Michel analysis updates

Aleena Rafique and Zelimir Djurcic

ProtoDUNE sim/reco meeting

11/13/2019

Argonne NATIONAL LABORATORY

DUNE DEEP UNDERGROUND NEUTRINO EXPERIMENT

Updates

- Investigation of anode piercing tracks in the sample
- Investigation of low true energy events
- Sample background investigation
- Investigation of energy calibration

Investigation of anode piercing tracks in the sample

Anode-piercing tracks

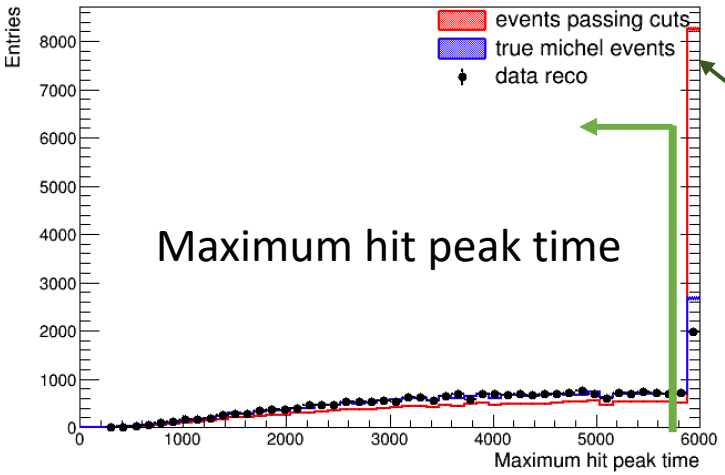
- Was considering both cathode crossers and anode piercers in the selection in prod 2
- Josh Thompson mentioned that the end x positions for anode piercing tracks is not necessarily as correct as for the cathode crossers
- Looked how many anode piercers do I have in the sample
- Checked the impact of removing anode piercers from the sample

Anode-piercing tracks in the sample

- In MC, 89% are cathode crossing tracks in the final sample
- In data, 99% are cathode crossing tracks

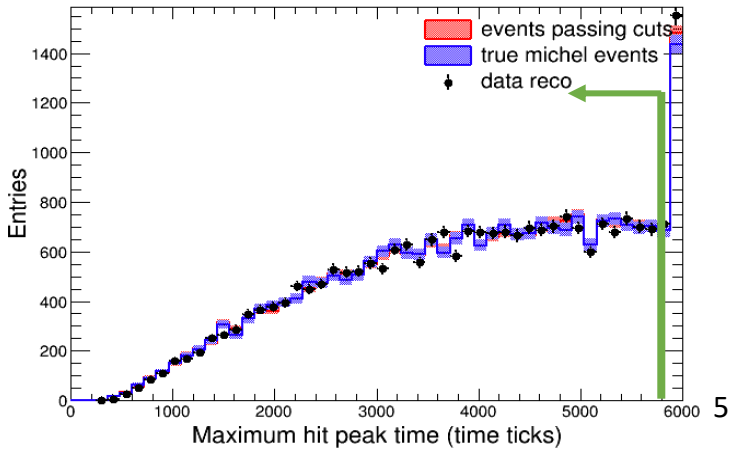
- Removed anode-piercers
  - No noticeable impact on the final purity
- Impact on “maximum hit peak time” distribution was observed
- Similar distribution as was observed in MCC11

