Minutes of the HSC section

184th meeting on Monday 19/08/2019 (10:30 in 6/R-012)

Present: See https://docs.google.com/spreadsheets/d/1fZiu3vtf546odhd2ONxtW0mx9p8cV-fURT9Kxi7QCys/edit?usp=sharing

1) Newcomers / visitors / departures

- Giulano Franchetti visiting us for few days, to work on IBS and related effects within the HSI section.

2) Comments on the minutes of the previous 183rd 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. Waiting for new HOM tables as they are still in the process of iterating on the design of the couplers (info from SergeyAnt on 05/11/18).

- 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/). Done.

- 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 very interesting results (see https://indico.cern.ch/event/752791/contributions/3118952/attachments/1709067/2754700/SPS_CBI_theoretical.pdf).

- 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 very interesting results (see https://indico.cern.ch/event/754245/contributions/3124979/attachments/1716520/2770001/PSB_HorInstability_tunescan_160MeV_EKP_HSC.pdf). Planned MD on Monday 12/11/18.

- 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: See also simulation results included in ICAP18 paper + https://indico.cern.ch/event/763977/contributions/3171002/attachments/1738041/2828049/TIwithSC_SPS_AOandEM.pptx + MDs being done in the SPS before the end of the run.

- 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 16 (SergeyAnt): Check the effect on Im[Z/n] of the HL-LHC coated inner triplets. Presented at WP2 on 03/07 and no measureable effect (https://indico.cern.ch/event/741104/contributions/3059804/attachments/1679470/2697601/Impedance_effects_of_the_HL-LHC_coated_inner_triplets_WP2.pptx).

- 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. News from XavierB on 05/08/19 (and discussion together), who updated the note on the octupole strategy with DA plots from Nikos: https://cernbox.cern.ch/index.php/s/JPM3ER2w4ktdCJI. It seems difficult to reach configurations with a tune separation larger than 5E-3, with either polarities. RogelioT said that a correction below 1E-4 is challenging, and PACMAN linear coupling (non-correctable) also gives a contribution in that order of magnitude. This does not seem compatible with the recommendation of C- / (delta Q_min) < 0.1 (see page 3 of http://cds.cern.ch/record/2301292/files/CERN-ACC-NOTE-2018-0002.pdf). Check what can be done and if we relax our request to ~ 0.2 (instead of ~ 0.1), what would be the required octupole current to compensate.

- 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). News from XavierB on 05/08/19: done and results reported at Evian2019.

- 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. This was clarified and now there should not be anything.

- 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 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? 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 => Done

https://indico.cern.ch/event/752407/contributions/3116866/attachments/1717559/2771554/2018-09-18_Amorim_WP2_HL_TMCI_update_v2.pptx.

- 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 different 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. News from XavierB on 05/08/19: done and results reported at Evian2019.

- 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. Done: talk done on Sept. 21st at the Run III meeting (https://indico.cern.ch/event/746728/contributions/3130409/attachments/1720381/2777223/20180921_RunIII_impedance_considerations.pdf).

- 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. Some meas. done on CFC and measurements revealed large difference between 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) => Seems indeed to be confirmed by pyHEADTAIL simulations (but still work in progress), as could be seen in the talk by CarloZ at the ABP Injectors Day 30/04/19 (see https://indico.cern.ch/event/799216/contributions/3388235/attachments/1836192/3008570/Impedance_ABPday_v3.pdf).

- 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. XavierB checked the actual gain and it seems to be more than 200 turns instead of 50 (05/11).

- 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). Done: see https://indico.cern.ch/event/658828/contributions/2687995/attachments/1507882/2350735/coherentEffectsatInjection_LRC_14-08-17.pdf.

- 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. Done.

- 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. Planned with GianniI (as discussed few days before HSC meeting of 06/05/2019). Status on 28/05/19 (GianniI): Simulations presently running in Bologna (including an intensive convergence scan). It will take a few weeks to accumulate 20000 turns. Should be able to present some first results towards the beginning of July (LHC intensity) and aim at having a more complete picture in fall.

- 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. Done by BenoitS.

