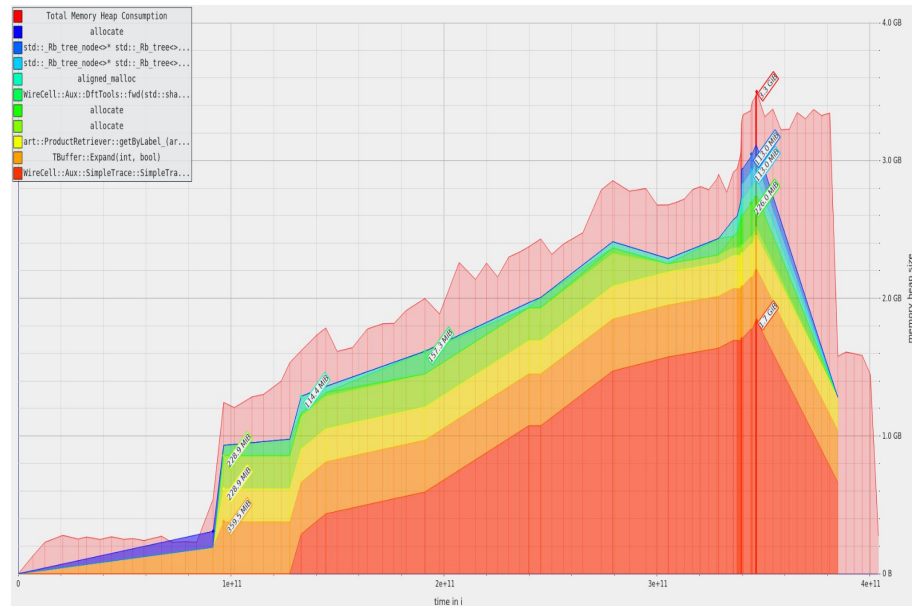
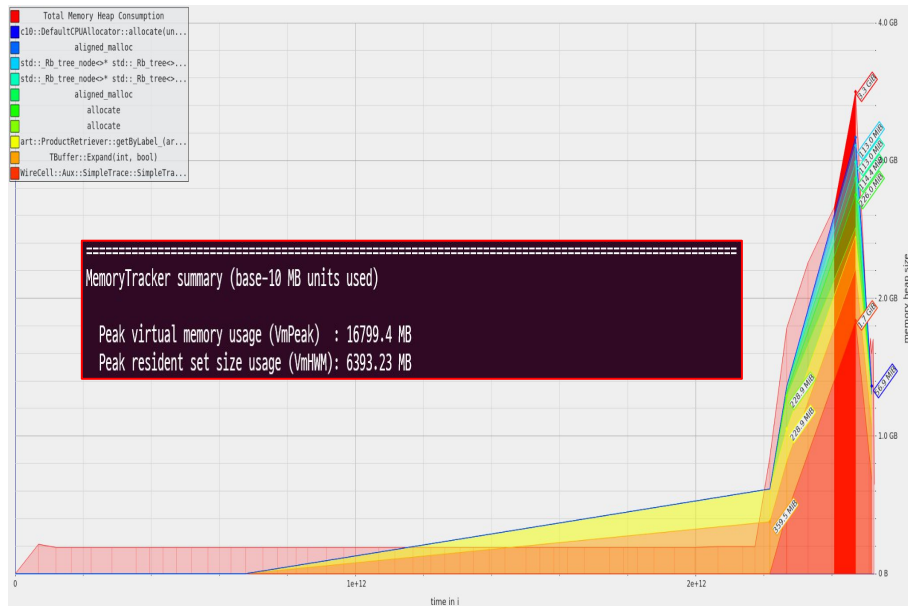




Status report on **DNNROI sigproc**

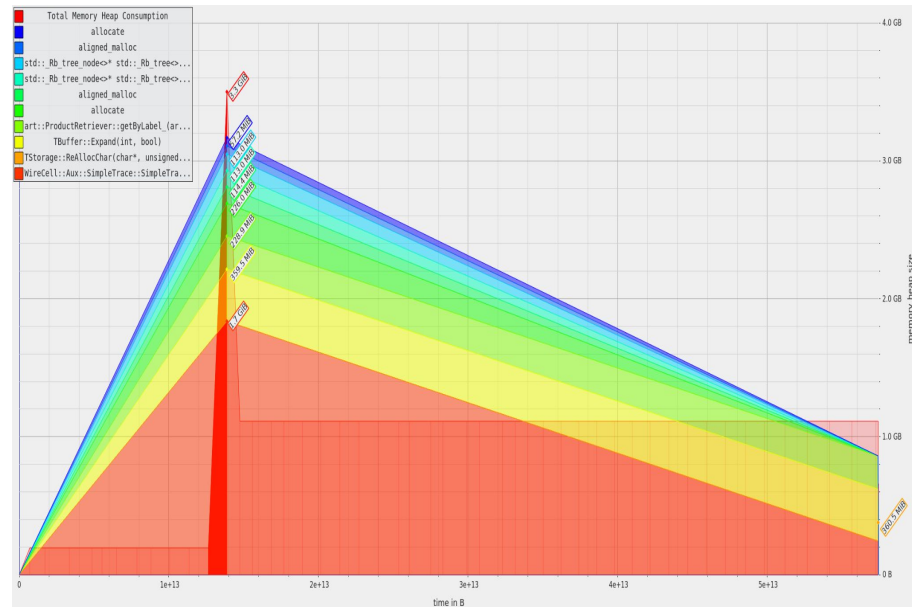
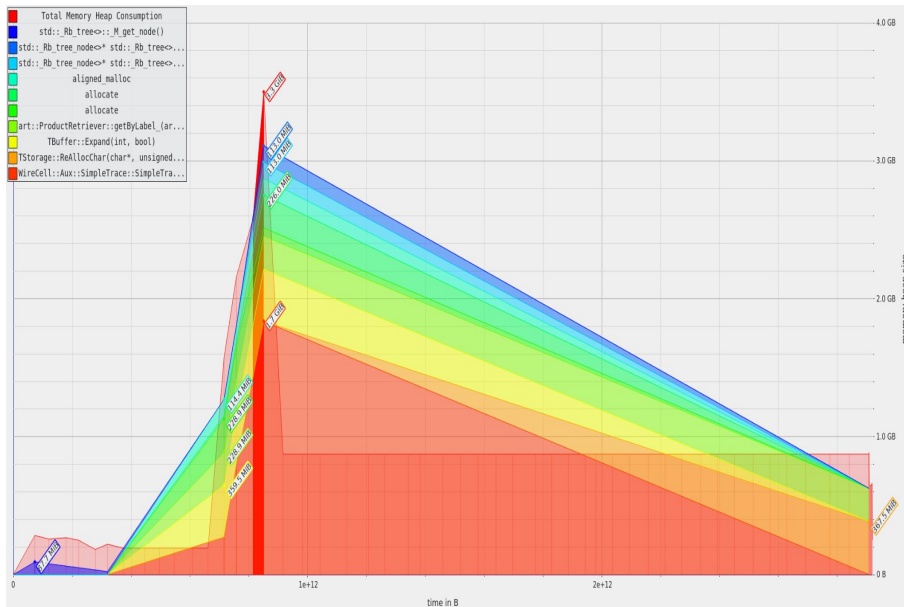
Hokyeong Nam
Chung-Ang University

Memory Profiling - Valgrind



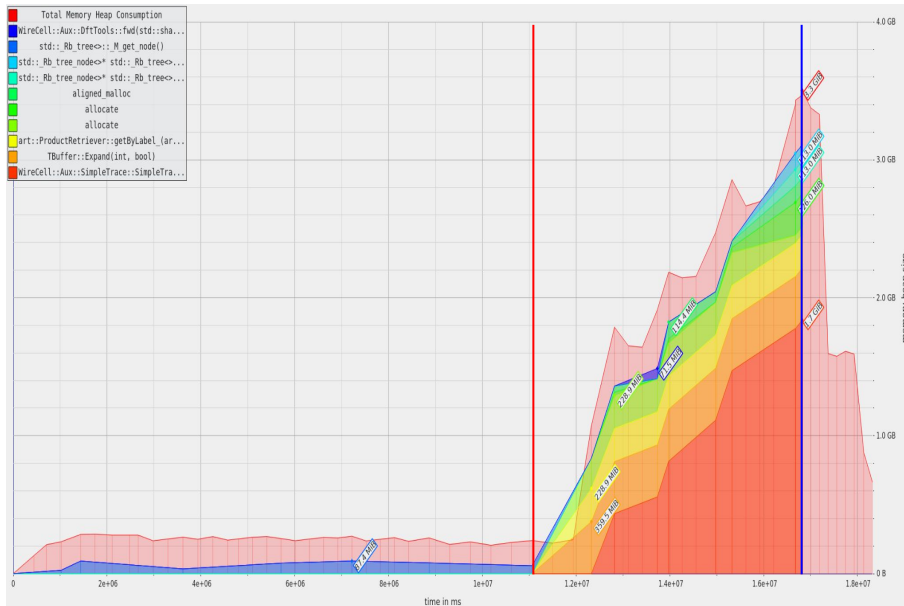
- Profiled twice over DNN SP (MobileNetV2) with a PD-HD data file (one event)
- Time unit: i - instructions (default)
- The left is what I shared in the last meeting, the right one is newly generated
- The peak appears near the end of the instructions
- The peak memory from Valgrind (~ 3.3 GiB) is different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

