Minutes of the 99th WP2 Meeting held on 25/07/2017

Participants: A. Alekou, G. Arduini, R. Bruce, J. Coello De Portugal, R. Corsini, R. De Maria, D. Gamba, S. Kostoglou, L. Medina, Y. Papaphilippou, D. Pellegrini, M. Schaumann, G. Sterbini.

Excused: M. Giovannozzi.

General Information (G. Arduini)

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

From the coordination meeting Rogelio reports discussions for the position of the forward detectors. Paolo proposed 160m and 220m. Requests for the beta functions were made, Gianluigi stresses the need to identify the requirements of the experiments in terms of physics and we should make a proposal taking into account space and optics constraints.

From the TCC, Rogelio reports that the RF multipoles cannot be measured for the crab cavities. Yannis adds that this has been removed from the LARP document as they are not sure that this could be delivered, although attempts could be made. Gianluigi highlights the importance of identifying what we can measure in the SPS and what are the tolerances that we can have in the LHC, with particular attention to the sextupolar component. Androula has recently completed some simulations for the SPS, she comments that the b3 component comes with a strong impact on DA (from 40 to 7 sigmas) and she plans to check the scaling with the strength of b3 and a3. Gianluigi asked Androula to run the simulations also for HL-LHC with realistic orbit offsets, indeed Riccardo pointed out earlier tighter tolerances on the crab cavities multipoles might be required if we relax the constraints on the orbit position in the non-crossing plane. **Action: Androula.**

Riccardo reports on going work for point 8 concerning the TANB. He also adds that a new absorber is being considered by WP14 to protect the injection. Gianluigi asks if it has been evaluated also by WP10 and the time scale. Riccardo replies that this is probably for LS3. Yannis will mention this in the TCC.

Follow up on the impact of crab cavity noise on luminosity (L. Medina Medrano)

In the CC review at the previous WP2, Philippe reported emittance growth rates for the amplitude noise 3.7%/h and for the phase noise 0.94%/h. This has been included by Luis. With respect to the simulation settings, Riccardo comments that a crabbing angle of 380 μrad can be used also for flat optics.

The predicted emittance evolution due to IBS and SR (including an extra 40h growth rate in the vertical plane) is shown with and without the CC noise, which gives a substantial contribution.

The loss of luminosity is shown for the different scenarios. For the nominal luminosity (5e34 Hz/cm²) flat loses about 1%, baseline 2% and aggressive crossing 2.7%. Slightly worse values are observed for the ultimate luminosity of 7.5e34 Hz/cm².

The total luminosity gain due to the CC goes from 9% to 7% for nominal and from 14.7% to 12.4% for ultimate when considering the noise.

Gianluigi identifies 1% luminosity loss as a maximum target, which means reducing the noise by at least a factor ~3.

Yannis asks if the IBS calculations follow the emittance evolution, Luis confirms that the grow rate is recomputed at every step.

Gianluigi suggests considering a case without the 40h growth rate in the vertical plane, i.e. the ideal case. The crab cavity noise will have a stronger impact in that case. **Action Luis.**

Yannis wonders if the two noise sources (phase and voltage) are additive, which shouldn't be the case if there are correlations. Rogelio comments that these come from the feedback and they should not be correlated.

Impact of noise in the main dipoles - orbit, induced energy deviation and tune ripple (D. Gamba, J. Coello De Portugal)

The aim of the study is to define the tolerances for WP6. Up to now the focus has been on the triplet, but the specs are now being checked also for the arcs. The simulations rely on MADX, assigning 1PPM errors to the power converters and checking their impacts. The frequencies are in the range 0~0.1 Hz. The optics settings are shown.

Dario asks if the octupoles and chromaticity should be raised as in the current scenario to account for possible emittance blow-up. Gianluigi replies that the first study aims at validating the possibility to measure the optics with low intensity, which can be done with low chromaticity and no octupoles. The impact in operation will have to be checked in future.

The dipoles in the ATS sectors contribute to the tune variation as much as the triplets, the other sectors less. The relative change of beam size at the IP is 1e-4; again the contribution from the ATS sectors is similar to the one of the triplets. The same estimates should be done for the flat optics. **Action: Davide.**

The impact on the orbit is shown. Large contributions come from the sector 23 and 34 and from the separation dipoles. Rogelio comments that it would be good to know the specifications for the orbit feedback for the HL. Gianluigi replies that there are no plans to upgrade it for the time being, discussions are on-going between Jorg, Roberto and Davide.

