**SPSU-BD WG meeting on 14th July 2011**

**Present:** Theodoros Argyropoulos, Hannes Bartosik, Chandra Bhat, Alexey Burov, Fritz Caspers, Wolfgang Hofle, Yannis Papaphilippou, Giovanni Rumolo, Elena Shaposhnikova, Mauro Taborelli, Joachim Tuckmantel.

**Excused:** G. Arduini, E. Metral

1. **RF measurements during long MD in Week 27 (Theodoros Argyropoulos)**

The aim of this MD was to compare the longitudinal parameters of 1 to 4 batches of the LHC beam with 50 ns bunch spacing for the nominal SPS optics and the low gammaT optics (without controlled longitudinal emittance blow up).

* First the 200 MHz RF voltage was adjusted to obtain similar longitudinal parameters in both cycles for the nominal intensity before the ramp (bucket area =0.6 eVs instead of 0.65eVs for Q26), however the two cycles were not exactly comparable in this MD since the RF voltage was not decreased from 3MV to 2MV at the injection of the 2nd, 3rd and 4th batches as it is usually done operationally. In all cases beam was unstable during the ramp, which would then require the higher harmonic RF system. It is interesting that slightly smaller bucket area in the Q26 cycle resulted in later occurrence of the instability (Theodoros explained it by the larger filling factor at smaller bucket area). Even though they are not completely comparable, Q20 appeared to be more stable than Q26.
* Then the double RF system was used in bunch shortening mode (BSM) and bunch lengthening mode with 1/10th of the main RF voltage. In BLM beam was unstable. In BSM the Q20 was stable and some bunches in the Q26 cycle were unstable at flat top with nominal intensities (more often in the first batch – the one for which the voltage was reduced at injection). The same was also observed with higher intensities (1.6e11 p/b at flat top).
* Using all three 80 MHz RF cavities in PS, the emittance and bunch length could be changed and preliminary results show that higher emittance leads to better stability but more losses and larger bunch length leads to more losses. Similar losses were observed for Q20 and Q26 (~5-6% at nominal intensity and 10% at ultimate intensity). Longitudinal emittance and bunch length at flat top was however significantly different due to the same (maximum) voltage used in both cycles.

*Discussion*

For next studies, it would be useful to have the voltage functions scaled by the slippage factor along the cycle to be really comparable (in particular to compare the instability occurrence during the ramp). The factor due to the slippage factor decreases to 1.6 when reaching flat top.

It was mentioned that increasing voltage at injection may create more tails and can be the reason of the increased stability.

Losses were a bit higher for Q20 but we need more statistics.

Maybe using 3MV for the first batch could help as it is the only one that becomes unstable. This should checked with further measurements.

Giovanni asked why losses are so high compared to the last MD. Yannis said maybe the injection kickers were not set properly. Maybe some losses occurred before first BCT point?

1. **Summary of the dedicated MD on July 4th : 50ns in the SPS with nominal and low γt optics – transverse aspects (Hannes Bartosik)**

Both optics were put in parallel in the SPS supercycle for direct comparison (nominal and low γt optics). The setting up of 50ns beams (double batch) was done with 4 batches (orbit, tunes, chromaticity, kicker timings, RF-voltage program, transverse dampers and longitudinal feedback). Measurements were performed with nominal intensity (~1.3e11 ppb injected) and with ultimate intensity (~1.8e11 ppb injected).

Issues encountered for the Q20 beam were with the transverse damper setup and the vertical orbit at high energy. This will be followed up. There were inconsistencies observed in multi bunch/multi batch emittance measurements and these will have to be understood .

From beam dynamics point of view there was no obvious show stopper for 50ns multi batch in Q20, which is very promising. Further MDs with injection into LHC have been requested for the next MD block. Besides, further studies with ultimate intensity 50ns beams for both optics are needed to optimize the cycles for high intensities and measure emittances and longitudinal beam characteristics. The next step will be the 25ns beams in the Q20 optics.

*Discussion:*

More tuning of the orbit correction is needed and a lot of time is needed for orbit settings in MD. The orbit is off every time we change the magnetic cycle. Maybe monitoring of the magnetic cycle could be useful (proposal of Fritz to follow-up).

Wolfgang said that there is a need for more time in the next MD. Since only 2 s are needed for damper setting-up, he could use the MD1 in parallel. The problem with the Q20 is that the phase advance between pickups is only 67 deg and 90 deg is hard-coded. S. Page needs to implement a change or Daniel could hard-code it in FPGA. For the short term, it needs another hour and it is not easy to access the hardware of the dampers.

For the SPS wire-scanner problem, the expert should be measuring with us next time.

Giovanni asked what the setting of the ZS was as a special setting may have prevented the trips with ultimate intensity.

Elena and Karel suggested using intermediate intensities before switching to ultimate intensities.

**ESME simulations of single bunch instability in the SPS (Chandra Bhat):**

Single bunch instabilities in the SPS were analyzed with longitudinal beam dynamics simulations using code ESME. The idea was to reproduce the longitudinal bunch distribution coming from the PS (after bunch rotation) and to observe the evolution along the flat bottom in the SPS. In the measurements 90% emittance (in 2D) was 0.21 eVs. The RF 200 MHz, RF 800 MHz and kickers (broadband model) were used for the impedance model. According to these simulations, it is not possible to match the beam with longitudinal emittance higher than 0.23eVs and with 3MV the incoming bunch is mismatched to the bucket.

*Discussion*

It was noted that the nominal gammaT in the SPS is 22.8, not 23.2.

Significant differences in distribution between simulations and measurement are seen, in particular in the tails. Since losses affect mainly the tails, Elena mentioned that a few percent losses are unfortunately not significant to conclude. Instability threshold or rms bunch length change should be compared instead.

Alexey advised to use a simple impedance in ESME simulations and compare with his analytical model. Action for Alexey and Chandra: take a distribution and compare results (and also with Headtail).

There will be a new fellow in RF/BR section to work on code for longitudinal beam dynamics simulations and the question is whether we should use Headtail, ESME or something else.

The next meeting will be on August 11th.

B. Salvant