The 2nd Fermi LAT catalogue: 2FGL

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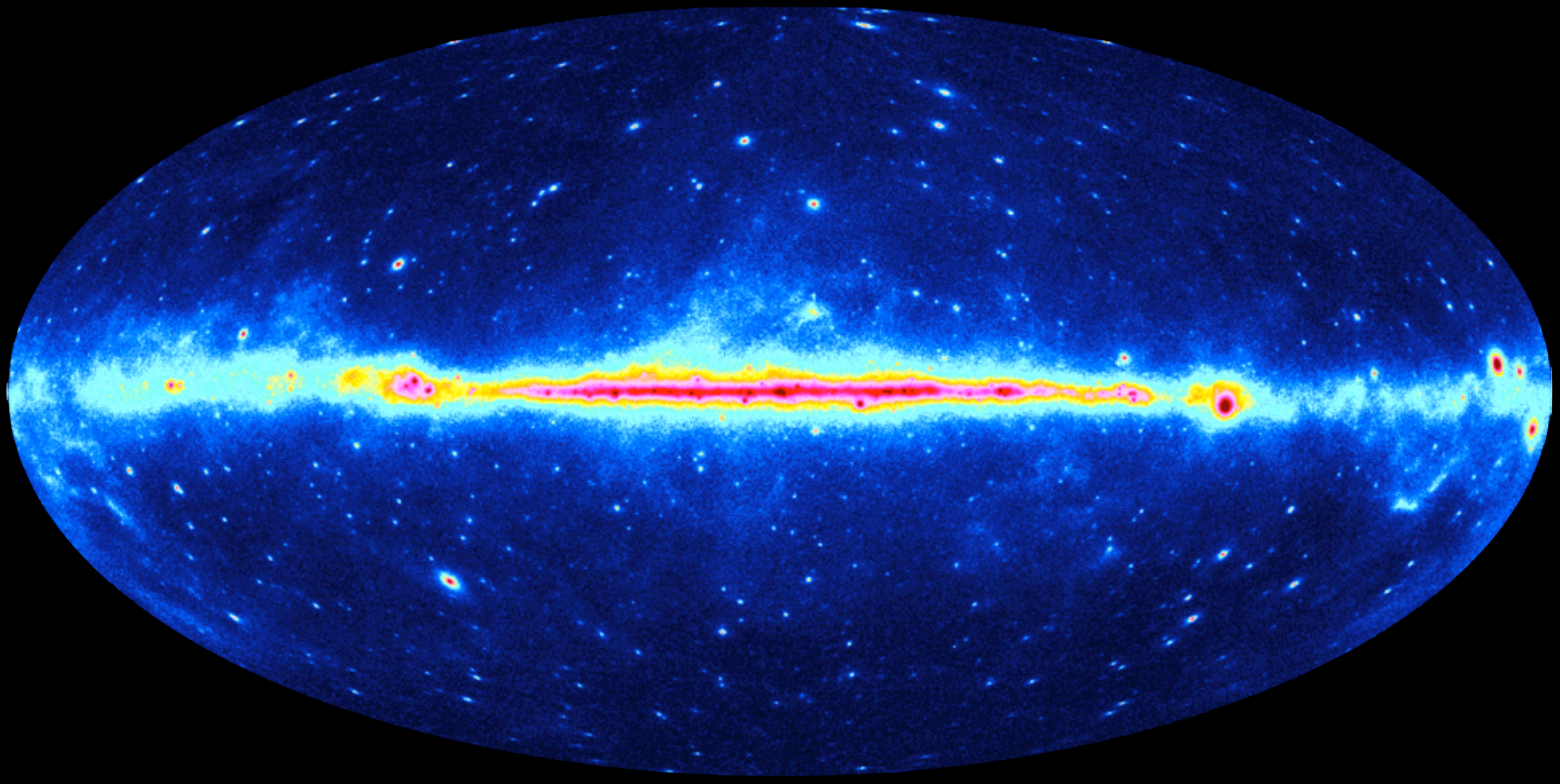
on behalf of
the Fermi LAT collaboration

INAOE July 11 2011

the GeV sky seen by Fermi

- 2 years, 0.1-10 GeV



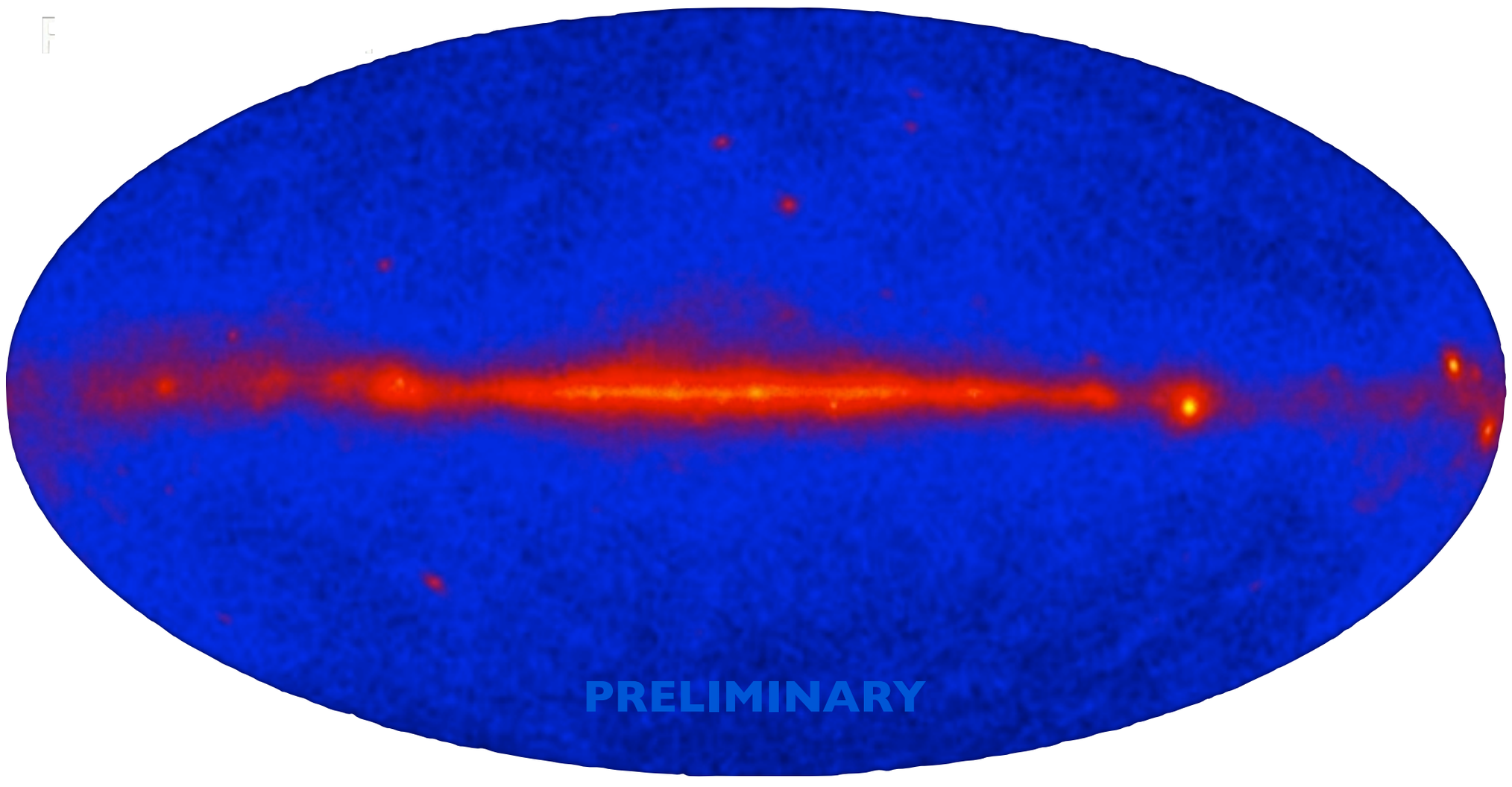
- results on http://fermi.gsfc.nasa.gov/science/symposium/2011/

new: photons & LAT response

- 1FGL: 11 months, γ from Pass 6
- 2FGL: 24 months, γ from Pass 7,

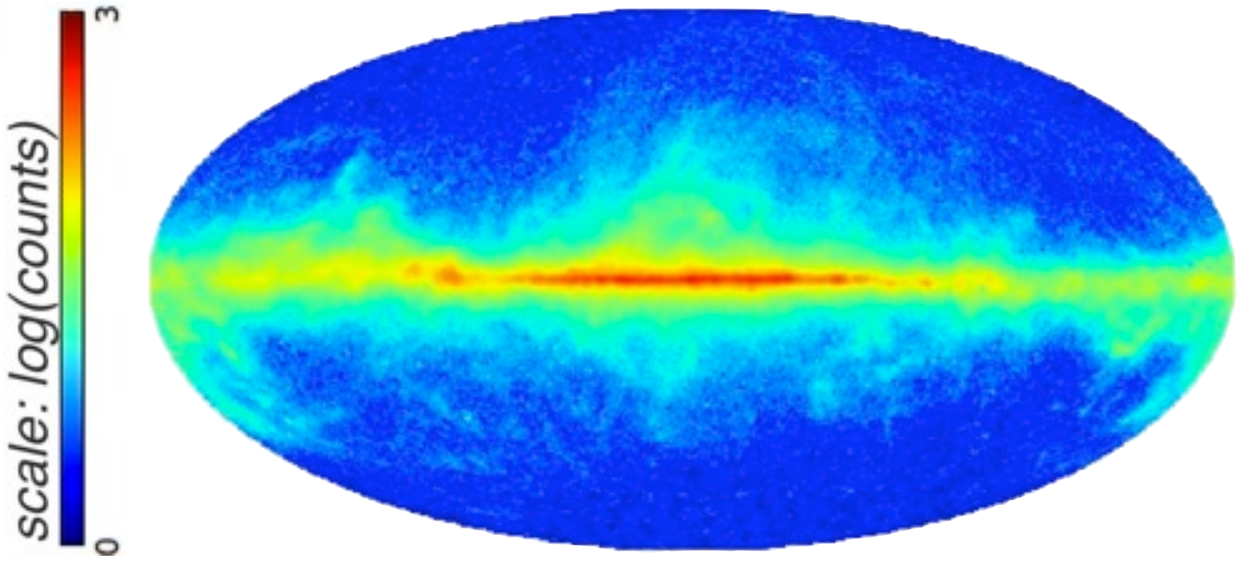
  lower background & more sensitivity at low energy

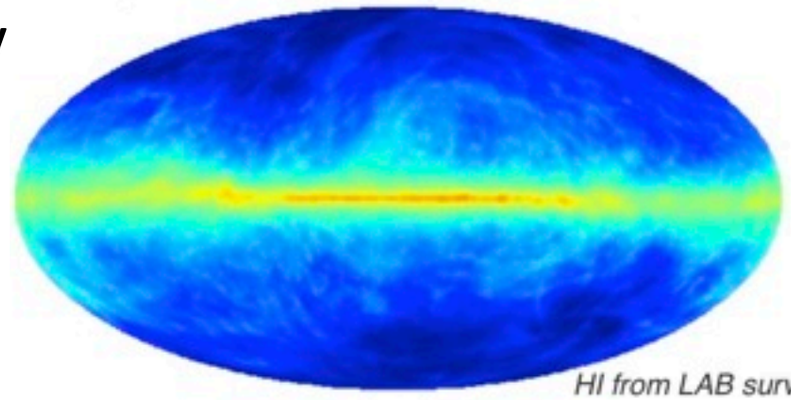
  ex: γ(P7) - γ(P6) =

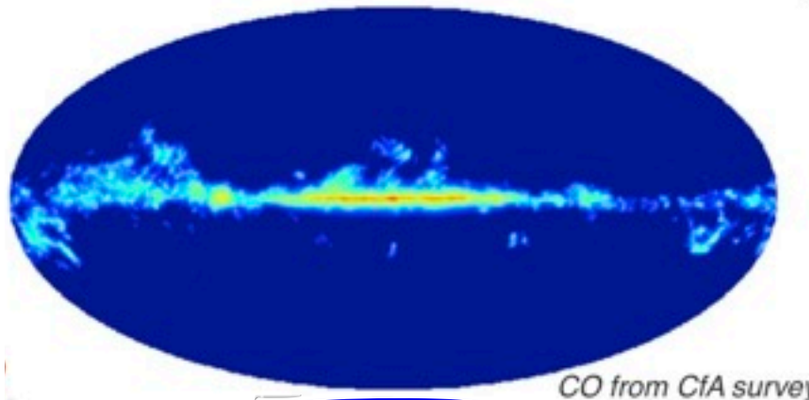


new: empirical diffuse emission model

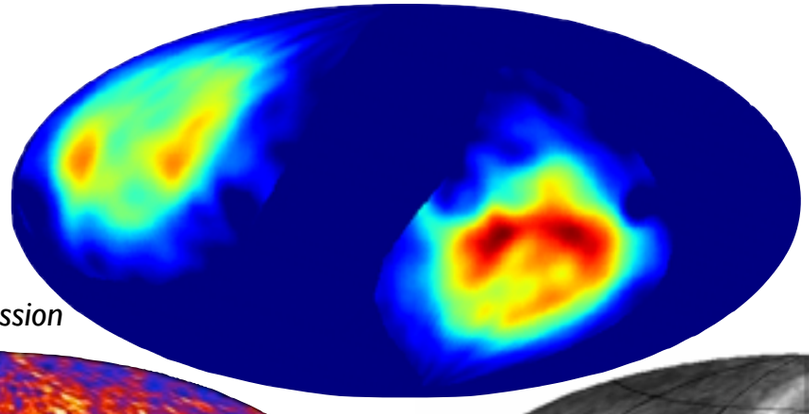
- sources and isotropic background removed > 300 MeV

