Minutes of the 120th WP2 Meeting held on 08/05/2018

Participants: G. Arduini (GA), X. Buffat (XB), R. De Maria (RDM), M. Giovannozzi (MG), G. Iadarola (GI), S. Kostoglo, N. Mounet, A. Oeftiger, S. Papadopoulo, Y. Papaphilippou (YP), F. Plassard, G. Sterbini, R. Tomas (RT), F. Van der Veken.

AGENDA:

1. Approval of minutes and general information
2. Long-range compensation: PACMAN and HO impact in HL-LHC dynamic aperture
3. E-lens for Landau damping
4. Round table

1 APPROVAL OF MINUTES AND GENERAL INFORMATION (R. TOMAS)

Rogelio chairs the meeting. The minutes of the last meeting are still under preparation. The actions in the last 2 meetings are reviewed:

"Investigate the feasibility and cost of having 3 μm Cu coating for the secondary collimators. Provide an estimate of thickness tolerance." → Stefano Redaelli to be contacted. **Action: G. Arduini**

"Reduction of MQSX length by 30% along with a confirmation of the 1mrad tilt tolerance on MQXF" → ECR has been circulated by E. Todesco and it should be presented in a coming TCC.

"Proceed with the planned upgrade of the ADT beam position modules for tests in 2018." → This is D. Valuch's plan.

"Check with experts if simulations for the vacuum pipe vibrations exist or could be performed in order to compare with tolerances." → **Action: R. De Maria**.

"Perform a measurement of amplification spectrum for HL-LHC triplet cold masses" → For next year when the HL-LHC cryostat is assembled. **Action: D. Duarte Ramos**

"Explore the possibility to perform Ground Motion measurements closer to the beam or even on top of the magnets." → **Action: D. Gamba and R. Corsini.**

"Explore the possibility to perform vibration measurements in an existing LHC dipole." → **Action: D. Gamba.**

2 Long-range compensation: PACMAN and HO impact in HL-LHC dynamic aperture (Y. Papaphilippou/N. Karastathis)

In the beginning of the physics fill the tune footprint is dominated by head-on while in the end it is dominated by long-range. Left PACMAN bunches see the long-range interactions only in the left of the IP (equivalently for right PACMAN). Due to this they see a different tune than the main bunches. Due to the octupoles PACMAN footprint is overcompensated and wings are folded, which is harmless for DA. Actually PACMAN bunches always have larger DA than nominal bunches. Therefore, one could also conclude that DC wires will also not affect DA of PACMAN bunches. The DA plots display the unperturbed machine tune as this is what is used to set-up.

Simulations without long-range but with the IR5 and IR1+IR5 wires in the 2018 configuration (beta*=30cm) are shown, demonstrating the impact of the wire on DA. Simulations for bunches with long ranges and wires show that indeed wires do not deteriorate DA in general, feature global improvement. In conclusion, there is no strong interest for a pulsed wire. XB asks if the orbit offset of the PACMAN is considered. YP agrees that this effect is not considered and it would be an interesting study. **Action: Y. Papaphilippou.** RdM asks about the effect of orbit shifts in the strong arcs from the long-range. XB says that this is under study and there is a presentation planed in WP2.

A first look at HO compensation with e-lens is explored by simply reducing HO charge by 20% in SixTrack (only for the HO). In this case the DA increases significantly and a tune change between start of the fill and end of the fill would not be necessary. GA compares this set-up to HO separation. Yannis agrees that indeed the situation is very similar. In conclusion we should gain even from a partial HO compensation in the beginning of the fill.

GA highlights that in terms of instability during the collision process PACMAN bunches, having different orbits, might cross the minimum of stability during the separation collapse at different timings. **Action: X. Buffat to look at these effects.**

3 E-lens. Tune spread enhancement: Potential to improve beam stability (X. Buffat)

Running with octupoles proved more difficult than initially thought in the LHC design report. Tight control of the machine linear and non-linear optics reduced the discrepancy on thresholds with the model to a factor 2. This factor 2 discrepancy has an unknown source but could be related to noise. We aim to design HL-LHC keeping this margin.

A strong octupole current is needed at injection for e-cloud instabilities, plus the HO was not enough to cure e-cloud instabilities at top energy. Therefore it is unclear if e-lens are adequate to stabilize e-cloud instabilities. Further simulations are needed. E-cloud actually affects the beam as a modulated quadrupole along z, rather than amplitude detuning. Yannis mentions that all these effects should be put together in DA simulations to better understand LHC lifetime.

In HL-LHC we will need a telescopic index of 1.7 to be stable at flattop to keep a factor 2 margin on stability also during the separation collapse. GA mentions that in LHC we see enhanced losses when the telescopic squeeze starts in combination with high octupole strength and beam-beam long range tune spread, therefore we might be limited by dynamic aperture and losses in the maximum acceptable

tune spread. Simulations should be carried out. Riccardo will prepare optics for the cases proposed by Xavier in a note being finalized.

GA recalls that the collision process is dynamic and MG in the past brought up that this could change the behavior w.r.t. the current static studies.

A. Valishev made studies comparing octupoles and e-lens for same instability diagram. The e-lens showed an improved performance (factor 2 in DA) thanks to the fact that e-lens has zero tuneshift for large amplitude particles (this is only with 100000 turns DA studies). This conclusion goes along the line of usual HO results.

As mentioned before the e-lens could help during the collapse process but needs to be studied.

Another advantage of e-lens is its capability to be pulsed and optimize bunch-by-bunch.

GA remarks that even if this new knob could remove the need of collimator impedance upgrade best strategy is always to remove the source as use as few new knobs as possible.

On the concerns side, e-lens has only been used for beam-beam compensation, not for Landau damping. PACMAN bunches will collide with an offset at the e-lens.

In RHIC they observed noise induced losses by e-lens with not fully clear mechanism. This would be an important threat for HL-LHC.

Hollow electron lenses, which are pulsed to remove halo, may feature some of the above mentioned concerns. Further studies are needed for hollow lenses too. **Action: Y. Papaphilippou.**

GA advises to focus studies on the actual baseline limitations. In particular the telescopic index can bring some complications that have not been fully studied yet in terms of DA. Alternatives should be considered after a solid baseline with studied risks is completed. The possibility of limiting the collimation impedance reduction to that planned for LS2 should also be studied. Xavier has addressed this in his note. Xavier agrees that the remaining collimator upgrade in LS3 brings only limited improvements.

Following from the above discussions, the MD requested by Stephane to advance the telescopic squeeze to the ramp is supported as high priority by WP2, after the studies to understand the heat load imbalance in the LHC arcs, the source of emittance blow-up in the LHC and the origin of the higher octupole threshold for stability

4 ROUND TABLE

Next meetings on 22/5/2018.