

Undulator-Based Production of Polarized Positrons



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Representing the E-166 Collaboration

ILC Workshop

Valencia, 6-10 November 2006

Outline

- E-166 experiment (Proposed in June 2003)
- The experimental setup at SLAC
 - Undulator method.
 - Photon and positron detectors.
- Data analysis and it's results
 - e^+ Asymmetries
 - e^+ Analyzing power and Polarization
 - Photon Asymmetries
- Summary and Outlook

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E-166 Experiment

- E-166 Collaboration:

*RWTH Aachen, Germany
Cornell University, USA
CCLRC Daresbury Laboratory, UK
University of Durham, UK
DESY/Hamburg, Germany
DESY/Zuethen, Germany
Humboldt University, Germany
Princeton University, USA
SLAC, USA
Tel-Aviv University, Israel
University of Tennessee, USA
Yerevan Physics Institute*

- Aim of the experiment:

- To demonstrate Undulator-based production of polarized positrons for the ILC.

- The method applied:

- Next Slide

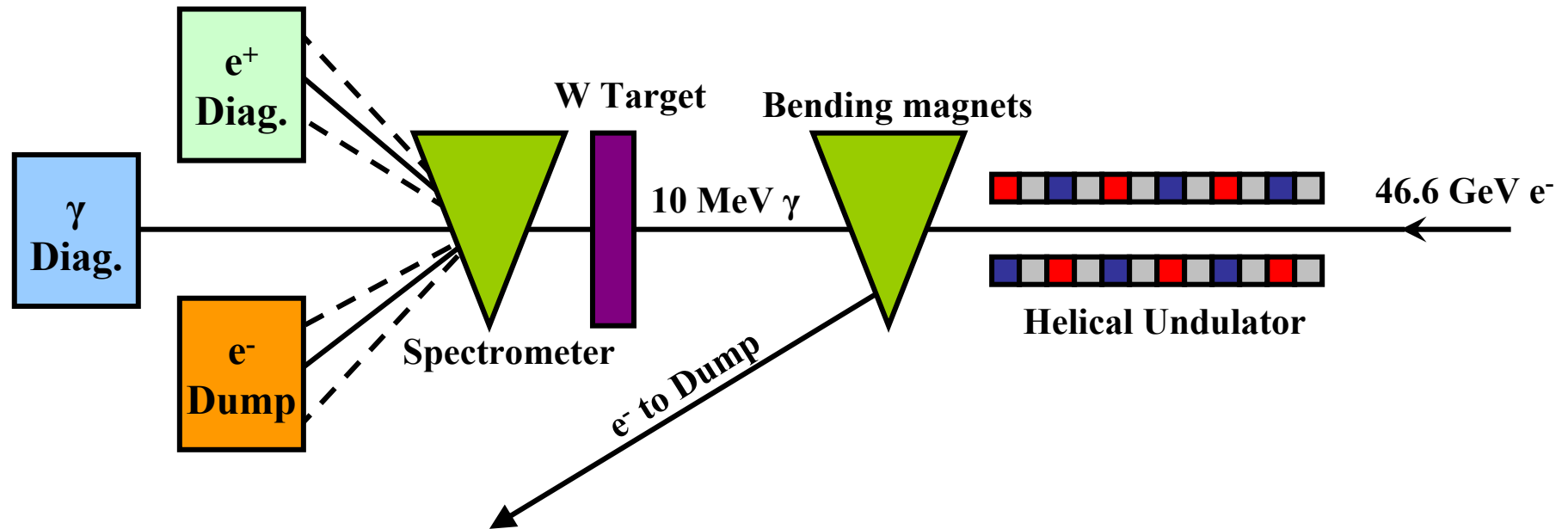
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E-166 Layout at SLAC

- The method applied:
 - An e^- beam of ~ 46.6 GeV passes through a ‘Helical Undulator’ to produce polarized photons which then hit a thin target that cause e^+e^- pairs production, positrons polarization is then measured.

