Polarimetry Group Status Report

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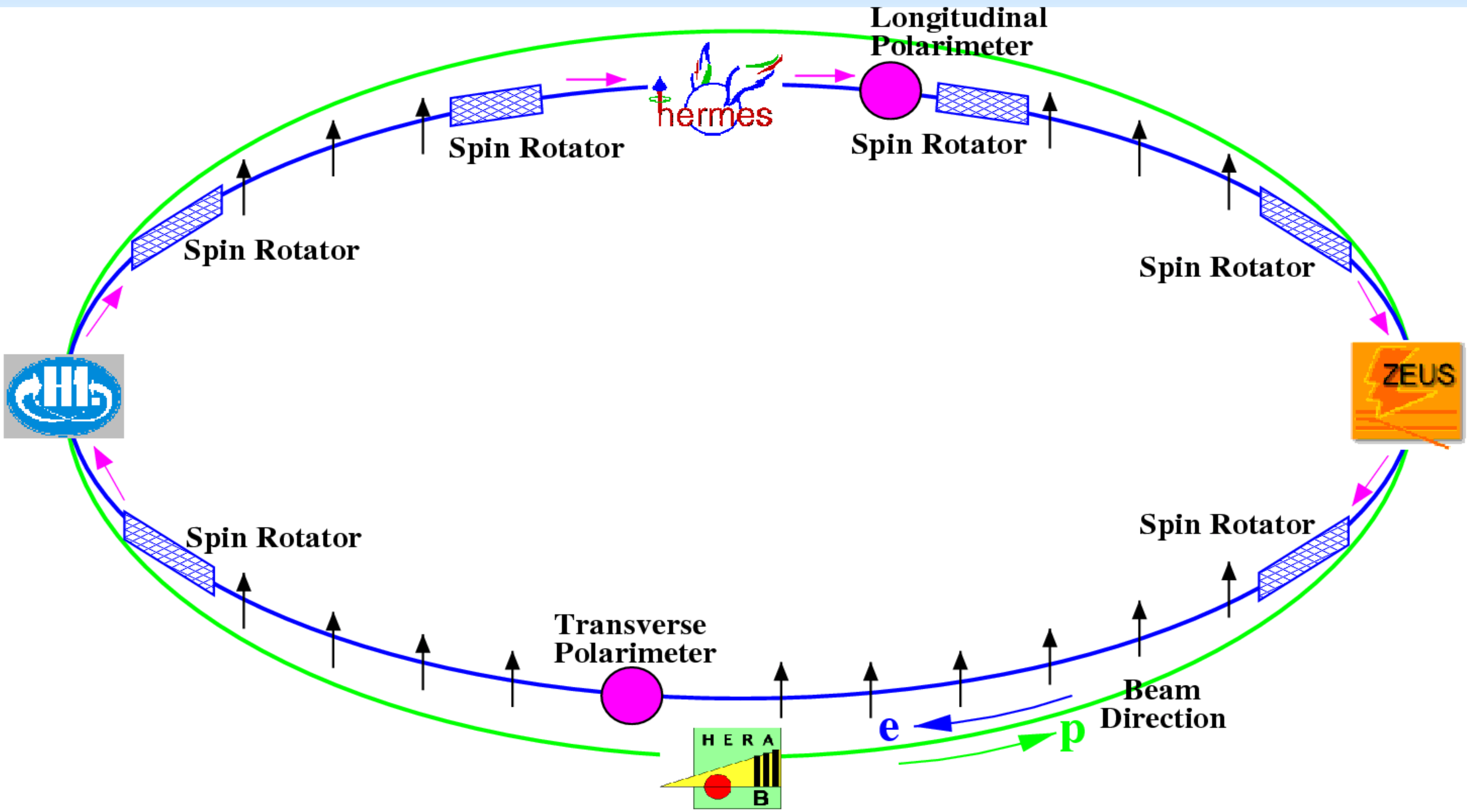
15 / 9 / 04
Technical Plenary
H1Collaboration Meeting, Budva, Montenegro

- Introduction
- LPOL Cavity Shutdown Work
- New LPOL Cavity Calorimeter
- TPOL Analyses
- Conclusions

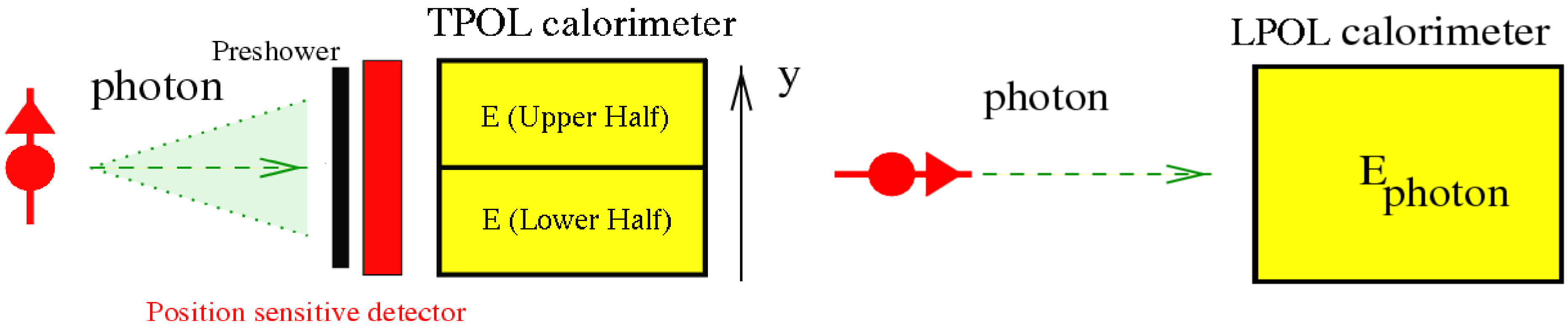
Polarisation at HERA II



- **LPOL**: measure longitudinal polarization between HERMES spin rotators
- **TPOL**: measure transverse polarisation far from spin rotators

