Timing Calibration Updates

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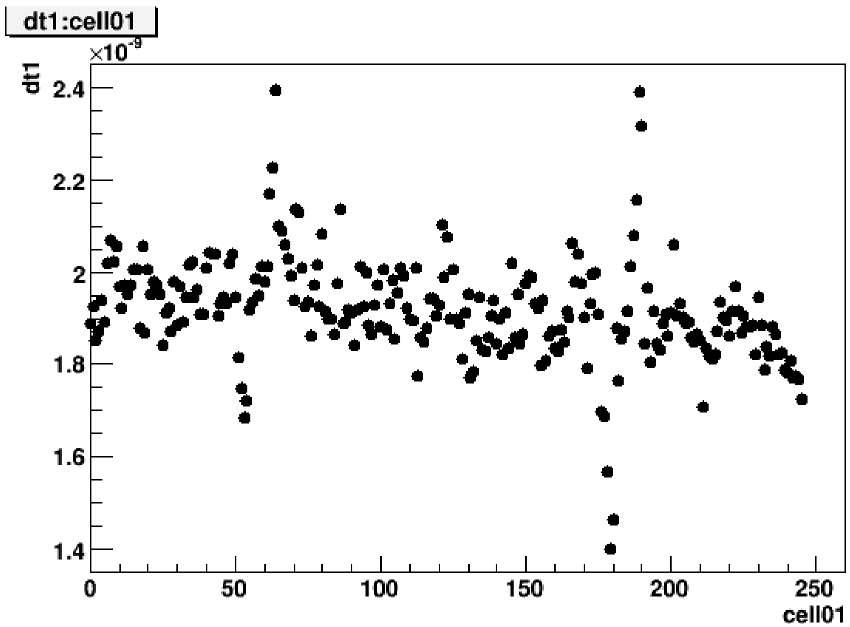
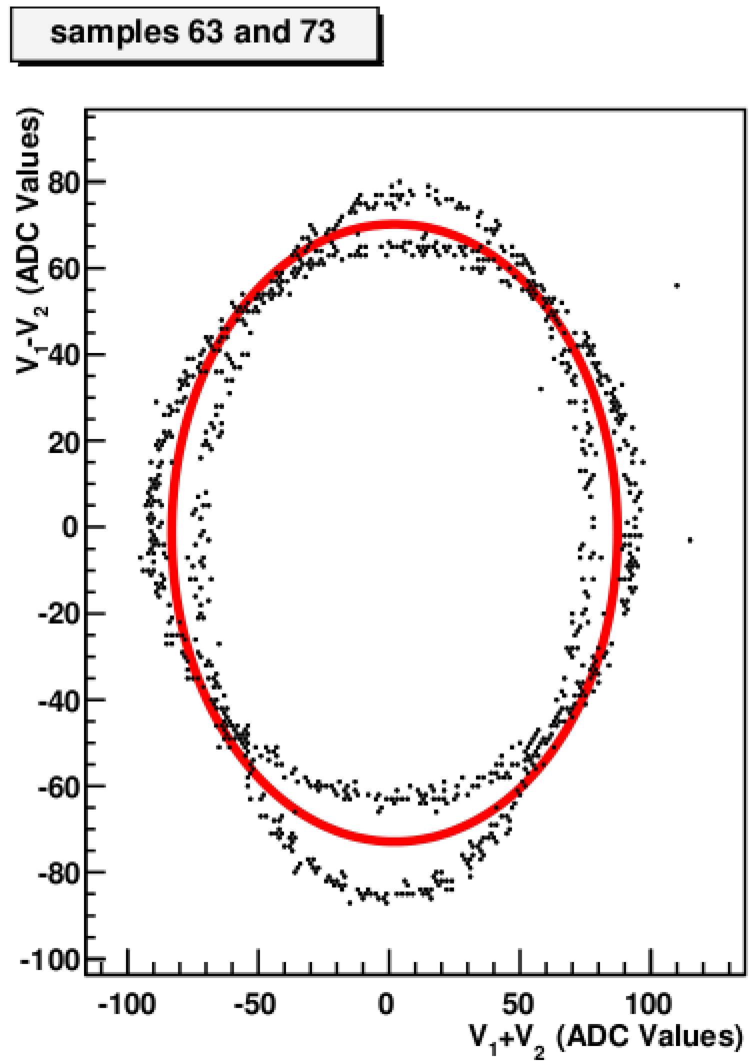
April 6, 2011

Last PSEC3 Data Anomalies





Last time, found some strange behavior in fits at cells 50-60, 170-190.

