Pulse Shape Analysis

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Introduction

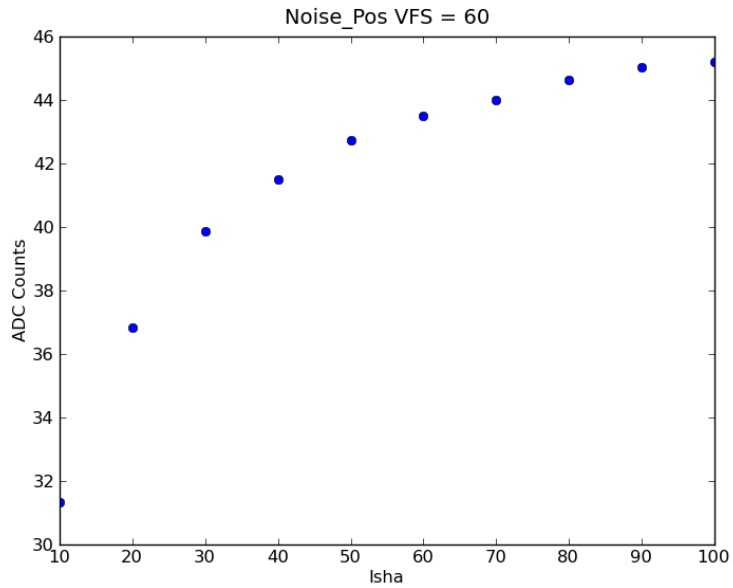
- Goal is to set APV parameters to shorten the preamp pulse
- Limited by power consumption - shorter pulse = higher power consumption
- Improve time resolution - high signal to noise ratio, steep rising edge, clean pulse shape
- Pulse shape is currently a 2 parameter fit. Explore different fits and possibly go to 3 parameters
- Develope a script to scan over parameters and timing resolution analysis. What settings give the best timing resolution?
- Repeat analysis while running cold (test temperature dependence of power consumption)

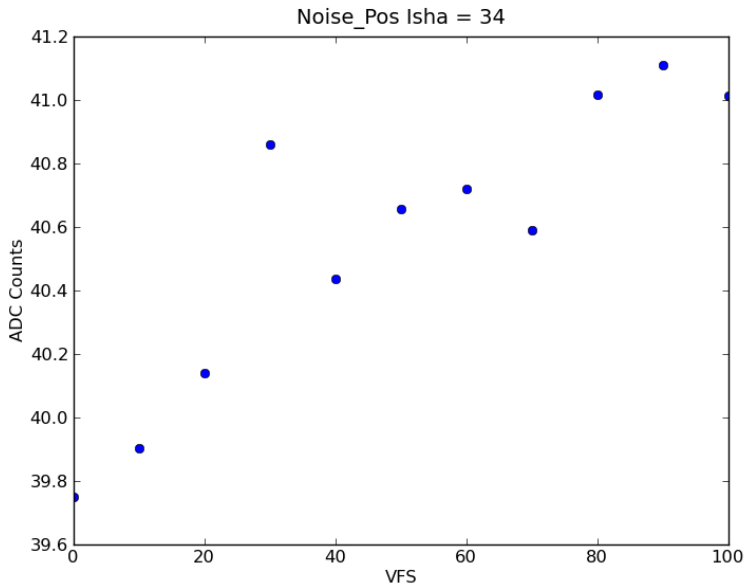
Accomplishments

- Successfully wrote script to run over variables Isha and VFS
- Initially ran over both parameters from $Isha \in [10, 100]$ and $VFS \in [0, 100]$ in increments of 10
  - Too much to deal with, already the default pulse shape was insufficient for some values of Isha and VFS
  - All channels had roughly the same behavior.
- Scanned over Isha for the nominal value of VFS (60) and scanned over VFS for nominal value of Isha (34)
  - Ran for Calibration Group 0 and all delays
  - Plotted noise, signal amplitude, signal to noise ratio, fit parameters, and χ^2 of the fits for a single channel (0)

