

Minutes of the HSC section

148th meeting on Monday 06/08/2018 (10:30, 6/R-012)

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

1) Newcomers / visitors / departures

- Welcome back MichaelS! => Will be COAS with us from 01/08/18 till 31/01/19, under the supervision of GiovanniR, to work on multi-bunch pyHEADTAIL.
- PARASCHOU Konstantinos => New PHD (started on 01/08/18) with Gianni to work on e-cloud and more precisely on “Studies of incoherent effects for the LHC and its upgrade”.
- WULFF Eric Gustaf Ted => New TECH (started on 01/08/18) with GianniI to work on e-cloud and more precisely on “Detailed modelling of the e-cloud formation in LHC cold elements”.
- RAHEMTULLA Adam => Will leave on 16/08/18 and will give a talk at the next HSC meeting.

2) Comments on the minutes of the previous 147th meeting + Actions

- No comment.
- Actions from last meetings => Will be reviewed in detail on 13/08:
 - Action 1 (SergeyAnt et al.): HL-LHC tolerances to beam position offsets at the Crab Cavities => To be followed up by/with RamaC.
 - Action 2 (BenoitS, NicoloB et al.): Provide the (current) impedance model (and wake function model) of all the CERN machines.
 - => Ongoing. 2 non-mbs Summer Students joined to help in this activity.
 - Action 3 (XavierB, BenoitS et al.): Follow-up of LHC instabilities (with automatic tools) => See LHC_TIM meetings (<https://indico.cern.ch/category/10168/>) and web site (<http://lhcinstitutability.web.cern.ch/lhcinstitutability/>).
 - Action 4 (Gianni et al.): Follow-up of heat load differences in the LHC sectors => On-going.

- Action 5 (LeeC et al.): SPS horizontal instability studies => On-going (KevinL and MichaelS could also help in the future). CarloZ will follow this up.

- Action 6 (MauroM et al.): PS horizontal instability at 26 GeV with adiabatic bunch shortening => To be followed-up by e-cloud team.

- Action 7 (TatianaR, MauroM, EiriniK): PSB impedance model and related instabilities => Talk by MauroM at the LIU-PSB beam dynamics on 23/04/2018. Talk today (25/06/18) by TatianaR. Following past studies from MauroM about some missing dipolar impedances, one should try and study the effect of a HOM (scanning the different parameters) with DELPHI to see how we can reproduce the observations and give more quantitative info about the possible missing impedance.

- Action 8 (ClaudiaT et al.): LHC BTF studies and possible instabilities due to noise

1) Try and explain the factor 3-4 between 2016 and 2017 (whereas the impedance model should be the same within ~ 10-20%).

2) What is the exact mechanism leading to instability? Is it the one from XavierB (with the white noise), drilling a hole in the stability diagram?

3) To be studied also in the presence of ADT and see if the modes observed are those from impedance as well as the rise-time.

=> Discussed at the LBOC on 27/03/18. To be continued to fully understand the mechanism behind.

- Action 9 (AdrianO): Continue and finalize the space charge studies on SPS TMCI => Discussed on 09/04/18, on-going and on-going discussions with A. Burov et al.

- Action 10: GianniI raised the question about the bunch length to be used for HL-LHC instability studies. Until now we have been using the rms value from a Gaussian distribution => To be reviewed in the future in case there are good arguments to use another function (such as the q-Gaussian).

- Action 11 (LottaM et al.): Detailed simulation studies to try and explain the 16L2 instabilities in 2017 => Some first simulation results were discussed on 23/04/2018 and others today (09/07/2018). To be continued. Some update discussed today (09/07/18).

- Action 12 (MarioB et al. and MichaelS): SPS coherent tune shift bunch-by-bunch: can we reproduce this from theory/simulation using the SPS impedance model (starting first with the resistive-wall)? => To be done by MichaelS after his PHD (as COAS).

- Action 13 (OlavB): Detailed simulation of the quadrupolar impedance to be performed for the 4-pole structure => Done.

