Polarization at SuperB

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SuperB Workshop at Frascati
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The people working on the polarization for SuperB are:

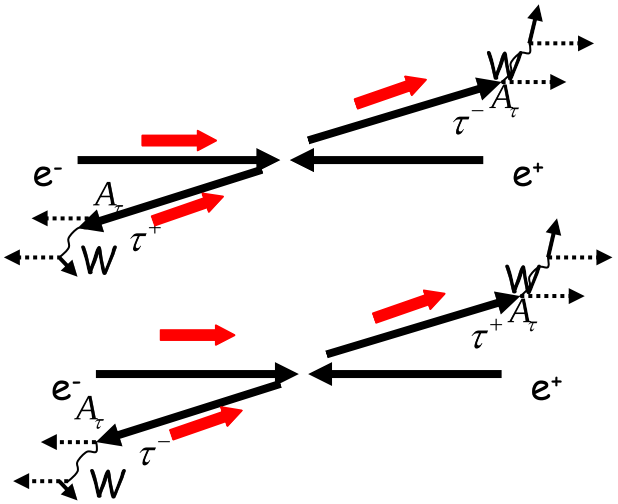
Ken Moffeit	Mike Woods	Michael Sullivan
Walter Wittmer	Yuri Nosochkov	Takashi Maruyama
Uli Wienands	Dieter Walz	David Leith

Jenny List and Desmond Barber from DESY have also contributed

The requirements for a polarization SuperB facility include:

- A stable longitudinal direction for spin at the IP;
- A depolarization time longer than one beam lifetime;
- The ability to provide arbitrary filling patterns, e.g., it would be very useful to have opposite polarizations in neighboring RF buckets;
- Polarization of the electron beam;
- High degree of polarization;
- Measure the longitudinal polarization at the IR of each bunch with accuracy $\Delta P/P < 1\%$.

Physics with polarized electron at SuperB:



Talks at this meeting:
- "Search for tau LFV with polarized beams" by Alberto Cervelli, INFN & Universita' di Pisa, Monday Physics I
- "Discusion on CP violation in Hadronic tau decays", Oscar Vives, Tuesday Physics V
- "Non-LFV Tau Physics with polarized beams" Michael Roney, Tuesday Physics V

Tau Lepton Flavor Violation: Polarized SuperB extends reach for LFV searches e.g. tau > $\mu\gamma$ and tau > $\mu\mu\mu$ by factor ~1.5 to 2. If tau LFV found then a polarized SuperB can better determine the features of the LFV interaction.

Tau asymmetry parameter:

Present asymmetry parameter measurements from PDG

$$A_e = 0.1515 \pm 0.0019$$

$$A_\mu = 0.142 \pm 0.015$$

$$A_\tau = 0.143 \pm 0.004$$

With polarized electrons SuperB can measure A_τ with the same precision as A_e

There is a 3-sigma discrepancy in weak mixing angle determined from lepton asymmetry measurements versus heavy quark asymmetry measurements at LEP-SLC; tau asymmetry measurements at SuperB will allow a 2nd precise lepton asymmetry measurements.

Physics with polarized electron at SuperB: A_{LR} for $\mu^+\mu^-$, …

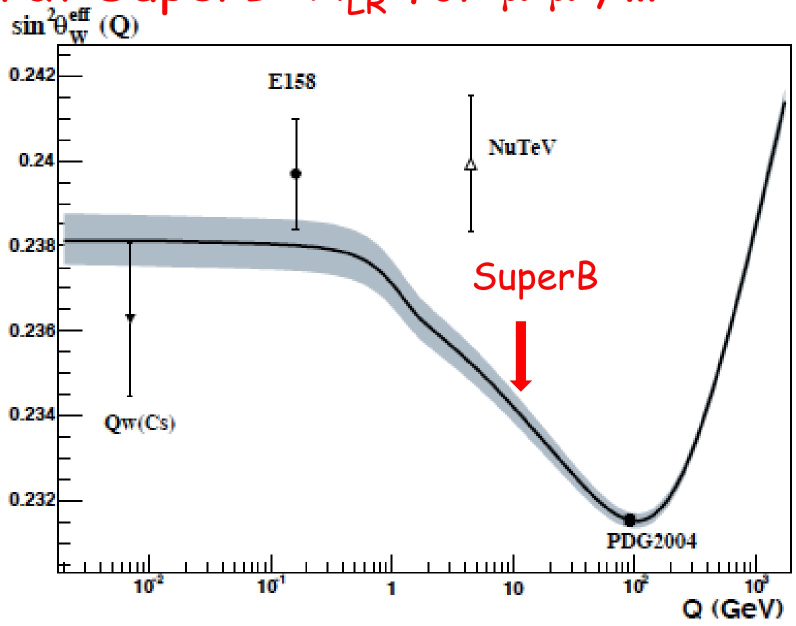


FIG. 2: Predicted variation [18] of $\sin^2\theta_W^{eff}$ as a function of momentum transfer Q (solid line) and its estimated theoretical uncertainty (shaded area). Results of prior low energy experiments [6, 16] (closed triangle, shown at an arbitrarily higher Q) and [7] (open triangle) are overlaid together with the Z^0 pole value [16] (square) and this measurement (circle).

$$A_\tau, A_\mu, A_b$$

From $|\gamma + Z|$ interference

and measurement of A_{LR} for muon pairs

e+e- > $\mu^+\mu^-$ at $\sqrt{s}$=10.58GeV

Diagram: $|Z+\gamma|^2$

Cross Section = 1.01 (nb)
A_{FB} = 0.0028
A_{LR}(Pol = 100%) = -0.00051

expected stat. error on A_{LR} = 4.6x10-6
- relative stat. error of 1.1% (pol=80%)
- So require <0.5% systematic error on beam polarization

Error on A_{LR} =5×10^{-6} gives error on ($\sin^2\theta_{eff}$) =0.00018
SLC A_{LR} error on ($\sin^2\theta_{eff}$) =0.00026

Similar measurement with tau-pairs –

see Michael Roney, "SuperB Neutral Current Polarisation Physics: Studies with Z_{Fitter} &tc"

Physics with polarized electron at SuperB: Tau anomalous magnetic moment

(J.Bernabeu, G. A. Gonzalez-Sprinberg, J. Papavassiliou, J. Vidal, Nuclear Physics B 790 (2008) 160 and
See Proceedings of SuperB Workshop VI arXiv:0810.1312v2 [hep-ph] 10 Oct 2008.

Electron anomalous magnetic moment is measured with the highest precision.

$$a_e = \mu_e / \mu_B - 1 = \frac{g_e - 2}{2} = \left(1159.6521810 \pm 0.0000007\right) \times 10^{-6}$$

$$a_\mu = \mu_\mu /(eh/2m_\mu) - 1 = \frac{g_\mu - 2}{2} = \left(1165.92080 \pm 0.00054 \pm 0.00033\right) \times 10^{-6}$$

Present knowledge of Tau anomalous magnetic moment is rather poor.

$$-0.052 < a_\tau < 0.013(95\% C.L.)$$

Standard model predicts: $a_\tau^{SM} = \mu_\mu /(eh/2m_\tau) - 1 = \frac{g_\tau - 2}{2} = 1177.21(5) \times 10^{-6}$

Electron polarization gives the tau polarization and the transverse and longitudinal asymmetries of the tau decays determine the tau anomalous magnetic moment.

Tau anomalous magnetic moment can be measured with a statictical error of ~2.4X10^{-6} with electron polarization in SuperB.

$$a_\tau^{SuperB} = \frac{g_\tau - 2}{2} \approx (11?? \pm 2.4) \times 10^{-6}$$

Physics with polarized electron at SuperB: Tau EDM

The electric dipole moment of the tau (CP violation) can be determined from the transverse asymmetries in the tau decays.

Present Knowledge: Search for the tau EDM with unpolarized beam has been reported by Belle (K. Inami et al.Phys. Lett. B551, 16 (2003)) with sensitivity $tau_{EDM} = [0.9-1.7]\times 10^{-17} e\cdot cm$

SuperB with unpolarized electrons sensitivity tau_{EDM} ~ [17-34] X 10^{-20} e cm

SuperB with Polarized electrons: Sensitivity for the real part of the tau electric dipole moment from 75ab^{-1} and 80% polarization, 80% geometric acceptance and 97.5% track reconstruction efficiency. See Proceedings of SuperB Workshop VI arXiv:0810.1312v2 [hep-ph] 10 Oct 2008.

