Status of RTML Design and Tuning Studies

PT

SLAC

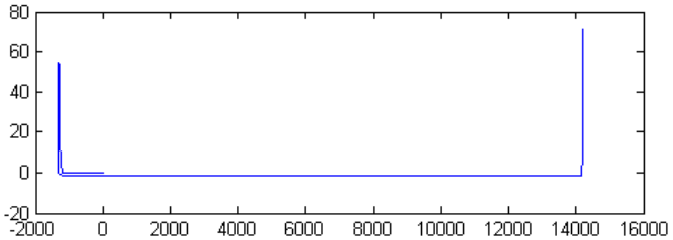
Activities

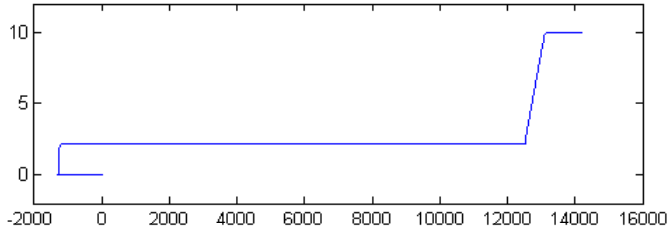
- Optics Design
- Return Line Issues
  - **Steering and Alignment**
  - **Stray Fields**
  - **Space Charge**
- Turnaround and Spin Rotator Tuning
- Bunch Compressor Tuning

