XIX International Workshop on Neutrino Telescopes

RESERVOIR SOURCES CONTRIBUTION TO THE ASTROPHYSICAL NEUTRINO FLUX

Starburst Galaxies Strike Back: a Multi-Messenger Analysis

ArXiv:2011.02483, AA, Marco Chianese, Damiano Fiorillo, Antonio Marinelli, Gennaro Miele, Ofelia Pisanti

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Why Starburst Galaxies?

https://hubblesite.org/image/3898/printshop

The Starburst Galaxy M82

Properties of SBGs

- High Star Formation Rate **(10-100 times higher than Milky Way)**
- They are abundant **(~10^4 — 10^5 Gpc^{-3})**
- Not very brilliant in gamma-rays **(only a few currently observed)**

Emission Properties of SBGs

dust, gas, ...

$$p + p \to \pi^+ \pi^- \pi^0 \ldots$$

p-p interaction is likely to occur when *density of gas higher than density of radiation* (for example in Starburst Galaxies)

- Generally, the SBGs are considered with the same properties of a ***prototype*** galaxy with "known" parameters (Peretti et al., **arXiv:1812.01996**, **arXiv:1911.06163**)

- In the calorimetric scenario, there are three main parameters:
  - Cut-off energy (p_{max})
  - Spectral index (α)
  - Rate of SuperNovae explosions

Our approach to the Problem: blending of spectral indexes

- We allow each starburst galaxy to have different a different spectral index

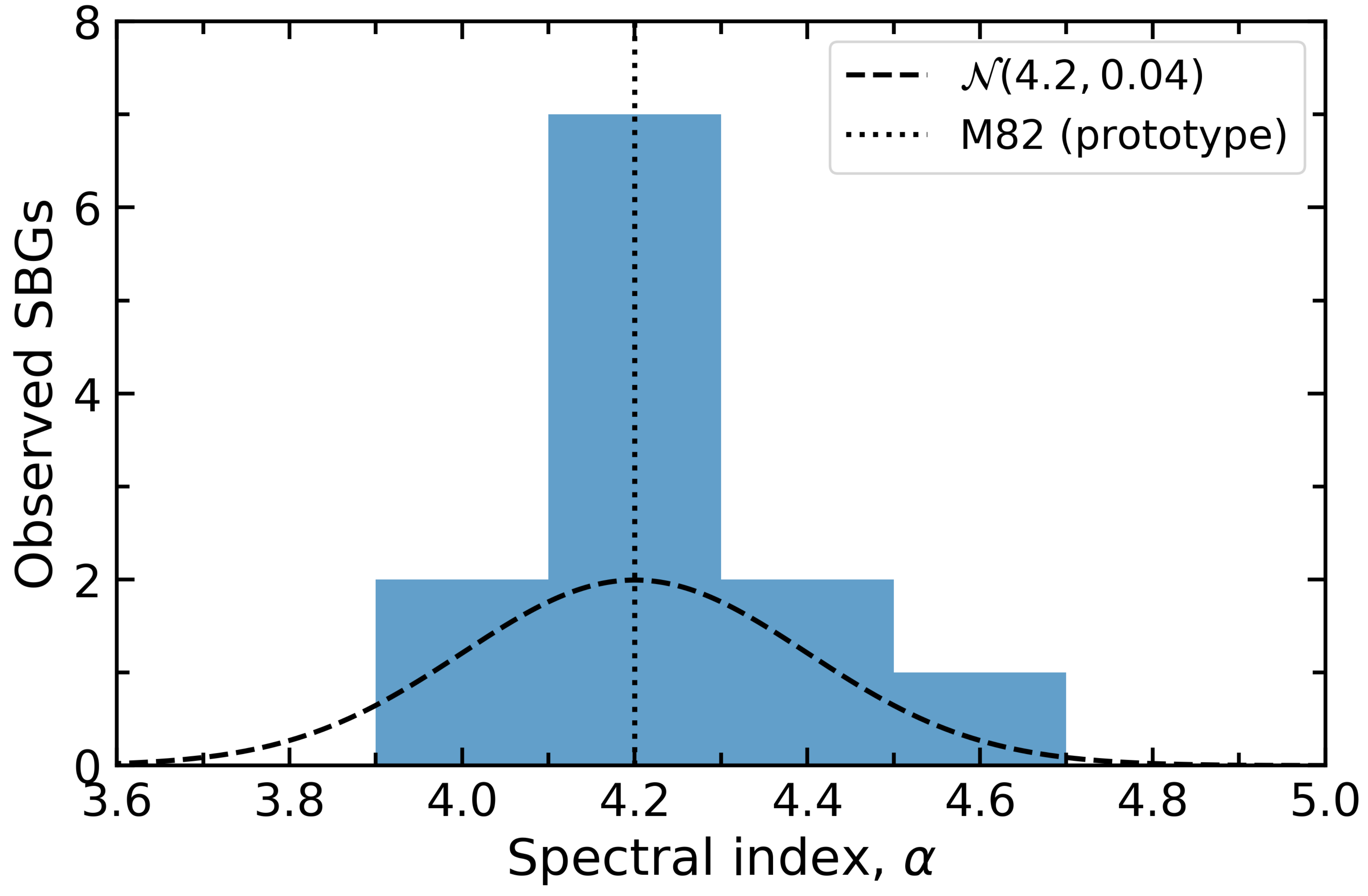
$$\left\langle \phi_{\nu,\gamma}(E|p^{\max},\alpha)\right\rangle_\alpha = \int \mathrm{d}\alpha\, \phi_{\nu,\gamma}(E|p^{\max},\alpha)\, p(\alpha)$$

