Master-2 internship: Analysis of data from the Time Projection Chambers of the T2K Near Detector

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Summary of the previous meeting

- At the previous meeting, I presented that the TPCs' energy resolution resulting from Production 7A Monte Carlo (MC) simulation is different from that of Prod6L MC, Prod6P Data and Prod7B Data.

Previous result for positively charged particles

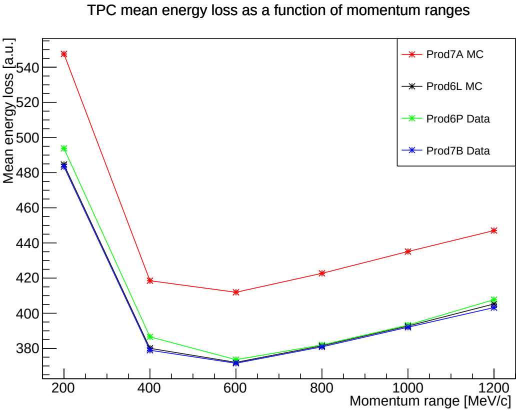

Figure: Mean energy loss of the positively charged particles as a function of the momentum ranges.

Previous result for positively charged particles

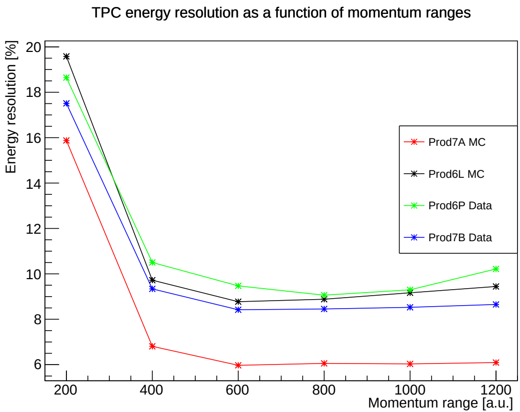

Figure: Energy resolution of the TPCs for the positively charged particles as a function of the momentum ranges.

Previous result for positively charged particles

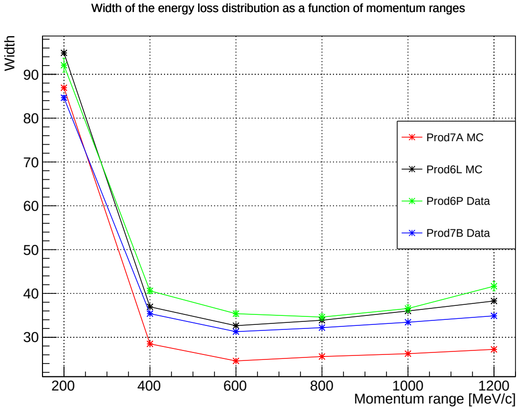

Figure: Width of the energy loss distribution of positively charged particles as a function of the momentum ranges.

Previous result for negatively charged particles

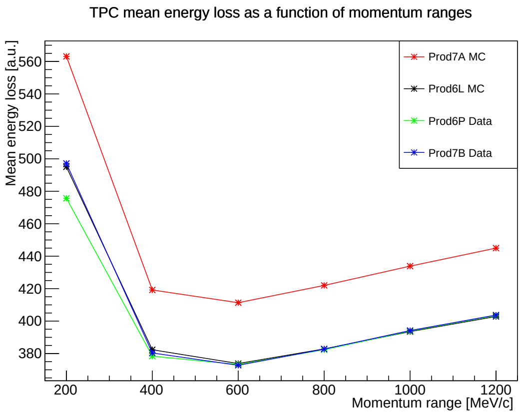

Figure: Mean energy loss of the negatively charged particles as a function of the momentum ranges.

Previous result for negatively charged particles

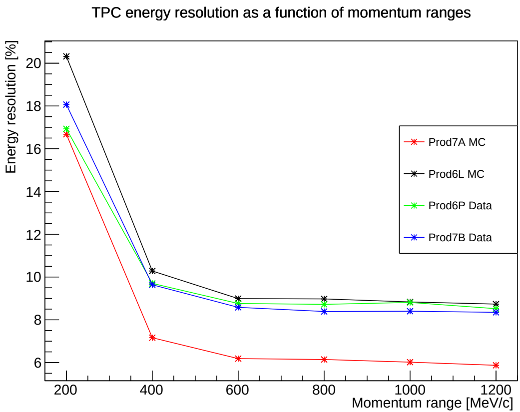

Figure: Energy resolution of the TPCs for the negatively charged particles as a function of the momentum ranges.

