Digitization simulations and comparisons to Cern TB data for the TCMT (and HCAL)

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Calice AHCal Meeting at DESY

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Outline

- The digitization simulation procedures (Hcal and TCMT only)
- Data cleanup: removing hot/dead cells and beam cleanup
- Data samples
- Data vs. Monte Carlo comparisons
- Separate digitization effects
- Topological separation
- Outlook

The digitization process

- MC comparisons to data is split into several separate steps:
  - AHcal: Mokka + ganging@DESY + noise extraction + "integrated digitization" (crosstalk, readout smearing, noise overlay, hit selection) + "integrated calibration"
  - TCMT: Mokka + DigiSim (ganging+hit selection) + mip calibration + noise extraction (w/mip calibration) + noise overlay
- The Hcal-ganging has not yet done at NIU, so we have been using only pre-ganged MC samples from the grid (no muon samples available)
- Final hit selection: Ehit > 0.5mip

The AHcal digitization simulation procedure

- Noise is combined with MC hits at ADC-counts level, to properly account for saturation corrections
- The procedure is split into following steps:
  - Noise events filtered from TB data ("level2" hits = pedestal-subtracted ADC)
  - MC-ganging processor (simulated virtual cells into real tiles) (not at NICADD)
  - OverlayProcessor: append noise collections from TB data into the MC event
  - IntegratedHcalDigitizationProcessor: merge hits into a single collection
    - MC hits: physics to electronics mapping, GeV to mips, crosstalk, smeared, *decalibrated* (converted to ADC counts) and combined with noise
  - IntegratedCalibrationProcessor: recalibrate combined hits into mip scale

The TCMT digitization simulation procedure

- The TCMT digitization procedure (a recent development!)
  - Noise: pedestal triggers filtered from TB data
  - DigiSim on MC data: ganging processor, optical crosstalk, smearing, simple mip calibration (no saturation simulation)
  - OverlayProcessor: copy noise collections from TB data into the MC event
  - TcmtOverlayProcessor: combine mip-calibrated noise + mip-calibrated MC hits
- See Niels' slides for a nice block diagram of this procedure

Data samples

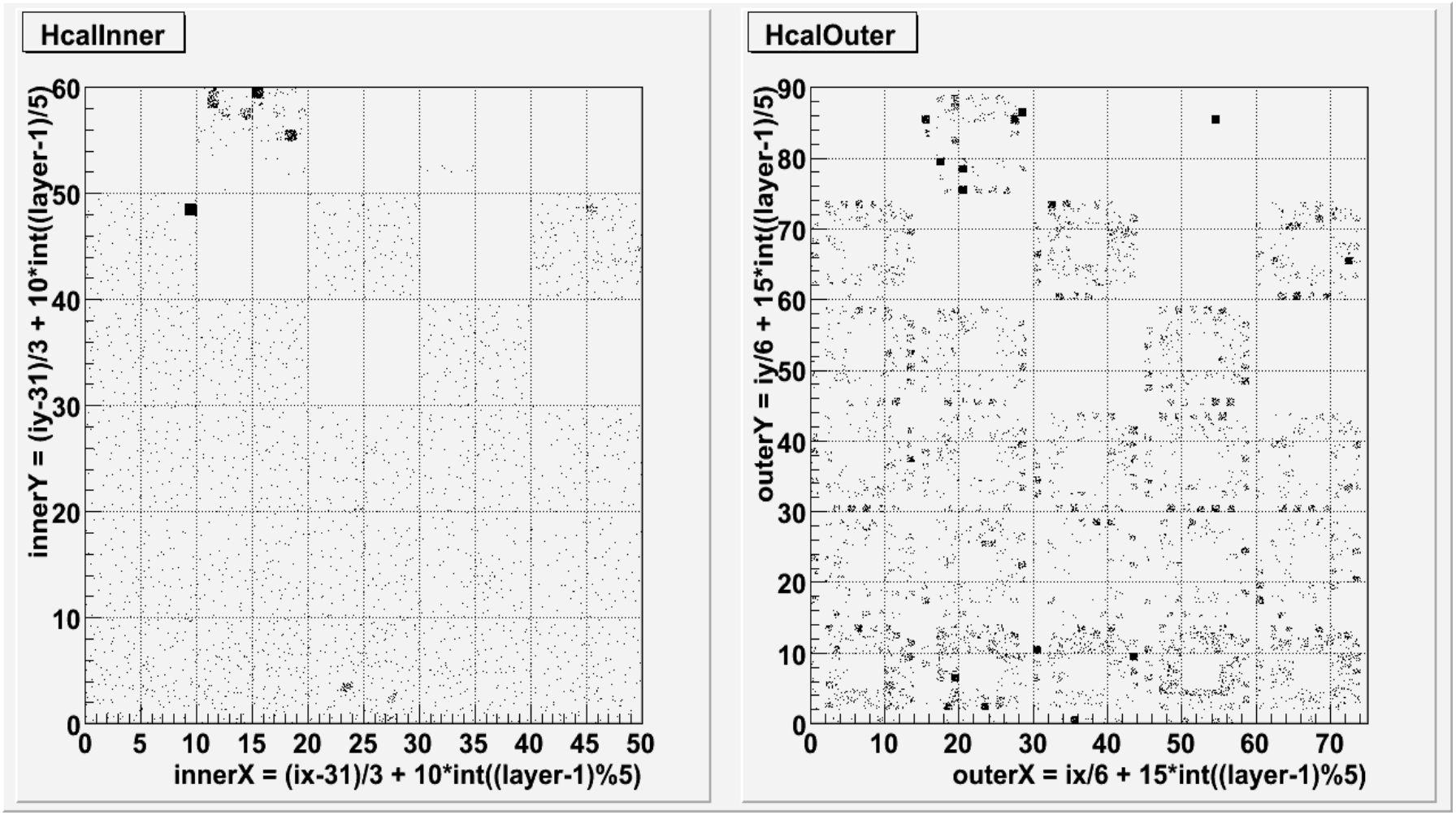
- Goal is to compare MC with real TB data (e.g. 20 GeV pi-)
  (digitization procedure under development, other energies and hadronic models will follow soon)

- Monte Carlo: Hcal-ganged data samples from the grid
  e.g. directory /grid/calice/tb-cern/sim/test_prod/desy
  file: Pim_20GeV_10000evt_TBCern1006_01Gang.slcio
  from run header: Mokka 06-03-p02 with QGSP_BERT_HP phys list

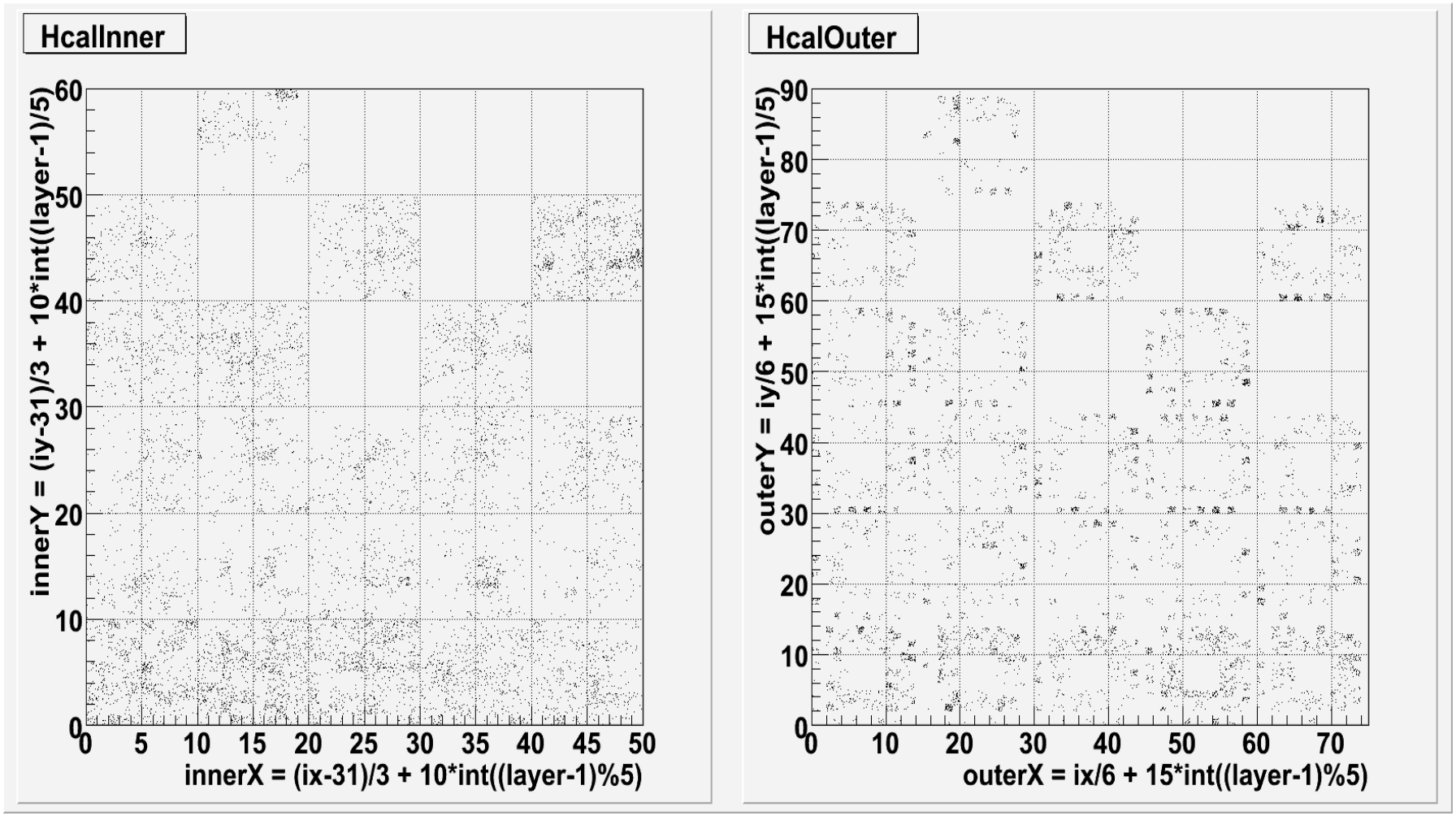
- Data: Run 300620 from official reprocessing (v04-06)

- Calibration constants used for digitization come from the same condDB directory as used by official reconstrution

