# Meeting of LIU SPS-BD WG on 11.05.2017

Present

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Agenda

1. Minutes and actions – E. Shaposhnikova
2. Beam losses in coast from recent SPS MDs – F. Antoniou
3. Update on simulations of capture losses in the SPS – M. Schwarz
4. Transverse impedance simulations and influence of 938 MHz-couplers, bead-pull results – P. Kramer
5. 200 MHz TWC transverse impedance calculations (from single-cell) and corresponding considerations – N. Nasresfahani
6. **–** **Minutes and actions – E. Shaposhnikova**

* To our current knowledge, the vacuum sliding fingers seem to deteriorate easily and should not be used in future. Different new designs are available but a decision has to be taken together with the vacuum section.
* Review of the vacuum flanges shielding during LS2 coming soon. New measurements can be done in the tunnel before the review (technical stop 31th of May). A plan for these measurements is required.
* Simulations of the respective effects of the longitudinal 624 MHz and 628 MHz modes on beam stability (Joël):
  + Done.
  + 628 MHz is the critical one regarding stability.
  + New design of the probe assessed, investigations ongoing but the factor 3 wanted could be achieved (from single cell results).
  + 4 sections simulations and equivalent circuit are needed.

**2 – Beam losses in coast from recent SPS MDs – F. Antoniou**

The test with the crab cavities in the SPS starts next year (2018). Very limited dedicated MDs time will be available once installed. These series of MDs prepare the ground to use efficiently the MD time with the crab cavities. A coast beam is used in the SPS to understand the mechanism which makes a single bunch grow and the intensity decrease on a long plateau.

* From 2015-2016 measurement:
  + Transverse size of the beam increase.
  + Difference between horizontal and vertical plan.
  + The chromaticity has an effect on both plan.
  + Bunch length (longitudinal) blow-up but saturates.
    - E. Shaposhnikova: Saturation is probably due to losses. This has already been observed.
  + Intra-bunch scattering (IBS) predicts smaller blow-up than observed (the calculation is done for the worst case).
  + Intensity losses not clear with BCT but obvious when the bunch profiles are summed.
* 2017 MD:
  + Feed-forward, longitudinal damper, blow-up: OFF.
  + Phase-loop, synchro-loop, feedback: ON.
  + No transverse damper, Q26.
    - Comparison with Q20 would be good (dependence with other parameters like the compaction factor).
  + Beginning of the year to observe if there is a dependence on the vacuum quality (bad vacuum during this period).
  + Results similar to last years.
  + Clear dependence of the losses on the feedback (when it is switched off).
    - **E. Shaposhnikova:** Could be simply due to RF noise. A signal from the beam is measured with noise and reinjected with more noise.
    - The sensitivity of the feedback has been modified and no changes were observed.
  + Bunch length evolution without feedback not clear. Analysis of the data from the Faraday cage needed (Joël).
  + Nothing unusual observed from the peak detector Shottky.
  + **R. Calaga:** we tried in the past to switch off adiabatically the RF 🡪 similar blow-up observed.
    - **E. Shaposhnikova:** when the beam debunches, δp/p changes and longitudinal instabilities can appear.
  + **W. Hofle:** using different bunches in the machine, it would be possible to separate the IBS effect and other effects.
* Plan for this year:
  + Study more systematically the effect of the chromaticity on the blow-up.
  + Switch off the feedback from the beginning and study the effect of the phase-loop
  + Use different intensities and bunch parameters.
  + Effect of 800 MHz RF system? (December 2016 MDs: 800 MHz was ON (10%)).
* IBS cannot explain fully the blow-up, probably another effect less dependent on intensity plays a role.

**3 – Update on simulations of capture losses in the SPS– M. Schwarz**

Capture losses in the SPS require more study. It is not clear how it will scale with HL-LHC intensities. Moreover at injection the feedback (and feed-forward) need a certain time to reach the steady-state (one turn delay feedback) and most of the losses seem to occur during this transient state. This talk present an update on the simulations studies.

