# Status of the polarimeters at HERA

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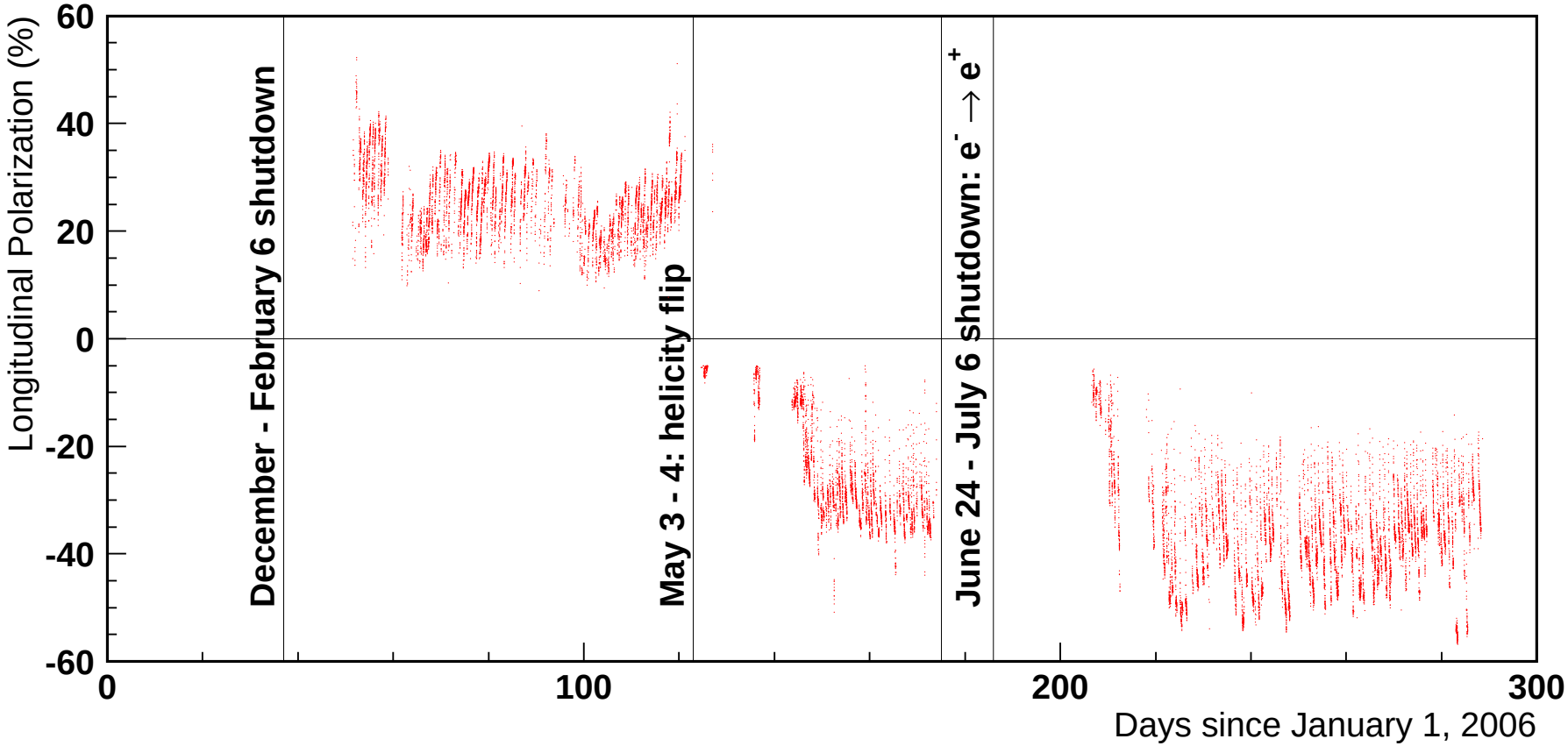
on behalf of POL2000

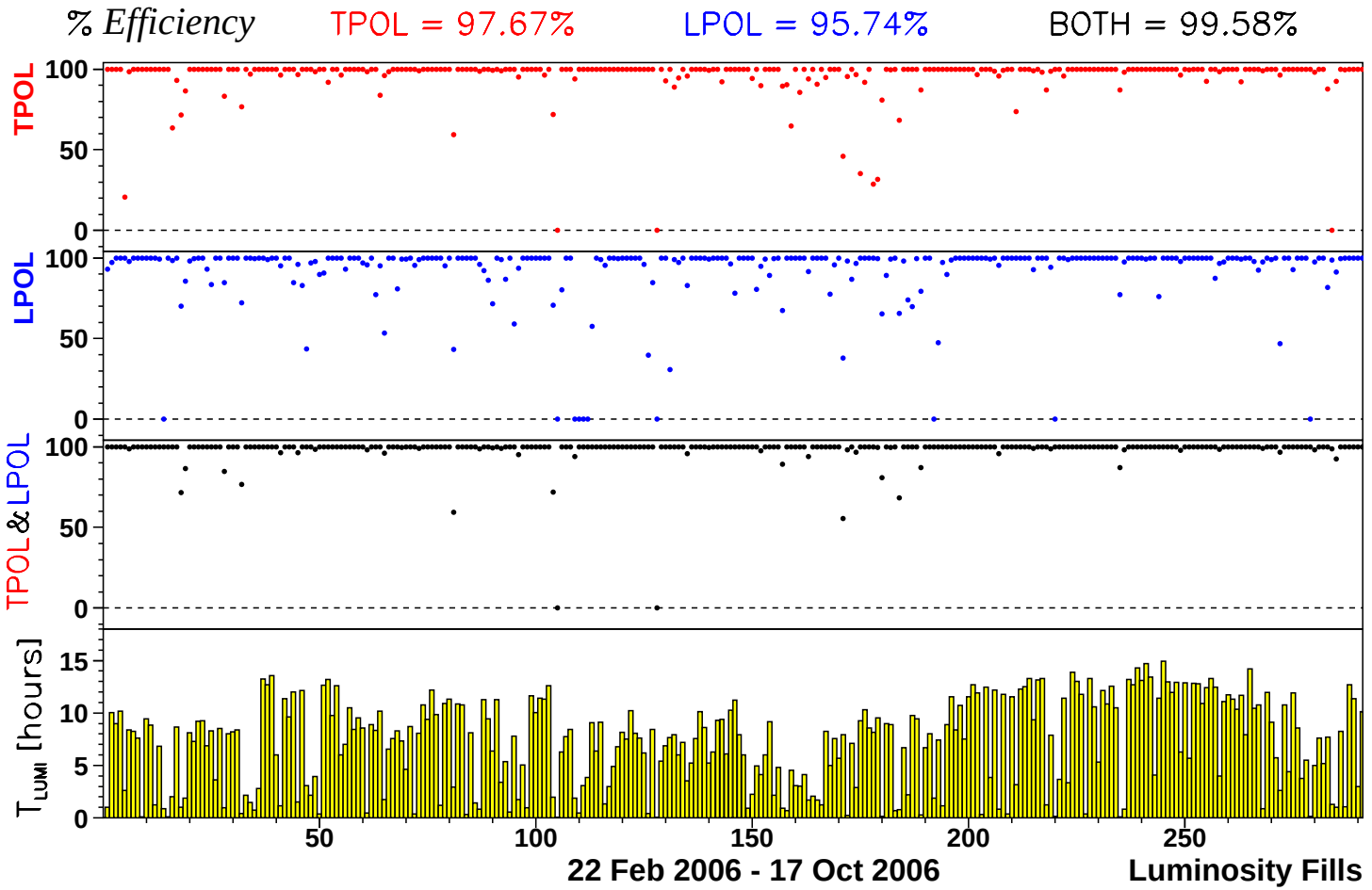
62nd Meeting of the DESY PRC
October 23 – 24, 2006

