Status report on

DNNROI sigproc

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Software Filter Study

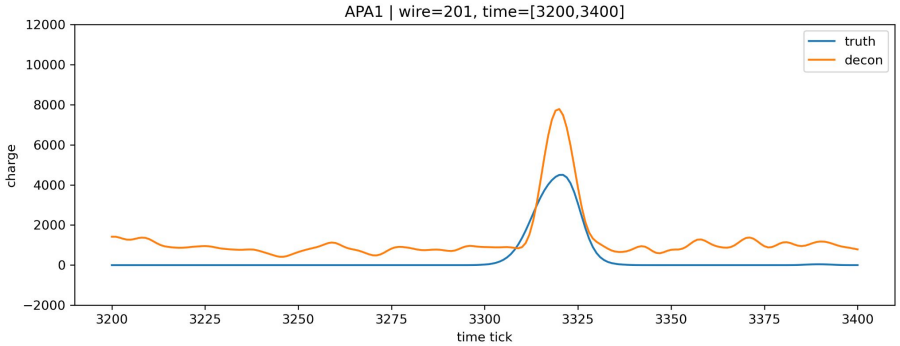
- Previously, decon results seem to change when I set different parameters for Wiener filter which is weird
- When I switched the sp-filters.jsonnet for the one I made for PD-VD, some parameters are also changed

```
// PDHD (ref)
lf('ROI_loose_lf', { tau: 0.002 * wc.megahertz }),  // 0.0025
lf('ROI_tight_lf', { tau: 0.016 * wc.megahertz }),  // 0.02
lf('ROI_tighter_lf', { tau: 0.08 * wc.megahertz }),  // 0.1
```

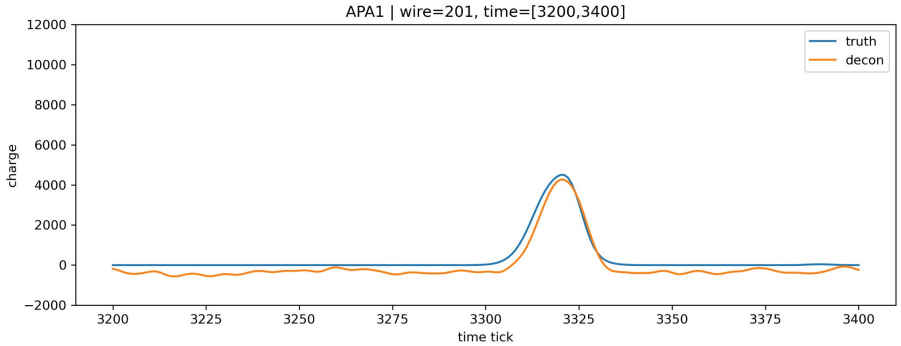
```
wf('Wire_ind', { sigma: 1.0 / wc.sqrtpi * 0.75 }),
wf('Wire_col', { sigma: 1.0 / wc.sqrtpi * 10.0 }),
```

- For PD-VD (copied from PD-SP), the parameters are set as follows
  - ROI_tight_lf (tau: 0.014 *..), ROI_tigher_lf (tau.0.06 *..), ROI_loose_lf (tau: 0.002 *..)
  - Wire_ind (sigma: 1.0 / wc.sqrtpi * 5.0)

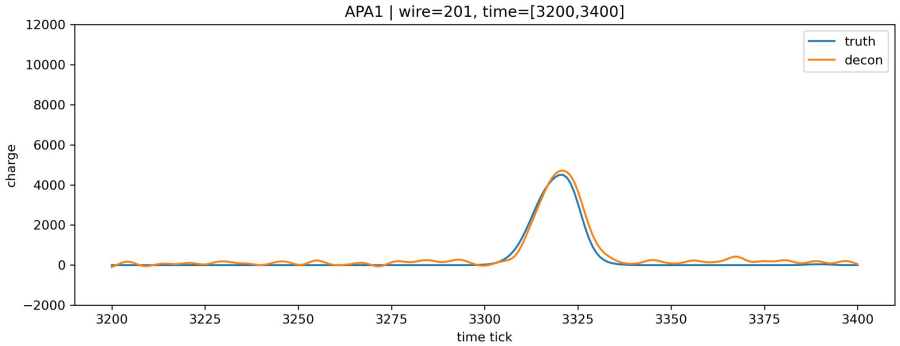
Software Filter Study



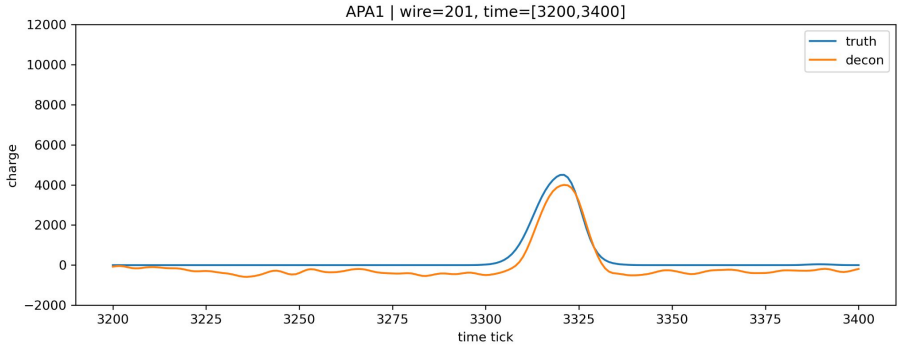
❏ PDSP ROI, PDVD HfFilter, **PDSP WireFilter**



