Minutes of the 45th WP2 Task Leader Meeting held on 27/03/2015

Participants: G. Arduini, R. De Maria, R. Jones, E. Métral, Y. Papaphilippou, T. Pieloni, A. Valishev.

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

Minutes were approved with comments from Massimo (clarify the strategy of the offset at the IP and possible limitations), Tatiana (updating the results of tune scans), Stephane (suggesting to look also at the $B_n(s)$ of D1).

On a question of Riccardo on the working point optimization, Tatiana commented that a good working point for the nominal bunch is also for Pacman bunches, based on LHC studies and experience. Yannis commented that for new optics and beam parameters, the studies should be repeated.

Gianluigi started a discussion with Stefano on the limited protected aperture in particular if one can gain at least in one plane when taking into account individual IR and crossing planes.

A draft of the updated operational scenarios has been circulated by Elias. Riccardo to provide IR8 update crossing schemes in version HL-LHCV1.0 hopefully within Easter.

Specifications for BBLR compensation with Wire embedded in TCT (present design) and e-lens scenarios. Required currents and expected minimum crossing angle achievable with flat optics (e.g. 30/7.5cm) with and without crab cavities (A. Valishev)

The study has been inspired by plan B from S. Fartoukh and aims at evaluating the range of parameters of BBLR specification (current, location, displacement) and the corresponding potential performance gain.

The tracking simulations are performed with levelling by assuming constant β*-ratio of 4 and 320 μrad of total crossing angle. Additional emittance blow-up from unknown sources has been added in the model. At beginning of the levelling no BBLR compensation is needed, at the end of the levelling however BBLR compensation is needed for small crossing angle, in particular for 320 μrad where the dynamic aperture in the absence of wire compensation would shrink to about 3 σ.

Gianluigi commented that the halo simulations could be repeated for the LHC for machine experiment in order to see if any measurable effect can be predicted.

The ideal location (based on driving term minimization) for the wire coincides with the one of the crab cavities. In the simulations the wire is placed at 9.3σ (for an emittance 2.5 μm) from the beam corresponding to 7.8 σ in the units used by collimation (i.e. for an emittance of 3.5 μm). It must be noted that for the present design of the compensator with a wire embedded in a TCT jaw the jaw would be at less than 6 σ while the TCTs should be set to 10.5 s according to the collimation settings proposed for HL-LHC. Wire strength of 198 A×m is required for the compensation assuming 2 wires per beam and per IP (one on each side of the IP). The footprint reduces in size and at the same time DA improves significantly when the wire is powered. Yannis commented that footprint features overcompensation and folding which may not be necessarily beneficial for diffusion; footprint optimization can be attempted and possibly achieve better results. Sasha replied that as Yannis correctly points out, folding of the footprint typically indicates over-compensation. Lower wire currents were tried but this did not lead to dramatic improvements in dynamical aperture. Additional optimization effort is needed of the wire current together with the working points and most probably, another 1-2 sigma may be recovered.

No solution could be found at 14 σ (2.5 μm) corresponding to 11.8 σ in collimation units, although some improvement can be seen from frequency map. Yannis would place the wire at 12 σ (2.5 μm) corresponding to 10.1 σ (3.5 μm). Gianluigi commented that presently the TCT are at 10.5 σ (3.5 μm) and, most optimistically no less than 9 σ (3.5 μm).

If instead of wire, one would use an e-lens, the needed strength would only be 33 A m. Sasha commented that β-ratio at the wire does not play a big role (ratio of 2 was assumed in the present simulations).

Gianluigi asked about the status of the implementation of the wire in SixTrack and Yannis confirmed that this will be presented by Andrei Patapenka at the next Beam-Beam meeting on Monday 30/3 (http://indico.cern.ch/event/384403/).

Rhodri asked whether the location in Q4-Q5 is possibly easier for the integration of the wire taking into account that the position presently proposed (between D1 and D2) is subject to a higher neutron flux.

Gianluigi thanked Sasha for the nice study and interesting results and suggested to

1) compare the performance of the wire in the presently assigned position (between D1 and D2) and in a position between Q4 and Q5 with that considered for the study (at the crab cavity location).
2) try to evaluate the dependence of the DA on the current of the wore for the studied configuration to see whether the considered value of 198 A×m lead to overcompensation and whether this has a negative impact in DA.
3) optimize the working point.

Action: Sasha

<u>Landau damping in the presence of BB and octupoles for the HL-LHC (T. Pieloni)</u>

Stability diagram are computed from tune spread taken from MAD-X tracking and used as input in the Pyssd code. For negative octupoles polarities the footprint reduce in size during the squeeze for small β* but before the ATS is fully developed. With fully squeezed optics the lattice octupole effects is enhanced by a factor of 2.5 in stability diagram for an increase of a factor 2.93 of the β in the arc. An asymmetry between negative and positive polarity is due to sextupoles. Tatiana asked if this can be reduced, mentioning a private communication from Stephane indicating a possible strategy. Riccardo commented it is would possibly imply changes of phase advances, for which he would like to keep some freedom for the time being.

Tatiana showed stability diagram plots as a function of the squeeze. At 40 cm negative polarity stability diagrams are smaller as compared to positive. In order to recover the tune spread, 8% larger β-functions are required in the arcs (with respect to an ATS squeeze starting at β*=44cm) at 40 cm linearly scaled from 0 at 70 cm and to 0 at 30 cm. In addition a half-separation of 2 mm instead of 0.75 mm helps in the reducing the effect to the long range and would also increase the footprint, but not as much as completely eliminate the need of larger β-functions. Gianluigi noted that the value of the half separation should be increased to 2 mm at high energy unless aperture issues are identified. **Action: Riccardo to verify that.**

In summary the negative polarity offers more area in the stability diagram than positive provided an 8% increase of the β function is applied in the arc and/or additional separation.

When discussing chromaticity, Elias proposed to set Q' to 3 as default value for the operational scenarios.

Report from Task Leaders:

Task 2.4 (Elias): Elias stressed the importance of having an update of impedance model of the crab cavities for each of the two cavity types and to have some information concerning the reproducibility of the resonant frequency of the HOMs and of the impedance spectrum around the fundamental mode. **Action: Gianluigi to re-iterate this point with Rama.**

Reported by Riccardo and Gianluigi