TPOL and LPOL

Compton scatter laser light off pol. electron beam



- Measure vertical asymmetry of compton photons η(y):

  $$\eta = (E_{upper} - E_{lower}) / (E_{upper} + E_{lower})$$

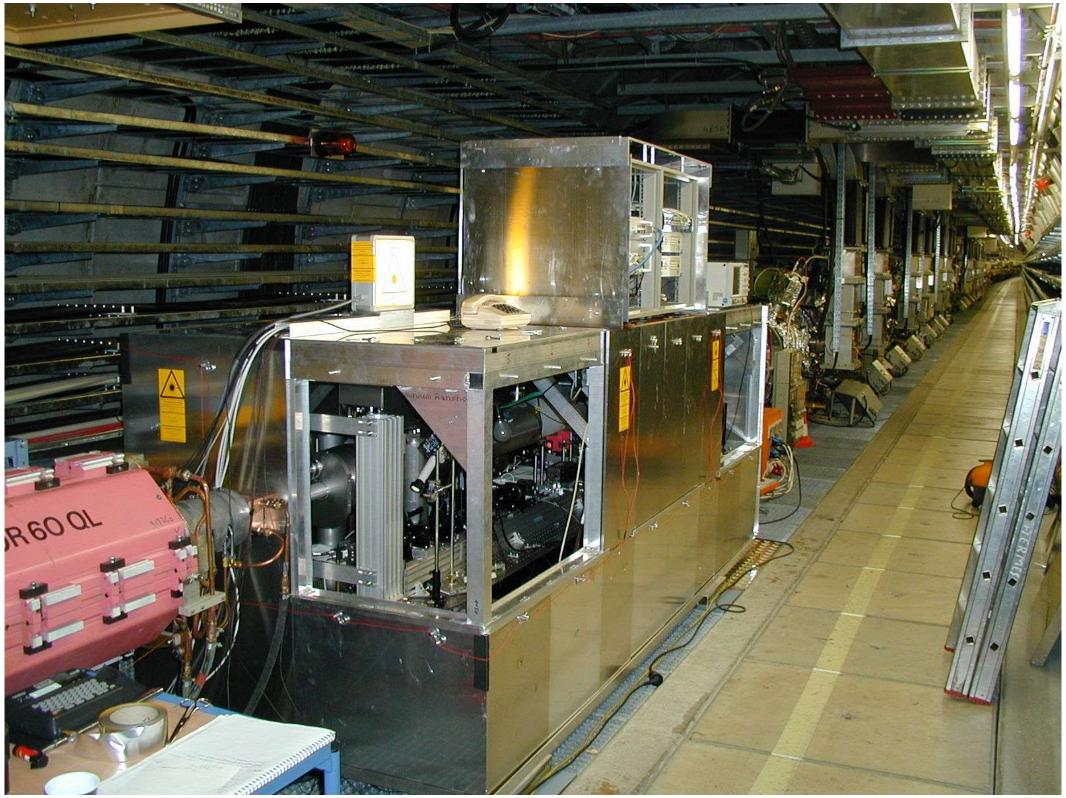
- Continuous laser (1-2 compton γ's in 200 bunch crossings)
- In-situ measurement of η(y) from Si strip and scintillating fibre

- Measure energy dependence of compton photons
- Pulsed laser (high power, low rate)
- Measure multi-γ spectrum
- New 1W laser + Fabry-Perot cavity
- Measure 'Few-γ' spectrum

LPOL Cavity Shutdown Work

Much work to repair previous synchrotron damage and avoid further damage

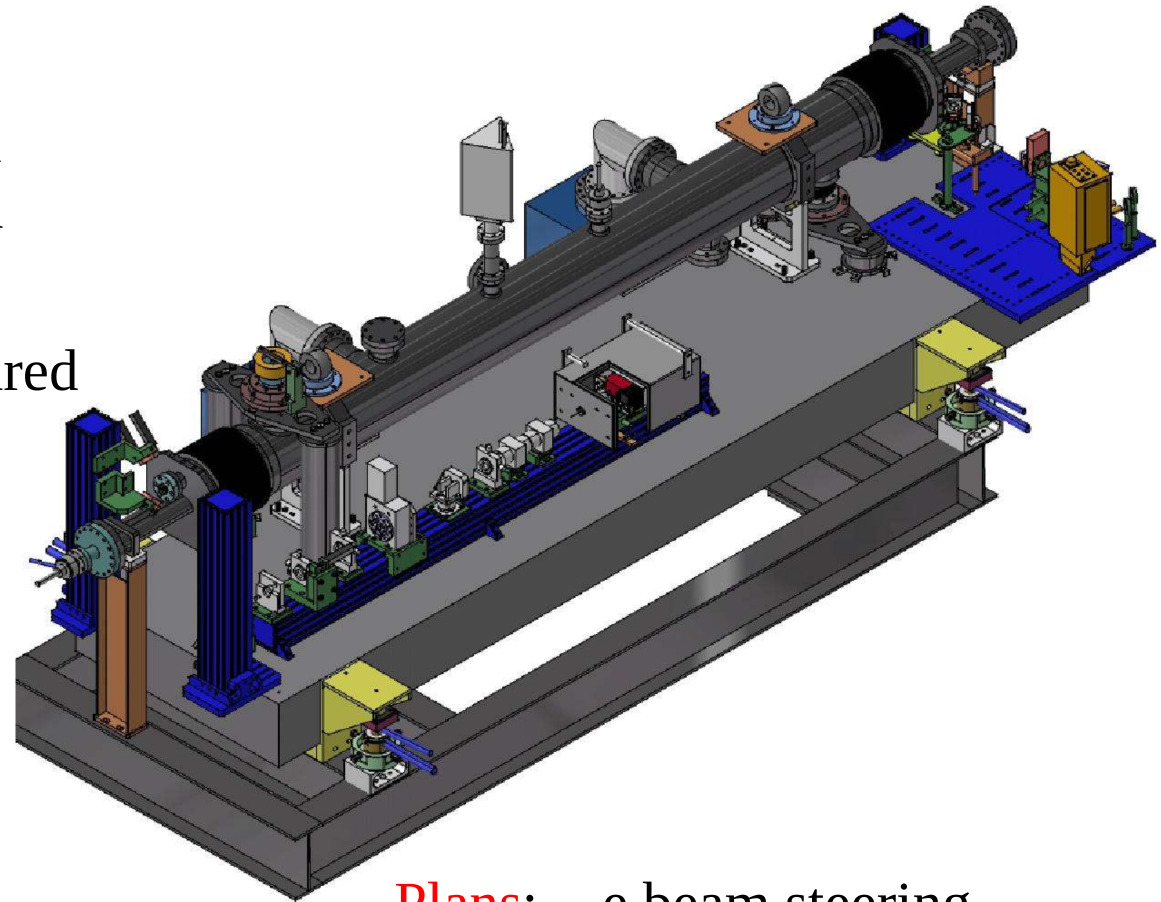
- Installation of new copper pieces at OR 54m by DESY vacuum group
  - reduce synchrotron radiation coming towards cavity
- Electronics:
  - electronics moved from top of lead house
  - power supplies, communication items under walkway concrete
  - two new 2.5cm lead boxes to house laser controller (under optical table) and motor controllers (front of cavity)



