The US Long Baseline Neutrino Experiment Study

Feb, 2008

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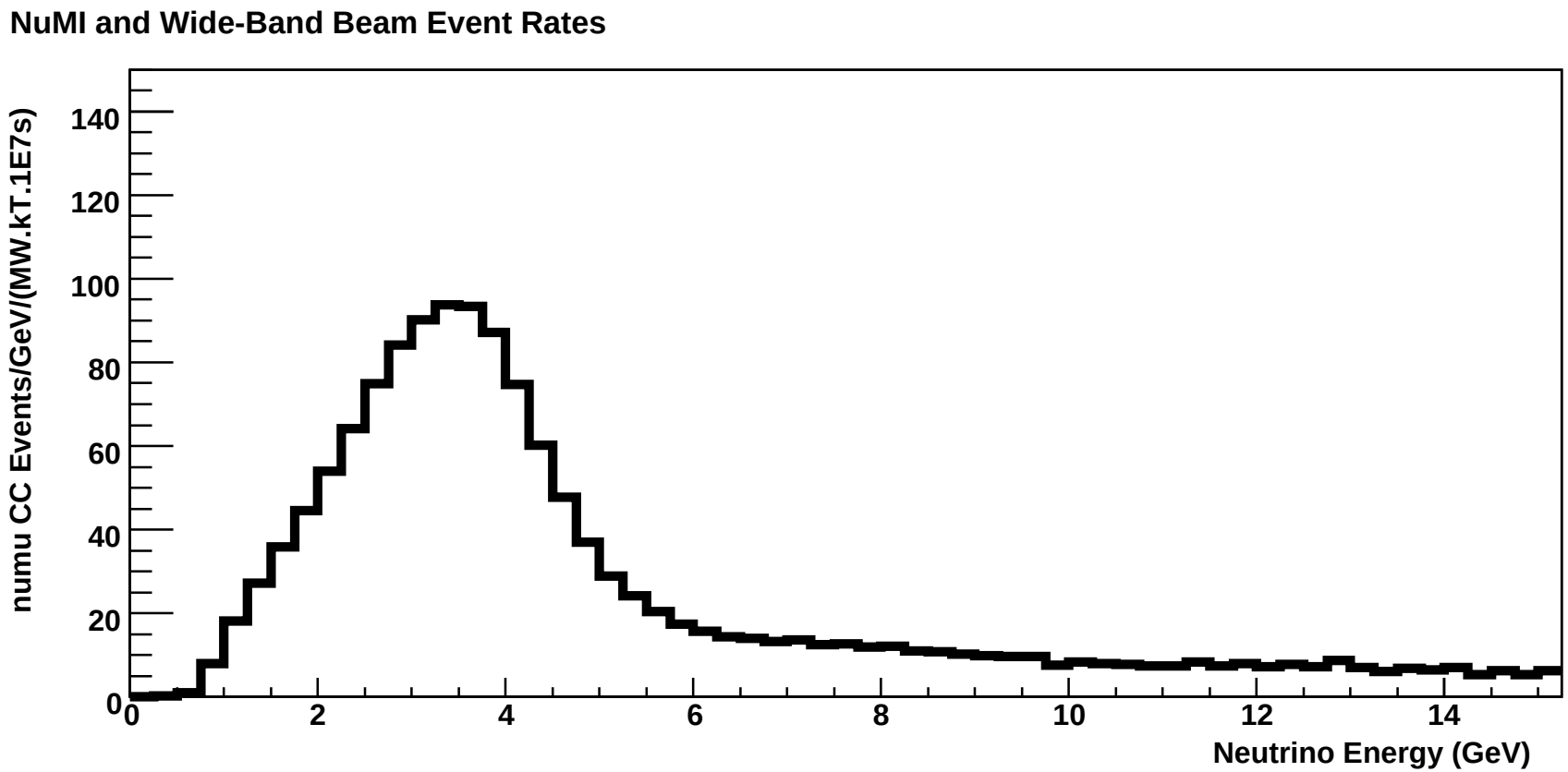
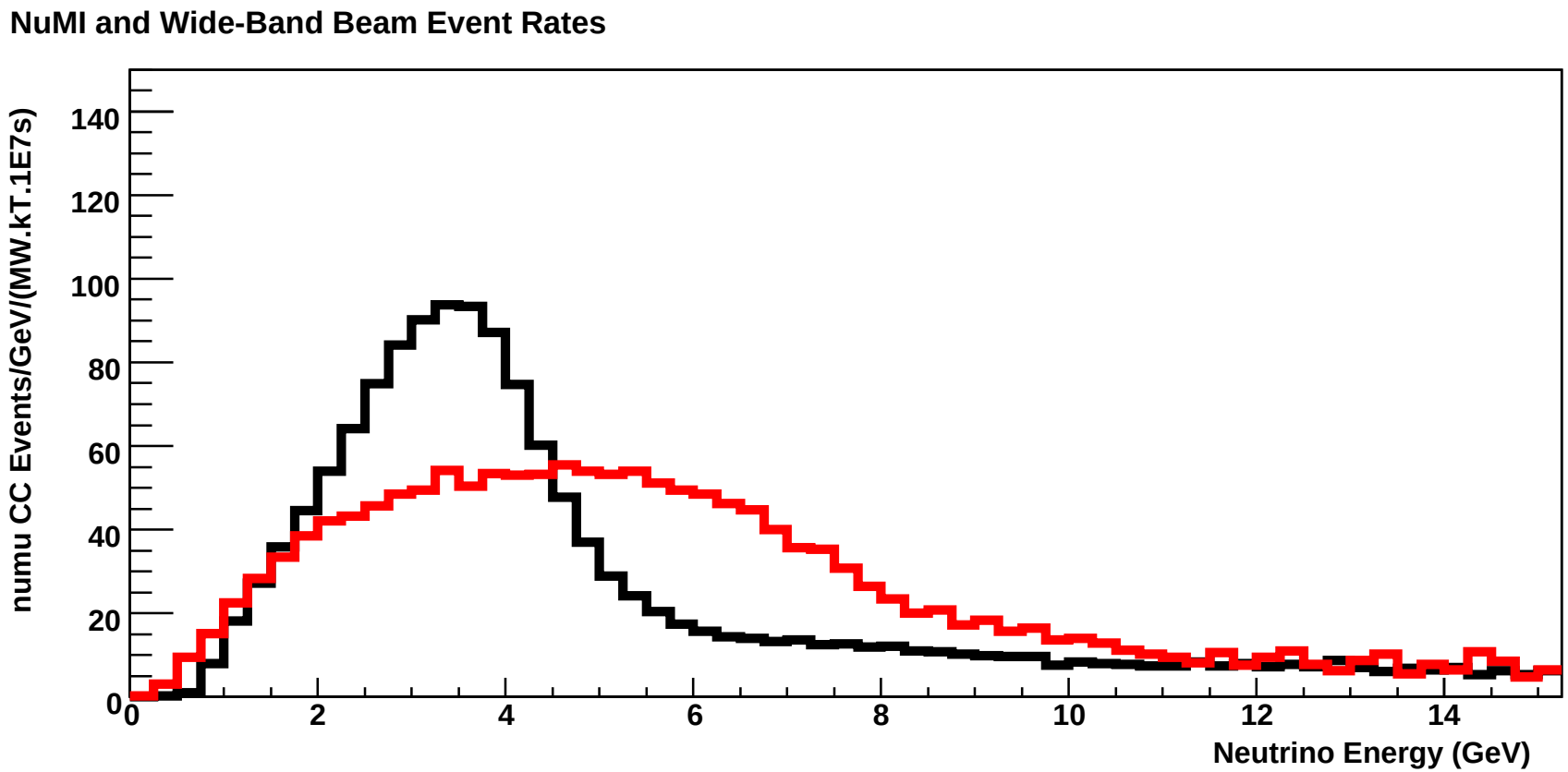
Neutrino Beam Rates



