Polarization-Energy workshop

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ALC07
23 October 2007

Workshop at DESY Zeuthen
EDR Progress and Plans

Workshop Polarization/Energy measurements at the ILC

DESY Zeuthen, Berlin, Germany
April 9-11, 2008

Local Organizing Committee

Sabine Riemann-DESY Zeuthen
Andreas Schaelicke-DESY Zeuthen
Heinz Juergen Schreiber-DESY Zeuthen
Jenny List-DESY Hamburg
Peter Schuler-DESY Hamburg

Program Committee

Stewart Boogert-RHUL
Mike Hildreth-Notre Dame
Jenny List-DESY Hamburg
Ken Moffeit-SLAC
Gudrid Moortgat-Pick - IPPP, Durham
Sabine Riemann-DESY Zeuthen
Peter Schuler-DESY Hamburg
Eric Torrence-University of Oregon
Mike Woods-SLAC

Topics

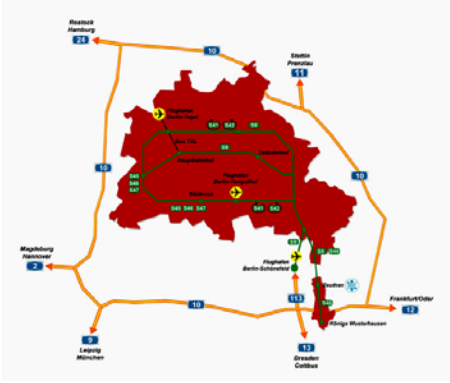
Polarization Physics
Overview of electron and positron polarization sources and spin transport
Polarimeter specifications and design (beamline chicanes, optics and backgrounds, integration with other instruments, laser systems, detectors, conventional facilities)
Energy spectrometers (Beam position monitors, Synchrotron radiation, Compton)
EDR work and co-ordination with GDE (Work packages, Milestones, Deliverables)

ILC positron source meeting at DESY, Zeuthen, April 2008

- April 7-9 ILC positron source meeting
- April 9-11 Workshop Polarization/Energy Measurements

½ day overlap of the meetings

Info about DESY Zeuthen:http://www-zeuthen.desy.de/



Baseline ILC Positron Source

Helical undulator (100 m long) produces ~10 MeV circularly polarized photons from 150 GeV electrons. Positrons of collected from a thin target.

Positron polarization depends on:

- Photon polarization spectrum (tight collimation increases polarization)
- Target material and thickness
- Positron capture phase space

Positron longitudinal polarization of ~30% can be expected from the baseline ILC

Fully implemented positron source polarization of 40 – 70% is expected.

Collimate photons from undulator increases circular polarization of photons hitting target.

Increase length of helical undulator to ~200 m to restore positron beam intensity.

Result is higher positron polarization.

Requirements for Physics with 30% positron polarization

Physics measurements will benefit from 30% positron polarization created in a source with a 100m long helical undulator.

- Effective polarization increased
- Cross section enhanced or reduced
- Removes uncertainty in zero polarization
- Errors reduced

See G. Moortgat-Pick, et. al., *The role of polarized positrons and electrons in revealing fundamental interactions at the Linear Collider*, SLAC-PUB-11087

The following systems are necessary to make use of 30% positron polarization. They should be available from the beginning or at least as soon as possible after the start of ILC operation:

- Spin rotators before and after the positron damping ring.
- Two parallel spin rotation beam lines (with kicker magnets to select the line) in the positron linac-to-ring transfer line before the damping ring for randomly flipping the positron helicity pulse train to pulse train.
- Positron polarimeters in the positron beam delivery system and the positron extraction line are mandatory.

BDS POLARIMETRY Work Package WBS 9

Ken Moffeit, Mike Woods, Peter Schuler, Jenny List

Precise Polarimetry with 0.25% accuracy is needed.

