Neutrino Directionality

Test with KLG4

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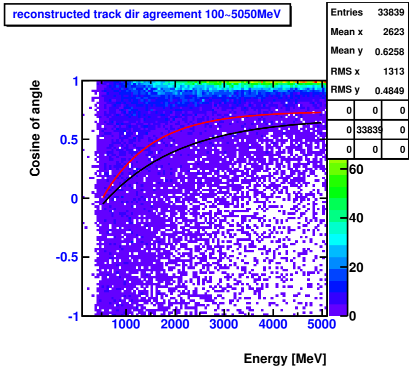
April 18, 2014

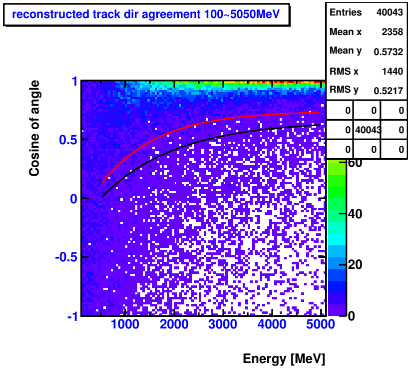
Agreement between true/reconstructed ν angle

no fiducial volume cut

$\nu_e + {}^{1}\mathrm{H} \longrightarrow e^{-} + ?$



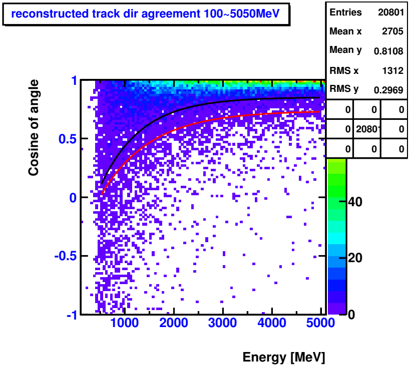
$\nu_e + {}^{12}\mathrm{C} \longrightarrow e^{-} + ?$



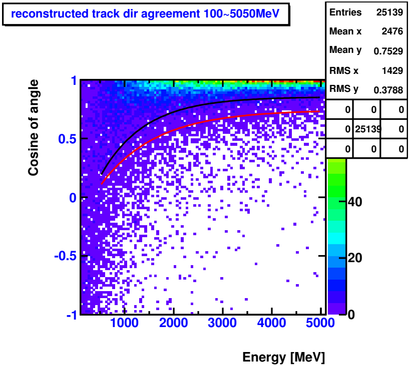
Agreement between true/reconstructed ν angle

vertex $R < 600\,\mathrm{cm}$

$\nu_e + {}^{1}\mathrm{H} \longrightarrow e^{-} + ?$

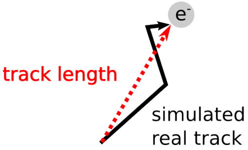


$\nu_e + {}^{12}\mathrm{C} \longrightarrow e^{-} + ?$

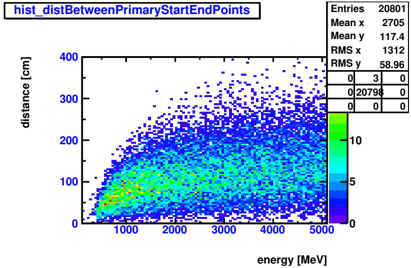


- Direction reconstruction is improved by fiducial volume cut on reconstructed vertex.
- What does the vertex mean for an finite size track shape event?

