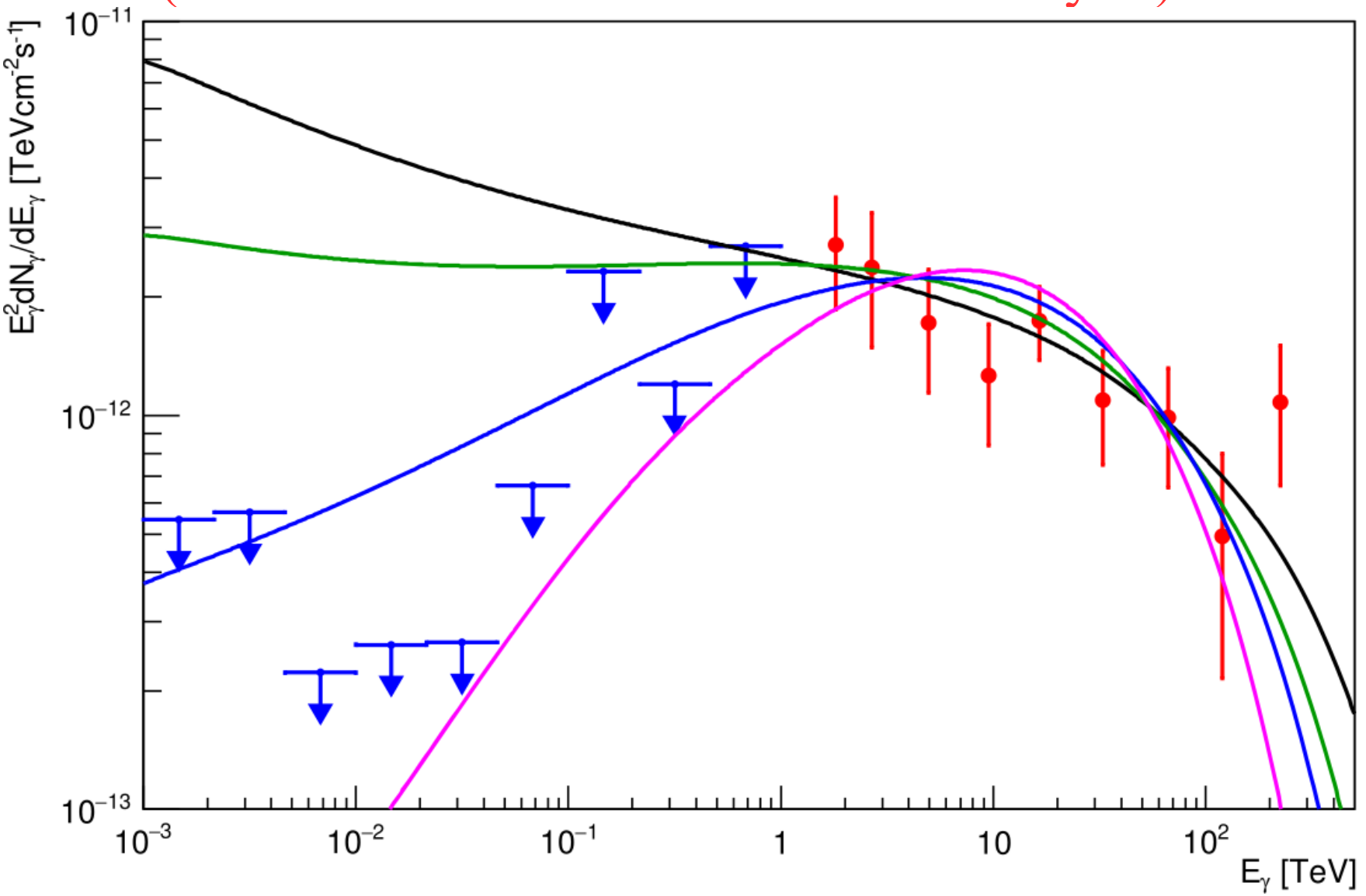
# Constraining the primary proton spectrum of the hadronic PeVatron candidate HAWC J1825-134