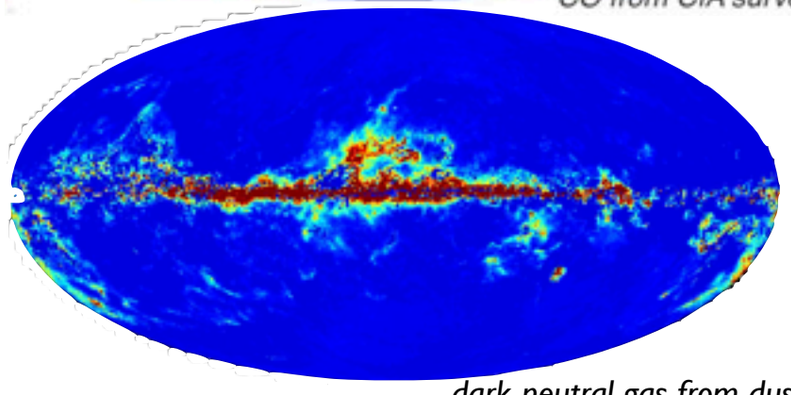


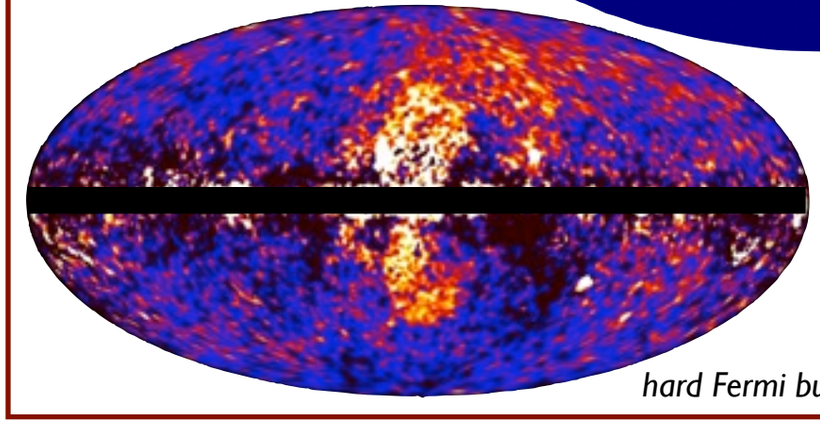

HI from LAB survey

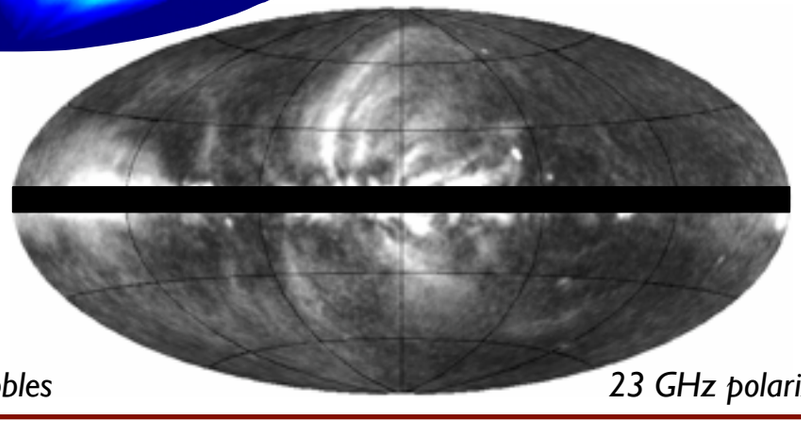

CO from CfA survey

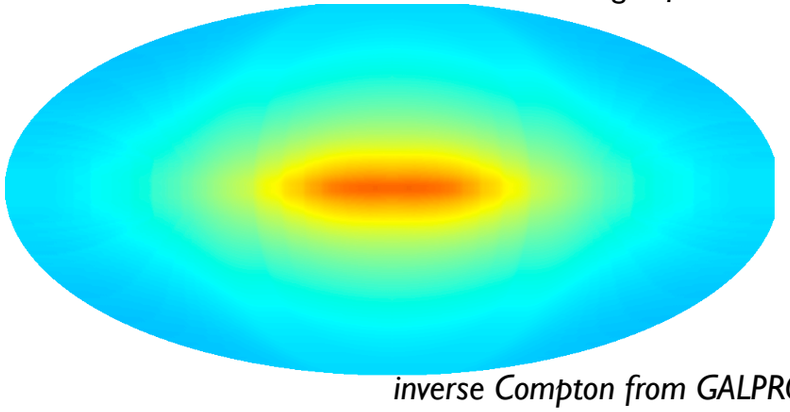
- Galactocentric rings for CR gradient when possible
- patches for extended sources across the sky


soft Earth limb emission


dark neutral gas from dust

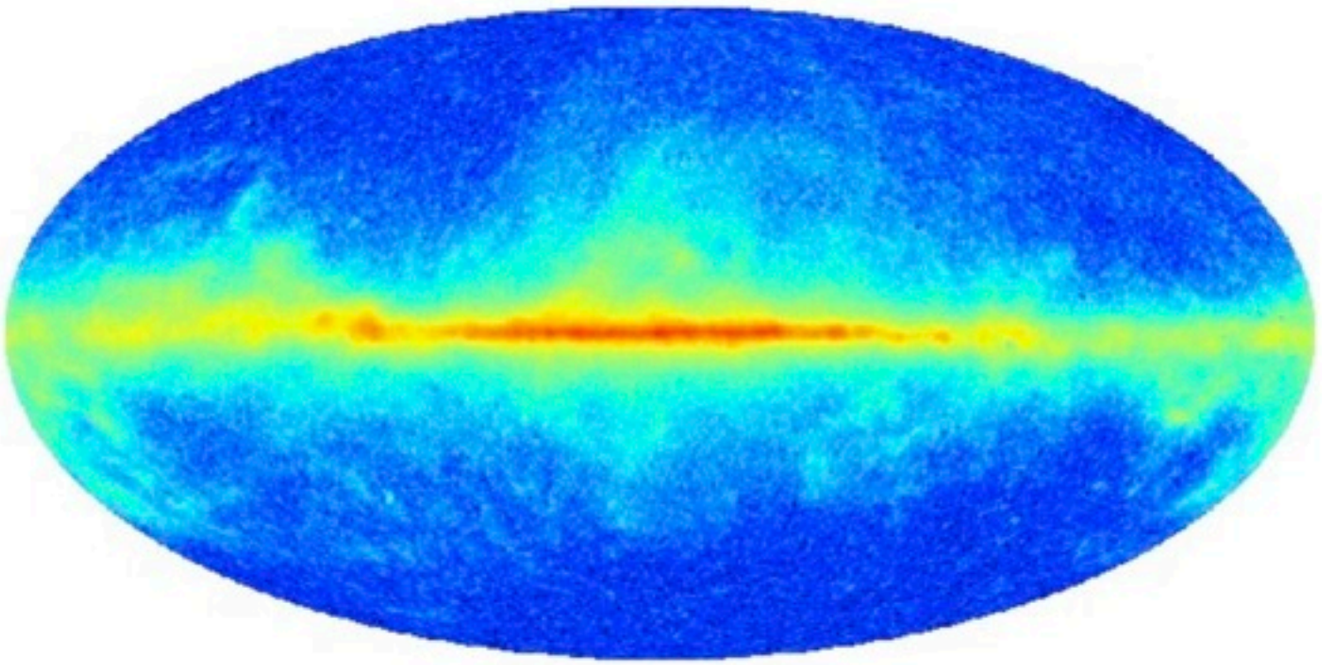

hard Fermi bubbles


23 GHz polarized


inverse Compton from GALPROP

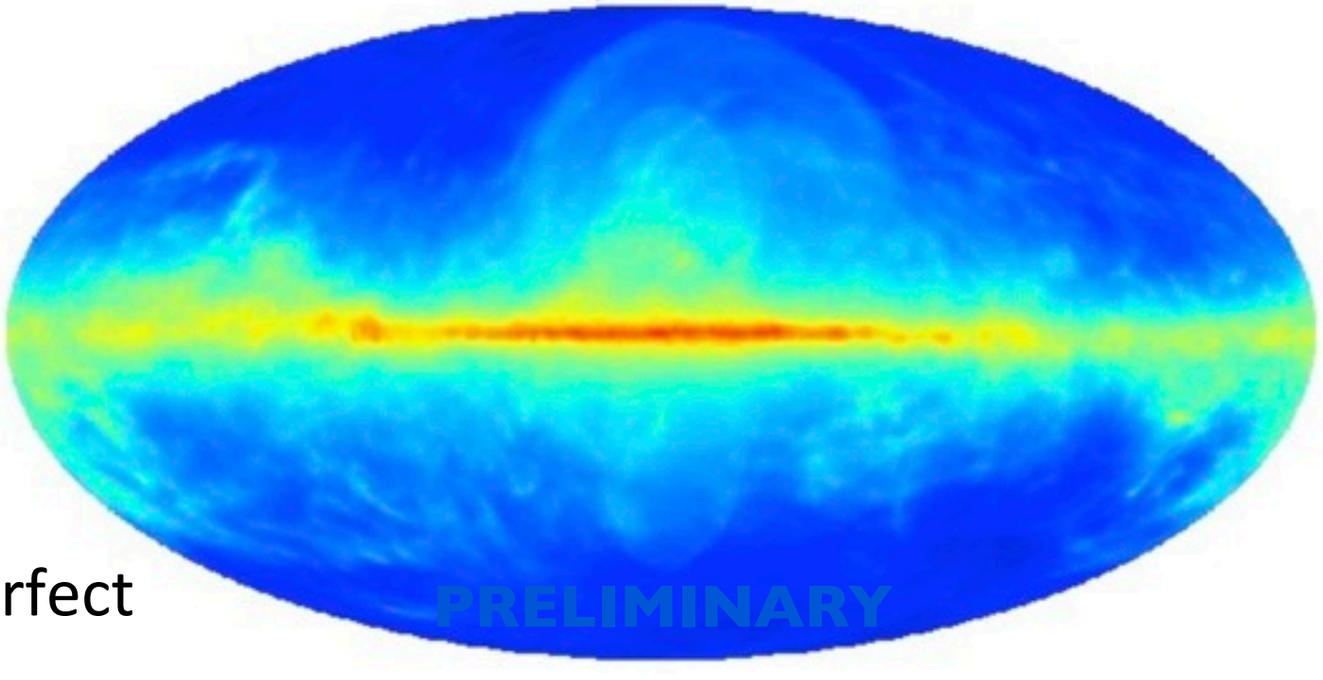
new LAT diffuse model

LAT counts minus sources and isotropic



scale: log(counts)

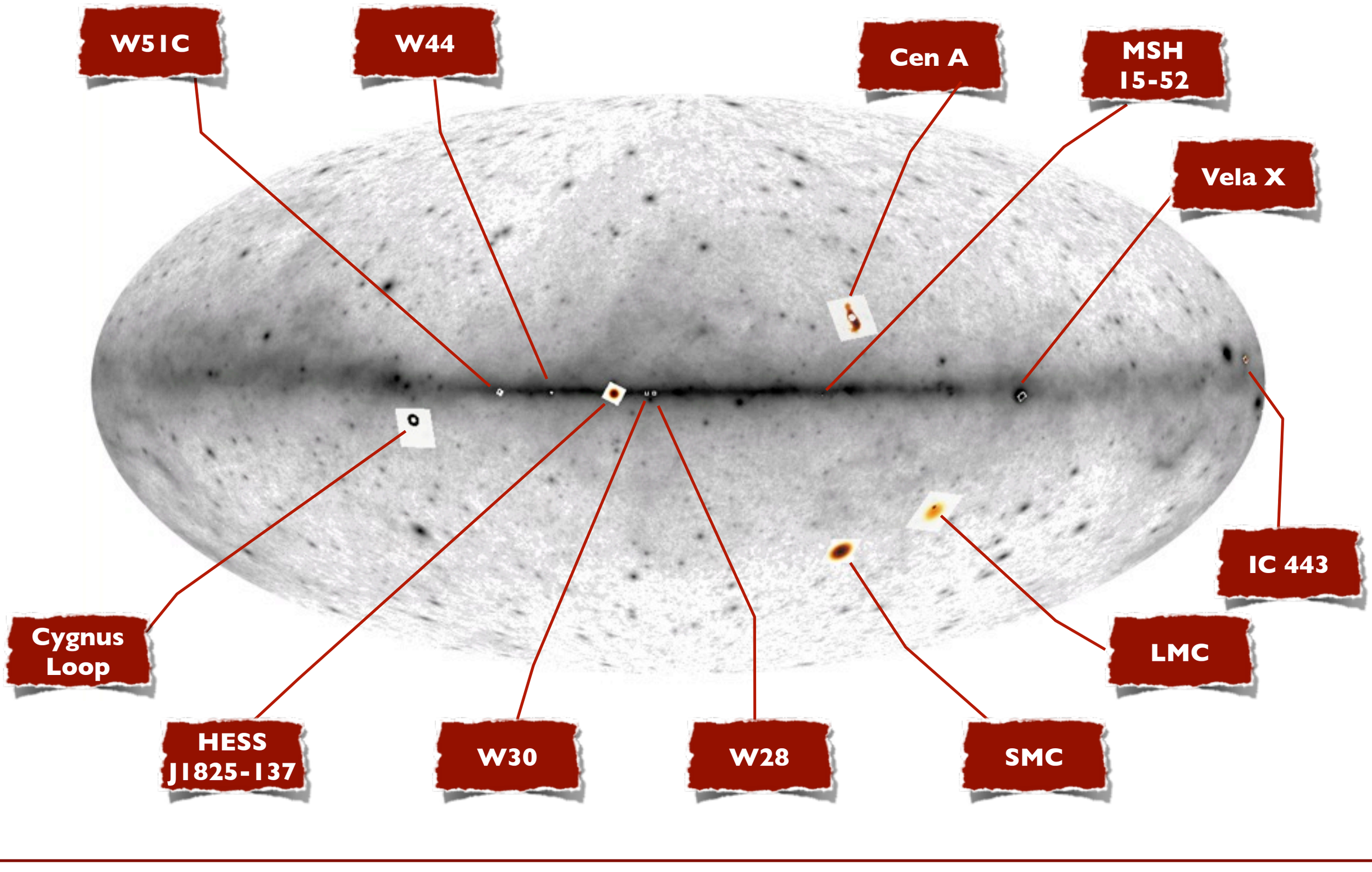
Template model



- still far from perfect

Casandjian et al. Fermi Symp. (2011)

