MDI Issues

T. Tauchi, KEK

Huge Detector Concept Study Meeting, TV, KEK
FFIR Working Group of ACFA-LC
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What is MDI?

MDI is Machine Detector Interface.

Machine: Beam Delivery System (BDS) from LINAC-end to beam dump
- collimation, energy/polarization, final focus,
- extraction (energy/polarization) and beam dump

Detector: Interaction Region
- experiment (physics; Higgs, Top, W/Z, SUSY, extra-D ...)
- luminosity, background and minimum veto-angle
Crossing angle
2 IP’s for 2 “identical experiments”
Precise energy and polarization measurements
Backgrounds (muons and synchrotron radiations)
**L* : Distance of QC1 from IP**

Minimum veto-angle (very forward calorimeter)

Backgrounds (pairs, mini-jets, backscattered γ and n)

Instrumentations (pair monitor, feedback, Shintake monitor ...)

Y. Sugimoto, LCWS2000
BDS: Extraction Line

Crossing angle
Choice of final quadrupoles (L* )
Precise energy and polarization measurements
Backgrounds (disrupted beam, back-scattered n and γ. )
L,E,P Measurement Goals

Luminosity, Luminosity Spectrum

- Total cross sections: absolute $\delta L/L$ to $\sim 0.1\%$
- Z-pole calibration scan for Giga-Z: relative $\delta L/L$ to $\sim 0.02\%$
- threshold scans (ex. top mass): relative $\delta L/L$ to 1%
  +L(E) spectrum: core width to $<0.1\%$ and tail population to $<1\%$

Energy

- Top mass: 200 ppm (35 MeV)
- Higgs mass: 200 ppm (25 MeV for 120 GeV Higgs)
- W mass: 50 ppm (4 MeV) ??
- ‘Giga’-Z $A_{LR}$: 200 ppm (20 MeV) (comparable to $\sim 0.25\%$ polarimetry)
  50 ppm (5 MeV) (for sub-0.1% polarimetry with e$^+$ pol) ??

Polarization

- Standard Model asymmetries: $< 0.5\%$
- ‘Giga’-Z $A_{LR}$: $< 0.25\%$ ($< 0.1\%$ with e$^+$ pol)
Present and Future Effort in ACFA-FFIR group

Comments and suggestions are very welcome. (toshiaki.tauchi@kek.jp)

Interaction Region

- Optimization of IR-layout ( L*, innermost layer of VTX, crossing angle, extraction line, FEATHER, pair monitor [Tohoku univ., minutes] and background)
  - Physics and detector
  - Accelerator
- First optimization was completed in 2000; B=2 and 3 Tesla, L*=2m, 4.3m.
- Recent background estimation; talk(pdf, 2.9MB) presented at LCWS04, 19 April,2004, and talk(pdf, 90KB) presented at the 6th ACFA-LC video conference, December 12, 2003, by T. Aso (Toyama National College of Maritime Technology).

Support Tube R&D

- short history
  - 2000, ANSYS calculations of the support tube in the JLC detector, fabrication of support tube prototype was started.
  - 2001, sensor,software improvement and measurements of vibration properties.
  - 2002, fabrication of the 1/10 model (cantilever with 4 segmentions, flat and taper flanges)
  - 2003, plan (test of the 1/10 model, optimization of the CFRP central tube thickness, etc.)
- 2004, plan
  - measurement of oscillating amplitude with different phases at both ends,
  - manufacturing of 1/10 model with realistic structures
    - photo:1/10 model (80mm outer diameter, 10mm thick, Al tube), Taper Flange
  - stiffness test of the model and study of a vibration isolation system.
  - active feedback system at sub-nanometer level.
Optimization of thickness of central connection tube, which shall be thinnest keeping stability of oscillation properties of the tube.

Recent progress report can be found here: tube with taper flanges, flat flanges, and loads.

