



Beam Instrumentation Activities in US

ECFA/DESY Linear Collider Workshop

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NIKHEF, Amsterdam

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with M. Woods and D. Cinabro

- “Status Report” document
- High priority items
- dL/dE studies

<http://www.slac.stanford.edu/~torrence/ipbi/>



Polarization Proposal



Polarization Needs

- Target $\delta P/P = 0.25\%$ per beam
SM, SUSY, other asymmetries
- Recognize desire for $\delta P_{eff}/P_{eff} = 0.1\%$
 $\Rightarrow$ Positron Polarization

Strawman Polarization Proposal

- Compton polarimeter at post-IP chicane
- 2% pulse stealing for undisrupted beams
- WW (t-channel) asymmetry
 $\Rightarrow$ Forward tracking...



Energy Proposal



Energy Needs

- Need 200 ppm from $2m_t < \sqrt{s} < 1TeV$

$$\Delta m_t, \Delta m_H \sim 50 \text{ MeV}$$

- Recognize desire for 50 ppm at $2m_W \dots$

$\Rightarrow$ Are we missing something?

Strawman Energy Proposal

- BPM-style at upstream 1mRad bend

RF BPMs

- WISRD-style at post-IP chicane

Energy width?

- Forward tracking 200-500 mRad ($\mu\mu\gamma$)

$\Rightarrow$ Also, machine diagnostics for width ...



Luminosity Proposal*



*More Speculative

Luminosity Needs

- Target dL/dE precision at 1% (tails)
0.1% (core width), 200ppm on mean $\sqrt{s'}$
- Target relative L precision at 0.01%

Threshold Scans, Z calibration

- Target absolute $\Delta L/L \sim (0.3 - 0.5)\%$

Hadronic cross-section

Contact interactions

⇒ Need Input from Physics Groups

Strawman Luminosity Proposal

- Forward Bhabha calorimeter
- Forward tracking 200-500 mRad
- Pair monitor
- Beamstrahlung diagnostic monitor
- Radiative Bhabha monitor downstream

⇒ Also, other machine diagnostics
for instantaneous luminosity



Highest Priority



dL/dE analysis

- Analysis to extract both tail and core
- Understand external inputs
(beam energies, widths, offsets, etc...)
- Understand beamstrahlung correlations
(dispersion, head-tail, disruption angle)
- Possible to extract physics correlations
(Beam energy, polarization, total lumi)

Extraction line studies

- Polarimeter/Spectrometer possible?
- Backgrounds?
- Detailed design...

Forward tracking

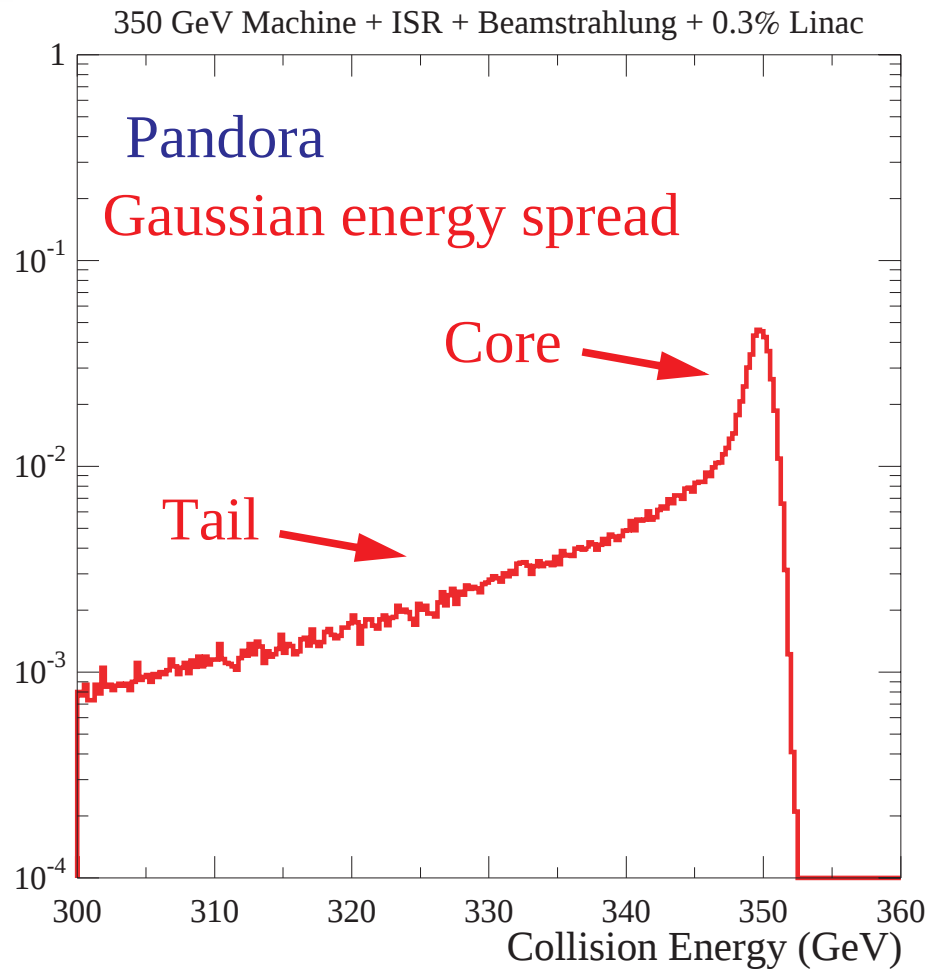
- Need **realistic** conceptual design
- Understand systematic limits (**alignment**)
- Understand machine/physics **backgrounds**

