Rescuing Low Energy Gammas in Milagro

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Summary of Forthcoming Memo

Work with

- **Madgalena Gonzalez**
  - Made Root Trees
  - Wrote Plotting Programs

- **David Noyes**
  - Got us Started
  - Concentrated on Fitting
  - Our Root Guru
  - Took the Pulser Data

Executive Summary
(anyone need a postprandial nap?)

- X2 doesn't work well for low-E gammas
  - Especially T20 (20 tubes, risetime < 50ns)

- Angular Accuracy is Poor for T20   **more from David**
  - Not enough tubes, rather than noise
  - Still, 90% efficiency if you can live with 5°

- T20 efficiency drops by 50% from random noise

- Our "noise" rates are dominated by muons
  - 30% of events have a μ potential inefficiency!
  - Uncorrelated noise may not be a great MC model
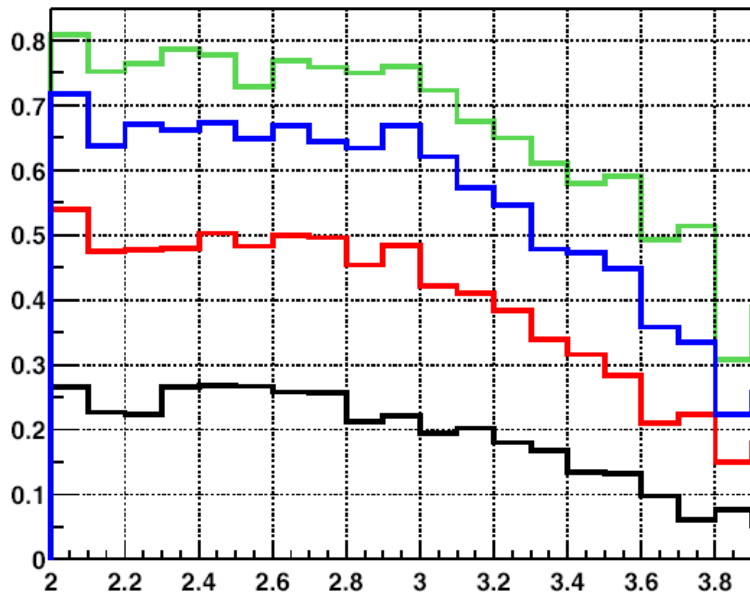
- Crab X2 in marginal agreement with MC

Which Gammas?

- E < 300 GeV   (non-attenuated GRB's)
- T20, since that's the new kind of data
  - With T20 as is: use existing sample
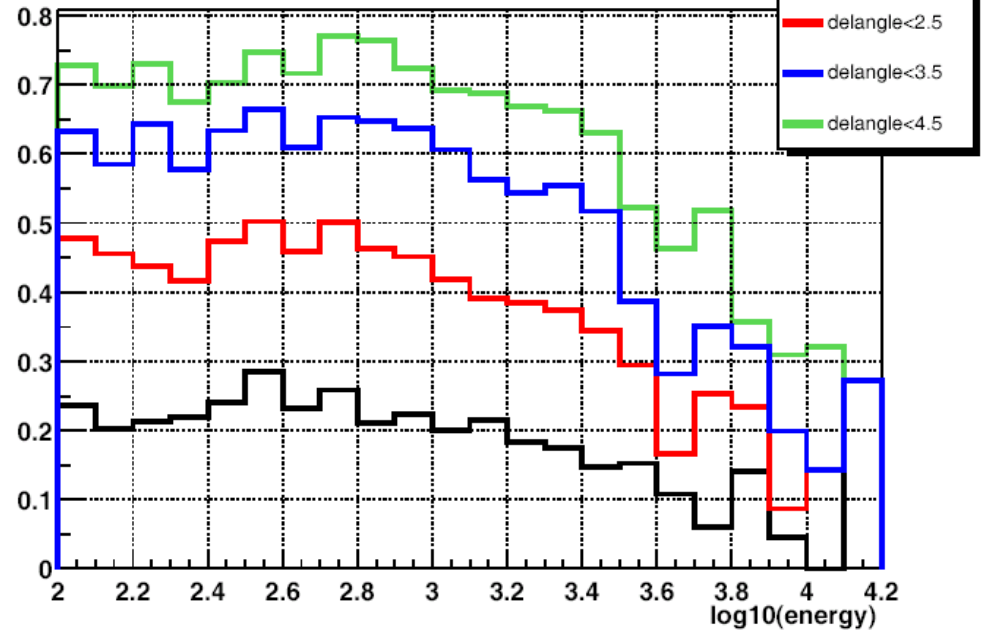- Hardest Case, so may help others, too

Little difference in MC γ fit efficiency (for fixed angular accuracy)

default MC noise   Off   vs.   On   **(More from David Noyes)**

Problems with fit resolution are not due to noise

so don't chase algorithms for removing noise

Noise <u>Reduces</u> T20 Efficiency

Default Uncorrelated MC Noise

		Eγ< 300 GeV	> 300 GeV
All Triggers	No noise	3294	15971
	Noise	2341 (-29%)	13182 (-17%)
Exclude T20	No Noise	902 2/3 are in T20	9491
	Noise	999 (+11%)	9973 (+5%)

