

Minutes of the 43rd WP2 Task Leader Meeting held on 13/3/2015

Participants: G. Arduini, I. Efthymiopoulos, L. Esposito, M. Fitterer, M. Giovannozzi, T. Lefèvre, E. Métral, Y. Papaphilippou, A. Valishev

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

The minutes of the last meeting were circulated late and will be approved at the next meeting.

Tatiana is in contact with Riccardo concerning the possibility to start the ATS squeeze earlier in order to increase the stability diagram during the squeeze.

Gianluigi reported from the 14th PLC on 12.03.2015:

1. Presentation by R. de Maria on “Approval of new triplet length/gradient”: Riccardo gave an update on the new IT layout based on the reduction of the gradient to 130 T/m and resulting increase of the length of the IT magnets. The length of the magnets have been optimized also taking the new interconnect length into account. The new length of the magnets is now 4.2 m for Q1a/b and Q3a/b and 7.15 m for Q2a/b. L^* is not yet defined and a reiteration with the integration, the beam instrumentation and optics team is foreseen to find the optimal distance in terms of available space for equipment and optimization of the BPM position in relation to parasitic beam-beam encounters.
2. Presentation by S. Gilardoni on “80 bunch scheme option for HL-LHC - production in injectors” and R. Tomas on “80 bunch scheme option for HL-LHC - physics potential”: Simone presented the possibility to produce 80 bunches with nominal emittance and intensity instead of 72 bunches. For this new 80 bunch scheme the length of the LHC injector kicker plateau still has to be verified as well as the machine protection in case of injection failures during the SPS to LHC transfer. In his presentation, Rogelio analyzed the possible gain in terms of LHC performance. With the new 80 bunch scheme a gain of 5% integrated luminosity could be achieved without increased pile-up. He also presented the 8b+4e scheme and it was decided at the PLC to consider this scheme as backup in case of performance limitations due to electron cloud instead of the 50 ns bunch spacing scheme. The 8b+4e scheme allows achieving a higher integrated luminosity respecting the current pile-up limits for HL-LHC compared to the 50 ns bunch spacing scheme. Massimo also mentioned that with this scheme it would be possible to reduce the crossing angle and β^* thanks to the fewer beam-beam long range interaction.
3. Presentation by F. Savary on the “11 Tesla - new baseline”: Frederic presented the new baseline scenario for the 11 T dipole, which consists of the installation of the 11 T dipoles for ion physics in IR2 during LS2 and optionally in IR7 for collimation, while IR1 and IR5 are not part of the new baseline - also not after LS3. Massimo noted that the quench tests in IR7 might have to be advanced in order to clarify the need for an 11T dipole in IR7. Gianluigi commented that this point was also raised during the Cost and Schedule Review and Lucio will take it up at the LMC. Gianluigi also mentioned that in the 13th HL-TC (<https://indico.cern.ch/event/339901/>) it was requested to study the possibility to install vacuum valves without RF shielding around the collimator in the dispersion suppressor for integration purposes. However, at the 51st Collimation Upgrade Specification Meeting held on Jan. 30, 2015 (<https://indico.cern.ch/event/366694/>) it was shown and decided that the collimator length can

be reduced to 60 cm instead of 65 cm allowing then for sufficient space for shielded vacuum valves.

Follow-up of impedance open actions (triplet BPMs, beam screen design, unshielded vacuum valves for 11 T dipoles) (E. Métral)

Elias informed that all impedance related aspects will in future be addressed in the impedance working group meeting and not in the WP2.4 meeting as done in the past. Gianluigi agreed for the technical aspects related to the impedance but for HL-LHC aspects that have implications for other HL-LHC work-packages these should be discussed either in Task 2.4 or in WP2 task leaders meetings.

Elias summarized in his presentation the status of the impedance studies concerning triplet BPMs, beam screen design, unshielded vacuum valves for 11 T dipoles, the new back-up RF fingers, the IR3 CFC collimators, the crab cavities and other studies on-going.

In the 28th WP2 task leader meeting, a first design of the stripline BPMs has been presented together with a first estimate of the impedance. With this design, the contribution of the BPMs to the overall impedance budget is non-negligible and can be seen as an upper limit. Elias pointed out that the new design will not include any Tungsten-Inermet absorbers any more. Thibaut confirms later that at the moment the Tungsten-Inermet absorbers are still part of the BPM design. He also added that he has sent the most recent BPM design to Benoit last week. At the moment they have an optimal RF design and the mechanical design could be finished in about 2 months. He will then send the new design, once finished, to Benoit in order to do some first estimates by the end of summer. Luigi also noted that they should repeat the energy deposition studies in order to assess the effectiveness of the BPM shielded (in particular previous studies were performed under the conditions that shielded BPM would leave 10cm unshielded gap or 50 cm without BPM, while presently the scenarios are 25cm and 40cm, respectively) . **Action Thibaut to provide the new mechanical design Benoit with the aim to have an update of the impedance by beginning of September.**

Elias continued with a summary of the impedance studies regarding the LHC beam screen:

