DRAFT: What have been done and what to do in ILC-LET beam dynamics

Beam dynamics/Simulations Group

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Upstream RTML (before BC)

- Kick minimization steering + Dispersion knobs + Coupling knobs will work for static misalignment of magnets and emittance growth is small.
  - Set of errors are given.
- Dynamic effects are still concerned
  - Stray field in the long return line.
  - Study orbit feed-forward and feedback, integrated up to IP
- Need SB2009 lattice design of central area (from DR)
- Reference: e.g., reviewed by P.Tenenbaum, parallel session of LCWS2007, DESY. J.Smith LET Workshop 2007 SLAC.

Downstream RTML (BC)

- For static misalignment
  - DFS is not good enough.
  - Dispersion bumps and cryomodule tilt adjustment will be necessary. (Ref., e.g., reports by A.Latina)
  - Need diagnostics section after BC for such corrections.
- Effect of coupler kicks
  - Need careful design of cavity+couplers
  - Can be cancelled by cryomodule tilt adjustment or crab cavity
- For dynamic errors
  - Tolerance of RF stability is in RDR. Need to check.

ML

- Work done by many people
- No problem for static errors (except long range alignment), using DFS or other methods (e.g. KM)
- Need reliable long range alignment model
- Tolerances have been given for fast movement of
  - magnet position, cavity tilt
  - magnet strength
  - RF phase and amplitude (?)
- Simulations should be repeated for
  - ML from 5 GeV (SB2009) instead of 15 GeV
  - Lower energy operation
  - Lattice may be modified in low energy part?

BDS

- No showstopper found for RDR lattice.
  - Some concerns in conversion speed
  - Need better understanding of functionality of tuning mechanism
- Try to improve/optimize tuning method.
- Need to study for SB2009
  - Need studies for traveling focus
- Test and verify in ATF2
- List of assumed errors was given by G.White.
- Need to check if the assumptions are reasonable from engineering point of view.
  - Magnet strength accuracy tolerance is tight.
- It is desirable to verify the results using other codes.
- Need more two beam simulations.

Others

- Study feed-forward and feedback
- Study crab cavity for correcting z-y correlation in a bunch
- Simulations with failed hardware
- Use 90% CL, instead of average for tolerances.

List of Standard errors

"Standard" Local Alignment Error in RTML and ML
(RMS, if not specified otherwise.)

Error	Cold Sections	RTML Warm	BDS Warm
Quad Offset	300 μm	150 μm	200 μm
Quad roll	300 μrad#	300 μrad	300 μrad
RF Cavity Offset	300 μm	---	---
RF Cavity tilt	300 μrad	---	---
BPM Offset (initial)	300 μm	100 μm w.r.t. magnet	100 μm w.r.t. magnet
Cryomoduloe Offset	200 μm	---	---
Cryomodule Pitch	20 μrad	---	---
Bend offset	---	300 μm	200 μm
Bend Roll	---	300 μrad	300 μrad

#Cold Quad roll 300 urad is tight
Misalignment with respect to …

Slide from LCWS 2008 Chicago

Mechanical fast movement (vibration)

	Cold Sections	RTML Warm	BDS Warm
Quad, Sext.	100 nm	10 nm	10 nm
Cavity tilt	3 urad	---	---

Tolerance may be determined by orbit change at IP.
Also should be looked:
RTML: emittance dilution in the turn-around (note that it is before the feed-forward)
ML: Orbit change at linac end. Quad 40 nm → 0.5-sigma orbit. Cavity tilt 1.8 urad → 0.5-sigma orbit.
Need post ML intra-pulse feedback? → Need to check.

“Standard” Magnet Strength Stability Requirement

Magnet to magnet independent, random

	Cold Sections	RTML Warm	BDS Warm
Quad	1E-4	1E-5	1E-5
Bend Strength	---	1E-5	1E-5
Corrector	1E-4	1E-3	1E-3
Sext.	---	---	1E-5
Oct.	---	---	1E-5

Tolerance may be determined by orbit change.
Also should be looked:
RTML: emittance dilution in the turn-around (note that it is before the feed-forward)
ML: Orbit change at linac end 1E-4 → 1 sigma.

“Standard” RF dynamic errors

from RDR

	Amplitude	Phase
BC Correlated	0.5%	0.24 deg.
Uncorrelated	1.6%	0.48 deg.
ML Correlated	0.07%	0.35 deg
Uncorrelated	1.05%*	5.6 deg
Crab e+e- Relative		0.015 deg

Correlated :same for all klystrons

Uncorrelated : klystron to klystron independent, random

What determines the tolerance?

BC: Timing at IP

ML: Energy jitter at the end.

Vertical orbit change: If fixed cavity tilt is 300 urad,

Crab: Horizontal offset at IP

Effect with 300 urad cavity tilt

BC: ?

ML: *1.2% amplitude change will cause 1-sigma orbit change.

Flat top stability requirement of each cavity may be very tight

- Transverse effect, with cavity tilt
  - 300 um tilt 1.2% amplitude change (each cavity) will cause 1-sigma orbit change at the end of ML
- Should be checked

“Standard” Magnet Strength fixed Error

	Cold Sections	RTML Warm	BDS
Quad	0.25%	0.25%	1 E-4
Bend Strength	---	0.25%	1E-4
Corrector	?	?	?
Sext.	---	---	1E-4
Oct.	---	---	1E-4

It is not clear what determines these tolerances.
1E-4 in BDS too tight?

“Standard” error of beam monitors

	Cold Sections	RTML Warm	BDS
BPM Resolution	1 μm	1 μm	0.1 μm
BPM Dynamic range	3 mm ?	3 mm ?	3 mm ?
BPM Scale error	10%	10%	10%
Beam size monitor resolution	1 μm		
Pair monitor (single pulse)	---		1%

Slim list of tasks

- ***Make a table of present assumptions and results: in April***
- ***Documentation of past works: by ILC-CLIC WS, Oct.***
- RTLM
  - **Stray field measurement**
  - Design SB2009 lattice of central area (from DR to return line)
  - Check tolerance of RF stability in RDR
- ML
  - Long range alignment model
  - Repeat simulations for SB2009 (initial energy 5 GeV)
  - Study for lower energy operation
- BDS
  - Try to improve/optimize tuning method.
  - ***Traveling focus (collision)***
  - Study for SB2009 (with traveling focus)
  - **Test and verify in ATF2**
  - Check assumptions in simulations.
    - Magnet strength fixed accuracy tolerance is tight.
  - Verify the results using other codes.
  - More two beam simulations.
- Inter-area
  - ***Study of orbit feed-forward and feedback***
  - **BC+ML simulation**
  - Study crab cavity for correcting z-y correlation in a bunch
  - Simulations with failed hardware

Make a table of present assumptions and results: in April

- Latina: RTML
- Kubo: ML
- Kubo + White : BDS