Polarized Positrons at the NLC

Polarized Positrons are not a feature of the NLC2001 configuration.

The NLC2001 R&D plan includes paper studies of Pol. e^+ feasibility.

This talk:

- The concept
- Helical undulator based
- Compton backscattering based

For further information, see the NLC web page: http://www-project.slac.stanford.edu/lc/local/systems/Injector/PolPosiRnD.htm

Polarized Positrons at the NLC

The basic problems

1) Generate circularly polarized gammas (20 – 60 MeV)
   - Helical undulator with high energy (>150GeV) electrons
   - Compton backscattering with high power laser system

2) Convert to e^+e^- in a thin target (0.2 – 0.4 RL)
   - Energy deposition in target per collected e^+ is ~¼ of conventional
   - Radiation damage to the area is similarly reduced

3) Collect e^+, issues: yield, polarization, polarization retention
   - How is the polarization washed out in the solenoid fields of the collection system?
   - Phase space of collected beam is large – Pre-damping ring is still necessary

Polarized Positrons at the NLC

Laser based (under study at KEK ATF for JLC)

Method

- Compton backscattered gammas retain the laser helicity
- e^+ polarization can be changed randomly at 120 hz.
- Laser system is demanding.

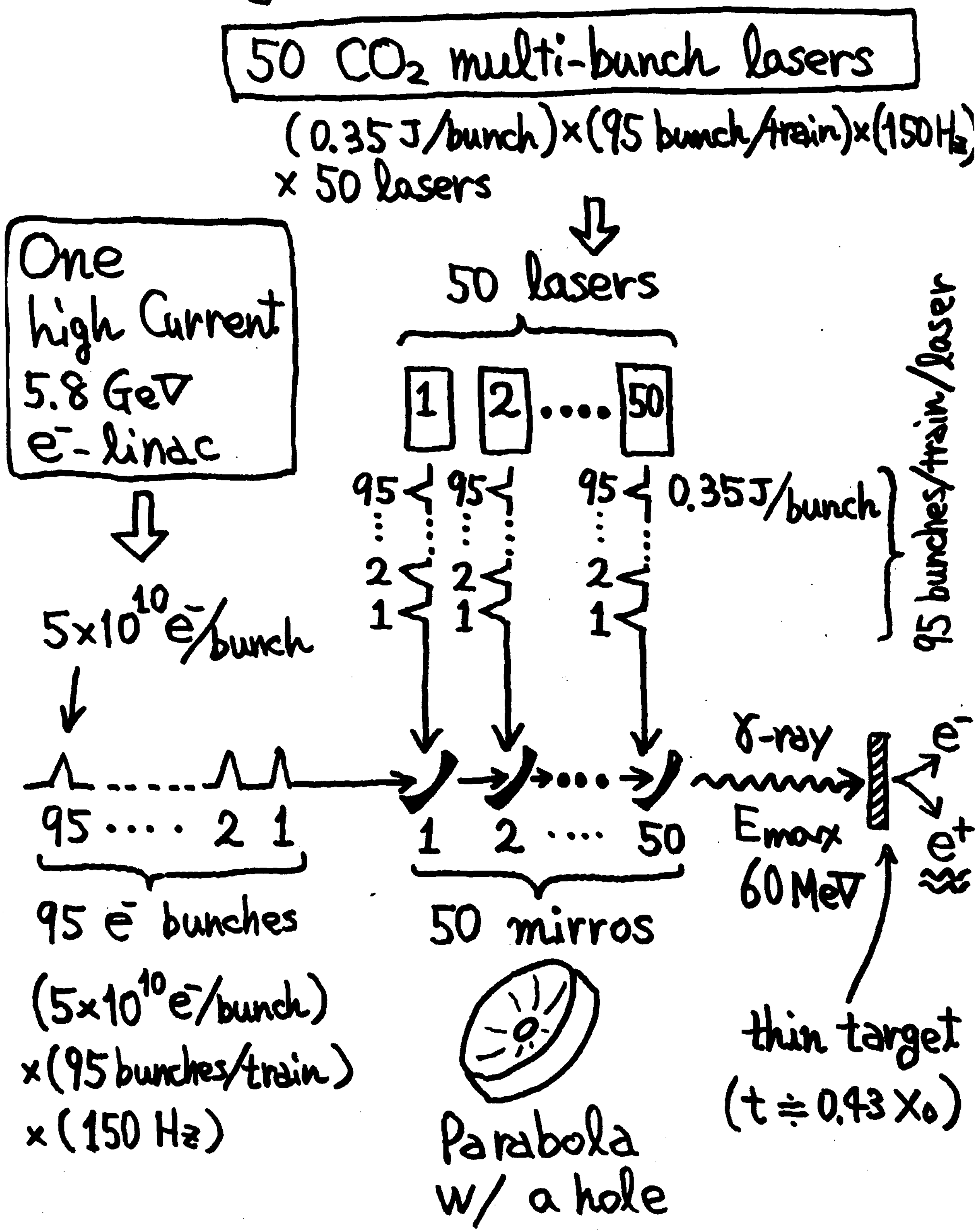
From Omori' talk at ISG6 (at KEK 11/5/00):

