Longitudinal shower profile - CERN electron runs 2006 -

Valeria Bartsch
University College London

Sampling fraction

- Allow sampling fraction f_{samp} to vary layer by layer
  - Take into account variation of energy deposition if energy of electrons in the shower is so low that they do not dominantly do bremsstrahlung
- Estimate sampling fraction f_{samp} with MC simulation

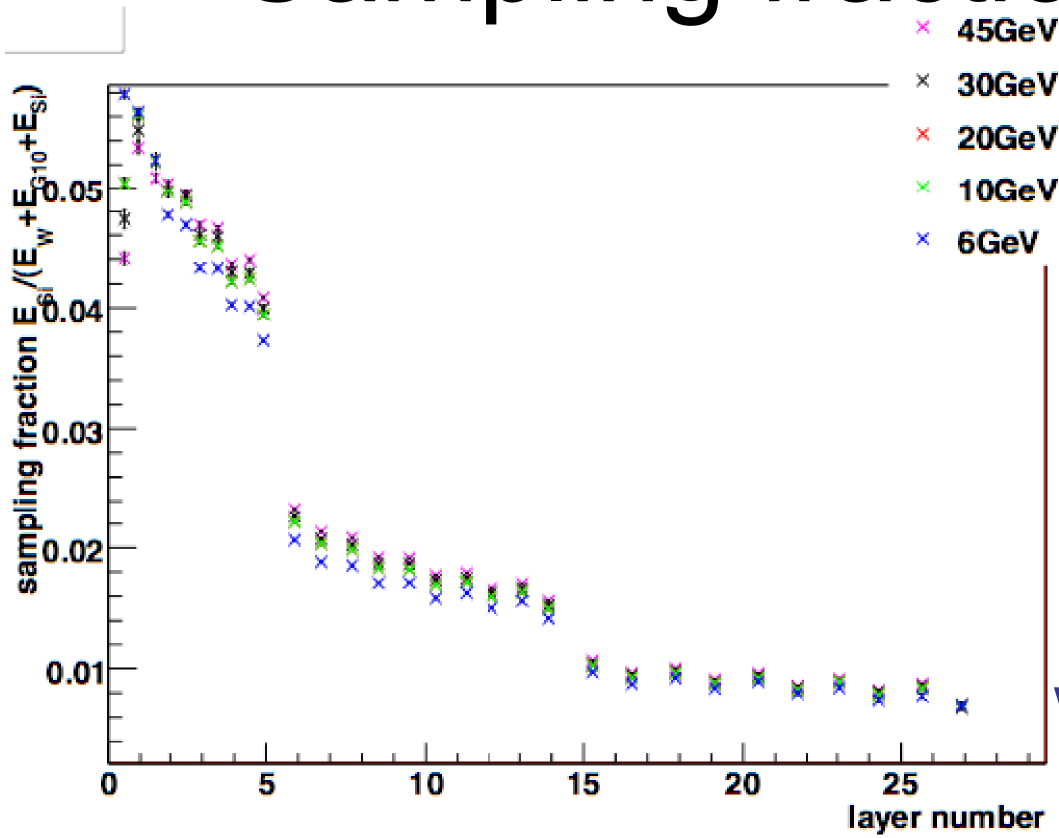
$$F_{samp} = E_{dep\ active} / E_{dep\ total}$$

- For $E_{dep\ total}$ only W and G10 used

  for 30GeV 96% of $E_{dep\ total}$ deposited in W, Si and G10
- Needed to write new MOKKA driver for this

  with the help of Gabriel Musat
- Resulting files large (50GB for 1000 events) due to structure of LCIO

Sampling fraction



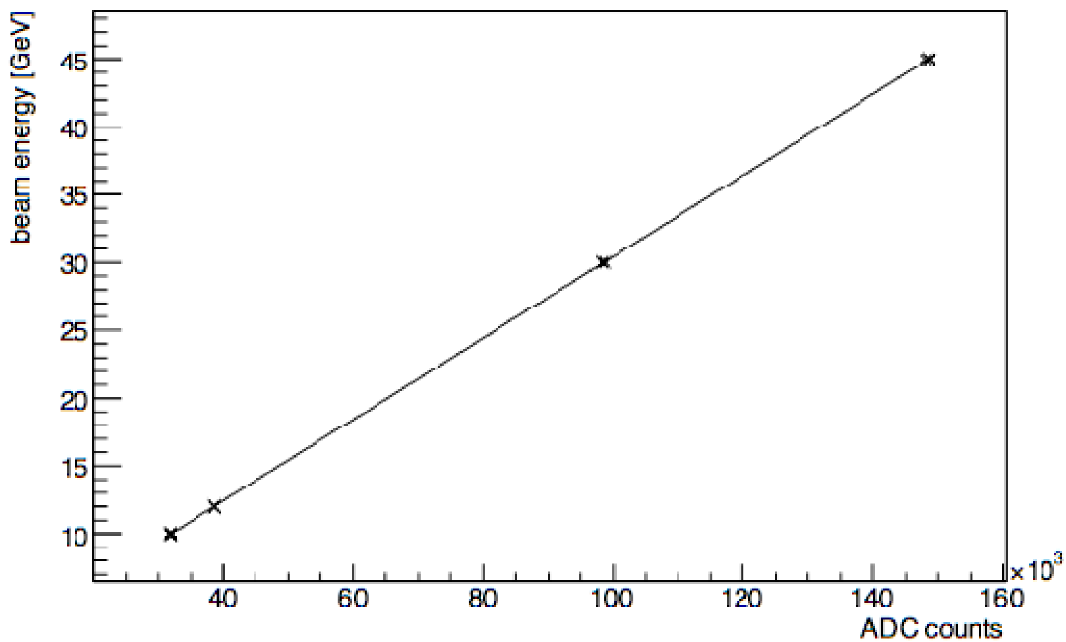
written up in CIN-013

- One can see odd/even layer difference
- 3 stack with differing W thickness
- However ratio between the stack is: 1/1.8/2.6 instead of 1/2/3 (also supported when carefully adding all radiation lengths

