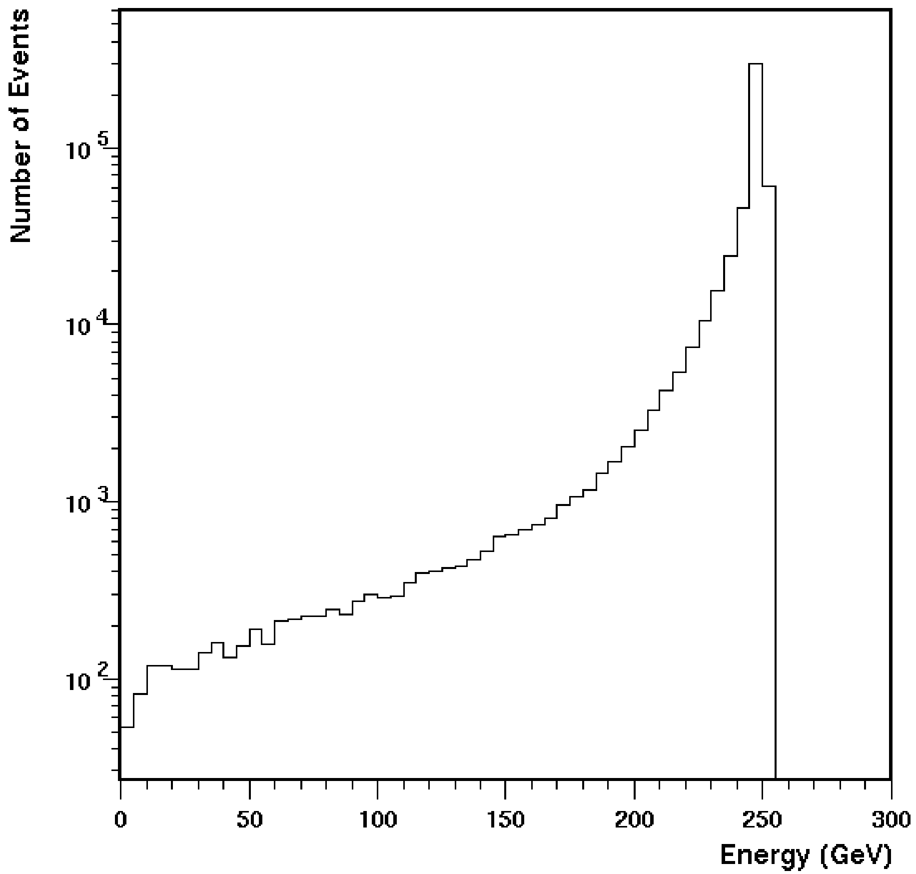
Introduction

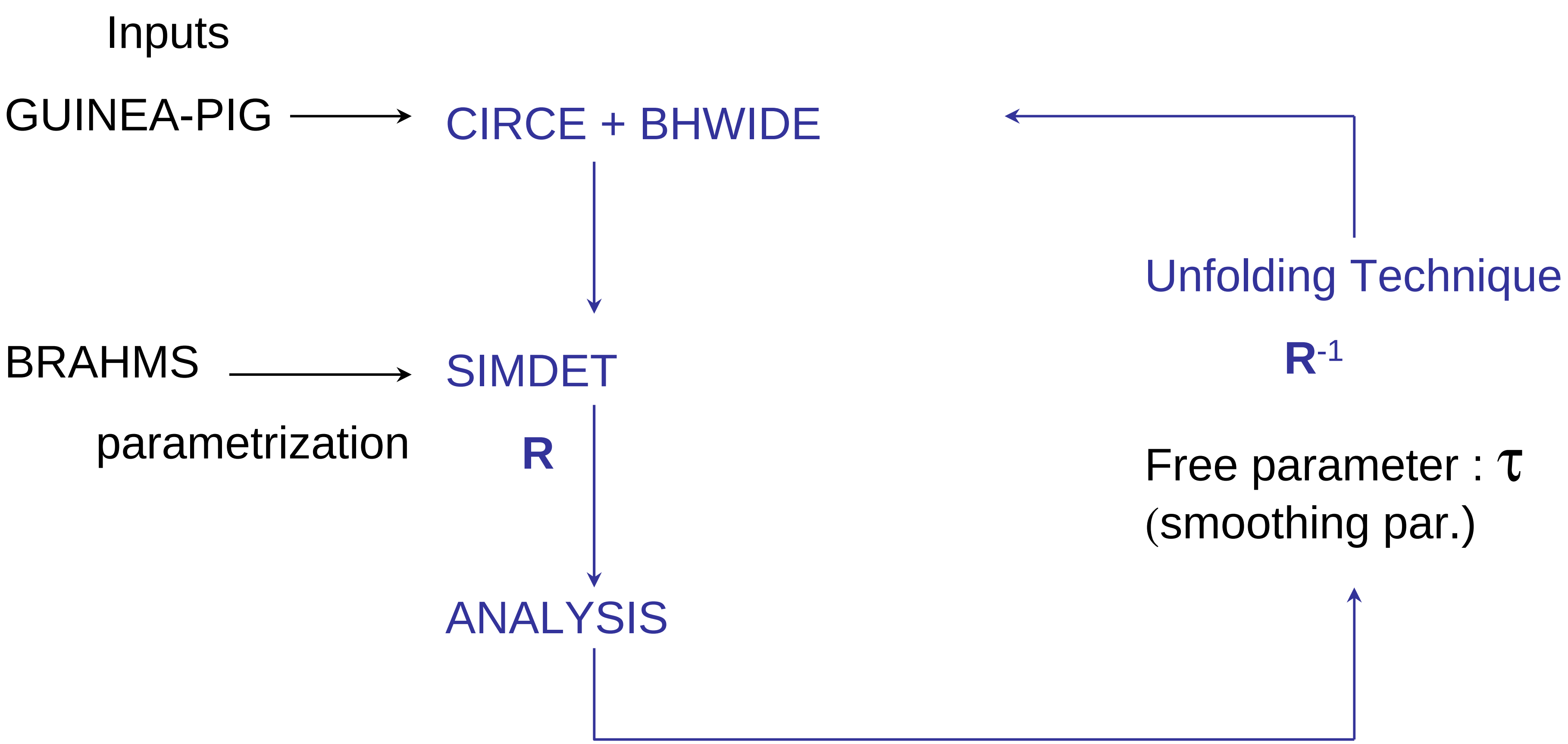
Goal: Check if the true luminosity spectrum can be obtained from Bhabha processes using the forward calorimetry by the employment of unfolding techniques.



$$\sigma_{e^+e^-}(5.4\,mrad < \theta < 83.1\,mrad) \approx 160\,000\ pb$$
$$for\ \sqrt{S} = 500\ GeV$$

Technique

Unfolding techniques using the transformation matrix of a detector for associated variables (Energies, angles,…) can be used. There are some packages such as GURU/ RUN.



More explanation

- For the present study GURU is used

“SVD approach to data unfolding”, Andreas Hoeker and Vakhlang Kartvelishvili.MC-TH-95/15

The unfolding is based on:

Measured data

Unknown initial vector (eg true energy spectrum)

$$(R.\grave{u} - b)^T (R.\grave{u} - b) + tau\, (C.\grave{u})^T C.\, \grave{u} = min$$

Small diagonal element

Smoothing term (stabilisation term)

Response matrix
(Energy smearing of detector)

If tau = 0 --> no smoothing big variation in the resulting unfolding

If tau= big --> flat result

Need of This Technique

Response matrix of a detector which requires precise parameterization.

For forward calorimetry(LCAL/LAT) parametrization is under way (W. Lohmann *et al*.) with and without background and is being included in SIMDET.

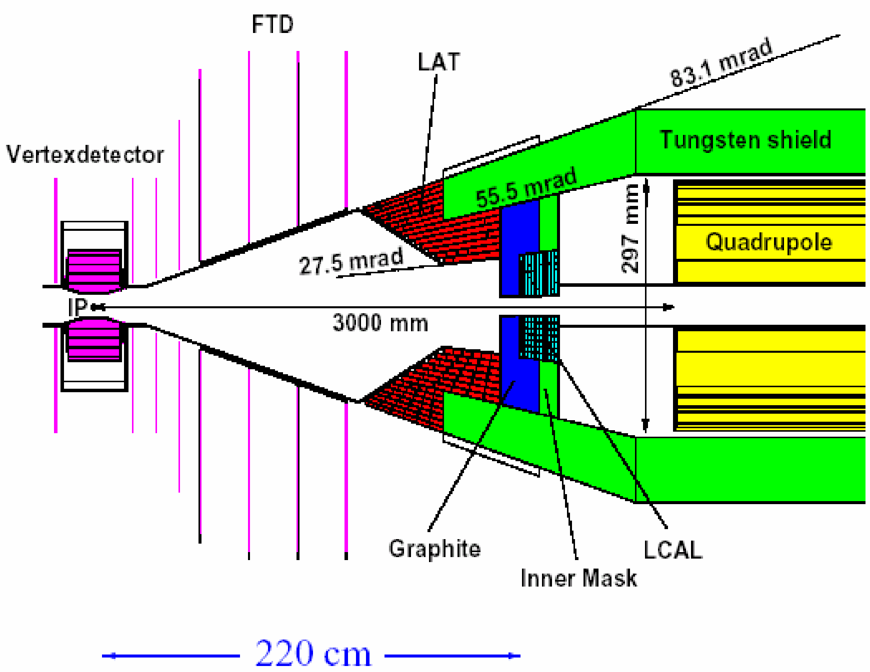
Energy resolution of calorimeter described as quadratic addition:

$$\frac{\sigma_E}{E} = \sqrt{\left(\frac{a}{\sqrt{E}}\right)^2 + b^2}$$

a: stochastic term

b: constant term

LAT (from TDR updated)
a=0.1
b=0.01
θ_{min} = 27.5 mrad
θ_{max}= 83.1 mrad



LCAL (updated to paramet.)

A and b as in the following slide, dependant on θ
θ_{min} = 5.4 mrad
θ_{max}= 30 mrad

Parametrization & Matrix

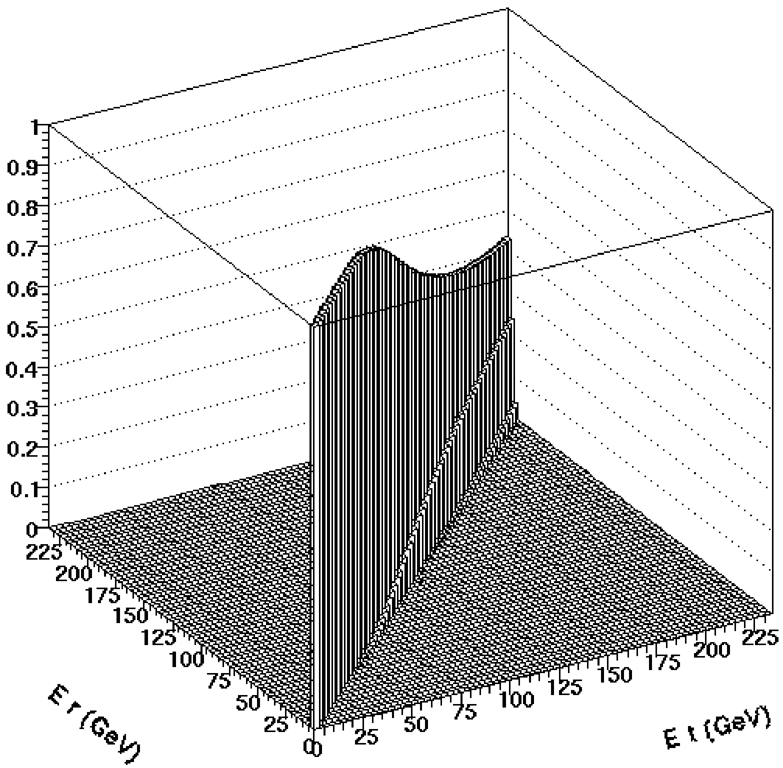
2 examples for unfolding:

LCAL Parametrization of energy (preliminary),

LAT Matrix of considered variables

LAT matrix (R) from TDR

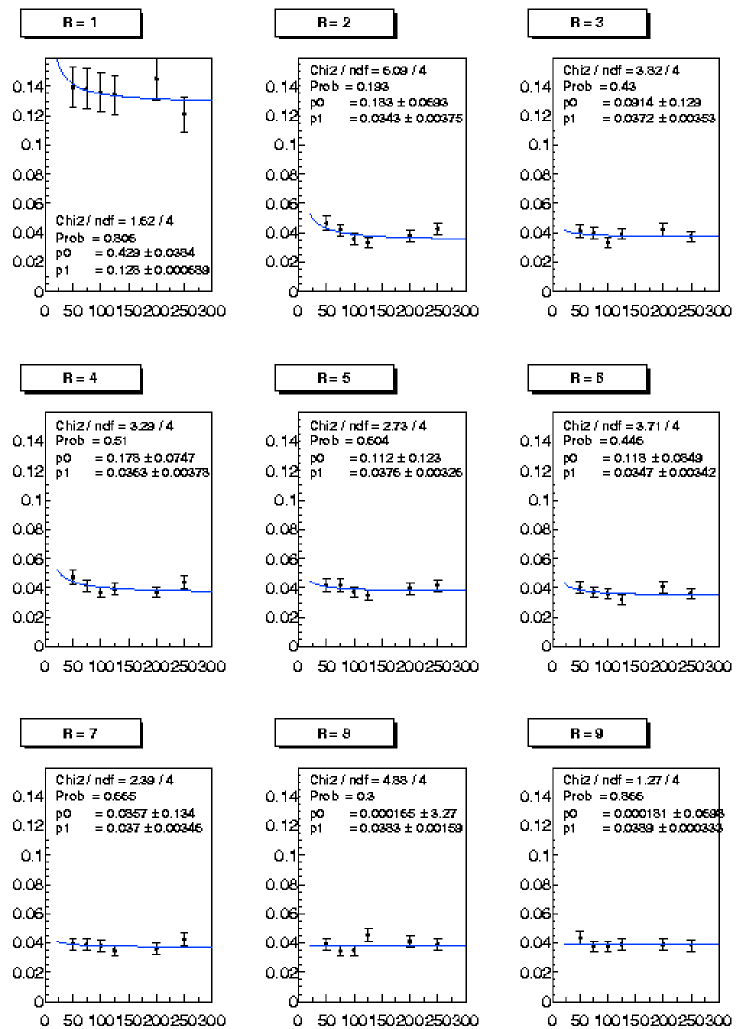
(R.ù – b)^T (R.ù – b) + tau (C.ù)^T C. ù = min



$E_{reconstruction}$ vs E_{true}

Efficiency = 100%

LCAL parameterization (k. kuznetsova)