## (with HAWC data and Fermi-LAT analysis)

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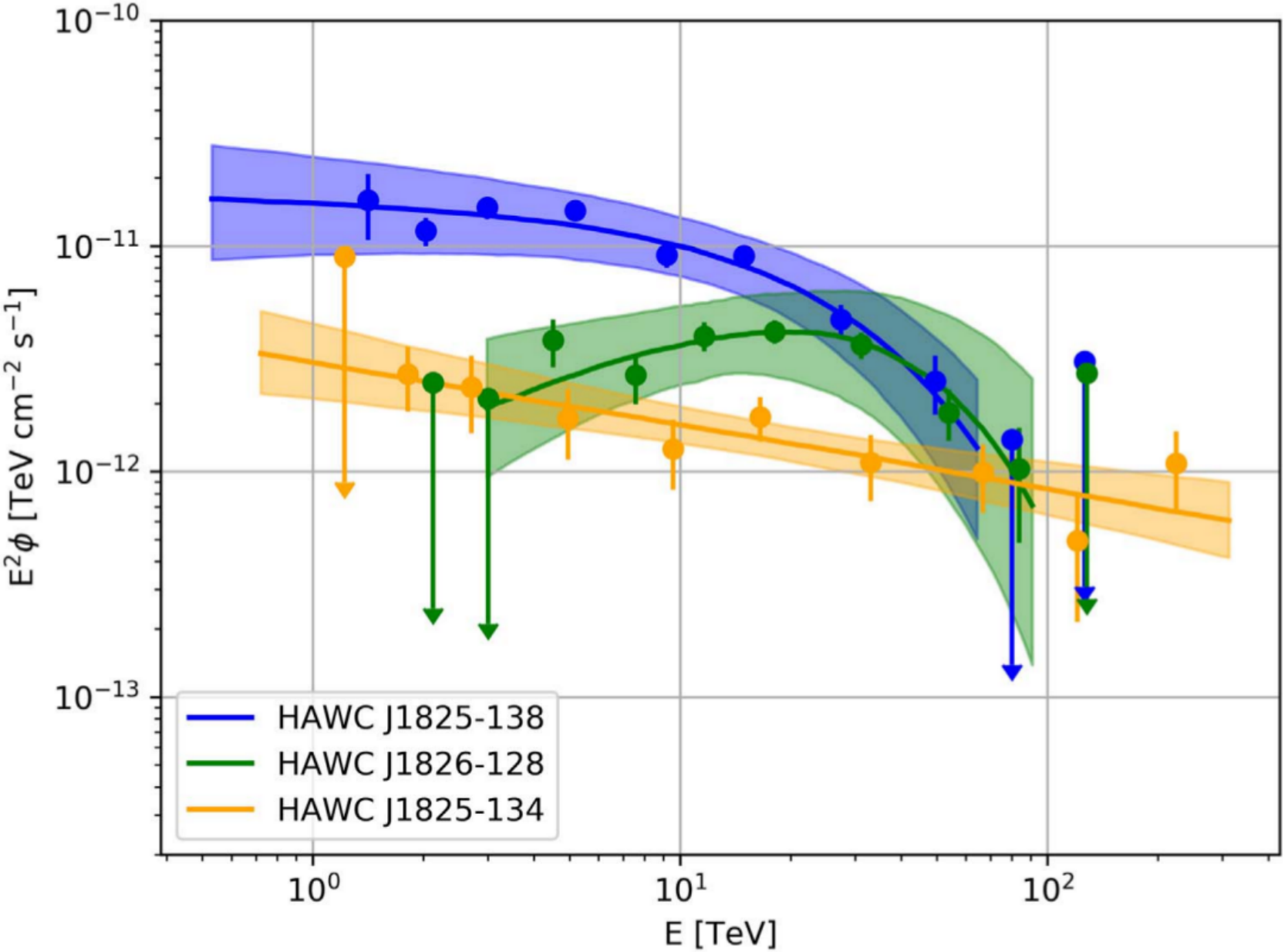
Dzhatdoev et al., ApJ, **929**, 25 (2022)

