# STUDYING THE CHARACTERISTICS OF THE FORWARD CALORIMETER

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CMS Group Meeting | DESY, Zeuthen | August, 15th 2013

# Goal

- Find energy resolution of BeamCal
- Find spatial resolution of BeamCal

# Plan

Find deposited energy from single high energy electron

↓

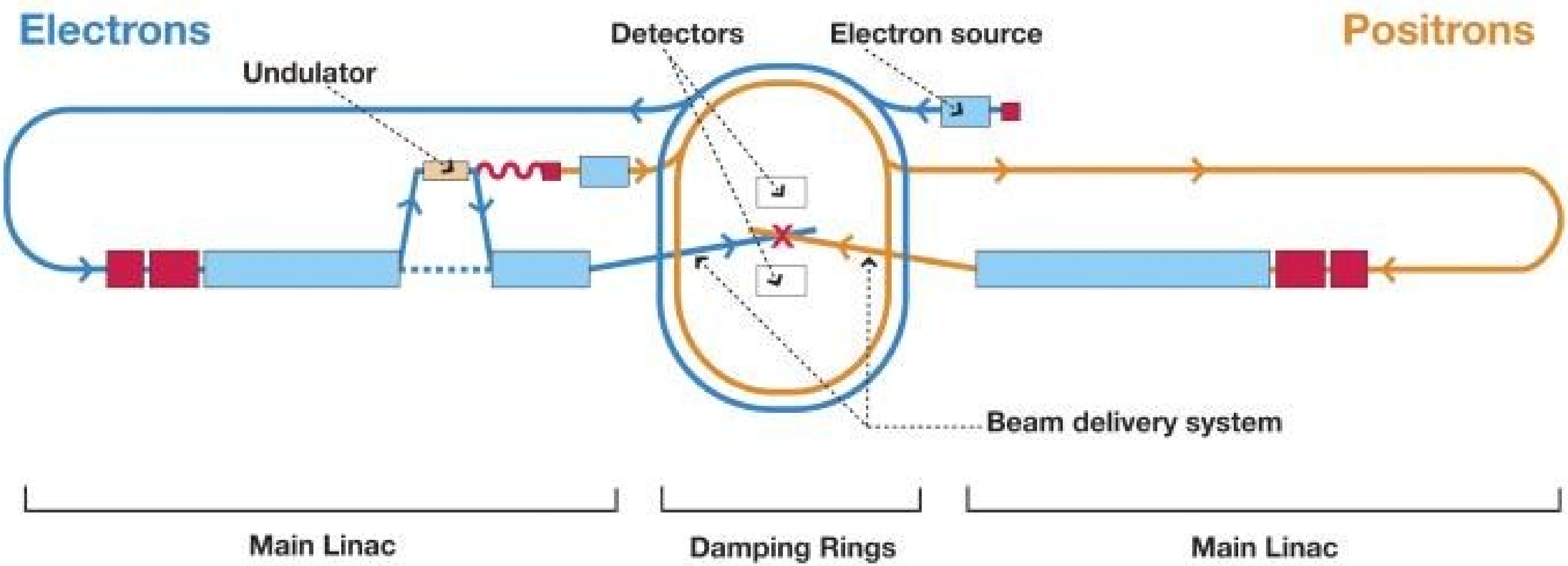
Standard Deviation and average deposited energy

↓

Energy Resolution

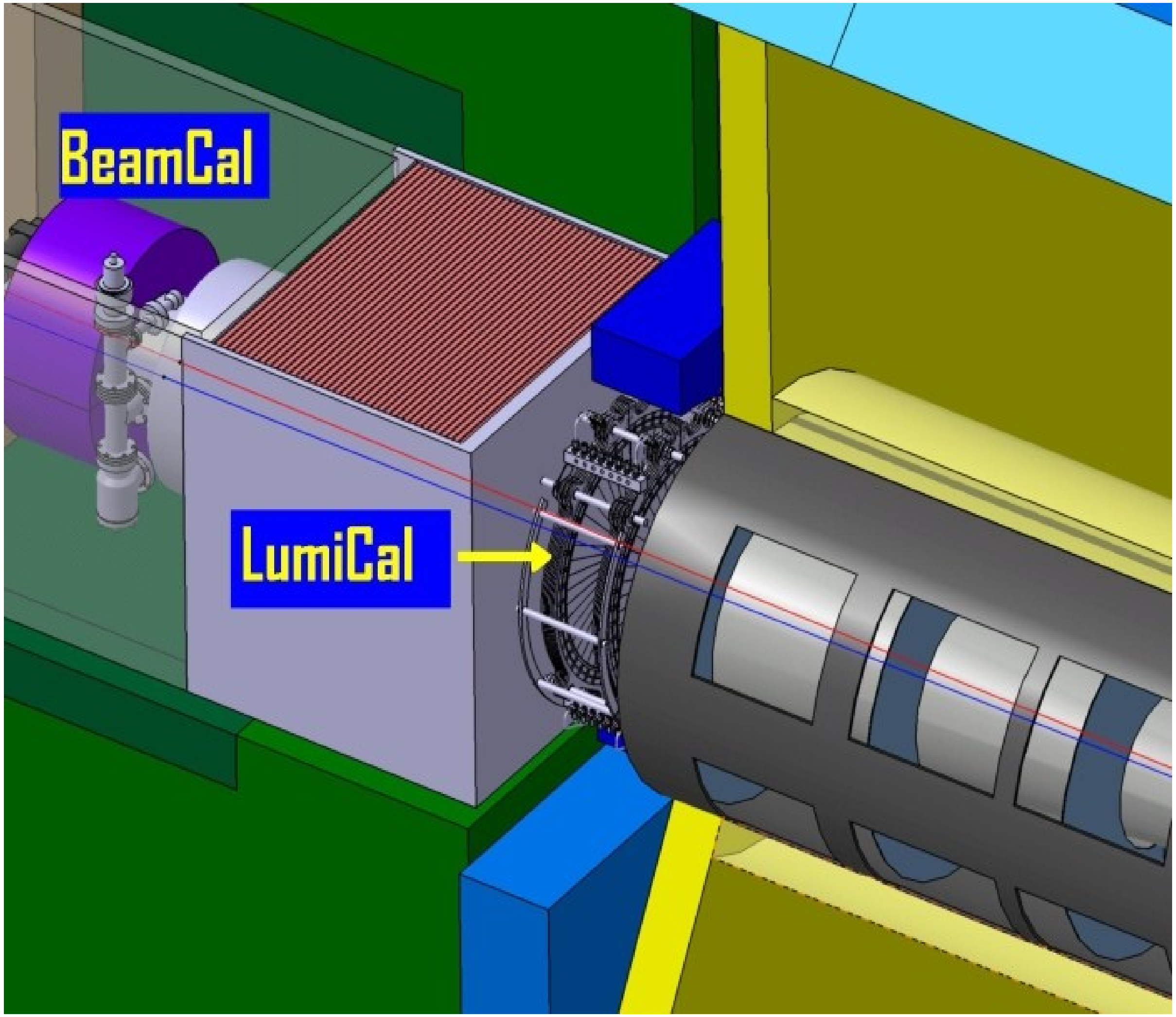
Spatial Resolution

# ILC




www.desy.de

# Forward Calorimeter

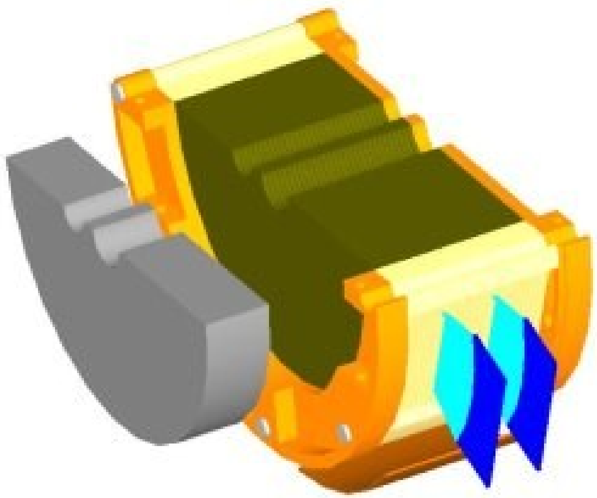



- BeamCal
- LumiCal
- Pair monitor

http://fcal.desy.de/

# BeamCal

- Measure energy deposition from single high energy electron on  top of background
- Assist beam tuning
- Protect inner part of detector



