# Meeting of LIU SPS-BD WG on 31.07.2018

Present

Elena Shaposhnikova, Joël Repond, Hannes Bartosik, Markus Schwarz, Giulia Papotti, Danilo Quartullo, Aaron Farricker, Ezgi Sunar, Nasrin Nasresfahani, Giovanni Rumolo, Christine Vollinger, Verena Kain, Michele Carla’, Carlo Zannini.

Agenda

1. Longitudinal stability of 12 bunches – J. Repond
2. Measurements with high intensity 25 ns beam in the recent MDs – Transverse – M. Carla’
3. Measurements with high intensity 25 ns beam in the recent MDs – Longitudinal – M. Schwarz
4. Update on BPV impedance model – A. Farricker

Actions

* pending
* **N. Nasresfahani**: Study the possibility to use the new coupler design to replace all existing 630 MHz HOM couplers.
* **M. Schwarz**: Include the momentum acceptance limitation in simulations.
* **M. Schwarz**: Is it possible to understand if the instability observed with the radial-loop is real or only related to numerical problems?
* For the slip-stacking cycle, determined the aperture needed for the collimation system.
* A list of the key moments in the various cycles (slip-stacking!) is necessary to adjust the design of the collimation system.
* Measurements of the beta beating to include optics errors in simulation of the collimation system.
* Check the impedance of the new collimation system.
* **M. Schwarz**: Quadrupole oscillations are observed at flat bottom with the feedforward activated. Study where this is coming from.
* **G. Papotti**: Check if it would be possible to decrease gradually the effect of the feedforward on the flat bottom and not in one turn.
* **A. Farricker**: Check with C. Zannini for the discrepancy in MKEs impedance.
* **A. Farricker**: Provide an updated longitudinal SPS impedance model for the present and future cases.
* **D. Quartullo**: Check the loss of Landau damping in Q26 for the ion cycle (are the oscillations more violent than in Q20?).
* Calculate the maximum voltage in the 800 MHz RF system due to power limitations and beam-loading.
* Ask the feedback team if it is possible to program a separated voltage program for a slip-stacking MD.
* New
* **J. Repond:** Simulation of the flat bottom instability with the latest impedance model

**1 – Longitudinal stability of 12 bunches – J. Repond**

The 800 MHz RF system is known to improve significantly the beam stability at flat top even for a large voltage ratio $V\_{800}/V\_{200}=$ 0.25 but not at flat bottom. The goal of the MD was to study the effect of the $V\_{800}/V\_{200}$ voltage ratio on the 12 bunches beam stability.

* Instabilities were observed on flat bottom for intensities $N\_{b}\geq 1.4×10^{11}$ in single RF, not reproduced yet in simulation.
* An increasing voltage ratio $V\_{800}/V\_{200}$ improves the stability at flat top but larger bunch length oscillations are observed at flat bottom for all the intensity range of the MD ($1.4-2.45×10^{11}$ ppb injected).
* At flat bottom, for voltage ratios $V\_{800}/V\_{200}$ $>0.1$, the bunch has a flat portion in the synchrotron frequency distribution.
	+ 🡪 Large coherent response which can explain the oscillations observed.
* To reduce the plateau in the synchrotron frequency distribution the relative phase between both RF systems can be adjusted, a negative phase shift improves the situation.
	+ The acceptance is reduced and the stability is not necessarily ensured, this need further studies.
* To avoid the bunch to have this flat portion in the synchrotron frequency distribution and still have a large ratio at flat top, the voltage ratio $V\_{800}/V\_{200} $can be programmed during ramp.
	+ At first approximation a ratio of 0.1 should be kept at flat bottom, increased to 0.15 after ~16 s and >0.2 after ~18 s (nominal LHC momentum program of 20 s).
* The intensity effects should be taken into account in the optimisation of the voltage ratio program.
	+ Due to beam loading each bunch sees a different synchrotron frequency shift and a different phase of the 800 MHz.
	+ The flat portion is enhanced by the intensity effects.
* The measurements show that at flat top an increasing voltage ratio $V\_{800}/V\_{200}$ improves the stability.
* **Important:** The simulations of the flat bottom instability should be run again, addressing the different issues (LLRF, simulation accuracy, bunch distribution, impedance model,…).
	+ If the instability cannot be reproduced it means that some impedance is missing in the model.

**2 – Measurements with high intensity 25 ns beam in the recent MDs – Transverse – Michele**

This talk presents measurements of the large uncontrolled emittance blow-up (larger than the usual 10%) in both transverse planes which was partially cured by a scrubbing run (e-cloud effect).

