Minutes of LIU-PSB Beam Dynamics WG #6 written by D. Quartullo

Participants

S. Albright, D. Amorim, F. Antoniou, H. Bartosik, G. P. Di Giovanni, V. Forte, E. Koukovini Platia, E. Metral, M. Migliorati, B. Mikulec, N. Mounet, A. Oeftiger, D. Quartullo, T. L. Rijoff, G. Rumolo, A. Santamaria Garcia.

Approval of minutes

Minutes are approved.

PSB instabilities: MD results, plans for 2018 and first simulations (M. Migliorati)

Slide 4: The speaker mentions two CERN notes as a reference for previous work and underlines that the synchrotron period is very similar to the growth time of the instability. E. Metral says that could be important since TMCI instability could be present and threshold could be close. The speaker says that could be one indication.

Slide 5 and 6: the speaker mentions some hypotheses for mode instability (unstable single mode, mode mixing, travelling wave).

Slide 7: the speaker asks the audience if the measurements were taken with the natural chroma (-0.8, -1.6). V. Forte observes that the correctors could have been powered with the base line current and the chroma could be different from the natural one.

Slide 12: E. Metral points out that the measurements show the mode 0 go down with intensity, and that the Q_s line (around $2 \cdot 10^{-3}$) is crossed for intensities above $1 \cdot 10^{12}$. He asks if the beam was stable during those measurements, T. L. Rijoff answers that the dampers were on.

Slide 16: E. Metral remarks that the impedance in green (real part of the impedance dipolar plus quadrupolar) can reproduce what the measurements show. However the method is not strictly correct and the PyHEADTAIL code should be used to continue the studies.

Slide 19: The speaker asks the audience if the normalized emittance of $2 \cdot 10^{-6}$ mm mrad used in simulation is correct. S. Albright asks which intensity has been used, the speaker answers that simulations cover a large scan of intensities (between 1 and $5 \cdot 10^{12}$). S. Albright remarks that emittance values from $2 \cdot 10^{-6}$ and $4 \cdot 10^{-6}$ mm mrad should be used (A. Oeftiger can give the right values through the brightness curve).

Slide 21: T. L. Rijoff comments that all the cases were stable (apart one point) and that the intention is to continue the measurements scanning the full area of parameters. She also points out that the sign of chromaticity is negative in both planes (typo). V. Forte says that he also found some instabilities during a tune scan, instabilities that were corrected changing the attenuation of the transverse feedback. The tunes where instabilities emerged were Q_x = 0.3 and Q_y = 0.4, and the instability frequency was 300 kHz.

E. Metral observes that 300 kHz corresponds to the peak of the quadrupolar impedance added in DELPHI.

Slide 23: The speaker asks the audience if it will be possible to change the termination of the kicker to test the hypothesis that the instability could be related to the external circuit of the extraction kicker. G. P. Di Giovanni answers that ABT should be contacted to assess the request feasibility.

After-presentation discussions:

- The speaker says that the last year was dedicated to impedance measurement and that this year the impedance model should be used for simulations and studies.
- E. Metral again points out that the artificial quadrupolar impedance added in DELPHI seems to reproduce the measurements. He raises the question if a dipolar impedance could be missing.
- S. Albright asks the speaker why in Slide 7 the order of curves is like that. The speaker does not know and also does not know why the thresholds vary like that.
- E. Metral points out that mode 0 is coupling mode -1 close to 2 or $3 \cdot 10^{12}$ p/b (Slides 13 and 14), that is close to the measured threshold; he says this is interesting and maybe not a coincidence for the presence of the TMCI instability. Nevertheless he reminds that the TMCI instability is generally observed in lepton machines while in proton machines two mechanisms could increase the intensity threshold: 1) the longer bunches with protons compared to leptons and 2) the presence of space charge. There are still some debates for the SPS, where a TMCI is believed to be observed (even in the presence of a significant space charge), and a detailed analysis should be also performed in the PSB. He adds that, as discussed during the meeting, very interesting results (close to observations) have been obtained by the speaker by adding the quadrupolar impedance to the dipolar impedance in DELPHI, which seems to indicate that some dipolar impedance is missing in this frequency range. As the observations reveal an impact of the tune, one can imagine that the missing impedance is a resonator (or several resonators) and this will be studied in detail in the future.
- F. Antoniou asks the speaker if he plans other MDs (that is continuing the measurements T. L. Rijoff did in 2017). T. L. Rijoff answers that she would like to continue. E. Koukovini Platia points out that it is important to collect all the measurements done up to now and all the pieces of information that different colleagues could have.
- For the simulations with PyHEADTAIL there is the problem of the wakes that change with energy (PSB is not a relativistic machine). H. Bartosik underlines that multi-turn wakes could be present. E. Metral adds that maybe a TMCI multi-turn is involved.
- S. Albright asks the speaker if all the support needed to continue the work with PyHEADTAIL will be available, the answer is positive. Then he asks for a timeline, the answer is as soon as possible.
- The speaker mentions that, relative to the PyHEADTAIL simulations, the next step is to ask C. Zannini for the script which performs an inverse FFT on the impedance to obtain the wake function, since large discrepancies are found between the wake function available in DFS and the one obtained using Filon's method (see N. Mounet's thesis). The frequency and time domain (with CST) approaches have to be checked to understand which one gives more reliable results.

- N. Mounet says that the only multi-turn wake contribution comes from the resistive wall impedance, however G. Rumolo disagrees saying that there are for sure also the contributions from the attenuation of the kickers and the HOM of the ferrite cavities.
- G. Rumolo says that the test done by the speaker using the quadrupolar impedance in DELPHI could be misleading, since DELPHI uses dipolar impedance, not quadrupolar. Then he adds that the distinguishing features of the instability depend on the energy and on the tunes (according to him this is important and has to be understood). Finally the fact that the instability is just in the horizontal plane could also give a hint relative to its nature.
- E. Metral says that the effect of space charge could also be included in PyHEADTAIL (asking a contribution from A. Oeftiger), as well as the model of the transverse damper.
- H. Bartosik asks if the instability is also present at constant energies changing the tunes, the fear being that simulations with acceleration would be problematic (wakes change during acceleration). He observes that it would be much easier to simulate at constant energies and changing the tunes.
- E. Metral asks T. L. Rijoff if the horizontal and vertical chromaticities have been swapped between them during measurements, the answer is negative. He observes that the horizontal chromaticity is always lower in absolute value than the vertical one. That could make the problem asymmetric and explain why the instability is seen just in the horizontal plane (lower in absolute value chromaticities imply lower mode excitement and therefore stronger instability effects).

Actions

- Continue MDs done in 2017 relative to the losses as a function of Q_H, Q_V **(T. L. Rijoff and E. Koukovini Platia)**
- Continue simulations with PyHEADTAIL including intensity effects **(M. Migliorati and E. Koukovini Platia)**
- Perform the two MDs proposed as Future plans in the slides: test the hypotheses that the instability could be related to a HOM from the present ferrite cavities or to the external circuit of the extraction kicker **(M. Migliorati and E. Koukovini Platia)**
- Provide the needed brightness curves to M. Migliorati **(A. Oeftiger)**