❏ PDSP ROI, PDVD HfFilter, PDHD WireFilter

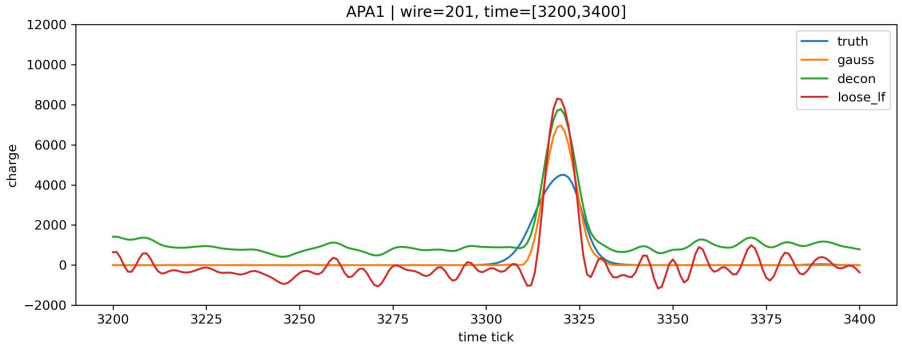


❏ PDHD ROI, PDVD HfFilter, PDHD WireFilter

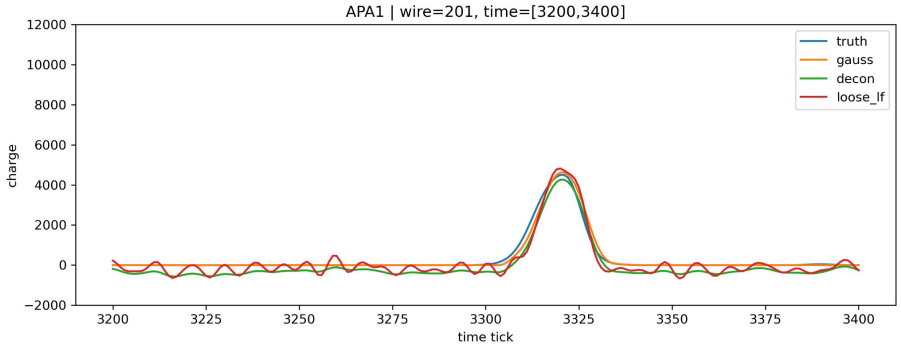


❏ PDHD ROI, PDHD HfFilter, PDHD WireFilter

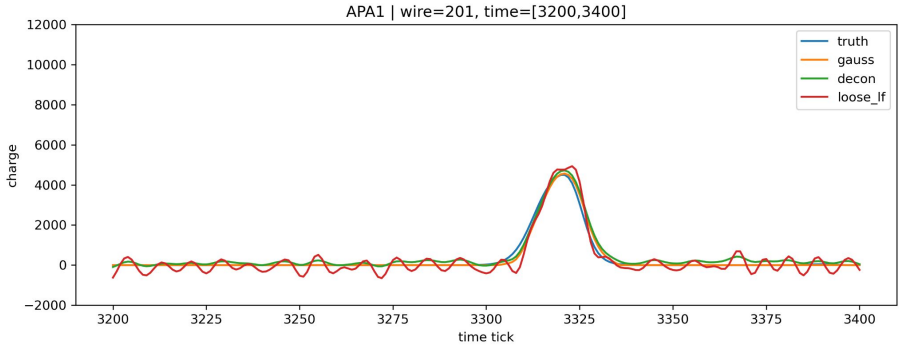
Software Filter Study



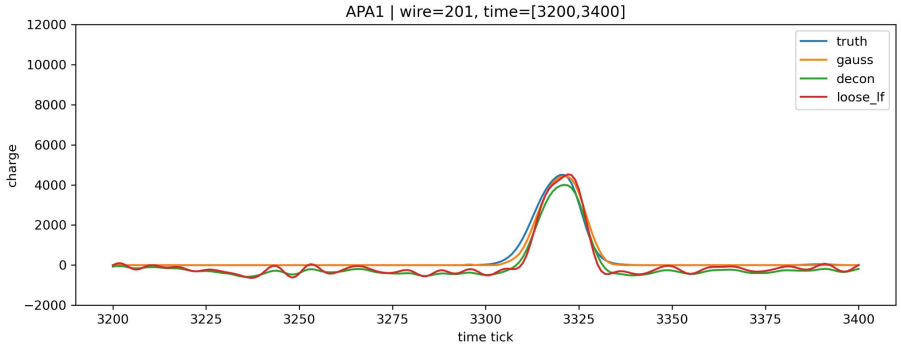
❏ PDSP ROI, PDVD HfFilter, **PDSP WireFilter**



