Update on the combined analysis

Guilherme Lima

NORTHERN ILLINOIS
UNIVERSITY

CALICE Workshop at Argonne
March 17-19th, 2008

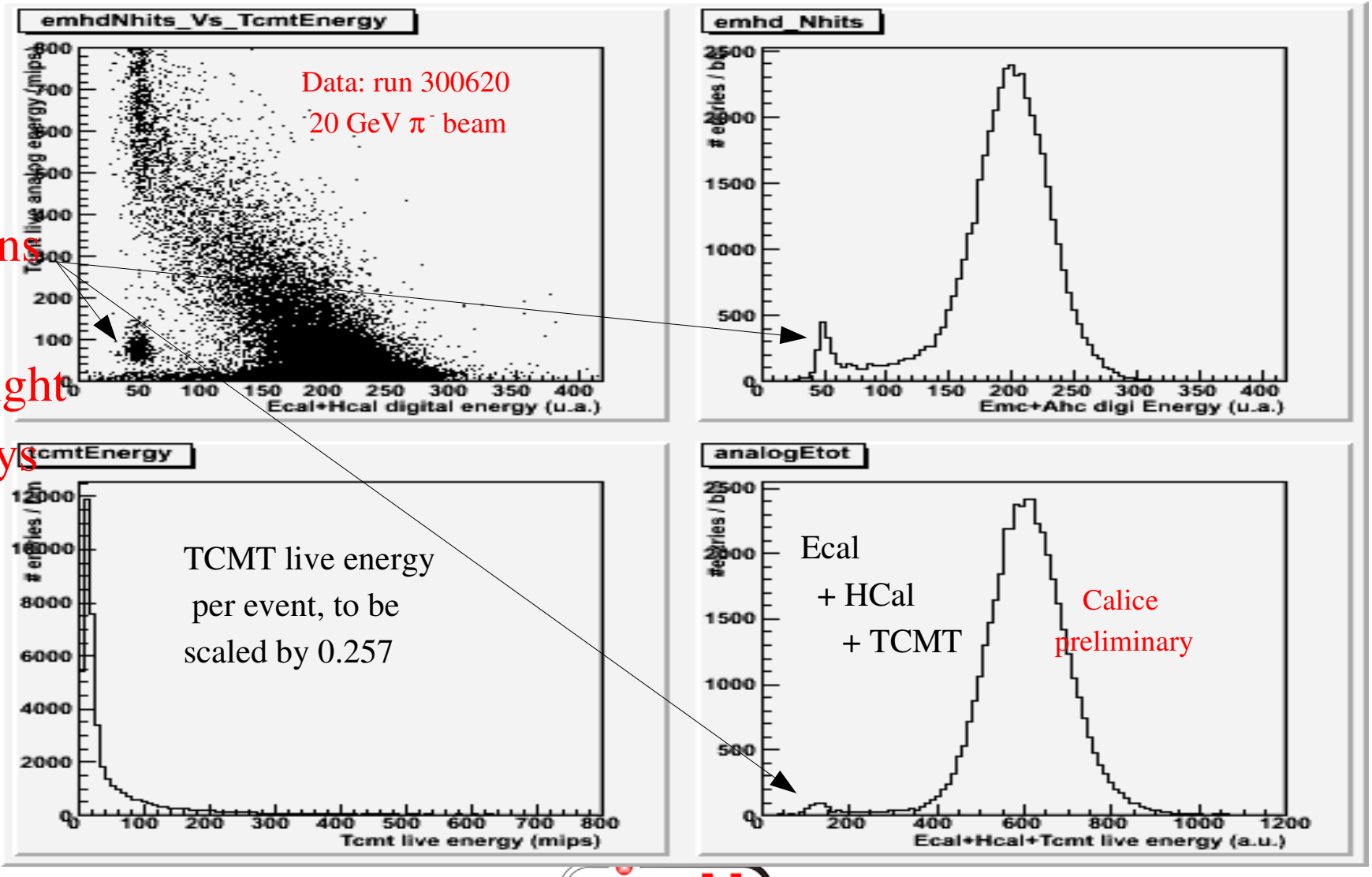
Overview

- Combined analysis: first complete version of note + presentation at LCWS in spring/summer 2007)
  Preliminary results of energy resolutions (pions 10-20 GeV).
  Further studies require improved agreement with simulations.
  - Detailed MC vs. data comparisons
  - Simulation of digitization effects
  - Sample cleanup
  - Clustering

Today's update

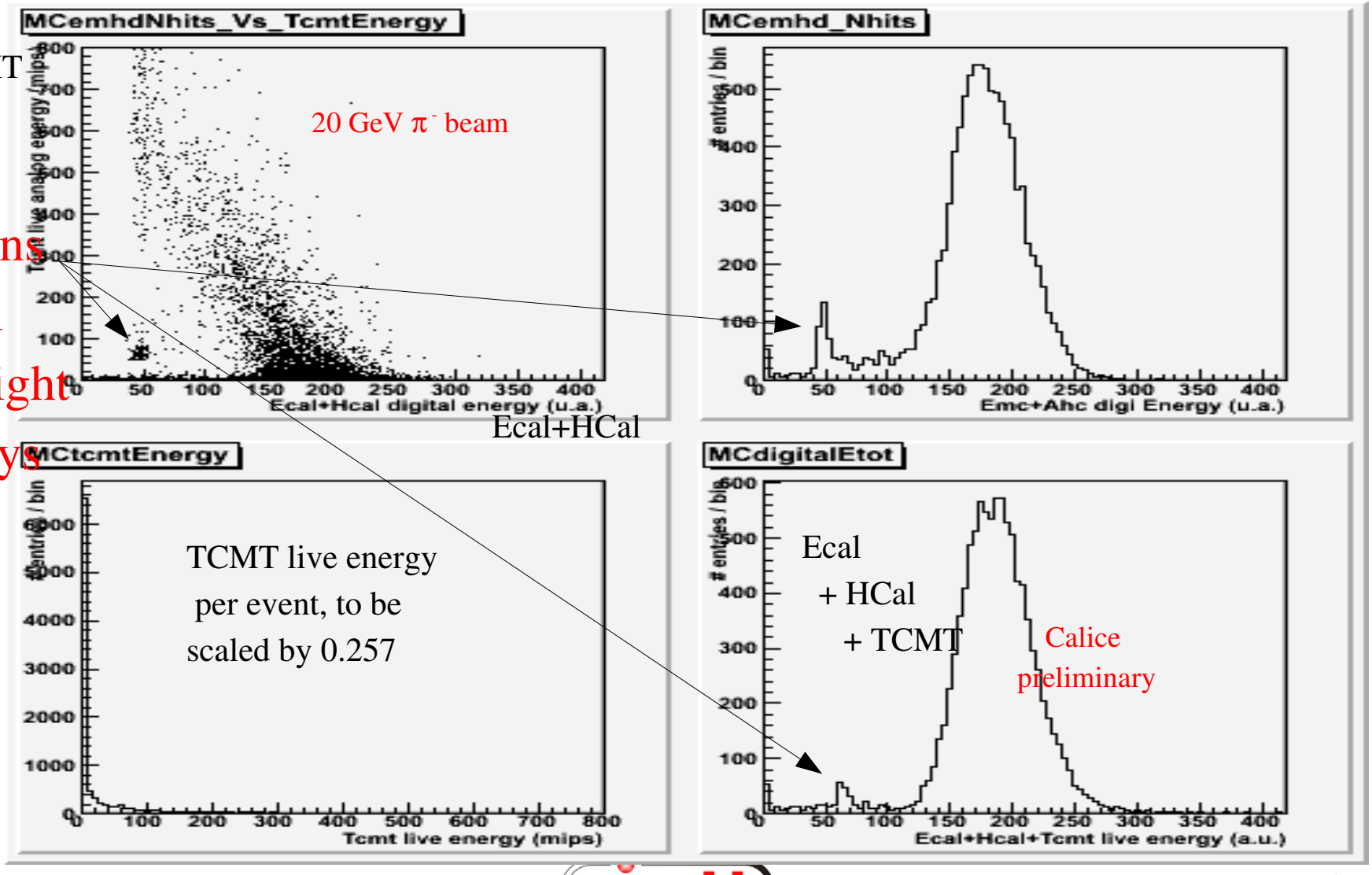
- Approaching a new round of results, with much better MC-data agreement (since Nov/07)
- In this talk:
  - Use Efrac10mips for event topology
  - Remove pion decays and early interactions from MC sample
    - require endPoint of original pions to be between Ecal and Tcmt
  - Updating to latest Hcal digitization + reconstruction software
  - Including saturation correction in Tcmt hits

Combining EM+HD and TCMT (hit counting) – TB data



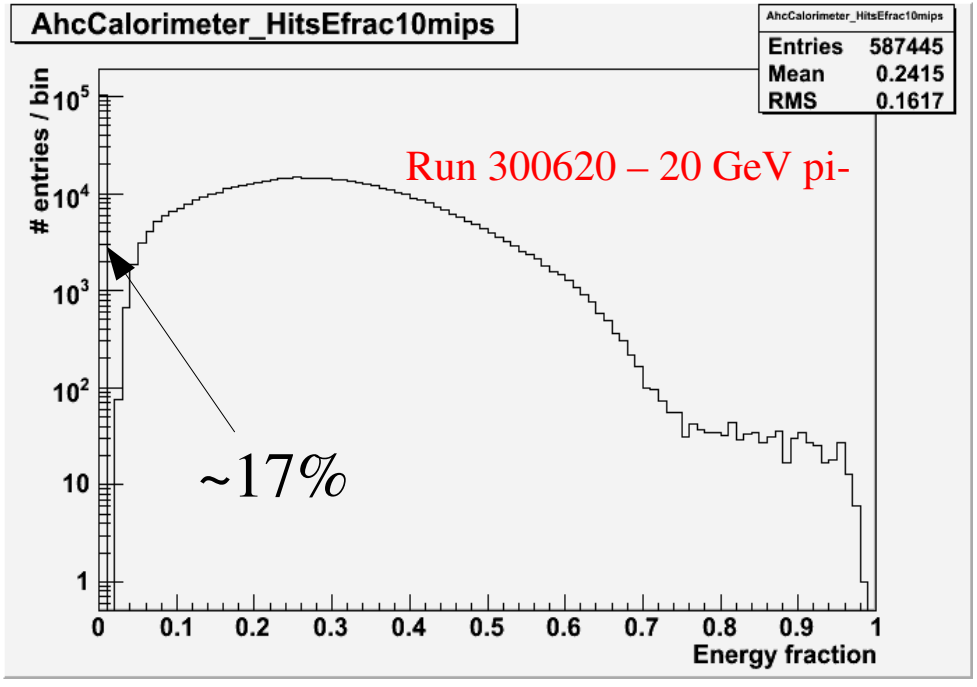
Muons from in-flight decays

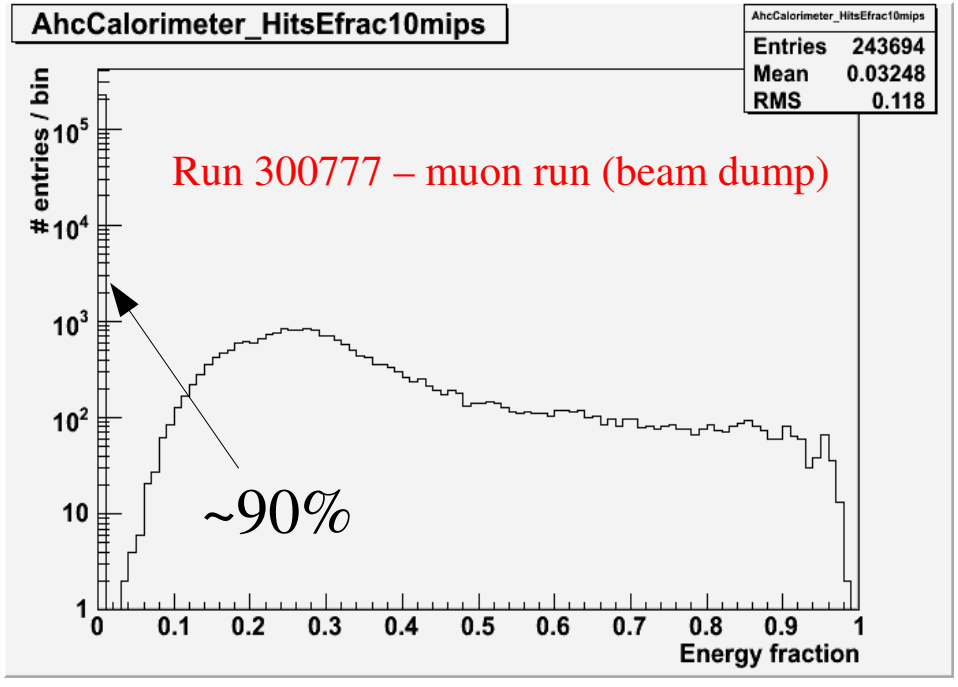
Combining EM+HD and TCMT (hit counting) - MC



