

# CRP4 Coldbox Results

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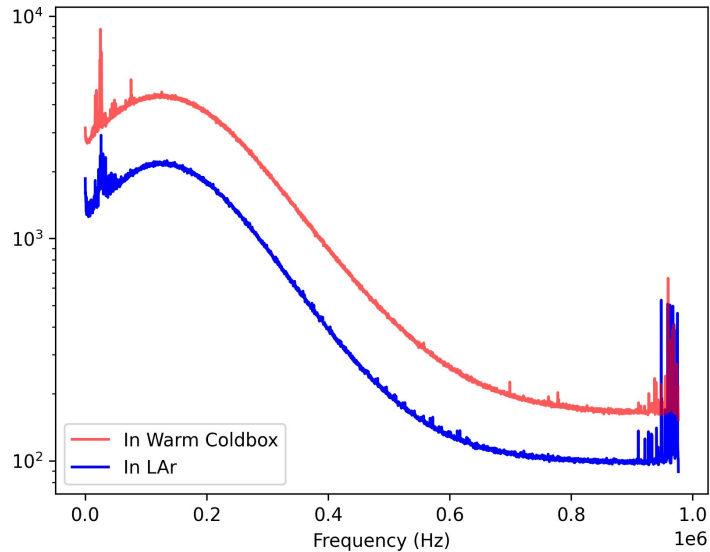
CE Consortium Meeting 3/21/2023

Roger Huang, Herilala Razafinime

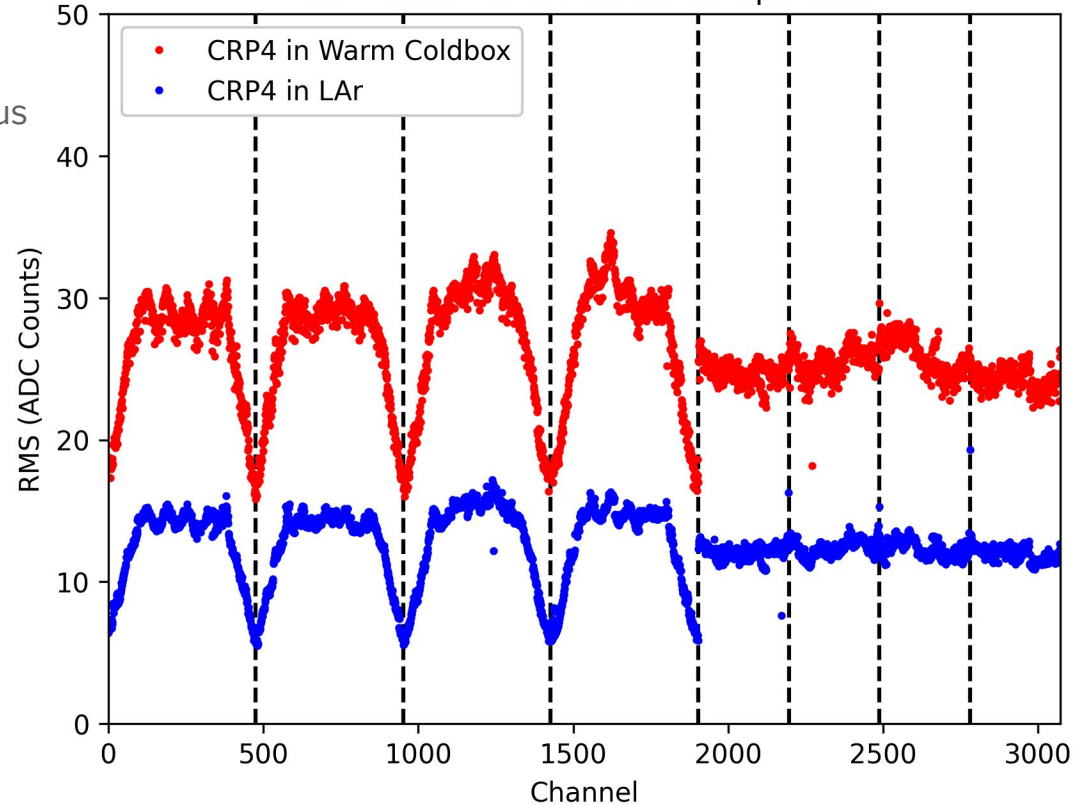
# CRP4 General Noise Performance

- No big surprises going to cold
- Channels 1243 and 2172 show anomalous noise response at cold, but are alive

