Update on the TPOL η-y Transformation Measurement

Recent developments due to new data

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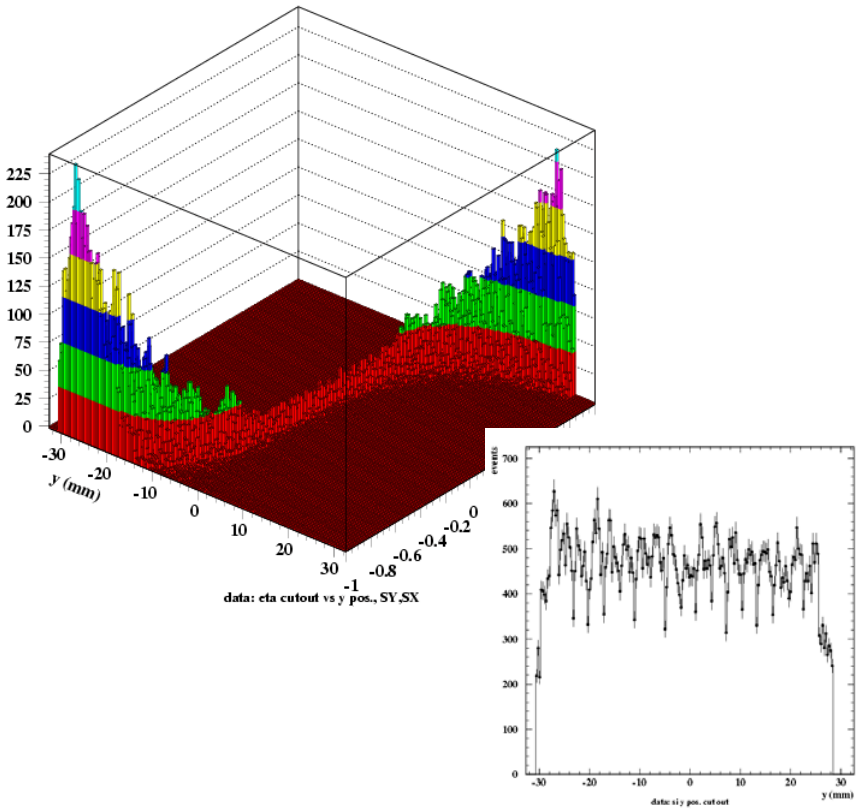
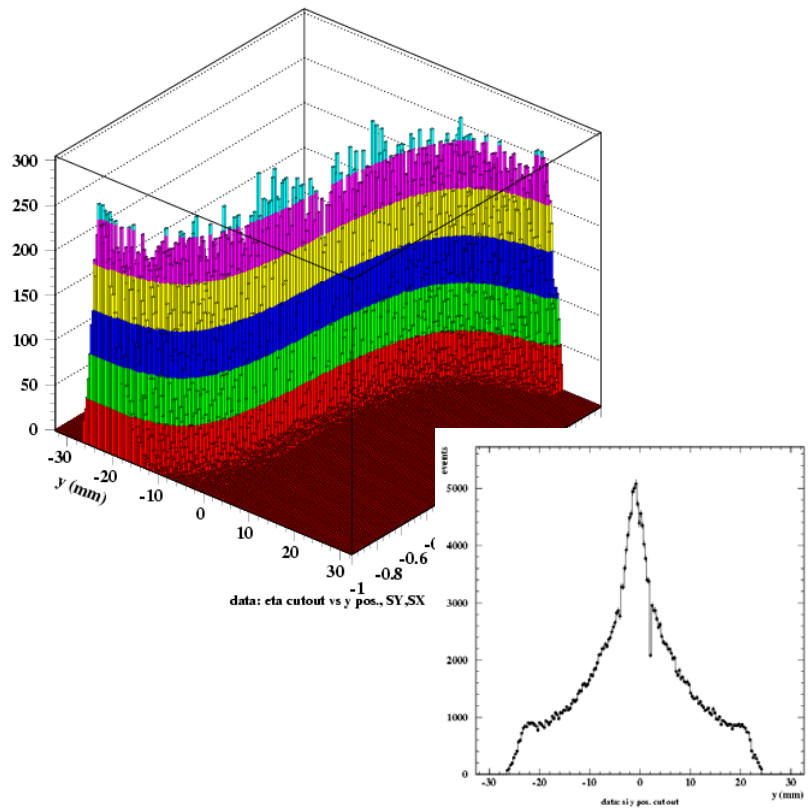
POL2000 meeting, 2nd October 2007

Table scan data - "Old" and "New"

- Data in August 2005
  - 19 runs à 100k events
  - y ∈[-30mm:30mm]
  - fixed step size of 3mm
  - ➢ limited statistics around eta=0



- Data taken on 30th June 2007
  - 70 runs à 100k events
  - y ∈[-25mm:25mm]
  - step size adapted to give flat 3D-profile



