CRP6 Coldbox Results

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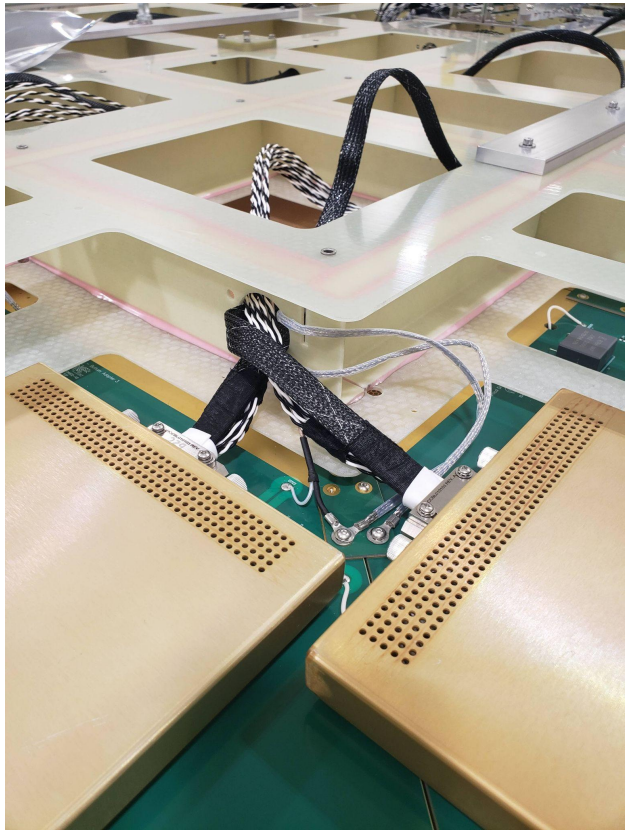
CE Consortium Meeting 12/5

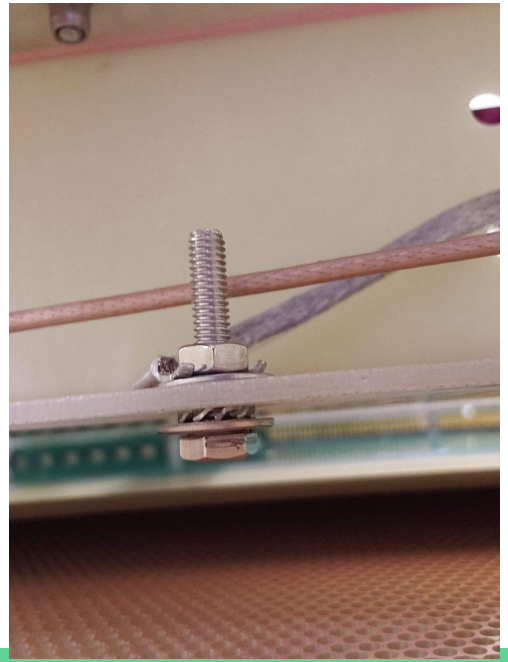
CRP6 Changes

- CRP6 uses an updated design compared to the CRPs already installed for ProtoDUNE-VD
- **Electronics changes:**
  - Updated FEMB design, mostly with minor changes for improved monitoring and additional ground planes
  - 27-meter cables instead of 25-meter cables
- **CRP changes**:
  - Updated anode production technique (for easier assembly)
  - New edge cards (connecting anode strips to the electronics)
  - Replacing the former copper ground plane with a bronze mesh incorporated into the composite frame
- Just completed testing in the NP02 VD LAr coldbox

Ground Mesh

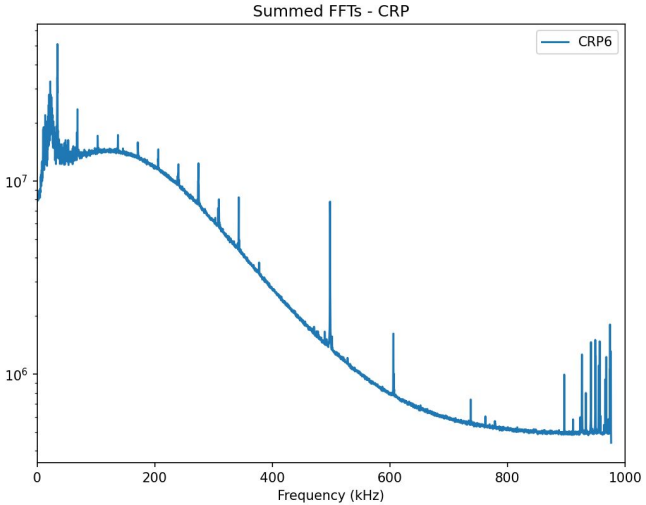
- CRP6 tests a design with a bronze mesh built into the composite frame, with grounding braids screwed into it and going to the FEMBs
- Multimeter measurements showed resistances of >= 0.8 ohms between the FEMBs and the ground mesh

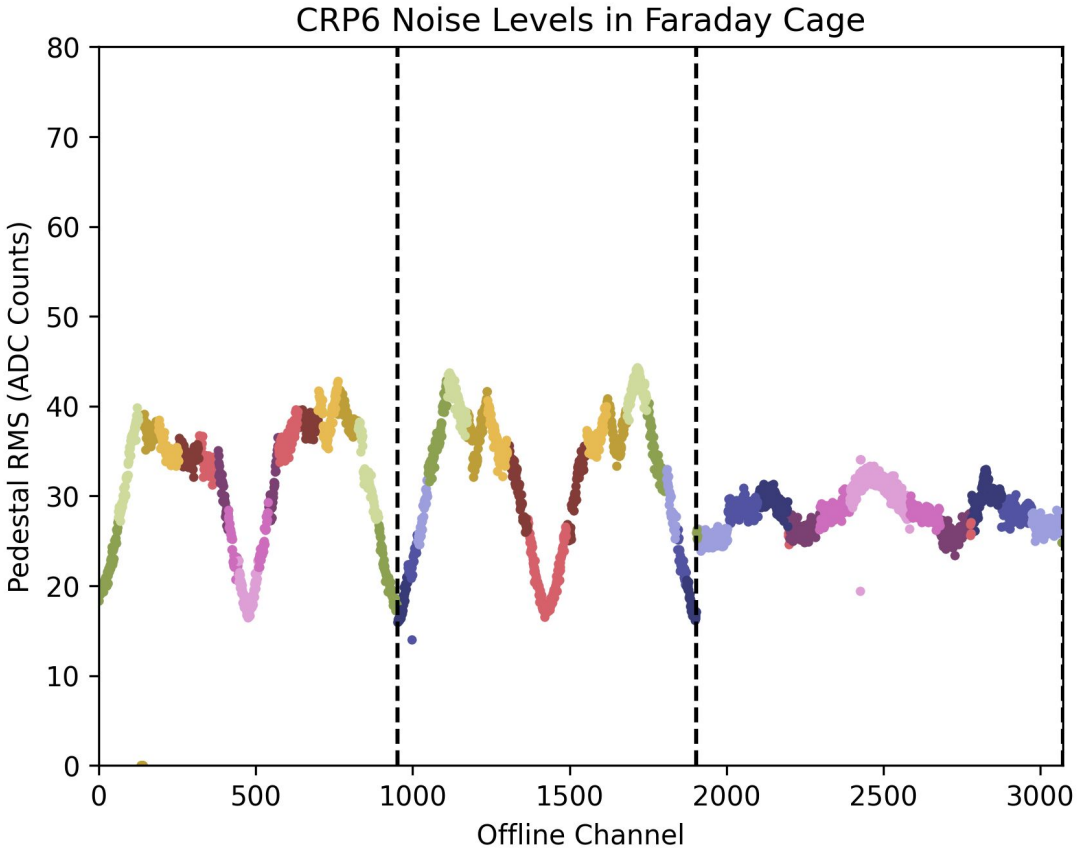




Faraday Cage Tests

- CRP6 tested in Faraday cage in EHN1 first
- Unexpected noise patterns already visible, and baseline noise higher than seen in CRP4/5



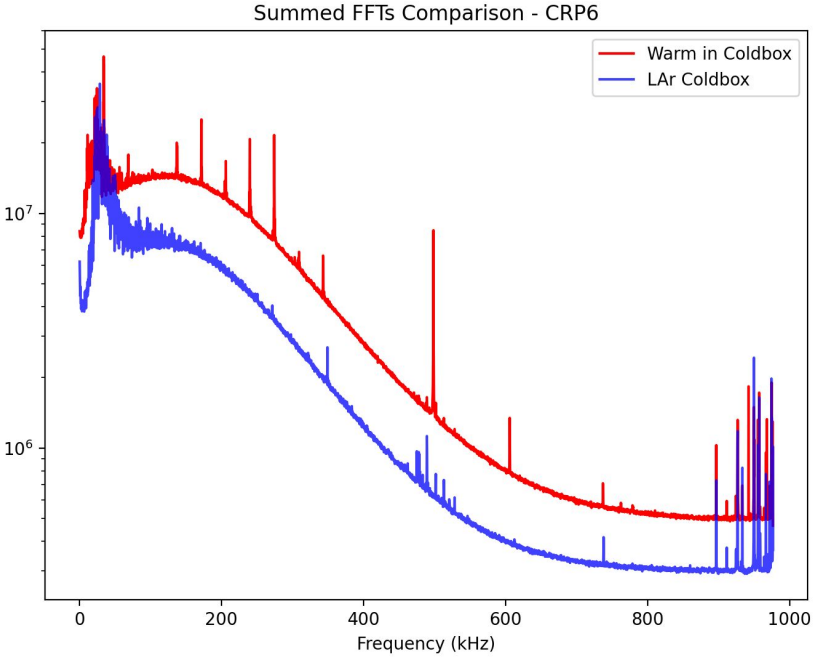


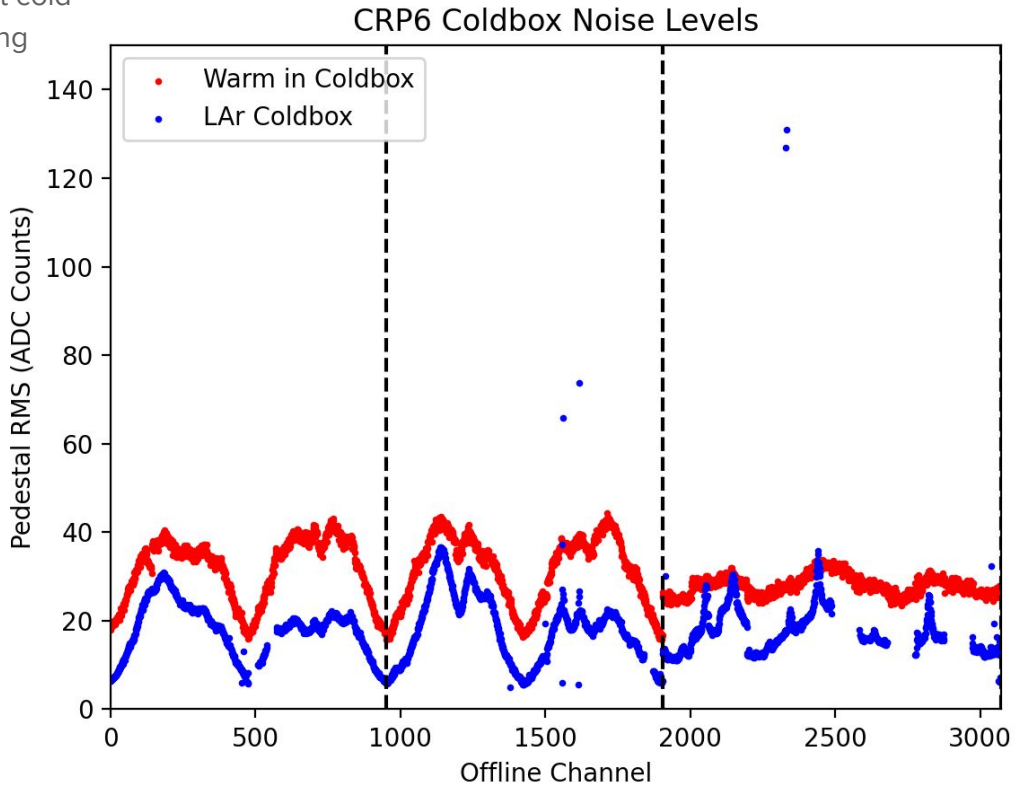
FEMB Issues During Coldbox Preparation/Cooldown

Affected FEMB	Issue Description	Severity	Resolution
FEMB 18	25% of I2C writes to one ColdADC fail	Operation is otherwise normal once the writes are successfully completed	Replaced before beginning of coldbox test. No issues with replacement
One COLDATA on FEMB3	Requires short-cable line driver settings (intended for upper APA) to not have corrupted data	The reason for this is unexplained, but it can be custom-configured	Hard-coded the corresponding WIB to provide the appropriate FEMB settings
FEMB 10	Cannot be powered. DC/DC module readings suggest the power line is disconnected.	Inoperable in LAr	Still broken after warmup. Will inspect power cable.
FEMBs 2 & 12	Do not respond to FAST commands. Can still be powered normally.	Inoperable in LAr	Self-recovered during warmup. Will inspect cables and connections

CRP6 Coldbox Noise Performance

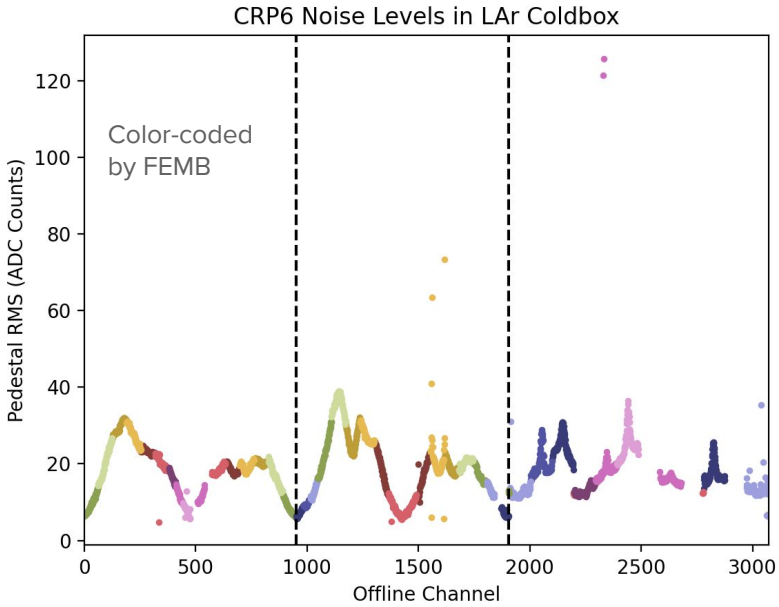
- Noise levels didn't worsen, but remained suboptimal at cold
- We observe the same old problems with channels losing connectivity in LAr

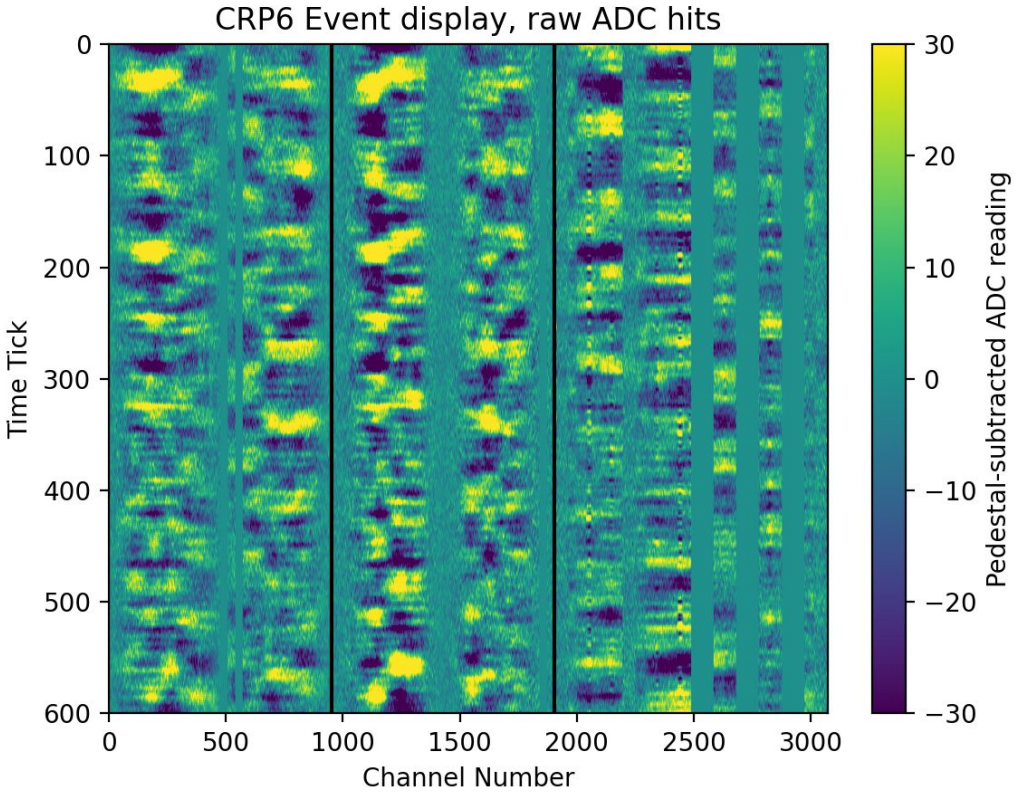




CRP6 Noise Performance in LAr

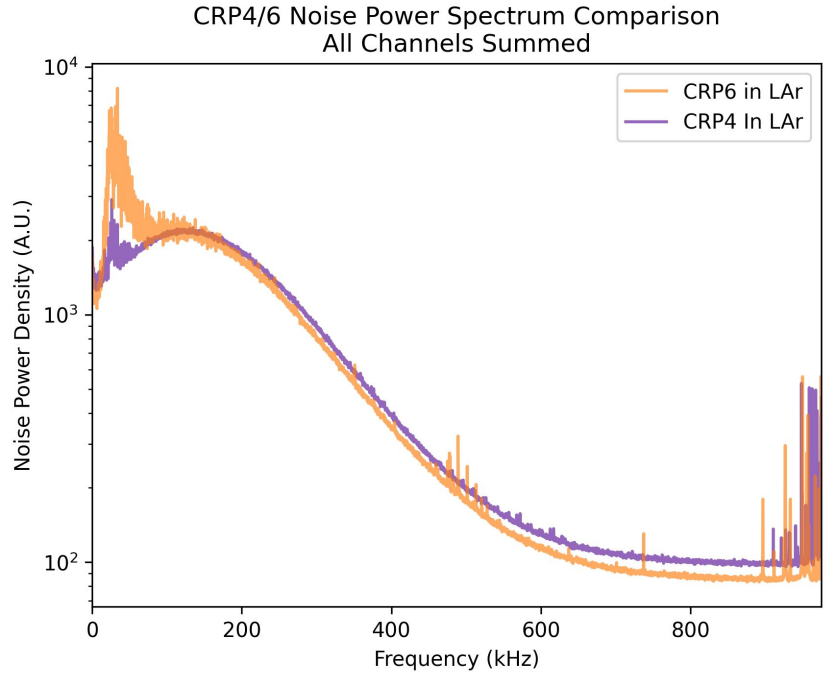
- Noise is coherent within sections, but not across the whole detector

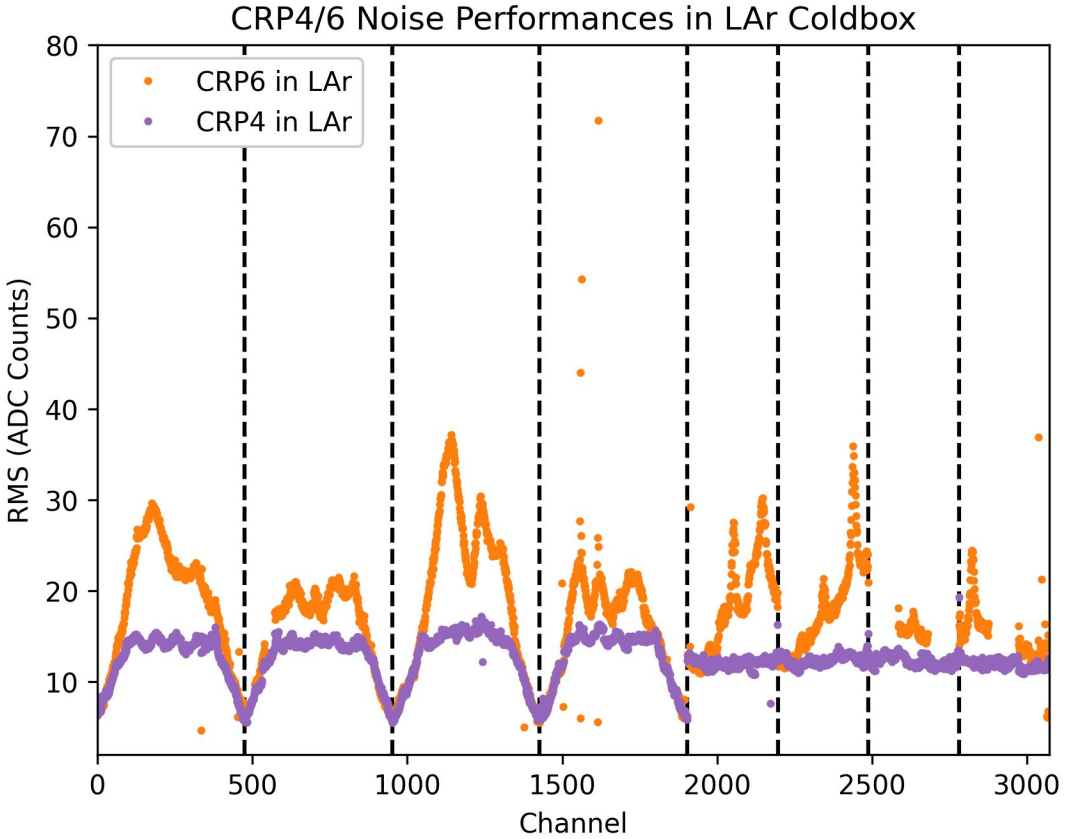




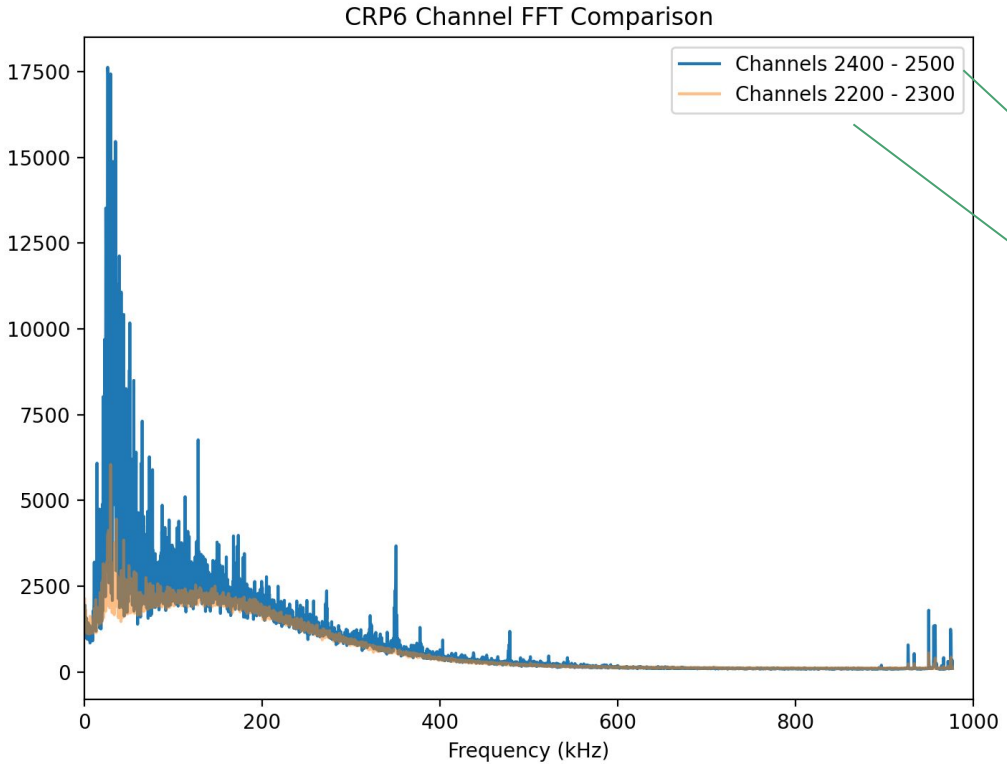
CRP6 / CRP4 Comparison

- Worsened performance in CRP6 largely comes from increased magnitude and width of peak around 25 kHz

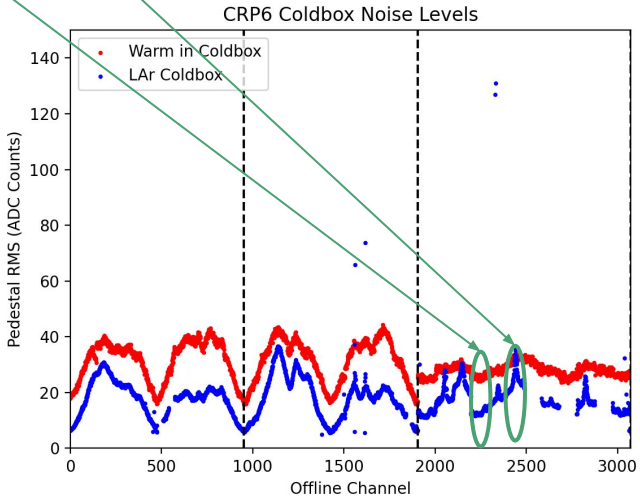




CRP6 Noise Comparisons

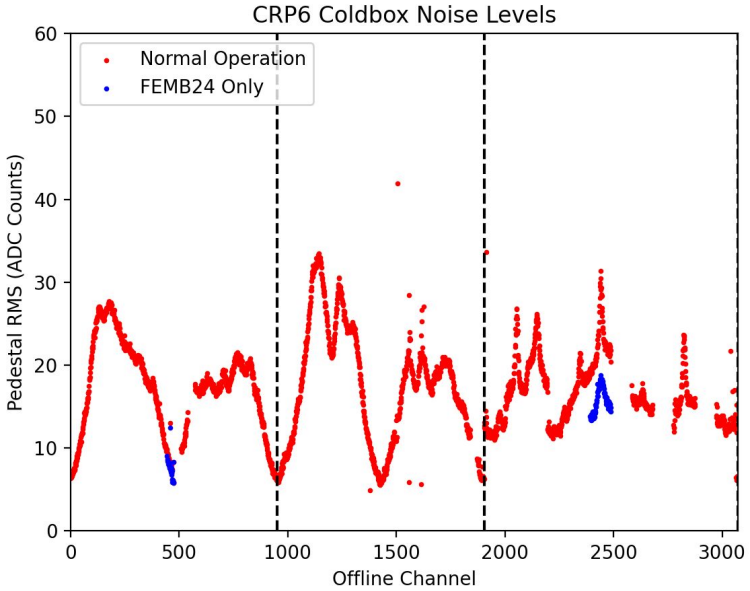


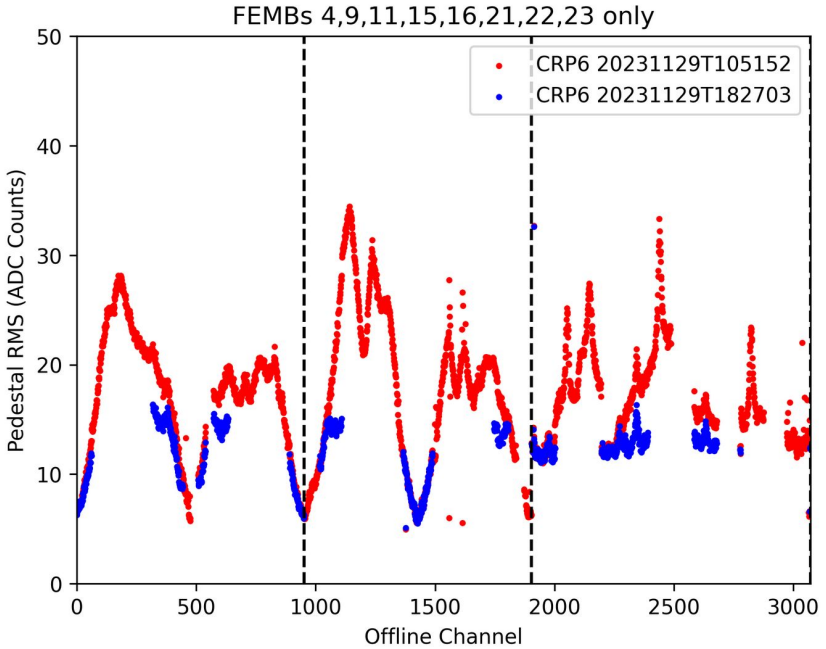
- FFT comparison of noisier vs quieter collection channels



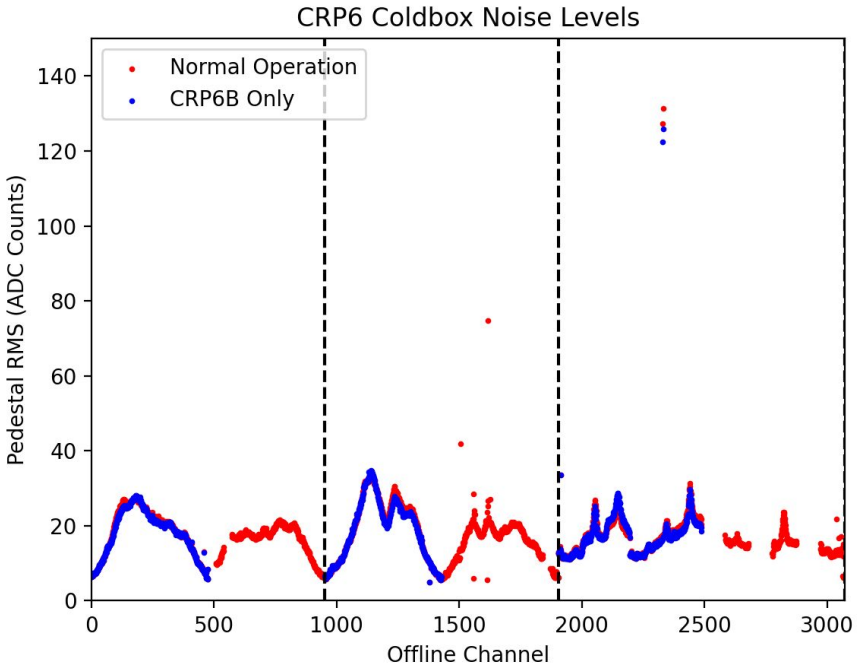
CRP6 Noise Studies

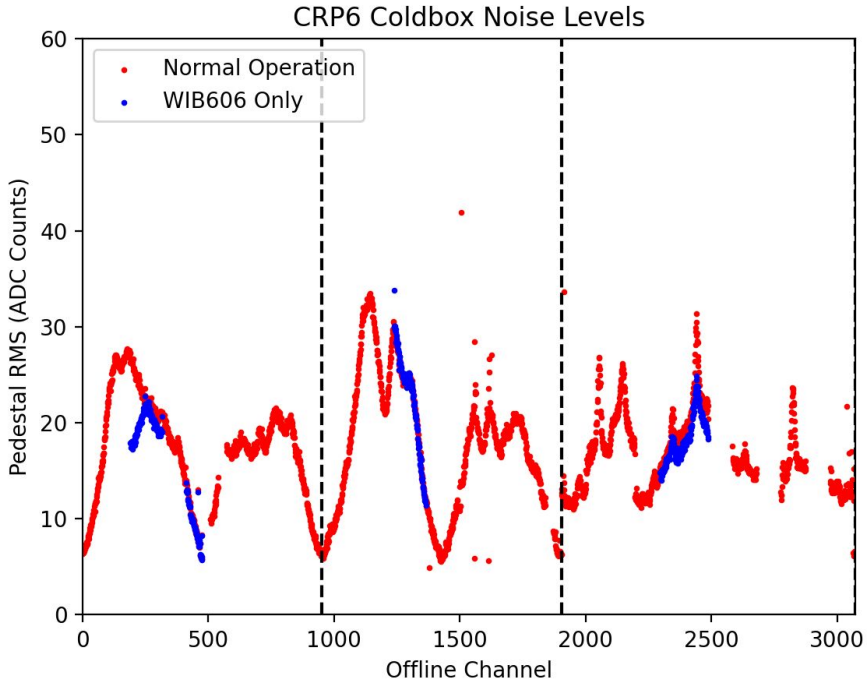
- Noise levels are better when only some subset of the FEMBs are powered
  - Consistent with power/grounding issues as the cause of excess noise



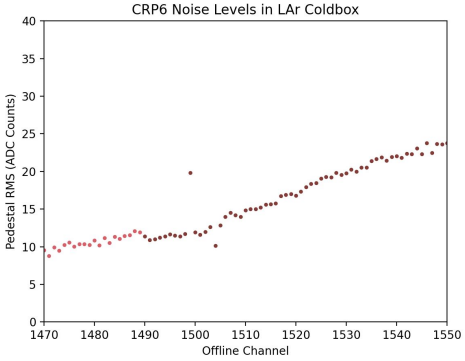


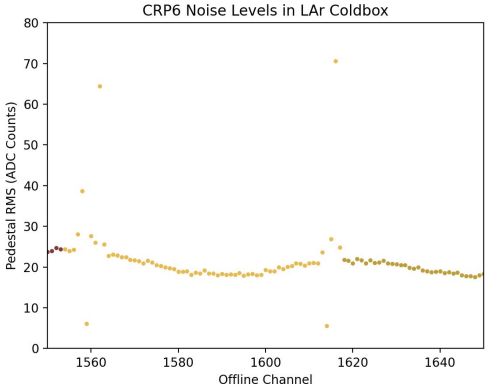
CRP6 Noise Studies

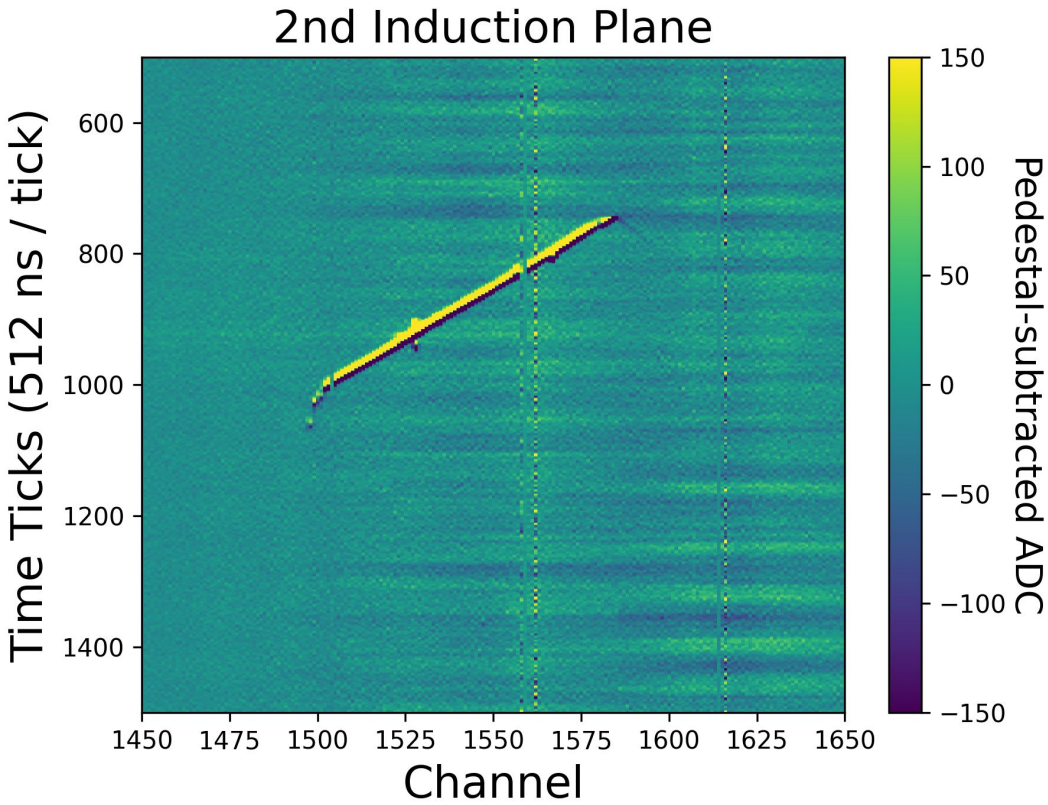




Channels with Broken Connections



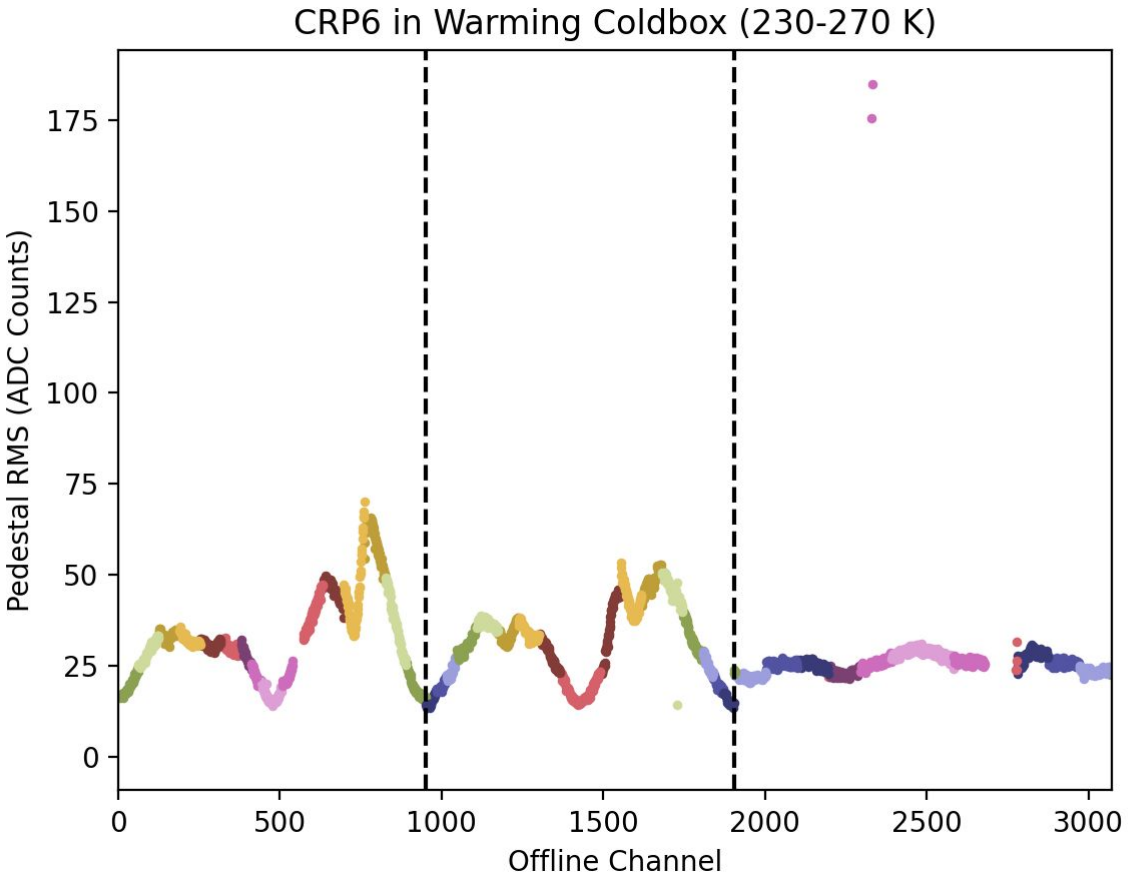




We can see the effects of some of the channels having broken connections in the tracks

Channel Connectivity

- Most of the channels with broken connectivity recovered themselves during warmup



Summary and Next Steps

- CRP6 has now been extracted from the coldbox
- The noise performance of CRP6 is notably worse than that of CRP4+5, with worsened grounding being the suspected culprit
- 3 (!) FEMBs had presumed cable-connectivity issues at cold
- Channel connectivity issues at cold from edge cards persist
- **Next Steps:**
  - Replace the bronze mesh with a solid copper plane again for another coldbox test in January
  - Investigate/replace the problem FEMBs and edge cards

- Fortunately, the noise issue is visible at warm
- Unfortunately, some of the cable issues may only be visible in cryo tests