Status and plan of PANDA EMC code checking, energy and position calibration

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EMC software 3, June, 2019 @Hefei

Outline

- Code checking
  - Review
  - New
- Energy calibration (by Dong Liu)
  - Status
  - plan
- Position calibration (by Yankun Sun)
  - Status
  - plan
- Summary

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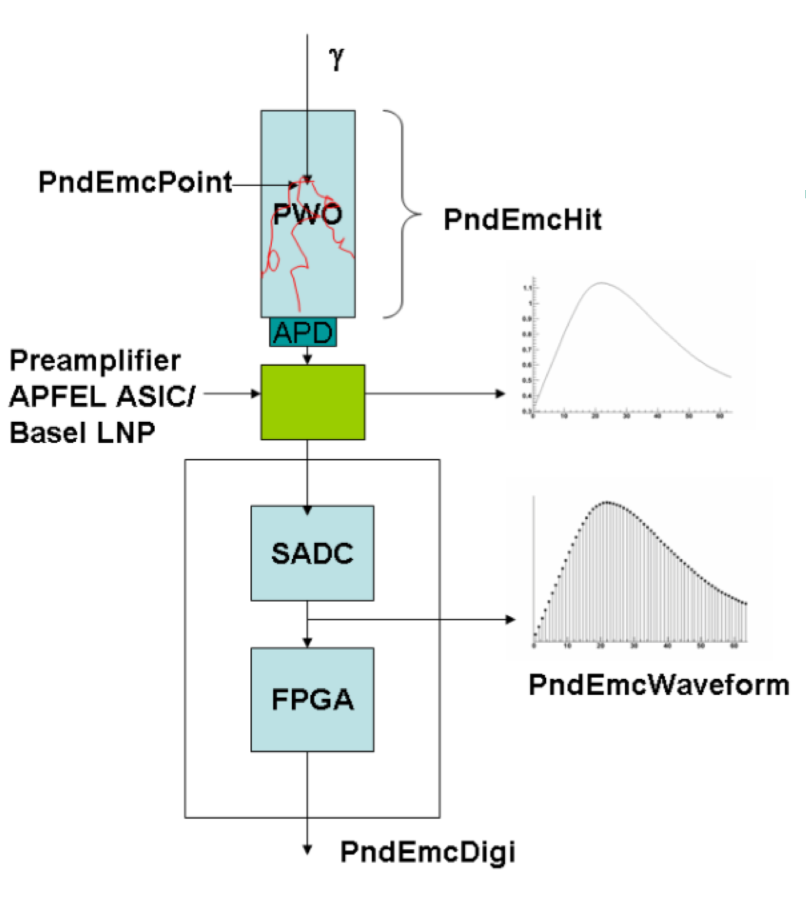
Code checking

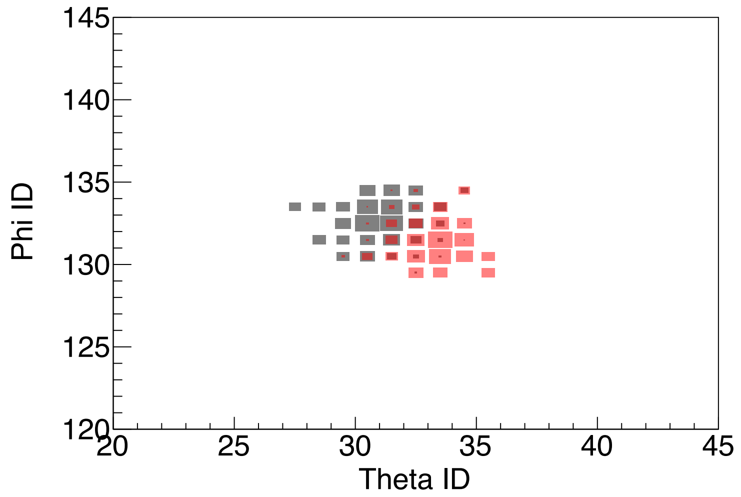
Code checking: review

- EMC Software
  - Simulation
    - geometry description
    - sensitive material
    - physical processes
    - signal collection
    - digitization
  - Reconstruction
    - cluster finding
    - bump splitting

Until 17/12/18 collaboration meeting

Code works fine





Code checking: status and plan

- Status
  - Data processing from injection to bump has been checked
- Plan
  - Check codes for energy and position calibration
  - Check codes for PID
  - Optimize and develop codes

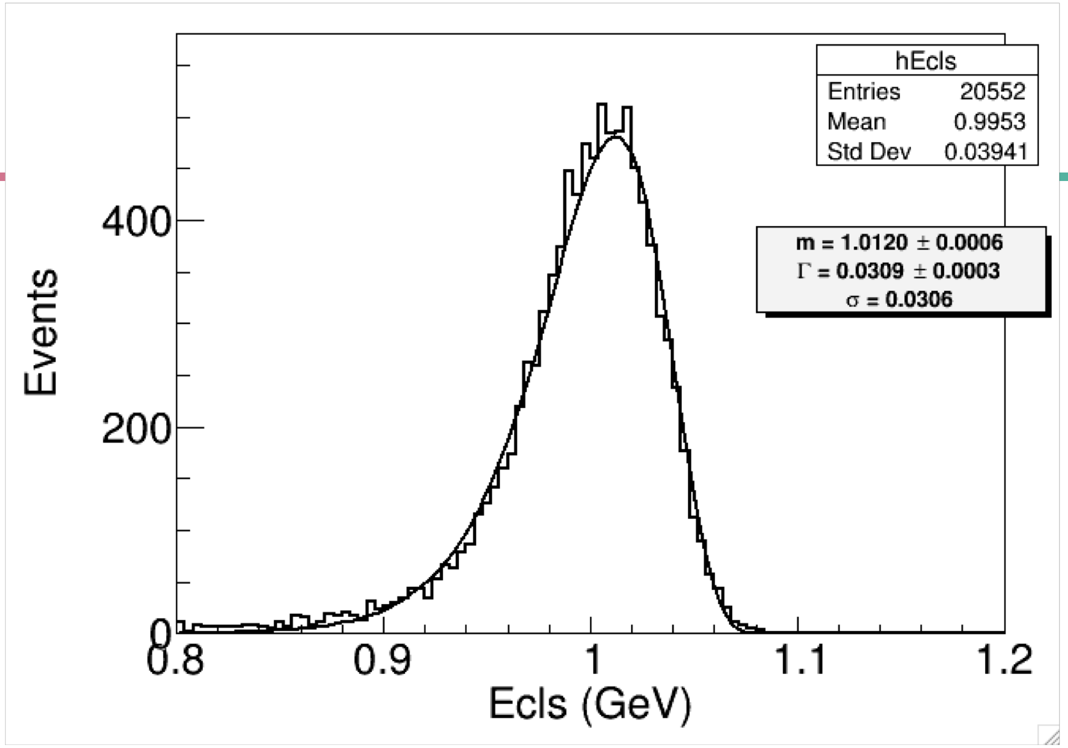
Energy calibration

Energy calibration

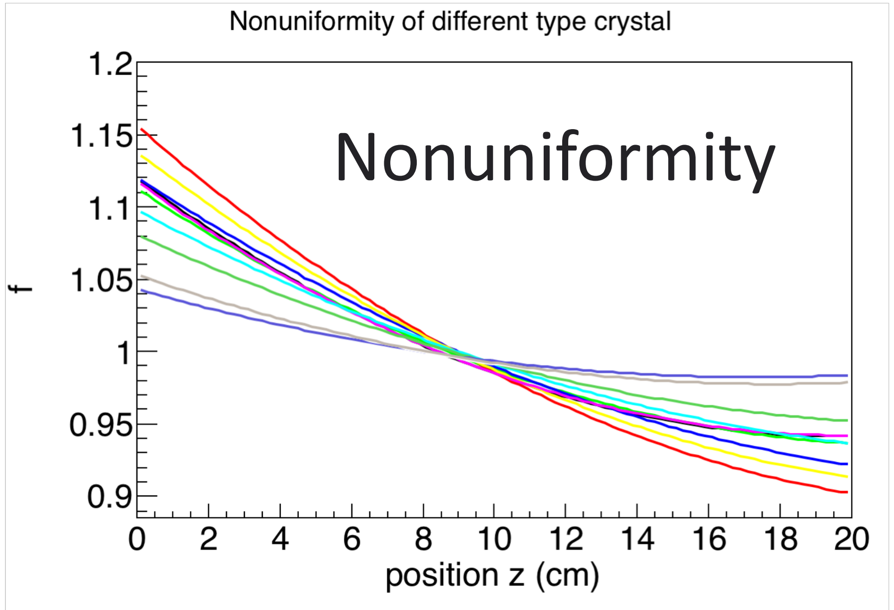
- Energy calibration
  - Design in TDR

$$\frac{\sigma_E}{E} = a \oplus \frac{b}{\sqrt{E/\mathrm{GeV}}} \qquad (3.1)$$

leads to the requirement $a \leq 1\%$ and $b \leq 2\%$.



  - Reasons



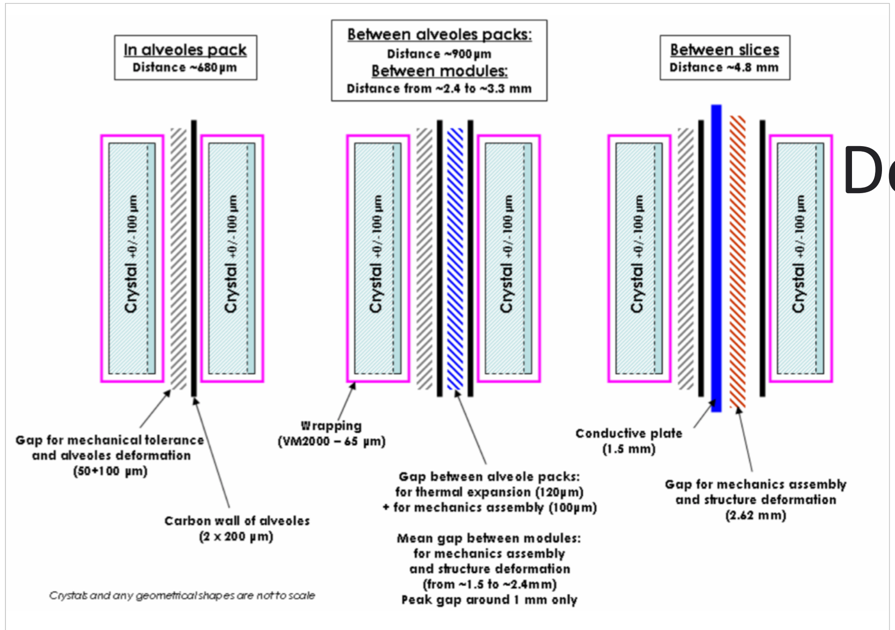


Figure 7.8: Summary of the expected dead space between calorimeter elements.

Dead area

Energy calibration

TDR

$E_{\gamma,\mathrm{cor}} = E * f(\ln E, \Theta)$ with

$$f(\ln E, \Theta) = exp(a_0 + a_1\, lnE + a_2\, ln^2 E + a_3\, ln^3 E + a_4\, cos(\Theta) + a_5\, cos^2(\Theta) + a_6\, cos^3(\Theta) + a_7\, cos^4(\Theta) + a_8\, cos^5(\Theta) + a_9\, lnE\, cos(\Theta))$$