Noise

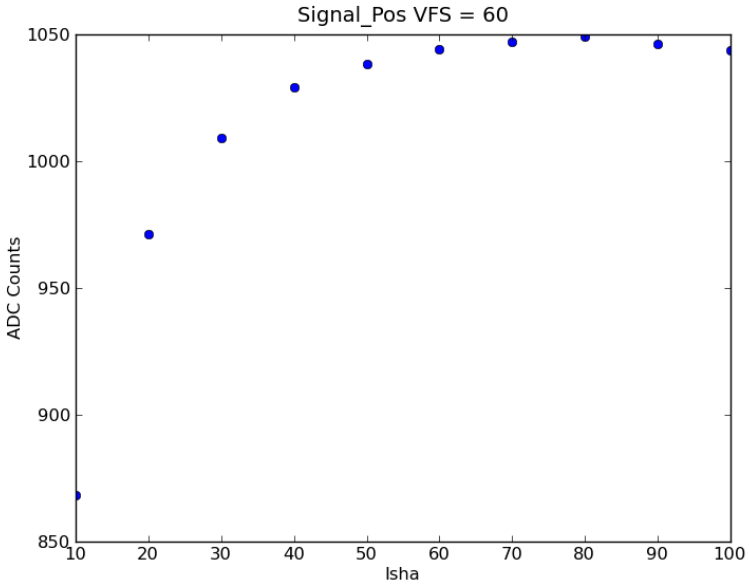
- Noise dependence on Isha (left) and VFS (right)
- Clear noise dependence on Isha. Less noise dependence on VFS.

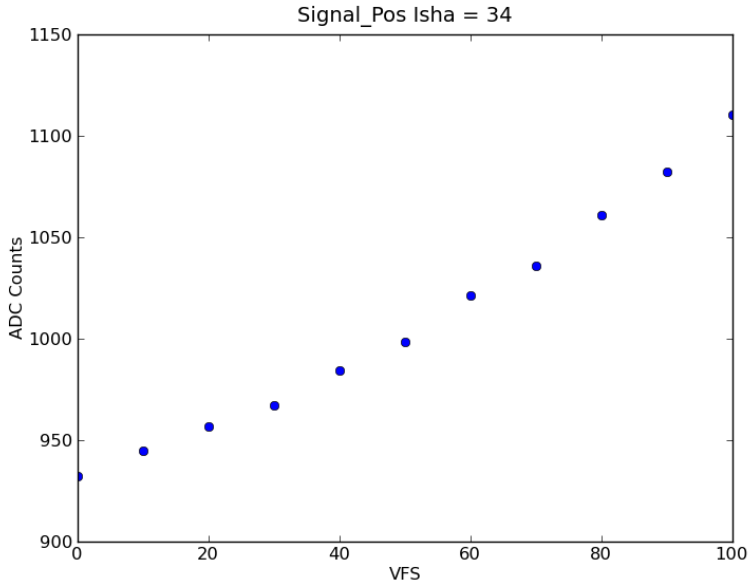




Signal Amplitude

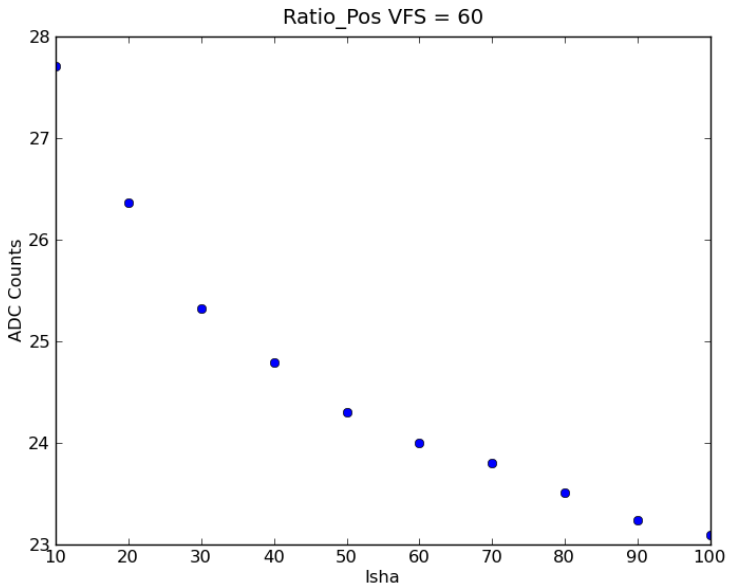
- Amplitude dependence on Isha (left) and VFS (right)

