LongBo Analysis Update

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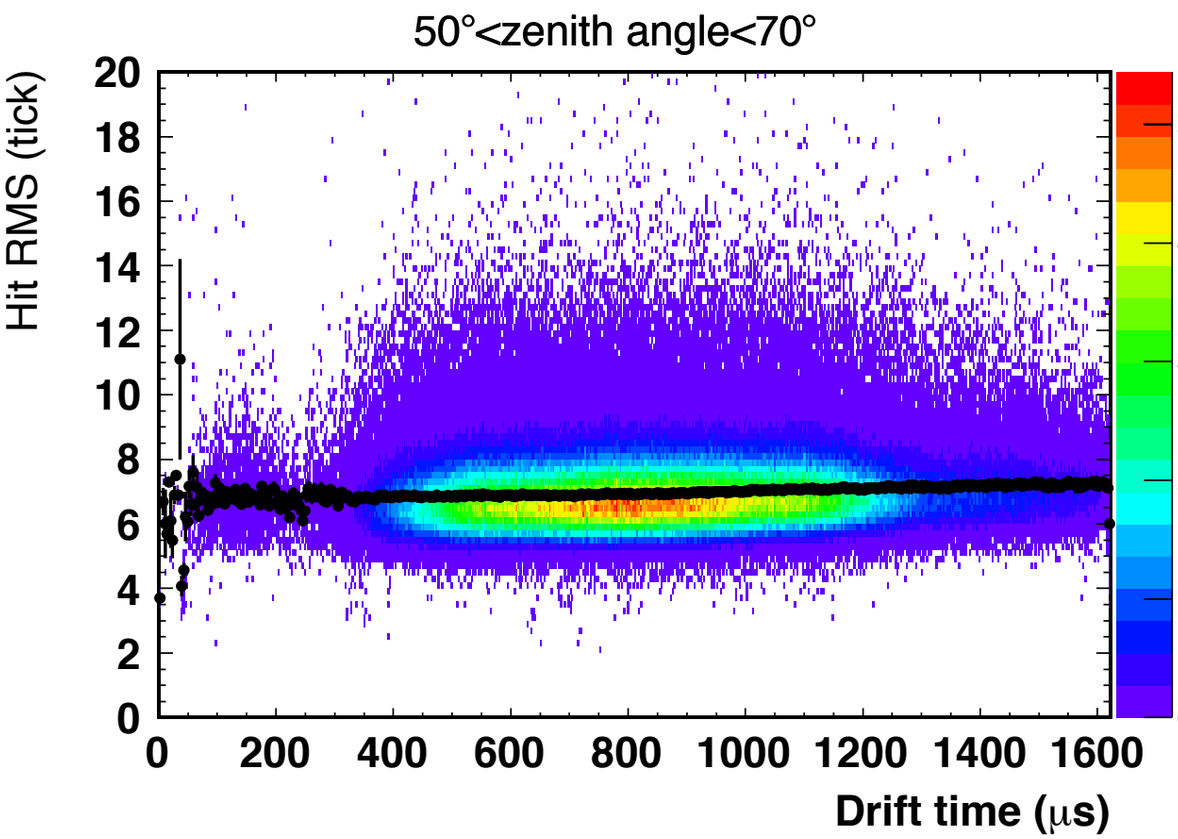
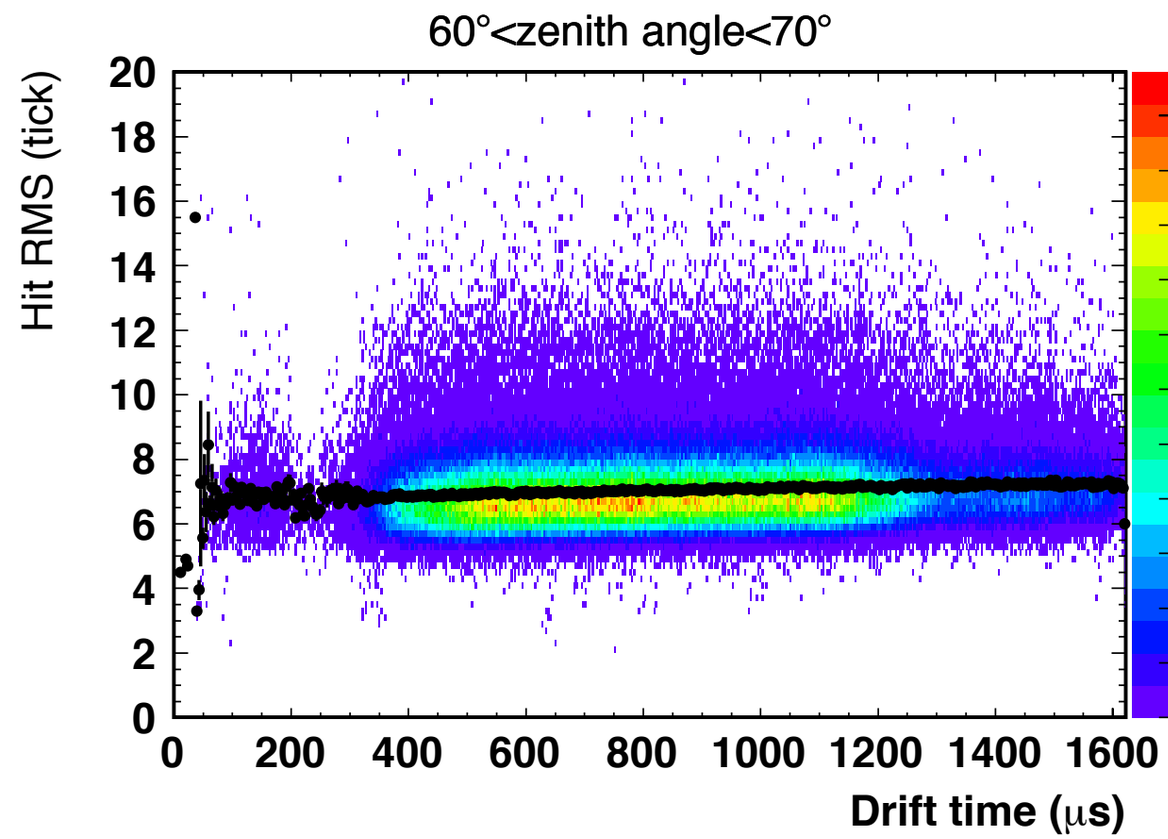
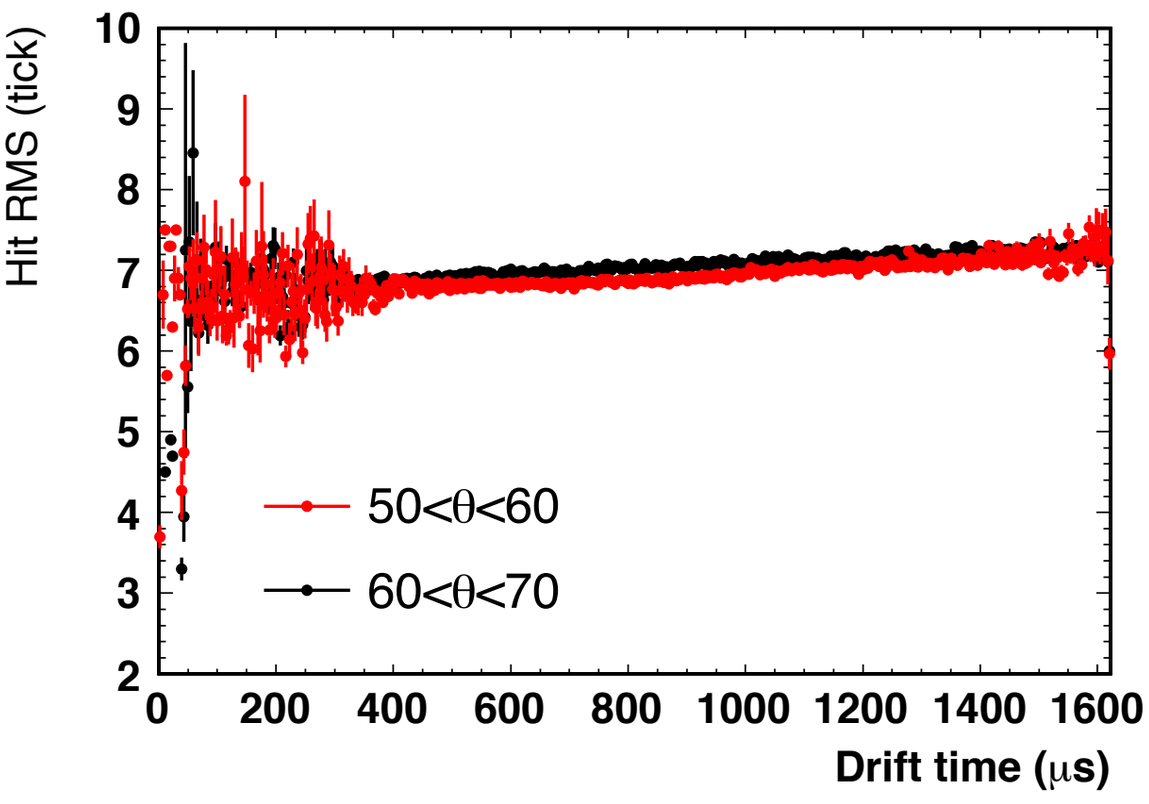
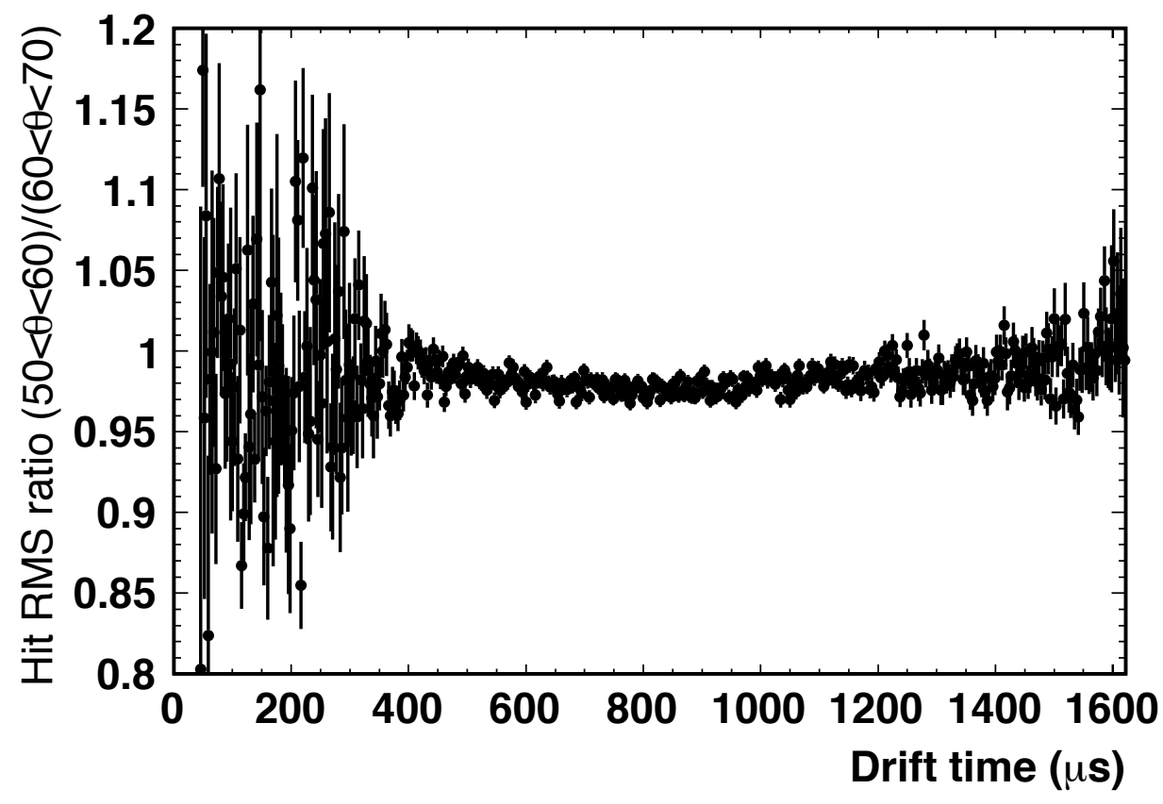
- Repeat previous studies using raw digits.
  - This is to check if there is bias caused by reconstruction.
- For each reconstructed hit, find the peak time (t) and hit sigma. Go back to raw digits and look at the range [t-3sigma, t+3sigma]
  - Pulse-height - highest ADC
  - Pulse area - integral of digits above the threshold 0.1*pulse-height
  - Pulse RMS - time RMS of digits above the threshold 0.1*pulse-height, weighted by pulse-height
- θ is wrt the vertical direction.