# Polarization in 2006




Since $e^- \rightarrow e^+$: higher polarization in longer fills.

# Polarization in 2006: online efficiency




TPOL
- 97.67%

LPOL
- 95.74%

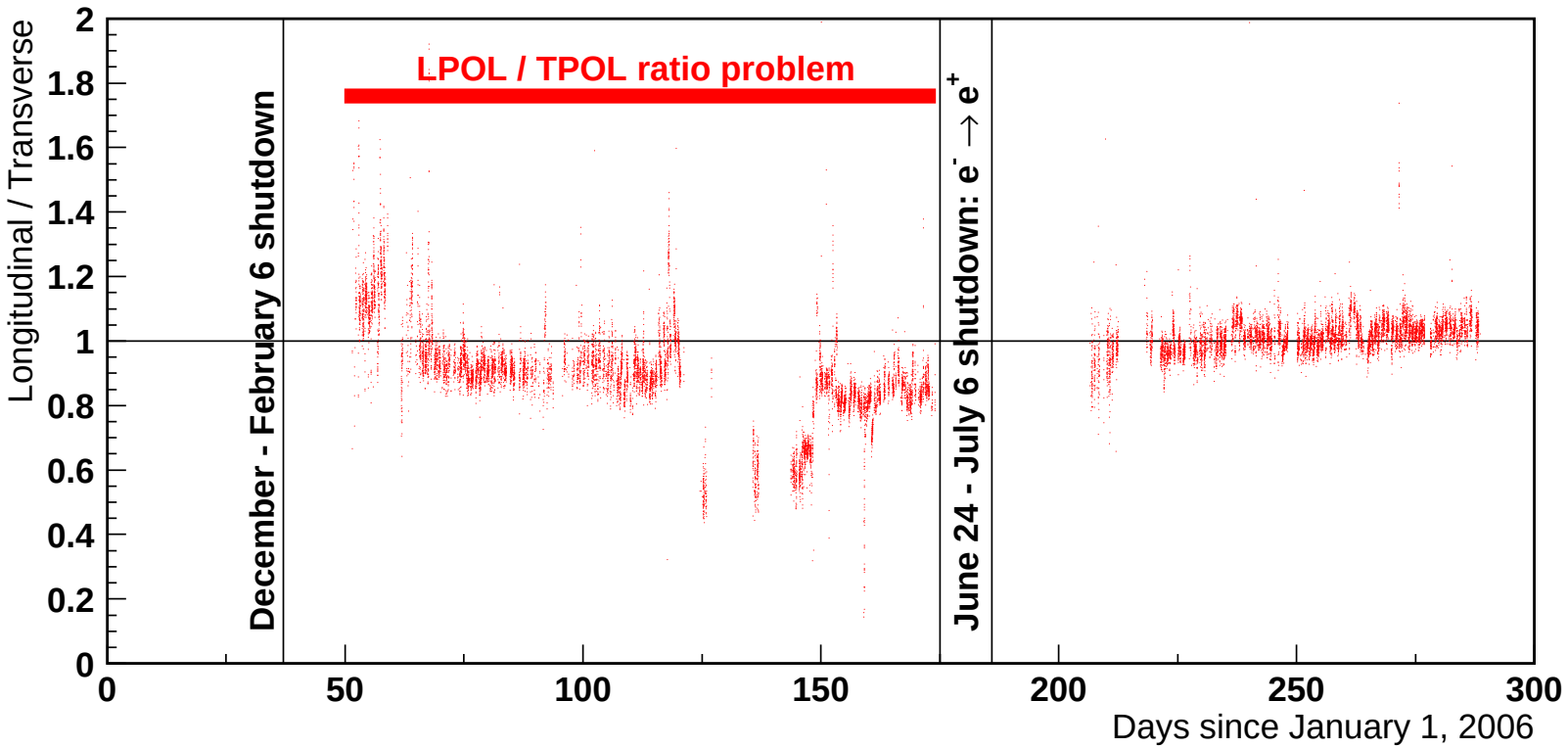
Combined
- 99.58%

LPOL affected by systematic studies and cavity project

TPOL and LPOL continue to deliver high efficiency measurements.

