大気ニュートリノフラックスの精密計算

201年12月8日、本田守広
@ICRR共同利用研究成果発表研究会

この一年の進展、

- 新しい一次宇宙線観データの理解
- 新しい実験サイトでの
  大気ニュートリノフラックスの計算
- 新しい大気モデルの取り込み
- … … …

査定金額：旅費3万円
年度内全額執行予定

アカゲラ

Gaisser Formula for illustration (by T.K.Gaisser at Takayama, 1998)

$$\Phi_{\nu} = \Phi_{primary} \otimes R_{cut} \otimes Y_{\nu}$$

$$\Phi_{\mu} = \Phi_{primary} \otimes R_{cut} \otimes Y_{\mu}$$

Where

$\Phi_{primary}$: Cosmic Ray Flux

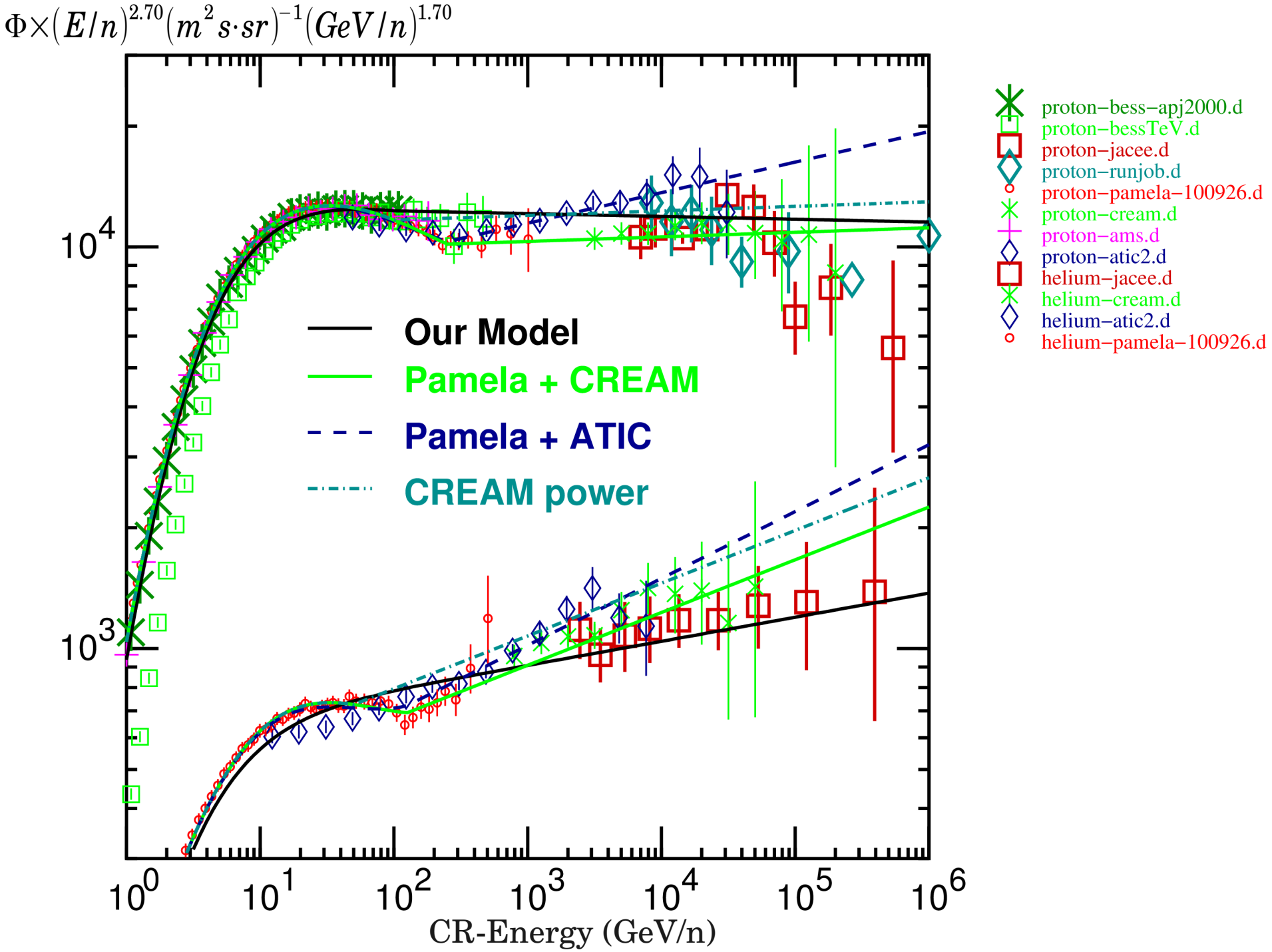
$R_{cut} = R_{cut}(R_{cr}, latt., long., \theta, \varphi)$: Geomagnetic field

$Y_{\nu} = Yield_{\nu}(h, \theta)$: Hadronic Interaction Model,
Air Profile, and meson-muon decay

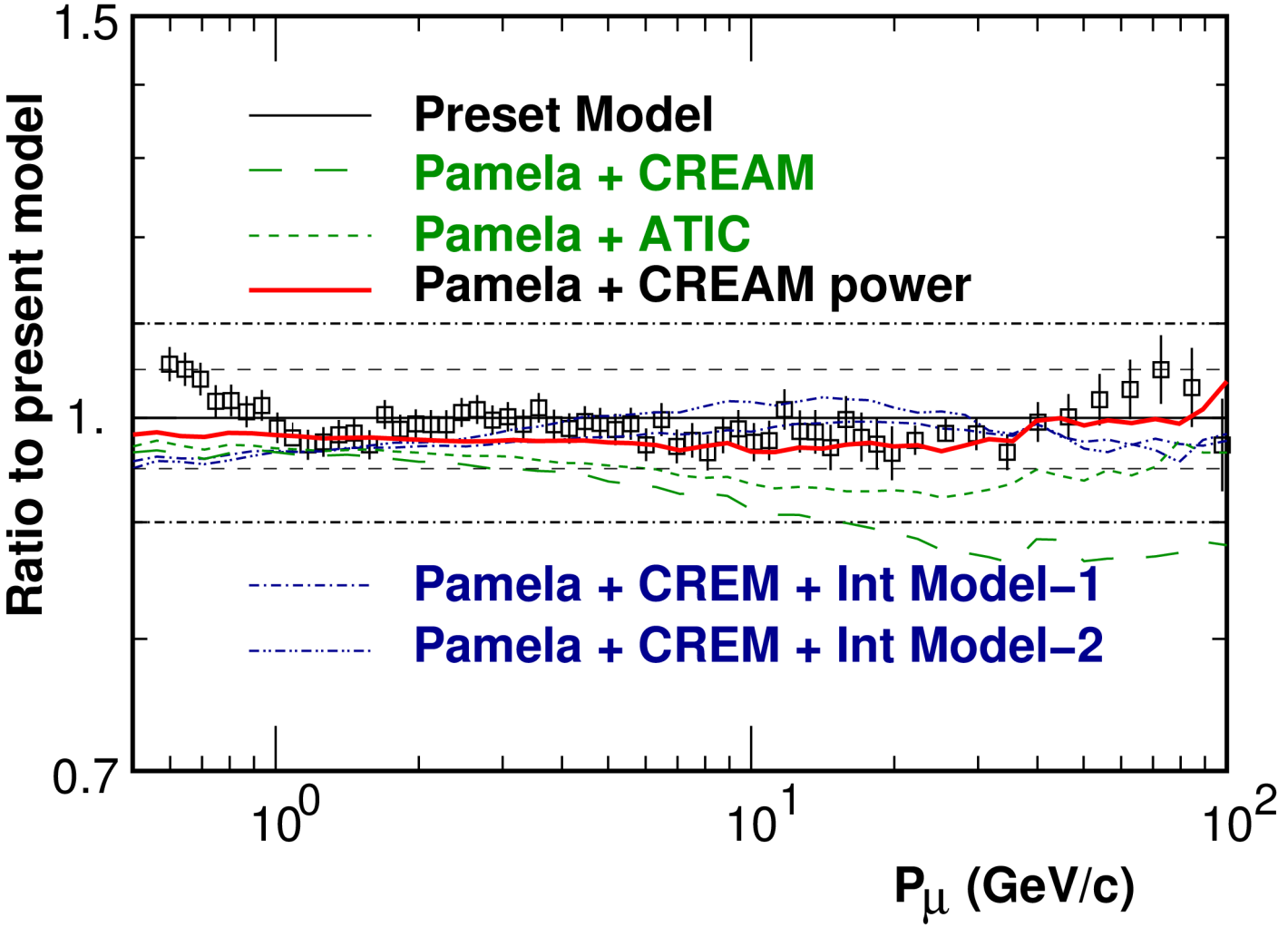
$Y_{\mu} = Yield_{\mu}(h, \theta)$: Hadronic Interaction Model,
Air Profile, and meson decay