Previous result for negatively charged particles

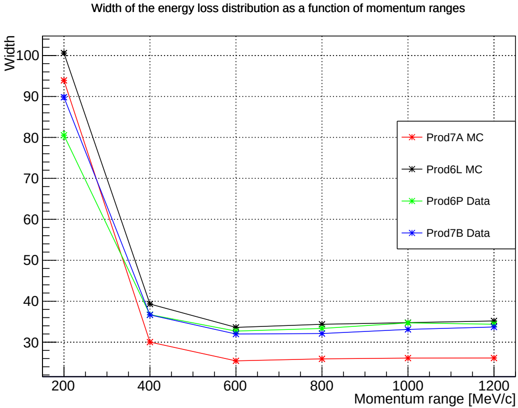

Figure: Width of the energy loss distribution of negatively charged particles as a function of the momentum ranges.

Current plan

• Since the difference is in the MC, the next step we would like to do is to compare true different particle types to see if only muons are affected or all particles are affected equally.

• To do this, we classify the true particle types according to the value of the variable sTrueTrackPDG.

• For example, sTrueTrackPDG=13 for a muon, -13 for a positively charged antimuon, 2212 for a proton, etc.

Results for negatively charged muons

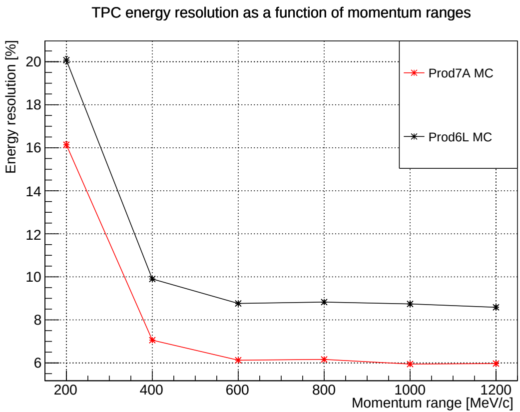

Figure: Energy resolution of the TPCs for MC negatively charged muons as a function of the momentum ranges.

Results for negatively charged electrons

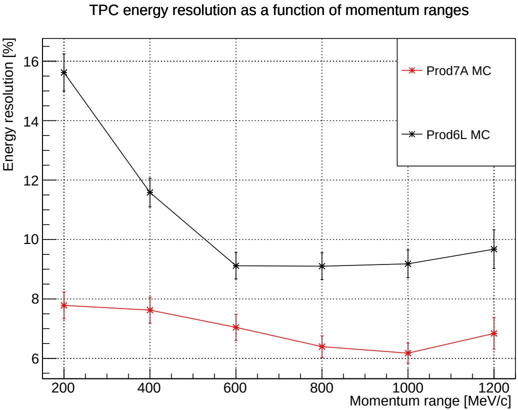

Figure: Energy resolution of the TPCs for MC negatively charged electrons as a function of the momentum ranges.

Results for negatively charged pions

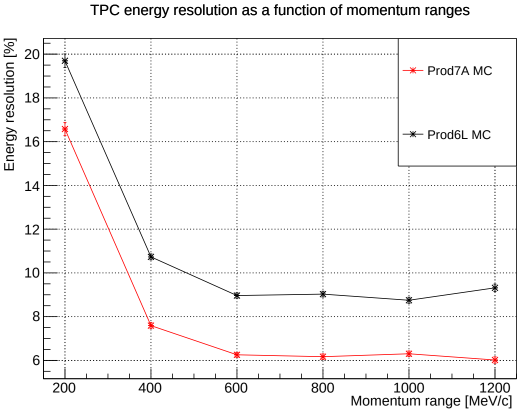

Figure: Energy resolution of the TPCs for MC negatively charged pions as a function of the momentum ranges.