Polarimeters both upstream and downstream of the IR based on Compton Scattering

Each work package will give the following:

Requirements

Scope

Milestones

Deliverables

Time line for three year EDR phase

Resources

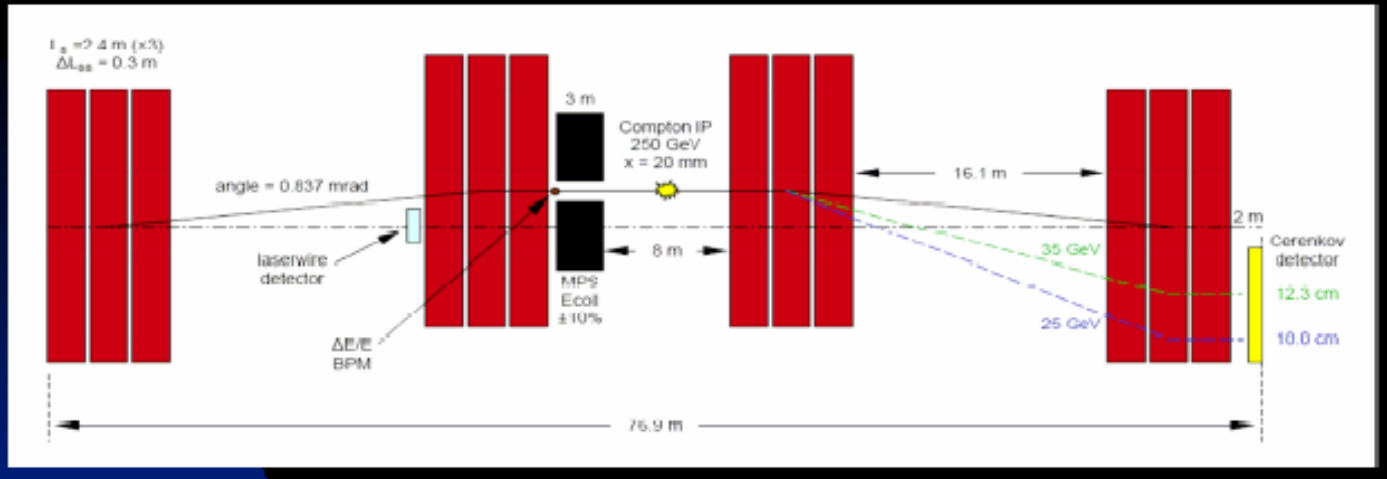
Polarimetry Work Packages

WBS L1	WBS L2	WBS L3	L1 Description	L2 Description	L3 Description	Leader	Institutions EOI
9	9.12	9.12.0	Beam Inst	Polarimetry	BDS Polarimetry		SLAC,DESY
9	9.12	9.12.1	Beam Instrumentation	Polarimetry	Upstream Compton	List, Schuler	DESY
9	9.12	9.12.2	Beam Instrumentation	Polarimetry	Downstream Compton	Moffeit, Woods	SLAC, Tufts
9	9.12	9.12.3	Beam Instrumentation	Polarimetry	Detectors	List	DESY, U. Iowa
9	9.12	9.12.4	Beam Instrumentation	Polarimetry	Laser for Upstream	Schuler	DESY
9	9.12	9.12.5	Beam Instrumentation	Polarimetry	Laser for Downstream	Moffeit, Woods	SLAC
9	9.12	9.12.6	Beam Instrumentation	Polarimetry	Optical Systems Upstream	Schuler	DESY
9	9.12	9.12.7	Beam Instrumentation	Polarimetry	Optical Systems Downstream	Moffeit, Woods	SLAC
9	9.12	9.12.8	Beam Instrumentation	Polarimetry	Conventional Facilities	Moffeit, Schuler	SLAC, DESY
9	9.12	9.12.9	Beam Instrumentation	Polarimetry	Data Acquisition		

WBS 9.12.1 BDS Polarimetry Work Package Upstream Compton

Upstream Compton polarimeter design, optics, background and performance.
Leader: Jenny List, Peter Schuler

