PSEC-3 Calibration Report

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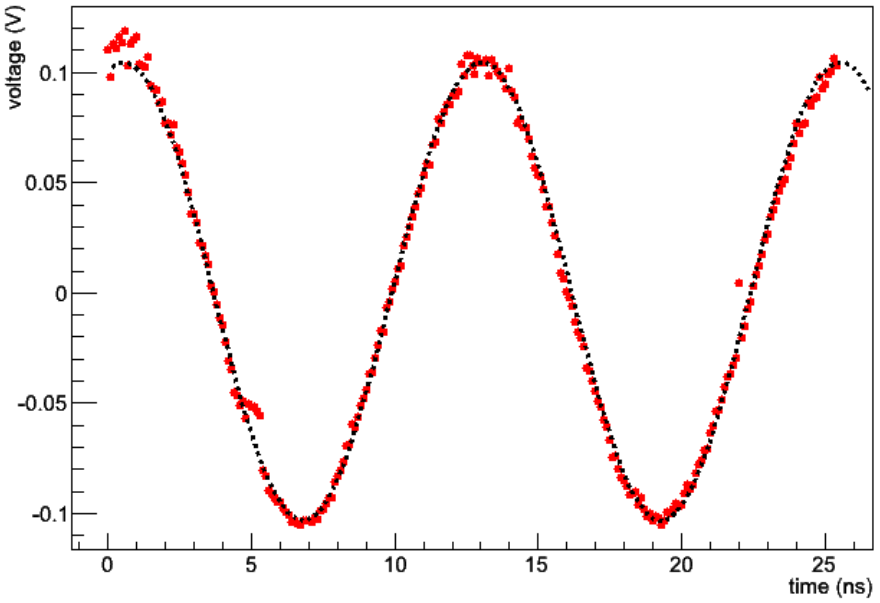
Calbration datasets

- Eric provided the following, all at 10 GSa/s:
  - 4x 1000 events 80 MHz input for channel 3
  - 4x 1000 events 80 MHz input for channel 4
  - 2x 1000 events 320 MHz input for channel 3
  - 2x 1000 events 320 MHz input for channel 3
  - Voltage lookup table
  - Pedestal table
    - (Are these calculated before or after lookup…?)

Uncalibrated Data

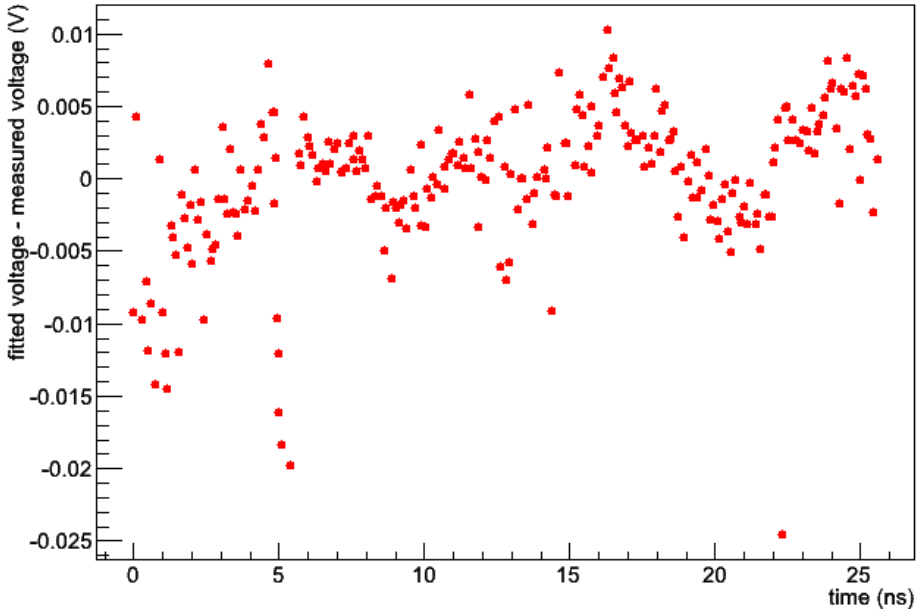
- Assuming nominal timing (100 ps per sample):



Sample 80 MHz event

Red points: data

Black line: sine fit w/ floated amplitude, phase, DC offset.