- completely tested and optimised for minimum noise

LPOL Cavity Shutdown Work II

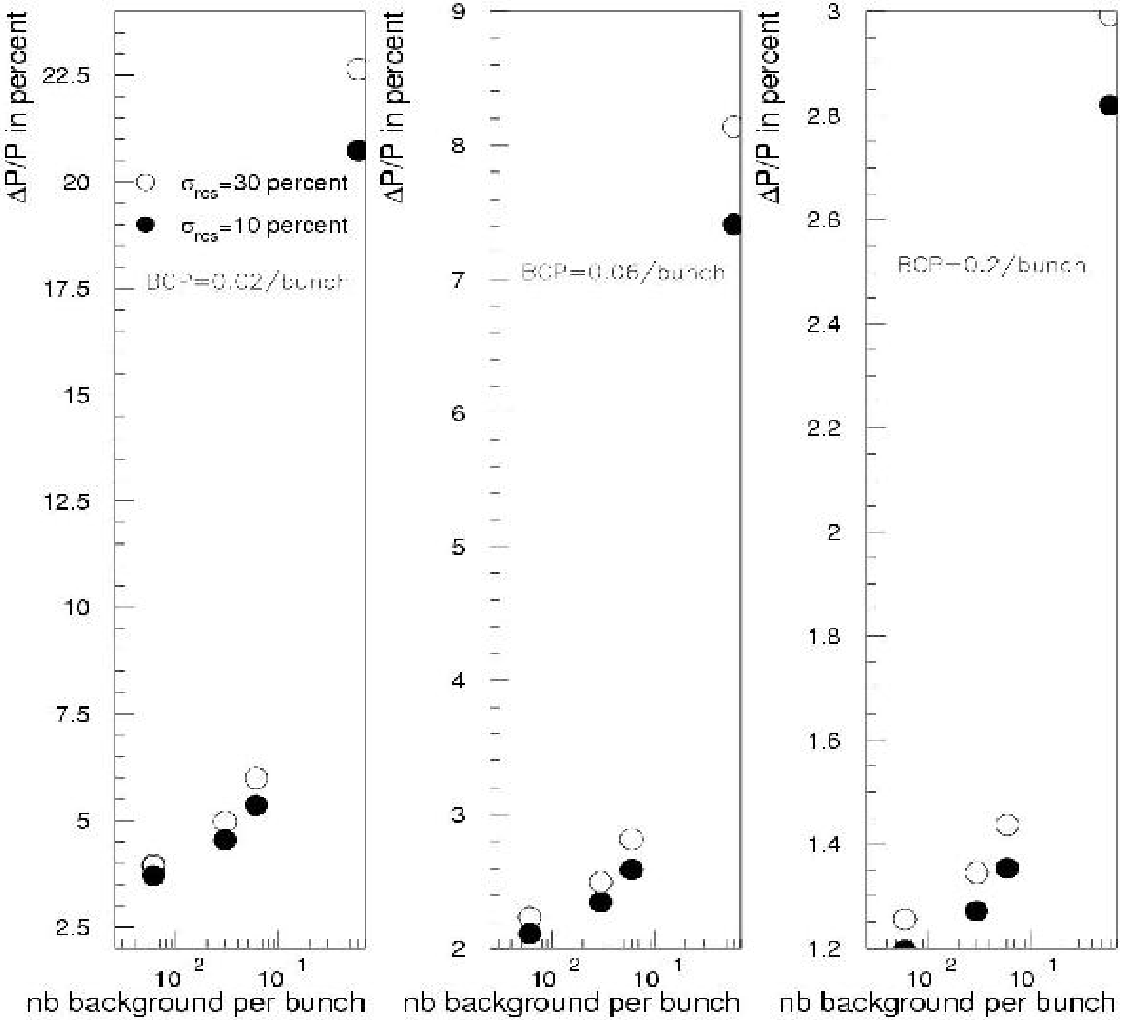
- Laser realignment
  - changed damaged parts (ccd cameras etc.) and reinstalled delicate parts
  - realligned both red and infrared laser lines
- Installation of new ellipsometer
  - new implementation for photodiodes for increased precision in measuring laser polarisation
  - presently being tested and calibrated



