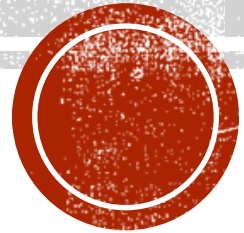
Cosmic selection: MC and data

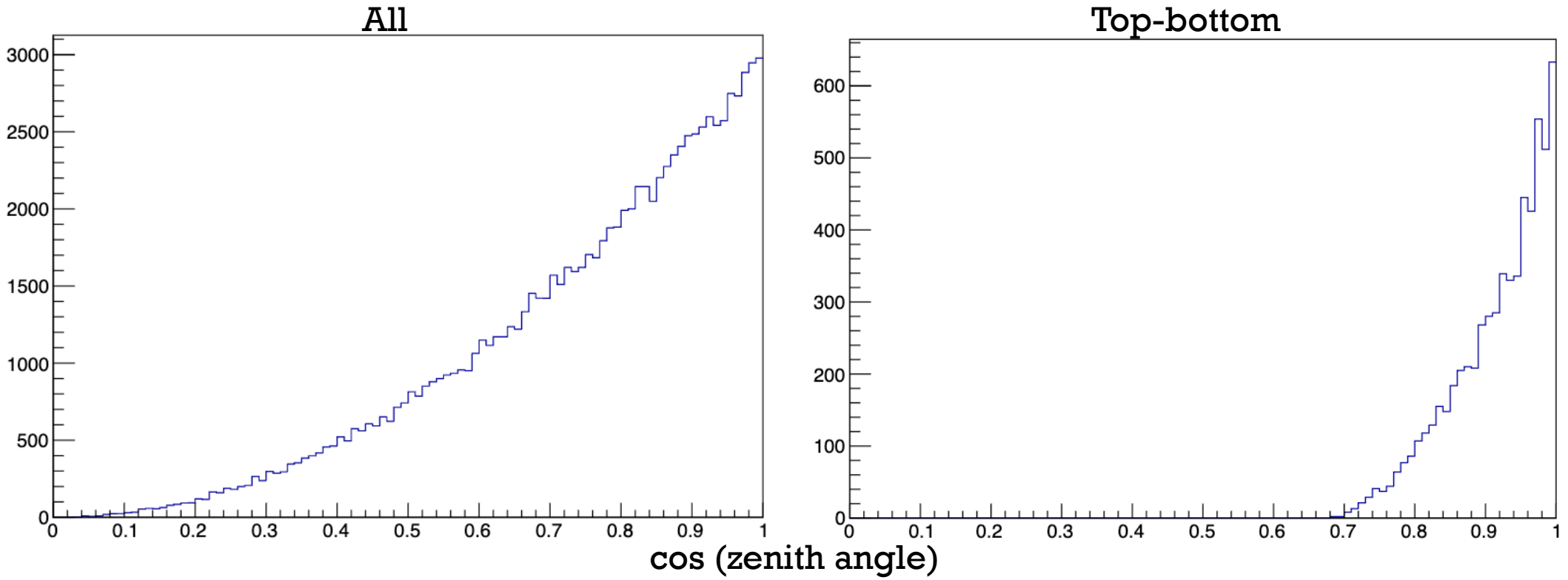
Ka Ming Tsui

kaming.tsui@ipmu.jp



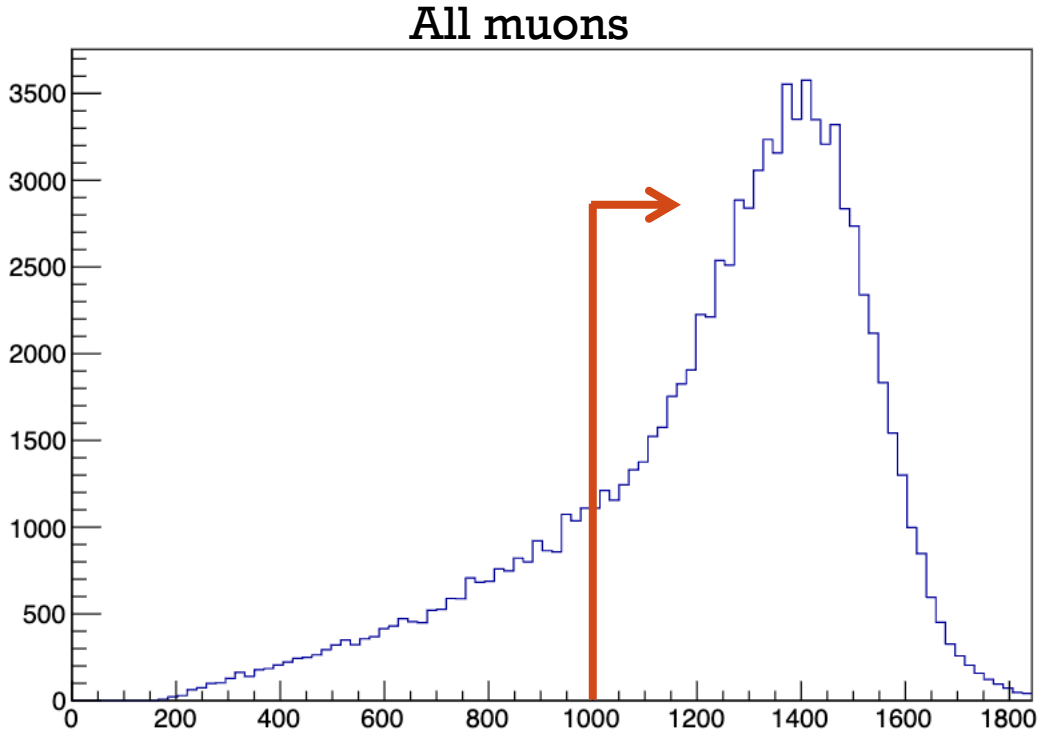
MC studies

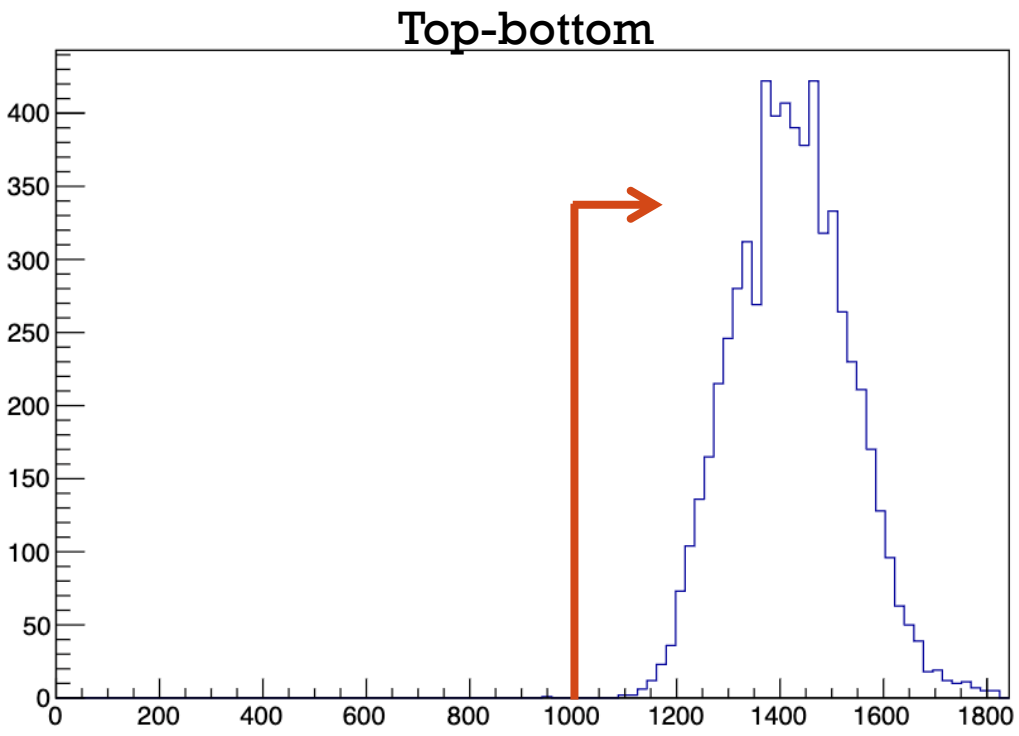
- Through going muon with sea-level angular spectrum
- Record muon entrance and exit points
- Select muons that enter through top cap and exit through bottom cap



MC studies

- (Loose?) cuts to select top-bottom events
- Known differences between MC and data
  - Function PMTs ~ 1550
  - Ex-situ mPMTs have lower efficiency



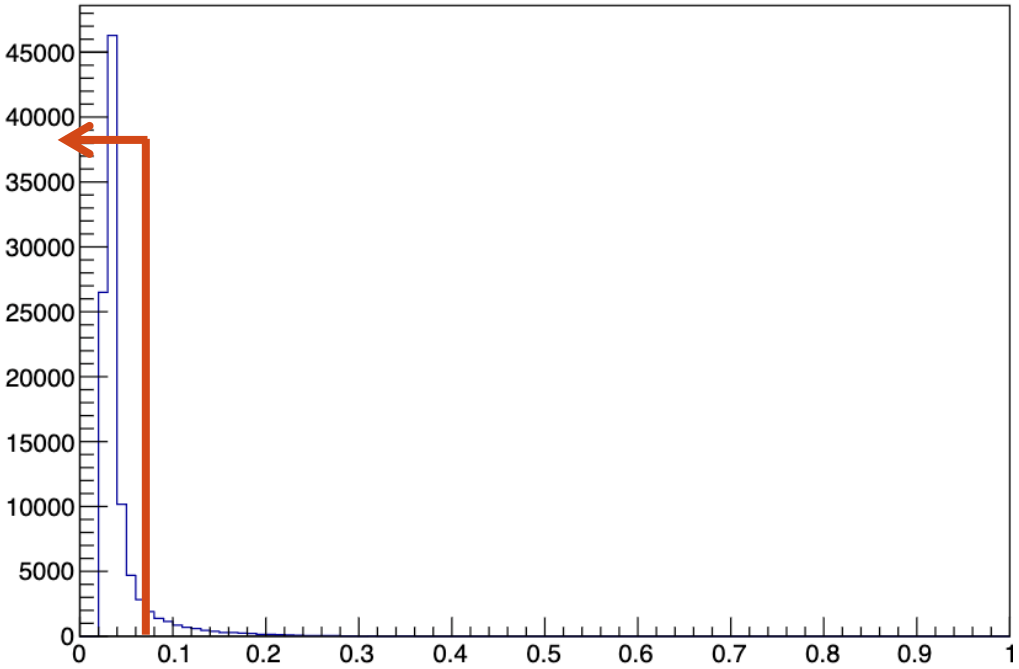


NHit

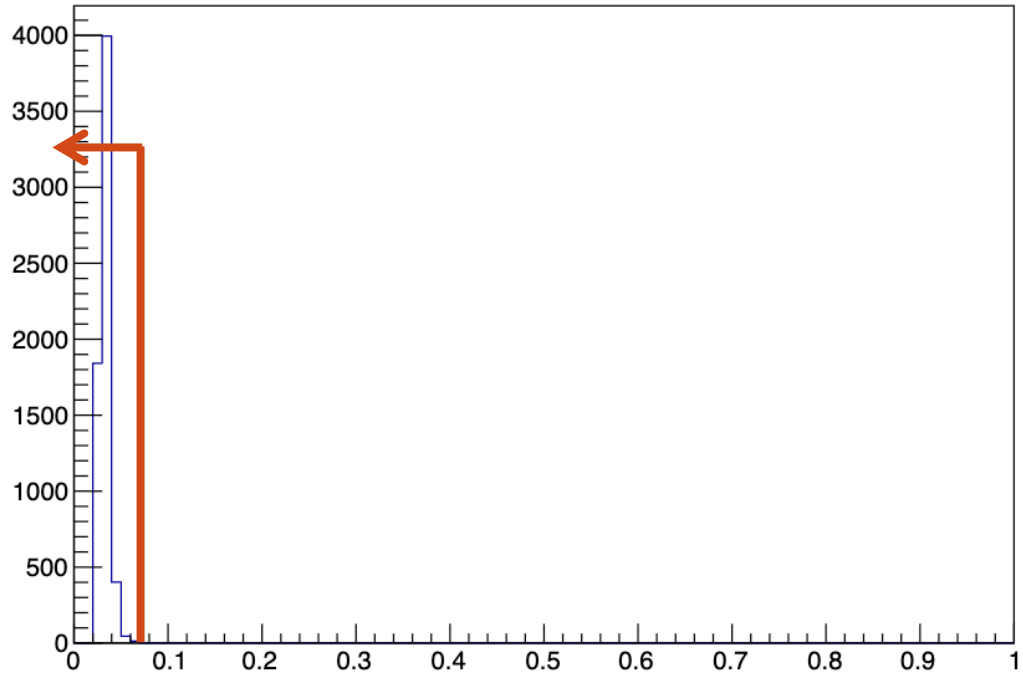
MC studies

- (Loose?) cuts to select top-bottom events
- Known differences between MC and data
  - Function PMTs ~ 1550
  - Ex-situ mPMTs have lower efficiency

All muons



Top-bottom

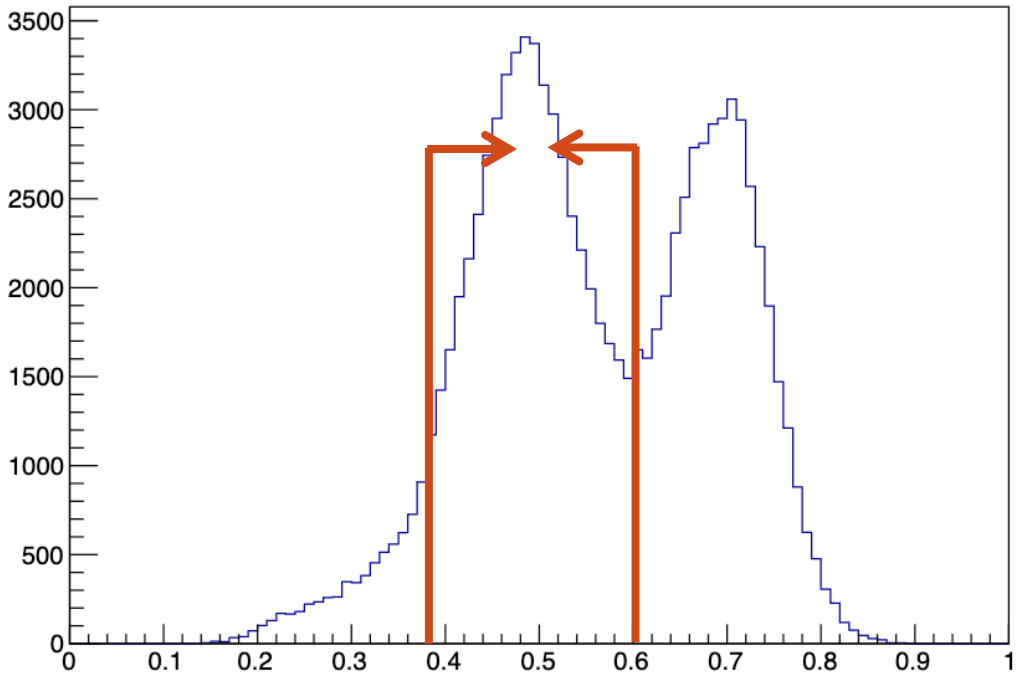


Top/Total charge

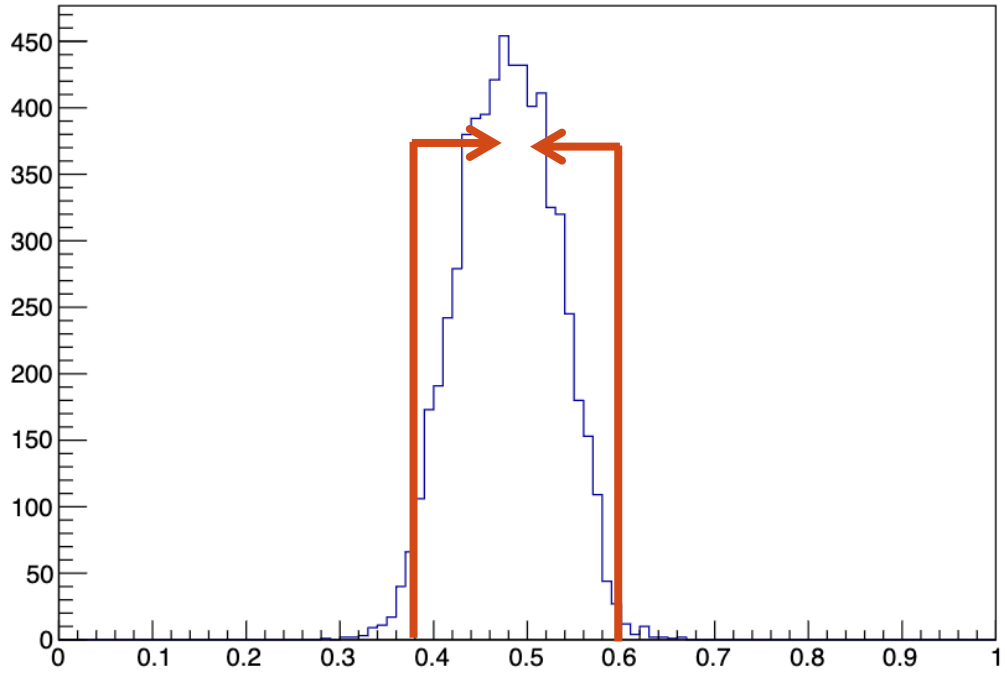
MC studies

- (Loose?) cuts to select top-bottom events
- Known differences between MC and data
  - Function PMTs ~ 1550
  - Ex-situ mPMTs have lower efficiency

All muons



Top-bottom

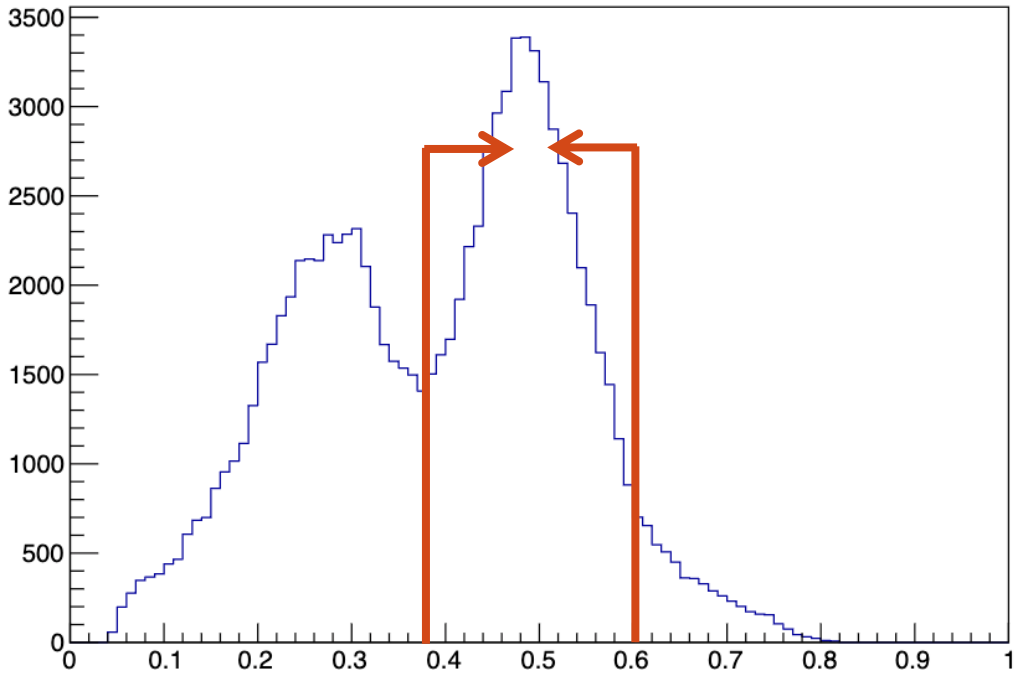


Barrel/Total charge

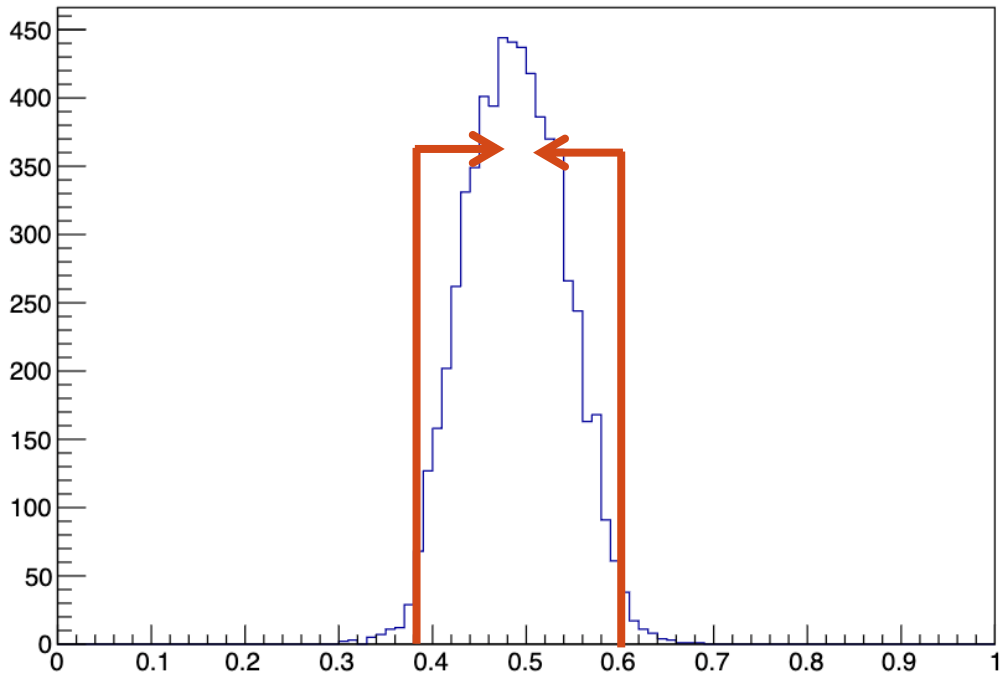
MC studies

- (Loose?) cuts to select top-bottom events
- Known differences between MC and data
  - Function PMTs ~ 1550
  - Ex-situ mPMTs have lower efficiency

All muons



Top-bottom

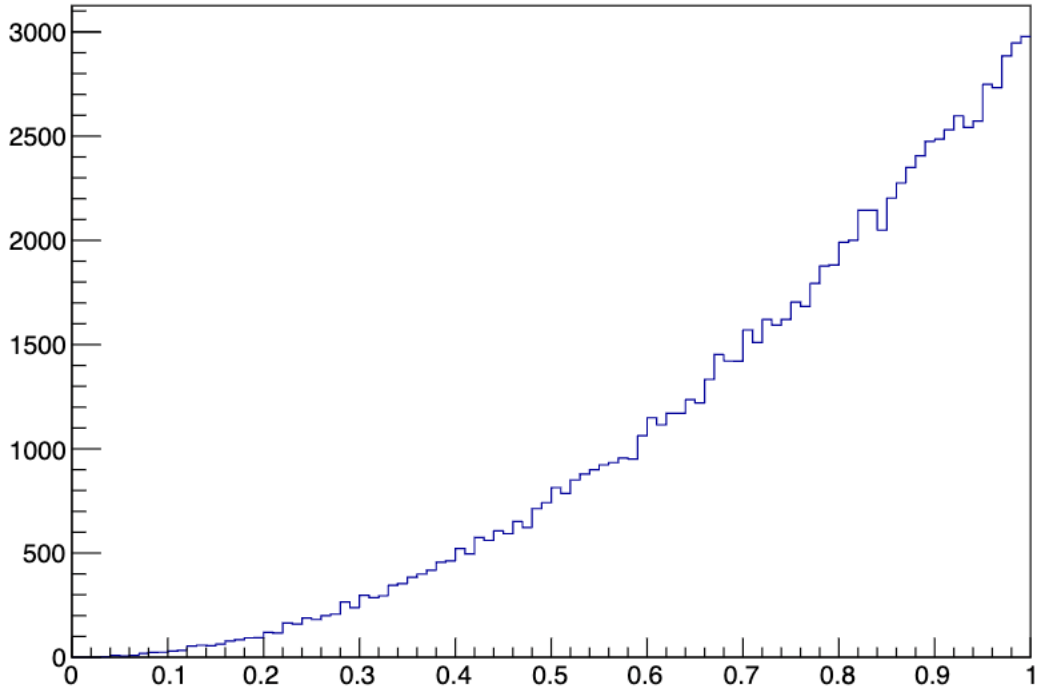


Bottom/Total charge

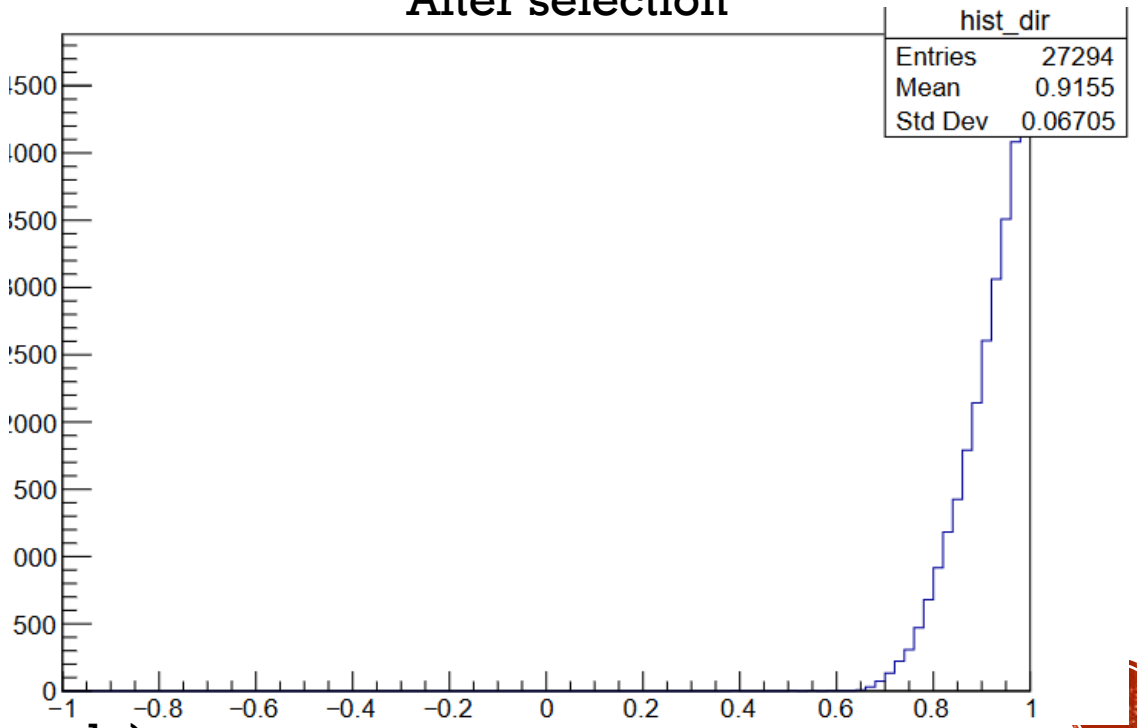
MC studies

- Further apply fiTQun and select reconstructed entrance/exit points on cap
- selection efficiency and purity of top-down events are 85% and 93% respectively
- over 99% of the selected events are with truth cos(zenith_angle)>0.7

Before selection



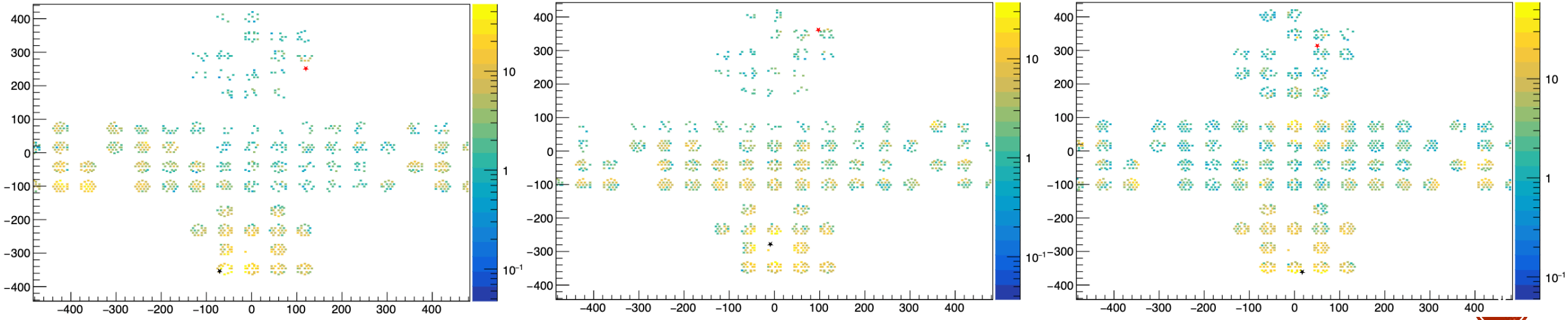
After selection



cos (zenith angle)

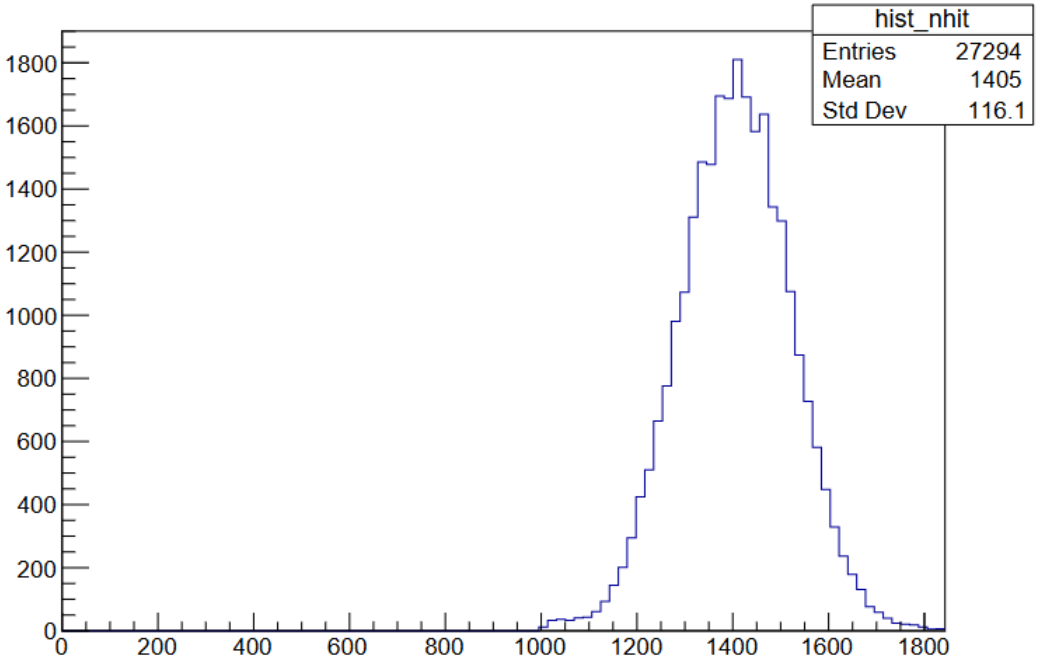
Application on data

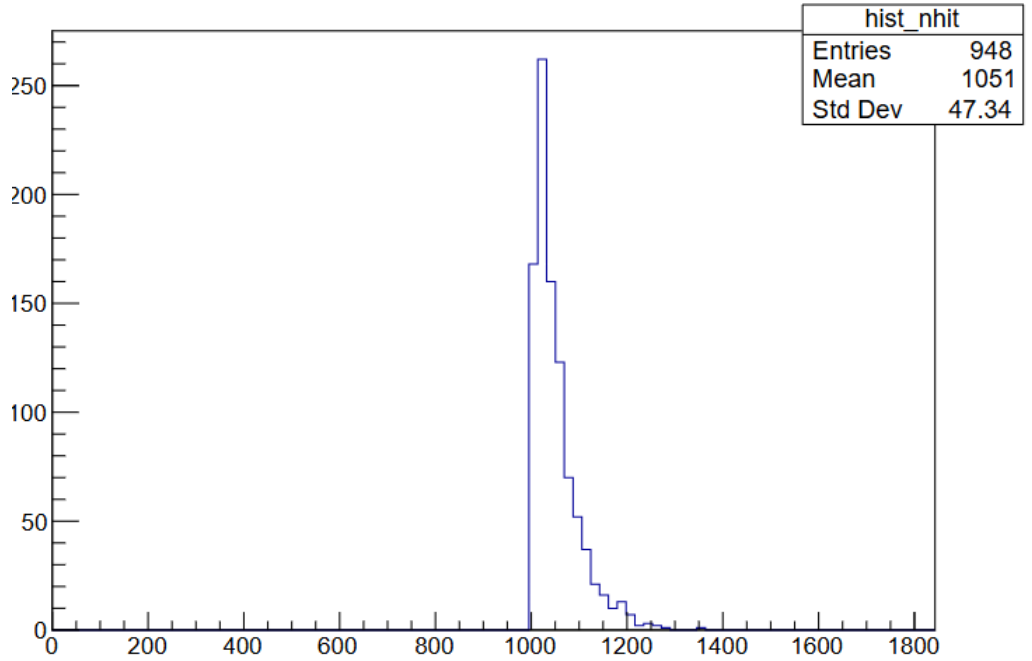
- Dataset: Run 1766, NiCf background run on Apr24, 442187 events * 500 μs = 211s
- N50 cluster search with threshold = 1000 & top/barrel/bottom PMT charge ratio cuts → 1403 candidates found
- Apply fiTQun and reconstructed entrance/exit point cuts → 948 candidates remain
- Some example event display and reconstructed entrance/exit points



MC (left) vs. Data (right) selection plots

- Less hits due to non-functioning PMTs and lower efficiency of ex-situ mPMTs
- Probably selecting longer (more diagonal) tracks in data

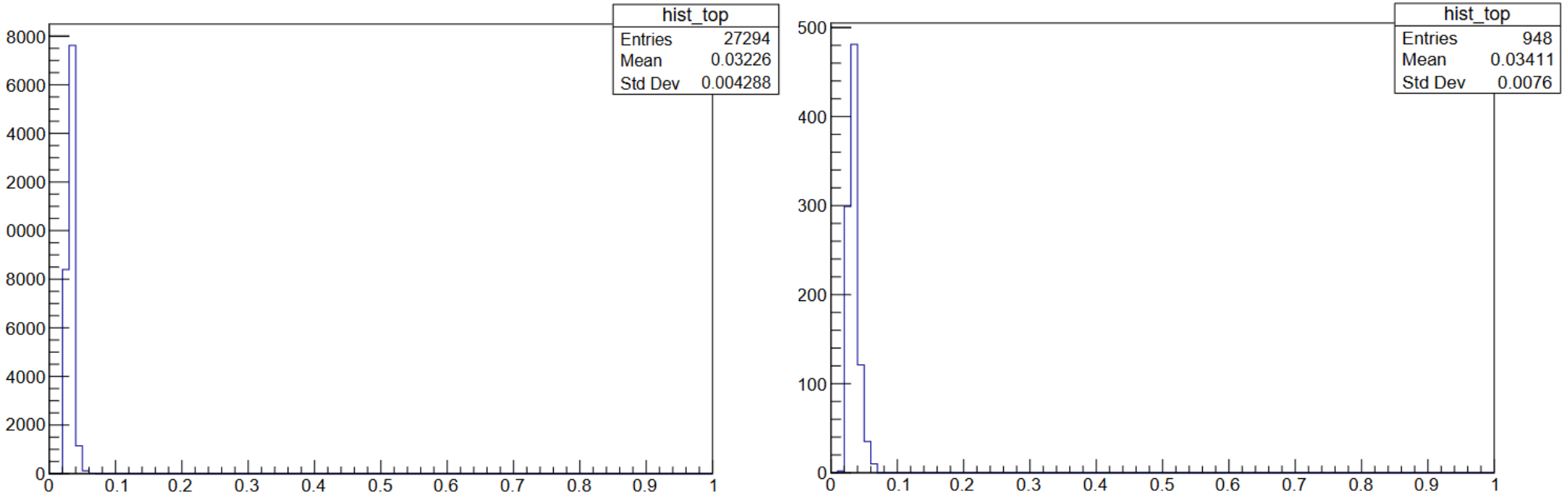




NHit per candidate

MC (left) vs. Data (right) selection plots

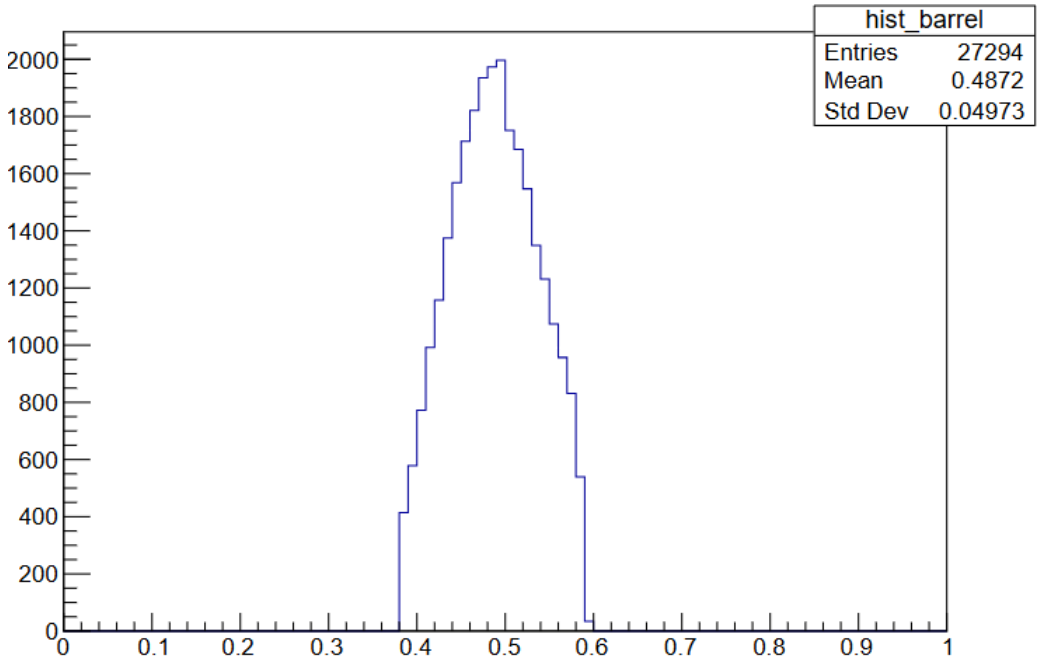
- Top charge ratio looks similar

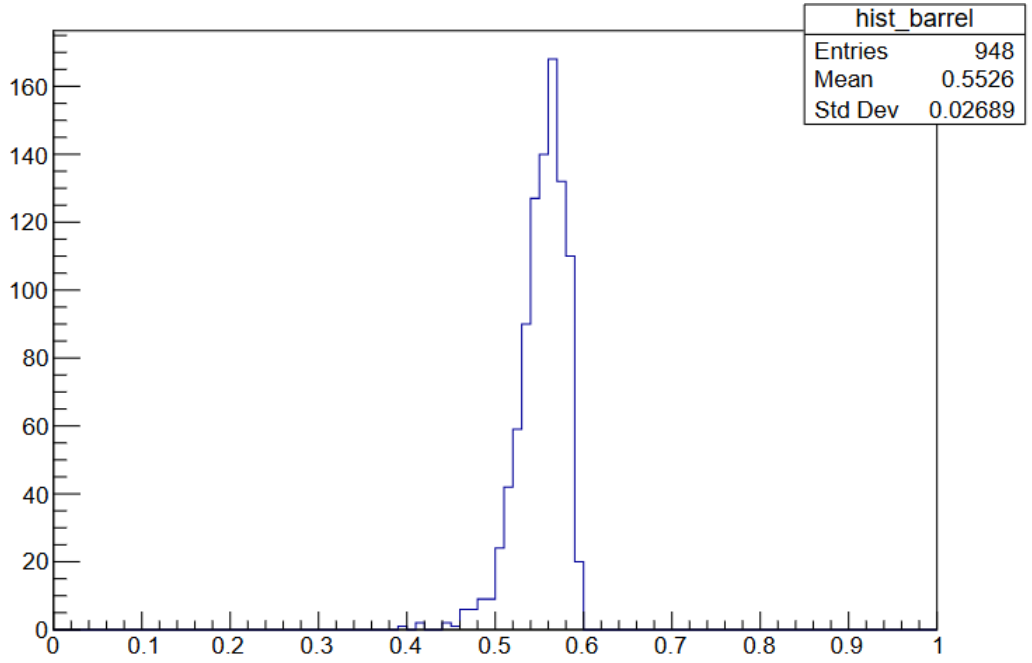


Top/Total charge

MC (left) vs. Data (right) selection plots

- Charge ratio larger in the barrel than bottom
  - 5 (7) out of 58 (21) mPMTs are not reporting in barrel (bottom)

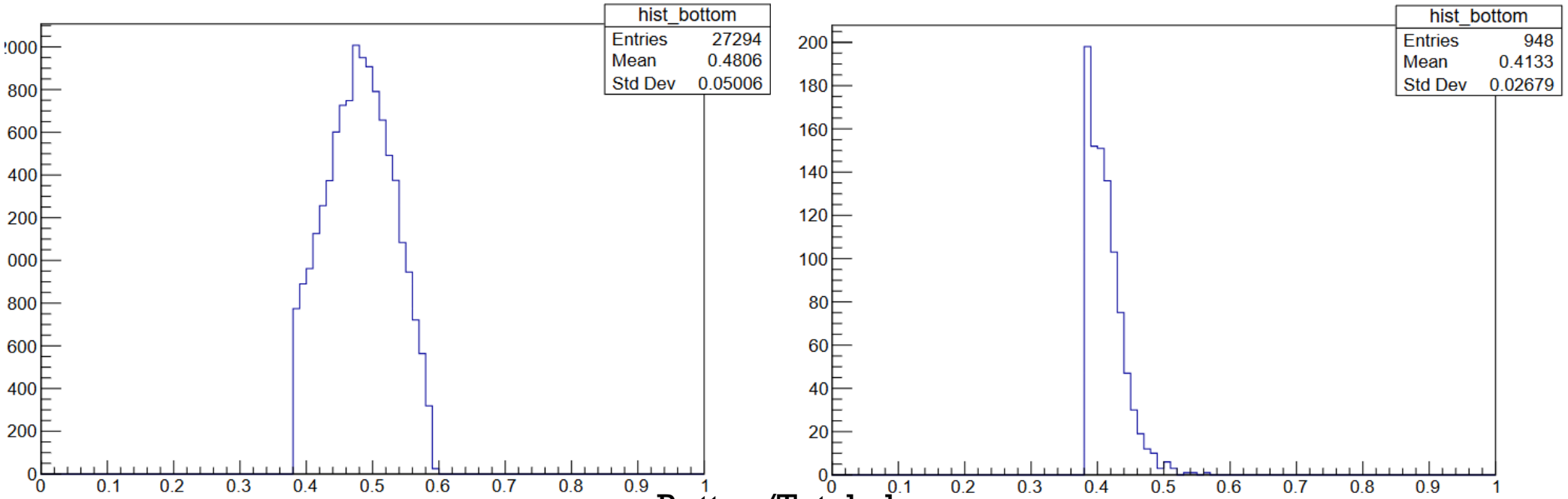




Barrel/Total charge

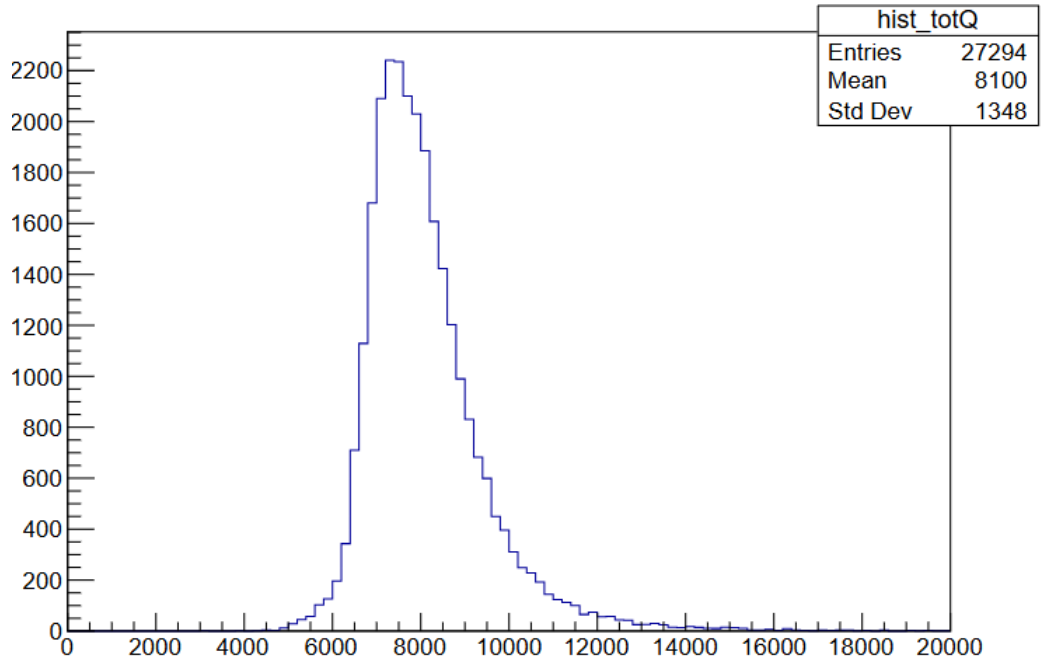
MC (left) vs. Data (right) selection plots

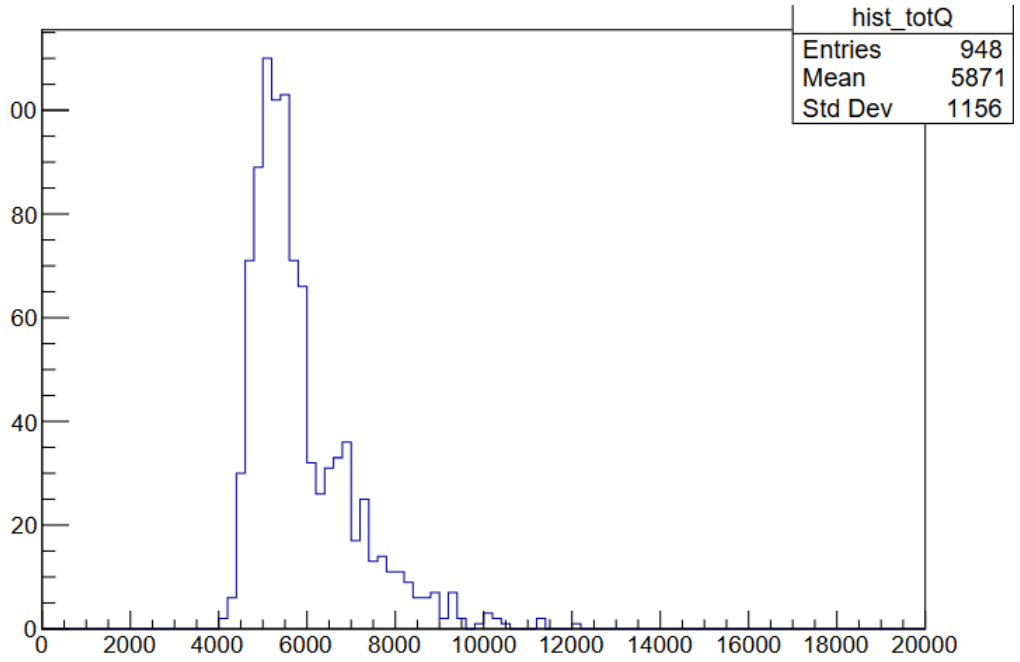
- Charge ratio larger in the barrel than bottom
  - 5 (7) out of 58 (21) mPMTs are not reporting in barrel (bottom)



MC (left) vs. Data (right) selection plots

- Less charge due to less hits

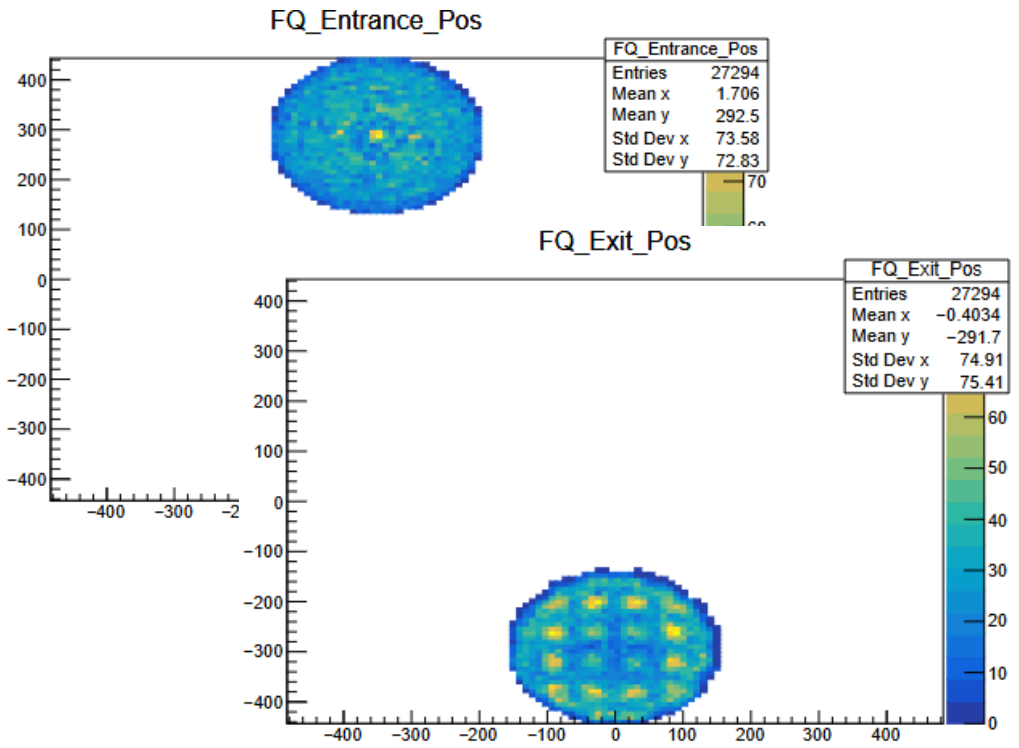


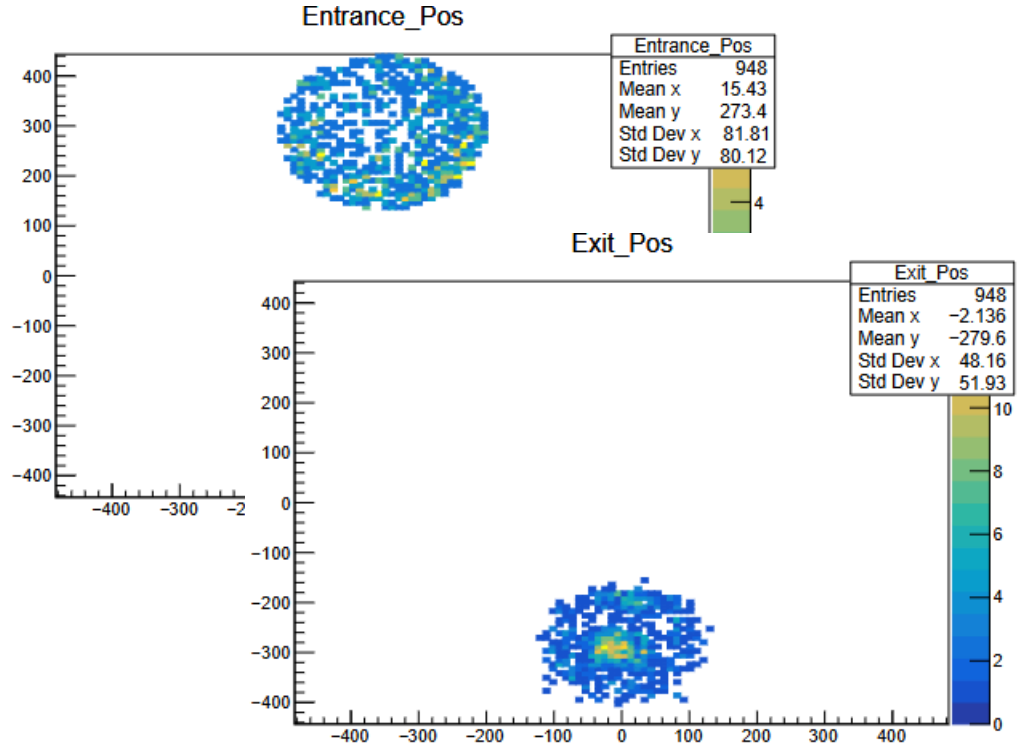


Total charge

MC (left) vs. Data (right) selection plots

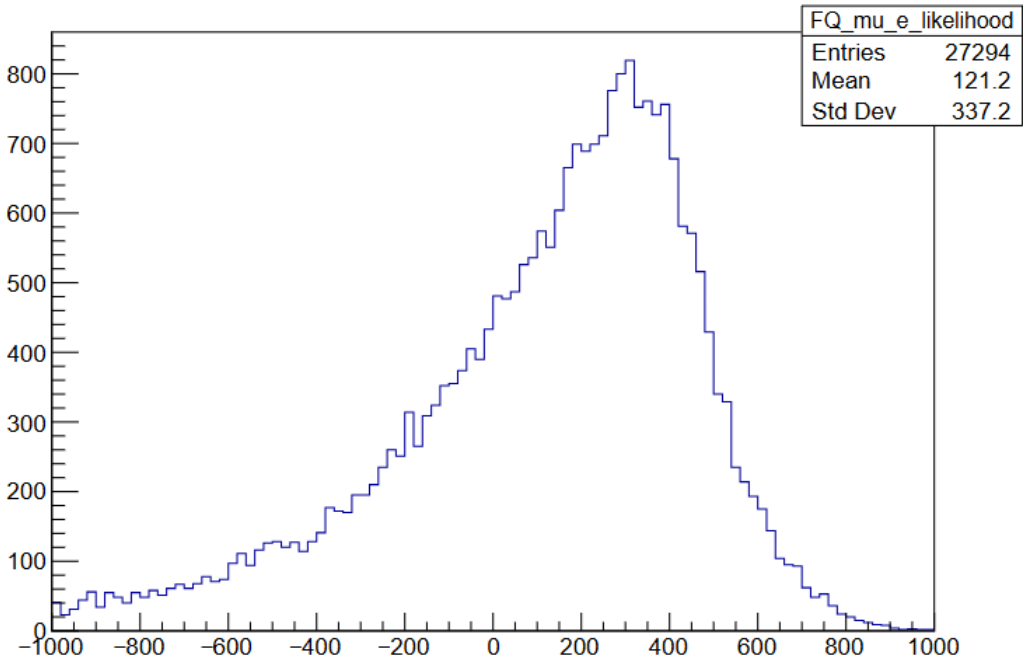
- Hard to interpret fiTQun results because of the missing PMTs
  - Masking study is needed
  - Exit point pulled towards bottom center (missing PMT slot)

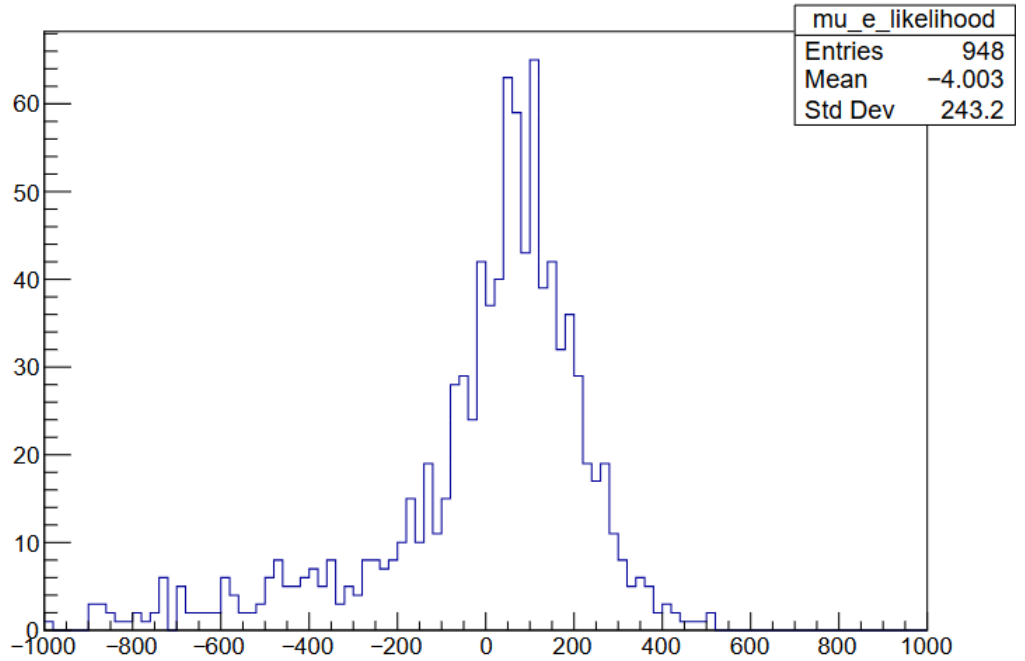




MC (left) vs. Data (right) selection plots

- Muon-electron separation is weaker, but somehow tail is shorter

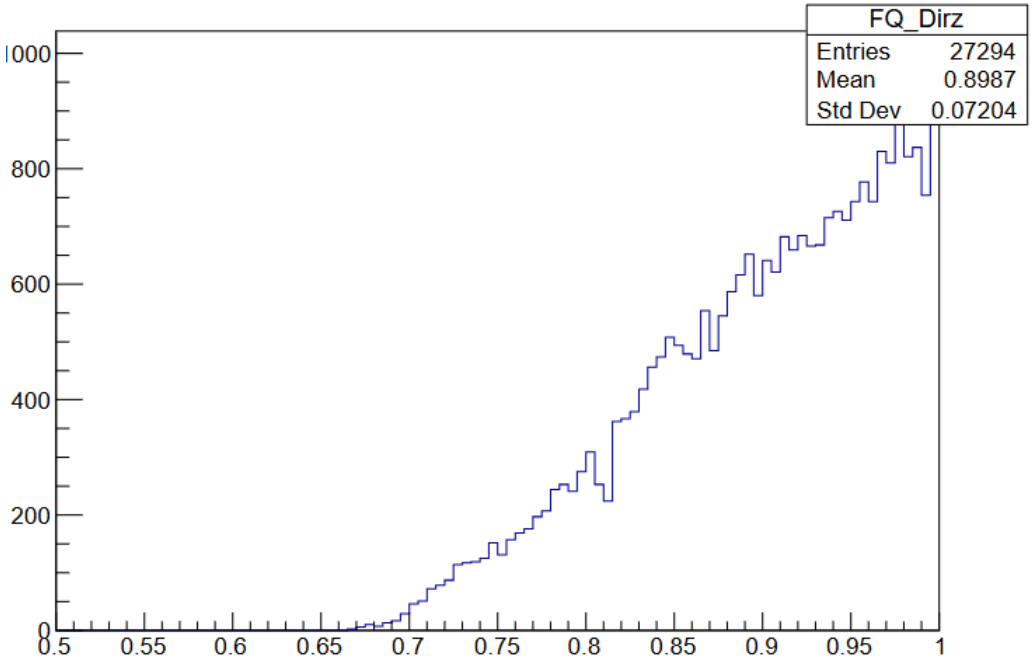


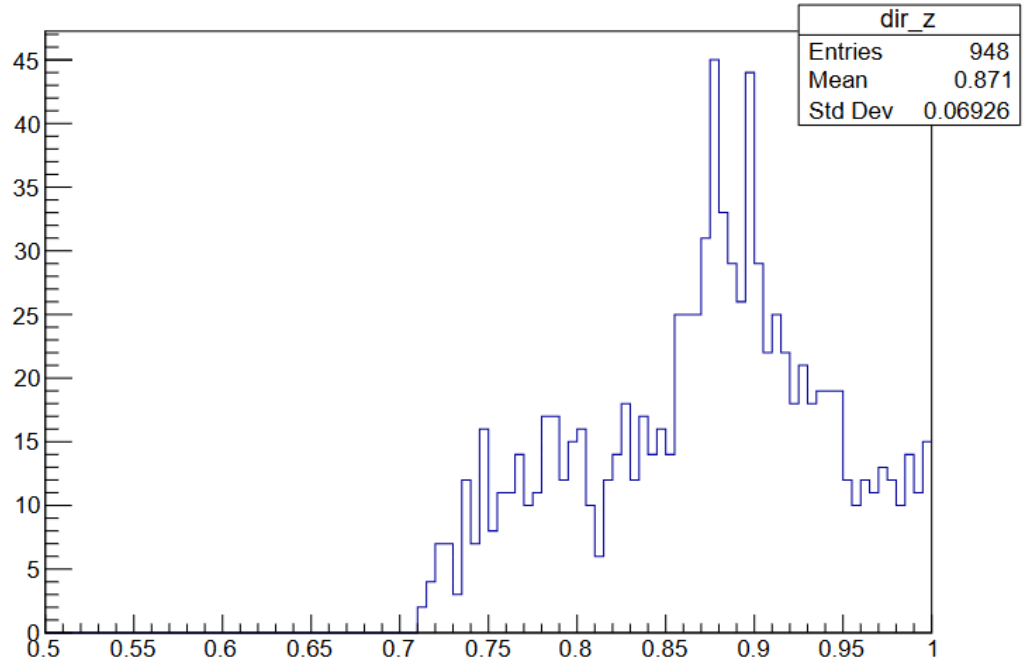


$-\ln L_e/L_\mu$

MC (left) vs. Data (right) selection plots

- Direction is quite biased

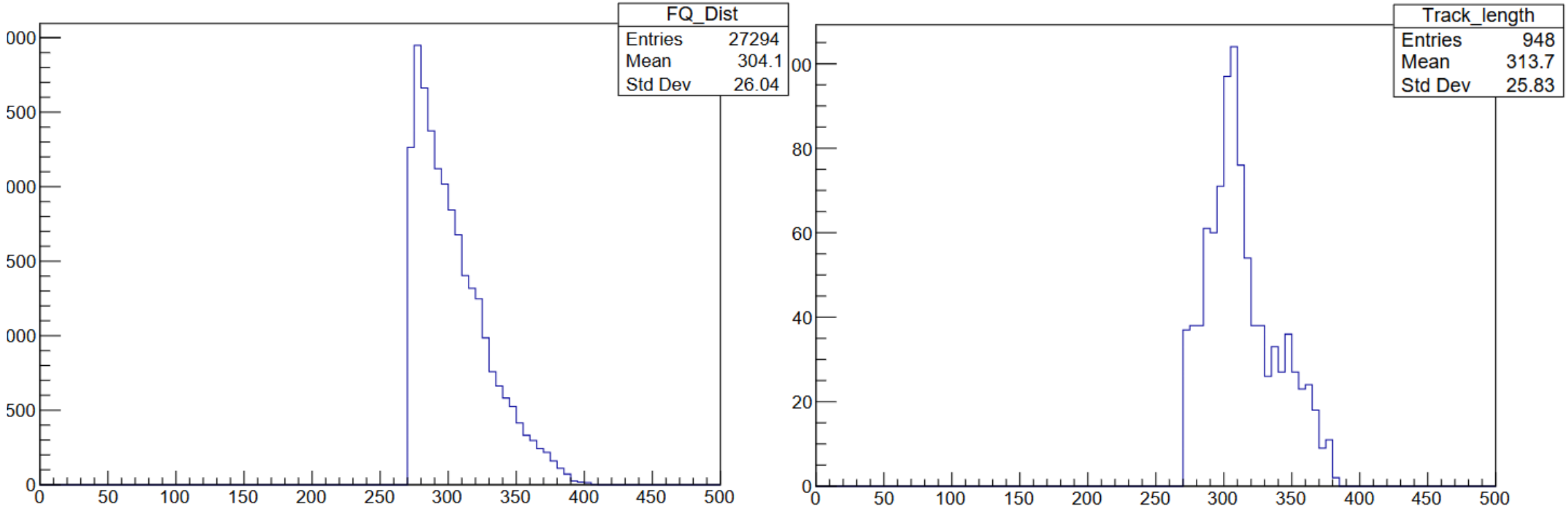




- Dirz

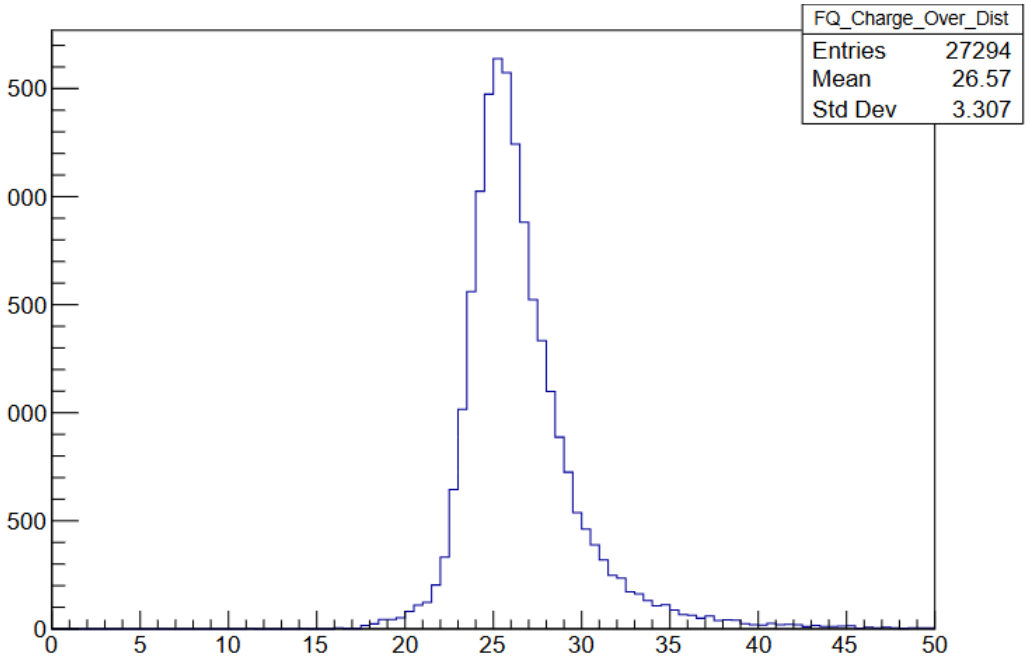
MC (left) vs. Data (right) selection plots

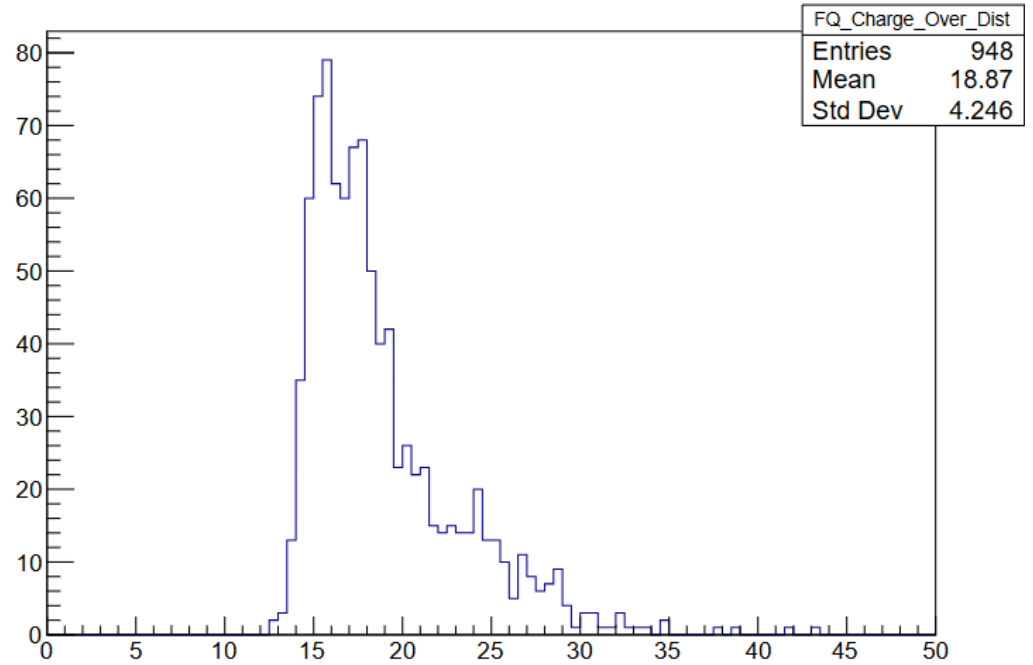