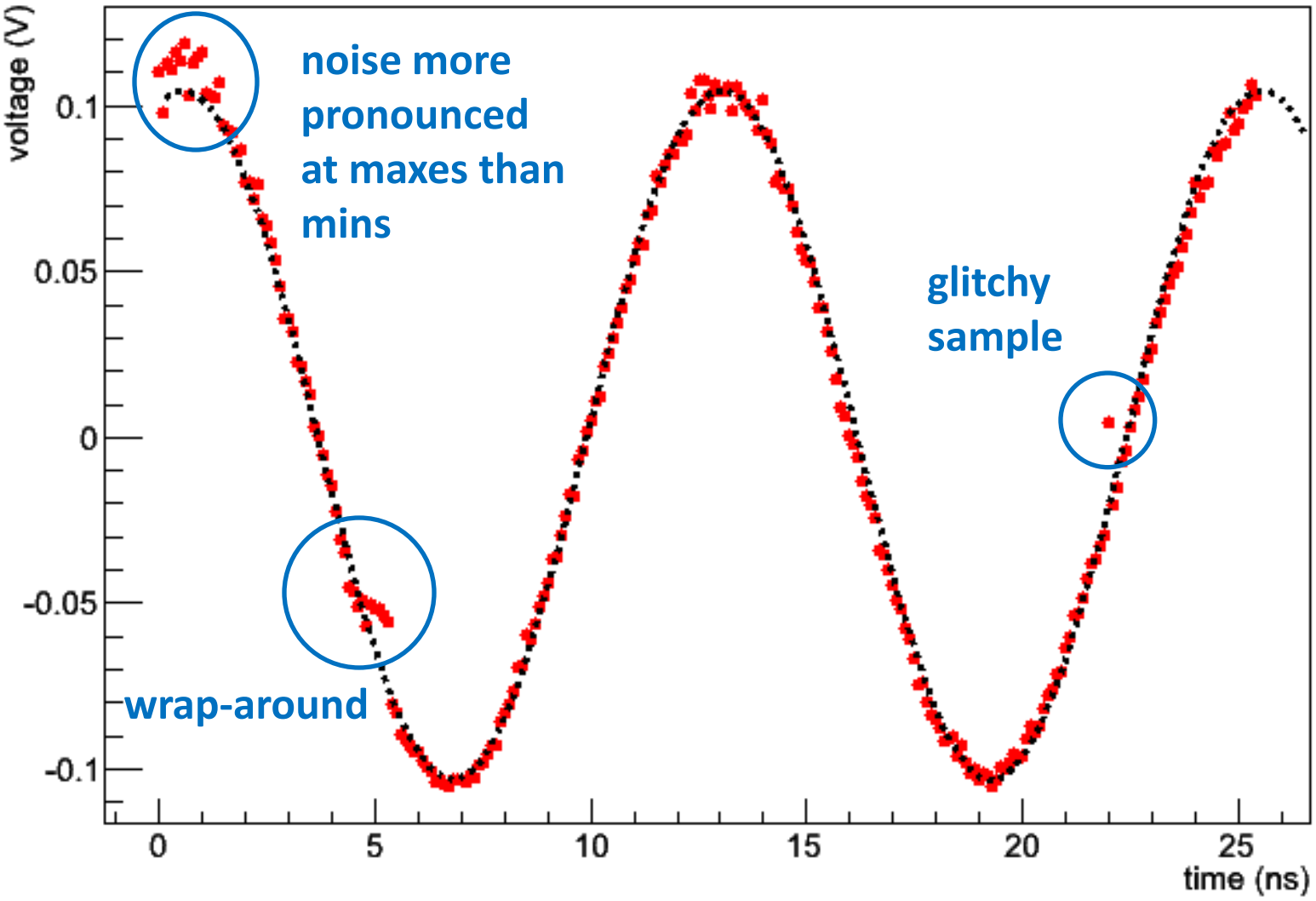
Residuals for event shown on left

Red points: best fit value – data value

➔ **Agreement is already quite good. A few features worth noting…**

Uncalibrated Data

- Assuming nominal timing (100 ps per sample):



