On ILC Simulation WPs

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DRAFT List of ILC Simulation Work Items

- RTML (emittance preservation)
  - Upstream RTML
  - Bunch Compressors
- ML Static tuning
- ML Dynamic tuning
- BDS (emittance/luminosity preservations)
- ATF2
- Feedback/Feedforward model and simulations
- Control of longitudinal phase space of the beam
- Emittance monitoring
- Start to End Simulation
- Background
- Machine protection
- Spin dynamics

Area by area (RTML through BDS)

Inter-area (Feedback/Feedforward through Spin dynamics)

Single Area WPs (almost single area)

Proposed by Sim. G.	Proposed by Area G.
RTML	RTML: Static Tuning study, Errors sensitivity study, Failure mode analysis, Specify and Study Magnetic stray fields, Study space-charge effects, Dynamic tuning, Specify and develop feed-back system
ML Static tuning	MLI: Static tuning, Initial Alignment
ML Dynamic tuning	MLI: Dynamic tuning
***	MLI: General ML BD
BDS	BDS: Most of "Acc & Det phys. design & optimiz." of BDS
ATF2	BDS: ATF2 Installation, integration, component commiss. Develop control & operation tools ATF/ATF2 commiss., operation & beam study

Inter-Area WPs

Proposed by Sim. Group	Related Wps proposed by Area Groups					
	RTML	ML	BDS	e-	e+	DR
ML Static tuning		Static tuning (Wakefields)			Undulator system Lattice design	
ML Dynamic tuning		Dynamic tuning				
Feedback/Feedforward	Dynamic tuning. Specify and develop feed-back system	**	Design feedback and tuning procedures			*
Control longitudinal phase space	**	Enery Errors	*			*
Emittance monitoring	**	**	**			*
Start to End Simulation	**	**	**		**	*
Background	Study of beam halo in the RTML	**	Background and beam-beam study			*
Machin Protection	Design, Specify MPS	**	Design MPS system of field value failure			*
Spin dynamics	**	**	** (?)	Polarization specific issues	Polarization specific issues	** (?)

* Some relation, but no specific WP proposed

** Strong relation, but no specific WP proposed

Institutes which are “Known” and Submitted EOI

	“Known” (can be incomplete)	EOI received
RTML	CERN, FNAL, KEK, SLAC, KNU	Cornell, FNAL, KEK, KNU
ML Static tuning	CERN, DESY, FNAL, KEK, SLAC, Oxford	FNAL, KEK
ML Dynamic tuning	CERN,DESY, FNAL, KEK, SLAC, Oxford	FNAL, KEK
BDS	CERN, SLAC, RHUL, LAL, Daresbury	RHUL, KEK, LAL, Manchester
ATF2	CERN, SLAC, KEK, RHUL, LAL, Daresbury	RHUL, KEK, LAL, KNU, RRCAT
Feedback/Feedforward		FNAL, KEK
Control longitudinal phase space		
Emittance monitoring		
Start to End Simulation		KEK, RRCAT
Background		
Machine protection		
Spin Dynamics	Liverpool, Durham	Liverpool, Durham

Appendix:
Draft Description of WP

by K.Kubo

Descriptions of some of tasks are based on
http://www.slac.stanford.edu/~quarkpt/EDRPlan
quarkpt 16-May-2007

Modified 2007.08.21, 20071010
, 20071012, 20071017

RTML

Sub-Packages

This work package can be divided into two sub-packages for different parts of RTML

- Upstream RTML (from the exit of the damping ring to the entrance of the bunch compressor)
- Bunch Compressors

Goals of the First Study

- The study will focus on the emittance tuning requirements of the Ring to Main Linac (RTML). The goal of the first phase of the study is **to demonstrate that the RTML's emittance preservation goals can be achieved**: the goal is to limit growth in the normalized vertical emittance to 4 nm.rad with 90% confidence, using standard assumptions of misalignment and component errors. It is preferred that multiple paths to achieve the emittance goal are demonstrated. Techniques that can achieve the necessary emittance without resorting to bumps are preferred to techniques which require bumps.
- **The results should be cross checked by different simulation codes and different persons.** The cross checking must include the key physics features of the RTML: misaligned quadrupoles, sector bends, and RF cavities; pitched RF cavities; quadrupole errors in the spin rotator section; transverse wakefields of uncompressed bunches; momentum compaction.
- **Essential Features of the Study**
  - A set of standard misalignments and errors which is considered appropriate by the relevant technical experts
  - The expected beam distribution from the extraction of the DR, including the correct bunch length, energy spread, and any non-Gaussian features; both the nominal and low-charge, short-final-bunch cases should be studied
  - Long-range wakefields, including any expected rogue modes or mode-rotation wakes