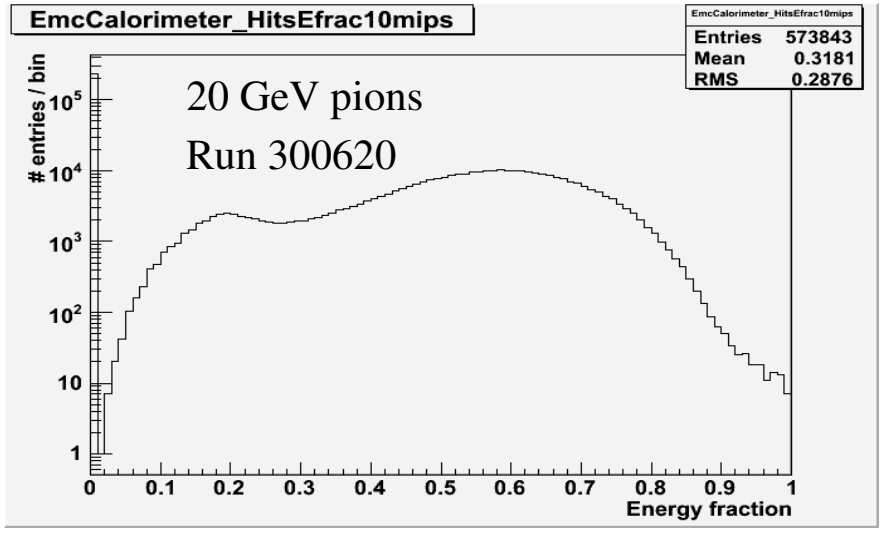
Beam cleanup and event topologies

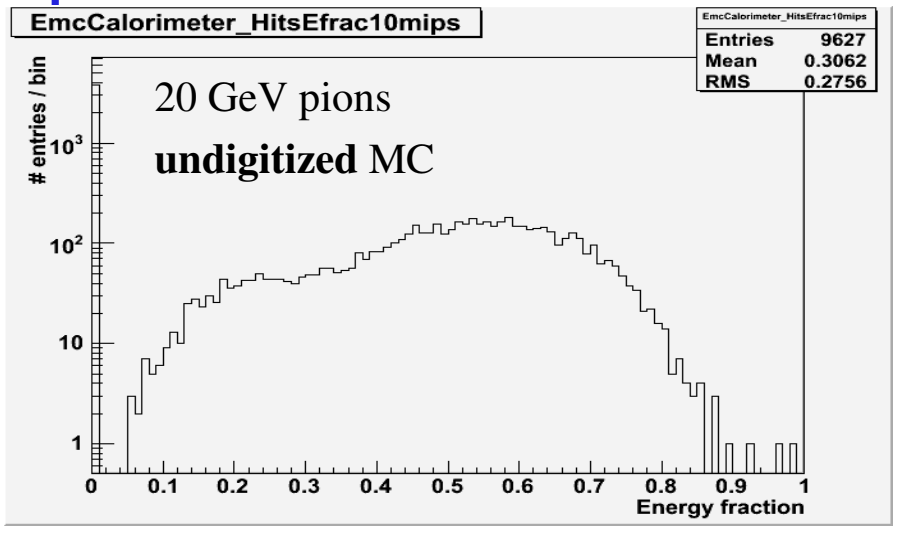
- For beam cleanup (remove muons and noise events from the pion samples), we used frac10mips = Esum(hits > 10mips) / Esum(hits > 0.5 mip), requiring that frac10mips > 0.02 for each one of Ecal, Hcal and TCMT

