APV25 Shape Time Tuning

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February 2, 2016

Introduction

- Goal is to set APV parameters to shorten the preamp pulse, improve timing reslution, and reduce pileup
- Pulse shape is currently a 2 parameter fit.
- Analyzed pulse shapes for various fit parameters for shortest pulse width
- Ran over both parameters from $Isha \in [0, 255]$ and $VFS \in [0, 300]$ on the Devboard at room temp
  - Ran for Calibration Group 0 and all delays for a single channel 32
- Ran for 6 runs on the real SVT at -20C

Shaping Parameters

- Isha: $n \times 1\mu A \quad \in [0, 255]$
- VFS: $-1.25V - (7.5mV) \times n \quad \in [0, 255]$

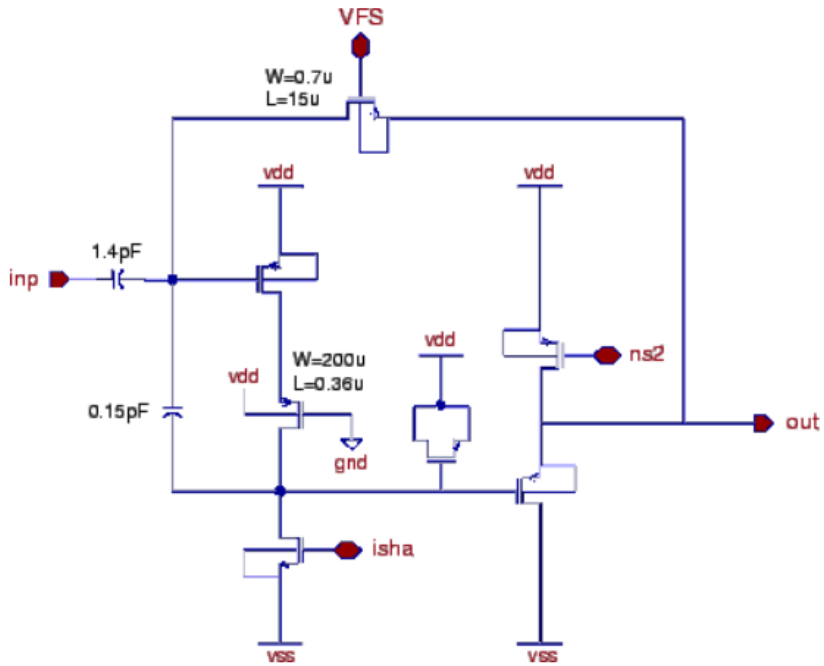


Figure: Schematics of the APV25 shaper.

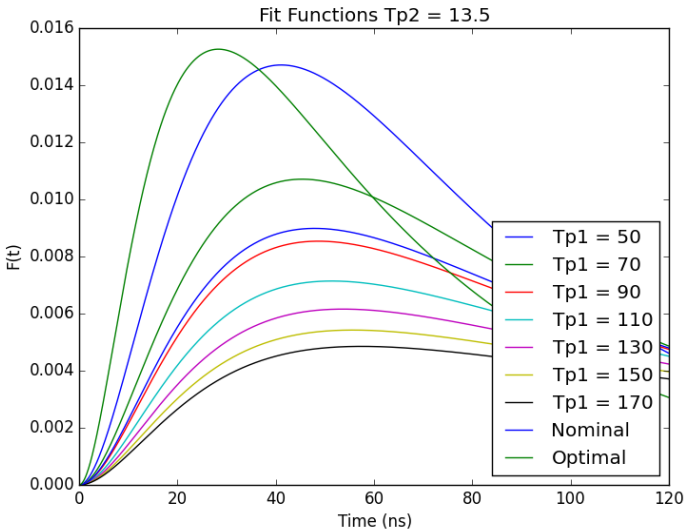
Fit Function

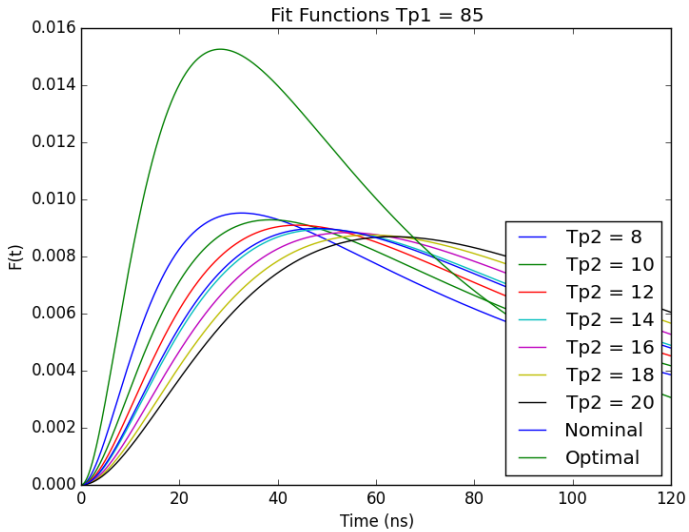
$$f(t) = \frac{\tau_1^2}{(\tau_1 - \tau_2)^3} \left(e^{-\frac{t}{\tau_1}} - \sum_{k=0}^{2} \left(\frac{\tau_1 - \tau_2}{\tau_1 \tau_2} t \right)^k \frac{e^{-\frac{t}{\tau_2}}}{k!} \right) \quad (1)$$

- 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

Previous Results

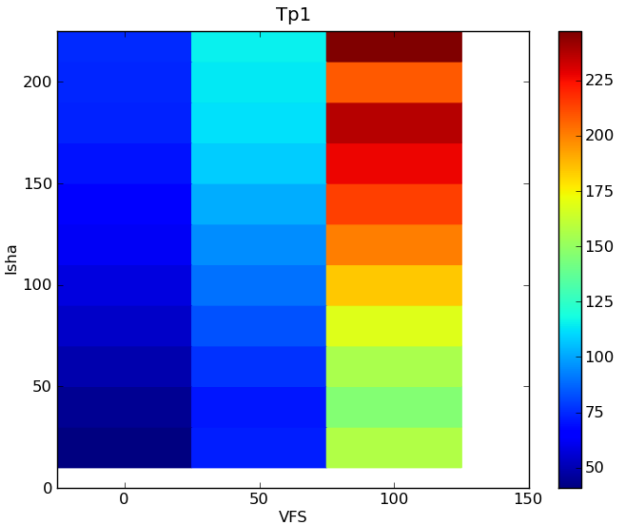
- Tp1 depends more on VFS (fall time) and Tp2 depends more on Isha (rise time)
- Smaller values of Tp1 and Tp2 produce shorter pulses
- Smaller VFS and larger Isha produce smaller Tp1 and smaller Tp2, respectively

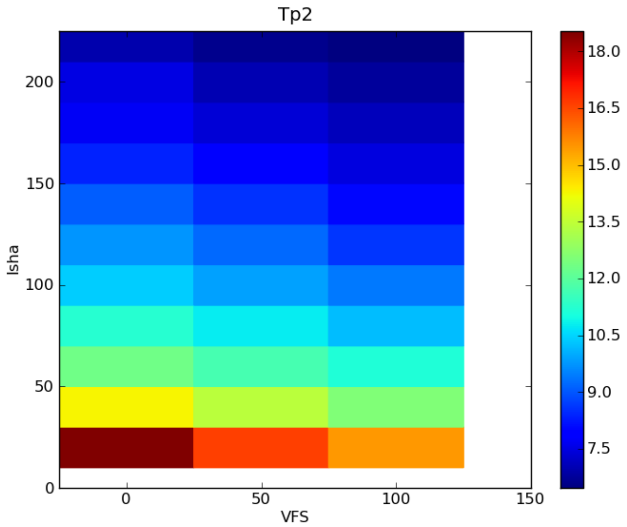




New Results: Wider Range of Isha/VFS (Dev)