- Action 14 (DavidA et al.): Try and solve the numerical issue in <https://indico.cern.ch/event/712792/contributions/2937067/attachments/1619147/2574>

[980/LandauDampingForISRinstability_EM_19-03-18.pdf](#) and compare the results with other codes.

- Action 15 (DavidA et al.): Check the TMCI results with tune spread (same numerical issue as above still to be solved) and compare the results with other codes.

- Action 16 (SergeyAnt): Check the effect on $\text{Im}[Z/n]$ of the HL-LHC coated inner triplets.

- Action 17 (OlavB): Understand why a 4-pole structure has exactly the same dipolar impedance as the one with 2 parallel plates.

- Action 18 (OlavB): Finalize the work on multi-polar impedances and document it.

- Action 19 (DavidA): Plot the increase in real and imaginary parts of the impedances (dipolar and quadrupolar) for 2016, 2017 and 2018 compared to 2015. Plot also the case 2017 compared to 2016 for ClaudiaT and her LBOC talk on 27/03/2018 => Done.

- Action 20 (DavidA): Finalize the impedance and related instability studies for the EOS and do the same for Injection and Flat-Top.

- Action 21 (NicoloB, DavidA and XavierB): Summarize all the past comparisons between predictions and measurements of LHC transverse instabilities at high-energy vs Q' WITHOUT ADT.

- Action 22 (Everybody): Some volunteers (2-3 people) for the ABP BBQ on 28/06/18 => Done: we have 2.

- Action 23 (NicolasM): Try and answer to the request from RogelioT's team to estimate the amplitude-detuning contribution of collimators.

- Action 24 (XavierB for week starting on 21/05/18): Beam stability studies for HL-LHC => Try and make the scenarios more robust by ensuring enough spread for the small BCMS emittance also during the collapse of the separation. Subsequent simulation work is needed by RiccardoDM and YannisP's team => Done but new version still to be read/commented (see Action 29 below) => Done.

- Action 25 (FrancescoG): In the framework of the beam-induced RF heating, collect somewhere all the "maximum temperatures" for all the different equipment, e.g. due to interlock or past observations, etc.

- Action 26 (Instability team): Organise and perform the tests at injection (to try and reduce the coherent activity and associate emittance blow-up) and high energy (to continue and check the margins) => Done but settings to be optimized.

- Action 27 (BenoitS et al.): Finalize the HL-LHC impedance report and send it to GA asap => Done by BenoitS et al. Next: I have to re-read it before sending it to GA => Done (a 2nd time) and comments will be given tomorrow (07/08/18) to the impedance

team before sending the new version to GA.

- Action 28 (SergeyA et al.): Scaling of impedance and related stability for collimators vs. gap and resistivity (assuming only 1 collimator; all collimators; all the machine)? => On-going.

- Action 29 (EliasM): Final reading of HL-LHC paper from XavierB => Done.

- Action 30 (BenoitS et al.): Possible use of a solenoid in the SPS ZS? => It seems that there is still the suspicion of electromagnetic fields inducing the sparking. Do we have an EM model of the ZS? It would be great if we could understand the origin of this limitation. Remark:

- Sparking in the ZS mainly occurs mainly when the bunch length of the LHC beams becomes very short, i.e. during the last part of the ramp and at flat top. This conditions slowly with time.

- Had also lots of sparking with the 8b4e beam (which was also slightly improved with time, but still it was relatively strong). This points more towards electromagnetic fields induced by the beam rather than electron cloud.

MarioB could help in this activity. CarloZ will follow this up.

- Action 31 (BenoitS et al.): EDMS document "Continuous Transfer Decommissioning in the PS Ring" Under Approval => There is a couple of points related to impedance (potential reduction) that would be good to answer.

- Action 32 (BenoitS et al.): Participation and follow-up of PaoloF's meetings for impedance aspects. BenoitS mentioned that the integration with the wrong layout was checked by BenoitS and RiccardoDM and noticed at the ECR level.

- Action 33 (SergeyAnt): Check DQW Crab Cavity impedance and related effects after new simulations (with new CST software), if the latter are confirmed/understood.