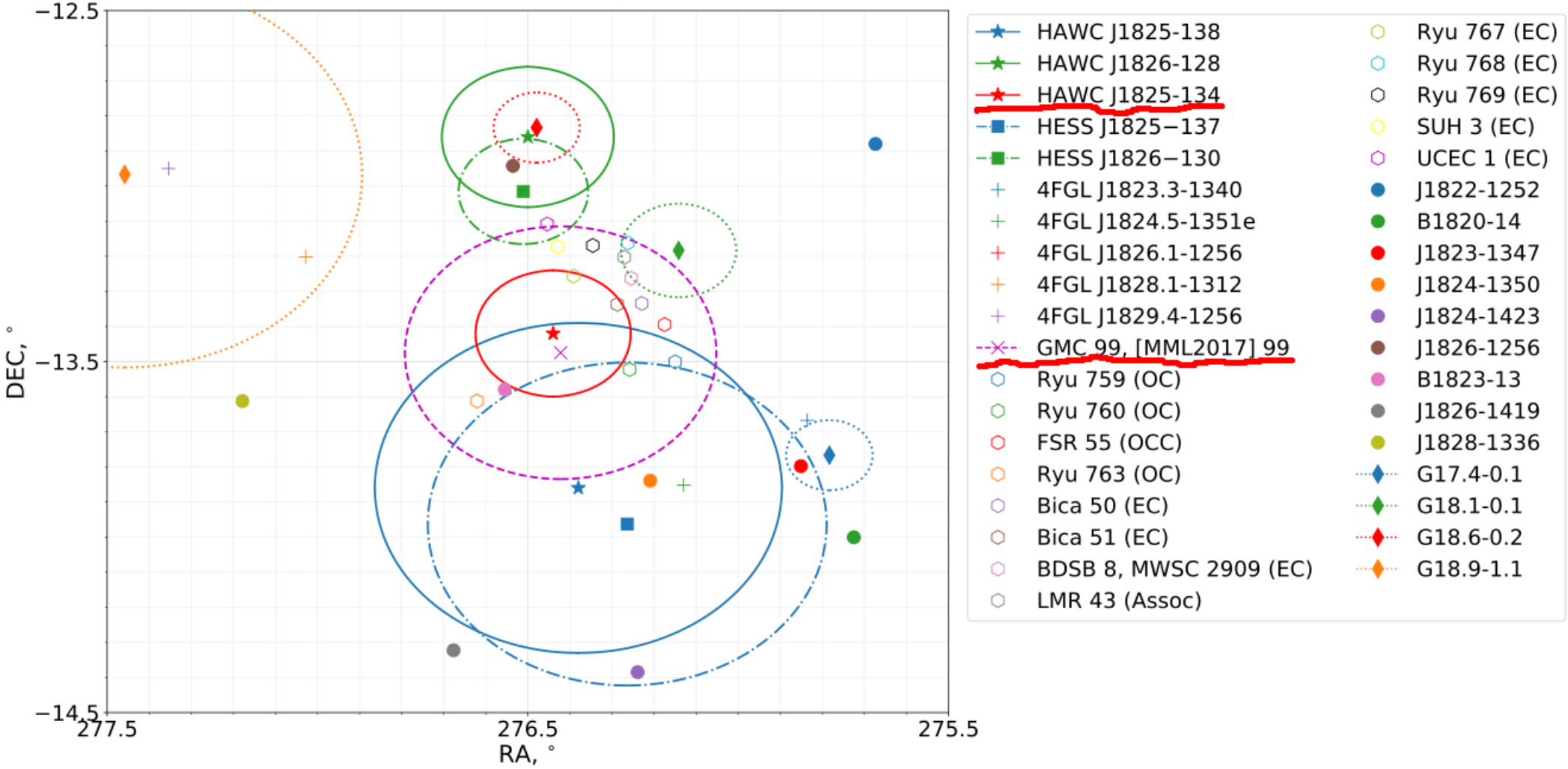
The spectrum of γ rays from HAWC J1825-134 and nearby sources (Albert et al. (HAWC), ApJ Lett., **907**, L30 (2021))




Apparently no cutoff, no "knee"

