TPOL Offline Analysis Update

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TPOL Analysis meeting
23.Feb.2005

OUTLINE

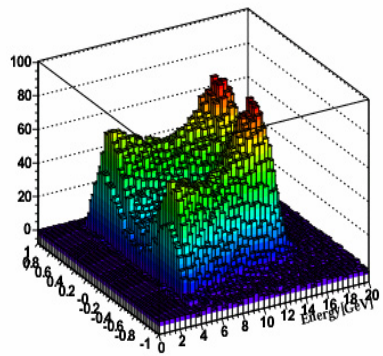
- The multi-parameter fitting.
- Study on the fitting range in η .
- Comparison with the data.
- Final parameter set.
- Results with all data.
  (October.03~August.04).
- Systematic check.
- Summary.

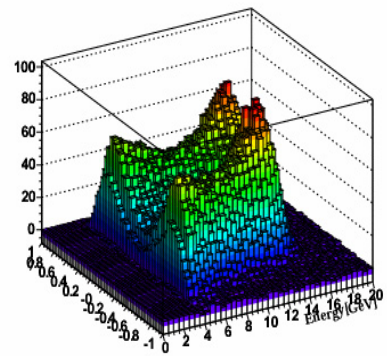
The fitting method

- Exploit full information of TPOL CAL
  - Fit to 2D data (E, η)
- Fitting parameters
  - CAL related
    - **Distance**
    - **Resolution / Calibration**
    - **Skew-factor**
  - Beam related
    - **Offset**
    - **Size**
  - Laser related
    - **Linear polarization**

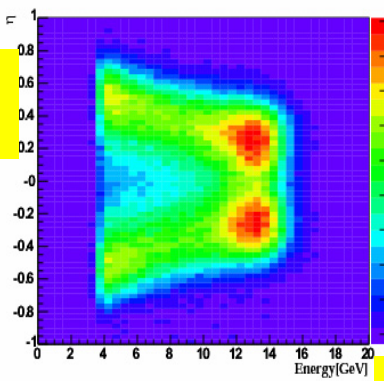
Laser=LEFT

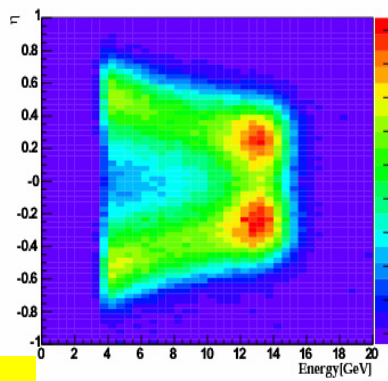
Laser=RIGHT





η





E

Fit procedure

$$\frac{d^2\sigma}{dE_{true}d\phi} = \Sigma_0(E_{true}) + S_1\Sigma_1(E_{true})\cos 2\phi + S_3(P_Y\Sigma_{2Y}(E_{true})\sin\phi + P_Z\Sigma_{2Z}(E_{true}))$$

$$\frac{d^2\sigma}{dE_{true}d\eta_{true}} = \int \frac{d^2\sigma}{dE_{true}d\phi}\frac{1}{\sqrt{2\pi\sigma_y}}\exp\left[-\frac{(y(\eta_{true}) - R(E_{true})\sin\phi - \delta_y)^2}{2\sigma_y^2}\right]\frac{dy}{d\eta_{true}}d\phi$$

$$\frac{d^2\sigma}{dEd\eta} = \iint \frac{d^2\sigma}{dE_{true}d\eta_{true}}\frac{1}{2\pi\sigma_\eta\sigma_E}\exp\left[-\frac{(\eta_{true}-\eta)^2}{2\sigma_\eta^2(\eta_{true},E_{ture})} - \frac{(E_{true}-E)^2}{2\sigma_E^2(E_{true})}\right]d\eta_{true}dE_{true}$$

$$\chi^2 = \sum_{L,R}\sum_{E_i}\sum_{\eta_j}\frac{(N_{i,j}^{ON} - (1-k_{off})N_{i,j}^{OFF} - k_s\frac{d^2\sigma}{dEd\eta})^2}{\sigma_{i,j}^2}$$

Study on the η range dependence

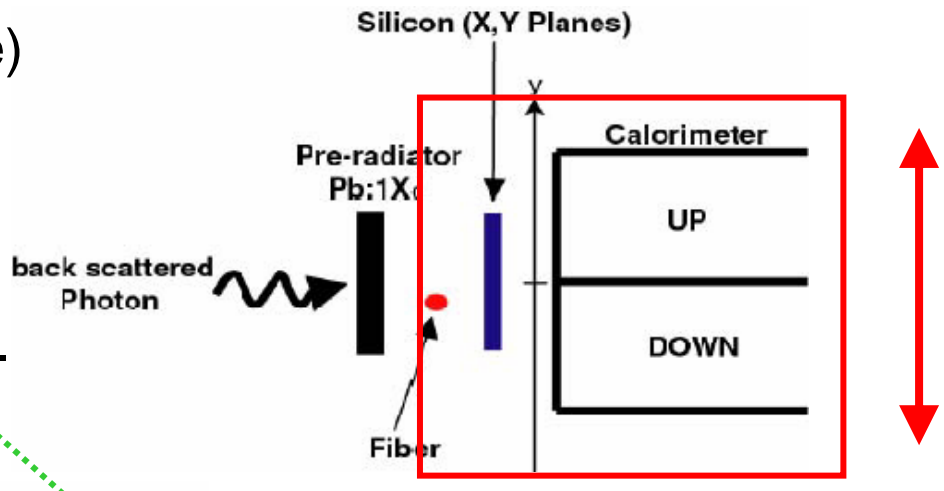
- At first, check with all parameters free.
  - η - y parameters are free.
- The skew-factor is fixed to be 0.

$$\sigma_\eta(\eta_{true}, E_{true}) = a\sqrt{\frac{1-\eta_{true}^2}{E_{true}}}\left(1 \pm f_{skew}\sqrt{\sqrt{|\eta_{true}|}E_{true}}\right)$$

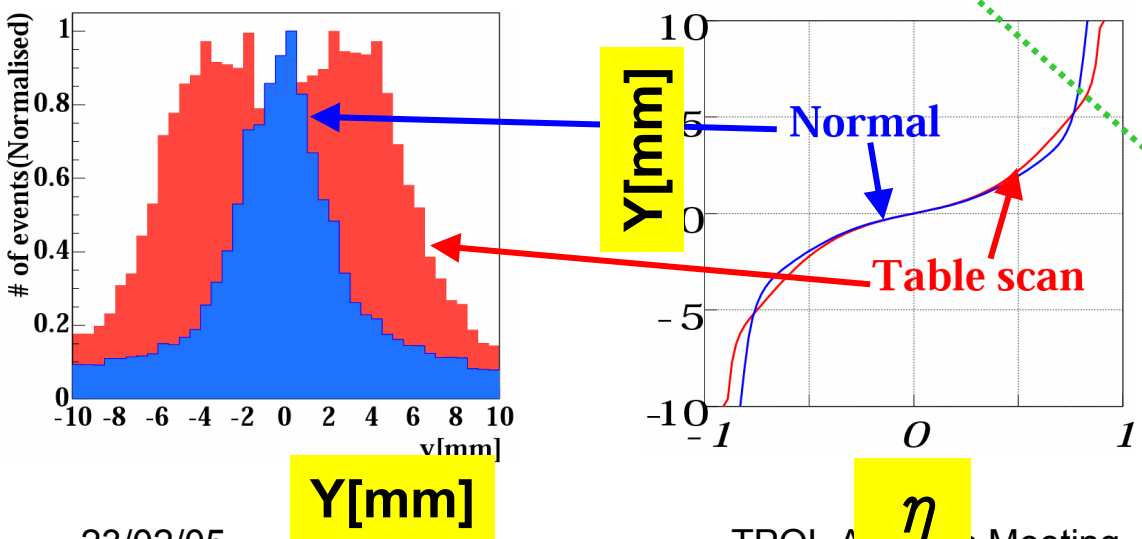
  - The skew-factor reflects the asymmetry in η.
  - Assume no asymmetry in η response between UP and DOWN.

η - y curve by Silicon

1. "Normal"(=usual data taking mode)
2. "Table scan"
   - To increase statistics at large η(y)
   - To reduce backgrounds which may cause bias in deriving η- y.

