**Minutes of the meeting of the SPSU-BD Study Group (Beam Dynamics) on 17 Feb 2011**

**Present:** Gianluigi Arduini , Theodoros Argyropoulos, Hannes Bartosik, Fritz Caspers, Silke Federmann, Giulianio Franchetti, Miguel Jimenez, Elias Metral, Nicolas Mounet, Juan Muller, Giovanni Rumolo, Benoit Salvant (scientific secretary), Elena Shaposhnikova (chair), Mauro Taborelli, Christina Yin Vallgren

Elena introduced Giuliano as a guest of the WG.

1. **Outcome of Chamonix workshop and new structure of the SPSU SG – Elena Shaposhnikova**

Summary:

The high priority tasks were presented and distributed among members of the working group. Everybody is in charge of his own question(s), which does not mean they should do it alone of course. Issues with limited RF voltage and power for low gammaT were presented. Elena mentioned the idea to redistribute voltage between 4 and 5-sections cavities to reduce power. Testing the low gammaT on LHCFAST is not enough for future use for high intensities and we need dedicated MDs with LHC beam, which means careful planning.

Discussion:

* Elias wondered about the question mark in the table with beam parameters achieved in 2010 and mentioned that emittance of 3.5um could be put in for the 50 ns ultimate beam. Elena: this value was measured only at injection and not on the flat top as for other beams.
* Elias asked what Hannes should do: Elena answered that we should redo measurements with correct voltage and correct parameters and also compare with current gamma transition
* Elias asked whether we could test the “Space charge limit” also for nominal optics. Elena said that probably we cannot because impedance effects are too big with nominal gammaT. With low gammaT the impedance effects are smaller so that we can probe the space charge limit (or other phenomena).
* Question from Fritz: what is the frequency range of HOMs responsible for longitudinal coupled-bunch instability? Is 10 MHz important? Elena: low frequency should have a very high threshold.
* Elias and Elena both agreed that we should profit from Nicolas’s implementation of the multibunch with Headtail

→ talk at the next SPSU-BD meeting

* Elias wondered about performing studies with debunching bunch to identify HOMs?
* Elena was asked to study an option with a low harmonic RF system in the SPS for PS-SPS beam transfer optimization.

→ talk at the next SPSU-BD meeting

* Elias asked about the splitting in SPS? Elena said no, referring to discussions with Roland and Daniel Boussard 20 years ago.
* Elias proposed to raise gammaT instead of decreasing it to reduce the needs in RF power (which would mean crossing transition in SPS). There were objections to that idea. In particular, Hannes mentioned the need to increase focusing in quads. Nicolas said that the gammaT should then be huge to try to get close to the slippage factor obtained by lowering gammaT, and Gianluigi mentioned the huge phase advance per cell. After the meeting, Elias confirmed that having the same slippage factor by increasing gammaT instead of decreasing gammaT was in fact impossible.
* Chandra asked about the capture voltage. Elena said we need to increase voltage for low gammaT.
* Gianluigi mentioned that Kevin Li could be involved in beam losses studies.
* Elias asked whether the goal was to see what is the maximum intensity with nominal emittance and vice versa.
* Fritz wondered which working group should treat kicker heating. Elena said that probably the WG of Malika Meddahi, it has to be discussed and Giovanni mentioned that it is a strong limitation for our studies. Miguel said that the kickers are limiting if we want to inject more batches and he sees 2 options: either we change the hardware or we rule out scrubbing. Elena mentioned that the machine is quite scrubbed now. Gianluigi said the situation would be much worse with 2 or 3e11 p/b. Fritz said that there the modification made by painting metallic stripes cannot be applied to other kickers (ndlr: due to their geometry).
* Elias mentioned that the scrubbing run would occur in LHC before SPS and that the first technical stop maybe postponed to the end of the MD. This has yet to be discussed and approved. Giovanni said that some scrubbing will be done during the MD.
* Elias said that maybe 1.5e11p/b in 50 ns would be asked by LHC. Fritz reacted that this would cause problems with RP and his electronics if 15% losses occur.
* Gianluigi said that we did not use the best wire scanners for low intensity (we should use the linear instead of the rotational). Elena proposed that someone from BI is involved in the working group.

→ talk at the next SPSU-BD meeting (tbc)?

1. **E-cloud MD on 10 November 2010 – Benoit Salvant**

Summary:

The purpose of the measurements performed on the SPS flat top with the 50 ns nominal beam was to observe coherent vertical instability driven by e-cloud. For this reason, the vertical chromaticity was reduced to a very small value. A vertical instability was observed with 3 batches (50 ns bunch spacing) when the vertical chromaticity was decreased at flat top. The chromaticity was very small, and most likely negative. The damper was on and is thought to have prevented heavy losses one should expect with negative chromaticity. Single and coupled bunch instabilities could be simultaneously observed with the LHC BPM. Analysis with the directional coupler showed that the main mode of oscillation inside the bunch was a mode 0, consistent with a negative chromaticity.

