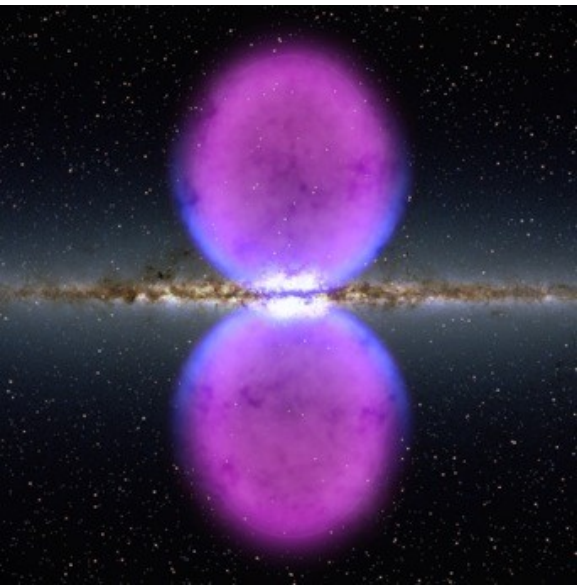
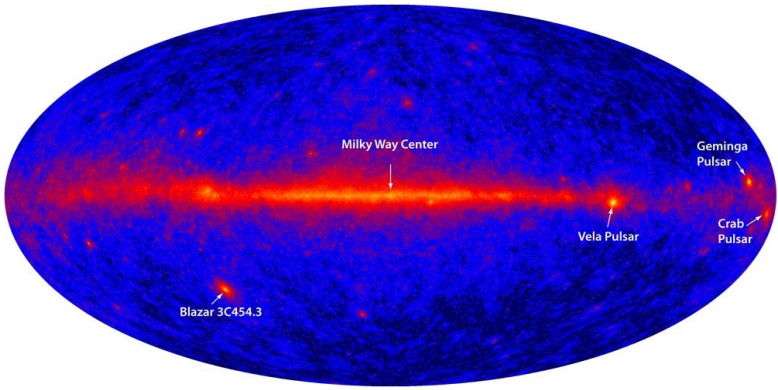
IC59+IC40
Extended Source Searches

The Galactic Plane &
The Fermi Bubbles





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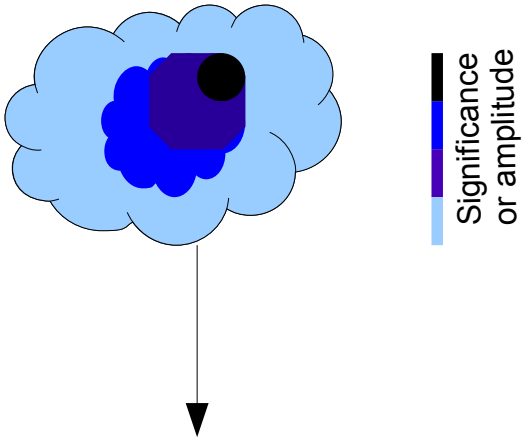
For the icecube point source working group

Likelihood Analysis with Spacial PDF Maps

Some extended source with structure



Grid the source and get the relative weights of expected signal at each point

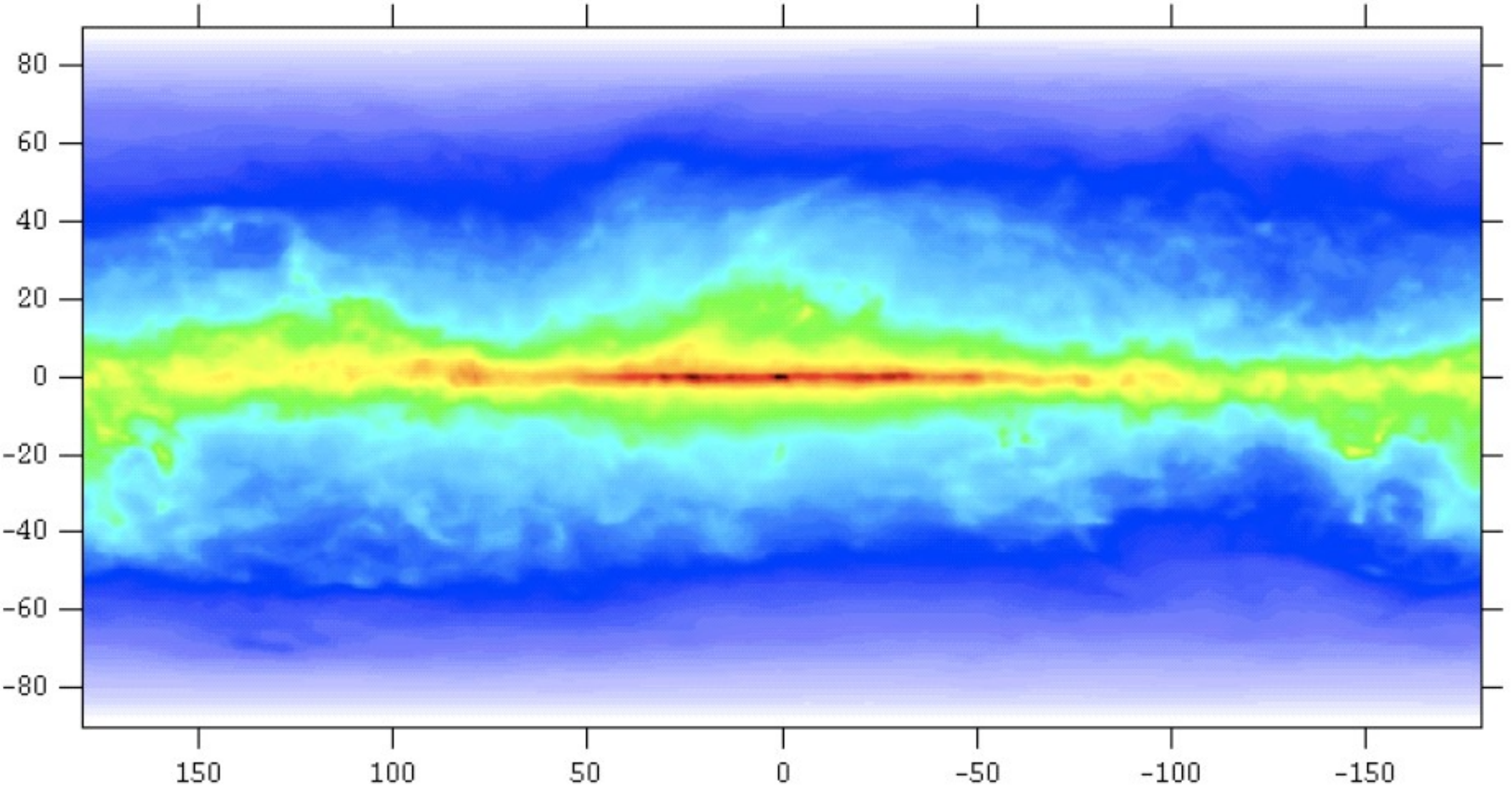
Fit all points <u>simultaneously</u> with correct weighting