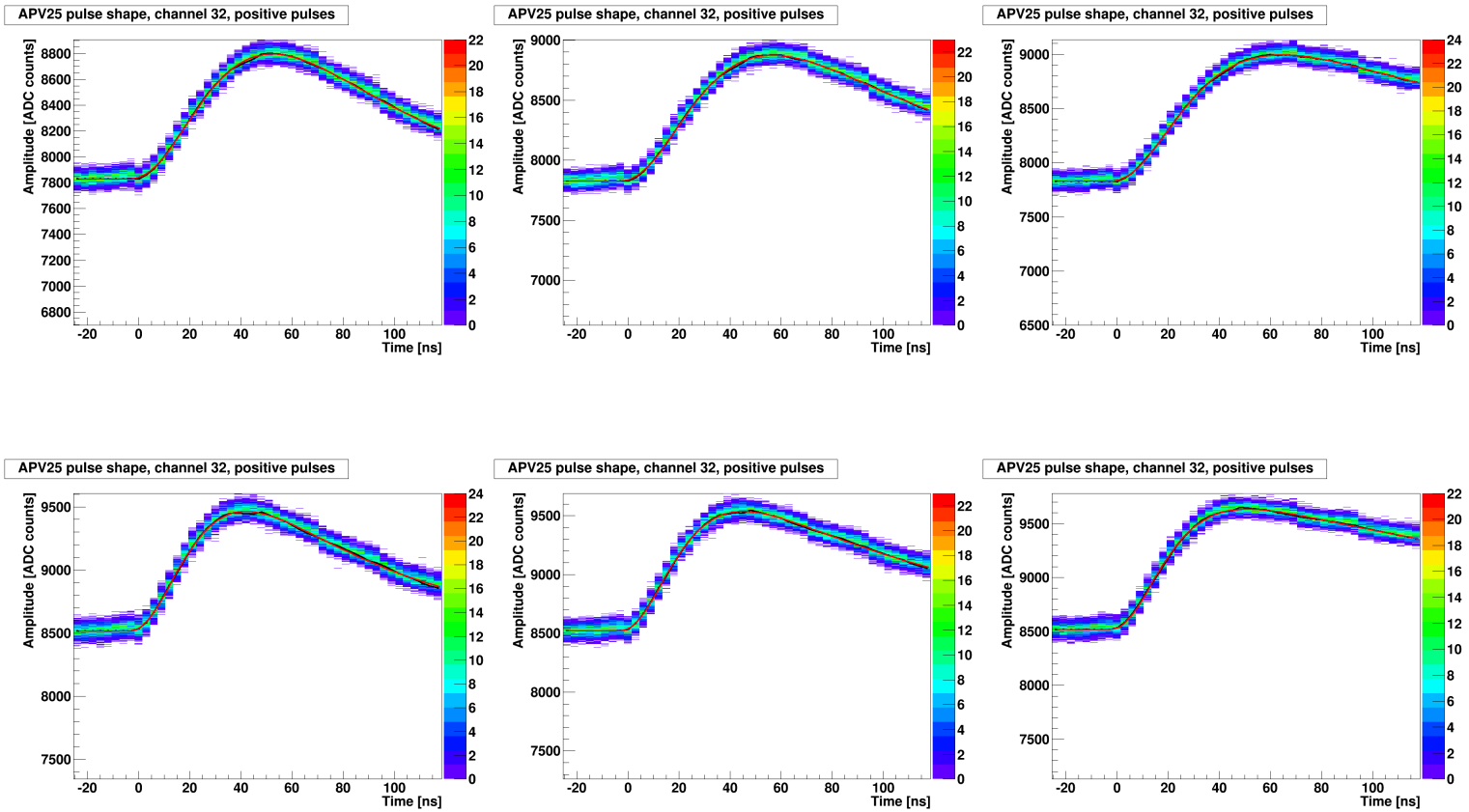
- VFS $>$ 100 makes a poor fit, yet has an extremely long tail. This analysis is ignored
- Tp1 and Tp2 depend on VFS and Isha as expected from previous results





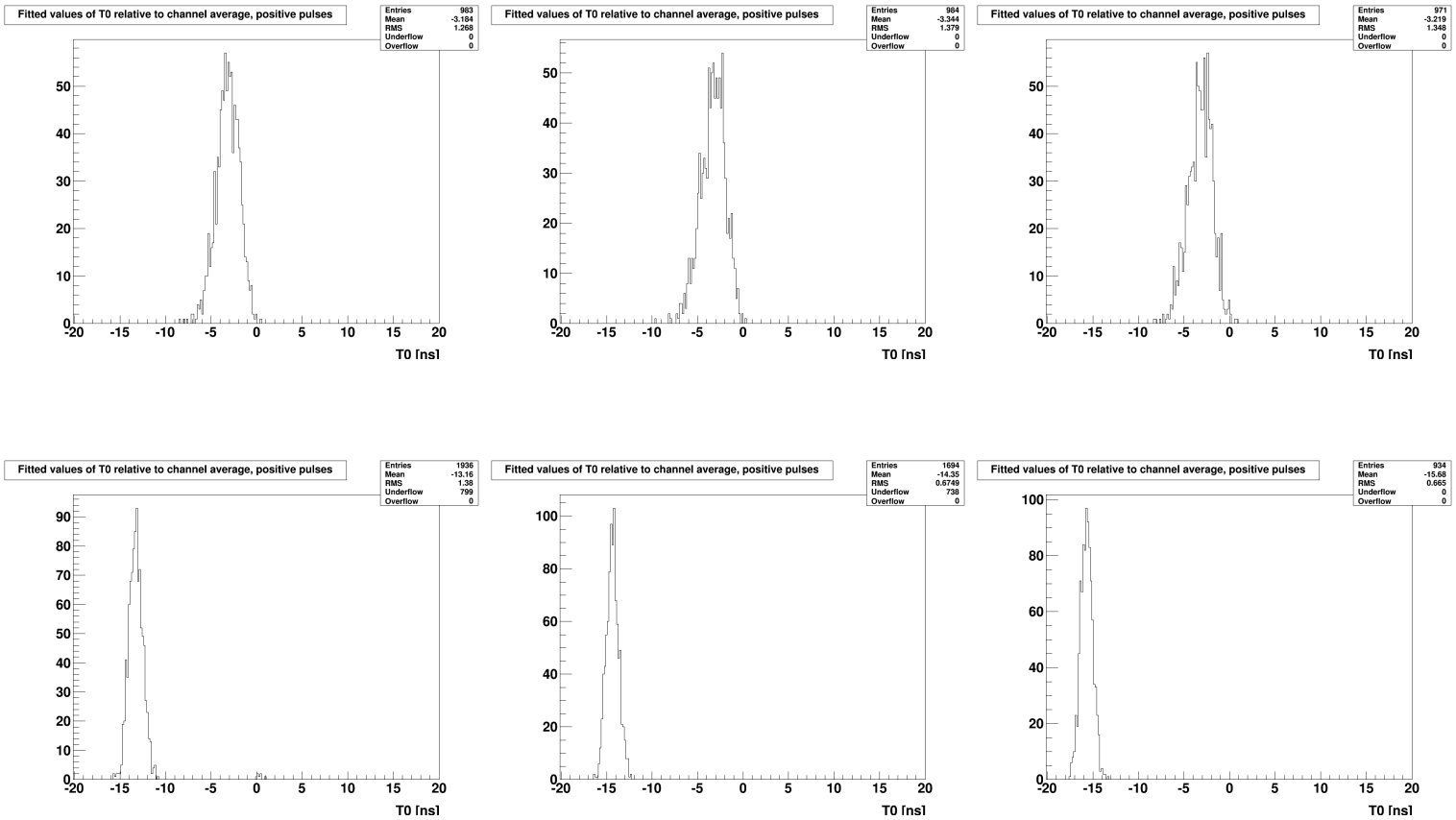
Sample Pulse Fits (Dev)

- Fitted individual pulses (6 samples) and threw T0's into a histogram



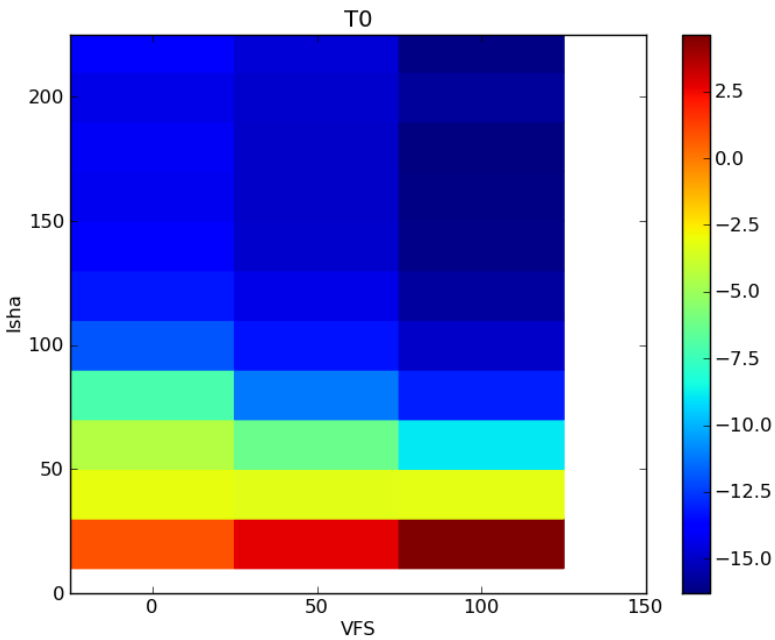
Sample T0 Histogram Fits (Dev)

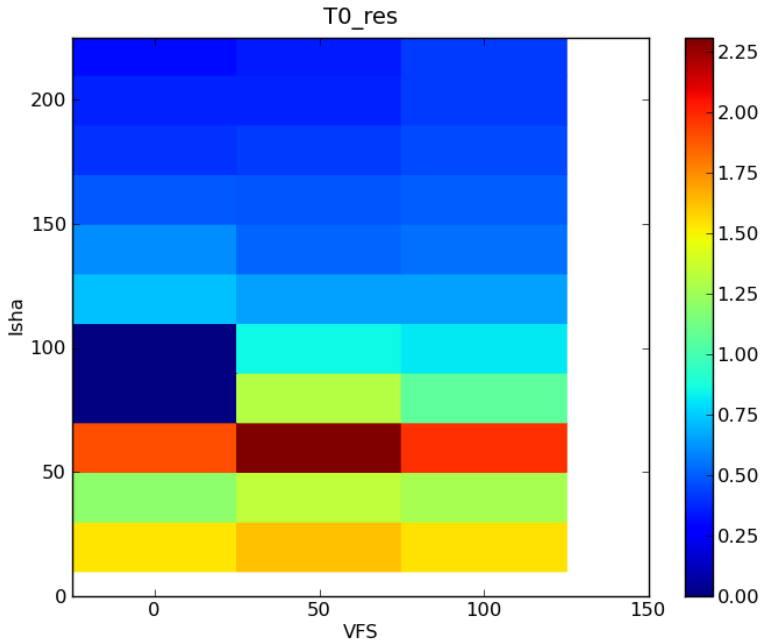
- Fitted these histograms and extracted average T0 and T0 resolution