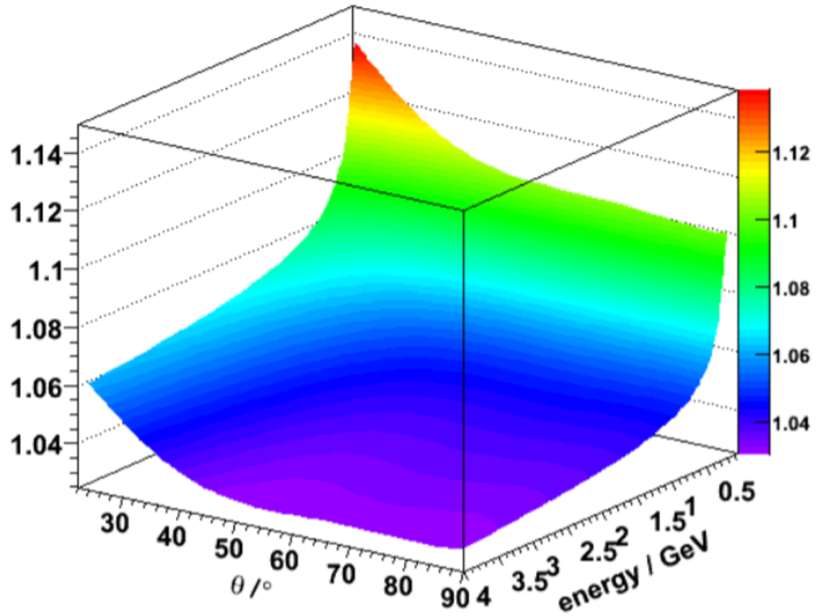
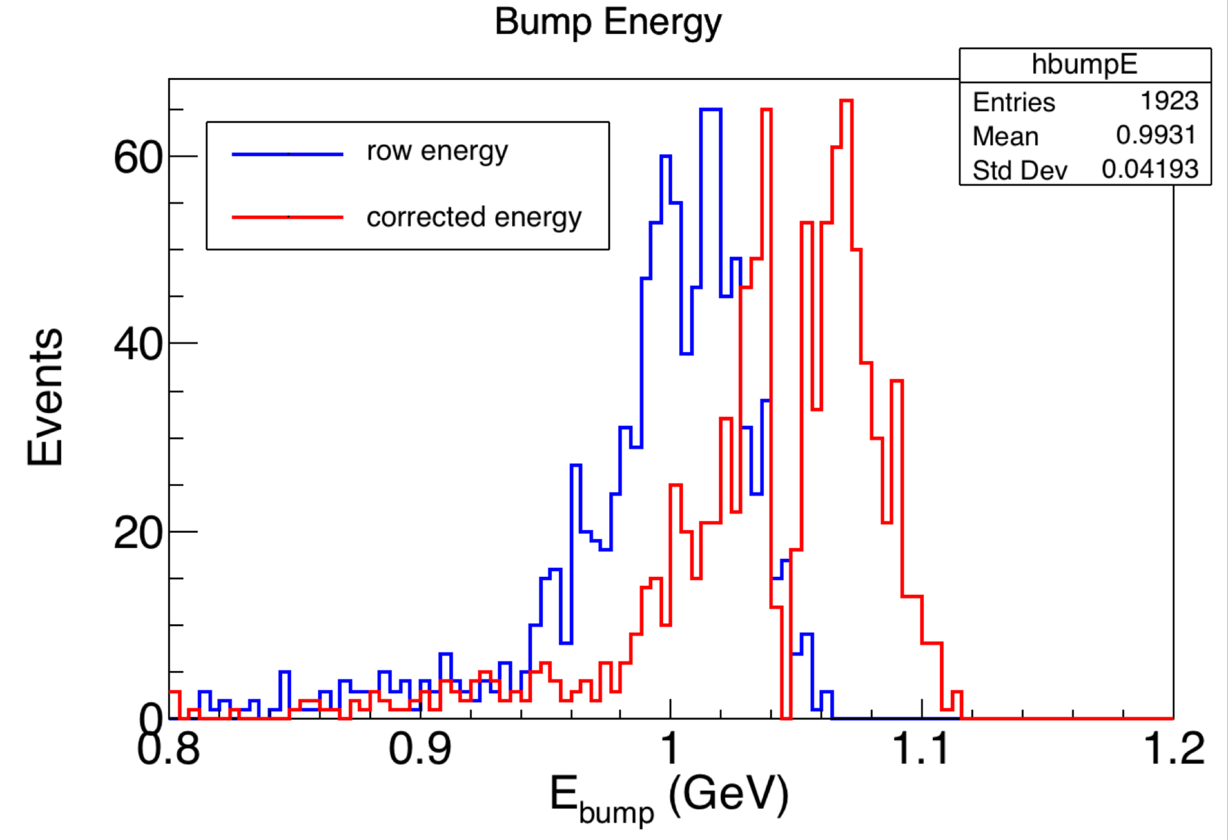


Figure 9.3: Leakage correction function for the barrel EMC in the Θ range between 22° and 90°.

In PandaRoot

```
double eout1=e* exp(factor1); // factor123 are from
double eout2=e* exp(factor2); // TDR but diff par
double eout3=e* exp(factor3);
```



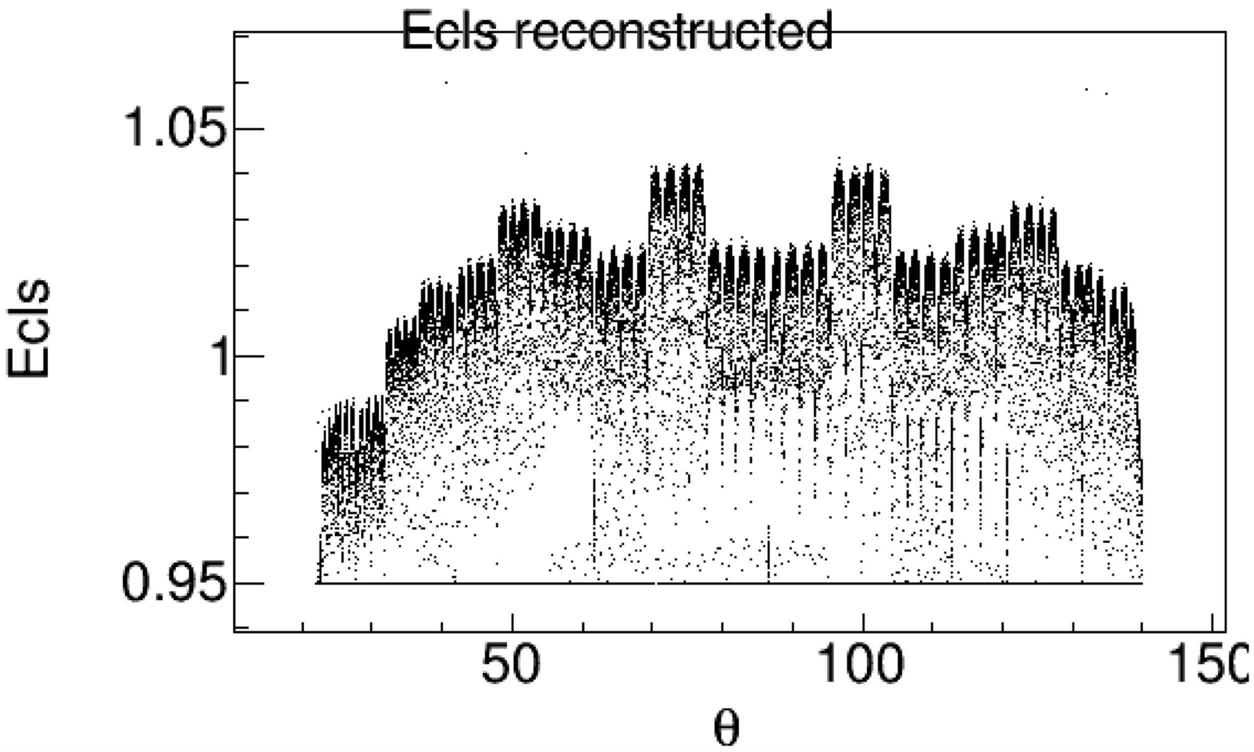
Energy calibration

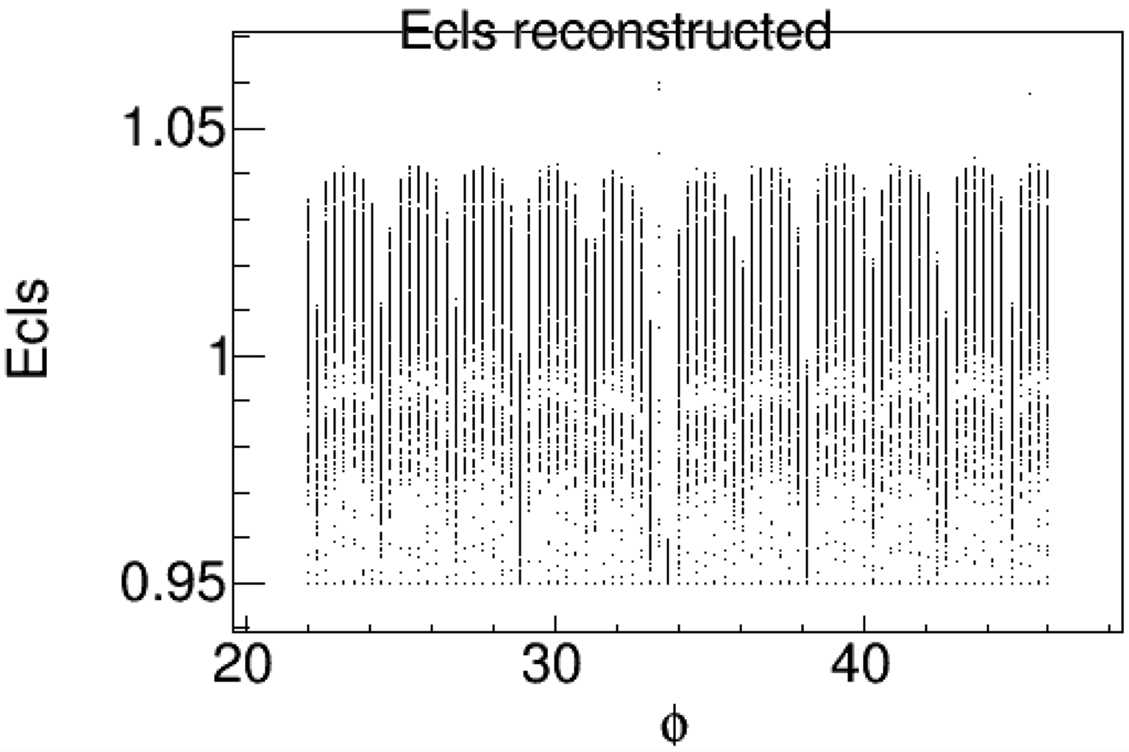
Plan

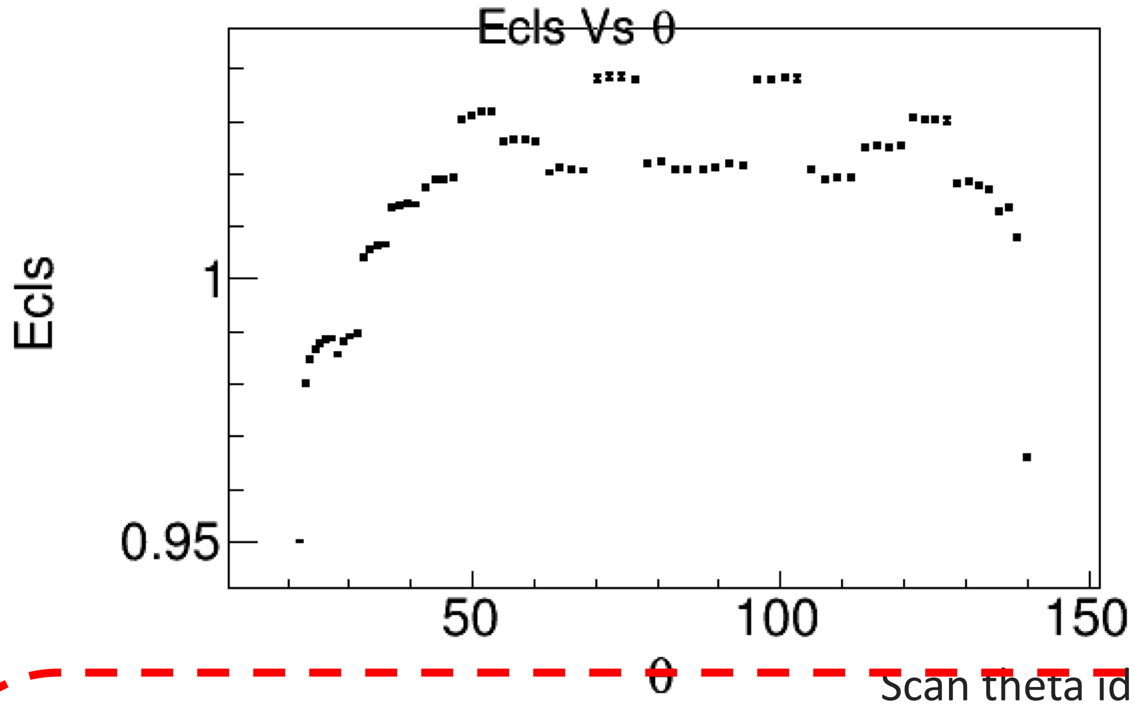
- ☐ Firstly, crystal calibraton
- ☐ Then, bump correction
  - C = f(Ecrstal, Ebump, E1/E9, r, moment, theta, …)
- ☐ Front material?
- ☐ monitor temperature, not by us

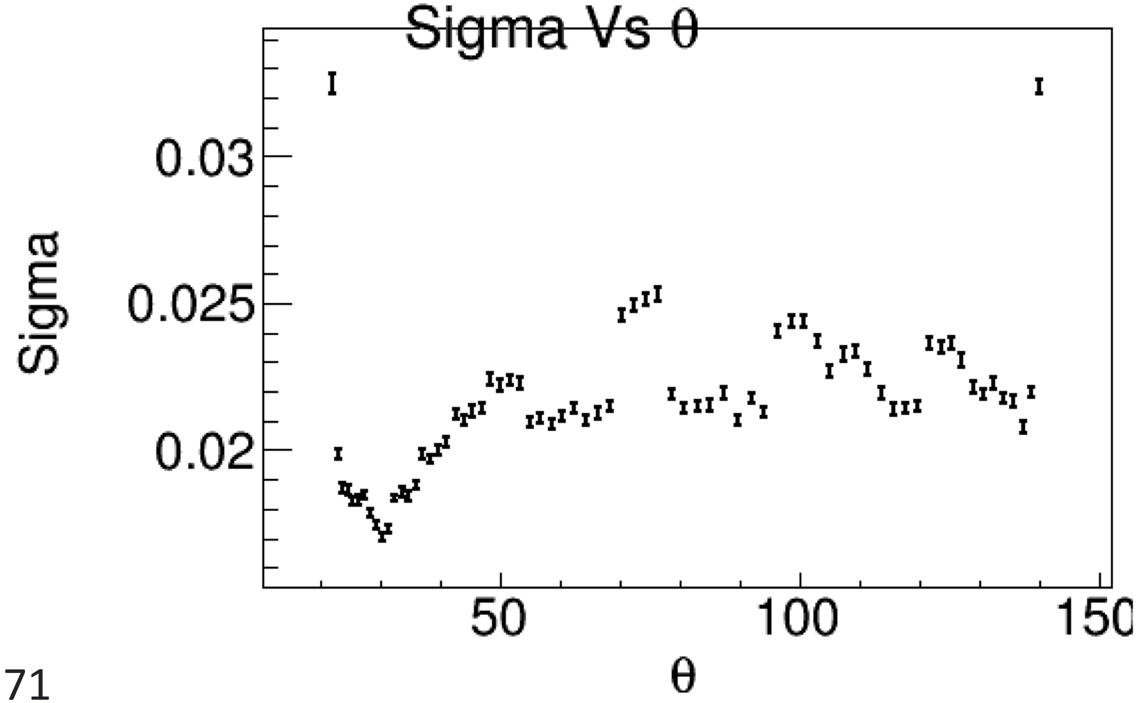
Energy calibration

Scan theta and phi, one slice,
Eγ = 1 GeV
theta: 22 – 140, 0.3 per sample
phi: 22-46, 0.3 per sample
1000 events per sample
> 30 k samples



