

Minutes of the HSC section

117th meeting on Monday 28/08/2017 (10:30, 6/R-012)

Present: See <https://docs.google.com/spreadsheets/d/1fZiu3vtf546odhd2ONxtW0mx9p8cV-fURT9Kxi7QCys/edit#gid=0>

1) Newcomers / visitors

- None.

2) Comments on the minutes of the previous 116th meeting + Actions

- **Action EleonoraB:** Produce a single plot with the 2 TMCI curves (i.e. without and with longitudinal wake) superimposed => Ongoing and should be presented at the next HSC meeting.

- Done today with an updated plot => See <https://indico.cern.ch/event/660626/#preview:2363736>. See also for more details https://indico.cern.ch/event/660626/contributions/2695336/attachments/1513914/2361818/HSCmeeting_19062017_complete.pptx.

- **Action ArekG:** Is the issue with dBLMs vs ADT due to some intrinsic limitations from the dBLMs or do we need just more time for the detailed analysis? => Some limitations solved and analysis still ongoing. Might need to postpone the LMC talk.

- **Actions XavierB:**

- What happens to the injection oscillations in the presence of beam-beam, impedance, e-cloud, etc.? => It might be wise to try and minimize the beam-beam coupling, which is mainly due to the BBLR, i.e. we should increase the Xing angle (but the effect goes linearly with the BBLR distance).

- Check the different roles of IP1 and/or 5, or 2 and/or 8? => Similar for all of them due to the linear dependence.

- Effect of polarity? => Probably it has an impact, to be looked at in more detail.

- Effect of the parallel separation? => It is small compared to the one of the crossing angle.

- The orbit effect at injection (~ 0.4 sigma oscillation) is predicted to have a negligible

effect of the transverse emittance growth, even for intermediate (~ 50 turns) ADT gains
=> What about HL-LHC? To be looked at.

- HL-LHC at ultimate energy of 7.5 TeV => Some actions from us by the end of September

- StefanoR should send us the settings for collimators by the end of the week.

- Then we should assess the impact on beam stability (Action: SergeyAnt, AdrianO, AnnalisaR)

 - Impact of higher energy on beam stability for proposed collimator settings.

 - Assuming sextupoles and octupoles being able to operate to 600 A, assuming constant kick voltage from the damper.

 - Electron cloud driven instabilities => Impact of higher energy.

 - Any intensity (number of bunches or bunch population) limitation?

- E-cloud and synchrotron radiation effects => Action GianluigiA, GiovanniR and GianniI

- Actions from last WP2 meeting => Action NicoloB and SergeyAnt

- "... This needs to be done in any case for the high frequency HOMs which are present also with longitudinal RF fingers installed".

- "Gianluigi proposes to identify one or two critical HOMs close to delicate components to be provided for a thermo-mechanical analysis to assess heating and outgassing".

- "Chiara asks if issues could appear also in the transitions next to the TDI. This is confirmed by Elias and Nicolo. Evaluate the impact of the transitions".

- "Elias adds that at some point stability studies need to be performed in addition of heating studies".

- Long-term upgrade/replacement of TRAIN => To be finalized with YannisP and XavierB by end September (Action EliasM, YannisP and XavierB).

- aC coating of HL-LHC: What would be the effect on beam stability and TMCI? Action NicoloB and SergeyAnt.

- Reminder from Giovannis: If the sectors would be as the good one, then we would not need to coat.

- If fact LHC could be coated ~ 1/2 or ~ 1/3.

- Might be good to review the effect for the SPS.
- HE-LHC impedance model: after discussion with FrankZ, the goal would be to have a first model by mid October (**Action BenoitS**).
- Low-impedance HL-LHC collimators (**Action SergeyAnt**): only show the delta in Ioct (for a certain chromaticity and ADT gain) for the different cases (and the different contributions to the impedance model) compared. It might be good to have this info both on plots and in tables. We should also put ourselves in the most critical case, i.e. assume the transverse emittance that we have at injection (as the blow-up might not occur at injection) => Update the plots etc. using the emittance at injection, i.e. 2.0 for the nominal HL-LHC and 1.7 for the BCMS beam.
- The results should also be updated with the measured Mo resistivity (see below).

3) General infos and follow-up (EliasM)

- SLM:
 - The option of building office space in Preveessin has been raised once more.
- LHC 08:30 meeting
 - 7 fills tried at 2200 bunches and 7 failed => So it is clear now that it depends on the number of bunches (as anticipated by GiovanniR ;-)).
 - We tried to push the instability later in the ramp by increasing the ADT gain and the octupole current until ~ 1.5 TeV but it seems it did not help much (we knew at least that from the octupoles the fastest rise-times that can be damped are ~ 100 turns).
 - Comment from FreddyB => He proposes to stay at 1548 bunches as now to produce lumi until LMC and if we go to 8b+4e or 50 ns we need to have observables to quantify / learn / etc., otherwise there is no need/reason to change.
 - 8b+4e => Is it ready in injectors?
 - Should we propose to increase the chromaticities? By how much? Based on which mechanism (it is true that for fast instabilities, such as TMCI etc., chromaticity is the most efficient knob)?
 - Should we propose to increase the gain of the ADT?
 - Comment from SergeC => The situation changed after the BS flushing and this is confirmed by 3 different measurements (cryo, BLM and Radmon): the process changed and there is much less steady losses.
 - Before there was a correlation between steady losses and dumps but now we cannot

see it for the moment.

- Seems there is no baffle in quadrupoles => Yes, I checked that with VincentB.

- LBOC

- Last one: Transverse coherent activity at injection (Lee Robert Carver)

- Next one (tomorrow): Detailed discussion for Gianni's talk at LMC.