This formula illustrates 1D-calculation well

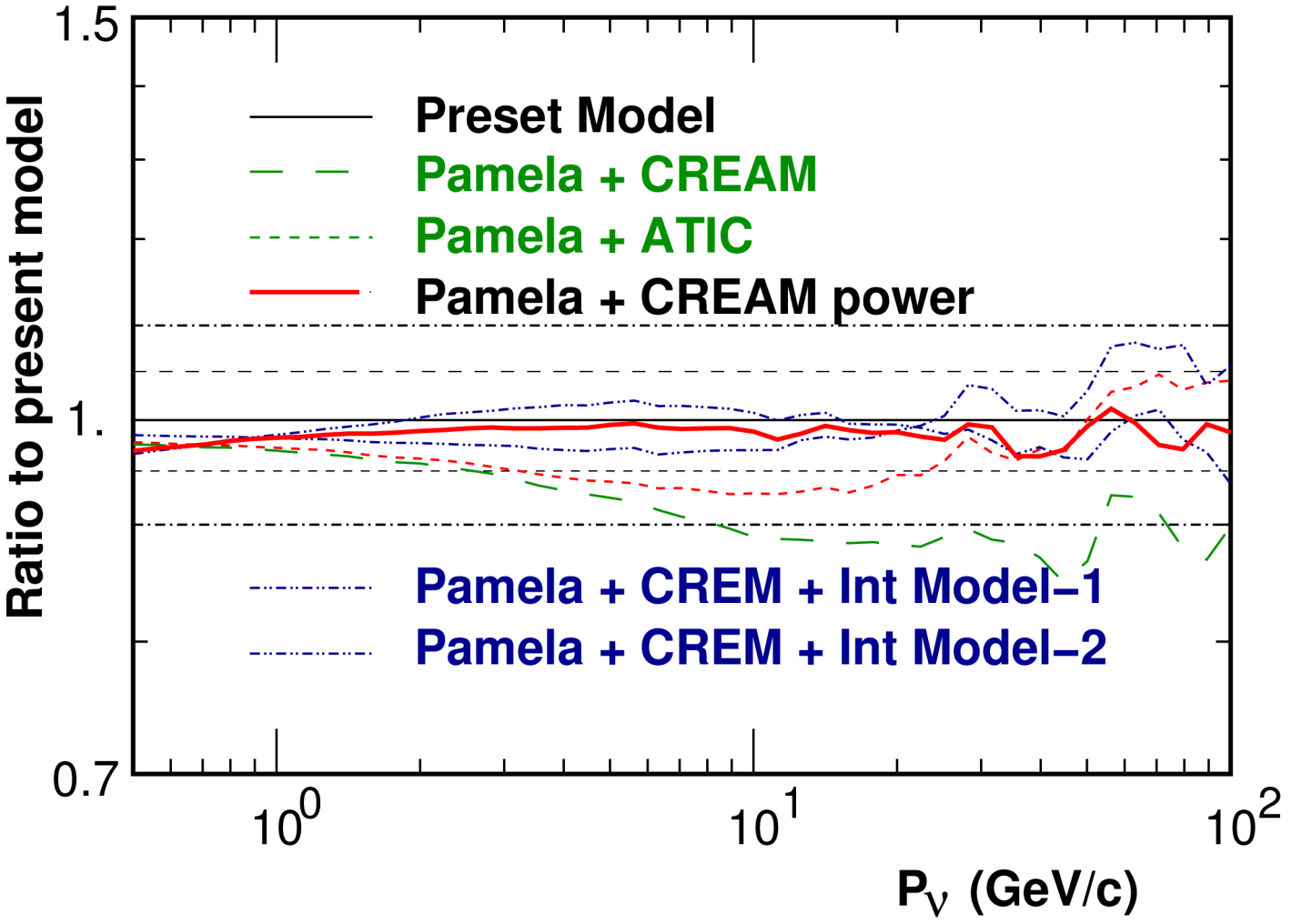
On the new cosmic ray observations



Tuning of Int. Model by atmospheric muons



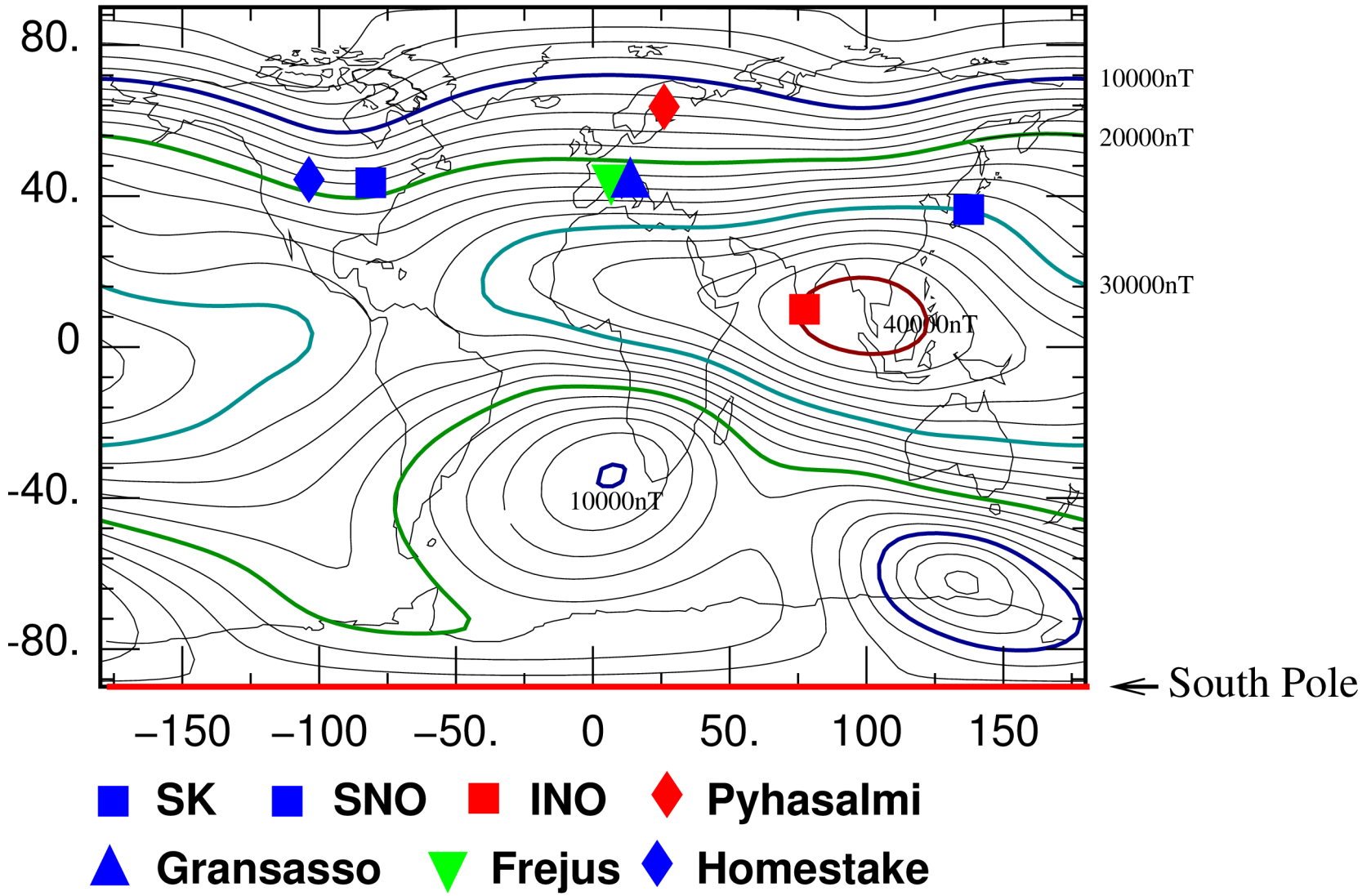
Resulting Neutrino Flux (all ν sum)



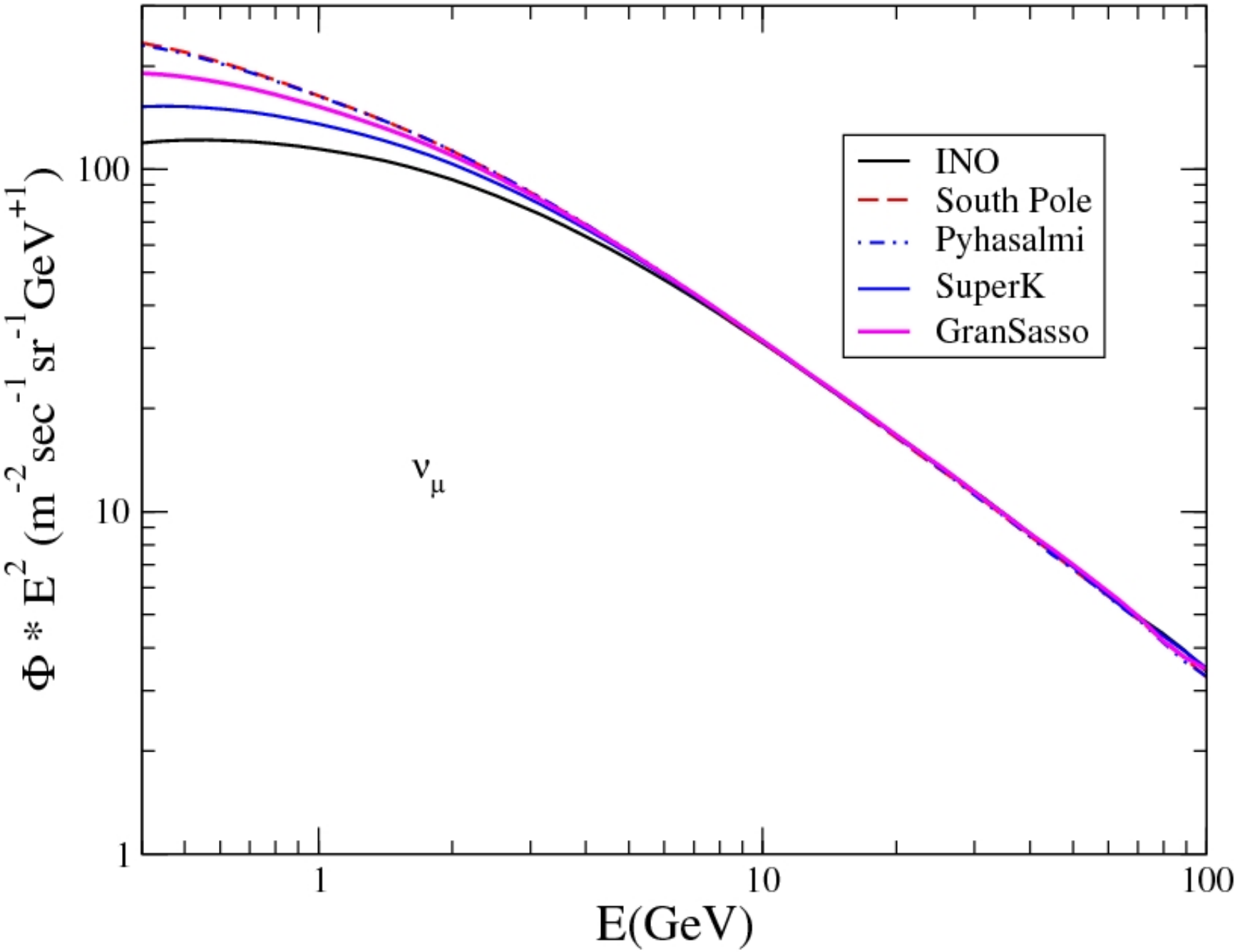
Muon Tuning works Well, however,

However, result of AMS-II is coming soon., I hope.