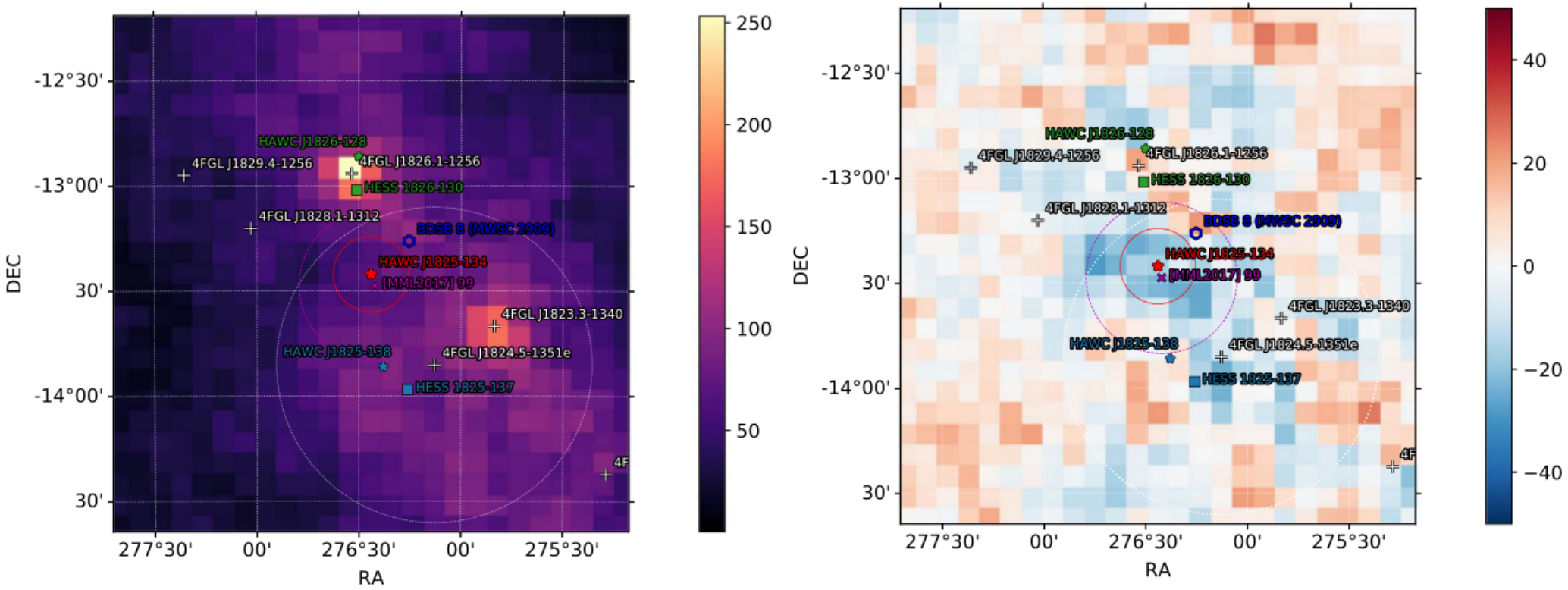
a very good hadronic PeVatron candidate

# The spectrum of γ rays from HAWC J1825-134: Albert et al. (HAWC), ApJ Lett., **907**, L30 (2021)




A likely target: molecular cloud GMC 99 → good hadronic PeVatron candidate

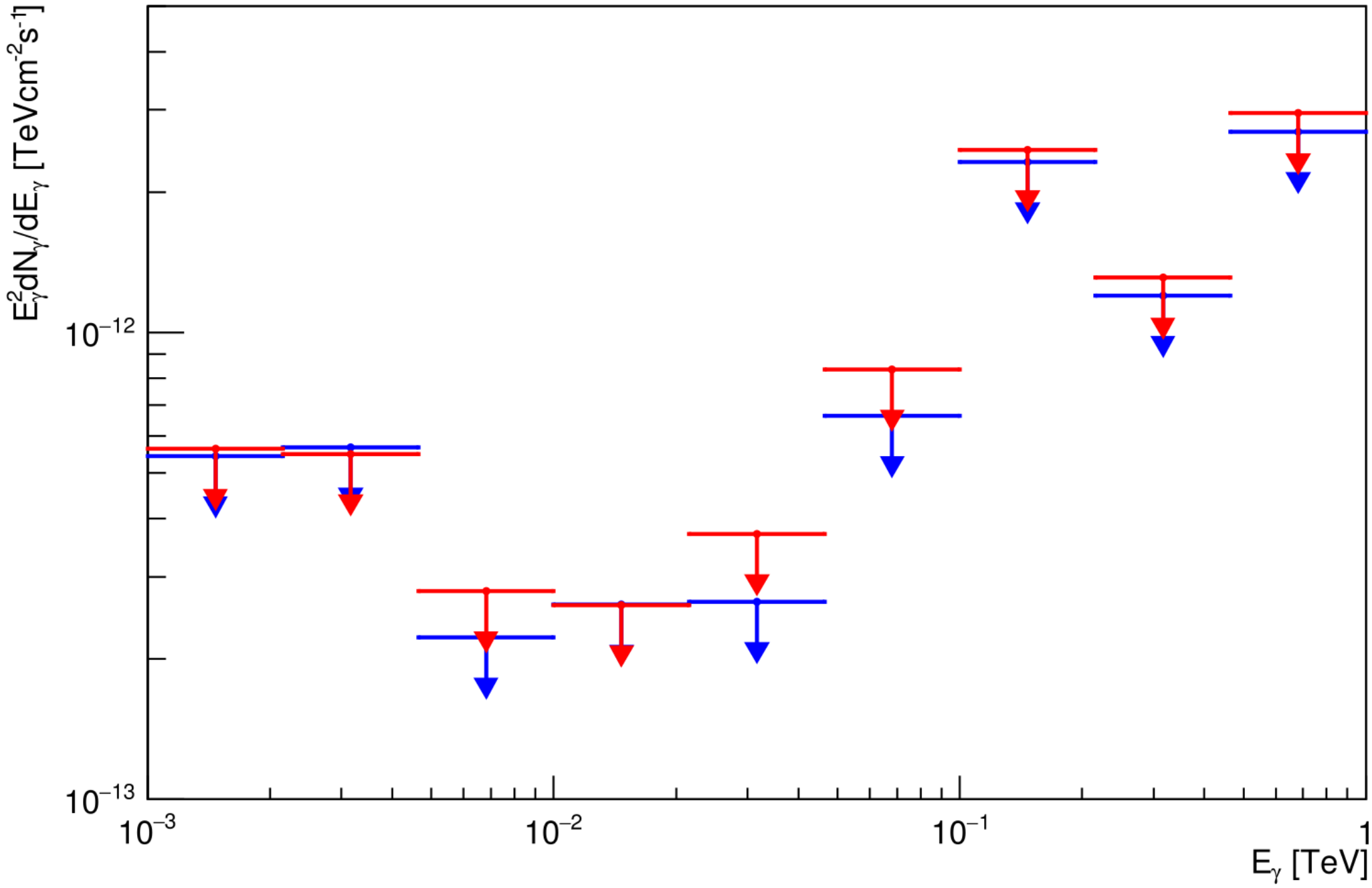
# Fermi-LAT count map and excess map for E>10 GeV