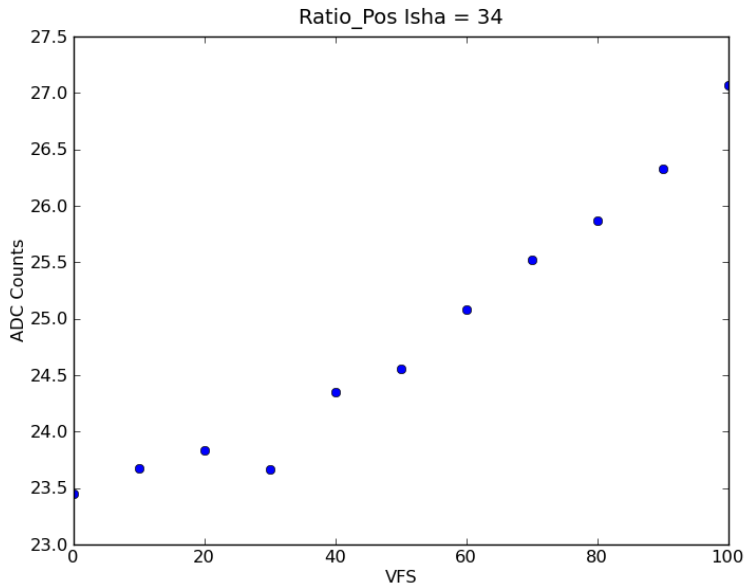




Ratio Amplitude to Noise

- Ratio ($\frac{Amplitude}{Noise}$) dependence on Isha (left) and VFS (right)





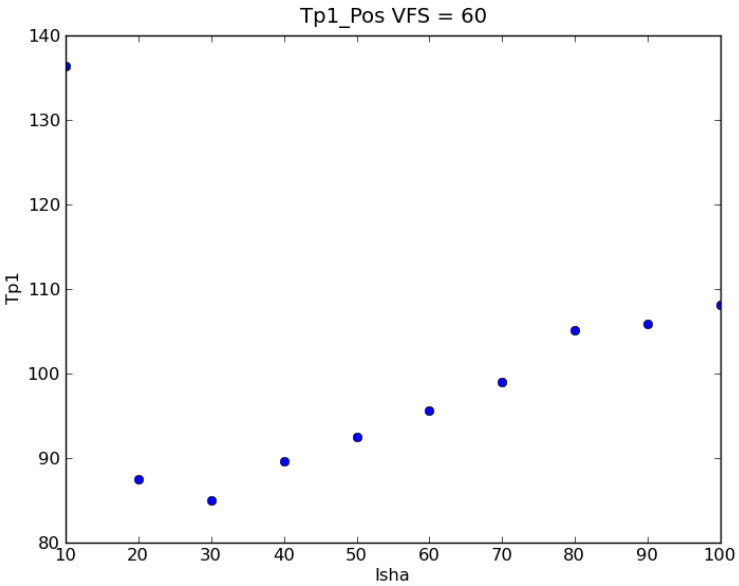
Fit Function

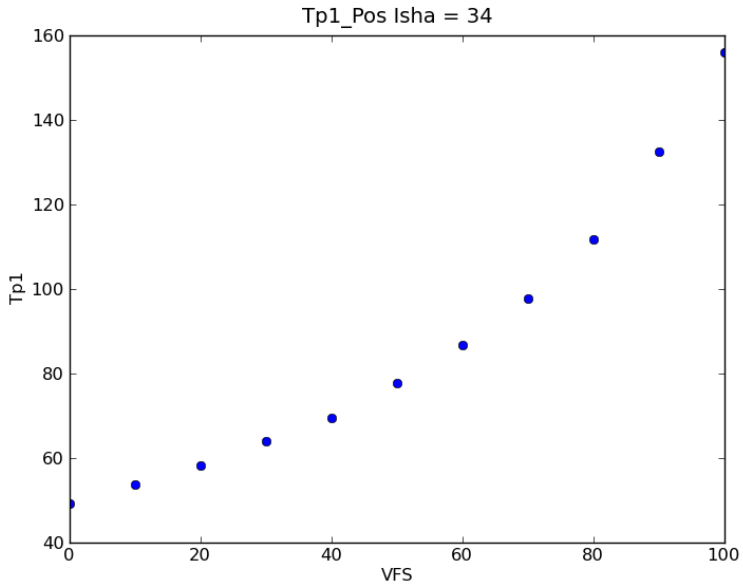
$$f(t) = \frac{\tau_1^3}{(\tau_1 - \tau_2)^3} \left(e^{-\frac{t}{\tau_1}} - \sum_{k=0}^{3} \left(\frac{\tau_1 - \tau_2}{\tau_1 \tau_2} t \right)^k \frac{e^{-\frac{t}{\tau_2}}}{k!} \right) \quad (1)$$

- Pulse shape function is a quadruple RC filter with 3 RC the same (τ_2) and one RC different (τ_1)
- τ_1 controls the fall time while τ_2 controls the rise time
- May need 3 parameter fits in the future