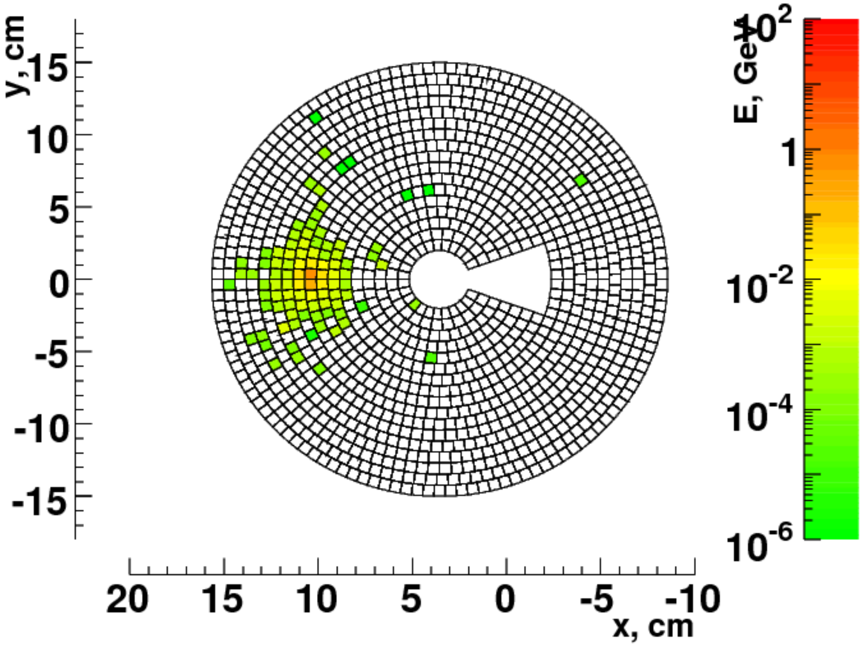
http://fcal.desy.de

# Simulation

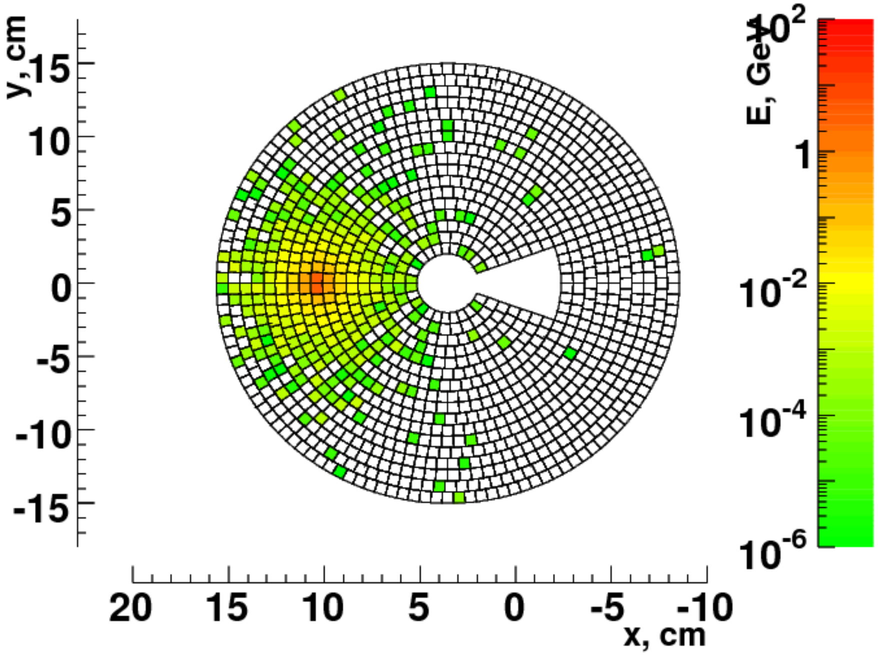
- Simulated energy deposition
  - Sent 200 times electron with energy 50 GeV
  - 100 GeV
  - 200 GeV
  - 300 GeV
  - 400 GeV
  - and 500 GeV to calorimeter

