Updates On Flux/Inclusive Meeting

Fitting Flux Using nu-e Elastic Scattering (POT Normalization)

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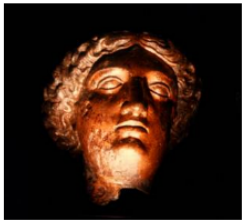


Neutrino Electron Elastic Scattering

Electron Spectrum Predictions

arXiv:hep-ph/0603036v1 3Mar 2006

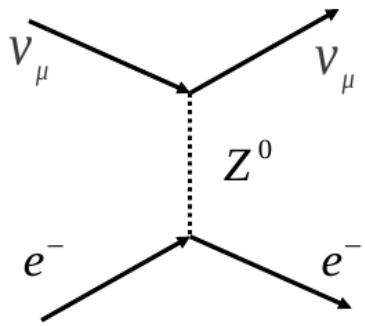
$$\frac{dN(T)}{dT} = Ne \times \int dE_\nu \frac{d\Phi(E_\nu)}{dE_\nu} \frac{d\sigma(T, E_\nu)}{dT}$$

Where

$$Ne = 1.98 \times 10^{30}$$

is the Number of available electrons in fiducial mass, T is the scattered electron energy

$$\nu_\mu + e^- \rightarrow \nu_\mu + e^-$$



Differencial Cross Section:

$$\frac{d\sigma}{dT} = \frac{2G_\mu^2 m_e}{\pi E_\nu^2}[a^2 E_\nu^2 + b^2 (E_\nu - T)^2 - abm_e T]$$

$$m_e = 0.000511\, GeV/c^2$$

$s^2 = \sin^2\theta_w \approx 0.23149 \pm 0.00015$
$for\ \nu_\mu, a = {}^1\!/_2 - s^2;\ b = -s^2$

$G_\mu = 1.16637(1) \times 10^{-5}\, GeV^{-2}$

$$\frac{dN(T)}{dT} = Ne \times \int dE_\nu \frac{d\Phi(E_\nu)}{dE_\nu} \frac{d\sigma(T, E_\nu)}{dT}$$

for the discrete case(per P.O.T):

$\frac{\Delta N}{\Delta T} = Ne \times \sum \Delta E_\nu (GeV) \frac{\Phi_{bin}(/m^2/P.O.T/GeV)}{\Delta E_\nu (GeV)} \times \frac{2G_\mu^2 m_e}{\pi} (GeV^{-1} \times 10^{-4} m^2) \times \frac{1}{E_\nu^2 (GeV^2)} [a^2 E_\nu^2 + b^2 (E_\nu - T)^2 - abm_e T](GeV^2)$

For 20E20 POT, Ke and flux histograms, binsize=0.1GeV, bin from 0-1000(0-100 GeV),

$$N_{bin}(/0.1\,GeV) = 20 \times 10^{20}(P.O.T) \times 0.1(GeV) \times \frac{\Delta N}{\Delta T}$$

Cross-section Factors

Differencial Cross-section:

$$\frac{d\sigma}{dT} = \frac{2G_\mu^2 m_e}{\pi E_\nu^2}[a^2 E_\nu^2 + b^2 (E_\nu - T)^2 - abm_e T]$$

$G_\mu = 1.16637(1) \times 10^{-5} GeV^{-2}$,

$$m_e = 0.000511 GeV/c^2,\ \hbar = 6.582119 \times 10^{-22} MeV \cdot s$$

$\frac{2G_\mu^2 m_e}{\pi} = 1.5 \times 10^{-41} GeV^{-1} cm^2$ from the reference is a rough approximation

