# ECAL Optimization in ND-GAr: Barrel vs. endcap studies

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Mar 1, 2021

# Introduction

- Which parts of the ECAL do we really need, i.e., Upstream/Downstream barrel, Endcap, and how do we answer this question?
  - This is a work-in-progress

- I am using an older geometry, where the barrel ECAL is ~ 7.2 m long
  - Eldwan is making files with new geometry model

TPCFidRadius = 222.5, cm  TPCFidLength = 215

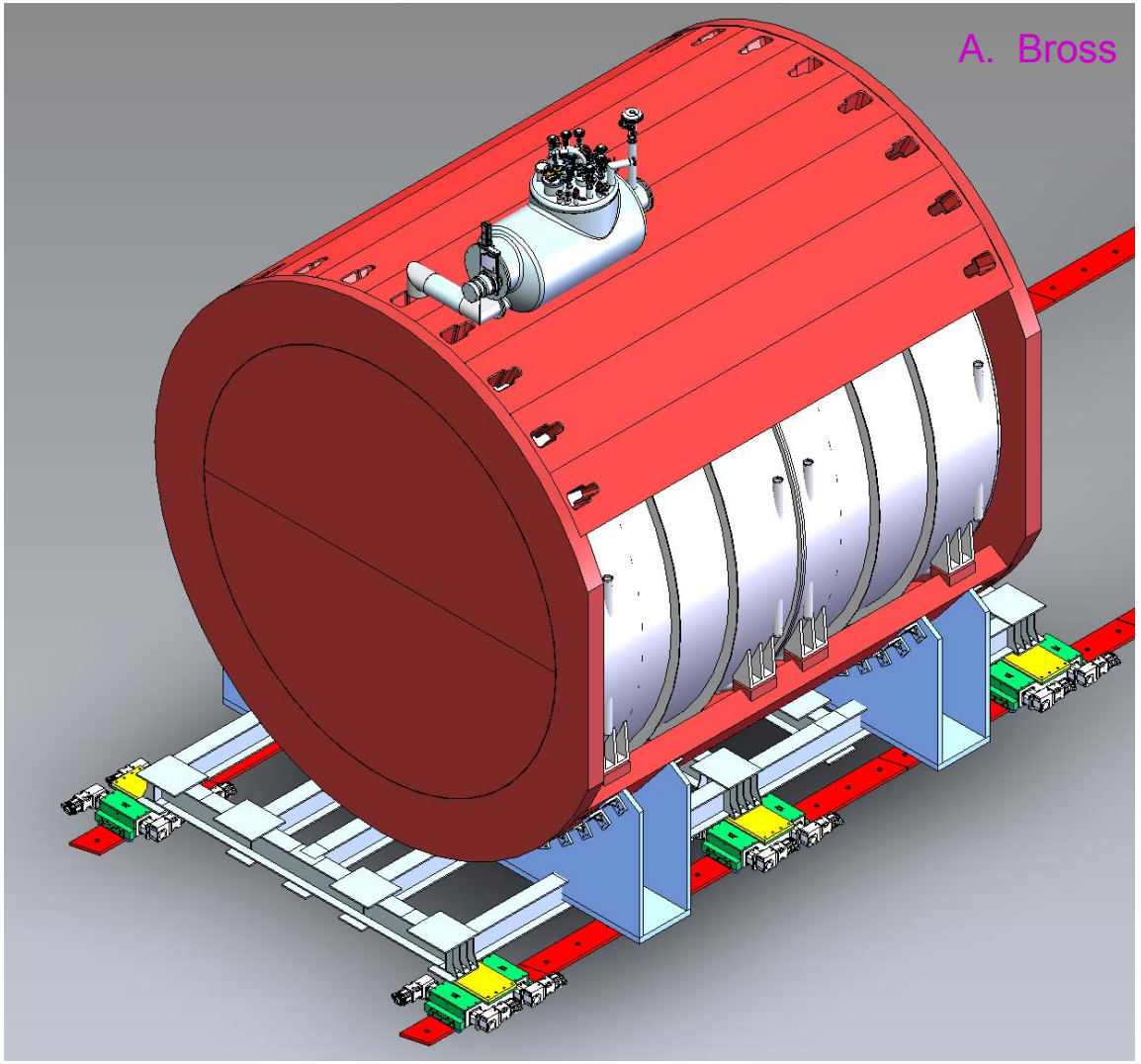
TPCRadius = 273, TPCLength = 259

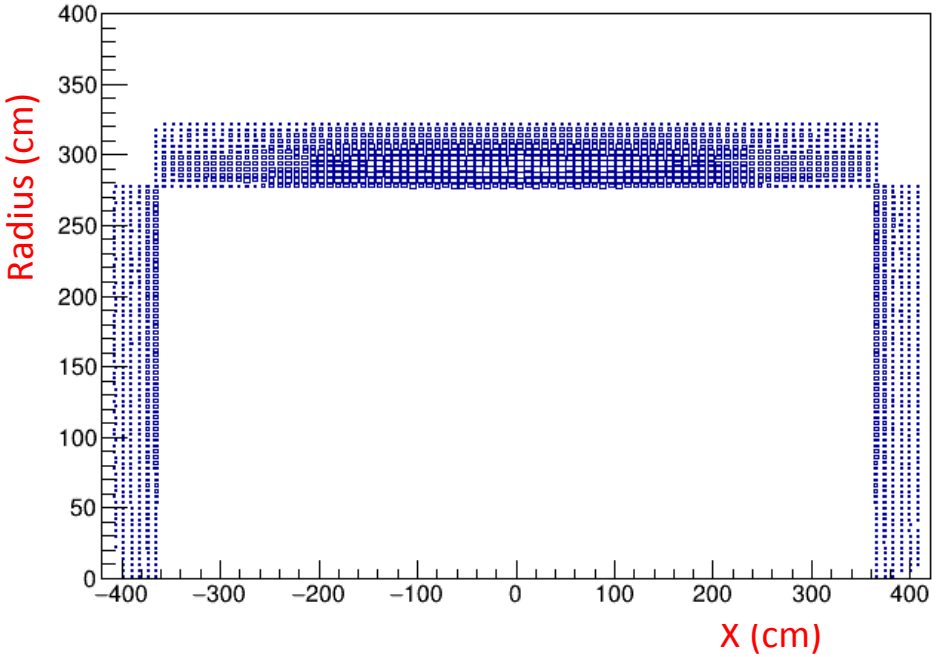
ECALInnerRadius = 278, ECALOuterRadius = 321

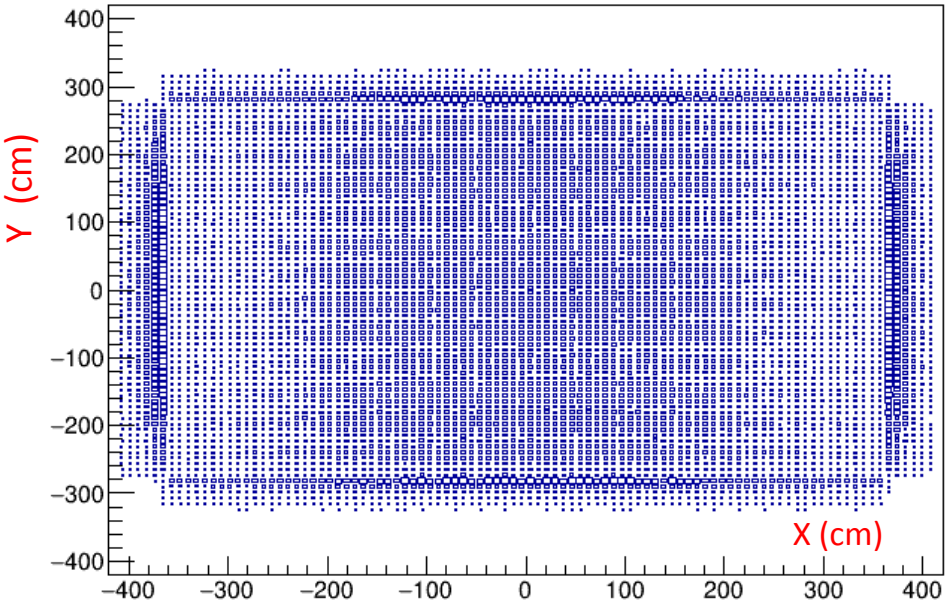
ECALStartX = 364,  ECALEndX = 406

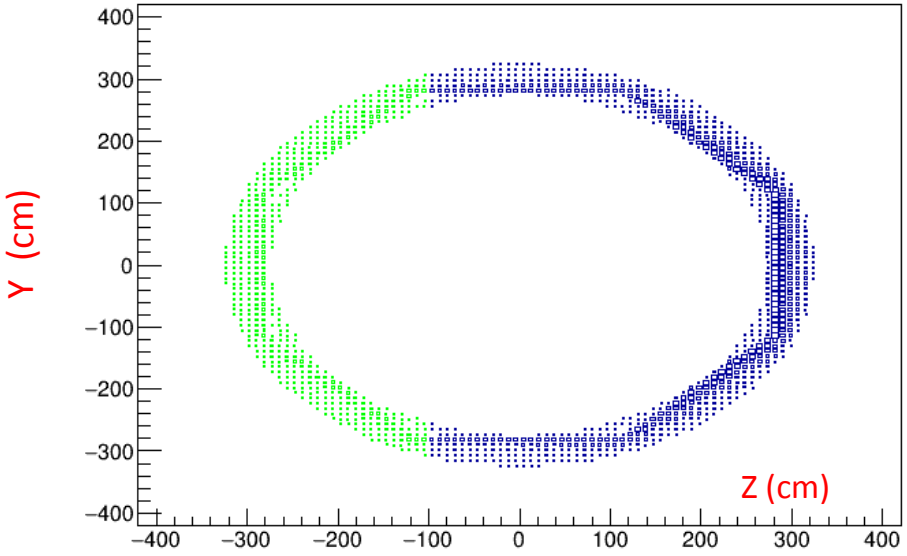
# ND-GAr

- Magnetized volume including high-pressure (10 atm) gaseous argon TPC + ECAL. Plus external muon tagger
  - Copy of ALICE TPC (5m in diameter X 5m long active)
  - 1t fiducial target mass
- Magnet: Solenoid with Partial Return Yoke (SPY)
  - 0.5T field
  - Acts as pressure vessel for HPgTPC
- HPgTPC surrounded by high-performance ECAL
  - Optimization study underway
- Muon tagger
  - Outside return Fe
    - Scintillator, RPCs or MicroMegas (tbd)






Positions of particles that **stop** in the ECAL

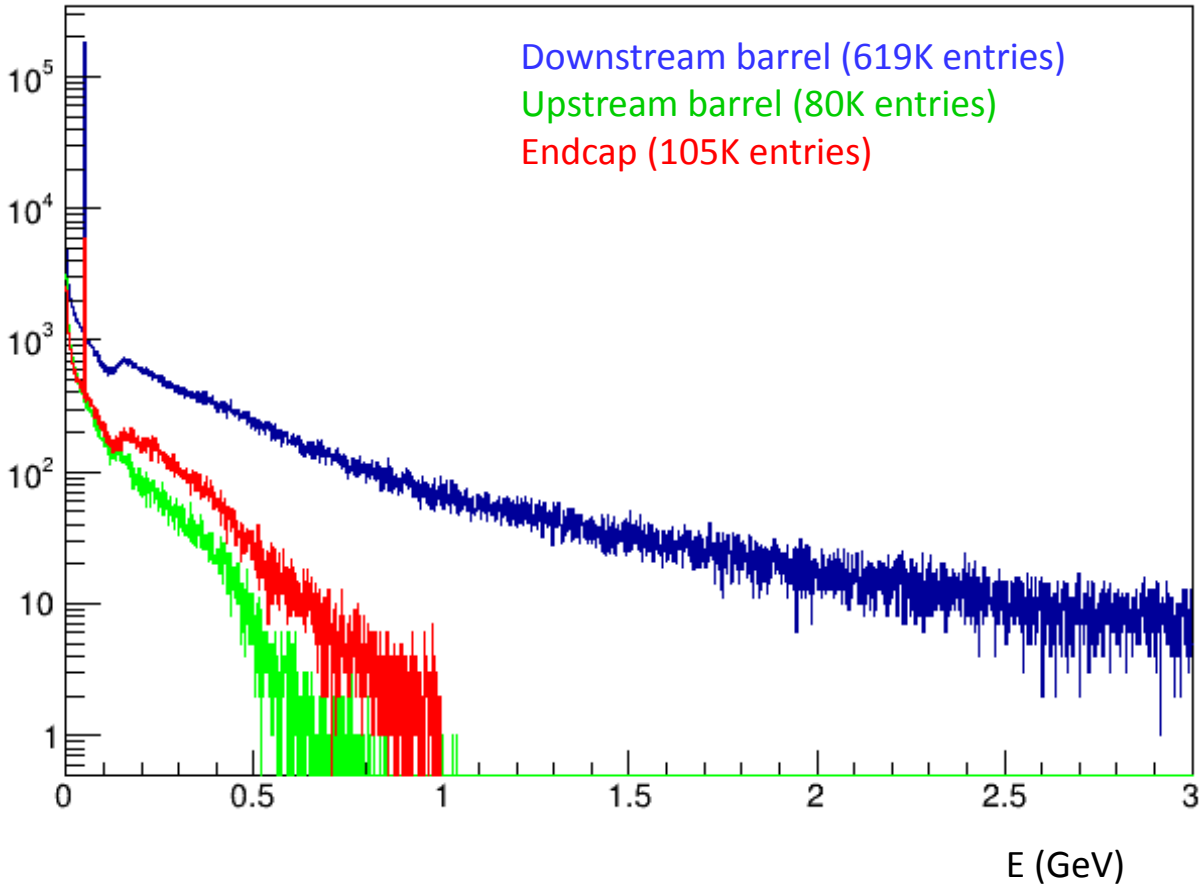
*Neutrino interaction is constrained to be in the TPC fiducial volume*

Aggregated over all modes, neutrino flavors (FHC)

**One entry per particle** – only use primary particles from neutrino event (instead of primary $\pi^0$, use their daughter photons)

Energy* of particles that stop in or go through the CALO (the spike at 49 MeV is due to through-going charged particles)

***Using truth information in all plots***



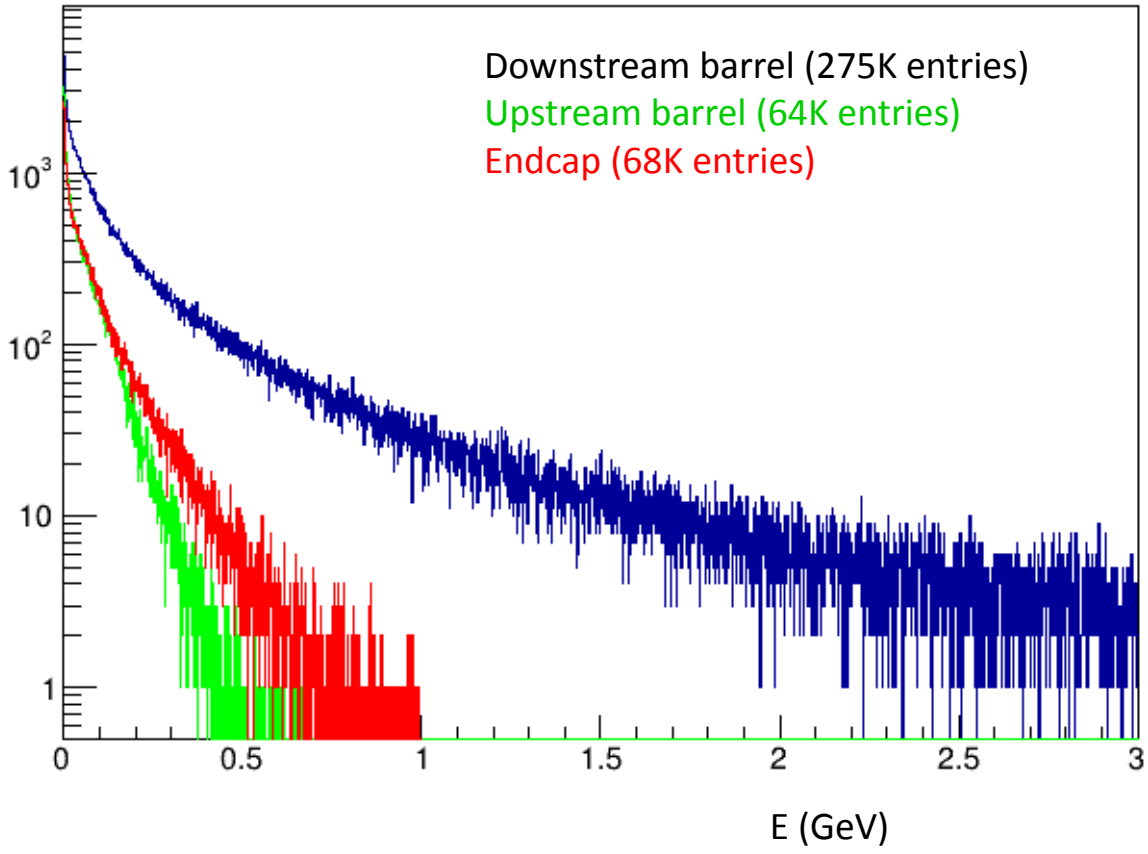

*KE for nucleons, total E for all others

The endcap plot was cut-off at 1 GeV, but very few entries above – will fix

**One entry per particle** – only use primary particles from neutrino event (instead of primary $\pi^0$, use their daughter photons)

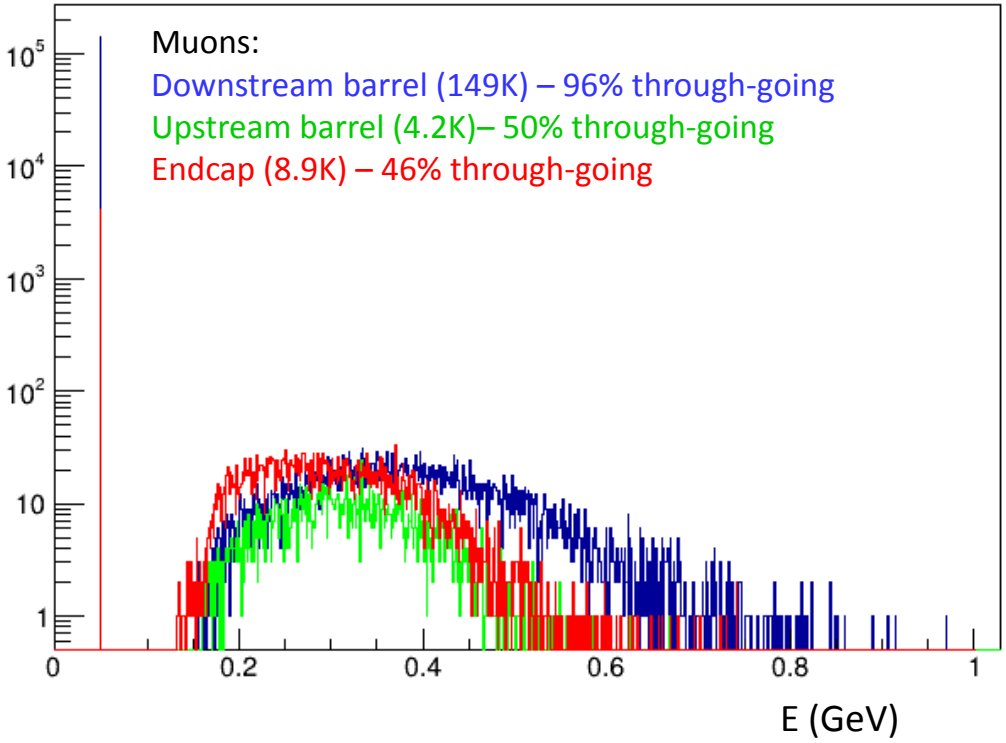
Energy* of neutrons and photons that stop in CALO (some of them do go through, but leave no energy)

***Using truth information in all plots***

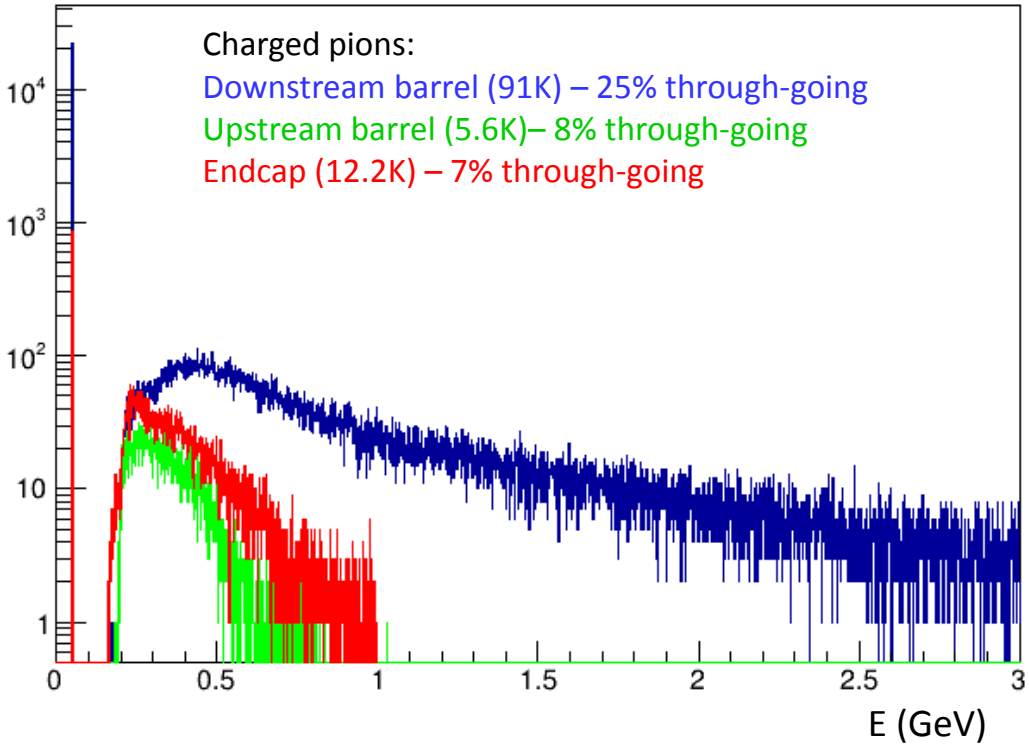



*KE for nucleons, total E for others

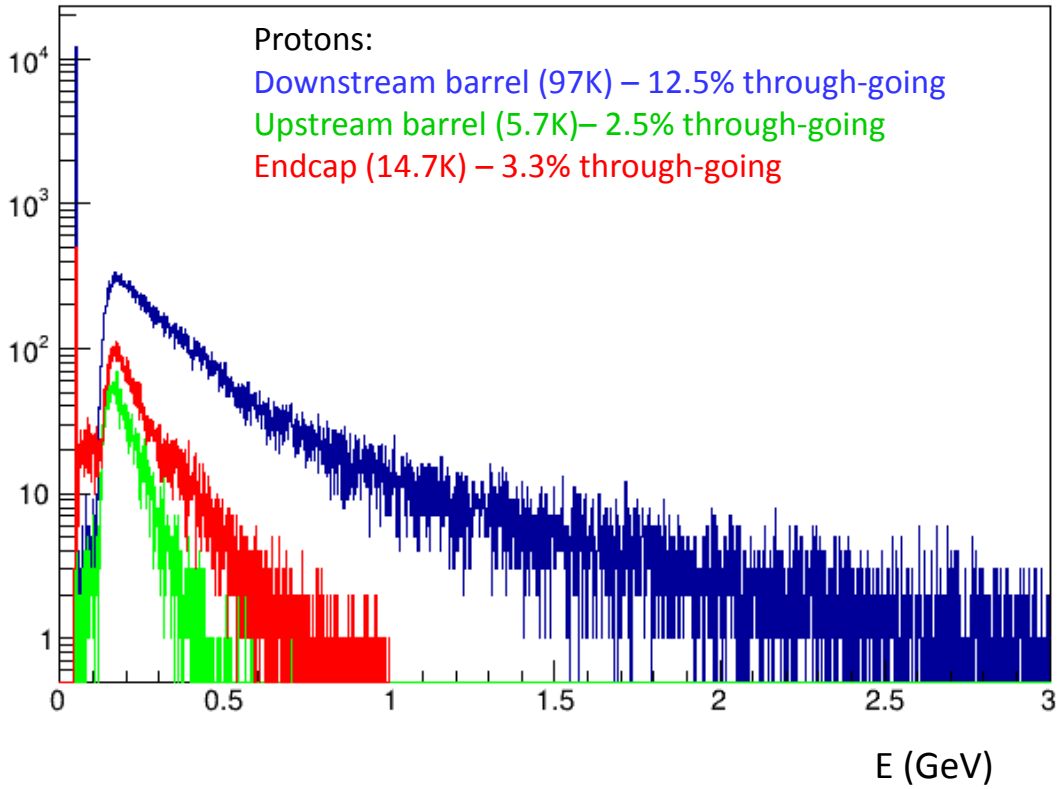
In backup: for $E_\nu$ < 4 GeV and > 4 GeV




How extensive should the muon tagger be?




The spike at 49 MeV is due to through-going charged particles




The spike at 49 MeV is due to through-going charged particles

# What metric to use to study impact of ignoring sections of the ECAL?

- Work is on-going:
  - $\Delta P$ = |Vector sum of P of all particles from primary vertex| – $|p_{Inc.neutrino}|$
  - $\Delta E$ = Sum (E of all particles from primary vertex) - $E_\nu$
  - Both metrics have their pros and cons
    - For **$\Delta P$,** we only need to figure out if shower is from neutron or proton – assume that TPC measures momentum of charged particles
    - For **$\Delta E$,** we would need to do PID on charged particles whose momentum is measured in TPC, but don't need to identify the source of the ECAL shower
- Idea is to ignore some of the particles in different parts of the ECAL and see how these distributions behave

# Outlook

- Have received many comments from ND-GAr group, and am working on addressing them
- Looking into adding more information to truth record, as well as updating geometry model
- Stay tuned!