* In the past the initial process of the feedback has not been taken into account.
* A constant stationary state reduction was assumed, decreasing the shunt impedance of the 200 MHz harmonic.
* Two type of simulations already done to understand the transient state:
  + 72 bunches, step function in impedance reduction to simulate the transient (J. Repond).
  + Single bunch assuming a periodicity of one bucket (5 ns) using an exponential increase of the impedance reduction (200-400 Hz bandwidth) (A. Lasheen).
* In this talk:
  + 72 bunches with exponential increase of the impedance reduction (200 – 400 Hz).
* Improvement of the simulations made from two side:
  + Input from the LLRF on the feedback reaction (200 Hz bandwidth).
  + Identification of the time scale needed in simulations
    - Half a synchrotron period with weaker effect of the feedback is sufficient to observe losses.
    - Beam losses in coast suggest that the long flat bottom of the SPS (LHC beam) could have an impact on beam stability and losses.
* Shape of losses along the batch similar in measurements and simulations (plateau after ~30 bunches)
* Next step: Use the feedback transfer function applied on the beam signal in simulation. Understand how this function is modified during the transient state (at injection).
* **R. Calaga:** What did you assume for the 800 MHz RF system? The feedback applied on the 200 MHz RF system has notches at 800 MHz too which can have an impact
  + **E. Shaposhnikova:** Measurements show no impact on the total losses with the 800 MHz RF system. Only the velocity with which the particles are lost from the ring is affected.
  + Comparison with and without 800 MHz should be done.
    - (Added by Joël) This has been tested, there is no observable difference in simulations in 1RF or 2RF and even if we remove from the simulation the 800 MHz main harmonic impedance completely.
* The focus has been done on the feedback because measurements show this is the critical LLRF loop regarding the losses. This MD has to be done a second time more systematically (free slots beginning of June).
* Main difference between simulations and measurements: in simulation the first bunch losses very few particles whereas in measurement, a few percent are observed.
  + It looks like another mechanism adds on top of the feedback transient state.
  + Observe in MDs the dependence on the bunch parameters coming from the PS.

**4 – Transverse impedance simulations and influence of 938 MHz-couplers, bead-pull results – P. Kramer**

It has been found in simulation that the 938 MHz transverse coupler has a negative effect on the 630 MHz longitudinal HOM which is critical for beam stability. This talk present further investigations of the HOMs and their coupling with the probes.

* Influence of the 938 MHz transverse coupler in the 630 MHz longitudinal range (no 630 MHz probe installed)
  + The addition of the probe breaks up the mode.
  + Maximum shunt impedance seems slightly reduced 🡪 contradiction with Toon’s results, simulations including the 628 MHz probes needed.
* 938 MHz probes have no impact on 460 MHz transverse HOM.
* 630 MHz probes have no impact on the 938 MHz transverse HOM.
* The 938 MHz couplers reduce the 938 MHz transverse HOM by a factor 2.
  + It seems difficult to reduce this damping to gain in the 630 MHz range.
* Action (Patrick): Important to repeat the same with 630 MHz coupler with old and new design of the couplers (Nasrin design).
* Bead-pull measurements of the 3 spare sections in the workshop:
  + R/Q of the 3 spare sections agree very well.
  + Spare one and two stored with the drift tube inside:
    - Transmission measurement agree perfectly for the fundamental pass band.
    - Third one (stored in another way) deviates by 100 KHz.
  + Measurements done in standing wave. Does it affect the travelling wave mode too?
* 4 sections simulations with all the probes would be nice but requires several weeks.

**5 – 200 MHz TWC transverse impedance calculations (from single-cell) and corresponding consideration – N. Nasresfahani**

This talk is coupled with the previous one an show new simulations results concerning the transverse impedance in the 940 MHz range.

* 940.8 MHz transverse, π/2 mode:
  + Hybrid mode, mix magnetic and electric field.
  + Cannot result in a large transverse impedance 🡪 negligible.
* 939.6 MHz transverse, π/6 mode:
  + Dipolar mode.
  + Large gradient 🡪 can cause instability.
  + Q = 61000
* Compared to the reference paper, the simulations show a higher impedance (x1.5)
  + 28 MΩ/m, horizontal mode for a single section.
* Reminder of the results of D. Amorim (ABP):
  + Fix target beam with a single bunch intensity of 1011.
  + Threshold weakly dependent on Q.
  + The mode becomes significant in the range of GΩ/m 🡪 if we multiply the value obtained by the number of sections, the 940 MHz transverse impedance of the entire RF system is about value (worrying).
* All the parameters are not indicated in the reference paper:
  + Simulations needed to check the dependence on various parameters.
* **E. Shaposhnikova:** Do we see in simulation other dangerous high order modes?
  + **N. Nasresfahani:** in the 900 MHz bandwidth no.

Actions

* Decision with vacuum section about the sliding fingers has to be taken.
* A plan for the measurements (vacuum flanges) during the technical stop (31th of May) has to be elaborated
* Coast beam MD with Q20 for comparison.
* Analysis of the MD data (BCT, integrated profile) of the coast beam (10th of May) (Joël).
* MD needed to study more systematically the losses with respect to the LLRF.
* Repeat the CST simulations with 630 MHz couplers included (Patrick)
  + With old and new design of the couplers (Nasrin design).
* The reference paper for the 940 MHz transverse mode is not clear about all the parameters 🡪 Study in transverse beam dynamics simulations the stability dependence with different parameters.

Minutes written by J. Repond