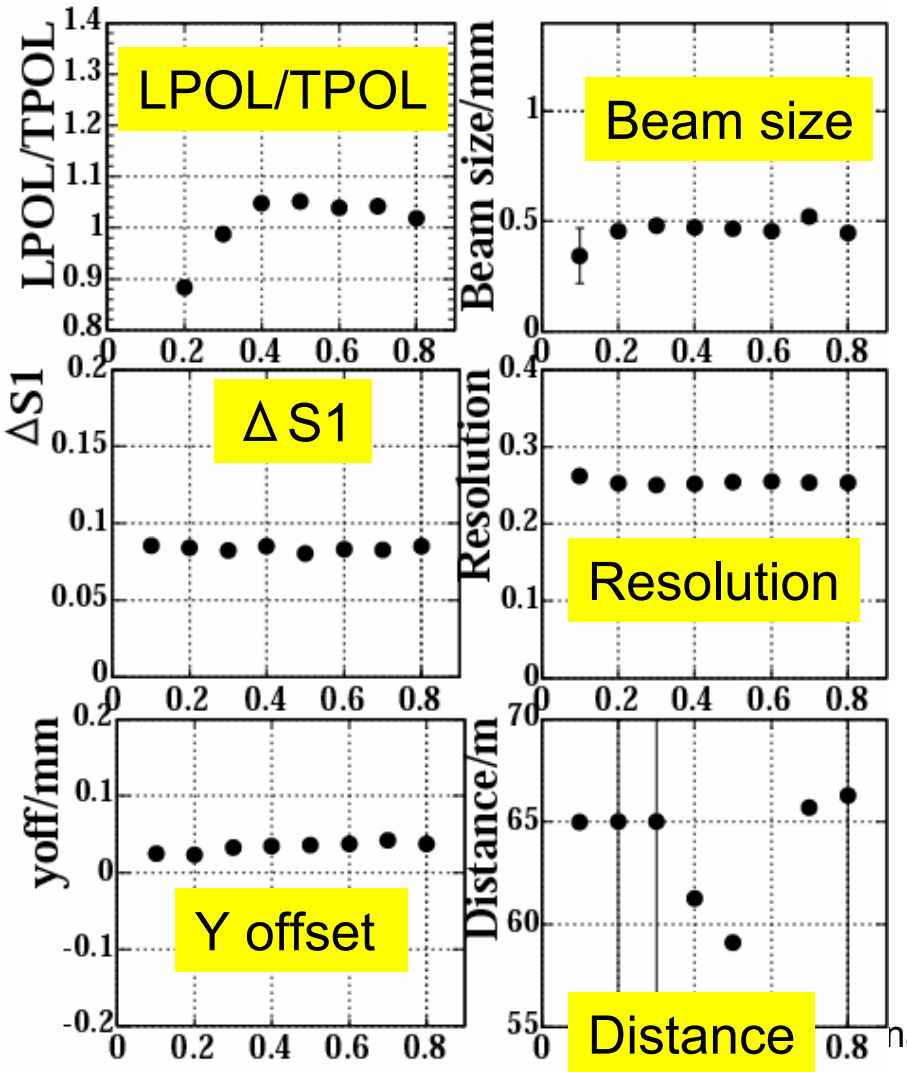


Whole(CAL, Si, Fiber) scan in vertical(y)



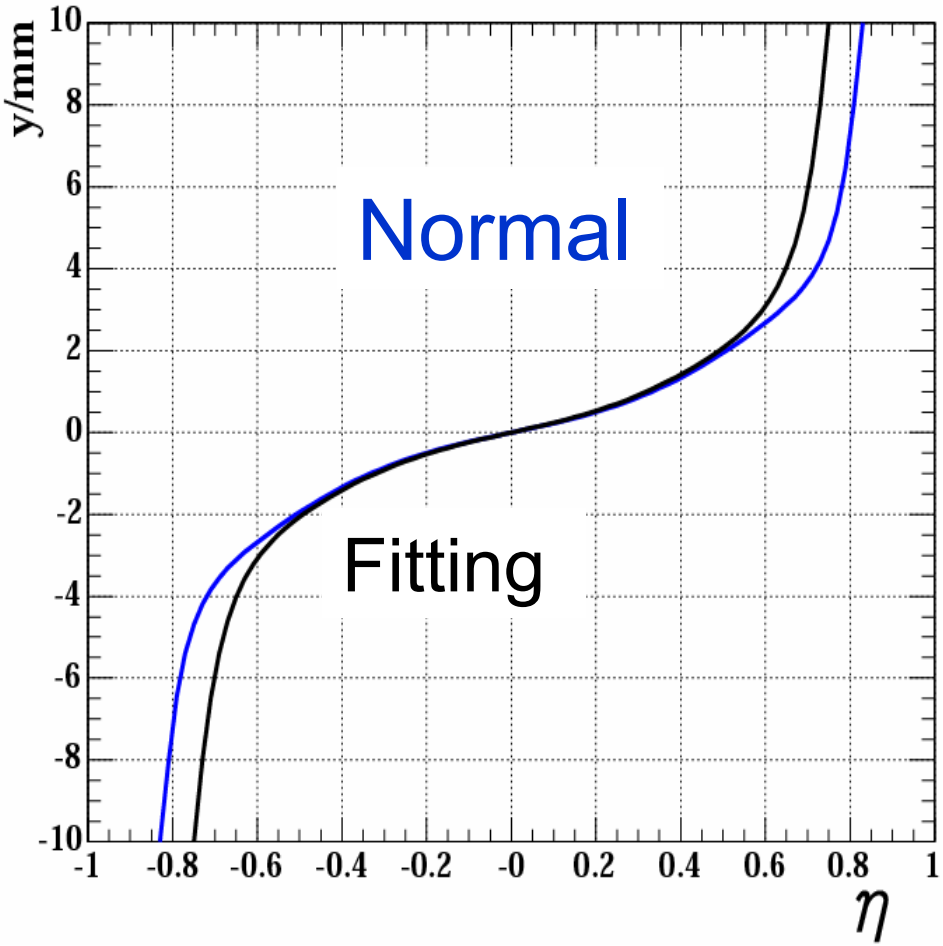
- Back scatter from CAL
- Entering with angle due pre-radiator

Stability check
All parameters free



- Fitting range.
  +/-0.1~+/-0.8, 0.1 step.
- Parameters except the distance are almost stable in high η region.
- Next, check the η – y curve from the fitting method.

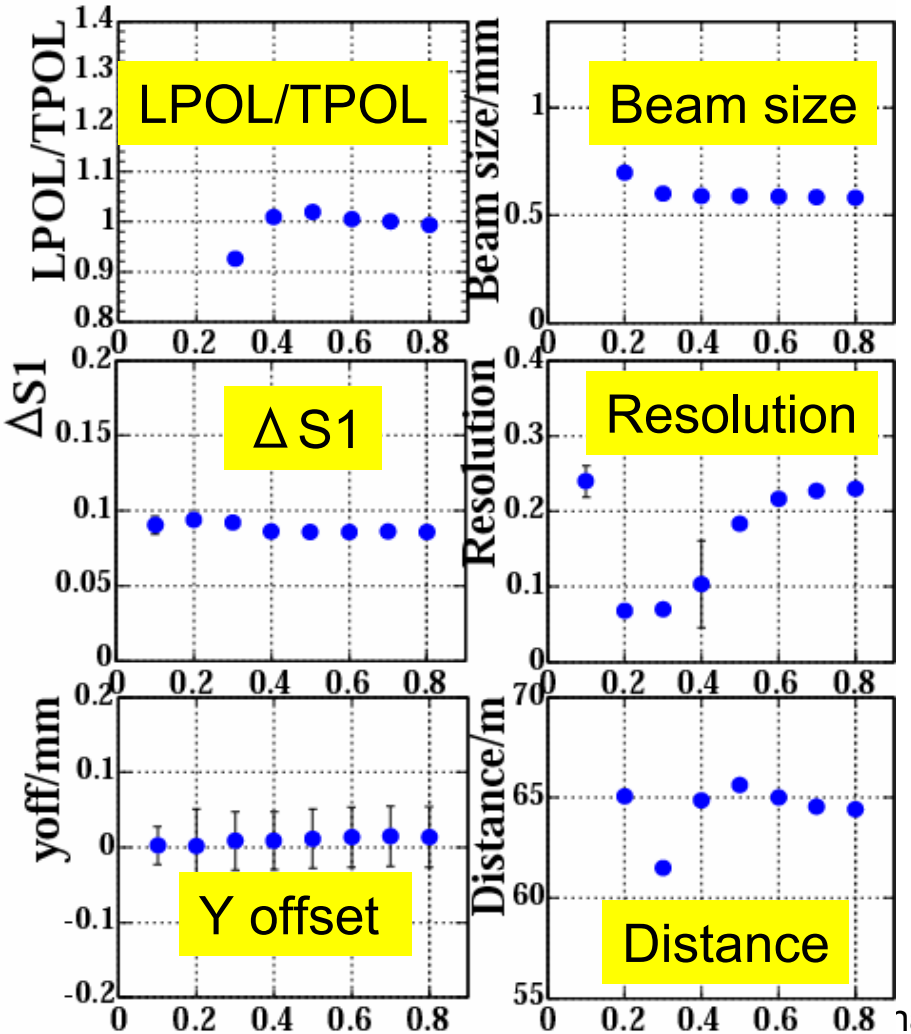
Comparison the η – y curves



- The fitting method can not reproduce the η - y curve.

