Minutes of the 104th WP2 Meeting held on 19/09/2017

Participants: Y. Alexahin, G. Arduini, I. Eftymiopulous, D. Gamba, P. Hermes, R. De Maria, S. Kostoglu, L. Medina, Y. Papaphilippou, D. Pellegrini, K. Skoufaris, R. Tomas.

General Information (G. Arduini)

Elias is finalising the document for the operational scenario. Gianluigi asks to provide the input requested. **Action: Task Leaders**. It is important to have a final draft of the document during next week. Riccardo points out that freezing the crossing plane is premature as this requires to complete the studies for the flat optics, and the ramp and squeeze calculations are being finalised. Gianluigi asks to check in particular if the ramp and squeeze can end up at the required beta* for the beginning of the fill (60 cm). One should check that there are no limitations such as aperture, beam-beam separations, ramp and acceleration rates of the concerned circuits including the sextupoles. Jorg points out that the acceleration rates is limited by the QPS. Riccardo reports that he is trying to smooth and speed-up the ramp by removing the unnecessary acceleration/deceleration in between matching points. Gianluigi concludes that one needs to aim at a reasonable reference including all the current experience that could be refined in the future. **Action: Elias to provide the final document before the end of September**

Gianluigi asks about the progress of the MS10 investigations. Dario reports that a DA scan of beta* vs crossing angle showed that MS10 starts to affect the DA below 30cm beta*. He is now focussing on limit case of 15 cm in order to establish the requirements for both MS10 and LHCb. Gianluigi asked if the optics for the alternatives to MS10 are available for the entire squeeze. Riccardo replies that the optics with and without MS10 are available, but we have only few points for the missing MS14f. Dario adds that this looks ok for the time being as the focus is now on 15cm. The completion of the optics can therefore proceed in parallel.

Gianluigi received notes on circuits from Davide and on optics measurements from Rogelio.

The agenda for the annual meeting is finalised. Gianluigi will contact the people involved.

The minutes of the previous meetings will be soon circulated.

Status of beta* levelling (J. Wenninger)

Jorg reports on the several levelling options: offset, crossing, beta*, ordered by increasing complexity.

Offset levelling

Levelling by offset is operational since Run1. It could be improved in the future by a deeper integration of the orbit feedback. Contrary to Run1, in Run2 instabilities have not been observed apart from a case in the Van Der Meer scans, possibly due to the absence of long range interactions.

When levelling by separation small orbit fluctuations induce larger excursions of the luminosity, B2H appears more affected. The luminosity readings typically contains fast oscillations of about 10-20 um separation, and a slower oscillation with a period of ~15 minutes. The resolution of the normal BPMs is not good enough to localise the source and the high resolution BPMs are not sufficiently distributed. Davide asks if the spikes are connected to the levelling steps. Jorg replies that they are not, appearing erratically during day and night.

Crossing angle levelling

The crossing angle levelling has been made operational since June 2017. The bumps are larger compared to those of the orbit separation levelling, therefore it requires to synchronize the orbit feedback and to move the collimators. The orchestration is implemented in the luminosity server software. It is a rather limited levelling technique but it helps integrating more luminosity with the intensity decay.
Dario asks if the limitation of changing the crossing angle one IP per time could be removed. Jorg replies in the positive as no technical limitation is expected.

After the crossing angle reduction the tunes and the luminosity are re-optimised manually. Rogelio asks how long the luminosity optimisation takes. Jorg replies that it requires 30 second per plane per IP. Tune trims could also be automatized if they were more reproducible.

Beta* levelling
The optics changes are implemented by parabolic-linear-parabolic interpolation between a series of fixed points in LSA. Riccardo asks if one could avoid to stop, he adds that he can provide fitting polynomials (5 order fits well). Jorg replies that a limitation comes from the orbit feedback and that polynomials could work. He is already discussing this option with Stephane.

Stefano asks if the matched optics is still a requirement. Jorg replies that for the time being it is, but we could switch to polynomials in RunIII. For the time being it is not yet clear how to handle them.

