

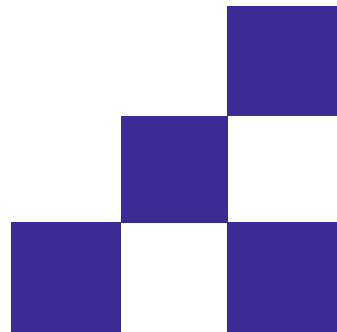
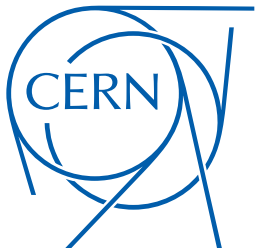


ProtoDUNE Beam Simulation Interface

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Introduction


- We have had some beam simulation files for a while now
 - We need an interface to these files in larsoft
- I have an implementation for the current format of these files
 - This will have to follow any updates to the files such as the inclusion of the beam halo once the beam design has been finalised
- I outline the input files and the module I have written in these slides

H4 Beam Simulation Files

- The H4 beam simulation files from Nikos and Yannis contain a TNTuple called NTuples/GoodParticle
- There are a lot of variables in there, but the ones of interest are:

| | |
|-----------------|--|
| Lag_ENTRY_x | Entry x position (cm) |
| Lag_ENTRY_y | Entry y position (cm) |
| Lag_ENTRY_z | Entry z position (cm) |
| Lag_ENTRY_t | Entry time (ns) |
| Lag_ENTRY_Px | Entry x momentum (MeV/c) |
| Lag_ENTRY_Py | Entry y momentum (MeV/c) |
| Lag_ENTRY_Pz | Entry z momentum (MeV/c) |
| Lag_ENTRY_PDGid | Particle PDG code |
| TRIG2_t | Second trigger time (ns) (Use for T0?) |

This is just to define a T0,
will check if I should be
using a different time



ProtoDUNEBeam Module

- I have added a file to larsim/EventGenerator called ProtoDUNEBeam_module.cc
- Contains an art::EDProducer inherited class called ProtoDUNEBeam.
- Reads in the H4 Beam file using a TTree, taking each entry as a separate art::Event.
 - This might well change in the future, but it is true for the current files
- Currently lives in the branch features/lhw_protoDUNE_evgen
 - Up-to-date with v06_15_01

ProtoDUNEBeam Module

- I have a .fcl file to run the code too, please ask if you want it
- The beam entry point defaults to the values used in protoDUNE_gensingle
- Rather, I shift the central value to keep and x,y spread

```
#include "services_dune.fcl"
#include "protodunebeam.fcl"
process_name: H4BeamGen

services:
{
  # Load the service that manages root files for histograms.
  # TFileService: { fileName: "gensingle_beam_protoDUNE_hist.root" }
  TimeTracker: {}
  RandomNumberGenerator: {} #ART native random number generator
  FileCatalogMetadata: @local::art_file_catalog_mc
  @table::protodune_simulation_services
}

#Start each new event with an empty event.
source:
{
  module_type: EmptyEvent
  timestampPlugin: { plugin_type: "GeneratedEventTimestamp" }
  maxEvents: 100
  firstRun: 1 # Run number to use for this file
  firstEvent: 1 # number of first event in the file
}

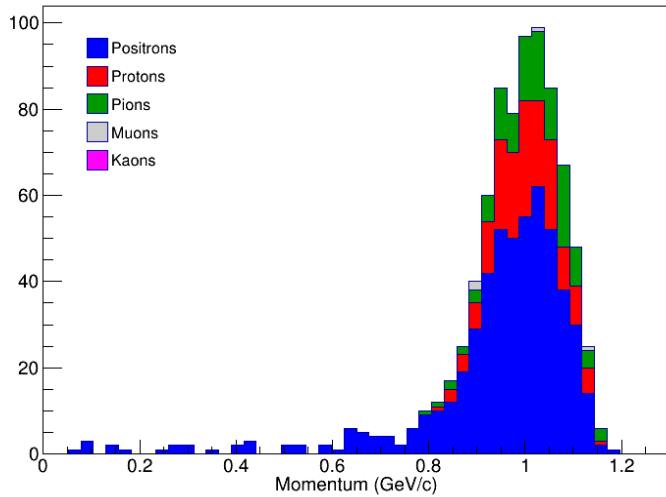
physics:
{
  producers:
  {
    generator: @local::protodune_beam
    rns: { module_type: "RandomNumberSaver" }
  }
  simulate: [ rns, generator ]
  stream1: [ out1 ]
  trigger_paths: [simulate]
  end_paths: [stream1]
}

outputs:
{
  out1:
  {
    module_type: RootOutput
    fileName: "gensingle_protoDUNE.root" #default file name, can override from command line with -o or --output
    dataTier: "generated"
    compressionLevel: 1
  }
}

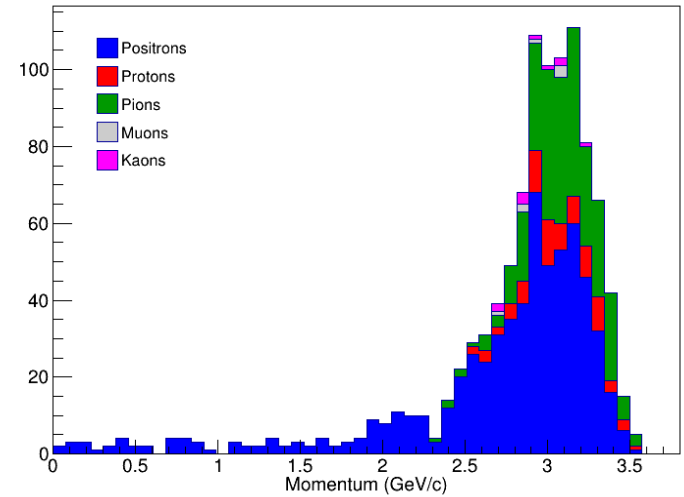
physics.producers.generator.FileName: "/mnt/nas00/scratch/h4/H4_TILT22_APR_FTFP_BERT_6GeV_6M.root"
physics.producers.generator.TreeName: "NTuples/GoodParticle"
physics.producers.generator.StartEvent: 0
physics.producers.generator.BeamX: 118.106 # In cm, taken from protoDUNE_gensingle.fcl
physics.producers.generator.BeamY: 395.649
physics.producers.generator.BeamZ: -196.113
physics.producers.generator.RotateXZ: -8.189 # In degrees, taken from protoDUNE_gensingle.fcl
physics.producers.generator.RotateYZ: 11.229
```

GEANT True Momentum Distributions

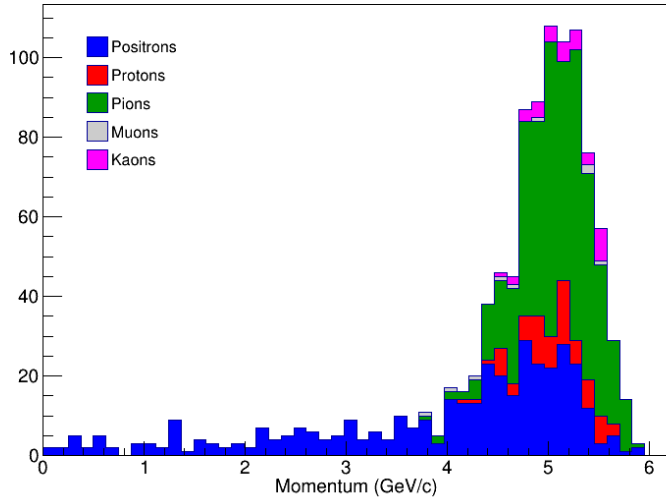
Beam Momentum = 1 GeV



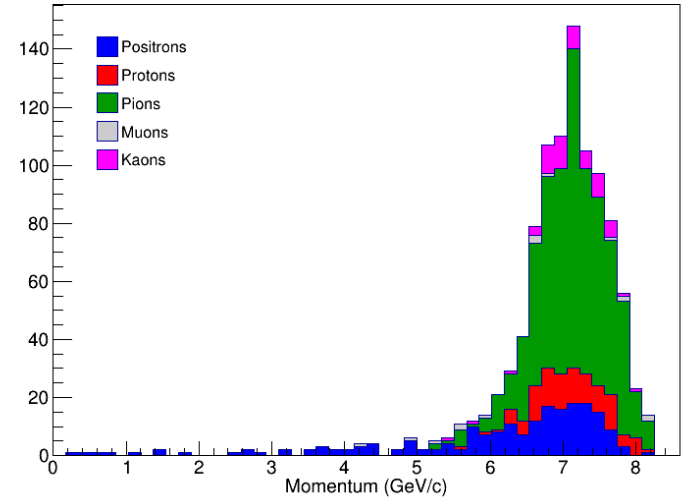
Beam Momentum = 3 GeV



Beam Momentum = 5 GeV



Beam Momentum = 7 GeV



Beam Interface Summary

- I have written an interface to the protoDUNE H4 beam files
 - Generates a single event for each beam particle
 - Distributions look sensible
- I will continue to develop the interface as the beam simulation is updated
 - The next major change foreseen is the addition of the halo muons
- At some point the simulation will hopefully provide the beam PID detector response
 - Will have to think how best to incorporate this information into LarSoft when we have it

Beam Interface Summary

- We (Dorota, Robert and I) will have a meeting with Nikos later this week to discuss how the input files will adapt to the changing needs of the simulation.
 - Likely that it will evolve to have a series of particles per event, such that each event will represent a beam spill.
- I can then begin changing the module to look something more like it's final state.
- I have also spoken to Paola Sala who is working on a FLUKA implementation of the protoDUNE beam line, and we will aim to get FLUKA files in the same format.
 - Will then be able to use the same interface for both simulations.