OPTIMIZATION OF POSITRON CAPTURE IN NLC

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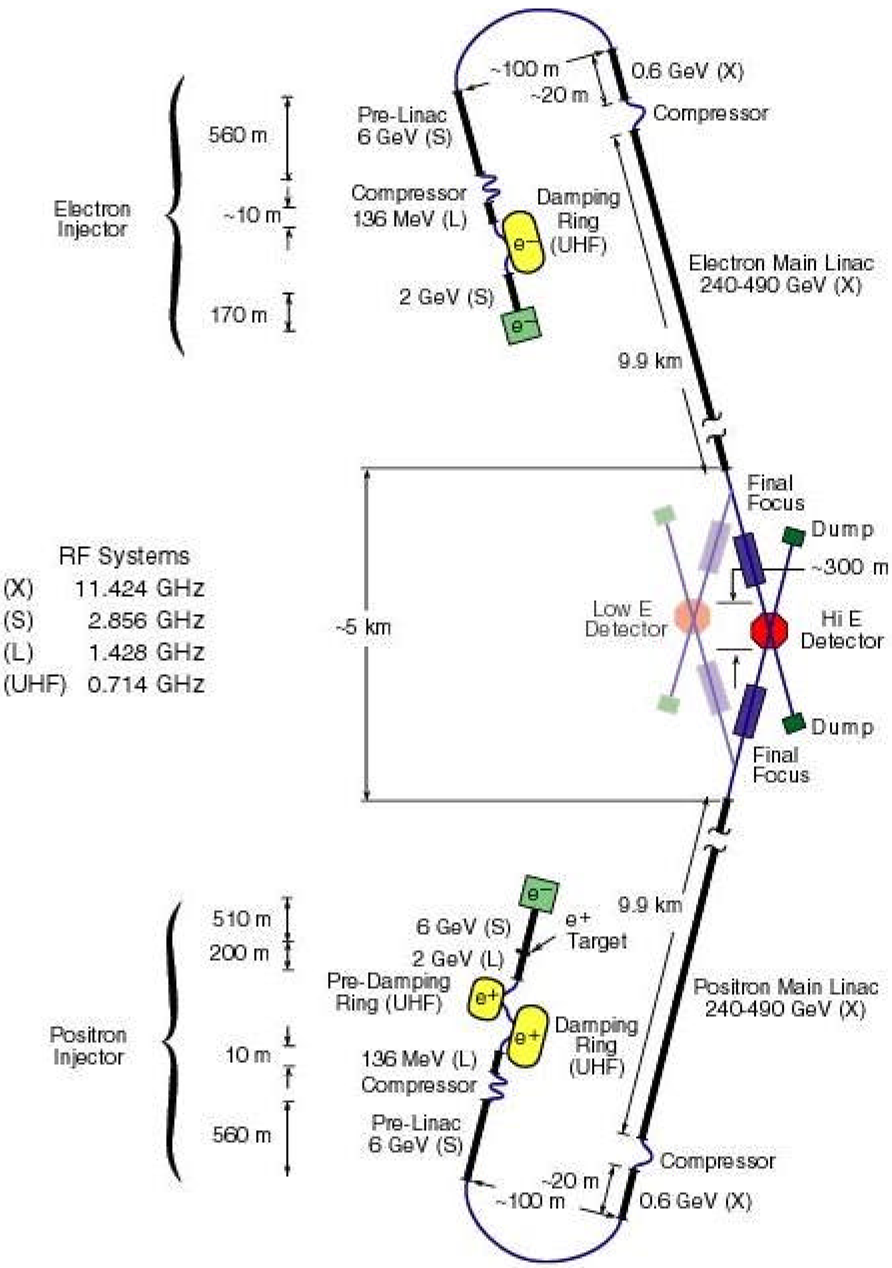
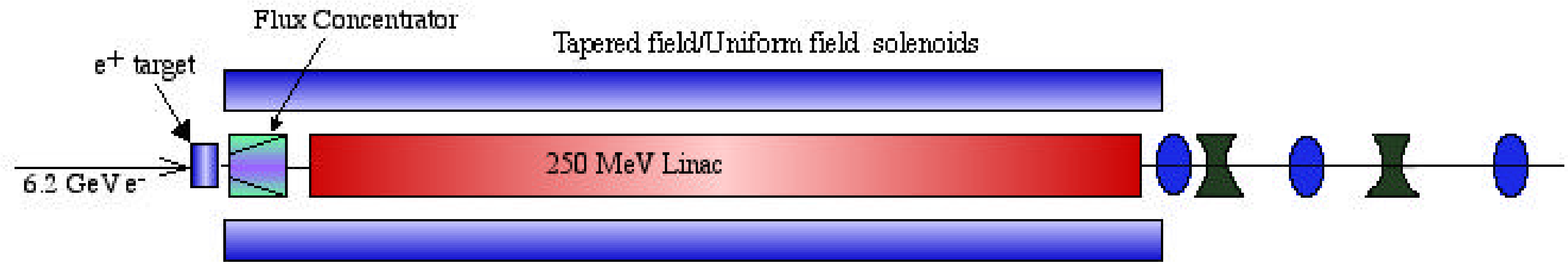
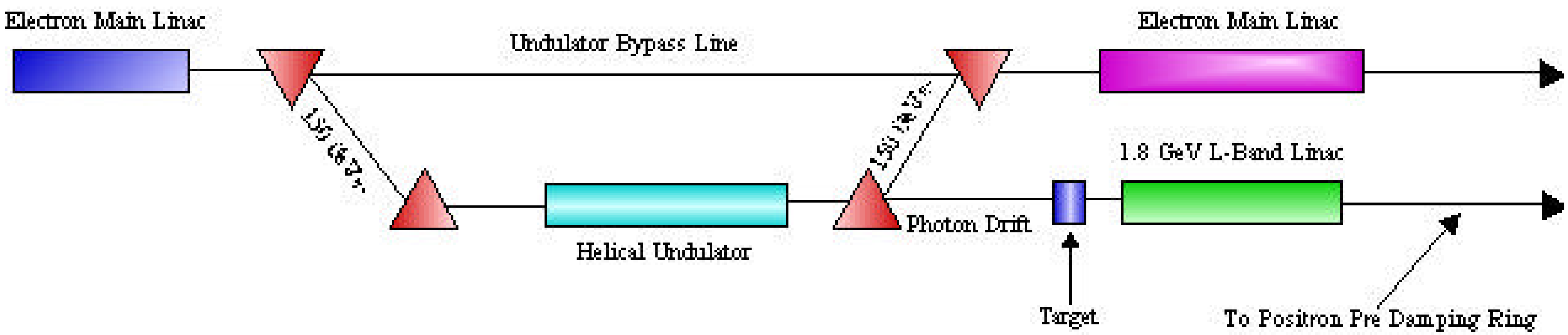