T0 and T0 Resolution Plots (Dev)

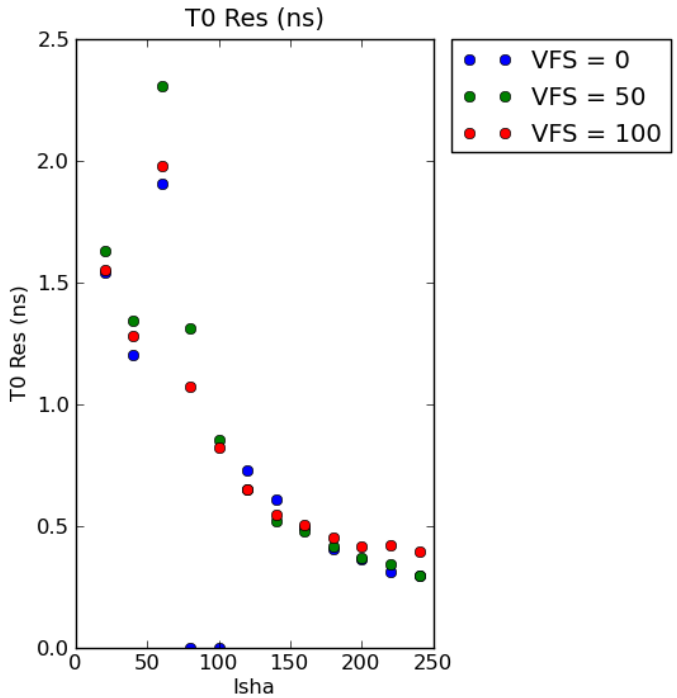
- High Isha and Low VFS is optimal for better T0 resolution
- Sidenote: χ^2, signal, noise, and ratio plots look fine but are not shown





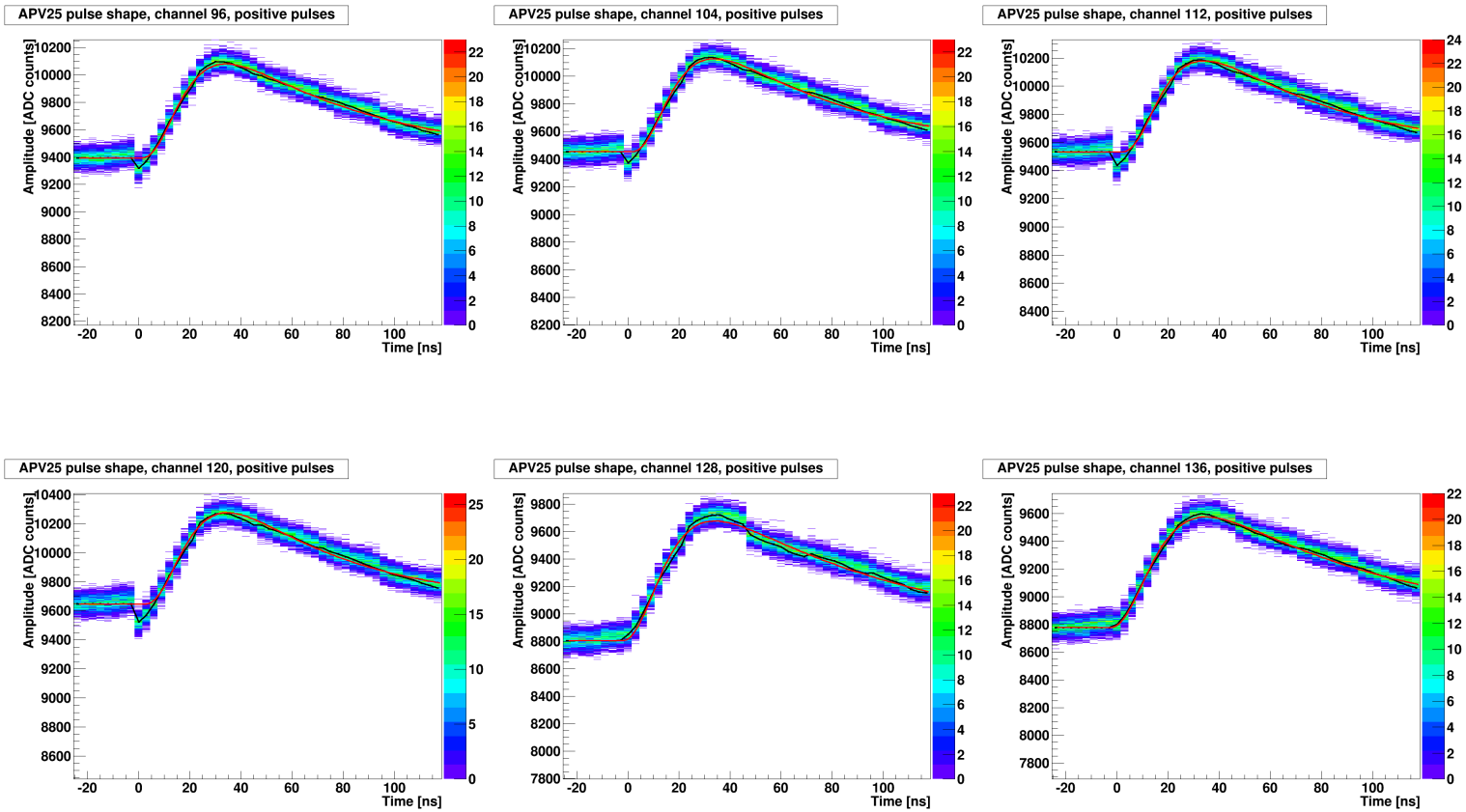
T0 and T0 Resolution Plots (Dev)

- Same plot as previous slide in 1D



Pulse Shape Issues (Dev)

- For higher Isha and near the edges of the sensor, there is a dip in the 2nd pedestal

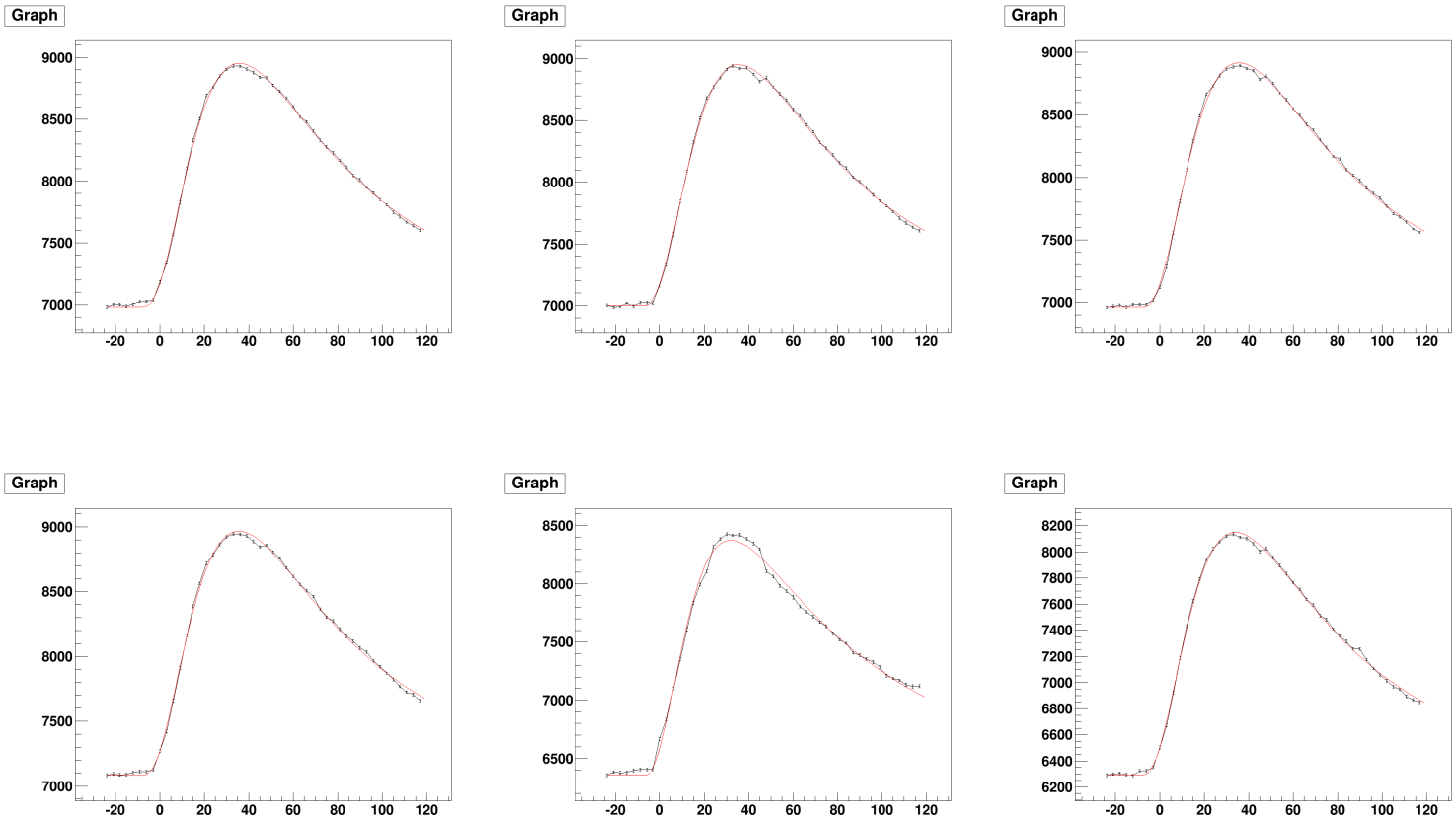


Real Runs (SVT)