Retrospection - Modelling eta-y

- Modelling one em shower by assuming a radial exponential energy distribution

$$\frac{dE}{dr} \propto E_0 \cdot e^{-r/\lambda}$$

- Proper integration over x and y for eta-y leads to an integrated Bessel-Function

$$\mathcal{K}_0(y_0) := \frac{2}{\pi} \int_0^{y_0} K_0(t)\, dt$$

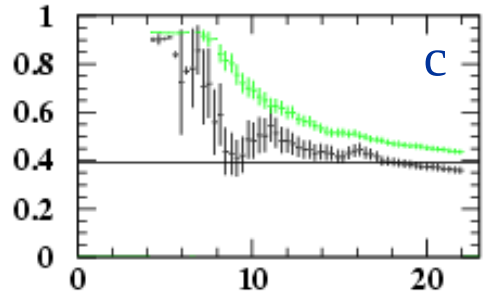
- Expect two component shower: core and halo of different shower lengths

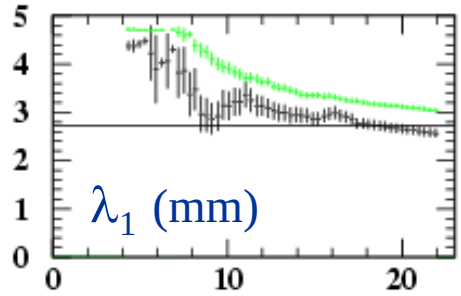
$$\eta(y_0) = \frac{E_u(y_0) - E_d(y_0)}{E_u(y_0) + E_d(y_0)} = \text{sign}(y_0) \left[c \cdot \mathcal{K}_0\left(\frac{|y_0|}{\lambda_1}\right) + (1-c) \cdot \mathcal{K}_0\left(\frac{|y_0|}{\lambda_1 + \lambda_2}\right) \right]$$

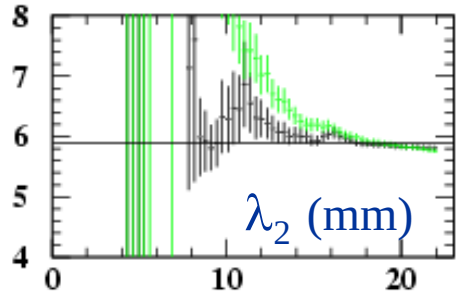
- This is the description of an em single-particle shower

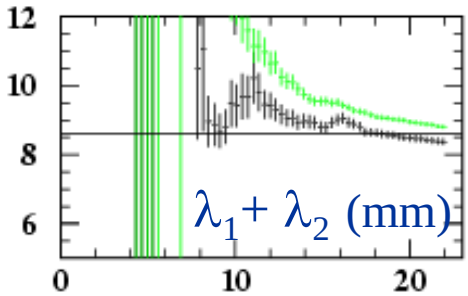
Fitting eta-y - Comparison of “old“ and “new“ table scan

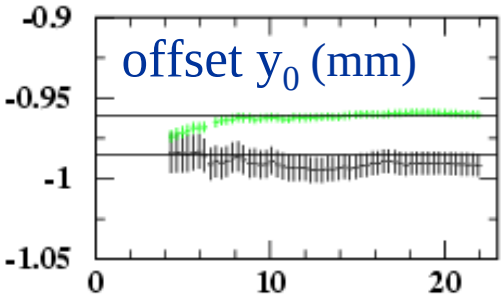
- ‚Evolution‘ of fitting parameters with increasing fit range [-y : y]
- Reveals model inconsistency with “new“ data