Before



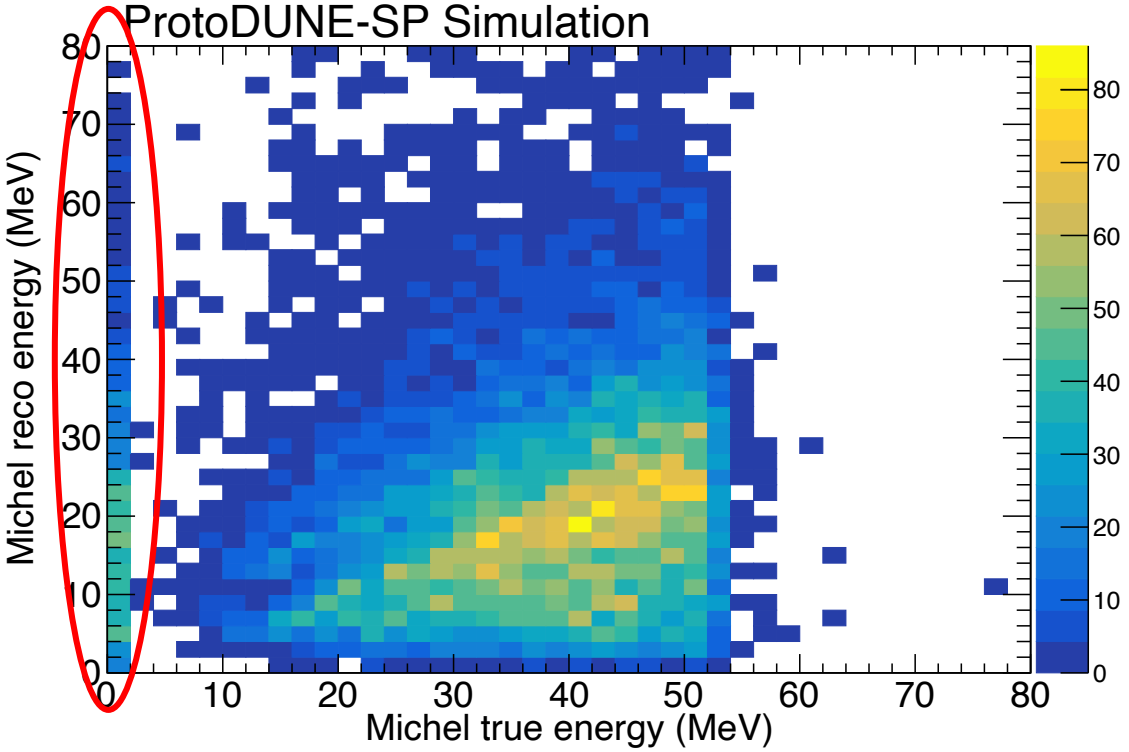
This peaks comes from anode piercers

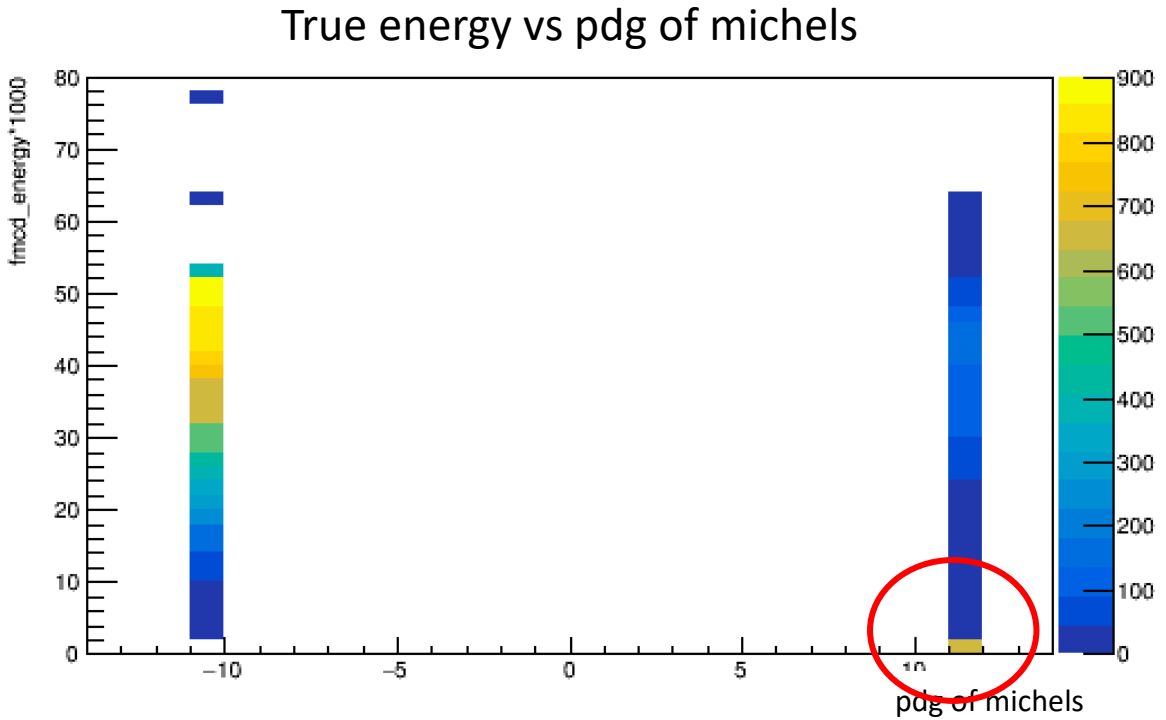
After



Investigation of low true energy events

Energy and pdg of true michels

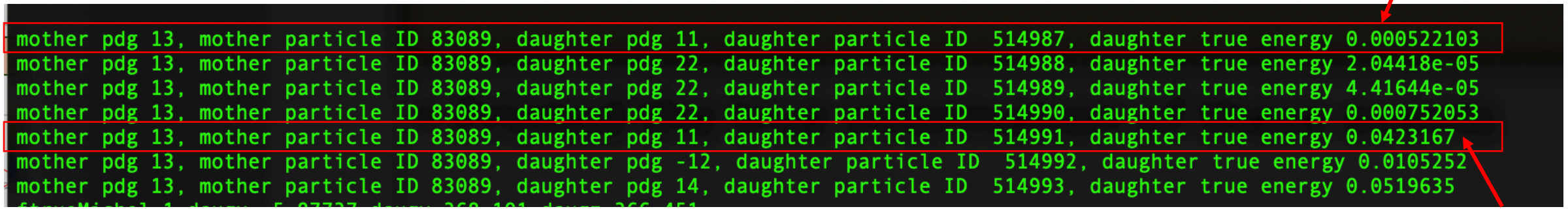




Low true energy particles are electrons

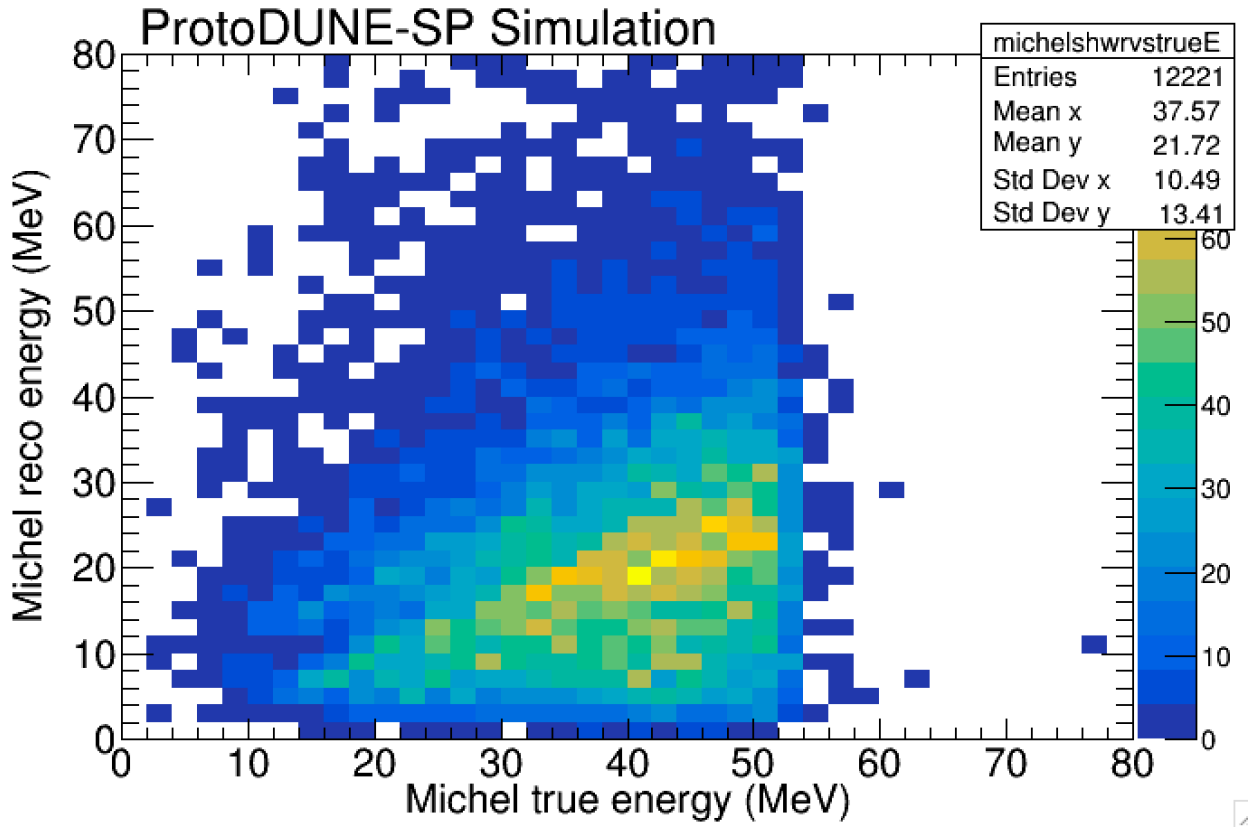
True info of these events

- Printed the true information of one of these event
- Used “simb::MCParticle” to loop over all daughters of the muon



- Delta ray or GEANT violates the lepton number conservation (?)
- Added a condition to consider the higher energy electron/positron to be the true michel if there are more than one electrons/positrons in an event

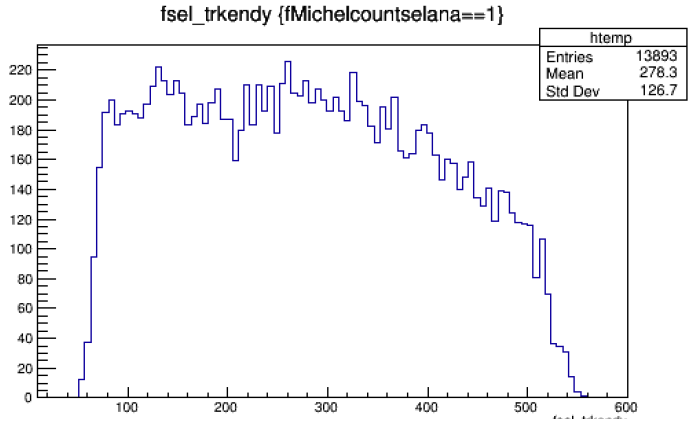
true vs reco michel energy after the fix

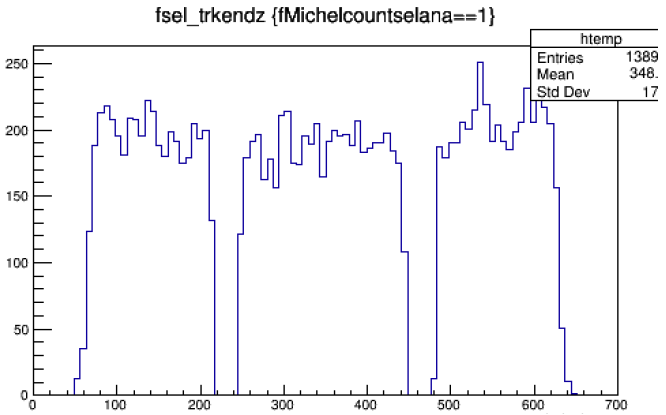


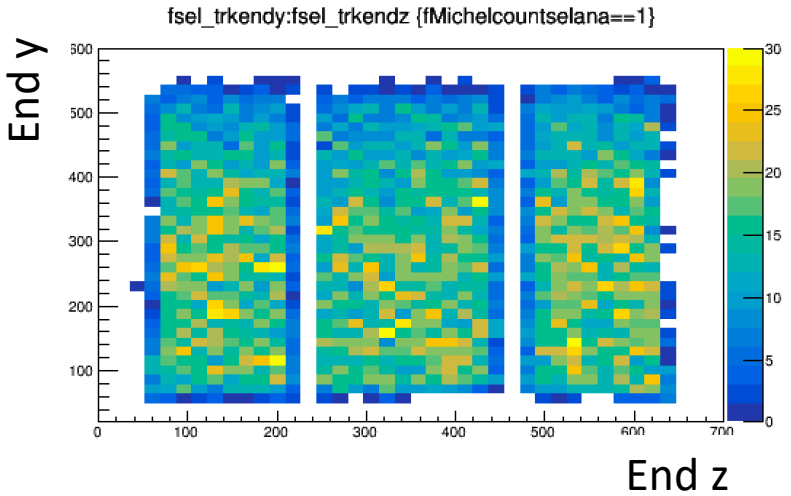
Sample background investigation

Candidate muon end y/z positions

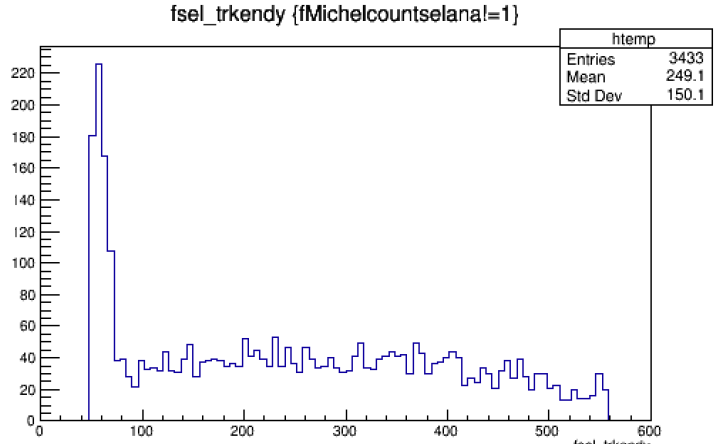
signal

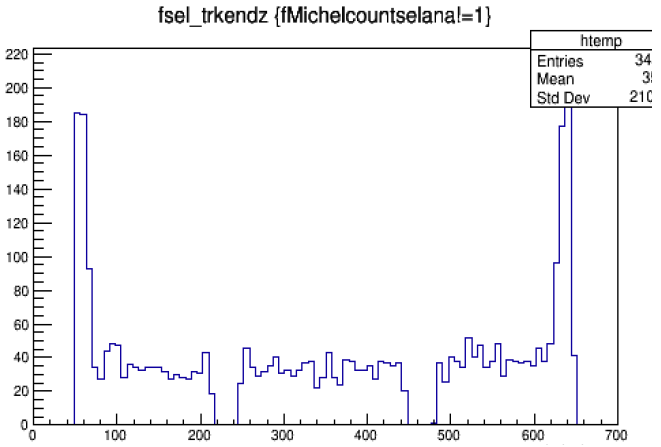


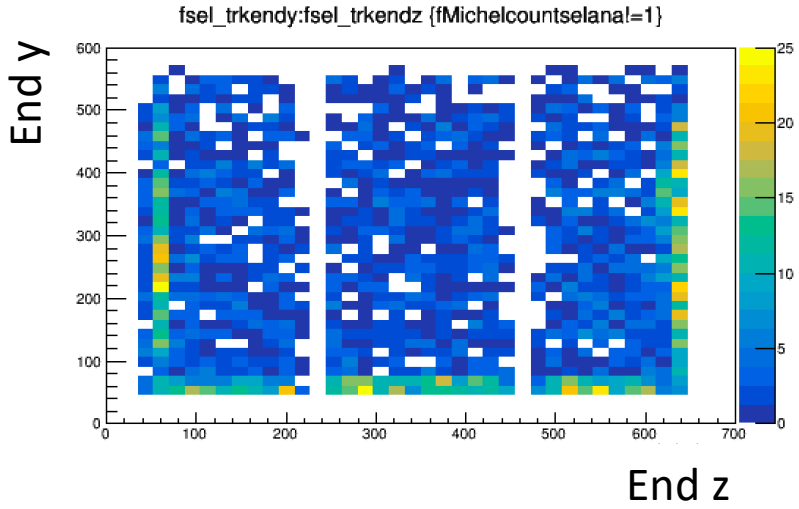




background



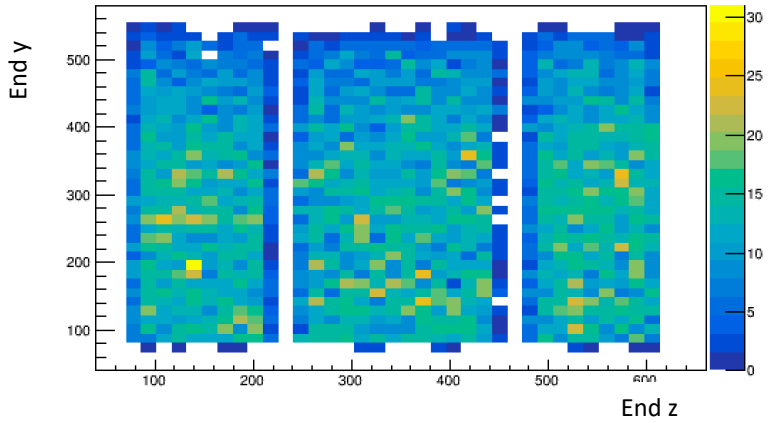




Improved purity

- Introduced additional cuts on end y and end z values of the candidate muons
  - Endy > 80 cm
  - 80 cm < endz < 610 cm
- Purity improved
  - 79% → 87%

