Work Packages for ILC Main Linac Beam Dynamics / Accelerator Physics PT
Version date: 13-Sep-07

Based on C. Adolphsen PPT presentation of 21 August 2007

Chris Adolphsen's 4 categories:

1. Quad Package Design
2. Static Tuning
3. Installation and Operation
4. WF / Cavity Topics

Here I attempt to flesh these out into more self-contained WPs with adequate definition of the WP dependencies, end points, deliverables, etc.

WP 2.1. Complete and Document Single Bunch Steering Studies (Sierra-4)

The goal here is to complete the work on static tuning which has been performed in a poorly-documented way by a huge number of teams over the course of the last 10 years. Simulations will begin with the RDR lattices for positron and electron linacs (including positron production undulator in the case of the electron linac, and vertical curvature in both linacs), with the expected beam conditions at injection (ie, the expected charge, RMS bunch length and longitudinal distribution, emittances, and beam matching), and with the canonical static errors and misalignments:

Error	WRT	RMS value
Cavity offset	CM	300 um
Cavity pitch	CM	300 urad
BPM offset	CM	200 um?
Quad offset	CM	300 um
Quad roll	CM	300 urad
Module offset	Survey Line	200 um
Module pitch	Survey Lne	25 urad

(At this time, no errors in quad strength, corrector strength, BPM scale factor, or RF voltage or phase; perfect BPM resolution).
(Should there be BPM roll errors? Probably yes; but hopefully they don't matter too much.)

Teams will study the effectiveness of the canonical 3 emittance steering techniques:

1. Ballistic Alignment (BA)
2. Dispersion Free Steering (DFS)
3. Kick Minimization (KM)

For this step of this process, no tuning bumps may be included.

Ideally, each of the 3 techniques will be studied by 2 teams working independently, so a minimum of 2 teams and a maximum of 6 teams are needed.

Deliverables:
For each of the 3 steering techniques, the teams performing the studies will submit a technical report to ILCDOC. The report will contain a description of the performance of the technique studied (mean and 90% CL emittance growth), along with a technical description of sufficient detail that another beam dynamicist could reproduce their study using the report alone, without resorting to interrogation of the report authors. The teams will also submit the source code for their simulation studies to EDMS, so that the source code can be studied by other interested parties along with the tech report. Note that by "source code for simulation studies" we mean the code for the algorithm, not the code for the beam-tracker, etc – the goal is that another physicist should be able to duplicate the tested algorithms on a different code if desired.

Deadline

WP 2.1 should be completed by March 1, 2008 (ie, about 4 months after the Fermilab ALCPG meeting). This is important, since the tools developed and published here will be the basis for future studies on the ML.

Management Action

Management may, at their discretion, perform a downselect amongst the 3 steering methods presented (ie, decide to stop studying 1 or more of them), or may carry all 3 forward if it is not thought that the studies have yet indicated a definitive optimum technique.

WP 2.2. Emittance Growth Driving Terms

For each of the Sierra-4 techniques which survive the downselect, perform studies in which individual errors are scaled (up and down) to understand the improvement or degradation of performance from each effect.

Dependencies

Work cannot begin until WP 2.1 is completed.

Deliverables

A technical note, submitted to ILCDOC, which documents the performance for the variations which are tested, and which documents which parameters of the steering algorithm, if any, were adjusted as part of the study (ie, it may be necessary to retune the algorithms for some error changes; if so, document that here).

Deadline:

WP 2.2 should be completed by May 1, 2008.

WP 2.3. Tuning Knobs

For each of the Sierra-4 techniques which survive the downselect, perform studies of dispersion, wakefield, and any other tuning knobs of interest, in order to determine the improvement in emittance performance produced. Bumps must be produced in a rigorously realistic way (ie, with real adjustment of adjustable devices in the beamlines – introducing linear correlations or cavity offsets by magic is not permitted). Similarly, tuning procedures must be realistic and use actual physical observables in the beamline, for example beam sizes on wire scanners that will actually be present in the beamline.

Dependencies

Work cannot begin until WP 2.1 is completed.

Deliverables

A technical mote, submitted to ILCDOC, which documents the design of the knobs (ie, which devices, what coefficients) and the performance improvement which they generate.

Deadline

WP 2.3 should be completed by June 1, 2008.

Notes

This WP may require the use of a BDS lattice at the end of the linac lattice to provide the emittance tuning wire scanners. That would also permit the WP team to study use of the BDS skew quads for emittance correction at the same time.

WP 2.4. Improved Models of Initial Conditions

In this WP, the tools developed in WP 2.1 and WP 2.3 are used to study the emittance preservation with more accurate representations of the initial conditions:

- Alignment model: a model which includes the long-wavelength correlations which are expected in the initial alignment, including settling of the tunnel after construction.
- RF model: a model which includes a more accurate short-range wakefield and RF kicks from coupler asymmetries, voltage errors, and phase errors (leading to errors in the energy profile and energy spread at the end of the linac).
- Instrumentation Model: a model which includes BPM scale factors, BPM offset drift, BPM resolution limits, laser wire resolution limits, laser wire systematics.

Dependencies

Work cannot begin until WP 2.1 is completed, and also depends on the delivery of the improved models of alignment, RF, and instrumentation.

Deliverables

Technical notes, submitted to ILCDOC, which document the changed assumptions about the initial errors and the results of the simulation studies.

Notes

I don’t really know how to assign a deadline to this one – in large part it depends on how rapidly the required models of alignment, RF, and instrumentation are delivered as inputs.