



# Status of CTB04 electron data vs MC analysis

Stathes Paganis (Sheffield)

Martin Aleksa (CERN)

Isabelle Wingerter (LAPP)

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# Objectives

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- ◆ To understand LAr energy **linearity**, **resolution** (Gaussian part) and **tails** (non-Gaussian part) in the presence of significant ( $>2X0$ ) amount of material in front of the calorimeter.
- ◆ Present status:
  - Electronics calibration (OFC, DAC2ADC, etc) and knowledge of the material distribution both affect reconstruction (especially tails) and obscure the analysis. Non-monochromatic beam (i.e. real tails) may also be present and affect the analysis (under study).

# Summary

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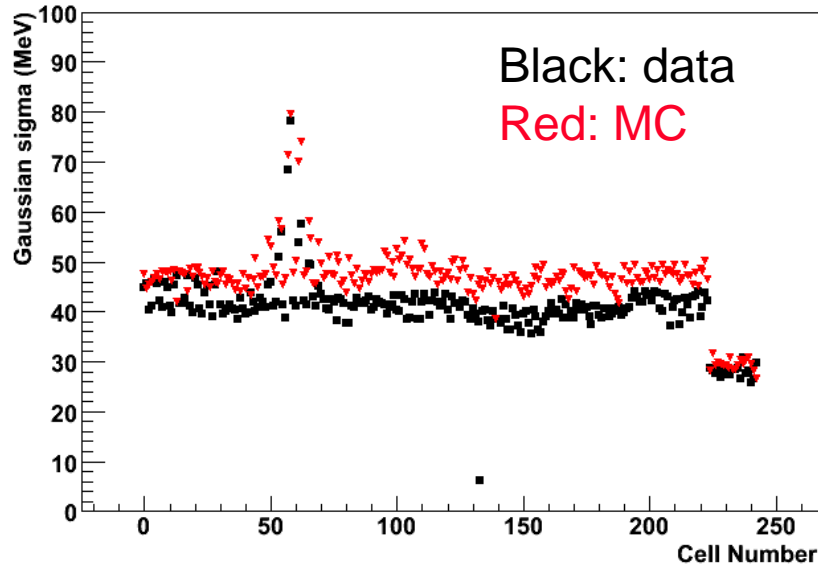
- ◆ Pedestals: OK, see <http://agenda.cern.ch/askArchive.php?base=agenda&categ=a052801&id=a052801s1t1/transparencies>
  - ◆ Beamline material (upstream of our triggers)
  - ◆ Beam Profiles
  - ◆ Energy vs TDC clock
  - ◆ Energy vs eta/phi
  - ◆ Cell Energies vs cluster eta/phi
  - ◆ Sampling Energies
  - ◆ Resolution (without weights)
  - ◆ Linearity (in progress)
  - ◆ Tails (in progress)
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# Data and MC: Sim/Dig/Rec details

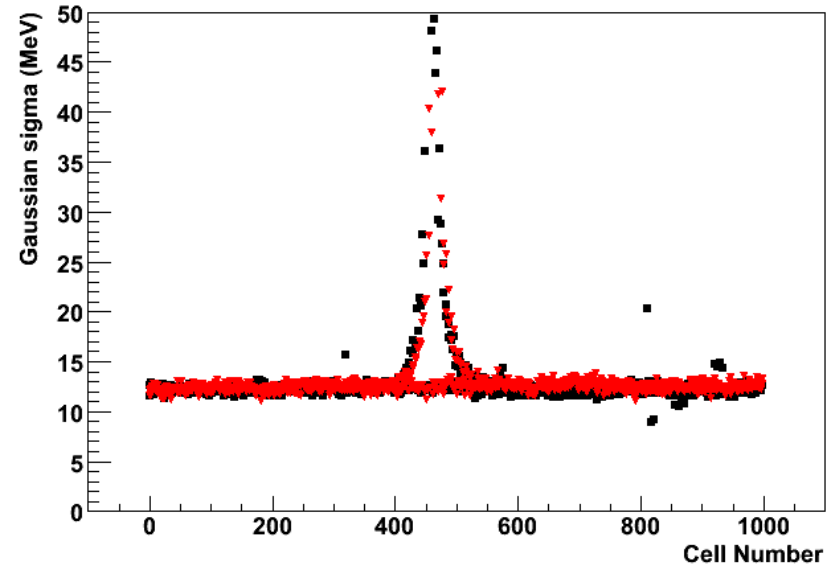
- ◆ Runs: 1000952-947-942-999 (20,50,100,180GeV)
  - Proposed by Isabelle W. from August, no extra Al material.
- ◆ Simulation: 10.0.4
  - PS E-field extends 13/11 longer in MC.
  - Strips Sampling depth is 1mm too short (in 10.0.4)
- ◆ Recon: 10.0.4 + Tags by Marco
  - OFCs : TB04-2
  - Pedestals: HEAD, Ramps, ADC2uA: TB04-default
  - uA2MeV: “new set” TB04-default
- ◆ Final Analysis (keep it simple):
  - $0.91 * E_{strips}$  (Data: first rough cross-talk approximation)
  - $11/13 * E_{ps}$  (MC: to account for E-field extend)
  - $0.97 * E_{rec}$  (MC: just a normalization)

# Pedestal Gaussian Sigma (Run: 1000952)

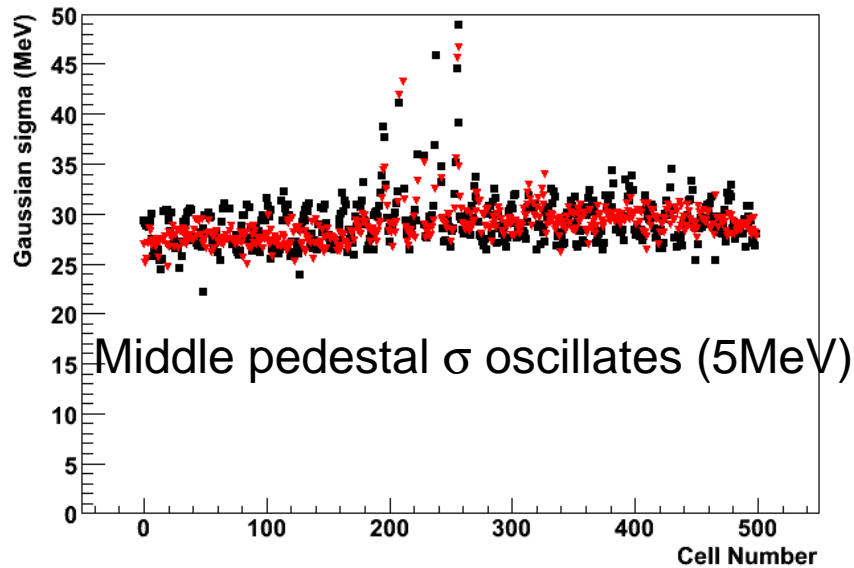
PS Cell Energies



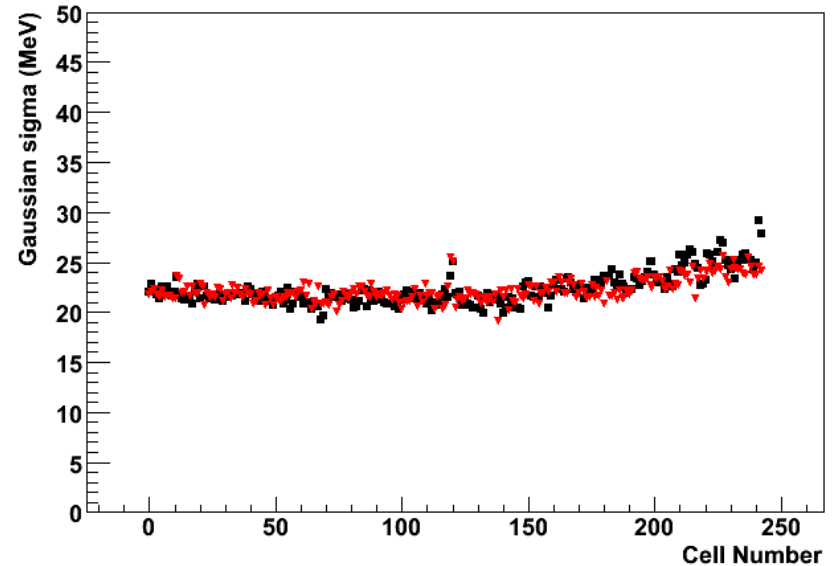
Strip Cell Energies



Middle Cell Energies



Back Cell Energies



# Material in the beam line

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- ◆  $0.15 \pm 0.02 X_0$  of material from tertiary target to the -27m point where our simulation starts.
- ◆ This is a 400m long line with magnets, so a mere addition of  $0.15 X_0$  in our G4Sim may not work.
- ◆ Status:
  - First Efforts to simulate the beamline (Maarten Boonekamp). This is worthwhile especially if we intend to look back in these data in the future. Better do it now than in 2008!
  - Presently I add  $0.15 X_0$  at -20m (poor man's solution).
  - I produced a first map of the region (in progress/see next page)

# Material in the beam line

Preliminary material budget I sent to Maarten (very preliminary). Please give any comments/corrections