Results for positively charged antimuons

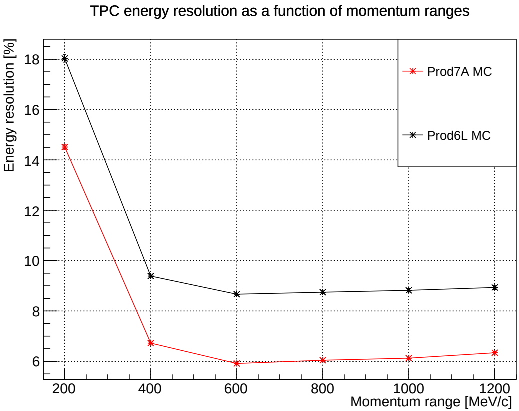

Figure: Energy resolution of the TPCs for MC positively charged antimuons as a function of the momentum ranges.

Results for positively charged positrons

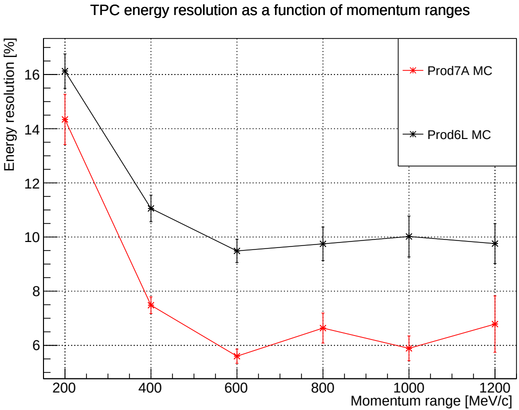

Figure: Energy resolution of the TPCs for MC positively charged positrons as a function of the momentum ranges.

Results for positively charged pions

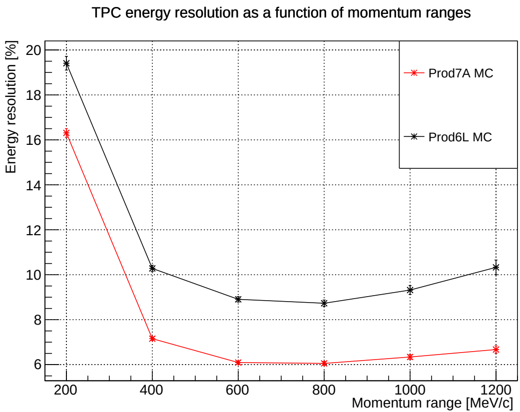

Figure: Energy resolution of the TPCs for MC positively charged pions as a function of the momentum ranges.

Results for positively charged protons

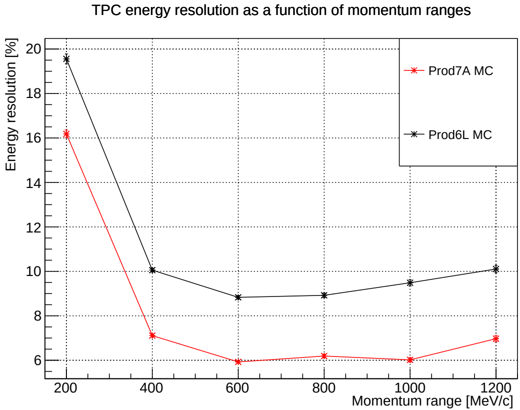

Figure: Energy resolution of the TPCs for MC positively charged protons as a function of the momentum ranges.

Current plan

• These shifts in energy resolution could be due to the fact that Prod7 MC uses a different gas mixture for the TPCs.

• To confirm this suspicion, two MC simulations were run using the old gas mixture of Prod6 and new gas mixture of Prod7.

• In these simulations, 40k muons were fired from FGD1 mid plane to TPC2 within a small opening cone and with momentum from 150 to 1400 MeV/c.

• Then, the produced ROOT files were given to me to do the analysis.

Notes

• **Negatively charged particles** were selected to produce the prod7A MC and Prod6L MC curves.