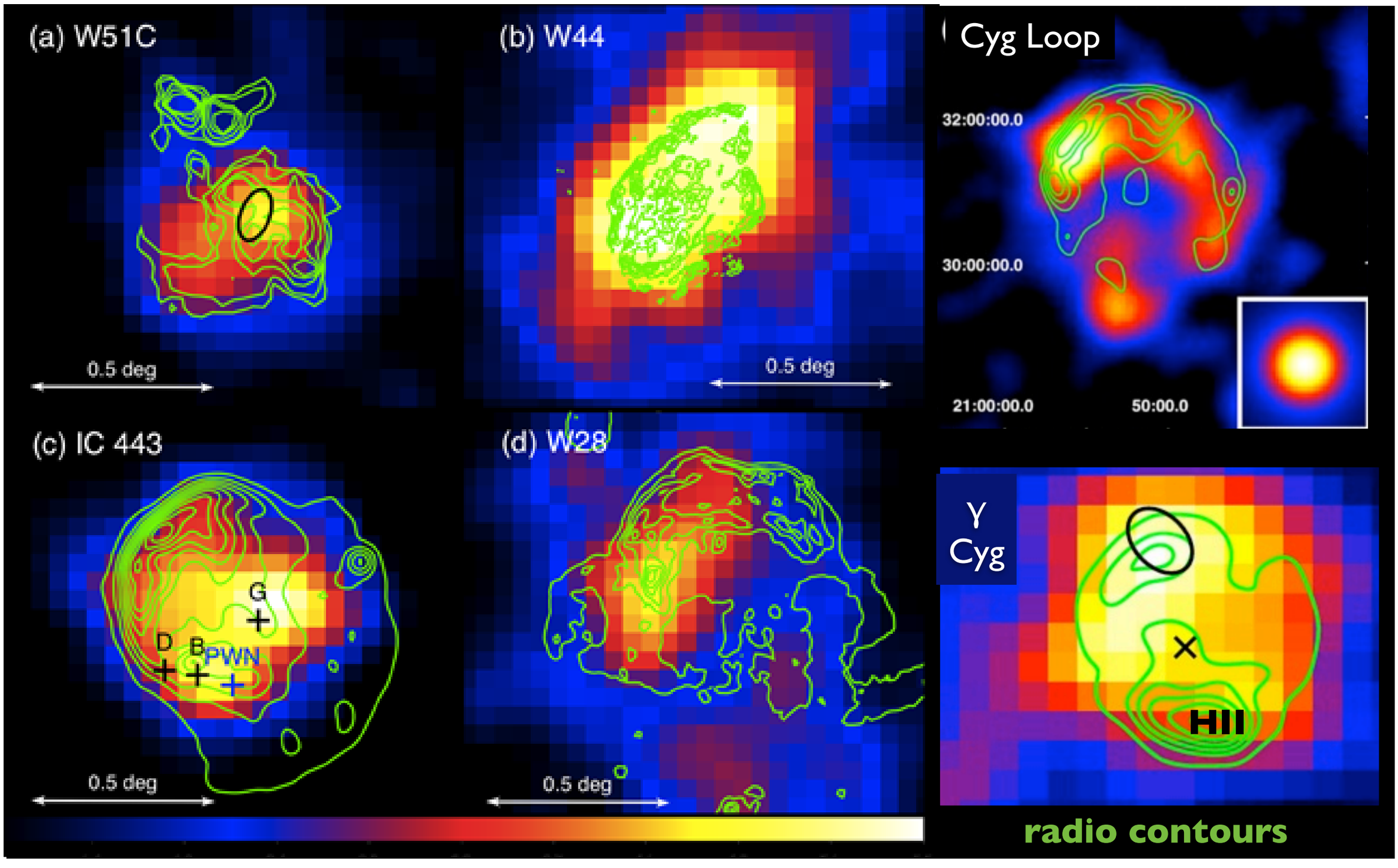
new: inclusion of extended sources



gallery of GeV supernova remnants

with H_2 cloud interaction

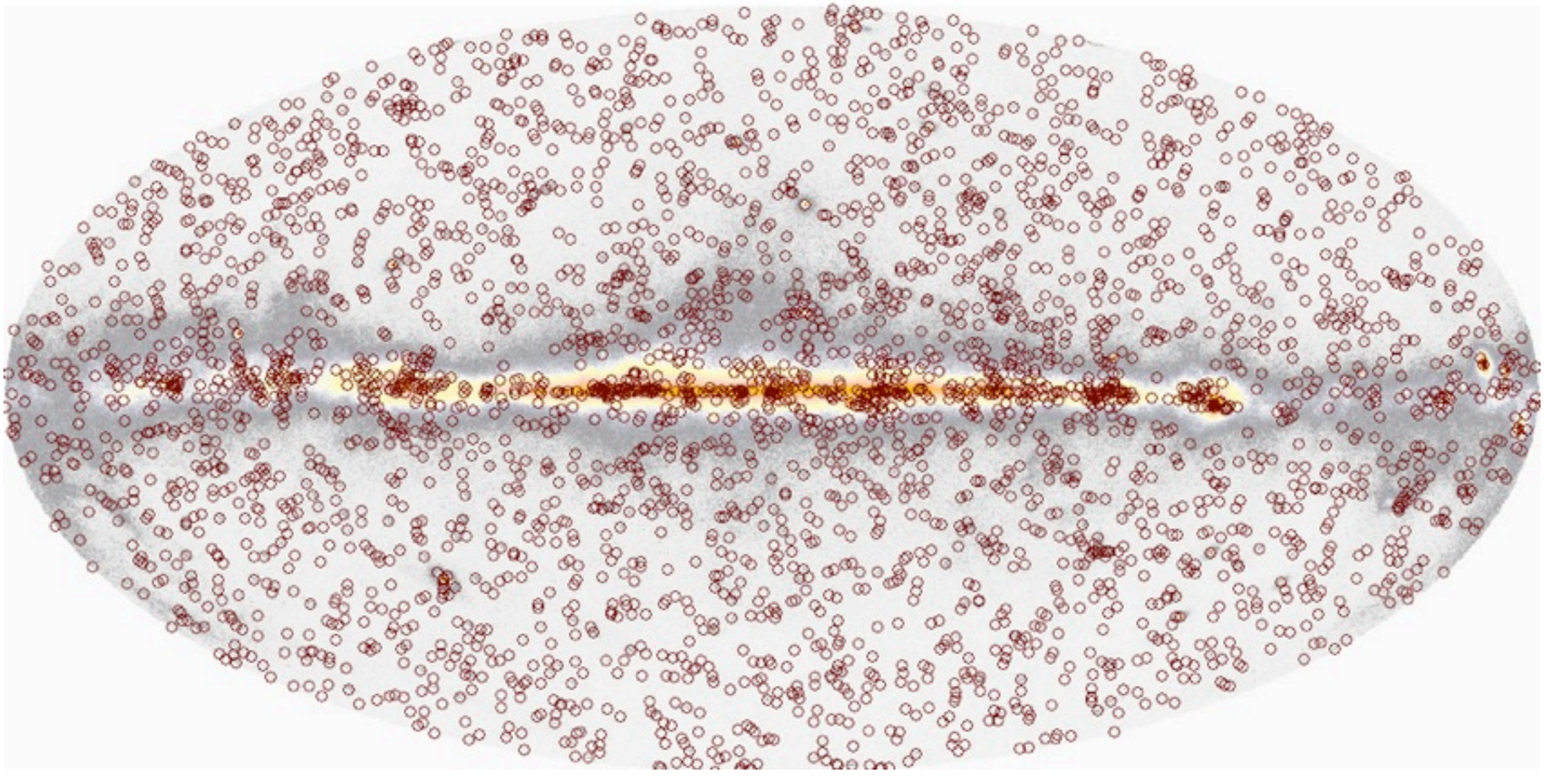
without



PRELIMINARY

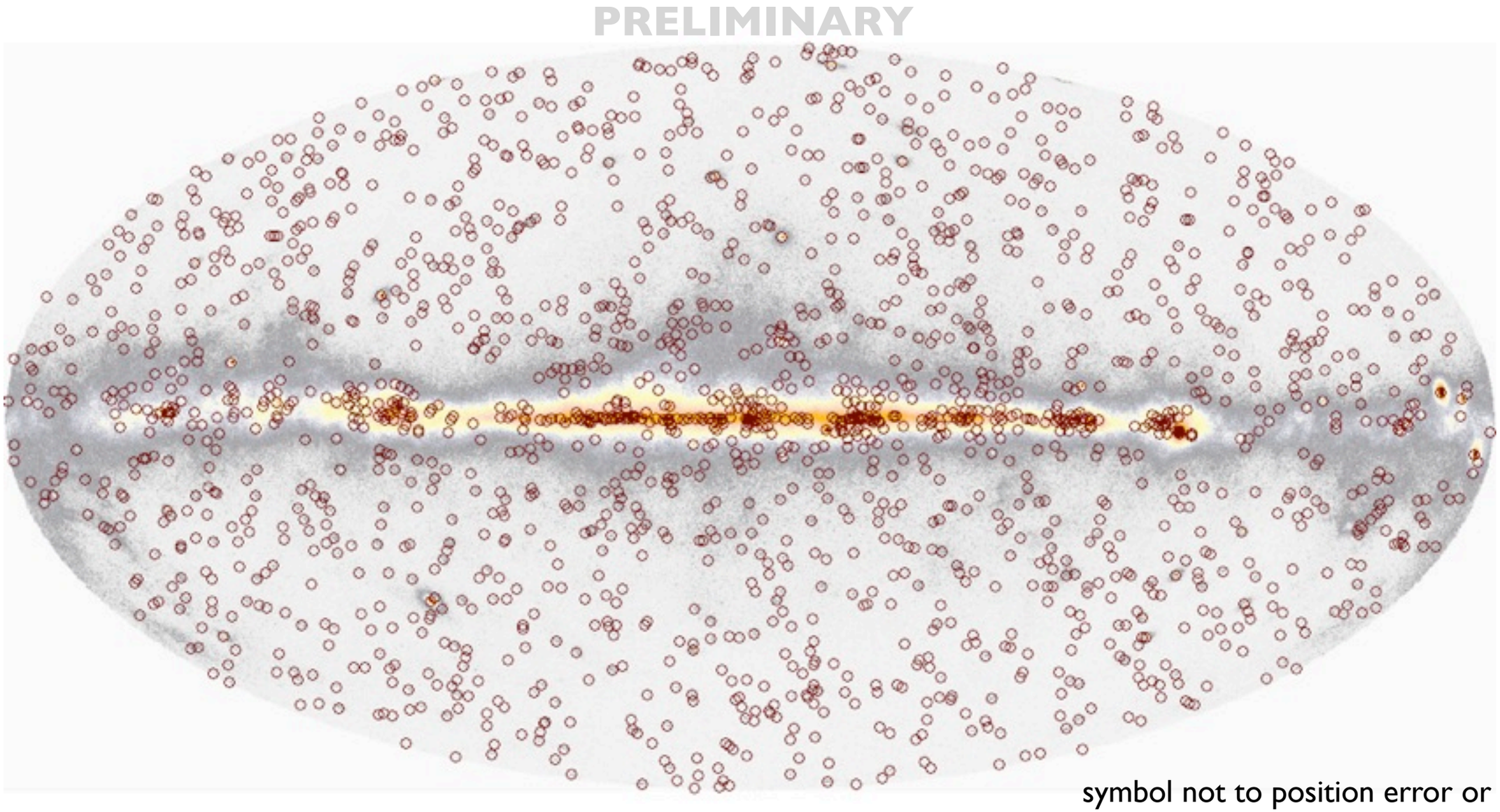
new: multi-search for seeds

- initial seed list = 1FGL +
  - wavelet detected sources (MRFilter, PGwave)
  - high-energy γ clusters (Minimal Spanning Tree)
  - TS map clusters with TS > 10 (Pointlike)
- ⇒ ~ 3500 seeds in the 2-yr data



source significance & location

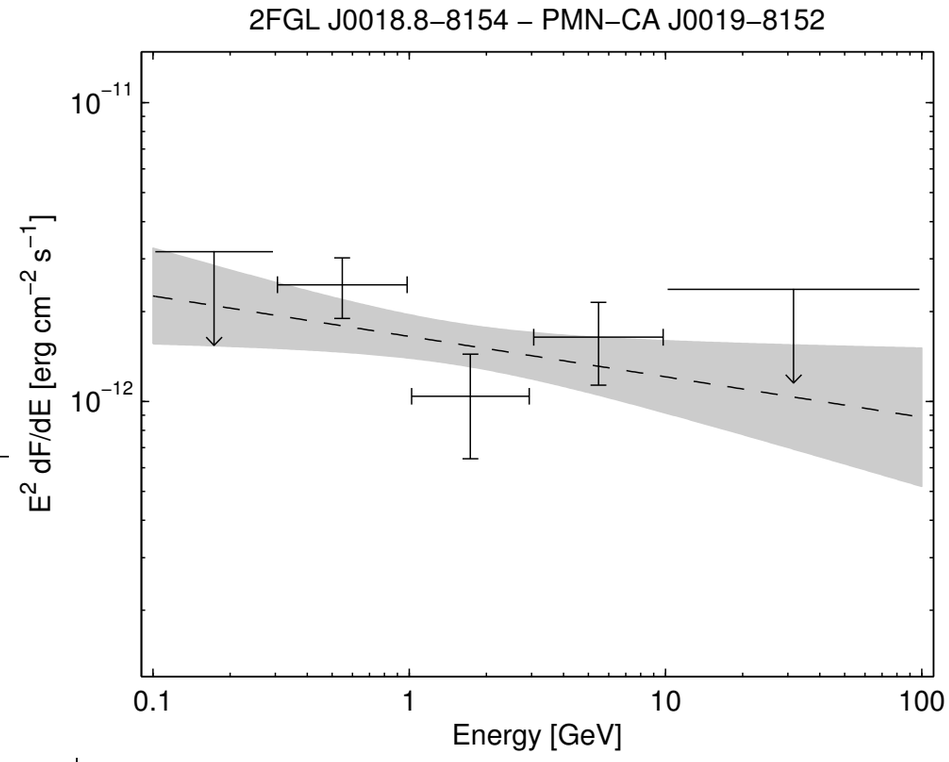
- 1873 sources with TS > 25 (~ 4 σ)
- 68% and 95% confidence ellipses
  - from Pointlike TS maps
  - formal error * 1.1 as in 1FGL

