The Third Catalog of Hard Fermi-LAT Sources (3FHL)

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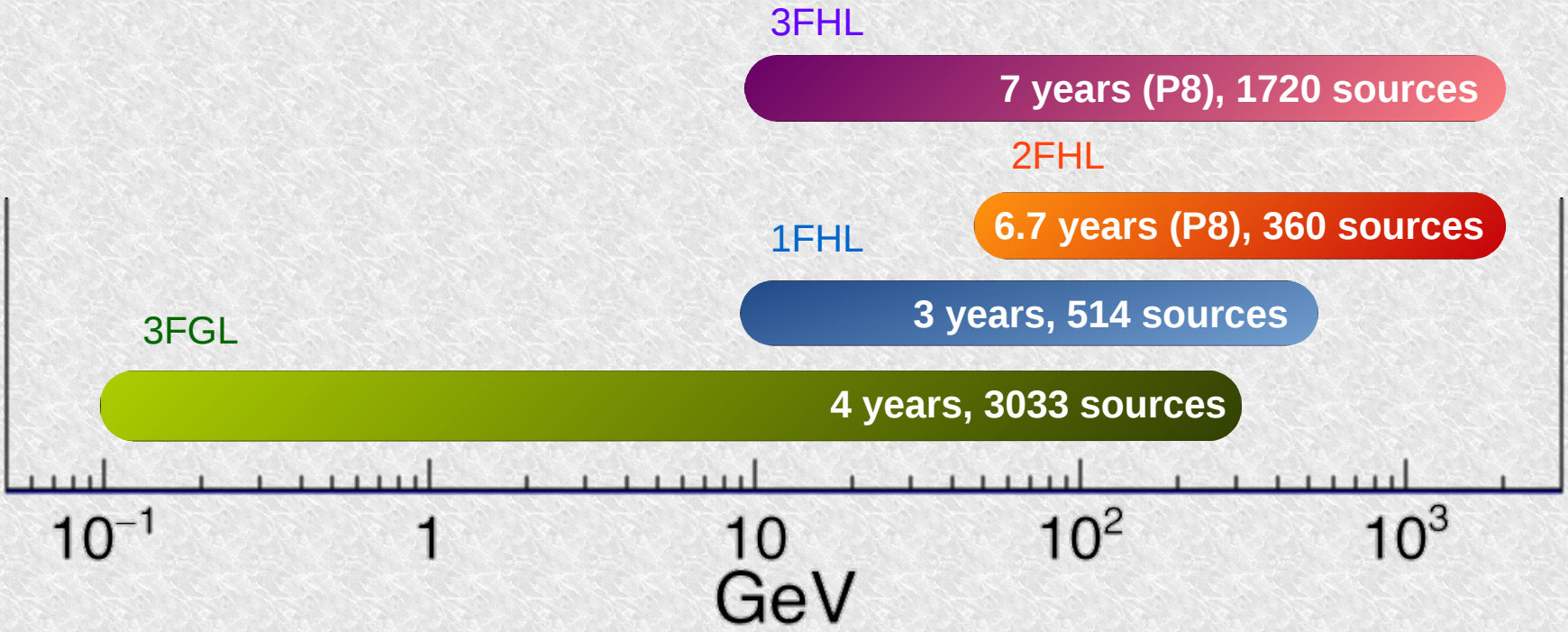
Fermi-LAT Catalogs

***n*FGL Catalogs detect and characterize sources in the ~0.1-300 GeV energy range**

***n*FHL Catalogs explore the higher-energy sky**



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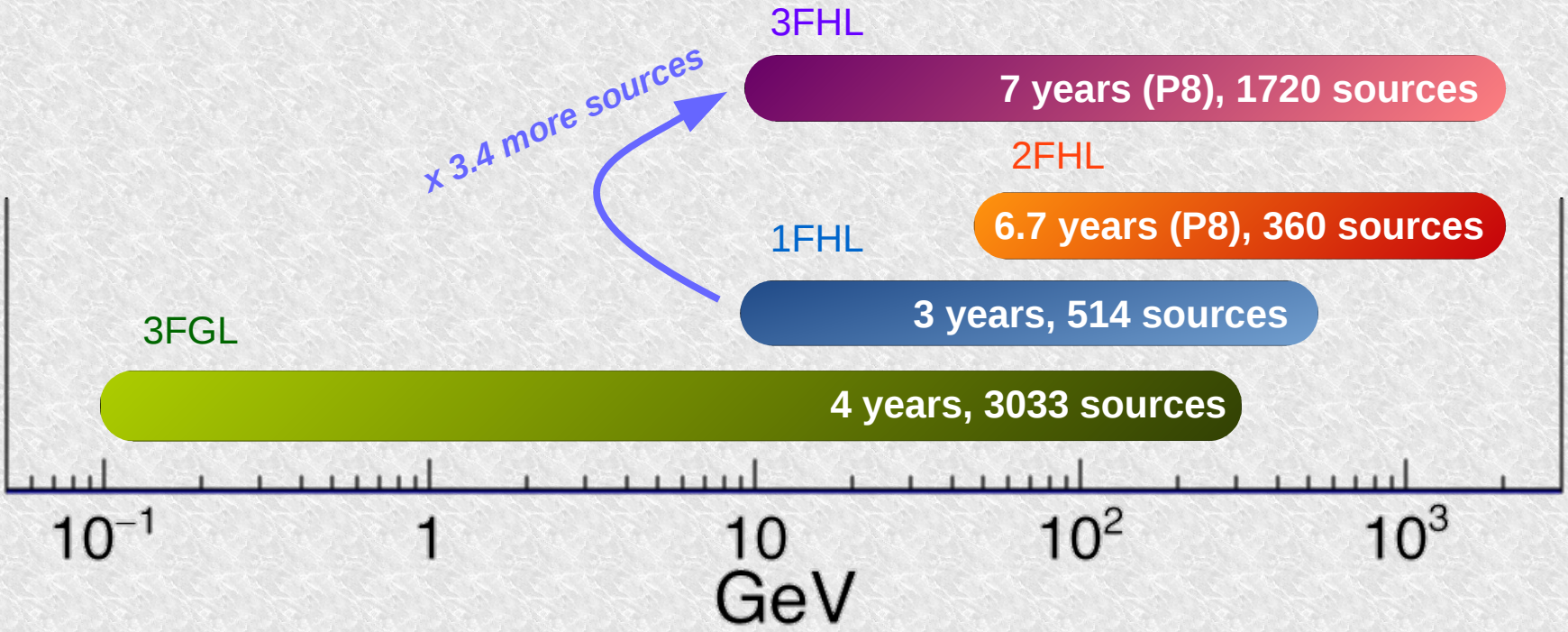
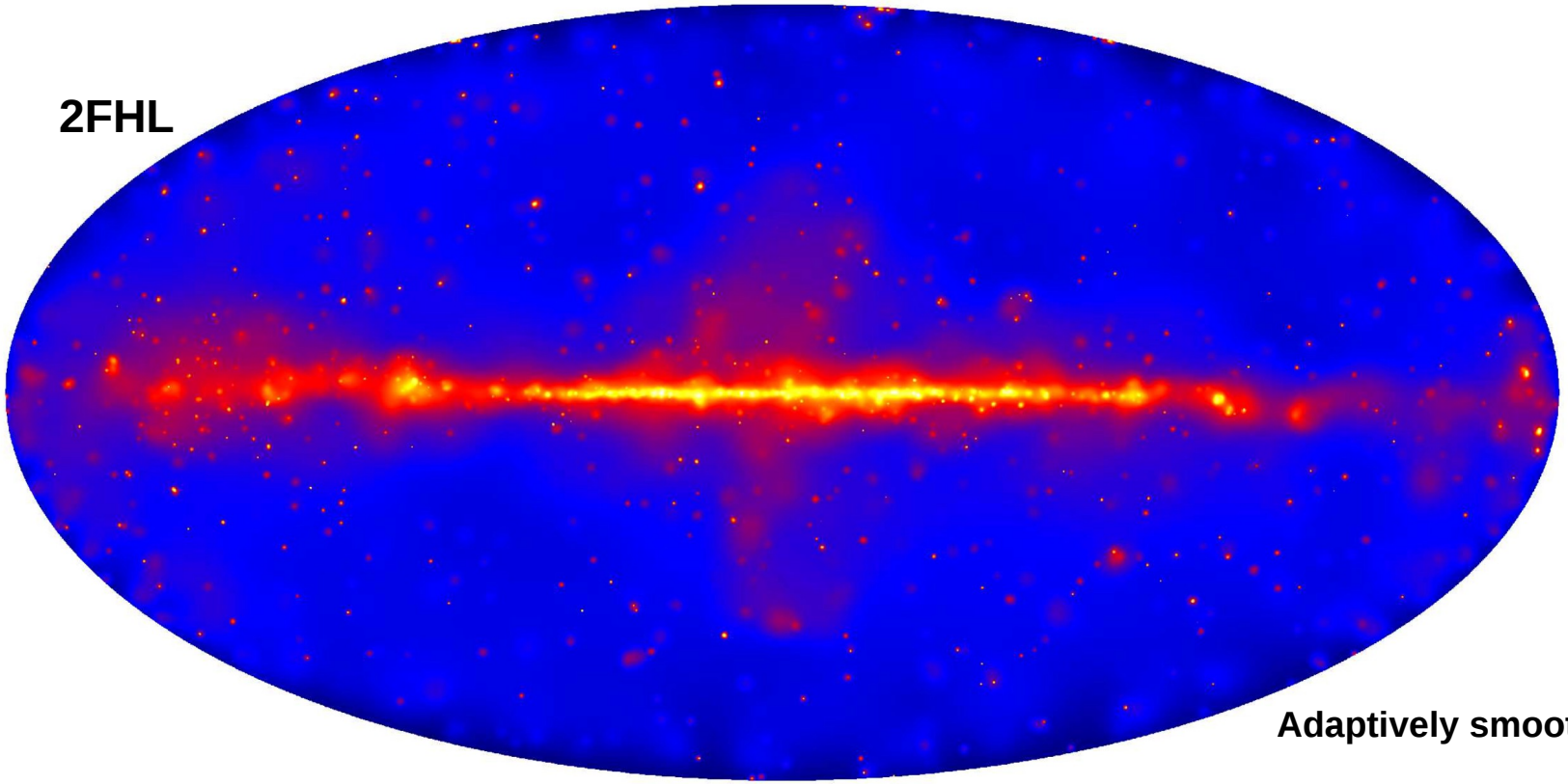
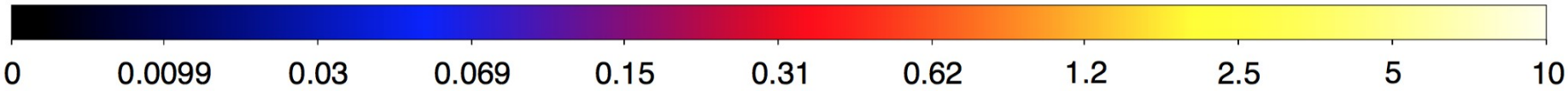