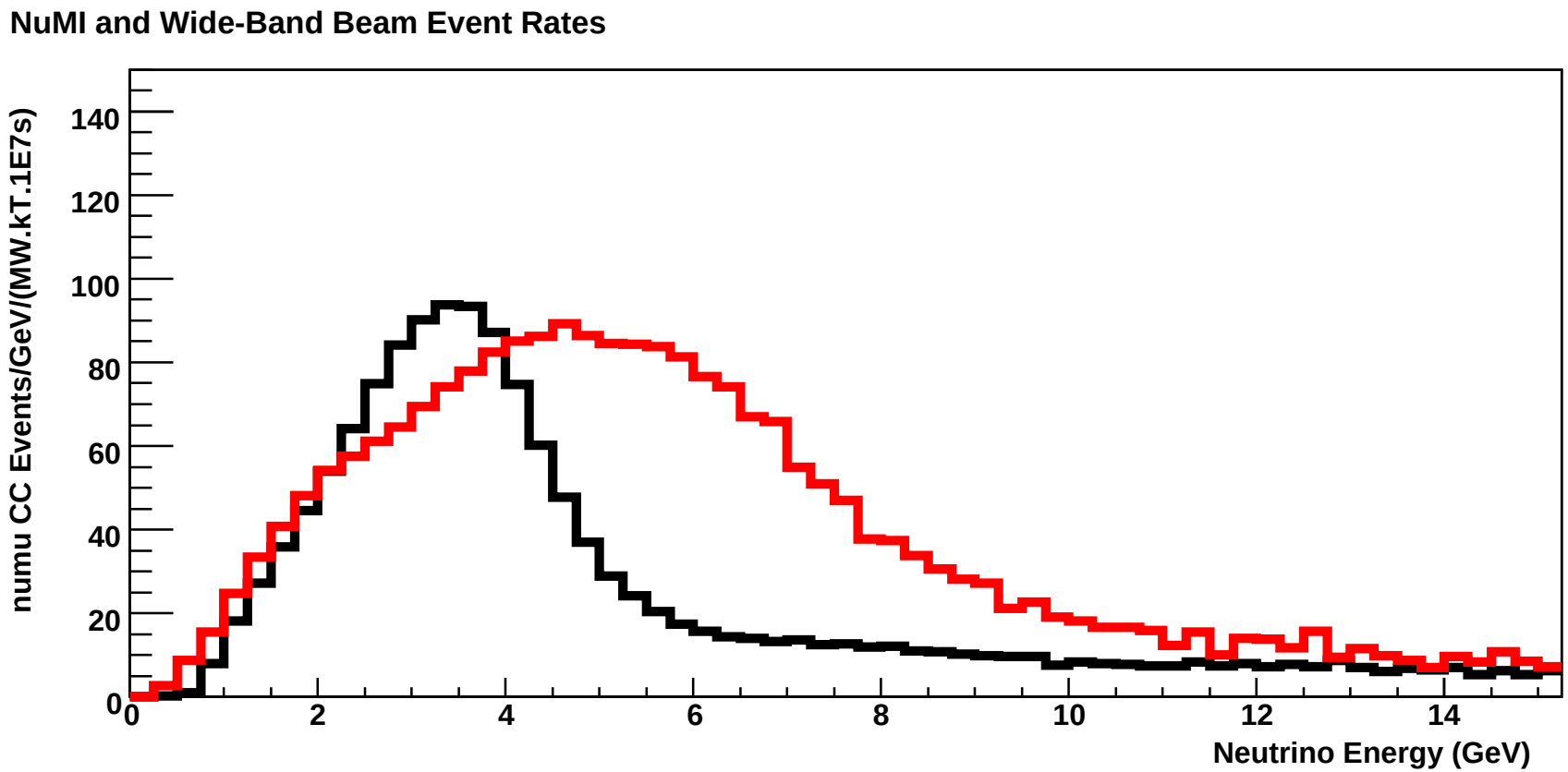
The NuMI LE beam at 735 km, with 185kA horn current

Neutrino Beam Rates



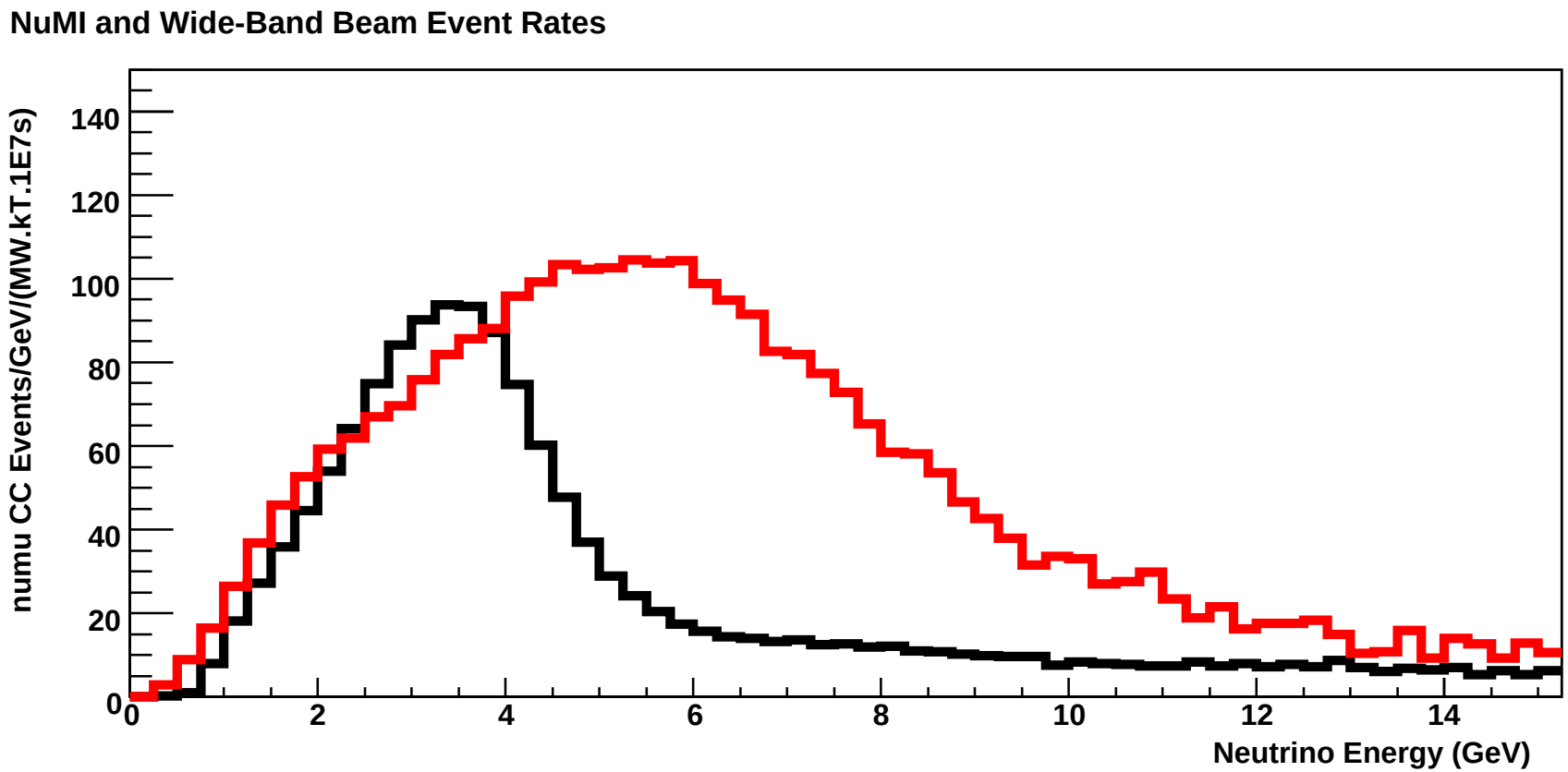
Replace with BNL wide-band target/horns at 185kA horn current