Sampling fraction

- New sampling fraction also takes care of odd/even layer difference
- Changes between odd/even layer and this method:
  - Shower max
  - Leakage Energy
  - Small change of the χ^2 of the fits to the longitudinal profile

Linearity



$\chi^2 = 0.5$

Fit:

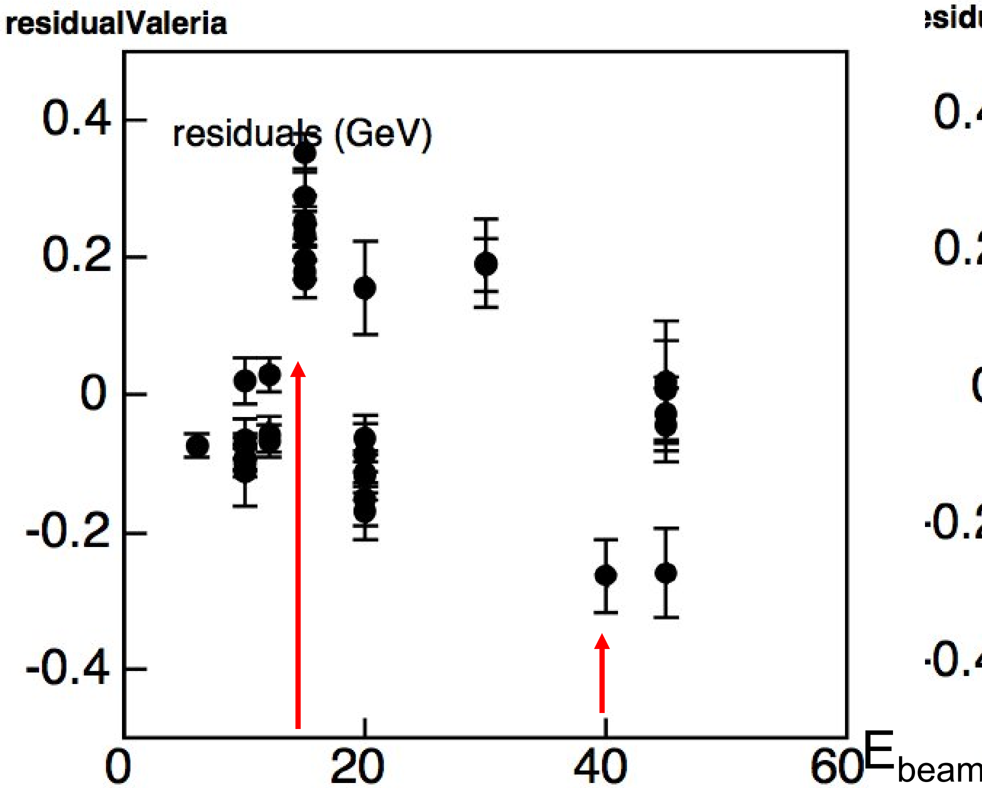
E_{beam} = ADC_counts * (2.97+-0.03)*10^{-4}

$\Rightarrow$ need new mip_conv for this method

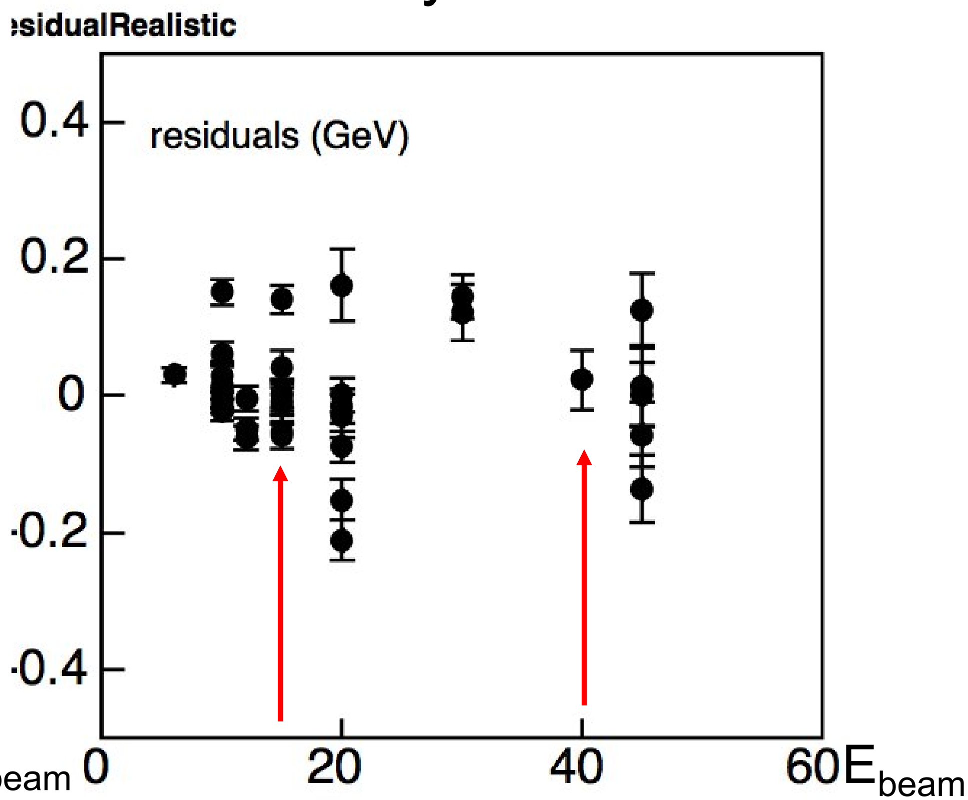
However looking closer….