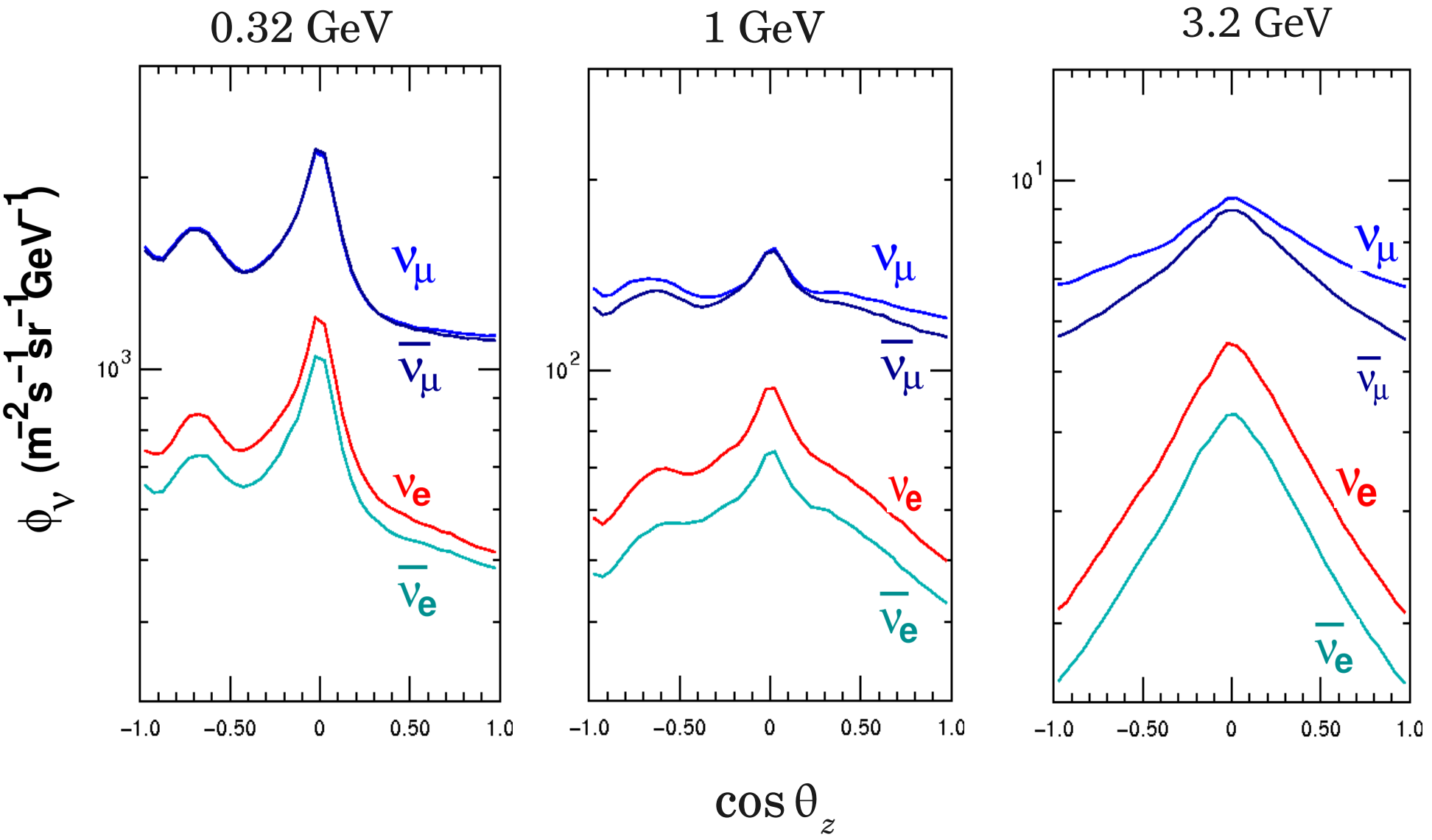
Presently going calculation (with M.S. Athar)



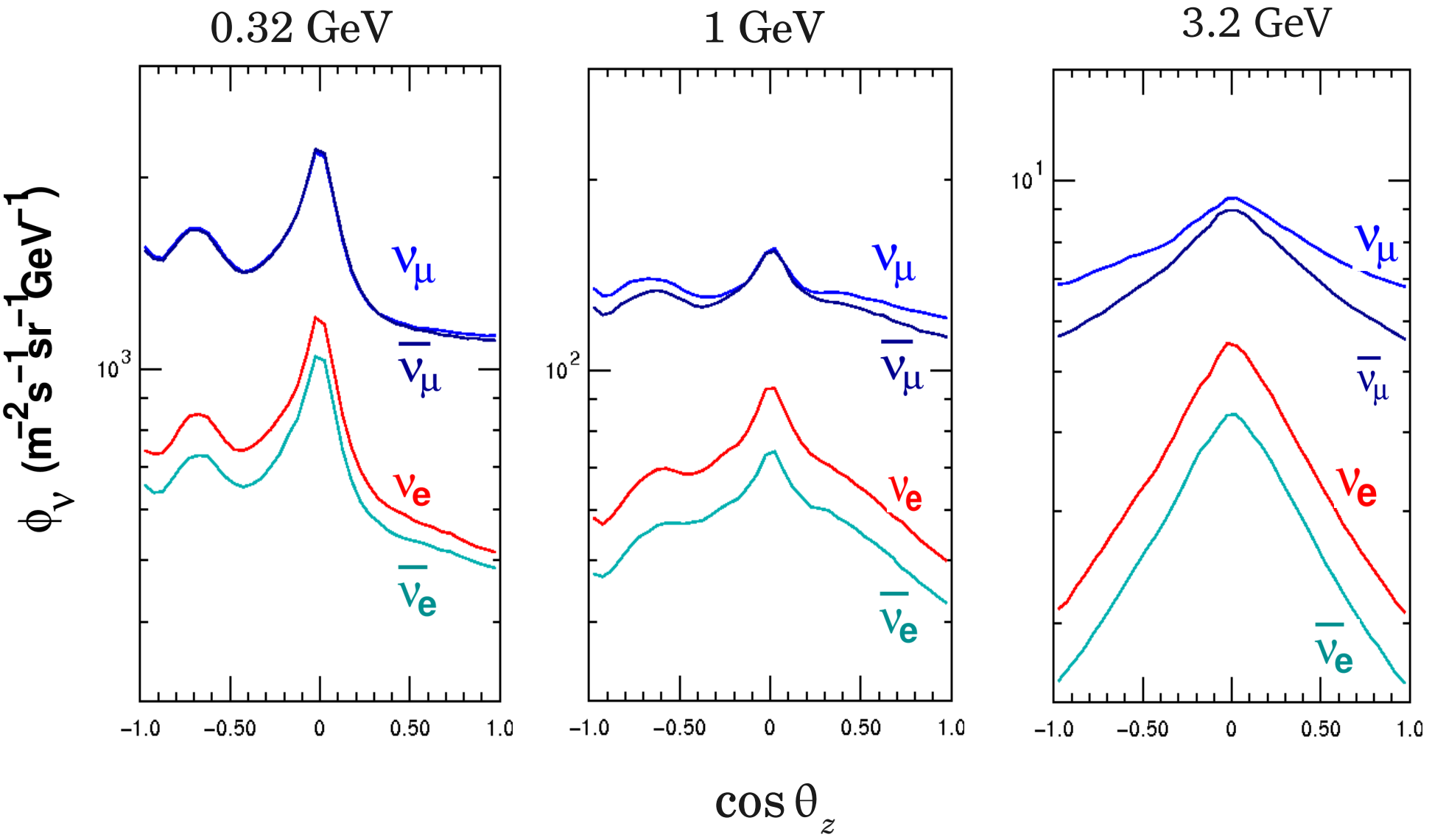
Sum of averaged neutrino flux over all directions



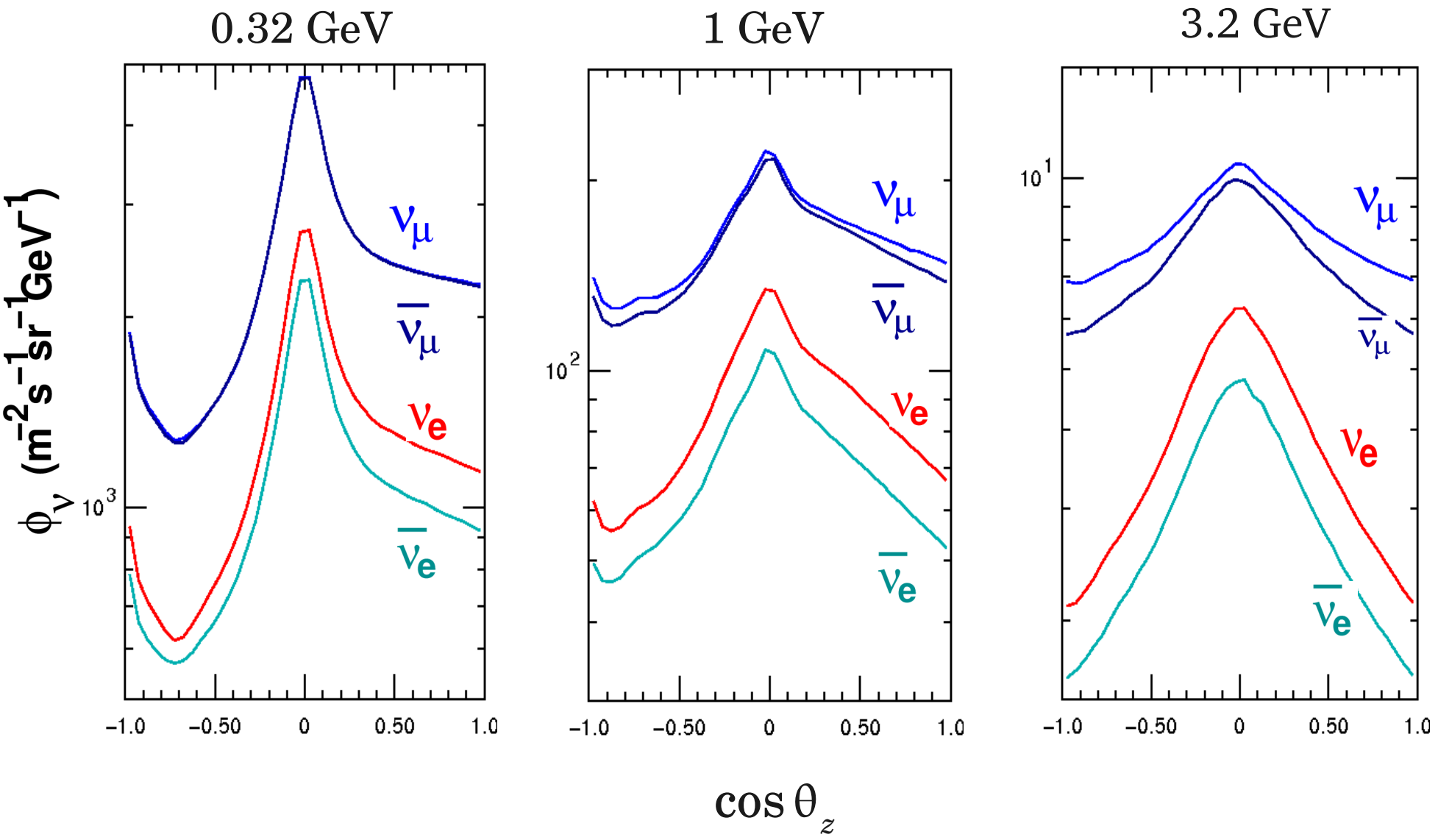
Zenith angle dependence of neutrino fluxes averaged over all azimuth angles at SK