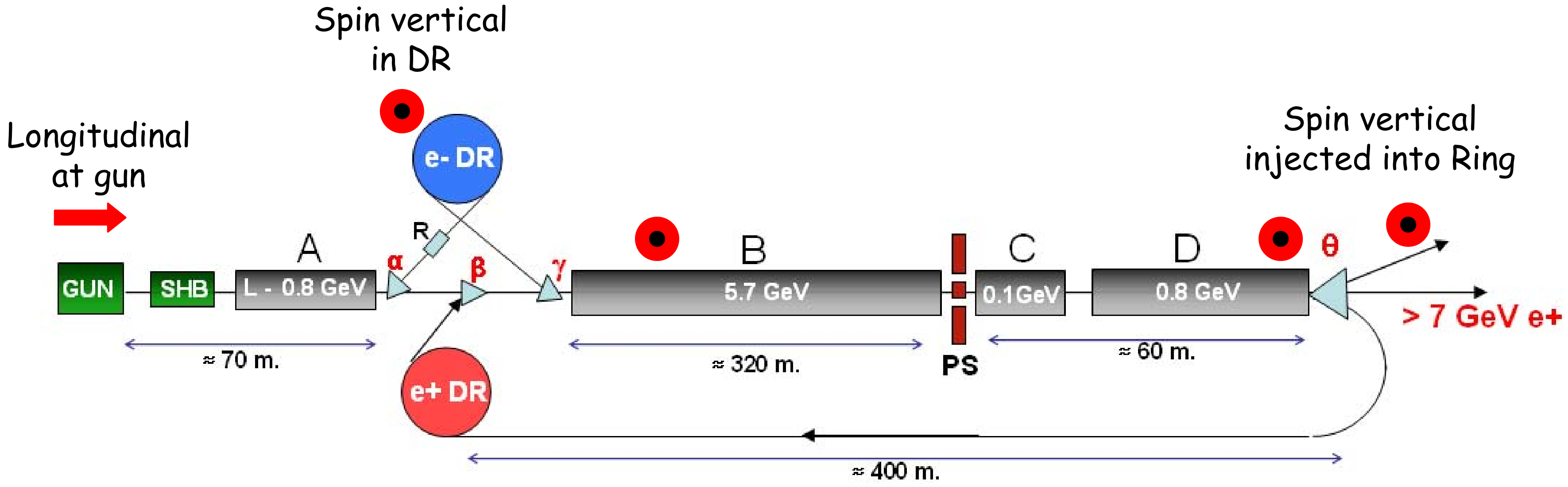
SuperB with P_e~ 80%

$$tau_{EDM} \approx 10\times 10^{-20} e\cdot cm$$

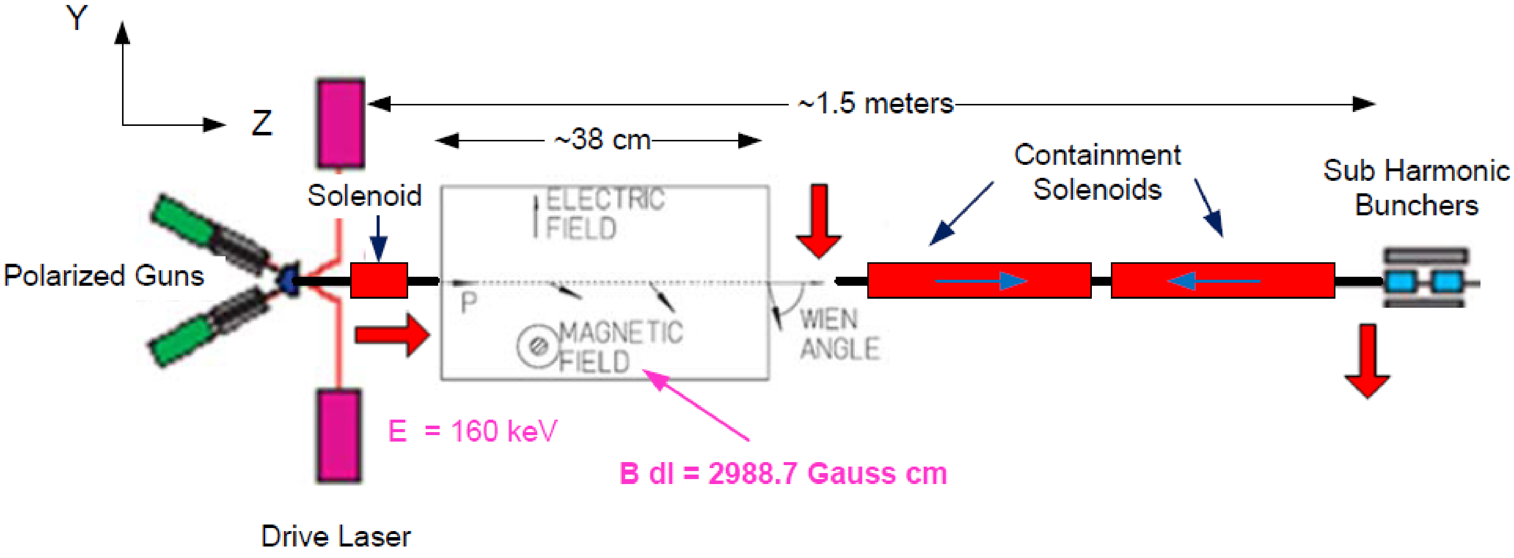
All the hadronic tau channels can be used to improve the measurement.

A polarized SuperB gives a factor of 1.7 to 3.4 improved sensitivity to an tau electric dipole moment over an unpolarized SuperB.

To preserve polarization spin must be normal to plane of damping ring and main ring arc bends.

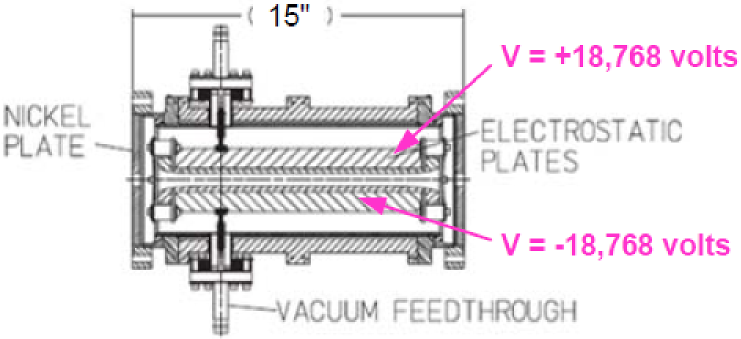


Spin Rotation to the Vertical at Polarized Gun with Wien Filter Energy is 100 and 160 keV



E = 160 keV

B dl = 2988.7 Gauss cm



V = +18,768 volts

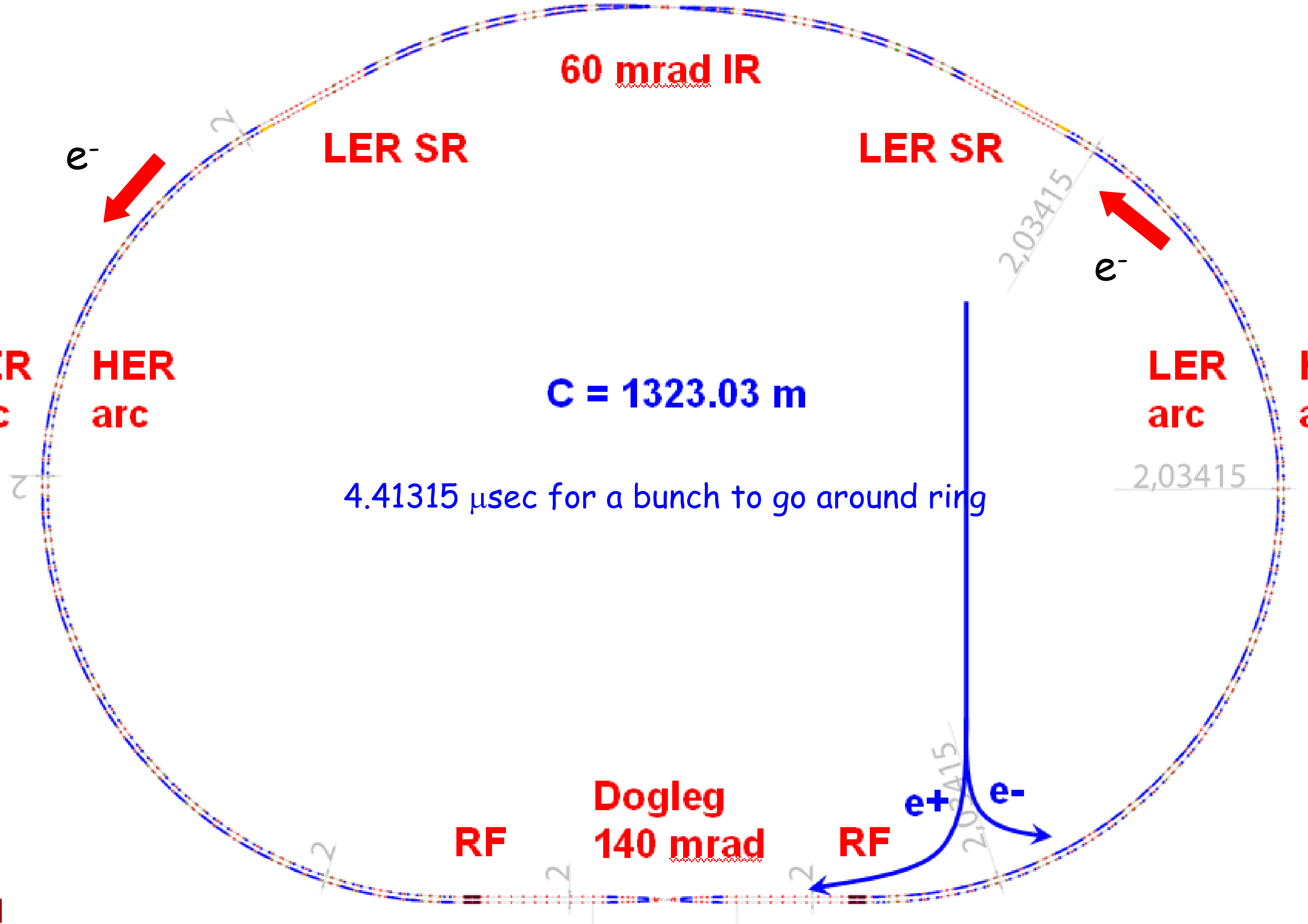
V = -18,768 volts

Wien filter spin manipulator
The magnet is not shown in the cutaway view

ILC source may run above **200 keV** to reduce space charge effects.
E=200keV has **B dl ~ 3600 Gauss cm** and **V=+/- 24,253 volts**