(plots from Daniel Jeans)

New sampling fraction



Odd/even layer correction

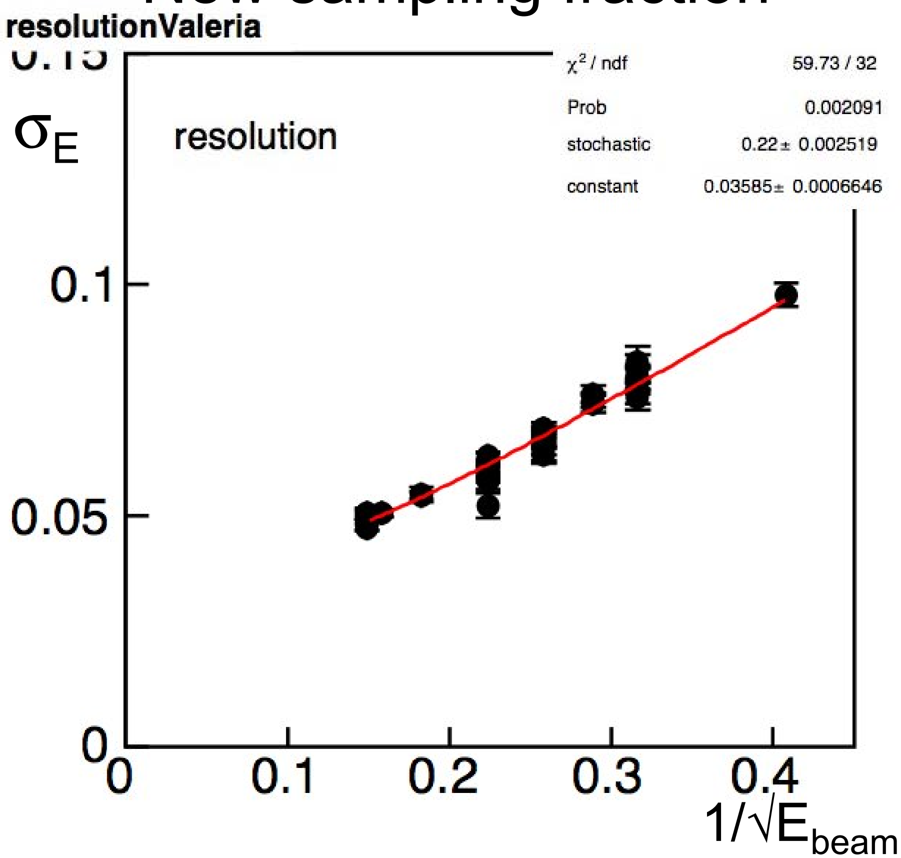


⇒Residual are higher for 15 GeV (no correct sampling fraction for this energy) and 40 GeV

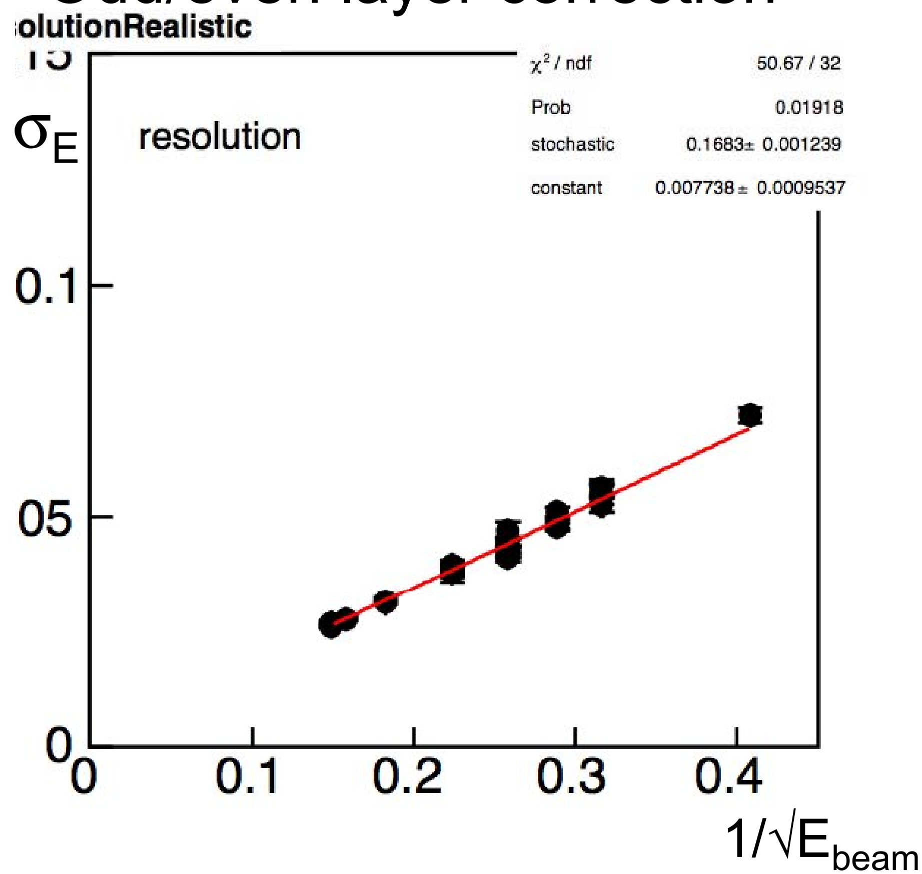
However looking closer….