Pulse RMS

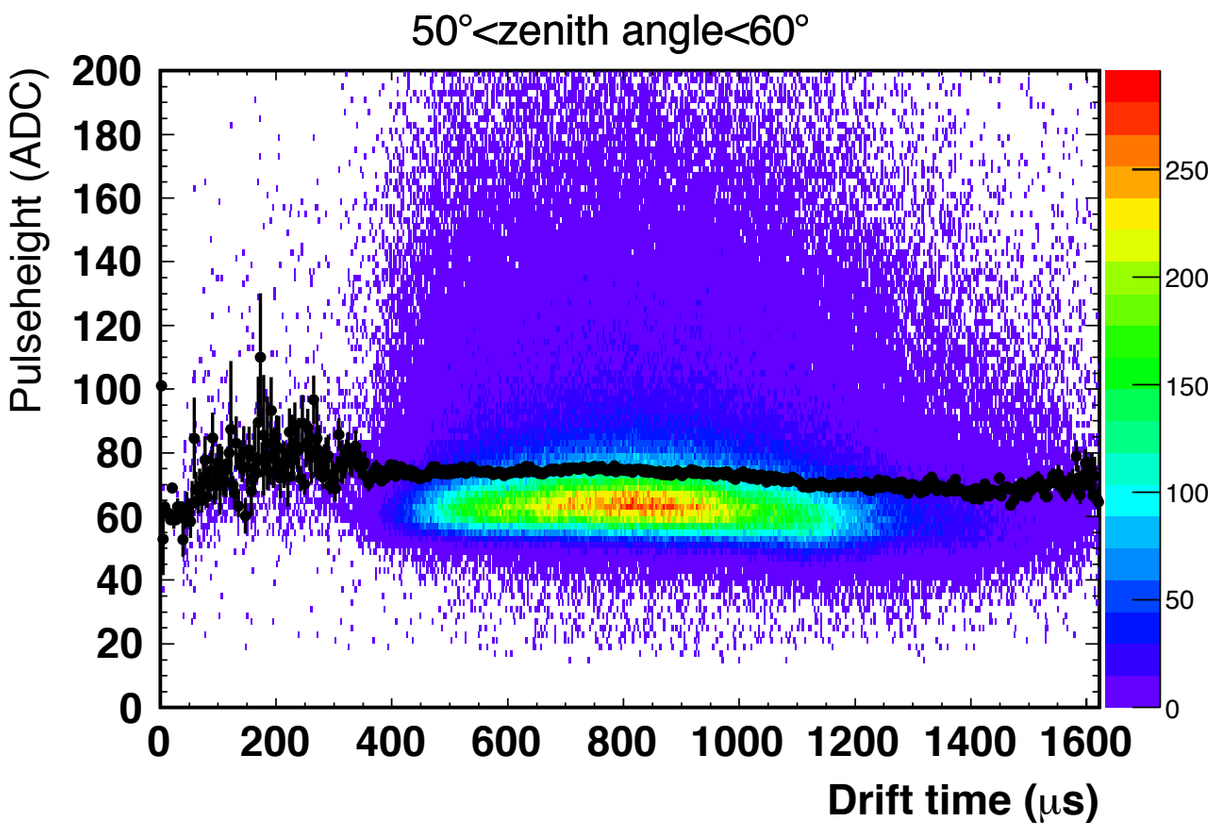

50°<zenith angle<70°
Hit RMS (tick)
Drift time (μs)