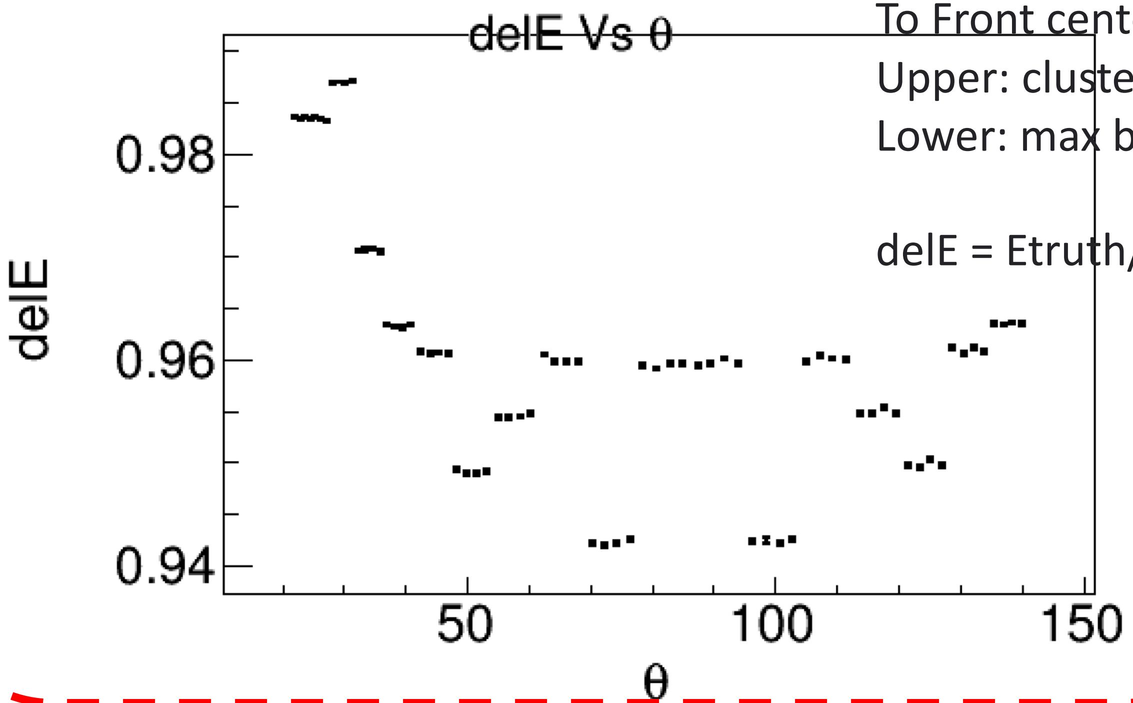


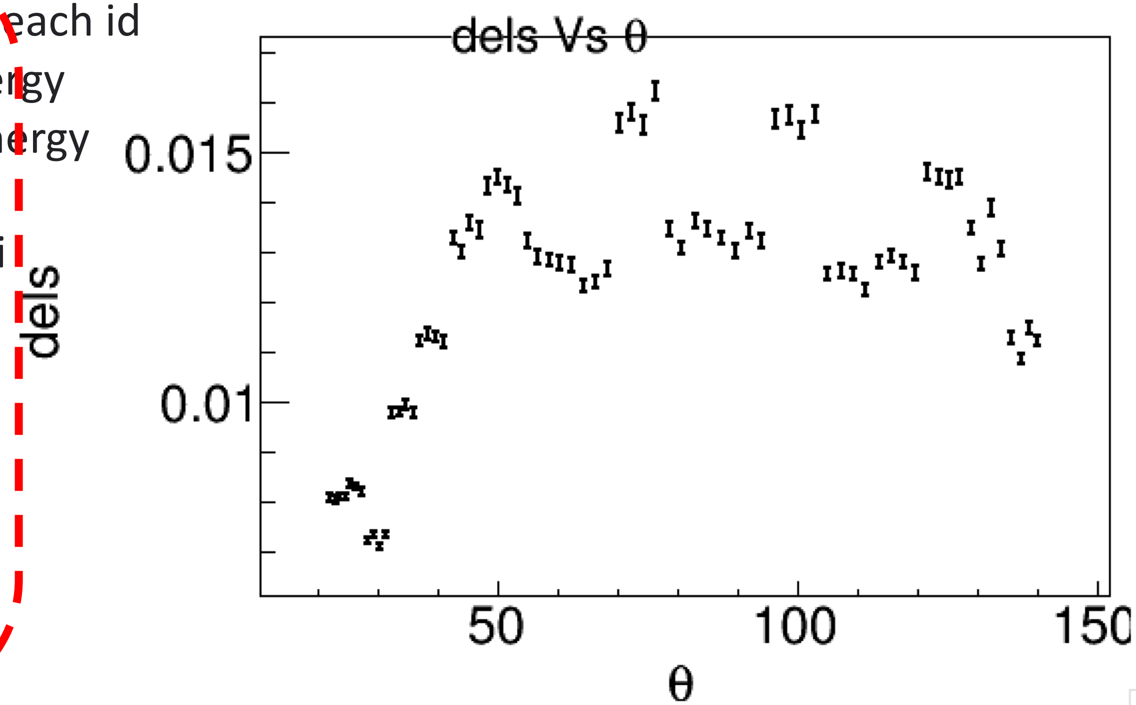




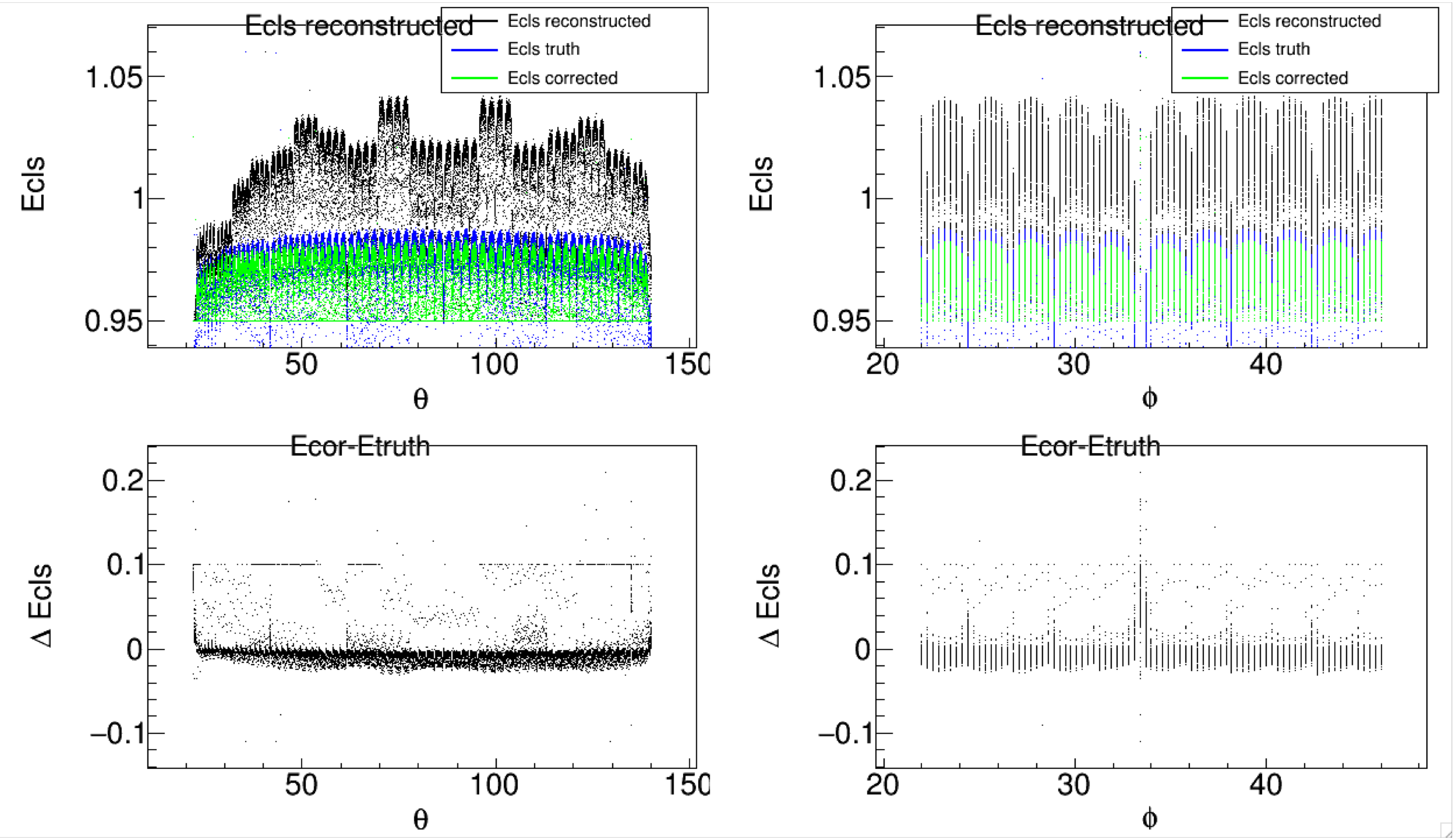
Scan theta id , 1 – 71
To Front center of each id
Upper: cluster energy
Lower: max bar energy

delE = Etruth/Edigi



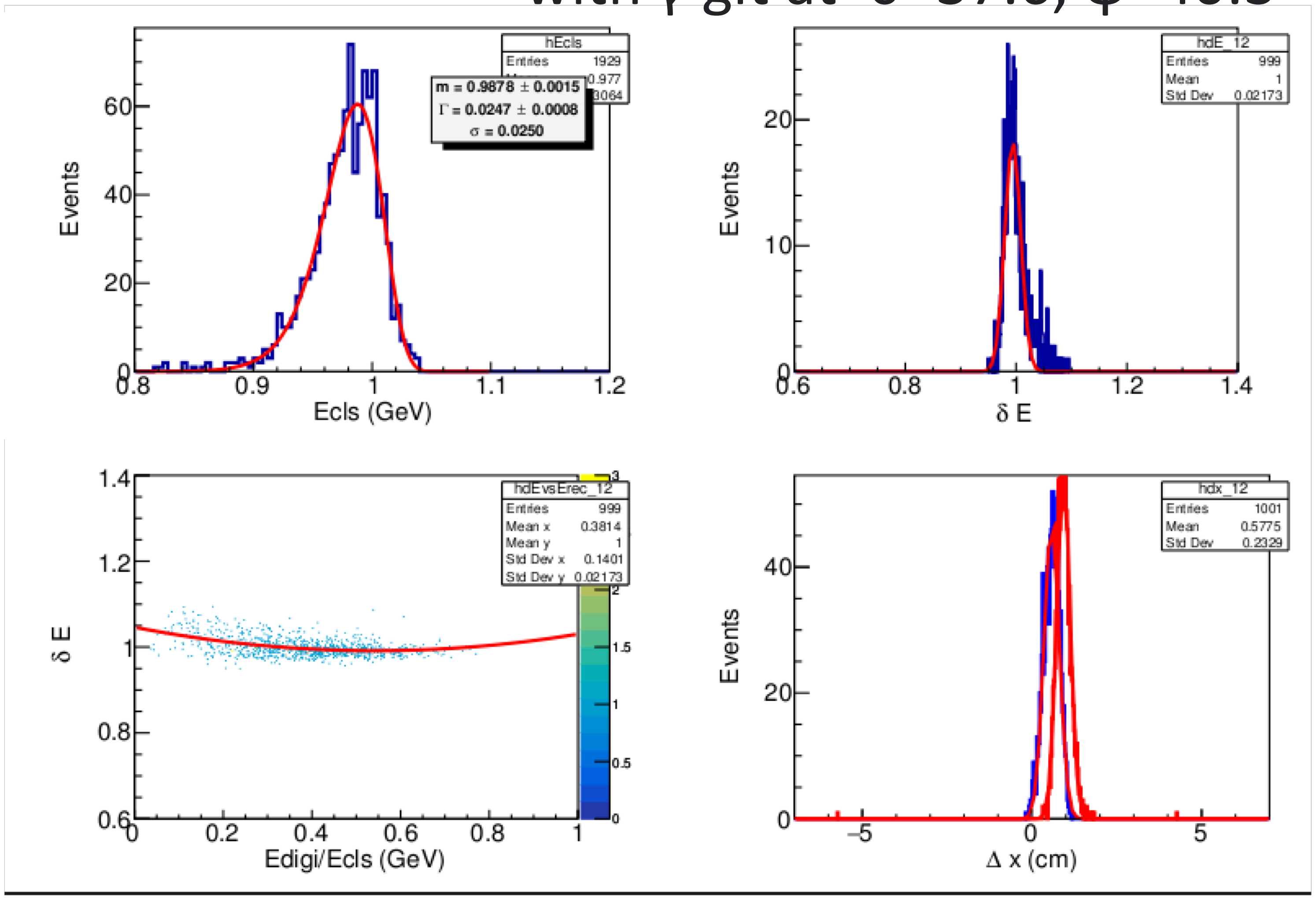


Energy calibration: correction based on crystal type



Energy calibration

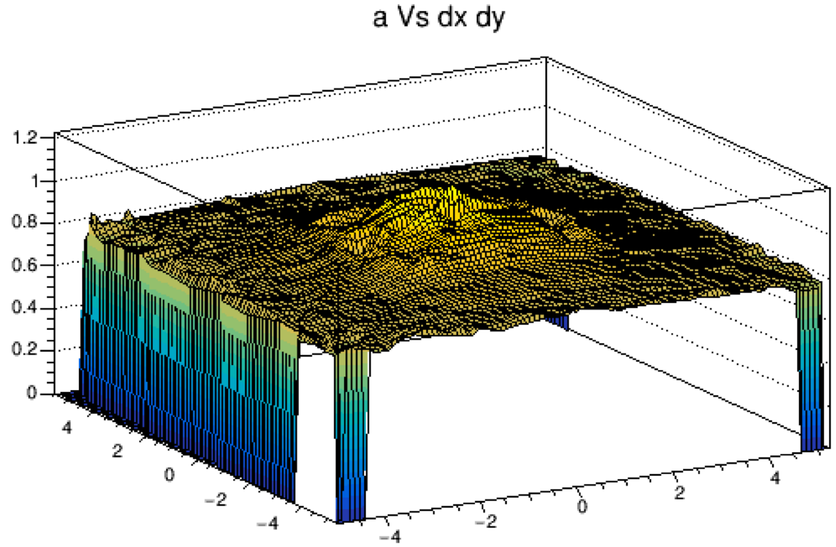
Example for crystal 12815008,
with γ git at θ=37.6, ϕ=40.3