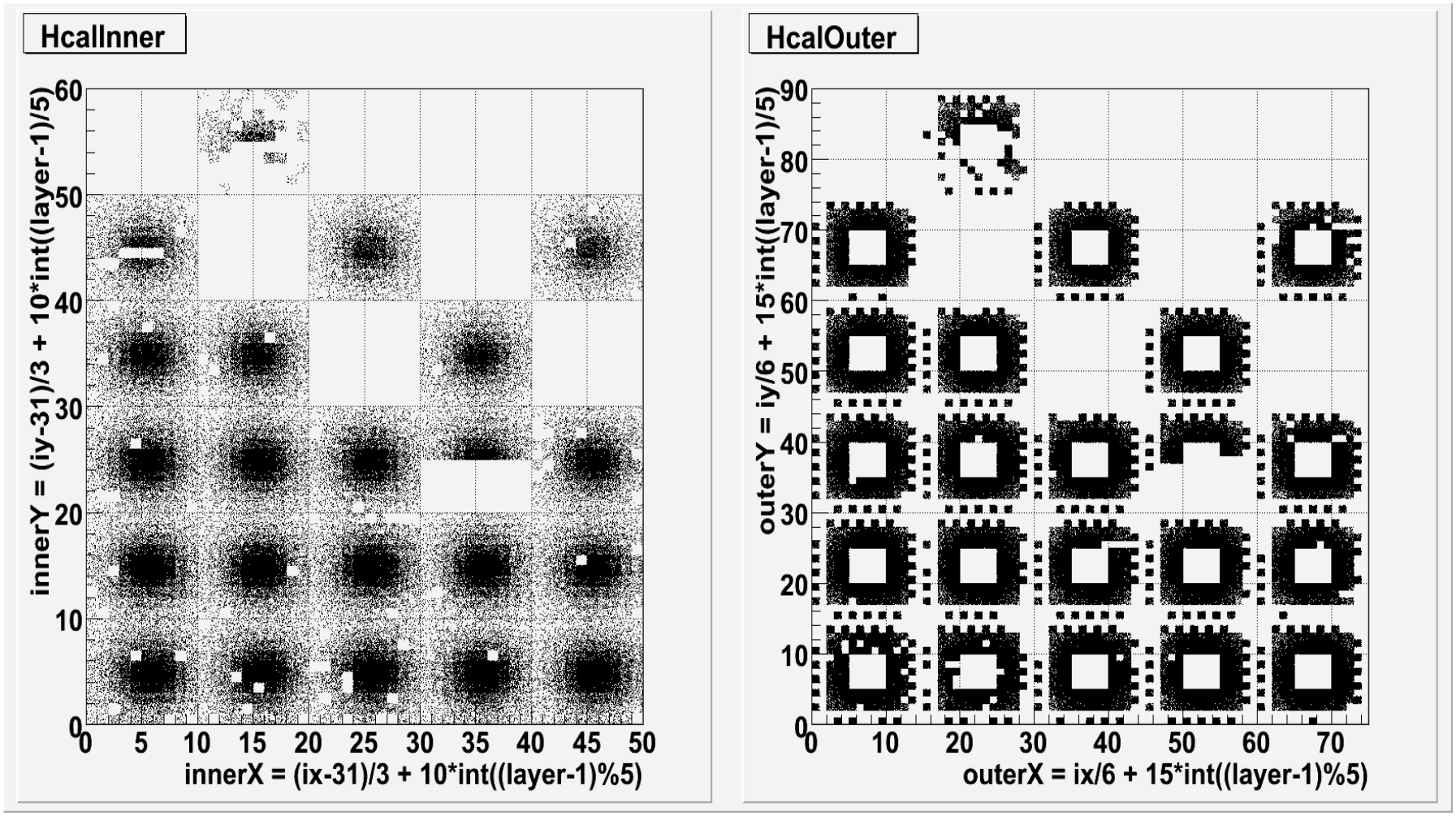
AHcal noise profile (pedestals)



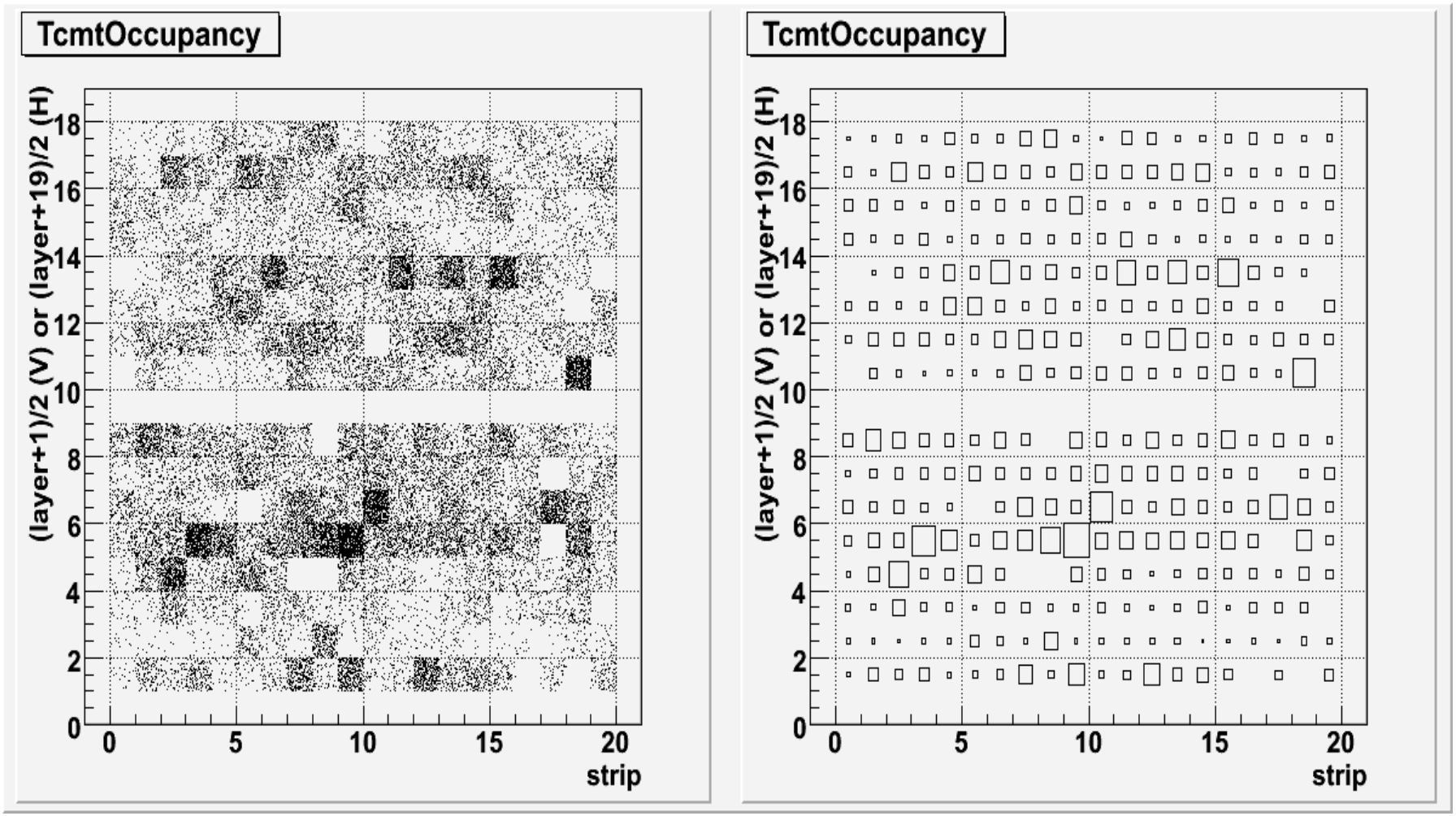
AHcal noise – no hot/warm cells



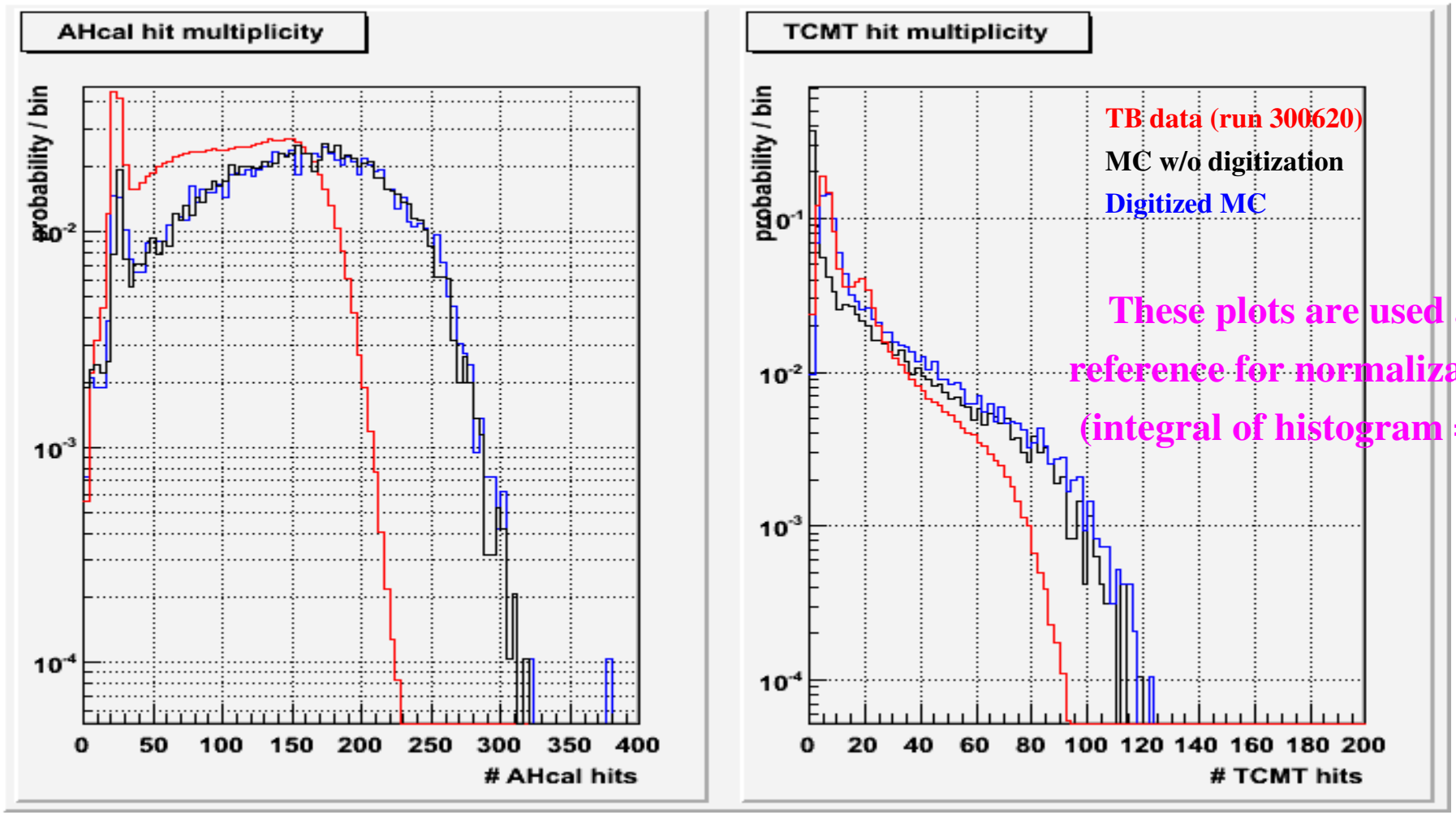
AHcal beam profile (no hot/warm cells)



