

National Aeronautics and Space Administration



Fermi

Gamma-ray Space Telescope

[www.nasa.gov/fermi](http://www.nasa.gov/fermi)



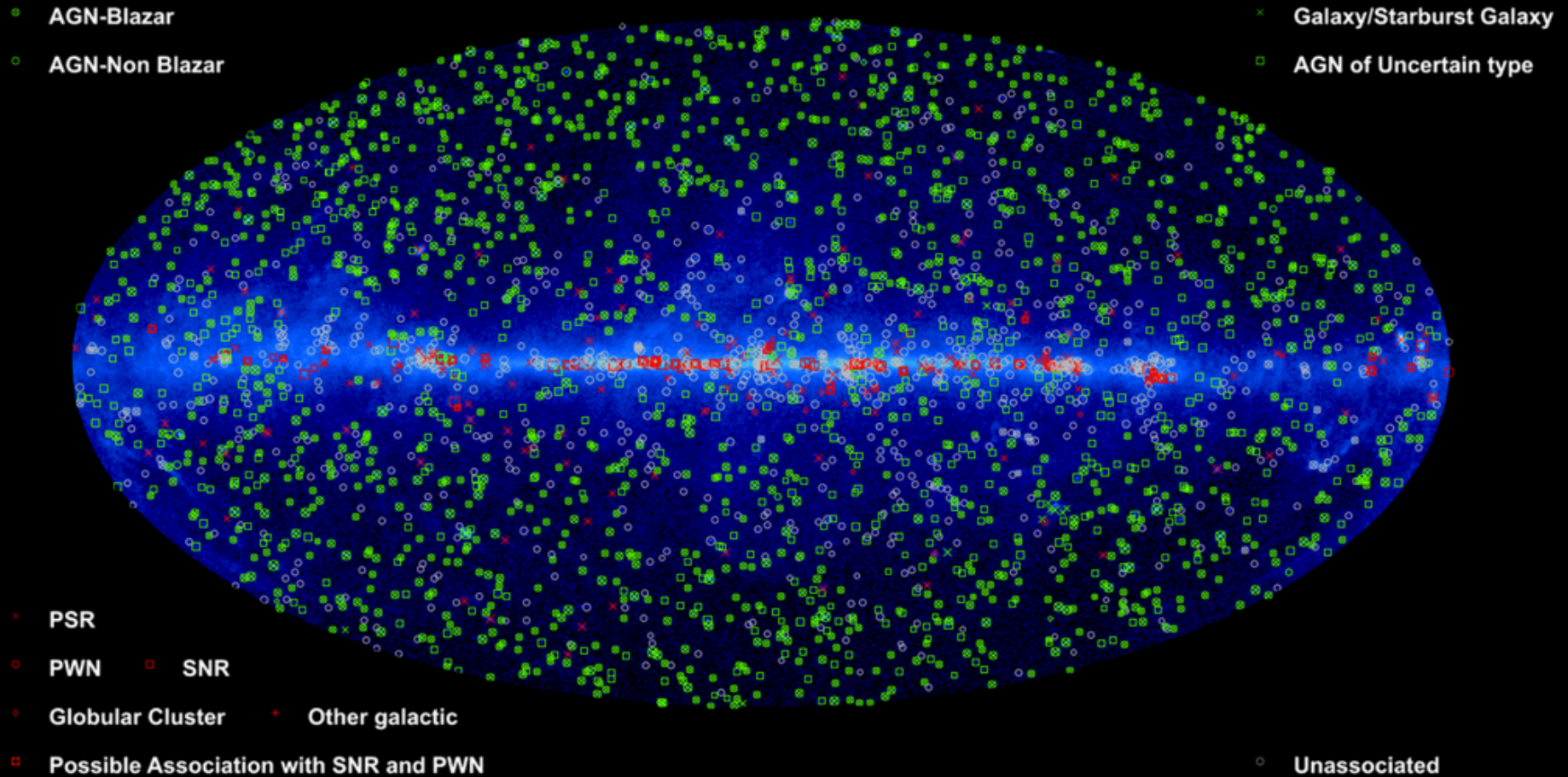
# A Catalog of *Fermi*-LAT Sources Detected Above 50 GeV

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Collaboration

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# Fermi Large Area Telescope 3FGL catalog

