Do blazars have additional spectral components in the TeV band?

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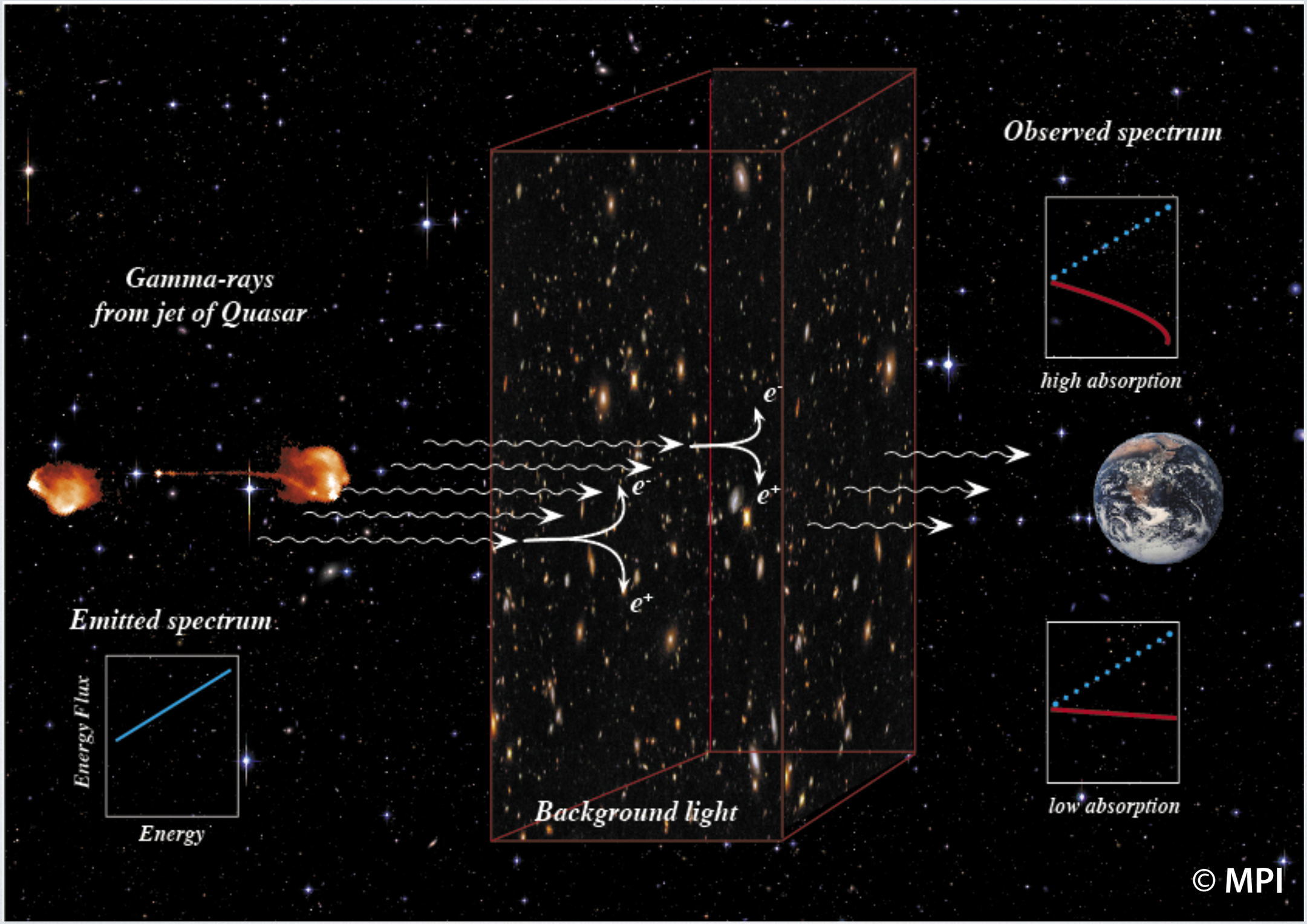
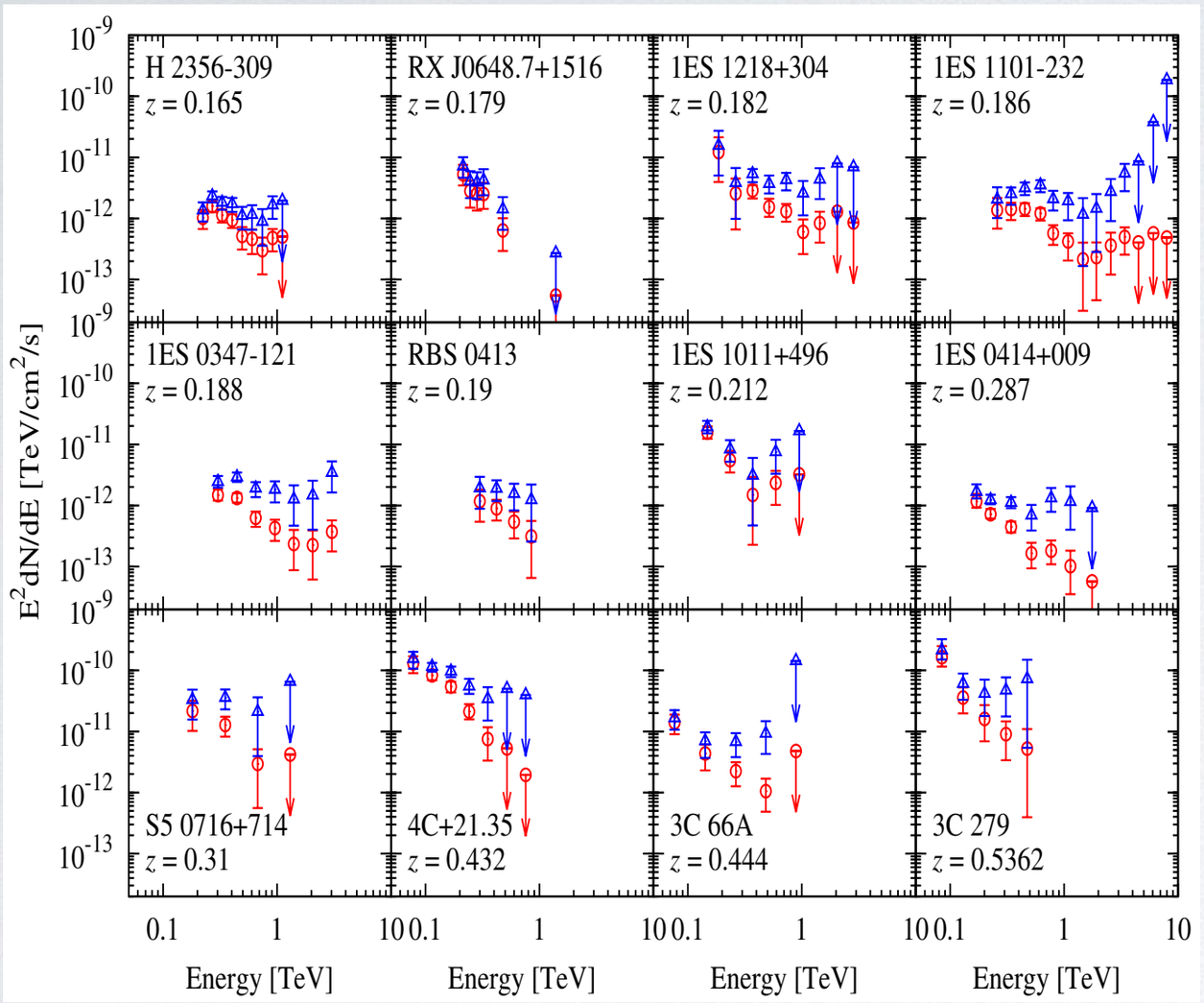
Gamma-ray Attenuation by Cosmic Optical & Infrared Background

