A Two-Prong Selection for Quasi-Elastic Muon Neutrino Interactions

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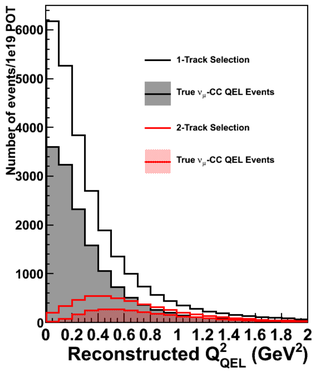
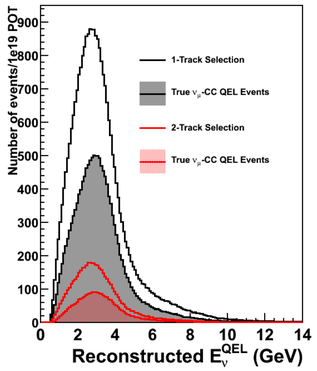
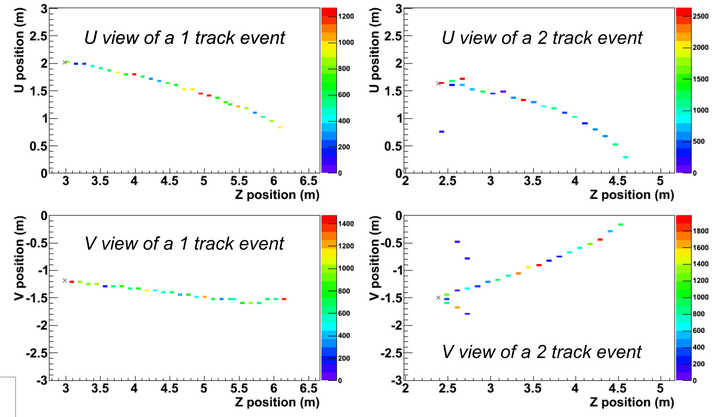
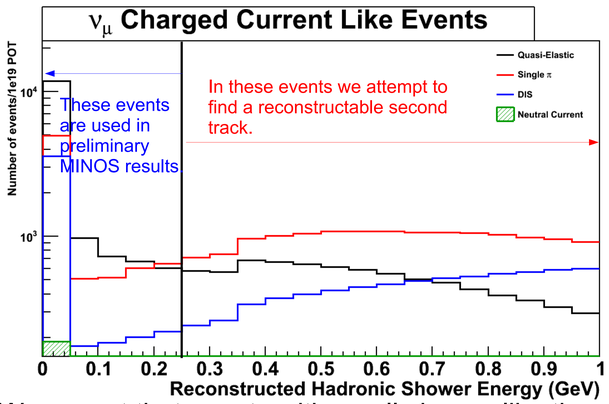
In order to measure the QE axial mass it is necessary generate a sub-sample that has enhanced with QE events. We measure the axial mass by fitting the data to distributions in Q^2, we can also perform a simultaneous fit in E_ν as a way to constrain the beam flux.





There are two channels for the detection of QE interactions. In the 1-track channel (on the left), which is used in the preliminary MINOS QE results, the recoil proton is below detector threshold. In the 2-track channel (on the right) the recoil proton is above detector threshold and leaves a reconstructable track.

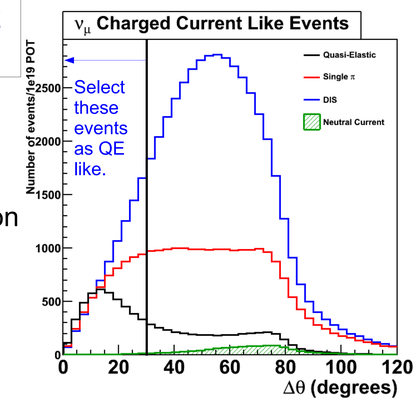


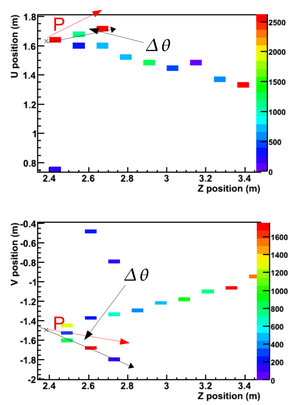


We expect that events with small shower like those used in the preliminary MINOS results will have too little vertex activity to reconstruct a 2nd track. We only look for a second track in events which have already failed the 1-track selection.