Tp1 (τ_1) Fit Parameter

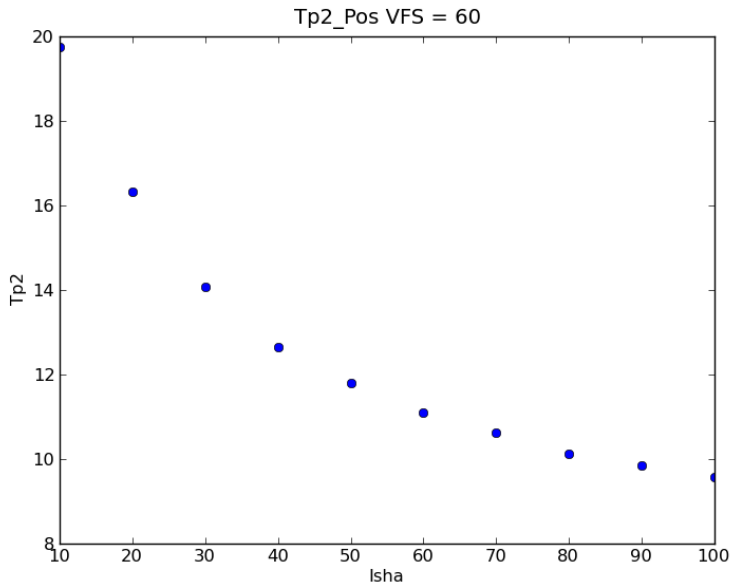
- Tp1 dependence on Isha (left) and VFS (right)
- Tp1 depends much more on VFS than Isha

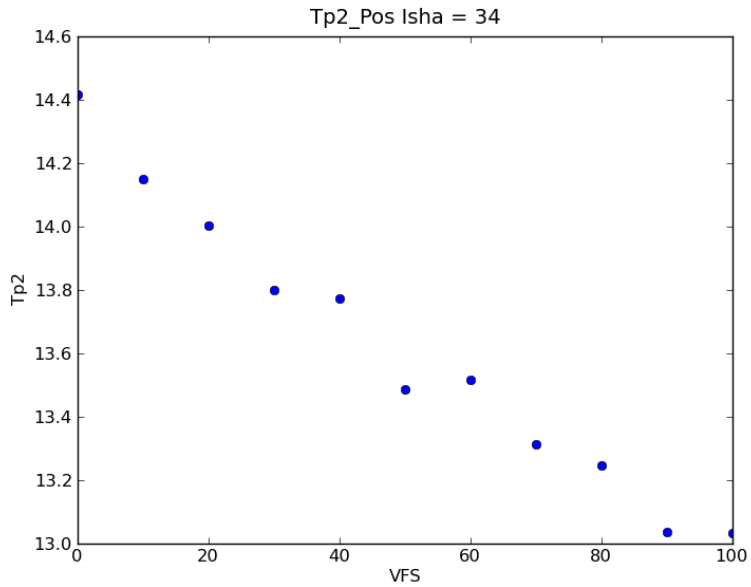




Tp2 (τ_2) Fit Parameter

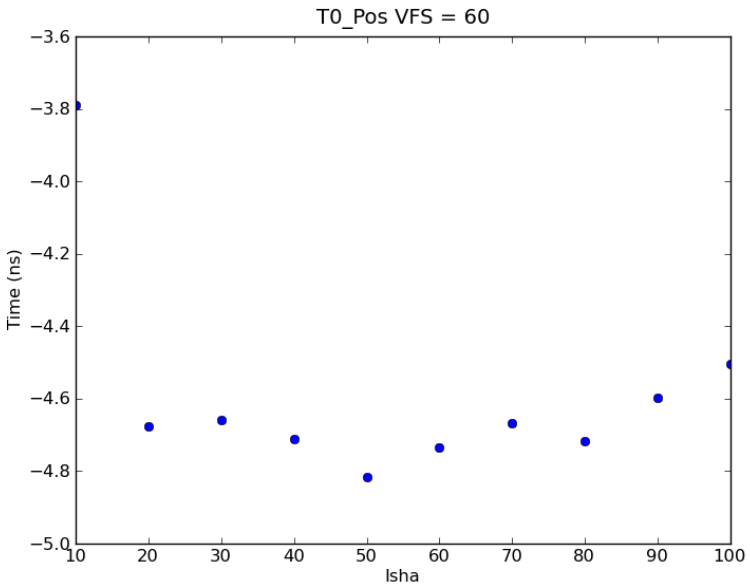
- Tp2 dependence on Isha (left) and VFS (right)
- Tp2 depends much more on Isha than VFS