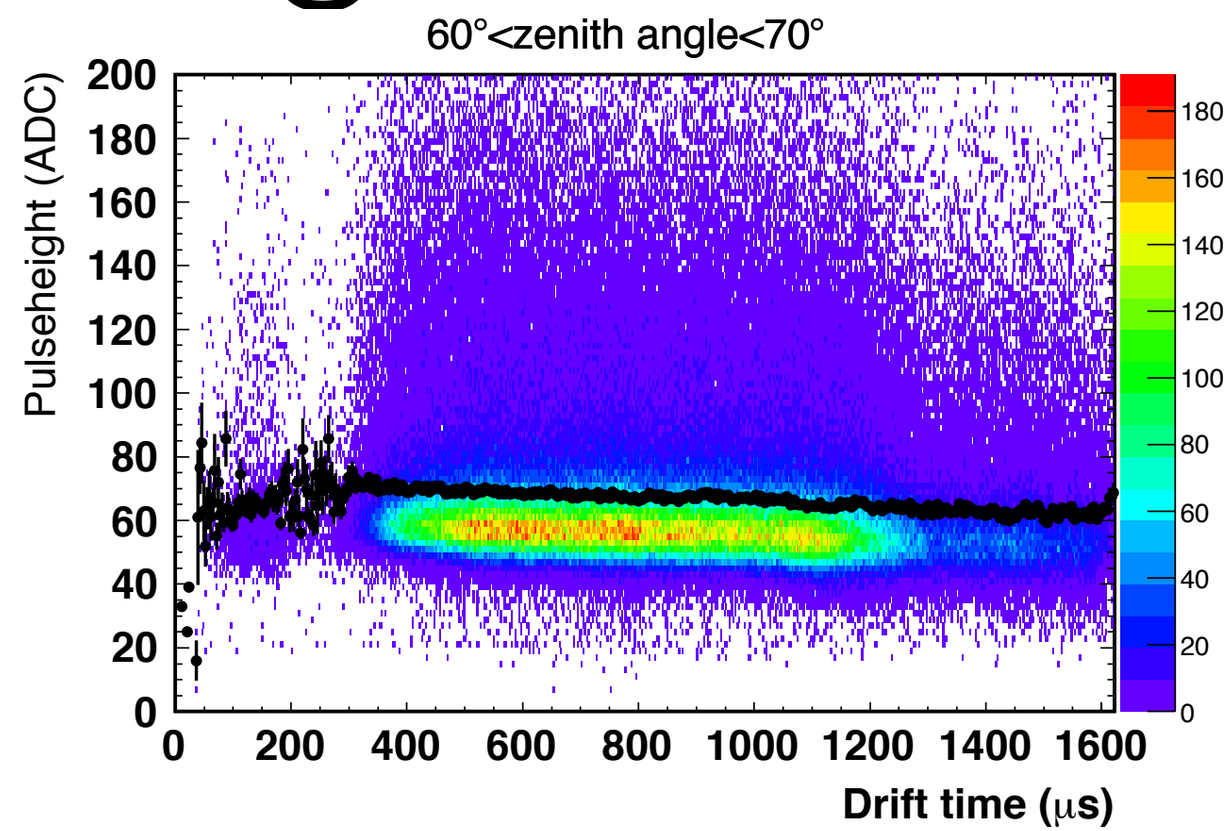

60°<zenith angle<70°
Hit RMS (tick)
Drift time (μs)

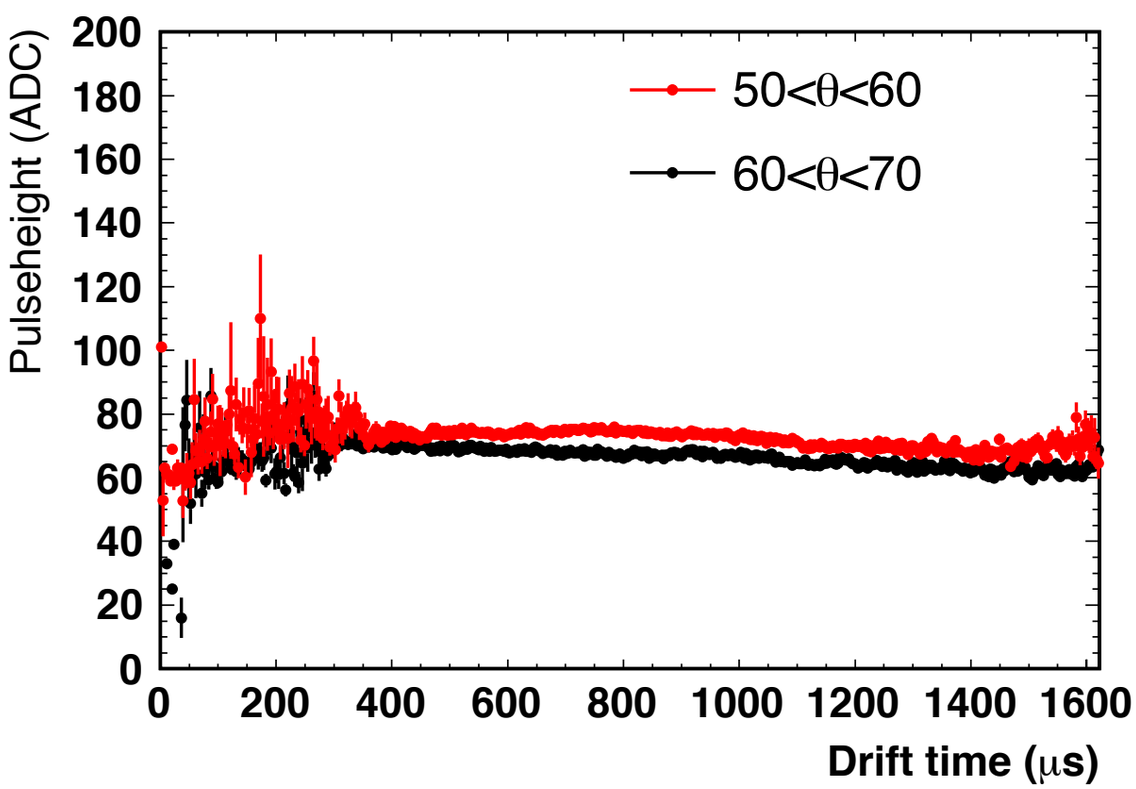

Hit RMS (tick)
50<θ<60
60<θ<70
Drift time (μs)