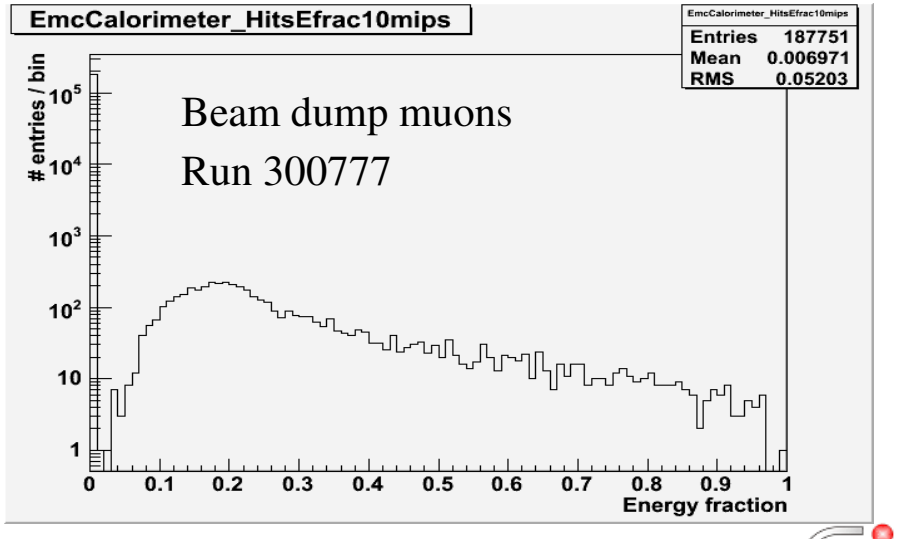


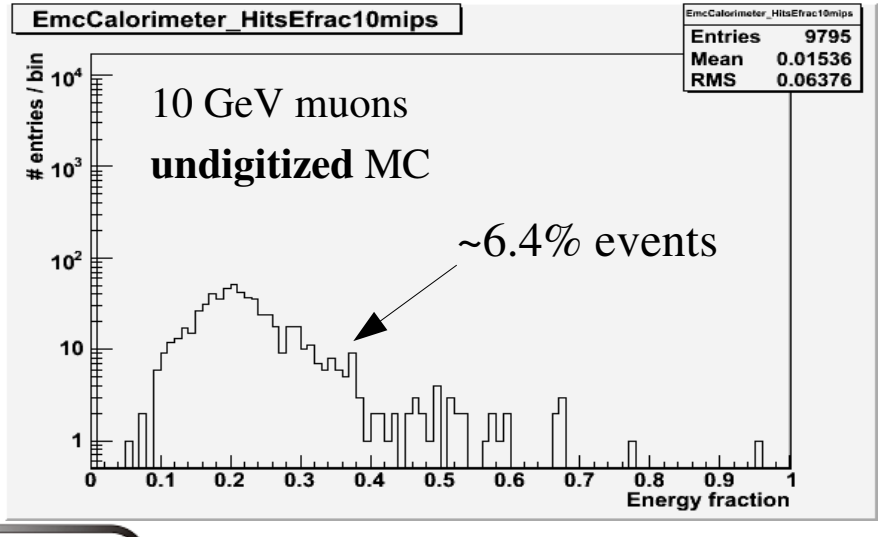


Efrac10mips in Ecal

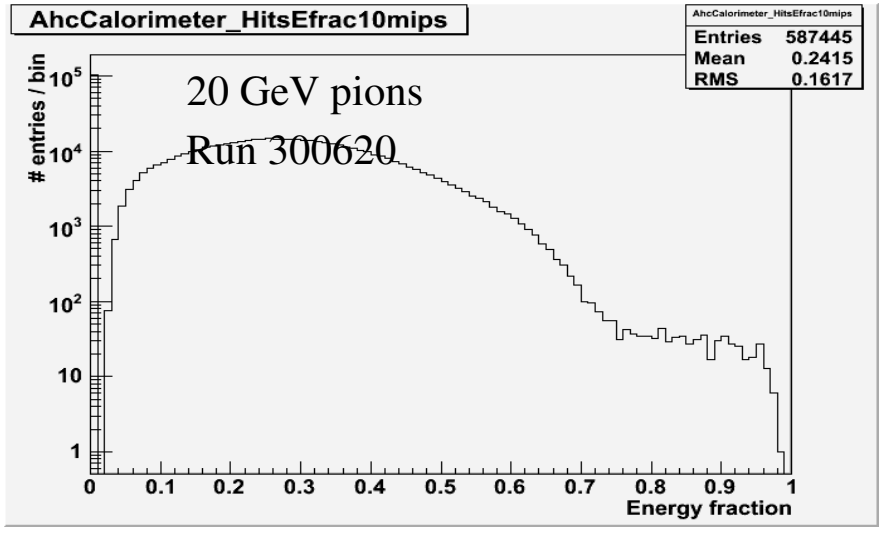


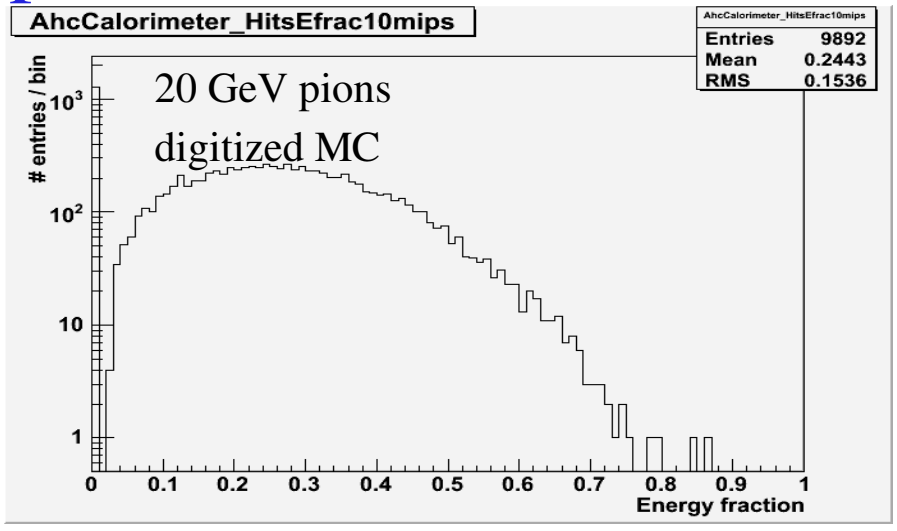


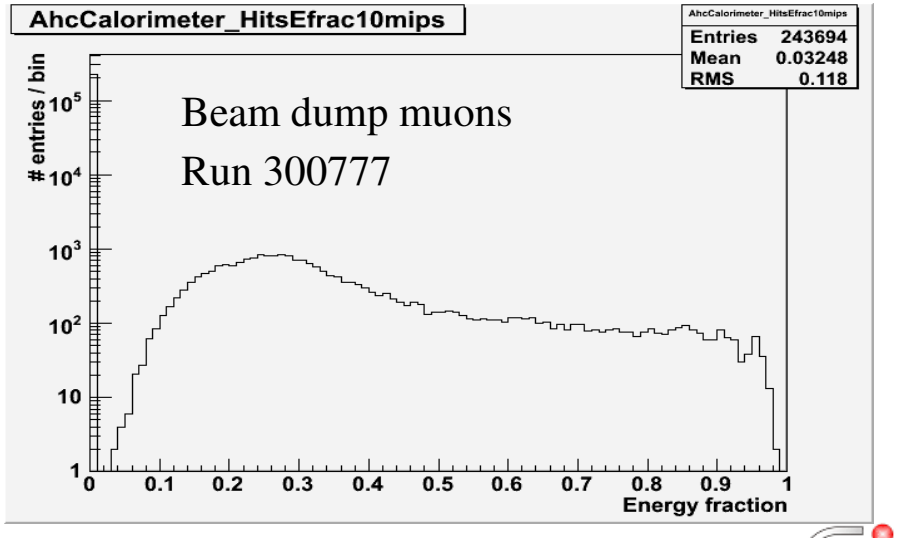




Efrac10mips in AHcal

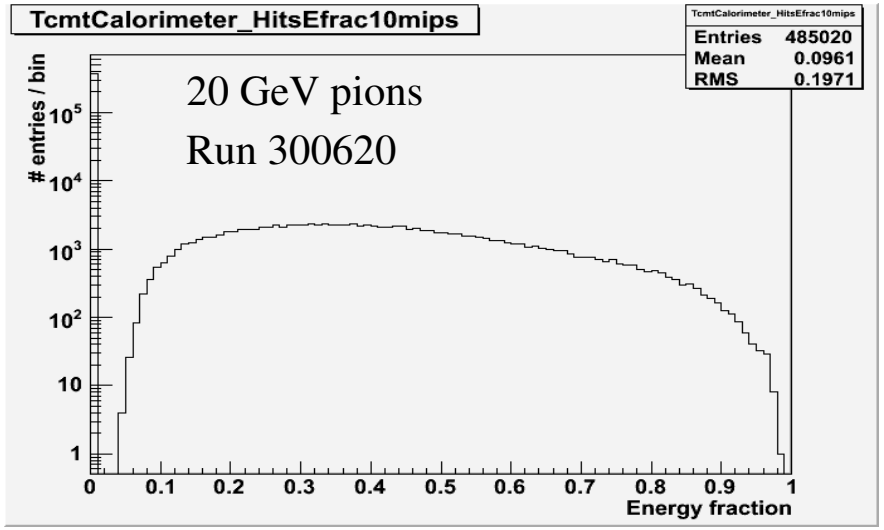


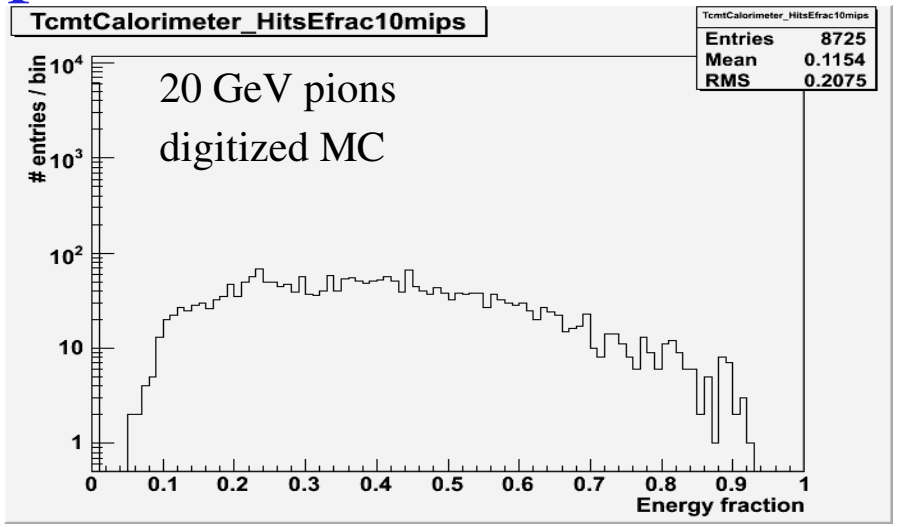


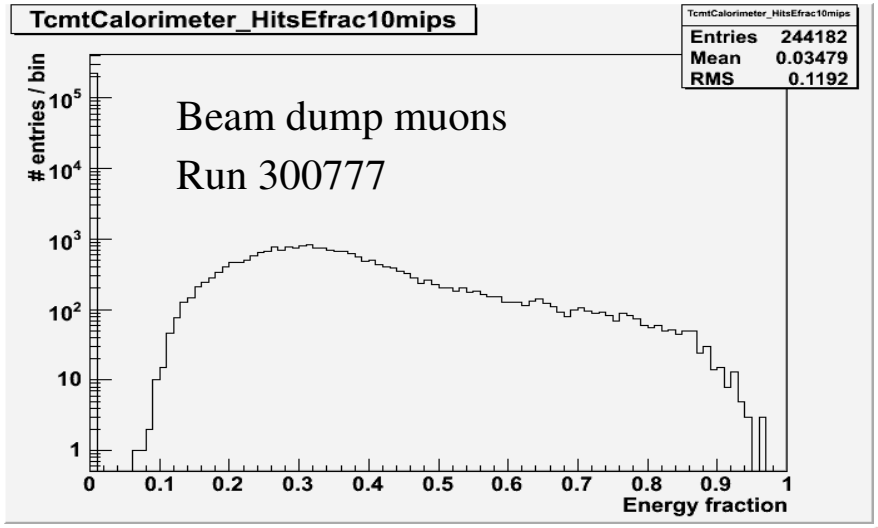


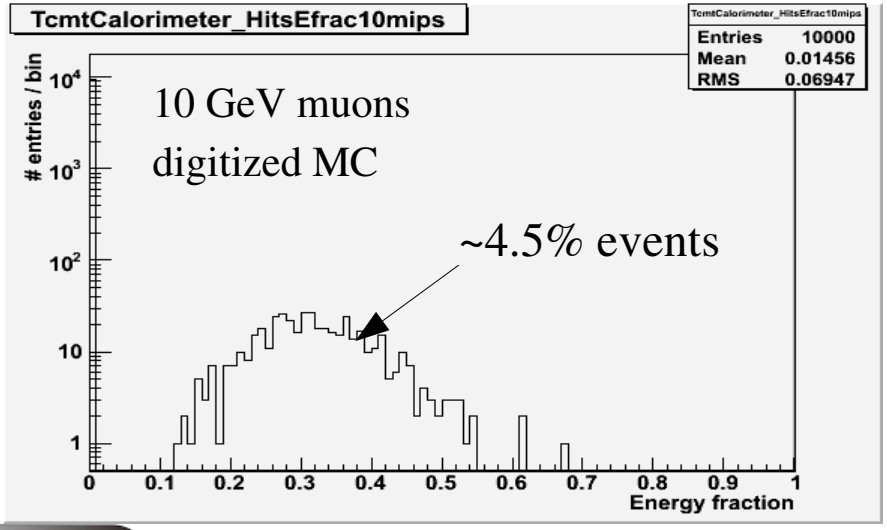
No digitized MC muon sample available yet :-(

Efrac10mips in TCMT







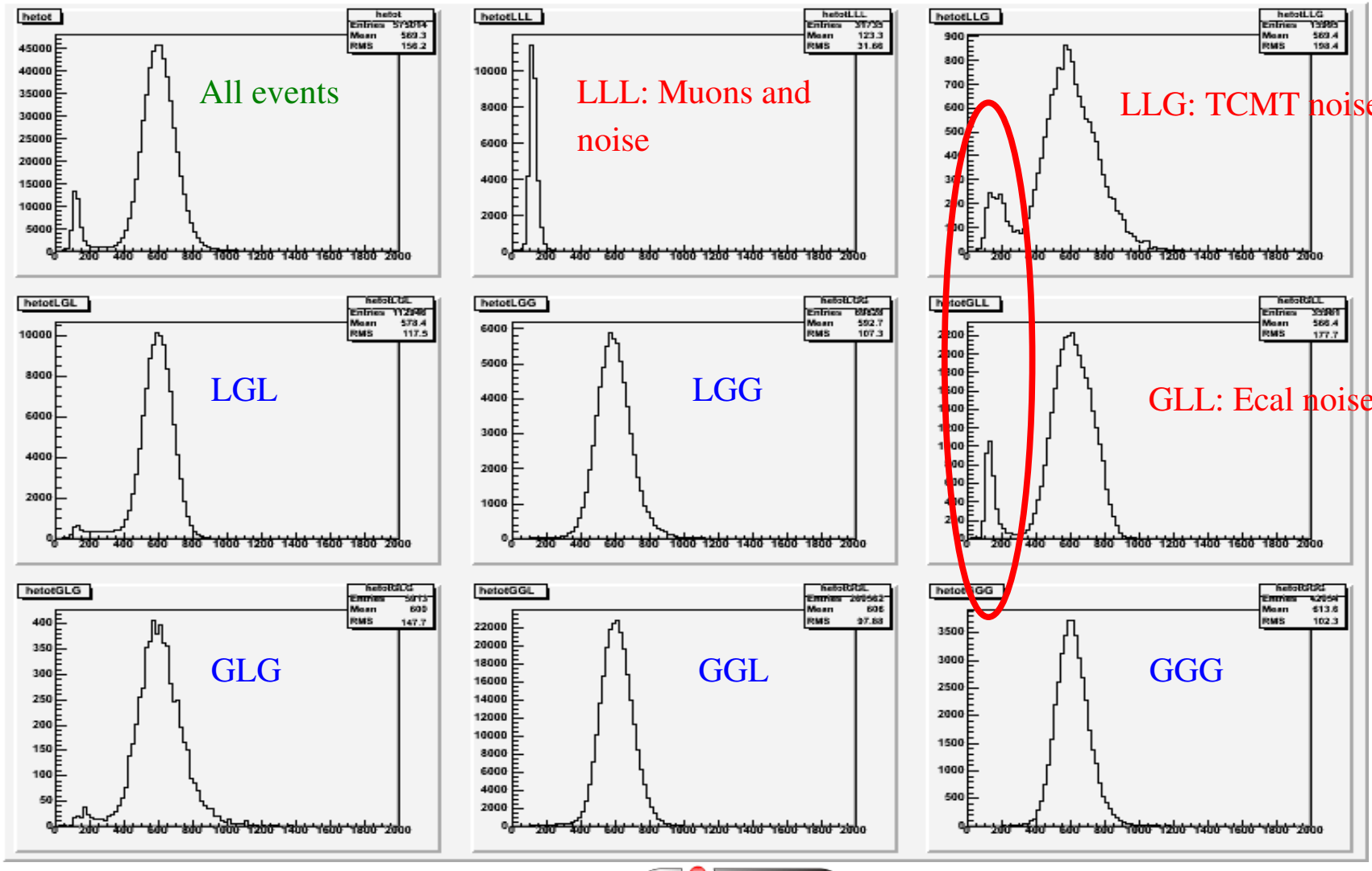


Defining event topologies

- Use frac10mips in Ecal, Ahcal and Tcmt to define event topologies:
  - G for frac10mips > 0.02
  - L for frac10mips < 0.02
- LLL, GLL, GGL, GGG etc., where order means (Emc, Ahc, Tcmt)

- How the pion events in test beam are split into these topologies?

20 GeV pions – run 300620



Topological separation - statistics

- Some statistics (based on Dec/07 digitization studies):

Run 300620

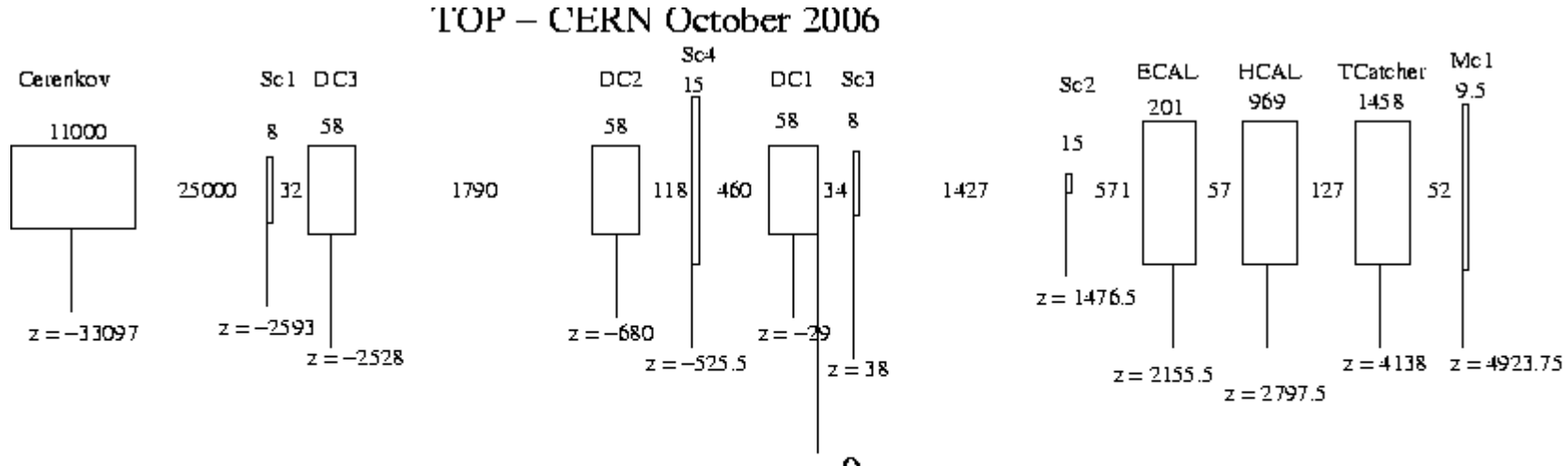
	Real data	Digitized MC
LLL	28809 (5.53%)	454 (4.54%)
GLG	5388 (1.04%)	114 (1.14%)
GLL	32563 (6.26%)	494 (4.94%)
GGL	236714 (45.5%)	4279 (42.8%)
LGL	101044 (19.4%)	1879 (18.8%)
LGG	63221 (12.1%)	1548 (15.5%)
GGG	38297 (7.36%)	929 (9.29%)
LLG	14519 (2.79%)	303 (3.03%)
	520555	10000

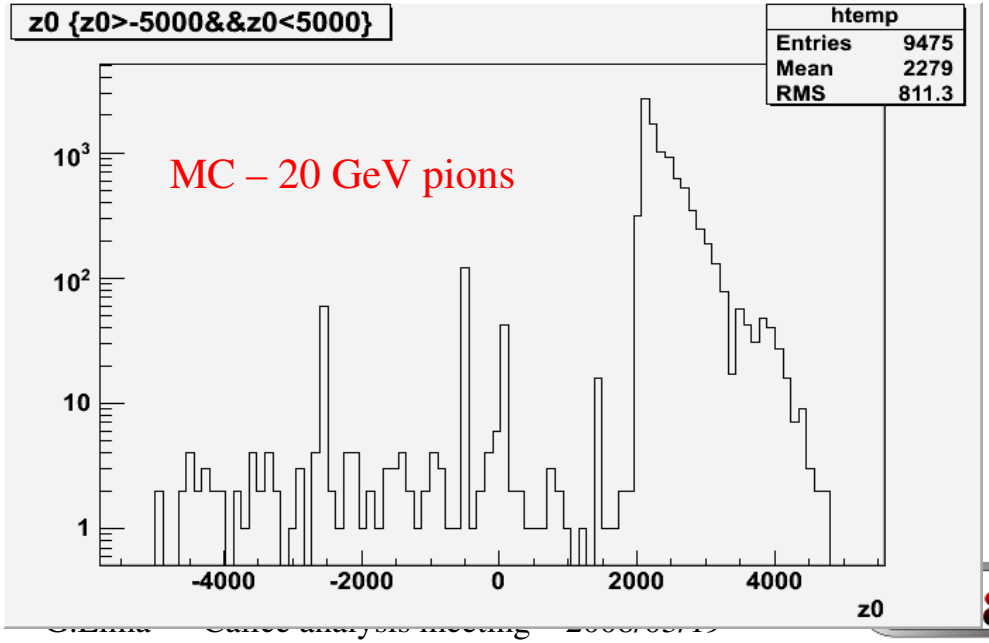
Muon contamination even in MC?

