Cornell University
Laboratory for Elementary-Particle Physics

Cornell Plans for RTML EDR Work

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Cornell's role in the RTML

- The RTML presents a significant number of accelerator physics design challenges, many of which must be confronted during the ILC EDR phase, currently envisioned for the period FY08-10. In most of these areas, participation of Cornell faculty, staff and students would be of major benefit to the ILC program.
- Cornell has already been active in this area, with partial funding coming from a DOE grant. Cornell is part of the low emittance transport working group collaboration, and has made significant contributions to the study of dilution mechanisms in the main linac and beam based correction algorithms.
- We have also contributed to the design of the spin rotator in the baseline design of the RTML.
- Our simulations are based on an existing object-oriented particle-tracking library, Bmad. Bmad has been extensively tested against an operating accelerator, CESR.
- To facilitate the efficient development of simulations, an accelerator design and analysis program based on Bmad has been developed called Tao (Tool for Accelerator Optics)

Cornell's role in the RTML

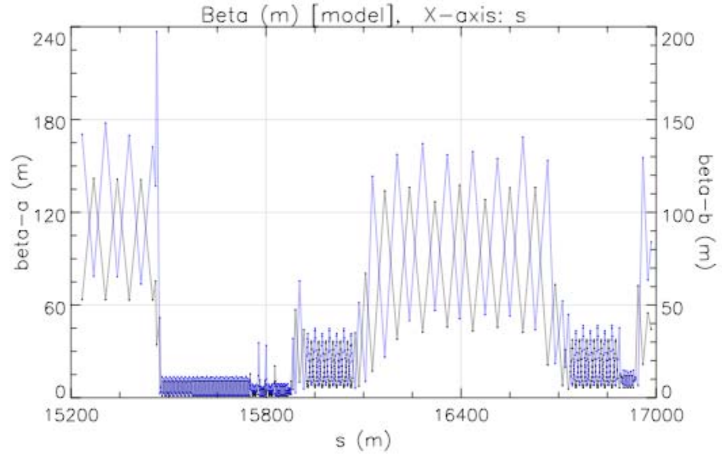
- Tao provides an environment for solving many simulation problems, including the design of lattices subject to constraints, and the simulation of errors and changes in machine parameters. It provides a single interface for both simulation work and machine control, and allows for the simulation of machine commissioning including the simulation of data measurement and correction.
- For the work proposed here, we will continue to work in close collaboration with the ILC Beam Dynamics group at SLAC, and continue to reproduce studies at SLAC, FNAL and elsewhere as needed to establish the credibility of the modeling software.
- The work packages proposed here cover the FY08-09 period, and were discussed at the RTML KOM meeting in late August.
- The funding source has not yet been established.

Lattice Design for EDR Geometry

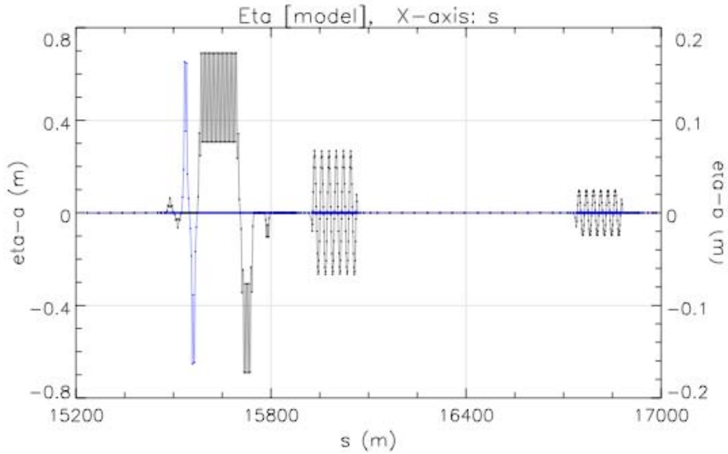
- This work package covers the optics design of transfer lines, arcs, doglegs, and betatron/dispersion matching, necessary to match the RTML design to the site geometry chosen for the EDR. It includes all the beamlines from damping ring extraction, through the "Escalator", the return line, and the turnaround, and thence through the bunch compressors and spin rotator to the start of the main linac.
- This lattice will implement all of the known major geometry constraints imposed by Conventional Facilities (CFS) requirements and component engineering details.
- First version of detailed lattice and descriptive technical note: May 2008.
- Second version: December 2008
- Final version: August 2009
- Resources: 0.4 FTE in FY08 and FY09

RTML lattice in Tao/Bmad

We have implemented a description of the current RTML lattice in Tao/Bmad and checked agreement with RDR design.



