236th Meeting of the Machine Protection Panel - Joint meeting with the Collimation Working Group

LHC topics

May 12th, 2023, via Zoom

Participants:
To-Do.

The slides of all presentations can be found on the website of the Machine Protection Panel and on Indico (236th meeting) and on the Indico page of the Collimation Working Group.

Minutes and actions from the 235st MPP meeting (Injectors topics)

Daniel commented that the minutes from the last MPP meeting (Injectors topics) have not yet been sent. The minutes from the last MPP meeting on LHC topics have been sent and no action is pending.

Observations from tomography and mechanical movement tests and proposal for insertion of VeLo after TS1 (V. Coco)

Victor started to recall the recovery plan as discussed by J. Sestak at the 457th LMC. Three main observations can be made from the recent tomography measurements:

- No visible broken rf finger on the upstream wakefield suppressor.
- No damage to the SMOG cell.
- The transverse position of the cell w.r.t. the foils is identical to last year.

In addition, no broken rf finger is visible at the contact point between the foil and the SMOG cell. The shape of the fingers is as expected. The detailed view of the exact shape of the fingers was shown. Victor added that it can be monitored with beam at different positions of the rf box (rf foil).

Concerning the deformation of the rf foil, the maximum displacement on the C-side is 1.7 cm. On the A-side it is 1.8 cm. The tomography data show a further 18% reduction in aperture compared to simulation. The shape is slightly different than predicted by the simulations, and the foil shows up to 30% more displacement.

Roderik asked if the difference between simulation and tomography is understood. Victor replied that the agreement is rather good. Daniel asked to confirm that only the 18% concern the aperture reduction, not the up to 30% change. Victor confirmed and added that the 30% figure affects the final closing value of the VeLo as the two halves should not touch.

Victor added that for the aperture calculation at injection, the beam position is considered, including the separation.

Concerning the recovery of the motion system, the movement observed during the event due to the force applied to the rf box was mainly recovered during the rebalancing. A residual displacement of the top support by 1.25 mm on the C-side was observed. It could indicate an elongation or damage to the coupling piece between the detector support and the gear box.

A good response of the system during the first mechanical tests has been observed. In the lab, deformation compatible with the residual movement of the halves was observed. On May 4 one half at a time was closed to inspect the mechanical coupling pieces. The system's response was good, and it could move correctly between 30 mm and 10 mm. No rotation was observed. Victor added that it is difficult to provide a definite answer regarding traction deformation due the light reflection.

Victor described how the maximal closing position from the foil perspective can be estimated. The estimation is still being finalized but the final gap will be between 34 and 36 mm (the nominal closing gap value is 0 mm). As a reminder, the gap is defined as the distance between reference points on the two halves. The aperture will be estimated at this maximum mechanical closing. If the aperture is smaller than 3 mm the mechanical closure will be reduced (increased gap) so that 3 mm aperture is always respected. Before reaching the smallest aperture, it is proposed to perform a tomography to confirm the aperture at an intermediate VELO position.

Discussion

It is agreed that the final "closed" position will be kept for 1 hour at each intensity step in the intensity rampup after TS1. On the 400-bunch fill a tomography will be performed at 2 mm from the final closest position to confirm the aperture.

Benoit asked if Victor could share the 3D geometry of the foil so that the impedance can be simulated. Victor replied that he will attempt to extract a surface from the cloud of points to produce a CAD file. Benoit added that before agreeing to insert the VeLo, the impedance should be simulated with the actual foil shape.

Action: Share a 3D model of the foil shape (V. Coco) and perform impedance simulations (B. Salvant).

Benoit asked about the vacuum gauges. Gregory will verify the status with Josef. After the meeting Josef confirmed that one vacuum gauge was indeed lost. However, there is a redundant vacuum gauge close by and another one 3 m away, which should allow for sufficient coverage of the vacuum level.

Christoph commented about the intensity ramp-up. Benoit asked to add one step at 1800 bunches. The 12-bunch step can be skipped. Daniel asked how many hours are required at these extra steps. Benoit replied that 1 fill with the VeLo inserted for 1 hour is sufficient.

Daniel asked Christoph to derive a proposal for this specific ramp-up.

Roderik asked if the VeLo aspects of the ramp-up are explicitly part of the checklist. The tomography is not covered and should be added.

Action: Proposal for the post TS1 ramp-up and for the documentation of the VeLo-related checks (C. Wiesner).

Daniel asked if more aperture measurements are required. Roderik proposed to first confirm from the tomography where the bottleneck is located (longitudinally). This can then be used for the aperture computation. If it matches the model, then aperture measurement will not be required.

The consistency checks between the tomography results and the aperture measurements have been presented by P. Hermes at the Collimation Working Group #272. The results of the beam-based aperture measurements are consistent with the tomography results.

Roderik asked if the final closed-position gap will be available before the LMC. Victor replied that he will attempt to finalize that information.

