



ProtoDune Workflow development and Analysis

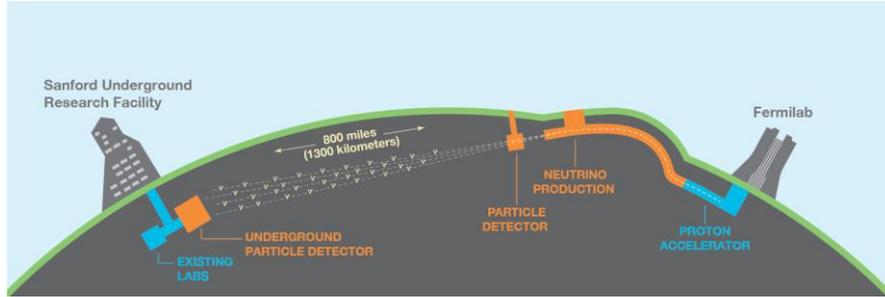
Lisa Paton

SIST Final Presentation

Supervisor: Ken Herner

03 August 2020

DUNE



The Deep Underground Neutrino Experiment (DUNE)

- Will use 70,000 tons of Liquid Argon
 - MicroBooNE uses 170 tons
- An International collaboration
 - 1000 scientists
 - 180 Universities and Laboratories
 - 30 Countries
- Will take place in the Long-Baseline Neutrino Facility (pictured to the right)
 - Between Fermilab and Sanford Underground Research Facility in South Dakota (800 miles)

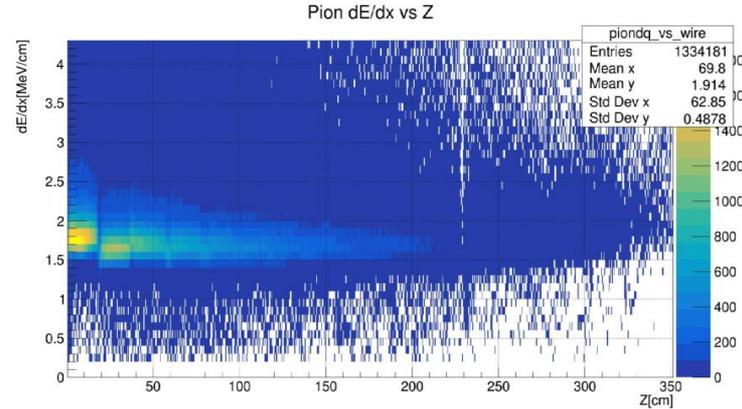
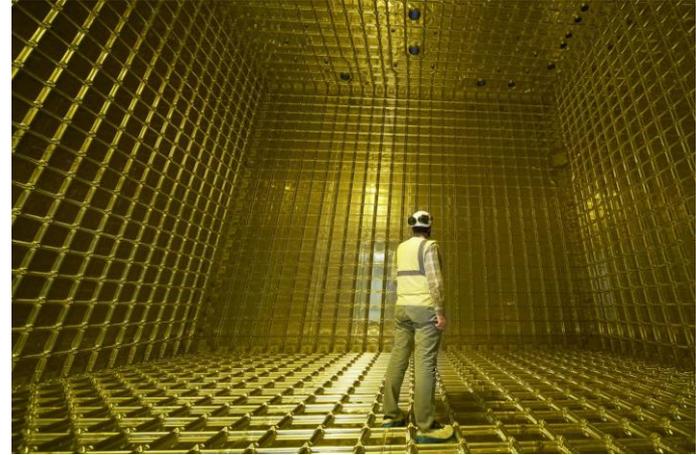
Understanding Neutrinos

Neutrinos have very little mass and oscillate between their three flavors. By studying neutrinos, we hope to answer key questions like “Why is there matter?”