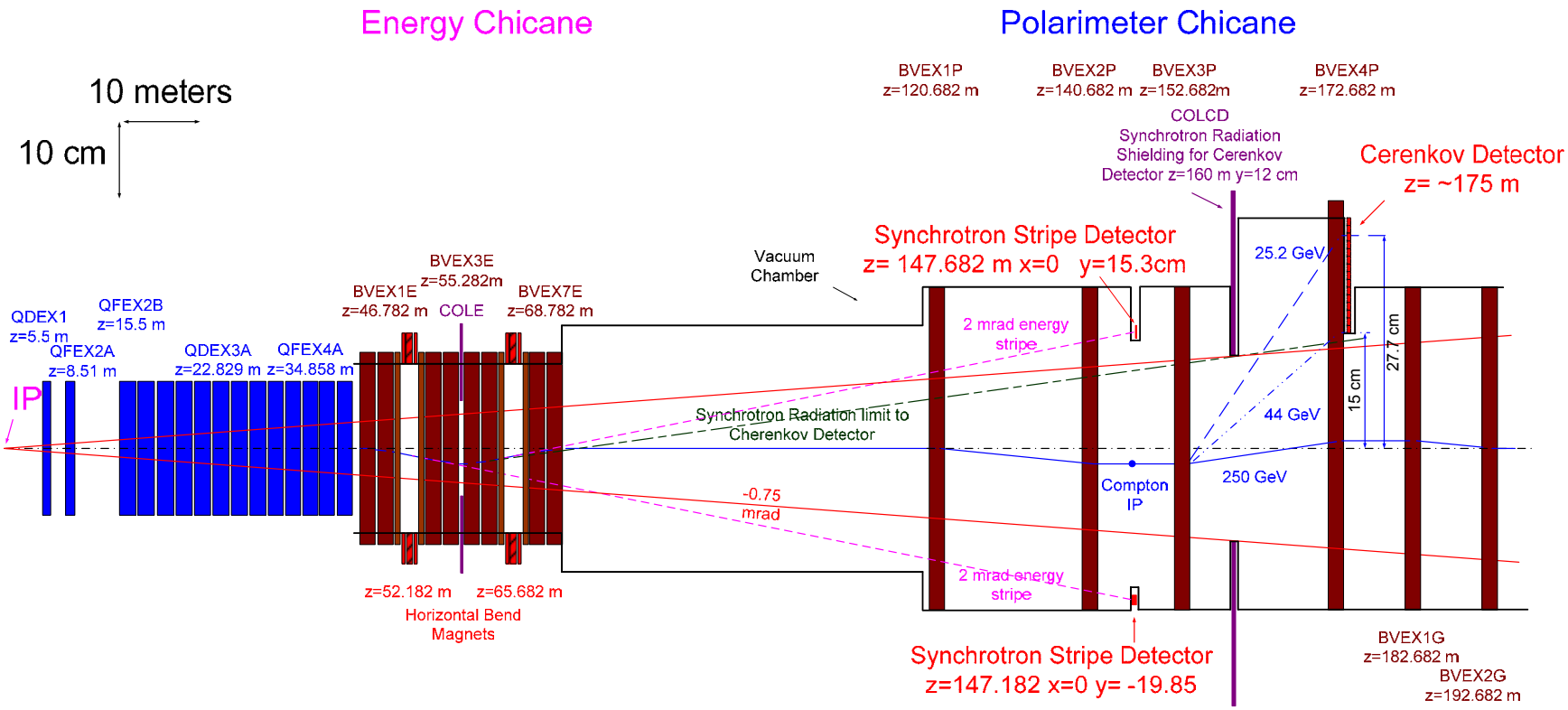
new upstream polarimeter chicane



- **constant integrated strength dipoles (0.097 Tesla) for all beam energies**
- **dispersion of 20 mm at 250 GeV (→ only 10 mm @ 500 GeV)**
- **combination of polarimetry with laser wire emittance diagnostic & MPS E-collimator saves ~100 m of beam line space, but creates several nasty issues:**
- **insufficient beam clearance for laser wire photon detector: < 5 mm @ 500 GeV**
  (this problem disappears, if the laser wire folks can switch to electron detection!!!)
- **wake field effects from inserted structures**
- **serious vacuum chamber engineering issues:**
  - collimator destroys tapered vacuum chamber concept
  - collimator position & aperture depend on beam energy

WBS 9.12.2 BDS Polarimetry Work Package Downstream Compton

Downstream polarimeter design, optics, background and performance. Leader: Ken Moffeit, Mike Woods



Extraction line design, beam studies, backgrounds at the Cherenkov detector from beamstrahlung tails and synchrotron radiation have been published:

Y. Nosochkov, T. Markiewicz, T. Maruyama, A. Seryi (SLAC), B. Parker (Brookhaven). ***ILC Extraction Line for 14 mrad Crossing Angle.*** SLAC-PUB-11591, Dec 8, 2005.