– Plans: - e beam steering
- observe compton γ's
- reinstall dosimeters

New LPOL Cavity Calorimeter: Requirements

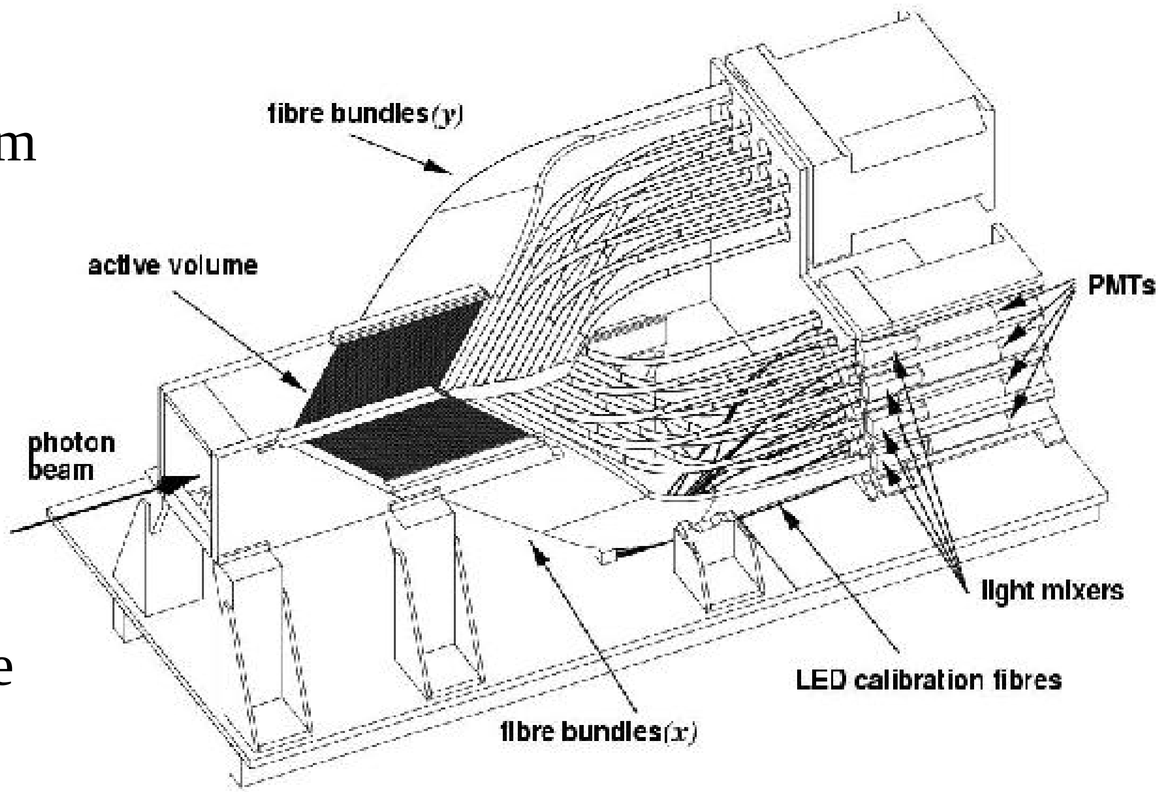
- Moderate energy resolution sufficient
- Radiation dose per year from compton radiation in shower core ~200 MRad
- Crystals: cannot stand radiation level
- Scintillators: slow components, pile up
- Quartz fibres: radiation hard, fast, moderate energy resolution



New Calorimeter: Ideas

- Base design on H1 Photon Detector
  - Tungsten absorber (0.7mm)
  - Quartz fibre sampling (0.6mm core diameter)
  - Signal from Cherenkov light
  - 12+12 strips (*x* and *y*) in oblique geometry
- New calorimeter can be simpler
  - Only measure in *x* coordinate

  ⇒ Only 'tilt' active volume in 1 dimension
- New calo to be built by DESY and Lebedev after shutdown

