

SUMMARY OF SESSION 5: BEAM LOSS AND MACHINE PROTECTION

Chairman: Brennan Goddard - Scientific Secretary: Laurette Ponce

INTRODUCTION

The fifth session of the LHC Beam Operation Workshop included the following presentations:

- **Machine protection system response** by Markus Zerlauth
- **UFOs in the LHC** by Tobias Baer
- **Multi-turn losses and Cleaning in 2011 and 2012** by Gianluca Valentino
- β^* -reach by Roderick Bruce

In addition, a summary was presented by Brennan Goddard and Laurette Ponce during the final workshop session.

MACHINE PROTECTION SYSTEM RESPONSE (M. ZERLAUTH)

- R. Assmann mentioned that the High Voltage BLM interlock was really a limitation for the collimator performance. He asked if the limit could be relaxed (with a lower rate for example). M. Zerlauth answered that we should be careful next year if operating at 4 TeV. R. Assmann insisted that the quench test MD failed because we were too much protected. R. Schmidt recalled that the 4 TeV run next year is based on the fact that we did not have any beam induced quench because of the risk of interconnect opening and questioned if the quench test MD could be done at lower energy. R. Assmann remarked that if quenches are so critical, we should avoid quenching and not run at higher energy. A. Siemko commented that all the sectors are not equivalent from the point of view of the interconnect quality. A quench test can be planned in a safer sector increasing the threshold while keeping the protection for operation.
- B. Goddard emphasized the need for a procedure for software release and validation test to be performed afterward. M. Zerlauth precised that BLM software release are checked in the MPP meetings. For CO release, we have to be more rigorous. V. Kain mentioned that there are different types of software and we need a bit of flexibility as it is not possible to test everything in a test environment.
- M. Lamont asked if there are actions planned to avoid experts mistake (i.e ramp down of the RF while beam was still in the machine). M. Zerlauth agreed that RBAC is not sufficient to protect at this level.

UFOs IN THE LHC (T. BAER)

- O. Bruning asked on which rate is based the extrapolation of 81 dumps for 7 TeV energy and if the cleaning can help. T. Baer answered that this is assuming the same conditions as in 2010. The scrubbing run may help, but the 25 ns bunch spacing make it worse.
- O. Bruning asked if we understand where it is coming from. B. Goddard answered that for the kicker it is probably some cleaning.
- R. Assmann wondered if the theory can explain the acceleration of dust particle. (we should have negative particle on top of the beam).
- G. Arduini asked why we have so many UFO in only one kicker if the ceramic is the source. B. Goddard answered that there are small differences for the different kicker.
- A. Siemko questioned why there are almost no UFO during the ions run. T. Baer answered that the pattern at MKIs looks different with ions and that UFOs are less probable at lower intensity. G. Arduini added that there is on top of that no e-cloud ingredient with ions.
- S. Redaelli answered a remark of Y. Papaphilippou concerning pulsing the kicker to study vibration effect. We do see a change in vibration of the kicker with different kick pulse, not yet correlated with UFO production.
- M. Ferro-Luzzi asked if the MKI UFOs could come from the outside, if the other particles could act as attractors. B. Goddard mentioned that the composition of the particle is the same as the ceramic. T. Baer added that this probably demonstrate that the UFO are produce in the kicker and not attracted there.

MULTI-TURN LOSSES AND CLEANING IN 2011 AND 2012 (G. VALENTINO)

- R. Schmidt asked why we saw more losses on TCTs in 2011. This is due to tight settings because of the optics change.
- M. Ferro-Luzzi questioned on the status of the use of transverse dampers for the loss maps. W. Hoeffle answered that the final testing is planned during the first Machine Development so it cannot be used from the start-up, even though it is ready. R. Schmidt mentioned that after the Technical Stop, there is an intensity ramp-up which could be used for final testing of

the ADT or even for the re qualification of the collimators if ADT is available.