IPBI_TN-2006-3, ***Update on Comparison of 2 mrad and 14 mrad Crossing Angle Extraction Lines at 0.5 GeV CMS***, K. Moffeit et al., October 2006.

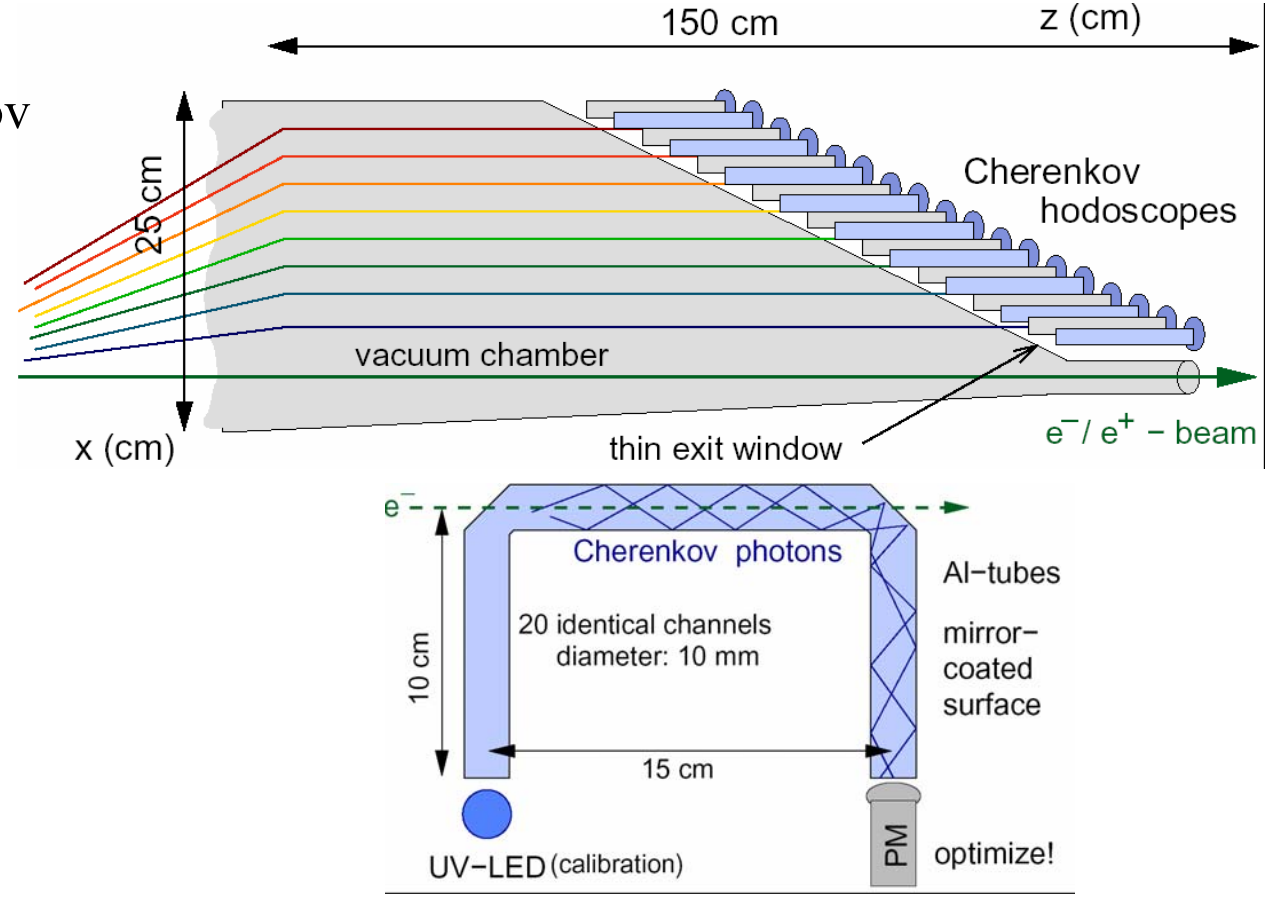
IPBI_TN-2006-4. ***Performance of Extraction Line Energy Spectrometers and Polarimeters at 1 TeV Center-of-Mass Collision Energy,*** K. Moffeit et al., October 2006.