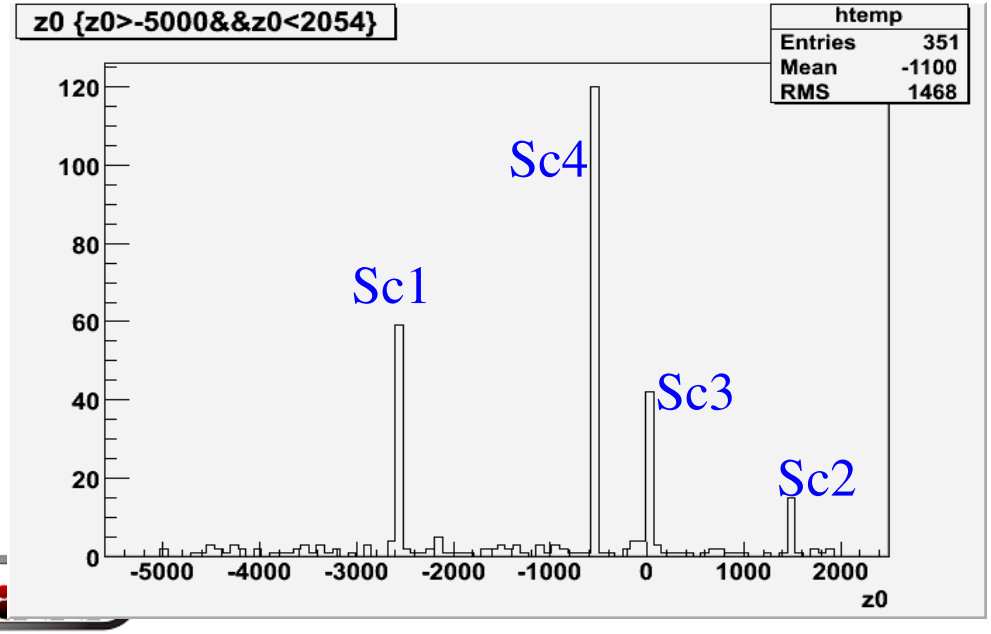
No truth in MC single particle samples to verify...

but can use endVtx for cleanup!

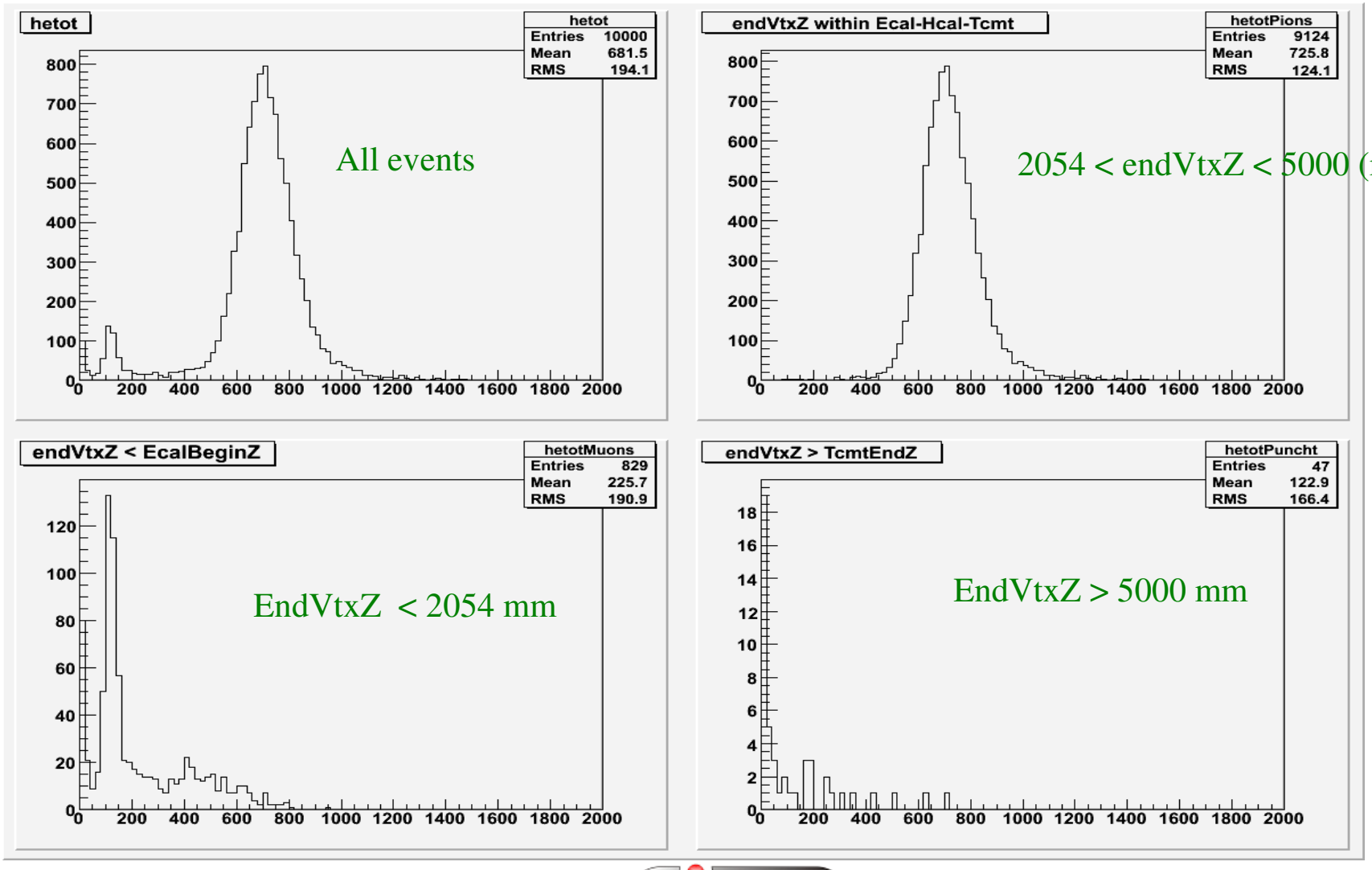
MC cleanup - EndVtxZ distribution



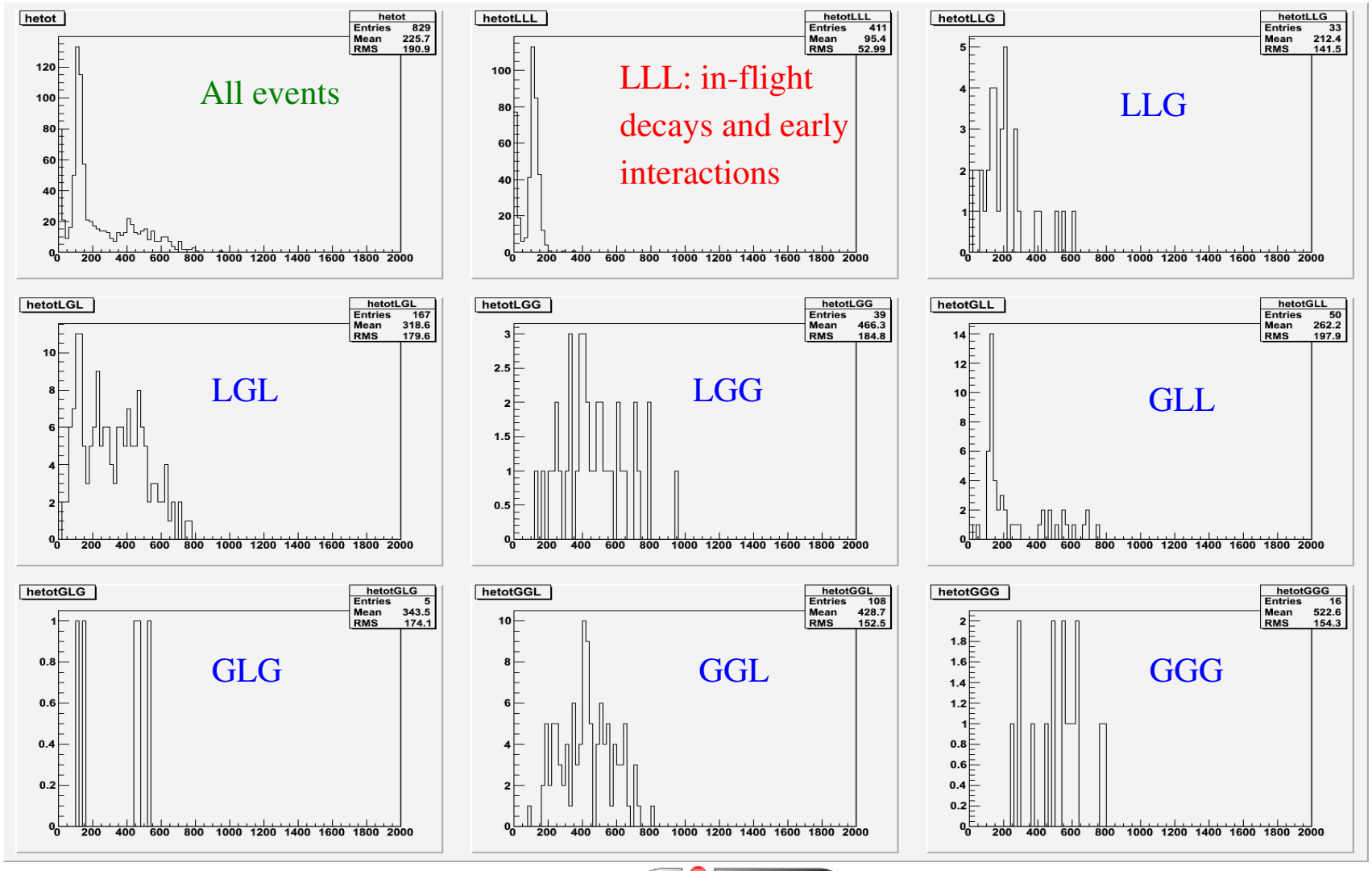




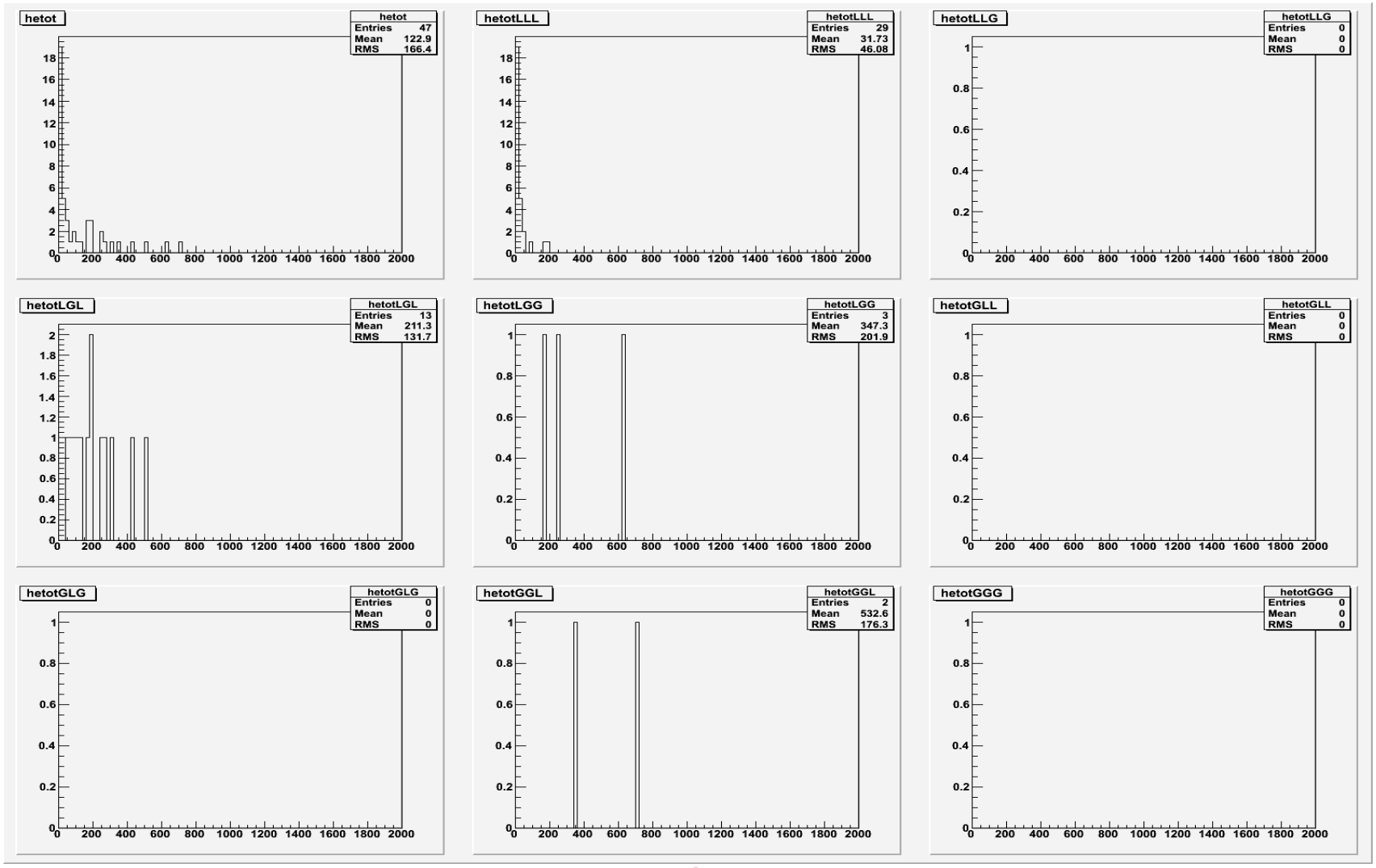
MC pions 20GeV – Ereco as f(endVtxZ)