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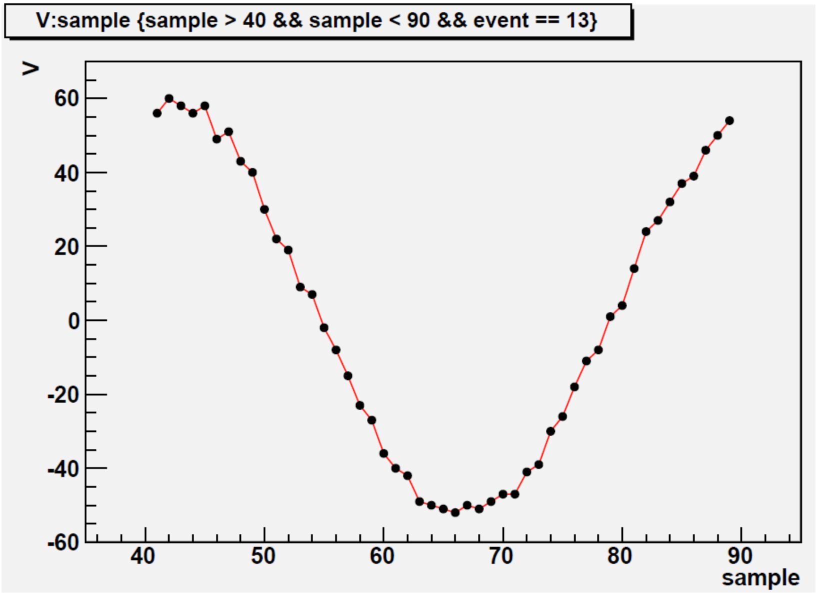
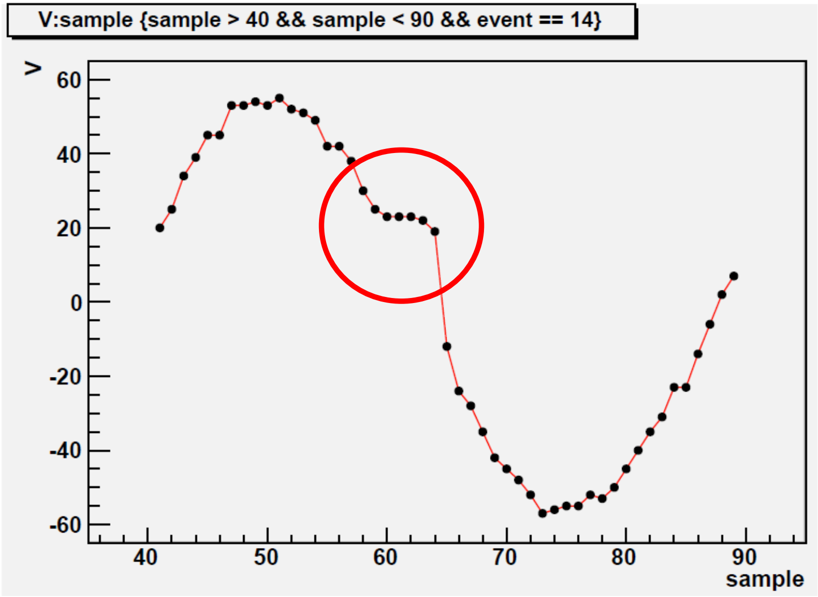