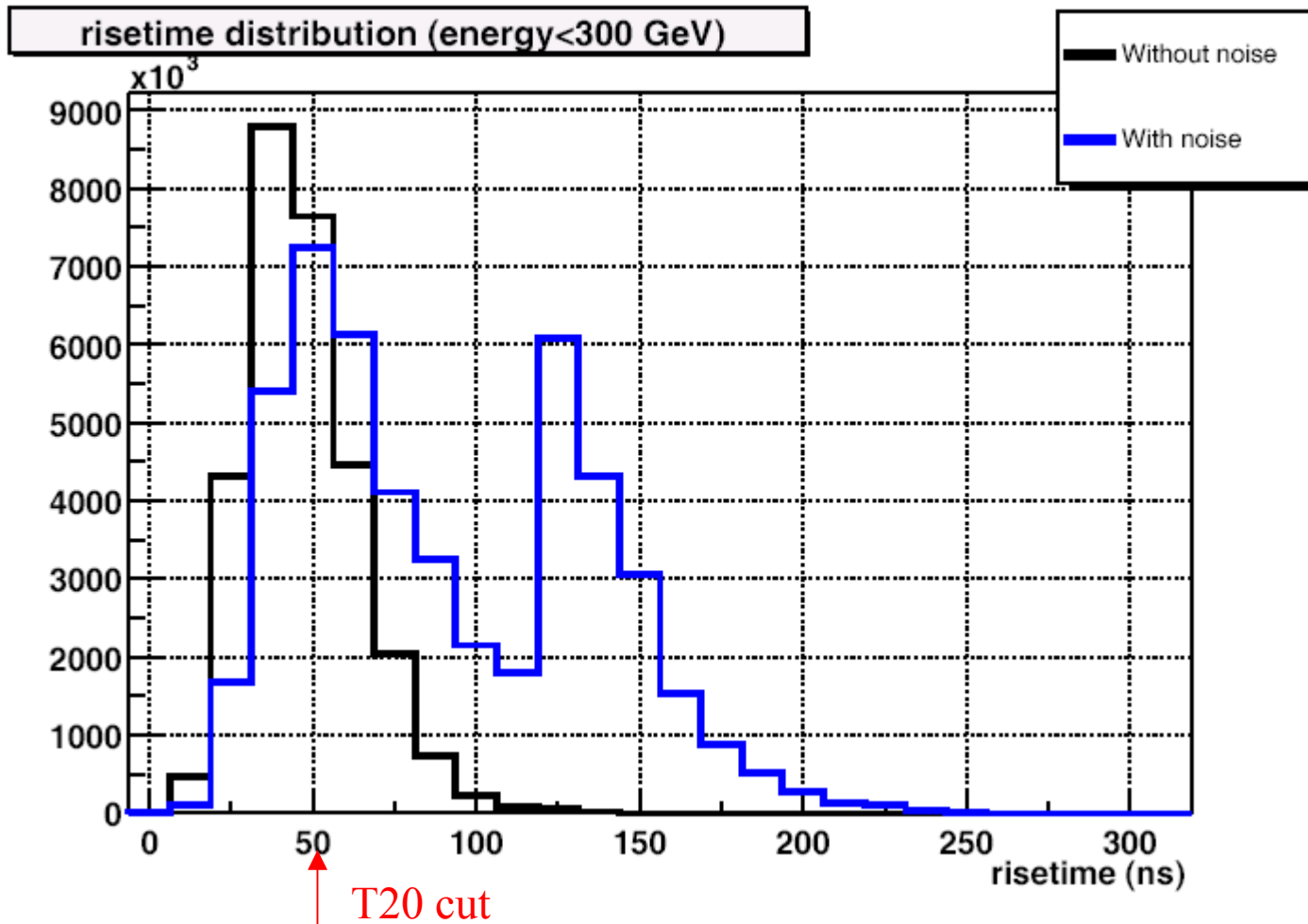**50% loss in T20!**

Should T20 be Changed from Risetime to something else???

Would a better Noise model change this conclusion?

Why?
Noise Increases Risetime

risetime distribution (energy<300 GeV)

Without noise

With noise

T20 cut

What is Our Actual Noise?

- **Take Pulser Trigger Data to See**
  - Uncorrelated with any other trigger
  - What nature will "overlay" with any real triggered event
    - In limit that it doesn't affect the trigger
  - Noise is a relatively larger effect for T20 events

- Scan in Event Display

  Our real noise is <u>not</u> uncorrelated!

  ~ 30% of events have associated AS and MU layer hits

  sensitive time of display is same as X2, fitter

  $\pm$ 200 ns (in edge finder)
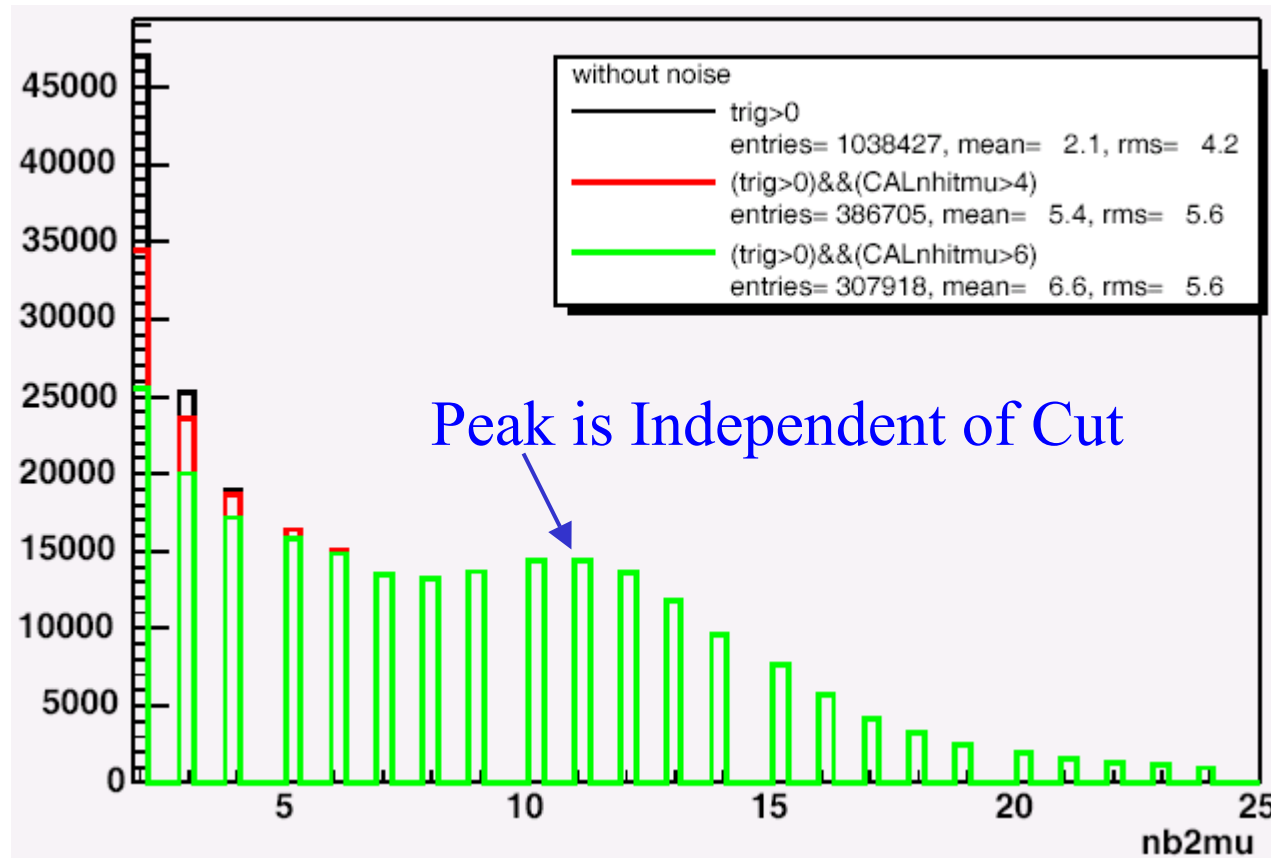
  CR muons implied rate ~ 1MHz (consistent w/ Gaisser)

