Polarization Updates

LCRD Proposals

Laser System for NLC-500 Design

Backscattered Gamma Measurements

Transverse Polarization Measurements?

"POWER" activities

Issues for baseline machine config

LCRD FY04 R&D Proposals to DOE

Polarimetry

1. **U. of Iowa (Y. Onel), Iowa State, Fairfield, Karlsruhe, Bogazici, Cukurova, META**

   Quartz Fiber Calorimeter or Counter
   - study utility for electron and photon detectors
   - compare counting and integrating (single and multi-Compton) modes

   W-pair asymmetry simulation; requirements for forward detectors

2. **Tufts U. (W. Oliver), SLAC**

   Background simulations
   - disrupted beam
   - beamstrahlung
   - also synchrotron radiation, beam-gas, radiative Bhabhas, pairs

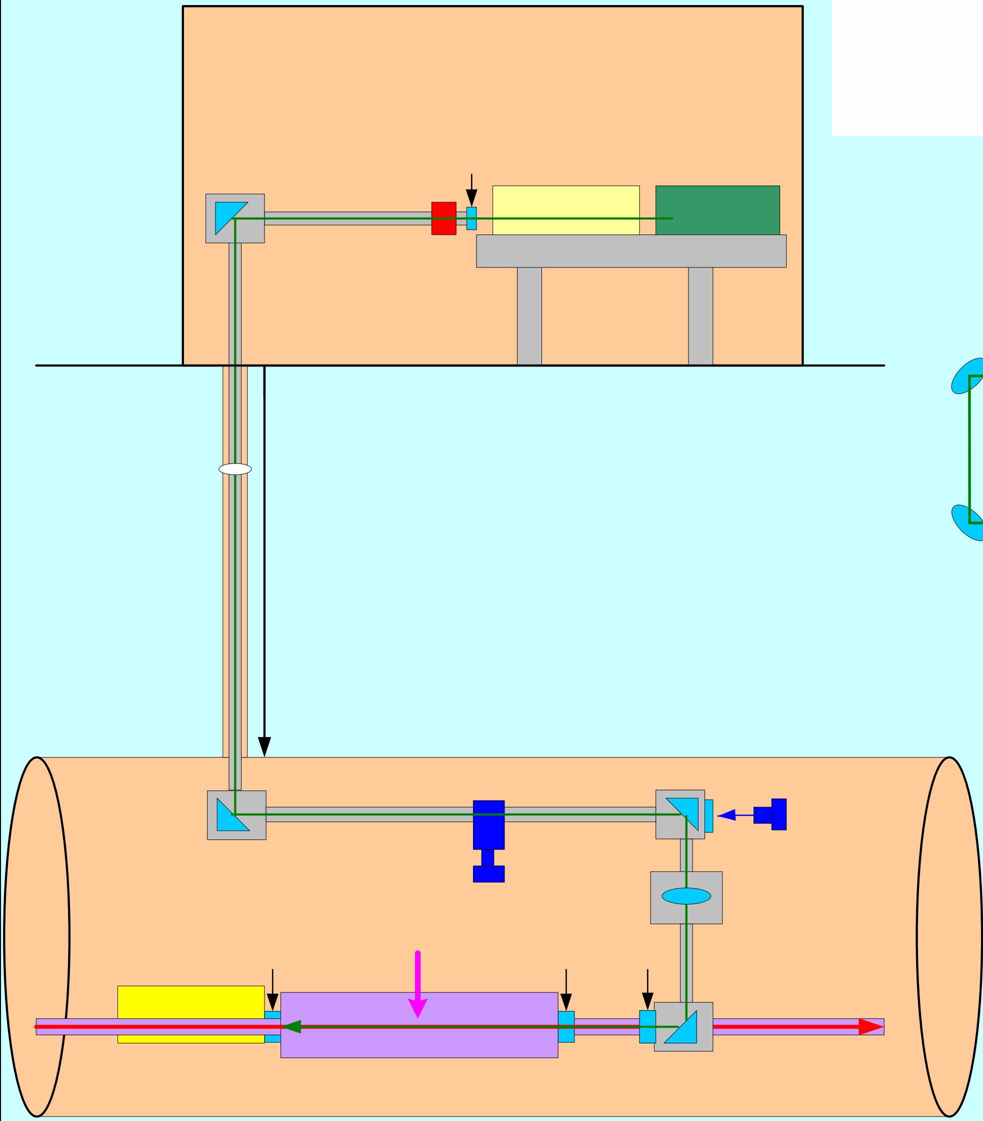
3. **U. of Tennessee (S. Spanier)**

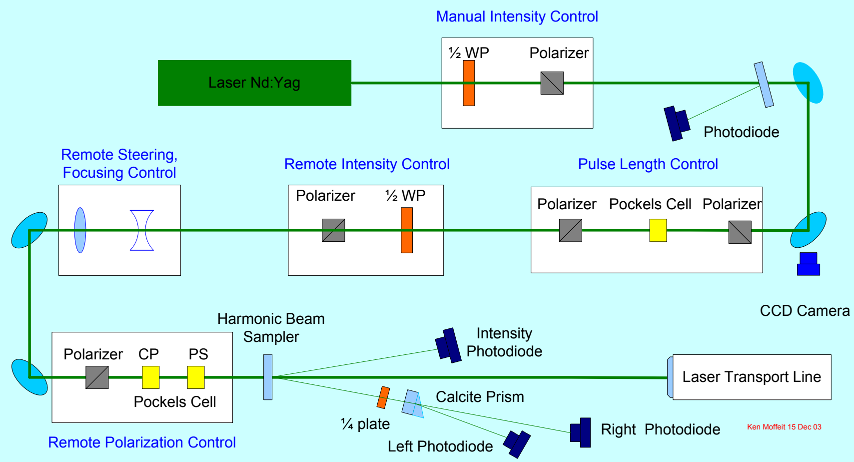
   Quartz Fiber Calorimeter for photon detector
   Pair spectrometer for converted photons
   Transverse Polarization measurement feasibility

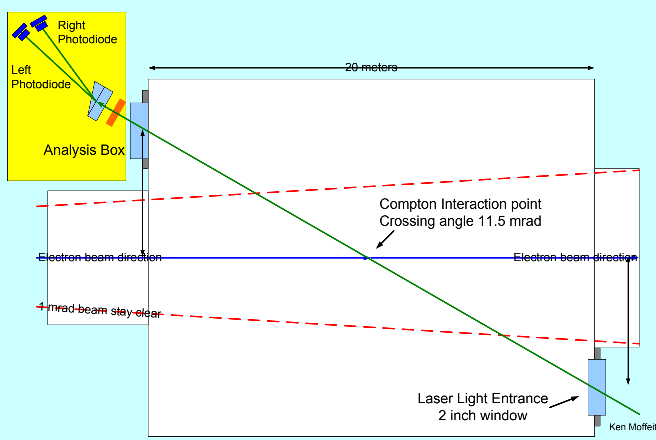
IPBI TN-2003-2
December 2003

Laser System for a Compton Polarimeter

Ken Moffeit and Mike Woods
SLAC







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Laser Parameters at Compton IP

Energy / pulse	100 mJ
Wavelength	532 nm
Pulse Width	2ns (FWHM)
Rep Rate	17 Hz
Spotsize σ_x, σ_y	100 µm