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

- 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...). 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.). Done and there is no perfect solution as the octupole currents are anyway not additive. The least bad approach is maybe to consider a machine without collimators first, compute the octupole threshold, and then gradually add up each collimator impedance and compute the resulting octupole threshold. But the order in which one chooses the collimators, will matter...

- 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.

- Action 62 (DavidA): Continue the past studies on instability rise-time above TMCI intensity threshold (using the SPS Q26 case) by looking in particular at the intra-bunch motion in the different regimes => On-going.

- Action 63 (BenoitS et al.): Send to StefanoR our quantitative estimate for the collimator impedance in parking position => Done: https://indico.cern.ch/event/763977/contributions/3171005/attachments/1746563/2828067/20181105_HSC_impact_oldTCSG_in_parking_RunIII.pdf. NicolasM did it, from the resistive-wall + taper impedance point of view: there is no impact from the secondary collimators in parking (<0.06% on the impedance itself, not visible impact on the octupole threshold). As BenoitS mentioned, there might still be the issue of the non-touching RF-fingers => BenoitS is following this up.

- Action 64 (XavierB et al.): Send input to DanielV before the end of the year if we need some modifications on the ADT system (the “baseline” is: no concrete input from ABP before December, the damper after LS2 will be exactly the same as today). => Evian19 as deadline? Done.

- Action 65 (machine coordinators => NicoloB): Send the week summary to GA, RS and all the SLs. Done by NicoloB.

- Action 66 (NicoloB): to finalise the identification of the source of the LEIR instability, come back to the initial configuration (termination) on the KQFHV31 (old BTF kicker) to see if the damper is then still needed to stabilise the beam. Done: in the end, the culprit for the LEIR instability at injection without damper is UHV41 (old BTF pickup) => It is now disconnected.

- Action 67 (CarloZ): In the framework of the PSB instability studies, check Sacherer’s formula for instability rise-times from the HOM at 1.7 MHz with Q = 100. On-going and the issue could come from the considered bunch spectrum (Gaussian vs. Sinusoidal modes…). At least the difference is not coming from the relativistic beta factor.

- Action 68 (AdrianO): Check what the reason is for difference in stabilizing octupole current for HL-LHC with pyHEADTAIL simulations compared to past predictions (~ 300 A) => Seems to be a factor ~ 2 lower (as mentioned by NicoloB and SergeyAnt, it might be due to the different transverse distribution used in the past (quasi-parabolic) instead of Gaussian here). Solved by AdrianO (different parameters used).

- Action 69 (EliasM and MassimoG): Check the maximum speed between 0 at ~ 1.5 sigmas for HL-LHC => Revision of separation bump collapse time for HL-LHC with MassimoG, DavideG, XavierB and NicolasM and it is OK.

- Action 70 (XavierB): Analysis of the 150 Hz oscillations on the beam observed during the last part of the run => High priority and quite urgent as if we knew where to look, we could maybe have a look with ions. Would be good also to know when this started to appear => See also with HSI section.

- Action 71 (XavierB and EliasM for March 2019): Document in a note why we think that for HL-LHC it will be OK with LOF < 0, whereas we had some issues in 2012 (explaining therefore what we think happened in 2012). Note written by XavierB and commented by EliasM on 04/05/19 (should be released soon).

- Action 72 (AdrianO): Re-do the same simulations to study the effect of space charge on the SPS TMCI with Q26 but using the space charge parameter of Q20 (i.e. ~ 5 instead of ~ 27). Then re-do also the same simulations but for the Q20 optics.

- Action 73 (XavierB): Check WP2 actions => Results and plans for the future. Done.

- Action 74 (EliasM): Following some checks/comparisons from SergeyArs, check GALACTIC (both theory and simulation results) => Done by EliasM for the comparsion between GALACTIC (and GALACLIC) and Laclare's approach: see https://indico.cern.ch/event/788200/contributions/3275041/attachments/1780791/2896974/SummaryOfMy3IPAC19papers_EM_17-01-19.pdf. Some past comparisons between GALACTIC and DELPHI were shown in https://cds.cern.ch/record/2652200/files/CERN-ACC-SLIDES-2018-0003.pdf.