CRP4 Noise Power Spectrum  
All Channels Summed



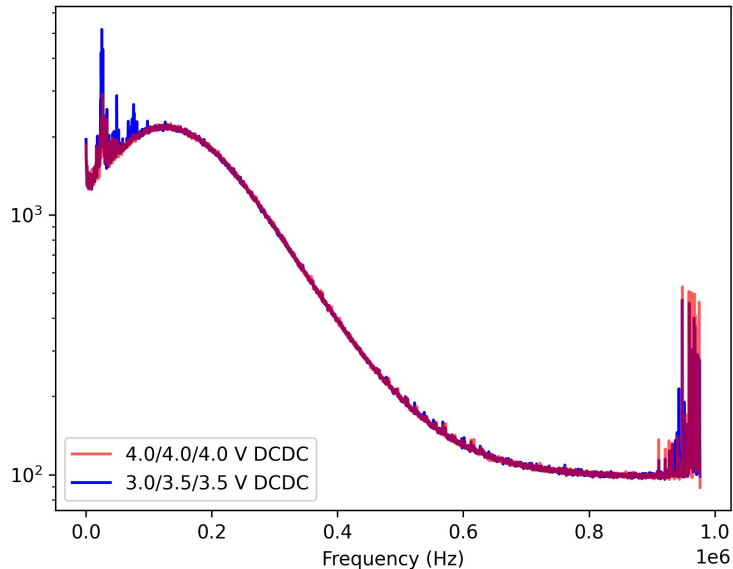
CRP Noise Performance Comparison



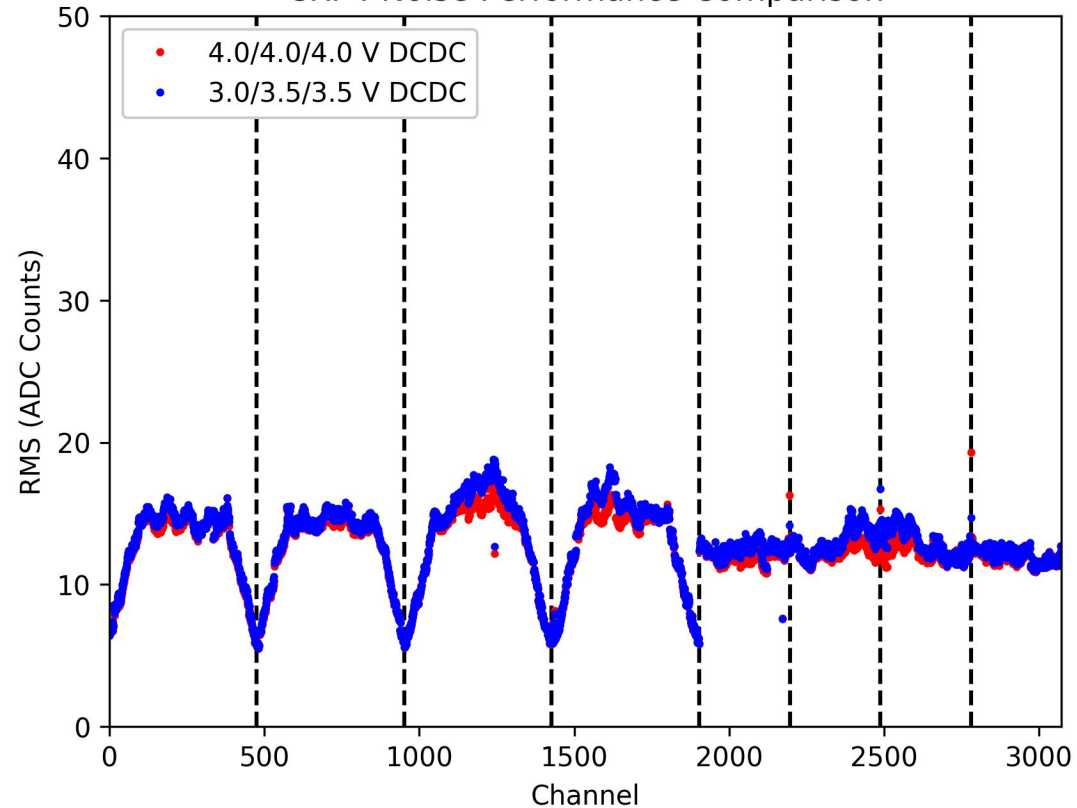
# Coherent Noise

- 25 kHz coherent noise and effect of DC/DC settings persists

CRP4 Noise Power Spectrum  
All Channels Summed



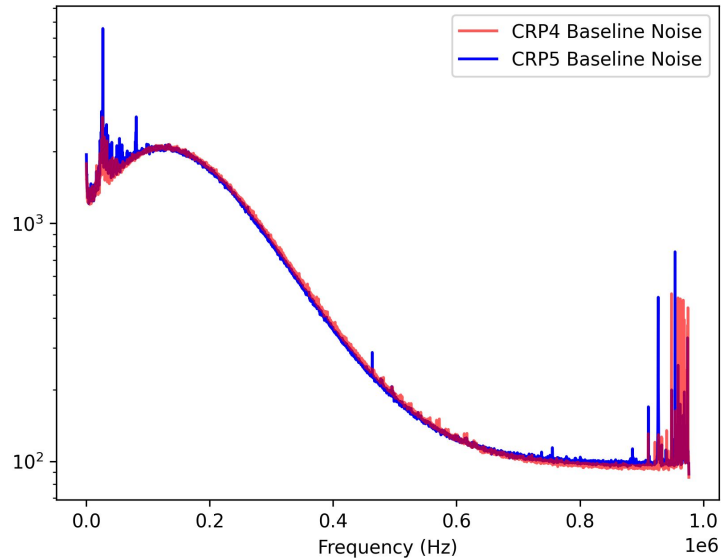
CRP4 Noise Performance Comparison



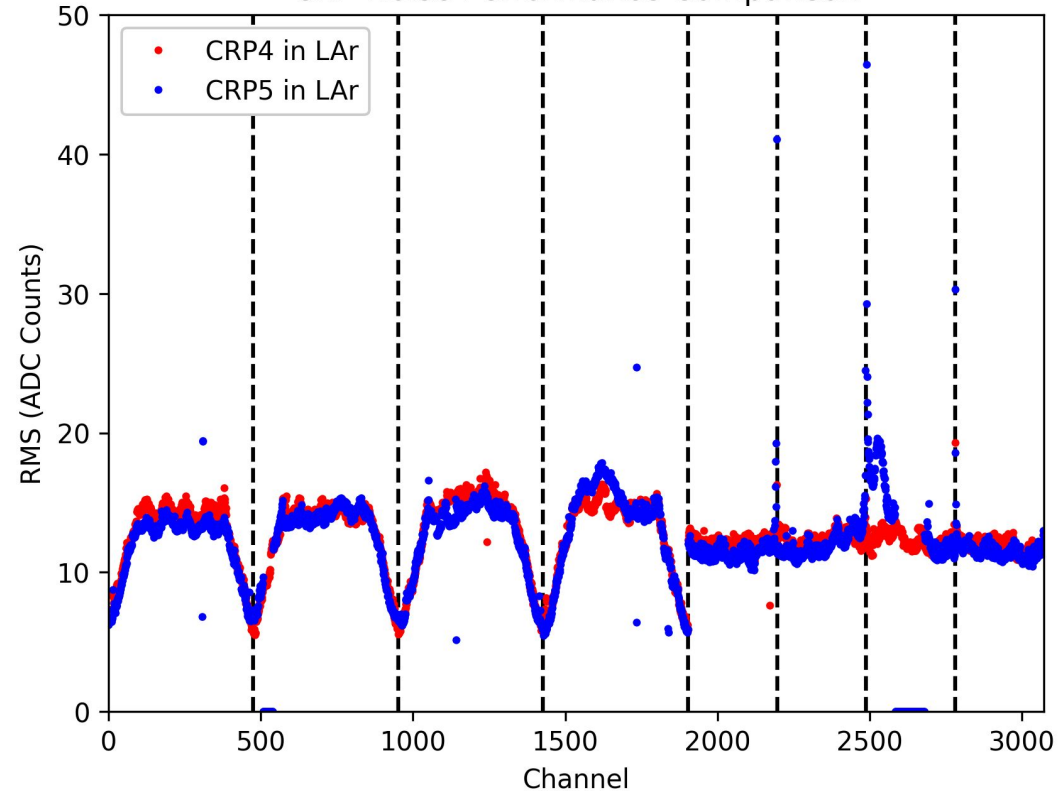
# CRP4/CRP5 Comparison

- Overall noise levels mostly comparable, but corrected grounding on CRP4 has mitigated the extra noise on collection strips at the CRU border

