

# Luminosity Energy Polarization Status

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3 March 2009



## Documentation

Status of Linear Collider Beam Instrumentation Design, D. Cinabro, E. Torrence and M. Woods, [LCD-ALCPG-03-0001 \(2003\)](#). May 2003

Executive Summary of the Workshop on Polarization and Beam Energy Measurements at the ILC, [J. List](#), [K. Mönig](#), [K.C. Moffeit](#), [G. Moortgat-Pick](#), [S. Riemann](#), [P. Schüler](#), [E. Torrence](#), [M. Woods](#), et al., ILC-NOTE-2008-047, August 2008

Polarimeters and Energy Spectrometers for the ILC Beam Delivery System, [S. Boogert](#), [M. Hildreth](#), [D. Käfer](#), [J. List](#), [K. Mönig](#), [K.C. Moffeit](#), [G. Moortgat-Pick](#), [S. Riemann](#), [H.J. Schreiber](#), [P. Schüler](#), [E. Torrence](#), [M. Woods](#), ILC-NOTE-2009-049, February, 2009 <sub>1</sub>

# Luminosity Energy Polarization Status

## Luminosity and $dL/dE$

LumiCal -- precision measurement

see also Takashi Maruyama's talk

BeamCal -- beam tuning

see also Takashi Maruyama's talk

GamCal-- beam tuning

## Energy

Measure top mass to 100 MeV.

Standard Model Higgs to 50 MeV.

Implies measuring luminosity-weighted mean collision energy to a level of  $(1 - 2) \cdot 10^{-4}$

- Upstream BPM-based spectrometer.
- Downstream synchrotron imaging energy spectrometers similar to that used at SLC  
measure disrupted beam energy spectrum
- Luminosity-weighted beam energy from radiative physics data:  
 $W+W-$  pairs and  $e^+e^- \rightarrow \gamma Z$  (with  $Z$  decay to  $\mu^+\mu^-$ )
- Precision energy measurement during Z-pole calibration data taking

## Polarization

$P_{e^-} > 80\%$

$P_{e^+} > \sim 30$  to 45%

Spin rotations systems for both electrons and positrons and helicity flip for both  $e^+$  &  $e^-$

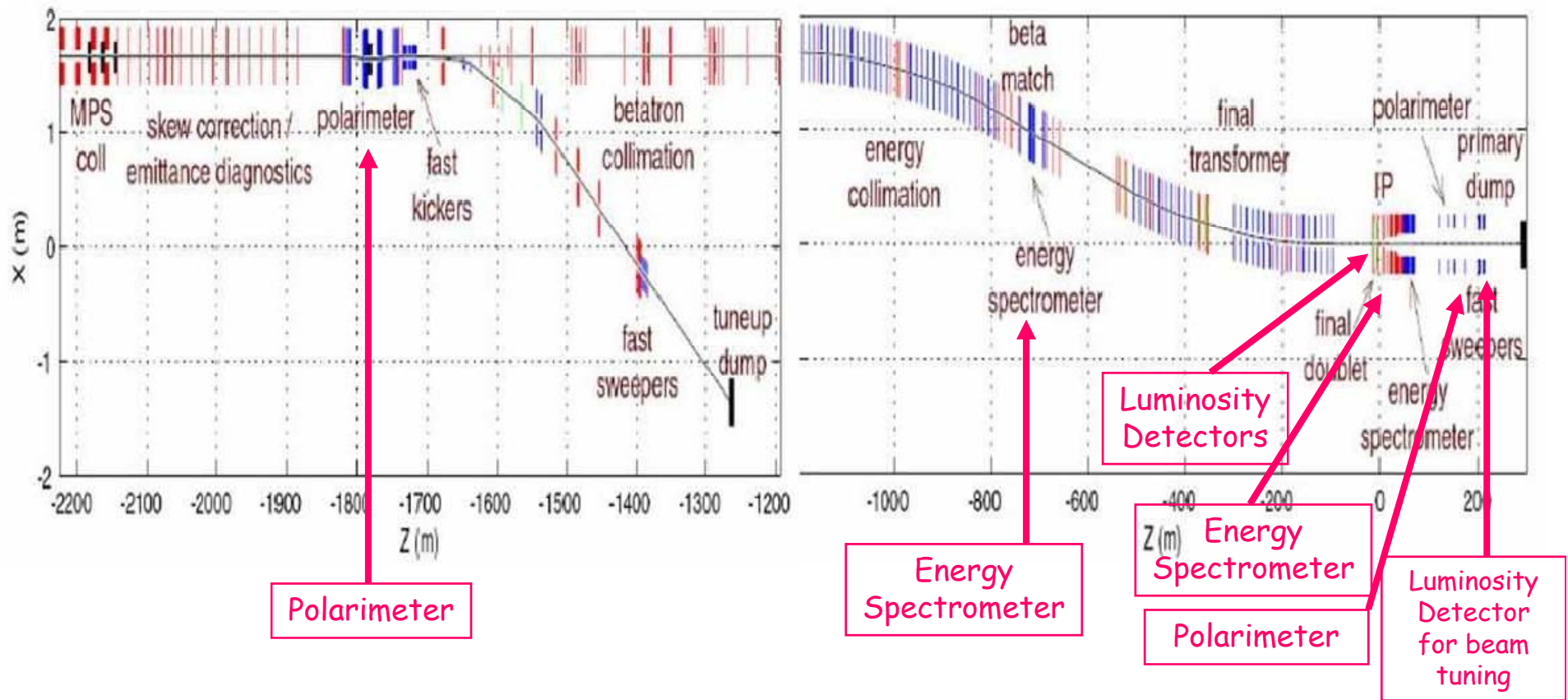
Polarization measurements to a precision of  $dP/P=0.25\%$

Upstream and downstream polarimeters for both electrons and positrons.

Polarimetry will be complemented by  $e^+e^-$  collision data, where processes like  $W$  pair production can provide an absolute scale calibration for the luminosity-weighted polarization at the IP, which can differ from the polarimeter measurements due to depolarization in collision.

Precision polarization measurement at the Z-pole during calibration taking: Understand <sup>2</sup> polarimeter and precision EW physics results.

## Luminosity, Energy and Polarimetry Measurements at ILC



Beam Delivery System showing the locations of the **polarimeter chicane 1800m upstream** of the IR and the **energy spectrometer 700 m upstream** of the IR. The location of the **extraction line energy spectrometer and polarimeter** are shown on the right side of the figure along with the location of the **luminosity detectors**.

# Luminosity

## RDR 4.3.1 Luminosity

Precision extraction of cross sections depends on accurate knowledge of the luminosity. For many measurements, such as those based on threshold scans, one needs to know the luminosity as a function of energy,  $dL/dE$ . Low-angle Bhabha scattering detected by dedicated calorimeters can provide the necessary precision for the integrated luminosity.

**LumiCal - precision measurement of luminosity:** Calorimetry in the polar angle region from 40-120 mrad Acollinearity and energy measurements of Bhabha,  $e+e- \rightarrow e+e-$  events in the polar angle region from 120-400 mrad can be used to extract  $dL/dE$  and are under study. Additional input from measurements of the beam energy spread and beam parameters that control the beamstrahlung spectrum will improve this determination of  $dL/dE$ .

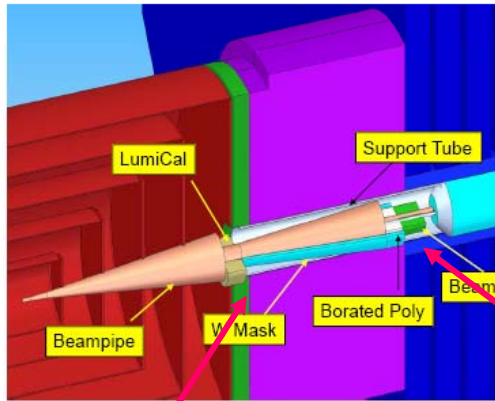
**BeamCal - beam tuning:** Techniques include measuring the angular distributions of  $e+e-$  pairs in the polar angle region from 5-40 mrad

**GamCal - beam tuning:** detect forward beamstrahlung gammas

All the proposed detectors may also be used for real time luminosity monitoring and tuning.



## SiD Forward Region



2008.11.18 Chicago SiD CM: FCAL LOI

T. Maruyama/SLAC

## LumiCal for SiD Detector

(see talk by T. Maruyama)

**Bhabha scattering**  $e^+ e^- \rightarrow e^+ e^-$  at small angles  
(~44 to ~86 mrad)

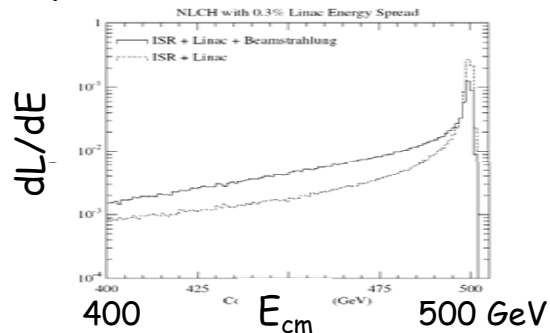
Luminosity precision goal  $\Delta L / L < 10^{-3}$   
 $10^6$   $W+W^-$  events in 5 years (500 fb<sup>-1</sup>)

$\Delta\theta$  is main systematic error.

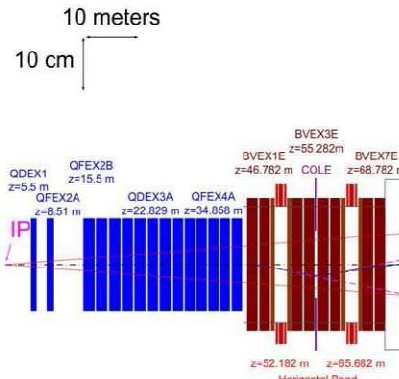
$\Delta\theta$  must be less than ~20  $\mu$ rad to reach  $\Delta L / L = 10^{-3}$

Detector radial location must be known within 30  $\mu$ m.

