

Forward Charm contribution to the Atmospheric Neutrino Flux

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in collaboration with Francis Halzen

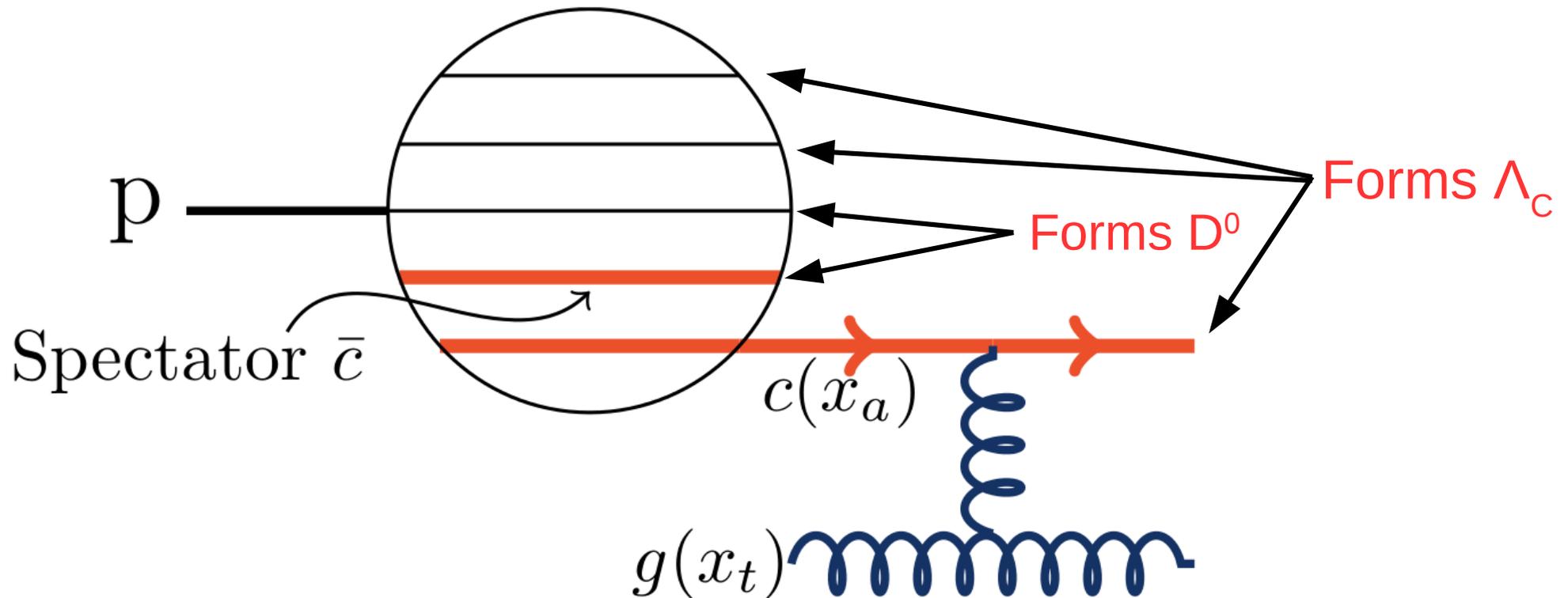
arXiv 1605.01409

IceCube Particle Astrophysics Symposium
Diffuse Session



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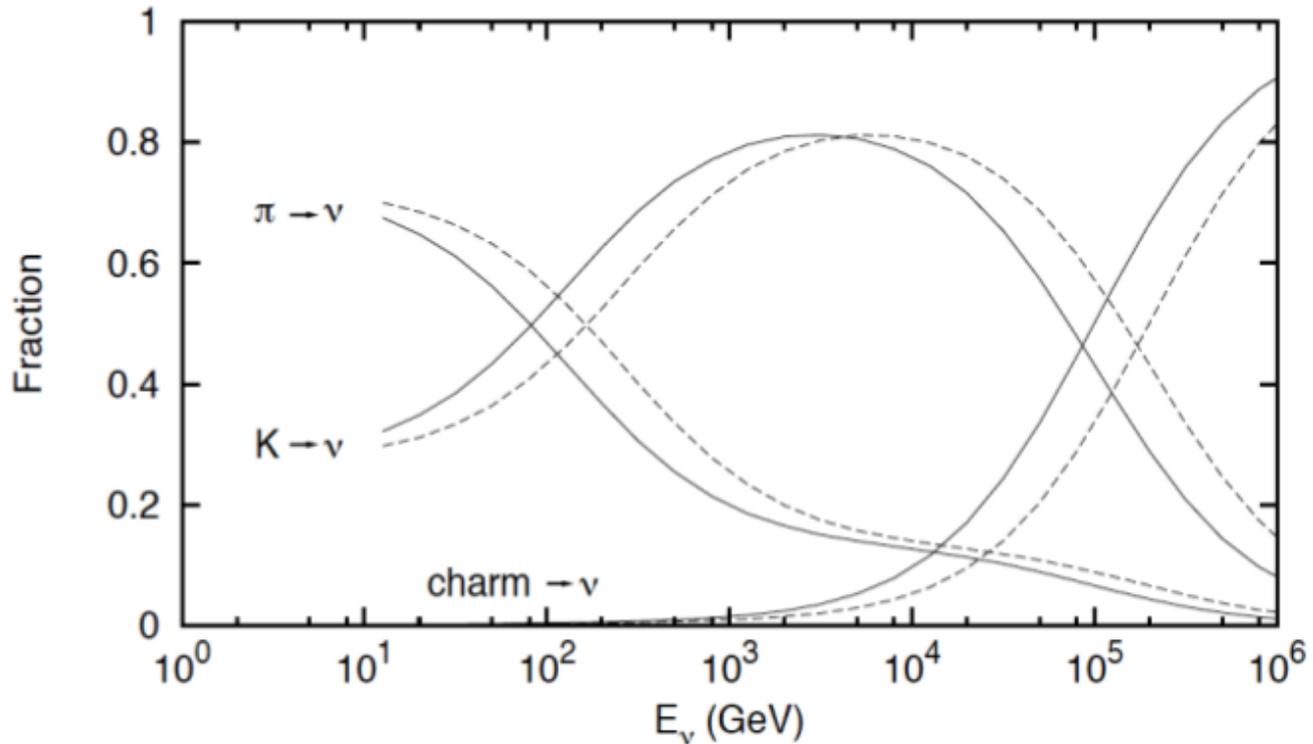
What is Forward Charm?