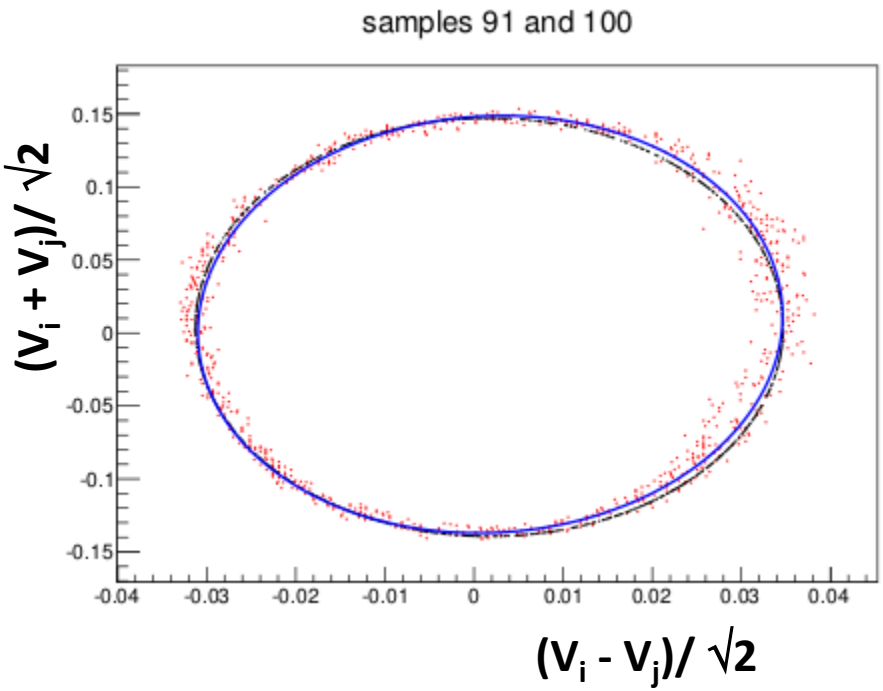
Correlation-Based Calibration

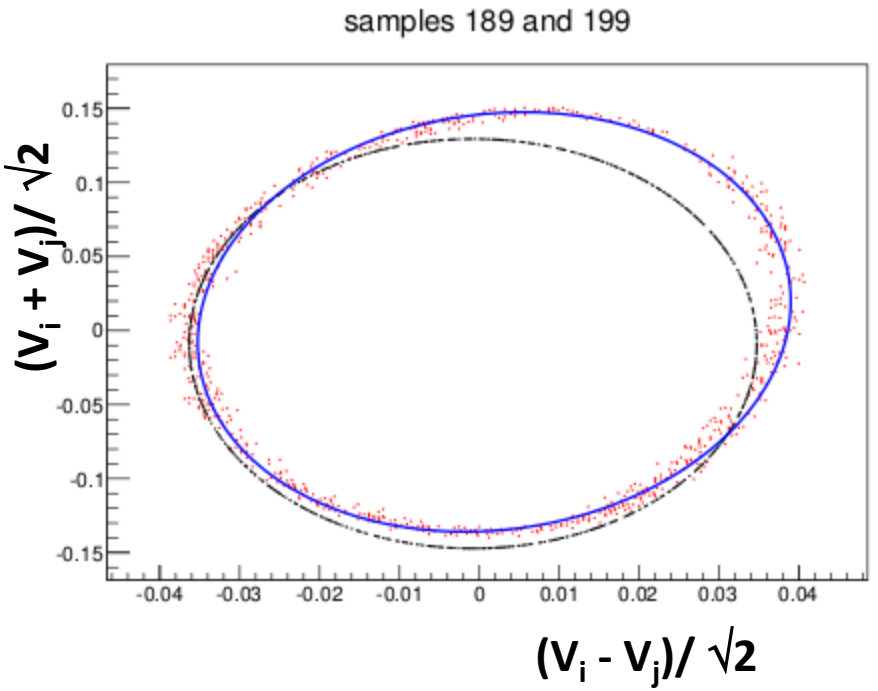
- I've tried two versions of the correlation-based calibration:
  - New version with gain variation.
  - Old version with no gain variation.