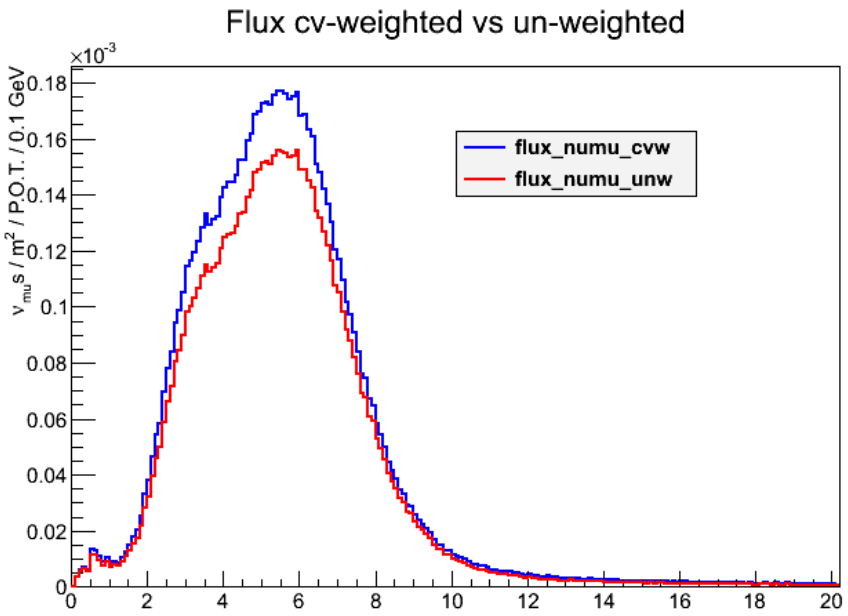
$$\frac{2\times\left(1.16637\times10^{-5} GeV^{-2}\right)^2\times0.511\times10^{-3}\times\left(2.9979\times10^8\times10^4 cm/s\right)^2}{\pi} \times \hbar^2 (GeV^{-1} cm^2)$$

by analyzing the unit, there is a $\hbar^2$ should be multiplied.

$= 1.72322 \times 10^{-41} GeV^{-1} cm^2$

ME Flux Histograms

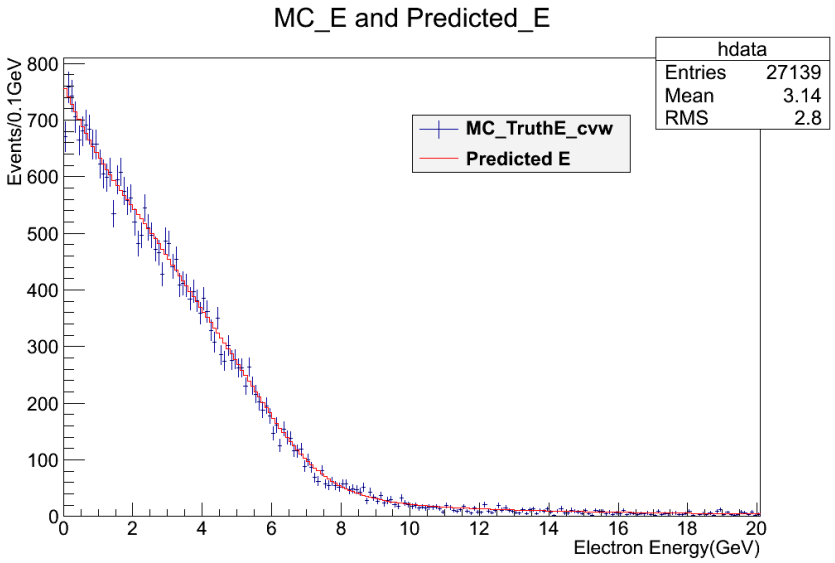
MINERvA Document 8253-v1

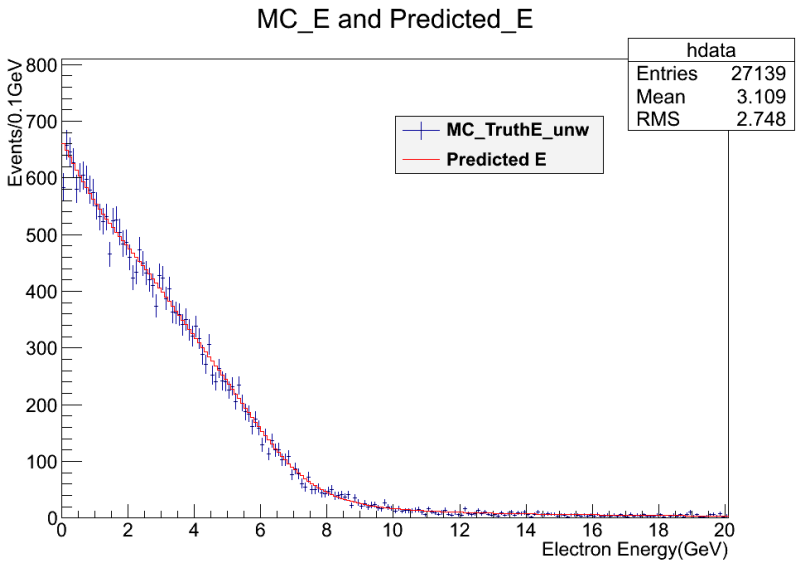


New root files in:
/minerva/data/users/dattam/NUE_EL_mc_v10r5p1/grid/central_value/minerva/
ME; 200e20 POT; NUE_EL;