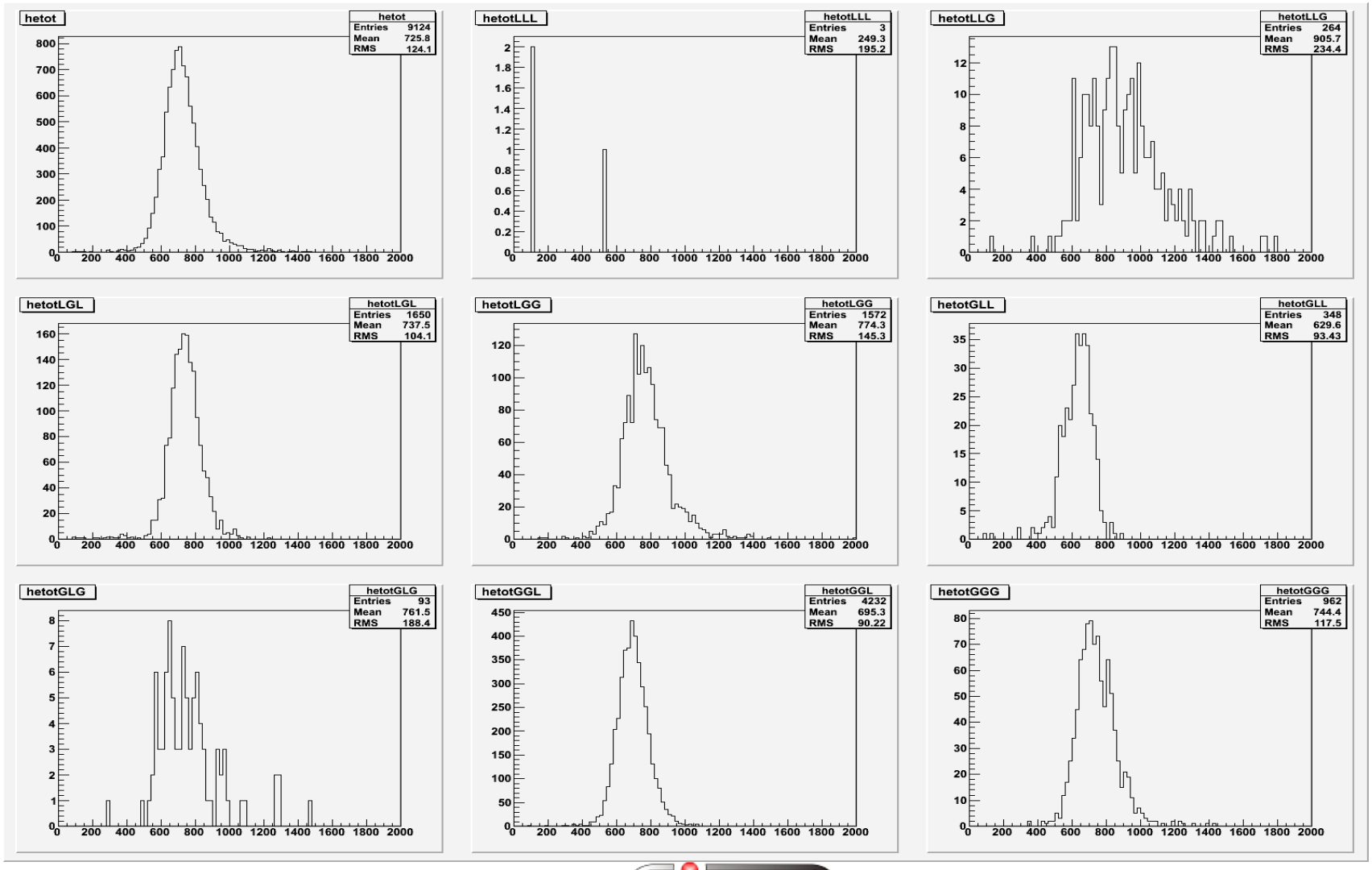
MC pions 20GeV – endVtxZ < EcalBeginZ



MC pions 20GeV – endVtxZ > TcmtEndZ



MC pions 20GeV – "good events"



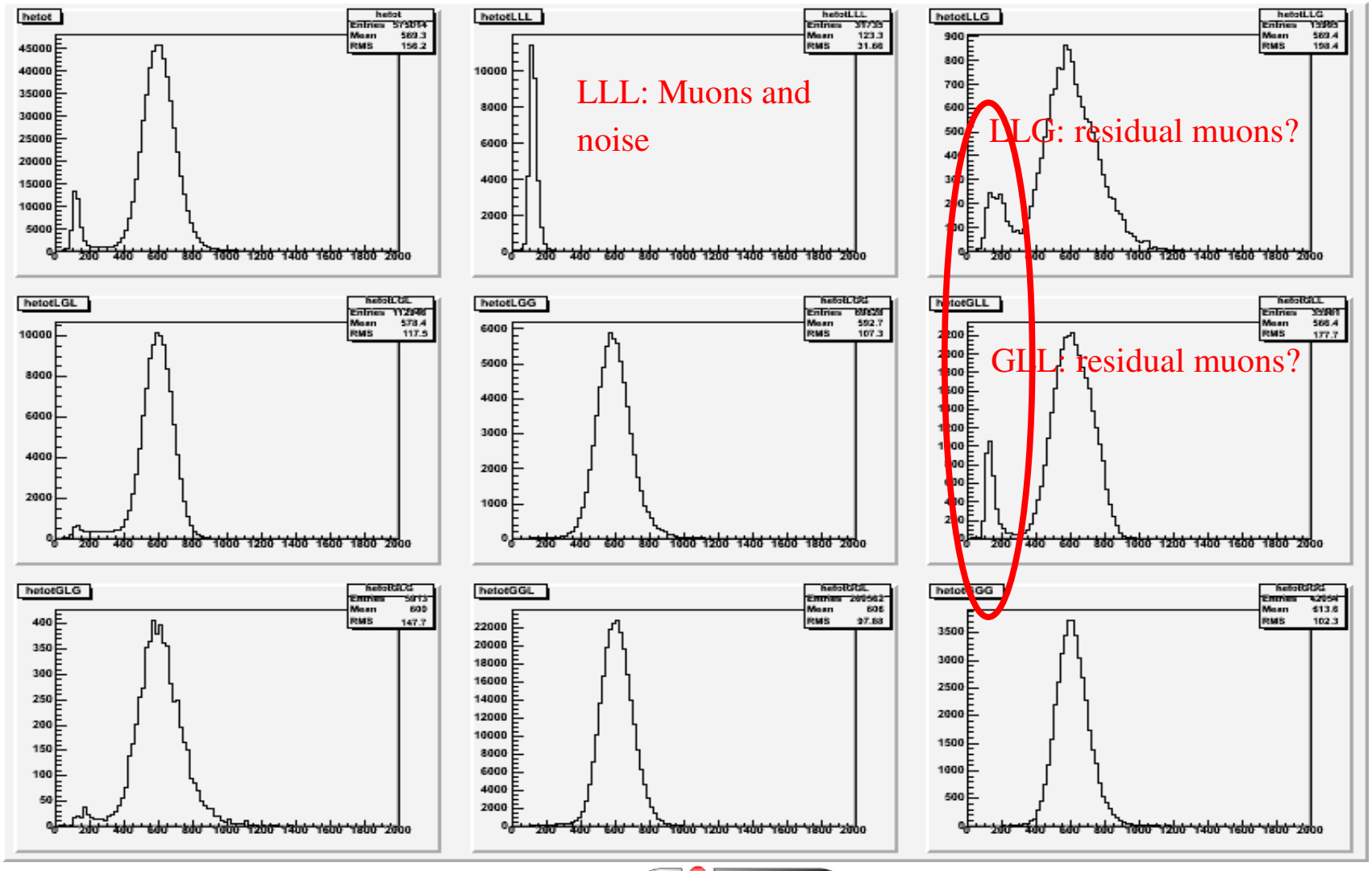
Statistics

	20 GeV pions Run300620	(%)	20 GeV pions MC	(%)	Muons Run300777	(%)
LLL	31735	(5.52)	3	(0.03)	185083	(80.48)
GLL	35981	(6.26)	348	(3.81)	3616	(1.57)
GGL	260562	(45.31)	4232	(46.38)	484	(0.21)
GGG	42054	(7.31)	962	(10.54)	55	(0.02)
LGG	69828	(12.14)	1572	(17.23)	2453	(1.07)
LLG	15995	(2.78)	264	(2.89)	19249	(8.37)
LGL	112946	(19.64)	1650	(18.08)	18609	(8.09)
GLG	5913	(1.03)	93	(1.02)	429	(0.19)
Total	575014		9124		229978	

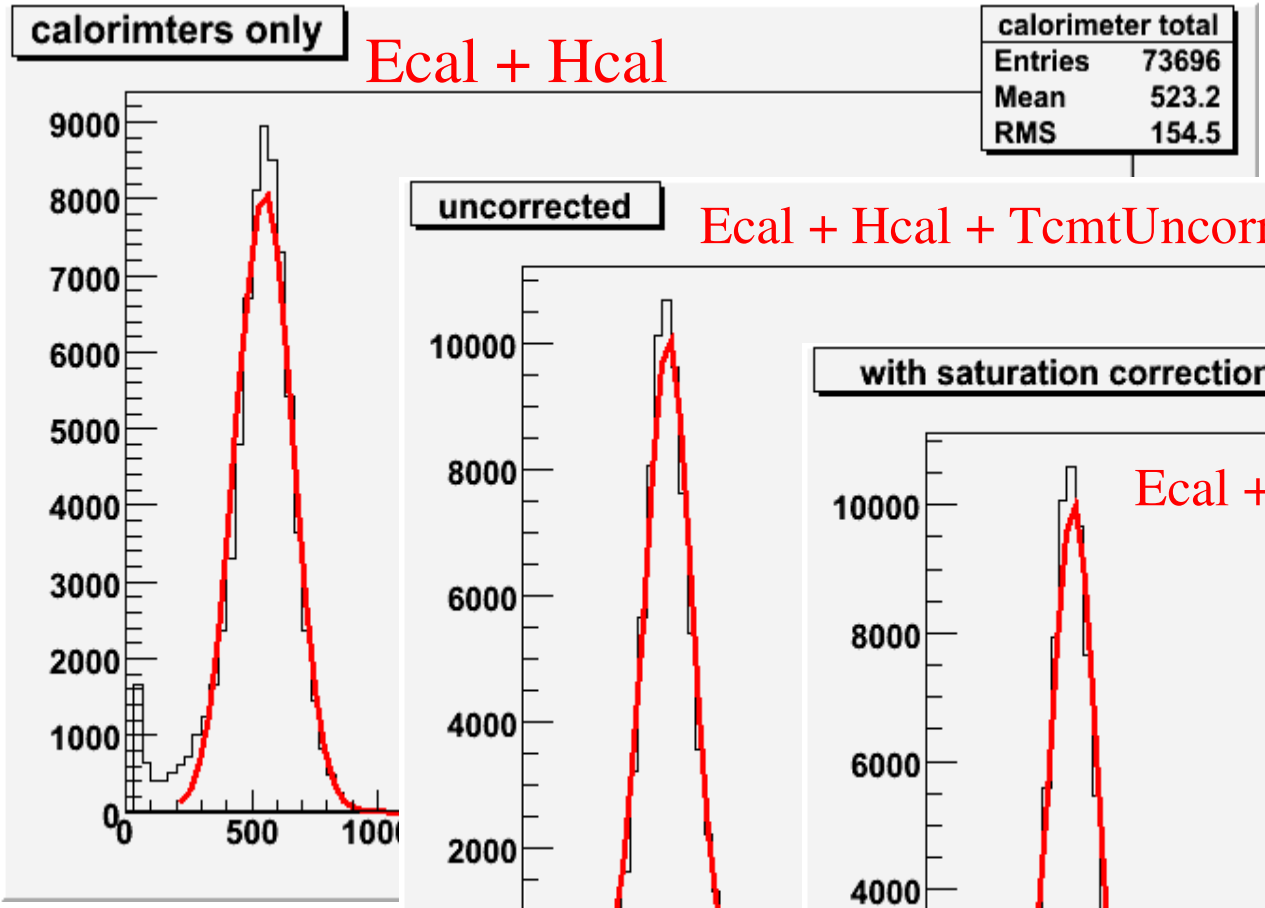
- Efficiency ~ (100-0.03)% = 99.97%
- Muon rejection > 80% (noise in data sample?)