Normal waveform



Anomalous waveform

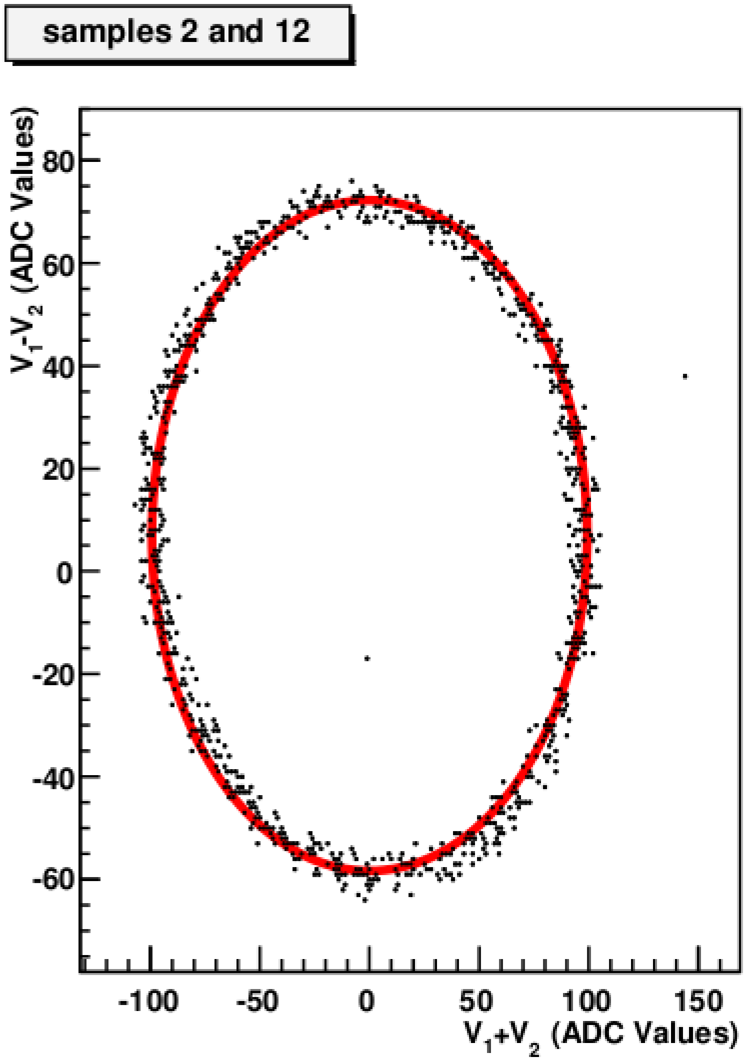
➔ Fundamental cause is still unknown, but more data under different conditions (varying input frequency, different PSEC3 channels) may help resolve it.

Timing Calibration w/ Scope data

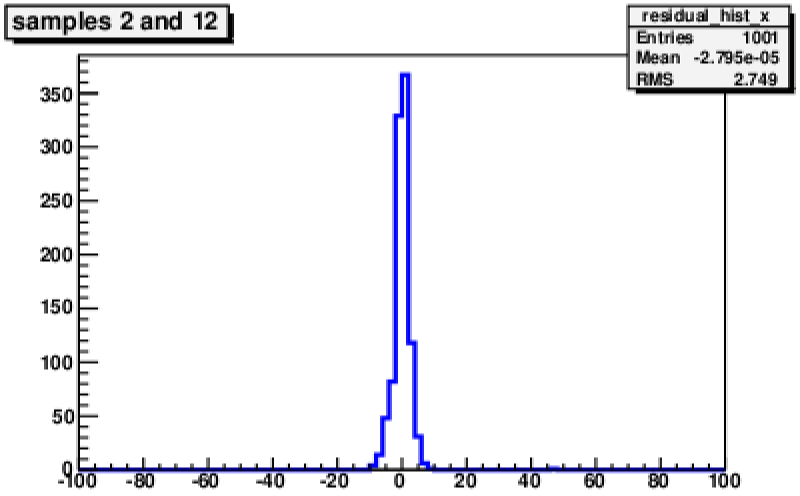
- Last set of PSEC3 data:
  - 5 GSa/s
  - CH3 (256 sample cells)
  - 1200 events (1000 usable) of:
    - 100 MHz
- Took roughly equivalent set of Tektronix data (TDS6804B):
  - 5 GSa/s
  - 500 sample cells
  - 2000 events of:
    - 100 MHz input (from an Agilent E4432B)
  - Some other sampling rates, frequencies taken, but no analyzed yet.