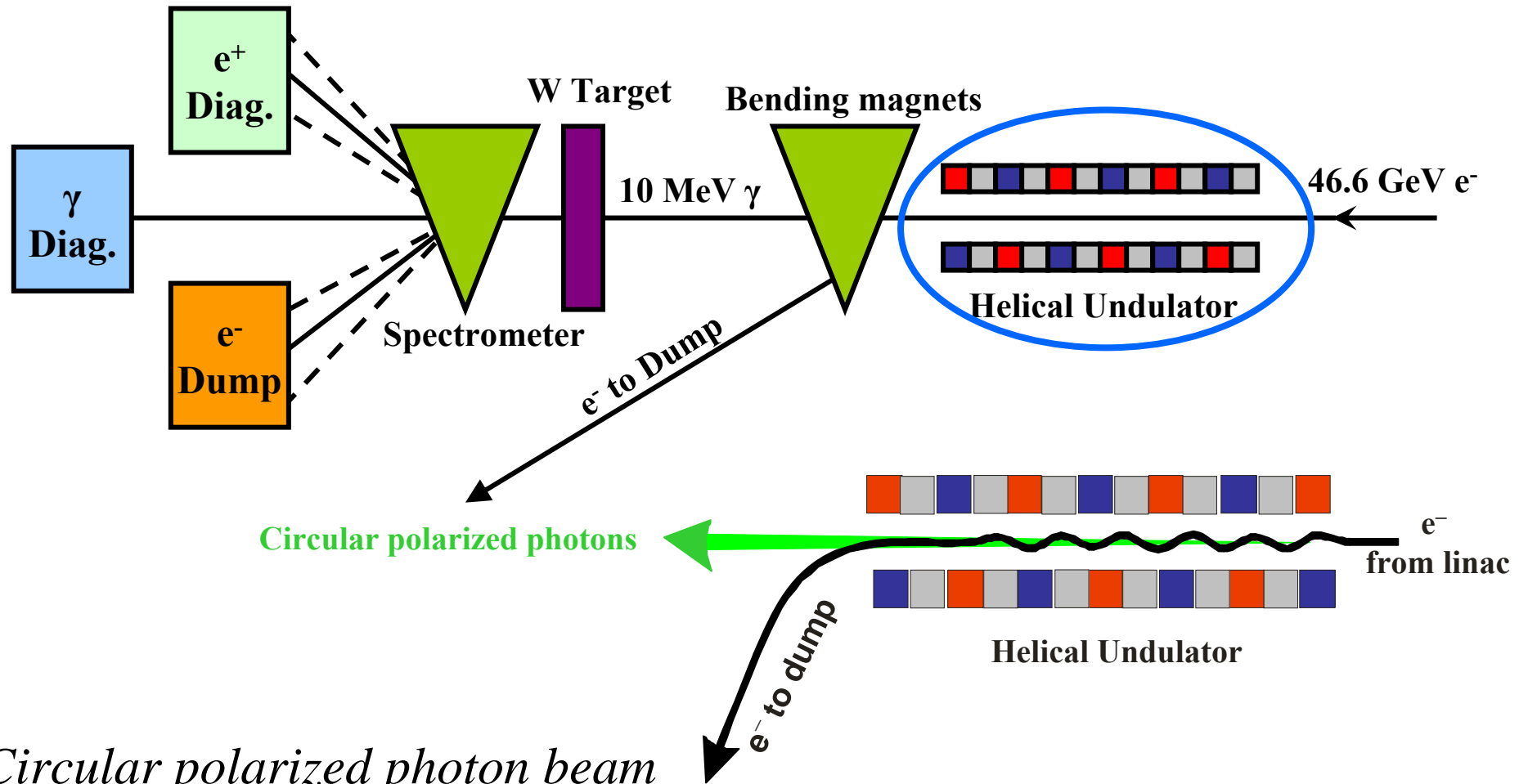


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E-166 Layout at SLAC



Circular polarized photon beam along the original electron beam line.

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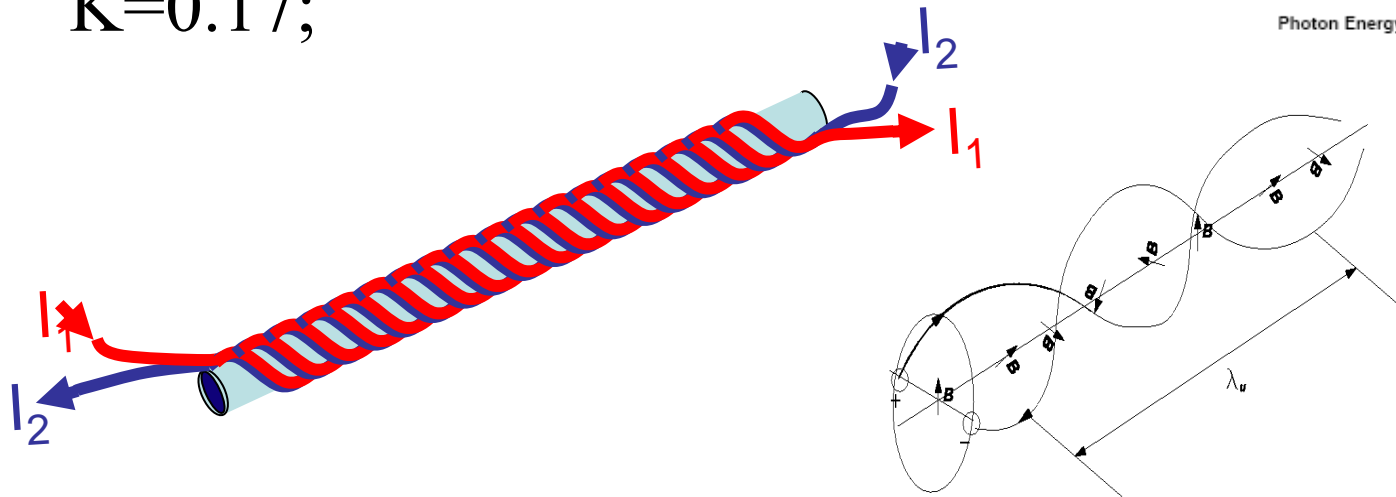
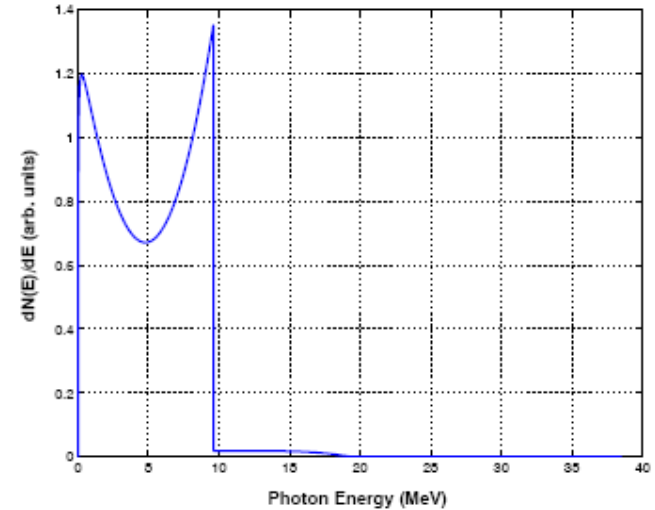
The Helical Undulator

Undulator energy spectrum

Up to 8 MeV;

$\lambda_u = 2.54\text{mm}$;