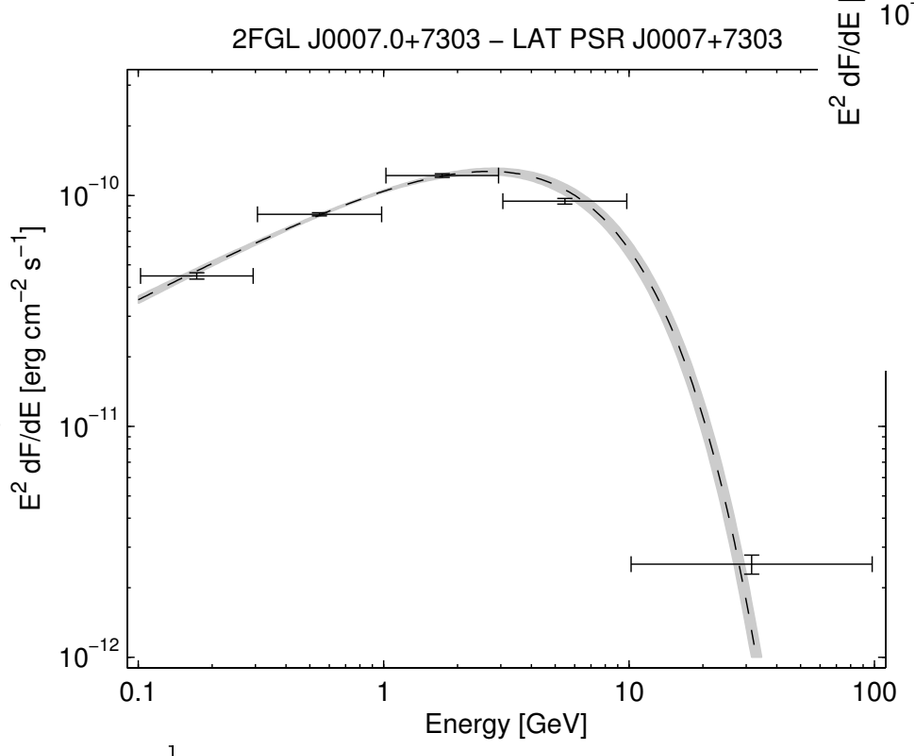


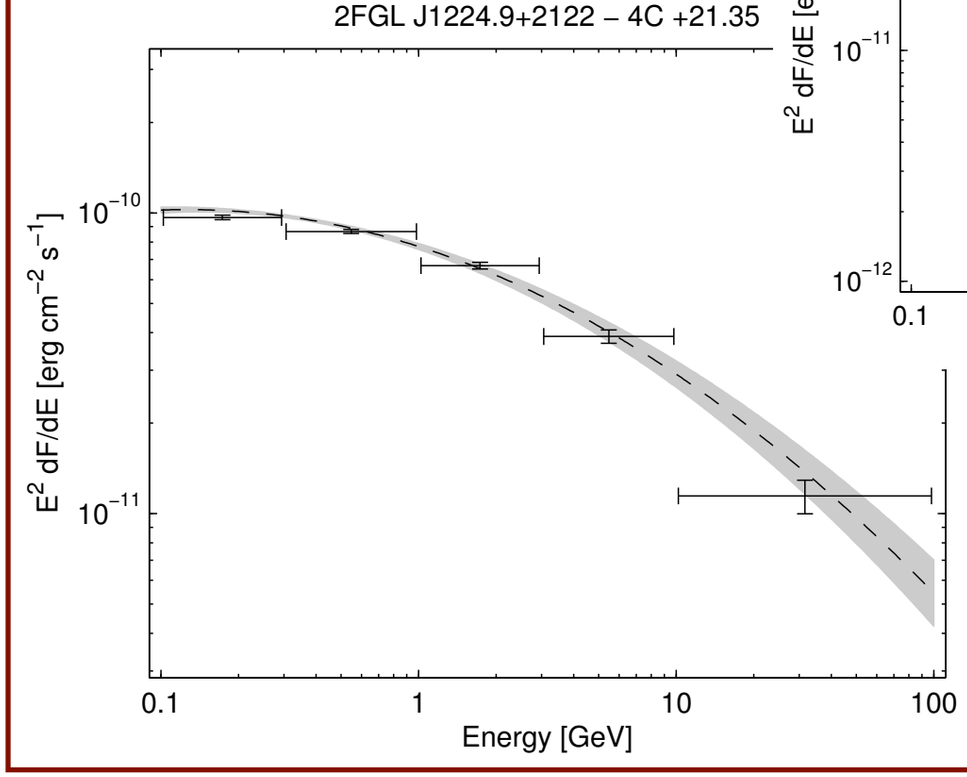
symbol not to position error or PSF scale

source characterization

- new spectral shapes: power-law, exponential cut-off, log-parabola
  - likelihood test for best shape
- flux in 6 bands
  - 0.03-0.1-0.3-1-3-10-100 GeV

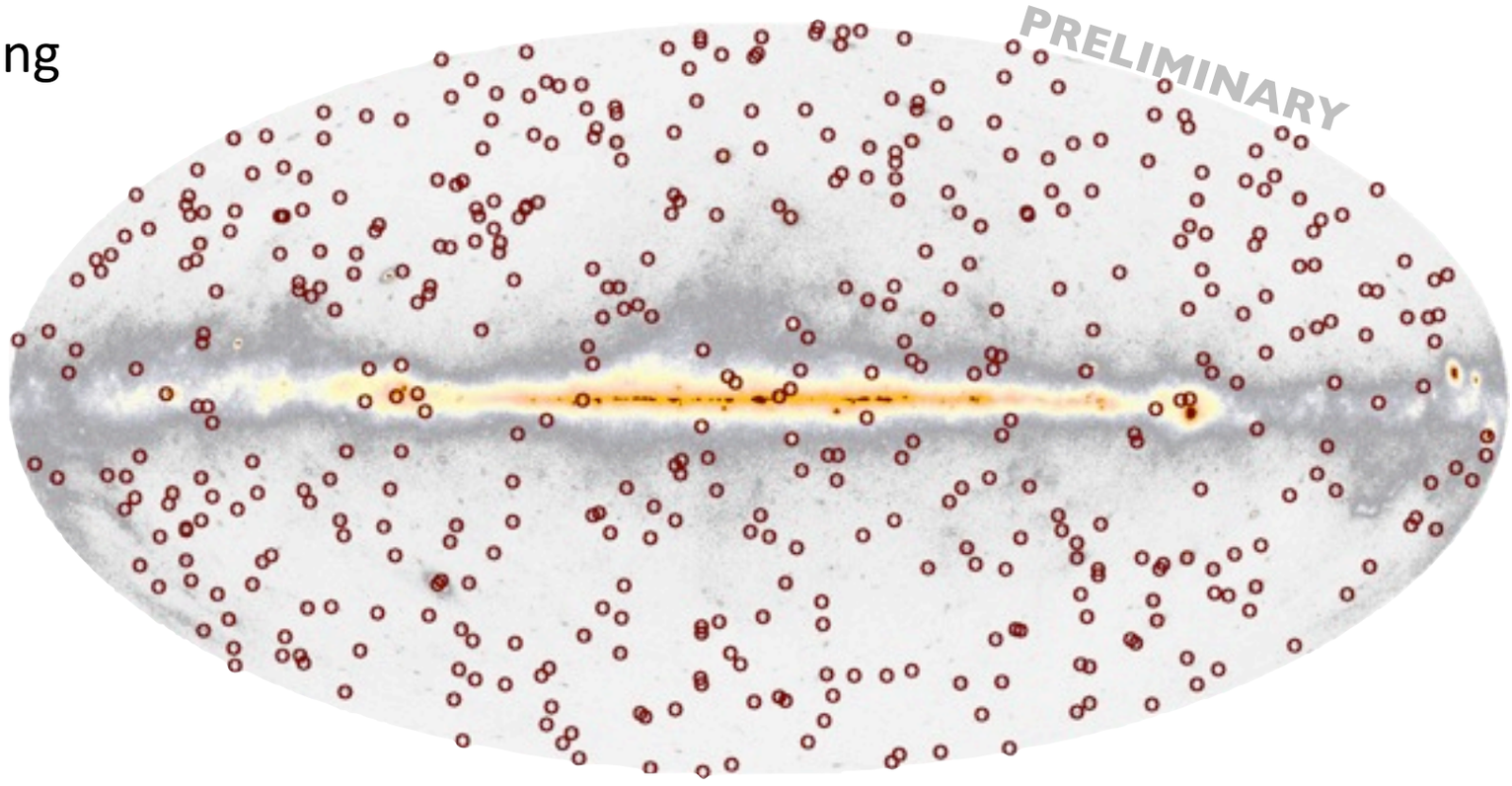






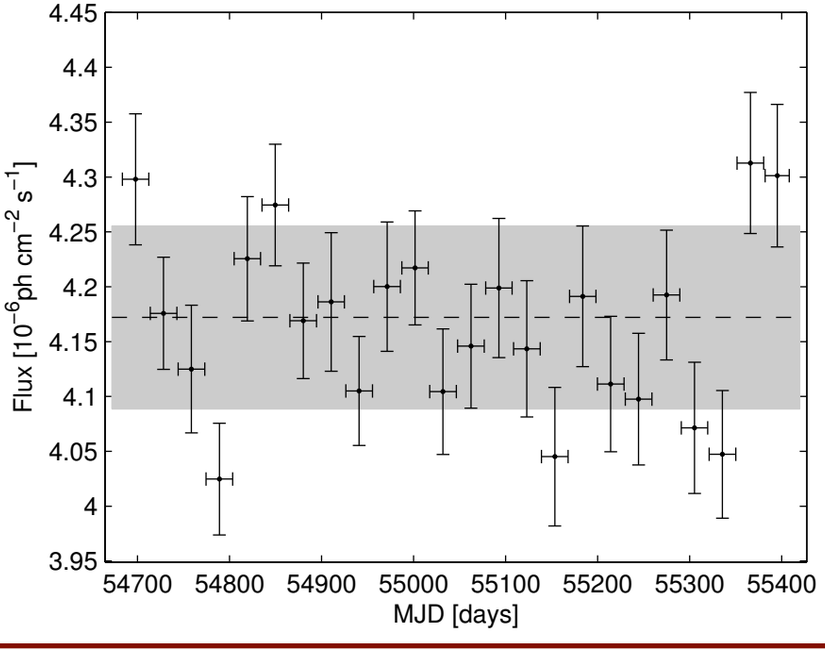
flux history & variability

- 2FGL sources = detected with TS > 25 in 2-yr data
  - ⇒ a few short transients missing
- flux history per month
- variability index
  - 458 variable sources
    with $TS_{var} > 41.6$