Energy width

- How well can this be measured in real time
- Understand expected beam instrumentation
- Extraction line WISRD spectrometer?

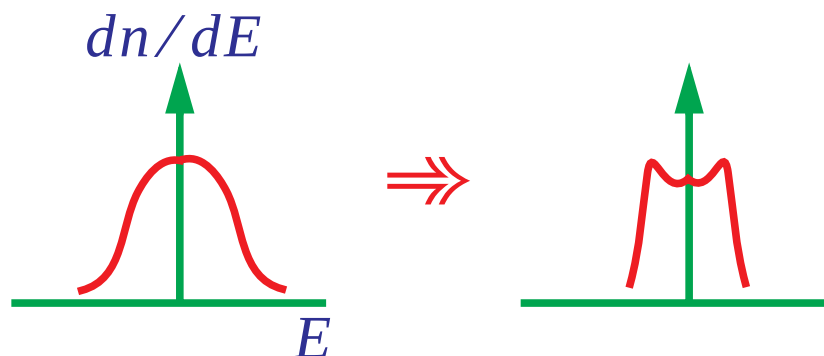


Bhabha acolinearity



Highly dynamic distribution...

Linac energy spread





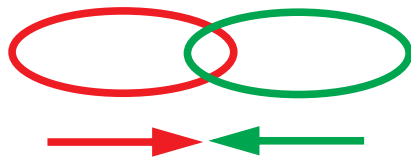
Acolinearity Problems



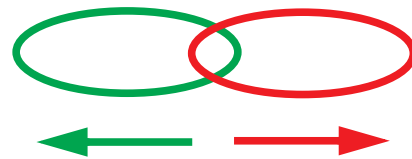
⇒ Acolinearity measures **boost**, not $\sqrt{s'}$

Beamstrahlung Correlations

- Disruption effects
- Early-late correlations



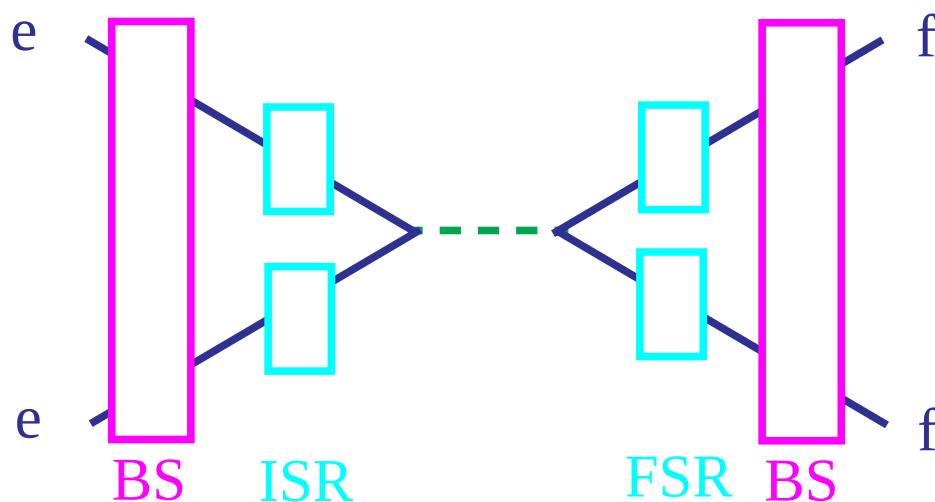
Higher L, less tail



Lower L, more tail

Probably can't trust simulation alone...

Final State Beamstrahlung Interactions



Particularly important for LA Bhabhas?



