Minutes of the HSC section

154th meeting on Monday 17/09/2018 (10:30, 6/R-012)

Present: See https://docs.google.com/spreadsheets/d/1fZiu3vtf546odhd2ONxtW0mx9p8cV-fURT9Kxi7OCys/edit#gid=0

1) Newcomers / visitors / departures

- None.

2) Comments on the minutes of the previous 153rd meeting + Actions

- No comment.

- Actions from last meetings

  - Action 1 (SergeyAnt et al.): HL-LHC tolerances to beam position offsets at the Crab Cavities => To be followed up by/with RamaC. RamaC et al. will get back to us in September.

  => Ongoing. 2 non-mbs Summer Students joined to help in this activity. On-going.

  - 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. On-going.

  - 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://lhcinstability.web.cern.ch/lhcinstability/).

  - Action 4 (Gianni et al.): Follow-up of heat load differences in the LHC sectors => On-going with high priority (see e.g. the ABP forum https://indico.cern.ch/event/740046/).

  - After the excellent talk given by GianniI at the LMC on 29/08/18, I think that now everybody is convinced that e-cloud is the key player. The next 2 steps are

  - Convince everybody that 1) in 2012 the difference in heat loads between the sectors was not present; 2) the measured load was/is reliable and 3) the measured heat load was the same or below what we had during Run 2. Was already shown in the past but it seems that there are still some questions about it => To be done at the LMC on 12/09/18.
- In close collaboration with vacuum team, try and identify the source(s)...

- 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. CarloZ obtained recently very interesting results, which he will present soon.

- Action 6 (MauroM et al.): PS horizontal instability at 26 GeV with adiabatic bunch shortening => To be followed-up by e-cloud team. For the moment, it is fine as the new scheme is currently not planned after the very good results from the PS.

- 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. EiriniK obtained recently very interesting results, which she will present soon.

- 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. On-going.

- 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. On-going.

- 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). Nothing for the moment.

- 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). Talk at LBOC on 31/07/18 (https://indico.cern.ch/event/746500/contributions/3087758/attachments/1695578/2729100/LBOC_20180731_16L2update.pdf).
- 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 (staring 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/1619147/2574980/LandauDampingForISRinstability_EM_19-03-18.pdf and compare the results with other codes. Should not be a high priority for DavidA => To be followed up by EliasM.

- 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. Will be done with NicolasM.


- Action 17 (OlavB): Understand why a 4-pole structure has exactly the same dipolar impedance as the one with 2 parallel plates. Not high priority. Info from OlavB: “Probably the best way to do it is to use the Schwarz-Christoffel Mapping as suggested by Simon Hirlander. This will be a big project in itself, and will probably require that we have a technical or maybe even a PhD student to do it”.

- Action 18 (OlavB): Finalize the work on multi-polar impedances and document it. High priority (before retirement). Info from OlavB: “The multipolar structures should be able to reduce the transverse impedance to zero. Many simulations still to be done to verify this. In order to strongly reduce the longitudinal impedances, the structures should probably be made of high impedance materials with low dielectric constant. Studies should still be done to understand the relationship between image charges and image currents.” OlavB suggested also to investigate single ended measurements of the transverse impedance, i.e. without using hybrids.

- 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 => Still to be finished.

- 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 => Still to be done (it is quite high priority for our LHC instability studies!).

- 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 => Started and some presentation at impedance meeting on 15/06 and also HSC on 25/06 (see https://indico.cern.ch/event/738175/contributions/3046069/attachments/1673678/2686078/20180615_impedance_meeting_nonlinear_terms_slide8.pdf): CST and analytical formula works.

- 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. BUT DA seems not so good so we need to find other parameters: an optimization is therefore still needed.

- 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. Done: warning and damage limits are now indicated (when possible) => See reports at https://rfheating.web.cern.ch.

- 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) => Still on-going => See for instance results of these studies during coming week 33 (coupled to some studies to reduce the RF voltage at injection).