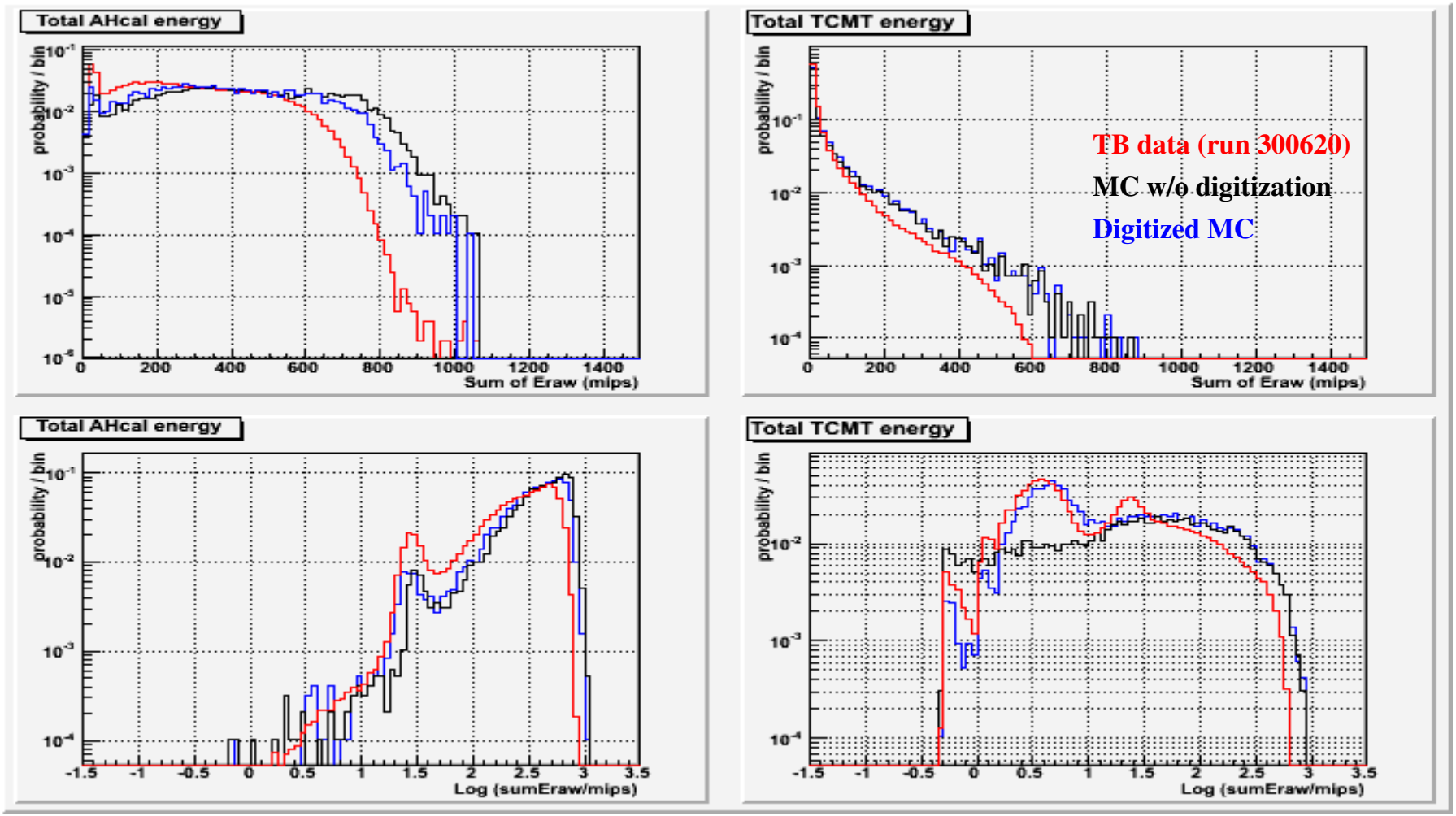
TCMT noise profile (no hot/dead channels)



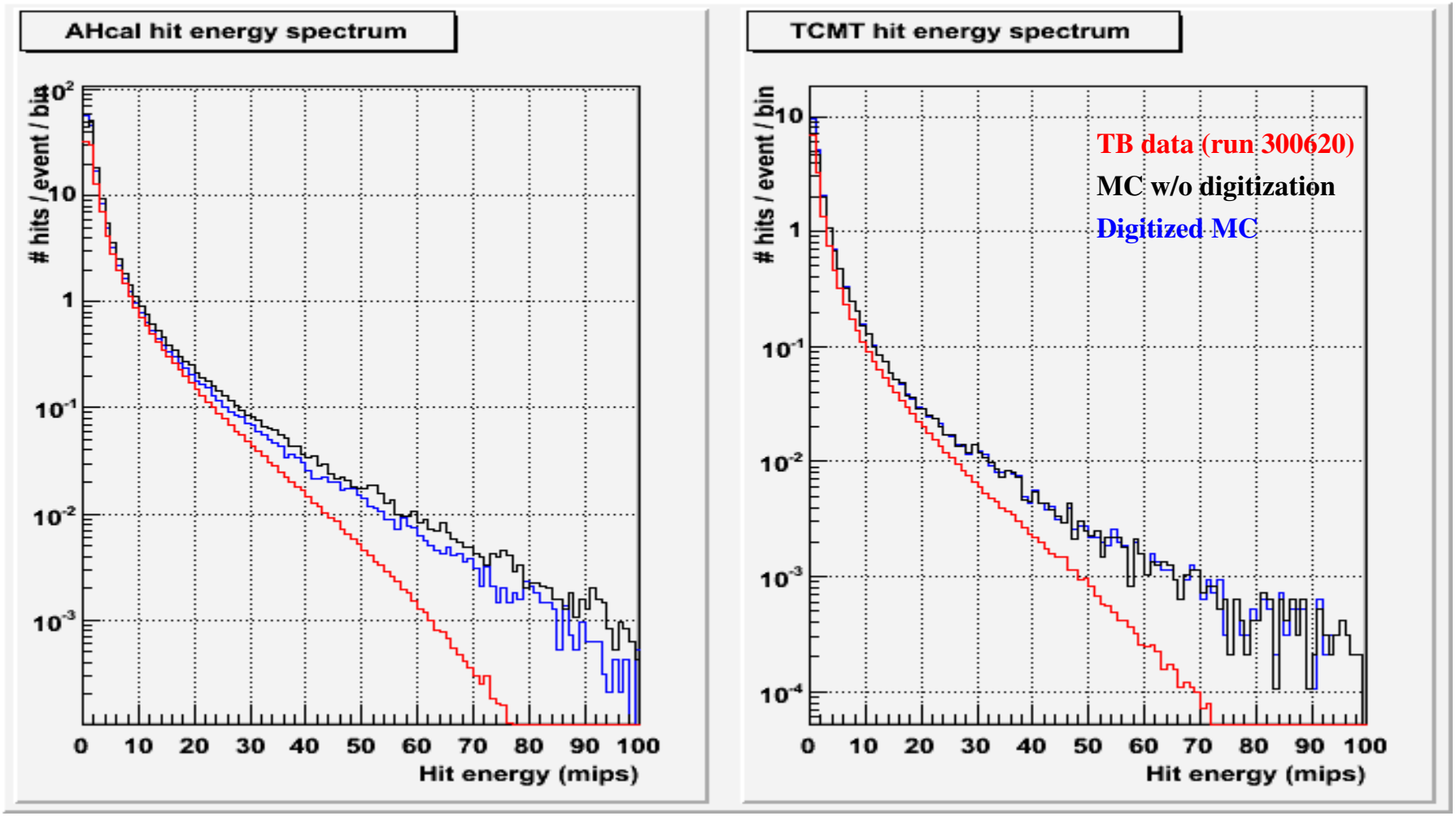
Hit multiplicity: 20 GeV pi-



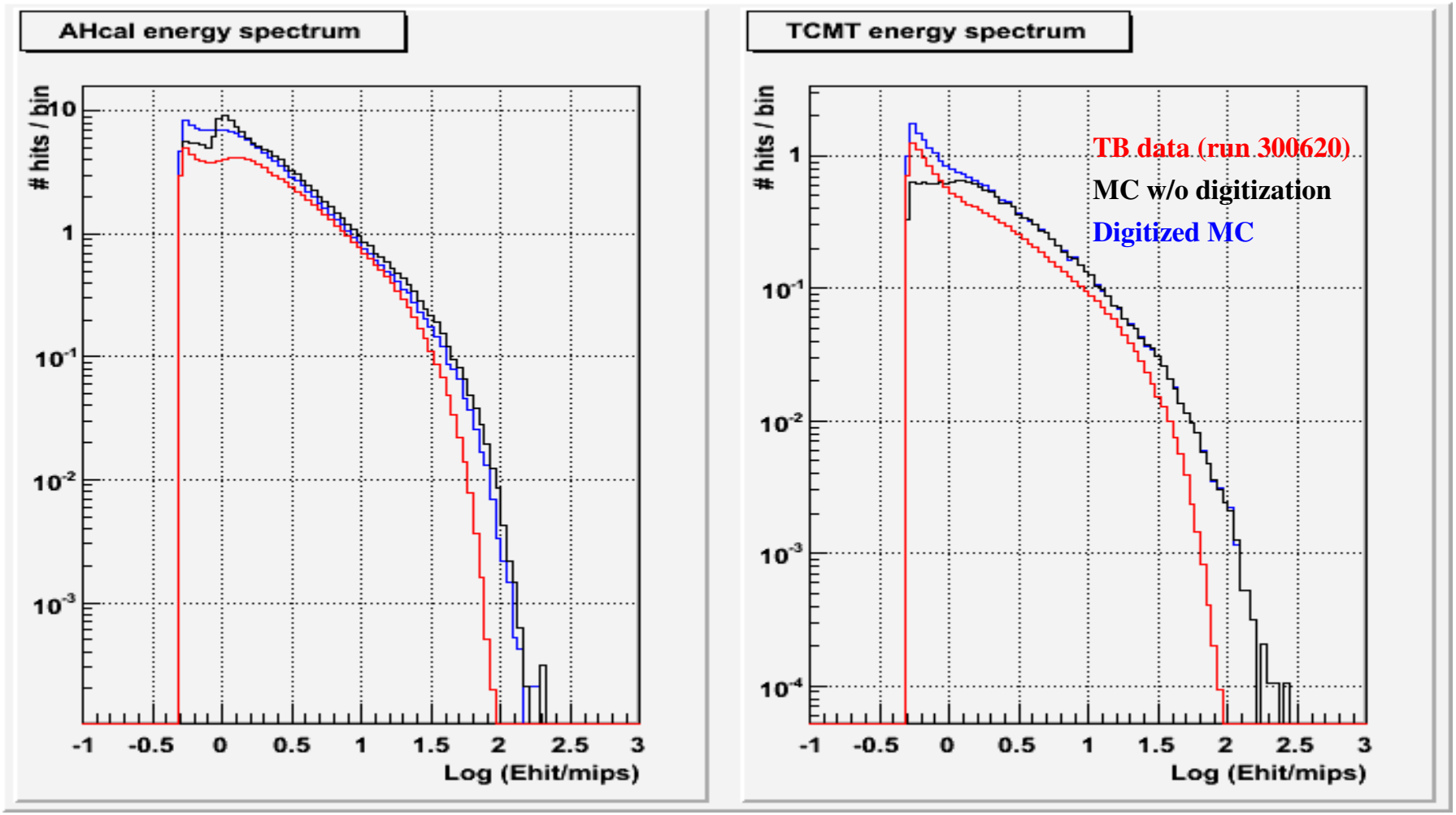
Total raw energy (unweighted hits)