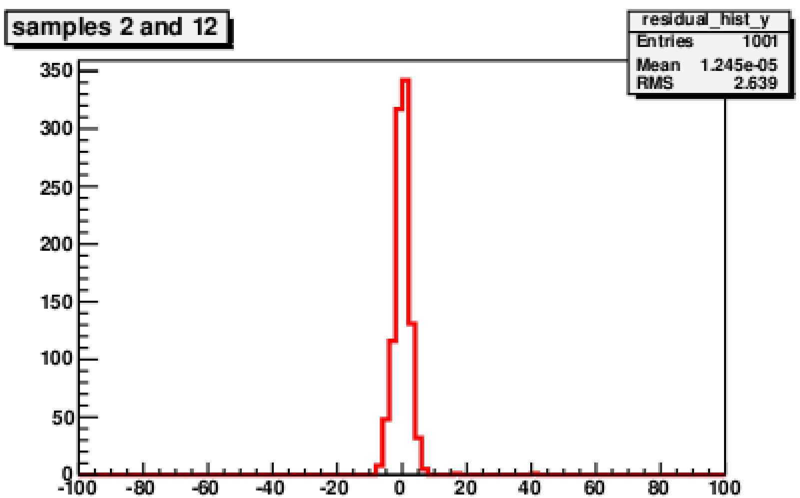
Example Fit (PSEC3)