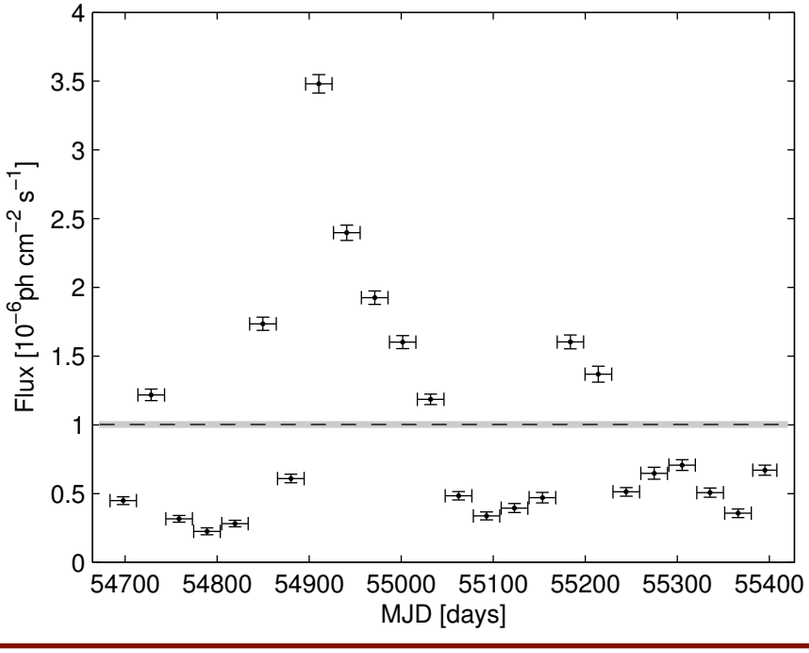
quiet pulsar

2FGL J0633.9+1746 – PSR J0633+1746, Geminga



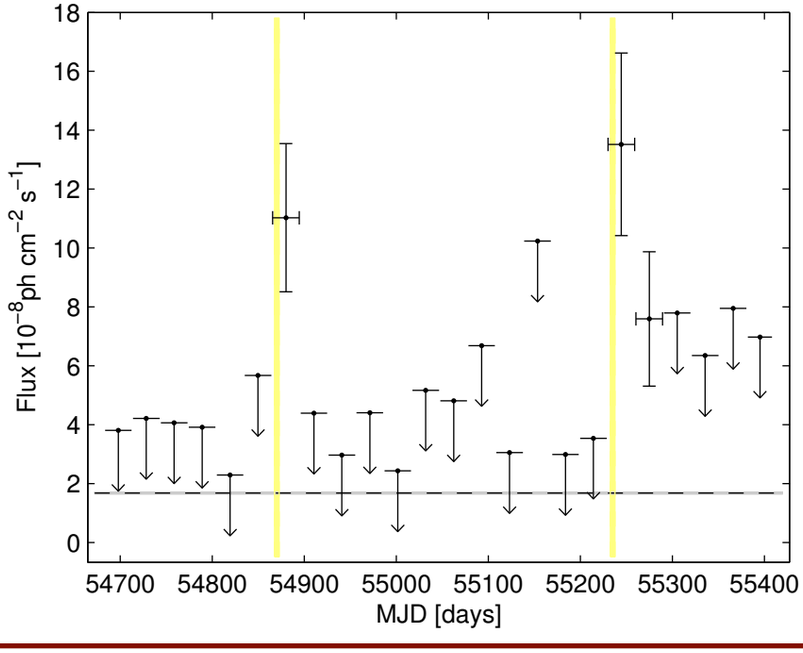
flaring blazar

2FGL J1512.8–0906 – PKS 1510–089



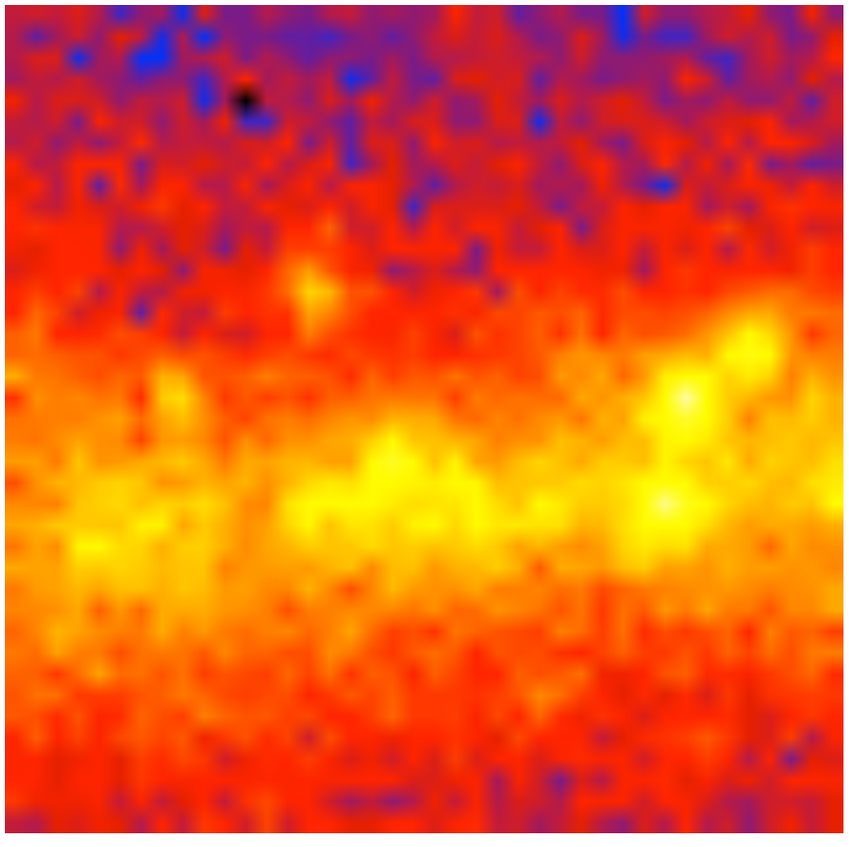
Sun contamination

2FGL J2124.0–1513

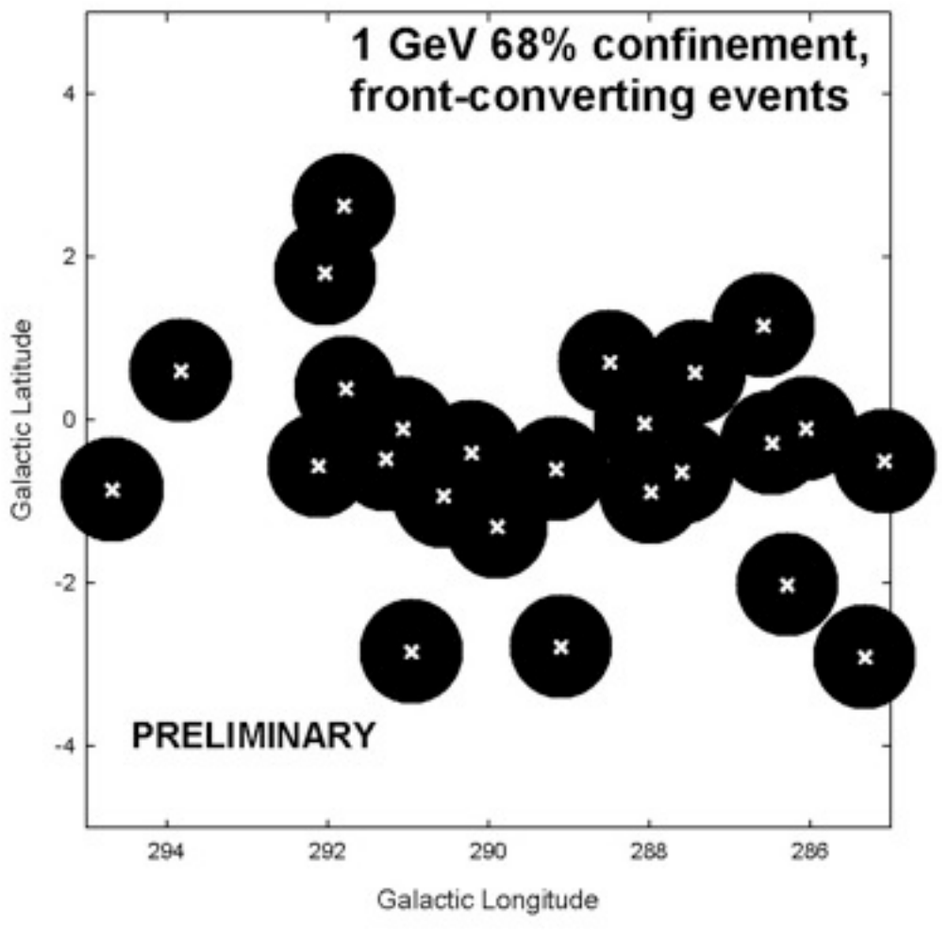


confusion & analysis flags

- confused neighbours in the Gal. ridge
  - limited confusion off the plane (5.5% missed sources vs. 7.6% for 1FGL)
  - flag “5”
- un-modelled diffuse excesses filled with sources, or uncertain source properties because of the underlying background
  - flag ‘c’ and numbered flags