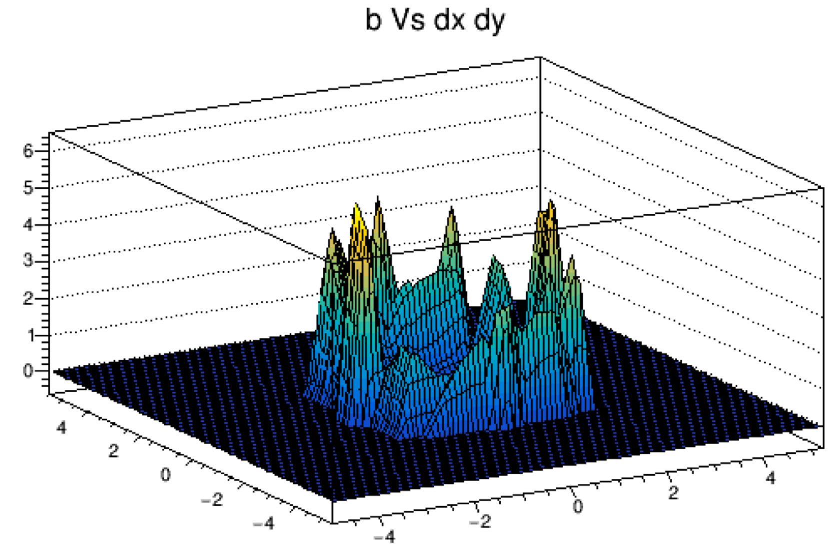


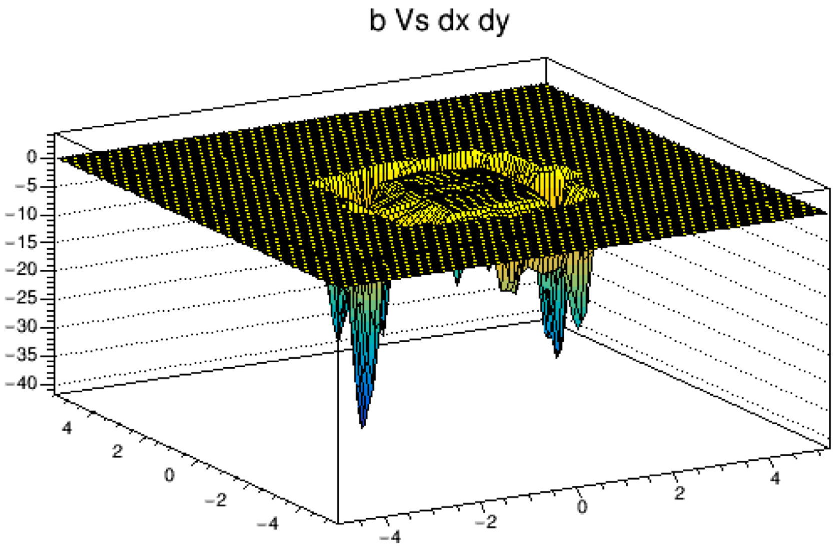
Scan theta and phi, one slice,
Eγ = 1 GeV
theta: 22 – 140, 0.3 per sample
phi: 22-46, 0.3 per sample
1000 events per sample
> 30 k samples

For each crystal
$f = a + bx + cx^2$
f Vs θ, ϕ
a, b, c Vs θ, ϕ
δE=Etruth/Edigi

Energy calibration







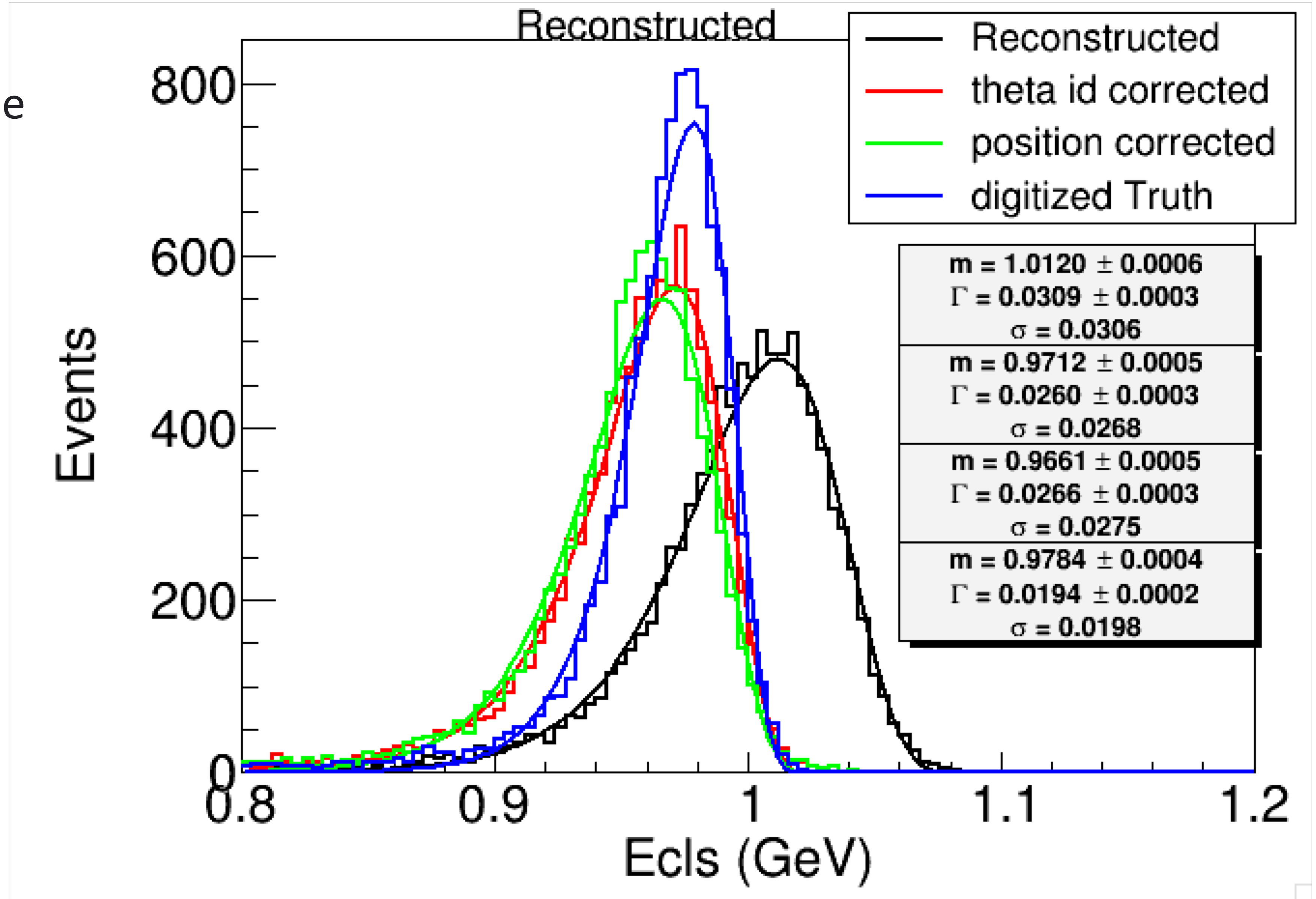
Example for crystal 12815008, with γ git at θ=37.6, ϕ=40.3

$f = a + bx + cx^2$

a, b, c Vs θ, ϕ

Energy calibration

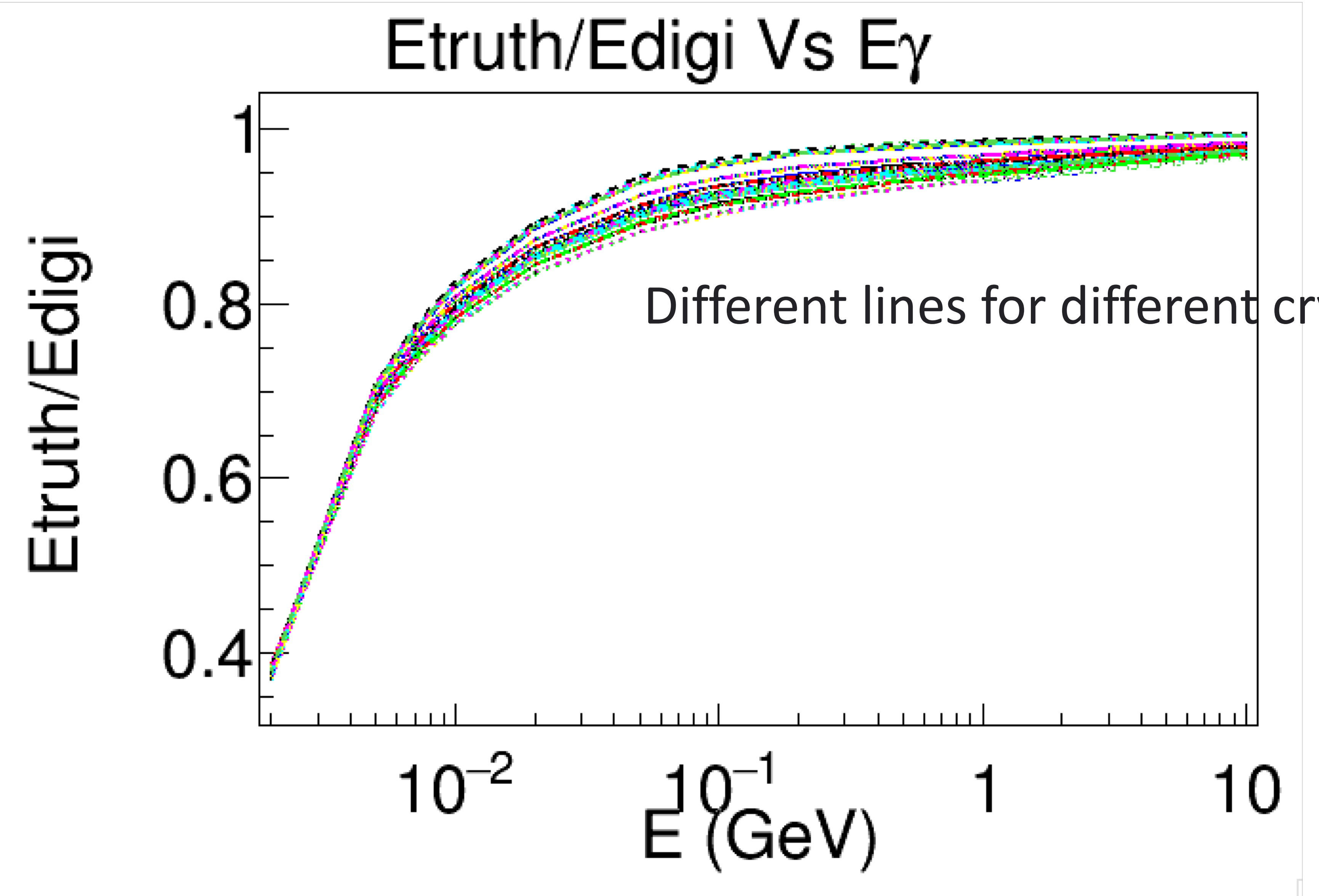
Test sample



Energy calibration: Status and Plan

- Status: Calibration on each crystal
  - ☐ Crystal type related correction
  - ☐ Position and energy related correction
- Plan
  - ☐ Consider energy relation for crystal type correction
  - ☐ Cluster energy leakage correction, in dead area and at rear
  - ☐ Nonuniformity correction
  - ☐ MVA or ML for energy correction

