L2G :
EARLY PERFORMANCE ANALYSIS

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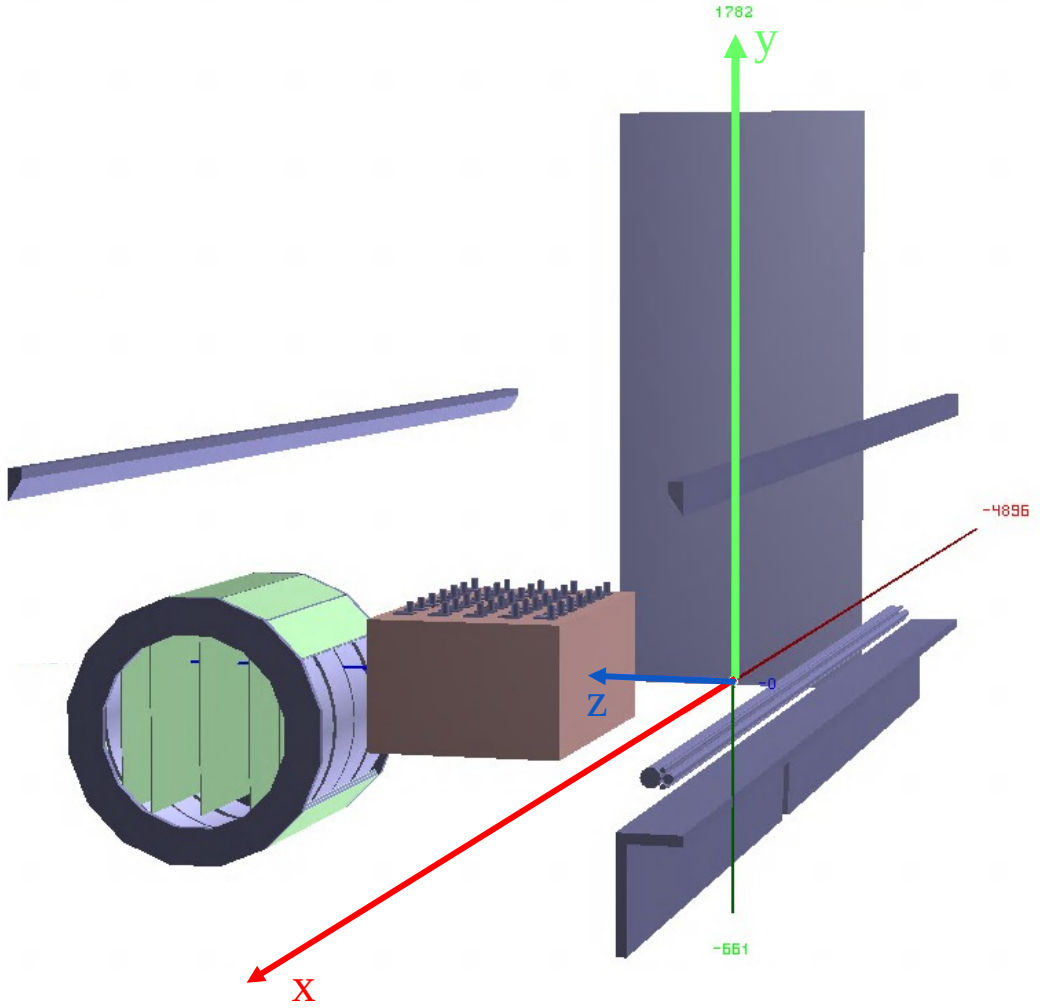
GENERATED SAMPLE: NEUTRINO INTERACTIONS IN LAR

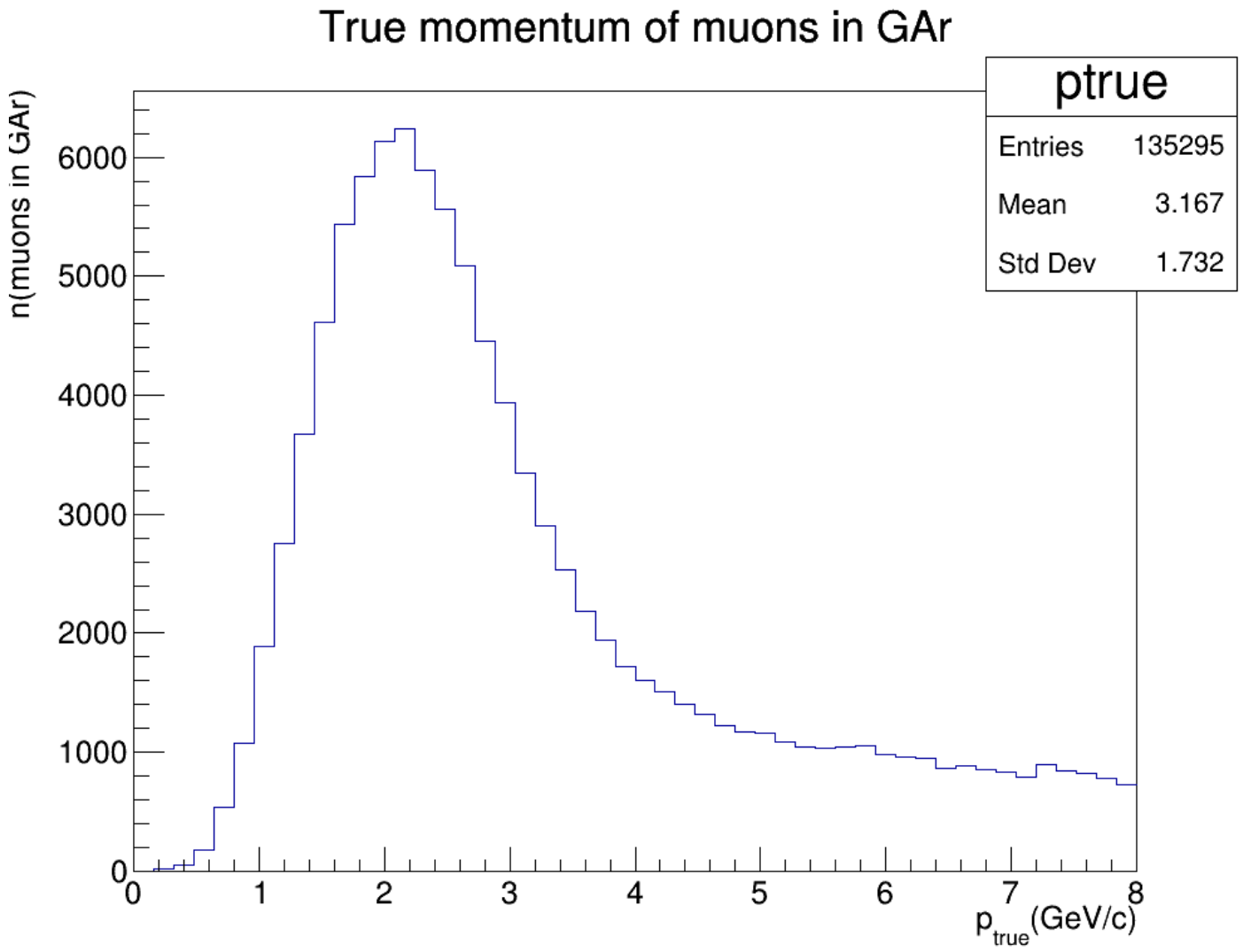
- Sample generated with GENIE v2
  - Gsimple flux in ND-Hall (from Tanaz)
  - 1M single interaction events in ND-LAr (volArgonCubeActive)

- Geometry used:
  - Baseline ND-LAr from dunendggd (apparently some updates are needed but not pushed yet...)
  - ND-GAr-Lite detector with SPY magnet (not the latest one acting as PV)
    - 5 Scintillator planes (Minerva-like) of 6mx5mx4cm at (-240, -150, 0, 150, 240) //Not Optimized yet!
    - Segmented with triangular shapes strips in X/Y (2 cm triangle base)
    - Includes a muon detector (3 planes of Sc of 2 cm around the magnet yoke of the ND-GAr) with 2x7.5cm iron for mu/pi separation over 500 MeV/c

- Coordinate sytem: z roughly the flux direction, y is the vertical direction and x is the drift direction (i.e. the magnetic field direction)



TRACK MATCHING AND MOMENTUM SPECTRUM IN GAR



Track matching (using Leo's original technique):

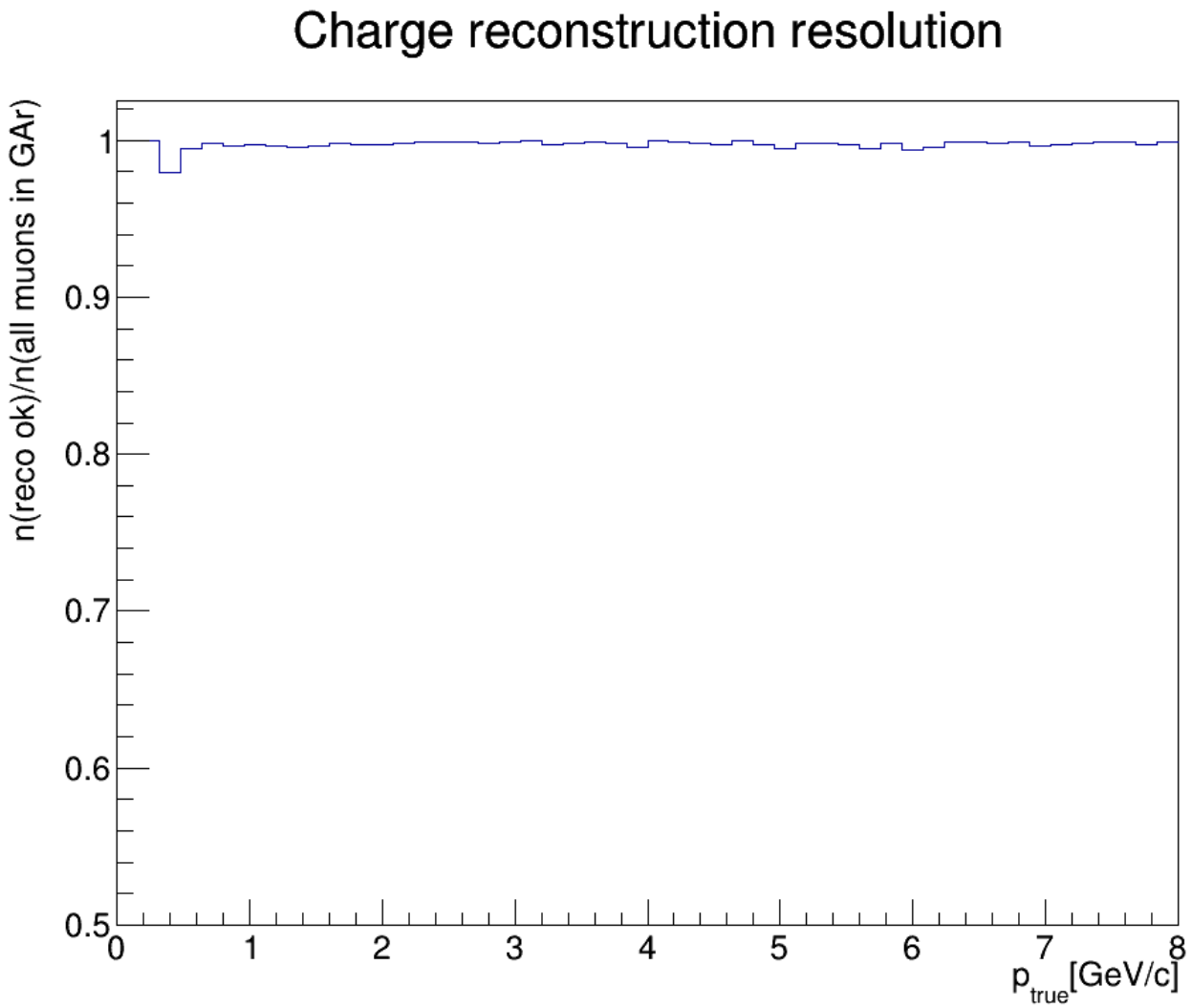
1. Event by event get all muon tracks that have at least one MC trajectory point in the GAr TPC volume, defined as:
   - GArCenter(0,-68.287,1486)cm;
   - GAr_radius = 349.9cm;
   - GAr_Length = 669.6cm;