(plots from Daniel Jeans)

New sampling fraction

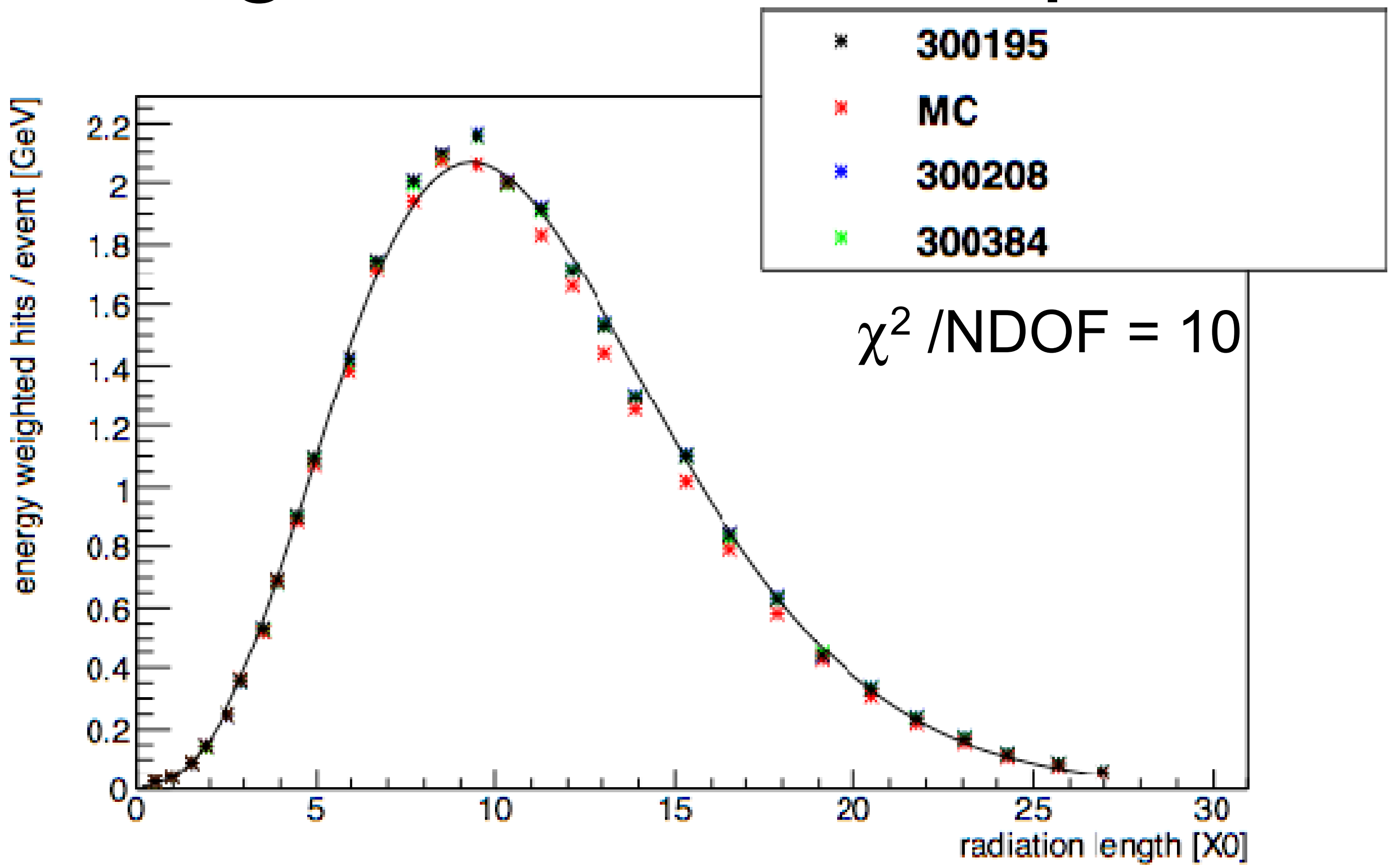


Odd/even layer correction



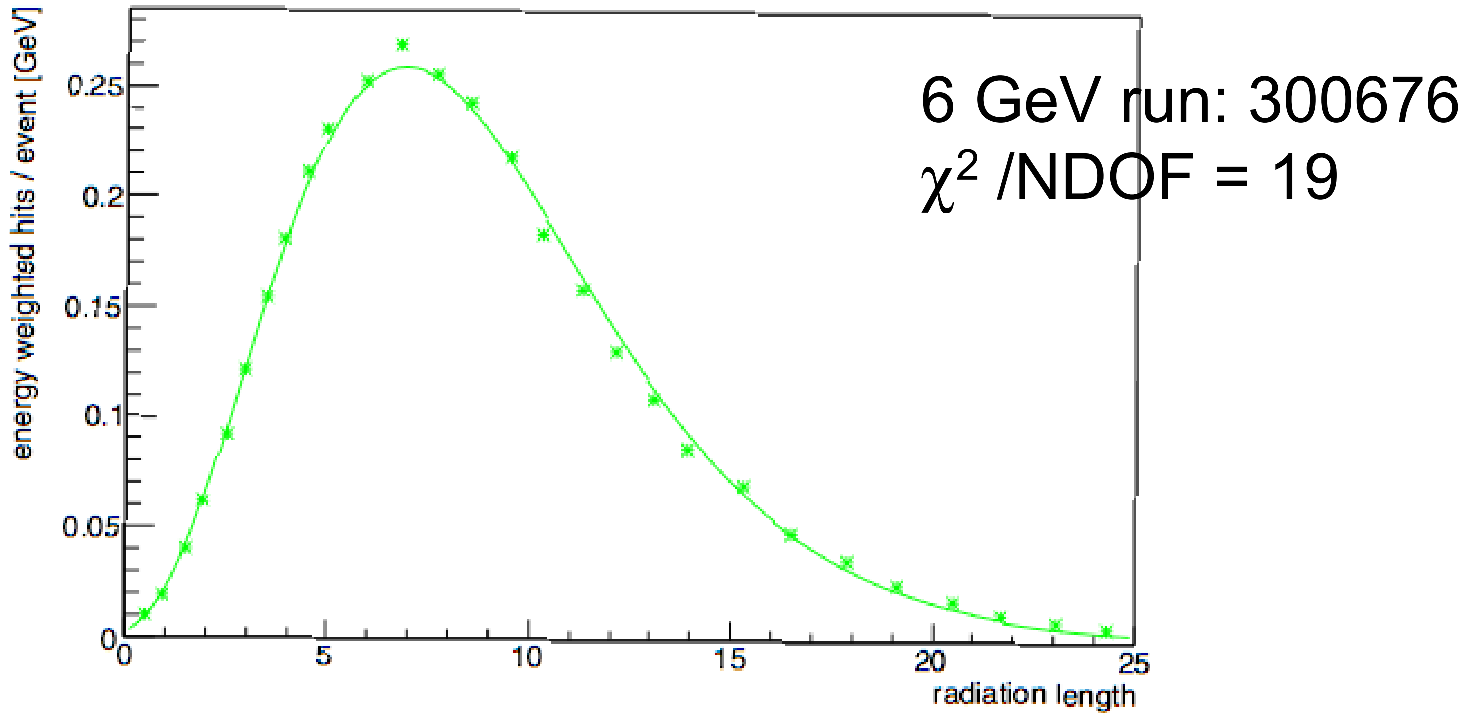
⇒ Effect on resolution not understood yet

Longitudinal shower profile



new G10 density solved disagreement between MC and data

Parameters to extract from profile



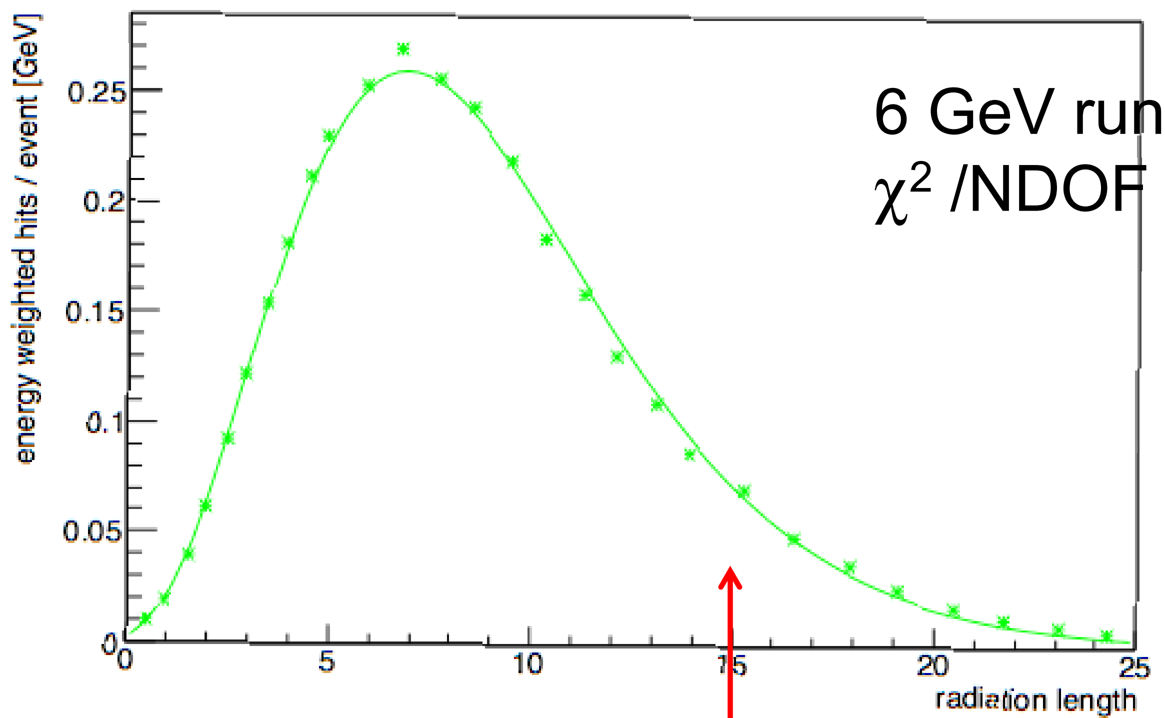
- Fitted with:

  $$f(X0) = Const.\ (X0-\beta)^{\alpha}\ \exp(-0.5\ (X0-\beta))$$

- Interesting parameters to extract:
  - leakage energy
  - shower max
  - material in front of calo β

Parameters to extract from profile

Side remark



For data of all energies this layer is always high
(checked that this is not true for MC)
⇒Could come from noise