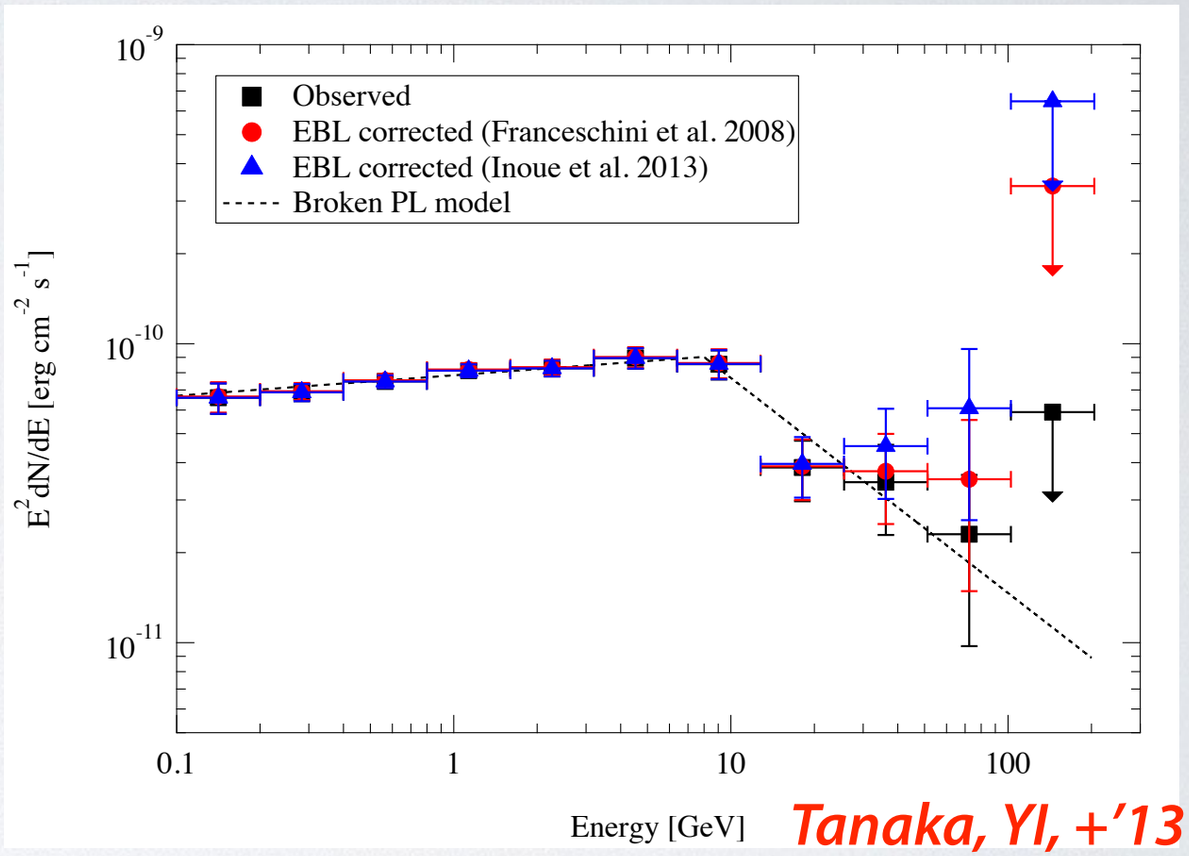


Spectral hardening at the TeV band?