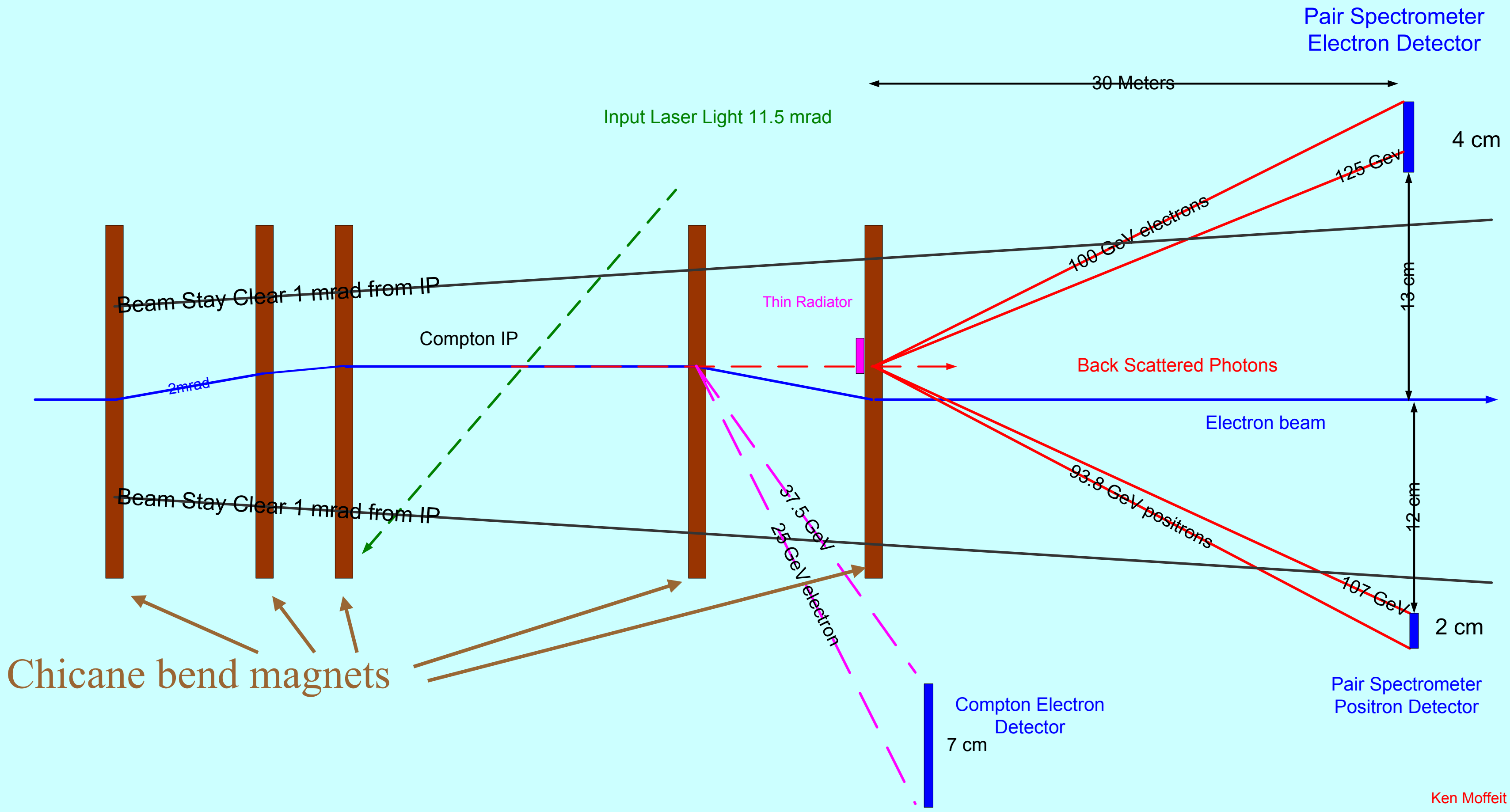
Colliding Beam Parameters at Compton IP

# electrons	0.75×10^{10}
# photons	2.7×10^{17}
Crossing angle	11.5 mrad
Endpoint rate*/ GeV	480
Endpoint rate* / cm	600

*rate is for undisrupted electron beam; with beam-beam disruption the rate drops by a factor 2

$$R = \frac{600 \text{ scattered electrons}}{\text{cm}} \cdot \left(\frac{100\,\mu m}{\sigma_y}\right) \cdot \left(\frac{11.5\,mrad}{\theta_{cross}}\right) \cdot \left(\frac{E_{laser}}{100\,mJ}\right) \cdot \left(\frac{2\,ns}{t_{FWHM}}\right)$$

Instrumentation for Polarimetry



Backscattered Photon Measurements?

Is a pair spectrometer feasible?

- detectors can be outside the 1mrad stayclear
- can converter be small and thin enough that background from disrupted electron beam and beamstrahlung photons is acceptable
- require coincidence of converted electron and positron with total energy near the kinematic endpoint
- counting mode measurement possible

2 LCRD proposals (U. of Iowa and U. of Tennessee)

are investigating backscattered photon measurement possibilites

Transverse Polarization
(if both beams polarized)

Physics examples:

1. *Transverse polarization signatures of extra dimenstions at Linear Colliders*,
   T. G. Rizzo, SLAC-PUB-9564; published in **JHEP 0302:008,2003**
   e-Print Archive: **hep-ph/0211374**

2. *CP violation at a Linear Collider with transverse polarization*, B. Ananthanaravan
   and S. D. Rindani; e-Print Archive: **hep-ph/0309260**

Measurements:

1. Null longitudinal measurement and knowledge of spin rotator settings

2. Direct measurement with Compton polarimeter?
   LCRD proposal by U. of Tennessee is investigating direct measurement
   possibilities with a transversely segmented quartz fiber calorimeter

POWER activities

(POlarization at Work in Energetic Reactions)