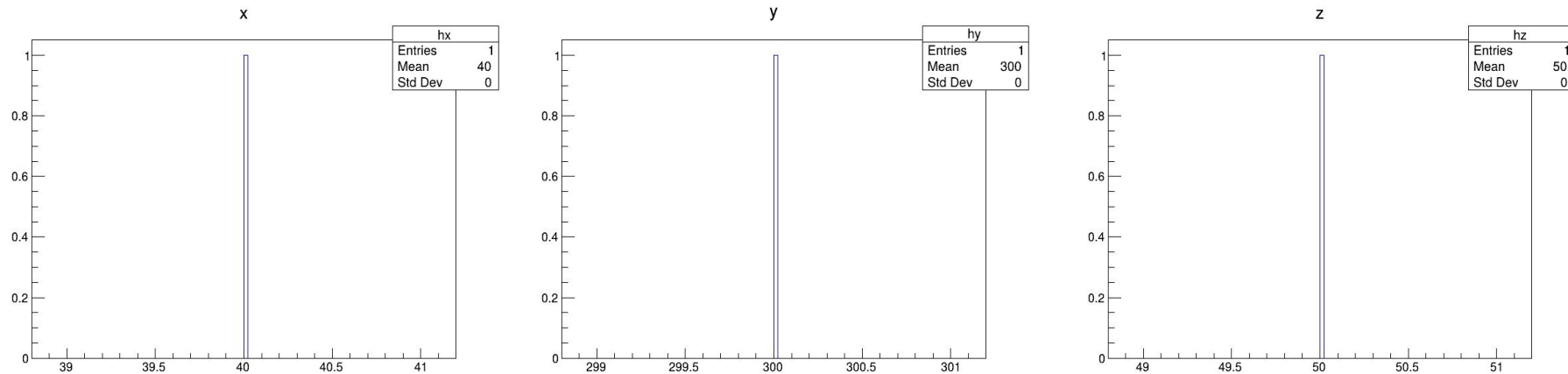


```
=====
MemoryTracker summary (base-10 MB units used)

  Peak virtual memory usage (VmPeak) :
XMSG-s ArtException: RootOutput:out1@EndJob 15-Jul-2025 15:33:06 PDT ModuleEndJob
---- SQLExecutionError BEGIN
      unique_value expected of non-unique query.
---- SQLExecutionError END
XMSG
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/run
027673/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
=====
```

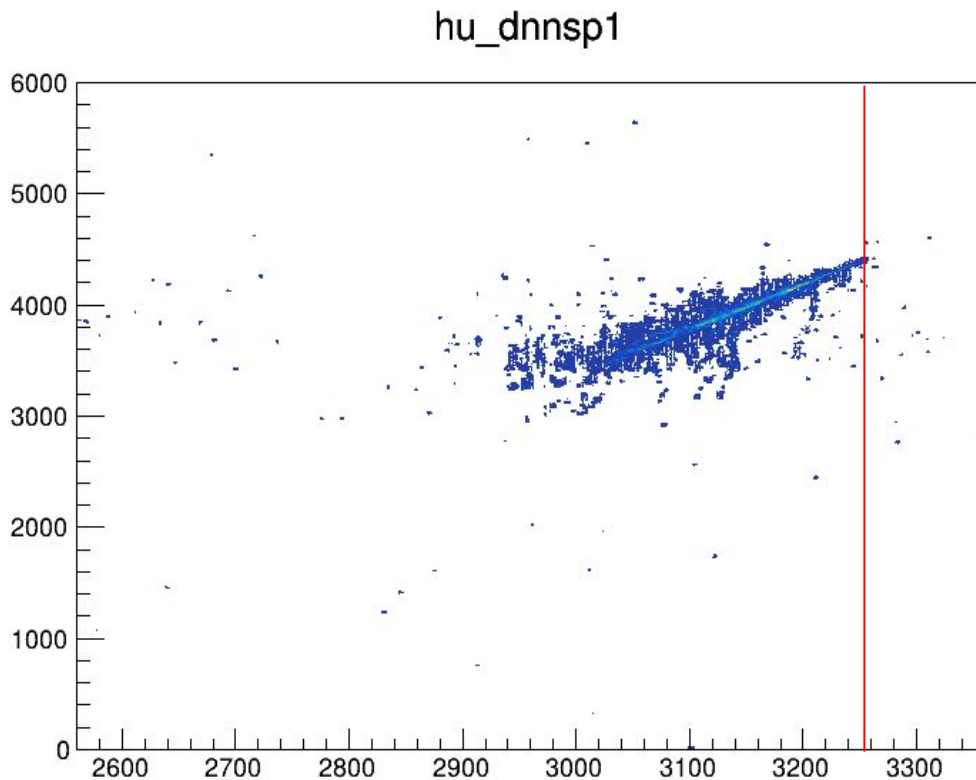
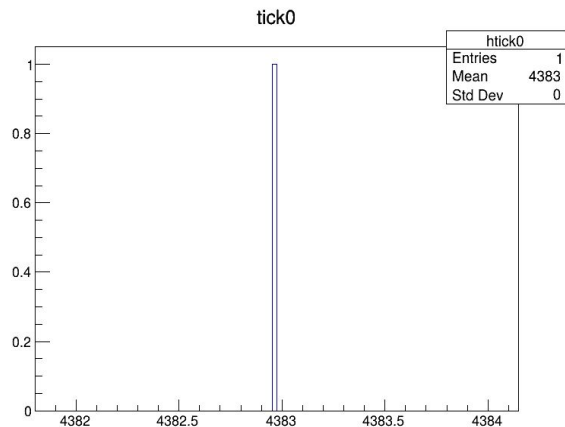
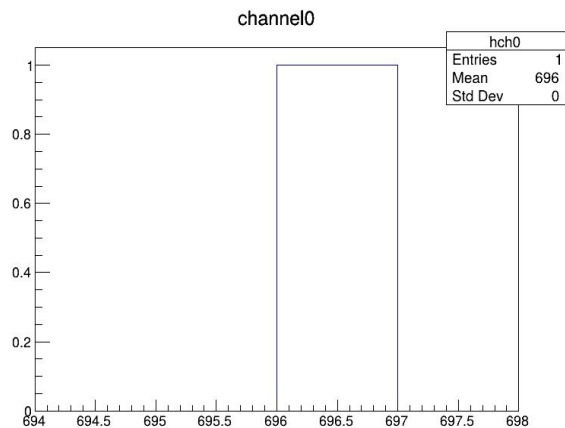
- Profiled twice over DNN SP (MobileNetV2) with a PD-HD data file (one event)
- **Time unit: ms - milliseconds**
- Profiling stopped due to error: unique_value expected of non-unique query
- Run time is almost 5 hours but the memory usage is low for 3 hours (red line)
- The peak snapshot is taken within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

ShowerAna module



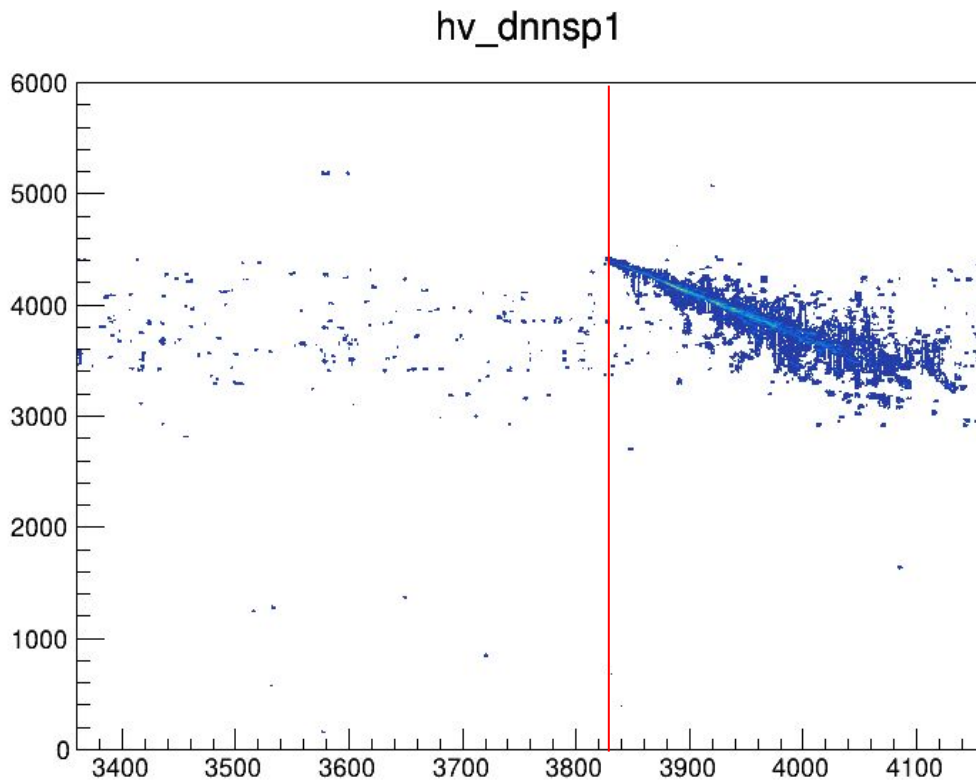
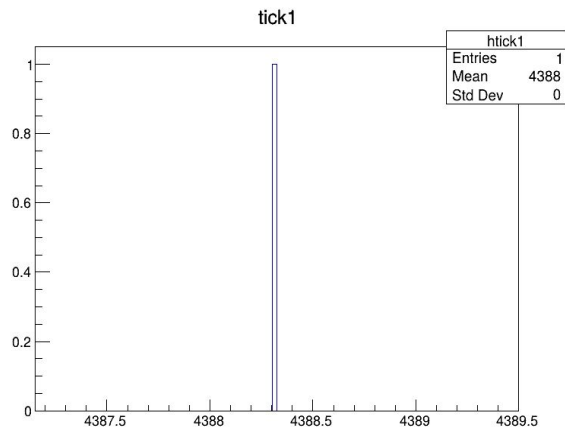
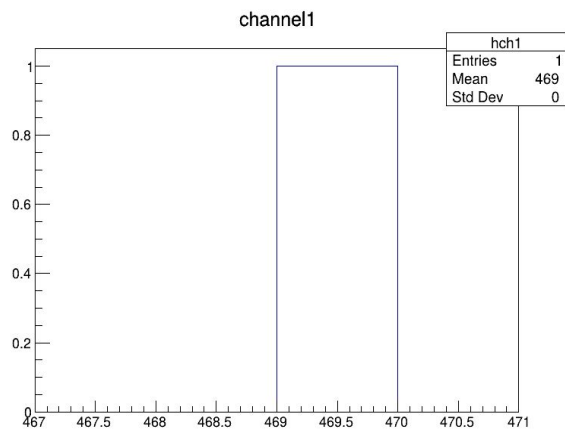
- Get the information of the primary electron, and save the followings:
 - initial position (x, y, z) and corresponding wire channels and time ticks
 - momentum (px, py, pz), pid, tpc id
 - normalized momentum \rightarrow unit direction (dirx, diry, dirz)
 - extrapolated position (x_ex, y_ex, z_ex) and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