YI+'13a

PKS 0426-380 @ z = 1.1
The most distant VHE blazar



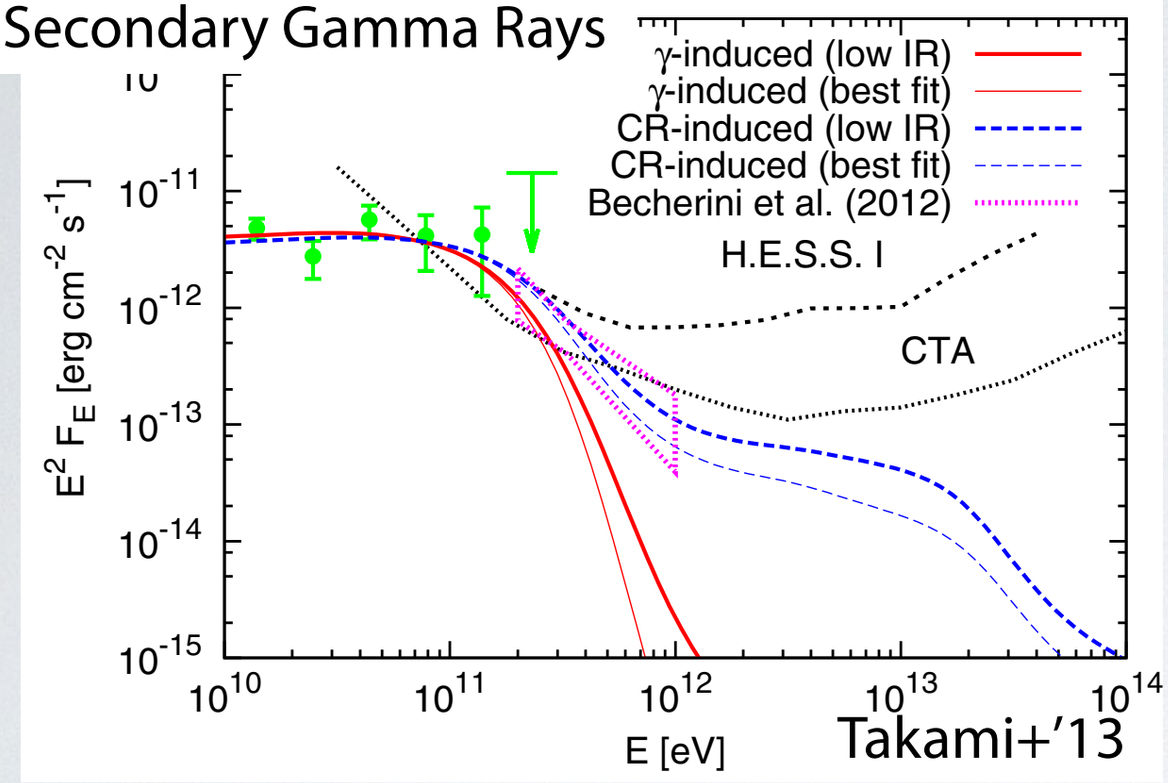
Tanaka, YI, +'13

- Spectra of TeV blazars seem to show hardening.
- It is also known that Cen A has a new spectral component at TeV.

What is the origin of the hardening?

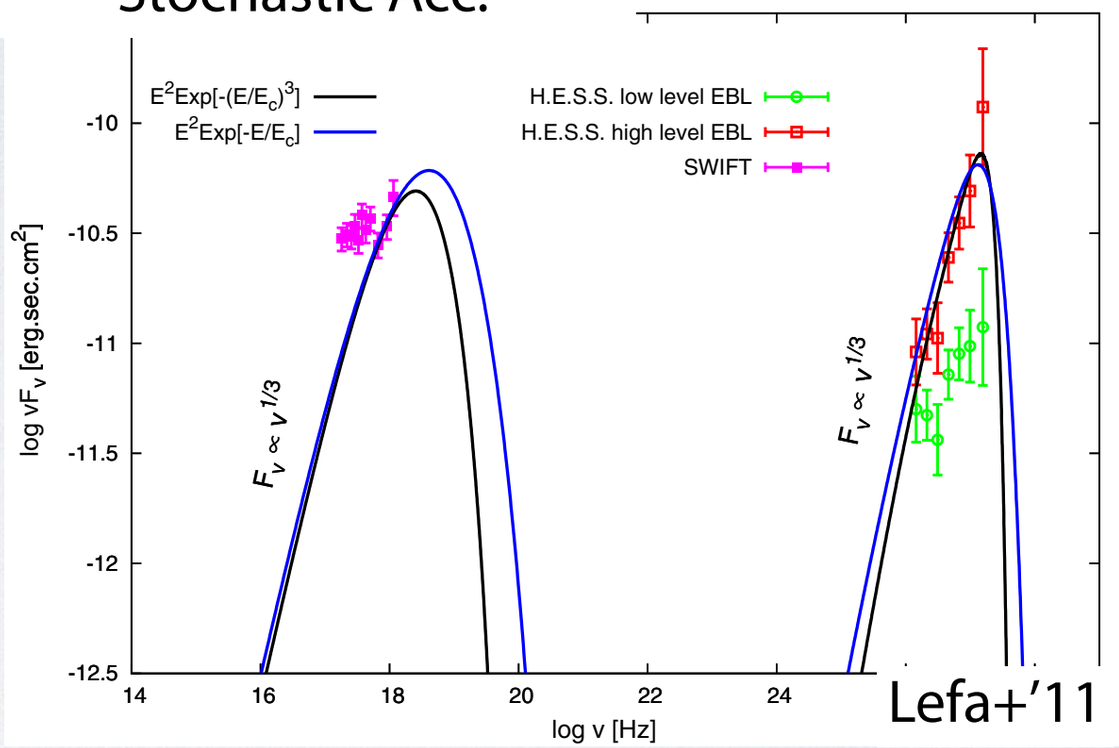
KUV 00311-1938 (z=0.61)