Check Electron Spectrum Predictions with Genie

using cv-weighted(left) and unweighted(right) flux, POT normalization





CV-weighted flux
$\chi^2 = 1.287$

unweighted flux
$\chi^2 = 1.038$

$$\chi^2 = \frac{1}{N}\sum_{i=1}^{N}\frac{(X_i - X_{oi})^2}{X_i}$$

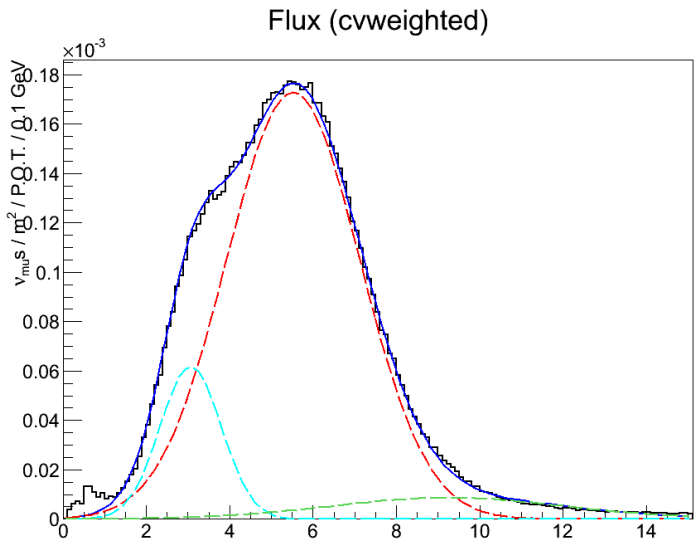
X_i is MC data, X_{oi} is expected Ke histogram, calculate it from 0-12 GeV.

Fitting Tool Developing

- Parameterize the flux, MINERvA Document 8253-v1 ;
- Input flux-function into the model. Get an electron energy histogram.
- Fit the smooth electron spectrum with minimum chi^2(manually);
- Fit the smooth electron spectrum with TMinuit;

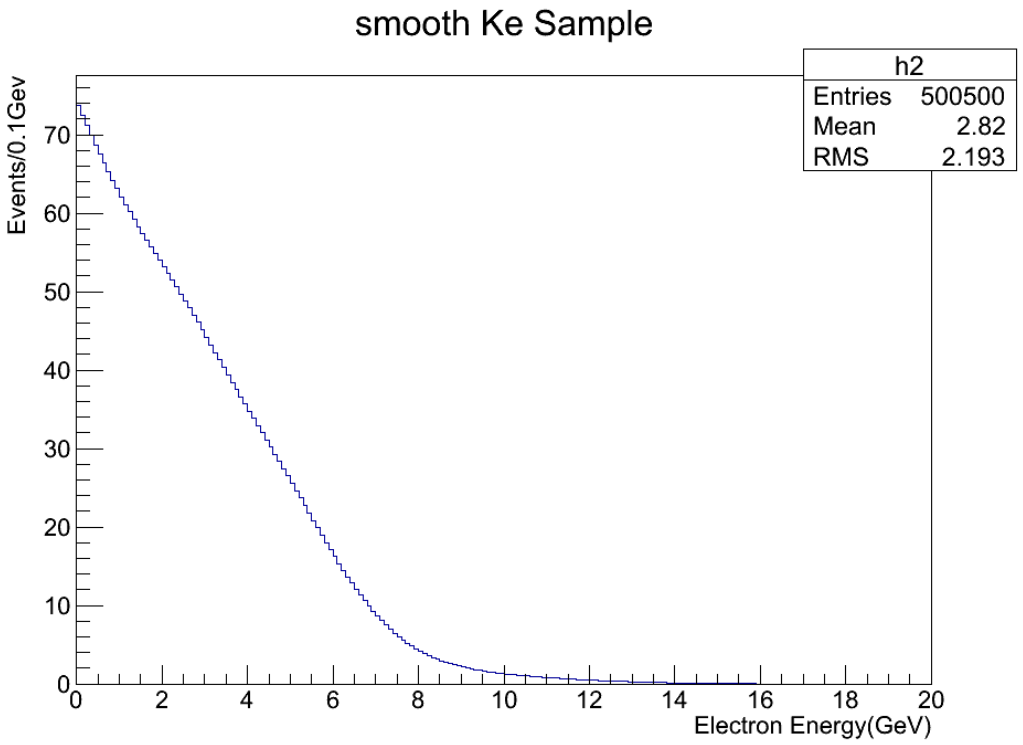
Parameterize New Flux Histogram

3 Gaussian, 9 parameters



par	value
a1	1.728e-04
m1	5.518
s1	1.601
a2	6.177e-05
m2	3.061
s2	0.738
a3	8.656e-06
m3	9.232
s3	2.814