The 2FHL Sky: Count Map

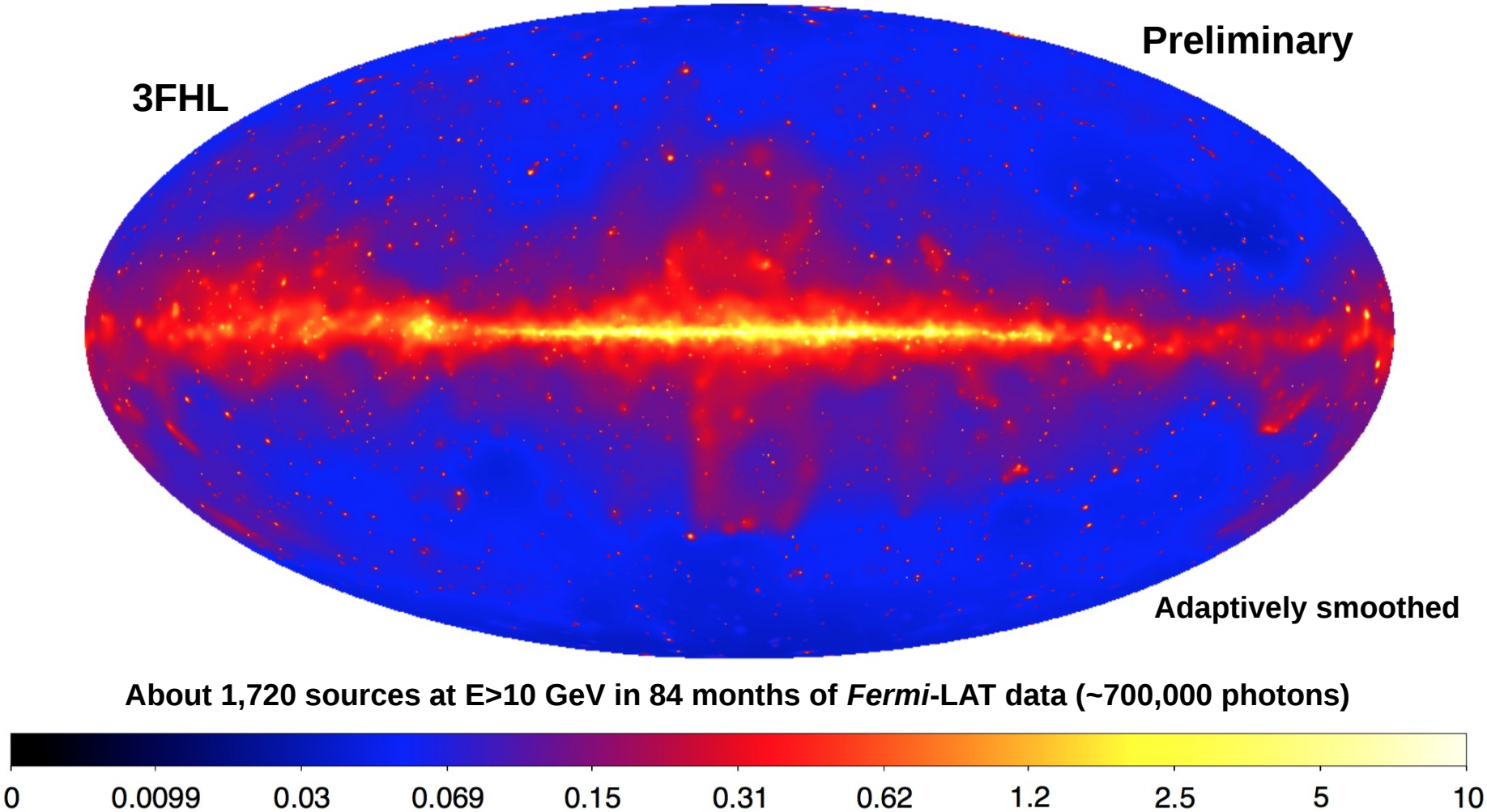


360 sources at E>50 GeV in 80 months of *Fermi*-LAT data (~61,000 photons)



Ackermann et al. (2016)

The 3FHL Sky: Count Map

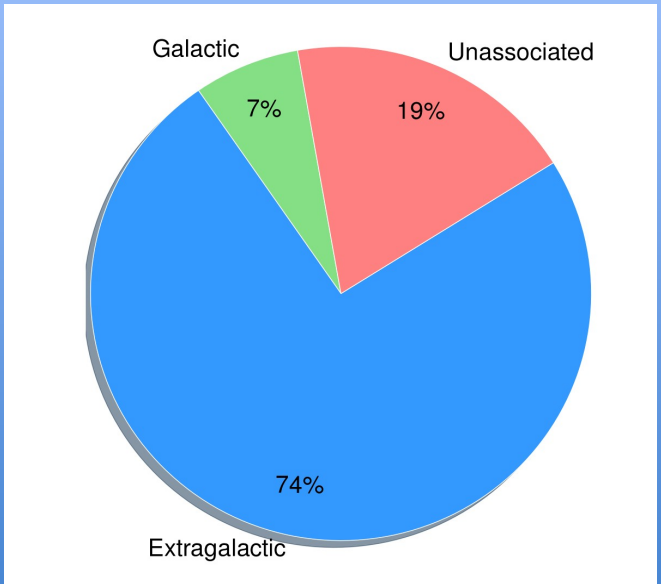


About 1,720 sources at E>10 GeV in 84 months of *Fermi*-LAT data (~700,000 photons)

The 3FHL Catalog

- **Analysis details**
  - 10 GeV – 2 TeV
  - 84 months of data (until August 2015)
  - Pass 8 (source)
  - PSF types
  - Unbinned likelihood
- **Detections (Preliminary!)**
  - 1720 sources (vs. 514 1FHL):
    - 74% extragalactic, 7% Galactic sources, 19% unassociated (in 1FHL 13%)
  - 54 extended sources (M. Lemoine-Goumard, J. Cohen, et al.)
  - 1308 detected in 3FGL
  - 484 detected in 1FHL
  - 323 detected in 2FHL
  - 129 detected by IACTs (TeVCat)
  - 358 brand new sources (not in 1FHL/2FHL/3FGL/TeVCat)

Associations



Preliminary

Bottom line: *plenty of sources to be followed with CTA. We find about 2 times more sources above 10 GeV than above 50 GeV at the same energy flux limit (1e-12 erg/cm2/s)*

Median localization accuracy is 2.3 arcmin in radius (95%) !