$K = 0.17$;

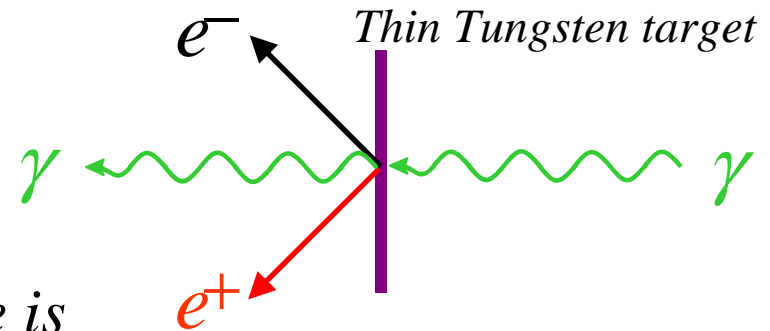
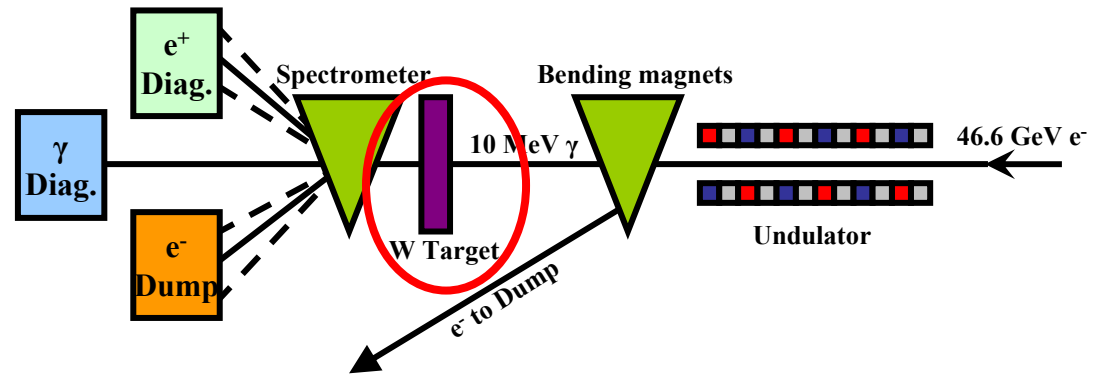
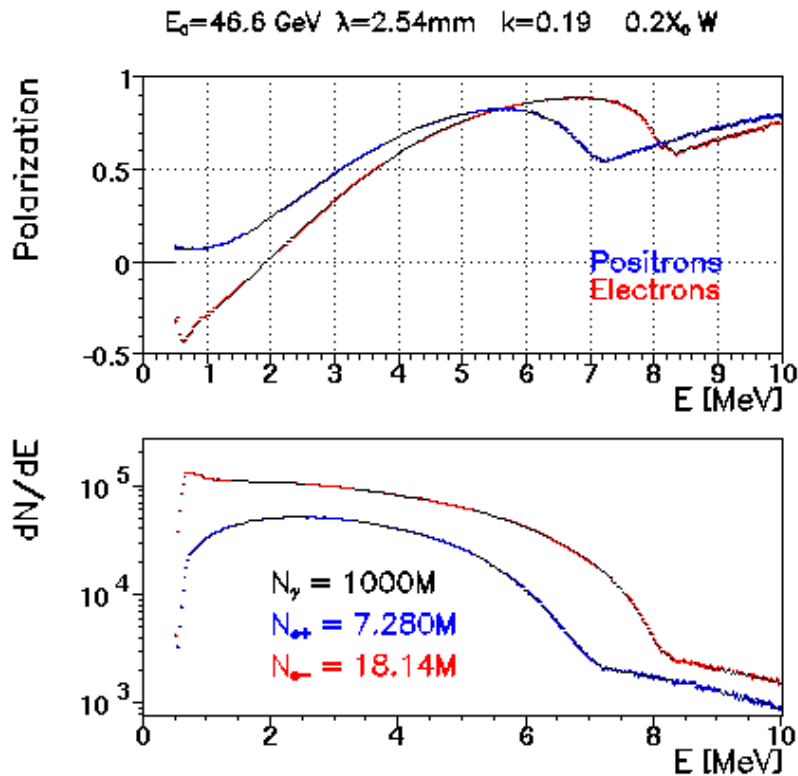


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Positron production target



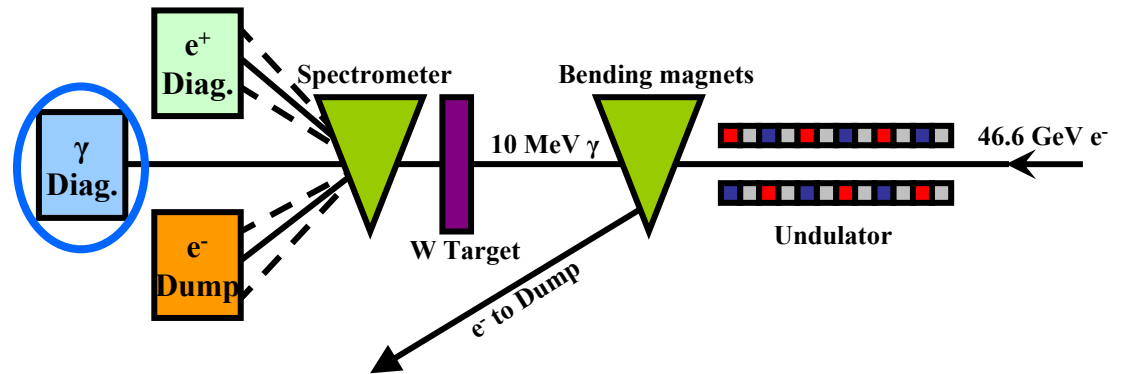
Photons initial polarization state is transferred to the outgoing leptons.