V. Barger, F. Halzen, and W. Y. Keung, Phys. Rev. D **25**, 112 (1982).

Atmospheric Neutrino Fluxes

Neutrinos



- **Charm particles promptly decay into neutrinos, avoiding energy losses which extends the flux to high energies**

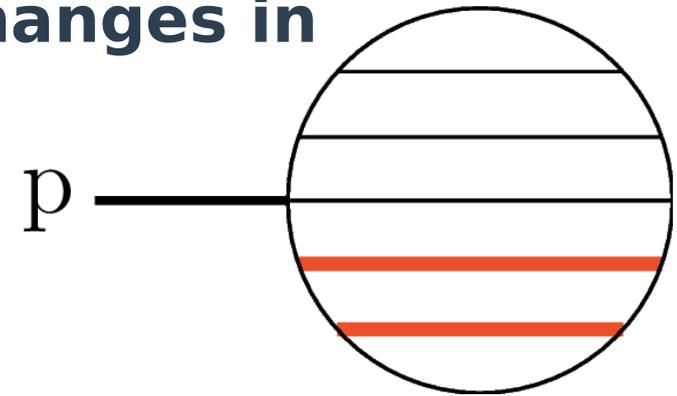
Why investigate Forward charm?

- **The amount of forward charm production is uncertain due to unobserved phase-space at colliders**
- **A forward charm could potentially create features in the high energy flux and be a large foreground to cosmic neutrinos**

The Forward Charm

- We use a parameterization of forward charm production. This allows us flexibility to investigate how the prompt flux changes in relation to charm production

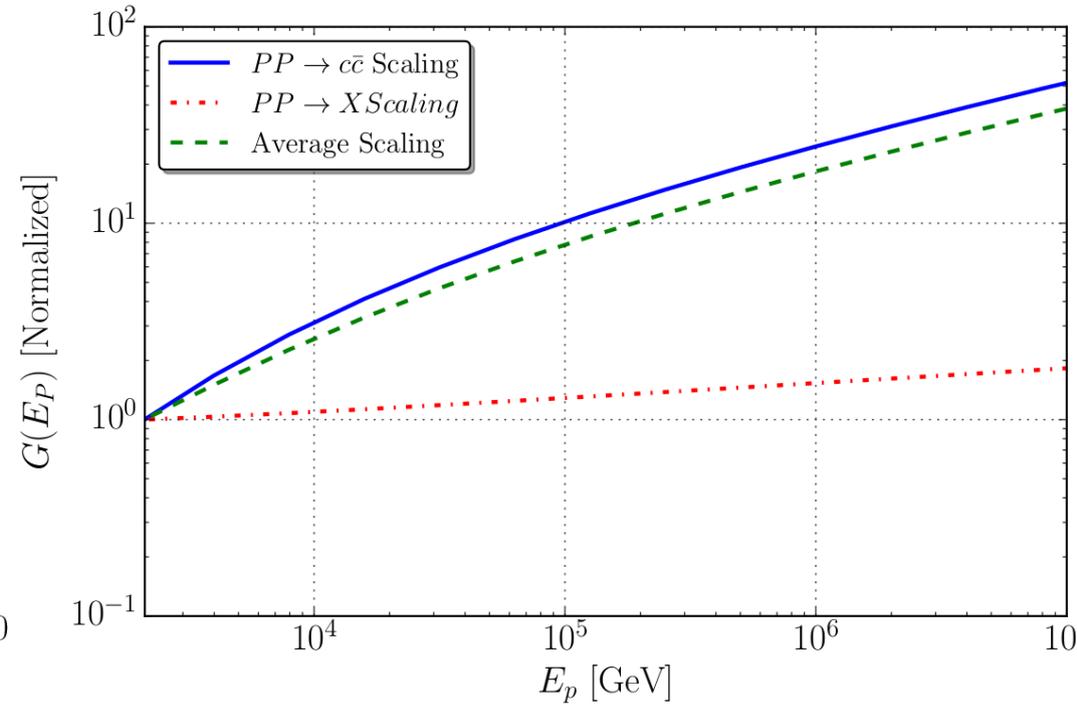
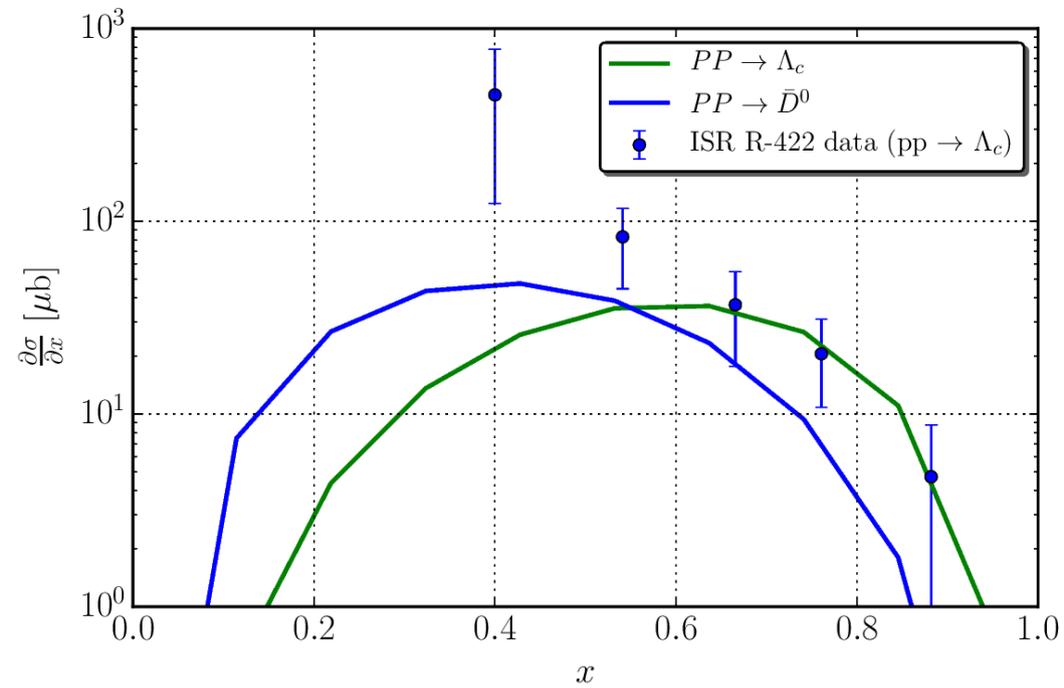
$$\frac{d\sigma}{dx_F} = g(x_F) f(E_p)$$



