Minutes of the 23rd PyHEADTAIL Development Meeting

25/07/2014

List of attendees: H. Bartosik, P. Baudreghien, A. Lasheen, K. Li, E. Metral, G. Rumolo, A. Oeftiger, E. Shaposhikova, H. Timko

Follow up from previous meetings, approval of the last minutes and arising matters

A quick summary of the last meeting which was dedicated to the instabilities in the transverse plane: Michael Schenk presented his work on the code along with benchmarks and convergence studies. Benchmarks were done against HEADTAIL and convergence studies were carried out mainly with respect to the number of slices necessary to resolve the respective wake fields. The transverse tracker has been redesigned and equipped with RFQ detuning.

Agenda

1. ***Basic longitudinal structure of PyHEADTAIL:***

   The PYlongitudinal branch is now the master branch for the longitudinal aspects of PyHEADTAIL. A version numbering scheme has been applied and described. The original design of the longitudinal tracking has been changed. The main components for now are tracking in multiple harmonic systems over several RF stations, intensity effects, post-processing tools and documentation. A LLRF module has been added. For now, it includes only phase noise but feedback and phase loops should also be provided soon. The main class performing longitudinal tracking is the RingAndRFSection class. It combines drifts and kicks according to the equations of motion presented HEADTAIL Meeting #21. Drifts can take into account up to second order in slippage factor. Kicks can apply multiple harmonic and accelerating RF fields. Momentum programs can be provided for each RF station. Of course, all RF stations should share the momentum compaction factor. Example files for longitudinal tracking and computation of intensity effects can be found in the _EXAMPLE_MAIN_FILES folder.

   Documentation has been started for PYlongitudinal. Examples of using Sphinx documentation were shown and explained and a link to the documentation page of PYlongitudinal was provided.

   In conclusion, PYlongitudinal has been tested and is ready to use. Any issues or requests should be directed to Danilo Quartullo.

A merge can take place when a common interface has been agreed on.

2. ***Intensity effects in the longitudinal plane:***

   The computation of impedance effects for now requires longitudinal discretization of the beam. In the general jargon this is called slicing. A slices class exists to perform this task. An additional slicing method has been added to the available methods which is basically the NumPy 1d histogram function which seems to be sufficient for computation of longitudinal intensity effects. New methods such as computation of the beam spectrum and the beam profile derivative have been added. Different impedance sources are available and can be imported either as impedance or as wake fields for calculations in frequency domain or in time domain, respectively. So far, resonator impedances, travelling wave structures and constant imaginary Z/n type impedances have been implemented. The time domain calculation is done using a convolution of the beam profile with the wake fields, either via a matrix multiplication which can be used in general or via the NumPy convolve function which can be used only for constant slicing. In frequency domain, the beam spectrum is multiplied with the impedance and the kicks are obtained via an inverse FFT. It was noted that space charge could perhaps be modelled by a high frequency resonator; this would give a constant imaginary Z/n and introduce resistive wall impedance as well, whereas pure imaginary Z/n models would give non-physical solutions.

   In conclusion, several options for computing intensity effects are now available. These should still be tested. Simulations have been started for the PSB and the results will help to benchmark the implementations. Example files on how to include intensity effects in the simulations are provided in the repository branch. Forthcoming developments include code clean-up, implementation of the MuSiC method (see HSC Section Meeting #14) and bunch generation taking into account multiple RF and intensity effects.

Kevin Li, 29/07/2014