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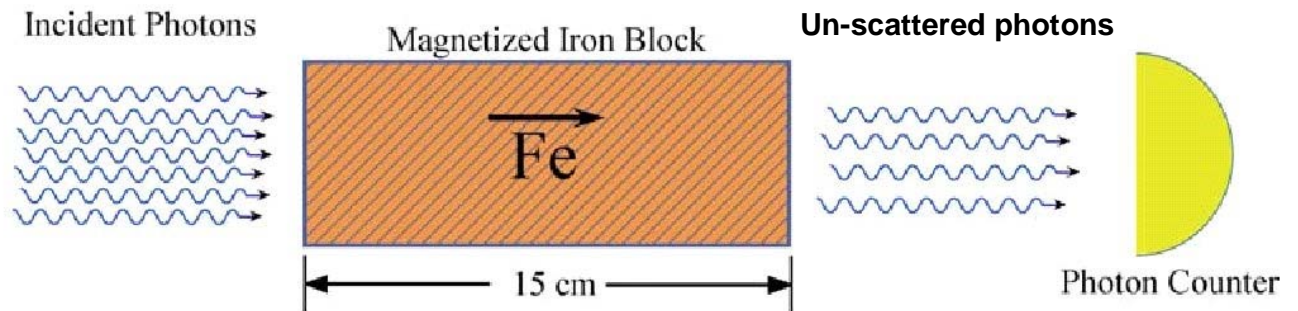
Photon Measurement



Collecting the unscattered photons, at two opposite magnetization directions of the iron.

$$\sigma = \sigma_{un} + P_{\gamma} P_e \sigma_{pol}$$

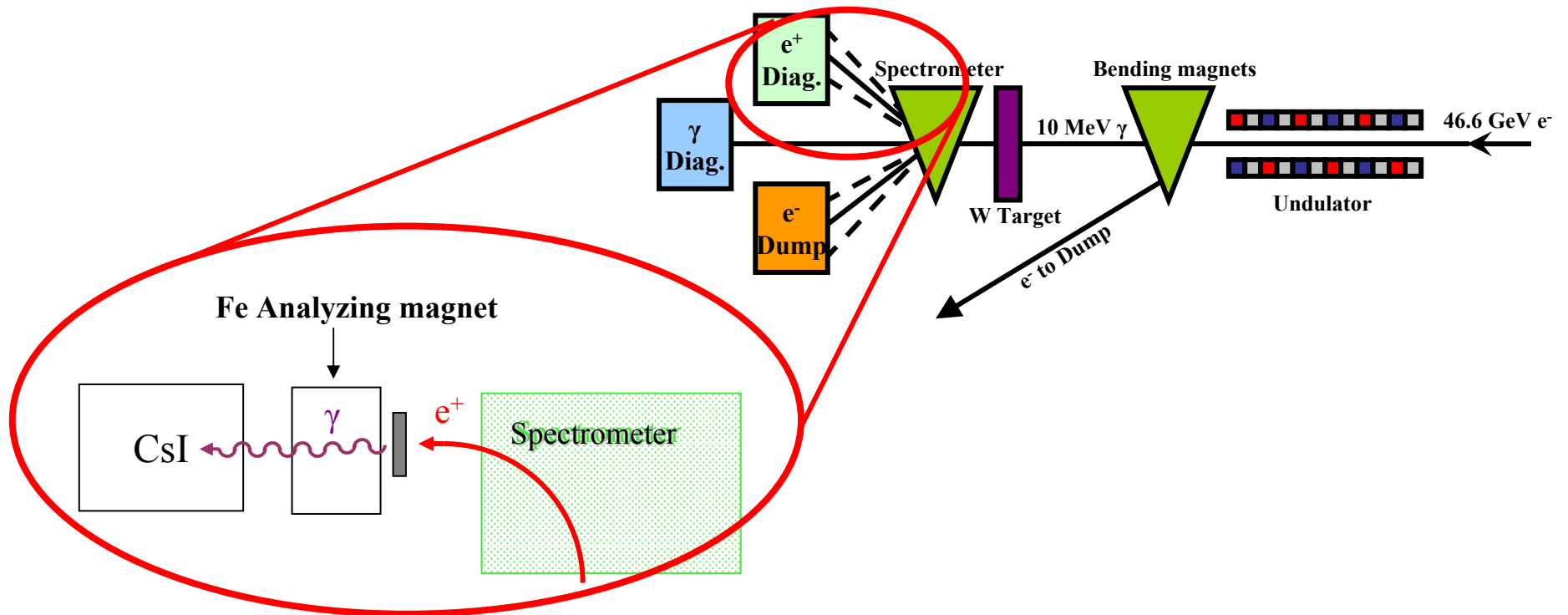
± 0.073



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Positron Measurement



1. *Converting positrons back into photons which then hit analyzing magnet.*
2. *Collecting as before the unscattered photons at two opposite magnetization directions of the iron.*