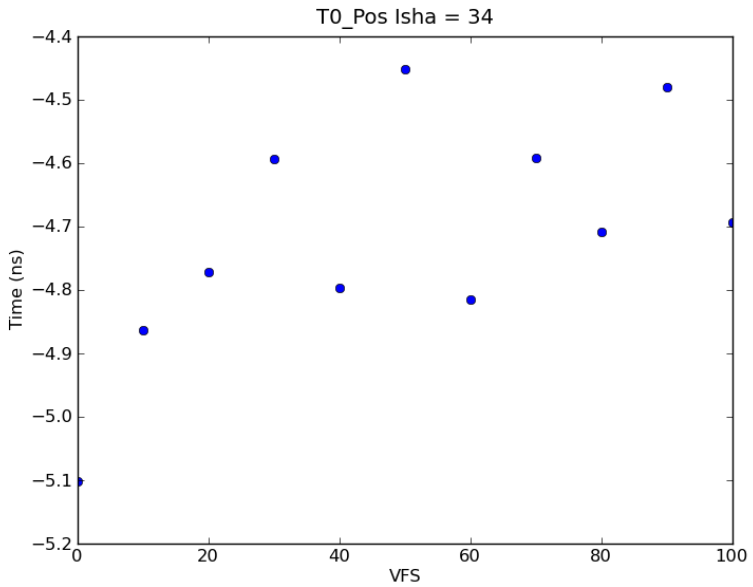




Tp2 Fit Parameter

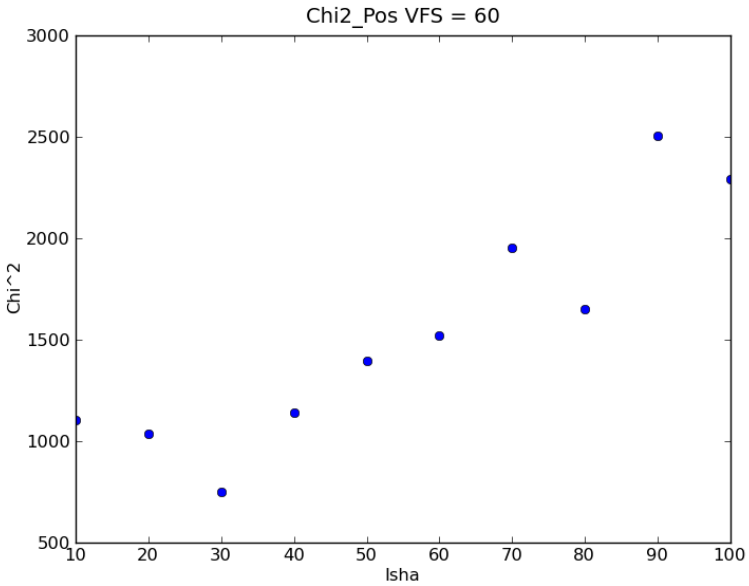
- T0 dependence on Isha (left) and VFS (right). T0 is pulse time relative to an arbitrary time.
- T0 seems roughly indenpendent of both Isha than VFS. We may only care about the error of T0

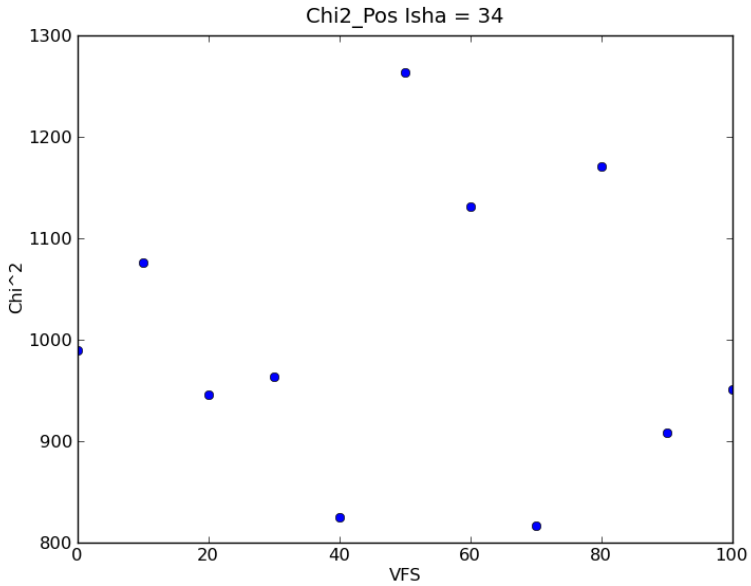




χ^2 of Fit

- χ^2 dependence on Isha (left) and VFS (right)
- χ^2 depends more on Isha than VFS





Conclusions

- Successful parameter scans and preliminary plots
- In the future...
  - Compare to Omar's previous plots
  - Need to add error bars and more plots need to be made
  - Look at pulse shapes and individual pulses
  - Begin time resolution analysis