Week 20 (only parallel)

Measurements of resonance lines with Q20 optics and comparison with the nominal optics (H. Bartosik, Y. Papaphilippou)

An SPS parallel MD session was dedicated to study the resonance behaviour in the vicinity of the working points of the nominal SPS optics for LHC beams (Qx,Qy)=(26.13,26.18) and the new low gammat optics with the corresponding working point (Qx,Qy)=(20.13,20.18). The strength of individual resonance lines can be identified from the beam loss rate, i.e. the derivative of the beam intensity measured with the BCT, at the moment of crossing the resonance. At present, the main goal was to identify lattice resonances and therefore a low intensity (5e10 ppb) single bunch LHCindiv beam with an injected transverse emittance of about 1.2um was used in order to resemble single particle behaviour. In this study, the the fractional vertical tune is being scanned from about 0.45 down to 0.05 during a period of 3s along the flat bottom of the MD1 cycle (MD_26_L7200_Q20_V1 and MD_26_L7200_V1), while the horizontal tune is kept constant during the same period within a given supercycle. The horizontal tune is then changed step-wise in successive cycles for scanning the 2D tune space. During the measurements, the tunes are continuously monitored using the BBQ and the beam intensity is recorded using the DC-BCT. For both optics, the normal sextupole resonance Qx+2Qy is the strongest. In the Q20 case, also the 2Qx+Qy skew sextupole resonance is quite strong. Other resonances that can be identified are coupling (diagonal, either Qx-Qy or some higher order of this), Qx-2Qy normal sextupole and 2Qx-Qy skew sextupole for the nominal optics. In the low gammat case, the normal sextupole Qx-2Qy, the skew sextupole resonance at 3Qy and the 2Qx+2Qy fourth order resonances can be identified. It seems that the stop-band width of the vertical integer is stronger in the Q26 optics than in the Q20 case. Further measurements will be followed, reversing the scan in the vertical plane to go from low to high vertical tunes and to scan the horizontal plane for fixed vertical tunes for excluding systematic effects due to the tune-scan "direction".

Longitudinal instabilities at flat top with radial steering and two bunches with different intensities in the SPS (T. Bohl)

Two single bunches were injected into the SPS and accelerated using the standard LHC ramp. The intensity of the 2nd bunch was varied and based on beam loss in the SPS a kind of threshold intensity as function of radial steering amplitude was established for this case. Measurements with the fast acceleration ramp did not yet show this unstable beam behaviour. One of the next steps will be to do comparative measurements at flat top using both ramp types.

Acknowledgements

G. Rumolo for optimal cycle selection in PSB and J. Baldy for his patience with numerous PSB intensity adjustments.

Batch compression scheme in the PS using 8 bunches from the PSB (A. Findlay, H. Damerau, M. Delrieux, S. Hancock)

Eight bunches from the PSB (h2+1) could be cleanly injected into h9 buckets in the PS. Thereafter, the RF manipulation h9 -> h10 (batch compression), h10 -> h20 (splitting) and h20 -> h21 (batch compression) could be tested successfully at 1.4 GeV and 2 GeV (very much in an MD style). The maximum permissible longitudinal emittance is about 0.8 eVs at 1.4 GeV and 1.2 eVs at 2 GeV. Though the results are quite promising, there are still many technical issues with the beam control to be sorted out, in case such a scheme should become operational.

Working point optimization (E. Benedetto, S. Gilardoni, G. Métral)

AIM: Identify destructive resonances to find the optimum working point which accommodate the largest possible space-charge neck-tie.

STATUS:

- Measurements at 1.4 GeV → done for bunched and debunched beam, without chromaticity correction
- Measurements at 2 GeV
  - ➔ Done for no chromaticity correction and bunched beam → same lines as for 1.4 GeV (as expected)
  - ➔ First attempt with working Point control and Chromaticity correction with Pole Face Windings (=PFW). Data are being analized.

MAIN PROBLEM:

- Varying the PFW to reach lower values in the tune diagram, while keeping chromaticity constant require additional study.

