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Status of the E166-Experiment

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The E166 experiment is a proof-of-principle experiment to demonstrate the production of polarized positrons with a helical undulator. The experiment has taken first data in June 2005 at SLAC. This article gives a short overview of the performance of various components of the experiment.

1. INTRODUCTION

The physics program at the International Linear e^+e^- Collider (ILC) can be substantially enriched if both incoming beams are polarized [1]. While the techniques to create polarized e^--beams are well established it is still an open question how to obtain polarized e^+ beams. For the ILC two options are currently under consideration; One is aiming for polarized positrons by Compton-Scattering of a circularly polarized laser beam on an electron beam [2]. In the E166 experiment [3], following a proposal of Balakin and Mikhailichenko [4], a helical undulator is employed in which circular polarized photons are produced by Synchrotron Radiation of the electron beam in the helical undulator field. In both cases the circular polarized photons with energies of the order of 10 MeV are sent onto a target where longitudinally polarized positrons (and electrons) are produced when the photons interact with the absorber material [5, 6].

2. EXPERIMENTAL SETUP

The E166 experiment is installed in the Final Focus Test Beam (FFTB) area at SLAC and uses the 50 GeV electron beam of the SLAC linear collider. Currently this facility provides the highest beam energy in conjunction with a very small emittance of the beam. The electron beam is sent through the helical undulator which is shown in Fig. 1 and of which some parameters are listed in Table I. The target is located roughly 40 m downstream of the undulator. The polarized positrons (and photons) are analyzed in a subsequent polarimeter which is schematically shown in Figure 2. Here we concentrate on the lower part of the polarimeter which measures the polarization of the positrons. To measure the positron polarization the method of transmission polarimetry is employed [7]. The positrons are filtered by their momentum in a magnetic spectrometer and are then re-converted into polarized photons. These photons pass through a saturated magnetized iron absorber and are subsequently measured in a CsI-Calorimeter. The transmission of the photons through the iron absorber and hence the signal in the CsI-Calorimeter depends on the orientation of the magnetization. The asymmetry in the signal measured with the CsI-Calorimeter for runs with different magnetizations is the key input to determine the polarization of the primary positrons.

3. DATA TAKING PERIOD IN JUNE 2005

The E166 experiment had a first period of data taking in June 2005. For technical reasons the beam energy was restricted to 46.6 GeV. One of the primary aims of the data taking period was to verify that all components of the E166 experiment are working properly, mainly to provide a routinely clean beam transmission through the small aperture of the helical undulator.