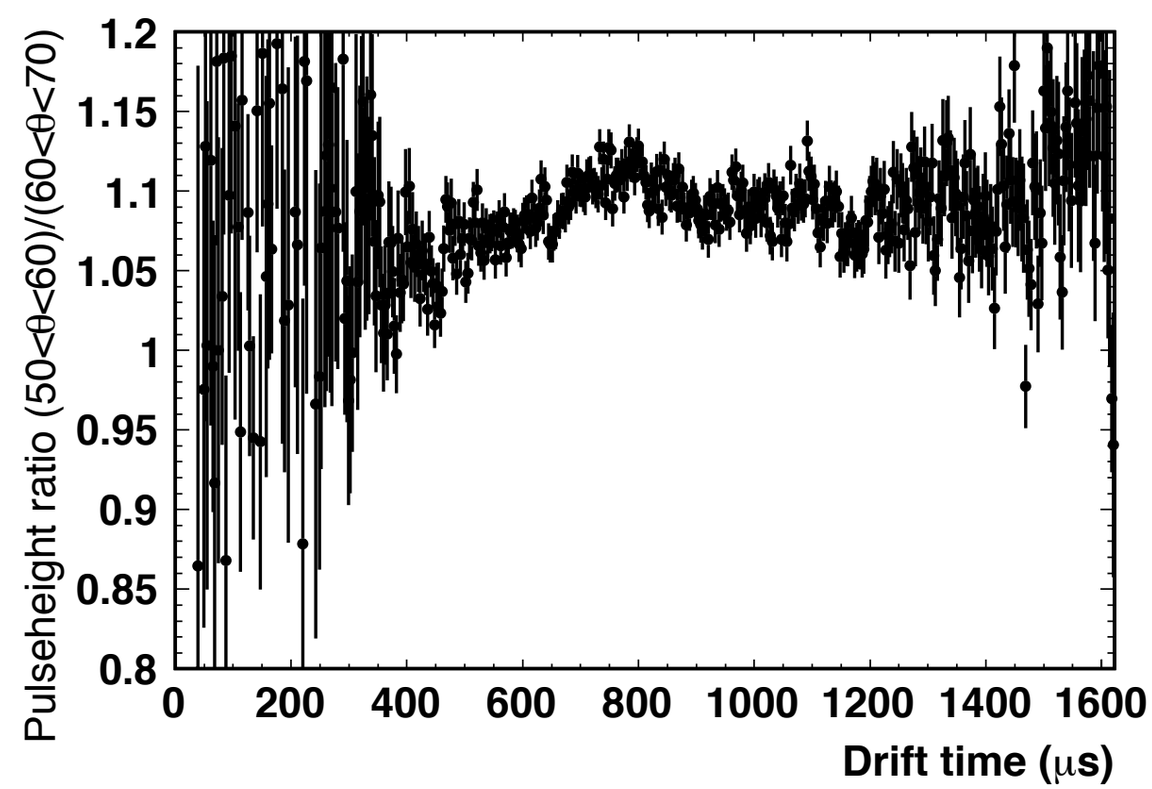

Hit RMS ratio (50<θ<60)/(60<θ<70)
Drift time (μs)