A "typical" muon event
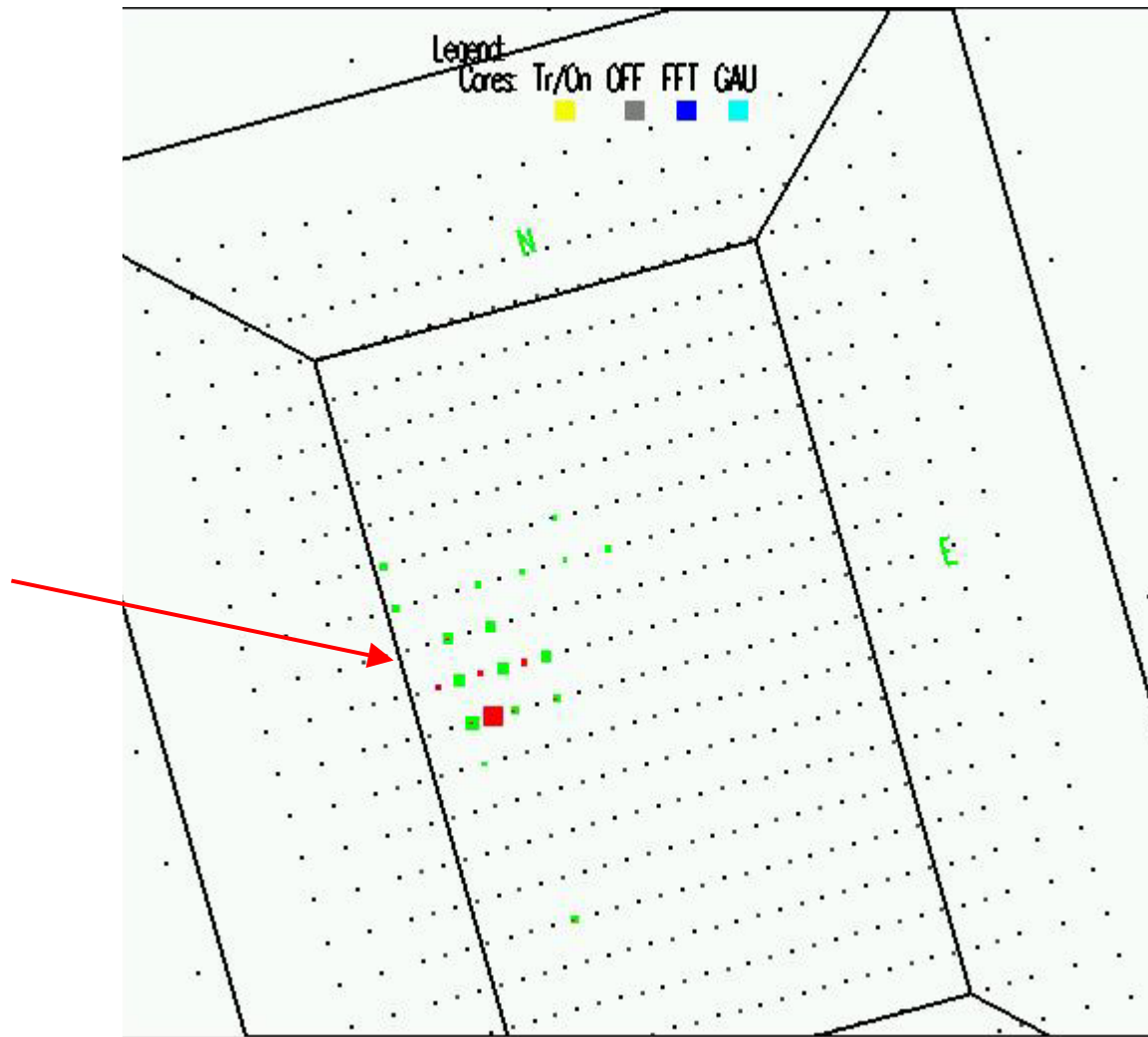
Muon: ~ 10 muon layer tubes

>6 Calibrated Mu hits in 30% of events: a good proxy for cluster

~80% such events have matched AS

legend:
without noise
- trig>0
  entries= 1038427, mean= 2.1, rms= 4.2
- (trig>0)&&(CALnhitmu>4)
  entries= 386705, mean= 5.4, rms= 5.6
- (trig>0)&&(CALnhitmu>6)
  entries= 307918, mean= 6.6, rms= 5.6

Peak is Independent of Cut

Suppressed Bins 0, 1

Extraneous Muon Layer Hits!

A Serious Confusion to X2?

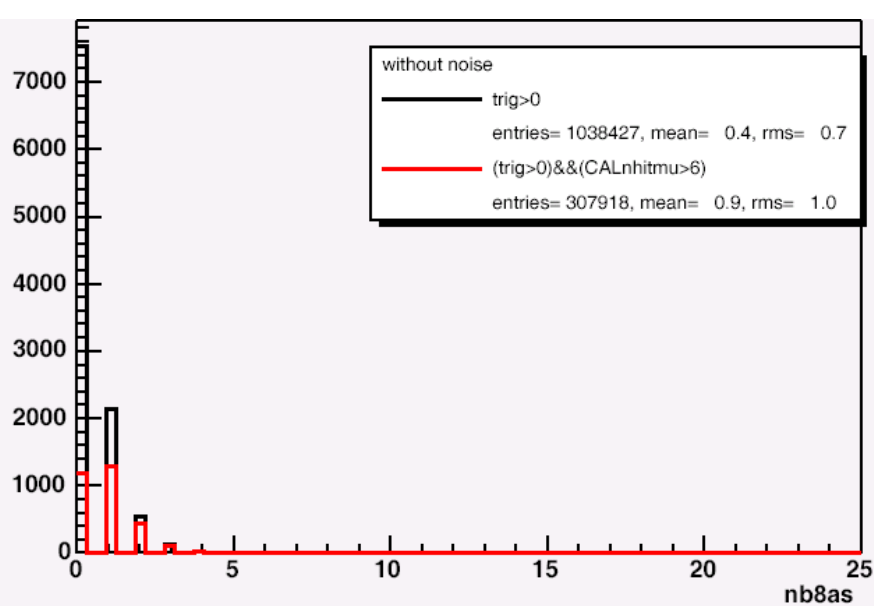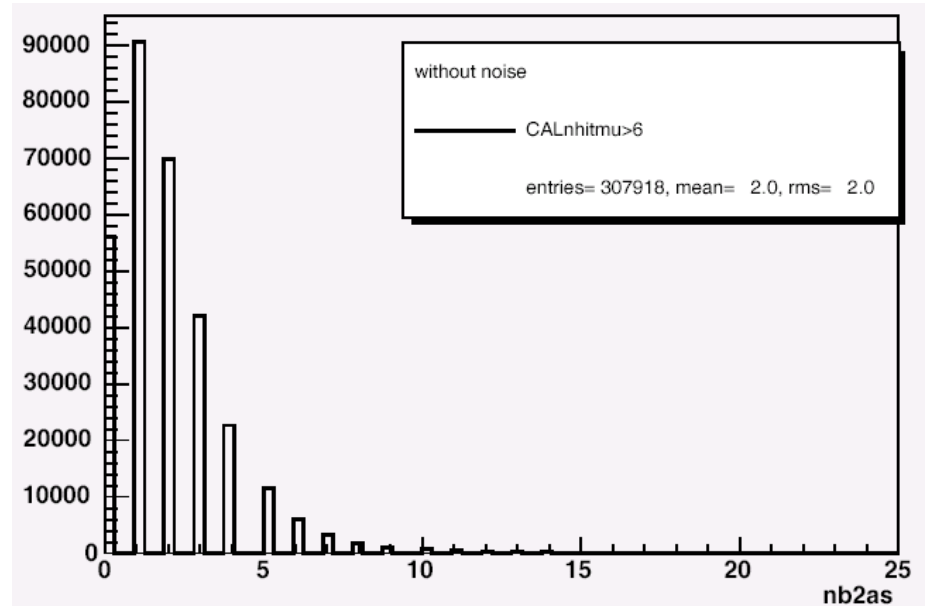# 80% of Muon Layer Hits in Cluster Events
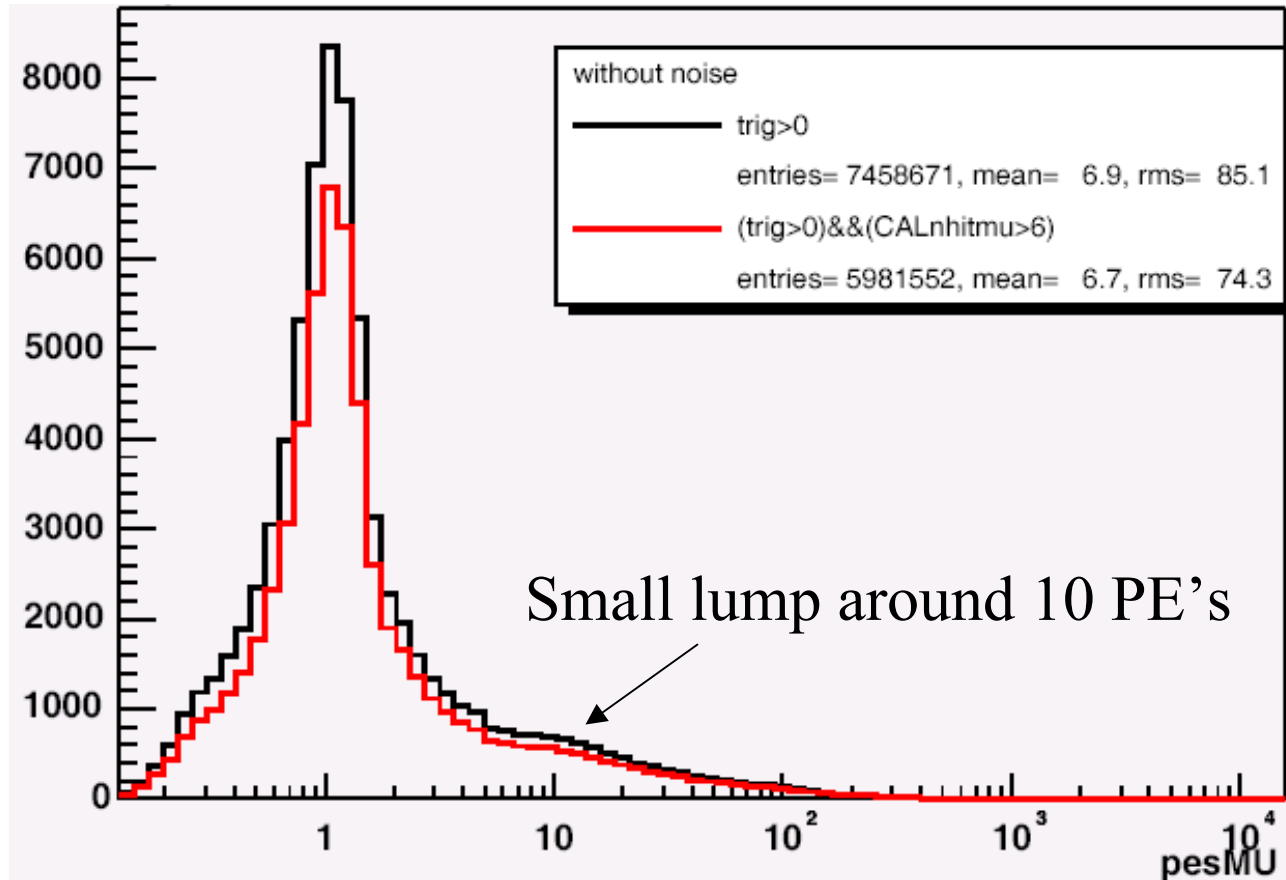
AS Layer: 62% in these events   **Outriggers: 32% (~random)**