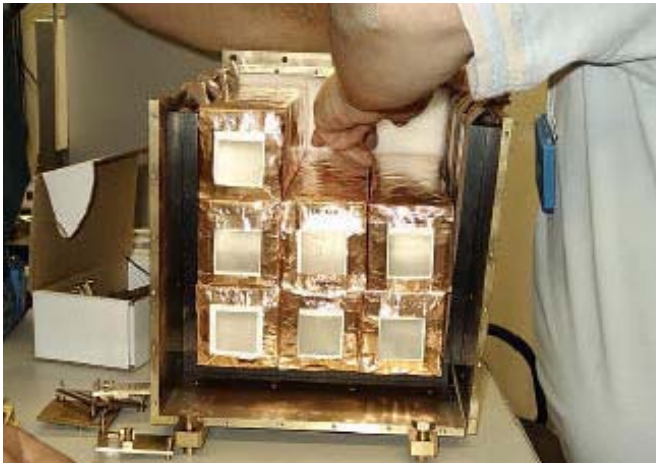
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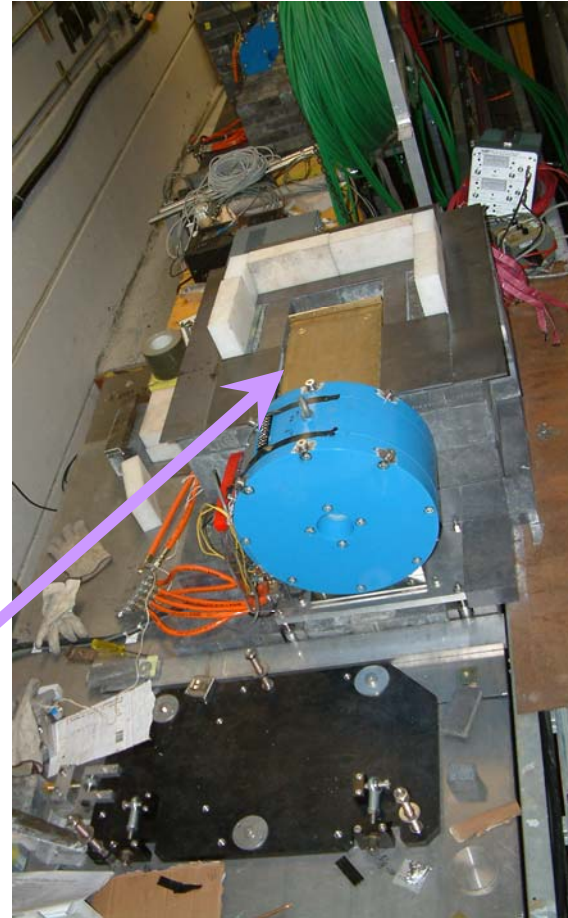
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Positron Measuring Equipment

- CsI detector being assembled



- CsI detector shielded around, behind the blue analyzing magnet



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E-166 γ & e^+ detectors setup at SLAC:

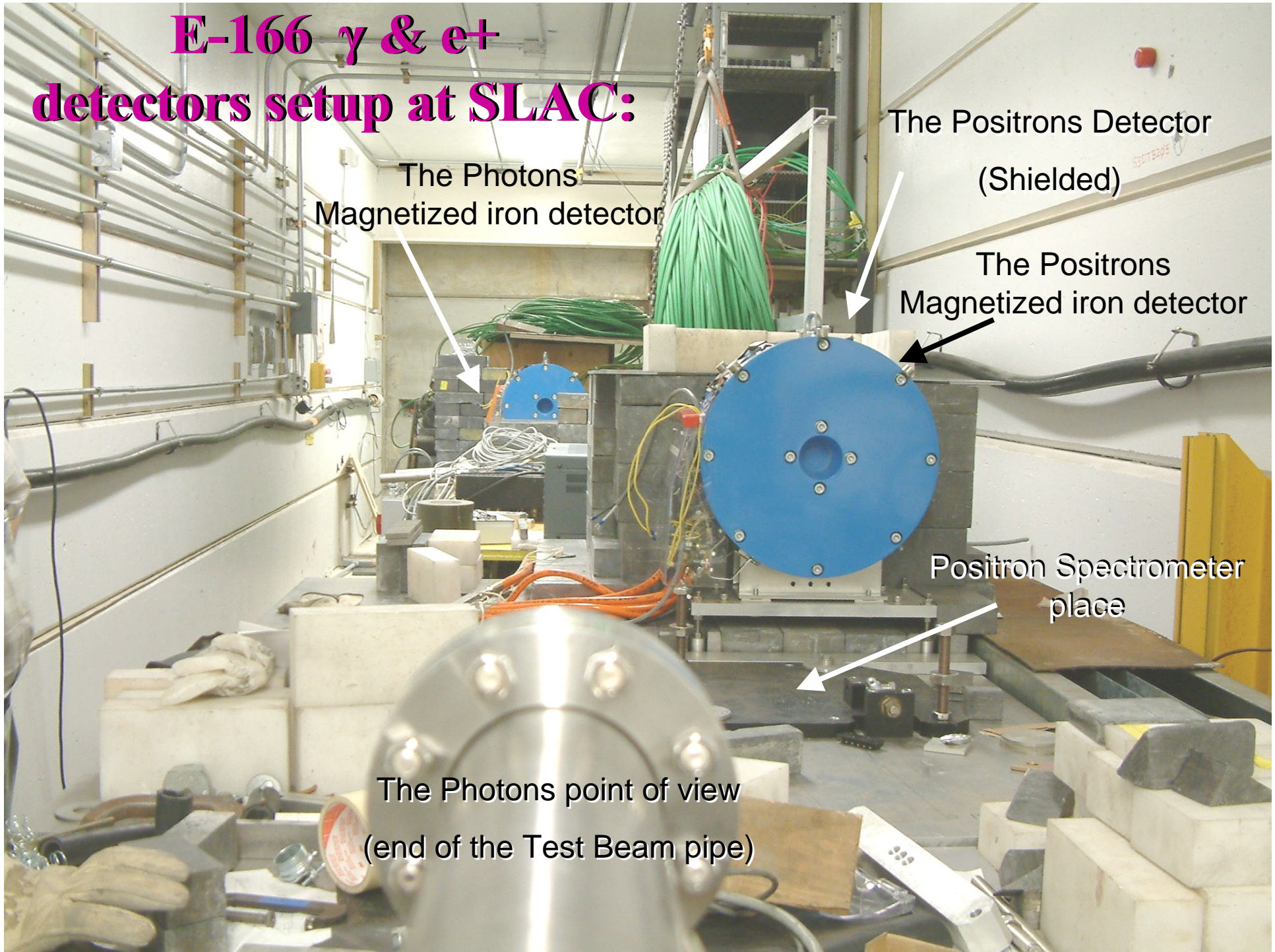
The Photons
Magnetized iron detector

The Positrons Detector
(Shielded)