March 2007 RTML lattice:
Bunch compressor region lattice functions

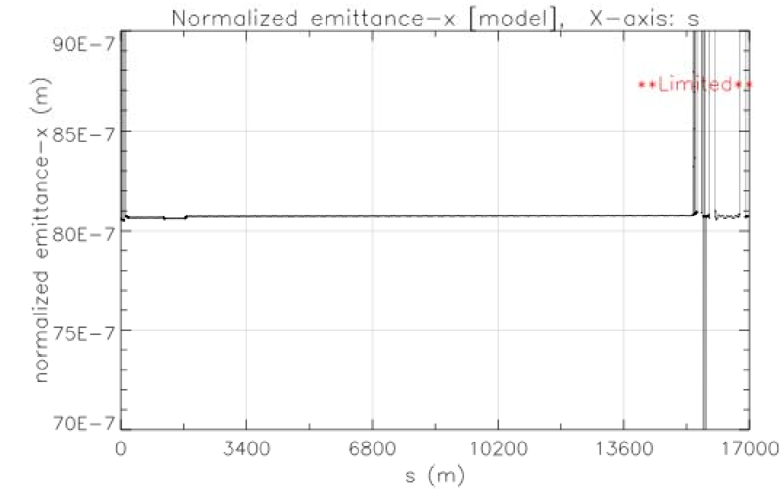


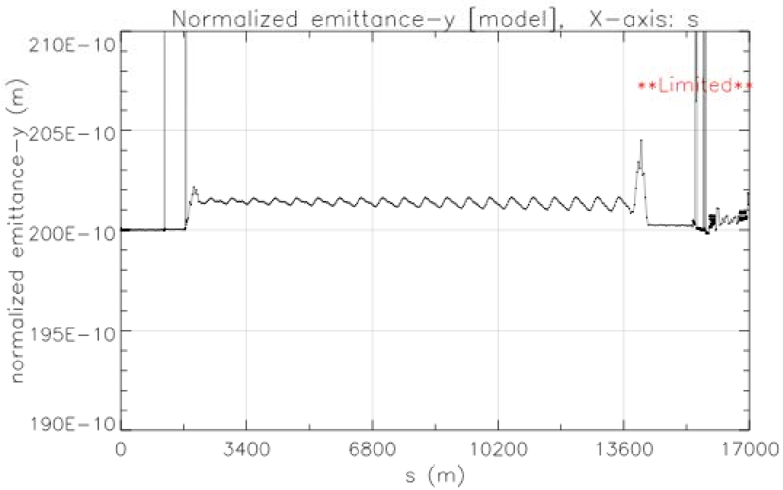
RTML Static Tuning 1

- This work package would demonstrate in simulations that the RTML's emittance growth budget of 4 nm with 90% confidence is achievable using the standard distributions of misalignments and errors.
- In the event that the studies find that the tolerances below are unacceptable from the point of view of static emittance preservation, identify the minimum set of improvements which are needed to achieve the emittance budget.
- Cornell would collaborate directly with SLAC in this effort. Any studies which originate with the Cornell group would be duplicated by the SLAC group, using a different simulation package and as much independent development as possible; and vice-versa.
- First version of technical note and scripts/code: May, 2008
- Final version of technical note and scripts/code: August, 2008
- Resouces: 0.6 FTE in FY08

RTML emittance in Tao/Bmad

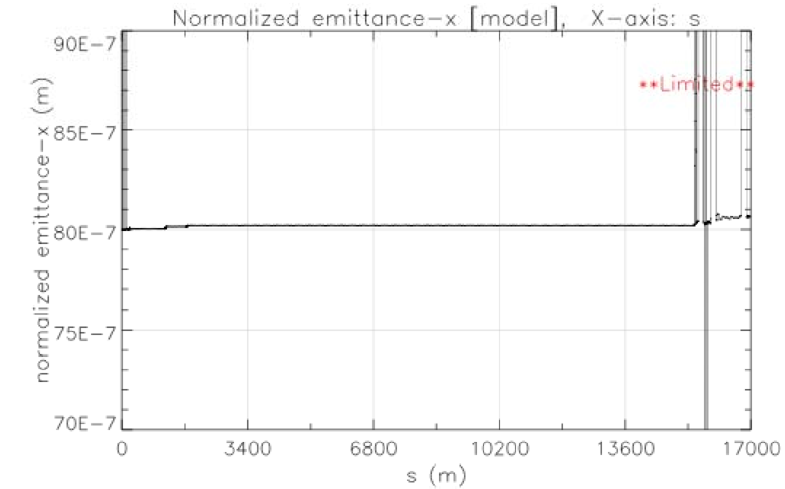
- Emittance transport in RTML (no errors)