No Ahcal-digitized MC muon sample available yet :-(

20 GeV pions – run 300620

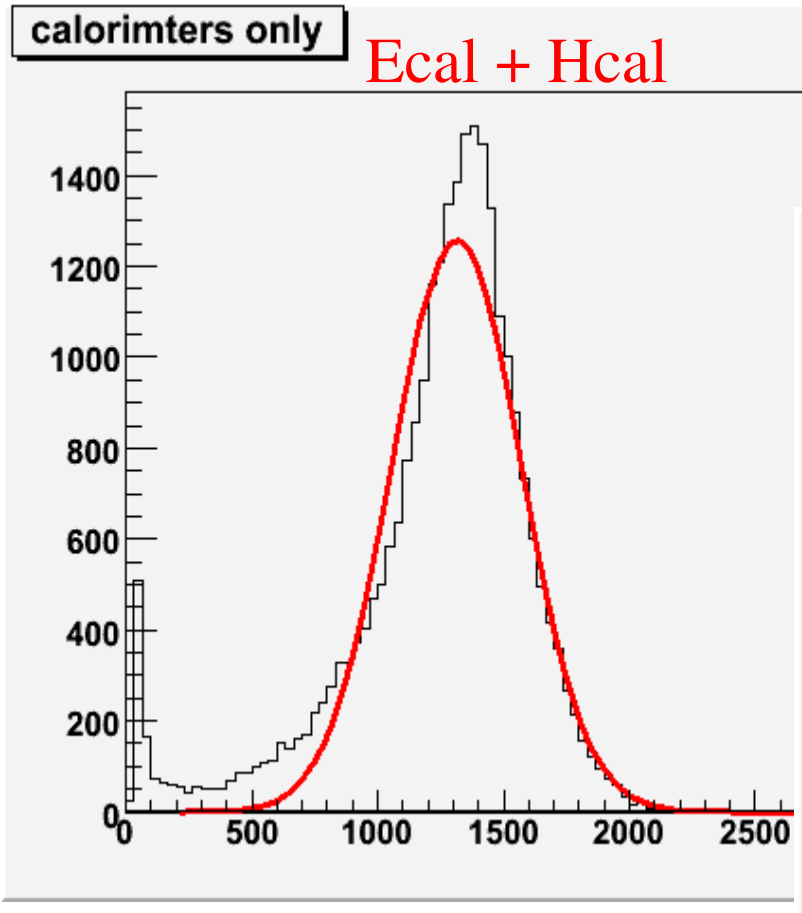


Saturation correction to Tcmt hits (Kurt Francis)

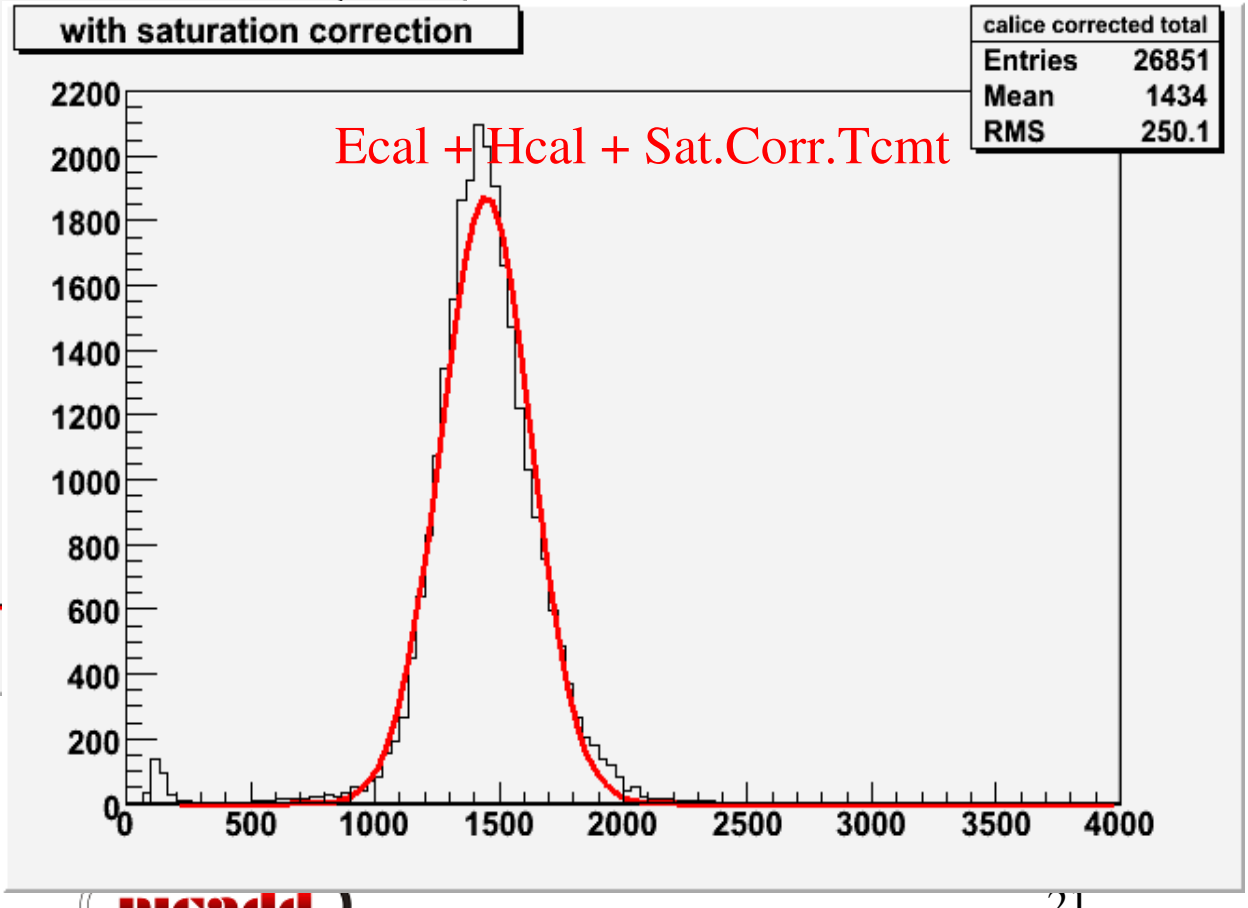


20 GeV pions

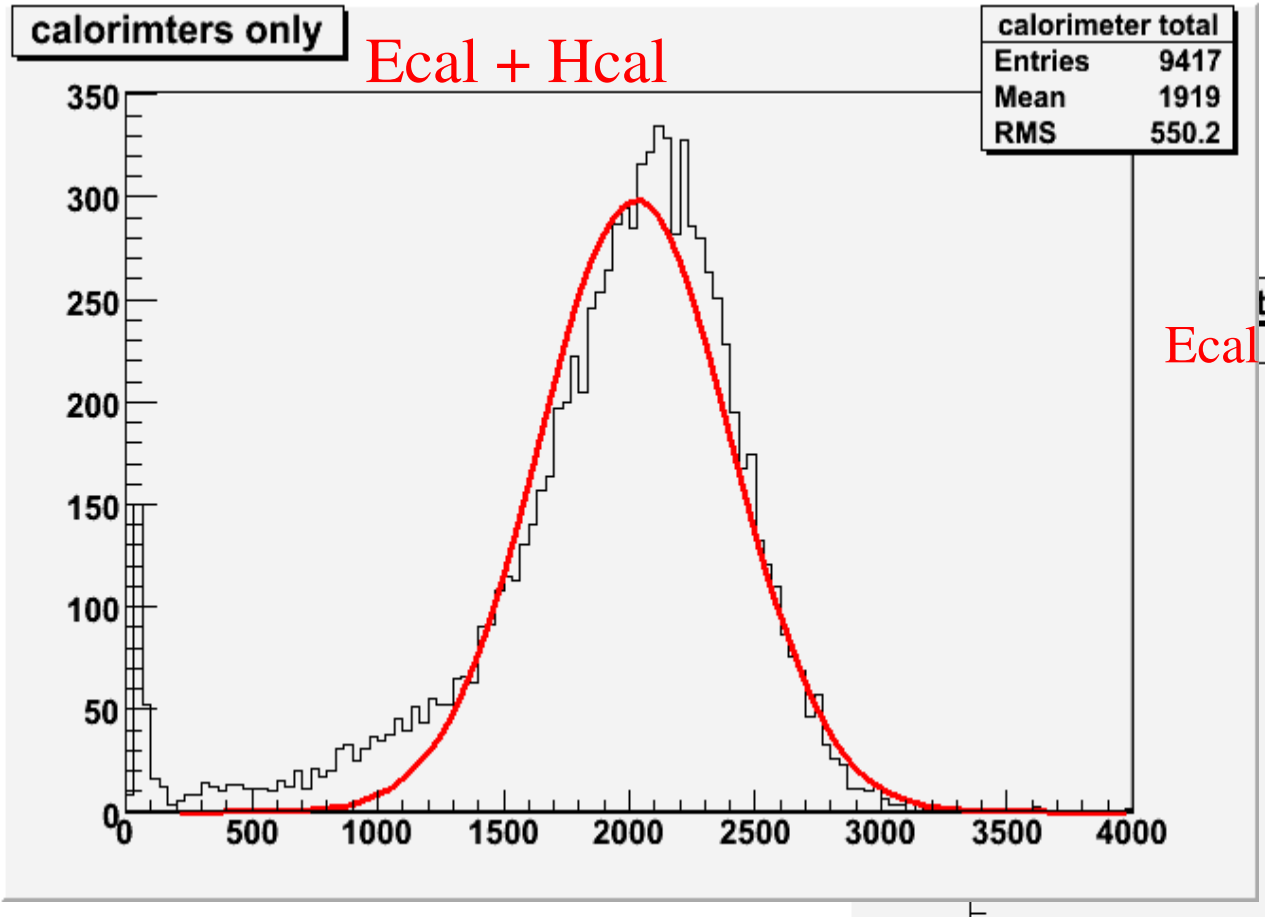
Saturation correction to Tcmt hits (Kurt Francis)