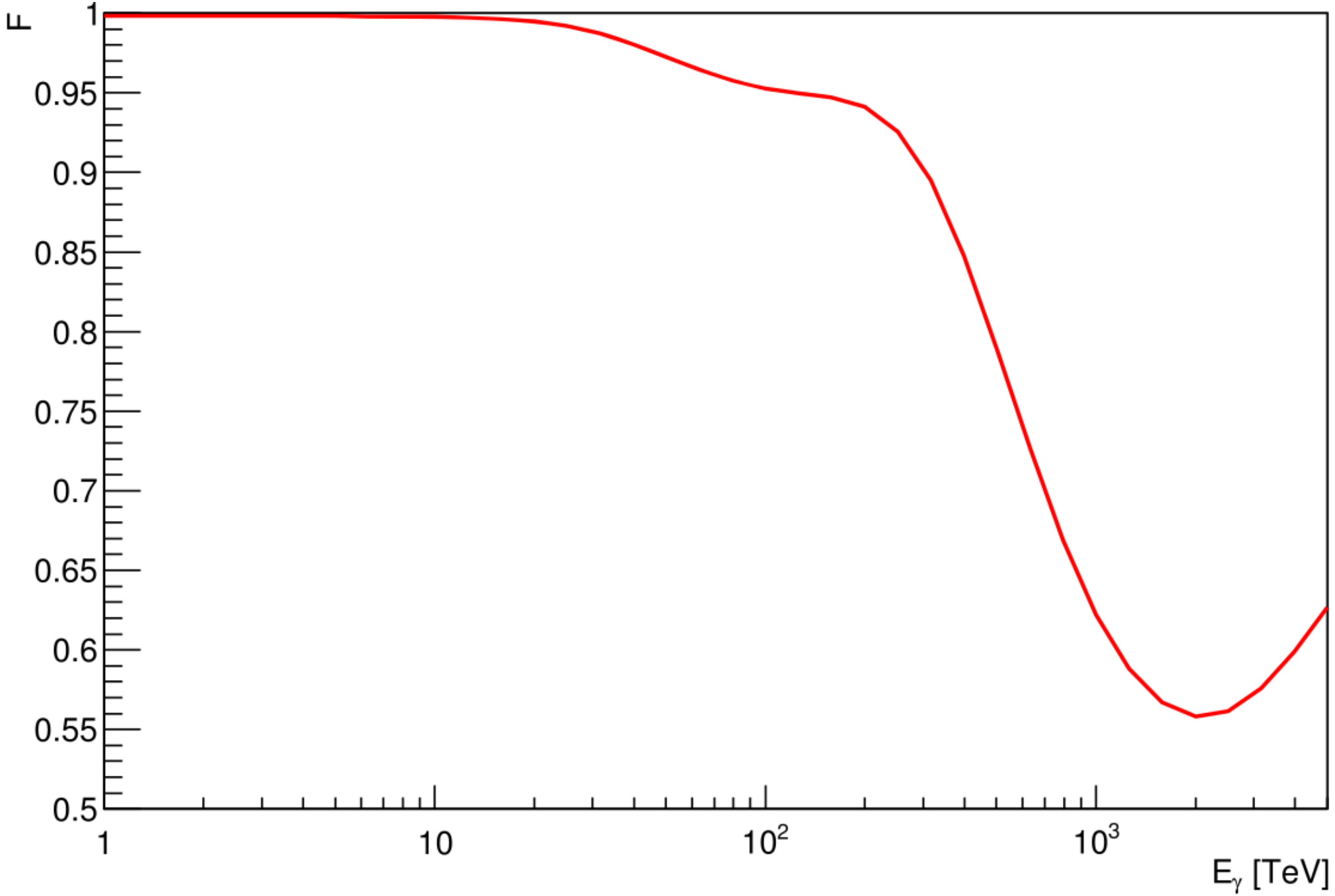

no excess of γ rays; even a small deficit!

"there might be a systematic shift of about 0°.2 in the HAWC J1825-134 source position. To ensure that this systematic error does not modify the negative result of our search, we also performed the source localization procedure using the