# LPOL/TPOL ratio problem

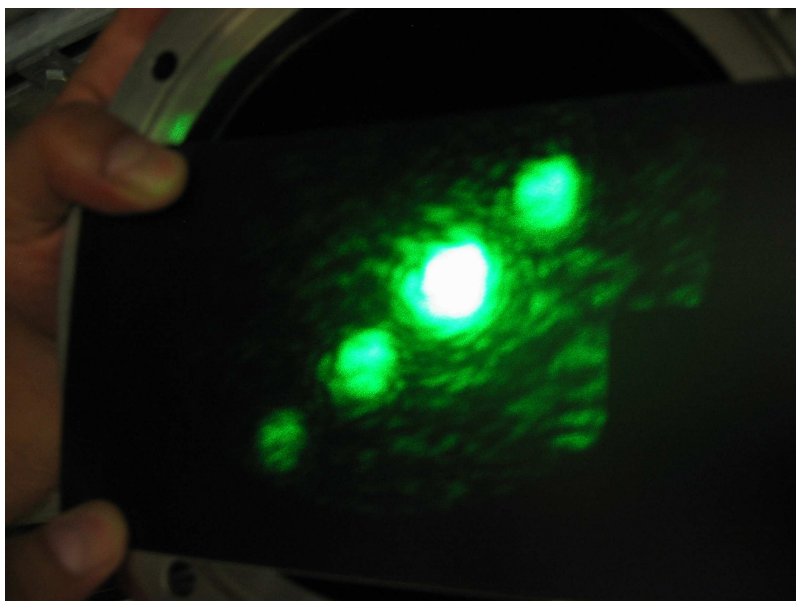
- Strong disagreement LPOL and TPOL in first half of 2006

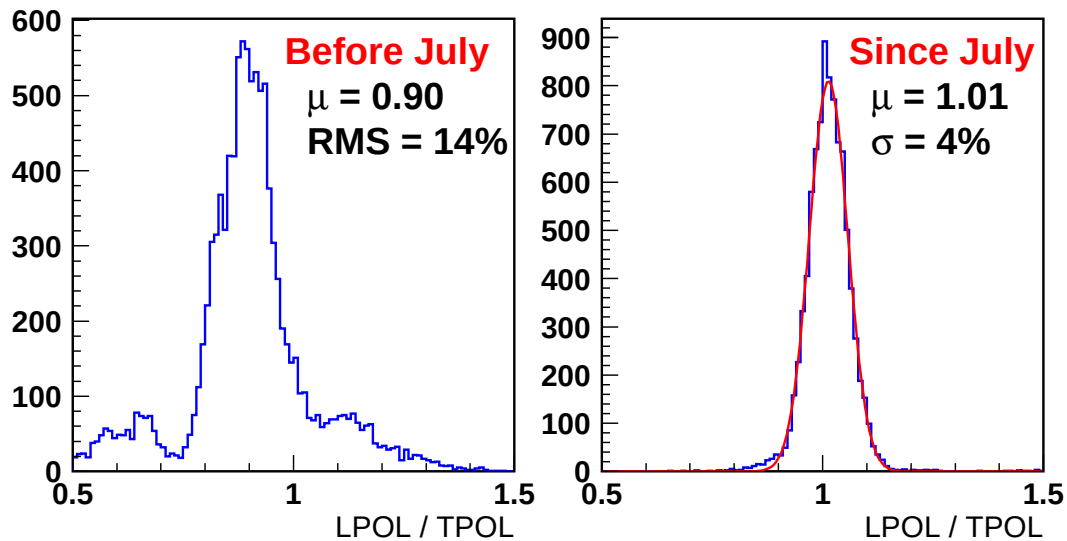



- Sparked a thorough check of both LPOL and TPOL systems
- Extensive physical inspection from laser system to calorimeter (during shutdown end of June)

# LPOL/TPOL ratio problem

- In LPOL optics, mirror M3 was mounted backwards
- Multiple reflections with unknown circular polarizations $P_{circ}$
- Measured LPOL polarization directly proportional to $P_{circ}$
- Installed in January 2006, corrected in June 2006






Now: agreement within systematics!

- LPOL unreliable during January – June 2006
- TPOL data should be used for January – June 2006

# LPOL systematic studies

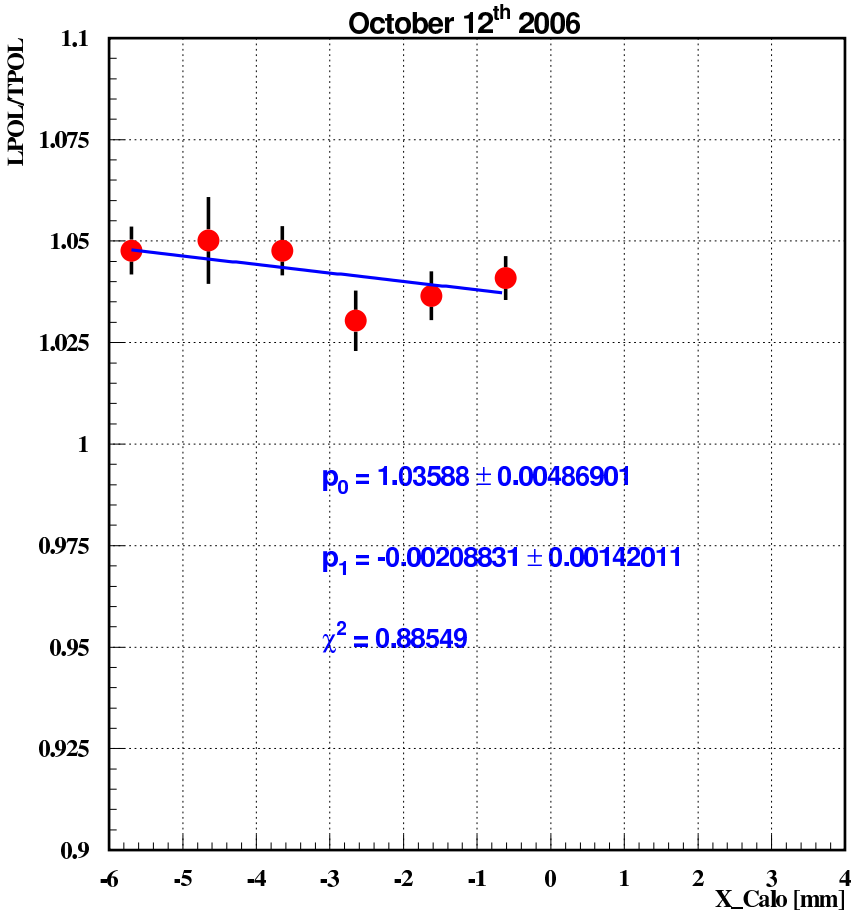
Continuous monitoring of hardware and systematics