$$p(\alpha) = \mathcal{N}(\alpha|4.2, 0.04)$$

- 12 SFGs and SBGs have been resolved in gamma-rays

Ajello et al., ***arXiv:2003.05493***

ArXiv:2011.02483



Larger contribution around 100 TeV! Potentially, It could alleviate the Tension between neutrino and gamma-ray data when using a hadronic model to explain IceCube observations.

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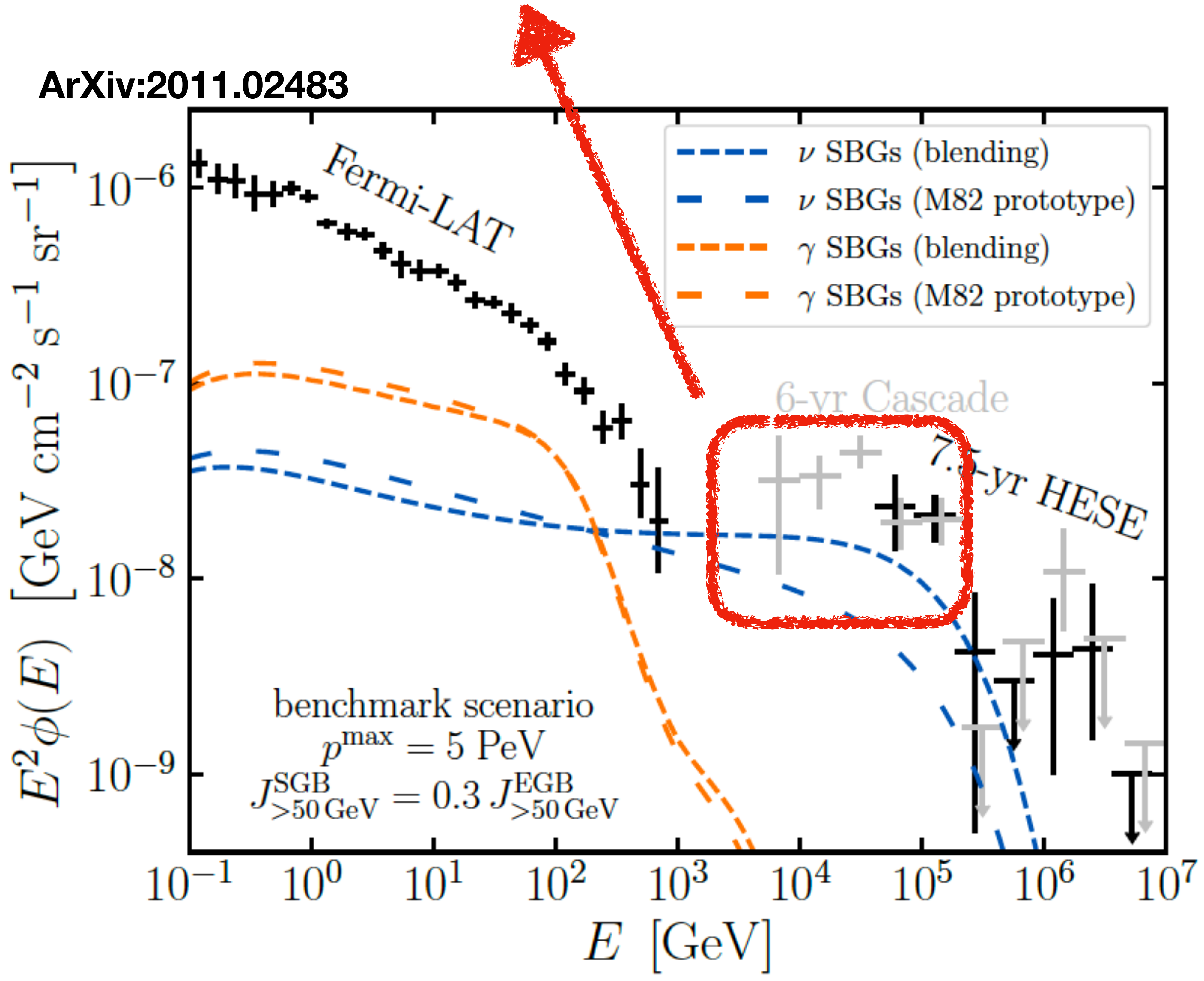


