Minutes of the HSC section

82\textsuperscript{nd} meeting on Monday 27/06/2016 (14:00-16:00, 6/R-012)

**HSC members:** Javier Barranco Garcia (JBG), Mario Stefan Beck (MSB), Eleonora Belli (EleoB), Olav Berrig (OB), Nicolo Biancacci (NB), Edoardo Bonanno (EdoB), Xavier Buffat (XB), Lee Robert Carver (LRC), Giovanni Iadarola (GI), Kevin Li (KL), Elias Metral (EM), Mauro Migliorati (MM), Adrian Oeftiger (AO), Tatiana Pieloni (TP), Tatiana Rijoff (TR), Annalisa Romano (AR), Giovanni Rumolo (GR), Benoit Salvant (BS), Michael Schenk (MS), Claudia Tambasco (CT), David Amorim (DA).

**Present/Excused:** JBG, MSB, EB, OB, NB, EdoB, XB, LRC, GI, KL, EM, MM, AO, TP, TR, AR, GR, BS, MS, CT, DA, Diego Ferrazza, Endre Bjorsvik, Ozhan Turgut and Claudio Rivetta (from SLAC), Rogelio Tomas, Daniel Valuch, Gerd Kotzian.

1) Newcomers / visitors

- Diego Ferrazza from Rome, summer student until September with Nicolo Biancacci and Benoit Salvant to work on impedance of some equipment and/or holes simulation.

2) Comments on the minutes of the previous 81\textsuperscript{st} meeting + Actions

- No comment. See actions from last minutes.

3) General infos

- SL meeting: nothing worth mentioning.

- LHC follow-up:


  - BBL meeting last Friday where we discussed the performance of BCMS beam in LHC ([http://indico.cern.ch/event/546248/contributions/2216247/attachments/1298365/1936926/2016-06-24-BCMS.pdf](http://indico.cern.ch/event/546248/contributions/2216247/attachments/1298365/1936926/2016-06-24-BCMS.pdf))

    - Predicted gain in integrated lumi for fills of 20 h of ~ 10-20%.

    - In the case of a bunch length of 1 ns, the longitudinal emittance blow-up might not be needed…

- With the latest fills with 72 b we still saw some instabilities (not with 48 bunches => Nothing seen for the moment).

- There is really a small band of intensities where the instability develops.

- No obvious correlation with bunch length.

- Not correlated to BB in IP2 and IP8.

- Fills with trains of 48 bunches are fine.

- Non-colliding bunches:
  - 1st 3 of B1 have only few BB LR interactions in IP2 => Why?

  - They are gone with the 48b scheme so no pb but we should nevertheless try and understand what happens.

- Injectors follow-up (HannesB):

  - SPS: Week 25 was devoted to North Area physics production, LHC beam delivery and a series of machine studies on the high bandwidth feedback system with colleagues from the LARP collaboration.

  Since the end of last week the cycle with the sort flat bottom is used for LHC filling. The fast debunching of the LHC beam observed occasionally in the last weeks could be resolved by the RF expert by replacing the 500 MHz frequency reference card. On Friday the LHC filling scheme was changed from injections of single batches of 72 bunches to trains of 2 times 48 bunches. Since some blow-up due to the rising edge of the MKP waveform was observed with the initial batch spacing of 225 ns, the batch spacing was increased to 250 ns in the following fills. The LHC also observed ghost bunches after the second batch, caused by re-captured beam at SPS acceleration. Some improvement was made by reducing the longitudinal emittance at SPS injection. Using the tune kicker for cleaning these ghosts at low energy in the SPS was not yet successful.

  The BCMS beam was tested in the SPS. It has transverse emittances of about 1.6 um for 1.15e11 p/b at extraction. As confirmed in the SPS, the PS can reliably perform controlled transverse emittance blow-up using the transverse feedback system, in case requested by the LHC.

  Progress was also made on the fixed target beam. The occasional beam dumps triggered by losses in T20 during the slow extraction due to an increased horizontal beam size could be traced back to a horizontal instability during the ramp. Beam
stability was improved by increasing the octupole strength.