2. For each muon thus found, cycle over all the ND-GAr reconstructed tracks for the event and evaluate the angle between the reco track momentum and the MC momentum taken at the first MC trajectory point in the GArTPC. Save the the track with the smallest angle θ

3. Calculate the distance between the saved track and trajectory in the plane transverse to the direction of the MC momentum ΔX

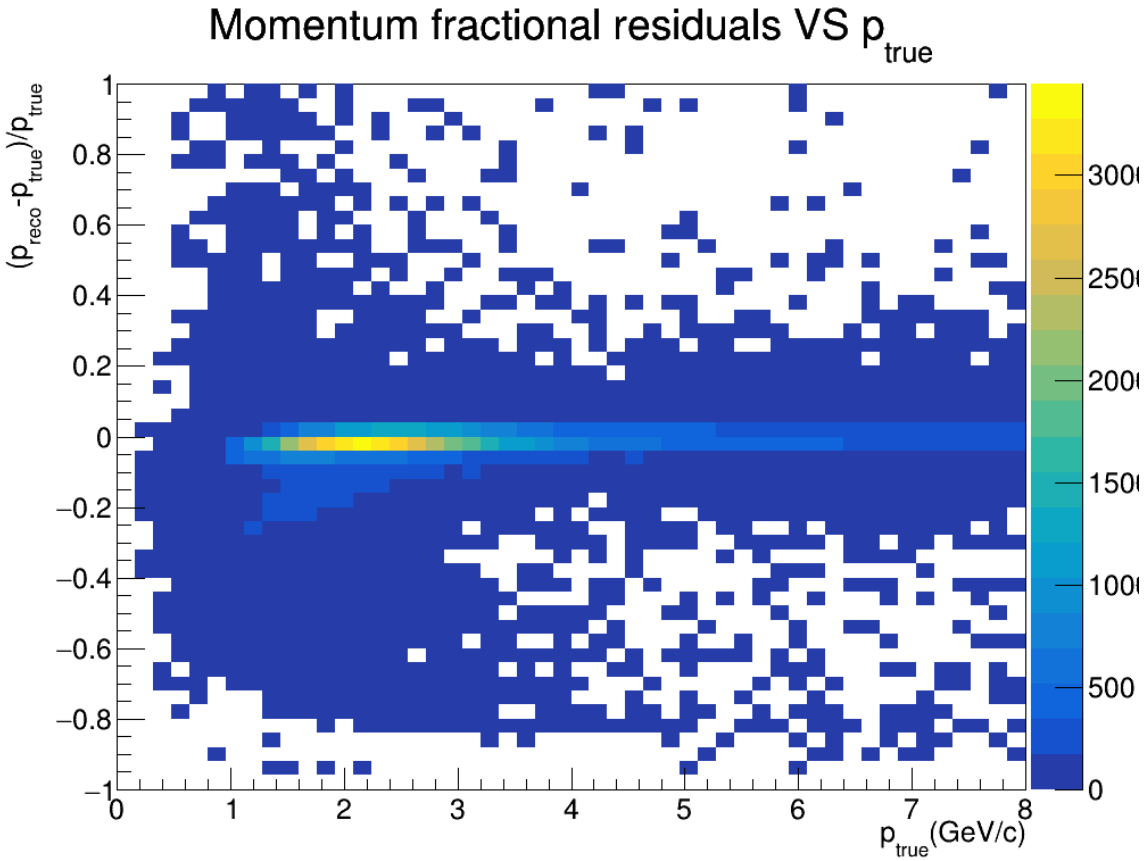
4. Impose the cuts: $\cos\theta > 0.997$ && $\Delta X < 3$cm . If these are passed the track was matched and we had a successfull reconstruction

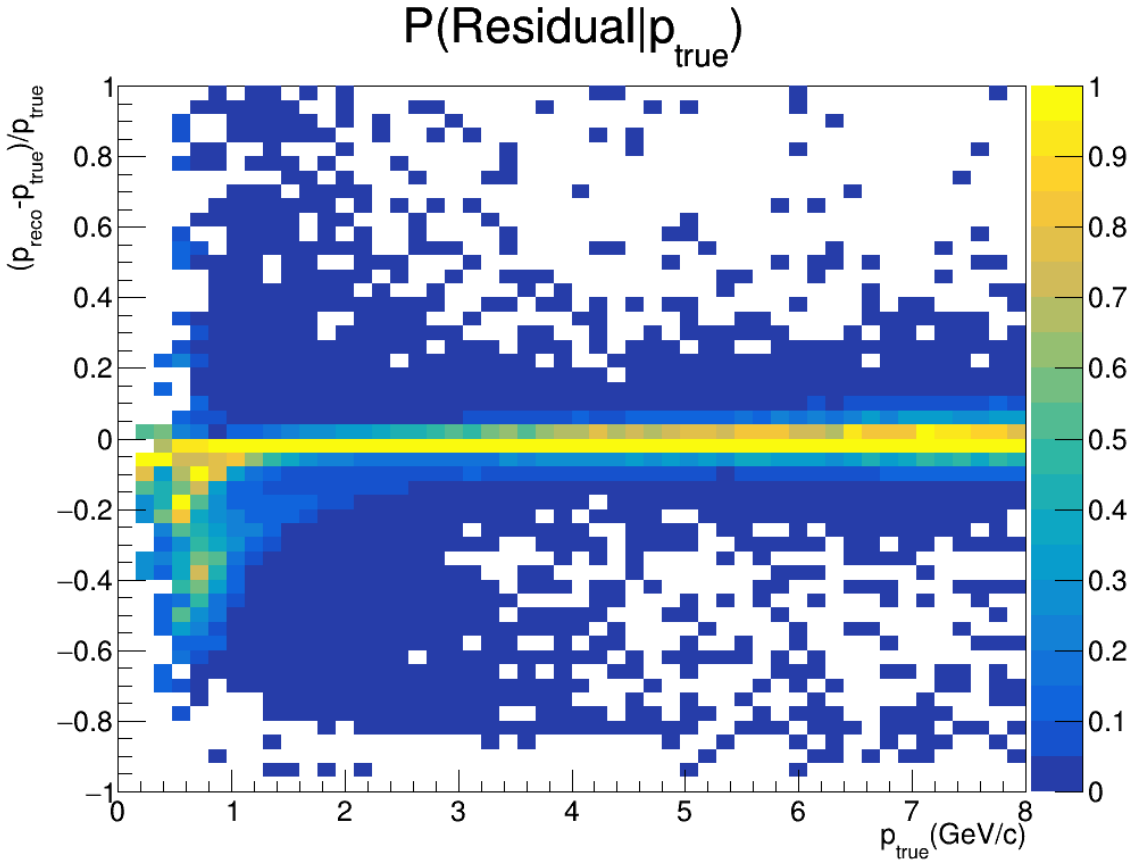
CHARGE RECONSTRUCTION EFFICIENCY



- *n(all muons in GAr)* = all MC muons that have been matched to a reconstructed track in GAr
- *n(reco ok)* = all MC muons that have been matched to a reconstructed track in GAr whose reco charge matches the MC truth charge
- p_{true} = muon momentum as it's entering the GAr TPC

RESIDUALS FITTED WITH CAUCHY AND GAUSS





- Note: The conditional probability plot is normalized so that for each column the maximum has the value 1 (i.e. these are not proper PDF's)