fermipy.GTAnalysis.localize method searching for a better position of the source in question inside the 0°.5 square with the center coinciding with the ROI center. This search yielded negative results."

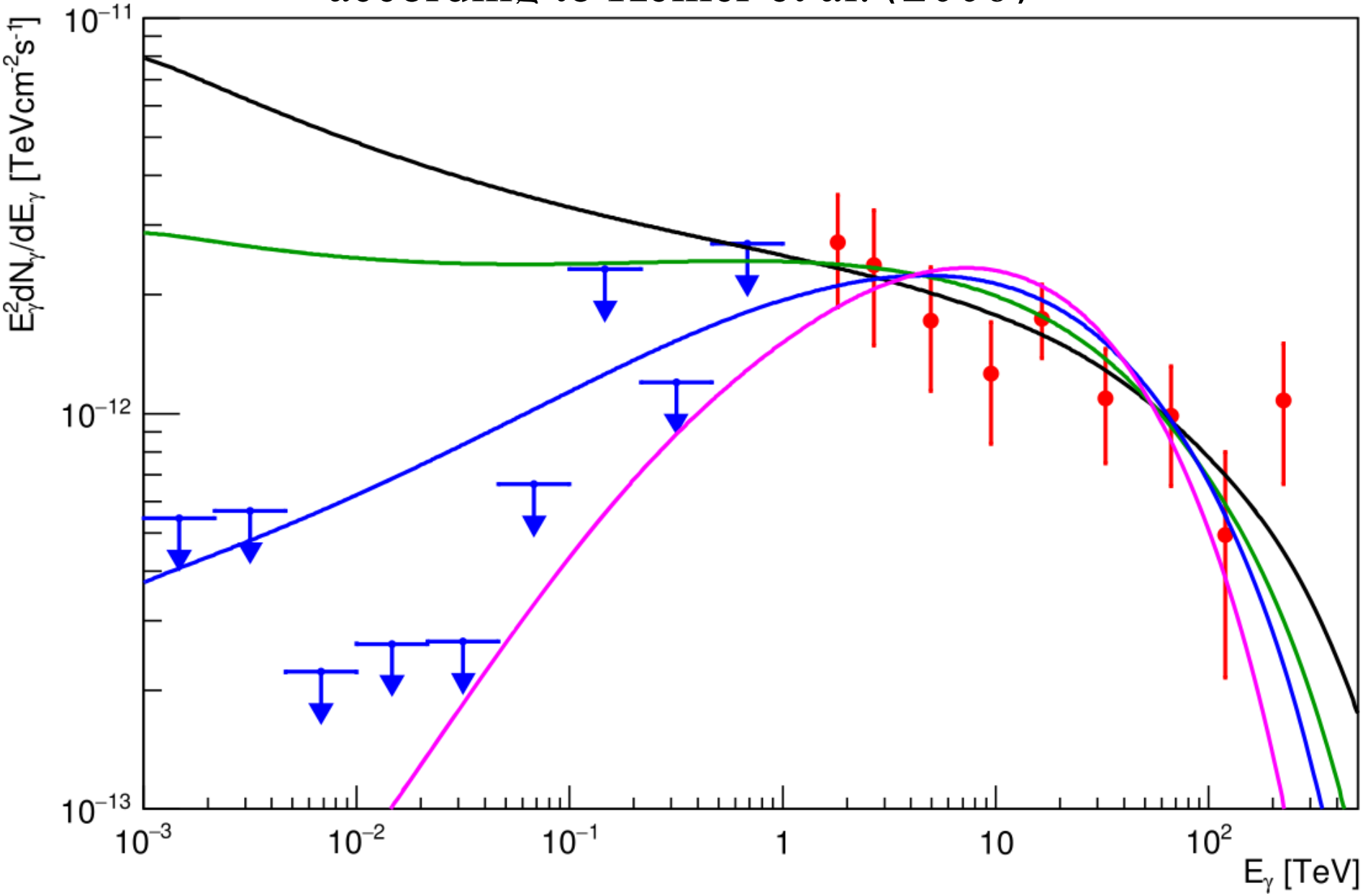
# Upper limits on the γ ray SED from Fermi-LAT:
point-like source; extended (R= 0°.18) source