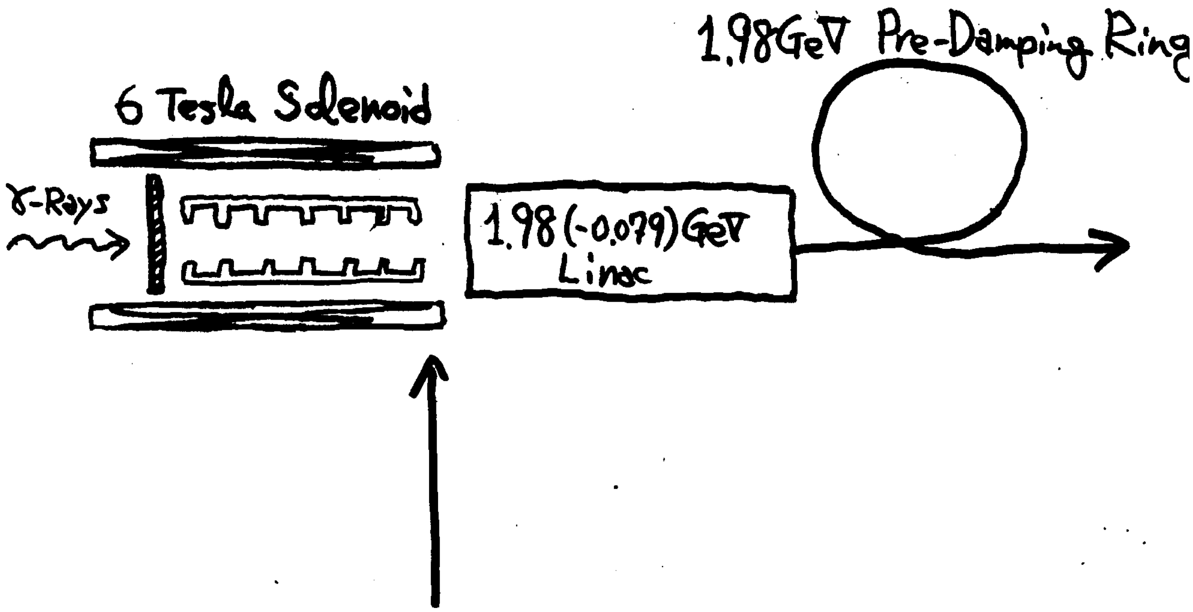
- 5.8 GeV linac, 95 bunches of $5x10^{10}$ e^-, $5x10^{-6}$ ε_η
- 50 CO_2 lasers, each with 95 pulses of 0.35J in 7.5ps, 5kW (50GW peak)
- e^- beam focused to $\sigma_r = 18\mu$, $\sigma_\theta = 25\mu R$
- Select 60% e^+ polarization by positron energy cut.