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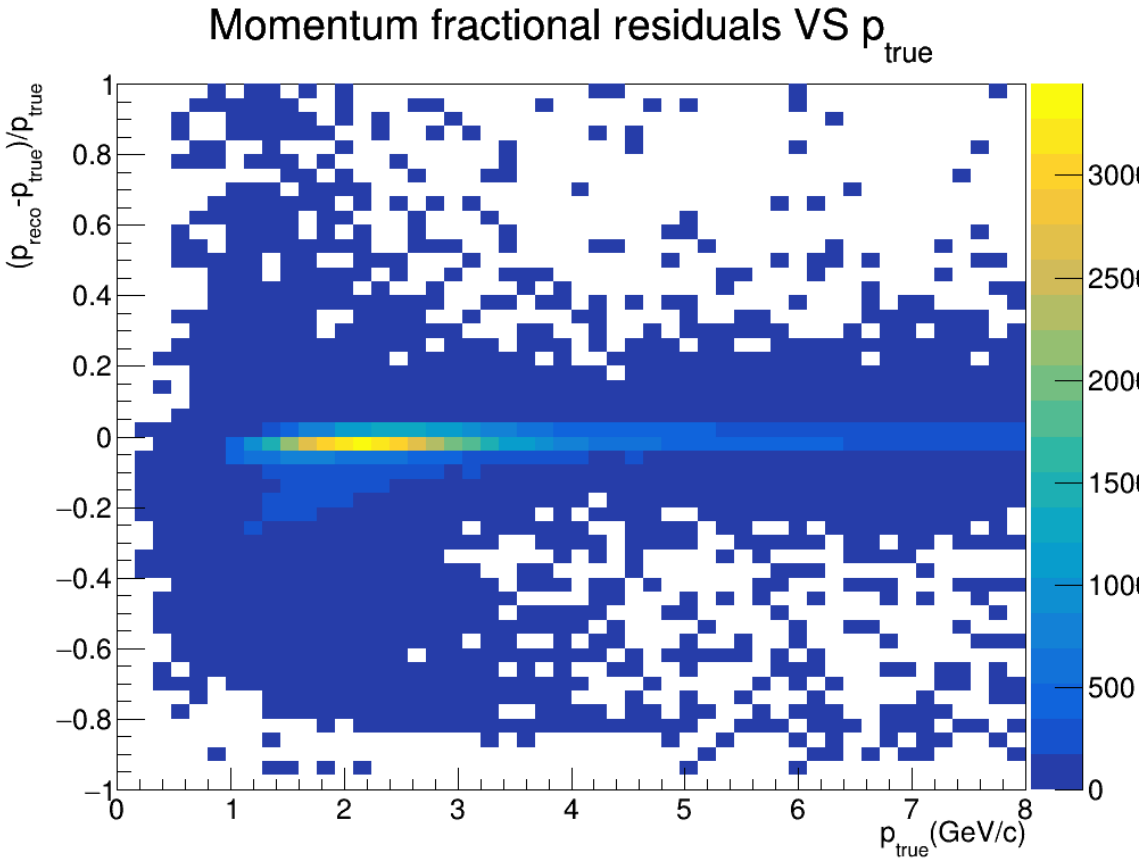
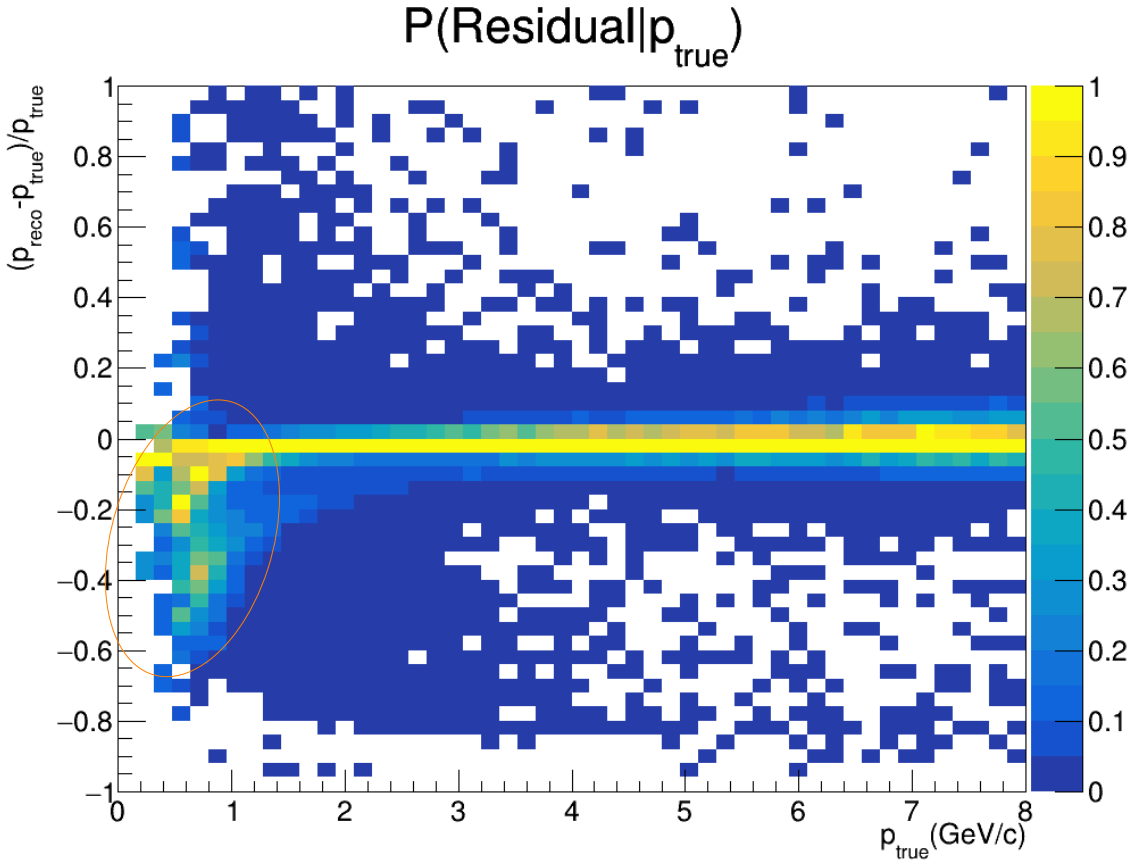
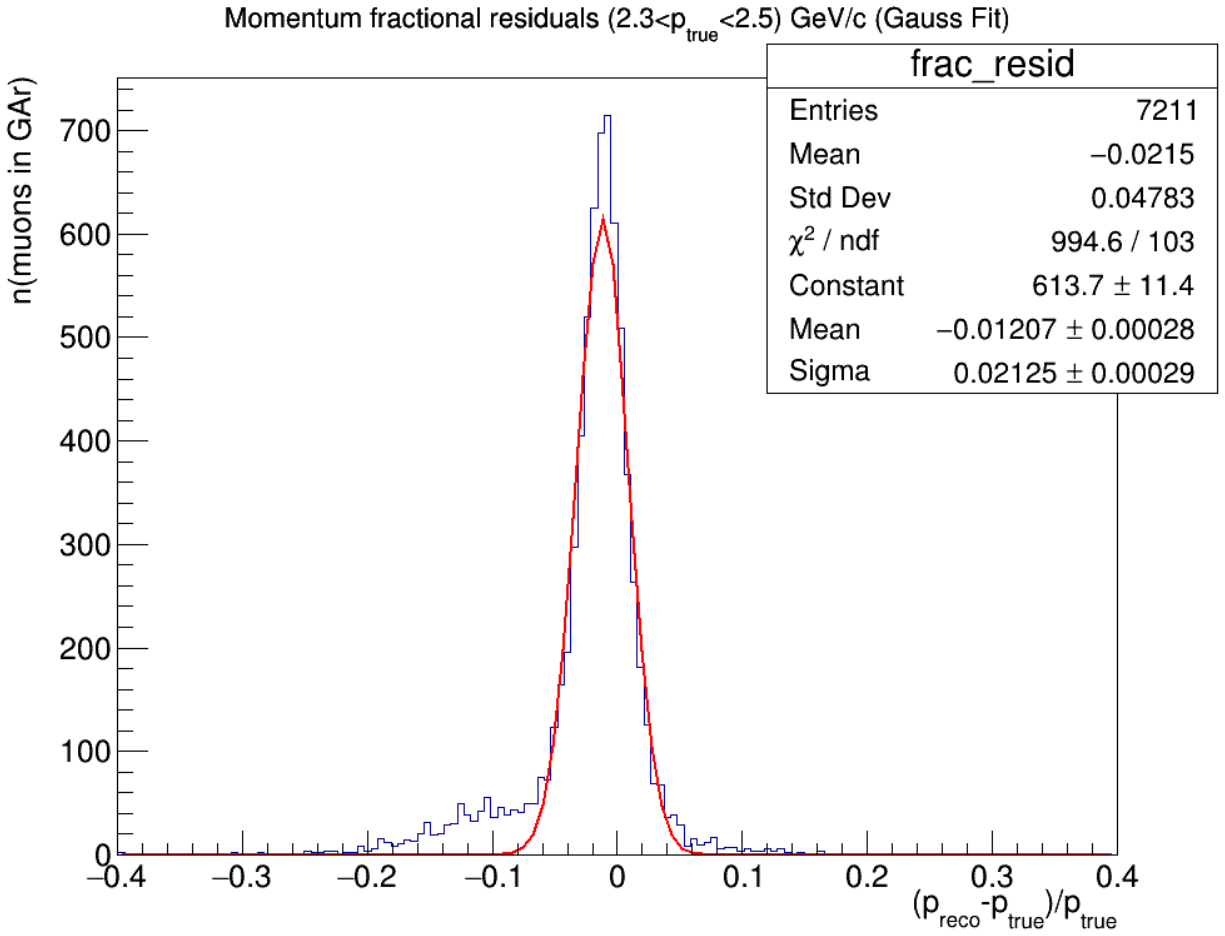
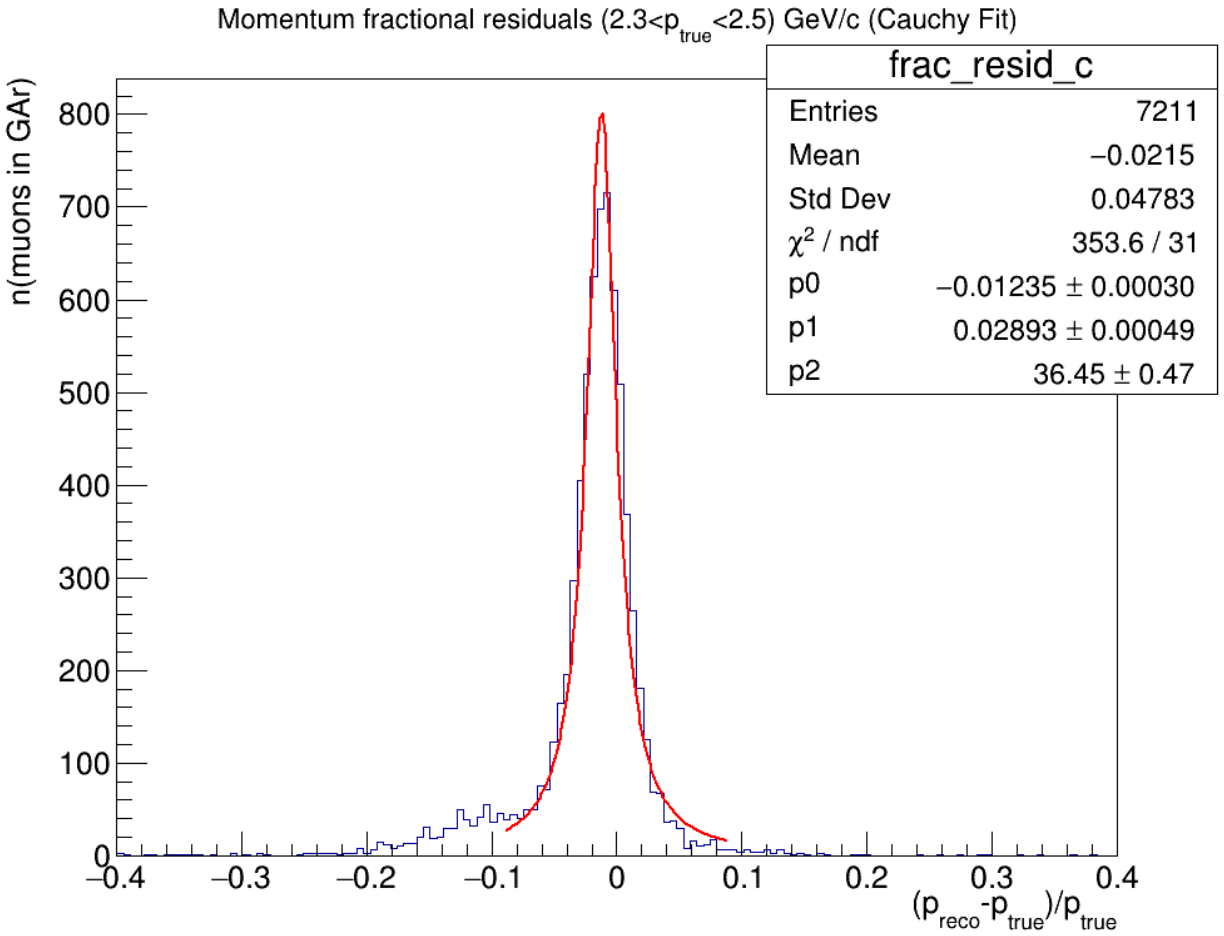




- Note: The conditional probability plot is normalized so that for each column the maximum has the value 1 (i.e. these are not proper PDF's)
- There are some noticible structures in the low true momentum region

RESIDUALS FITTED WITH CAUCHY AND GAUSS

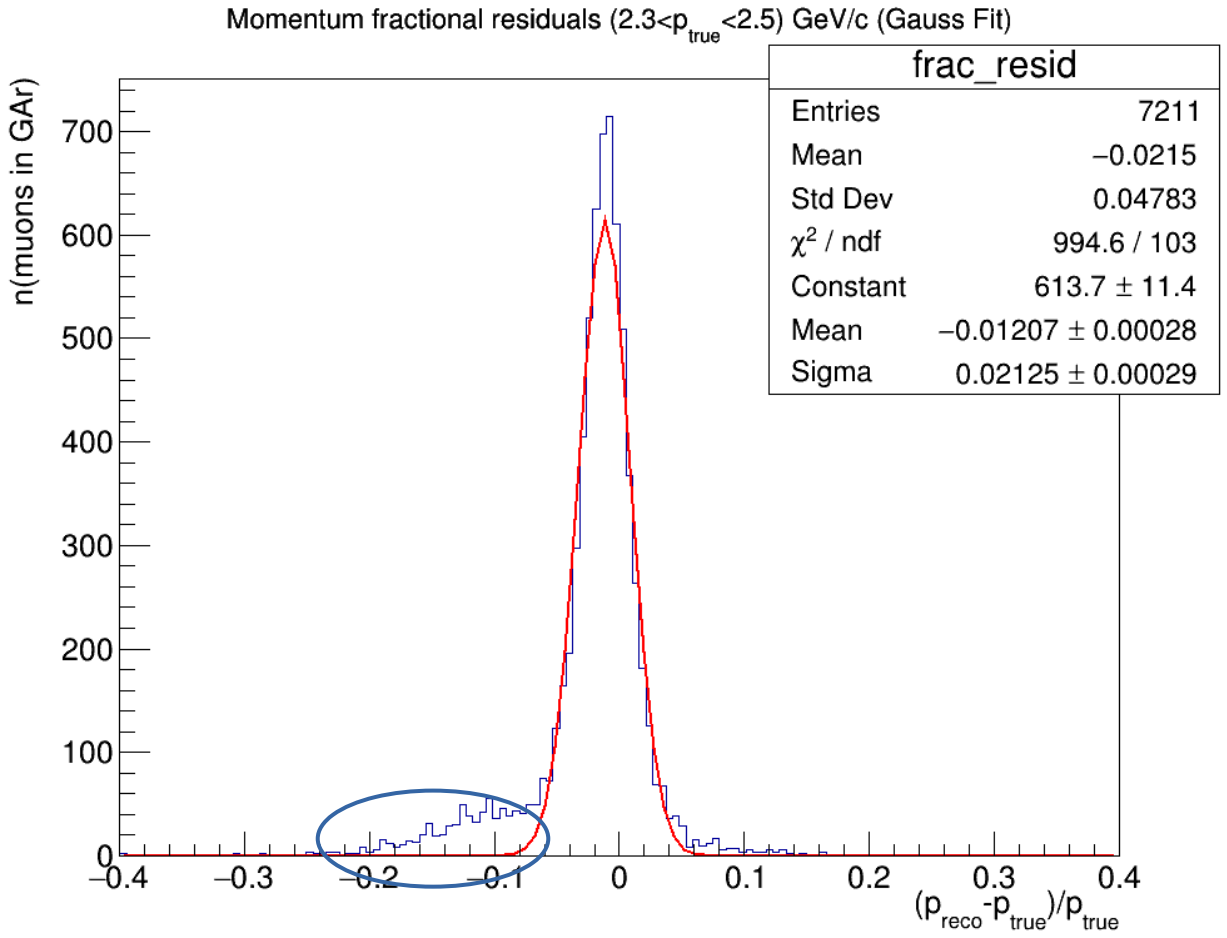


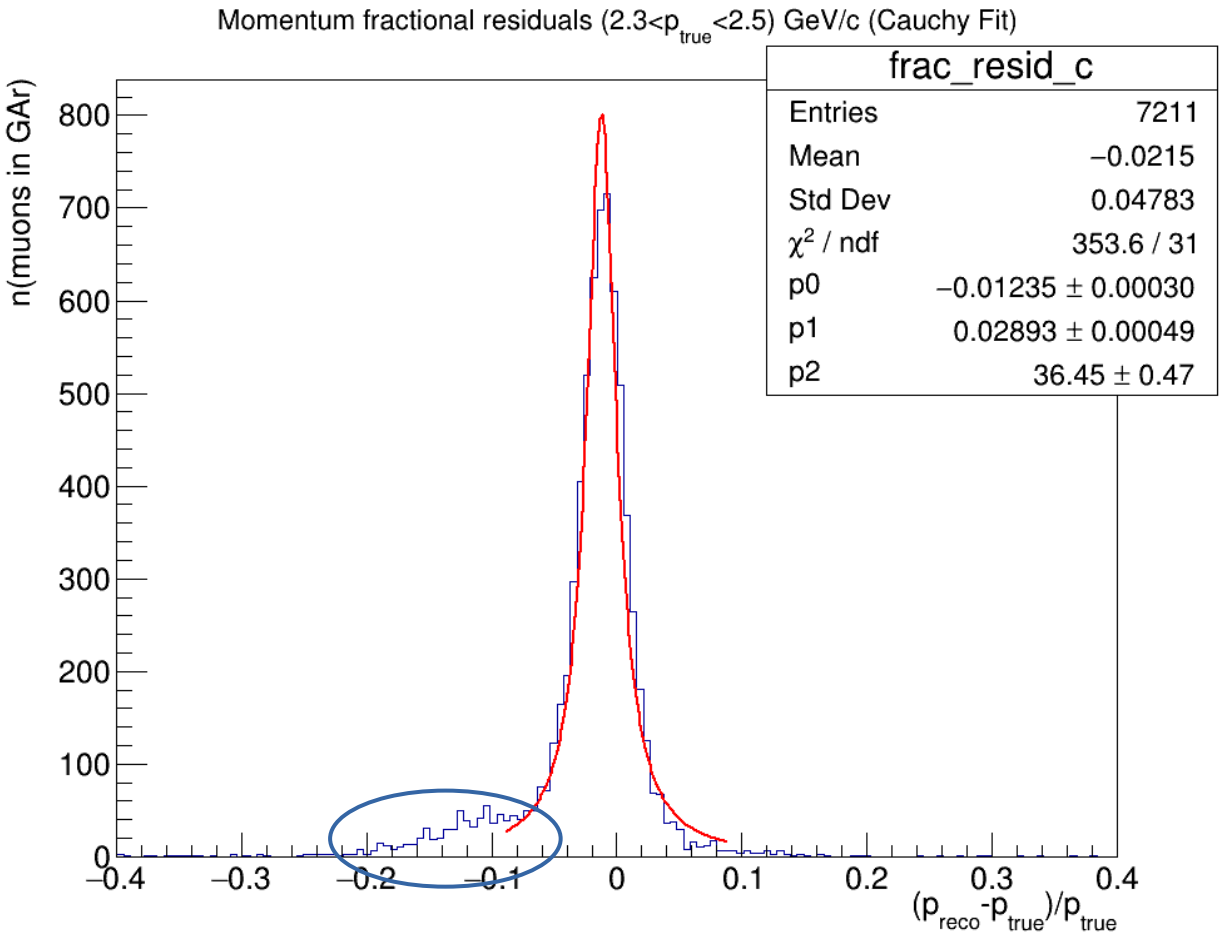


- p_{true}= MC true momentum of muon entering the TPC
- p_{reco}= reconstructed momentum of the matched track

- *n(muons in GAr)*= number of matched tracks
- Checked a limited range: (2.3<p_{true}<2.5)GeV

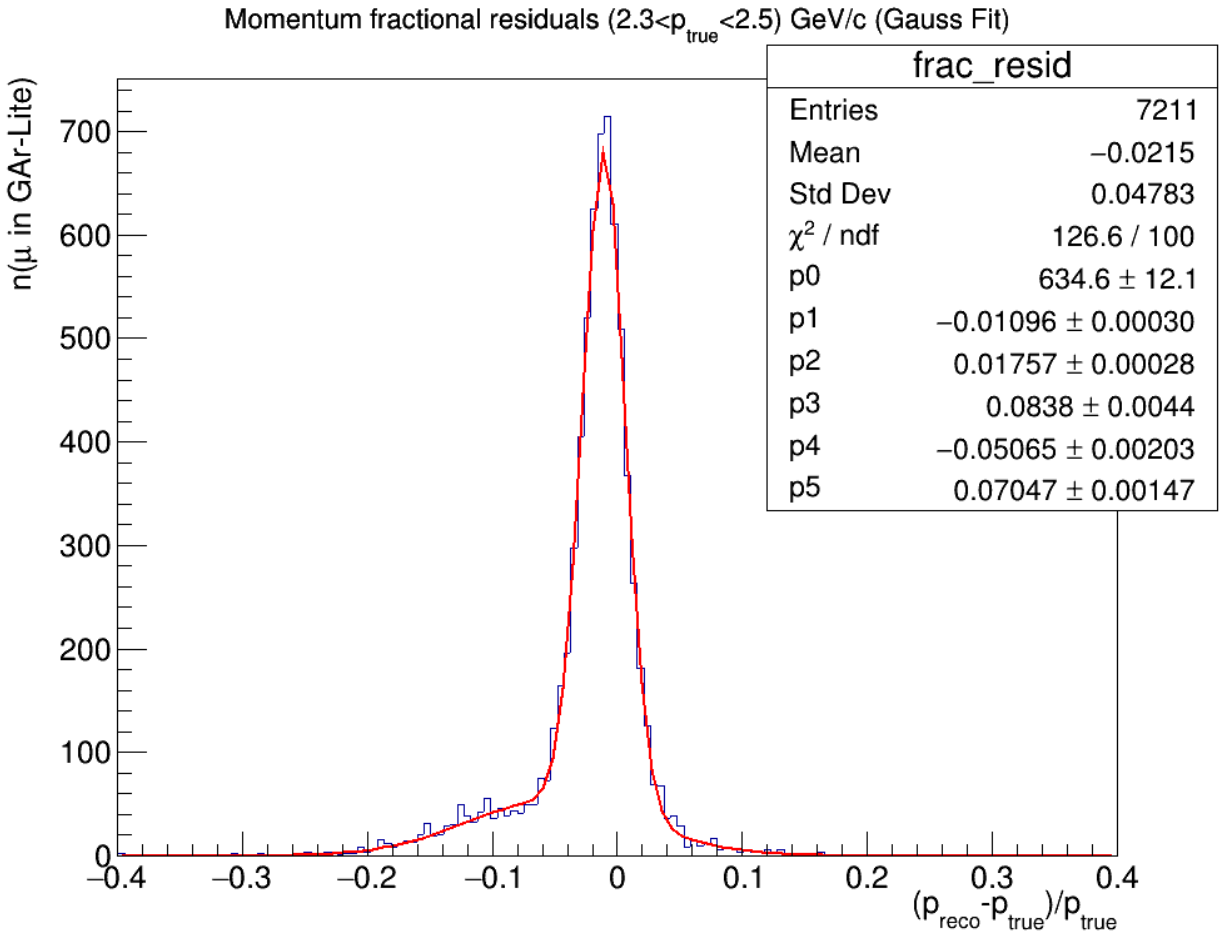
RESIDUALS FITTED WITH CAUCHY AND GAUSS





- Need to investigate what is causing the residuals tail that is visible between -0.2 and -0.1

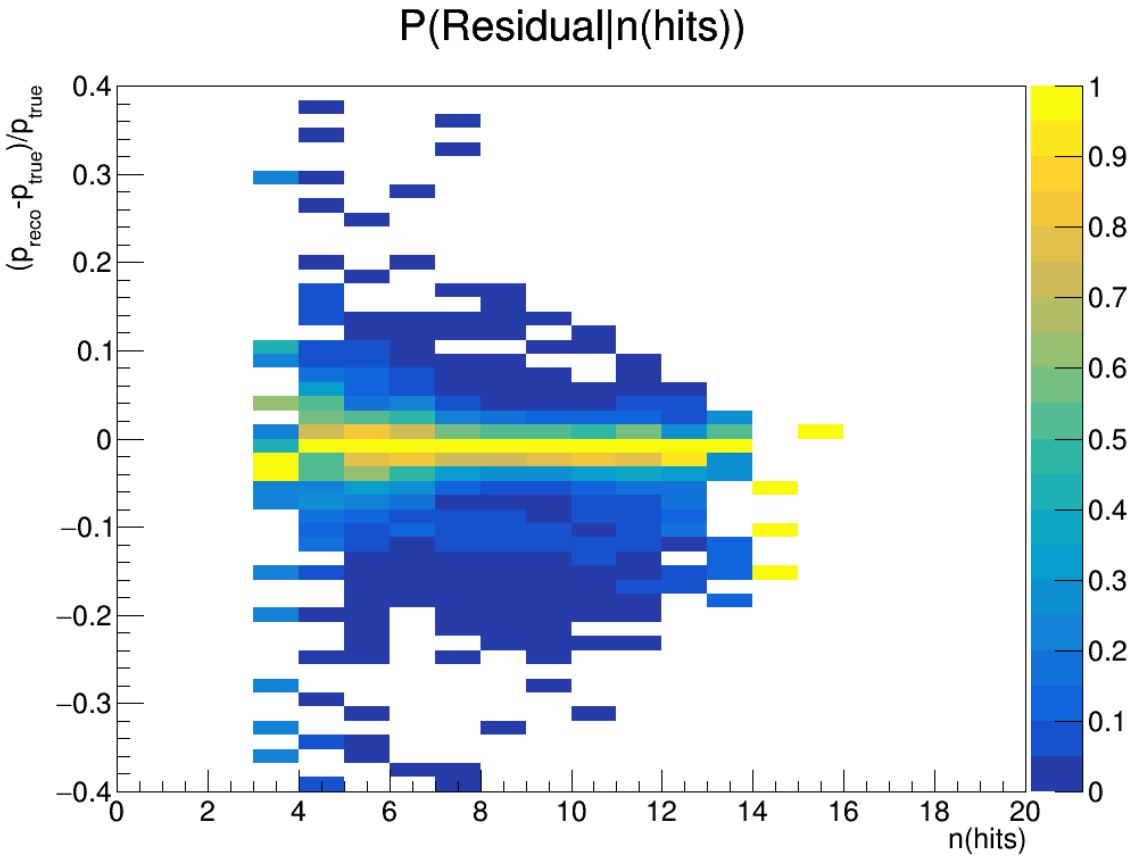
RESIDUALS FITTED WITH 2-GAUSSIAN

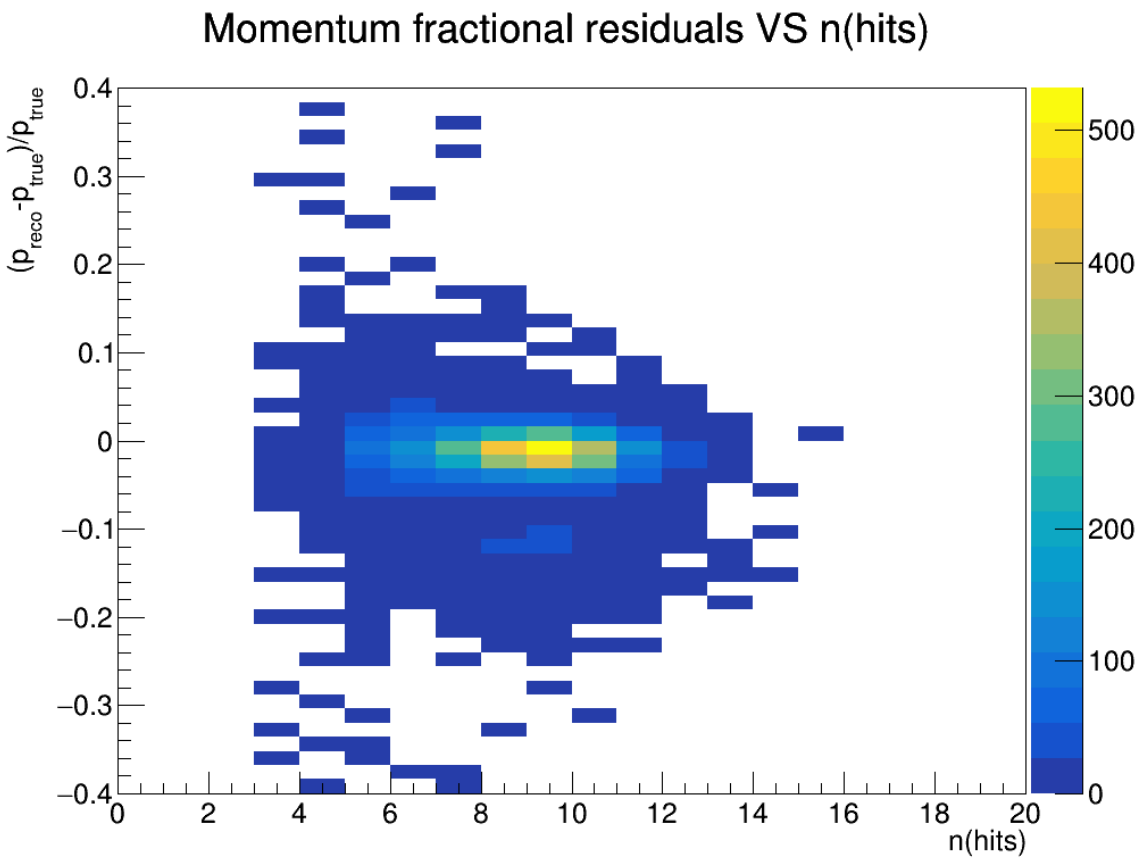


- We fit with a double Gaussian
- The tail seem to be about 10%

$$Gauss = p_0 \times (\exp(\frac{(x-p_1)^2}{(2p_2)^2}) + p_3 \exp(\frac{(x-p_4)^2}{(2p_5)^2}))$$

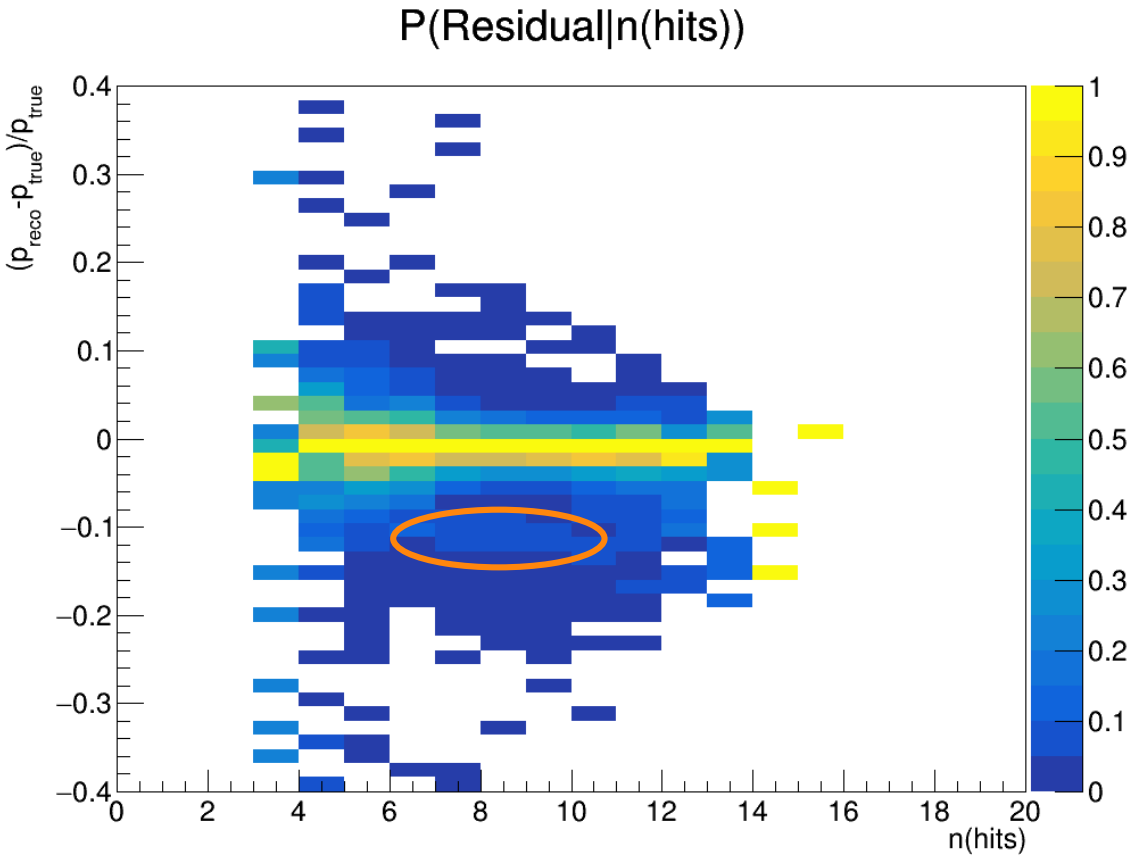
RESIDUALS VS N HITS

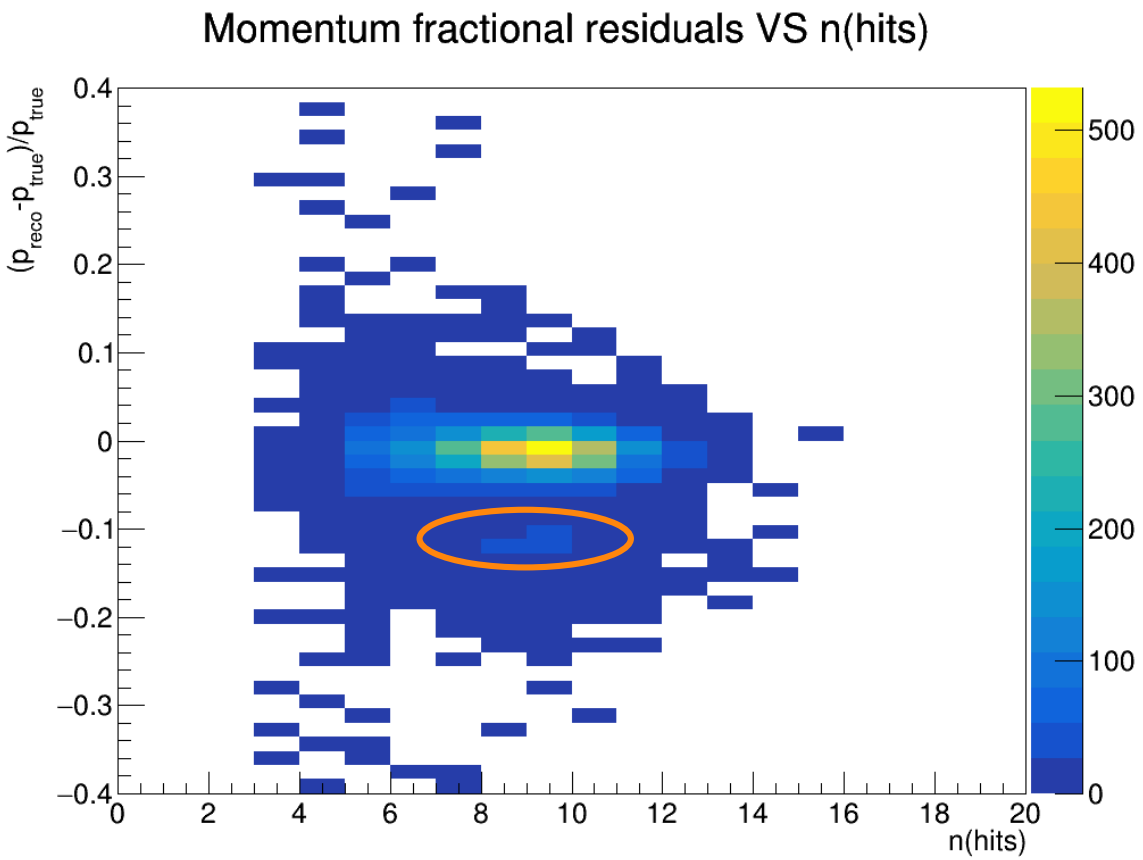




- First thing we checked was to look at Residuals VS nhits in the track to see if there was a correlation between the two quantities

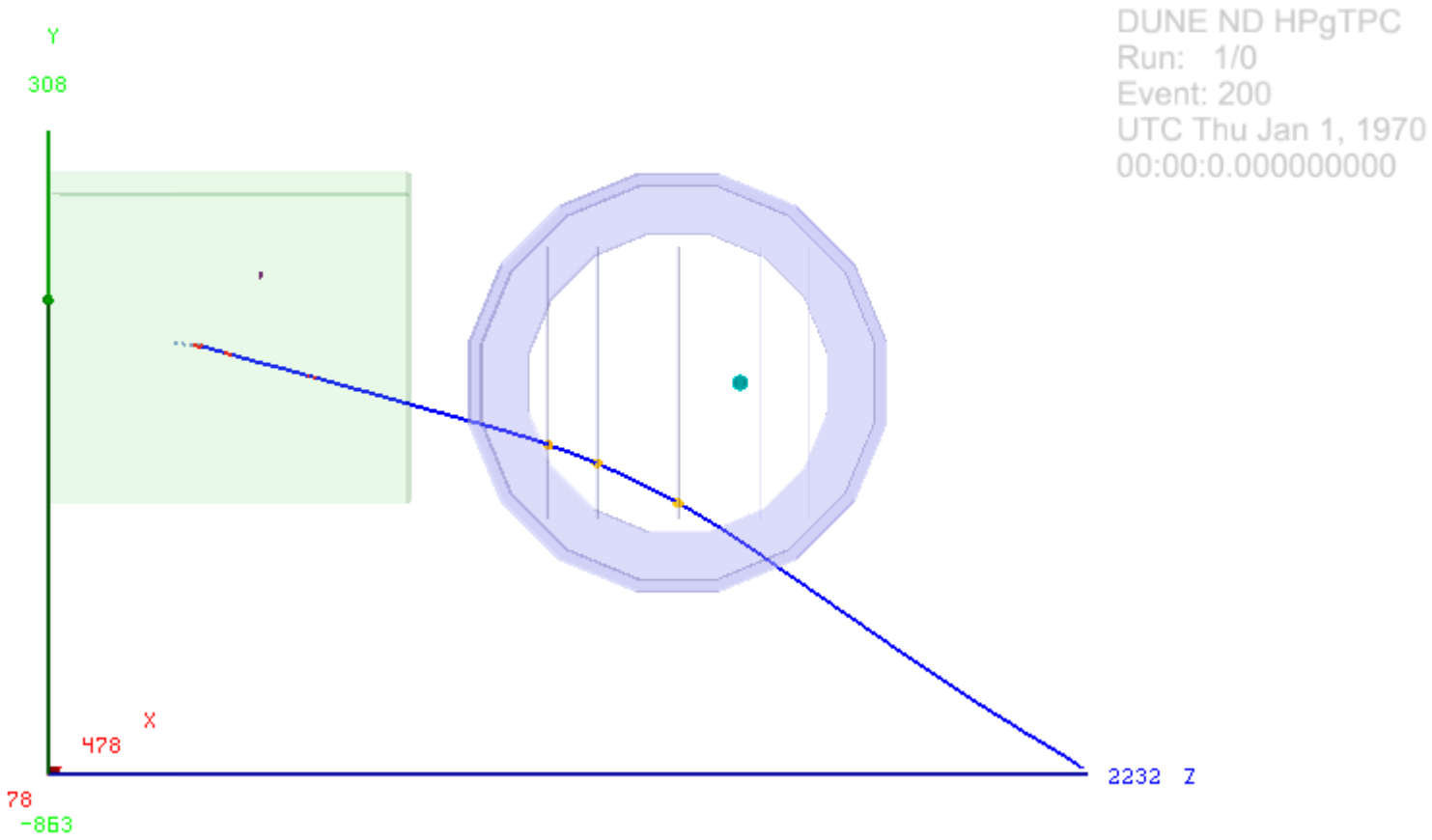
RESIDUALS VS NHITS





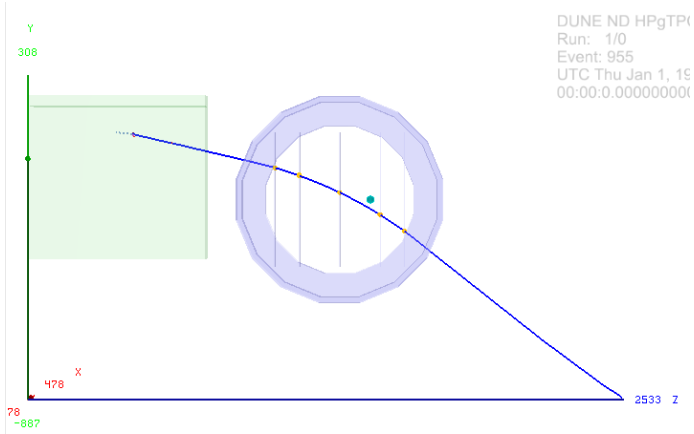
- First thing we checked was to look at Residuals VS nhits in the track to see if there was a correlation between the two quantities
- The tail somewhat surprisingly seems to be constituted mostly of tracks with a large number of hits, especially 9 or 10

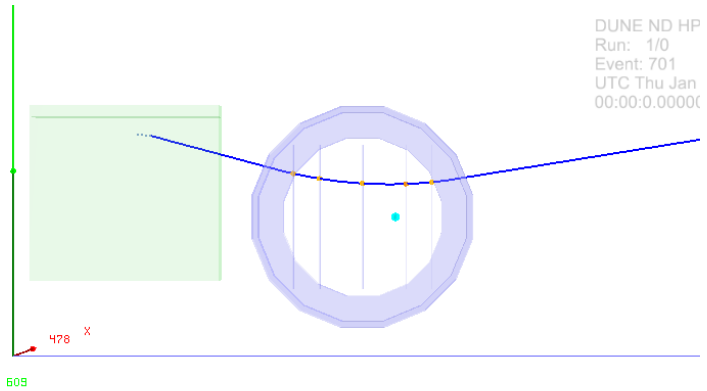
EVENT VIEWER

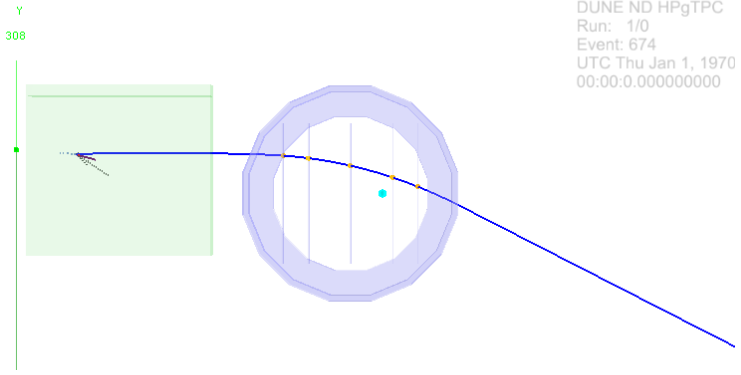


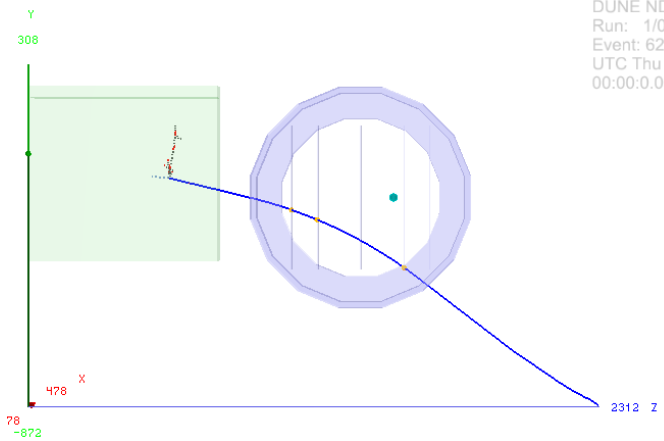
- Looked at event viewers for events in a sample of 1000 that had Residuals < -0.1
- Unfortunately these events seem to be fairly unremarkable at first glance

