Preliminary Ahc + Tcmt analysis status and plans

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CALICE software phone meeting
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Introduction

- Recent SiD workshop at Fermilab, on April 9-11, where we presented some preliminary Calice data analysis (two talks on Monday, April 9).
- Our slides were submitted to general Calice mailing list, for comments and suggestions from Calice members (not a lot or feedback, as expected in the middle of Easter Holidays weekend)
- Considering that results had not been previously shown inside the collaboration, David suggested to remove statistics from several plots. Presentation should emphasize the qualitative aspects of the Ahcal+Tcmt analysis.
- Show the work in analysis meetings, and an analysis note before LCWS07

Outline

- Sanity checks:
  - Compare Monte Carlo and real data (show data processing chains)
  - Verify Ecal and Hcal calibration (show software-triggered hits)
  - Hit selection and background rejection
- Present status:
  - Interesting results on energy resolution (Emc + Ahc + Tcmt) at several beam energies
  - Kurt's talk also contains new material on Tcmt pedestal and gain stability
    http://ilcagenda.linearcollider.org/contributionDisplay.py?contribId=57&sessionId=23&confId=1390
- Please note: there is a lot of information in these slides... probably not enough time to discuss all of them today, but I kept them all here in case anyone has comments or suggestions!

Software processing chain

- Real data processing:
  - Selected runs from Niels' list of hadron beams in October/06

    http://polywww.in2p3.fr:8081/CALICE/Members/watson/lcws07/runlist_Oktober.xls
  - LCIO-converted files from the grid: /grid/calice/tb-cern/raw/conv_v0402
  - Reconstruction frameworks: (Marlin + LCCD/CondDBMySQL + Calice libs)
    - Roman's (CVS + make) and Sebastian's (git + autotools)
    - Pedestal subtraction, calibrations (gain, intercalib, saturation, mip)
    - Output: calibrated hits, zero suppressed, global hit position(*not used)
  - Analysis: root ntuple with all Ecal,Hcal,Tcmt hits above 0.5 mip, and event-based energy sums (both analog and hit-counting).

Steering file for real data

For reference, here is the list of Marlin processors used for real data
(file raw2calohit/steer/gl.steer)

Thanks to S.Schmidt et.al. for all the support and for providing lots of code and calibration constants!!!

```
###Initialization processors
        ActiveProcessors CaliceCondDBConditionsProcessor
        ActiveProcessors MyCaliceTriggerProcessor
#       ActiveProcessors MarkAllTransient

###DC Processors a la Michele
##        ActiveProcessors DriftChamberDigitization
#        ActiveProcessors DriftChamberEfficiency
#        ActiveProcessors DriftChambertoTrack

###Emc Processors
        ActiveProcessors EmcSimpleHitSearch
#       ActiveProcessors EmcSimpleClusteriser
#       ActiveProcessors EmcPedestalNoiseHistograms
#       ActiveProcessors EmcAverageHistoryGraphs
#       ActiveProcessors EmcSquareFinderNoCluster
#       ActiveProcessors ExcludeEcalClusters
###Veto Counter
#        ActiveProcessors VetoCounter
### AHcal Processors
        ActiveProcessors MyFastMappingIProcessor
        ActiveProcessors MyPedestalOnTheFlyProcessor
        ActiveProcessors MyFastInterCalibrationProcessor
        ActiveProcessors MyFastGainCalibrationProcessor
        ActiveProcessors MyFastSaturationCalibrationProcessor
        ActiveProcessors MyFastMIPCalibrationProcessor
#       ActiveProcessors MySimpleHcalCalibrationProcessor
        ActiveProcessors MyFastMappingIIProcessor
### TCMT Processors
##        ActiveProcessors tcmtMappingIProcessor
        ActiveProcessors tcmtMappingI
        ActiveProcessors tcmtPedestalSubtraction
        ActiveProcessors tcmtMipCalibration
        ActiveProcessors tcmtMappingII

## Guilherme's stuff
        ActiveProcessors GLAnalyzer
        ActiveProcessors MyBasicAnalysis
#       ActiveProcessors GLHitCollections
#       ActiveProcessors GLMuonCalib
#       ActiveProcessors GLLEDCalib
### other miscellaneous stuff
#       ActiveProcessors MyLCIOOutputProcessor
#       ActiveProcessors MyCollectionHistogramer
#       ActiveProcessors GlobalHistogramOutput
#       ActiveProcessors MyEventSeparator
#       ActiveProcessors MyProgressHandler
```

Software processing chain

- Monte Carlo processing:
  - Mokka (Geant4): version 06-03-p01 with TBCern1006_01 geometry model
  - Roman's Hcal ganging processor (class TB03ahcalGangingProcessor, modified)
    - Changes: output SimCalorimeterHits, and excluded (I,J) = (7,67) and (7,85)
  - DigiSim:
    - energy threshold at 0.5mip, MIP calibration
    - no x-talk or noise simulated yet
    - Output: calibrated hits, zero suppressed, global hit position
  - Data analysis: Marlin processors, ntuple filler, root scripts
    - Some effort to enable visualization in org.lcsim + JAS3

Steering file for Monte Carlo

For reference, here is the list of Marlin processors used for Monte Carlo (file digisim/tbeam.steer)

Thanks to R.Pöschl for the Hcal ganging code.

For more info, source files will be made available at:
http://nicadd.niu.edu/~lima/calice

```
# the active processors that are called in the given order
ActiveProcessors CalHitMapProcessor
ActiveProcessors TBhcalGangingProcessor
ActiveProcessors EMDigitizer
ActiveProcessors HADDigitizer
ActiveProcessors TCDigitizer
ActiveProcessors EcalCalibrationProcessor
ActiveProcessors HcalCalibrationProcessor
ActiveProcessors TcmtCalibrationProcessor
ActiveProcessors AnalysisProcessor
#ActiveProcessors OutputProcessor
```

```
##############################################################
# A processor to convert raw hits into calibrated hits.
#define the module parameters after '.begin ModuleName' :
.begin TBhcalGangingProcessor

# mandatory module type (the name of the class)
ProcessorType TB03ahcalGangingProcessor
RequiredCollection TBhcal06_01_hcalSD
OutputCollection TBhcal06_01_hcalSD_ganged

#Choose beween 'user' and 'default' setting
#choosing default makes all of the following paramters
#ineffective
Setting default

.end ------------------------------------------------
```

```
##############################################################
# A processor to convert raw hits into calibrated hits.
.begin AnalysisProcessor

# mandatory processor type (the name of the class)
ProcessorType Analysis

# Input collections
EcalCollectionName EmcCalorimeterHits
HcalCollectionName AhcCalorimeterHits
TcmtCollectionName TcmCalorimeterHits

.end ------------------------------------------------
```