IPBI_TN-2007-1. ***Proposal to modify the polarimeter chicane in the ILC 14 mrad extraction line,*** K. Moffeit et al. SLAC-PUB-12425, March 2007.

WBS 9.12.3 BDS Polarimetry Work Package Detectors

Detectors for upstream and downstream Compton Polarimeters.
Leader: Jenny List

Gas Cherenkov



Quartz Fiber

WBS 9.12.4 BDS Polarimetry Work Package Laser for Upstream Compton

Laser for upstream Compton polarimeter

Leader: Peter Schuler

Plan to use source type laser for Compton scattering on each bunch in the pulse train

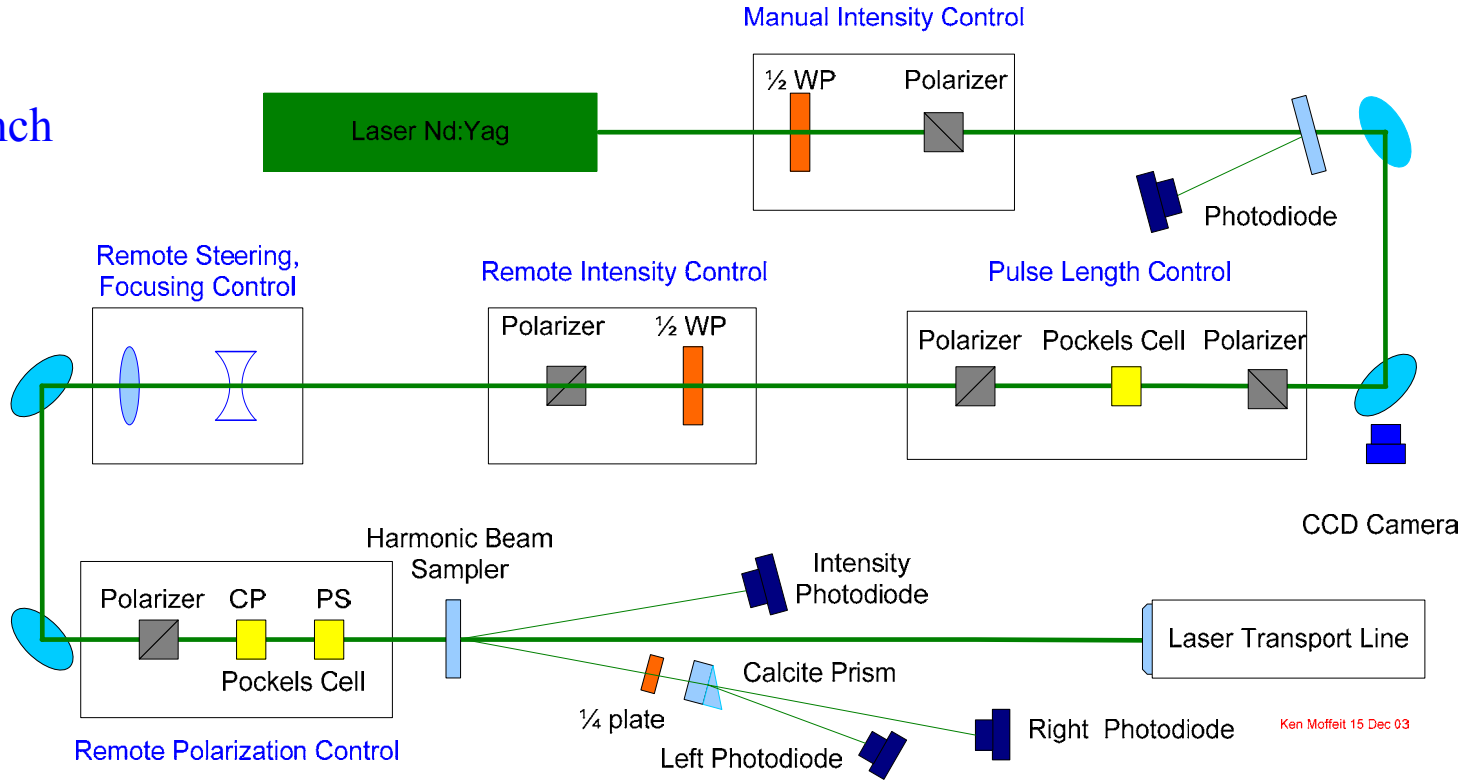
WBS 9.12.5 BDS Polarimetry Work Package Laser for Downstream Compton

