**Meeting of LIU SPS-BD WG on 12/03/2015**

**Present:** Theodoros Argyropoulos, Hannes Bartosik, Thomas Bohl, Fritz Caspers, Alexej Grudiev, Verena Kain, Alexandre Lasheen, Jaime Perez Espinos, Serena Persichelli, Danilo Quartullo, Benoit Salvant, Elena Shaposhnikova, Mauro Taborelli, Jose Varela Campelo, Alpo Valimaa, Christine Vollinger, Carlo Zannini;

**Agenda:**

1. Long bunch simulations with the latest impedance model – A. Lasheen
2. Progress on the Vacuum Flange Shielding Studies – J. Perez/J. E. Varela Campelo
3. Preliminary Results on the Impedance Characterization of the 200MHz TWCs – J. E. Varela Campelo
4. Impact of the proposed modifications of the flanges on the transverse impedance – C. Zannini
5. Discussion on the modification of the TPST to be installed in the SPS – S. Persichelli

**Arising matter: Outcome of the LIU cost and schedule review (E. Shaposhnikova)**

* The committee recommended to perform the impedance reduction campaign for the SPS vacuum flanges in order to extend the beam intensity reach of the SPS, even though this implies additional cost for LIU-SPS – the decision if the impedance reduction campaign becomes part of the LIU baseline needs to be taken end of June
* 10M CHF should be saved from the LIU-SPS budget – potential for cost saving was identified by going for the internal instead of external beam dump solution, postponing the upgrade for the fast ion injection and by reducing the scope of the a-C coating (i.e. deploying the coating only in the most critical parts of the SPS) or postponing it to LS3
1. **A. Lasheen – Long bunch simulations with the latest impedance model**

Measurements with long bunches injected into the SPS with RF off revealed a significant impedance contribution at 1.4 GHz with both Q20 and Q26 optics. Past simulations could reproduce the Q26 measurements, but not the observations with the Q20 optics.

* The analysis of the measurement data shows that the 1.4 GHz peak in the bunch spectrum is dominant at high intensity, while the 200 MHz resonance from the RF cavities is dominant at low bunch intensity. Resonances at 1.2 and 1.6 GHz are mainly observed when both 200 MHz and 1.4 GHz peaks are present.
* The refined SPS longitudinal impedance model including the results from the survey of the vacuum flanges performed during the Christmas stop is used for the simulation studies.
* The bunch spectra after the de-bunching simulated with BLonD depend strongly on the initial particle distribution and, in particular for the Q20 optics, on the momentum spread. The particle distributions were generated such as to fit the measured asymmetric line density profiles at PS extraction. The energy spread was chosen according to the PS RF parameters and taking into account intensity effects based on the PS impedance model. The beam induced voltage at PS extraction is quite high compared to the RF voltage, since the extraction was done without bunch rotation.
* All resonances observed in the measurements are also found in the simulations. However, the amplitudes of these resonances are not reproduced well. In particular the 200 MHz component in the bunch spectrum is systematically bigger in the simulations compared to the measurements for both Q20 and Q26 cases. Maybe a better model of the 200 MHz traveling wave cavities impedance could resolve this discrepancy. Work in this direction is done by Jose (see presentation below).
* The longitudinal space charge impedance adds additional focusing in the longitudinal plane and enhances the high frequency modulation of the line density. Also the transverse dependence of the longitudinal space charge force could play an important role, especially in the Q20 optics (due to the larger beam size variation in the horizontal plane induced by the bigger dispersion).
* Measurements with higher intensity will be performed with the Q26 optics in order to complete the measurements.
1. **J. Perez/J. E. Varela Campelo – Progress on the Vacuum Flange Shielding Studies**

An overview of the different shielding options and their impact on impedance for the flanges with elliptical vacuum chambers (“group I” with main resonance at 1.4 GHz) were presented.