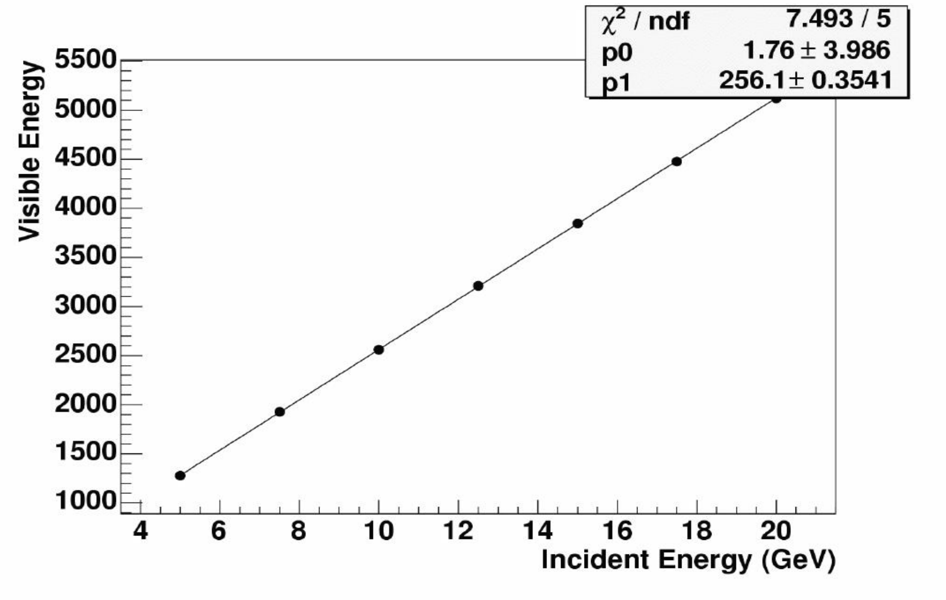


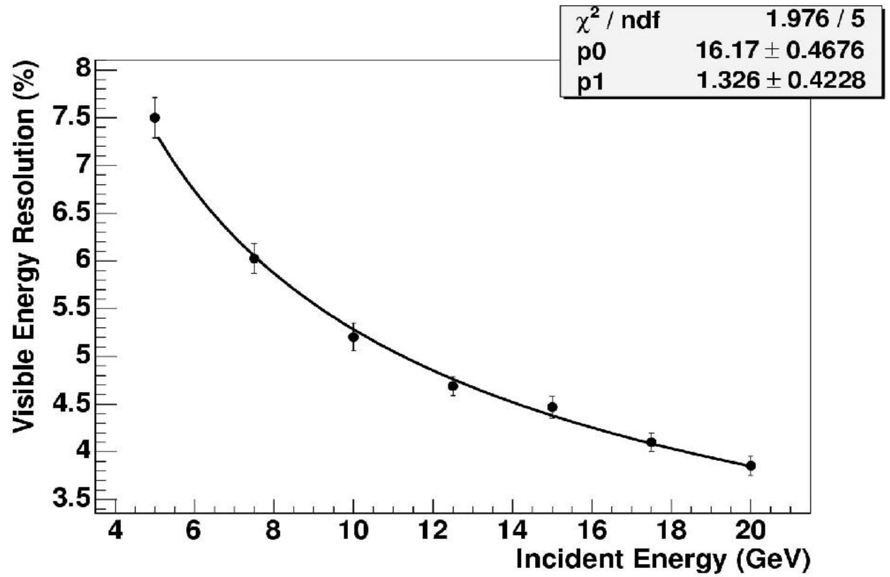
New Calo: Simulation

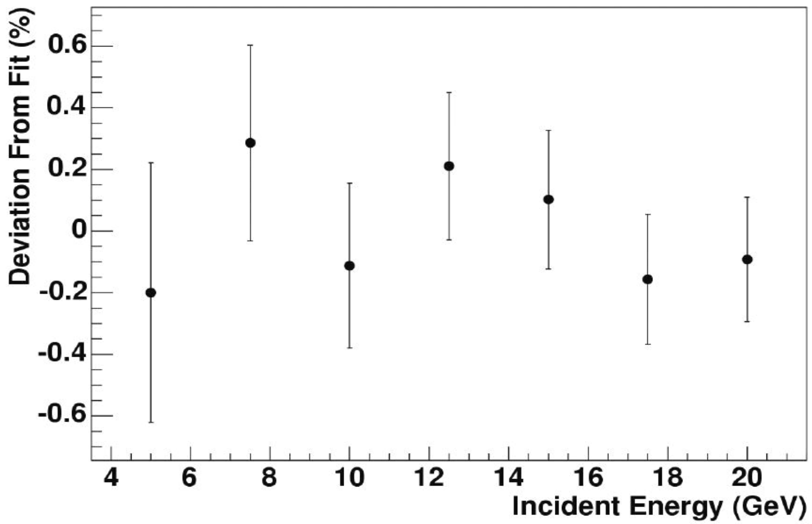
- Simulate using GEANT3
- Alternating W (0.7mm) and Si (0.6mm) layers
- Dimensions $5\times 5\times 13$ cm
  - 100 layers, 20 X_0 W, $0.14X_0$ Si
  - Approx. 8000 fibres
- Cherenkov light proportional to length of charged path in sampling layers

  $\Rightarrow$ Reconstruct visible energy
- Cut at 700 keV to approx. Cherenkov threshold
- Consider 5×1cm strips in x