0. The "official" test beam setup can be found at:  
<http://eagroup.home.cern.ch/eagroup/beatch/h8-2004a.txt>

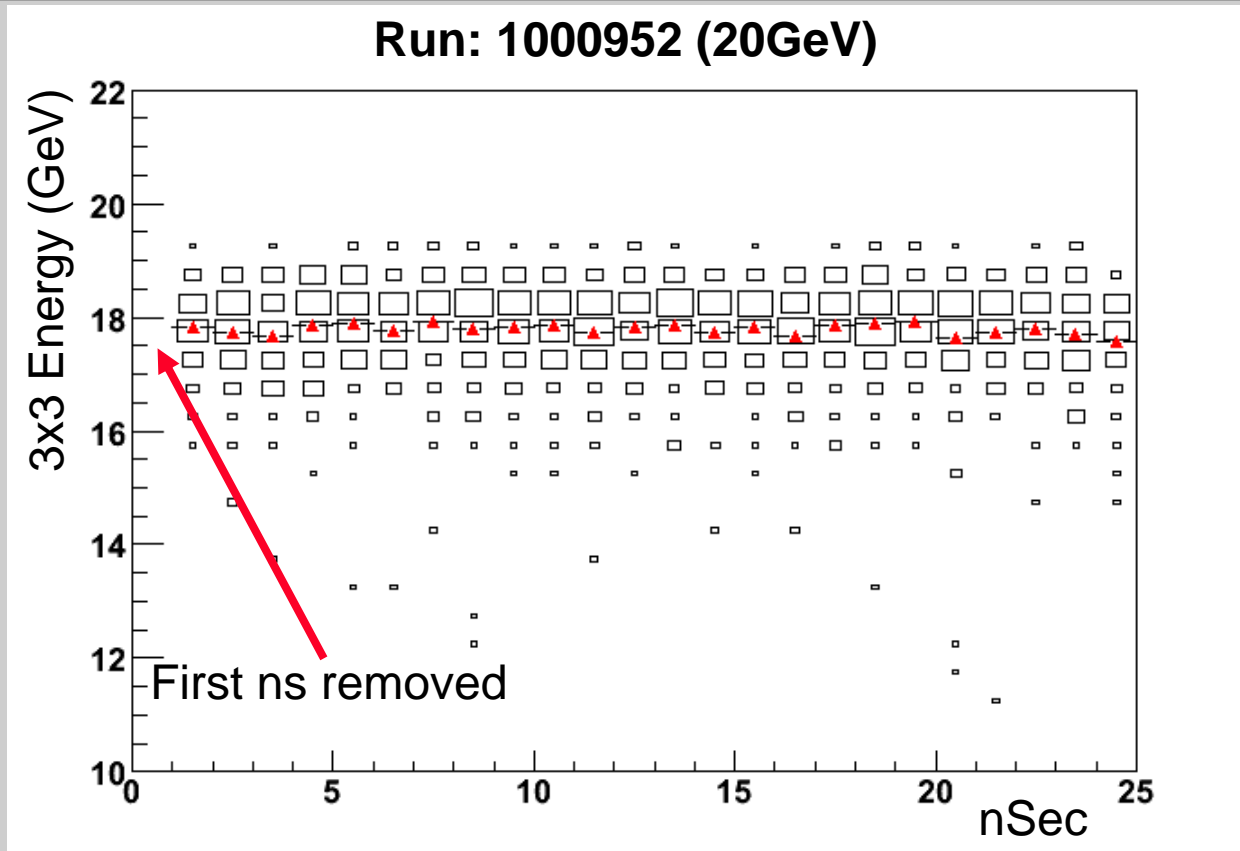
1. Starting point: a tertiary target at: 130.817 meters

For more info click here:

<http://agenda.cern.ch/askArchive.php?base=agenda&categ=a052801&id=a052801s1t1/transparencies>

Material	Thickness	Start	End
Air	0.531m	130.817	131.348
Al Window	0.1mm	131.348	
Al Window	0.1mm	198.280	
Air	0.357m	198.280	198.637
Al Window	0.1mm	198.637	
Al Window	0.1mm	235.330	
Air	0.555m	235.330	235.885
Al Window	0.1mm	235.885	
B3 B4 B4 - B3 B3 B4 (MAGNETS)			
Al Window	0.1mm	403.840	
Air	0.22m	403.840	404.06
My Window	0.12mm	404.060	
Air	0.60m	409.110	409.71
My Window	0.12mm	409.710	
B5 B6			
My Window	0.12mm	419.732	
Air	1.0m	419.732	420.732
My Window	0.12mm	420.732	
My Window	0.12mm	463.468	
Air	12.412m	463.468	475.88
Scint TRIG5	3mm	463.598	(~0.024X0)
Cherenkov1	???	475.385	(~0.01X0)
My Window	0.12mm	475.885	
My Window	0.12mm	476.507	
Air + NA45	6.671m	476.507	483.178
(in NA45 there are 2 thin Kapton windows - Ilias knows thickness)			
My Window	0.12mm	483.178	
My Window	0.12mm	509.168	
Air	2.493m	509.168	511.661
My Window	0.18mm	511.661	
My Window	0.18mm	532.867	
Air	3.214m	532.867	536.081
My Window	0.18mm	536.081	
My Window	0.18mm	541.710	
Trigger Counters		542.680	(is that the -27meters?)
Atlas LAr Calorimeter		577.807	(is this right?)

# Energy vs TDC clock



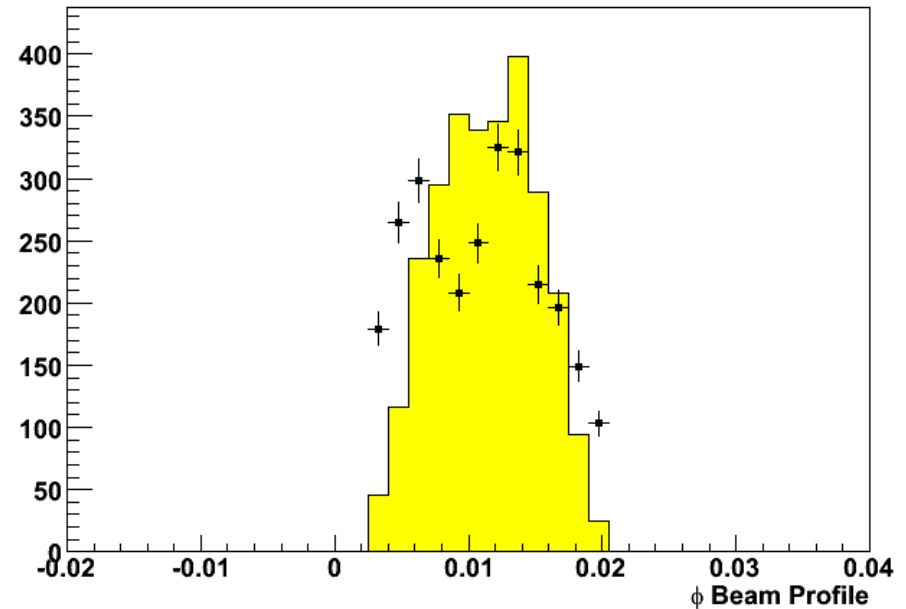
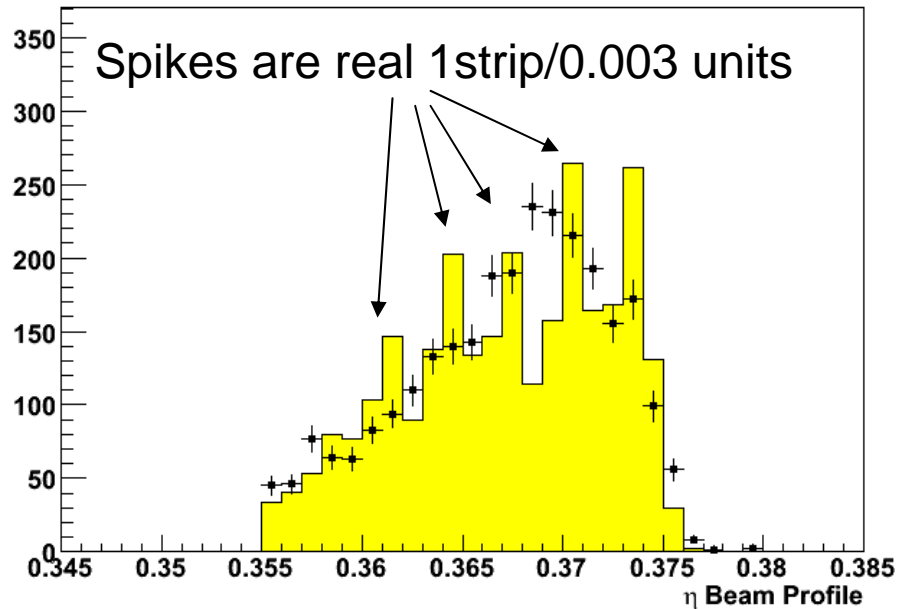
All runs show similar level of fluctuation per ns bin:  
Expect worse Gaussian resolution in data due to the fluctuation  
(can be modelled and added in the MC from the spread of the red triangles in the figure).

# Beam Profiles

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- ◆ Data vs MC comparisons must be done after reasonable agreement in etaRec/phiRec (including their correlations).
- ◆ Solution that works:
  - MC: Start with flat distributions in eta/phi and reconstruct.
  - MC: Save histograms per run after reconstruction.
  - Data: Save histograms per run after reconstruction.
  - MC: Read the MC and Data eta/phi histograms and attempt to reweight the MC to match the data.
  - CAUTION: cell-miscalibrations may bias the eta/phi distributions! This means reweighting absorbs these problems (bad).

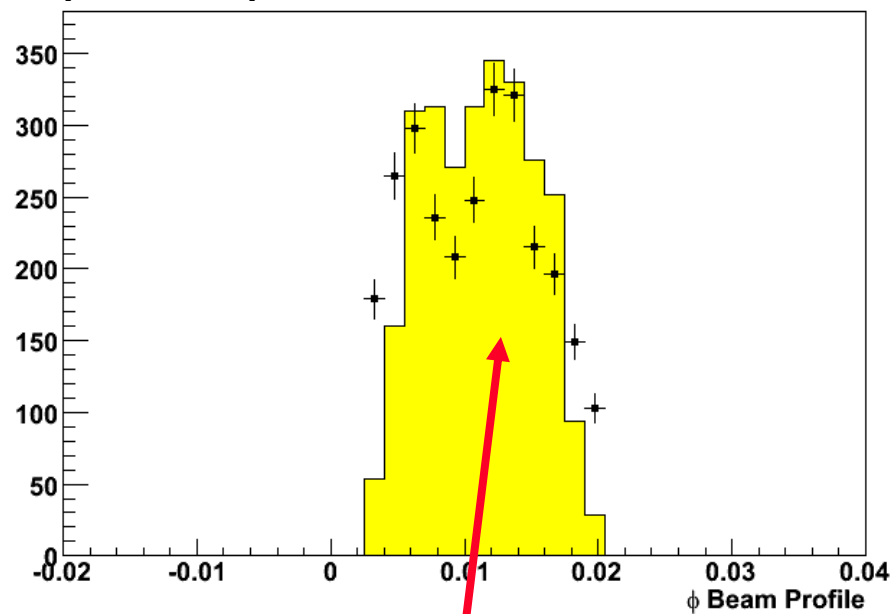
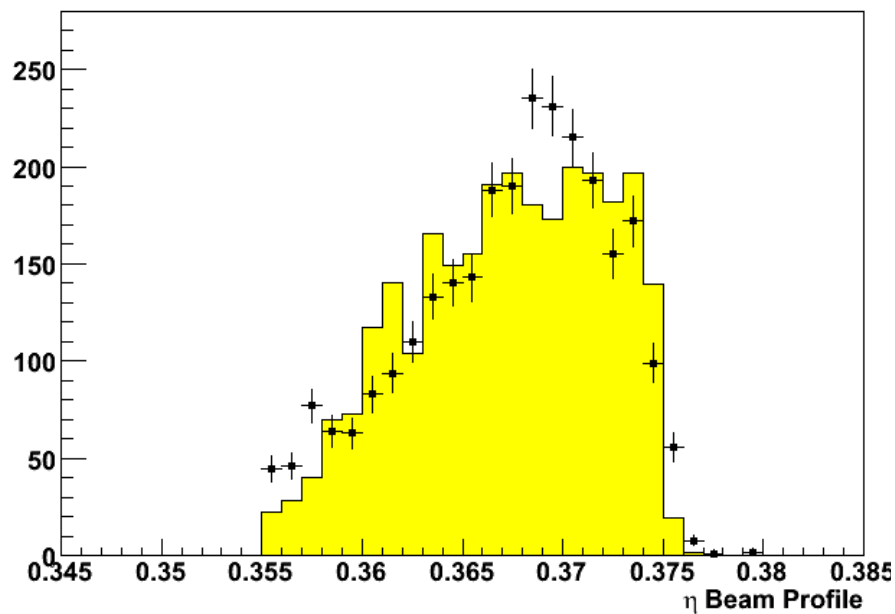
# Beam Profiles (before reweighting)



Note: if we calculate eta from the strips (by linear weighting) position is biased towards the center of the strips. The effect is more pronounced in the MC probably due to the reduced cross-talk in the simulation.