Neutrino Beam Rates



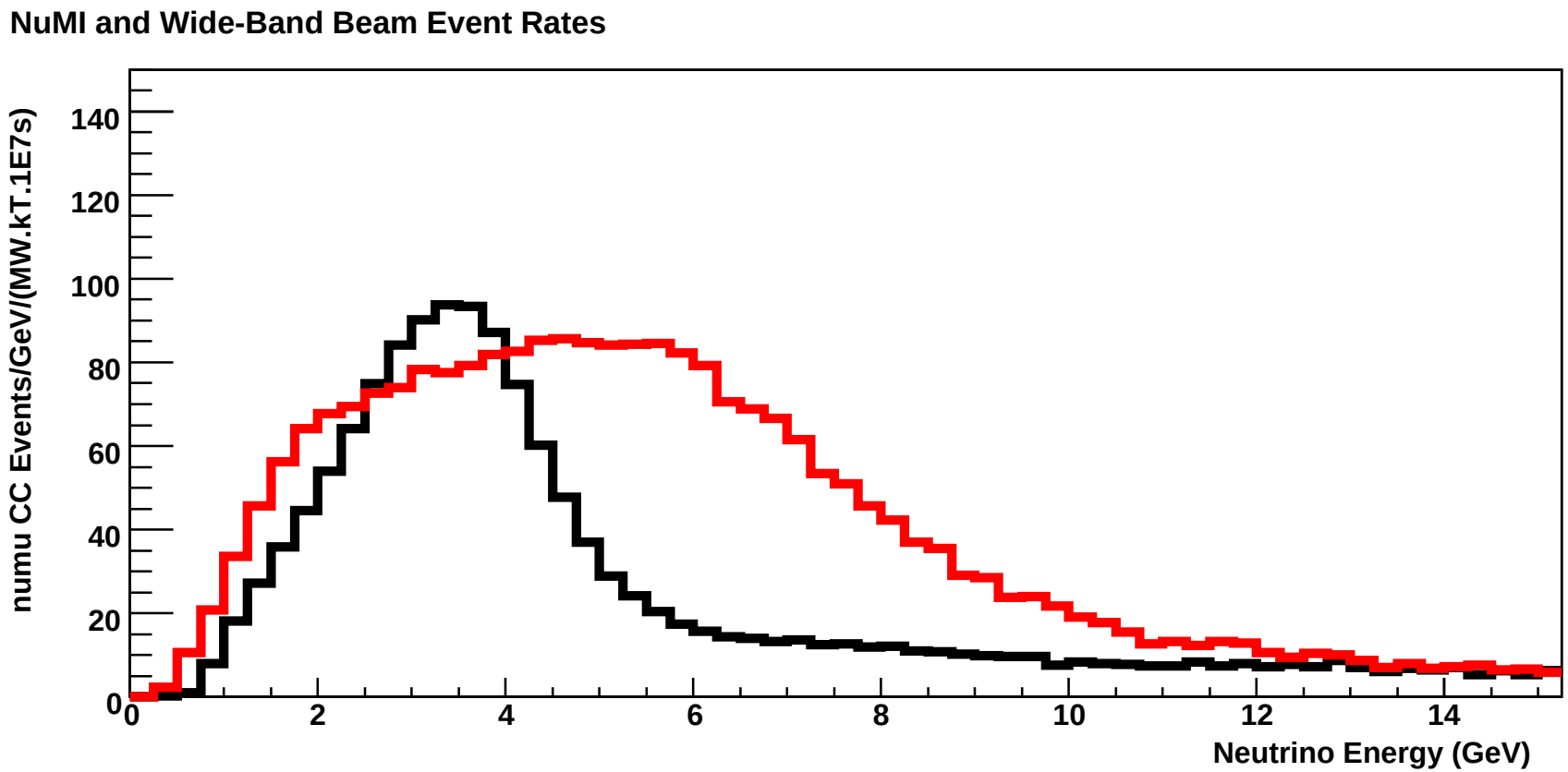
Increase tunnel diameter from 2 to 4m

Neutrino Beam Rates



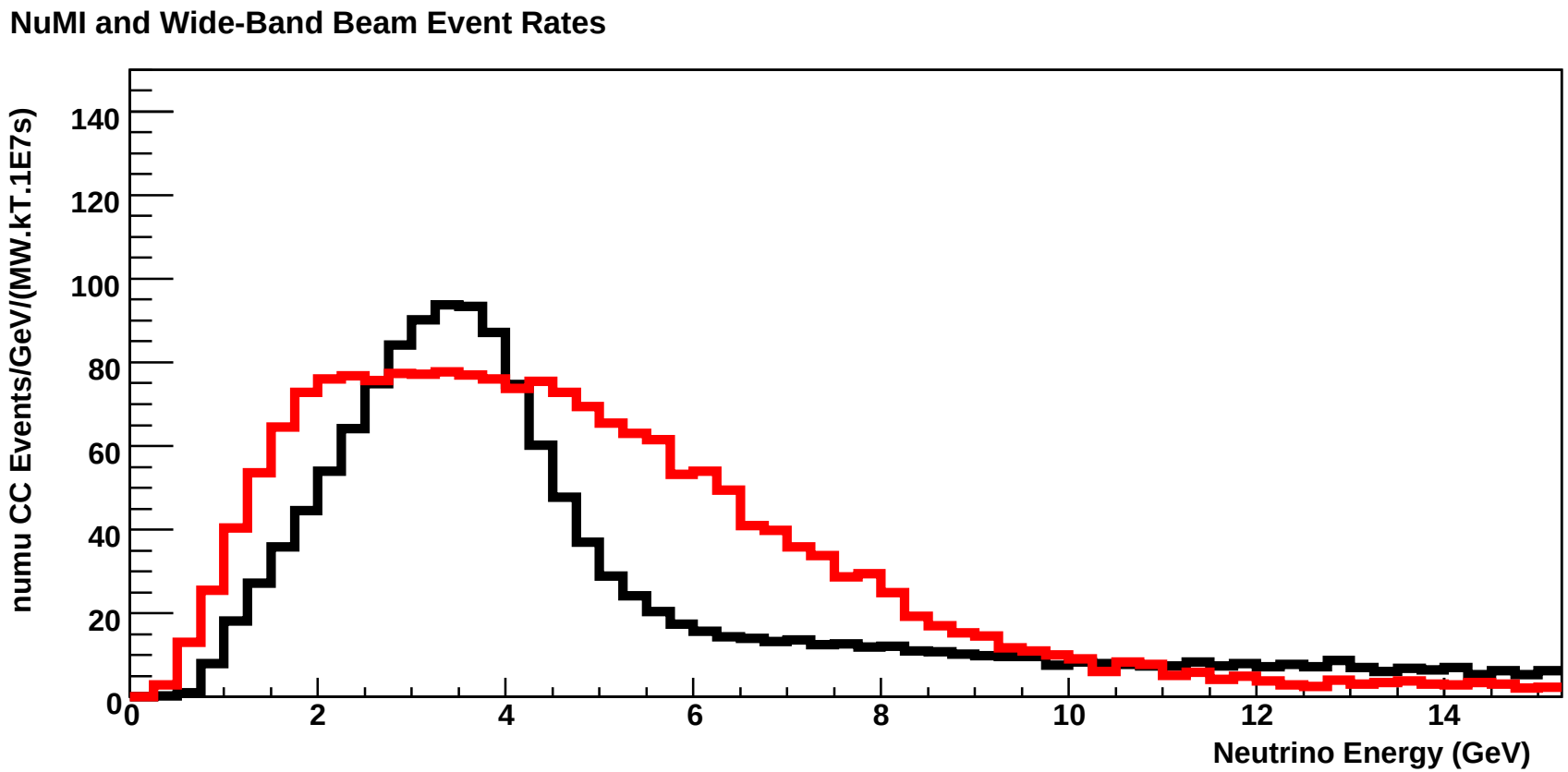
Increase wide-band horn current to 250kA

Neutrino Beam Rates



Decrease tunnel length from 677 to 380m (smaller target chase)