# Examples of Energy deposition by simulation

50GeV




500GeV

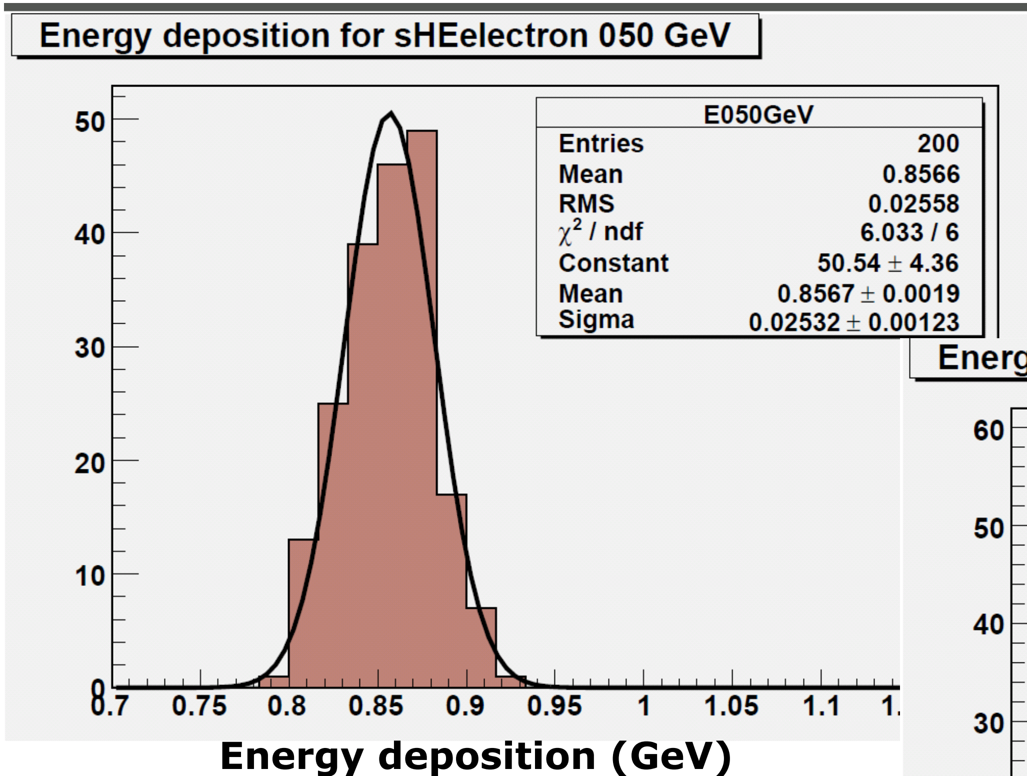


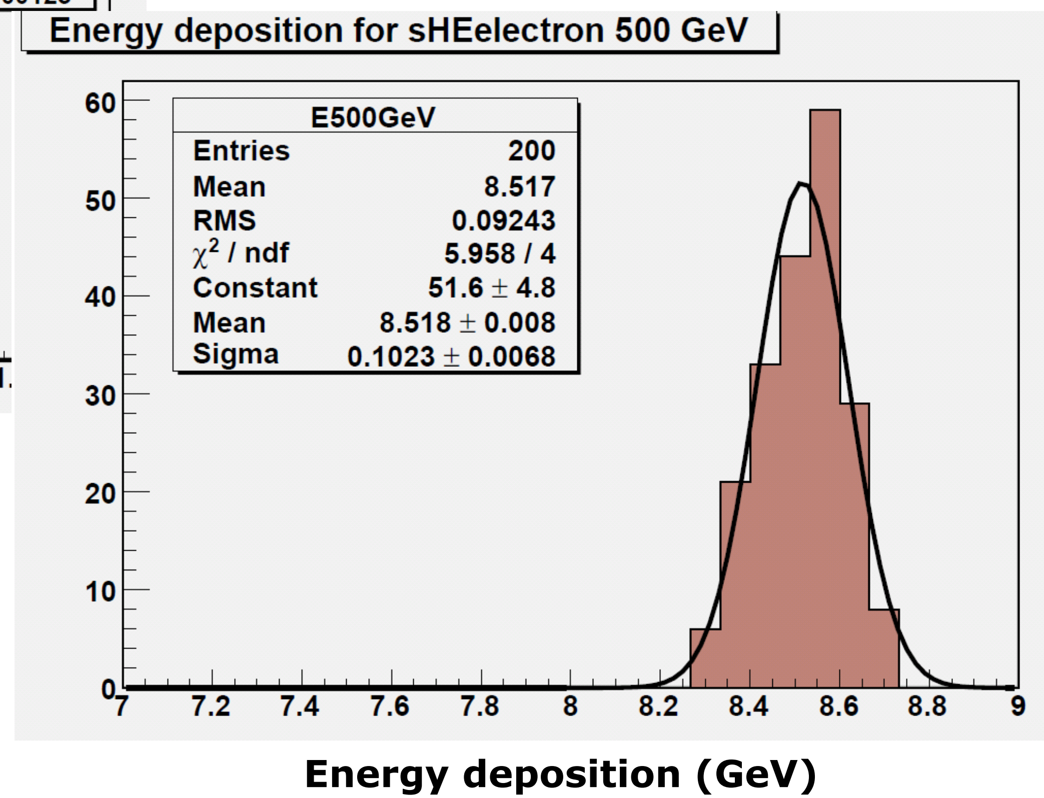
# Processing

- Created energy deposition histograms from simulation data
- Fitted these histograms with gauss function
- Found average deposited energy
- Found standard deviation
- Calculated energy resolution
- Plotted energy resolution vs energy of electron
- Fitted the plot and got parameters