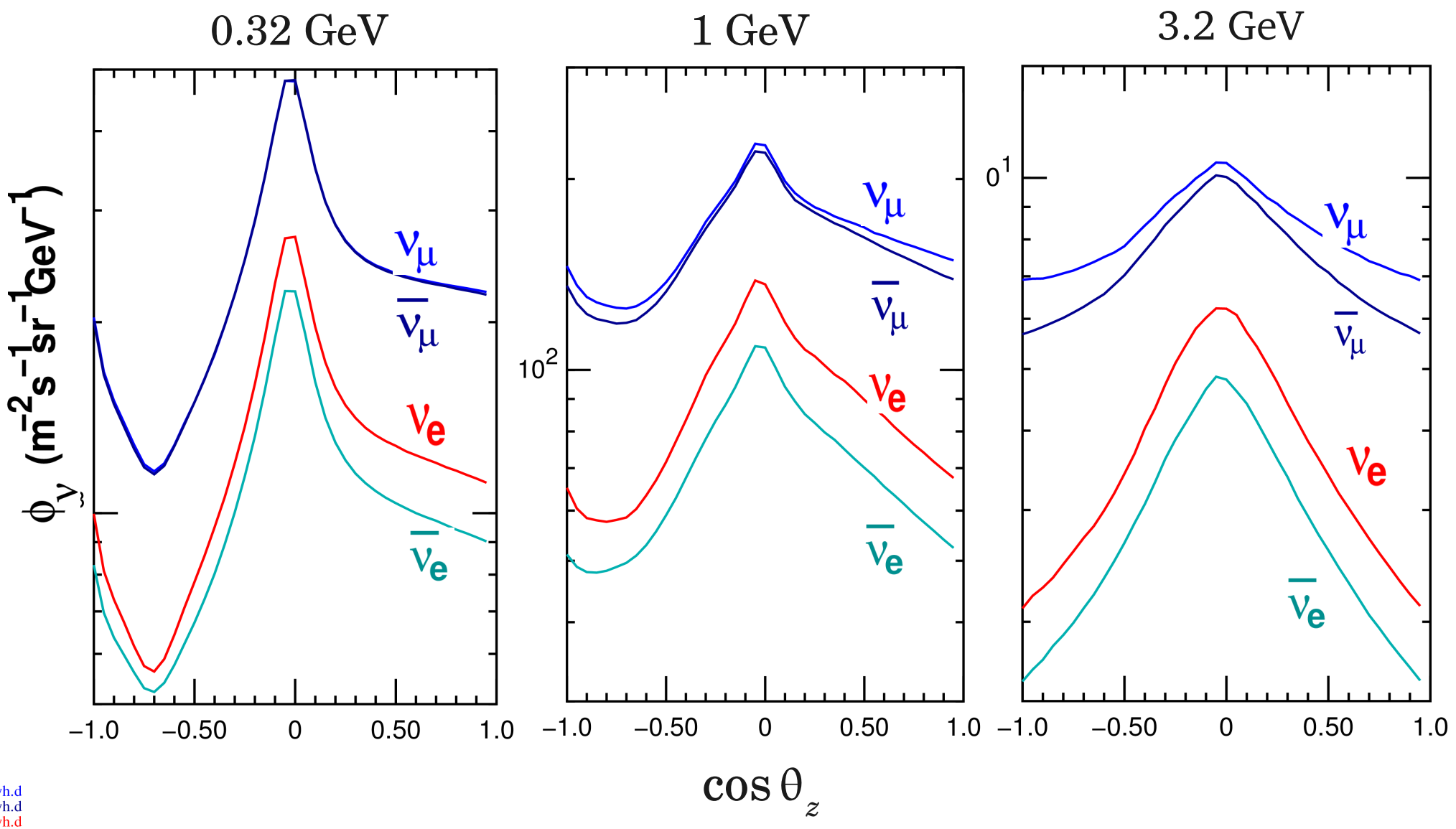
Zenith angle dependence of neutrino fluxes averaged over all azimuth angles at SK



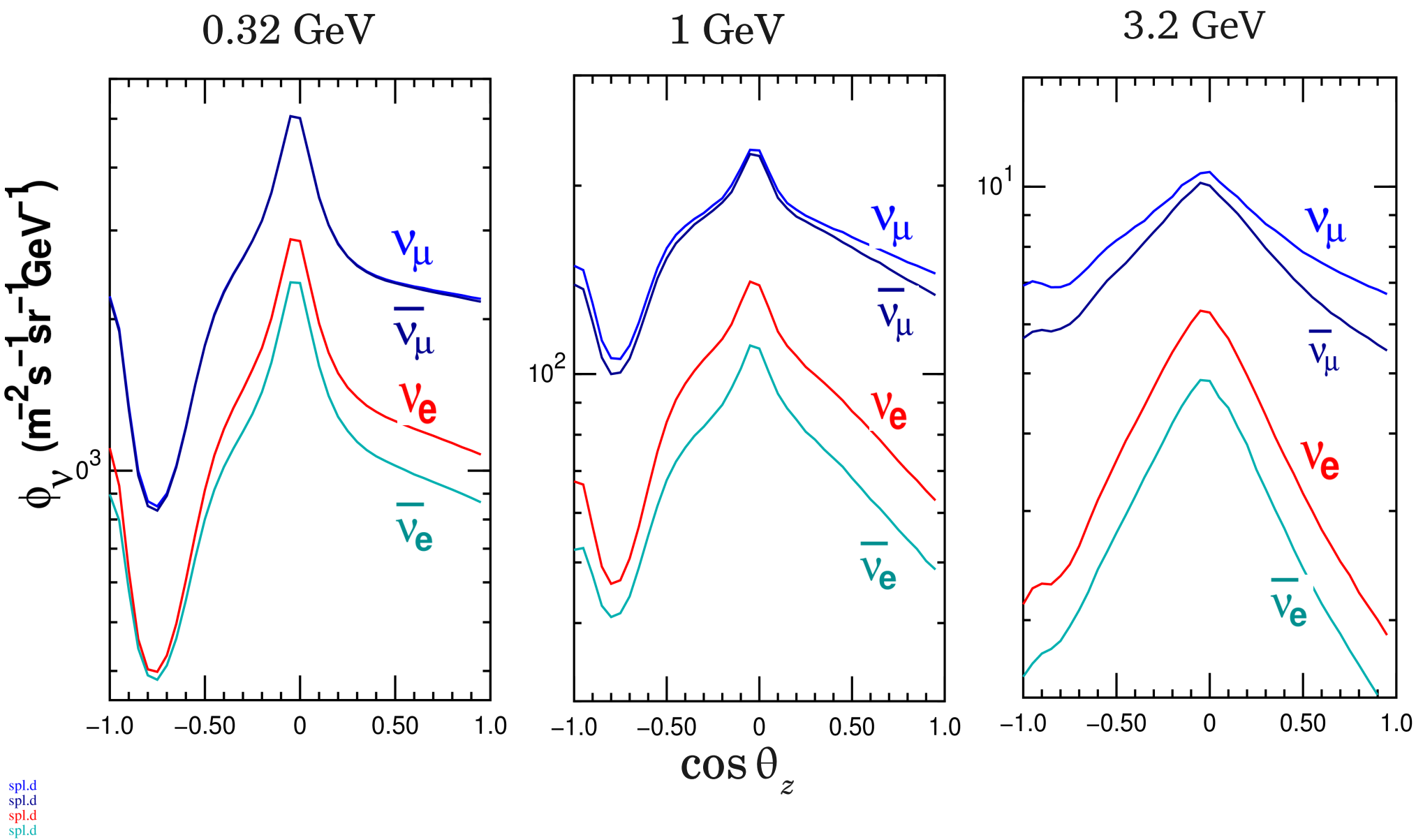
Zenith angle dependence of neutrino fluxes averaged over all azimuth angles at SNO



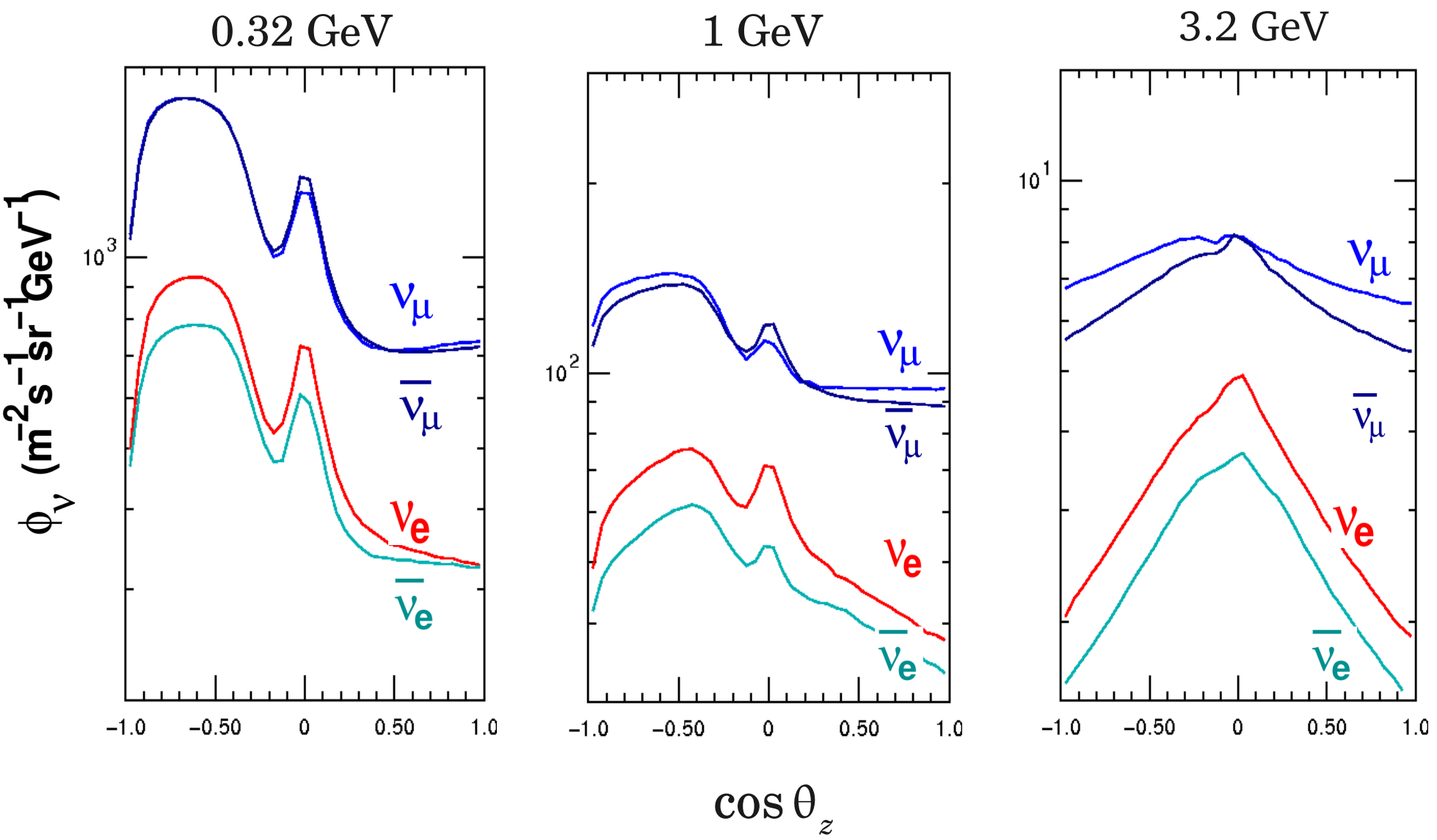
Zenith angle dependence of neutrino fluxes averaged over all azimuth angles at Pyhsalimi