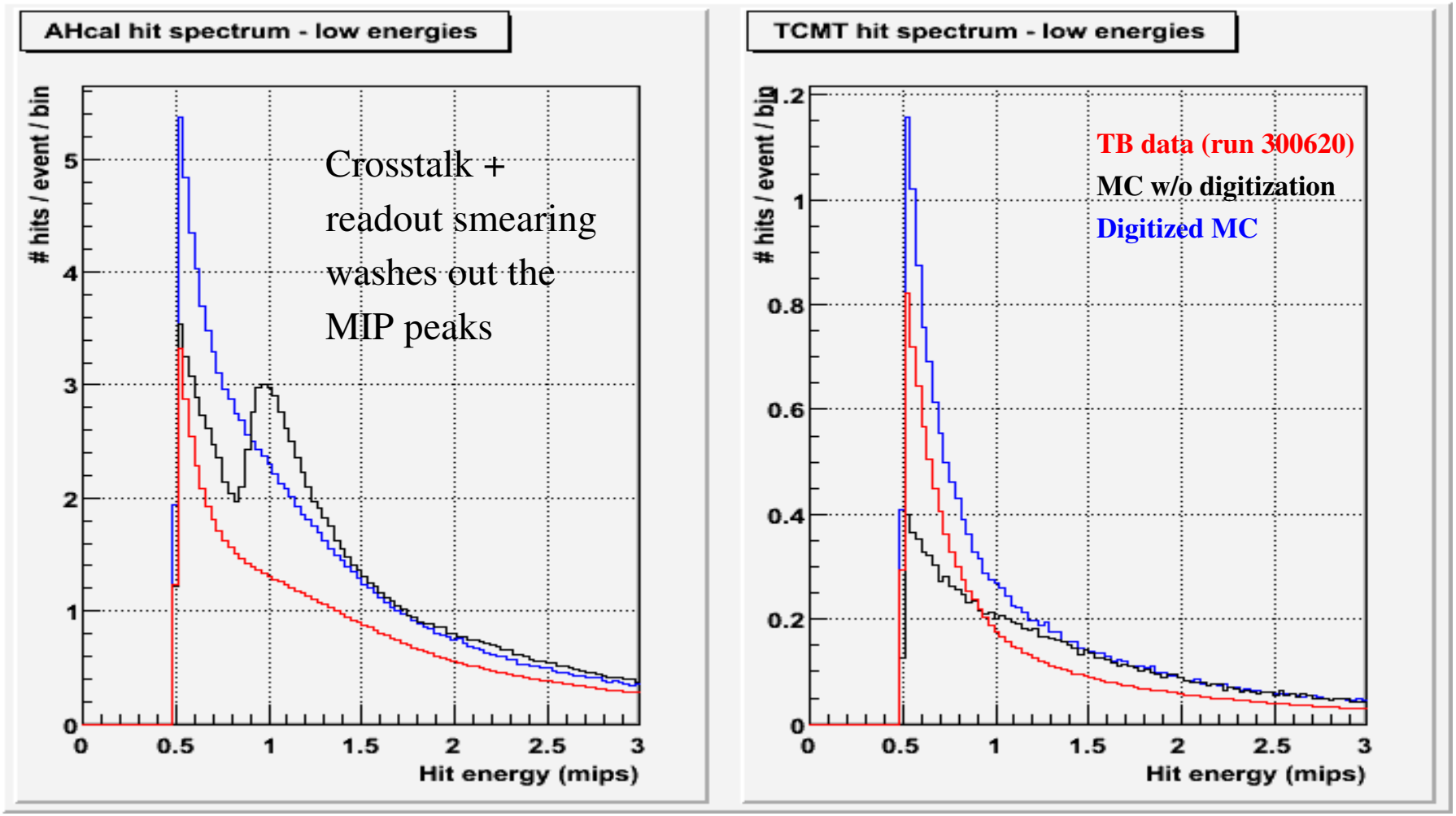
Hit spectrum: 20 GeV pi-



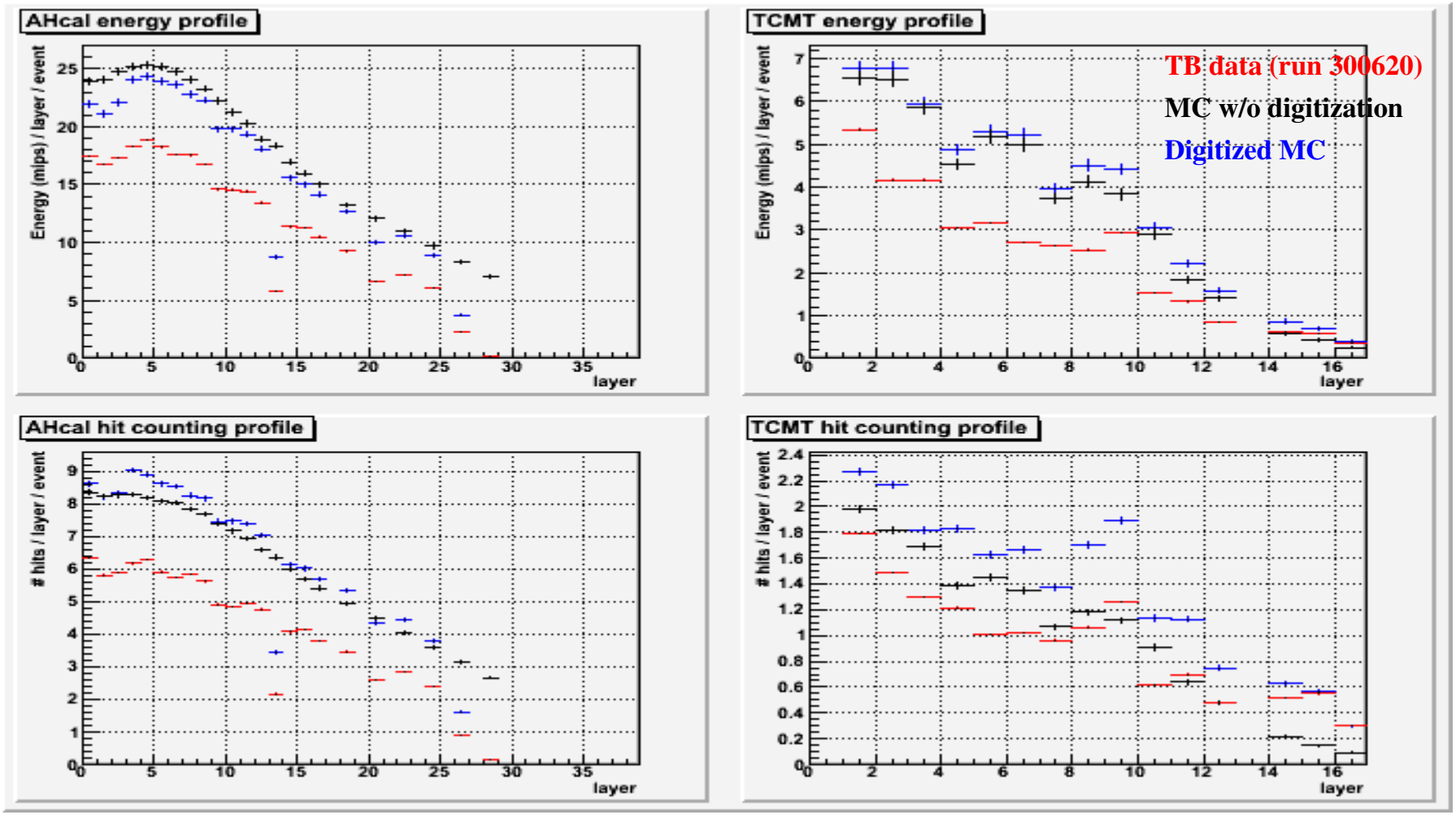
Hit spectrum: Log(Ehit) for 20 GeV pi-



Hit spectrum @ low E: 20 GeV pi-



Longitudinal profiles: 20 GeV pi-



Separate digitization effects

- Attempt to turn on/off individual digitization effects, for a better understanding on how they affect the data

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  As implemented, all the effects above can be controlled from the steering files:

* AHCAL: from HcalDigitization-test.str or AhcDigitization.str:

     --parameter--            --effect ON--        --effect OFF--
     LightLeakage                 0.1                  0
     ApplySmearing                 1                   0
     NoiseCollectionName    NoiseHitsLevel2     NoiseHitsLevel2Disabled (or any non-existing name)

* TCMT:
  - Smearing and crosstalk are controlled from TcmtDigitizer.str (or TcmtDigitizer-test.str)

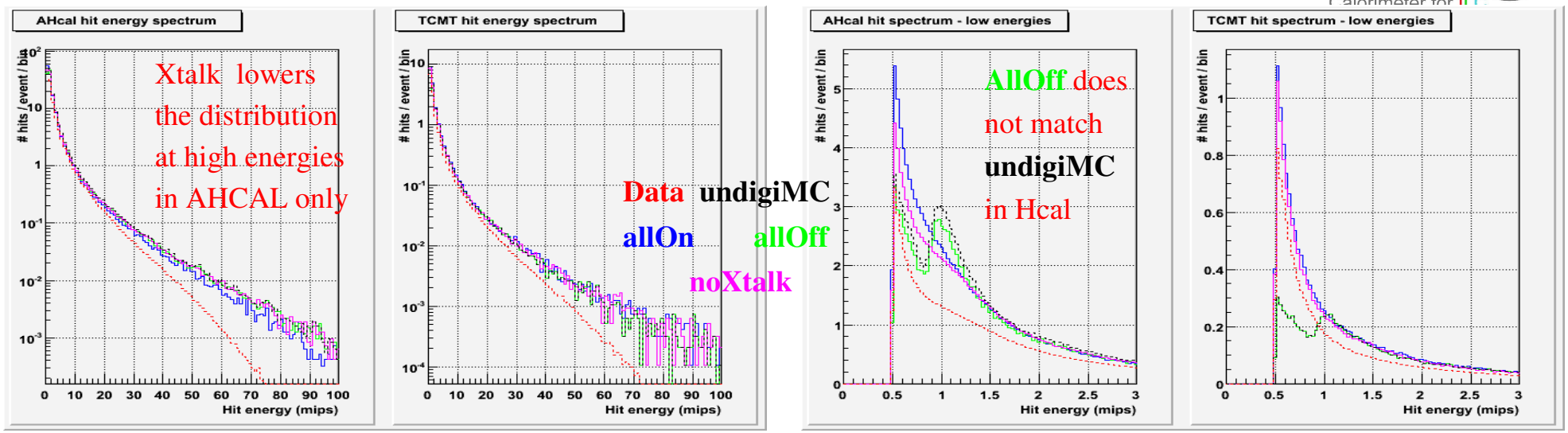
     # for xtalk and smear ON
     ModifierNames    TCganging TCEnergyMultiplier TCxtalk TCsmear TCCalib

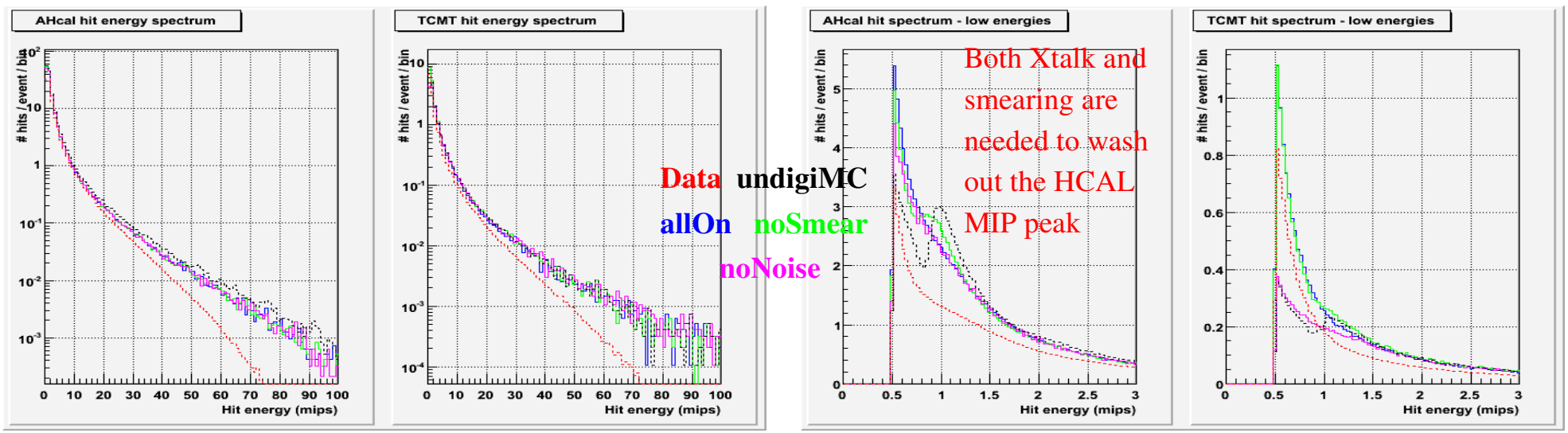
     # for xtalk OFF
     ModifierNames    TCganging TCEnergyMultiplier TCsmear TCCalibNoXtalk