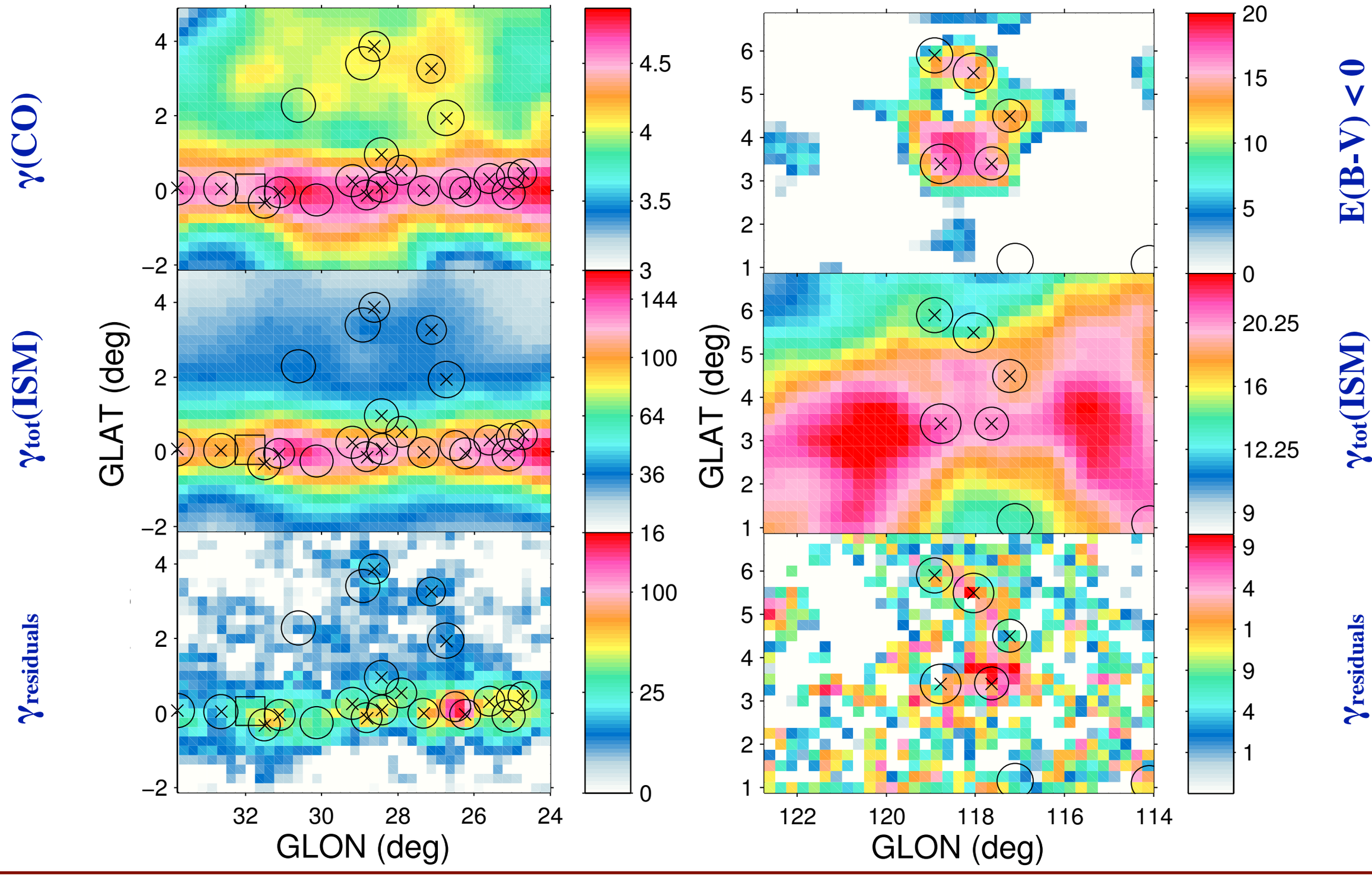
Counts map E > 1 GeV



- Sun contamination and spectral difficulties also flagged

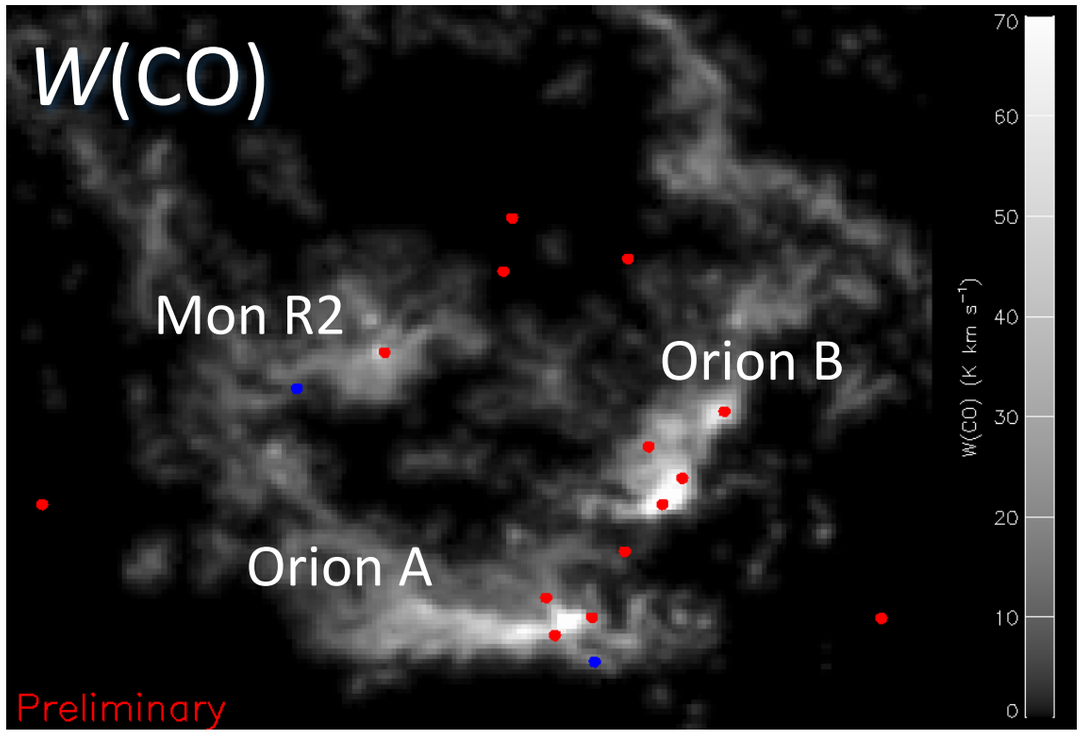
‘c’ = diffuse confusion

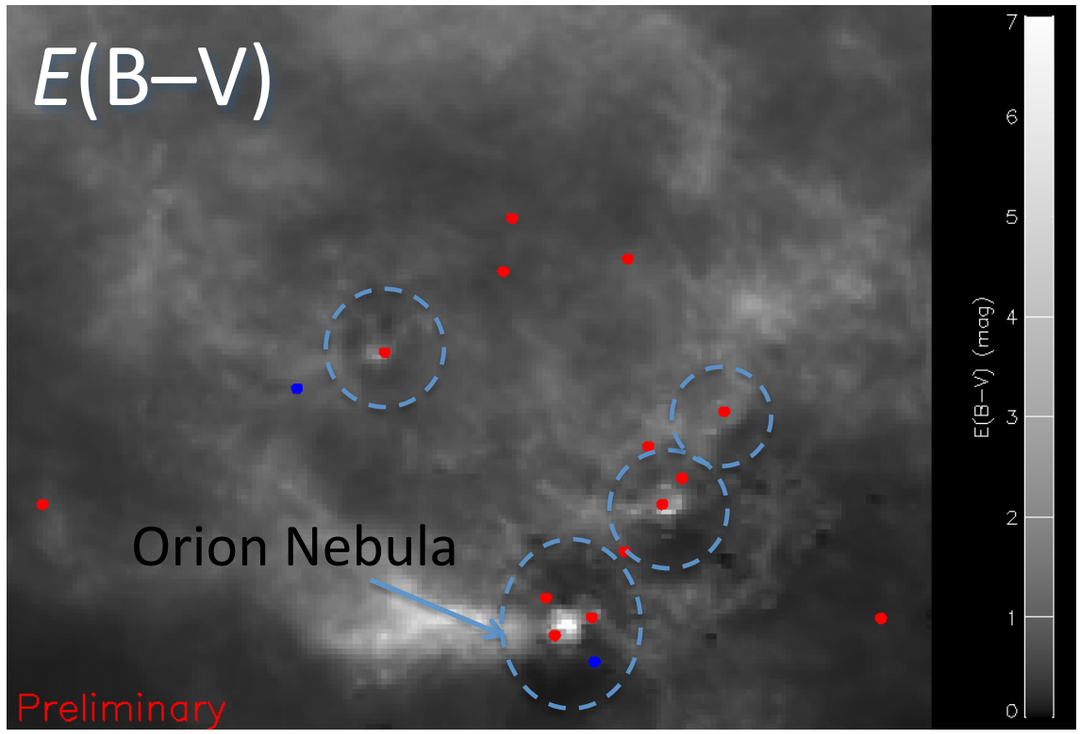
- 50% containment PSF radii at 1-10 GeV

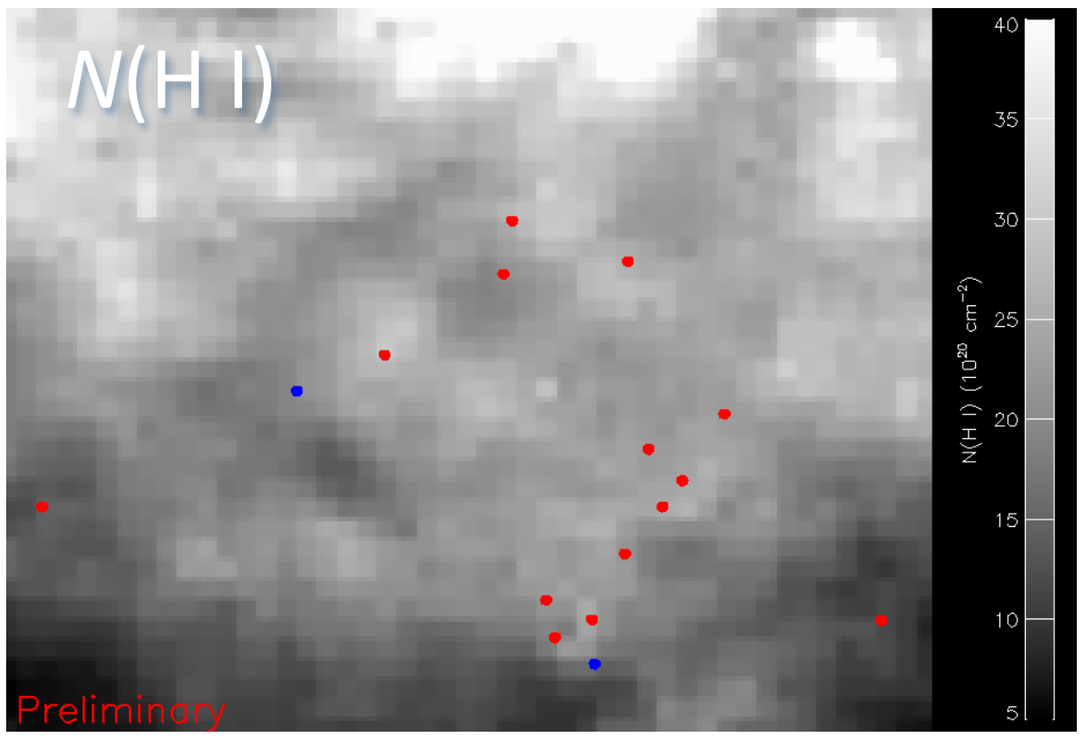


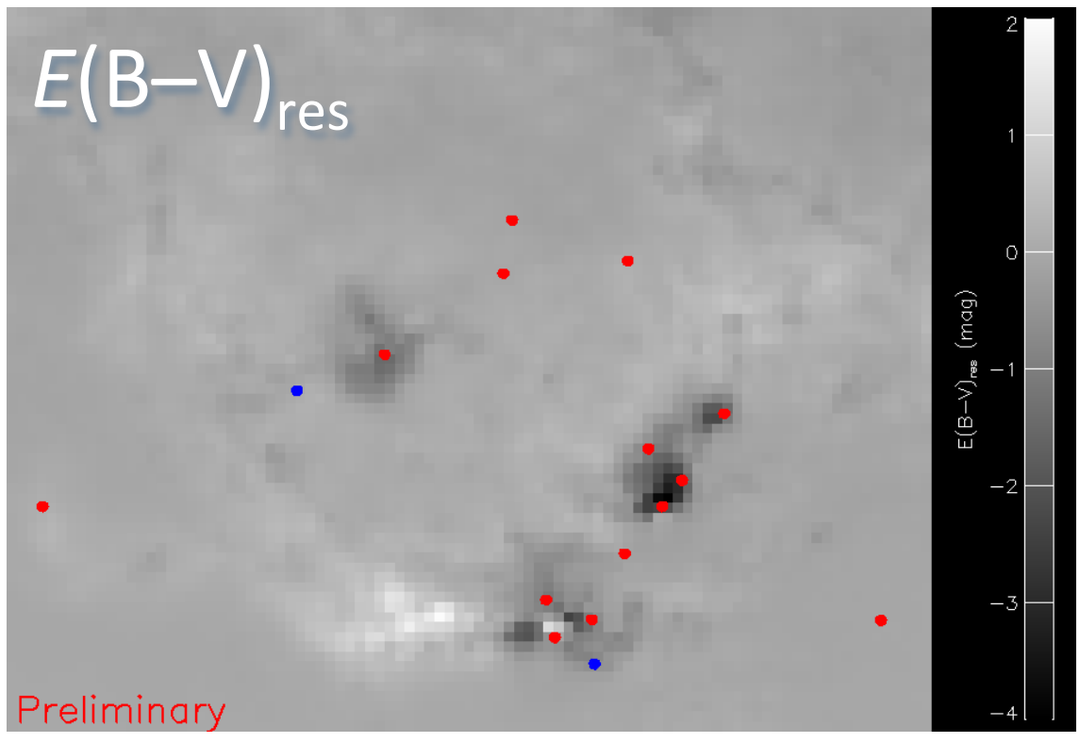
‘c’ = diffuse confusion

- dust temperature correction problems



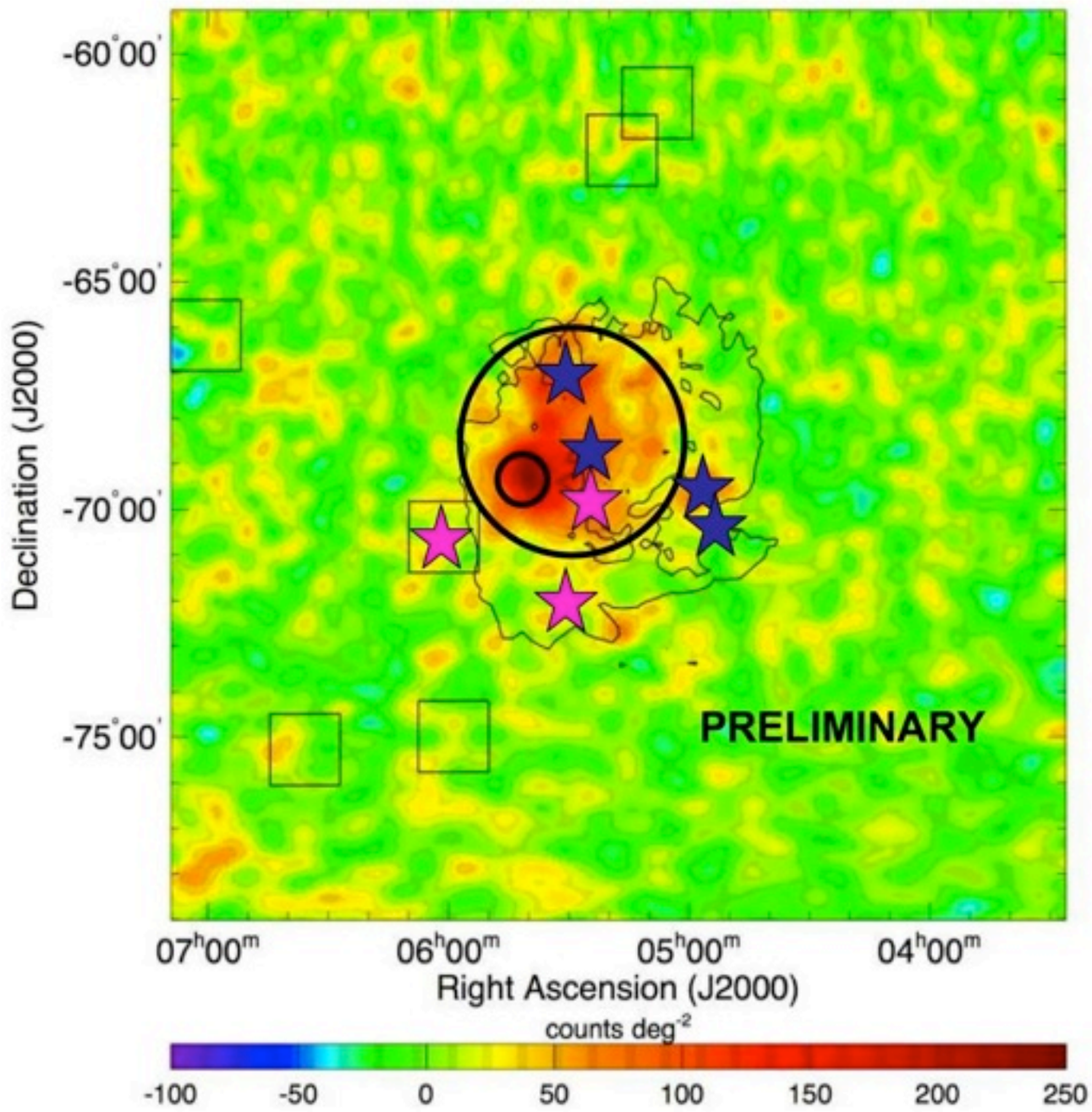






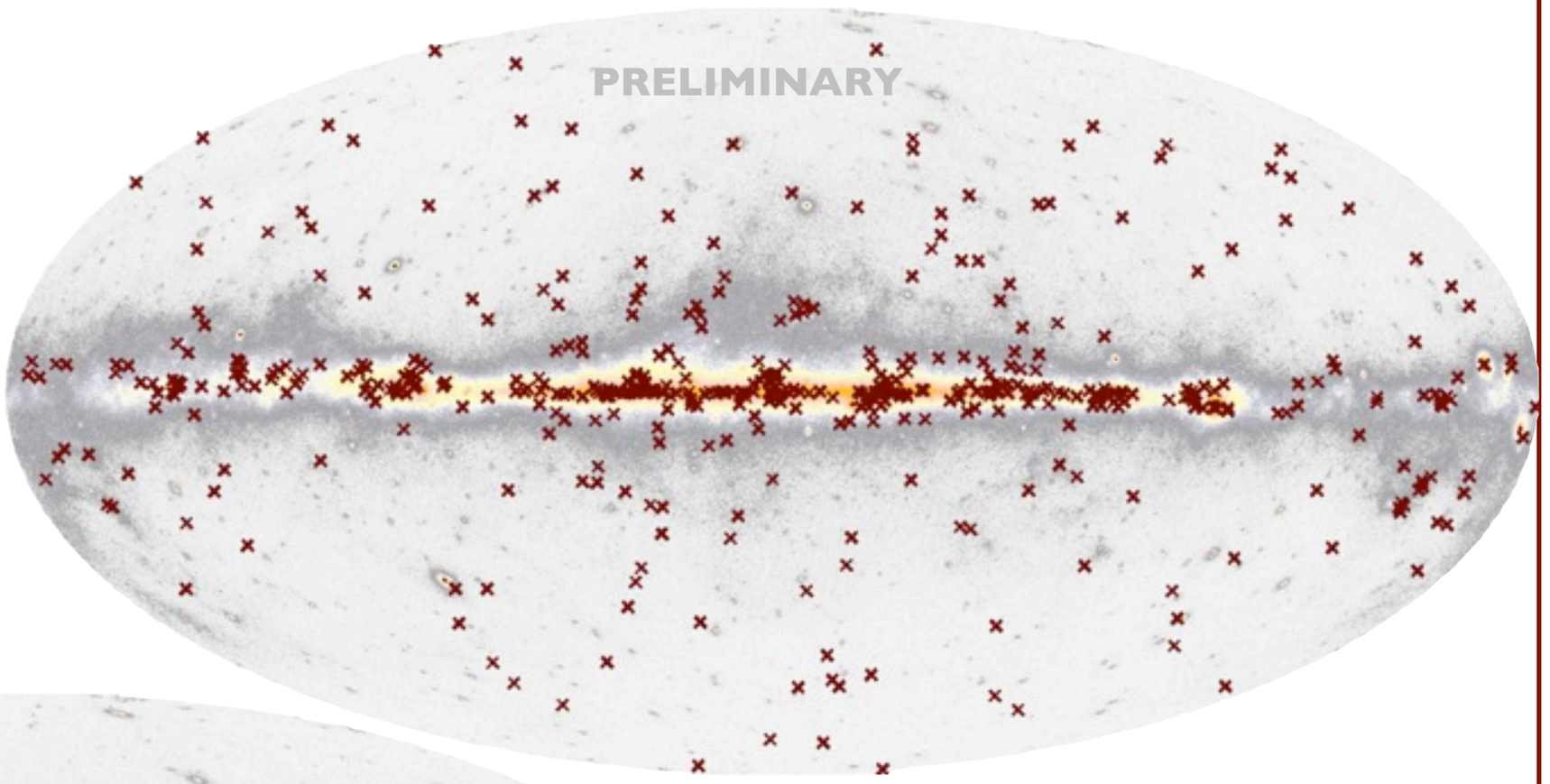
spatially extended sources models

- "best" templates for the 12 extended sources in 2FGL, but not perfect
- ex: LMC
  - 3 blazar/radio source associations
  - ≥ 3 probable artifacts