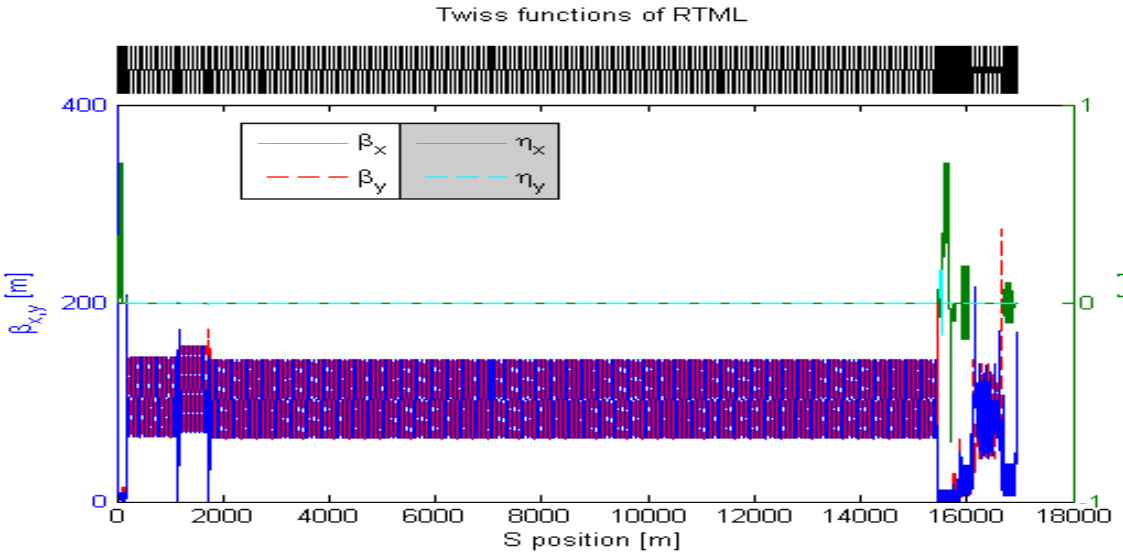
- Next steps

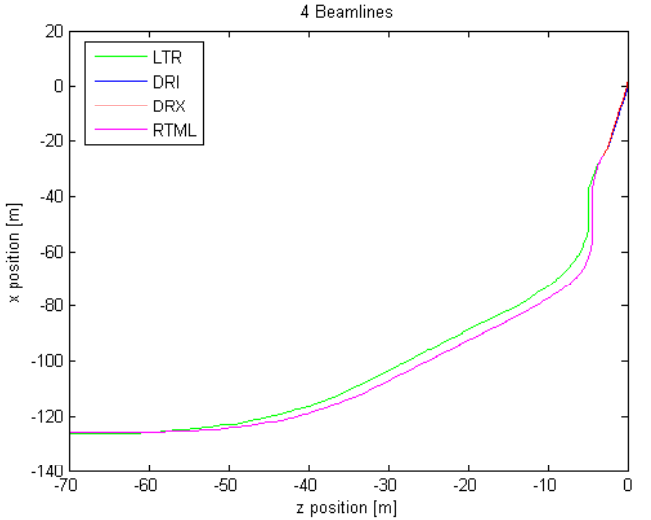
Optics Design

- First “complete” optics since central injector
- Includes
  - **Everything from DRX to ML**
  - **Different lengths for e+ and e- Return lines**
  - ***Approximately* correct lengths and elevation changes**
- Doesn’t yet include
  - **Extraction lines**
  - **Exact geometry match to site**
    - Meeting Sunday to discuss this
  - **Adequate lattice matching in some areas**
- Posted to RDR wiki