Next Linear Collider layout.



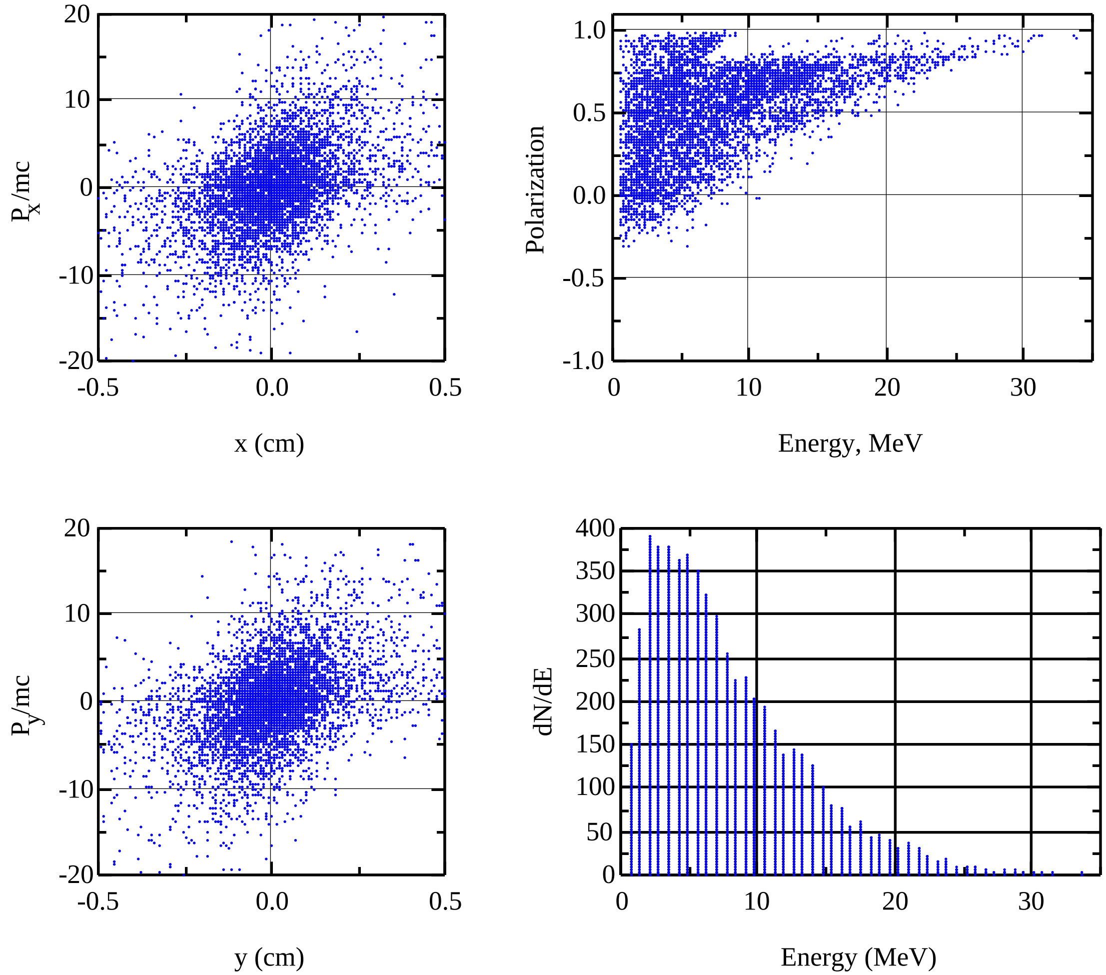
Conventional positron source layout.



NLC polarized positron injector layout.

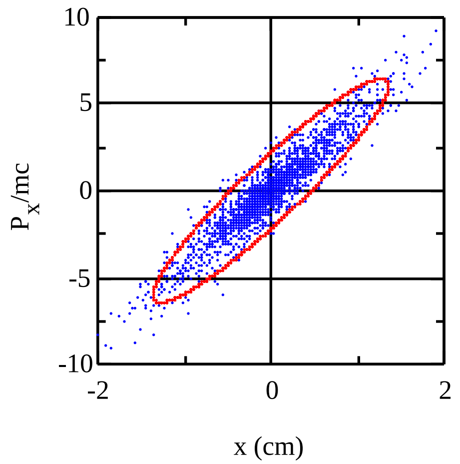
Positron beam parameters

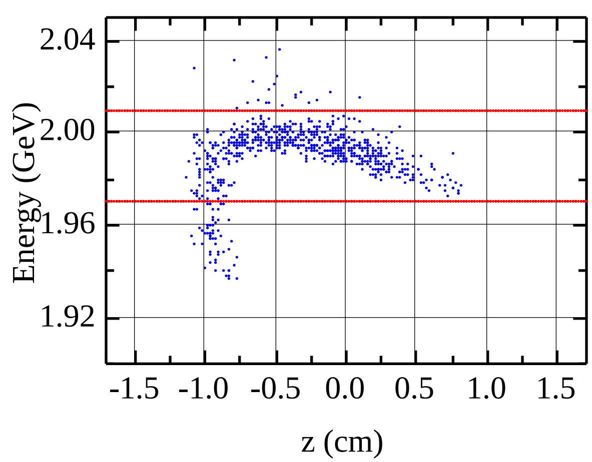
Parameter	Value
Energy	1.98 GeV
Bunch spacing	1.4/2.8 ns
Bunch energy variation	1% FW
Single bunch energy spread	2% FW
Normalized emittance	0.03 π m rad
Bunch length, σ_z	10 mm
Particles/bunch	0.9/1.8 x 10^{10}
Train population uniformity	1% FW
Bunch-to-bunch pop. uniformity	2% rms
Number of bunches	190/95
Repetition rate	120 Hz
Beam Power	58 kW

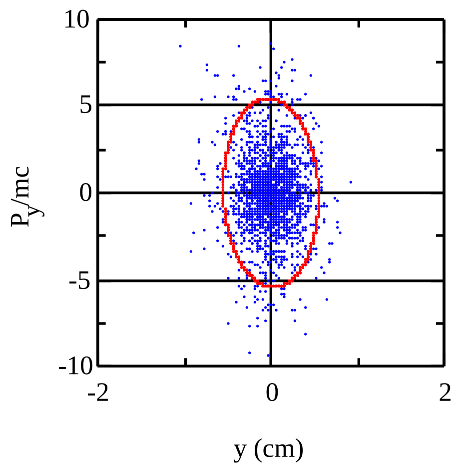


Initial distribution of positrons generated by 10.7 MeV γ-flux.

