

Minutes of the HSC section

132nd meeting on Monday 05/02/2018 (10:30, 6/R-012)

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

1) Beam loading (or power efficiency) vs instability in plasma accelerators (Sergei Nagaitsev from FNAL):
https://indico.cern.ch/event/689771/contributions/2832231/attachments/1594972/2525758/CERN_Nagaitsev_Feb5_2018.pdf

- SergeiN is the accelerator division head of FNAL; Professor at the University of Chicago) and member of the CMAC (he attended the Chamonix workshop last week). He will also give an ATS seminar tomorrow: Fermilab and Accelerator Science.

- Reminder: PWFA = Plasma WakeField Accelerator.

- 2 regimes for the trailing beam

- Quasi-linear regime => Suitable for both e- and e+

- “Bubble” (or blow-out) regime => Suitable for e-, not suitable for e+ (at least with e-driver) => This regime (where there is no e- inside the bubble) is discussed here.

- The bubble (which is the equivalent of the accelerating structure) is moving along the plasma

- FACET experimental program is now finished => Starting to think about the next step: FACET-II (as a community resource).

- Motivation for this study comes from a paper by J.P. Delahaye et al. mentioning an acceleration efficiency (drive-to-beam) of 50% (to be compared for instance to 30% for CLIC): how is it possible?

- Power efficiency is important because power = cost.

- Difference between conventional RF and plasma

- RF: energy does not dissipate due to $Q \gg 1$.

- Plasma: $Q \sim 1$ => Challenge is to transfer as much as energy (from the wake field) to the trailing bunch within the same bubble as the driver (such operation of a conventional cavity is only possible because the Q-factor is $\gg 1$).

- Be careful => “Plasma wakefields”: The terminology of wakefields in plasma can be confusing. The original meaning of the wake in plasma is the field generated by the drive bunch, which accelerates the trailing bunch (the driver could be particle beam or laser). In this presentation, wakefields = fields (longitudinal and transverse) with which the trailing bunch acts on itself => Our usual definition of wakefields...

- Transverse Beam Break-Up (BBU) instability (also called hose instability): single-bunch at short distance => This is what prevents CLIC from being more efficient. The solution is BNS damping (The N stands for Novokhatsky who is currently visiting us for few weeks).

- The short-range transverse wake (for solid walls) scales linearly with the distance and with the inverse of the 4th power of the transverse dimension. Does this hold for a PFWA? => Deriving the proper equations (starting with the Lu plasma bubble equation) we see that YES.

- Assumption made: the bubble radius $R_b \gg 1 / k_p$.

- Power transfer from drive to trailing bunches => Let's define η_{tap} = Ratio between the power gained by trailing bunch and the power lost by the driving bunch.

- Let's define η_{at} = ratio of the defocusing (wake) force to the focusing force => Between 0 and 1.

- A universal “efficiency-instability” relation can be derived (without any detail of beams and plasma).

- Reminder: μ is betatron phase advance.

- BNS can help but then it limits the power transfer efficiency.

- The role of plasma ions

- So far, considered plasma ions to be stationary
- In fact, in the bunch density is high enough, the plasma ions are pulled into the electron bunch and create highly nonlinear focusing
 - Found to be detrimental because of emittance growth.
 - However, nonlinear focusing might be helpful to suppress the BBU instability by Landau damping.

- After this work => Clear proposal for FACET-II.

- Reminder: there is a natural stabilization of drive beam (through BNS) but this gives a jitter... The main issue is however for the trailing bunch.

2) Newcomers / visitors

- MauroM is back for 6 months.

- VittorioV is visiting us this week.

- CARIDEO Emanuela is a new TECH with SergeyAnt to work on the geometric impedance of the LHC (HL-LHC) collimators.

- LOGE Isaac Appelquist is a new TECH with OlavB to work on the impedance-induced power loss.

- SABATO Luca (already presented at the last ABP info meeting) is a new TECH working on e-cloud with GianniI.

=> Welcome to all of you! Please don't hesitate to ask question to all the team members and many thanks in advance for all your help.

3) Comments on the minutes of the previous 131st meeting + Actions

- None.

4) General infos and follow-up (EliasM)

- SLM:

- YannisP has been elected as a delegate of the Staff Association (as well as Silvia Schuh). YannisP will be the department representative to the BEMB.
- Telephones: This migration is on stand-by after the software supplier has indicated a possible significant price rise => **Keep your telephone for the moment.**
- New chair of the Asset and Maintenance Management: Lars Jensen.
- Lars Jensen will also take over the BE newsletter, which has been dormant for some time => NicoloB accepted to become our new group representative.
- The CERN energy consumption can be seen online here: <https://energy.cern.ch>.
- Objectives for 2018
 - Operation as good as last year (> 50 fb⁻¹ for LHC).