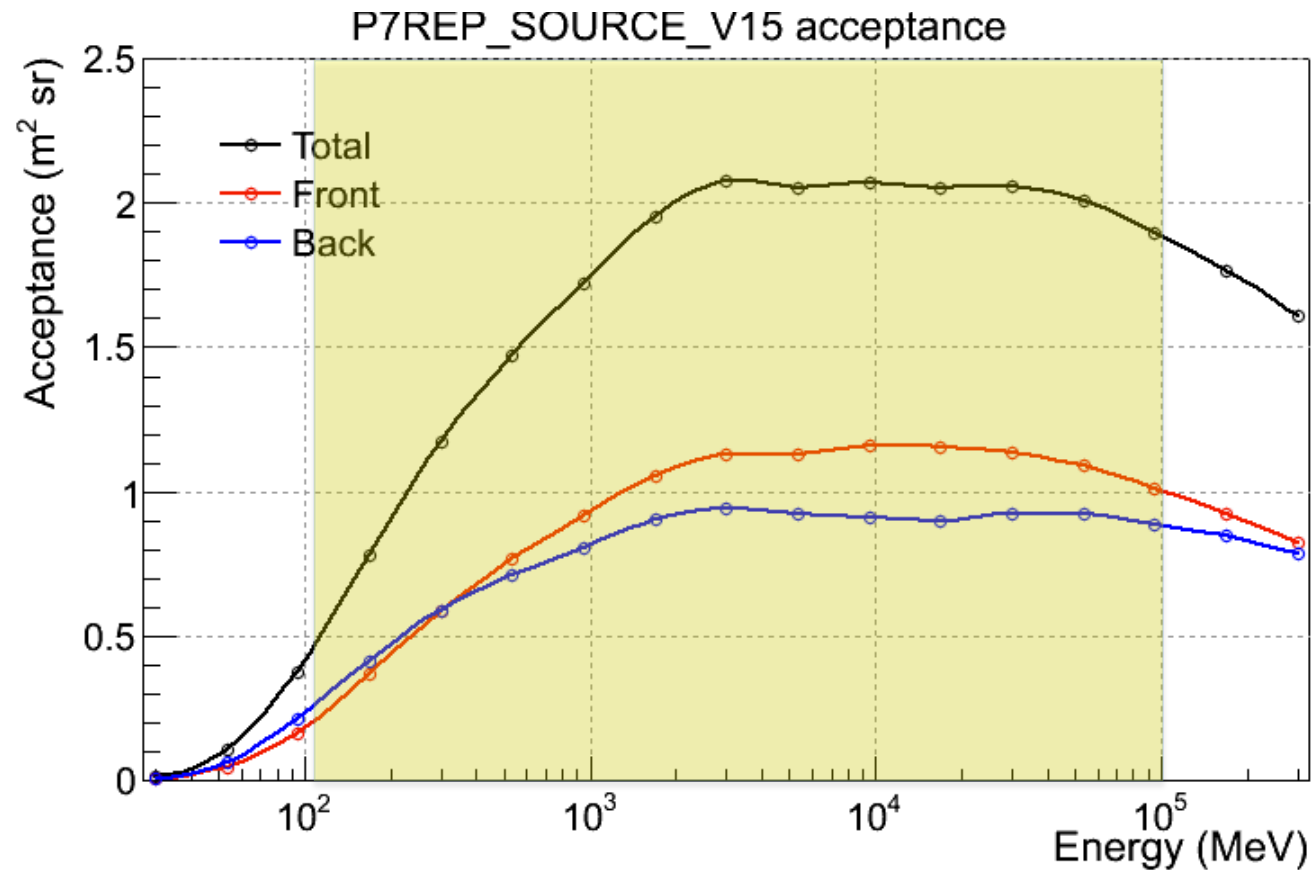


Credit: Fermi Large Area Telescope Collaboration

*Preliminary*



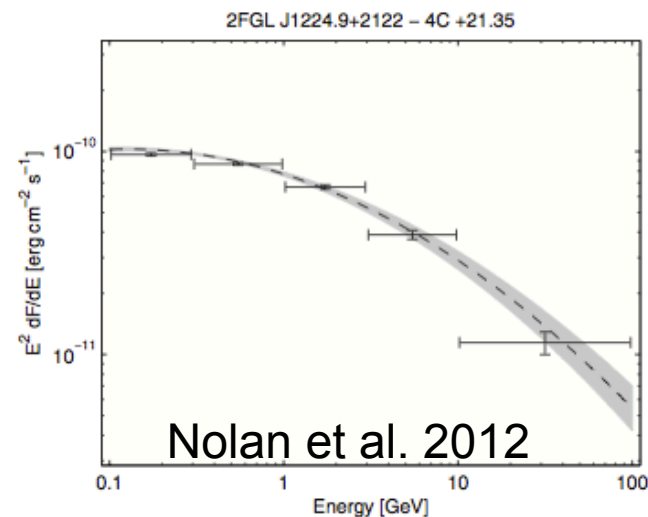
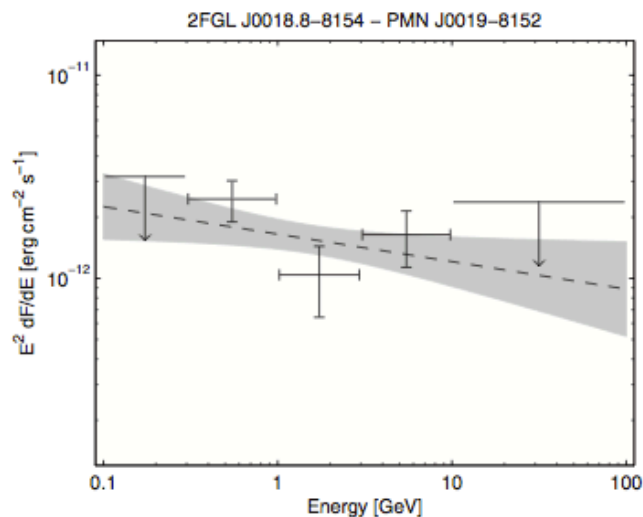
- **Fermi-LAT (1FGL, 2FGL, 3FGL) catalogs do an excellent job in characterizing variability and energetics of sources detected in the 0.1-100 GeV band\***



\*3FGL goes up to 300 GeV



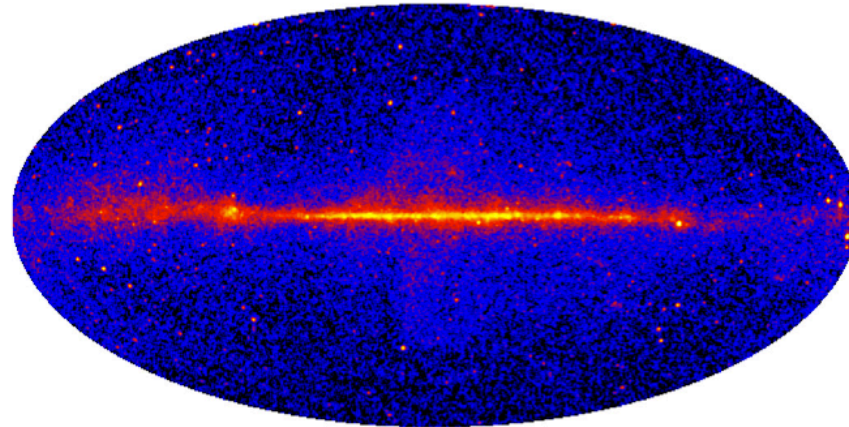
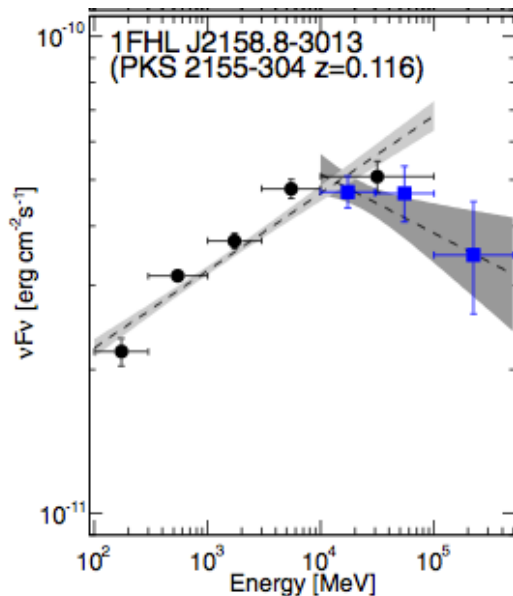
- **Fermi-LAT (1FGL, 2FGL, 3FGL) Catalogs do an excellent job in characterizing variability and energetics of sources detected in the 0.1-100 GeV band**
  - PROS:
    - Excellent characterization in energy/variability of the gamma-ray sky
    - Serendipitous survey over a large energy band
  - CONS:
    - `coarse' 5-bin spectra, good for intermediate-brightness sources
    - Spectra `biased' by the larger statistics of low energy photons
      - 0.1-100 GeV fit might not be representative of the spectrum at high-E