Frequency response analysis

**Collimation System**

- calculation of synchrotron radiations by SAD (new implementation in SAD): 1, 2
- JLC scheme with muon attenuators (presented at APPI03 by Ohgaki): 1
- estimation of muon background by MUCARLO in cooperation with Namito-san, short muon attenuator?
- understanding of TFO (Tail Folding Octupoles) role quantitatively and optimization of the collimation system
  - First estimation
- collimator design
  - collimation depth -- innermost layer of a vertex detector
  - calculation of wake field at the spoilers and absorbers; Yokoya's calculations and a short review,
- beam halo
  - gas scattering; brief review, NLC, 1, 2, 3 and Yamamura's master thesis, Tokyo univ., 2004.3 Japanese, pdf,8,4MB
  - dark current; 1, 2, 3, 4, 5, 6, 7
  - longitudinal tail, to be collimated at pre-LINAC collimation.
- Possibility of shorter collimation: 1

**BDS Simulation**

- estimation of beam halo and dark current at LINAC; beam gas scattering, wake field etc; project, 1
- estimation of backgrounds at detectors; results of 1, 2.
  - synchrotron radiations from final doublet and others
  - muons (collimators)
  - neutrons (dump line): 1, 2, 3
  - pairs (IP), primary in VD and secondary in CDC
- energy loss along the beam line -- radiation loss

**Final Focus System**

- New Final Focus with large L*
New optics interest: 1, 2, 3, 4, 5
Optimization of L*: L* = 3.5m (roadmap) or 4, 5m? (3.5/4.3m, 4.3m, chromaticity; 1, 2, 3: ATF2) from physics/detector
Assessment of effects due to errors in strength (Q, SEXT), positions (Q, SEXT) and rotations/longitudinal position (Q, SEXT) of each magnet at the FF system
Beam stabilization; study on feedback method with orbit corrections
Estimation of momentum acceptance in terms of luminosity and background

- **Q/A of errors and L* at the old design (by Oide)**

- **Crab Crossing**
  
  7mrad or 20 mrad? | discussion
  Review of NLC crab cavity by H. Hayano, 23 April, 2003
  Crab cavity at KEKB by K. Akai

- **Superconducting final doublet (large aperture with 7 mrad crossing)**
  
  design: 1, 2, 3, 4, 5, 6, 7, 8
  - L* = 4.3m
  Estimation of background at the dump line, specially synchrotron radiations generated by extracted beam in the final Q, by the BDS simulation

- **Permanent final doublet**
  
  R&D issues
  method of varying the strength (for Ebeam=45GeV – 250GeV) -- rotation of segmentations?
tolerances of various errors for the design: strength
recent progress report can be found here (pdf), which was presented at the ISG11, December 16-19, 2003, by T. Mihara (Kyoto university).

- **Conventional final doublet**
  
  Design for the optics of L* = 3.5m or 4.3m
Extraction Line and beam dump

- Design of extraction line: 1, 2, 3, 4, 5, 6, 7, 8, SQ: 9, 10, 11, 12, 13
- Dump design: water dump (1, 2), beamstrahlung photons
- Optimization of optics (the second IP through the beam dump); two dumps and single dump
- Design of magnets considering neutron background
- Estimation of neutron background from a single or two dumps for beamstrahlung photons and electron(positron) beam

SLEPT Project

- Interface to SAD and CAIN for a unified program routine: SLEPT
- Effect of missing quad-movers and BPMs
- Various BNS damping and low β optics
- Assessment of Ground motion effect on main linac and BDS; studies of 1, 2, 3.
- References
  Requirements for movers at LINAC

Ground Motion

( JLC site study group: home page (access control) )