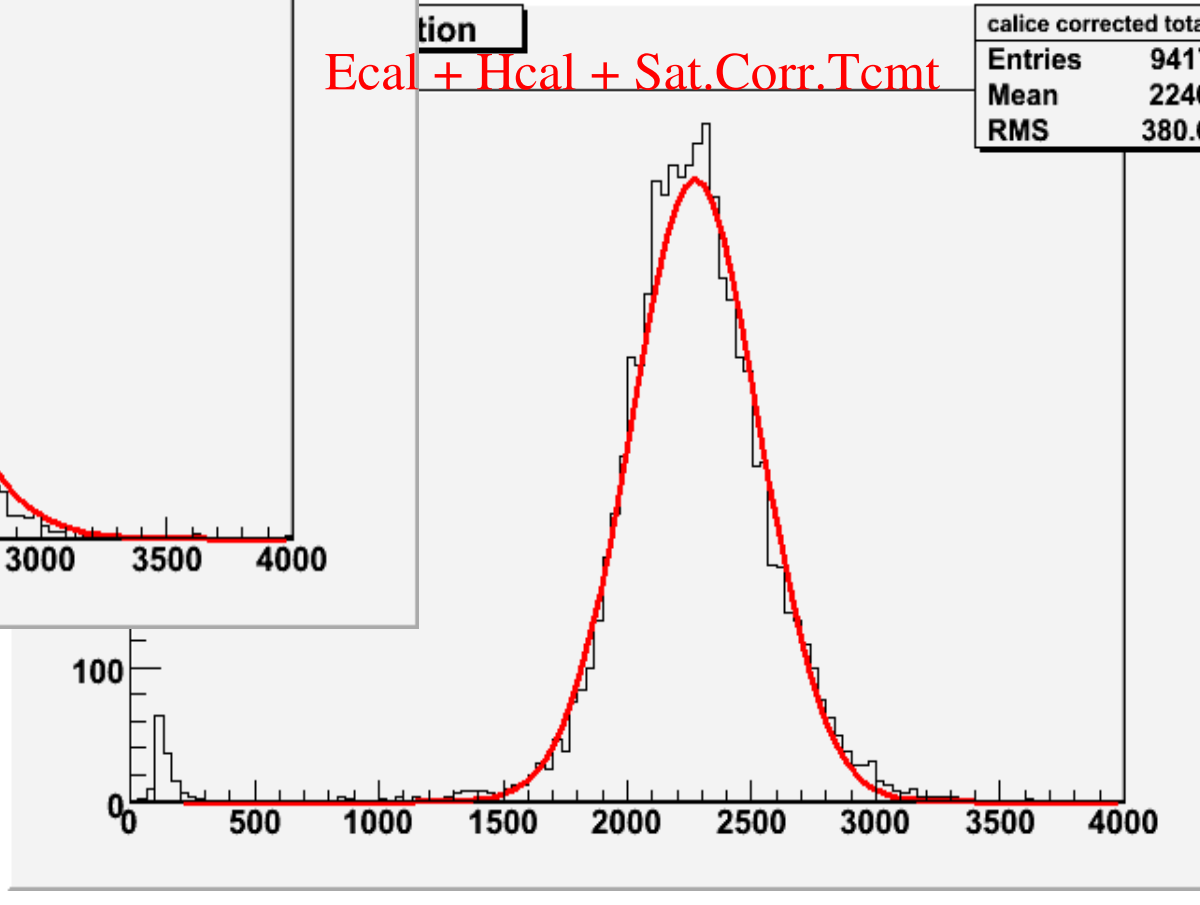
50 GeV pions



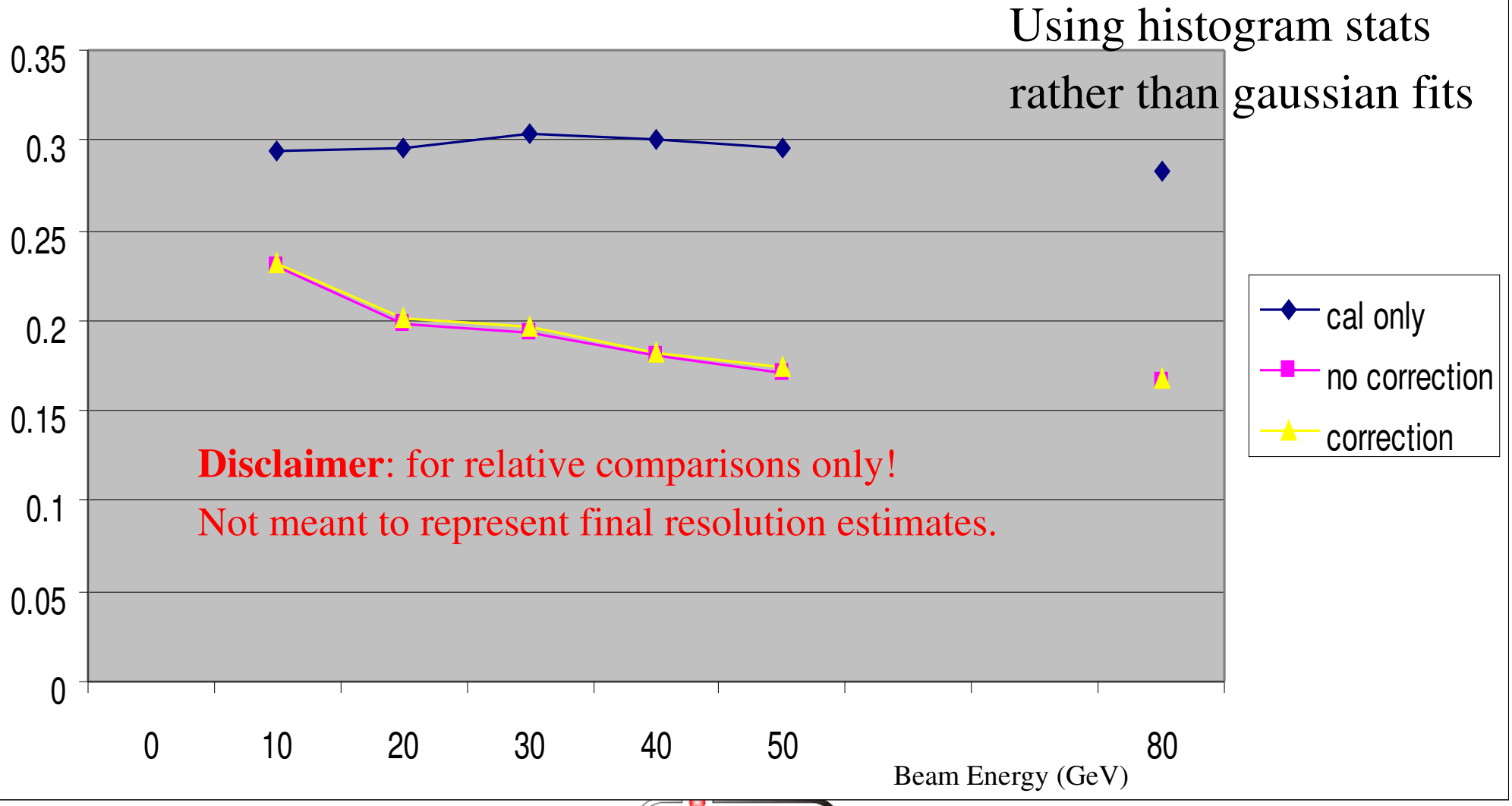
Saturation correction to Tcmt hits (Kurt Francis)