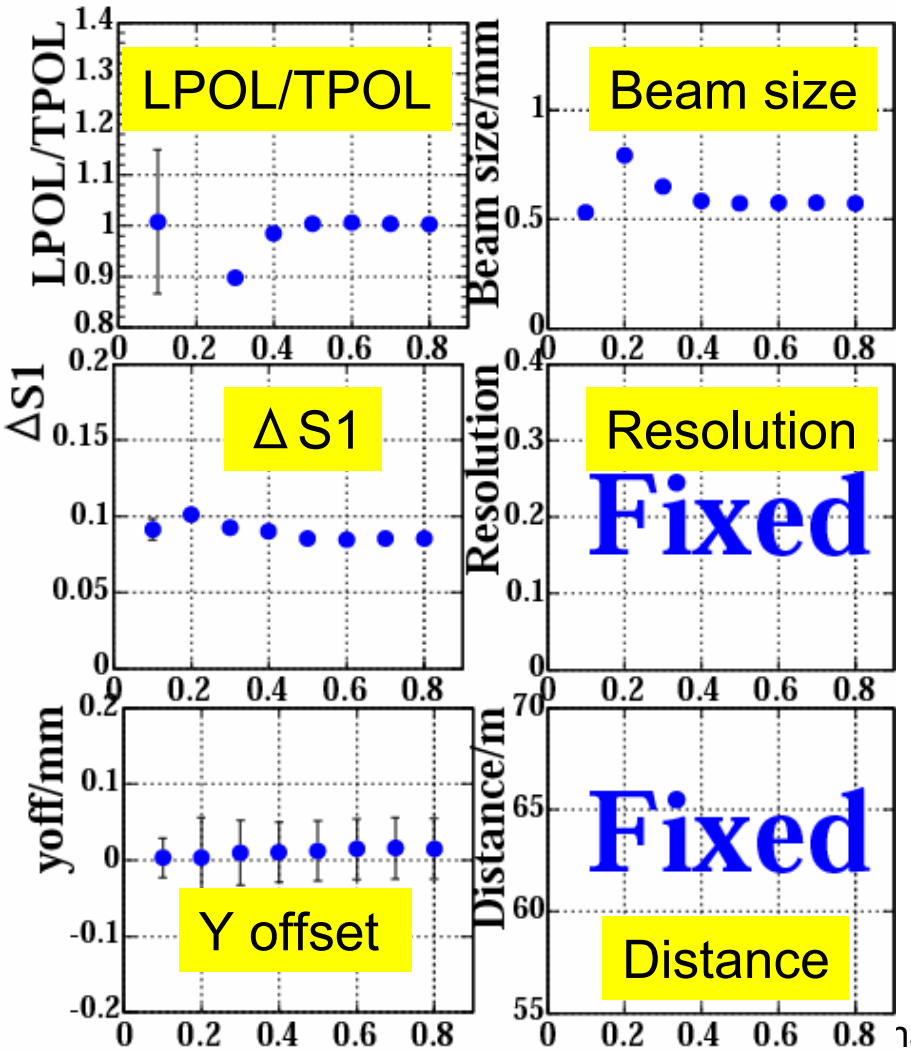
→ have to fix the η - y parameters with the silicon measurement.

Stability check
η - y parameters fix



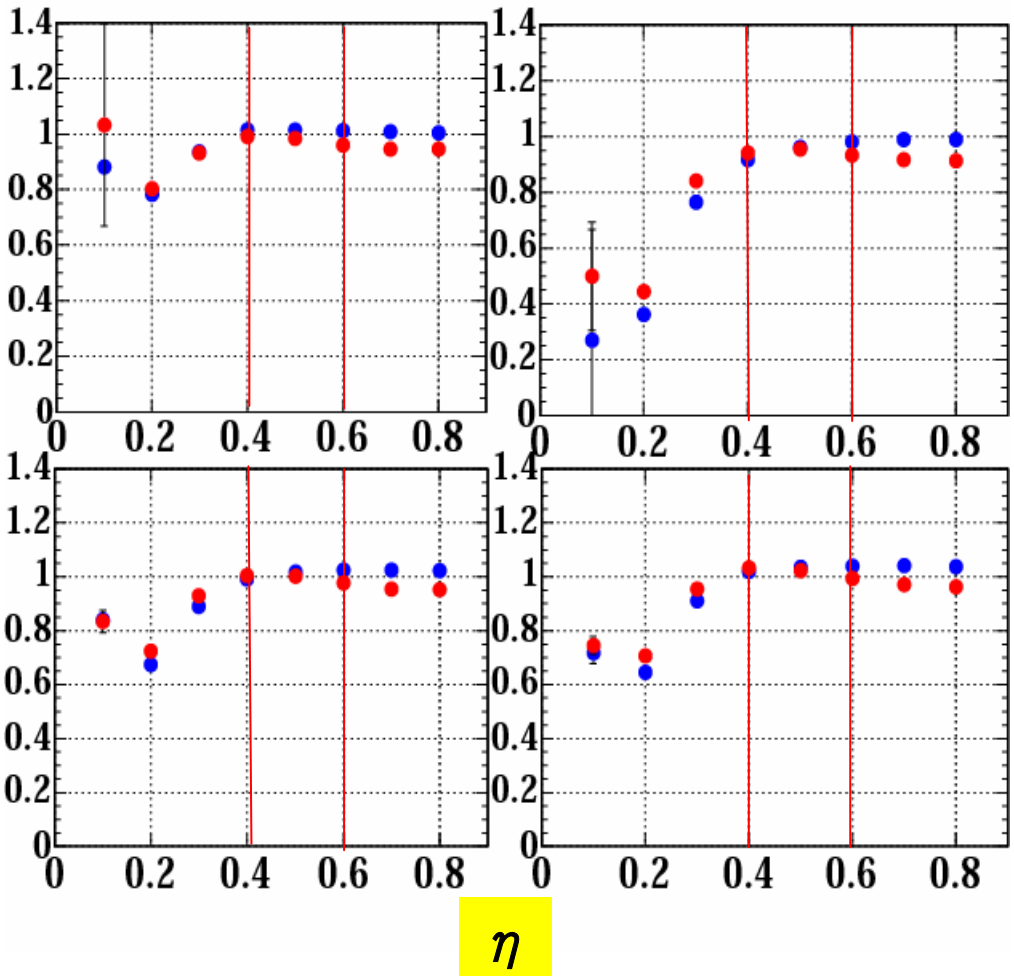
- The energy resolution, the stochastic term, and the distance from the IP to the CAL are unstable in η .
- Fix to
  - 23.77% for the energy resolution. (CERN test beam)
  - 65m for the distance.

Stability check
resolution & distance fixed



- Parameters are almost stable.
- So far, the η – y parameters are extracted from the Normal mode.
- To decide the fitting range, also check from the Table scan mode.