Fewer Hits in AS Layer for Muon Events

probably not a disaster for fit

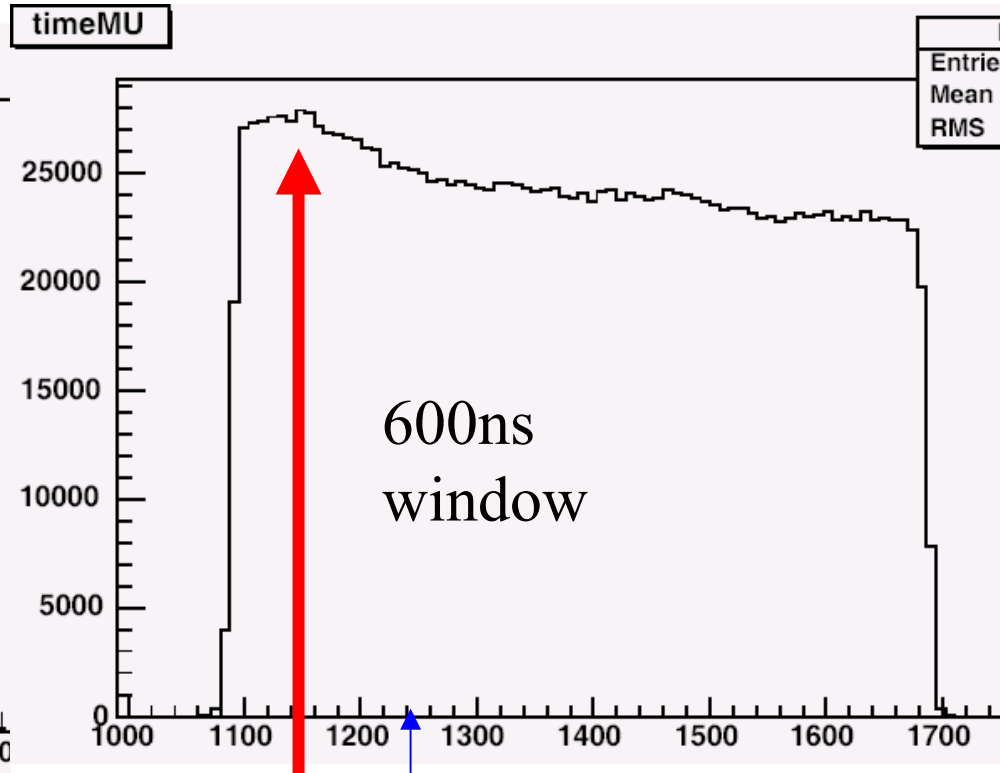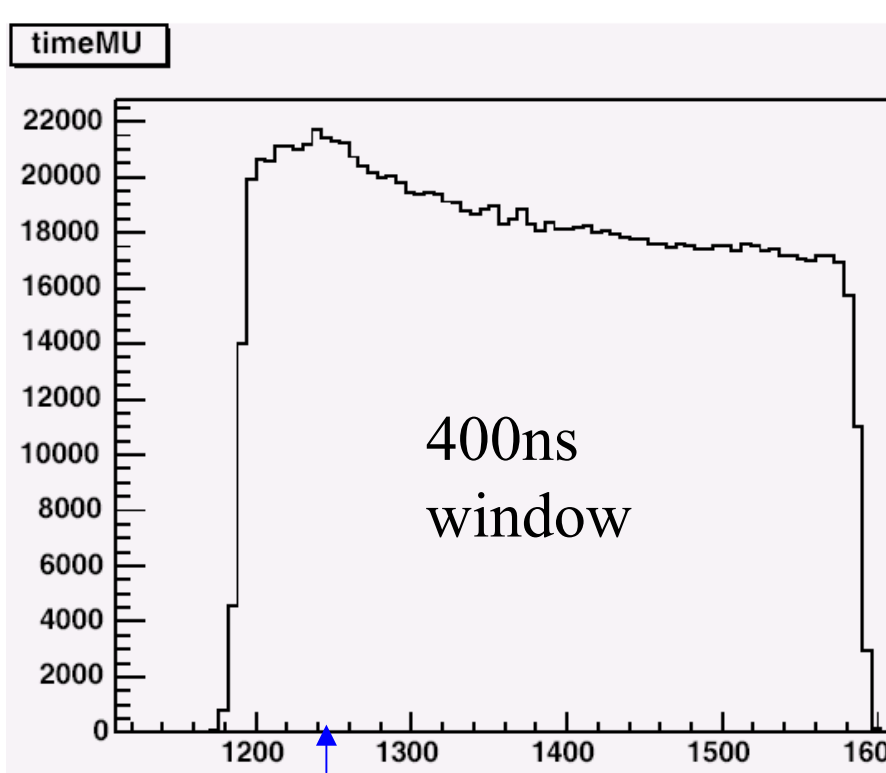maybe not too bad for T20 either?