MC Prod7 Muon Gun for Old and New Gas Mixtures

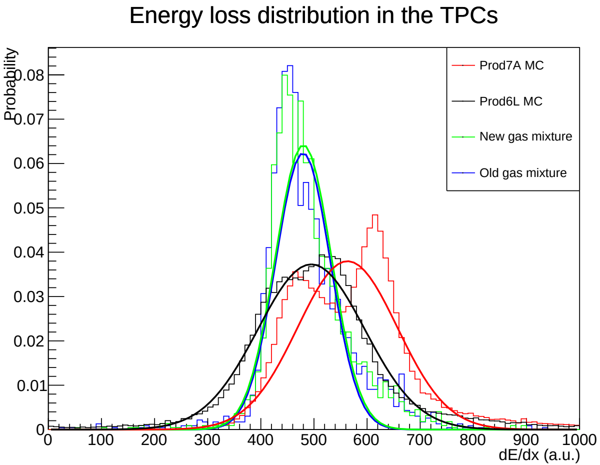

Figure: Energy loss distribution of the particle gun muons in the new and old gas mixtures (green and blue), and of the negatively charged particles (red and black) with momenta between 100 and 200 MeV/c.

MC Prod7 Muon Gun for Old and New Gas Mixtures

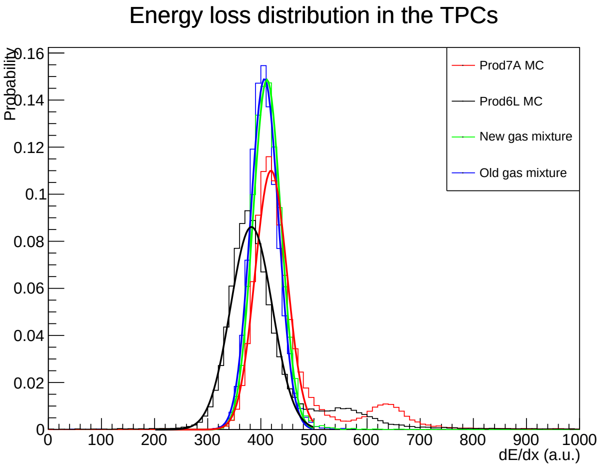

Figure: Energy loss distribution of the particle gun muons in the new and old gas mixtures (green and blue), and of the negatively charged particles (red and black) with momenta between 200 and 400 MeV/c.

MC Prod7 Muon Gun for Old and New Gas Mixtures

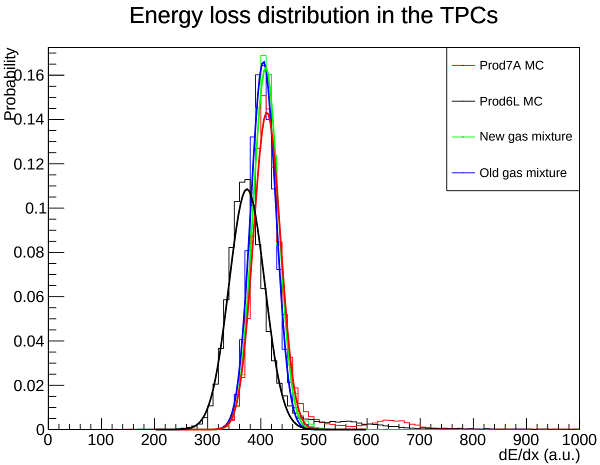

Figure: Energy loss distribution of the particle gun muons in the new and old gas mixtures (green and blue), and of the negatively charged particles (red and black) with momenta between 400 and 600 MeV/c.

MC Prod7 Muon Gun for Old and New Gas Mixtures

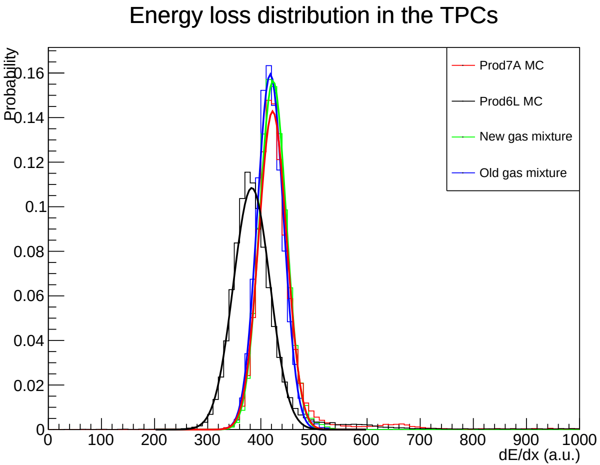

Figure: Energy loss distribution of the particle gun muons in the new and old gas mixtures (green and blue), and of the negatively charged particles (red and black) with momenta between 600 and 800 MeV/c.