- Action 75 (SergeyAnt et al.): Perform pyHEADTAIL simulations with space charge to try and reproduce the measured stability diagrams (with the damper used as a controlled impedance) and compare with some past analytical estimates. See also some past studies in https://journals.aps.org/prab/pdf/10.1103/PhysRevSTAB.11.014201. On-going (06/05/19).

- Action 76 (XavierB, by 14/01/2019 to be ready also with the DA simulations by HSI by the end of January in preparation of the collimation review that is going to take place on 11-12/02/2019): Check the stability limits (i.e. telescopic factor/octupole current required to stabilize the beam during the collapse of the separation bumps) for the ultimate scenario and BCMS emittance for the 3 cases already considered (No collimator upgrade, LS2 upgrade, baseline upgrade) but for POSITIVE octupole polarity => Done by XavierB (see HSC meeting of 21/01/2019).

- Action 77 (WP2 team, < 25/02/2019: exact date still to come…): Contributions will

certainly have to be sent to GianluigiA for 1st draft of the new version of HL-LHC TDR + HiLumi book (proposed to be done in parallel and the info should be sent to LucioR and OliverB by 25/02/2019) => Work on TDR is ongoing with some updates from EliasM for the part on beam stability (as of 20/02/19). Done (as of 06/05/19).

- Action 78 (ClaudiaT and impedance team): Check the factor ~ 1.5 stronger impedance than model from BTF measurements in the LHC (see HSC meeting on 17/12/2018) => Done and seems to be in agreement with other observations from impedance team (see Action 81). Reminder: BTF was done on B1H at top energy.

- Action 79 (DavidA et al., during LS2): (i) taking all the impedance measurements performed so far, try and conclude on the impedance of the LHC for B1H, B2H, B1V and B2V at the different phases of the LHC cycle (done, see Action 81 below); (ii) perform beam dynamics simulations with the measured impedance model and compare with the results with the ideal one.

- Action 80 (SergeyAnt with NHTVS and NicolasM with DELPHI): quantify the required tune spread to stabilise a single bunch assuming that we are running at a factor ~ 2 (~ 3) below TMCI (for Q' = 0) with ADT, and that the impedance is ~ 2 times higher. => Done on 18/02/2019 : non-linear effect confirmed by NHTVS and DELPHI (with LHC impedance model) but smaller than GALACTIC (with broad-band impedance model) => Is the difference due to the different impedances ? To be looked at in the future (see Action 83).

- Action 81 (Impedance team for Wednesday 04/02/2019): quantify the factor between the measured impedance-induced tune shift and the predicted one for B1H, B1V, B2H and B2V in the LHC at flat-top => Done, see slides from today's meeting (18/02/2019): https://indico.cern.ch/event/795854/contributions/3306471/attachments/1791211/2923590/2019-02-11_tune-shifts_measurements_16-17-18_v2.pdf.

- Action 82 (SergeyAnt with NHTVS and NicolasM with DELPHI): check which impedance would be needed to reproduce the past measurements with Q' < 0 (see summarising plot from LeeC et al.) => Done on 18/02/2019 => No simple impedance factor can reproduce the past measurements. Furthermore, some differences appear between NHT and DELPHI for Q' < 0 => To be followed up.

- Action 83 (SergeyAnt with NHTVS and NicolasM with DELPHI): as a follow-up of Action 80, compare results with GALACTIC (see https://indico.cern.ch/event/794757/contributions/3306443/attachments/1789562/2915350/DestabilisingEffectOfADTwithLargerImpedance_EM_04-02-19.pdf) if the same impedance as GALACTIC is used (see http://accelconf.web.cern.ch/AccelConf/ipac2018/papers/thpaf048.pdf) => Concluded on 06/05/19 (see slides by NicolasM: https://indico.cern.ch/event/818165/contributions/3417043/attachments/1838893/3014013/20190506_NMounet_HSC_action83_DELPHI.pdf).

- Action 84 (SergeyAnt with NHTVS and NicolasM with DELPHI): Try and understand (at some point… low priority) why a significant difference seems to be observed for Q' < 0 as a region with 0 current in octupoles is observed in DELPHI contrary to NHTVS.