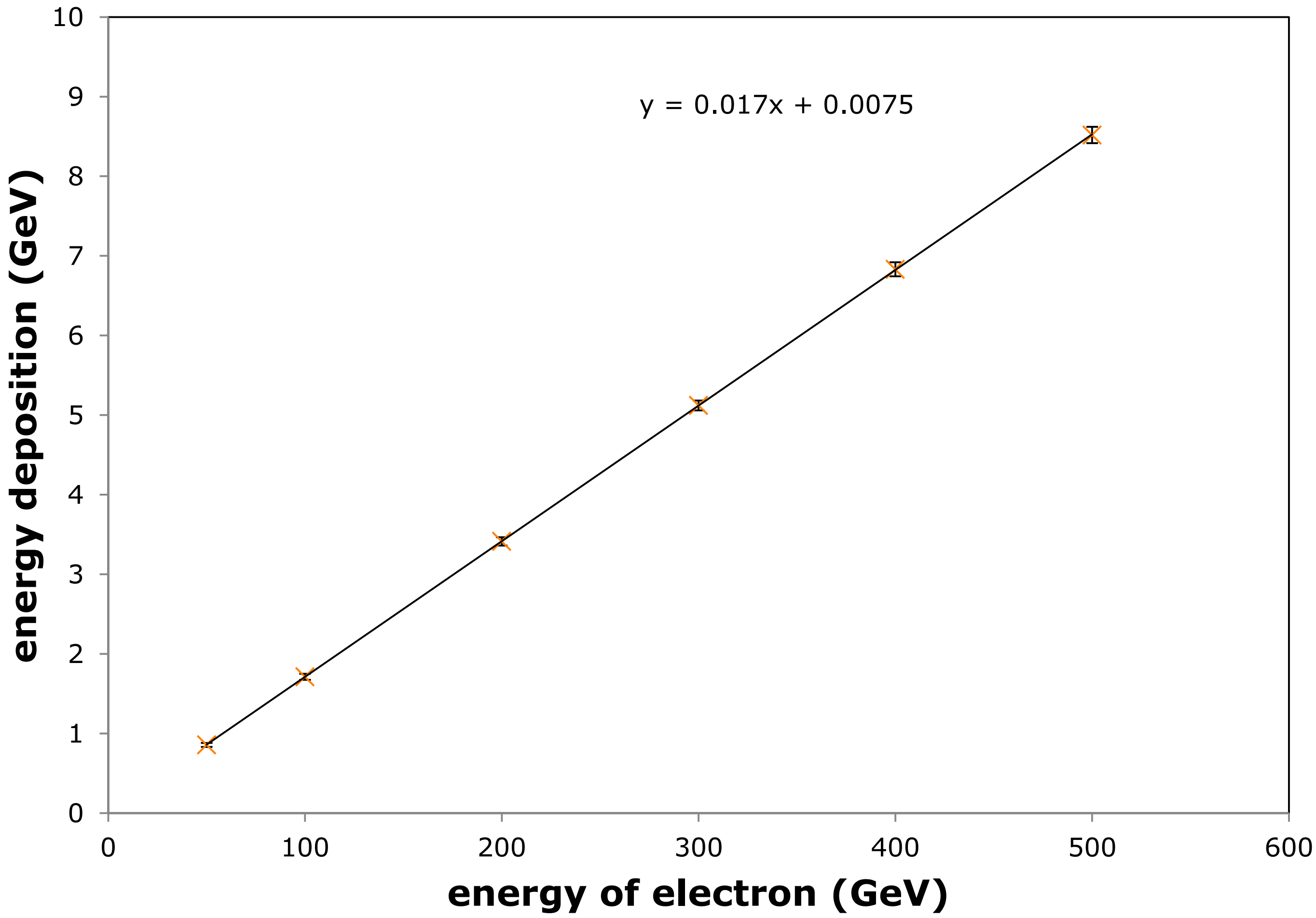
# Examples of Histograms

energy deposition from simulation



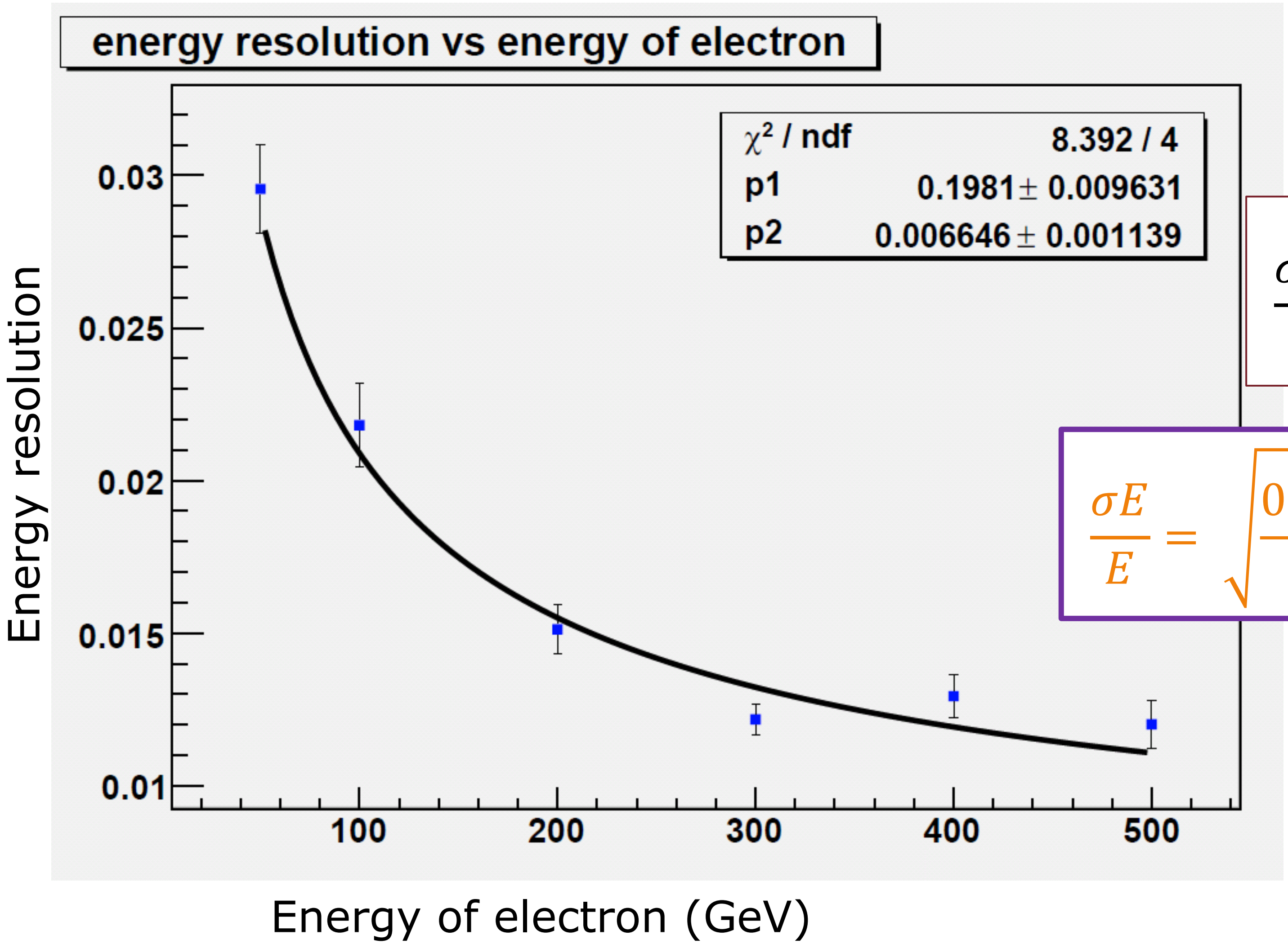



# Deposited energy versus energy of electron




$$E = 58.82 * E_{dep} - 0.44$$

# Plot energy resolution versus energy of electron




$$\frac{\sigma E}{E} = \sqrt{\frac{{p_1}^2}{E} + {p_2}^2}$$

$$\frac{\sigma E}{E} = \sqrt{\frac{0.1981^2}{E} + 0.006646^2}$$

# Conclusion

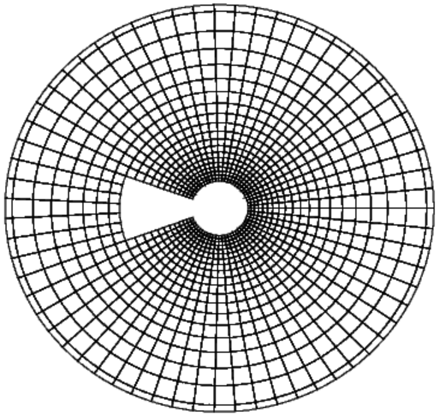
## Have done

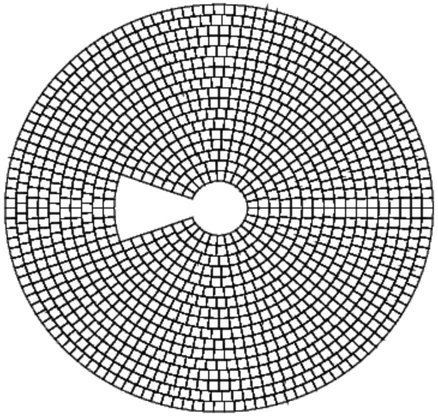
- Studied Linux
- Reviewed FCAL
- Studied data from supervisor
- Planed to get result
- Learned how to write shell script
- Simulated single high energy electron
- Found standard deviation
- Plotted energy resolution versus energy of electron
- Fitted this plot and found parameters $p_1$ and $p_2$

