

Weekly Updates On n u e Meeting

Predictions' Discrepancy Research (in files of v10r5p1)

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January 30, 2013



Absolute Event Rate Calculation

 <http://personalpages.to.infn.it/~kotzinia/lectures/pdf/l6-neutrino.pdf>

For neutral current, the total cross section is:

$$\sigma_{NC}(\nu_\mu e) = \frac{2G_F^2 m_e E_\nu}{\pi} \left[\left(-\frac{1}{2} + \sin^2 \theta_w \right)^2 + \frac{1}{3} \sin^4 \theta_w \right] = 0.15 \times 10^{-43} \left(\frac{E_\nu}{10 \text{ MeV}} \right) \text{ cm}^2$$

Absolute event rate:

$$\begin{aligned} N_{\text{event}} &= \text{Flux} \times \sigma \times N_{\text{electrons}} \\ &= \sum \left(\frac{\nu_\mu s(E_\nu)}{m^2 \times P.O.T \times \text{GeV}} \right) \times \sigma_{NC} \times \Delta E_\nu \times 1.98 \times 10^{30} \\ &= \sum \left(\frac{\nu_\mu s(E_\nu)}{m^2 \times P.O.T \times \text{GeV}} \right) \times 0.15 \times 10^{-43} \left(\frac{E_\nu \text{ GeV}}{10 \text{ MeV}} \right) \text{ cm}^2 \times \Delta E_\nu \text{ GeV} \times 1.98 \times 10^{30} \end{aligned}$$

$$N_{\text{event}} \sim \text{Flux} \odot Ev$$

Absolute Event Rate Calculation

For 20E20 POT

Event Rate	Theoretical	MC ANA Truth(new)	MC Genie
Flux cv-weighted	3056	3104	-
Flux un-weighted	2667	2714	2769 ± 52

Genie doesn't put weight information;

Flux files [MINERvA Document 8253-v1](#), MC samples, MC selections
information in back up slides

ANA Truth and Genie Discrepancy

For Fiducial Events

ANA Truth_E :Truth_Ev

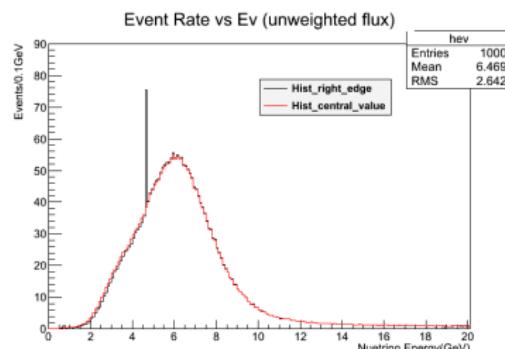
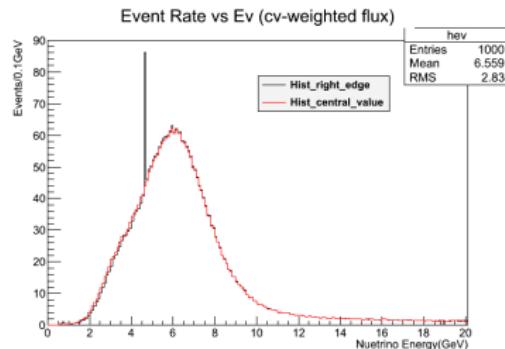
```
ming==14");
*****
Row * truth_E/1 * truth_Ev *
*****
1 * 5.2715289 * 5.2706661 *
9 * 6.8502450 * 6.8494323 *
12 * 2.3554825 * 2.3555927 *
14 * 4.4207015 * 4.4202023 *
25 * 3.8010635 * 3.8029313 *
27 * 2.4058306 * 2.4050482 *
28 * 5.1003993 * 5.1010970 *
29 * 0.6821820 * 0.6819760 *
33 * 6.3878114 * 6.3869060 *
53 * 4.4114983 * 4.4115906 *
62 * 6.8279882 * 6.8278385 *
63 * 7.4827174 * 7.4832326 *
73 * 3.4636780 * 3.4646682 *
75 * 1.5288815 * 1.5289715 *
88 * 2.9302737 * 2.9304785 *
91 * 0.3988338 * 0.3985472 *
92 * 1.8035504 * 1.8034849 *
93 * 2.6268719 * 2.6273410 *
95 * 7.6812589 * 7.6826317 *
96 * 0.1952138 * 0.1948066 *
98 * 0.1526737 * 0.1522417 *
99 * 0.2004246 * 0.2000132 *
101 * 2.5161334 * 2.5163491 *
104 * 6.5255945 * 6.5262371 *
109 * 1.0902824 * 1.0900285 *
ype <CR> to continue or q to quit ==>
110 * 3.9760927 * 3.9768982 *
111 * 2.6128827 * 2.6124526 *
115 * 0.0247247 * 0.0242316 *
118 * 7.2102494 * 7.212949 *
121 * 1.1568478 * 1.1568945 *
123 * 3.4047759 * 3.4050228 *
```