- Action 85 (DavidA): all the predictions of LHC transverse tune shifts from impedance are made with Sacherer's formula (using dipolar and quadrupolar impedances) and it should be compared to pyHEADTAIL simulations in the future to see what is the error made (should be within few tens of % depending on the longitudinal distribution, but we are now at this level of precision between measurements and predictions…).

- Action 86 (SergeyArs): Check the longitudinal impedance of the HL-LHC pumping holes and evaluate to possible beam-induced RF heating. Try and estimate the impact of a certain randomization of the pumping holes. These results should be then presented at the WP2. BenoitS looked at it and concluded that it is small.

- Action 87 (?): Detailed analysis of the different stages of a realistic model of the LHC transverse damper implemented in pyHEADTAIL. In other words, how does it compare quantitatively to a perfect bunch-by-bunch damper as concerns the single-bunch and coupled-bunch stability vs. chromaticity and Landau octupole?

- Action 88 (AdrianO): Using the same parameters as in IPAC18 paper (and the broad-band resonator), try and identify from pyHEADTAIL simulations when and how the 2-mode approach starts to become important. => Done on 25/03/2019.

- Action 89 (AdrianO): Following the same approach as for Action 88, find the curve of stability for Landau damping WITHOUT transverse damper, to be able to compare to the case WITH transverse damper (and compare to predictions https://indico.cern.ch/event/807899/contributions/3362767/attachments/1816203/2971974/LDforTMCI_EM_25-03-2019_2.pdf).

- Action 90 (KevinL, AdrianO and LottaM): Try and understand why the results of the new pyHT simulations from MauroM for the PS instability at injection are not the same as with the HT code and published in the PAC07 paper (see https://accelconf.web.cern.ch/accelconf/p07/PAPERS/FRPMN074.PDF) => This is important and urgent to do this as other people such as FrankZ also obtained some strange results: is there an issue or is it a matter of "correctly using pyHT"?

- Action 91 (DavidA with DELPHI, SergeyAnt with NHT, AdrianO et al. with PyHT): The effect of the longitudinal distribution on the instability rise-time seems quite important for Q' = 0 => This should be confirmed, first, if it is the same thing with the threshold octupole current. Could this be that the effect of the controlled longitudinal blow-up on the longitudinal distribution has such an important impact for Q' close to zero?

- Action 92 (DavidA, SergeyAnt, SergeyArs, BenoitS): Question from GianluigiA triggered by the IPAC19 paper from FrankZ et al. "Updated high-energy LHC design" => What is the expected tune variation vs. bunch position expected for the LHC at injection and flat-top due to impedance? Might be good to compare the past LucVos' predictions (see Ref. [28] of the IPAC19 paper) with NHT (for which the "Arbitrary filling pattern" will be discussed by SergeyAnt on Monday 29/04/19) and pyHT. Similar studies should be done for the SPS (CarloZ and GiovanniR) => Already started by MichaelS. BenoitS and DavidA started to look at that (29/04/19).

- Action 93 (NicoloB et al.?, with a timeline which remains to be defined as this should require some code development): study the SPS transverse stability with ions and slip-stacking. Profit also from the visit in FNAL in June to learn from their experience, as I saw some nice simulations from them in the past (at least in longitudinal…).

- Action 94 (EliasM et al.): decide on the place and date for the HSC hiking day (many thanks SergeyAnt for the excellent proposals!) => Not possible before the summer vacation. Will see at the end of the summer.

- Action 95 (EliasM et al. for HSC section): Follow up list of actions from ABP Injectors Day held on 30/04/12 (https://indico.cern.ch/event/799216/)

  - ABP-ID-1: "LEIR – The possibility to use Tune kicker or the transverse damper for optics measurement is under investigation (NicoloB). Clarify the status and possibilities".

  - ABP-ID-2: "SPS horizontal instability is the major challenge. What to do after identification, already seen at 1.8e11 protons/bunch. => Review the findings by September 2019. Extrapolation after impedance reduction campaign".

  - ABP-ID-3: "Produce comparison impedance models before and after LS2 for each machine and evaluate observables to compare with".

  - ABP-ID-4: "Define measurement programme for validating the models and include it in the re-commissioning planning".

