Production of a short-bunch polarized positron beam
and design of a positron beam polarimeter

Tokyo Metropolitan University
M. Fukuda, A. Ohashi

Advanced Research Institute for Science and Engineering, Waseda University
T. Hirose, M. Washio, I. Yamazaki

KEK, High Energy Accelerator Research Organization
Y. Kurihara, T. Okugi, T. Omori, J. Urakawa

National Institute of Radiological Sciences
M. Nomura, I. Sakai
Abstract

We have been pursuing a basic study of a polarized positron source for the next generation linear collider, JLC. Generation of polarized positrons is based on two fundamental processes, i.e. inverse Compton scattering of a circularly polarized laser-photon and pair-creation of a polarized gamma-ray. We have accomplished production of polarized gamma-rays through collisions of circularly polarized laser-beams with the wave length of 532nm, i.e. second harmonic of Nd:YAG with counter-propagating electron beams of 1.28 GeV. Since the time-duration of produced gamma-rays is extremely short i.e. 30 ps, we have developed, on the basis of extensive Monte Carlo study using a simulation code GEANT, a transmission method in which a total flux of gamma-rays transmitting through a magnetized iron is measured resulting in determination of an asymmetry. We will report technical details of a positron production system and a positron polarimetry as well, which will be soon employed to substantiate our proposed idea of a production system of the JLC polarized-positrons beam.
Our aim

the production and the polarization measurement of polarized positrons

Schematic design for a polarized positron

Circularly Polarized Laser Light

$\lambda = 532\text{nm}$

1.28GeV

e$^-$ beam

Compton scattering

Polarized $\gamma$-ray

Tungsten

Pair creation

$\gamma$-ray

e$^-$
e$^+$
In high energy region, $\gamma$-rays and positrons are highly polarized.
Collision System

Collision Point

Circularly polarized laser light

wire
screen
knife edge

Wire Scanner Chamber

Screen Chamber

BPM

e⁻ beam
Wire Mount

Wire: Tungsten, $\phi = 10\mu m$

Knife edge: stainless steel plate, $t = 500\mu m$

Screen: Almina(Cr doped) plate, 8mm x 8mm, $t = 100\mu m$

Stay position, $\phi = 20\,mm$

Min. step: 1$\mu m$

e beam-\gamma ray-scan-signal
Cross section of Compton scattering

\[ (\sigma_{comp}(\uparrow\uparrow) < \sigma_{comp}(\uparrow\downarrow)) \]

\[ A = \frac{N_+ - N_-}{N_+ + N_-} \]

Transmission depends on the direction of the magnetic field

Expected asymmetry

\[ A = 1.3\% \quad (\text{Pol.:} \ 88\%) \]

(Threshold energy 21.4 MeV)
Spin of $\gamma$

**Entry Transmission [a.u.]**

- A = $-0.9 \pm 0.1\%$
- A = $1.4 \pm 0.1\%$

(Error: statistical)
Schematic design for positron polarization measurement

Polarized $\gamma$-ray

E-$\gamma$-ray

Circulary polarized $\gamma$-ray

Air Cherenkov counter

Pb converter

Transmitted $\gamma$-ray

Fe target

Pb converter

Positron beam polarimeter
Electron - Positron Linear Collider \(JLC\)

500GeV JLC-I \(\rightarrow\) 1.5TeV JLC
The overall scheme of the positron source