Neutrino Beam Rates

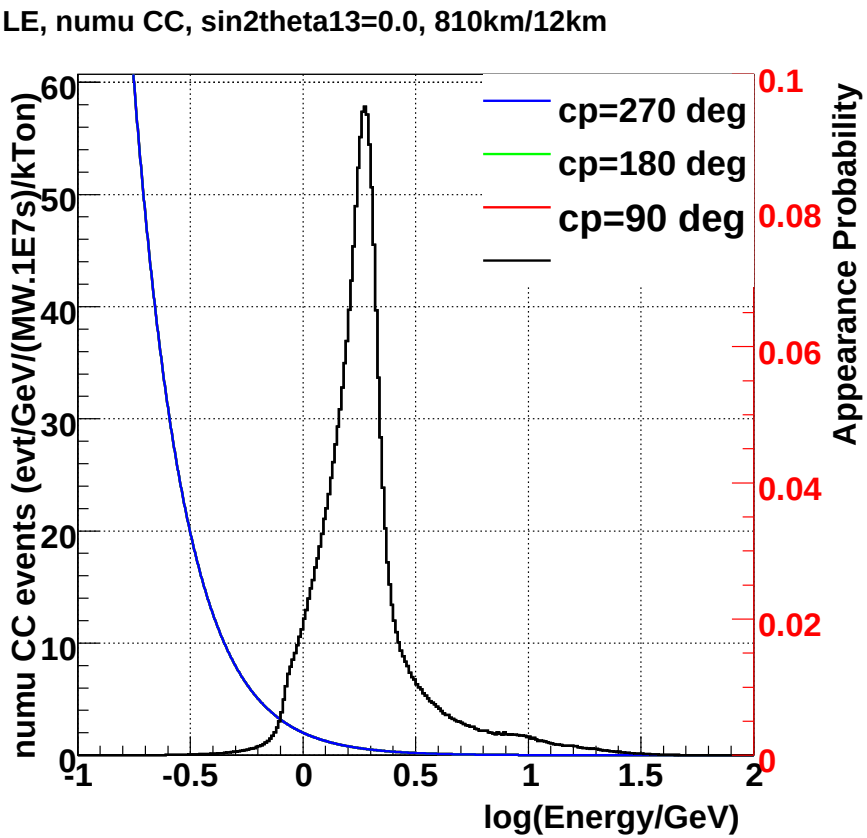


Decrease proton beam energy from 180 to 60 GeV

ν_e Appearance Probabilities

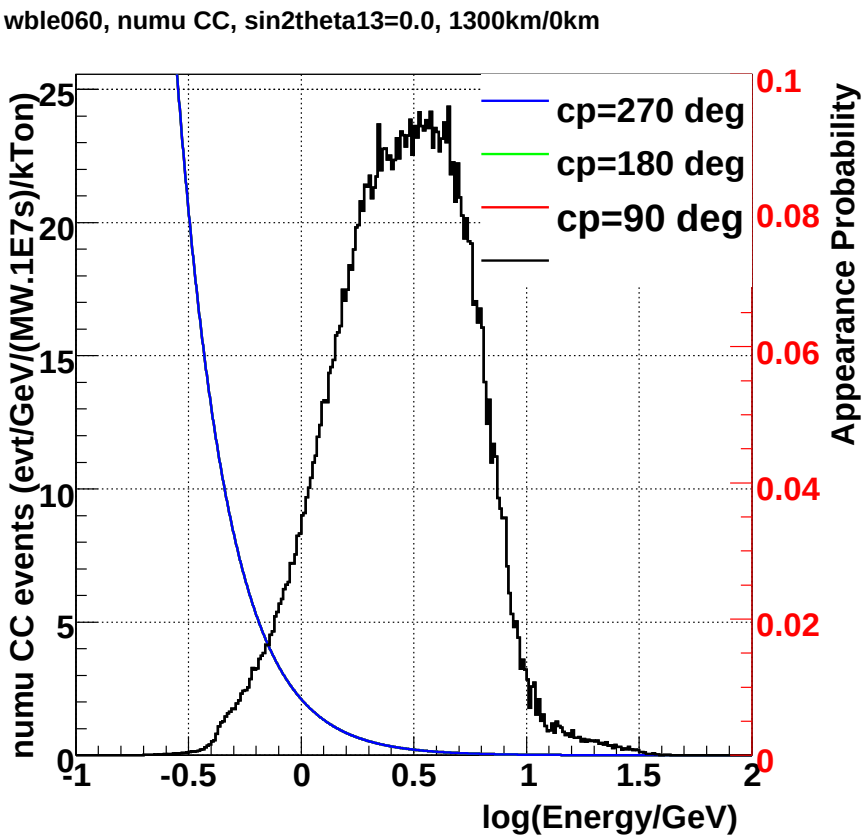
Normal hierarchy, $\Delta m^2_{32} = 2.5 \times 10^{-3}$ **eV**^{2}**,** $\Delta m^2_{12} = 8.6 \times 10^{-5}$ **eV**^{2}**,**