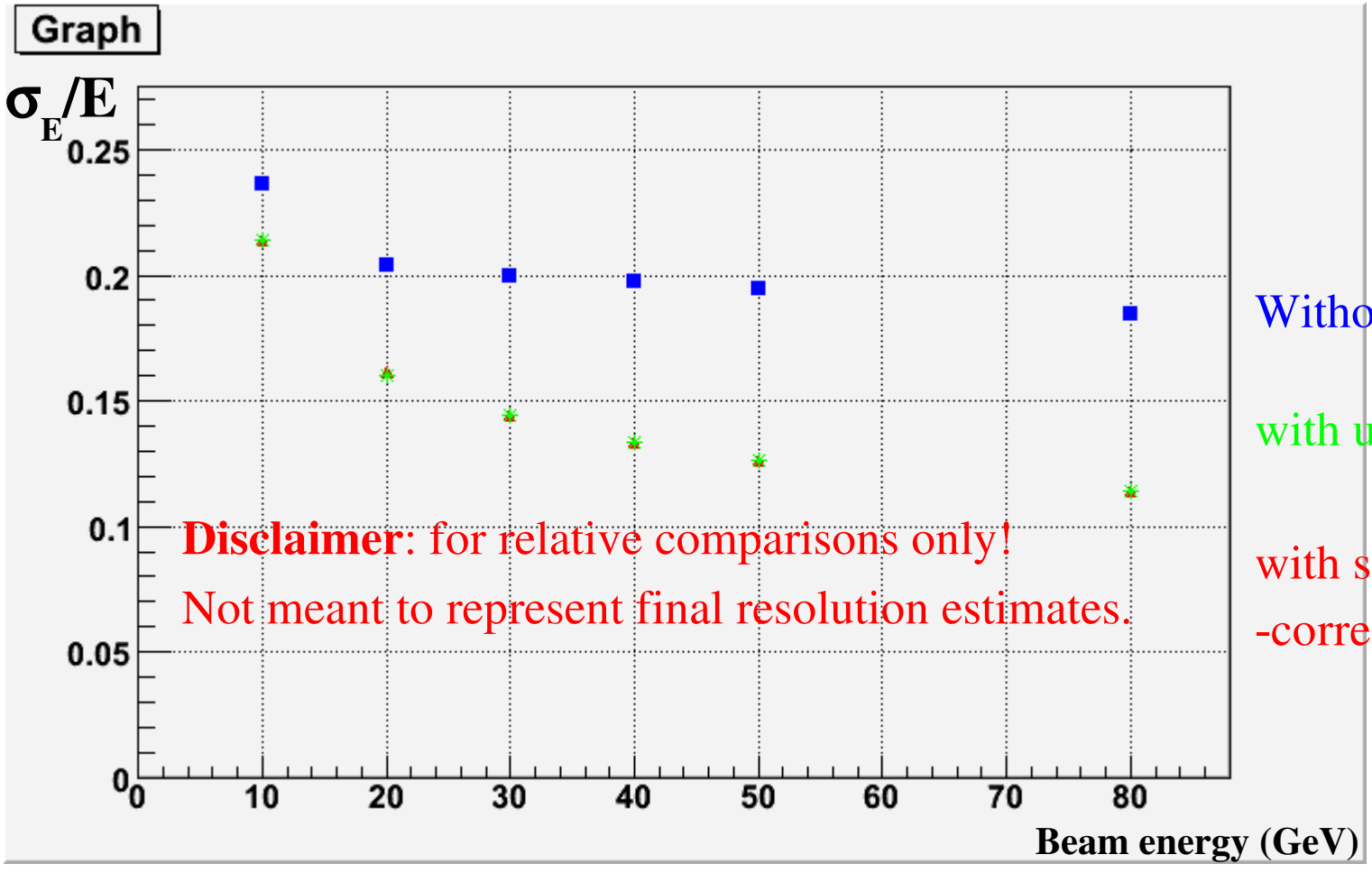
80 GeV pions



Energy Resolution



Energy resolutions from gaussian fits

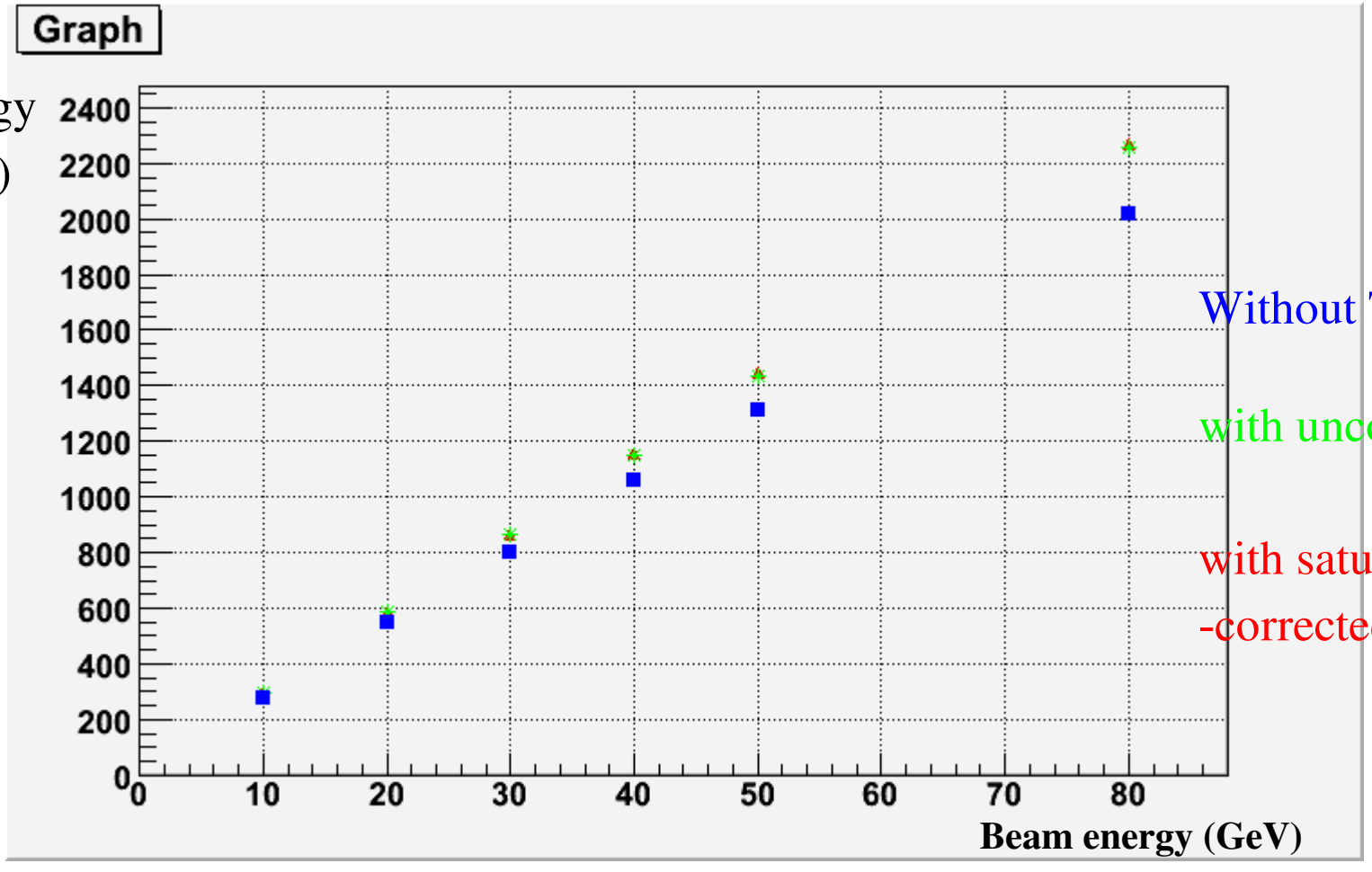


Without TCMT

with uncorrected TCMT

with saturation-
-corrected TCMT

Saturation correction: linearity



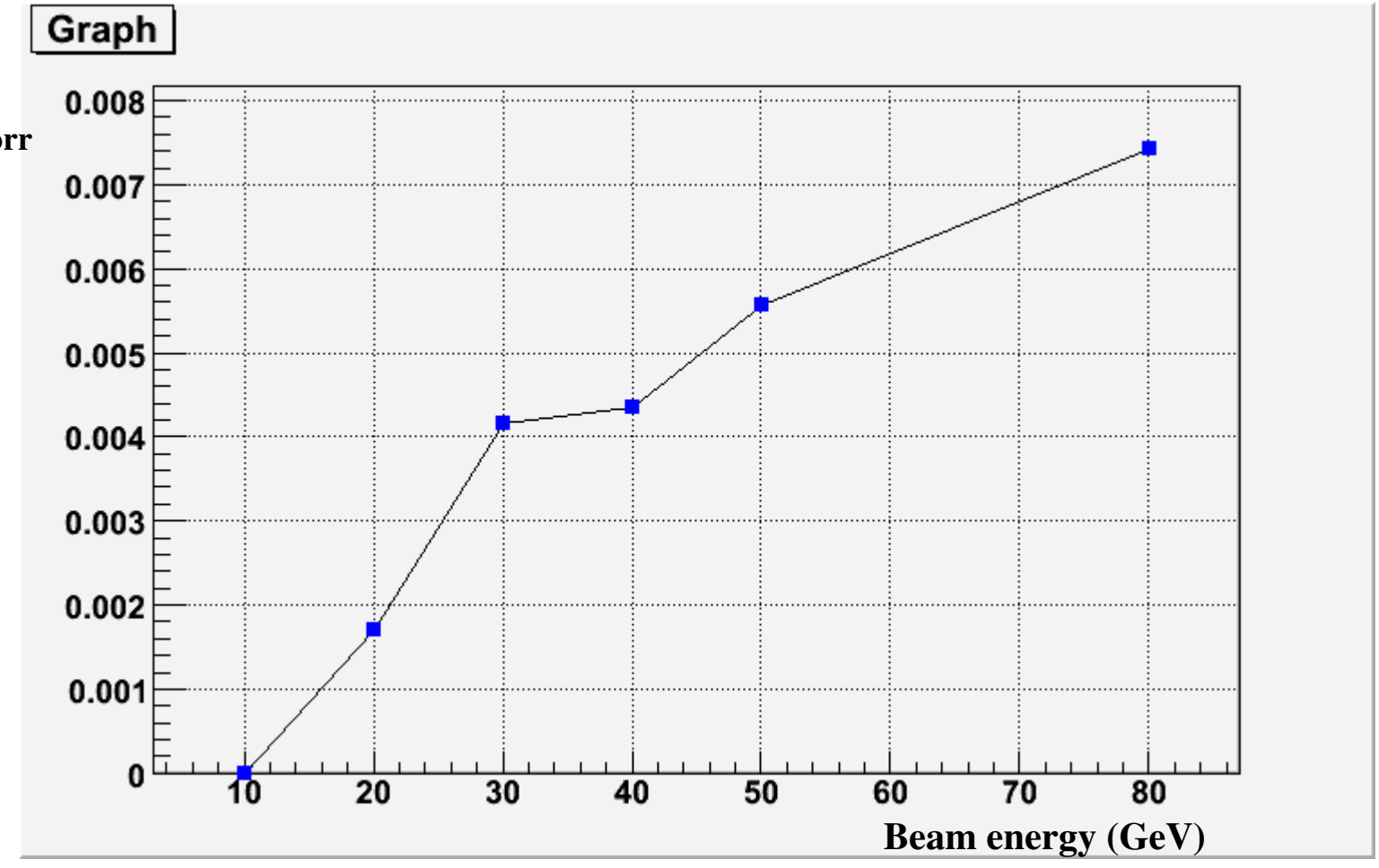
Without TCMT

with uncorrected TCMT

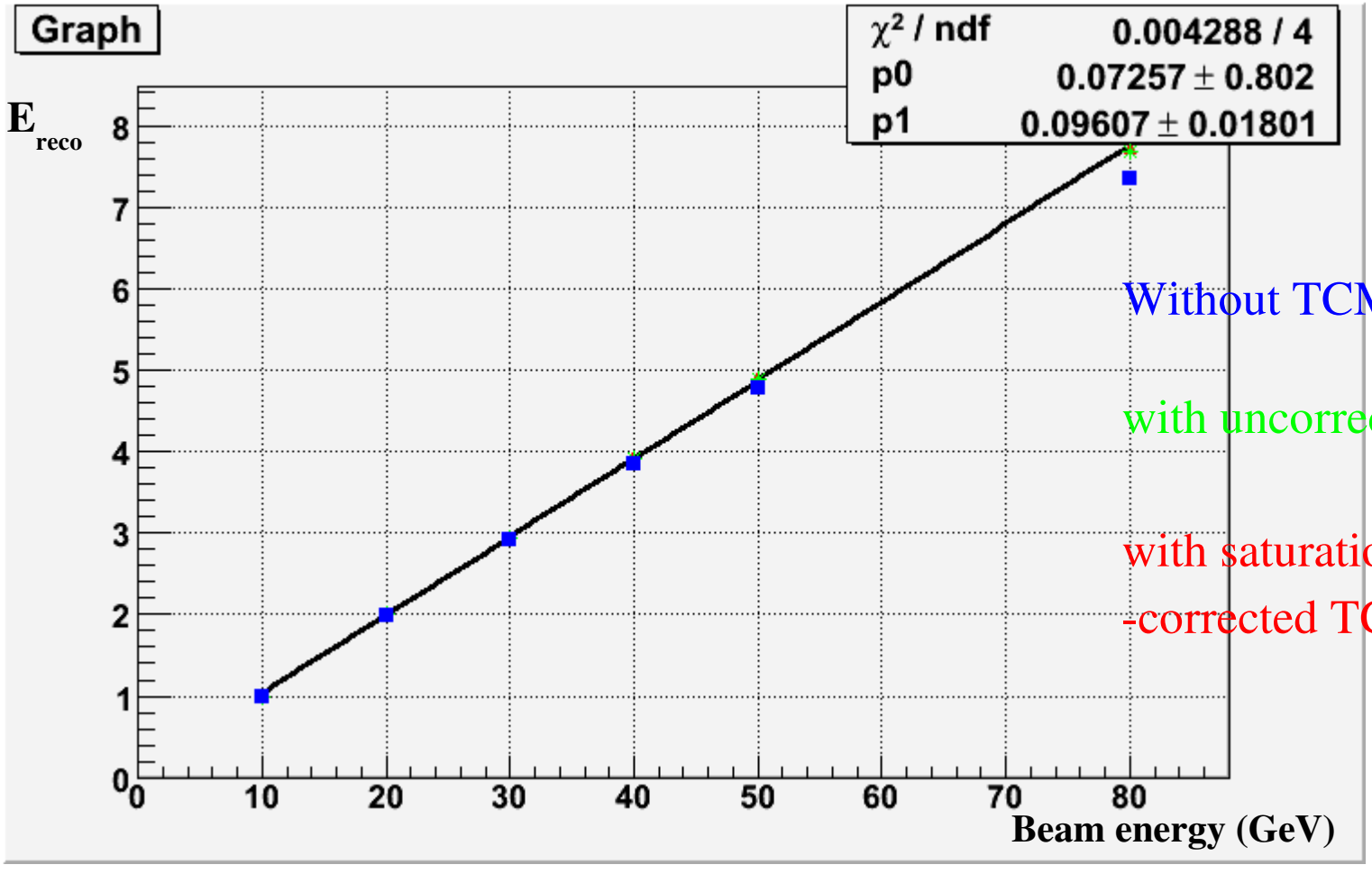
with saturation-corrected TCMT

Increase in reco energy due to Tcmt saturation correction

$\Delta E/E_{uncorr}$



Normalizing energies w.r.t. 10 GeV

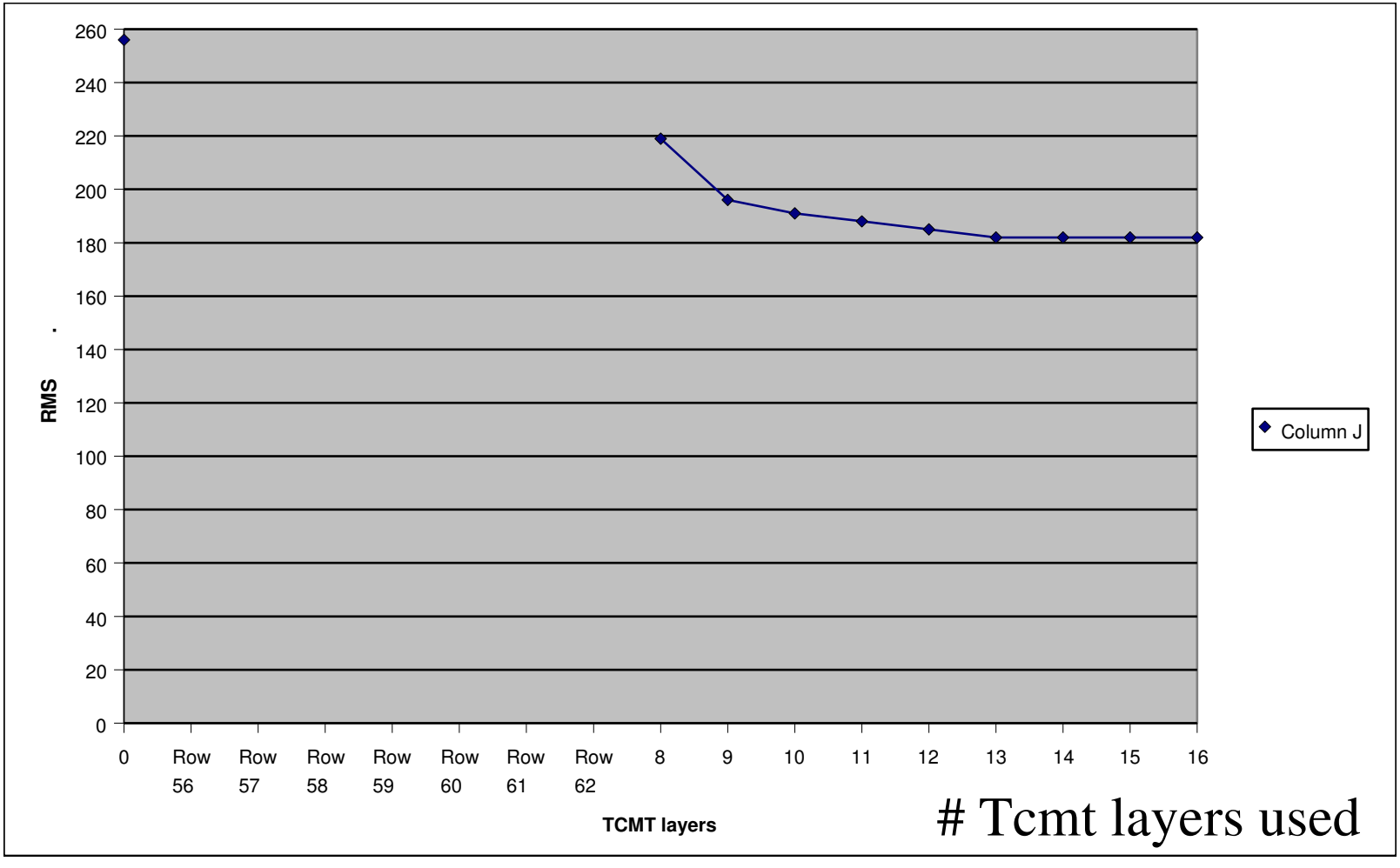


Without TCMT

with uncorrected TCMT

with saturation-
-corrected TCMT

Partial TCMT performance (by Kurt)



Updates to digitization

- Detailed MC vs. data comparisons, for different topologies.
  - TCMT digitization includes readout smearing and average crosstalk
  - Correction for saturation effects (Kurt) to be included soon
  - Latest updates to Hcal ganging and digitization
    problems in local installation prevented the availability of new results for this presentation.

- **Unfortunately, due to technical problems, it was not possible to obtain new results, including the latest HCAL digitization, on time for this presentation. Hopefully these will be available soon.**

Summary

- Current studies show that a simple LLL algorithm for muon tagging is about 99.97% efficient for 20GeV pions, while rejecting at least 80% of the muons from pion decays
- End vertex selection is useful for cleanup of MC samples
- Next steps:
  - Finalize implementation of saturation corrections for Tcmt in Marlin
  - Fix technical problems with our local Hcal digitization (and add Ecal!)
    - MC muon sample ASAP
    - Investigate muon contamination on GLL and LLG topologies
    - Updates to the MC vs. data comparisons
  - Port Directed Tree clustering algorithm to Marlin / C++