Energy Spread Studies

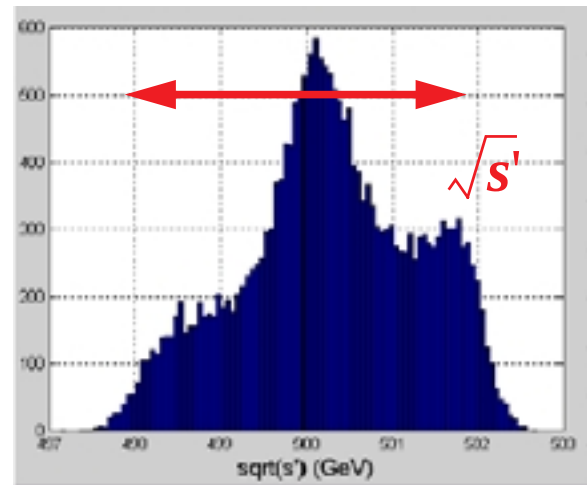
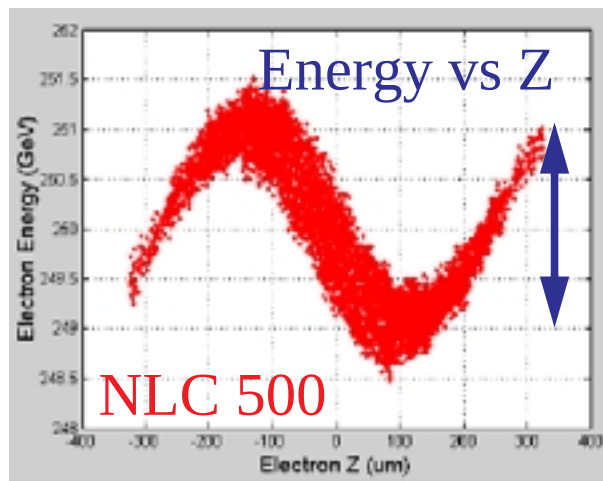


Use TRC simulated 'imperfect' machine

Feed to GuineaPig for IP simulation

No Beamstrahlung for now!!!

(M. Woods using A. Seyri)



$\pm 0.4\%$ range indicated!

Mean collision energy offsets

NLC File	1	2	3	4	5	6
$L (10^{34} \text{ cm}^{-2} \text{ s}^{-1})$	2.0	2.0	1.8	2.0	1.7	1.7
$\Delta \langle \sqrt{s'} \rangle \text{ (ppm)}$	+547	+365	+512	+244	+647	+707

+450 ppm lumi-weighted mean offset

~180 ppm variance...

(Energy correlation + head-tail lumi correlation)

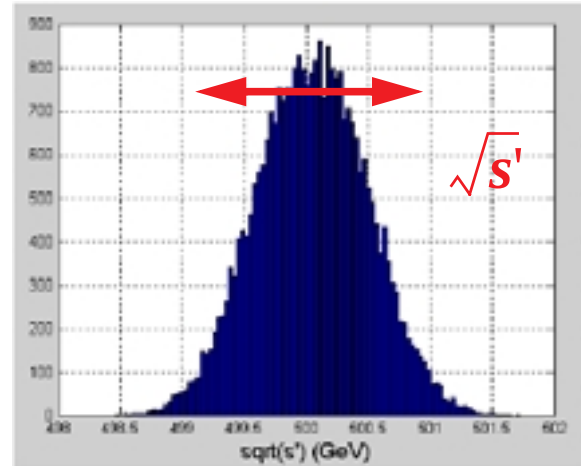
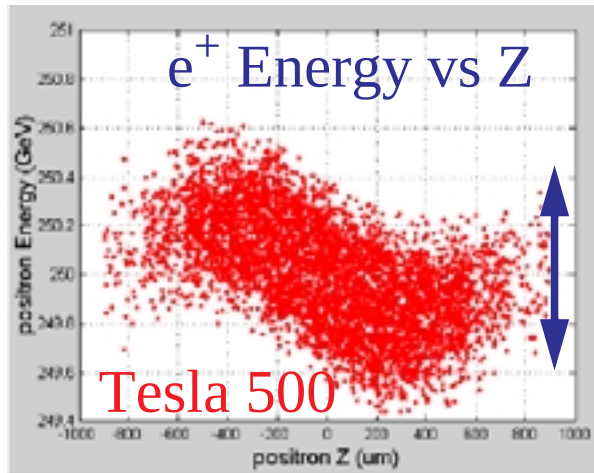


Tesla Results



Use TRC simulated 'imperfect' Tesla machine

No Beamstrahlung for now!!!



