WP2 Meeting #154

Tue 23 July 2019, 10:00 – 12:00

Chair:	R. Tomás
Speakers:	R. De Maria, S. Izquierdo Bermudez, E. Todesco
Participants:	J. Andersson, S. Antipov, P. Fessia, L. Fiscarelli, M. Giovannozzi, M. Gonzalez de la Aleja Cabana, M. Modena, N. Mounet, J. Oliveira, F. Plassard, M. Sabaté-Gilarte, G. Sterbini

AGENDA

The meeting was devoted to magnet field quality measurements and various issues related to the progress on v1.5 optics.

MEETING ACTIONS

Massimo	Investigate the impact of b2 in the D2 dipole and provide acceptable limits for it
Ezio	Provide an update on D2 measurements by October
Riccardo	Update the aperture values in D1 and TAXN-D2 areas
Riccardo	Find out what the strength required for the non-conform MQTLs would be for further optimization

GENERAL INFORMATION (R. TOMÁS)

At the previous meeting a new feature of Power Converter (PC) stability – the stability shortly after the end of the ramp - has been raised by Miguel. With no immediate issues seen by WP2 Miguel and Davide will proceed with the documentation of PC specification.

Another important topic, the stability of linear coupling in Run 2 will be reviewed by Tobias, following the talk by Xavier, in one of the next meetings.

1 FIELD QUALITY IN THE TRIPLET (S. IZQUIERDO BERMUDEZ)

Five short models and two long prototypes have been built and tested, two more long prototypes are under assembly. Among the short models the setups were different, for example the AP1 has coils of different cross section.

Transfer function measurements are in line with expectations. Longitudinal field variation was measured at ±5 units for short models and up to ±10 for long. Magnetic measurements at room temperature reveal a ~10 mm discrepancy in magnetic length for some prototypes. It is required that the integrated gradient is within a 10 unit spread. The measurements will be repeated at cold. Cycle-to-cycle reproducibility is at the level of 1 unit for short models (dominated by measurement resolution), while 0.1 or better is required; more measurements are needed.

Several corrective actions have been taken in the process. First, some short models had non-allowed multipole values, in particular a4, b5 (for short models). High Order (HO) corrector strength has been increased by increasing their length to correct the multipoles. The long prototypes comply with the multipole requirements. Then, systematic field errors between -3 and -6 units of b6 were observed. A fine tuning of cross-section has been performed with the insulation thickness adjusted – both the pole and the coil were acted upon to correct 4 units in b6. The first magnet featuring the new layout will be coming soon.

Magnetic shimming has been tested; the obtained corrections of a4, b3, and b4 multipoles are in line with expectations. Cold-warm correlation test shows a small difference in the strength of harmonics, therefore measurements at room temperature can be used in the future as representative of multipole strength at 1.9 K.

- **Rogelio** inquired when the magnets with adjusted insulation thickness will be tested. **Ezio** reported the plan is to measure BP2 by Spring 2020 and a4 correction – beginning of next year.
- **Michele** asked about the outliers in the cold-warm multipole comparison plot. **Suzanna** explained it was the magnet with mixed coils of different conductor types. In the future with uniform coils the discrepancy should disappear as seen in later magnets.
- **Rogelio** asked to clarify the accuracy of the transfer function measurement. **Lucio** replied a transfer function can be measured with a 10 unit accuracy due to calibration uncertainty; for

cycle-to-cycle measurements a special set up was used with resolution down to 1 unit. It is expected that the cycle-to-cycle reproducibility is better than 1 unit, but it cannot be measured at that level with the present setup. **Rogelio** pointed out that 1 unit reproducibility would not be comfortable for operation.

2 FIELD QUALITY IN D1 AND D2 (E. TODESCO)

Three short models of D1 were assembled in Japan, two of which were tested at KEK. No measurements have been done at CERN yet. Changes of cross section are ongoing between short models, and another one is foreseen for the prototype. Transfer function is in good agreement with 3D models in OPERA. The first short model had multipoles close to the target with an agreement in b3 within 3-4 units and b5, b7 – better than 1 unit. After the iron shape adjustment made on CERN request to accommodate cooling lines a large discrepancy appeared in the second and the third short models. The b3 is off by 20 units. This nonconformity seems to be a purely geometric effect, investigation is ongoing. D1 has a large flexibility to adjust the wedges thanks to their machining manufacturing process.