Since Wednesday evening the super cycle duration is reduced from 34 to 28 basic periods to improve the duty cycle for the North Area. However, the LHC cycle and its ramp to 450 GeV seems to have a larger impact on the spill quality. Sometimes the fixed target had to be switched off during LHC filling and LHC beam preparation.

The 65 Hz hump in spill is still present.

During the dedicated MD on Wednesday a vertical coupled bunch instability of a single batch of the 25 ns beam could be stabilised with the prototype high bandwidth feedback system in multi bunch mode.

- Internal BTF meeting => Slides from ClaudiaT: https://espace.cern.ch/be-dep/ABP/HSC/Meetings/BTF_with_combi_update.pdf

  - In particular some “loopings” are observed both in measurements and in simulations at synchrotron sidebands, which still need to be understood.

  - Note that the parametric equations of a looping is given here https://espace.cern.ch/be-dep/ABP/HSC/Meetings/BTFofALooping.nb (see picture: https://espace.cern.ch/be-dep/ABP/HSC/Meetings/BTFofALooping_Picture.png).

- WP2 meeting

  - A meeting took place with LIU

    - No interest for them to use 200 MHz (the limit in the SPS is mainly related to beam loading) => So, in the end the 200 MHz would be only for e-cloud.

    - Furthermore, the RF colleagues would like to increase the bunch length from ~ 8.1 cm to ~ 10 cm due to the predicted loss of Landau damping with ~ 20% increase of the inductive part of the longitudinal impedance => BenoitS and NicoloB are checking the impedance values as i) if we have less Crab Cavities the impedance should be smaller and ii) what should matter for the loss of longitudinal Landau damping is the effective impedance for mode 1 => See https://espace.cern.ch/be-dep/ABP/HSC/Meetings/Crabcavitieslongitudinalimpedance_BS.pptx

      - We propose to revise the statement that the longitudinal impedance of HL-LHC increases by 20% (at 1 ns) and the corresponding need to increase the design bunch length.

      - Action EliasM: Discuss with ElenaS.

- LBOC meeting with discussions on bunch length from LHCb (=> one should not go below 0.9 ns); on TCSG collimators by NicoloB (=> good agreement with predictions for last year’s
setting of 8 sigmas and this year settings of 7.5 sigmas. Factor between ~ 1.2 and 1.6 larger impedance for settings of 6.5 and 6 sigmas => To be followed up) and lifetime drops in squeeze and adjust by JorgW (=> was improved by increasing the gain of the orbit feedback. Remaining spike still to be understood).

- LMC

  - Slides from GiovanniR about the predicted effect of bunch length (e-cloud and integrated lumi with FanouriaA’s results) => Could gain ~ 15% in peak lumi (and therefore reaching the design value of 1E34) and few % in integrated lumi for long fills (~ 20 hours). However, the gain would be larger for shorter fills.

  - PaulC gave the next steps
    - Go to 2*48 bunches, still with standard beam, for the next or next but one fill.
    - Then we will see how the SPS TIDVG dump will behave.
    - If fine, then move to 2*48 bunches with the BCMS this time but blown up in the injectors to have the same transverse emittance as the standard beam.
    - Then gradually reduce the transverse emittance…

  => We are checking internally with YannisP et al. what our predictions/recommendations are with the BCMS beam (to be able to report if requested/needed at the next LMC meeting).

- HL-LHC TC

  - FreddyB mentioned that the HL-LHC project formal approval was more difficult than foreseen and that there is no way to go above 950 MCHF in the future => We need to identify some potential savings due to a larger cost from CE => ½ number of CC, etc.

  - As concerns the performance, GianluigiA presented a loss of ~ 10% on nominal performance (and ~ 15% on ultimate performance). I mentioned that also without CC we were also within ~ 10% if I remember well some analyses by RogelioT et al. (but then we increase the peak pile-up).