C. Y. Prescott, SLAC Engineering Note 71, 8 Feb 1977

Latest Ring Layout



60 mrad IR

LER SR **LER SR**

e$^-$ e$^-$

LER arc **HER arc**

LER arc **HER arc**

C = 1323.03 m

4.41315 μsec for a bunch to go around ring

RF **Dogleg 140 mrad** **RF**

e+ **e-**

Polarimeter

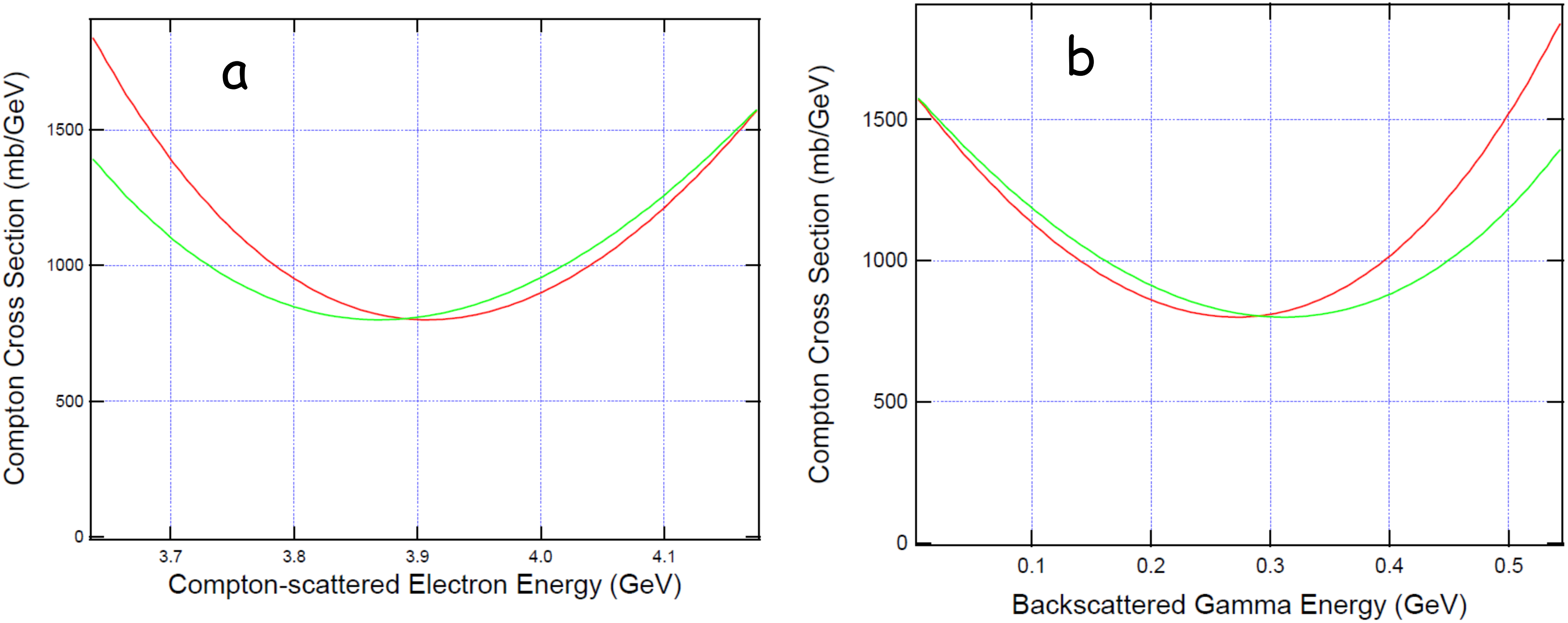
Compton scattering of polarized laser light on polarized electron beam is non-invasive and allows fast measurement of the polarization for each bunch in the ring.

Measure polarization for each bunch in the ring allowing helicity selection for each bunch. Bunches are separated by 4.2 nsec (2.1 nsec possible in future). Bunch length of beam is ~15 picosec. Compton gamma and electron detectors must have time resolution < 4.2 nsec.

Preferable to measure polarization asymmetry for both Compton scattered electrons and gammas.

Compton Differential Cross Section

Endpoint asymmetry is ~0.15 at 4.18 GeV



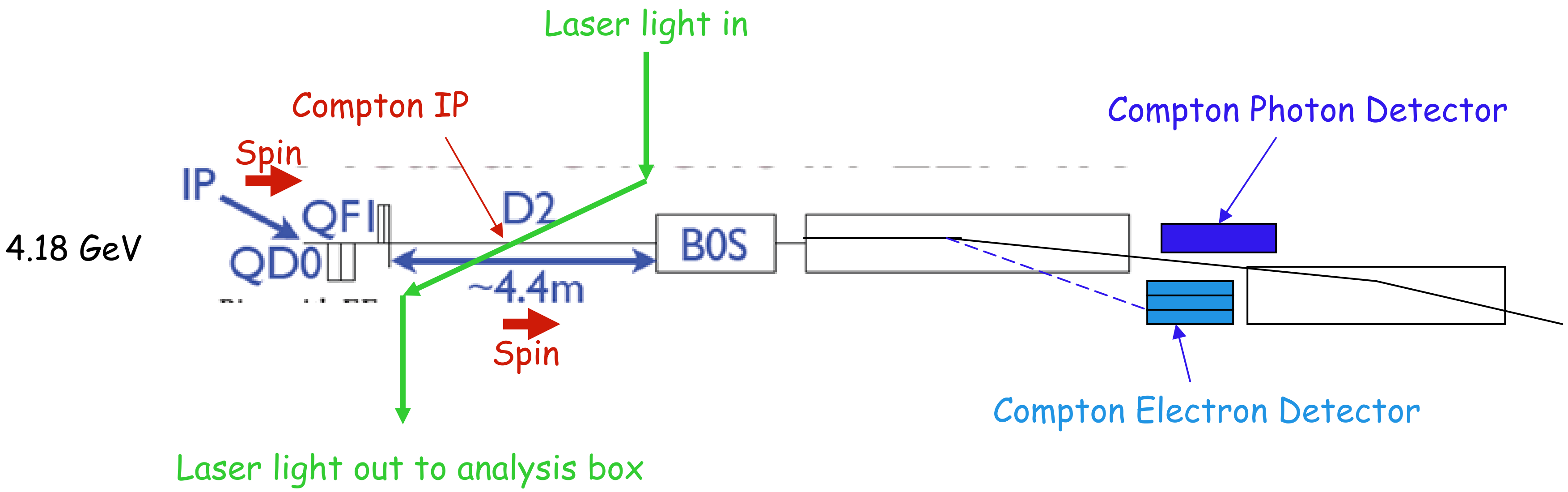
Compton differential cross section versus scattered
(a) electron energy (b) Gamma energy
for same (red curve) and opposite (green curve) helicity configuration of
laser photon (2.33 eV) and beam electron (4.18 GeV).

Compton Kinematics for different beam energies.

Beam Energy (GeV)	Compton Gamma Wmax (GeV)	Analyzing Power Max	<Analyzing Power> Flux weighted	<Analyzing Power> Energy weighted	Endpoint Compton Electron Energy (GeV)
250	224.48	0.98	-0.15	-0.068	25.19
45.6	28.25	0.75	0.042	0.179	17.35
27.5	13.62	0.59	0.063	0.187	13.88
7	1.40	0.22	0.043	0.096	5.60
4.18	0.54	0.137	0.030	0.064	3.64
4	0.50	0.13	0.029	0.061	3.50
2.5	0.20	0.084	0.020	0.040	2.29

Location of Compton Polarimeter

Option A: Near IP as beam electron leave IR.



Laser light in

Compton IP

Spin

4.18 GeV

Compton Photon Detector

Spin

Compton Electron Detector

Laser light out to analysis box

Pros:

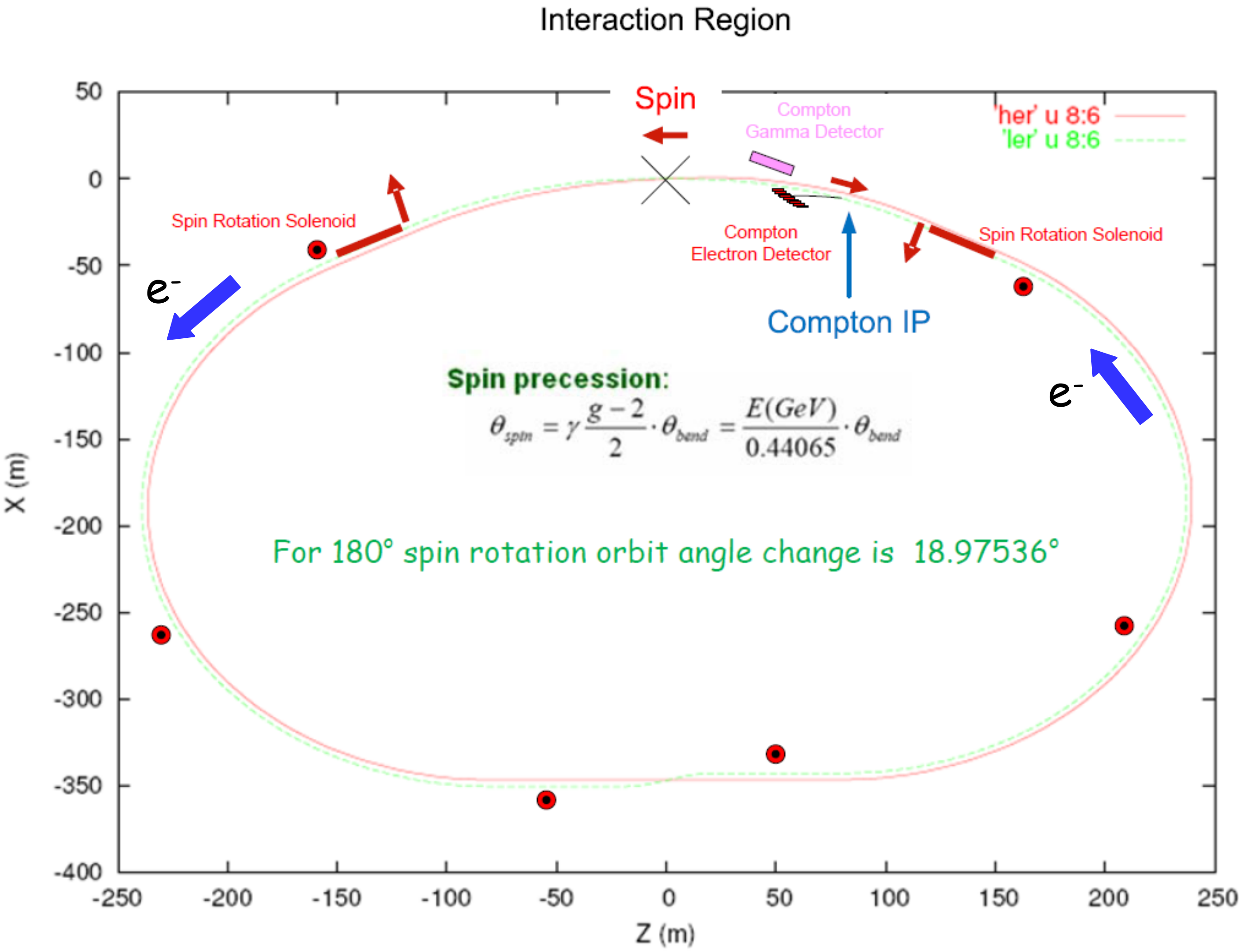
- Near IR. Beam direction same as that at IR. Easy to verify beam direction is within 7.5 mrad of beam direction at IR. A change in beam direction of 7.5 mrad between the IR and the Compton IP gives a spin projection at the Compton IP lower by 0.25%.
- Polarization measurement accurate even when beam is not at designed energy of 4.18 GeV for P.