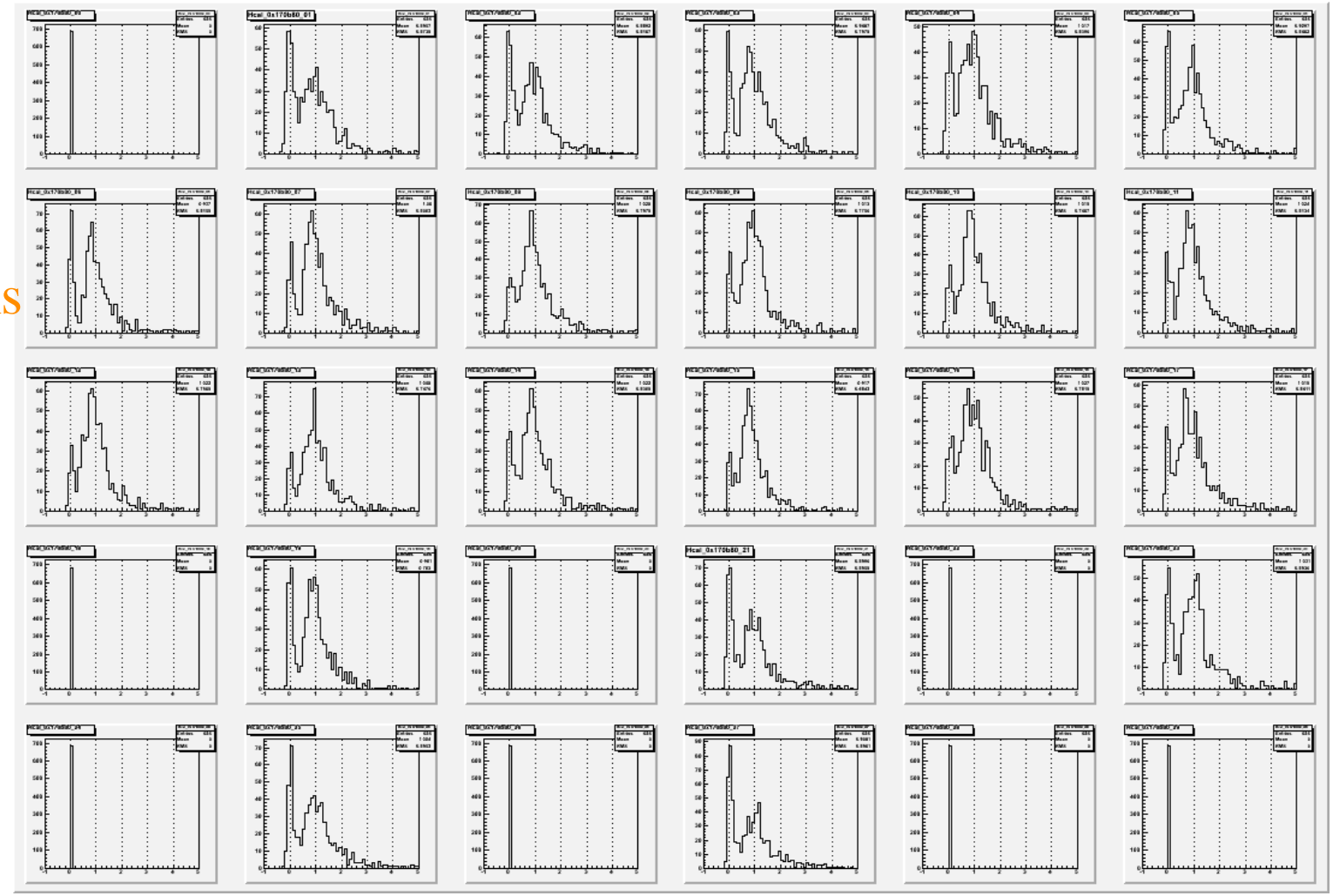
Overview of our test beam data analysis

- Recent developments (since last presentations at SiD phone meetings):
  - Use of official reconstruction framework + calibration constants from conditions DB
  - Better background rejection (trigger bits and veto counter amplitude)
  - Account for different detector thicknesses (7 distinct hit weights)
  - Simple-minded procedure for finding sampling fractions
- Hit selection requirements: Ehit > 0.5 Emip .and. Ehit > 2 $\sigma_{pedestal}$
- Compare test beam MC vs. real data taken at Cern (focus on Hcal/Tcmt response)
  - MC samples of muons (6, 10 GeV) and pions (6, 8, 10, 12, 15, 18, 20, 30, 40, 50, 80 GeV)
- Basic sanity checks, energy correlations, combined live energies, etc.
- Preliminary look at pion samples at several different energies

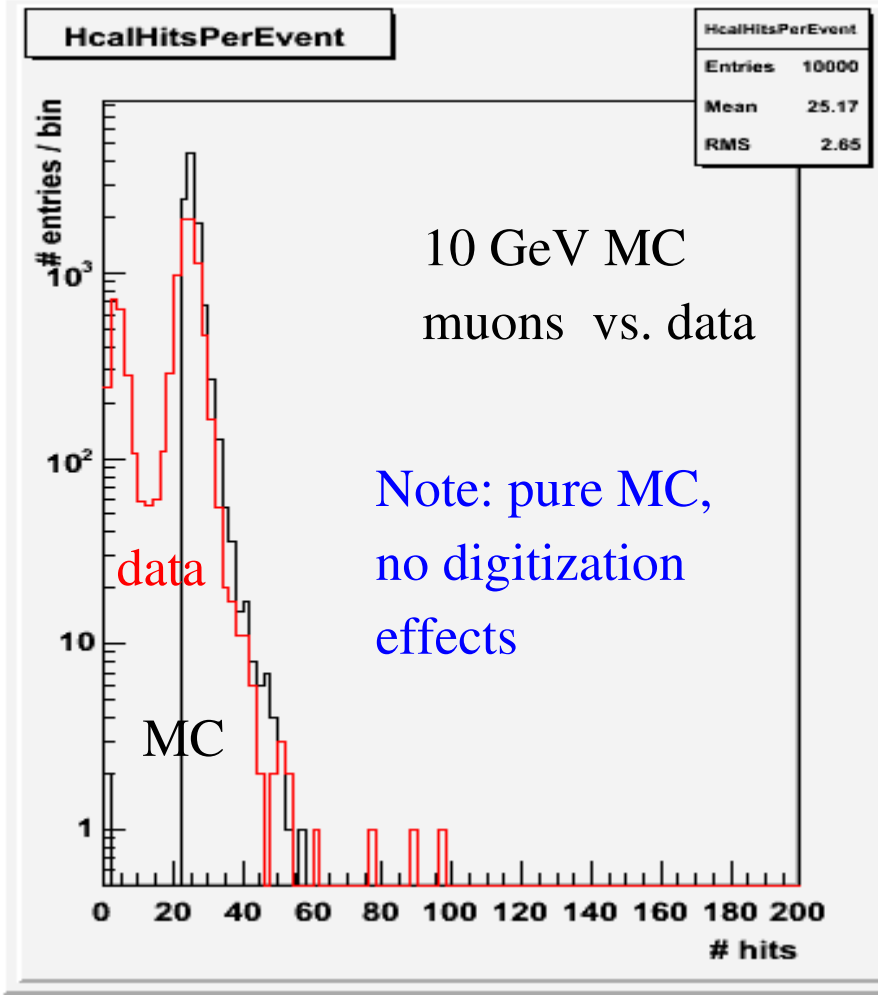
Checking mip calibration in Hcal

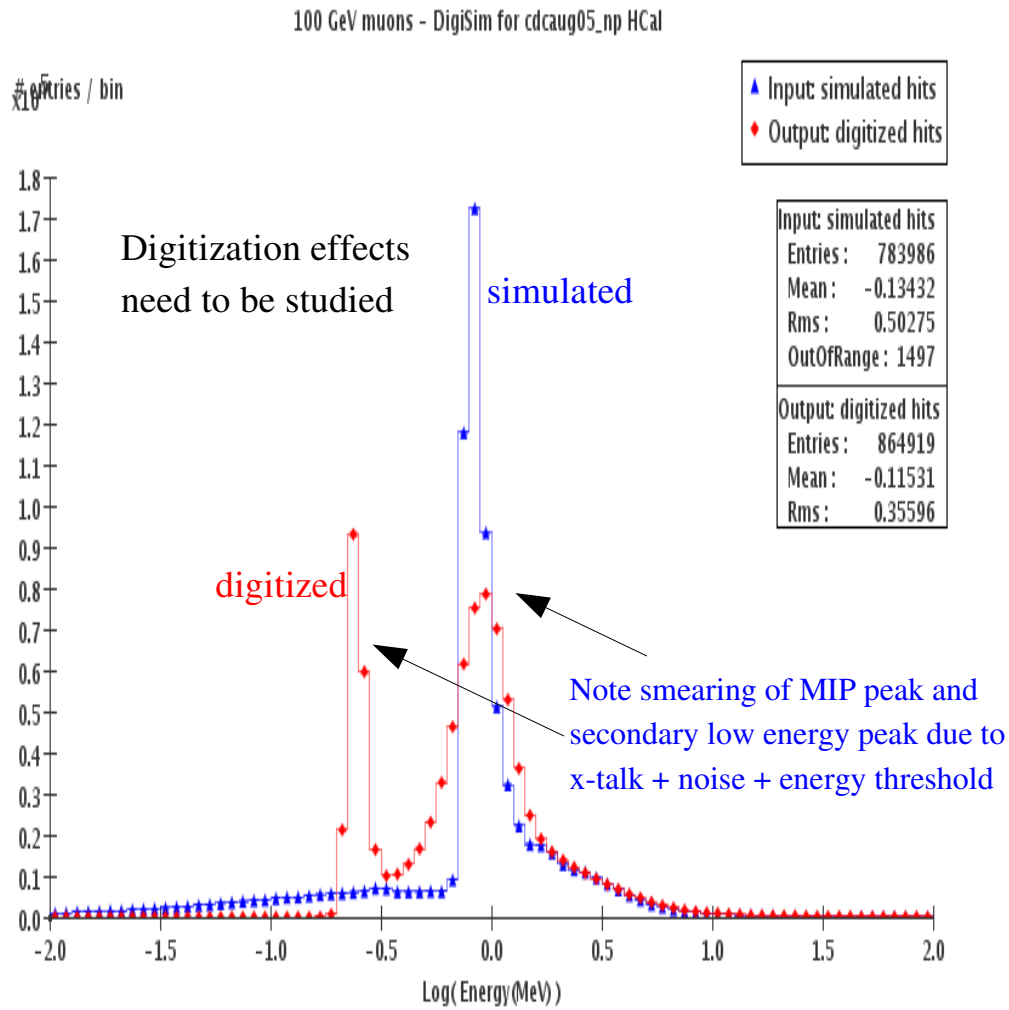
Calorimeter for ILC

Use software triggering to select mip tracks (8 aligned hits), then plot response of every cell.