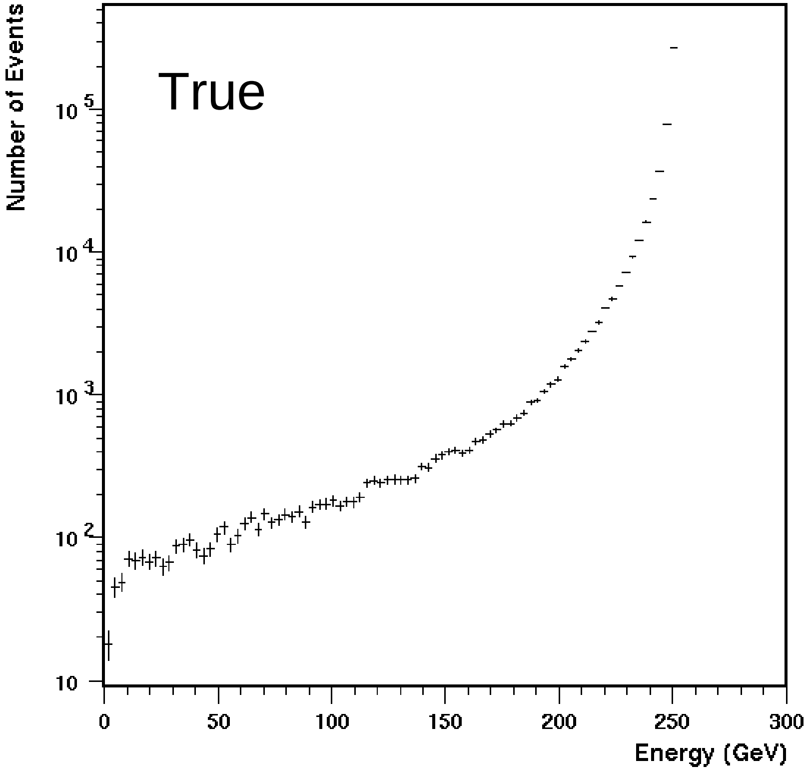
Unfolding with LAT

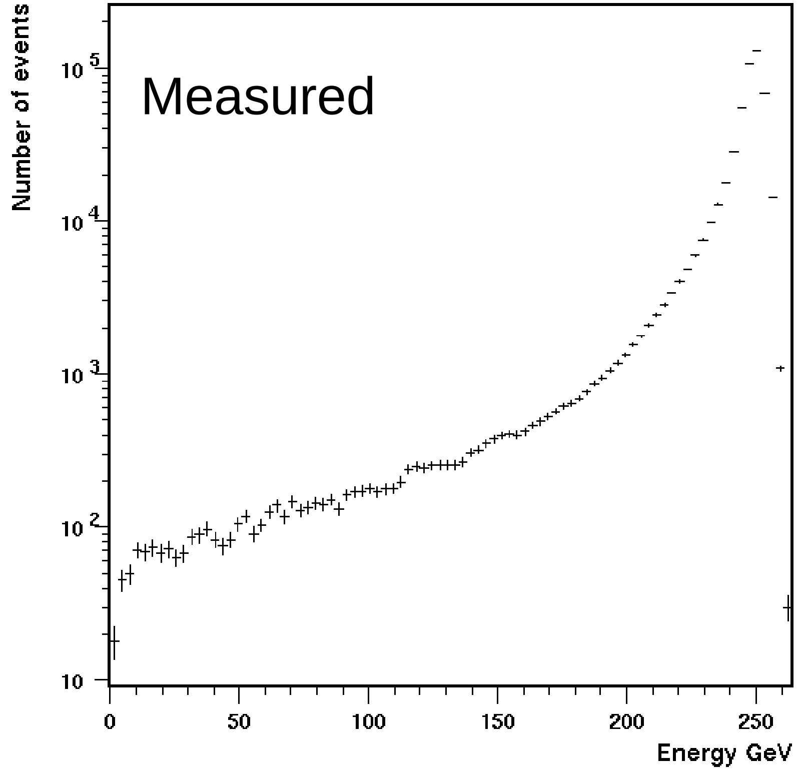
Lower statistic than LCAL (30 times),
Better resolution,
Less background.

Integrated luminosity: 2.5 fb^{-1} at $\sqrt{S} = 500\ GeV$

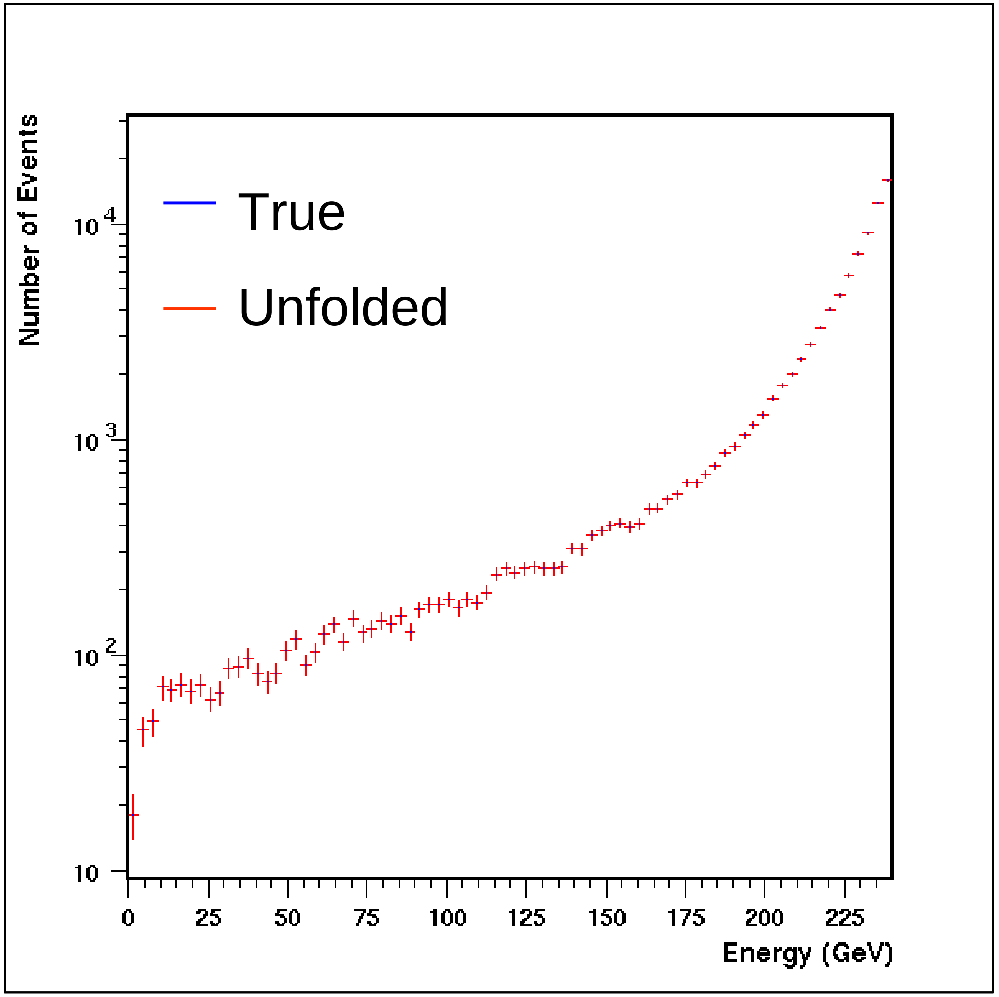
True distribution from CIRCE 1.0
+ BHWIDE 1.04

