Status report on

DNNROI sigproc

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Memory Optimization

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MemoryTracker summary (base-10 MB units used)

  Peak virtual memory usage (VmPeak)  : 17755.8 MB
  Peak resident set size usage (VmHWM): 6958.67 MB
  Details saved in: 'mem.db'
================================================================================
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================================================================================
MemoryTracker summary (base-10 MB units used)

  Peak virtual memory usage (VmPeak)  : 16437.5 MB
  Peak resident set size usage (VmHWM): 5689.09 MB
  Details saved in: 'mem.db'
================================================================================
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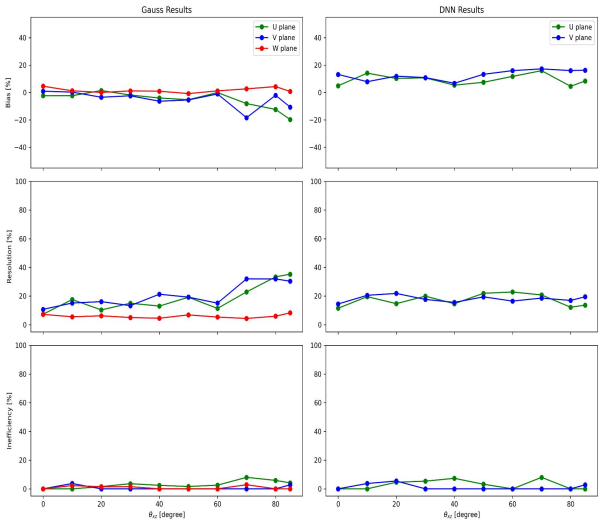
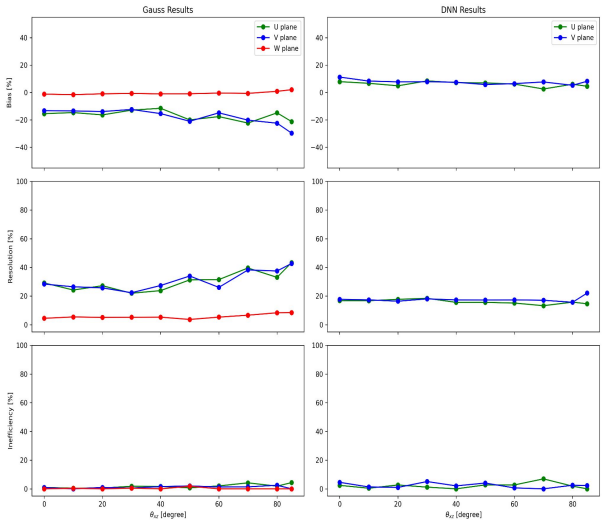
- Tested with UNet
- Deactivating save_data reduces the memory usage about 1 GB

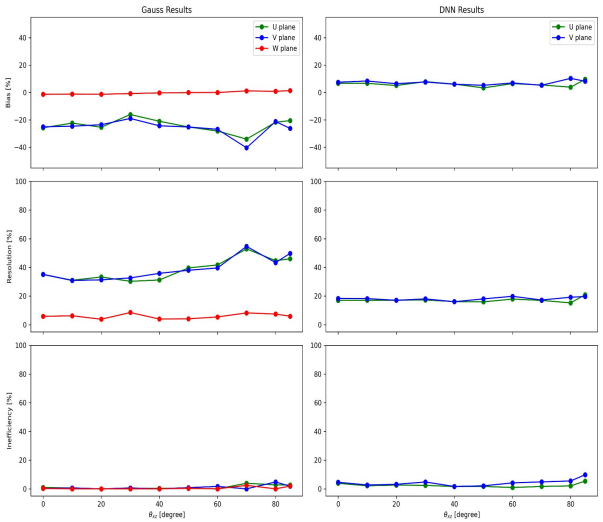
DNN SP evaluation - single shower event



❑ P0: 100 MeV, SigmaP: 0.05



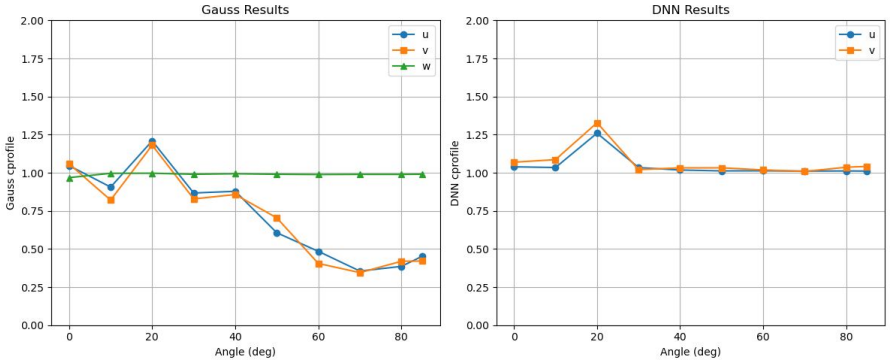
❑ P0: 1 GeV, SigmaP: 0.05

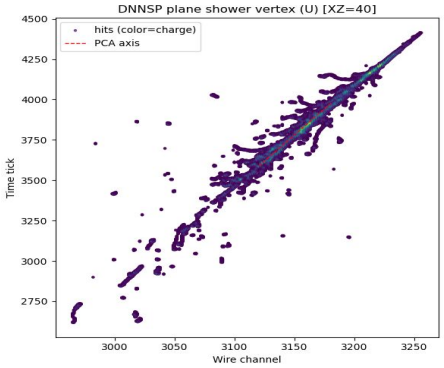


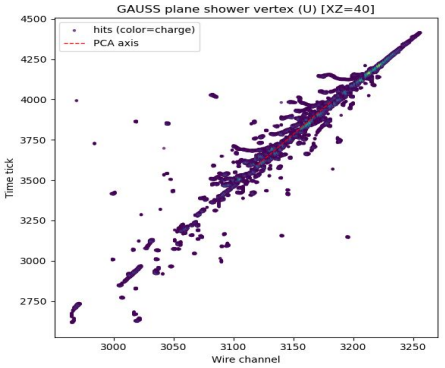
❑ P0: 5 GeV, SigmaP: 0.05

- As the energy increases, the bias and resolution in Gauss is getting worse
- DNN SP maintains more consistent performance across all energy levels

DNN SP evaluation - single shower event







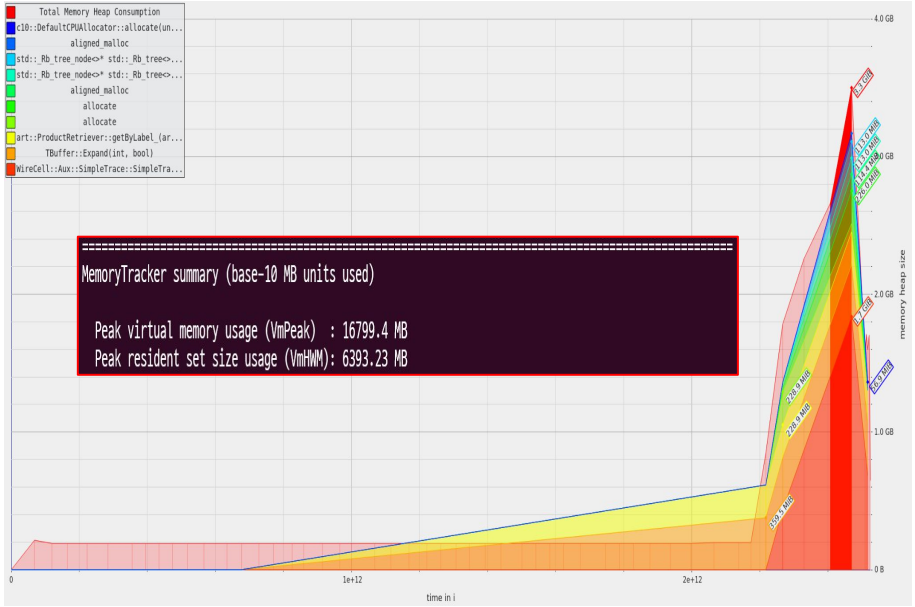
- P0: 5 GeV, SigmaP: 0.05

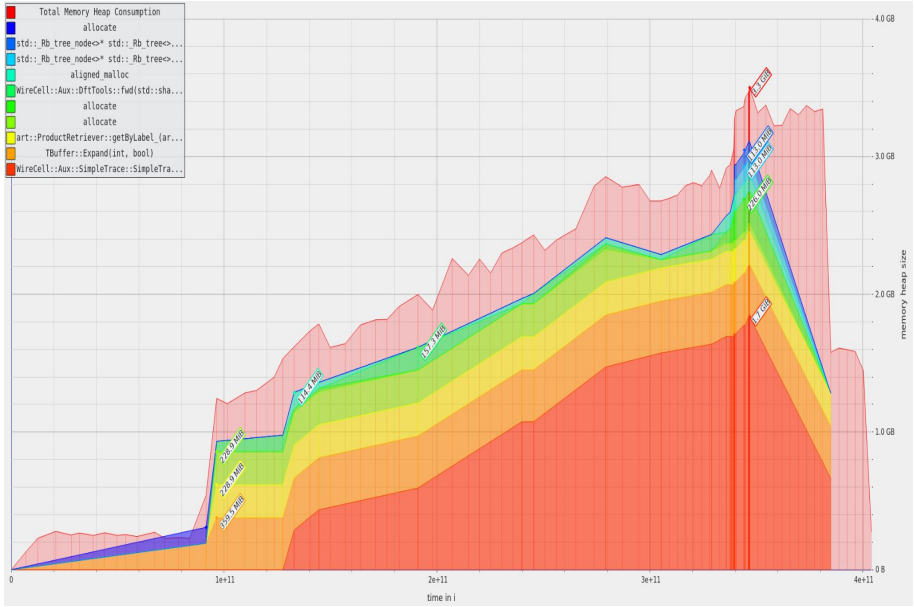
- New metrics for Shower evaluation:
  - Angle diff
  - Charge profile within 1 radiation length (14 cm ~ 47 wire channels)
- Charge Profile: Decon / Truth
- DNN showed better performance when we look at near the vertex

	Angle diff	
	Gauss (deg.)	DNN (deg.)
U plane	0.74	0.82
V plane	0.52	0.51
W plane	1.22	

Back Up

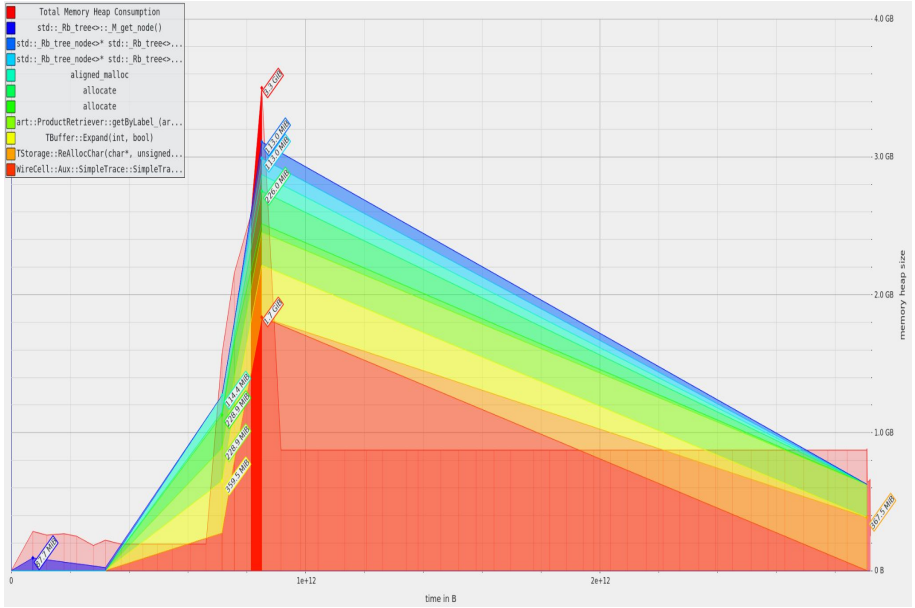
Memory Profiling - Valgrind

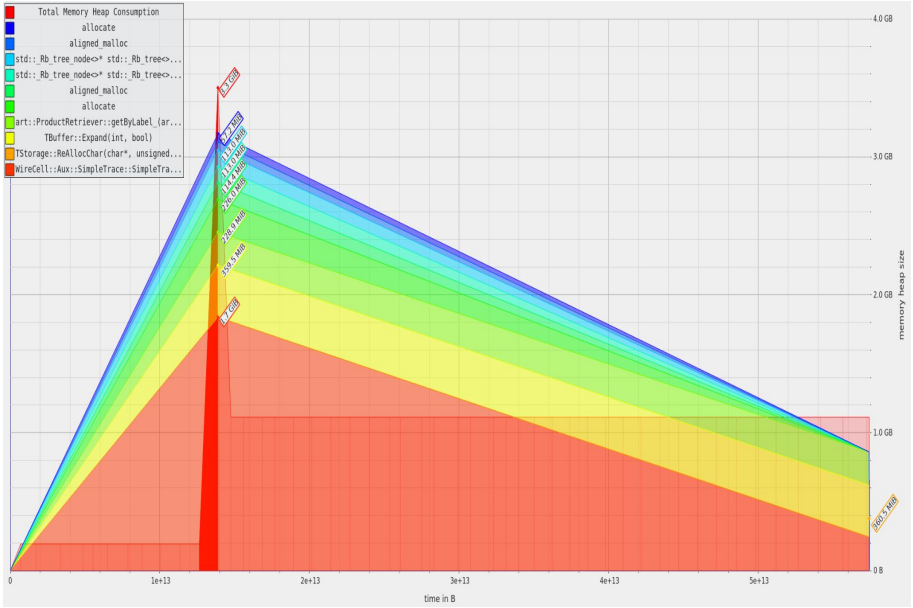




- Profiled twice over DNN SP (MobileNetV2) with a PD-HD data file (one event)
- Time unit: i - instructions (default)
- The left is what I shared in the last meeting, the right one is newly generated
- The peak appears near the end of the instructions
- The peak memory from Valgrind (~ 3.3 GIB) is different from LArSoft's MemoryTracker (~6.4 GB)

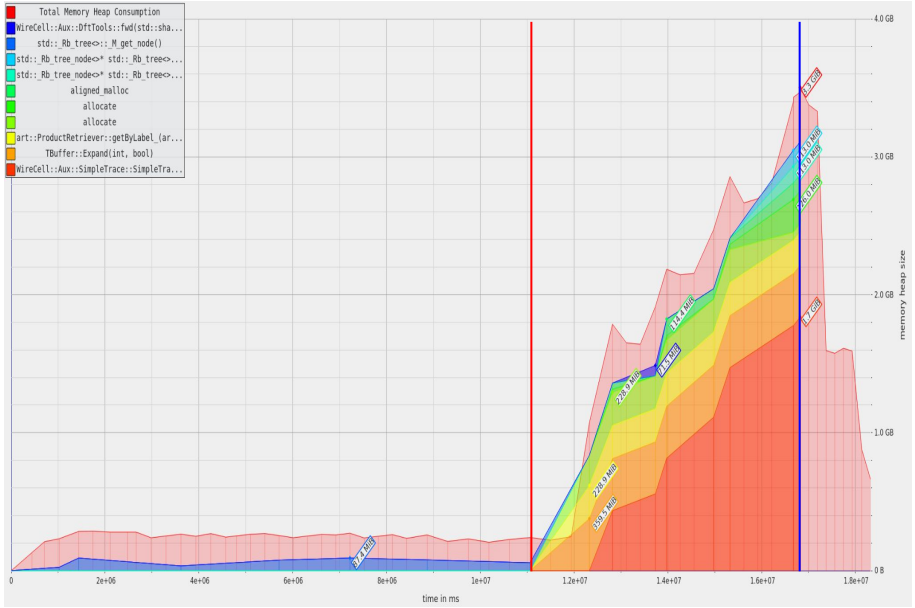
Memory Profiling - Valgrind





- Profiled twice over DNN SP (MobileNetV2) with a PD-HD data file (one event)
- Time unit: B - Bytes
- For the same data processing, total amount of heap memory allocated is different
- The peak appears abruptly, and there is low memory usage after the peak

Memory Profiling - Valgrind

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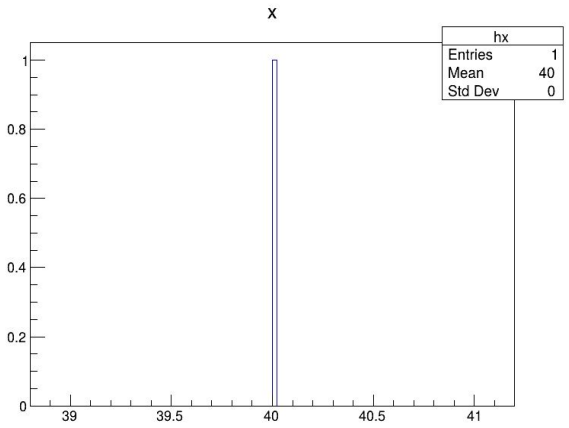
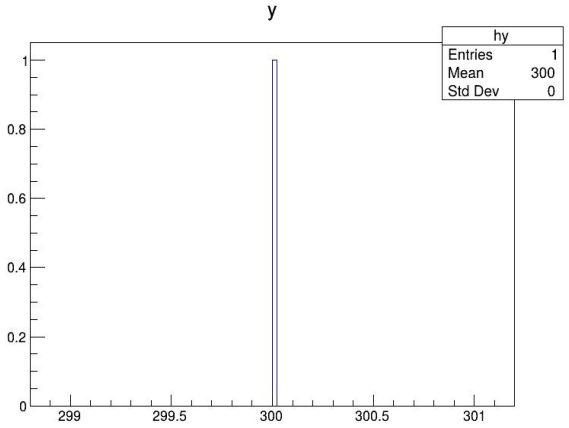
================================================================================
MemoryTracker summary (base-10 MB units used)

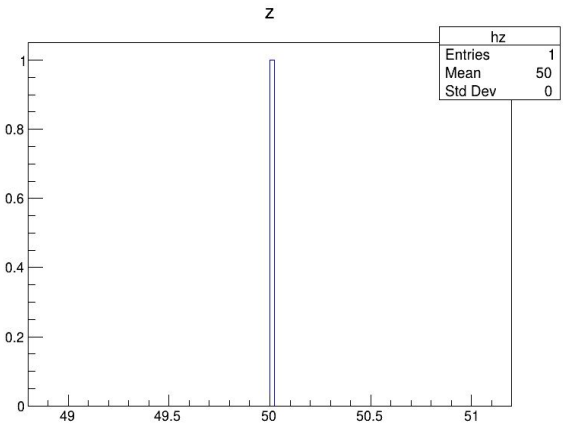
  Peak virtual memory usage (VmPeak)  :
%MSG-s ArtException:  RootOutput:out1@EndJob 15-Jul-2025 15:33:06 PDT  ModuleEndJob
---- SQLExecutionError BEGIN
  unique_value expected of non-unique query.
---- SQLExecutionError END
%MSG
Art has completed and will exit with status 1.
Command exited with non-zero status 1
        Command being timed: "valgrind --tool=massif --time-unit=ms --massif-out-file=massif_output_mobilenetv2_timems2.out --stacks=yes --log-file=valgrind_timems2.log lar -n1 -c my_standard_reco_stage2_calibration_protodunehd_keepup_dnnroi.fcl -s ../../../../data/stage1/run027673/np04hd_raw_run027673_0000_dataflow0_datawriter_0_20240704T050545_reco_stage1.root"
        User time (seconds): 6884.62
        System time (seconds): 11417.65
        Percent of CPU this job got: 99%
        Elapsed (wall clock) time (h:mm:ss or m:ss): 5:06:16
        Average shared text size (kbytes): 0
        Average unshared data size (kbytes): 0
        Average stack size (kbytes): 0
        Average total size (kbytes): 0
        Maximum resident set size (kbytes): 6398684
        Average resident set size (kbytes): 0
        Major (requiring I/O) page faults: 73
        Minor (reclaiming a frame) page faults: 1606802
        Voluntary context switches: 307636
        Involuntary context switches: 122524
        Swaps: 0
        File system inputs: 0
        File system outputs: 241944
        Socket messages sent: 0
        Socket messages received: 0
        Signals delivered: 0
        Page size (bytes): 4096
        Exit status: 1
Done.
Massif output file: massif_output_mobilenetv2_timems2.out
Valgrind log file:  valgrind_timems2.log
```

- Profiled twice over DNN SP (MobileNetV2) with a PD-HD data file (one event)
- Time unit: ms - milliseconds
- Profiling stopped due to error: unique_value expected of non-unique query
- Run time is almost 5 hours but the memory usage is low for 3 hours (red line)
- The peak snapshot is taken within very short time (blue line)

ShowerAna module



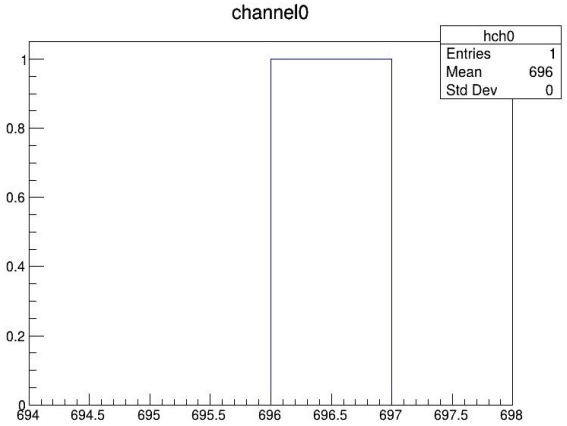


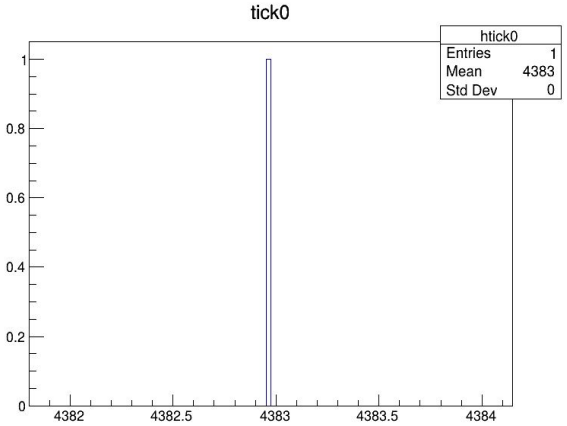


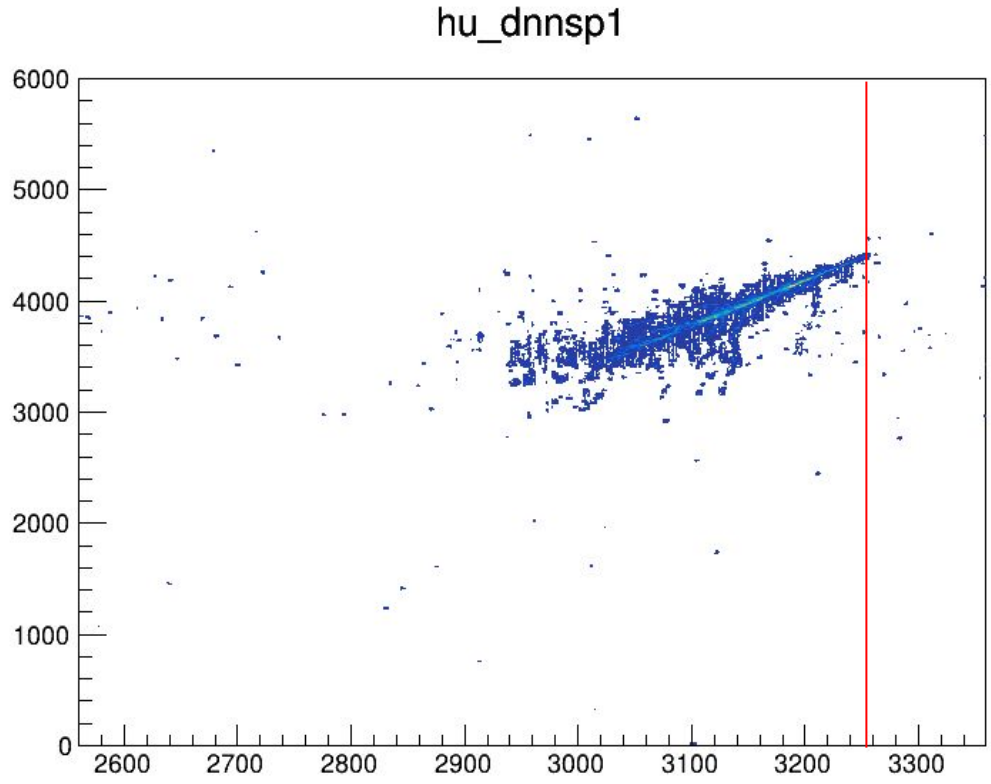
- Get the information of the primary electron, and save the followings:
  - initial position (x, y, z) and corresponding wire channels and time ticks
  - momentum (px, py, pz), pid, tpc id
  - normalized momentum → unit direction (dirx, diry, dirz)
  - extrapolated position (x_ex, y_ex, z_ex) and corresponding wire channels and time ticks
    ex) x_ex = x + step * dirx

- Detector Geometry (@local::protodunehdv6_geo) from fcl files below:
  - standard_g4_protodunehd.fcl
  - standard_detsim_protodunehd.fcl

Truth Info. from MCParticle

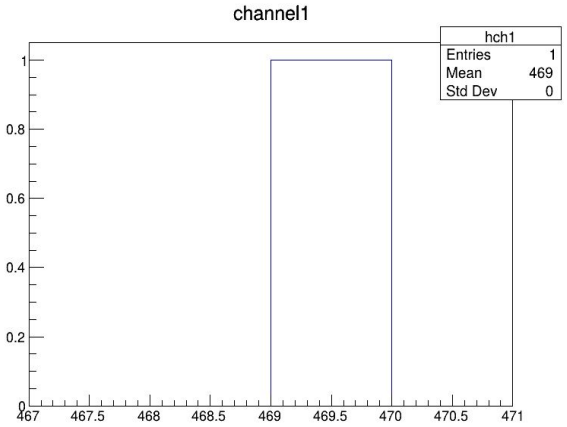


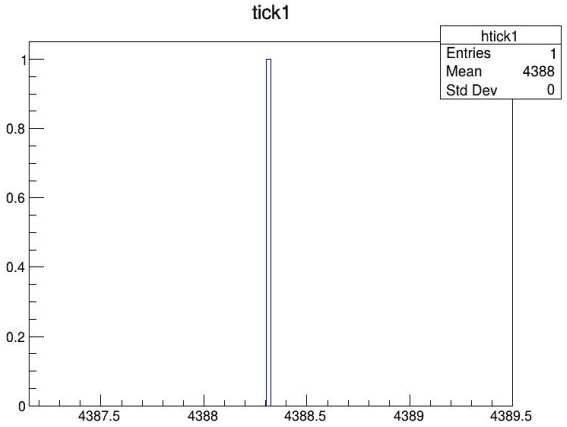


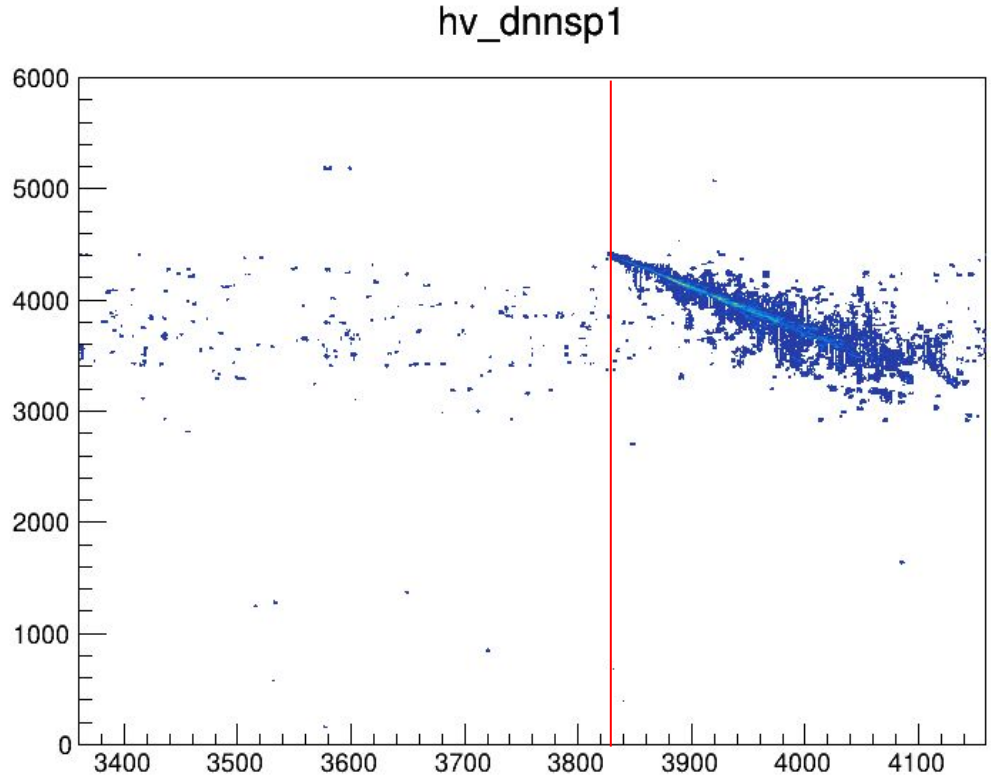


- For u plane of APA2, the (wire channel, time tick) is
  - wire channel: 2560 + 696 = 3256
  - time tick: 4383

Truth Info. from MCParticle

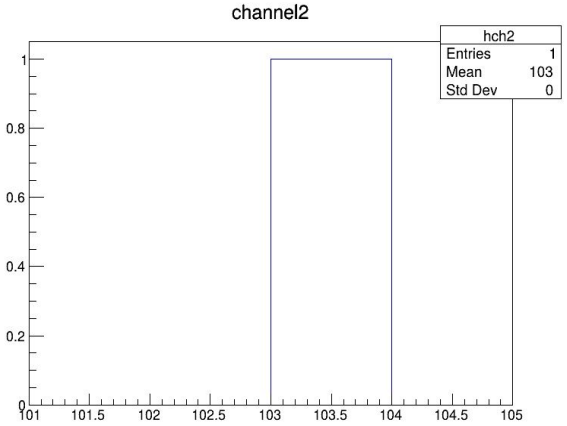


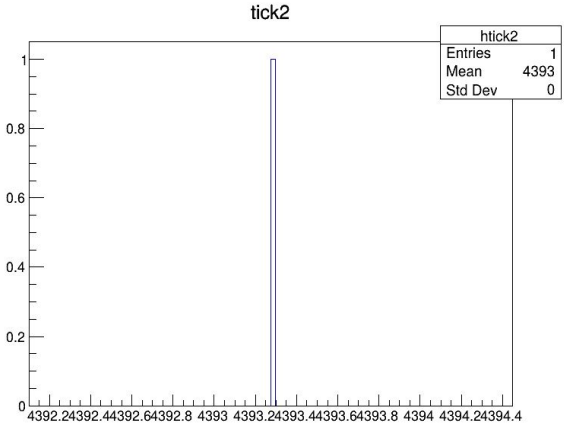


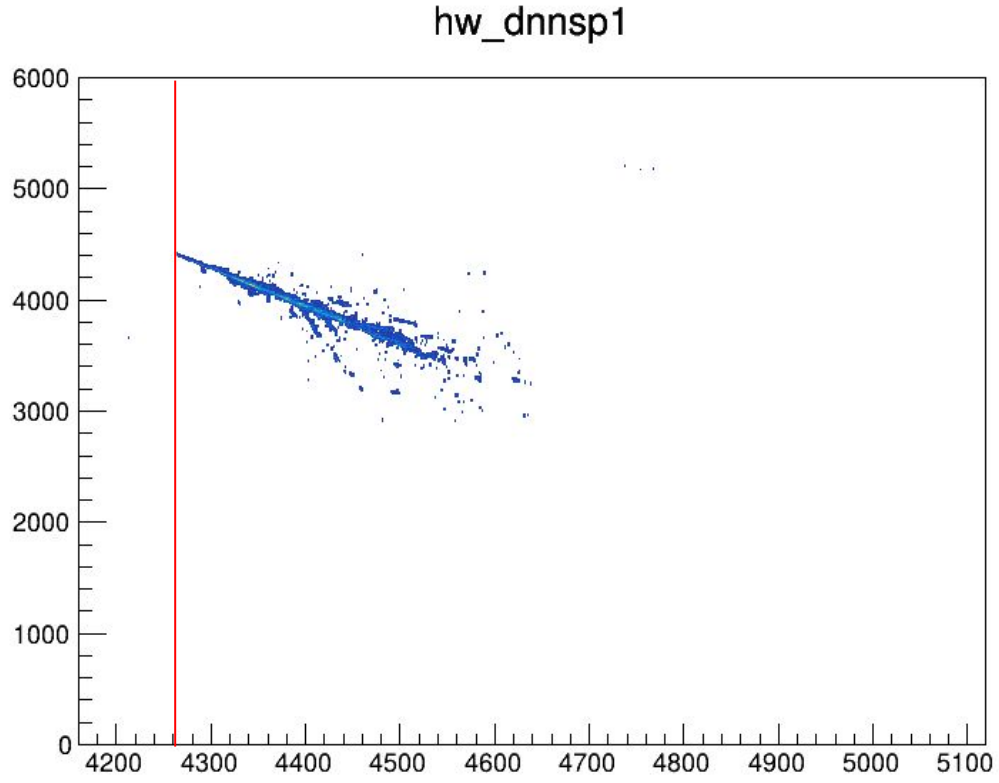


- For v plane of APA2, the (wire channel, time tick) is
  - wire channel: 2560 + 800 + 469 = 3256
  - time tick: 4388

Truth Info. from MCParticle

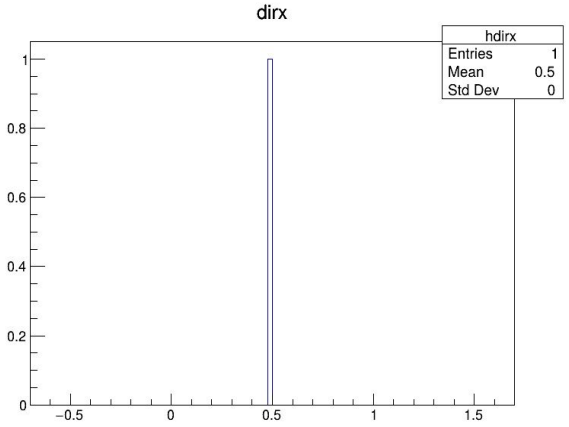


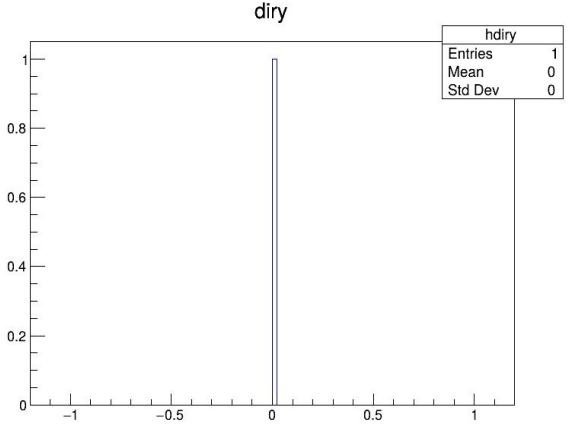


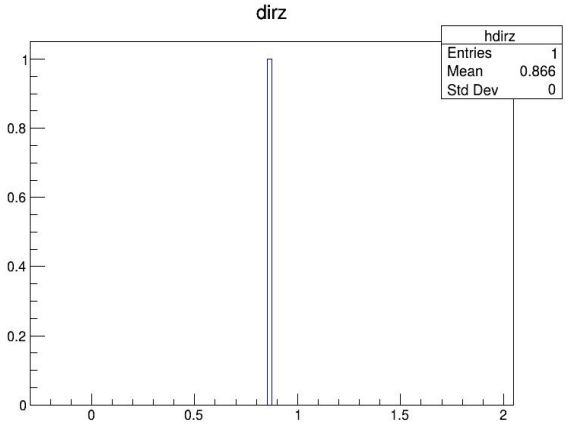


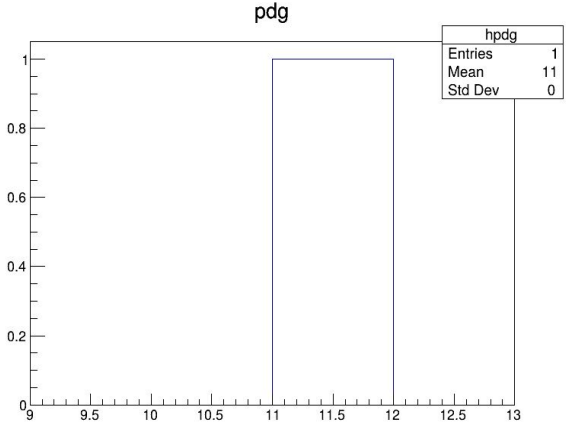
- For w plane of APA2, the (wire channel, time tick) is
  - wire channel: 2560 + 800 + 800 + 103 = 3256
  - time tick: 4393

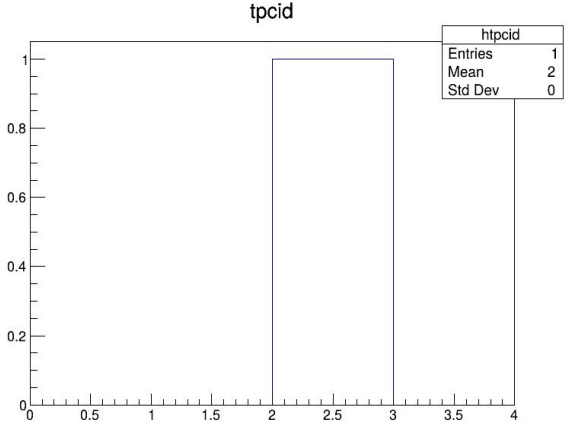
Truth Info. from MCParticle



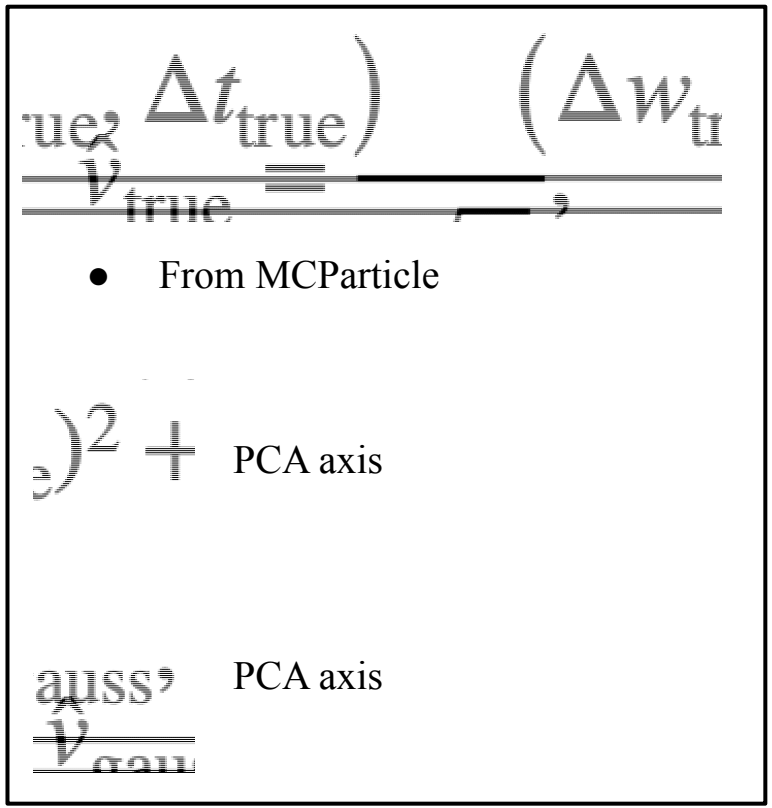








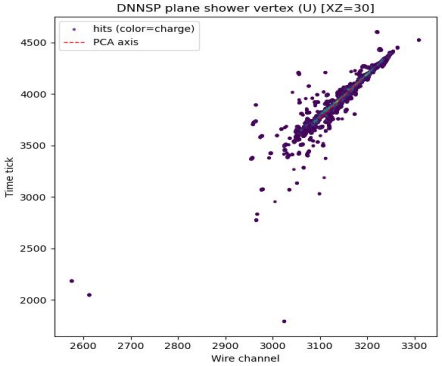
Angle between reco and true direction

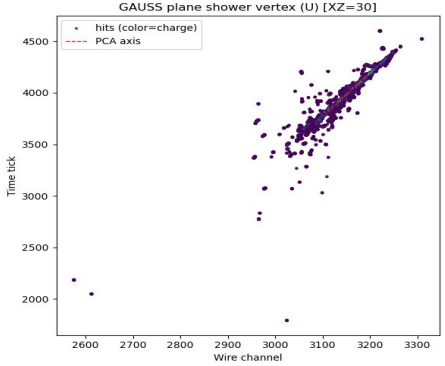


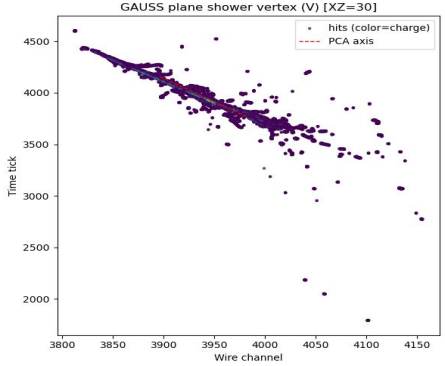
$$\cos\theta = \hat{v}_{true} \cdot \hat{v}_{reco} = \frac{\Delta w_{true}\Delta w_{reco} + \Delta t_{true}\Delta t_{reco}}{\Delta w$$

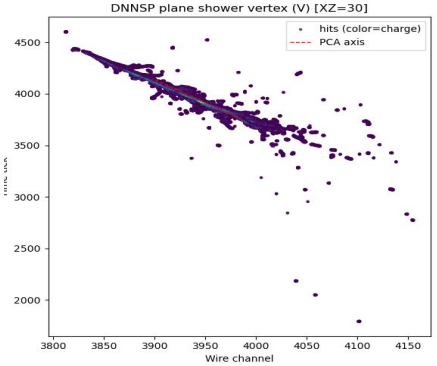
$$\theta = \arccos($$

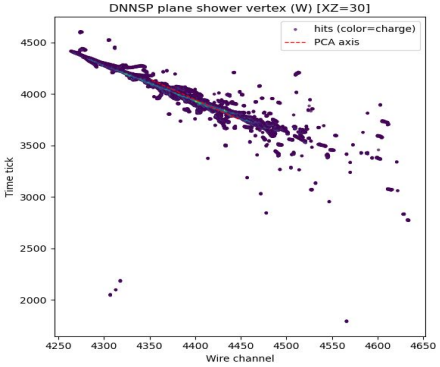
Angle between reco and true direction (E = 5 GeV, XZ = 30)





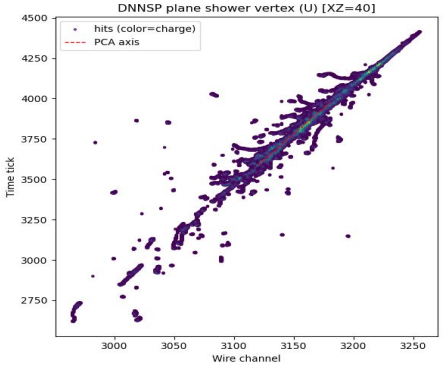


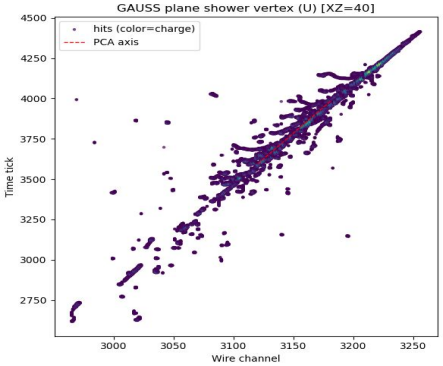


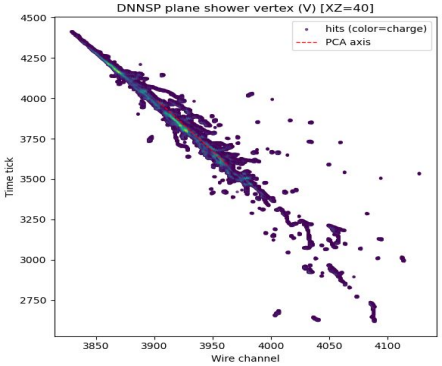


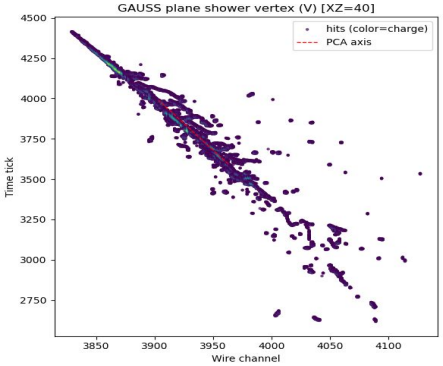
	Angle diff	
	Gauss (deg.)	DNN (deg.)
U plane	0.58	0.53
V plane	1.10	0.83
W plane	2.52	

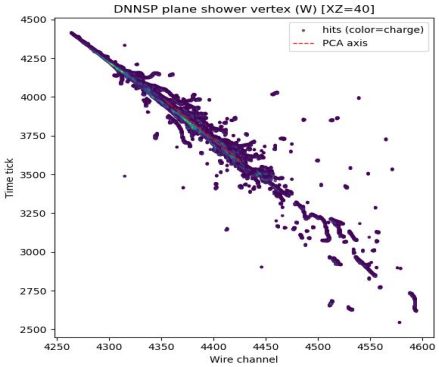
Angle between reco and true direction (E = 5 GeV, XZ = 40)





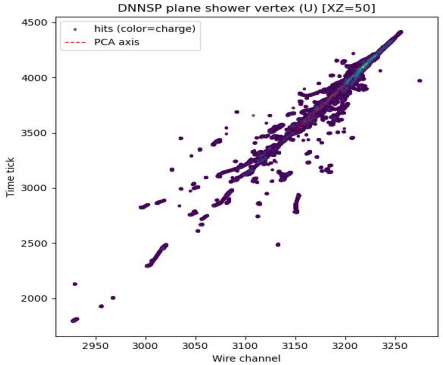


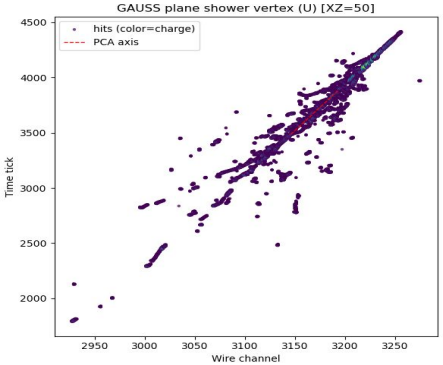


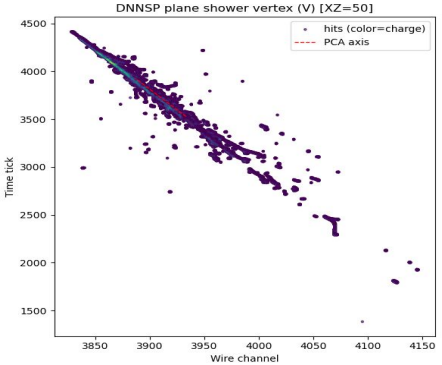


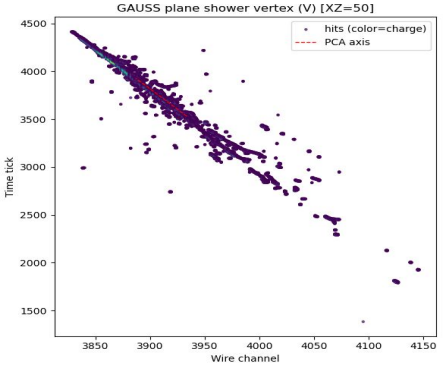
	Angle diff	
	Gauss (deg.)	DNN (deg.)
U plane	0.74	0.82
V plane	0.52	0.51
W plane	1.22	

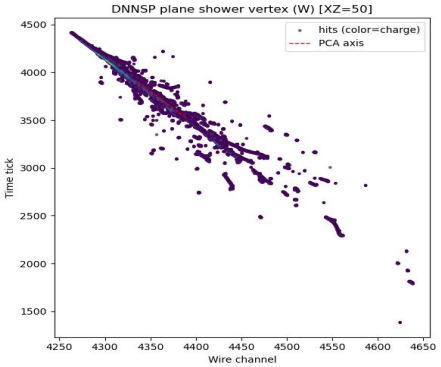
Angle between reco and true direction (E = 5 GeV, XZ = 50)





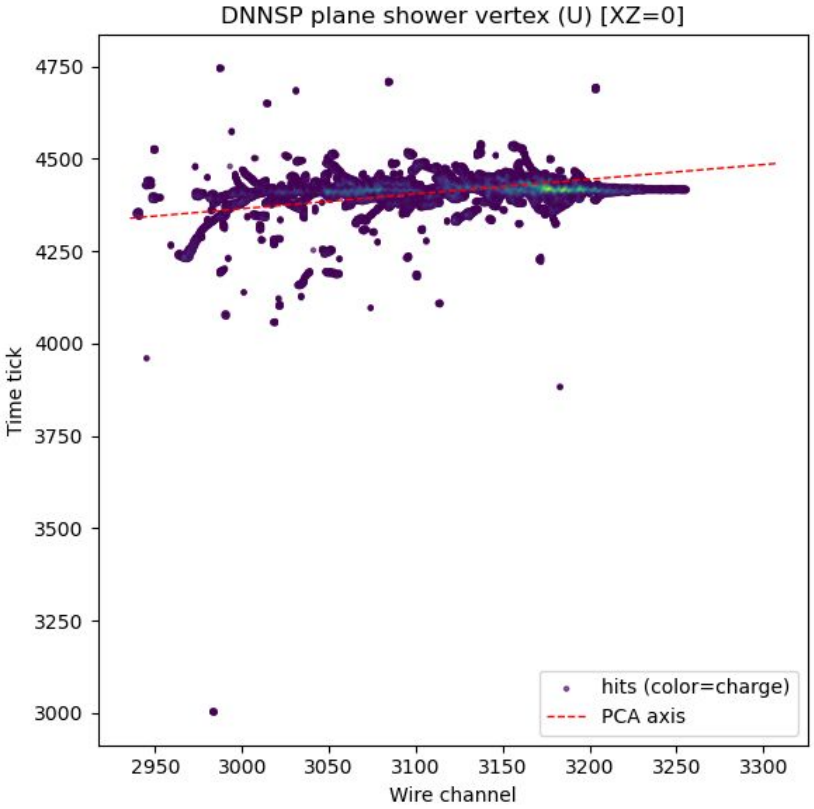


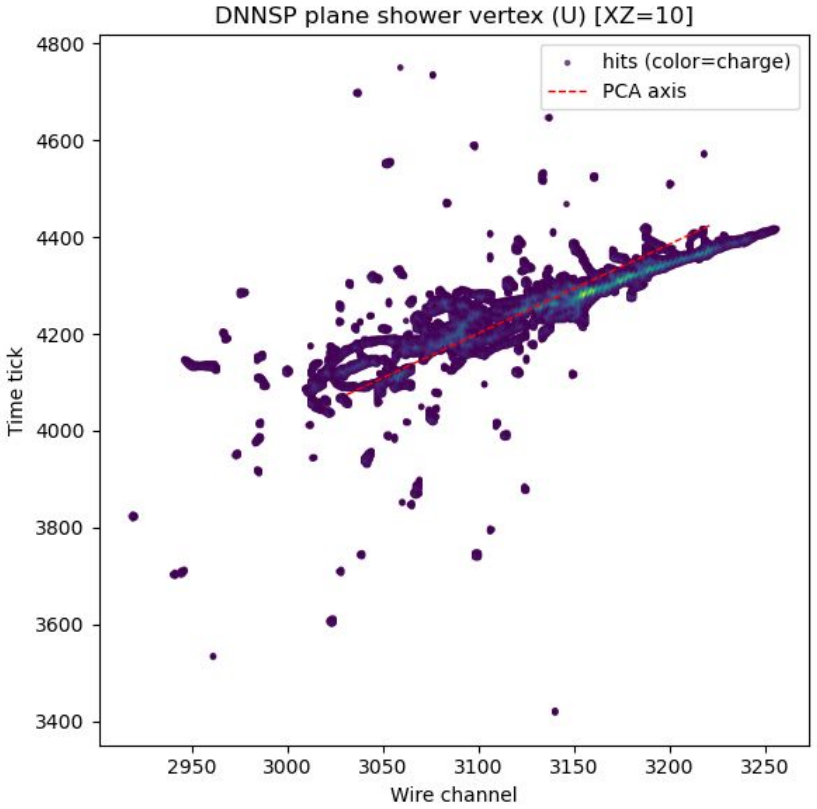




	Angle diff	
	Gauss (deg.)	DNN (deg.)
U plane	0.06	0.09
V plane	0.33	0.29
W plane	0.10	

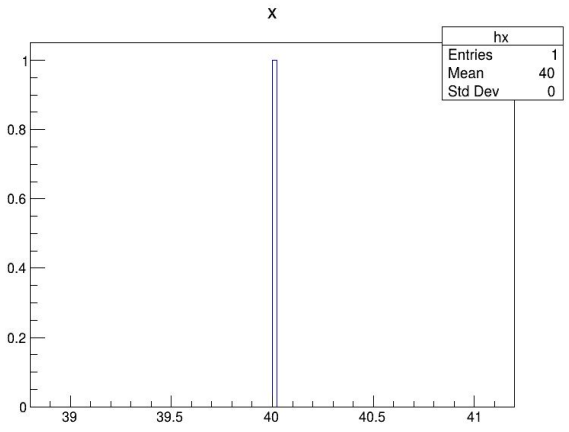
Issues in PCA axis analysis

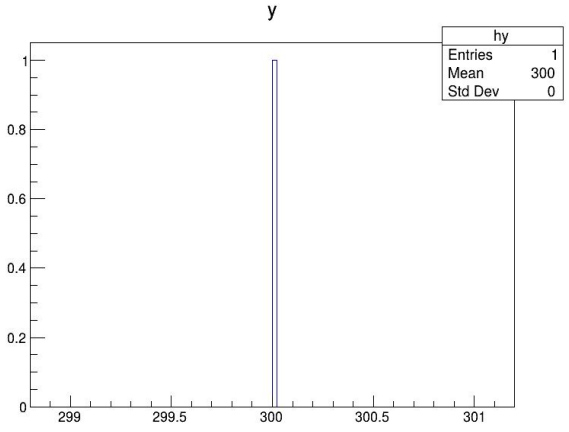


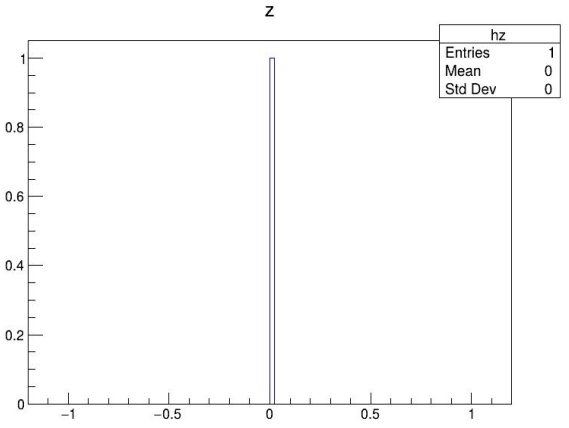


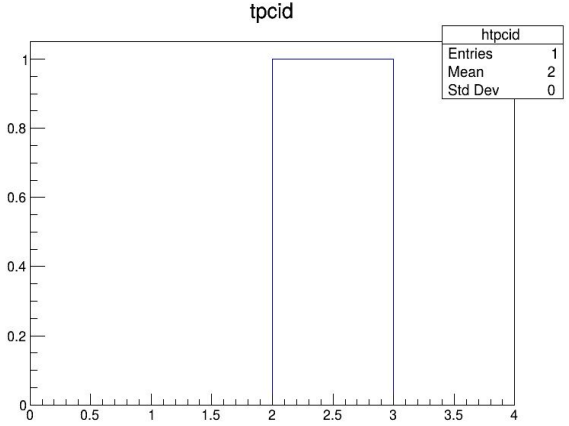
- PCA fails particularly for lower angles

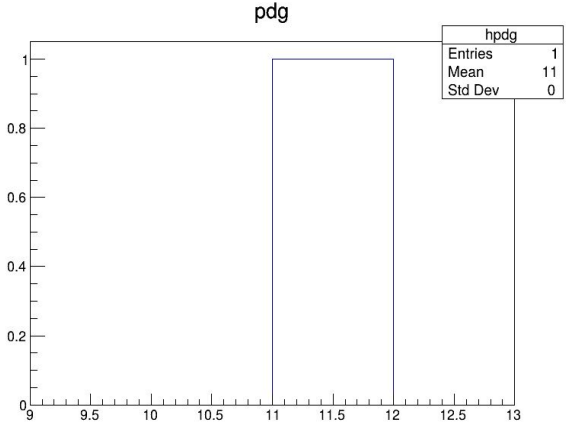
ShowerAna module





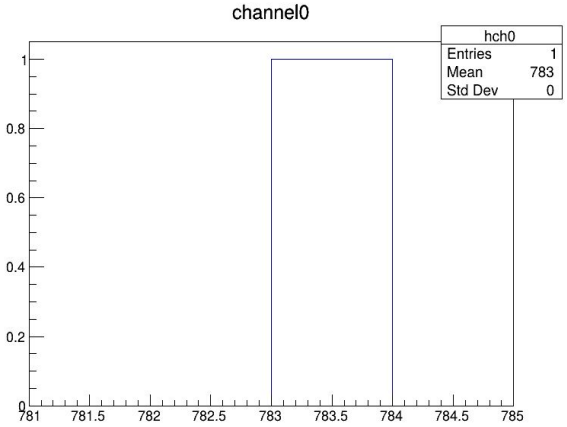


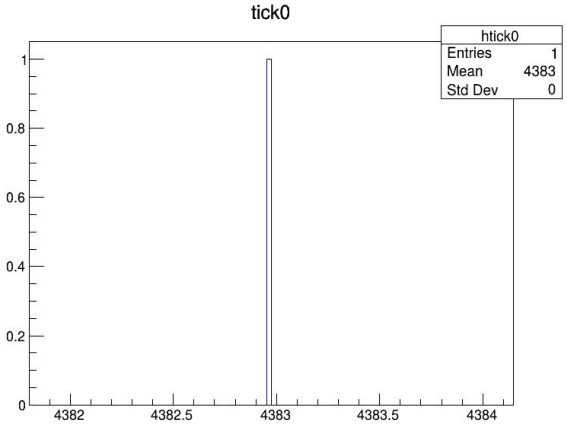


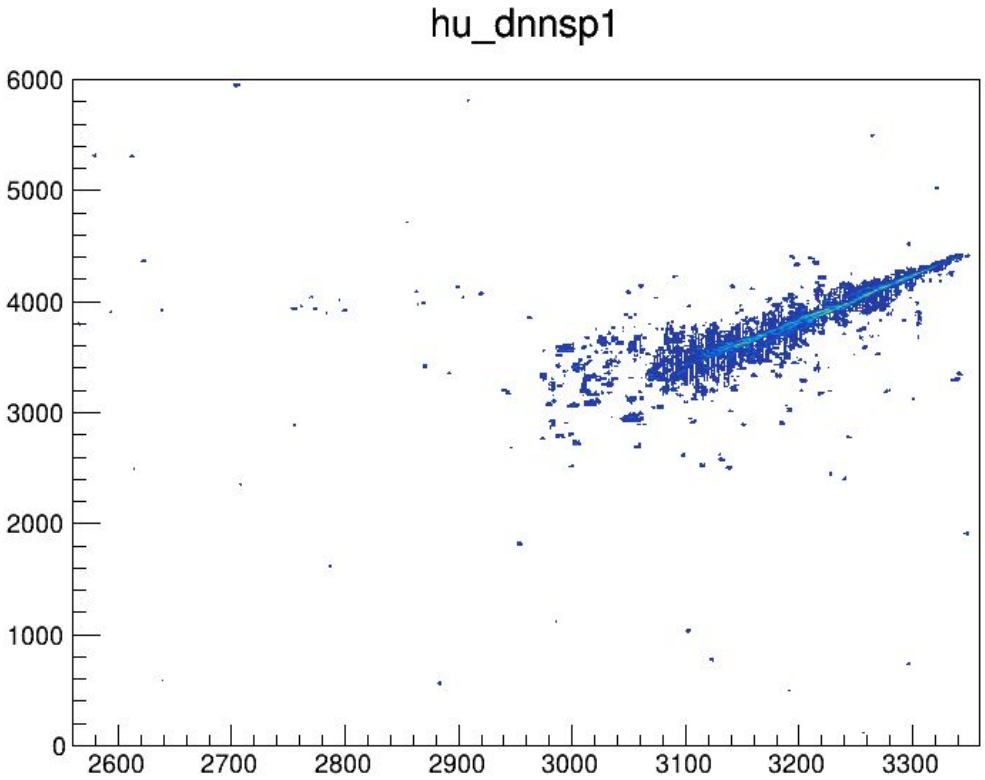



```
# This block defines starting parameters
physics.producers.generator.PosDist: 0
physics.producers.generator.X0: [40.]
physics.producers.generator.Y0: [300.]
physics.producers.generator.Z0: [0.0]
```

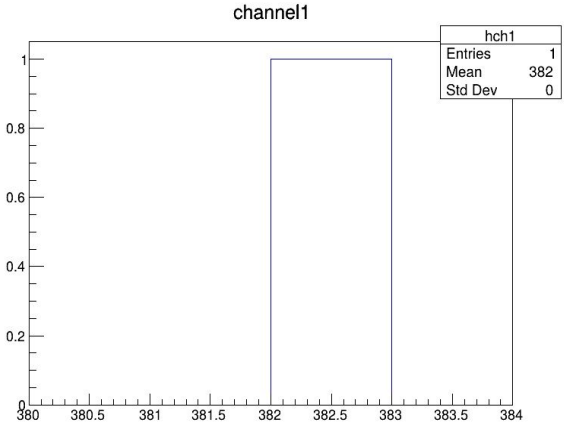
Truth Info. from MCParticle

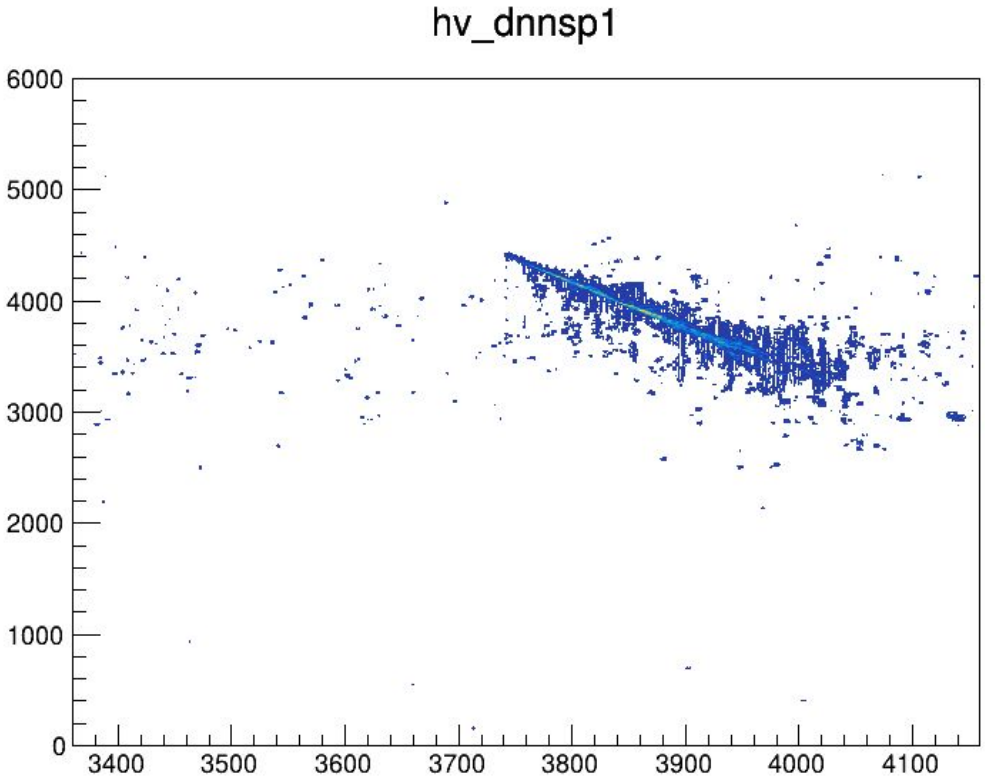




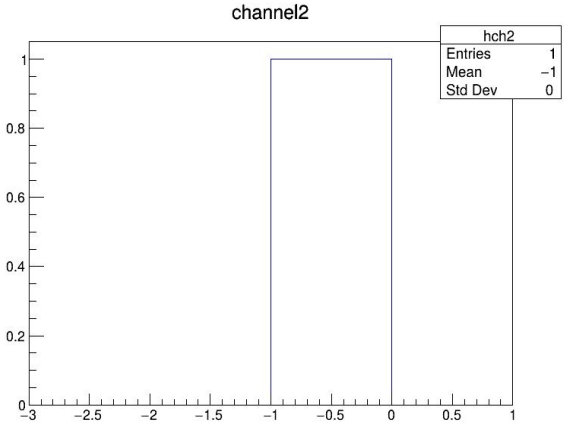


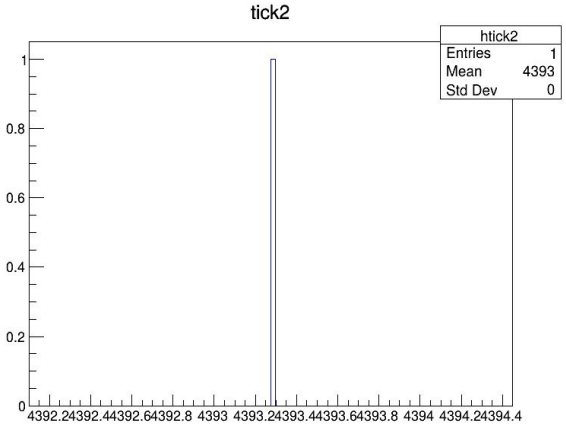
Truth Info. from MCParticle

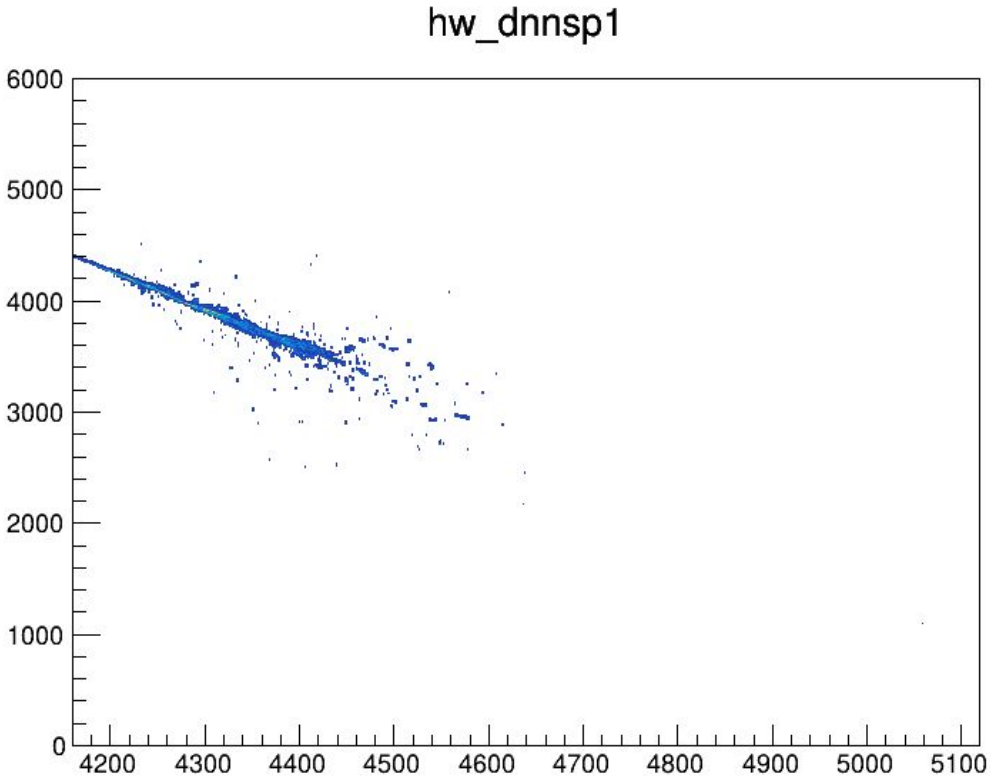




Truth Info. from MCParticle







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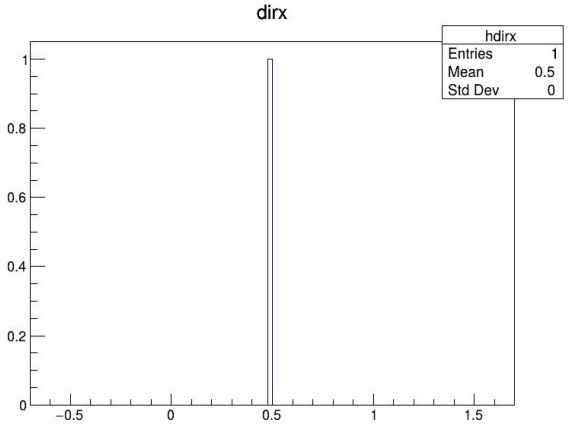
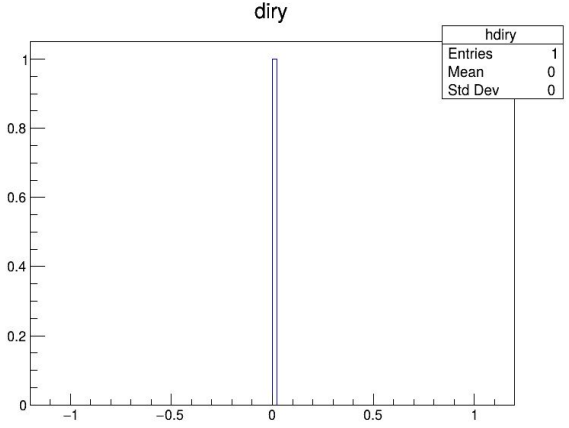
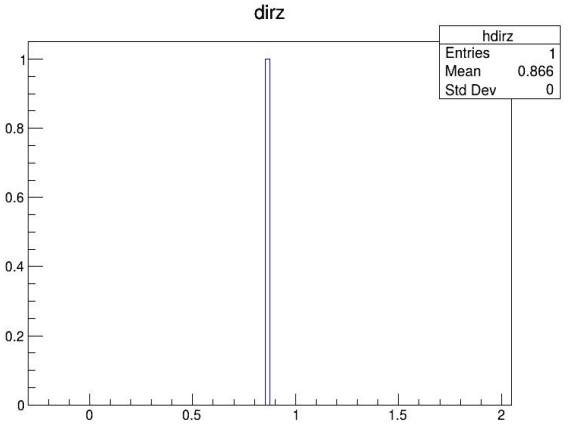
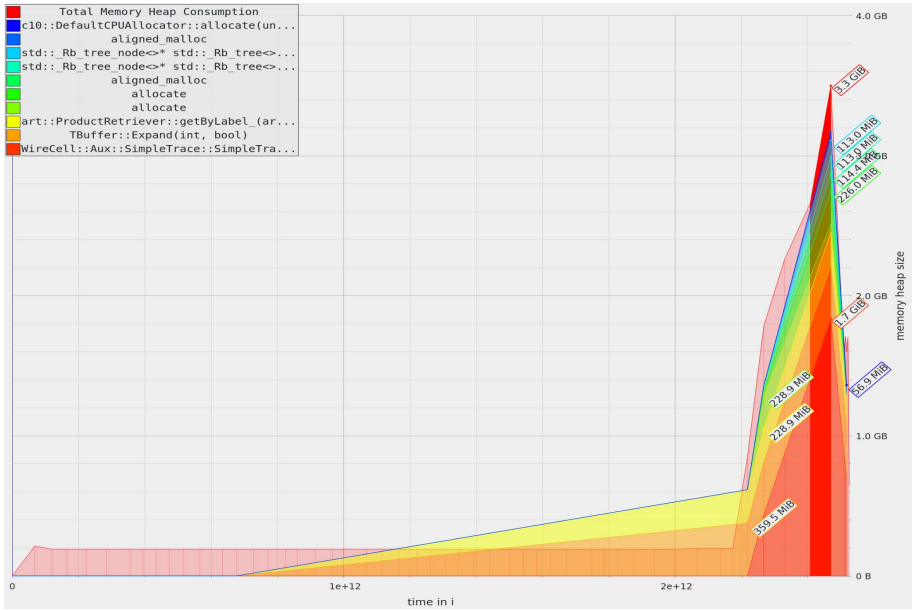
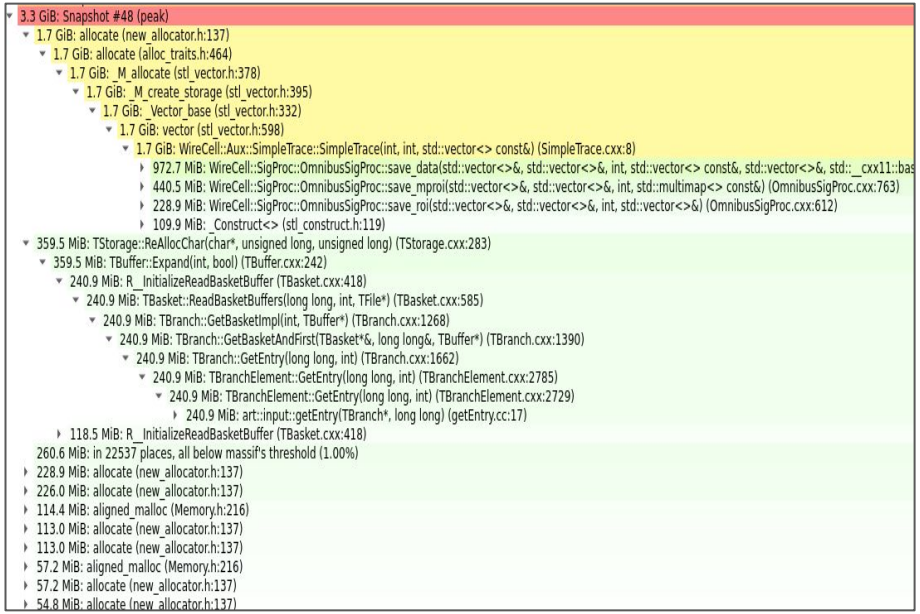






Memory Profiling - Valgrind

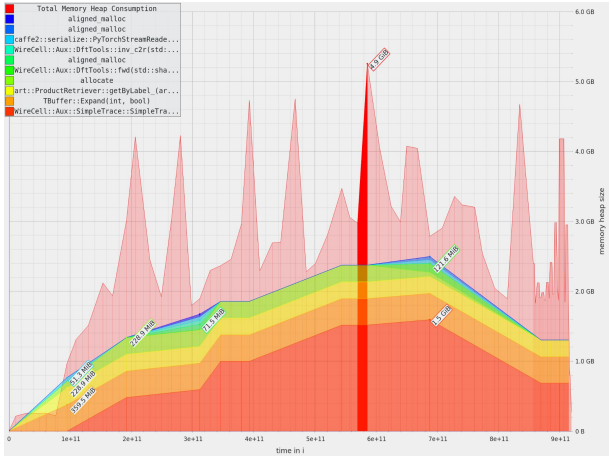




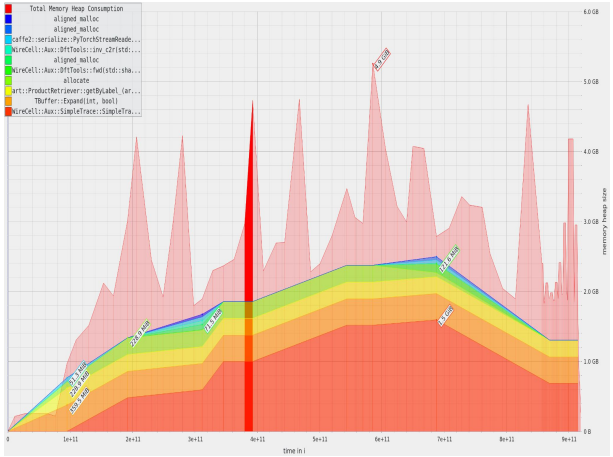
- PD-HD data, DNN SP with MobileNetV2
- The peak memory recorded is 3.3 GiB
- Almost half of the memory (~1.7 GiB) is due to:
  - WireCell::SigProc::OmnibusSigProc::save_data (972 MiB out of 1.7 GiB)
  - WireCell::SigProc::OmnibusSigProc::save_mproi (440 MiB out of 1.7 GiB)

do_not_mp_protect_tradtional is set to true

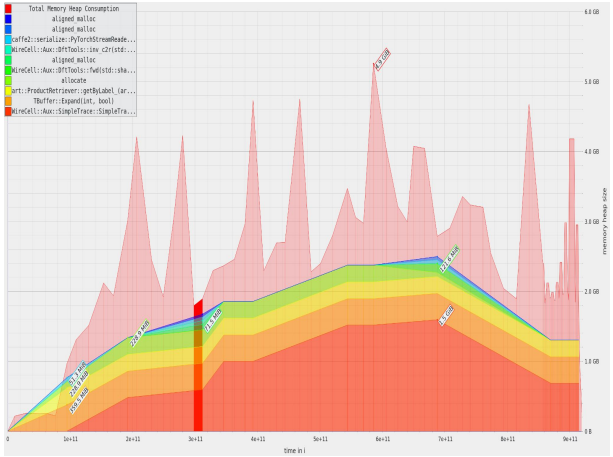
Memory Profiling - Valgrind



❏ 1st peak



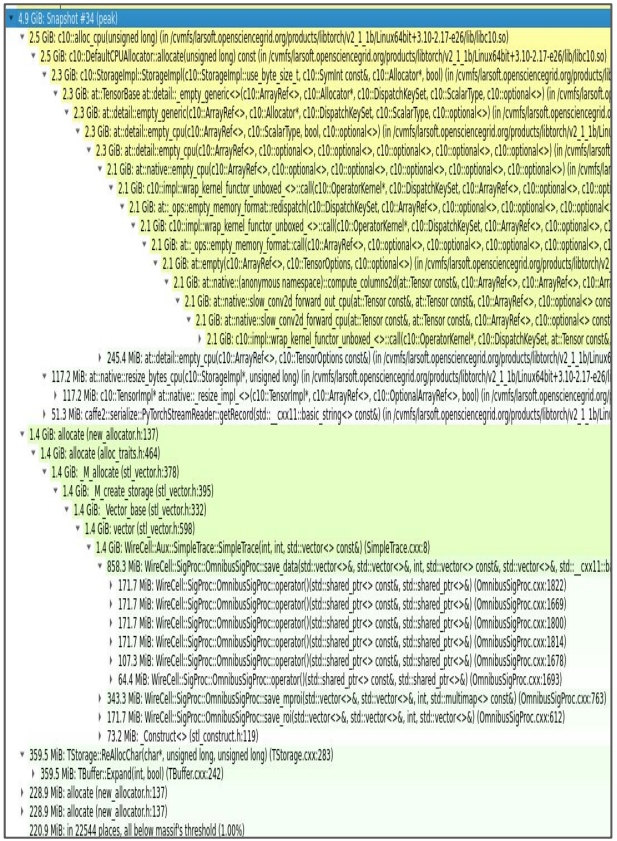
❏ 2nd peak

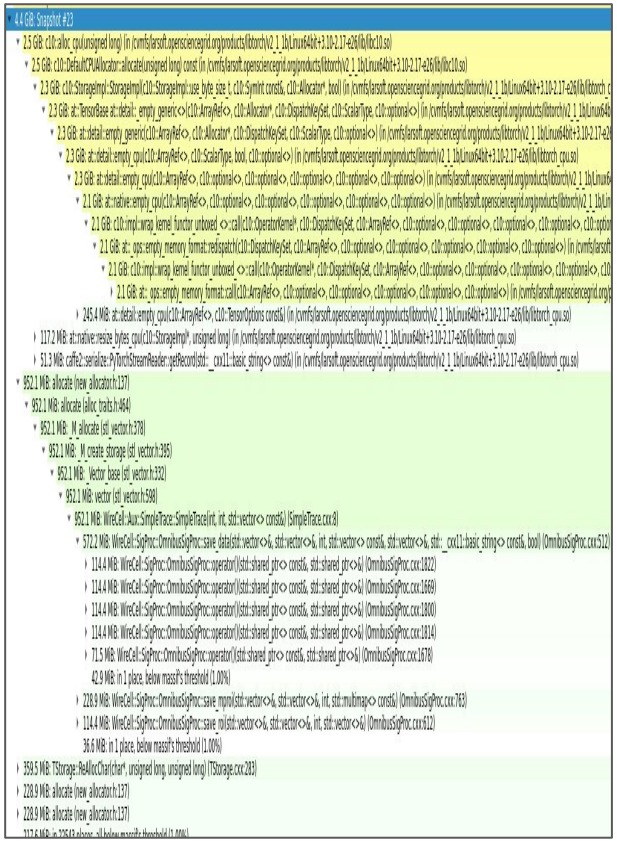


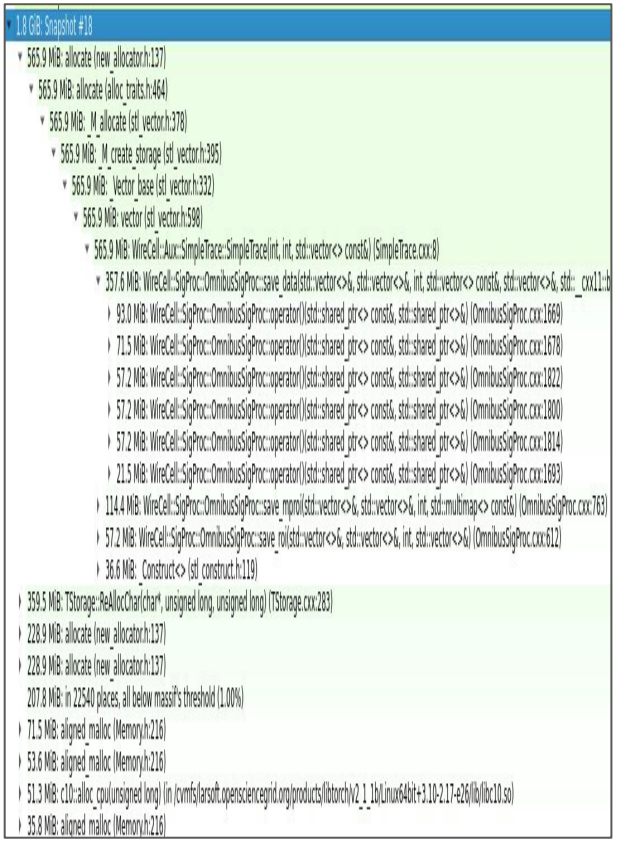
❏ low torch activity

- PD-HD data, DNN SP with UNet
- The peak memory recorded is 4.9 GiB
- Not like a MobileNet result, the total cost graph has several peaks
- Almost half of the memory (~2.5 GiB) is allocated to libtorch_cpu.so around the peak
- Another major contributions are from:
  - WireCell::SigProc::OmnibusSigProc::save_data (853 MiB out of 1.4 GiB)
  - WireCell::SigProc::OmnibusSigProc::save_mproi (343 MiB out of 1.4 GiB)

Memory Profiling - Valgrind







❑ 1st peak ❑ 2nd peak ❑ low torch activity