Lasers for downstream Compton polarimeter

Leader: Ken Moffeit, Mike Woods

A frequency doubled Nd:YAG (Neodymium:Yttrium-Aluminum-Garnet) laser will be used with a wavelength of 532 nm (2.33 eV). A 10 hertz laser can be use for 5 hertz collision with a single electron bunch of the beam train and 5 hertz for laser pickup noise measurements. A possible available commercial laser is the Continuum Powerlite Model 8020: 20Hz; 550 mJ at 532nm; 6ns pulse width (FWHM).

Optics Bench



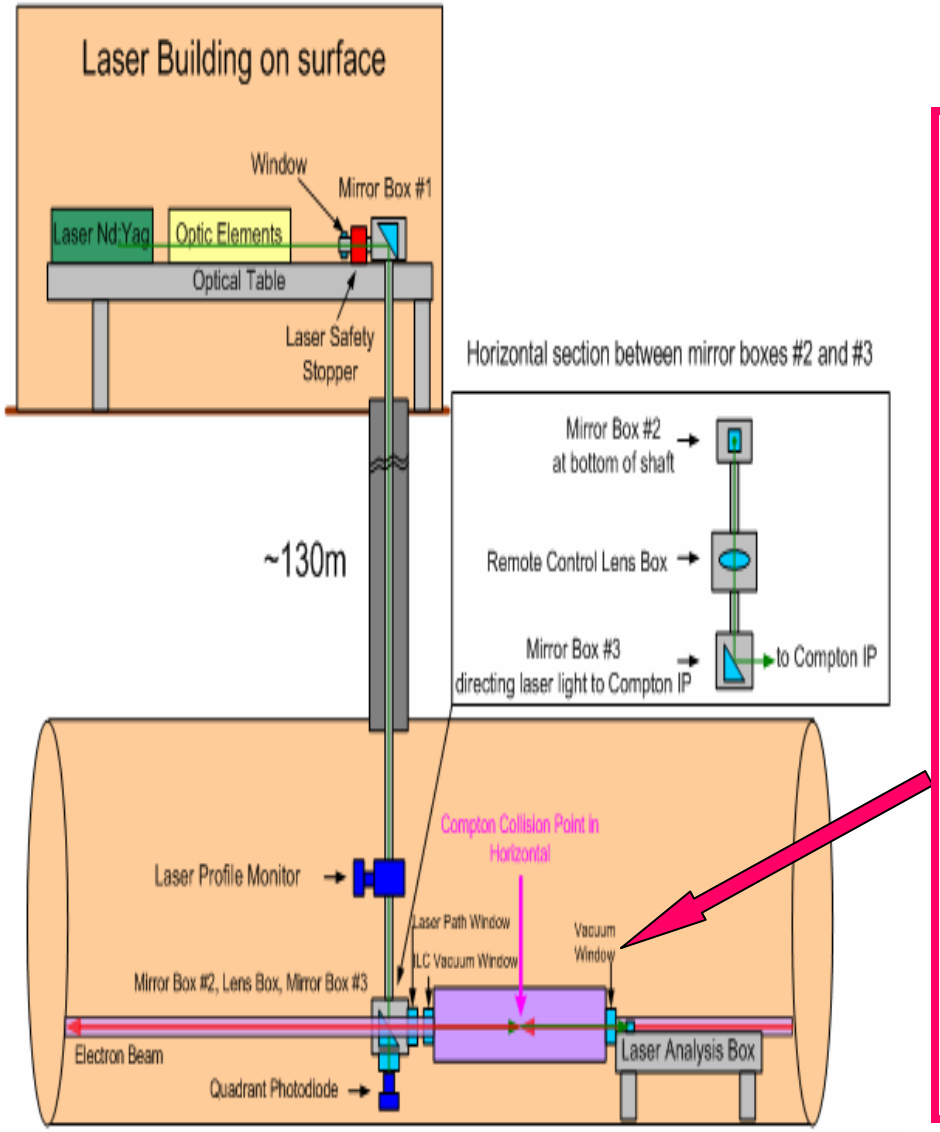
WBS 9.12.6 BDS Polarimetry Work Package Optical Systems for Upstream Compton