Beamstrahlung + ISR included

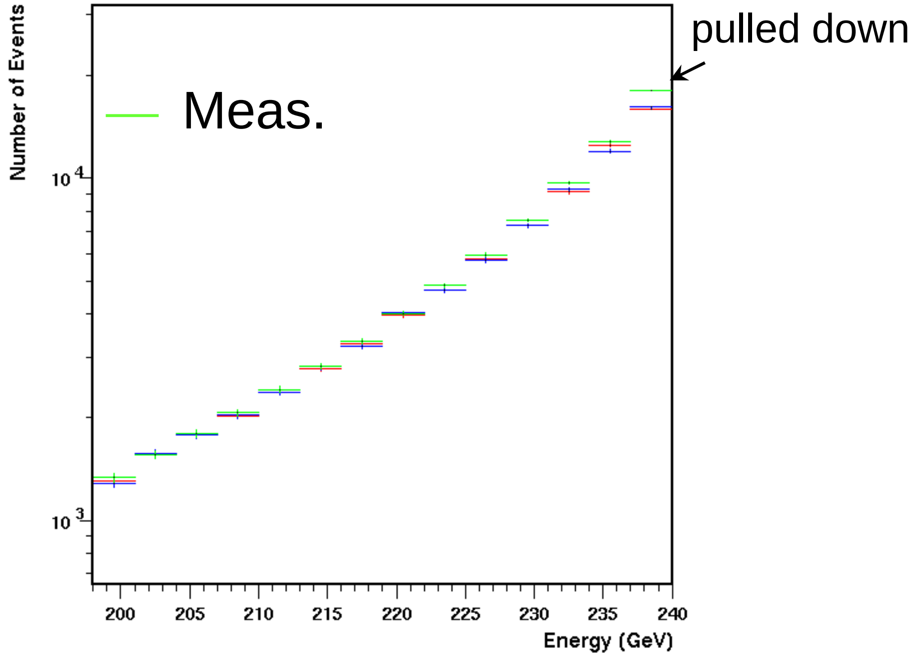




Unfolding (cont'd)



$$\chi^2 = \sum_{i=bin\#} \frac{(x^i_{unf} - x^i_{true})^2}{\left|x^i_{true}\right|}$$



Works if we constrain our study up to 240 GeV:

$$\chi^2 = 0.135 \quad for \quad \tau = 0.399\ 10^{-6}$$

Unfolding does not work if we ask up to 250 GeV!!

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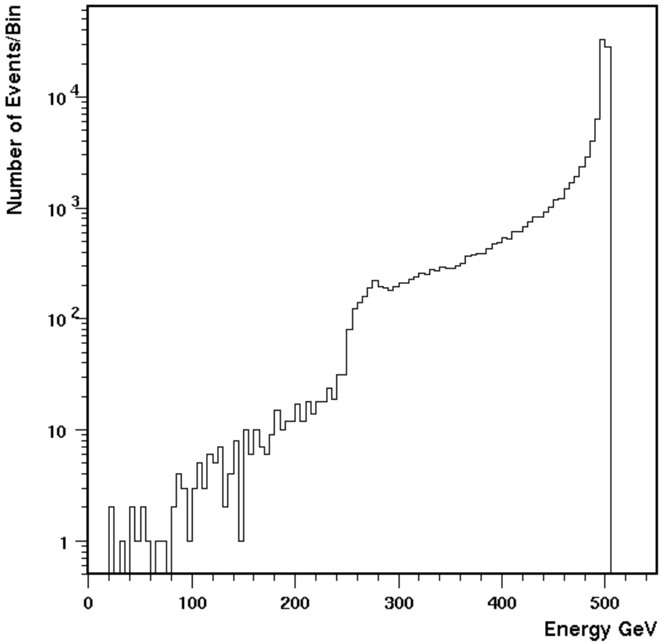
Present Work

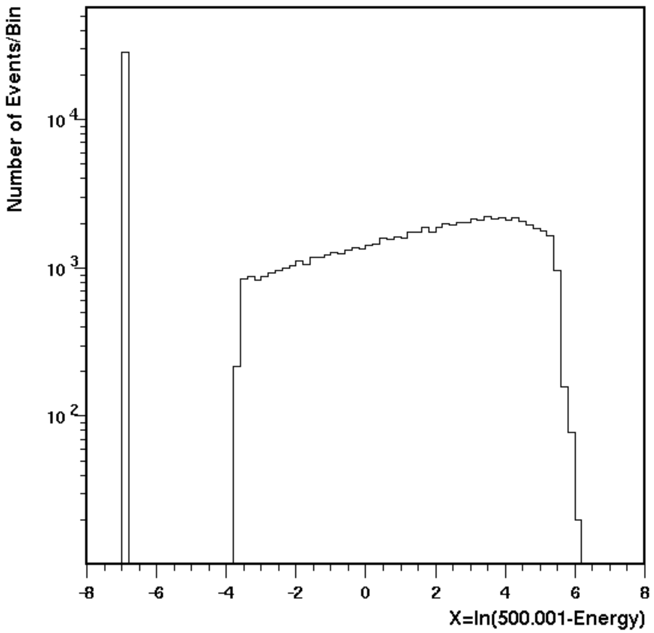
A method to deal with the difficulties to unfold as close as possible to the highest energies is to smooth the energy spectrum