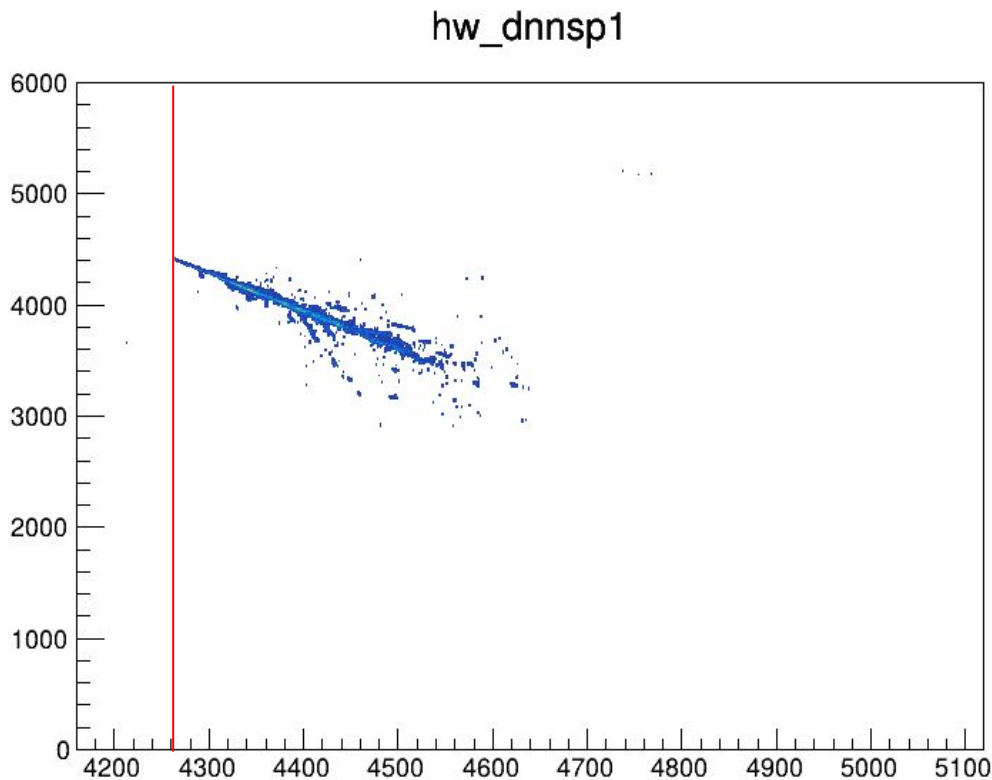
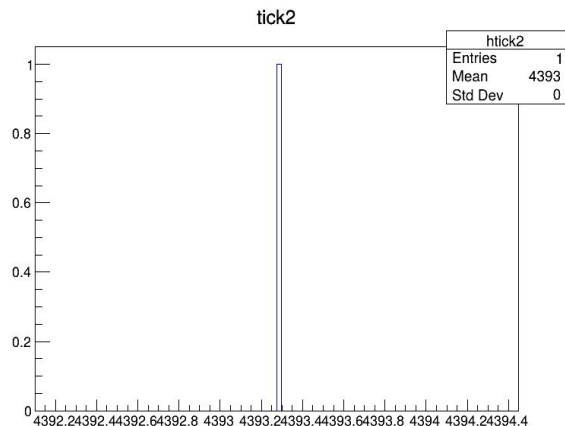
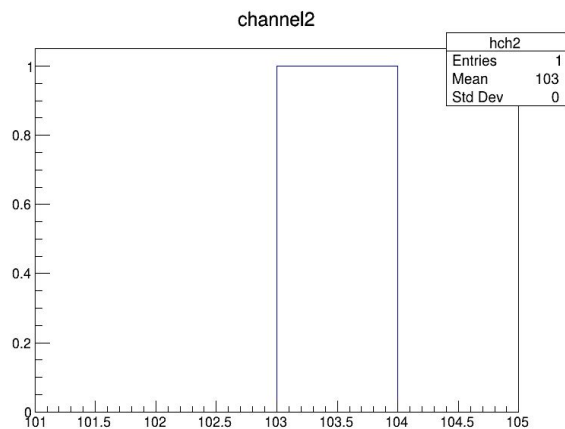
- For u plane of APA2, the (wire channel, time tick) is
 - wire channel: $2560 + 696 = 3256$
 - time tick: 4383

Truth Info. from MCParticle



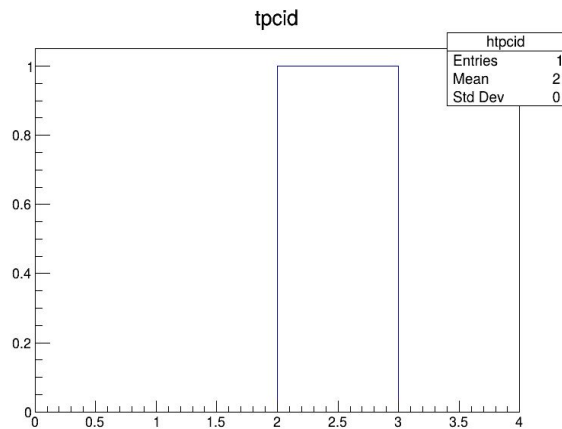
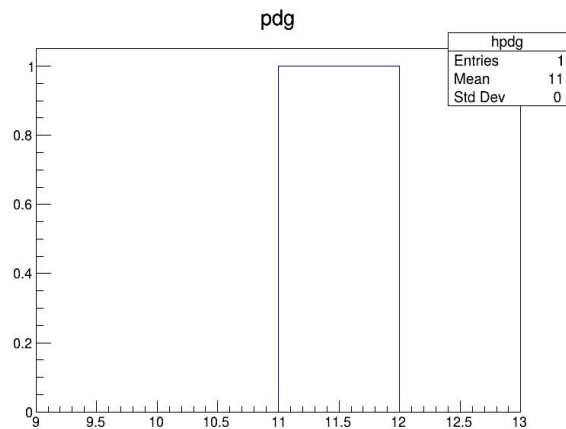
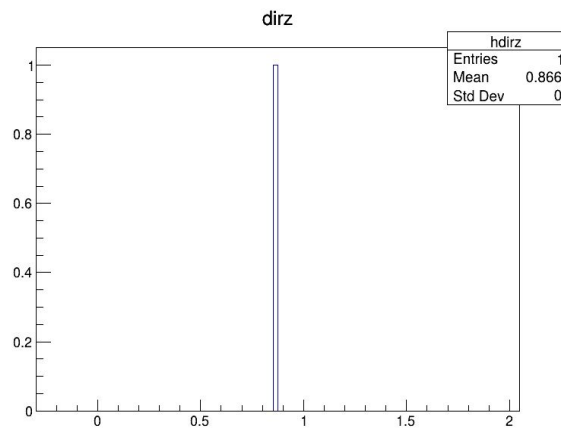
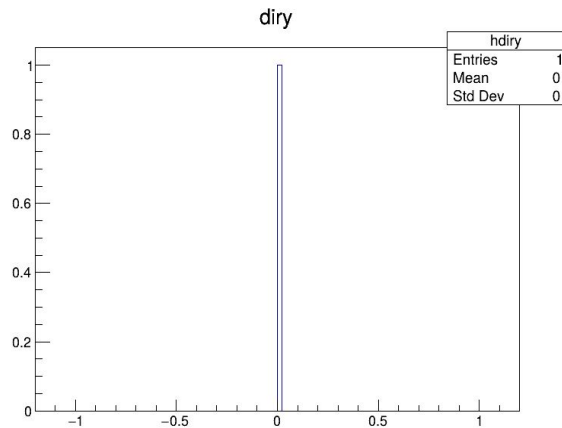
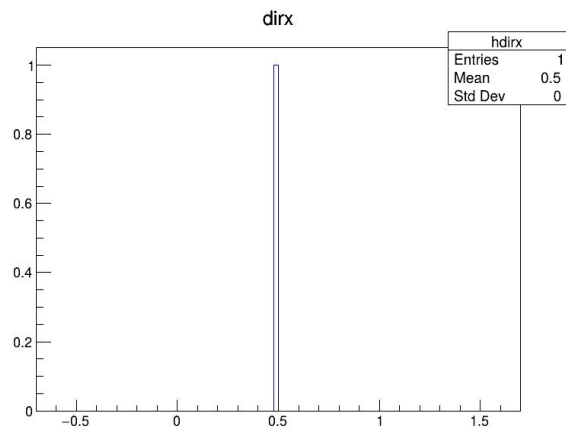
- For ν plane of APA2, the (wire channel, time tick) is
 - wire channel: $2560 + 800 + 469 = 3256$
 - time tick: 4388

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

$$\hat{v}_{\text{true}} \equiv \frac{(\Delta w_{\text{true}} \Delta t_{\text{true}})}{\sqrt{(\Delta w_{\text{true}})^2 + (\Delta t_{\text{true}})^2}}$$

- From MCParticle

$$\hat{v}_{\text{reco}} \equiv \frac{(\Delta w_{\text{reco}} \Delta t_{\text{reco}})}{\sqrt{(\Delta w_{\text{reco}})^2 + (\Delta t_{\text{reco}})^2}}$$

PCA axis

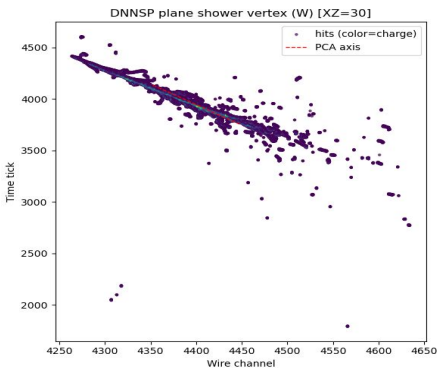
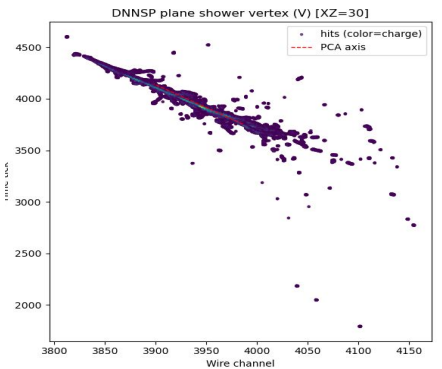
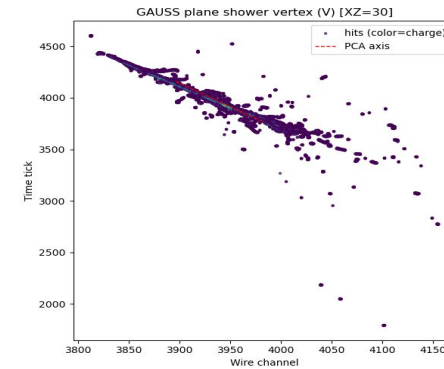
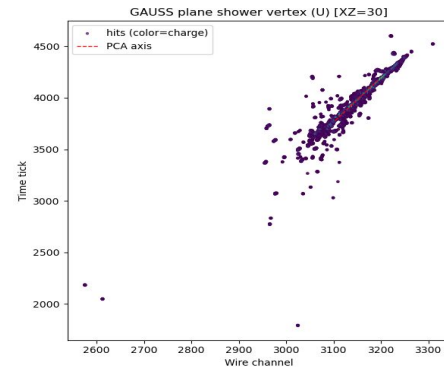
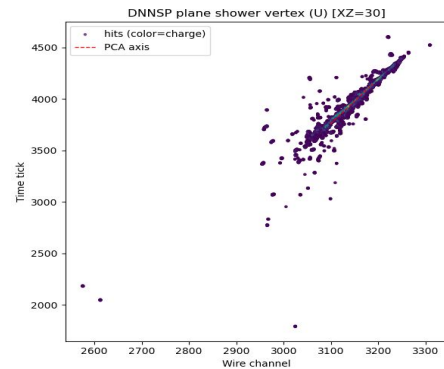
$$\hat{v}_{\text{reco}} \equiv \frac{(\Delta w_{\text{reco}} \Delta t_{\text{reco}})}{\sqrt{(\Delta w_{\text{reco}})^2 + (\Delta t_{\text{reco}})^2}}$$

