# Filter for Dirt events

Eric Church, 7-Aug-2014

# Motivation

- We now have one project (xml) file to run a Numi dirt +cosmics and another one to run a BNB dirt + cosmics.
- In these samples GENIE uses volWorld for the topVolume for the beam events and CRY uses volTPC for its primaries.
- Only few %-ish of GENIE events penetrate the TPC.
- That means we need 100x more events but want to only detsim+calwire +hitfind+ … those that penetrate the TPC. Yet, last week we decided we want the G4-level info for all particles — even if produced in the “dirt.”
- We do not want to process events with just cosmics in them: we have no shortage of such events from the pure cosmics sample — if we want those.

# Solution: art::EDFilter

- Recall all our modules derive from art::EDProducer, art::EDAnalyzer, art::EDFilter

- Filters are easy. You return a value from

```
bool FilterNoDirtNeutrinos::filter(art::Event& evt) {}.
```

- If result is true, subsequent processing for the event continues and the data is put on the event and written out to the art-ROOT file, as normal. If false, no further modules are run.

# new detsim fcl file

- In standard_detsim_uboone_tpcfilt.fcl
  - `simulate: [rns, filtDirtNus, optdigitizer, optfem, triggersim, optreadout, daq]`
- These are all the usual modules in detsim fcl, but with the filtDirtNus filter prepended.

# 5 NuMI dirt+cosmics events

- In one particular 5 event sample it happens that 1 GENIE evt leaves a daughter in the TPC.
  - Statistical fluctuation up.
- (In another 100 evt sample 7 produced a GENIE daughter in the TPC and thus survive the filter)

# Output w no filter

```
Begin processing the 2nd record. run: 1 subRun: 2 event: 102 at 06-Aug-2014 14:23:53 CDT
TimeModule> run: 1 subRun: 2 event: 102 rns RandomNumberSaver 0.000169039
TimeModule> run: 1 subRun: 2 event: 102 optdigitizer UBOpticalADCSim 2.05094
TimeModule> run: 1 subRun: 2 event: 102 optfem OpticalFEM 0.262836
TimeModule> run: 1 subRun: 2 event: 102 triggersim UBTriggerSim 0.00050211
TimeModule> run: 1 subRun: 2 event: 102 optreadout OpticalDRAMReadout 0.00558496
TimeModule> run: 1 subRun: 2 event: 102 daq SimWireMicroBooNE 19.4564
TimeModule> run: 1 subRun: 2 event: 102 TriggerResults TriggerResultInserter 4.69685e-05
TimeModule> run: 1 subRun: 2 event: 102 out1 RootOutput 63.2778
TimeEvent> run: 1 subRun: 2 event: 102 85.0558
Begin processing the 3rd record. run: 1 subRun: 2 event: 103 at 06-Aug-2014 14:25:18 CDT
```

# Output with Filter

Note all modules executed for event 102 because a GENIE daughter was found in the TPC. Only first 2 modules were executed in the other events.

```
Begin processing the 1st record. run: 1 subRun: 2 event: 101 at 06-Aug-2014 14:10:22 CDT
TimeModule> run: 1 subRun: 2 event: 101 rns RandomNumberSaver 0.000545025
FilterNoDirtNeutrinos: mclist.size() is 4
FilterNoDirtNeutrinos: mcpHandle->size() is 109718
TimeModule> run: 1 subRun: 2 event: 101 filtDirtNus FilterNoDirtNeutrinos 2.02967
TimeModule> run: 1 subRun: 2 event: 101 TriggerResults TriggerResultInserter 0.000141144
TimeModule> run: 1 subRun: 2 event: 101 out1 RootOutput 0.000216007
TimeEvent> run: 1 subRun: 2 event: 101 2.04091
Begin processing the 2nd record. run: 1 subRun: 2 event: 102 at 06-Aug-2014 14:10:24 CDT
TimeModule> run: 1 subRun: 2 event: 102 rns RandomNumberSaver 0.000164986
FilterNoDirtNeutrinos: mclist.size() is 3
FilterNoDirtNeutrinos: mcpHandle->size() is 87526
FilterNoDirtNeutrinos: Genie daughter found in TPC. G4Particle 85668 , TrackID/pdg 509966/ 12 is discovered.
TimeModule> run: 1 subRun: 2 event: 102 filtDirtNus FilterNoDirtNeutrinos 1.28909
TimeModule> run: 1 subRun: 2 event: 102 optdigitizer UBOpticalADCSim 2.13245
%MSG-w MemoryCheck:  UBOpticalADCSim:optdigitizer 06-Aug-2014 14:10:28 CDT  run: 1 subRun: 2 event: 102
MemoryCheck: module UBOpticalADCSim:optdigitizer VSIZE 1138.28 8.48047 RSS 568.578 8.63672

%MSG
TimeModule> run: 1 subRun: 2 event: 102 optfem OpticalFEM 0.274043
%MSG-w MemoryCheck:  OpticalFEM:optfem 06-Aug-2014 14:10:28 CDT  run: 1 subRun: 2 event: 102
MemoryCheck: module OpticalFEM:optfem VSIZE 1141.71 3.4375 RSS 572.008 3.42969

%MSG
TimeModule> run: 1 subRun: 2 event: 102 triggersim UBTriggerSim 0.00201201
%MSG-w MemoryCheck:  UBTriggerSim:triggersim 06-Aug-2014 14:10:28 CDT  run: 1 subRun: 2 event: 102
MemoryCheck: module UBTriggerSim:triggersim VSIZE 1141.71 0 RSS 572.039 0.03125

%MSG
TimeModule> run: 1 subRun: 2 event: 102 optreadout OpticalDRAMReadout 0.00635314
%MSG-w MemoryCheck:  OpticalDRAMReadout:optreadout 06-Aug-2014 14:10:28 CDT  run: 1 subRun: 2 event: 102
MemoryCheck: module OpticalDRAMReadout:optreadout VSIZE 1141.71 0 RSS 572.062 0.0234375

%MSG
TimeModule> run: 1 subRun: 2 event: 102 daq SimWireMicroBooNE 21.565
%MSG-w MemoryCheck:  SimWireMicroBooNE:daq 06-Aug-2014 14:10:50 CDT  run: 1 subRun: 2 event: 102
MemoryCheck: module SimWireMicroBooNE:daq VSIZE 1334.25 192.535 RSS 764.742 192.68

%MSG
TimeModule> run: 1 subRun: 2 event: 102 TriggerResults TriggerResultInserter 5.19753e-05
TimeModule> run: 1 subRun: 2 event: 102 out1 RootOutput 63.8217
%MSG-w MemoryCheck:  RootOutput:out1 06-Aug-2014 14:11:54 CDT  run: 1 subRun: 2 event: 102
MemoryCheck: module RootOutput:out1 VSIZE 2198.2 863.953 RSS 1633.15 868.41

%MSG
TimeEvent> run: 1 subRun: 2 event: 102 89.0933
```

# Performance w no Filter

```
TrigReport ---------- Event  Summary ------------
TrigReport Events total = 5 passed = 5 failed = 0

TrigReport ------ Modules in End-Path: end_path ------------
TrigReport  Trig Bit#    Visited     Passed     Failed      Error Name
TrigReport     0    0          5          5          0          0 out1

TimeReport ---------- Time  Summary ---[sec]----
TimeReport CPU = 437.749477 Real = 437.492492

TimeReport> Time report complete in 439.293 seconds
 Time Summary:
 Min: 83.1992
 Max: 92.7064
 Avg: 87.8587
```

# performance with Filter

```
TrigReport ---------- Event  Summary ------------
TrigReport Events total = 5 passed = 1 failed = 4

TrigReport ------ Modules in End-Path: end_path ------------
TrigReport  Trig Bit#    Visited     Passed     Failed      Error Name
TrigReport     0    0          5          5          0          0 out1

TimeReport ---------- Time  Summary ---[sec]----
TimeReport CPU = 96.195248 Real = 96.093391

TimeReport> Time report complete in 97.3298 seconds
 Time Summary:
 Min: 1.46732
 Max: 89.0933
 Avg: 19.466
```

```
TrigReport ---------- Event  Summary ------------
TrigReport Events total = 100 passed = 7 failed = 93

TrigReport ------ Modules in End-Path: end_path ------------
TrigReport  Trig Bit#    Visited     Passed     Failed      Error Name
TrigReport     0    0        100        100          0          0 out1

TimeReport ---------- Time  Summary ---[sec]----
TimeReport CPU = 850.924859 Real = 832.054506

TimeReport> Time report complete in 864.229 seconds
 Time Summary:
 Min: 1.01686
 Max: 103.915
 Avg: 8.64229
```

# file Sizes

- with 5 events in: ls -lat

```
-rw-r--r-- 1 echurch microboone 543275631 Aug  6 14:58
prodgenie_numi_dirt_nu_cosmic_uboone_17337819_1_gen_0_0_g4_0_0_detsim_NOFILT.ro
ot
-rw-r--r-- 1 echurch microboone  97501671 Aug  6 14:34
prodgenie_numi_dirt_nu_cosmic_uboone_17337819_1_gen_0_0_g4_0_0_detsim_FILT.root
```

```
-rw-r--r-- 1 echurch microboone 366979835 Aug  5 16:30
prodgenie_numi_dirt_nu_cosmic_uboone_17337819_1_gen_0_0_g4.root
```

with 100 evts in (7 passing)

```
<uboonegpvm06.fnal.gov> ls -lat /uboone/data/users/echurch/v02_03_02/detsim/prodgenie_numi_dirt_nu_cosmic_uboone/17364245_0/*.root
-rw-r--r-- 1 echurch microboone 703384792 Aug  6 16:23 /uboone/data/users/echurch/v02_03_02/detsim/
prodgenie_numi_dirt_nu_cosmic_uboone/17364245_0/
prodgenie_numi_dirt_nu_cosmic_uboone_17337819_1_gen_17337910_0_g4_17364245_0_detsim.root
```

# code highlights

- many thanks to Hurricane Kazu.
- larsim/SimFilters/FilterNoDirtNeutrinos_module.cc
- In the end it's very straightforward: we used the associations between GENIE's MCTruth's and LArG4's MCParticles (as is done by bt, but no use of bt here!). Then, I walk the MCParticle trajectories for particles originating from GENIE, not CRY, and look for penetration into TPC.
- We abandoned any use of bt. In particular, painful lesson of performance of bt->ParticleList() is learned and avoided.