3FHL vs. 1FHL: General Comparison

Comparison Summary	1FHL (3 years+Pass7)	3FHL (7 years+Pass8)
Number of sources	514	1720
Number of extended sources	18	54
Flux above 10 GeV (ph/cm2/s)	1.29 (0.87, 2.74) x 10^-10	4.64 (3.00, 9.34) x 10^-11
Spectral Index	2.36 (2.01, 2.90)	2.15 (1.77, 2.73)
Positional Uncertainty (deg)	0.079 (0.054, 0.097)	0.037 (0.026, 0.049)
Significance	6.17 (4.71, 9.37)	6.92 (5.11, 10.72)

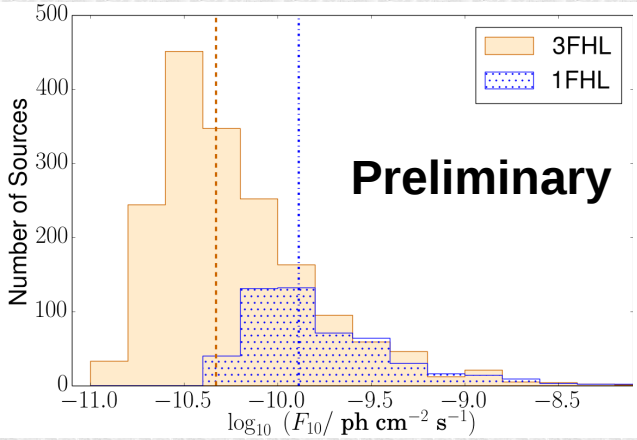
x 3.4 more sources

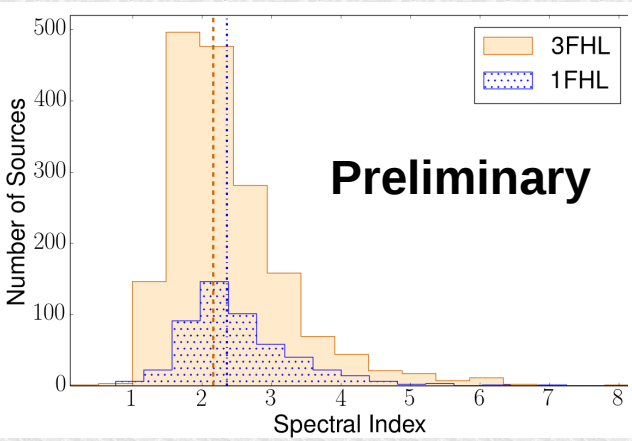
x 3 more extended sources

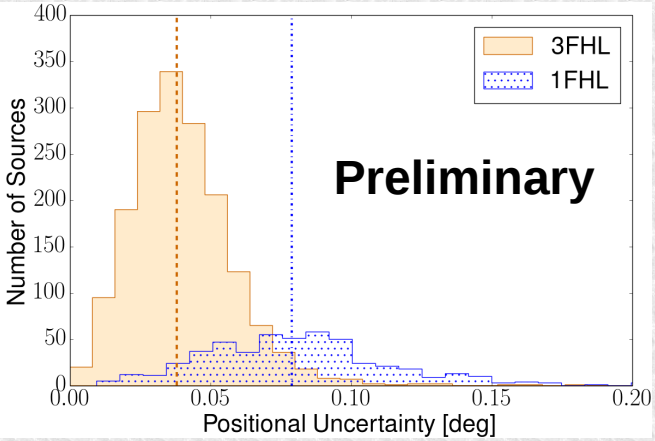
x 2.8 deeper in flux

x 2.1 better location accuracy

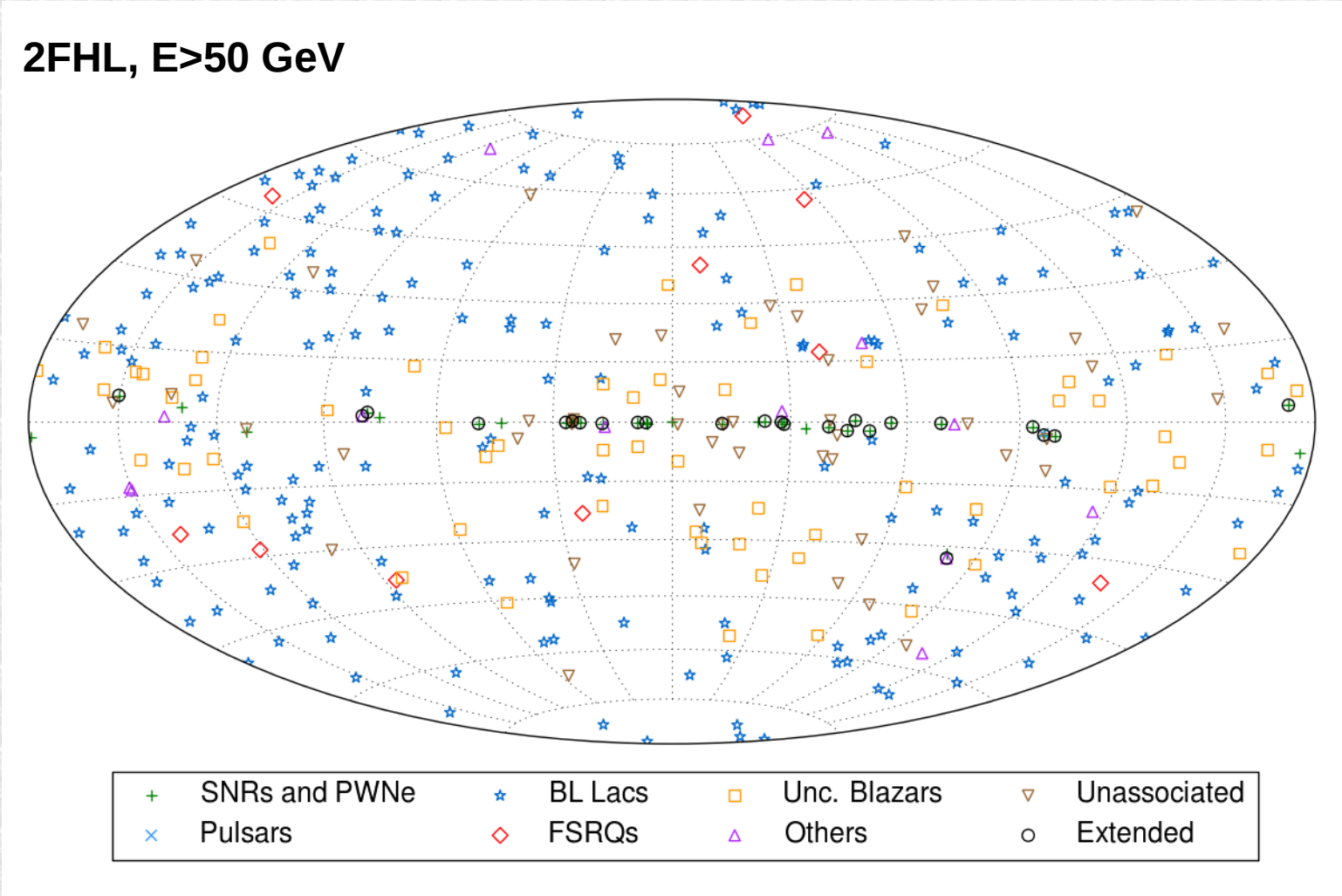
The table shows the median and the 25% and 75% quartiles