PCA axis

$$\cos \theta \equiv \hat{v}_{\text{true}} \cdot \hat{v}_{\text{reco}} \equiv \frac{\Delta w_{\text{true}} \Delta w_{\text{reco}} + \Delta t_{\text{true}} \Delta t_{\text{reco}}}{\sqrt{(\Delta w_{\text{true}})^2 + (\Delta t_{\text{true}})^2} \sqrt{(\Delta w_{\text{reco}})^2 + (\Delta t_{\text{reco}})^2}}$$

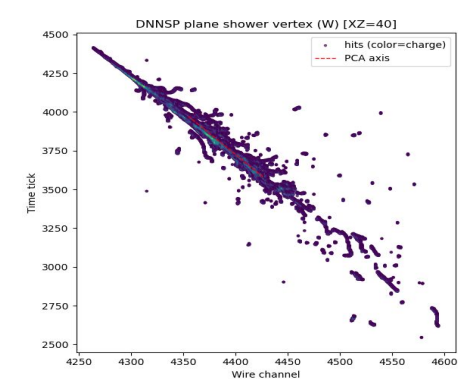
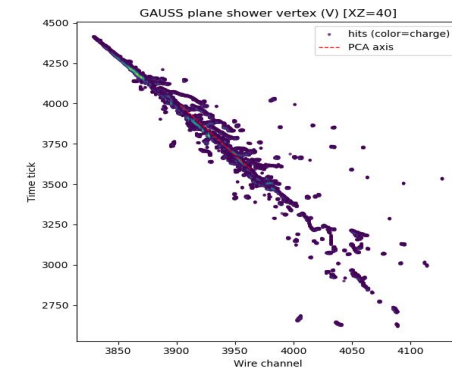
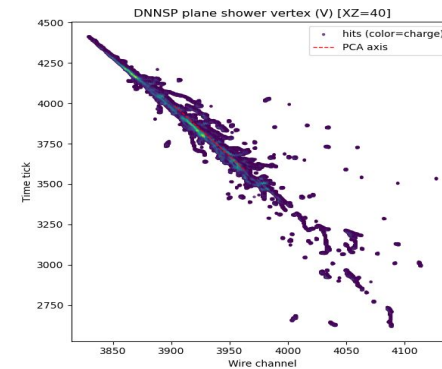
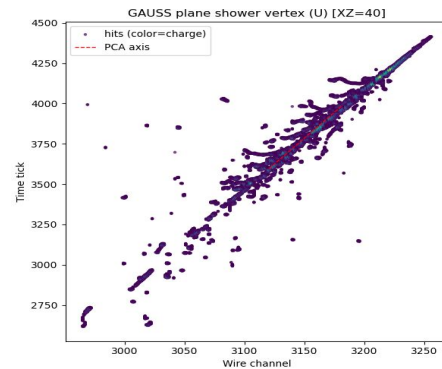
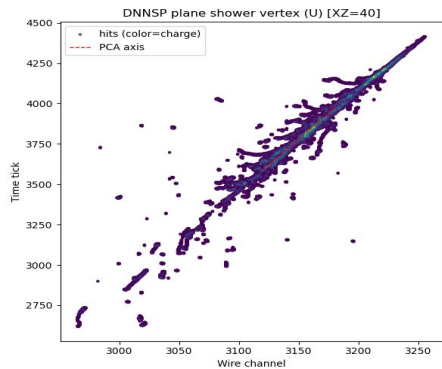
$$\theta = \arccos(\cos \theta)$$

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



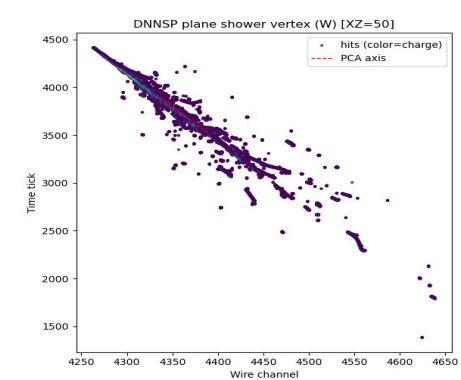
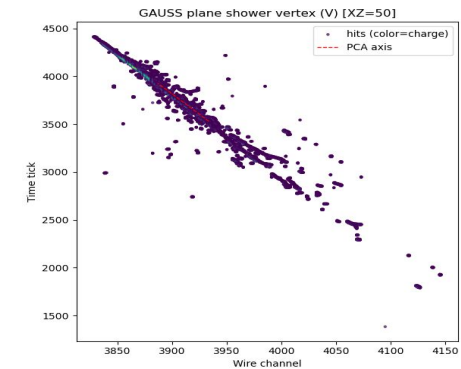
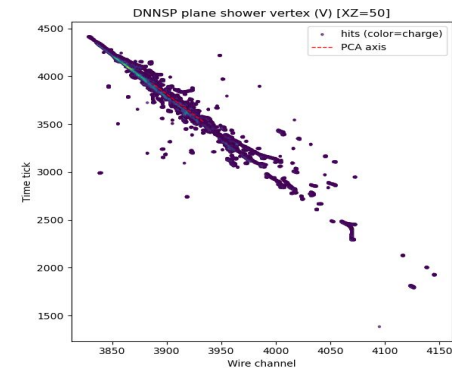
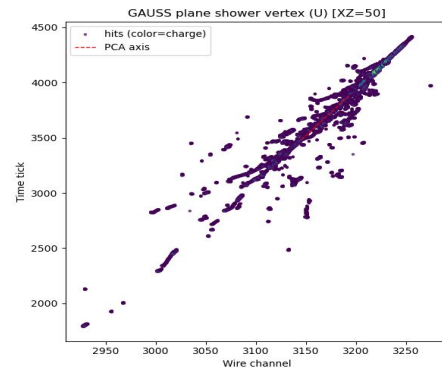
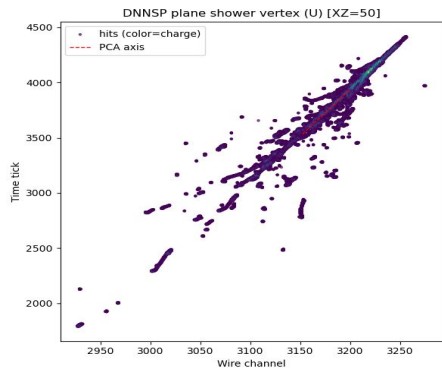
	Angle diff	
	Gauss (deg.)	DNN (deg.)
U plane	0.58	0.53
V plane	1.10	0.83
W plane	2.52	

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



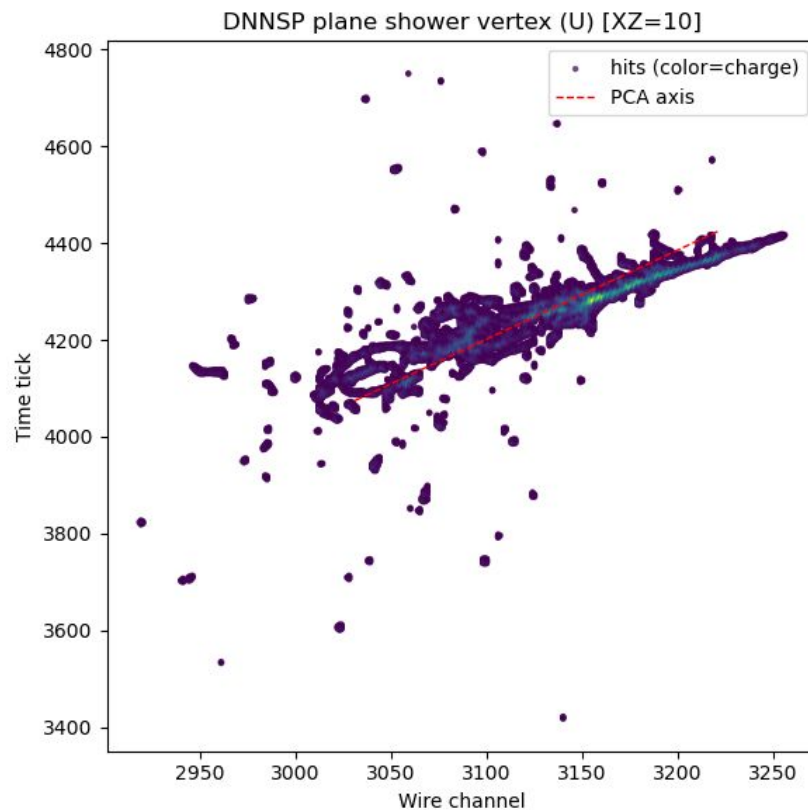
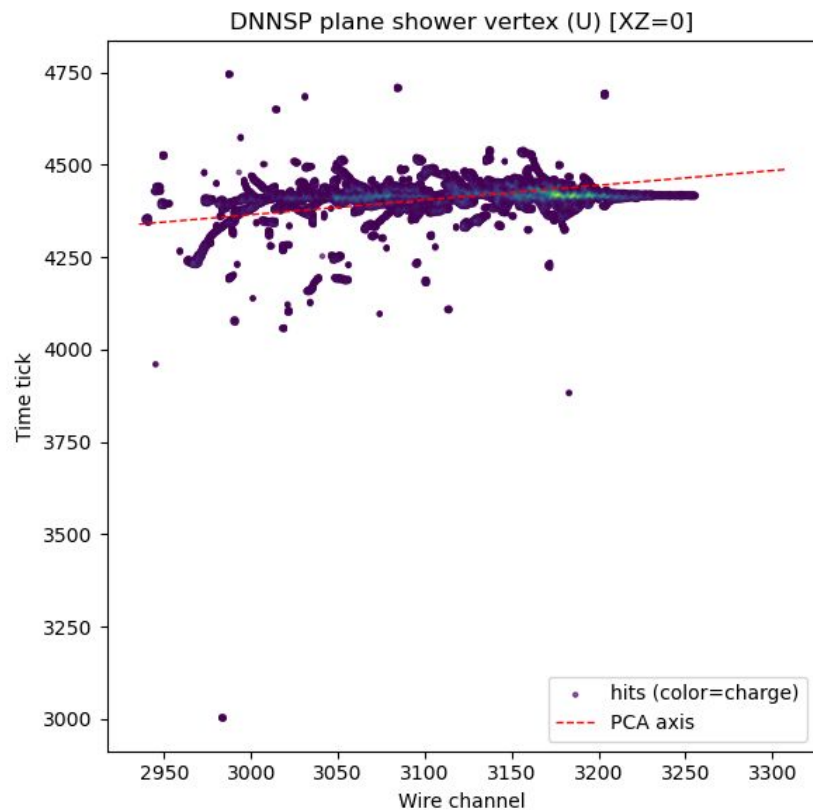
	Angle diff	
	Gauss (deg.)	DNN (deg.)
U plane	0.74	0.82
V plane	0.52	0.51
W plane	1.22	