New Calo: Linearity, Resolution

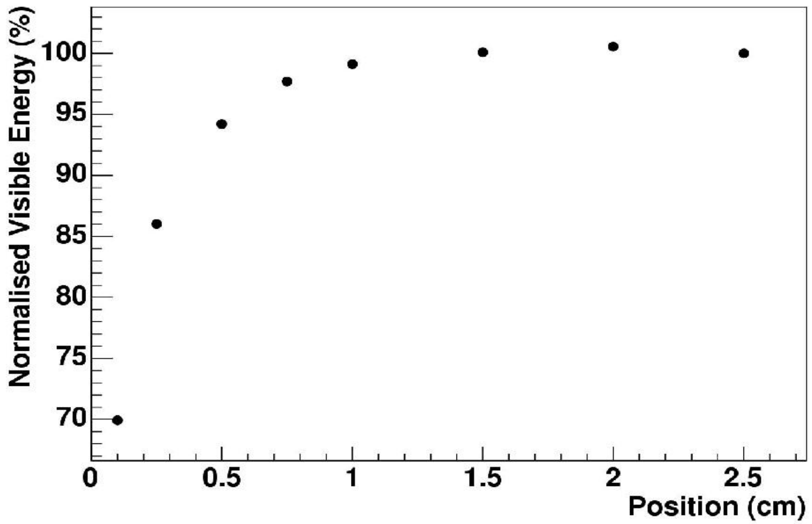


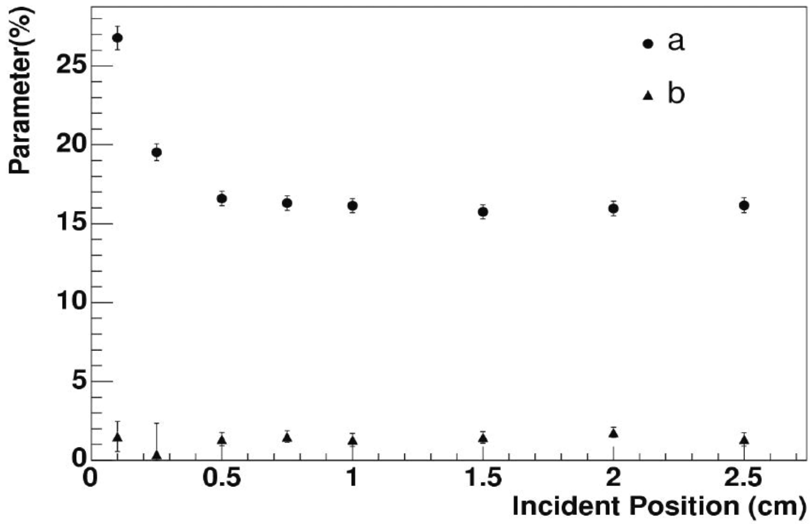


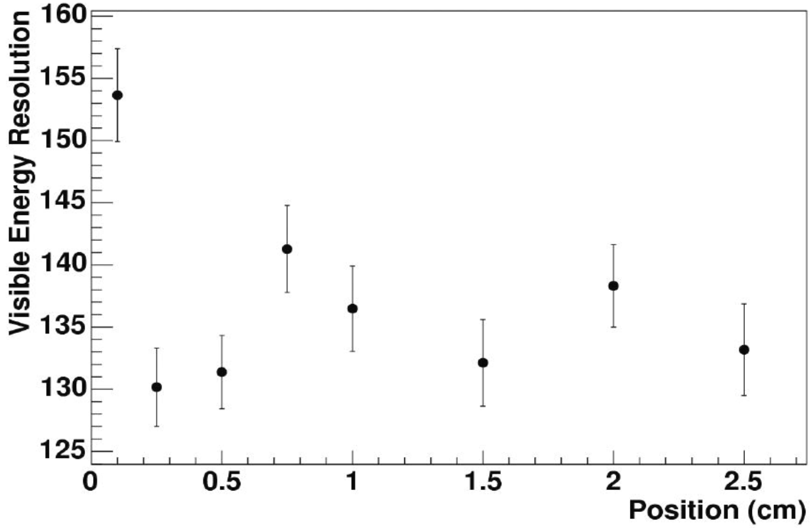


- Linear response to less than 0.5%
- Fit $\frac{\sigma(E)}{E} = \frac{a}{\sqrt{E}} \oplus b$
  - $a = (16.2 \pm 0.5)$ %
  - $b = (1.3 \pm 0.4)$ %
- Resolution within requirements

New Calo: Position Scan

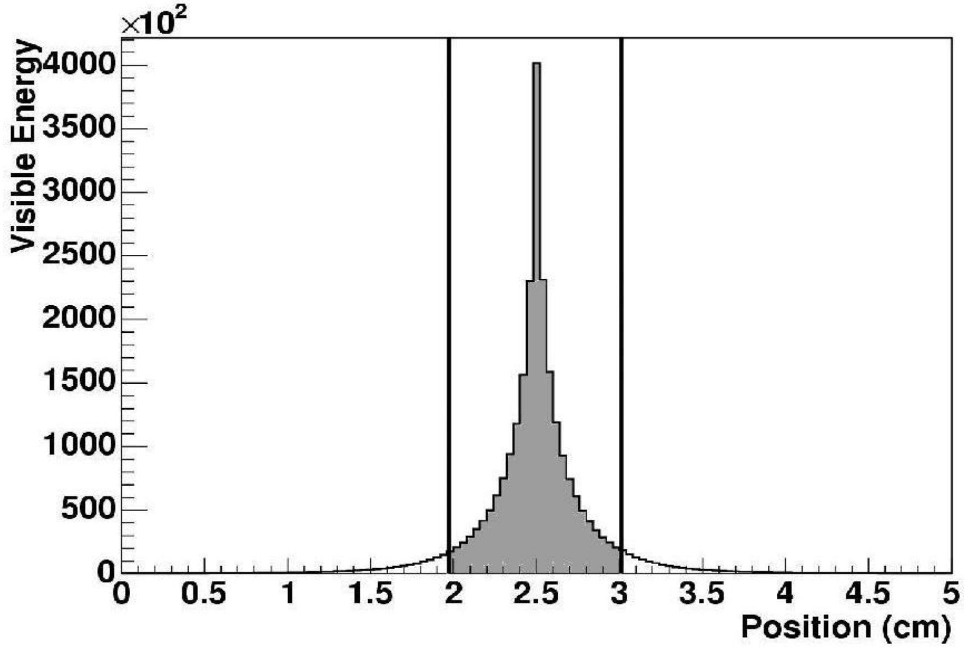


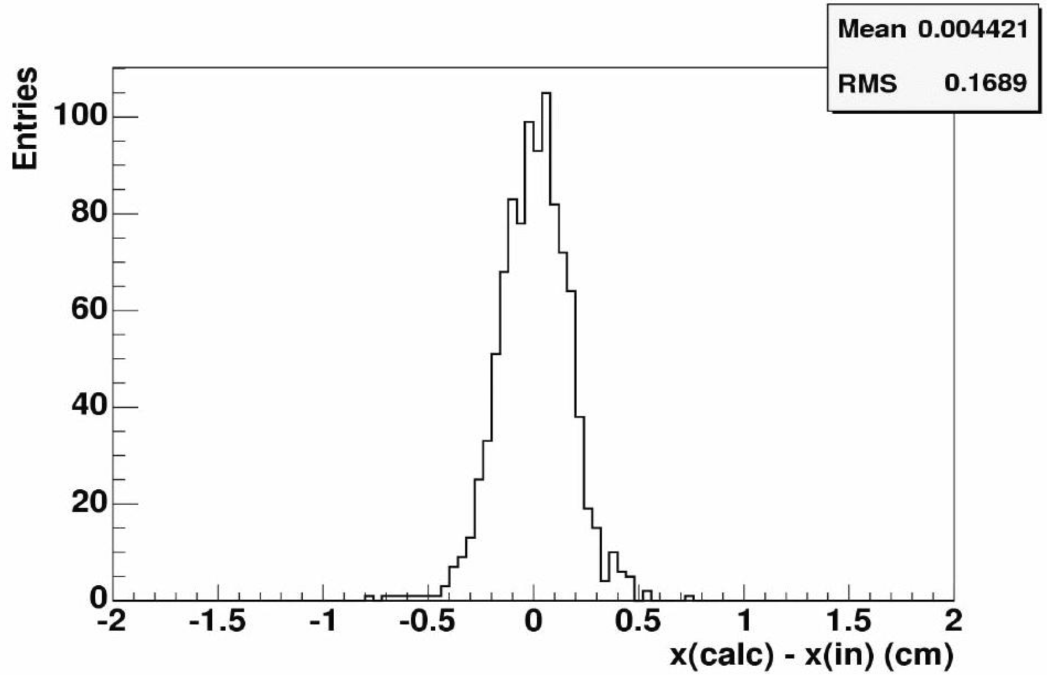




- Response and resolution remain constant for most of calorimeter
- Response drops by ~30% near to calo edge
- Reduced resolution reflected in sampling term