- All calgroups and delays analyzed
- Isha = 120, VFS = 0
  - Run Number = 7024, Baseline Run Number = 7020
- Isha = 120, VFS = 100
  - Run Number = 7026, Baseline Run Number = 7022
- Isha = 240, VFS = 0
  - Run Number = 7025, Baseline Run Number = 7021
- Isha = 255, VFS = 0
  - Run Number = 7029, Baseline Run Number = 7028
- Isha = 34, VFS = 60 (Nominal)
  - Run Number = 7030, Baseline Run Number = 7015
- Isha = 70, VFS = 0
  - Run Number = 7027, Baseline Run Number = 7023

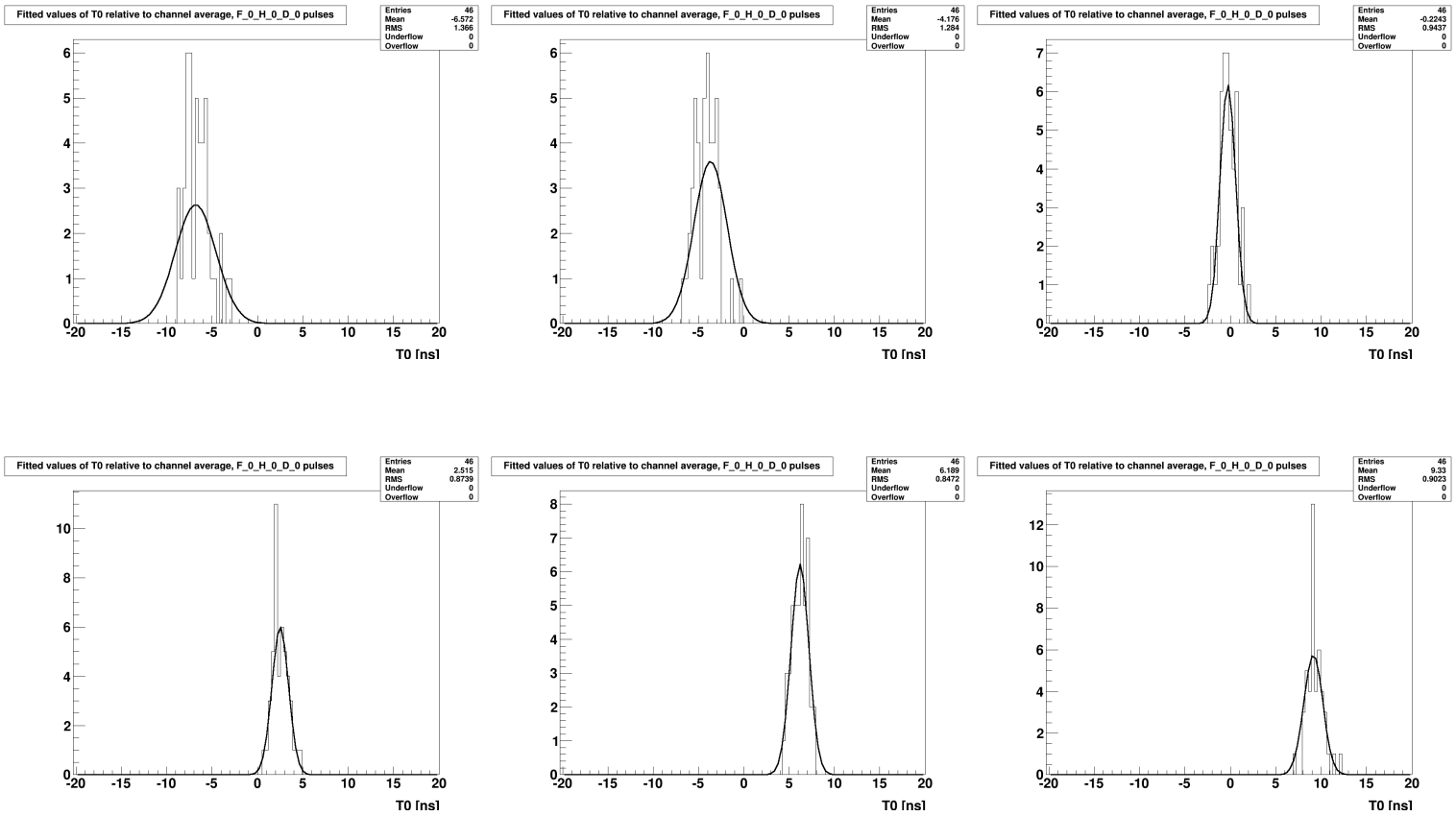
Sample Pulse Fits (SVT)

- Small dip in the 3rd pedestal as you approach the edge of the sensor



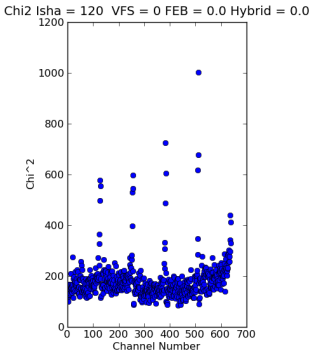
Sample T0 Histogram (SVT)

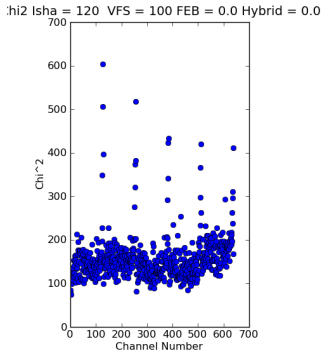
- Fewer statistics than the Devboard, fits slightly worse but generally still acceptable

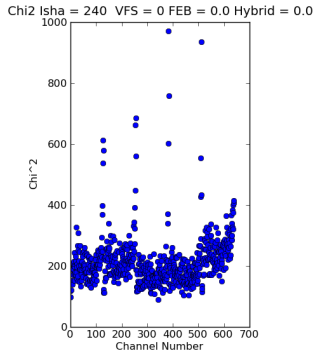


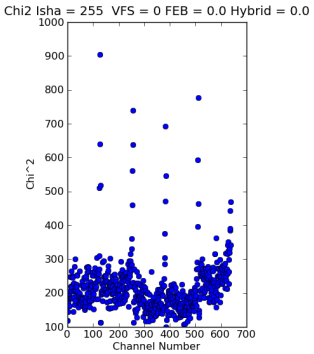
χ^2 Plots (SVT)

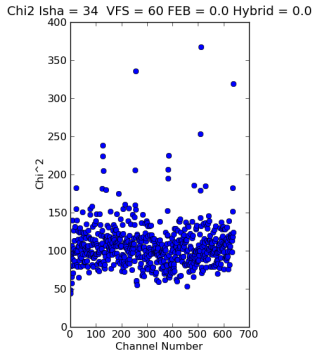
- Looking at Feb0 and Hyb0, χ^2 gets worse with increasing Isha

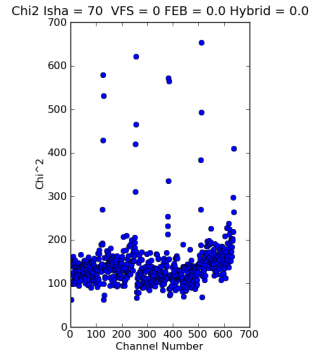






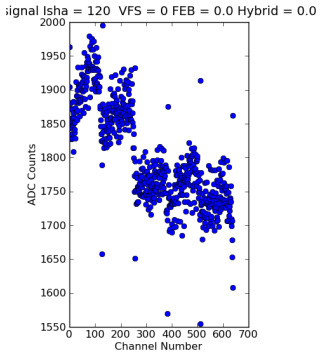


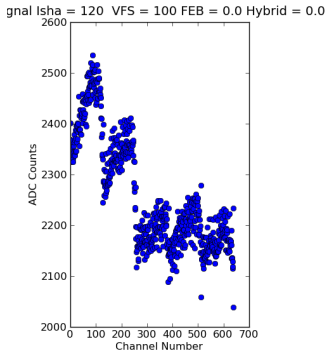


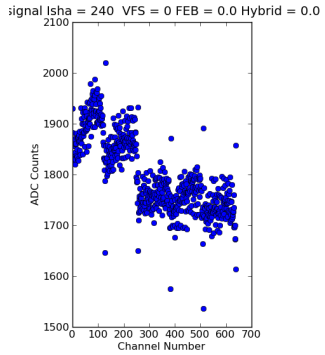


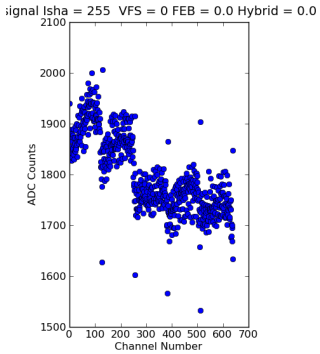
Signal Plots (SVT)

