DUNE workflows on the EAF for analyzing data from ProtoDUNE-II

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Background

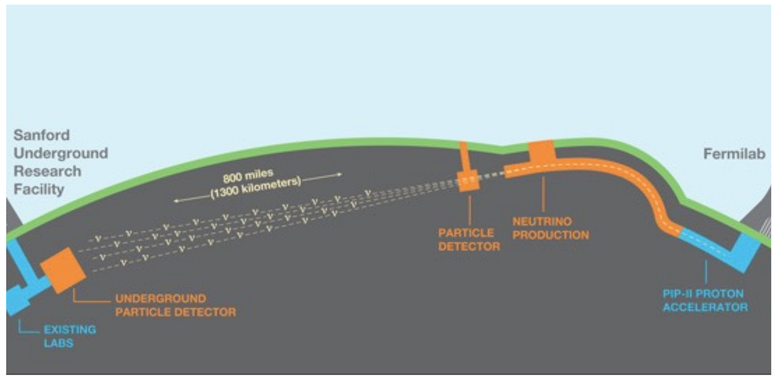
The **Deep Underground Experiment(DUNE)** is an international flagship experiment that works to unlock the mysteries of neutrinos. The three science goals of Dune are to search for the origin of matter learn more about neutron stars and black holes and lastly to shed light on the unification of nature's forces.

Dune Computing is global and collaborative:

15 storage sites and 36 computing sites.

https://lbnf-dune.fnal.gov

https://computing-wiki.dunescience.org/wiki/MainPage



DUNE at LBNF

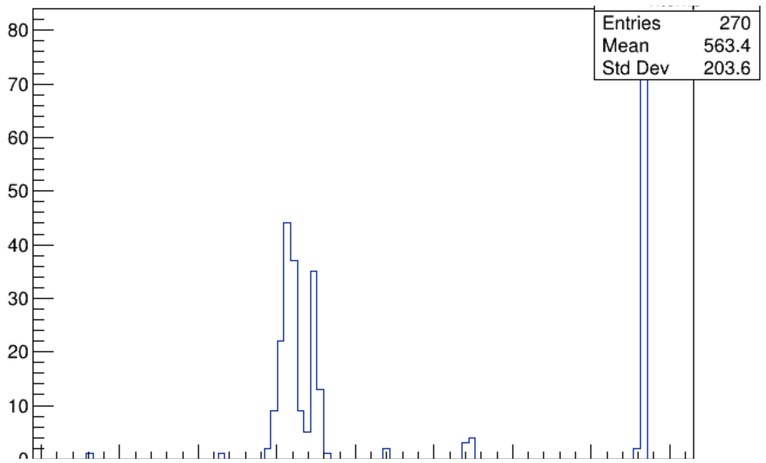
Purpose

The workflows that are currently being used by individuals analyzing data from ProtoDUNE-II are presently contained in one or more scripts of ROOT macros. The purpose of this project is to identify a DUNE workflow to serve as a representative candidate and adapt the workflow to run on the Elastic Analysis Facility(EAF) using a prototype EAF containerized environment.

Materials and Method

- Elastic Analysis Facility goals:
  - Provide different environments and customization
  - Supports low latency applications
  - Documented and packaged to be deployed elsewhere

  Learn more about the EAF at Fermilab here.
- The prototype EAF containerized environment used during this project was a notebook-based environment.
- Iterating with EAF providers to fix roadblocks:
  - Getting experiment software to be imported from CVMFS locations.
  - Libraries installed for ROOT(xxhashlibs,libzstd..etc
- PyROOT tutorials were used to confirm that the building of the notebook-based environment works.
- With the use of Event Selection for PDSP analysis:
  - Monte Carlo File
  - EventSelection fcl file



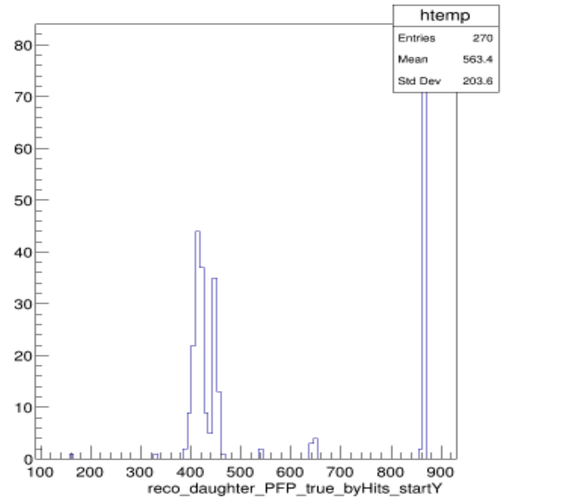
The plot above was produced using c++ and ROOT's R interface.

- The code for the Event Selection for PDSP analysis is then ported to the notebook environment using Python to produce a similar plot.

Results

```
[16]: import ROOT
      import sys, os
      from ROOT import TFile, TNtuple, TROOT
      from ROOT import TCanvas, TPad, TFormula, TF1, TPaveLabel, TH1F

[18]: f = ROOT.TFile.Open("root://fndca1.fnal.gov:1094/pnfs/fnal.gov/usr/dune/scratch/users/laylay/eaftesting/eventSe

[24]: f.cd('pduneana')

[24]: True

[25]: f.ls()
      TNetXNGFile**          root://fndca1.fnal.gov/pnfs/fnal.gov/usr/dune/scratch/users/laylay/eaftesting/eventSele
       TNetXNGFile*          root://fndca1.fnal.gov/pnfs/fnal.gov/usr/dune/scratch/users/laylay/eaftesting/eventSele
        TDirectoryFile*              pduneana        pduneana
         KEY: TTree    beamana;1     beamana
        KEY: TDirectoryFile   pduneana;1       pduneana

[26]: tree = f.Get("beamana")

[29]: tree = f.Get("pduneana/beamana")

[31]: tree.Draw("reco_daughter_PFP_true_byHits_startY")

[32]: c1.Draw()
```

The code above accesses the output file through xrootd to plot a specific entry.



The plot above was produced using Python on the notebook environment.

Conclusion/Next Steps

Through this project, I was able to improve the platform for future users. The next steps in the project, which are some of the objectives I was not able to get to, are developing more metrics to evaluate the performance of the workflow, as well as creating relative documentation for others to use. In addition, distributing the environment for testing and feedback within DUNE.

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