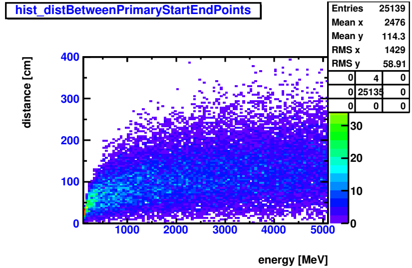
e^- track length



$$\nu_e + {}^{1}\mathrm{H} \longrightarrow \mathrm{e}^- + ?$$

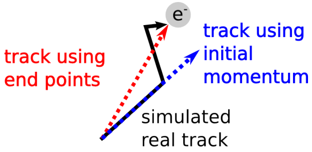


$$\nu_e + {}^{12}\mathrm{C} \longrightarrow \mathrm{e}^- + ?$$

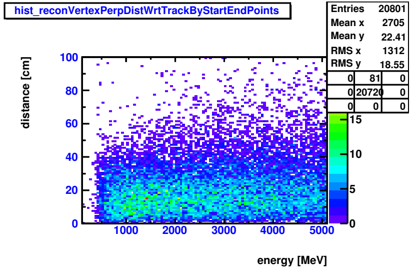


Perpendicular distance from reconstructed vertex to track

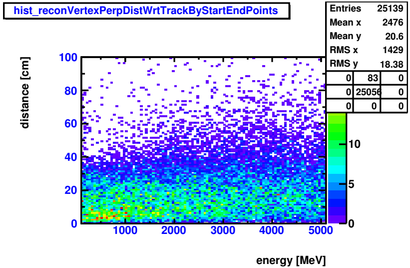
track using simulated track end points



$\nu_e + {}^{1}\mathrm{H} \longrightarrow \mathrm{e}^- + ?$

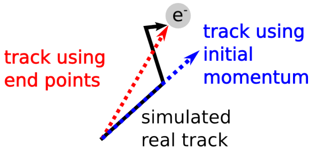


$\nu_e + {}^{12}\mathrm{C} \longrightarrow \mathrm{e}^- + ?$

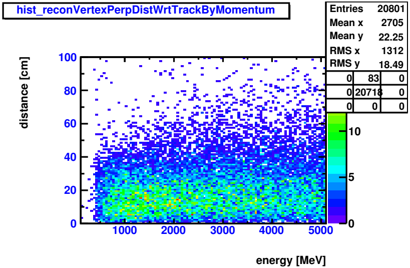


Perpendicular distance from reconstructed vertex to track

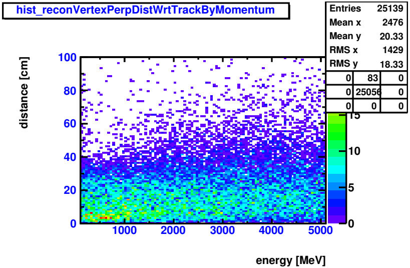
track using simulated initial momentum



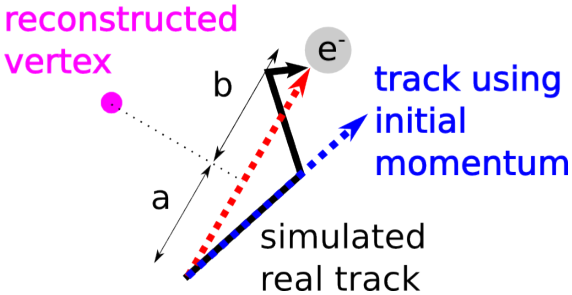
$\nu_e + {}^{1}\mathrm{H} \longrightarrow \mathrm{e}^{-} + ?$



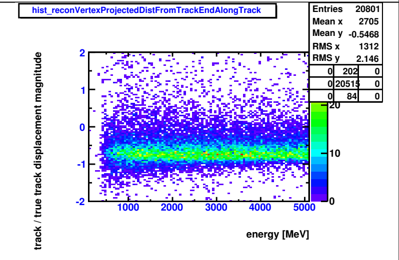
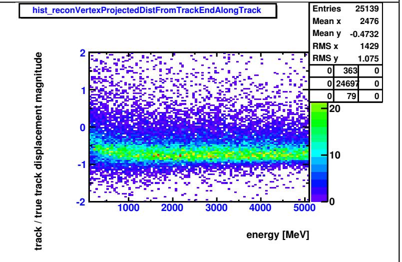
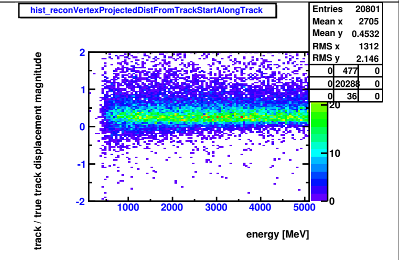
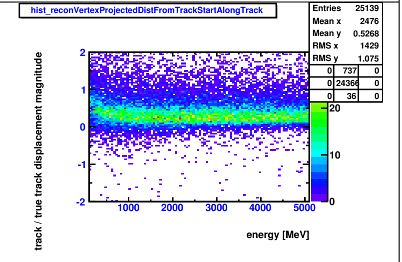
$\nu_e + {}^{12}\mathrm{C} \longrightarrow \mathrm{e}^{-} + ?$