signal



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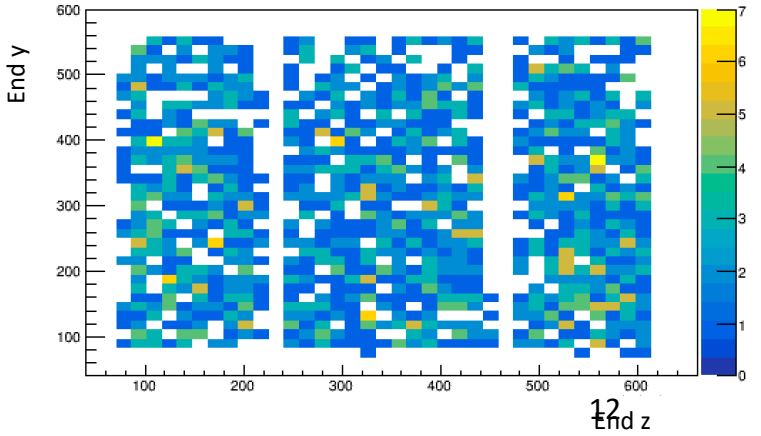
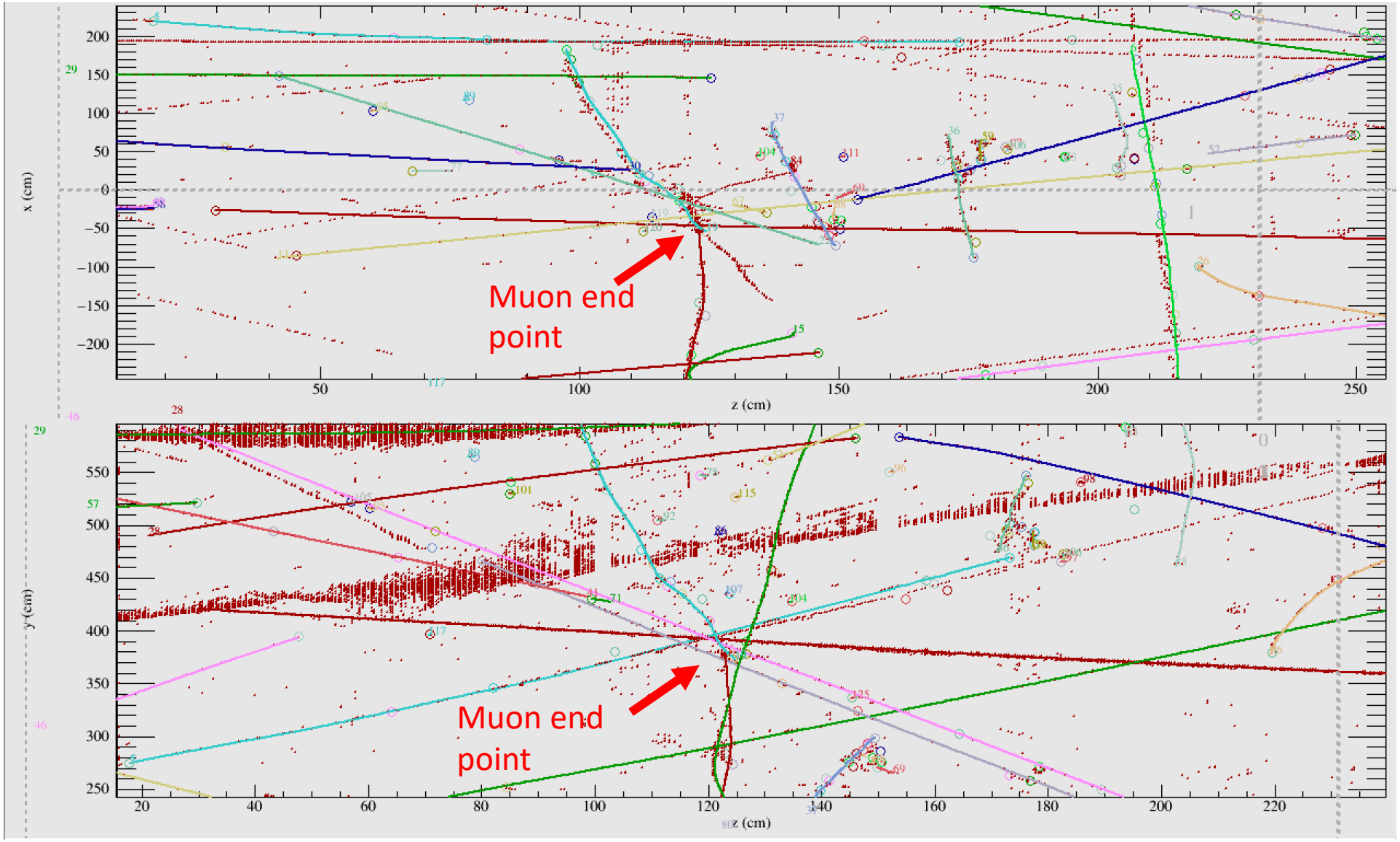