Cons:

- Backgrounds from beamstrahlung large.
- Horizontal beam size large ~900μm at Compton IP reducing Compton luminosity.
- Crossing angle with the beam may be as large as 50mrad resulting in lower Compton scattering rate.

Compton Polarimeter must be downstream of IR if located near the IR. The Compton scattering will give backgrounds in physics detector if located upstream of IR.

Option B: Compton IP at location with pi spin rotation between Compton IP and IR



Spin precession:

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

For 180° spin rotation orbit angle change is 18.97536°

Pros:

- Backgrounds small. Smaller Compton Crossing angle (~18mrad) due to more room for Compton IP.
- Horizontal beam size ~500 μm..

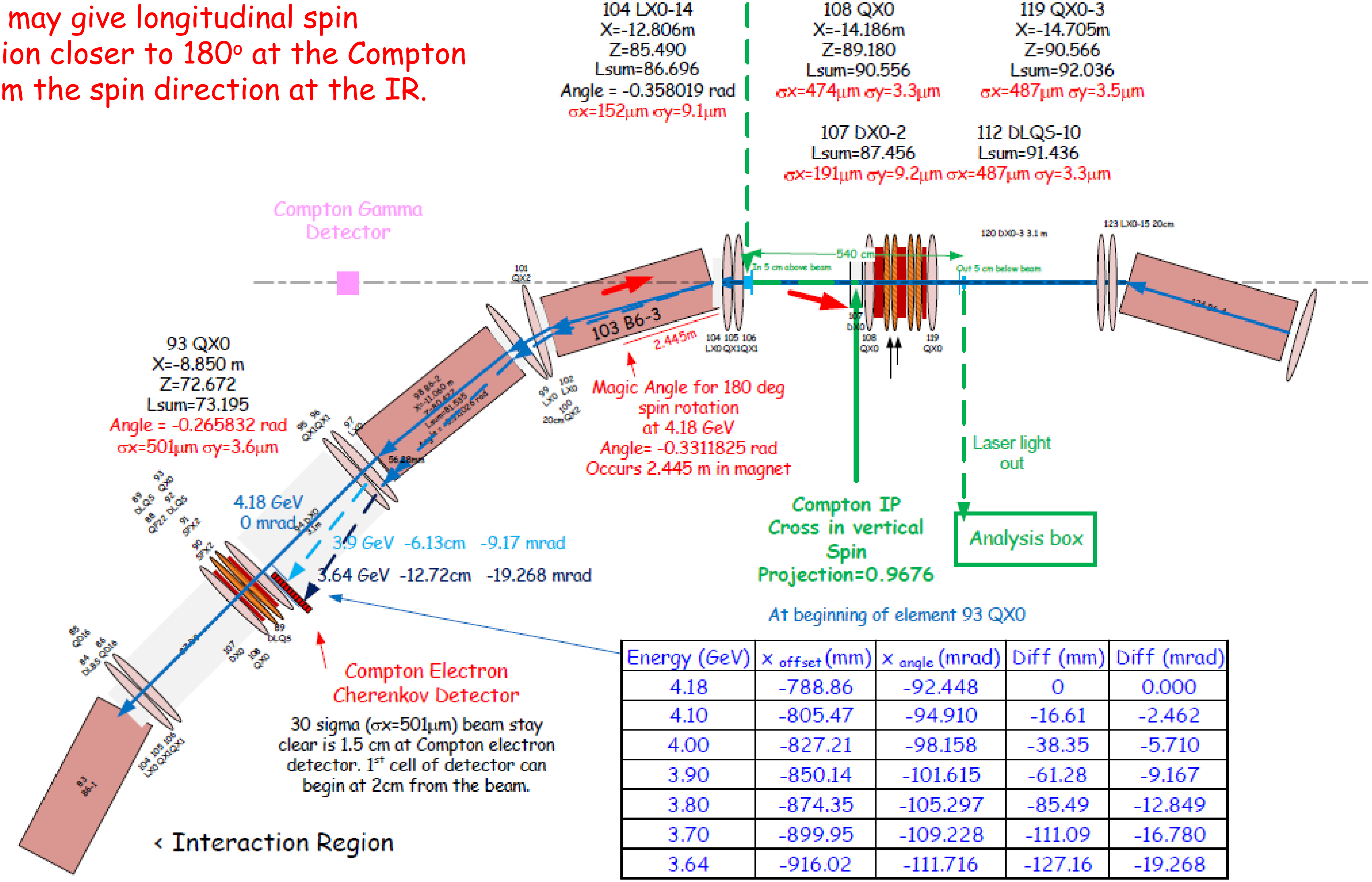
Cons:

- After n*pi spin rotations systematic error due to uncertainty in the orbit angle between IP and Compton IP. Uncertainty in electron beam orbit angle must be < 1 mrad.
- Compton IP may not be at magic angle for π spin rotation.

Compton IP near 180° spin rotation from spin direction at IR (orbit -0.358019 mrad from orbit at IR)

Future iterations of SuperB machine optics may give longitudinal spin direction closer to 180° at the Compton IP from the spin direction at the IR.

Laser light in horizontal direction perpendicular to beam ~30 cm above beam pipe, then down to lower mirror (6 cm above beam and right into vacuum pipe 5cm above beam 5.4 m between windows for 18.5mrad crossing angle

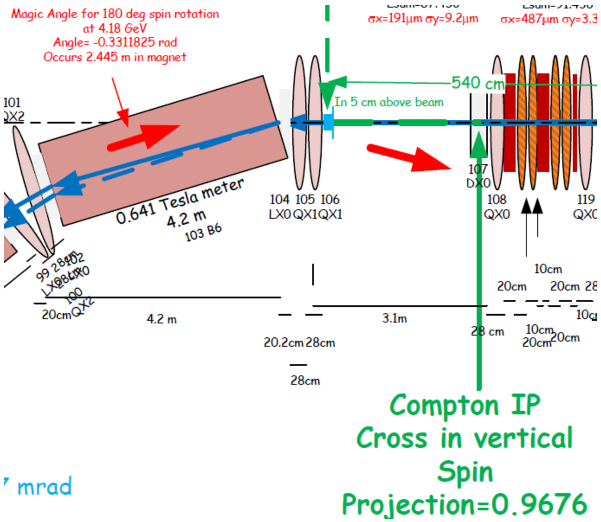


30 sigma (σx=501μm) beam stay clear is 1.5 cm at Compton electron detector. 1st cell of detector can begin at 2cm from the beam.

At beginning of element 93 QX0

Energy (GeV)	x_{offset} (mm)	x_{angle} (mrad)	Diff (mm)	Diff (mrad)
4.18	-788.86	-92.448	0	0.000
4.10	-805.47	-94.910	-16.61	-2.462
4.00	-827.21	-98.158	-38.35	-5.710
3.90	-850.14	-101.615	-61.28	-9.167
3.80	-874.35	-105.297	-85.49	-12.849
3.70	-899.95	-109.228	-111.09	-16.780
3.64	-916.02	-111.716	-127.16	-19.268

Compton IP not at 180° spin rotation



Compton IP
Cross in vertical
Spin
Projection=0.9676

Magic angle is -18.975° (-0.3311825 rad) at 4.18 GeV for 180° spin rotation from longitudinally polarized electrons at the Interaction Region.

Angle after element 124 B6-4 is -0.358019 where Compton IP is located.

Magic angle of 0.331105 rad occurs 2.445m into dipole 103 B6-3 where the orbit angle has changed -26.84 mrad from the orbit angle at the Compton IP.

Longitudinal Spin Projection at Compton IP is 0.9678.

An uncertainty of 1 mrad in the orbit at the IR and at the Compton IP gives an uncertainty in the polarization at the Interaction Region of 0.25%

Beam energy off 20 MeV from 4.18 GeV gives a ~0.2% difference in the polarization measured at the Compton IP and that at the IR.