Compared to D1, D2 is a less complex magnet. For D2 room temperature magnetic measurement data is available for two short models. All the multipoles are within 1 unit except b2, b3, and b5. The out-of-tolerance wedges seem to be causing the discrepancy in b3. There is an indication of possible issues with b5, larger than 3 units but there is no need to change the cross-section right at this point.

- **Rogelio** asked to clarify the timescale for D1 magnets. **Ezio** replied that by the end of July the new cross section has to be done. A prototype will be built by mid-2020 and test by the end of the same year.
- **Rogelio** raised a question on the non-conforming b2 in D2 magnets. **Ezio** replied that for b2 one needs to account for iron saturation, for which no data is available and about the tolerable magnitude. **Massimo** replied the b2 is something that has to be carefully checked as it might have an impact on β-beating (Action: **Massimo**). Ezio promised to come back with an update on D2 by October (Action: **Ezio**).

3 OPTICS V1.5 UPDATE (R. DE MARIA)

Optics v1.5 is expected to be released in October together with the drawings. The current v1.4 optics, which is the first one to feature matching section optimization and remote alignment and which was used for the TDR, was released in September 2018 without the accompanying drawings.

V1.5 changes include longitudinal position non-conformity of TAXS, elongated beam screen in D1, optimization of TAXN-D2 area, changes in crab cavity positions, and possible new positions of TCT6 collimators.

Pending decisions include exact TAXS position and length, TAXN Cu length, D2 BPM length, position of TCT6 protecting Q5, and possible rotation of Q4. The Q4 rotation has a major impact as it might require a change of optics files. It allows gaining aperture in Q4 with minor implications for orbit corrector budget.

Ongoing studies include alignment requirements for full remote alignment specifications, redefinition of mechanical aperture of BPMs, update of orbit corrector budget, optics optimization with/without MS10 (a baseline element), optics scenarios for combined Ramp and Squeeze as well as flat optics with crab cavities, BGV location optimization, and optimization of the beam size at the window of the dump to minimize stresses to the window. The beam size optimization at the dump window require relaxing MKD/TCT phase advance only for flat optics (with V crossing in CMS) and allows increasing the beam size at the dump by ~10%. Further optimization is limited by non-conforming MQTL.

There are some issues with alignment. Crab cavities may need a small shear, up to 0.8 mm in the crossing plane depending on the available strength of MCBRD. This can be done by the flexible bellows that are already foreseen. The cavities should be aligned to ±0.5 mm. Alignment priorities go as follows: first, the crab cavities, then the quadrupole magnetic centers (orbit), and finally the beam screens (aperture). Some quantities needed for alignment tolerance studies need to be updated and synchronized with Vacuum, in particular for D1 and TAN-D2 area apertures.

- Regarding the TAXN-D2 area, **Paolo** inquired if Riccardo is aware of a new object near TAXN and suggested requesting the information and forwarding it to Riccardo (Action: **Paolo**).
- For the TCT6, **Joao** noted a 1 m displacement has been agreed upon, they are in contact with WP5 for this matter. **Riccardo** suggested getting in touch with Stefano and Roderick for this matter (Action: **Joao**).
- On the D2 BPM length **Paolo** stressed the length has been fixed. He proposed to organize a meeting with Riccardo and other interested parties by the end of the week to review the issue and finally close it (Action: **Paolo**, **Riccardo)**.
- On the Q4 rotation **Paolo** proposed if the decision is made by the end of August to include it, if not – to go ahead as is.
- Regarding the aperture, **Massimo** pointed out it is strange that WP2 and WP12 are doing aperture computations independently, emphasizing that the final number should come from WP2 (Action: **Riccardo** to update the aperture values in D1 and TAXN-D2 areas).
- Reviewing the minutes, **Gianluigi** asked to verify what would be the strength required for the non-conform MQTLs for further optimization (Action: **Riccardo**).

4 FOLLOW-UP AFTER THE MEETING

For the object near the TAX, **Riccardo** reported that BI proposed to replace the BPM close to D1 with a head-tail monitor close to TAXN for crab cavities. This option has several challenges, the first being that the phase advance between IP1 and 5 is a handle for beam lifetime optimization, and the second - the geometries close the TAXN are not trivial for an head-tail monitor.

For the BPM in D2, a meeting including Paolo Fessia has been held; the sides reached a consensus on the technical solution. An ECR will be circulated.

The final TAXN length has been settled at 3.452 m by Francisco.

The new TCT6 position has been agreed upon by Stefano.

Reported by S. Antipov