- 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 (proposed deadline for the impedance team to send it to GA: Friday 17/08 => Was sent to GA on SU 19/08).

- 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. To be reported at next WP2 meeting on 21/08 (https://indico.cern.ch/event/750135/).

- 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. CarloZ is following this up: he started to contact some relevant people and to identify some impedance modes which could play some role. To be followed 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. Linked to Action 1.

- 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 Gianni.

- 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? Done and DavidA gave a talk at WP2 on 24/07 (https://indico.cern.ch/event/743627/contributions/3071936/attachments/1692446/2723312/2018-07-24_Amorim_WP2_v2.pptx). Still some follow-up to be done by DavidA to answers to the questions raised during the meeting.

- Action 36 (AdrianO): Re-simulate the SPS Q26 optics as this is where we have the largest disagreement with AlexeyB. On-going. AdrianO (and RiccardoDM) could restart the GPU server with the aid of HerveM on Monday 27/08/18.

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

- 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. See Action 35.

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

- 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%. Next: see Action 46 below.

- 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… Linked to Action 26.

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

- Action 44 (Everybody) for Monday 13/08: Pros/cons of moving to Prévessin.
  
  - People relying on public transportation to come to work from the Swiss side, will be heavily penalized.
  
  - We will get away from experts in materials properties from the TE dpt (unless they move as well); close collaboration with them is often useful for e.g. resistivity characterization / knowledge of coating properties / etc.
  
  - One should think of a better shuttle service (i.e. much more often than every hour or so, and running also early in the morning / late in the evening), or, better, trying to get a public bus or tram up to Prevessin.
  
  - If going to a new building, try and improve the temperature control.
  
  - Other pros to go to Prévessin:
    
    - Closer to CCC,
    
    - Closer to BE-RF and TE-ABT colleagues,
    
    - Chance to be in a building that is in a better state and healthier (in our building: asbestos, woodworms, lab dust, radiation from PS complex, humidity, temperature).
- Other pros to stay in Meyrin:

- Much easier to reach by public transport for students and visitors. CERN shuttle service would not compensate the loss,

- Much more central: most things happen in Meyrin,

- Closer to all general services (bank, Uniqa, post office, doctor, football pitch),

- Closer to most technical groups and experiments,

- Very nice and useful PS cafeteria,

- That must depend on home location, but for BenoitS for instance, traffic in the morning would get significantly more difficult => It would be more convenient for people living in Prévessin and Eastward in Pays de Gex, but much worse for all the others,

- Restaurant 3 is really far from the standards of R2 and R1, and many would commute every day at lunch time.

- 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. On-going.

- Action 46 (NicoloB et al.): Linked to action 41 above, we should try and measure on a bench a collimator and see which resistivity we have in the 3 directions.

- Action 47 (EliasM): Will check all the ECRs and comment them as of now (checking that it is fine from impedance and e-cloud in particular).

- Action 48 (EliasM): Check past predictions about the effect of the serigraphy on SPS beam stability in transverse (following some nice analysis from CarloZ, which seems to be the possible explanation of some recently observed horizontal instability).

- Action 49 (EliasM et al.): Continue the discussions with DanielV to check what the ADT is sending to the beam (compared to what we think is sent). Also important after the results of the recent tests with reduced ADT bandwidth (and instability observed while increasing the gain by 30%) and possible future MDs to use the ADT on excitation mode for Landau damping studies.

- Action 50 (XavierB et al.): Provide the lists of recommended parameters to assure beam stability in the LHC (during the full cycle) for the (main) different beams which can be used in operation or MDs, and present them at some future LBOC meeting => 1 bunch (or few bunches) not colliding; 1 beam; 2 beams. Others? One should try and provide in particular some information about the requirements on octupole strength as
a function of brightness to provide guidelines for the definition of the settings for future calibration fill or special runs.

=> Done at LBOC on 27/06/2017 (https://indico.cern.ch/event/648641/): it is the same for 2018.