The Positrons
Magnetized iron detector

Positron Spectrometer
place

The Photons point of view
(end of the Test Beam pipe)



The Data Analysis

- **Positron Asymmetries**
- **Positron Polarization**
- **Photon Asymmetries**

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Positron runs and events

- The experimental runs:
 - Pilot run in June 2005
 - Main run in September 2005
- The energy values used:

Spectrometer [A]	100	120	140	160	180
Positrons energy [MeV]	4.46	5.26	6.11	6.95	7.9
Events used in the analysis	306k	278k	602k	265k	242k

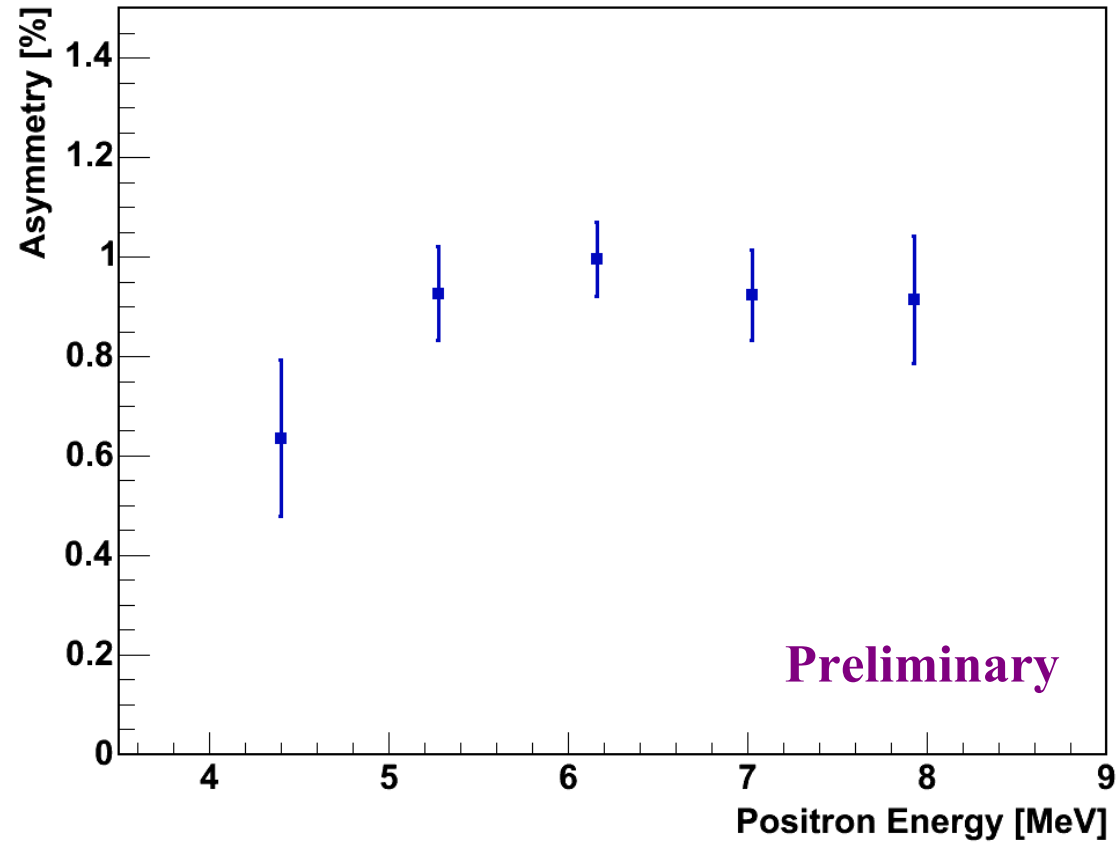
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Positron Asymmetry results vs. E_{e^+}

Statistical errors only



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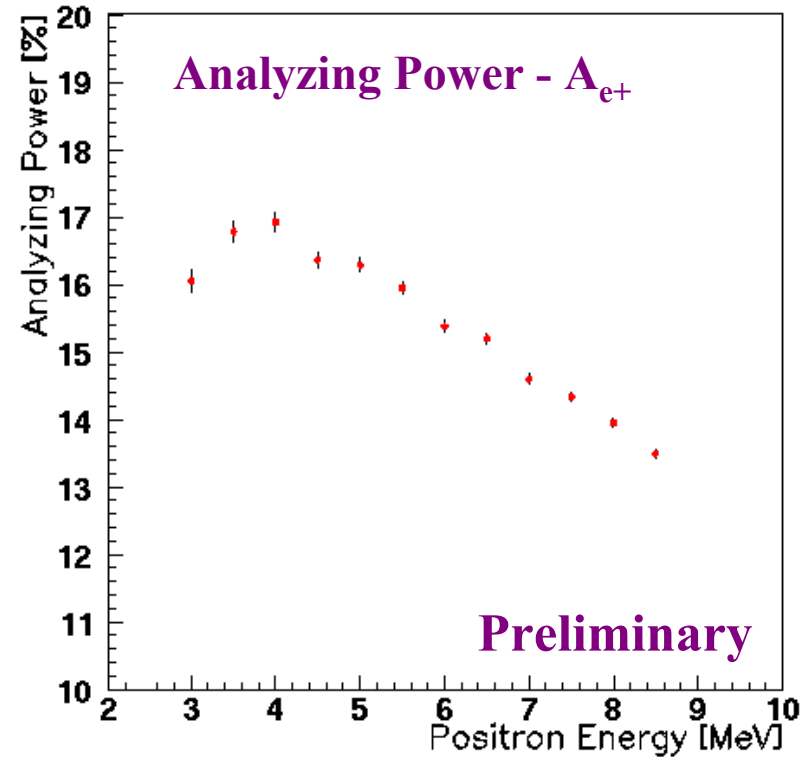