Data and fit



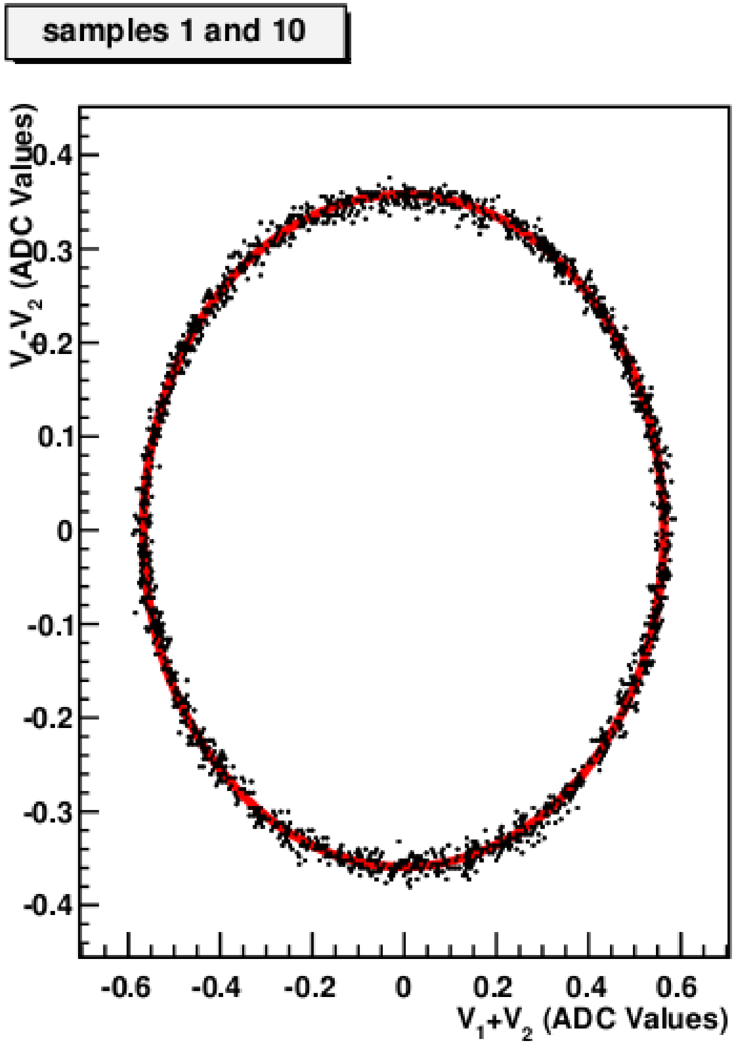
Residuals in x, y



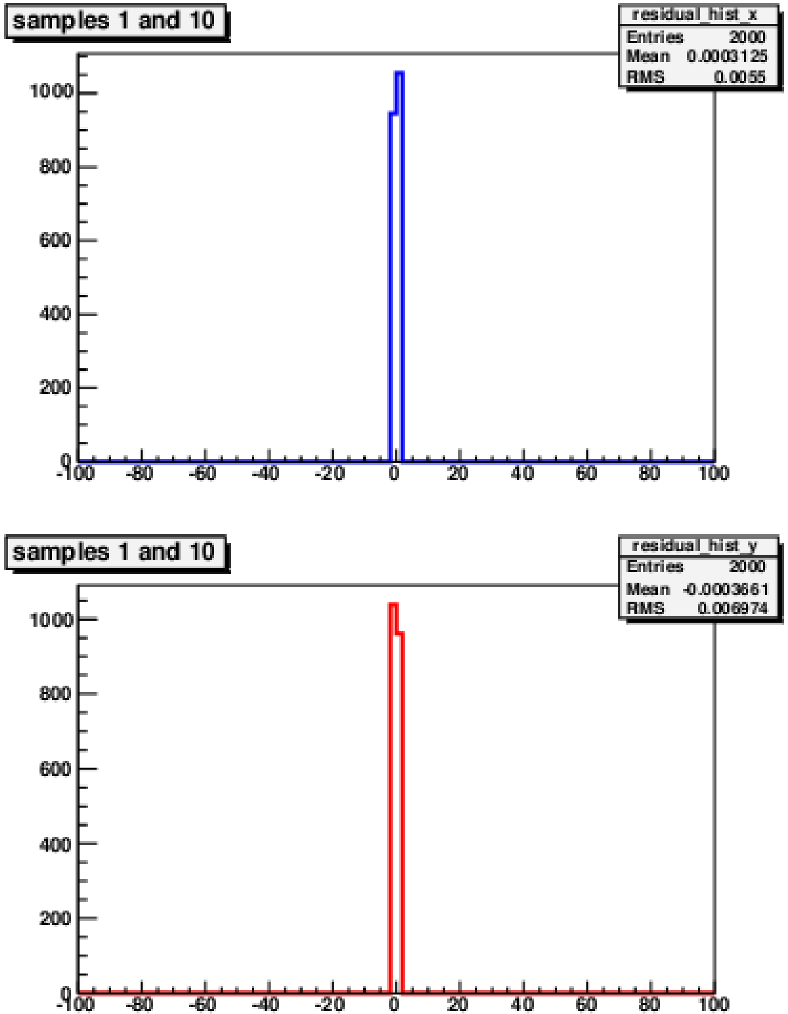


Example Fit (TDS6804B)