$$x_F = \frac{p_z}{P}$$

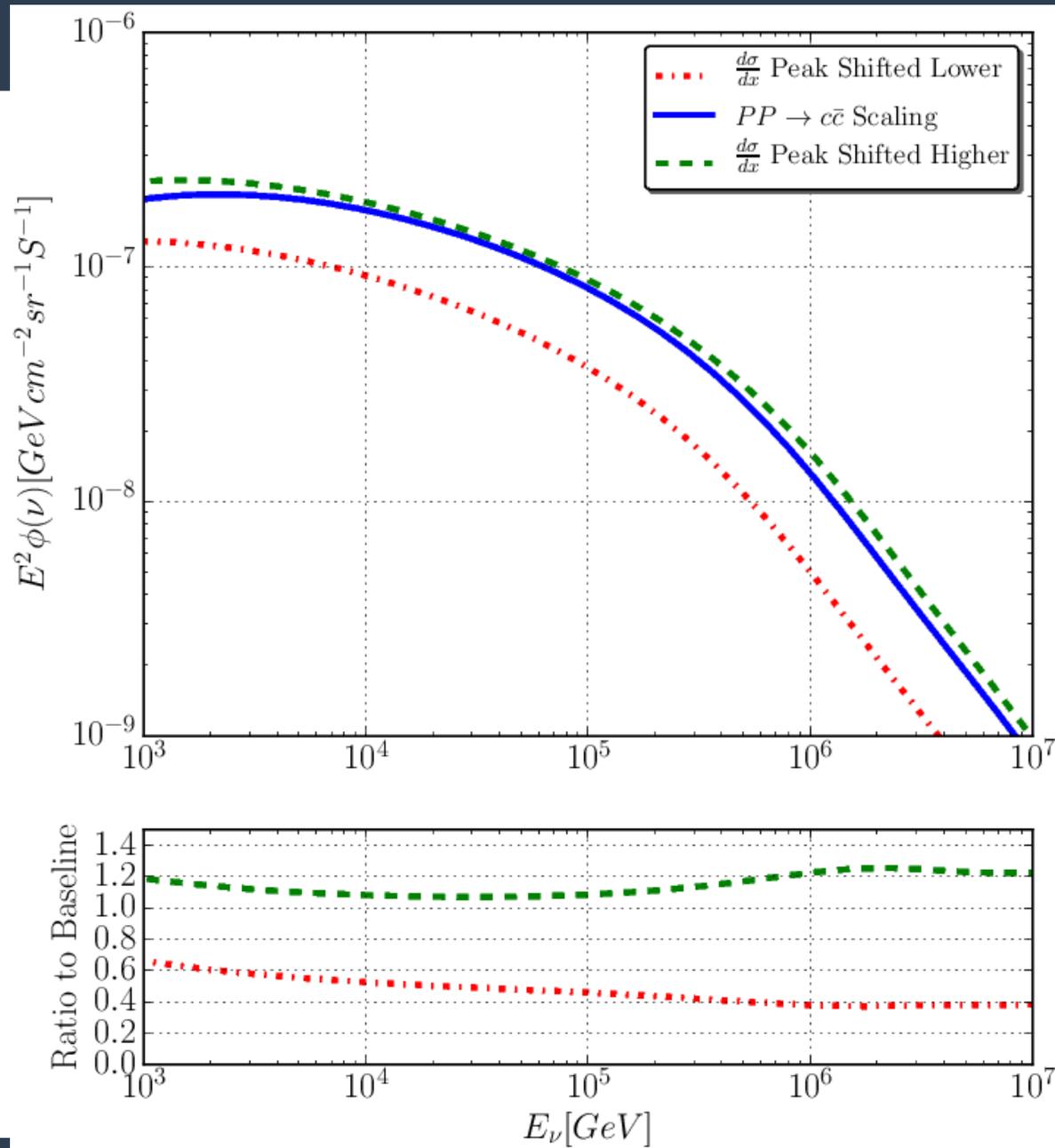
- Our goal is to draw an upper limit prompt flux that matches forward charm data and doesn't exceed measured atmospheric neutrino data