Smoothing function (Later): x=ln (250.01- beam energy)

True energy spectrum

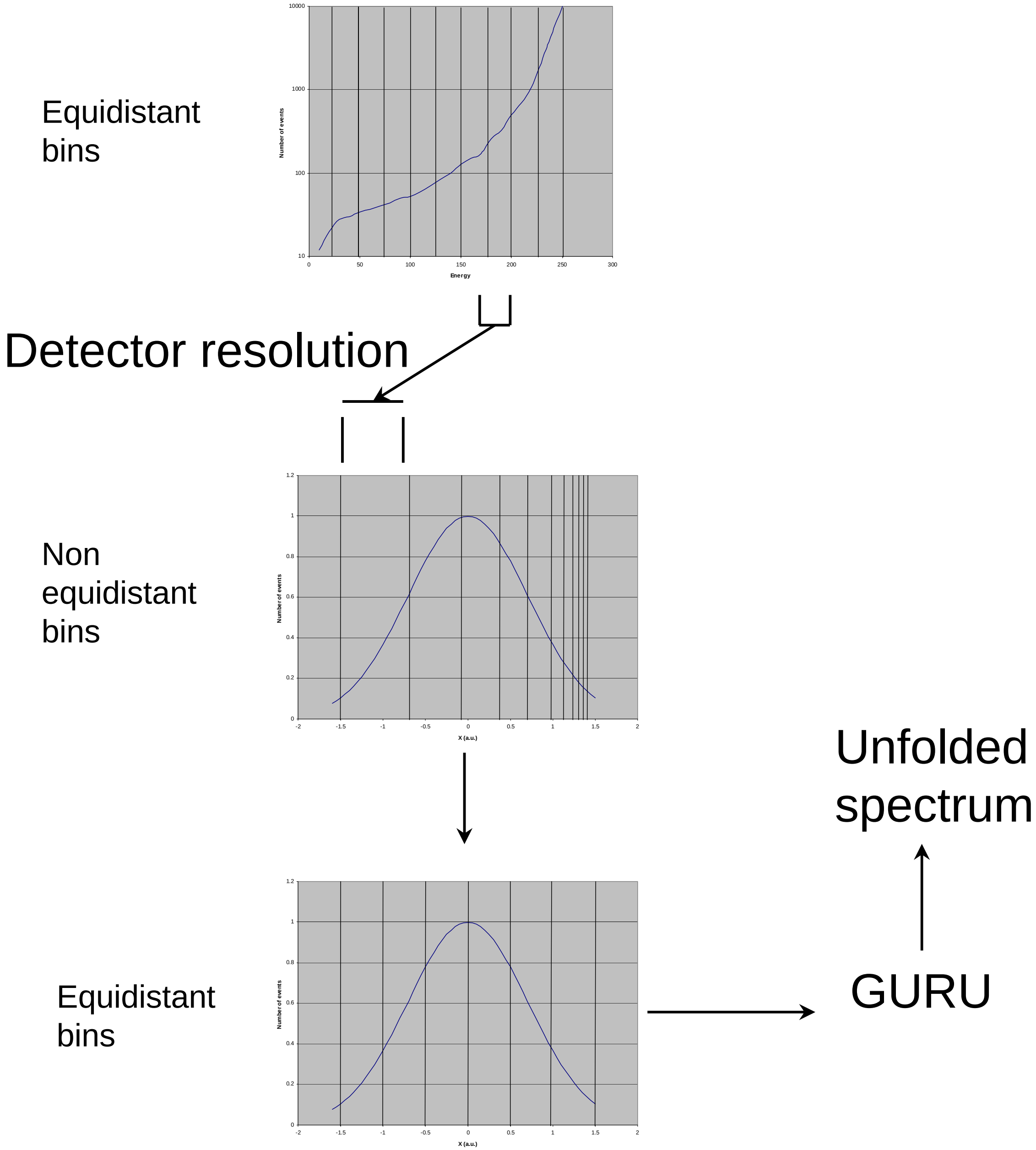


Smoothed true spectrum



With isr only.