Laser Optics Bench

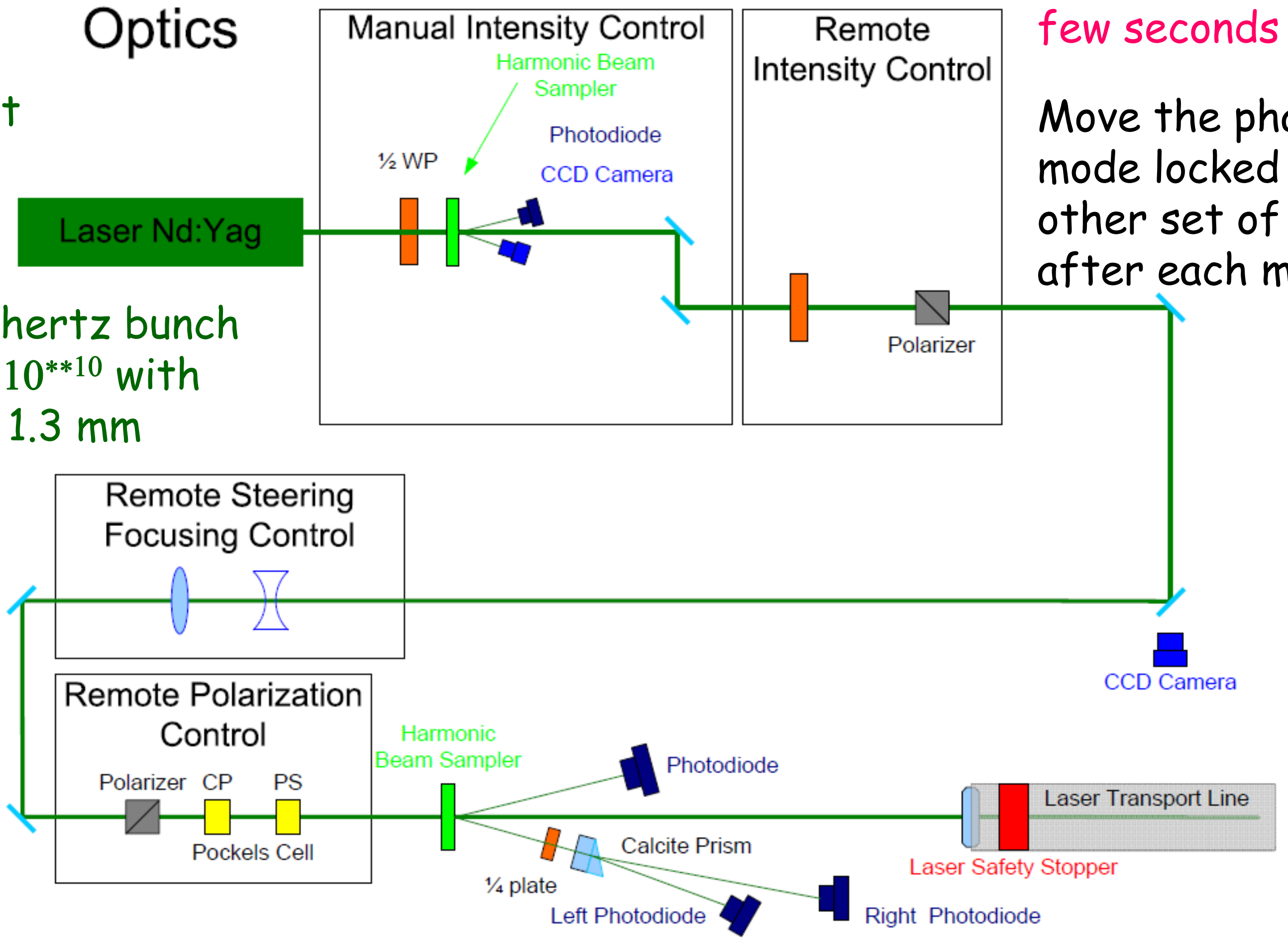
Mode locked
YAG Laser 119
megahertz
532 nm 1 watt
average power

Each 119 megahertz bunch
has $N_{\gamma} = 2.25 * 10^{**10}$ with
pulse width of 1.3 mm

1% measurement on every
bunch in the ring every
few seconds

Move the phase of the
mode locked laser to hit
other set of bunches
after each measurement.

Optics

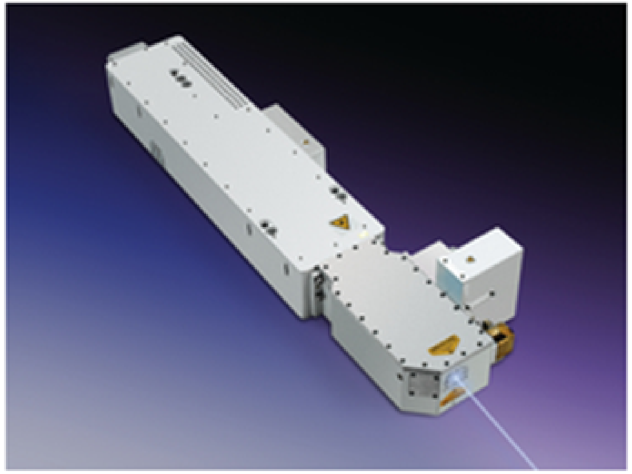


Randomly flip polarization of laser light with CP Pockels cell at ~100 hertz. To avoid ringing effects in the Pockels cell a short dead time may be necessary after each voltage change on the Pockels cell.

There are a number of Ti:sapphire (800nm) 119 megahertz lasers in operation at SLAC.
We expect to expect to be able to achieve similar capability with 532nm or 355nm.

Commercial Laser from Spectra-Physics at E_γ = 3.45 eV

Vanguard™ Quasi-CW Solid State UV Laser



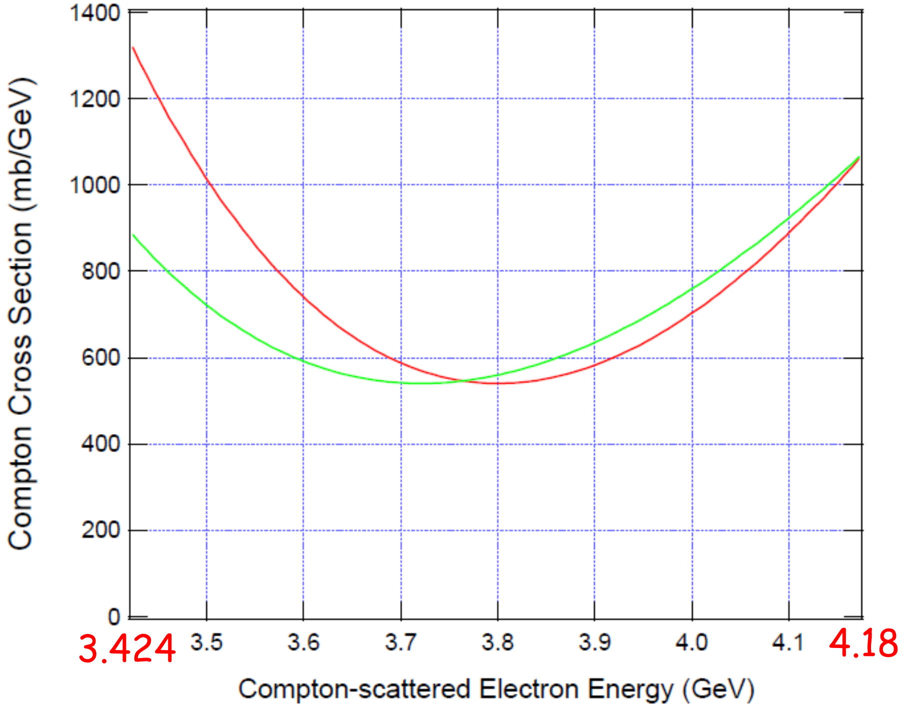
The Vanguard Advantage

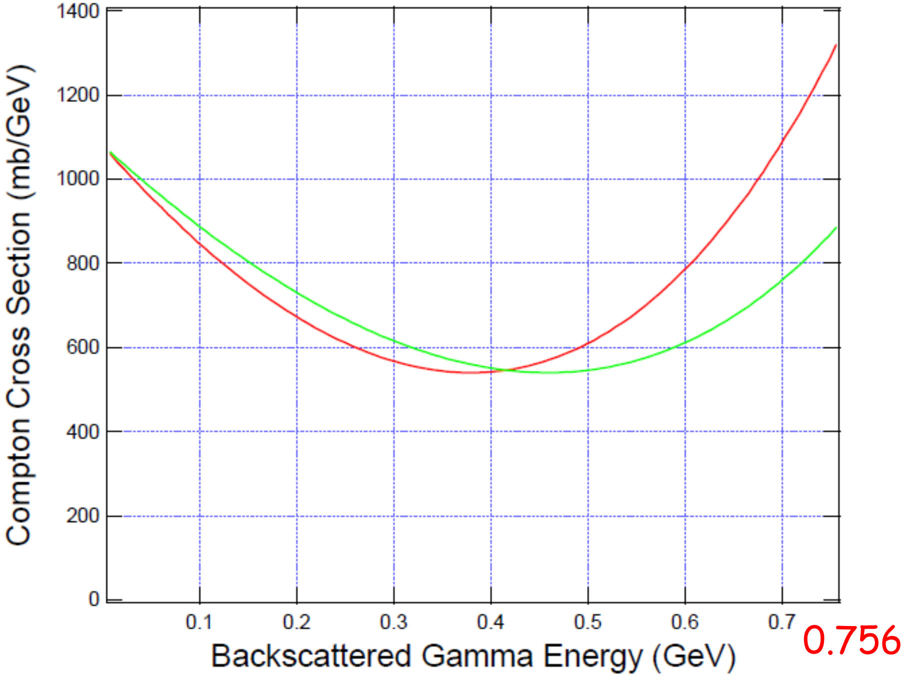
- High power, quasi-CW UV output up to 2.5 W
- Outstanding power stability
- Ultra-low noise
- Near diffraction-limited TEM_{00} output
- Hands off performance with computer control
- All solid state
- Rugged industrial platform
- Field-proven FCbar™ technology
- Low cost of ownership

Specifications

Output Characteristics	**Vanguard 2.5 W**	**Vanguard 350 mW**
Wavelength	355 nm	355 nm
Power	2500 mW	350 mW
Repetition Rate	80 MHz (±2 MHz)	80 MHz (±2 MHz)
Spatial Mode	TEM_{00}	TEM_{00}
M^2	<1.3	<1.3
Far Field Divergence, full angle	<1 mrad	<1 mrad
Beam Diameter ($1/e^2$)	1.0 mm nominal	1.0 mm nominal
Beam Pointing Stability	<25 µrad/°C	<25 µrads/°C
Beam Ellipticity	<20% far field	<20% far field
Average Power Stability	<2%	<2%
Amplitude Noise	<1% rms, 10 Hz to 2 MHz	<1% rms, 10 Hz–2 MHz
Polarization Ratio	>100:1 vertical	>100:1 vertical
Cold Turn-on Time (AC off to full power)	<30 min	<30 min
Cold Turn-on Time (AC off to full specs)	<1 hr	<1 hr
Temperature Range	21–25°C mean; <±2.5°C variation from mean (chiller required)	20–27°C

