"Freight Train" production model on the NOvA experiment and NOvA efforts at Argonne Leadership Computing Facility

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Freight Train
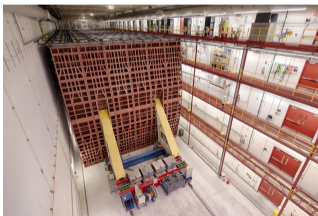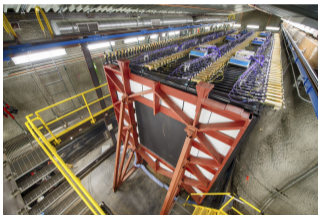○○○○

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The NOvA experiment - the beam

▶ Long baseline, high energy experiment to study neutrino oscillations

▶ NuMI Off-axis ν_e Appearance

    ▶ NuMI, Neutrinos at the Main Injector

        ▶ Nominally 700kW beam fired at graphite target

        ▶ Pions from collision selected utilizing focusing horns

        ▶ Pions decay into muon and muon neutrinos

        ▶ Muon neutrinos continue from near to far detector, ideally oscillating into electron neutrino

    ▶ Detectors placed 14mrad off center of beamline to maximize electron neutrino appearance

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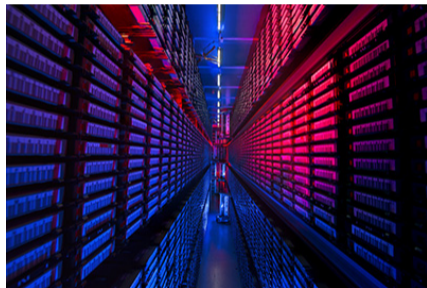
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The NOvA experiment - the detectors

- ▶ Near detector
  - ▶ Located at Fermilab
  - ▶ 105m underground
  - ▶ 0.3 kiloton with 20k detection channels
- ▶ Far detector
  - ▶ Located 810km away in Ash River, Minnesota
  - ▶ On the surface
  - ▶ 14 kiloton with 344k detection channels

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Data management for the NOvA experiment at Fermilab

- ▶ The NOvA experiment needs to store large amounts of data
  - ▶ On the order of 10's of petabytes
- ▶ This data is stored on physical tape at Fermilab
  - ▶ Must be fetched by robot and loaded
  - ▶ Raw data from many trigger streams stored on each tape
  - ▶ Fermilab wrote a short article about this process
- ▶ Getting data to the server, known as prestaging, takes time
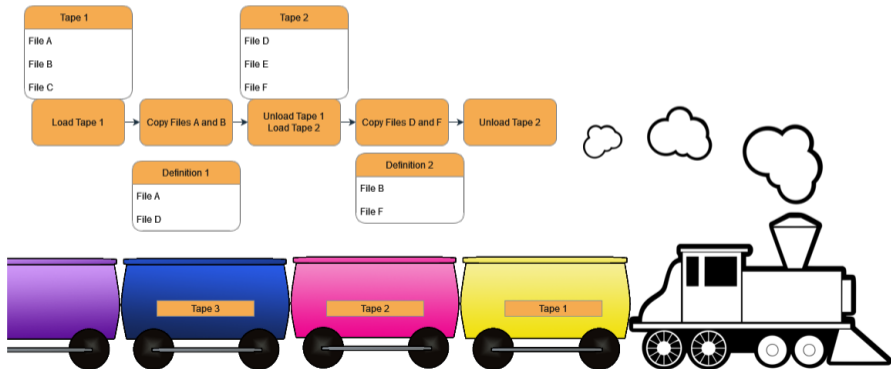 - ▶ Prestaging is a large bottleneck for production at NOvA

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NOvA

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How NOvA used to request data

▶ Create groupings of files based on need

  ▶ Called "Definitions"

▶ Process each Definition one by one
▶ Potentially load a tape multiple times
  ▶ A major contributor to the bottleneck

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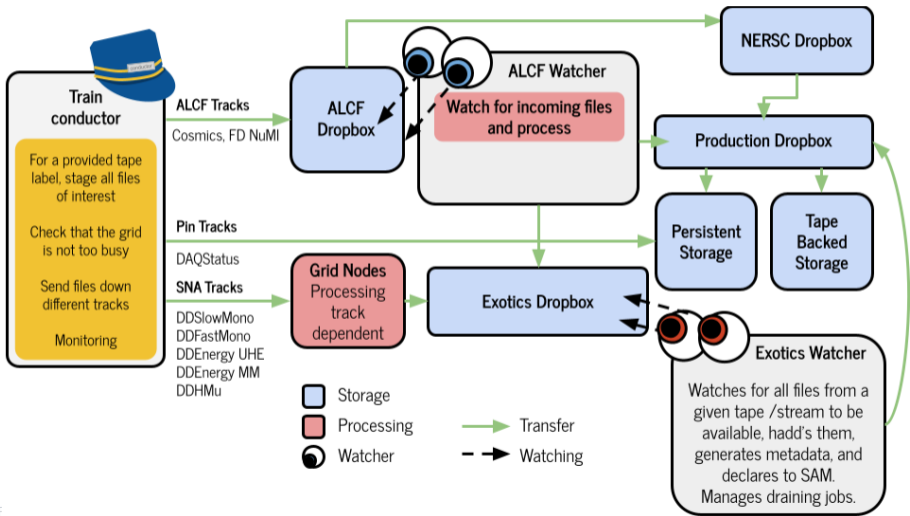Freight Train
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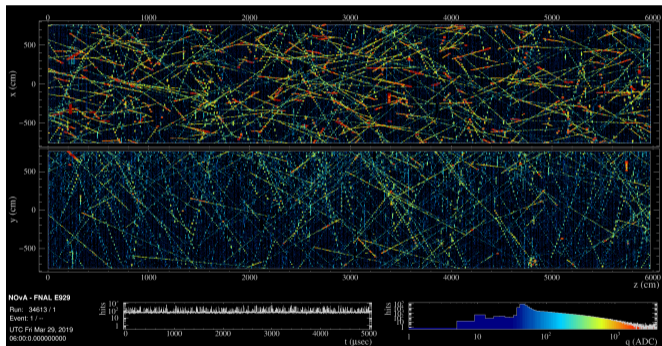○○○○○

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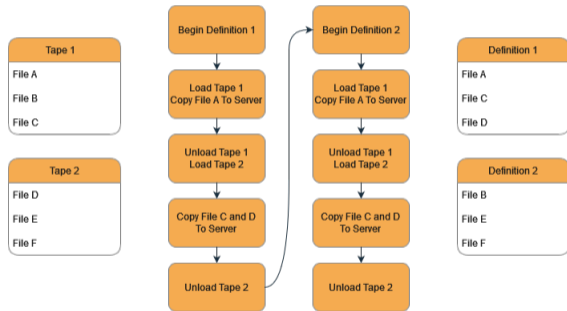
Freight Train Model – Simple

▶ Still create Definitions as normal

▶ Go through each Definition and arrange files by what tape it lives on

▶ Move sequentially through tapes, pulling listed files for every Definition

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Freight Train Model – Full

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▶ Far detector – on the surface – large amount of cosmic rays

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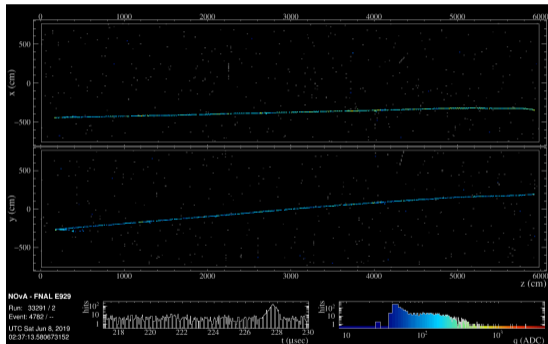Freight Train
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Cosmic Filtering

▶ Filtering necessary since there could be candidates for the oscillation analysis in the background

▶ Amount of recorded cosmic data coupled with probability of finding candidate seems overwhelming
  ▶ To fully process all recorded cosmic data currently would take over 2 years of continous processing
  ▶ Only 1 in 10^7 cosmics will be candidates

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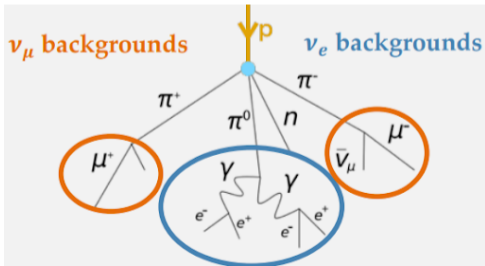
▶ Cosmic filtering – computationally expensive – 10^6 rejection power

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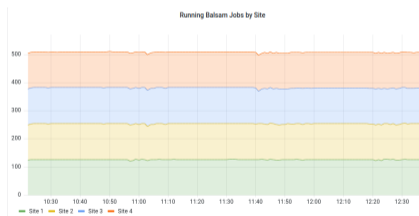Freight Train
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NOvA at Argonne Leadership Computing Facility (ALCF)

▶ For efficient filtering, we require a reliable access to large number of GPUs
  ▶ Process involves running event display images through a neural network
  ▶ Image based algorithms benefit greatly from GPU processing
▶ ALCF provides this resource via its ThetaGPU farm
 ▶ A High-Performance Computing Facility with a few very powerful GPU nodes

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State of Cosmic Filtering at ALCF
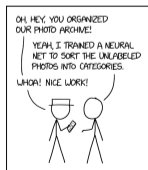
► Currently have 4 different streams of jobs running on ThetaGPU
  ► Each stream able to run 128 jobs simultaneously
    ► 512 jobs at once!

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Summary and Moving Forward
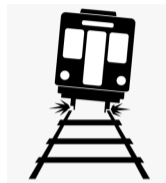
- ▶ Freight Train production model set to increase overall throughput of data
  - ▶ Moving ahead, only need to make sure the trains don't derail!
- ▶ Cosmic filtering at ALCF on track and is a valuable asset to the NOvA Collaboration
  - ▶ Keep aware of any other jobs that could benefit from GPU processing

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Thank you

Questions?