MC Prod7 Muon Gun for Old and New Gas Mixtures

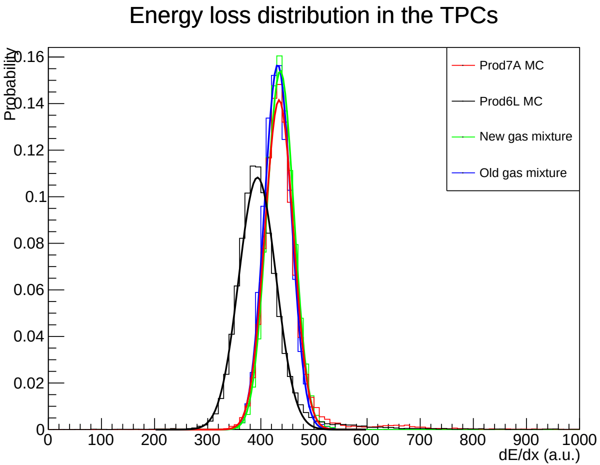

Figure: Energy loss distribution of the particle gun muons in the new and old gas mixtures (green and blue), and of the negatively charged particles (red and black) with momenta between 800 and 1000 MeV/c.

MC Prod7 Muon Gun for Old and New Gas Mixtures

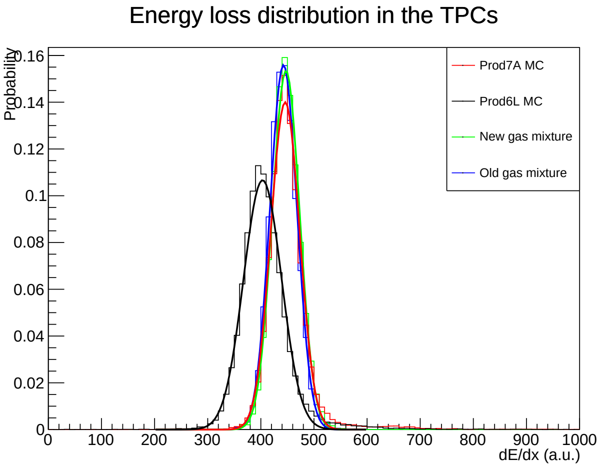

Figure: Energy loss distribution of the particle gun muons in the new and old gas mixtures (green and blue), and of the negatively charged particles (red and black) with momenta between 1000 and 1200 MeV/c.

MC Prod7 Muon Gun for Old and New Gas Mixtures

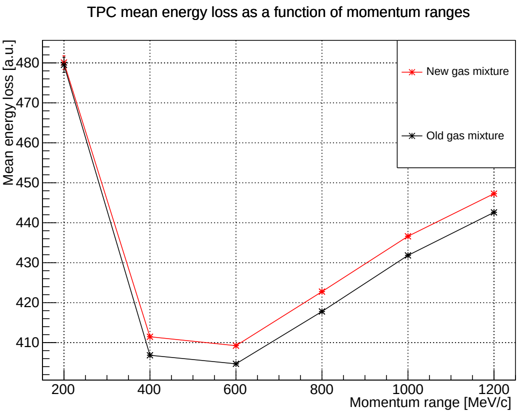

Figure: Mean energy loss of the particle gun muons in the new and old TPCs' gas mixtures (red and black) as a function of the momentum ranges.

MC Prod7 Muon Gun for Old and New Gas Mixtures

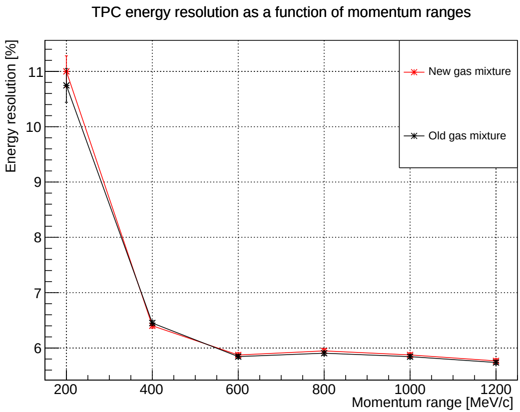

Figure: Energy resolution of the TPCs for the particle gun muons in the new and old TPCs' gas mixtures (red and black) as a function of the momentum ranges.