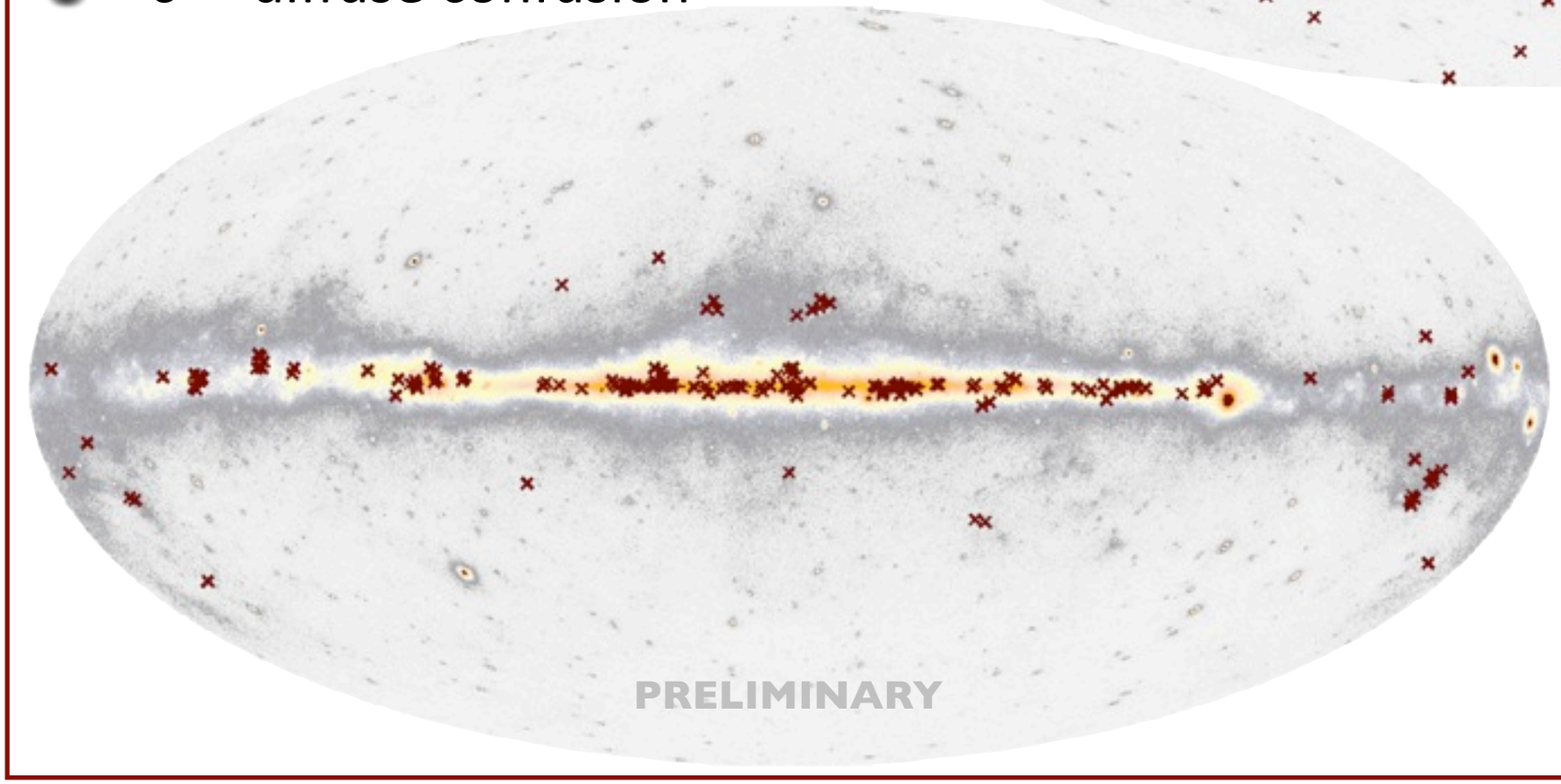


flagged sources

- all flags

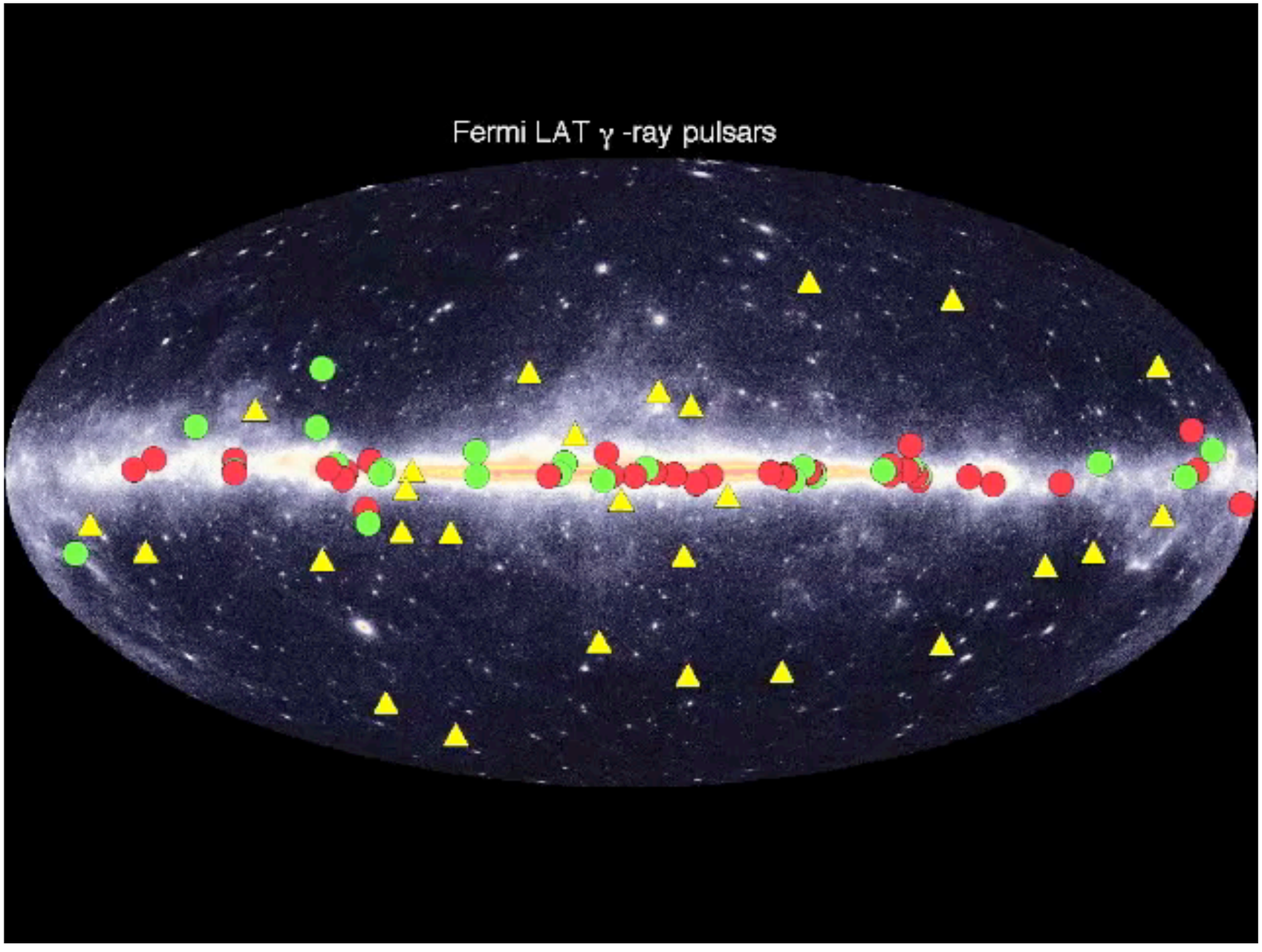


- ‘c’ = diffuse confusion



identified 2FGL sources

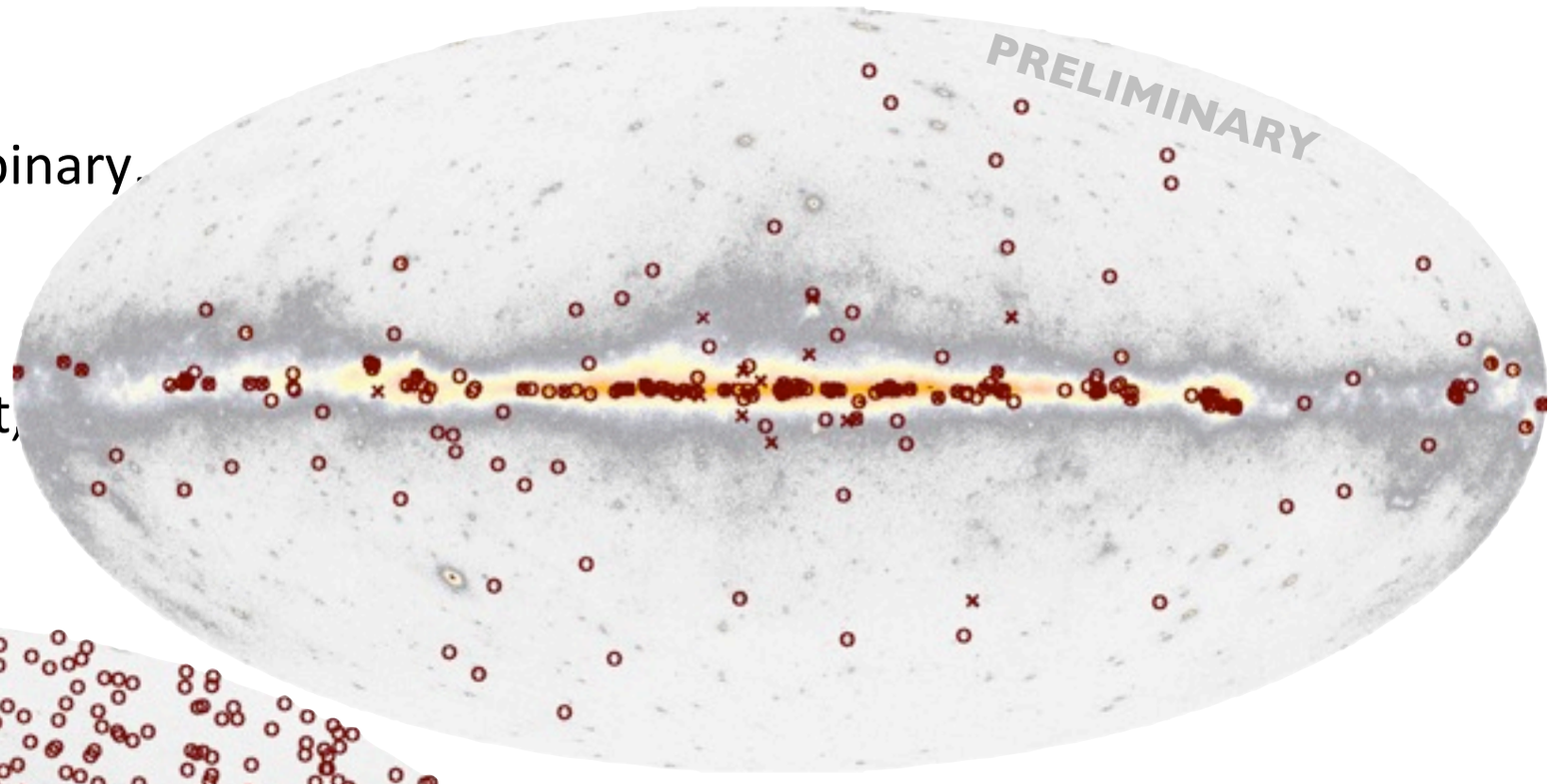
- 127 sources firmly identified (by timing or morphological signature):
  - 83 pulsars, 3 PWN, 6 SNR, 4 binaries, 1 nova
  - 24 blazars, 1 agn, 2 radiogal., 1 Seyfert gal., LMC, SMC