Final distribution of positrons at 1.98 GeV







POSITRON CAPTURE AT 1.9 GeV

$$C = \frac{N_{e^+,\ 1.9GeV}}{N_{e^+,\ target}}$$

POSITRON YIELD AT 1.9 GeV

$$Y = \frac{N_{e^+,\ 1.9GeV}}{N_{e^-}}, \qquad Y = \frac{N_{e^+,\ 1.9GeV}}{N_{\gamma}}$$

LONGITUDINAL POLARIZATION OF POSITRONS

Polarization of positrons

$$P = \frac{N_+ - N_-}{N_+ + N_-}$$

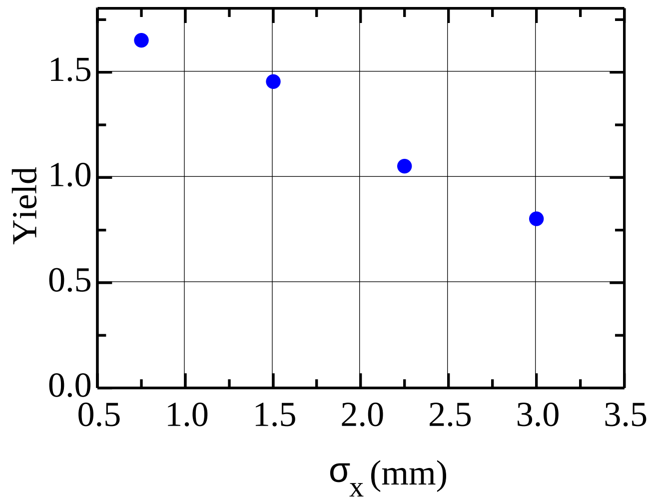
Longitudinal polarization of positron beam

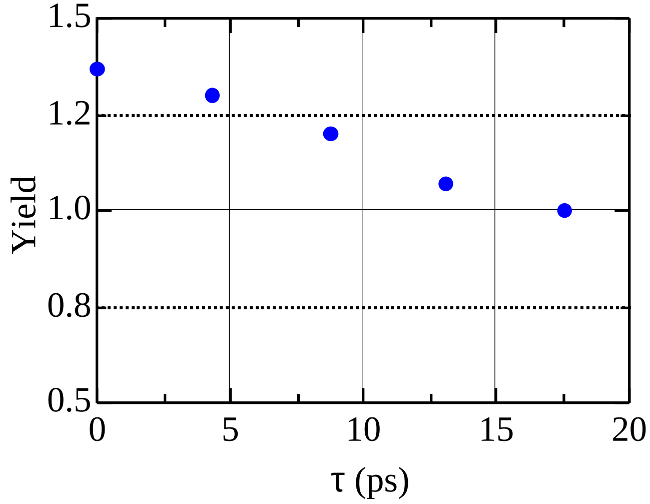
$$\langle P_z \rangle = \frac{1}{N} \sum_{i=1}^{N} S_z^{(i)} P^{(i)}$$

Positron yield after 1.98 GeV linac as a function of 6D acceptance

6-D phase space	$\varepsilon_x,\varepsilon_y < 0.03$ π m rad ΔE/E =2%	$\varepsilon_x,\varepsilon_y < 0.045$ π m rad ΔE/E =2%	$\varepsilon_x,\varepsilon_y < 0.06$ π m rad ΔE/E =2%	$\varepsilon_x,\varepsilon_y < 0.03$ π m rad ΔE/E =4%	$\varepsilon_x,\varepsilon_y < 0.045$ π m rad ΔE/E =4%	$\varepsilon_x,\varepsilon_y < 0.06$ π m rad ΔE/E =4%
Positron yield, N_{e+}/N_{e-}, within 6-D phase space	**1.01**	**1.26**	**1.36**	**1.25**	**1.55**	**1.69**

