Minutes of the 101st WP2 Meeting held on 22/08/2017

Participants: A. Aleoku, F. Antoniou, G. Arduini, P. Baudrenghien, A. Castilla, D. Gamba, P. Hermes, W. Höfle, E. Jensen, G. Iadarola, K. Li, A. Macpherson, T. Mastoridis, L. Medina, E. Metral, A. Oeftiger, D. Pellegrini, B. Salvant, K. Sjobaek, G. Sterbini, R. Tomas, E. Yamakawa.

Excused: M. Giovannozzi, Y. Papaphilippou.

General Information (G. Arduini)

The minutes of the previous meeting have been circulated. Gianluigi summarises the outcomes and the actions of the previous meeting.

The program of the annual meeting is being reviewed following the request from the project management to reduce the number of WP2participants. A dedicated WP2 meeting will be organized to go through the subject that will not be covered at the annual meeting.

Before the annual meeting Engineering Change Requests (ECR), covering the planned changes of the TDR, will have to be produced. The optics part is being followed up by Riccardo, the beam parameters are being collected by Rogelio and Elias.

Gianluigi introduces the talk of Themis by summarising the previous results on the luminosity impact of the emittance growth due to the CC noise. Philippe clarifies that the estimated emittance growth has been reduced by taking into account the beta* levelling which comes with lower beta at the CC at the beginning of the fill. Luis reminds the latest values: 2% integrated luminosity loss for the baseline and 3% for the ultimate. Means of reducing the effect of the crab cavity noise are being pursued to reduce even further the impact on the integrated luminosity.

Noise mitigation by means of CC phase noise and amplitude feedback (T. Mastoridis)

The idea for the mitigation of the emittance growth due to CC noise consists in introducing a feedback system acting on CC voltage and phase based on the measurement of the head-tail motion at a dedicated pick-up. Performances and sensitivity have been assessed in simulations relying on a modified version of PyHeadtail. The beta function is assumed the same at the CC and at the pickup (4 km).

Gianluigi asks what will be the location of the pickup. This is not yet clear; a possibility is to use the same pickup of the ADT. Rogelio points out that this is in IR4, with a much smaller beta. Wolfgang reports that the possibility of increasing the beta function at the damper pick-up has been discussed with Riccardo and could be studied.

The simulations of the CC feedback system show that:
- The corrections of phase noise and the amplitude noise are additive, no crosstalk is observed.

- The kick can also be applied at later turns. Only for a delay of 20 turns instabilities start to appear at high gain.
- The tune sensitivity can be cancelled by having two pickups at 90° phase difference, this also allows to use an arbitrary delay without phase constraints.
- The tune spread affects the performance of the system, making larger delays significantly less effective.
- For high noise levels at the pickup, high gains become prohibitive. A possibility to reduce the noise consists in averaging over many bunches. This was discussed with Daniel, taking into account the new ADT front-end. It is estimated that an average over 400 bunches allows to reach a sensitivity of 7.5 nm (with a beta of 4 km).

Rogelio asks about the error on the determination of the bunch tilt. Wolfgang states that the measurement could already be accomplished in the LHC although it is yet to be tried. Rogelio points out that slicing the bunches decreases the signal-to-noise ratio, Themis replies that only two samples are needed. Wolfgang mentions the possibility of doing tests in the SPS.

Gianluigi points out that with a realistic value of beta in IR4 of ~400 m for the present optics (a factor 10 less than the assumed), the noise at the pickup will be a factor ~3 higher.

Philippe stresses that the 7.5 nm accuracy is really pushed.

Concerning the possibility of conflicts with the ADT, Themis stresses that the CC feedback targets the head-tail motion, which cannot be reduced with the ADT. In addition the bandwidth of the CC, limited at 100 kHz, does not allow going bunch-by-bunch as possible with the ADT; therefore the two systems are complementing each other. A common front end is desirable in order to split the actions to the CC and to the ADT. This is expected to solve the eventuality of the two systems fighting each other and therefore introducing even more noise.

A summary plot, including realistic settings, shows very promising results. Themis clarifies that the plot could be optimistic due to the limited number of particles used in the simulation..

Rogelio wonders if one could avoid acting on the phase in order to reduce the conflict with the ADT. Themis replies that the two act on different time scales, this is considered in the simulation and makes them already quite orthogonal. Rogelio asks if it is possible to act only in the amplitude. Themis replies that we need to understand what is better between having some crosstalk among the two systems or having them completely decoupled, he can look into this. **Action: Themis.**

Wolfgang states that from the impedance point of view this system will kick the beam in the bad direction, a rectangular kick is better in order to damp instabilities. Philippe replies that this was proposed as a mitigation of the CC noise. Gianluigi comments that the system cannot distinguish the source of noise. Erk adds that the two systems appear to be nicely complementary, the only bad case is when they fight each other, this has to be clearly understood.

Wolfgang asks if the emittance growth rate estimates include the RF demodulators as well as the betatron compensated correlator filter. Themis replies that most of the noise comes from the RF demodulator. Philippe adds that the numbers quoted come with a 20 db improvement of the current system which could be arbitrarily split among several components.

Elias asks if anything can be learnt from the SPS. Philippe replies that there are no possibilities before LS2. Erk confirms that next year the CC will be operated in a very basic way, but one should collect the ideas to see what is feasible before and after LS2.

In the SPS the pickup will possibly be next to the CC. Themis asks how much the fractional tune can be changed. Rogelio replies that there are no particular limitations. Androula adds that the integer part can be changed as well.

Themis summarises the outcomes of the meeting. The CC feedback system appears to be effective in fighting the emittance growth due to CC noise; however there are additional points to be addressed:
- Pick up location and achievable beta function.
- Interplay with the ADT, especially in the presence of impedance.

Action: Themis, Riccardo, Elias.

Reported by Dario, Gianluigi, Riccardo and Rogelio.