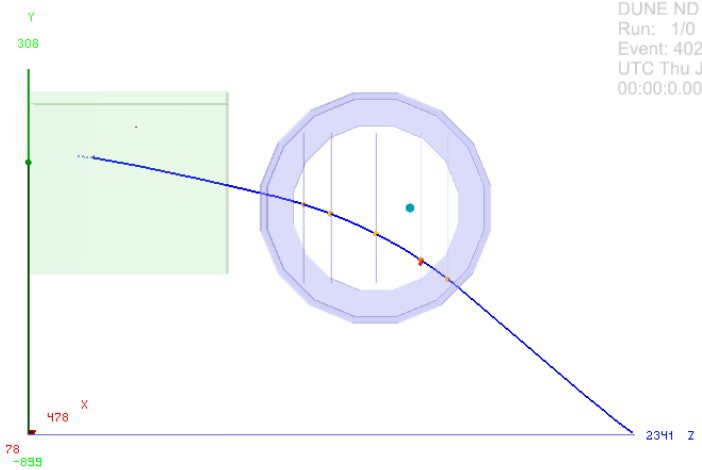
EVENT VIEWER

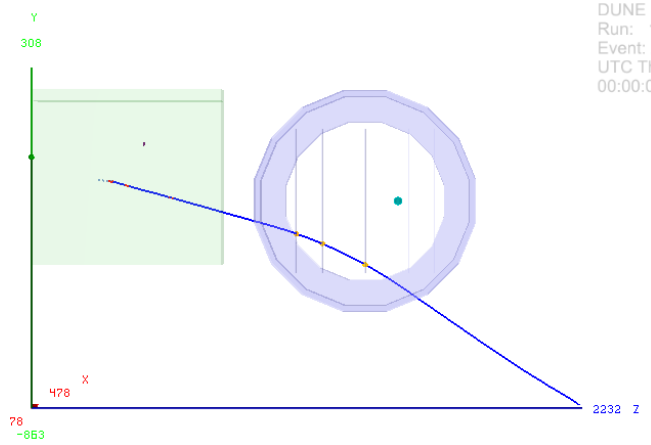




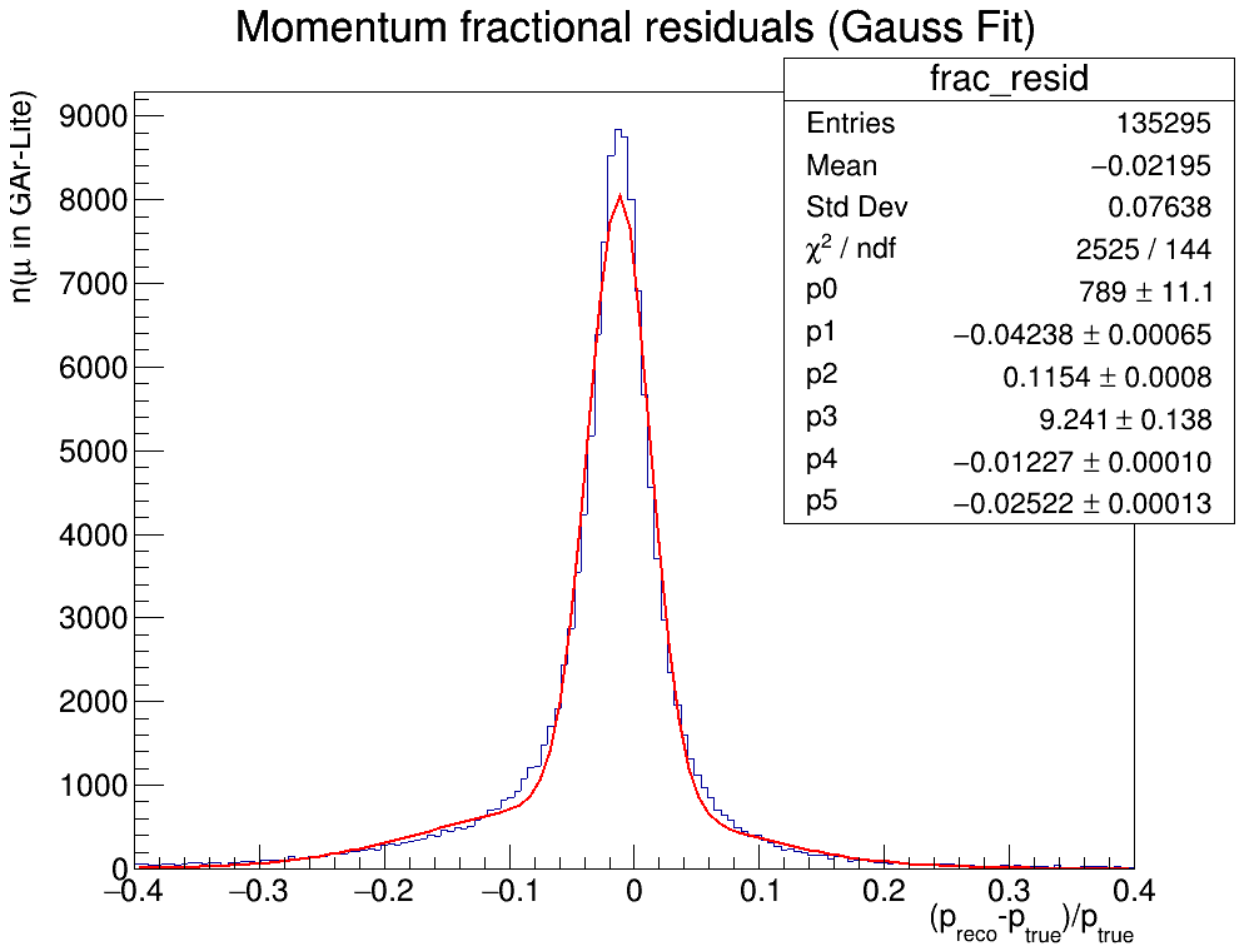








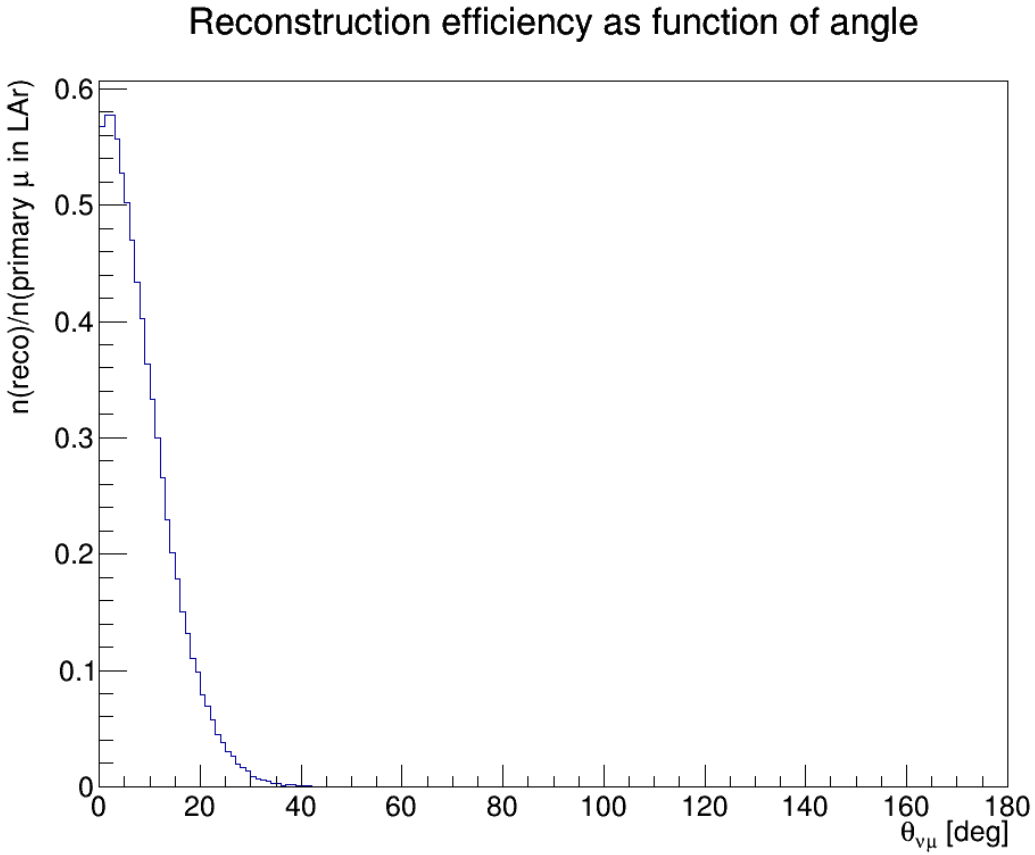
RESIDUALS FITTED WITH 2-GAUSSIAN

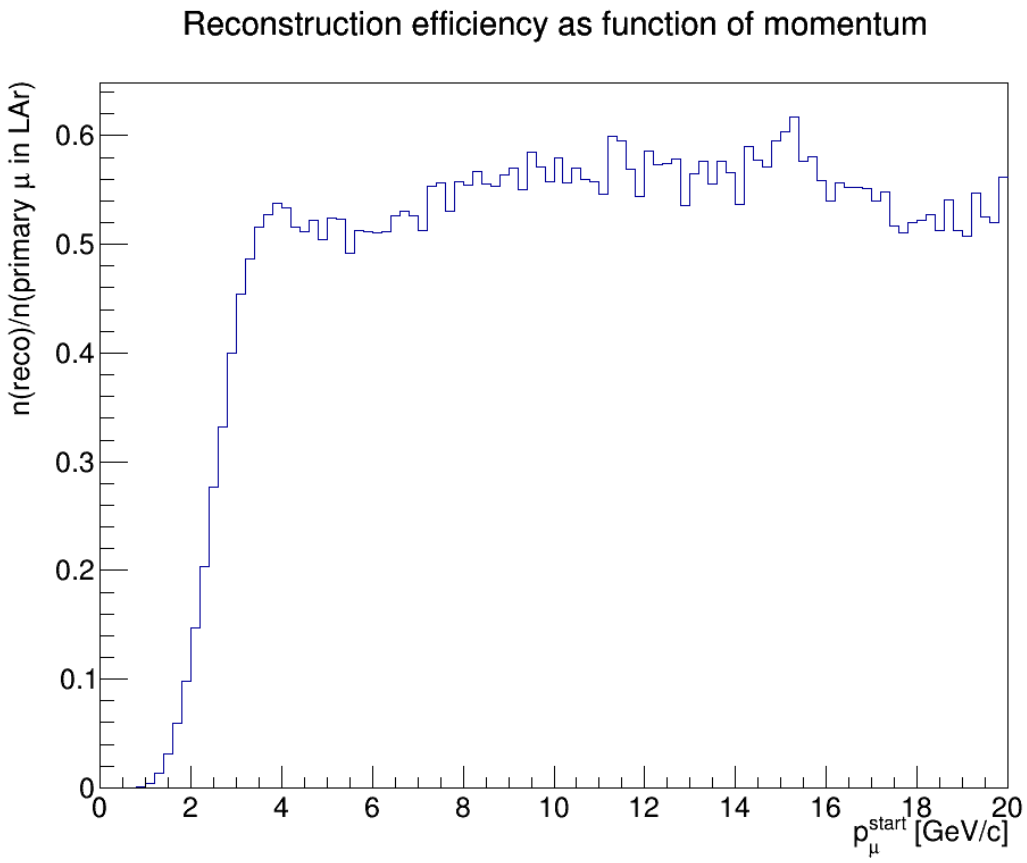


- We fit with a double Gaussian also to the full momentum spectrum
- The tail seem to be about 10%

$$Gauss = p_0 \times (\exp(\frac{(x-p_1)^2}{(2p_2)^2}) + p_3 \exp(\frac{(x-p_4)^2}{(2p_5)^2}))$$

RECONSTRUCTION EFFICIENCY PRIM MUONS IN LAR



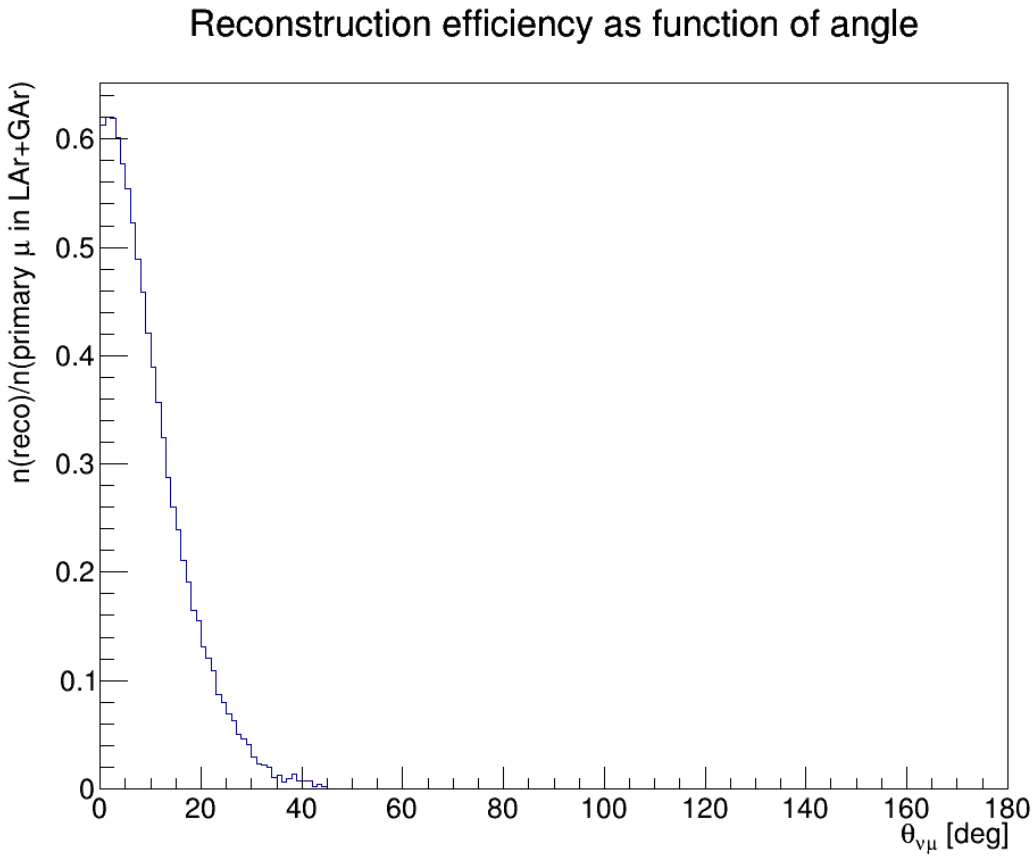


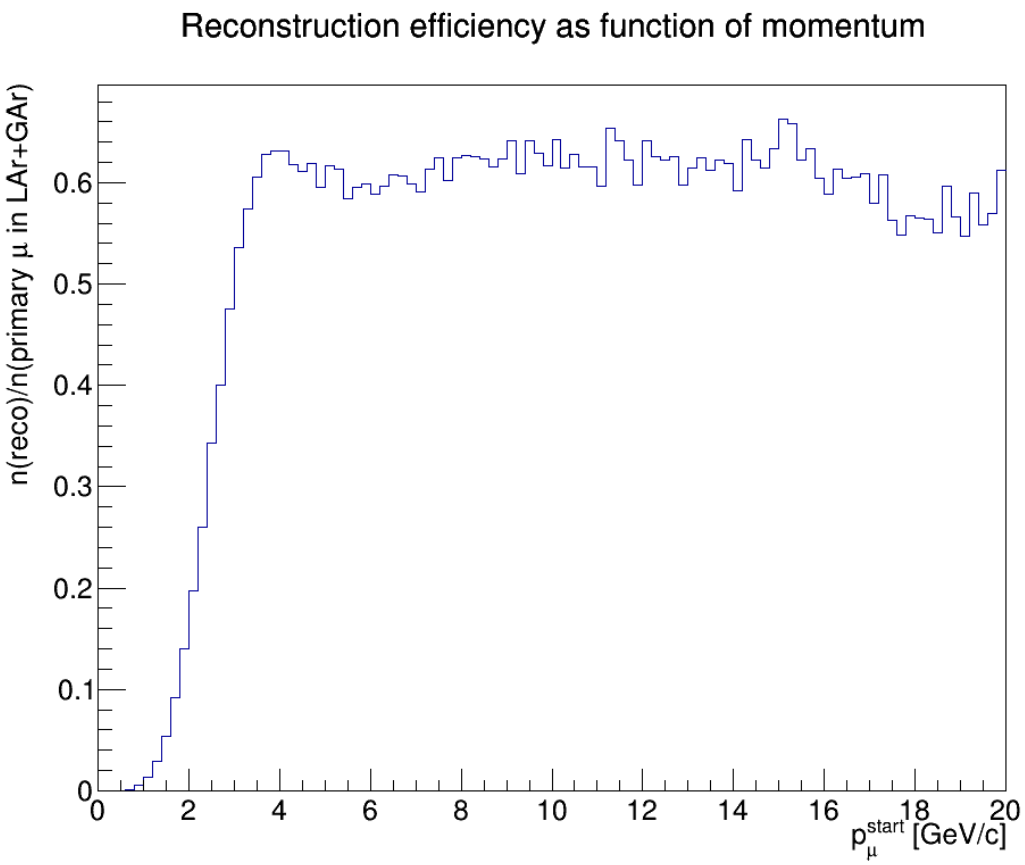
- *n(primary mu in LAr)*: primary muons produced in LAr
- *n(reco):* matched track in the event

p_{μ}^{start}*:* true momentum at creation

$\theta_{\nu\mu}$*:* angle between μ and ν at creation

RECONSTRUCTION EFFICIENCY PRIM MUONS IN LAR+GAR





- *n(primary mu in LAr+GAr)*: primary muons produced in LAr having at least one traj point Gar
- *n(reco):* matched track in the event
- p_{μ}^{start}*:* true momentum of muon at creation
- $\theta_{\nu\mu}$*:* angle between μ and ν at creation

SUMMARY AND FUTURE PROSPECTS

- My new track matching algorithm, based on Leo Bellantoni's, allowed me to start studying the performace of NDGAr-Lite in terms of:

1) Charge Resolution as a function of MC momentum (Very good over all the spectrum)
2) Momentum residuals VS True momentum distribution (Interesting features found in low momentum region)
3) Momentum residual distribution over the entire momentum range and in (2.3<p<2.5)GeV/c (Found a tale which needs to be investigated)
4) Find a preliminary efficiency distribution as function of angle and initial momentum at vertex (Possibly low due to inefficiencies in track matching)

- Immidiate future steps:

1) Try to produce Reconstructed files which contain hit by hit information
2) Improve track matching
3) Add chi^2 to track fit
4) Possibly use a simple Kalman Filter in track fit