Data and fit



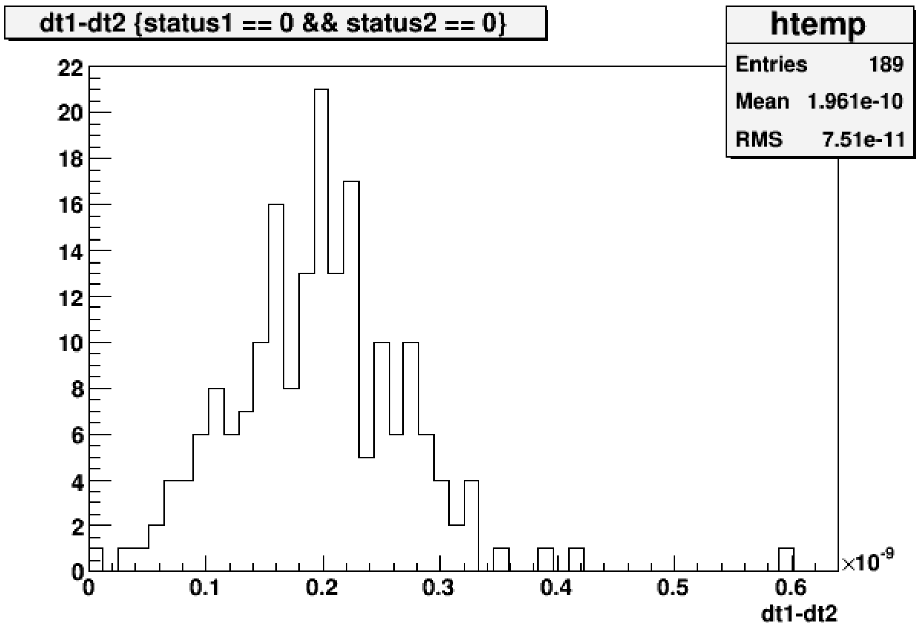
Residuals in x, y



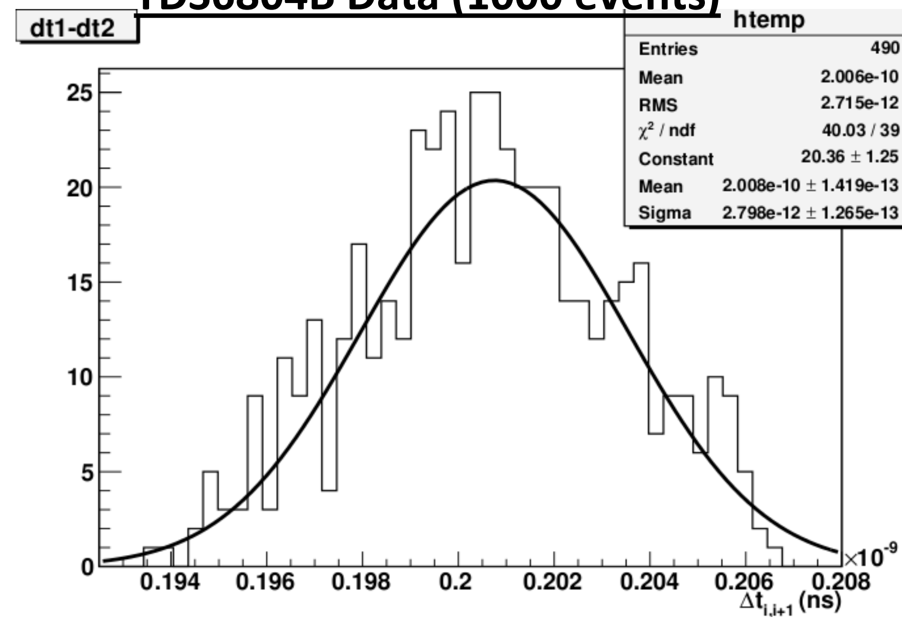
➔ Fits very well behaved. No obvious outliers, no fit failures. Very small residuals.

Derived Distributions of $\Delta t_{i,i+1}$

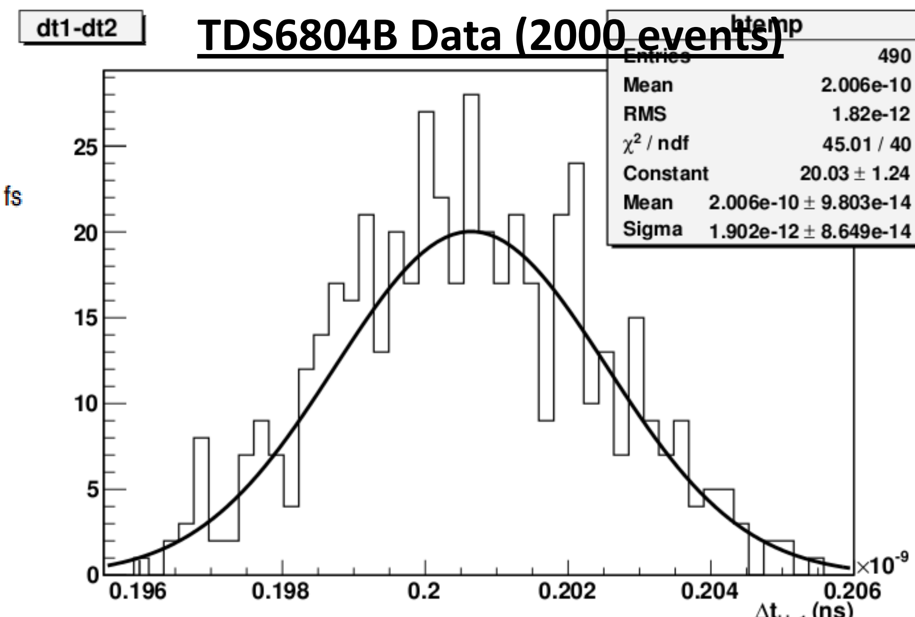
Last PSEC3 Data (1000 events)