ECFA Polarization Working Group convenor is G. Moortgat-Pick

http://www.ippp.dur.ac.uk/~gudrid/power/

Major activity is a comprehensive document on "Polarization at the LC"

- physics, machine and polarimetry aspects
- focus is polarized positrons
- importance of transverse polarization (need both beams polarized)
- recent meeting at SLAC in October, joint with E-166 meeting

  (E-166 is a SLAC experiment to demonstrate production of polarized positrons with a helical undulator)

Issues for Baseline Machine Configuration

1. Polarized positrons

- helical undulator required for positron source
- additional spin rotators and polarimeter needed
- **should we support this in the baseline design?**

(with 2 caveats: - < 20% loss to integrated luminosity
- < 2% incremental cost)

2. Polarized electron-electron

- additional polarized electron source required
- additional spin rotators and polarimeter needed
- reversible magnet power supplies needed
- **should we support this in the baseline design?**

(with 2 caveats: - achieve at least 10% of e+e- luminosity
- <2 % incremental cost)

I propose that we support both of these options for the baseline design

Warm-Cold aspects of polarized e+ and e-e- options

1. Polarized positrons and Giga-Z

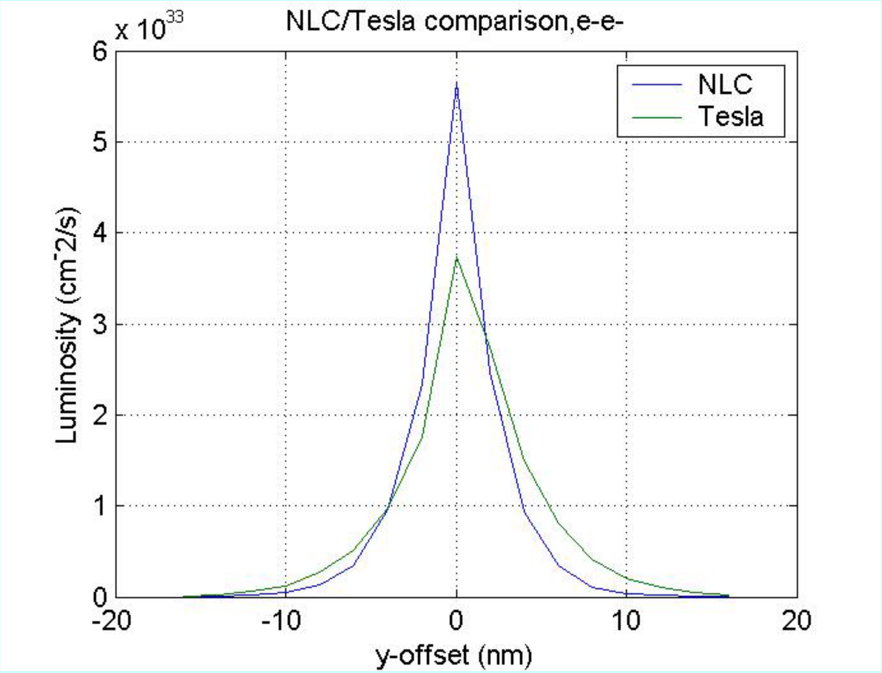
- one difference is the beamstrahlung energy loss which can impact the lum-wted E_{CM} determination
- one study of this is by Rowson and Woods, presented at LCWS 2000 (SLAC-PUB-8745; hep-ex/0012055)

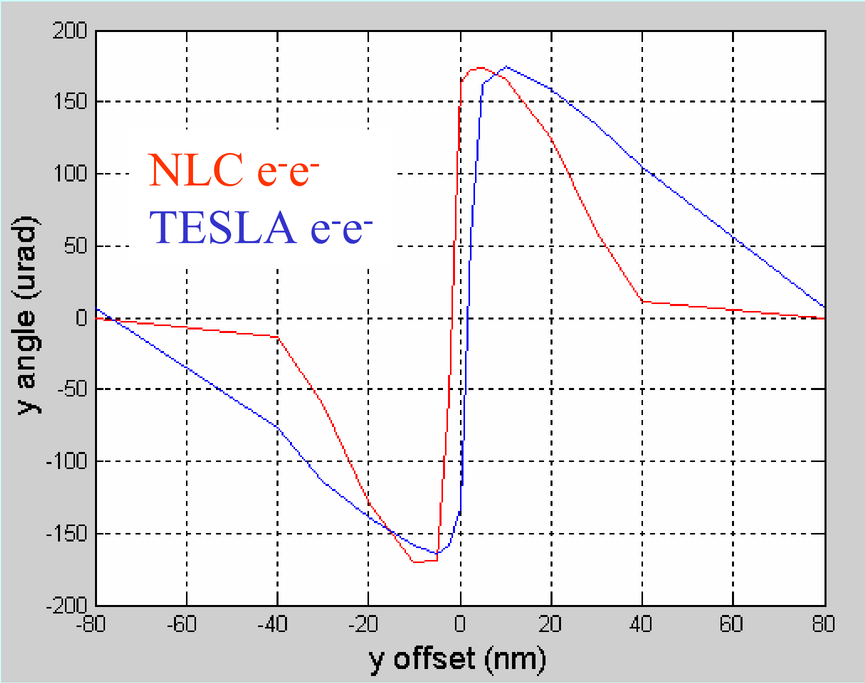
TABLE 2. Some Z-pole machines and parameter sets simulated using GUINEAPIG. The luminosity-weighted beamstrahlung energy loss corrections are given in the last row.

