Overview of Trigger Tests

GLAST Instrument Analysis Workshop

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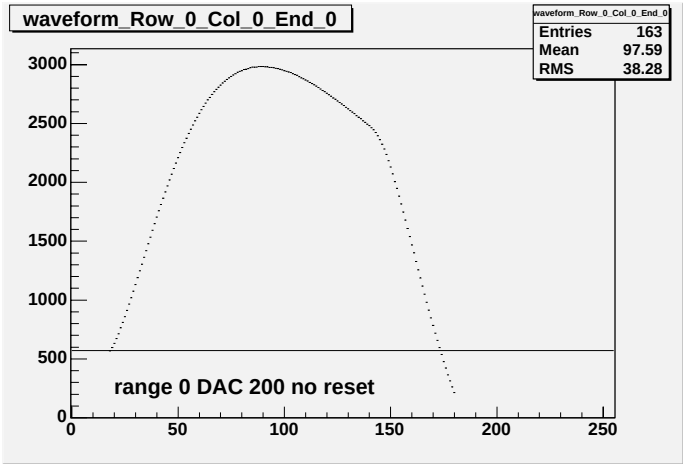
- Tests done so far
- Planning for future tests
- Proposal for trigger timing

Introduction

- There is now a dedicated effort for trigger integration
- So far the group consists of Su Dong, M. K.
- Trigger group started its work a few weeks ago
- Thank you to many people from Online, Electronics, Analysis Software , and the subsystems, for their help and cooperation

Tests done so far

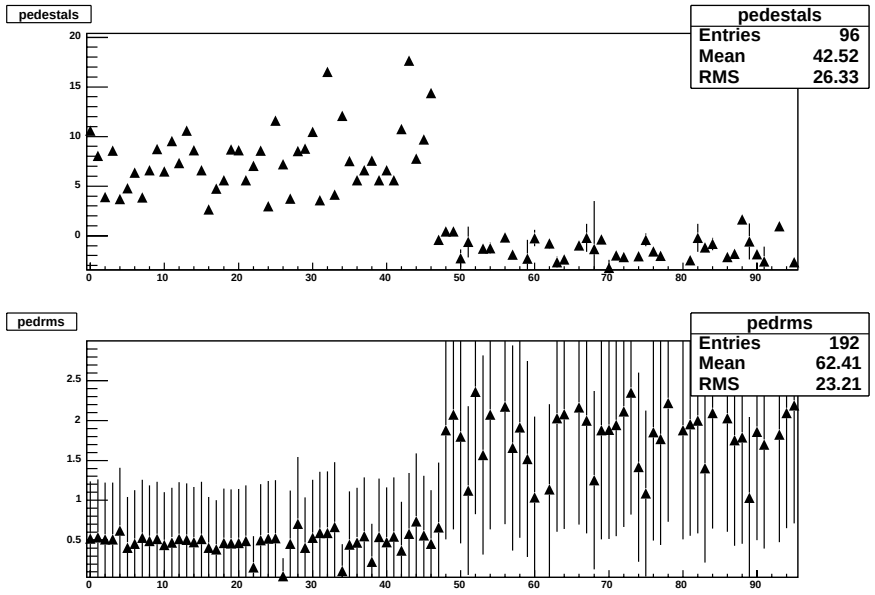
- Started with tests on the minical
- Checked basic quantities like pedestals, gains, waveforms
- Used charge injection for most purposes



- There is a GASU in bldg. 33 now that has an external trigger
- We are able to trigger on cosmics from a muon telescope
- Alignment of external trigger vs. calorimeter is in progress

