

Wire-Cell Status and Plan for DUNE FD

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DUNE FD Sim/Reco Meeting



@BrookhavenLab

Wire-Cell Event Reconstruction

Part 1: Sim-NP-SigProc

Part 2: Img-Clus-QLMatching-nu-select

Part 3: 3D PatRec



TPC simulation

noise filtering

signal processing

3D imaging

clustering

charge-light matching

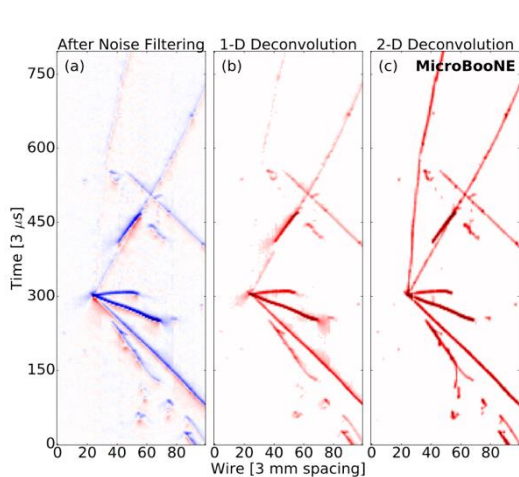
3D trajectory & dQ/dx fitting

cosmic muon tagger

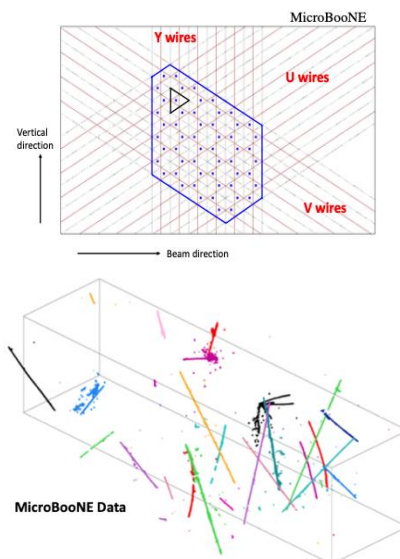
multi-track fitting

DL-3D vertexing

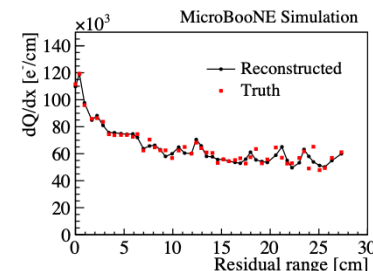
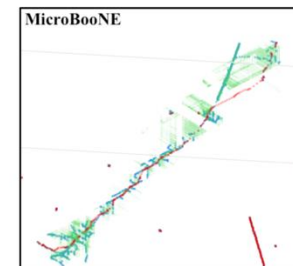
particle identification



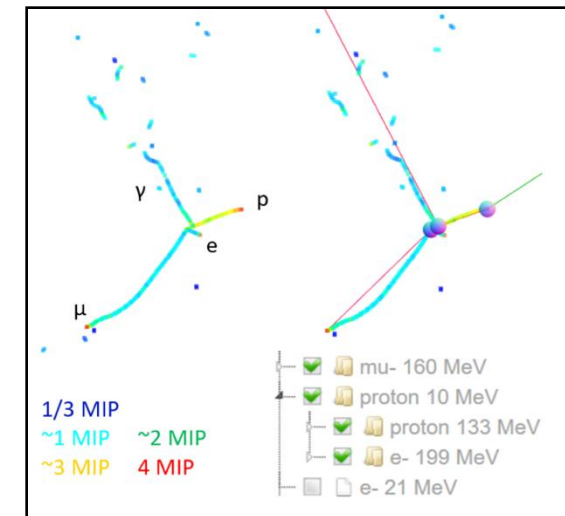
[JINST 12 P08003 \(2017\)](#)
[JINST 13 P07006 \(2018\)](#)
[JINST 13 P07007 \(2018\)](#)
[JINST 16 P01036 \(2020\)](#)



[JINST 13 P05032 \(2018\)](#)
[JINST 16 P06043 \(2021\)](#)



[Phys. Rev. Applied 15, 064071 \(2021\)](#)



[JINST 17 P01037 \(2022\)](#)