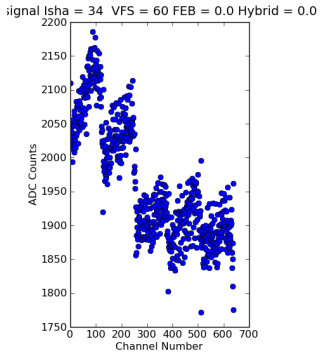
- Looking at Feb0 and Hyb0, amplitude looks similar for all runs

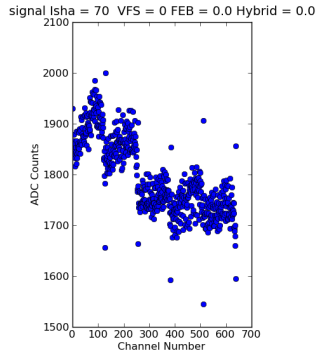






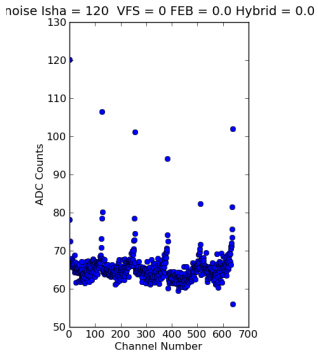


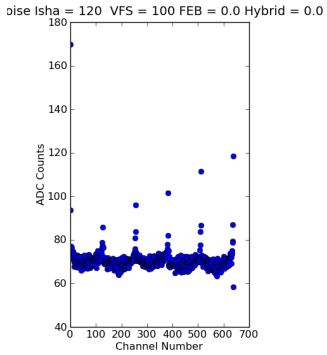


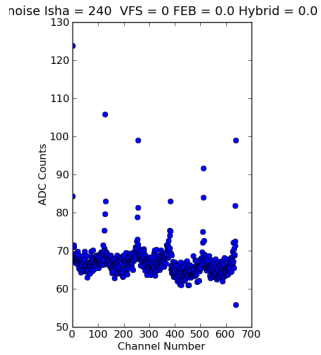


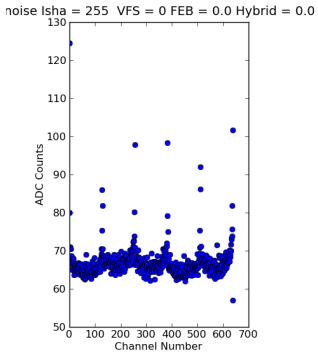
Noise Plots (SVT)

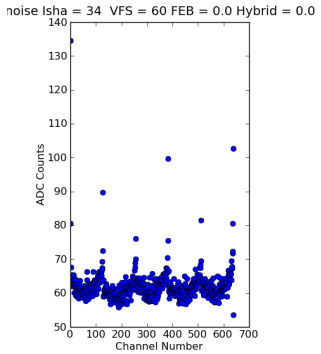
- Looking at Feb0 and Hyb0, noise looks consistant for all runs

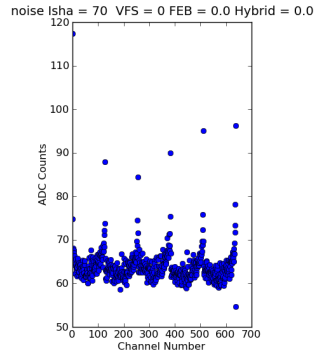






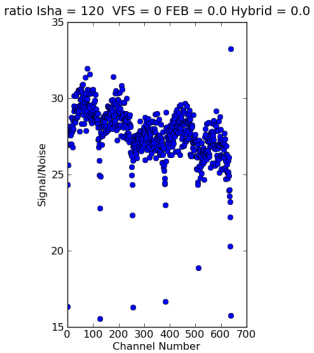


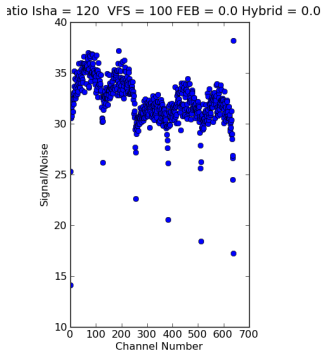


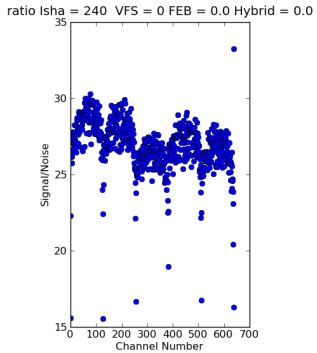


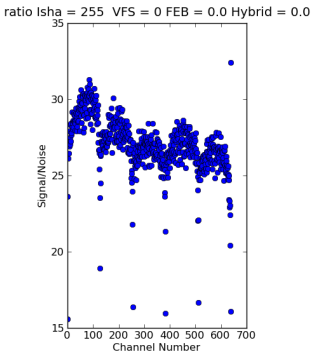
Signal to Noise Ratio Plots (SVT)

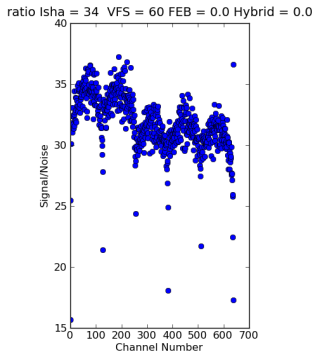
- Looking at Feb0 and Hyb0, signal to noise ratio slight decrease for higher Isha

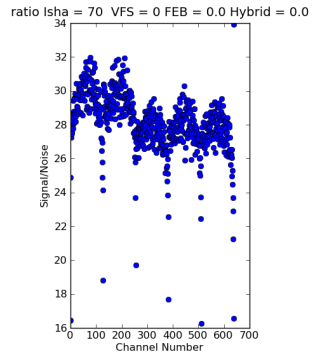




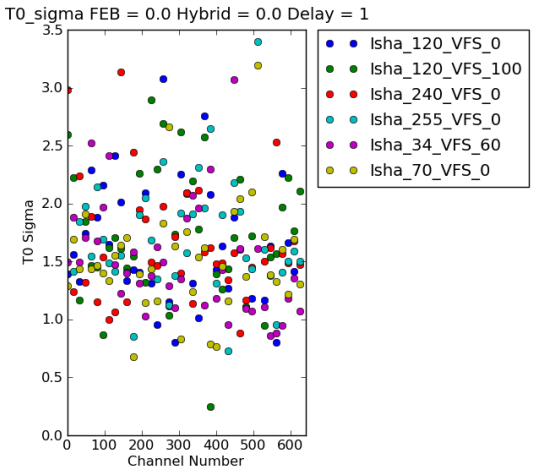


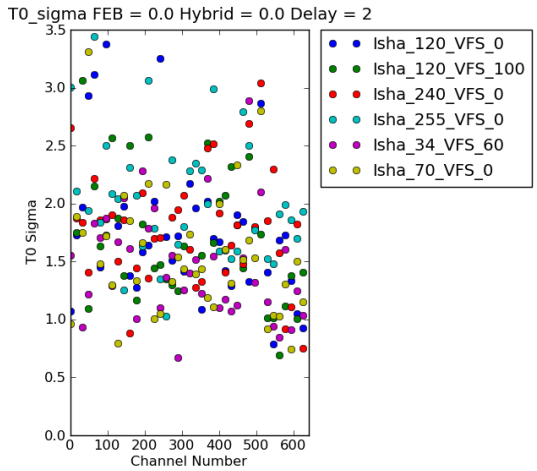


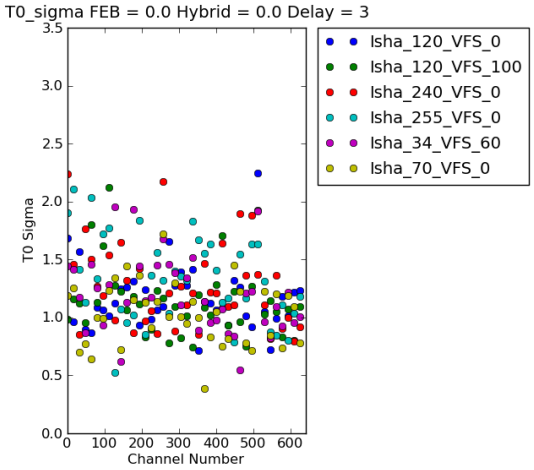


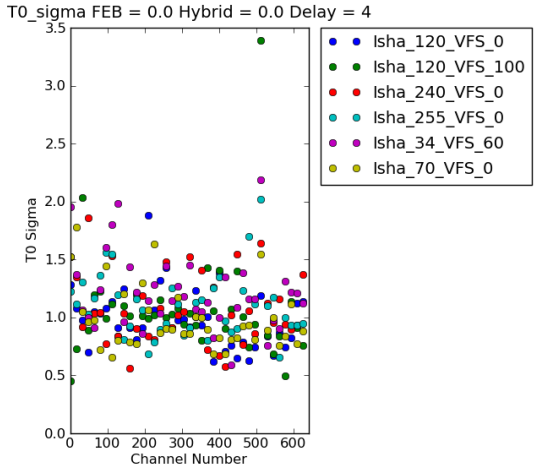


T0 Resolution All Delays (SVT)