  - ABP-ID-5: "LottaM is looking at PS electron cloud. Margin for longitudinal and transverse emittance? Is the transverse feedback sufficient to counteract electron cloud instabilities? End of 2019".

  - ABP-ID-6: "Strategy for correction of the coherent vertical tune shift along the batch. End of 2019".

  - ABP-ID-7: "Trade off SPS 200MHz HOM damping and transverse stability. Proposal by September 2019".

  - ABP-ID-8: "Transverse stability for ions in slip stacking. End of 2019".

  - ABP-ID-9: "Optics study at LEIR: define (with MassimoG and RichardS) the plans for optics measurements and requirements and include in the recommissioning planning."

  => See 1st status report on 04/07/19 (https://indico.cern.ch/event/829903/contributions/3474994/attachments/1874561/3086173/ABPinjectorsMeeting_EM_04-07-2019.pdf).

- Action 96 (EliasM et al. for HSC section) from WP2 meeting of 02/07/2019 (https://indico.cern.ch/event/826475/): Estimate the effect of electron cloud, impedance,

and beam-beam force on the observed crabbing.

- Action 97 (XavierB et al. for HSC section) from WP2 meeting on 09/07/2019 (https://indico.cern.ch/event/831847/): As a follow-up of the talk from XavierB (on "Summary of instability observations: implications for HL-LHC"), GianluigiA mentioned that it would be important to identify which measurements we would like to do during Run 3: what do we want to measure and how do we plan to do? Would be great to have a written procedure. SergeyAnt stressed the importance to have a reliable measurement of Landau damping (estimated for the moment either with BTF or anti-damper) and GianniI suggested also to try and profit from the Van der Meer cycles to try and perform some of our measurements => Deadline: end 2019 – beginning 2020.

- Action 98 (EliasM et al. for HSC section): Following discussion with GianluigiA (on 09/07/19) and previous discussion with RogelioT, StefanoR, MassimoG and YannisP:

- If we want for HL-LHC to use a tele-index of 1.7 and LOF < 0 (keeping the same assumptions as in the 2019 collimation review), what would be the maximum bunch intensity with the LS2 upgrade?

- Similarly to the previous study, what would be the minimum beta* which could be reached for the nominal HL-LHC intensity, LOF < 0 and tele-index of 1.7?

- Contact RoderikB to have his latest collimators' settings (after optimization of the optics to reduce the impedance and improve the collimation efficiency) and check what would be the gain in octupole current when the LS2 upgrade is assumed?

- As a follow-up of Action 98 (and after discussion with GianluigiA, YannisP, XavierB and NikosK):

- XavierB: update the stability plot from collimation review, without coupling => Needs r ~ 1.9 (instead of 1.7) for LS3 upgrade and ~ 2.2 (instead of 2.0) for LS2 upgrade.

- NikosK: check the required r for DA such that there is enough space, i.e. to have a tune separation of 5E-3 with tune accuracy of 1E-3, i.e. 6E-3 tune separation.

- Then, see with this r what is the required coupling correction to achieve this => With RogelioT and see if this is feasible.

- And then finally see what would be the intensity limit with the assumed feasible parameters, both with LS2 and LS3 upgrade and with LS2 upgrade only.

- Finally, it was recently mentioned that cryo will need ~ 15 min before going in collision at 5E34, starting at ~ 1.5E34 => What are the

implications for us, as it would mean collide at ~ 2 m?

- Action 99 (EliasM): EliasM (and YannisP) to send some feedback to GianluigiA et al. on the Fermilab Experiment by end of August.

- New actions from this meeting:

- Action 100 (XavierB): Detailed analysis of the effect of the radial modes (with the Circulant Matrix formalism) for the case of the SPS TMCI with a BBR impedance.

3) General infos and follow-up (EliasM)

- No SLM (next one on 26/08/19).

- Comment on 2-particle model: see first part of this paper from A. Burov (https://journals.aps.org/prab/pdf/10.1103/PhysRevAccelBeams.19.084402), where he already treated the 2-particle case for a round chamber and then a flat chamber (considering the detuning impedance), adding then also the effect of the chromaticity and damper => Would be good however to re-derive all this and give all the steps, as GiovanniR did recently for the case of the detuning impedance.