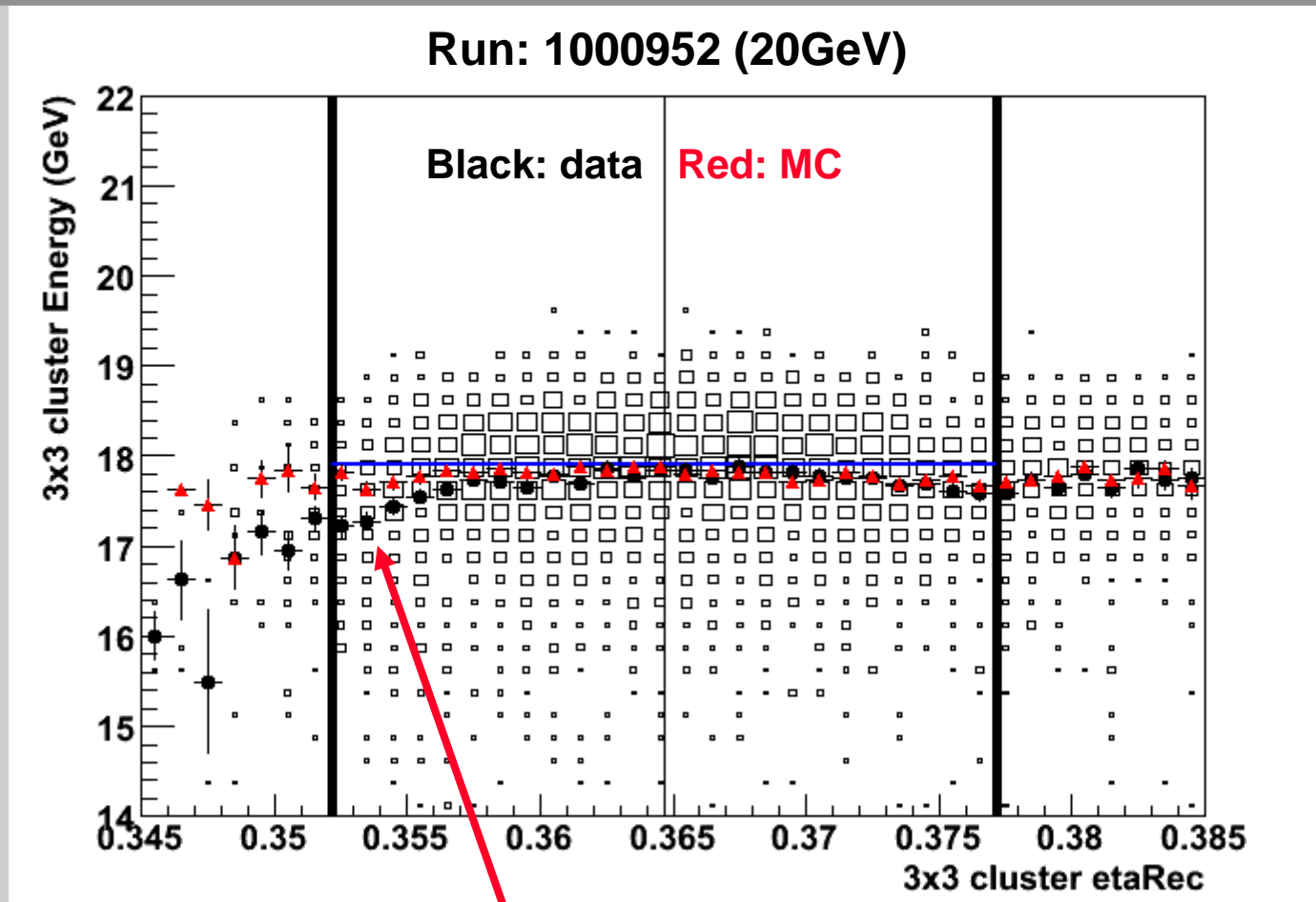
# Beam Profiles (after reweighting)

Run: 1000942 (100GeV)