Joe Frisch's idea, presented at the '97 e^+ sources workshop, (SLAC-R-502)

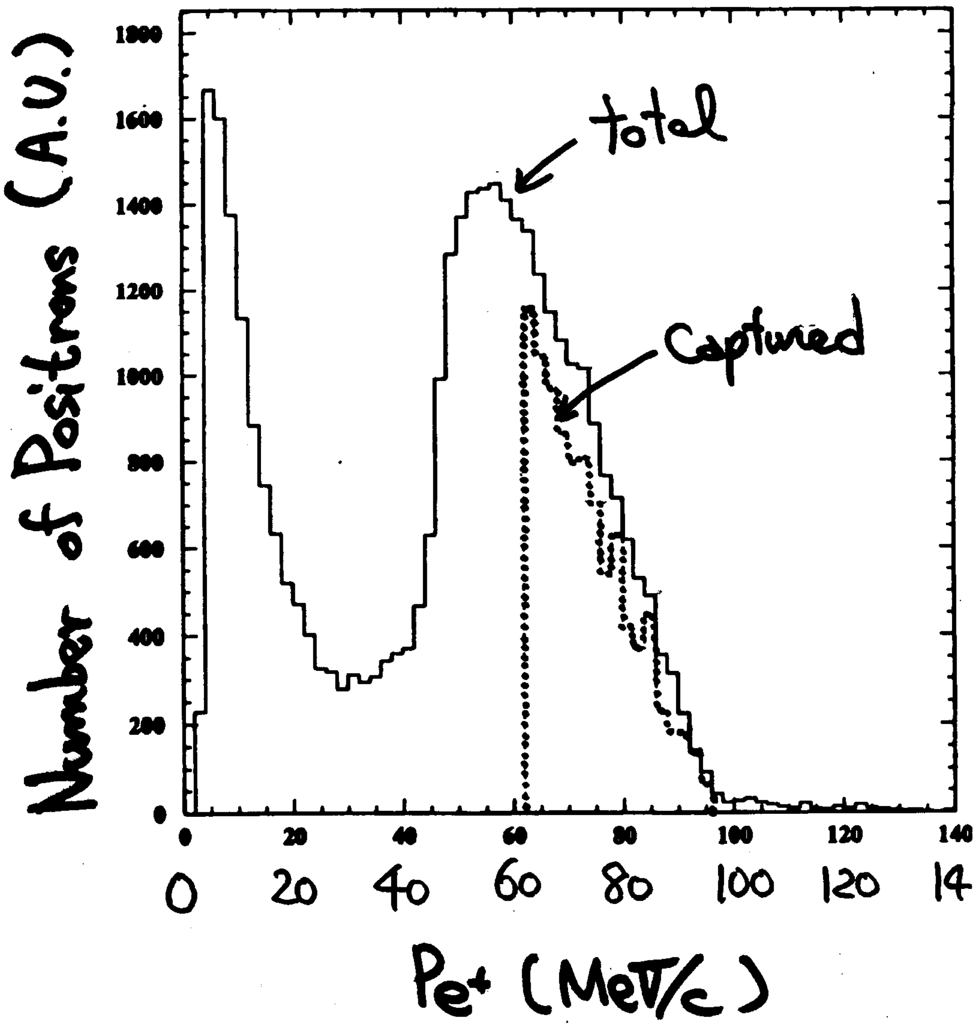
- uses an optical resonator to get high peak photon energy