RTML (continued)

Goals of the Second Study

- The next steps will be: to **include BPM and corrector "hard failures"** in the study (failed BPMs and correctors known to have failed); to use realistic models of misalignment, magnet errors, etc (if not included in the initial set of studies). The studies will be used to set specifications and tolerances on many parameters, for example determining the actual requirements on initial alignment. The exact dimensions of this last part of the study will be determined later based on experience from the initial portions of the study and demands from the various area, technical, and global experts.
- In parallel with the above, incorporate **dynamic features into the tuning model**. These features include: ground motion and component vibration based on the accepted model; 5 Hz, feedbacks, 3 MHz feedbacks, "train-straightener" feedbacks, and feed-forward; bunch-by-bunch and train-by-train beam jitter.

Deliverables

- The key deliverable is a "white paper" summarizing the results of the study, which is to be available at the time of the Engineering Design Report (ie, in early FY10).
- For cross checking and later use
  - The algorithms must be documented and made publicly available in some form, whether as source code or as a fully-developed technical note on the algorithms; this will allow other users to develop studies which take the tuning algorithms as a starting point.
  - Datasets representing the misalignments, other errors and corrector settings for a number of "seeds," which can be loaded into other simulation programs.

Time schedule

- **The first study should be completed in mid 2008?** and its summary and datasets should be documented.
- **The second study should be completed in March2009?.**
- This study is followed by “Start to End Simulation”

ML Static tuning

Goals of the Study

The study will focus on main linac emittance tuning and preservation in the presence of static effects. A lot of works have already done. The past work should be reviewed and documented in well organized way. Also there are a few remaining issues to be studied:

- Study effects of long range misalignment, then, set tolerances for realistic survey-alignment models.
- Multibunch effects
- Undulator section of e- linac
- Include realistic error models, failed components.

Deliverables

- The key deliverable is a "white paper" summarizing the results of the study
- For cross checking and later use
  - The algorithms must be documented and made publicly available in some form, whether as source code or as a fully-developed technical note on the algorithms; this will allow other users to develop studies which take the tuning algorithms as a starting point.
  - Datasets representing the misalignments, other errors and corrector settings for a number of "seeds," which can be loaded into other simulation programs.

Time schedule

- **The main part of this study has already done. The summary should be available in ?March 2008.**
- This study is followed by “Dynamic tuning”

ML Dynamic tuning

Goals of the Study

The study will focus on main linac emittance tuning and preservation in the presence of dynamical effects. It should incorporate the following refinements:

- The ground motion and vibration model for the ILC
- Time-dependent errors in the magnet settings, RF power, and BPM performance
- 5 Hz feedbacks, 3 MHz feedbacks, and train-straightener feedbacks
- Resteering or continual steering models
- Initial beam jitter, both train-to-train and intra-train, which is expected from the results of the RTML dynamic study

The study will quantify the degradation in the initial tuning due to dynamic effects, determine the optimum mitigation of the dynamic effects, set specifications, tolerances, and limits on dynamical effects, and determine the necessary procedures and equipment to maintain optimum emittance performance of the main linac over time.

Deliverables

- The key deliverable is a "white paper" summarizing the results of the study
- For cross checking and later use
  - The algorithms must be documented and made publicly available in some form, whether as source code or as a fully-developed technical note on the algorithms; this will allow other users to develop studies which take the tuning algorithms as a starting point.
  - Datasets representing the misalignments, other errors and corrector settings for a number of "seeds," which can be loaded into other simulation programs.

Time schedule

- **The summary should be available in March 2009.?**
- This study is followed by “Start to End Simulation”

BDS

Goals of the Study

- The study will focus on the **luminosity tuning** requirements of the Beam Delivery System (BDS). The goal is to demonstrate that the designed luminosity can be achieved with 90% confidence, using standard assumptions about the initial alignment of components, the accuracy of electromagnetic fields in the devices and various dynamical errors.

  The key physical issues to be studied include:
  - The typical misalignments, rotations, and strength errors of beamline devices
  - Crab cavity effects, including wakefields, phase and amplitude errors, and xy rotation errors
  - Wakefields, including both collimators and the vacuum chamber itself
  - Dynamic effects: ground motion, technical noise (especially on the final doublet and detector), train-by-train and intra-train feedbacks
  - Beam-beam effects
- The results should be cross checked by different simulation codes and different persons.

Deliverables

- The key deliverable is a "white paper" summarizing the results of the study, which is to be available at the time of the Engineering Design Report (ie, in early FY10).
- For cross checking and later use
  - The algorithms must be documented and made publicly available in some form, whether as source code or as a fully-developed technical note on the algorithms; this will allow other users to develop studies which take the tuning algorithms as a starting point.
  - Datasets representing the misalignments, other errors and corrector settings for a number of "seeds," which can be loaded into other simulation programs.

