ECFA DESY
Linear Collider Workshop

22 - 25 September 2000

Compton Polarimeter Summary

(1) Why Compton ?

→ basic QED process
→ well-established technique
→ precise: $\Delta P/P \sim 0.5\%$ possible
→ non-destructive photon target
→ well-suited for TESLA

(2) Kinematics, X-Sections, Asymmetries

→ two-body process
→ very small scattering angles ~ 5 μrad
→ large X-Sections & Asymmetries → fig.

(3) Polarimeter Location

→ end of 337 m long BDS straight section, 625 m upstream of e^+e^- IP → fig.
→ beam & spin direction precisely aligned with e^+e^- collision axis & spin dir.
→ use 0.77 mrad bend for momentum analysis of recoil Compton electrons
→ convenient environment for robust & continuous beam pol. measurement

(4) Spectrometer & Detectors

→ scattered electron momentum analysis with existing C-type bending magnets. Beam Sep. $\Delta x \geq 8.4$ mm for $E < E_0/2$, this covers region of interest (high anal. power).

→ electron det. ← principle instrum.
segmented gas Čerenkov + Shower

→ photon det. ← secondary instrum.
Calorimeter

→ need electron & photon exit windows, photon beam extraction requires enlarged apertures for some beamline magnets.

(5) Laser System

→ Wavelength: $\lambda \sim 1\,\mu m$ (infrared) baseline choice
[$0.5\,\mu m$ (visible) equivalent option]

→ similar to pulsed Laser system → fig.
for RF photo-injector gun (TTF FEL) developed by Max-Born-Institute (Berlin), $\leq 250\,\mu J$/bunch, $\sigma_t = 16 \pm 1$ ps, $P_{av} \leq 2$ W, matched to TESLA pulse pattern!

→ Laser location not yet decided, either in the tunnel (may require backup laser) or in dump hall (requires long beam transport).

(6) Some Numbers & Conclusions

e^+/e^- beam		Laser beam	
energy	250 GeV	energy	1.2 eV
charge/bunch	2×10^{10}	energy/bunch	70 μJ
bunches/sec	14100	bunches/sec	14100
bunch length	1.3 ps	bunch length	16 ps
average current	45 μA	average power	1 W
$\sigma_x \times \sigma_y$	~ 10 μm × 1 μm	$\sigma_x \times \sigma_y$	50 μm × 50 μm
emittance	~ 10^{-5} mm·mrad	emittance	≳ 0.17 mm×mrad

beam crossing angle	10 mrad
Compton events/bunch (*)	2×10^4
Compton events/sec (*)	3×10^8

* cannot be counted,
must process analog signals
(so-called "Multi-Compton" method)

→ very high statistics

→ allows meaningful polarization measurement for individual bunches

→ overall error dominated by systematics

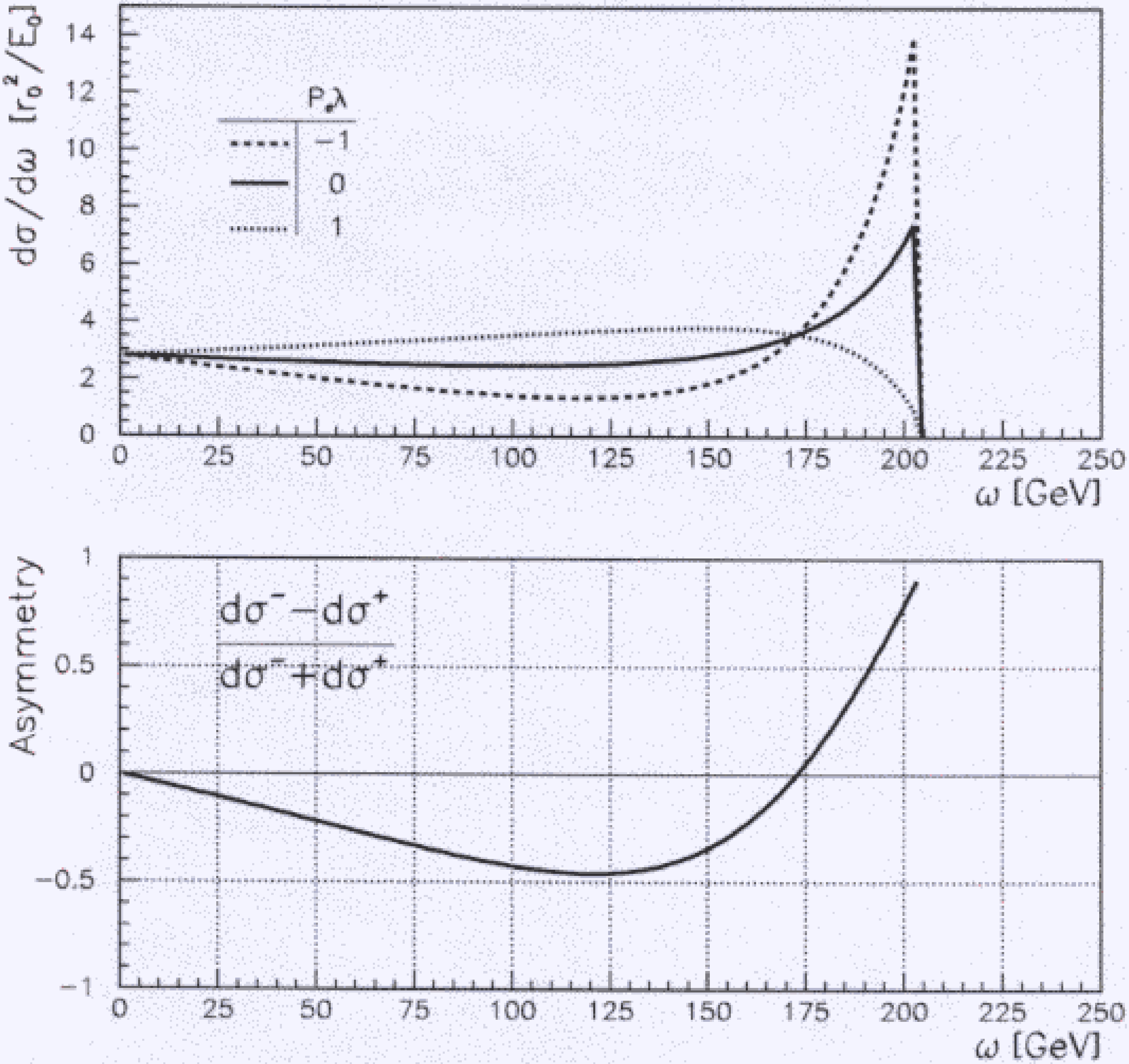
→ $\Delta P/P \sim 0.5\%$ is a realistic goal