Acolinearity allows measurement of  $dL/dE$

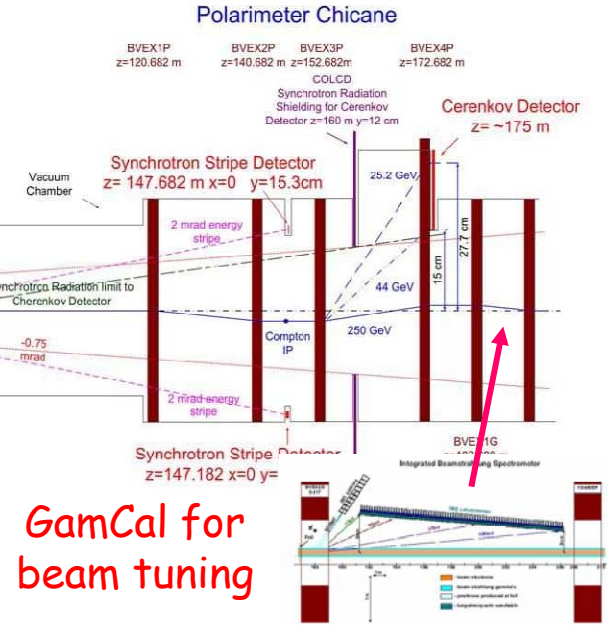


# Luminosity



**BeamCal** for beam tuning  
location is in a high radiation environment. This is an integral part of the SiD detector.

**GamCal** for beam tuning



## **GamCal** measures Beamstrahlung Photons

Power( $\gamma$ )  $\approx$  2% Power( $e$ )  $\approx$  0.3 MW  $N_\gamma \approx 1.5 N_e \approx 3 \times 10^{10} / BX$   
Small radiation length converter (e.g. gas target) gives  $e^+e^-$  pairs from beamstrahlung photons.  
Dipole magnet gives  $P_+$  kick of 0.25 GeV/c  
Calorimeter measures 1-10 GeV positrons.

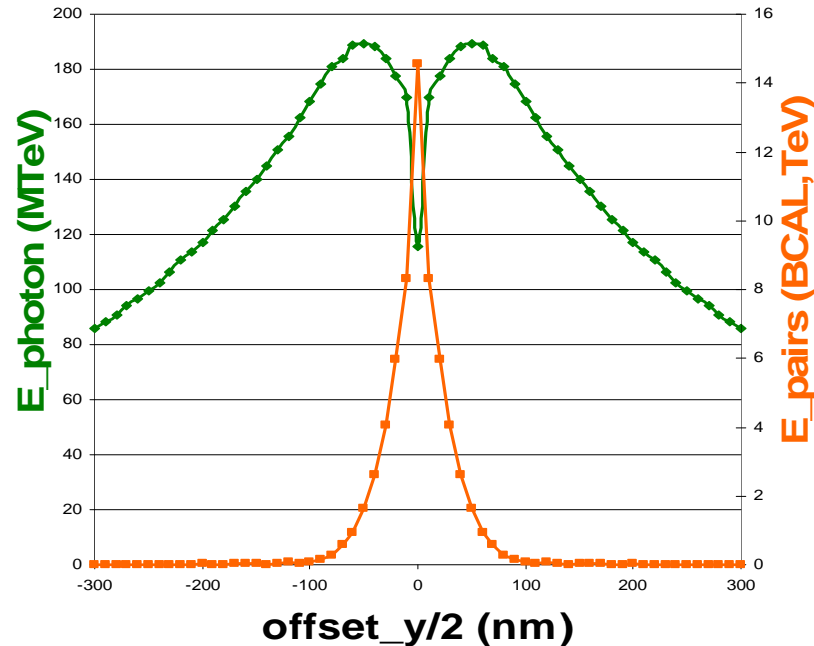
## **BeamCal** measures Beamstrahlung Pairs

Bethe-Heitler:  $\gamma e \rightarrow e^+ e^-$   
 $\sigma_{BH} \approx 38$  mb  $\langle E \rangle \approx 1$  GeV  
Landau-Lifshitz:  $ee \rightarrow ee^+ e^-$   
 $\sigma_{LL} \approx 19$  mb  $\langle E \rangle \approx 0.15$  GeV

Ratio of **BeamCal** pairs to **GamCal** gammas is largely proportional to the instantaneous luminosity <sup>5</sup>

# GamCal and BeamCal signals for Vertical Offsets

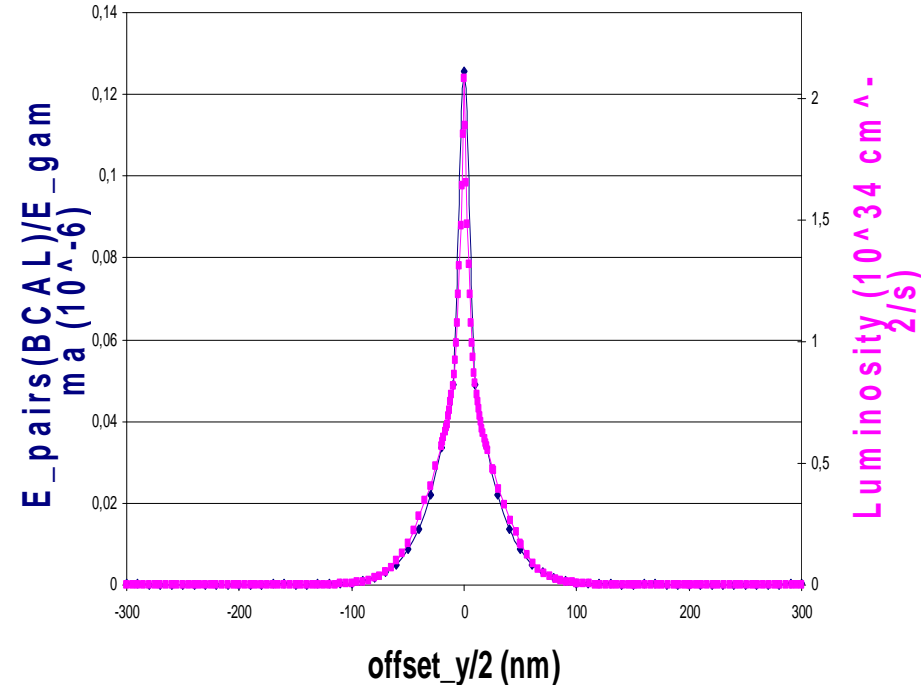
**E\_pairs (BCAL) and E\_photon**



- complementary information from
1. total photon energy vs offset\_y
  2. BeamCal pair energy vs offset\_y

see: William M. Morse, GamCal - A Beam-strahlung Gamma Detector for Beam Diagnostics

**Ratio of Energies (BCAL)**

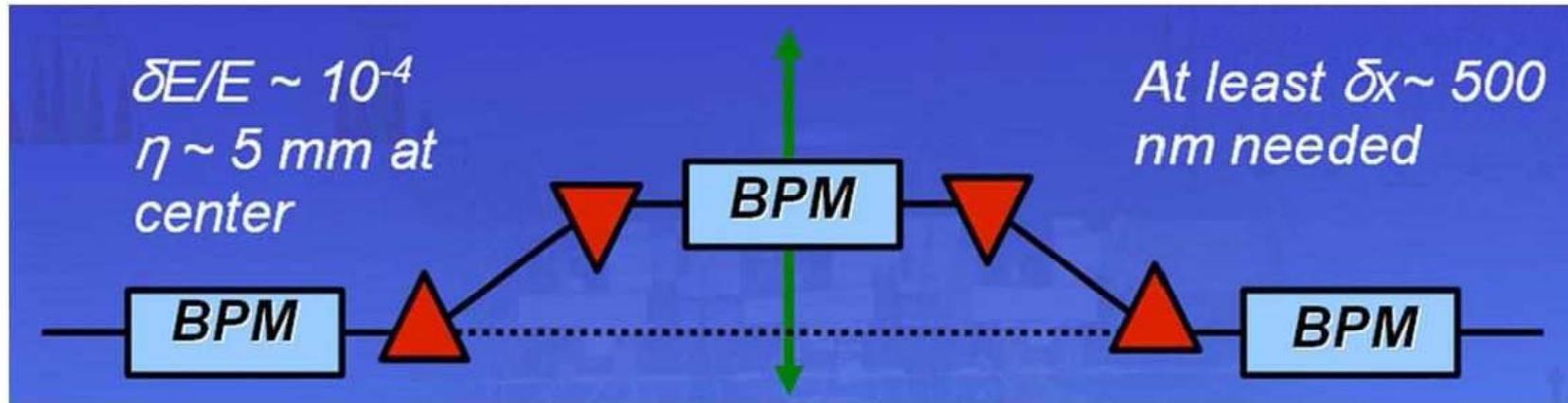


ratio of  $E_{\text{pairs}}/E_{\text{gam}}$  vs offset\_y is proportional to the luminosity

similar behaviour for angle\_y, waist\_y ...

Statistical precision of 1% per beam crossing

# Upstream Energy Spectrometer



Schematic for the upstream energy spectrometer using precision BPMs.

Located  $\sim 700$  meter upstream of the IR

Precision measurements between 45.6 and 500 GeV

Note due to fixed dispersion magnets operate at low field at 45.6 GeV where field measurement may not be accurate enough.

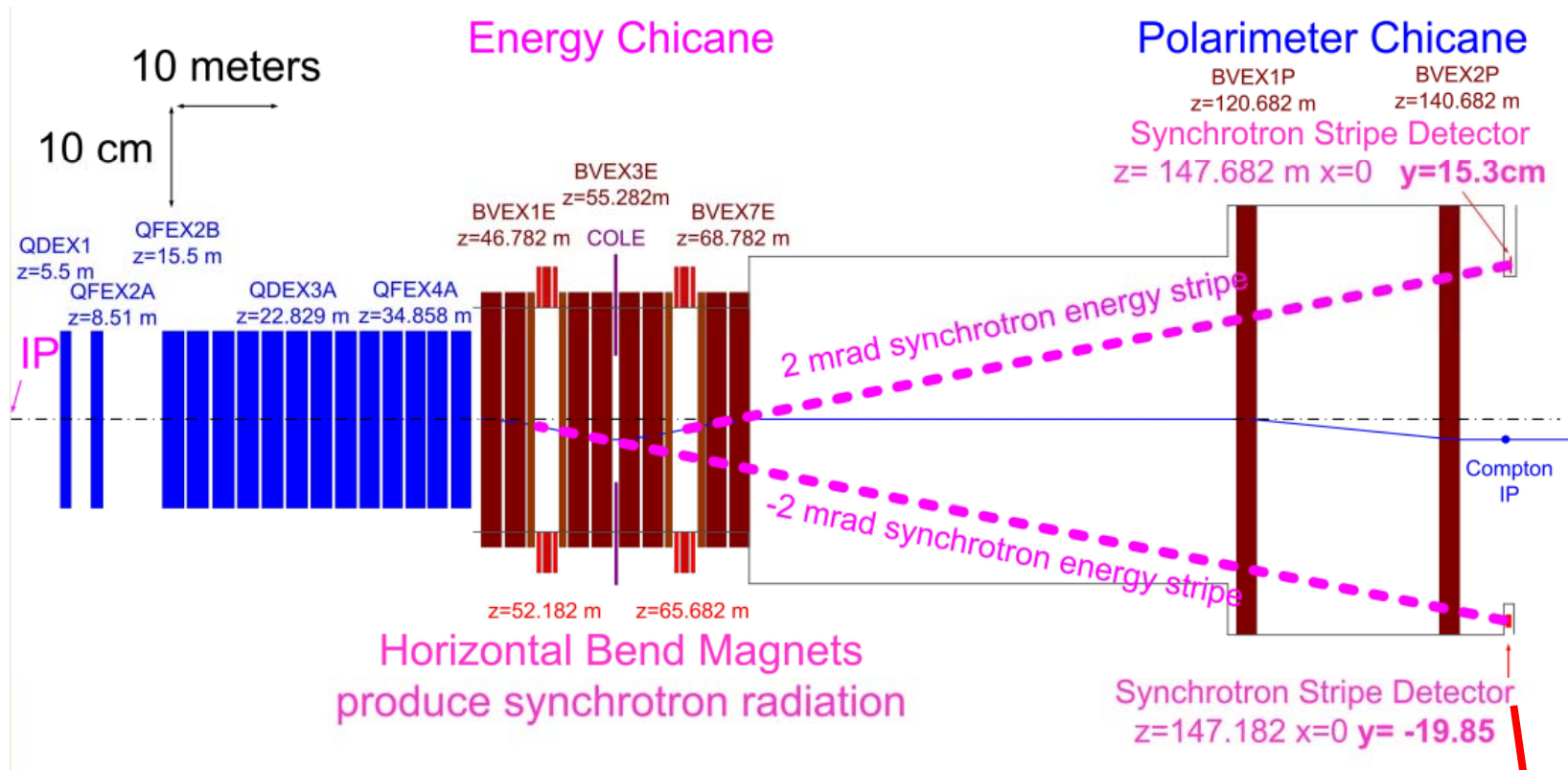
**T-474 End Station A test:** 4 dipole magnets and high precision RF cavity BPM's with test beam similar to ILC expectation. System measured a resolution of  $0.8 \mu\text{m}$  in  $x$  and  $1.2 \mu\text{m}$  in  $y$  and was stable at micron level, which would translate to an energy precision of 200 ppm.