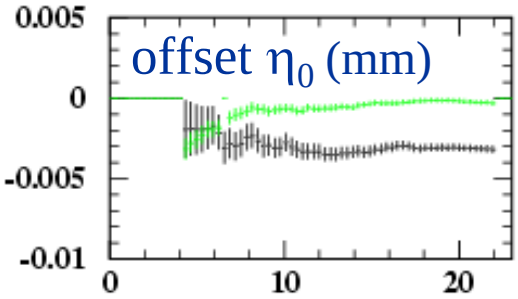












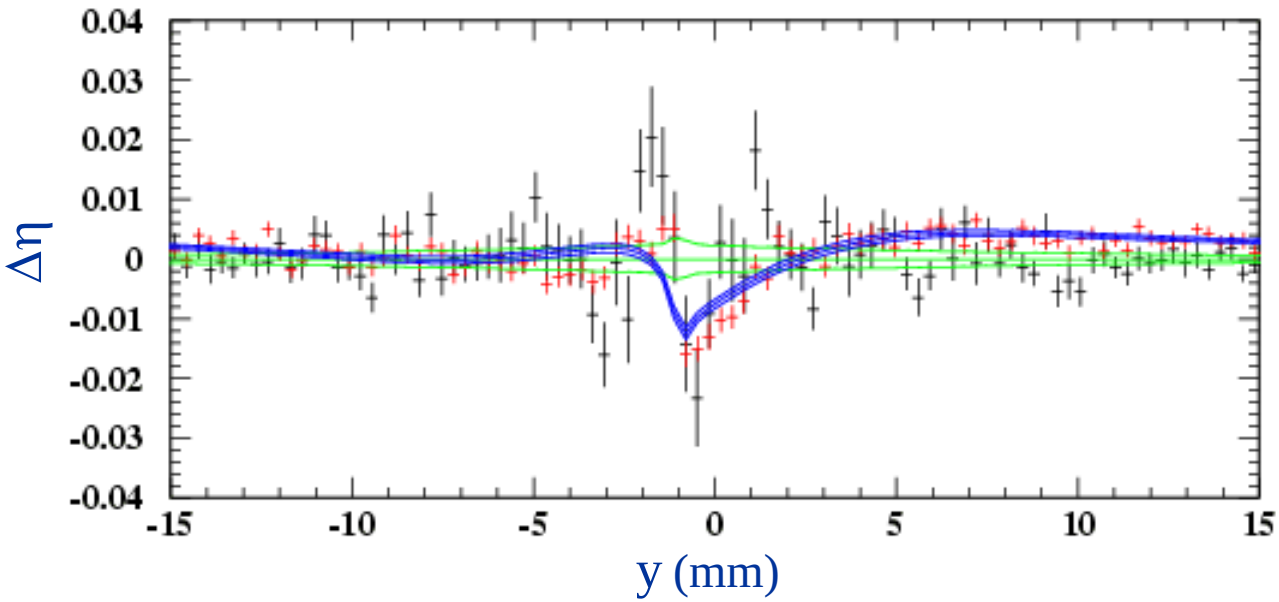
- “Old“ data
-“New“ data

Residua of the fits - A closer look

- Residua with respect to the fit to “Old“ data
- Each fit has his own offsets y_0 and η_0
  - have to be nulled to compare data and fit results

➢ comparison reveals some common systematic effect !

Data and fit results with y_0 and η_0



- “Old“ data
- Fit to “Old“ data
- “New“ data
- Fit to “New“ data

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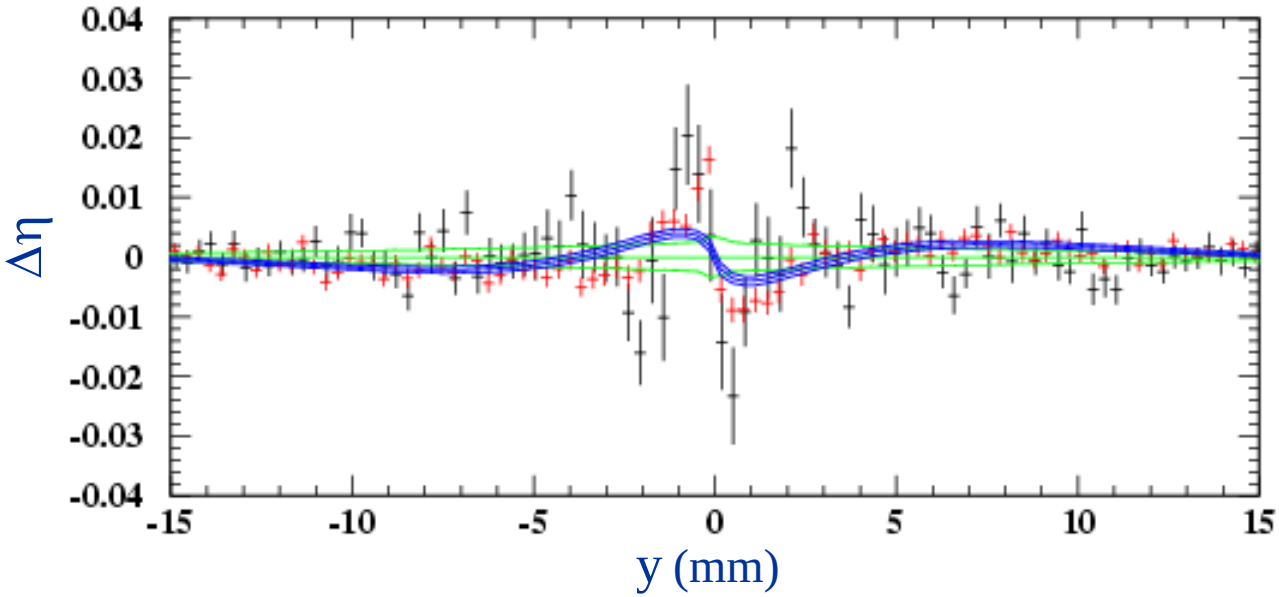
Data and fit results without y_0 and η_0

