WP2 Meeting #150

Tue 11 June 2019, 09:00 – 11:00

Chair:	G. Arduini
Speakers:	D. Gamba, I. Efthymiopoulos, T. Leferve
Participants:	A. Alekou, S. Antipov, R. Bruce, X. Buffat, R. De Maria, M. Giovannozzi, G. Iadarodla, E. Maclean, E. Métal, N. Mounet, Y. Papaphilippou, S. Papadopoulou, F. Plassard, S. Redaelli, F. Van Der Veken

AGENDA

The meeting covered several topics, including beam instrumentation, orbit stability, and luminosity variation.

MEETING ACTIONS

Stefano	Analyze the LHC data to see if we observe orbit variations compatible with those induced by power converters at injection.
Gianni	Summarize the data evidence concerning the main source of the observed electron-cloud induced emittance blow-up
Riccardo	Compose a list of possible options for the BGV location

GENERAL INFORMATION (G. ARDUNI)

Gianluigi reviewed the minutes and action items of the last two meetings. For the nonlinear corrections and field quality, **Ezio** will review the error tables used in the simulation and **Frederik** will further analyze the source of the b4 discrepancy. **Massimo** commented that the team is reviewing ID card of installed magnets.

For the MCBRD field quality, **Frederik** will update the results using the v1.4 optics by late June – early July.

For the dynamic aperture (DA) at injection energy, **Nikos** will investigate DA at larger chromaticities and lower octupole currents while the team of Elias will look at the coherent beam stability aspect. **Elias** commented the first results could be obtained during Summer and suggested reporting the issue in Fall.

1 BUNCH-BY-BUNCH LUMINOSITY VARIATIONS IN LHC AND ITS CORRELATIONS AND ITS IMPLICATION FOR HL-LHC (I. EFTHYMIOPOULOS)

Luminosity variation can be caused by a variation of beam intensity, longitudinal and transverse dimensions, or the crossing angle. Observations of luminosity throughout a fill show an increase of relative luminosity spread between bunches compared to the spread they had at injection. Both experiments, ATLAS and CMS see similar fluctuations of luminosity.

From the experimental point of view, only a 10% luminosity increase with respect to the mean value is considered acceptable for trigger systems. A greater increase is observed; it cannot be explained by the luminosity model, which includes intrabeam scattering, burnoff, and synchrotron radiation. The discrepancy remains when one of the experiments is levelled. The variation seems to be largely caused by intensity variation in both beams that could be caused by electron cloud. Overall, an increase of rms luminosity spread up to 20% was observed for the BCMS fills in 2018, mainly due to fluctuations in the bunch intensities, while the 8b4e fills did not show an increase, instead the rms decreased with time in Stable Beams, as expected.

Analyzing the beam distribution at Injection, the rms intensity and emittance variations are relatively small – about 4% and 5% respectively, almost conserved up to arriving in Stable Beams. The non-colliding bunches retain their rms intensity variation, which excludes a standalone contribution of a conventional electron cloud.

Regarding the impact on experiments, a luminosity variation within 10% would be acceptable for HiLumi and LHC Run 3. If the variation is larger, the experiments may need to have the levelled luminosity set to a smaller mean value to accommodate for the higher peak bunch luminosity.

- **Sergey** inquired if integrated luminosity is being lost due to luminosity variation. **Ilias** explained that presently in LHC there is a minimal loss as the luminosity is not levelled, however for Run 3 there might be a loss because high pile-up might induce dead time. **Rogelio** noted the experiments desire to operate in stable conditions that would not require recalibration of trigger thresholds;

if the pileup exceeds a critical threshold the experiments would rather request a new beam. **Gianni** pointed out dumping the beam is inefficient when one can re-optimize the leveling. **Gianluigi** suggested the opportunity to run with 8b4e beams that do not suffer a large luminosity spread as a mitigation measure that would be preferable to early dumping of fills or running with a lower levelled luminosity.

