Implications for high-energy astroparticle physics

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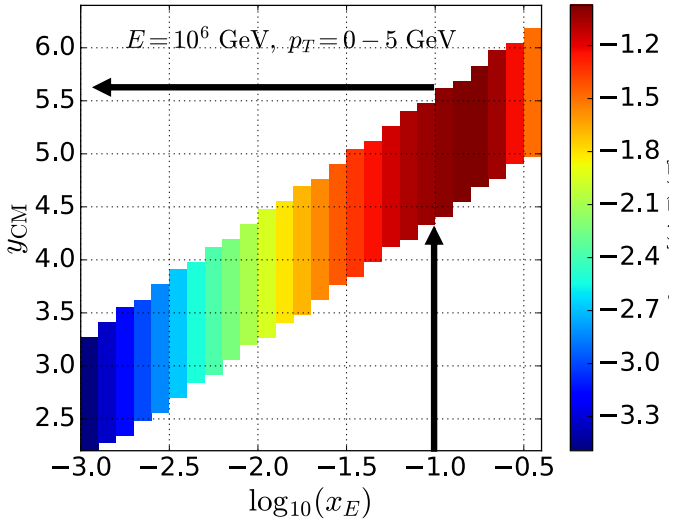
- Tight connection between forward physics at the LHC and the atmospheric lepton fluxes at high energies.
- Atmospheric charm production, with its large theoretical uncertainties can benefit from data-driven “constraints” & “calibrations” of theory prediction:
    - heavy quark production (NLO, large theory uncertainties for charm)
    - large- and small-*x* PDFs (interesting here and in other contexts)
    - fragmentation (and beam coalescence)
    - nuclear corrections
    - connection to Monte Carlo simulations

Atmospheric neutrinos from charm

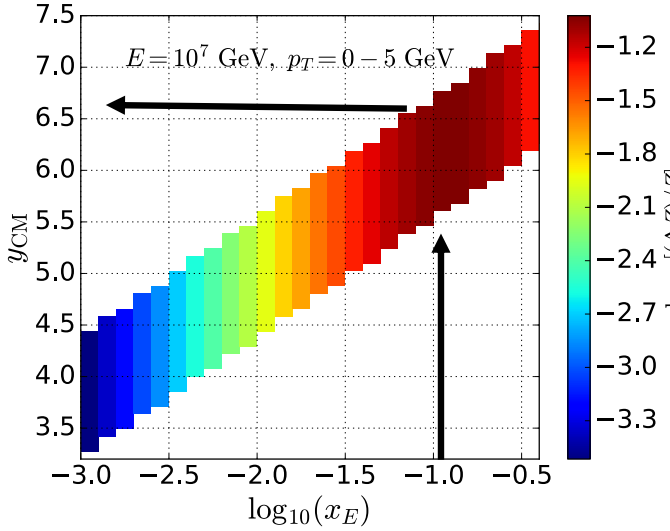
$$x_E = E_D/E_p$$
$$x_E(\sqrt{s}, p_T) \to y$$

- Higher neutrino energies, weighted with falling cosmic ray spectrum, mean higher charm rapidities.

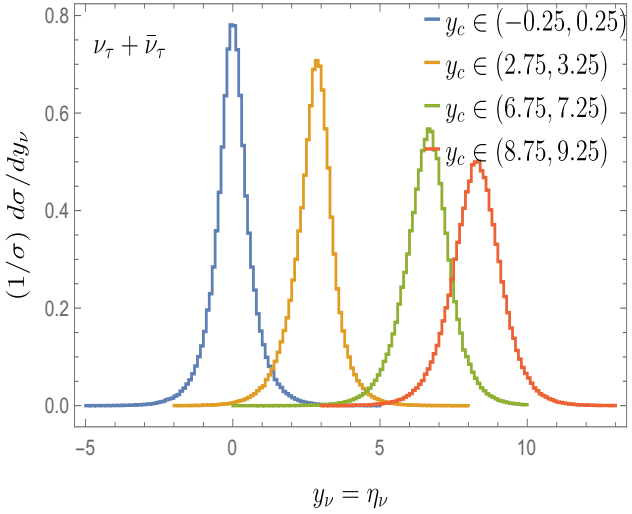
10^6 GeV



10^7 GeV

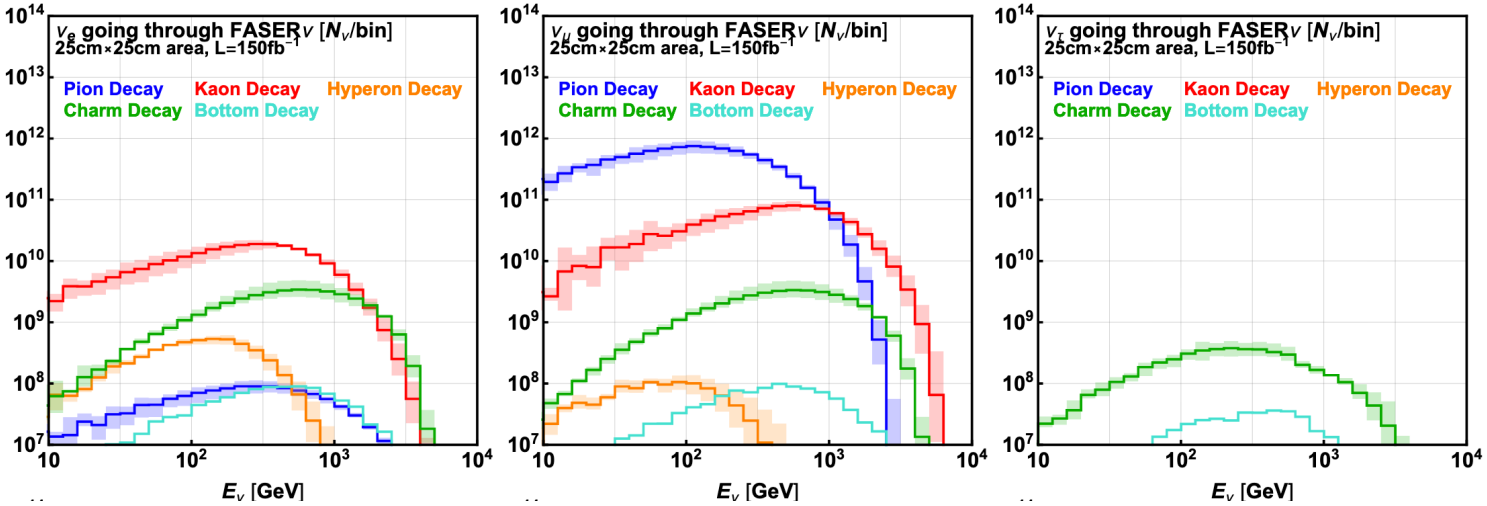


$y_c \to \eta_\nu$



Ingredients

- Cosmic ray flux: spectrum and composition
- Cosmic ray cross section with air
- Leading nucleon energy after interaction
- ✓ Charm production cross section and fragmentation
- ✓ Charm hadron energy distributions
- ✓ Charm hadron decay distribution
- Charm re-scattering distribution



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Discussion

- Other ties between forward physics and astroparticle physics?
- Wish list for charm and neutrino production