Electron Spectrum Sample

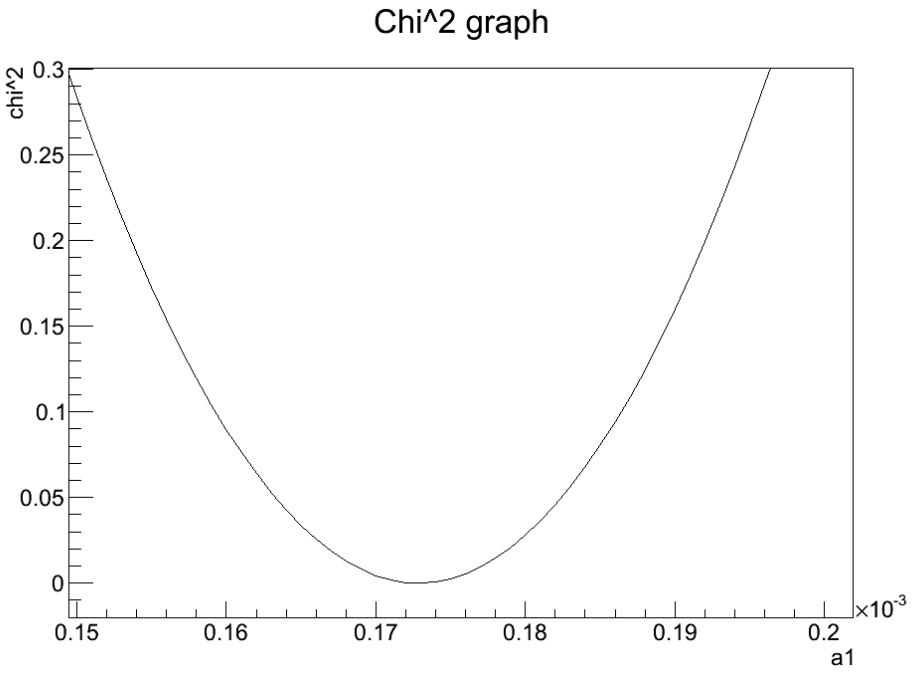


Smooth histogram;
Consider this as a sudo data;

Fitting Amplitude of First Gaussian(the first parameter a1)

Manually Minimum Chi^2 Fitting

- Vary a1 of the flux from 0.1 to 0.2, input varied fluxes into model
- Get a series electron energy histograms
- Compare those electron histograms with the electron spectrum sample, calculate the chi^2
- Pick up the a1 value, respect to the minimum chi^2
- Got a1 fitted: 1.725e-04 (True a1=1.728e-04)



Fitting Amplitude of First Gaussian(the first parameter a1)

Automatically TMinuit Fitting in Root

TMinuit Fitted Parameter: 1.728e-04
Fitting Error: 0.429e-04

(True a1=1.728e-04)

Fitted 9 Parameters in TMinuit

or checking

- Fitting on the perfect shape of electron energy sample (TMinuit fitting errors are not the real errors for this research)
- Fit one parameter at one time, fixed other 8 parameters

	a1	m1	s1	a2	m2	s2	a3	m3	s3
True	1.728e-04	5.518	1.601	6.177e-05	3.061	0.738	8.656e-06	9.232	2.814
Fitted	1.728e-04	5.520	1.601	6.177e-05	3.065	0.738	8.657e-06	9.232	2.814
Error	0.429e-04	0.897	0.383	13.928e-05	5.989	1.739	10.734e-06	4.765	3.039

Fitted results are consistent with true values of the flux

Next Steps

1, Research Errors

- Get ramdomly generated samples with fluctuate
- Fit the samples using TMinuit and get the fitting errors

2, Find out corelated parameters & Fitting 9 parameters simultaneously

3, Research binning effects