0-2 > 8 PEs

~40% with 0

0-4 > 2 Pes

~18% with 0

Pulser Event Times Not Flat (Random) ?!

Due to Edge Finder

Do we want to change edge finder?

Times near edge:

enhanced in low PE's

consistent with edges 3,4 in window; 1,2 early

Peak moves:

So it's not the data

Monte Carlo Noise Problems
Simulated Milagro, at Least, is <u>Way</u> Too Polite!

- Uncorrelated noise is default
- Hits are = 1.000 PE
  - below X2, 1st fit iteration threshold
- **If there is a MC hit, noise hit is dropped (!)**
- Works in (t,PE, not edges)   No electronics/edgefinder simulation
  - Want to do better than picking <u>either</u> MC <u>or</u> noise
  - Early hits: time and PE's affected
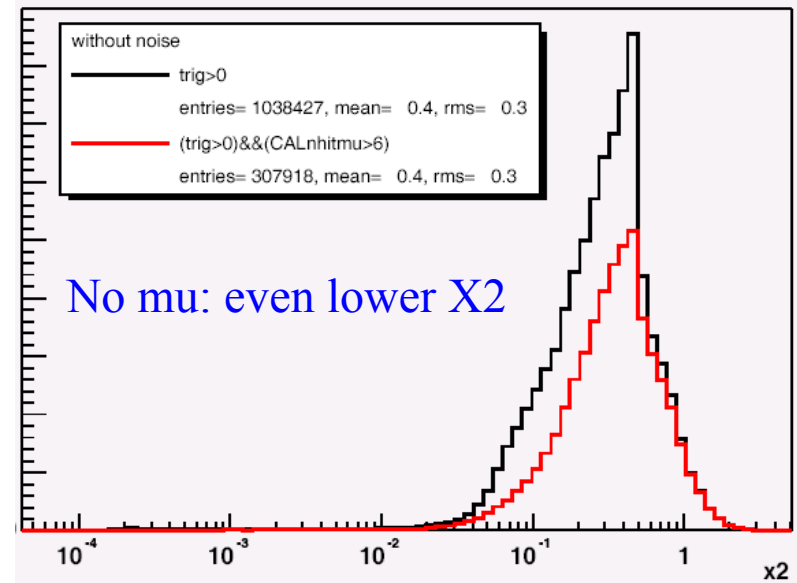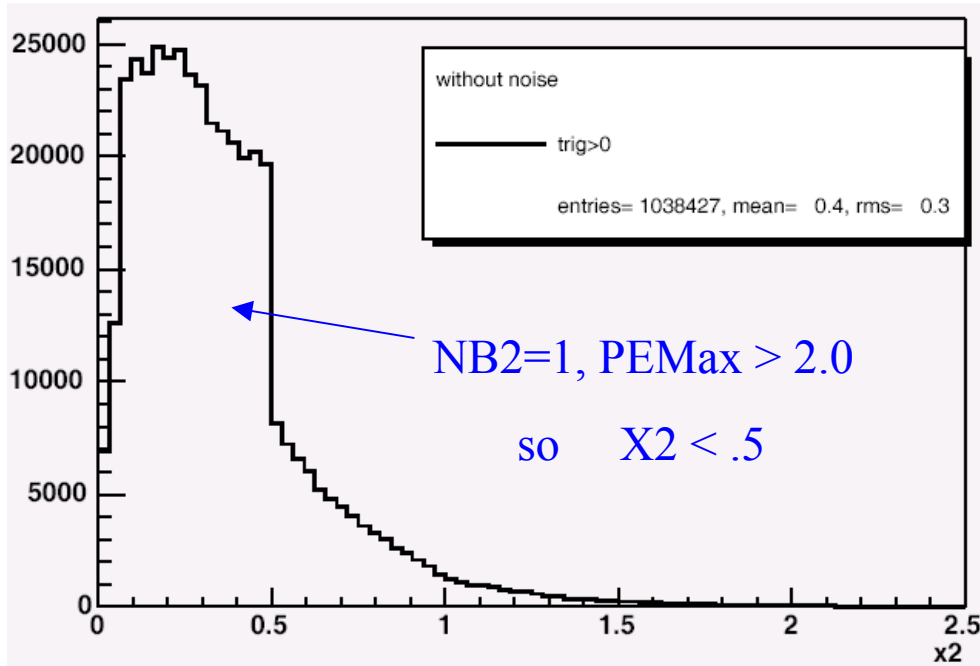 - Late hits: PE's only

Why Improve the MC Noise?

- **Effects on Hadron Separation Variables for T20**
  - Especially in muon layer (like X2!)
  - **Potential inefficiency of up to 30% if all γ + μ events fail**
- **See if really need to improve T20**

$X2 = NB2 / PEMaxB$
For Pulser Events is Small

NB2=1, PEMax > 2.0

so   X2 < .5

No mu: even lower X2

Net effect on Gamma events of mix of μ + weaker uncorrelated noise?