Secondary Gamma Rays



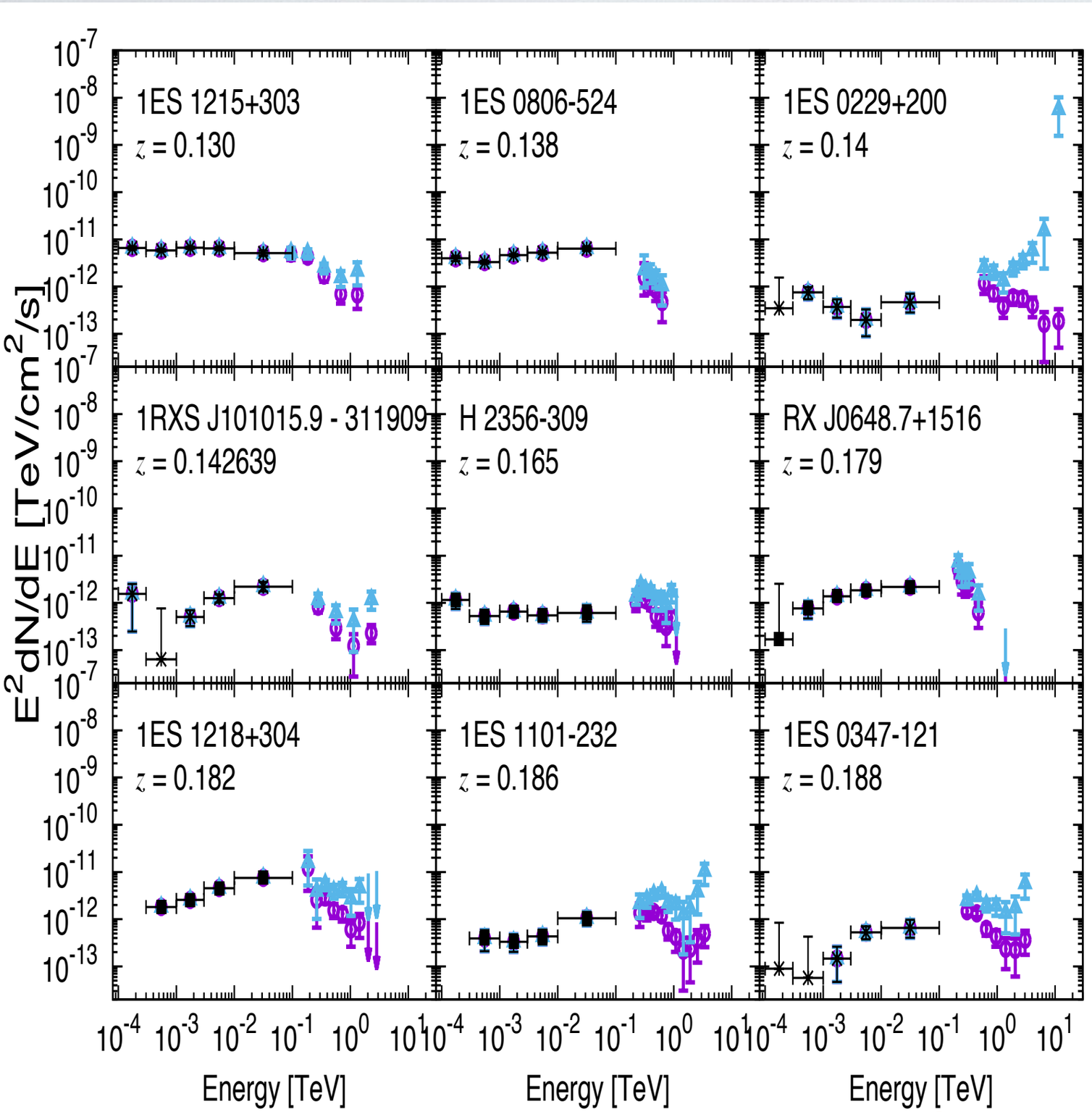
1ES 0229+200 (z=0.1396)

Stochastic Acc.



- Secondary gamma rays from cosmic rays along line of sight (Essey & Kusenko '10, Essey+'10, Essey+'11, Murase+'12, Takami+'13, YI+'14b).
  - Observed GeV-TeV photon index dependence on redshift will be different from simple CIB attenuation. There should also be additional spectral components in the TeV band.
- Stochastic acceleration (Stawarz & Petrosian '08, Lefa+'11).
- Lepto-hadronic emission (Cerutti+'14).