- Action 34 (YannisP and EliasM): Review the situation of machine settings for starting after TS1 (tunes, chromaticity, octupoles) in view of continuing the studies on the beam 1 / beam 2 lifetime difference => Done by GianniI.

- Action 35 (SergeyAnt and EliasM): TMCI measurements and implications for HL-LHC => What would be the impact of the various impedance scenarios (with present collimation system, with upgraded collimation system after LS2 and with full collimator upgrade) on TMCI threshold and implications in terms of stability?

- Action 36 (AdrianO): Re-simulate the SPS Q26 optics as this is where we have the largest disagreement with AlexeyB.

- Action 37 (EliasM): Follow-up of the issue with the mouse of the 6/R-012 room.

- Action 38 (EiriniK): Compare the pictures of the nTOF gammat-jump before and after optimization => Done in the last slide of the MSWG talk on 13/07/18 https://indico.cern.ch/event/735644/contributions/3034031/attachments/1686408/2712004/nToFOptimization_MSWGmeeting_13072018.pdf

=> No dramatic changes, a small change at the extremities according to MAD-X.

- Action 39 (DavidA et al.): TMCI for HL-LHC at WP2 ~ mid July (exact date tbd)
=> Done on 24/07 + Follow-up of questions raised during the WP2 meeting.

- Action 40 (SergeyAnt et al.): Detailed explanation of the effect of coating collimators at WP2 ~ mid August (exact date tbd) => Linked to Action 28 above.

- Action 41 (NicolasM and SergeyArs): Check that the CFC conductivity of the collimators is the smallest one in the direction of the beam (it should be a factor 5 larger in the transverse plane, according for instance to NicolasM's PHD thesis on p.183) => NicolasM mentioned that this was discussed at the WP2 meeting on 24/07: it seems clear that all the LHC collimators were not cut in the wrong direction (where the resistivity is much higher than in the other 2 directions, by a factor ~ 5). However, it seems that a doubt still exists in the other 2 directions where the resistivity could differ up to ~ 30%.

- Action 42 (XavierB and instability team): continue to try and decrease the Landau octupole current at flat-top to see where the limit is. We are at 450 A at the moment...

- Action 43 (XavierB and instability team): feedback from ABP about the use of the ADTObsBox => I will answer to DanielV on 07/08/18.

- New actions from this meeting:

- Action 44 (Everybody) for Monday 13/08: Pros/cons of moving to Prévessin.

- Action 45 (EliasM et al. => XavierB and NicolasM) by the end of 08/18: Detailed analysis of beam stability for Run III for a reference scenario provided by StéphaneF, highlighting in particular the "delta" from the new LS2 collimators.

3) General infos and follow-up (EliasM)

- SLM

- The proposal of moving to Prévessin in a new building has been discussed again. We should re-discuss in each sections and see what were/are the reservations to move (e.g. the issue "students and lack of transportation", etc.)
=> See Action 44 above.

- LHC

- The accumulated lumi since the beginning of the year is now on top of the prediction curve, i.e. we need now to produce!
- LBOC tomorrow by XavierB to review the status of the injection instabilities.
- Abstracts for IPAC19 => Reminder deadline 14/08 and we will discuss the list altogether at the HSC meeting on 20/08.
- Discussion with StéphaneF about the estimation of beam stability for Run III => **See Action 45 above.**
- TMC1 with SC => AdrianO needs to re-simulate the case Q26 (all the instability community is waiting for that...).
- Proceedings for Benevento
 - GiovanniR needs to have this finalized before the end of 08/18.
 - Papers from NicolasM and BenoitS commented.
- LIU => GiovanniR will report next week.
- HL-LHC (SergeyAnt and XavierB)
 - Discussion on 21/08 about MDs to be done before the end of the run.
 - DA seems not very good with max telescope index => We need to optimize the parameters.
- Optimized neutron Time-Of-Flight (n-ToF) cycle - beam sent to target (EiriniK): https://indico.cern.ch/event/747741/contributions/3092642/attachments/1697757/2733297/nToF_newCycle_sentToTarget_HSCmeeting_06082018.pptx
 - TOF_doubleFB is the new name.
 - Delivers the required intensity of $\sim 7E12$ p/p with $\sim 2\%$ less beam losses compared to before => Very good starting point for further intensity increase.