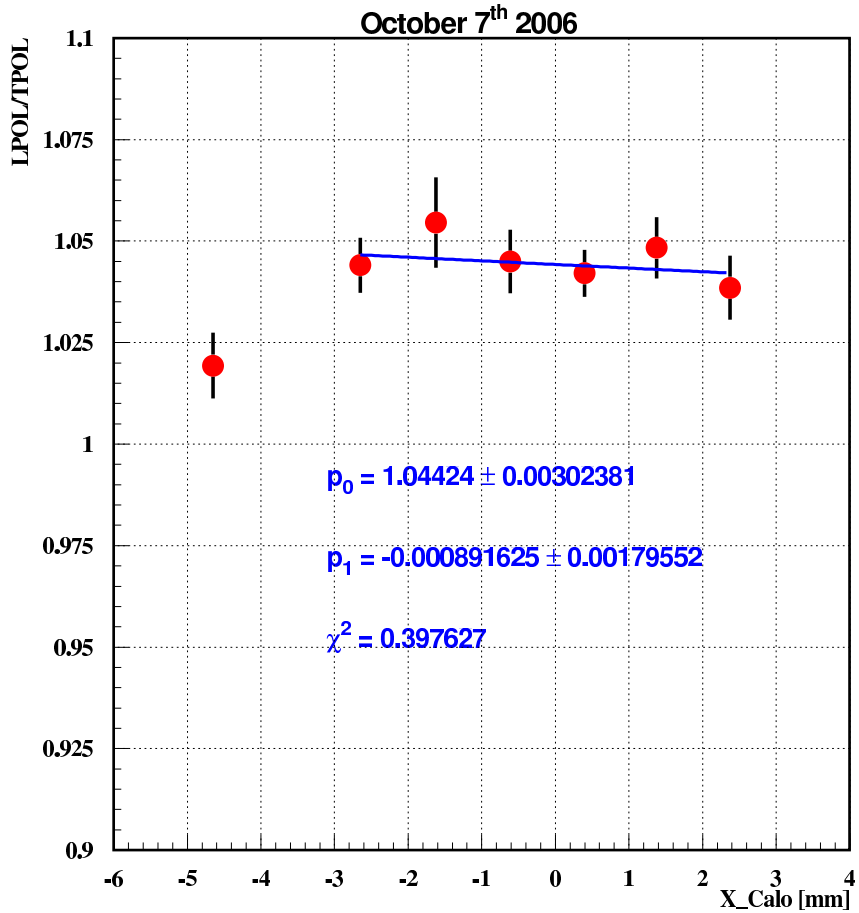
- Laser polarization stable and symmetric for L and R
- Laser intensity, PMT high voltage do not affect measurement
- Beam position and slope at interaction point
- Artificial deviations of calorimeter alignment: no effect
- Agreement between crystal and sampling calorimeters
- No false asymmetries with unpolarized laser ($< 0.5\%$)
- Visual inspection calorimeter on access days

LPOL system is stable

# LPOL systematic studies: beam slope scan

- Move Compton cone by steering lepton beam
- Keep calorimeter in Compton cone: scan exit window

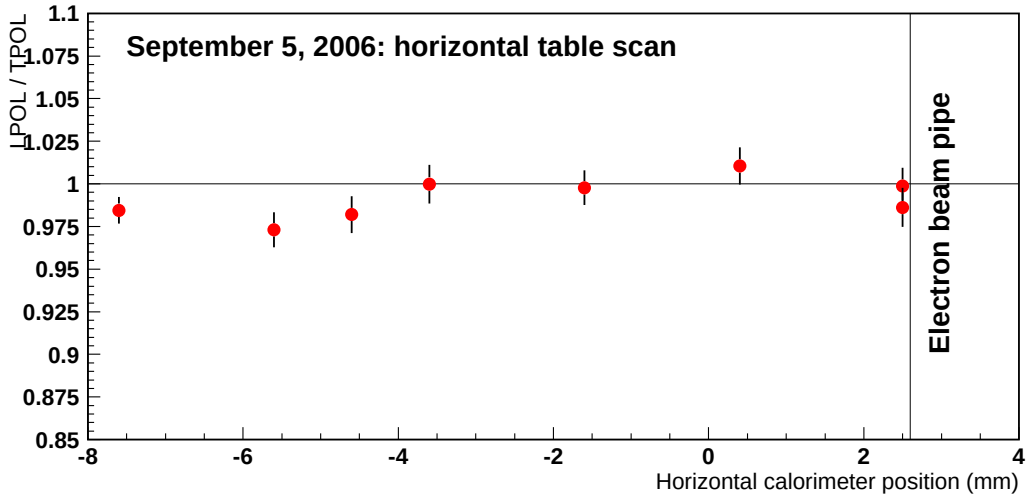


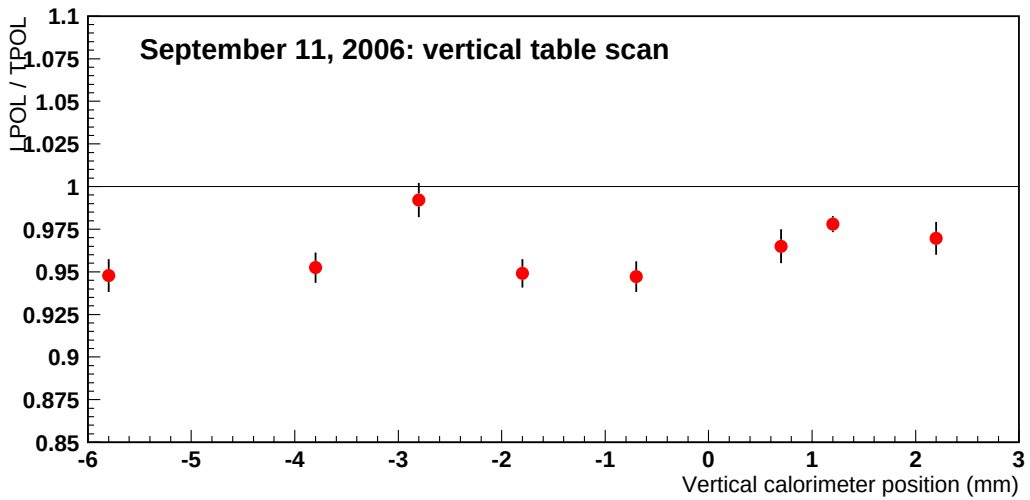




In allowed region $[-5, 2.5]$ mm for $x$, no systematic effect on ratio

# LPOL systematic studies: calorimeter table scan

- Keep Compton cone fixed (stable lepton beam and laser)
- Move calorimeter: Compton cone scans calorimeter front face

