# Meeting of LIU SPS-BD WG on 06.04.2017

Present

Theodoros Argyropoulos, Thomas Roland Kaltenbacher, Elena Shaposhnikova, Patrick Kramer, Joel Repond, Christine Vollinger, Heiko Damerau, Helga Timko, Verena Kain, Hannes Bartosik, Alexandre Lasheen, Kevin Shing Bruce Li, Benoit Salvant, Nasrin Nesresfahani, Giulia Papotti, David Amorim, Marcin Patecki.

Agenda

1. Minutes and actions – E. Shaposhnikova
2. First simulations of capture losses in the SPS – J. Repond
3. PS bunch capture with transient beam loading in SPS– A. Lasheen
4. Possible modifications of 630 MHz HOM damping – N. Nasresfahani
5. Update on transverse stability studies for the 200 MHz cavity HOM – D. Amorim
6. Priorities of the SPS MDs in 2017 – H. Bartosik

Foreword

* + Presentation of the new comer:
    - Marcin Patecki: work with the collimation team, longitudinal profile for the SPS.

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

* Sliding fingers status?
  + Input from vacuum people needed.
  + A decision has to be taken.
* Gasket gap:
  + All beams seem to work properly with the short circuit (clamps still installed).
  + No green light from operation for the moment.
  + V. Kain: can we be sure that they are perfectly conducting?
    - Not necessary, because the closed gasket gap will not be perfectly conducting.
    - T. Kaltenbacher: contact is good enough without any doubt.
  + V. Kain: after clamp installation they are some changes staying in the tolerance limit but we do not know what we should expect.
    - Lack of studies.
    - No negative effects are observed. We can assume that the gasket gap can be closed to improve shielding.
  + Elena: We can remove the clamps and do new measurements to have more statistics.
    - Observe if we recover previous beam parameters.
    - Lot of efforts was put for the clamp installation 🡪 profit to take a second measurement while removing them.

**2 – First simulations of capture losses in the SPS – J. Repond**

The capture losses in the SPS are known to be mainly longitudinal. This talk tries to give a first estimation of the scale of the problem in terms of time and impedance, assuming simplified hypothesis.

* Open questions:
  + Effect of the 800 MHz RF system on uncaptured beam.
  + Effect of beam-loading on losses.
  + How will the losses change after LS2.
* Using a realistic phase space distribution of the injected bunches, simulations with 72 bunches spaced by 25 ns on the SPS flat bottom were performed to study the losses.
* The beam-loading compensation at injection by feedback is not perfect (20 dB in stationary state).
  + To simplify the problem, a stationary weaker impedance reduction is assumed.
  + An estimation of the feedback (fixed) reduction at injection and flat-bottom, for different intensities is obtained in simulation.
  + Using for each intensity the reduction giving ~8% losses, the time scale of the transient can be estimated.
* Half a synchrotron period (~0.7ms) is sufficient to explain the losses.
* Because of beam-loading, bunches are not perfectly centered in the RF bucket along the beam.
  + By recentering them manually in simulation, losses are smaller for the same reduction but still important.
  + In both case losses increase along the batch.
* Concerning the optics Q20/Q22/Q26, no significant changes in stability threshold between optics for given bunch length.
* For future intensity and RF system: threshold in Q26 10% higher at nominal bunch length.
* Losses on the flat bottom are comparable between Q20 and Q22 optics.
* First attempt to simulate the uncaptured beam but more work is needed.

**3 – PS bunch capture with transient beam loading in SPS – A. Lasheen**

A finer analysis of the transient at injection can be done by taking into account the characteristic response time of the one turn delay feedback (OTDF). Using a single bunch assumed periodic on the ring, the observed losses can be reproduced in simulation.

* The characteristic time of the OTDF correspond to a bandwidth of 200 kHz.
* Bunch in simulation:
  + parabolic distribution with tail,
  + centered manually to minimize dipole oscillations.
* For nominal intensity, transient beam loading has small effects but for higher intensity, no negligible effect 🡪 careful with LIU intensity.
* For future, it would be important to have a model of the transient beam loading.
  + Would help optimization of PS bunch by predicting the losses after extraction.
* E. Shaposhnikova: we did not put any specification for transient beam-loading regarding the new LLRF after LS2.
  + Further study required.