	SLC	NLC-90	NLC-90(low)	TESLA-90	TESLA-90(low)
Luminosity (10^{33} cm^{-2} s^{-1})	0.0024	3.9	0.9	6.5	1.5
Repetition rate (Hz)	120	180	180	5	5
Bunches per train	1	95	95	2820	2820
Bunch charge (10^{10})	4.0	1.0	1.0	2.0	2.0
$\gamma\epsilon_x/\gamma\epsilon_y$ (10^{-8} m-rad)	6000/1200	400/6	400/6	1000/3	1000/3
β_x/β_y at IP (mm)	3.6/3.7	10/0.10	90/0.10	15/0.4	135/0.4
σ_z (μm)	920	125	125	400	400
Lum.Wt. beamstr. E-loss (MeV)	49	125	18	44	1

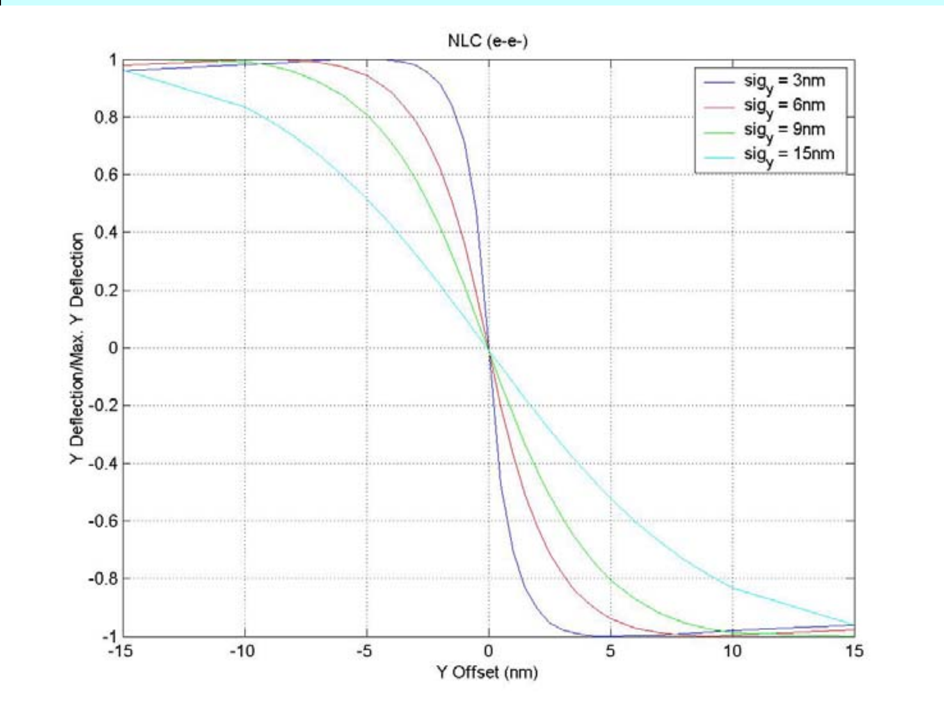
2. e-e-

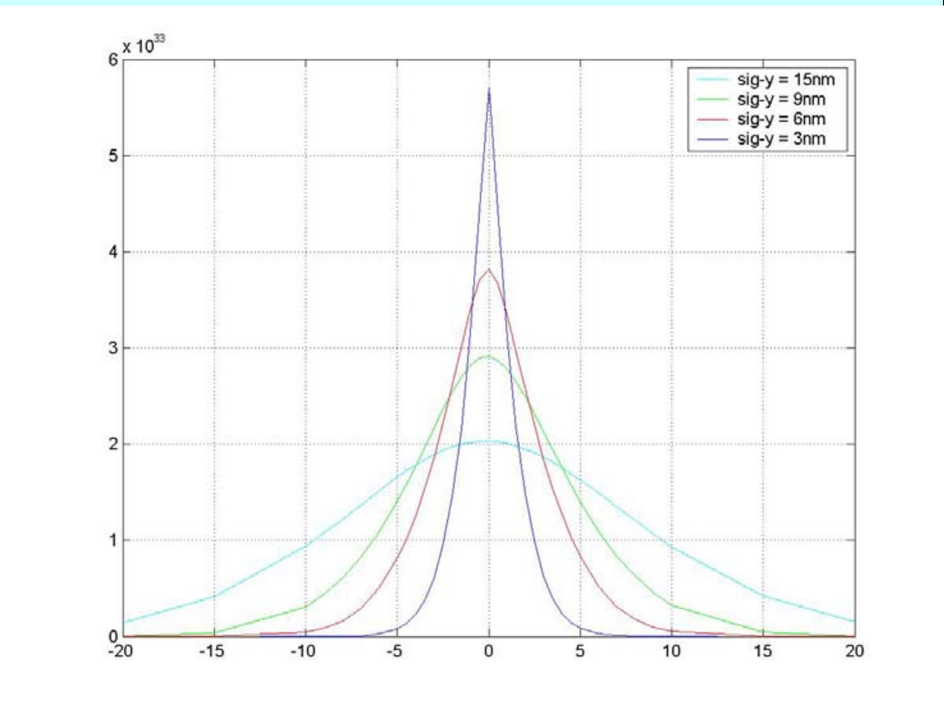
- deflection curves are much narrower than for e+e-, which impacts the IP steering feedbacks





NLC study of this by C. Sramek et al.; see See LCC-Note-125 and http://www.slac.stanford.edu/~sramek/