Energy calibration: fdigi Vs Ecluster



Different lines for different crystal type

Energy calibration: correction for leakage in dead area
Based on i theta correction

2007 JINST 2 P04004

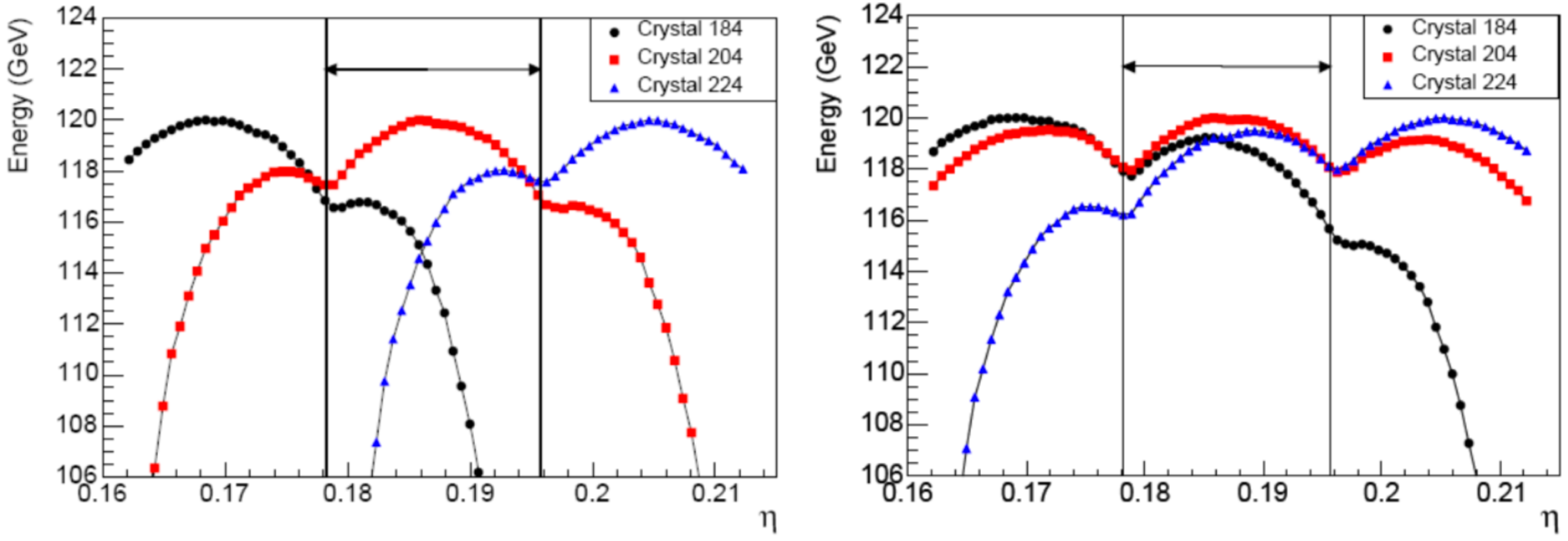


Figure 7. Left: mean energy measured in 3×3 arrays centred on crystals 184 (dots), 204 (squares), 224 (triangles) as a function of incident position, η. Right: same for 5×5 arrays. The arrows indicate the region where crystal 204 has the largest energy deposit.

Energy calibration: correction for leakage in dead area
Based on i theta correction

2007 JINST 2 P04004

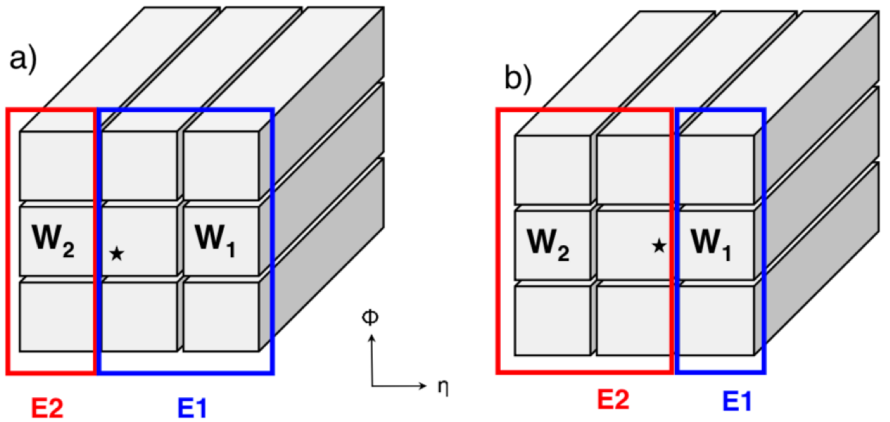


Figure 8. Definition of E1 and E2 when a) W1 < W2 and b) W1 > W2 (see text). The star represents the electron's incident position.

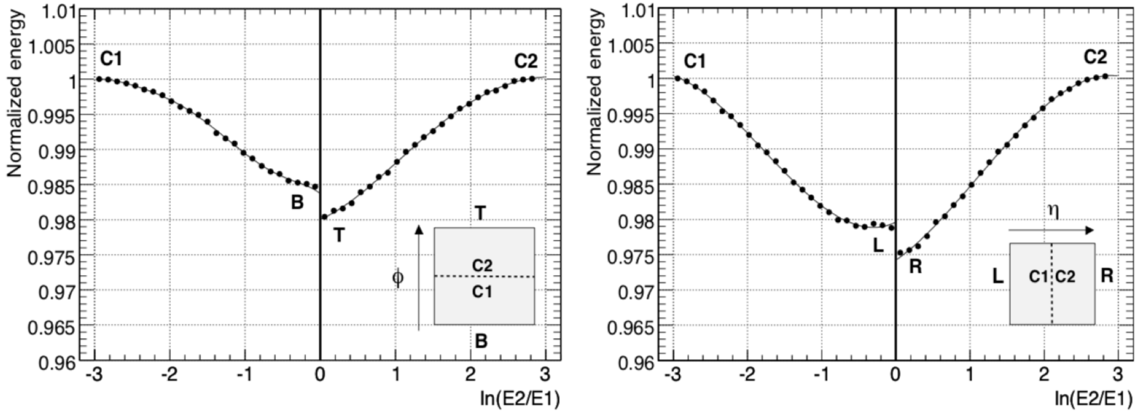


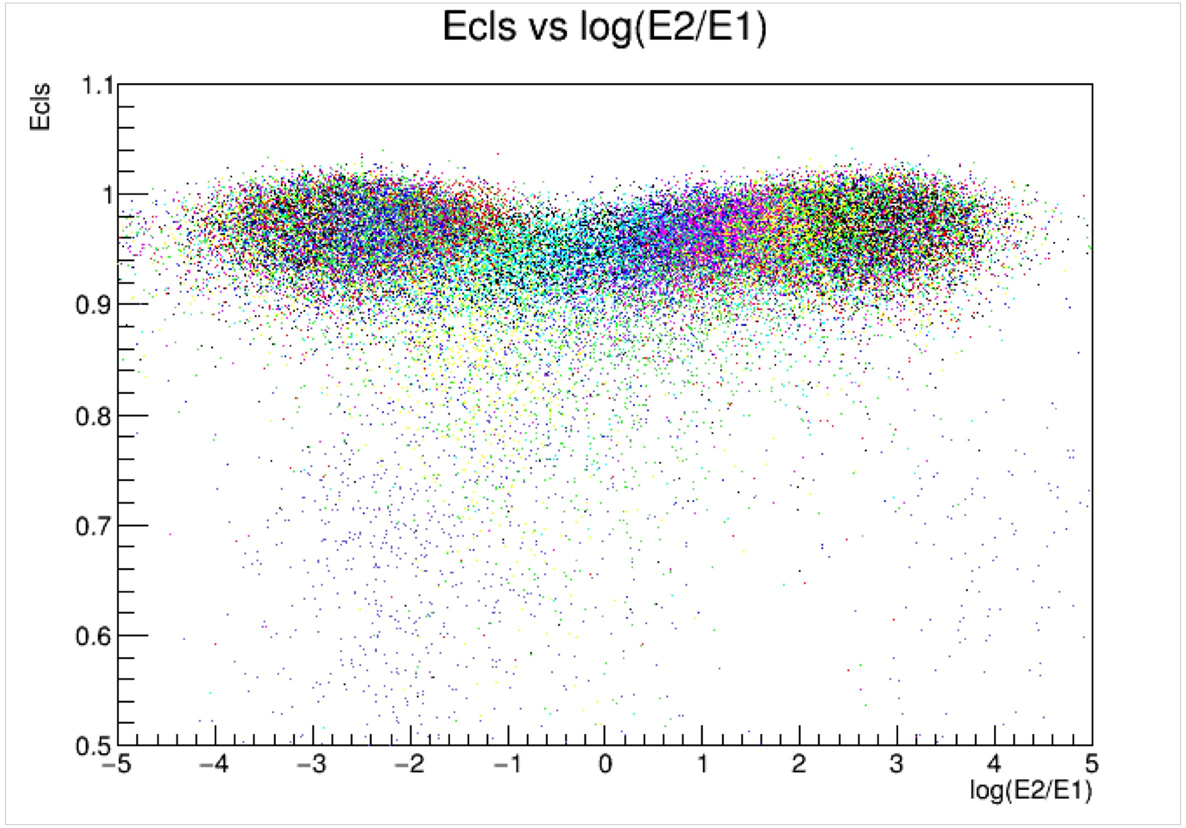
Figure 10. Normalized mean energy measured in the 3×3 array around crystal 204 versus ln(E2/E1) in the Φ (left) and η (right) directions. The curves are 3rd order polynomial functions fitted to the measured distributions, independently for positive and negative values of ln(E2/E1). The square panels represent the central crystal with various regions indicated: T (top), B (bottom), L (left), R (right) and C1 and C2 (just off centre on each side). The labels on the distributions indicate in which region the electrons were incident.

For theta and phi, the definitions of E1 and E2 are in different direction

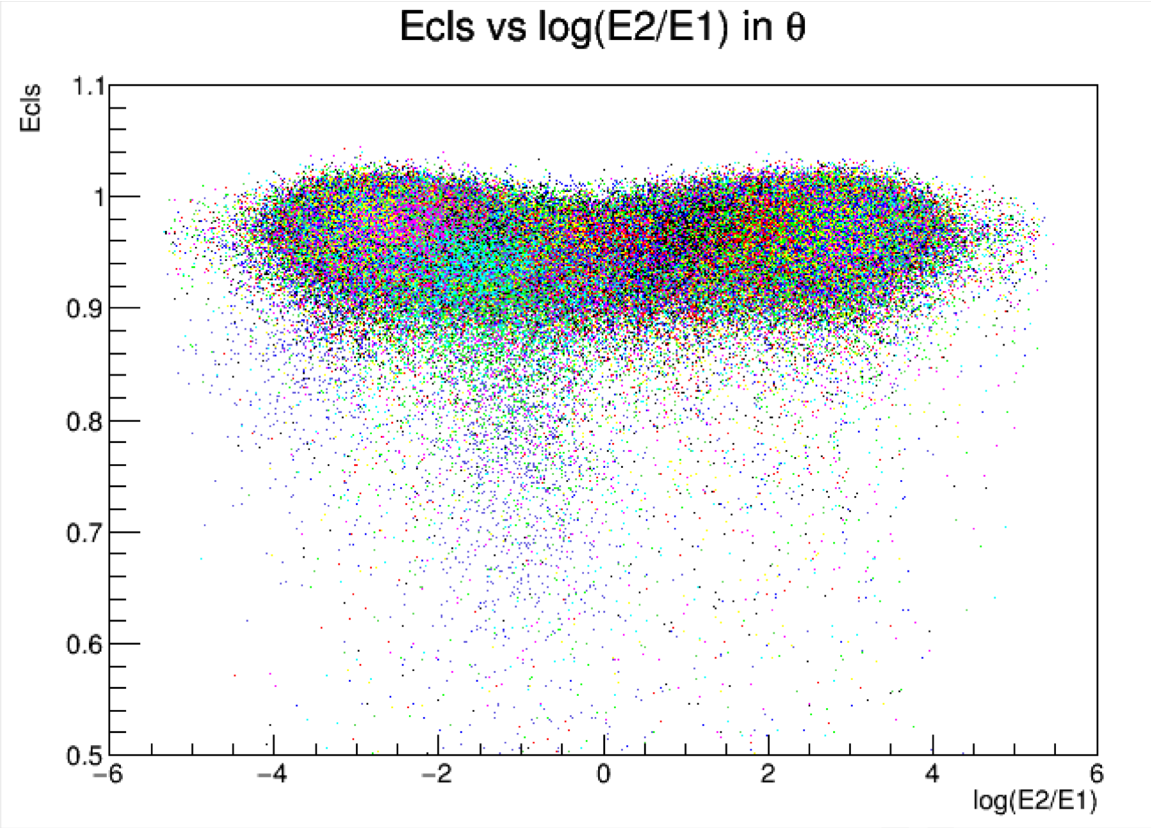
Energy calibration: correction for leakage in dead area Based on i theta correction