* The standard flange geometry with MBA-type chambers and short bellow was used as reference in order to compare the different shielding options in terms of reduction of R/Q and Im(Z)/n.
* Compression/extrusion of 10 mm is considered for the mechanical movement of the bellow in order to allow for extreme (i.e. non-conformal) cases. The proposed shielding options are designed such as to allow for this variation of the bellow length.
* The impedance for the nominal length, the fully compressed and the fully expanded bellow was studied for four different shielding options. In some cases the impedance spectrum and the reduction factor for R/Q of the main resonance depends strongly on the extrusion of the bellow.
* The biggest impedance reduction is achieved with shield type II, which gives a reduction of R/Q by a factor 6 for all extrusions of the bellow (about the same as originally expected from an idealized proposal of Jose). However, resonances at higher frequency (1.6 GHz, 2 GHz, 3 GHz) are introduced by the mechanical transition from the vacuum chamber to the shielding and by the convolution, which is needed to allow for different bellow extrusions.
* All shield options are designed such that there is no contact with the flange on the other side. This is needed for ensuring electric insulation for flanges with Enamel coating. Much simpler mechanical designs would be possible if there is no need for insulated flanges (e.g. RF fingers). It needs to be clarified urgently if insulated flanges are required in the SPS (e.g. for BPMs and other beam instrumentation), since maybe they were mainly a precaution to avoid disturbance of eddy currents on beam instrumentation. In some cases, the flanges next to the BPMs are already without Enamel coating. The question if Enamel flanges are really needed should be brought up in the MSWG. The remaining cavity like volume between the flange and the shield can be closed by a plate welded on the flange such that only a small gap for electric insulation is left. In this case a reduction of R/Q by another factor 2 can be achieved so that finally R/Q would be about 6 Ω.
* A prototype of the shielding type II will be produced in order to perform impedance measurements in the lab. Furthermore, the priority of the different flange types will be set.
* A complete redesign of the flanges with elliptical bellows would provide the best impedance reduction factor (R/Q of about 4 Ω) and would be mechanically more robust but more expensive.
1. **J. E. Varela Campelo – Preliminary Results on the Impedance Characterization of the 200MHz TWCs**

The work on an accurate characterization of the SPS 200 MHz travelling wave cavities impedance has been started in view of the cavity rearrangements planned for LS2 and for improving the understanding of the longitudinal beam instabilities.

* The importance of the main couplers and their good matching was demonstrated in simulation studies by comparing two main coupler geometries. Current main couplers are not matched to the travelling wave inside the cavity at the considered reference plane. A matching network exists in the input and output lines so that the generator ‘sees’ the cavities as matched loads. Future studies will be carried out including the aforementioned matching network and the HOM couplers in the real cavities.
* The longitudinal impedance over the fundamental passband of a 1 tank TWC was calculated for the two main coupler geometries considered before. The influence of the main couplers in the ‘shape’ of the impedance was demonstrated.
* Bead-pull measurements and simulations of a short-circuited tank were carried out last year and the R/Q of the main of HOMs was successfully characterized. After significant improvement of the bead-pull setup, these measurements will be repeated and presented in the next meeting.
* A direct measurement of the reflection coefficient of the cavities in the tunnel is not possible since the directional couplers are not calibrated.
1. **C. Zannini – Impact of the proposed modifications of the flanges on the transverse impedance**

The impact of the redesigned flange for QF-QF type chambers on the transverse impedance was studied in time domain simulations using CST.

* The vertical broadband impedance of the new flange design with elliptical bellows is about a factor 4 times smaller compared to the present design. Significant improvement is also obtained in terms of narrow-band impedances in both horizontal and vertical plane.
* The transverse impedance of the presently installed flanges and vacuum chamber step transition induces about 25% of the total vertical coherent tune shift with intensity, but there is no big impact on the TMCI threshold. The redesign of the QF-QF flanges would result in a reduction of the total vertical tune shift by about 6% and no impact on TMCI thresholds is expected.
* The difference between the redesigned flange and the various shielding options in terms of transverse impedance (in particular horizontal) should also be studied.
1. **S. Persichelli – Discussion on the modification of the TPST to be installed in the SPS**

A new TPST (dummy septum in front of MSE/MST extraction septa) will be installed in the SPS on the 19th of March. The impact of the new design on the impedance was studied.

* The simulation studies show that there is no big change of the inductive longitudinal impedance. A slight improvement of the horizontal dipolar impedance is expected. No significant resonances are introduced due to the new design.
* Measurements performed the week before also did not reveal any unexpected resonances.
* The modifications of the design should not be a problem from the impedance point of view.

Minutes written by Hannes Bartosik