More About Shaped Readout Noise

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Introduction

- Recall Sasha’s presentation from 2-Tower study

- Small bias in normal events that follow closely after a first event
  - What is it? Where is it from?
    - Digital readout noise picked up by channels nearest the digital path on each CAL AFEE board, shaped by the slow shaping amp, and added to readout of current event.
  - How large is the effect?
    - See below
  - How close in time must the events be?
    - $\Delta t < \sim 35\text{ms}$ (strongest at 25-30ms)
  - Effect is strongly systematic, so it “can be calibrated out”
    - Specific channels are most susceptible, can be filtered out
    - Shape is known, can be calibrated out
Spurious signals at $\Delta t < 30 \mu s$

- **Spurious signal in a few channels**
  - *normal* muon events within 31 $\mu s$ from previous trigger show exponentially decaying signals in empty xtals
  - amplitude $\sim 170$ LEX8 ADC units ($\sim 1/2$ MIP)

- **These are normal, TKR-triggered muons**
  - Statistics: $\sim 50$ events out of 150k, consistent with 80 Hz event rate:
    - (31 $\mu s - 26.5$ $\mu s) \times 80 \text{ Hz} \times 10^{-6} \times 150,000 = 54$ events
  - This is **not** a retriggering issue.

Data: 150k muons from run 135002134 (Flight config, 2 twrs)
Largest effect

- Channel with largest effect is Tower 2, Layer 1, Col 5
  - Amplitude at $\Delta t = 26.5$ us
    - $\sim 1$ MIP, $\sim 12$ MeV
  - Color indicates $\Delta t$
  - Weaker effect in all other channels
    - See next page

- Suggests possible filter
  - Short $\Delta t$
  - Deviation from typical asymmetry measure
  - Known GCFEs
    - See next page
Summary of all channels

- Effect is much smaller in typical channel, but has same time-dependence.

- To study all channels, we remove the exponential:
  - Pick one reference channel, with strong contamination
    - refChan = FM117, row Y0, face -, xtal column 5
  - Event by event, normalize each channel to the reference channel
    - normSignal[iChan] = signal[iChan] / signal[refChan]
  - Calculate the median of the normalized signal for all events with $\Delta t < 35 \mu s$.
  - Plot normalized signal
Summary of all channels

- **Normalized**
  - Recall 1 unit ~ 1 MIP at 26.5 us
  - Five chans with >0.8
  - Seven chans with >0.5

- **Systematic location (magenta)**
  - $X^+, Y^- \text{ column 5}$
  - $X^-, Y^+ \text{ column 6}$
  - We know where to look

- **Recall XtalRecon**
  - Energy in xtal = geometric mean of both ends
    - $E = \sqrt{E_{\text{plus}} \times E_{\text{minus}}}$
  - Thus, effect on energy measurement is diluted

(Same plot as previous page)
Effect on simple energy sum

- **CalEneSum**
  - *Simplest total E*
    - Upper limit to this effect
    - No filtering of known xtals
  - *Affects short times*
    - Strongest below ~30 us
    - Negligible above ~35 us

- **Stay tuned**
  - Need to remove known xtals
  - Try correction factor
  - ...

Events miss the CAL

Muon peak