For θ=49.9

One color corresponding to one sample

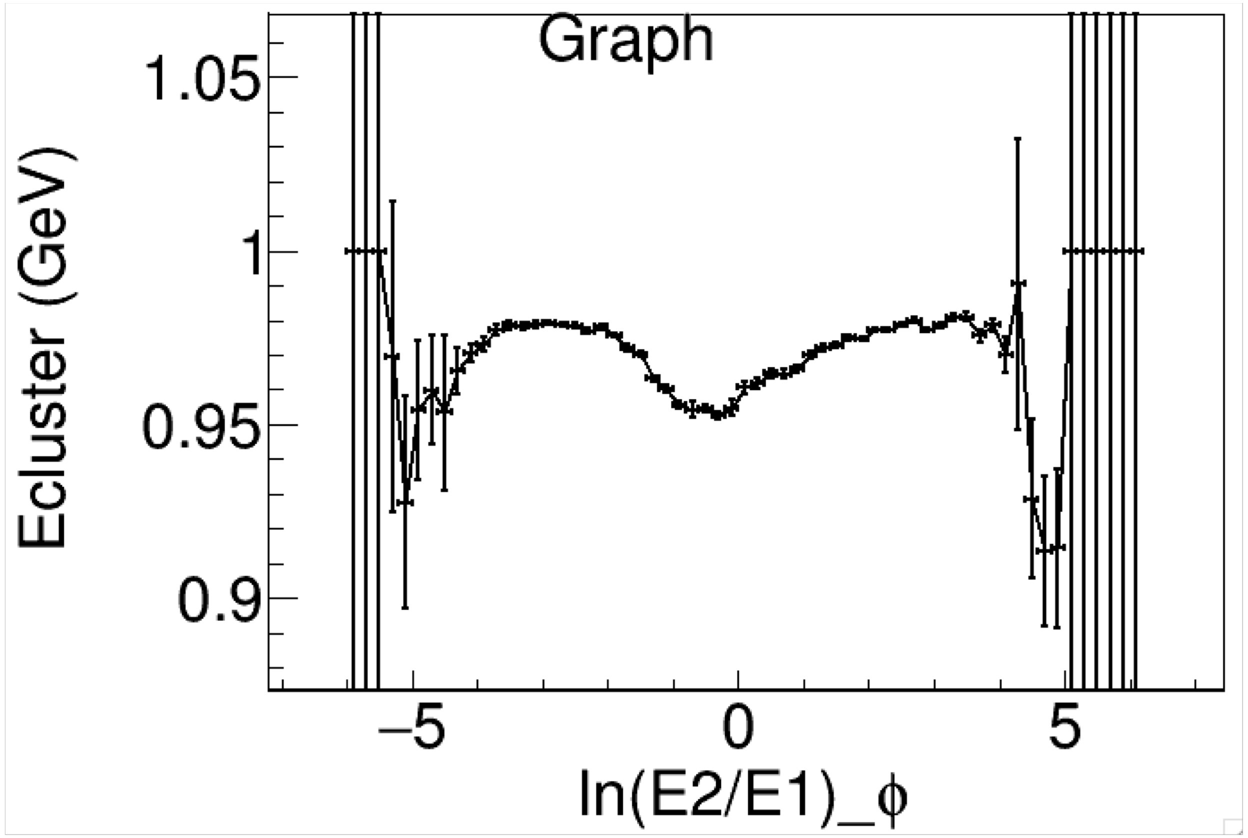


For ϕ=30.1

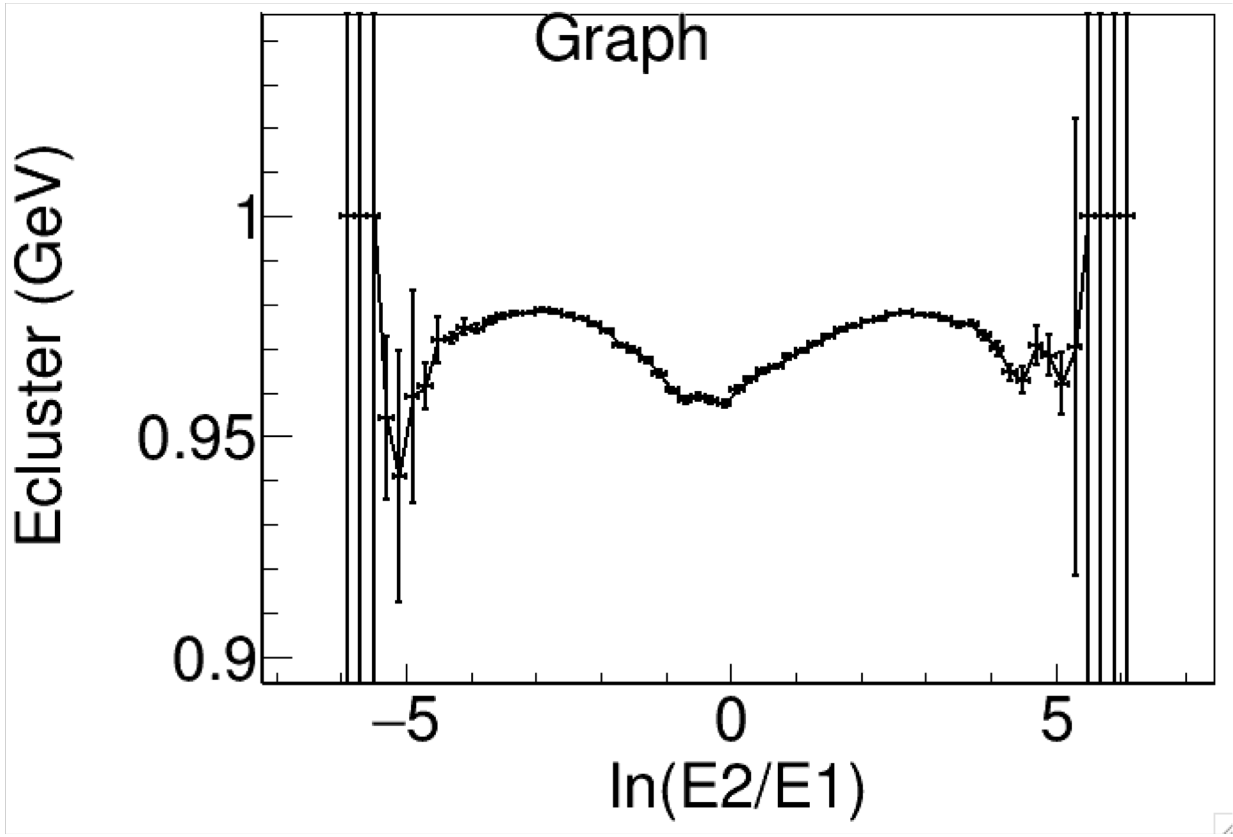


Energy calibration: correction for leakage in dead area Based on i theta correction

For θ=49.9



For ϕ=30.1



Energy calibration: correction for leakage in dead area
For different gaps

	iMod: 2							iMod: 1												
super modules	SM1	SM2			SM3			SM4			SM5			SM6			SM7			
L / R	7me	6me	5me	4me	3me	2me	1me	1pe	2pe	3pe	4pe	5pe	6pe	7pe	8pe	9pe	10pe	11pe	e
L / R	7md	6md	5md	4md	3md	2md	1md	1pd	2pd	3pd	4pd	5pd	6pd	7pd	8pd	9pd	10pd	11pd	d
L / R	7mc	6mc	5mc	4mc	3mc	2mc	1mc	1pc	2pc	3pc	4pc	5pc	6pc	7pc	8pc	9pc	10pc	11pc	c
L / R	7mb	6mb	5mb	4mb	3mb	2mb	1mb	1pb	2pb	3pb	4pb	5pb	6pb	7pb	8pb	9pb	10pb	11pb	b
L / R	7ma	6ma	5ma	4ma	3ma	2ma	1ma	1pa	2pa	3pa	4pa	5pa	6pa	7pa	8pa	9pa	10pa	11pa	a
alveole type	7m	6m	5m	4m	3m	2m	1m	1p	2p	3p	4p	5p	6p	7p	8p	9p	10p	11p	

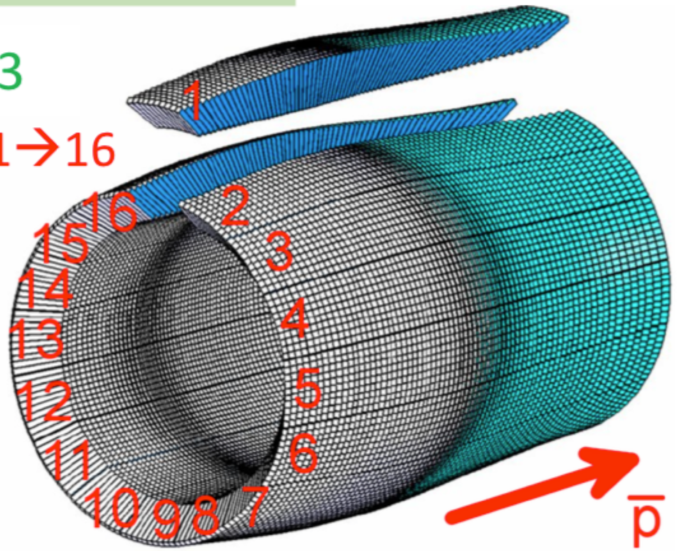
crystal shape left/right — *alveole position*

iCry: 10 ↑ 1

iRow: 28←1

iRow: 1→43

iCopy: 1→16

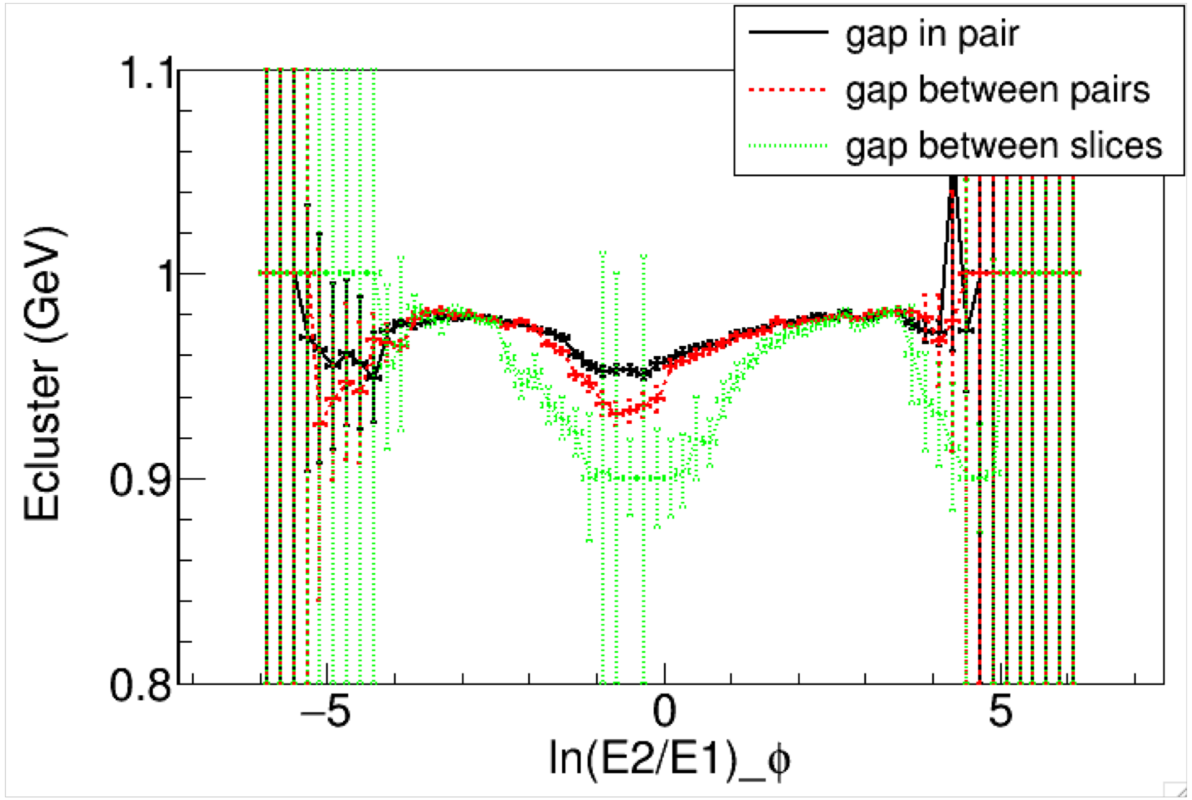


From Guang ZHAO

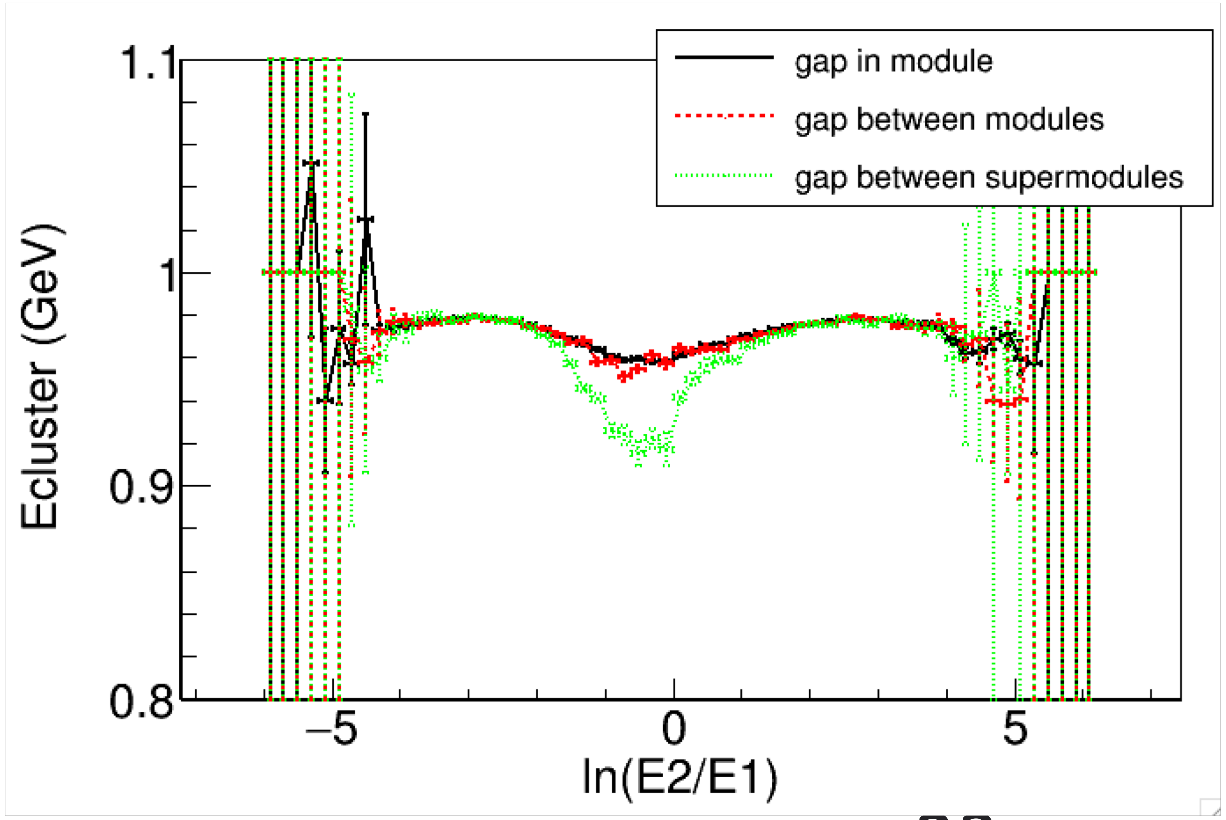
detID = iMod*1E8+iRow*1E6+iCopy*1E4+iCry

