

Minutes of the 69th WP2 Meeting held on 07/06/2016

Participants: G. Arduini, N. Biancacci, X. Buffat, M. Giovannozzi, L. Medina, E. Métral, G. Iadarola, Y. Papaphilippou, D. Pellegrini, B. Salvant, G. Sterbini, R. Tomas, C. Voellinger.

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

Previous minutes have been approved without comments.

The actions from the past minutes are:

- Includes 11T dipoles in the baseline layout (Riccardo)
- Evaluate the triplet corrector strength for D2 (Massimo)
- Evaluate alignment tolerances for triplets (Rogelio)
- Impact of Inermet shielding on field quality for Q1 and Q2/Q3 (provided by Susana at the LARP meeting)
- Define the target β^* for p-Pb run in the future (Riccardo with John)
- Check temperature and operational current of MCBY in Point 1/5 (Ezio confirmed larger currents as Q5 is operated at 1.9 K).
- Collect the list of parameters for 200 MHz (Rogelio)
- Evaluate minimum bunch length for the given bunch charge (Gianni)
- Quantify limits of cooling capacity in the arc coming from cooling power and heat transfer from capillary (Gianni with Serge)

A recent review of the civil engineering work in IR1 and IR5 has evidenced an extra cost of it. Lucio and Oliver are looking for possible cost reduction and their impact on performance review. Operate with only two crab cavities per side per beam is being considered. The impact on integrated luminosity depends on the maximum acceptable pile-up density, operation at constant normalized crossing angle (instead of constant crossing angle) and reduction of the normalized crossing angle during the fill (based on the present performance of the LHC for which operation with 10-11 σ normalized separation appears to be feasible at nominal bunch population). It must be noted that both these measures make operation more complex (at present the crossing angle is kept constant during the squeeze) and they strongly rely on the feasibility of β^* levelling. Gianluigi and Rogelio stressed the importance of validating β^* levelling in operation (e.g. starting in IP8) during a meeting with Lucio and Oliver. Gianni asked how the 200 MHz scenario performs with only two cavities. Simulation have not been done. **Action: Rogelio to review the performance estimates for the different scenarios once the new baseline is confirmed.** Other possible measures are the staging of the installation of the large aperture Q4, MS in Q10, operation of Q5 to 1.9 K in IR6 on both sides taking into account the updated values of the β^* reach. Finally, Lucio has suggested increasing the thickness of the shielding in the triplets to further reduce the heat load at 1.9 K.

Points emerging for the US-LARP meeting (G. Arduini)

Gianluigi highlighted the point of interest and actions emerged in the LARP meetings, in particular the ones at the interface with other work packages.

For field quality:

- Update DA with latest field quality table including impact of field quality of fringe fields. Rogelio asked whether generalized multipole are provided, Riccardo confirmed that only the integrated 2D multipoles in the body and in the coil ends are provided. The compensation of the field errors of D2 with the non-linear triplet correctors should be considered too as suggested by Stephane at the WP2 meeting on 26/4.
- Extend the DA studies on Beam 2.

Action: Massimo.

Optics measurements:

- The need of the trim between Q2a and Q2b should be assessed. Riccardo will try to evaluate the impact on matched optics, however he highlighted that any uncertainty in the transfer function will introduce hidden variables in the model that would make the convergence of optics corrections slower. He stressed that known imperfections are much more manageable than unknown imperfections.
- Specifications for the waviness of the triplets, in particular tilt has to be studied.
- Power converter specifications needs to be completed.

Action: Riccardo, Rogelio.

Beam Stability and Electron Cloud:

- For the 200 MHz scenario, clarify any possible gain in the beam brightness achievable by the injectors (a meeting will take place on 9/6).
- Evaluate whether the wideband feedback can be useful for the LHC. Elias stressed that the point is to see whether a wide band feedback can reduce the strength of octupoles and chromaticity that are expected to affect the DA and lifetime.
- Update the injection working point based on the present LHC experience.
- Estimate the deviation of the distribution from Gaussian in presence of multiple/single scatterings. Yannis commented that distribution in simulations indicate that the core emittance blow-up follows the Gaussian theory, while non-Gaussian tails develop in simulations in particular at injection. In the machine, the vertical emittance growth observed at injection during Run 1 is not explained and it looks smaller in 2016 (effect of the new working point?).

Action: Elias, Yannis.

Evaluation of the RF-fingers “new design” for triplet

Christine presented the impedance measurement of the RF-fingers for the HL-LHC triplets for two samples:

- 2-convolution RF finger design ID=80mm,
- 3-convolution RF finger design ID=111mm.

Initial measurements were performed without outer bellow and did not show strong resonances that appeared when the measurements were repeated with an outer bellow. Simulation shows that the structure works as two coupled resonators. Wire measurement cannot fully qualify the resonances. Simulation shows that the structure works as 2-coupled resonator and, in particular, they are not suited to measure high-Q resonances and determine their shunt impedance therefore time-domain transmission was used. The coupling with the outer volume decreases when the fingers are stretched, which reduces the coupling. The measured electrical length appears always to be shorter than the mechanical one, which is not expected.

Difference may be explained with an imaginary part of the impedance due to the observed resonances that are nevertheless located at high frequency and should weakly couple with the beam. This needs to be confirmed with simulations.

Measurements have been carried out also with lateral movement and they did not show significant changes.

The 3-convoluted RF fingers behave similarly to the 2-convoluted ones without outer bellows but, differently from the 2-convoluted ones, the resonances are damped with the bellow. This behaviour is not understood. Simulations are needed to clarify these observations.

If problems are confirmed, mitigation measures include ferrites and HOM couplers.

Riccardo asked about the inner diameter since 111 mm of the objects does not fit with the typical aperture in the triplet. Benoit confirmed that the specification are 100 mm (for Q1) and 120 (for Q2-3) mm, however it is not clear why vacuum provided a 111 mm sample. **Action: Riccardo to check the design aperture with Cedric and inform Benoit.**

Gianluigi asked about the impact of a mechanical tilt, but Christine said that as long as voids are present in between fingers the structure react similarly.

The drawings shows that a double layer is present, but not aligned to cover the holes. Christine confirmed that the second layer was not well manufactured. It is not clear whether the manufacturing process would allow a staggered installation of the slots. Gianluigi asked whether randomized shapes could help. Christine did not see an advantage.

Benoit commented that modes are above 1 GHz, which are not critical in beam simulations, and seem to indicate that this design (in particular the 3-convoluted one) should be acceptable from the point of view of impedance.

Gianluigi asked whether a-C coating is considered for the RF fingers. Christine commented that coating could detach because of the contraction/extension movements. Gianluigi noted that this might lead to multipacting and therefore heat load and pressure rises that might result in background to the experiments sides: impact on build-up and mechanical stability. Cooling seems not provided (to be checked with Vacuum). This should be clarified with WP12, as it would result in additional heat load on the triplet. **Action: Gianluigi**

Reported by Gianluigi, Rogelio and Riccardo