Maybe in the future we could try and do more to separate according to the different kind of beams (at least 1 bunch and full beam) and LHC phases (injection; FT; etc.).

- Action 51 (XavierB and NicolasM): There are always a lot of discussions about the emittance growth from injection oscillations (as the steering of the lines seem difficult these days) => Would be great to show on some slides what the emittance growth is predicted with the chroma we have (~ 15 units), the octupoles we have (~ 60 A) and the ADT damping time we have (~ 10-20 turns? tbc). As the ADT damping time is very fast, it should be fine but would be good to have some simulation results (partly done already in the past by XavierB).

- Action 52 (DavidA): for TMCI in HL-LHC, try also and compare to a case for HL-LHC with the same settings (gaps) of the collimators.

- Action 53 (EliasM to answer to W. Hofle): What is our requirement wrt the ADT (at injection and high energy) for the report being compiled by O. Brüning on the full energy exploitation of LHC (7.5 TeV)? => After discussion with W. Hofle and X. Buffat, it was decided to have:

  1) Injection damping time: 10 turns.

  2) High-energy damping time: 50-100 turns.

  3) Noise: reduction by a factor of 4 at full bandwidth, i.e. bunch-by-bunch (there would then be also the reduction of bandwidth as an additional means to reduce noise).

- Action 54 (EliasM et al.): Report at the LMC about the instability studies status => Will be done once finalized (both at injection, after the RF voltage reduction, and high energy).

- Action 55 (GianniI et al.): Perform simulations of e-cloud instabilities at LHC (and HL-LHC) injection, scanning the RF voltage at injection (currently reduced in the LHC from 6 MV down to 4.5 MV, with a last step to be done at 4 MV) to try and study the impact on the required chromaticity and octupole settings to stabilise the beam.

- Action 56 (DavidA et al.): Check beam stability from impedance for high-beta run at injection (collimator settings sent by RoderikB) => Done by D. Amorim and N. Mounet (see slides today – 03/09/18 – to be also discussed at the CollWG in the afternoon).
- Action 57 (BenoitS and LottaM): finalize the contributions to Evian2017.

- Action 58 (LMC action for LHC coordination and BE-OP): continue to explore beam parameters (voltage and octupoles) in a controlled way.

- Action 59 (SergeyAnt et al.): Action for us for the HiLumi meeting to review the strategy and further optimization of the impedance reduction, in particular for after LS2 => Should we work more on geometric part? Or RW? Or some other collimators? For this we need to have a plot per collimator of the octupole needed with RW only and with RW + geometric part (with all the usual assumptions of the OP scenario: Q’ = 15, assumed collimator settings, etc.). It would be also interesting to have the same plot produced to see the improvement in the required octupole current vs. the possible upgrade made by adding the case where the collimators geometric impedance would have been reduced to the (reasonably) bare minimum (which does not mean that this will be done...).

- Action 60 (SergeyAnt and NicolasM): Check that the split in Landau octupole current between the different collimators is fine (as NicolasM raised the point of the non-additive contribution of the different elements (leading to different modes, etc.).

- Action 61 (KevinL): What is the (detailed) explanation of the transfer line (between SPS and LHC) instabilities? => Discussing with KevinL, it seems that this was due to e-cloud and once the SPS was scrubbed the instability did not appear anymore => Is it really the cause and is it really fully understood? See also IEFC 15/06/18: https://indico.cern.ch/event/736870/contributions/3039866/attachments/1668465/2675680/01b_Instabilities.pptx.

- New actions from this meeting:

  - None (just follow-ups of started activities…).

3) General infos and follow-up (EliasM)

- SLM
  - I did not attend it last week as I was in Rostock (Germany, university of Ursula Van Rienen) for the JUAS Advisory Board.
  - However, there is nothing worth reporting here.