The Association Skymap



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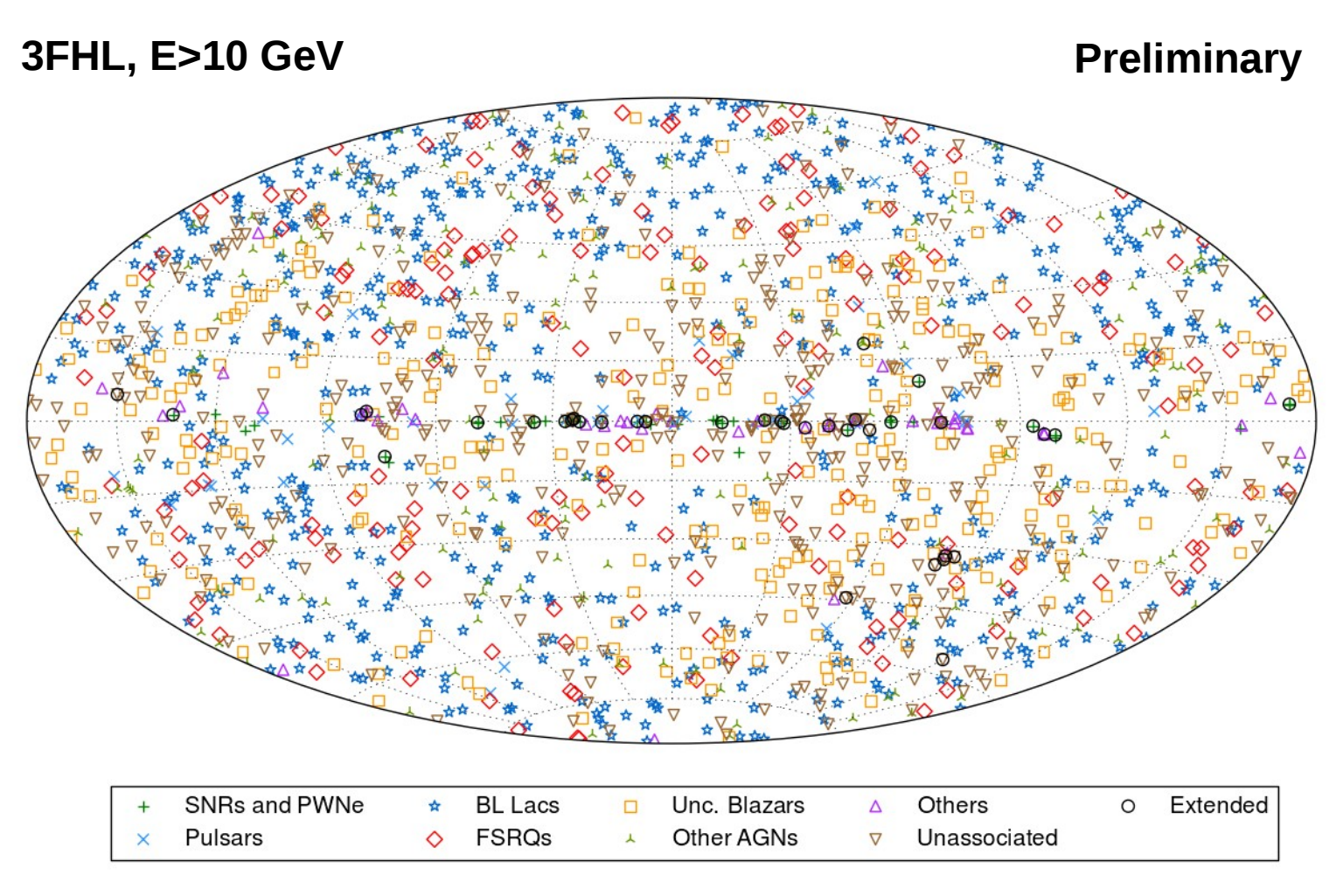
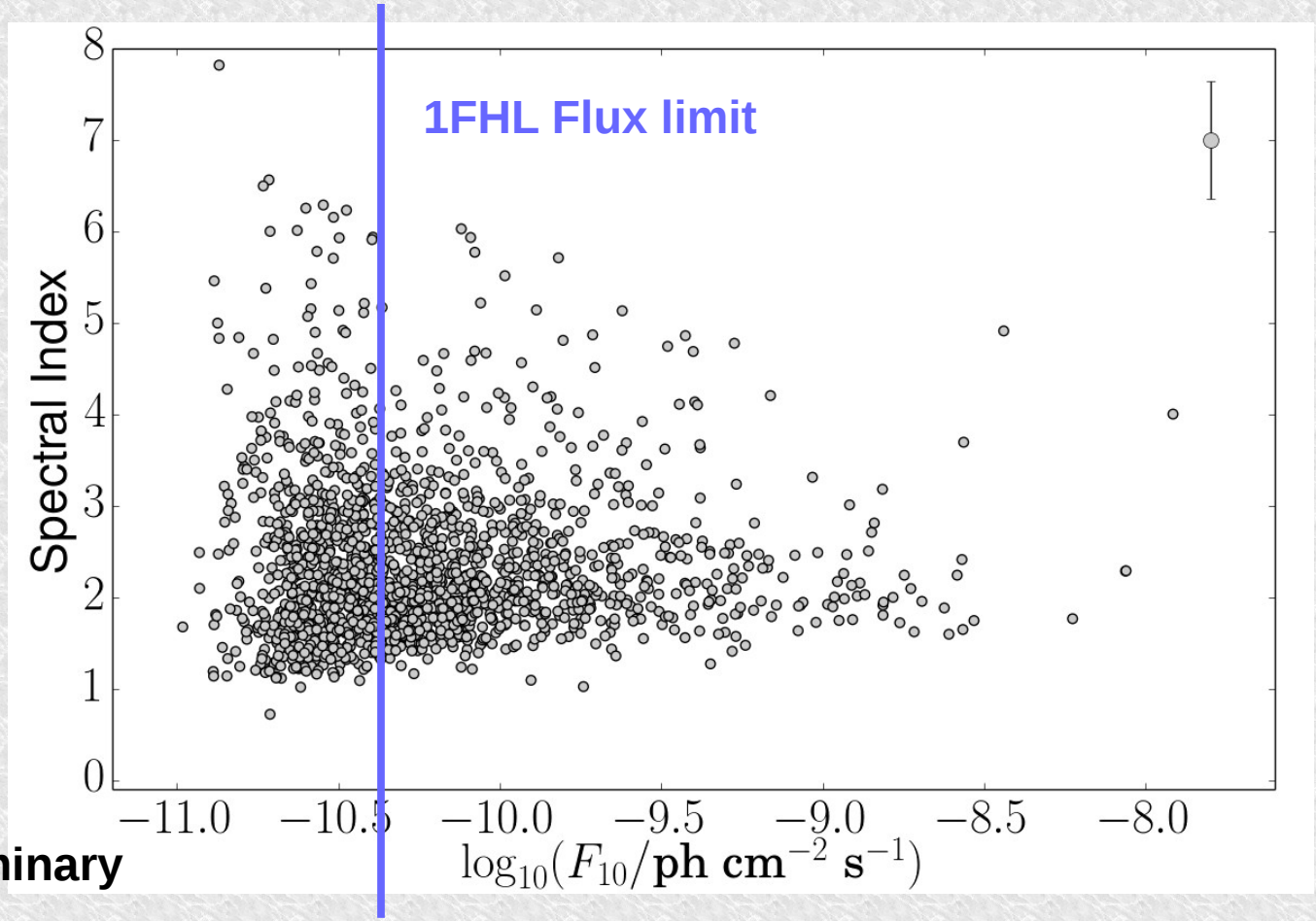


