Minutes of the 79th WP2 Meeting held on 11/10/2016

Participants: F. Antoniou, G. Arduini, X. Buffat, F. Carlier, D. Gamba, M. Giovannozzi, G. Iadarola, E. Métral, D. Pellegrini, B. Salvant, G. Sterbini, R. Tomas, F. Van Der Veken.

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

The minutes of 23/8, 2/9, 13/9, 23/9 have been approved.

Last MD on stability at the end of the squeeze showed that the correction of Q'' (checked online) and triplet field quality correction (measured in another MD) was not enough to destabilize the beam as expected from the models.

The longitudinal distribution needs to be clarified in future meetings. **Action: Rogelio**

A review on the needs for a hollow electron lens for the HL-LHC has taken place last week. The review committee strongly recognized the importance to have active halo cleaning and in particular a hollow-electron lens given the large stored energy on the beam halo (up to 35 MJ) new mode of operation (crab cavity and beta* levelling). Extrapolation from past experience in 2012 might be too pessimistic and 2016 too optimistic. Scaling as a function of bunch population is not trivial. Gianni noted that it might be good to conduct tests with 50 ns beams with higher bunch population as suggested during the review and by Rogelio earlier. **Action: Rogelio to include these MDs among the list of Hl-LHC tests to be performed next year.** The experience at Tevatron is conclusive on the efficiency of hollow-electron lens as a tool for halo cleaning.

At the TCC the table of beam parameters has been updated to account for the new baseline parameters.

Lucio expressed the need to keep the official goal of 5 10^{34} instead of 140 pile-up. Gianluigi will discuss with Lucio and Oliver. **Action: Gianluigi**

Effects of the crossing angle on the coherent beam stability (X. Buffat)

Xavier presented a summary of mode coupling instabilities, stability diagrams. The instability model includes Mo-Gr collimators but not crab cavities. **Action: Xavier to consider the full impedance model**

The circulant matrix model (implemented in BIMBIM) includes several effects, but does not include Landau damping. The head-on model is 6D (neglecting the energy kick). The model is used to extrapolate the effect of the beam-beam coupling instability as a function of the beam-beam parameter but assuming the impedance effects for the nominal bunch population.

Starting from a simplified model with Q'=0 and damper gain equal to zero, that shows coupling instability, the damper is increased showing the stabilizing effect. With Q' sigma and pi mode do not exists anymore in their strict definition (in which the pi mode has no net dipolar component) and all the modes acquire dipole component. The ADT again is capable of stabilizing all modes.

Synchro-betatron coupling due to large crossing angle or hourglass effect is needed to induce head-tail modes that cannot be stabilized by the damper. In the HL-LHC it is not possible to access this regime in

the case of full crab crossing compensation. The synchro-betatron coupling from hourglass is smaller than that due to crossing angle. **Action: Xavier to check whether this is still the case for the new baseline with partial crab crossing compensation.**

Without crab cavities and still round beam, there are modes that need Landau damping to be stabilized, however they are very slow, so it is expected they will be stable.

For long-range modes, the modes depend on the phase advance between IP1/5. The horizontal plane is close to a symmetric configuration and the vertical plane is close to anti-symmetric. All the instabilities will be stabilized by the feedback because there is no expected synchro-betatron coupling. The effect of dispersion in the triplet should be small, but needs to be verified. **Action: Xavier.**

In HL-LHC, with negative LOF the long-range tune spread does not cancel that induced by octupoles, unless the crossing angle becomes smaller. Riccardo asked what is the Q" that would be needed to be relevant in stabilizing HL-LHC beam. Xavier replied that 20k -40k are significant but a full study needs to be carried out. Gianluigi asked to study a scenario with a reduced normalized crossing angle at the start of levelling as this could be a possible option to reduce radiation and pile-up density during a significant fraction of the fill. **Action: Xavier**. An additional margin comes from starting the telescopic squeeze sooner in the squeeze. Riccardo commented that the only potential issues with this approach could come from optics corrections, since local IR1/IR5 correction will be needed at smaller β* as compared to the baseline.

The effect of the transverse distribution has impact on the stability diagram; higher octupoles current can recover stability.

Scaling of DA with beam-beam effects (LR-HO): experience and simulations (D. Pellegrini)

Dario presented scaling of beam-beam effect using the last HL-LHC optics (v1.2). Gianluigi asked whether there is a criterion on the number of long-range interactions and off momentum offset to be taken into account and suggested to review it critically. **Action: Dario to perform a DA scan on number of LR encounters and momentum offset**. For the latter the results should be weighted taking into the longitudinal distribution to see how many particles are present at those amplitudes.

A scan of the crossing angle shows that the nominal setting for the crossing looks quite conservative, good DA is maintained when reducing the crossing angle, negative (or moderate) octupoles allow to run with high chromaticity, the best DA is obtained for negative octupoles: LR compensation.

The polarity of the LHCb does not seem to give visible differences in lifetime. **Action: Dario to provide comparing plots for the two LHCb polarity configurations.**

A scan on octupoles current as function of crossing angle and bunch population shows that with negative octupoles there is margin in the crossing angle and bunch population. Positive octupoles give worse DA. Further studies are in progress to study the dynamic aperture evolution during the levelling process taking into account the possibility of reducing the normalized long range separation at the beginning of the beta* levelling process. Filed errors will be included too. **Action: Dario to report as soon as possible on the results**.

Experimental results in the LHC (2012) show that in the first hour of the fill there is a dependence of the lifetime on long-range encounters that disappears in the following hours.

On the profiles one can see that bunches with a smaller number of long range encounters seem to be less prone to the development of tails as compared to those with a larger number of long range encounters (differently from expectations). The behaviour is not always consistent. Studies are ongoing to increase the statistics.

There is an asymmetry in lifetime between Beam 1 and Beam 2 regardless of the optics. The long range MD in summer this year also showed a larger sensitivity of lifetime to crossing angle for Beam 1 as compared to Beam 2. Xavier commented that an analysis showed that losses seem to be mostly in the vertical plane for this case.

Reported by Gianluigi, Riccardo and Rogelio.