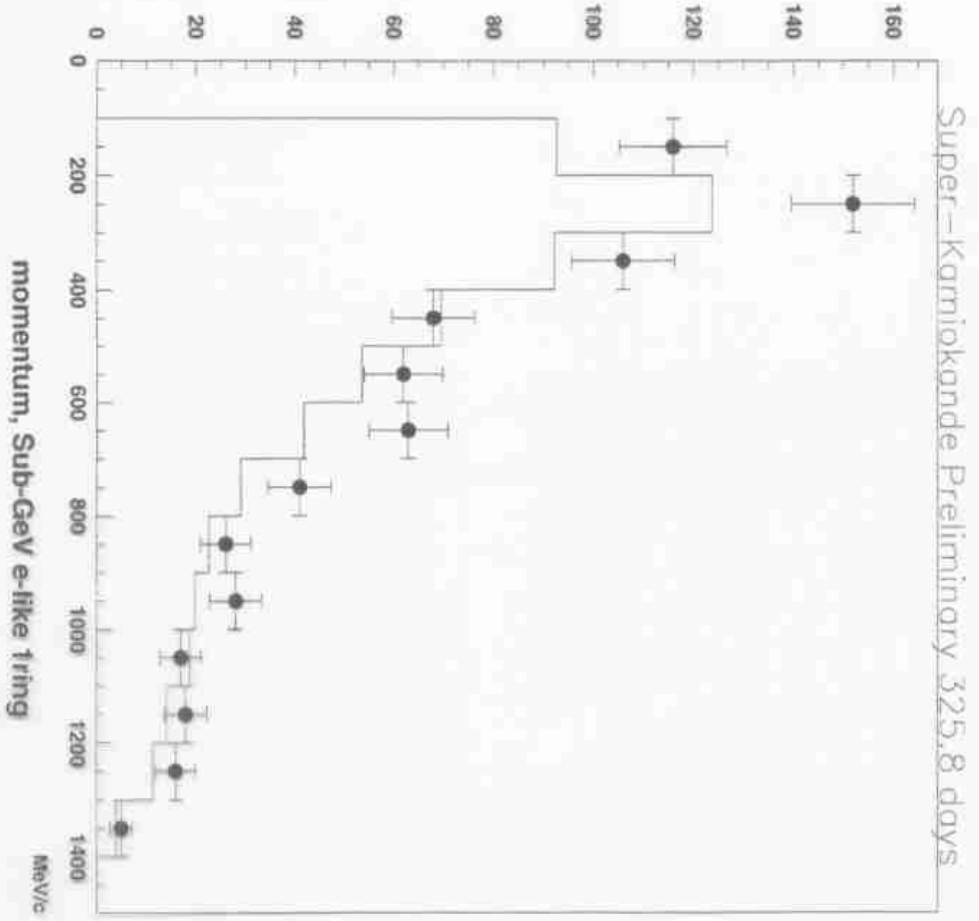


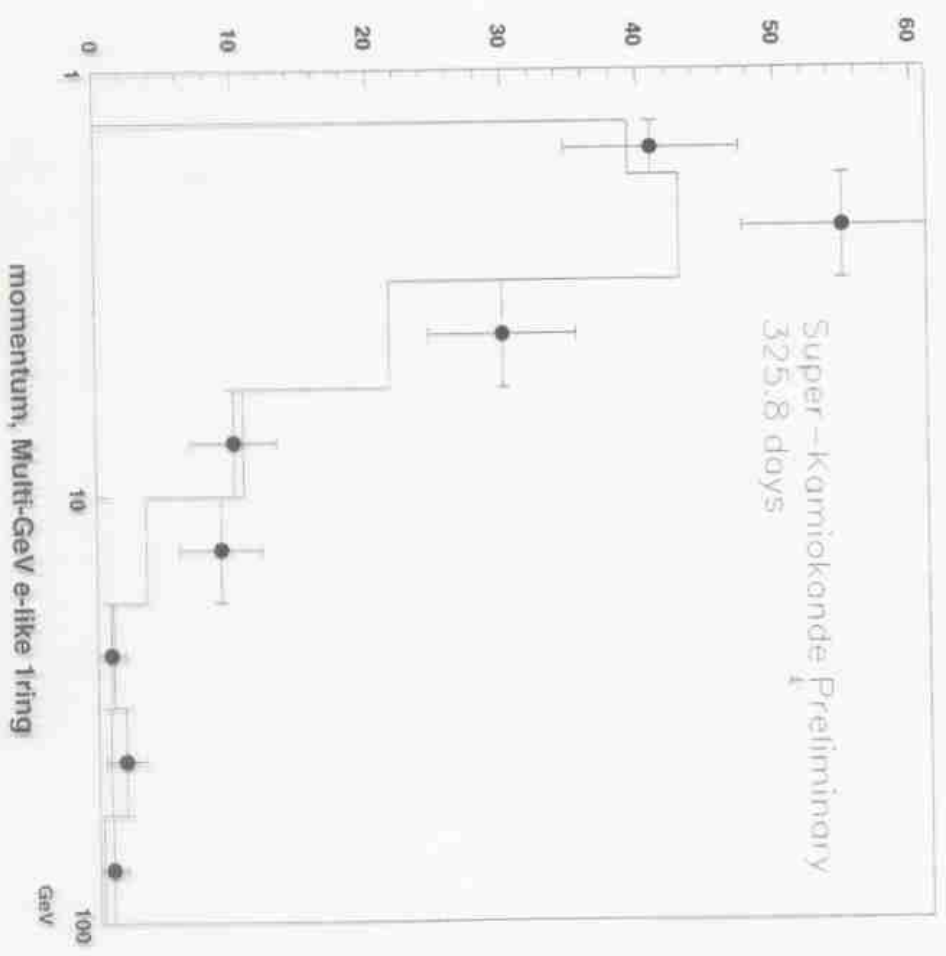
## Summary

1. Variation Models to HKKM are studied
2. **Absolute** value varies  $\pm 25\%$  from Min to Max within the studied parameter region.
3. However, the **Ratios** vary only  $\pm 5\%$  from Min to Max
4. **Primary Cosmic Ray Flux** is the major source of uncertainty, but mainly affects the absolute values.
5. The study of **Hadronic Interaction** at  $10 \sim 30\text{GeV}$  is important to fix the ratios more accurately.

Need. 15% Normalization!



SK 20Kyr



## 1. The source of Uncertainties

### a. Primary Cosmic Ray Spectrum ( $\pm 20\%$ )

*Who to believe !*

### b. Hadronic Interaction

Inelastic cross section ( $\pm 10\%$ )

*How to calibrate the luminosity ?*

Secondary particle spectrum (x-distribution,  $\pm 10\%$ )

*Who is interested in the old physics ?*

Multiplicity. ( $\pm 5\%$ )

*Probably OK*

K/ $\pi$  ratio ( $\pm 10\%$ )

*Probably OK*

### c. Atmospheric density structure ( $\pm 10\%$ )

*Probably the Standard Atmosphere model is good enough*

### d. One dimensional approximation

*Not so bad above a few 100MeV, and is good above 1GeV.*

## Studied Variations

### 1. Hadronic interaction (0 means HKKM standard)

$\alpha$	-0.1	-0.05	0	0.05	0.1
$\sigma_{inel}$	-10%	-5%	0	+5%	+10%
K/ $\pi$	-20%	-10%	0	+10%	+20%

#### Note

Same  $\alpha$  is assumed for All  $\pi$ 's and k's

Same change ratio for  $\sigma_{inel}$  for all hadronic particle

### 2. Atmosphere Model

US standard atmosphere model

+ Single scale height model

Scale height (8.4km)	-10%	-5%	0	+5%	+10%
Column density (1035g/cm <sup>2</sup> )	-10%	-5%	0	+5%	+10%

### 3. Primary Cosmic ray

Webber79, HKKM flux, BESS97(A,B)

## Modification of x-distribution.

Assume a set of x-distribution and Multiplicity satisfies Energy conservation statistically