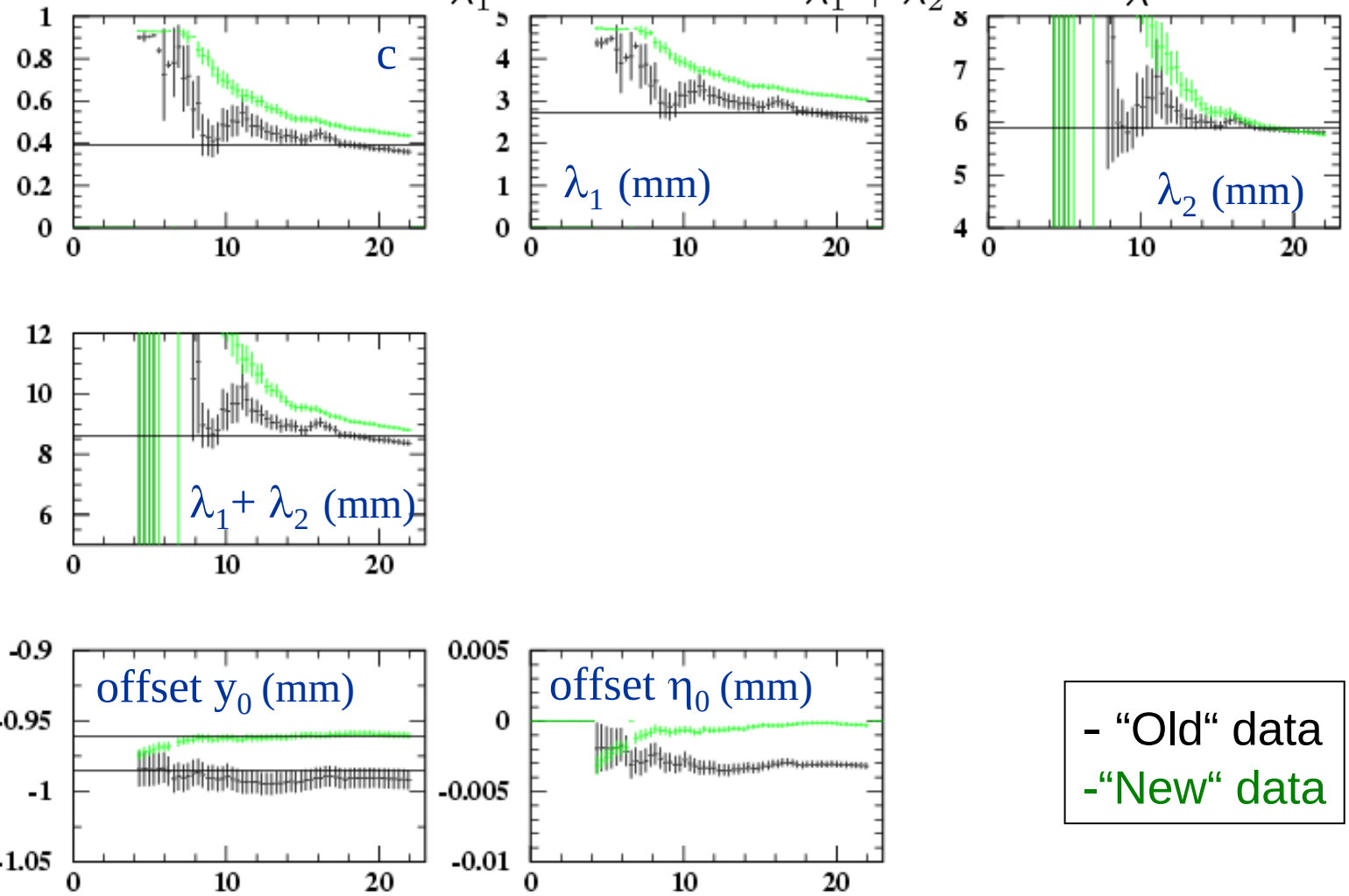


- “Old“ data
- Fit to “Old“ data
- “New“ data
- Fit to “New“ data

Trying to extent the eta-y - Fit results

- Heuristic ansatz: Extent eta-y fitfunction by a third component:

$$\eta(y) = \text{sign}(y)\left[c\cdot\mathcal{K}_0\left(\frac{|y|}{\lambda_1}\right)+(1-c+\bar{c})\cdot\mathcal{K}_0\left(\frac{|y|}{\lambda_1+\lambda_2}\right)-\bar{c}\cdot\mathcal{K}_0\left(\frac{|y|}{\bar{\lambda}}\right)\right]$$