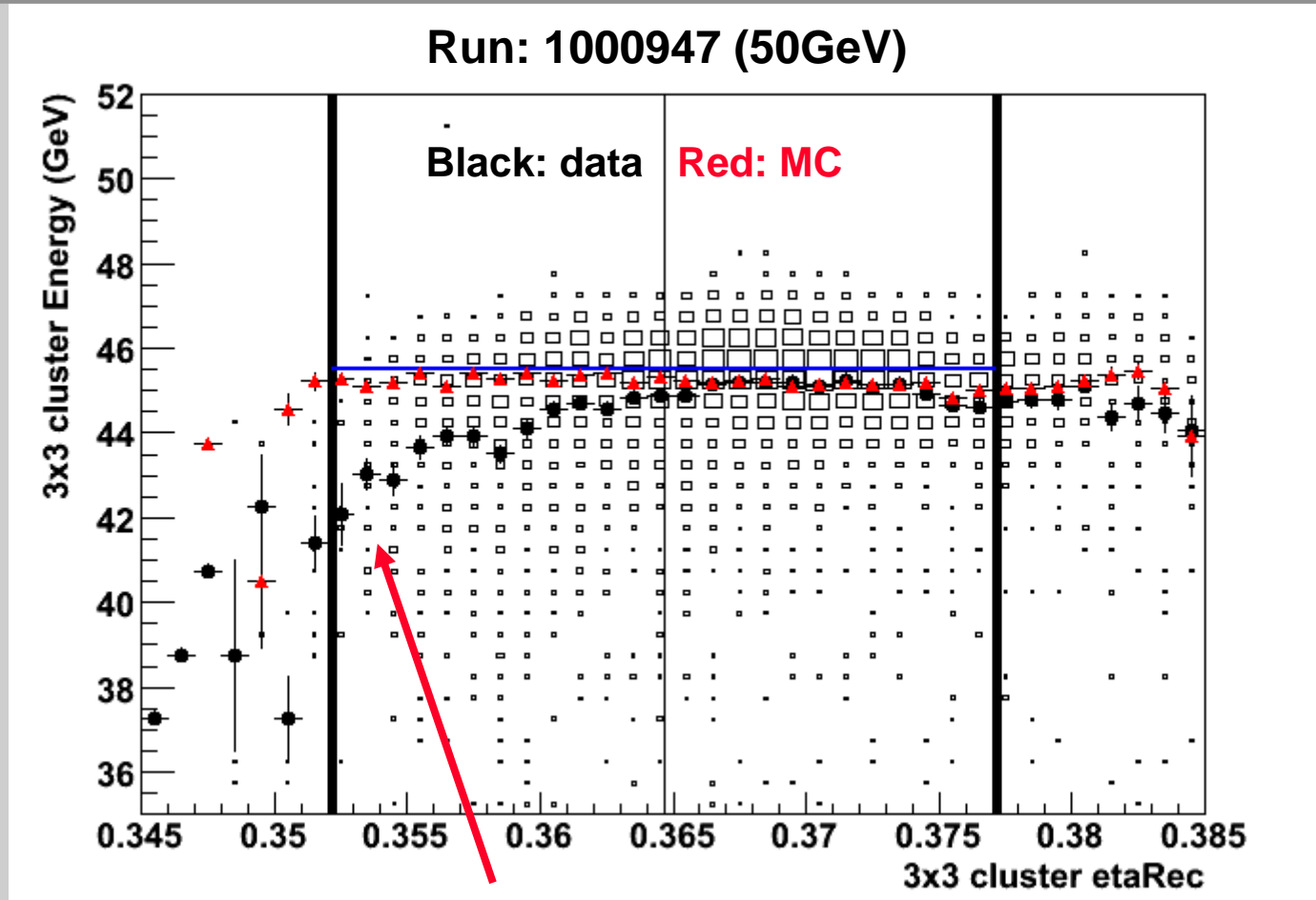
Phi profile not well reproduced

# Energy vs eta



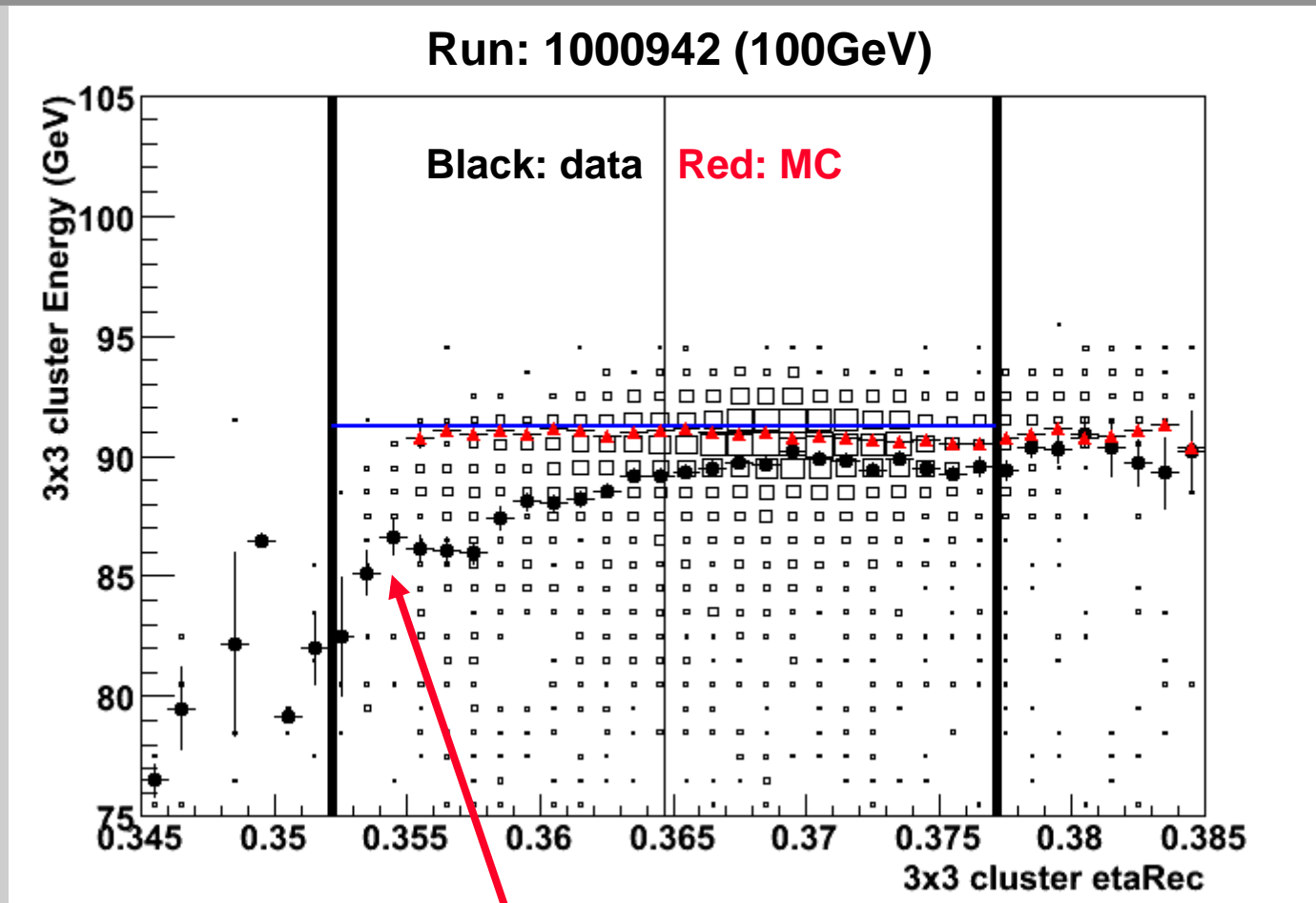
1% Drop at the edge of the cell visible  
At low eta we see  $\gg 1\%$  drop in the data only

# Energy vs eta



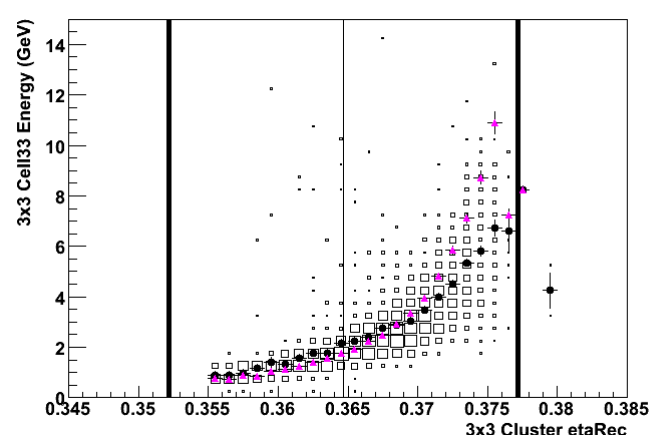
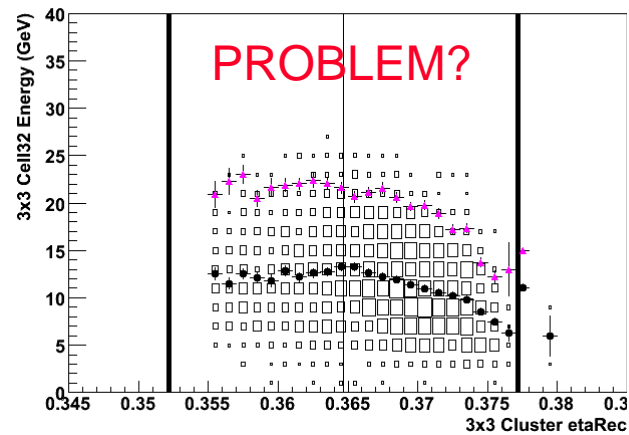
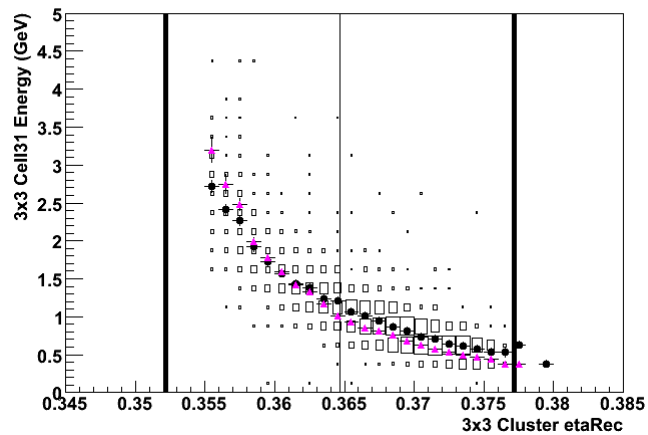
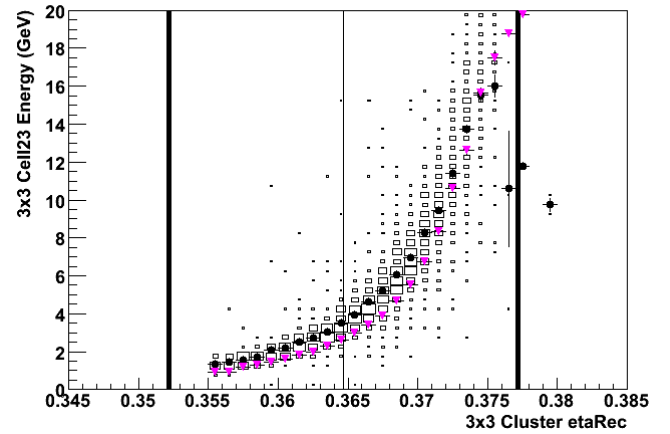
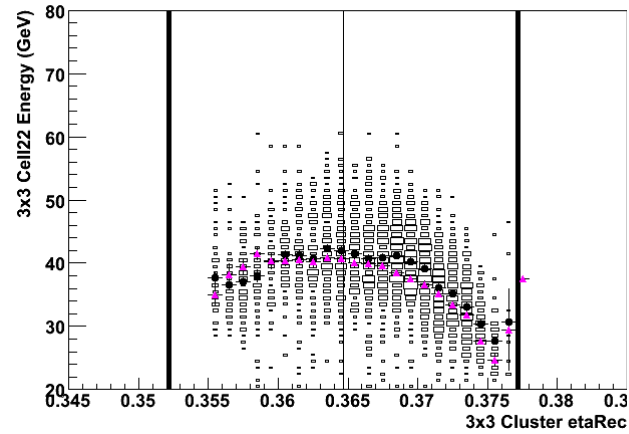
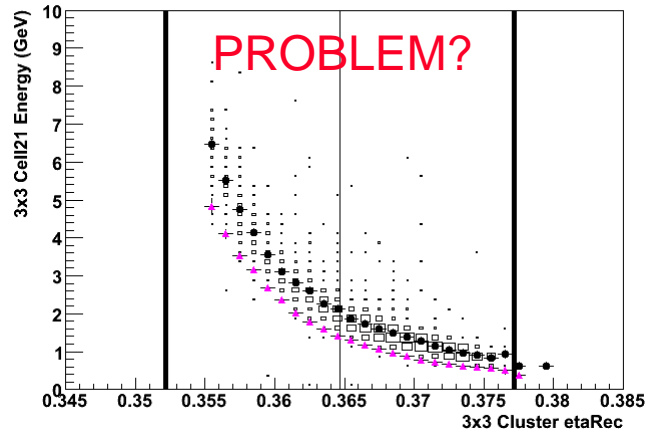
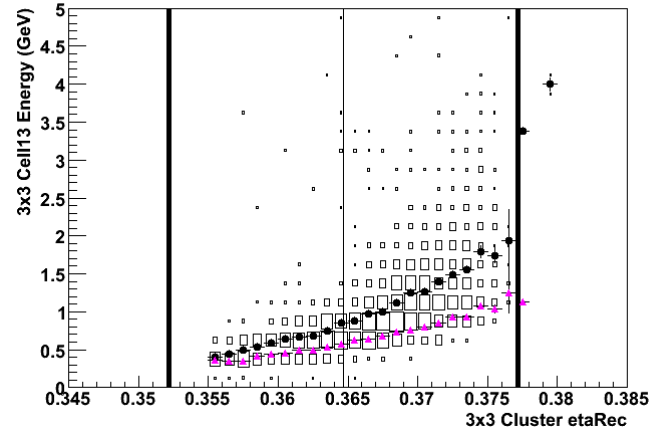
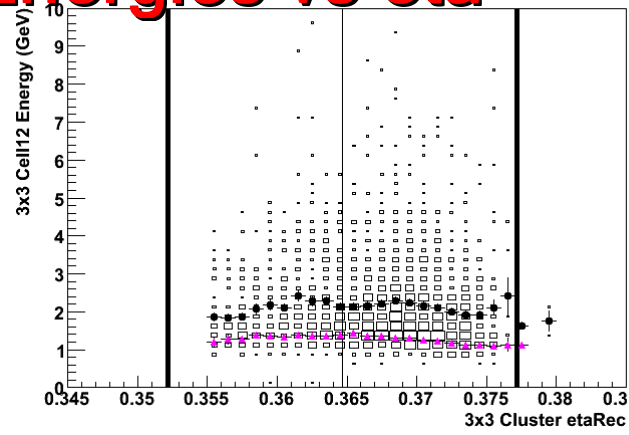
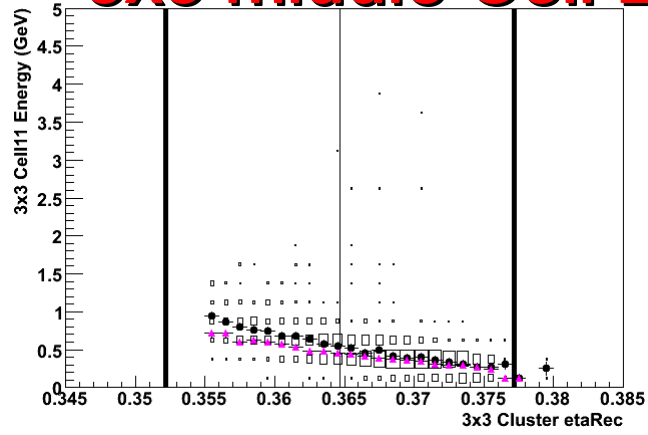
At low eta we see increased drop in the data only