[M. Slater et al., Cavity BPM system tests for the ILC energy spectrometer Nucl. Instrum. Meth. A592, 201-217 \(2008\)](#)

A. Lyapin, B. Maiheu, F. Gournaris, M. Wing, D. Miller, University College London (UCL) M. Slater, D. Ward, M. Thomson, University of Cambridge  
S. Boogert, G. Boorman Royal Holloway, University of London (RHUL) M. Woods, R. Arnold, Z. Szalata, C. Hast, D. McCormick, J. Ng, C. Adolphson  
Stanford Linear Accelerator Center (SLAC) S. Kostromin, N. Morozov, V. Duginov Joint Institute for Nuclear Research (JINR) Y. Kolomensky, M.  
Chistiakova, E. Petigura University of California, Berkeley and LBNL H.-J. Schreiber, M. Viti Deutsches Elektronen Synchrotron (DESY) M.  
Hildreth University of Notre-Dame

# Extraction Line Energy Spectrometer

E. Torrence, Downstream Synchrotron Radiation Stripe Spectrometer Status, 2008 Workshop on Polarization and Energy Measurements at the ILC.



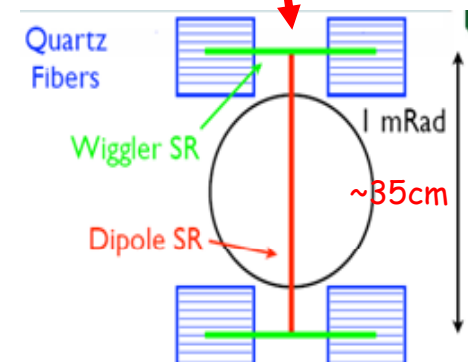
Vertical separation of synchrotron stripes is  $\sim 351$  mm  
 Goal for detector: Precision measurement of synchrotron stripes to  $\sim 40 \mu\text{m}$   
 using radiation-hard  $100 \mu\text{m}$  quartz fibers.

$$\delta E_b / E_b \sim 1 \text{ to } 2 * 10^{-4}$$

Systematic errors: Relative component alignment and magnetic field mapping.

Energy measurement between  $45.6$  GeV and the highest ILC energy of  $500$  GeV

Some information about the beam energy width can be extracted using information from the undisrupted energy spread and the disrupted beam energy distribution





## Alternative Methods for Energy Measurement

### Compton backscattering (Muchnoi, Schreiber and Viti)

- A magnetic spectrometer (~25 m long)
- precise position of the electron beam  $0.5 \mu\text{m}$
- The centroid of the Compton Photons to  $1 \mu\text{m}$
- Kinematic edge of the Compton-scattered electrons of  $10 \mu\text{m}$

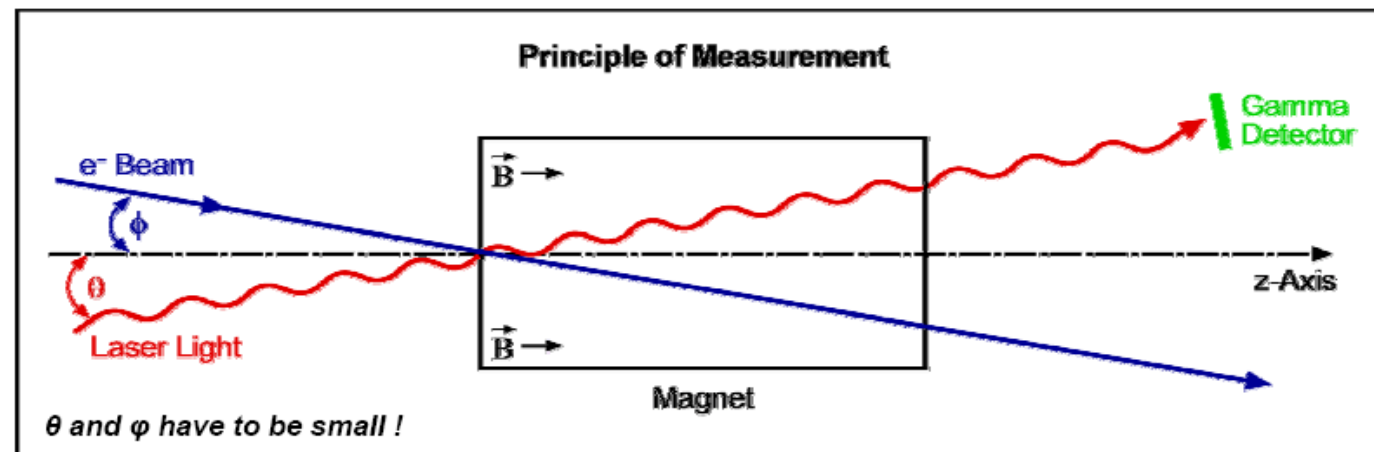
### Synchrotron radiation (Hiller, Makarov, Schreiber, Syresin, Zalikhanov)

- In the dipole magnets of the upstream BPM-based spectrometer
- Measure edges of the synchrotron radiation fan.

### MEASUREMENT OF THE BEAM ENERGY USING RESONANT ABSORPTION OF LASER LIGHT (R. Melikian, A. Ghalumyan)

Absorption of circular polarized laser light by the beam particles in a static magnetic field permits to measure the beam energy with high precision,

$$\Delta E_b/E_b = 10^{-4} \dots 10^{-5}$$



# Physics with polarized beams: motivation and requirements

$$\sigma_{P_{e^-}P_{e^+}} = \frac{1}{4} \left\{ (1 + P_{e^-})(1 + P_{e^+})\sigma_{RR} + (1 - P_{e^-})(1 - P_{e^+})\sigma_{LL} \right. \\ \left. + (1 + P_{e^-})(1 - P_{e^+})\sigma_{RL} + (1 - P_{e^-})(1 + P_{e^+})\sigma_{LR} \right\}$$

$\sigma_{RL}$  cross section  $e^-$  beam is completely right-handed polarized ( $P_{e^-} = +1$ )  
 $e^+$  beam is completely left-handed polarized ( $P_{e^+} = -1$ )

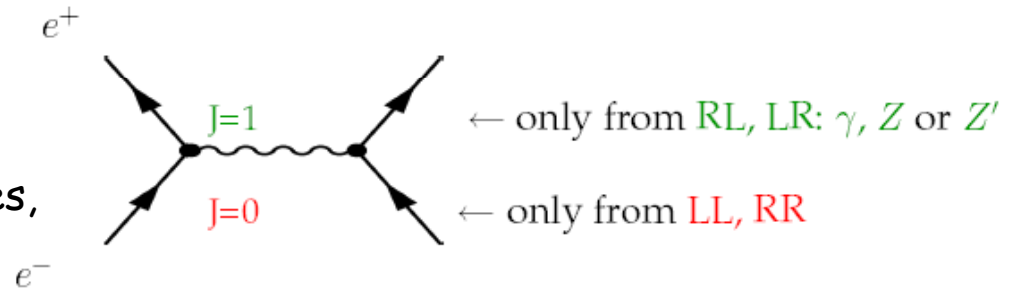
	$e^-$	$e^+$		
$\sigma_{RR}$			$\frac{1+P_{e^-}}{2} \cdot \frac{1+P_{e^+}}{2}$	$J_z = 0$
$\sigma_{LL}$			$\frac{1-P_{e^-}}{2} \cdot \frac{1-P_{e^+}}{2}$	
$\sigma_{RL}$			$\frac{1+P_{e^-}}{2} \cdot \frac{1-P_{e^+}}{2}$	$J_z = 1$
$\sigma_{LR}$			$\frac{1-P_{e^-}}{2} \cdot \frac{1+P_{e^+}}{2}$	

# Physics with polarized beams: motivation and requirements

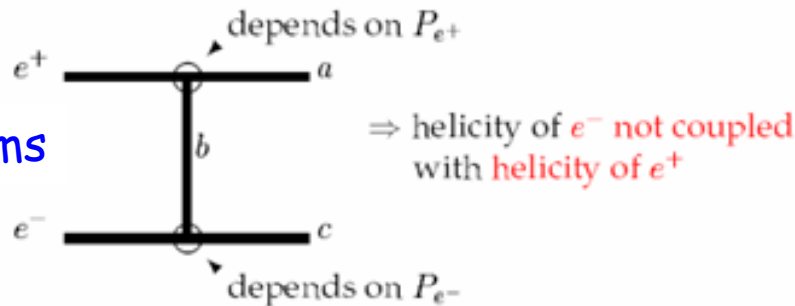
## Annihilation diagrams

Standard Model only  $J = 1$  is possible.

New Physics models:  
 may contribute to  $J = 1$   
 may allow the production of scalar particles,  
 $J = 0$  would be allowed

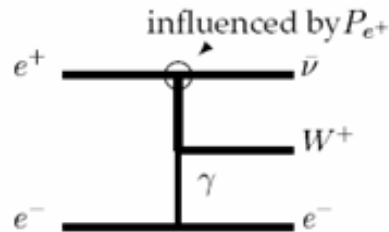


## Exchange diagrams



## T- and u- channel diagrams

The helicity of the incoming beam is directly coupled to the helicity of the final particle and is completely independent of the helicity of the second incoming particle.