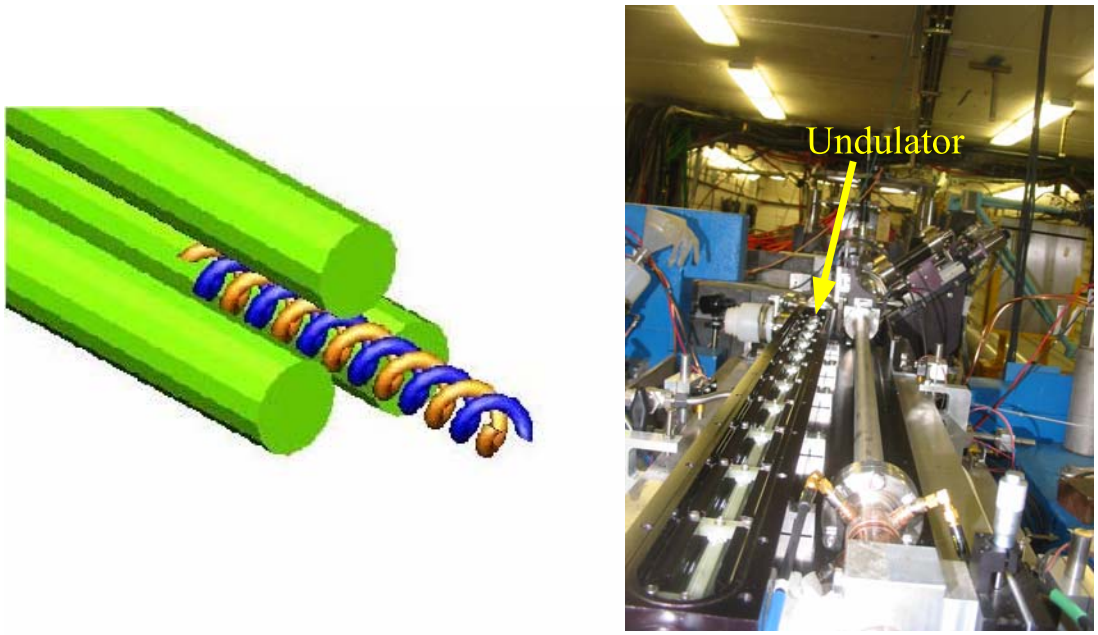

Figure 1: Left: Schematic view of the bi-helical winding of the undulator of the E166 experiment. Right: Undulator of the E166 experiment as installed in the FFTB area at SLAC.

Table I: Main parameters of the undulator of the E166 experiment in comparison with tentative parameters of a full scale undulator for the ILC.

	E166	**ILC Parameters**
e^- Injection Energy [GeV]	50	$\sim$200
Undulator Period λ [mm]	2.4	$\sim$10
Undulator Parameter K	0.17	$\sim$1
Inner Diameter [mm]	0.9	$< \lambda$
Undulator Length [m]	1	$\sim$130

As an example, Figure 3 shows the signals in a silicon counter close to the beam pipe in the photon arm of the polarimeter for events in which the undulator field is pulsed in phase with the electron bunch (called “undulator on” herafter) and background events in which the undulator pulse is delayed with respect to the electron bunch (called “undulator off” herafter). The signals for the “undulator-on” type of events are significantly larger than for the case of “undulator-off” type of events. This demonstrates clearly the passage of the electron beam through the undulator and the production of photons.

Fig. 4 shows the signal measured in the central part of the CsI-Calorimeter for the same type of events. Again a difference between ”undulator on”-events and ”undulator off”-events of a few 100 MeV is clearly visible. The signal in the CsI-Calorimeter has been measured as a function of the current in the solenoidal focussing lens at the entrance of the spectrometer and the spectrometer current. It can be seen that by the optimization of these parameters the signal in the CsI-Calorimeter can be enhanced.