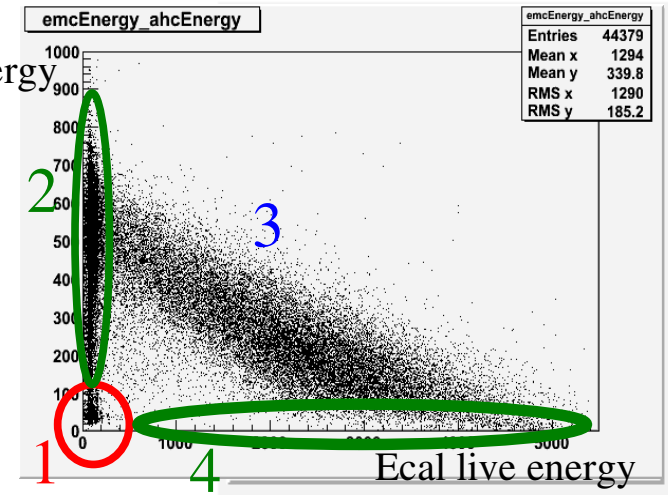
MC comparisons: # Hcal hits per event

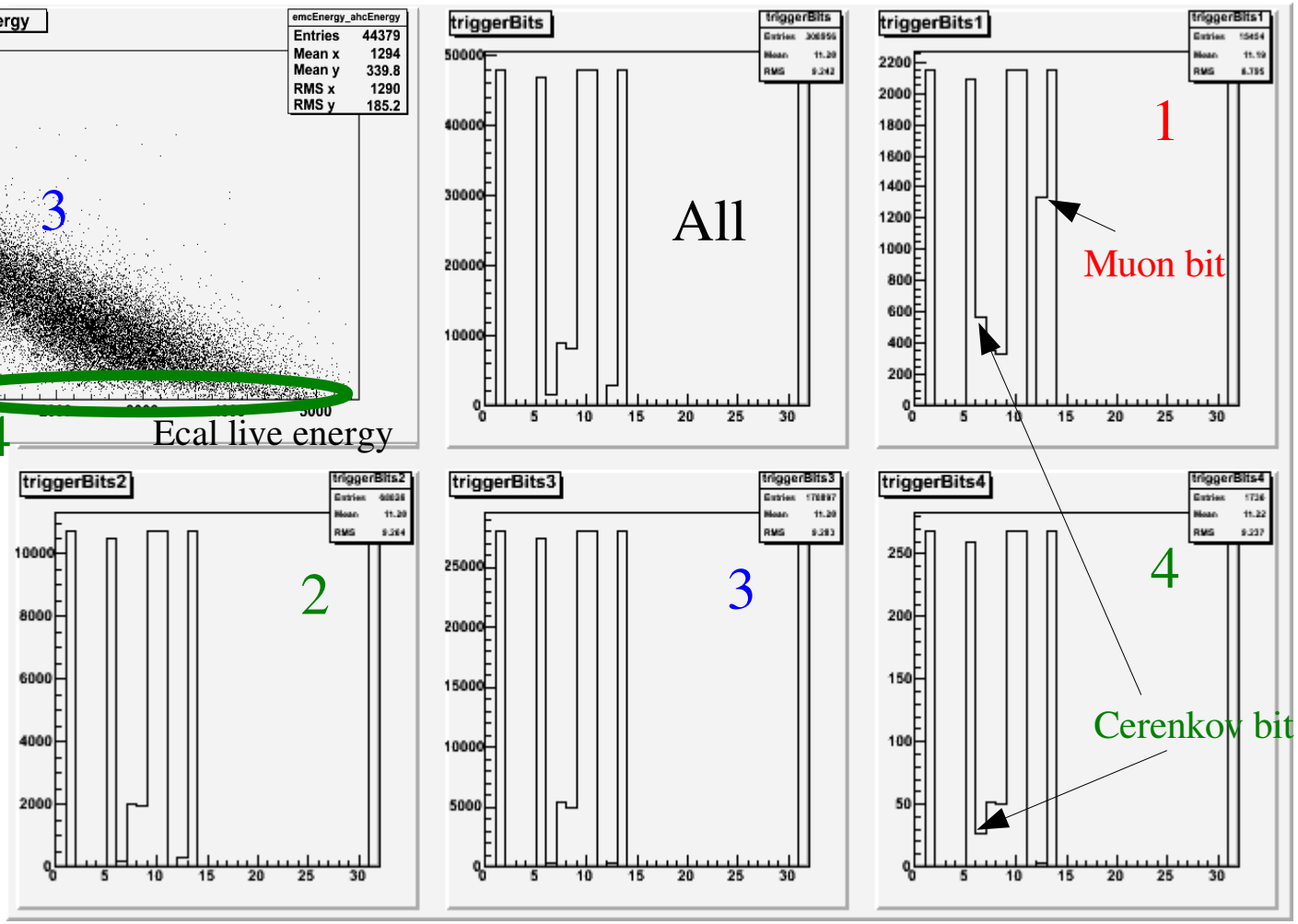




Background rejection: muons in pion samples

Hcal live energy



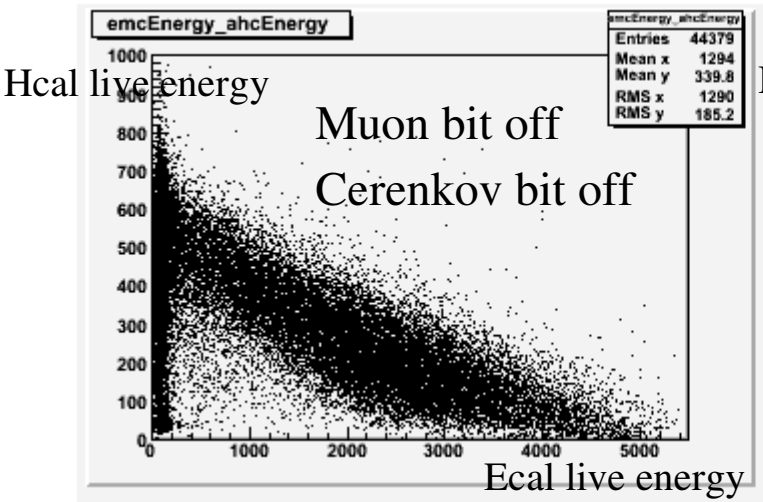


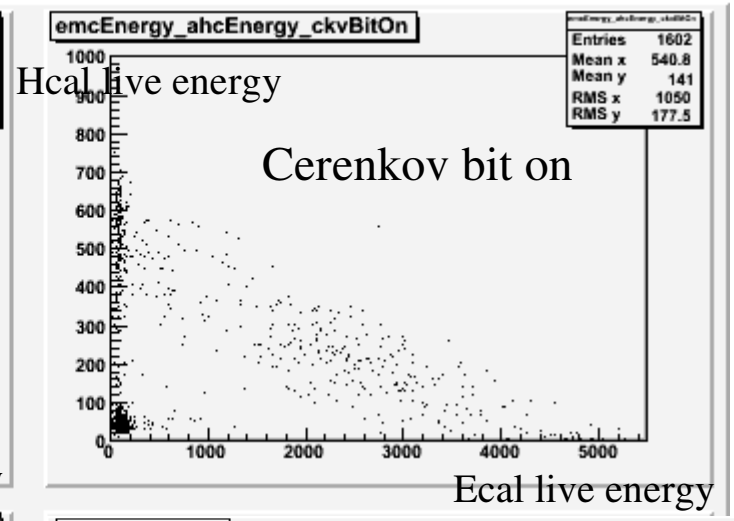
Trigger bits:

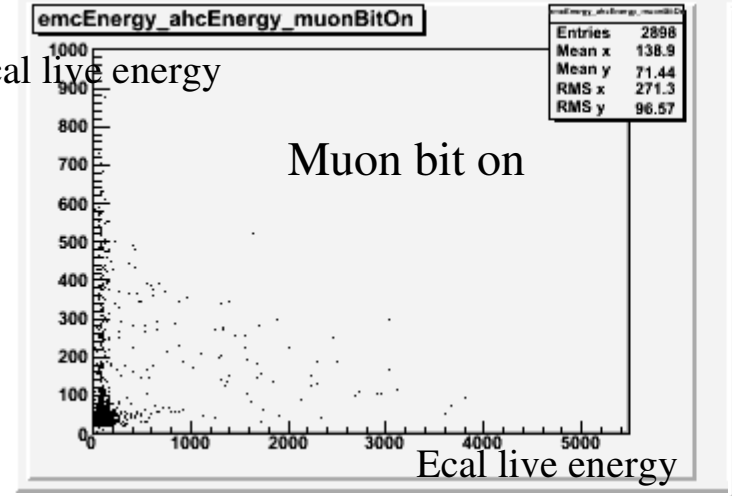
12: muon counters

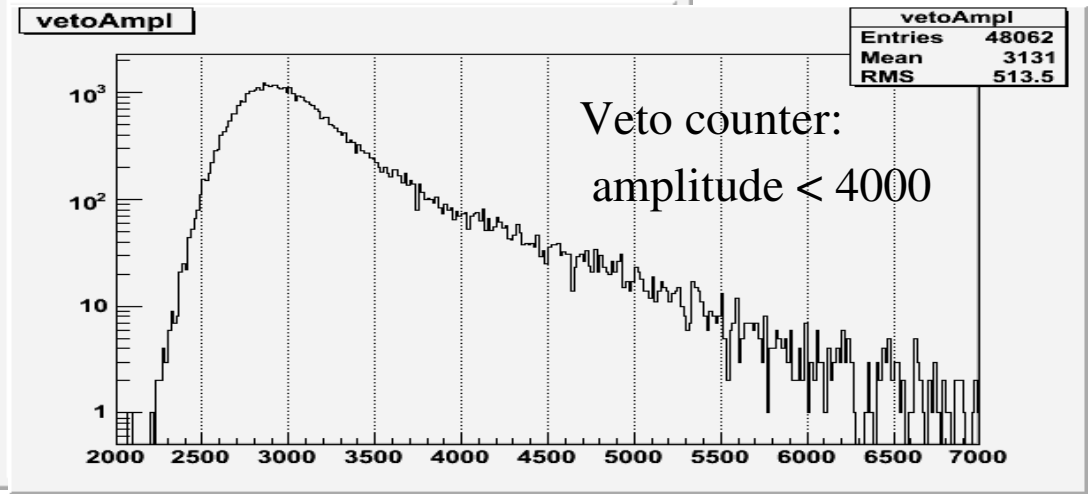
6: Cerenkov

Background rejection handles







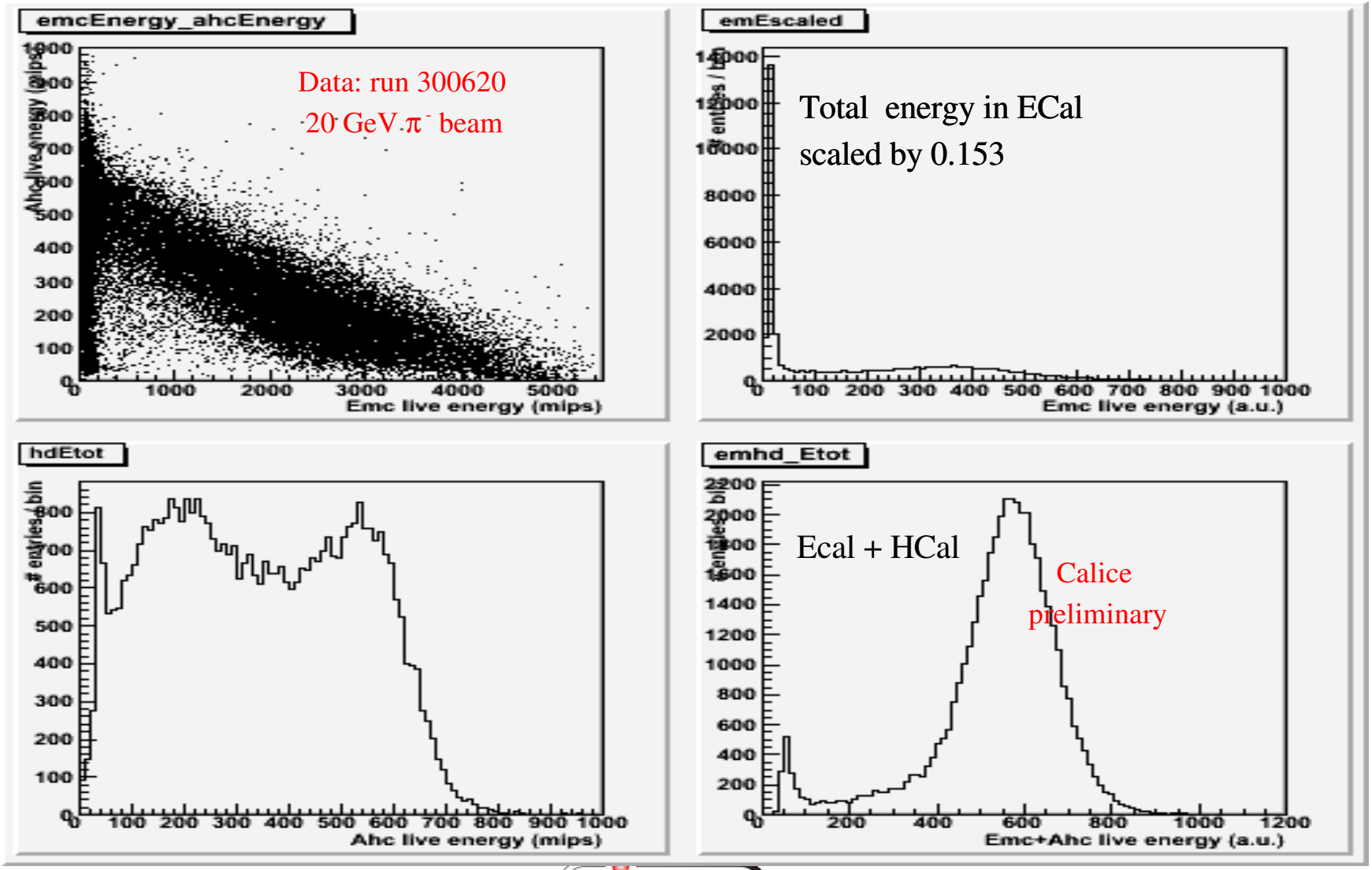


Energy correlations in a sample of 20 GeV π^-

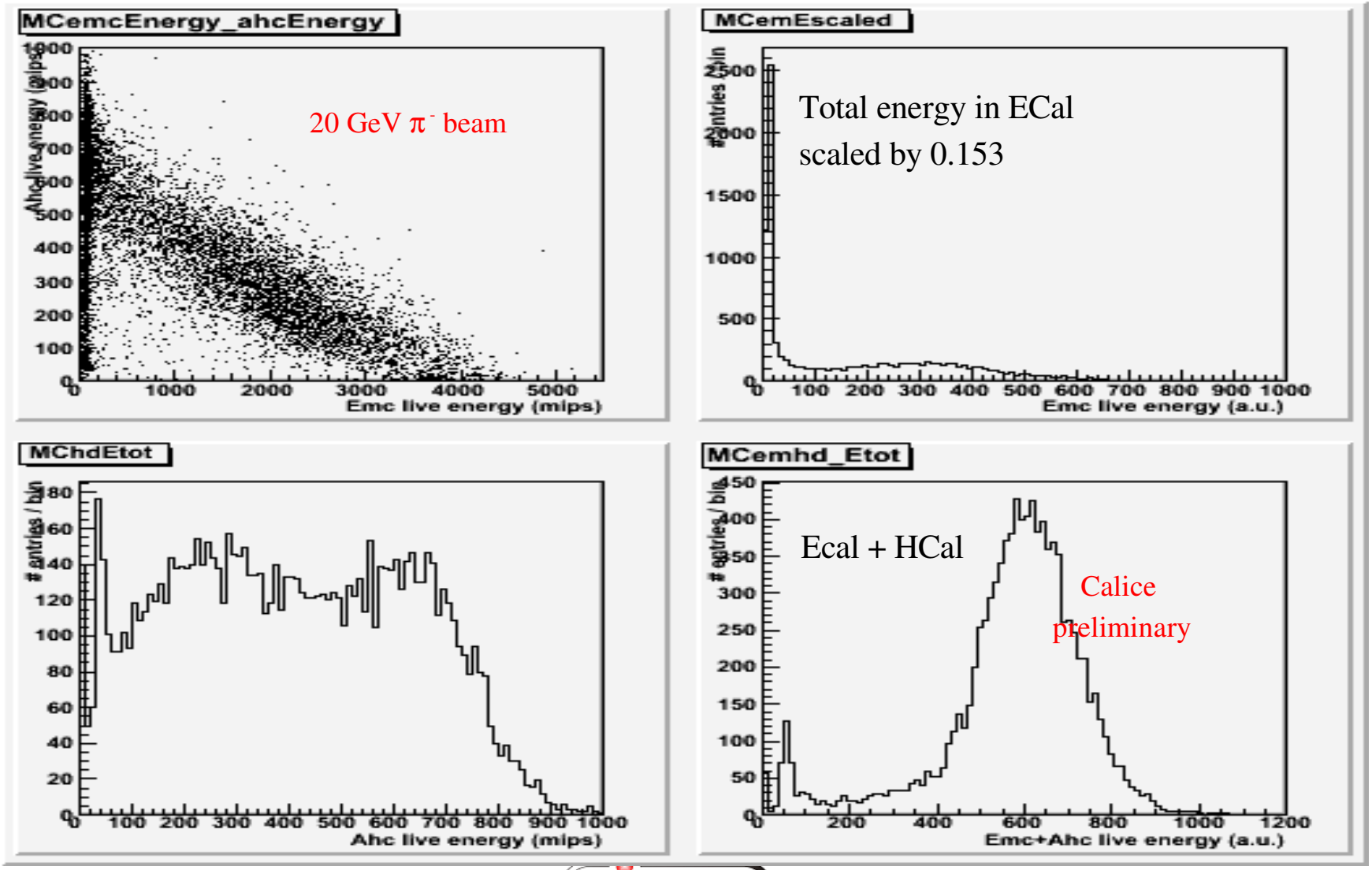
- Energy combination accounts for relative intra-component absorber thicknesses (Rel.Abs.Th.) and for inter-component sampling fractions (ICF)
- SW_analog = (Rel.Abs.Thickness) * (ICF_analog) and similar for digital
- Simple-minded ICF factors: angular coefficient of a line representing the anti-correlation scatter-plots.

	Rel.Abs.Th	ICF_ana	ICF_digi	SW_ana	SW_digi
Ecal1	1	0.153	0.292	0.1526	0.292
Ecal2	2	0.153	0.292	0.3052	0.584
Ecal3	3	0.153	0.292	0.4578	0.876
Hcal1	1	1.000	1.000	1.0000	1.000
Hcal2	2	1.000	1.000	2.0000	2.000
Tcmt1	1	0.909	0.257	0.9091	0.257
Tcmt2	4.92	0.909	0.257	4.4728	1.264