- Ecloud meeting (GianniI)

- Update on LHC beam screen analysis by Valentine Petit => We think that the source of the discrepancy between the heat loads of the different LHC sectors was finally found!

- Implementation of cross-species ionization in PyECLOUD by LottaM.

- Commented

- Paper from GianniI and GalinaS on "Beam-induced heat loads on the beam screens of the HL-LHC arcs".

- Paper from MichaelS et al. on "Studies on use of a radio frequency quadrupole cavity for Landau damping in HL-LHC".

- Several other papers still to comment.

- GianniI mentioned that within the WP2 studies, there are ongoing discussions with MassimoG and RiccardoDM to try and understand better why we are more constrained for HL-LHC at injection wrt LHC as concerns DA and find possible solutions.

- DavidA showed clearly in the past how the bunch signal is pushed towards the tail when the intensity is increased above the TMCI intensity threhsold (see https://indico.cern.ch/event/824835/contributions/3449637/attachments/1863099/3062661/2019-04-25_DELPHI_PyHT_comparison_update_v1.pdf). Furthermore, the intrabunch motion frequency increases with intensity as can be seen on these new slides:

https://indico.cern.ch/event/840690/contributions/3527258/attachments/1894592/3125380/2019-08-19_damorim_results_intrabunch_motion_frequency.pdf. This is important in the framework of the understanding of what happens in the presence of space charge as AdrianO mentioned in the past that space charge was pushing the signal towards the tail and increasing the frequency (see https://espace.cern.ch/be-dep-workspace/abp/HSC/Meetings/SUPAG01.pdf).

- As a follow-up of last meeting

  - Effect of detuning impedance on TMCI for constant wake and zero chroma => See https://indico.cern.ch/event/840690/contributions/3528490/attachments/1892682/3125098/EffectOfDetuningImpedanceOnTMCIForConstantWake_EM_19-08-2019.pdf. A good agreement has been reached between the 2 (slightly different however) methods (Burov-Danilov_1998 extended to constant wake with only 2 modes) and 2-particle model (GR, 12/08/19). The air-bag model used in previous is fully described by a simple matrix to be diagonalized (see last page).

  - Effect of detuning impedance on TMCI for zero chroma with BBR impedance: Recent analysis (see 05/08/19) vs. Circulant Matrix => See https://indico.cern.ch/event/840690/contributions/3528490/attachments/1892682/3125100/BenchmarkDetuningImpedWithCirculantMatrix_EM_19-08-2019.pdf. A good agreement has been reached between the 2 methods. Next: detailed analysis of the effect of the radial modes with Circulant Matrix (XavierB => Action 100).

  - SPS TMCI with flat chamber (without SC): can we better explain some past HEADTAIL simulations? => See https://indico.cern.ch/event/840690/contributions/3528490/attachments/1892682/3125099/SPSTMCIwithFlatChamber_EM_19-08-2019.pdf. Seems that the effect of the asymmetry (flat chamber) on the TMCI intensity threshold (for this SPS case) can be explained mainly by the Yokoya dipolar factor (as also discussed in BenoitS' PHD thesis). Next: would be interesting now to analyse in detail the effect(s) of the radial modes with Circulant Matrix (XavierB => Action 100).

  - Effects of space charge and detuning impedance on TMCI for BBR impedance: Part 2 => See https://indico.cern.ch/event/840690/contributions/3528490/attachments/1892682/3125102/EffectsOfSCandDetuningImpedanceOnTMCIforBBR_EM_19-08-2019.pdf. Similar results as on 05/08/19 but this time (with the correction mentioned in the slides and the successful benchmark made above without SC), SC is always helping first (moving the coupling from negative modes to positive modes) and then it is destabilising and for the highest SC parameters considered here, the TMCI intensity threshold is similar or below the TMCI intensity threshold without SC. Next: Check convergence and with A. Burov and T. Zolkin, who studied this in detail in their PRAB paper https://journals.aps.org/prab/pdf/10.1103/PhysRevAccelBeams.21.104201 and who found indeed that a sufficient number of modes needs to be used as well as an extremely good accuracy in the wake matrix elements computation.