Energy calibration: correction for leakage in dead area
For different gaps

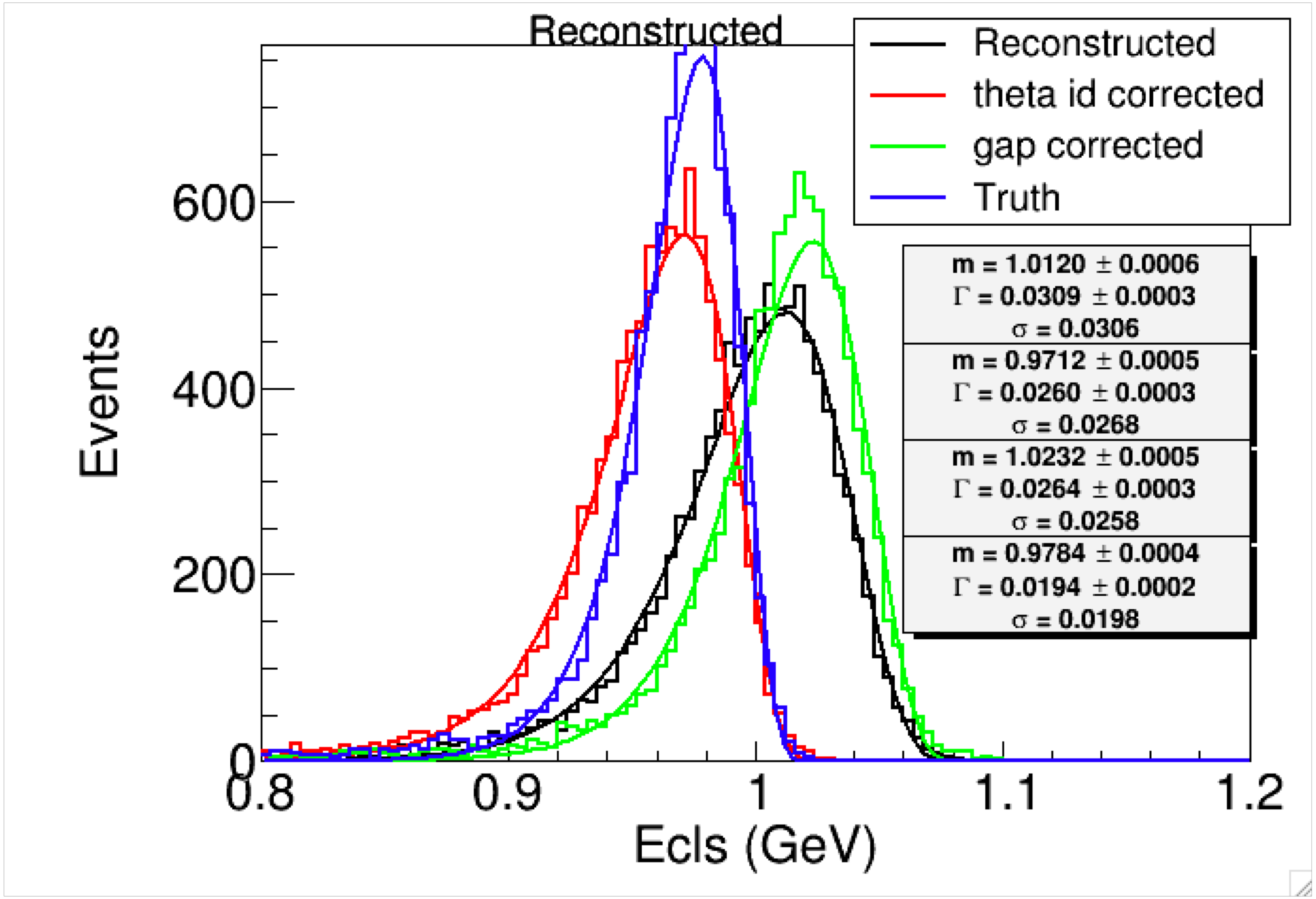
For θ=49.9, ln(E2/E1) in phi direction



For ϕ=30.1



Energy calibration: correction for leakage in dead area



Energy calibration: Status and Plan

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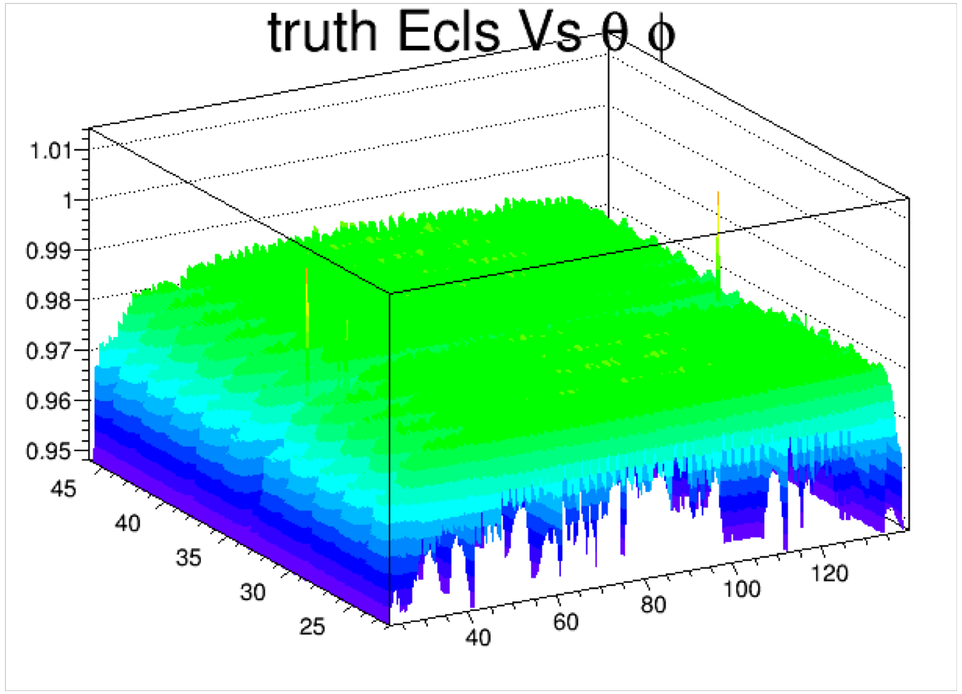
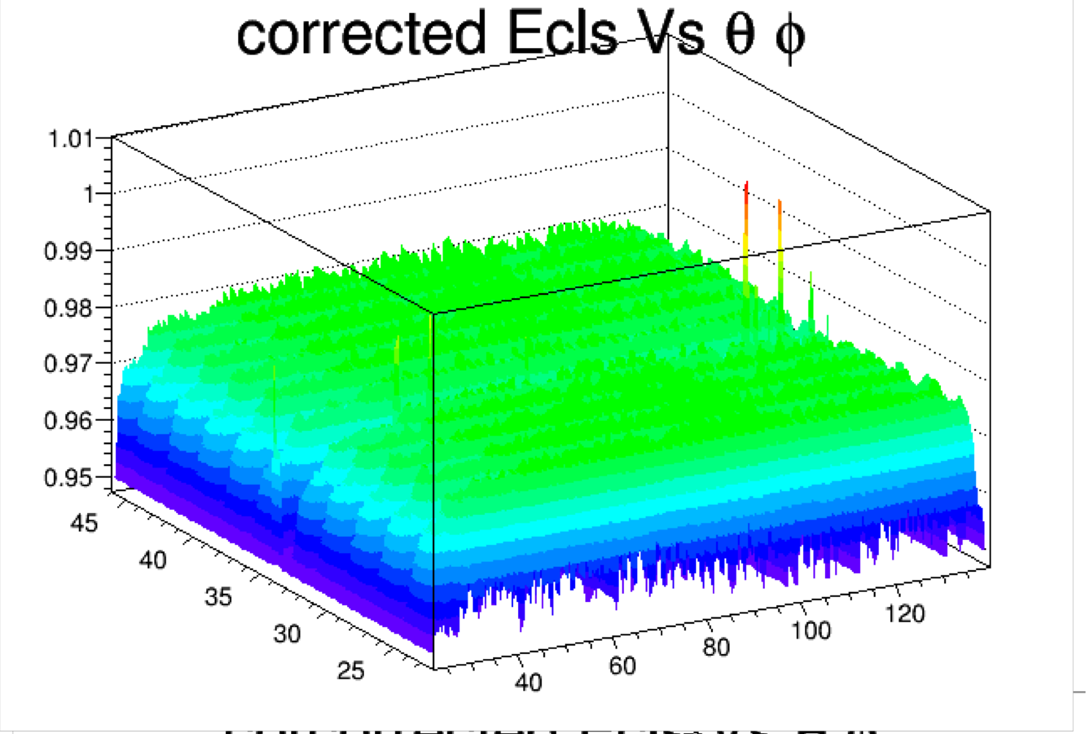
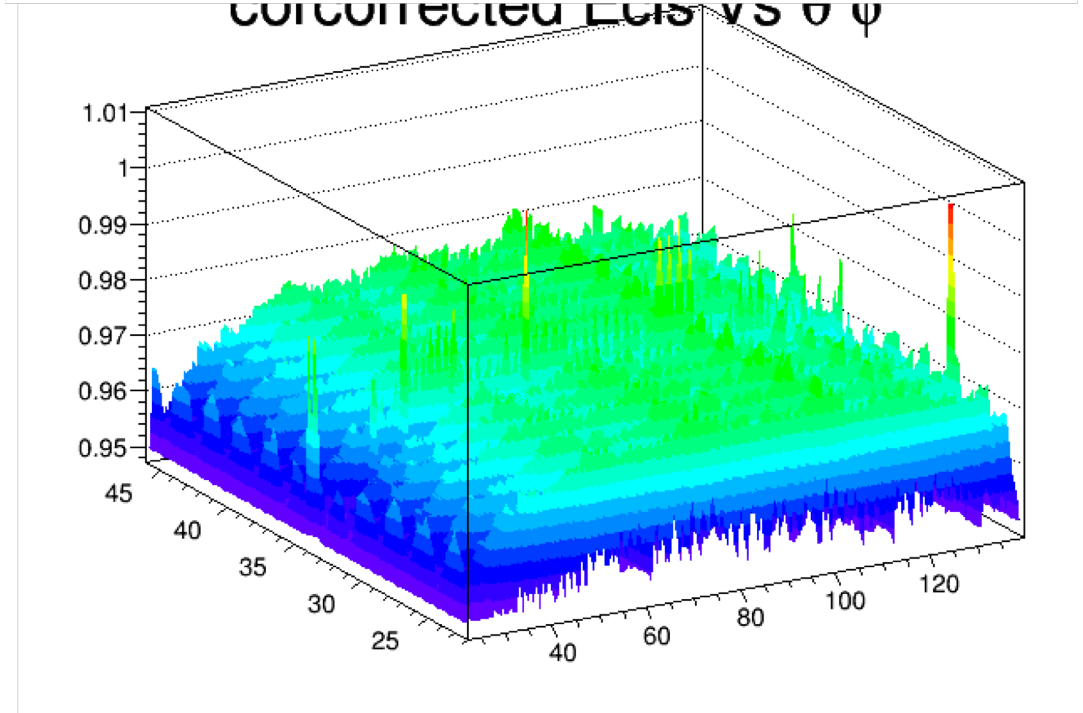
  - MVA or ML for energy correction