CRP Noise Power Spectrum Comparison  
All Channels Summed

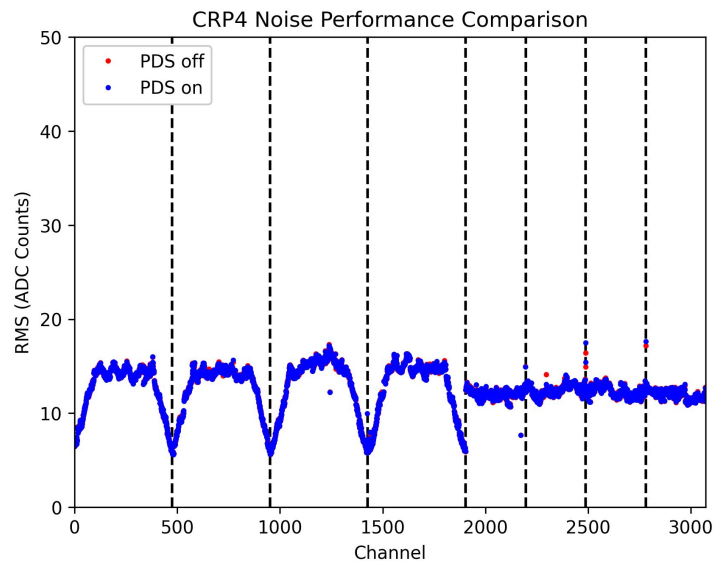


CRP Noise Performance Comparison

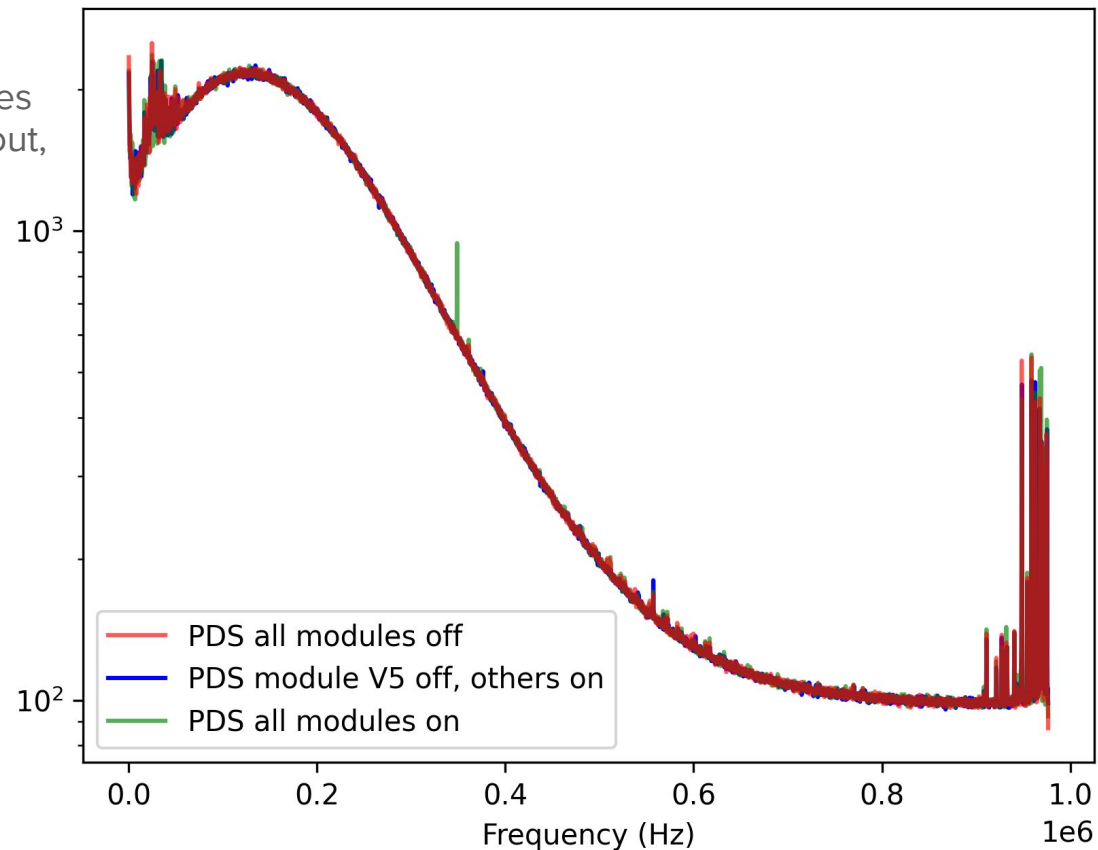


# PDS Tests

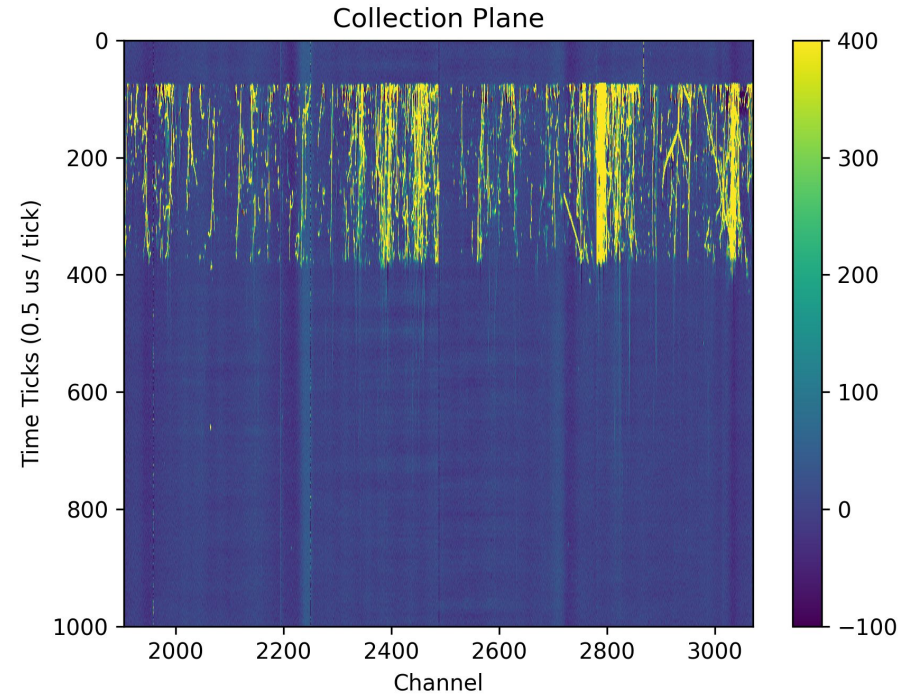
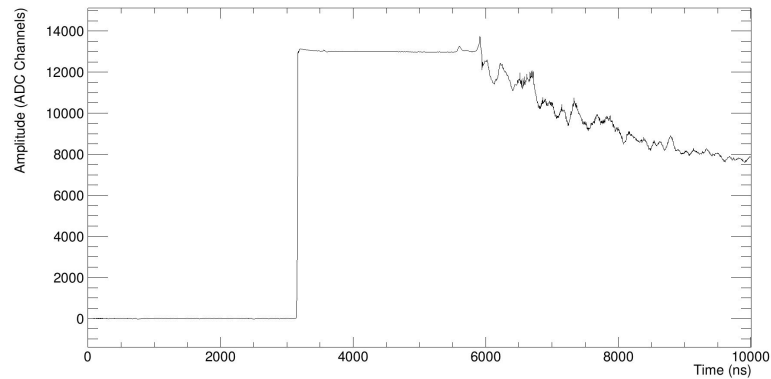
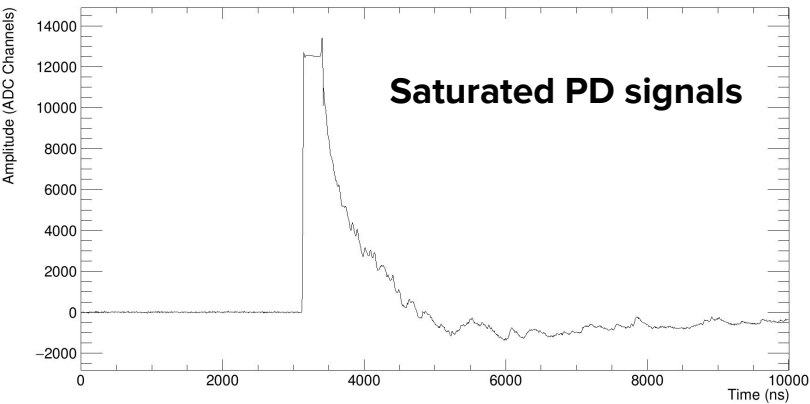
- One of the cathode PD modules induces a 350 kHz noise peak in CRP CE readout, though the effect on overall noise is negligible
  - This frequency is known to the PDS group



## CRP Noise Power Spectrum Comparison All Channels Summed



# Coincidence Data with PDS



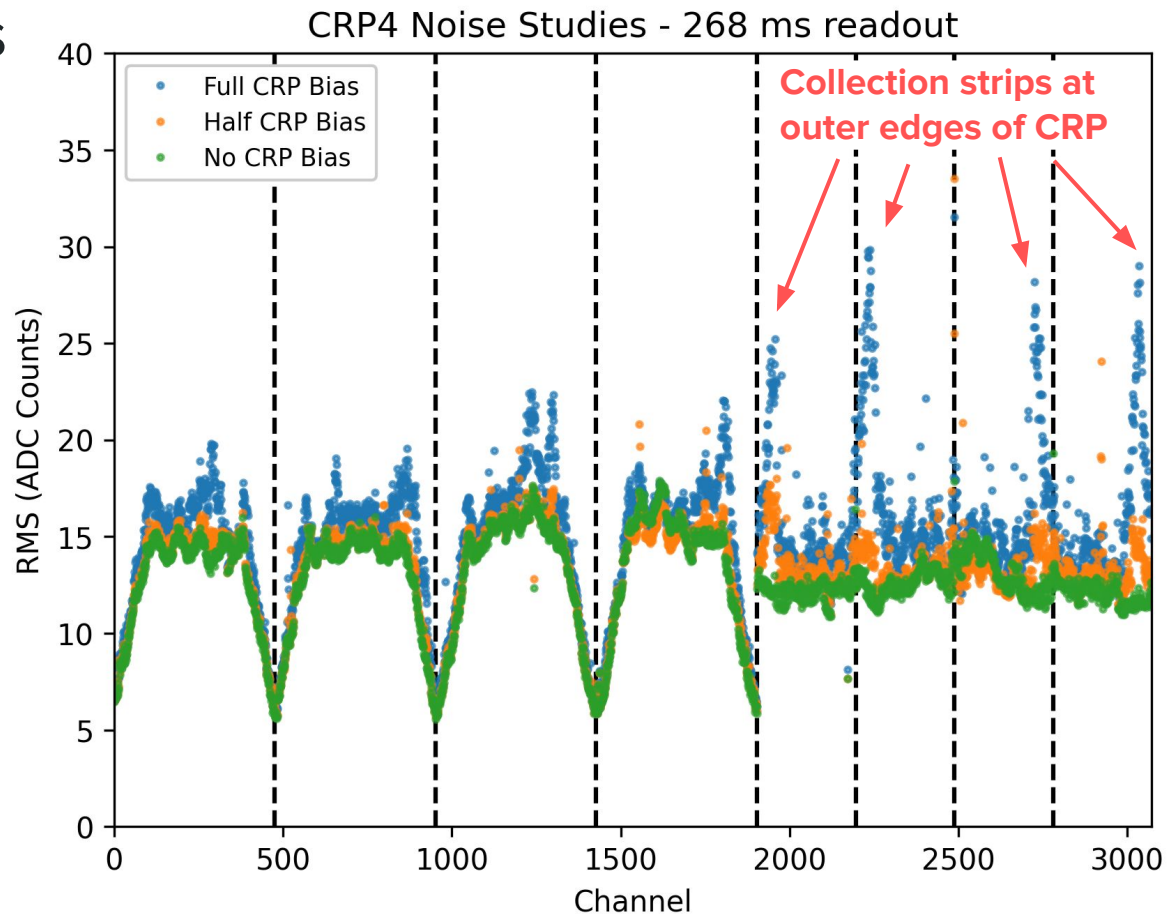
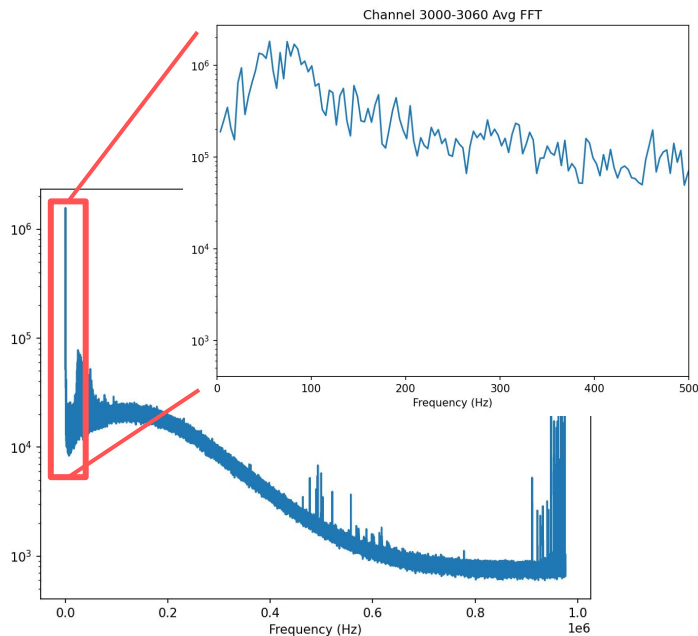
- Data using external trigger from CRT signal, sent to both PDS and CE DAQ
- Timestamps and signals look like they match

