WP2 Meeting #190  
Mon 19 April 2021, 09:00 – 10:30

Chair: Rogelio Tomás  
Speakers: Ezio Todesco, Frederik Van der Veken, Xavier Buffat  
Participants: 19 Roderik Bruce, Xavier Buffat, Riccardo De Maria, Stefania Farinon, Hector Garcia, Massimo Giovannozzi, Pascal Hermes, Gianni Iadarola, Dobrin Kaltchev, Elias Métral, Nicolas Mounet, Andrea Musso, Tatsushi Nakamoto, Yannis Papaphilippou, Konstantinos Paraschou, Arnaud Pascal Foussat, Stefano Redaelli, Benoît Salvant, Ezio Todesco, Rogelio Tomás, Frederik Van der Veken.

### AGENDA

<table>
<thead>
<tr>
<th>No.</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Meeting Actions</td>
<td>1</td>
</tr>
<tr>
<td>2.</td>
<td>General Information and News (Rogelio Tomás)</td>
<td>2</td>
</tr>
<tr>
<td>3.</td>
<td>Field Quality Measurements of D1 and D2 with a Single Coil (Ezio Todesco)</td>
<td>3</td>
</tr>
<tr>
<td>4.</td>
<td>DA Acceptance Criteria for the Non-Linear Corrector Package (Frederik Van Del Veken)</td>
<td>4</td>
</tr>
<tr>
<td>5.</td>
<td>AOB - Instability Latency with the E-Lens Residual Dipole Kicks (Xavier Buffat)</td>
<td>5</td>
</tr>
<tr>
<td>6.</td>
<td>Round Table and Agenda of next meeting (Rogelio Tomás)</td>
<td>6</td>
</tr>
</tbody>
</table>

### 1. MEETING ACTIONS

**Rogelio, Elias**  
Following proposal from Yannis, establish which kinds of measurements we could/should propose to better understand the HEL (and we should gradually start the simulation work to see the expectations).

**Philippe**  
Provide new estimates of emittance growth using the rms tune spread values during the fill computed by Xavier.
2. GENERAL INFORMATION AND NEWS (ROGELIO TOMÁS)

Rogelio mentioned that the HL-LHC Hollow Electron Lens (production) kick-off meeting took place last Tuesday 13/04/2021 (https://indico.cern.ch/event/1014640/). Minutes are not released yet but Rogelio asked already to have a summary (on WP2 aspects) during a forthcoming WP2 meeting. Rogelio thanked again all the TLs and people who contributed to all the comments made in the Google Doc prepared by Rogelio (for the HEL Functional Specs) which was very useful and which was sent to Stefano. This is during this exercise that Xavier raised a concern linked to the residual dipolar kick (coming from the asymmetry between start and end fields): this will be discussed today in the third talk.

Rogelio mentioned that unfortunately neither him nor Elias could attend the TCC this time (Elias and Roderik could join for short parts) but there was nothing special for WP2. Markus Z. recommended having a look at the presentation of the STI colleagues on interesting studies and validation program they propose for new absorber materials.

Nicolas mentioned that we received an email from Chiara B. concerning the BETS TCDQ upgrade and that they need to know about the need for the BETS TCDQ upgrade at the latest one year before the start of LS3 so by the end of 2023. Rogelio mentioned that Riccardo will soon have a look to try and find an optics and we will need to report about it during a TCC meeting before the Cost & Schedule in November 2021.

Elias reminded everybody that the 3rd TCC Day is taking place tomorrow (https://indico.cern.ch/event/1022433/).

Rogelio went through the minutes and actions of the last but one meeting which was a Special Joint HiLumi WP2/WP4 Meeting on 23/03/21:

- Philippe, Rama: Report to the TCC on the update of the noise estimates and the related emittance growth rate from the crab cavities together with mitigations (Q4 2021). It should be considered to bring this up to the project attention before the C&S in case there is an additional cost during the common WP2-WP4 meeting foreseen in May below.