Single  $W^+$  production: the vertex  $e^+W^+\bar{\nu}$  depends only on  $P_{e^+}$ .

# Physics with polarized beams: motivation and requirements

Comparison with (80%,0): estimated gain factor when

**most (80%, 60%) (80%, 30%)**

Case	Effects for $P(e^-) \rightarrow P(e^-)$ and $P(e^+)$	Gain& Requirement
<b>Standard Model:</b>		
top threshold	Electroweak coupling measurement	factor 3
$t\bar{q}$	Limits for FCN top couplings improved	factor 1.8
CPV in $t\bar{t}$	Azimuthal CP-odd asymmetries give access to S- and T-currents up to 10 TeV	$P_{e^-}^T P_{e^+}^T$ required
$W^+W^-$	Enhancement of $\frac{S}{B}, \frac{S}{\sqrt{B}}$	up to a factor 2
	TGC: error reduction of $\Delta\kappa_\gamma, \Delta\lambda_\gamma, \Delta\kappa_Z, \Delta\lambda_Z$	factor 1.8
	Specific TGC $\tilde{h}_+ = \text{Im}(g_1^R + \kappa^R)/\sqrt{2}$	$P_{e^-}^T P_{e^+}^T$ required
CPV in $\gamma Z$	Anomalous TGC $\gamma\gamma Z, \gamma Z Z$	$P_{e^-}^T P_{e^+}^T$ required
$HZ$	Separation: $HZ \leftrightarrow H\nu\nu$	factor 4
	Suppression of $B = W^+\ell^-\nu$	factor 1.7
$t\bar{t}H$	Top Yukawa coupling measurement at $\sqrt{s} = 500$ GeV	factor 2.5

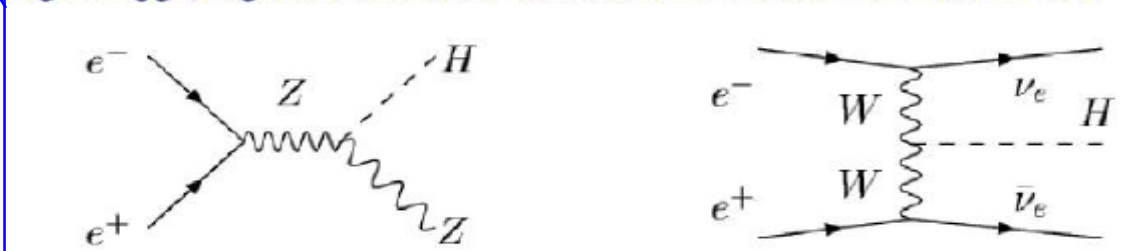
gain factor 2  
gain factor 1.4  
 $P_{e^-}^T P_{e^+}^T$  required  
factor 1.3 worse than with  $P_{e^+}=60\%$

$P_{e^-}^T P_{e^+}^T$  required

gain factor 2

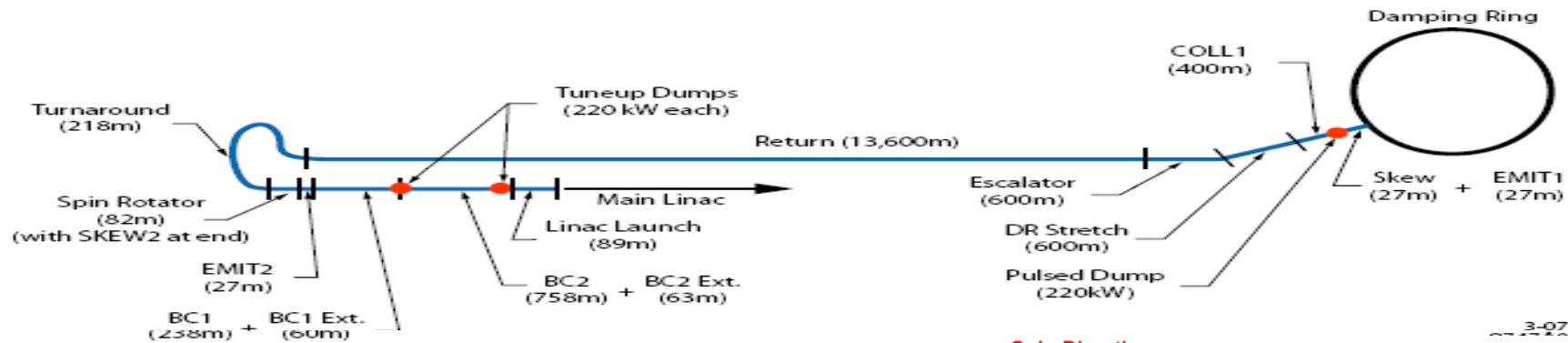
gain factor 1.6

Light Higgs, e.g.  $m_H=130$  GeV:  $HZ$  and  $H\nu\nu$  similar rates at 500 GeV



# Spin Rotation

RDR Baseline: Spin rotations systems for both electrons and positrons



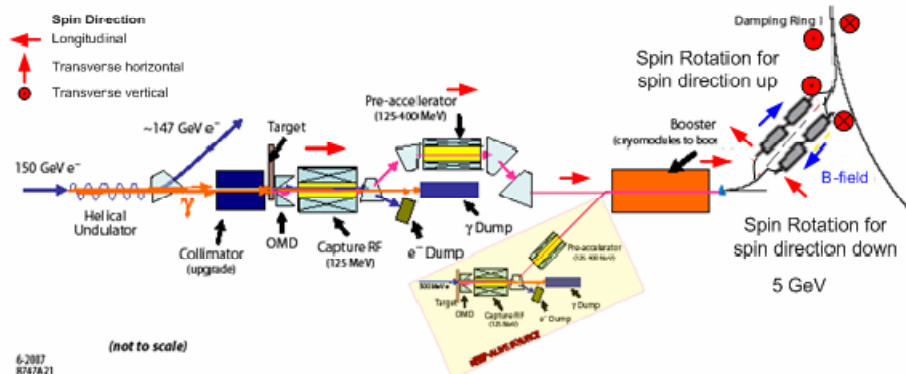
$$\theta_{spin} = \gamma \frac{g-2}{2} \cdot \theta_{bend} = \frac{E(\text{GeV})}{0.44065} \cdot \theta_{bend}$$

At 5 GeV rotate spin transverse with a bend of  $7.9317^\circ$

Superconducting solenoid of 26.2 Tesla-meters rotates to the vertical

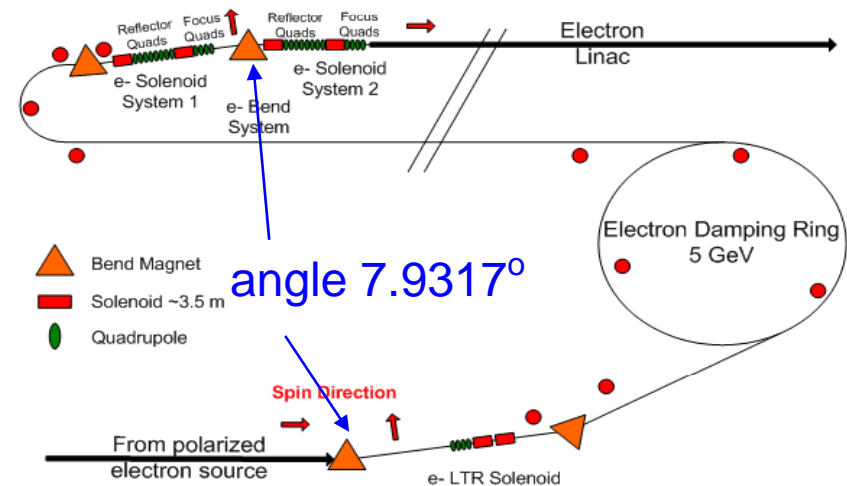
Positron helicity flip not in baseline. Scheme for fast positron helicity flipping has been proposed.