     # for smearing OFF
     ModifierNames    TCganging TCEnergyMultiplier TCxtalk TCCalib

  - Noise is controlled by selecting appropriate steering block in digi.str:
     ActiveProcessors   TcmtOverlayProcessor  (default: with noise)
     ActiveProcessors   TcmtOverlayProcessor-noNoise   (no noise)
```

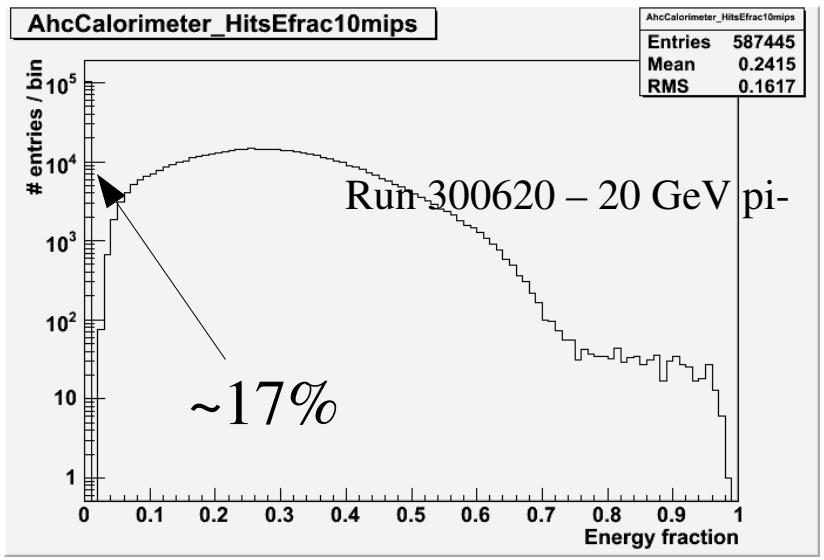
Separate digitization effects

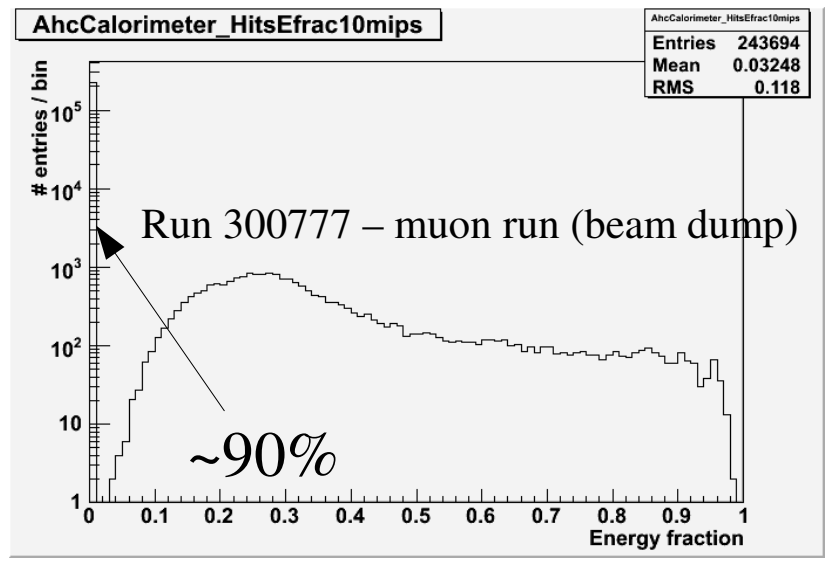




Quick cut at event topologies

- frac10mips = Esum(hits > 10mips) / Esum(hits > 0.5 mip)



