MERLIN-BASED START-TO-END SIMULATIONS OF LUMINOSITY STABILITY FOR THE ILC *

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Abstract

In this paper, we report the progress and status of a full-featured so-called start-to-end simulation based on the MERLIN library. The current model comprises acceleration in the superconducting main linac, beam delivery system and finally collision at the IP. Realistic modelling of the beam-beam interaction is included by using the code GUINEAPIG. Results on ground motion modelling and trajectory control are presented.

INTRODUCTION

The International Linear Collider (ILC) requires the preservation of an ultra-small vertical emittance from the damping ring to the interaction point (IP) where the nanometre-sized beams are made to collide. It is well-known that ground motion and component vibration will need to be compensated by fast intra-train feedback systems and slower semi-continuous trajectory corrections. This complex system can in general only be modelled using simulation. The ILC is still an evolving system. Technical specification and details of the overall design will change. The software of a start-to-end simulation must easily allow for modifications and should provide a framework to study design alternatives.

GENERAL LAYOUT OF THE SIMULATION CODE

A model from the main linac to the beam delivery system and the interaction point has been set up as a first step towards a full ILC simulation. The model contains wake fields within the accelerating cavities and will allow for realistic alignment and field errors. The electron main linac includes the bypass for the undulator which is part of the positron source.

For the study of correlated ground motion it is necessary to model both, the electron and the positron side, of the ILC. Both halves are defined by independent lattice files which have to be integrated into a common model. Here, the MERLIN library provides the concept of *support structures* which represents an independent layer of geometrical relations on top of the lattice file geometry. Beyond that, a special kind of *support structures (girders)* can be used to define rigid structures, as for example cryomodules or a common support for the magnets of the final focus system. Our code includes an interface for several ground motion models: a random walk approach (ATL [4]) and the models for correlated ground motion from A. Sery[5] [1].

Another interface is implemented to accommodate different beam steering algorithms. This is currently used to realise a one-to-one steering for the horizontal and vertical planes. Fast feedback systems between the main linac and the beam delivery system and for the colliding beams at the IP are part of the simulation although still in a simplified way. The same holds for the tuning of beam parameters at the IP (see below).

MERLIN provides two different bunch types: The *ParticleBunch* class is a collection of 6D phase space coordinates, whereas in the *SMPbunch* (sliced macro-particle) class the transverse coordinates are replaced by 1st and 2nd order moments. SMP tracking is faster but not sufficient for higher-order magnetic fields, or in cases where the detailed bunch distribution is of interest (collimation, beam halo etc.). In our model SMP tracking is favourable for the first and second half of the electron main linac (before and after the undulator insert) and for the whole positron main linac. When SMP tracking is used in these areas the total (ML and BDS) simulation time is reduced typically by a factor of 5.

Finally, GUINEAPIG [3] is utilised to calculate the total cross-section and luminosity for the colliding bunches including beam-beam effects.

SOFTWARE DESIGN FOR FLEXIBILITY

MAD8 [7] is used to define the ILC lattice. Standard accelerator components are defined by MAD keywords, and so-called markers are used to label begin and end of subsystems, or structures as cryo-modules, non-standard components (e.g. undulator) and so forth. In addition names, i.e. character strings, are use to identify individual elements as magnets, monitors etc. The simulation code has to cope with the fact that naming conventions may change and new elements appear or disappear. Therefore it is crucial for the long-term usability that already the basic program design takes into account potential changes. Wherever possible, string identifier should only be used in isolated places so that the program can be adapted quickly. For special studies or cross-checks the simulation code should be able to track only parts of the ILC lattice, and it should support an easy change change between the two different bunch models. Furthermore, a modular accelerator construction should allow a stepwise development of the full simulation

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