RDR Positron Source to Damping Ring with Spin Rotation in LTR at 5 GeV



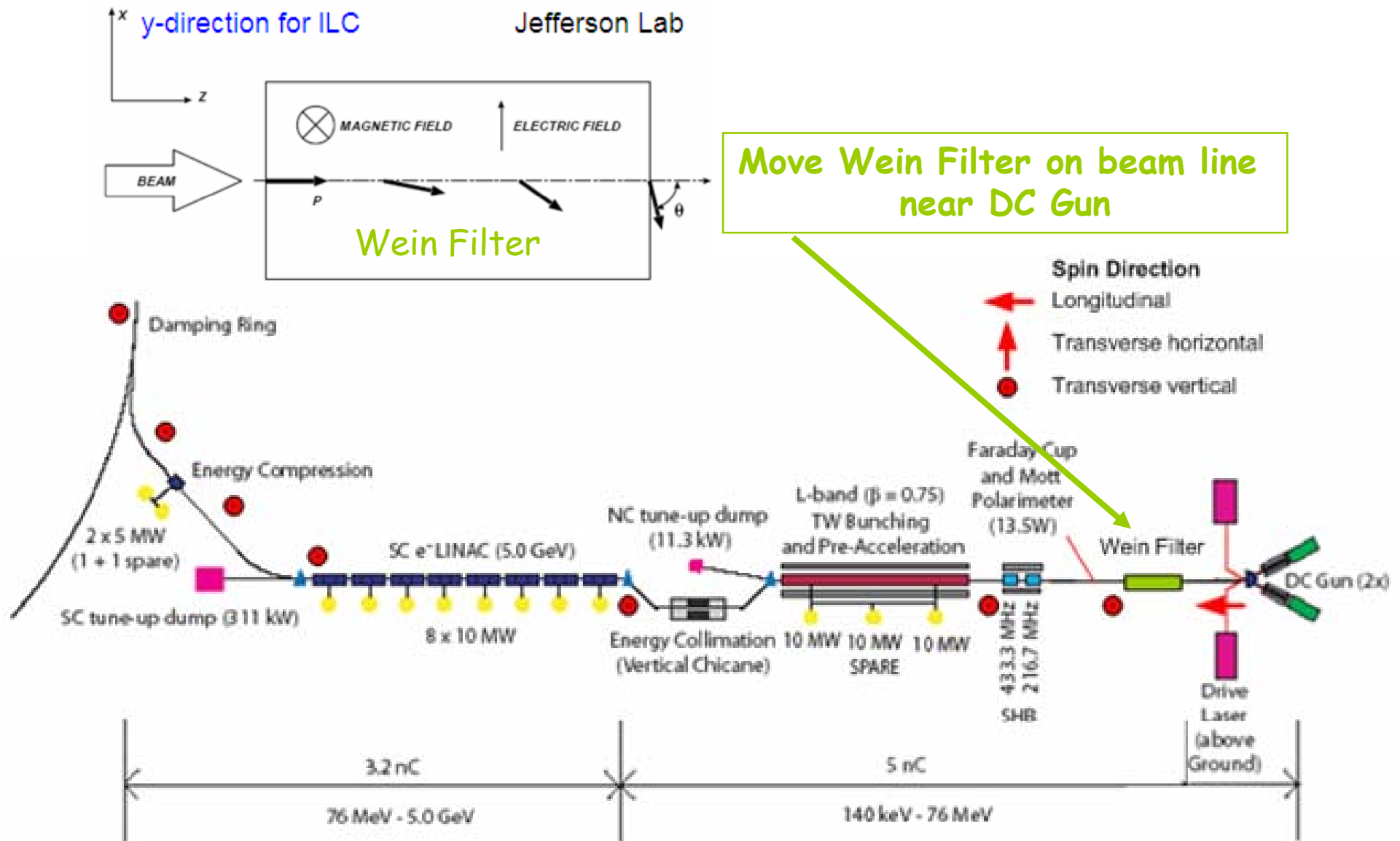
**Spin Direction**

Solenoid 1	Solenoid 2
Off ●	● Off
Off ●	● On ↑
On ↑	→ Off



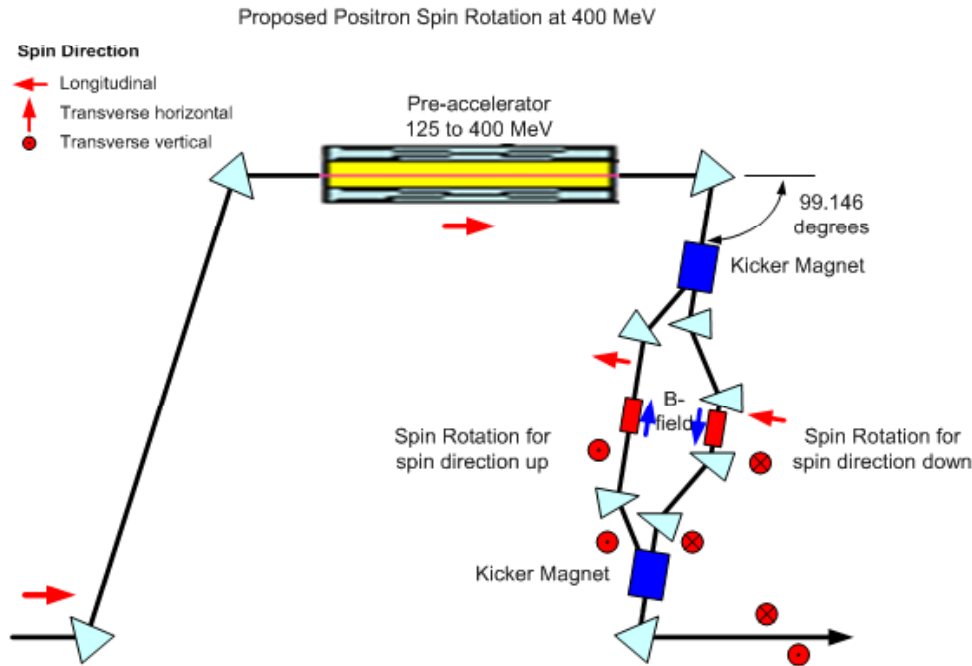
SiD endorses implementing capability for fast positron helicity flipping, which is needed to minimize systematic errors for some of the precision measurements planned.

# Proposed electron spin rotation to the vertical near polarized electron source



Space charge affecting beam as it traverses the Wien Filter needs study. At Jefferson Lab this was done at 5 MeV. May need to go after the SHB.

# Spin Rotation for positrons at 400 MeV directly following Pre-accelerator when beam energy is 400 MeV

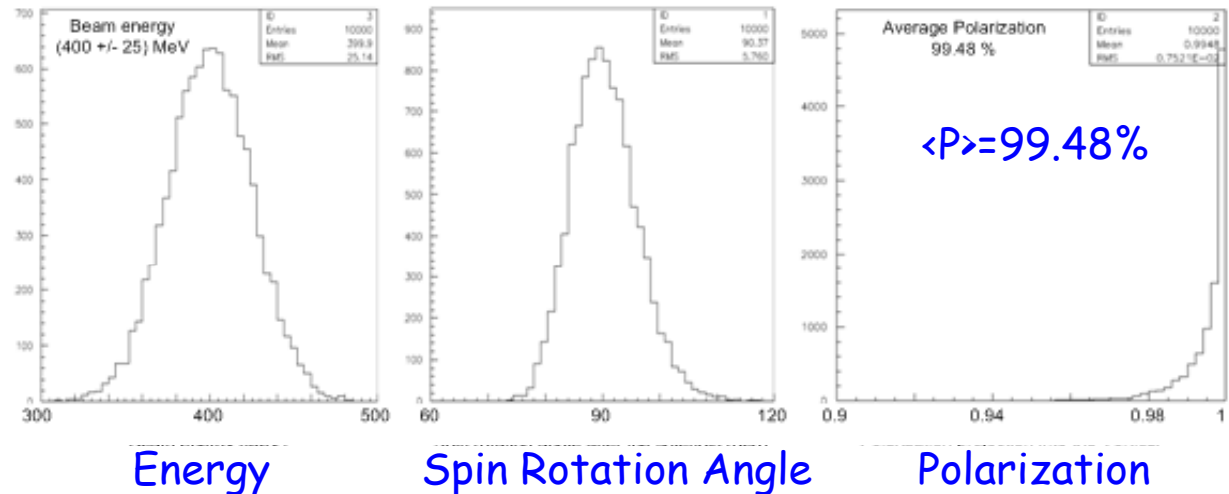


After a bend of 99.146 degrees a copper wound solenoid of 2.096 Tesla meters 2.2 meters long with an axial field of 9.53 Kilogauss will rotate the spin from the transverse horizontal direction to the vertical.

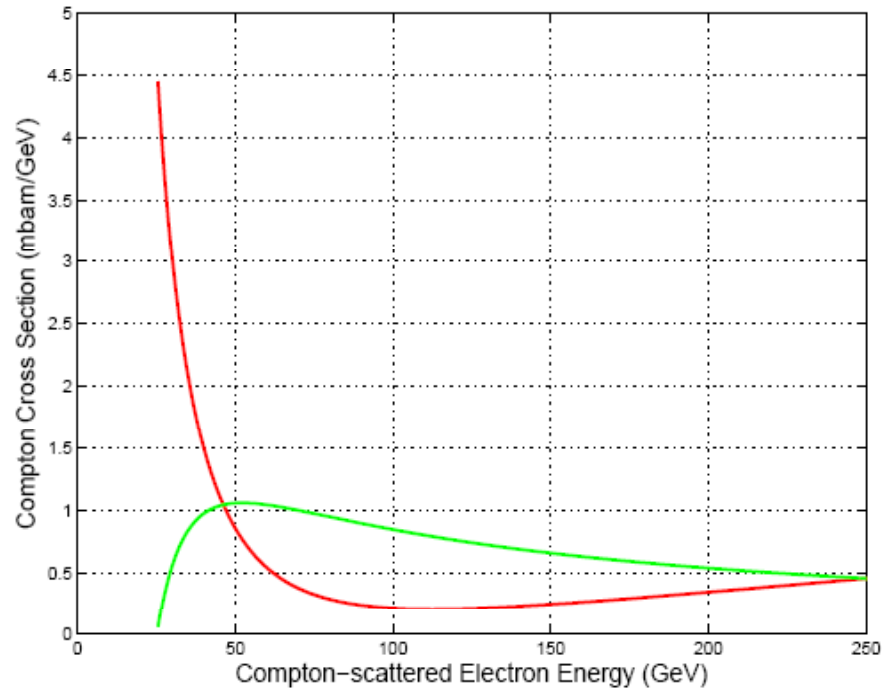
Criteria for the kicker magnets for spin flip and tunnel space is much less demanding at 400 MeV than at 5 GeV.

Energy Spread at 400MeV may be as large as +/- 25MeV

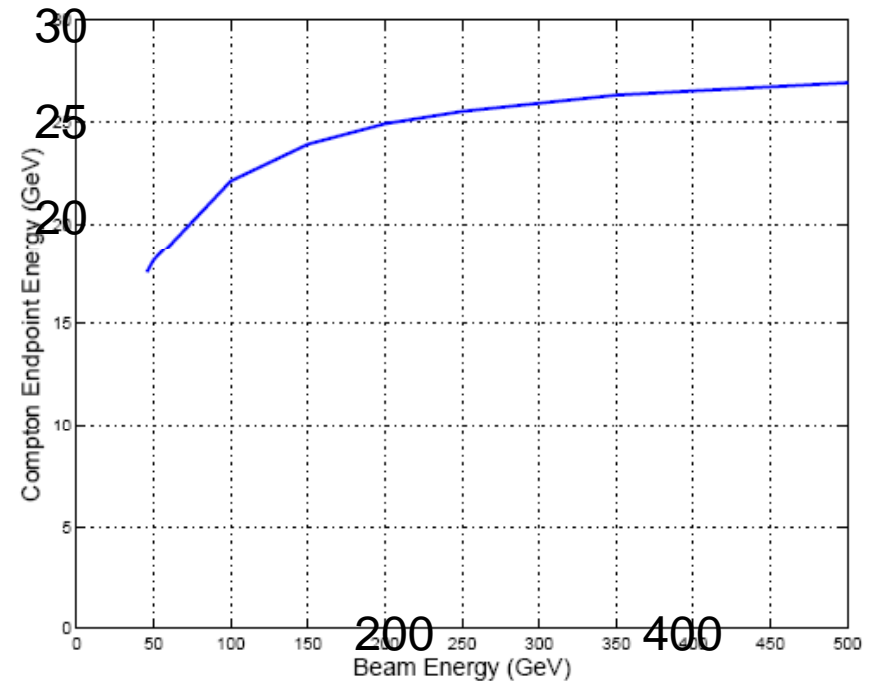
- Depolarization: only 0.52%
- Positron beam loss in 99.146° bends and parallel spin rotation lines is a concern.



# Compton Scattering Polarimetry



Compton differential cross section versus scattered electron energy for  $J=3/2$  (red curve) and  $J=1/2$  (green curve). Beam energy is 250 GeV and laser photon energy is 2.3 eV.