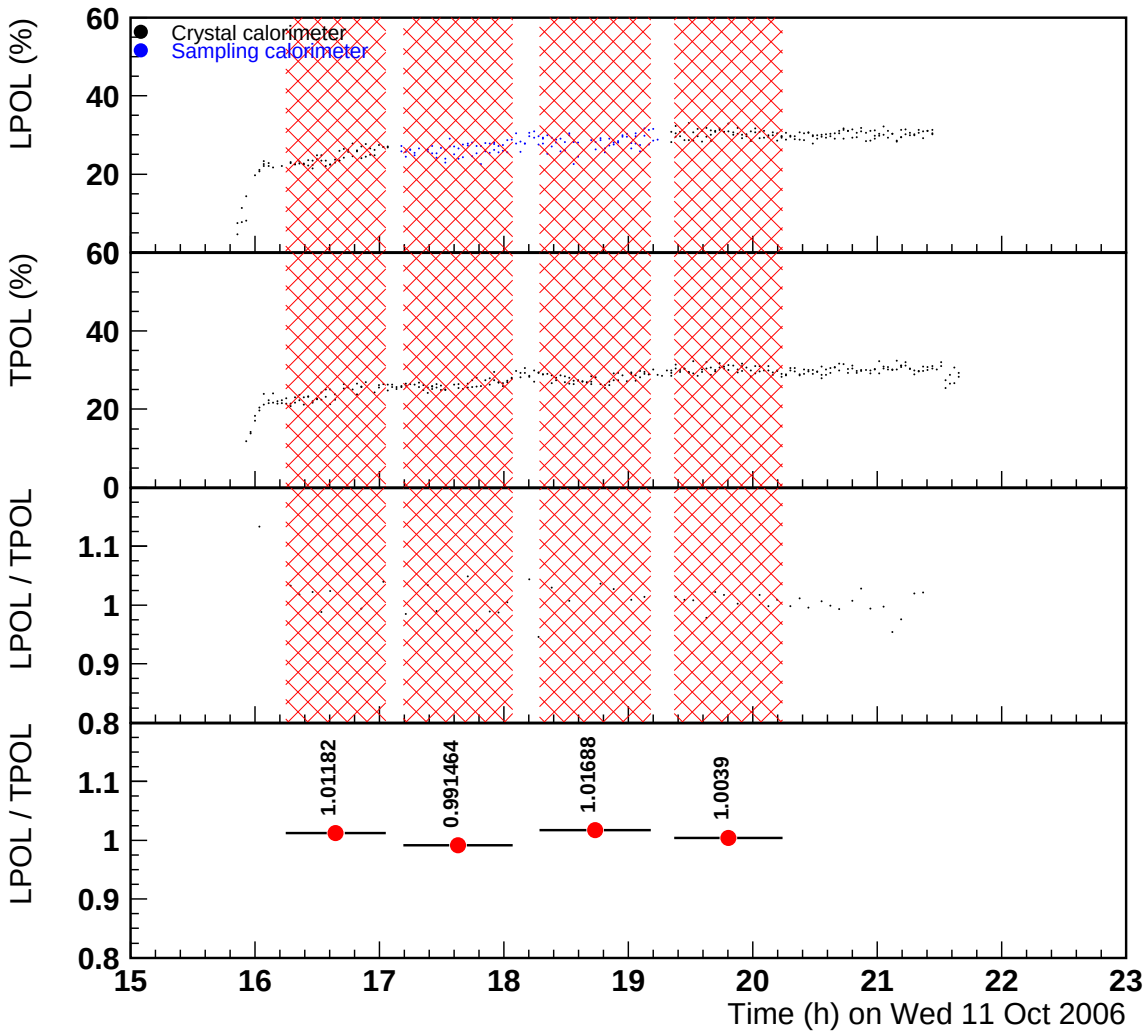



In allowed region $[-5, 2.5/5.0]$ mm for $x/y$, no systematic effect on ratio

# LPOL sampling calorimeter

- Calorimeter used for cavity project
- Cross check for LPOL crystal calorimeter (almost weekly)




Comparison

- Sampling calorimeter
- Within 2% of crystal calorimeter

# TPOL systematic studies

Analyzing power variations = main uncertainty in TPOL system

- Distance between calorimeter and interaction point
- Transformation energy asymmetry ($\eta$) to vertical position ($y$)
- Absolute scale of analyzing power

Attempts to calibrate analyzing power differently

- Silicon detector in front of TPOL calorimeter (SiPOL)
- Rise time measurements

Re-evaluation of systematic uncertainty in progress [1]