Wire-Cell Plan for FD

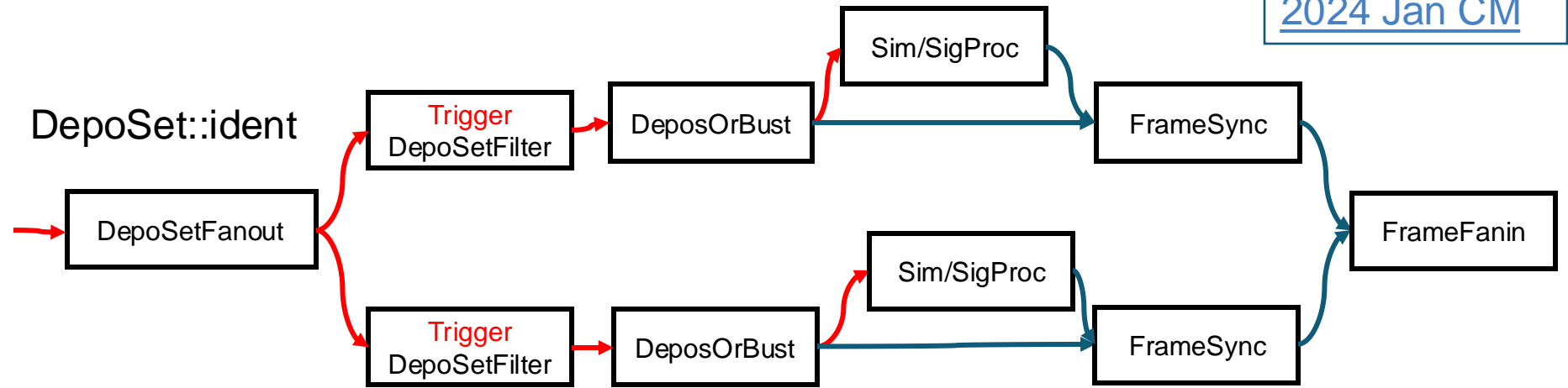
- Part 1: Sim-NP-SigProc
 - Keep up with the maintenance
 - **New techniques for DUNE FD scenario (hydra-skip)**
- Part 2: Img-Clus-QLMatching-nu-select
 - Establish this chain for FD for the 3D information
 - potential enhanced reconstruction with light information
 - nu-select may not be needed
 - Establish similar chain for ProtoDUNEs
- Part 3: 3D PatRec
 - Expecting initial version of this part around mid-year 2025
 - Potential enhancement with AI/ML

FD Sim/Sigproc computing improved with hydra-skip

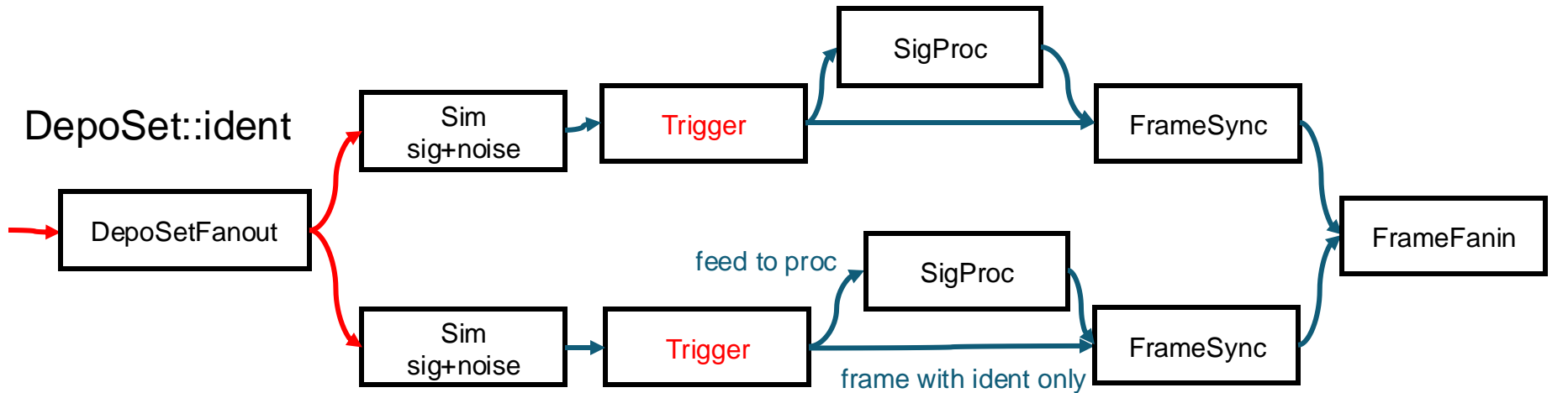
[issue #148](#)

2024 Jan CM

Cheat trigger to skip both Sim/SigProc



- Sim all APAs
- Trigger alg. to determine whether to do SigProc



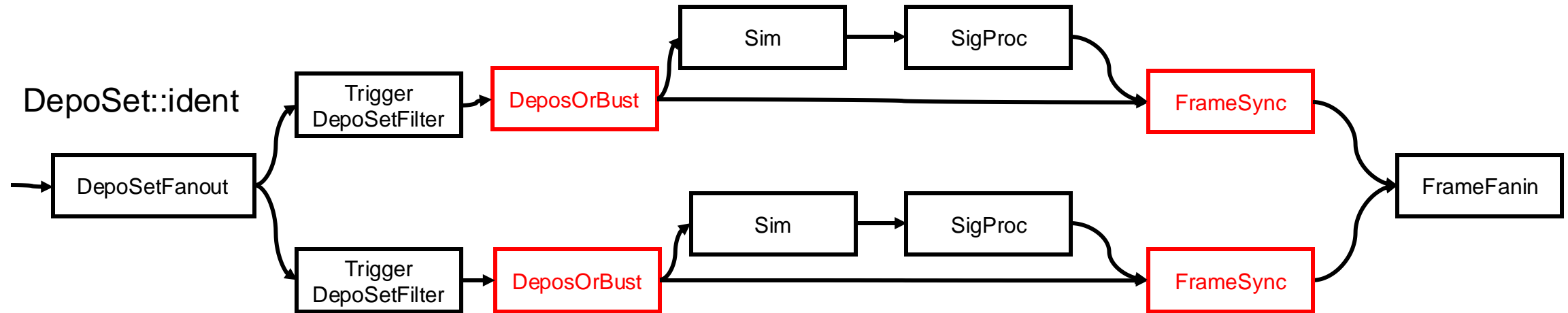
Hydra-skip development

Previous hydra configuration for HD:

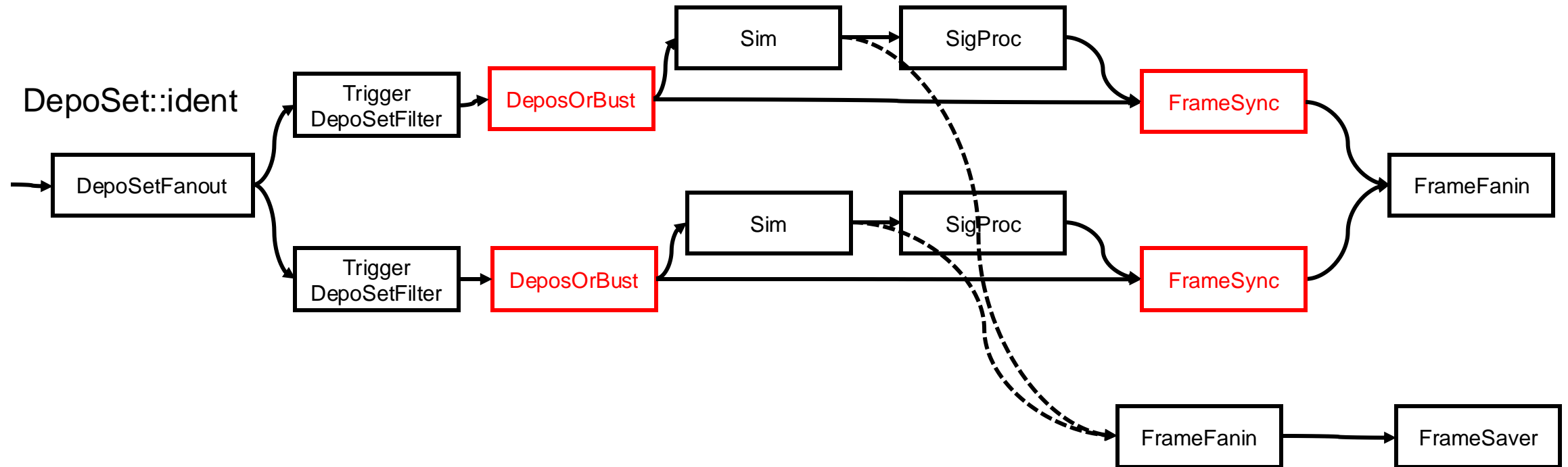
<https://github.com/DUNE/dunereco/pull/108>

- Hydra for VD10kt – base configuration available
 - <https://github.com/HaiwangYu/hydra-skip>
- **Option to save rawdigits**
 - <https://indico.bnl.gov/event/25449/> **Splice**
 - **Multiple unsynchronized branches**
 - **Source code update needed in addition to wirecell 0.29.5**
- **Tests for memory usage**

Unsynchronized nodes to allow shortcuts - no rawdigits

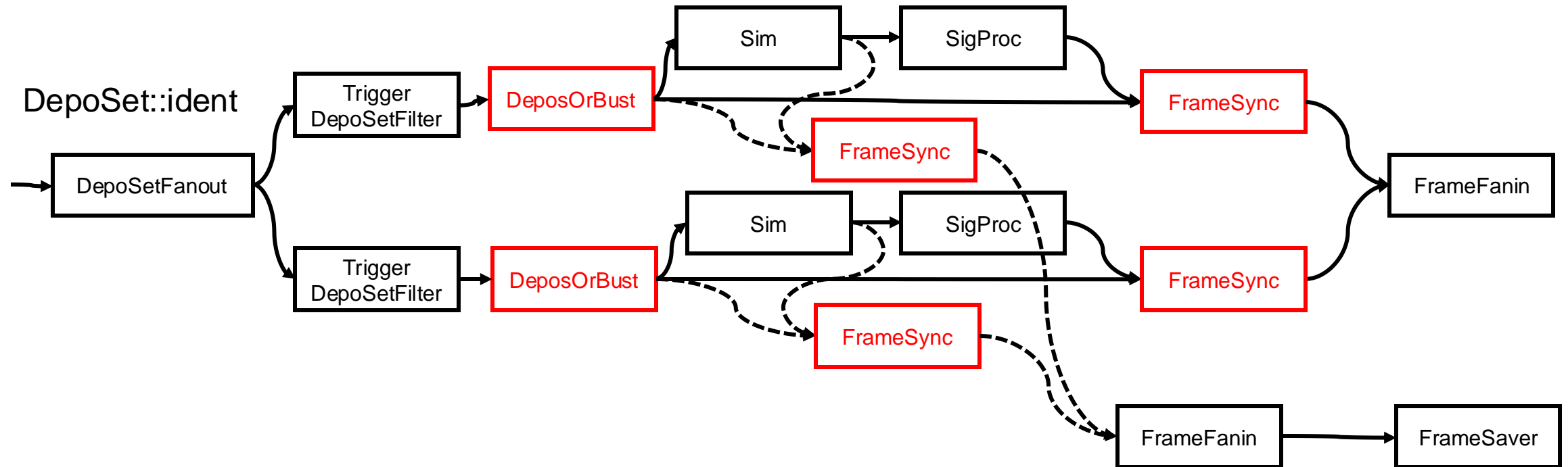


Initial try to tap out rawdigits – does not work



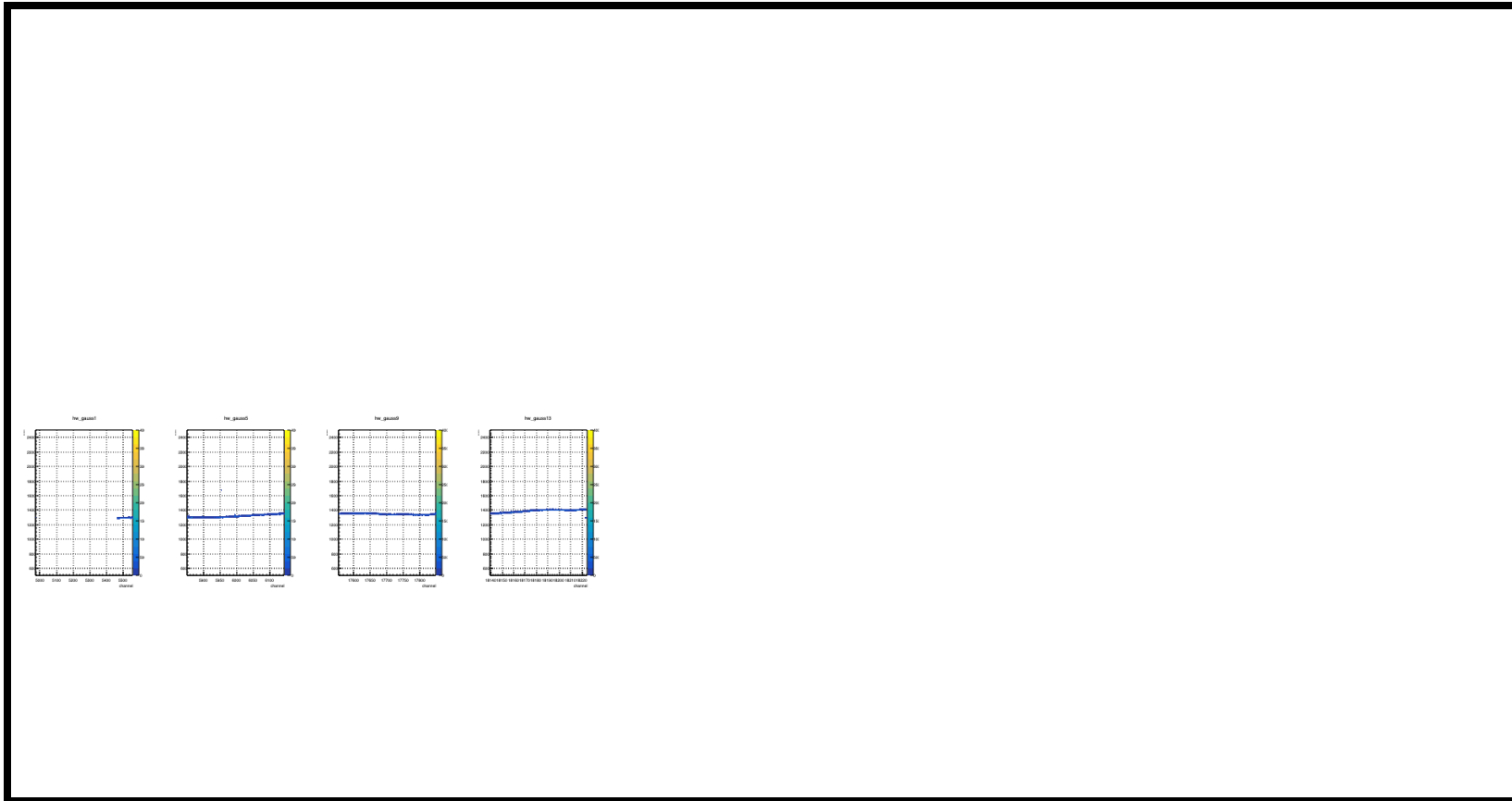
* Use new `Splice` jsonnet tool, check backup slide

Add another unsynchronized branch – this works



* FrameFanin with tags and DumpFrame and does not like the `bust` (traceless) frame, need to update wirecell source code

Test event: single muon – 4/320 active APAs



*Total 2x4x40, showing 4x10 region

eventdump.fcl

320-hydra-norawdigit

wclssim.....	tpcrawdecoder.	daq.....	std::vector<raw::RawDigit>.....0
wclssim.....	tpcrawdecoder.	simpleSC.....	std::vector<sim::SimChannel>.....	491520
wclssim.....	TriggerResults	art::TriggerResults.....1
wclssim.....	tpcrawdecoder.	gauss.....	std::vector<recob::Wire>.....	491520
wclssim.....	tpcrawdecoder.	dnnsp.....	std::vector<recob::Wire>.....	491520
wclssim.....	tpcrawdecoder.	wiener.....	std::vector<recob::Wire>.....	491520
wclssim.....	plopper.....	bogus.....	std::vector<sim::SimEnergyDeposit>.....	...713

320-hydra-saverawdigit

wclssim.....	tpcrawdecoder.	daq.....	std::vector<raw::RawDigit>.....	491520
wclssim.....	tpcrawdecoder.	simpleSC.....	std::vector<sim::SimChannel>.....	491520
wclssim.....	TriggerResults	art::TriggerResults.....1
wclssim.....	tpcrawdecoder.	gauss.....	std::vector<recob::Wire>.....	491520
wclssim.....	tpcrawdecoder.	dnnsp.....	std::vector<recob::Wire>.....	491520
wclssim.....	tpcrawdecoder.	wiener.....	std::vector<recob::Wire>.....	491520
wclssim.....	plopper.....	bogus.....	std::vector<sim::SimEnergyDeposit>.....	...713

Basic computing stats

320-hydra-norawdigit

```
31823 TrigReport ----- Event summary -----
31824 TrigReport Events total = 1 passed = 1 failed = 0
31825
31826 TrigReport ----- Modules in End-path -----
31827 TrigReport      Run      Success      Error Name
31828 TrigReport      1        1          0 out
31829
31830 TimeReport ----- Time summary [sec] -----
31831 TimeReport CPU = 44.928438 Real = 45.317756
31832
31833 MemReport ----- Memory summary [base-10 MB] -----
31834 MemReport  VmPeak = 6465.95 VmHWM = 4611.89
31835
31836 Art has completed and will exit with status 0.
top-320-hydra-norawdigit/log
```

`time`

```
real    7m34.555s
user    11m4.866s
sys     0m4.341s
```

file size:

7.4MB

320-hydra-saverawdigit

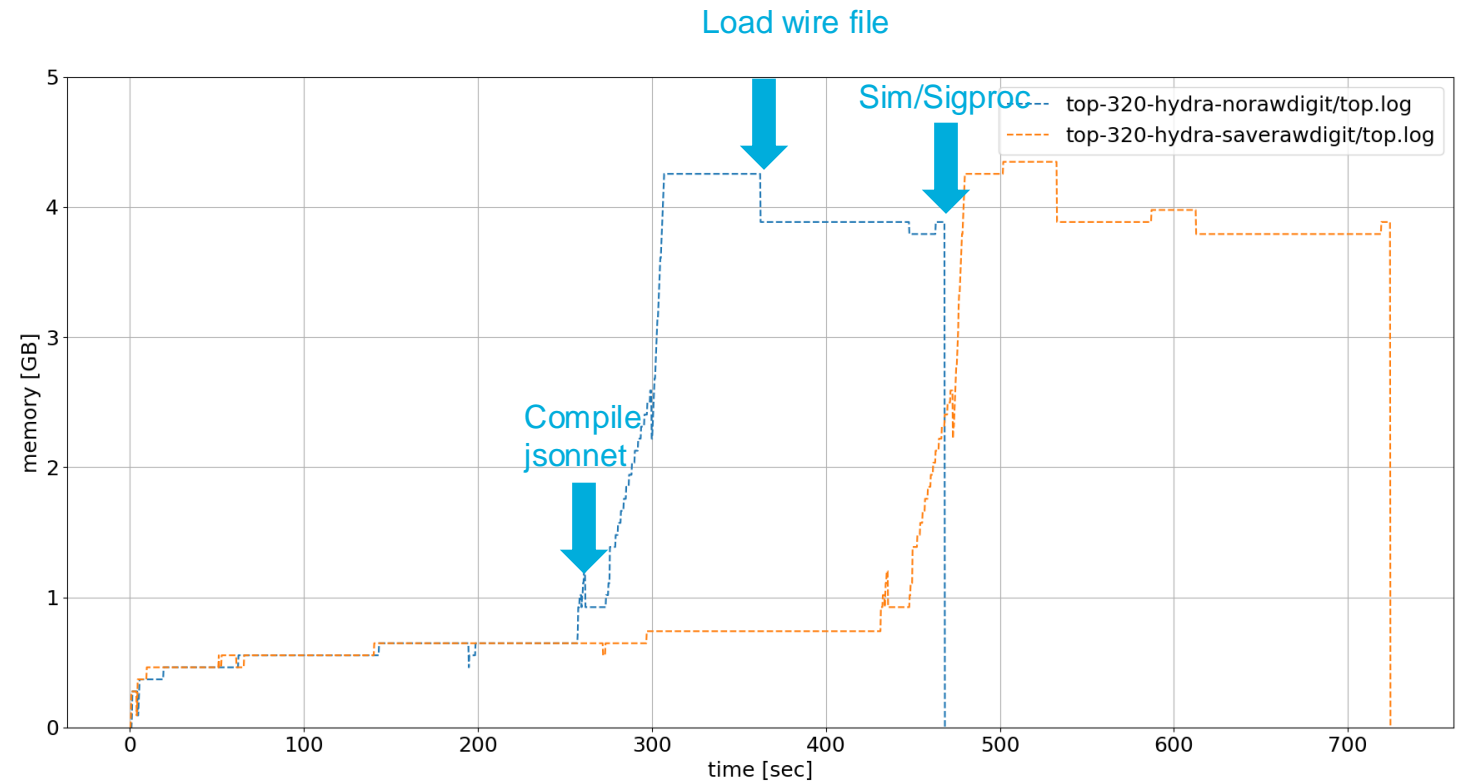
```
47592 TrigReport ----- Event summary -----
47593 TrigReport Events total = 1 passed = 1 failed = 0
47594
47595 TrigReport ----- Modules in End-path -----
47596 TrigReport      Run      Success      Error Name
47597 TrigReport      1        1          0 out
47598
47599 TimeReport ----- Time summary [sec] -----
47600 TimeReport CPU = 131.261684 Real = 132.802931
47601
47602 MemReport ----- Memory summary [base-10 MB] -----
47603 MemReport  VmPeak = 6617.47 VmHWM = 4645.48
47604
47605 Art has completed and will exit with status 0.
top-320-hydra-saverawdigit/log
```

```
real    12m9.413s
user    18m32.616s
sys     0m5.420s
```

31MB

Memory usage from `top`

- `time` results are closer to `top`
- took longer time to compile jsonnet
- running time is also longer
- Saving rawdigits for only active volume does not add much to memory usage



1-event test

previous CM

- HD test: dunegpvm08, apptainer, v09_82_01d00
- gpmvs are much faster, May vs. Mar
- **VD/HD ratio: due to the finer granularity of VD (320 vs. 150), which could make the skip-processing (sparse-processing) more efficient**
 - total: time x2, mem 0.74x, comb 1.5x
 - skip (this event): time 1.5x, mem 0.8x, comb 1.2x

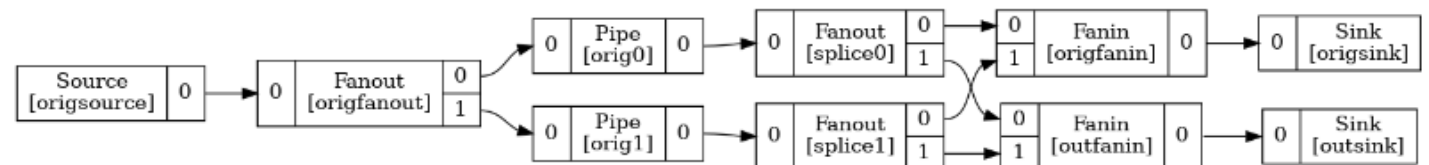
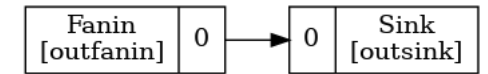
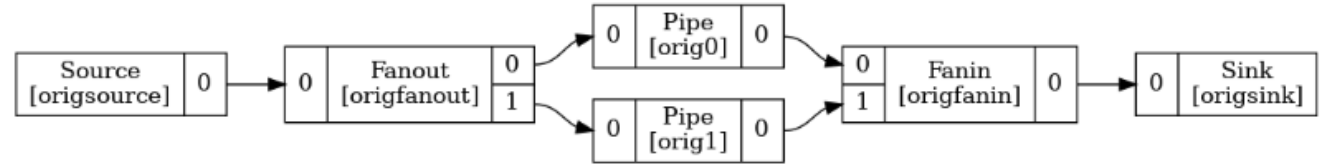
	CPU time (sec)	VmHWM (GB)	magnify output (MB)
HD-6apa	56	6.0	2.2
HD-6apa-skip (2)	19	6.0	
HD-150apa	870	6.2	50
HD-150apa-skip (9)	72	6.2	4.6
VD-320 (Mar/25)	4032	4.8	
VD-320-skip (15,Mar/25)	259	4.5	
VD-320 (May/13)	1717	4.6	
VD-320-skip (15,May/13)	109	5.0	

Summary

- Hydra-skip configuration available for FD-VD Sim/SigProc
 - **new option to tap out rawdigits**
 - **updates to wirecell needed to have that option**
 - FrameDump, FrameFanin, funcs.jsonnet
 - 5-8min to compile jsonnet
 - may be OK if run multiple events for each job?
 - Will make PRs for what I currently have for broader tests
 - **Add Wire-Cell as part of DUNE CI?**
- We are working on propagating the TPC clustering chain to DUNE FD and ProtoDUNEs
- We are also working on porting the rest Wire-Cell algorithms to DUNE

backups

“2-wire” splice in WCT configuration(jsonnet)



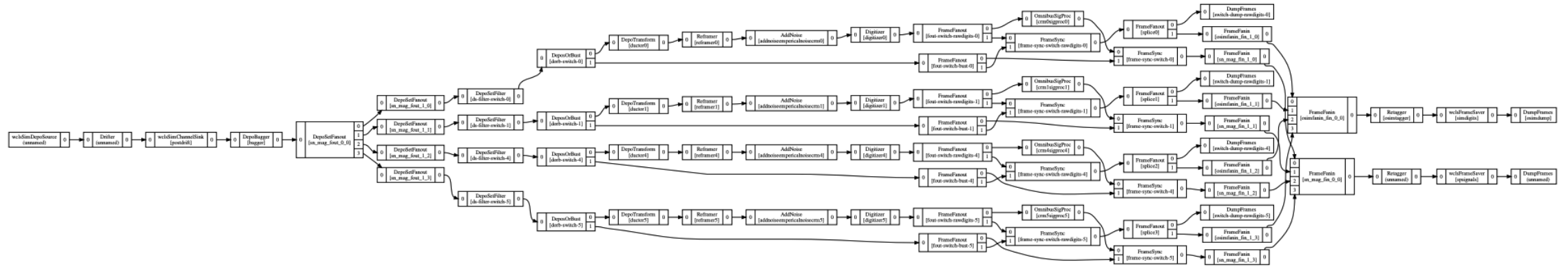
```
local edge_selector(e) = std.startsWith(e.tail.node, "Pipe:");
local fanout_factory(n,e) = { type:'Fanout', name:"splice%d"%n };
local spliced = pg.splice(orig, out, edge_selector, fanout_factory);
```

<https://github.com/WireCell/wire-cell-toolkit/blob/master/cfg/test/test-splice.jsonnet>

Brett V.

4APA Splice

<https://www.phy.bnl.gov/~yuhw/dunefd/hydra-skip/cfg/pgrapher/experiment/dune10kt-vd/save-rawdigits/wcls-sim-drift-simchannel-nf-sp.pdf>



DumpFrame needs traces

```
[00:00:31.442] D [ glue ] <FrameSync:frame-sync-switch-rawdigits-4> port 0 empty
[00:00:31.442] D [ glue ] <FrameSync:frame-sync-switch-rawdigits-4> port 1 frame 0
[00:00:31.442] D [ glue ] <FrameSync:frame-sync-switch-rawdigits-4> port 0 empty
[00:00:31.442] D [ glue ] <FrameSync:frame-sync-switch-rawdigits-4> port 1 empty
[00:00:31.442] D [ glue ] <FrameSync:frame-sync-switch-rawdigits-4> oqs size: 1
[00:00:31.442] D [ glue ] <FrameFanout:splice2> call=0: input->output x2: frame: ident=0 time=0 tick=0 with null trace ptr!] 0
tagged trace sets:[ ] cmm:[ ]
```

```
#0 WireCell::Gen::DumpFrames::operator() (this=0x5141570, frame=...) at ../../source/wirecell-0.29.5/gen/src/DumpFrames.cxx:23
#1 0x00007fff88b7b5fa in WireCellTbb::SinkBody::operator() (in=..., this=0xaf554658)
   at /scratch/workspace/build-larsoft/BUILDTYPE/prof/QUAL/s131-e26/label1/swarm/label2/AlmaLinux-9.4/build/gcc/v12_1_0/Linux6
ptr_base.h:1349
```

```
bool Gen::DumpFrames::operator()(const IFrame::pointer& frame)
```

```
{
    ... if (!frame) {
    ...     log->debug("frame sink sees EOS");
    ...     return true;
    ... }
```