The beta* levelling has been tested in MD. In between the matching points some beta beating and tune shift appear, which are observed as losses. Yannis points out that some additional smoothing could help. Jorg replies that this will come naturally with polynomials. The tune transients can be corrected by feed-forward but the orbit cannot once the crossing and (small) separation bumps are introduced. Davide asked whether the poor convergence of the orbit correction is due to the inaccuracy of the transfer matrix (the matrix corresponding to injection optics is used throughout the ramp and squeeze), Jorg replies that the gains also enters into the divergence. Power converters are also suspected to have an impact.

Up to 2015 the beta* levelling MDs used the local squeeze. In 2017 the telescopic squeeze was used for a levelling test in MD, this has the advantage that IR1 and IR5 are left untouched. The MD was successful at first attempt requiring only small but measurable trims on the beam separations. IR2 and IR8 were separated at 1 sigma to get the highest sensitivity, and they required adjustments up to 0.3 σ (~10-15 μm) for certain steps.

The luminosity optimisation shows small gains after the beta star steps. The correction is just about half micron. This was fed-forward in a second fill with positive results.

A new idea consists in applying all the settings for orbit feedback, collimators, PC interlocking and LSA internals (optics) as a “mega-trim”. The levelling architecture would consist therefore in a repository of settings which could be loaded as required. This allows to easily go back and forth. A test is planned in MD4; in case of success, one could have it in operation in 2018. Yannis asks if in MD4 one could have two trains to start probing lifetime. Jorg replies that one need at least a fill with nominal beams, therefore is probably difficult for MD4. Yannis asks if the crossing angle can be changed as well, Jorg replies in the positive.

In conclusion Jorg points out that beta* steps for 5-15% luminosity steps are reasonable. Rogelio points out that they are assuming 2% steps. Jorg replies that this can be complemented with offset levelling. He stresses that it is important to use the levelling in order to keep it improving it. Rogelio points out that one could already go below 30 cm.

For the time being it is not envisaged to have independent levelling in IP1 and 5.

The DOROS BPMs are currently not considered reliable enough to build an additional feedback loop to maintain collision. In particular unrealistic fill-to-fill variations of the separation of about 20 microns are measured. Next year experience could be used to provide input for the instrumentation.

Gianluigi agrees on the fact that there is no need to have a completely different levelling for the IP1 and 5, separation could always be used for small trims. He asks if one need to correct and validate every point. Stefano points out that this might be the case if the constraint of the monotonicity of the TCDQ movement cannot be lifted.
Gianluigi asks the number of levelling steps for 2% luminosity. Rogelio replies that they are about 50. Gianluigi suggests using 20 steps giving 5%, providing additional smoothing with separation. Rogelio replies that one could possibly not need validation for a high number of intermediate steps, but still only for some of them along the fill. Stefano reports that we have to learn more especially going to 20cm. He adds that Brennan was positive about organising some tests with no beam to assess the mechanical inaccuracies.

Gianluigi asks how much beta beating one could have between the matching points. Rogelio replies that measurements were done between the steps, and no significant changes were observed. Stefano adds that continuous loss maps were performed even outside the matching points and the hierarchy was maintained. Jorg adds that also the measurement of the tune is in agreement with the expectations outside the matching points.

Ilias asks about the implementation and the choice of the beta* during levelling. Gianluigi explains that the ending value is fixed by aperture considerations, the starting point is defined in term of luminosity that we want to achieve, one could be pessimistic, assuming a smaller required beta* and reduce the luminosity to the target value by separating the beams. This will cause small variation in the pileup that will be taken by the experiments. Yannis comments that the main uncertainty on the required beta* at the beginning of the fill is the emittance. Rogelio adds that since we are anyway driven by luminosity, one could go in collision with a safe, large value of beta* and use the first step in stable beam to reach the target luminosity, Gianluigi agrees.

Gianluigi stresses the importance of checking that the beam can be kept stable for separations below one sigma.
Action: Elias

Reported by Dario, Gianluigi, Riccardo and Rogelio.