$$f(x) = \frac{dN}{dx}$$

Then

$$\frac{dN}{dx} = A(\alpha) f(x^{1+\alpha})$$

Also satisfies the Energy conservation statistically, where

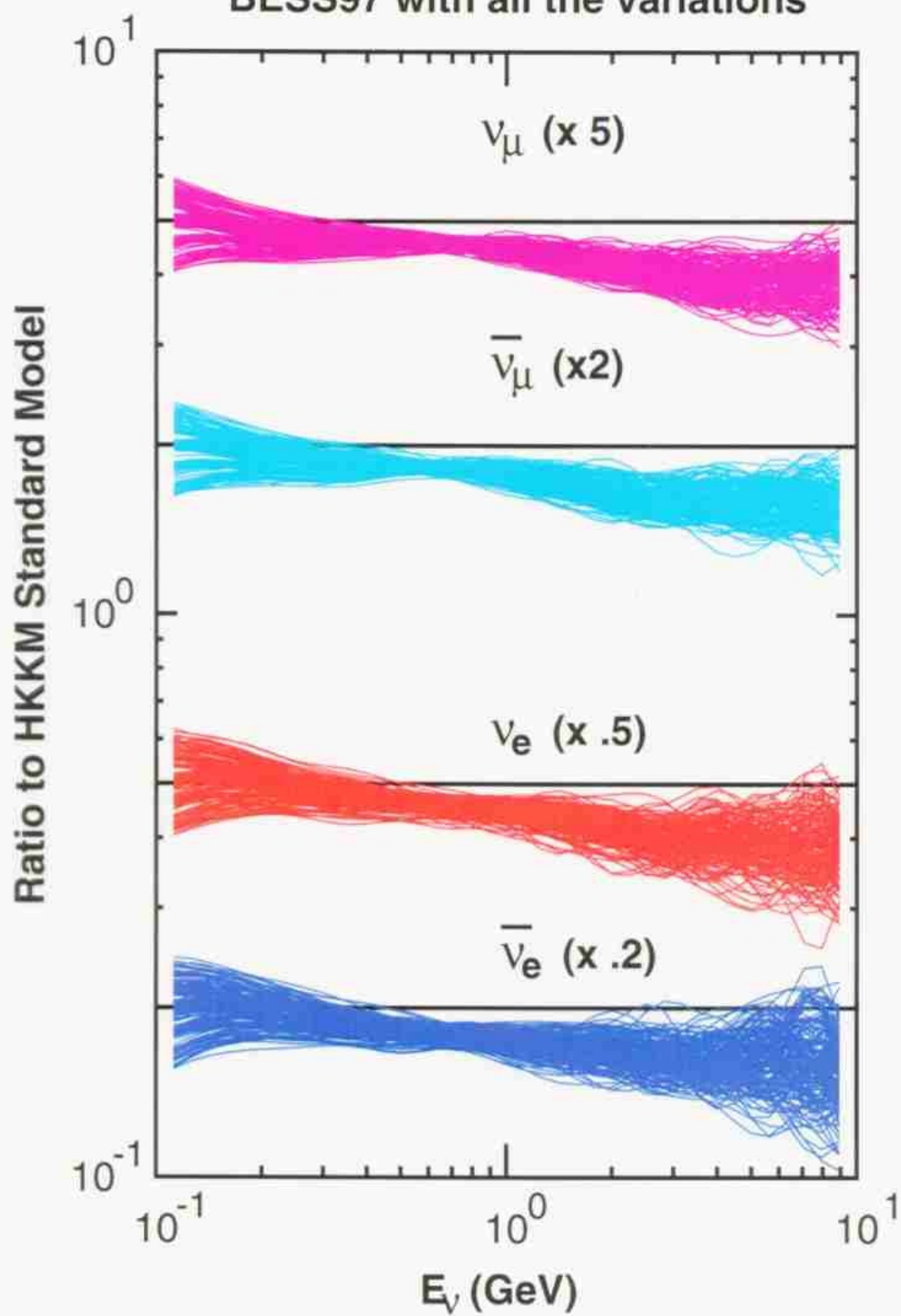
$$A(\alpha) = \frac{\int x f(x) dx}{\int x f(x^{1+\alpha}) dx}$$

The stating x-distribution is taken from LUND (Fritiof) for  $E > 5$  GeV, and from NUCRIN for  $E < 2$  GeV. For  $2 < E < 5$  GeV, smooth interpolation of x-distribution and Multiplicity is used.

Around for  $\alpha = 0.1$ , required modification for N(multiplicity) is around 20%. This is taken as the maximum variation of x-distribution.

$k/\pi$  ratio can be changed with a similar manner without violating the statistical Energy conservation.