NuMI off-axis at 810 km



$$P(\nu_\mu \to \nu_e, \delta_{cp} = 0) = 0.9 \times 10^{-3}$$

WBLE 60 GeV at 1300km



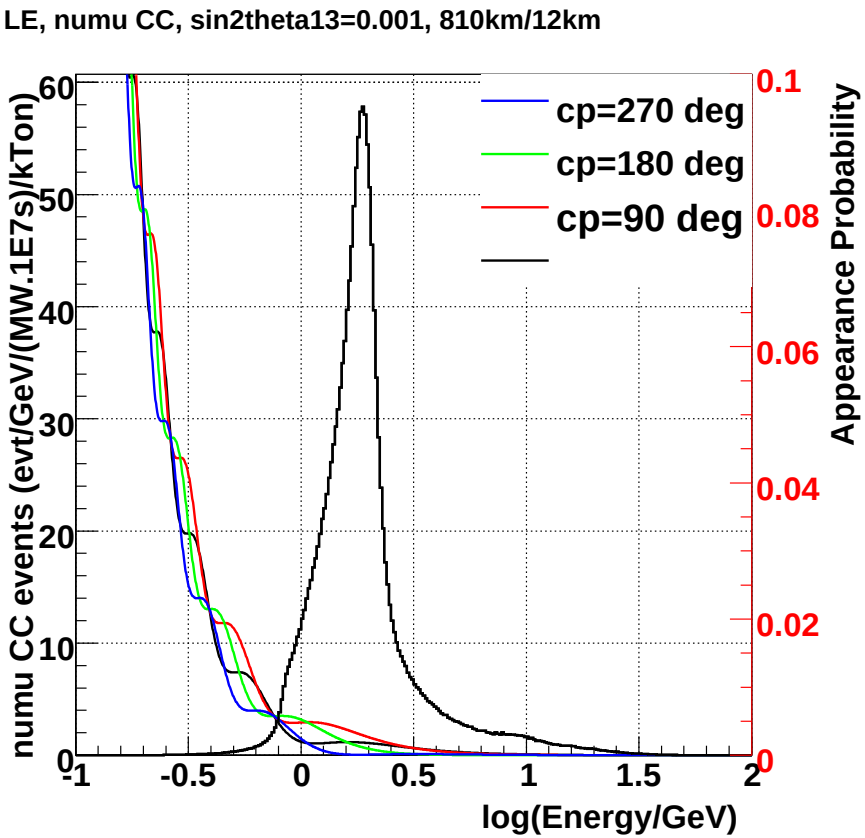
$$P(\nu_\mu \to \nu_e, \delta_{cp} = 0) = 1.1 \times 10^{-3}$$

$$\sin^2(2\theta_{13}) = 0.000$$

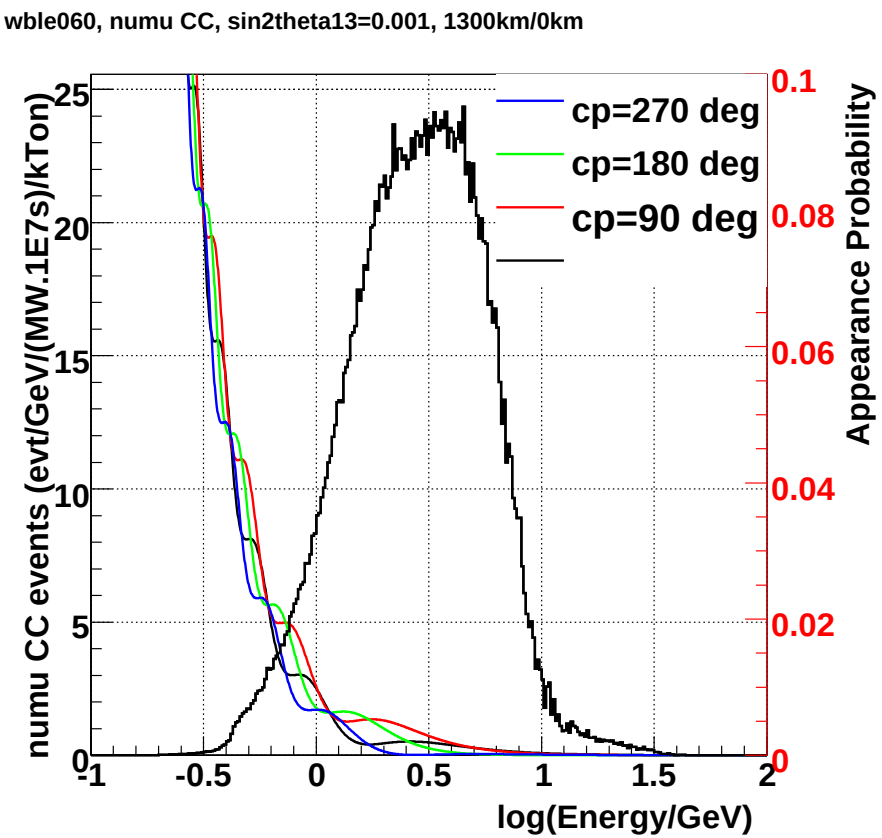
ν_e Appearance Probabilities

Normal hierarchy, $\Delta m^2_{32} = 2.5 \times 10^{-3}$ **eV**^{2}**,** $\Delta m^2_{12} = 8.6 \times 10^{-5}$ **eV**^{2}**,**