- **Gianluigi** raised a question if one can say definitely what stands behind the luminosity variation observed in collision and also how relevant the initial conditions are (e.g. emittance variation from injectors and ramp). **Gianni** replied all the indications (including the dependence on β^*) suggest it is not the electron cloud in the arcs. **Rogelio** suggested the evidence indicate electron cloud in the triplet region as the likely source, in that case coating of the triplet beam screen would likely suppress this issue. **Gianni** proposed to analyze available data on electron cloud build-up (Action: **Gianni**). **Gianluigi** inquired if a study can be made with two trains of different emittance. **Gianni** replied this can be done by scraping.
- For the non-colliding bunches, **Stefania** pointed out there is an extra emittance blow-up in the Vertical plane with respect to the model.

2 IMPACT OF FLUX JUMPS ON ORBIT STABILITY (D. GAMBA)

Davide presented an analysis of flux jumps impact on the orbit stability. According to Lucio Fiscarelli, the flux jumps are mostly observed at low energy. Their impact is the most prominent on the current regulation for 11 T dipoles, where it is at the level of 6 ppm, based on the studies by Michele Martino.

For the most challenging scenario at the top energy: 295 μrad half crossing angle and 15 cm β^* the orbit deviation due to flux jumps, dominated by the triplet contribution, could be as large as 5.6% of the rms beam size.

At the injection energy, the variation, mostly caused by main dipole power converters, is up to 1.3% of the rms beam size. The variation is slow and can be corrected by the feedback.

- **Gianluigi** concluded that in a more realistic scenario during the ramp ($\beta^* > 40$ cm, half crossing angle of 250 μrad, etc) orbit variation does not exceed 2% of rms beam size; it must be within the tolerance of collimation system and does not constitute a serious issue. **Stefano** confirmed and proposed looking at the LHC data for observations of slow orbit variations compatible with those induced by power converters at injection. (Action: **Stefano**)

3 UPDATE ON REQUIREMENTS FOR HL-LHC BEAM INSTRUMENTATION: V1.4 OPTICS IN IR-4 (T. LEFEVRE)

IR-4 optics changes are important for Beam Instrumentation, since this is where many devices are installed. The latest optics changes do not have a major impact on most devices with the only exception being the Beam Gas Vertex (BGV). It currently has too small vertical β-functions, which limit its resolution. Ideally the β-functions should be above 300 m, while they are as low as 24 m and 162 m in the Vertical plane for Beam 1 and Beam 2 respectively.

For crabbing observation, BI foresees installation of additional head-tail pickups at the locations optimal for crabbing observations. At least 4 are needed (1 per beam/plane) and 8 are required (2 per beam/plane) to guarantee avoiding constraints on the phase advance.

Other BI activities include designing a Schottky monitor capable of working at beam harmonics up to 20 GHz, designing the electro-optical BPM that uses laser interferometry to measure beam position, and quadrupolar pickups on movers capable of producing a ±2 mm transverse displacement in order to align the center of the pickup with the beam orbit for beam size measurements.

- **Riccardo** pointed out that optimizing the optics for BGV one can lose performance of other devices due to little flexibility with the aperture constraints and proposed instead considering alternative locations. **Thibaut** suggested both options could be feasible, for example the Beam Gas Ionization (BGI) monitor was not used in 2018. **Gianluigi** proposed taking a look at other areas, such a Point 6. **Thibaut** recalled there were similar studies, it is probably not possible due to the large length of the device, about 4-5 m. **Gianluigi** proposed making a list of possible areas (Action: **Riccardo**) having appropriate optics conditions while investigating further possible optimizations.
- **Riccardo** noted that the optimization performed for the locations of the HT pickups for crabbing observation depends significantly on the phase advance, which might change. One therefore has to opt for 4 pickups per beam. **Thibaut** emphasized the space for the pickups has to be reserved now.
- For the electro-optical BPMs, **Riccardo** proposed checking the device aperture. **Benoit** pointed out impedance of these complex devices will have to be measured. **Benoit** inquired if a test in SPS is foreseen. **Thibaut** replied a test can be performed on a bench, the plan is to have a prototype ready as soon as possible.

Reported by S. Antipov