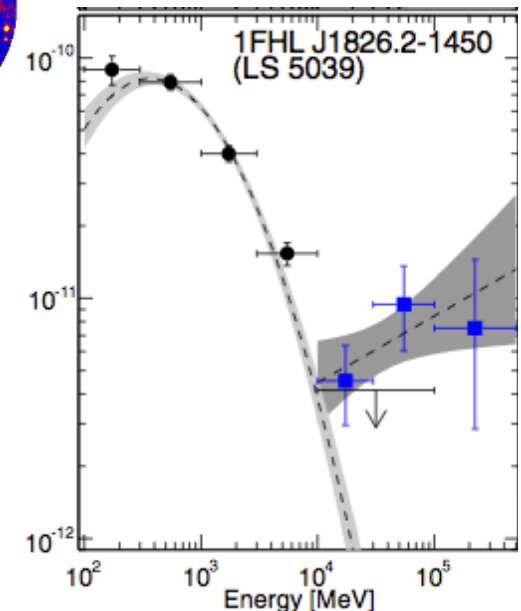


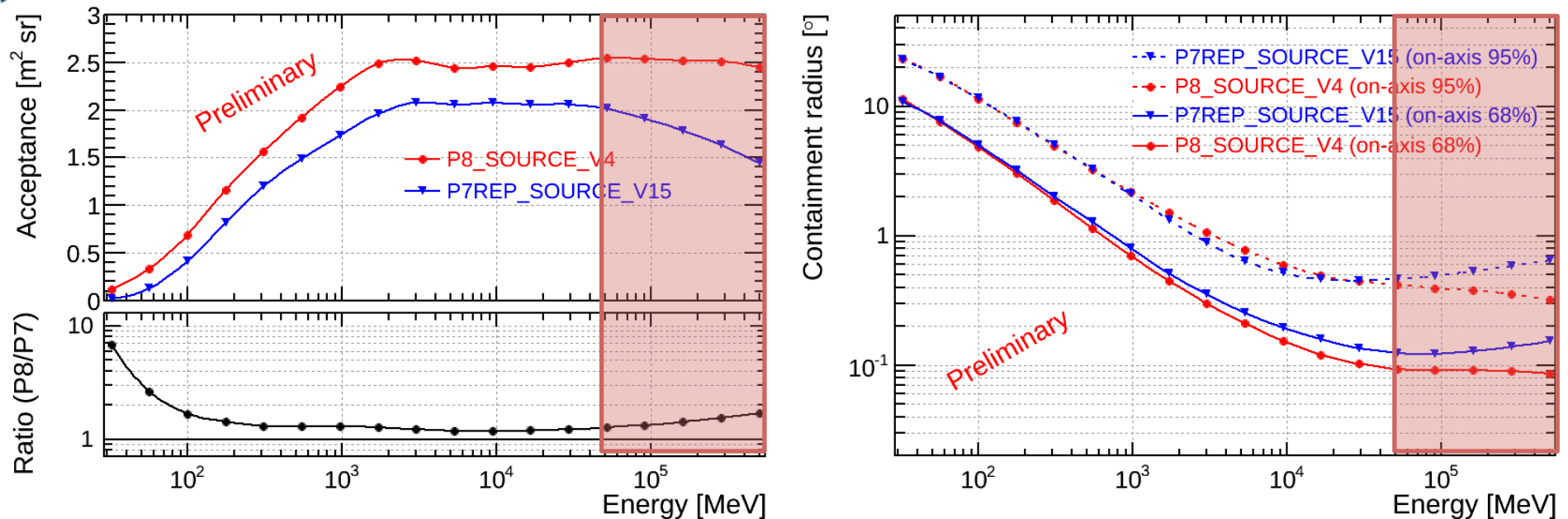


- The 1FHL, based on 3 years of data, was a dedicated study of *Fermi*-LAT above 10 GeV
  - Aim to connect to the VHE band and to characterize the sources at  $>10$  GeV
  - 514 sources of which 63 not in 2FGL



Ackermann et al. 2013, ApJS, 209, 304





- **Large Progress Expected at >50 GeV:**

1. Improve PSF and Acceptance (factor of 0.5-2 in P8)
2. Low background and good (constant) PSF (0.1 deg at 68%)
3. All-sky exposure

See P. Bruel's talk on wed.

- **Catalog of sources detected at >50 GeV**

- Allows study of the EBL, EGB, Galactic plane etc.
- Continues our effort to characterize sources at high energies
- Connects well to ACTs, HAWC and the upcoming CTA

# Count Map



~6 years of P8 data (50 GeV – 2 TeV)