- Philippe, BI: Provide the feedback pickup specifications to BI (timeline to be defined) and to WP2 concerning new estimates of emittance growth with the rms tune spread provided by Xavier.
• **Ilias, Rogelio**: Provide new performance estimates in case no solution is found to reduce the emittance growth from the crab cavity, aiming at May common WP2/4 meeting.

• **Xavier, Nicolas, Philippe**: Check the impact on stability of a head-tail feedback used to damp the crab cavity noise (first estimates aiming at May common WP2/4 meeting).

• Concerning the heat load, **Rogelio** added that we should not forget to ask to **Rama** to come back in the future once he has some results of the SEY.

Finally, **Elias** went through the minutes and actions of the last (189th) meeting he chaired on 06/04/21:

• **Sofia, Riccardo**: Present in the TCC the conclusion of WP2 concerning the NoMS10 option and follow-up, if also endorsed by TCC, with the write-up of an ECR.

• **Roderik**: Follow up the new IP2 aperture with detector colleagues. **Roderik** mentioned that they want to check first with **Riccardo** the aperture with ion optics at beta* = 0.3m as there could be an issue.

• **Riccardo, Benoit**: Pass new IP2 aperture information to **Benoît** for impedance OK.

### 3. Field Quality Measurements of D1 and D2 with a Single Coil (Ezio Todesco)

**Ezio** presented, as he said, some good news overall of magnetic measurements for Q1 (MQXFA07), D1 and D2 (still debatable here as mentioned by **Rogelio**, see below):

• **Q1 MQXFA07**
  - Transfer function within the previous measured values. Full width of spread of about 60 units. This does not include yet contribution from magnetic length.
  - Room temperature magnetic measurements show multipoles within expectations.

• **D1**
  - Measurements made on the magnet only on a limited part (1.5 m out of 7). This is a special additional measurement carried out in Hitachi by KEK personnel, not foreseen in initial plan and added to have an earlier indication on FQ.
  - Most critical components are b3 and b5 – they are within 2 units from what expected, and therefore we should end up within the requirements already with the prototype. In June, we will have completed magnetic measurements carried out in KEK.

• **D2**
  - First aperture was collared one month ago.
  - Aperture had a interturn short; nevertheless, magnetic measurements were carried out to squeeze as much information as possible, even in a nonconforming situation.
Most critical components are the value of b3 (should be within 3 units) and b5 (within 5 units, and no strong impact up to 10 units). Actually, in functional specifications b5 is +4 units.

This is badly coupled with larger coils, requiring to use a non-nominal shimming.

First indications:
- We could have a very large b5 (17 units, first method).
- We could have a large b3 (9 units, second method) and a large b5 (11 units, second method).

Conclusions
- The copper wedge production for the D2 series was not given the OK.
- Agreed with ASG company to postpone the series coil winding from June to September => Good news, as we have more time to react.
- We just had the second collaring and we will have soon a magnetic measurement, hopefully without any anomalies.
- A second aperture could be collared in May.
- By June we could have magnetic measurements of two apertures in the yoke – this is the most reliable measurement we can have to anticipate if a fine tuning of cross-section is needed or not.

Rogelio commented that for D2 all the data are out of specs so it is maybe not that clear that it is good news. But let’s wait for the other (more precise) measurements with two apertures.

Rogelio reminded also that for D2 the beam pipe is also contributing with an extra 1 unit. Ezio mentioned that was checked and that it is smaller by a factor 2. Still, Rogelio mentioned that during our meeting in July we should combine all the info and not forget the impact of the beam pipe.

4. DA Acceptance Criteria for the Non-linear Corrector Package (Frederik Van Der Veken)

Frederik reminded the acceptance criteria for the Non-linear Corrector package (NLC), mentioned the assignments of misalignments (x, y and angle) and discussed the impacts on DA of both magnetic errors and misalignments.