After the meeting, Victor has presented results regarding the allowed closed gap value at the LMC #463. A circular aperture of 3 mm is obtained for a gap of 30 mm. This needs to be further confirmed.

Roderik asked about additional tests of the motion system. Victor replied that the motion system will be tested multiple times (O 10) during the TS.

Re-qualification loss maps after collimation settings update (N. Triantafyllou)

The cleaning inefficiency in the DS of IR7 has been worse than last year for B1 horizontal at top energy after the tune change. Also, a large “banana factor” (amplitude of the losses on the downstream part of IR7) was observed. Two collimators are known from the initial alignment to have a large tilt: TCSPM.E5R7.B1 and TCSPM.6R7.B1.

Tests on 13 April showed that with angular alignment of the BPM collimators in IR7 and after retracting the TCSPM.E5R7.B1 by 500 μm the cleaning can be improved. However, these settings were not implemented operationally, since it was not deemed critical and further tests were planned in MD1 with the goal of updating the settings after TS1. Fill 8694 was dumped on losses trigerred by the BLM at 31 kw on the TCLA.D6R7.B1. The dump losses indicated issues with the lifetime and decreased cleaning performance which were blocking the intensity ramp-up, triggering the review of the collimator settings.

Four new configurations were tested:

1. Nominal settings for TCSPM.E5R7.B1 and TCSPM.6R7.B1
2. TCSPM.E5R7.B1 retracted by 500 μm (8.2 sigma) and TCSPM.6R7.B1 at nominal settings
3. TCSPM.E5R7.B1 at nominal settings and correction of the tilt of TCSPM.6R7.B1 (effective retraction at 7 sigma)
4. TCSPM.E5R7.B1 retracted by 500 μm and correction of the tilt of TCSPM.6R7.B1 (effective retraction at 7 sigma).

A general improvement of the DS inefficiency and of the “banana factor” were observed with the new settings. Configuration two was found to provide the largest improvement without any degradation in IR6, which was observed for configuration four.

In addition to the change in IR7, the vertical IR1 TCTs were re-aligned following the change of the crossing angle in ATLAS.

As revalidation a sub-set of loss maps from flat top to 30cm were performed (see Fig. 1).

450 GeV	6.8 TeV																														
	Injection		Non colliding			Colliding XRP OUT			Colliding XRP IN																						WIRE
									Anti-telescopic													Telescopic								
	Prot. IN	Prot. OUT	FT	EoS / EoR	QC	120 cm	60 cm	30 cm	120 cm	112.5 cm	105.5 cm	99 cm	93 cm	87.5 cm	82.5 cm	77.5 cm	72.5 cm	68 cm	64 cm	60 cm	56 cm	52 cm	48.5 cm	45 cm	41.5 cm	38.5 cm	35.5 cm	32.5 cm	30 cm	30 cm
B1H			✓						✓				✓				✓			✓		✓		✓			✓		✓	✓
B1V			✓						✓				✓				✓			✓		✓		✓			✓		✓	✓
B2H			✓						✓				✓				✓			✓		✓		✓			✓		✓	✓
B2V			✓						✓				✓				✓			✓		✓		✓			✓		✓	✓
+dp/p																				✓										✓
-dp/p																				✓										✓
ASD																				✓										✓

Figure 1 Revalidation loss maps following the changes in IR7 and IR1.

In the new loss maps, the inefficiency and “banana” factors are back to the levels of 2022. The TCSP losses are at similar levels as the first 2023 validation up to 60cm. For lower values, a clear improvement is seen for B1H. The TCT losses in IP1 are lower than in 2022 below 35 cm. In IP5 they are lower than in 2022 below 45 cm.

In conclusion, the retraction of the TCSPM.E5R7.B1 led to an improvement of the cleaning compared to the first validation round in 2023. The reason of the worse cleaning performance observed in B1H before the retraction of the TCSPM needs to be understood with simulations.

Discussion

Belen asked if it is understood why the losses on the TCSP in IR6 are higher than in 2022. Roderik replied that this is unknown so far. Frederik confirmed and pointed out that the E5 collimator is not the root cause of the issues (same position as last year). Something else drives the higher losses there.

Daniel asked about the collimator angular alignment in IR7. Daniel asked if this could be used for the settings generation tools. Roderik replied that an MD is planned for MD block 1. Function generation tools are adapted. However, aligning the E5 with an angle led to hierarchy breakage when it was first tried in 2023.

Daniel mentioned the physical realignment of the collimator during the next LS. Roderik mentioned that options are evaluated for the TS already. It was already re-aligned about one year ago based on observations in the initial 2022 commissioning. Stefano commented that something is not understood on that collimator as no issue was found last year despite same angle.

Summary of actions

The pending actions from the meeting are:

- Observations from tomography and mechanical movement tests and proposal for insertion of VeLo after TS1
    1. Share a 3D model of the foil shape (V. Coco) and perform impedance simulations (B. Salvant).
    2. Proposal for the post TS1 ramp-up and for the documentation of the VeLo-related checks (C. Wiesner).