NuMI off-axis at 810 km



WBLE 60 GeV at 1300km



$P(\nu_\mu \to \nu_e, \delta_{cp} = 0) = 1.3 \times 10^{-3}$

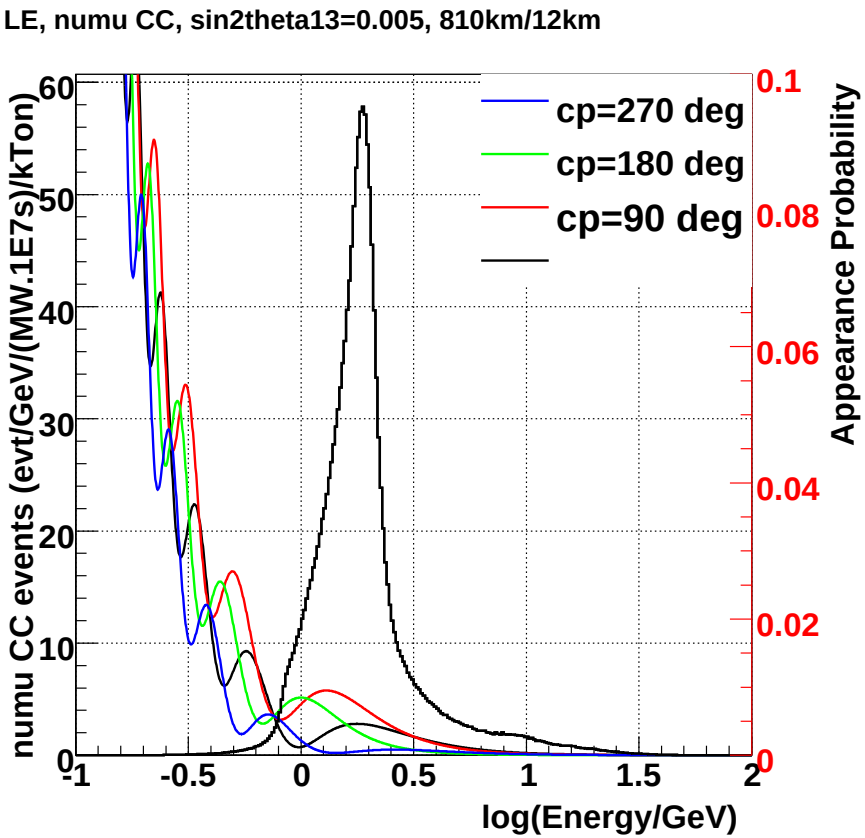
$P(\nu_\mu \to \nu_e, \delta_{cp} = 0) = 1.6 \times 10^{-3}$

$\sin^2(2\theta_{13}) = 0.001$

ν_e Appearance Probabilities

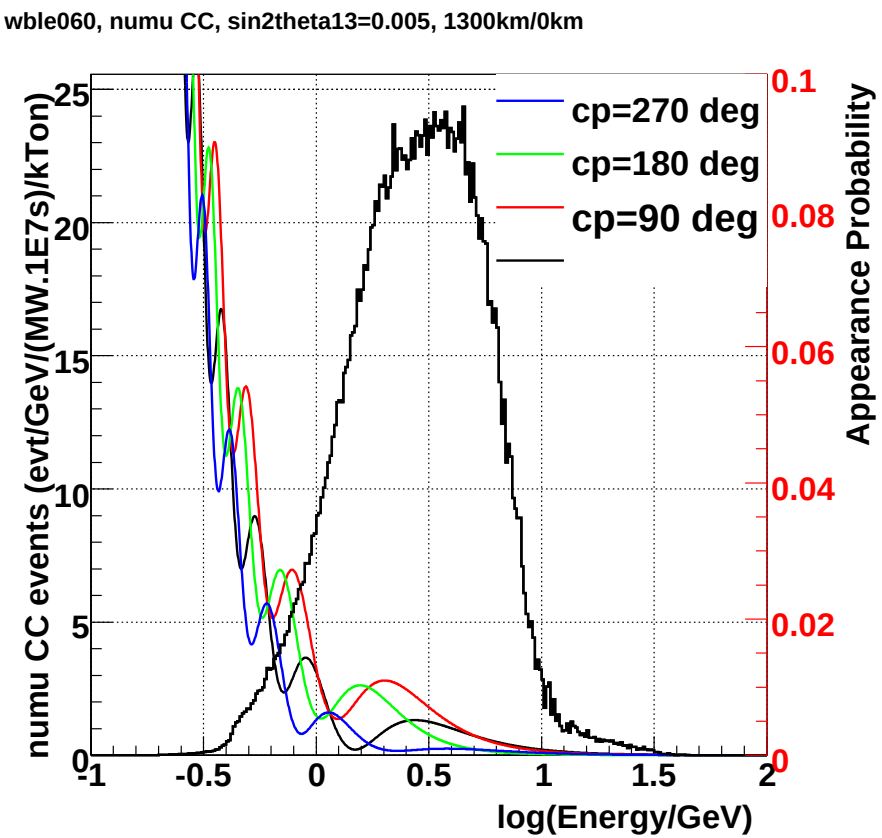
Normal hierarchy, $\Delta m^2_{32} = 2.5 \times 10^{-3}$ **eV**^{2}**,** $\Delta m^2_{12} = 8.6 \times 10^{-5}$ **eV**^{2}**,**

NuMI off-axis at 810 km



$$P(\nu_\mu \to \nu_e, \delta_{cp} = 0) = 3.0 \times 10^{-3}$$

WBLE 60 GeV at 1300km



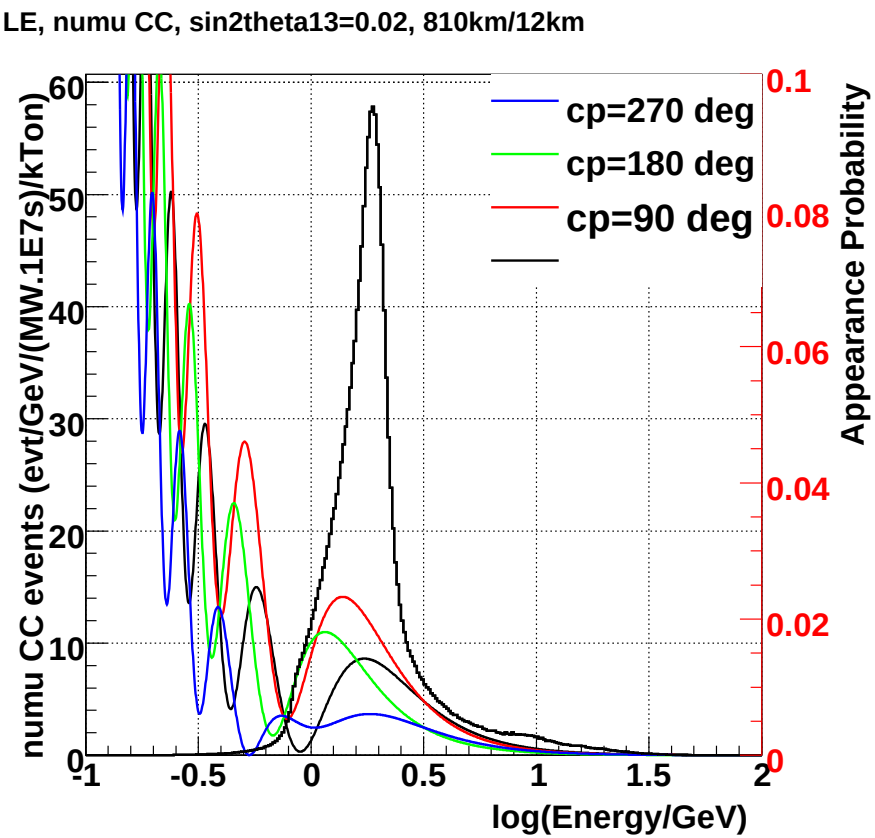
$$P(\nu_\mu \to \nu_e, \delta_{cp} = 0) = 3.2 \times 10^{-3}$$