Charm Parameterization

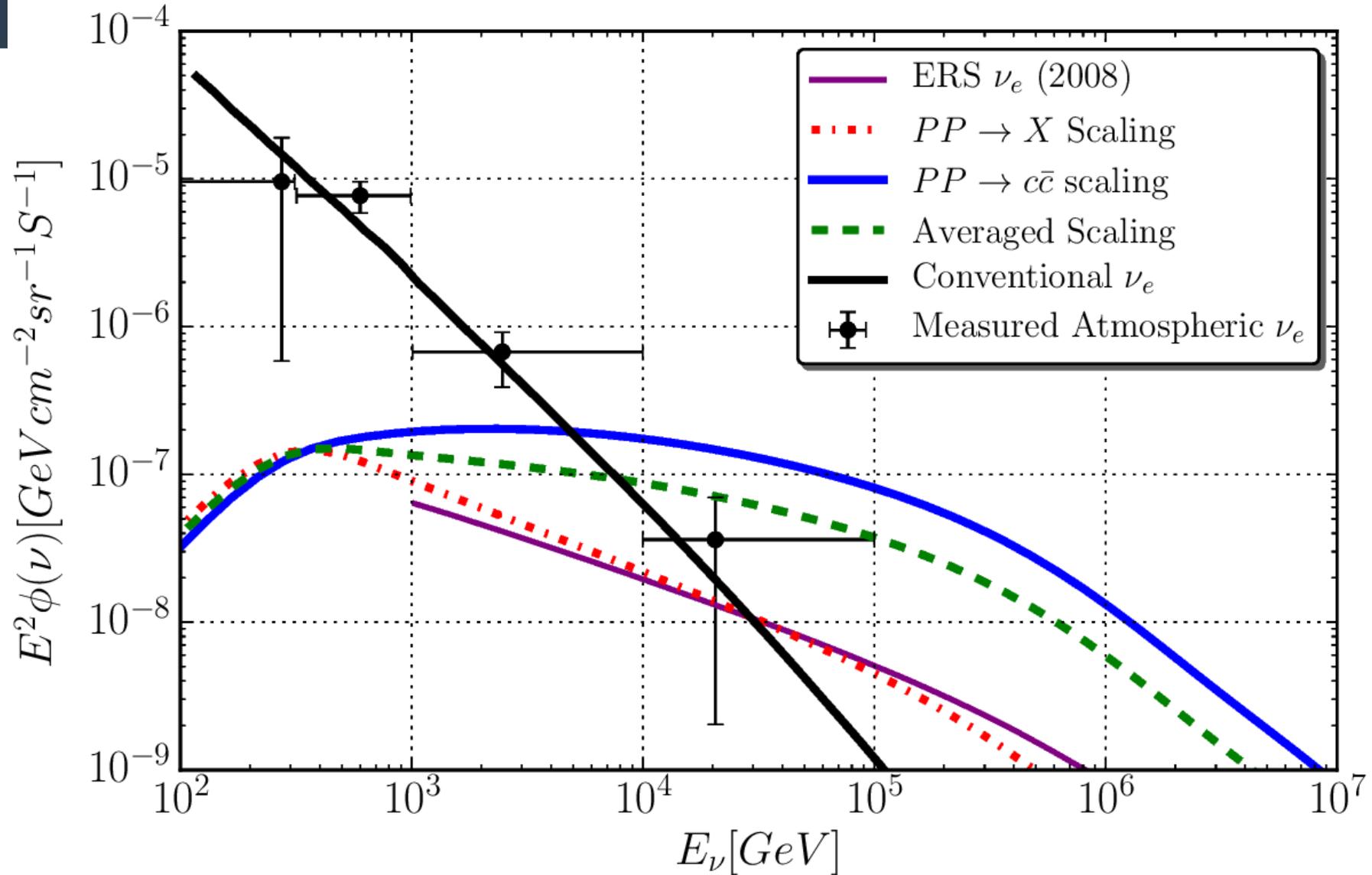


$$\frac{d\sigma}{dx_F} = g(x_F) f(E_p)$$

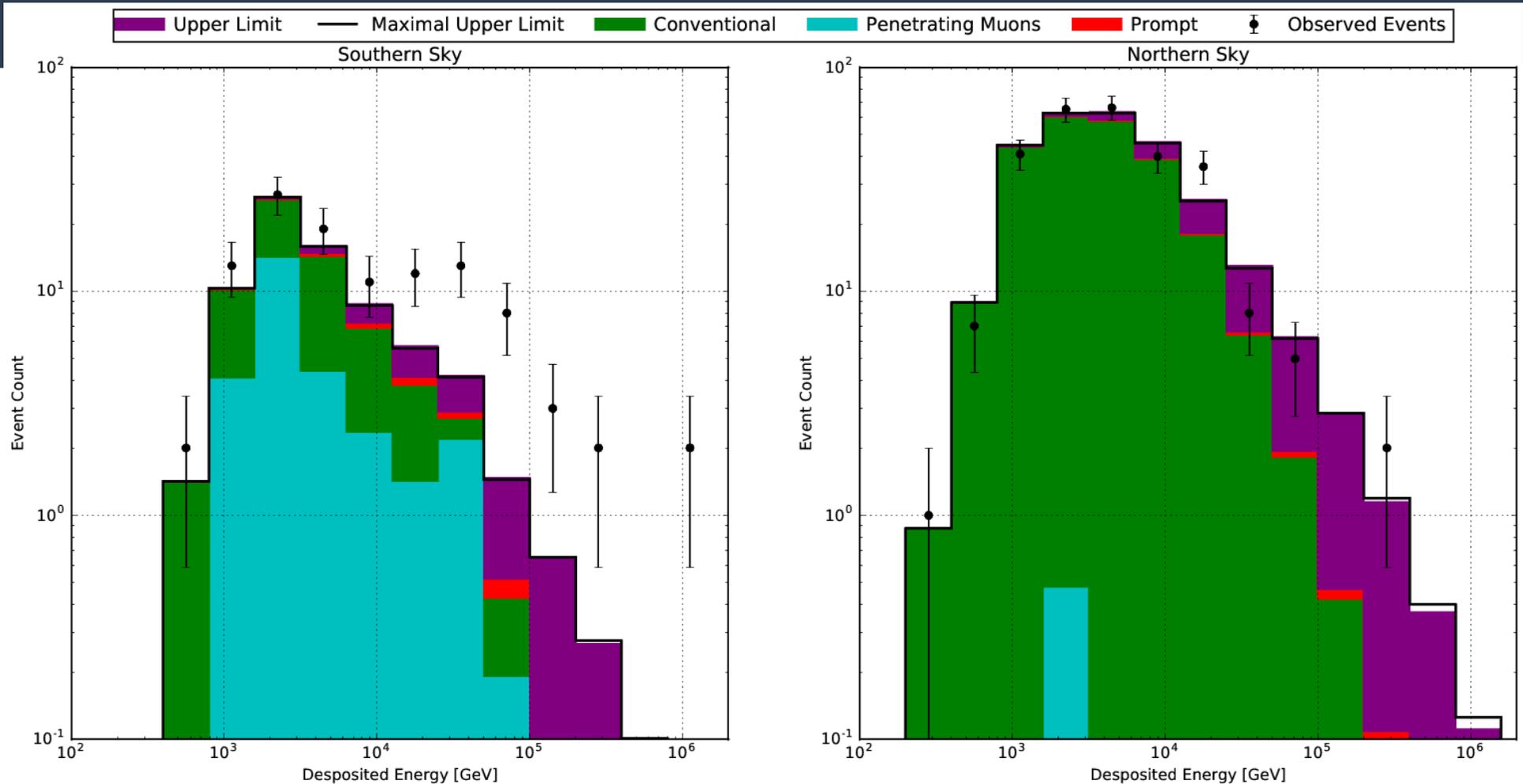
Fluxes when changing shape



Fluxes when changing Scaling



What does this look like in IceCube?



- **Forward charm produces significant number of events, but cannot explain the highest energy events or 30 TeV bump**