$\pm 0.15\%$ range indicated

Mean collision energy offsets

Tesla File	1	2	3	4	5	6
$L (10^{34} \text{ cm}^{-2} \text{ s}^{-1})$	3.3	3.2	3.3	3.6	3.2	3.3
$\langle \Delta E_{\text{cm}} \rangle$ (ppm)	+95	+71	+8	+35	+72	+36

+50 ppm lumi-weighted mean offset

~30 ppm variance...

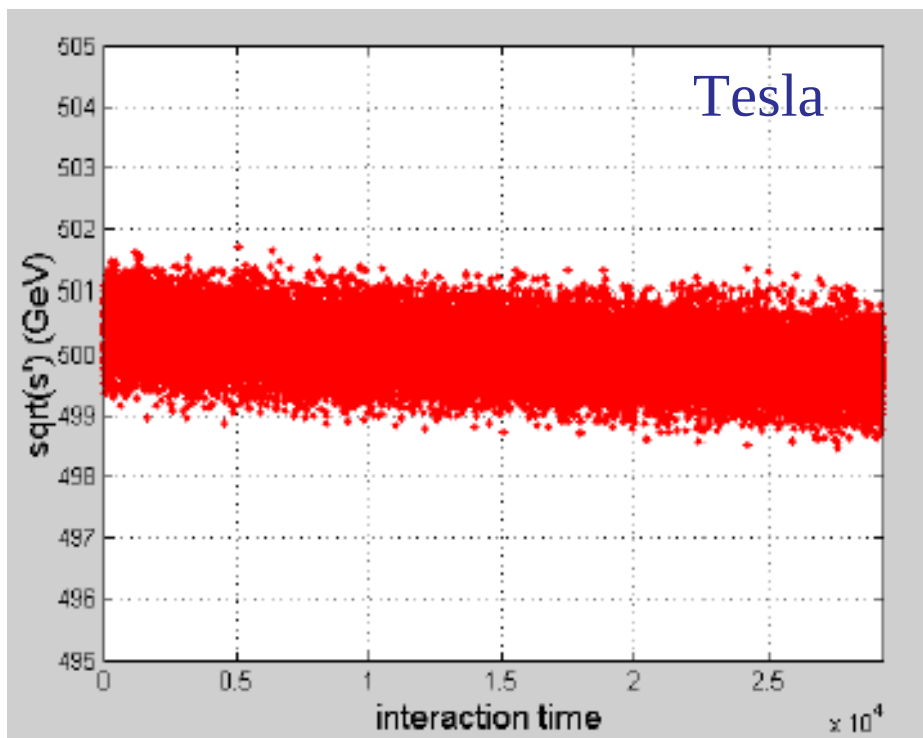
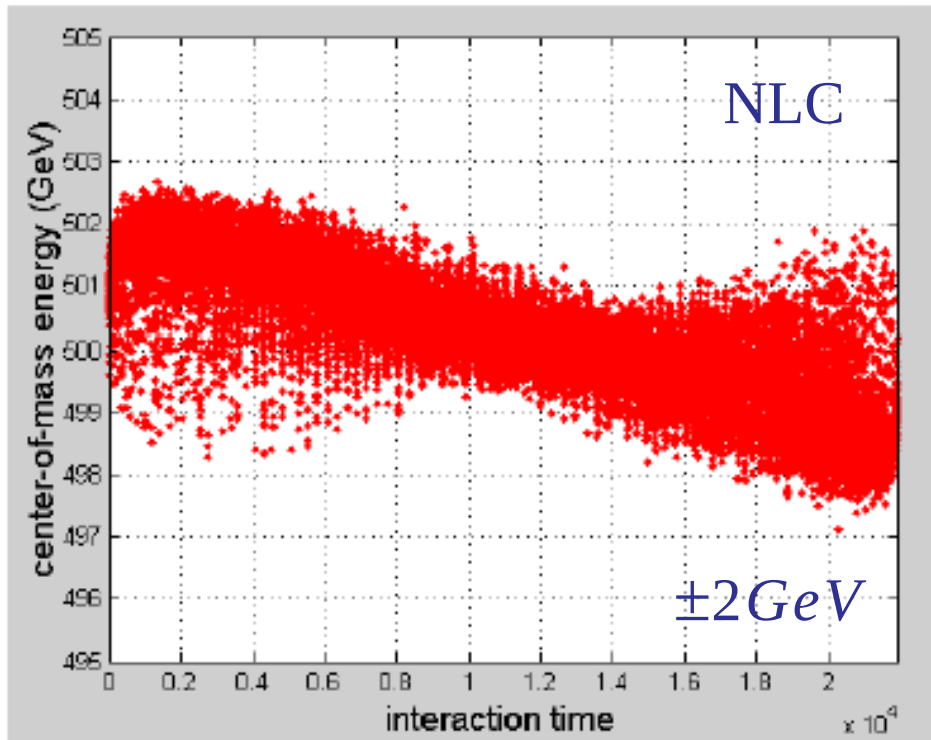
Beamstrahlung will only make this worse...