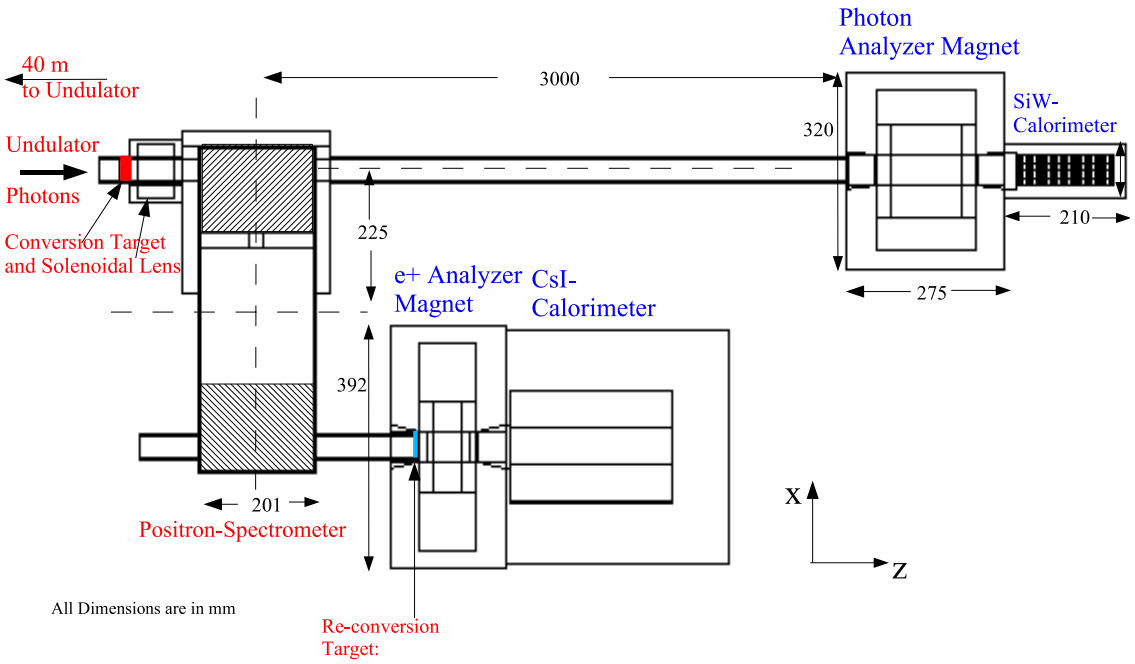

Figure 2: Schematic view of the polarimeter of the E166 experiment. The upper part analyzes the photon polarization ('photon arm') while the lower part analyzes the positron polarization ('positron arm').

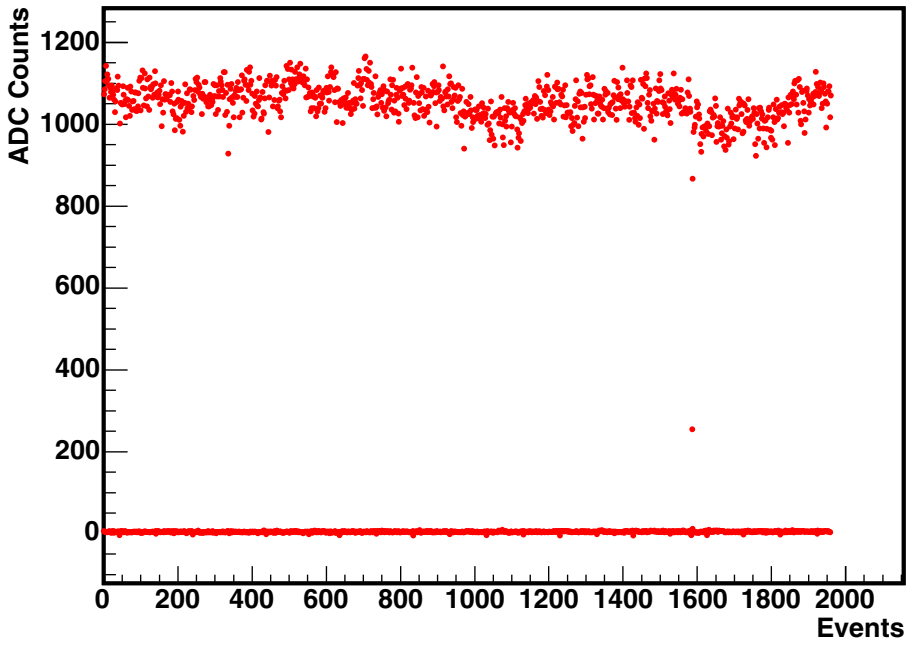

Figure 3: Signals in a Silicon-Counter of the E166 Experiment as a function of the event number. The upper entries display the signal for events in which the undulator is switched on, the lower entries for those in which it is switched off.