New Calo: Cluster Radius, Position Resolution



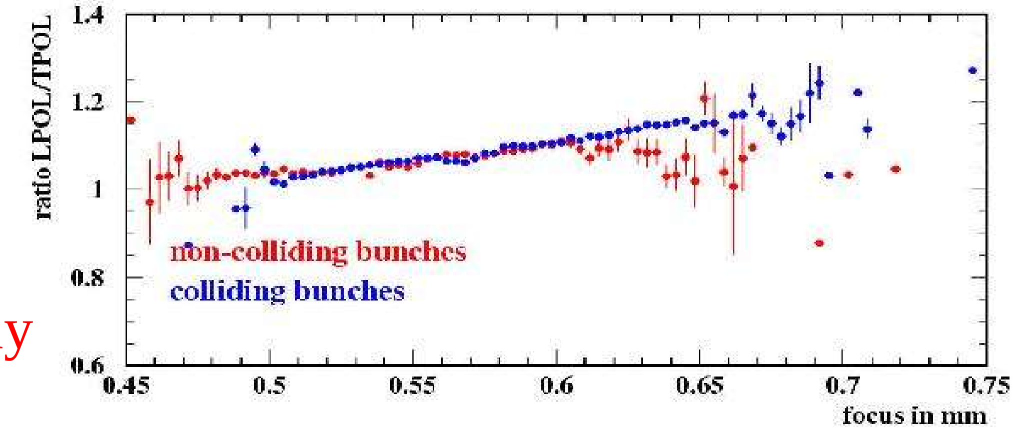


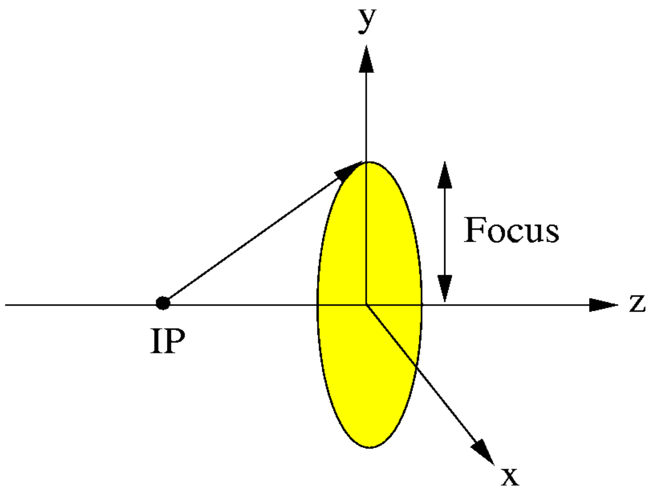
- 90% energy contained within 0.535 cm width

- Good position resolution, even with modest granularity

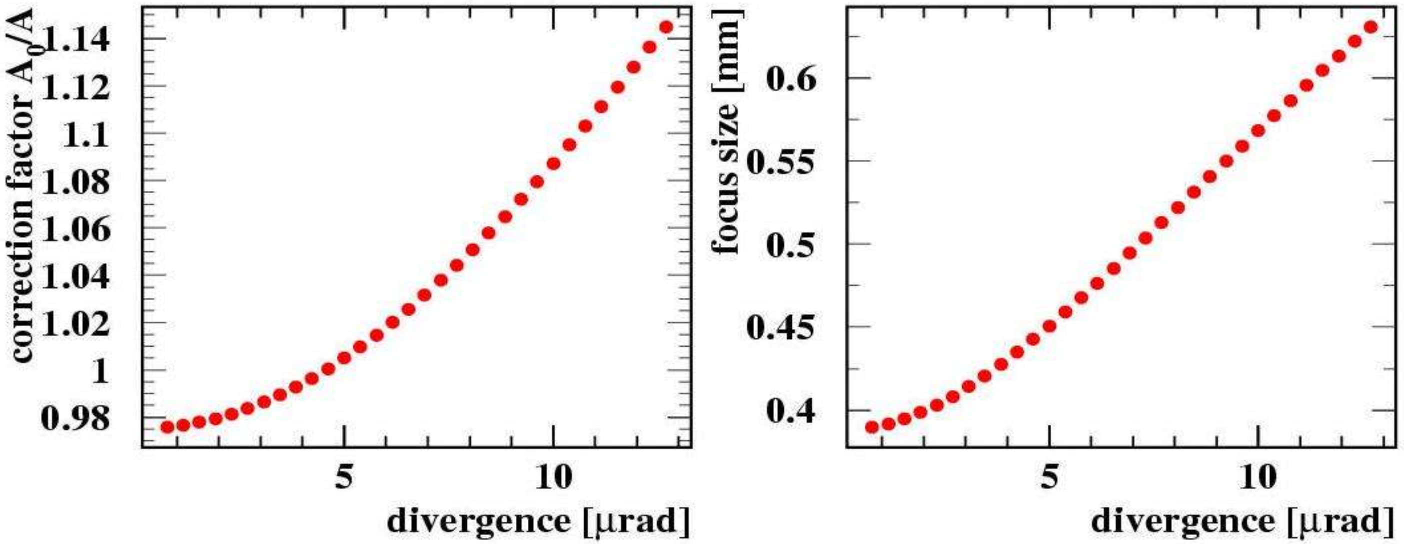
TPOL/LPOL Ratio

- Ratio should be unity!
  - At HERA I agrees to 2%
  - At HERA II disagrees to 5-15%
- Most critical parameter not previously accounted for online - focus size
- Stable at HERA I, but varies at HERA II from fill to fill
- Depends on size and angular divergence of electron beam at TPOL interaction point