- "Old" data
- "New" data

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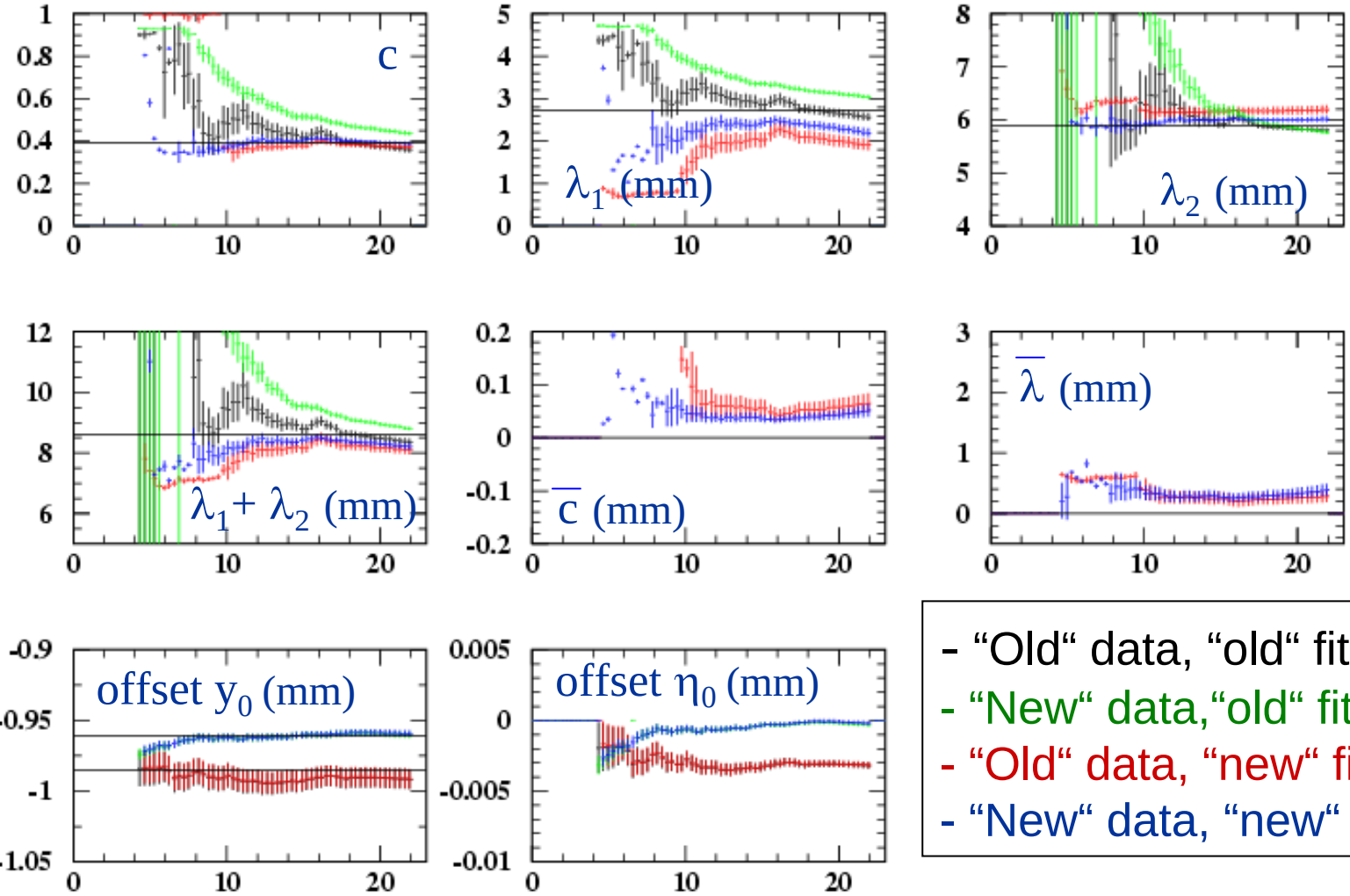


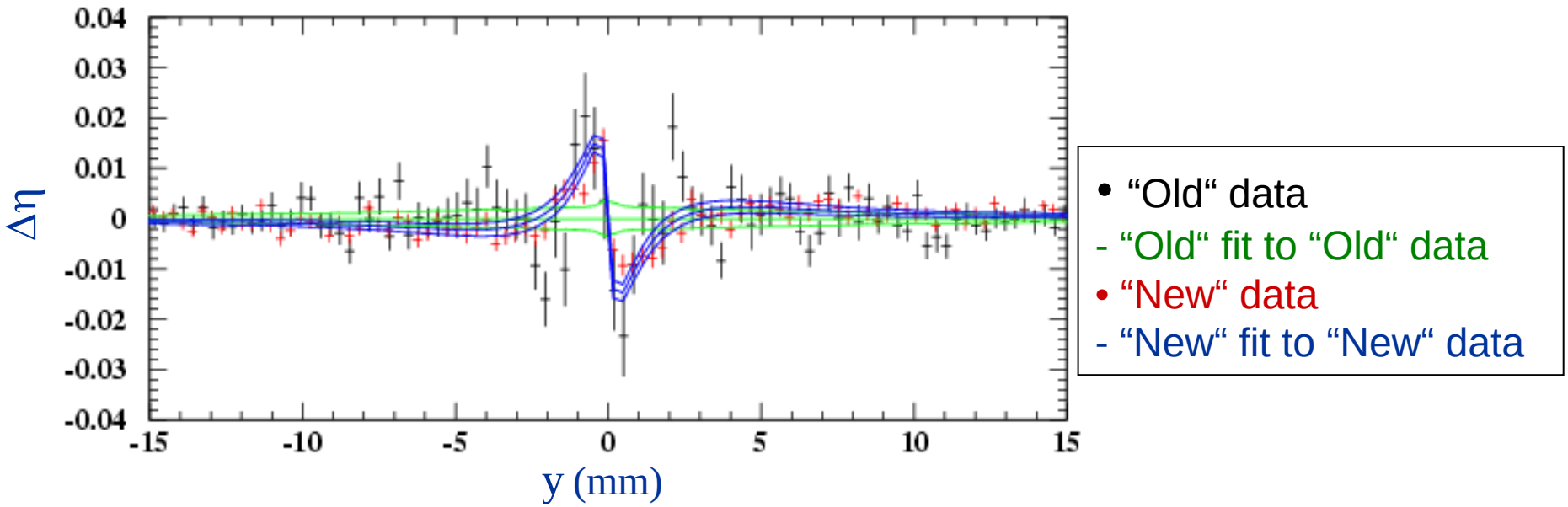
- "Old" data, "old" fit
- "New" data,"old" fit
- "Old" data, "new" fit
- "New" data, "new" fit

