Source constraints from ν & p with GCOS

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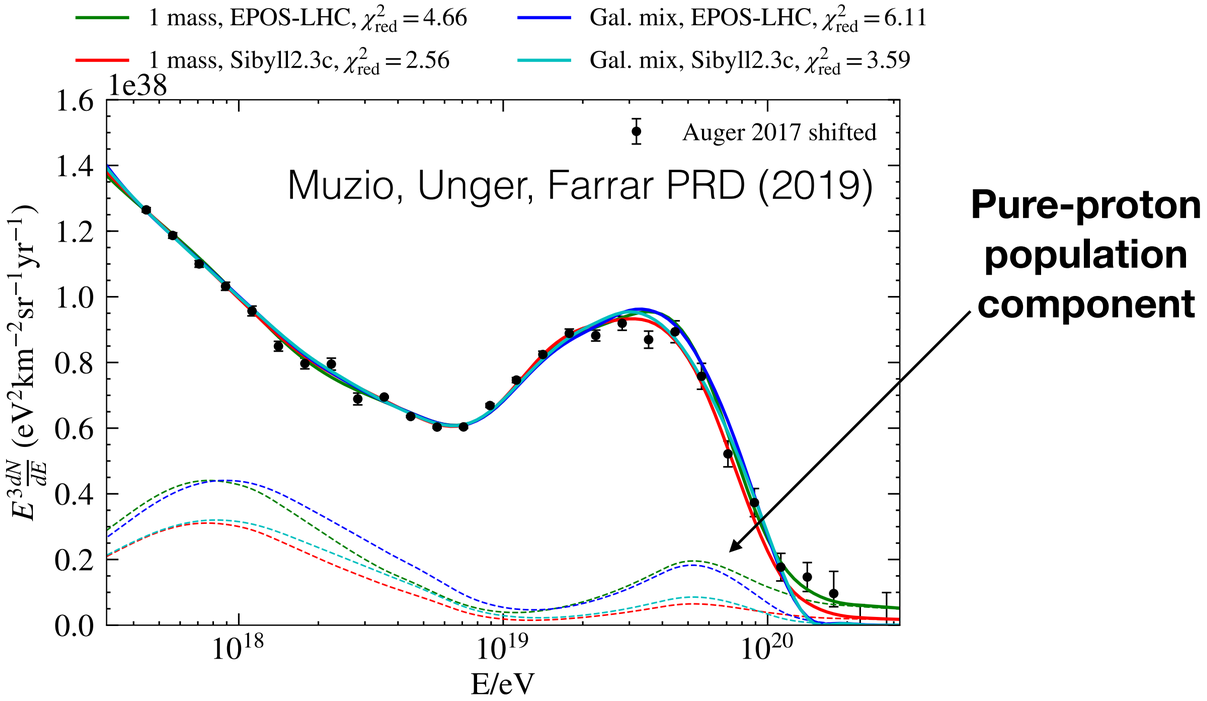
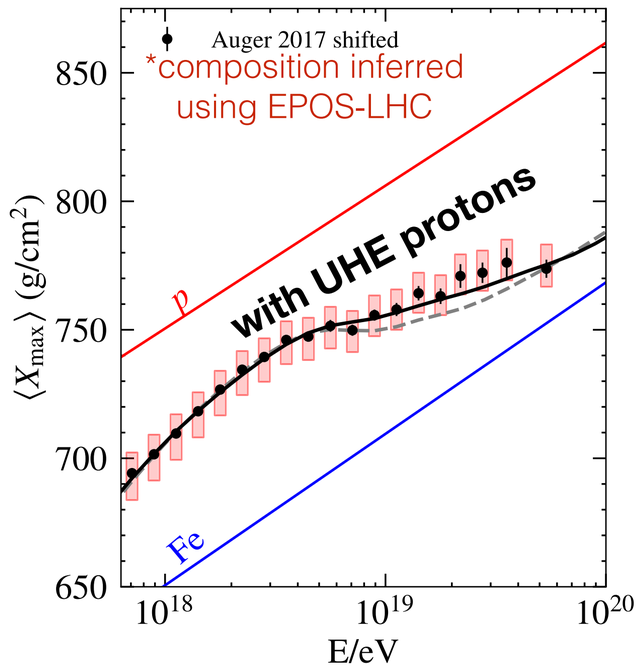
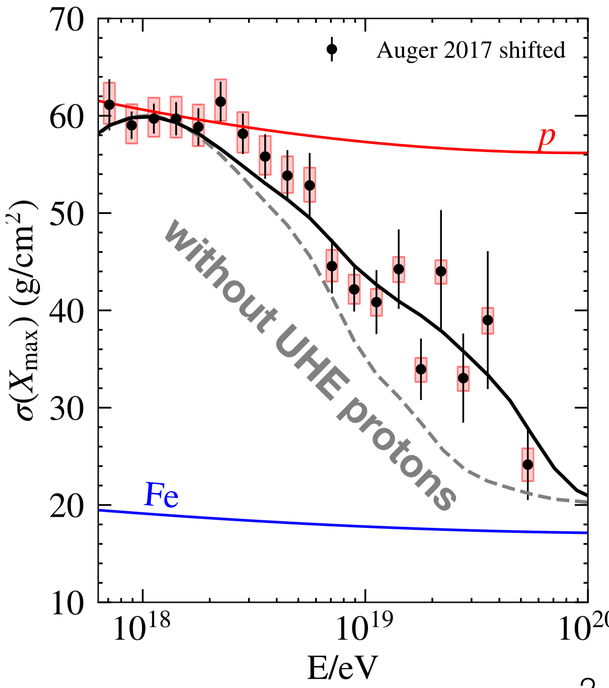
This study