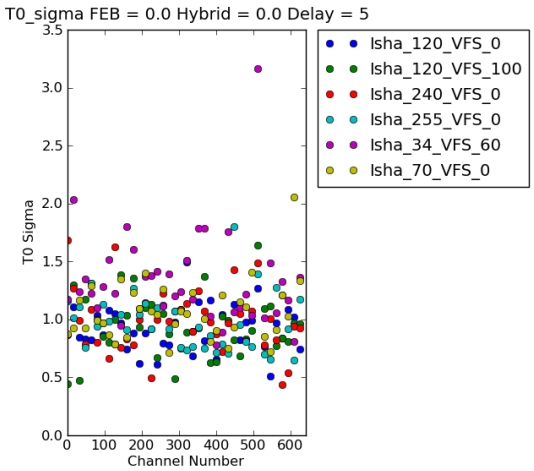


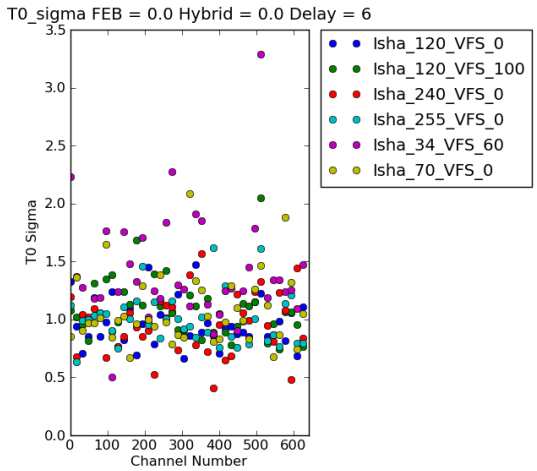


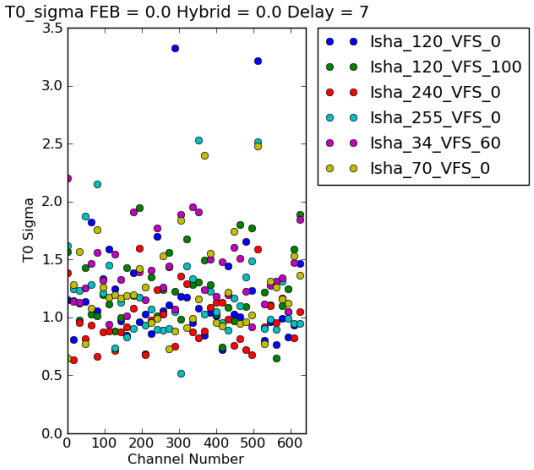


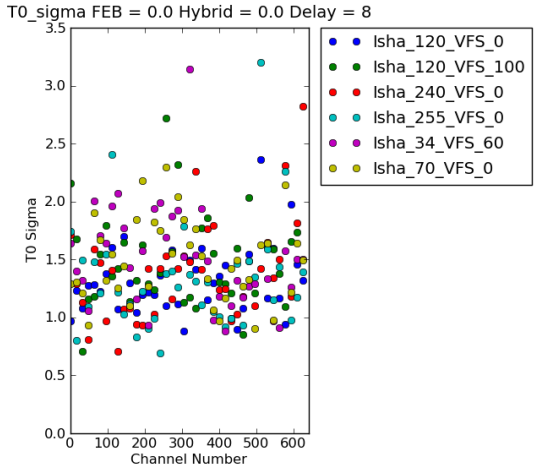


T0 Resolution All Delays (SVT)



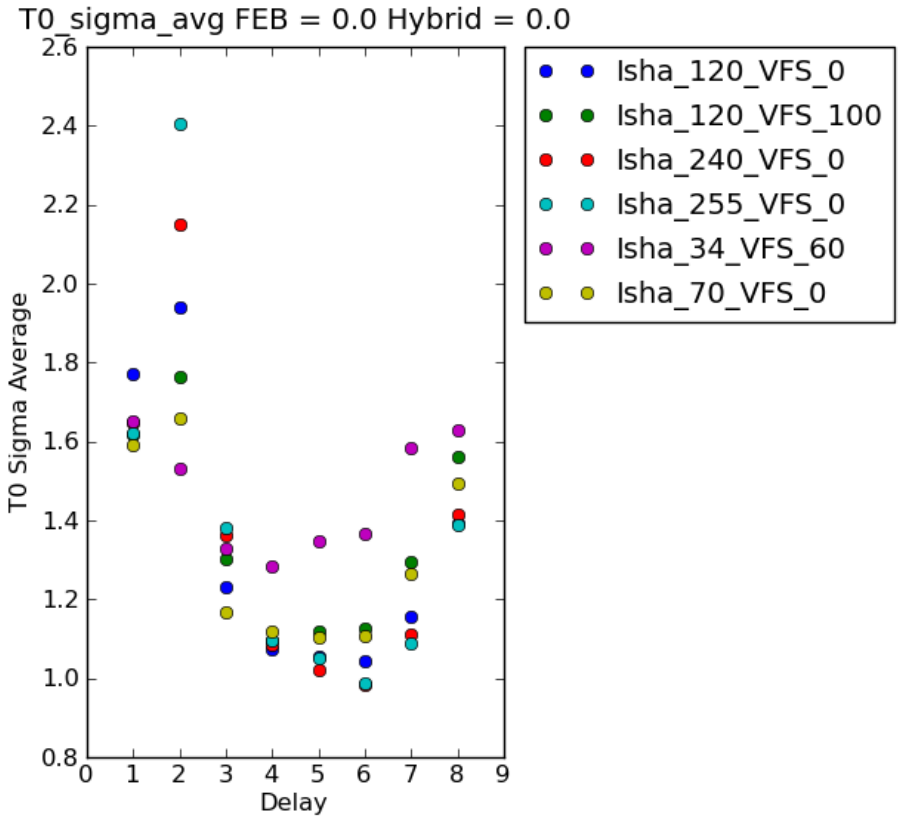






Average T0 Resolution (SVT)

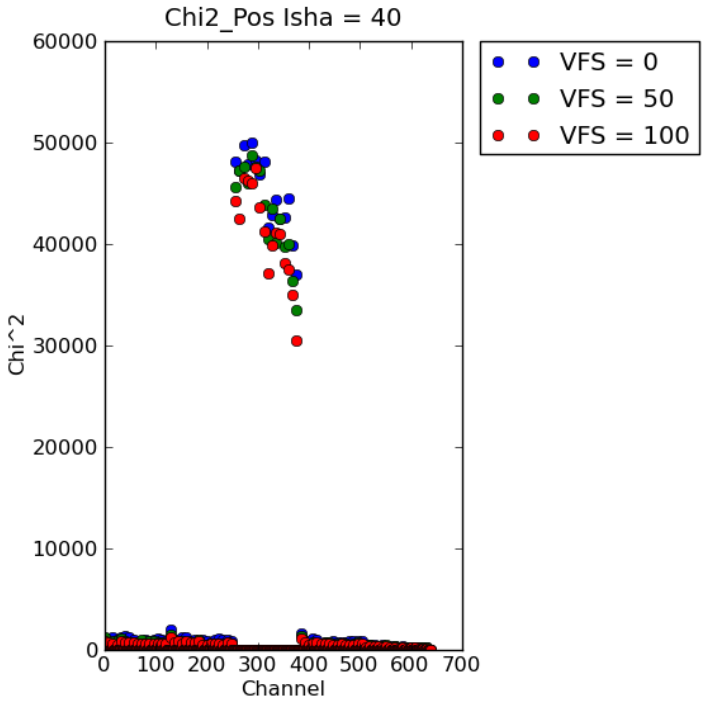
- Average T0 resolution across all channels for FEB=0 Hyb=0 as a function of delay
- Delay 2 looks wierd and is still being investigated