- Poster presented at the ITRP meeting (KEK); gif, 951KB
- Preliminary results of KEK GM measurements, talk (pdf, 52.9MB) presented at the ISG10, June 17-20 2003, by T.Tauchi.
- Measurements; KEK, Konoike-Tsukuba, F-net etc.
  Preliminary Results (PDF, 2.3MB) presented at the ISG video meeting, 8 May, 2003, by T.Tauchi, K.Fujii, T.Matsuda, H.Yamaoka and N.Uchida.
- Measurements at TRISTAN ring, KEK
- GM models
  Brief review of GM model and talk(PDF, 2.5MB)
Fast feedback system: **FEATHER**

- Simulation by using CAIN -- evaluation of feedback performance
- Performance with beam blow up for 7 mrad crossing and L* = 3.5m
- Design of the fast feedback system (simple, delayed, improved models, etc.)
- Construction of prototype system (Kicker, BPM etc.) at the ATF extraction line for beam test
- Link to FONT

**Nanometer BPM ; collaboration with SLAC, LLNL and UK groups**

- Demonstration of nanometer beam position resolution by cavity-type BPM
- Future Plan, December, 2003

**Laserwire ; collaboration with UK, DESY and SLAC groups**

- Laser Based Beam Diagnostics at the ATF
- Beam profile measurement
- Beam energy distribution measurement at the 2nd IP of the GLC extraction line.

**Polarimetry**

- Upstream Compton polarimetry; before collisions at sources, DR, LINAC etc.
- Downstream Compton polarimetry after collisions at the dump/extraction line.
  - Development of polarized positron beams for JLC, T. Hirose (Tokyo Metropolitan), presented at LCWS95
- Physics events; WW scattering
- Depolarization during collisions
  - ref 1) Depolarization due to beam-beam interaction in electron-positron Linear Colliders, Kaoru Yokoya, Pisin Chen. **SLAC-PUB-4692**, Sep 1988

http://acfahep.kek.jp/subg/ir/minutes/future.effort.html
Luminosity

- Luminosity measurement as a function of the center-of-mass energy
  Energy spread before collisions and beamstrahlung effects as well as initial state radiation
  Bhabha scattering; acollinear angle
- Luminosity monitor (forward calorimeter) and active mask: first study results
- Beamstrahlung monitor: studies of 1, 2, 3
Plan of MDI mini-workshop

- We would like to discuss on future direction of MDI R&D after the “COLD” decision.
- Under discussion, January 2005, place?
- First (world-wide), we meet at the 1st ILC workshop, 13-15 November 2004, KEK
- Asian discussion at the 7th ACFA-LC workshop, 9-12, November, Taipei.

Crossing angle, L*, minimum veto angle
Luminosity, Energy, Polarization measurements
Background evaluation
and
Design of IR & Beam Delivery System
From Mike Woods, 15 September 2004;  Dear MDI advocates,
To further concrete the October phone meeting, let me suggest
1. prior to phone meeting,
   - merge and organize MDI task lists from 3 regions into one common list
   - identify current efforts and people for tasks where known
   - exchange ideas on MDI workshop format and agenda; have a strawman proposal
   - are we agreeing to not have an MDI detector sub-system review at Taiwan ACFA meeting?
     We should clarify and communicate this with Bob Hsiung
2. we have a 2-hour phone conference with following start times:
   SLAC time (10 pm Wed. Oct. 6)
   UK time (6am Thurs. Oct. 7)
   Europe time (7am Thurs. Oct. 7)
   KEK time (2pm Thurs. Oct. 7)
   (is this too soon given proposed agenda below and prior work to be done above? Other conflicts?)
3. Meeting agenda:
   - review/comments on task list
   - review/comments on resources (people, facilities, budget) to carry out tasks
   - prioritization and timeline for R&D (with emphasis on what's needed for CDR)
     (above 3 items will be useful input for ILC meeting at KEK in November)
   - MDI workshop format and agenda
   - discuss/agree on
     i) communication to ICFA/ILCSC regarding MDI workshop
     ii) date and/or location for MDI workshop
        (possibilities include standalone January meeting, connection to LCWS at
         SLAC in March)
     iii) next phone conference