Too hard for me! Need to run MC with pulser events as noise…

X2 for Low E Gammas

- ## Main Problem is for T 20

  11% efficiency for X2 > 2.5   for all Eγ >100

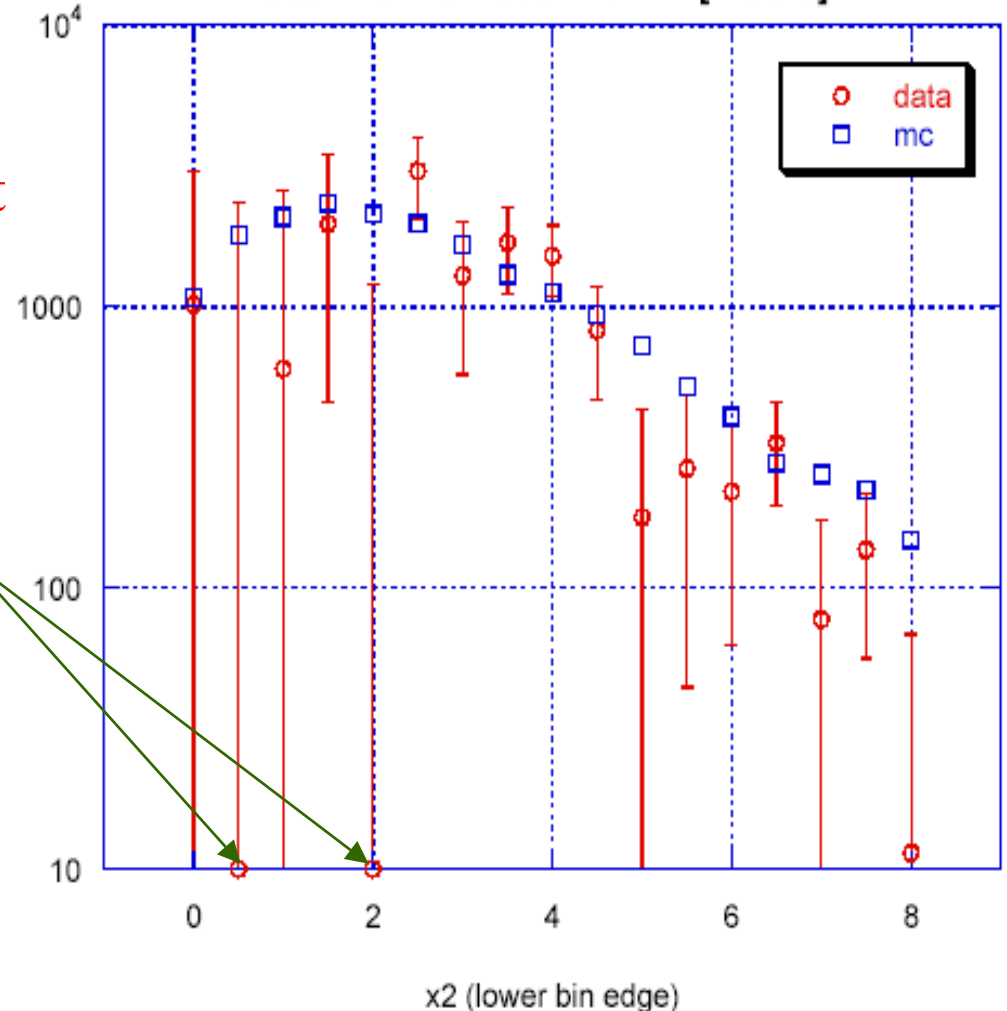   Same for 100 < Eγ < 300

  T20 Data: 4.1%   **Q=.5**

  Will try lowering the X2 cut value

- ## X2 ~ same for good and bad fits

  <X2> = 1.46 $\rightarrow$ 1.63 for $\Delta\theta \rightarrow$ 1.5º

X2: MC vs. Crab Data

~30% flux change w/ X2 cut

Largest flux for X2 > 2.5 cut

Match X_2 [3-4]: same flux

Fit to all X_2 gives –57%

Best χ^2 gives -37%

$X_2 < 2.5$ has negative bins

Need bigger systematic?

Lower flux estimate?

But: shape agrees to < 2σ

Memo next week

Gamma Events vs X2 bin
MC vs Data
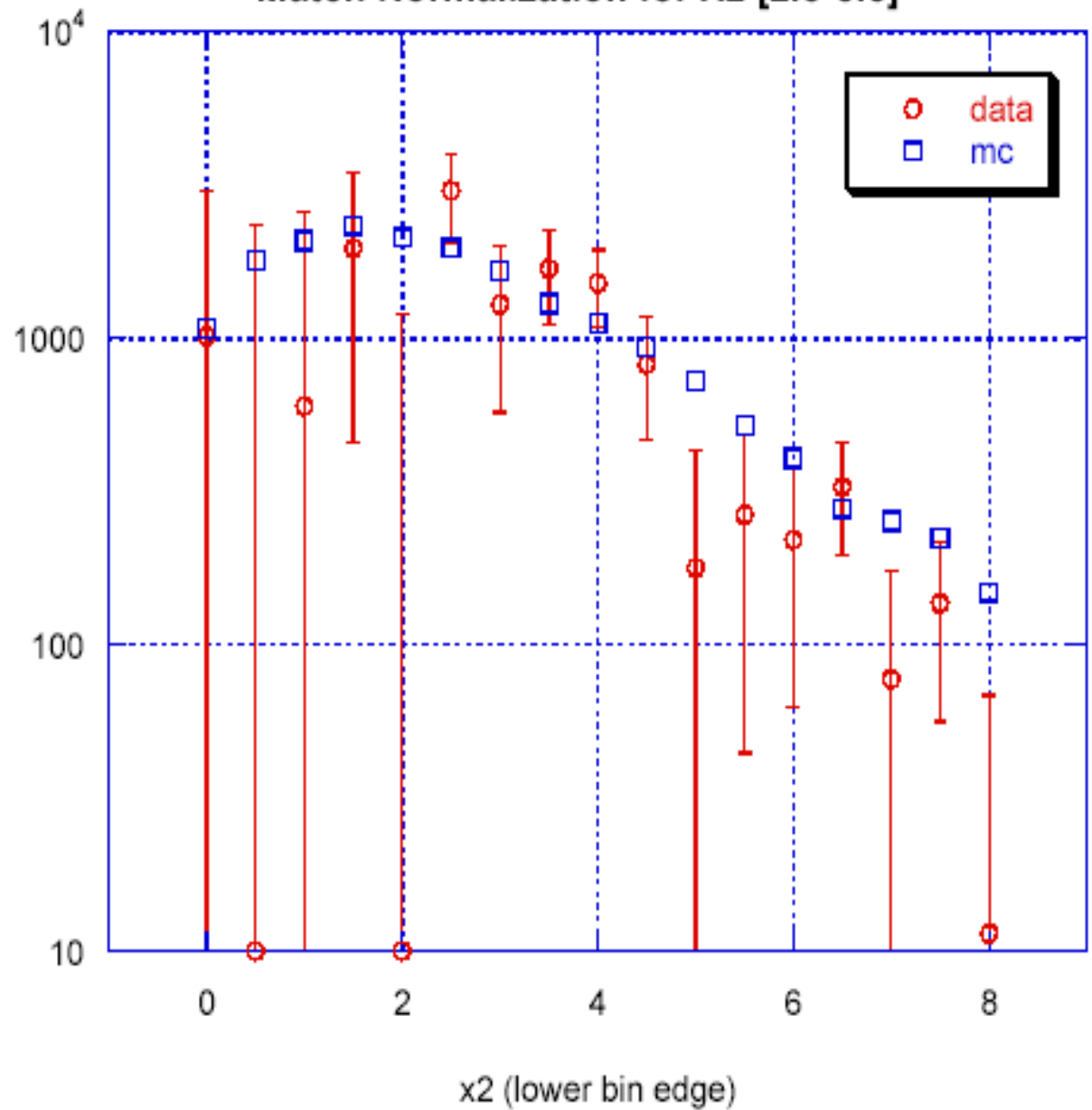Match Normalization for X2 [2.5-8.5]

Rocky Road, but Attractive Goal

Deer Trap Mesa

Phase I: Understanding the Problems

Alas, no answers yet…

- Which Gammas to Worry About?
- Angular Reconstruction for T20 ("20" tube trigger)
- Noise and T20
- Our Actual "Noise"
- Problems with the MC Noise
- X2 Efficiency for Low E Gammas
- Reliability of MC Prediction of X2

