based measurements of the impedance of certain elements in the model.

Status of PSB / PS optics measurements – Piotr Skowronski

Ring optics measurements techniques were introduced motivating the turn-by-turn orbit analysis method that was pursued in detail. The method of the measurements was explained: (i) exciting the beam with kicker or AC dipole, (ii) orbit data processing including FFT of each BPM to attain phase of the tune line before (iii) the beta function perturbation from the model value is computed using the measured phase of three consecutive BPMs.

The PSB measurements were severely limited by the 90 degree phase advance between BPMs and other problems encountered with the orbit measuring system were outlined. At high intensity the measurements are limited by re-coherence that perturbs the measurements and at low intensity the signal-to-noise level in the BPM is a limiting factor. The subsequent noise ringing on the BPM's at low intensity is an issue. Interestingly the stability in the horizontal plan in both the PSB and PS proved a large issue and limited the measurements. This must be followed up.

The AC dipole performance in both the PSB and PS were discussed at length.

The software developed for LHC is being used and lots of work is on-going to adapt it to the PSB and PS.

The errors on the beta-beating in the PSB are too large to give conclusive results. Measurements on a modified machine optics have been carried out and first result show an improvement in the phase advance and results. For the PS, initial issues with the LHC stability without coupling led to a TOF-like beam being studied. First results show a low beating of less than 5% during the first turns after injection. Results using the AC dipole with different machine configurations were presented. Coupling corrections to minimise the coupling around the ring has been computed and will be applied next week.

A to-do list was presented for future work.

Discussion:

B. Mikulec stated that the list of known issues with the BPM system is being discussed and followed up offline together with BI.

S. Albright suggested that for the horizontal stability issues on the 160 MeV flat-top, a fixed synthetic frequency could be provided. **P. Skowronski** pointed out that just turning off the phase loop helped the situation. **H. Damerau** suggested that the PSB is synchronised and locked to a fixed frequency at 160 MeV, with the remaining stability issues would come from the B-field only.

V. Forte asked if low chromaticity was tried but there is no option for this. Only the chromaticity in one plane can be minimised.

B. Mikulec sought clarification on the next steps, which will be the analysis of the data to check resolution for the beta-beat measurements in the PSB: whether it is needed to increase ADT or BPM resolution. Presently, nothing is blocking for the moment.