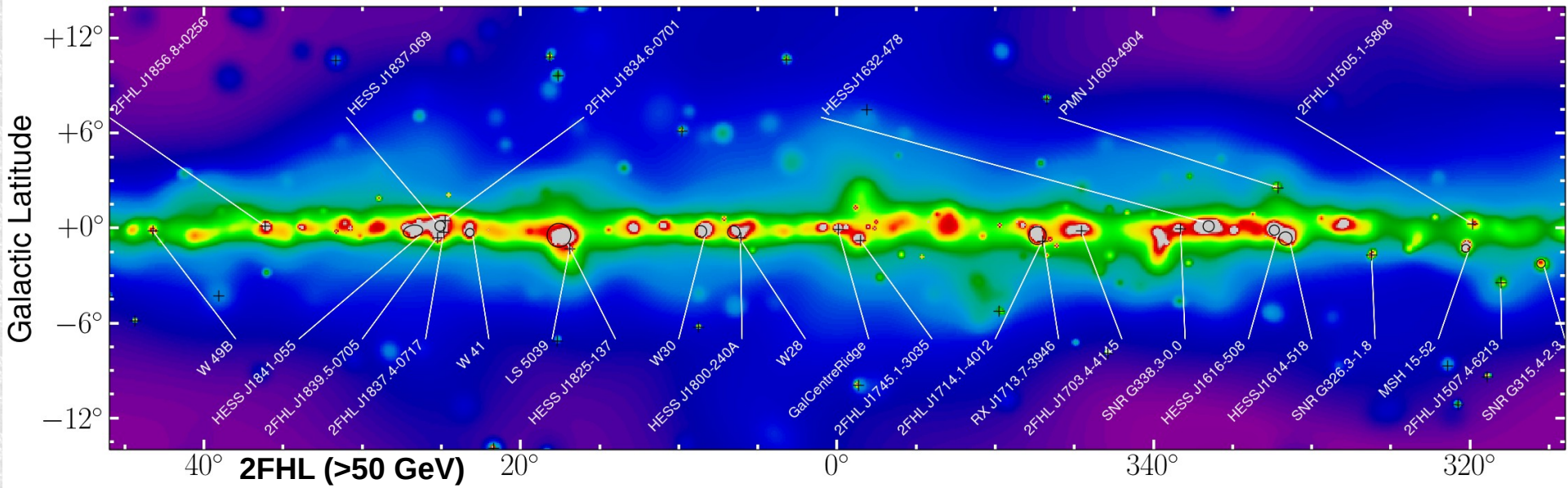
3FHL Flux Limits



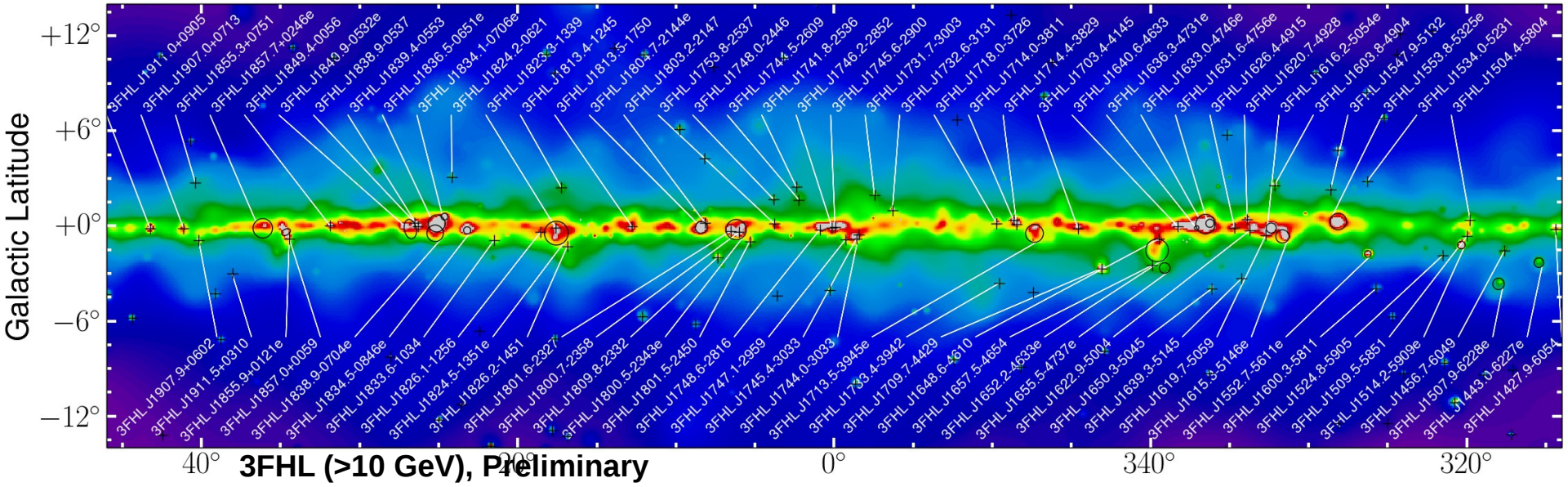
Preliminary

Spectral Index versus Integrated Flux above 10 GeV

Galactic Plane Maps

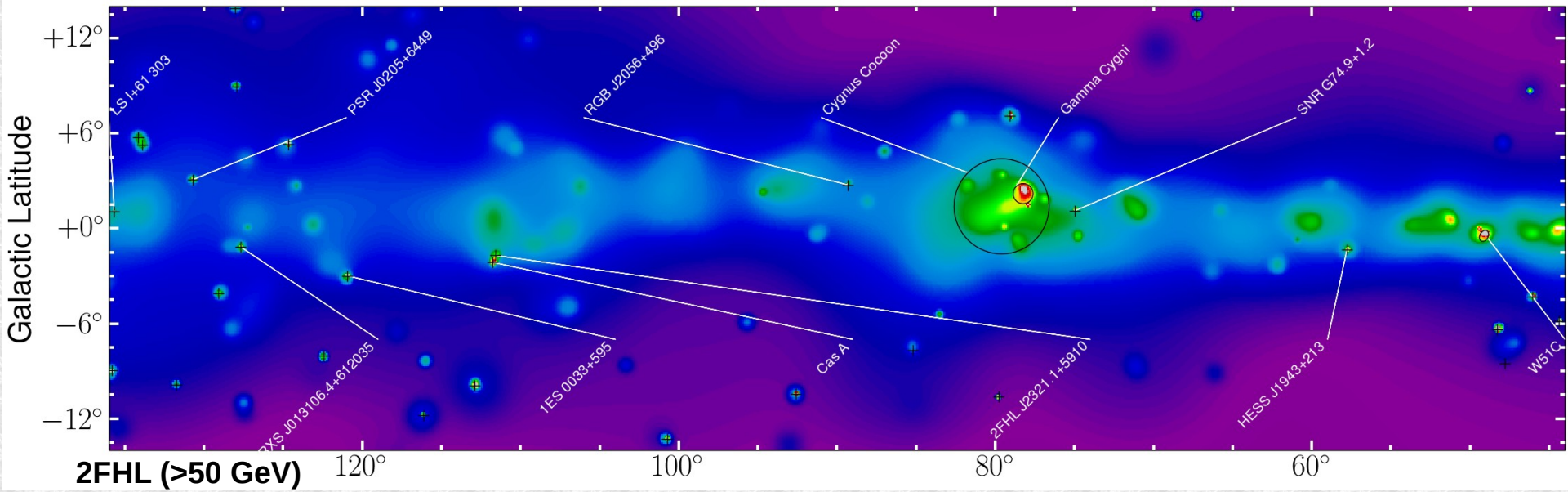


2FHL (>50 GeV)