4) Highlights from LHC MD2 (Everybody involved)

- E-cloud MDs (GianniI): https://indico.cern.ch/event/747741/contributions/3092644/attachments/1697774/2733192/20180805_MD_for_HSC.pdf
- Lot of very interesting observations on

- 1) heat load (with only B1 or only B2 => B1 worse!),
- 2) lifetime (with clear e-cloud signature and impact of beta*),
- 3) limit of heat-load ($\sim 3E10$ p/b as anticipated).

- Lifetime: we could change the tune before the ADT change => To be mentioned at the LBOC.

- Lifetime with 1 beam is great, both B1 (only shown in the slides) and B2.

- Note: we are close to the limit with sextupoles at 30 cm (there is margin only for ~ 1 unit as we are already at ~ 15 units)...

- Impact of beta* on lifetime => Seems more the triplets than the arcs (comparing the 1 beam and 2 beams) => **Another motivation to coat the triplets!**

- Possible MD3 studies

- Go to flat-optics as we see issues with triplets. Reminder from XavierB: we tried to do this last year and many transients were observed => To be checked, discussed and prepared.

- Other important items are the forbidden things linked to 16L2...

- Asymmetric collimator settings (DavidA):
https://indico.cern.ch/event/747741/contributions/3092644/attachments/1697774/2733187/2018-08-06_HSC_MD_highlights.pdf

- Goal: investigate asymmetric settings for IR7 collimators (i.e. using only 1 jaw).

- This MD almost failed due to issues with ADT but some data could be taken with BBQ which need to be analysed in detail.

- Slide 3 => Moving the jaw of 4 TCSGs.

- Possible MD3 studies

- Re-do symmetric TCSG measurements => We have meas. but no agreement yet with predictions due to issues with losses etc. And TCTs.

- Beam screen => Need predictions first (of the effect we want to measure).

- Summary of the instability observations during MD block 2 (XavierB):

- Heat load MD (full B1, 2 bunches in B2): Activity B1H during the squeeze, without blowup and instabilities in stable beam (~ 20 minutes steady after the collapse of the separation bumps). The bunches at the end of the trains were affected. The HT monitor indicates a coupled bunch mode with intrabunch motion, to be verified. The octupoles were at 376 A. The MD results were not affected by the instability.

- Wire BBLR: The issue with the strong beam was solved by increasing the octupole current and maintaining the tune separation in ADJUST. However, an instability of a single bunch during the squeeze with maximum octupole current occurred. The tune measurement is noisy due to the high octupole, however there are no signs that coupling increased or that the tune separation reduced. This instability remains unexplained, nevertheless the MD was successful, since they intended to blow up the bunches to measure lifetime. Similarly to the heat load MD, instabilities were observed at the end of train (non-colliding), the first one after ~ 1.5 h steady.
- Partially stripped ions MD: Instability with 0 A and w/o ADT (low intensity/low emittance \Rightarrow Possibly within expectation but to be checked).
- High teleindex MD: The first fill was performed with the positive polarity, 200 A and $r=3.1$. There was a weak (almost no blowup) instability during optimisation of IP2 of a single bunch that does not colliding in IP2 (Feed down in IP2 ?). While colliding the polarity of the octupole was swapped and the beams were re-separated in all IPs (6 sigmas). The instability threshold was found at -20 A / 0 A during the octupole scan \Rightarrow doubtful measurement due to previous instability. The second fill was performed with the negative polarity, there was no instabilities during the cycle. Again, flipping the polarity in collision and re-separating, the instability threshold was found at 100 A. ($r=3.1$). The machine is almost setup for trains with high tele index at the end of the ramp in the next MD block.
- Asym coll.: Presented by DavidA.
- RF MD: Unclear observations of transverse activity, possibly due to RF manipulations.
- Latency MD: The noise level was reduced w.r.t. last MD, since the emittance growth was quite large compared to operational conditions, leading to longer latencies. Starting at $Q'=5$, the results were not worse than at $Q'=15$ (last MD): We needed to reduce the octupole current to obtain an instability, the instability threshold did depend on the noise amplitude (for B2: 290, 240 and 200 A). At $Q' = 0$, the beams were already unstable at 550 A, therefore the test was compromised. In a second fill, we re-did the test in the same condition as last MD, to evaluate the effect of the lower noise level, but decreasing the octupoles to avoid too long latencies. In B2, we aimed too low (400 A), the bunches with noise became unstable within 2 min, the other bunches became unstable w/o noise after 2 minutes). This threshold is not consistent with last MD, where we could reduce the octupoles to 226 A. In B1, the experiment worked perfectly, with latencies of 15, 23, 38 and larger than 45 min for the bunches with high to low noise amplitudes. Reducing the ADT gain (1/2 and 1/5 of nominal) no instabilities were observed after 30 minutes in steady configuration. Weird observation: the two bunches with highest noise became unstable when setting the gain back to nominal (transient effect?, modified distribution?). With a ADT higher gain (twice nominal), the latencies became None, 3, 7 and 22 minutes. Clear effect of the damper, i.e. low gain are beneficial for the instability latency. This observation can be compatible with Sondre's model in the sense that the damper plays a major role in the modification of the distribution. At the end of fill, one bunch in B1 was still ok: we reduced the octupole current without latency and obtained an instability threshold at 100 A, which is lower compared to the 226 A obtained with lower gain in the last MD.