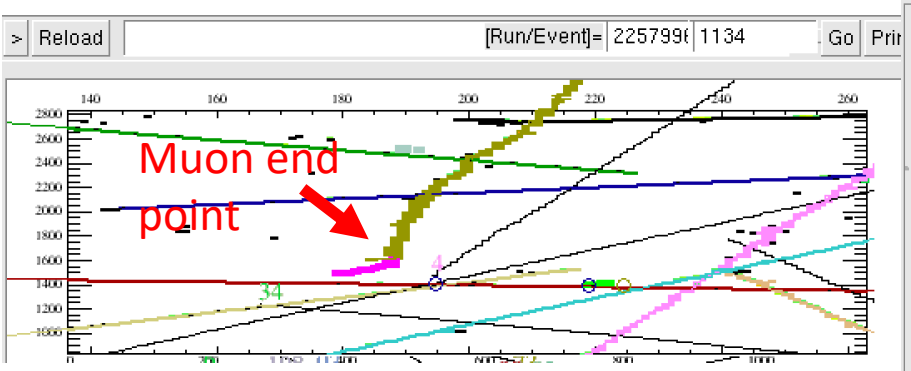
A background event



Wrong end x position

50 nearby hits within 10 cm circle

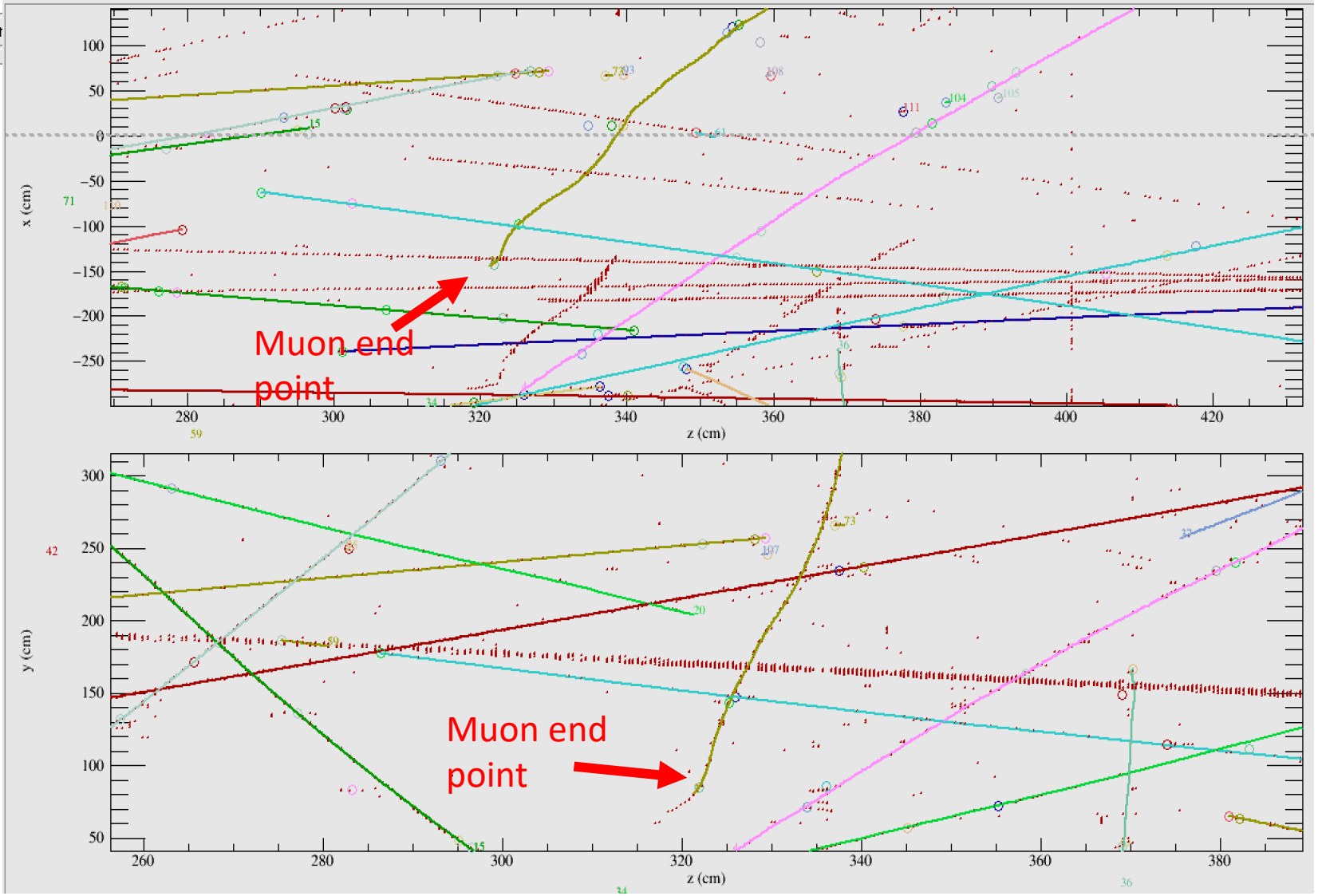
Another background event



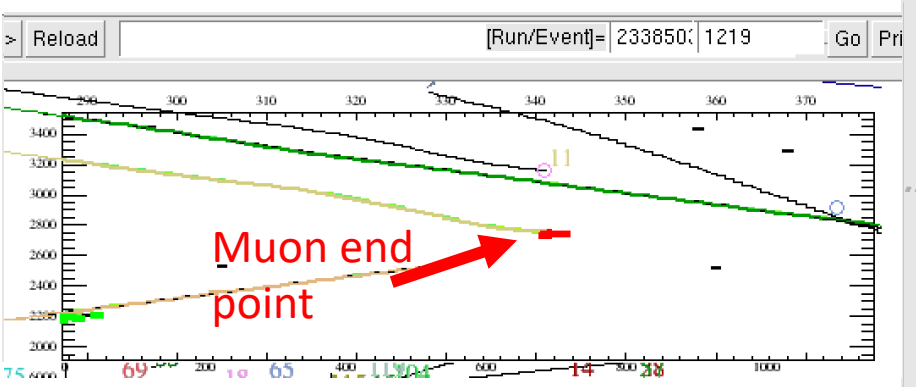
15 nearby muon end point

$$\mu^- \rightarrow \nu_\mu + 2\gamma + \text{nucleus}$$

GEANT process name:
MuMinusCaptureAtRest



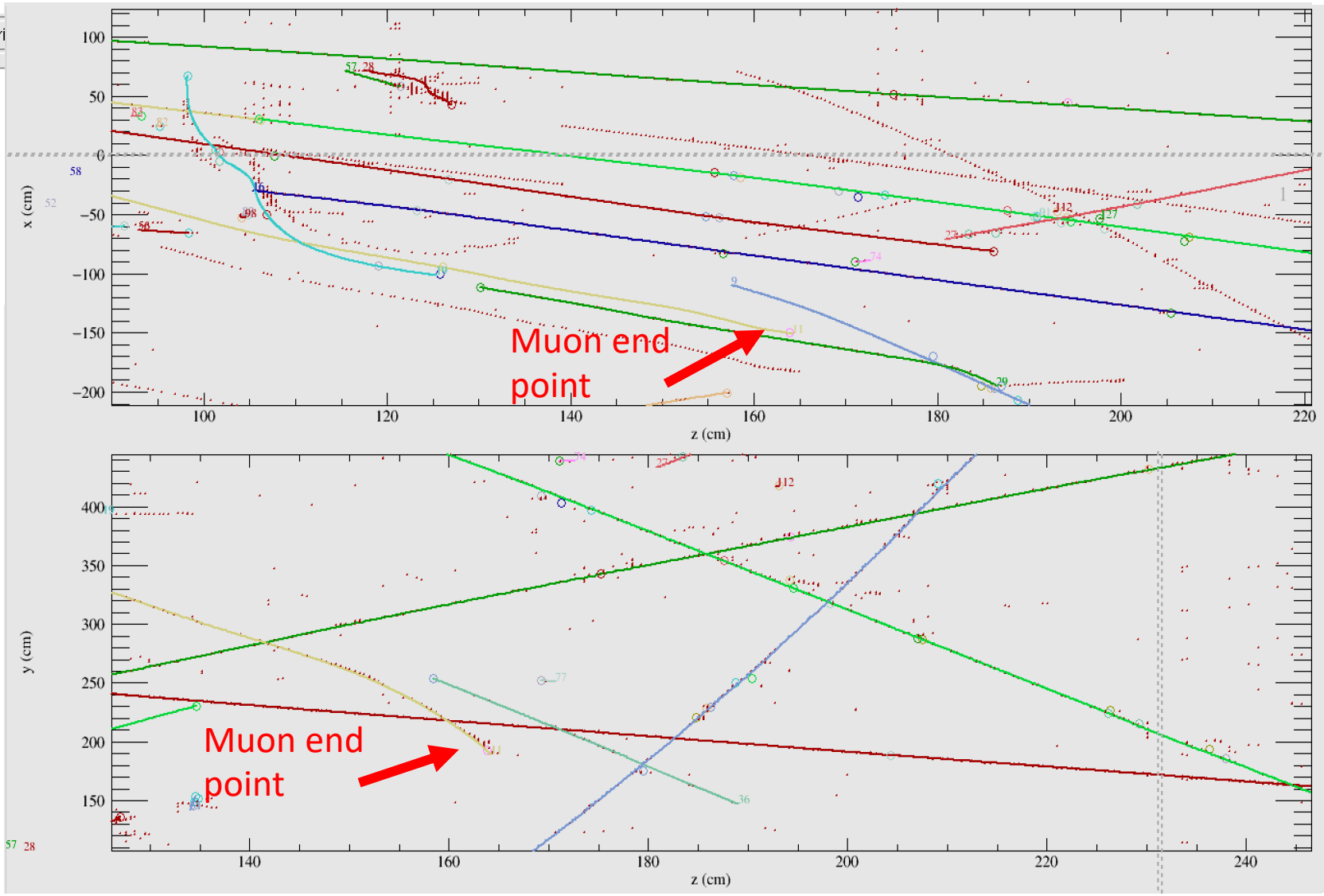
Another background event



5 nearby muon end point

$\mu^- \rightarrow \nu_\mu + 3\gamma$ +p+2n+nucleus

GEANT process name:
MuMinusCaptureAtRest



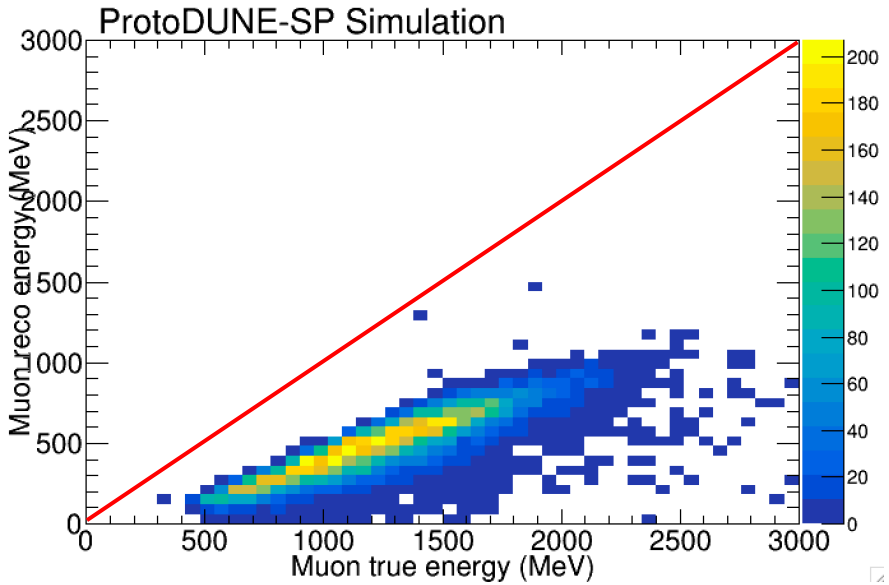
Investigation of energy calibration

Muon reconstructed vs true energy

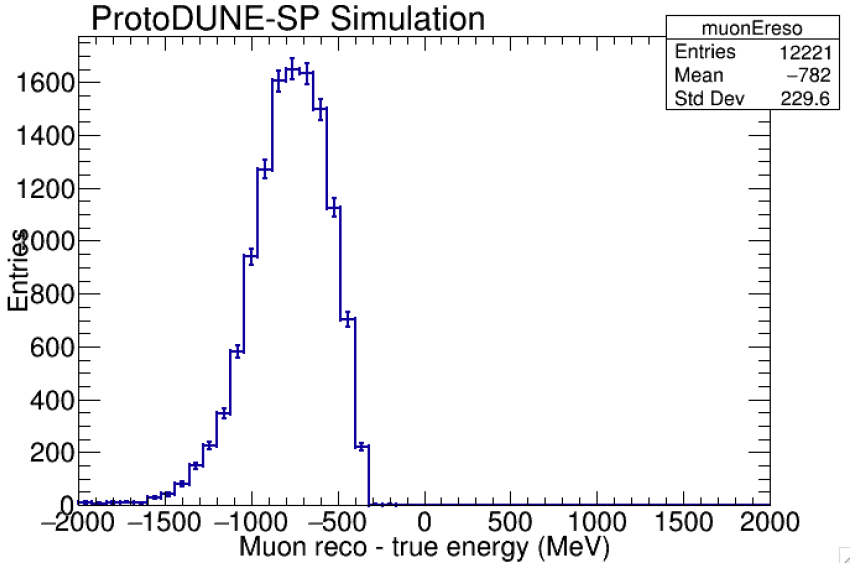
Recombination factor = 1

$$E = \sum_{i=coll.\,plane\ hits} \frac{Q_i * Cx * Cyz * Wion * Norm\_factor}{Calib\_const * Recomb\_factor}$$

Muon true vs reco energy



Muon energy resolution

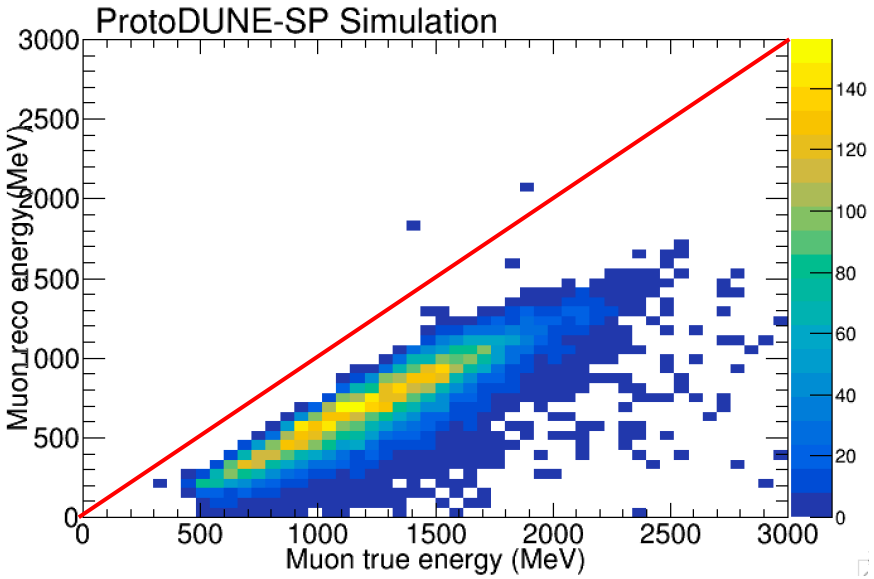


Ajib: https://docs.dunescience.org/cgi-bin/private/RetrieveFile?docid=15974&filename=prod2_calibration_constants_for_selected_runs.pdf&version=2