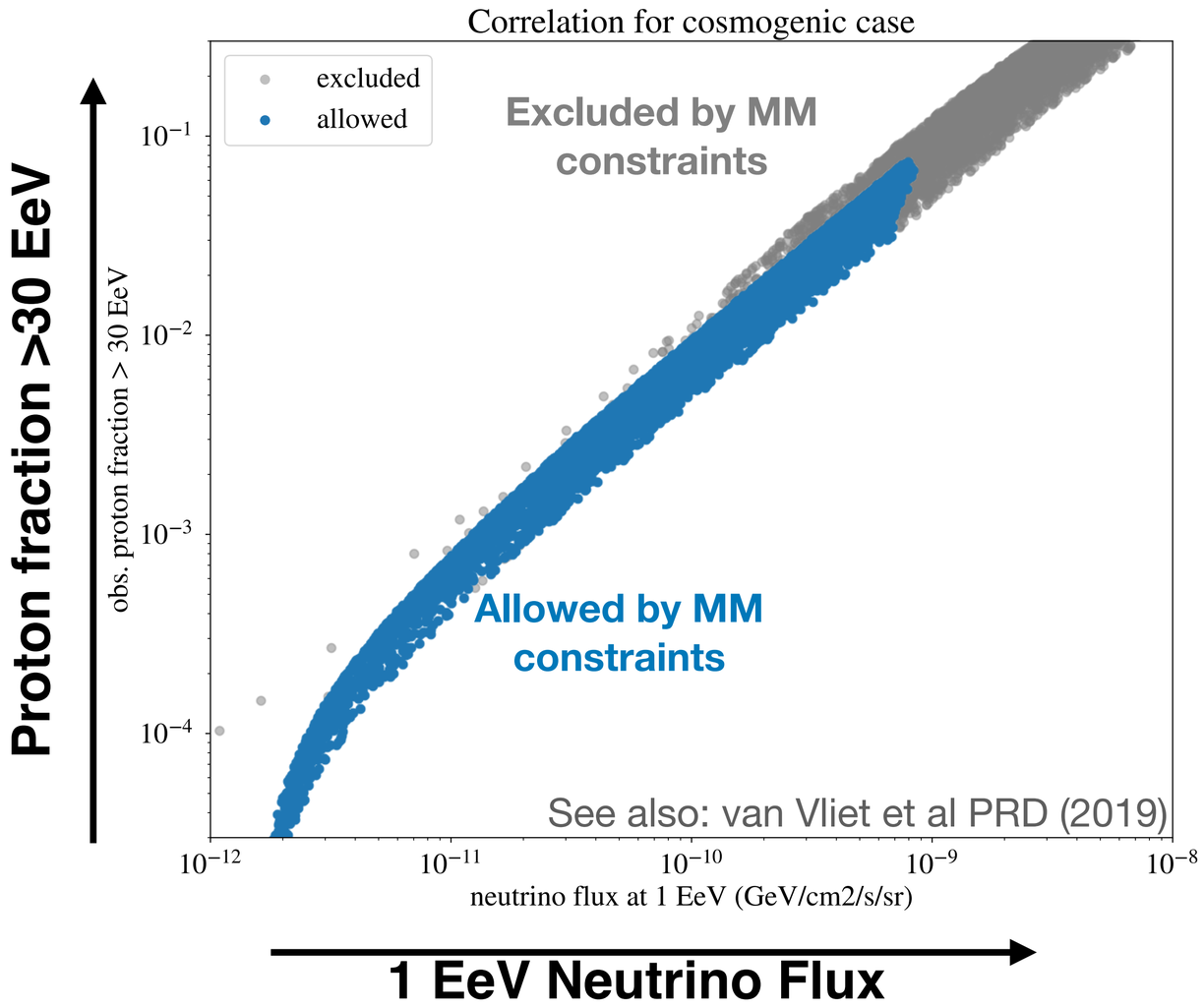
- CR source model: Unger-Farrar-Anchordoqui (UFA)
- Two source populations:
  - Baseline population, fitting most of UHECR data
    - Fixed to best-fit parameters for given evolution
  - Pure-proton population, producing protons >10 EeV
    - Model parameters uniformly sampled, explore full range of model predictions
    - Exclude models that violate UHECR, neutrino, & gamma-ray data
- **To what extent can UHE protons & secondary neutrinos constrain source evolution if source interactions are significant?**