$$\sin^2(2\theta_{13}) = 0.005$$

ν_e Appearance Probabilities

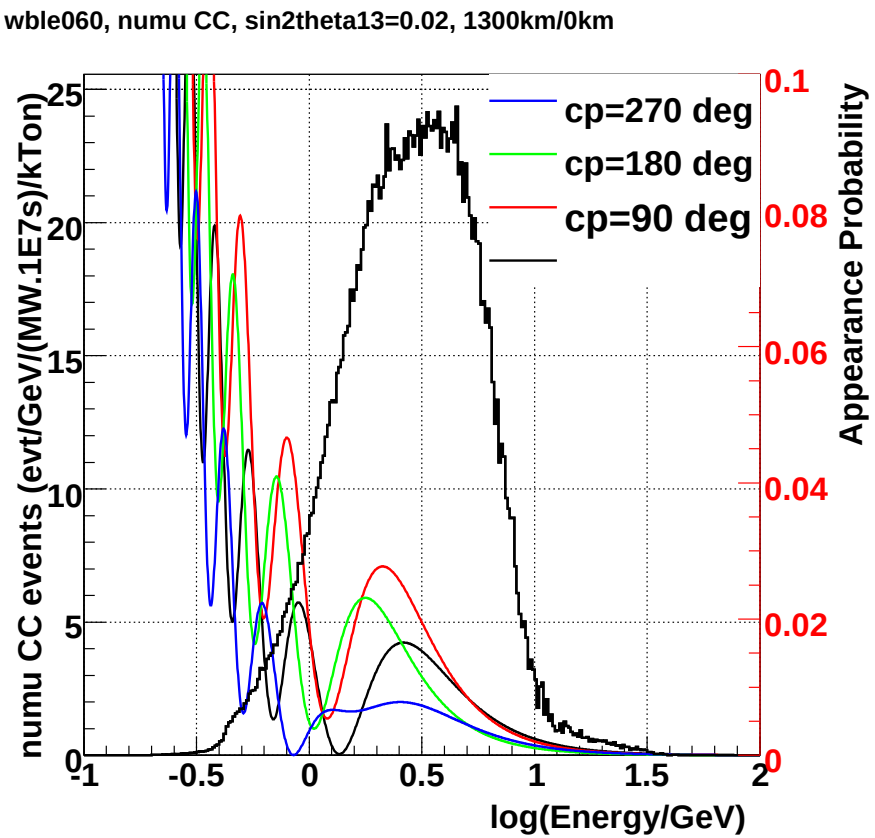
Normal hierarchy, $\Delta m^2_{32} = 2.5 \times 10^{-3}$ **eV**^{2}**,** $\Delta m^2_{12} = 8.6 \times 10^{-5}$ **eV**^{2}**,**

NuMI off-axis at 810 km



$$P(\nu_\mu \to \nu_e, \delta_{cp} = 0) = 8.9 \times 10^{-3}$$

WBLE 60 GeV at 1300km



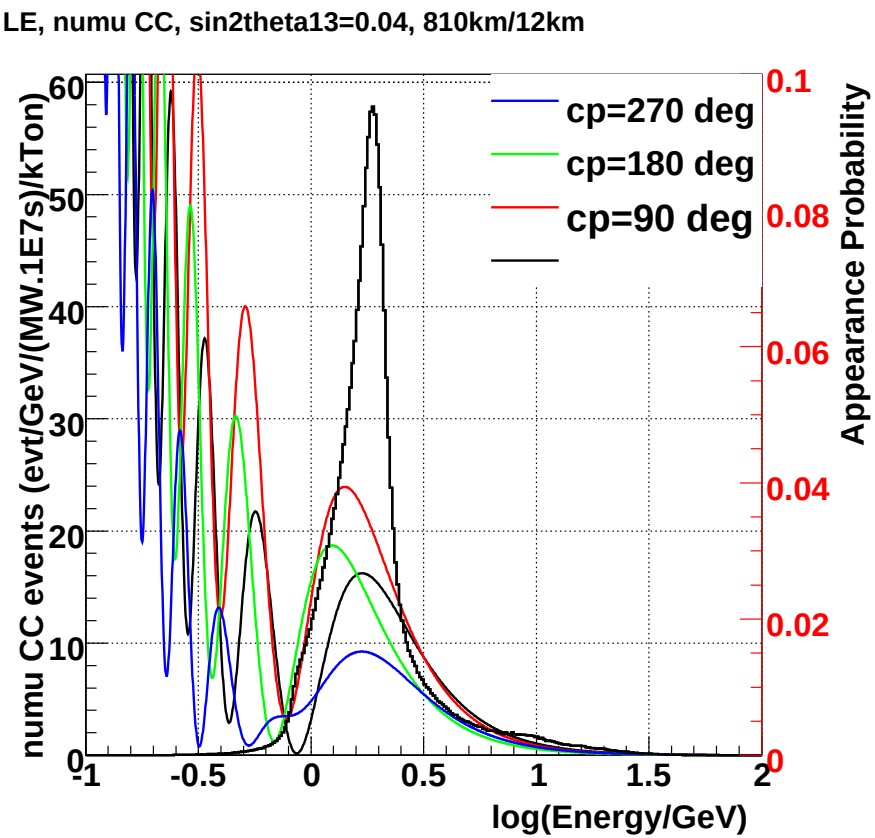
$$P(\nu_\mu \to \nu_e, \delta_{cp} = 0) = 9.1 \times 10^{-3}$$