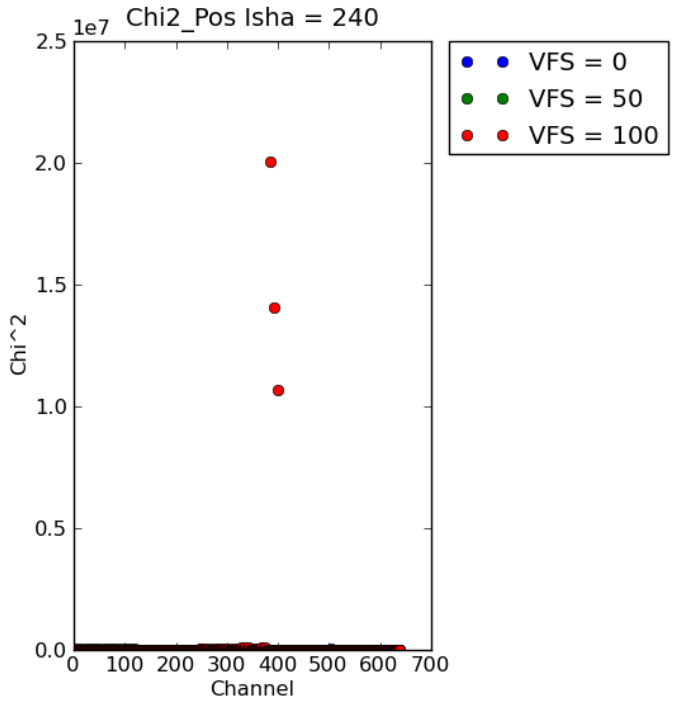


Conclusions

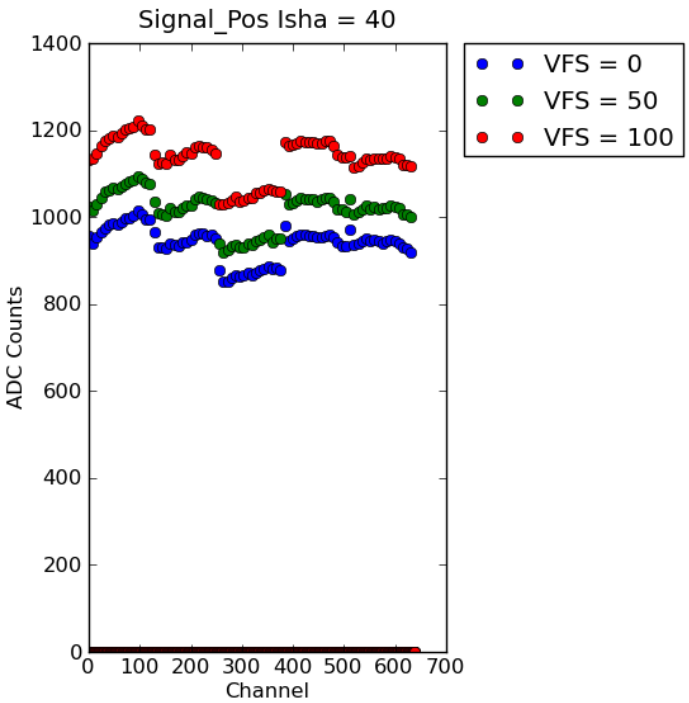
- Two parameter fit function appears to work quite well
- Explored full range of shaping parameters and found optimal parameters for reduced pulse shape and pulse tail, as well as minimal T0 resolution (high Isha, low VFS)
- Tested these parameters on the actual SVT
- In the near future:
  - Many more plots to look at and a few minor issues to be resolved
  - Look at other FEBs/Hybrids
  - Analyze power consumption for various shaping parameters (Pelle)

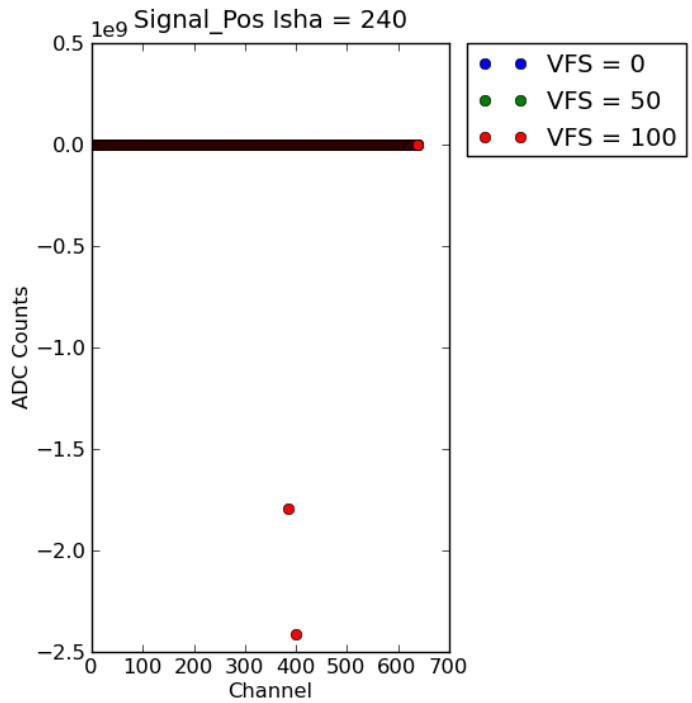
χ^2 Plots (Dev)



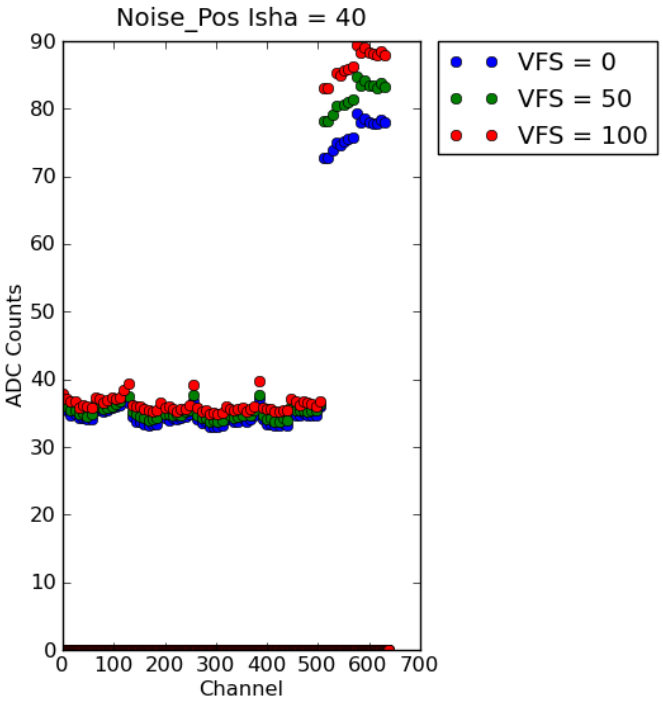


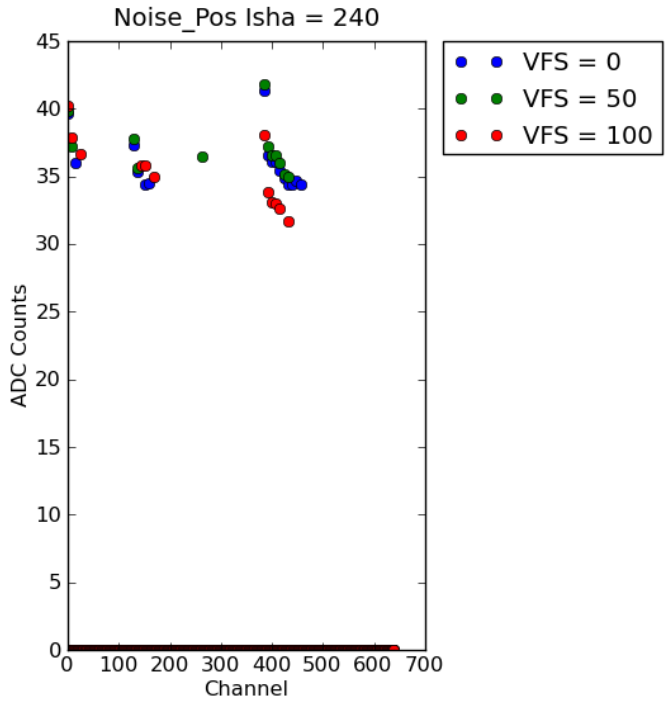
Signal Plots (Dev)



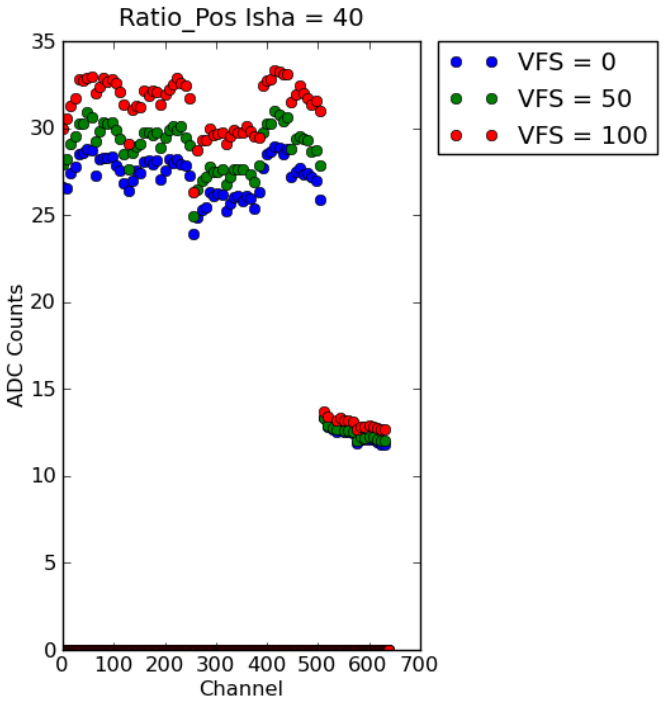


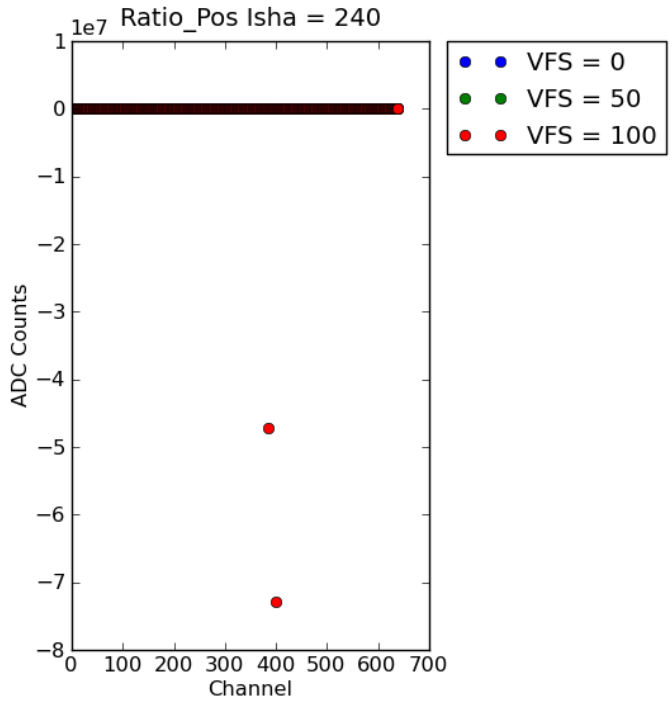
Noise Plots (Dev)