Pulse Height

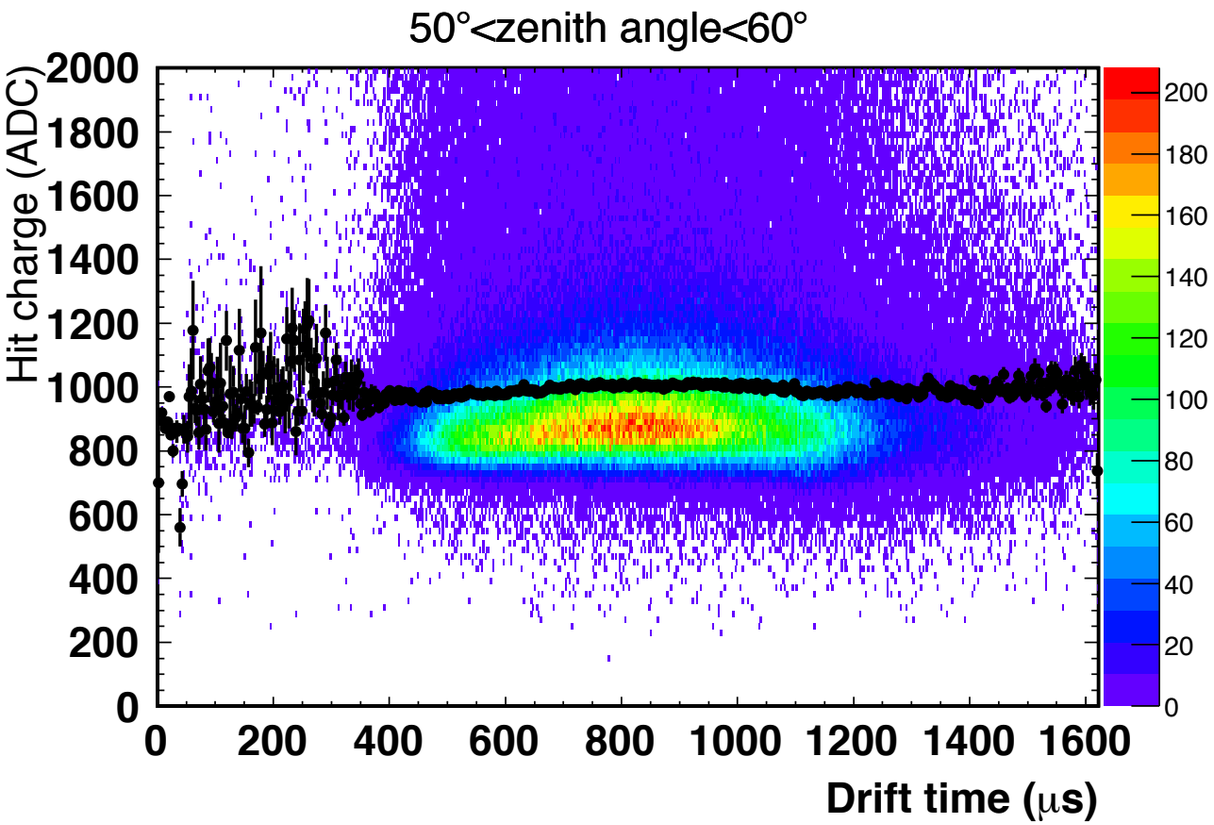


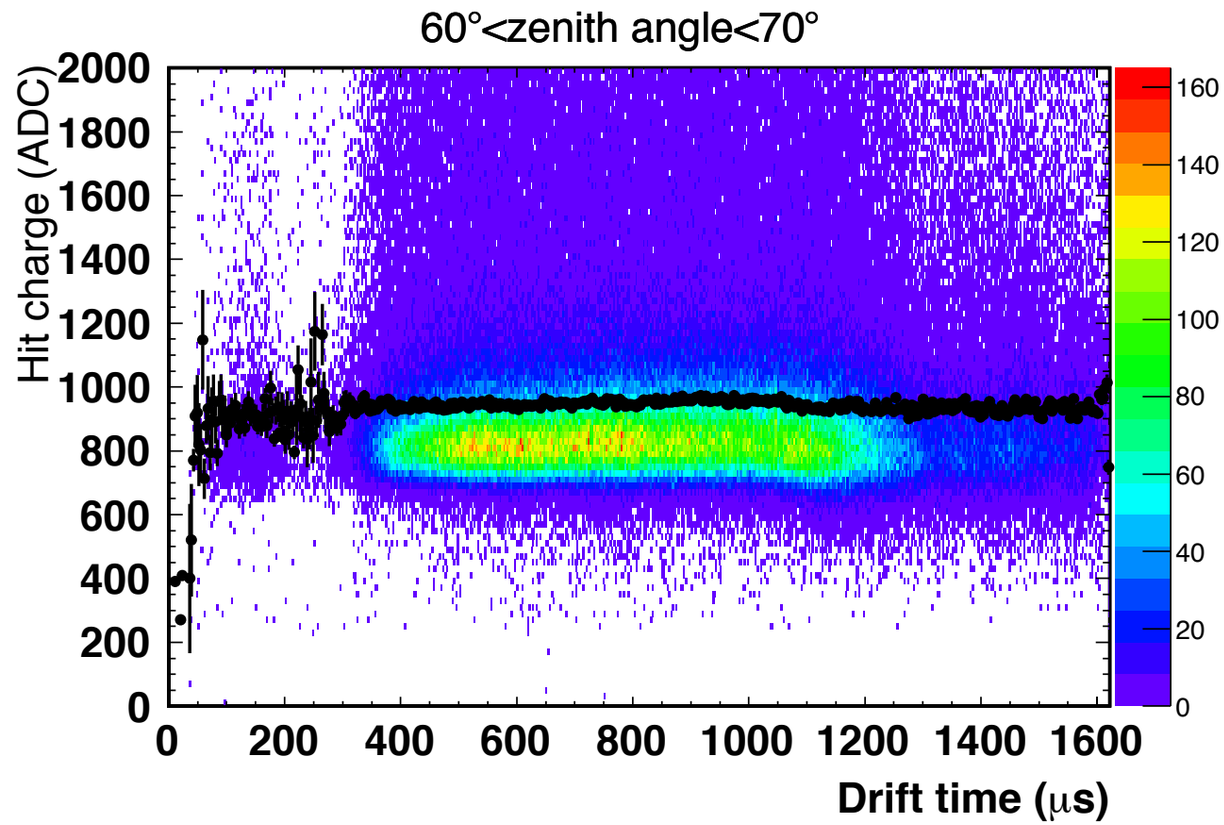


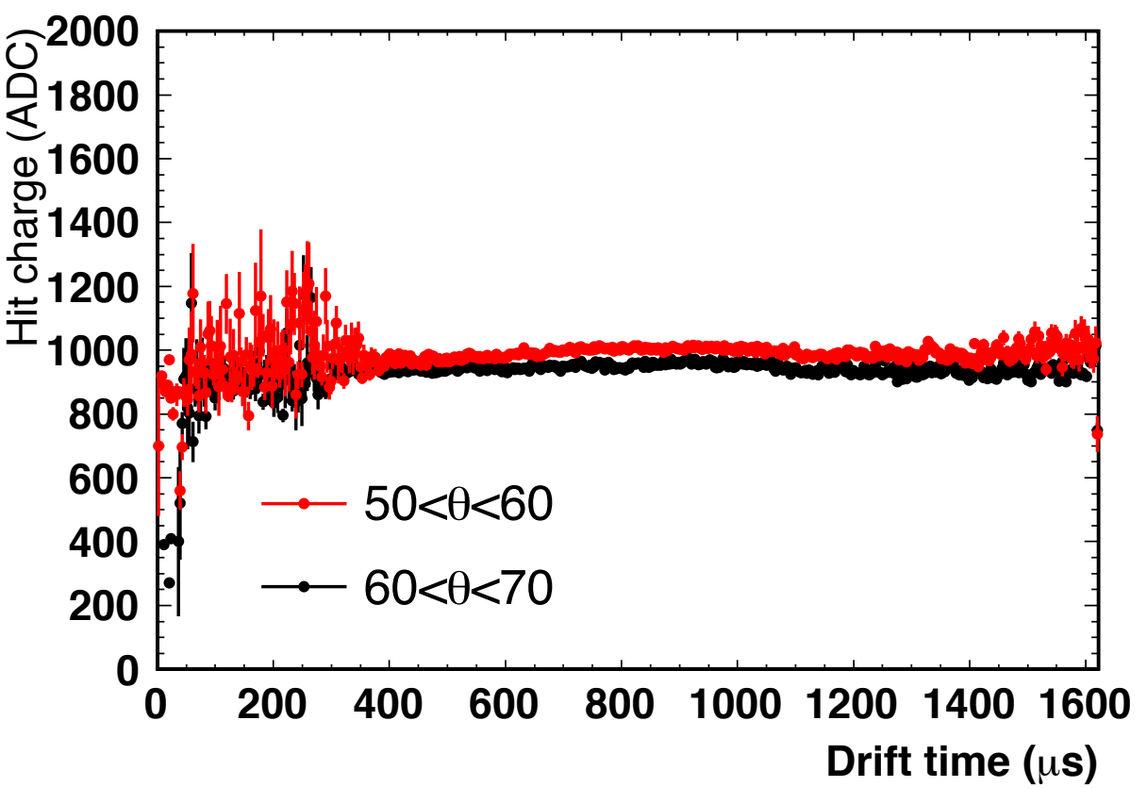