Positron yield as a function of incident electron bunch size





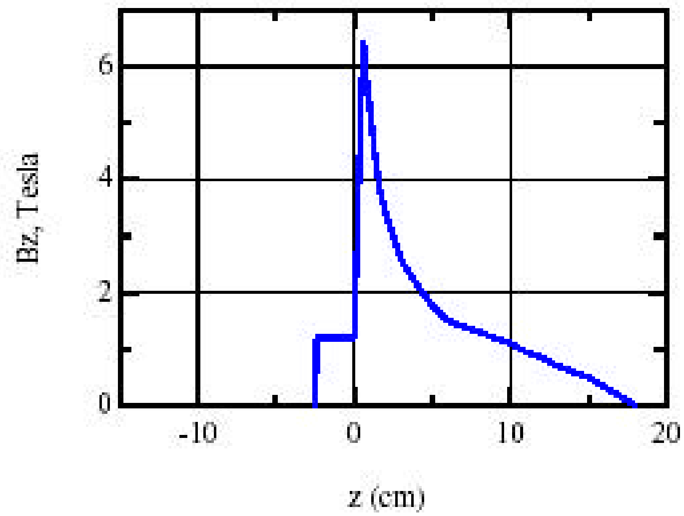
Positron yield as a function of transverse electron bunch size (bunch length τ = 4 ps, target Hg, 4 RL).

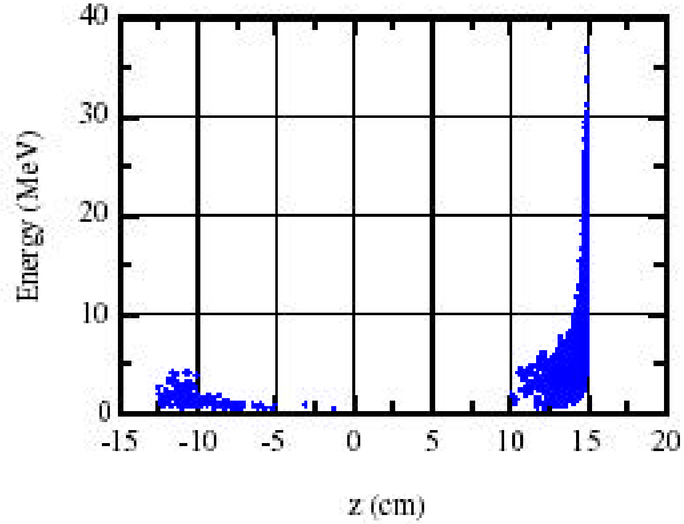
Positron yield as a function of bunch length (bunch size σ_x=1.6 mm, target W-Re, 4.5 RL).

Yield of positrons with respect to incident γ - flux

Energy of γ - flux 1st harmonic cutoff, MeV	Positron yield at the target, $\frac{N_{e^+}(\text{target})}{N_\gamma}$	Positron capture at 1.9 GeV	Positron yield at 1.9 GeV, $\frac{N_{e^+}(1.9\ \text{GeV})}{N_\gamma}$	Positron polarization
10.7	0.029	0.20	$5.8\cdot10^{-3}$	0.6
30	0.11	0.058	$6.4\cdot10^{-3}$	0.6
60	0.17	0.026	$4.4\cdot10^{-3}$	0.6

Optimization of transmission through flux concentrator





(Top) Magnetic field in flux concentrator
(Bottom) Distribution of positrons after flux concentrator

Positron capture as a function of magnetic field configuration

B_z at target, Tesla	FC field $B_z(z)$, Tesla	Aperture along FC, cm	Capture after FC	Capture at 250 MeV
1.2	6.4…0.5	0.5…2	0.29	0.24
6.4	6.4	0.5…2	0.42	0.09
6.4	6.4	2	0.42	0.09
6.4	6.4…0.5	0.5…2	0.39	0.33

SUMMARY

1. Start-to-end simulations of positron capture were done from positron target until injection into positron pre-damping ring.

2. Two schemes for positron production were considered:
   - conventional scheme, utilizing 6.2 GeV electron beam interacting with high-Z positron production target,
   - - polarized positron production scheme based on polarized photons generated in helical undulator.

3. Positron yield in the conventional scheme has been increased from 1.0 to at least 1.5 and capture in the polarized positron scheme from 0.25 to 0.30 while maintaining 60% positron polarization.