Genie Ev

```
*****
File Edit View Search Terminal Help
*****
* Row * Ev *
*****
* 1 * 8.5317719 *
* 9 * 6.9577564 *
* 12 * 9.0542363 *
* 14 * 5.3890140 *
* 25 * 32.555984 *
* 27 * 2.8287353 *
* 28 * 9.8286375 *
* 29 * 3.6134891 *
* 32 * 5.0880065 *
* 34 * 6.5202966 *
* 55 * 8.7942701 *
* 65 * 7.2153971 *
* 66 * 8.6671807 *
* 77 * 6.5330191 *
* 79 * 3.8736401 *
* 93 * 8.1634552 *
* 96 * 6.6520562 *
* 97 * 2.8381008 *
* 99 * 3.8589889 *
* 102 * 11.251016 *
* 104 * 6.6063246 *
* 106 * 4.0549021 *
* 107 * 3.2881798 *
* 109 * 6.6065781 *
* 112 * 19.350603 *
Type <CR> to continue or q to quit ==>
* 117 * 3.2401819 *
* 118 * 8.4234108 *
* 119 * 5.6531921 *
* 125 * 5.4620361 *
* 128 * 35.182336 *
* 131 * 6.1231157 *
```

Theoretical Ev Histogram for cvw and unw flux

Fiducial Event Rate vs Ev, for 20e20 POT

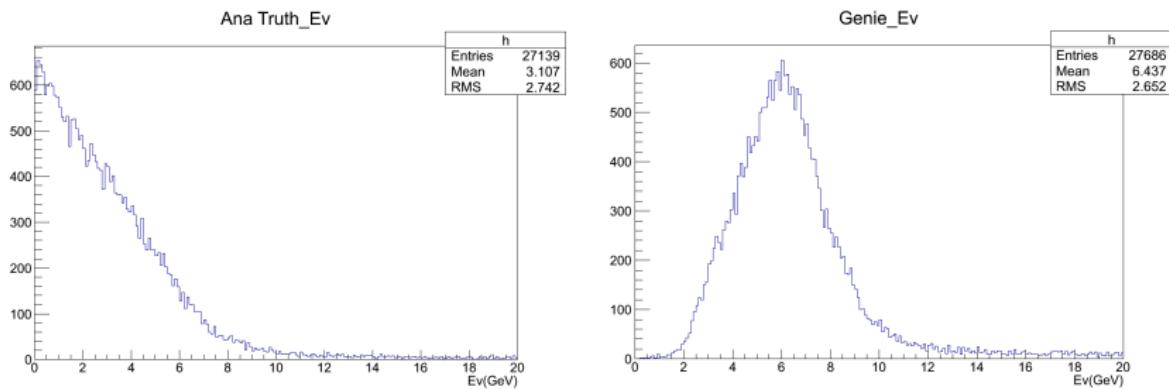


Absolute Event Rate(cv-weighted flux):
Integral of hist filled with right edge value is 3056
Integral of hist filled with central value is 3030

Absolute Event Rate(unweighted flux):
Integral of hist filled with right edge value is 2667
Integral of hist filled with central value is 2643

