# Meeting of LIU SPS-BD WG on 13.07.2017

Present

Elena Shaposhnikova, Patrick Kramer, Joel Repond, Christine Vollinger, Danilo Quartullo, Alexandre Lasheen, Thomas Bohl, Nasrin Nasresfahani, David Amorim, Markus Schwarz, Marcin Patecki, Verena Kain, Benoit Salvant, Aaron Farricker.

Agenda

1. Minutes and actions – E. Shaposhnikova
2. Tomography of the rotated PS bunches in the SPS – A. Lasheen
3. Measurements of the 200 MHz induced voltage and comparison with simulations – M. Schwarz
4. Update on the 628 MHz HOM damping – N. Nasresfahani, P. Kramer

Actions

* Show results of the simulations taking into account power limitations at the next meeting (Joël).

1. **–** **Minutes and actions – E. Shaposhnikova**

The minutes of the last meeting are accepted. H. Bartosik and P. Kramer added a few comments.

* Old action ongoing: Simulated threshold taking into account the power limitations of the 200 MHz RF system are in progress. The threshold becomes flatter as expected. The simulations show that a larger bunch length than the nominal 1.65 ns is not an option. Results will be presented during the next meeting.
* Natural frequency spread in 3 and 4 sections 200 MHz cavities: all important frequencies sit in a window of 1 MHz. The maximum impedance damping of the 630 MHz HOM through this spread will be negligible.

**2 – Tomography of the rotated PS bunches in the SPS – A. Lasheen**

This talk presents the new tomography in the SPS in order to measure the effect of the optimized rotation in the PS. In the past, the reconstruction of the phase space was hardly feasible due to the quality of the signal measured in the wall current monitor.

* History
  + First tested in 1997, results were not encouraging. Studies restarted in 2006 to study bunches after extraction from the PS.
  + The quality of the signal was not sufficient at that moment.
  + Since then various improvements regarding the quality of the signal were done:
    - After 2006/2007 shutdown the long coaxial cables were replaced by an optic fiber link.
    - The pick-ups of the wall current monitor were changed.
    - A scope with much higher sampling rate is now available.
* To use the bunch profiles for tomography, the transfer function of the measurement line has to be taken into account.
  + The transfer function includes:
    - Longitudinal pick-up.
    - Cables.
    - Optic fiber link to BA3.
  + Signal above 3 GHz may not be accurate.
  + The transfer function is applied together with a Chebyshev type II filter.
  + A bunch lengthening of 5-10% is observed if the transfer function is not applied.
* Effects of linearization in the PS (optimized rotation):
  + Measurement done in single RF.
  + Distribution slightly more “square” as expected.
  + After filamentation, the bunch exhibits fewer tails.
    - The measurement has to be done systematically. For the moment only one measurement to compare.
  + The effect of the phase-loop could affect the reconstruction of the tomogram.
* E. Shaposhnikova: During rotation in the PS, the voltage changes constantly and the tomography is not possible. This tool in the SPS will be very useful.
* Implementation for OP?
  + Relies on the correction from the transfer function
  + Must be tweaked manually for each measurement.
  + Some manpower would be necessary to implement this for an OP usage.
  + E. Shaposhnikova: Even with all imperfections it can be very useful.

The tomogram routines used in the PS and PSB were applied with 66 contiguous frames to reconstruct the phase space.

**3 – Measurements of the 200 MHz induced voltage and comparison with simulations – M. Schwarz**

Update on measurements and simulations of the fast injection losses in the SPS. I-Q measurements of the induced voltage in the cavities were carried out to estimate the time scale of the losses and observe effects of the feed-back (FB) and feed-forward (FF). Ultimately the goal is to reproduce the measurement in simulations.

* Observation:
  + FB not acting for first 8 turns, FF acts after turn 1.
  + When FB kicks in, FB and FF together overcompensate the beam-loading. Takes a few turns (~200 turns) to reach a steady state.
  + The amplitude of the induced voltage oscillates with the frequency of the quadrupole oscillation of the bunch.
  + Asymptotic value of induced voltage reduction 🡪 80%.
* Simulations parameters similar to the previous meeting (72 bunches, 200 MHz main harmonic reduced by a factor frequency and time dependent). More realistic bunches are used (but simulated not measured), nominal case of last year using 1x40 MHz + 1x 80 MHz for rotation.
* By tuning gain and time constant of FB for each cavity independently, simulated induced voltage and measurement agree.
  + Overall reduction converges.
  + Amplitude of oscillations different (factor 3).
  + E. Shaposhnikova: synchrotron period different between simulations and measurements 🡪 Further improvement are needed.
* Preliminary results (not observed during all MD sessions):
  + Integration of the profiles exhibits a sharp decrease in intensity after 1ms.
  + Sum of all the batch (including empty buckets) stays constant.
* E. Shaposhnikova: Losses happen on a short time scale of 1ms. Studies are very difficult, precise simulations and measurements are needed. This is a first step in the understanding of the mechanism of losses.
* A. Lasheen: With small bunches losses (2%) were observed too. The problem is not particles leaking out of the bucket.

**4 – Update on the 628 MHz HOM damping – N. Nasresfahani, P. Kramer**

A closer look on 3 and 4 sections cavities and the impedance of their HOMs.

* Single section cavity (available in workshop):
  + HOM coupler perform very well at 628.5 and 631.5 MHz but less sensitive at lower frequency.
  + One mode with high Rsh and Q has been discovered. For this mode, the maxima of electric field (oriented towards the probe of the HOM couplers) are located in the region of accelerating gap instead of being above the drift tubes.
    - Q ~ 30’000, Rsh ~ 200 kΩ, fr ~ 629.1.
    - Couplers are not efficient on this mode because they are not placed at the maximum of the electric field.
      * A loop coupling to the magnetic field can be used.
      * Options under consideration:
        + Magnetic loop (very effective but could couple the magnetic field of the fundamental passband).
        + Modified design of the electric coupler.
    - Study of modified electric coupler and magnetic coupler ongoing.
    - E. Shaposhnikova: Do you consider an exchange of the position of the current couplers?
      * N. Nasresfahani: The maximum of the field is on the accelerating gap, moving the existing couplers cannot improve the situation.
    - P. Kramer: The plan is to try first the electric coupling and then to model a loop for the magnetic field. Ultimately a loop coupling both could be imagine.
      * A suitable spot on the single section cavity has to be found such that the result can be directly applied to 3 and 4 sections cavities.
      * New prototype in production soon.
* Next meeting:
  + N. Nasresfahani, P. Kramer: Update.
  + M. Schwarz: Update.
  + J. Repond: Threshold with power requirement, MD multi-bunch stability 12th of July.
  + T. Bohl: Preliminary results of instability at FT.

Minutes written by J. Repond