* 20 s flat bottom scrubbing cycle, 48 bunches BCMS beam with intensity $N\_{b}=1.9×10^{11}$ ppb.
	+ 🡪 Strong blow-up with an e-cloud pattern.
* **E. Shaposhnikova**: why the uncontrolled emittance blow-up of the first bunch is larger?
	+ **H. Bartosik**: It can be due to the injection pattern, more investigations needed.
* **E. Shaposhnikova**: You did not observe an instability? Only incoherent emittance blow-up?
	+ **H. Bartosik, M. Carla’**: We did not monitor this systematically but no instability was observed, the intensity was below the threshold.
* The horizontal chromaticity and the uncontrolled emittance blow-up in both planes are clearly related.
* **E. Shaposhnikova**: In the past the uncontrolled emittance blow-up was always more significant in the vertical plane. Do we understand why now it is comparable in the horizontal plane?
	+ **H. Bartosik, G. Rumolo**: Further studies are necessary, it can be due to the e-cloud effect.
* From the BGI measurements, the emittance growth is continuous and linear with time (over 18 s).
	+ **H. Bartosik**: It is the sign that the uncontrolled emittance growth is the result of an incoherent process, the longer the beam is stored, the more significant is the uncontrolled emittance blow-up.
* After the scrubbing run, the emittance growth went down from 45% to the usual 10%.
	+ It is the sign of an e-cloud effect.
* From the data of the injected intensity versus the extracted one, it seems that bunches with smaller emittance loose sometimes more particles.
	+ Not totally conclusive, only a few points.
	+ **E. Shaposhnikova**: If it is the case, it means that the losses are caused by intensity effects. There is an interplay between the intensity effects and the bucket size.
* No more uncontrolled emittance blow-up in the transverse planes (more than the usual 10%) since the last two months.

 **– Measurements with high intensity 25 ns beam in the recent MDs – Longitudinal – M. Schwarz**

This talk presents the latest measurements data regarding the flat bottom instability for different machine and beam parameters with a batch of 48 BCMS bunches in the Q20 optic.

* Scan of the intensity, the longitudinal emittance and the voltage ratio $V\_{800}/V\_{200}$.
* For high intensity beams ($2.2×10^{11}$ ppb), we are limited by the RF power (uncompensated beam loading).
	+ 🡪 The dynamics of the beam is dominated by the uncompensated beam loading, it is difficult to extract information on the “pure” flat bottom instability.
* The particle losses increase with a high voltage ratio ($V\_{800}/V\_{200}$ $>0.15$).
* An instability was observed for small emittance beams (0.3 eVs) in a single RF system with an intensity $N\_{b}=1.3×10^{11}$ ppb.
	+ The 800 MHz RF system helps to cure the instability. A voltage ratio $V\_{800}/V\_{200}$ of 15% gives the more stable beam (48 bunches).
	+ With a larger voltage ratio ($V\_{800}/V\_{200}\geq 0.2$), bunch tails are created.
		- **E. Shaposhnikova**: Particles in the tails of the bunch are driven by the plateau of the synchrotron frequency distribution (more than the potential well distortion).

**4 – Update on BPV impedance model – A. Farricker**

The BPV are vertical Beam Position Monitors usually found with a QD-type flange. An inconsistency has been found in their longitudinal impedance model. This talk presents the latest results of the CST simulations of the BPV including its QD flange.

* 90 BPV-QD are present in the ring.
* Inconsistency found between B. Salvant and J. Varela models.
* The latest results of the CST simulations show two important resonant peaks (in the longitudinal impedance) around 1.8 GHz and 2.3 GHz.
	+ In the present impedance model the peak related to the BPV-QD is at 1.25 GHz.
	+ The new result is consistent with the other QD flanges.
	+ The new resonant peak at 1.8 GHz is consistent with the long bunch measurements (RF off, A. Lasheen).
		- 1.8 GHz excitation observed in the measured spectrum but not reproduced in simulation at that time.
* There is a discrepancy between the eigenmode and the wakefield simulations for a peak at 270 MHz not explained yet.
	+ Not present in J. Varela data but in B. Salvant.
	+ Further investigations are needed, it should be an effect of the meshing.
	+ **C. Zannini**: What kind of boundary conditions do you use?
		- **A. Farricker**: The result should be relatively insensitive to the boundary conditions.

Next meeting last week 28th of August.

Minutes written by J. Repond