$$\frac{\sigma E}{E} = \sqrt{\frac{{p_1}^2}{E} + {p_2}^2}$$

## To do

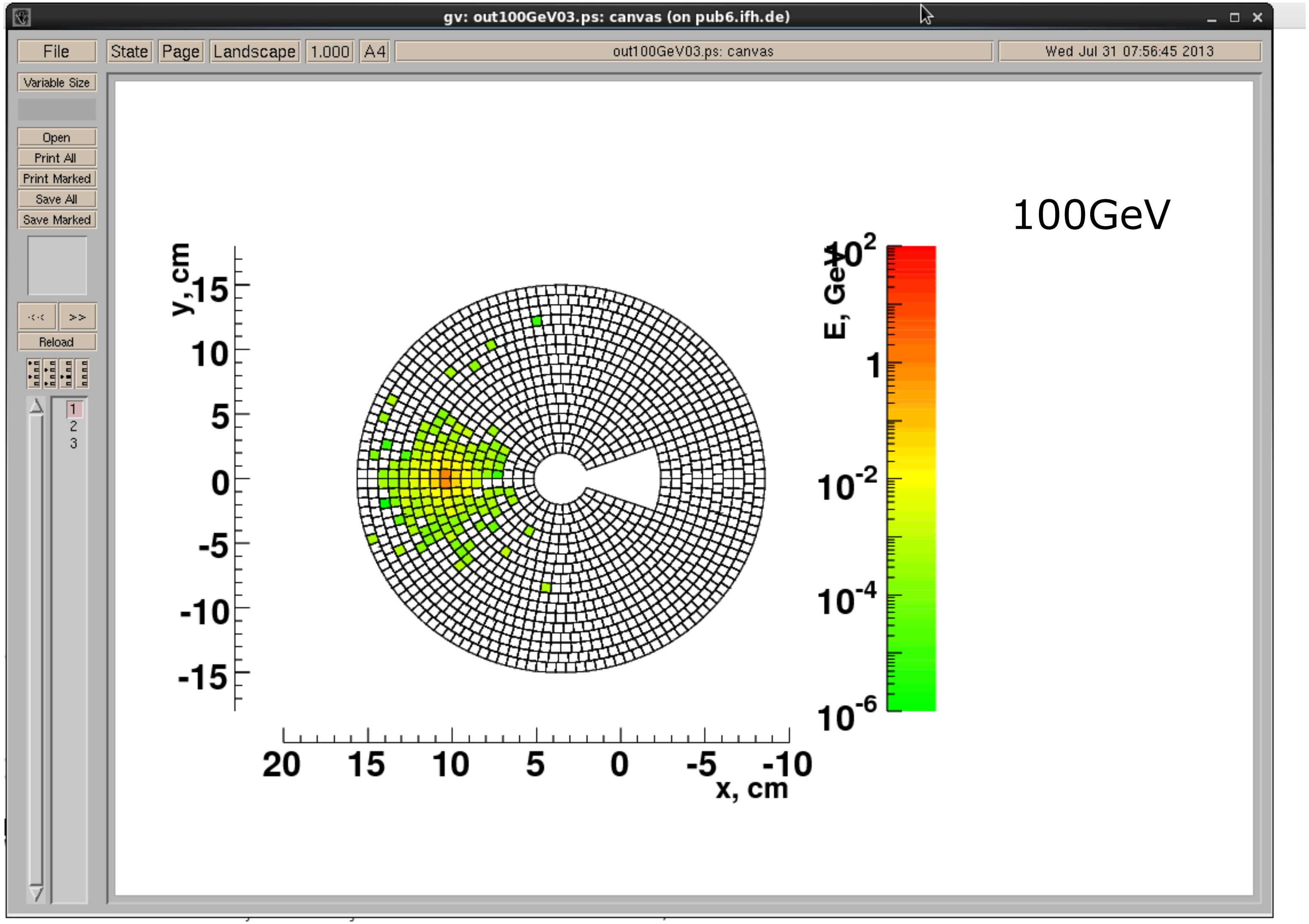
- Find spatial resolution





Thank you

# Energy deposition by simulation



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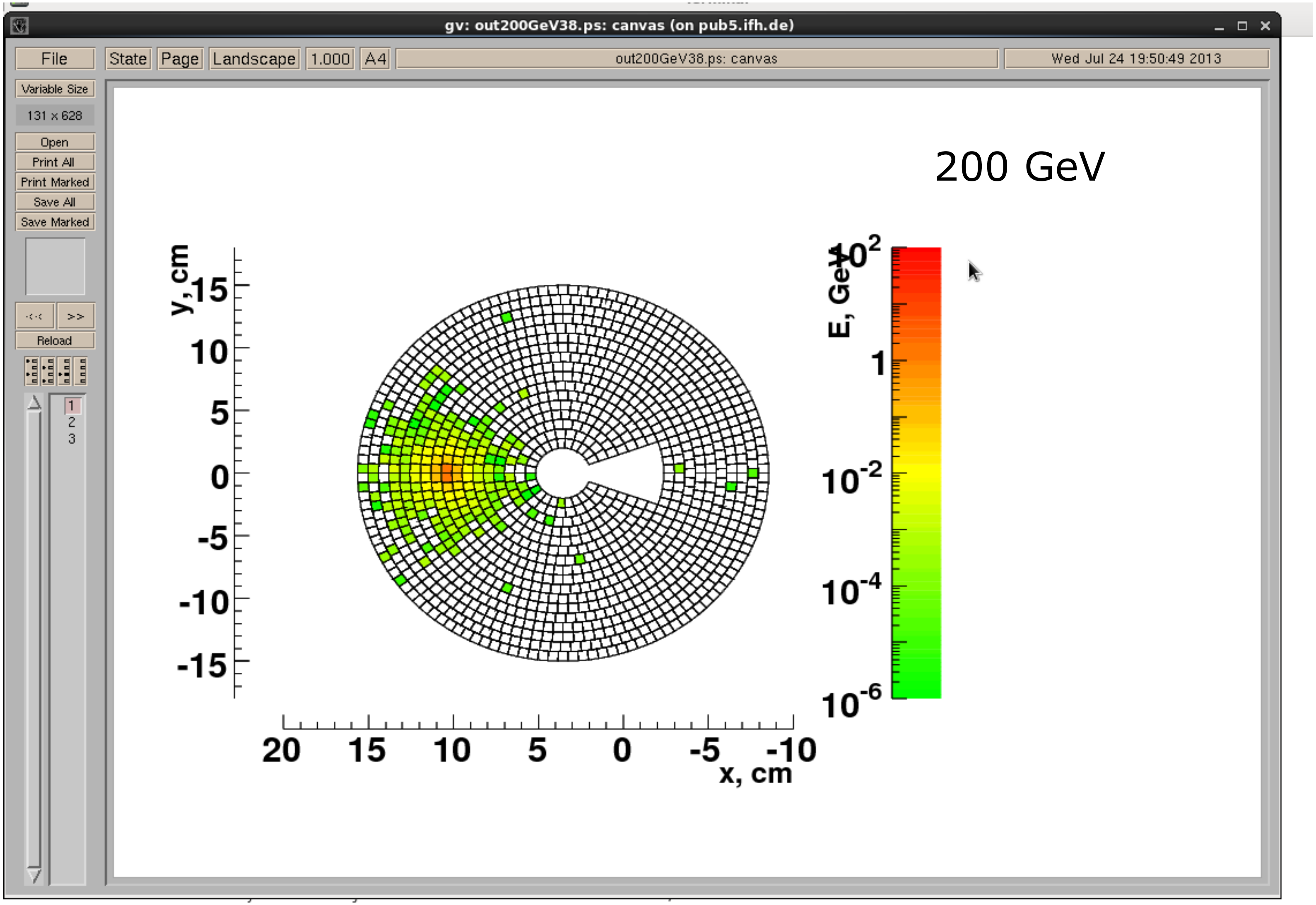

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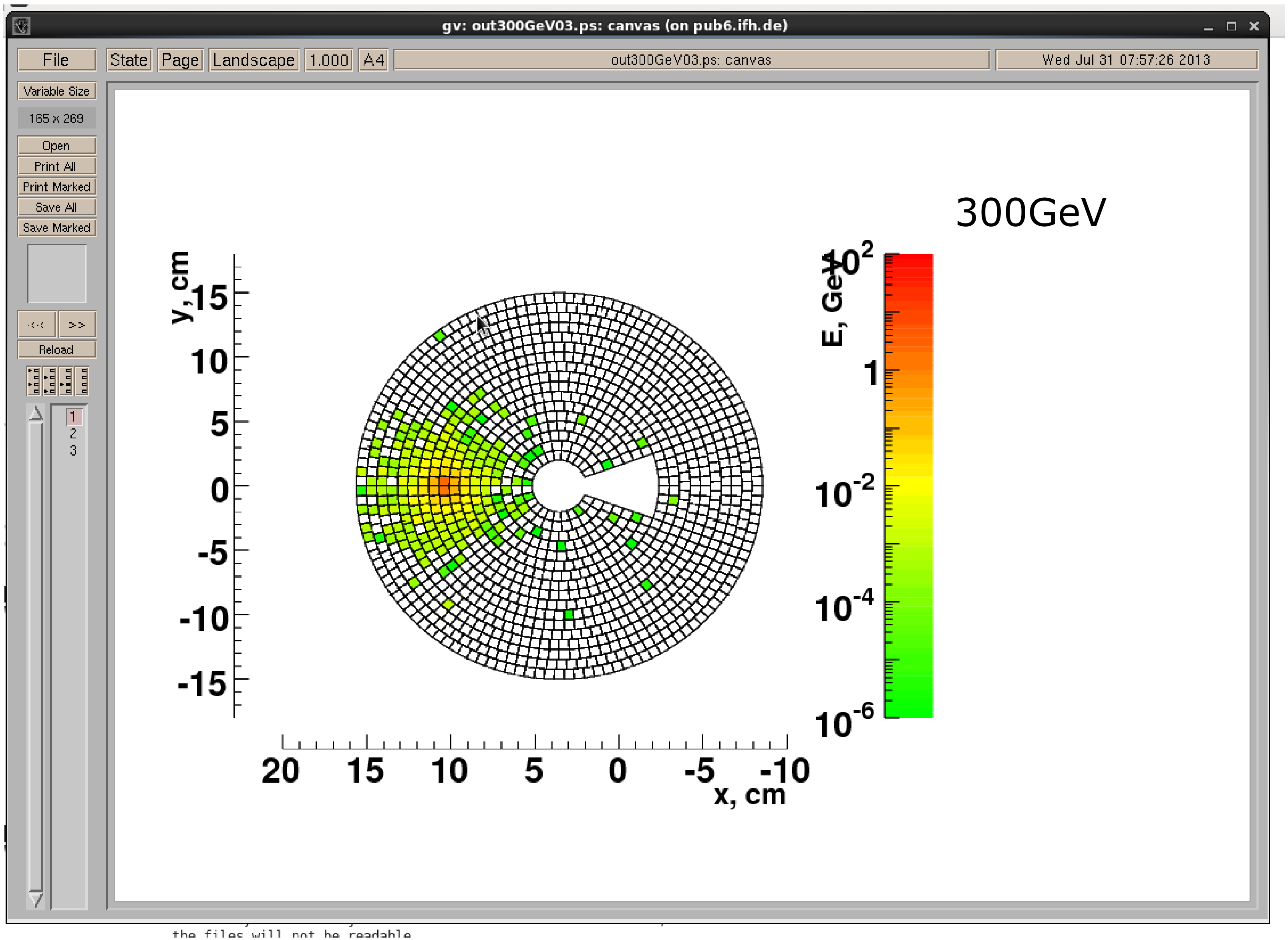