ProtoDUNE

Large scale prototype of DUNE

- Located at CERN
- Single Phase
 - Liquid argon only
- Dual Phase
 - Both gas and liquid argon



My Project

Problem:

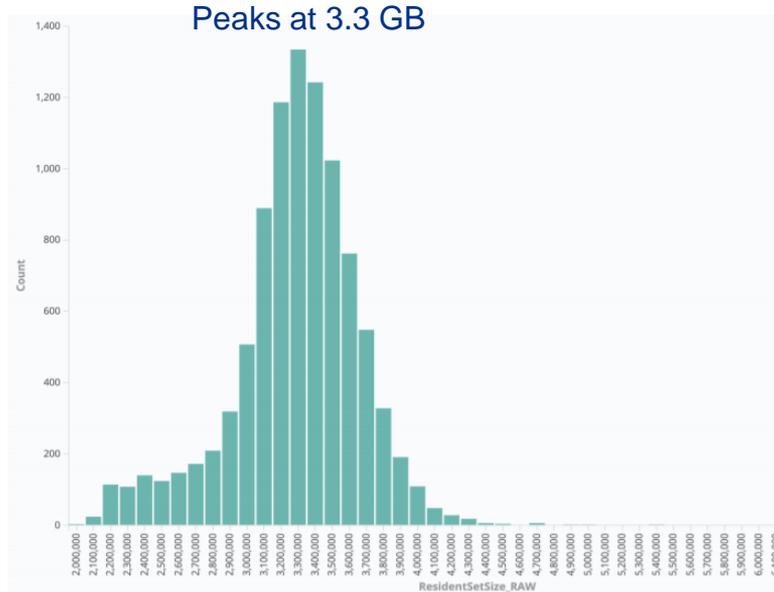
- Too much memory required to run simulation
 - Recent (early 2020) changes to the ProtoDUNE SP workflow have resulted in a larger memory consumption
 - This change was the decision to save more output information

Solution:

- How can we consume less memory?
 - Split workflow stages into substages
 - Iterate workflow so that each new modified chain has more substages
 - This reduces how many subdetectors are in memory at the same time

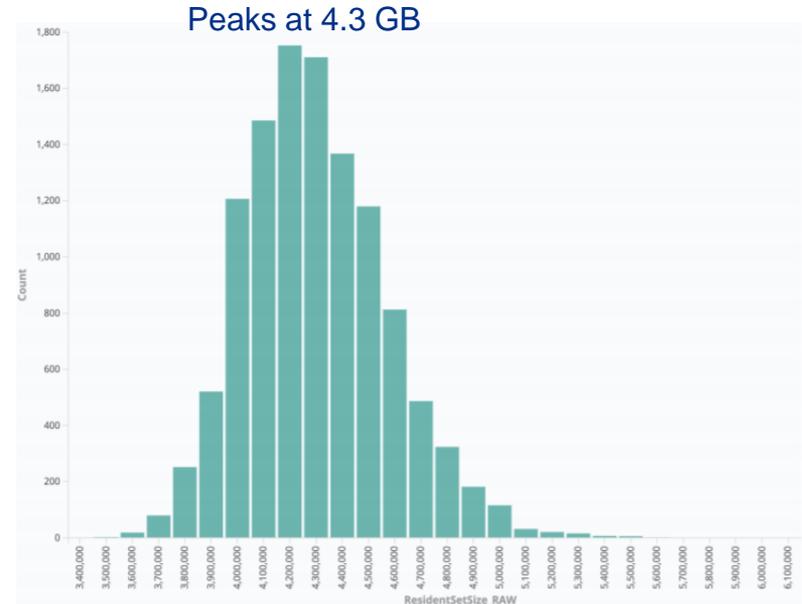
Memory Consumption Increase

2019 Workflow



Job count vs Resident Set Size

2020 Workflow without stage splits

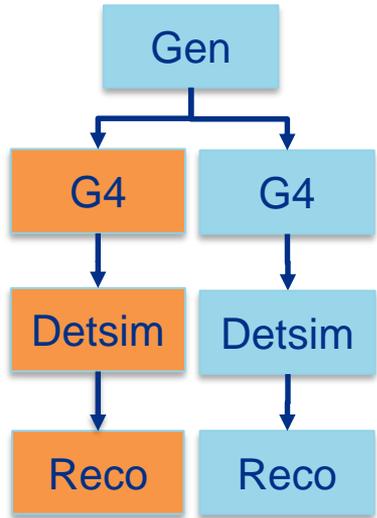


Job count vs Resident Set Size

Workflow terms defined

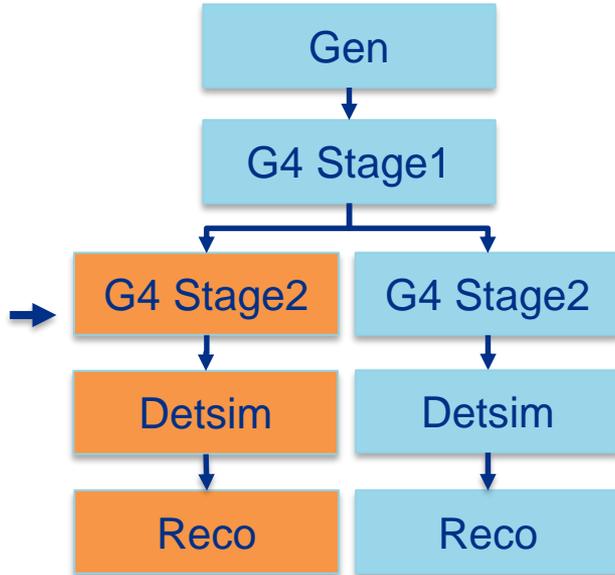
- Neutrino Interaction Generation
 - Abbreviated to Gen
 - Simulates DUNE's particle beam
- Geant 4 Simulation of Interactions
 - Abbr. to G4
 - Simulates the particles interaction with the detector
- Electronics simulation
 - Abbr. to Detsim
- Event Reconstruction
 - Abbr. Reco
- Why do some stages have two sides?
 - Each side either shows that the space charge effect is or isn't being corrected
 - The Space charge effect is the distortion of reconstructed particle tracks or electromagnetic showers due to electrons released from hot cathodes

Workflow



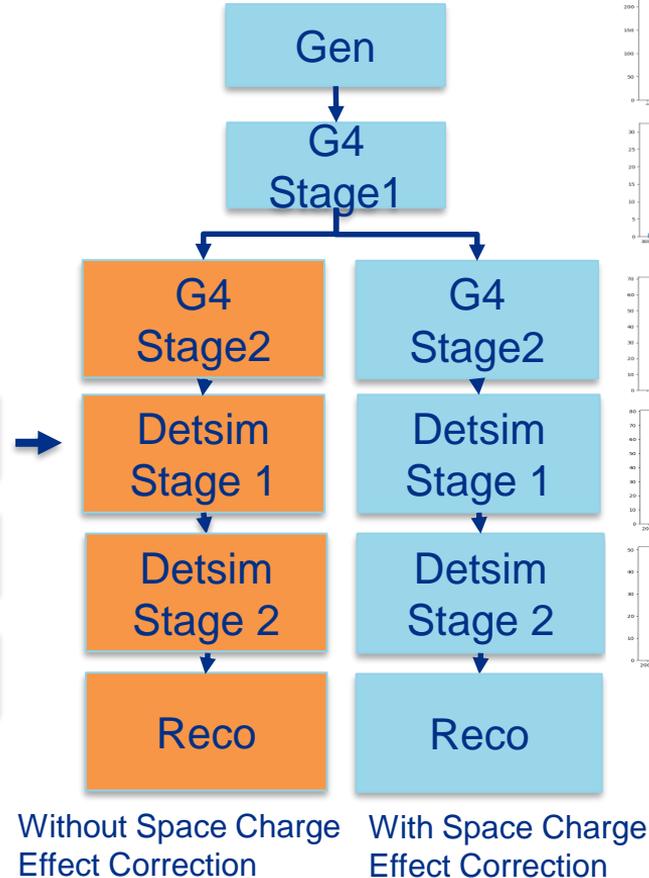
Without Space Charge Effect Correction

With Space Charge Effect Correction



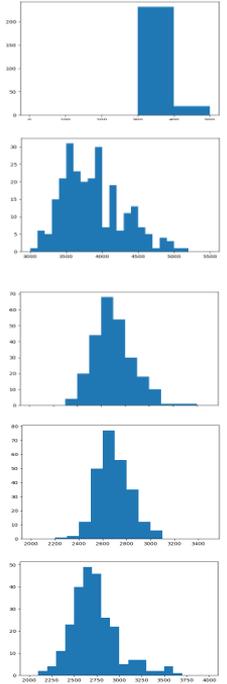
Without Space Charge Effect Correction

With Space Charge Effect Correction

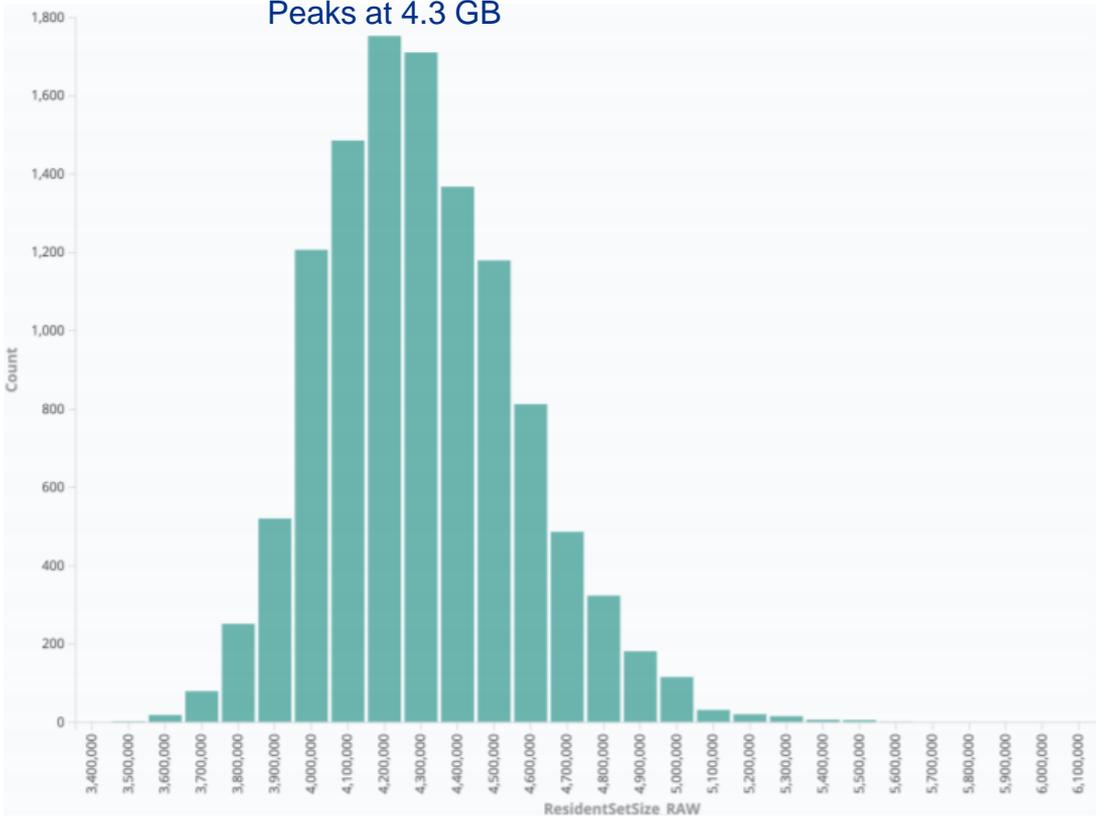


Without Space Charge Effect Correction

With Space Charge Effect Correction

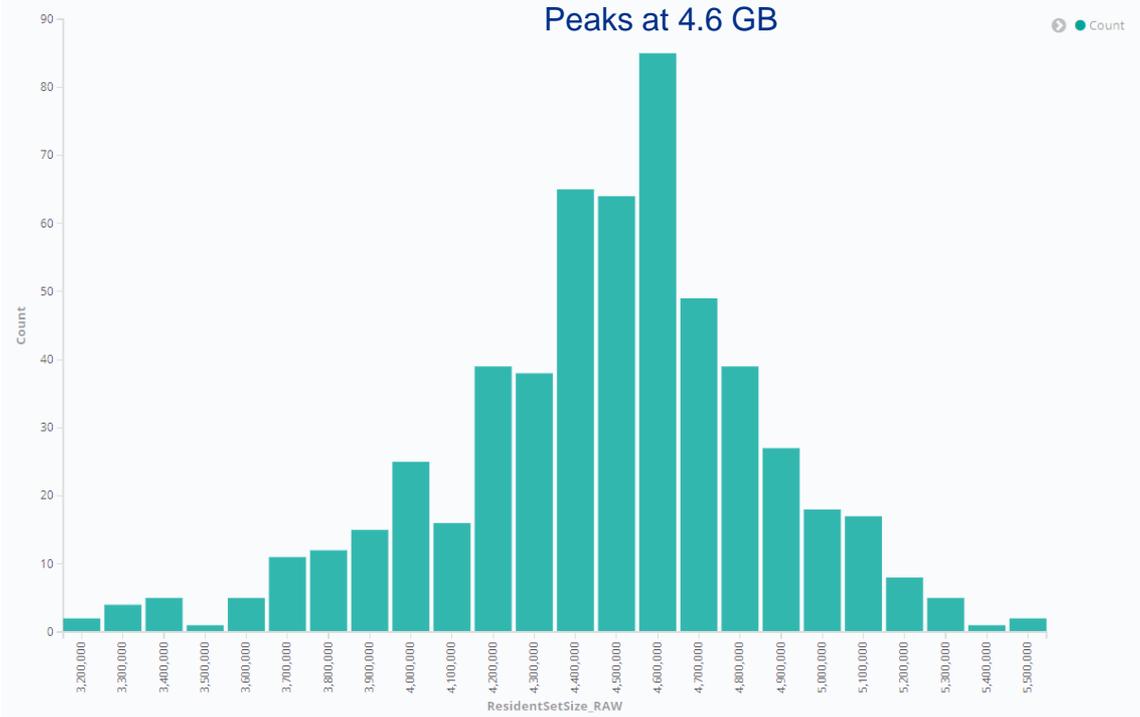