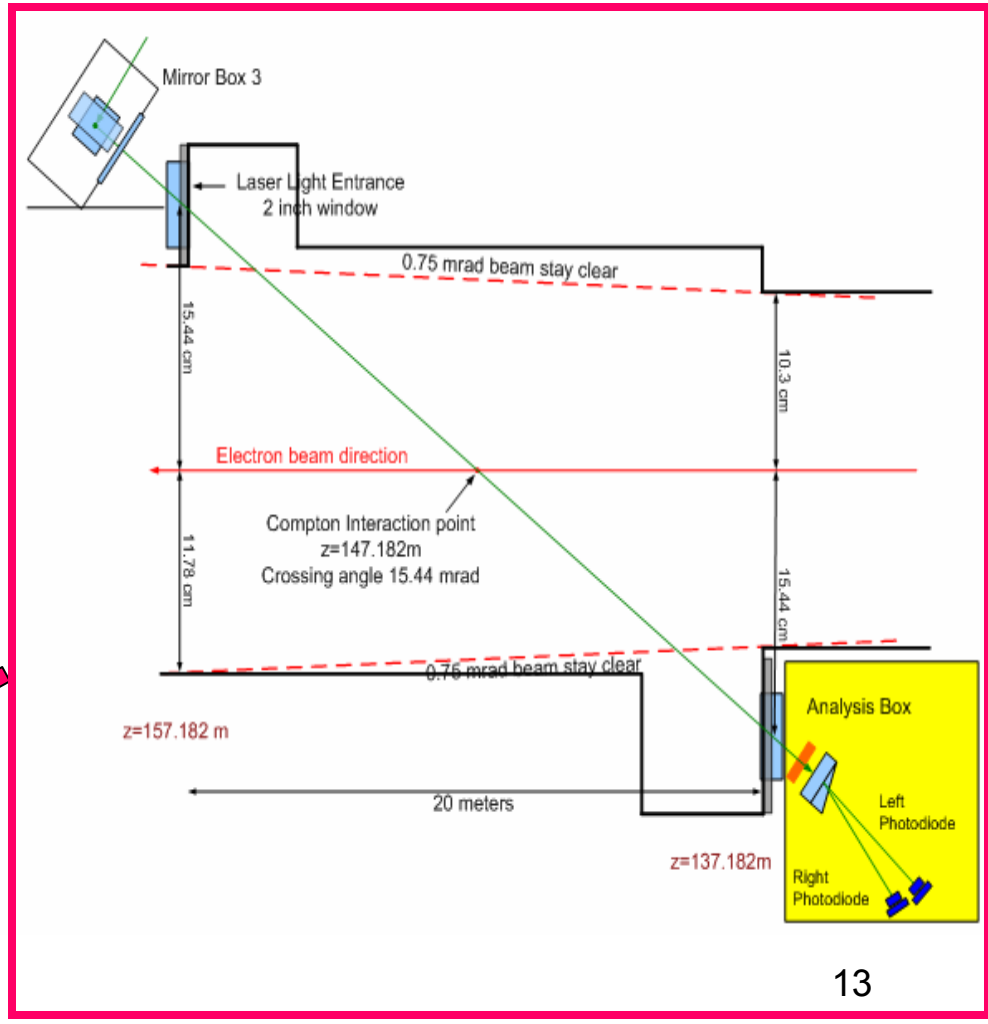
Laser light transport lines and diagnostics for upstream polarimeter.