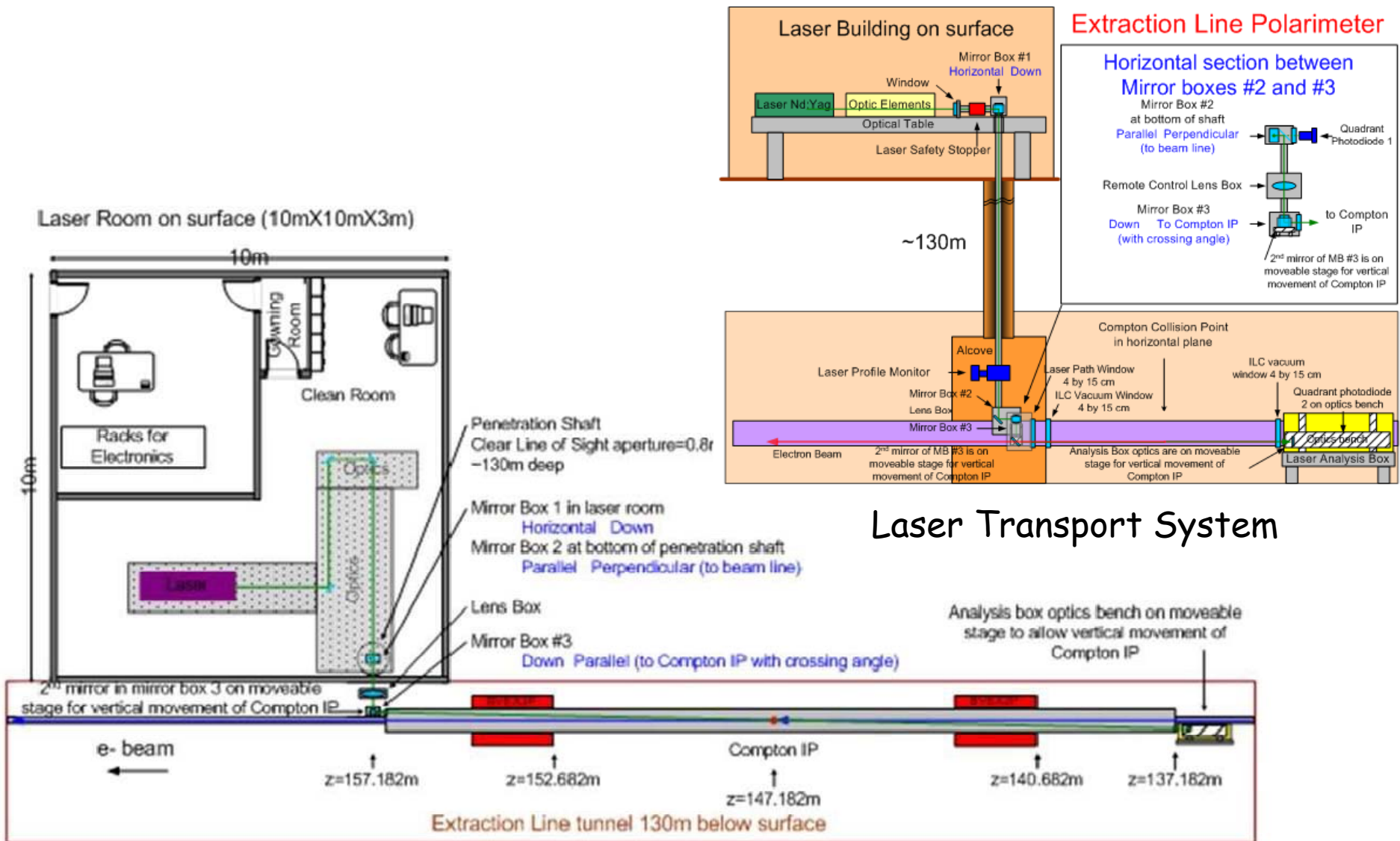
Compton edge energy dependence on beam energy.

- Compton scattering understood with radiative corrections less than 0.1%.
- Detector backgrounds measured with laser off pulses.
- Compton electrons ( $E \sim 25$  GeV) can be identified, measured and isolated from backgrounds
- Polarimetry data taken parasitic to physics data
- Compton rate high with sub-1% precision in one minute
- Laser helicity selected pulse-by-pulse
- Laser circular polarization determined with 0.1% accuracy



# Laser room and laser transport to Compton IP

## Laser Transport



Laser Room on surface above Compton IP ~130m underground

## Magnetic chicane parameters for the BDS Compton polarimeters.

Chicane Parameters	Upstream Polarimeter	Downstream Polarimeter
Chicane Length (m)	75.6	72.0
No. magnets	12	6
Magnetic Field (T)	0.0982	0.4170 (1, 2) 0.6254 (3, 4) 0.4170 (5,6)
Magnet Length (m)	2.4	2.0
Magnet 1/2-gap (cm)	1.25	11.7 (1-3) 13.2 (4) 14.7 (5,6)
Magnet pole-face width (cm)	10.0 (1-3) 20.0 (4-9) 30.0 (10-12)	40.0 (1-3) 54.0 (4) 40.0 (5-6)
Dispersion at mid-chicane at 250 GeV (mm)	20	20

# Polarimeter Cherenkov Detector

**SLD Čerenkov Detector**

- Horizontal deflection of Čerenkov light
- PMTs: 185-650 nm
- Propane

Ulrich Velte, DESY 11. 4. 2008 Zurbach Workshop

**Single electron response**

- 3 - 7 photo electrons
- Simulation: 5.5 - 6.5
- Well within expectations

Ulrich Velte, DESY 11. 4. 2008 Zurbach Workshop

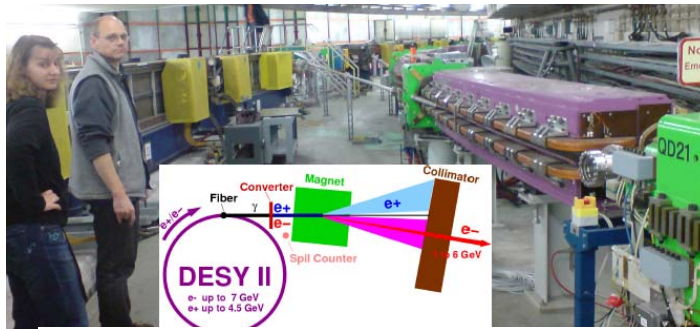
SLD Kanal 5		nominal	
Entries	1000434		
$\chi^2 / \text{ndf}$	483.3 / 488		
PhiElectr	7.082 ± 0.013		
Area	1.104e+04 ± 1		
CSigma	2.899 ± 0.005		

**90° signal**

- More photons by shooting beam into bend section
- length  $\uparrow \rightsquigarrow$  photons  $\uparrow$
- reflections  $\uparrow \rightsquigarrow$  photons  $\uparrow$
- ratio allows tuning of reflectivity in simulation

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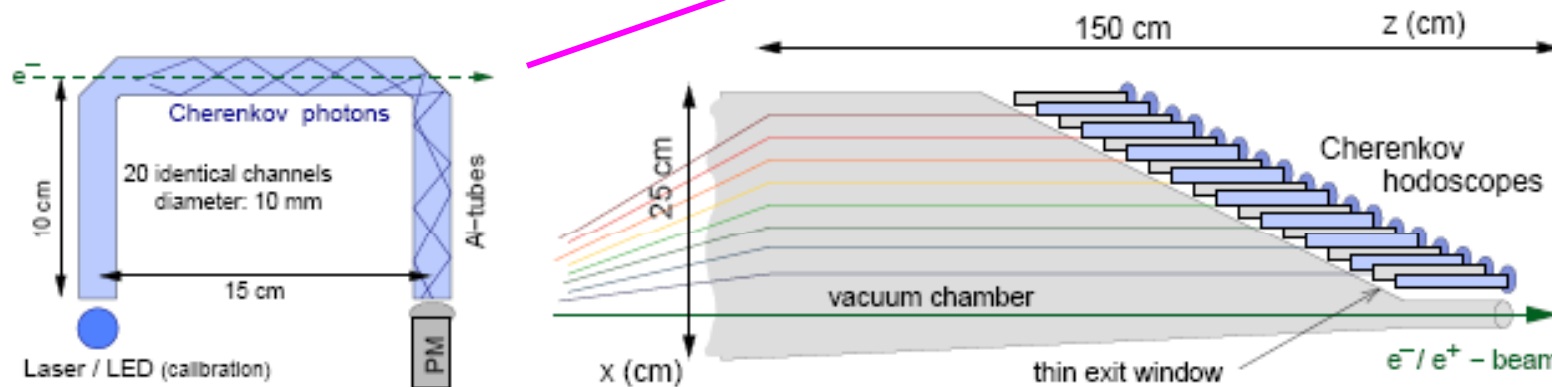
SLD Kanal 5, 90grad		90deg h5	
Entries	1000000		
$\chi^2 / \text{ndf}$	112.3 / 112		
PhiElectr	35.09 ± 0.05		
Area	1.110e+05 ± 175		
CSigma	14.22 ± 0.03		



**Simulation of the ILC Polarimeter**

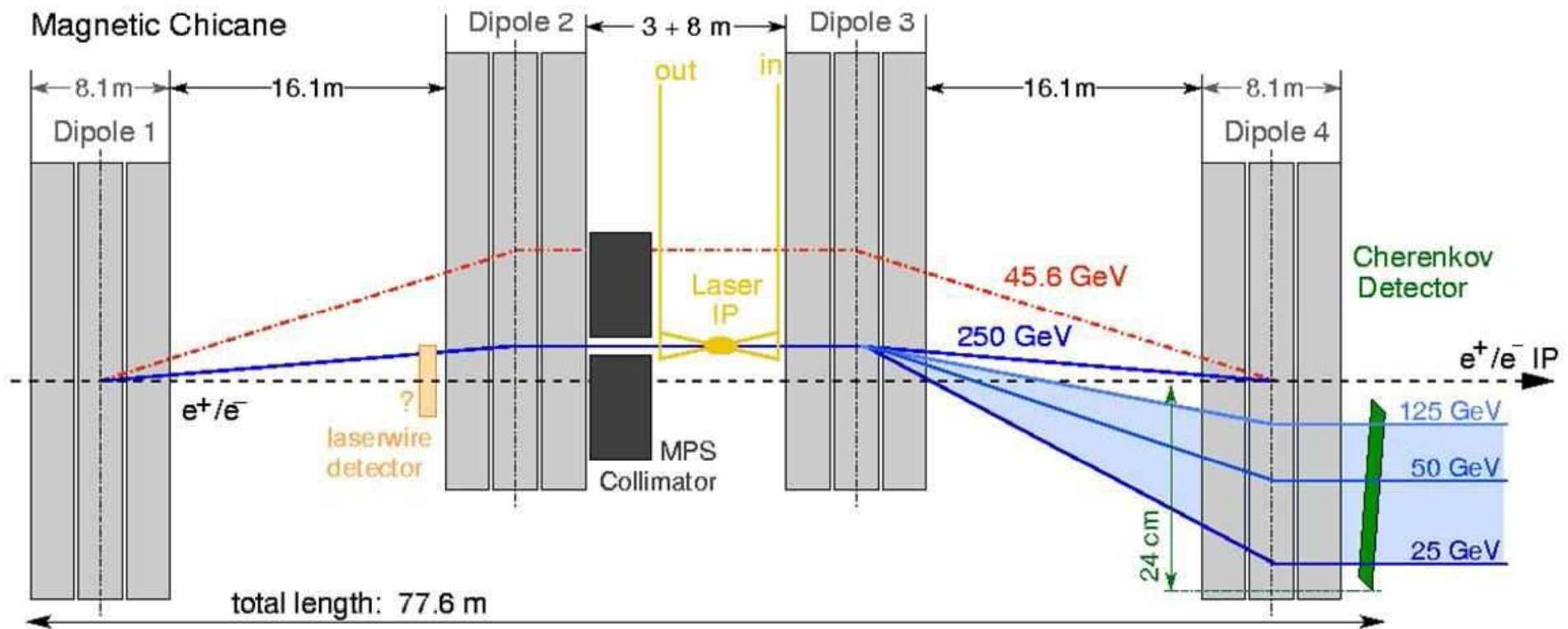
- electron generation with BDSIM
- optical detector simulation with GEANT 4

Ulrich Velte, DESY 11. 4. 2008



Schematic of a single gas tube (left) and the complete array of 18 tubes(right) as foreseen for the Cherenkov detector for the polarimeters.