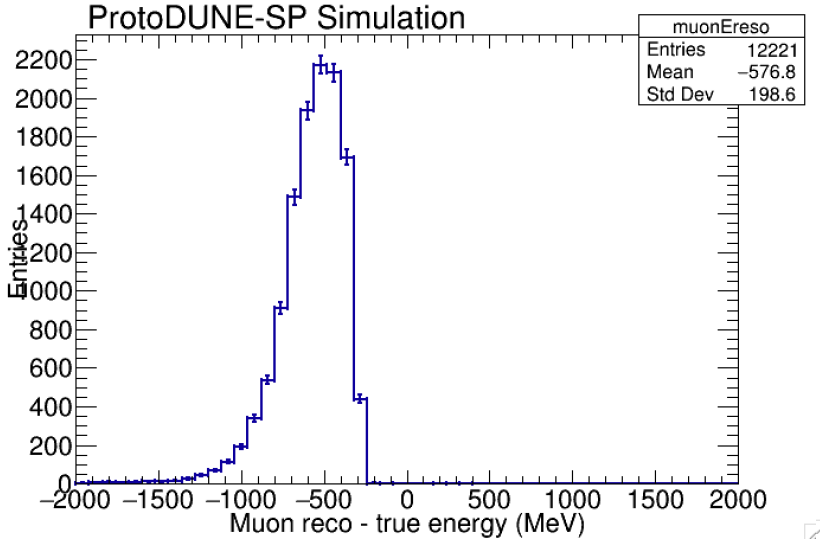
Muon reconstructed vs true energy

Recombination factor = 0.7

Muon true vs reco energy



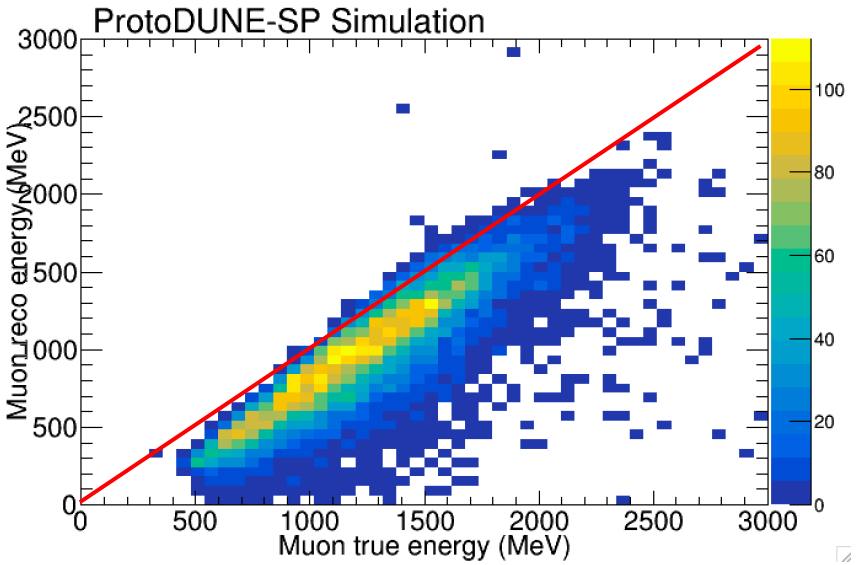
Muon energy resolution



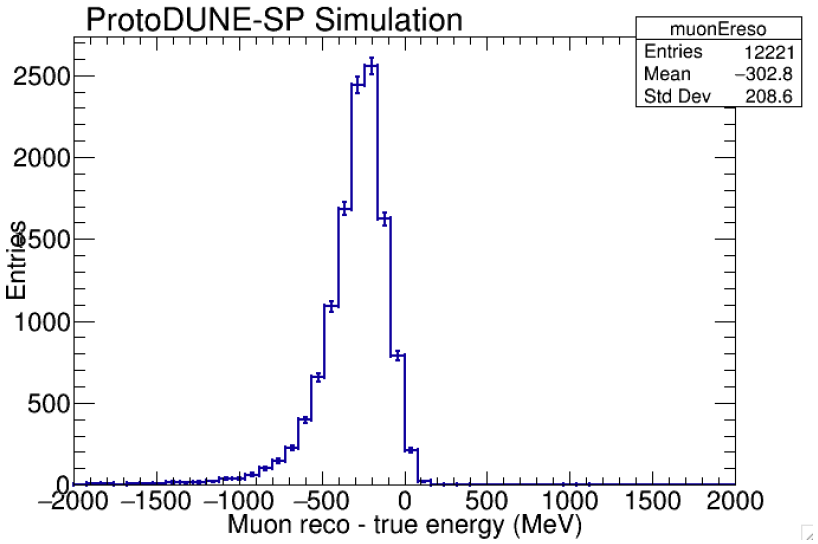
Muon reconstructed vs true energy

Recombination factor = 0.5

Muon true vs reco energy

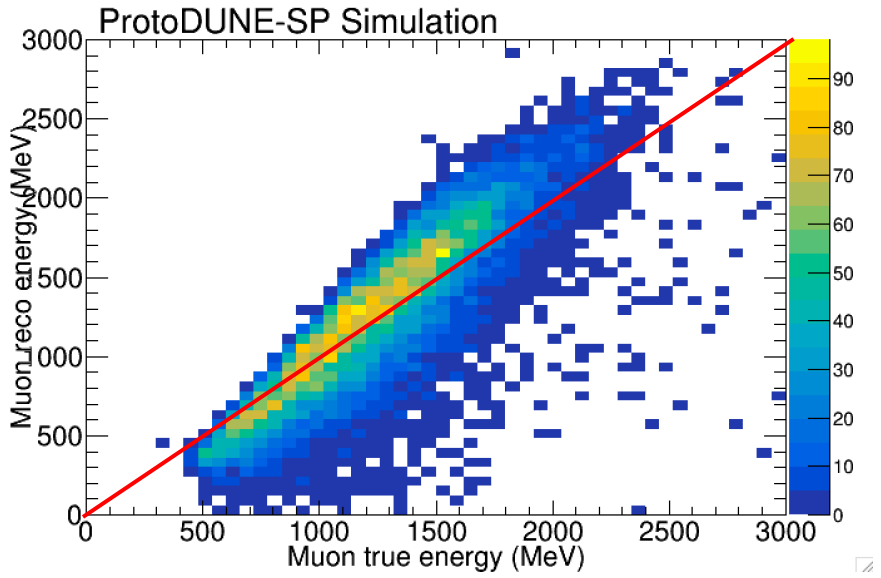


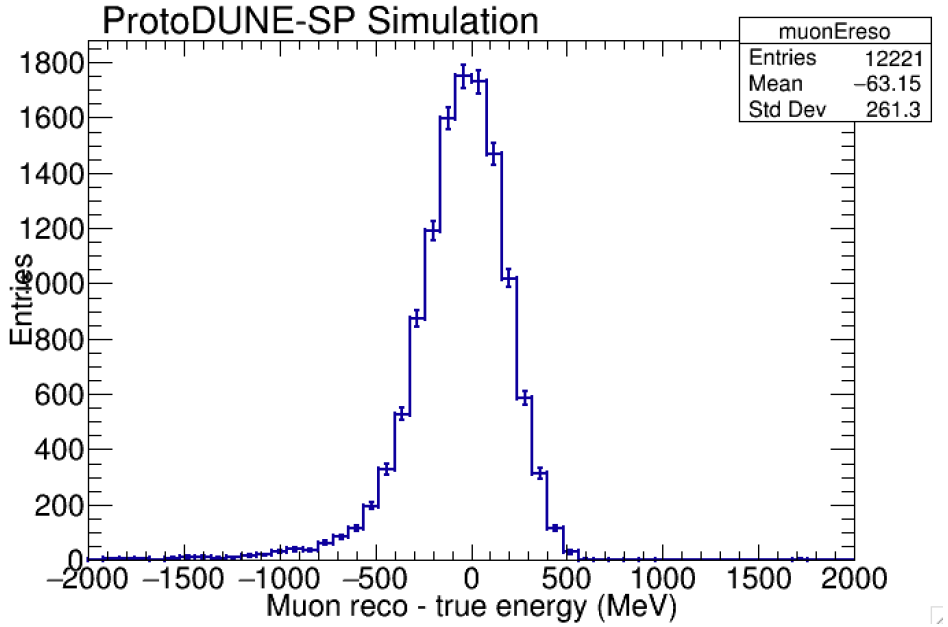
Muon energy resolution



Muon reconstructed vs true energy

Recombination factor = 0.4

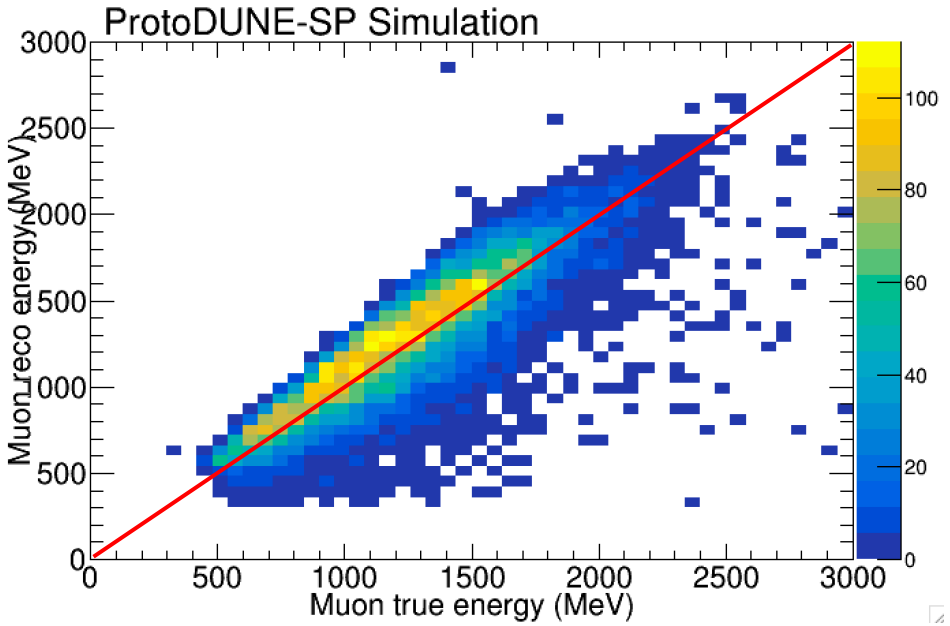