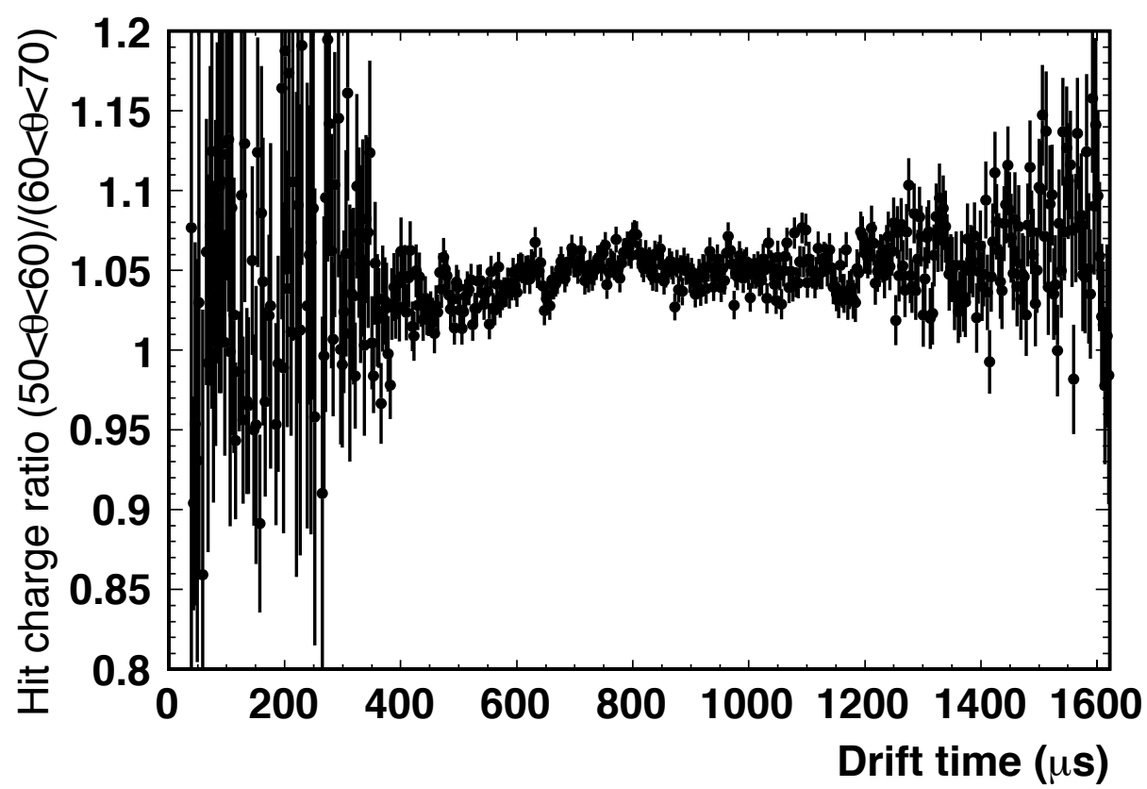


Pulse Area

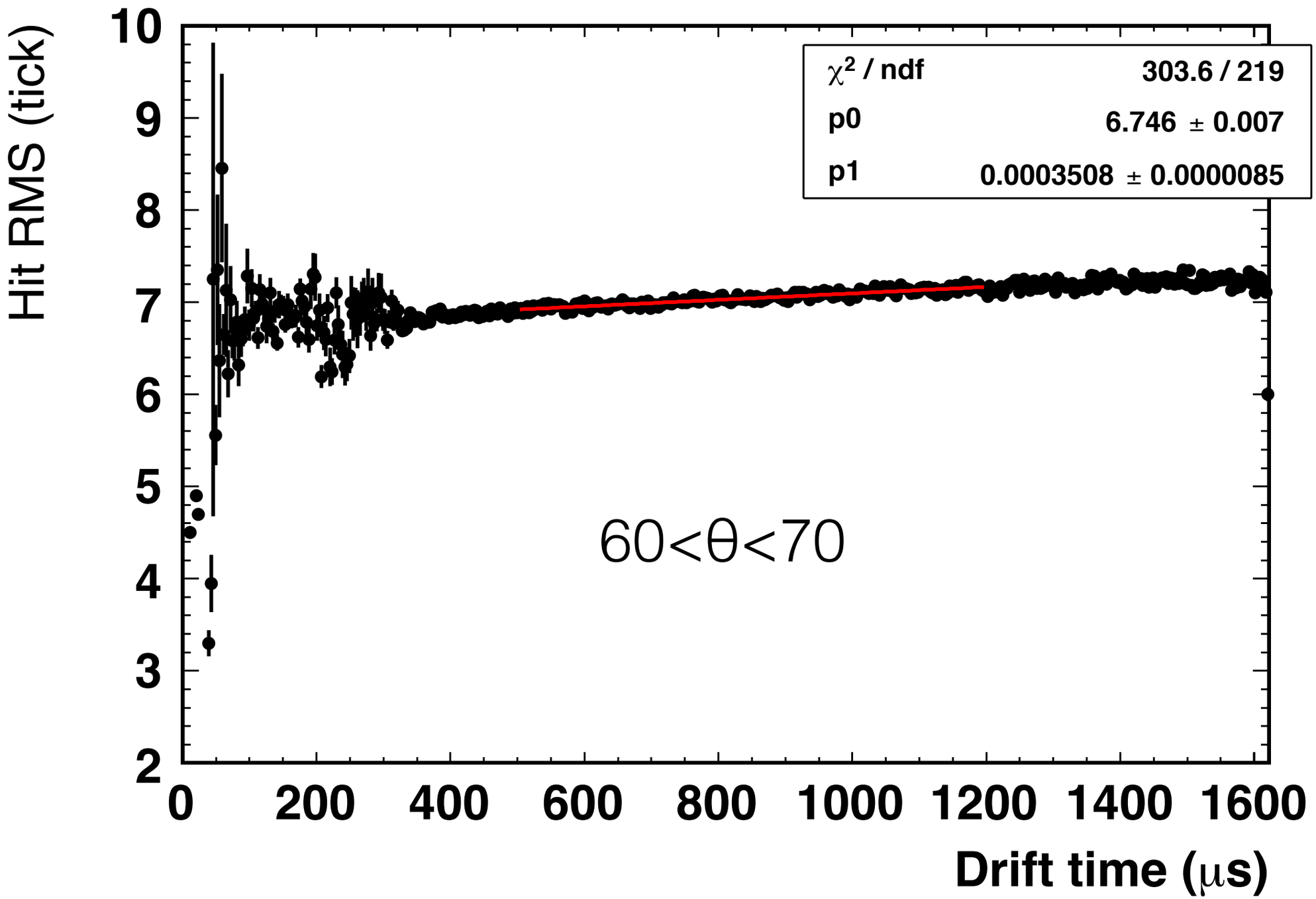

50°<zenith angle<60°
Hit charge (ADC)
Drift time (μs)