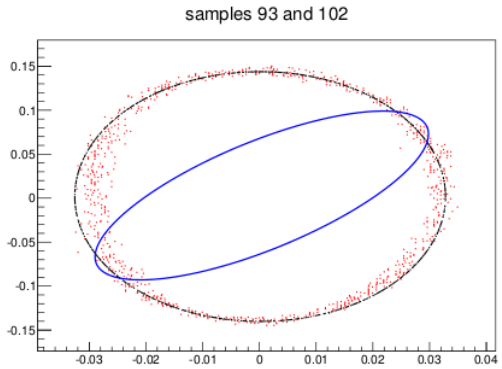
- And two other versions:
  - Zero crossings
  - Amplitude near zero crossings

Fitting w/ gain

- Sample fits, 1000 data points, 80 MHz, ch 3:



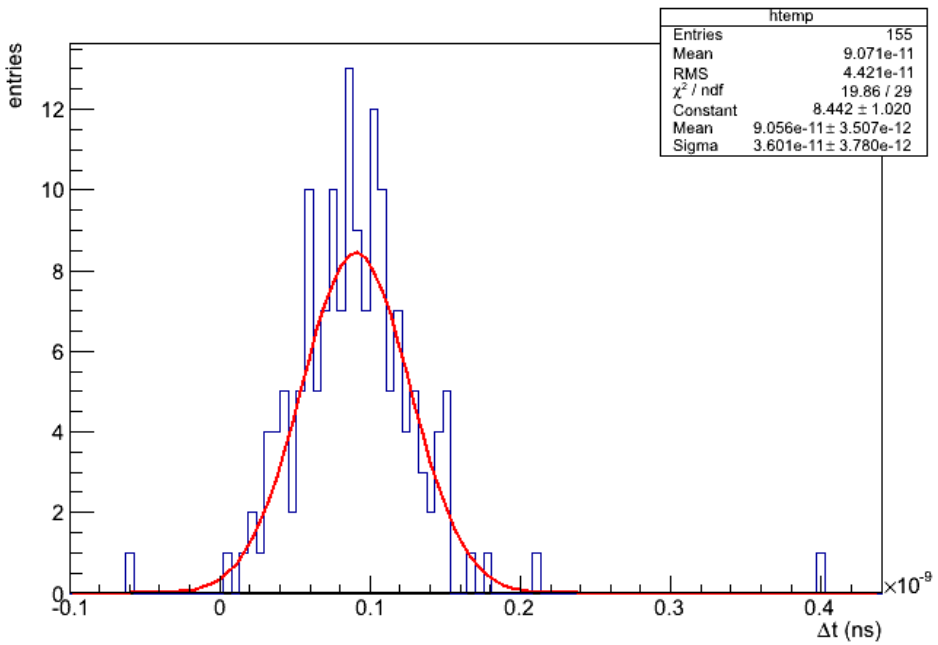


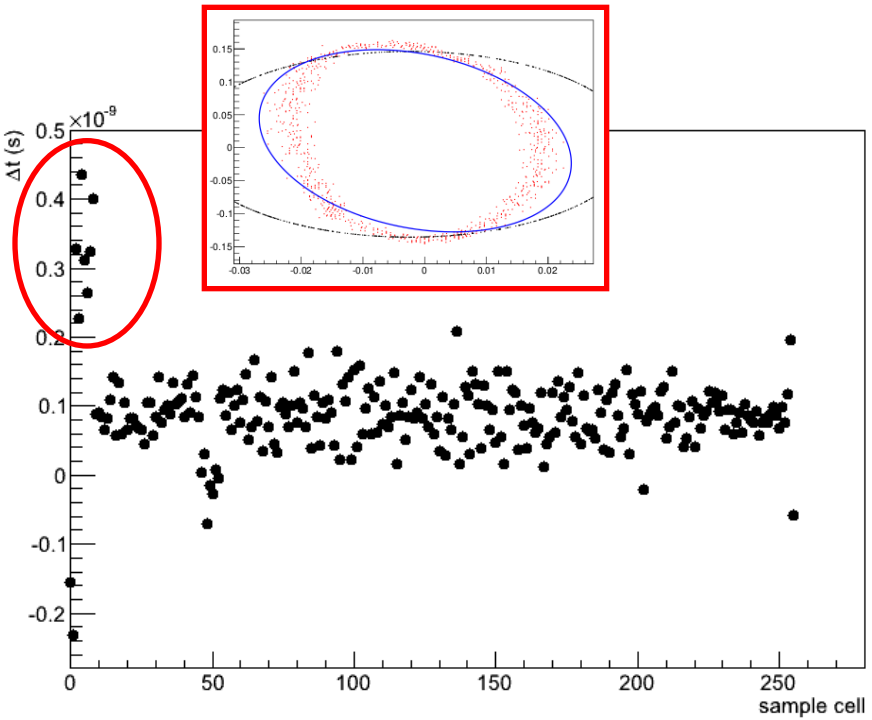


Red points – data
Blue line – fitted contour
Black line – nominal 10 GSa/s contour

➔ Some fit failures… can sometimes be recovered with different initial guesses.