# Upstream Polarimeter



Schematic of the upstream polarimeter chicane described in the Reference Design Report. This system combines functions for the laserwire detector, machine protection collimator and the Compton polarimeter.

Polarization group recommends to ILC management to relocate the laser-wire emittance diagnostic and MPS energy collimator away from the upstream polarimeter chicane.

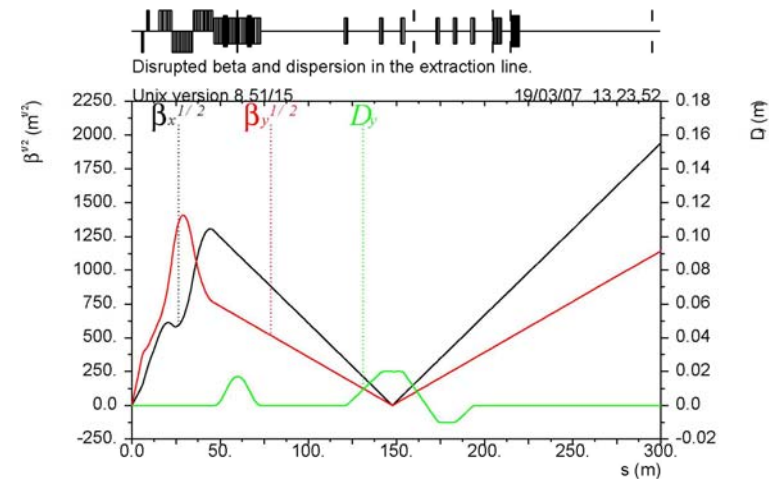
Laser similar to source laser permitting measurement of every bunch with precision of 1% in 4 sec

$dP/P = 0.25\%$  or better with the largest uncertainties coming from the analyzing power calibration<sub>20</sub> (0.2%) and the detector linearity (0.1%)

# Extraction Line Polarimeter and Energy Spectrometer

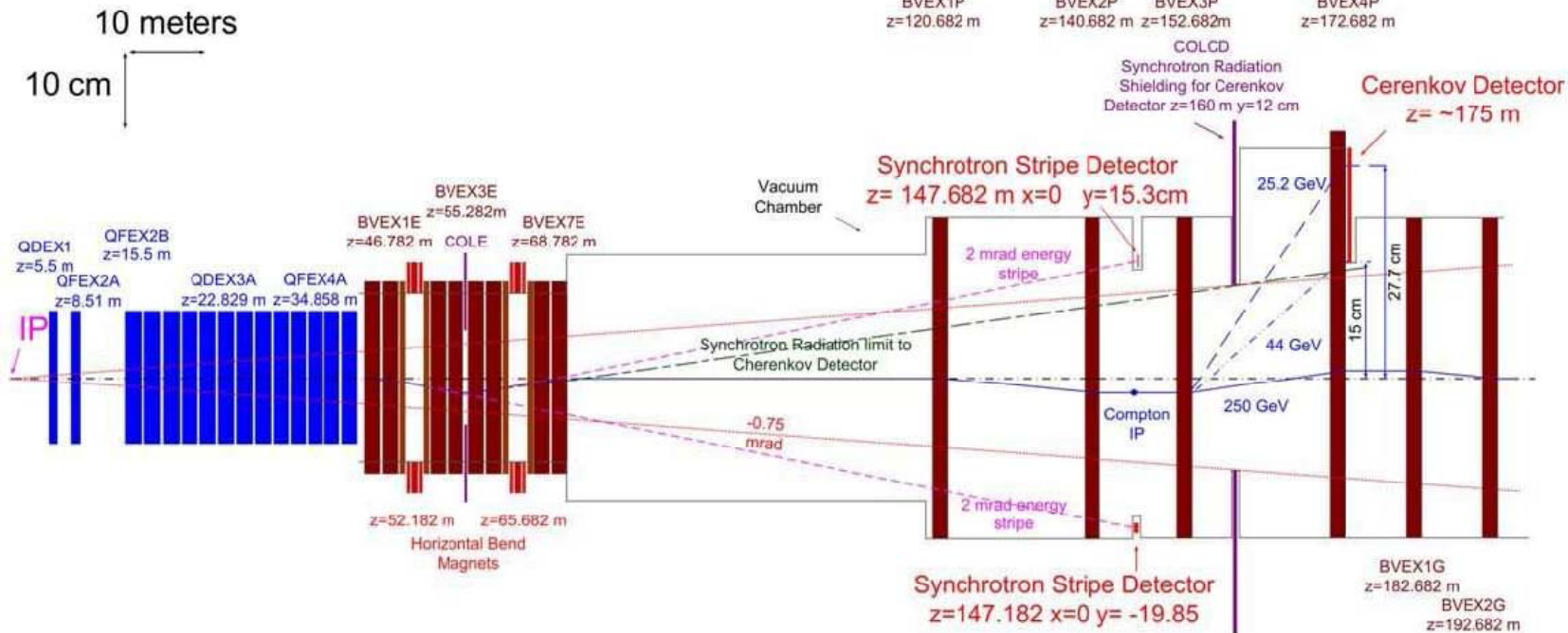
High power low rate lasers give **1000 Compton scattered electrons** on 3 bunches. 1% statistical uncertainty in less than 1 minute. Cycle through bunches in train.

**Systematic errors at  $dP/P = 0.25\%$**  with contributions from detector Analyzing power of 0.2%, linearity 0.1%, laser polarization 0.1% and electronic noise and background subtraction 0.05%.