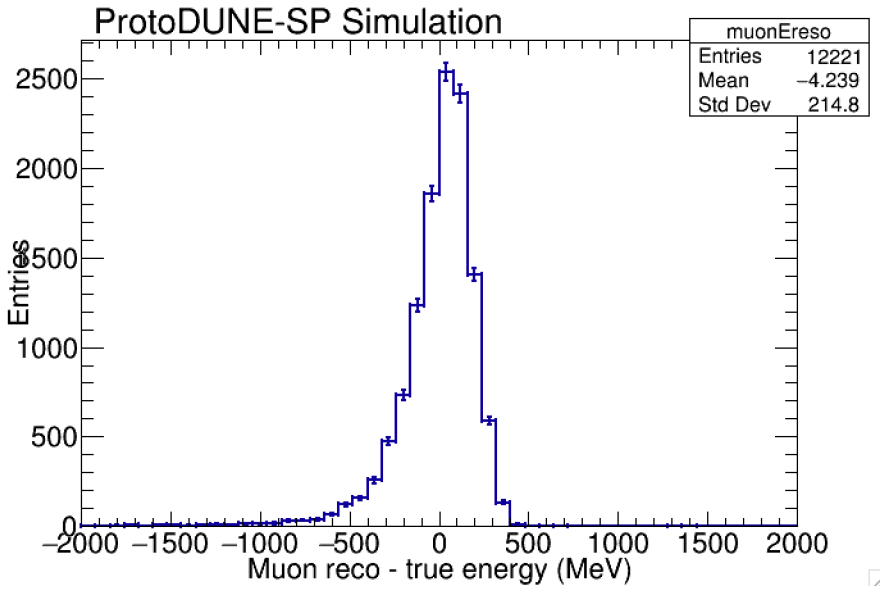


Muon reconstructed vs true energy

Recombination factor = 0.5

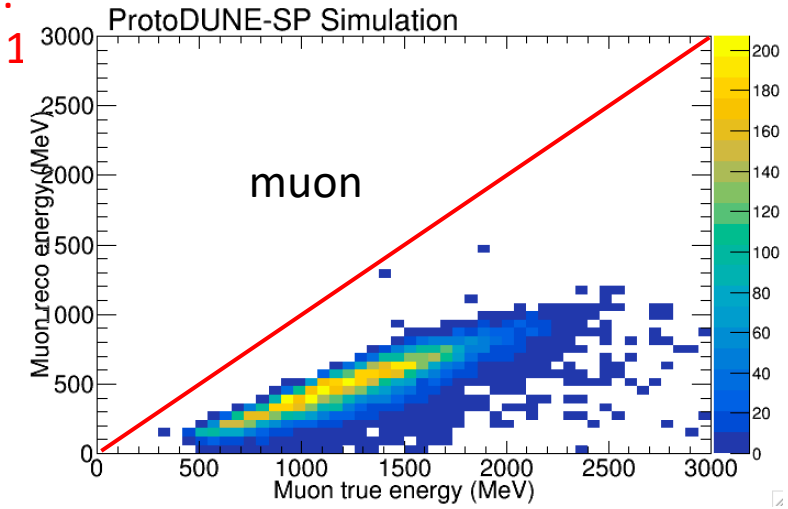
Added 300 MeV in observed energy

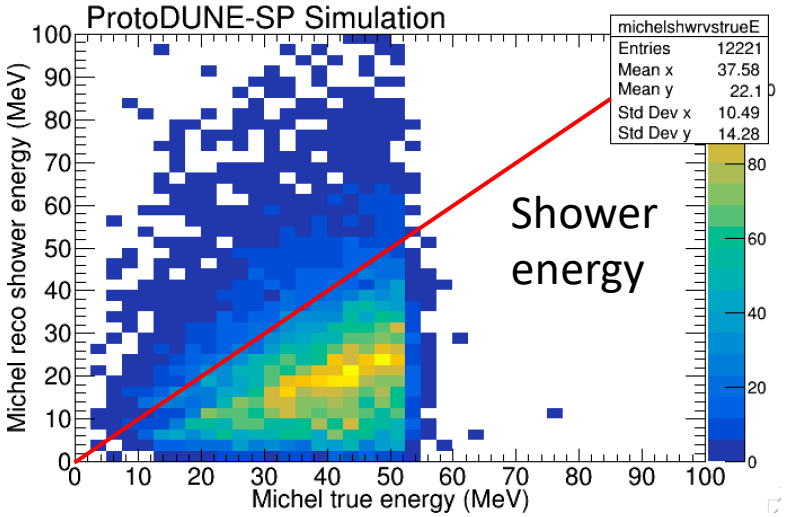


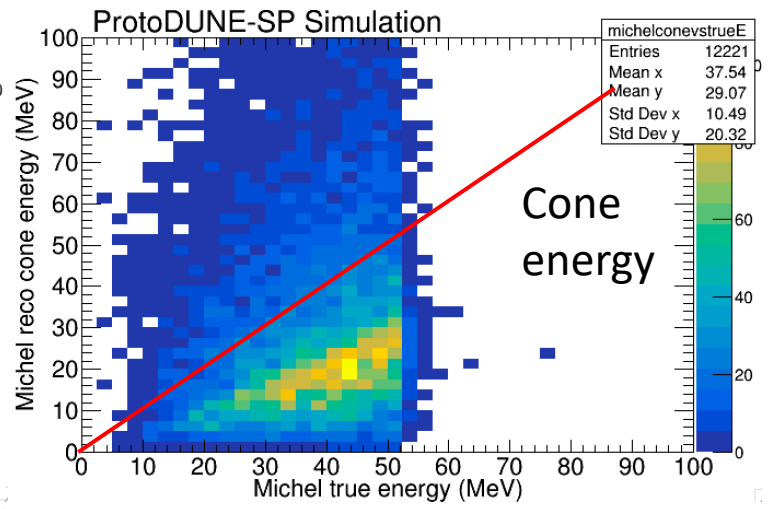


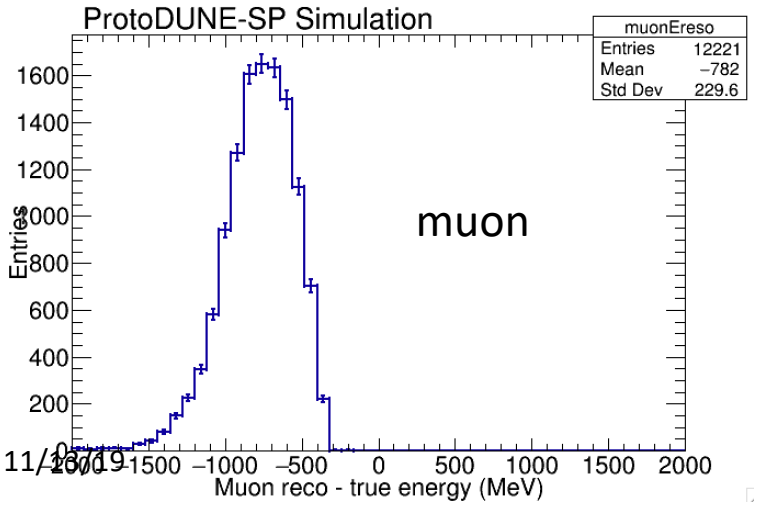
True vs reco energies

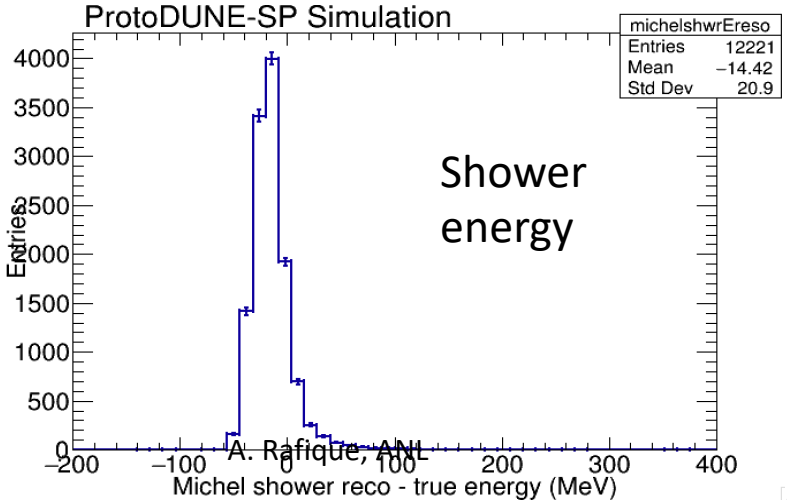
Recomb. factor = 1

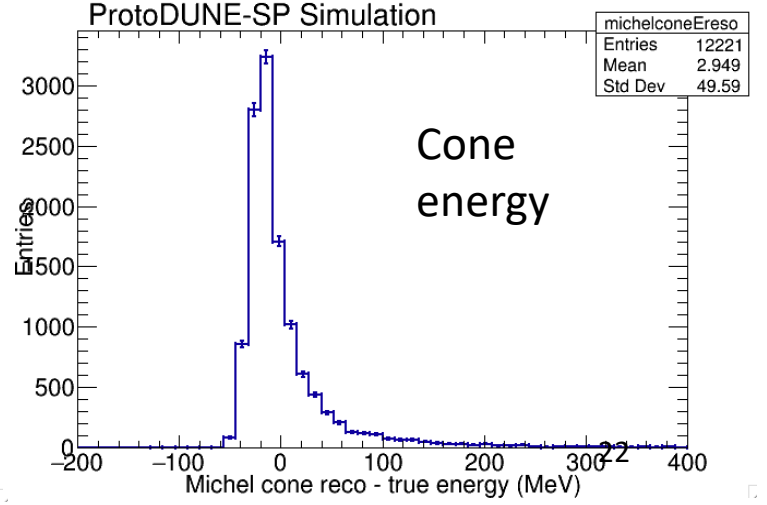






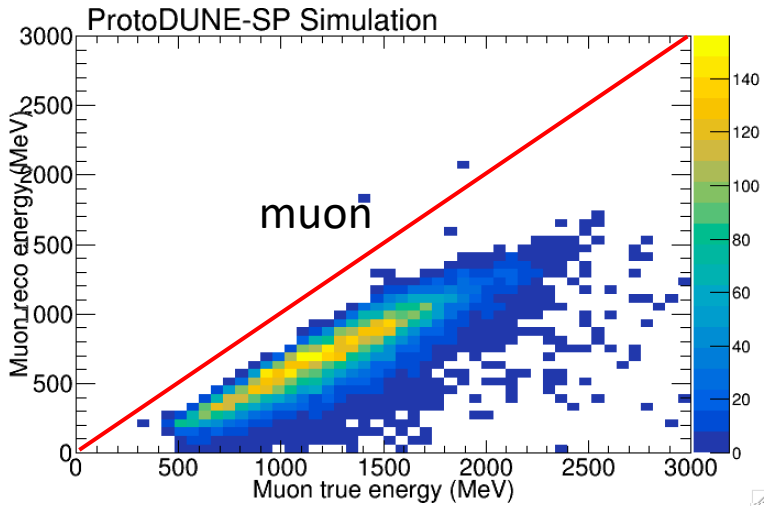


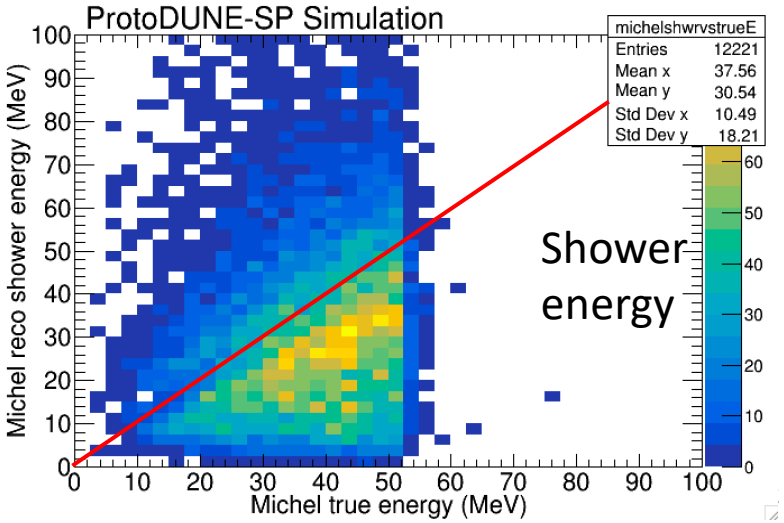


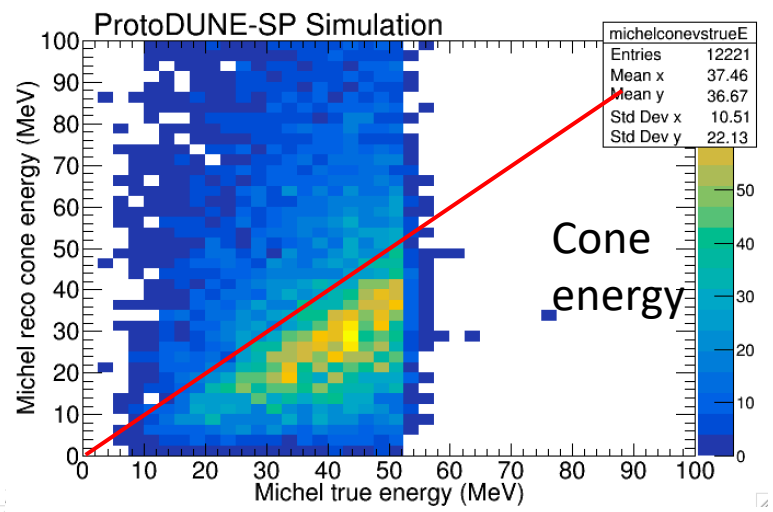