Distance of reconstructed vertex from track end points projected along tracks



Distance of reconstructed vertex from track end points projected along tracks

	$\nu_e + {}^{1}\mathrm{H} \longrightarrow e^{-} + ?$	$\nu_e + {}^{12}\mathrm{C} \longrightarrow e^{-} + ?$
b		
a		

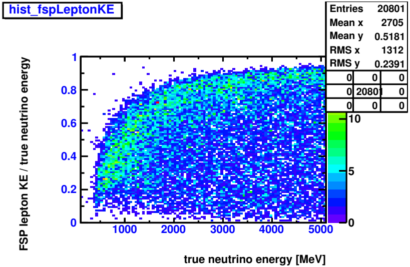
Conclusion for reconstruction vertex

For ν energies 100 MeV to 5000 MeV:

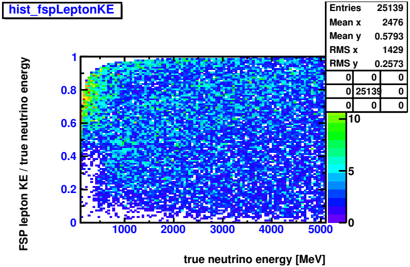
- Vertex is within 40cm from track
- Vertex is on average at middle of track
- peak of vertex distribution is biased toward track beginning.

Lepton energy vs true ν energy

$\nu_e + {}^{1}\mathrm{H} \longrightarrow e^- + ?$

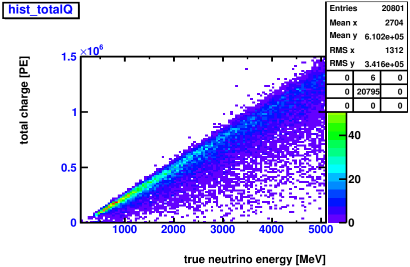


$\nu_e + {}^{12}\mathrm{C} \longrightarrow e^- + ?$

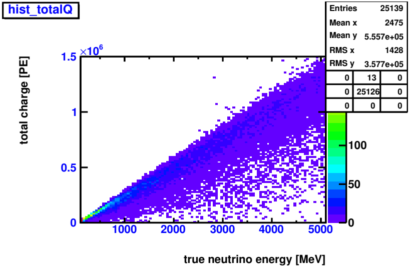


Total charge vs true ν energy

$\nu_e + {}^1\mathrm{H} \longrightarrow e^- + ?$

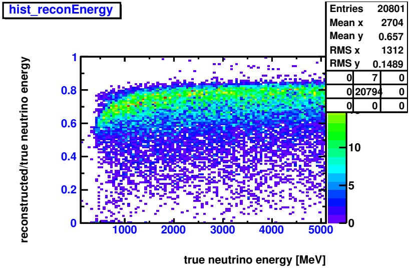


$\nu_e + {}^{12}\mathrm{C} \longrightarrow e^- + ?$

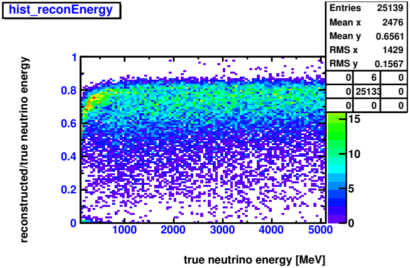


Reconstructed vs true ν energy

$\nu_e + {}^{1}\mathrm{H} \longrightarrow e^{-} + ?$



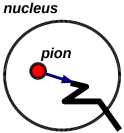
$\nu_e + {}^{12}\mathrm{C} \longrightarrow e^{-} + ?$



Consistently 80% of energy is reconstructed for extremely large energy range.

Pion energy loss in nucleus?

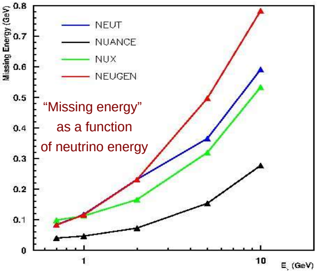
Intranuclear rescattering

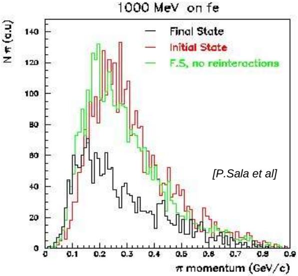


Very important effect at low energies !!

E*(visible)* $\neq$ E*(neutrino)*

- *Large fraction of the pion energy can be lost within the nucleus*
- *Hadronic energy scale calibration has MC-dependence*





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