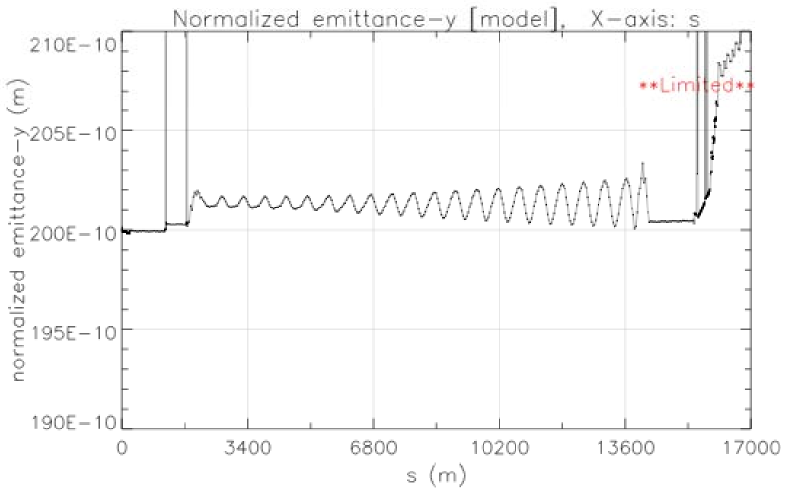




RTML emittance in Tao/Bmad

- Emittance transport in RTML (5 μm vertical offset in one QD in the return line at 4577 m)





RTML Static Tuning II

- This set of simulations can only proceed as the necessary inputs become available from the technical experts, and after the completion of Static Tuning I.
- Using the simulation tools and results developed and posted to the server in Static Tuning I, repeat the simulations as better models of the initial alignment, BPM errors, magnet errors, RF errors, and wakefields become available, including assumptions about failed correctors and BPMs.
- The simulations will be used to verify acceptability of the alignment and error models from the standpoint of emittance preservation.
- In the interest of verification, it is expected that Cornell would partner with another team, as in Static Tuning I, so two teams can independently perform these studies and verify that similar results are obtained.
- First version of technical note and scripts/code: November, 2008
- Final version of technical note and scripts/code: November, 2009
- Resources: 0.2 FTE in FY08, 0.7 FTE in FY09

RTML Static Tuning III

- This set of simulations can only proceed as the necesary inputs become available from the technical experts, and after the completion of Static Tuning I.
- Using the simulation tools and results developed and posted to the server in Static Tuning I, repeat the simulations while varying the error parameters and/or models. The variations in the parameters and models are to be specified by ILC technical leaders, and the purpose of Static Tuning III is to determine whether those variations are acceptable from an emittance tuning standpoint, or are unacceptable. (Examples: cavities with larger wakefields; looser alignmen specifications; poorer performance of BBA; poorer BPM resolution.)
- Again, Cornell would partner with another group to ensure independent verification of the results.
- First version of technical note and scripts/code: December, 2008
- Final version of technical note and scripts/code: December, 2009
- Resources: 0.2 FTE in FY08, 0.7 FTE in FY09

Study of beam halo in the RTML

- Beam tails generated in the damping ring and return line will be eliminated by collimation upstream of the main linac. This work package will extend the tracking studies to include tails (particles at large energy and transverse amplitudes), so that we can evaluate the effectiveness of collimators in eliminating damping ring generated halo. Effects of multiple Coulomb scattering will be included.
- This work will begin in the middle of FY08. The first deliverable will be the development of models of the halo generation in the damping ring and RTML (by September, 2008).
- The second milestone will be the modification of tracking codes to incorporate the halo models developed in FY08 (by February, 2009).
- The final milestone will be the completion of the tracking simulation runs to design and evaluate the pre-linac collimation systems (by October, 2009).
- Resources: 0.3 FTE in FY08, 0.4 FTE in FY09

Ultra-Short Bunch Compressor

- An ultra-short bunch compressor design has been developed by E. S. Kim, PAL (see later talk). This design can in principle deliver beams with the required parameters to the start of the linac and at somewhat lower cost than the baseline design.
- This work package would modify the current design of the ultra-short compressor to be compatible with required constraints, and would perform studies of the tuning of the bunch compressor which duplicate the ones in Static Tuning I and II, to provide a true "apples to apples" comparison between the two bunch compressors in terms of their lengths, costs, etc. If this comparison finds that the ultra-short compressor has unacceptable limitations in its tunability, modification of the optics and the deployment of instrumentation will be considered in the interest of attaining adequate tunability.
- Cornell will work in full collaboration with PAL and other institutions who are also interested in developing this design.
- Resources: 0.5 FTE in FY08, 0.4 FTE in FY09

Resources

- Faculty: G. Dugan, D. Rubin (summer salaries)
- 1 full-time post-doc
- 1 full-time grad student
- Computing support and travel funds
- Totals: approximately $350K per year in FY08 and FY08, which includes $100K indirect costs.

Conclusion

- At Cornell, we are ready to contribute modestly to the ILC RTML EDR effort.
- Our intention is to capitalize on our strengths, by a focus on physics analysis and simulations.
- We have substantial experience in accelerator design, and we provide an opportunity to train future students in the field.