Check η range dependence

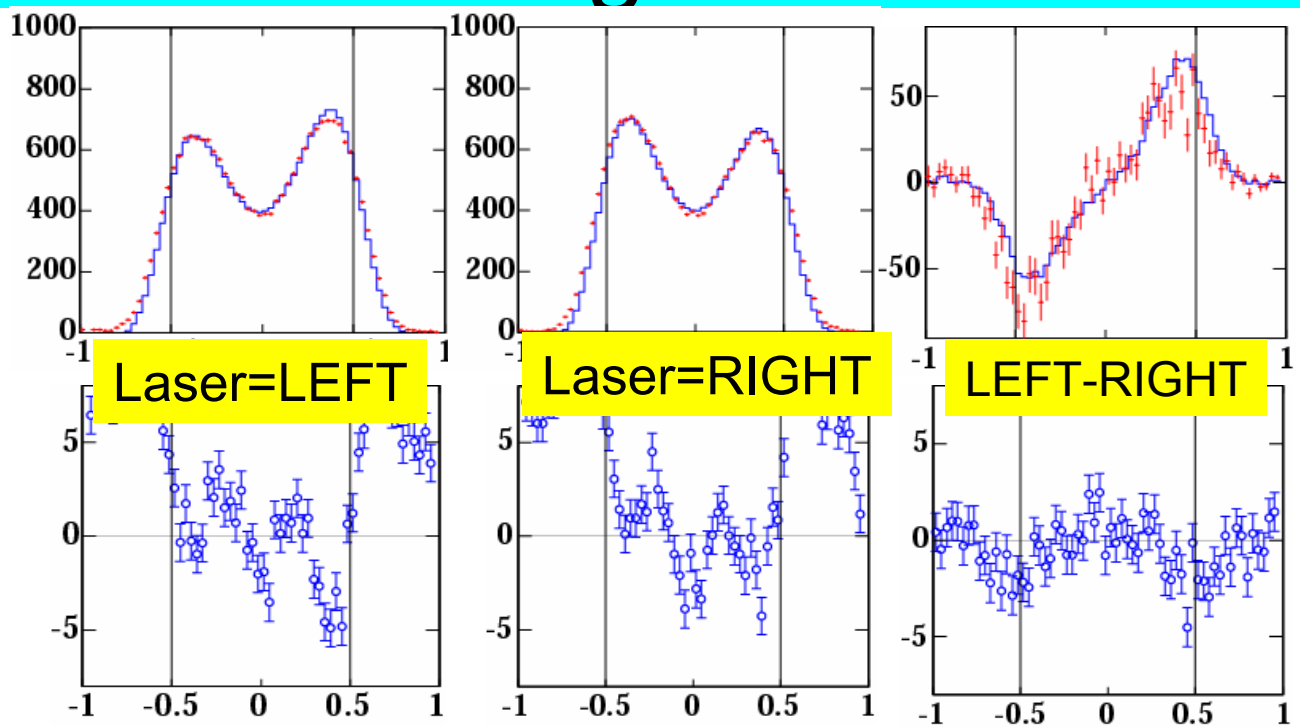


- High η region
  - Uncertainty due to background events and low statistics.
- Low η region
  - Unstable due to small data used for the fitting.

→Fitting region should be between +/-0.4 ~+/-0.6.

- Selected +/-0.5

Comparison the data and the fitting Histogram/Pull



- The fitting can not describe the data in each laser state perfectly, besides asymmetric structure in η .
- Polarization is sensitive to the LEFT-RIGHT in the end.
- Will consider the asymmetry later.

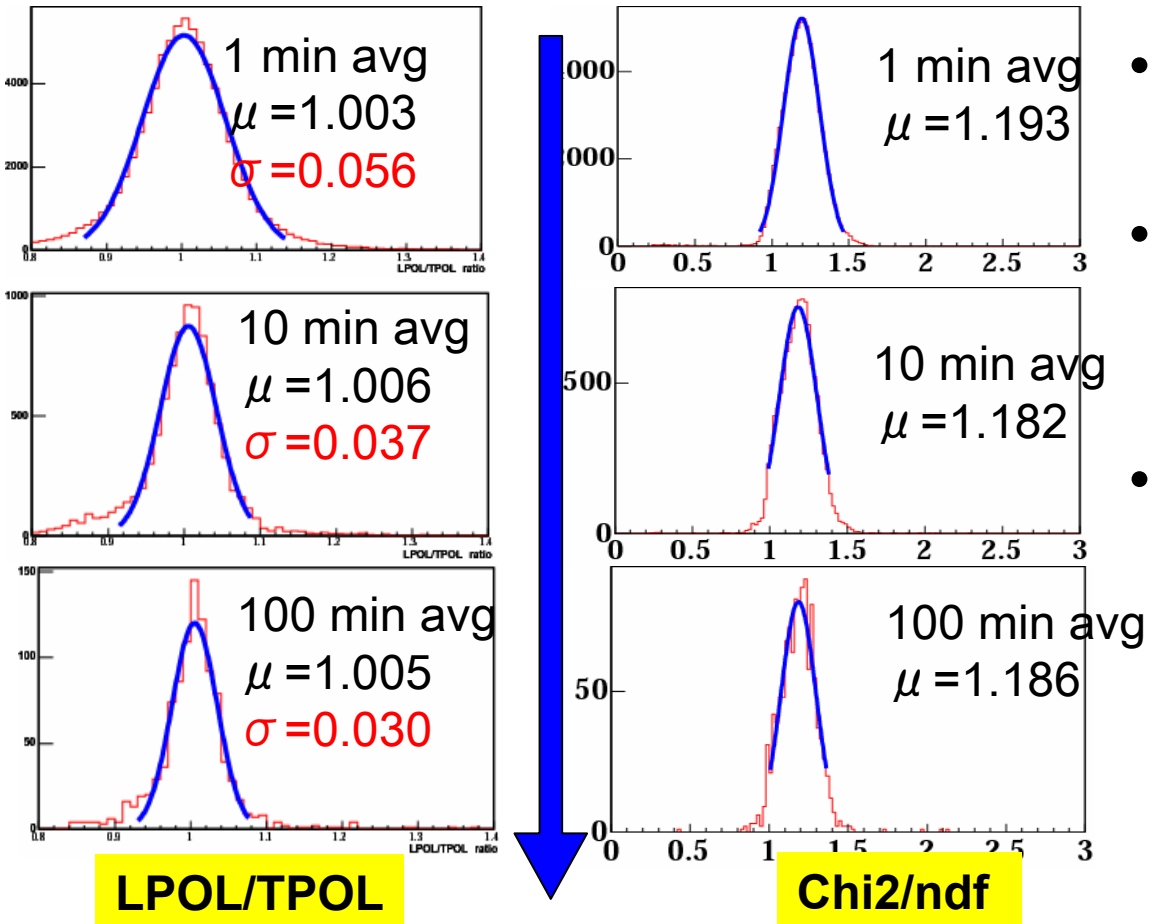
Final parameter set

η - y 4 parameters	the Normal mode
η range	+/- 0.5
beam offset	free
beam size	free
CAL calibration	free
distance	fixed to 65m
skew factor	fixed to 0.0
a (stochastic term)	fixed to 23.77%
b (constant term)	free

Results with all data

- LPOL/TPOL ratio.
- Beam dependence.
  - Focus size (Beam size), Beam offset.
- Polarization from laser left and right.
  - The skew-factor
- Other parameters
  - Calibration, resolution (constant term)
- Laser linear component

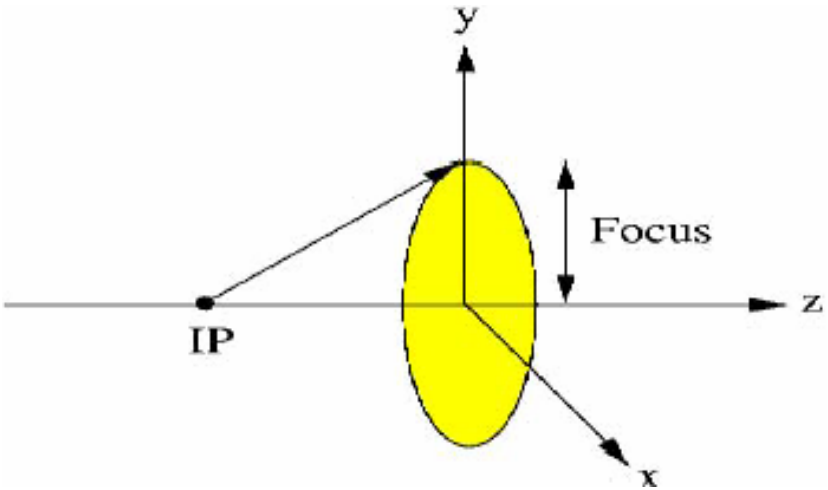
The LPOL/TPOL ratio

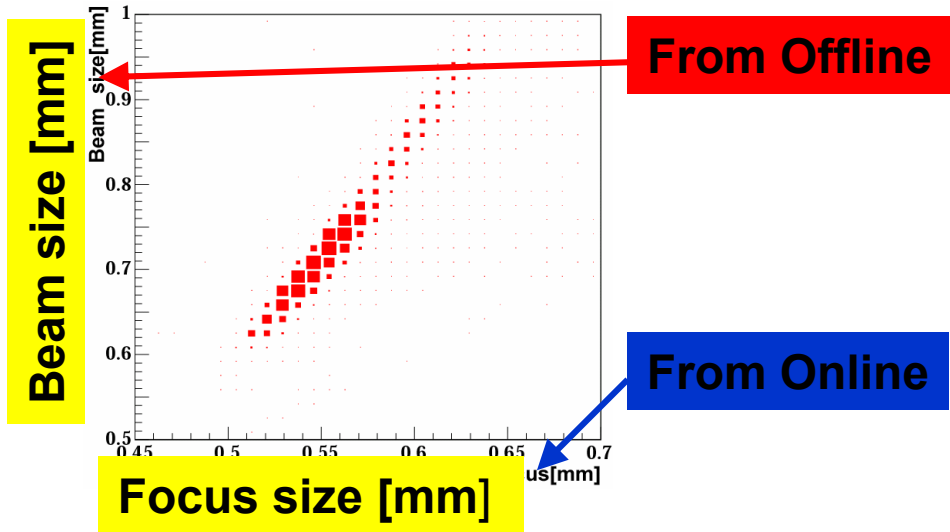


- TPOL and LPOL agree within 0.5%☺
- With more averaging time, variation of L/T become getting smaller.
- No strange dips is seen in both the ratio and chi2/ndf.