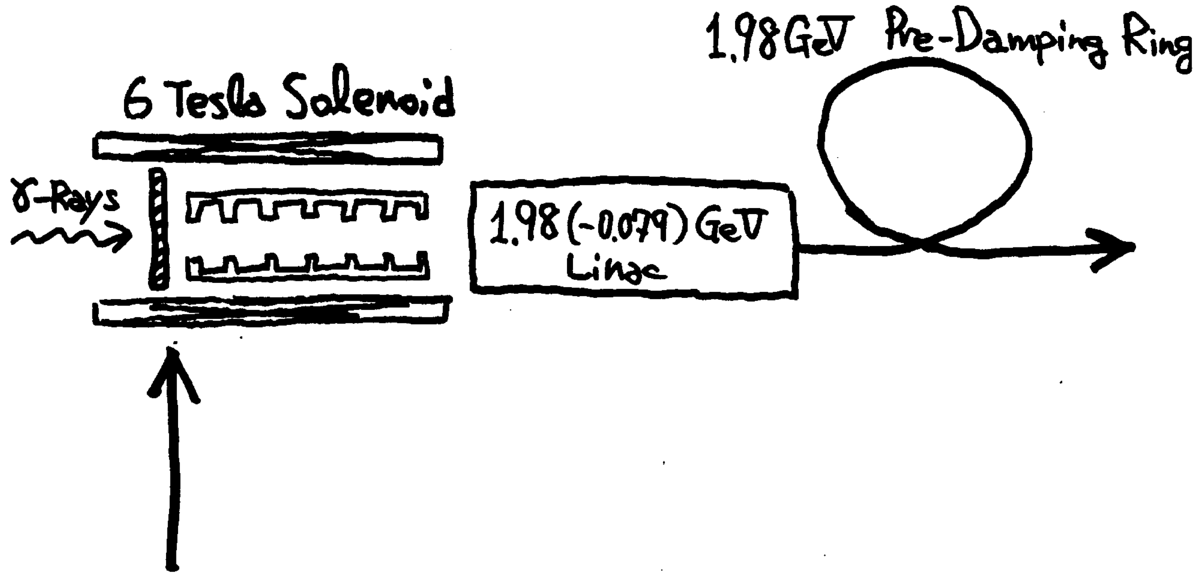
Configulation



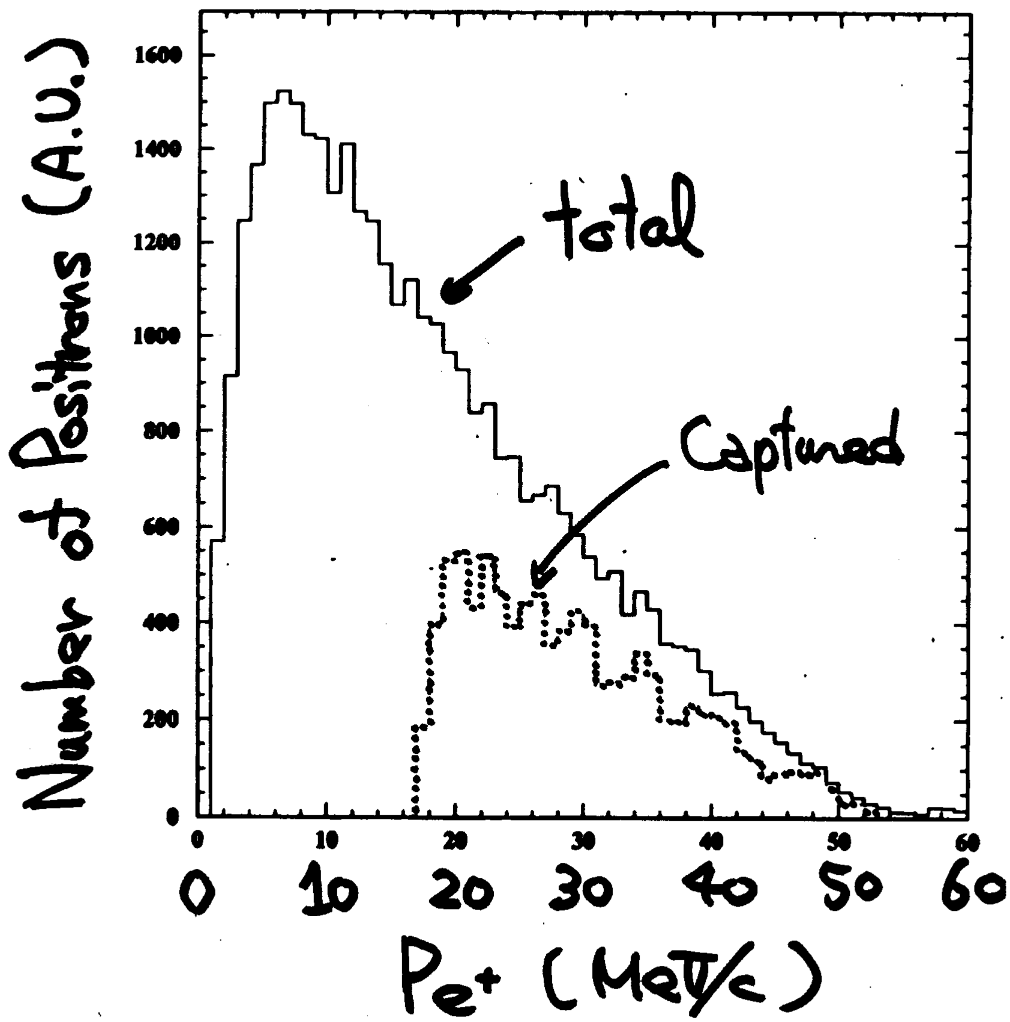


Here: e^+ Momentum Distrib

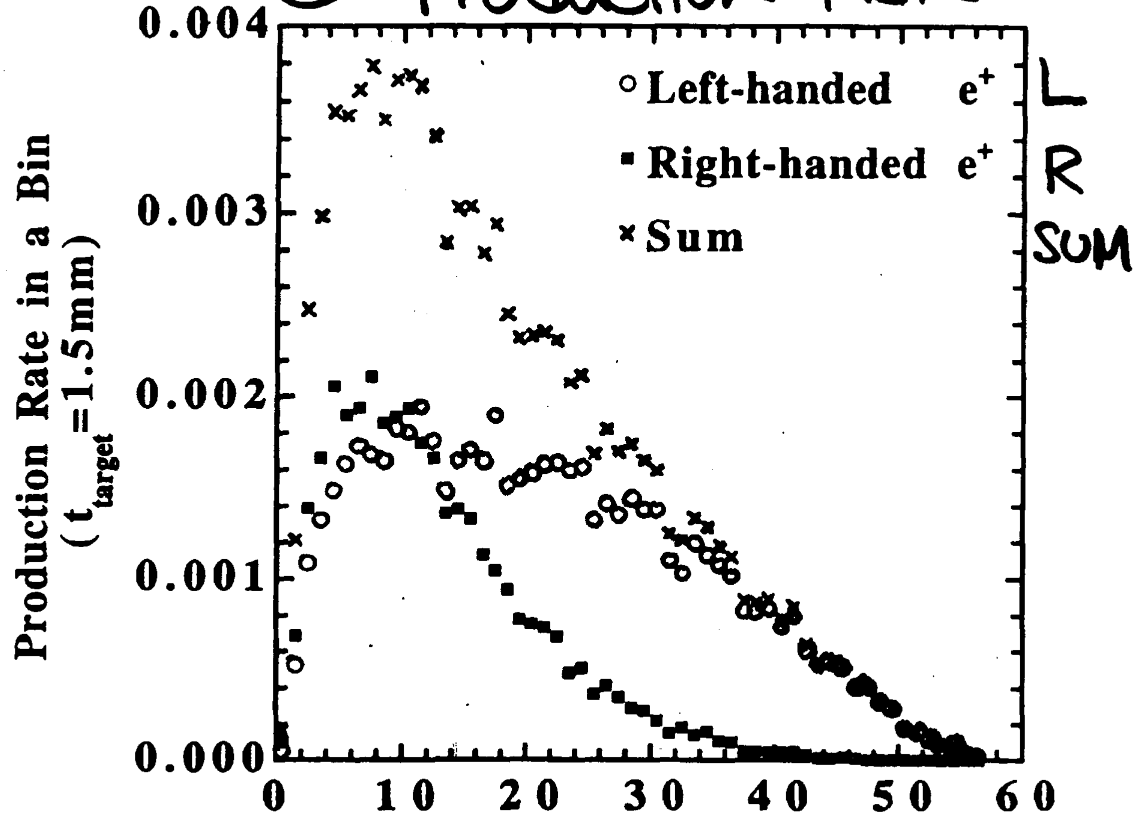




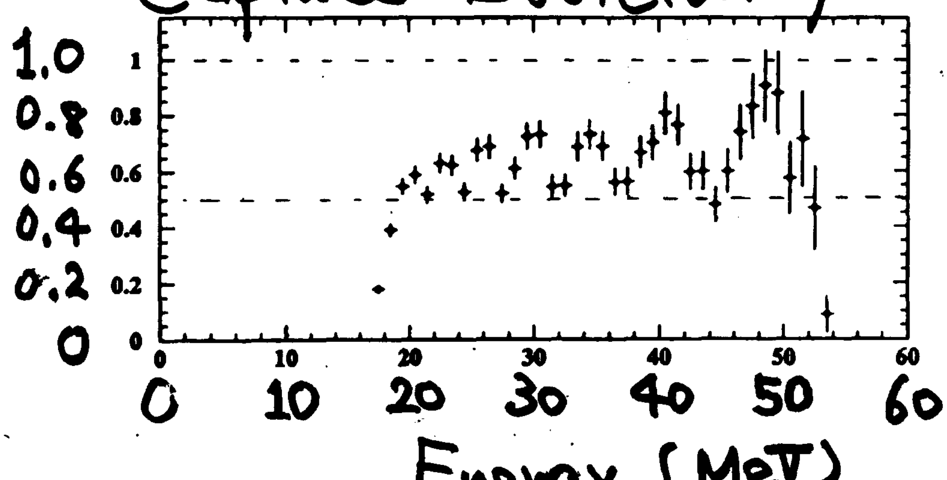
Here: e^+ Momentum Distribution



e^+ Production Rate



Capture Efficiency