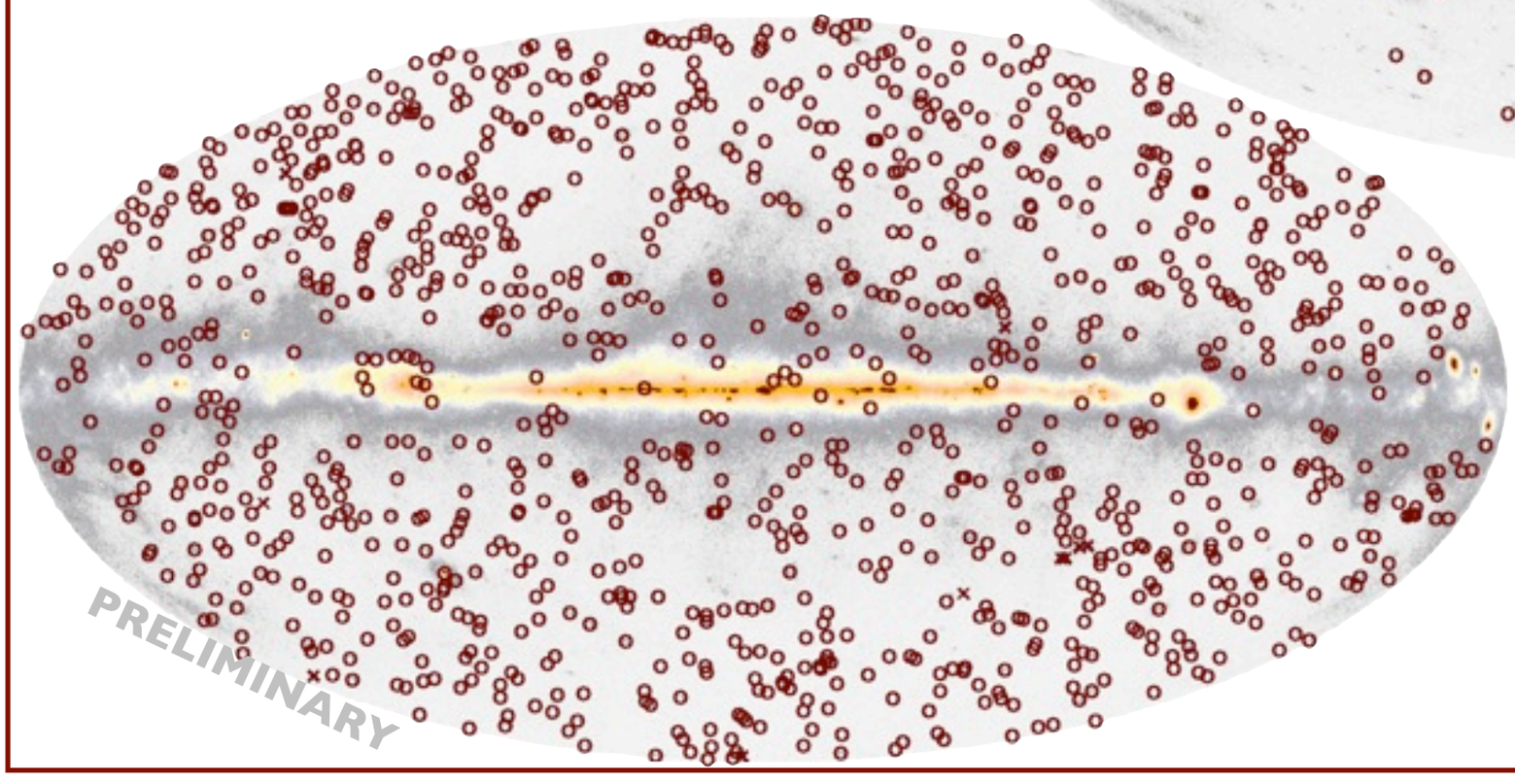


ms
radio-loud
radio-quiet

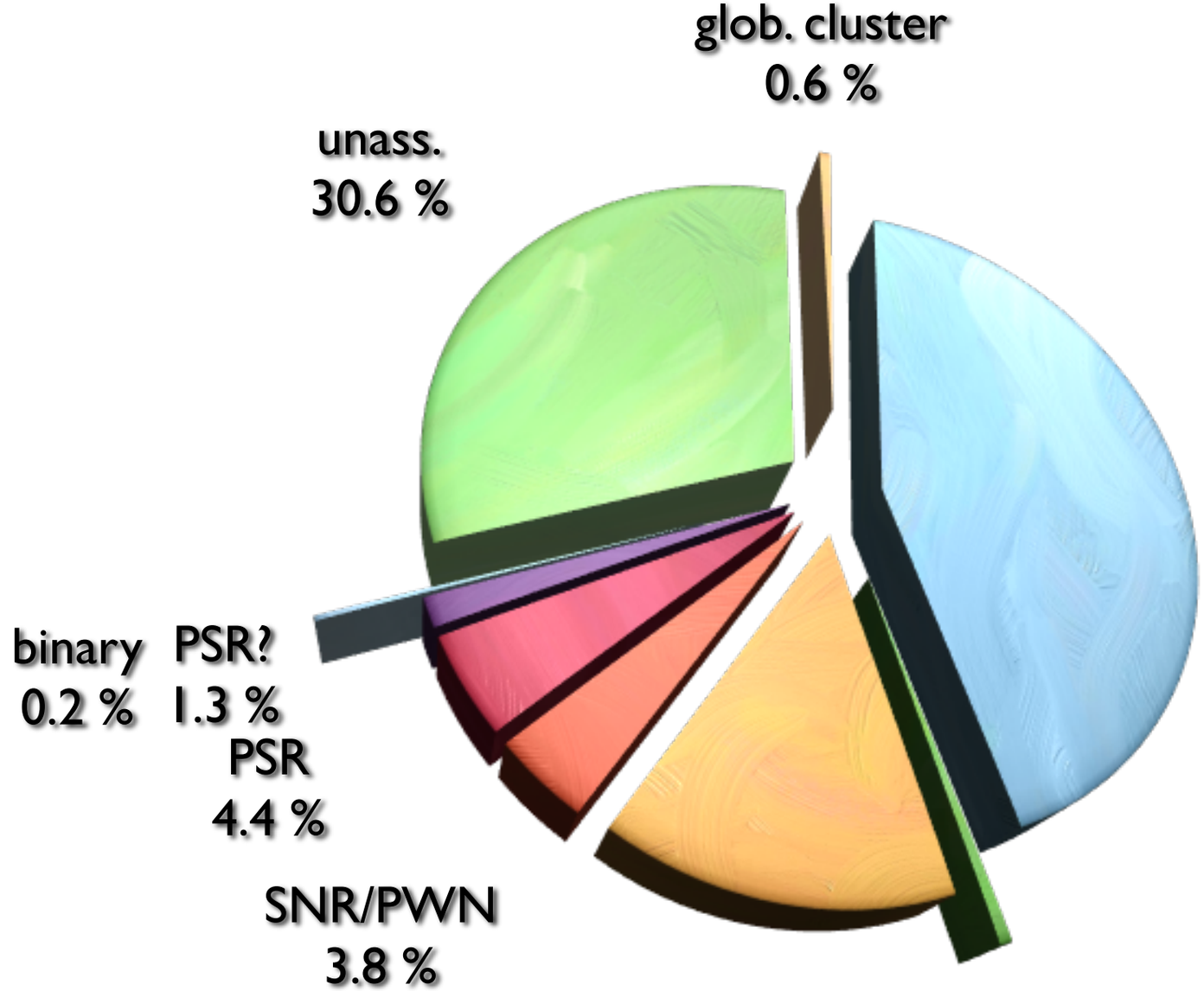
source associations

- Bayesian probability analysis based on the local density of sources from catalogs of likely γ-ray emitters. Additional tests by the LAT AGN group
  - $\langle \Delta\theta \rangle \sim 7'$
  - 195 galactic
    - o = PSR, SNR, PWN, high-mass binary
    - x = glob. cluster, nova
  - 1105 extragalactic
    - o = blazar, agn, radiogal, Seyfert,
    - x = normal & starburst galaxies





2FGL associations

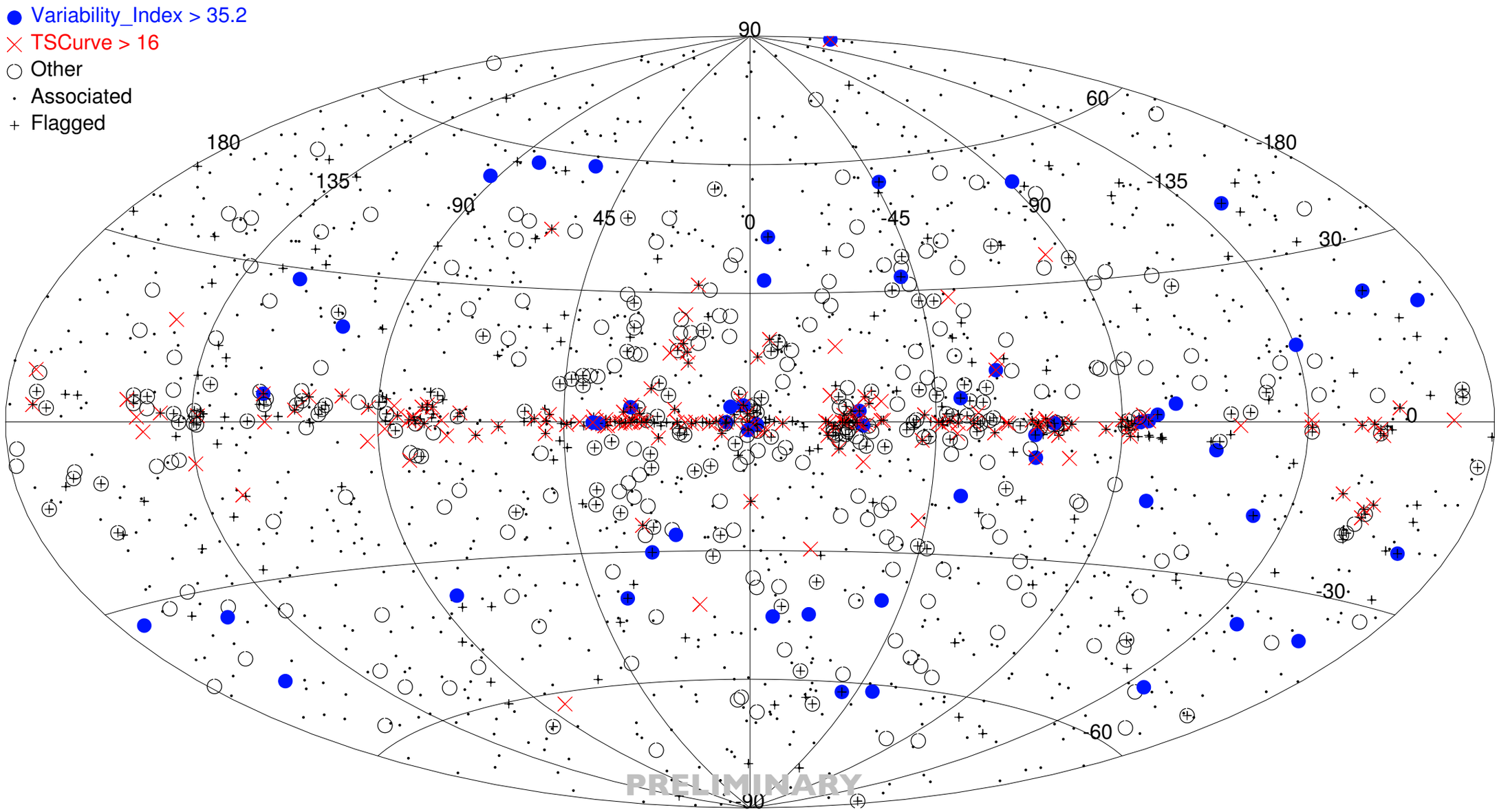


no gal. clusters
no dwarf spheroidals

AGN galaxies AGN? SNR/PWN PSR
PSR? binary unass. glob. cluster

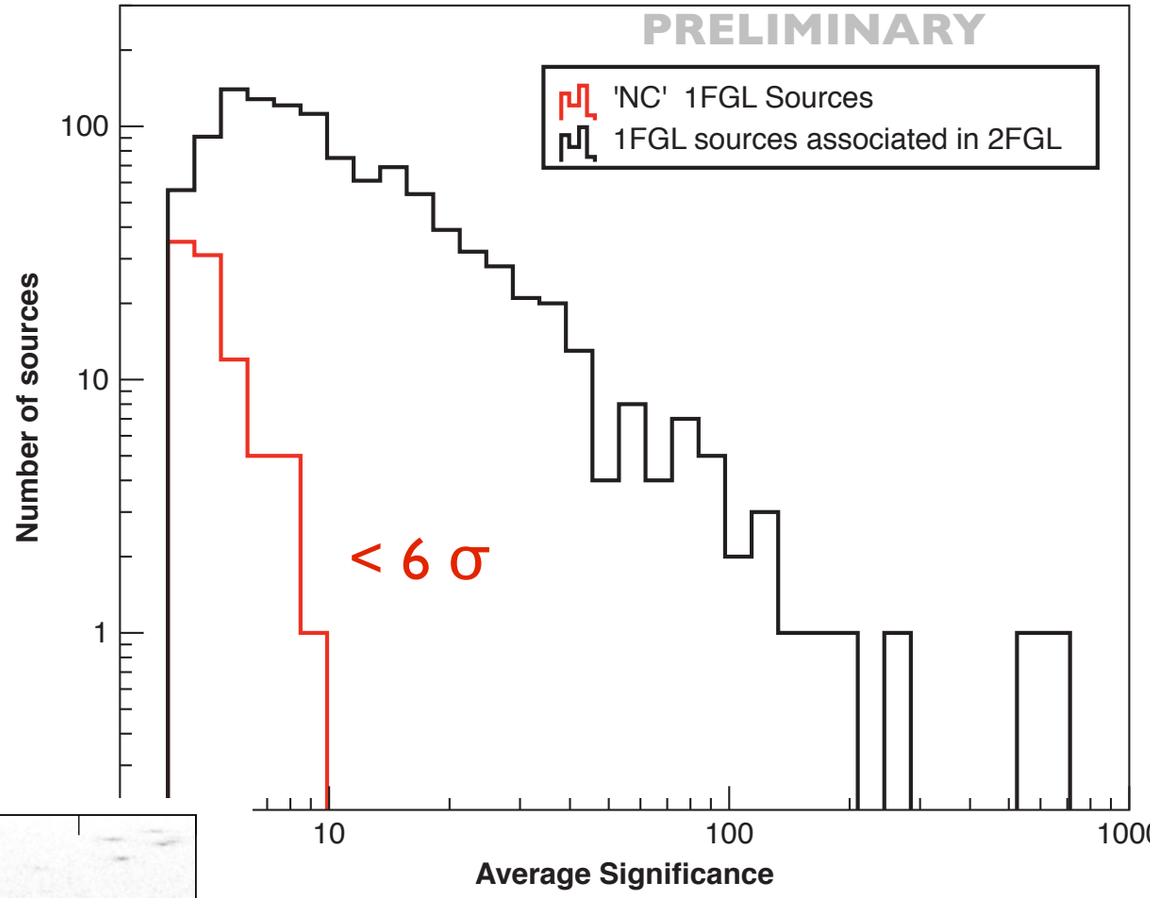
unassociated sources

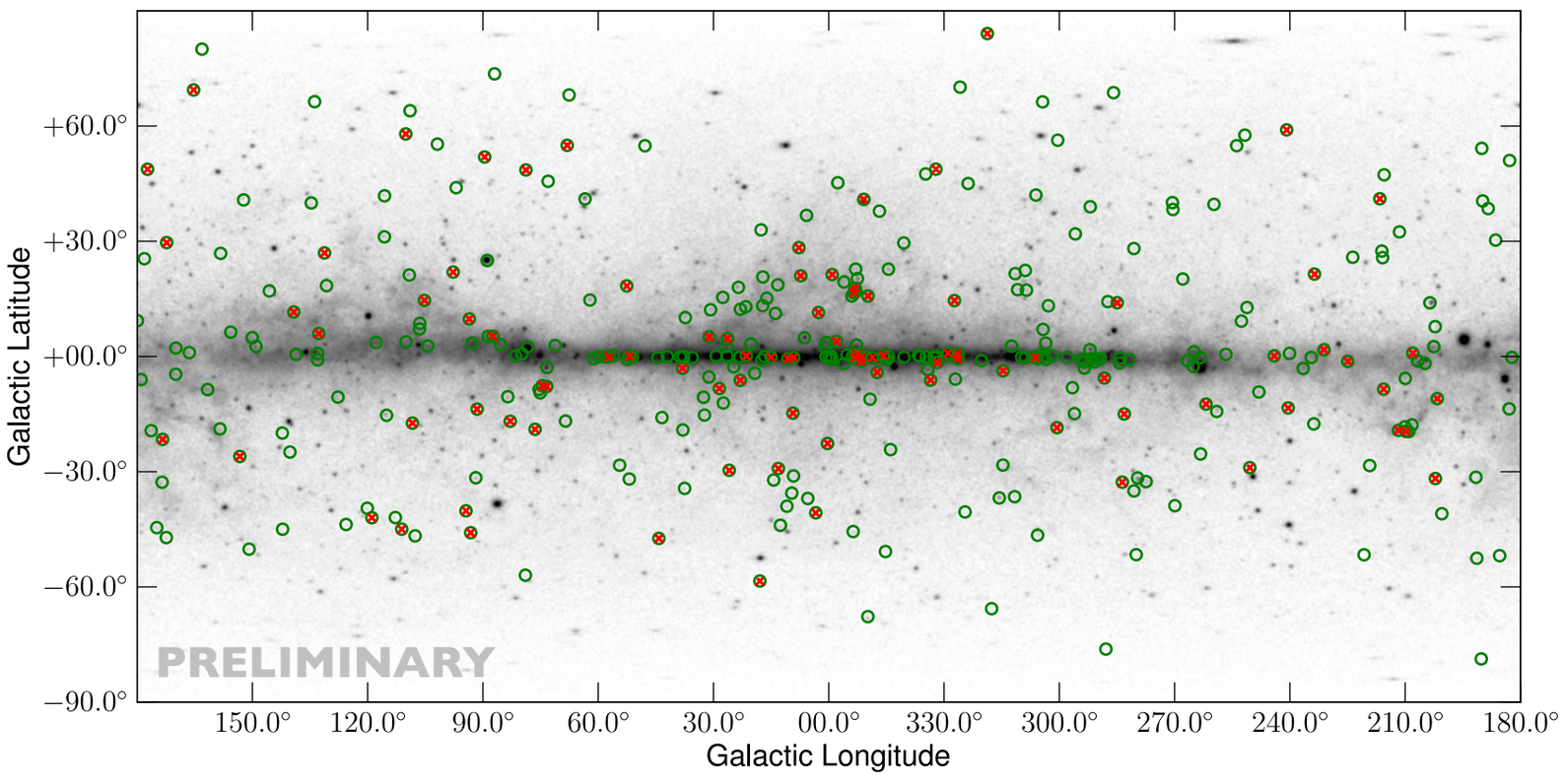
- targets for discoveries



2FGL versus 1FGL

- 352 1FGL sources not found in 2FGL
  by overlapping 95% error region
  - different photons
  - different TS estimate
    unbinned likelihood TS somewhat optimistic
  - new diffuse background & extended sources
  - 88 1FGLc + 21 with other flags
  - only 67 had associations in 1FGL
  - threshold + variability + split in two





not in 2FGL
not confirmed by reanalysis
of 11 months
8 var + 4 Sun + 89

Fermi LAT sources catalogues