→ Modeling is good for polarization analysis.

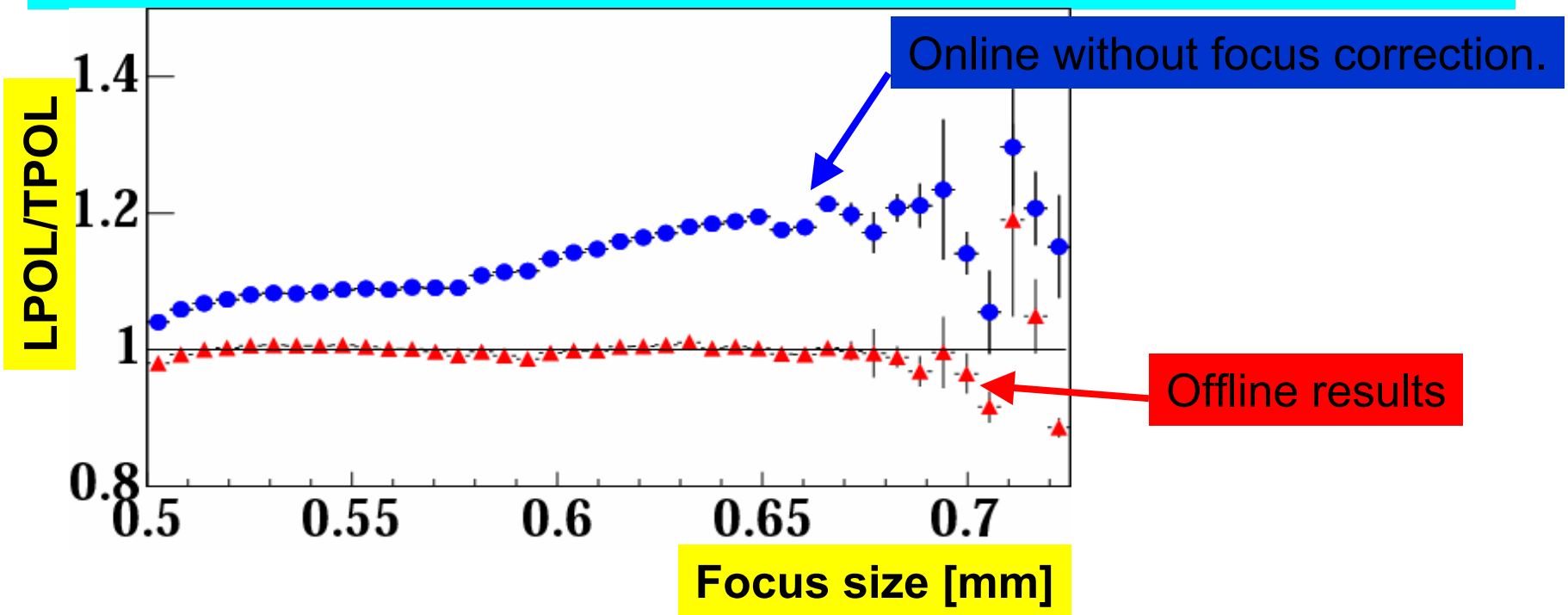
Focus dependence





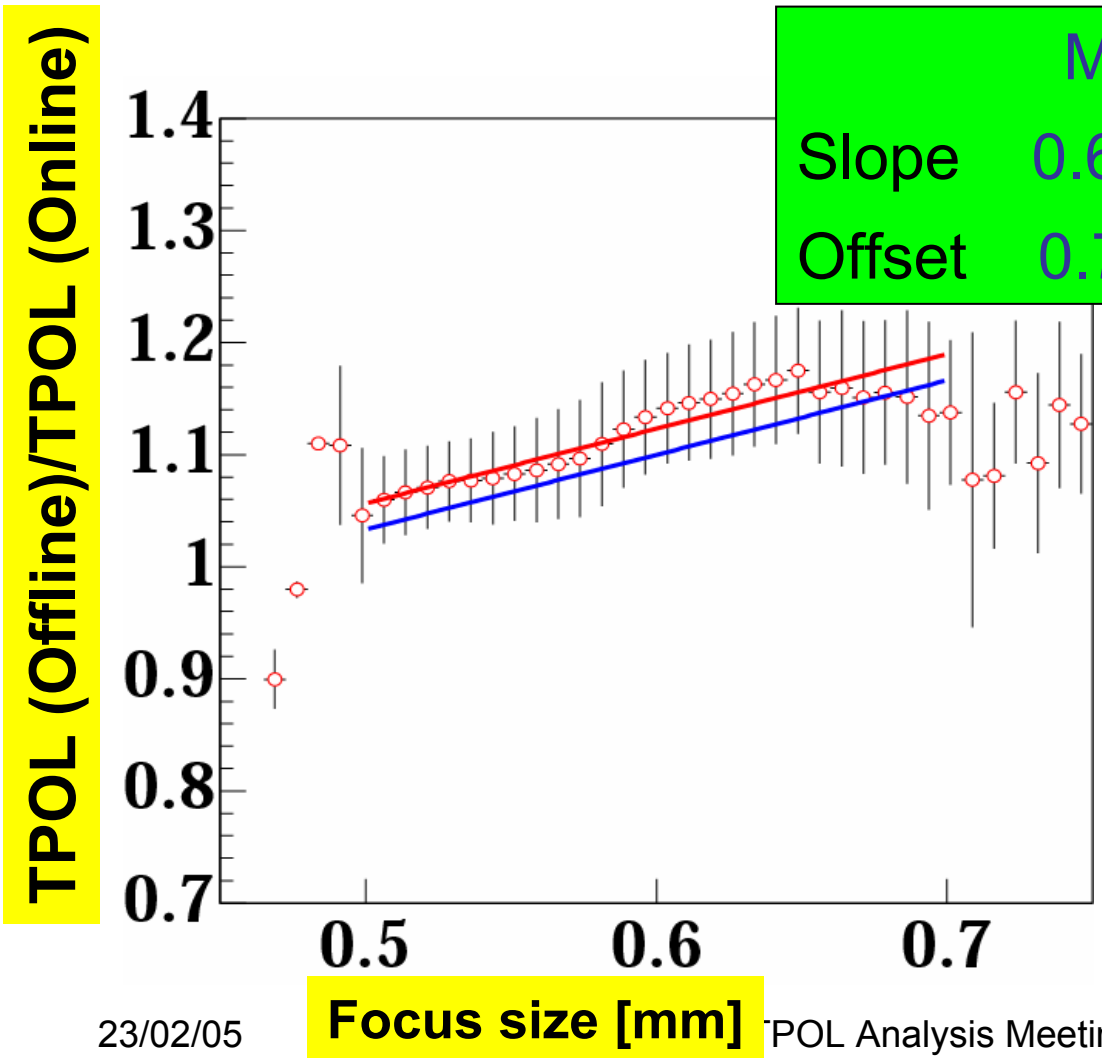
- Focus size (Online)
  - Vertical beam width on the calorimeter surface.
- Beam size (Offline)
  - Vertical beam width at the Interaction Point.
- It is possible to check focus size dependence through the beam size.

Cont'd



- The fitting method can almost absorb the focus dependence, so that the Focus dependence is hardly seen.

Focus correction

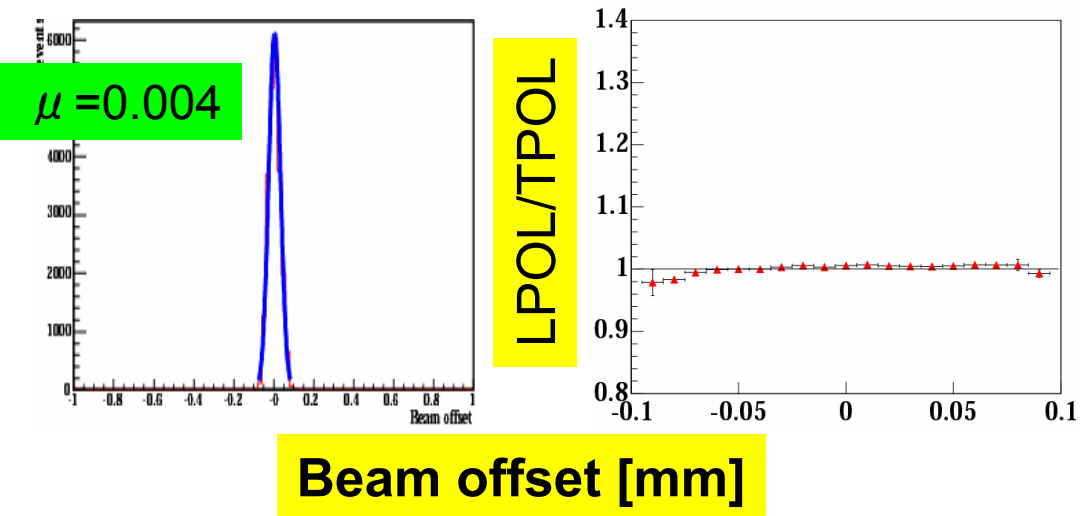


	MC	Fitting
Slope	0.6649	0.6658+/-0.1816
Offset	0.7009	0.7236+/-0.1052

- The results of the fitting method agree with the MC within its error.

