Minutes of the LIU-PS BD WG #28 on the 21st of March 2019

Agenda (https://indico.cern.ch/event/806316/***)***

Present:
Nuria Ayala Cintas, Alvaro Ferrero Colomo, Matthew Fraser, Massimo Giovannozzi, Klaus Hanke, Oliver Hans, Alexander Huschauer, Pawel Kozlowski, Alexandre Lasheen, Rodolphe Maillet, Mauro Migliorati, Salim Ogur, Branko Popovic, Mihaly Vadai, Ben Woolley,

1. Introduction

Heiko reported on the outcome of the 80 MHz tuner checkpoint meeting (summary), by mentioning that the LIU Beam Dynamics coordination meeting recommended to proceed with the development of the tuner and to equip one single cavity. Klaus asked for the number of tuners, Heiko answered that only one pre-series tuner is considered. Oliver asked whether there is still the need to turn cavity C80-88, Heiko answered no.

Slides summarizing the priorities and commitments of the LIU-PS BD WG for 2019 are available here. Deadlines will be updated with more realistic constraints.

2. KFA45 field measurements (N. Ayala, pdf)

Nuria presented the results of field measurements of the KFA45 kicker, which will be removed and be replaced in view of the injection at 2 GeV. The magnet termination has already been replaced by a direct short circuit, which can lead to increased ripple on top of the pulse and post-pulse.

Measurements of magnetic field were done with a stripline loop in the magnet aperture (measuring the field in one module of the kicker), together with measurements of the applied current before KFA45 was removed from the ring. Nuria indicated that a systematic baseline offset is seen in magnetic field measurements after the pulse and should be investigated. The main result is that the relative amplitude of the flat top ripple increases with the kicker voltage, while the relative amplitude of the post-pulse ripple decreases with the kicker voltage. The kicker can be operated with 3 modules only, although in that regime it works in saturation of the ferrite.

The direct field measurements were compared with beam-based measurements provided by Vincenzo Forte (progress presented in meetings in 2018: #13, #17, #18, #20), and are in good agreement. Direct field measurements were also compared with simulations, which reproduce well the rise and fall time of the kick but not the ripples (top and post-pulse).

Heiko asked whether the kicker is expected to perform at 2 GeV the same it used to perform at 1.4 GeV. Nuria answered positively.

Heiko asked if the fact that the absolute amplitude of the post-pulse ripple does not change with the absolute amplitude of the pulse is confirmed (decrease in relative terms). Nuria confirmed this statement.

Heiko asked if simulations were done using the lumped element circuit model shown in Slide 6. Nuria answered positively.

Alexander asked whether the connection box is contributing to the ripple. Nuria answered that the connection box can reduce the ripple, and that the ripple comes from the main switch. Alexander asked whether this could be improved. Alvaro answered that it will be difficult, on a last resort it can be tried to attenuate the ripple with filters.

Heiko asked how reproducible the measurements done directly in the machine will be in comparison to measurements done in the lab. Results should match very closely since measurements will be done on an exact replica of the kicker.

Heiko asked whether measurements were done from both sides or only one side of the kicker. Nuria answered only from one side, but that measurements will be done from both sides with the new kicker magnet before installation.

3. Optimization of rf manipulations (A. Lasheen, pdf)

Alexandre presented the results of simulations to optimize the bunch splittings (double and triple). He reminded the present criterion (based on Fourier harmonics) to assess the quality of the splittings, and presented the implementation of optimizers in simulation (with and without beam loading).

The optimizers managed to reach the optima, after a number of iterations that is presently too large to be used comfortably in operation. The algorithms were chosen to be Powell and Nelder-Mead, as presently used with success in LEIR. Further machine learning techniques will be tested to reduce the required number of iterations.

Heiko asked why optimizer works better for triple splitting (50 iterations) than for double split which is much simpler. Alexander answered that the optimizers were not “optimized” and that the number of iterations depends on the original error which was set arbitrarily. The step size of optimization should also be adjusted to find a compromise between convergence speed and robustness.

Massimo asked about the use of simplex methods instead of optimizers based on derivatives. Alexandre answered that the first goal was to re-use the same methods that were shown successful in LEIR/SPS, since those methods are known to be robust and reliable. Gradient descent methods will be introduced next.

Oliver asked about how to approach when settings are far away from optimum parameters during triple splitting (e.g. disabling h=21, to adjust the first step). Heiko answered that we need to manually bring triple splitting close and then let the optimizer run.

Heiko asked whether we should run continuously during LHC filling to keep quality optimum all the time, and asked about the experience in the LEIR. Alexander answered that optimizers are disabled in LEIR during LHC fillings. Alexandre explained that the condition to use the optimizer for filling is that the optimization should take a comparable amount of time with respect to usual adjustments made by operators.

Minutes by A. Lasheen