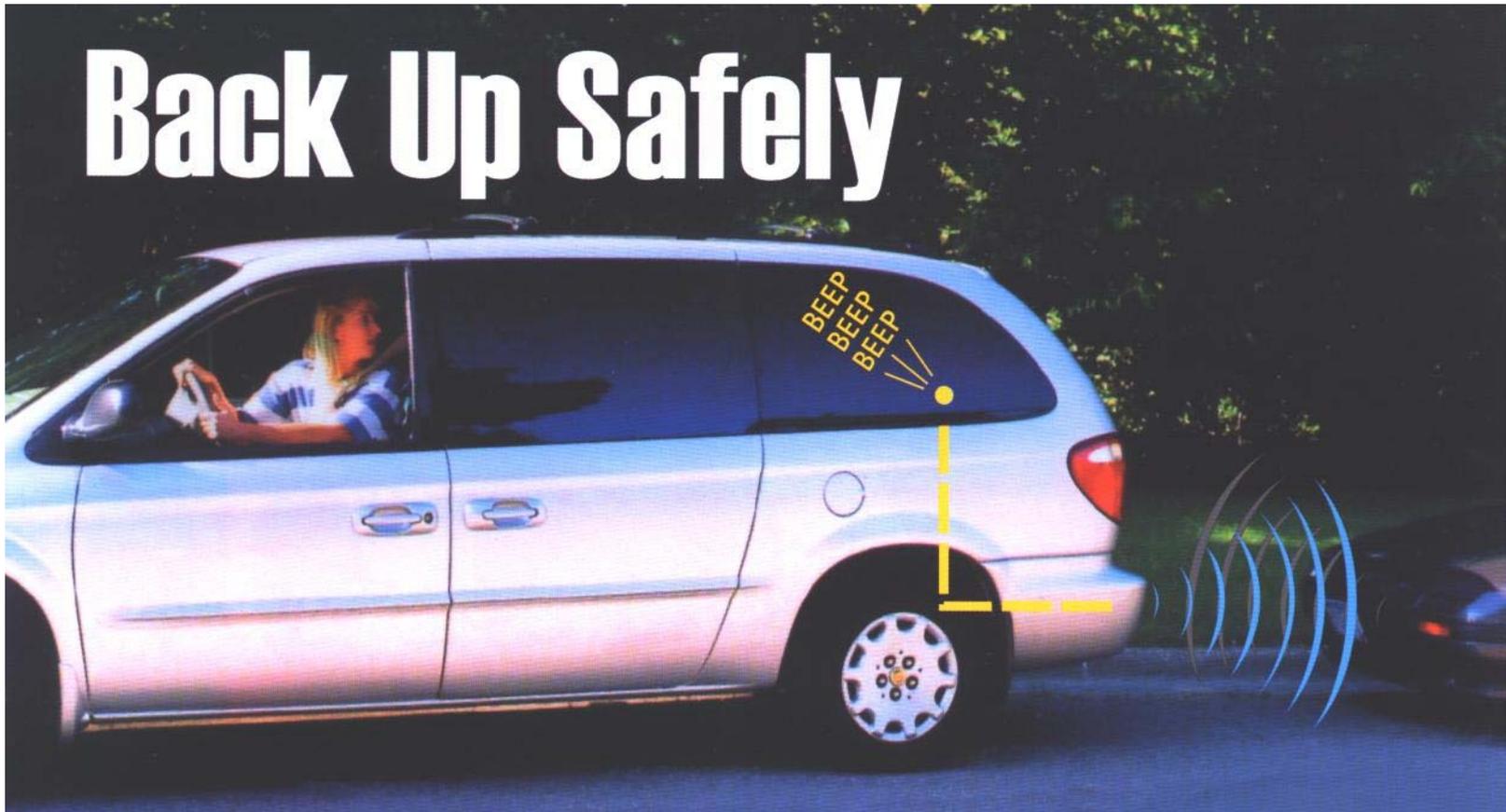
What we can conclude

- **Highest energy neutrino events cannot be explained by any prompt neutrino flux**
- **Forward charm can add a significant prompt neutrino flux, however, it is difficult to make a prediction due to very limited data and many different models**
- **IceCube could look for intrinsic charm which would compliment LHC searches**

