172nd Meeting of the Machine Protection Panel

The meeting took place on November 9th 2018 in 774/1-079.
Participants:
P. Fessia, D. Lazic, A. Lechner, D. Mirarchi, Y. Nie, B. Petersen, C. Schwick, J. Uythoven, M. Valette, A. Waets, J. Wenninger, D. Wollmann, C. Wiesner, 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/ and https://indico.cern.ch/event/770856/

1.1 Approval of MPP#171's minutes

- Actions from the 171st MPP (https://indico.cern.ch/event/763995/):
  - None
- No additional comments have been received on the minutes; they are therefore considered approved.

1.2 HL-LHC: Remote alignment of Q1 to Q7 in IR1/5 in HL-LHC and MP requirements (P. Fessia)

- Paolo presented a proposal of Full Remote Alignment (FRA) from Q1 to Q5 in IR1/5 in the HL-LHC, its advantages, next steps, and its machine protection requirements.
- The FRA is planned to be implemented in LSS1 and LSS5 (from Q1 to Q5, including crab cavities) in LS3 as part of the HL-LHC project. An operational FRA is foreseen from Run IV. The remote accessible stroke would reach ±2.5 mm, while a larger stroke is accessible using the standard alignment procedure. The FRA is intended to be usable both without beam and with safe beam.
  - The proposed maximum stroke for the FRA of ± 2.5 mm would cover the movements from LS to LS with a safety factor of at least 2, avoiding major realignment interventions during the operational run. This meets the requirement of the experiments and fits with the experimental vacuum system.
- The objectives of using the FRA are mainly to reduce radiation dose to the alignment team, to cope with experiment-machine misalignment in Run IV, to correct yearly ground motion drift without manual intervention, to minimize the residual alignment error taking the beam as the final reference, and to cope with other unexpected sources of misalignment.
- Meanwhile, there are many by-products when using the FRA, e.g. aperture gain in various equipment, matching section optimization, and reduction of the requirement on the orbit corrector system in the matching section.
  - Jan asked why the number and strength of the orbit correctors could not be reduced from Q1 to D2, compared to the matching section from Q4 to Q5. Jorg and Paolo explained that the main contributor to the requirement of the orbit correctors from Q1 to D2 is the crossing angle.
- For the FRA project, a presentation will be given to the HL-TCC on the 15th November for endorsement in the HL-LHC baseline. Next works include the

preparation of the HL-ECR and the full functional specification with all interfaces described in 2019. The total cost of the deployment is within the original estimation presented in Chamonix 2018.

- There are some machine protection considerations to be followed when implementing the FRA.
    - Interlocks shall be implemented to avoid that nearby elements move separately in dangerous way, putting at risk the mechanical integrity. Interlocks could be implemented to limit the maximum amplitude movement according to the machine status. Key-type interlocks shall be implemented to avoid that elements can be moved in non-safe conditions.
    - Machine re-qualification with beam is required after each movement.
    - Experience using the system could allow possible operational optimization and "more freedom" to use it after few years into Run IV.
    - An integral part of the FRA is the tracking and logging of the movement of the elements/interconnects. This is needed to know their exact position before applying any correction.
        - Jan asked what the advantage is to be able to perform an alignment with beam, compared to the one without beam. Jorg commented that after the quench of a triplet magnet, a movement of 0.5 mm normally occurred, and the most accurate diagnostic today is the DOROS BPMs. Daniel said that the alignment with beam would only be carried out at injection energy. Paolo added that machine safety would determine how to apply the FRA.
        - There were some discussions about what to interlock on (wire sensors or the motors), and whether the interlock should be maskable or non-maskable. From a machine protection point of view, a reliable interlock will certainly be needed especially if the interlock is active all the time.
        - One of the possible interlocking methods would be a key system as for the aperture kicker, which closes out the motors of the FRA.

1.3 ION EOF (MD4168): crystal collimation with Pb ions (D. Mirarchi)

- Daniele reported the latest news about the MD4168, crystal collimation with Pb ions. In the morning on 9th November, the second fill of ion ramp-up with 64b was dumped when inserting crystal collimators. At the moment of beam dump, three crystal collimators were in design position while one did not fully reach its IN position yet. Increasing losses were observed during the automatic insertion, hence the operation crews decided to manually dump the beam.
- To move on, another 64b (or low intensity) fill would be needed to address the crystal insertion problem and validate the mitigation strategy of the high TCT losses. A slower, manual step-wise insertion seems to be the most conceivable mitigation for upcoming EOF tests.