Minutes of the 57th WP2 Task Leader Meeting held on 09/10/2015

Participants: G. Arduini, S. Claudet, M. Fitterer, R. De Maria, S. Fartoukh, G. Iadarola, E. Métral, Y. Papaphilippou, G. Rumolo, R. Tomás, A. Valishev.

Minutes, Follow-up of Actions, General Information (Gianluigi)

Minutes have been approved.

The pending actions of 31/7 are:

- How much we can reduce crossing angle in IR1/IR5 for the nominal and ultimate scenario (**Action**: Y. Papaphilippou, A. Valishev)
- Use a realistic scenario with β* levelling for strong-strong simulations. Sasha progressed with Ji Qiang, but not conclusive results, yet (**Action**: Y. Papaphilippou, A. Valishev).

The pending actions of 25/9 are:

- Layout 1.2 is frozen, discussion with Paolo and Oliver for next layout approvals (Action: G. Arduini). The idea is to specify precise deadlines for
    - draft optics release
    - mechanical integration iterations ending with a freeze of mechanical features
    - update optics files and final drawings
- Limits in IR8 crossing angles to find LHCb to run with 1-2 10^{34} $cm^{-2}s^{-1}$ levelled luminosity with or without IP shift (**Action**: Y. Papaphilippou, A. Valishev).

The pending actions of 2/10 are:

- Allowed current ripple during ramp for triplets (**Action**: M. Giovannozzi).
- Do damper needs upgrades to provide 50 turns flat bandwidth? Is intra-bunch feedback useful? (**Action**: E. Métral)

From the technical committee: Ezio presented a status of magnets and powering. Triplet powering scheme with one single main power converter is under discussion. The baseline is Q1-Q3 in series with large trim and Q2a-Q2b in series with small trim. Q4 currents changed from 16 kA to 5 kA. Operational gradients and lengths are 120 T/m and 3.67 m. D2 and Q4 design correctors changed from 2 kA to 600 A (but higher inductance). Riccardo gave the specification to achieve the same integrate field variation (Tm/second) of the present MCBY. **Action: Ezio**. Powering in series for D1/D2 is under discussion assuming that a trim that will be able to compensate small current differences. Ezio asked if only one Q5 could be doubled in IR6. Stephane has studied an optics solution that offers smaller gradient needed in Q5.R6 and possibly in Q5.L6. He will present this at one of the future WP2 meetings. Q6 in IR15 is kept at 1.9K, studies to operate at 4.5K are ongoing.

From the steering committee: V. Baglin announced that a beam screen in the DFBX is needed. Riccardo mentioned that he is trying to meet with Vincent and Francisco to define the stay clear region from the end of D1 to the TAXN. Gianluigi asked to involve Elias as well for impedance consideration. DOROS electronics allows a much narrower excluded zone for the stripline BPMs in the triplet region as compared to the present electronics. In particular the allowed signal time-separation passes from ±6.5 ns (regular BPMs with WBTN electronics) to ±2.5 ns with DOROS. An update of the specifications in terms of precise excluded zone (taking also into account the coupler lengths and port positions) should be defined before

the iterations on the next layout with new L* starts. **Action: Thibaut.** V. Baglin communicated that a SEY of 1.1 has been reached for the aC coating of the triplet beam screen. Gianluigi noted that a SEY of 1 or lower is required to avoid multipacting in the triplets and asked whether the option of installing clearing electrodes should be studied too. Lucio supported this.

Discussion with Beniamino took place for the Machine Detector interface session to organize a panel session on update on pile-up density, pile-up levelling, and limitation of 200 MHz (15 cm) bunch lengths.

Electron cloud update: stability, baffles, lessons learned from the 25 ns run so far (G. Iadarola)

Gianni presented an update of the e-cloud studies: e-cloud of baffles, instability simulations, and lessons learned for 25 ns operations.