51,000 photons  $E > 50$  GeV

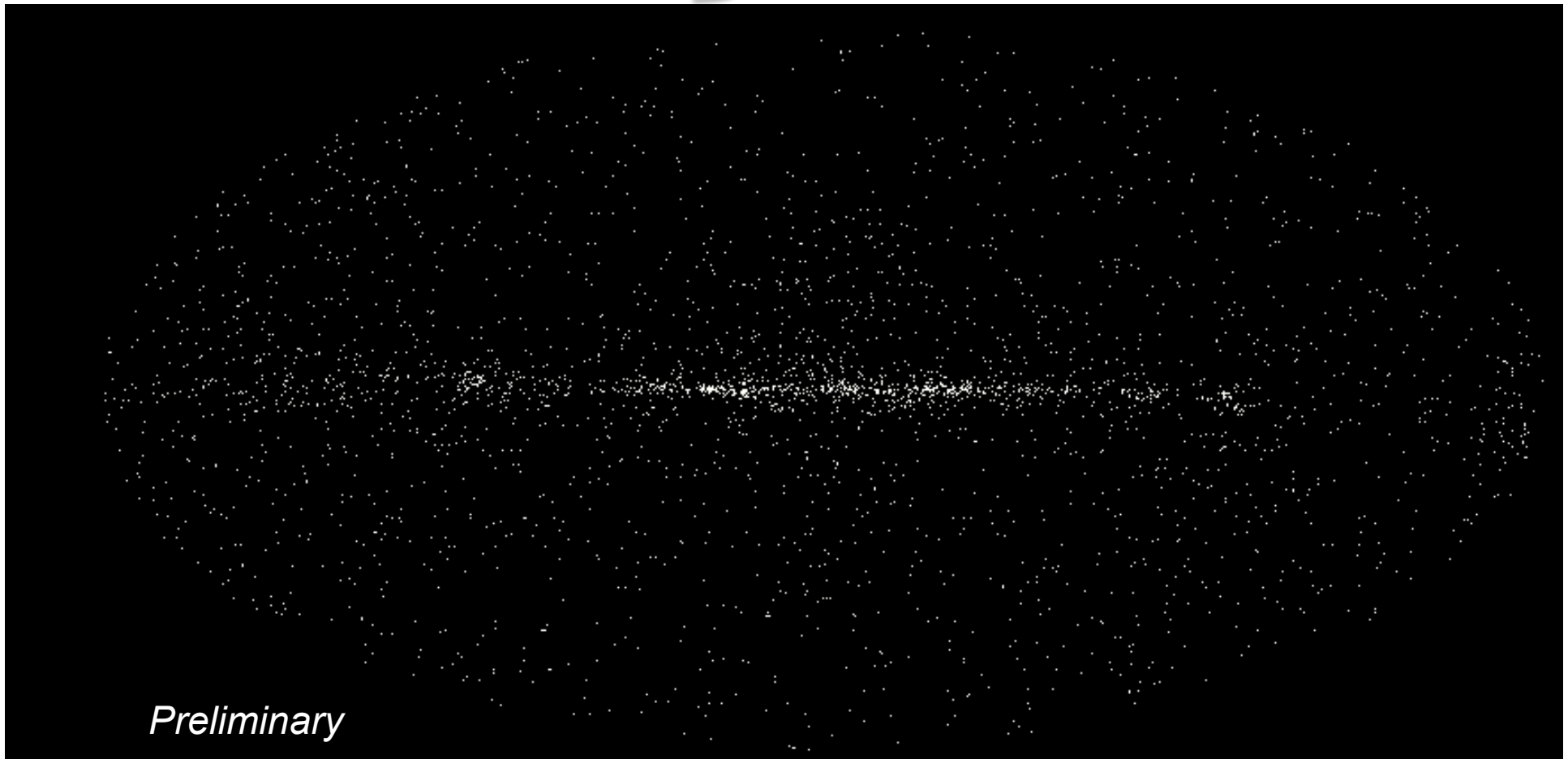
18,000 photons  $E > 100$  GeV

2,000 photons  $E > 500$  GeV



~1 photon every  $\text{deg}^2$

Number of photons at  $>500$  GeV are preliminary



*Preliminary*

## Count Map



~6 years of P8 data (50 GeV – 2 TeV)

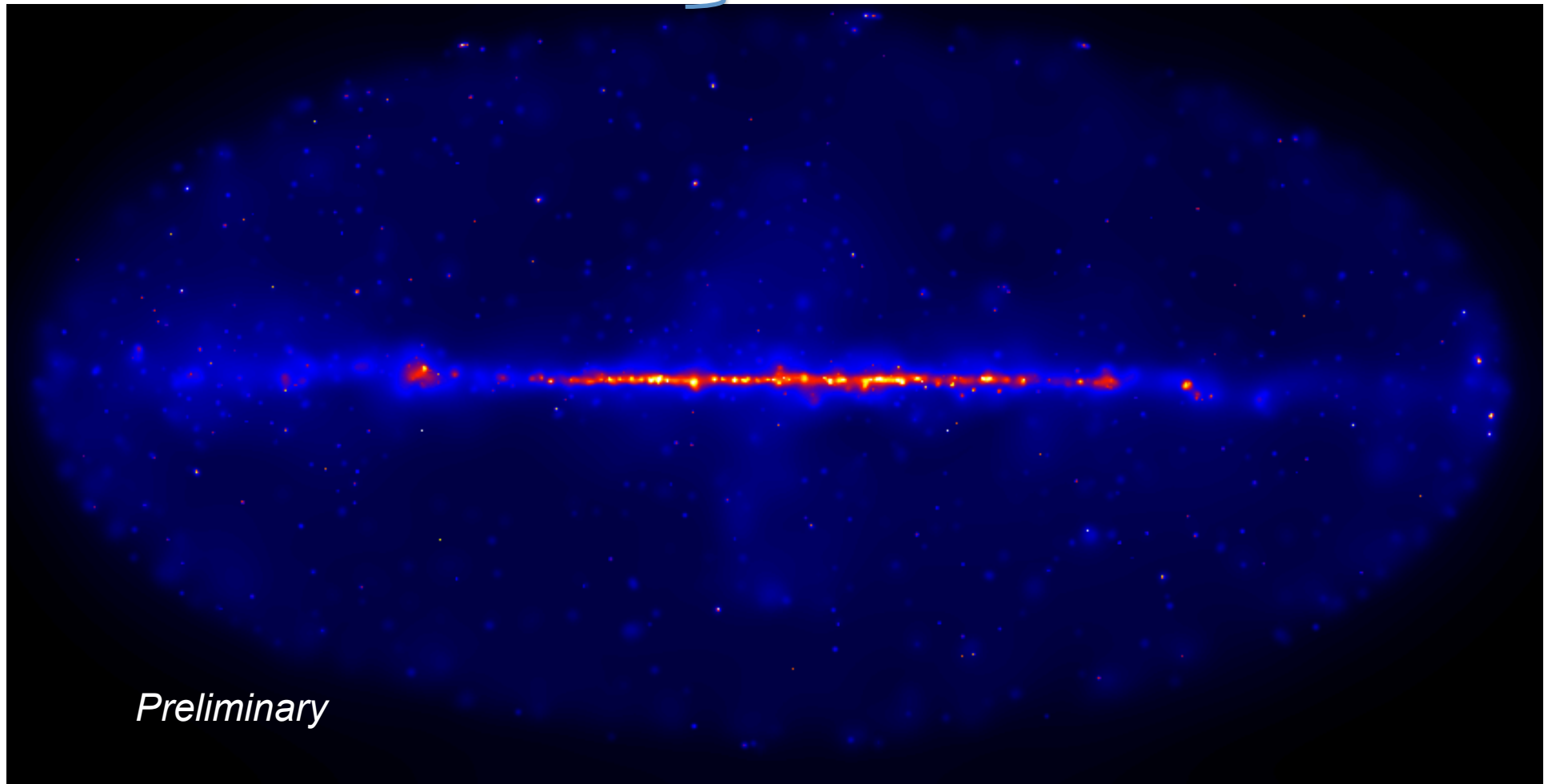
51,000 photons  $E > 50$  GeV

18,000 photons  $E > 100$  GeV

2,000 photons  $E > 500$  GeV



~1 photon every  $\text{deg}^2$







- **Analysis**
    - 50 GeV – 2 TeV
    - ~6 years of data
    - Pass 8 (source)
  - **Detections (preliminary numbers, will change somewhat)**
    - ~320 sources
    - 71 detected by ACTs (TeVCat)
    - 206 detected in 1FHL
    - 234 detected in 3FGL (4 years, up to 300 GeV)
    - ~60 brand new sources
- Numbers are not definitive since depend on IRFs and diffuse emission model which are subject to change