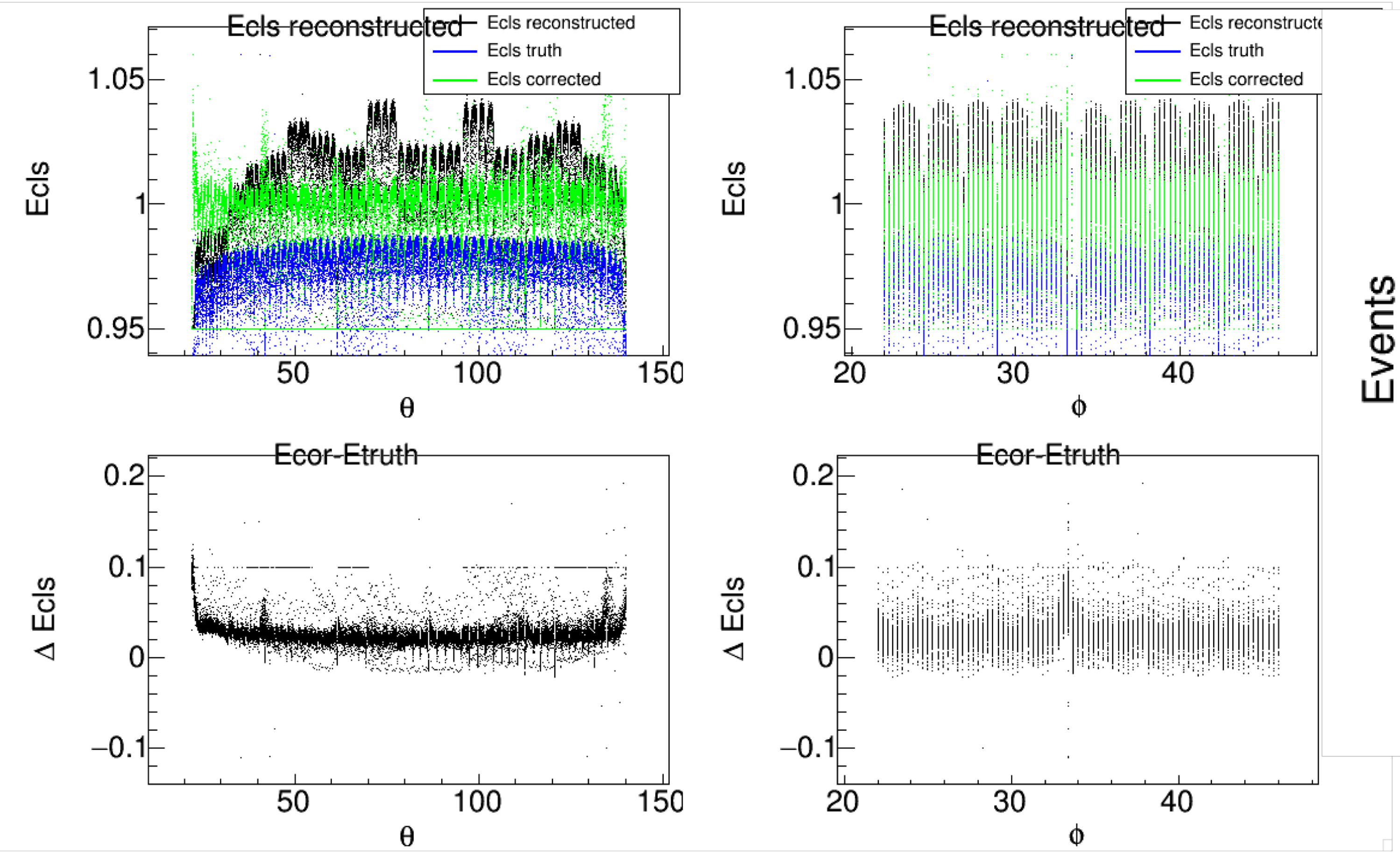


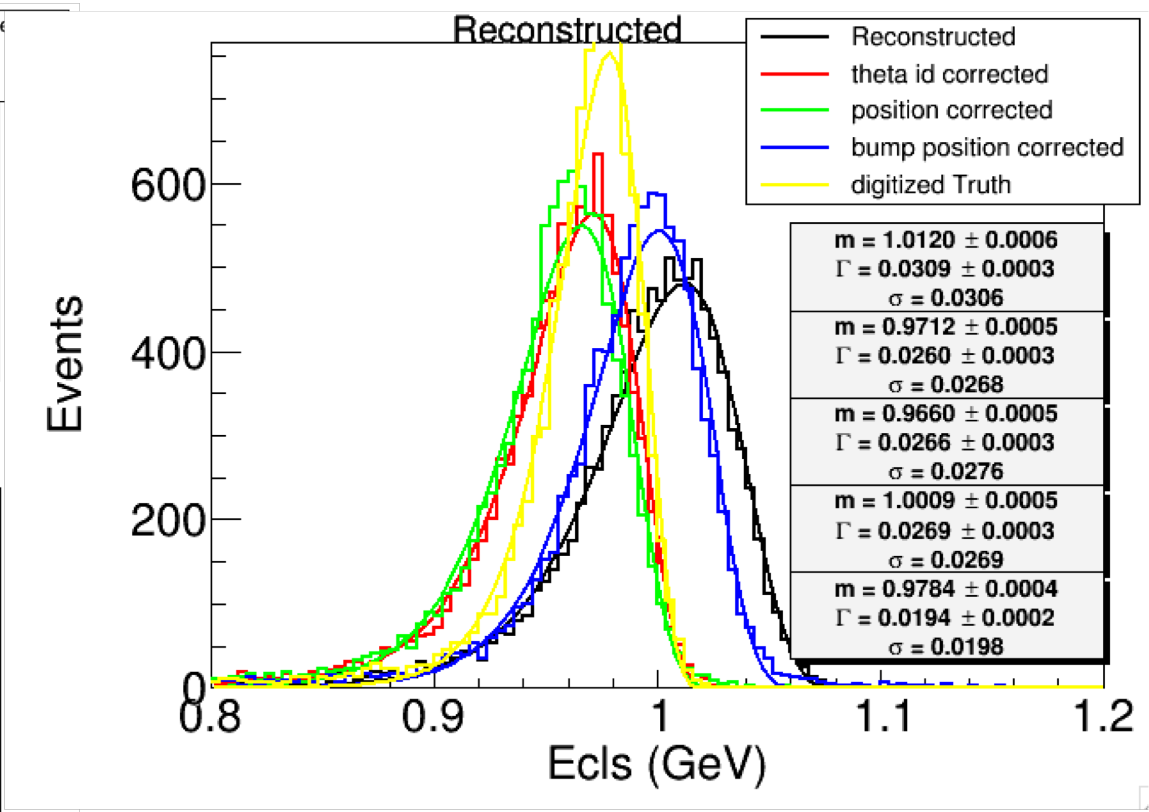
Problems:

For scan sample, position uncertainty affect the result



Energy calibration: correction base on bump position



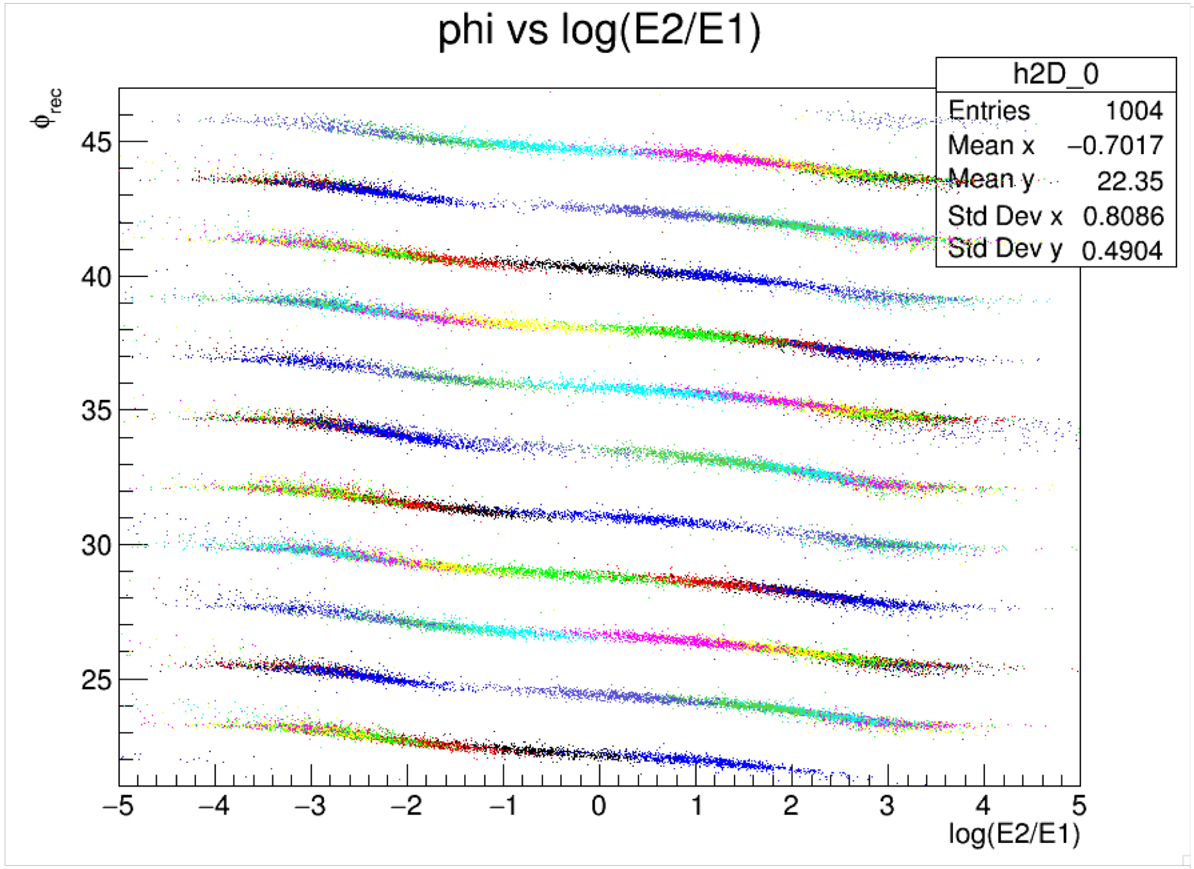


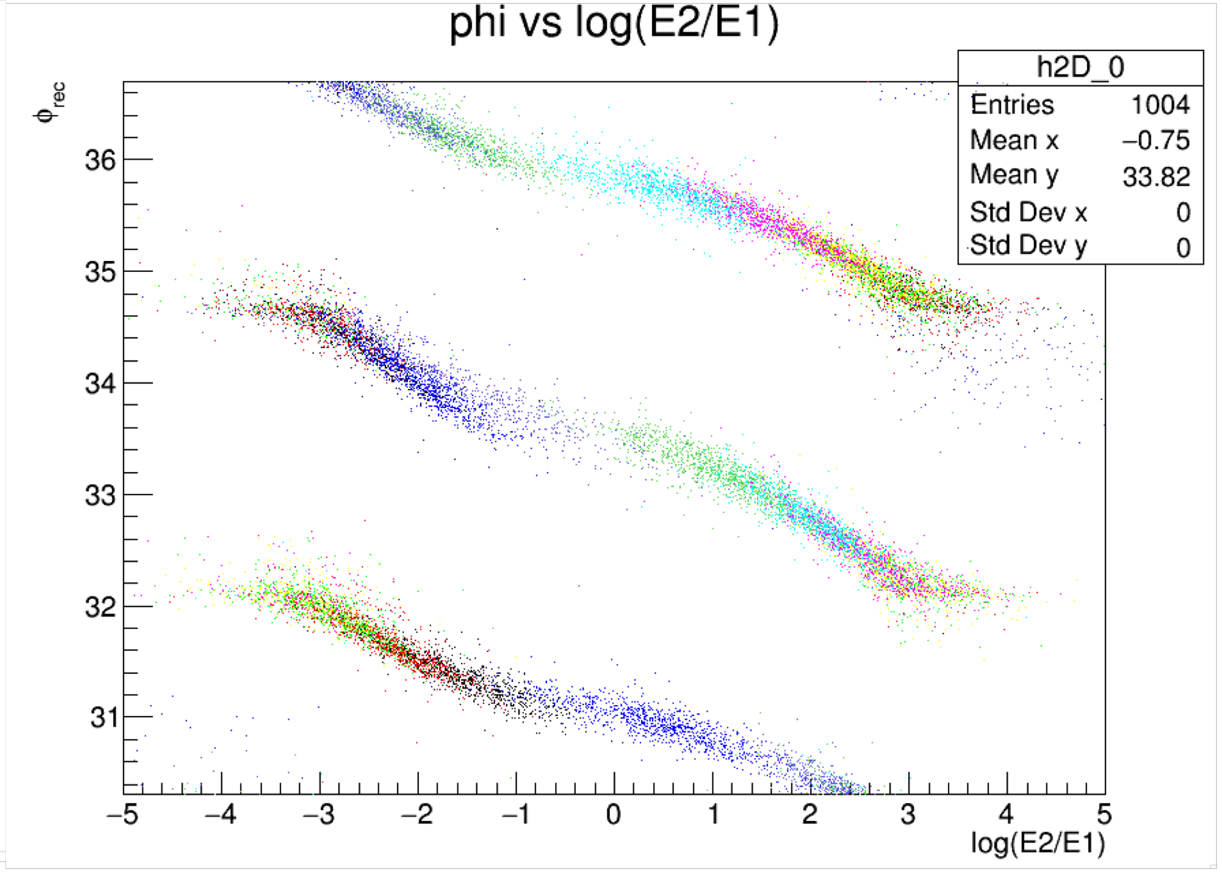
Position calibration

Position calibration
Based on i theta correction

For θ=49.9

One color corresponding to one sample





Position calibration
Based on i theta correction

For ϕ=30.1

One color corresponding to one sample