# Energy vs eta

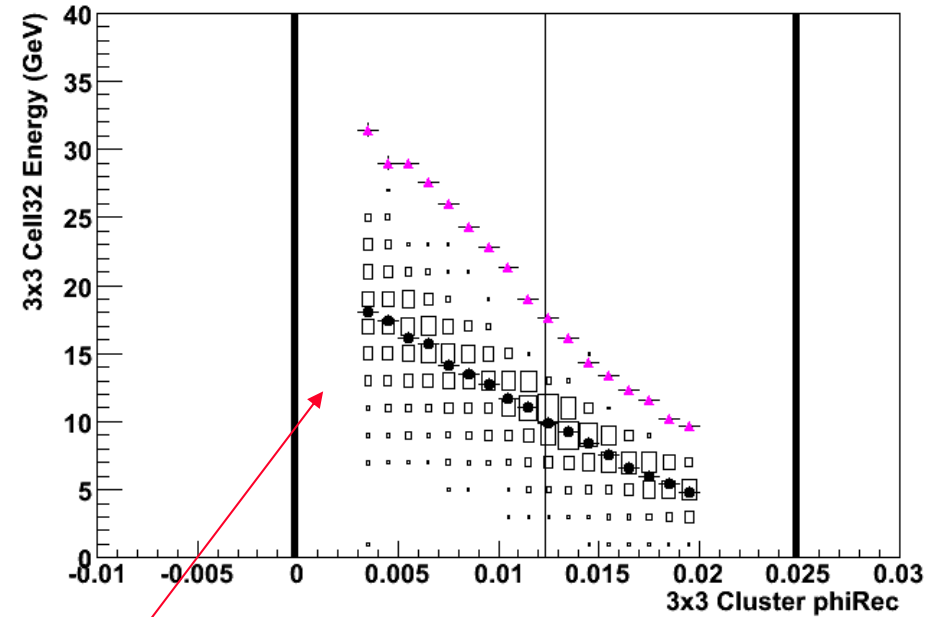
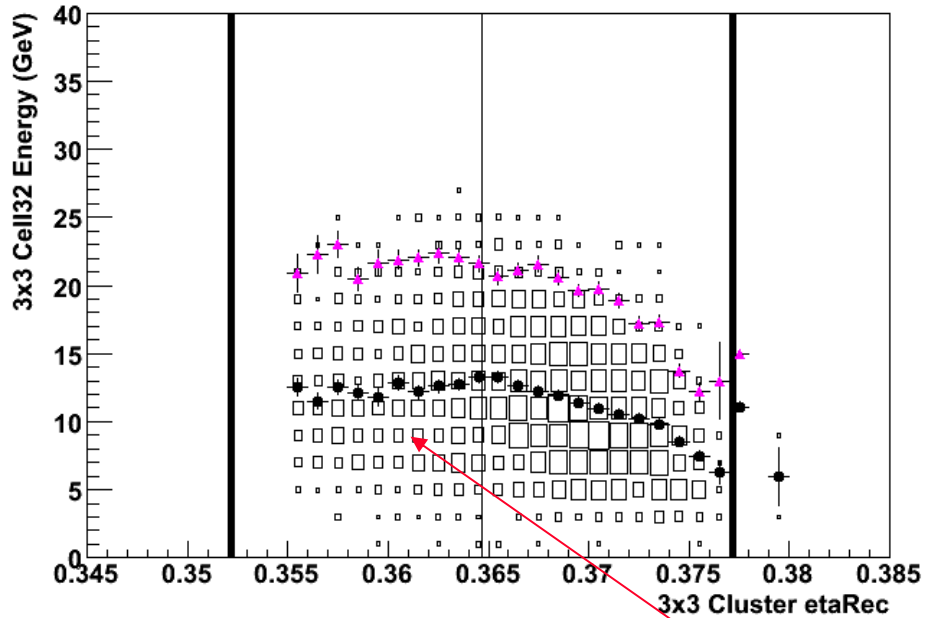