MC Prod7 Muon Gun for Old and New Gas Mixtures

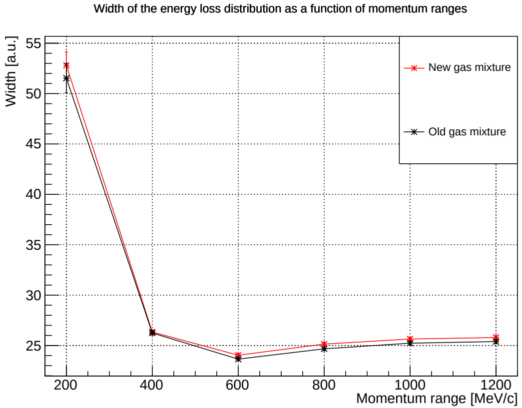

Figure: Width of the energy loss distribution of the particle gun muons in the new and old TPCs' gas mixtures (red and black) as a function of the momentum ranges.

MC Prod7 Muon Gun for Old and New Gas Mixtures

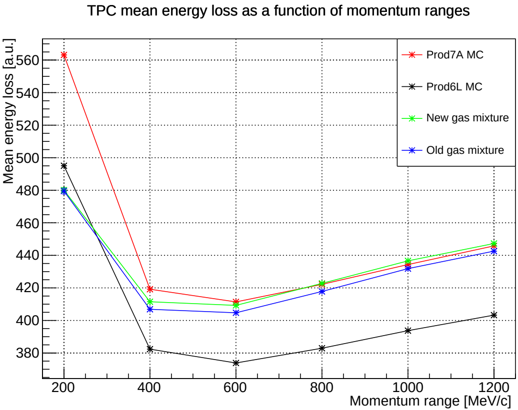

Figure: Mean energy loss of the particle gun muons in the new and old TPCs' gas mixtures (green and blue) and of the negatively charged particles (red and black) as a function of the momentum ranges.

MC Prod7 Muon Gun for Old and New Gas Mixtures

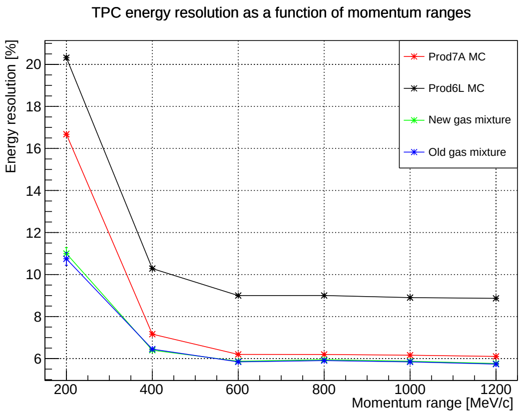

Figure: Energy resolution of the TPCs for the particle gun muons in the new and old TPCs' gas mixtures (green and blue) and of the negatively charged particles (red and black) as a function of the momentum ranges.

MC Prod7 Muon Gun for Old and New Gas Mixtures

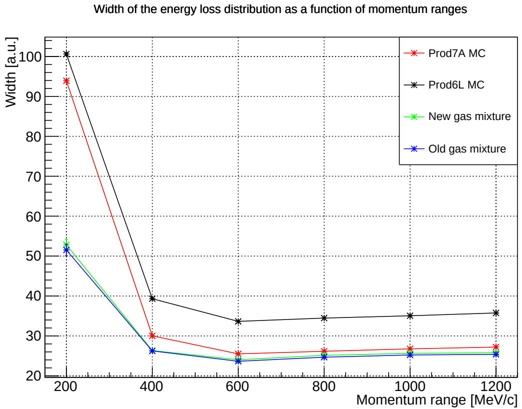

Figure: Width of the energy loss distribution of the particle gun muons in the new and old TPCs' gas mixtures (green and blue) and of the negatively charged particles (red and black) as a function of the momentum ranges.