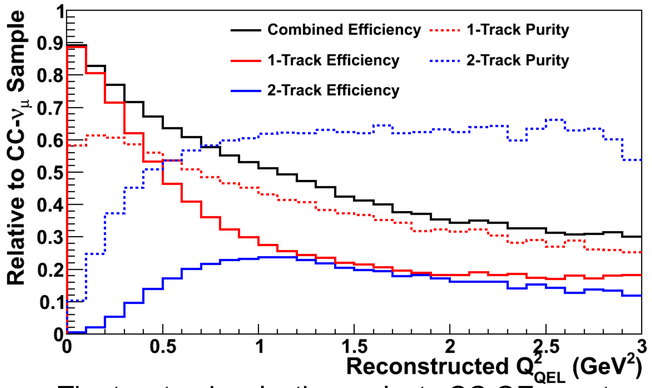
Two Track Event Selection

The nature of QE kinematics lets us reconstruct the neutrino kinematics from measured muon quantities. We can also use this knowledge, along with the neutrino beam direction to predict the momentum of the recoil proton.

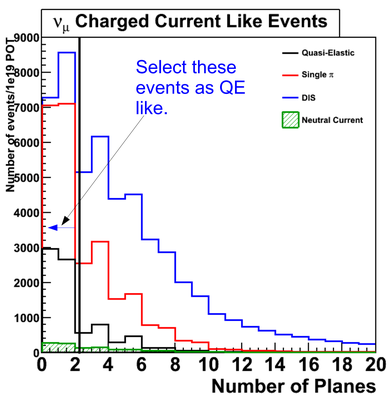


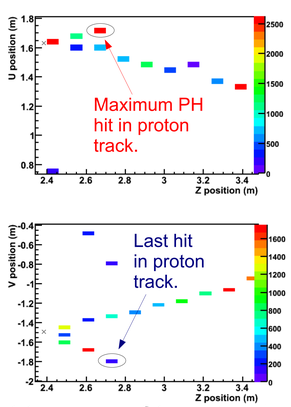


$\Delta\theta$ is defined as the 3-D opening angle between the predicted trajectory of the recoil proton and the reconstructed trajectory of the candidate proton track.

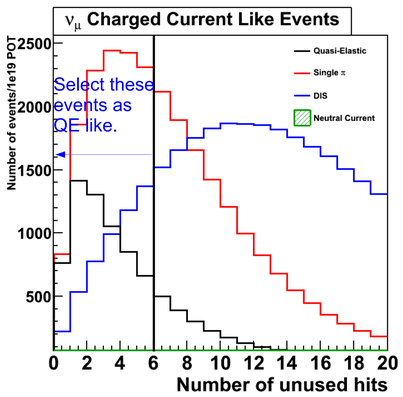


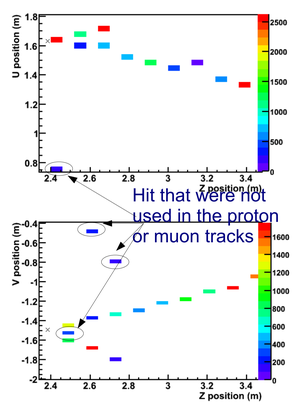
The two track selection, selects CC QE events with 10% efficiency and is 52% pure. Although we have only selected 63% of the total QE in our CC sample. The unselected events occur at higher values of Q^2. We are continuing to examine other event selections with a goal of increasing our efficiency, perhaps by using 1 or more background dominated samples.





Protons lose most of their energy at the end of their track. Thus we require that the highest pulse height hit in the candidate proton track is within 1 plane of the last hit in the candidate proton track.





We expect that QE events should have very little vertex activity out side of the reconstructed muon and proton tracks. Thus we require that the number of hits that were not used in either the muon track or the proton track be less than 6.