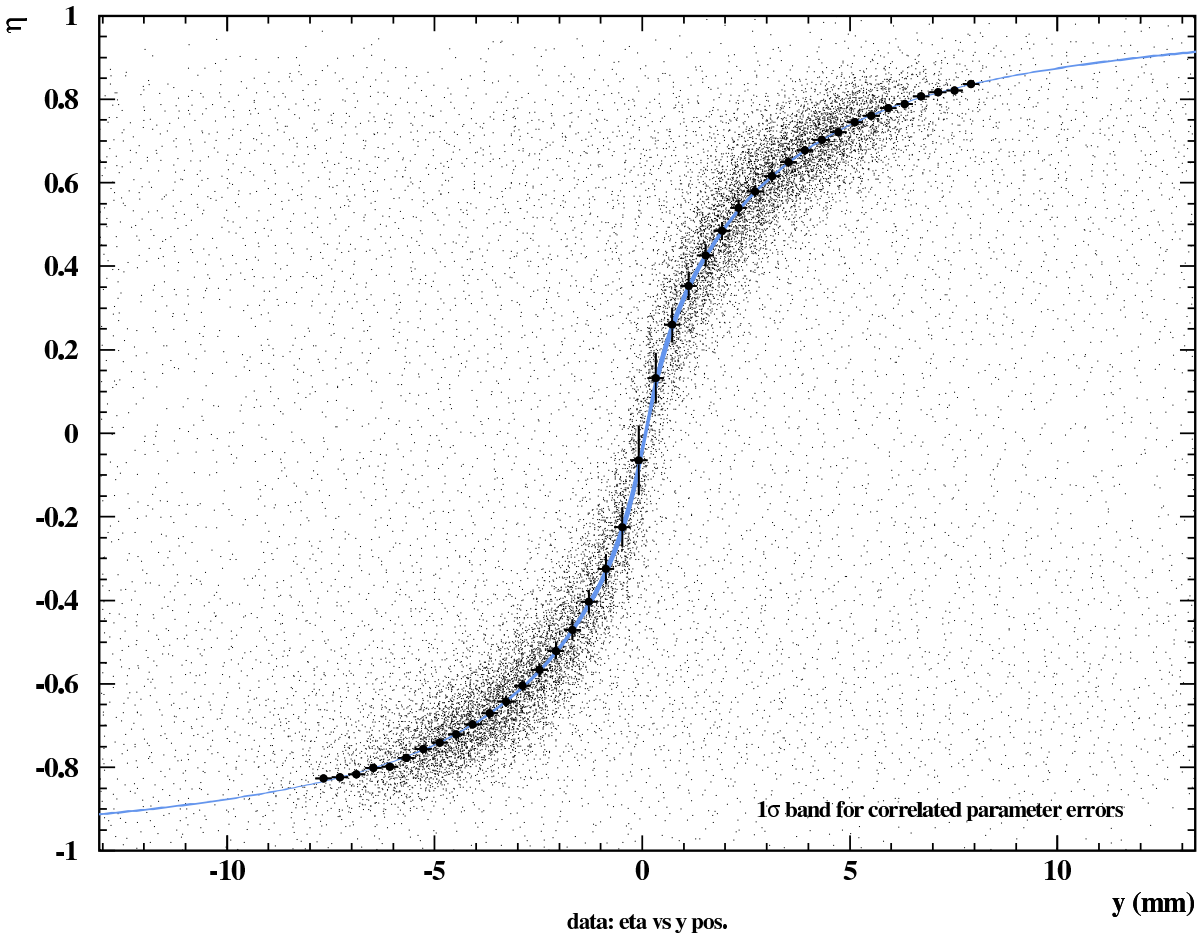
- Focus correction: 0.35%
- Interaction region due to finite laser width: 0.3%
- Uncertainty in exact location interaction region: 2.0%

[1] Internal note in preparation

# TPOL: SiPOL for $\eta/y$ transformation

Determine transformation energy asymmetry $\eta$ to position $y$

- Blue band: correlated systematic uncertainty (very accurate!)
- Agreement with Monte Carlo
- Reproducible between $e^+$ and $e^-$

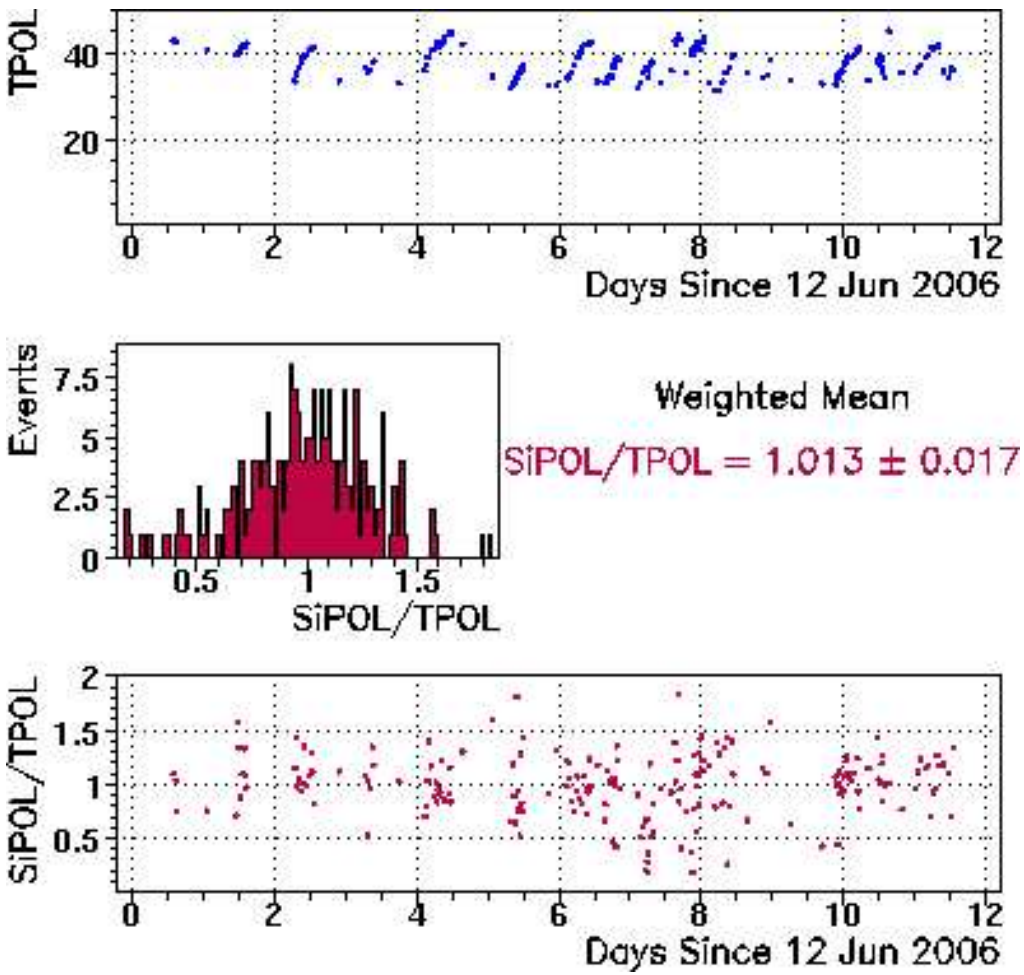



Work in progress by
Blanka Sobloher

# TPOL: SiPOL for absolute scale?

Use SiPOL to determine polarization independently

- Measures spatial distribution, no $\eta/y$ transformation needed!