At low eta we see increased drop in the data only

# 3x3 middle Cell Energies vs eta

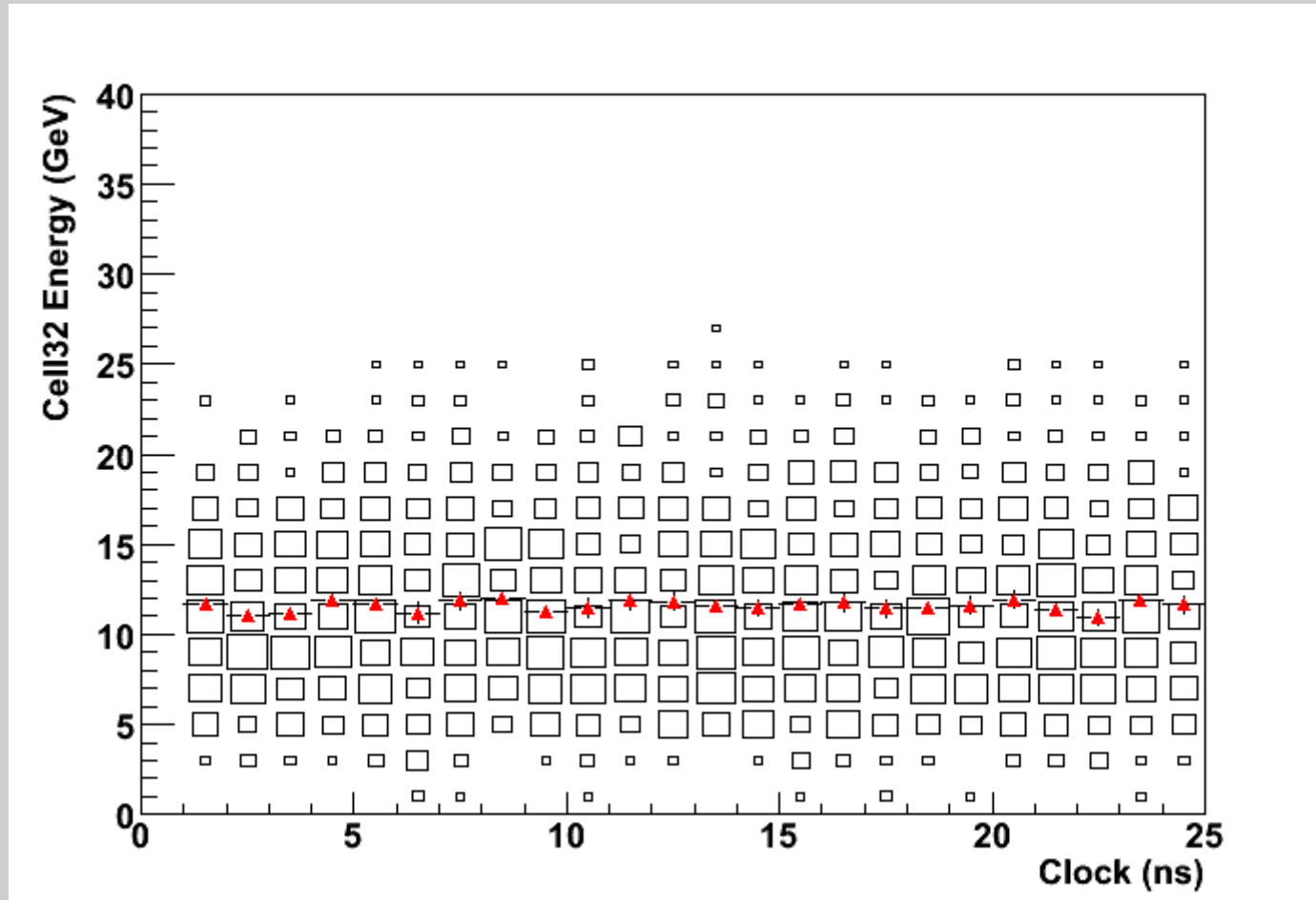


# Cell32 Energy vs eta/phi

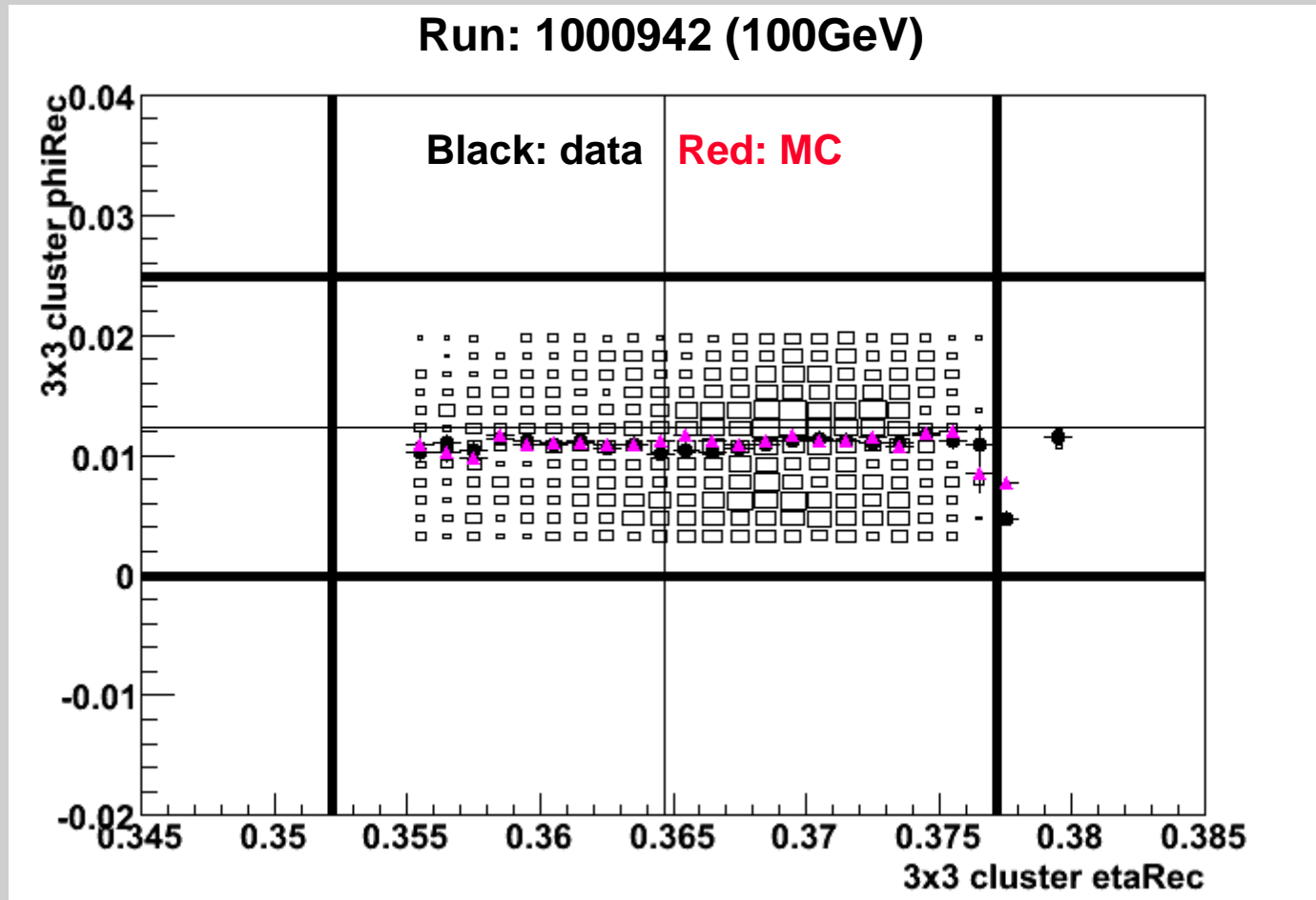


1. Absolute Energy difference between data and MC increases when we go lower in eta and phi: this can cause the tail.

# Cell32 Energy vs Clock



# Phi vs Eta comparison

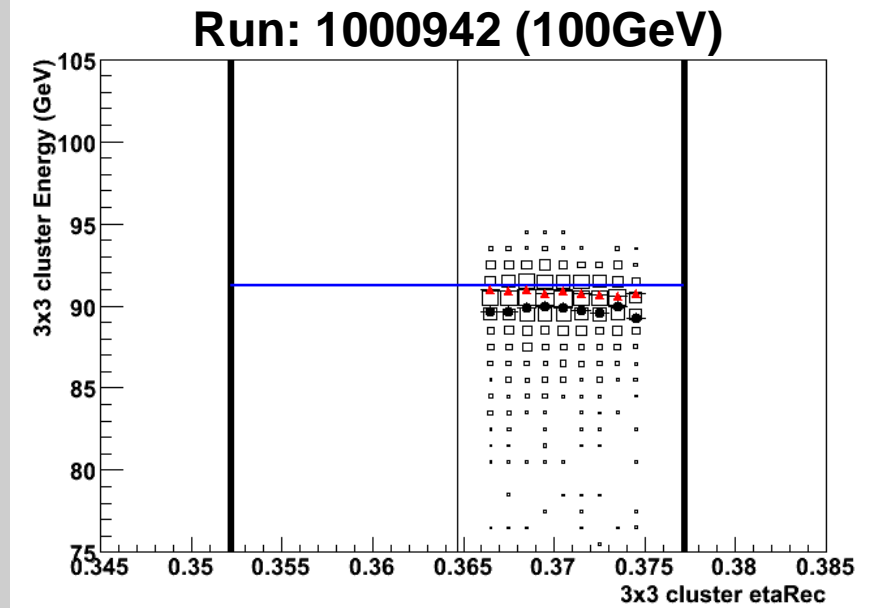
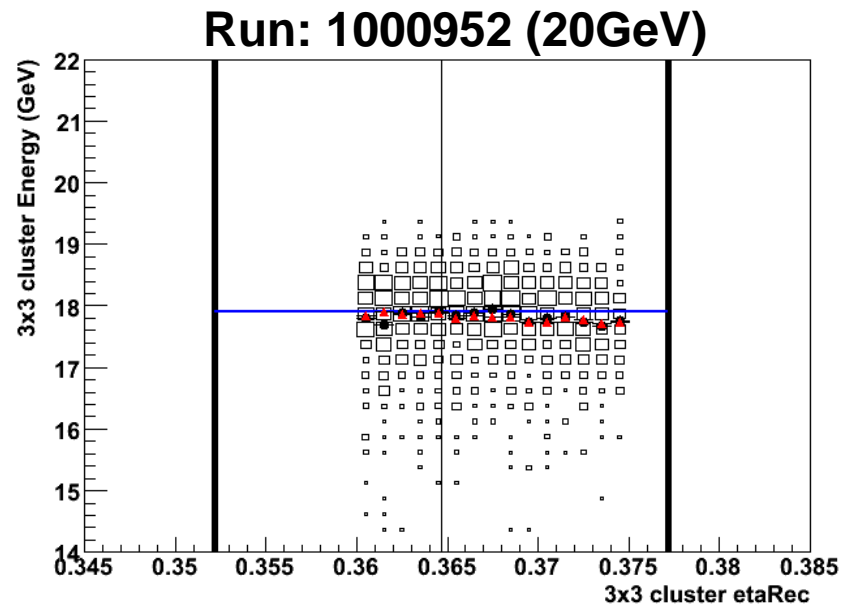


No strong correlation is seen.

# Resolution Study

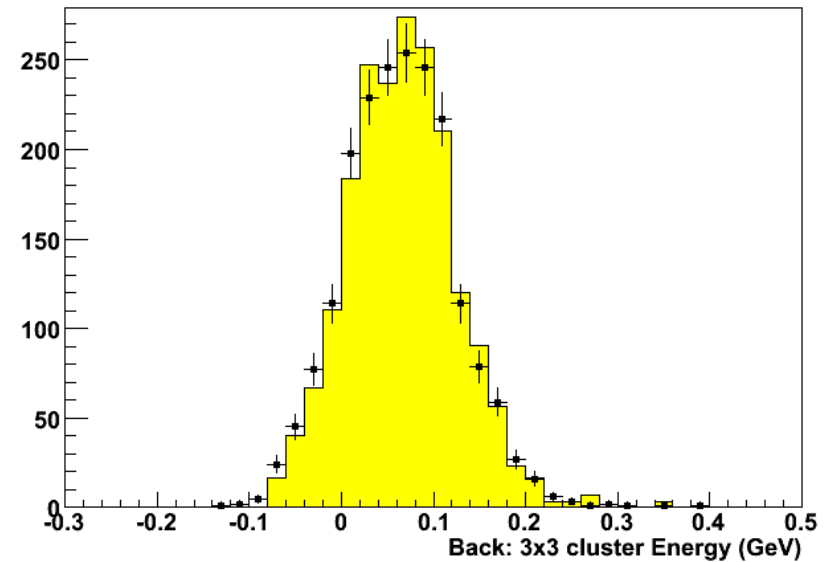
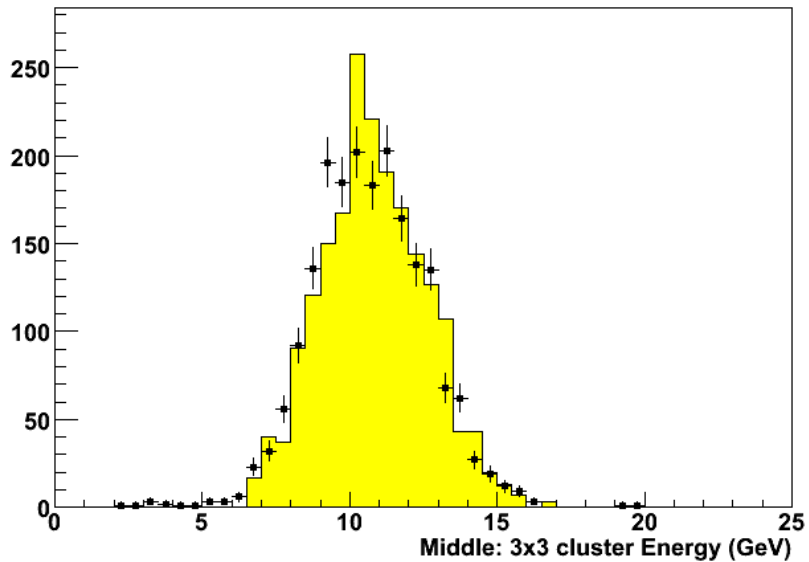
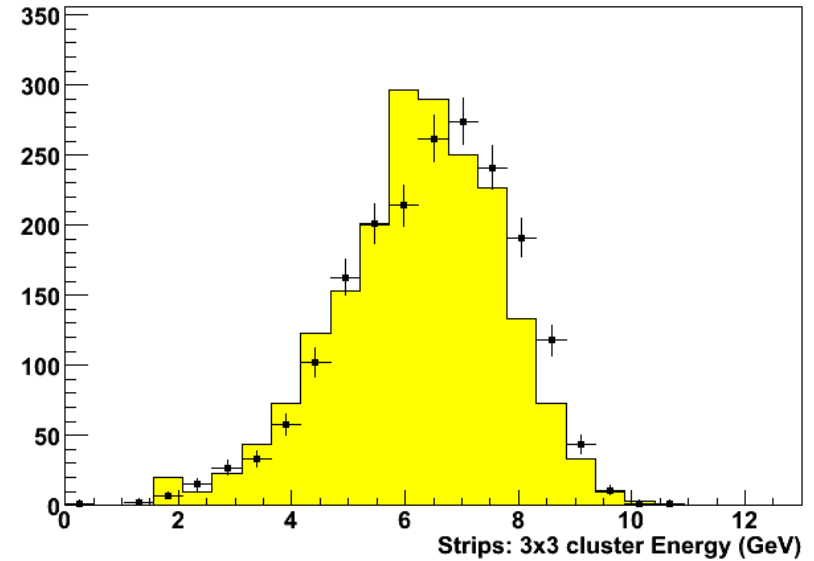
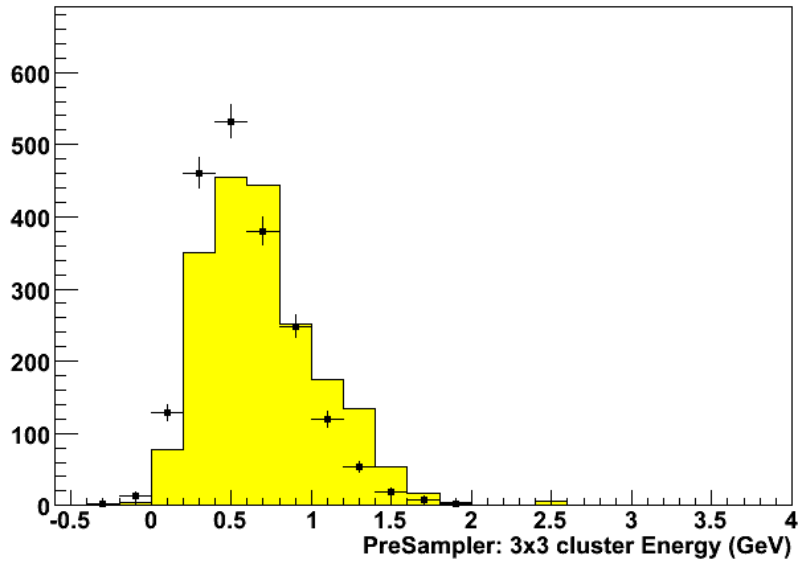
- ◆ Use extra 0.15X0 at -20m, and 0.15X0 in front of cryostat.
- ◆ To get an idea for the resolution: we make an eta cut to avoid the tail problem.
- ◆ Use 3x3 with at least 67 cells
  - MC always have 69 = 6+48+9+6
- ◆ Simple Normalizations:
  - Data:  $E0 = 11/13 * E0$  (from PS simulation)
  - Data:  $E1 = 0.91 * E1$  (cross-talk)
  - MC:  $E_{3x3} = 0.97 * E_{3x3}$  (just a normalization)
- ◆ **Reminder: a small shift higher for the MC in the middle and lower in the strips is expected**
  - Guillaume's strip length fix not in 10.0.x