5) Intensity record in LEIR (NicoloB):
https://indico.cern.ch/event/747741/contributions/3092643/attachments/1697803/2733162/HSC_LEIR_06082018_NB.pdf

- NicoloB reviewed all the (10) detailed studies performed since the 2016 record after the crash programme: LEIR has reached $10.35e10c$ extracted with an average injected current of 27 uA from Linac3 (i.e. much smaller than in 2016). The high performance, w.r.t 2016, is mainly due to the better injection efficiency (>20% higher).
- Red is in the ring => 70% which is great as on paper this is ~ the limit. And sometimes they did even better...
- Get less from linac3 but extract more ;-)
- Slide 13 => Very helpful new program to optimize the injection. Thanks to it, even after some stop recently, after 3 h they went back to LIU parameters.
- Slide 18 => Detailed measurements done on cooling and with the code of AndreaL some comparisons were started but we are not there yet.
- Reproducibility is what they are now working on => Different sources (temperature fluctuation, source current, etc..) are being identified and ranked in terms of impact to performance reached.

6) A high-performance synchrotron model with pipelined coherent multi-bunch interactions (SondreF)

- Postponed to next week.

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

- LHC_TIM (XavierB)
 - Not discussed.
- ATS-IWG (BenoitS)
 - Not discussed.
- HSC-IWG (NicoloB):
 - Not discussed.
- E-cloud (GianniI)

- Not discussed.
- Beam-beam (XavierB)
 - Not discussed.
- Space charge (AdrianO)
 - Not discussed.
- ABP-CWG (GiovanniR):
 - Not discussed.
- PyHEADTAIL (KevinL)
 - Not discussed.
- DELPHI (DavidA)
 - Not discussed.
- NHTVS (SergeyAntipov)
 - Not discussed.
- LIU (GiovanniR):
 - Not discussed.
- HL-LHC
 - TCC:
 - Not discussed.
 - WP2:
 - Not discussed.
- FCC
 - Not discussed.
- PBC (EiriniK)
 - Not discussed.
- Machines

- Not discussed.
- MDs (past and future)
 - Not discussed.

8) Miscellaneous

- The next (149th) meeting will take place on Monday 13/08/2018 (in room 6/R-012 at 10:30)
=> Current agenda:

- 1) General info and follow-up (EliasM)
- 2) Detailed review of all actions (EliasM and everybody involved)
- 3) Analytical computation of wake functions using the residue theorem (Adam Rahemtulla)
- 4) A high-performance synchrotron model with pipelined coherent multi-bunch interactions (SondreF)
- 5) Status of LIU (GiovanniR)
- 6) Progress/status in the different activities/projects, reports from meetings and in particular 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, 08/08/2018.