3. Positron Source Description

Table 3.1 lists the performance requirements of the ILC undulator-based positron system and outlines key aspects of the system. The undulator based system uses a 100m long helical undulator placed at the 150GeV point of the ILC electron linac. The ILC electron beam passing through this undulator generates circularly polarized photons. The photons pair-produce in a relatively thin, high strength Ti-alloy target. The positrons from this process are collected and accelerated up to the damping ring energy of 5 GeV. A yield into the damping ring of 1.5 positrons per electron through the undulator has been chosen for the design as an operational safety factor. This overhead is manifested in extra photon beam power incident on target and in the power and peak energy handling capabilities of the pair-production target system as well as the power load considerations of the downstream capture systems.

Figure 3.1 shows the undulator located at the 150 GeV point of the electron main linac. There are several layout options for the undulator in the linac (chicane, dog-leg, etc). The undulator will consist of a number of identical segments, each segment being several meters long. The active length of the full undulator is 100 m. The example helical undulator parameters used are K=1, and a period of 10 mm. This undulator system is designed to operate at a fixed electron drive beam energy of 150 GeV with an overhead factor of 1.5 in the estimated captured positron yield. In order to describe undulator operation, the ILC linac energy can be divided into ranges of 50 to 150 GeV and 150 GeV and above. In the energy range of 150 GeV and above an electron beam of 150 GeV is passed through the undulator and the remainder of the linac is used to increase the energy to the value required. For energies below 150 GeV electrons of 150 GeV are still passed through the undulator and the beam is then decelerated in the remainder of the linac to the required energy.

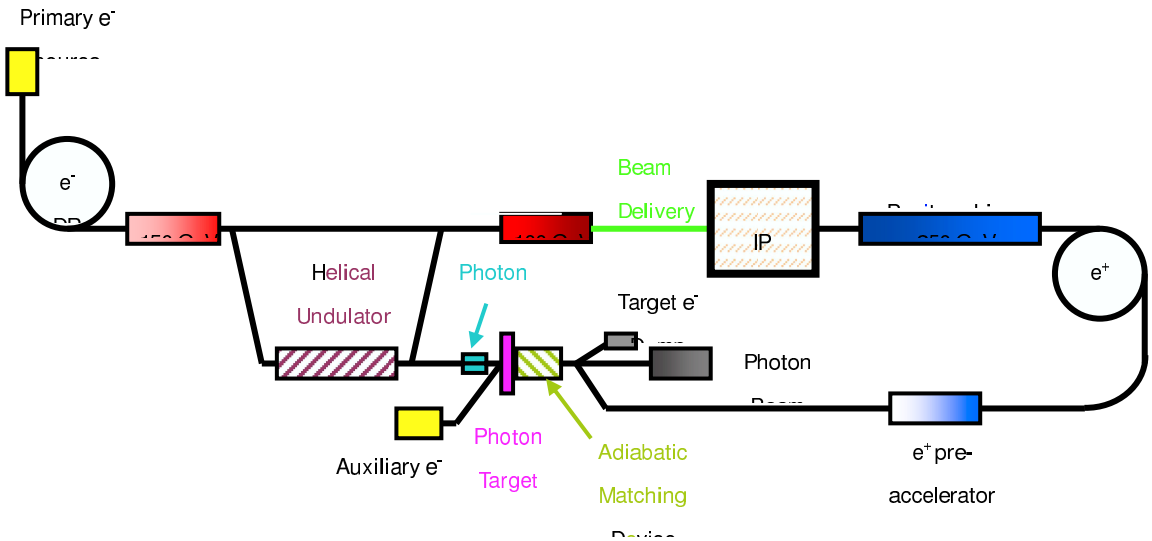

Figure 3.1: Schematic overview of Undulator Based Positron Source in which the undulator is located at the 150GeV point in the electron main linac. The option of the undulator in a chicane is shown here.

A key feature of the undulator based source is the capability of producing positrons with a longitudinal polarization of about 60%. The upgrade to a polarized positron source is easily achieved through the addition of ~100 m more undulator, photon collimation, polarimeters, and spin rotators as appropriate.

Photons are converted in a rotating target wheel of high strength, radiation hard, Ti-alloy. Positrons are captured downstream in an L-band RF linac operating at a nominal gradient of 15 MeV/m. After acceleration to 250 MeV, the captured positrons are separated from captured electrons in a magnetic chicane and injected into the 4.75 GeV booster linac for acceleration to the full damping ring energy of 5 GeV. The booster linac is a standard ILC L-band superconducting system operating at a gradient of about 25 MeV/m.

A "hot spare" positron conversion target and capture system is included in the design to enhance system availability. A keep alive source has been included in the design to add flexibility during commissioning, reduce the loss of machine time due to downtime (scheduled or otherwise) of the primary electron beam, and provides a source of polarized electrons for e^-e^- and $\gamma\gamma$ ILC options. The proposed intensity for the keep-alive source has been specified at 10% of nominal charge.

Parameter	Value	Units
Positrons per bunch	$2x10^{10}$ ($1x10^{10}$)†	number
Bunches per pulse	2820 (5600) †	number
Pulse Repetition Rate	5	Hz
Positron Energy	5	GeV
Electron Drive Beam Energy	150	GeV
Electron Drive Beam Energy Loss	3.23	GeV
Undulator Period	10	mm
Undulator Strength	1	-
Undulator Type	Helical	-
Undulator Length (unpolarized source)	100	m
Photon Energy (1st harmonic cutoff)	10.7	MeV
Max Photon Beam Power (unpolarized source)	147	kW
Target Material	Ti-6%Al-4%V	-
Target Thickness	0.4	r.l.
Max Target Absorption	11	kW
Incident Spot Size on Target	0.75	mm, rms
Positron Polarization (upgrade)	60	%