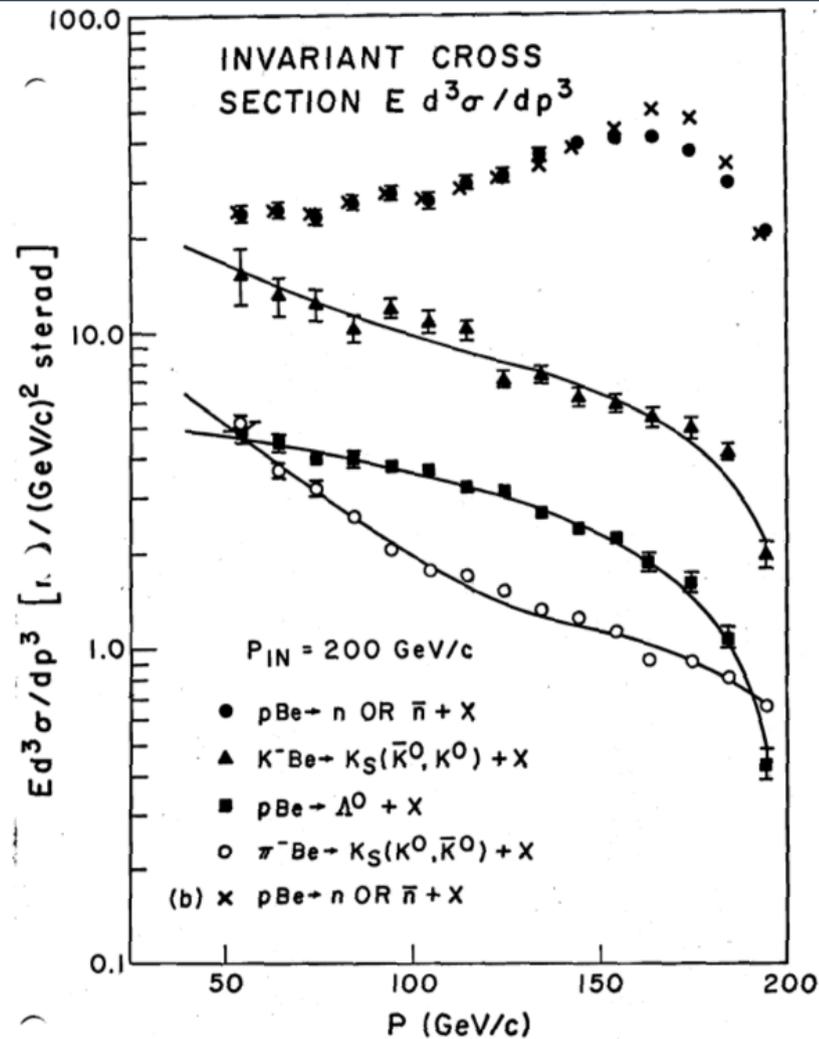


Thanks!