**Bottom line:** ~100 sources not in 1FHL and ~250 not in TeVCat

## 2FHL vs 1FHL



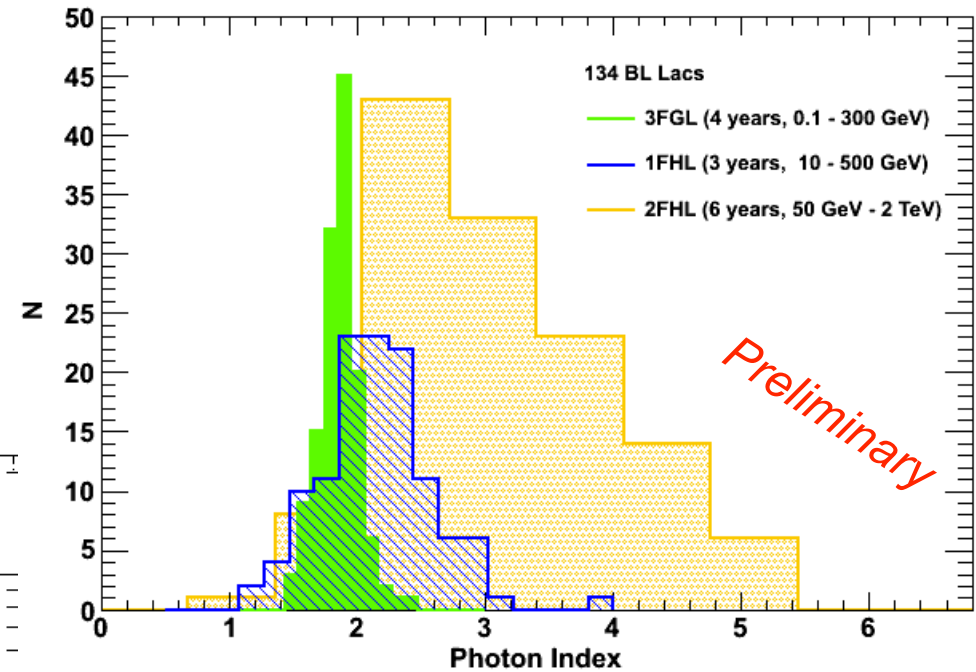
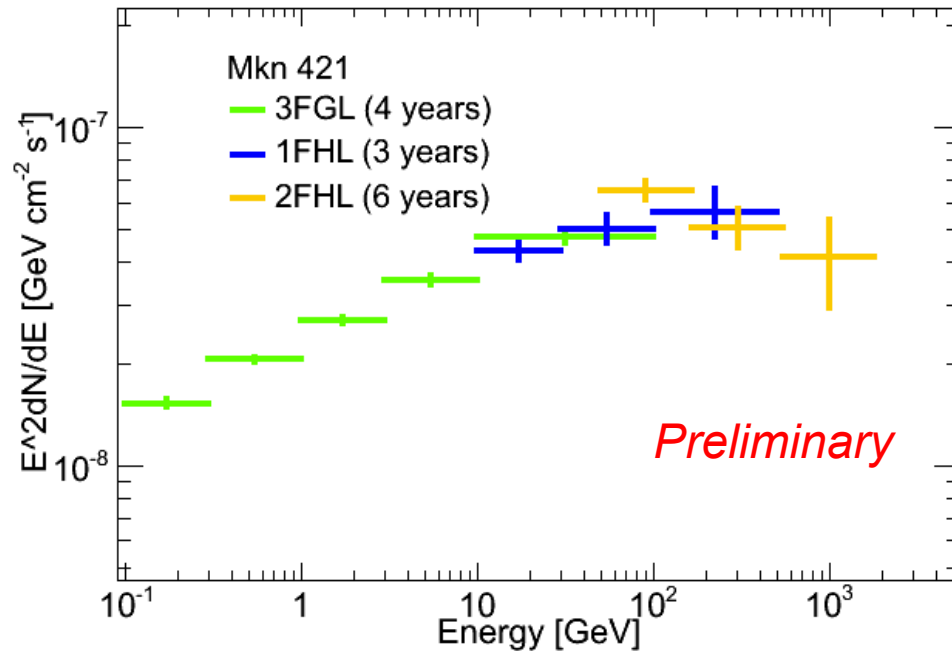
	2FHL	1FHL
<b># Sources</b>	320	514
<b>Energy Range</b>	50 GeV – 2 TeV	10 GeV – 500 GeV
<b>Exposure</b>	6 years	3 years
<b>Av. Sp. index</b>	2.9+/-0.9	2.54+/-0.87
<b>Av. Error Rad (95%)</b>	0.068 deg (4 arcmin!)	0.088 deg
<b>% BL Lacs</b>	~51%	~51%
<b>% FSRQs</b>	~ 1%	~14%

*These numbers are preliminary*

- **Median sensitivity of  $\sim 10^{-11}$  erg/cm<sup>2</sup>/s**
- **Half of the sources are in the plane of the Galaxy**
- **Sources are even softer than at >10 GeV**

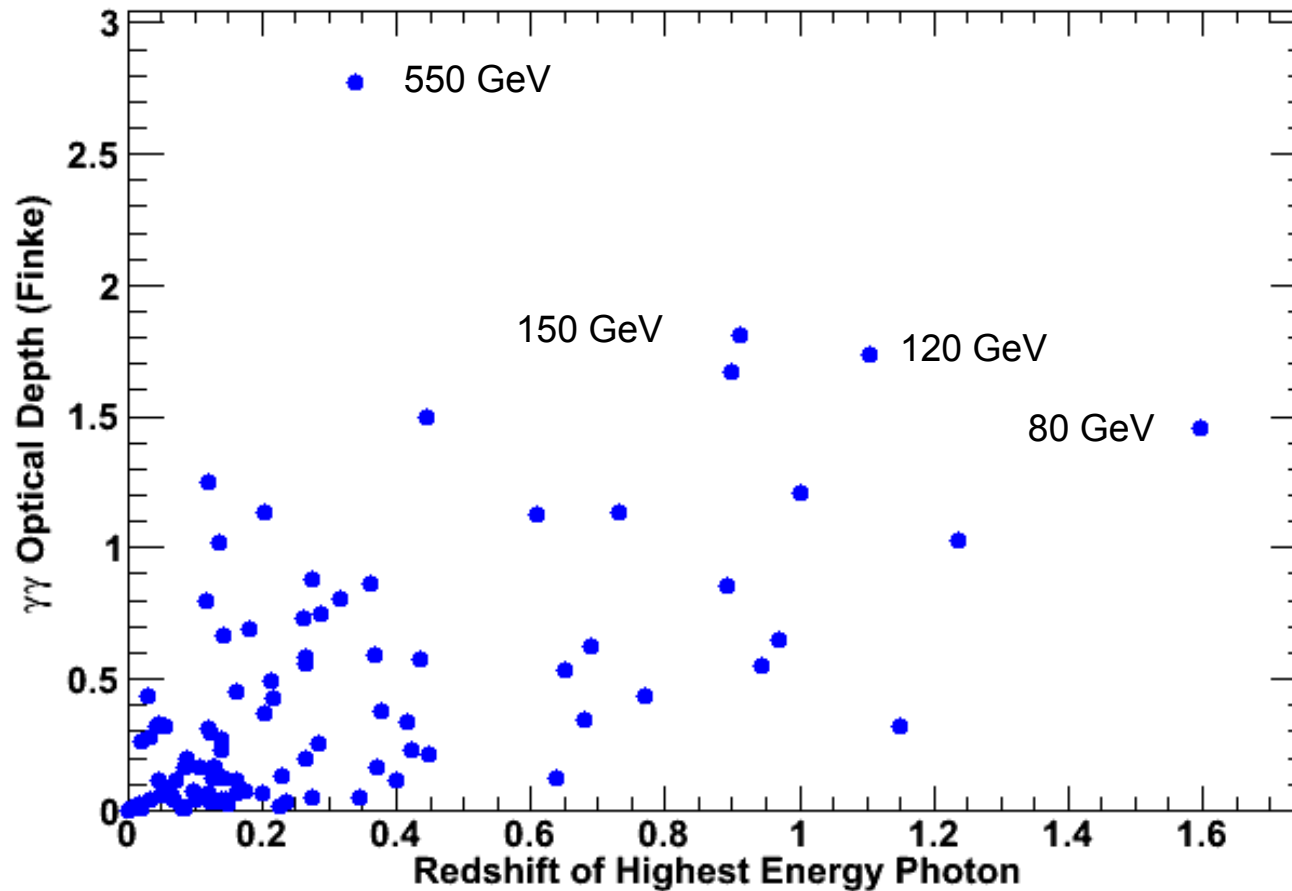


- BL Lacs of the HSP kind typically have their IC peak somewhere at  $E > 100$  GeV





