# ZDC neutron study for pi+

Tyler Hague
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Sullivan Process

- Scattering off a virtual meson formed with sea quarks
- For now, focusing on pi+
  - Will extend this to K+ once we have a handle on this
  - pi+ is easier
- Cross section of this process is ~1000x smaller than proton scattering
  - We have ~1000x larger luminosity than HERA
  - -> Similar pion precision to the proton precision achieved at HERA
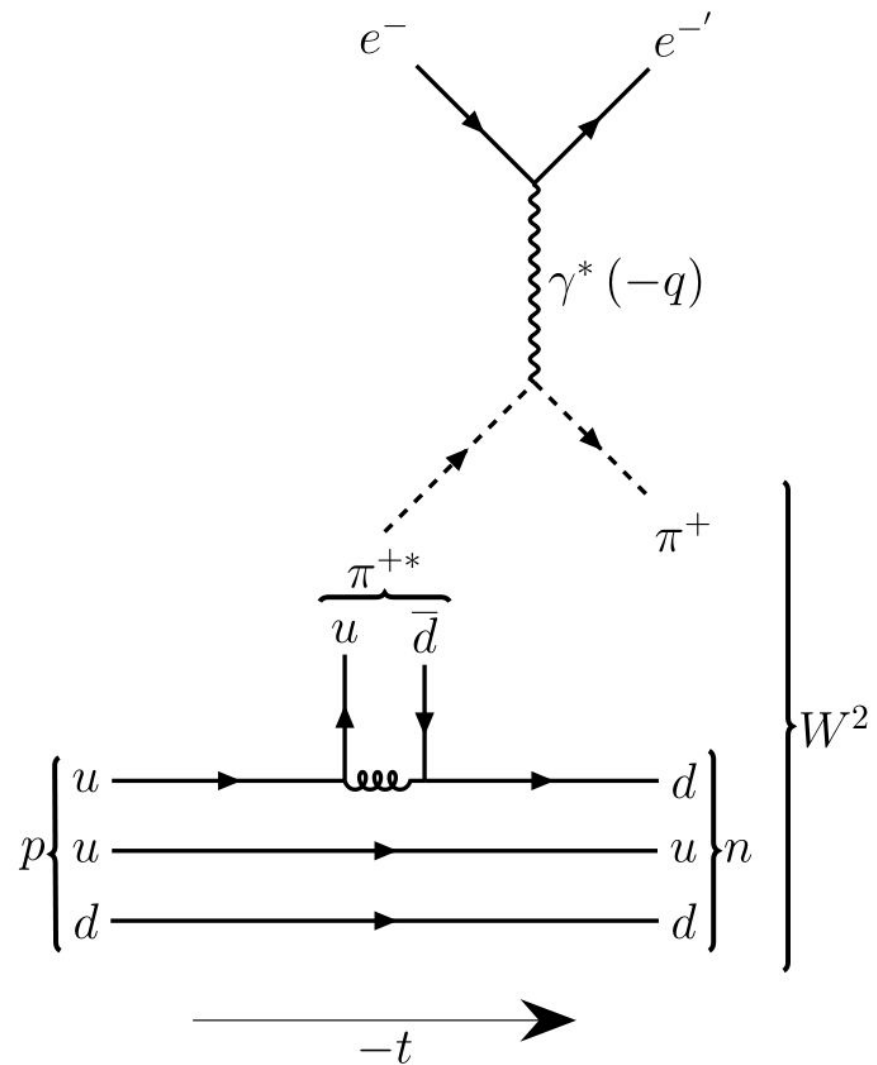
Limitations

- Simulation design uses Athena ZDC rather than the Yellow Report ZDC
  - ~~Switching this is in the works by software group, but requires a refactor of the code~~ Learned this morning that it is fixed, will reprocess soon. Should not make large difference.
- There is no inbuilt smearing, clustering, or tracking for the ZDC
  - Smearing by hand is simple
    - Energy: sigma = 50%/sqrt(E) ⊡ 5%
    - Polar angle: sigma = 3mrad / sqrt(E)
  - Clustering and tracking are not so important at this point, but will be important in the future

First pass acceptance

- Threw 118k neutrons - kinematics calculated based on 41 GeV protons
  - First 100k distributed evenly over 0<-t<0.5 GeV^2 and 0<theta<12.5 mrad (with respect to proton axis)
  - Extra 18k required that the energy fall in specific bins that didn't fill up due to unphysical phase space disfavoring higher energy neutrons
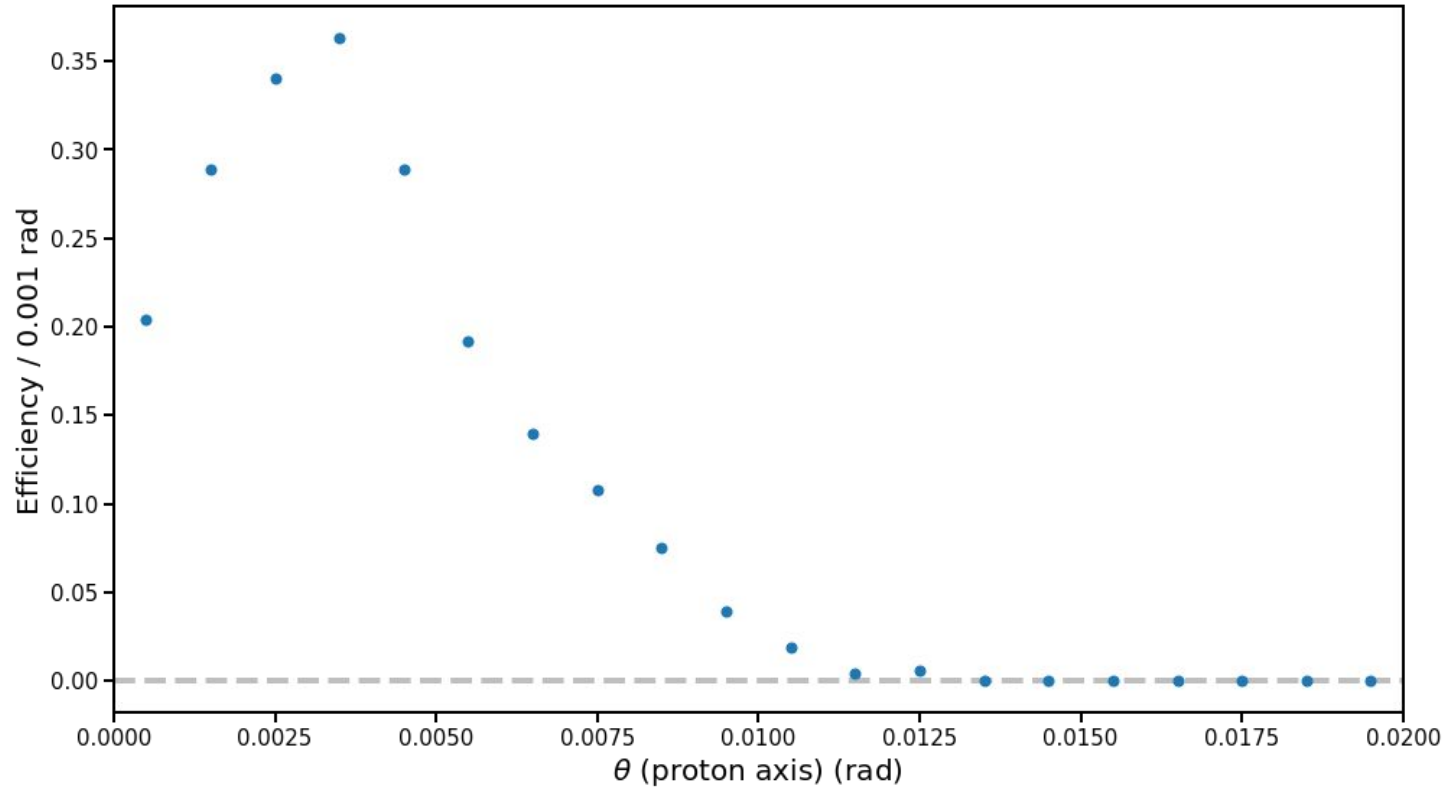- Used for making efficiency plots with the statistics unbiased by cross section
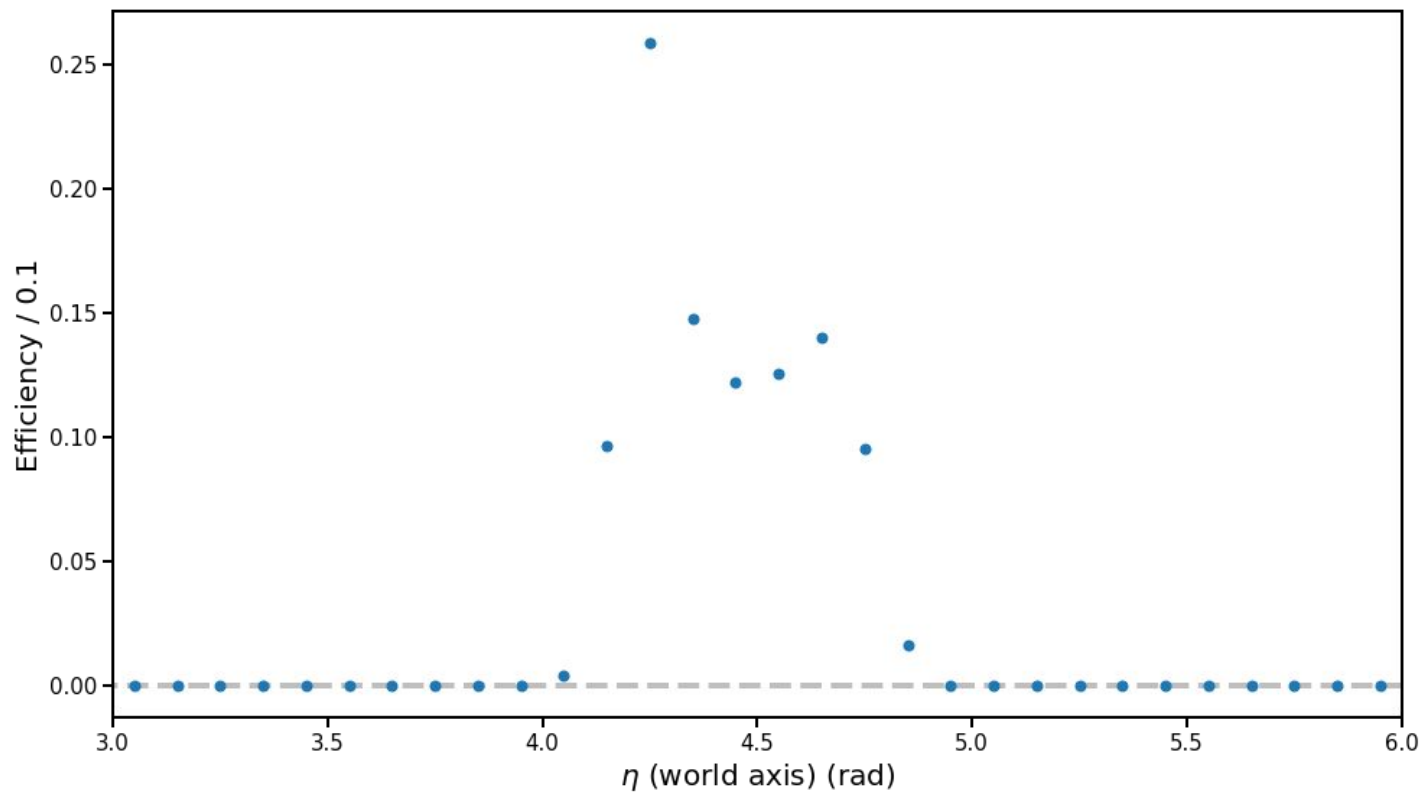
Energy Efficiency
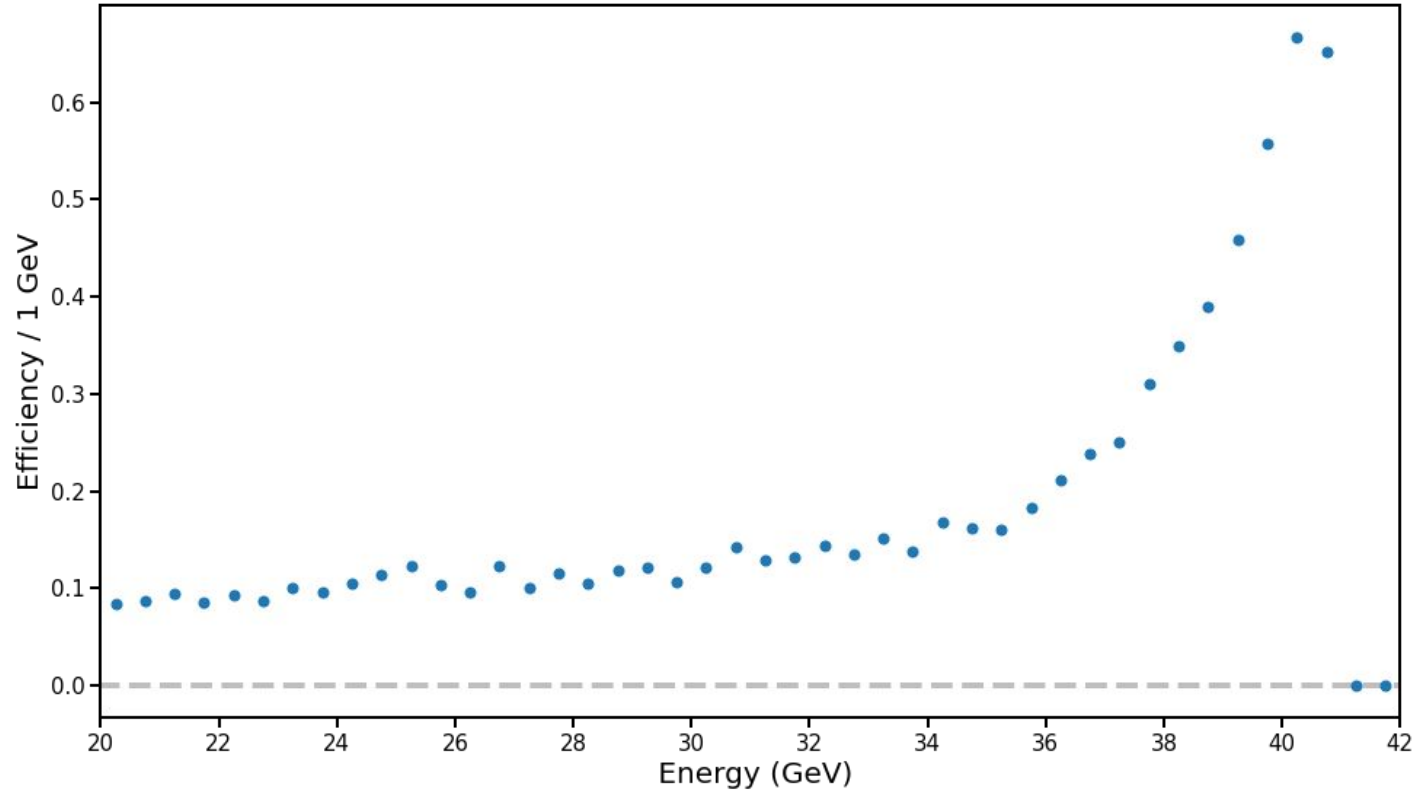
Polar Angle (world coordinates) Efficiency
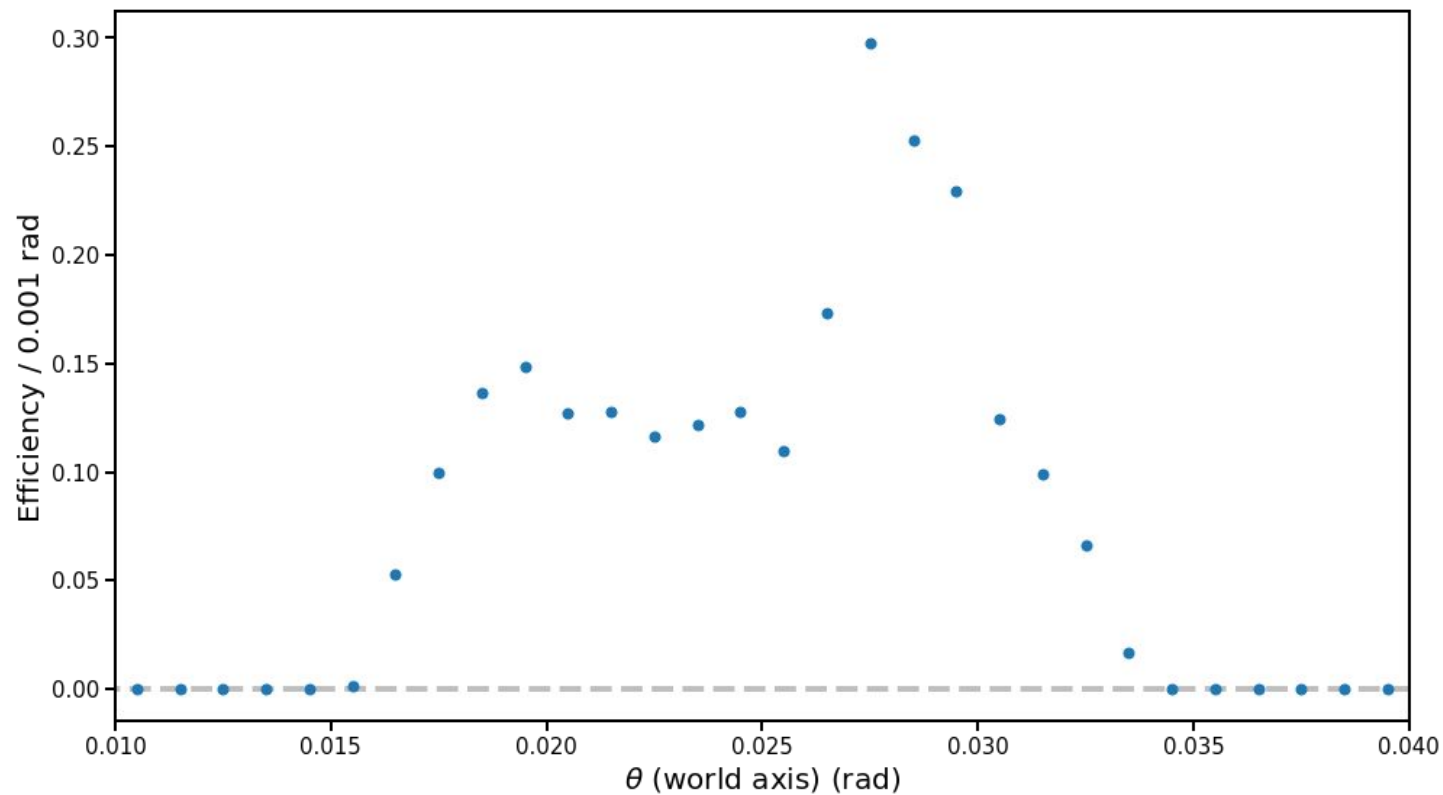
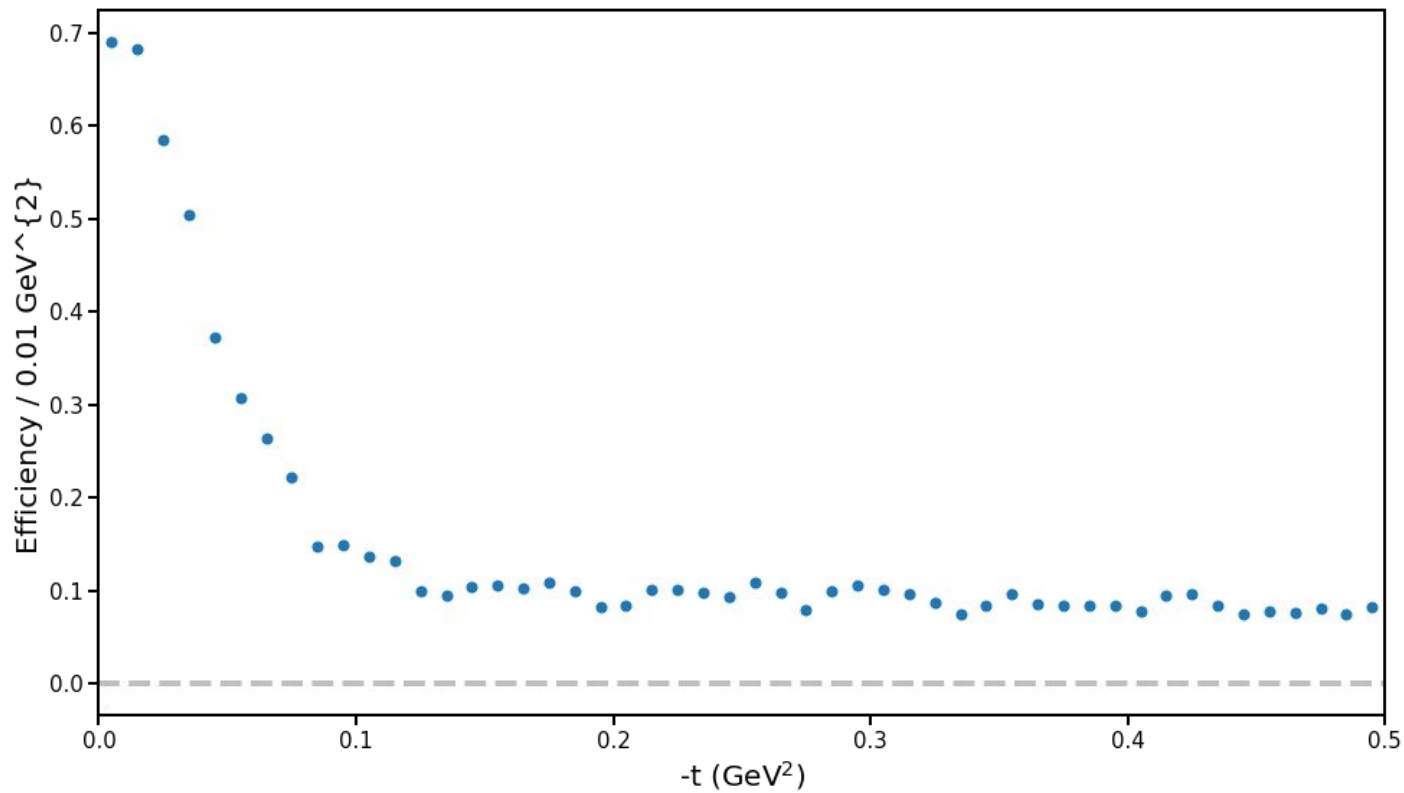# Polar Angle (proton coordinates) Efficiency
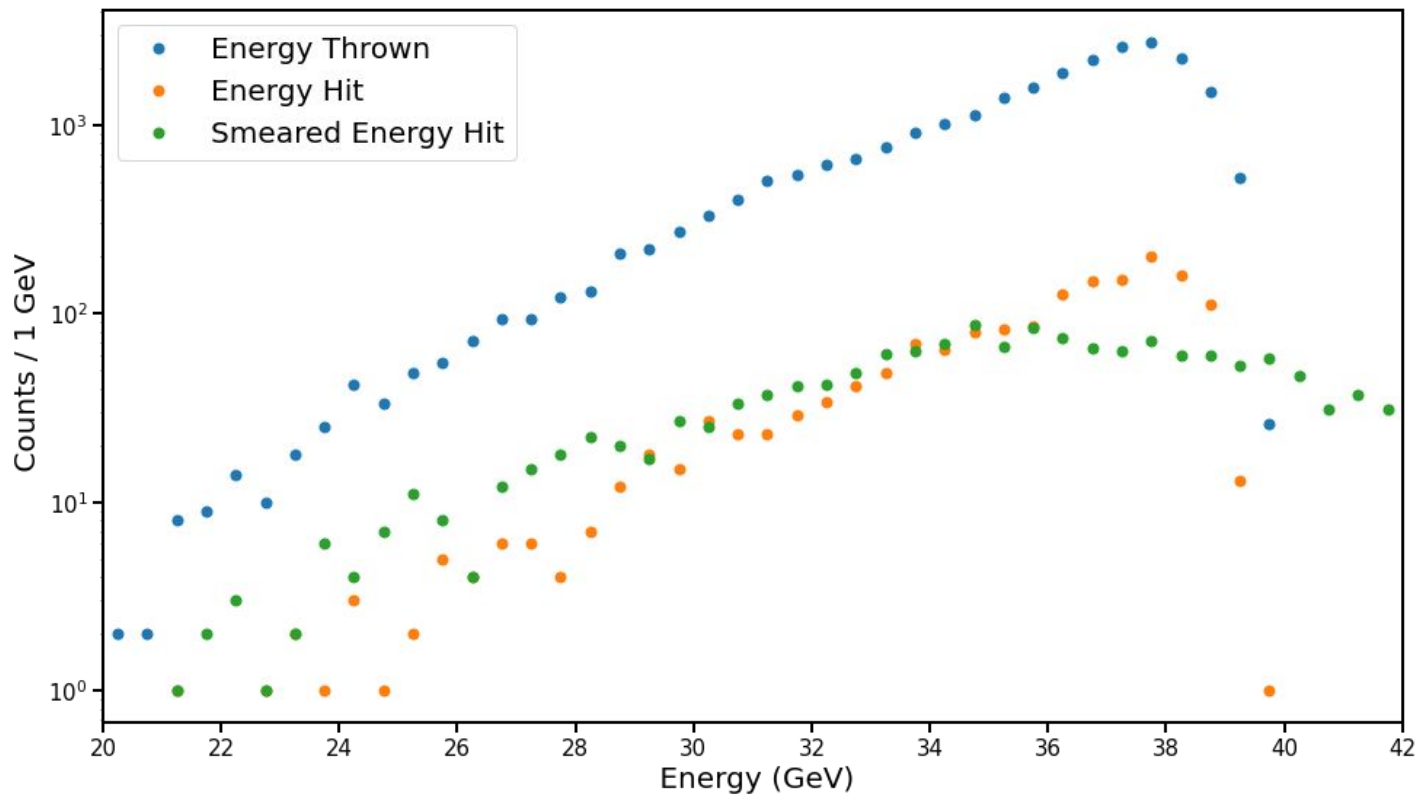