Gamma Events vs X2 bin
MC vs Data
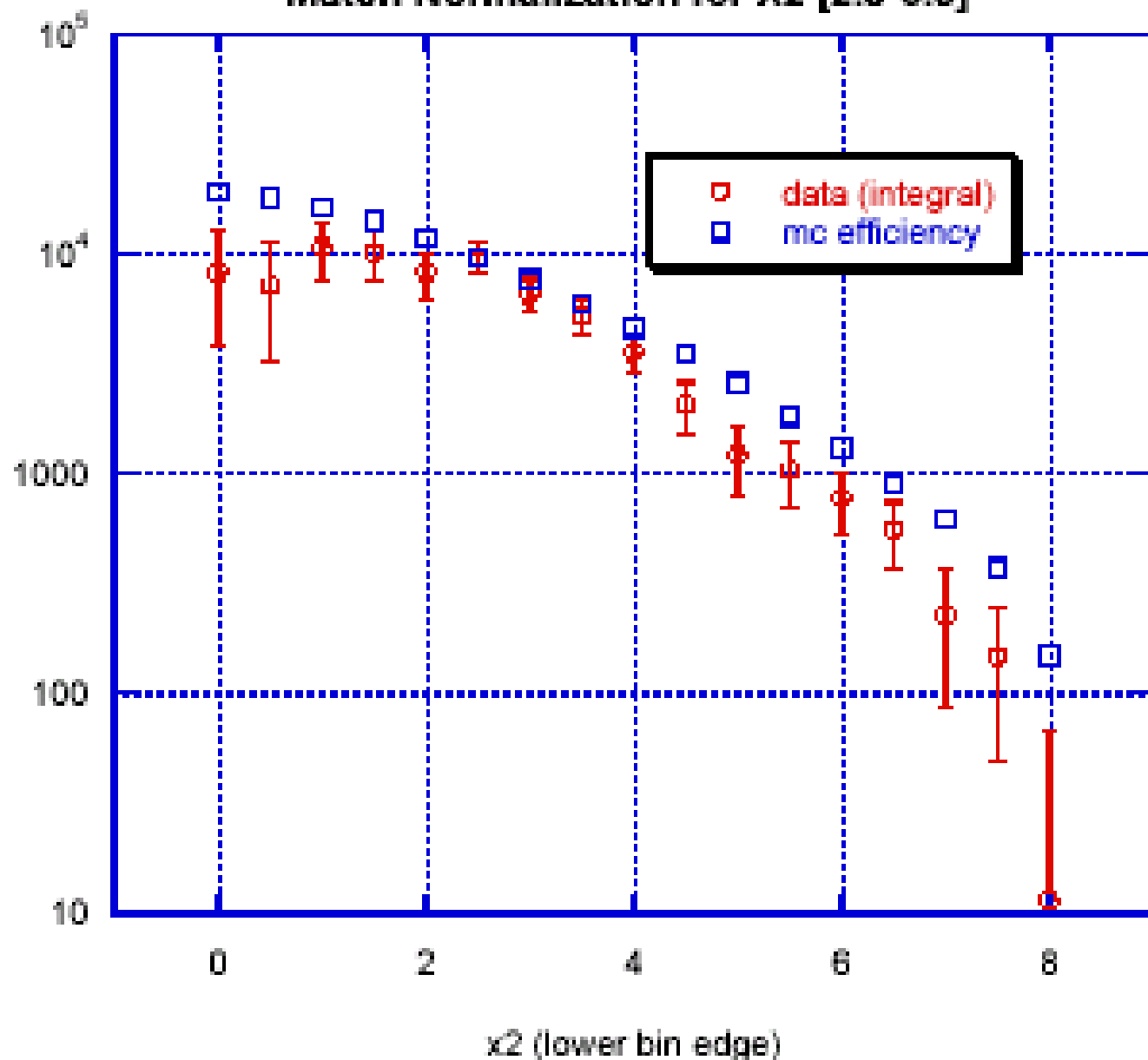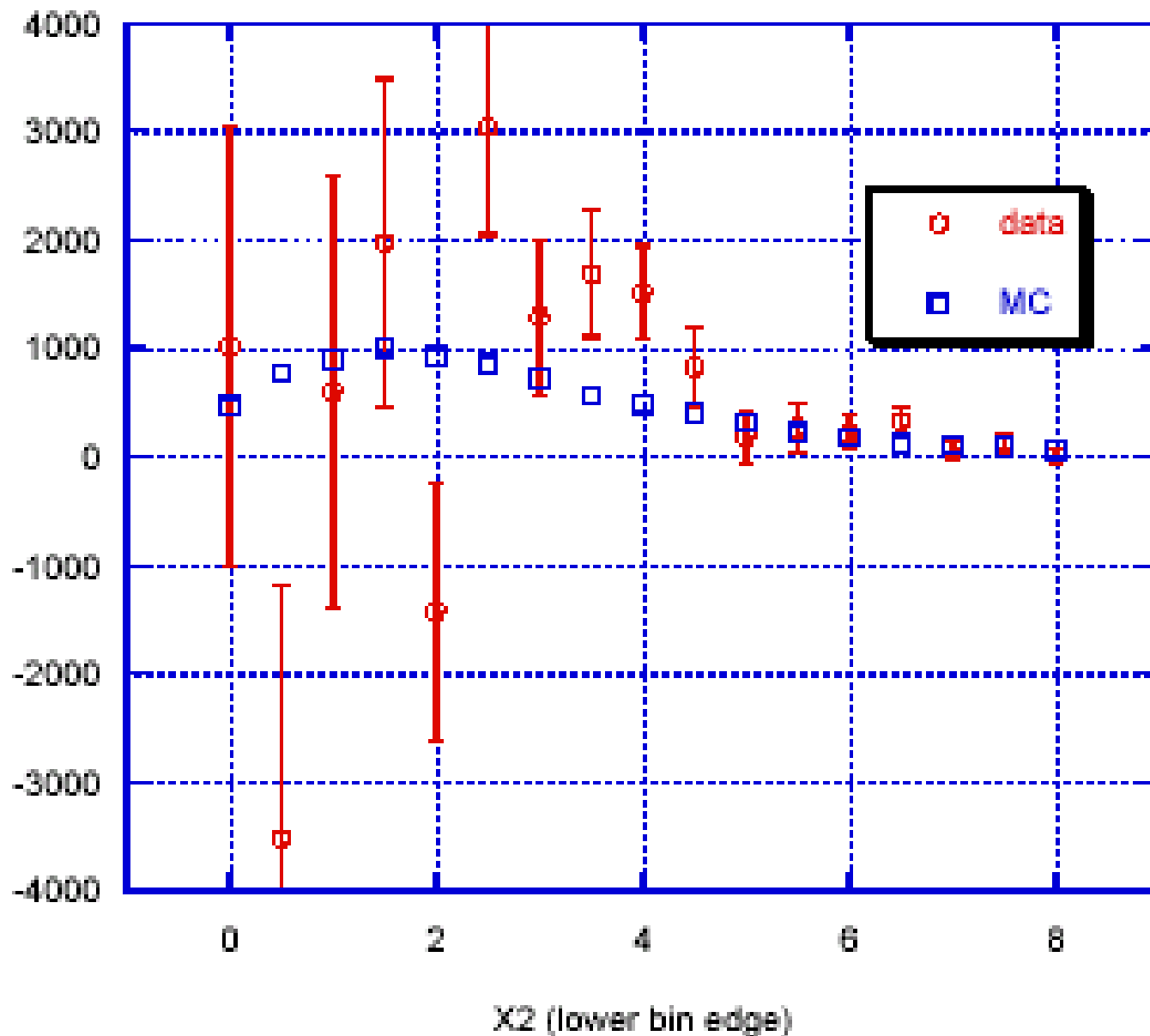Match Normalization for X2 [2.5-8.5]

x2 (lower bin edge)