# Electronics Response Stability in CRP4

- Upon initial cooldown, missing frames were appearing in data coming from 2 FEMBs (compared to 7 in CRP5)
- After adjusting the PLL\_band settings on the COLDATA chips from 0x20 to 0x25, these errors have vanished entirely, and all electronics channels have been well-behaving for the entirety of the CRP4 cold run
  - We will attempt the same fix on CRP5 during its retest
- The most recent WIB firmware version tracks CRC errors that show up in each frame it sends
- Investigation of the data before the COLDATA PLL adjustment shows CRC errors never appeared in frames that actually got sent
  - The “CRC errors” we were previously identifying were purely the result of entirely missing frames

# Microphonic (?) Effects

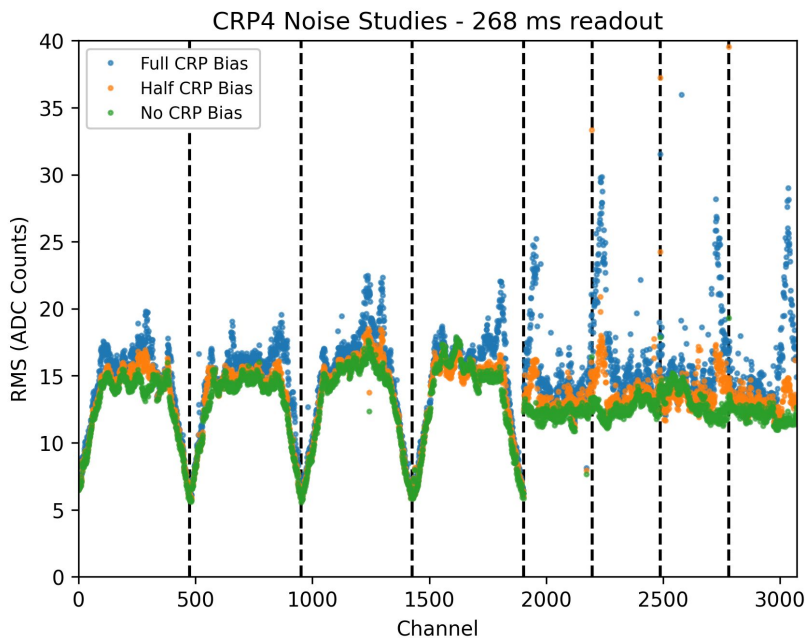
- Very low frequency (50-100 Hz) oscillations on some collection strips when CRP bias is on
  - Channels that run under the adapter boards?



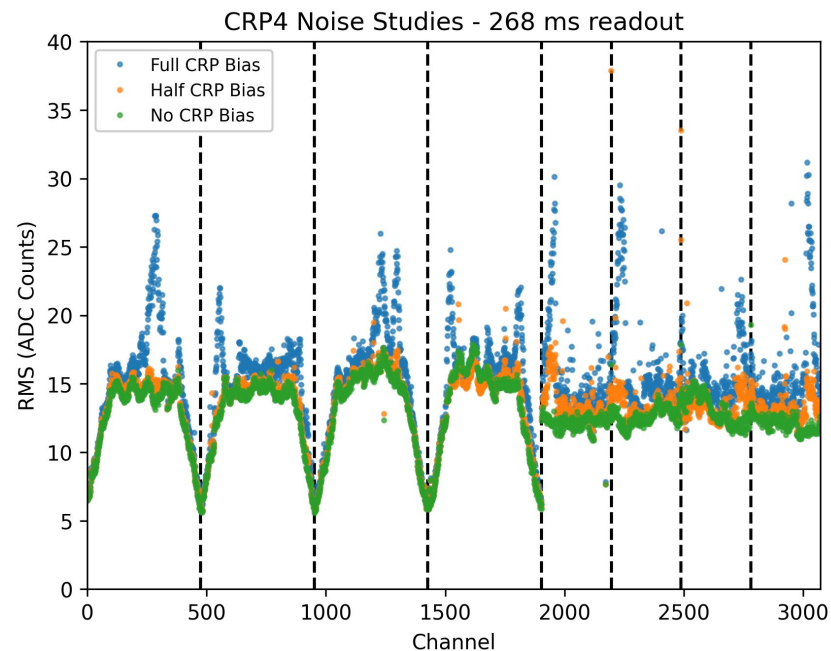


# Variation over Time

- Intensity of oscillations in different areas varies over time

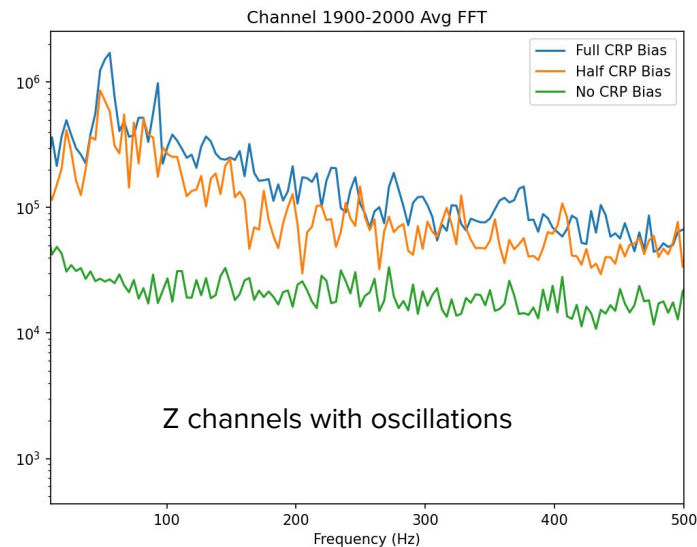
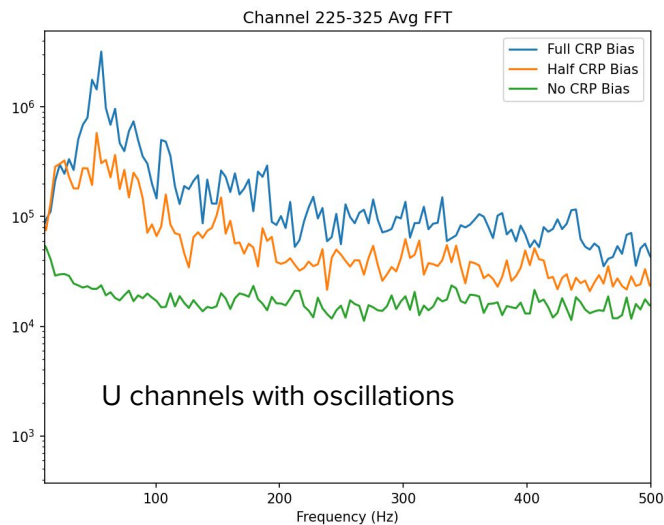
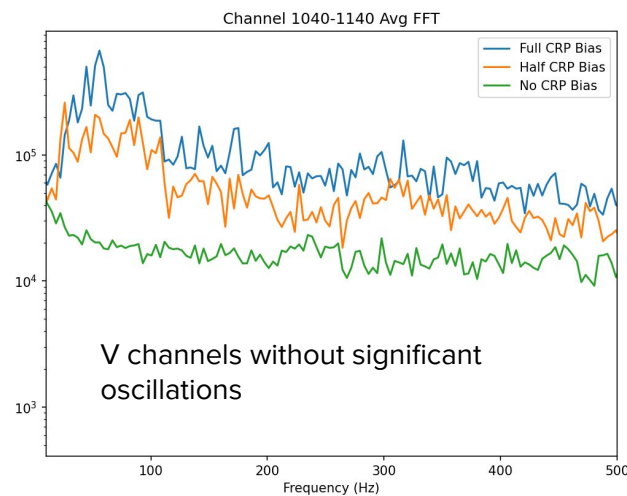