Beam Energy 4.18 GeV   Energy Laser photon = 3.45eV   15 mrad crossing angle

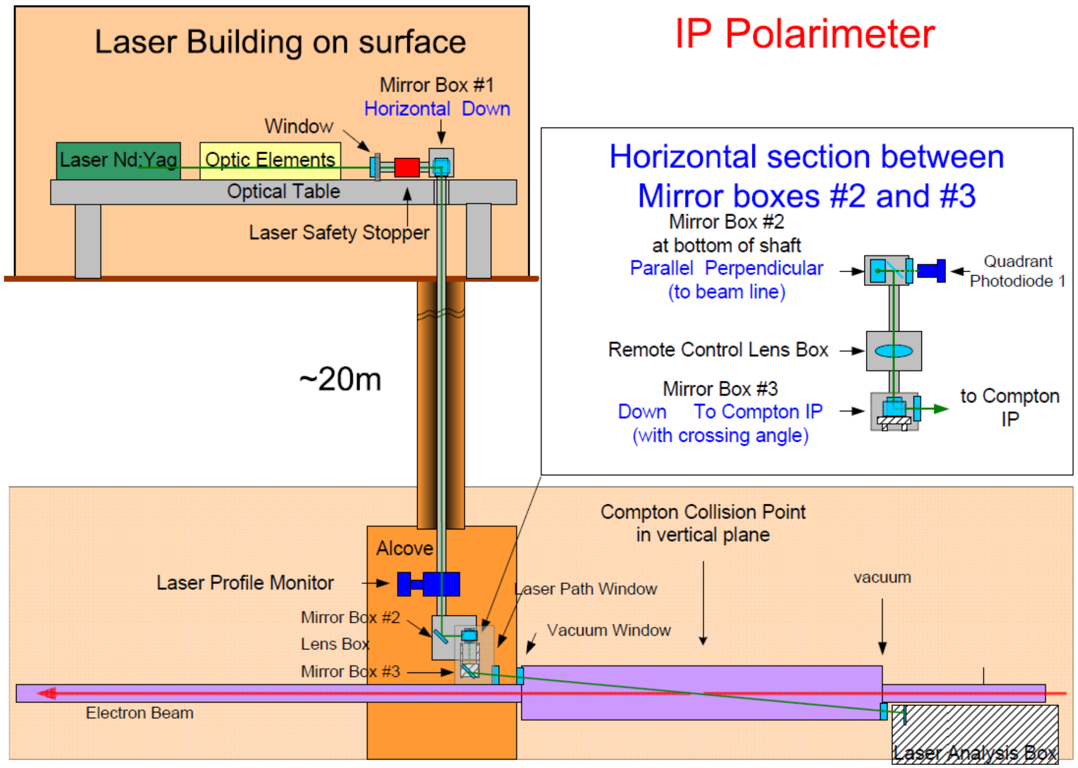




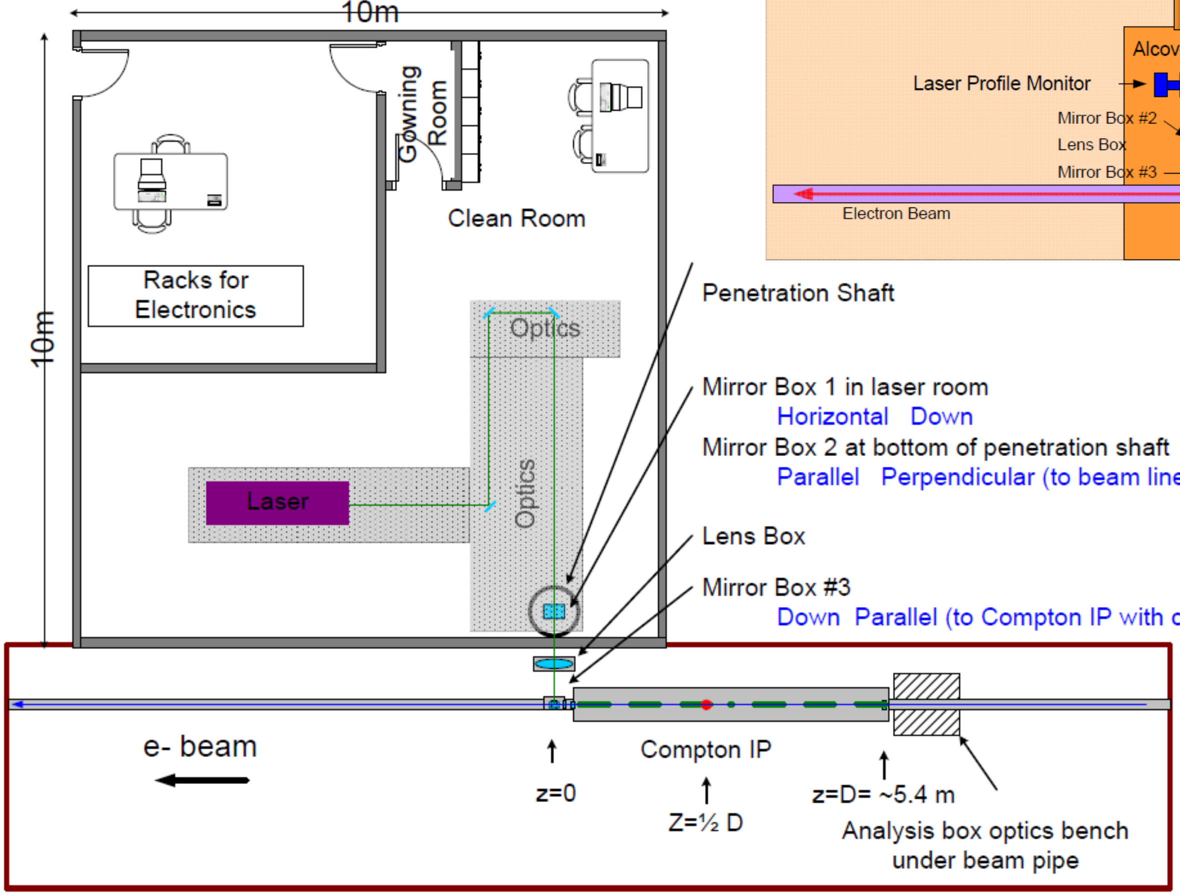
E_{beam} (GeV)	E_{photon} (eV)	Wmax (GeV)	$A\gamma_{max}$	$A\gamma_{flux\ wt}$	$A\gamma_{E\ wt}$	σ_{unpol} (mbarn)
4.18	2.3 green	0.537	0.137	0.030	0.064	1089
4.18	3.45 UV	0.756	0.197	0.040	0.088	731

Laser Transport to Compton IP

IP Polarimeter



Laser Room on surface (10mX10mX3m)



Penetration Shaft

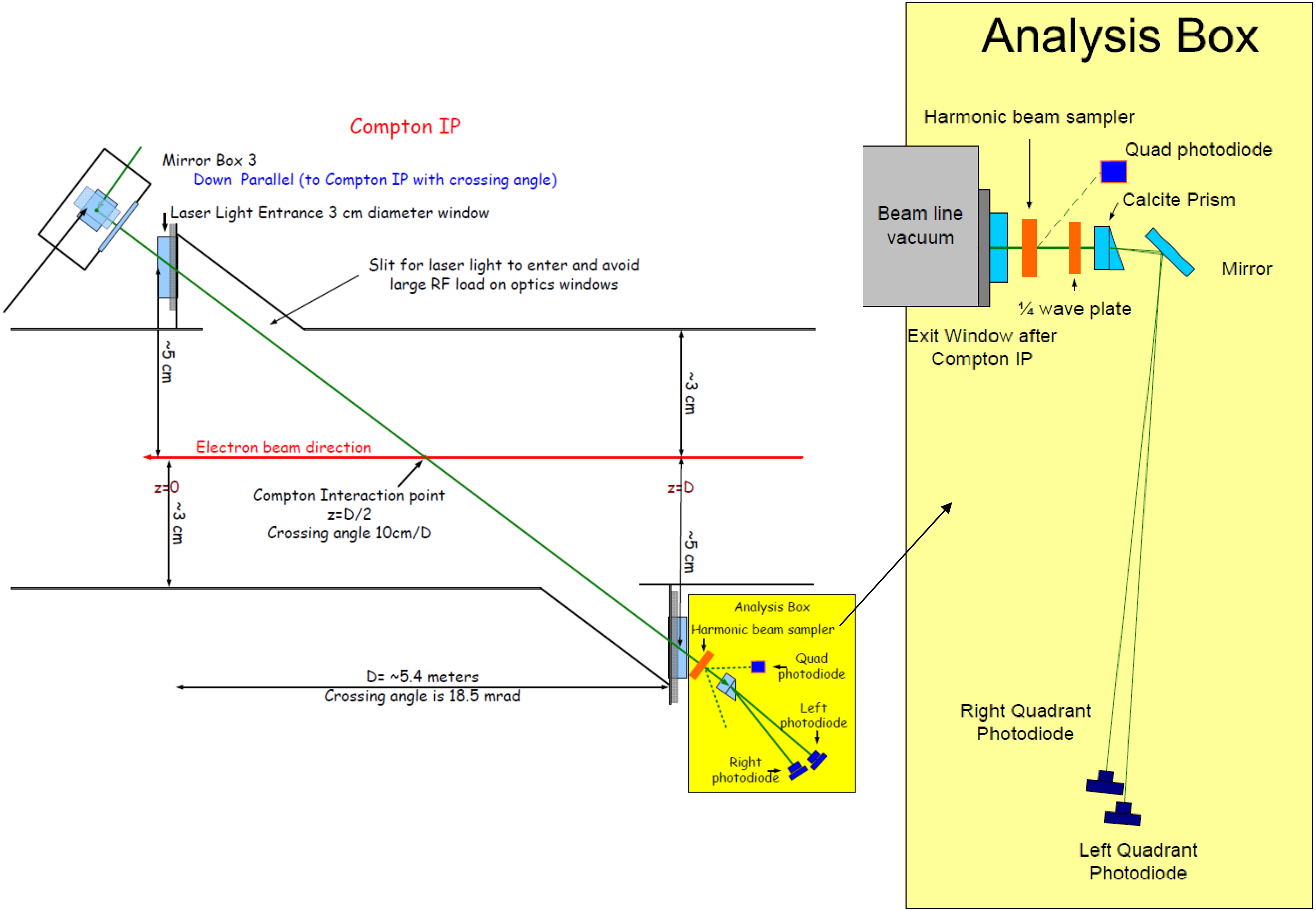
Mirror Box 1 in laser room
Horizontal Down