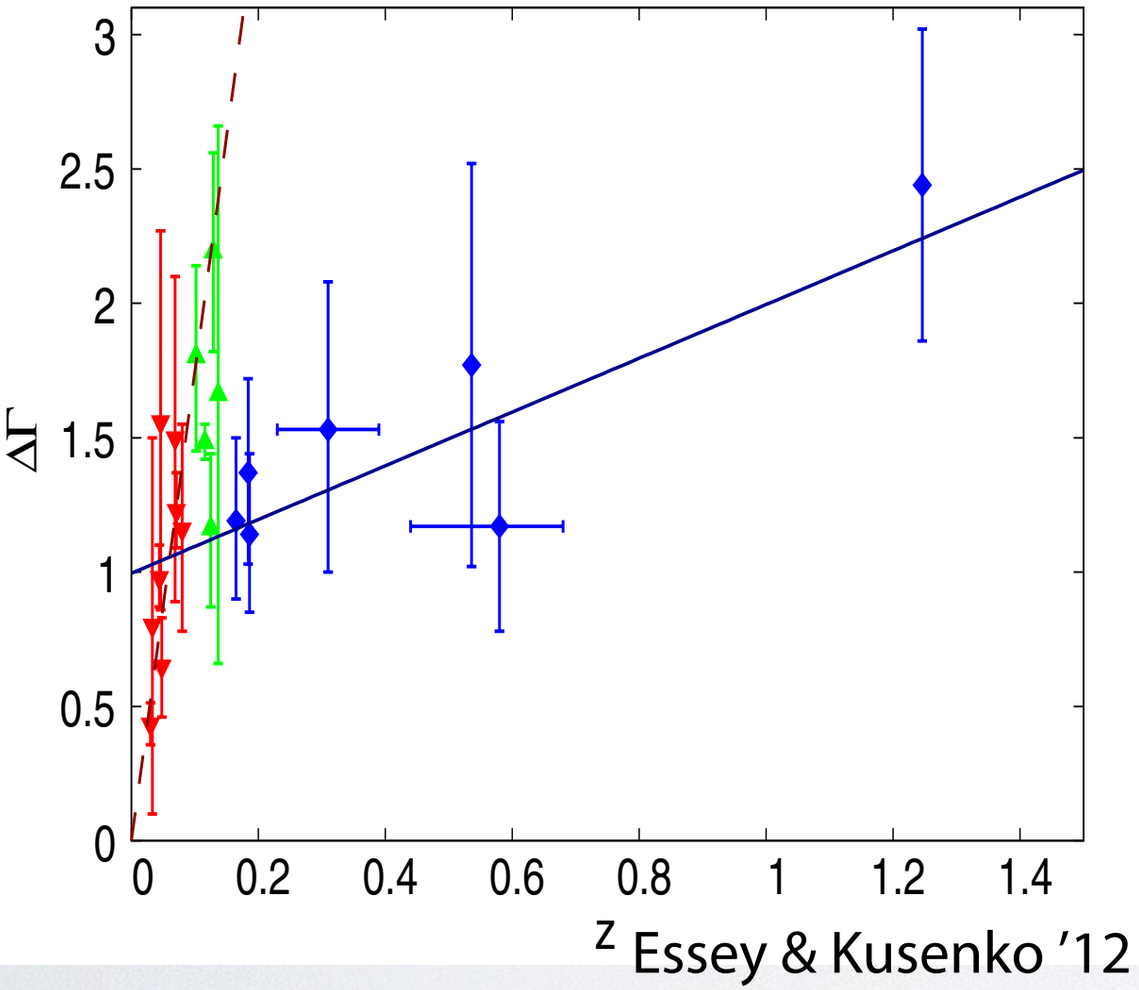
TeV blazar sample

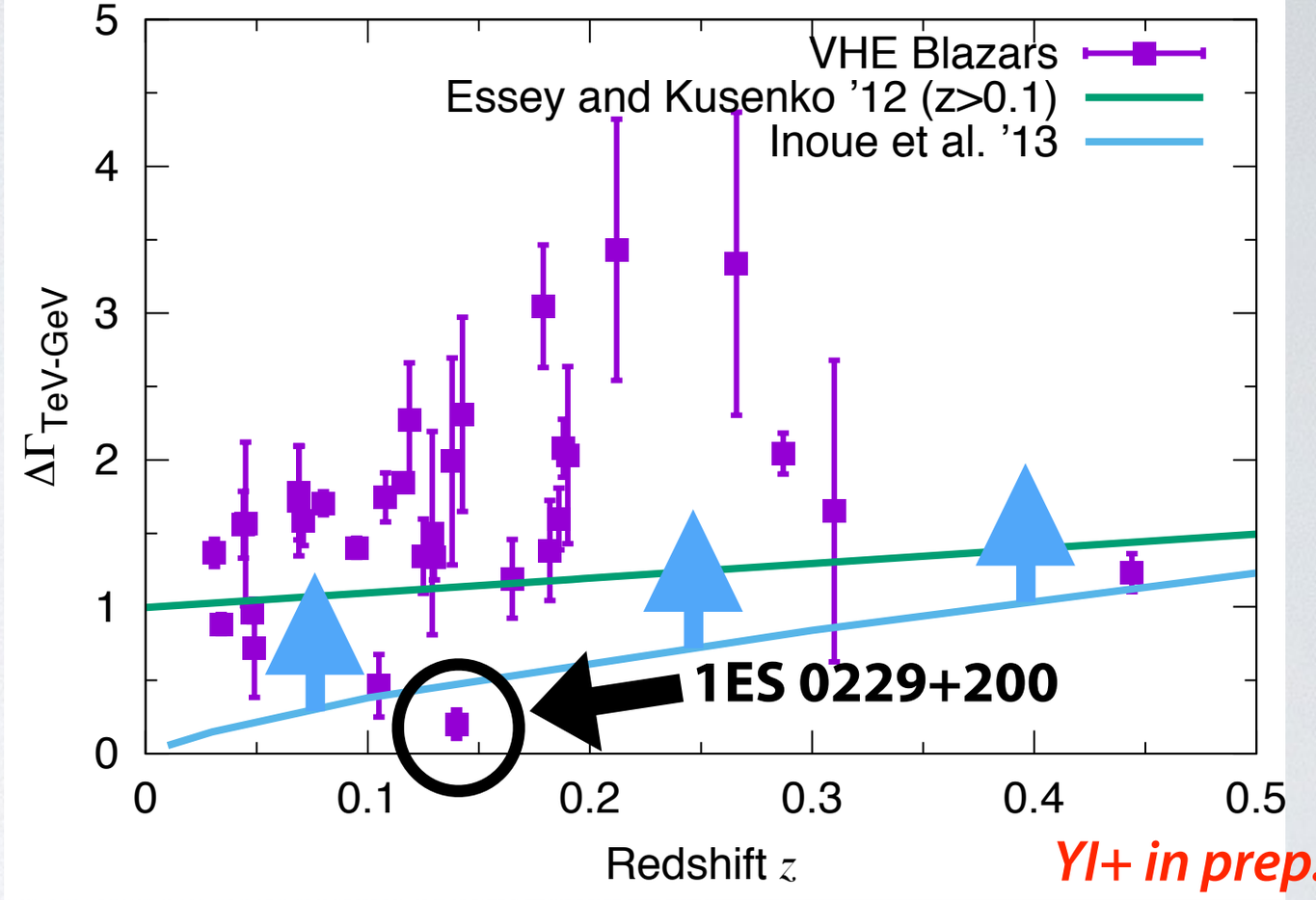


YI & Tanaka in prep.

- Select 36 blazars with z from the default TeVcat catalog.
- Low-state data are available for 31/36.
- 3FGL SED data.
- CIB correction by YI +'13.
- Systematic parameter study w/ MWL data is also on-going.