The New Technique



The **measured spectrum** is first **smoothed**.

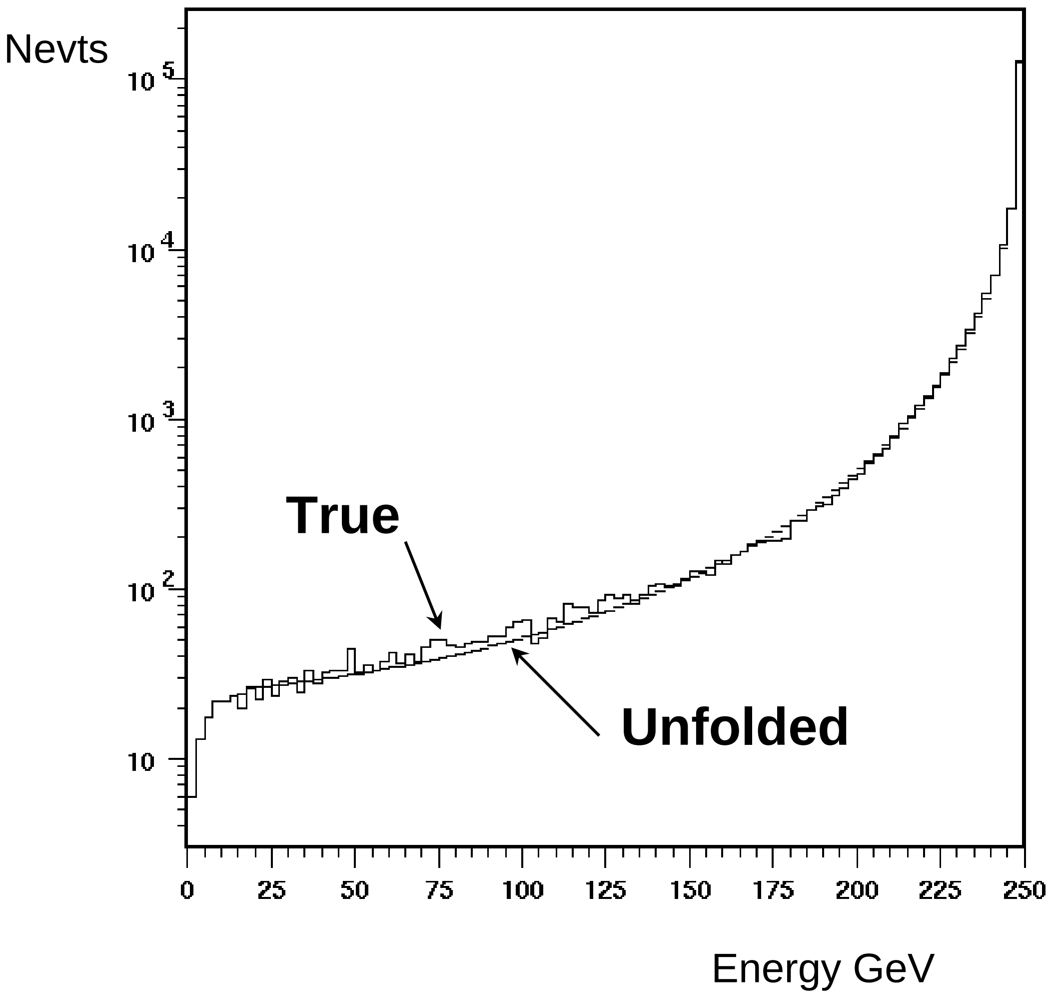
The number of events found within one bin is kept and reported to the smoothed spectrum.

Then a fitting using **polynomial spline** is performed to get the number of events within equidistant bins.

This is used then by GURU (needs equidistant bins)

The unfolded energy distribution is obtained by inverting the method.

Results



Mean E_{true} = 241.1 GeV

± → Needs several iterations

Mean E_{unf} = 241.3 GeV

Tau = 0.00475

Chi^2 = 287 !!!

Error on each bin from error propagation calculated with covariance matrix provided by GURU

Unfolding can be pushed via this method, to much higher energy.

Future plan

- Result Looks promising

- need to extend the study
- i.e. include Beamspread, jitter
- Explore a wider theta range (LCAL to LAT?),
- Check this unfolding method helps to distinguish between different beamstrahlung conditions.
- Need to optimise the smoothing parameter (tau).