MC ANA Truth_Ev Histogram and Genie_Ev Histogram

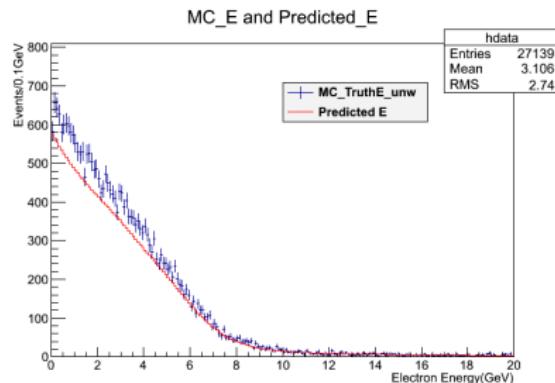
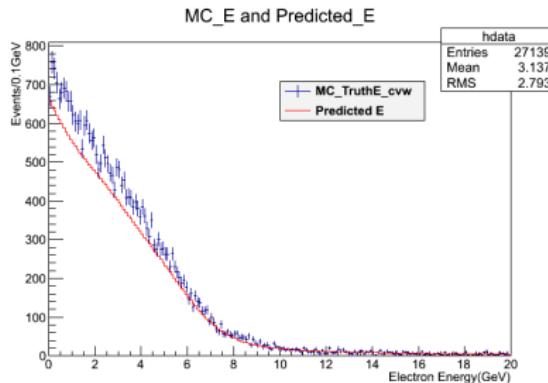
Fiducial, 200e20 POT



Genie_Ev histo shape is consistent with Theoretical calculation.
Truth_Ev in ANA tree represents other information. (It's
consistent with electron spectrum)

Electron Spectrum Predictions

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

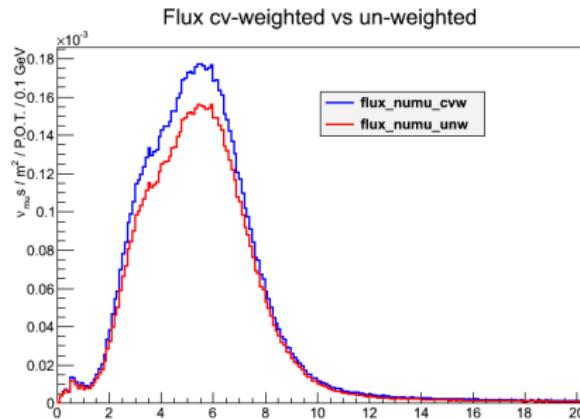


Theoretical Event Rate(Integral of the hexp is not consistent with table in slide3)

Back Ups

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;

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

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

$$m_e = 0.000511 \text{GeV}$$

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

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

$$\frac{2G_\mu^2 m_e}{\pi} = 1.5 \times 10^{-41} \text{GeV}^{-1} \text{cm}^2$$

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

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

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

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

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

code:

```
double dct=0; double T=0;
n1[0]= hFlux_xlo - ( hFlux_binWidth/2.0 );
double ss=0.23149;
double A=0.5-ss;
double B=-ss;
double y=0;
double yStep;

for (int j=1;j<=nFluxbinS;j++) {
    n1[j]= n1[j-1] + h_flux->GetBinWidth(j);
    //get flux in each Ev bin
    FluxbinS[j] = h_flux->GetBinContent(j);
    //the y bins # depends on the max Ev (which is n1[j])
    yStep=1.0/(n1[j]/yStepSize);
    y=0.5*yStep;
    for (int i=1;i<(1+(n1[j]/yStepSize));i++)
    {
        //dct: dsigma/dy
        dct=n1[j]*(A*A+B*B*(1-y)*(1-y))-A*B*0.000511*y; T=y*n1[j];
        h_elecE->Fill(T,1.98e30*1.5e-
        45*(200e20*FluxBinSize*FluxbinS[j]*dct/n1[j])*(h2_binWidth));
        y=y+yStep;
    }
}
```

- ▶ MC ANA Event Rates are **Integrals** of Histograms `histo_cvw` and `histo_unw` for ν_μ , which

chain-

```
>Project("histo_cvw","truth_E","wgt*(truth_fiducial_evt==1&&mc_incoming==14)")
```

chain-

```
>Project("histo_unw","truth_E","truth_fiducial_evt==1&&mc_incoming==14")
```

- ▶ MC Genie Event Rates are **Integrals** of Histograms `yEv_cvw` and `yEv_unw` for ν_μ , which

```
chain->Project("yEv_cvw","y*Ev","wght* (neu==14 && fid_cut)");
```

```
chain->Project("yEv_unw","y*Ev","neu==14 && fid_cut");
```