Week 21 (parallel + floating block)

Dependence of the fBCT measurements on bunch position and bunch length (D. Behlorad, L. Soby, B. Salvant)

During the MD we have tried to observe the behavior of the SPS BA3 FBCT when we change the position of the beam passing the aperture of the FBCT. We did scan in horizontal and vertical plane, for bunch lengths of 2.5 and 2ns. Preliminary analysis shows that the measurements provided by the FBCT are bunch position dependent. The rough approximation would be something like that the value provided by the FBCT changes by approximately 0.8%/mm of displacement. This is however true only partially because

a) apparently the response of the FBCT is not symmetrical wrt beam centerline (either the transfo is displaced by some amount, or the 'default' centerline does not pass by FBCT center)

b) the beam displacement affects the side-bunch slots as well. It affects 4 consecutive bunch slots counting from the bunch slot, where the bunch was injected.

This measurement confirms, that the behavior of the LHC and SPS measurements is defective in a very similar manner. For the moment no quick fix exists, works in progress. There has been already some preliminary discussion about moving of this FBCT to a location, where we could minimize the effect of long cables, which is a contributing factor increasing the beam position dependency of the FBCTs as well.

Transverse emittance measurements with 4 batches of 25ns beam (K. Cornelis, A. Guerrero, G. Rumolo)

The 25ns beam was injected into the SPS on a parallel cycle with the long flat bottom to allow for injection of 4 batches. The transverse emittances were measured with only 1 batch and with 4 batches, yielding similar values of about 2.9um in the horizontal plane and 2.7um in the vertical plane. The wire scanner had been gated on the whole 4 batches (Acquisition mode STANDARD 1 – 320). Subsequently, some setting was changed in SPS or in one of the injectors, which caused the emittances to blow up to values of above 3um in both planes. If the change was caused by the increase by 10% of the intensity in the Booster, this issue needs to be investigated further in the next dedicated MD sessions, because it could indicate that the nominal 25ns LHC beam could be sitting right at an instability/emittance growth threshold, such that a tiny change in intensity can lead to a large emittance increase.

Instability measurements at transition crossing with gamma-jump (S. Aumon, P. Freyermuth)

Since the fast vertical instability measurements with gamma jump done at the end of last year were not clean because of the chromaticity setting (head-tail instability occurring), we did again this week the setting up of the beam and started to take few data as a function of the beam intensity to see if we observe a similar behavior the case without gamma jump. The first instability movie looks correct. The MD will continue next week.

Test of the collimator set up (R. Assmann, D. Wollman, et al.)

We started about 2hs late due to delay in the previous MD and other problems. Thanks to the next MD we re-gained an hour at the end.

Problems:

At the beginning of the MD it was hard to see the losses from touching the beam with the collimators jaws. Therefore we scraped the beam twice away with the collimator jaw. We finally found BLM-8 in the crystal collimator application and used this during our measurement.

Performed measurements:

1) At different collimator gaps (28mm, 20mm, 12mm, 8mm) we scanned the gap across the beam to measure the linearity of the in jaw BPM buttons and to compare these data with simulations. We also performed several BLM based jaw - alignments within this measurement.
2) We made a quick test with a 3 corrector closed orbit bump at the TCSM.51934 and measured the change of the beam position in the collimators with the implemented BPMs (3x 1mm). It seems that we only measured the half of the inserted bump amplitude. To be analysed in detail.

To come: Perform precision measurements with the BPM electronics in the next floating MD in 2 weeks (gap scans, angular scans, bumps, measure the influence of primary and secondary particle losses, ...).

Emittance growth measurements in coast (R. Calaga, E. Métral, R. Tomás, F. Zimmermann)

After optimization of the machine settings for a low intensity single bunch (2.2e10p) and nominal tunes (0.13, 0.18), the beam was coasted for over 2 hrs showing a horizontal emittance growth rate of ~0.6μm/h having started from an initial value of ~3μm). A second coast with new tunes (0.28, 0.31) and slightly lower intensity (1.4e10p) was attempted, which just confirmed this growth rate from an initial 2.6μm. During the third coast, the bunch was initially shortened by increasing the RF voltage to 6MV. The observed growth rate still remained the same from an initial 2.5μm and having been recorded over more than 3 hrs. The effect of the wire scan on the emittance measurements was also investigated. It is not understood why the working point or bunch length seem to hardly affect the rate of the observed emittance growth. It was not attempted to study this emittance growth with the damper on, which could possibly partly cure it if it is caused by random “hump” excitations.