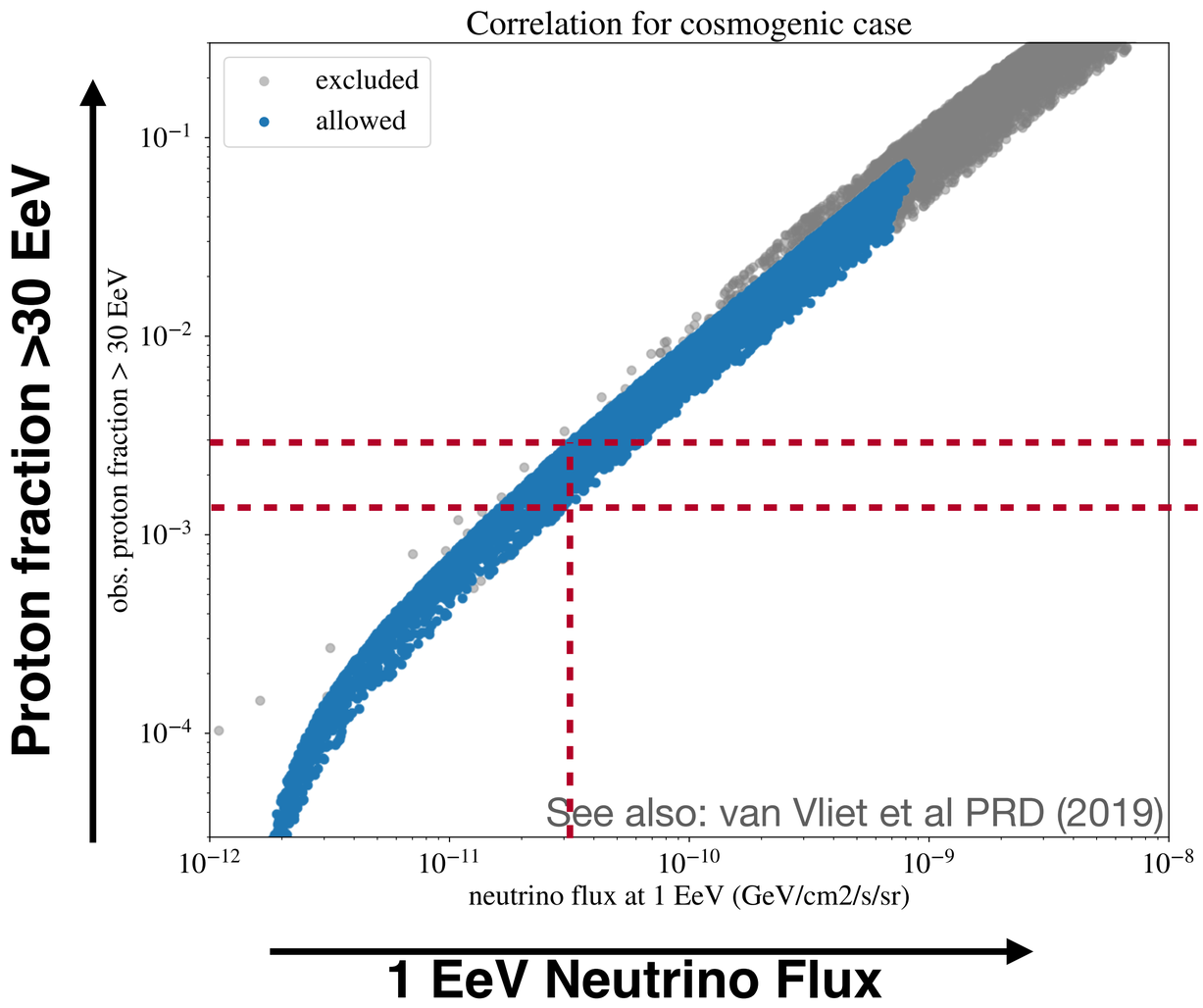


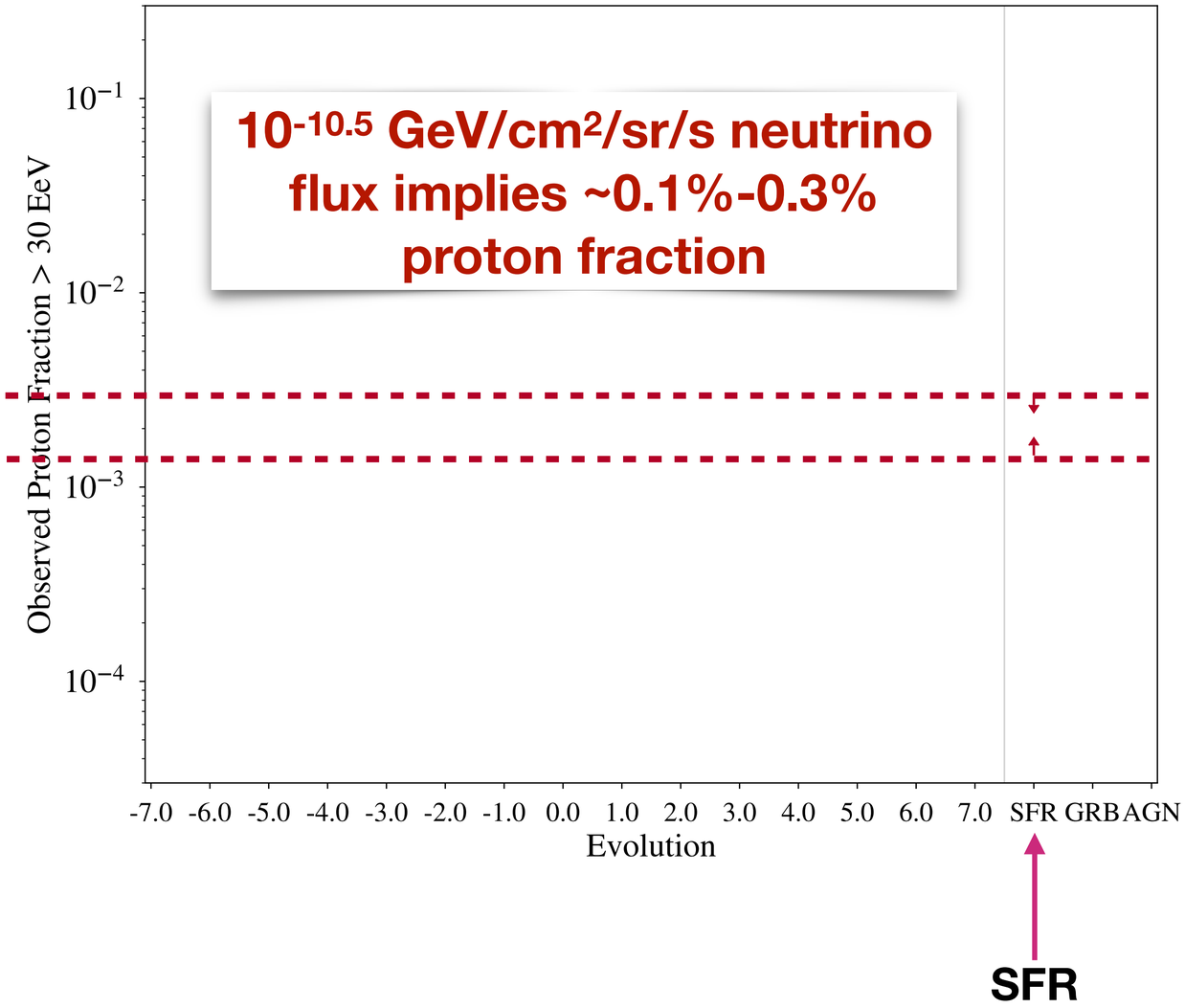


Example: SFR, cosmogenic neutrinos only



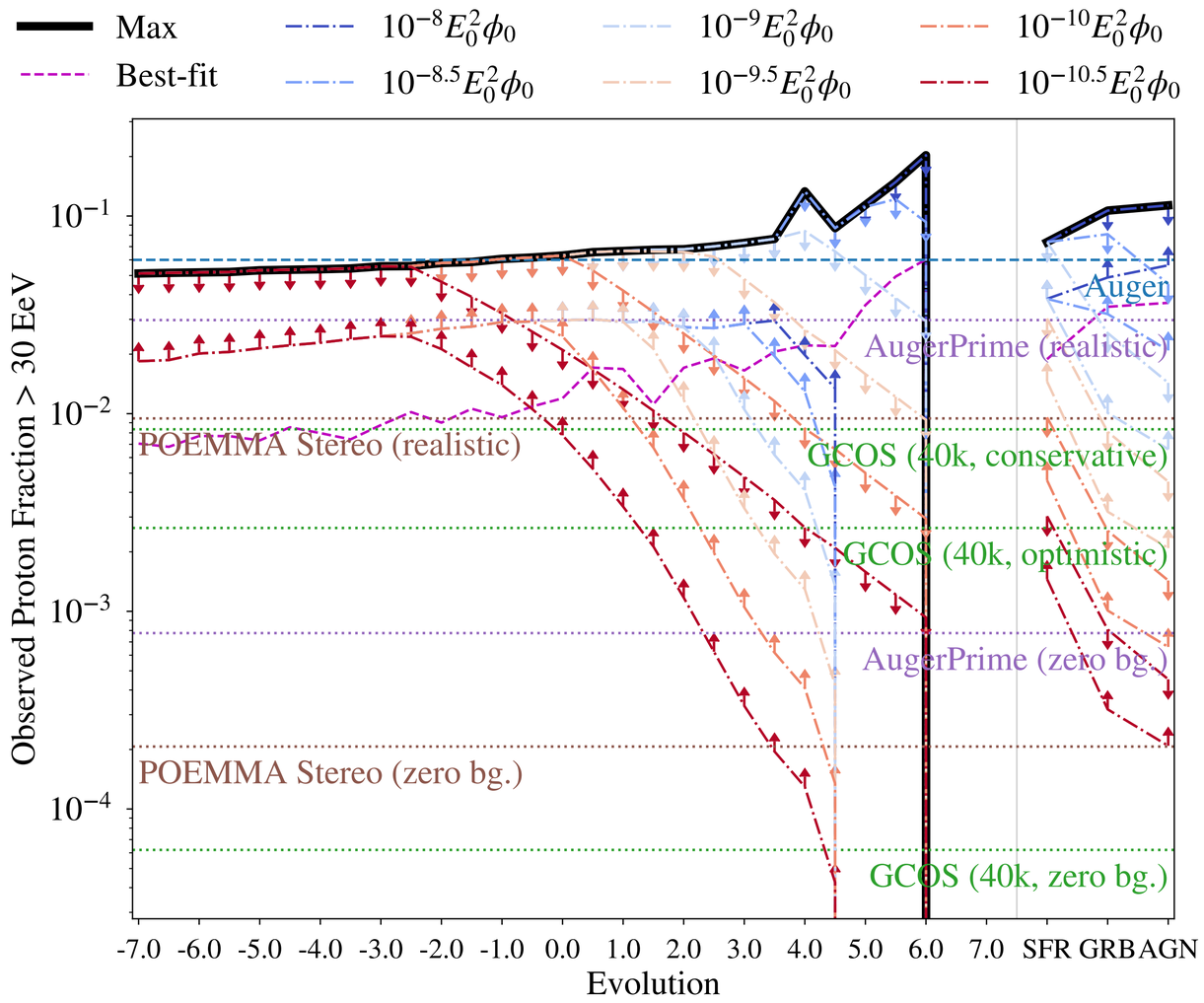
Example: SFR, cosmogenic neutrinos only





Cosmogenic neutrinos only

$$\xi(z) = \begin{cases} (1+z)^m & z \le z_0 \\ (1+z_0)^m e^{-(z-z_0)} & z > z_0 \end{cases}$$