Results: Comparison between "Blending" and "Prototype"

- We performed a multi-component fit

The Gamma-Ray Contributions:
1. **SBGs**
2. **Blazar + Electromagnetic Cascades**
3. **Radio Galaxies**

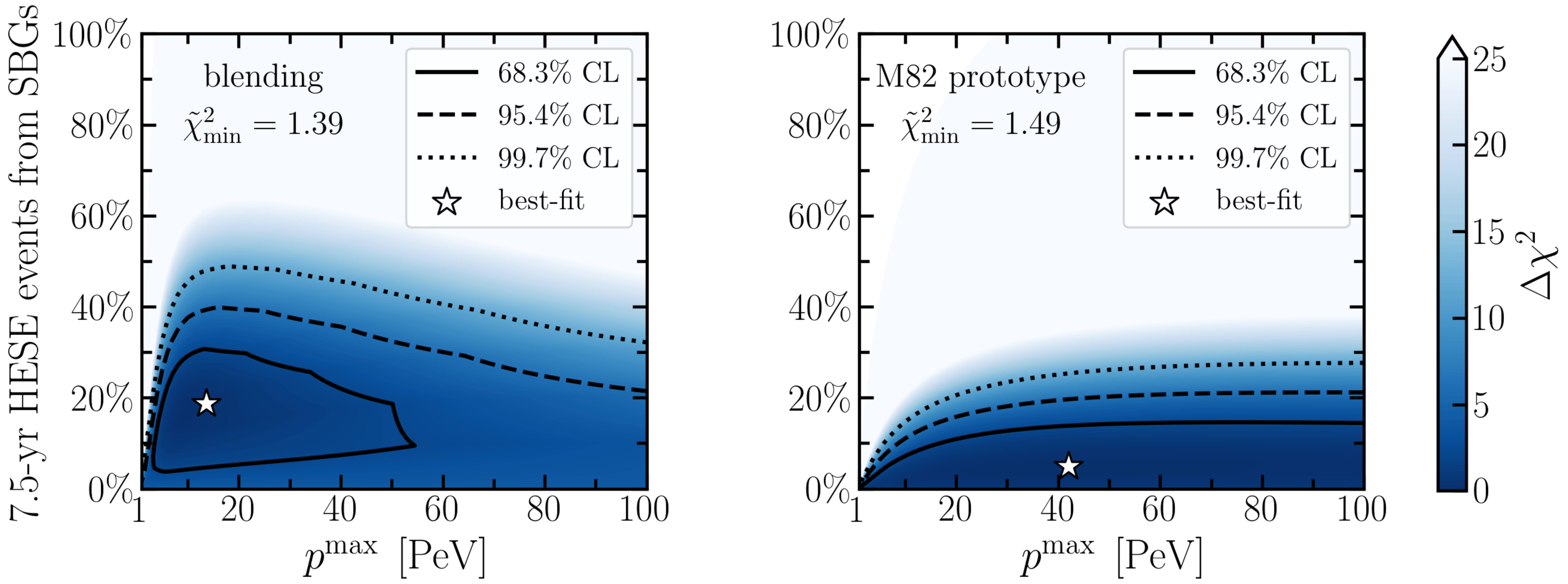
For Blazars and Radio Galaxies, we used the estimations given by Ajello et al. 2015 **(ArXiv: 1501.05301)**

The Neutrino Contributions:
1. **SBGs**
2. **Blazars**

For Blazars, we used the estimations given by Palladino et. Al 2019 **(ArXiv:1806.04769)**

Main Result

ArXiv:2011.02483



- **Non-Zero SBG component at 68% Confidence Level**
- **Preferred smaller values of the maximum energies for injected CRs: $p^{max} < 50$ PeV**

Conclusions and Future Scenarios

- ★ **SBGs could play an important role for explaining the measured Astrophysical Neutrino Flux.**

- ★ **We show how using the spectral behaviour of a new sample of Fermi-LAT SBGs increases the full-sky neutrino expectation at 100 TeV.**

- ★ **The reported multi-messenger study that considers gamma-ray EGB and neutrino HESE and cascades samples suggests a Pmax below tens of PeVs.**

- ★ **A new VHE catalogue of SBGs with the incoming CTA will constrain better the calorimetric parameters of these sources.**