Pedestals for trigger thresholds

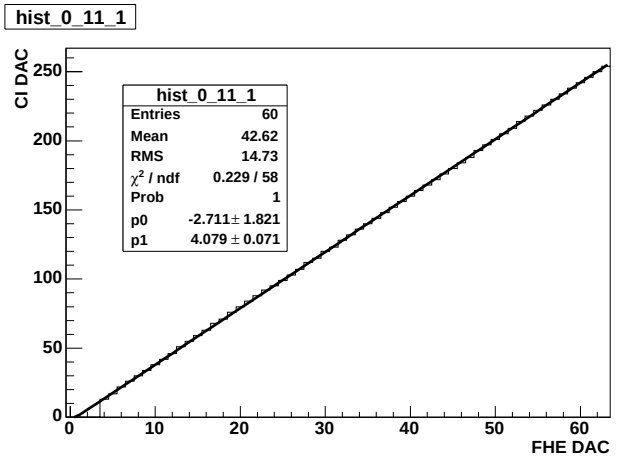
- Scanned through all channels to measure pedestals
- FLE (electronics chain for callow threshold): on channels with crystals the RMS is about 0.5 counts
- There is a large variation of the thresholds between channels



Pedestal (top) and RMS (bottom) by channel (chan 0 - 47 have crystals):
bin = layer*24 + end*12 + column

Scan of threshold DACs

- Scans were performed for the 4 threshold ranges (2 FLE ranges, 2 FHE ranges)
- Offsets and gains were measured

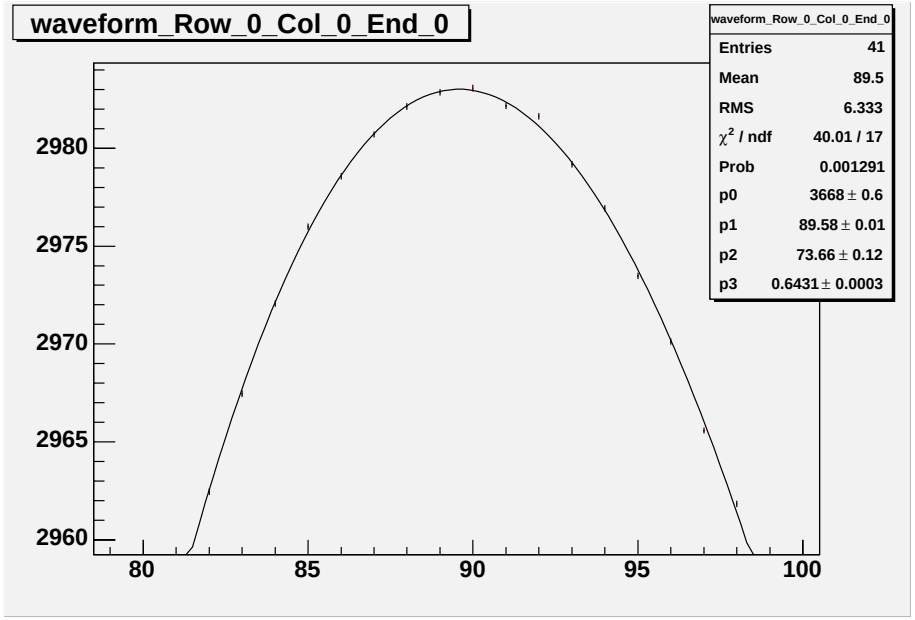


!!! It appears that readout causes a lot of noise in the trigger circuit (up to five noise triggers on every readout)

- This makes the LRS counters (a register that counts triggers regardless of data readout) useless for many purposes