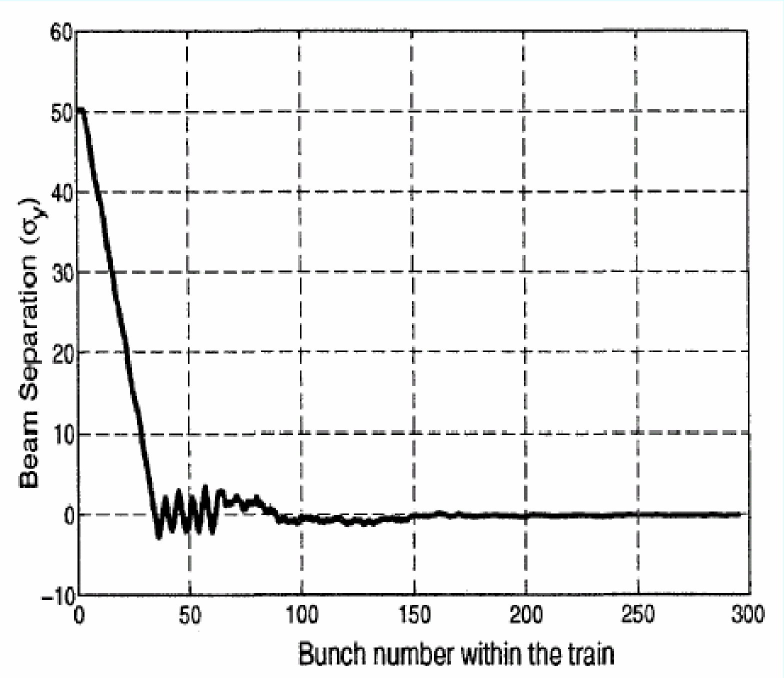




For NLC case only option for obtaining "acceptable" deflection curves was determined to be increasing the vertical spotsize in study by Sramek. This comes at expense of luminosity.

(Tor's editorial comment)

TESLA Study by Reyzl, Schreiber



Reyzl, Schreiber: Fast intra-train IP feedback can correct large beam offsets even for e-e- case.

(What are expectations for random bunch-to-bunch jitter at level of 1-2 nm with 337-ns bunch spacing?)

Note: for either NLC or TESLA (warm or cold), realistic e-e- luminosity is probably closer to 1/10 of e+e- luminosity; ie. much worse than the canonical 1/3 that most people use.