Minutes of the LIU-PS BD WG #27 on the 28th of February 2019

Agenda (https://indico.cern.ch/event/801198/***)***

1. *How to 'quadrupolar pick-up' - a teaser*
2. *Longitudinal impedance model*
3. *AOB – 80 MHz cavity fast tuner*

Present:

Foteini Asvesta, Hannes Bartosik, Heiko Damerau, Alexander Huschauer, Adrian Oeftiger, Branko Popovic, Haroon Rafique, Eugenio Senes, Frank Tecker, Mihaly Vadai, Christine Vollinger

1. How to 'quadrupolar pick-up' - a teaser (Adrian Oeftiger, pdf)

A. Oeftiger presented the initial motivation for studies with the quadrupolar pick-up (QPU), namely a measurement of the direct space charge tune shift based on the frequency of the beam envelope oscillations. A measurement campaign was carried out during the 2018 run, providing a deeper insight into the functionalities of the QPU. In its current setup (and profiting from a new front-end installed in 2018) the PS BBQ system provides dipolar and quadrupolar channels in parallel.

After introducing how the quadrupolar signals can be obtained from a regular PU, he presented the experimental results and provided a recipe on how to identify modes in the QPU spectra.

A. Oeftiger showed how horizontal and vertical injection errors can be inferred from the QPU spectrum and, furthermore, how skew modes can be observed. With this technique the so-called odd (skew) modes, first explained by Chernin, could be experimentally observed for the first time. **A. Huschauer** asked whether data had been recorded without coupling to complement the results shown on slide 7. **A. Oeftiger** replied that this was the case, but the data still needs to be analysed. Furthermore, he remarked that all other measurements shown on previous slides were recorded using an uncoupled machine.

In addition, dispersive coherent modes such as driven by instabilities (or dispersion mismatch between the transfer line and the ring) can be observed using the QPU.

A. Oeftiger also remarked that the space charge-modified frequency shift of the envelope oscillations could not be observed so far, as these modes are Landau damped by space charge. However, a betatron mismatch, which was created by modifying one quadrupole in the BTP-line, could be clearly observed with the QPU, even though only 30 turns could be recorded during this dedicated MD.

In the last part of his presentation **A. Oeftiger** explained how the kicker of the TFB can be used as quadrupolar exciter. The FESA class of the TFB provides the necessary settings to invert the settings sent to the different plates.

Together with **M. Coly**, **A. Oeftiger** has developed a first version of an application, which can be used during Run 3 to exploit the signals of the QPU. Some modifications, such as incorporating the dipolar tunes measured with the other BBQ channels, are still foreseen to simplify the identification of the different modes.

H. Damerau remarked that it would be interesting to wrap-up the experience with the QPU in a summary table, showing for which measurements the presented approach would be more useful than using the standard operational tools.

2. Longitudinal impedance model (B. Popovic, pdf)

B. Popovic presented the current status of the longitudinal impedance model of the PS with a special focus on elements, which will be installed during LS2.

A CST model of KFA04 has been developed based on 2D drawings and the simulations show a broad-band impedance, with some narrow modes related to the structure of the tank. **H. Damerau** suggested to verify the correctness of the 3D model with experts from TE/ABT.

To reduce the impedance contribution of the vertical BGI vacuum chamber, tapers have been included on either side of the box housing the instrument. **H. Damerau** suggested to model also the vacuum chamber of the horizontal BGI and to add it to the impedance model.

Furthermore, simulations of the new injection bumper vacuum chambers have been performed, revealing only broad-band impedances.

The new KFA45 will rely on enlarged ferrites, which slightly shifts the modes when considering a model of a single cell. However, considering all cells together, only minor changes to the impedance of the current KFA45 version are expected.

With respect to the new injection septum, direct measurements will be done as the simulations are difficult. The results of the simulations critically depend on the exact knowledge of the thickness and the packaging of the laminations. Even if the septum is assembled within the mechanical tolerances, the simulations won't be accurate due to the variation of the packaging along the device.

Concerning the CT elements, which will be removed from the ring, **H. Damerau** asked whether the impedance can be evaluated either in simulations or by measurements. **C. Vollinger** replied that the simulation setup is extremely time-consuming, as the 3D models are not available. Furthermore, measurements are not possible due to the activation of the elements. However, it was suggested to verify whether spares for the CT equipment are available, which could be used to measure the impedances of the devices.

H. Damerau suggested that this new impedance model should be used by **A. Lasheen**, to evaluate the longitudinal stability after implementation of all upgrades.

3. AOB (H. Damerau, B. Popovic, C. Völlinger)

3.1 Outcome of the checkpoint meeting for the 80 MHz fast tuner (B. Popovic, pdf)

B. Popovic presented the goal of the activities related to the fast tuner, namely the operational availability of one tuner by the end of LS2. He furthermore explained that this would be beneficial for

operation, as only two 80 MHz cavities instead of three would be required in the future. The clear advantage would be that this would reduce the impedance seen by the beam.

C. Vollinger remarked that this new tuner will come with a return yoke for the bias solenoid to reduce the fringe field, which hasn't been there so far. Therefore, any closed orbit perturbation should be significantly reduced. The current situation with the prototype tuner is very complex, as there are many metallic components in the close vicinity of the tuner. Therefore, this situation is very complicated to model and study in simulations.

3.1 Outcome of the checkpoint meeting for the 80 MHz fast tuner (H. Damerau, pdf)

H. Damerau explained the different operational scenarios in which the 80 MHz cavities are currently used. He furthermore explained the available time to carry out the tuning, considering either subsequent proton cycles, or a combination of proton/ion cycles.

Given the current situation, i.e. the absence of a fast tuner, parallel operation of protons and ions is not possible anymore as soon as one cavity is not available. Furthermore, the impedance of the ion cavity is seen by the proton beams. These operational constraints would be significantly reduced by the availability of a fast tuner and the proton bunch rotation could also again be studied using all three 80 MHz cavities at 300 kV.

F. Tecker asked whether the tunable cavity would be more likely to fail. C. Vollinger replied that if the case, the fast tuner can be removed and a shortened plug can be inserted, which allows to still operate the cavity as today. Therefore, **F. Tecker** remarked that full failsafe operation would require two fast tuners (slide 6).

Minutes by A. Huschauer on 28.02.2019