2020 Workflow without stage splits



Job count vs Resident Set Size

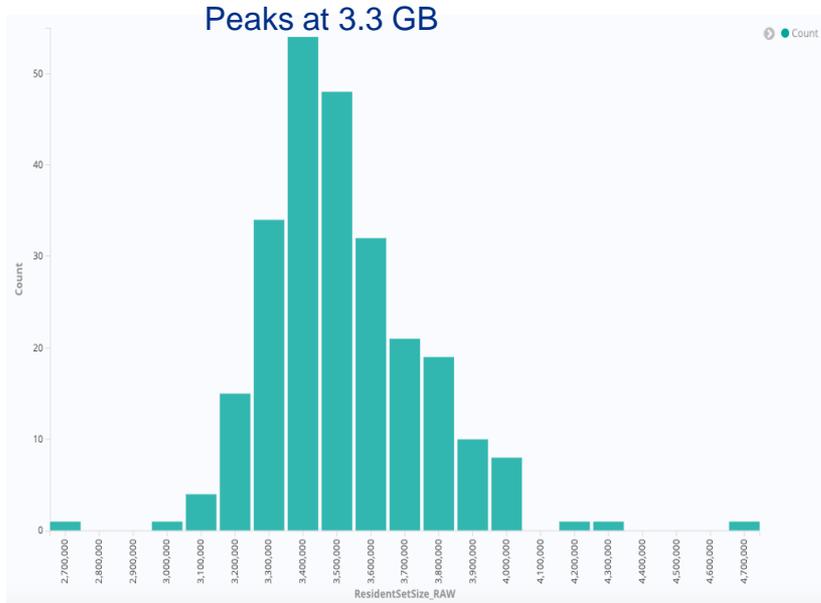
Split G4 Workflow



Job count vs Resident Set Size

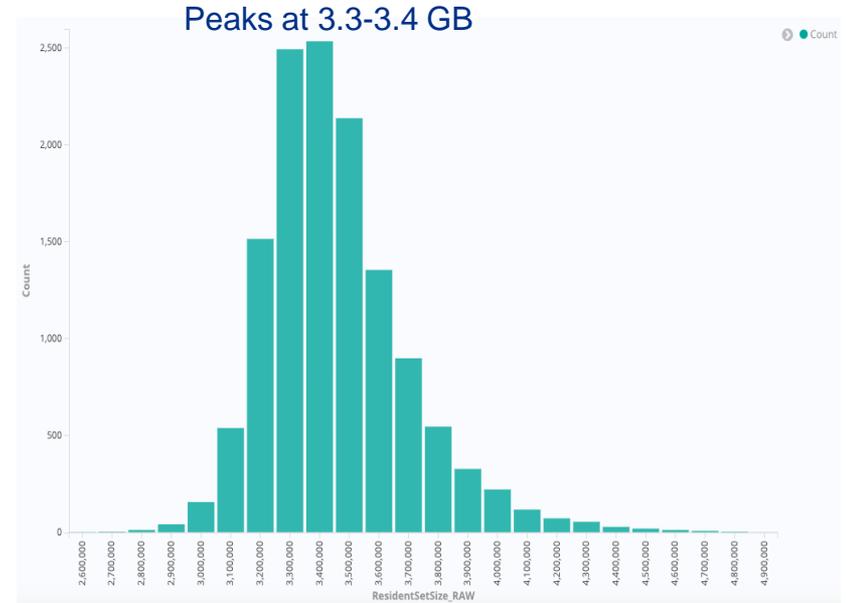
Split G4 and Split Detsim Workflow

Using 1 GeV particle beam



Job count vs Resident Set Size

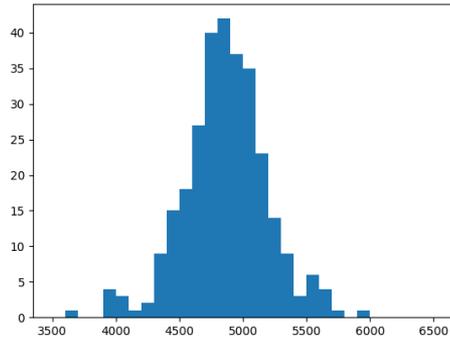
Using 3 GeV particle beam



Job count vs Resident Set Size

Breaking the Stage into substages

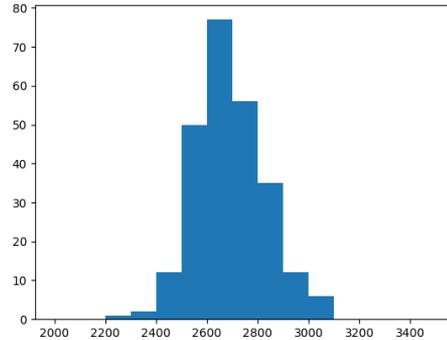
Detsim stage from second workflow



Job count vs Resident Set Size



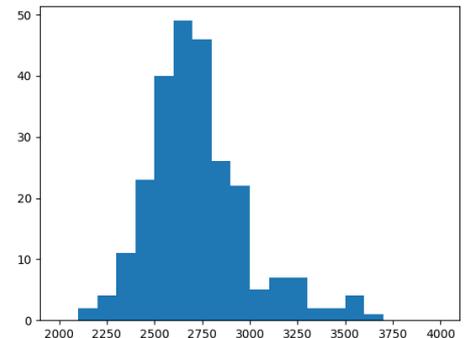
Detsim stage 1 from third workflow



Job count vs Resident Set Size

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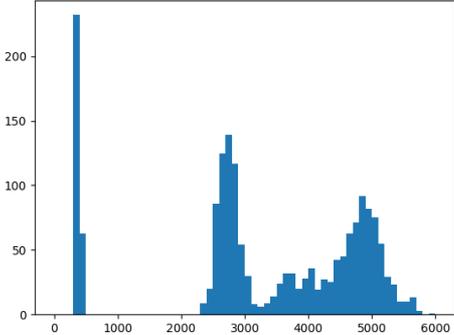
Detsim stage 2 from third workflow



Job count vs Resident Set Size

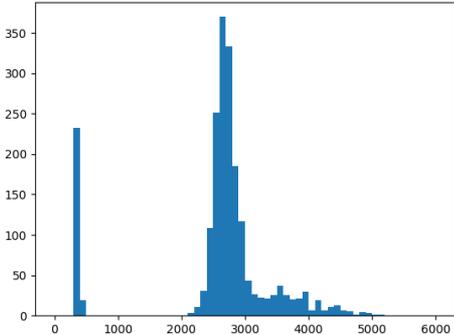
Total Memory of Different Workflows

Split G4 with 3 GeV



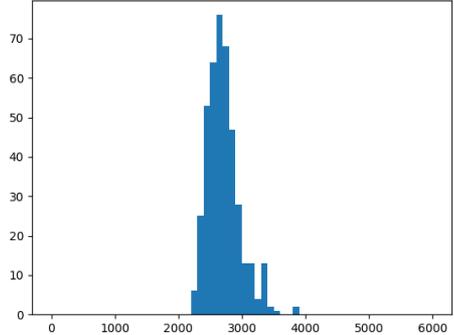
Job count vs Resident Set Size

Split G4 and Split Detsim with 3 GeV



Job count vs Resident Set Size

Split G4 and Split Detsim with 1 GeV



Job count vs Resident Set Size

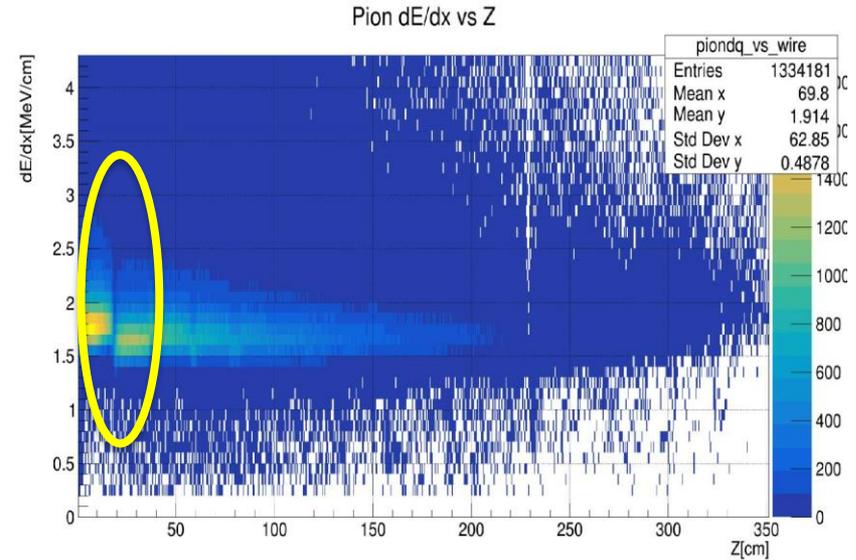
Results of Workflow testing

- Reduced memory consumption
 - By splitting the stages into substages, we brought the peak resident set size from 4.3 GB to 3.3 GB

- Showed that resident set size is dependent on the momentum of the particle beam
 - Since particles with higher momentums have higher energies, they will react more often with the detectors

Continuations for the Future

- Further testing for workflow developments
- Investigate the Space Charge vs Z discontinuity bug



Acknowledgements

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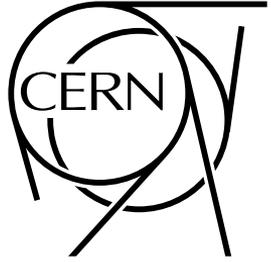
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