Pumping slots could have let electrons hit the cold bore and baffles were introduced as a shielding. The pyEcloud code has been upgraded (electron detection algorithms and handling in pyEcloud and boundary condition for pyPIC) to simulate the effects. In conclusion Baffles protects the cold bore from a non-negligible head load. The size of the hole does not matter (few tens microns of cyclotron radius compared to 1 mm). **Action: Gianni to verify the absolute values of heat load that would be intercepted by the cold bore in the absence of baffles.**

E-cloud simulation at 7 TeV needs finer time steps and grid size. The number of kicks is then reduced. Convergence scans were performed and confirmed the first guess on the parameters. One-parameter scans were performed to benchmark the expected scaling. Tune spread due to octupoles, Q' and e-cloud are shown at injection. While tune spread due to chromaticity dominates the tune shift along the diagonal, the tune shift with amplitude due to octupoles is mainly visible in the anti-diagonal. E-cloud provides a z-dependence and adds to the shift along the diagonal so that the bunches in the second half of the train could have a tune spread overlapping with the 3rd order resonance. The simulations were done assuming a uniform electron cloud density of $5x10^{11}$ electrons/m^3 all along the LHC. The behaviour is consistent with machine observations. Stephane asked if it possible to know the shift of Q' due to e-cloud. He mentioned that the separation between the vertical and horizontal tune at injection could be reduced given the good control of coupling achieved and that one could consider the possibility of having a working point mirror symmetric with respect to the diagonal. Gianluigi suggested to repeat the same estimates for the duplet beam. **Action: Gianni to estimate Q' and dQ/dJ induced by electron cloud and the total tune footprint for the nominal and doublet beam at injection and at 6.5/7 TeV considering the octupole and chromaticity settings at injection and at flat-top.**

2015 experience showed that scrubbing conditions in 2012 were lost due to deconditioning after the long shut-down. Intensity ramp-up improved the conditioning. For the HL-LHC scenarios, one should aim at improving the regulation of the cryogenics. Improved vacuum in the MKI and more robust TDI is essential to speed-up scrubbing. Transverse damper is essential to keep the beam stable. High Q' and octupoles are needed therefore one needs flexibility in the working point. Cooling capacity is important to minimize the scrubbing time. The heat load has an increasingly steeper dependence on the bunch population with increasing SEY but it can be controlled by varying the number of circulating bunches while the saturation electron cloud density and the threshold electron cloud density are only marginally dependent on the bunch population. In that case the operating with the nominal bunch population during scrubbing might be the correct strategy.

IR6 Squeeze Update (M. Fitterer)

Miriam reviewed the constraints for IR6 from ABT and collimation team emerged in the last year till very recent discussions. For the dump limits, Gianluigi asked whether this is related to the constraints imposed by the energy deposition in the window before the dump. Riccardo replied that the change window have not been mentioned in the discussion with Jan and team.

Miriam reviewed the injection optics in V1.2 that has been revised with respect to HLLHCV1.0 and HLLHCV1.1 because of the change of double of Q5 and for a better compromise between aperture and dump constraints, respectively. Stephane observed the beta function in Q5 is larger than nominal and we have there a global bottleneck today. Riccardo replied that the measured bottleneck is still at about 13 σ, so it should not be a concern and still the aperture in Q5 is at the same level of the arc when using the new injection aperture tolerances.
Miriam found smooth squeeze solutions for round and flat scenarios respecting the dump constraints. The scenarios use the pre-squeeze of β*=48 cm to produce 15cm round and 40cm/10cm, 30cm/7.5cm flat β* in IP5. The optics use the additional strength provided by the double MQY in the last part of the squeeze. In particular Q5 right is just beyond the limit for a flat case, but without margin on β* reach and β* presqueeze. Stephane commented that one could circumvent this limitation by limiting the strength of Q5 in the matching process. Riccardo agreed that it is possible to attempt the optimization but added that it would be better to introduce this additional constraint when the other optics constraints will be fully clarified since it reduces the optics flexibility of the insertion. Stephane added that he has found optics that are compatible with the present LHC IR6 layout and also provide the phase advance between MKD and TCTs that are well apart from 90 degrees.

Report from Task Leaders:

Elias reported that the talks related to HL-LHC for the HL-LHC/LIU meeting are going to be rehearsed at the Task 2.4 meeting on Wednesday 14/10. He also noticed a discrepancy between the parameters of the TDR and those in the operational scenarios document. The discrepancy will be corrected.

Reported by Gianluigi and Riccardo