Mirror Box 2 at bottom of penetration shaft
Parallel Perpendicular (to beam line)

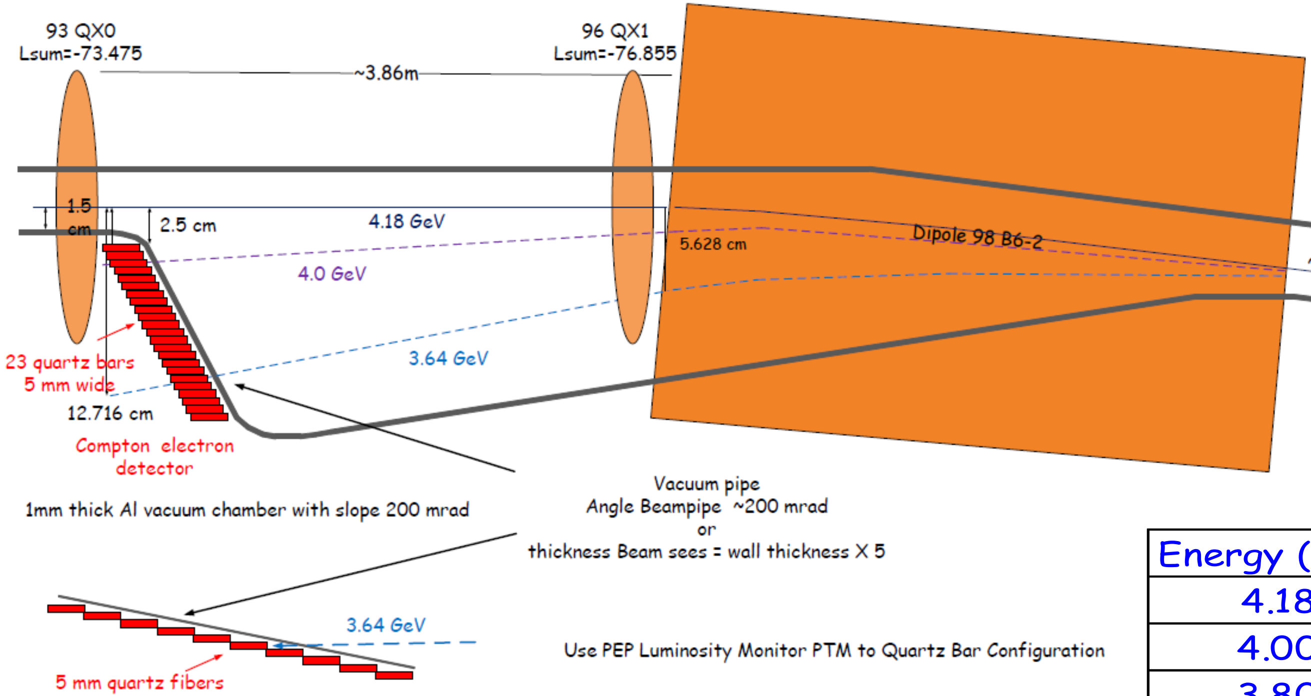
Lens Box

Mirror Box #3
Down Parallel (to Compton IP with crossing angle)

Compton IP and Analysis Box

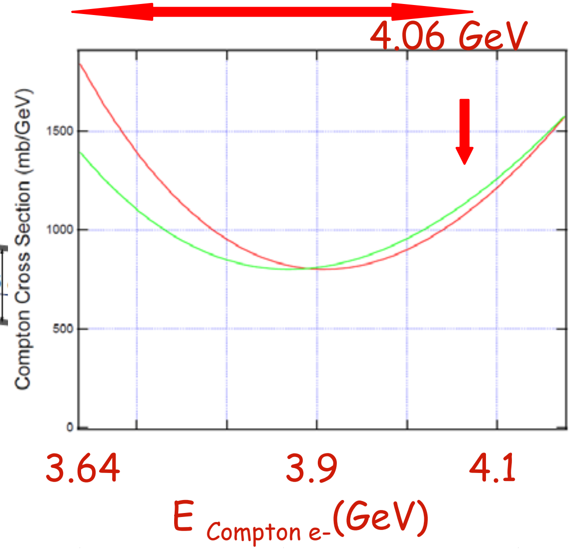


Compton Electron Detector



Use PEP Luminosity Monitor PTM to Quartz Bar Configuration

Compton Detector Acceptance



Energy (GeV)	Diff (cm)	Diff (mrad)
4.18	0	0.000
4.00	-3.84	-5.710
3.80	-8.55	-12.849
3.64	-12.72	-19.268

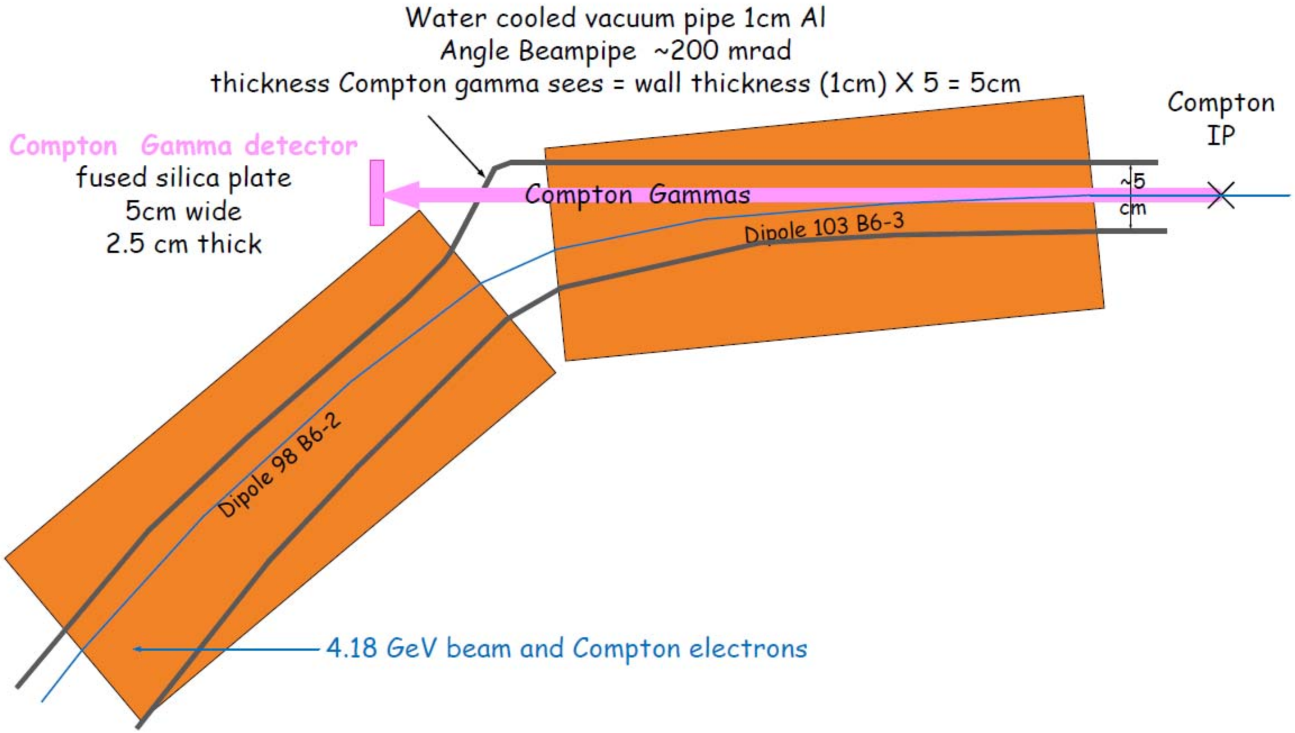
- Detect electrons with 2.5cm thick silica bar mated to a bi-alkali PMT. The silica bar is 5mm wide accepting ~21 MeV of backscattered electrons. Starting the 1st cell of the Quartz Cherenkov Detector at 2.5 cm from the beam gives acceptance from 3.64 to 4.06 GeV for Compton electrons .

- The 200 mrad angled 1mm think aluminum vacuum pipe upstream gives roughly 12 photoelectrons per track. Higher Compton scattered electron rate is preferred, but, Compton gamma detector prefers low rate of ~0.2 per laser electron bunch collision.

- Silica bars staggered enough to allow the PMTs (which would likely be 16 mm diameter using present-day technology) to match the pitch of the counters. As a guide, following the design of the PEPII luminosity counters, the Cherenkov light would be taken out upwards or downwards to the PMT, possibly through an air lightpipe.

- Radiation dose in these counters will absorb ~50 Megarads per year from the signal itself. Fused silica is a good match for this radiation dose.

Compton Gamma Detector



Compton gammas exit beam pipe through ~1.5 RL (water cooling + Al window). Window is water cooled to remove heat from synchrotron radiation which is all absorbed.

Compton gamma detector close to beam pipe.

Shower rejuvenated using local plate of tungsten or lead of ~2 RL covering. Remote insertion of different thickness radiators will allow systematic studies as was done at SLC and PEPII.

Close to radiator is a fused silica plate 5 cm square by 2.5 cm thick which will cover the active region.

Cherenkov light is taken out through a slanted roof into a light pipe, and converted in one or more 8 mm cathode fast PMTs. Fused silica may be extended a few cm to best match the PMT.

Shielding the calorimeter from background will be necessary.