TPOL Analysis



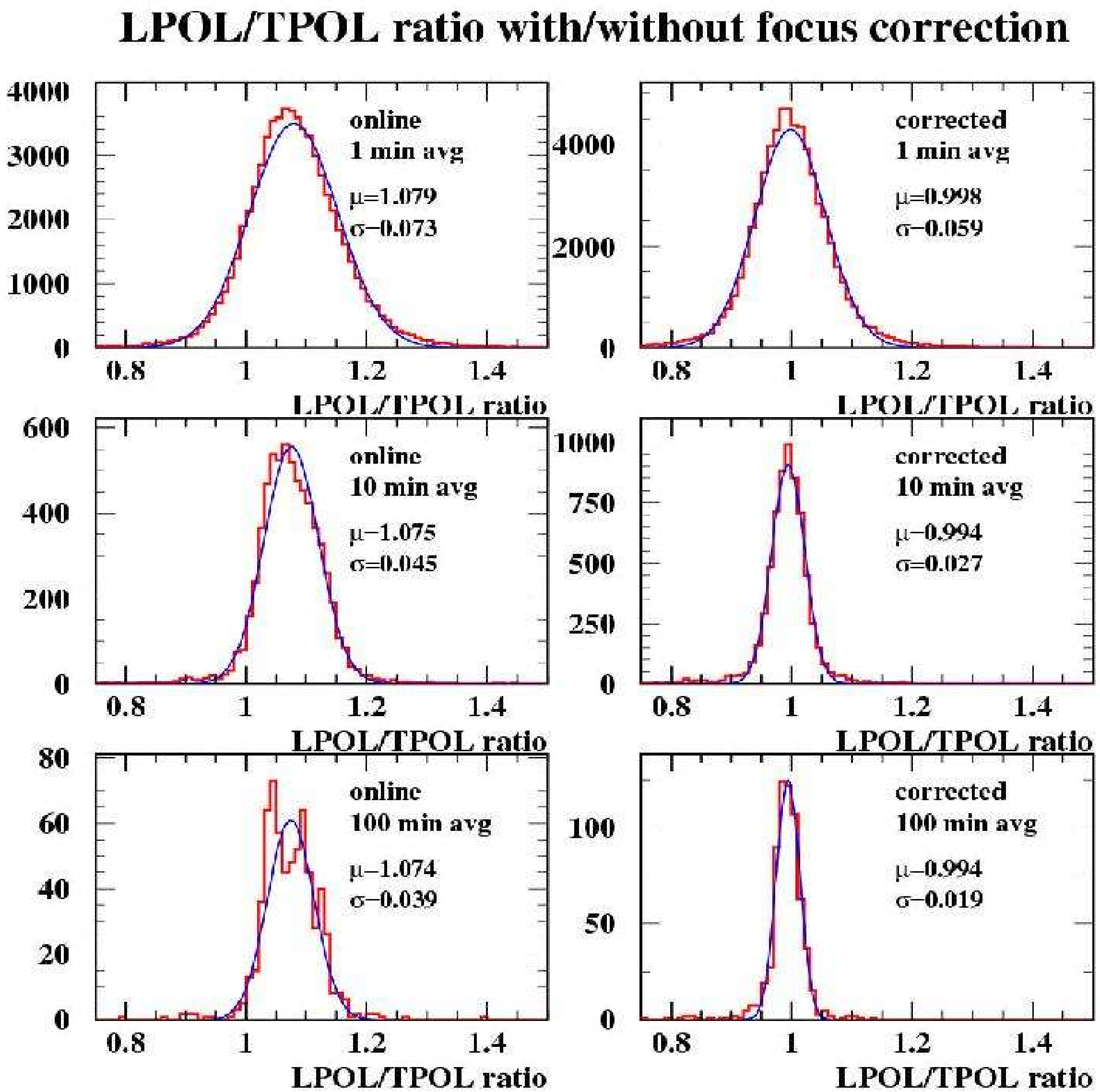
- MC study of TPOL response
  ⇒ still independent of LPOL
- Absolute calibration from HERA I
- Change in analysing power, *A*, with change in beam divergence
- Focus well suited to extract beam divergence ⇒ change in *A*

- Dominant systematic (1%) from stability of HERA I rise time calibration to focus size
- Combine with HERMES HERA I error:

$$\left(\frac{\Delta P_{TPOL}^{corr}}{P_{TPOL}^{corr}}\right)_{sys} = 3.5\,\%$$

TPOL Analysis 2

- Compare TPOL with LPOL for uncorrected (left) and corrected (right) TPOL measurements
- Ratio $R = \frac{P_{LPOL}}{P_{TPOL}}$ for averaging periods 1, 10, 100 mins
- Uncorrected TPOL shifted by more than 7%
- Corrected TPOL in good agreement with LPOL
- Other ongoing work:
  - improved integration of position detectors in DAQ
  - ongoing analyses of η(y) transformation



Conclusions

- Much work carried out to repair and protect LPOL cavity against synchrotron radiation
  - New copper beampipe pieces, repositioned electronics
- Reinstalled optical components and improved ellipsometer
- Plan to optimise e beam to observe compton photons, reinstall dosimeters
- Tungsten/Quartz fibre calorimeter
  - Most suitable design for new cavity calorimeter
  - Base design on H1 photon detector
  - Simulation shows good lineariry, resolution, position resolution
- Improvement TPOL online measurement through focus dependence
  - Improved agreement with LPOL
  - TPOL systematic $\left(\frac{\Delta P_{TPOL}^{corr}}{P_{TPOL}^{corr}}\right)_{sys} = 3.5\%$