Time schedule

- **The summary should be available in March 2009.**
- This study is followed by “Start to End Simulation”

ATF2

Goals of the Study

The goal is **to demonstrate achieving small beam size and stable beam in ATF2** by simulations of the beam commissioning and tuning of ATF2. **To compare with experimental results and extract useeful information for ILC**.

This will include simulation of:

- Commissioning:
  - Making the beam go through the beam line and rough tuning.
- Tuning and monitoring for small beam size at IP
- Tuning, controlling and monitoring for stable beam at IP
- Orbit feedback and feedforward, inter pulse and intra-bunch

Deliverables

- One or more documentations of simulation studies, before full ATF2 beam operation.
- One or more documentations including comparisons with experimental data and impact to the real ILC machine.

Feedback/Feedforward model and simulations

Goals of the Study

The goal is **to develop a model of the orbit feedback and feedforward system and to demonstrate its performance** by simulations. The model should incorporate the following components:

- Train-to-train (5 Hz) feedback loops
- Intra-train (3 MHz) feedback loops
- Bunch by bunch feed-forward (in the turnaround)
- Train-straightener feedback loops (nearly fixed, bunch by bunch orbit correction)

To the extent possible, the developed system should include specific locations for sensors and actuators, bandwidth requirements for sensors and actuators, and descriptions of the algorithms used by each loop, and communications between them, which are adequate to incorporate into a simulation package.

Deliverables

One or more technical notes which document the design and expected performance of the system.

Time schedule

- **The document should be available in 2008?.**
- This study is followed by “Start to End Simulation”

Control of longitudinal phase space of the beam

Goals of the Study

The is to develop a model of the control system in the longitudinal phase space of the beam, and to demonstrate its performance by simulations. This includes

- Monitoring, tuning and control scheme of:
  - Bunch length, timing, energy spread (tuning of the bunch compressors)
  - Measuring the beam energy profile and matching the quad lattice
  - Regulation of energy at the end of the linac

Deliverables

One or more technical notes which document the design and expected performance of the system.

Time schedule

- The document should be available in 2008?.
- This study is followed by “Start to End Simulation”

Emittance monitoring

Goals of the Study

The goal of the project is to simulate performance of emittance monitoring system, and/or estimate required performance of the system. This should include diagnostics in RTML, ML and BDS.

Deliverables

One or more technical notes which document the design and expected performance of the system.

Time schedule

- The document should be available in 2008?.

Comment:

This study strongly related to tuning studies. IT is not clear this should be an independent workpackage.

Start to End Simulation

Goals of the Study

This study will **integrate the RTML, Main Linac, and BDS simulations into a common framework and produce direct estimates of the ILC luminosity** (rather than indirect estimators such as the emittance). As such, it will incorporate the static tuning algorithms of each area, the dynamic effects and feedbacks, and the beam-beam interactions necessary to achieve a fully-realistic luminosity estimate.
In the event that the integrated simulations predict a luminosity which is lower than what is expected from the emittance-preservation studies, the efforts will be directed towards understanding the discrepancy and increasing the luminosity.

Deliverables

- The key deliverable is a "white paper" summarizing the results of the study.
- For cross checking and later use
  - The algorithms must be documented and made publicly available in some form, whether as source code or as a fully-developed technical note on the algorithms; this will allow other users to develop studies which take the tuning algorithms as a starting point.
  - Datasets representing the misalignments, other errors and corrector settings for a number of "seeds," which can be loaded into other simulation programs.

Time schedule,

The summary should be available at the time of the Engineering Design Report (ie, in early FY10). (? too late ?)

Backgrounds

Goals of the Study

The goal is to simulate backgrounds, and performance of background mitigation system and/or estimate required performance of the system. This study includes:

- Beam Halo
- Synchrotron radiation
- Maltipacting
- Dark currents

Deliverables

One or more technical notes which document the expected background and performance of the mitigating system.

Time schedule

- The document should be available in ?2009.

Comment:

This may be a part of (or sub-workpackage of) a workpackage which include hardware design.

Machine protection

Goals of the Study

The goal is to simulate machine protection system, and/or estimate required performance of the system.

Deliverables

One or more technical notes which document the design and expected performance of the machine protection system.

Time schedule

- The document should be available in ? 2009.

Comment:

This may be a part of (or sub-workpackage of) a work package which include hardware design.

Spin Dynamics

Goals of the Study

The goal is demonstrate preservation of polarization of the electron and positron beams in the whole beam lines by simulations, studying spin dynamics and depolarization effects.

Deliverables

Documents summarizing the results of the study.

Time schedule

- The document should be available in 2009?.