Source Evolution

$E_0^2\phi_0 = \mathrm{GeV/cm^2/s/sr}$

Cosmogenic neutrinos only

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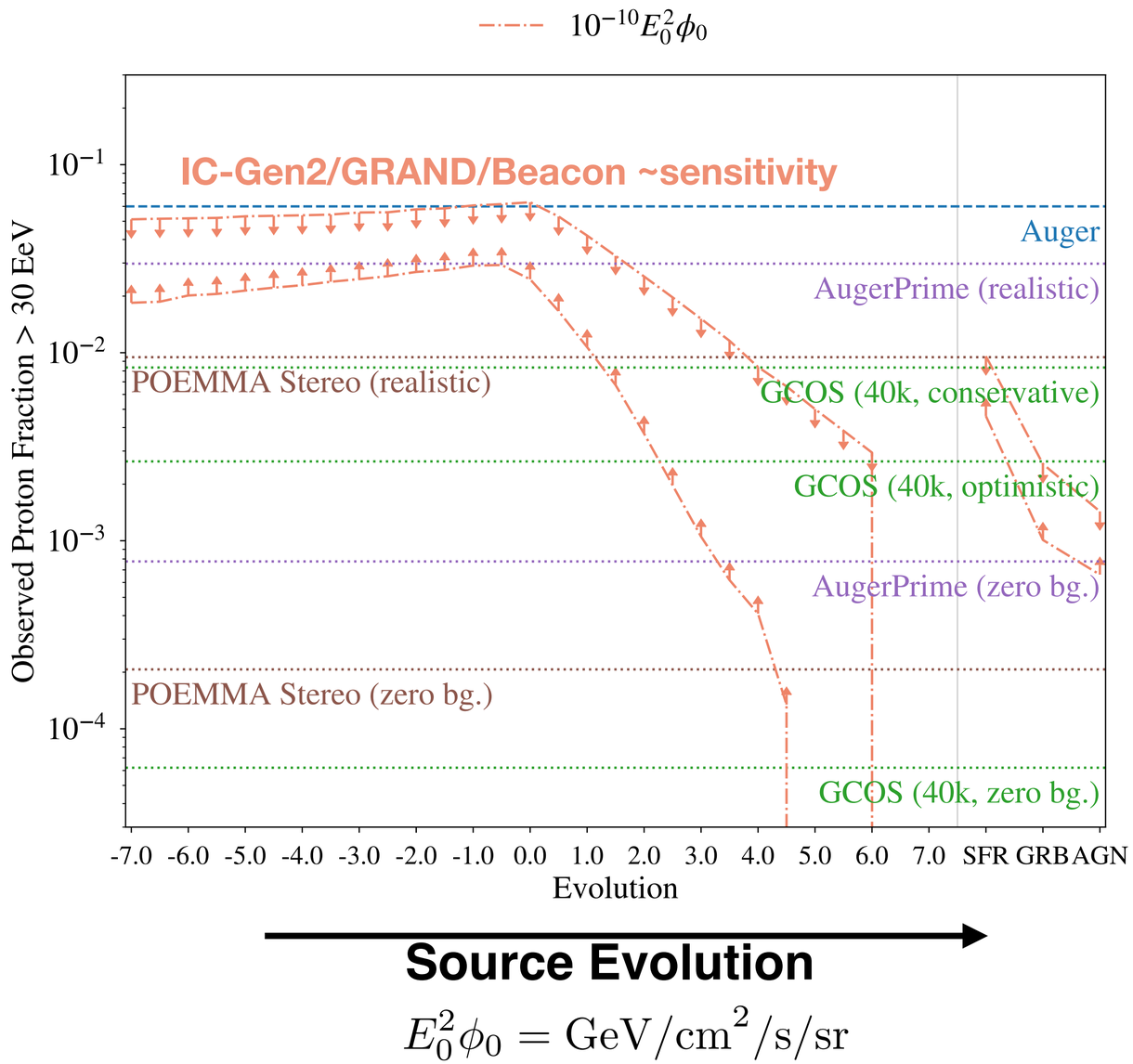
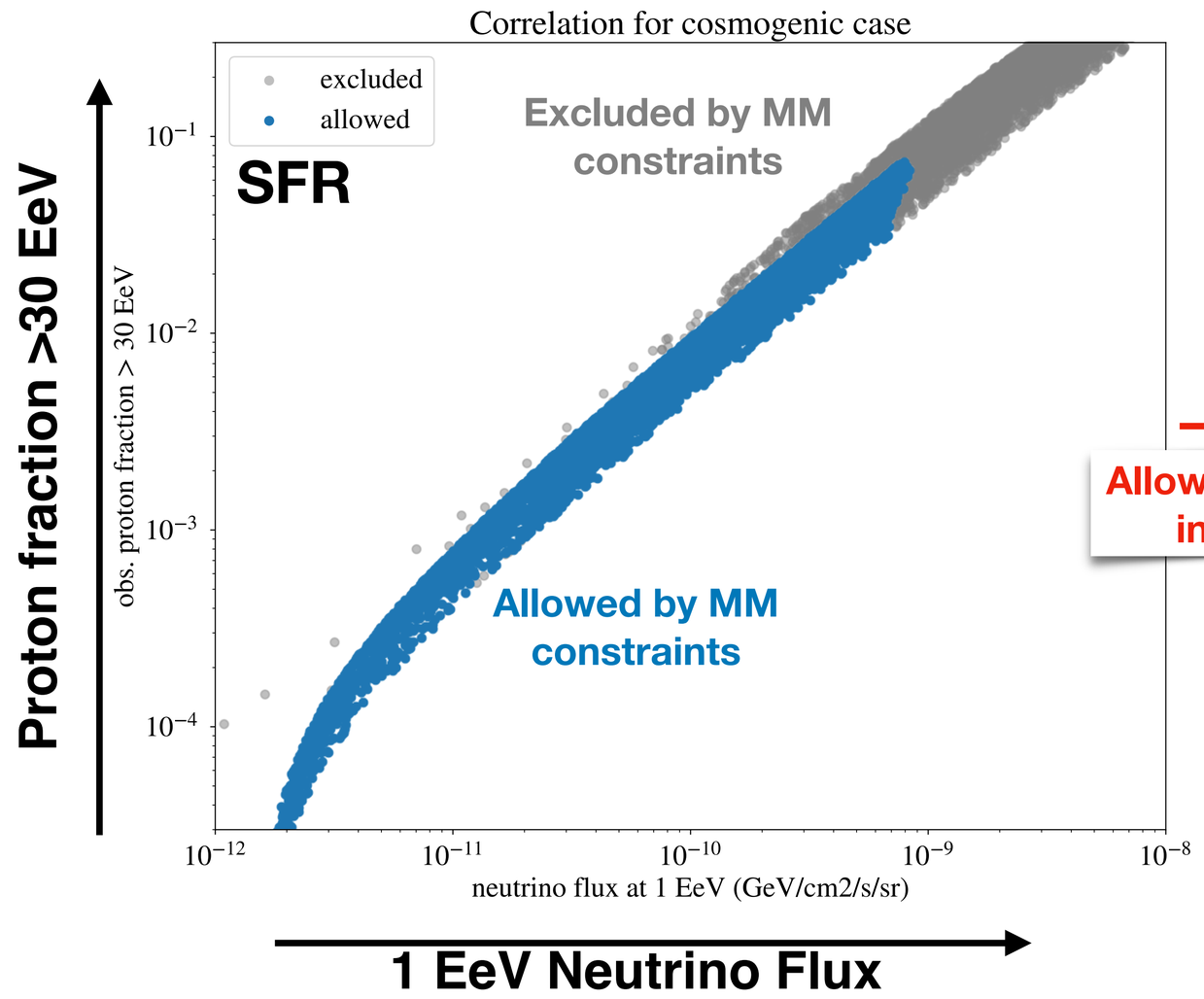
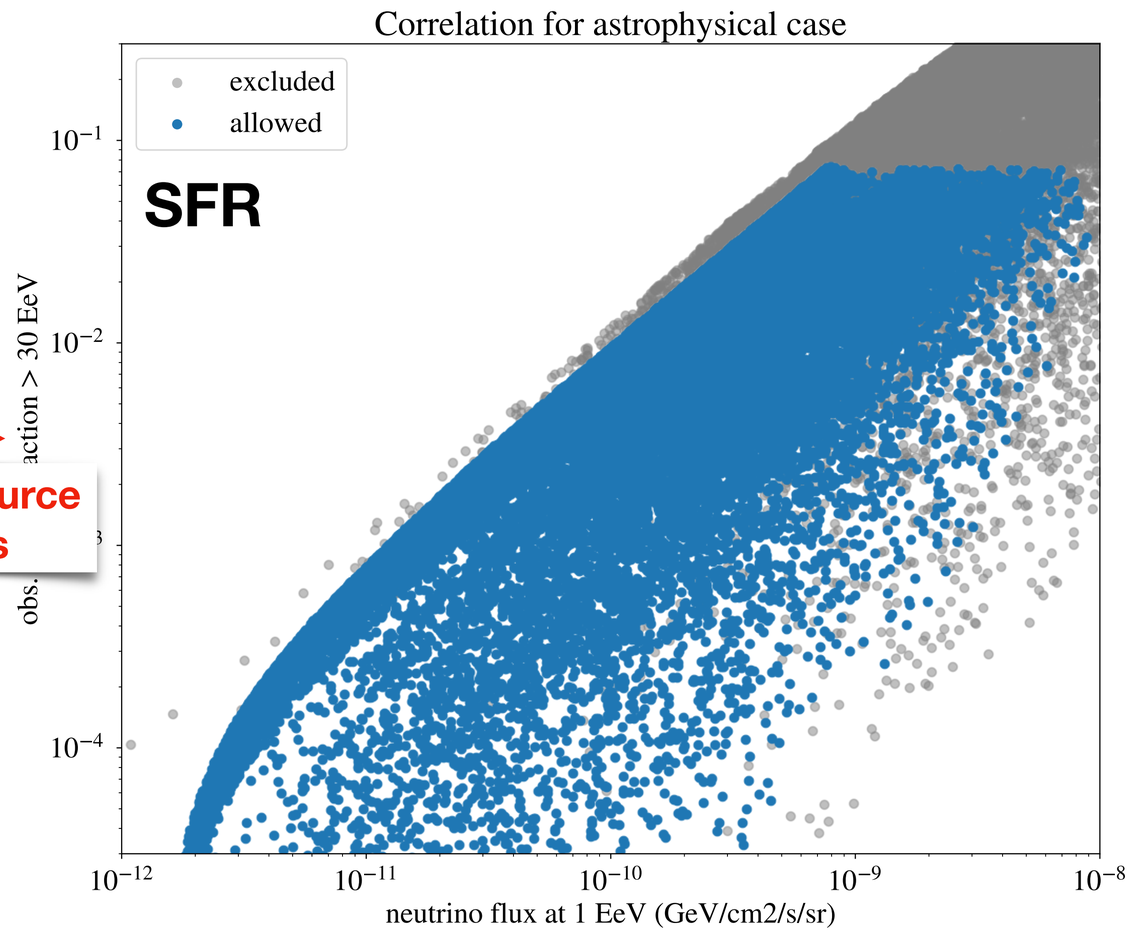
- Combined UHE neutrino & proton fraction measurement can constrain source evolution
- IC-Gen2 Radio/GRAND200k/Beacon + GCOS measurement will give source evolution for:
  - $m < 4$, conservative case (p-He MF~0.3)
  - $m < 6/\mathrm{SFR}$, optimistic case (p-He MF~0.7)
  - GRB/AGN, background-free case