Residua - Again a closer look

- Residua again with respect to the “old“ fit to “Old“ data
- Each fit has his own offsets y_0 and η_0
  - have to be nulled to compare data and fit results

➢ no further systematic effect to be seen upon comparison !

Data and fit results without y_0 and η_0



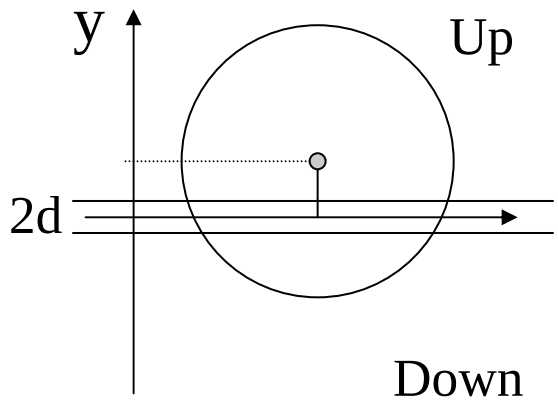
What could it be? - Idea: the gap?

- A small gap between the scintillator plates up and down
  - leads some energy loss for energy reconstruction and eta-y
- Modelling the gap: analytical calculation using eta-y
  - Here: 100% loss, but easily extendable to fractional loss

