(Preparation for) PSEC3 Timing Calibration

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March 9, 2011
Data samples

- Eric has supplied me with PSEC3 data:
  - 10 GSa/s
  - CH3 (256 sample cells)
  - 100 events each of:
    - 40 MHz
    - 120 MHz
- Have only just started...
Conversion to ROOT

- Data converted to ROOT trees with:
  - Voltage
  - Sample number
  - Event number

- Allows histogram, waveform display (40 MHz shown)
High Frequency Data

- Amplitude modulation in higher freq data?

\[ f_{\text{in}} = 40 \text{ MHz} \]

\[ f_{\text{in}} = 120 \text{ MHz} \]
Toward Timing Calibration

• Notes on preparing for ellipse-fitting:
  – Ratio of sampling rate to input frequency is large.
  • As a result, adjacent sample cells are not viable for fitting.
  • Example: voltage in cell 10 vs cell 11, 120 MHz input
Toward Timing Calibration

• Notes on preparing for ellipse-fitting:
  – Ratio of sampling rate to input frequency is large.
  • As a result, adjacent sample cells are not viable for fitting.
  • Maybe we can instead use further separated samples and combine, e.g., \((\Delta t_{10,20} \text{ and } \Delta t_{11,20})\) to get \(\Delta t_{10,11}\):

\[\text{Preparing code to do this now, as well as remove obvious outliers.}\]

\[\text{chart showing a scatter plot of } V[10]:V[20] \text{ against } V[10]:V[20] \text{ with a red square and dot indicating an outlier.}\]
Timing Calibration w/ Correlations

• Plot correlations between pairs of samples:
  – To determine $\Delta t_{ij}$, 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°:

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

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

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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Timing Calibration w/ Correlations

• Ellipse features:

1) Different $\Delta t$ (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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