Minutes of the 65th WP2 Meeting held on 01/04/2016

Participants: X. Buffat, R. De Maria, M. Giovannozzi, E. Métral, Y. Papaphilippou, T. Pieloni, R. Tomás, A. Valishev.

Minutes, Follow-up of Actions, General Information (R. Tomas)

Minutes of the last meetings are postponed.

LHCb upgrade: minimum crossing angle from Beam-Beam (Y. Papaphilippou)

Yannis presented a set of simulation results for scenarios in which LHCb runs with large luminosity. The optics version used are from the V1.2 repository with LHCb β*=1 m or 3 m and horizontal crossing angle of -250 to -50 µrad in steps of 50 µrad and fully head-on condition in IP8. Bunch population of $1.1\ 10^{11}$ and $2.2\ 10^{11}$ are used to study the sensitivity to different tune spread (e.g. at the end of separation levelling in IP8).

For large crossing angle, large bunch population have about 2 σ impact on DA (dropping below 6 σ) while the differences due to β* are not visible. Spectrometer polarities effects are also minor (the sign definition used in the slides – the one of MAD - is opposite of that used in the control system). The effect of crab crossing in IP1 and 5 (e.g. increase tune spread) seems to have a beneficial effect with the polarity that increases the effective crossing angle (to be understood, maybe due a working point difference).

A crossing angle scan shows that there is a safe limit at 150 µrad and hard limit at 100 murad for 3m for the low bunch population case. The next steps are completing the analysis with 6D beam-beam and for the missing cases (for 2.2e11, β* = 2m), study vertical crossing angle, include other sources of non-linearities (octupoles, multi-pole errors) and extend the analysis with other linear and non-linear indicators.

Sasha suggested to look at 70 cm with $2.2\ 10^{11}$ and chaotic boundaries. Yannis said that he would like to study first the points defined in the TDR.

Best IP1-IP5 phase advance for coherent effects (X. Buffat)

Xavier presented an analysis of coherent beam-beam modes expected for LHC and HL-LHC and its dependence on IP1-IP5 phase advance.

In case of two strong IPs, the coherent modes may or may not be inside the incoherent spectrum depending on the phase advance between IP1 and IP5. In case the modes are in the incoherent spectrum the modes are damped by Landau damping, however the motion is more sensitive to noise effects and emittance growth. In case of another strong IP, like IP8, the symmetry is broken and the phase advance between IP1-IP5 do not play a major role.

Concerning the phase advances between IP1 and IP5 in beam 1 and beam 2 two reference cases are identified: symmetric (phase advance differences) and anti-symmetric. The LHC phase-advance configuration is antisymmetric in the horizontal plane and close to the symmetric configuration in the vertical. The HL-LHC phase advances are close to symmetric in the horizontal plane and anti-symmetric in the vertical plane. In all cases the coherent beam-beam modes can be damped etiher by the damper or by Landau damping. Having the modes inside the incoherent spectrum does not allow for an efficient transverse damper operation. Therefore, experimental studies in the LHC are required to validate the HL-LHC configuration and instability models. **Action: Xavier, Tatiana request an LHC MD with phase advances as close as possible as for the HL-LHC.**

If the LHCb has <2 sigma separation the modes are all inside the incoherent spectrum for any phase advance between IP1 and IP5. E. Metral checked that the initial beam-beam separation in LHCb is expected to be 1.3 sigma.

For long ranges, the coherent mode spectrum of the LHC is complex due to IR2/8.It is very sensitive to bunch-by-bunch variations and all modes are inside the incoherent spectrum regardless of the phase advances. For the HL-LHC, in the nominal case with weak LHCb LR collision, there are main coherent lines for which a choice of phase advance could be used to preserve emittance. The effect could be quantified in MD following the action already mentioned above.

Orbit effects are strong in LHC and can result in up to 5% luminosity loss for selected bunches. Beta* levelling considerably reduces this estimate. With symmetric phase advances and assuming collisions only in IP1 and IP5 all bunches collide head-on in both experiments, even if the IP is shifted. Collisions in LHCb introduce orbit effects that propagate differently to IP1 and IP5. .

Elias commented that strong Q’ and e-cloud effects should also be included in the models.

Reported by Rogelio and Riccardo