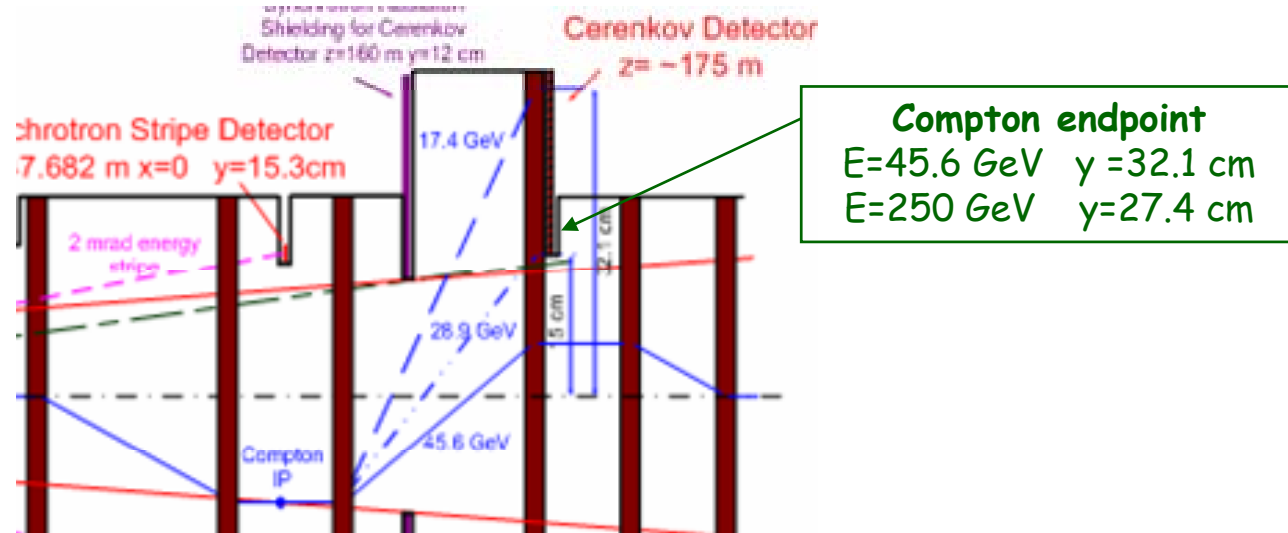
Energy Chicane

Polarimeter Chicane

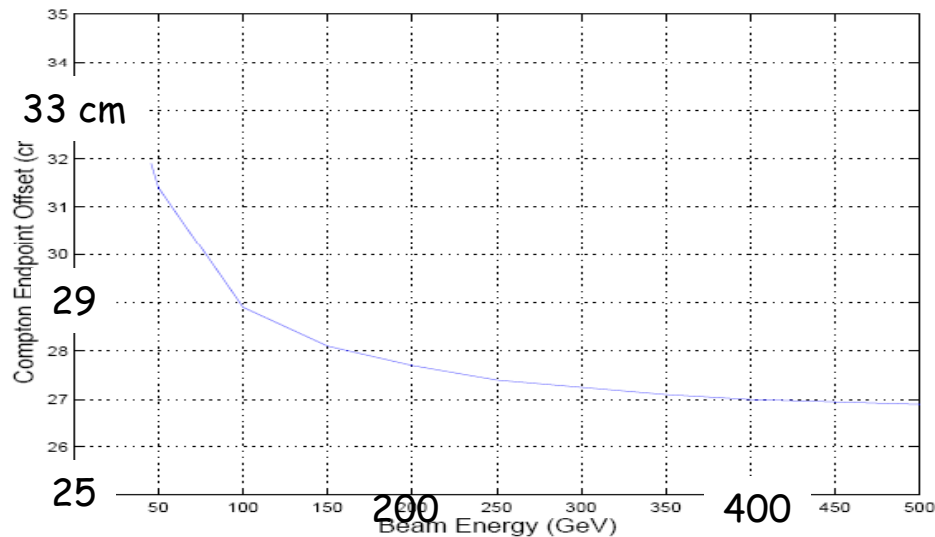


Recommend 6-magnet chicane to move Compton electrons further away from beam line

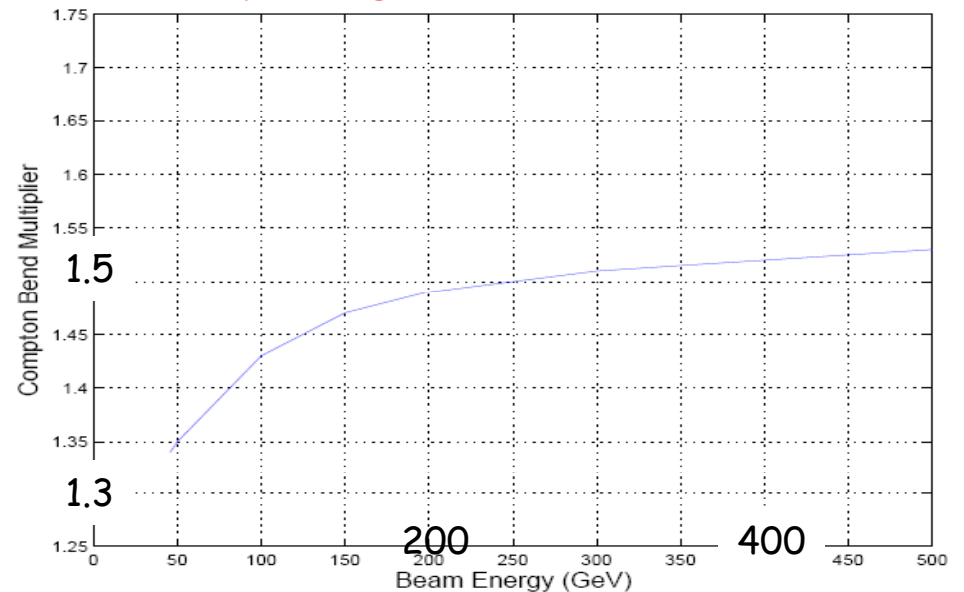
# Beam Energy and Compton Endpoint



Vertical offset of the Compton endpoint for a fixed-field chicane with 20mm dispersion at 250 GeV and the last 2 polarimeter "chicane" magnets 50% stronger than the first two.



Scaling Multiplier of the last two dipoles to keep the Compton edge at 27.4cm from beamline



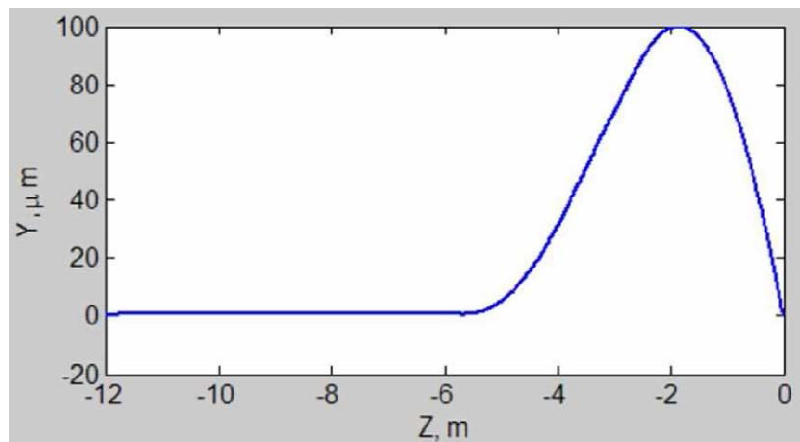
Beam Energy (GeV)

## Impact of Crossing Angle and IR Magnets on Polarimetry

Beam trajectory and detector solenoid axis are not aligned due to crossing angle results in vertical deflection of the beam and impacts trajectory of low energy pairs produced in the collisions.

A detector integrated dipole (DID) included in the solenoid compensates for the problems.

To reduce backscattering of the pair background into the tracking detectors it is preferable to align the trajectory of low energy pairs with the extraction beamline (anti-DID solution) resulting in a **significant vertical beam angle at the IP**.



Angle 102  $\mu\text{rad}$  for SID at IP

Beam angle at IR is different than the beam trajectory before and after the detector.

However, the beam trajectory at the upstream and downstream Compton IP s must be within **50 $\mu\text{rad}$**  of that at  $e^+e^-$  Interaction Region.

- Corrector compensation in polarimeter chicane is more easily done for the downstream polarimeter.

- For the upstream polarimeter, it is highly desirable to implement local orbit compensation near the IR to align the incoming vertical beam trajectory with the trajectory at the collider IP. **Correction in the upstream polarimeter chicane may not be feasible due to vertical emittance growth.**

## Measurement of beam polarization using $W^+ W^-$ production

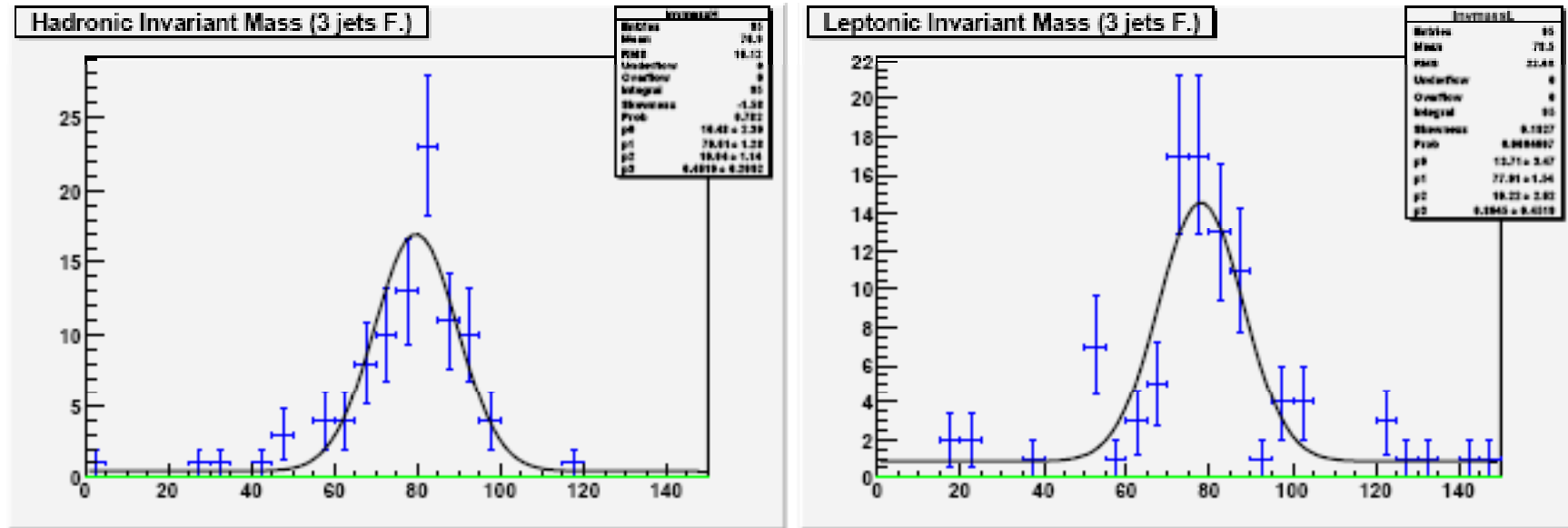


Figure 2: The  $W$  invariant mass measured from the hadronic decay (left) and from the leptonic decay (right).

### The Blondel scheme

$$|P_{e^\pm}| = \sqrt{\frac{(\sigma_{-+} + \sigma_{+-} - \sigma_{--} - \sigma_{++})(\pm\sigma_{-+} \mp \sigma_{+-} + \sigma_{--} - \sigma_{++})}{(\sigma_{-+} + \sigma_{+-} + \sigma_{--} + \sigma_{++})(\pm\sigma_{-+} \mp \sigma_{+-} - \sigma_{--} + \sigma_{++})}}$$

With 860 fb<sup>-1</sup> of luminosity, the error on  $P_{e^-} \sim 0.1\%$  and the error on  $P_{e^+} \sim 0.2\%$ .

Requires randomly flipping positron polarization.

Comments:

The Blondel scheme can be used for any  $J=1$  process not just  $W$ -pairs. The scheme requires that both beam be polarized.  $W$ -pairs gives an additional tool since  $W$ s couple only to left-handed particles. One can make use of  $W$ -pairs for a beam-based measurement if only the electrons are polarized. Non-standard  $W$  couplings can be extracted from the angular dependence of the  $W$  asymmetry.



# Integration with SiD

LumiCal and BeamCal need to be a subsystem of the SiD Detector collaboration since they are integral to the SiD detector.

GamCal can be a joint effort of the ILC BDS team and the SiD Detector collaboration.

The polarimeter and energy spectrometer systems need to be a joint effort of the ILC BDS team and the SiD Detector collaboration. SiD intends to take significant responsibility for the design, development, operation and performance of these systems.

- SiD participants are already active in making significant contributions to their design and development.
- Data from the polarimeters and spectrometers must be delivered to the SiD DAQ in real time to be logged and permit fast online analysis.

Fast online analysis results must also be provided to the ILC controls system for beam tuning and diagnostics.

Details for integrating the luminosity, polarimeter and energy spectrometer data with the SiD DAQ remain to be worked out. SiD DAQ experts will assume responsibility for integrating the luminosity, polarimeter and spectrometer data streams with the SiD DAQ.

# Conclusions

Members of the SiD collaboration have worked for many years on the luminosity, energy and polarization systems for the ILC. This effort has been important in establishing the footprint/baseline parameters for the ILC that allows precision physics measurements depending on luminosity, energy and polarization and is reflected in the baseline of the ILC described in the RDR. Proposals to modify the baseline ILC were made at the 2008 Workshop on Polarization and Beam Energy Measurements at the ILC:

- Relocate the laser-wire emittance diagnostic and MPS energy collimator away from the upstream polarimeter chicane. **SiD LOI endorses!**
- Modify the extraction line polarimeter chicane from 4 magnets to 6 magnets to allow the Compton electrons to be deflected further from the disrupted beam line. **SiD LOI endorses!**
- Include precise polarization and beam energy measurements for Z-pole calibration runs into the baseline configuration. **SiD LOI endorses!**
- Realize the physics potential for the initial positron polarization of 30-45% **SiD LOI endorses!**
- Implement parallel spin rotator beamlines with a kicker system before the damping ring (DR) to provide rapid helicity flipping of the positron spin. **SiD LOI endorses!**
- Move the pre-DR positron spin rotator system from 5 GeV to 400 MeV to eliminate expensive superconducting magnets and reduce costs. **ILC cost reduction-does not effect physics!**
- Move the pre-DR electron spin rotator system to the source area to eliminate expensive superconducting magnets and reduce costs. **ILC cost reduction-does not effect physics!**

Continued active SiD participation in ILC machine design is important for optimizing physics results depending on polarization, energy and luminosity measurements.

SiD participation in machine design should emphasize those areas that impact capabilities for polarization and energy. These include:

Energy spread

Correlations in beam parameters such as E-z correlations,

Spin diffusion and de-polarization effects,

Polarization and energy measurements.