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	

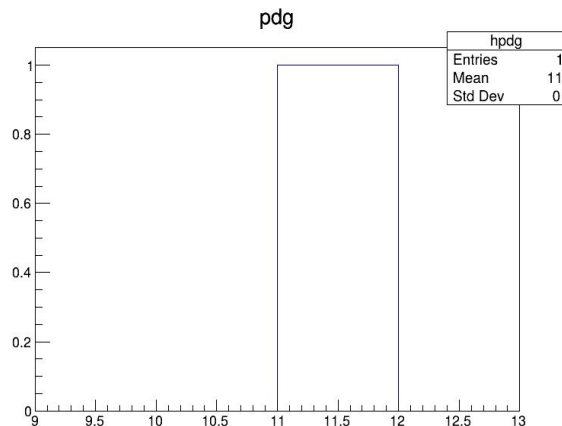
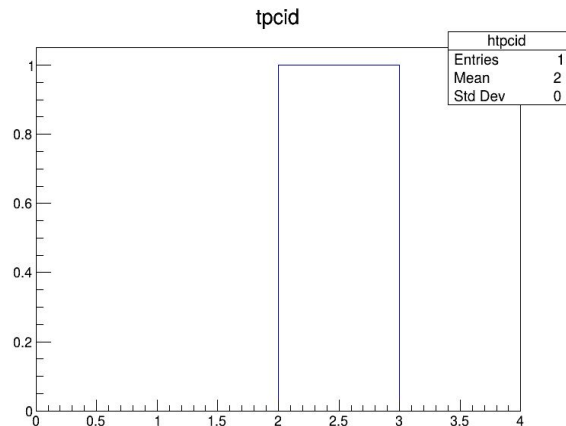
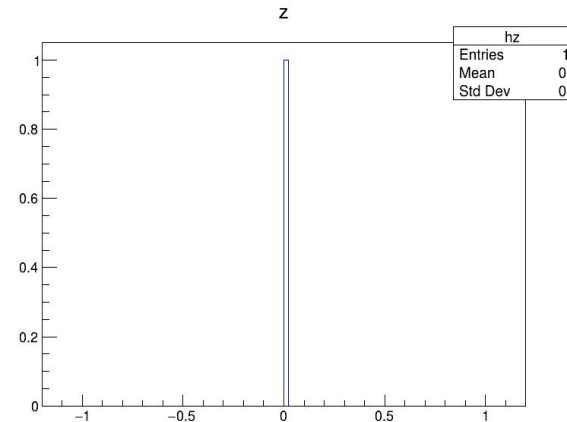
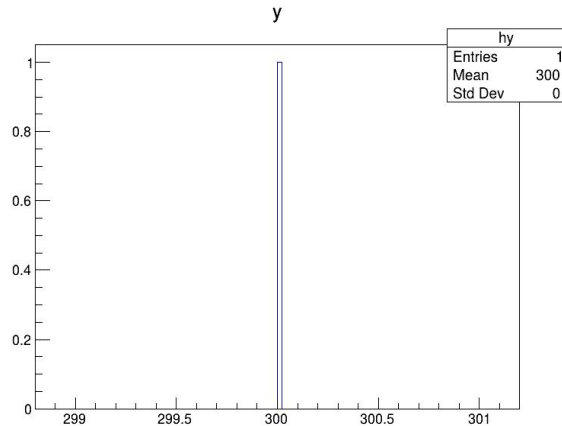
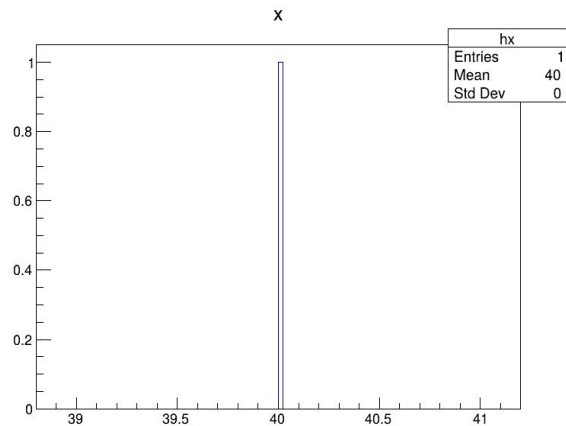
Issues in PCA axis analysis



- PCA fails particularly for lower angles

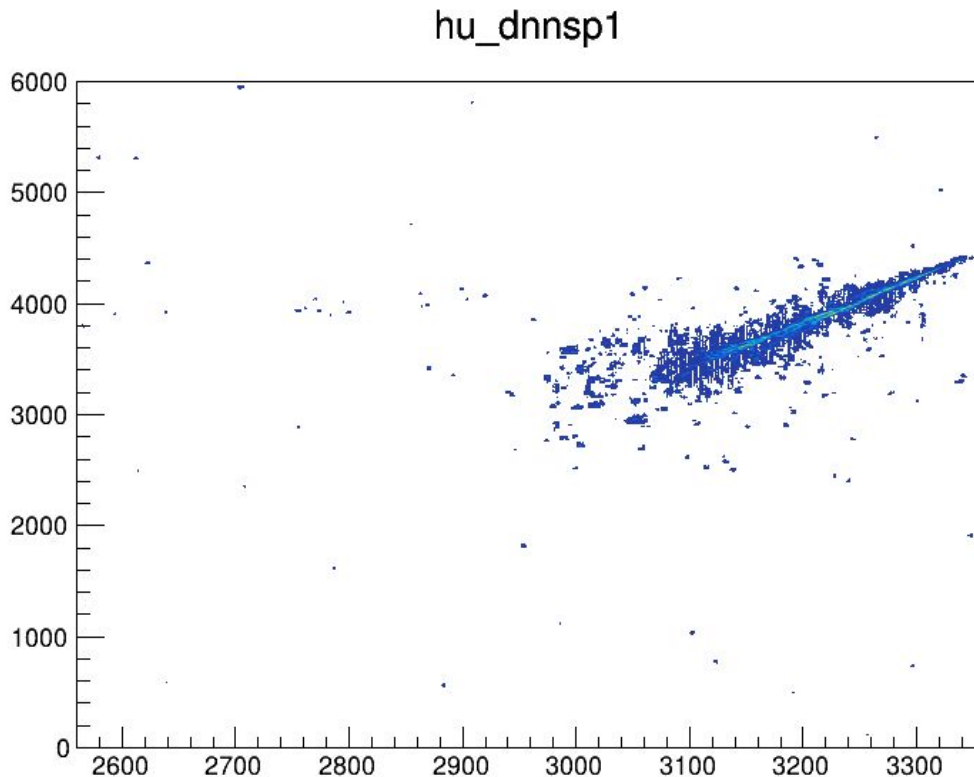
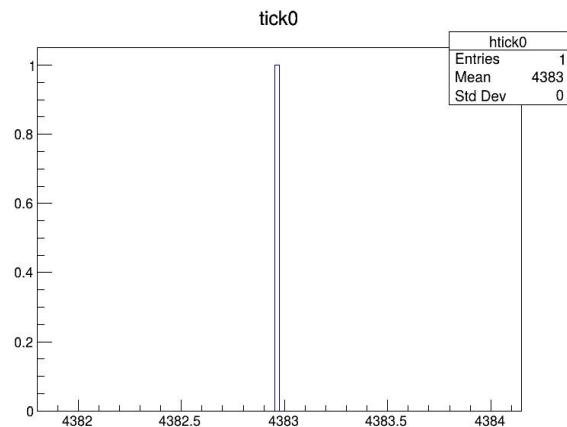
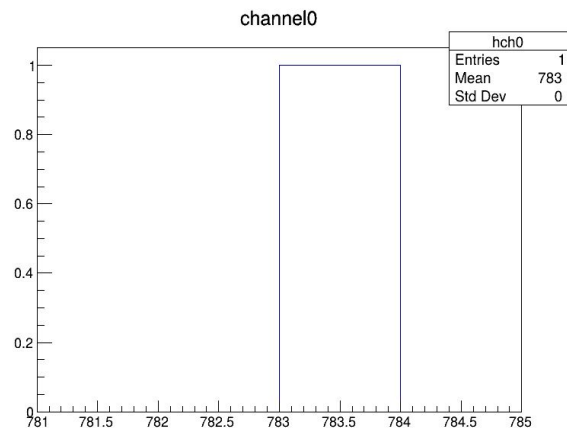
Back Up