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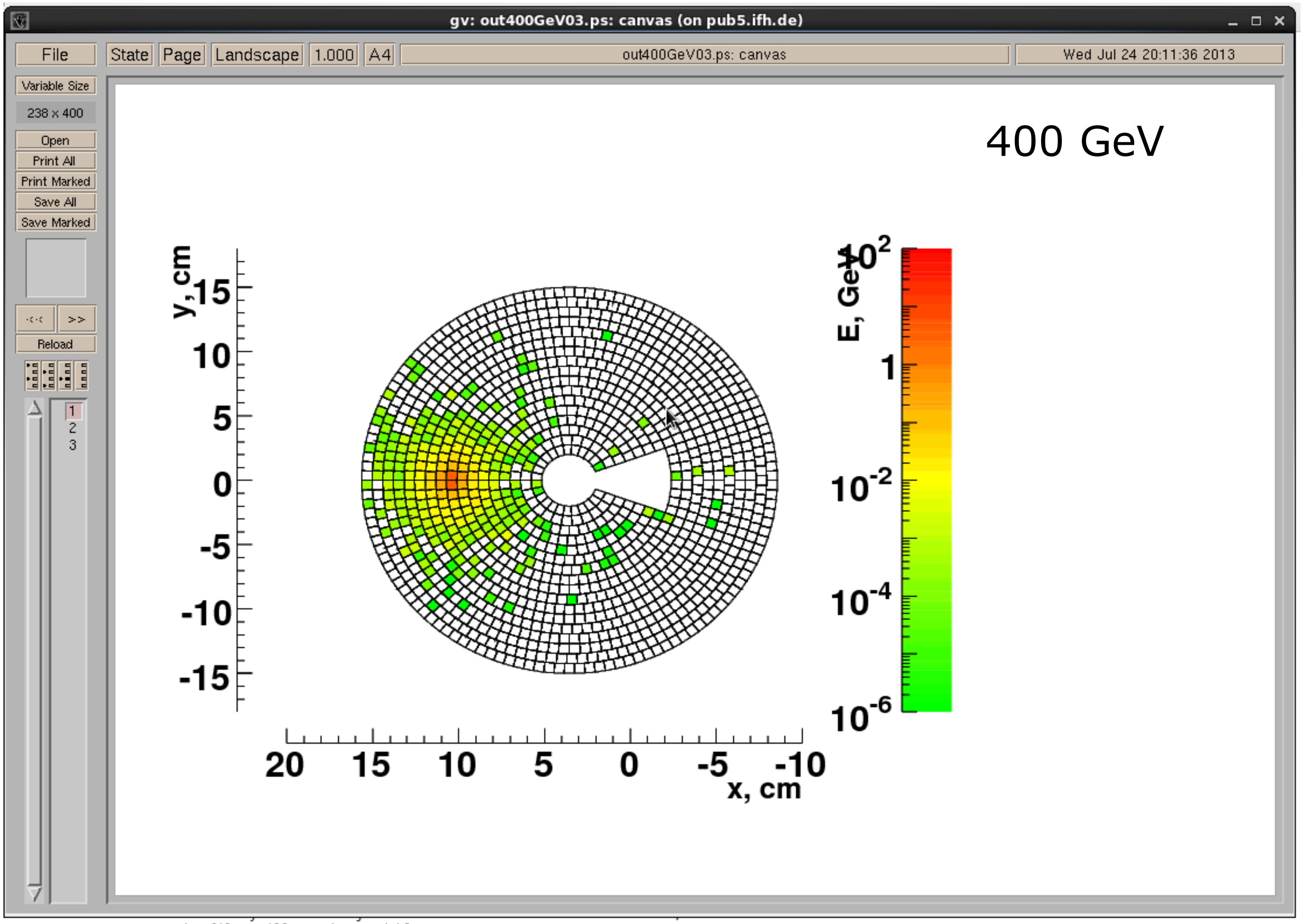
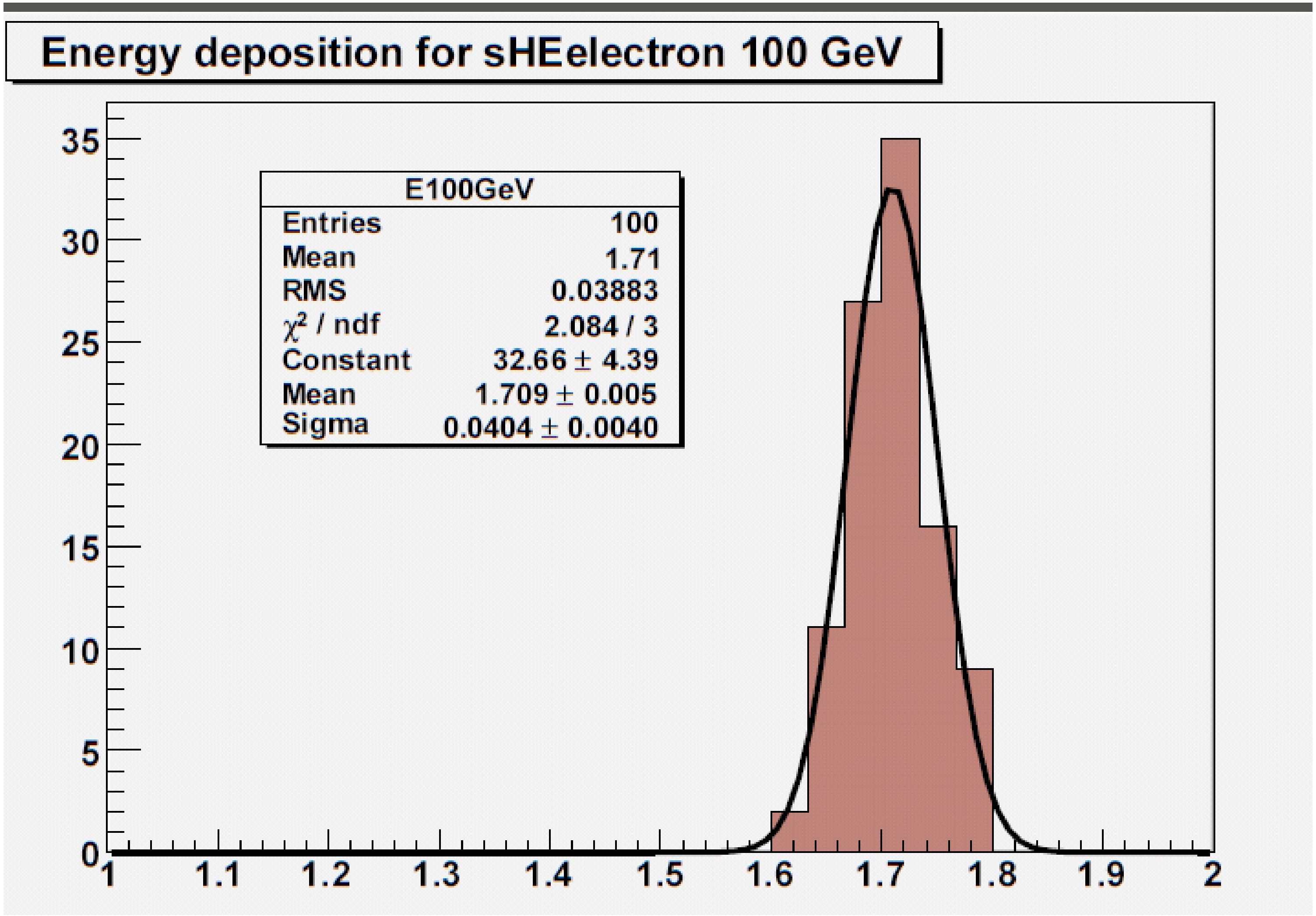


# Histogram : energy deposition from simulation




Deposited energy (GeV)