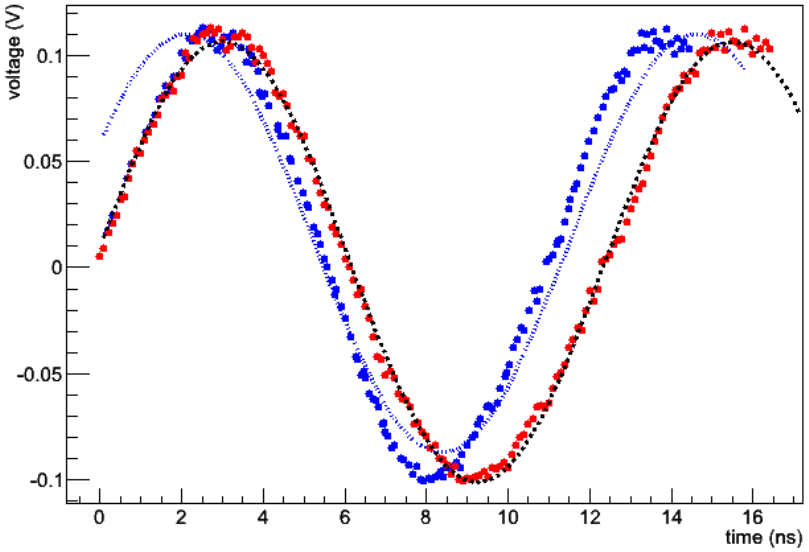
Fitter w/ gain: Δt distribution

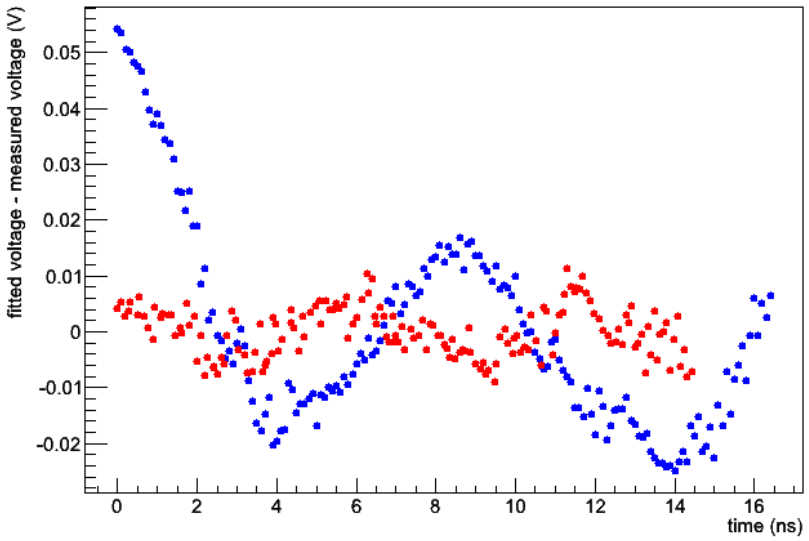




- Mean of distribution indicates a sampling rate close to 11 GSa/s.
  - But original sine-fit doesn't seem to support that.
- Data is rather poor quality passing the 255 ➔ 0 boundary.
- A few outliers, maybe due to poor fit quality
  - Visually inspected plots, reasonably good fit behavior between samples 95-245, so focused on that region….