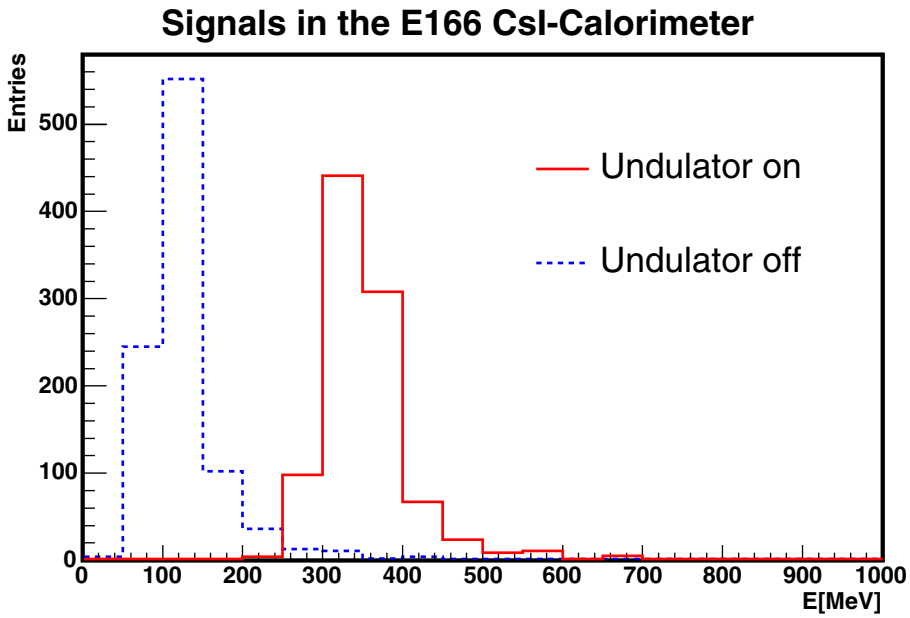

Figure 4: Signals in the CsI-Calorimeter of the E166 Experiment. The full histogram shows the energy deposition for "undulator on" type of events, the dashed histogram shows the energy deposition for "undulator off" type of events (Definition see text).

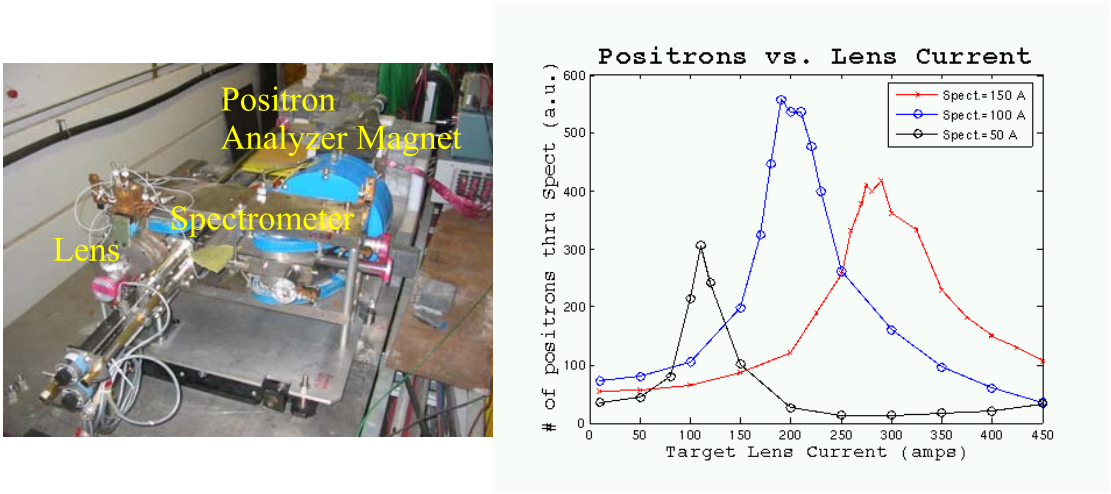

Figure 5: Left: Picture of the Positron Polarimeter, see Fig. 2, showing the Solenoidal Lens, the Spectrometer and the Positron Analyzer Magnet. Right: Signals in the CsI-Calorimeter of the E166 Experiment as a function of the current in the Lens and the Spectrometer.

4. SUMMARY AND OUTLOOK

The E166 experiment has completed its first data taking period in June 2005. It has been demonstrated that the main components of the experiment are functional. Signals for events in which the undulator is pulsed are clearly distinguishable from background signals. The extraction of spin dependant asymmetries and the determination of the polarization of the photons and positrons is still subject to a dedicated analysis of the data. The E166 collaboration is preparing for a second data taking period envisaged for September 2005.

References

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