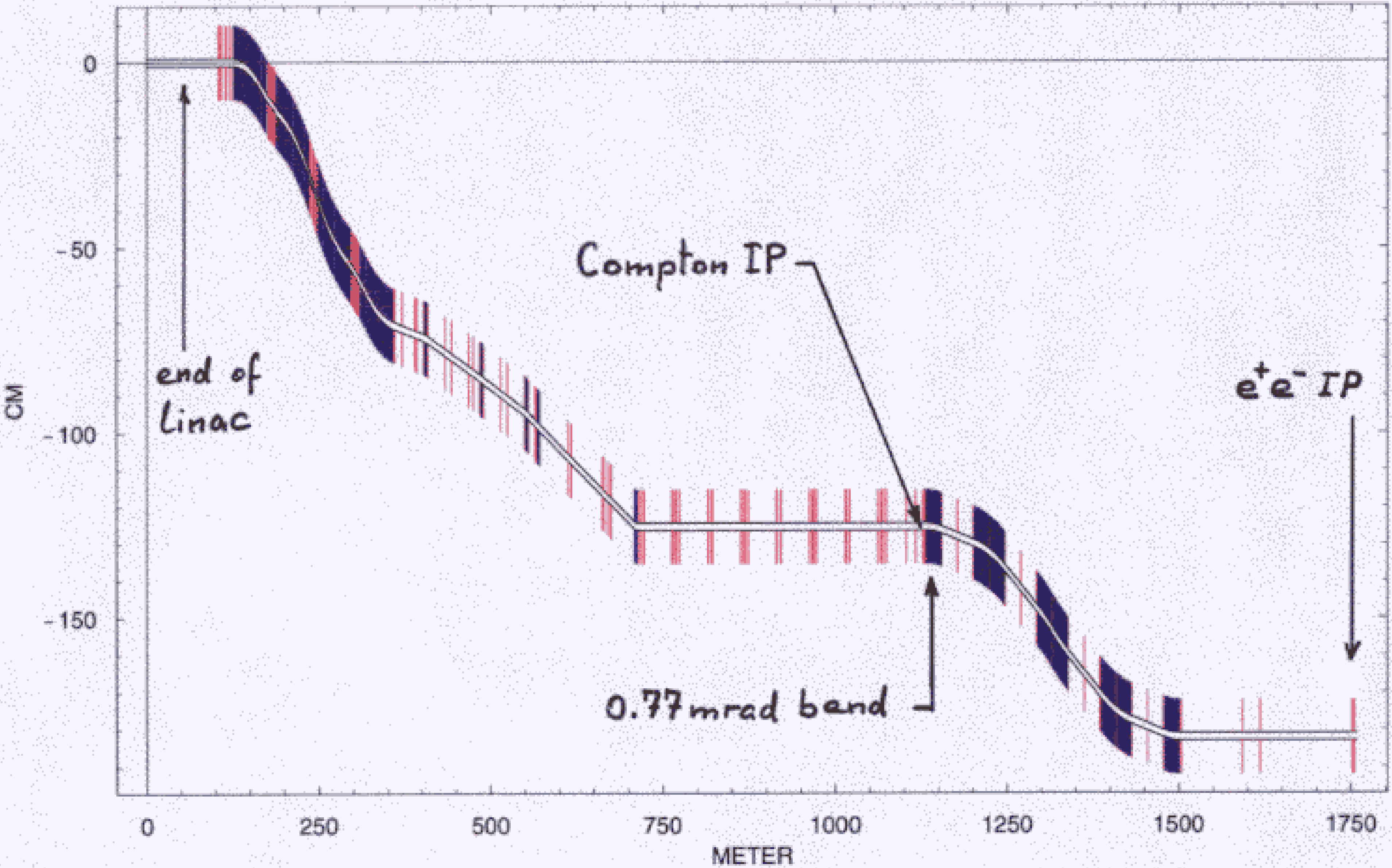
→ works also at other beam energies
$E_0 = 45.6 \rightarrow 400$ GeV

→ works equally well for e^+ beam of similar quality

Compton Cross Section & Asymmetry

$E_0 = 250$ GeV
$\omega_0 = 1.165$ eV




end of linac
Compton IP
0.77 mrad band
e+e- IP
CM
0
-50
-100
-150
METER
0
250
500
750
1000
1250
1500
1750