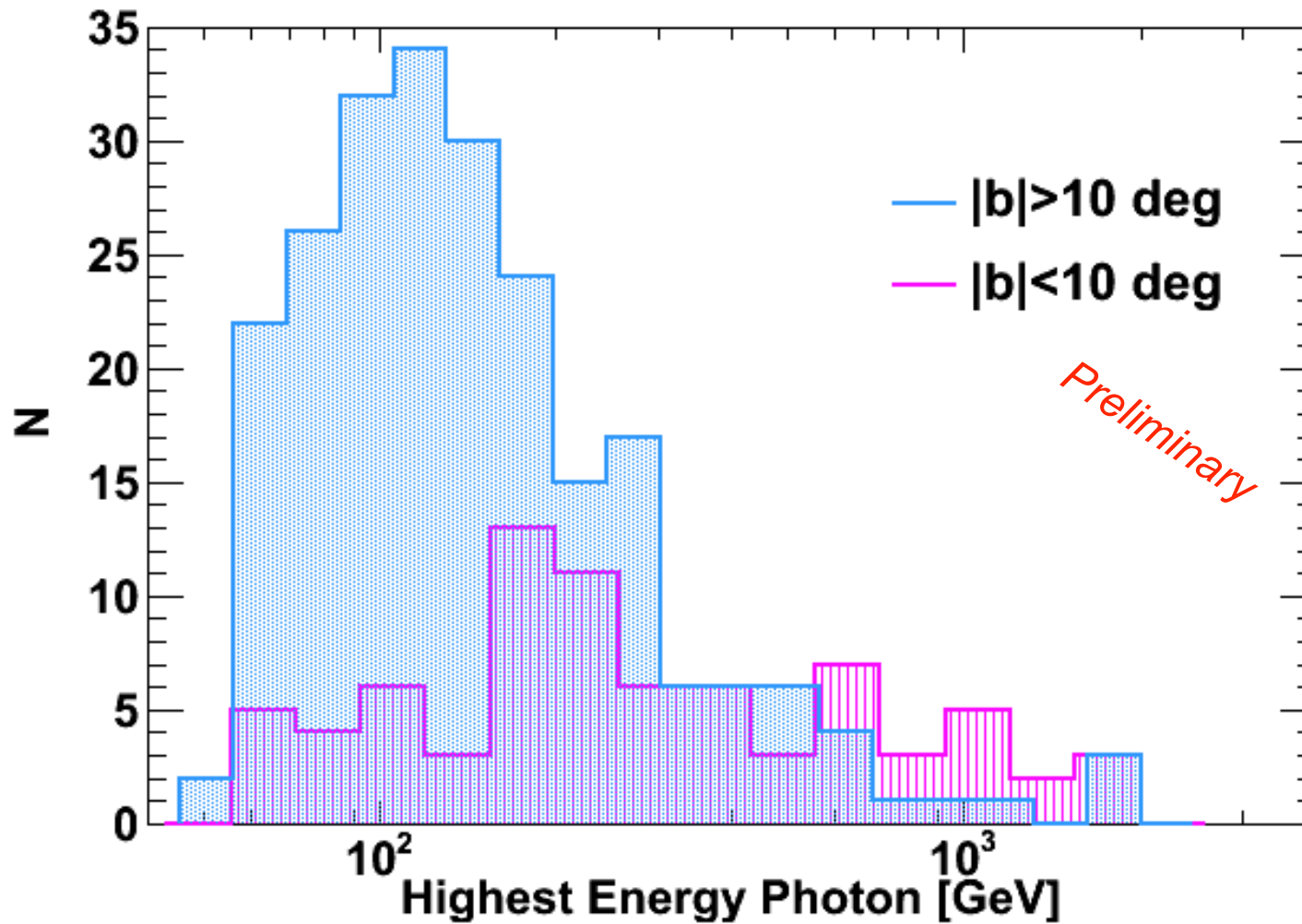
- Highest Energy Photons with  $>95\%$  probability of belonging to a source
  - several photons probe  $\tau \geq 1.0$



# Highest Energy Photons



- It appears that there are hard sources in the plane

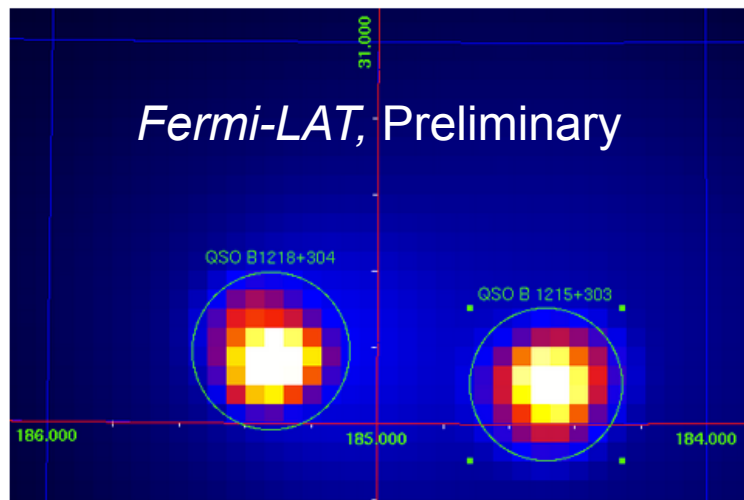




# Excellent Point Spread Function

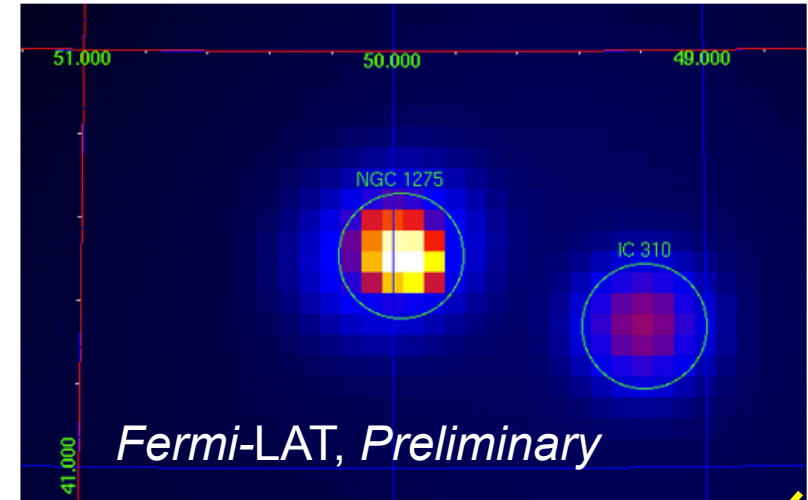


- Excellent angular resolution (0.1deg at 68%), comparable to ACTs, makes it easy to separate adjacent sources