3FHL (>10 GeV), Preliminary

Galactic Plane Maps



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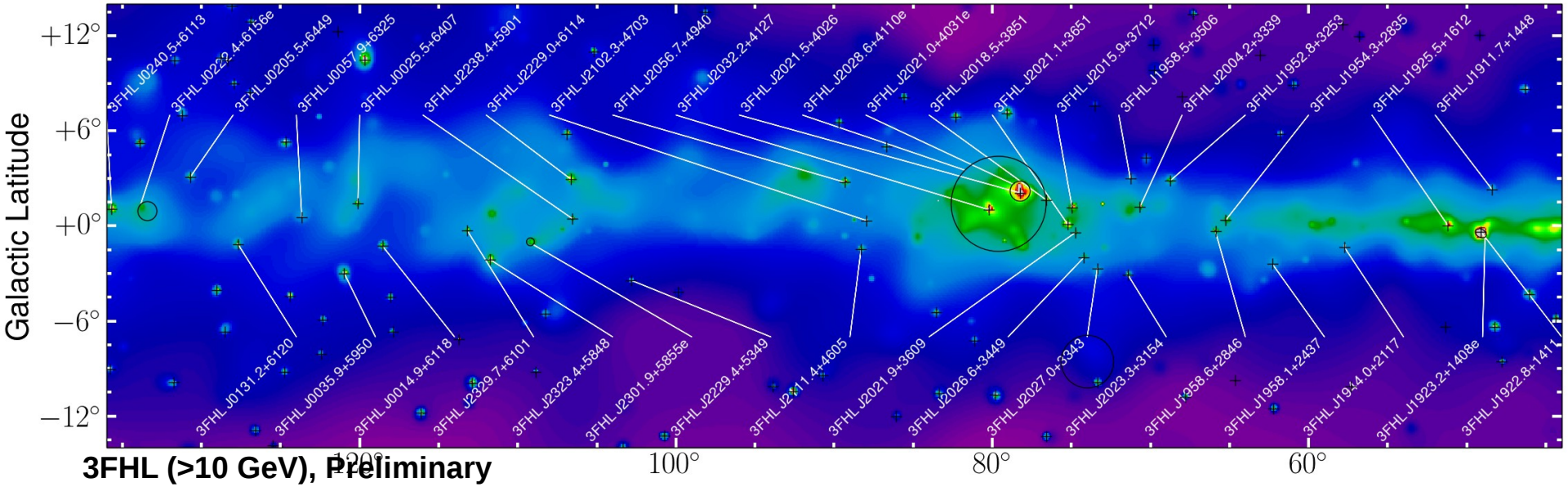
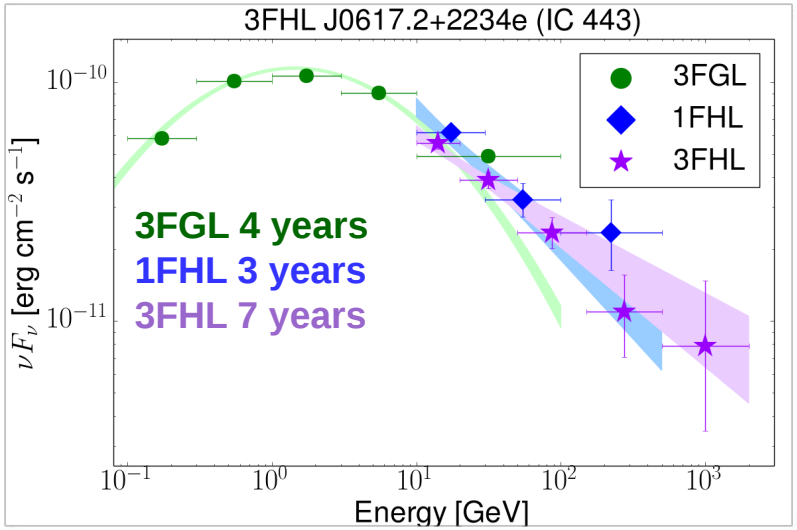
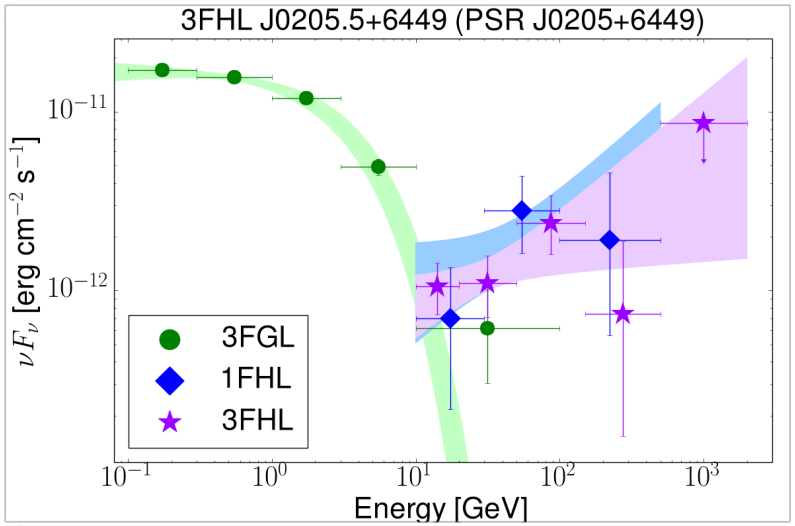


3FHL (>10 GeV), Preliminary

Spectral Energy Distributions





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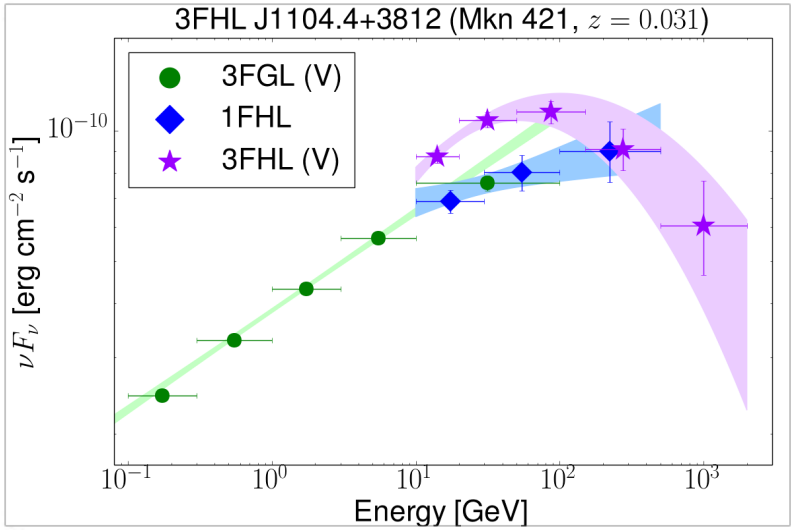
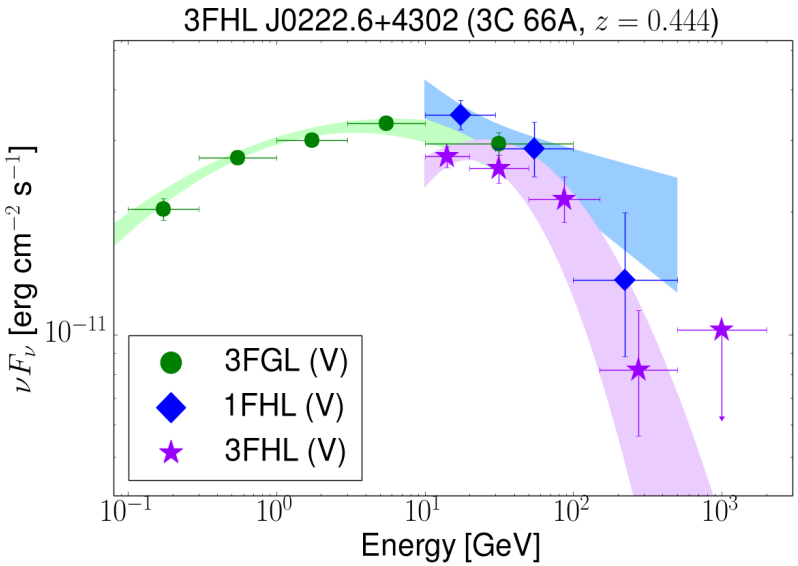
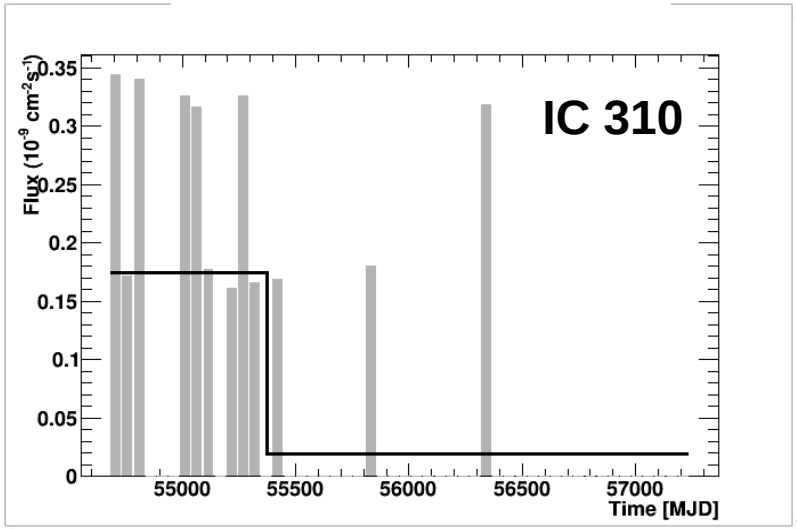
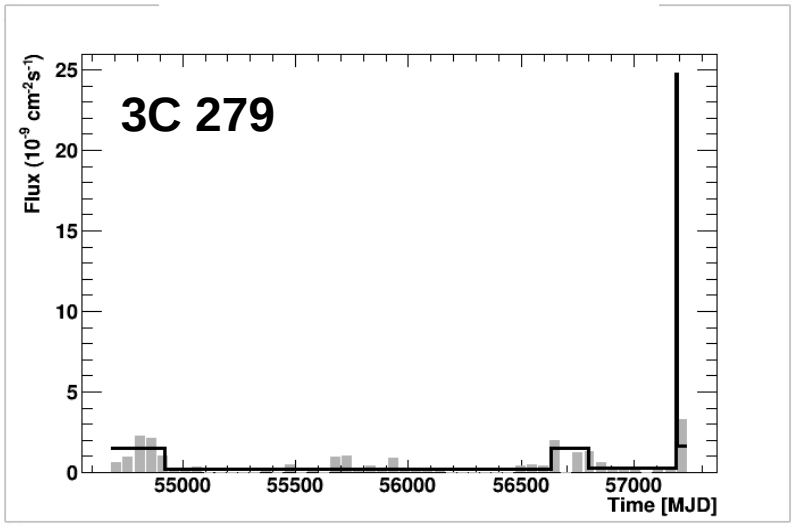




