Minutes of the 82nd WP2 Meeting held on 12/01/2017

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Minutes, Follow-up of Actions, General Information (G. Arduini)

The minutes of the 81st WP2 meeting have been approved.

Gianluigi summarises the main points from the previous meeting. Concerning orbit corrector needs and alignments needs, Gianluigi reiterated the request to Oliver discuss the topic in one of the following TCC, who agreed and tentatively scheduled for mid-February. Riccardo added that he is receiving updates from Francisco on the expected alignment needs from ATLAS and CMS

Benoit asks if the report of the TDI review is available. Gianluigi replies that is has not received it..

RF settings and longitudinal distribution for nominal and ultimate schemes (E. Shaposhnikova)

Elena clarifies the definition of the bunch length as measured in the LHC: the FWHM (Full Width Half Maximum) is the obtained value. The RMS value that is quoted is determined by dividing FWHM by $2\sqrt{2ln2}$ assuming a Gaussian distribution although the distribution is often different from Gaussian, in particular at the beginning of the flattop: after the application of longitudinal blow-up during the ramp and before the characteristic times of restoring effects such as IBS and SR.

Spread in bunch length comes already from injectors (min 50 ps) and it leads to different synchrotron frequency shifts vs. longitudinal amplitude. This has an impact on the emittance blow up and on the reproducibility. The current procedure consists in blow up with increased target at the beginning of the ramp to reduce spread and obtain the right length at the end of the ramp with margins.

In a single RF system the average bunch length should be 1.2 ns to guarantee stability. The values required for different harmonic systems are collected in a table, in particular the 200 MHz system increases the stable bunch length by a factor 2, while the 800 MHz allows for a substantial reduction. Elena points out that the scaling of the stability threshold goes with the 5th power of the bunch length, while it is linear for the intensity.

Elias asks details about the profiles, in particular the flatness. Elena replies that the table is a summary for both simulations and measures which already include realistic profiles and that she will argument that in the following slides.

A stability plot shows substantial variations of the thresholds for different profiles for the same maximum length, when instead the FWHM is kept constant all the longitudinal distributions show a similar threshold. Kevin asked whether this is also the case for RMS. Elena replies that the simulations were only done for fixed FWHM and bunch length, showing that the stability threshold depends on FWHM. This is in agreement with the theoretical predictions where the threshold scales rather with RMS than with max length.

The bunch profiles are fitted with a binomial line density distribution, giving a good agreement both at flat bottom and flat top after the controlled blow up. The distribution then becomes Gaussian due to IBS and SR in the time scale of hours depending on bunch intensity and transverse emittance.

Davide asks if one can predict the sigma of the bunch after some time from the FWHM after the blow up. Elena and Yannis reply that the IBS and synchrotron radiation models are required, they can be deployed on the actual profile after the blow up and the main dependency of the relaxation time is the intensity.

Stephane asks if one can gain stability by acting on the impedance. Elena replies that the scaling is just linear and if substantial steps are required, the strategy would be acting on the distribution e.g. by using 800 MHz. Elias adds that some percent could be gained also by increasing the voltage.

The Peak Detected Schottky spectra after the blow up show a hole in the synchrotron frequency distributions. The current understanding of its origin is the phase loop acting while limited band noise is injected in the bunch. Kevin suggests to make a test without the phase loop. However the ramp is not possible without phase loop and results of blow up on flat top (bottom) are different.

Concerning the double-RF operation, the proposal is to go for 400 + 800 MHz. The bunch lengthening mode is very sensitive to the phases of the two systems, therefore it is not compatible with the main RF in full detuning mode while the bunch shortening mode is more robust.

Ilias asks what is the time required to go back to Gaussian. Yannis answers that is in the range of hours from the profile observations.
Stephane asks if a longitudinal feedback could replace the 800 MHz. Elias replies that it has been discussed in the past. Elena adds that it could be useful for multi-bunch instability driven by narrow-band impedance, but for now we are only concerned by the single bunch instability.

Elias points out the impact of the impedance which should be kept low. Elena stresses the fact that if short bunch length is required, 800 MHz is the most efficient way.

Rogelio asks about the longitudinal distribution for the 200 MHz RF and emittance blow-up. Elena replies that the scenario is difficult to simulate in detail, however assuming Gaussian or Binomial distribution as for the 400 MHz case is a good approximation.
Benoit adds that the longitudinal impedance mostly comes from the beam screens, and there is not much margin for intervention. The collimators do not contribute much.

Gianluigi concludes that the stability is mostly affected by the spectrum of the synchrotron frequencies, and that the 800MHz is the most effective way of altering the distribution if shorter bunches are needed. The present proposed baseline with a FWHM bunch length measured by the BQM of 706 ps (corresponding to 1.2 ns 4 sigma average bunch length for a Gaussian distribution) provides sufficient margin to operate without 800 MHz cavities.

Reported by Dario, Gianluigi, Riccardo and Rogelio.