Charge injection waveforms

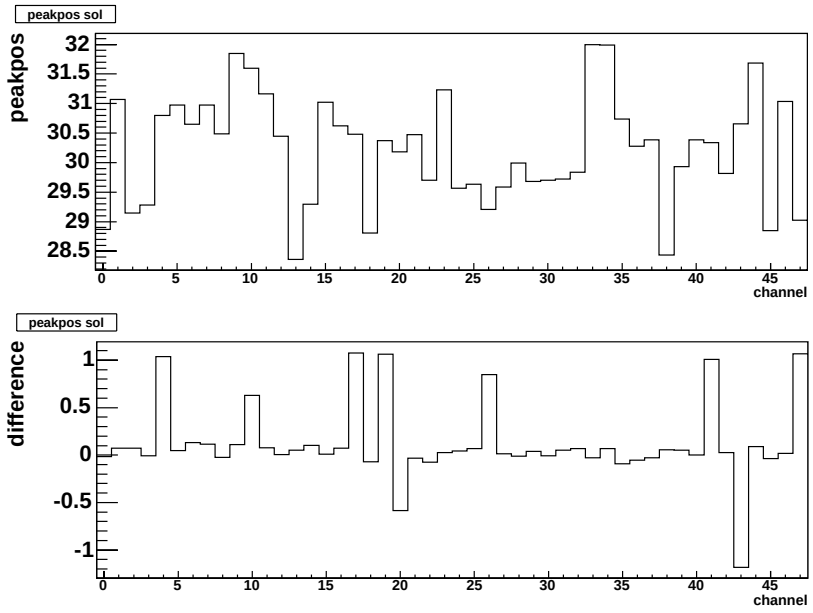
- For C.I. peaking time is ca. 3.7 μs (Low gain) and 4 μs (high gain) from start of pulse to peak
- Within each of the four gain ranges the peak remains stable within 0.5 clock ticks over the full range
- Pulses in the high energy readout chain peak about 5 - 6 clock ticks later than in the low energy chain
- Less than 3 ticks variation over all channels (0.1 % in energy)



Calorimeter trigger delay

- Lowcal trigger jitters less than 1 tick within a given CI setting
- Trigger time (with all delays set to 0) for low threshold is ca. 53 clock ticks (2.65 μs)
- Less than 2 clock ticks variation over all channels
- No systematic variation in trigger time by position

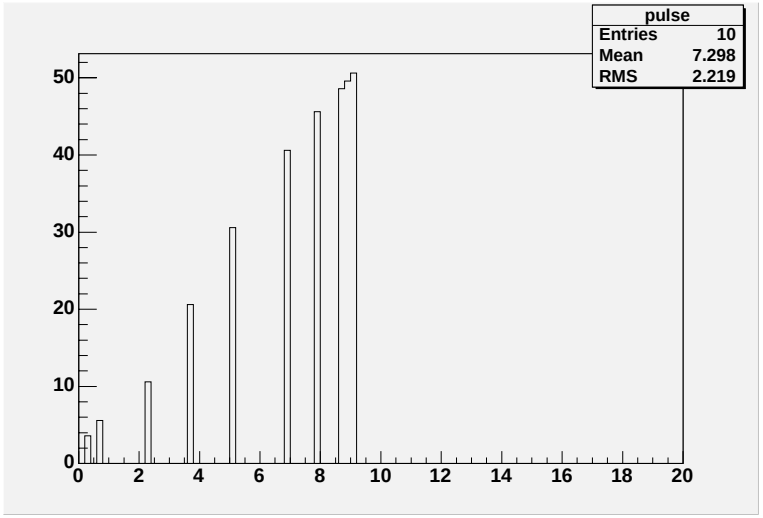
Top plot: Peaking time for CI (arbitrary offset)
Bottom: Peak time difference CI - callow - 53.1 clock ticks



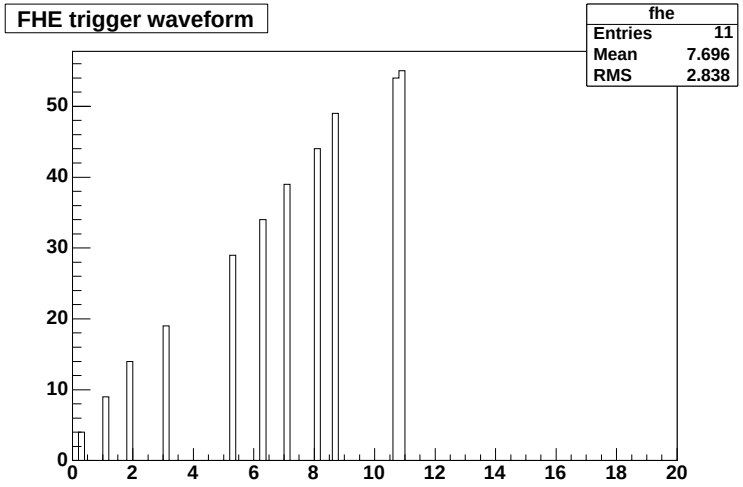
Trigger jitter

- Fast shaped signal threshold crossing determines trigger time
- Did a scan of the fast shaping waveform

callow (FLE)



calhigh(FHE)