60°<zenith angle<70°
Hit charge (ADC)
Drift time (μs)


Hit charge (ADC)
50<θ<60
60<θ<70
Drift time (μs)


Hit charge ratio (50<θ<60)/(60<θ<70)
Drift time (μs)

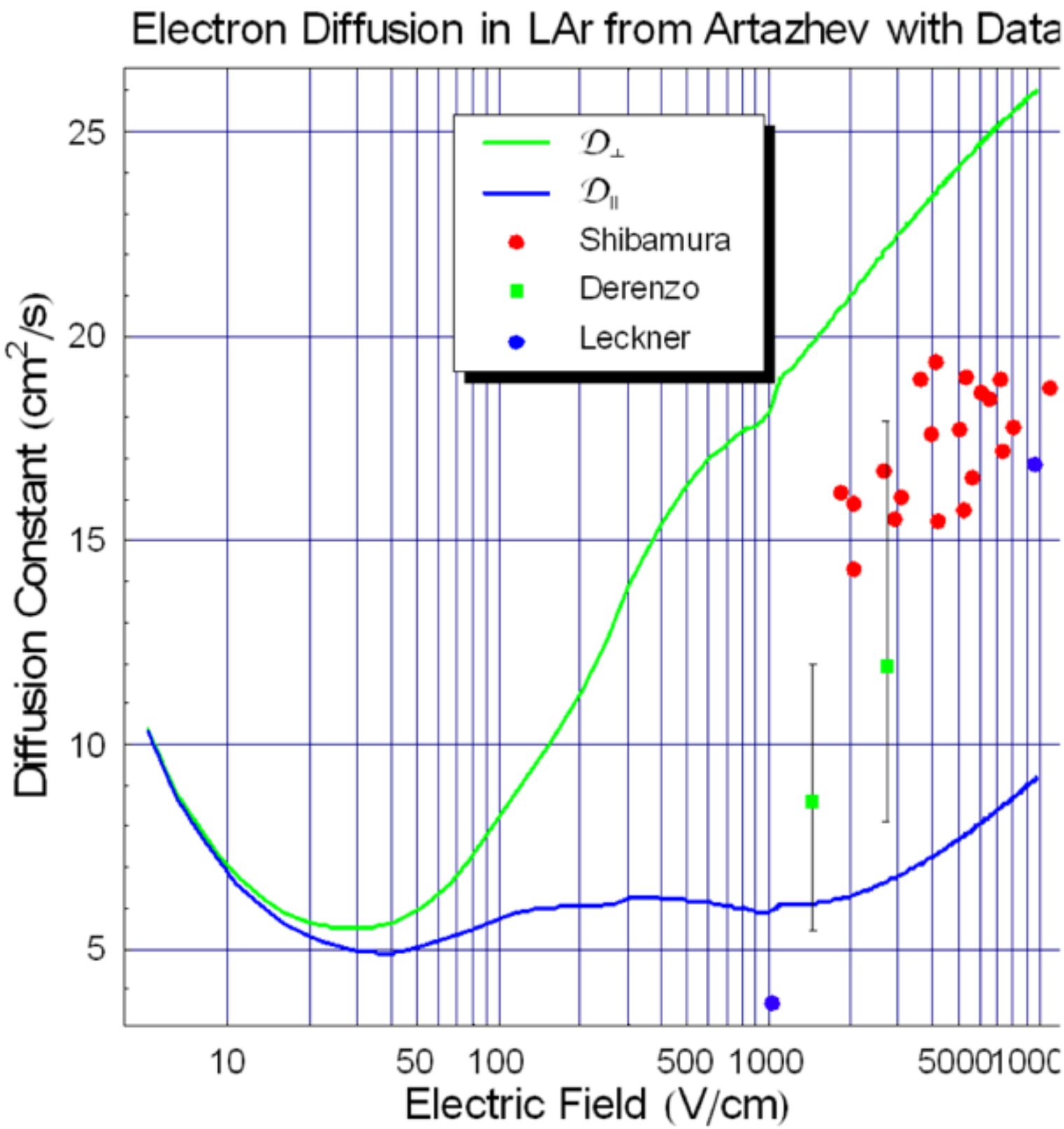
- Pulse width/RMS increases as drift time increases.
- Pulse height decreases as drift time increases.
- Pulse area is relatively flat.
- Steep tracks (small θ) have smaller width and larger pulse height and larger pulse area.



Can we use the slope to measure longitudinal diffusion?

- Longitudinal diffusion introduces additional spread to the hit width.
- $\sigma = \sqrt{(\sigma_0^2+\sigma_D^2)}$
- σ_0 is the hit width at 0 drift time.
- σ_D is the spread caused by longitudinal diffusion:
  - $\sigma_D = \sqrt{(2D_L t)}/v = 0.0269\sqrt{(D_L t)}$ (tick)
  - D_L is the longitudinal diffusion constant in cm^2/s.
  - t is the drift time in μs.
  - v = 1.33 cm/μs is the drift velocity at E = 350 V/cm.
- $\sigma = \sigma_0 + \sigma_D^2/(2\sigma_0) = \sigma_0 + 3.605e\text{-}4*D_L t/\sigma_0$
- The slope is $3.605e\text{-}4*D_L/\sigma_0$
- $\sigma_0 = 6.746+0.0003508*40 = 6.76$ (tick), 40 μs is the trigger time.
- $D_L = 0.0003508*6.76/3.605e\text{-}4 = 6.6\ cm^2/s$

MicroBooNE-doc-289-v2



MicroBooNE uses D_L = 6.2 cm^2/s at E = 500 V/cm