Sine wave w/ "calibrated" Δt values





Sample 80 MHz event

Red points: "uncalibrated" data

Blue points: "calibrated" data

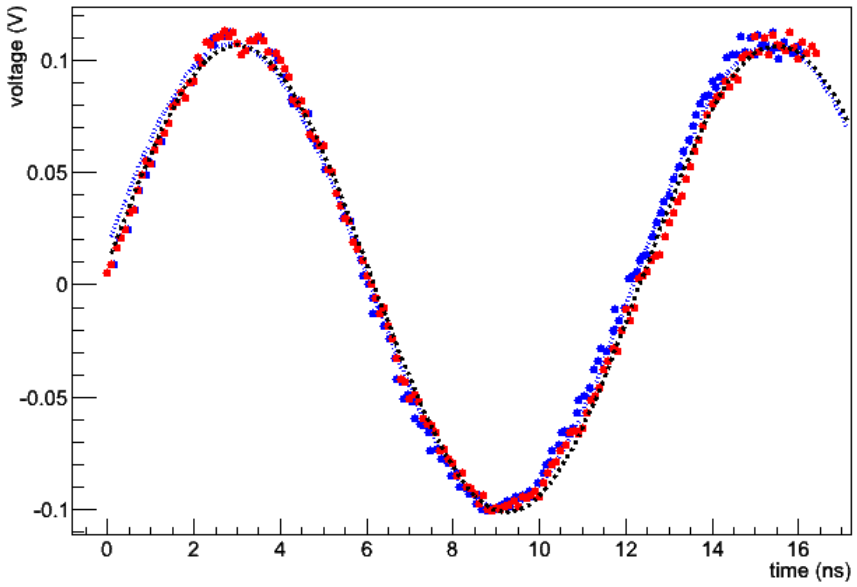
Lines: sine fit w/ floated amplitude, phase, DC offset.

Residuals for event shown on left

Something seems distinctly wrong.

Cross checks w/ old fitter

- Check against Δt obtained from old fitter (without gain).



Sample 80 MHz event

Red points: "uncalibrated" data

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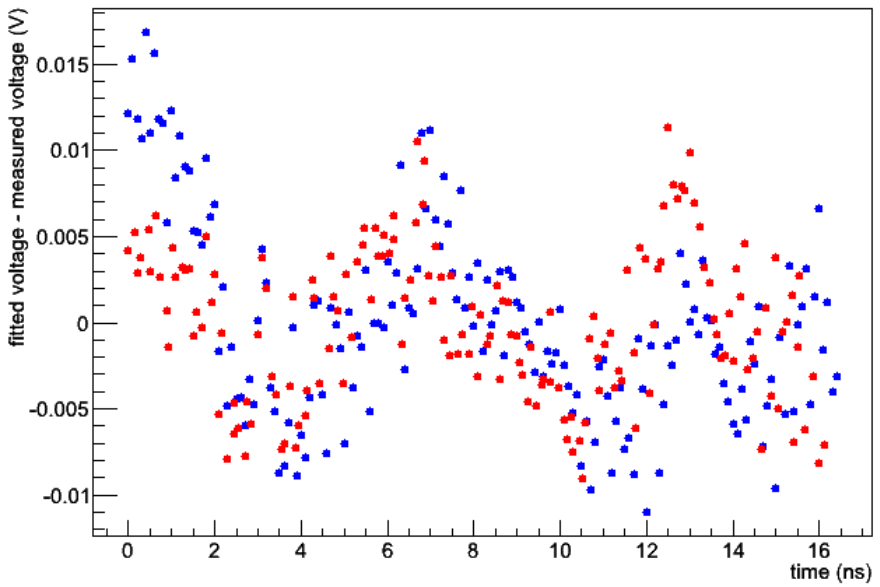
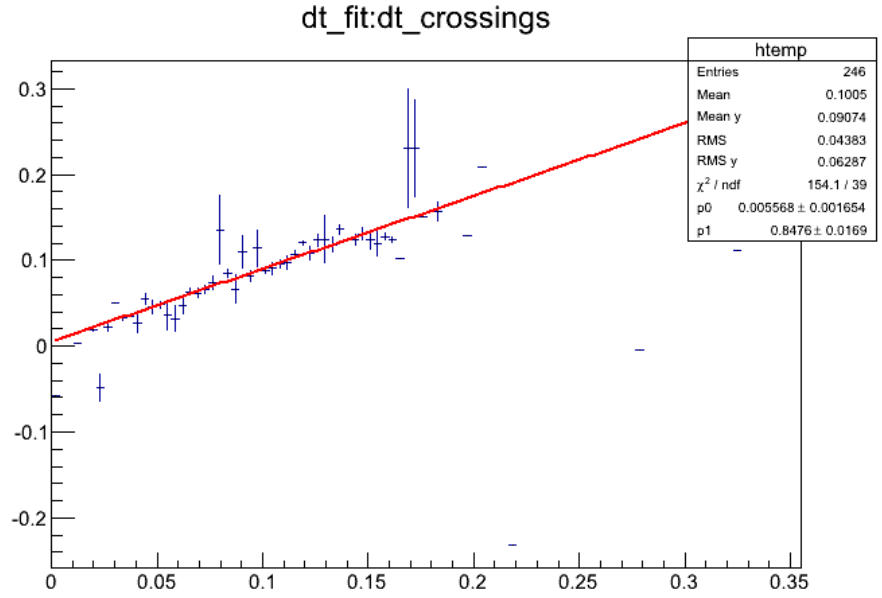
Lines: sine fit w/ floated amplitude, phase, DC offset.