3FHL Flux Variability





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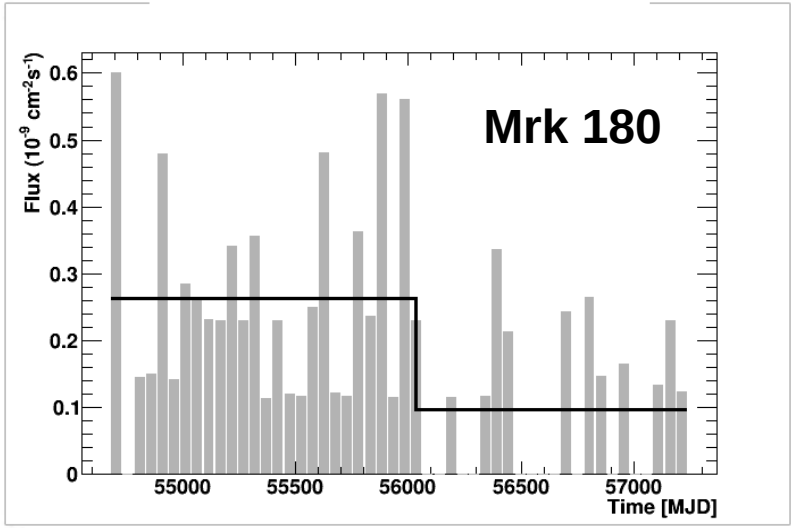
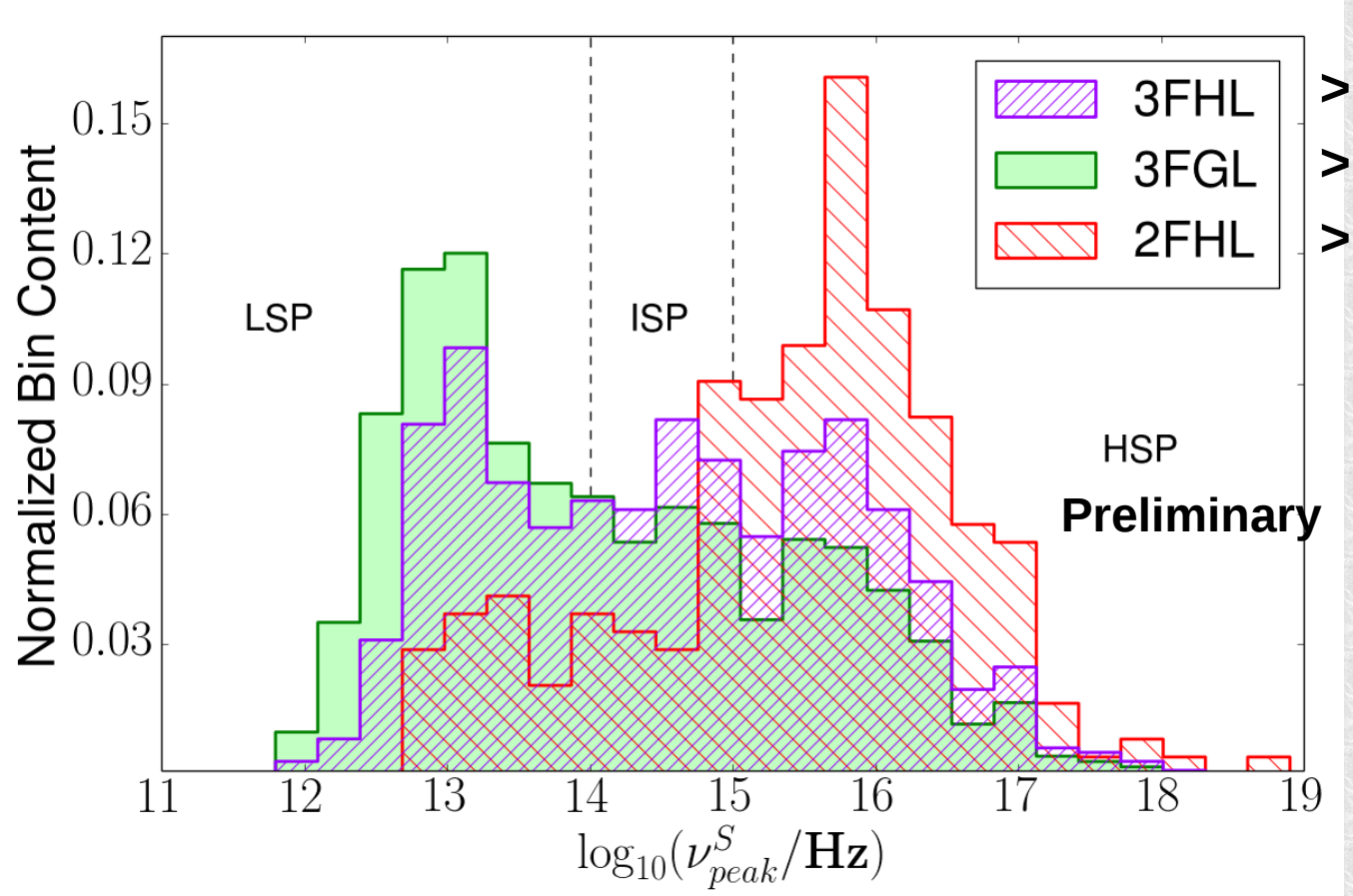


- **Bayesian Block Analysis results in 166 variable sources at E>10 GeV**
- **74 BL Lacs, 55 FSRQs, 24 BCUs, 2 RDGs, 11 unassociated**