Effect of Source Interactions



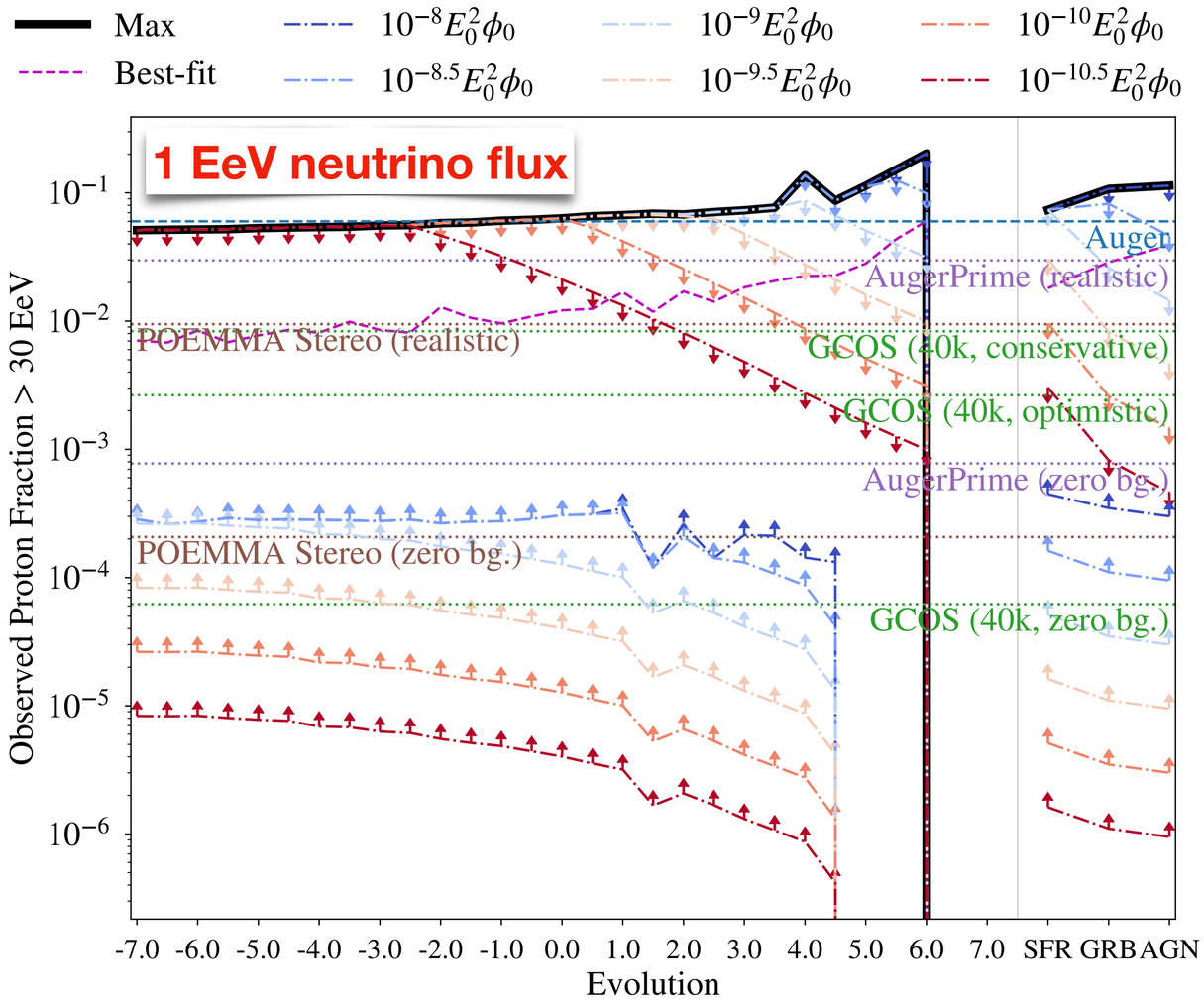
Allowing for source interactions

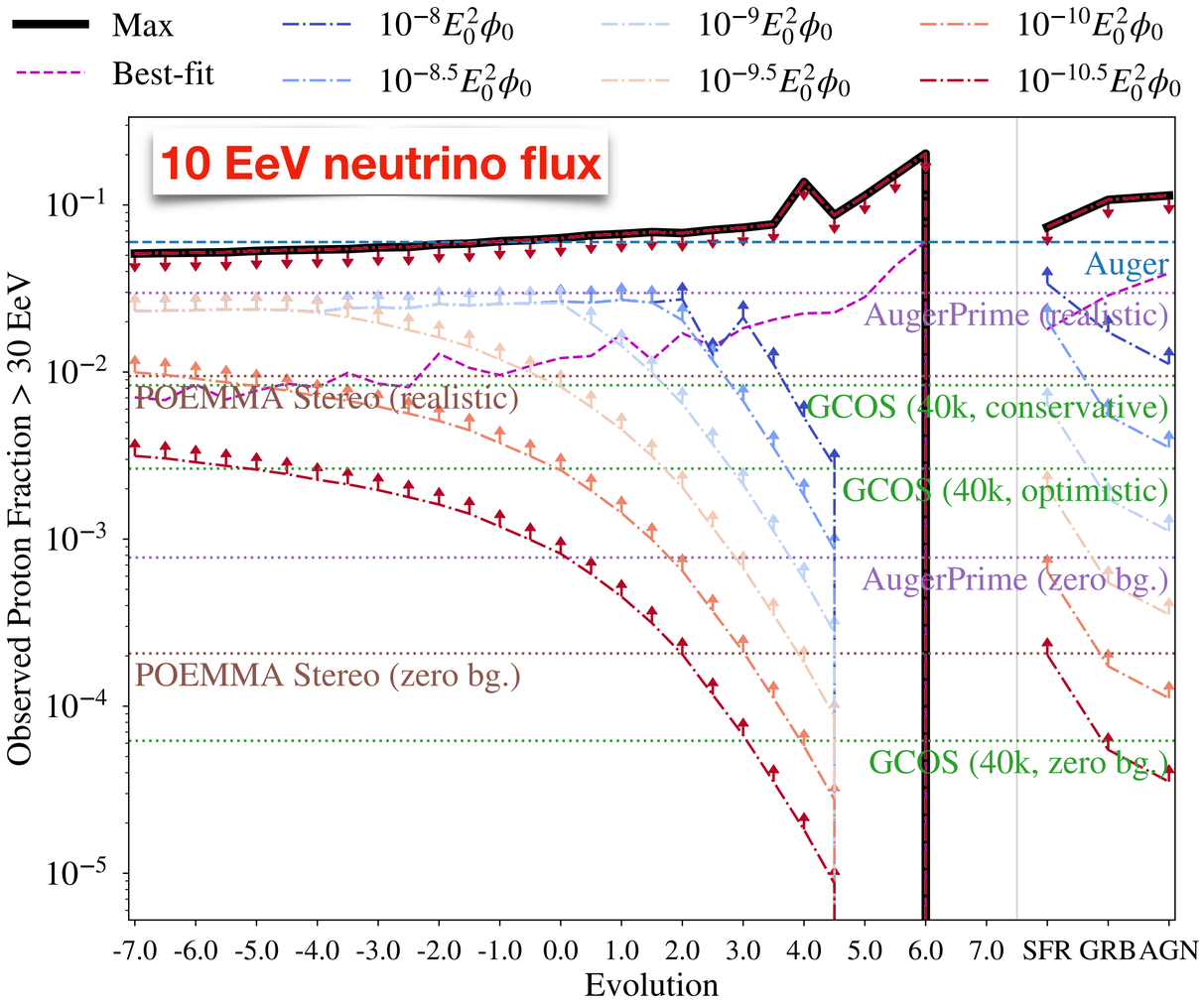


Correlation has much wider dispersion, but still exists

Effect of Source Interactions

$E_0^2\phi_0 = \mathrm{GeV/cm^2/s/sr}$





1 EeV neutrino flux → upper-bound on *m*

10 EeV neutrino flux → lower-bound on *m*

Summary

- GCOS will constrain observed proton fraction:
  - He contamination case: O(0.1%)
    - Conservative merit factor ~0.3 gives constraints comparable to POEMMA
  - Background free case: O(0.001%)
- **GCOS & planned neutrino experiments will strongly constrain UHECR source evolution**
  - Cosmogenic only case: *m* is measured
  - General case: constrain *m* with 1 EeV & 10 EeV neutrino measurements