Combining Ecal and Hcal (analog) – TB data

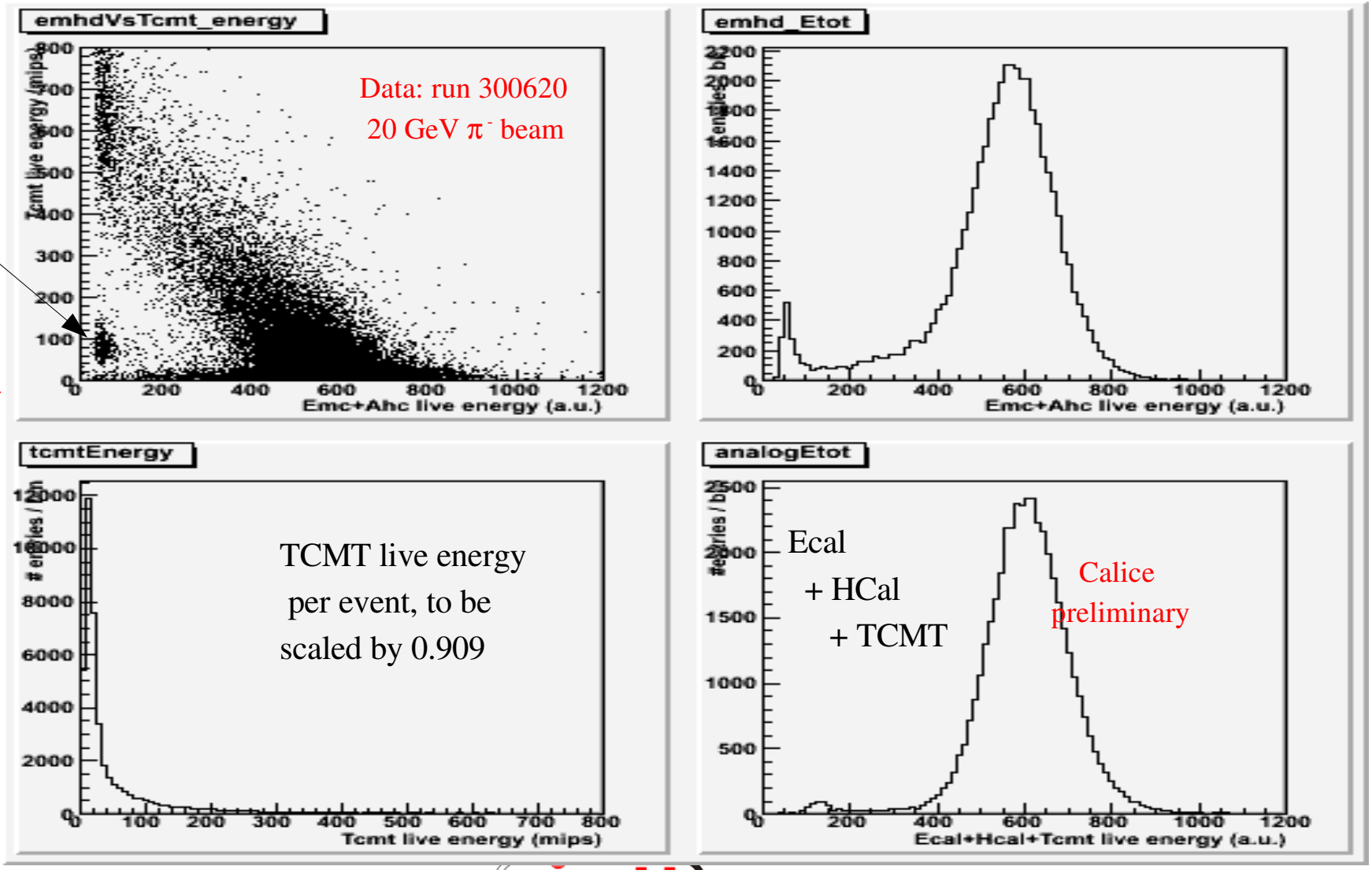


Combining Ecal and Hcal (analog) - MC



Combining EM+HD and TCMT (analog) – TB data