Zenith angle dependence of neutrino fluxes averaged over all azimuth angles at South Pole

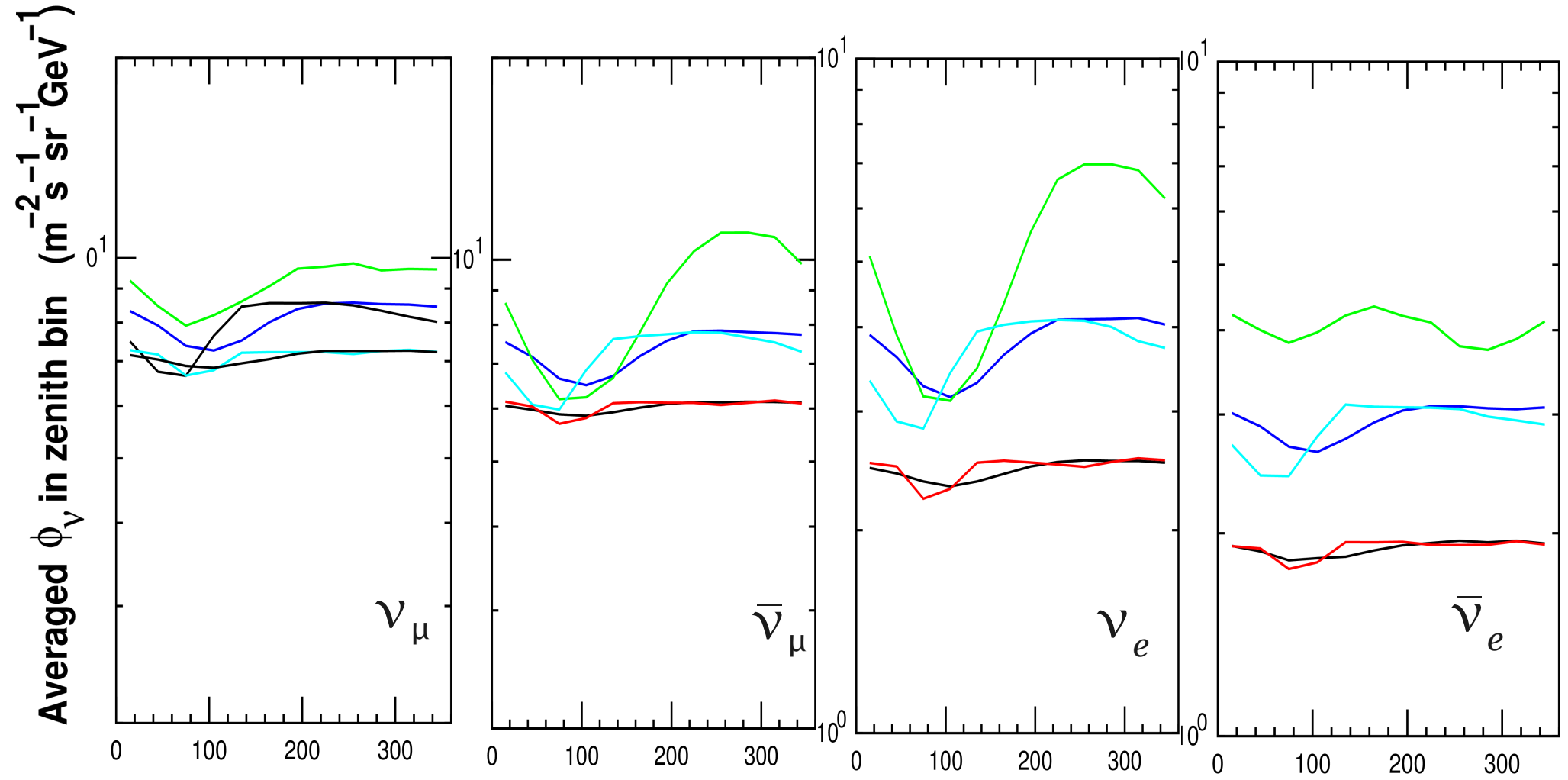


Zenith angle dependence of neutrino fluxes averaged over all azimuth angles at INO