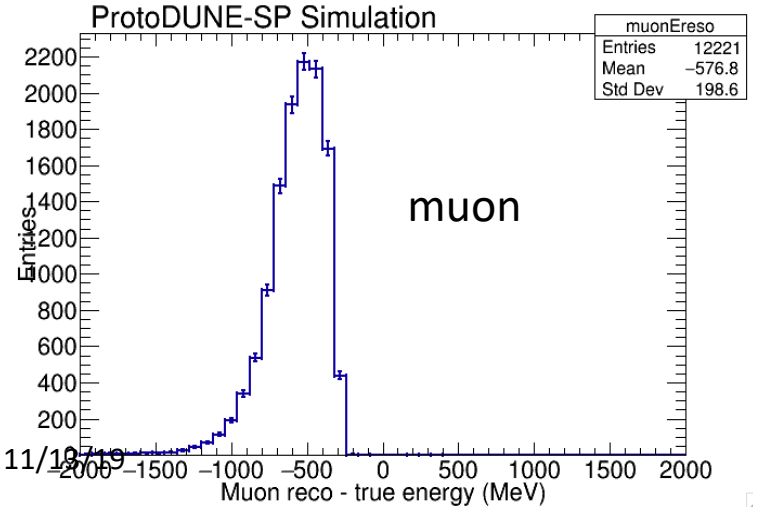
True vs reco energies

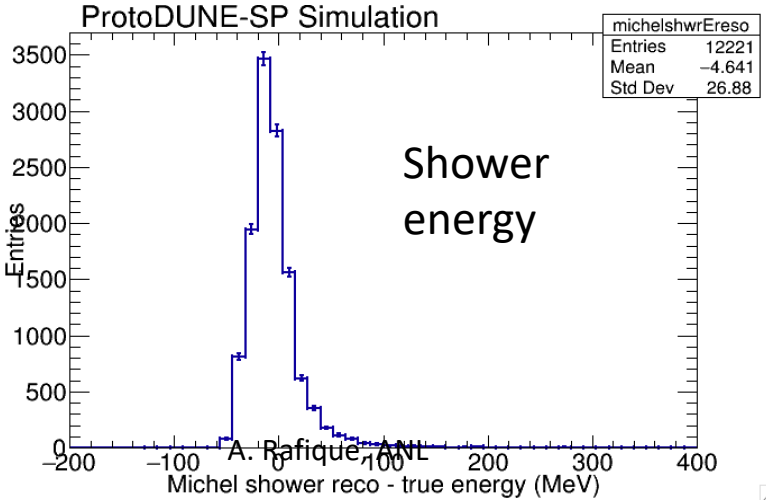
Recomb. factor = 0.7

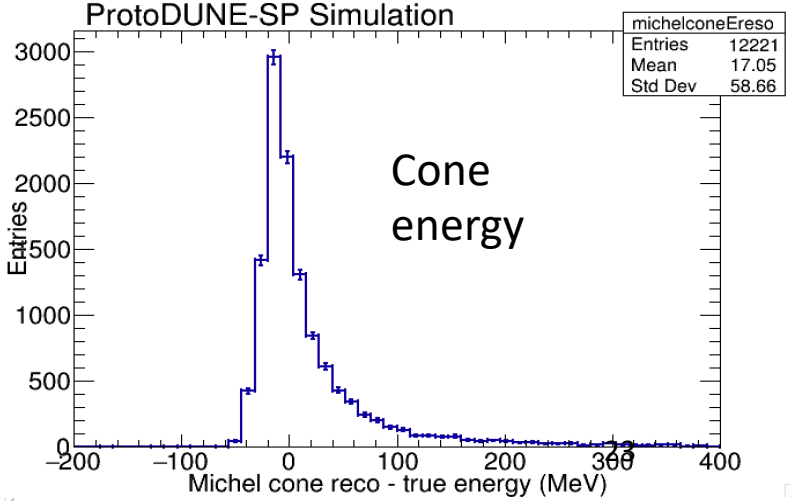






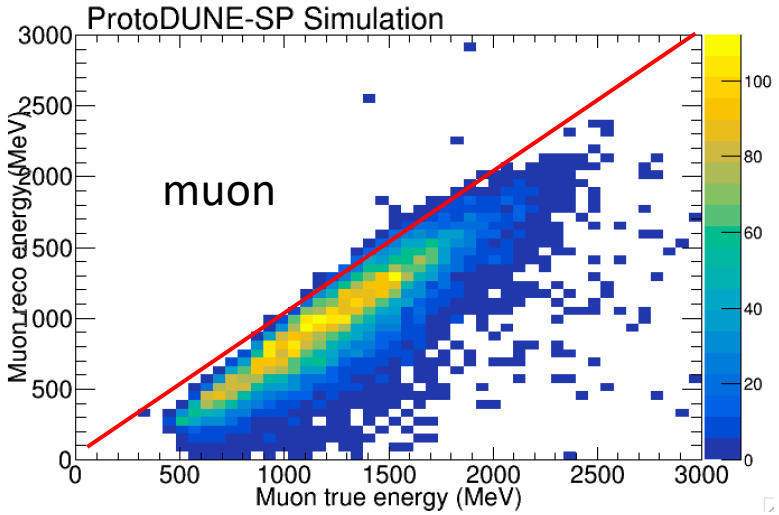


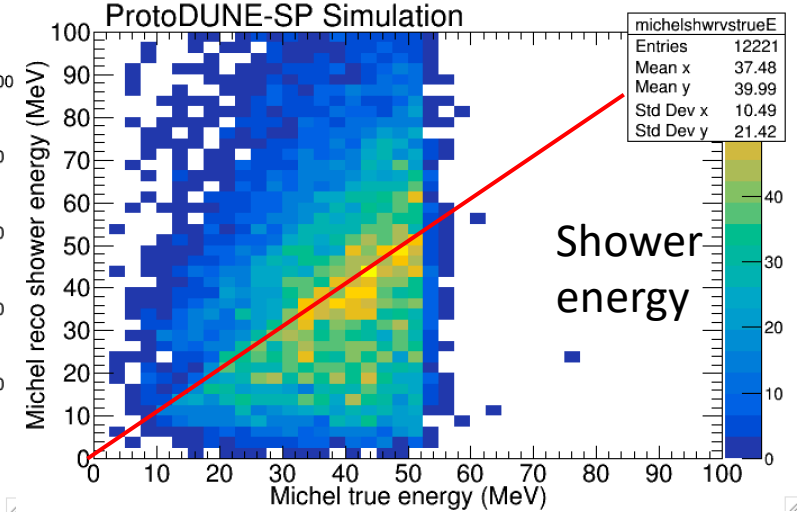


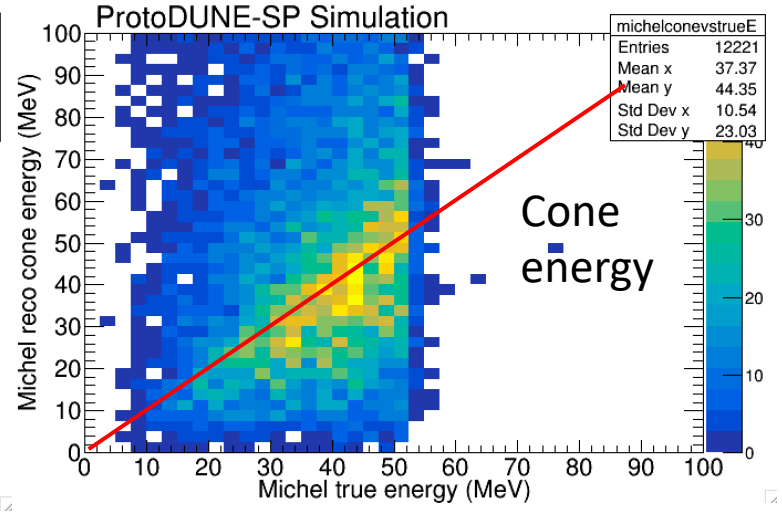


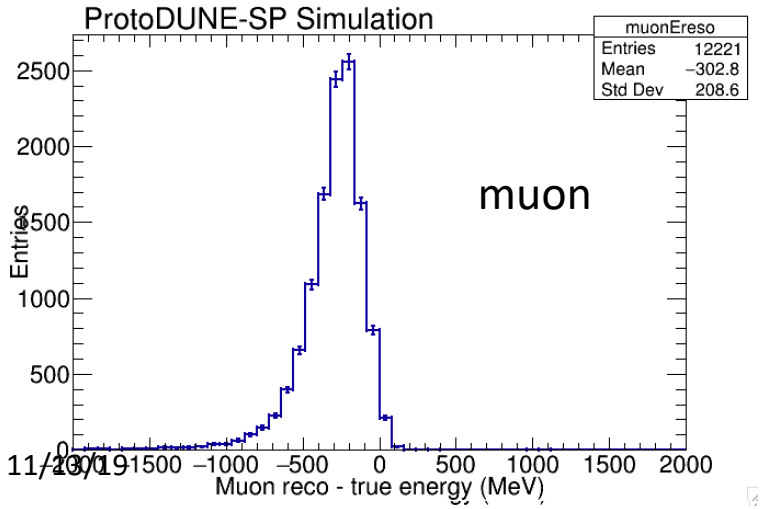
True vs reco energies

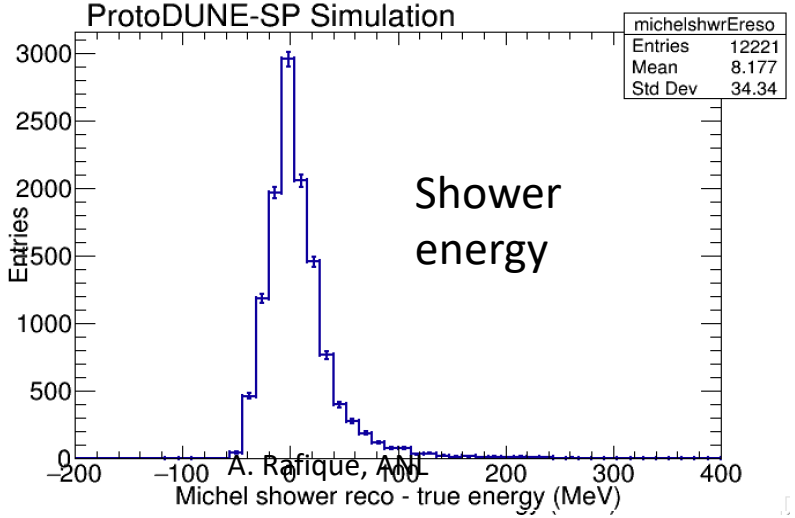
Recomb. factor = 0.5

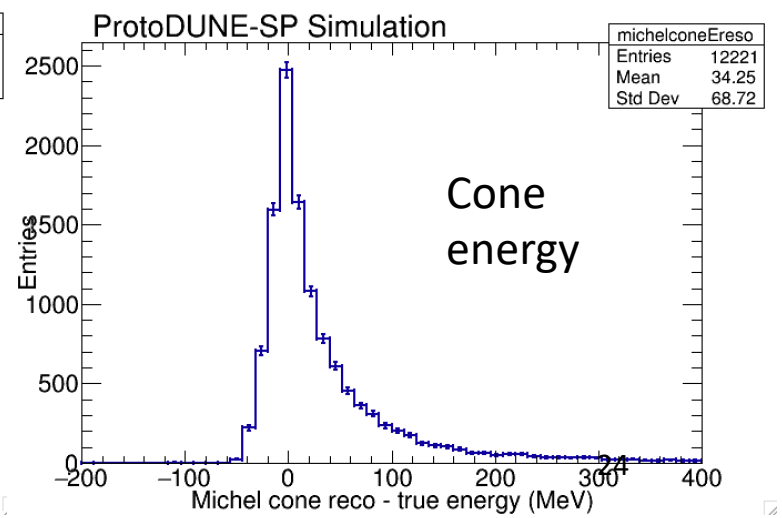






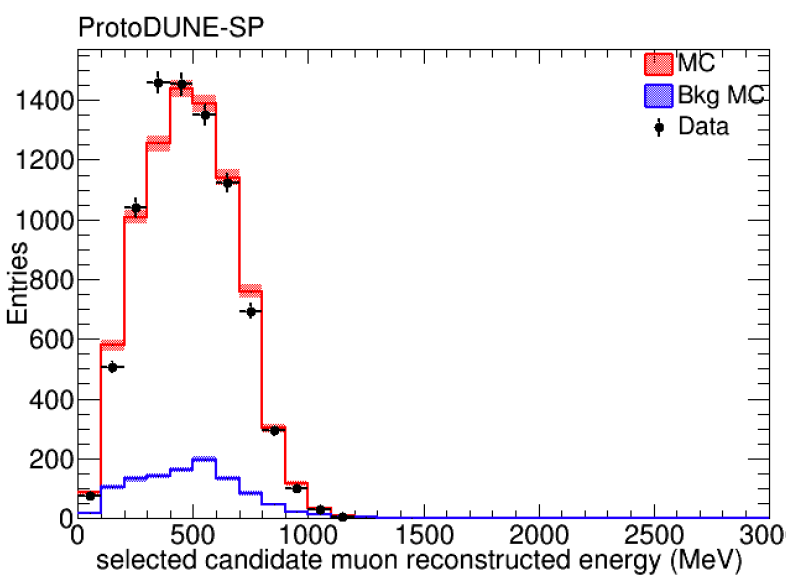


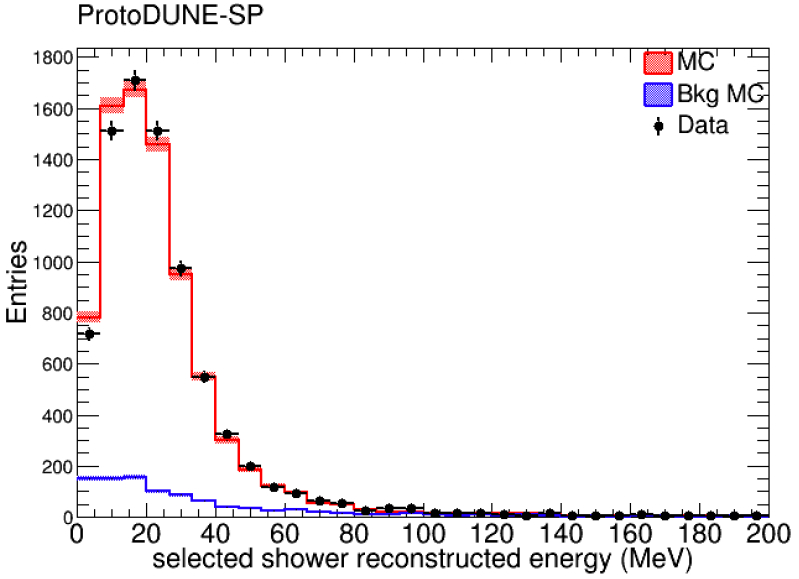