- Impact on DA of magnetic errors
  - For both a3-a7 and b3-b7, similar results are obtained:
    - Lower orders have cancellations and increase DA, which is to be disregarded (as this won’t necessarily be reproduced in reality).
    - Higher orders have no impact.
• Similar behaviour in all seed lines
  
  o Impact of the reference field. This is studied by artificially scanning the impact on DA for multipolar components computed at nominal reference strength or assuming a maximum powering of the NLC package (keeping nominal powering in simulations)
    
    ▪ At nominal reference strength, DA under control.
    ▪ At maximal reference strength, DA drops a lot.
    ▪ With minimum DA far below target.
    ▪ Currently no issue, as needed corrector strength low enough.
    ▪ If this would change, deeper investigation needed.

• Impact on DA of misalignments
  
  o No impact on DA up to ±2 mm (same for horizontal, vertical and rotation and all together).

Rogelio commented that in the alignment document the NLC package magnets will be aligned with a precision of ±4 mrad, instead of ±2 mrad. Massimo argued that based on the studies from Frederik, it is reasonable to expect that the impact will remain negligible. This will be checked in future studies.

5. AOB - Instability Latency with the E-Lens Residual Dipole Kicks (Xavier Buffat)

According to Sondre F.'s formula, the latency scales with the noise amplitude squared. For the brightest BCMS bunch at flat top and a residual kick of Δ = 3 nrad (as it recently appeared in draft document of the HEL Functional Specs, coming from the asymmetry between start and end fields), this leads to a latency of ~3 min. As the formula is known to be optimistic by a factor ~2 wrt to self-consistent models, this prevents the usage of the HEL at full power for more than ~1 min at flat top. Therefore, it was recommended in comments of the HEL Functional Specs to decrease the residual kick to Δ = 1 nrad. With this value, the latency becomes ~30 min, which gives sufficient time for any HEL manipulation.

Xavier reminded us that this is for the power scheme called R0.5 and the concerns is the operational procedure with the HEL before collision.

Rogelio added that the residual kick of Δ = 3 nrad could lead to a lumi loss of about 1% when used during the entire fill and therefore, also from the point of view of lumi, it would be good to have no reduction from this new equipment.

Following the discussions at the HEL kick-off meeting of last week and possible tests, Yannis mentioned that for him the big question is: how do we qualify the full system? He proposed that through WP2 we establish which kinds of measurements we could/should propose to better understand this new equipment (as he thinks that if time and budget permit we should make these measurements). Xavier presented a non-exhaustive list of other possible sources of residual kicks (e- beam position jitter, e- beam image currents, e- beam azimuthal asymmetries, electron losses
through the lens, etc.). Furthermore, Yannis mentioned that at the same time we should also start some simulations to see what we expect.

Roderik asked about the specification from the instability team about the latency time. Xavier, Elias and Rogelio agreed that the value proposed by Xavier (30 min from the formula) looks reasonable as between 5 TeV and collisions we foresee 20 min in the operational scenario.

Stefano mentioned that several aspects could be looked at to try and reduce the residual kick as the residual field scales more than linear with current. Using 4 A instead of 5 A at flat top to clean the tails could be enough. All this will be carefully studied in the future.

Yannis reminded us that the HEL is an in-kind contribution from our Russian colleagues but at some point, we will need to operate and understand this equipment for HL-LHC, so we will have to gradually work on all these aspects and perform our studies (even if we don’t have the resources at the moment...). Rogelio supported this also following the recent work from Nicolas, mentioning that for collective effects many quite involved simulations remain to be performed.

6. ROUND TABLE AND AGENDA OF NEXT MEETING (ROGELIO TOMÁS)

The agenda and date of the next meeting will be announced in due time.

Reported by E. Métal (with Rogelio, Nicolas, Ezio, Frederik and Xavier: many thanks!)