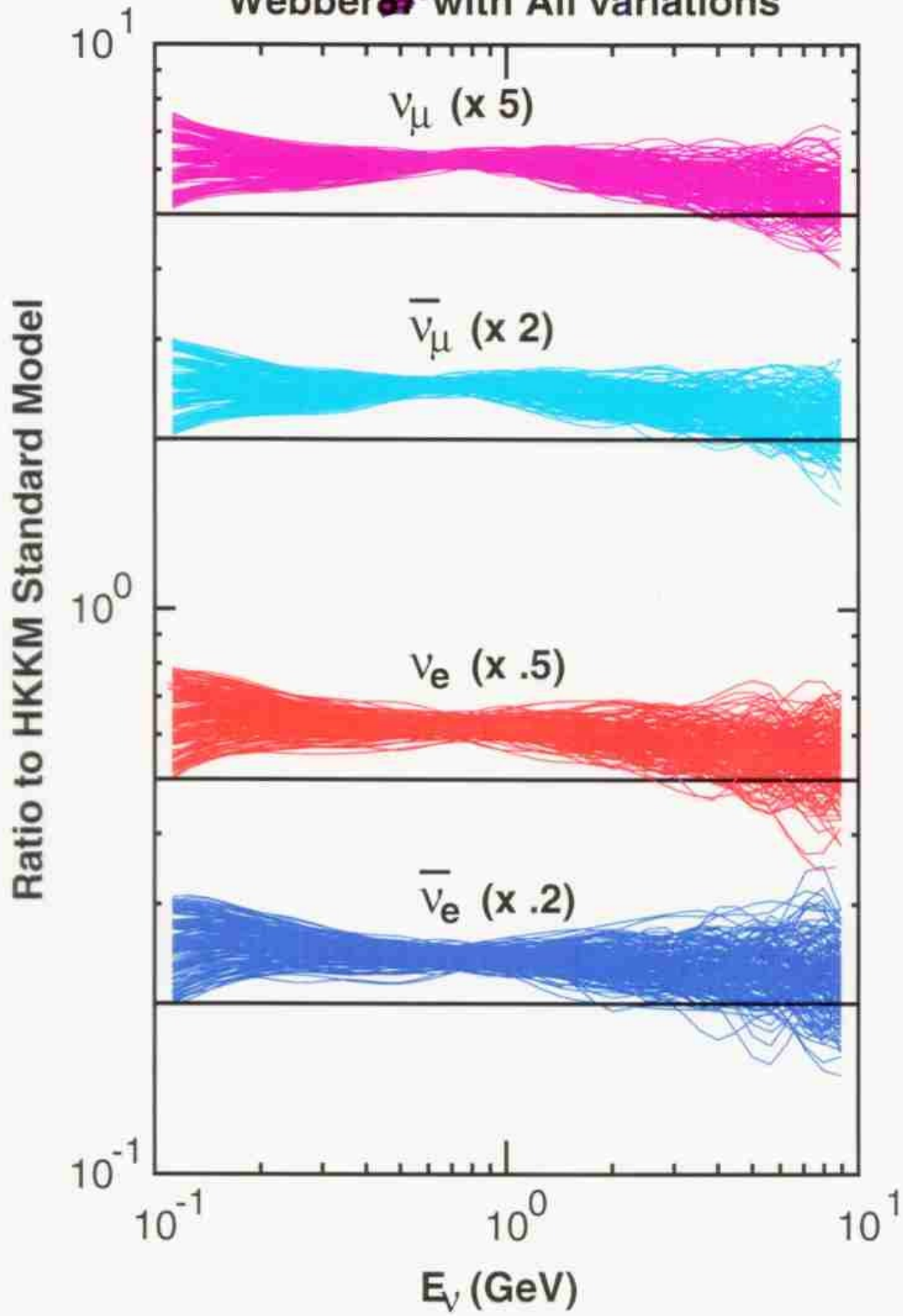
### BESS97 with all the variations



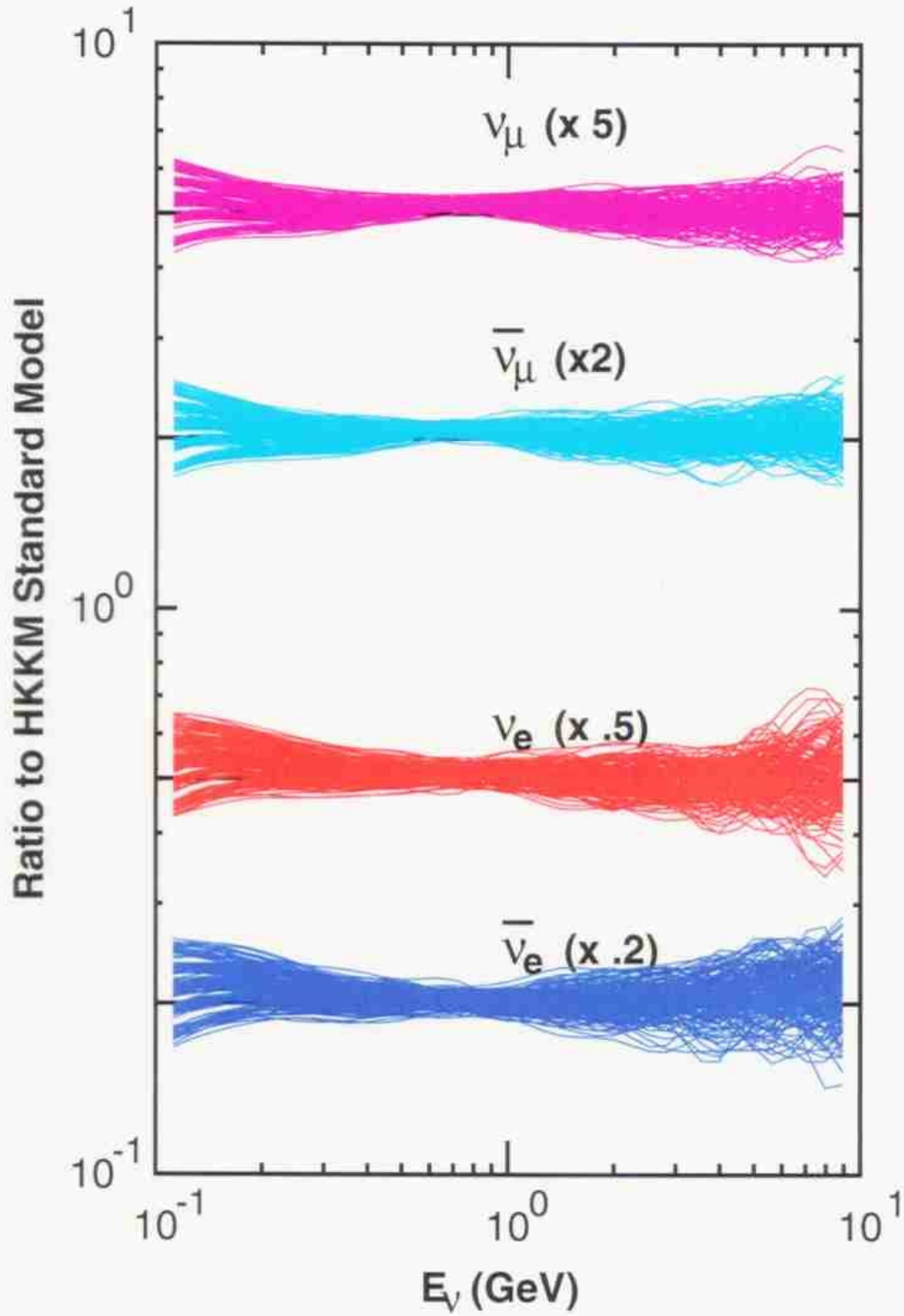


79

### Webber ~~87~~ with All variations

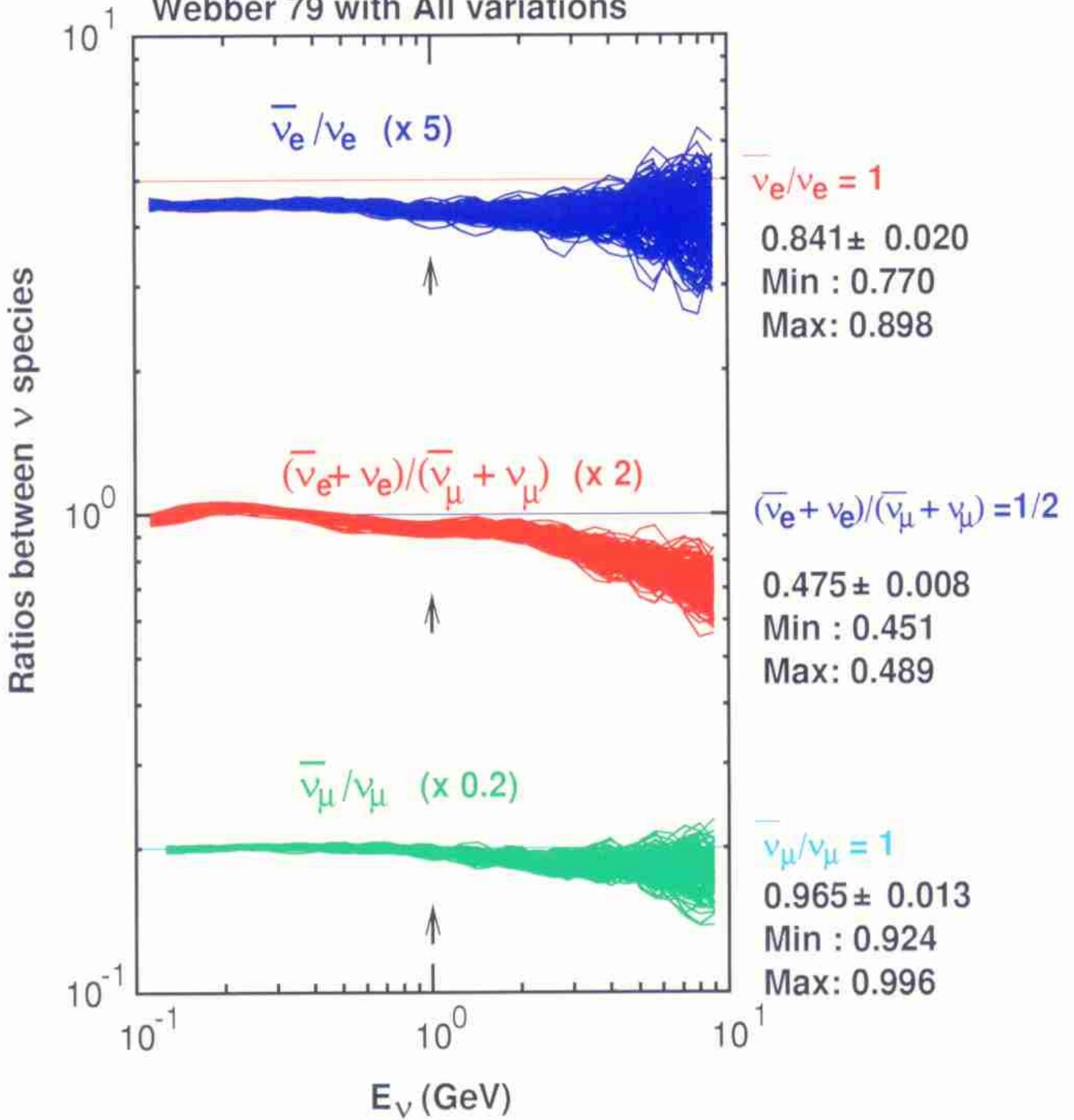


### HKKM flux with all variations

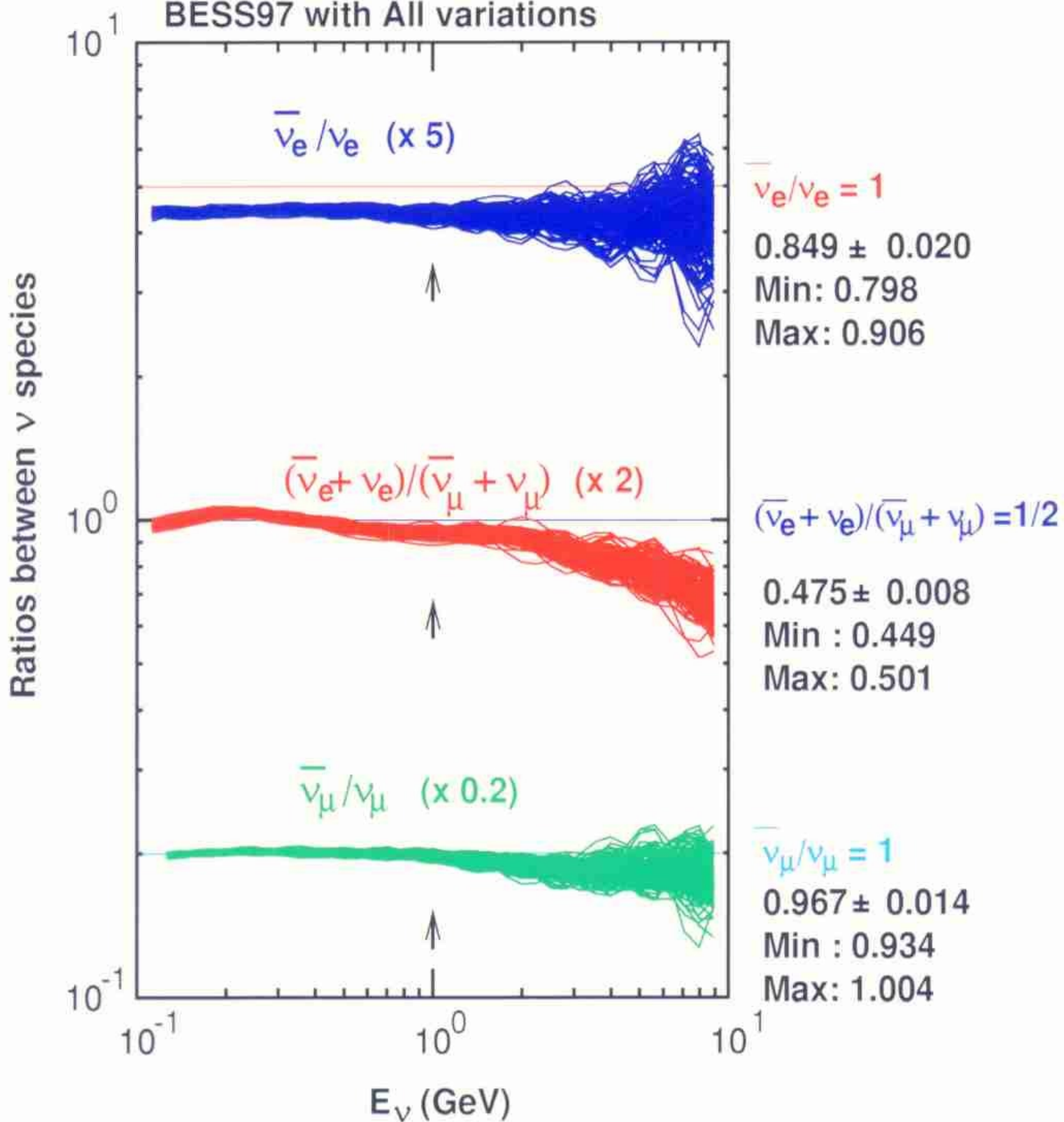




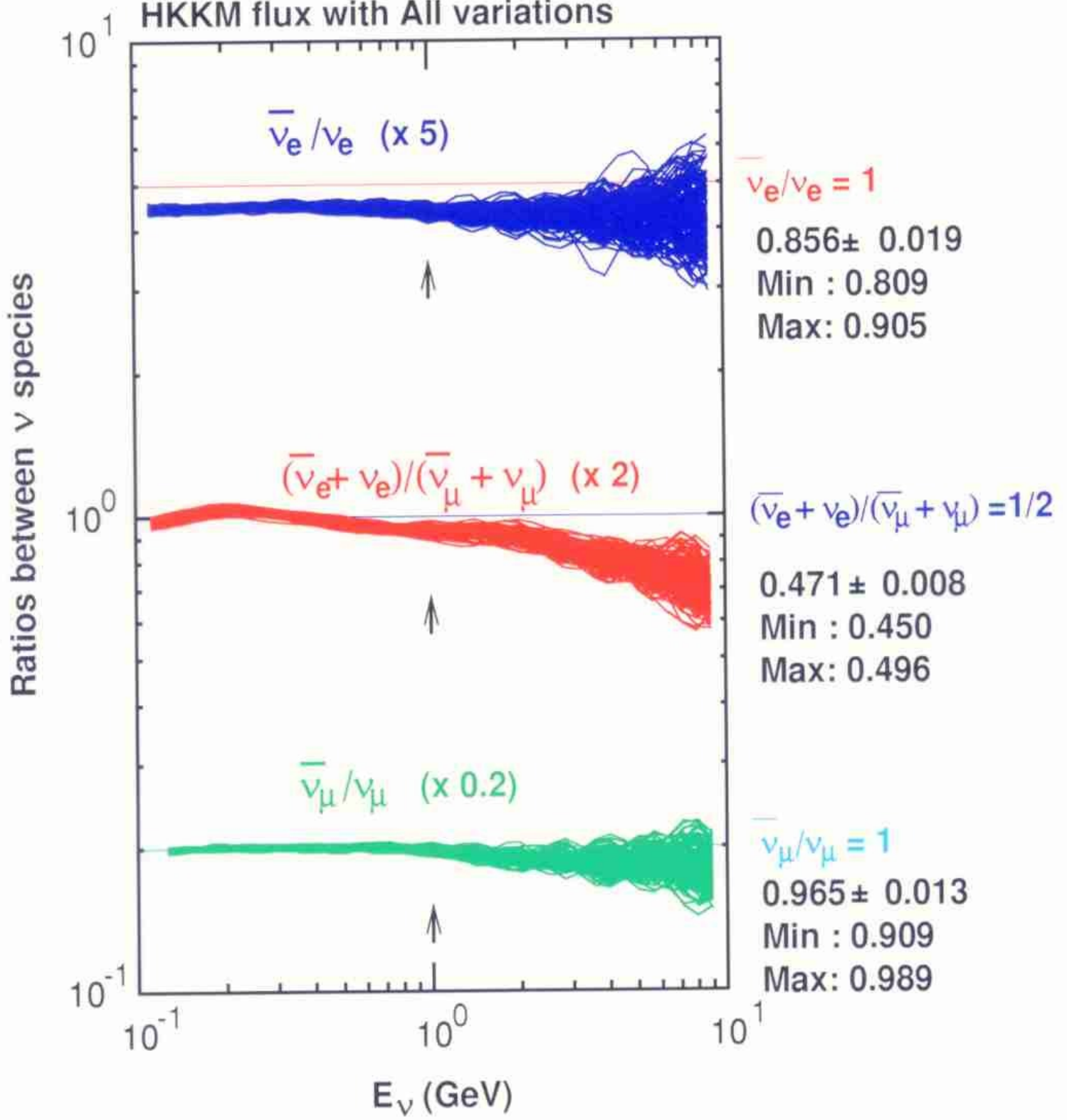
Webber 79 with All variations



# BESS97 with All variations



### HKKM flux with All variations



SubGeV

Event  
↓  
Event (per 1Kyr)  