MC Prod7 Muon Gun for Old and New Gas Mixtures

The mean energy loss [a.u.] of the selected particles in the TPCS as a function the momentum ranges [MeV/c]
Productions: 7AMC 6LMC NewGas7 OldGas7
[100, 200] 563.142 +/- 0.433783 495.058 +/- 0.410986 480.084 +/- 1.69083 479.502 +/- 1.90525
[200, 400] 419.189 +/- 0.121268 382.354 +/- 0.143493 411.48 +/- 0.253388 406.854 +/- 0.253742
[400, 600] 411.386 +/- 0.10253 373.857 +/- 0.131789 409.247 +/- 0.222065 404.707 +/- 0.220617
[600, 800] 422.175 +/- 0.118288 382.926 +/- 0.15163 422.771 +/- 0.232177 417.806 +/- 0.228807
[800, 1000] 434.339 +/- 0.132842 393.722 +/- 0.172166 436.615 +/- 0.236422 431.836 +/- 0.231242
[1000, 1200] 445.807 +/- 0.150136 403.259 +/- 0.195125 447.277 +/- 0.240566 442.596 +/- 0.235894

MC Prod7 Muon Gun for Old and New Gas Mixtures

The TPCs' energy resolution [%] as a function of momentum ranges [MeV/c]
Productions: 7AMC 6LMC NewGas7 OldGas7
[100, 200] 16.6779 +/- 0.0494995 20.3194 +/- 0.0794131 10.9997 +/- 0.282392 10.7473 +/- 0.305283
[200, 400] 7.16254 +/- 0.0222131 10.2835 +/- 0.0316571 6.4013 +/- 0.0450079 6.45057 +/- 0.0475223
[400, 600] 6.19907 +/- 0.0204764 9.00009 +/- 0.0293758 5.87282 +/- 0.0427926 5.84411 +/- 0.0389496
[600, 800] 6.19631 +/- 0.0227841 9.00203 +/- 0.0324004 5.94708 +/- 0.0409006 5.90519 +/- 0.0404743
[800, 1000] 6.16098 +/- 0.0260443 8.90194 +/- 0.0363594 5.87406 +/- 0.0401539 5.84295 +/- 0.0389288
[1000, 1200] 6.10284 +/- 0.0289929 8.86675 +/- 0.040546 5.76618 +/- 0.0410378 5.73719 +/- 0.0400222

MC Prod7 Muon Gun for Old and New Gas Mixtures

Width [a.u.] of energy loss distribution as a function of momentum ranges [MeV/c]

Productions: 7AMC 6LMC NewGas7 OldGas7

[100, 200] 93.9203 +/- 0.269201 100.593 +/- 0.384169 52.8075 +/- 1.3429 51.5337 +/- 1.44944

[200, 400] 30.0246 +/- 0.092709 39.3194 +/- 0.120139 26.3401 +/- 0.184487 26.2444 +/- 0.192652

[400, 600] 25.5021 +/- 0.083997 33.6475 +/- 0.109181 24.0343 +/- 0.174641 23.6515 +/- 0.157104

[600, 800] 26.1593 +/- 0.0959092 34.4711 +/- 0.123316 25.1425 +/- 0.172364 24.6722 +/- 0.168563

[800, 1000] 26.7596 +/- 0.112824 35.0489 +/- 0.142332 25.647 +/- 0.174767 25.2319 +/- 0.167565

[1000, 1200] 27.2069 +/- 0.128927 35.756 +/- 0.162587 25.7908 +/- 0.183028 25.3926 +/- 0.176619

Current Plan

• The first analysis shows that the difference in energy resolution is present for all types of true particle types. The second analysis shows that it is not the change in the gas mixture that results in the change in energy resolution. However, these results are just preliminary and need more checks to be sure.

• In particular, sTrueTrackPDG is a variable for the true tracks, but the measured energy loss trTpcdEdxMeas is a variable for the reconstructed tracks, so I will need to match the reconstructed tracks with the corresponding true tracks.

• For the new and old gas mixture simulation, my supervisor suspected that some corrections were applied at the flat-tree creation level, so he will check this. If this is true, he will turn the corrections off and give me the new ROOT files.

The End