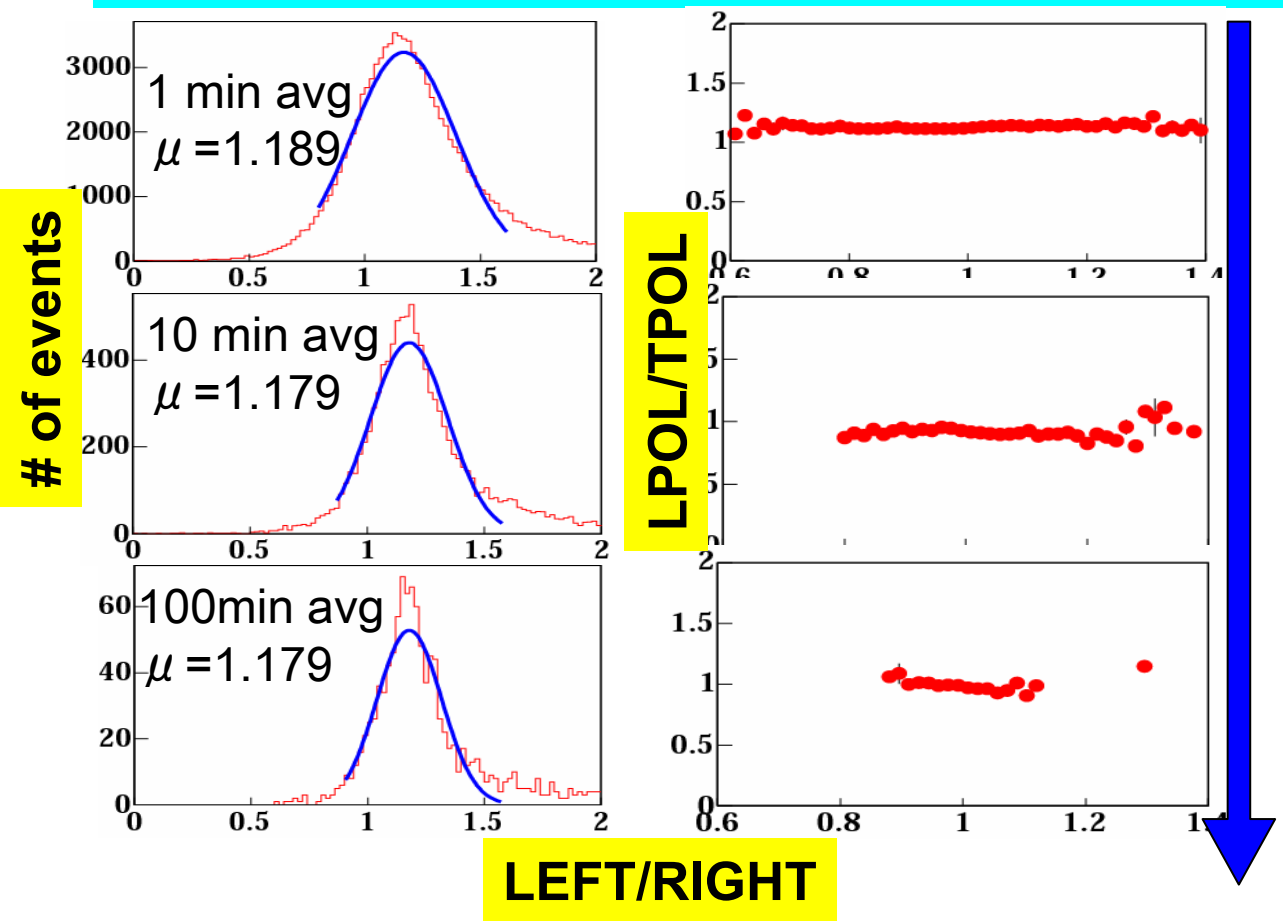
Beam offset

- Check the beam offset to see if the fitting method can absorb the beam dependence.



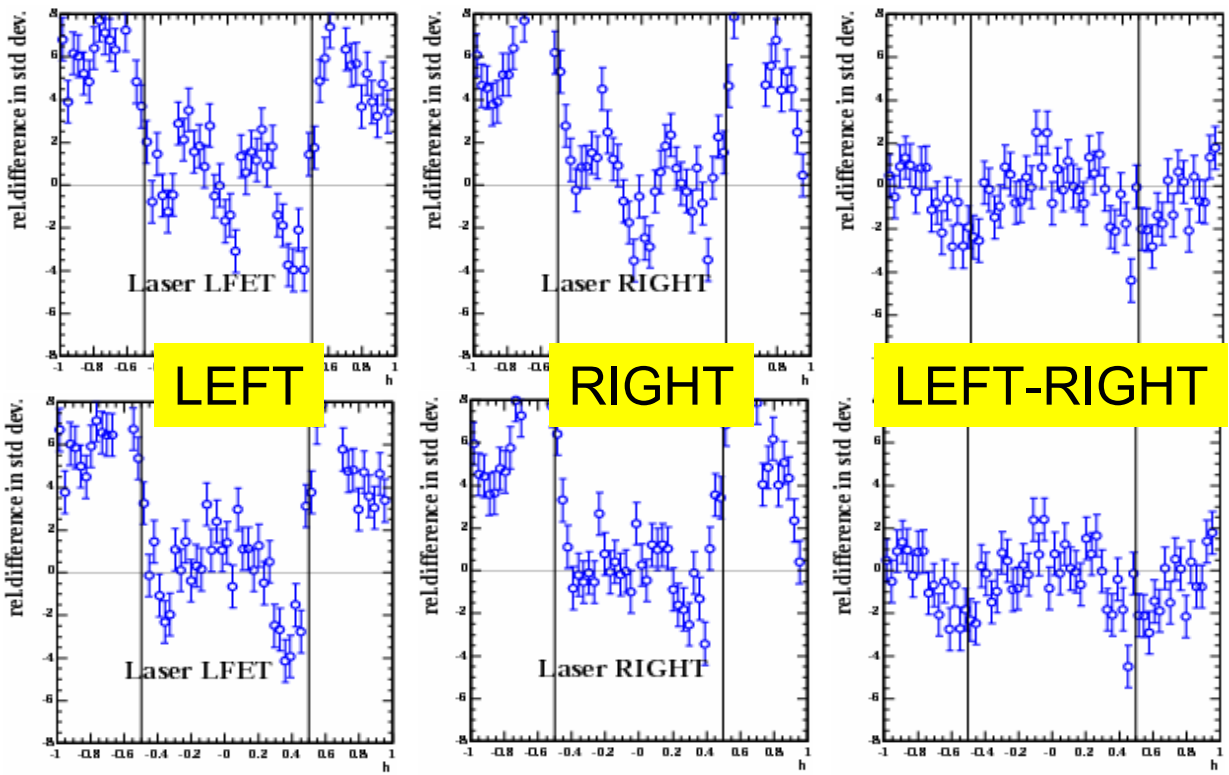
- In the fitting method, no dependence is seen and the ratio is 1.
- Considering the focus and the offset, it can be concluded that the fitting method can absorb the beam dependence.

Polarization from laser left and right



- Polarization from left tends to be larger than polarization from right .
- Very weak effect to the LPOL/TPOL.
- Check this further, the skew-factor was considered.