- The risetime of the fast shaped pulse is about 12 clock ticks (for CI)
- This needs to be cross-checked with muons

Trigger Cross-Talk

- Checked peakheight dependence on trigger threshold reported by A. Chekhtman
- Confirmed effect of about 1 - 2 % for both FLE and FHE
- Investigated channel cross-talk by charge injecting all channels but one and counting triggers on the channel with no CI
- Up to 10 FLE counts of cross-talk when injecting huge pulses
- Effect is not linear
- The cross-talk might partly be induced by the CI electronics (?)
- Injecting charge into HEX circuit has small cross-talk

Next steps

- Cleanroom:
  - Latest version of GASU has external trigger
  - Use Gary Godfrey's muon telescope to trigger on cosmics externally
  - Add tracker and ACD to do time-in tests on all systems with cosmics
  - Use diagnostic data to determine trigger efficiencies
- Trigger teststand
  - GASU based teststand at the Central Lab
  - Components are ready
  - May or may not add a TEM

Single Tower Tests

- A test procedure needs to be set up to make sure all channels trigger properly.
- Basic parameters like thresholds, threshold DACs, trigger delays, on individual subsystems can be checked using charge injection (fast and well defined)
- For inter-subsystem timing and efficiency tests cosmics are needed. This requires large data taking intervals because of low rates. Without GEM timing data many scan points are needed. Efficiency tests can probably run in parallel with subsystem tests. The muon telescope is an important tool here because it provides identical timing when swapping towers and provides us with an unbiased trigger for efficiency tests
- For deadtime and high rate tests a BNC random pulse generator has been bought to produce external triggers simulating noise. For higher precision tests we would need a software driven generator for arbitrary patterns and reproducibility. No fast solution in sight.

Full system tests

- Single/two tower tests are the main test. As many tests as possible should be done at this level to minimize the chance of any problems at the LAT level.
- Full LAT tests will check multiple tower trigger functionality.
- A muon telescope can be moved around on the LAT to provide external information for trigger time and efficiency. If the use of a muon telescope proves mechanicall impossible at a LAT level alternatively we may have to use the ACD to trigger on cosmics instead.
- A pulse generator can be used to simulate background triggers.
- We are working on a detailed test plan and some of the decisions will be motivated by the tests of the next weeks.

Trigger Timing DAQ Proposal

- In the present scheme only a global trigger time is available
- Relative timing for individual trigger lines would facilitate alignment
- Timing from individual towers would assure data quality (efficiency and energy measurement)
- Analysis could benefit from cleanup of out-of-time data

Limitations:

- Available elements in FPGA. Enough space seems available.
- Additional data transmission volume from the GEM must not be a significant contribution to the LAT deadtime. This is the main issue. A solution to this problem could be the prescaling of the data. For example 256 bits of data transmitted on every 8^{th} event would add 1.6 μs of readout time per event on average.

Trigger Timing DAQ Proposal

Proposal:

- Add 256 bits of DAQ data
- Word 1 - 2: 8-bit 50 ns resolution trigger times for 8 summary conditions (TKR, CAL_L, CAL_H, CNO, ROI, EXT, Periodic, Solicited)
- Word 3-4: 4-bit 400 ns res. TKR trigger time for each tower
- Word 5-6: 4-bit 400 ns res. Callow trigger time for each tower
- Word 7-8: 4-bit 400 ns res. ROI trigger for each ROI region

!!! Discussion is needed

- See also Su Dongs posting on the trigger mailing list

Summary and Outlook

- The new trigger group has started its work
- Tests on the minical were performed to understand the calorimeter trigger. There will be a write-up in TD-04827
- A muon telescope and an external trigger will be used for timing in the subsystems in the near future
- A trigger teststand is being commissioned.
- A proposal for adding trigger times has been made.