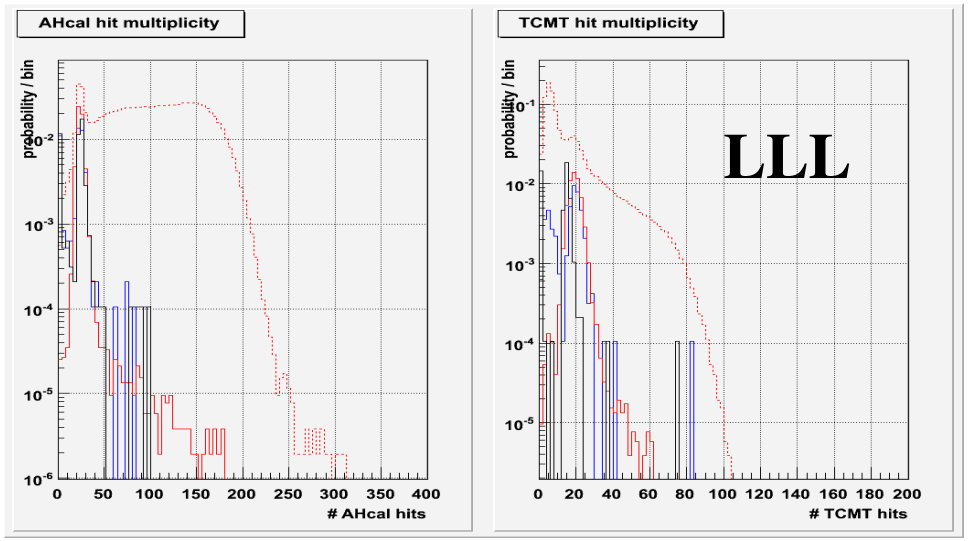


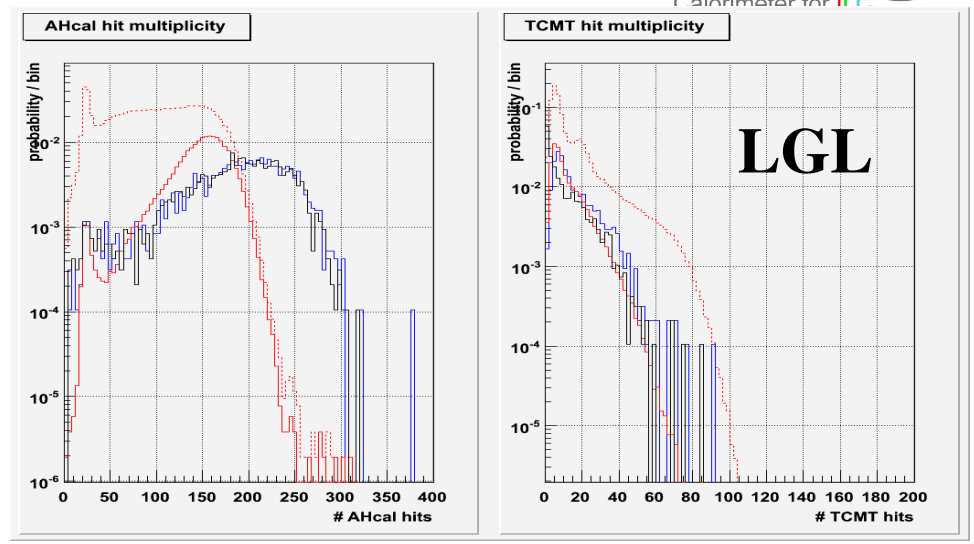
Topological separation

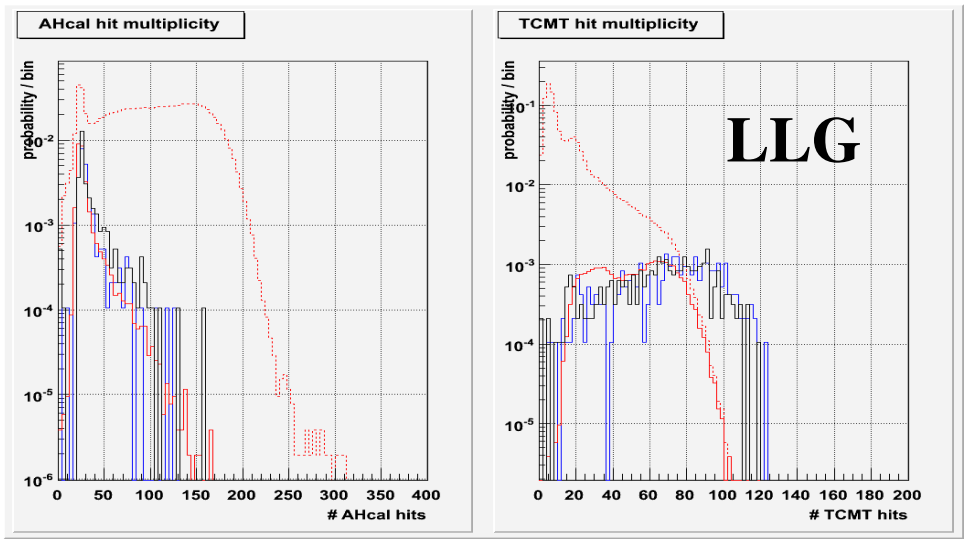
- LLL, GLL, GGL, GGG, etc. Order means (Emc, Ahc, Tcmt)
  - L for frac10mips < 0.02
  - G for frac10mips > 0.02
- Some statistics:

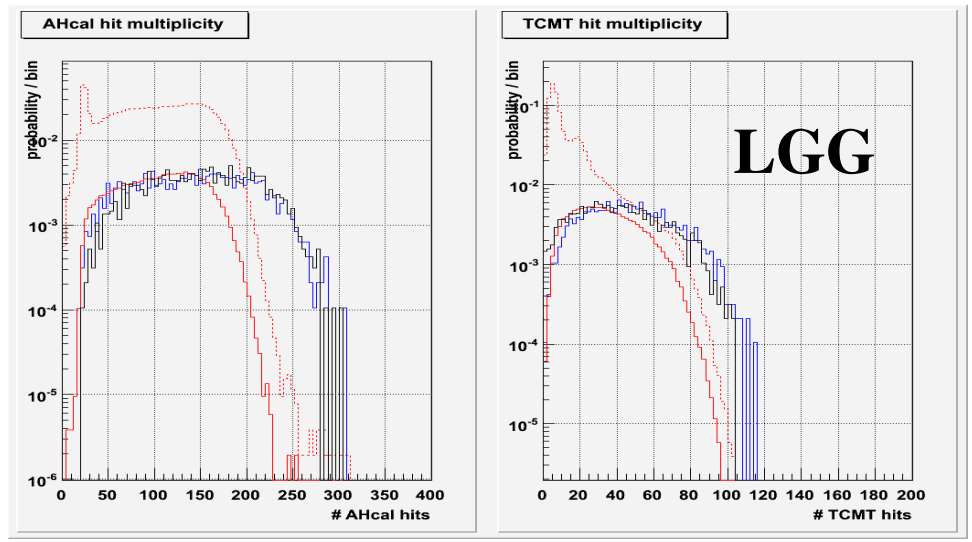
	Real data	Digitized MC
LLL	28809 (5.53%)	454 (4.54%)
GLG	5388 (1.04%)	114 (1.14%)
GLL	32563 (6.26%)	494 (4.94%)
GGL	236714 (45.5%)	4279 (42.8%)
LGL	101044 (19.4%)	1879 (18.8%)