Pulls with the skew-factor



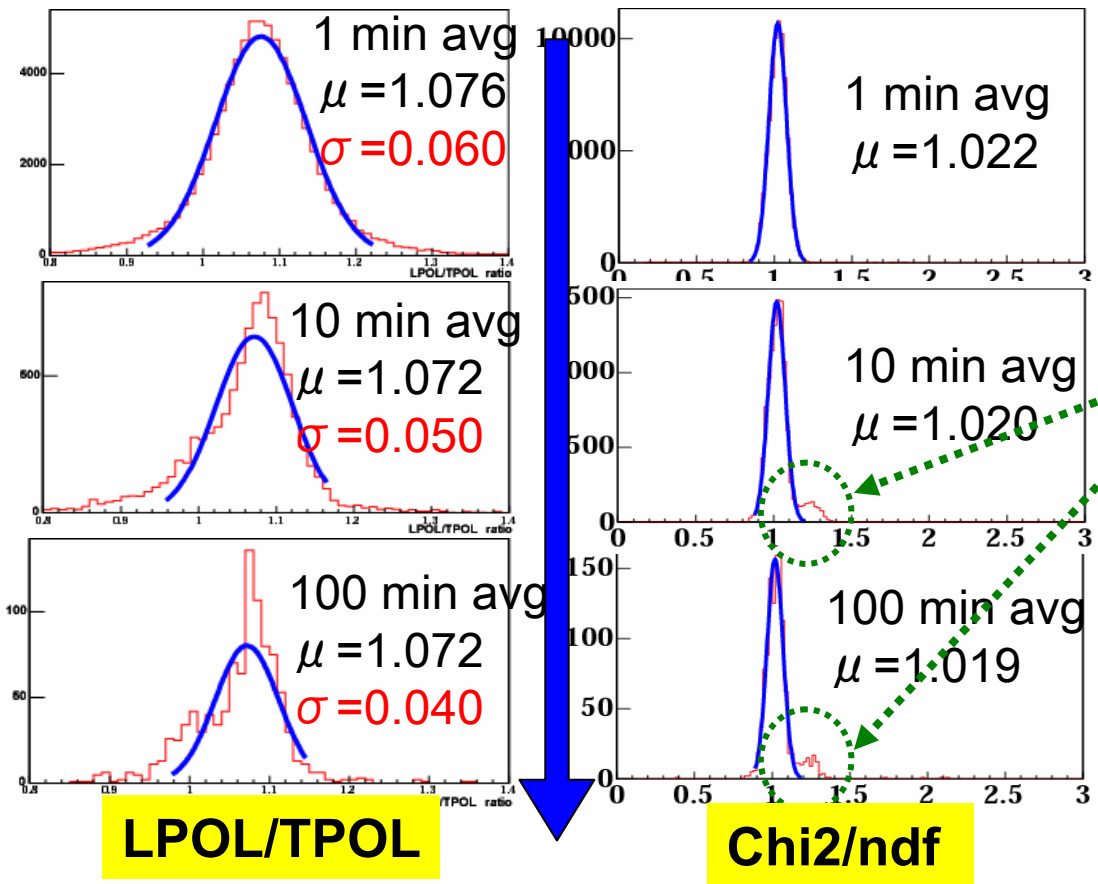
Skew is fixed to be 0

Skew is free

The pulls are improved with the skew-factor, especially the laser right.

Check the LPOL/TPOL ratio to see if the skew-factor is properly for the modeling.

The LPOL/TPOL ratio with the skew-factor

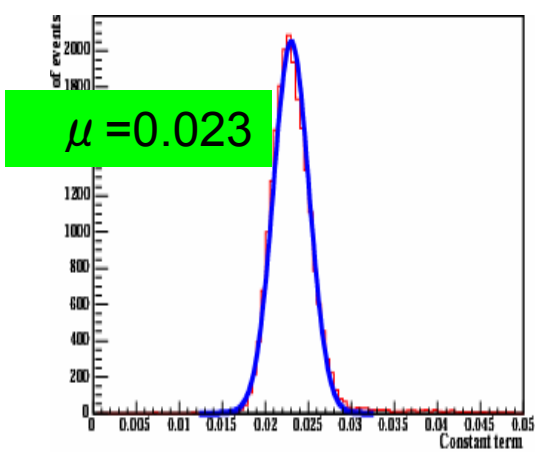


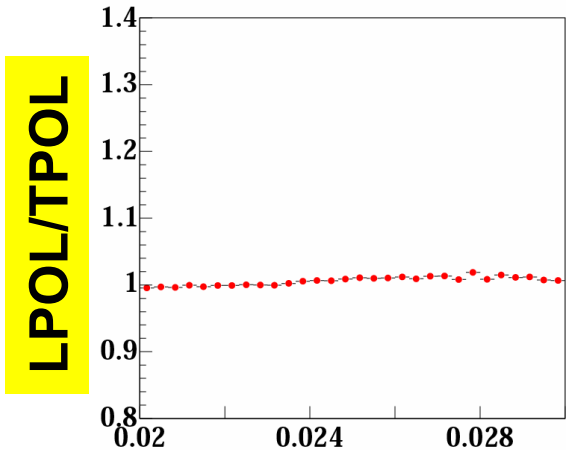
- With more averaging time, strange dips are seen and the chi2/ndf has strange structures.
- The modeling with the skew-factor is wrong for the polarization analysis.

→ The skew-factor is unnecessary parameter.

The energy resolution

- In the fitting method, the stochastic term (a) was fixed to 23.8% (CERN), but the constant term (b) was free, since it depends on the experimental environment.



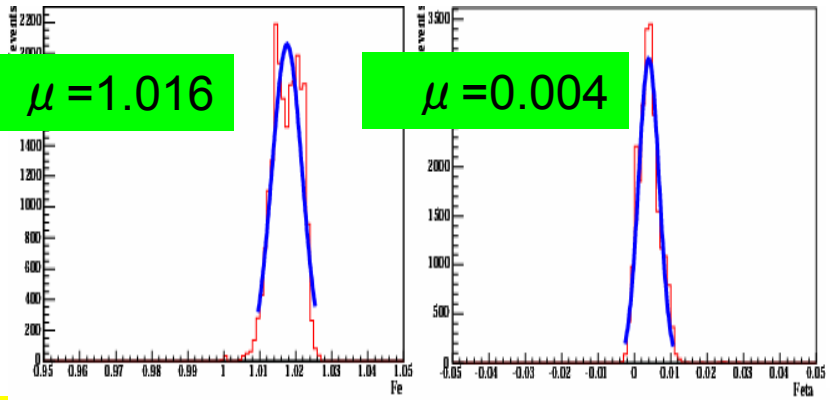


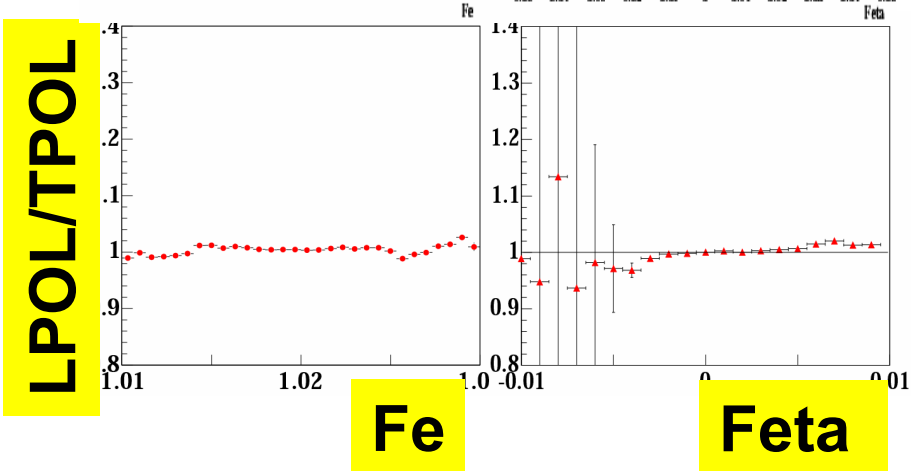
The constant term (b)

$$\frac{\sigma_E}{E} = \frac{a}{\sqrt{E}} \oplus b$$

- Even if the constant term changes, the LPOL/TPOL ratio is 1.