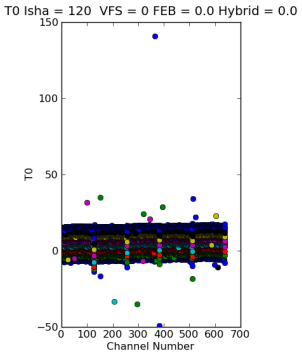


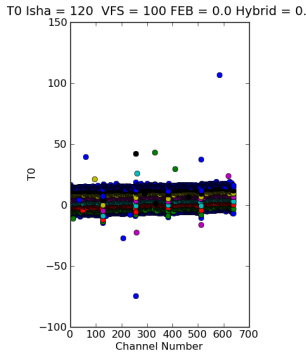
Signal to Noise Ratio Plots (Dev)

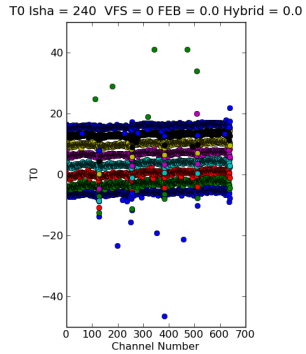


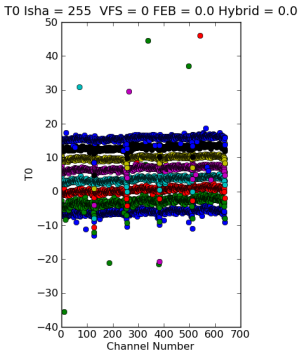


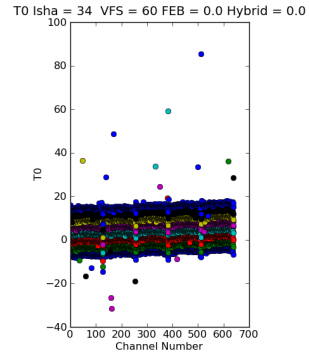
T0 Plots (SVT)

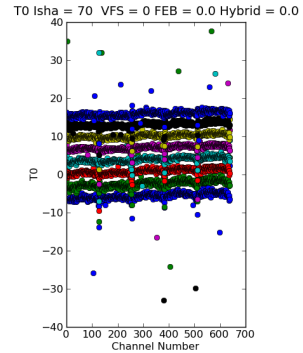

T0 Isha = 120 VFS = 0 FEB = 0.0 Hybrid = 0.0
T0
Channel Number


T0 Isha = 120 VFS = 100 FEB = 0.0 Hybrid = 0.0
T0
Channel Number

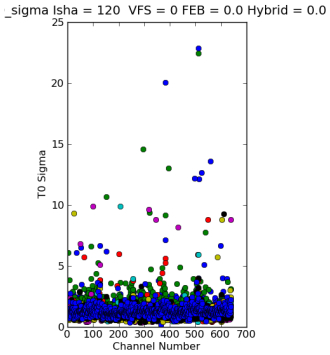

T0 Isha = 240 VFS = 0 FEB = 0.0 Hybrid = 0.0
T0
Channel Number

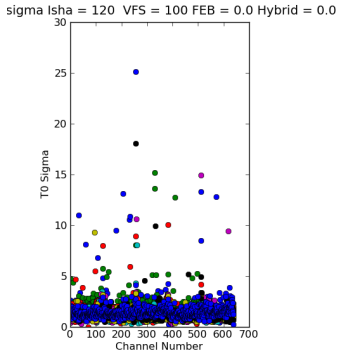

T0 Isha = 255 VFS = 0 FEB = 0.0 Hybrid = 0.0
T0
Channel Number

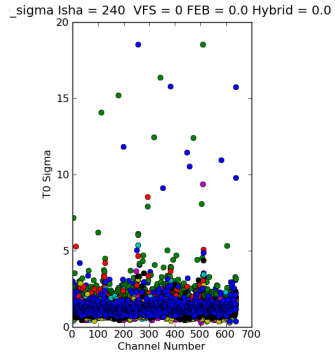

T0 Isha = 34 VFS = 60 FEB = 0.0 Hybrid = 0.0
T0
Channel Number

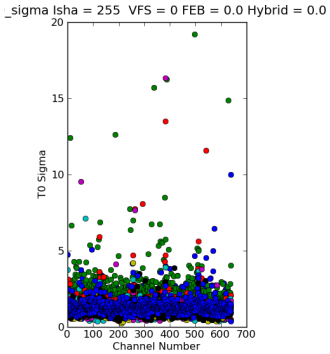

T0 Isha = 70 VFS = 0 FEB = 0.0 Hybrid = 0.0
T0
Channel Number

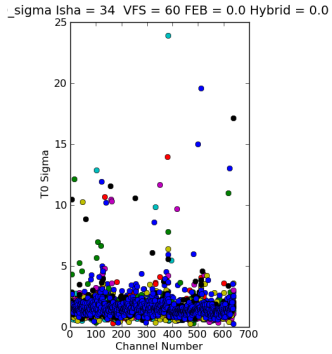
T0 Sigma Plots (SVT)

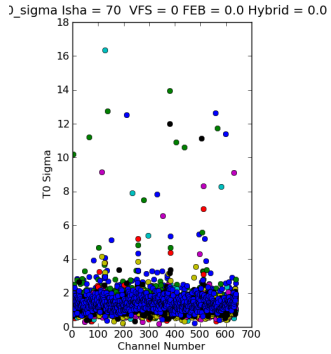




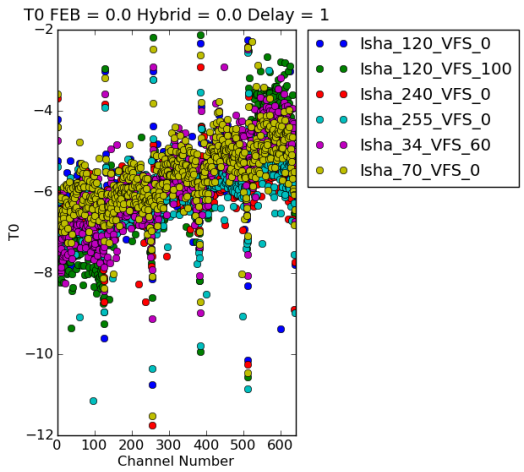


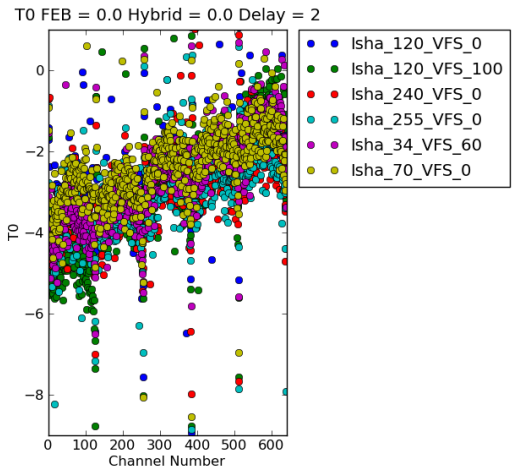


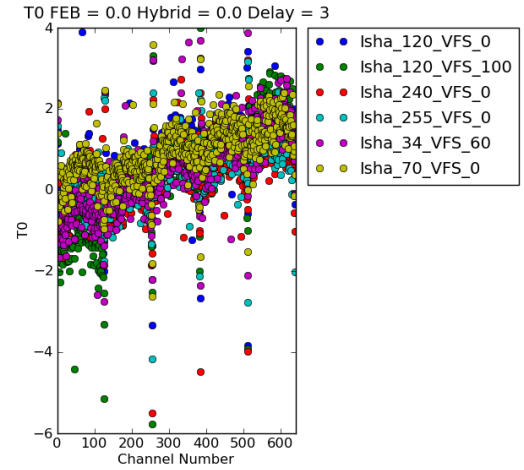


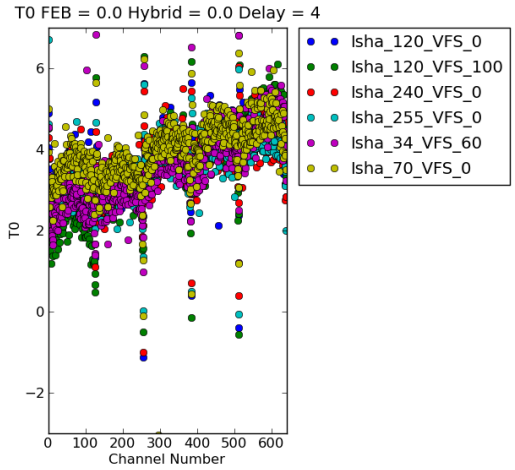


T0 All Delays (SVT)









T0 All Delays (SVT)