❏ PDSP ROI, PDVD HfFilter, PDHD WireFilter

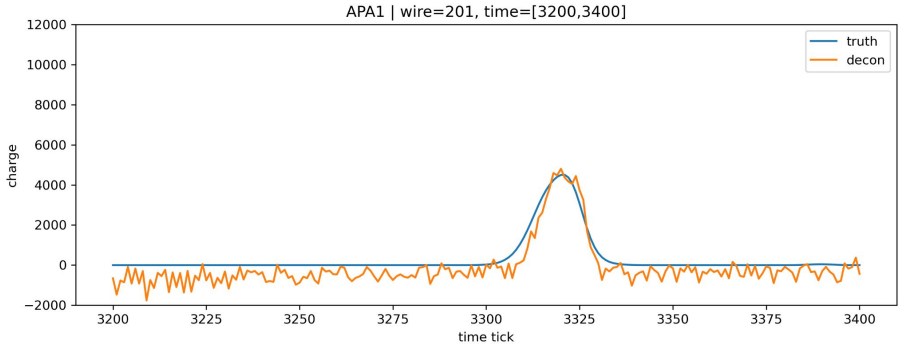


❏ PDHD ROI, PDVD HfFilter, PDHD WireFilter

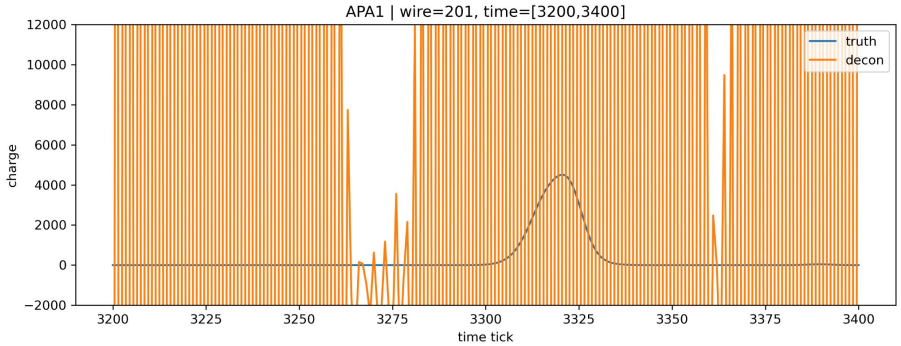


❏ PDHD ROI, PDHD HfFilter, PDHD WireFilter

Software Filter Study



❑ Gauss sigma = 0.24



❑ Gauss sigma = 0.48

- All other parameters are set as the same
- Confirmed Gauss sigma acts as expected

Next Steps

- Do we need optimizations for
  - ROI parameters
  - Wire_ind and Wire_col

HDF5 Compression Test

```
=== Analysis by Dataset Name (Grouped) ===
Name                    | Cnt | Type      | Shape           | Logical    | Storage    | Ratio | Comp
------------------------------------------------------------------------------------------------
frame_decon_charge0     | 1   | float32   | (1536, 6400)    | 37.50 MB   | 37.50 MB   | 1.0   | None
frame_gauss0            | 1   | float32   | (1536, 6400)    | 37.50 MB   | 37.50 MB   | 1.0   | None
frame_loose_lf0         | 1   | float32   | (1536, 6400)    | 37.50 MB   | 37.50 MB   | 1.0   | None
frame_mp2_roi0          | 1   | float32   | (1536, 6400)    | 37.50 MB   | 37.50 MB   | 1.0   | None
frame_mp3_roi0          | 1   | float32   | (1536, 6400)    | 37.50 MB   | 37.50 MB   | 1.0   | None
channels_decon_charge0  | 1   | int32     | (1536,)         | 6.00 KB    | 6.00 KB    | 1.0   | None
channels_gauss0         | 1   | int32     | (1536,)         | 6.00 KB    | 6.00 KB    | 1.0   | None
channels_loose_lf0      | 1   | int32     | (1536,)         | 6.00 KB    | 6.00 KB    | 1.0   | None
channels_mp2_roi0       | 1   | int32     | (1536,)         | 6.00 KB    | 6.00 KB    | 1.0   | None
channels_mp3_roi0       | 1   | int32     | (1536,)         | 6.00 KB    | 6.00 KB    | 1.0   | None
tickinfo_decon_charge0  | 1   | float64   | (3,)            | 24 B       | 24 B       | 1.0   | None
tickinfo_gauss0         | 1   | float64   | (3,)            | 24 B       | 24 B       | 1.0   | None
tickinfo_loose_lf0      | 1   | float64   | (3,)            | 24 B       | 24 B       | 1.0   | None
tickinfo_mp2_roi0       | 1   | float64   | (3,)            | 24 B       | 24 B       | 1.0   | None
tickinfo_mp3_roi0       | 1   | float64   | (3,)            | 24 B       | 24 B       | 1.0   | None
------------------------------------------------------------------------------------------------
TOTAL                   | 15  | -         | -               | 187.53 MB  | 187.53 MB  | 1.0   | -
```

❑ gzip = 0

```
=== Analysis by Dataset Name (Grouped) ===
Name                    | Cnt | Type      | Shape           | Logical    | Storage    | Ratio | Comp
------------------------------------------------------------------------------------------------
frame_loose_lf0         | 1   | float32   | (1536, 6400)    | 37.50 MB   | 34.84 MB   | 1.1   | gzip
frame_decon_charge0     | 1   | float32   | (1536, 6400)    | 37.50 MB   | 34.77 MB   | 1.1   | gzip
frame_gauss0            | 1   | float32   | (1536, 6400)    | 37.50 MB   | 462.11 KB  | 83.1  | gzip
frame_mp2_roi0          | 1   | float32   | (1536, 6400)    | 37.50 MB   | 192.14 KB  | 199.9 | gzip
frame_mp3_roi0          | 1   | float32   | (1536, 6400)    | 37.50 MB   | 175.06 KB  | 219.4 | gzip
channels_decon_charge0  | 1   | int32     | (1536,)         | 6.00 KB    | 6.00 KB    | 1.0   | None
channels_gauss0         | 1   | int32     | (1536,)         | 6.00 KB    | 6.00 KB    | 1.0   | None
channels_loose_lf0      | 1   | int32     | (1536,)         | 6.00 KB    | 6.00 KB    | 1.0   | None
channels_mp2_roi0       | 1   | int32     | (1536,)         | 6.00 KB    | 6.00 KB    | 1.0   | None
channels_mp3_roi0       | 1   | int32     | (1536,)         | 6.00 KB    | 6.00 KB    | 1.0   | None
tickinfo_decon_charge0  | 1   | float64   | (3,)            | 24 B       | 24 B       | 1.0   | None
tickinfo_gauss0         | 1   | float64   | (3,)            | 24 B       | 24 B       | 1.0   | None
tickinfo_loose_lf0      | 1   | float64   | (3,)            | 24 B       | 24 B       | 1.0   | None
tickinfo_mp2_roi0       | 1   | float64   | (3,)            | 24 B       | 24 B       | 1.0   | None
tickinfo_mp3_roi0       | 1   | float64   | (3,)            | 24 B       | 24 B       | 1.0   | None
------------------------------------------------------------------------------------------------
TOTAL                   | 15  | -         | -               | 187.53 MB  | 70.45 MB   | 2.7   | -
```

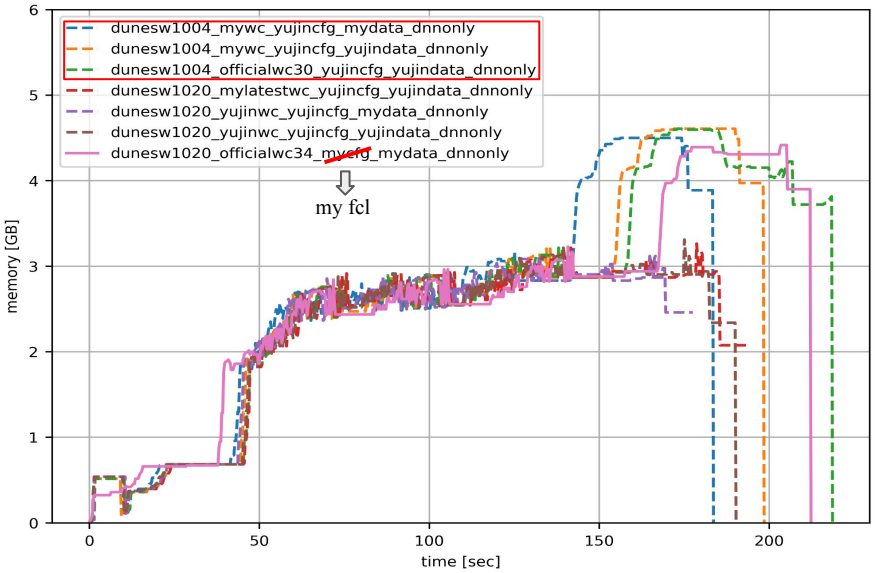
❑ gzip = 2

```
=== Analysis by Dataset Name (Grouped) ===
Name                    | Cnt | Type      | Shape           | Logical    | Storage    | Ratio | Comp
------------------------------------------------------------------------------------------------
frame_loose_lf0         | 1   | float32   | (1536, 6400)    | 37.50 MB   | 34.74 MB   | 1.1   | gzip
frame_decon_charge0     | 1   | float32   | (1536, 6400)    | 37.50 MB   | 34.67 MB   | 1.1   | gzip
frame_gauss0            | 1   | float32   | (1536, 6400)    | 37.50 MB   | 309.53 KB  | 124.1 | gzip
frame_mp2_roi0          | 1   | float32   | (1536, 6400)    | 37.50 MB   | 50.13 KB   | 766.1 | gzip
frame_mp3_roi0          | 1   | float32   | (1536, 6400)    | 37.50 MB   | 42.13 KB   | 911.4 | gzip
channels_decon_charge0  | 1   | int32     | (1536,)         | 6.00 KB    | 6.00 KB    | 1.0   | None
channels_gauss0         | 1   | int32     | (1536,)         | 6.00 KB    | 6.00 KB    | 1.0   | None
channels_loose_lf0      | 1   | int32     | (1536,)         | 6.00 KB    | 6.00 KB    | 1.0   | None
channels_mp2_roi0       | 1   | int32     | (1536,)         | 6.00 KB    | 6.00 KB    | 1.0   | None
channels_mp3_roi0       | 1   | int32     | (1536,)         | 6.00 KB    | 6.00 KB    | 1.0   | None
tickinfo_decon_charge0  | 1   | float64   | (3,)            | 24 B       | 24 B       | 1.0   | None
tickinfo_gauss0         | 1   | float64   | (3,)            | 24 B       | 24 B       | 1.0   | None
tickinfo_loose_lf0      | 1   | float64   | (3,)            | 24 B       | 24 B       | 1.0   | None
tickinfo_mp2_roi0       | 1   | float64   | (3,)            | 24 B       | 24 B       | 1.0   | None
tickinfo_mp3_roi0       | 1   | float64   | (3,)            | 24 B       | 24 B       | 1.0   | None
------------------------------------------------------------------------------------------------
TOTAL                   | 15  | -         | -               | 187.53 MB  | 69.83 MB   | 2.7   | -
```

❑ gzip = 6

- gzip option works now (chunk should not be zero)
- File sizes per event (1 CRU)
  - gzip = 0, reco 188 MB, truth 38 MB
  - gzip = 2, reco 70 MB, truth 744 KB
  - gzip = 6, reco 70 MB, truth 600 KB
- gzip=2 gives enough suppression rate
- For 1000 events, estimated required storage ~ 70.7 GB

Memory Study



- Performed several tests using different:
  - dunesw version: v10_04_07d01, v10_20_01d01
  - wire-cell version: 0.30.3, 0.34.2
  - wire-cell-cfg: Hokyeong's cfg, Yujin's cfg
- Under specific conditions, the last peak appeared
- What I confirmed
  - irrelevant to the wire-cell version
  - irrelevant to the wire-cell-cfg
  - happened when using old dunesw
- Even with the latest dunesw, the peak appeared when using my FCL file

Memory Study

- I was using the fcl file dumped out using old dunesw (v10_04_07d01)
- When dumping out the fcl, some parameters differ from which dunesw is set
- Tested how each parameter affects
- The problem was difference “clock_speed” is given depending on dunesw version
  - in wirecell-dune.jsonnet → clock_speed: @local:protodunehd_services.DetectorClocksService.ClockSpeedTPC
  - /cvmfs/dune.opensciencegrid.org/products/dune/dunecore/**v10_20_01d01**/fcl/detectorclocks_dune.fcl

```
66 # This is 2MHz rather than 1.953125 (1./512ns) because we are resampling from
67 # 512ns tick period to 500ns within wirecell
68 protodunehd_detectorclocks.ClockSpeedTPC: 2.0
```

  - /cvmfs/dune.opensciencegrid.org/products/dune/dunecore/**v10_04_07d01**/fcl/detectorclocks_dune.fcl

```
64 protodunehd_detectorclocks: @local::protodune_detectorclocks
65 protodunehd_detectorclocks.ClockSpeedTPC: 1.953125
```

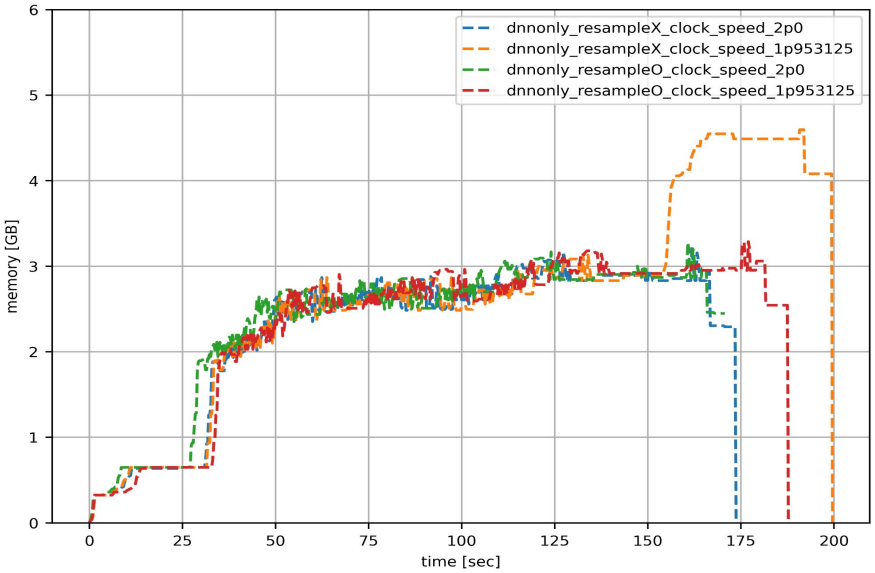
- Extracted clock_speed goes to tick in params.jsonnet

```
39          tick: 1.0/std.extVar('clock_speed') * wc.us,
```

- That tick fed into the wclsRawFrameSource

```
62    local wcls_input = {
63      adc_digits: g.pnode({
64        type: 'wclsRawFrameSource',
65        name: '',
66        data: {
67          art_tag: raw_input_label,
68          frame_tags: ['orig'],  // this is a WCT designator
69          //nticks: params.daq.nticks,
70          // nticks: nsample,
71          tick: params.daq.tick,
72        },
73      }, nin=0, nout=1),
74
75    };
```

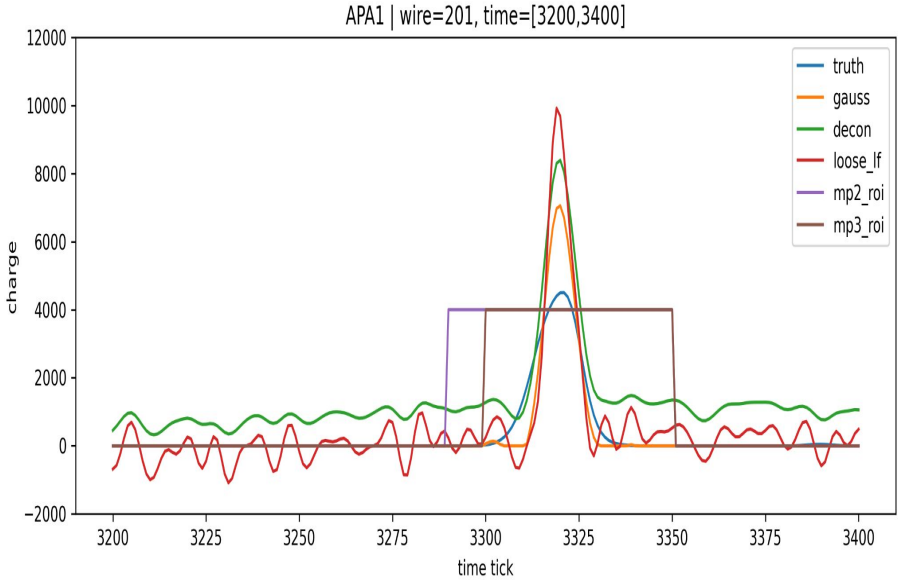
Memory Study



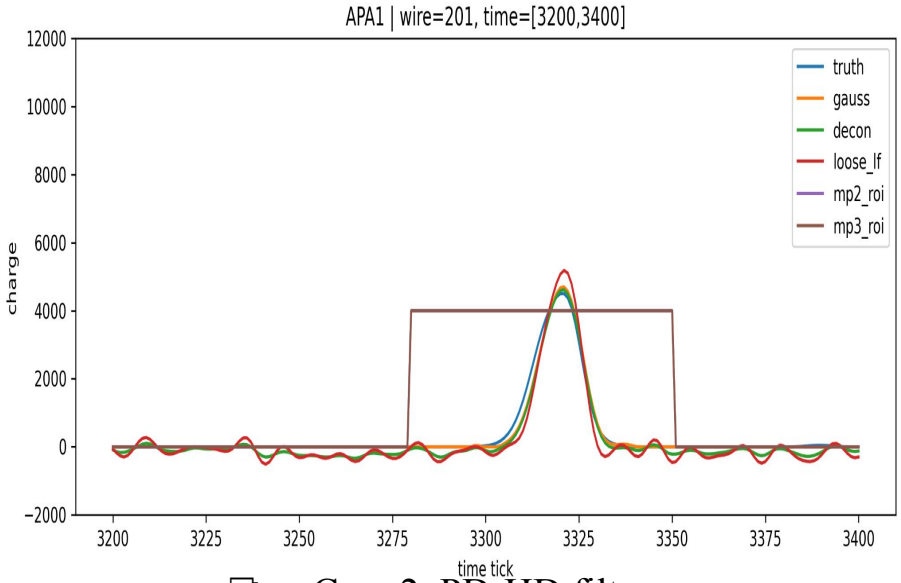
- Regardless of which version of WC and dunesw used, the peak appears when the clock_speed is set to 1.953125
- However, resampler is able to suppress the peak
- Yujin will report the results of the Valgrind heap profiling on this issue
- I opened a PR to merge the TagSelector (https://github.com/WireCell/wire-cell-toolkit/pull/458)

Back Up

Software Filter Study



❑ Case 1. PD-VD filter

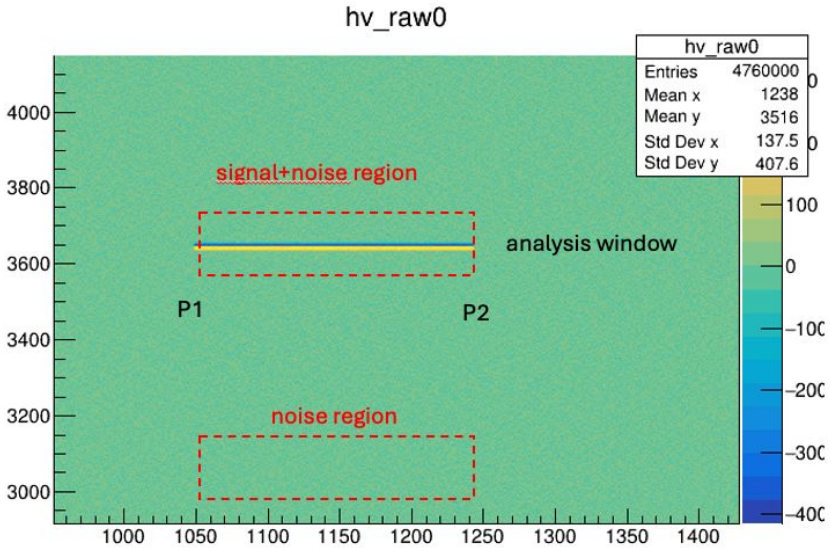


❑ Case 2. PD-HD filter

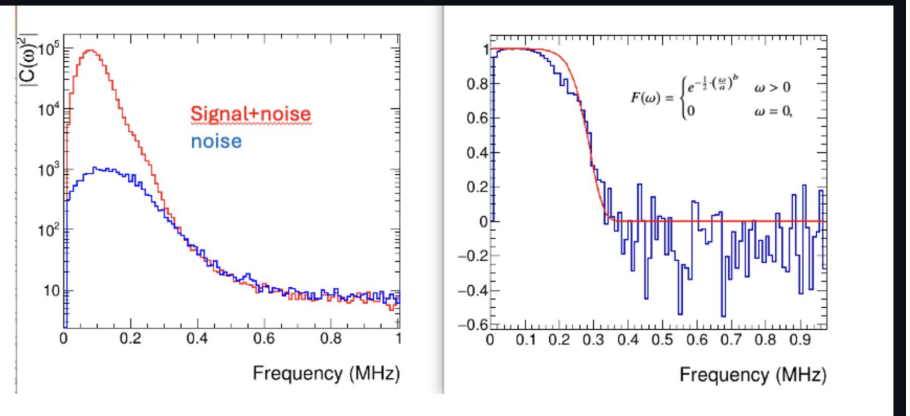
- Decon waveform seems to be affected by changes of Wiener filter parameters which is weird
- Haiwang and I am investigating this

Software Filter Optimization

- There is a tool to get the optimized sigma and power for the HfFilter
  - https://github.com/WireCell/wire-cell-toolkit/blob/feature/xn_WF_fitter_script/root/test/calcFilter.C
  - https://github.com/WireCell/wire-cell-toolkit/blob/feature/xn_WF_fitter_script/root/docs/calcFilter.org
- Isochronous track sample is needed



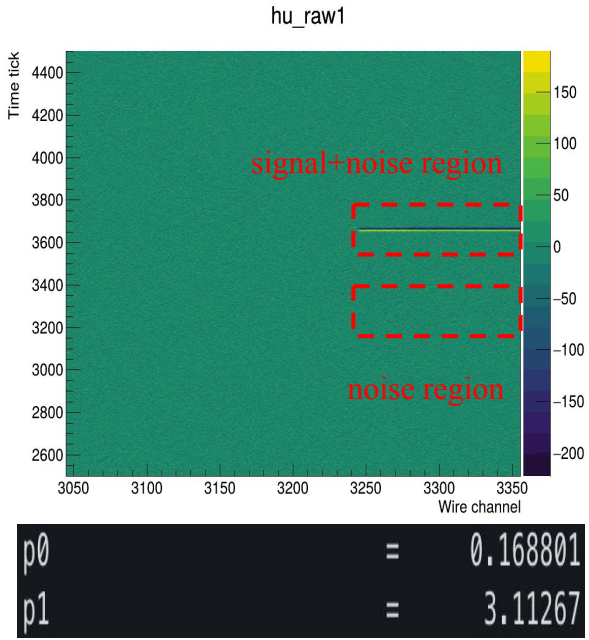
1. **c1**: Power spectral density comparison
   - Red: Signal + noise power density
   - Blue: Noise-only power density
2. **c2**: Wiener filter response
   - Normalized to maximum value of 1
   - Fitted with function: `exp(-0.5*(x/p0)^p1)`
   - Fit parameters printed to console

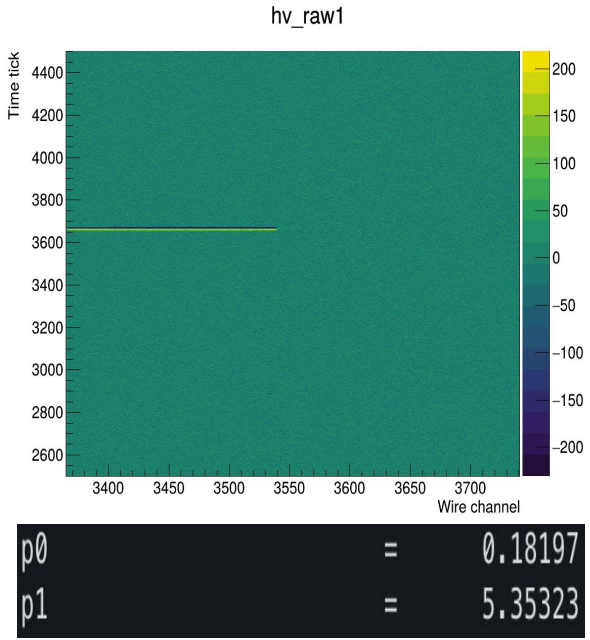


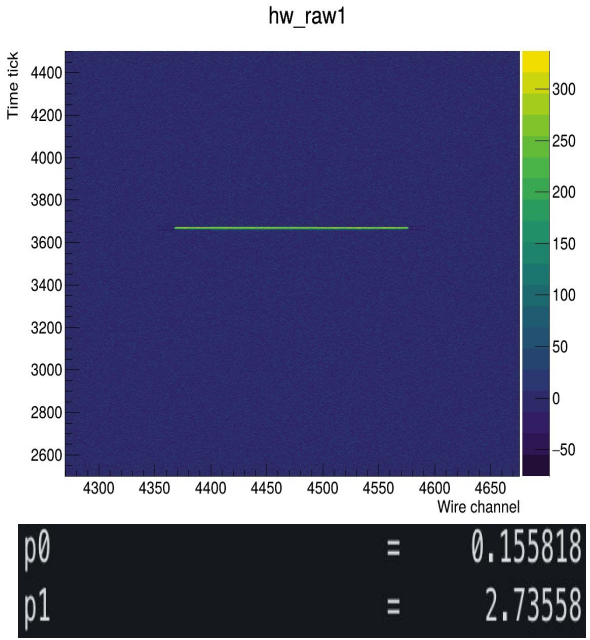

```
EXT PARAMETER                                   STEP         FIRST
NO.   NAME      VALUE            ERROR          SIZE      DERIVATIVE
 1  p0           2.69885e-01   3.74802e-02   2.98269e-05   3.55623e-02
 2  p1           8.34938e+00   6.86118e+00   5.42952e-03  -2.51530e-04
```