Back Up Safely

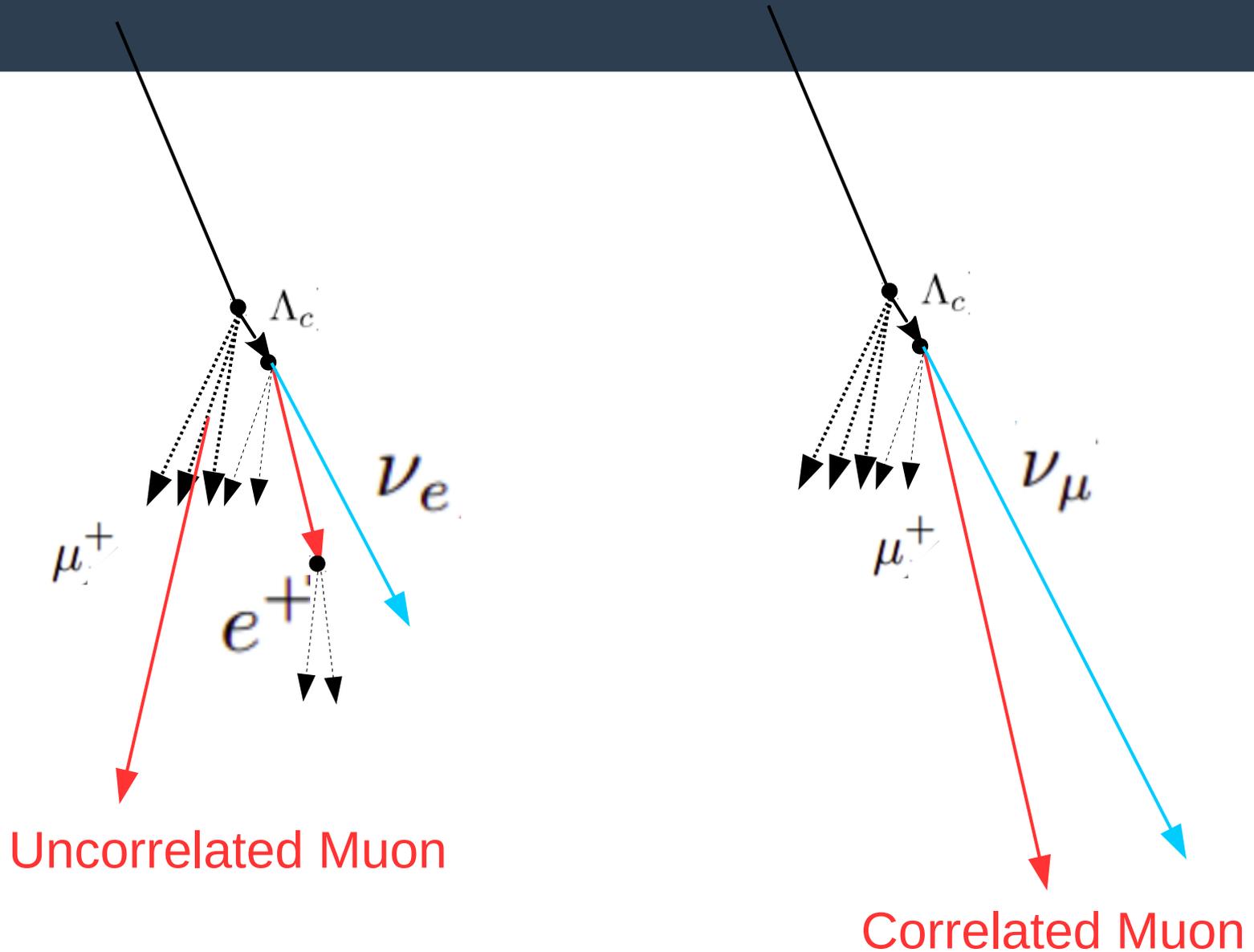


Forward strange production also occurs for $K^+ \Lambda$

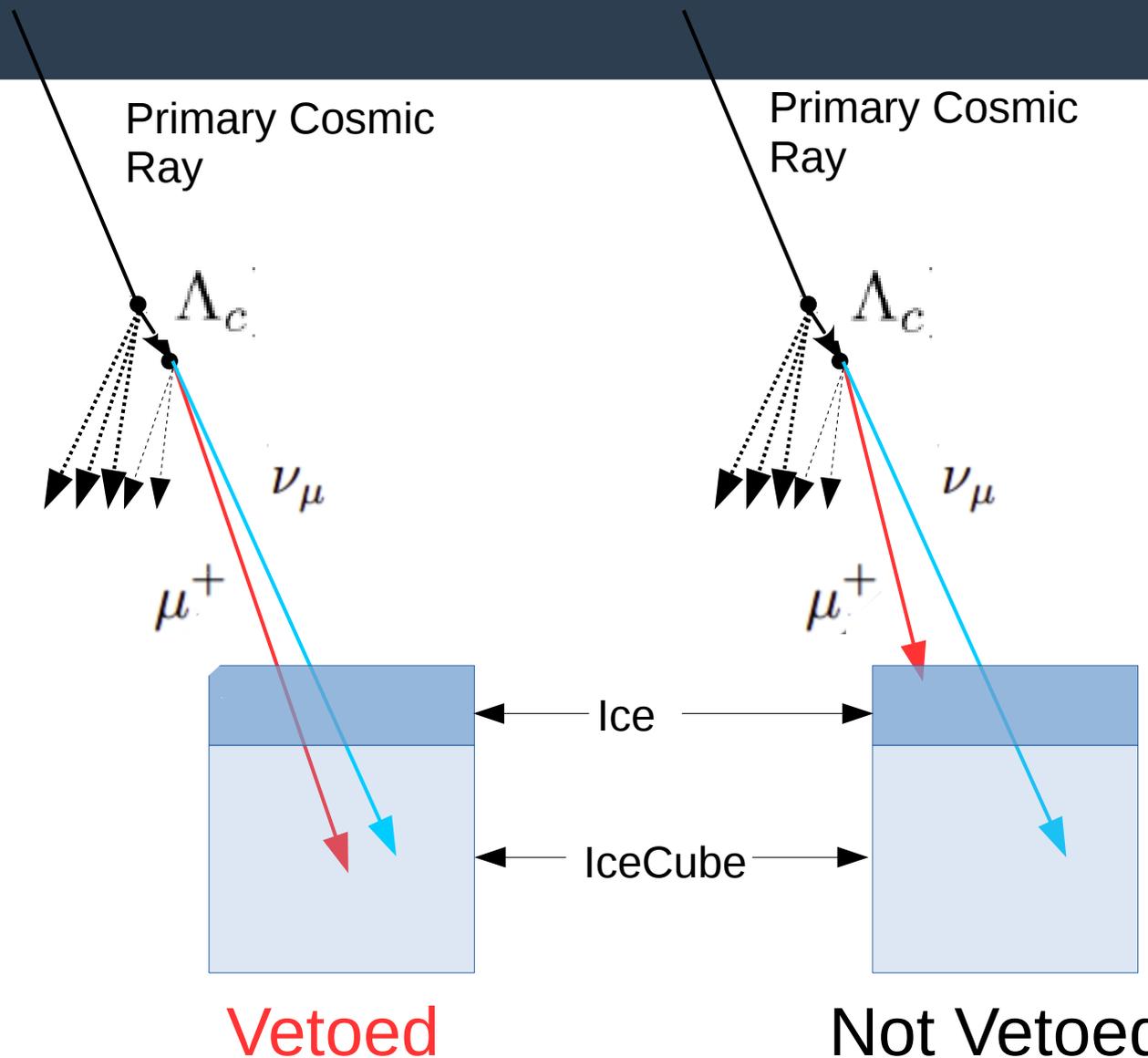


R. T. Edwards et al., Phys. Rev. **D18**, 76 (1978).

Muon Airshower Types

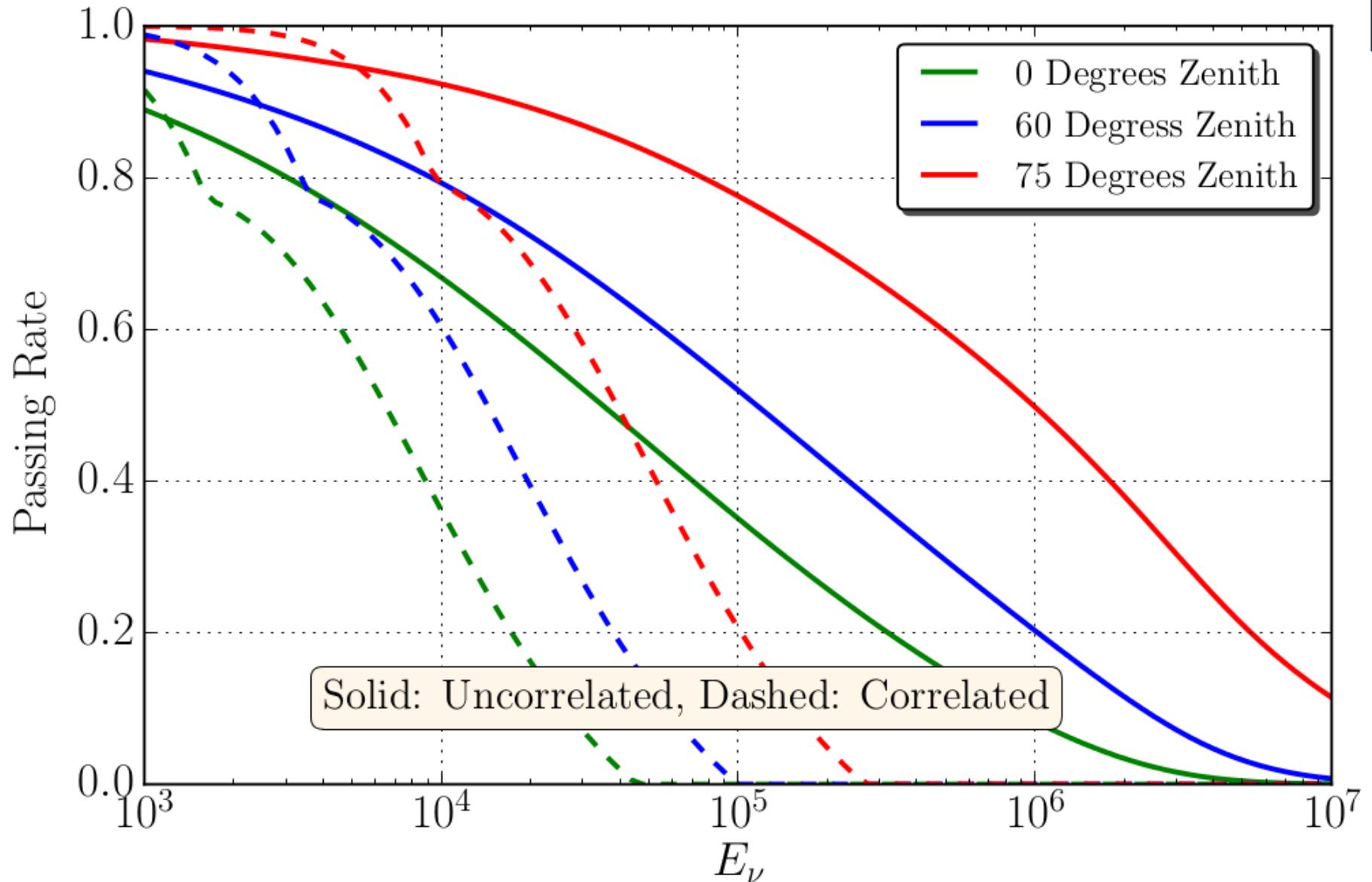