Azimuth angle dependence at SK

3.2 GeV

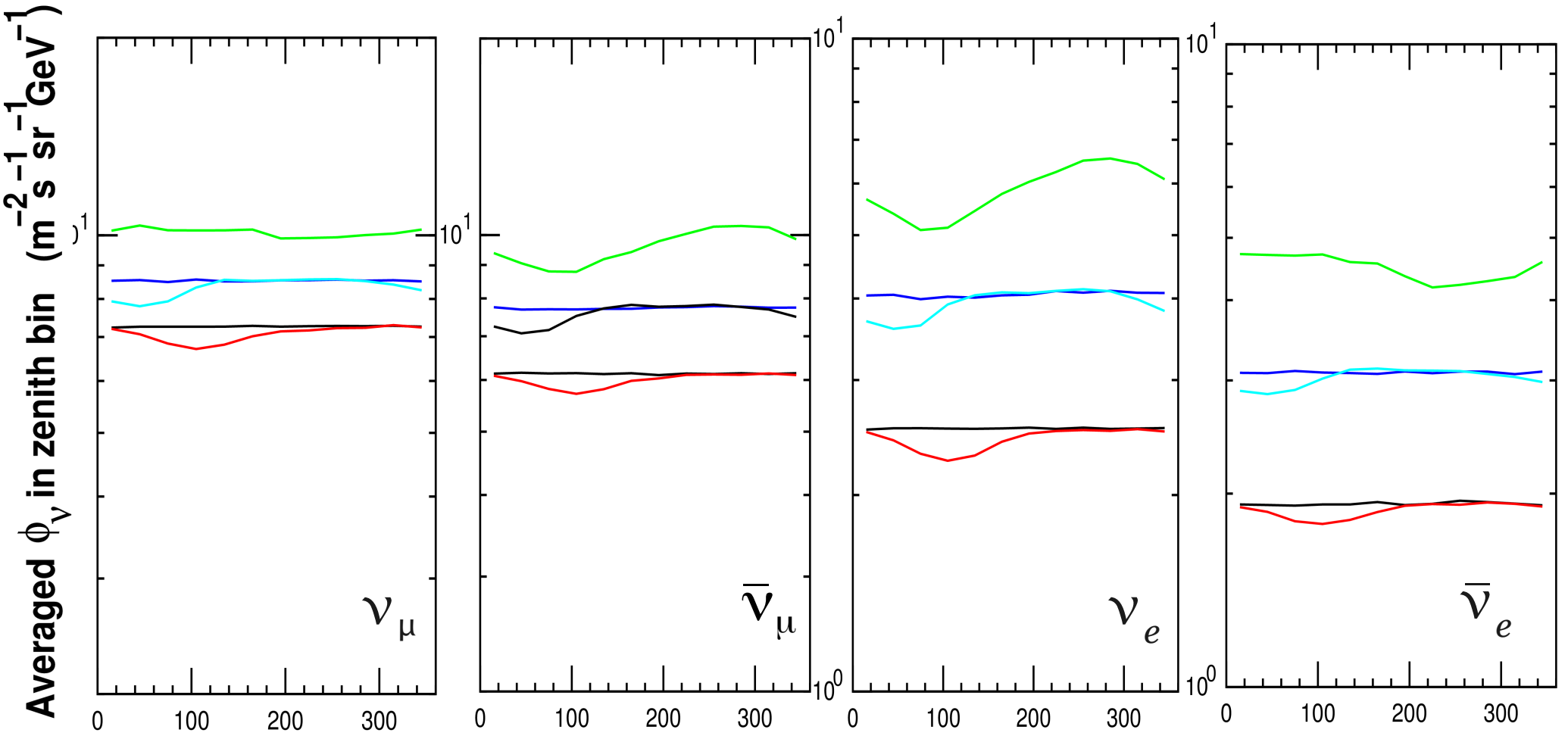


kam.d

Counter clockwise azimuth angles measured from South

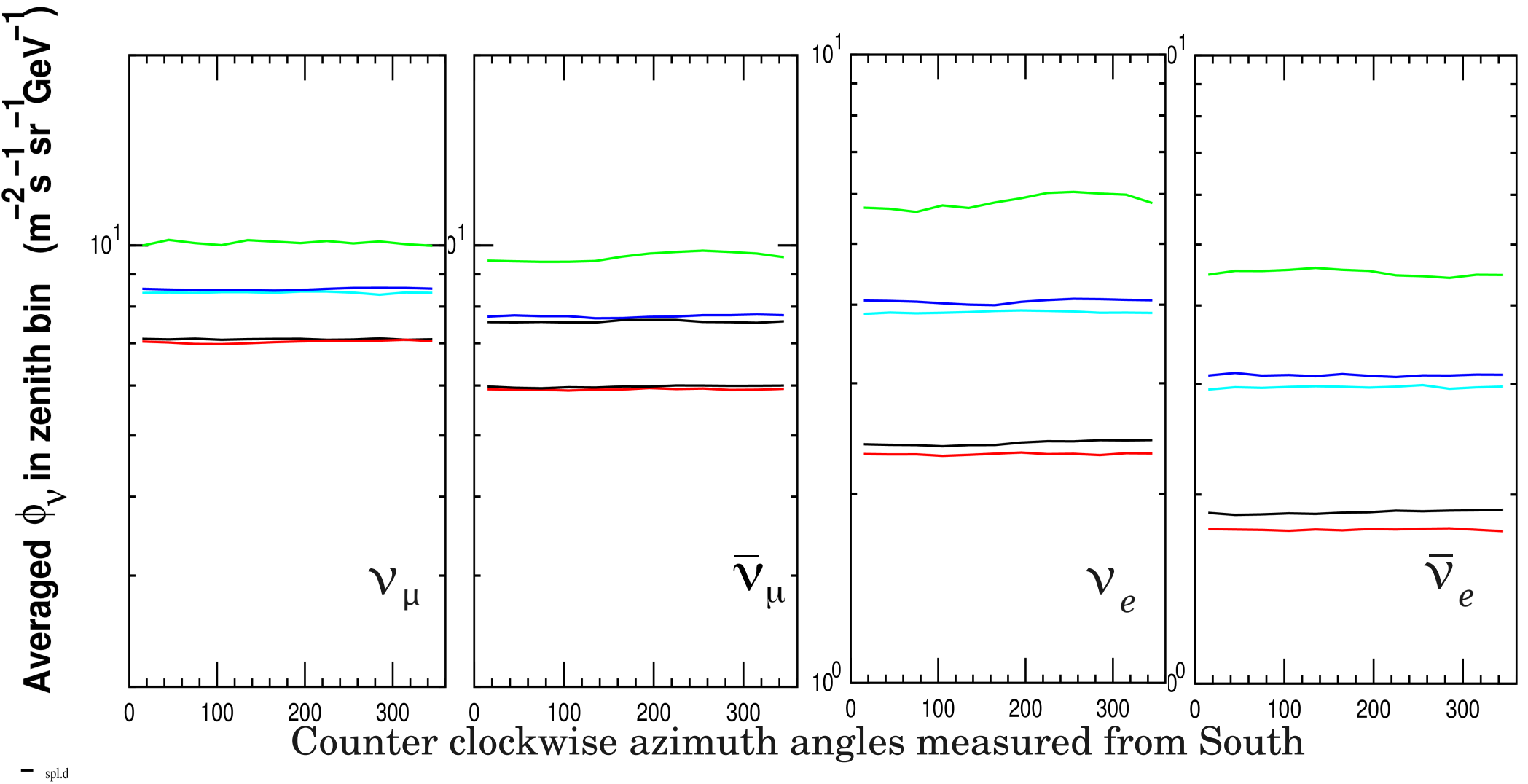
Azimuth angle dependence at Pylhasalmi

3.2 GeV



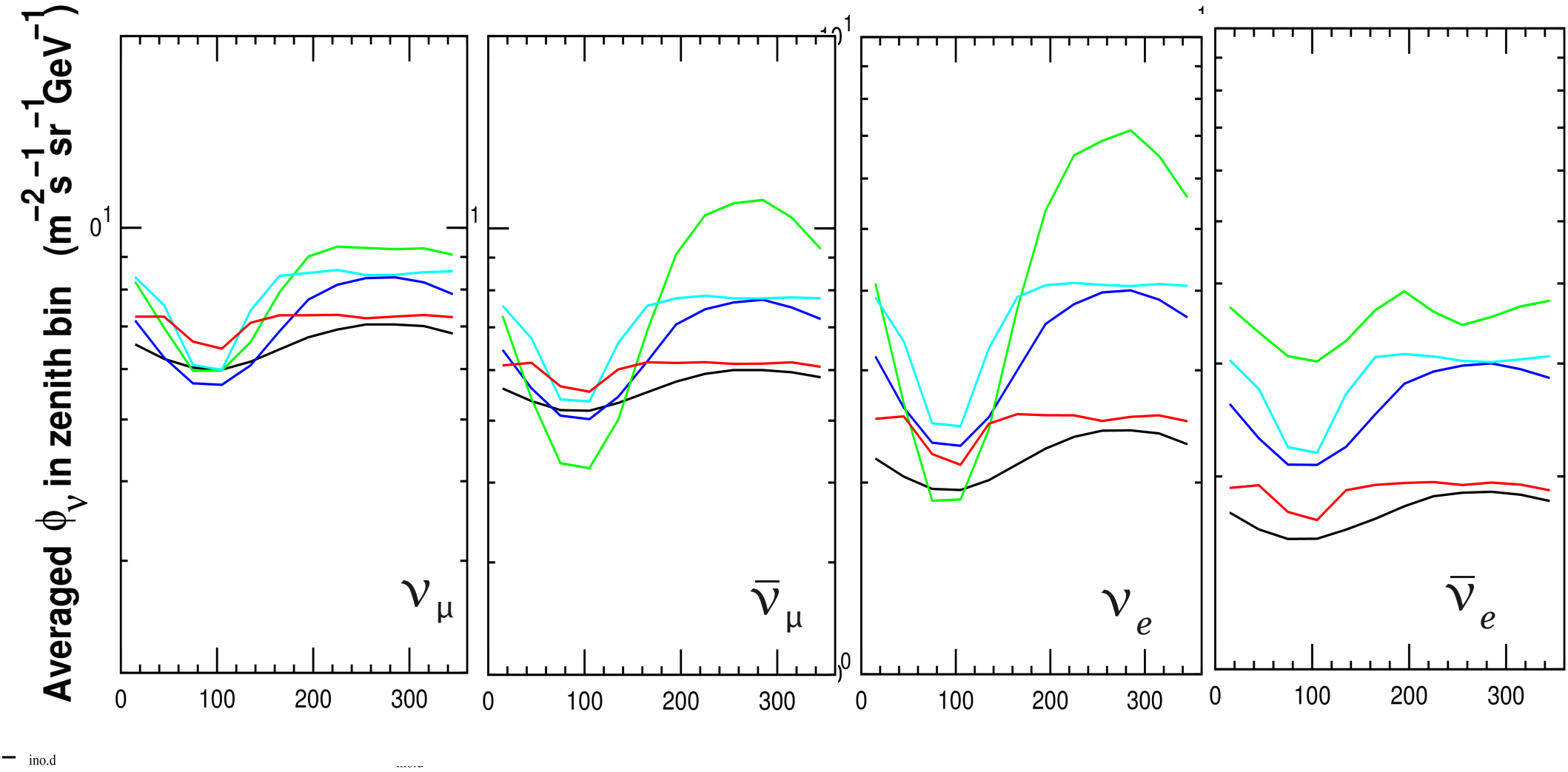
Azimuth angle dependence at SouthPole

3.2 GeV



spl.d

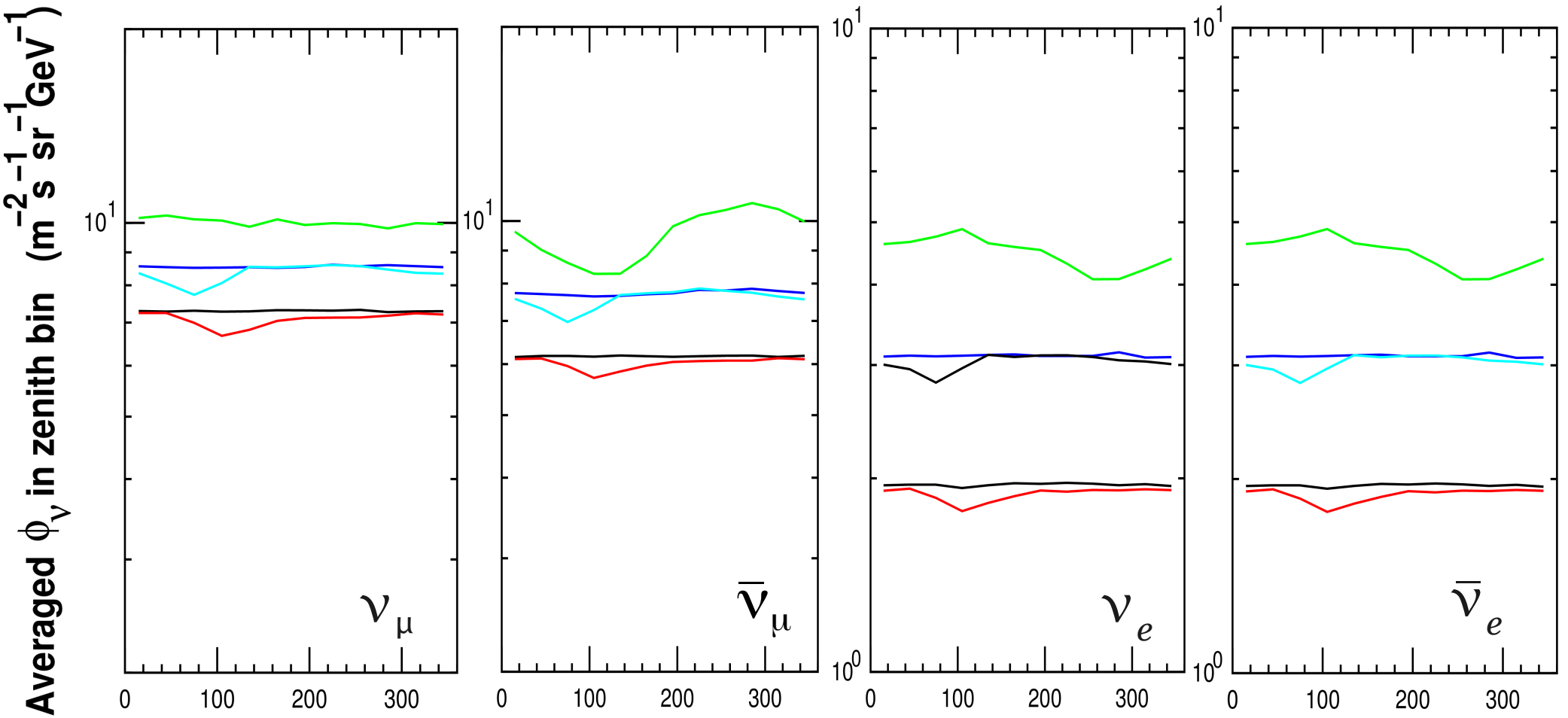