↓

```

solmin-diraver-cr+0.0+0.0+0.0 49.21 53.35 23.63 25.62 0.746799 0.564199
solmin-diraver-cr+0.0+0.0+0.4 50.99 55.28 24.51 26.58 0.72073 0.544501
solmin-diraver-cr+0.0+0.0-0.4 47.92 51.96 23.02 24.96 0.766903 0.579292
solmin-diraver-cr+0.0+0.2+0.0 49.65 53.84 24.04 26.07 0.740181 0.559064
solmin-diraver-cr+0.0+0.2+0.4 51.05 55.36 24.76 26.85 0.719882 0.543714
solmin-diraver-cr+0.0+0.2-0.4 48.02 52.08 23.30 25.27 0.765306 0.577957
solmin-diraver-cr+0.0-0.2+0.0 47.71 51.72 22.55 24.45 0.770279 0.58198
solmin-diraver-cr+0.0-0.2+0.4 48.65 52.74 23.08 25.02 0.755396 0.570724
solmin-diraver-cr+0.0-0.2-0.4 46.50 50.42 21.90 23.75 0.790323 0.596985
solmin-diraver-cr+0.2+0.0+0.0 48.29 52.35 22.79 24.71 0.761027 0.574976
solmin-diraver-cr+0.2+0.0+0.4 49.57 53.74 23.36 25.33 0.741376 0.560104
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solmin-diraver-cr+0.2-0.2+0.0 46.71 50.64 21.69 23.52 0.786769 0.594392
