

Joint Meeting of the Collimation Working Group and the Machine Protection Panel

Participants: G. Azzopardi, C. Bracco, R. Bruce, M. D'Andrea, N. Fuster, M. Gasior, A. Gorzawski, E. B. Holzer, B. Lindstrom, T. Markiewicz, A. Merenghetti, D. Mirarchi, M. Rijssenbeek, B. Salvant, C. Schwick, M. Trzebinski, G. Valentino, M. Valette, J. Wretborn, M. Zerlauth.

The slides of all presentations can be found on the website of the Machine Protection Panel:

<http://lhc-mpwg.web.cern.ch/lhc-mpwg/>

1.1 Experience with AFP insertions (S. Jakobsen)

- Sune remotely presented some general observations on the AFP roman pots insertions in 2017. With the margins agreed upon at the beginning of the year ($12 \sigma + 0.3 \text{ mm} + 0.5 \text{ mm}$ margin, with a minimum of 1.5 mm, for reference) the lowest roman pots settings were achieved on the B stations at 2.04 mm. The general philosophy for insertion was to insert the pots after two hours of stable beam during the second fill of each intensity step and directly after stable beams from the third fill. The AFP pots have experienced no problem during insertions and led to no unexpected retractions or beam dumps.
- There is a clear correlation between the heating of the pots and the number of bunches in the machine. The peak heating reaches 42 °C after three hours on the B pots which are closest to the beam, which was expected due to impedance. Removing the margins is expected to yield an additional 30% heating, with conservative estimates of thermal expansion ($2 \mu\text{m}/^\circ\text{C}$), the distance from the beam should not be reduced by more than a sigma.
- On the vacuum aspect, the behaviour is very reproducible from fill to fill. There is some indication of heating during high intensity fills, some small ($1\text{E}-9$ mbar) spikes when moving in the TCLs and the RPs. Larger spikes are observed on the right side when moving the pots out, which could be related to friction.
- The losses basically scale with luminosity. There is a visible increase when moving in the TCL6 and the RPs, which is not alarming. Overall the losses are below 10% of the dump thresholds on RS06-12. Regarding fast losses; no spikes can be associated with RP movement and losses are generally below 1% of thresholds.
- There were respectively 7 and 37 UFOs on B1 and B2 near the RPs, which is no source of concern. Most UFOs are within 2-3% of thresholds and some reach up to 25%.
- In conclusions all observations did not reveal any worrying issue from the temperature, vacuum and losses points of view. Loss maps were performed with ultimate RP settings and no instability was observed.

M. Valette

- Markus commented that a reduction of the margin by one sigma due to heating would in fact be worrying. Sune answered it is a maximum assuming the whole pot heats up uniformly which is not the case. He added that the real reduction should be 10-20 μm depending on the temperature distribution. Markus concluded this is very similar to what was observed in the past for TOTEM.

1.2 Orbit stability around AFP pots (J. Wenninger)

- Jorg was being held in the CCC so Roderik presented his results.
- The general orbit stability and reproducibility around the RP is good, the changes are below 200 μm and the long-term reproducibility is around 50 μm .
- A small structure appeared in the horizontal plane around the triplet following the cryo stop on July 17, which led to peaks of around 120 μm during the luminosity optimisation trims after the stop.
- In summary, the orbit stability around the RPs is similar to the rest of the ring, which justifies the removal of the margin on the pots.
 - Markus proposed the 600 bunch fill after the next technical stop would be a good opportunity to try and remove the margin. One could then run AFP without the margin after that. One should check the vacuum and temperature around the pots during that fill and the following ones as it will be a short fill and one needs ~ 3 hours to see the full extent of heating.

1.3 Analysis of SIS interlock triggering in 2017 run and outcome of dedicated beam tests (A. Gorzawski)

- Arek presented a third summary of the SIS interlock triggering and associated tests with beam. He summarized the previous iterations in which the analysis of the log file lead to thousands of spurious triggering of this (masked) interlock, which were due to crossing angle levelling and OFB tests at injection as well as triggers related to an actual dump.
- On July the 10th some SIS logbook entries suggest the beam would have been dumped by SIS but there are no OP logbook entries or dump associated with this event, which suggests there could have been a spurious dump due to an orbit drift, which was recovered by the OFB.
- Tests with beam were also performed by first moving the collimators to 90% of the dump threshold and then an additional 15% more to trigger the interlock.
 - On July the 9th all channels were tested successfully with the exception of IP2 where the tolerance was found to be 6.5 σ instead of 4 σ , which comes from the ATS optics in which the TCT β increases around IP2 without a change of the β^* .
 - On July the 10th the rest was reproduced at flat top and squeeze, one IP1 channel had a 4 σ tolerance instead of 1 σ , the IP8 tolerances were found at 2.95 σ instead of 2.5 because the β had changed after optics corrections, all other channels were ok.

M. Valette

- **Action (OP, Coll):** investigate whether it is needed to implement a smoother change of the tolerance during squeeze instead of going from 4 to 1 σ at the end. Roderik commented that the beam size is not linear with β so going with $\sqrt{\beta}$ might be more relevant.
- In summary, all the recorded spurious interlocks were explained but one, which would have led to a dump, the tests were performed successfully and inconsistencies were fixed.
 - Marek asked about the spurious trigger and if anything was visible in the logging at that time. Arek answered there is nothing in the logbook but he didn't check the BPM data.
 - Arek has shown after the meeting that the remaining spurious trigger could be attributed to an asynchronous beam dump test.
 - Roderik commented the BPM reading uses the bilinear fit taking into account the collimator gap and asked if the gap was taken into account into the interlock, which is the case. Markus then asked if this calibration of the second linear parameter was done for all collimators as Stefano wanted. It was requested but not done.
 - Roderik commented that since the logging was off for the past two weeks one could check the data acquired from now on in a couple of days and verify the absence of spurious interlocking before unmasking the interlock after an offline meeting once Stefano is back. Markus agreed and added the goal was to unmask by early-September, to gain some operational experience ahead of TS#2 and an eventual decrease of the beta* to 30cm.

1.4 AOB: Beam 2 loss maps at injection after TS1 (D. Mirarchi)

- Daniele presented a summary of this issue, which came up during the validation loss maps after TS1. Losses at TDI.4R8 (B2) were 40 times higher than during commissioning. As a follow-up, the alignment was verified to be within tolerances on a later occasion, after correcting well the orbit. A series of new loss maps were then performed with various TDI settings and they showed that the losses mostly come from the left jaw, which might be due to the phase advance from the TCP to the TDI left jaw. Loss maps were repeated with nominal settings and showed a now good agreement with respect to the commissioning. One possible reason for the high losses in the initial loss maps could be imperfect orbit correction.
 - Chiara commented that the transfer line steering should not affect the closed orbit. She suspects the losses come from the orbit being wrong around the TDI.
 - Roderik concluded it is not worrying with the observed levels but it should be monitored.