$$\sin^2(2\theta_{13}) = 0.02$$

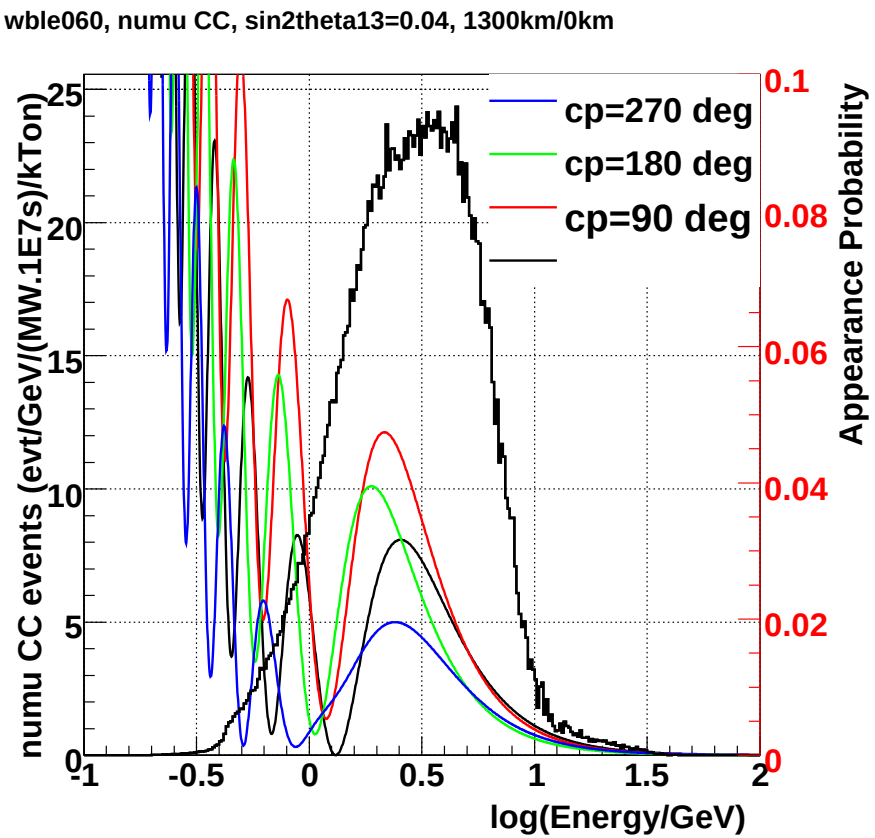
ν_e Appearance Probabilities

Normal hierarchy, $\Delta m^2_{32} = 2.5 \times 10^{-3}$ **eV**^{2}**,** $\Delta m^2_{12} = 8.6 \times 10^{-5}$ **eV**^{2}**,**

NuMI off-axis at 810 km



WBLE 60 GeV at 1300km



$P(\nu_\mu \to \nu_e, \delta_{cp} = 0) = 1.7 \times 10^{-2}$

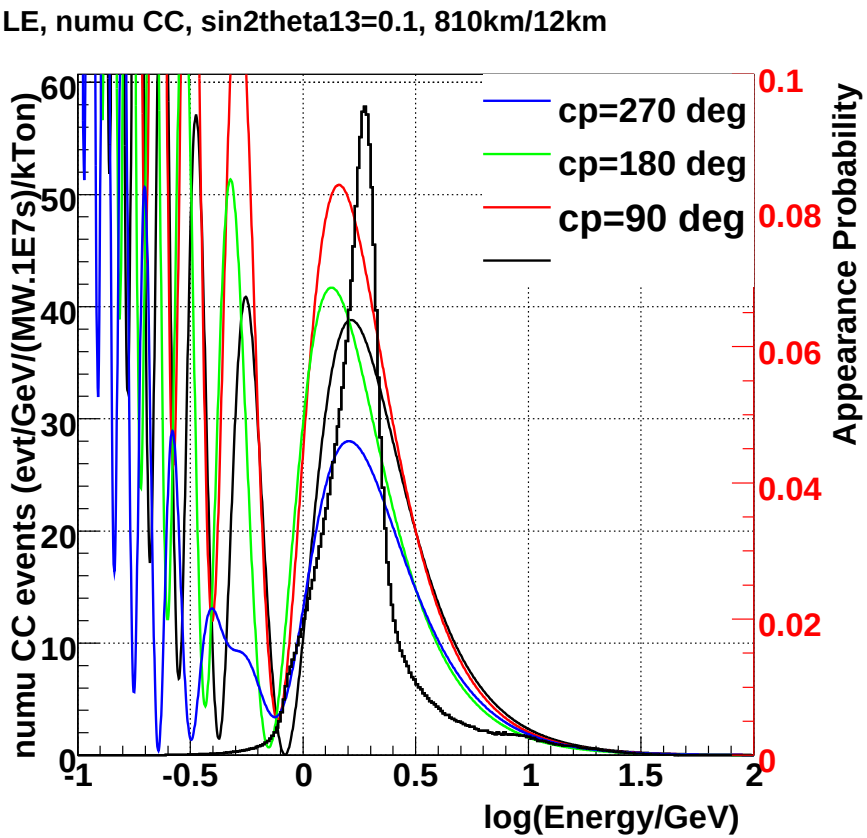
$P(\nu_\mu \to \nu_e, \delta_{cp} = 0) = 1.7 \times 10^{-2}$

$\sin^2(2\theta_{13}) = 0.04$

ν_e Appearance Probabilities

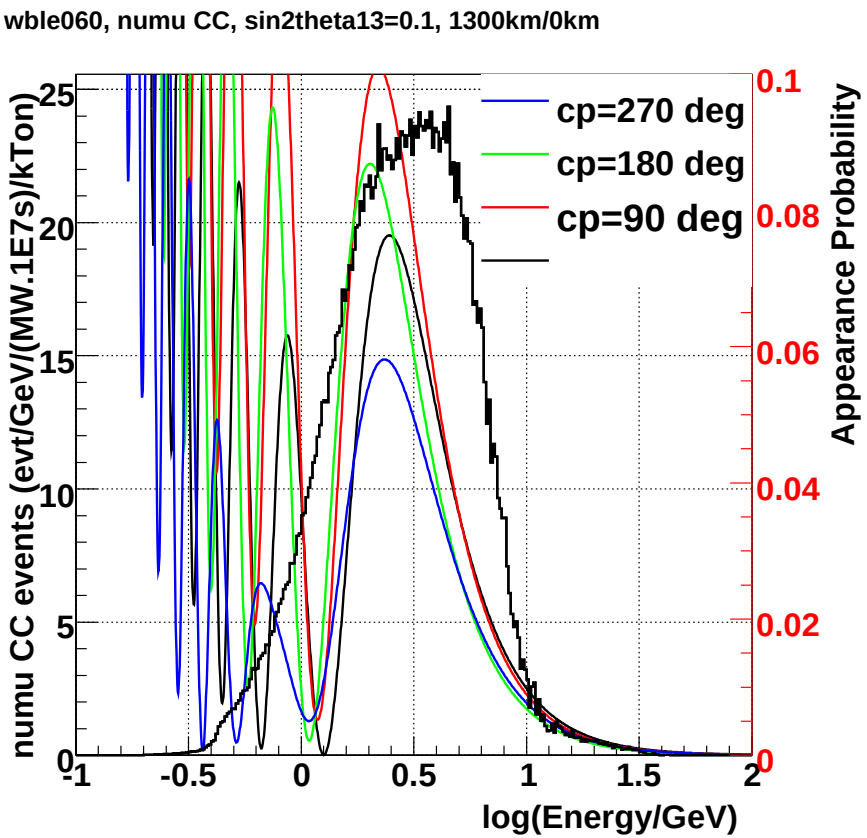
Normal hierarchy, $\Delta m^2_{32} = 2.5 \times 10^{-3}$ **eV**^{2}**,** $\Delta m^2_{12} = 8.6 \times 10^{-5}$ **eV**^{2}**,**

NuMI off-axis at 810 km



$$P(\nu_\mu \to \nu_e, \delta_{cp} = 0) = 4.0 \times 10^{-2}$$

WBLE 60 GeV at 1300km



$$P(\nu_\mu \to \nu_e, \delta_{cp} = 0) = 3.9 \times 10^{-2}$$

$$\sin^2(2\theta_{13}) = 0.1$$