Energy Correlations



ECM



GP Interaction Time



Other Concerns

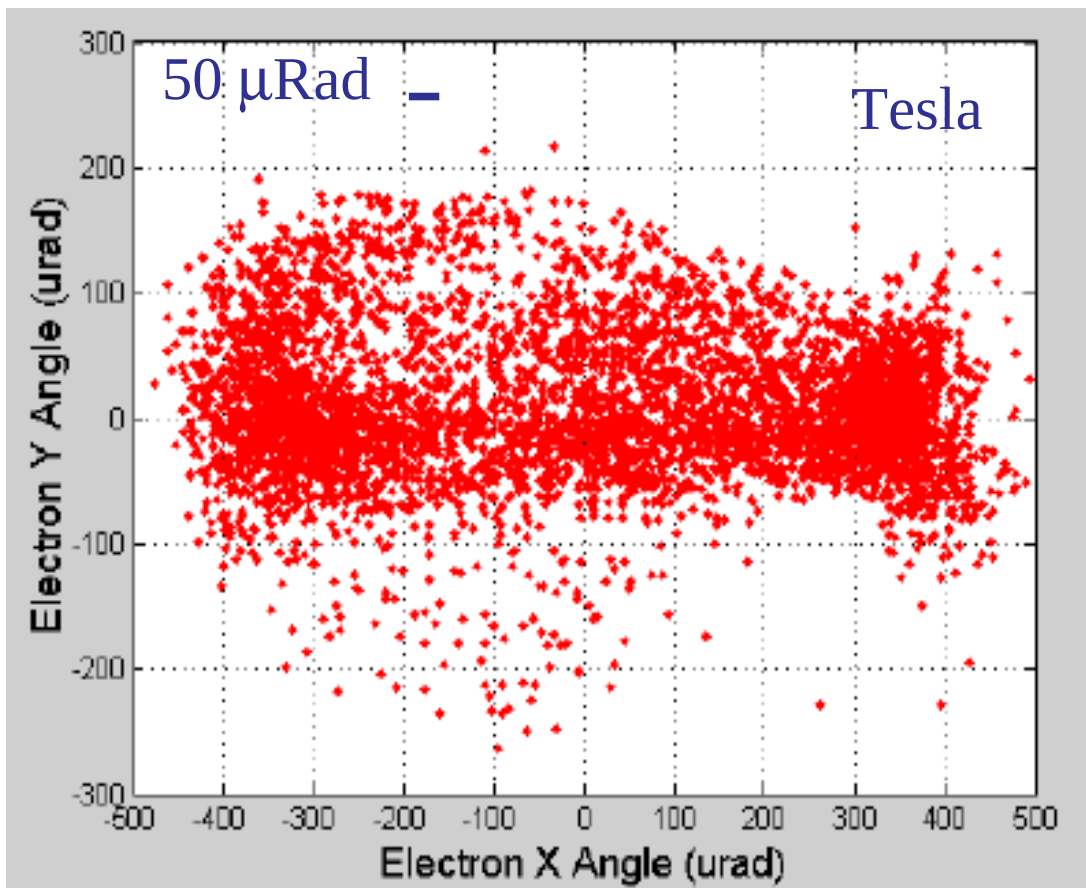


Energy Correlations

- not measured by **acolinearity**
- need beam energy profile as **input**
- correlates with **dL/dE**, **polarization**

⇒ NLC profile may be 'fixable'...

Disruption Angles



Large compared to accuracy $\Delta\theta \sim 50 \mu\text{Rad}$
Sensitive to beam offsets/jitter...



Need Specific Requests

- Energy Spectrometer
- Polarimetry
- Forward Detectors
- dL/dE ???

Current and Proposed SLAC Programs

- E158 (running)
Polarized source, RF BPMs, Pol asymmetries
- Deep Inelastic Scattering (proposal soon)
Precision polarimetry (0.25%)
- LYNX (proposal not soon?)
FF dynamics, polarimetry, spectrometers, gamma-gamma, etc...

Need a more specific list of R&D items
to be addressed with specific test beams...