$\varepsilon_{capture} = 26\%$ Pol. = 60%

N_{e^+}(captured) = 0.79×10^{10}/bunch

Wall Plug Power (W.P.P.

e⁻-linac

5.8 GeV/electron
× 5×10^{10} e^-/bunch
× 95 bunches/train
× 150 Hz
→ 0.66 MW
$\varepsilon = 8\%$ assume
→ 8.3 MW W.P.P.

laser System

0.35 J/bunch
× 95 bunches/train/laser
× 50 lasers
× 150 Hz
→ 0.25 MW
$\varepsilon = 4\%$ assume
→ 6.3 MW W.P.P.

→ total ~14.6 W.P.P.

Polarized Positrons at the NLC

Laser based: gamma collimation and polarization

Very preliminary

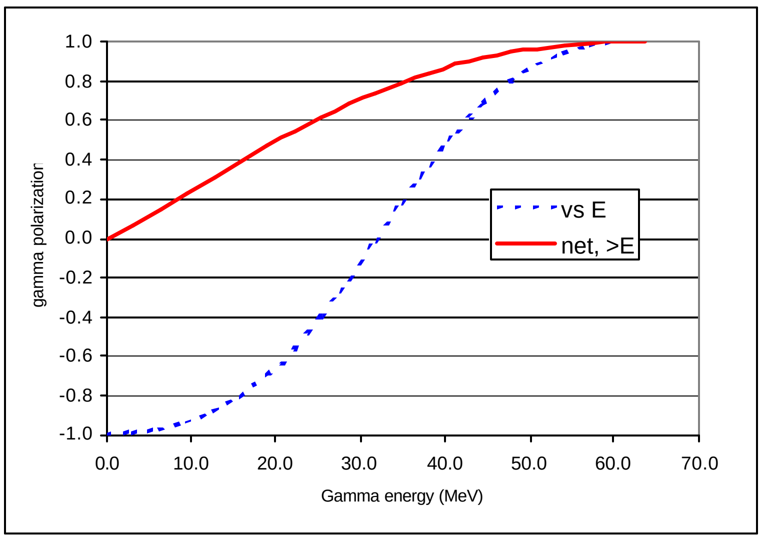
Following Borden, Bauer and Caldwell, SLAC Pub 5715, published in Phys.Rev.D48:4018-4028,1993