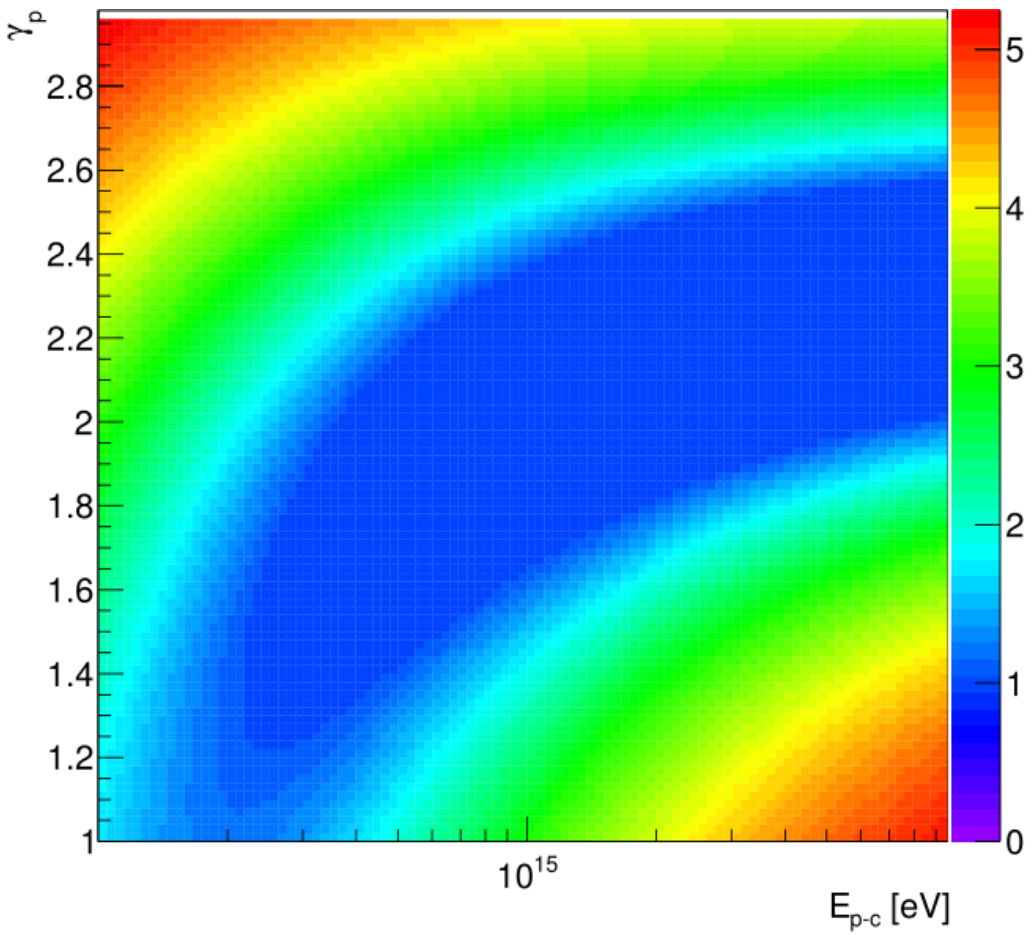
# γγ absorption: survival factor vs. the energy assuming the model of Vernetto & Lipari (2016)