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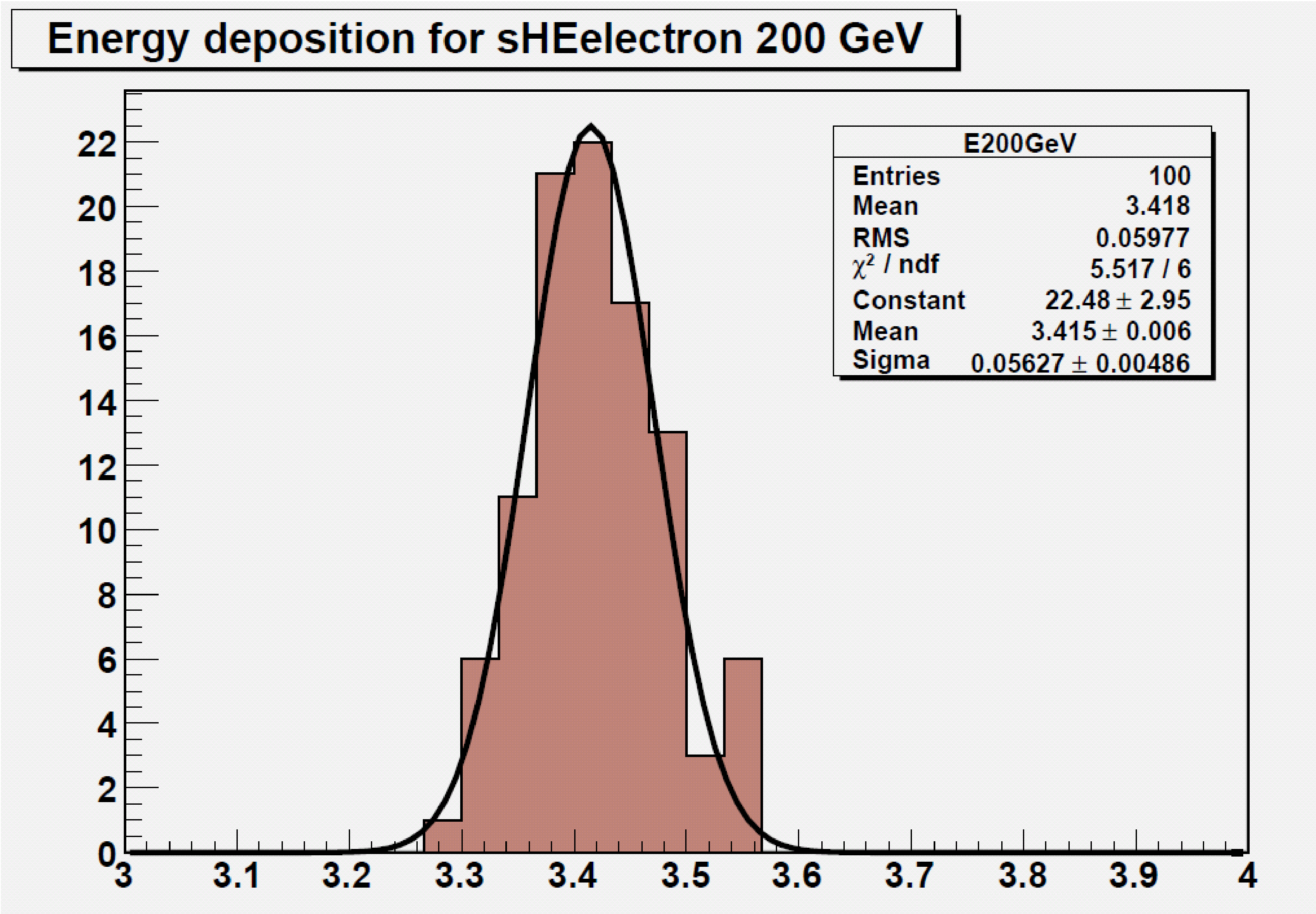


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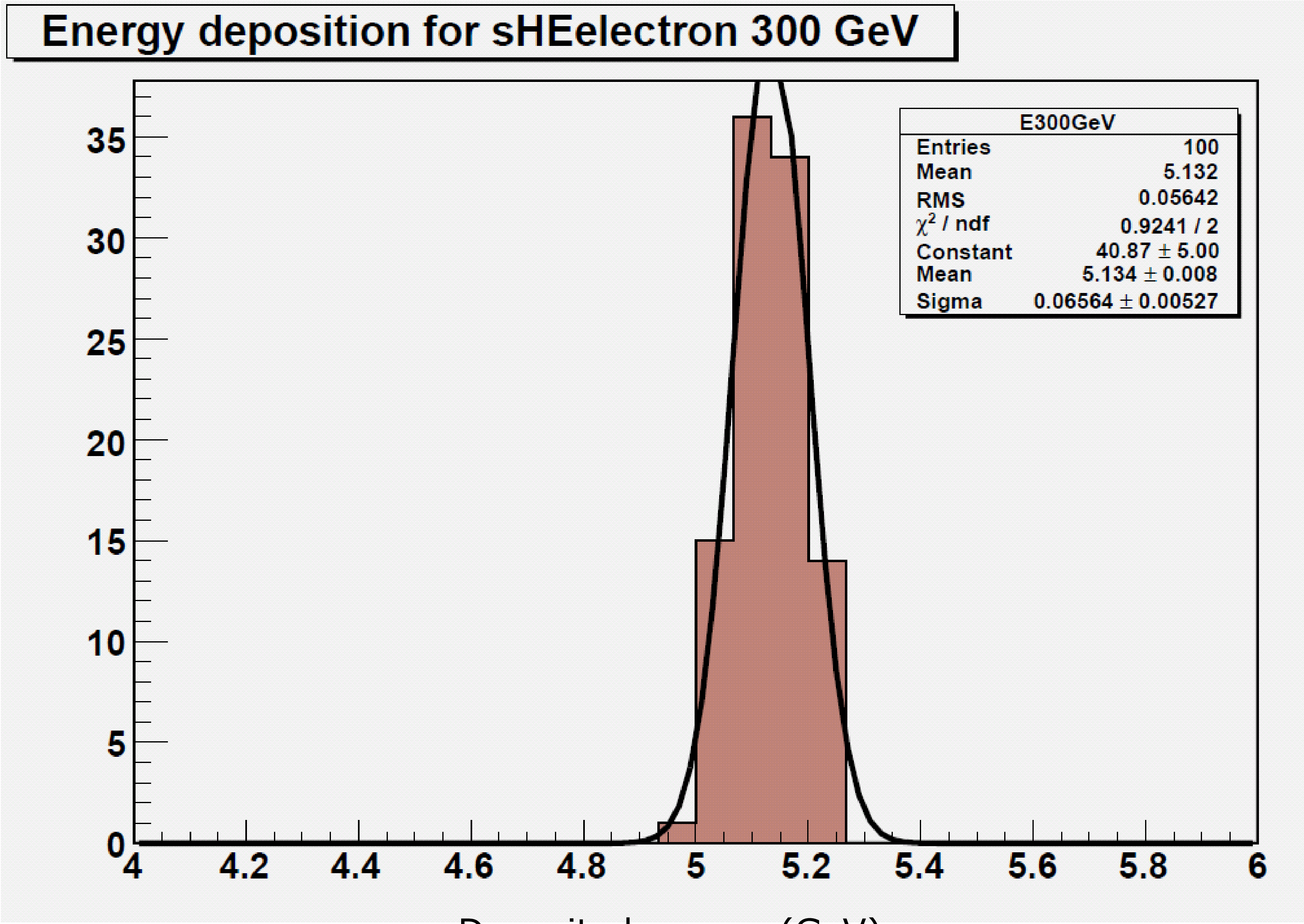