Counting Rate for E= 4.18 GeV
Scattered electron rate for each laser/electron bucket crossing

Beam Parameter	Electron Beam	Laser Beam
σx	500 μm	100 μm
σy	5 μm	100 μm
σz	5 mm	1.3 mm
# particles/bunch	5.7 x 10^{10}	2.3 x 10^{10}

Compton cross section (unpolarized) for head-on collisions of 4.18 GeV electrons with 2.3 eV photons is 1.09 barns

$$R^0_{Compton} = \sigma_{Compton} \cdot \frac{N_{electrons} \cdot N_{photons}}{\pi \sigma_x \sigma_y}$$

$$R^0_{Compton} = 0.9 / bunch$$

The small vertical crossing angle, coupled with the electron bunch length, will increase the effective vertical spotsize of the colliding beams. This is parameterized by f_{geom}, which for small crossing angles is given below.

$$R^{eff} = R^0_{Compton} \cdot f_{geom}$$

$$f_{geom} = \frac{\sigma_y}{\sqrt{(\sigma_y)^2 + (\theta_y^{Compton} \cdot \sigma_z)^2}}$$

$$f_{geom} = \frac{100\mu m}{\sqrt{(100\mu m)^2 + (18.5mrad \cdot 5mm)^2}} = 0.73$$

Hence, the effective rate for Compton scatters (total number of Compton gammas per collision) will be 0.66 scatters/collision for a 1W laser beam w/ parameters: 532nm, 119MHz, 10ps bunch length.

Counting Rate for E= 4.18 GeV

Scattered electron rate for each laser/electron bucket crossing

The effective rate for Compton scatters (total number of Compton gammas per collision) will be 0.66 scatters/collision for a 1W laser beam w/ parameters: 532nm, 119MHz, 10ps bunch length.

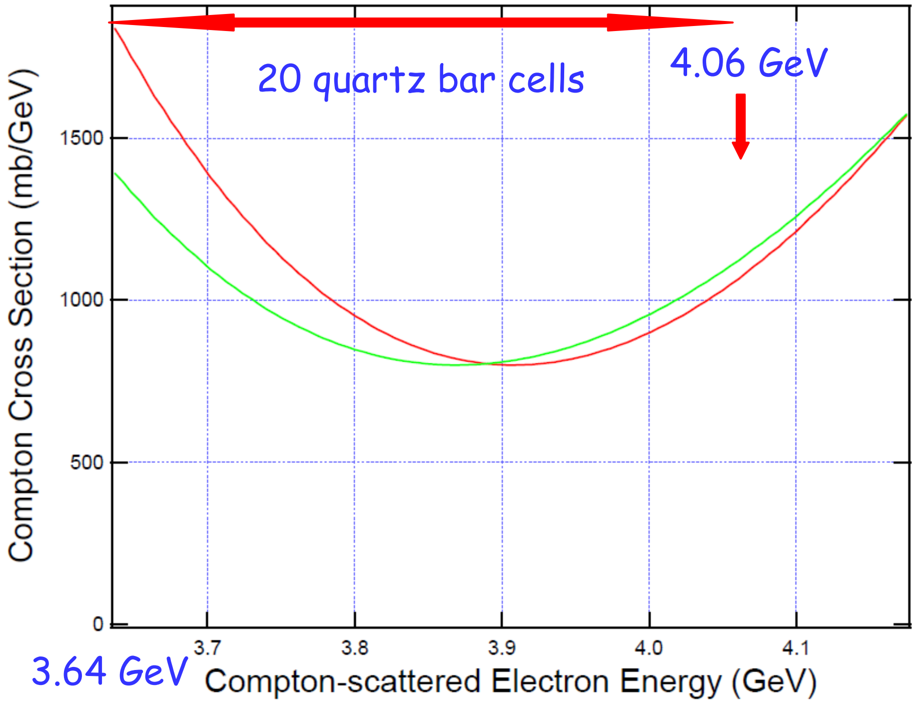
Each of the 1011 buckets goes around the 1323.02 m ring 226,597 revolutions per sec
Using a 119 megahertz mode locked laser the polarization of every 2nd bunch (i.e. 505 bunches) is measured.

Laser at full power =1 watt (119 megahertz hitting every other bucket)

- Compton Gamma Detector: Rate is ~ 149,554 gammas/sec for each electron bunch. Measurement of Polarization every few seconds. Note: total gamma rate is ~75.5 MHz for the 505 bunches.

- Compton electron Detector: Rate is ~ 6350 electron/sec in each quartz bar for each bunch of electrons. Each of the 20 cells covering the backscattered electrons between 3.64 GeV and 4.06 GeV have similar rates and provide a robust measurement of the electron beam polarization.

Compton Electron Detector Acceptance



Electron Beam Polarization from Compton Polarimeter Data

$$\sigma(E/E_0) = \sigma_0(E/E_0)\left[1 + P_e P_\gamma A(E/E_0)\right]$$

and the measured asymmetry in i^{th} channel

$$A_i^m = \frac{N_i^{\rightarrow\rightarrow} - N_i^{\rightarrow\leftarrow}}{N_i^{\rightarrow\rightarrow} + N_i^{\rightarrow\leftarrow} - 2N_i^{off}} = a_i P_e P_\gamma$$

where the analyzing power is calculated from the Compton Cross section and the channel response function, R_i.

$$a_i = \frac{\int \frac{d\sigma_0}{dx} A(x) R_i(x)\, dx}{\int \frac{d\sigma_0}{dx} R_i(x)\, dx}$$

1) Identify Bucket j
2) Collect data for Laser light right-handed and left-handed for time interval of ~1sec.
3) From laser analysis data during interval measure $P_\gamma^{\text{right-handed}}$ and $P_\gamma^{\text{left-handed}}$.
4) Measure asymmetries for electron bunch j
   $A^m_{\text{Compton gamma}} = (N_{right} - N_{left})/(N_{right} + N_{left} - 2N^{off})$ and $A^m_{\text{e- channel i=1 to max}} = (N_{right} - N_{left})/(N_{right} + N_{left} - 2N^{off})$
5) Correct asymmetries for analyzing power for each channel, i.e. channel containing the Compton electron at 3.64 GeV will have an analyzing power of $a_{\text{e channel i}}$ = ~ 0.137 and the forward gamma flux weighted asymmetry is $a_{\gamma\text{ flux wt}}$ = ~ 0.03
6) Calculate P_{e-}^{γ} (j^{th} bunch) = $A^m_{\text{Compton gamma}} / (a_{\gamma\text{ flux wt}} \times P_\gamma)$
7) Calculate $P_{e-}^{\text{Compton e}}$ (j^{th} bunch i^{th} channel) = $A^m_{\text{e- channel i}} / (a_{\text{e channel i}} \times P_\gamma)$
8) Use $P_e^{\text{Compton e}}$ (j^{th} bunch i^{th} channel) determined from each e- channel to obtain $P_e^{\text{Compton e}}$ (j^{th} bunch)
9) Measure simultaneously polarization of every other bunch hit by laser.
10) Move phase of 119 megahertz to hit 2nd set of bunches.
11) Record latest $P_e^{\text{Compton e}}$ and P_e^{γ} for jth bunch with physics trigger occurring on j^{th} bunch.
12) Time average polarization measurement for each bunch for specific time period (say ~ 30 sec). Record time averaged $P_e^{\text{Compton e}}$ and P_e^{γ} for all electron bunches in the ring along with physics data every time period (say ~ 30 sec).

Note: The polarization measurement of each bucket will give the helicity as well as the degree of polarization. The known helicity of each bucket from the polarized gun information should be recorded with each physics event and also along with the time averaged polarization every say ~30 sec.

Systematic Errors

	$\delta P/P$
Laser Polarization	~ 0.1%
Background uncertainty	< 0.25%
Uncertainty in Energy* of beam (20 MeV = ~ 0.2%)	< 0.2%
Error in beam direction at Compton (1 mrad = ~ 0.25%)	< 0.25%
Linearity of phototube response	< 0.25%
Luminosity weighted polarization uncertainty	< 0.1%
Uncertainty in asymmetry analyzing power	~ 0.5%
Total Systematic Error	<1.0%

Note:
A_{LR} measurement for $\mu^+\mu^-$ from [γ-Z] interference requires the systematic error on $\delta P/P < 0.5\%$. To reach this level we will need to reduce the uncertainty in the asymmetry analyzing power below 0.5% and know the energy and beam direction to higher precision.

Experiment Cost: Laser, optics on laser bench, optics in analysis box, optic elements in laser transport line, Compton gamma and Compton electron detectors, local data acquisition.

Super B project Costs:
Pays for laser building, penetrations, beam line elements, vacumn system, Laser safety system, ie all infrastructure

Conclusions

Spin rotation to the vertical at polarized electron gun. Helicity selected at electron gun randomly for each electron bunch in Linac (at 50Hz). Capability to select correct helicity bunch for injection to ring to match helicity of bunch in ring.

Compton Polarimeter: Located ~87m upstream of the IR where spin is nearly opposite the spin direction from IR.

- Laser: 1 watt, frequency doubled YAG (2.33eV), mode locked at 119 megahertz giving buckets of photons colliding at the Compton IP with every other electron bunch in the ring.
- Backgrounds expected to be small based on PEPII experience.
- Electron beam horizontal size ~500μm at Compton IP
- Crossing angle of laser light with electron beam ~18.5 mrad
- Compton electrons detected between 3.64 (12.7cm from beam) and ~4.06 GeV (2.5cm from beam).
- Compton gammas are detected in a forward fused silica plate detector with rate ~0.66 per γ/e bunch.
- Compton electron rate is ~ 0.03 in each 5mm quartz bar detector.
- Each bucket goes around the 1323.02 m ring 226,597 revolutions per sec giving 6,350 Compton scattered electrons/5mm cell detected each second for each of the 505 bunches out of 1011 in the ring. Twenty quartz bar cells each have comparable rates.
- New commercial laser is being considered having frequency in the UV (3.45eV vs 2.33eV) gives larger Compton asymmetries (19.7% vs 13.7%) with the Compton electron energy at 3.42 GeV vs 3.64 GeV.
- Electron beam polarization is not exactly longitudinal at Compton IP. Longitudinal spin projection at Compton IP is 0.968.

Systematic error can be controlled to below 1%. ALR measurement for mu pair production wants < 0.5%.

Polarimeter detectors must have time resolution less than 4.2 nsec so that the polarization of each bunch can be measured along with no-laser bunches.

Polarization measured on every bunch every few seconds in Compton gamma detector and separately in Compton electron detector.