Sampled  
at a  
different  
time with  
the same  
conditions



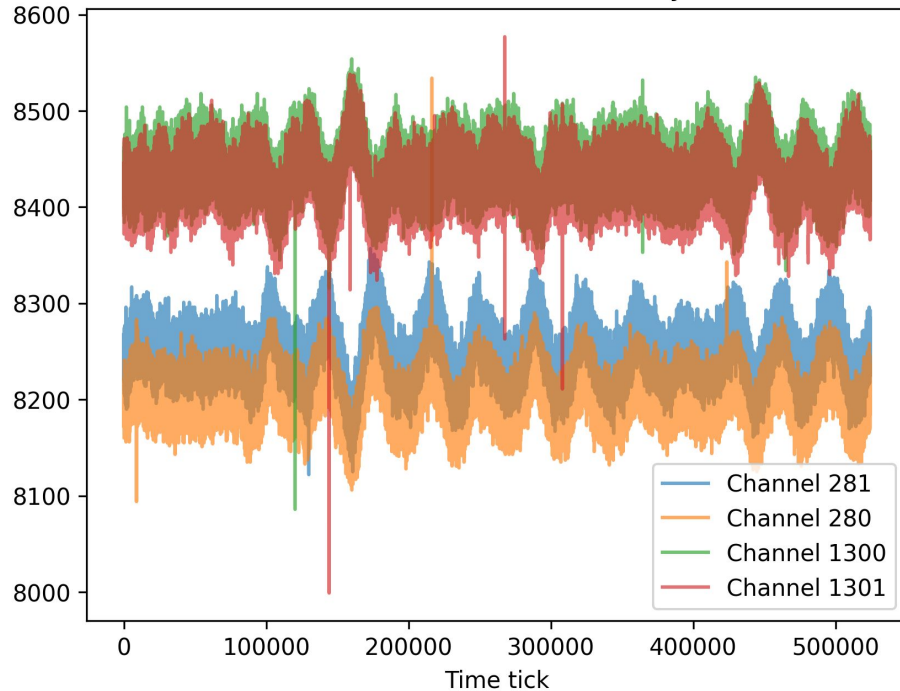
# Oscillation Frequency

- Effect is consistently in the 50-100 Hz region (maybe most peaked around 50 Hz?) on channels where it appears



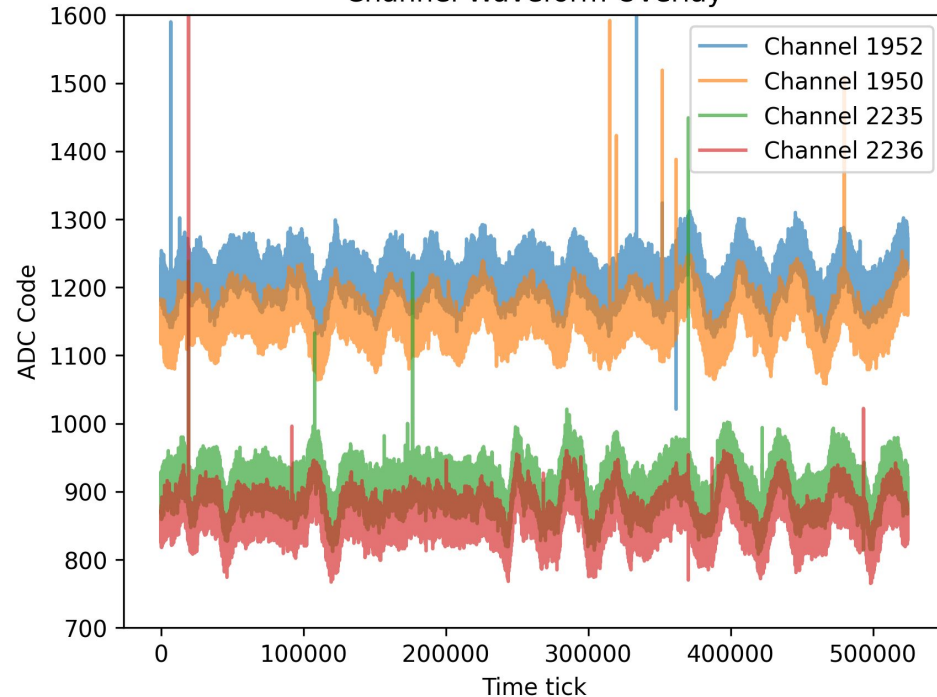
- Induction channel oscillations are coherent within the same area of the same plane
- Oscillations are coherent but flipped between U and V channels in the same area

Channel Waveform Overlay



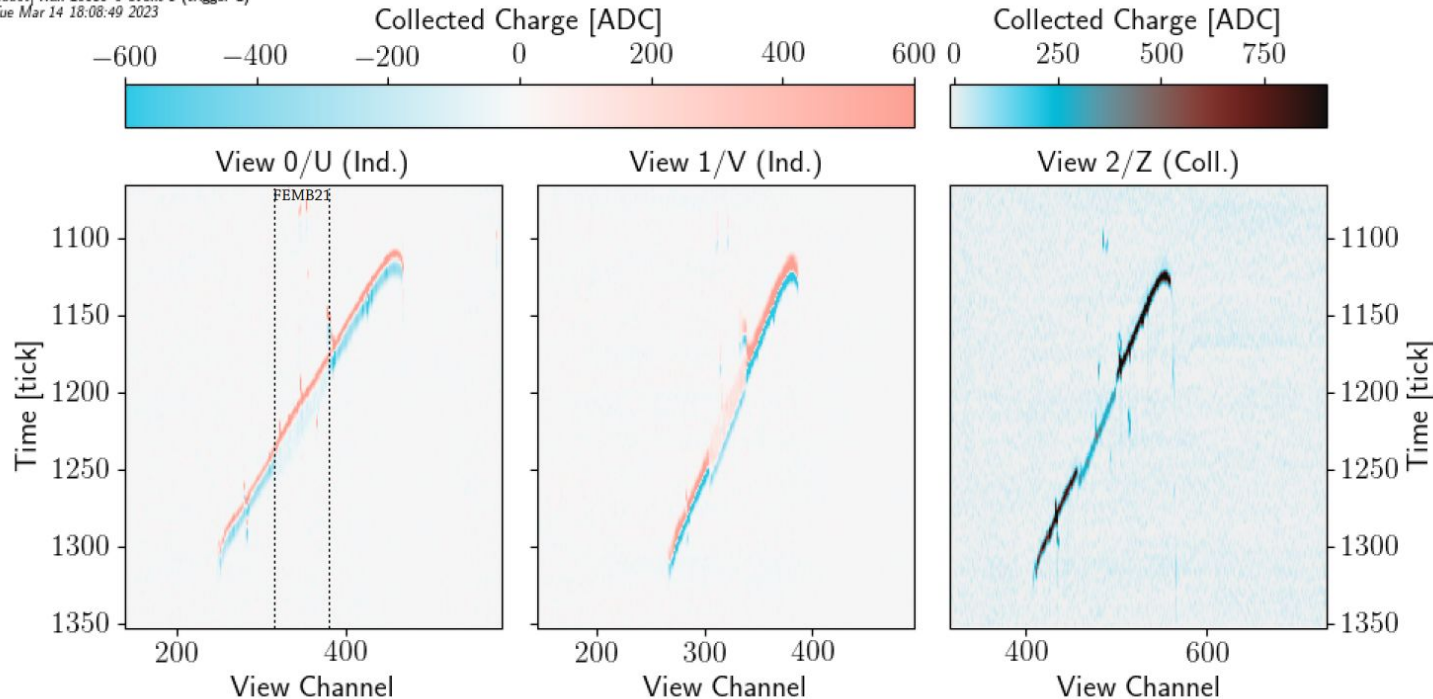
- Collection channel oscillations are coherent within the same quarter of the CRP, but not across different sections

Channel Waveform Overlay



# Missing U Bias on 2 Boards

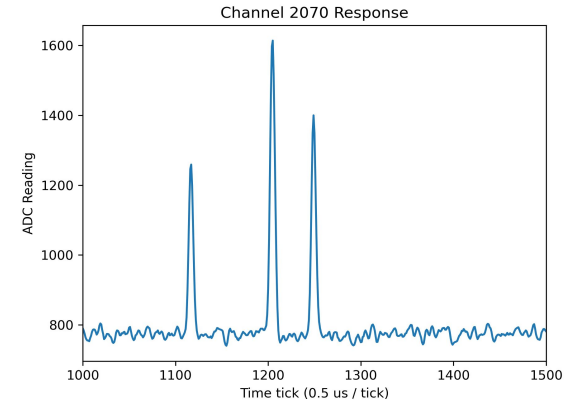
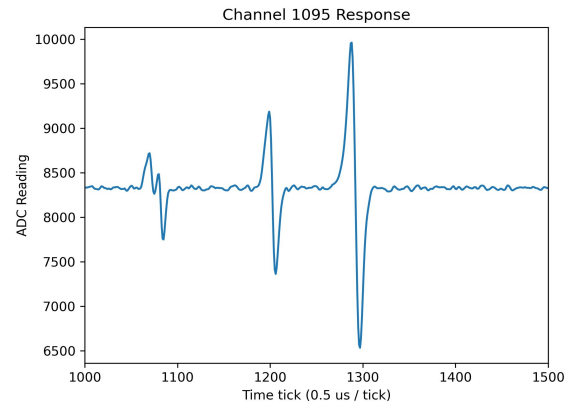
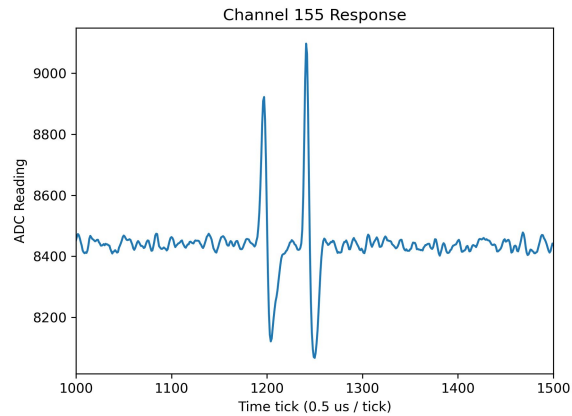
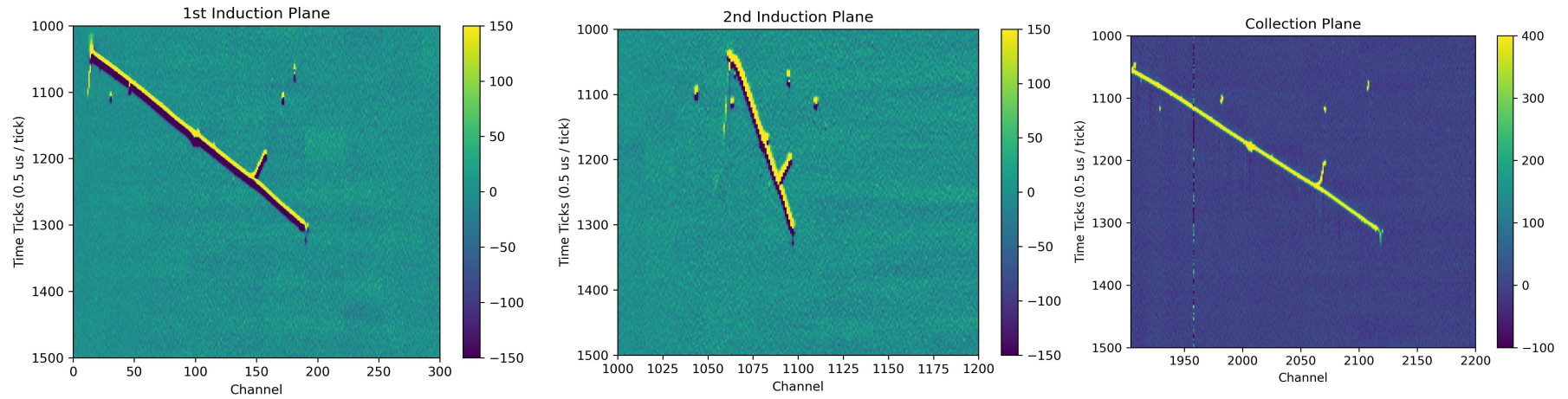
[cbbot] Run 20616-0 event 1 (trigger 2)  
Tue Mar 14 18:08:49 2023



- The boards of FEMBs 9 and 21 were missing their U layer bias due to missing jumper cables
- Confirmed after extraction from coldbox

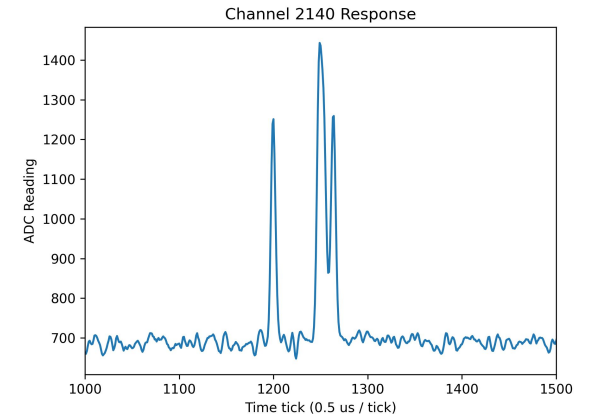
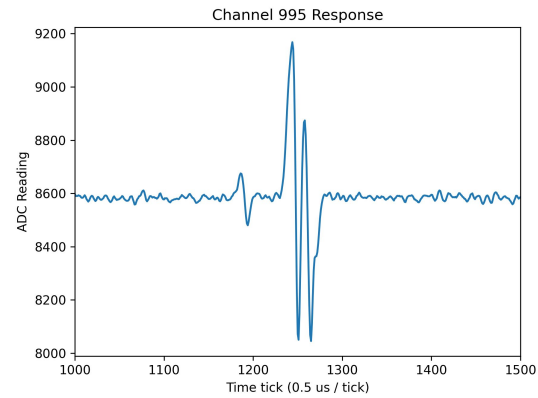
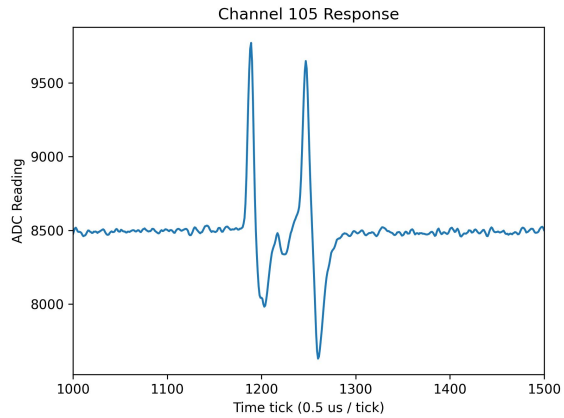
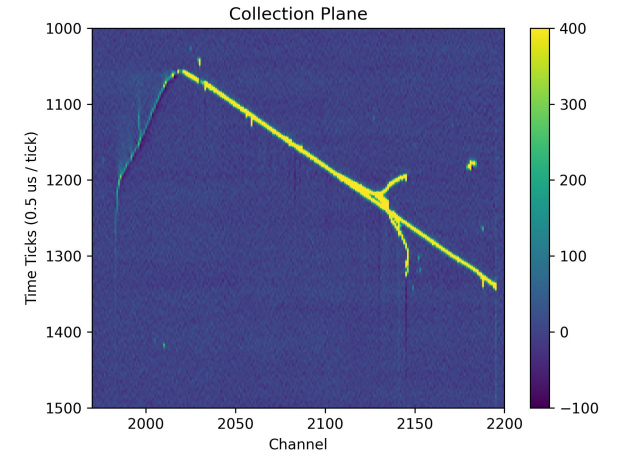
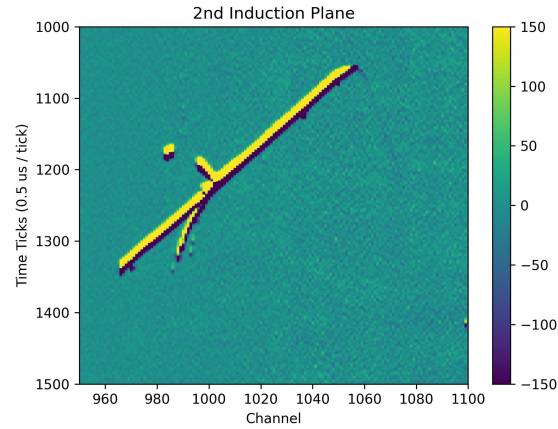
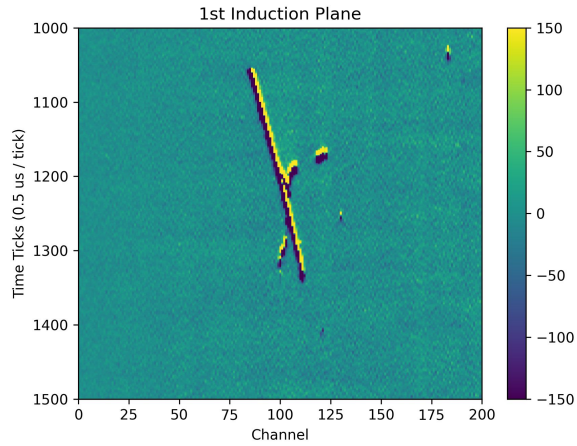
Plot from Laura Zambelli (see [VD analysis slides](#))

## Taken from DAQ trigger tests, run 20472



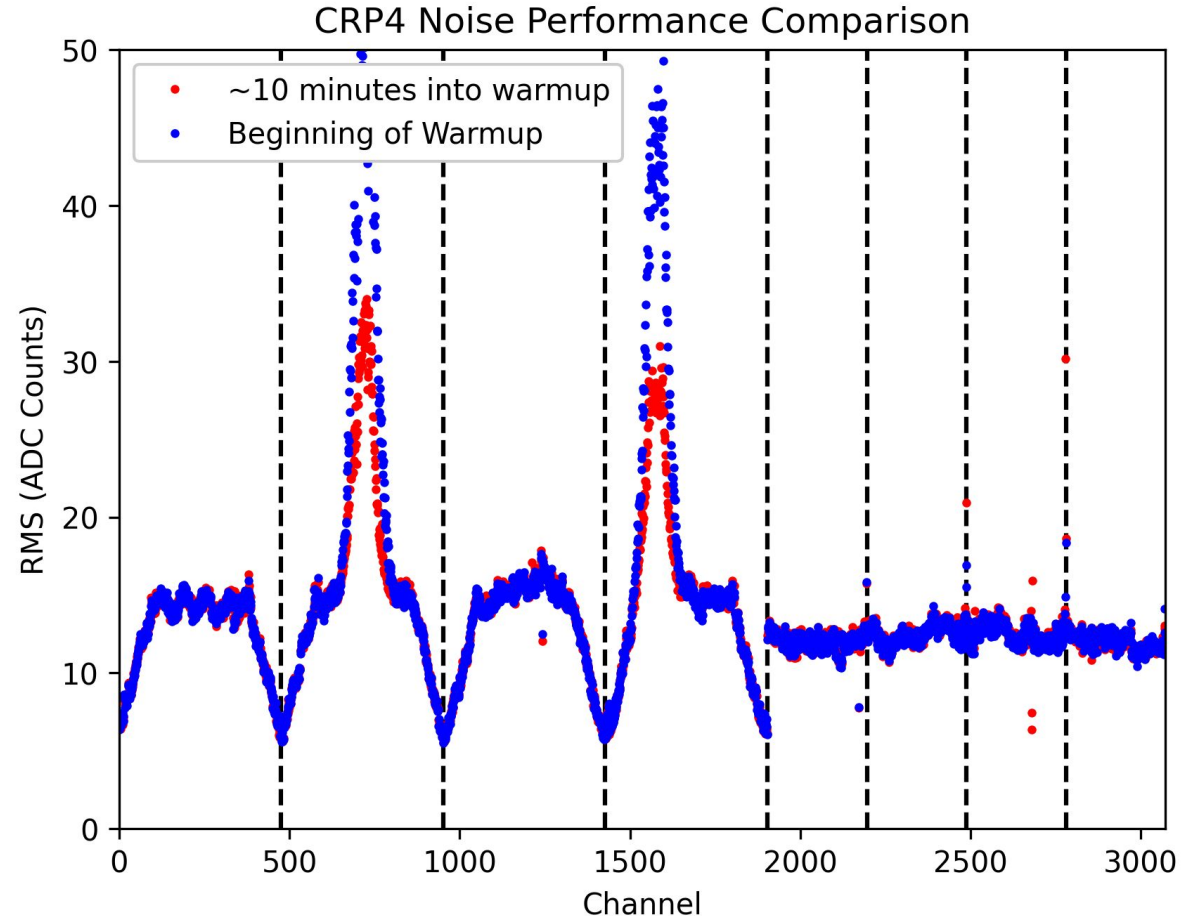


## Taken from DAQ trigger tests, run 20472



# Warmup

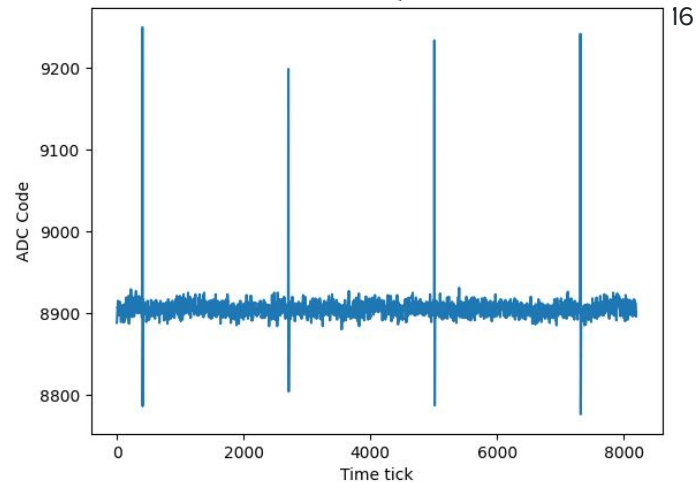
- Shortly after warmup began, we lost two channels to discharge-like damage
  - Channels 2679 and 2680 on the collection plane, on FEMBs 10 and 11
- Cathode and anode HV bias had been ramped down about 45 minutes prior to beginning of warmup



# Channel 2679 Response

**Pulsar DAC=20, low  
baseline setting  
(sees crosstalk but  
not the actual directly  
injected pulses)**

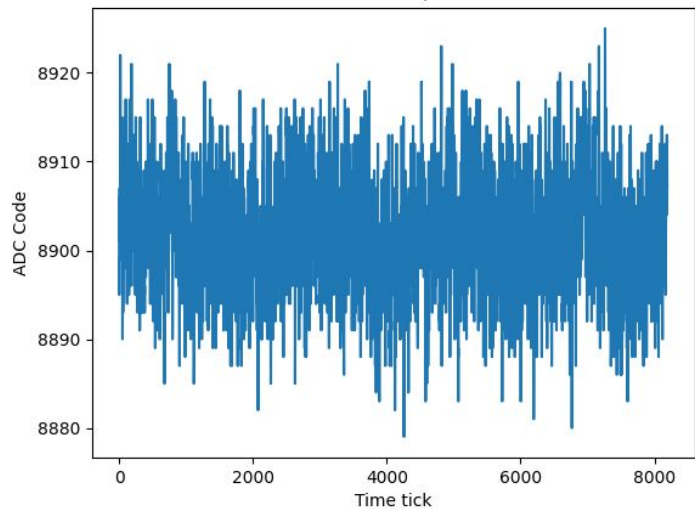
Offline ch 2679, RMS 13.8



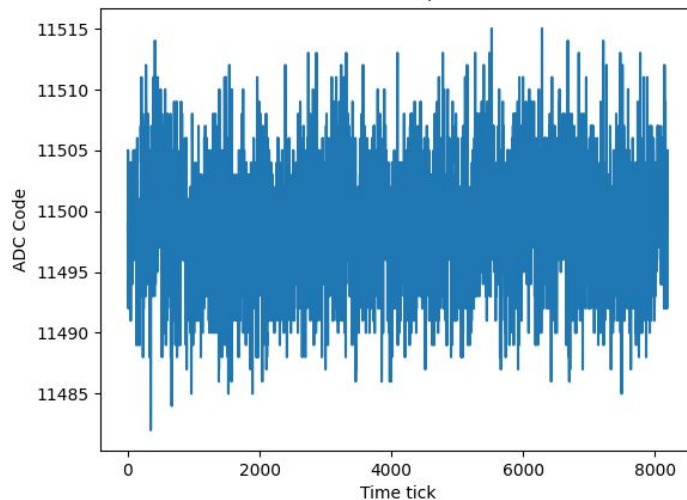
16

**Low baseline setting**

Offline ch 2679, RMS 6.4



Offline ch 2679, RMS 4.7

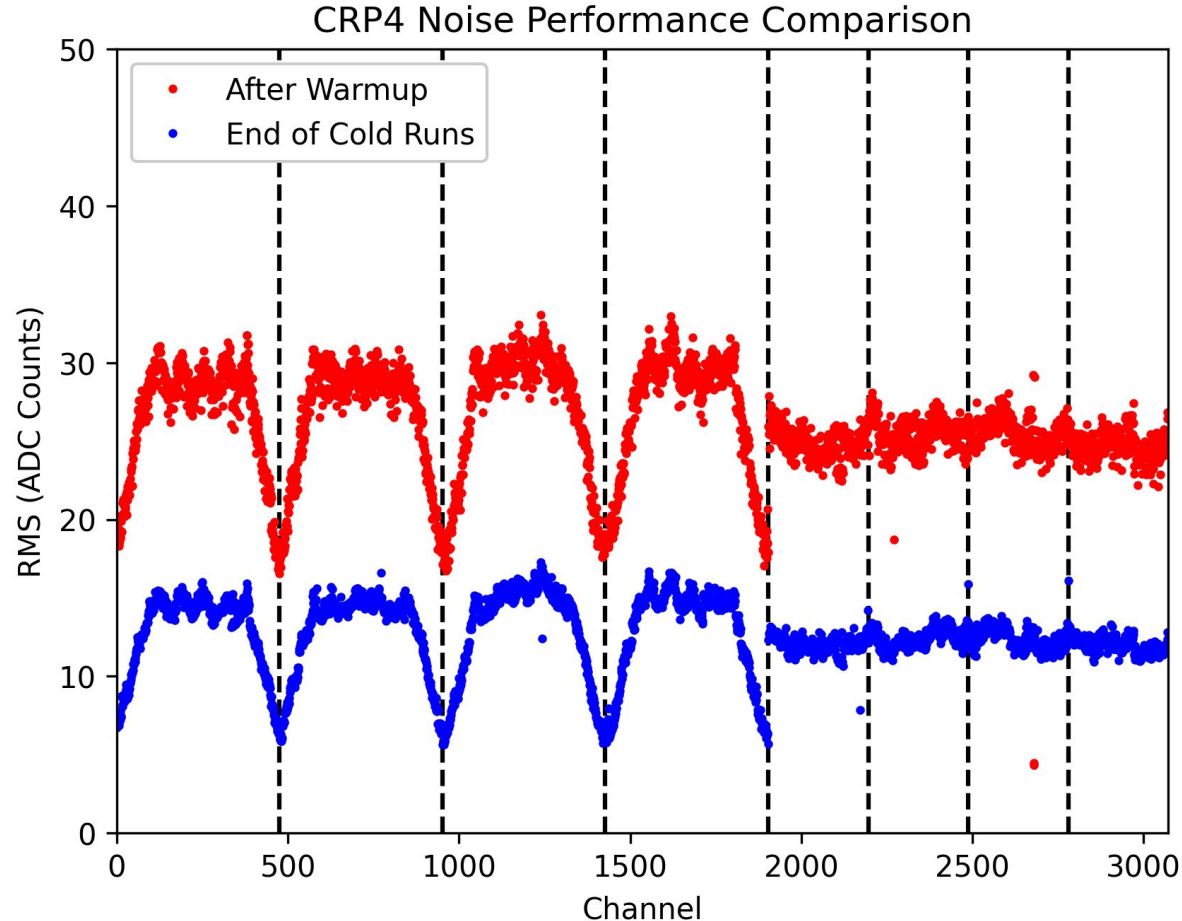


**High baseline  
setting**



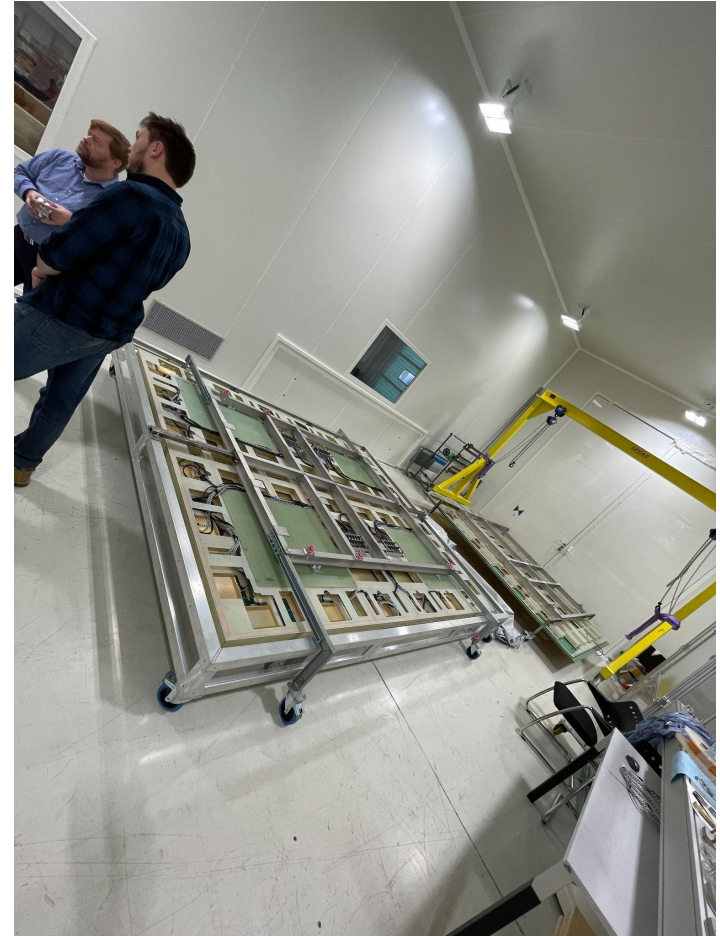
## After Warmup

- Two channels lost - these two FEMBs have now been replaced on CRP4
- Channels 1243 and 2172 seem to be disconnected from part of their strips only at cold
- Channel 2272 seems to have dome connectivity issue only at warm



## Current Status

- CRP4 went back to 185 for 2 FEMB replacements, installation of adapter plates, and fix of 2 boards missing U bias
  - New FEMBs respond as expected
- Modifications completed today, and CRP4 will return to EHN1 at the end of this week for installation in NP02
- CRP4 will not be cold tested again until PD2-VD operation



# Summary

- Overall noise conditions were good on CRP4, and all electronics channels were stably sending good data for the entire cold run
  - Collected coincidence data with PDS, and demonstrated negligible effect on noise from simultaneous operation
- Summary spreadsheet of CE tests at [https://docs.google.com/spreadsheets/d/1kITBjhjOxpX\\_5PvHlAnY9aTm8fa4zeQE8lbcees9ZXc/edit?usp=sharing](https://docs.google.com/spreadsheets/d/1kITBjhjOxpX_5PvHlAnY9aTm8fa4zeQE8lbcees9ZXc/edit?usp=sharing)
- We see a microphonics-like effect at  $<100$  Hz when CRP bias is on, similar to what was seen on CRP5
  - Has minimal impact on signal-to-noise ratios in most normal analyses, but causes non-negligible pedestal oscillations between trigger windows
- 2 channels suffered discharge-like damage shortly after warmup began
  - Corresponding 2 FEMBs have been replaced, and will be sent back to BNL