Extragalactic Science



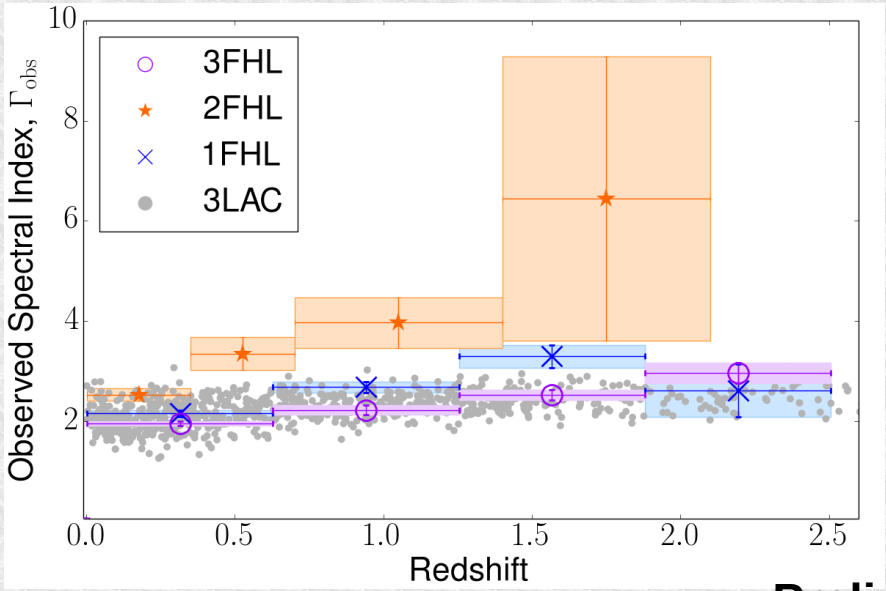
> 10 GeV

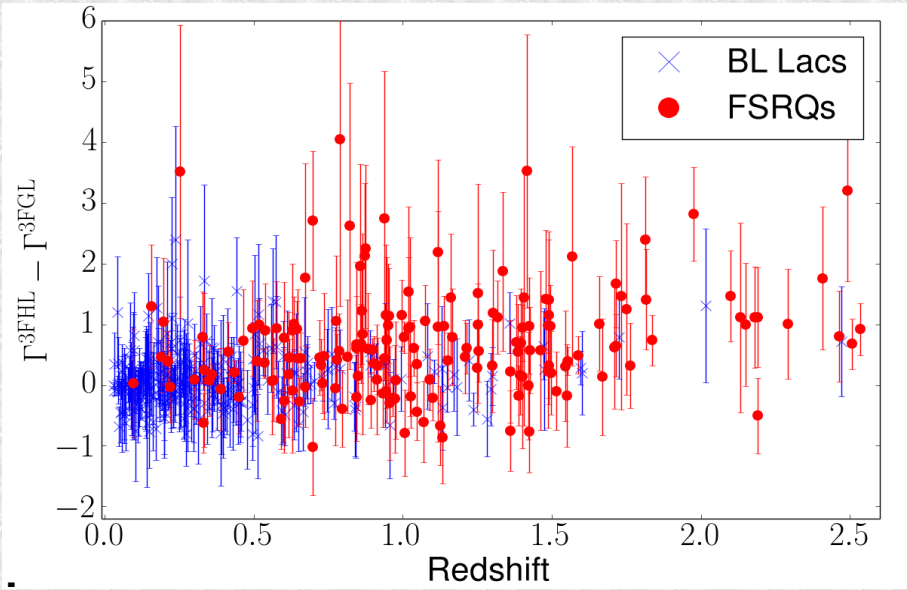
> 0.1 GeV

> 50 GeV

- **Flat distribution on synchrotron peak frequency**

EBL from the 3FHL (I)

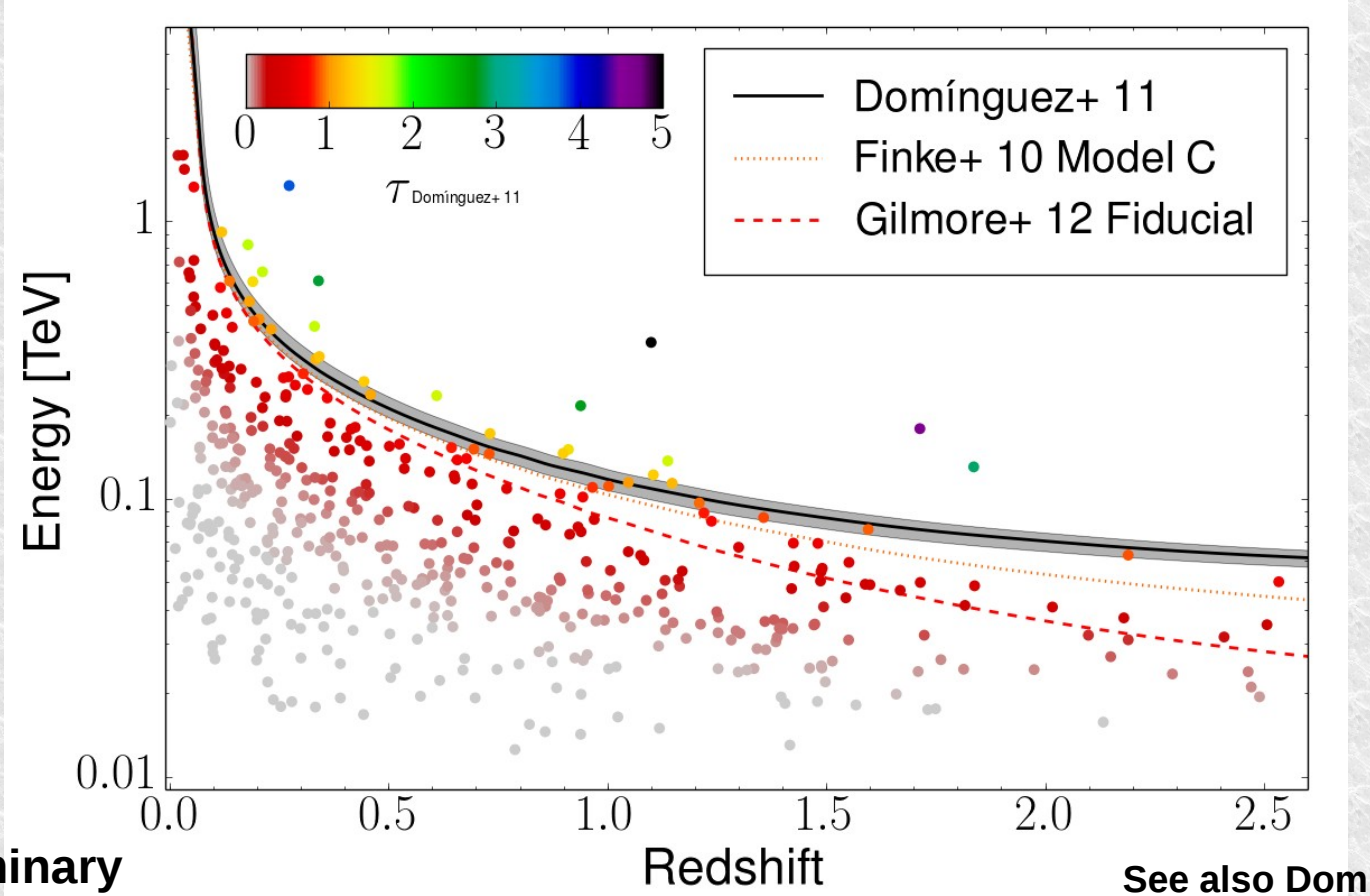




Preliminary

- **Clear evidence for softening of the E>10 GeV spectra at higher redshifts**
  - Most likely due to EBL
- **The difference between the 3FHL and 3FGL indexes with redshift behaves similarly for FSRQs and BL Lacs.**

EBL from the 3FHL (II)



Preliminary

See also Dominguez+ 13 about the CGRH

- **Several photons detected beyond the cosmic gamma-ray horizon**
  - Very important to constrain the EBL

Summary

1.- We have presented (preliminary) results from an all-sky survey at E > 10 GeV using 7 years of Pass 8 data taken with the Fermi-LAT (3FHL).

2.- This survey finds 1720 sources, this is a factor 3.4 more sources (3 times deeper in flux) than the previous LAT survey at these same energies (1FHL).

3.- About 75% of the catalog are extragalactic sources with a rich variety of AGNs.

4.- The 3FHL extragalactic population is a different mix of FSRQ and BL Lacs than the population found in the 3FGL and 2FHL.

5.- Clear signs of EBL attenuation at these energies are found at z~2.