- Complete ELENA commissioning and possibly first gbar run.
 - Preparation for strategy review: CLIC and FCC. The Nine will be used to try and collect other ideas at CERN.
- PaulC asked for some feedbacks about the session “Discussion with the CERN Directorate”, which took place in fall 2017 between the management and the personnel (Format? Was it useful? Should it be more thematic? Etc.) => Please send me any comment/proposal you would have.
 - Still discussion about the possible new building in Prévessin site.
 - BE representative for the CEPS (CERN Environmental Protection Steering Board): The BE representative was already decided and it will become official when the chair is nominated.
 - BE welcome format: full day with presentation in the morning (intro by PaulC), then safety, overview of complex, etc.
 - ErkJ mentioned, after discussion with LIU, that the RF group would install an additional Landau cavity in the PS to fight against the longitudinal instabilities.
 - YETS: The Linac2 source had several vacuum items fail in the AUG tests, but nothing critical for the tanks. Several Linac4 SEMs wires have slackened as well as a WS wire broken - reason is being investigated.
 - ECRs: The ECR for 3QD aperture repairs in SPS was agreed. LIU has taken on the 25 QD aperture replacements in LS2 (for which the impedance should be optimized).
- HL-LHC OP note released: <https://cds.cern.ch/record/2301292/files/CERN-ACC-NOTE-2018-0002.pdf>.
 - Talk from BenoitS at last LSWG to report about the MD done with the 16L2 solenoid.
 - Rehearsal talks for Chamonix (GianniI and DanieleM).
 - Chamonix workshop and CMAC close-out on Friday:
 - As concerns the critical topic of the differences in heat loads between the 8 sectors of the LHC, we need to continue to work on it and follow our current explanation => We need to try and find how / why some beam screens / equipment could have acquired a larger SEY after LS1. And of course continue to think about other possible explanations.
 - JorgW presented a conservative scenario where we could produce $\sim 68 \text{ fb}^{-1}$ => Let's wait for the final official number after FreddyB's summary.
 - Talk from AdrianO on space charge at the last ABP info meeting. Meanwhile, AdrianO did

some (even more precise) other simulations, confirming the minor effect of space charge => To be sent to A. Burov and Y. Alexahin.

- Impedance meeting last week with in particular talks from OlavB and MauroM on simple ways to compute the resistive-wall impedance in the classical thick-wall regime (and explain the origin of the real and imaginary parts).

5) General discussion about the 16L2 instabilities (Everybody):

- Current understanding very well explained by DanieleM at Chamonix.

- News: LottaM implemented, on the build-up side, the possibility to have several species => Some benchmarks are on-going.

6) Update of the PS instability at transition (EiriniK): https://indico.cern.ch/event/689771/contributions/2832926/attachments/1594648/2525099/Koukovini_HSC_05022018.pdf

- Current motivation: push the intensity of the nTOF bunch in the framework of the PBC.

- Repeating the steps from scratch (which impedance model, how to obtain the wake function, building the analysis scripts etc.), EiriniK succeeded to simulate and reproduce the characteristics of the transition instability in terms of frequency.

- Some differences with previous studies were found and some further checks are being done.

- The effect of transverse space charge on the predicted threshold was studied using a 2.5D PIC module in PyHEADTAIL => Transverse space charge helped to increase the predicted threshold by almost a factor 2 (out of the factor ~ 3 discrepancy observed before).

- There is still a discrepancy between measured and predicted threshold and the threshold sensitivity on the transverse emittance, chromaticity etc. is underway.

- The effect of the CT equipment on the threshold was studied and was found to be negligible.

- On the other hand, reducing the impedance of the PS kickers would help significantly to raise the threshold => To be continued.

- Comment from OlavB: using a faster (larger?) gammat-jump could also help => Can this be done?

7) Review of slots impedance studies for LHC, HL-LHC and FCC: history and current

status

(NicoloB):

https://indico.cern.ch/event/689771/contributions/2850280/attachments/1594845/2525613/HSC_05022018_Review_of_slots_impedance_NB.pdf

- NicoloB reviewed the theoretical models/formulae used in the past and the comparison with measurements and simulations. He also discussed the particular cases of the LHC, HL-LHC and FCC-hh.

- Lot of work done during the last decades => Both simulations and measurements performed are in agreement (or within factor 2) with expectations.

- Impact of small holes with respect to wavelength is well covered by theoretical models (OK for LHC, HL-LHC beam screens).

- Addressed also (but not covered here): trapped modes, higher order propagating modes in the coaxial regions => Might be important second order effects, not to be forgotten!

- Large holes impedance mainly assessed with 3D codes => Lack of theoretical models for large holes (to our knowledge at least...): powerful techniques exist (mode matching) that could explore these regimes.

- FCC-hh:

- Simulations performed with wakefield/travelling wave methods.

- Work on going to clear out discrepancies and bridge to known theories for small holes.

- Need to assess the heating to the cold bore as well.

- LHC:

- Mixed approach for longitudinal impedance (A.Mostacci + Kurennoy) => Too pessimistic?

- Kurennoy's formula used in transverse plane for small number of holes too pessimistic?

- LHC liner measurements in good agreement (within factor 2) with expectation.

- No details on trapped modes or higher order modes.

- Large dependence of power loss on hole manufacturing (see A.Mostacci's thesis) => Can be responsible of larger heating among sectors? Should not change with time, and normally in shadow of resistive wall...

- HL-LHC:

- Same modeling as for LHC.
- Simulations performed for octagonal triplet beam screen.
- Benchmark cases show discrepancy of factor 4 w.r.t. theory => To be further investigated.

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

- ATS-IWG (BenoitS)

- Not discussed.

- HSC-IWG (NicoloB)

- Not discussed.

- Ecloud (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 (GiovanniR)
 - Not discussed.
- Machines
 - Not discussed.
- MDs (past and future)
 - Not discussed.

9) Miscellaneous

- The next (133rd) meeting will take place on Monday 19/02/2018 (in room 6/R-012 at 10:30)
=> Current agenda:

- 1) General info and follow-up (EliasM)
- 2) On the choice of the slice length for tracking stability simulations (SergeyArs)
- 3) Two-beam stability studies in the FCC-hh and HE-LHC (ClaudiaT)
- 4) Ion studies for FCC-ee (LottaM)
- 5) 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, 05/02/2018.