LGG	63221 (12.1%)	1548 (15.5%)
GGG	38297 (7.36%)	929 (9.29%)
LLG	14519 (2.79%)	303 (3.03%)
	520555	10000

Hit multiplicities for some topologies







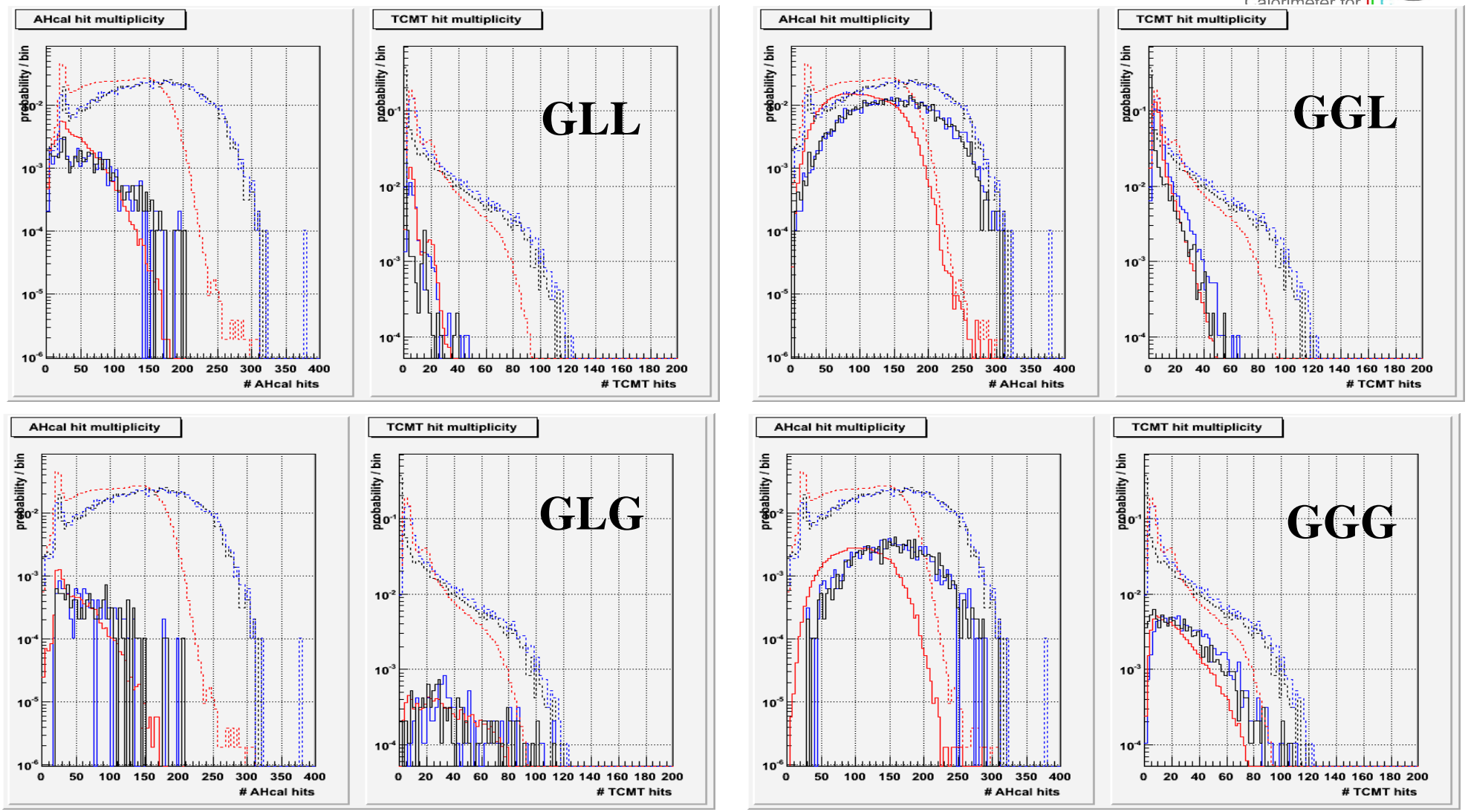


Outlook

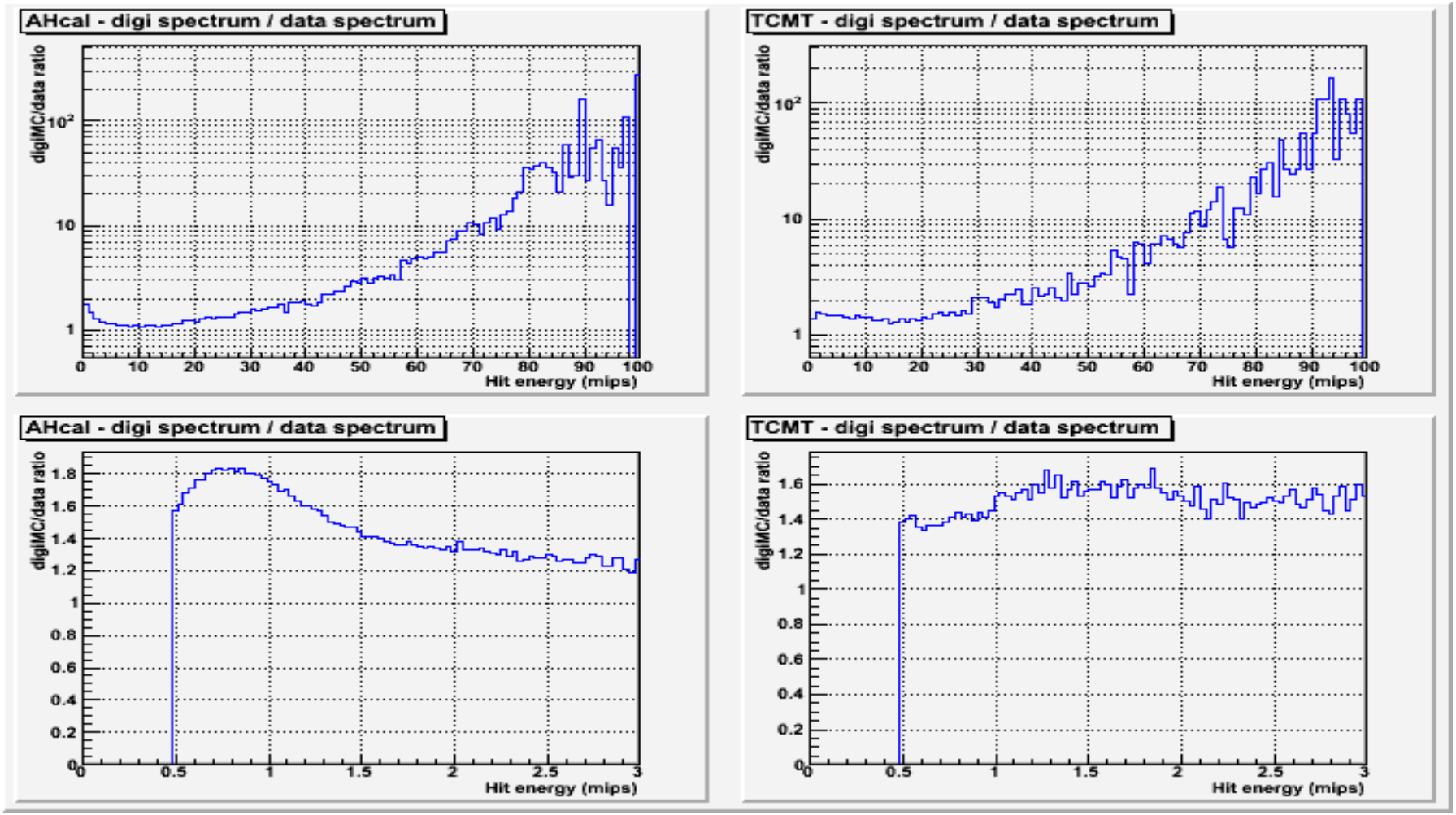
- Need to better understand and refine digitization effects
- Need to be able to do all processing chain locally
- Look at other data samples
- Check other hadronic physics lists in the simulation

Backup slides

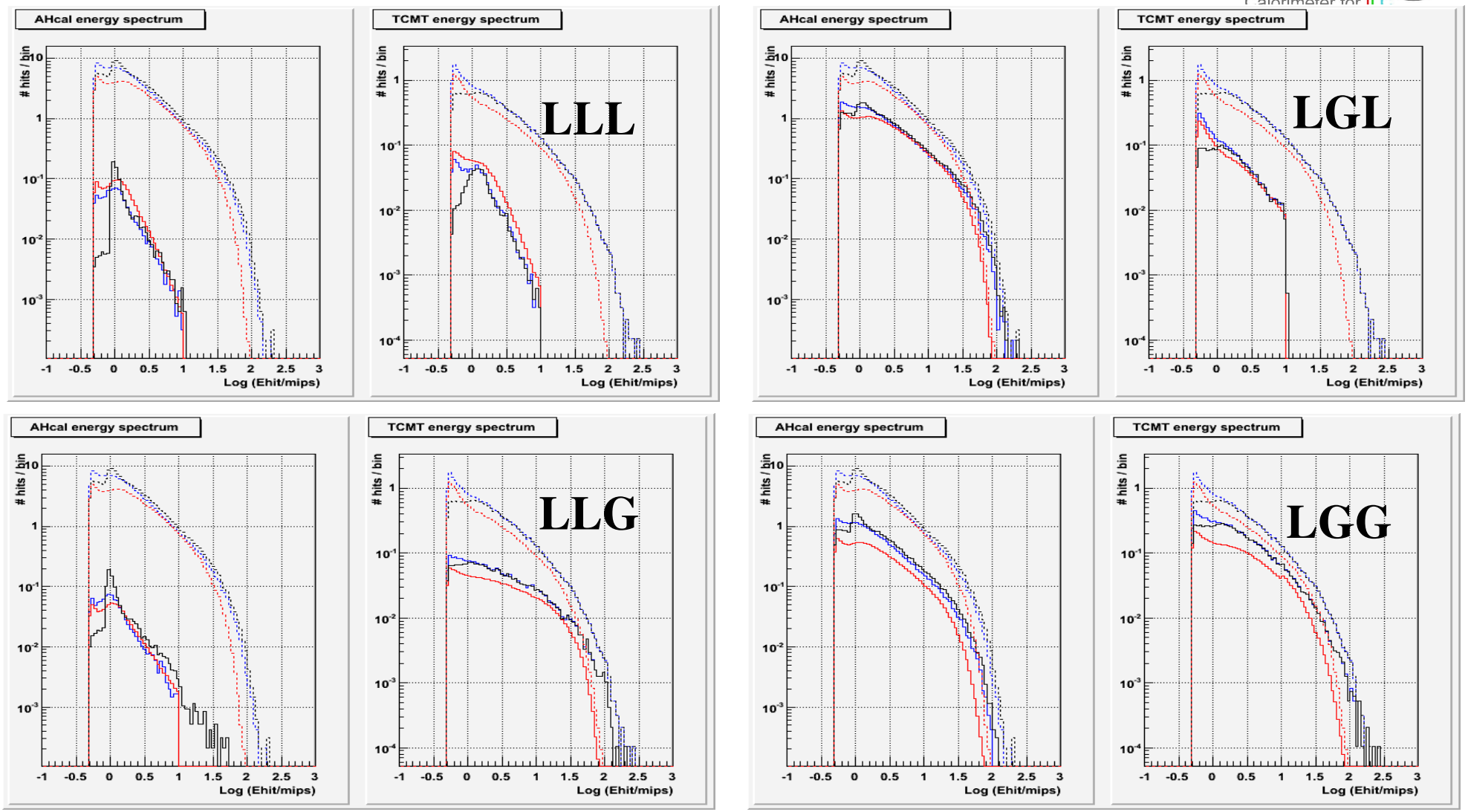
Hit multiplicity (2/2)