Muons from in-flight decays



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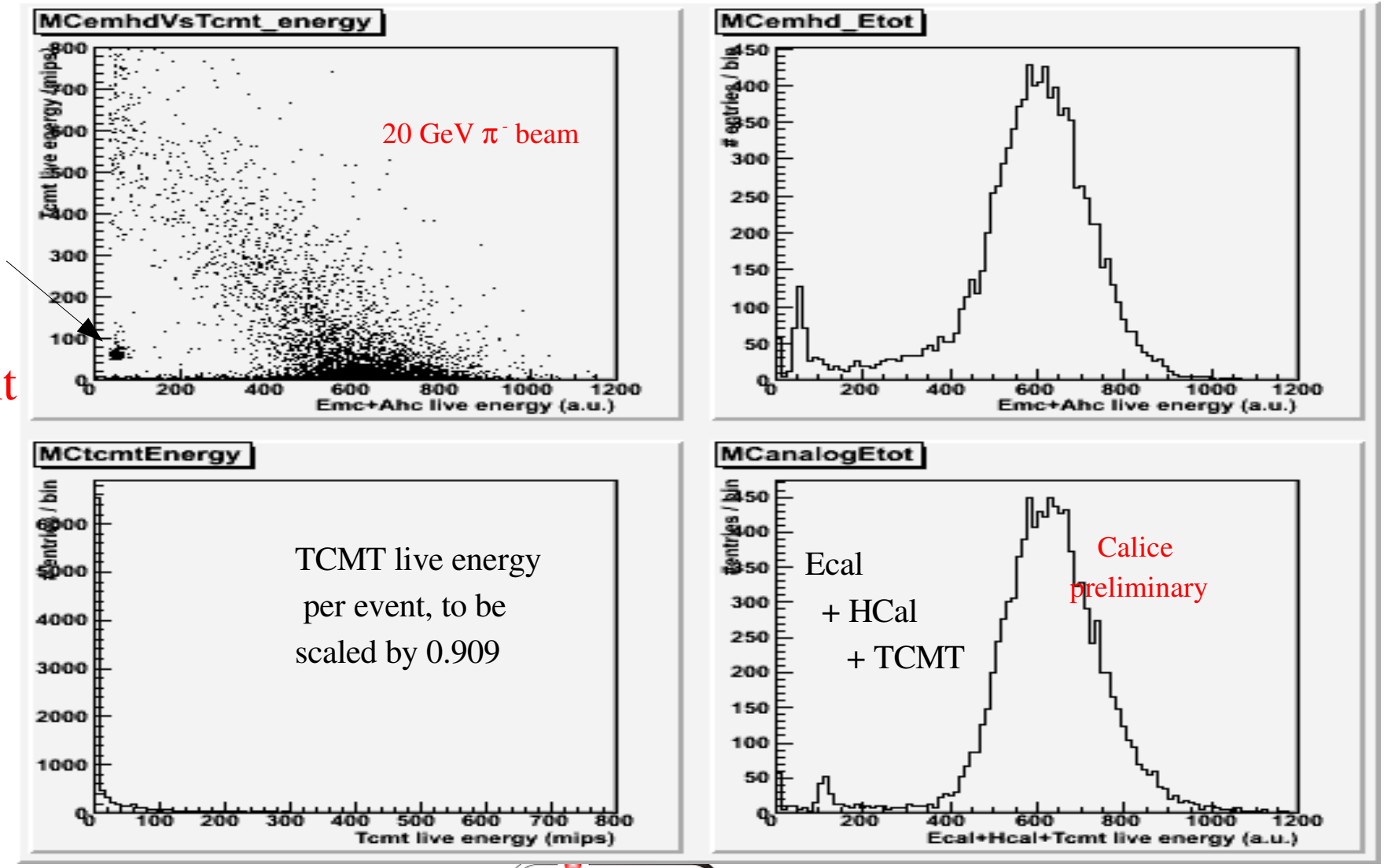
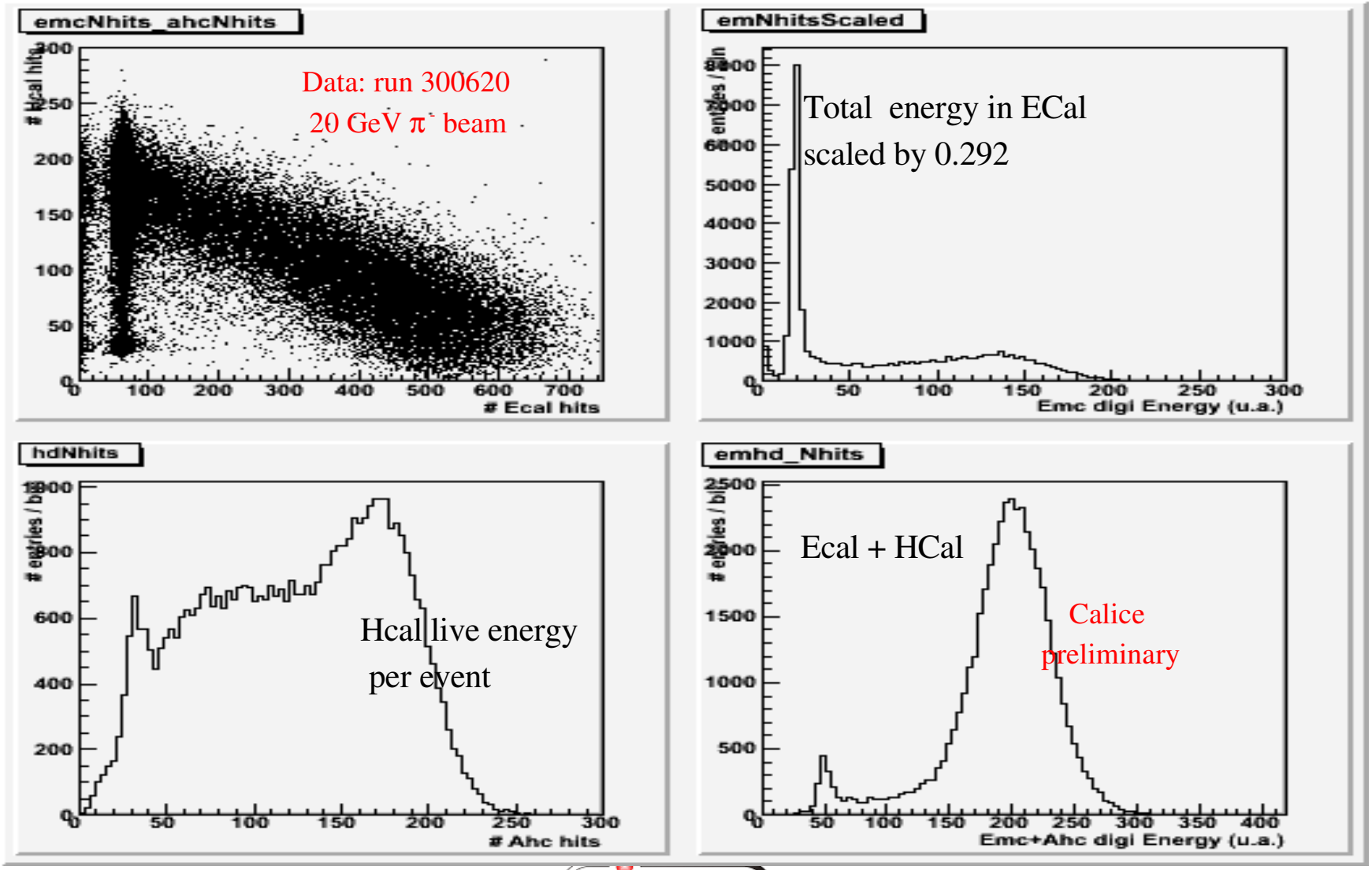
Muons from in-flight decays



