15/05/12

16th HDWG Meeting

Members:
Theodorus Argyropoulos (TA), Sandra Aumon (SA), Hannes Bartosik (HB), Elena Benedetto (EB), Nicolo Biancacci (NB), Alexey Burov (AB), Hugo Day (HD), Christian Hansen (CH), Giovanni Iadarola (GI), Eirini Koukovini Platia (EK), Kevin Li (KL), Elias Metral (EM), Mauro Migliorati (MM), Nicolas Mounet (NM), Serena Persichelli (SP), Giovanni Rumolo (GR), Benoit Salvant (BS), Helga Timko (HT), Vittorio Vaccaro (VV), Carlo Zannini (CZ)

Present:
HB, NB, HD, GI, EK, EM, MM, NM, GR, HT, VV

Excused:
KL (at SLAC until October 2012), CZ

Agenda:

1. Review of minutes from last meeting and open actions → GR
2. Effect of Q'' on beam stability → NM

Review of minutes from last meeting and open actions (GR):

- Open points carried on from previous meetings
  - Study head-tail instabilities and TMCI with double harmonic RF (2 regimes: bunch shortening and bunch lengthening) → BS
  - Include the possibility of using real Twiss maps in electron cloud HEADTAIL + study stabilization of ECI through octupoles in the LHC → NB (Twiss maps, this meeting), KL
  - Investigate the mode pictures to distinguish between coherent and incoherent emittance growth → HB, KL
  - Study of the effect of numerical parameters on the saturation value oftheemittance for ECI → ?
  - Initial excitation of single modes in HEADTAIL → ?
  - Loss of Landau damping → CH, KL (see below)
  - Simulations of the CLIC-DRs with two kicks per turn → NB, EK (this meeting)
- Compare the mode shift pictures for ECI with the predictions from Perevedentsev's extended theory with wakes dependent on both the position of the source and the witness separately, W(z,z') instead of the distance between them W(|z-z'|) → It will be reviewed by Alexey in one of next meetings.
- Loss of Landau damping and space charge module with Alexey's model → Since CH has left CERN and KL is presently in SLAC, this work will need to be re-assigned and followed up to understand the modeling issues that cause the observed numerical instabilities.
- Need to set up a test suite for standard checks to be run when changes

are introduced in the trunk version of HEADTAIL (single bunch, multi-bunch, longitudinal, transverse).

- Resume the use of HEADTAIL for the longitudinal plane, as this is needed for PS simulations (impedance measurements, coupled-bunch instabilities) and also possibly for the SPS (Helga's studies)
- Follow up from last meeting:
    1. It would good to have from Nicolò a user guide of the HEADTAIL version with the lattice implementation.
    2. It is desirable to have the TMCI study on the DRs done including also space charge, perhaps using Alexey's simplified model.

Effect of Q'' on beam stability (NM)

- Q'' causes particle detuning correlated with the momentum deviation. An approximate dispersion relation has been derived to study the stabilizing effect of Q'' on a beam under the effect of an external dipolar impedance. A possible source of Q'' are the octupoles in LHC.
- When neglecting the effect of Q'', the effect of the octupoles only introduces the same amplitude detuning in x and y, and therefore the two planes exhibit the same stability regions in the plane of the complex tune shift (for the same octupole powering current). When including it, the stability regions are enlarged, with the most significant effect found in the H plane for Re[DQ]<0 and only a smaller effect observed in the V plane for Re[Dq]>0. Octupole currents of -50 to -150 A have been considered.
- HEADTAIL simulations have been run to try to explore the enlargement of the stability region due to Q''. This case was analyzed: single-bunch, 4 TeV/c, linear bucket, emittances of 2.5 eVs & 2um, 1.7e11 p, Q' = 6 and various octupole currents. The bunch appeared to become stable with octupole currents between 110 and 130 A.
- Stability of a bunch can be assessed from a HEADTAIL simulation in several different manners: 1) visually, 2) when assuming that a chosen variable does not exceed a 10% growth over the simulated time, 3) by plotting growth rates as a function of the octupole current and extrapolating the zero crossing.
- Mode 0 (excited for negative chromaticity and Q''=0) would need in principle octupole currents above 700A to be stabilized. It is stronger for more negative chromaticity values. The theoretical values of the growth rates have not been derived but could be found from theory by drawing in the complex tune shift plane the curves with constant instability growth rate instead of the stability region (growth rate = 0)
- The simulated Landau damping thresholds as a function of Q' for positive values (mode 1) are in a fair agreement with the theory for Q''=0, but the strong impact on stability anticipated by theory (especially in the H plane) is not found in simulations. The impact of Q'' is much weaker and does not depend on how many sigmas of the bunch are used to represent it in the code.
- The anticipated enhanced stabilization of mode 0 in the H plane for negative chromaticities is not found in simulations. The curves found with HEADTAIL simulations (run for different sets of numerical parameters to

check the sensitivity to them) seem to better match the curve calculated without Q'' than the one including the Q'' contribution.

- To allow quicker simulations in future when exploring stability limits, an adaptation of HEADTAIL to slow instabilities could be envisaged, in which a new “one kick per several turns” approach can be tried (opposite of the multi-kick)
- It is curious to see that the spectrum of the coherent motion of the bunch, when it is unstable on mode 1, exhibits the appearance of a second line close to the main tune line, which then decays quite rapidly. This has not yet been interpreted.

Attachements: