

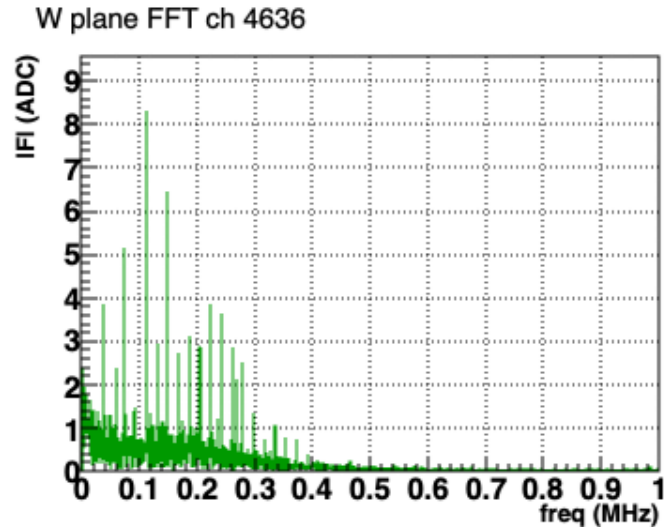
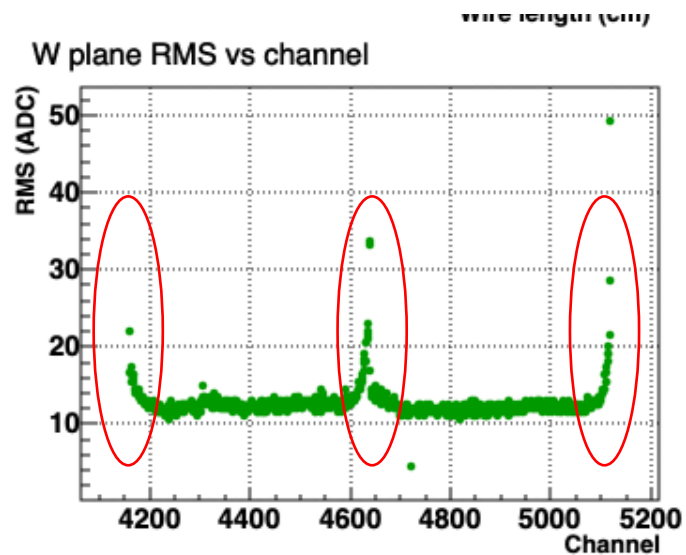
Noise filter revisit summary

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One channel noise filter:

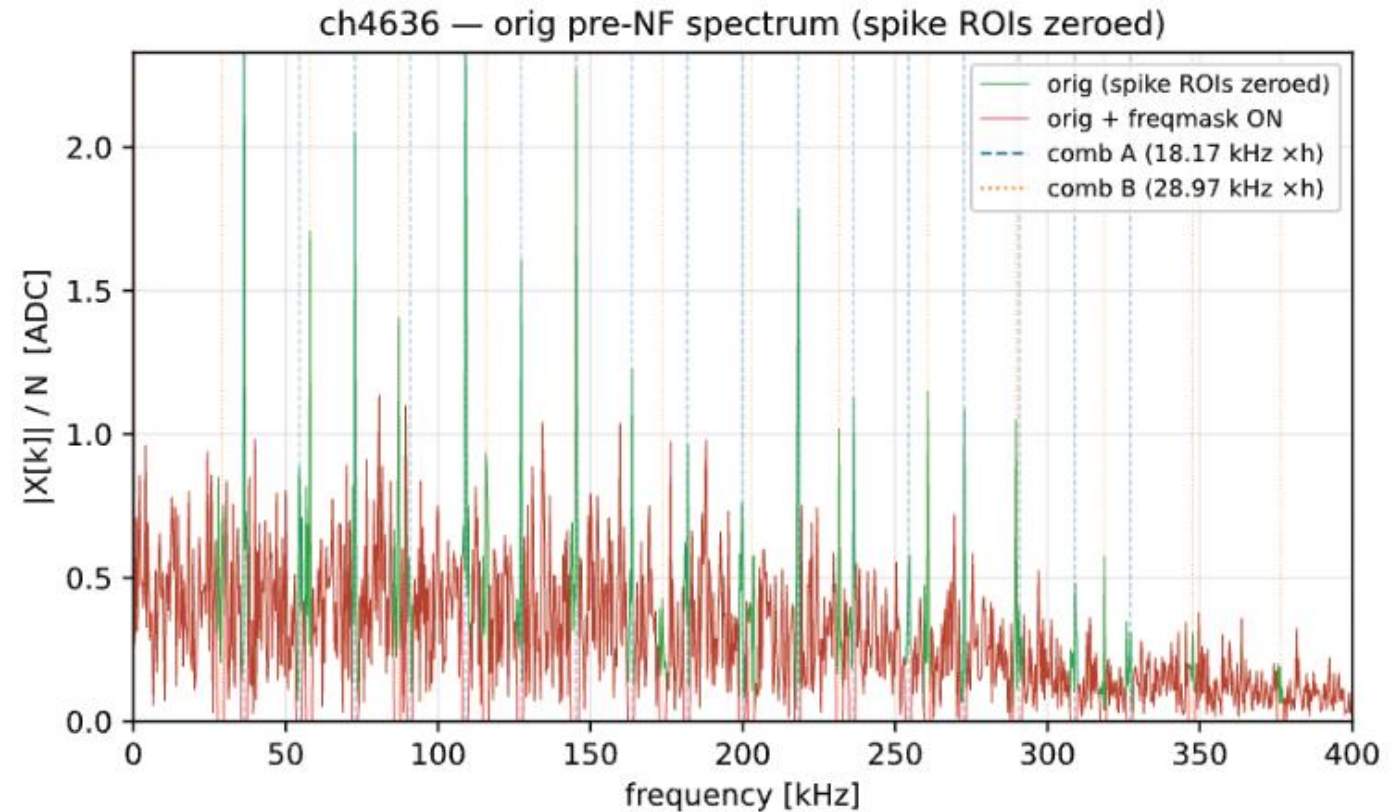
- Bad channel determination and fix:
 - Hand-scan and pre-existing list.
 - Understand bad channel symptom
 - Combine algorithm tag and bad list tag
 - Frequency mask: zeroes FFT bins listed in noisedb
- RMS cut: flags channel if RMS outside [min_rms_cut, max_rms_cut]
 - PDHD:
 - gain dependent (7.8 or 14) flat cut; $10 < \text{rms} < 30(?)$ @14mV/fC
 - PDVD:
 - Top anodes (4–7): flat cut, $8 < \text{rms} < 30$.
 - Bottom anodes (0–3): wire-length-dependent linear cut; scale = gain / 7.8 mV/fC.
- RC filter: confirmed with Shanshan, no AC coupling between front end and ADC now.
- Reconfig problem: not heard yet, will ask on-site people to confirm.

Frequency mask



- Channels may have elevated RMS due to CW pickup
- High RMS, but still has valid signal

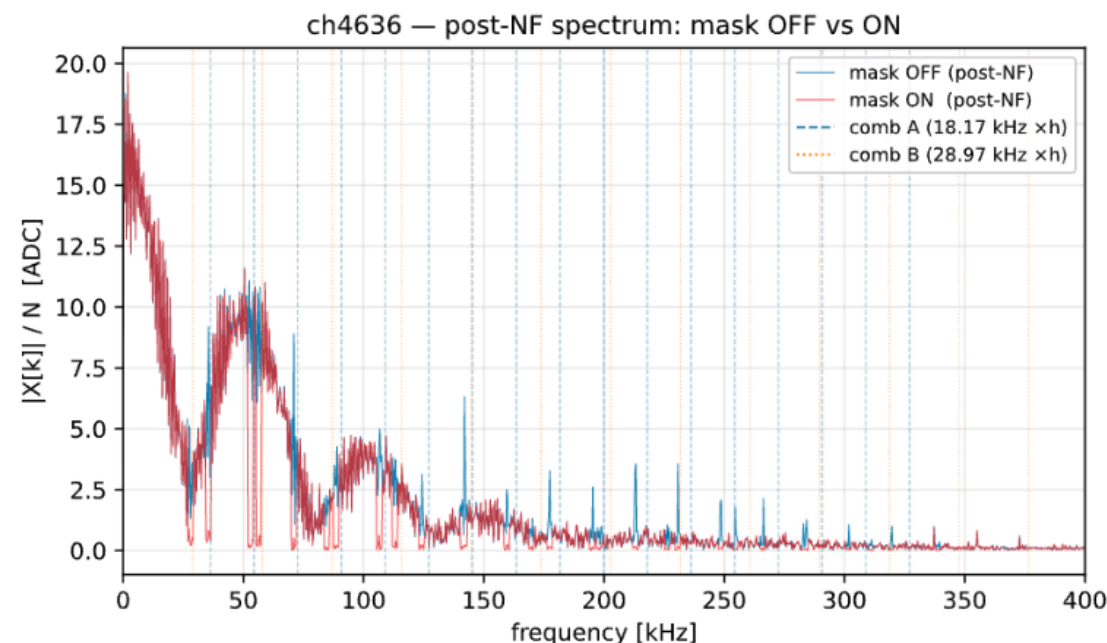
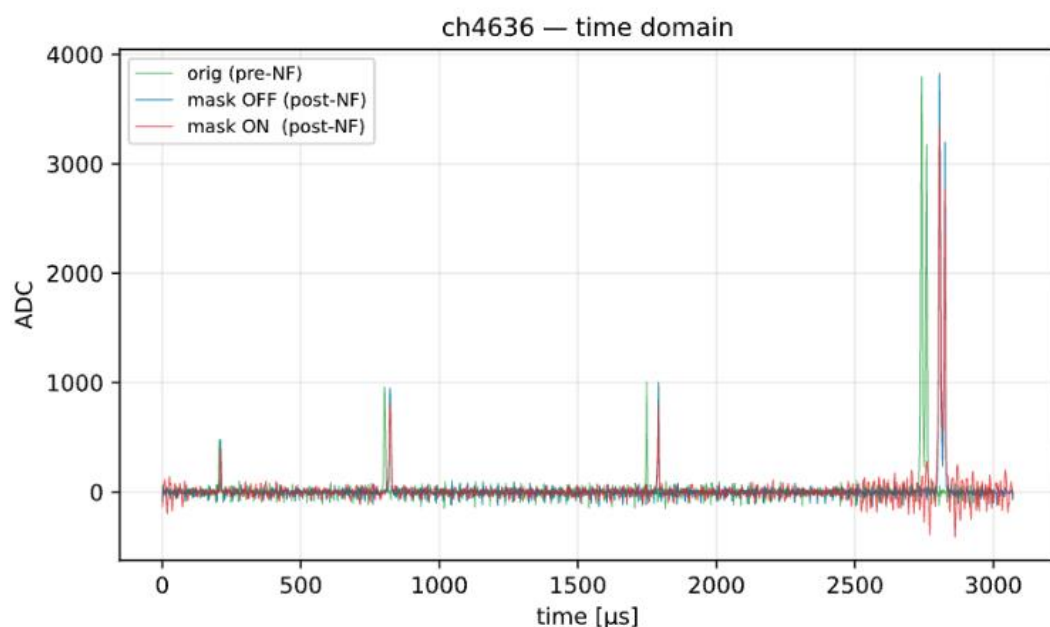
signal region removed:



- Zero specific FFT frequency bins to suppress narrowband **Continuous Wave pickup**

Frequency mask problem

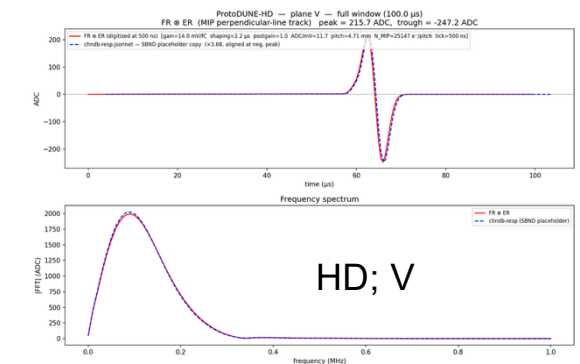
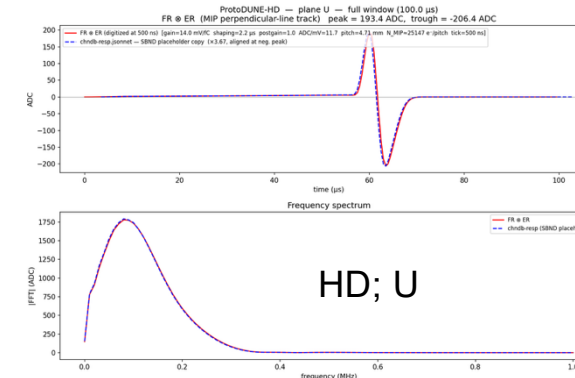
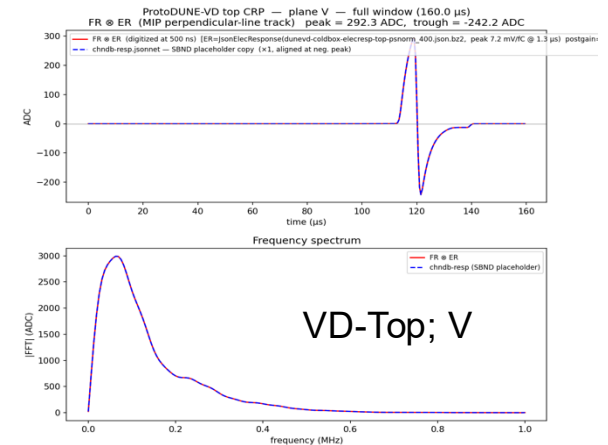
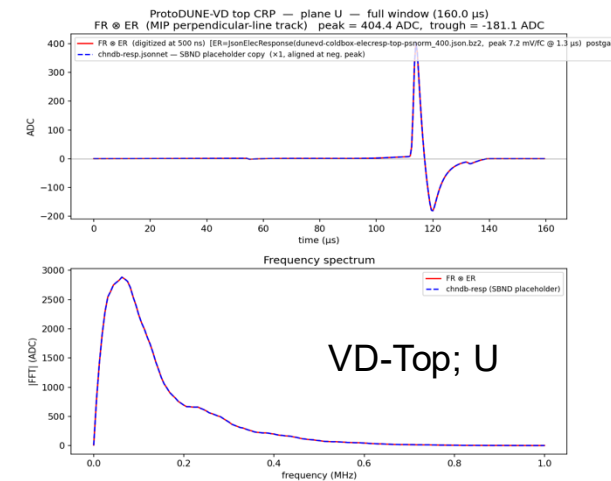
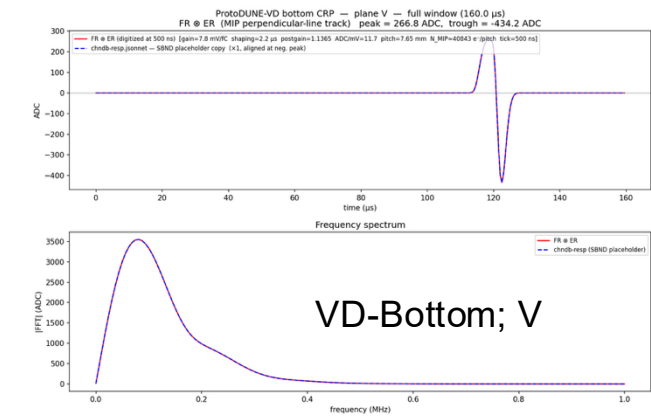
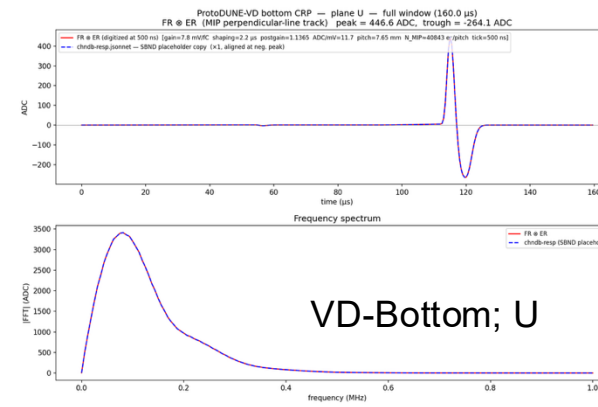
- Observed frequency:
 - PDHD: harmonic comb at 18.17 / 28.97 kHz;
 - PDVD: 23.5 kHz harmonics ($n=2..12$, 1 kHz wide) and 711 kHz doublet.
- Zeroing spike bins causes ringing in the time domain (Gibbs effect): energy spreads hundreds of ticks into the quiet baseline region outside the spike core.



- Coherent noise removal (CNR) will suppress the residual CW coherent component anyway.
- Proposal: omit the frequency mask entirely and relax the RMS upper bound; CNR handles the residual without the Gibbs ringing side-effect.

Coherent noise removal

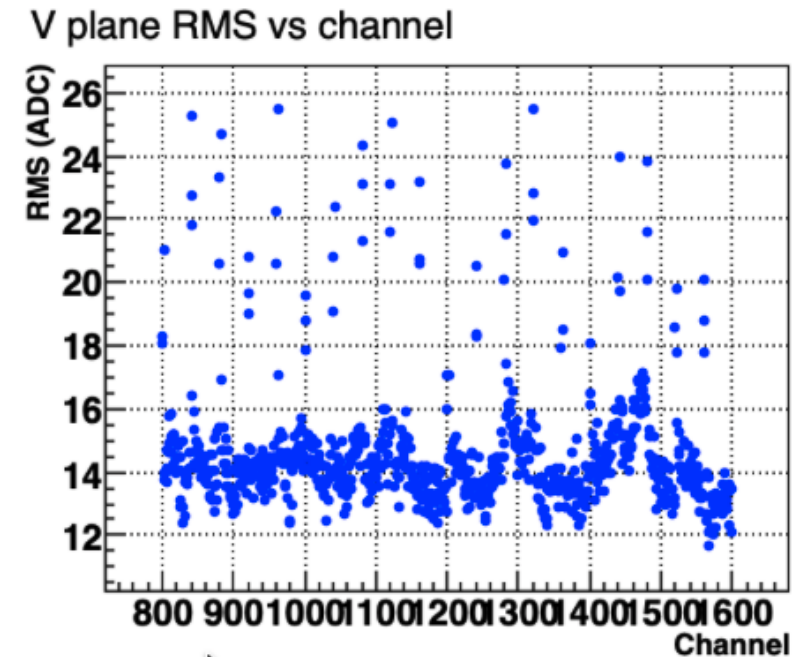
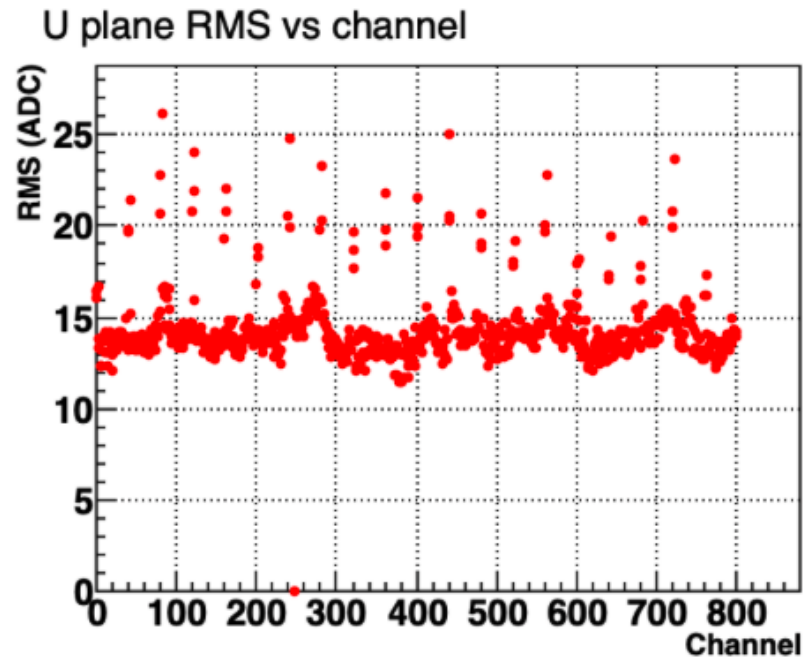
- Decon kernel in CNR:
 - CNR uses a 1D mini-deconvolution to locate ROI regions before group median subtraction.
 - decon kernel = $FR \otimes ER$ convolution.
 - hardcoded in PDHD, empty in PDVD
- Now: detector-specific $FR \otimes ER$
 - *wirecell-sigproc track-response*, stored in `chndb-resp.jsonnet`.
 - cross check between pure calculation and simulate an ideal MIP track.



Coherent noise removal

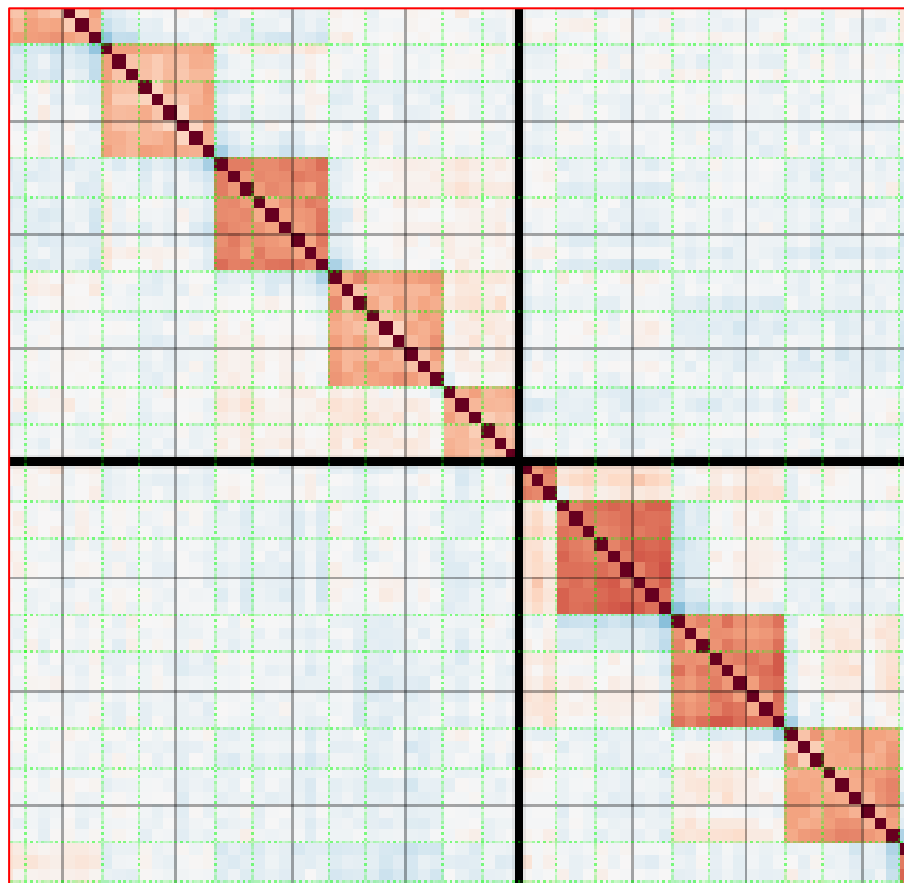
- PDHD issue: 3 channel shift is observed in coherent noise grouping.

After the CNR



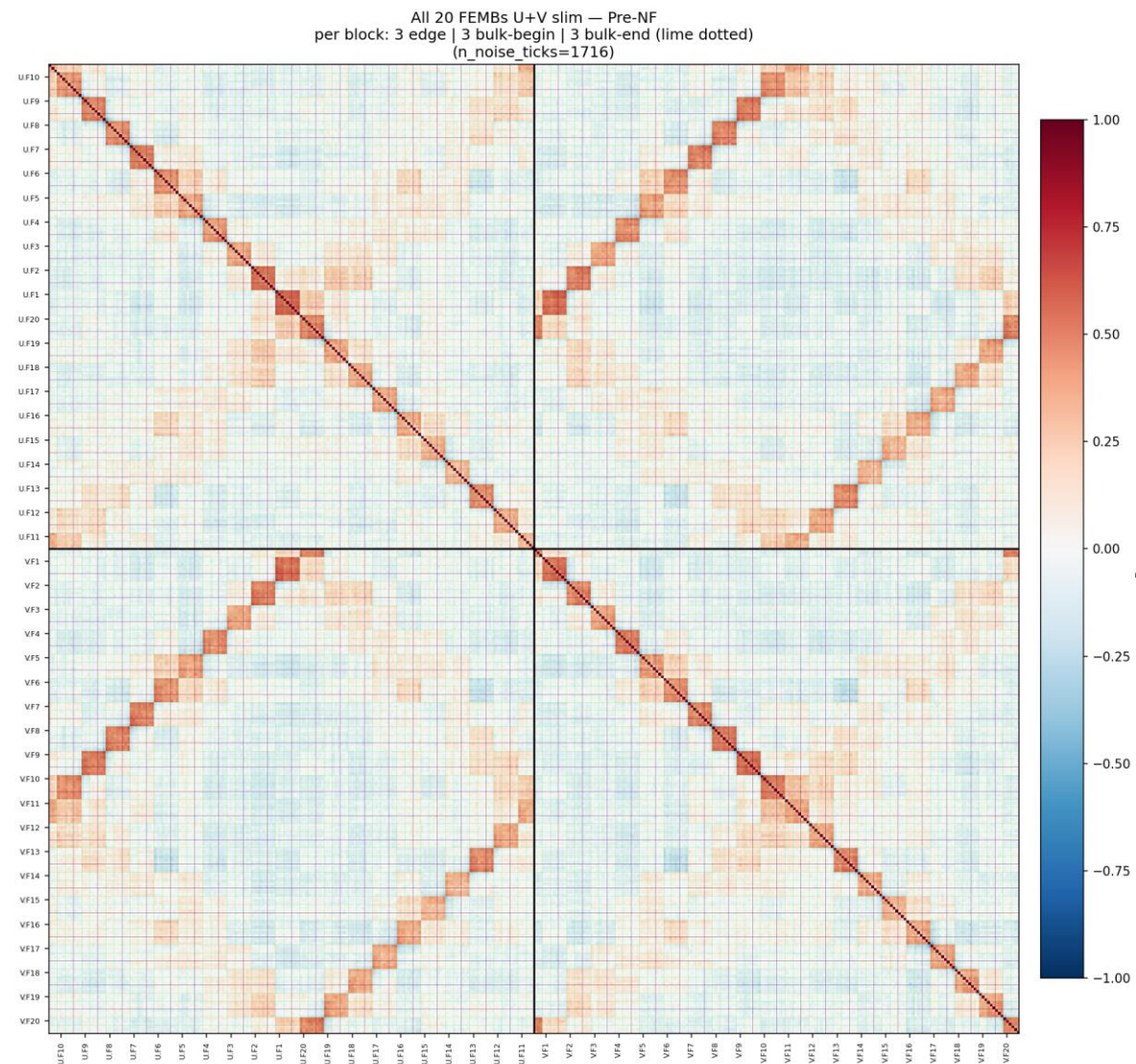
- CNR group matches CE FEMB hardware group mapping.
- **Data shows group boundaries are misaligned by 3 channels.**

Coherent noise removal



one group

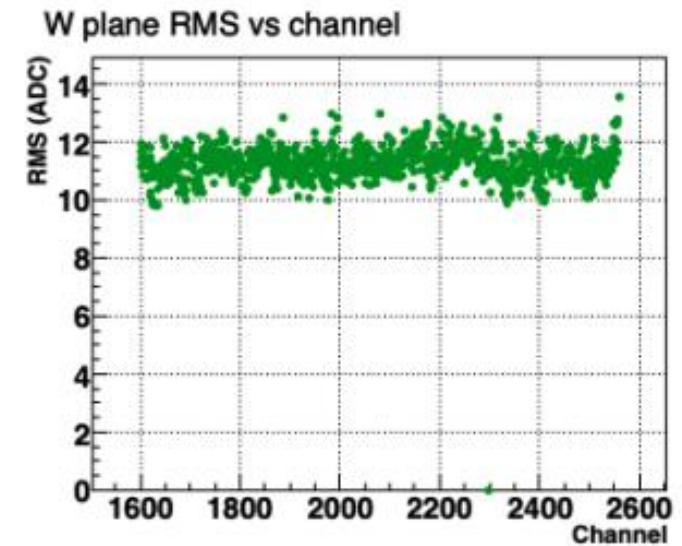
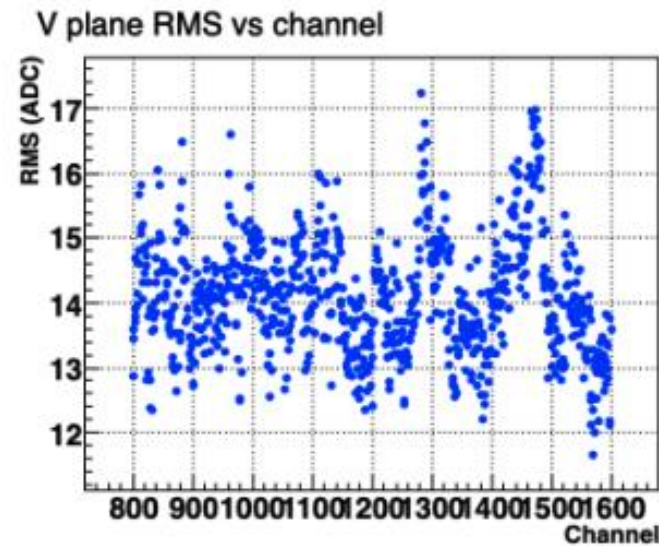
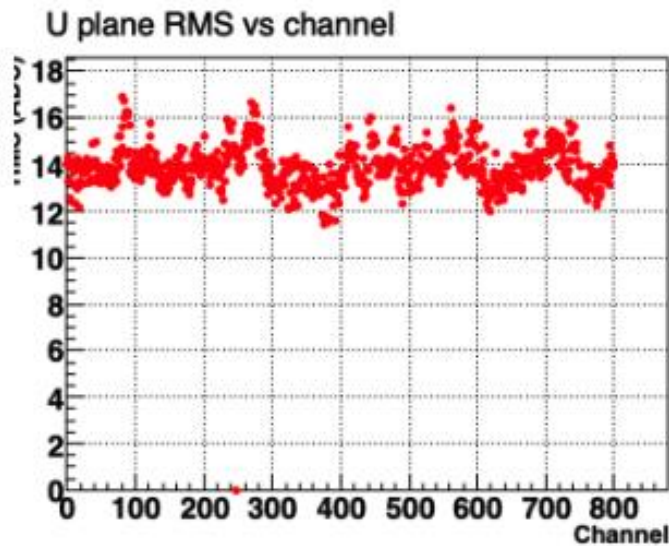
edge 3 wires
begin 3 wires
end 3 wires



Edge 3 wires with the bulk beginning/ending 3 wires

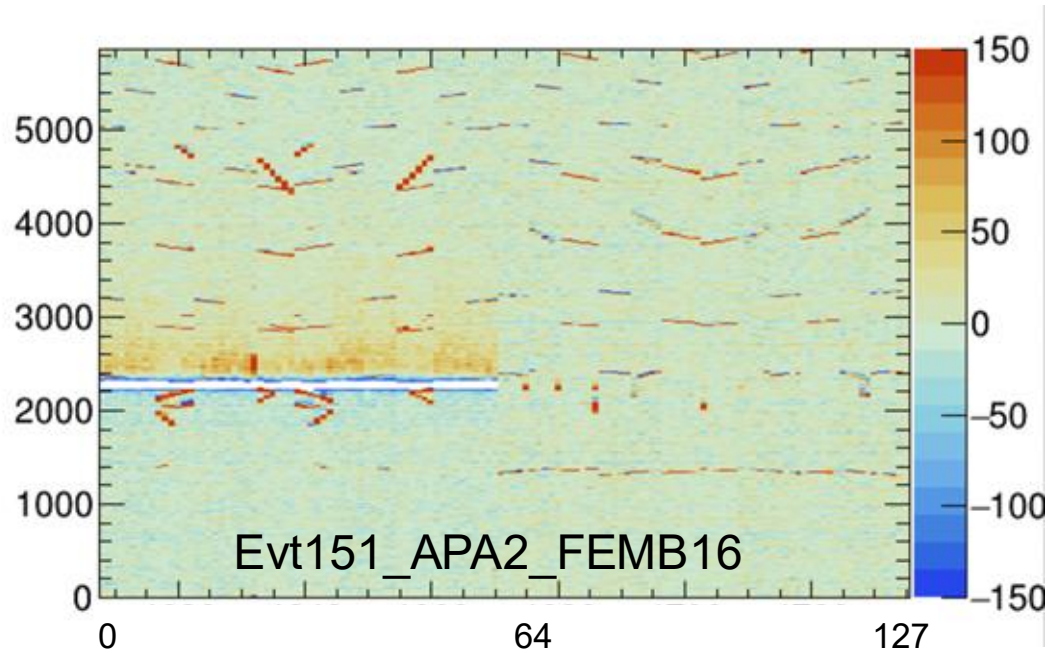
Coherent noise removal

After fix: shift +3.

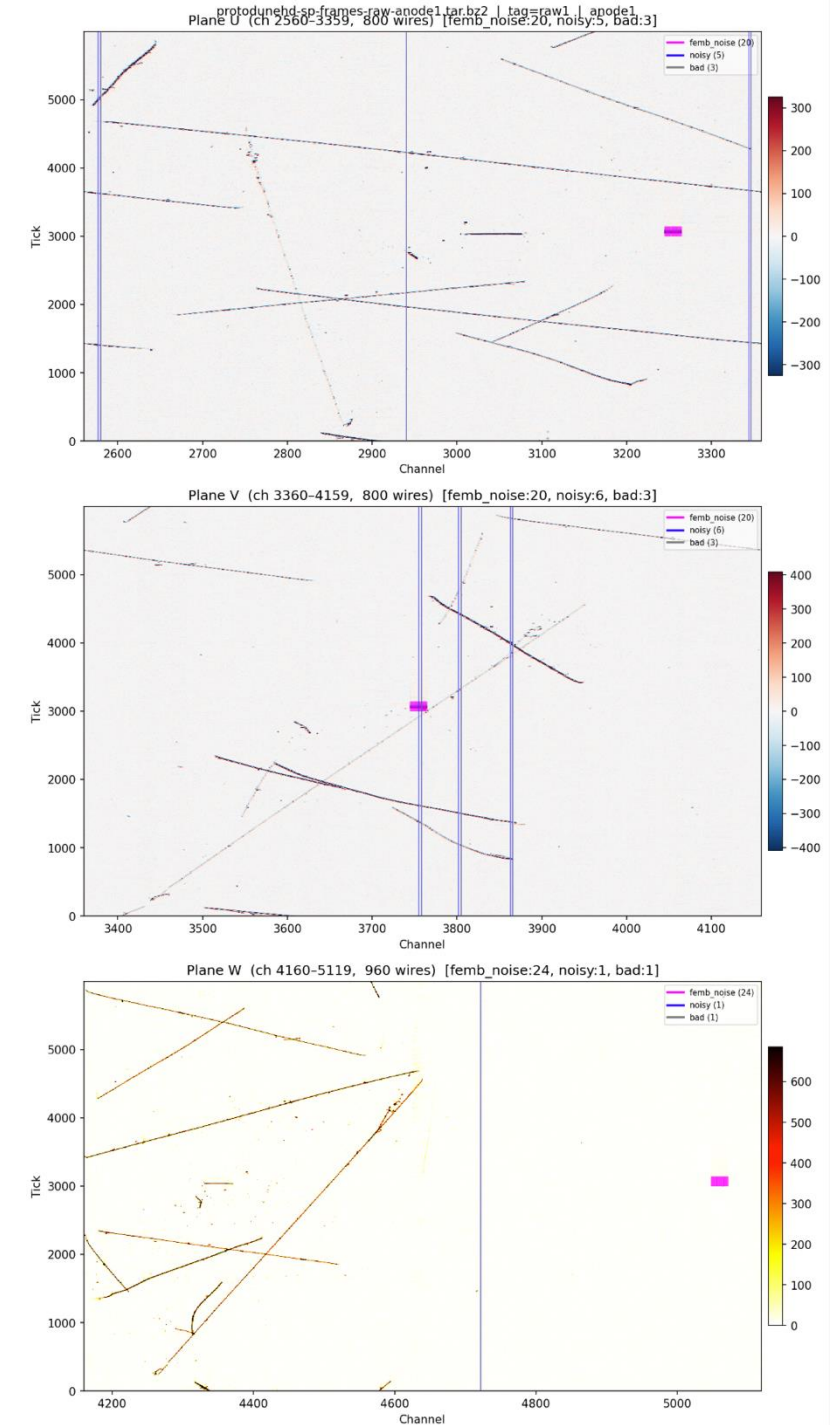
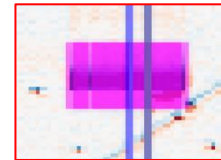
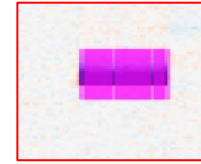


- After **+3 cycle** shift: coherent noise is properly contained within each group.

PDHD; FEMB saturation noise



- Affects half-FEMB units; spans all 3 planes.
- Flags only, downstream masking handles the flagged samples.
- now included in the HD noise filter chain
- **FEMB negpulse group should apply -3 cycle shift, net 6-channel discrepancy compared to coherent noise removal.**



By the way fix a small bin range merge bug

```
WireCell::Waveform::BinRangeList WireCell::Waveform::merge(const
WireCell::Waveform::BinRangeList& brl)
{
    WireCell::Waveform::BinRangeList tmp(brl.begin(), brl.end());
    WireCell::Waveform::BinRangeList out;
    sort(tmp.begin(), tmp.end());
    Waveform::BinRange last_br = tmp[0];
    out.push_back(last_br);

    for (size_t ind = 1; ind < tmp.size(); ++ind) {
        Waveform::BinRange this_br = tmp[ind];
        if (out.back().second >= this_br.first) {
            out.back().second = this_br.second;
            continue;
        }
        out.push_back(this_br);
    }
    return out;
}
```