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solmin-diraver-cr-0.2+0.0+0.4 51.80 56.17 25.43 27.58 0.709459 0.535873
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solmin-diraver-cr-0.2+0.2+0.0 50.70 54.98 25.10 27.22 0.724852 0.547472
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solmin-diraver-cr-0.2+0.2-0.4 48.95 53.08 24.24 26.29 0.750766 0.567069
solmin-diraver-cr-0.2-0.2+0.0 48.61 52.70 23.48 25.45 0.756017 0.571157
solmin-diraver-cr-0.2-0.2+0.4 49.44 53.60 23.98 25.99 0.743325 0.561567
solmin-diraver-cr-0.2-0.2-0.4 47.35 51.34 22.78 24.70 0.776135 0.586287
0.4798 0.0092 0.4798 0.0092 0.7537 0.0263 0.7032 0.8136 0.5693 0.0199 0.5311 0.6147

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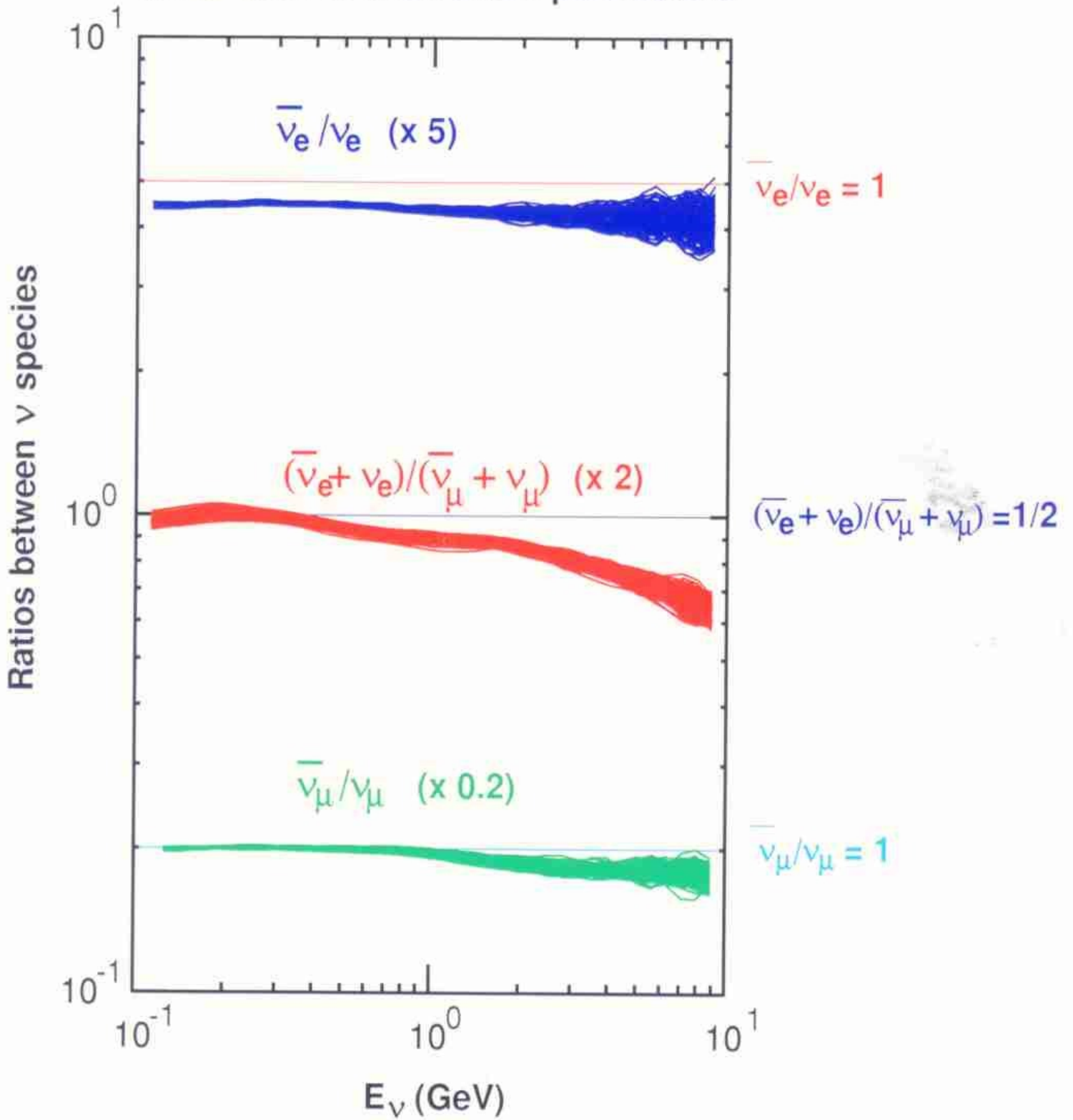
$\sigma_{ind} \pm 20\%$

$\chi\text{-dist} \pm 20\%$

$K/\pi \pm 40\%$



# Wider scan of interaction parameters



### Wider scan of interaction parameters