Integral Events above X2 cut (Efficiency vs cut)
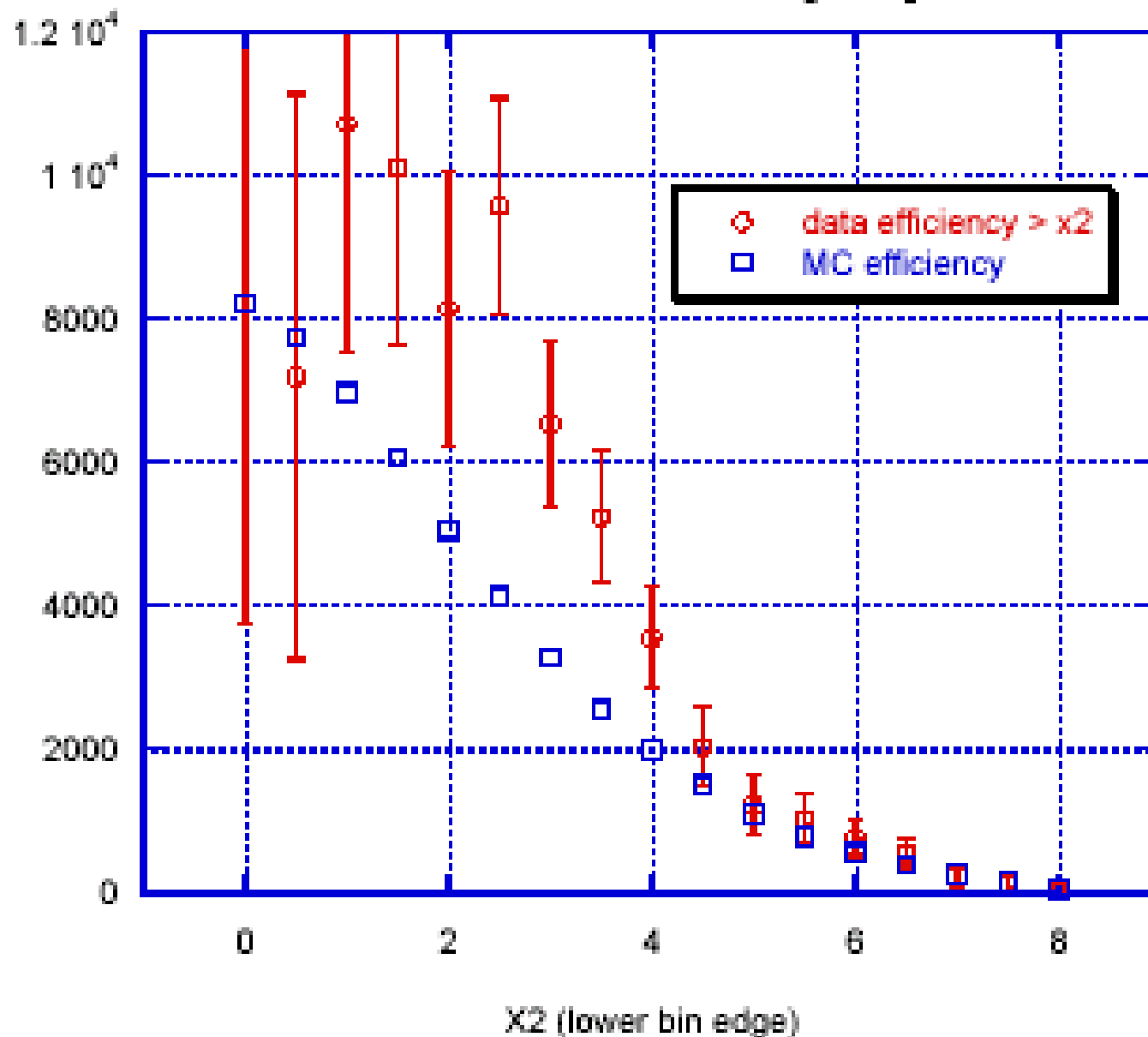MC vs Data
Match Normalization for X2 [2.5-8.5]

Gamma Events vs X2 bin
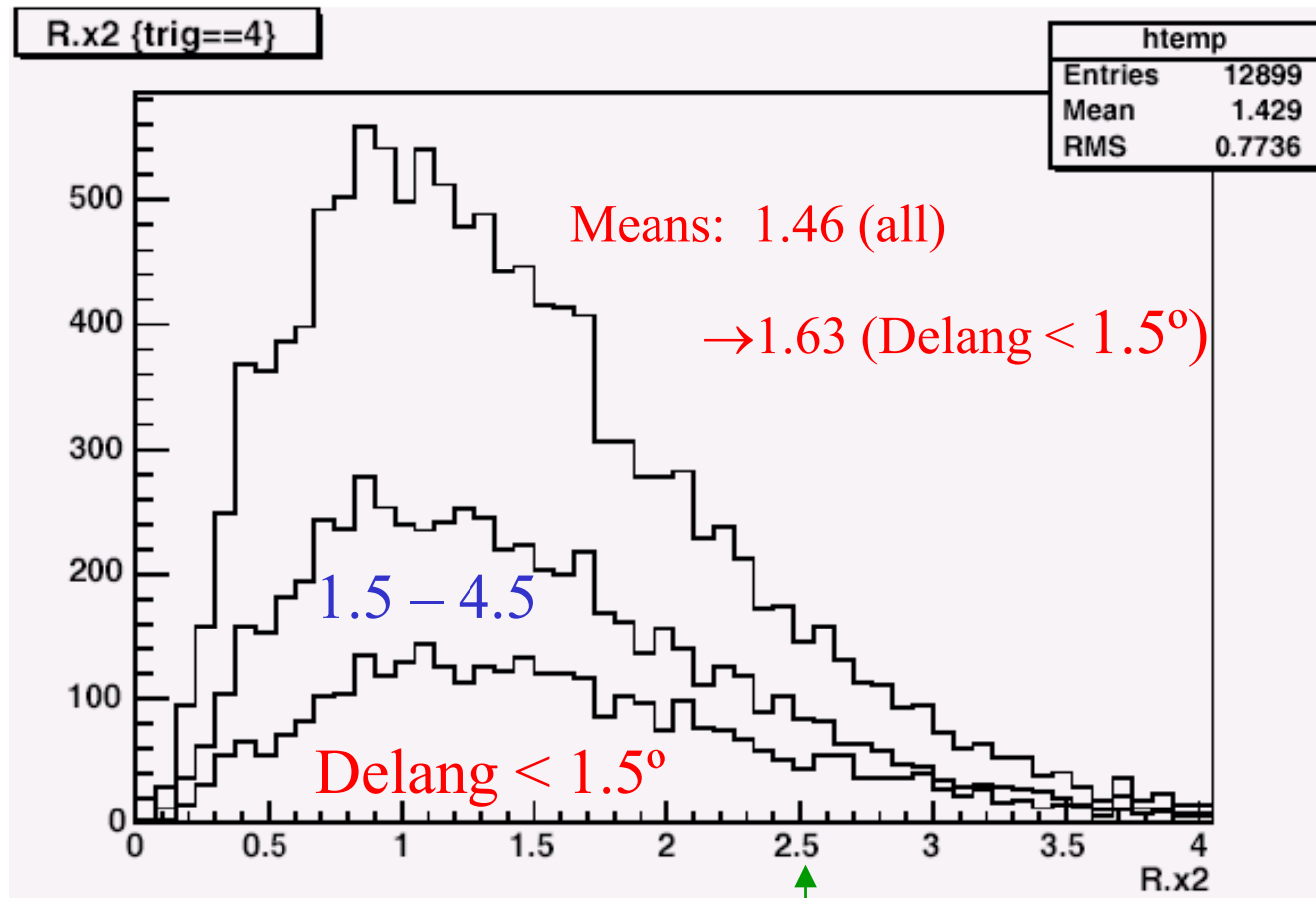MC vs Data
Match Normalization for X2 [0-8.5]

X2 (lower bin edge)

Integral Events above X2 cut (Efficiency vs cut)
MC vs Data
Match Normalization for X2 [0-8.5]

X2 ~ Independent of Fit Quality

~ same for all E and E<300

X2>2.5 has poor γ efficiency T20, or low Eγ

- **11%**   for T20, all Eγ >100   Data: 4.1%, **Q=.5**
                Same for 100 < Eγ < 300

- 17%   for all triggers, Low Eγ
                100 < Eγ < 300

- 31%   for all triggers, all Eγ >100

- 53%   for all triggers excluding T20 (Crab paper)

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To check: try lowering X2 cut