Azimuth angle dependence at INO



Counter clockwise azimuth angles measured from South

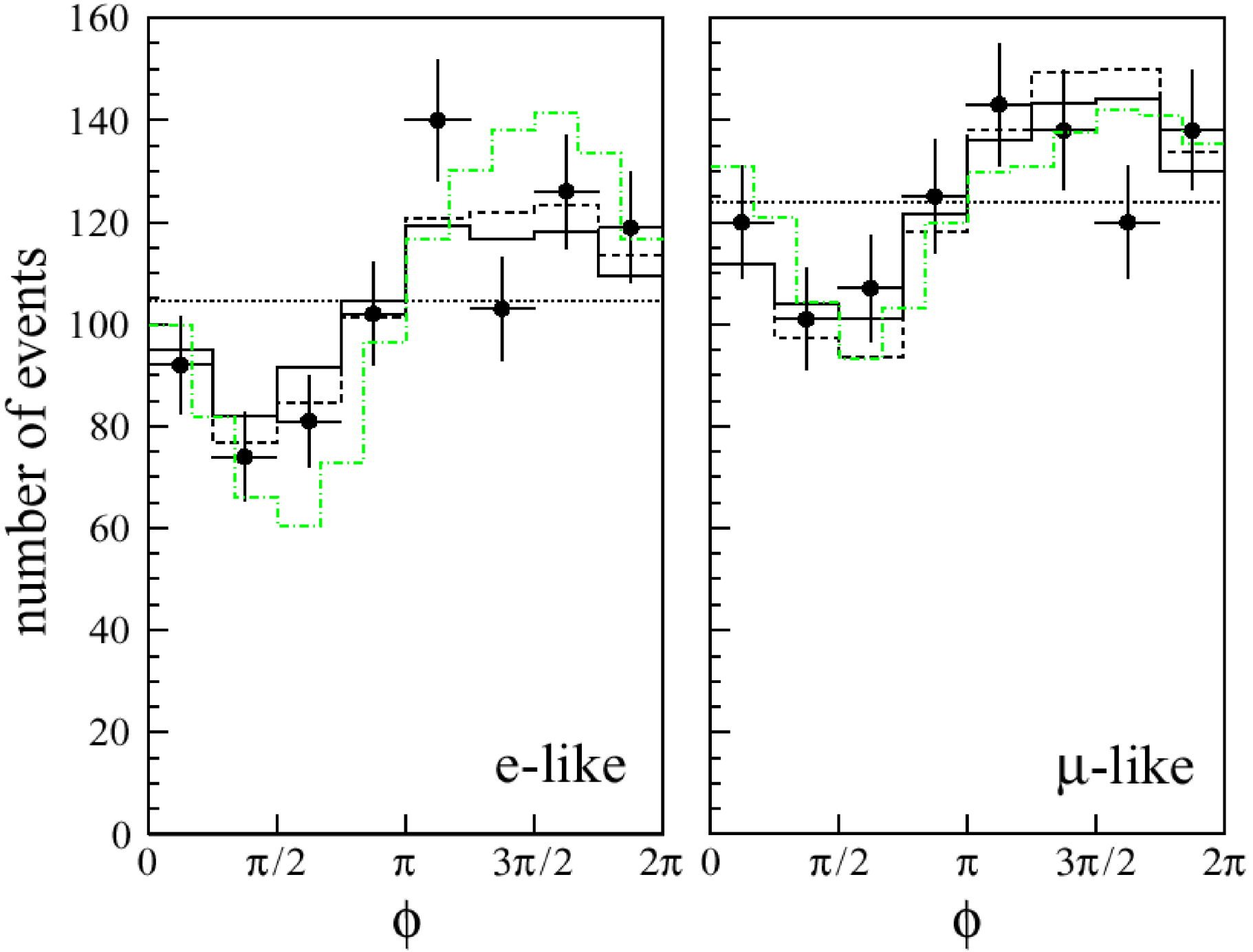
Azimuth angle dependence at SNO

3.2 GeV



sno.d

Observed azimuth angle dependence at Kamiokande



Muon bending

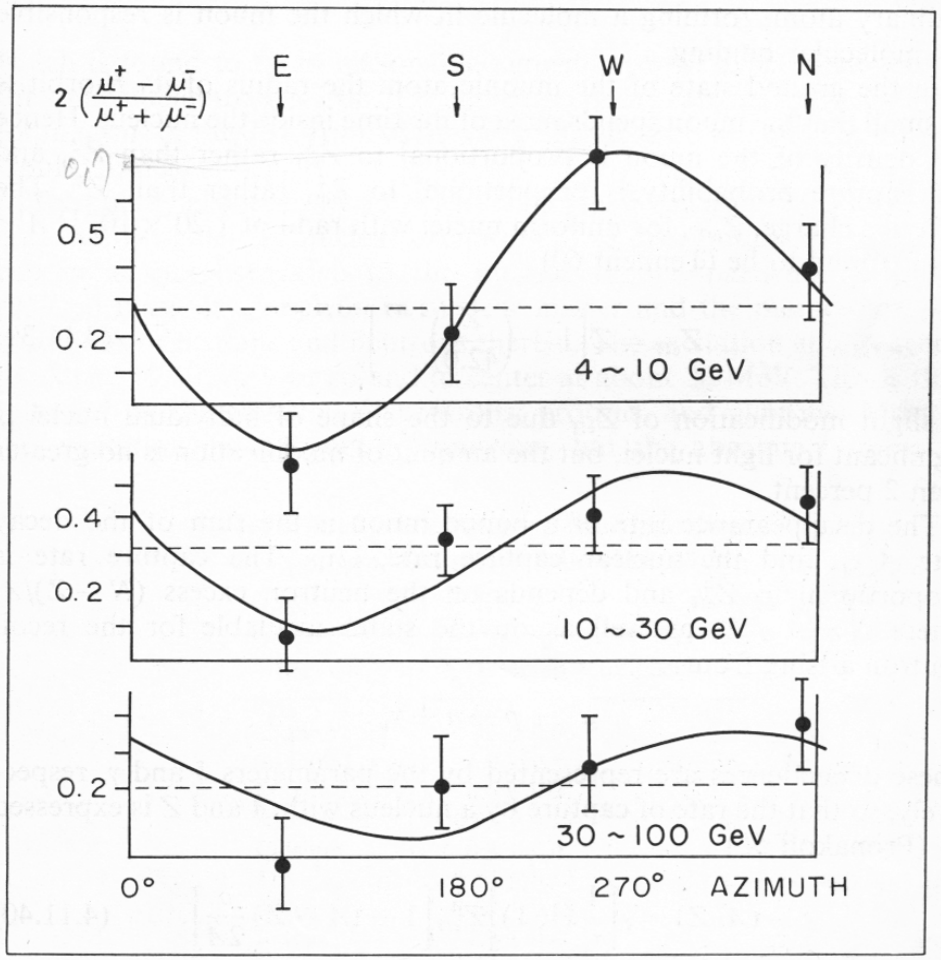
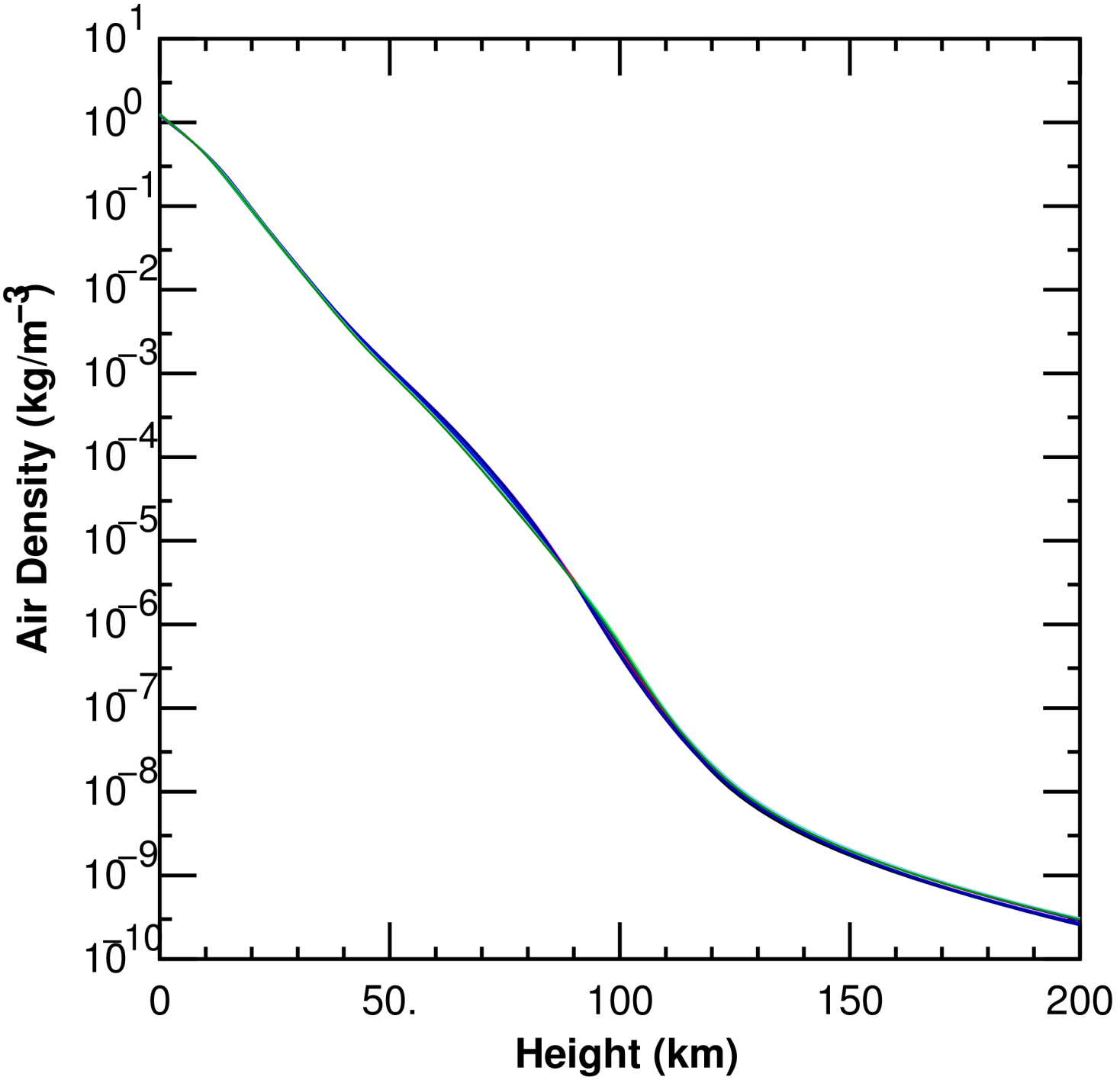
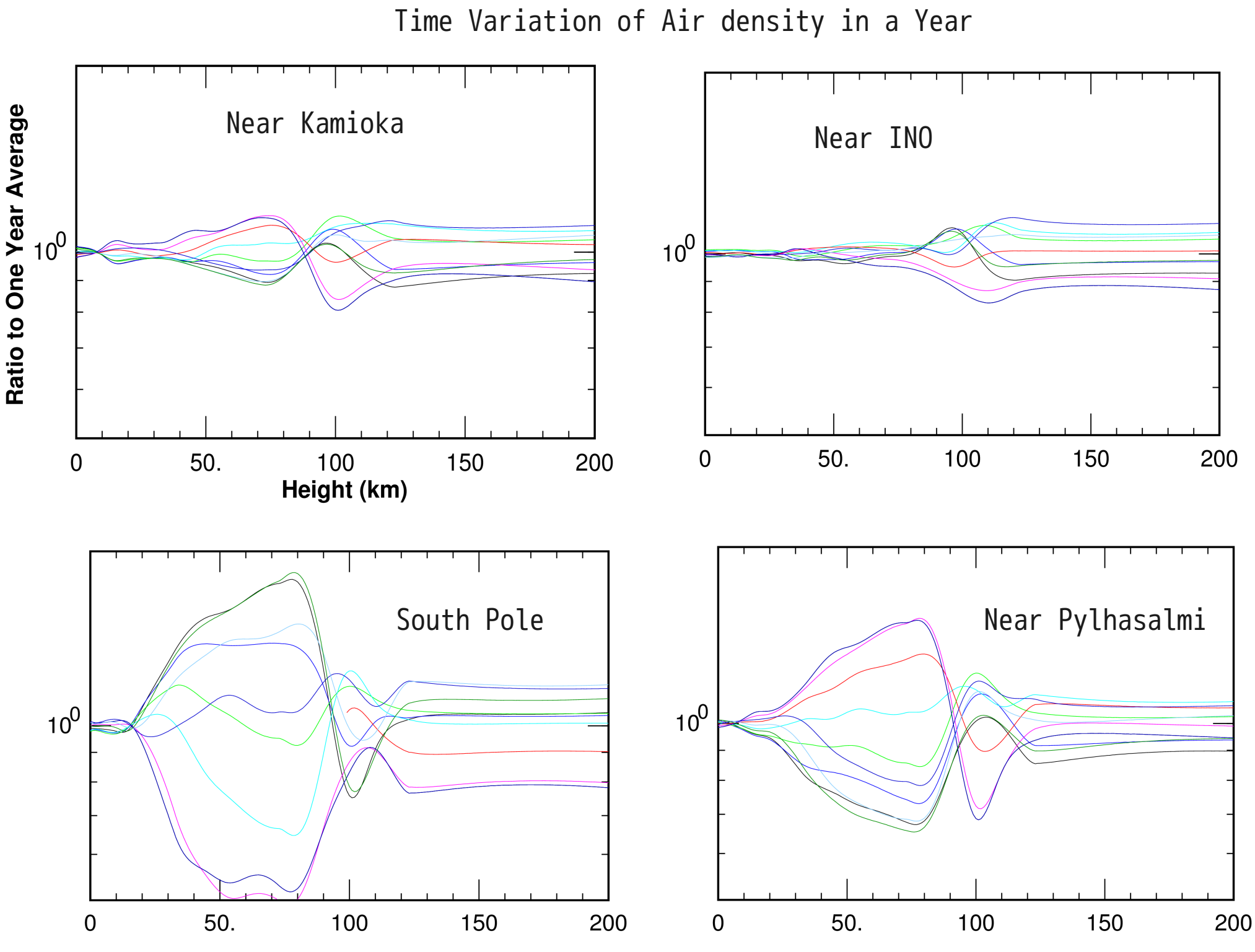