- S. Redaelli commented on the reduced rate of collimator qualification which is a good investment, even more with ADT. The 3 re-qualifications mentioned in the talk refer to the standard procedure. R. Assmann added that there is no need more than every 3 months for re qualification to guarantee the safety of the system, and in addition, we could use extra data from continuous monitoring for example.
- J. Wenninger commented that the check of TCP alignment confirms what was observed in STABLE BEAMS and added that loss maps cycles were used to validate light operational procedure changes (as test ramp for feedbacks for example).
- M. Lamont asked if we can already go to tight settings during the ramp. S. Redaelli answered that combined ramp and squeeze is then recommended (but we should be carefully with the TCT settings because of the scaling with energy and β^*).

β^* -REACH (R. BRUCE)

- G. Arduini mentioned that the comparison between 25 ns and 50 ns bunch spacing is assuming the same emittance, but we should take into account that the emittances will be different ($\epsilon = 3.2 \mu\text{m}$ for 25 ns).
- W. kozanecki asked if we could performed Van Der Meer scan with tight collimators settings. R. Bruce answered that if we keep the same conditions, with smaller β^* , the situation improves.
- W. Venturini-Delsolaro reminded that we are using the octupoles for stabilization with 500 A for 4 TeV. We may have a problem for 7 TeV.
- R. Alemany pointed out that with a β^* of 60 cm, the pile-up is of 40 events and asked if the experiments can afford it. For ATLAS, it was answered that a pile-up of 30 is comfortable and that 40 should be OK for a short time.
- F. Zimmermann reminded that the theoretical aperture at 7 TeV (squeeze to 50 cm) is 18σ so may remeasure the aperture for 1 m. S. Redaelli answered that during the aperture measurement, they found not much more than 14σ .
- J. Wenninger mentioned that the orbit interlocks could be tighter in average, but there are some outliers where it will not be possible.
- E. Todesco recalled that below 1 m β^* we may need the non-linear correctors in the triplet. S. Fartouk answered that with the TCP below 4σ , we should not worry too much.

- B. Goddard commented that with the present 94 degree phase advance between the dump kicker and the TCDQ, there is a small leakage. When going to 90 degree, you catch more on the TCDQ so the window could be reduced allowing larger error margin for TCDQ position. But a decision to rematch the region should be taken early on.
- M. Aleksa asked if it is possible to use new statistical methods to derive the margins. It was answered that the β -beat is not measured dynamically so it is difficult to see if there is a correlation with the other parameters. No correlation observed between the collimators alignment and the orbit.

SUMMARY OF SESSION 5: BEAMLOSS AND MACHINE PROTECTION (B.GODDARD, L.PONCE)

All speakers were warmly thanked for their detailed, comprehensive and concise presentations. No issues were identified for running at 4 TeV. A selection of the main points requiring discussion or decision were presented.

Considerations for 2012

- Are DIDT monitor and new orbit bump interlocking available from the startup? This needs commissioning time and procedures (BI and OP).
- Do we need to improve change management procedures for SW? If so, how is this to be managed? For instance, should each group submit all changes both before and after each TS, to a wider audience (coordinators, rMPP, ...) for approval?
- How to improve interlocking of the critical TDI element? It is important to remove the human element - a separate HW surveillance interlock could be added for this specific element. A follow-up in MPP is needed, with LIBD and COLL teams.
- No major UFO issues are expected for 4 TeV in 2012. The MKI rate has to be estimated, and we need to learn as much as possible for post-LS1 operation at 6.5 or 7 TeV, where UFOs might become a serious limitation. Priorities need to be given for machine time, analyses, simulations and lab measurements (UFO team).
- It seems feasible to start with tight collimator settings in 2012. The question of the overall orbit stability needs some fixes which remain to be demonstrated early in 2012 commissioning.
- ADT bunch-by-bunch blow-up needs commissioning at the start of year. Is this then the only collimator setting validation needed, or do we still do full loss maps in addition?

- 70 cm β^* seems comfortable always assuming tight collimation settings work in other respects (impedance, orbit in IR3/7, etc.).
- Margins for 60 cm β^* seem tight - all tolerances have to be uncorrelated, and 1.5σ TCSG6/TCT retraction is at the interlock limit.
- What extra information is needed to decide between 70/60 cm β^* ? And when do we need this decision, to prepare functions, settings etc.?
- Can we possibly increase margins slightly by re-matching IR6 to 90.0 degree MKD-TCSG6 phase advance? Implications need to be examined (MPP?) before a final proposal.