Combining Ecal and Hcal (hit counting) – TB data



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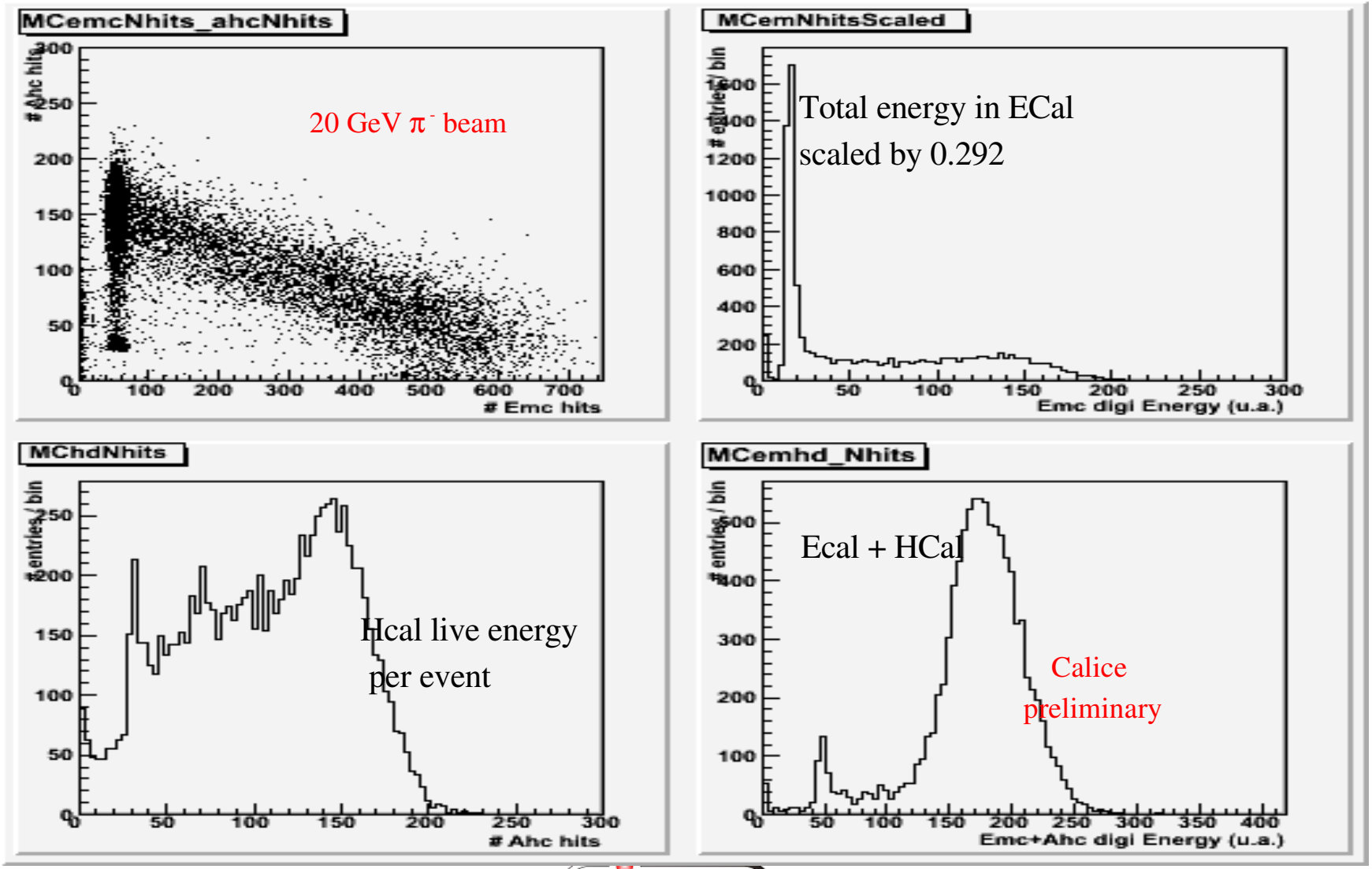

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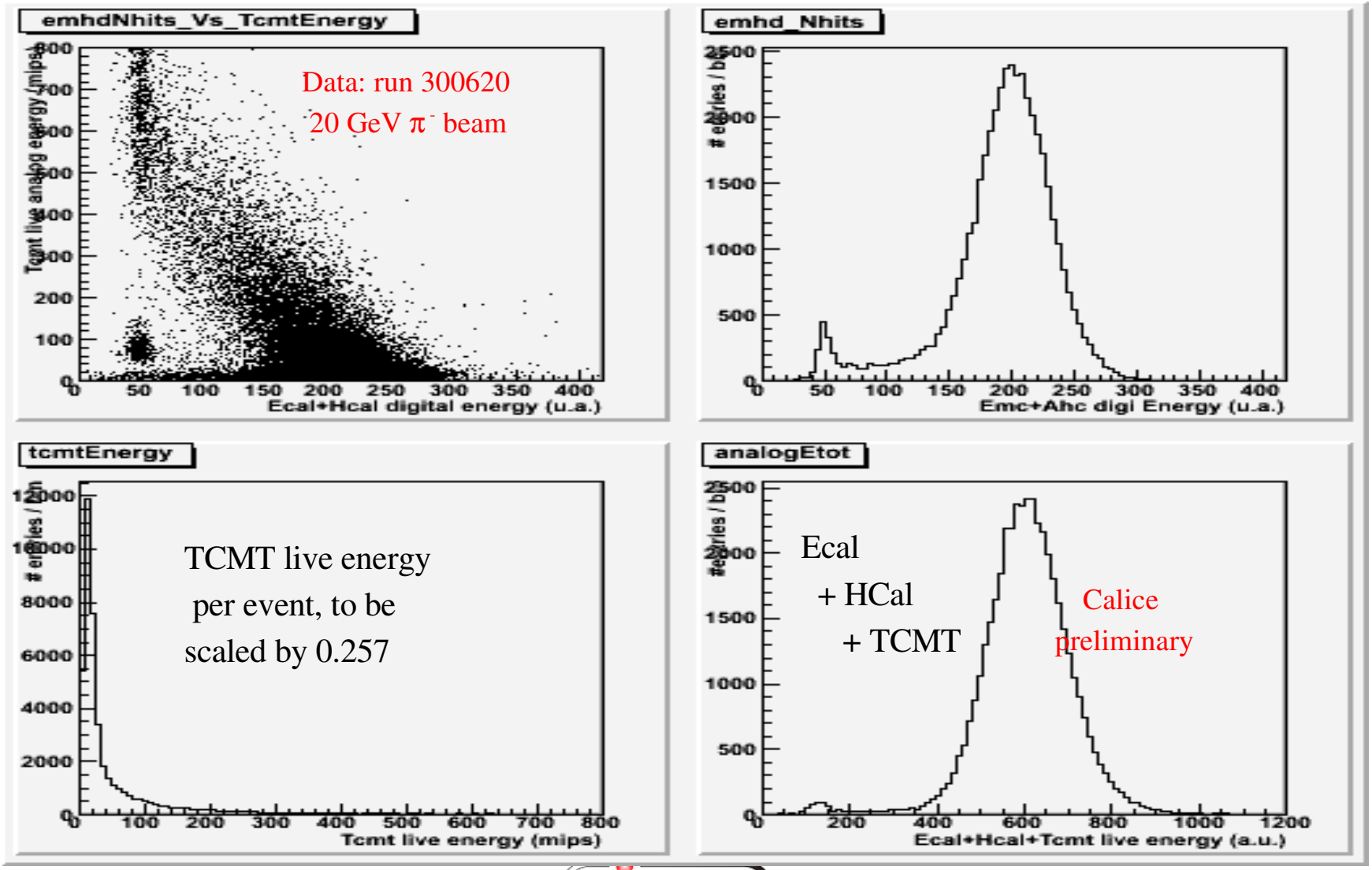