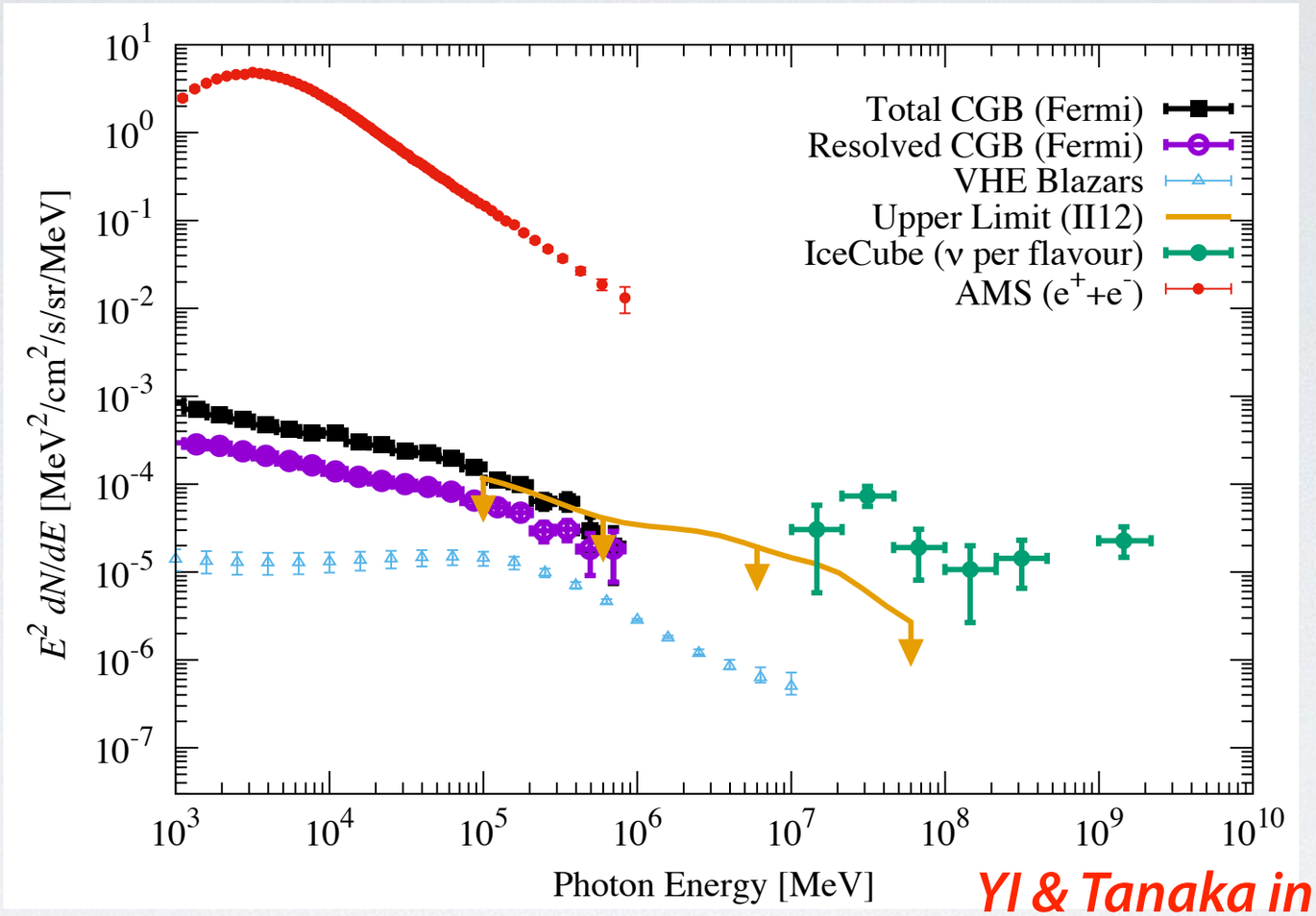
GeV-TeV index dependence on redshift





- there is no clear signature supporting the secondary gamma-ray scenario.
  - no significant correlation for z>0.1.
  - But, 1ES 0229+200 seems to be peculiar.
- additional components at TeV band are not significantly seen via F-test. No sources with P(F)<0.05.

Cosmic TeV Gamma-ray Background



YI & Tanaka in prep.

- These TeV data give lower limit on to the cosmic gamma-ray background.
  - Current limit at 0.3-10 TeV is

$$3\times10^{-5}\left(\frac{E}{100\mathrm{GeV}}\right)^{-1}\ [\mathrm{MeV/cm^2/s/sr}] < E^2\frac{dN}{dE} < 5\times10^{-5}\left(\frac{E}{100\mathrm{GeV}}\right)^{-0.7}\ [\mathrm{MeV/cm^2/s/sr}]$$

- Fermi has resolved more portion of the TeV sky than IACTs do?
- Need to remove ~3 orders higher electron background to detect the CGB with CTA.

Summary

- We use 31 TeV blazar samples from TeVcat together with the Fermi 3FGL data.

- GeV - TeV index distribution has no correlation and no significant evidence for the secondary gamma-ray scenario

- Resolved cosmic TeV gamma-ray background fluxes by IACTs is lower than that resolved by Fermi.

- To measure the cosmic TeV gamma-ray background, CTA needs to remove ~3 orders of magnitude higher electron background.