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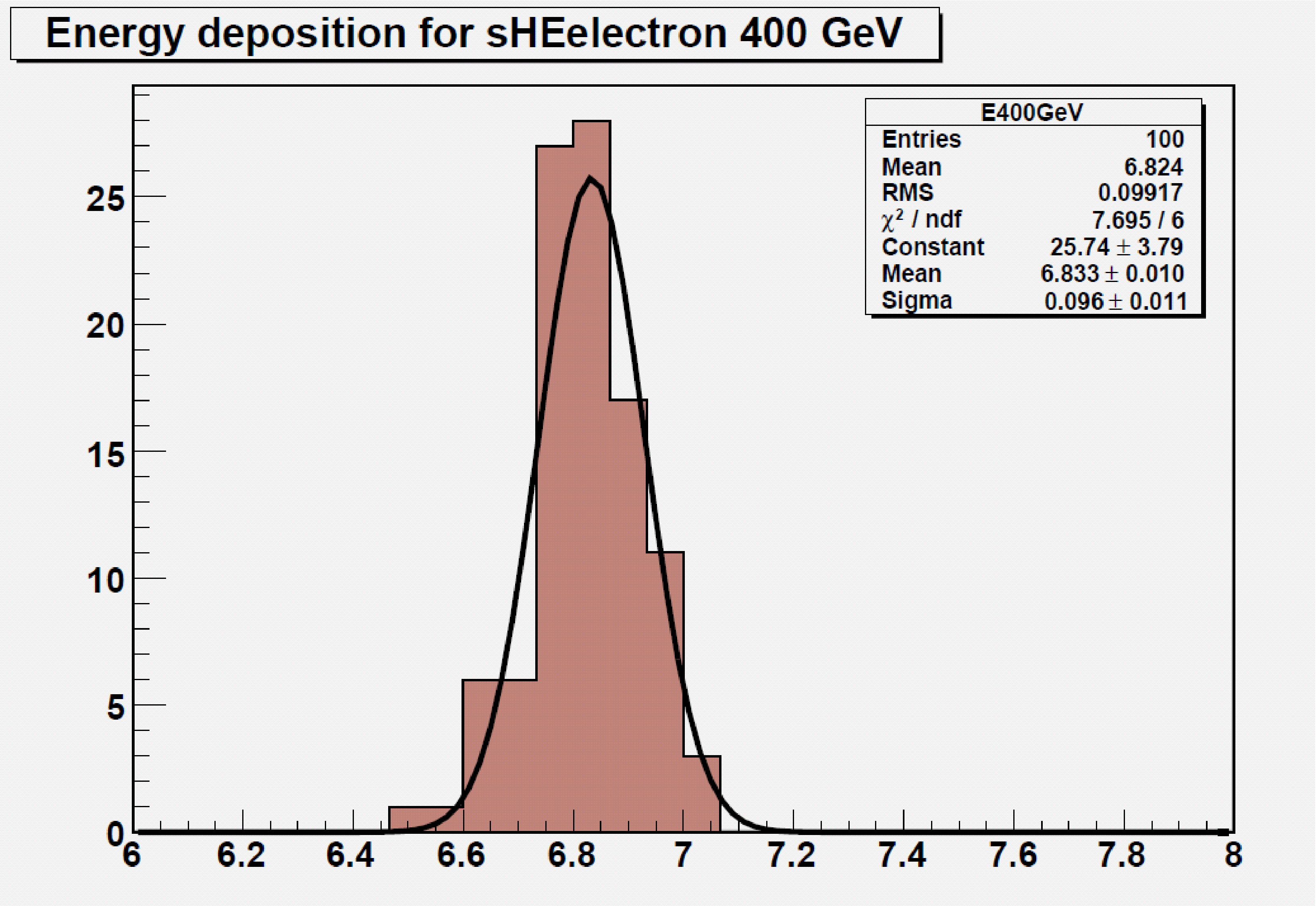
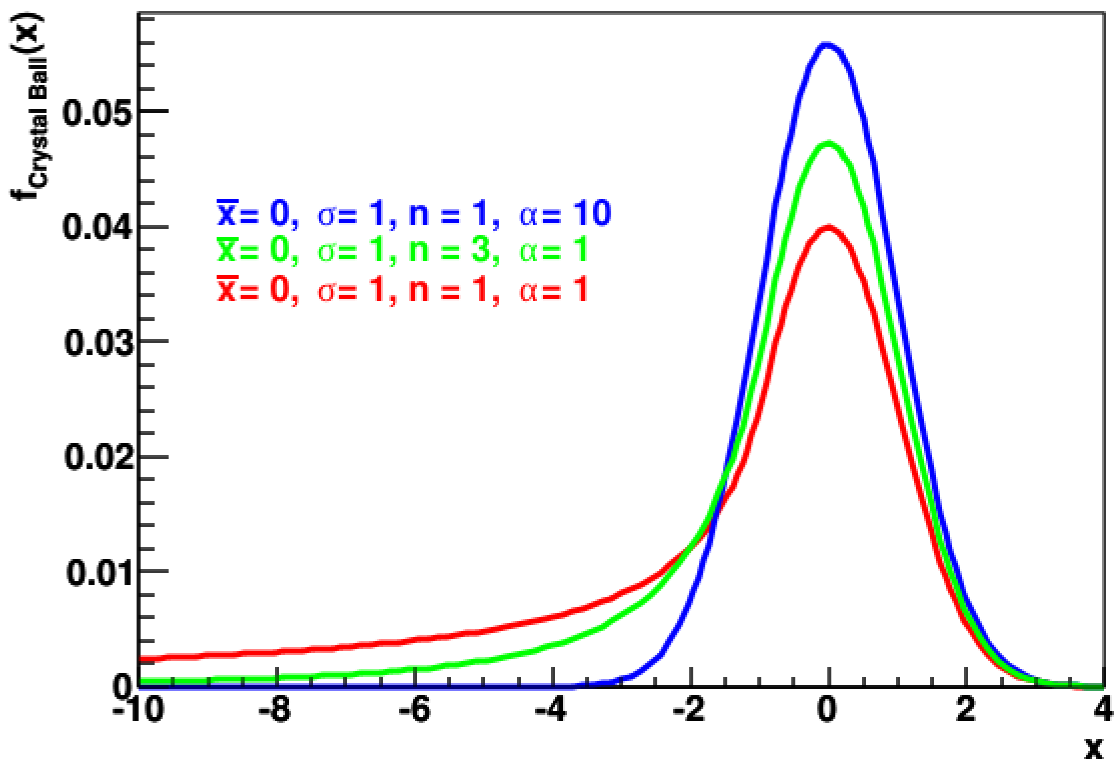
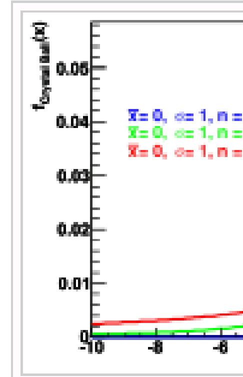



Deposited energy (GeV)




http://en.wikipedia.org/wiki/File:CrystalBallFunction.svg

The **Crystal Ball function**, named after the Crystal Ball Collaboration (hence the capitalized initial letters), is a probability density function commonly used to model various lossy processes in high-energy physics. It consists of a Gaussian core portion and a power-law low-end tail, below a certain threshold. The function itself and its first derivative are both continuous.



Examples of the Cr

The Crystal Ball function is given by:

$$f(x;\alpha,n,\bar{x},\sigma) = N\cdot\begin{cases}\exp(-\frac{(x-\bar{x})^2}{2\sigma^2}), & \text{for } \frac{x-\bar{x}}{\sigma} > -\alpha \\ A\cdot(B-\frac{x-\bar{x}}{\sigma})^{-n}, & \text{for } \frac{x-\bar{x}}{\sigma} \leqslant -\alpha\end{cases}$$

where

$$A = \left(\frac{n}{|\alpha|}\right)^n \cdot \exp\left(-\frac{|\alpha|^2}{2}\right),$$

$$B = \frac{n}{|\alpha|} - |\alpha|,$$

$$N = \frac{1}{\sigma(C+D)}$$

$$C = \frac{n}{|\alpha|}\cdot\frac{1}{n-1}\cdot\exp\left(-\frac{|\alpha|^2}{2}\right)$$

$$D = \sqrt{\frac{\pi}{2}}\left(1+\operatorname{erf}\left(\frac{|\alpha|}{\sqrt{2}}\right)\right)$$

$N$ (Skwarnicki 1986) is a normalization factor and $\alpha$, $n$, $\bar{x}$ and $\sigma$ are parameters which are fitted with the data. erf is the error function.

BeamCal is an electromagnetic sandwich calorimeter that uses Tungsten as absorber. It serves three major purposes:

- Improving the hermeticity of the ILC detector by providing electron and photon identification down to polar angles of a few mrad. This is a specially challenging task due to the vast amount of deposited energy from the electron-positron pairs originating from beamstrahlung.
- Reducing the backscattering from pairs into the inner ILC detector part and protecting the final magnet of the beam delivery system.
- Assisting beam diagnostics. A fast luminosity signal will be provided by BeamCal. The detailed analysis of the shape of the energy deposition from pairs hitting the BeamCal grants access to parameters of the colliding beams.