4) Interaction of a relativistic particle with an electron cloud (GianniI):

https://indico.cern.ch/event/840690/contributions/3527259/attachments/1894423/3125049/012_ecloud_force.pdf

- GianniI gave a very nice and detailed analysis of the interaction of a relativistic particle with an electron cloud, going through all the steps as written in a note recently released: http://cds.cern.ch/record/2684858/files/CERN-ACC-NOTE-2019-0033.pdf.

- Summary

  - The forces acting on a beam particle due to an electron cloud, can be conveniently calculated in a boosted reference frame moving rigidly with the beam.

  - In such a reference frame, charge and current densities are stationary => Electric and magnetic fields are solution of an electrostatic and a magnetostatic problem respectively.

  - The force acting on the bunch (in the lab frame) is proportional to the gradient of the scalar potential and is therefore irrotational.

  - This happens since the force due to the non-irrotational component of the electric field is cancelled exactly by the magnetic field term.

  - For a relativistic beam the scalar potential can be calculated with good approximation as the solution of a 2D Poisson problem.

  - The Hamiltonian of the resulting transformation can be written as a function of the position coordinates, showing that the map is symplectic.

5) Generating non-white transverse noise in COMBI (Juan Sebastian Pereira Cubillo): https://indico.cern.ch/event/840690/contributions/3528497/attachments/1894424/3125050/Noise_v5.pdf

- Congratulations Juan (and supervisor) and many thanks for your help! Wish you a good continuation for your future career.

- SergeyAnt asked what the period of the pseudo-random generator is compared to the number of particles? SondreF mentioned that it might be better to compare it not to the number of particles but number of turns. XavierB mentioned that this period is more than 10^9 and we never went to more than this number.

6) Calculation of the PSB BTV impedance and investigation of mitigation measures (Domagoj-Kresimir Jukic): https://indico.cern.ch/event/840690/contributions/3528533/attachments/1894461/3125126/Understanding_and_possible_mitigation_strategies_of_the_PSB_BTV_like_impedances.pdf

- Congratulations Domagoj (and supervisor) and many thanks for your help! Wish you a good

continuation for your future career

- SergeyArs said that it is a good case to benchmark his recent theory, where the dipolar and quadrupolar contributions can be disentangled. Here, both contributions were added and not disentangled.

7) Faulty connections in the BPM and their effect on the beam (Otto Ellonen): https://indico.cern.ch/event/840690/contributions/3528971/attachments/1894421/3125046/Faulty_Connections_in_the_BPM_and_their_effect_on_the_Beam.pdf

- Congratulations Otto (and supervisor) and many thanks for your help! Wish you a good continuation for your future career.

8) An analytical method for computing wake functions for a circular beam pipe - an update (Ekaterine Dadiani): https://indico.cern.ch/event/840690/contributions/3529263/attachments/1894510/3125223/An_Analytical_Method_for_Computing_the_Wake_Functions_in_the_case_of_a_Circular_Beam_Pipe_-_An_Update.pptx

- Congratulations Ekaterine (and supervisor) and many thanks for your help! Wish you a good continuation for your future career

- The method seems to work for the indirect space charge (which is now find after the improvement from Ekaterine) but seems difficult for the resistive-wall…

9) 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 and heat load (GianniI)

    - Not discussed.

- Beam-beam (XavierB)
    - Not discussed.
- Space charge (AdrianO)
    - Not discussed.
- ABP-CWG (GiovanniR):
    - Not discussed.
- PyHEADTAIL (LottaM)
    - Not discussed.
- DELPHI (NicolasM)
    - 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.

9) Miscellaneous

- The next (185th) meeting will take place on Monday 26/08/2019 (in room 6/R-012 at 10:30) => Current agenda:

    1) General info and follow-up (EliasM)

    2) Potential of meta-materials for passive mitigation of coherent instabilities in the HL-LHC (Dimitris Tsangaridis)

    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.

- Web site: https://espace.cern.ch/be-dep/ABP/HSC/default.aspx.

Minutes by E. Metral, 20/08/2019.