Calibration effects (Fe, Feta)



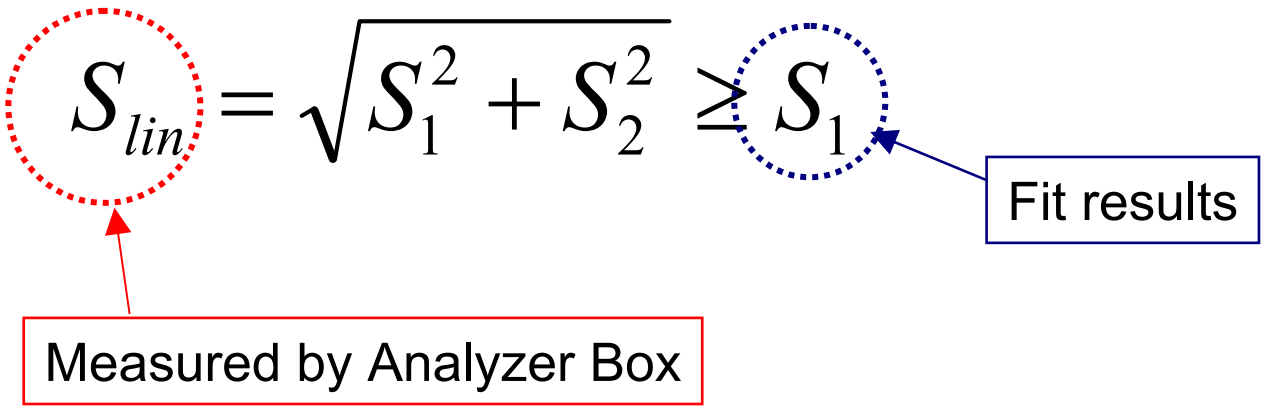


$$U_{abs} = (Fe \times (1 + Feta)) \times U_{calo}$$

$$D_{abs} = (Fe \times (1 - Feta)) \times U_{calo}$$

- Fe and Feta reflect the imperfect calibration up and down.
- These parameters (constant term, Fe and Feta) have fluctuation, but no critical dependence to the LPOL/TPOL ratio.

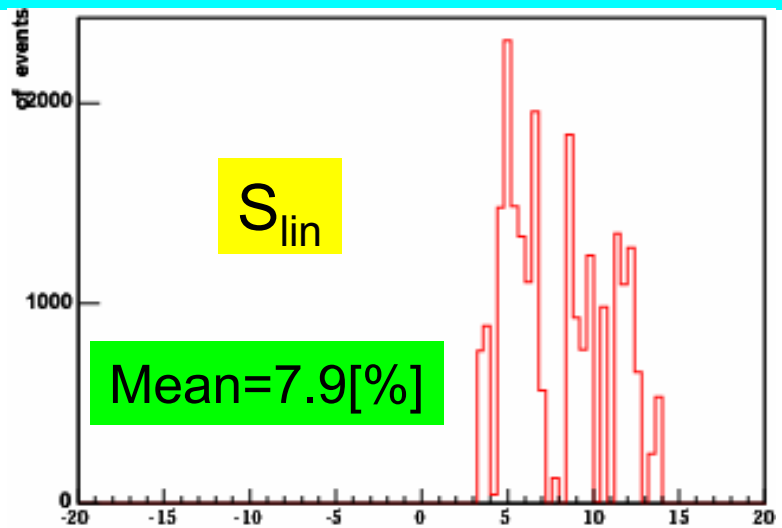
Laser linear component

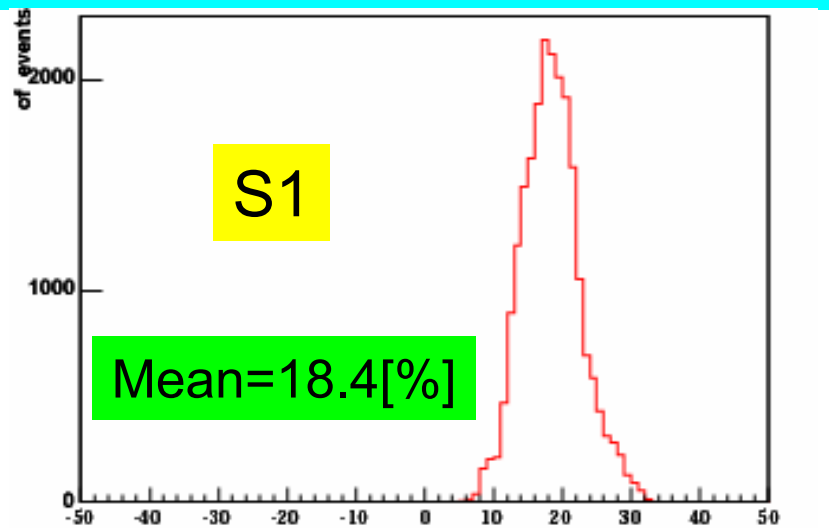


- We can not measure S_1,S_2 separately and only S_1 includes the Compton cross section.

  → S_{lin} is upper limit of S_1.
- Compared these two values and checked the fitting was reasonable or not.

Cont'd

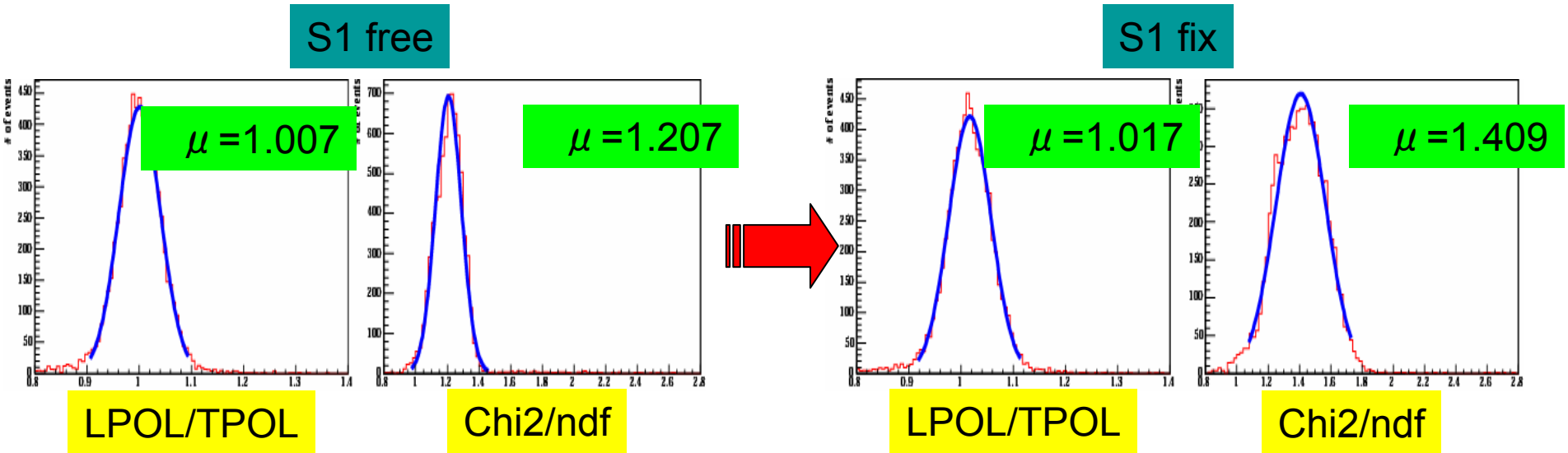




$$S_{lin} = \sqrt{S_1^2 + S_2^2} \geq S_1$$

- Fixed S_1 to the S_{lin} and checked how impact on the fitting. If no critical influence to the results, this discrepancy should not be considered.

Results with S1 fixed.



- With being fixed S1, the LPOL/TPOL was off the nominal by 1%.

  → The fitting method can not reproduce the laser linear component, but we do not care the effects.

Systematic check

- The η - y curve
  - Normal
  - →Table scan
- Fitting range in η
  - 0.5
  - →+/- 0.05
- Distance
  - 65m
  - →+/-1m
- CAL miscalibration
  - (Fe, Feta) free
  - →(1.0, 0.0) fixed
- CAL energy resolution
  - 23.8%
  - →Compton edge (19.7%)
- Beam offset
  - free
  - → 0.0

Cont'd

• The η - y curve	0.87%
• Fitting range	1.99%
• Calibration of CAL	1.97%
• Beam offset	0.02%
• Distance IP to CAL	0.78%
• Energy resolution	1.16%
Total	3.25%

➢ Error from the calibration seems to be overestimation, cause assumed the calibration was perfect.

Summary 1

- The stability check indicates some parameters have to fix for the fitting, i.e. distance, resolution and the η - y curve.
- Analyzed all data (October.2003~August.2004),
  - The TPOL and the LPOL agree within 0.5%☺.
  - The focus / beam offset dependence is hardly seen in the fitting results.
  - The fitting method can reproduce the focus correction function which is estimated by MC.

  → These results indicate the beam condition does not influence on the fitting method.

Summary 2

- The polarization from the laser left tends to be larger than that of the laser right.
- Looking at the pull, there are asymmetric structures in η → considered the skew-factor.
- With the factor, the pull was improved, but strange dips were included in the LPOL/TPOL ratio → Modeling with the factor was wrong, the factor was unnecessary parameter.
- Other parameters, b, Fe and Feta, have no critical dependence to the polarization.

Summary 3

  - The fitting method can not reproduce the laser linear component.
  - In fixing the linear component with optical measurement, the LPOL/TPOL changed only 1%.
- Total systematic error is 3.25%☺
  - The error from the miscalibration effects seems to be overestimation.

  →Will check online data to find out the value which should be fixed in the error estimating.
- All results of the fitting will include in the pol note.