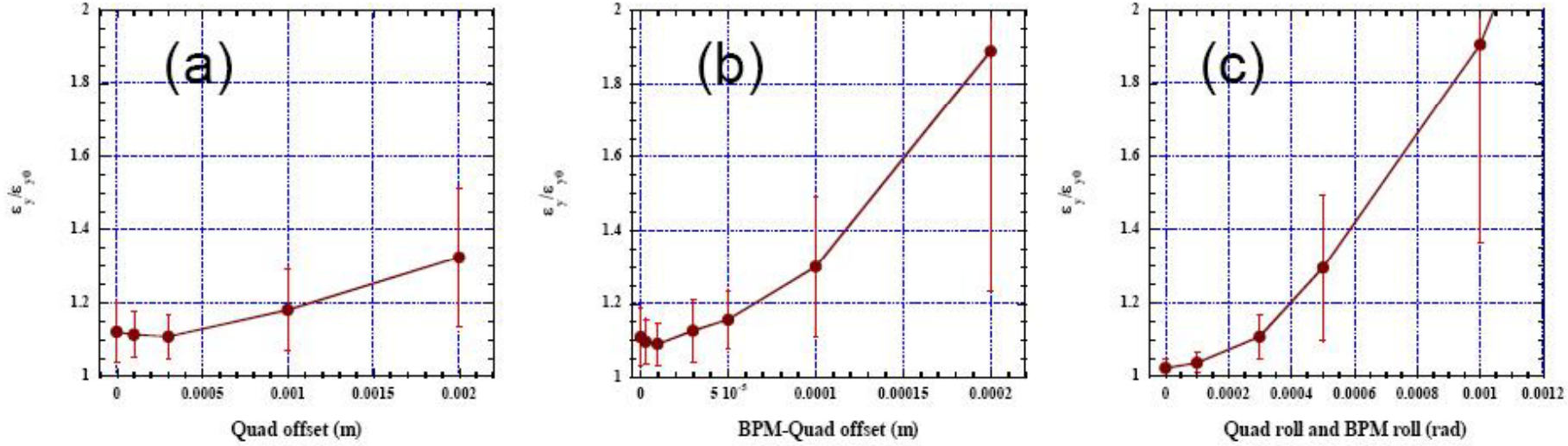






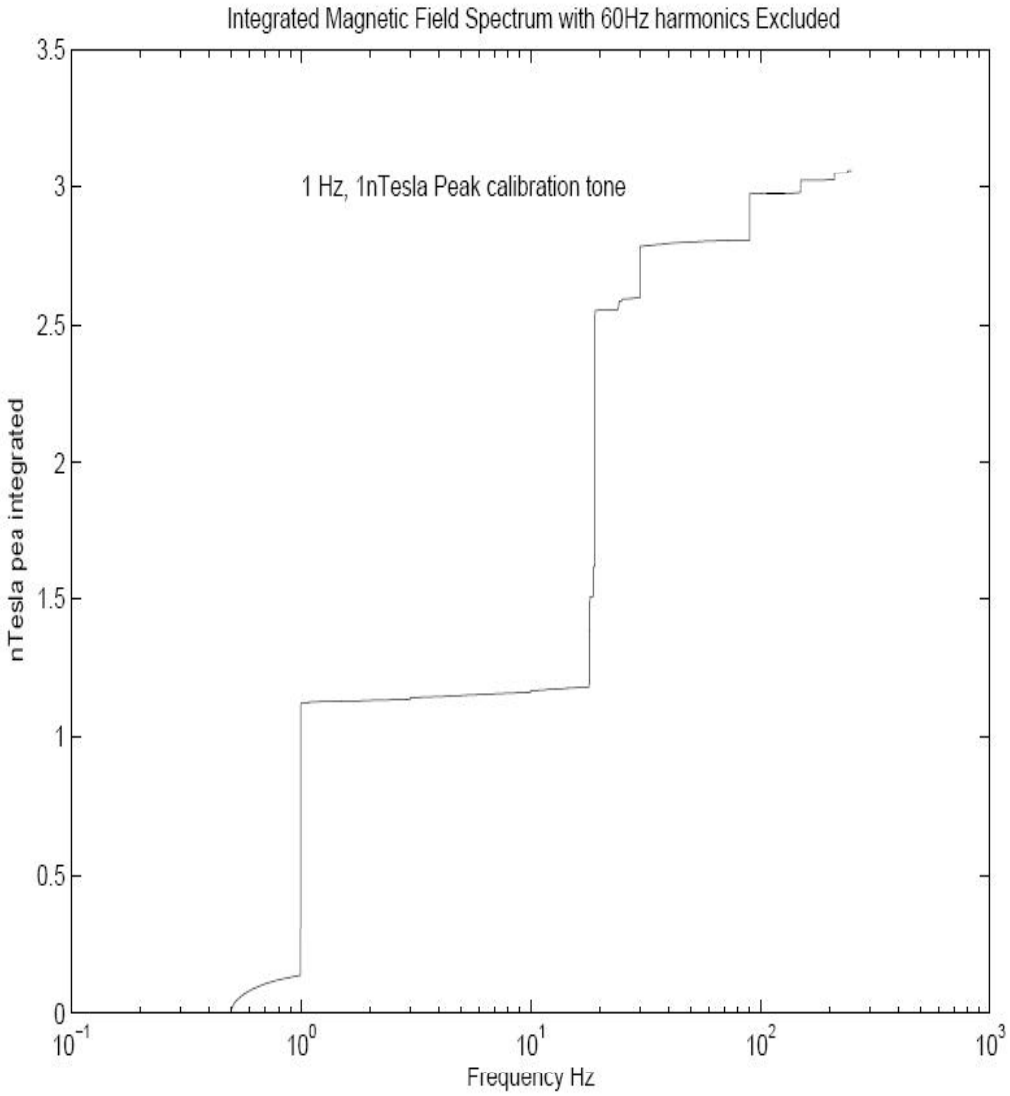
Return Line Steering and Alignment

- Usual issue of static misalignments → growth in emittance
- K. Kubo simulation – perform KM assuming
  - **RMS Quad offset == 300 μm**
  - **RMS BPM-to-Quad offset == 30 μm**
  - **RMS quad/BPM roll == 300 μrad**
- Resulted in 2 nm (10%) emittance growth
  - **Dominated by xy coupling from quad roll**
    - Expect xy coupling to be corrected by global decoupling, not simulated in this study



Return Line: AC Stray Fields

- Two effects
  - **Centroid motion (train to train jitter)**
    - Don't want to exceed capture range of feed-forward
  - **Emittance growth from offset in turnaround**
- K. Kubo did simulations and estimations
  - **Centroid: ~0.1 σ_y RMS motion for 1 nT RMS dipole field**
    - Can tolerate ~2 nT if feed-forward reduces jitter ~10x
  - **Emittance: 5% emittance growth for ~7.5 nT RMS dipole field**
- SLAC End Station B measurements: ~2 nT
  - **Excludes harmonics of 60 Hz US line frequency**
- OK if ILC is at comparable level