1. The aC coating of the LHC beam screen introduces an additional contribution to the imaginary part of the impedance but not the real one (C. Zannini, [TE-VSC meeting on 24/02/15](#)), which is responsible for the heating.
2. Following the [TE-VSC meeting on 24/02/15](#) a list of possible scenarios has been provided by N. Kos and will be studied by C. Zannini. Gianluigi asked if it is confirmed that a tapering angle of 15 degrees or smaller should be used. Elias confirmed.
Elias added that for the TAXS vacuum chamber copper with aC coating will be used as in this case no bake-out is needed. **Action Elias: send TAXS design to Elias for impedance estimates.**
3. The new beam screen will have 2 longitudinal welds and transverse welds every 3 m. In particular the shortly spaced transverse welds are expected to result in larger impedance and a reduction of the distance between the welds might have to be considered. The effect of the welds and their optimum (transverse) position is currently under study. Massimo commented if the longitudinal spacing of the transverse welds could not be chosen in accordance with the IT magnet length to reduce the number of transverse welds. Gianluigi asked if the brazing of the Tungsten on the Copper will change the conductivity of the copper and if this has an effect on the impedance. **Action Elias: check with the vacuum team if the conductivity of the Copper is changed by the brazing of the Tungsten on the Copper and check whether alternative solutions can be found for the transverse weldings.**

Gianluigi asked later if Elias confirmed the thickness of the copper coating of the beam screen and if he has taken bypass effects into account. Elias answered that he has considered this. Gianluigi also asked if the contribution of the eddy currents to the beam screen heat load has been estimated as requested at the WP2 meeting on 3/10. Elias replied that he has not yet followed that up with Ezio. **Action Elias: discuss with Ezio the heat load due to eddy currents during the ramp of the magnets.**

Furthermore, measurements of the new design of the RF fingers for a possible implementation in the dispersion suppressor collimators have been performed. The measurements showed some electromagnetic leakage through the fingers when the outer bellow is mounted leading to large resonances. Elias emphasized that, in particular in regions with high beta functions (e.g. the inner triplet), these resonances are amplified proportionally to the beta-function and the applicability of this RF finger design in these regions should be carefully studied. First simulations of the new RF fingers have been done in order to better understand the measurements. In these first simulations the RF fingers have been replaced by a perfect shielding following the convolutions but without electro-magnetic leakage. In this case a small $\text{Im}(Z/n)$ is observed in the longitudinal plane with a small resonance around 1.8 GHz. The transverse plane also shows a small $\text{Im}(Z/n)$, however a large resonance is visible around 1.6 GHz, which could become dangerous. Following these first simulations, the resonance in the transverse plane should be understood, the effect of the convolutions studied and some electro-magnetic leakage included in the simulations.

The HL-LHC stability limit with IR3 and IR7 Mo-coated Mo-Gr collimators has been presented at the 4th Joint HiLumi Annual Meeting. Following a request from S. Redaelli, the scenario with only IR7 Mo-coated Mo-Gr collimators and keeping the IR3 CFC collimators is currently analysed. **Action: Elias to update the stability limit in case Mo-coated Mo-Gr collimators are installed only in IR7.**

The estimated transverse kick factor for single and coupled bunch for the crab cavities have been presented in the [19th HiLumi WP2 Task 2.4 meeting](#). The transverse kick factor for single bunch is estimated to be around 1.4 V/mm pC leading to 50 kV for a bunch with $2.2 \cdot 10^{11}$ ppb displaced by 1 mm instead. Elias added that these results will be further checked. In the coming [20th HiLumi WP2 Task 2.4 \(and 2.7\) meeting](#) the impedance of the crab cavities, the list of HOM modes considered, the operational scenarios and the longitudinal beam parameters for HL-LHC will be discussed.

The estimate of the LHCb VELO have been presented at the [VELO Upgrade RF Foil Workshop \(LHCb \)](#). The longitudinal impedance is expected to be around 5% of the full LHC impedance (instead of presently 1%) and the transverse impedance is expected to be small due to the smaller β^* . Furthermore, some first estimates have been done for the new design for the stochastic cooling. Gianluigi noted that the option of stochastic cooling is at the moment not considered as baseline. In connection with the study of the impact of radiation on the conductivity of materials, the impedance team will provide tolerance limits and their dependence on the resistivity. Concerning the hollow electron lens, the impedance team is currently waiting for the first design. Also for the TDI the impedance teams is waiting for the first design. Elias noted that it is presently proposed to split the new TDI jaw in 3 for mechanical reasons. This would not be optimal for impedance as it increases the number of transitions. Moreover, the MKI optimisation is on-going.

Elias asked whether the diameter of the TAXS could be increased to increase the tolerance for misalignments. Gianluigi and Massimo replied that the requirements for aperture at injection for the TAXS are going to be presented soon and provided that sufficient beam stay clear is provided there is no reason to exclude that. Luigi added that the past energy deposition simulations showed that there is no strong constraint on the TAXS aperture from that. Gianluigi and Massimo reminded that an analysis of

the failure scenarios was requested to clarify the requirements in terms of aperture for the TAXS.

Action: Ilias

Gianluigi reminded that the list of actions is available at:

<https://espace.cern.ch/HiLumi/WP2/Wiki/Team%20Discussions.aspx?&&View={bdcd6f32-0b23-4f14-b525-f77a22ea9a41}&SortField=AssignedTo&SortDir=Asc>

and encouraged the Task Leaders to consult it an follow-up. **Action: Task Leaders.**

Reported by Gianluigi and Miriam