**4 – Possible modifications of 630 MHz HOM damping – N. Nasresfahani**

Stability threshold simulations show that a factor 3 in damping for the 630 MHz longitudinal HOM is needed for LIU intensity. New possible methods of damping are investigated in this talk.

* Entire 4 sections of 11 cells is really heavy to simulate.
  + Reduces the possibility to scan different parameters.
  + An equivalent circuit has been developed to approximate the impact of modifications of the couplers.
* The longitudinal HOM around 630 MHz is made of two modes at 624 and 628 MHz respectively.
* The effect on the damping/shifting of the modes has been studied with respect to the length of the coupler.
  + The frequency of the first mode (624 MHz) can be shifted while the second mode (628 MHz) does not move.
  + Doing this, the quality factor increases significantly.
* 2 MHz shift can be obtained but at the expense of Q.
* Tuning of the second mode is not possible.
  + Study of a possible damping needed.
  + Simulations of the respective effects of the two modes on beam stability are needed.
* Is there another way to shift the HOMs?
  + Width of the coupler defined by the coupling with the E.M. field, no freedom.
  + Orientation of the coupler? 🡪 To be careful with main harmonic.
  + Main harmonic is the principal concern, not much freedom.
* Two times Q reduction possible by:
  + 1) Using 17 Ohm load.
  + 2) Omitting the filtering part of the couplers.
* E. Shaposhnikova: could we modify the load and change the length?
  + Yes complementary.

**5 –** **Update on transverse stability studies for the 200 MHz cavity HOM – D. Amorim**

This talk gives an update on the transverse stability regarding the 940 MHz transverse HOM of the 200 MHz cavity. The transverse couplers acting on this mode have an effect on the 630 MHz longitudinal HOMs (enhancement) which are identified as critical for beam stability.

* The DELPHI code is used (transverse stability Vlaslov solver), cross-checked with Sacherer formula.
* Impedance model:
  + Developed by Carlo Zannini.
  + Does not include yet all the HOM of the 200 MHz cavity.
  + Resonant frequency of the HOM: fr = 938.493 MHz.
    - Worst case scenario, biggest effect from the coupled bunch spectrum line.
  + The model stops at 1.9 GHz but is extended up to 10 GHz to cover higher azimuthal mode.
  + More general benchmarking of the transverse impedance model is necessary.
* Simulations done for full machine (4620 bunches) with 1011 ppb, zero chromaticity, no damper and no octupole.
* Scan of the growth rate versus shunt impedance.
  + Below 10 GOhm/m, growth rate negligible with respect to the rest of the machine (1 GOhm/m with Sacherer formula).
* No precise knowledge of the mode.
  + Study needed, damping requirement not clear.
  + Nasrin: in reference, the mode is vertical but we measure it as horizontal.
  + Action (Nasrin, Patrick): Measurements of the mode.
* Next time:
  + Add transverse damper and chromaticity (to reproduce measurement).
  + Q26 study (used for fixed target).
  + Move the HOM by few kHz to see sensitivity of the result.
  + Add the other transverse HOM (460MHz, Q=70’000 undamped).
* Dedicated MD to observe stability without coupler possible.
  + It is known that removing them completely is not possible but it would allow to check damping requirements.

**6 –** **Priorities of the SPS MDs in 2017 stability – H. Bartosik**

This presentation discuss the different MD topics of the SPS for 2017. See slides for a complete list.

* MDs subjects:
  + Further characterization of the losses.
    - Full beam needed, high intensity.
    - Repeat measurements of losses with different LLRF components.
      * Would help to known what can be neglected in simulation.
  + Longitudinal impedance, instability and intensity limitations.
    - Coupled bunch instability for different train length, different intensity, dependence with energy.
    - Bunch rotation on FT.
  + Study of Q22.
* E. Shaposhnikova: more studies with simulation for Q22 before setting up all the machine for this optic?
  + Not everything can be simulated, experimental results would give better knowledge.
* We will have 10 blocks of 10 hours for dedicated MD in September.

🡪 Careful setup/preparation needed.

* Necessary to choose where is the highest priority.

Next meeting will take place on the 5th of May.

Actions

* Take a decision for the vacuum sliding fingers and the gasket gaps.
* Simulation of the respective effects of the longitudinal 624 MHz and 628 MHz modes on beam stability (Joël).
* Measurements of the 940 MHz transverse HOM (Nasrin, Patrick).

Minutes written by J. Repond