NLC - The Next Linear Collider Project

DIMAD Simulation of an Extraction Line Energy Spectrometer Progress Report

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• Energy spectrometer in extraction line, before dump.
• Horizontal bends create synchrotron radiation stripes.
• Vertical spectrometer magnet separates stripes.
• Measure separation of stripes on wire arrays.
• Measurements at 120 Hz beam rate.
SLC/SLD Energy Spectrometer
SR Stripes Define Beam Directions

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SR from Stripe Magnet: \( k_c \approx 3\text{MeV} \)
Vertical focus in detector plane
Spectrometer Magnet SR: \( k_c \approx 1\text{MeV} \)
NLC Extraction Line Chicane
(Location for Instrumentation)

- Four vertical bends form a 2 cm chicane
- Secondary focus; out of neutral beam core

Nominal Trajectory

Distance after IP (m)
NLC Extraction Line Chicane
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Nominal Trajectory

Trajectory $\delta = -90\%$

$\pm 1$ mrad photon aperture

Distance after IP (m)
NLC Extraction Line Chicane
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\[ \delta = -90\% \]

Nominal Trajectory

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<th>± 1 mrad photon aperture</th>
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- Use half of 2\textsuperscript{nd} chicane bend as spectrometer magnet
- Add horizontal bends to generate SR stripes
Outline of DIMAD Simulation Progress
Followed by Details

- Verify that we can reproduce IPBI distributions
- Reproduce Yuri Nosochkov’s simulation of a wire scanner energy measurement at secondary focus
- Add horizontal stripe magnets, and look at effect on
  - Distributions at the dump
  - Distributions at the secondary focus
  - Particles lost in extraction line (number, energy, location)
- Estimate vertical size of SR stripe at detector

**Note:** The results shown here were calculated
- For 1 TeV $E_{cm}$,
- Using a 50,000 ray Guinea Pig file
- With the 36 mm aperture extraction line lattice
Repeat Wire Scanner Simulation
Energy Measured at SF / Energy at IP

- Ratio of energy “measured” at secondary focus (SF) to energy at IP
- “Measured” means calculated from the dispersion and the vertical position at the SF
- Yuri Nosochkov
  LCC-0045
- Our calculation
Repeat Wire Scanner Simulation
Energy from $\eta_y$ and $\eta_y$ at SF vs. Energy at IP

- Energy at IP - Blue
- Energy at SF, calculated from $\eta$ and $\eta_y$ at SF - Green

Yuri Us
• Addition of the two stripe magnets caused no major changes in beam distributions.
  No obvious change in beam size at the dump!
Beam at 2\textsuperscript{nd} Focus with Stripe Magnets

- Y vs X
- X' vs X
- Some change in X distribution also seen elsewhere.

Nominal Beamline: Blue
Magnets Added: Red

ALCPG, Cornell, 15 July 2003
C. Mills, S.S. Hertzbach, UMass
Lost Particles with Stripe Magnets
Location of Particle Loss

Addition of stripe magnets did not change particle loss significantly
Lost Particles with Stripe Magnets

Energies of Lost Particles

Addition of stripe magnets did not change lost energy significantly.
Simulation Issues

- Some details in the simulation of the wire scanner energy measurement differ from Yuri’s results
  - to be discussed with him next month.
- Remaining simulations did not have “batman” energy distribution due to a problem with file.
- We saw an energy loss of 8.0 kW vs. 2.3 kW for Yuri; need to understand this
- These simulations were with the 36 mm aperture extraction line used for Yuri’s wire scanner simulation; will run the 10 mm aperture version.
Chicane Beam Optics Issues

- Chicane bends are $\sim 1$ mrad (0.5 + 0.5)
- SR must focus at the SR detector; the secondary focus (SF) is in the center of the 10 m chicane
- Using a chicane bend for the spectrometer, the stripe separation is $1 \text{ mrad} \times 5 \text{ m} = 5 \text{ mm}$, too small!
- SR from bend of 1 mrad/m
  - $k_c = \sim 280 \text{ MeV}$ for 500 GeV beams
  - $k_c = \sim 35 \text{ MeV}$ for 250 GeV beams
- Can one measure the stripe separation, with high SR energies, short stripes, close together?
Summary

• Horizontal stripe magnets can be added without significantly changing the beam at SF or dump
• We want to understand the small differences between our simulation results and Yuri’s
• Will run simulation for 500 GeV Ecm and small aperture extraction line
• Could move to a simulation that includes the SR, But ... energetic SR and small distances =>
• We will need to explore changes in XL design to determine if this concept is feasible
Addendum
Added after the Workshop

- **Mike Woods** suggested that the SR detector does not have to be at a focus, as long as one could find the centroid.
  - As Ray Frey pointed out, there are lots of photons for finding the centroid of the SR distribution.
  - This is true; the size of detector segments can increase.
  - We will look at this in future simulations.

- **Dispersion throughout the chicane may be a problem.**
  - This was not an issue at SLC, I believe by design.
  - Caleb is running simulations to study the effect of the presence of spatial and angular dispersion at both stripe magnets.
Large Aperture XL has Better Energy Resolution

- $\gamma = \eta \delta / (1 + \delta)$
- Large aperture optics follows the equation better than the alternate small aperture optics.

**LARGE Aperture**

**SMALL Aperture**
SR Stripe Detector must be at 2\textsuperscript{nd} Focus

- When the SR detector is at the secondary focus, the width of the distribution of stripe positions is due to just the energy spread.
- Stripe at secondary focus  \quad \text{Stripe 50 m away}