$$U = \frac{E}{2}(1+\eta(y)) \qquad U' = \frac{E}{2}(1+\eta(y-d))$$

$$\Rightarrow$$

$$D = \frac{E}{2}(1-\eta(y)) \qquad D' = \frac{E}{2}(1-\eta(y+d))$$

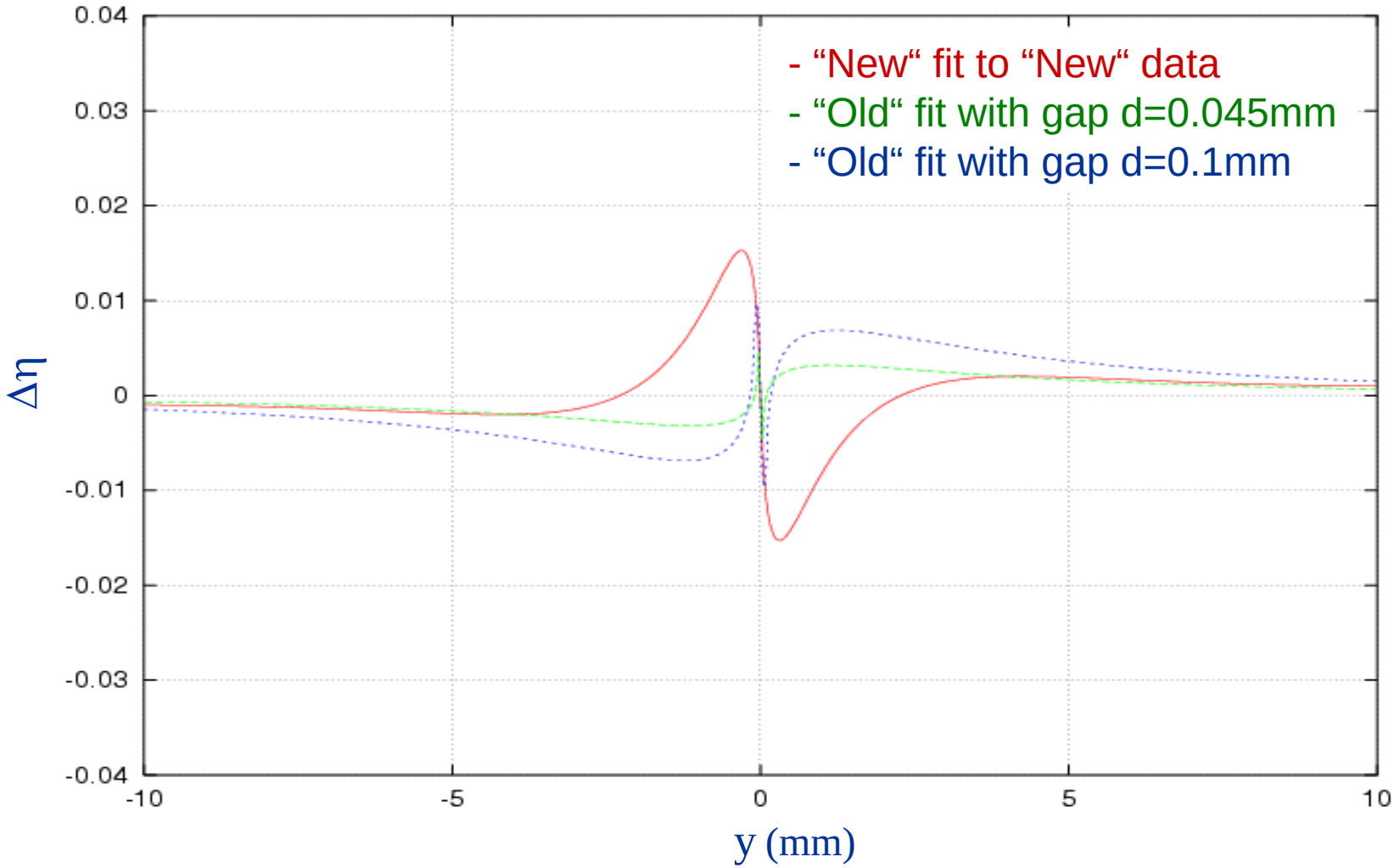


$$E'(y) = E[1+\frac{1}{2}(\eta(y-d)-\eta(y+d))]$$

$$\eta'(y) = \frac{\eta(y-d)+\eta(y+d)}{2+\eta(y-d)-\eta(y+d)}$$

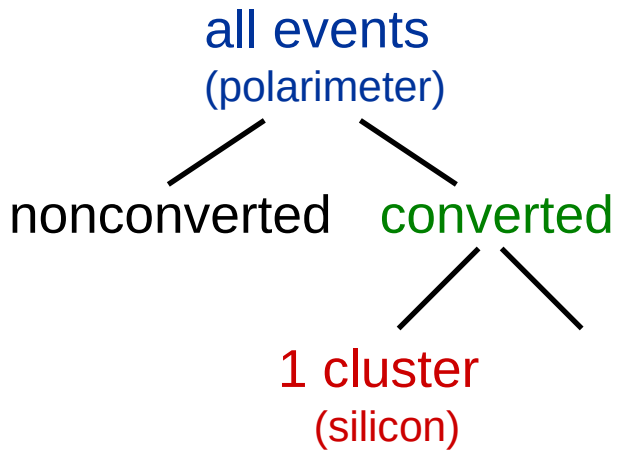
What could it be? - Idea: the gap? Probably not only...

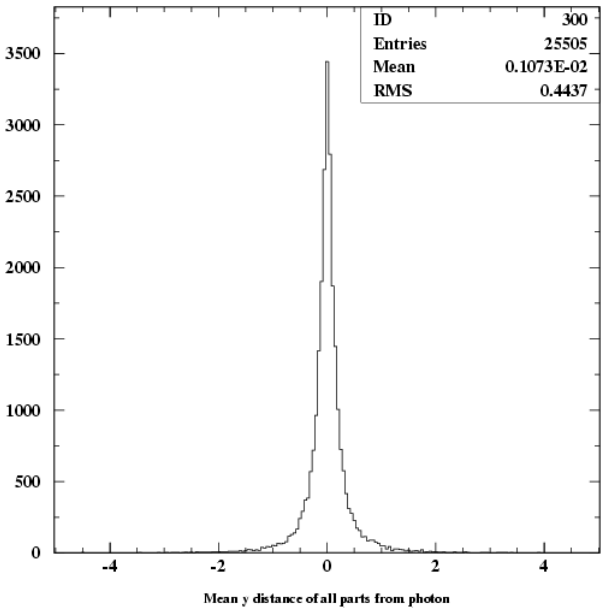
- Residua with gap effects again with respect to “old“ fit to “old“ data
  - a PURE gap effect would be not large enough and would have wrong sign !



What could it be? - What about the showers?

- Reminder: Silicon measures converted photons
- Polarimeter measures converted and non-converted photons
- Upon conversion photon energy is spread on multiple particles with a fraction of the total energy
  - ➢ This particle distribution has a finite width!