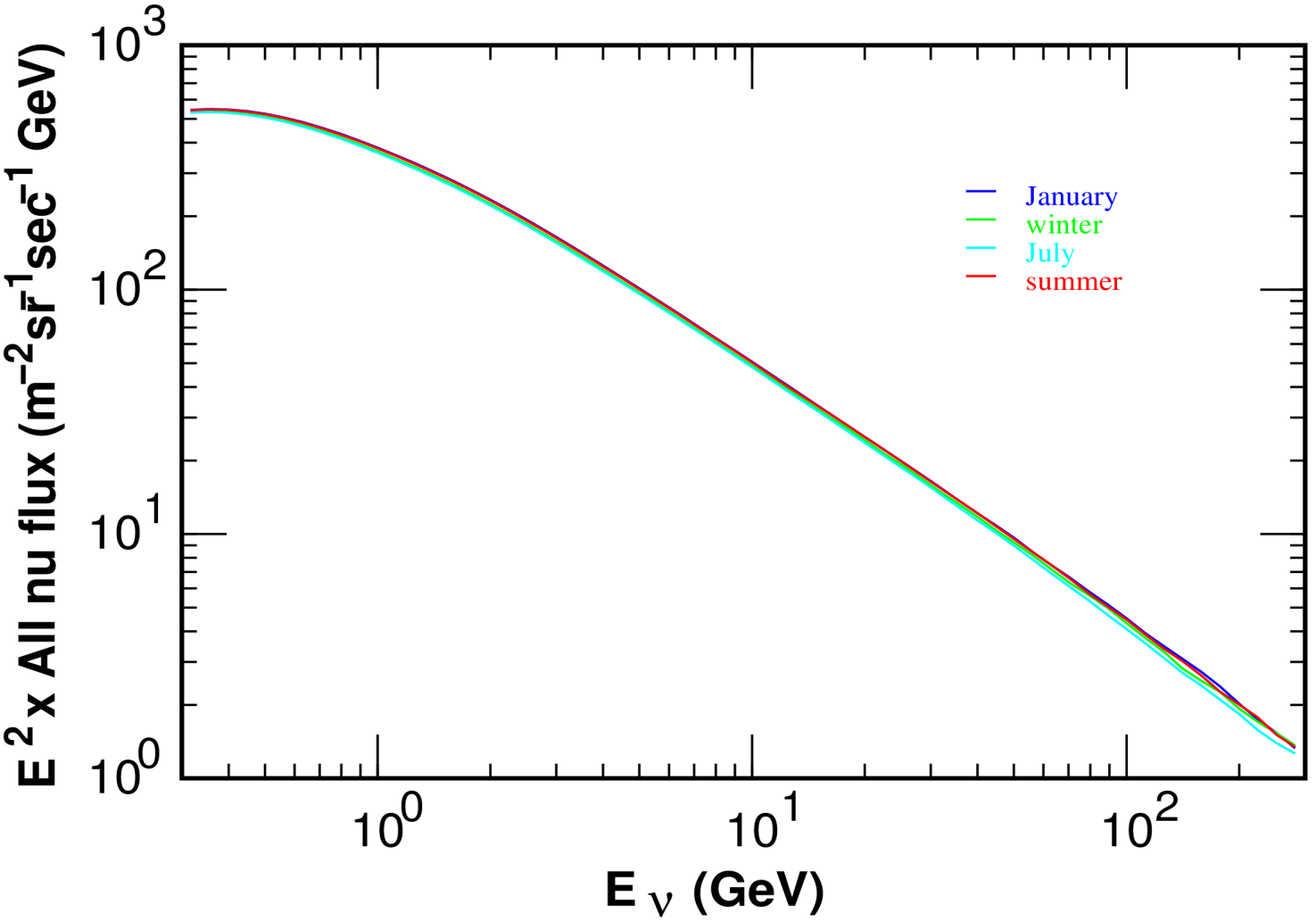
Fig. 4.27 Azimuth dependence of the positive excess of muons at zenith angle 78° at sea level. The energy intervals of sea-level muons are indicated (Kamiya 62).

From Hayakawa "Cosmic Ray"

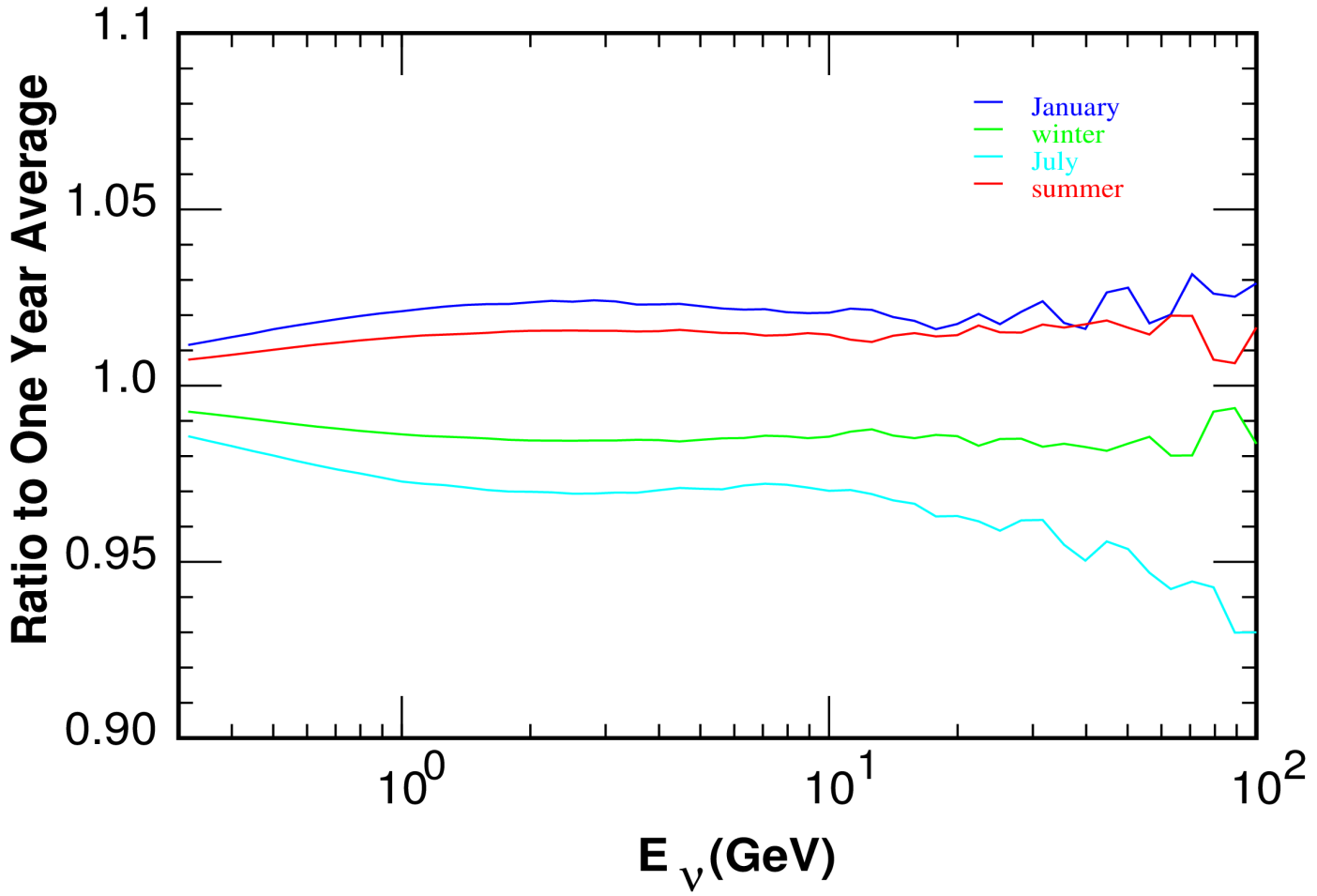

Air Density (kg/m^{-3})
10^{1}
10^{0}
10^{-1}
10^{-2}
10^{-3}
10^{-4}
10^{-5}
10^{-6}
10^{-7}
10^{-8}
10^{-9}
10^{-10}
0
50.
100
150
200
Height (km)


Time Variation of Air density in a Year
Near Kamioka
Near INO
South Pole
Near Pylhasalmi
Ratio to One Year Average
10^0
0
50.
100
150
200
Height (km)

Seasonal variation of neutrino flux at South Pole



Seasonal variation of neutrino flux in ratio



まとまらない、まとめ

•新しい実験サイトに対する、大気ニュートリノの計算が
進んでいる(PL in print)が、
統計不足で、季節変化が十分理解できていない。

•高いエネルギーのニュートリノフラックスに大して、
新しい一次宇宙線観測、加速器実験の結果が重要であるが、
まだ十分取り込めていない。

•まだまだやることが、...

トモエガモ