TDS6804B Data (1000 events)



TDS6804B Data (2000 events)



TDS6804B Datasheet

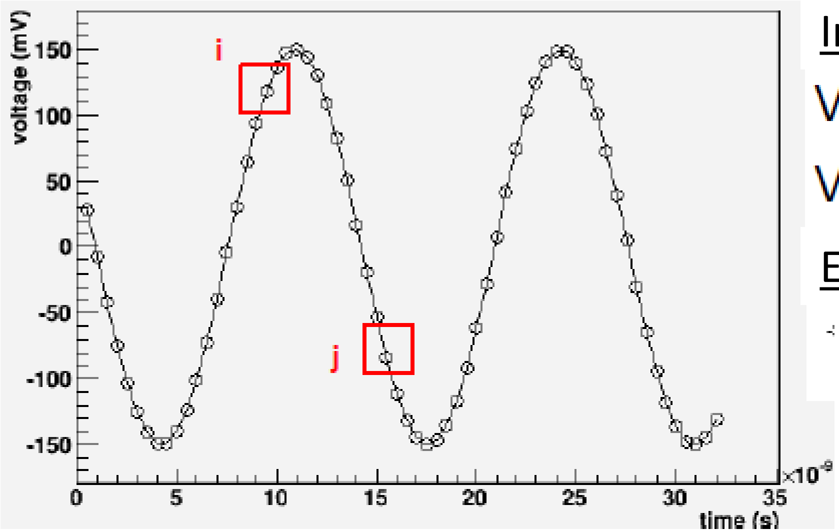
Aperture uncertainty, typical	Short term: ≤1.5 ps rms, records having duration ≤100 ms ≤800 fs rms, records having duration ≤10 µs Long term: ≤15 parts per trillion rms, records having duration ≤1 minute

➔ Still seem statistics limited on scope data. Could be a valuable resource for studying optimal sampling rate to input frequency, error distributions, etc.

BACKUP

Timing Calibration w/ Correlations

- Plot correlations between pairs of samples:
  - To determine Δt_{ij}, plot $V_i - V_j$ versus $V_i + V_j$



Input signals given by:

$V_i = A \sin(\omega t_i + \phi)$

$V_j = A \sin(\omega t_j + \phi)$

Effectively rotate by 45°:

- $x := V_i + V_j$
- $y := V_i - V_j$

➔ $$\frac{x^2}{4A^2\cos^2(\omega\delta t/2)} + \frac{y^2}{4A^2\sin^2(\omega\delta t/2)} = 1$$

i and j can be adjacent (or not), but should not be > 1 period apart.

*Method and results from Andres-Romero Wolf and myself, with data from LAB3. Planning as TIPP submission(?)