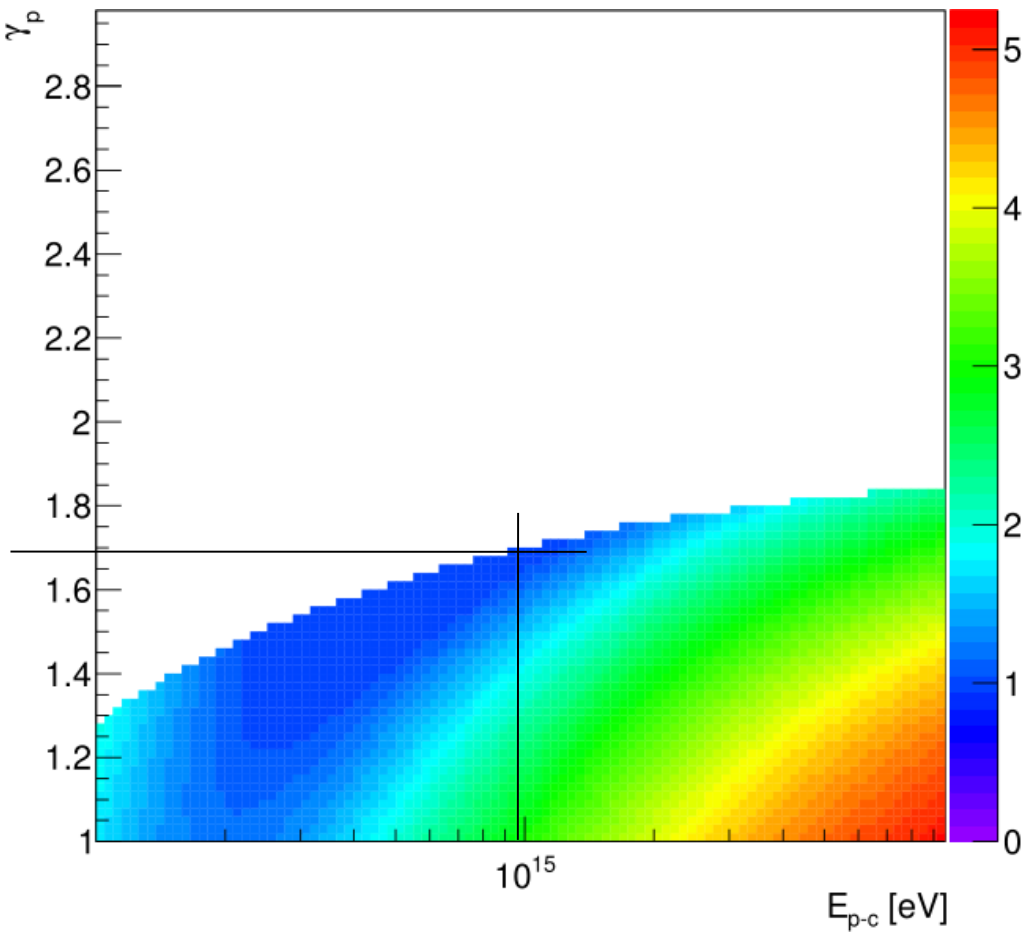


Model curves calculated for various proton spectrum parameters: (γ_{p},E_{p-c})= (2.2, 3 PeV); (2.06, 1 PeV); (1.8, 500 TeV); (1.3, 200 TeV). γ rays from pp interactions according to Kelner et al. (2006)



# Exclusion significance using HAWC data only (left); HAWC+Fermi-LAT data (right)




only very hard proton spectra satisfy both HAWC measurements and Fermi-LAT upper limits

# Conclusions

1. HAWC J1825-134 is an unique, relatively bright γ-ray source, a very good candidate for a hadronic PeVatron.

2. Fermi-LAT upper limits were set by us in the 1 GeV – 1 TeV energy domain.

3. Only a very hard ($\gamma_{p}<1.7$) primary proton spectrum at $E_{p}<10$ TeV describes the Fermi-LAT data set well.

4. Such hard spectra at low energies may serve as a spectral signature for hadronic PeVatrons in the Galaxy.