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The Positron Polarization

a. Analyzing power

$$P_{e^+} = \frac{A_{sy}}{P_{e^-} A_{e^+}} \quad ; \quad P_{e^-}(Fe) = 0.073$$



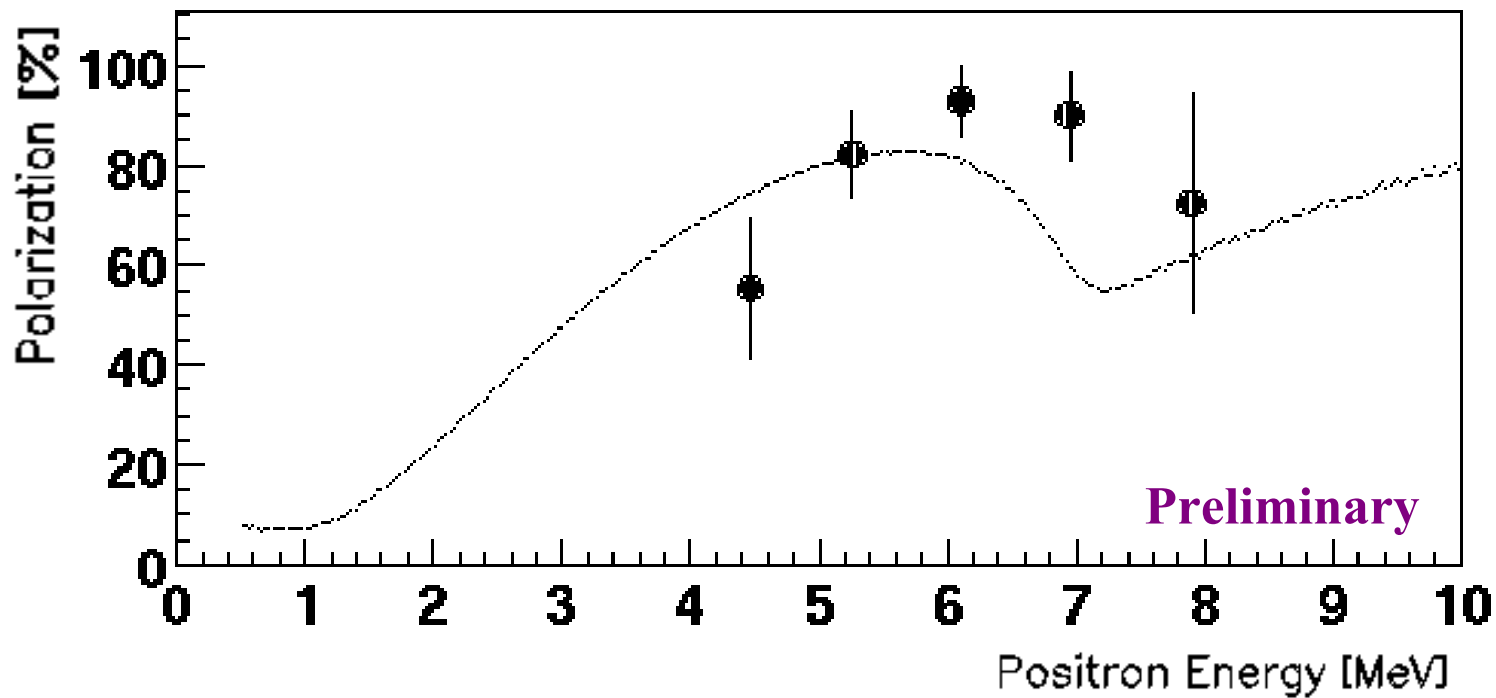
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The Positron Polarization

b. Preliminary results



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Analysis Results

Photons

- Measured separately by two counters:
 - Photon counter
 - Calorimeter counter

- The measured Asymmetries are:

	Asymmetry [%]	Error [%]
Photon Counter	3.84	0.19
Calorimeter	3.85	0.20

Electrons

- One single spectrometer setting, data is still being analyzed.

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Summary and Outlook

- E-166 has shown that the Undulator based method to produce longitudinal polarized positron beam is practicable and could be applied to a future ILC.