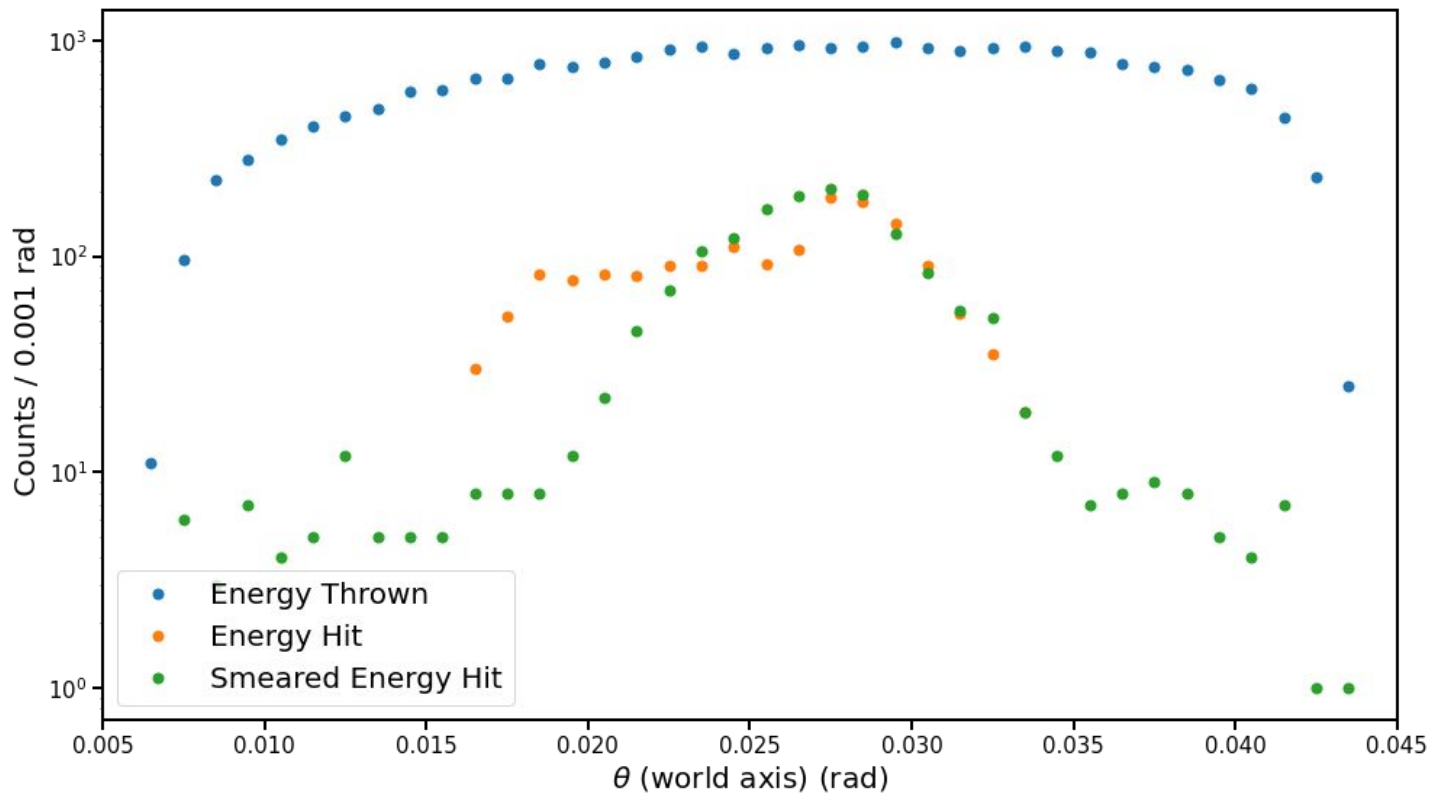# Psuedorapidity (world coordinates) efficiency

-t Efficiency

Pion form factor study

- 25k Sullivan process pi+ elastic scattering events (5 on 41)
- So far looking only at neutron in ZDC
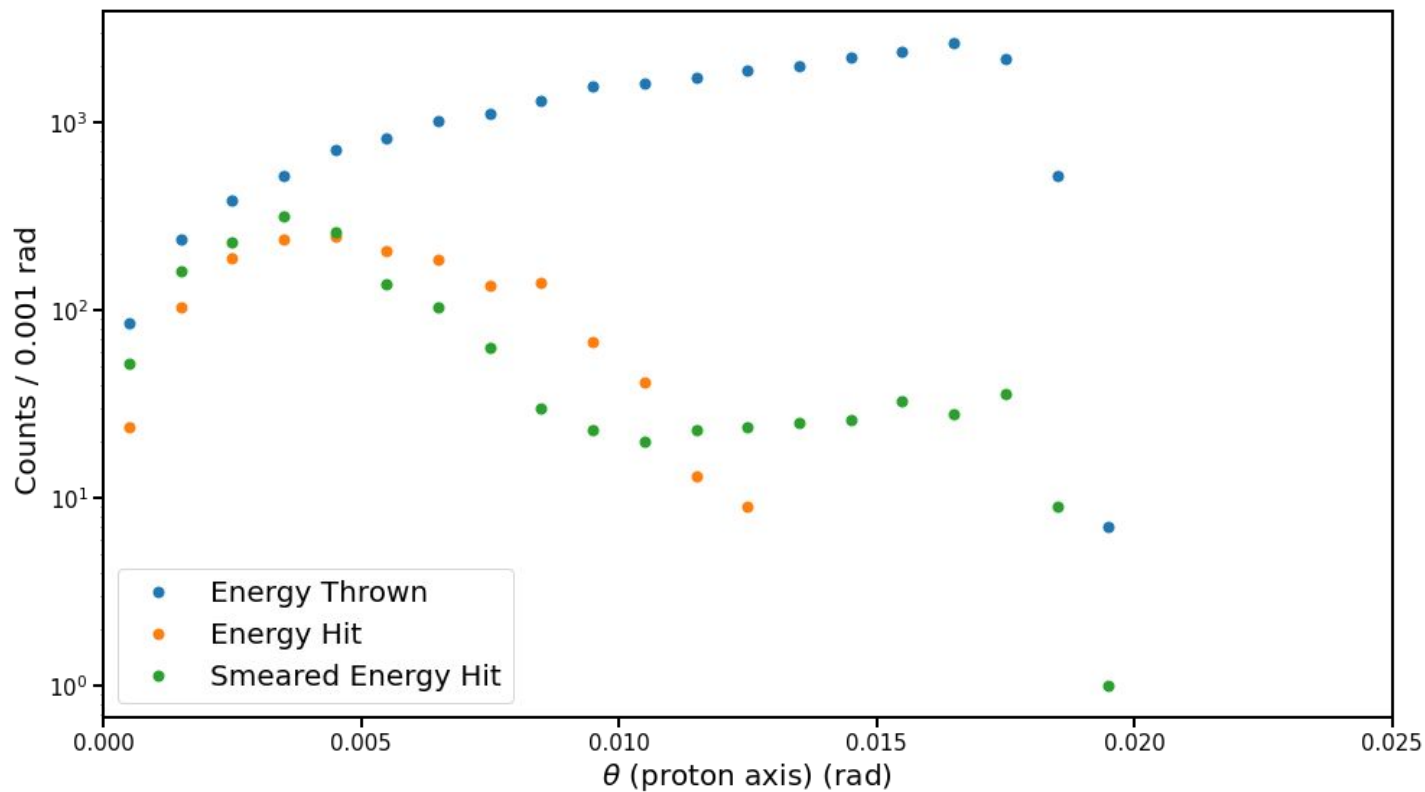 - Adding in electron and pi+ to analysis is the next step

Neutron Energy

Neutron Polar Angle (world axis)

Neutron Polar Angle (proton axis)

-t Distribution (raw)