Broad distribution

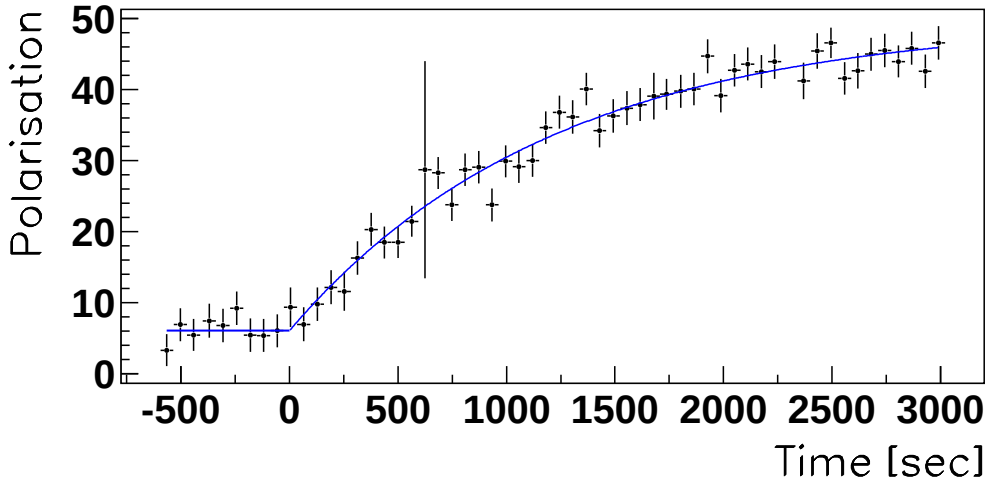
- SiPOL not suitable for fast measurements
- No systematic difference

Work in progress by Vahagn Garibyan

# TPOL: rise time for absolute scale?

Depolarize (stable) beam and measure rise time $\tau$

- Only one measurement taken
- Theoretical uncertainties several percent (*e.g.* no flat machine)




3 parameter fit with Baseline

Calib.Const. k = 1.00983 ± 0.057586

Rise Time $\tau$ = 1216.19 ± 78.5825 sec

Base Line $P_0$ = 6.02462 ± 0.661366

$\chi^2$/ndf = 39.73/54 prob = 92.7%

k calculated for $P_{st}/\tau_{st}$=89.1/2161.5 $E_e$=27.519GeV

Not the preferred way to determine absolute scale uncertainty

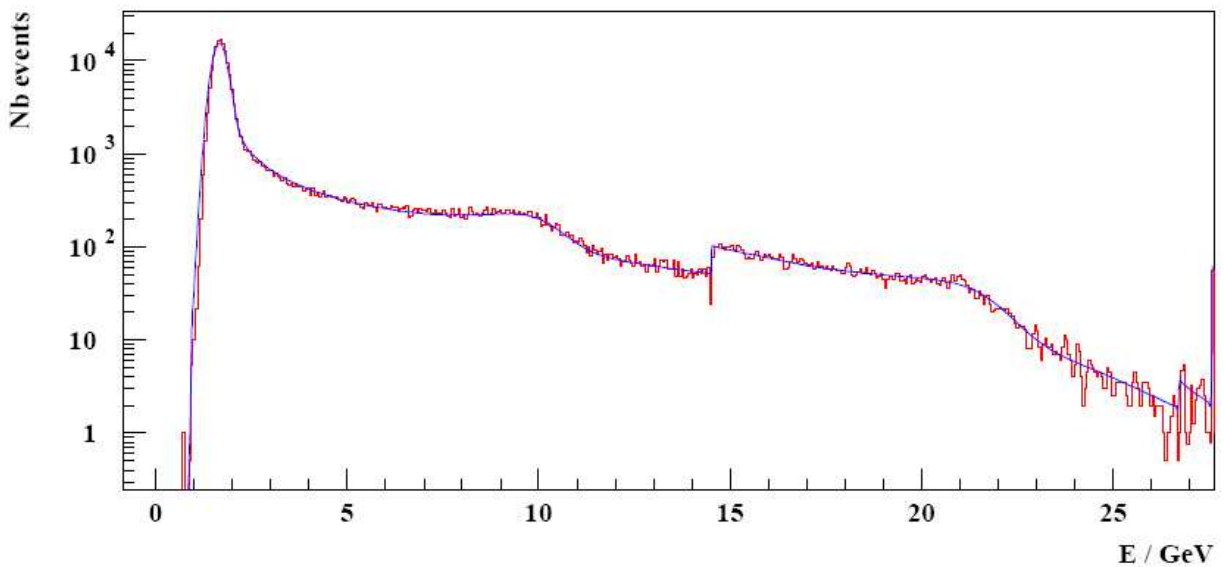
# Cavity polarimeter

Hardware working fine now

- Using LPOL sampling calorimeter
- No problems finding beam or locking cavity

Regular data taking (weekly for approximately 1.5 hour)

- data (binning changes at 15 GeV) with fit




Cavity polarimeter working, systematic studies ongoing

# Cavity polarimeter: systematic studies

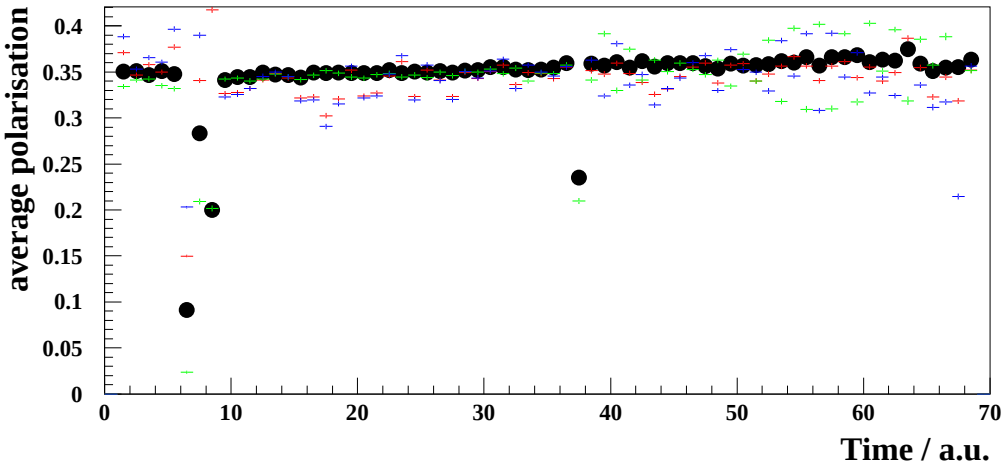
Systematic studies performed:

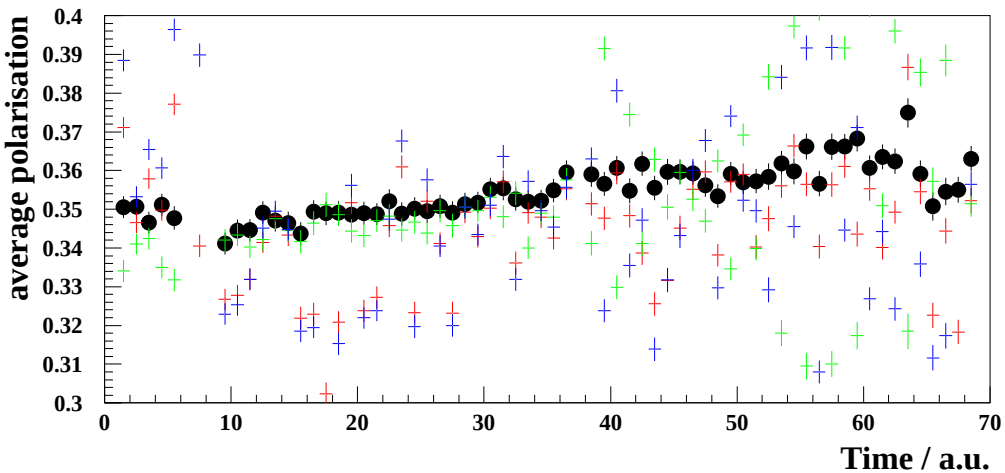
- L/R asymmetry of laser intensity: taken into account, resulting uncertainty is negligible
- Different detector models: uncertainty at per mille level
- Different blackbody radiation: uncertainty at per mille level

Statistical precision (for 4 s integration time)

- 2.5% per bunch
- 0.4% for all bunches

# Cavity polarimeter: L/R asymmetries




October 13, 2006

Allow L/R asymmetry in fluxes

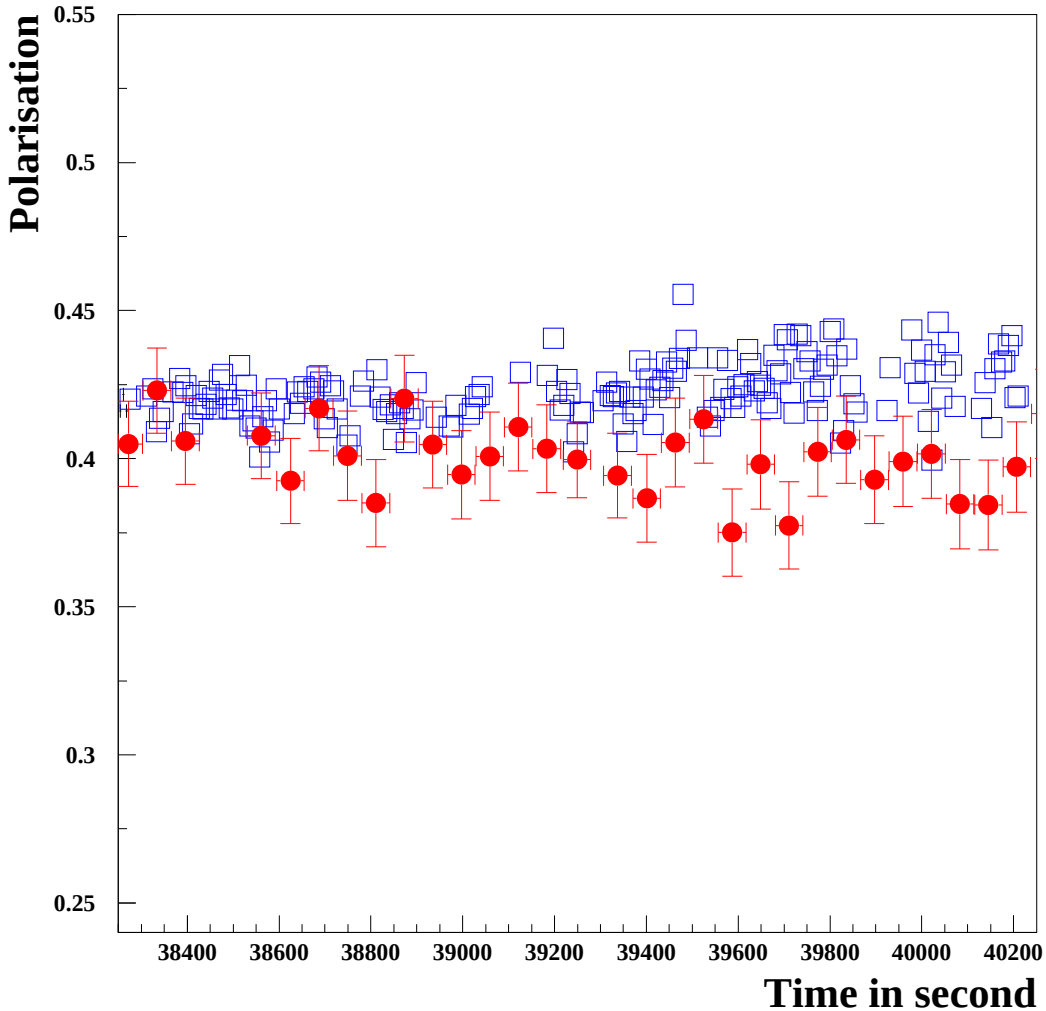
- no asymmetries allowed
- asymmetric bremsstrahlung
- asymmetric Compton flux
- asymmetric Compton flux and bremsstrahlung

Asymmtries L and R important!

Other stabilizing changes

- Integration time (4 s $\rightarrow$ 20 s)

# Cavity polarimeter: comparison with TPOL




September 25, 2006

Comparison

- TPOL measurements
- Cavity measurements
- Higher statistical precision! (0.4% error bars invisible)

# Cavity polarimeter: future plans

Continue commissioning of the cavity polarimeter

- Finalize systematic studies
- Optimal integration time needs to be determined

Slowly increase data taking

- Collecting data about once a week now
- Longer data taking period on October 18 – 20
- Future:
  - More frequent data taking towards end of year
  - Extended data taking periods to check stability

# Conclusions

- LPOL
  - LPOL / TPOL ratio problem solved
  - Systematic uncertainty well under control
- TPOL
  - Progress in improved determination of analyzing power
  - Re-evaluation of systematic uncertainty underway
- Cavity
  - Hardware steadily improving
  - Regular polarization measurements
  - Systematic studies in progress
  - More frequent and longer data taking planned