Leader: Peter Schuler

WBS 9.12.7 BDS Polarimetry Work Package Optical Systems for Downstream Compton

Laser light transport lines and diagnostics before and after Compton IP for downstream polarimeter
Leader: Ken Moffeit, Mike Woods

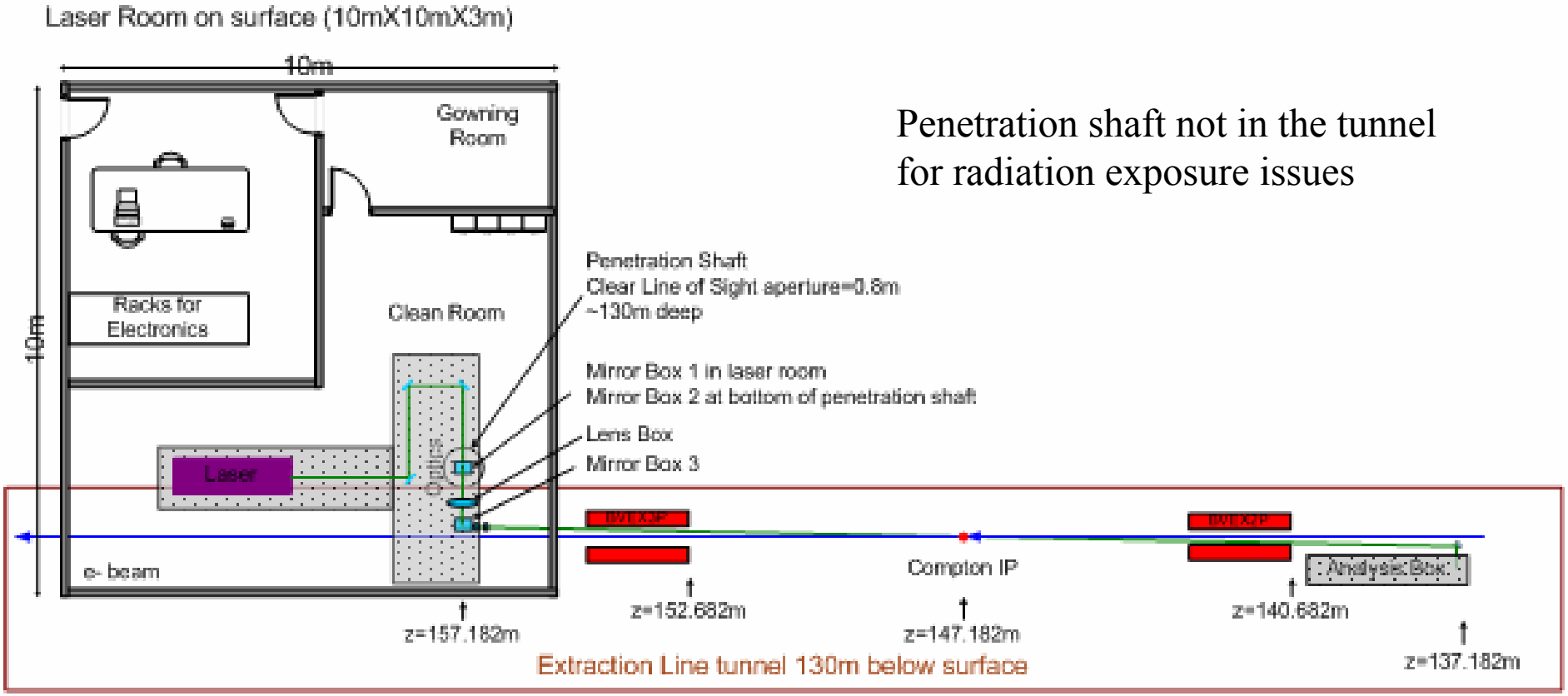




WBS 9.12.8 BDS Polarimetry Work Package Conventional Facilities

Conventional facilities for laser rooms, electronics/control rooms, penetrations for laser transport lines to Compton IP. Specifies power, air conditioning, clean room, water requirements.

Leader: Ken Moffeit and Peter Schuler



Penetration shaft not in the tunnel for radiation exposure issues

WBS 9.12.9 BDS Polarimetry Work Package Data Acquisition

Specify computer, data acquisition and control, data from source and spin rotators, data to experiment.

Leader: