Status Report

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FNAL DUNE Sim-Reco Group Meeting

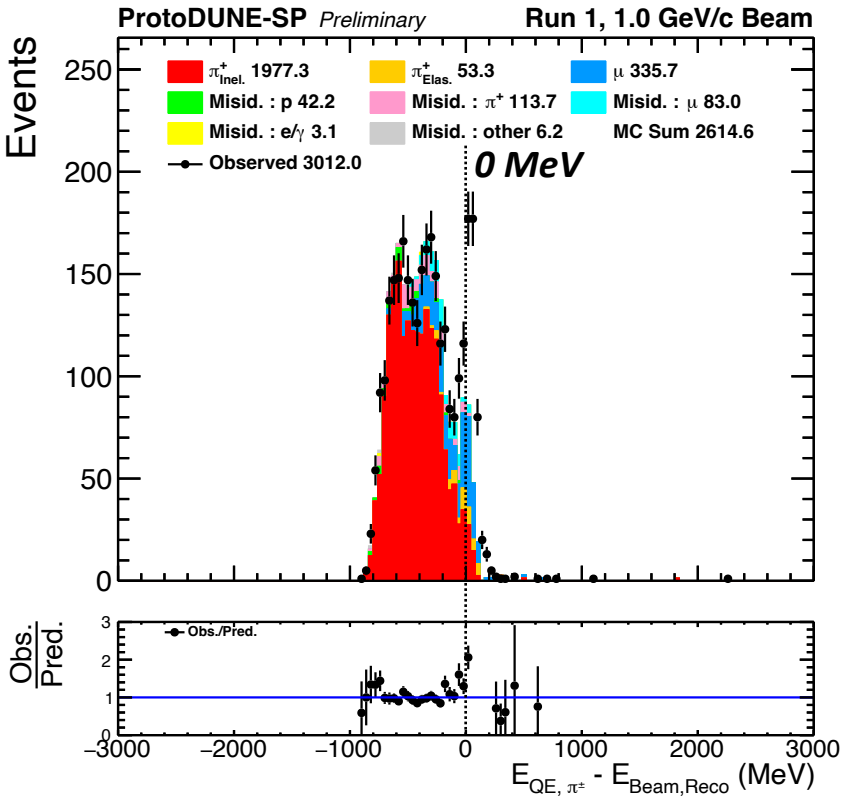
17 August 2022

Study for Quasi-elastic Scattering of Charged Pions - ProtoDUNE-SP

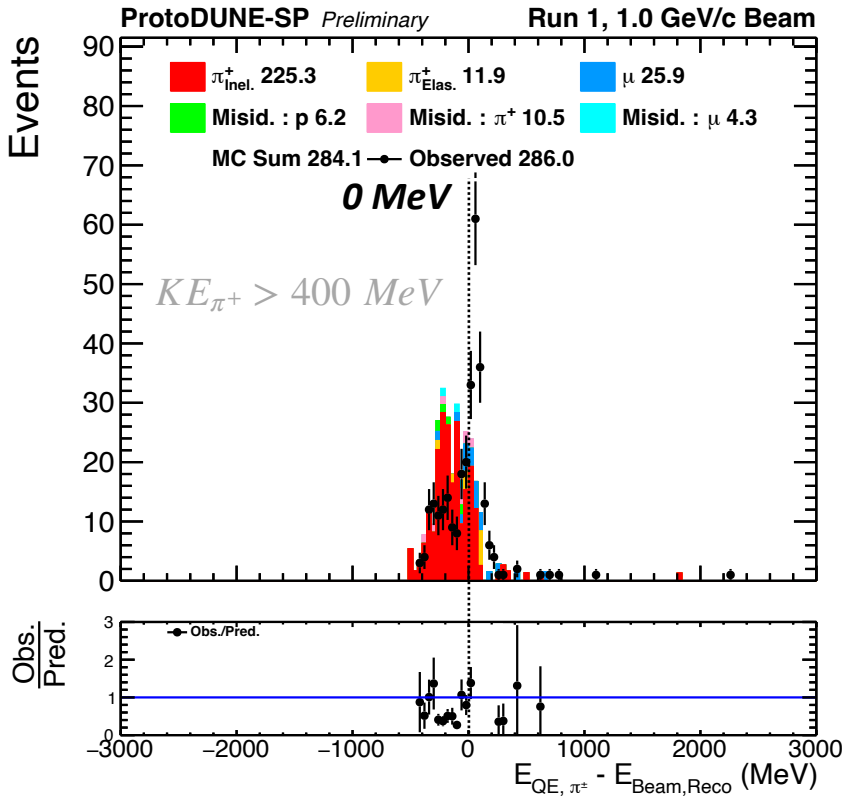
Data vs MC distributions

- Charged pions with Michel score > 0.5, energy using the CSDA
- A clear peak at zero from data : it could be muon's peak, need more study on it

$E^{-}_{QE}(E_b = 4\ MeV)$



$E^{-}_{QE}(E_b = 4\ MeV)$



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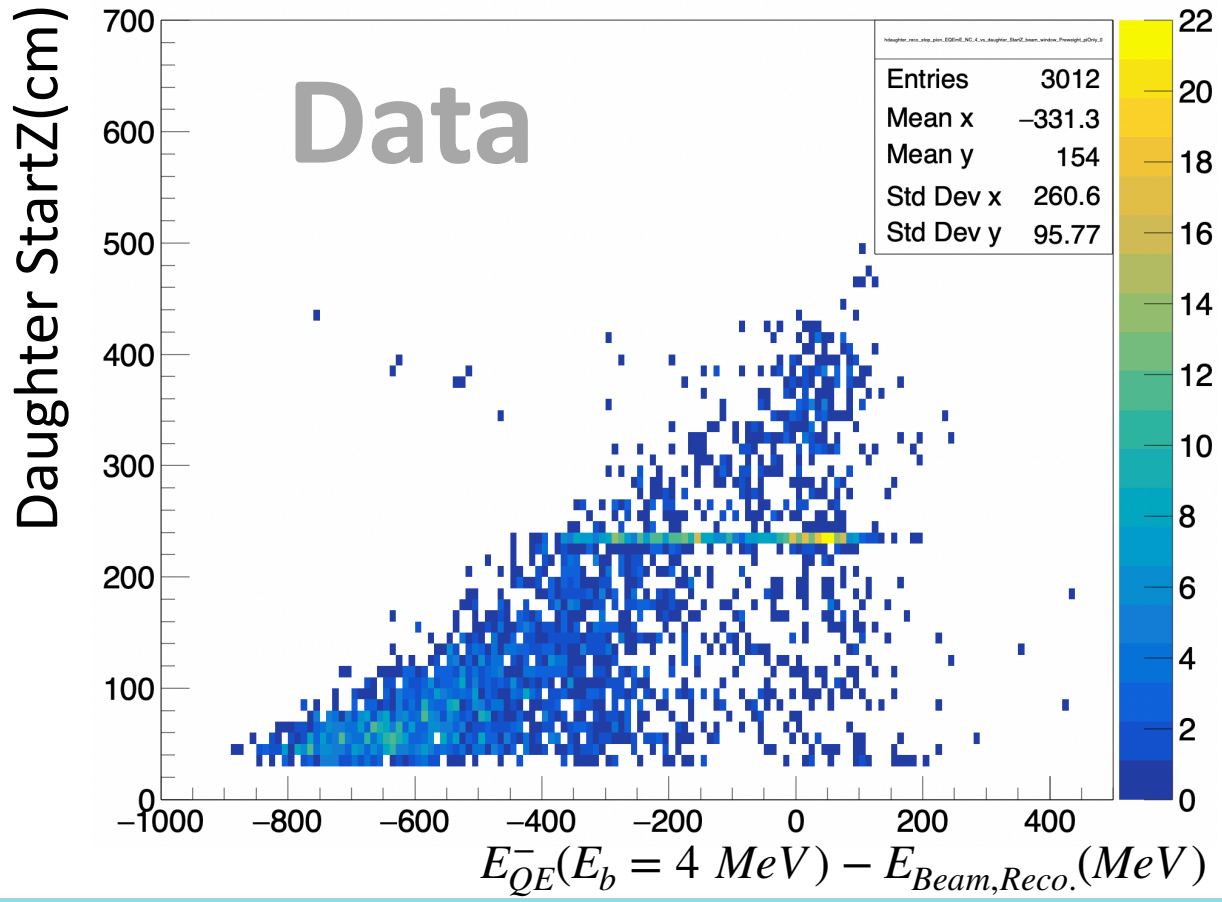
Study for Quasi-elastic Scattering of Charged Pions - ProtoDUNE-SP

Data vs MC distributions

- Charged pions with Michel score > 0.5, energy using the CSDA
- Big contribution from broken tracks due to the electron diverter



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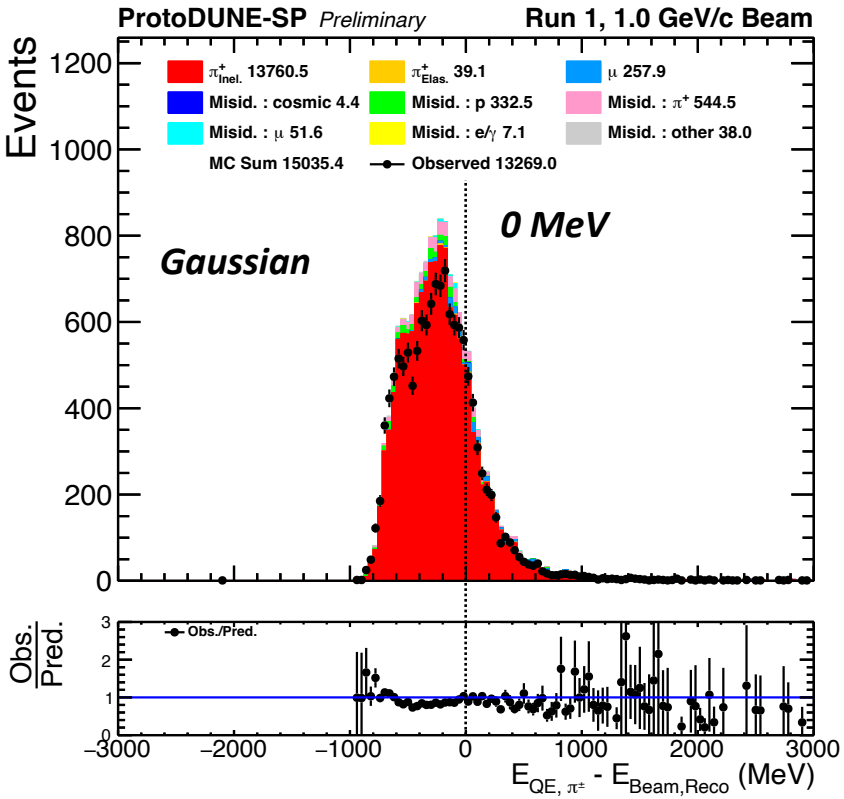
Study for Quasi-elastic Scattering of Charged Pions - ProtoDUNE-SP

Data vs MC distributions

- Charged pions with Michel score < 0.5, energy using hypothetical track length
- A clear peak at zero from the maximum likelihood method

$E^{-}_{QE}(E_b = 4\ MeV)$



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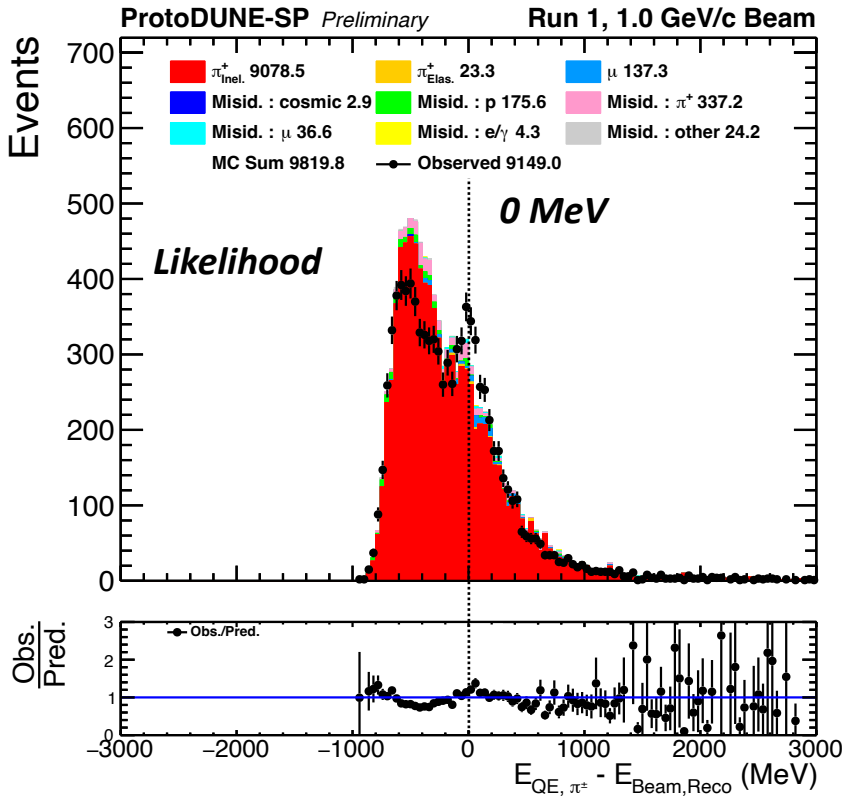

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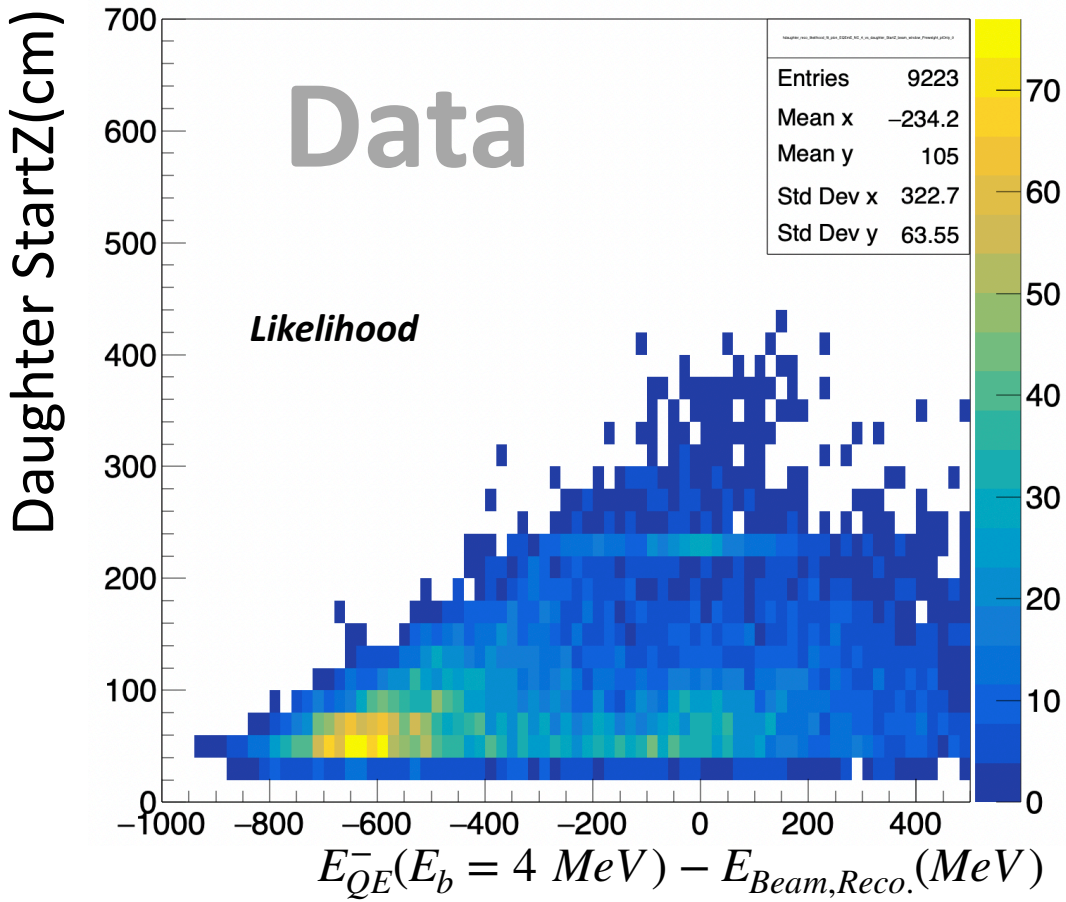
Study for Quasi-elastic Scattering of Charged Pions - ProtoDUNE-SP

Data vs MC distributions

- Charged pions with Michel score < 0.5, energy using hypothetical track length
- Big contribution from broken tracks due to the electron diverter, but still there is QE peak



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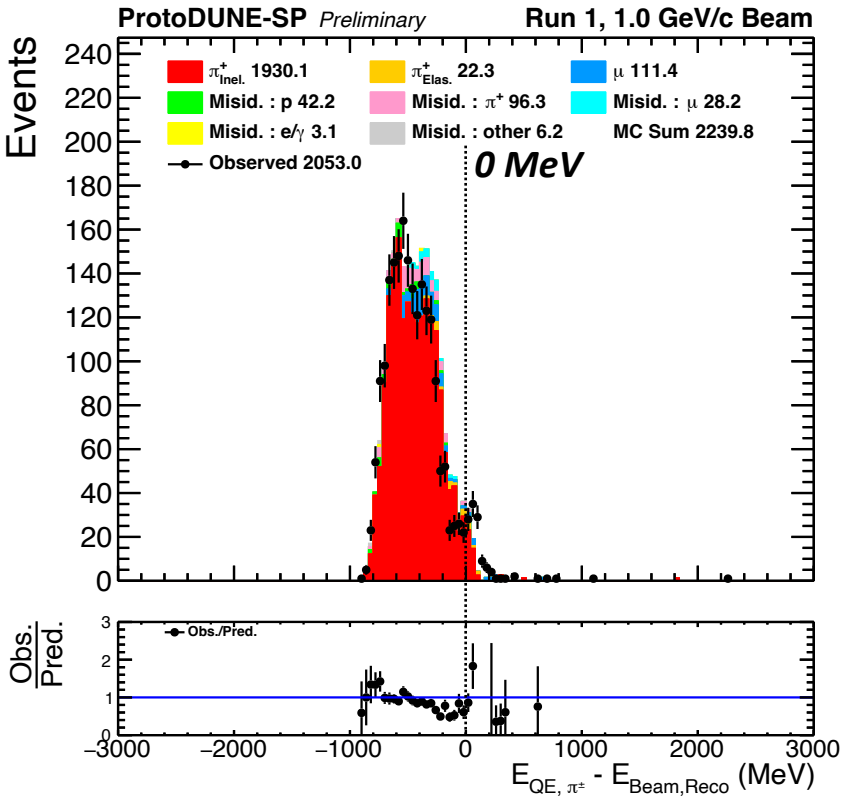
Study for Quasi-elastic Scattering of Charged Pions - ProtoDUNE-SP

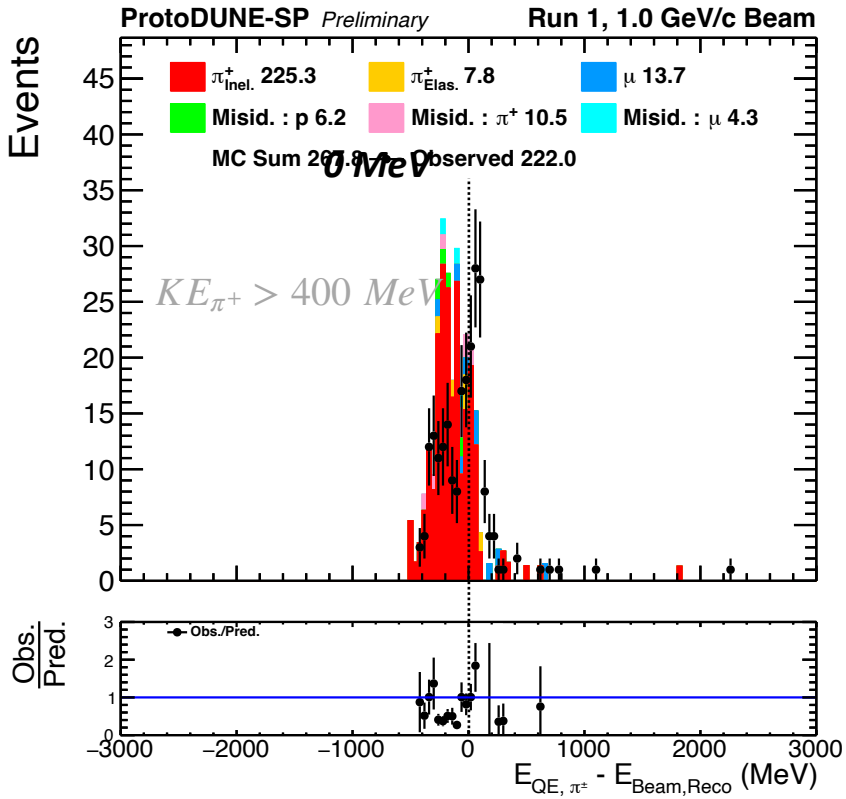
Data vs MC distributions

- Charged pions with Michel score > 0.5, energy using the CSDA
- StartZ of daughter < 220 cm

$E^{-}_{QE}(E_b = 4\ MeV)$



$E^{-}_{QE}(E_b = 4\ MeV)$



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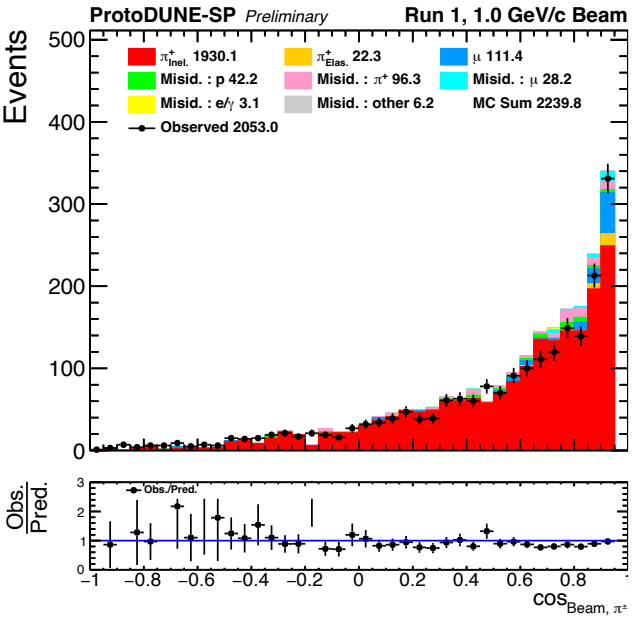
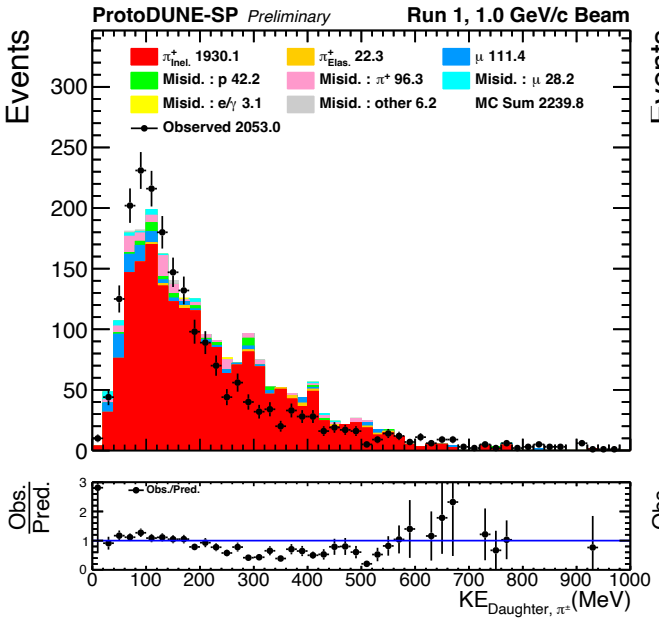
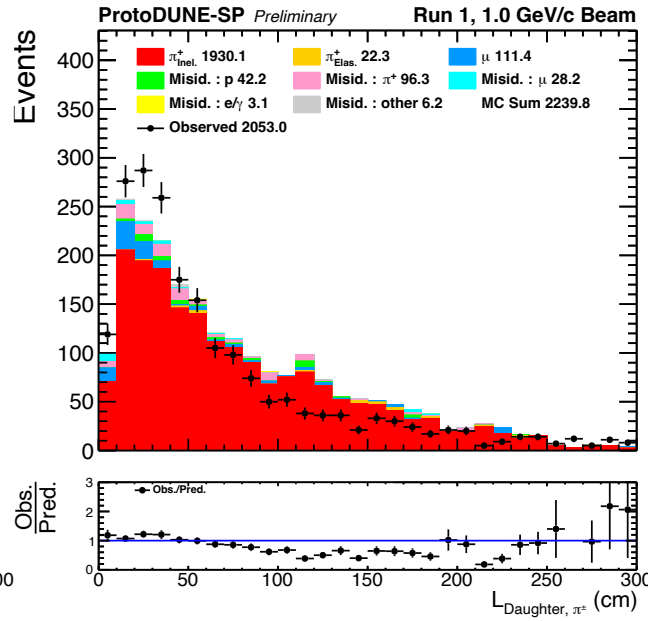
Study for Quasi-elastic Scattering of Charged Pions - ProtoDUNE-SP

Other variables for reconstructed charged pion

- Angle between beam and charged pion is well described
- But, track length of charged pions is not described well
  - Charged pions in data is generally shorter than the MC
  - I will check if daughter tracks are also cut off due to diverter





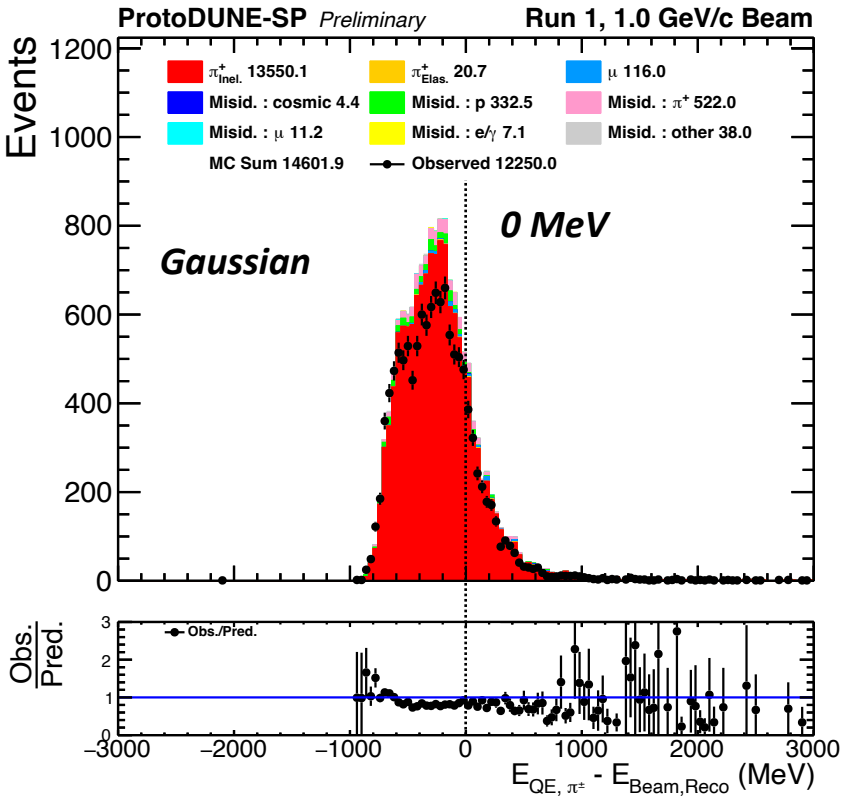


Study for Quasi-elastic Scattering of Charged Pions - ProtoDUNE-SP

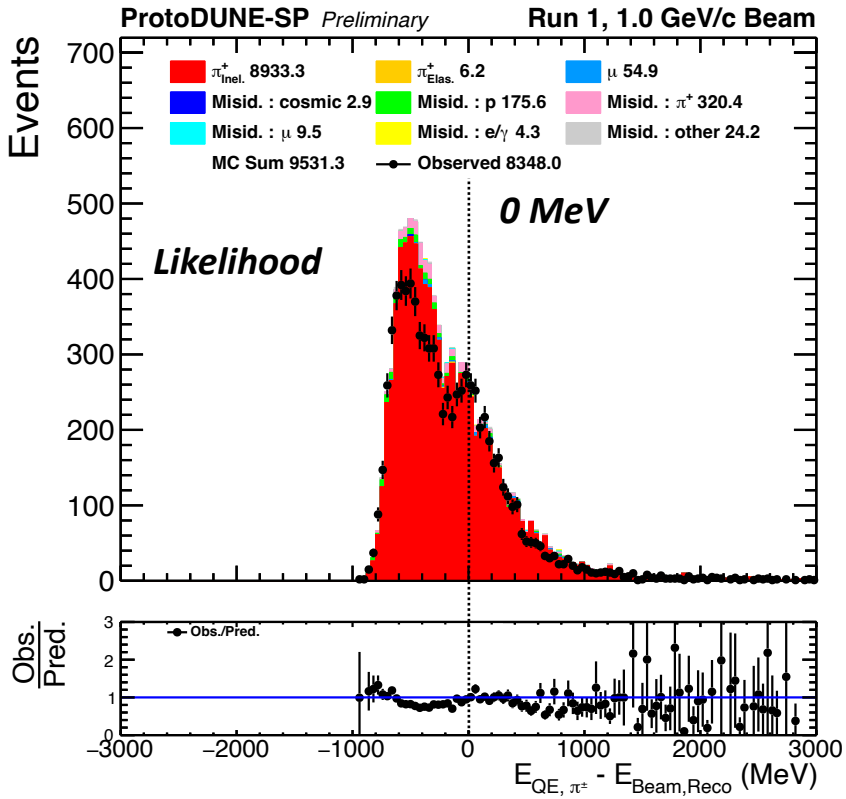
Data vs MC distributions

- Charged pions with Michel score < 0.5, energy using hypothetical track length
- StartZ of daughter < 220 cm

$E^{-}_{QE}(E_b = 4\ MeV)$



$E^{-}_{QE}(E_b = 4\ MeV)$



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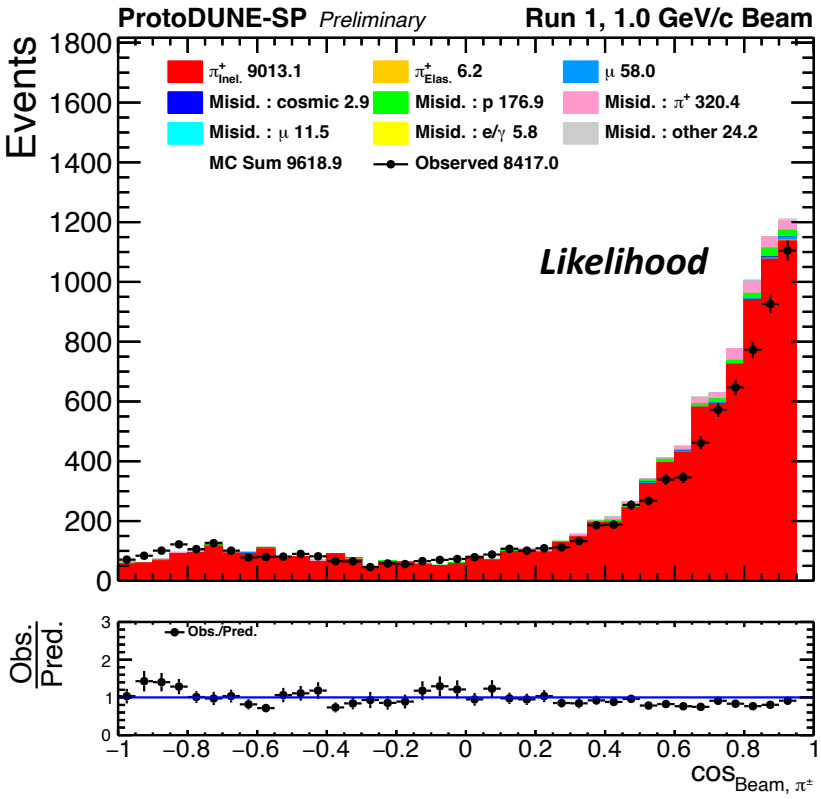
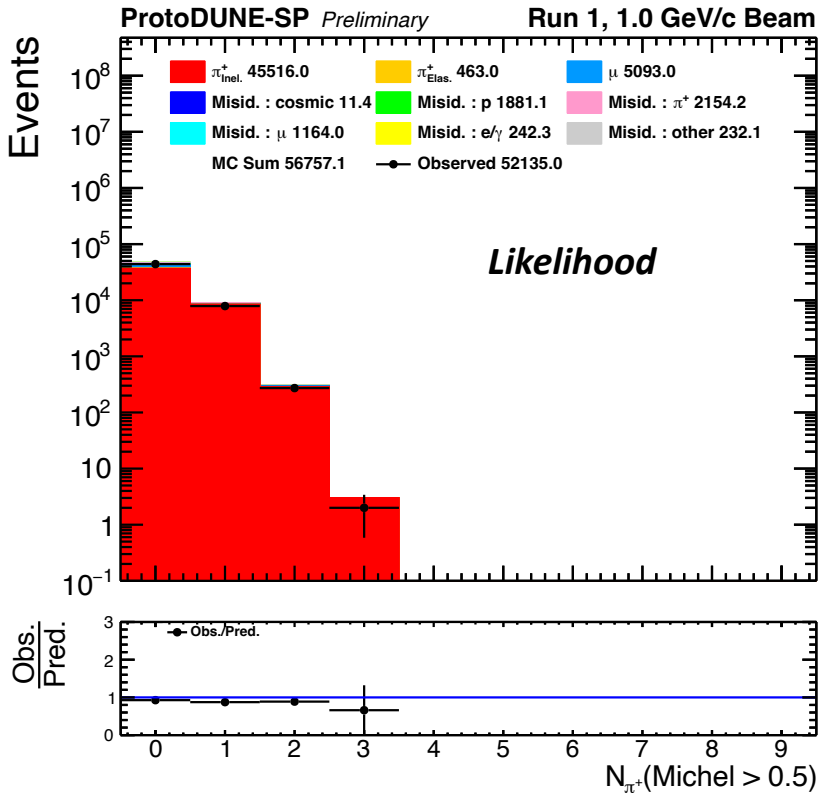
Study for Quasi-elastic Scattering of Charged Pions - ProtoDUNE-SP

Data vs MC distributions

- Angle between beam and charged pion is well described





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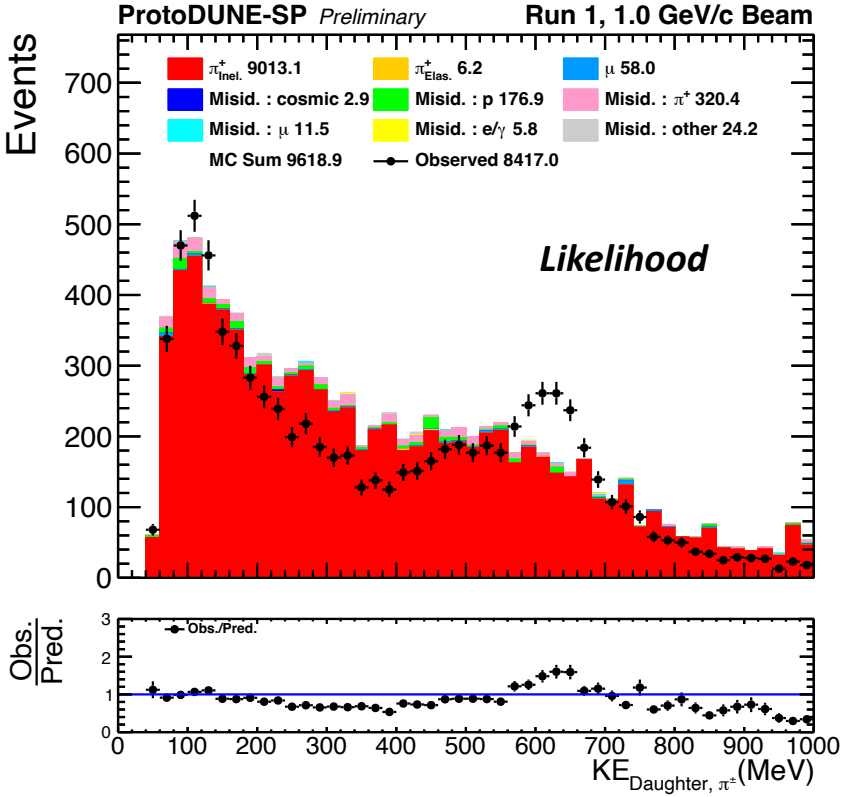
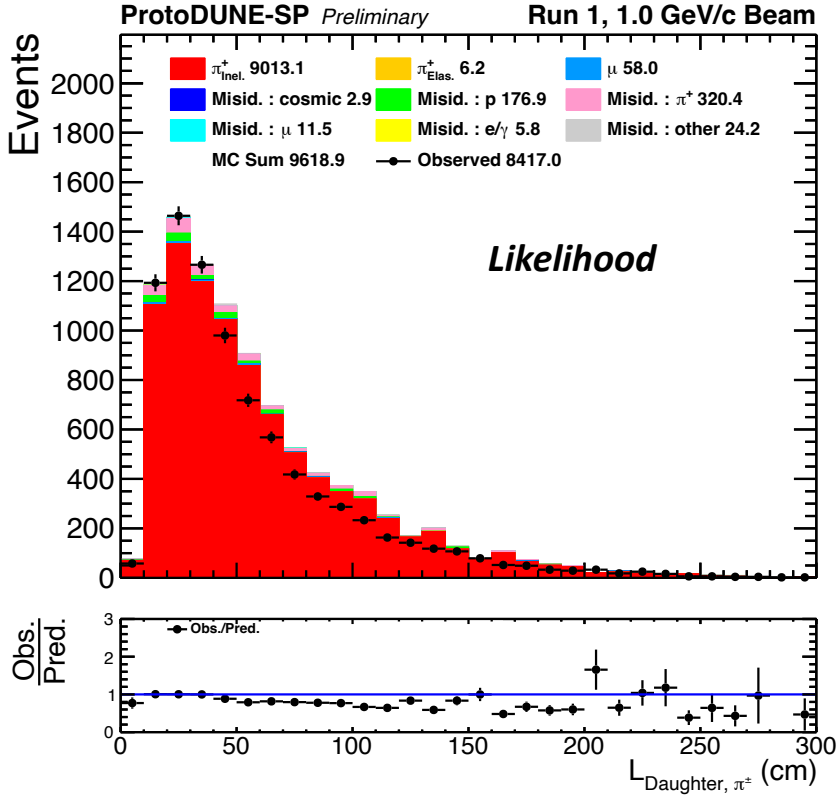
Study for Quasi-elastic Scattering of Charged Pions - ProtoDUNE-SP

Data vs MC distributions

- A bump around KE = 600 - 650 MeV
  - Tendency is similar with the ΔEQE distribution
- Again, data shows shorter daughter track length in general





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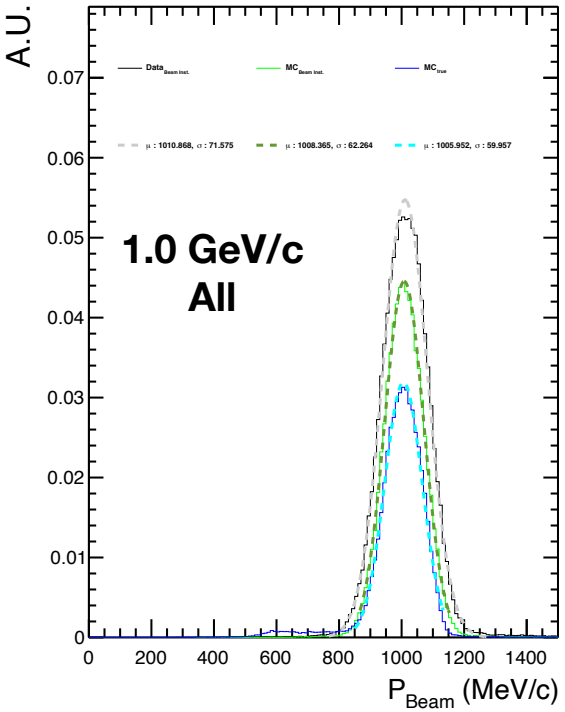
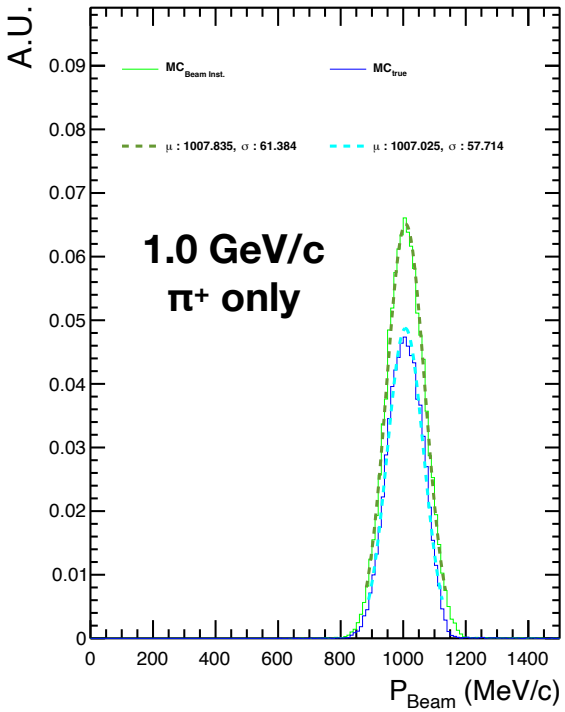
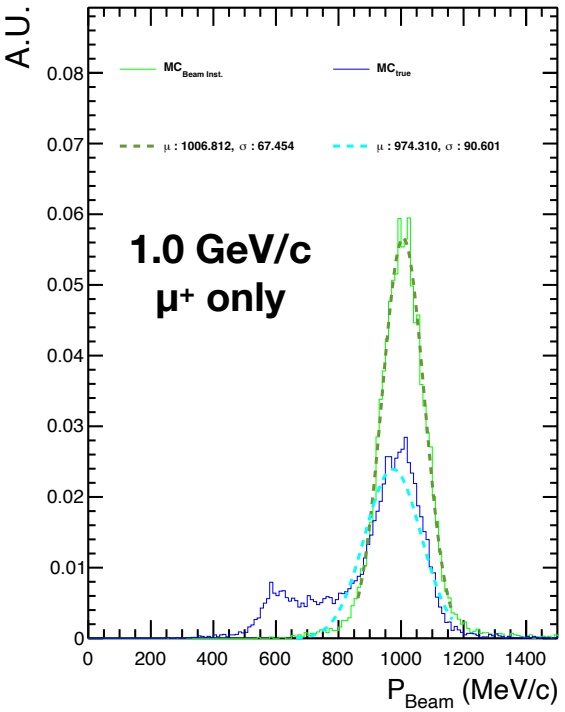
Study for ProtoDUNE-SP Beam

Purpose of the study

- I want to understand muon contribution better
- Black : data, green : MC, blue : MC truth
- To solve the well known mismodeling problem for muon beam contribution







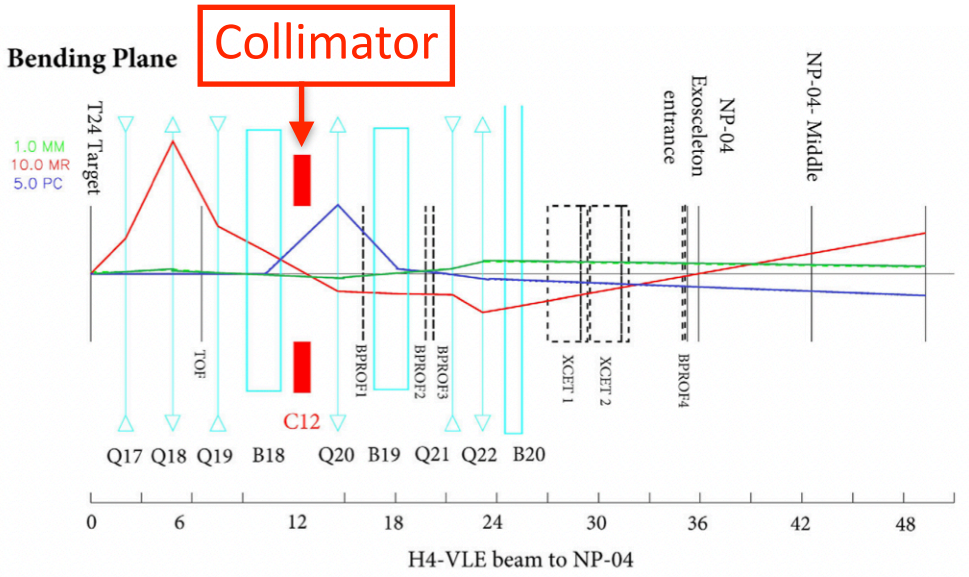
Study for ProtoDUNE-SP Beam

H4-VLE Beam line

- Secondary target to collimator : 12 m
- To BPROF1 (~ 15.4 m), BPROF2 (~ 19.1 m), and BPROF3 (~ 19.5 m)
- To cryostat : 36 m

Let's assume that muon contribution is negligible right after the secondary target

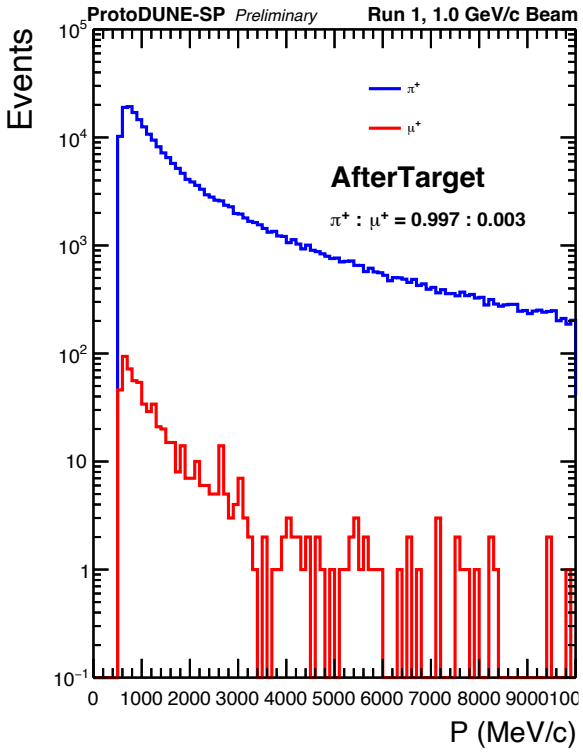
- γcτ of 1 GeV/c π^+ is 56.4 m
- At collimator
  - Exp[-12 / 56.4] = 0.808
- BPROF1
  - Exp[-15.4 / 56.4] = 0.761
- BPROF2, 3
  - 0.7127, 0.7077
- Cryostat
  - Exp[-36/56.4] = 0.5282

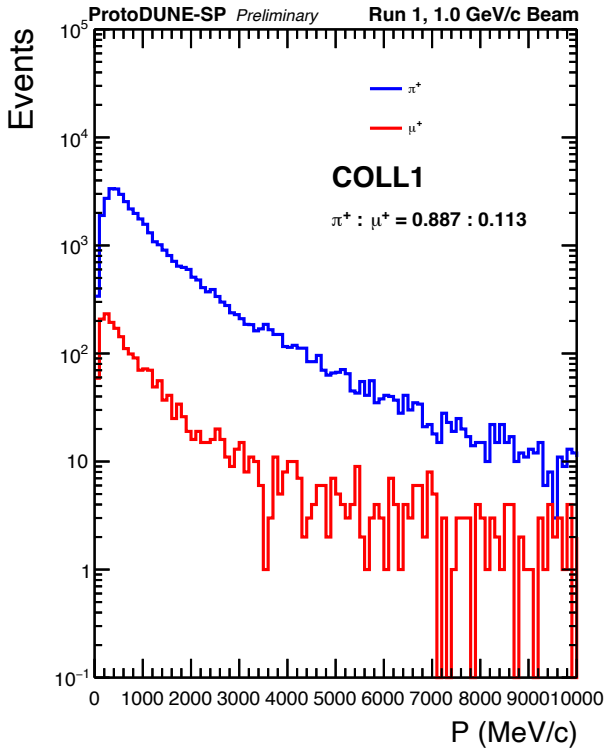


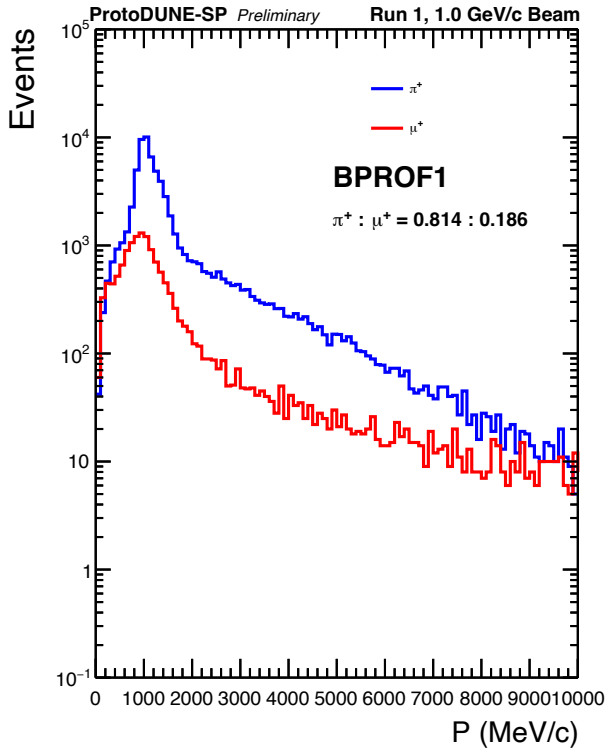
Study for ProtoDUNE-SP Beam

Using the 1 GeV/c G4beamlineVersion3.06 sample

- 0.5M events for each stage
- After collimator, a peak at 1 GeV/c is observed
- Muon contribution is increasing due to decay-in-flight of charged pions



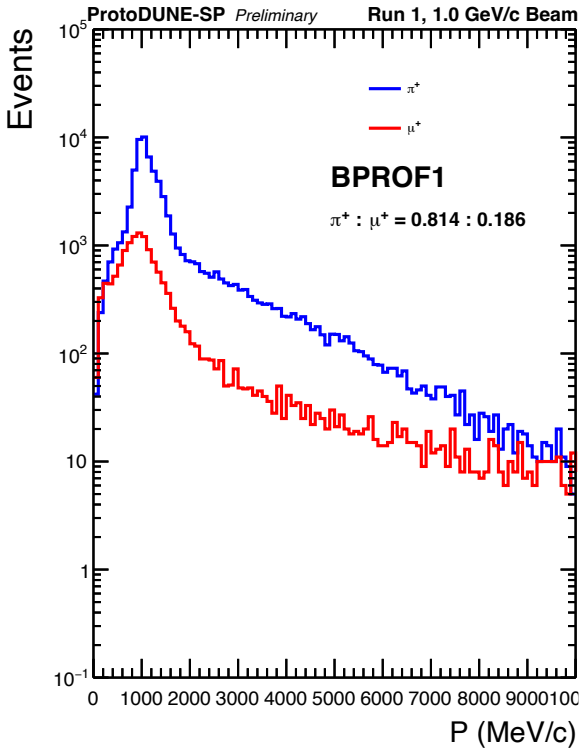


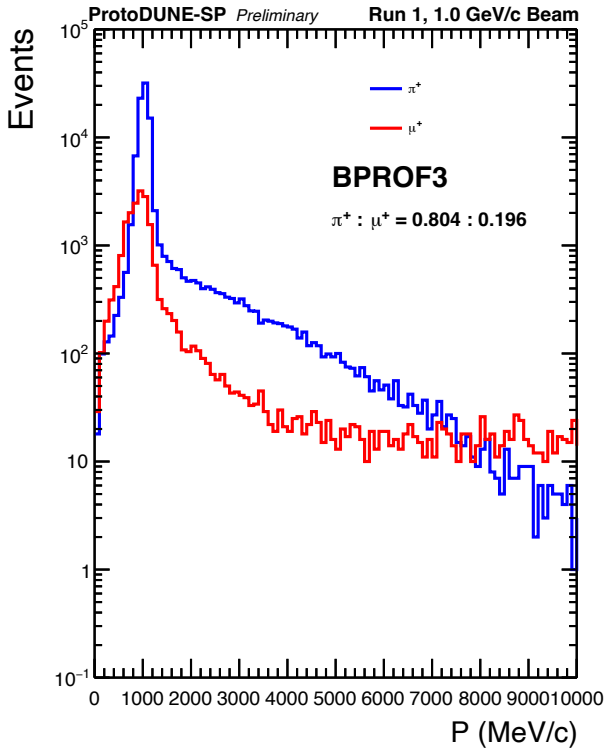


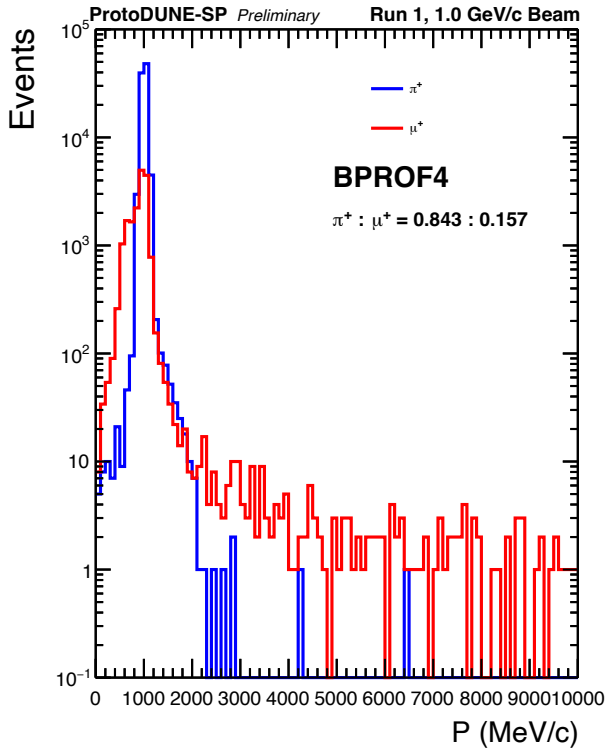
Study for ProtoDUNE-SP Beam

Using the 1 GeV/c G4beamlineVersion3.06 sample

- The 1 GeV/c peak becomes more clear due to B-field at momentum spectrometer
- We also see decay-in-flight muon shoulder at BPROF4 (close to the cryostat)
- Muon contribution decreases at BPROF4







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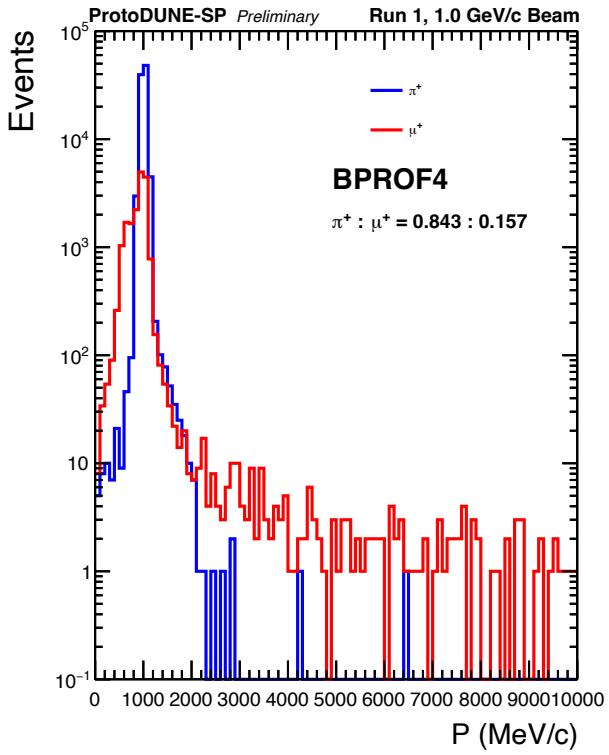

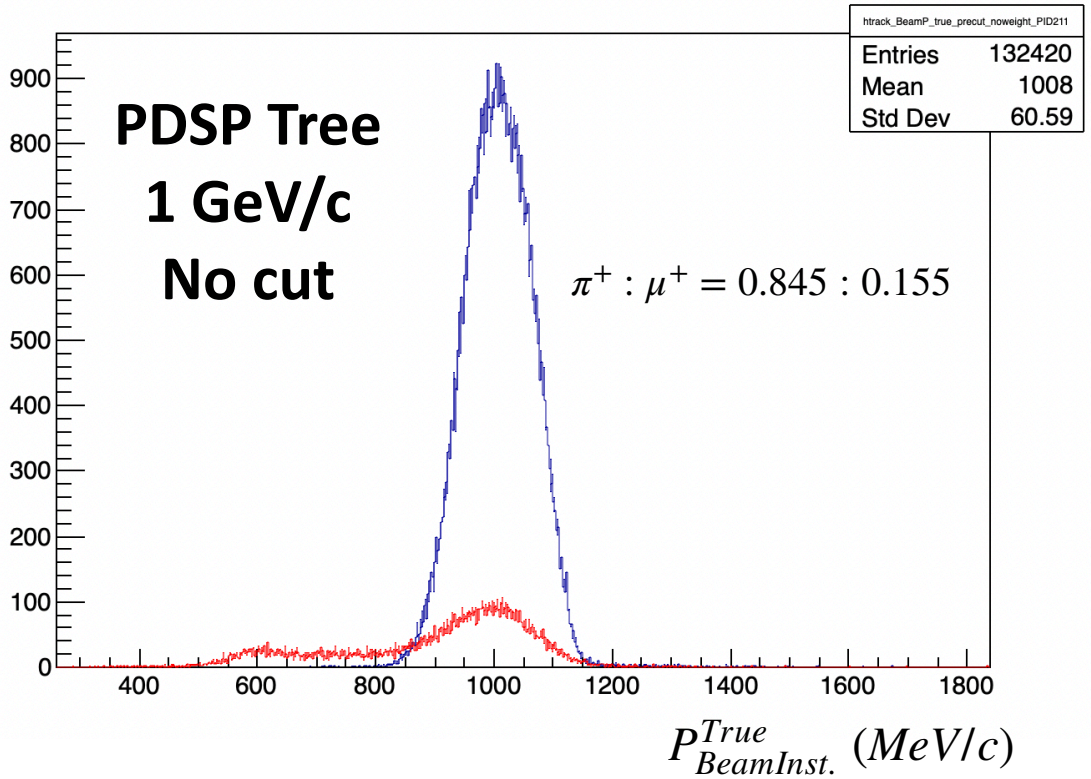

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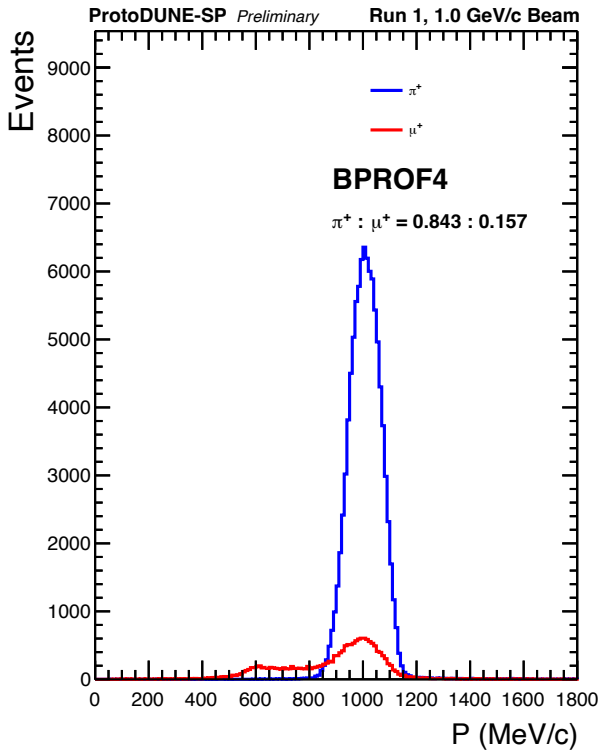

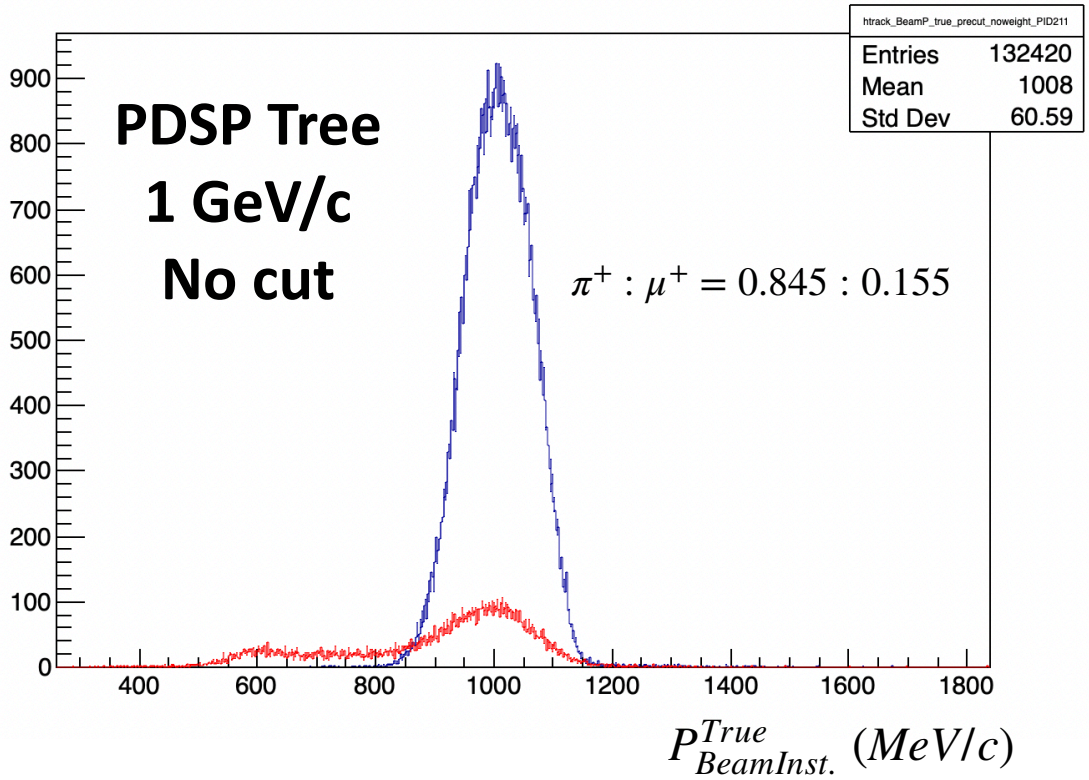

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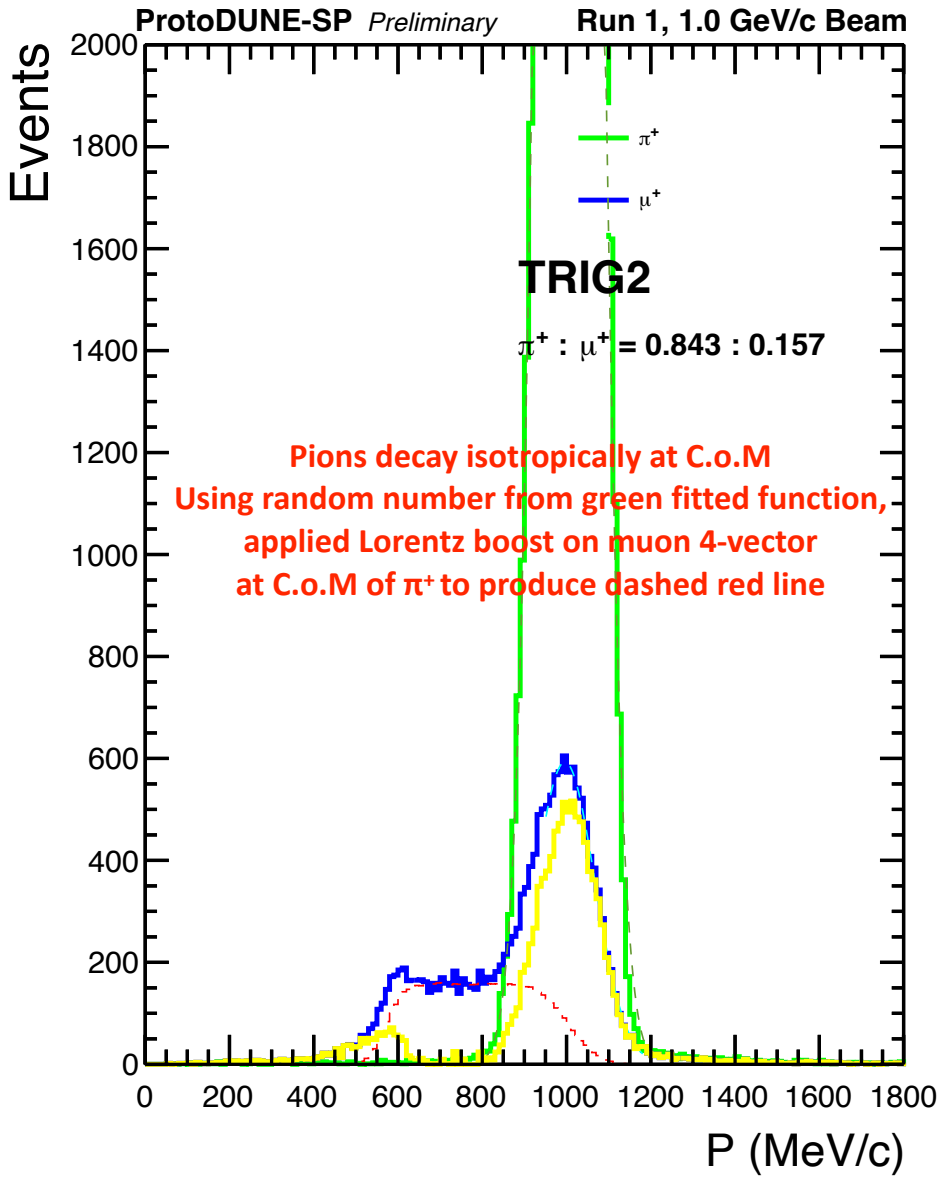
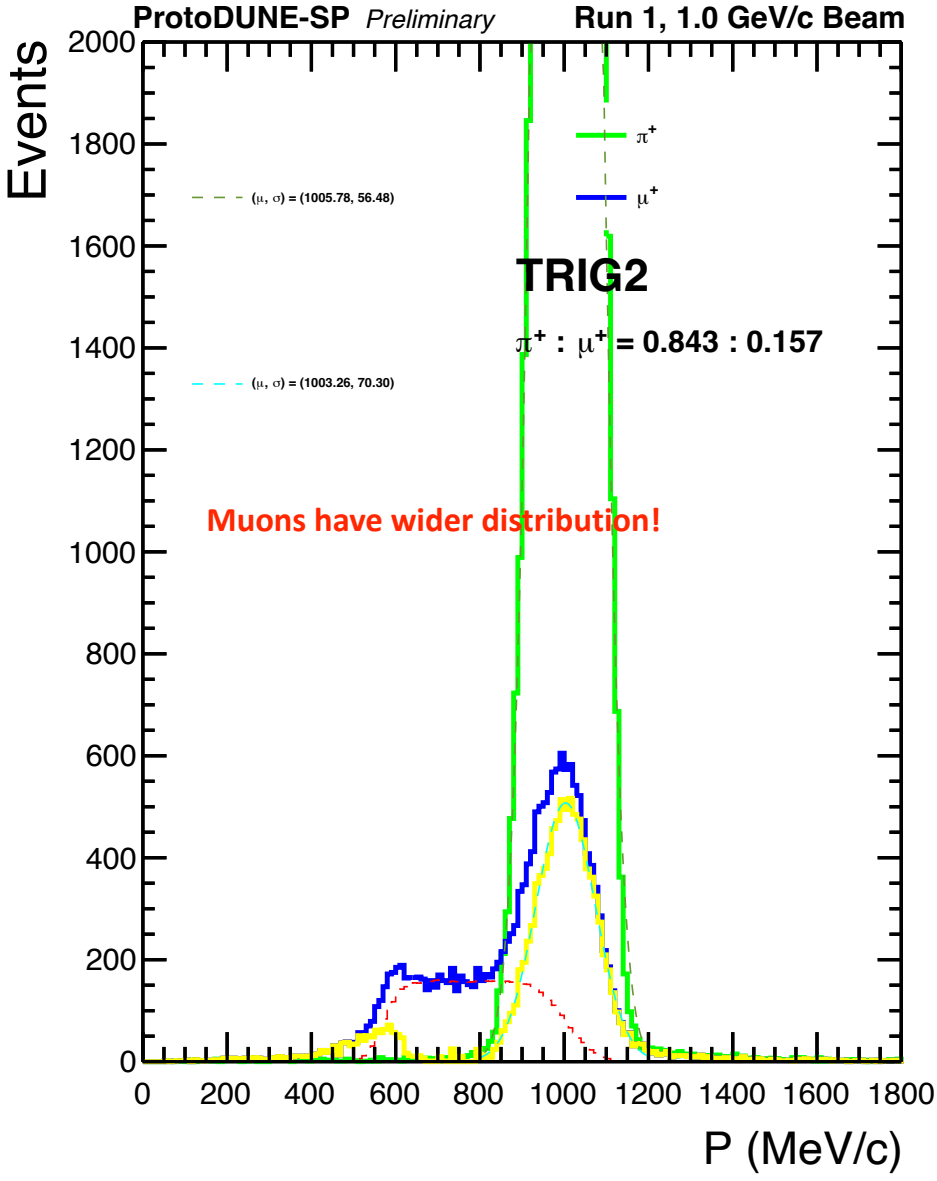

ProtoDUNE-SP Preliminary
Run 1, 1.0 GeV/c Beam
Events
P (MeV/c)
π+
μ+
TRIG2
π+ : μ+ = 0.843 : 0.157
Pions decay isotropically at C.o.M
Using random number from green fitted function,
applied Lorentz boost on muon 4-vector
at C.o.M of π+ to produce dashed red line


ProtoDUNE-SP Preliminary
Run 1, 1.0 GeV/c Beam
Events
P (MeV/c)
π+
μ+
(μ, σ) = (1005.78, 56.48)
(μ, σ) = (1003.26, 70.30)
TRIG2
π+ : μ+ = 0.843 : 0.157
Muons have wider distribution!