Software Filter Study

- Confirming the method to get parameters is correct



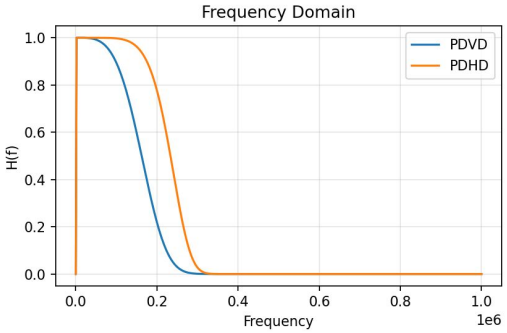


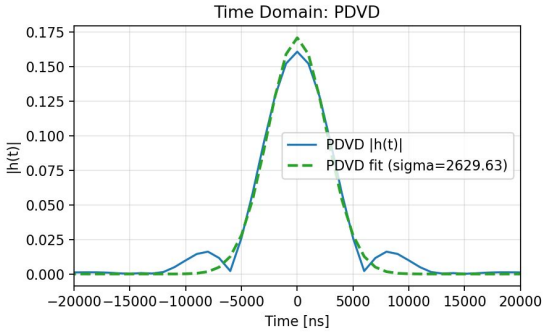


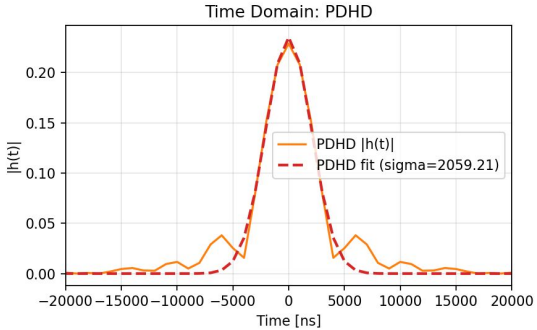
- The fitted parameters are different from PD-HD HfFilter we used

Truth Smearing Study

- Frequency domain Wiener filter → IFFT → Time domain signals → Gaussian fit





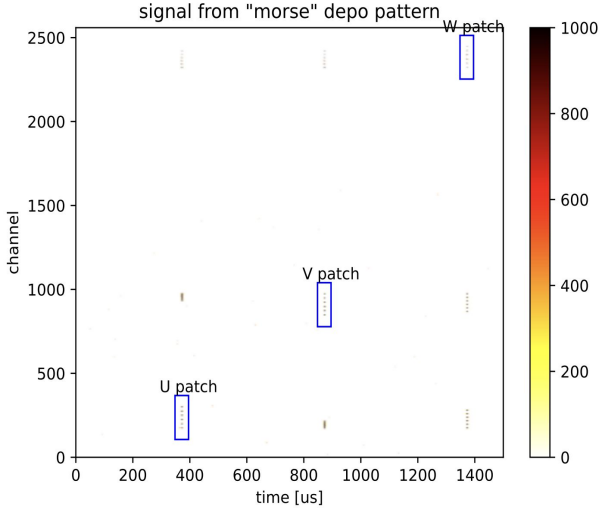


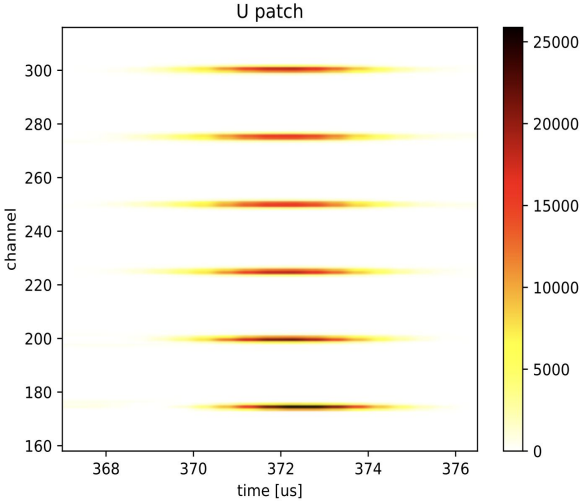
Gaussian fit sigmas:
PDVD: 2629.63
PDHD: 2059.21

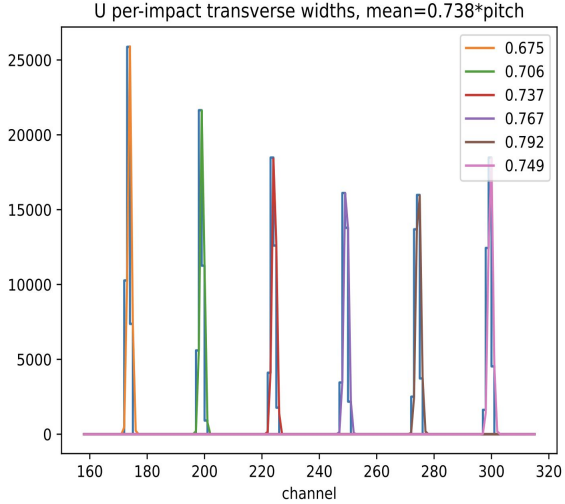
- Changes:
  - line color for the gauss fit to prevent misreading
  - Fitting range
- The sigmas are still much larger than the parameter used in the cfg
- Currently studying Brett's morse test tool to make it work for PD-VD

Truth Smearing - Approach 1

- Morse test tool provided by Brett
  - https://github.com/WireCell/wire-cell-toolkit/blob/master/test/scripts/bats-debug
  - https://github.com/WireCell/wire-cell-toolkit/blob/master/test/test/test-morse-pdsp.bats







- The tool is not fully ready for PD-VD
- Would be precise, but need to understand how to use