- Short track muons are less favored



MC (left) vs. Data (right) selection plots

- Much asymmetric in data

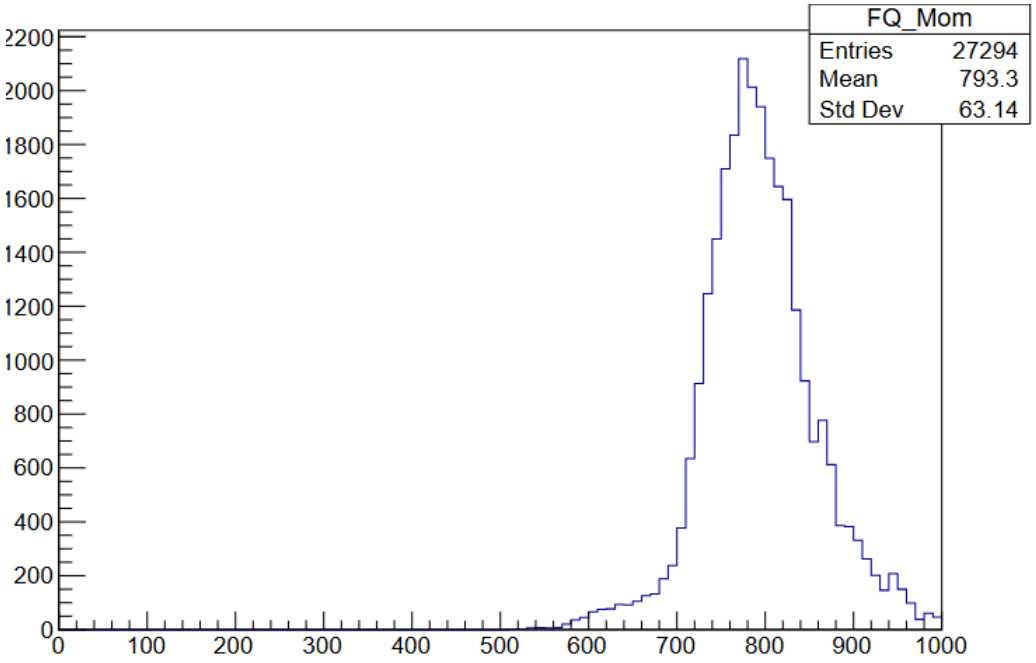


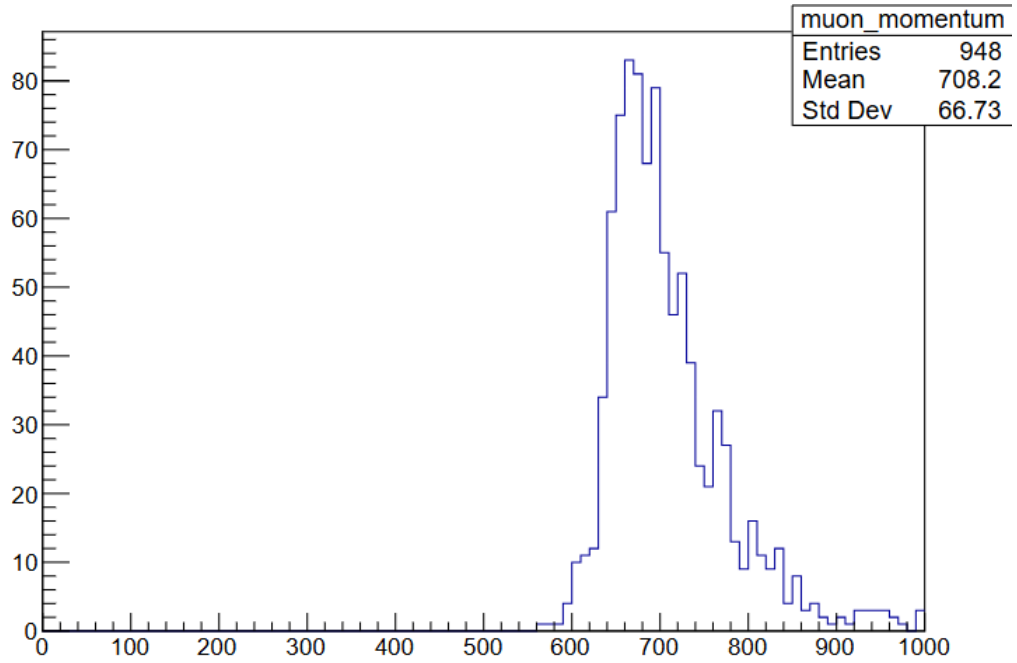


Total charge/Track Length

MC (left) vs. Data (right) selection plots

- Momentum reconstruction is less meaningful
  - Missing PMT is pulling down momentum?





Reconstructed momentum (MeV)

MC (left) vs. Data (right) selection plots

- Reconstructed momentum and total collected charge are correlated