  - Reminder for papers for HB => Deadline this Wednesday midnight (and workshop next week)…

- Was seen already in the past (April 2015) and here is a follow-up => Confirmation that there is a clear compensation of BBLR effects using octupole magnets powered with negative polarity.

  - The compensation is best with crab crossing ON.
  - At -550 A we have (by chance) the maximum compensation.
  - DA goes from ~ 5.5σ to ~ 8.5σ.

- TatianaP then looked in detail at what is happening, looking at the tune diagram, excitation of resonances, compensation and overcompensation effects, effect of crossing angle, the impact of chromaticity and the impact of the optics:

  - It was found that the negative effect of chromaticity on DA can also be compensated by the octupoles, which is an important new result!

  - The optics also matters as for large separation the BBLR effects are small and there is nothing to compensate with the octupoles => No octupoles is the best. However, when the BBLR effects become more important, then the octupole current can be optimized.

  - There is a strong dependency on the octupole families => Using only the Defocusing family is more effective than both families together! This identifies the important resonances to be compensated. The best compensation happens for a non-symmatric compensation of the tails (the diagonal – on the right – is not the bad one for DA but the 7th, 9th and 11th orders – on the left – are, as seen in the past by FrankS et al.).

  - Compensation also depends strongly on the BBHO: Crossing angle at BBHO introduces odd resonances => Compensation suffers more if no crab crossing applied.

- LHC case => The situation is different:

  - BB alone leads to the best DA.
  - Negative octupole polarity has a small impact.
  - Positive octupole polarity is much worse when BB is weak (above 10 σ).

- Question: how does this compare to the BBLR compensation scheme (wire or e-lens)? Is this compensation enough or not?

  => To be discussed with YannisP, DarioP and StephaneF.

- Reminder: for the moment it is limited at ~ 1 GHz, but if we would need 2 GHz for instance in the LHC it would be only a question of money.

- Main current limitation: limited power in kicker and sometimes we cannot damp the instabilities because otherwise we saturate => Need to find an instability which is not too fast.

- With an intensity bunch of ~ 1E11 p/b and a (large) transverse emittance of ~ 3.5 microm (i.e. lowering the space charge tune spread) we see several side-bands, and in particular mode 1 excited (but not growing). The chroma was very close to zero such that we have a long decoherence time. With the damper on, the damping could be done much quickly => Next: see what the classical damper would do in this case? Would be also good to see the spectrogram in the damped case.

- In multi-bunch, the beam was unstable and it could be stabilized by the damper => Detailed analysis to be done and further measurements to be performed during the week.

6) Discussion on e-cloud MD (GianniI): https://espace.cern.ch/bedep/ABP/HSC/Meetings/000_ecloud_MDs_GI-27-06-16.pptx

- Motivation twofold:

  - Need to understand e-cloud dependence on beam parameters and benchmark simulation models in order to make solid predictions for the HL-LHC era.

    - Heat load could become a serious intensity limitation,

    - Need to identify bottlenecks which could limit post LS2 tests with high intensity.

    - Gain further information on emittance blow-up in collisions (presently avoided in physics by running with very high chromaticity, i.e. Q’v = ~20.)

- Ask for the lumi data => To be added for tomorrow’s talk at LSWG.

7) Miscellaneous

- The next (83rd) meeting will take place on Monday 11/07/2016 (in room 6/R-012 from 14:00 till 16:00) => Agenda:
1) BSRT measurements for BCMS beam (Georges Trad). Discussion also about some analyses by Gianni and KevinL

2) General info and follow-up (EliasM)

3) LEIR impedance model and Study of PS instability at transition energy (MauroM)

4) Why direct space charge was/is believed to have only a small effect on the TMCI intensity threshold of the SPS? (EliasM) => If time permits otherwise to be discussed in the future

5) AOB (everybody)

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

- Preliminary agendas for the next meetings: https://espace.cern.ch/be-dep/ABP/HSC/SitePages/MinutesOfMeetings.aspx.


Minutes by E. Metral, 14/07/2016.