# Resolution study: eta cuts



# Resolution Study: Sampling Energies

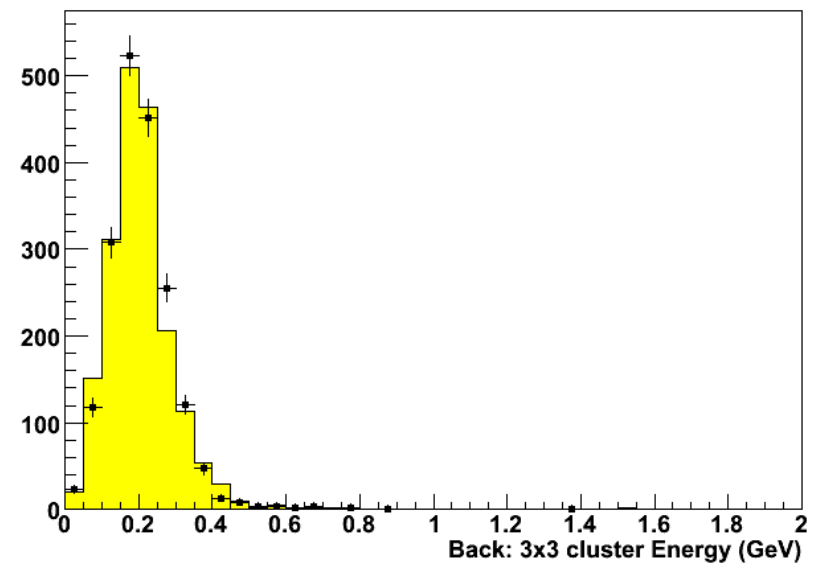
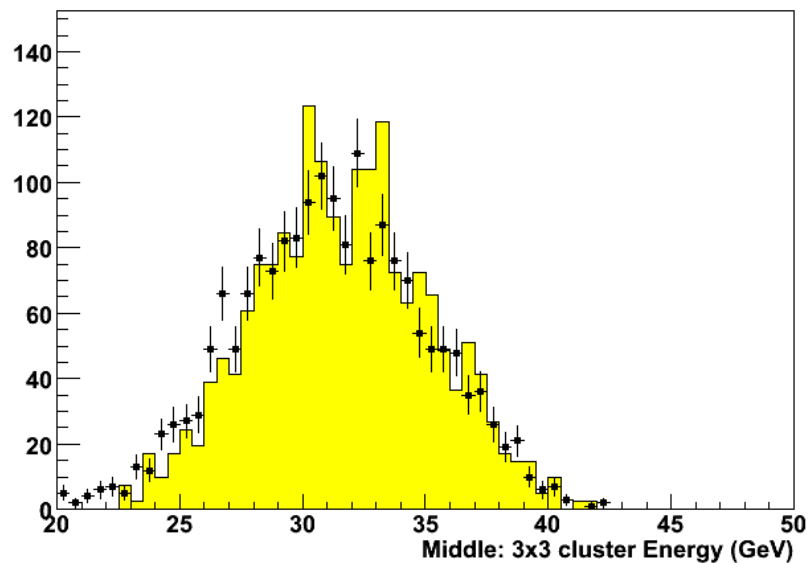
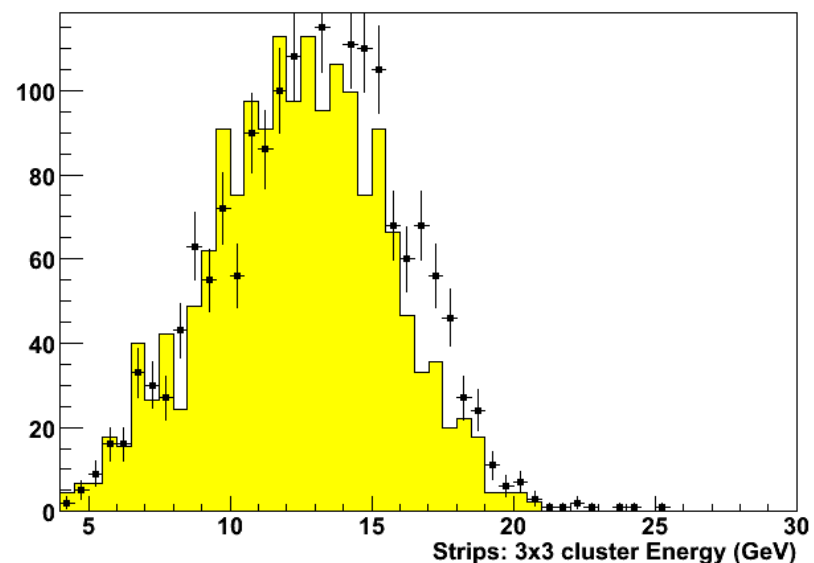
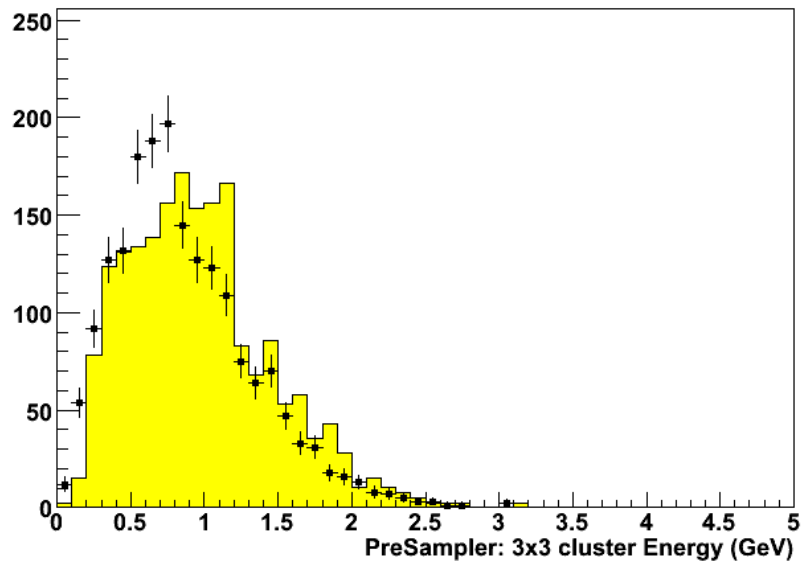
Run: 1000952 (20GeV)



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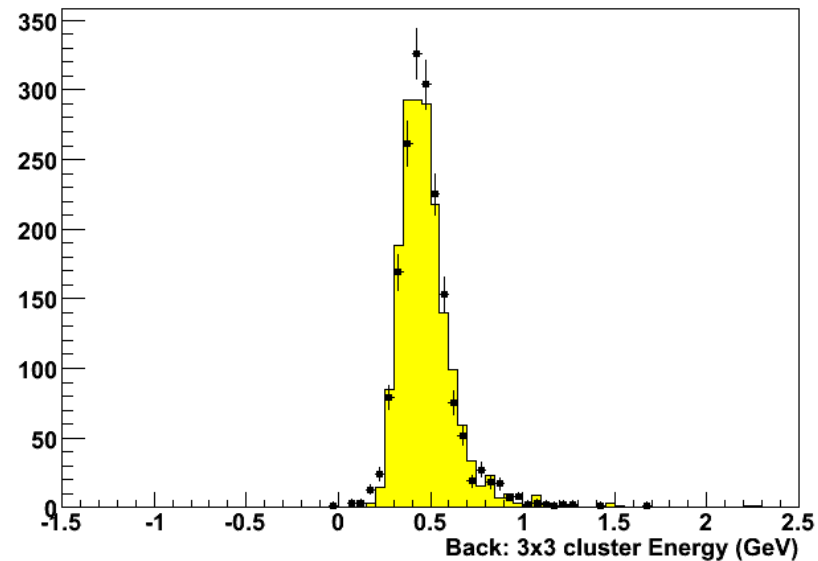
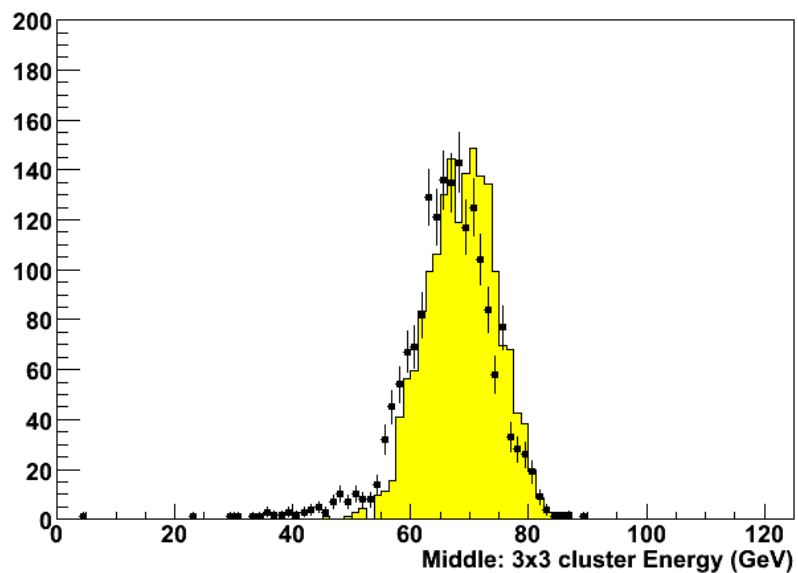
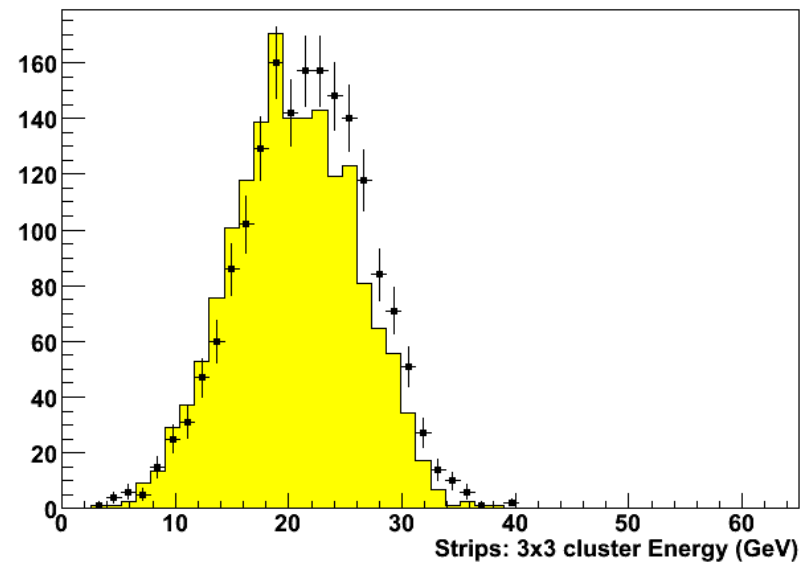
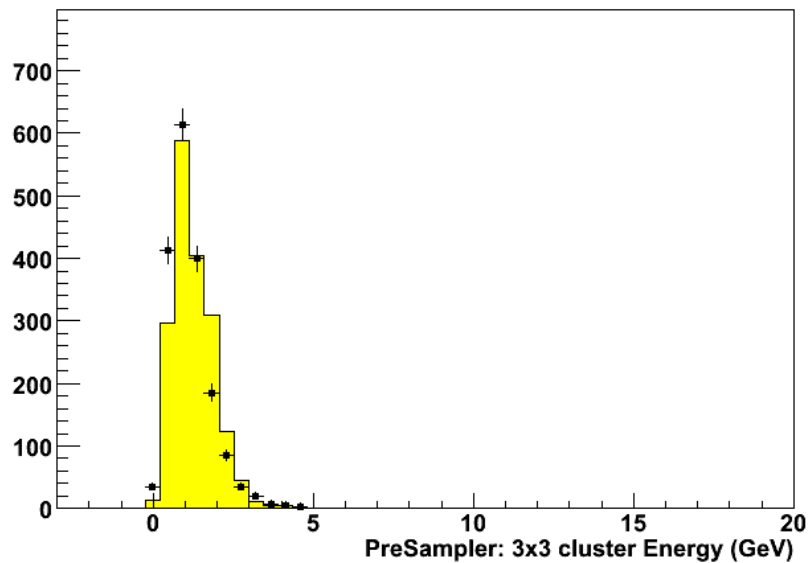
# Resolution Study: Sampling Energies