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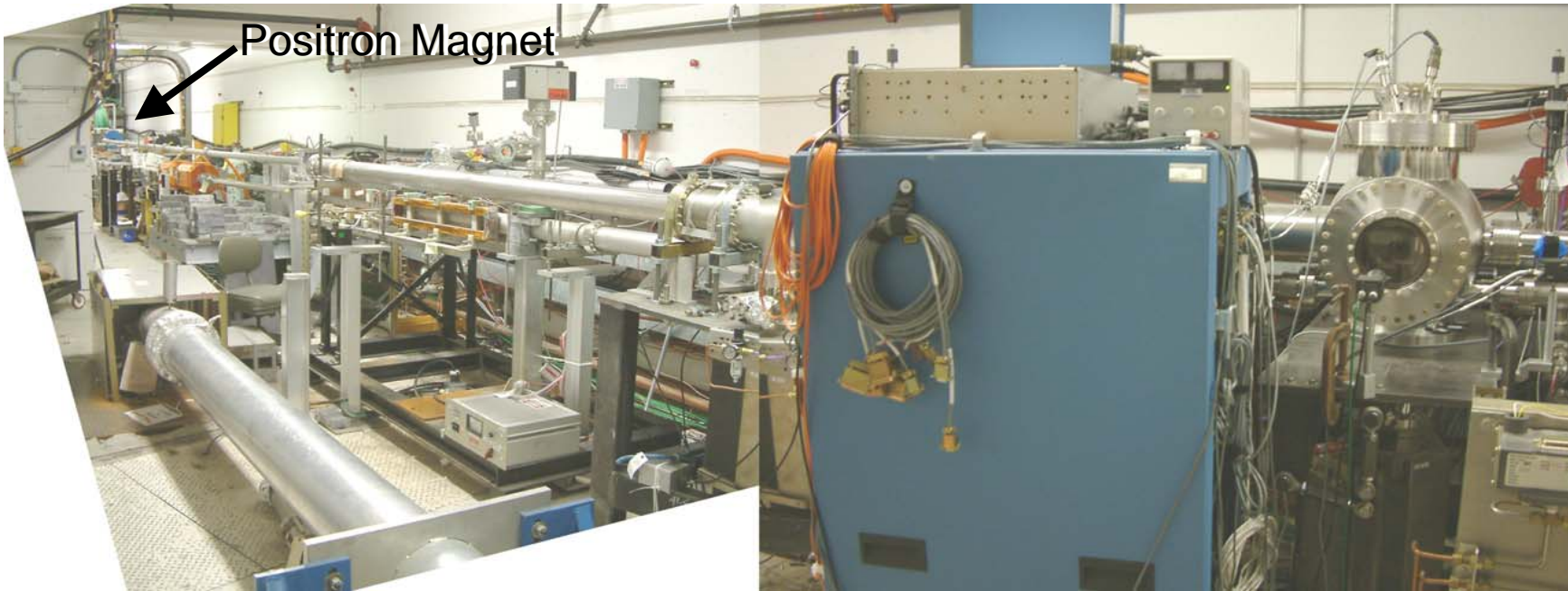
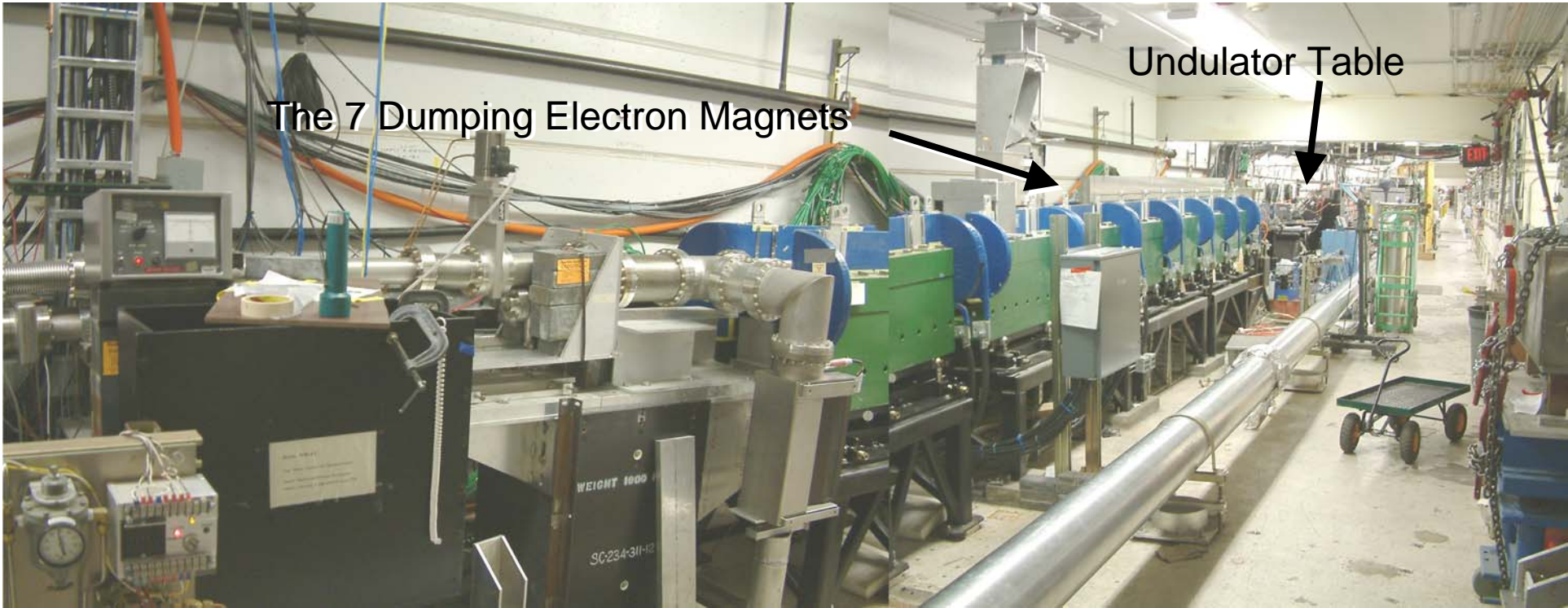
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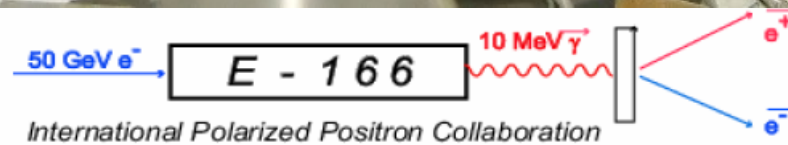
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The gamma point of view



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