Minutes of the 51st WP2 Task Leader Meeting held on 19/06/2015

Participants: G. Arduini, R. Calaga, O. Capatina, R. De Maria, M. Giovannozzi, M. Fitterer, E. Metral, Y. Papaphilippou, R. Tomas, S. Weisz.

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

Previous agenda were approved without comments.

The preliminary agenda of the summer meetings will be circulated based on the availability of the participants.

In the last integration meeting Paolo mentioned that the region between Q4 and Q5 is considered for the installation of the DFBM. Yannis mentioned that this area could be of interest for the BBLR installation (following the results of studies performed by Stephane) and possibly for collimation. Paolo has been informed but in the meantime another location for the DFBM is being considered.

Herve provided a possible mapping for the installation of the MQYY quadrupoles as Q5. More than one option is possible. WP2 will see if any preference can be formulated based on field quality. **Action: Massimo, Riccardo**.

At the HL-TC meeting, there was a status on the space requests for IR4. Rama suggested trying to install the hollow electron lens in the dogleg. Gianluigi suggested a critical review of the positions of the various elements. Rogelio will lead that.

For the SPS crab-cavities test the location has been moved from LSS4 to LSS6.

50ns option is discarded as backup and replaced by 8b+4e, beam parameters have been provided by Giovanni to Gianluigi. Gianluigi will pass them to Rogelio to update the PLC parameter table accordingly.

Updated scenarios and simulations for the BBLR test (Y. Papaphilippou)

Yannis gave a general overview of the BBLR test by updating the information from what he presented at the LARP meeting.

Yannis reviewed the equation of the effects wire and gave an estimates on the wire current needed per encounter (5.5 Am for 1.15 10^{11} ppb). He noted that previous estimates of the requirements in terms of current were over-estimated by a factor two. The wire should be positioned at a normalized (w.r.t. beam size) distance from the beam close to the average BBLR separations to have the full compensation of the resonant driving terms. Stephane found that Ideal β aspect ratios are found to be 2 or ½. From a multipole expansion of a wire fields, one can conclude that putting in the wire on the opposite side of the "strong" beam cancel either the odd or even multipoles according to the sign of the current in the wire and for alternating crossing, the b2, b6, b10 effects on tune spreads (not phase dependent) cancel.

The nominal optics and layout shows that a new TCL (therefore an ECR) would be needed to provide wires in both sides of IR1 for one beam, which is the preferred scheme. The planning slipped by one year and installation is scheduled in the year end-technical stop 2016/2017.

The existing wire model in SIXTRACK has been corrected and a new one allowing introducing a generic field map has been added. First simulations were performed showing agreement with theory on simplified scenarios. The next steps are to develop equivalent MADX models and perform SIXTRACK simulations at 6.5TeV with different ingredient in order to cover all needs from benchmarking the theory and varying beam test conditions.

For the actual wire test, several set-ups and conditions have been described in terms of bunch train composition, beam separations, observable and diagnostics. Possibly new optics could be developed, however the commissioning time for high intensity may be very long. SPS wire test has been mentioned.

A full list of short term and long term plans have been detailed and, in particular, for the HL-LHC different layout options needs to be developed separately for wire or electron beams.

Gianluigi suggested to perform tests at 450GeV initially (with reduced crossing angles) this could relax the machine protection constraints and asked whether the optics requirements would be satisfied. Yannis will verify that **(Action: Yannis)** and added that an ultimate test at top energy would be more convincing. Both jaws of the installed collimators will be equipped with wires but likely only one of them can be powered at a time. Yannis will verify that.

The results of the simulations for the LHC experiment are expected in September.

Requirements on Crab cavity beam-based alignment (R. Calaga, M. Fitterer)

The specification of 80kW for the maximum power available for the crab cavities limits the acceptable offset of the beam with respect to the electrical centre of the cavity to +/-1 mm during collision because of beam loading. +/-2 mm offset could be accepted for short periods and would be at the limit of operation for nominal voltage. 3mm at 15% of the nominal voltage (i.e. before going in collision) are acceptable. Beam or live mechanical alignment will be attempted. Gianluigi asked whether the electrical centre of the cavities could be determined and fiducialized with respect to an external reference during the assembling. Ofelia mentioned that this is planned and they will aim at aligning the electrical centre of the cavities with respect to an external (to the cryostat) reference within ±0.5 mm (r.m.s.?) Rama pointed out that the feasibility of that should be confirmed during the SPS tests. Ofelia said that for the LHC one could conceive a system to align remotely the cryostats. A motorized option has implication on space, on top of complexity. Sylvain reminded that the triplets' jacks offers very similar functionality to the ones needed by a mechanical alignment of the crab cavity cryostats. In case of troubles, voltage can be reduced to gain margin. It is worth to have remote alignment to correct for long-term drift.

During the discussion, due to the combination of the effects (residual alignment, ground motion, orbit reproducibility, margins for luminosity optimization and possible IP transverse offsets) both remote alignment of the crab cavities cryostats and crossing knobs are required to provide the sufficient operational margin. Without alignment of the crab cavity cryostats or any beam based alignment, the operational margin would be given by:

> +/-1 mm – [+/-0.5 mm (initial align. error of electrical center)] - [+/- d_{mis} (alignment error between alignment campaigns)]
> = +/-0.5 mm – [+/-d_{mis}] operational margin

Assuming that:

1. the alignment error d_{mis} between alignment campaigns can be absorbed by the voltage margin in terms of acceptable beam loading (+/-1 mm offset in the crab cavities is the reference, whereas the limit from beam loading is reached at +/-2 mm), and
2. the misalignment of the electrical center with respect to the reference orbit can be compensated by:
    a. a mechanical alignment system of the cryostats (+/-$d_{align,mech}$)
    b. beam-based alignment of the crab cavities (+/-$d_{align,beambased}$), for which currently +/-0.5 mm are assumed and taken into account in the orbit corrector budget

the operational margin increases to:

+/-1 mm – [+/-0.5 mm (initial align. error of electrical center)] + [+/- $d_{align,mech}$] [+/- $d_{align,beambased}$] = +/- 0.5 mm + [+/-$d_{align,mech}$] + [+/- $d_{align,beambased}$] – [+/-$d_{residual\ msialignment}$] operational margin

This operational margin has to be sufficiently large to account for eventual changes in the crossing angle during the run and orbit deviation at the location of the crab cavities due to orbit reproducibility (e.g. drifts due to ground motion), margins for luminosity optimization and possible IP transverse offsets. It should be noted that the mechanical alignment as well as the beam-based alignment of the crab cavities only align two points in the crab cavity section, meaning it chooses the "best line" between the four cavities, but does not align all four crab cavities represented by [+/-$d_{residual\ msialignment}$] in the above equation.

Report from Task Leaders:

Task 2.4: Interaction with WP14 on TDI. The work on the impact of the crab cavity impedance on beam stability is continuing and a Task 2.4 meeting will take place on 1/7 to summarize the results. Rama is waiting for the latest information concerning the HOM for the two crab cavity models. He will contact Elias and Gianluigi once he will have the data.

Reported by Riccardo and Gianluigi