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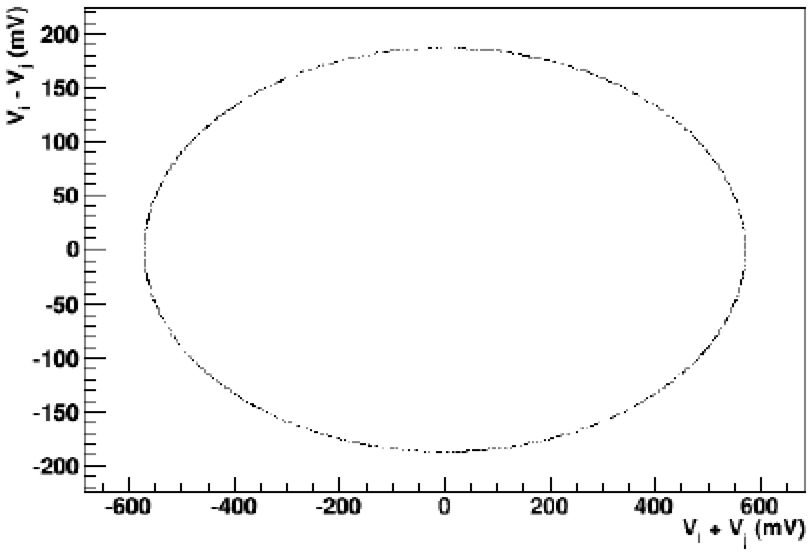

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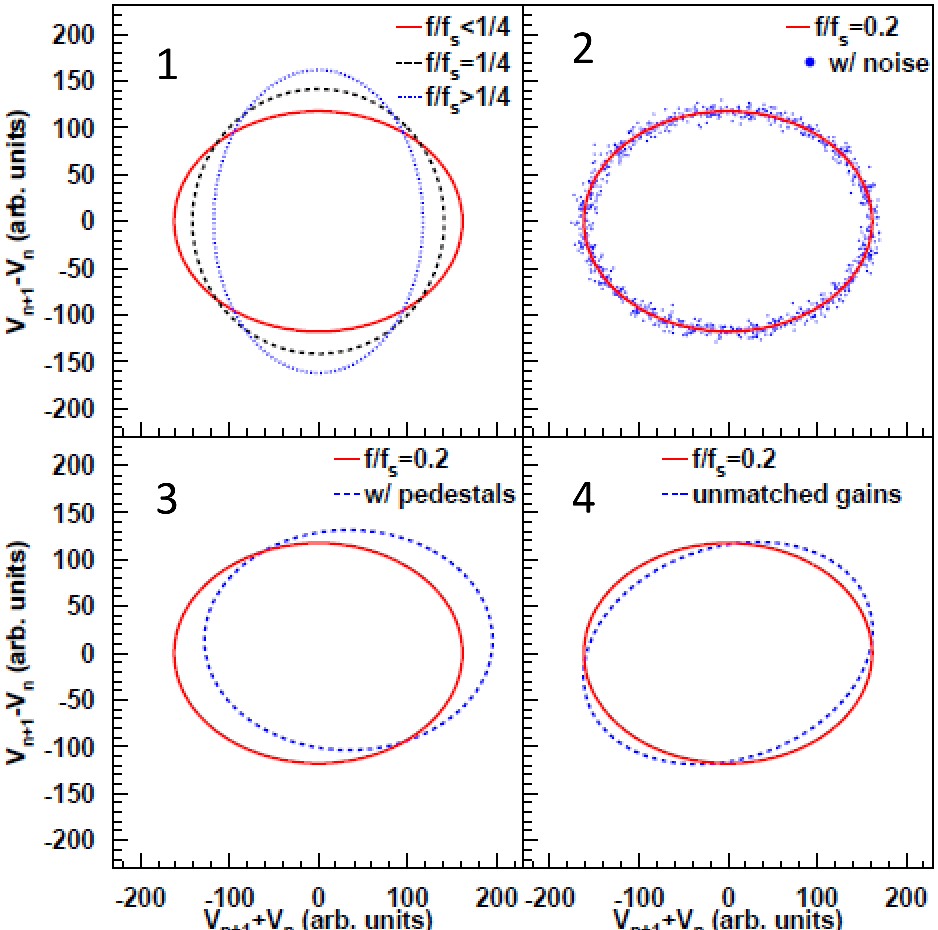
Timing Calibration w/ Correlations

- Ellipse features:



1) Different Δt (for known sampling frequency) give different major/minor radii.
2) Noise makes ellipse "fuzzy"
3) Nonzero pedestals shift origin
4) Difference in gain between two cells causes a rotation.

➔ We have written an ellipse fitter to perform this method.

➔ Even without fitting, it provides nice qualitative check on results.

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