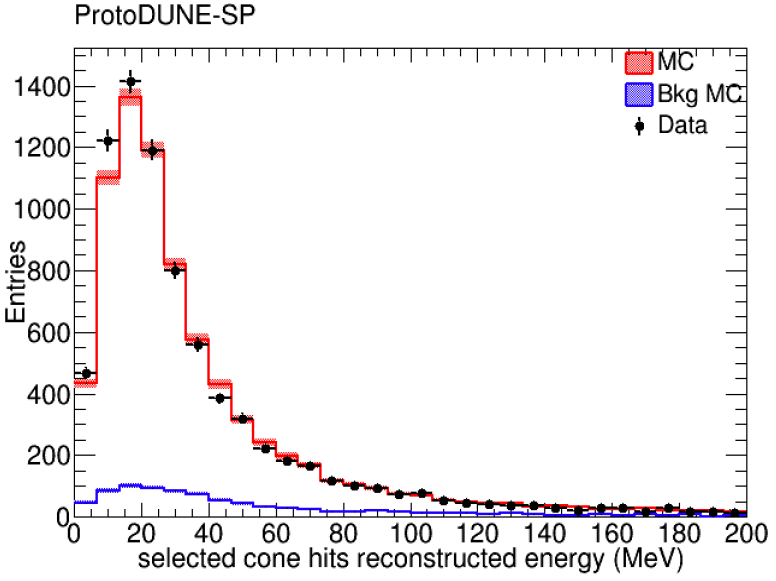


Energy spectrums

Recombination factor = 1

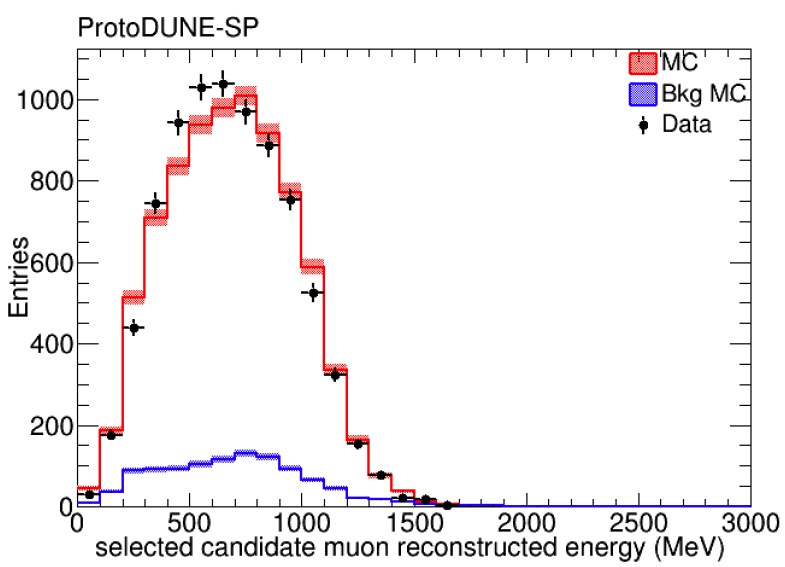


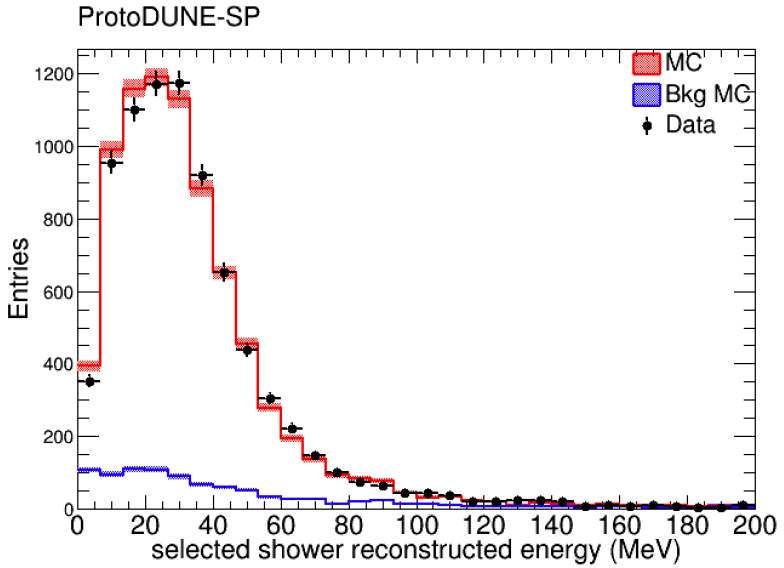


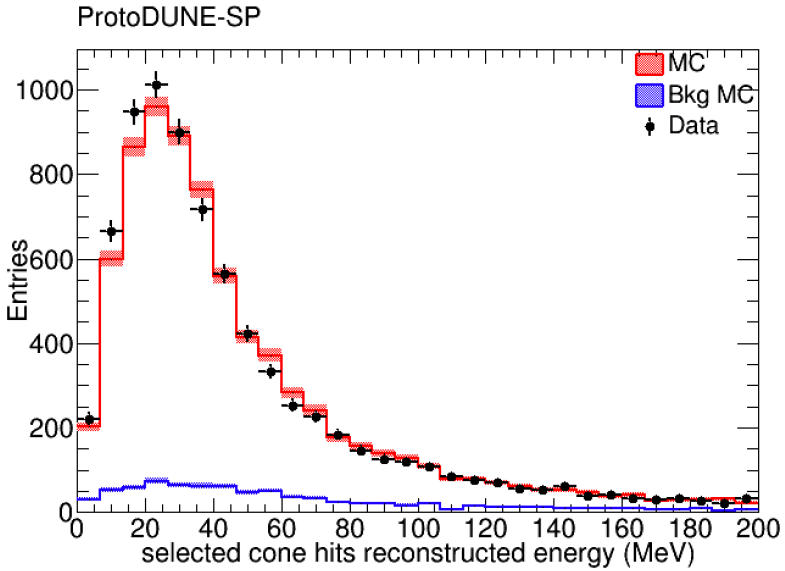


Energy spectrums

Recombination factor = 0.7

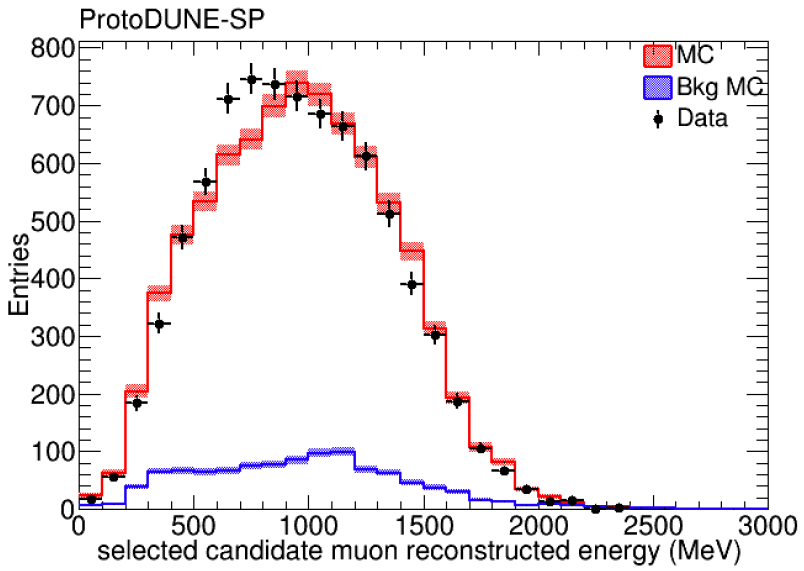


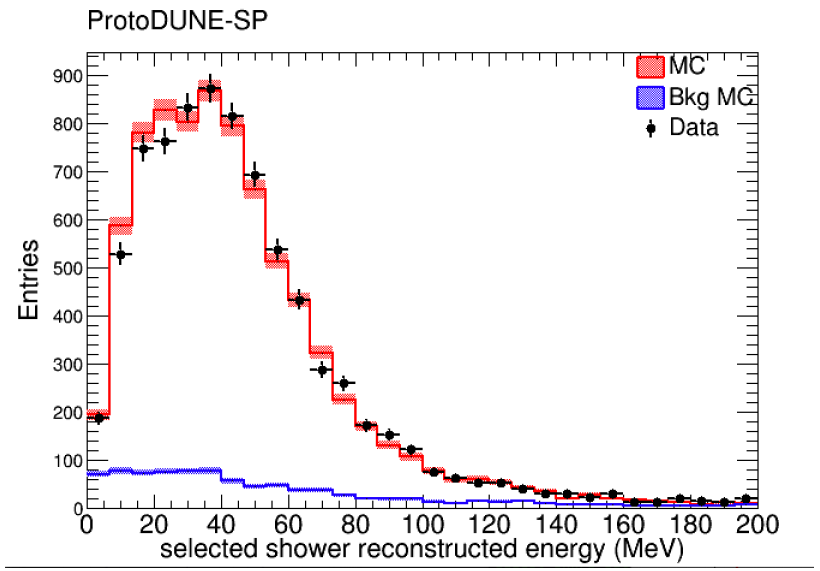


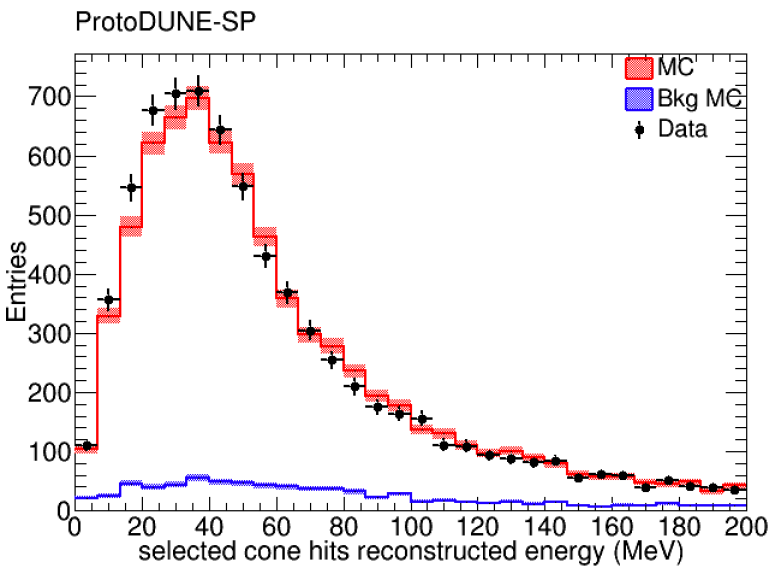


Energy spectrums

Recombination factor = 0.5







Summary

- Made several updates in the analysis as described
- Analysis note in progress