ShowerAna module

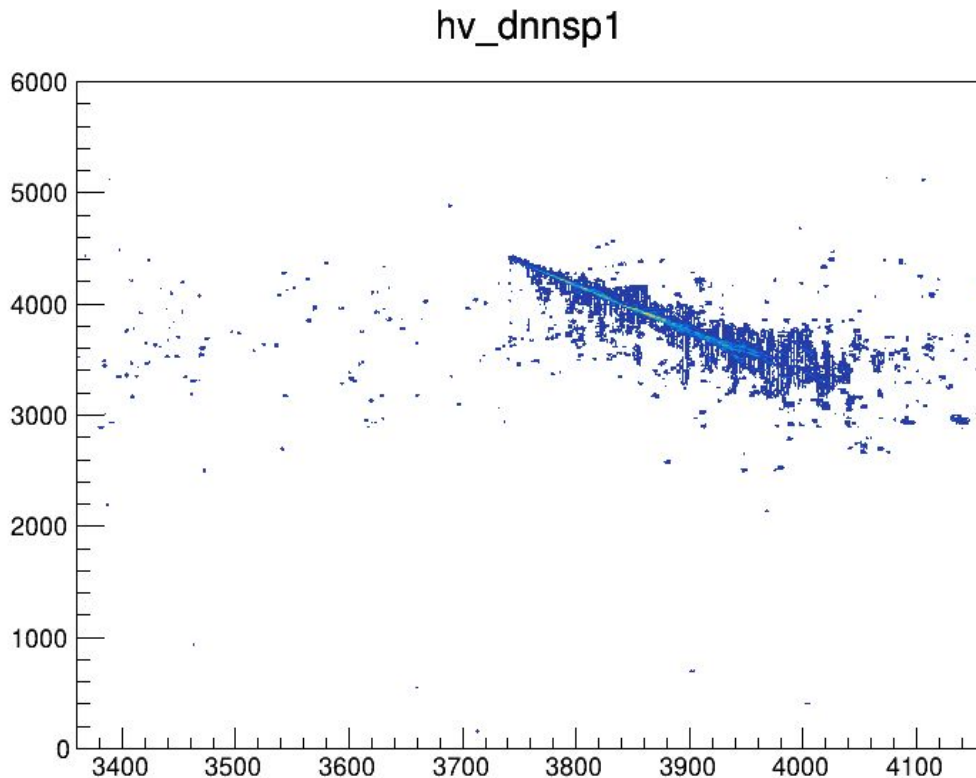
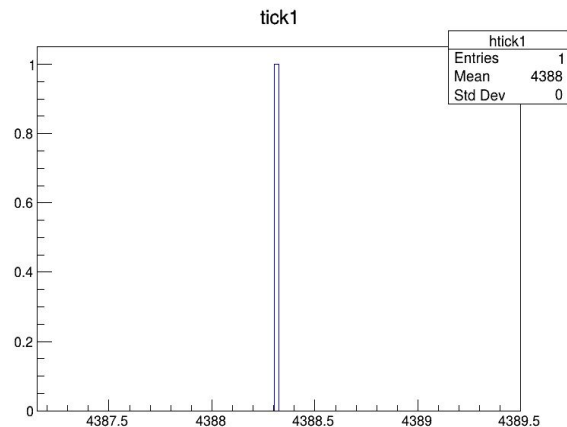
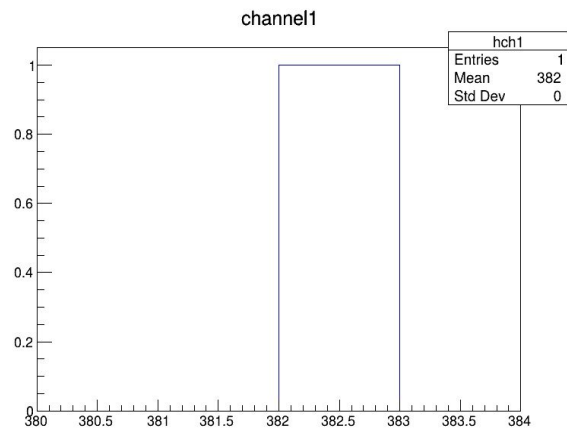


```
# This block defines starting parameters
physics.producers.generator.PosDist: 0
physics.producers.generator.X0: [40.]
physics.producers.generator.Y0: [300.]
physics.producers.generator.Z0: [0.0]
```

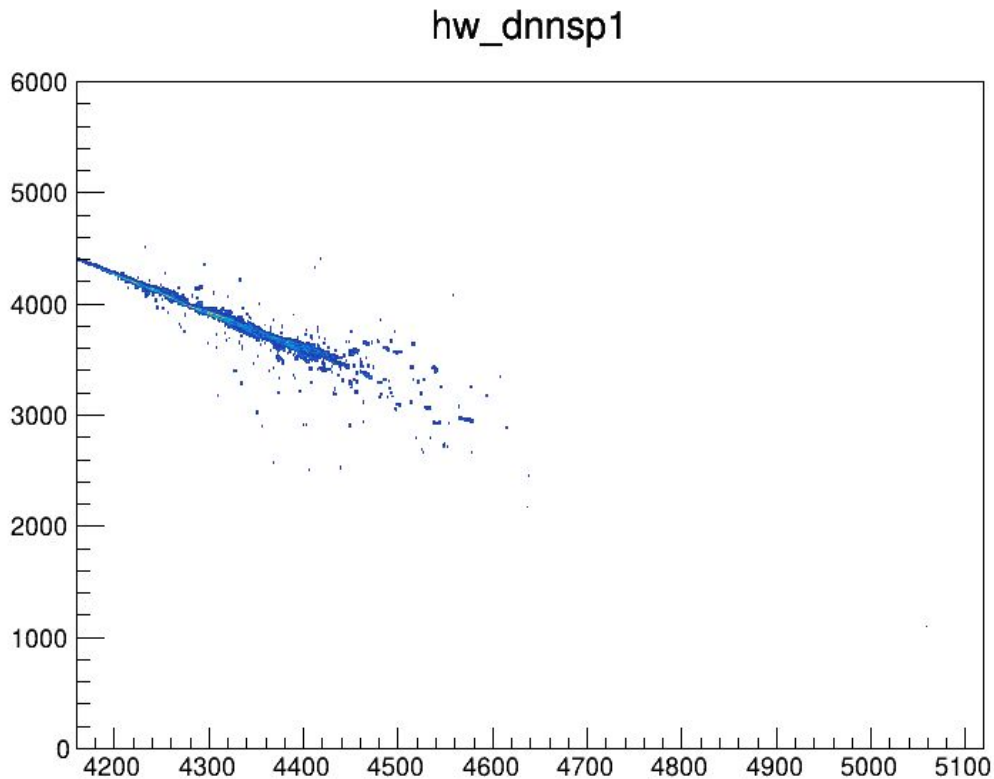
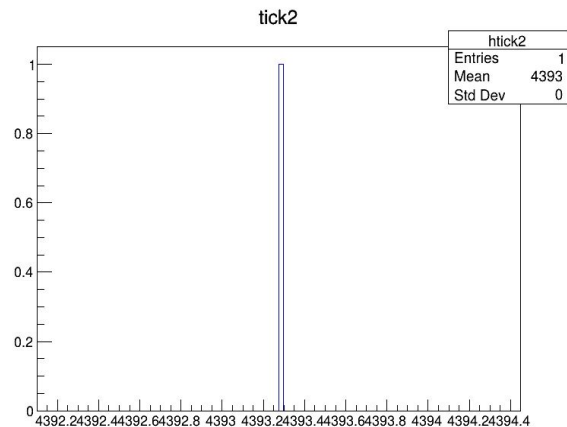
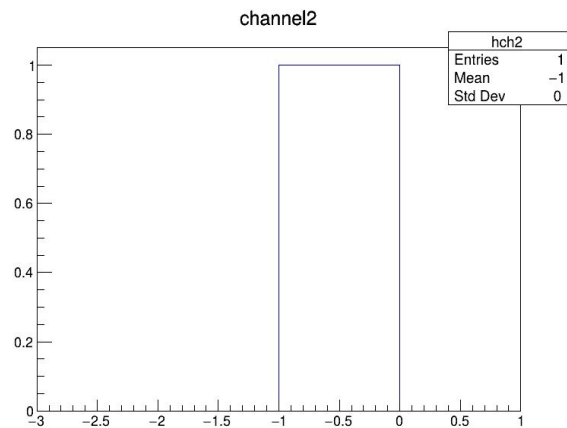

Truth Info. from MCParticle



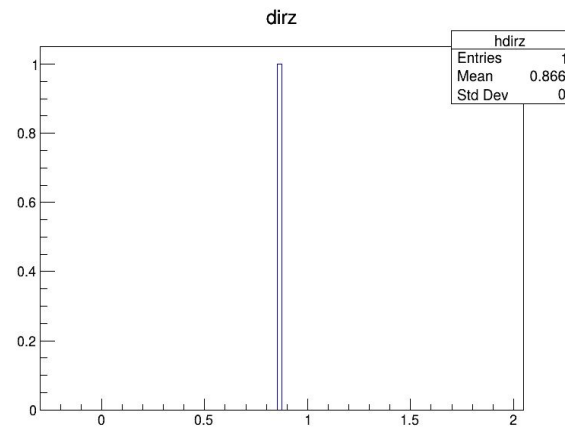
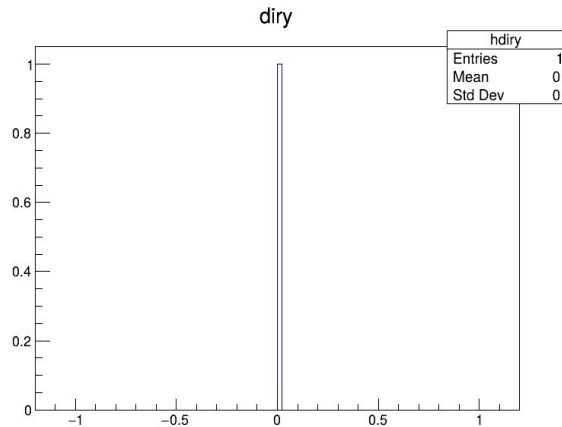
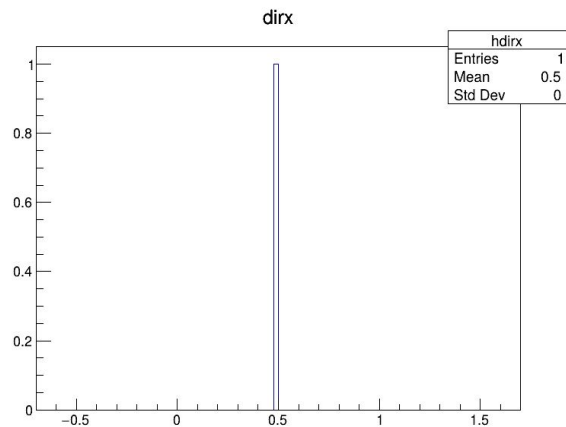
Truth Info. from MCParticle



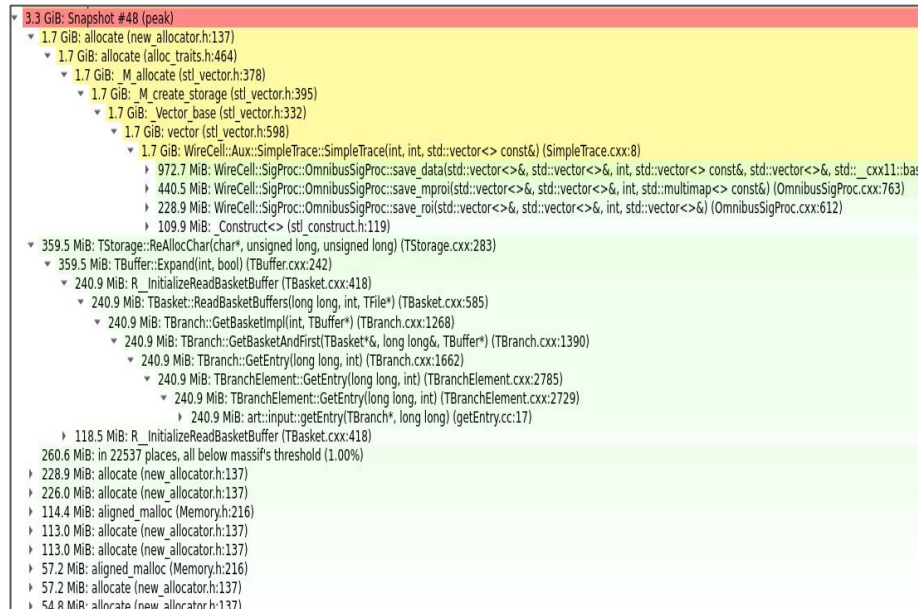
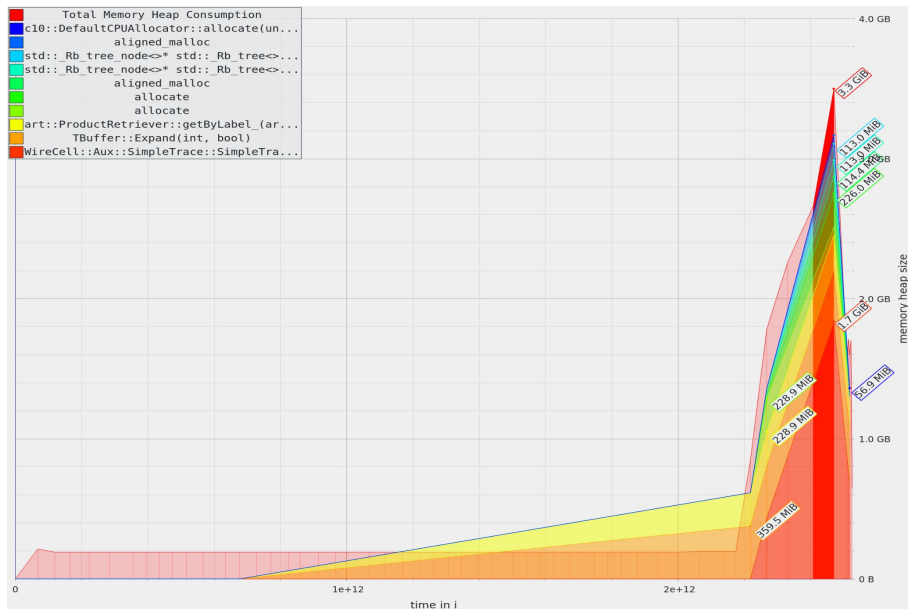
Truth Info. from MCParticle



Truth Info. from MCParticle



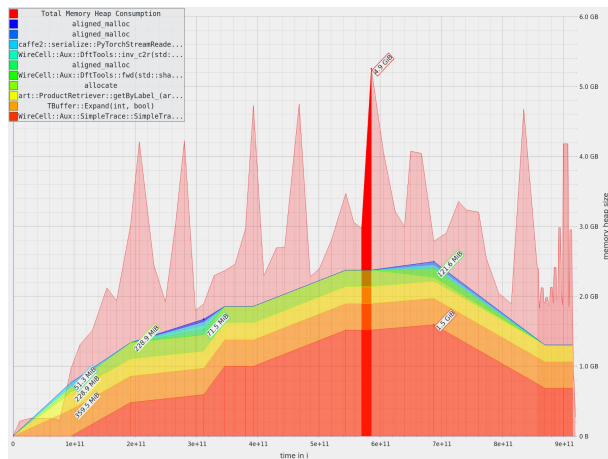
Memory Profiling - Valgrind



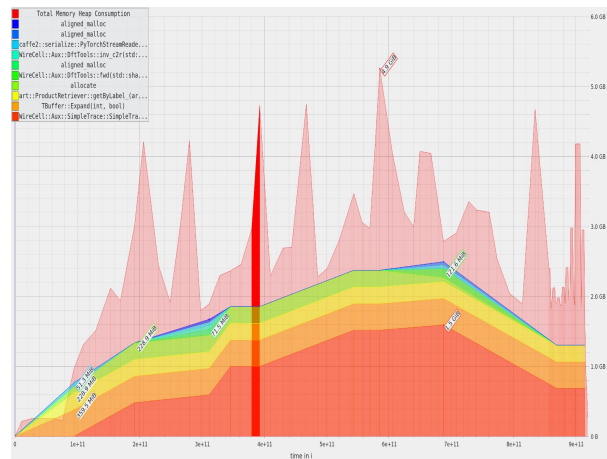
- PD-HD data, DNN SP with MobileNetV2
- The peak memory recorded is 3.3 GiB
- Almost half of the memory (~1.7 GiB) is due to:
 - WireCell::SigProc::OmnibusSigProc::save_data (972 MiB out of 1.7 GiB)
 - WireCell::SigProc::OmnibusSigProc::save_mproi (440 MiB out of 1.7 GiB)