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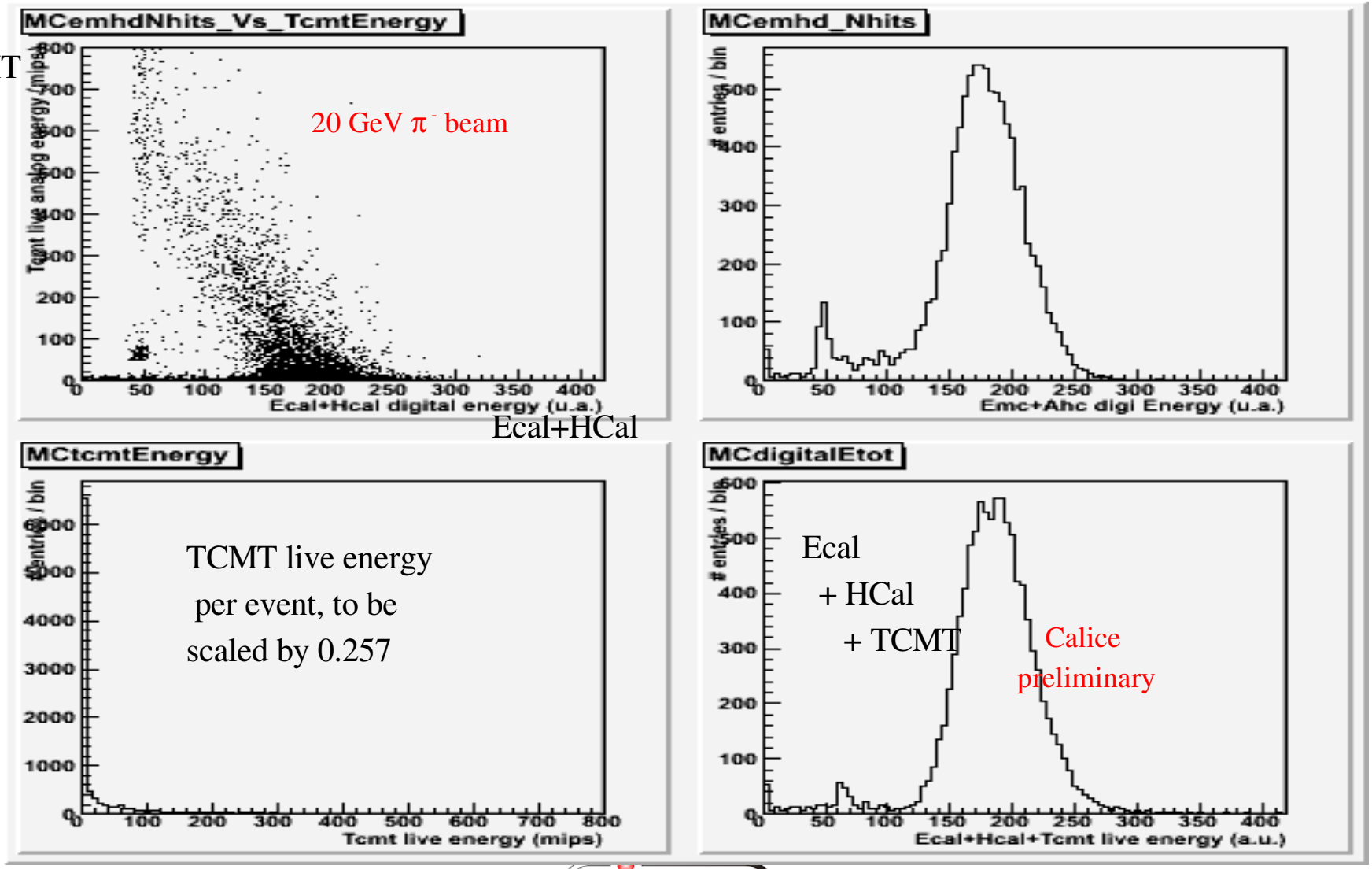
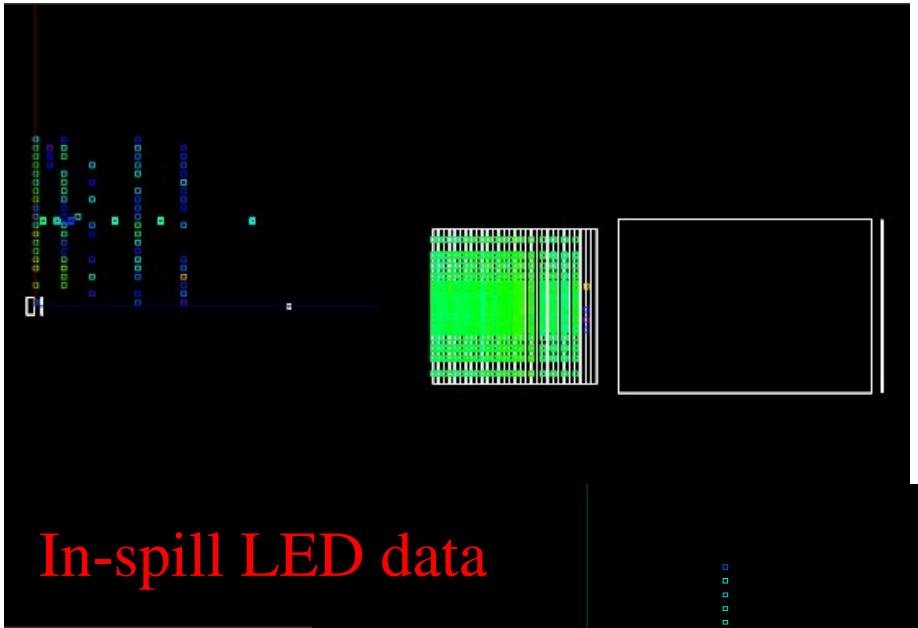
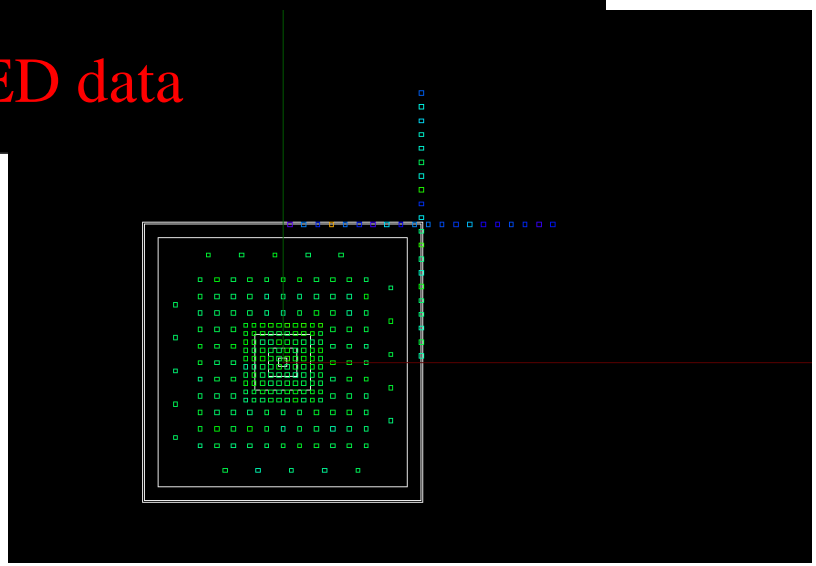
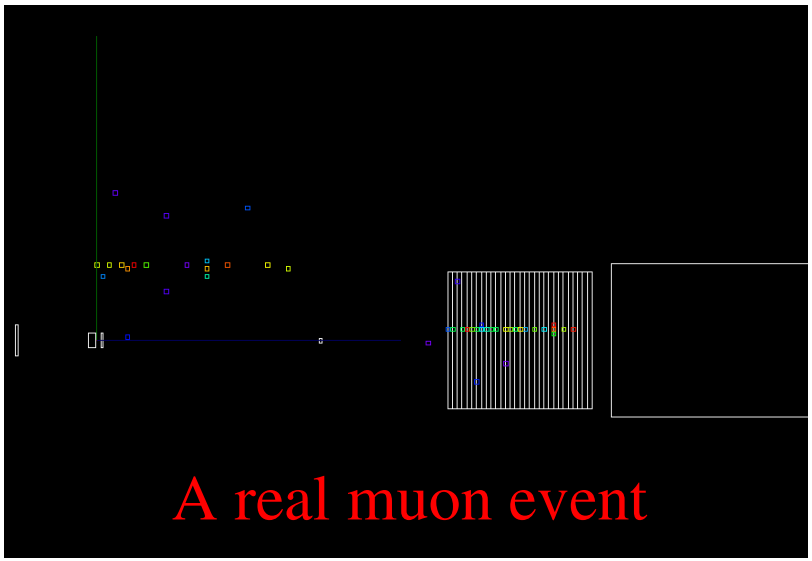


Calice TB data – visualization in JAS3



In-spill LED data





A real muon event

TCMT global position from CalorimeterHits is incorrect.

Nevertheless, a good start!!

Things to do next

- Chisquare-based method for finding sampling factors
  - First pass is done, but plots not yet shown today
- More sophisticated hit weighting schemes on real data, for better energy resolution
- Hcal/TCMT alignment ---> look at transverse shower shapes
- Exercise directed tree clustering in test beam data (plans to use org.lcsim + JAS3)
- Introduce corrections for SiPM saturation effects in TCMT
- Energy resolution studies

Summary

- Lots of test beam data already available, detailed analysis is just starting
  - Still more data to come (Jul/Aug '07 @ CERN, late 2007 @ MTBF/FNAL)
- Results will show the performance of SiPM readout for high-granularity calorimetry
- Prototype's high granularity allows a detailed study of shower shapes
  - validation of hadronic shower simulation models
  - evaluation (and developments) of clustering and particle flow algorithms in future, high-granularity calorimeters
- Preliminary results look very encouraging!