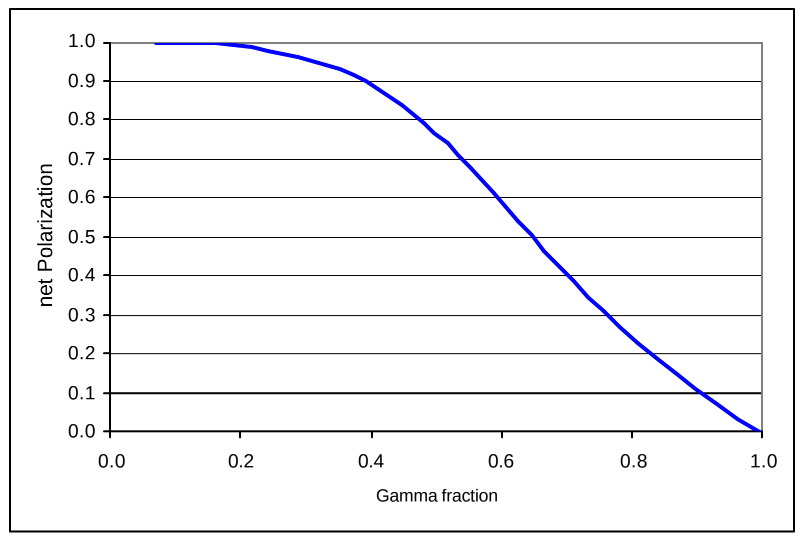
6 GeV e- beam on 0.11 eV (10μ) photons

Accept ~40% of gammas: ~40 – ~60 MeV, < ~60 μR → net ~90% polarization

Accept ~20% of gammas: ~55 – ~60 MeV, < ~30 μR → net ~98% polarization

10^{-5} ε_η, 9 μR divergence → 90 μ beam size sets the laser power





Polarized Positrons at the NLC

Undulator based (As TESLA, but using a flat wiggler)

Method

- Helical undulator magnet to make circularly polarized gammas.
- A more conventional technology, undulator placement an issue.
- Randomization of e^+ helicity more difficult
- Polarization maximal for open angles $<1/\gamma$
  - need long gamma drift length for reasonable radius spot on target
  - electron beam is focussed to that spot on the positron target.

Polarized Positrons at the NLC

Undulator designs

Flöttmann: (DESY 93-161)
(now) 250-160 GeV electron beam, before the TESLA IP
~0.8T, ~1.4cm period, K~1, 140-190 m long, 2-3 mm inner radius
80% of gamma power is collimated
66% polarization

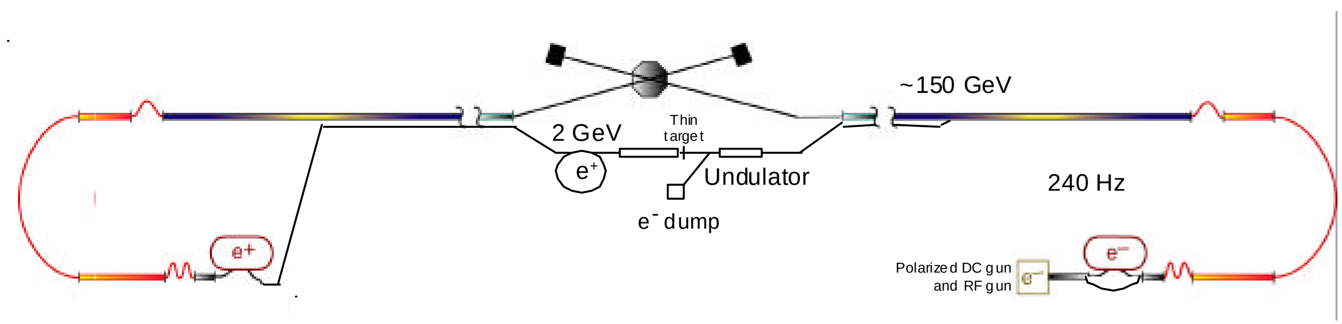
Kulikov: (from Mikhailichenko, see the ’97 e^+ sources workshop, SLAC-R-502)
165 GeV electron beam, 12 undulators with beam steering between
0.5T, 1cm period, K~.5, 10 m long, 3 mm inner radius
~50% polarization

Polarized Positrons at the NLC

Undulator based

The Complex:

- Requires ≥150 GeV low ε electron beam
- 100m long undulator, superconducting?
- Gamma drift line (1/2 km)
- Thin positron target and collection facilities



Polarized Positrons at the NLC

- The NLC2001 R&D plan
  - Simulation (common to both) of collection; yield, polarization retention
  - Look at gamma production options at LLNL (laser) and at SLAC (undulator)
  - Look at testing polarized e+ production.

    Collaborate ?

    with Omori (JLC) @ ATF and/or Flottmann (DESY) @ ?

Conventional e^+ source needed for commissioning.