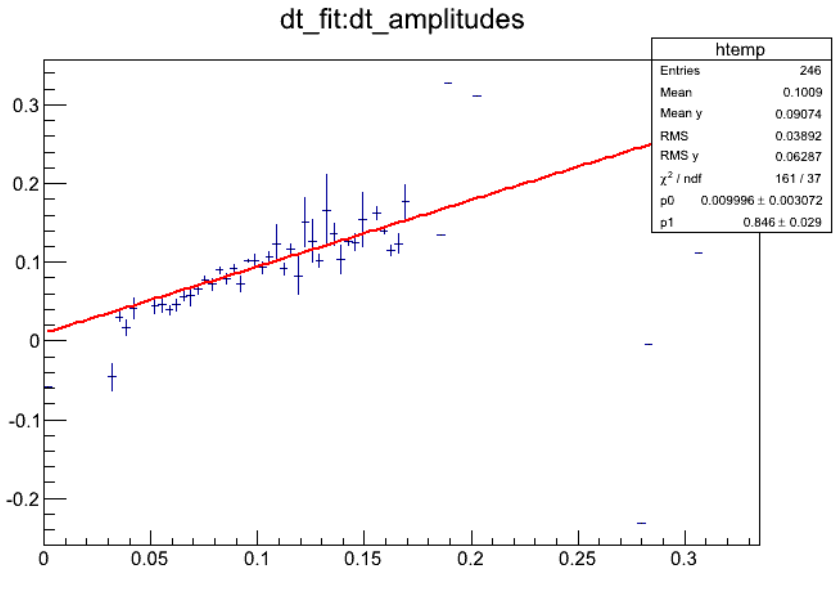


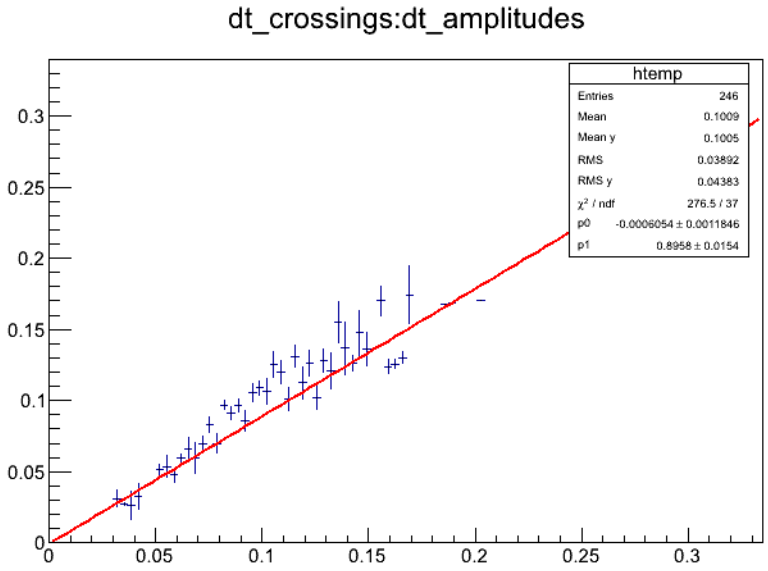
Residuals for event shown on left

Better than new version of fitter, but not obviously better than uncalibrated version.

vs. zero crossing methods







Summary

- Immediate term:
  - What would be best for the sine wave plot for PSEC-3 TIPP paper?
    - Maybe “uncalibrated” and refer that studies of timing are ongoing?
- Longer term:
  - Toy MC for new fitter version to check bias/pull.
    - I have a slight concern that the gain is actually partially degenerate with the timing…
  - More detailed cross checking against other methods.