- LHC
  - Very nice MD3 block with many interesting results!
    - E-cloud => 2 highlights
      - Missing point at 0.8E11 p/b => ~ as predicted.
• Heat load reduced in arcs with bunch length => ~ as predicted. Reminder: it is increases in the quads.
  - Instability rise-time at injection => See slides from DavidA: https://indico.cern.ch/event/754245/contributions/3124977/attachments/1716805/2770039/2018-09-17_MD3308_overview.pptx
    • Seems close to predictions at first sight, with B2 quality much better than B1 => To be analysed in detail.
  - BTF
    • Could not collide and issue with V.
    • But good measurements made in H at FT without and with noise => To be analysed in detail.
  - ATS with LOF < 0 and (asynchronous) collapse
    • Seems that it worked very well => Good news for the future! => To be analysed in detail.
  - Tight collimators at injection => NicolasM et al. made quickly some tune shift measurements => To be analysed in detail.

- LMC talk by GianniI

  o Seems that after the 2 talks from GianniI at the LMC, everybody is now convinced that 1) e-cloud is the key ingredient to explain the heat loads in the different LHC sectors and 2) before LS1 the difference between the LHC sectors was not present AND the heat loads were smaller than or similar to what is measured today.

- E-cloud meeting

  o Update on laboratory measurements on LHC beam screens by Valentine Petit
    - e- irradiation modifies oxidability, depending on the surfaces exposed.
  o Investigation of copper conditioning and deconditioning processes for particle accelerators by Valentine Petit
    - Storage conditions of primary importance for the analysis of conditioned sample after air exposure
    - Copper shows memory of conditioning from both SEY and surface chemistry point of view
    - Memory seems to be a long-term effect
    - Contrasts between conditioning states have a shorter life-time
    - Results presented here: samples treated with special care. In reality of components extracted from accelerators, samples are cut from the massive component to fit into the system. Surface state can only degrade...
Ions do not play an important role => Good, as it means that all the past simulations are still valid.

Would be good at some point to see how this evolves when we approach a situation close to the 16L2, where LottaM found an important role of the ions.

4) Horizontal instability studies at 160 MeV mimicking the future injection energy in the PSB (EiriniK): https://indico.cern.ch/event/754245/contributions/3124979/attachments/1716520/2769449/PSB_HorInstability_tunescan_160MeV_EKP_HSC.pdf

- Many very nice measurements / scans performed which reveal clearly the range of unstable horizontal tunes.

- The worst case is for Qh ~ 4.26, which is very close to the tune which we wanted to use for space charge considerations… Furthermore, during the first milliseconds the damper will not work well, so it is really a potential worry for LIU…A possibility could be to use a slightly higher horizontal tune during the first milliseconds.

- A record number of nodes (13) could be obtained with a chromaticity of ~ -2.5!

- After a detailed analysis with the RF cavities, it could be concluded that the normal RF cavities cannot be the source of the instability => Concentrate now on the kickers.

- Using Sacherer’s formula, CarloZ could reproduce the shape of the instability rise-times using a resonator with a resonance frequency of 1.7 MHz, a shunt impedance of 20 MOhm/m and a Q factor of 100. The value of 20 MOhm/m seems very high but according to CarloZ, it is maybe possible to reach such values if the attenuation of the cables is very low => To be followed up.


- Following recent discussions about the effect of space charge on transverse instabilities (see A. Burov, Convective Instabilities of Bunched Beams with Space Charge, https://arxiv.org/pdf/1807.04887.pdf, and the recent simulations from AdrianO, see last HSC meeting), some past work about BBU instabilities in synchrotrons is reviewed.

- With TMCI we approach the intensity threshold from below, while with BBU we approach the intensity threshold from above => Full theory to unify both approaches still to be done. Then, add also the effect of space charge.
6) 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.

7) Miscellaneous

- The next (155th) meeting will take place on Monday 24/09/2018 (in room 6/R-012 at 10:30) => Current agenda:

  1) General info and follow-up (EliasM)

  2) Destabilizing effect of resistive damper in FCC (Nico Klinkenberg and SergeyArs)

  3) 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.


Minutes by E. Metral, 17/09/2018.