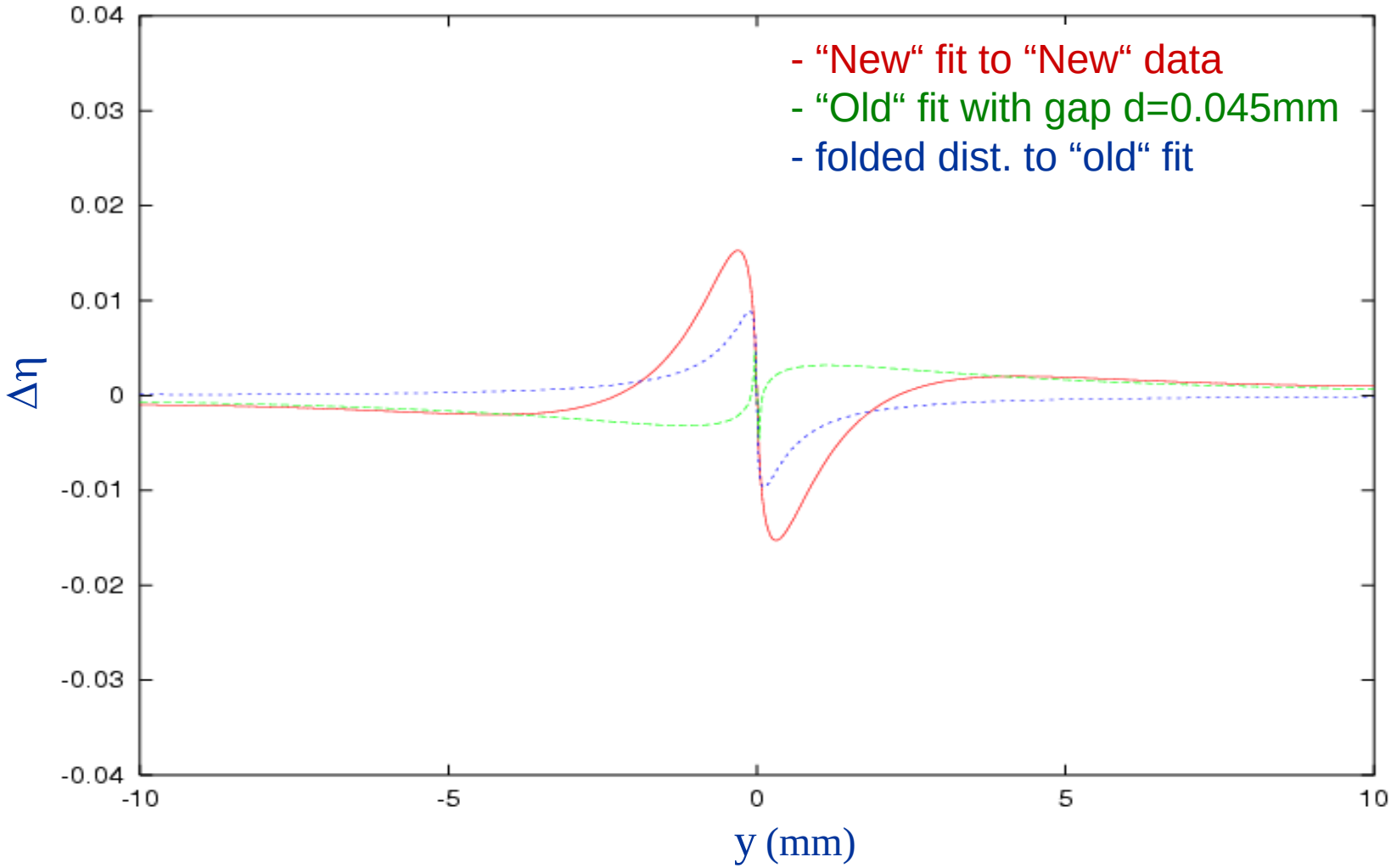




- In a simple picture this distribution will fold into the current eta-y
  - ➢ Equivalent to a transition of a single-particle shower description to a multi-particle shower description

What could it be? - What about the showers? Folding results...

- Idea: Folding the multi-particle distribution with a single-particle eta-y



Résumé - Counting ingredients to the eta-y

- Main contributions to the shape of the eta-y:
  - 1) Single-particle showers are exponential in radial energy distribution,
    - the resulting eta-y is a single-particle eta-y
  - 2) The multi-particle distribution folds into the single-particle eta-y
    - yields a change in the inner part,
    - which can (presumably) be described by a third K0 component.
  - 3) The gap induces an energy loss,
    - changes eta-y
    - can be modelled analytically using eta-y.
- Effect of 3) somewhat smaller than the effect of 2), opposite sign, but overall same range of influence
  - no sensitivity to fit it together with 2), but possible to account for a fixed gap
  - Robert tracks the value anyway down with the Geant MC using position dependent energy reconstruction with good precision.
- Fitting of a “3K0-function with fixed gap“ is still missing, will show hopefully nice results next time.