Described in CIN-015

Some statistics

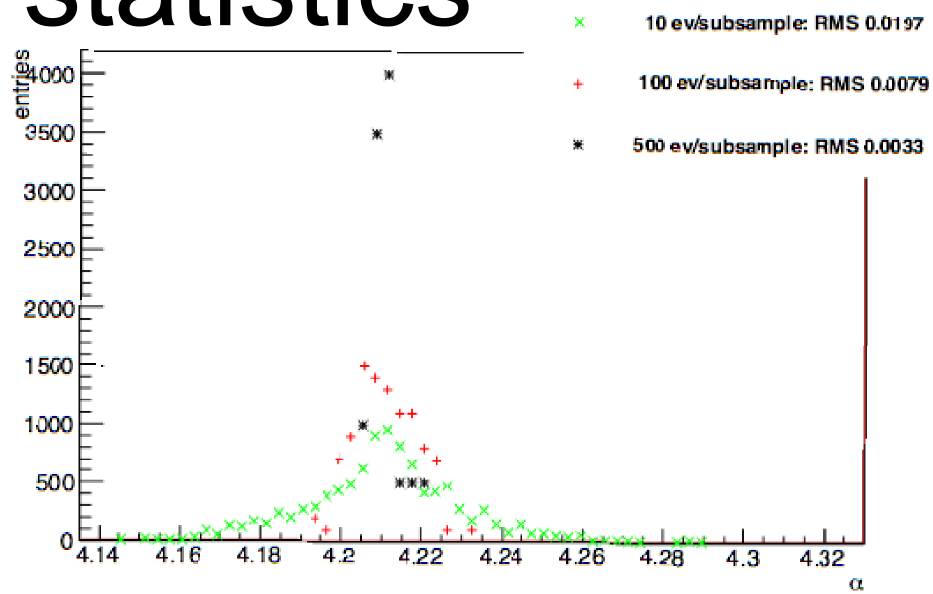
- Some of the parameters to extract from the fit are not identical with the fit parameters:
  - $E_{leakage}$ = integral from X0=26-infinity
  - Shower maximum = maximum of the distribution
- Errors on the MINUIT fit parameters not equal to errors on these parameters

⇒ Used a different method which splits the sample into subsamples to extract errors of the leakage energy and the shower maximum

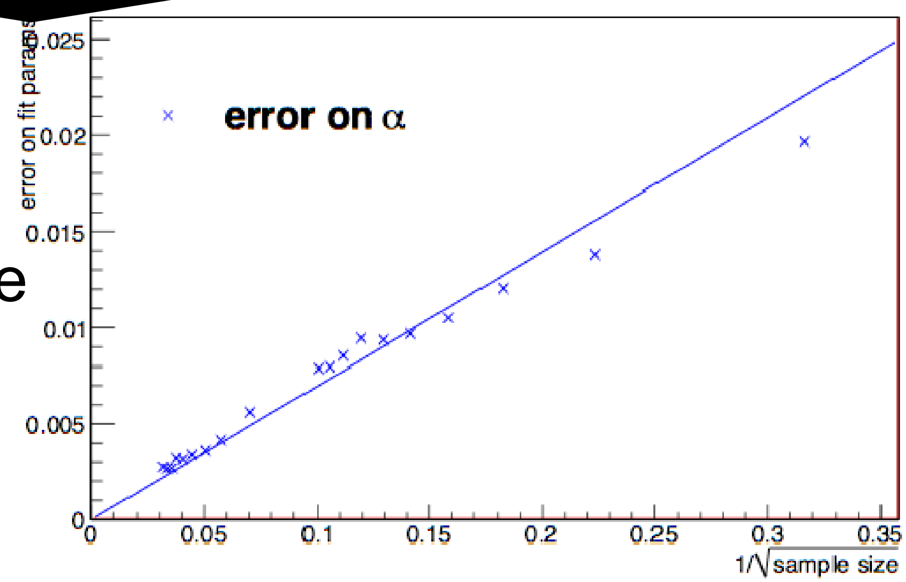
⇒ first need to show that this method works

Some statistics

- Get RMS on distribution of each fit parameter
(later of the integral..)
- Change subsample size



- Plot against subsample size



Comparison with MINUIT errors

Fit parameter	σ	σ_{MINUIT}
α	$7.0\ 10^{-4}$	$6.7\ 10^{-4}$
β	$2.90\ 10^{-4}$	$2.89\ 10^{-4}$
γ	$5.3\ 10^{-5}$	$5.1\ 10^{-5}$

- Statistical error can be extracted like this
- Systematics: $\sigma_{sys+stat}$ = const. σ_{stat}

Systematic errors …

- Effect from error on calibration:
  - 0.4% from statistical error
  - 0.5% from systematic for 99.1% of all channels

    See Anne Marie's paper
  - These errors both add up to give the systematic error which is not correlated:

$\Rightarrow \sigma_{sys\ calib} = 0.9\% / \sqrt{\text{no of cells}}$

More on systematic errors

- Statistical error on sampling fraction:
  - –Can be up to 4% for first layers due to small number of hits
    - $\Rightarrow$ create more MC for sampling fraction
  - –Usually less than 0.5%

- Small effect from
  - –Error on beam energy
    - e.g.450MeV largest uncertainty for 45GeV
  - –Rotation of the detector
  - –Error on collimator settings

Systematic error

- $\sigma_{sys+stat}$ = const. σ_{stat}
- Const. = 5 on average, depending on run
- Const. the same for all fit parameter

$\Rightarrow$ Add sys errors in following plots

χ^2 on fits

- Only after determining the errors correctly the χ^2 of the fits makes sense
- Comparison the χ^2 of data to MC:

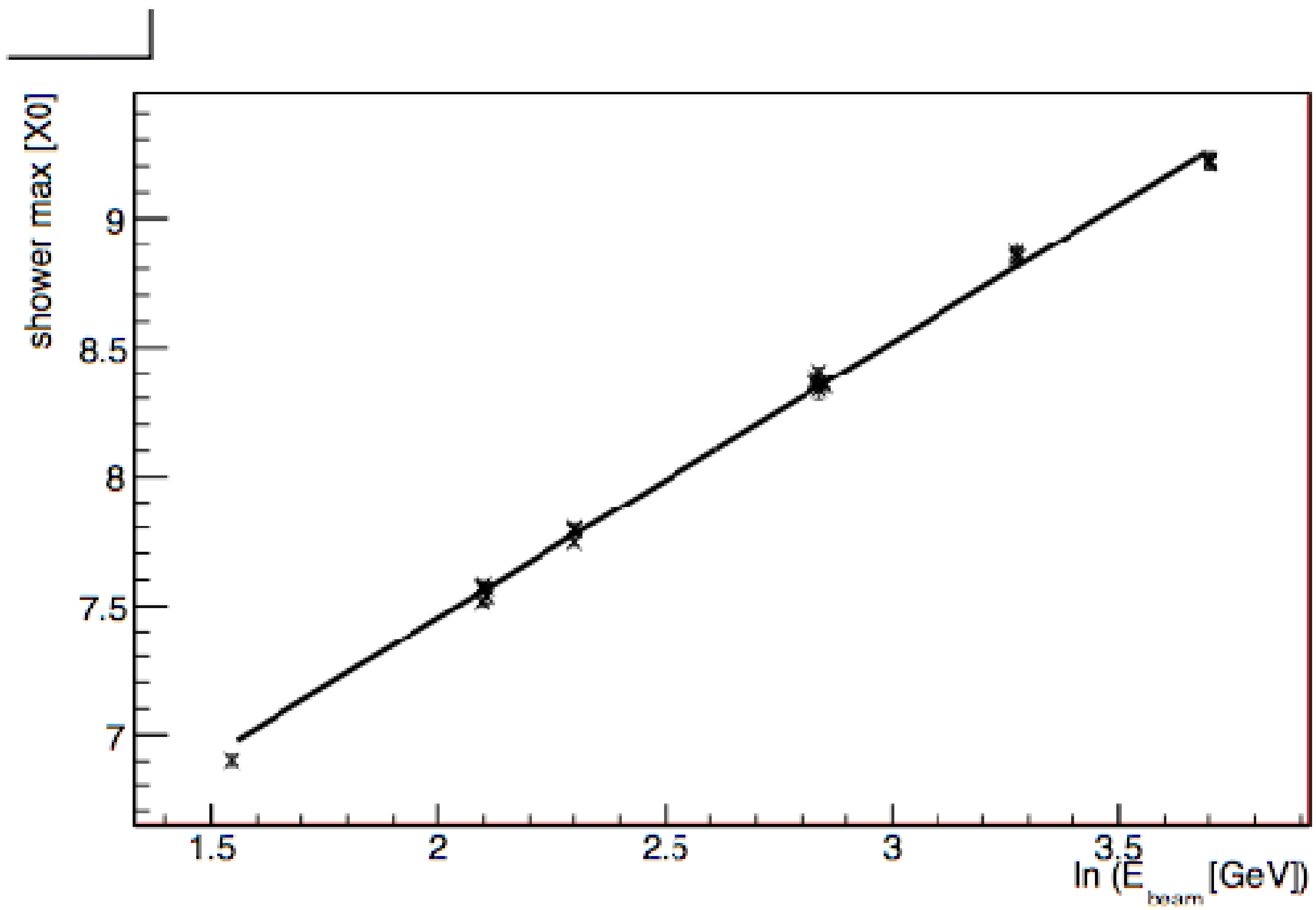
  e.g. run 300676: 19/NDOF
- Comparison the χ^2 of fit to the data:

  e.g. run 300195: 8/NDOF

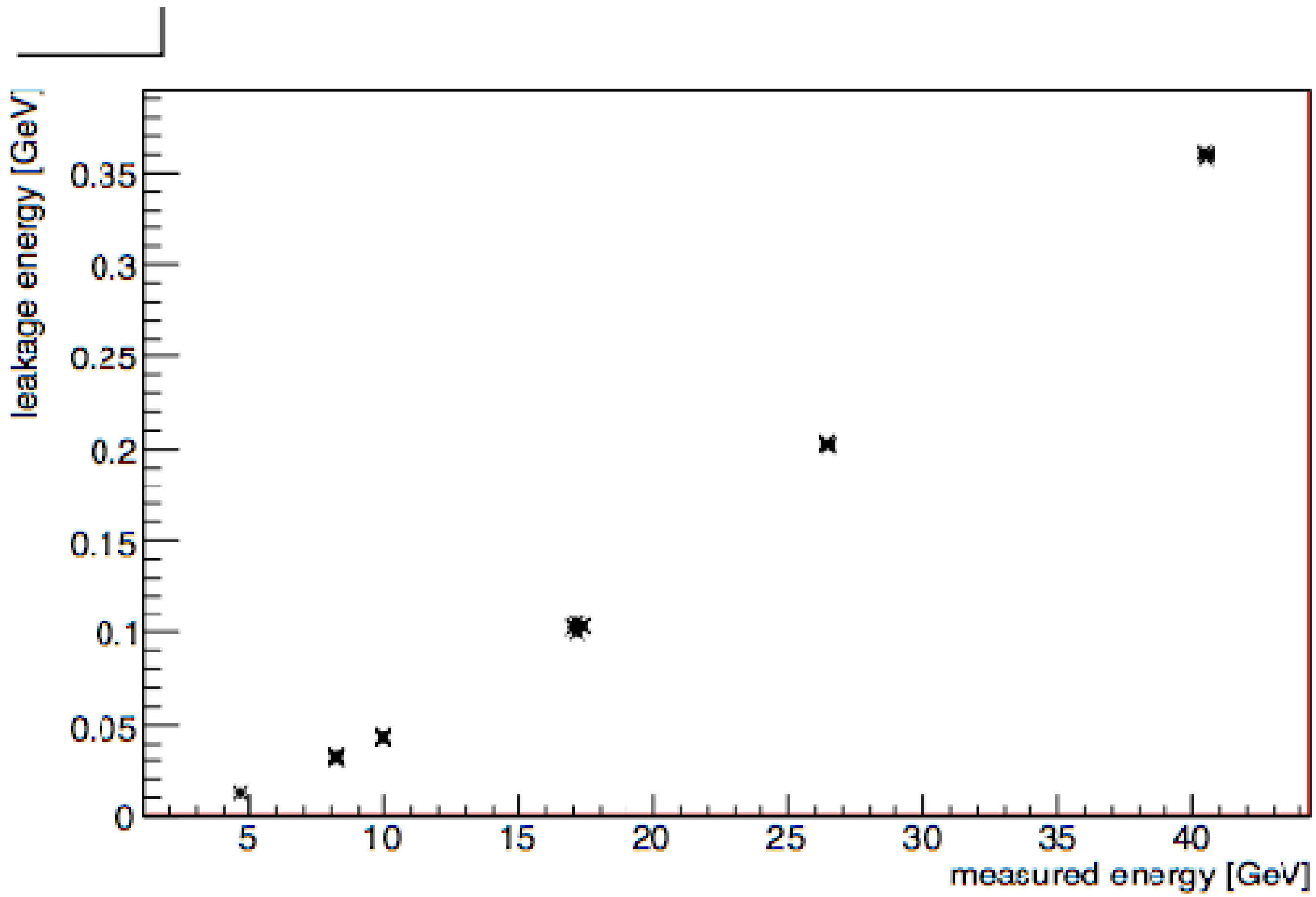
$\Rightarrow$ Close however χ^2 for fit still a bit high

$\Rightarrow$ I think I need to take noise into account (correction in MC for noise is fine, but fits can not get good χ^2 if there is too much noise)

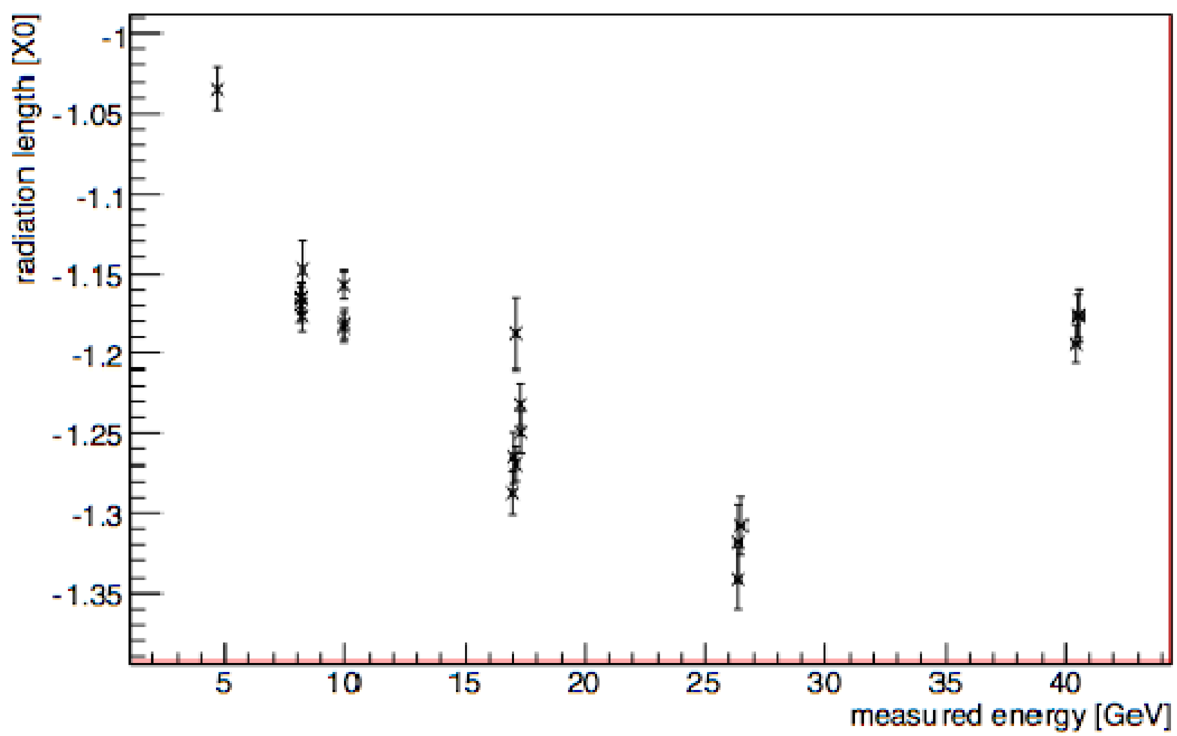
Extraction of final values: shower maximum



Extraction of final values: leakage energy



Extraction of final values: material in front of calo β



Extraction of β difficult:

- depending on estimate on error
- correlated with γ (here γ is set to 0.5)