Changes of the field in one of the sector can be partially compensated by energy adjustments, taking into account the momentum compaction. While this has no visible impact on the tune, an effect of few microns per PPM is observed in the orbit.

Orbit effects to be clarified are also observed for errors in MBA in presence of crossing angle.

Results for the LHC with the 2016 40 cm optics are shown. Specific features such as the large impact on orbit of sectors 23 and 34 are observed also in this case.

The latest measurements on the class 1 power converters show a reduction of the noise by a factor 30, now being 0.1 PPM. Davide assumed the same reduction factor also for the other classes although Gianluigi points out that this might not be the case and it should be verified with EPC.

The assumed stability of the power converters are collected in plots, the resulting impact on tune orbit and beam size are collected in a table for the different assumptions of the PS noise.

Gianluigi suggests verifying with EPC the values for the higher class power converters and, in case of discrepancies, re-check their impact. **Action: Davide.**

The tune jitter in the LHC was measured with the AC dipole at the 10e-5 level. Lower tune jitter was observed for the deployed telescope. Rogelio suggests adding the predictions from simulations in order to understand if there is an extra source. **Action: Davide**.

Measurements logged in Timber for a recent fill (5966), show stability well below the 1PPM level. Yannis questions the validity of the logged values, the origin should be clarified. **Action: Davide to verify with EPC.**

It looks that the power converters are generally coming with better stability than the original specifications; we need to make clear if we need this to become the new specification.

Follow up of vibration studies including estimations of the impact at the collimators (D. Gamba)

The procedure consists in displacing the triplet magnets and checking the impact at IP and collimators for different correlations of the movement. The impact on the orbit is shown for different cases of the correlation. The plots are now normalised to the beam size.

The impact on luminosity neglects the impact of crossing angle variations, but it includes the turn-by-turn variation of separation which allows recovering some luminosity also for very large separations. The normalised luminosity is shown for the different correlation cases. As the luminosity does not scale linearly with the separation, a value of 0.5 um is considered for normalisation.

Dario asks if the possible correlation between the motion of the two beams is taken into account as this could reduce the impact on the luminosity. Davide replies that the plots take that into account.

The results at the collimators are shown. Roberto points out the higher orbit movement in the HL case, stressing the importance of the scaling factor.

Yannis comments that there are observations of luminosity loss due to triplet movements which could be considered.

Roderik points out that large orbit excursions should be seen by the collimators. This however depends on the frequency and on the correlations between the movements.

Rogelio wonders why the effect in the vertical plane is much smaller; Roberto replies that the phase advance between the IPs and collimators can play a role.

Davide shows plots of the mechanical resonances of the cold mass, for two different ways of supporting it. A factor 100 amplification can be assumed as worst case scenario, although Roberto adds that this is only true for a small part of the spectrum, so one needs to convolve with the noise spectrum to get a more realistic picture.

Estimations were carried out by the ground motion team, pointing out that the movement should be below 0.5 um for the entire spectrum from 4 to 100 Hz.

Davide shows that the cold mass presents several modes of oscillation, although this is always assumed rigid in simulation. Riccardo reports discussions on how to suspend the cold masses, which Davide is following up.

Gianluigi asks if from the available measurements from the geophone, DOROS and collimators we could constrain the model defining the maximum amplitudes, possibly synchronising turn-by-turn data. Michaela reports that correlations were observed between the geophone data and the ADT data, the DOROS is going to be included.

Gianluigi asks if the turn-by-turn synchronization could give information on local sources. Roberto replies that the analysis normally foresee to integrate over a large number of turns and this makes it hard to spot local sources whose effects are seen as global.

Gianluigi suggests adding the current maximum vibration expected and look at the impact on the luminosity. This could be used to put an upper limit.

Roderik reports that the collimation system does not seem to be disturbed by vibrations, although more carefully analysis could be carried on. Scraping can also give some information. **Action: Davide, Michaela, Roberto, Roderik to analyse the present observables (luminosity variations, losses, DOROS data, geophones data) to constrain the pattern and amplitude of vibration of the triplet and possibly identify other sources.**

Reported by Dario, Gianluigi, Riccardo and Rogelio.