- Meeting for the Task Force on LHC Operation limitation in 16L2 + report from MiguelJ at the LMC

- 1st LIU-PS Beam Dynamics Working Group meeting by HeikoD => 2 highlights from my side:

- Impressive tune change during the injection bump => Can this be corrected? To be followed up.

- Microwave instability observed during PS bunch rotation => It cannot be seen in the PS but it is seen in the SPS during the 1st turn. This happens for a bunch intensity already slightly above nominal...

- Follow-up by XavierB about the octupole strength needed at injection (following the test from the HIS team, who succeeded to reduce the current in the octupoles and the chromaticities) => See https://indico.cern.ch/event/660626/contributions/2695336/attachments/1513914/2362086/2017-08-28_injectionInstability.pdf

- Conclusion: assuming a linear dependence on the beam brightness, this observation is not in contradiction with past observations and observations in physics (with high brightness).

- Question after the meeting by GA: Is this consistent (I mean the linear dependence on the brightness) with the simulations? If this is the case then we have an explanation. Would this explain also that in 2012 we could go lower as all sectors had the same conditioning differently from 2015 and following?

- Some past studies from KevinL revealed the effect of the brightness
=> https://espace.cern.ch/be-dep-workspace/abp/HSC/Meetings/002_hsc_lhc_elcoud_19-09-16.pptx:
“The effectivity of the octupole is reduced with the emittance – the exact scaling does not look entirely linear. We know that the e-cloud itself also contributes significantly to the tune footprint”.

- Follow-up of LeeC about the transverse coherent activities at injection => Nice movie produced which reveal clearly some issues:

- See <https://cernbox.cern.ch/index.php/s/eTNTOTKwgqJxof8>.

- SergeyAntipov:

- Mo resistivity is 5 times higher than expected => The results need to be updated.
- Other information he found: aC resistivity can vary a lot => To be followed up in detail.

4) Simulation studies for the transverse coherent instability linked to 16L2 losses in the LHC (LottaM):

https://indico.cern.ch/event/660626/contributions/2695335/attachments/1513887/2365406/LHC_ion_instability_HSC_20170828.pdf

- Usual ion-instability in leptons machine => Only coupled-bunch.
- Same ionization cross-section used for all the ions in first approximation (2 MBarns as usually done for these kind of studies).
- The e-cloud could outgas more and ionize more. The ions are generated almost at rest and then they are kicked by the beam. Could the ions also create the avalanche effect? Could be for high pressure, to be checked.
- E-cloud will always ionize to have positive ions by removing 1 electron (scattering).
- Check the pressure and corresponding density
 - 0.1 mbar with $\sim 1E19$ atoms?
 - $1E-4$ mbar with $\sim 1E22$ atoms?
- Next
 - Include gas ionization by e-. And then also by ions as proposed by XavierB.
 - Comment from BenoitS: seems that the solid/flake is already evaporated for the coherent instabilities, so maybe there is no need to consider the solid in our studies but just the corresponding gas density.
 - BenoitS asked if we could learn something from COLDEX?
- Comment from LottaM after the meeting to stress that her study so far cannot explain why the instability would develop at the beginning of the batch:
 - On slide 8, I present a study where I generated ions only with the first bunch, but not the trailing ones, to be able to better study how fast the ions move and from how far they affect the trailing bunches. The situation that we could expect to have with gas in the machine would look more like the one presented on slide 10. There, ions are generated by every bunch, leading to a growth of motion with a rather undefined

pattern along the train. Indeed, if we had to make a prediction on the type of instability we could see, it would be the full beam oscillating, with no clear difference between head and tail.

5) Transverse emittance blow-up of the first bunch of the trains, except the first one: 2015-2016-2017 (KevinL):

https://indico.cern.ch/event/660626/contributions/2700059/attachments/1514036/2362102/first_bunches.pdf

- 2015 is similar to 2017 but nothing was seen in 2016 => To be checked more carefully.
- Emittance rise-time $\sim 1\text{-}2$ microm/h.
- GiovanniR asked if the observed effect could be linked to the longitudinal beam loading? To be followed up.
- Next plan
 - Try and change the gap from 200 ns to 1 micros in SPS to see if the gap has any effect. As PaulC would like to have spare MDs at injection, this could be a good test to be done.

6) Towards an LHC optics model in PyHEADTAIL (Felix Pol Gaston Soubelet):

https://indico.cern.ch/event/660626/contributions/2700602/attachments/1514010/2362138/Towards_an_LHC_optics_model_in_PyHEADTAIL.pdf

- Felix presented his subject and the results he obtained so far and the next steps. Further checks are needed in the treatment of linear coupling.

7) Progress/status in the different activities/projects and reports from meetings and in particular the issues/successes in the different machines (Everybody)

- HSC-IWG (NicoloB) => https://indico.cern.ch/event/660626/contributions/2695336/attachments/1513914/2362893/HSC_Imp_28082017_NB.pptx

8) Miscellaneous

- The next (118th) meeting will take place on Monday 04/09/2017 (in room 6/R-012 at 10:30)
=> Current agenda:

- 1) General info and follow-up (EliasM)

2) ATS MD3 study (SergeyA)

3) Progress/status in the different activities/projects, reports from meetings and in particular the issues/successes in the different machines (Everybody)

- Important events and dates for HSC: <https://espace.cern.ch/be-dep/ABP/HSC/SitePages/EventsAndDates.aspx>.
- Web site: <https://espace.cern.ch/be-dep/ABP/HSC/default.aspx>.

Minutes by E. Metral, 04/09/2017.