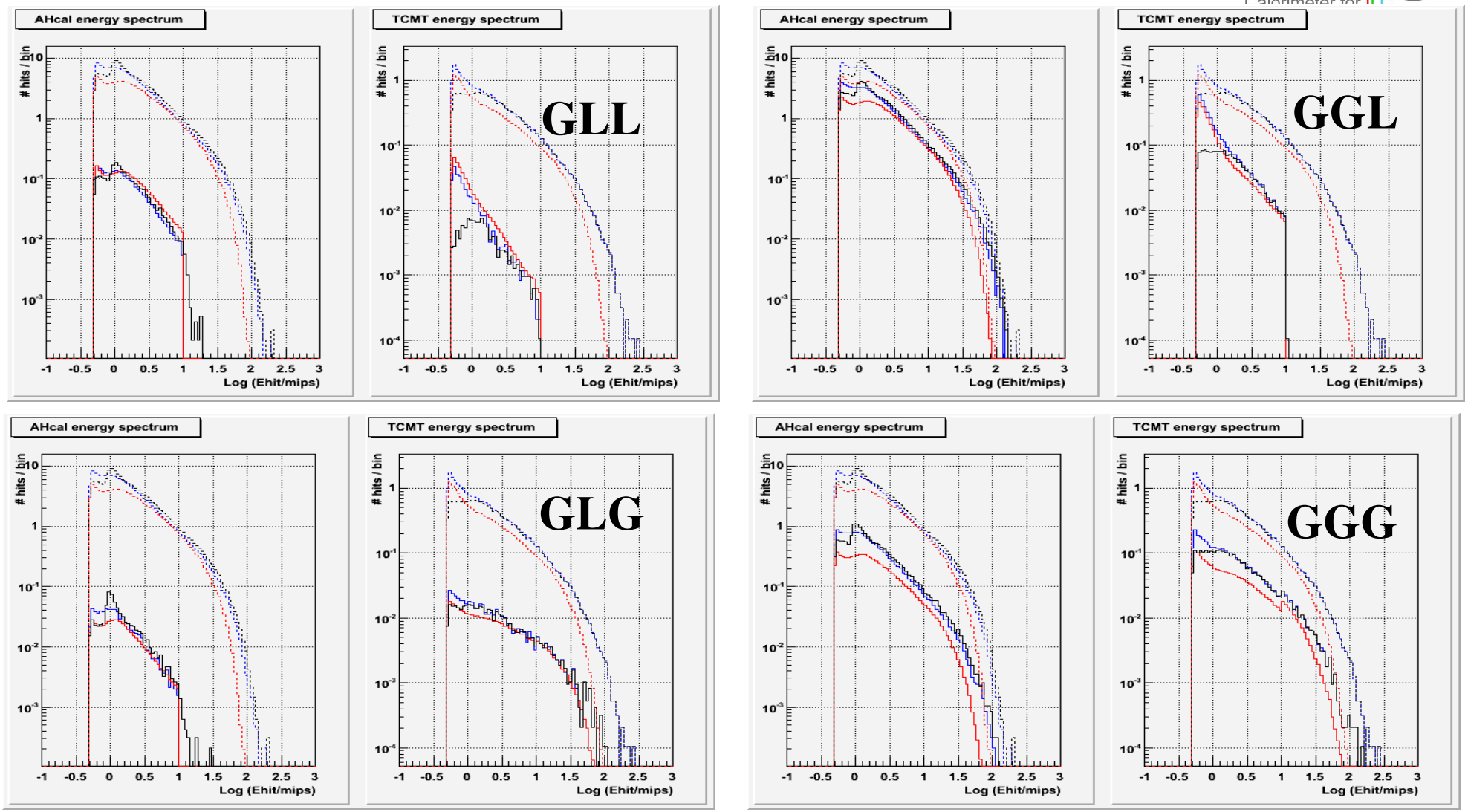
DigiMC/data ratio: 20 GeV pi-



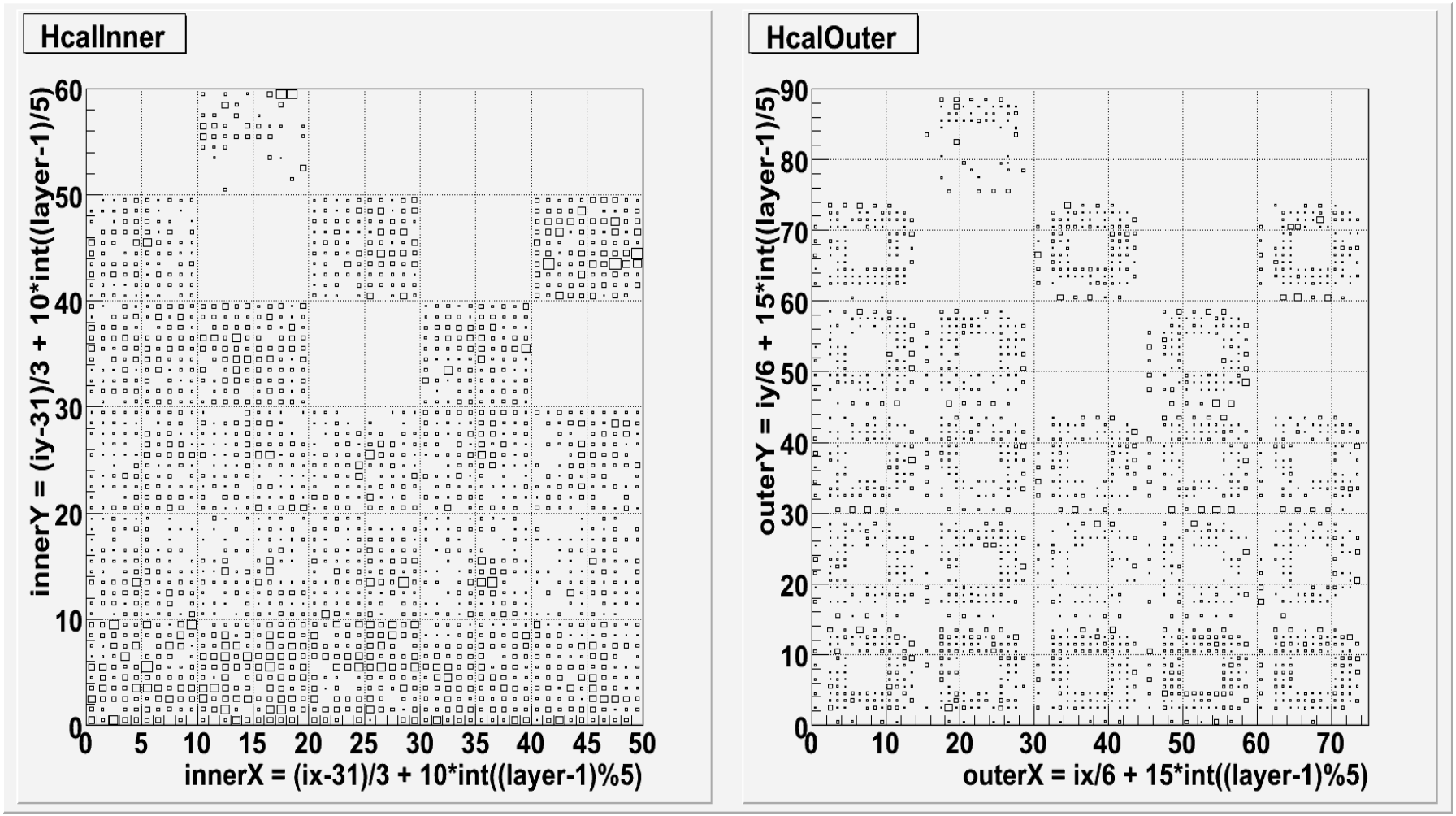
Hit spectrum (log scales) (1/2)



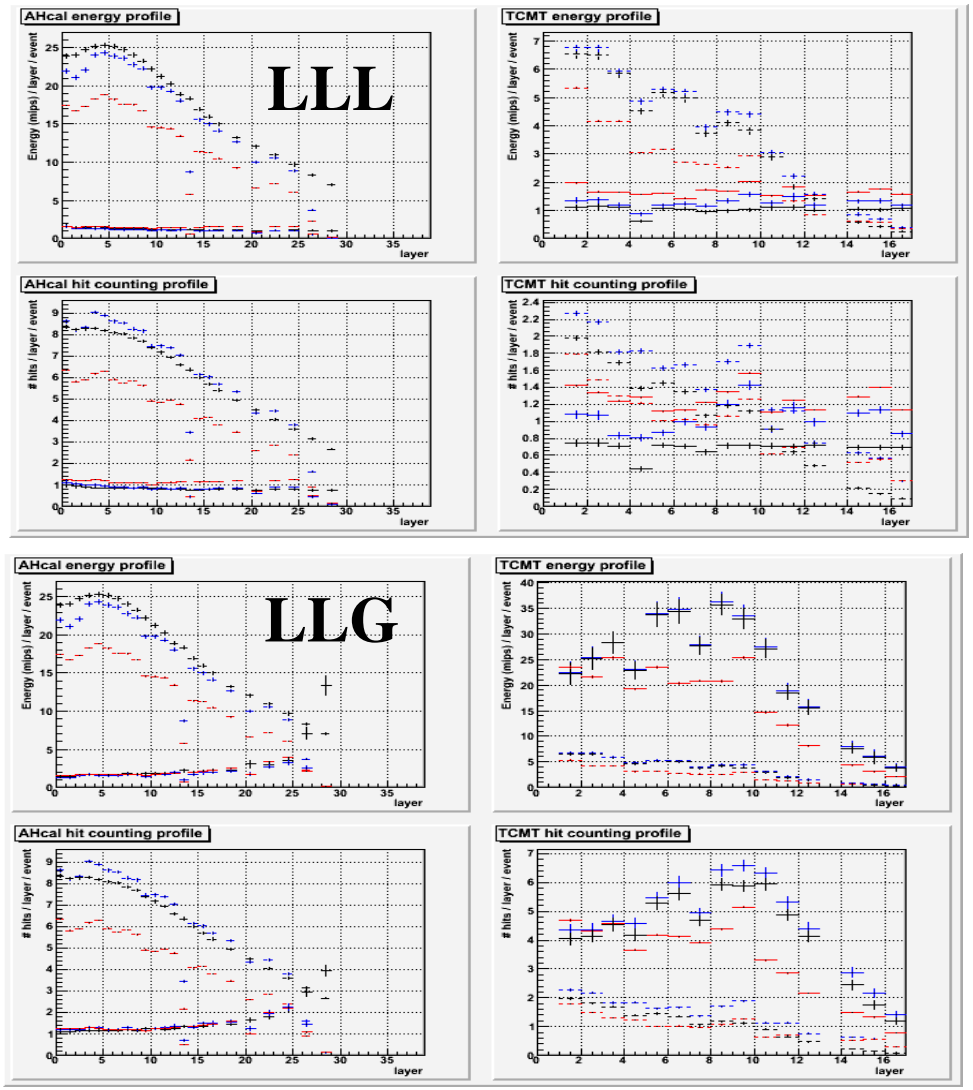
Hit spectrum (log scales) (2/2)

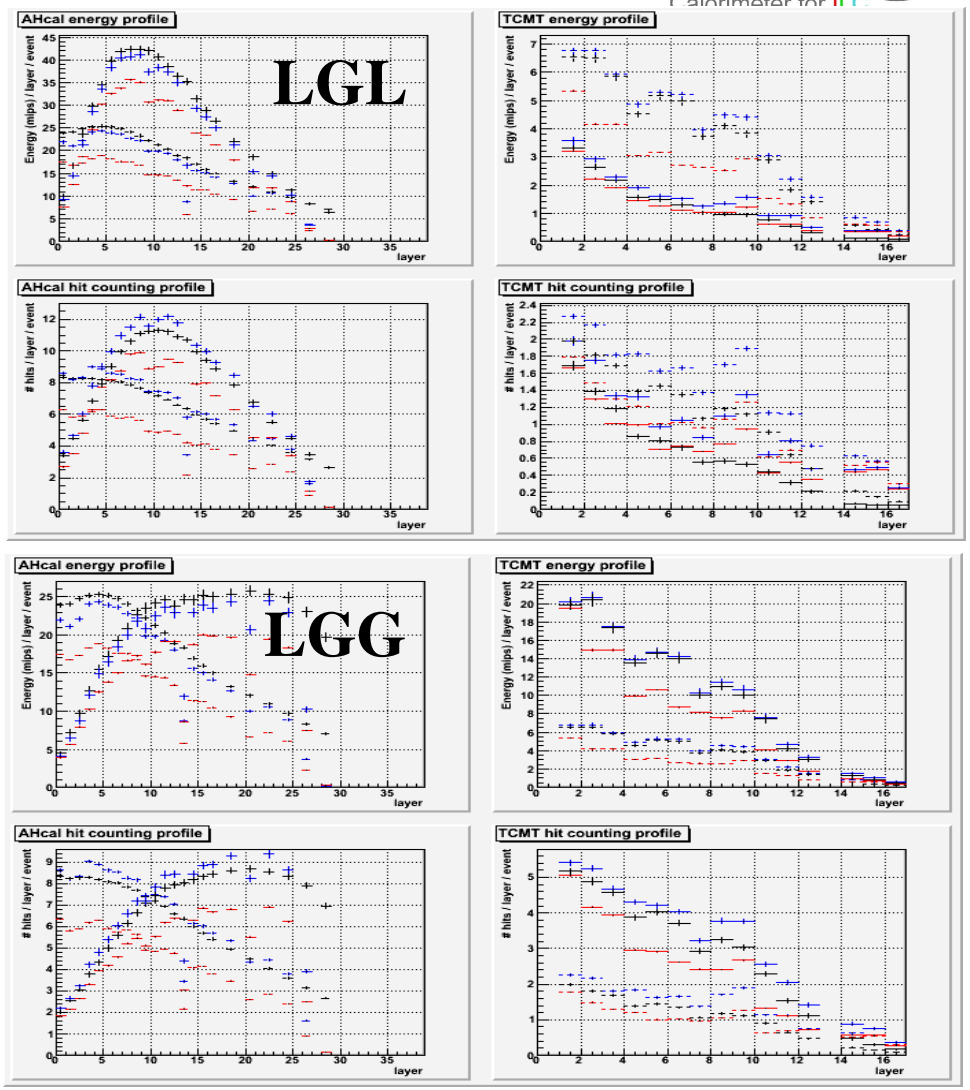


AHcal noise – no hot/warm cells

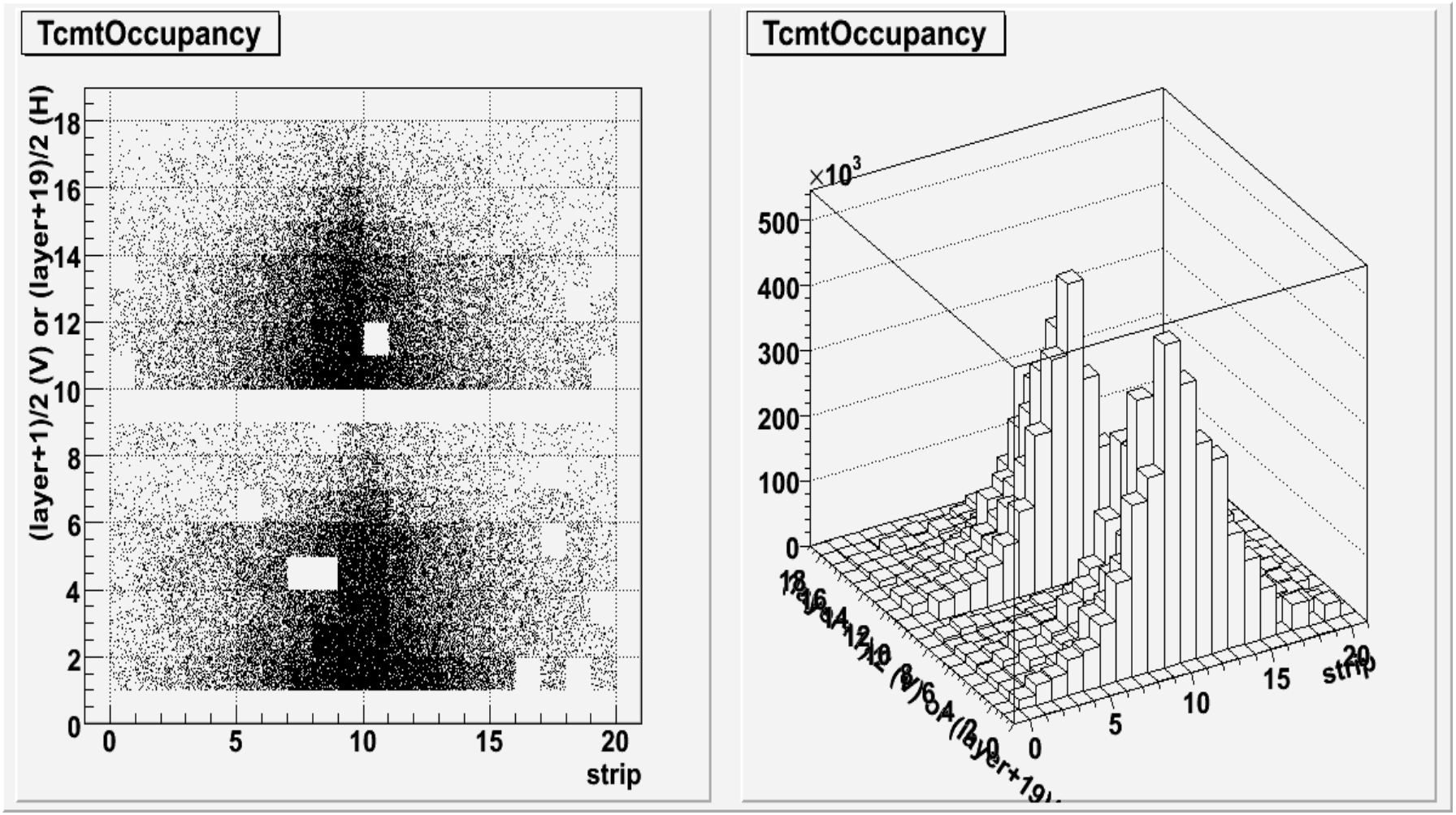


Longitudinal profiles (1/2)

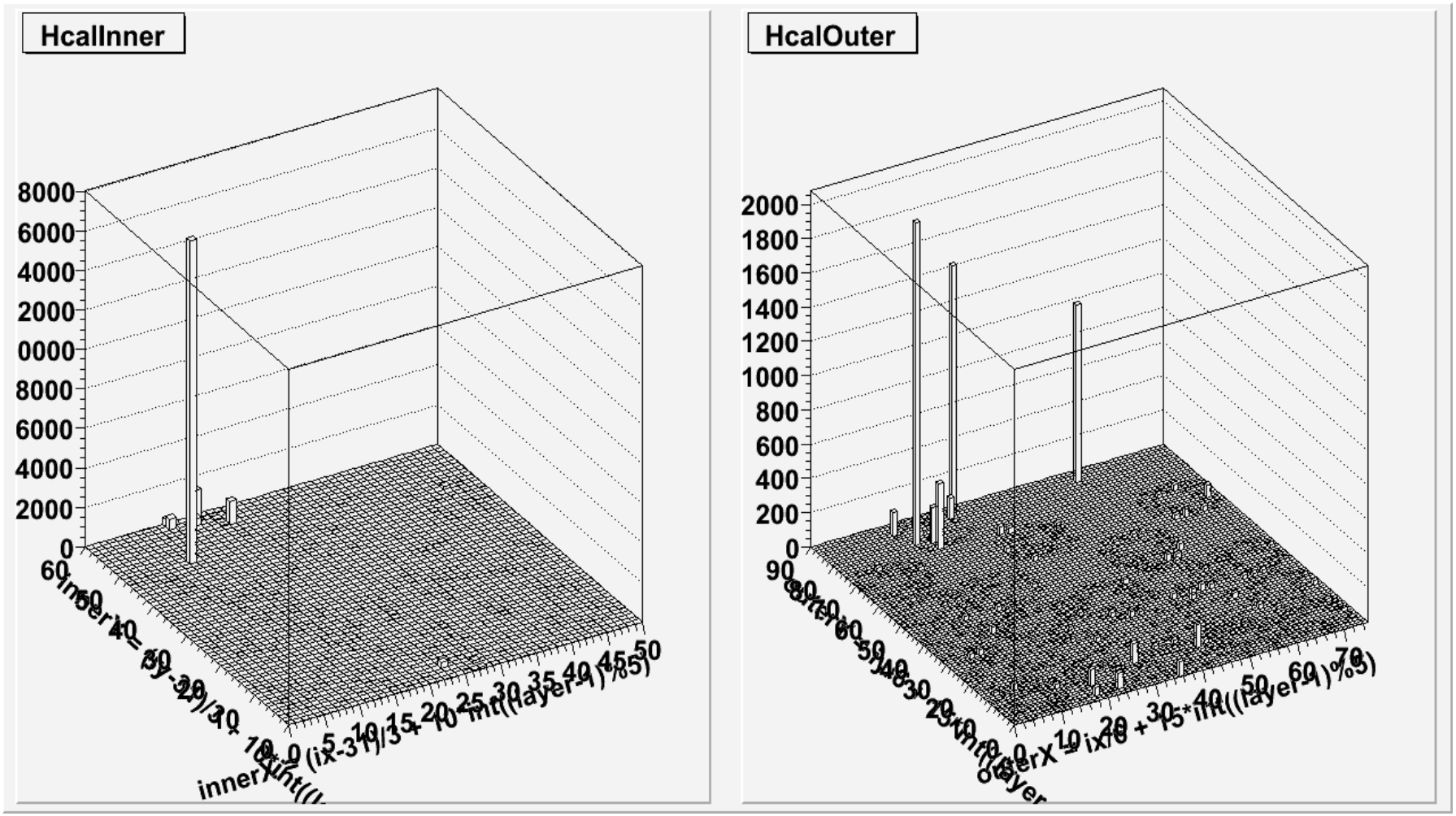




AHcal beam profile (no hot/warm cells)



AHcal noise profile



Longitudinal profiles (2/2)