

MSWG Meeting 19-Nov-2013

Present:

S Gilardoni, G Sterbini, W Bartmann, R Steerenberg, H Damerau, K Cornelis, S Hancock, L Ventura, E Benedetto, JE Mueller, T Argyropoulos, H Timko, A Findlay, C Rossi, R Wasef, A Huschauer, A Lasheen, G Sterbini, B Salvant, W Hoefle

Agenda:

- Approval of minutes
- Main presentations:
 - Longitudinal coupled bunch instability in the PS - simulations vs. measurement results – Letizia Ventura
 - Longitudinal coupled bunch instability in the PS - measurement technique – Heiko Damerau
- AOB

The MSWG minutes of the last meeting were approved.

Longitudinal coupled bunch instability in the PS - simulations vs. measurement results – Letizia Ventura

Letizia introduced the longitudinal coupled bunch simulation code (LCBC) where the longitudinal dipole motion of all bunches is tracked for these studies. A frequency domain longitudinal FB system had been implemented in the code and was tested using the nominal beam parameters in the PS. Presently acceleration is not implemented. The simulation results were benchmarked with theory and very good agreement was found.

To simulate and compare to measurements of the PS, the impedance model of the 10 MHz cavity system (most probably source of CBI) was used. So far the model was established by measuring the transfer function with/without FB around the amplifier, and fitting a model to it to extract the fit parameters. For these simulations the best fit of the impedance model has been found with 4 resonant modes. The instability rise time given by the code was then in good agreement with the growth rate obtained from the eigenvalue system.

The simulations at $h=21$ (18 and 21 bunches) predicted the strong oscillation mode=2 which was confirmed by measurements in 2013.

The effect of the 40 and 80 MHz systems is being investigated; preliminary results show that no additional contribution to CBI has to be expected. Also the wideband kicker cavity which shall be installed in LS1 seems not to give a significant contribution to CBI.

Discussion

W Hoefle was asking in the impedance model of the cavities if the 1-turn delay feedback was included – no there is also no measurement data to compare to; so this is a worst case estimate.

WH asked if it was tried to improve the impedance model fit (slide 27) by using less resonators and checking the phase – the phase agrees; no better fit could be found. B Salvant was asking whether the model fits also the imaginary impedance part – yes it fits real and imaginary part.

H Damerau was asking if the wideband kicker was taken into account in the model with the feedback – no the feedback is not taken into account, so again worst case assumption.

WH was asking whether all the gaps were included in the impedance model - yes.

Longitudinal coupled bunch instability in the PS - measurement technique – Heiko Damerau

At the end of the run in 2013 there were ideal conditions to rigorously measure the CB feedback. For exciting, measuring and damping the frequency domain FB system is used. The FB is put in antiphase to adjust the phase, then a perturbation is injected and the natural decay observed which is needed for corrections. A Fourier analysis of the time domain signal gives the amplitudes per mode.

As predicted by simulations, for 21 bunches accelerated with $h=21$, mode 2 develops most strongly during the cycle. For the standard case of 18 bunches accelerated with $h=21$, the data is also reproducible over several years.

In order to excite only a single side-band both perturbations have to be used with a 90 deg shift between sin and cos.

For the measurements each mode was individually excited and its spectrum measured; plotting the excitation vs. mode number shows a clean excitation of the excited modes but also mixtures of these modes. The line which seems to be a double harmonic - freq could be an artefact introduced by the FB.

Measuring the damping rate with FB on vs. gain shows correctly zero damping for zero gain when the signal is corrected for natural damping. Measuring the damping rate vs. intensity shows an increase of the damping with intensity, a non-zero damping at zero intensity could come from saturation. The damping efficiency is independent from the longitudinal emittance and reduces for higher energy which agrees with theory.

The required kick voltage from the wideband kicker which allows damping all modes at once was estimated with about 1 kV per sideband with a maximum of 5 kV.

Cross-damping is important for the new cavity system since the preferred range for the excitation is in the lower frequency range while the preferred range for the detection is better far away from the revolution frequency where the synchrotron frequency sidebands to be measured are much lower

than the main signal. This was successfully tested by demodulating a coupled-bunch oscillation on one harmonic and re-modulating the signal on the mirrored harmonic of the revolution frequency. Additionally swapping the sin/cos of the local oscillator signal to the kick signals of the conversion mixers is required to exchange upper and lower sidebands.

Discussion:

S Gilardoni was asking whether this voltage scales linearly when different modes have to be damped – yes, the maximum of 5 kV can be separated for several modes. Also the FB normally will start before the oscillations fully develop and therefore less voltage should be required than specified. If needed, it could be imagined to install a second kicker cavity in the long-term; however a difficulty could come from the LLRF for distributing correctly phases kick voltages at different harmonics simultaneously.

K Cornelis was asking whether simulations and measurements were done with only one booster ring and fewer bunches in the PS, since this is one of the beams being required – no but less performance needed for these beams.

S Gilardoni was asking whether it was preferable to have a full machine or a gap – a full machine would help the feedback, but it has the opposite effect for the excitation growing along the batch; for shorter batches the empty part helps for the instability decay. So a little gap is preferable to the full machine.

AOB:

The meetings next year will be moved back to the Friday afternoon slot due to the overlap with the FOM.

Next meeting: 26-November-2013