NP04 TPC Electronics Response Studies

NP04 Coordination Meeting 8/6/2024

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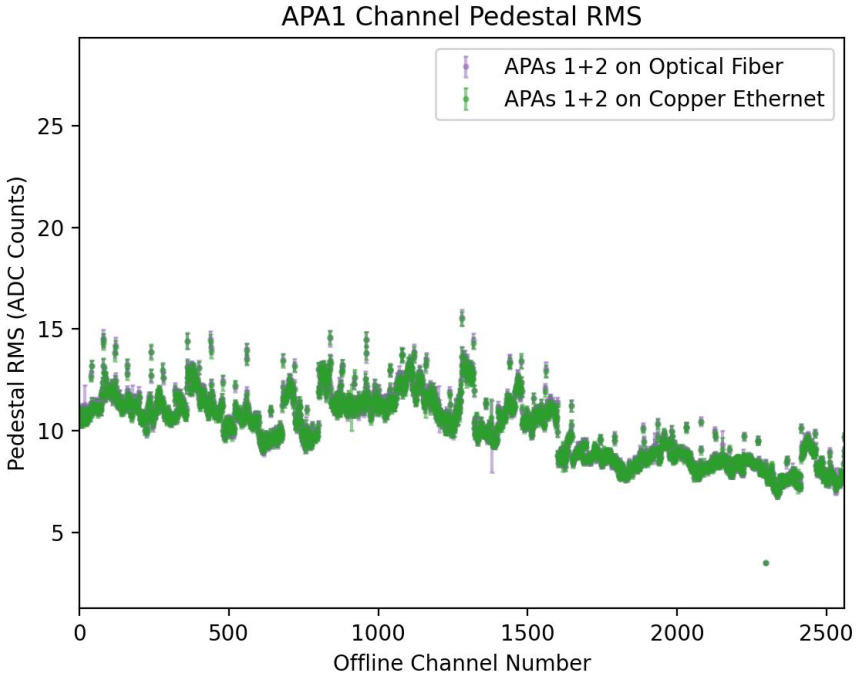
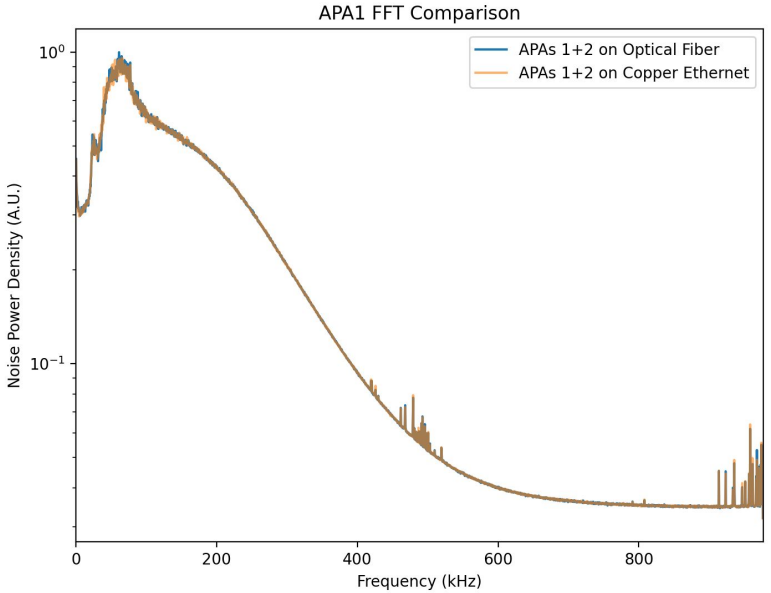
Copper/Fiber Network Tests

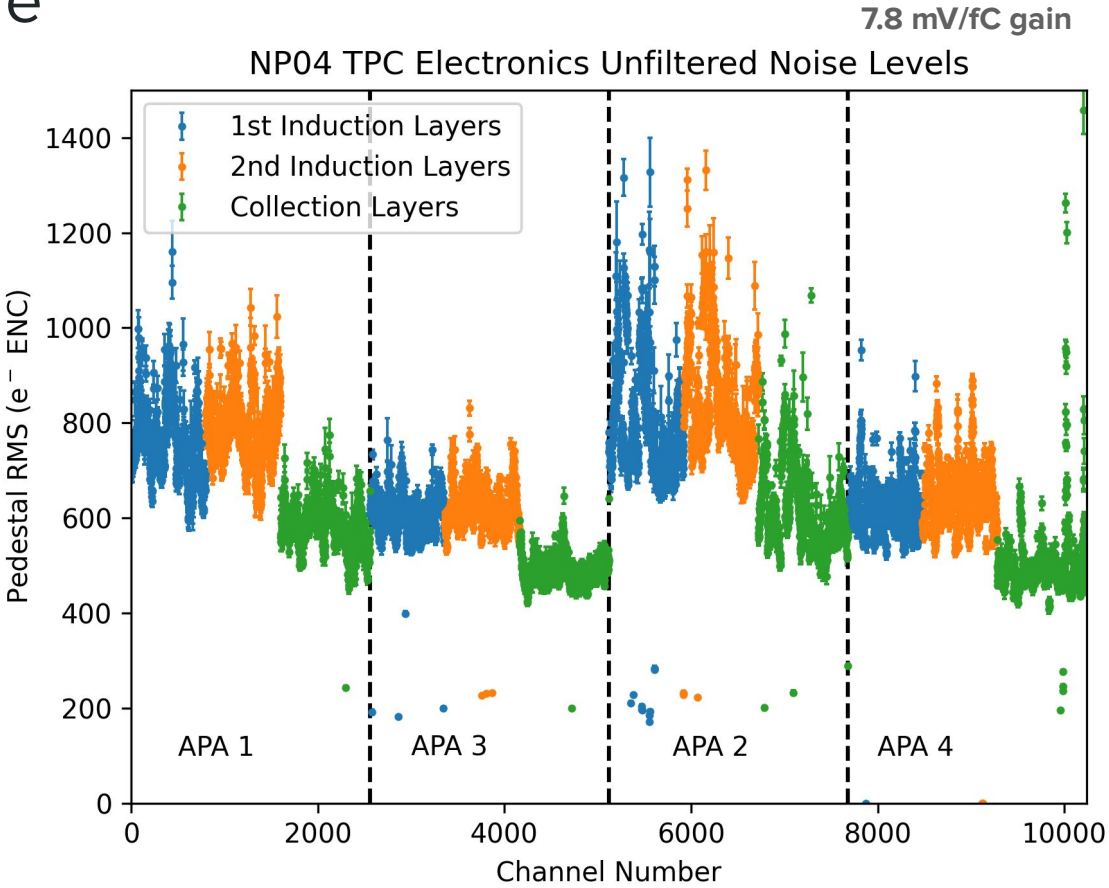
- Coordinated with DAQ team to run noise tests on copper vs optical fiber network connections for the WIBs
- Observed no noise difference between the setups (no issue with copper network connections)





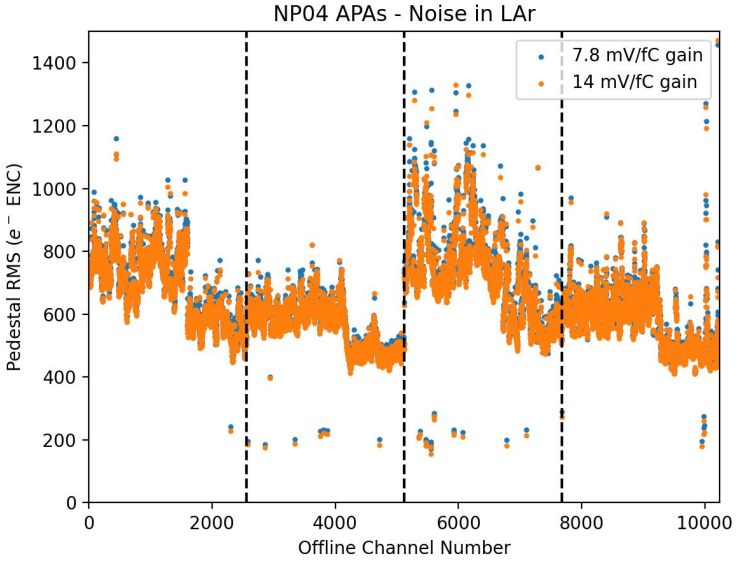
Frontend Gain Change

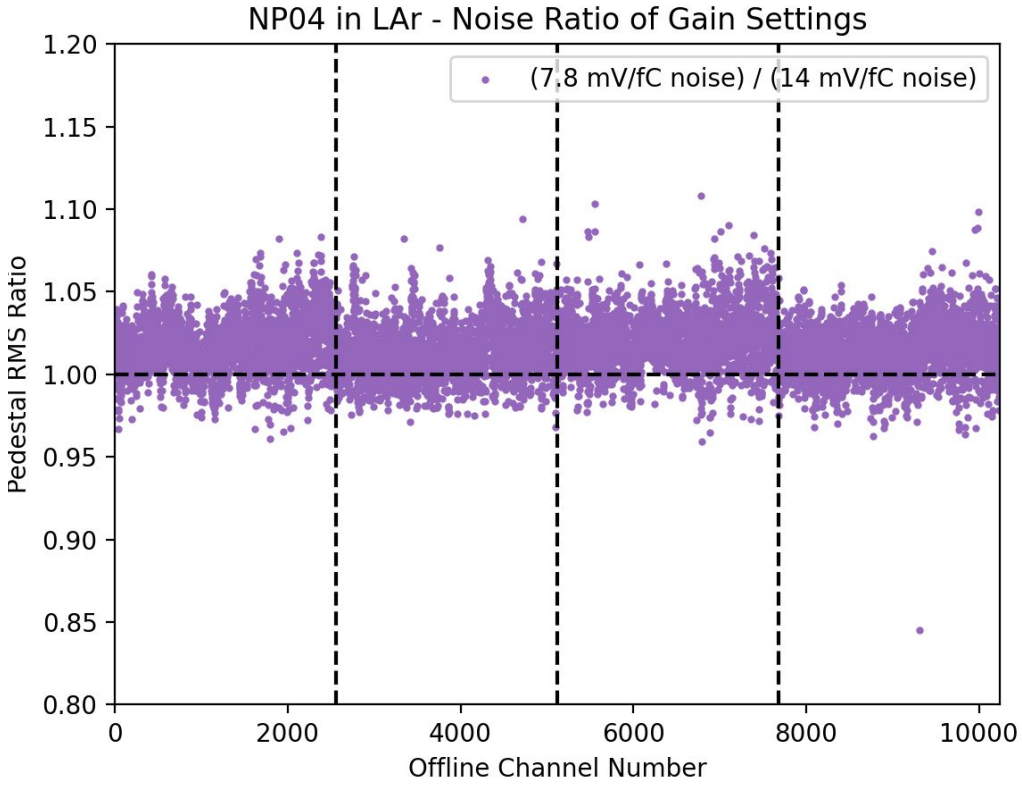
- Since run 27977, we have been using a **gain of 7.8 mV/fC** instead of the previous default 14 mV/fC
- Noise levels are in general comparable to what we had at the old gain setting



Frontend Gain Change

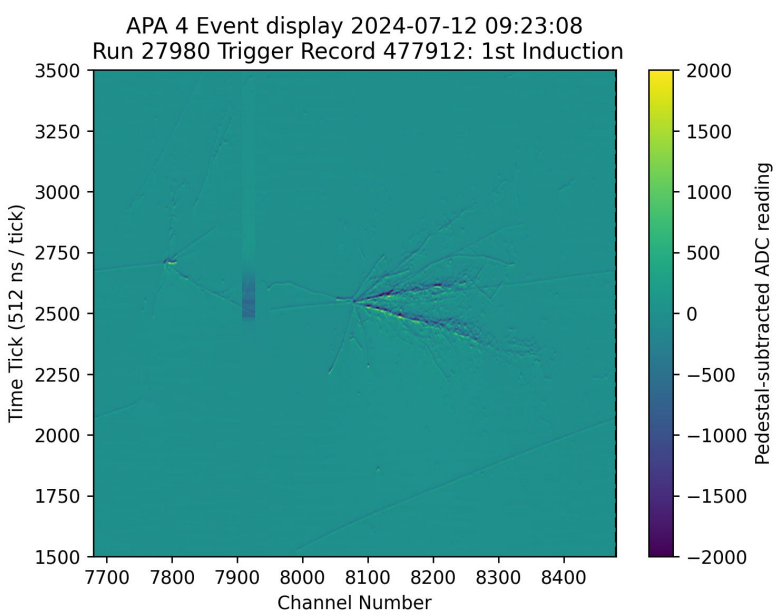
- Estimate that average noise levels are **~2% worse** at the new gain setting

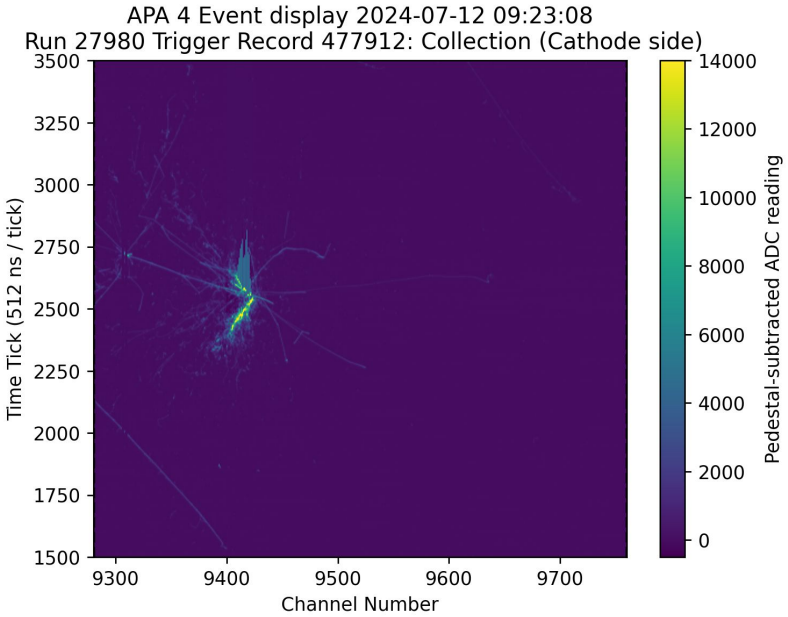




Half-FEMB Negative Pulses

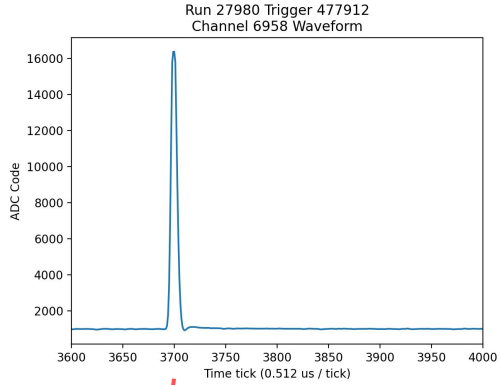
- When a lot of charge is collected in a few ASICs, it induces a negative “bounce” signal in the rest of the same half-FEMB
- This may be related to the power rails, which are supplied per half-FEMB

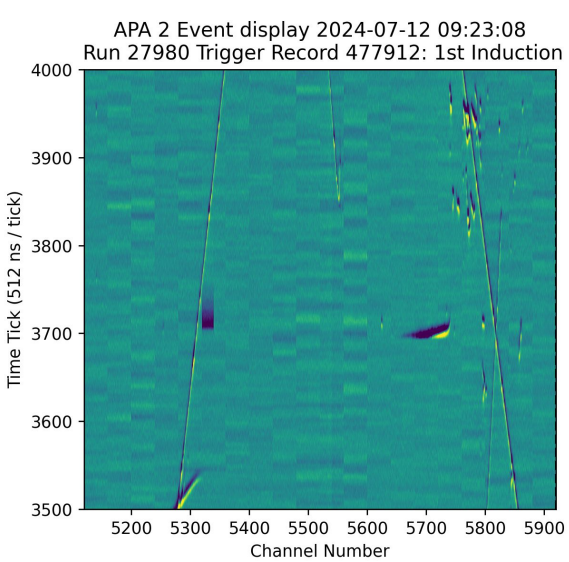


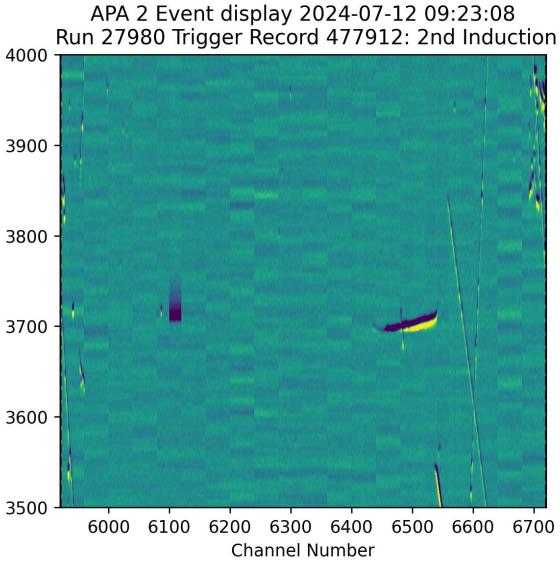


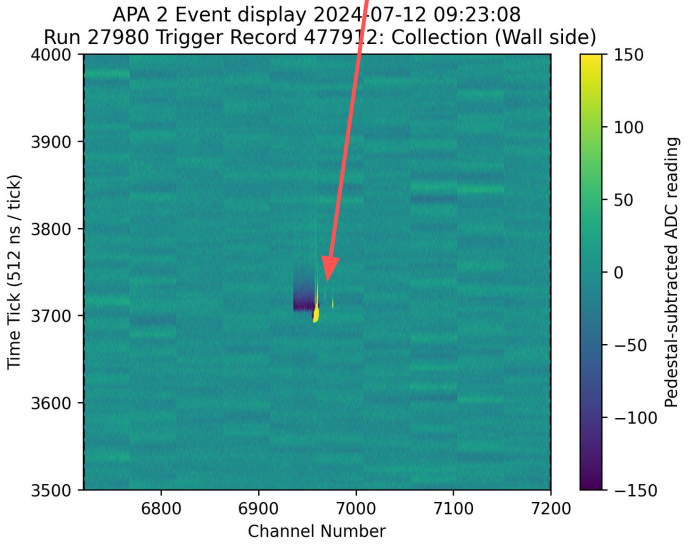
Half-FEMB Negative Pulses

- Also visible with a very concentrated charge deposition on just a few channels



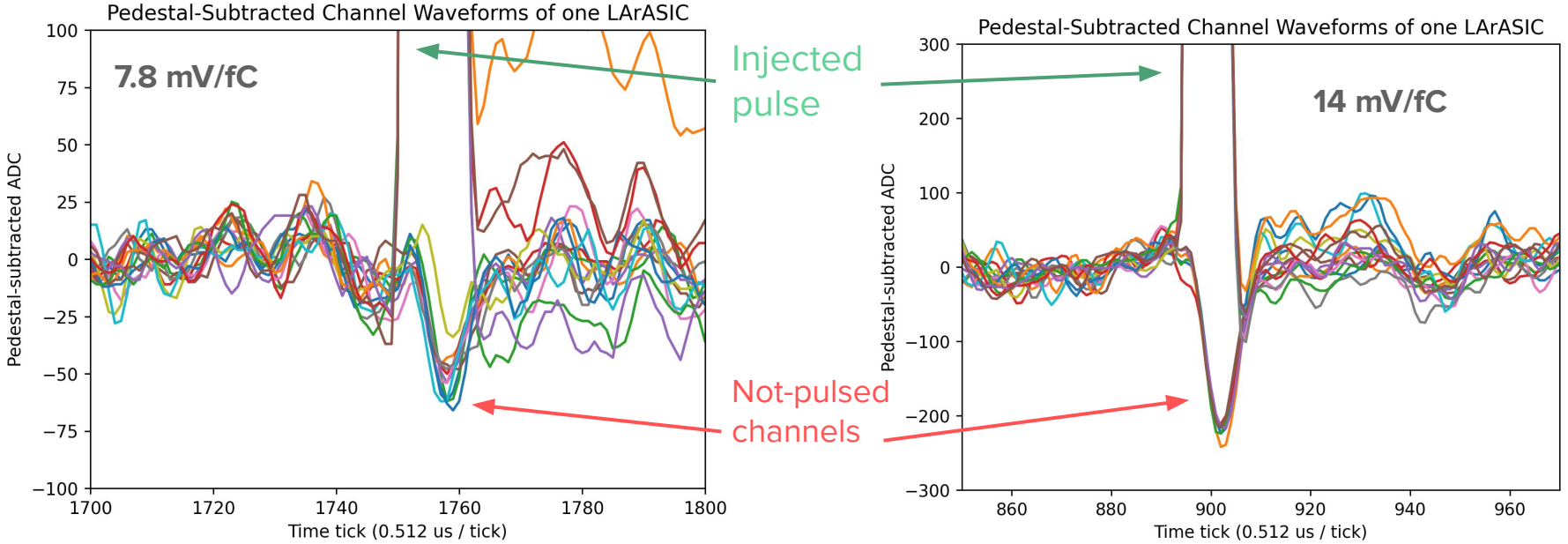






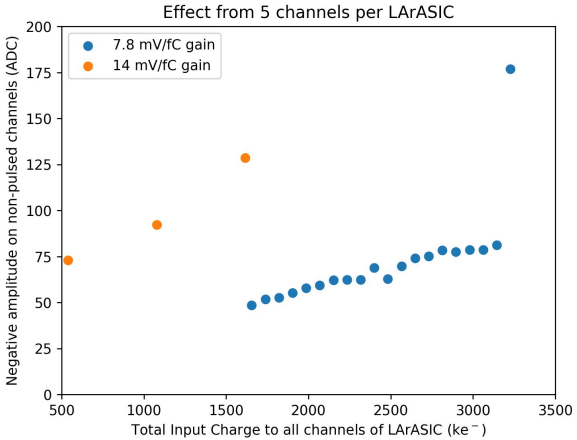
Negative-Bounce Gain Dependence

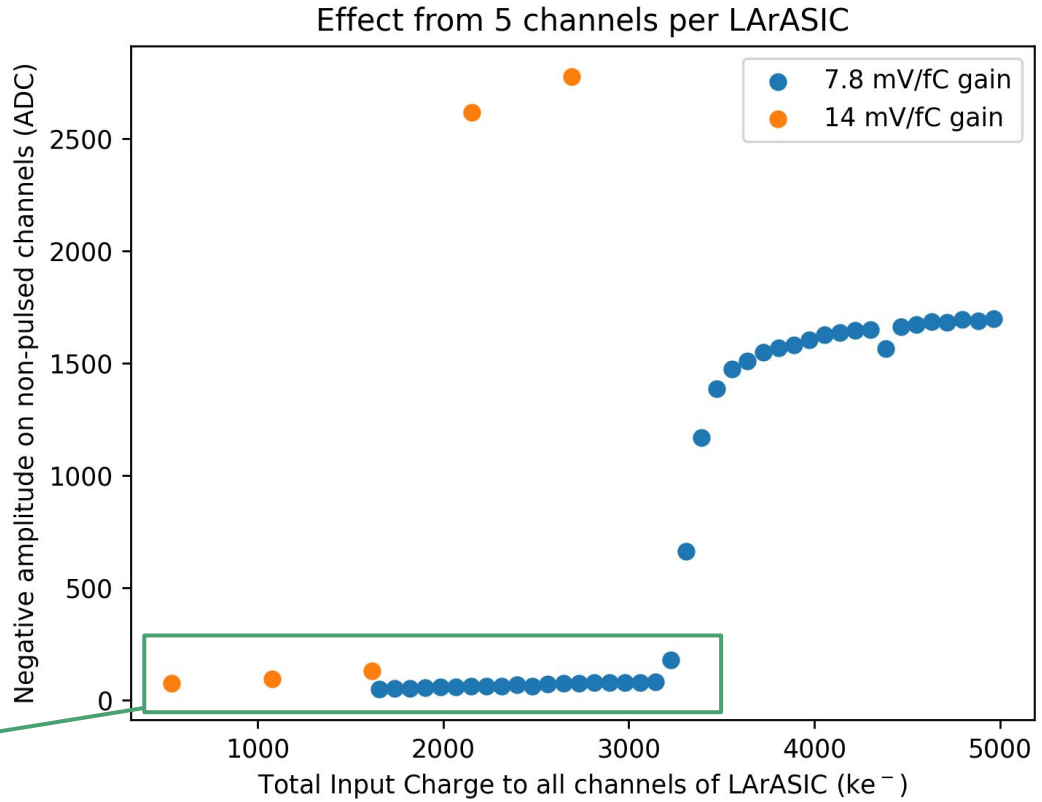
- **Configuration**: Injecting ~325k electrons per channel, pulsing 10 channels per ASIC
- At the same injected charge, the magnitude of the effect is disproportionately larger at higher gain
  - This partially motivated the switch to 7.8 mV/fC gain



Negative-Bounce Gain Dependence

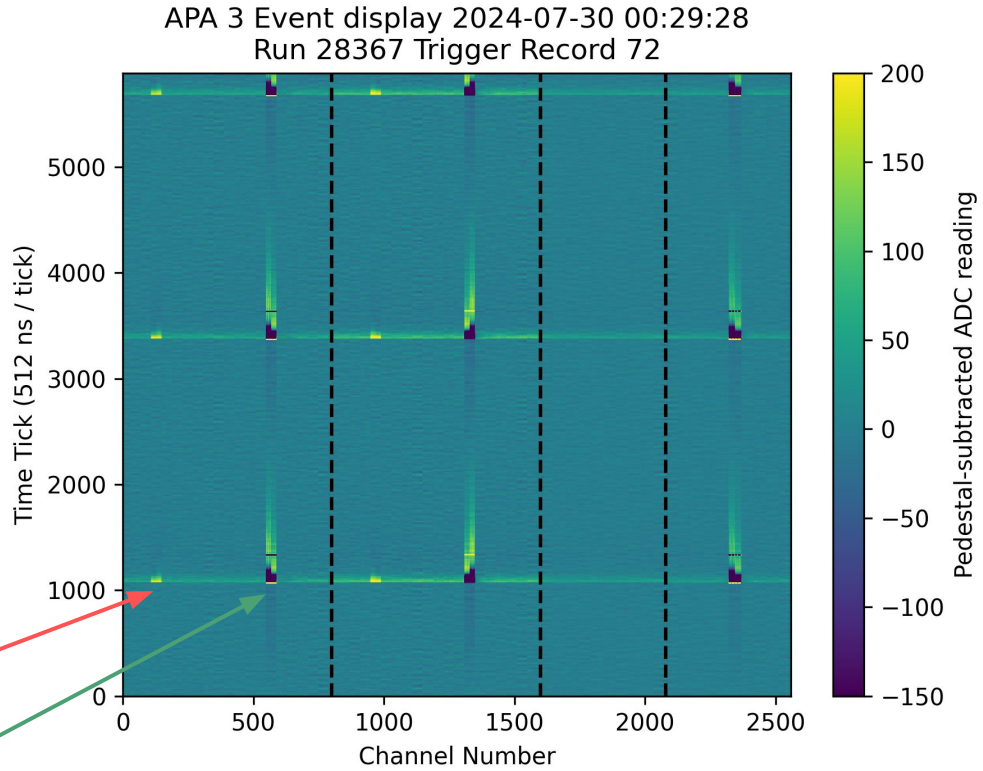
- Onset of the effect begins at lower total input charges for higher gain
- Note the scale of input charges here is millions of electrons
  - How much this affects the data in practice is to be seen





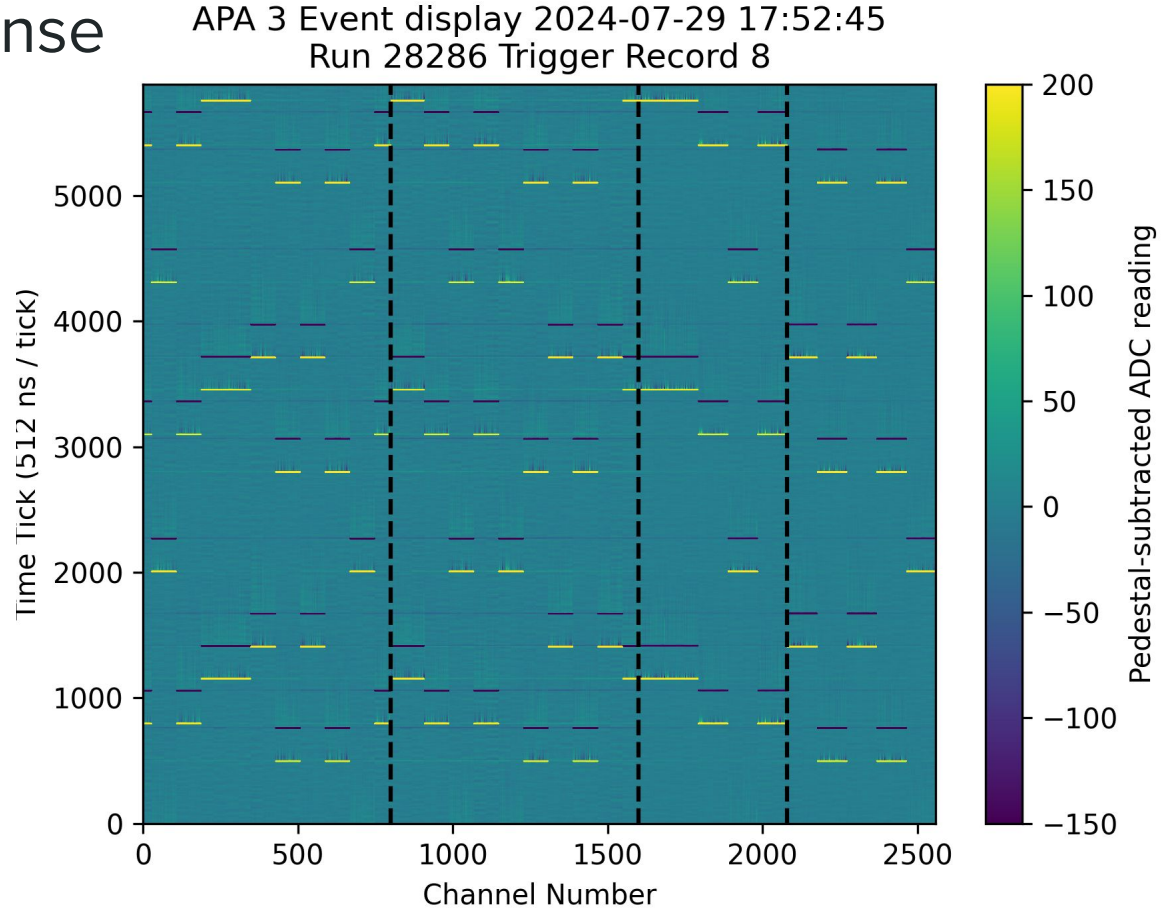
APA-wide effect from large pulse injection

- **Configuration**: 14 mV/fC gain, **only pulsing one FEMB**, input charge of ~540k electrons on each of 40 channels on the FEMB
- Sufficiently large channel saturation causes an APA-wide response
  - Presumably from a disturbance to the entire APA ground



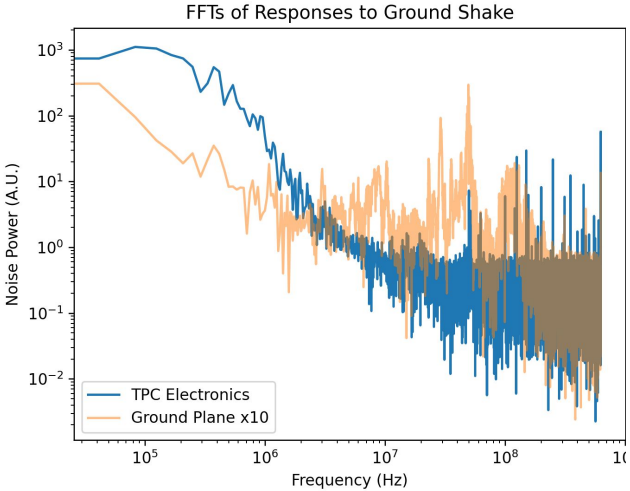
Typical Pulser Response

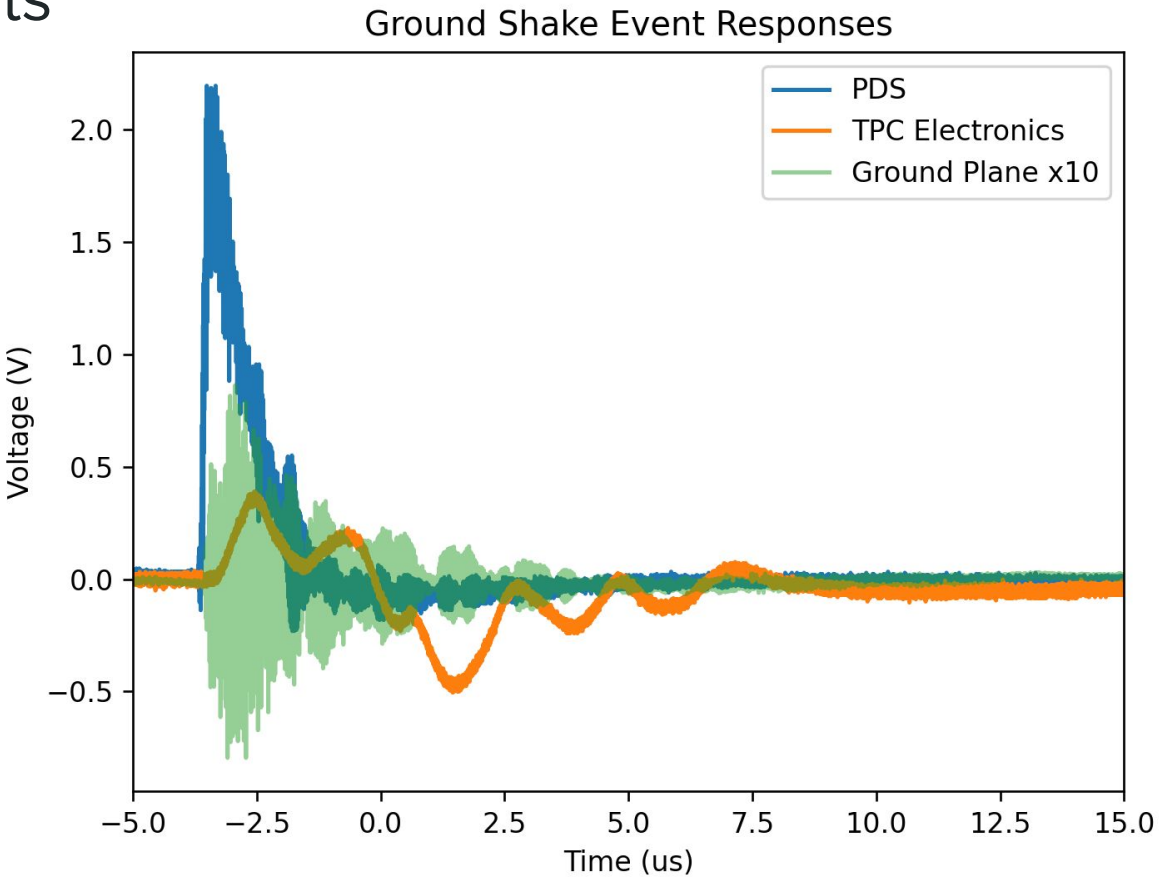
- **Configuration**: 7.8 mV/fC gain, pulsing all channels, input charge of ~500k electrons on each channel
- Due to lower gain, signals here are not saturating, and the APA-wide effect is not visible



Ground Shake Events

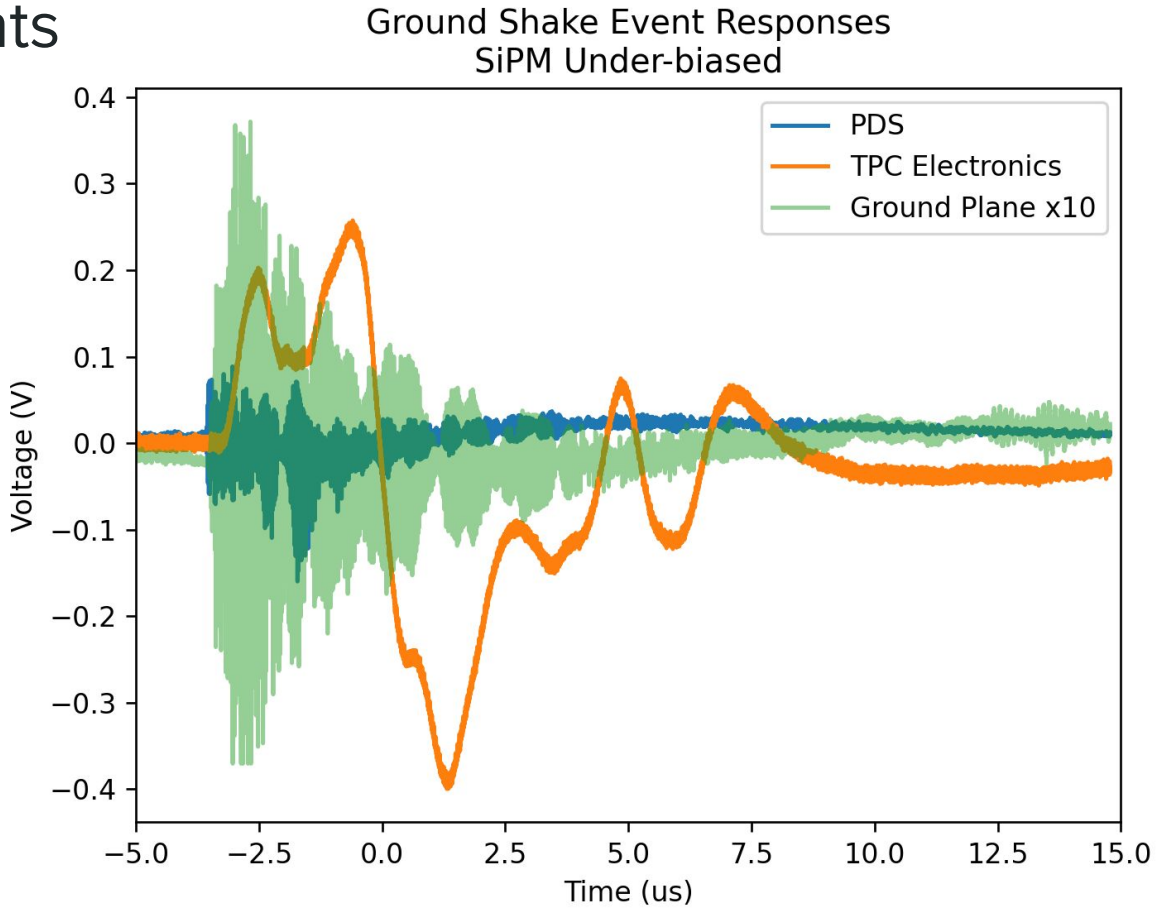
- Setup: using an oscilloscope to probe the analog signals of the ground plane monitor, TPC electronics response, and PD response
- Confirmed simultaneous “signal” in all systems





Ground Shake Events

- Also used same setup of analog probes with SiPMs underbiased
- We still see a burst of noise in the PDS readout, but no pulse



Summary

- TPC electronics have been operating at a new, lower frontend gain setting for a few weeks now (since run 27977)
  - Estimate an average ~2% effect on noise
  - Pulser studies (see 7/29-7/30 section of electronics studies spreadsheet) show this should reduce the relative magnitude of the power bounce effect from large charge deposits
- Further studies on this power bounce effect are planned with both benchtop setups and for after NP04 completes beam data
- Further studies on ground shake events planned using the analog probe + oscilloscope setup after beam data completes as well