Run: 1000947 (50GeV)

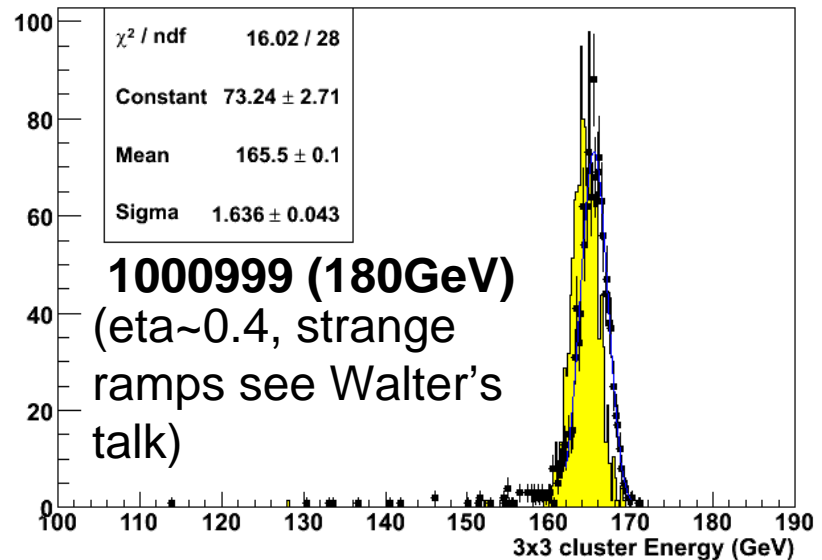
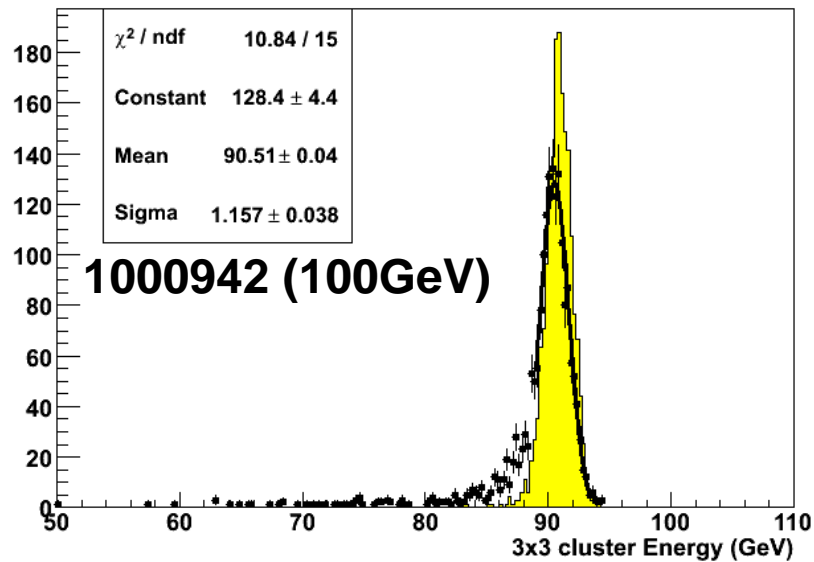
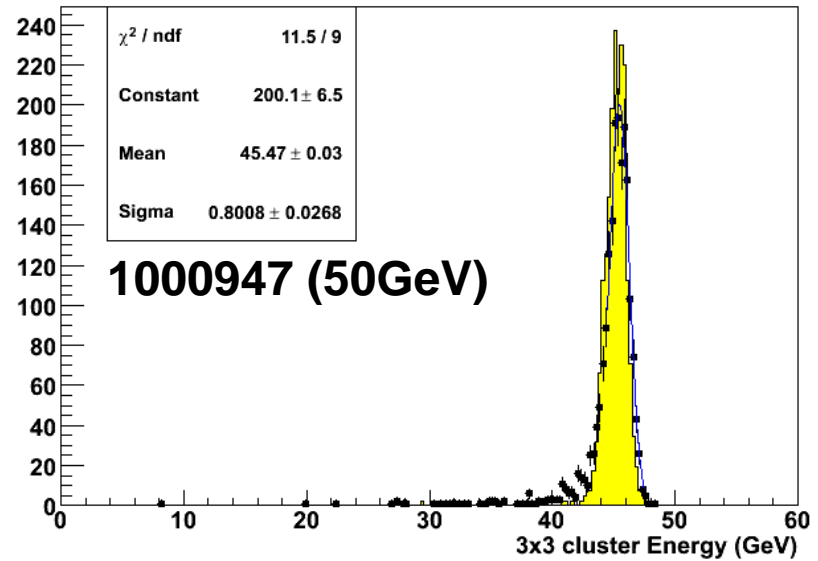
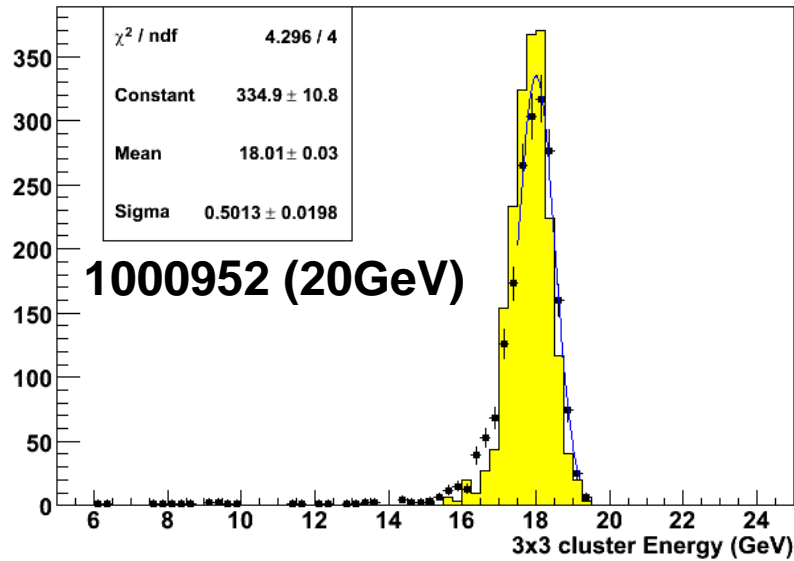


# Resolution Study: Sampling Energies

Run: 1000942 (100GeV)



# Resolution Plots without cluster corrections: not so bad!



# Resolution Summary

$$\frac{\sigma}{E} = \frac{\text{Noise}(\text{GeV})}{E} \oplus \frac{\text{Stoch}\%}{\sqrt{E}} \oplus \text{Const}\%$$

- Const = 0.5% (assumed)
- Noise = 145MeV (data)
- E vs TDC effect was not included!

## Run1000952 (20GeV):

SigmaTotal: 0.501296 GeV

SigmaNoise: 0.145523 GeV

Constant Term (c\*E): 0.090042 GeV

SigTotal/<E> = 0.0278368 stochastic 0.471182 or 11.1033%/sqrt(E)

## Run1000947 (50GeV):

SigmaTotal: 0.800815 GeV

Constant Term (c\*E): 0.227355 GeV

SigTotal/<E> = 0.0176116 stochastic 0.753948 or 11.1808%/sqrt(E)

## Run1000942 (100GeV):

SigmaTotal: 1.15695 GeV

Constant Term (c\*E): 0.45254 GeV

SigTotal/<E> = 0.0127828 stochastic 1.05478 or 11.0871%/sqrt(E)

## Run1000999 (180GeV):

SigmaTotal: 1.63623 GeV

Constant Term (c\*E): 0.827342 GeV

SigTotal/<E> = 0.00988848 stochastic 1.40413 or 10.9156%/sqrt(E)

# Summary/Future

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- ◆ Understanding of CTB data is in progress and analyses are leading to problem identification and fixing:
  - OFC quality is improving.
  - Cells with DAC2ADC (ramp) problems are found and fixing is ongoing.
  - Systematics due to beam optics and upstream/LAr material are under study (agreement between data vs MC was dramatically improved during the summer).
  - Cell noise description is fine, Strips cross-talk under study.
- ◆ We are close now in applying high level cluster corrections and we are looking at Calibration Hits. However the use of MC requires first unfolding of all other systematics which is our top priority.