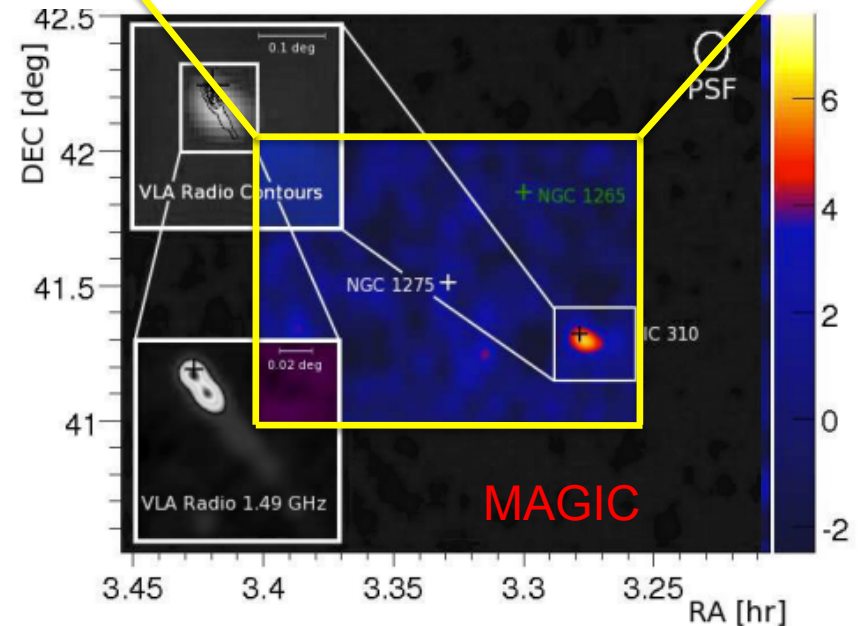


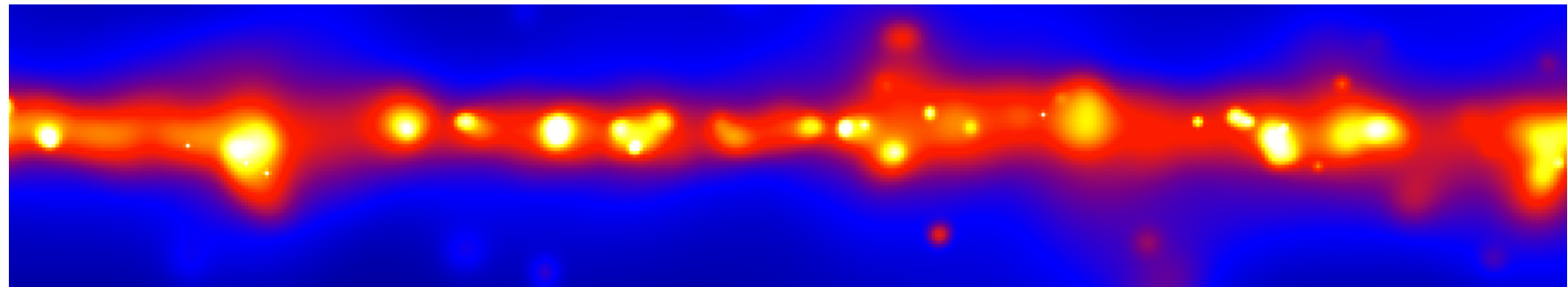
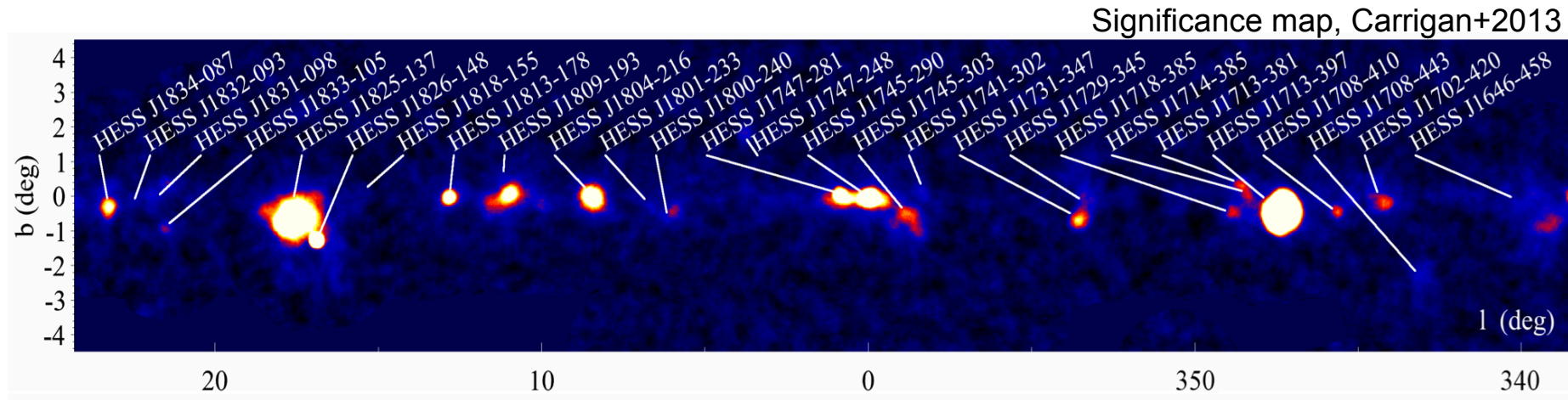
2 degree