1. **News on HEADTAIL simulations for the SPS – Benoit Salvant**

Summary:

Possible mechanisms, which could explain transverse emittance blow-up below instability threshold were discussed. The aim is to explain the difference between emittance blow-up measured with the low gammaT and nominal optics. Among the potential mechanisms we find the direct space charge and the quadrupolar (incoherent) part of the transverse impedance. Intensity thresholds and tune shifts were obtained for the nominal and low gamma transition from Headtail simulations (single turn, single kick, single bunch) with the impedance model of SPS (accounting for kickers, beam pipe, BPHs, BPVs, RF200 and RF800). At zero chromaticity, the main threshold for nominal gammaT is 1.6 1011 p/b and for low gammaT it is 2.8 1011 p/b. The RF voltage used was the same in both cases (as in measurements) so that the longitudinal emittance was much smaller in the low gammaT case. As a consequence the thresholds should not scale with the slippage factor only in this case. Other simulations should be performed with higher voltage to really be able to compare. The tune shifts were very similar in low and nominal gammaTs, as well as the mode spectra, which show the same general behavior, except that the synchrotron tune is multiplied by 2 in the case of low gammaT. This leads to mode couplings occurring at much higher bunch currents, and therefore a higher threshold. It is however interesting to note that the modes that couple and decouple are the same for nominal and low gammaT. The incoherent effects on the emittance growth were also looked at but they were not conclusive as strange behavior was observed (exponential emittance blow up of the horizontal emittance for instance). The vertical emittance blow up was always smaller than the horizontal plane, which means that the simulations as they were performed do not grasp the physics of the measured vertical emittance blow up for high intensity bunches with nominal gammaT. Since the quadrupolar impedance is much larger in the horizontal plane than in the vertical plane (in absolute value), one could expect that the simulation would show more blow up in the horizontal plane. However, the sign change should also be considered. This has to be studied in more details and fully benchmarked with the Headtail with lattice. In fact, the single kick Headtail version and the multi kick Headtail version with lattice have been successfully benchmarked for coherent effects of the SPS kickers (tune shifts, growth rates) but incoherent effects were not looked at. This is the next step and the validity of using a single kick for incoherent effects should be checked.

Also, other incoherent effects should be looked at, in particular space charge (with PTC/ORBIT and/or Giuliano Franchetti’s code micromap for instance).

Discussion:

* Fritz mentioned that we should not use “incoherent” to refer to the quadrupolar (detuning ) impedance. Fritz also said that it is a pity that the Schottky is not used anymore. This transverse Schottky signal could be useful for these studies → check with Thomas Bohl what is possible. Fritz also proposed to use a BPH as Schottky pickup.
* No coupling between planes was used in these simulations.
* No emittance blow-up was observed for dipolar impedance only.
* The effect of chromaticity should also be checked since higher values were used in MDs.
1. **News on coatings– M. Taborelli**

Summary:

Summary of what is going on in the e-cloud mitigation working group. New coating process without magnetic field (hollow system) is under development and the prototype gives promising results (in terms of SEY and homogeneity, apart from small shadows at the location of the carbon grid). Now the team is focused on getting longer prototypes and checking the properties of the coating besides SEY (in particular microstructure by SEM, ageing). Fritz’s testbench could be used for that purpose. Mauro said that a student is arriving to help and Jeremie is looking for a place for the test-bench in bld. 867.

Discussion:

* A discussion was raised on coating in situ using this technique, even a series of magnets, but moving the system through the beam pipe does not seem a viable idea (in particular through pumping ports , since the prototype is 80 mm wide).
* Studies showed that decreasing concentration of CO and H2 leads to decrease of SEY. Another coating process is therefore envisaged, in which the sides of the beam pipe would be coated by NEG while the center of the beam pipe is coated by amorphous carbon. As the pumping speed is smaller in the middle of the magnet, this would be a way to improve the quality of the coating.
* Gianluigi wondered whether it would be possible to use inserts on one half of the magnets and coat the other half to improve efficiency of installation.
* Mauro mentioned we should expect to have problems to coat some hot places (e.g. close to septa) as RP may not allow work there.
* Clearing electrode should be installed in the liner at one of the next stops also with antennas. Gianluigi said we should test what we measure on the testbench.

Minutes by B. Salvant