The Self-veto effect

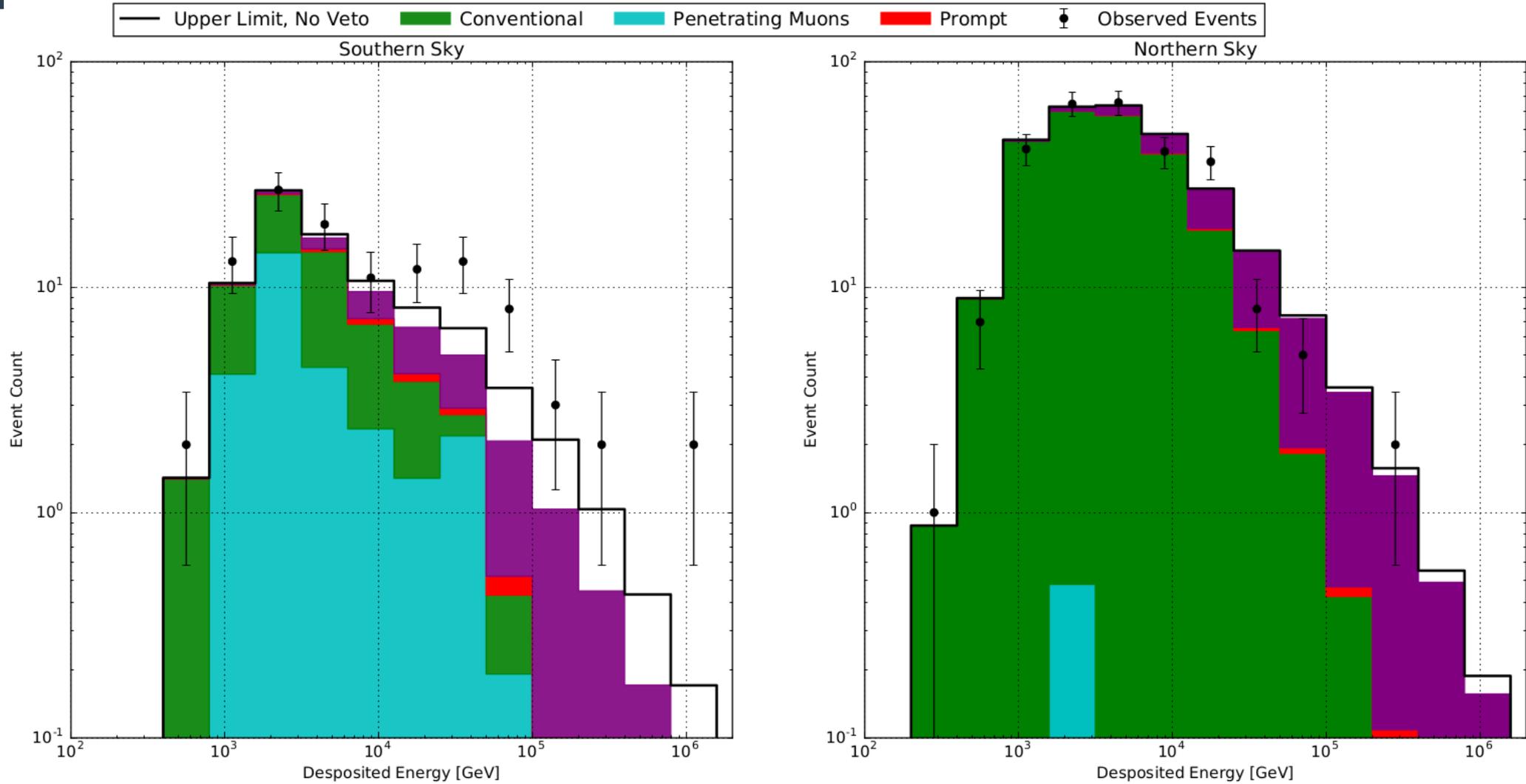


- We used Gaisser et al.'s technique to calculate the self-veto probability of prompt neutrinos

Self-veto Probabilities



Removing Self Veto



Prompt flux with E^{-2} Spectrum