Return Line: Space Charge

- For ILC damped beam at 5 GeV, incoherent space charge tune spread ~ 0.01/km
- Adds up to ~0.15 over length of Return line and turnaround
- Is this a problem?
  - **Maybe not – single pass beamline, no resonances to worry about**
  - **Maybe so – emittance blowup, breakdown in global tuning techniques**
- S. Panagiotis (FNAL) and M. Venturini (LBL) looking into this issue
  - **Hope to solve it before the end of the fiscal year**

Turnaround and Spin Rotator Tuning

- Studies performed with 2006 optics
  - **Stronger focusing in turnaround**
- Steering studies
  - **Used KM + dispersion knobs**
  - **Included quad offsets, rolls + errors, BPM offsets, bend rolls + errors**
  - **Mean emittance growth reduced to 7.6 nm**
    - 6.1 nm from xy coupling, not tuned in this study
    - 1.5 nm from chromaticity of lattice matching areas
      - Improved in 2007 optics
    - Dispersion *eliminated*, subject to limited resolution and systematics of wire scanners

Turnaround + Spin Rotator Tuning (2)

- J. Smith looked at coupling correction
  - **Used similar parameters for errors and misalignments**
  - **Coupling could be completely corrected using skew quads near the emittance station, tuning to zero <xy> in 4-D emittance station**
  - **Skew quads far away not as effective**
    - Exciting skew quads changes the orbit thru the turnaround…
    - …which leads to vertical dispersion at the wires…
    - …where there's uncorrected horizontal dispersion…
    - …which leads to confusion when trying to tune <xy>
  - **Switching to 2-D emittance station also reduces effectiveness**
    - Correction algorithm may have been non-optimal
    - Need to revisit this issue

BC Tuning

- Used 2006 optics and beam conditions
  - **Shorter beam from DR**
    - 6 mm, now up to 9 mm
  - **Different BC configuration**
- K. Kubo and PT looked at the situation
  - **Got different results – Kubo-san's were worse than mine**
  - **Differences are now understood**
    - Kubo-san left out cavity fringe fields – reduces effect of cavity pitch by factor of 2, emittance effect by factor of 4
    - I left out sector bend vertical offsets – leads to ~3 nm additional emittance growth after steering
  - **Need to go back, do simulations, see if we get the same answer?**

Emittance Tuning: Summation

- Return line: might be OK
  - **2 nm emittance growth dominated by coupling**
  - **Coupling not corrected in that study**
  - **Space charge may cause problems!**
- Turnaround + spin rotator: might be OK
  - **Dispersion correction seems very effective**
  - **Need closer look at coupling correction**
  - **Need to include bend magnet offsets**
- Bunch compressor: Problem!
  - **Initial simulations show 7.5 nm emittance growth at 90% CL**
    - Tolerance is 4.0 nm for all RTML!
  - **Existing simulations not at satisfactory level of completeness**
  - **Most serious problem is cavity pitches**
  - **Possible that improvements in techniques are possible**
- Need to migrate studies to 2007 optics
  - **Many differences from 2006 optics**
    - Longer bunch in DR == more problems in BC
      - Changed BC configuration should mitigate this somewhat
    - Weaker focusing in turnaround == fewer problems there
    - Improved lattice matching in some areas (not all!)

Next Steps

- Optics Design
  - **Work on defining magnet types with Magnet TS**
    - In progress
  - **Define beamline geometries in DR inj/ext area**
    - In progress, meeting this week
  - **Improve lattice matching and match geometry of design to CFS geometry**
    - Work package for Cornell in FY08 (if funded!)
- Emittance Preservation
  - **Migrate to 2007 optics**
  - **Integrate dispersion and coupling correction**
  - **Improve performance in BC**

Questions / Comments?

“Watch out, you can’t ignore what’s going on
When your visions are drying out
Like the oceans from the underworld…”

-Alphaville