1 degree



Aleksic, 2010, ApJ, 723, 207





Close up of map on slide 9

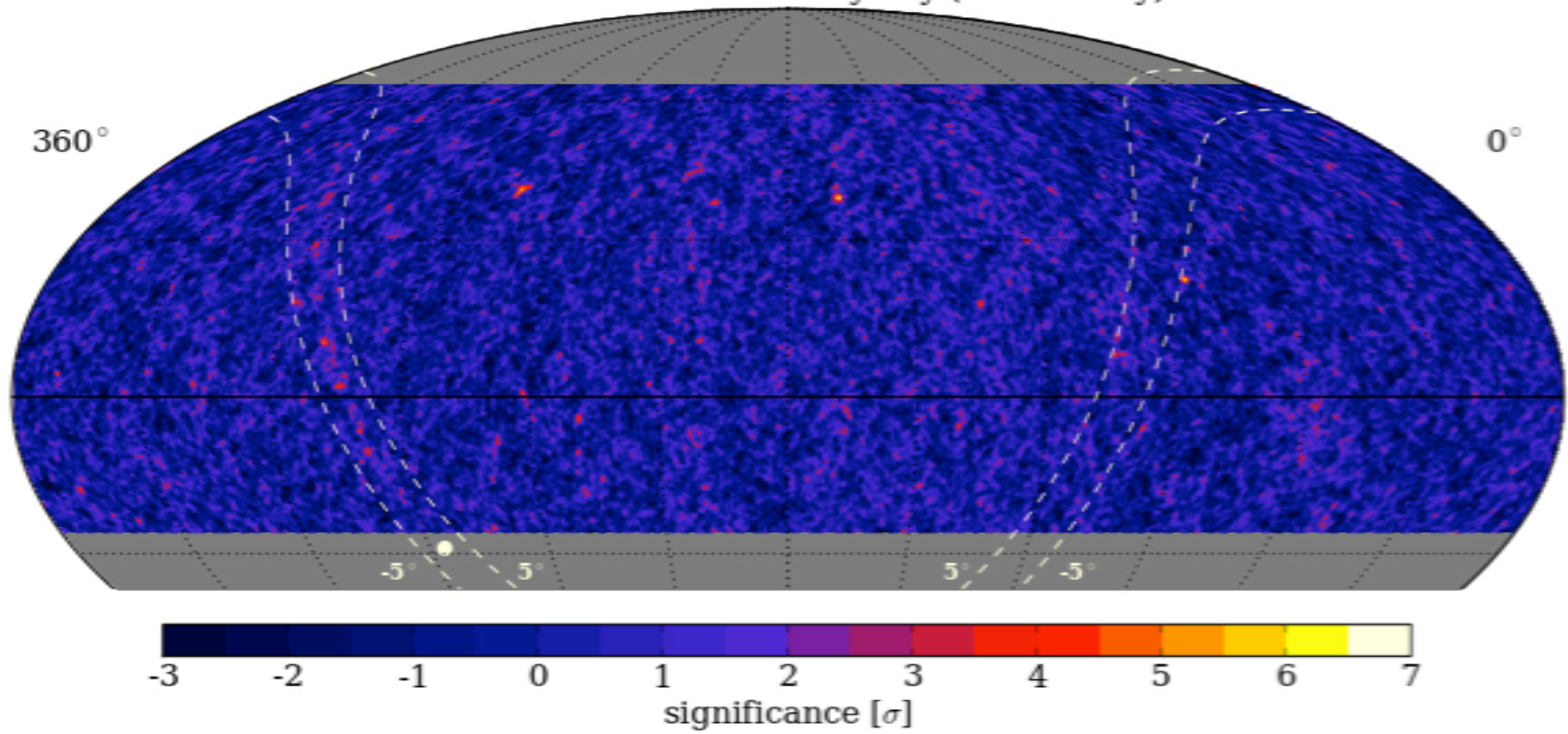
*Preliminary*

Good match between HESS and *Fermi* (50 GeV-2TeV) maps

# Comparison with HAWC



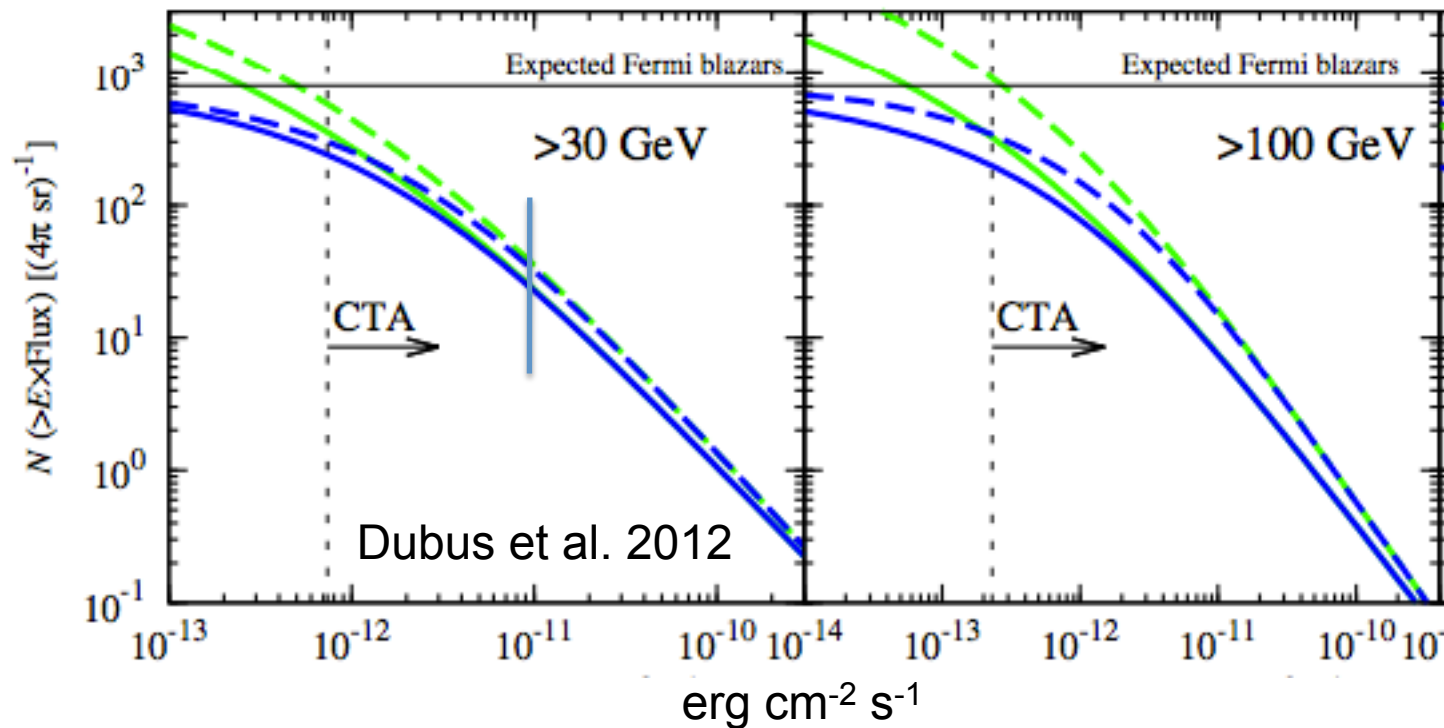
HAWC-95+111 Gamma-Ray Sky (Preliminary)



Preliminary



- A  $>50$  GeV all-sky *Fermi* survey is a perfect complement to future large area surveys performed by CTA
  - Expect *Fermi* sensitivity in this band to scale approx. linearly with time





- Pass 8 performance improvements ([angular resolution + acceptance](#)) and 6 years of exposure allow the characterization of sources directly at  $E > 50$  GeV
- Excellent angular resolution allows detailed studies of the Galactic plane and its sources
- Increased acceptance provides more photons from sources which enables studies of the EBL and of the SEDs of sources
- A survey of  $>50$  GeV gamma-ray sources connects well to ACTs, HAWC, and CTA