do_not_mp_protect_traditional is set to true

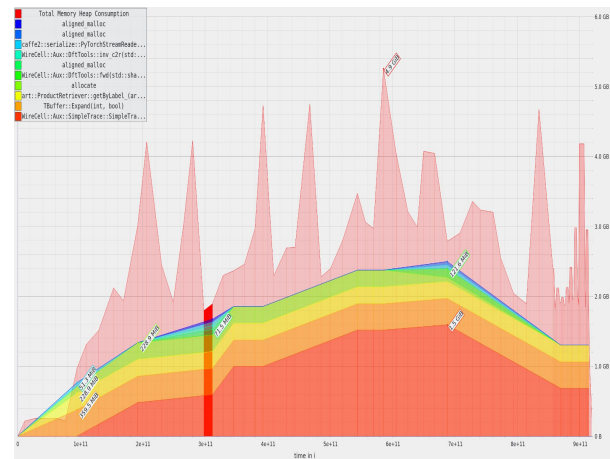
Memory Profiling - Valgrind



❑ 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

```

* 4 GB: Sigmoid (x34 [peak])
* 25 GB: c10::alloc_cpy(unsigned long) (in /cvmfs/lasfsoft.opensciencegrid.org/products/lbtorch/v2.1_1bLnnu40h+3.10-12.7+26fb/fbc10.so)
* 25 GB: c10::DefaultPAllocator::allocate(unsigned long) const (in /cvmfs/lasfsoft.opensciencegrid.org/products/lbtorch/v2.1_1bLnnu40h+3.10-12.7+26fb/fbc10.so)
* 23 GB: c10::StorageImpl::StorageImpl(size_t, c10::Symint const&, c10::Allocator, bool) (in /cvmfs/lasfsoft.opensciencegrid.org/products/lbtorch/v2.1_1bLnnu40h+3.10-12.7+26fb/fbc10.so)
* 23 GB: at::TensorBase::detail::empty_cxx<c10::ArrayRef<>, c10::Allocator, c10::DispatchKeySet, c10::ScalarType, c10::optional<>> (in /cvmfs/lasfsoft.opensciencegrid.org/products/lbtorch/v2.1_1bLnnu40h+3.10-12.7+26fb/fbc10.so)
* 23 GB: at::detail::empty_generic(c10::ArrayRef<>, c10::Allocator, c10::DispatchKeySet, c10::ScalarType, c10::optional<>) (in /cvmfs/lasfsoft.opensciencegrid.org/products/lbtorch/v2.1_1bLnnu40h+3.10-12.7+26fb/fbc10.so)
* 23 GB: at::detail::empty_cxx<c10::ArrayRef<>, c10::ScalarType, bool, c10::optional<> (in /cvmfs/lasfsoft.opensciencegrid.org/products/lbtorch/v2.1_1bLnnu40h+3.10-12.7+26fb/fbc10.so)
* 23 GB: at::detail::empty_cpy(c10::ArrayRef<>, c10::optional<>, c10::optional<>, c10::optional<>, c10::optional<>, c10::optional<>) (in /cvmfs/lasfsoft.opensciencegrid.org/products/lbtorch/v2.1_1bLnnu40h+3.10-12.7+26fb/fbc10.so)
* 21 GB: at::native::empty_cpy(c10::ArrayRef<>, c10::optional<>, c10::optional<>, c10::optional<>, c10::optional<>, c10::optional<>) (in /cvmfs/lasfsoft.opensciencegrid.org/products/lbtorch/v2.1_1bLnnu40h+3.10-12.7+26fb/fbc10.so)
* 21 GB: c10::impl::wrap_kernel_function_unboxed<>::call(c10::OperatorKernel, c10::DispatchKeySet, c10::ArrayRef<>, c10::optional<>, c10::optional<>, c10::optional<>) (in /cvmfs/lasfsoft.opensciencegrid.org/products/lbtorch/v2.1_1bLnnu40h+3.10-12.7+26fb/fbc10.so)
* 21 GB: at::ops::empty_memory_format::redispatch(c10::DispatchKeySet, c10::ArrayRef<>, c10::optional<>, c10::optional<>, c10::optional<>, c10::optional<>) (in /cvmfs/lasfsoft.opensciencegrid.org/products/lbtorch/v2.1_1bLnnu40h+3.10-12.7+26fb/fbc10.so)
* 21 GB: c10::impl::wrap_kernel_function_unboxed<>::call(c10::OperatorKernel, c10::DispatchKeySet, c10::ArrayRef<>, c10::optional<>, c10::optional<>, c10::optional<>) (in /cvmfs/lasfsoft.opensciencegrid.org/products/lbtorch/v2.1_1bLnnu40h+3.10-12.7+26fb/fbc10.so)
* 21 GB: at::ops::empty_memory_format::call(c10::ArrayRef<>, c10::optional<>, c10::optional<>, c10::optional<>, c10::optional<>, c10::optional<>) (in /cvmfs/lasfsoft.opensciencegrid.org/products/lbtorch/v2.1_1bLnnu40h+3.10-12.7+26fb/fbc10.so)
* 21 GB: at::empty(c10::ArrayRef<>, c10::TensorOptions, c10::optional<>) (in /cvmfs/lasfsoft.opensciencegrid.org/products/lbtorch/v2.1_1bLnnu40h+3.10-12.7+26fb/fbc10.so)
* 21 GB: at::native::anonymous_namespaces::compute_columns_id::Tensor::const, c10::ArrayRef<>, c10::ArrayRef<>, c10::ArrayRef<>, c10::ArrayRef<>, c10::ArrayRef<>) (in /cvmfs/lasfsoft.opensciencegrid.org/products/lbtorch/v2.1_1bLnnu40h+3.10-12.7+26fb/fbc10.so)
* 21 GB: at::native::slow_conv2d_forward_out::cpuAt::Tensor::const, at::Tensor::const, c10::ArrayRef<>, c10::optional<>, c10::optional<>, c10::optional<>, c10::optional<>, c10::optional<>) (in /cvmfs/lasfsoft.opensciencegrid.org/products/lbtorch/v2.1_1bLnnu40h+3.10-12.7+26fb/fbc10.so)
* 21 GB: at::native::slow_conv2d_forward_cpu::cpuAt::Tensor::const, at::Tensor::const, at::Tensor::const, c10::ArrayRef<>, c10::optional<>, c10::optional<>, c10::optional<>, c10::optional<>, c10::optional<>) (in /cvmfs/lasfsoft.opensciencegrid.org/products/lbtorch/v2.1_1bLnnu40h+3.10-12.7+26fb/fbc10.so)
* 21 GB: c10::impl::wrap_kernel_function_unboxed<>::call(c10::OperatorKernel, c10::DispatchKeySet, at::Tensor::const, at::Tensor::const, at::Tensor::const, c10::ArrayRef<>, c10::optional<>, c10::optional<>, c10::optional<>, c10::optional<>, c10::optional<>) (in /cvmfs/lasfsoft.opensciencegrid.org/products/lbtorch/v2.1_1bLnnu40h+3.10-12.7+26fb/fbc10.so)
* 245.4 MB: at::detail::empty_cpy(c10::ArrayRef<>, c10::TensorOptions const&) (in /cvmfs/lasfsoft.opensciencegrid.org/products/lbtorch/v2.1_1bLnnu40h+3.10-12.7+26fb/fbc10.so)
+ 117.2 MB: at::native::resize_bytes::c10::StorageImpl, unsigned long (in /cvmfs/lasfsoft.opensciencegrid.org/products/lbtorch/v2.1_1bLnnu40h+3.10-12.7+26fb/fbc10.so)
+ 117.2 MB: c10::TensorImpl::at::native::resize_impl<>::c10::Tensor, c10::ArrayRef<>, c10::OptionalArrayRef<>, bool (in /cvmfs/lasfsoft.opensciencegrid.org/products/lbtorch/v2.1_1bLnnu40h+3.10-12.7+26fb/fbc10.so)
+ 51.3 MB: caffe::SerializeProtoStreamReader::getRecordId::__cxx11::basic_string<const char> (in /cvmfs/lasfsoft.opensciencegrid.org/products/lbtorch/v2.1_1bLnnu40h+3.10-12.7+26fb/fbc10.so)
1.4 GB: allocate (new_allocator:137)
+ 1.4 GB: allocate (libc::traits:464)
+ 1.4 GB: M::allocate (std::vector:378)
+ 1.4 GB: M::create storage (std::vector:395)
+ 1.4 GB: Vector base (std::vector:332)
+ 1.4 GB: vector (std::vector:598)
+ 1.4 GB: WireCell::Aux::SimpleTrace::SimpleTrace(int, int, std::vector<> const&) (SimpleTrace:cx:8)
+ 85.3 MB: WireCell::SigProc::OmnibusSigProc::save_data(std::vector<> c4, std::vector<> c4, int, std::vector<> const&, std::vector<> c4, std::__cxx11::basic_string_view<char, std::char_traits<char>, std::allocator<char>> const&) (OmnibusSigProc:cx:1622)
+ 171.7 MB: WireCell::SigProc::OmnibusSigProc::operator()(std::shared_ptr<c0> const&, std::shared_ptr<c1>) (OmnibusSigProc:cx:1889)
+ 171.7 MB: WireCell::SigProc::OmnibusSigProc::operator()(std::shared_ptr<c0> const&, std::shared_ptr<c1>) (OmnibusSigProc:cx:1892)
+ 171.7 MB: WireCell::SigProc::OmnibusSigProc::operator()(std::shared_ptr<c0> const&, std::shared_ptr<c1>) (OmnibusSigProc:cx:1804)
+ 171.7 MB: WireCell::SigProc::OmnibusSigProc::operator()(std::shared_ptr<c0> const&, std::shared_ptr<c1>) (OmnibusSigProc:cx:1810)
+ 107.3 MB: WireCell::SigProc::OmnibusSigProc::operator()(std::shared_ptr<c0> const&, std::shared_ptr<c1>) (OmnibusSigProc:cx:1678)
+ 64.4 MB: WireCell::SigProc::OmnibusSigProc::operator()(std::shared_ptr<c0> const&, std::shared_ptr<c1>) (OmnibusSigProc:cx:1693)
+ 343.3 MB: WireCell::SigProc::OmnibusSigProc::save_mpjoid(std::shared_ptr<c0> const&, std::vector<> c4, int, std::multimap<> const&) (OmnibusSigProc:cx:763)
+ 171.7 MB: WireCell::SigProc::OmnibusSigProc::save_poloid(std::vector<> c4, std::vector<> c4, int, std::vector<> c4) (OmnibusSigProc:cx:612)
+ 73.2 MB: Construct<>::sf::construct::h:119)
+ 359.5 MB: TStorage::ReAllocCharChart, unsigned long, unsigned long (TStorage:cx:283)
+ 359.5 MB: Buffer::Expand::bool, T(Buffer:cx:242)
+ 228.9 MB: allocate (new_allocator:137)
+ 228.9 MB: allocate (new_allocator:137)
220.9 MB: in 22544 places, all below massifs's threshold (1.00%)


```

[illegible]

- 1.8 GB: Snapshot #18
 - 565.9 MB: allocate (new allocator:h137)
 - 565.9 MB: allocate (alloc_traits:h464)
 - 565.9 MB: `_M_allocate (std::vector:h378)`
 - 565.9 MB: `_M_create_storage (std::vector:h395)`
 - 565.9 MB: `Vector base (std::vector:h332)`
 - 565.9 MB: `vector (std::vector:h390)`
 - 565.9 MB: `WireCell::Aux::SimpleTrace::SimpleTrace(int, int, std::vector<> const&)(SimpleTrace.cxx:8)`
 - 357.6 MB: `WireCell::SigProc::OmnibusSigProc::save_data(std::vector<> &, std::vector<> &, int, std::vector<> const&, std::vector<> &, std::cxx11::basic_string_view<char, std::char_traits<char>, std::allocator<char>>> const&)(OmnibusSigProc.cxx:1669)`
 - 93.0 MB: `WireCell::SigProc::OmnibusSigProc::operator()(std::shared_ptr<> const&, std::shared_ptr<> &)(OmnibusSigProc.cxx:1670)`
 - 71.5 MB: `WireCell::SigProc::OmnibusSigProc::operator()(std::shared_ptr<> const&, std::shared_ptr<> &)(OmnibusSigProc.cxx:1678)`
 - 57.2 MB: `WireCell::SigProc::OmnibusSigProc::operator()(std::shared_ptr<> const&, std::shared_ptr<> &)(OmnibusSigProc.cxx:1822)`
 - 57.2 MB: `WireCell::SigProc::OmnibusSigProc::operator()(std::shared_ptr<> const&, std::shared_ptr<> &)(OmnibusSigProc.cxx:1800)`
 - 57.2 MB: `WireCell::SigProc::OmnibusSigProc::operator()(std::shared_ptr<> const&, std::shared_ptr<> &)(OmnibusSigProc.cxx:1814)`
 - 21.5 MB: `WireCell::SigProc::OmnibusSigProc::operator()(std::shared_ptr<> const&, std::shared_ptr<> &)(OmnibusSigProc.cxx:1693)`
 - 114.4 MB: `WireCell::SigProc::OmnibusSigProc::save_mpi(std::vector<> &, std::vector<> &, int, std::multimap<> const&)(OmnibusSigProc.cxx:763)`
 - 57.2 MB: `WireCell::SigProc::OmnibusSigProc::save_nu(std::vector<> &, std::vector<> &, int, std::vector<> &)(OmnibusSigProc.cxx:612)`
 - 36.6 MB: `Construct<> (std::construct:h119)`
 - 359.5 MB: `TStorage::ReAllocChar(char*, unsigned long, unsigned long)(TStorage.cxx:283)`
 - 228.9 MB: allocate (new_allocator:h137)
 - 228.9 MB: allocate (new_allocator:h137)
 - 207.8 MB: in 22540 places, all below massfs's threshold (1.00%)
 - 71.5 MB: aligned malloc (Memory:h216)
 - 53.6 MB: aligned malloc (Memory:h216)
 - 51.3 MB: `c10::alloc_cpu(unsigned long) [in /cvmfs/soft.opensciencegrid.org/products/libtorch/v2.1.1b/Linux64bit+3.10-2.17-e26/llvm/libc10.so]`
 - 35.8 MB: aligned malloc (Memory:h216)

 1st peak

Hokyeong Nam

 2nd peak

BNL-ProtoDUNE meeting

- low torch activity

Jul. 16, 2025