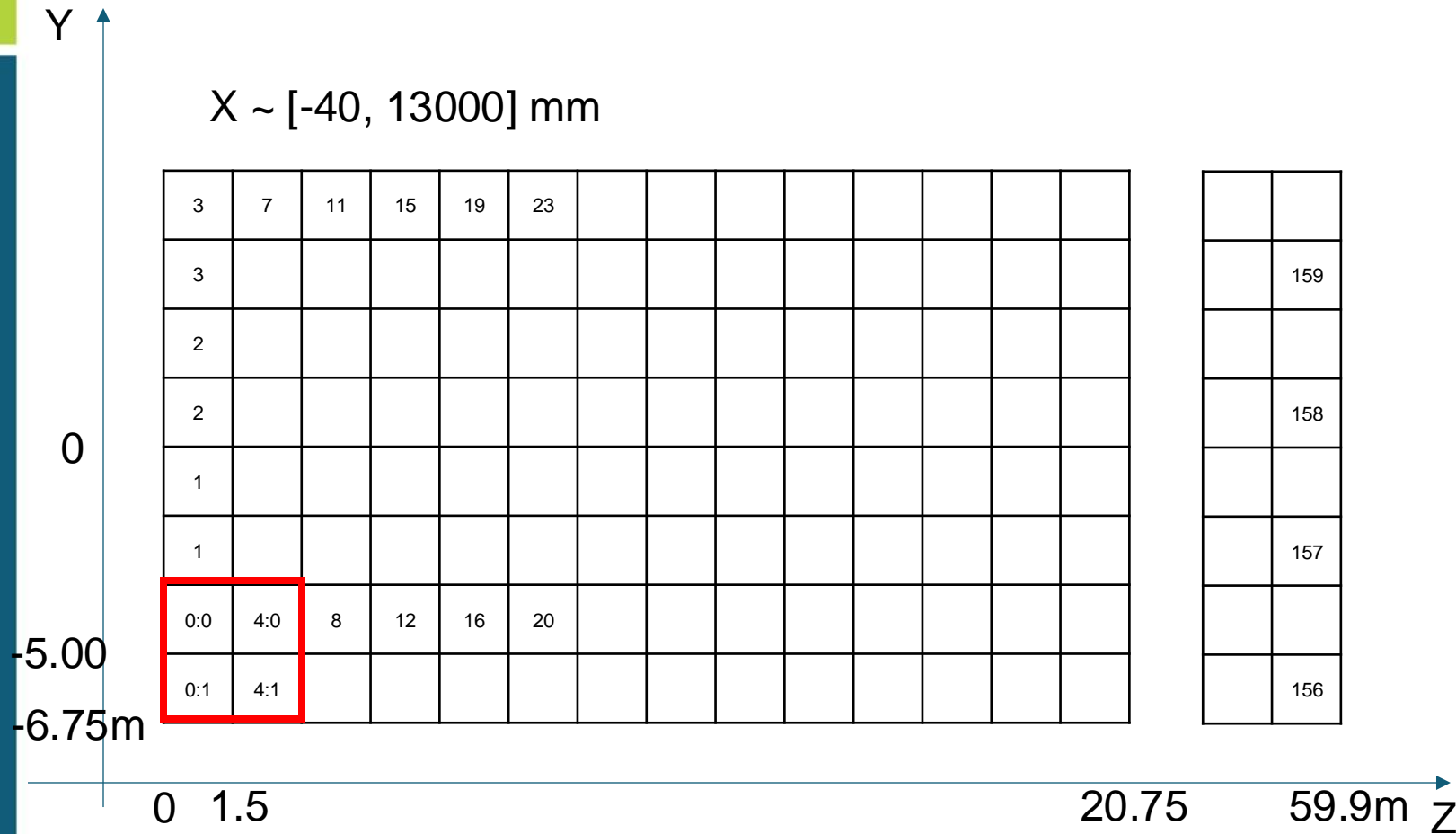
```
... auto traces = frame->traces();
```

```
... const int ntraces = traces->size();
```

Brett Viren, 5 year

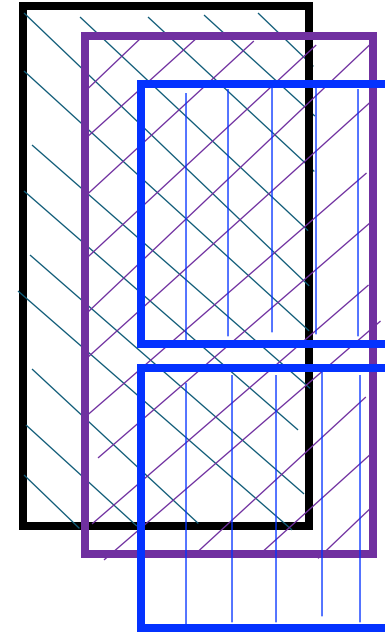
FD-VD, bridged, CRU numbering

- dunevd10kt_3view_30deg_v6_refactored.json.bz2
- XYZ: 2x4x40



CRU0

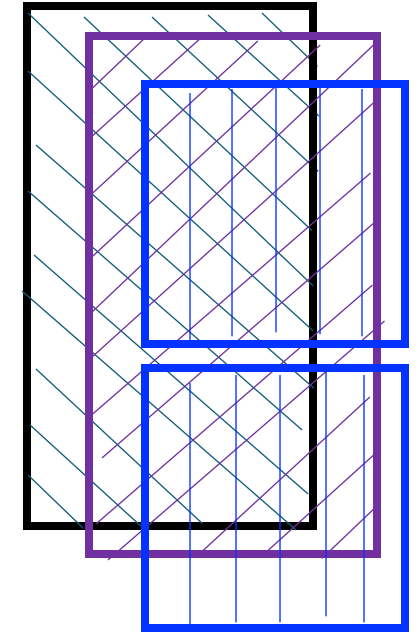
f0U: 189-475
f0V: 1427-1142
f0Z: 2196-2487



f1U: 0-285
f1V: 1238-952
f1Z: 1904-2195

CRU4

f0U: 666-951
f0V: 1617-1903(r)
f0Z: 2780-3071



f1U: 476-762
f1V: 1713-1428
f1Z: 2488-2779

SigProc save/read scaling

<https://github.com/LArSoft/larwirecell/blob/develop/larwirecell/Components/FrameSaver.cxx#L318>

<https://github.com/DUNE/dunereco/blob/develop/dunereco/DUNEWireCell/dune-vd/wcls-sim-drift-simchannel-nf-sp.js>

wclsFrameSaver::frame_scale:

- dune10kt-hd/wcls-sim-drift-simchannel-nf-sp.jsonnet: 0.005
- dune-vd/wcls-sim-drift-simchannel-nf-sp.jsonnet: 0.005
- pdsp/wcls-nf-sp.jsonnet: 0.001