Minutes of the 60th WP2 Task Leader Meeting held on 20/11/2015

Participants: G. Arduini, A. Garcia-Tabares, M. Giovannozzi, T. Lefevre, E. Maclean, E. Métral, R. Tomás

General Information (G. Arduini)

The configuration for the Q5 in point 6 will be reviewed in one of the next technical committees (in 2016). Two options are feasible and acceptable from the optics point of view (pending confirmation of the constraints at the dump protection elements by WP14):

- Operation of Q5 to 1.9 K to allow reaching the gradient of 200 T/m
- Doubling of the Q5 and operation to 4.5 K

The implications of the two options are being considered by the integration, cryogenics and magnet team and the summary will be presented at a technical committee

MD results: alignment optics (A. Garcia-Tabares)

The concept of the alignment optics, where the triplet magnets are not used, has been devised ahead of the LHC commissioning to have the possibility to measure possible offsets in the BPMs in the triplets, to calibrate the BPM beam position readings between the D2 magnets and to disentangle the effect of magnetic errors of Q4 from those of the triplet. An accurate calibration of the BPMs readings between the D2 magnets would allow to use the amplitude information for the measurement of the optics.
Measurements could only be performed at injection and only on Beam 2.
The calibration of the BPMs readings in the triplet area has been obtained by comparing the beta measurements obtained from betatronic phase reconstruction and from betatronic oscillation amplitude (note that in slide 8 the red markers represent the values of the beta function reconstructed from betatronic phase measurements). The offset data are being analysed by J. Wenninger. The MD demonstrated the feasibility of calibrating the BPM oscillation amplitude readings within less than a percent. The results of these measurements are being discussed with the instrumentation team. Thibaut mentioned that part of the deviations could be explained and might be corrected at the level of the beam position reconstruction algorithm from the button signal. Further MDs will be performed in 2016 including Beam 1 and measurements at high energy.
In the future we will also profit from the DOROS acquisition.

MD results: non-linear corrections (E. Maclean)

Nonlinear errors of the triplet lead to a reduction of the dynamic aperture by up to 5 sigmas in HL-LHC and nonlinear correctors are available. Tests in the LHC have been performed in order to understand the consistency of the magnetic model of the machine with beam-based measurements and to devise methods that allow to complement the magnetic model with beam-based measurements.
The assessment of the magnetic model is performed by comparing the measured tune dependence on the amplitude of localized closed orbit bumps with the expected dependence based on the available magnetic model. The measurements performed in 2012 and 2015 show discrepancy between the measured and expected values, indicating that we cannot completely rely on the magnetic model.
In order to provide additional constraints for the fit of the magnetic field error to the measured data a measurement of the amplitude detuning based on AC-dipole excitation has been developed. The combination of the two type of measurements seem to indicate the b4 component in the IR1 triplet is

compatible with the expected values while the b4 component in IR5 seems to be compatible with zero. The deterministic measurement of higher order field errors is even more challenging. The measurement of Resonance Driving Terms is delicate as it requires measuring tiny spectral components, although the choice of the working point could be used to enhance them. Other methods do not allow to disentangle clearly the various effect induced by multipolar correctors. The possibility to squeeze independently the IRs would allow at least to separate the effect of the field errors in the two low beta points.

MD results: impedance (E. Métral)

Measurements of the octupole strength required to stabilize single nominal bunches for different values of the chromaticity and with the transverse feedback ON have been performed at flat to validate the impedance model. The agreement with the model for positive chromaticities above 3 (which is the expected operational range for LHC and HL-LHC) is good and little dependent on the damper gain. More precise comparison requires a calibration of the damping time of the damper as a function of the selected gain parameter which is expected by the damper team but not yet obtained. The dependence of the threshold octupole strength for different gap opening of the secondary collimators has also been studied although it provided unexpected results with higher octupole thresholds for larger emittances. It is suspected that some of the measurement point correspond to bunches that had already suffered important losses and should be analysed in more detail. This will be done in preparation of the Evian workshop. The discrepancy observed for negative chromaticity could be explained by a more precise model of the transverse damper that has been implemented in COMBI by Xavier Buffat.
The measurements with 50 ns trains and with 25 ns trains after scrubbing are consistent with the single bunch data as expected indicating also that the behaviour of the transverse feedback for damping coupled bunch oscillations is not far from ideal (this is what is assumed for the simulations). On the other hand the measurements performed in the early part of the 25 ns run when significant electron cloud activity was observed in the main magnets indicate that electron cloud can play a role in the beam stability at high energy but scrubbing, reducing (and hopefully suppressing) electron cloud in the dipoles seems to be effective for suppressing this type of instabilities as observed by the measurements at the end of the 25 ns run.
The observed deviations for low positive chromaticity might be explained by the effect of second order chromaticity but this needs to be further studied in simulations and with experiments where the second order chromaticity could be varied.
The reason for the larger octupole strength required to stabilize the beams observed with two beams at the end of the squeeze remains for the moment unexplained and the impact of beam distributions on stability and the effect of coupling are being studied.
Elias finally reminded the instabilities observed with the BCMS 25 ns beam during the only fill that was performed with this beam in 2015 although the exact machine parameters for this fill needs to be determined. He also noted that the BCMS beam is expected to be at the limit of stability based on the 2012 experience.

Reported by Gianluigi