A lot like a stacking analysis

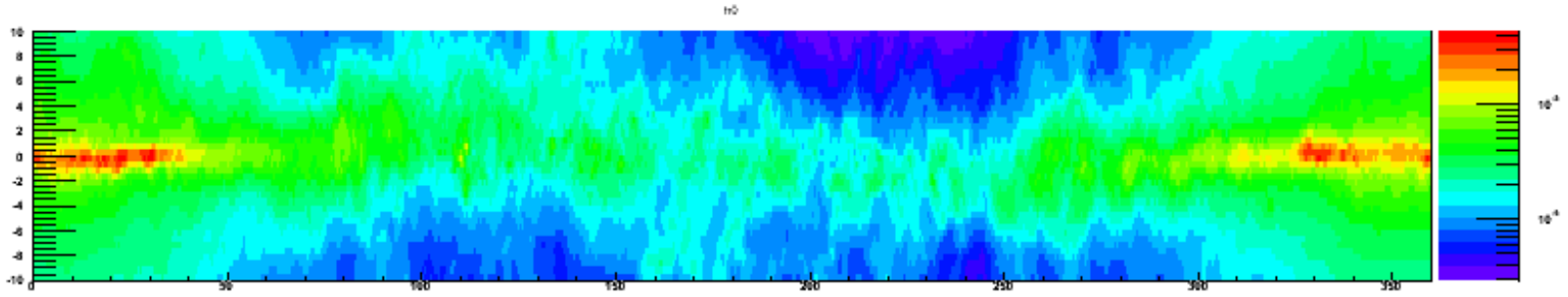
$$S \rightarrow \frac{Wi}{\Sigma Wi} Si$$

Delta functiion + PSF treatment

Galactic Plane

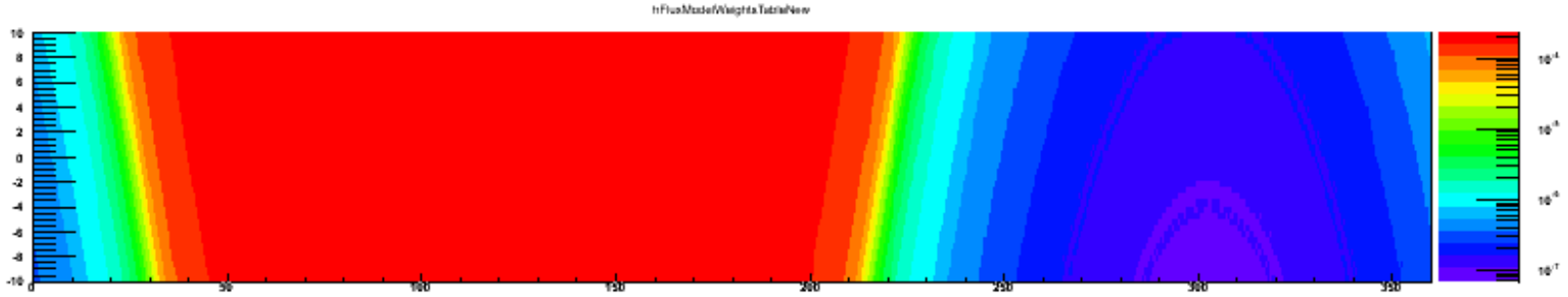


Gamma-ray properties are measured
If gamma-rays come from pion/other meson decays, neutrinos should be proportional
We already have a density map thanks to Fermi measurements and GALPROP.



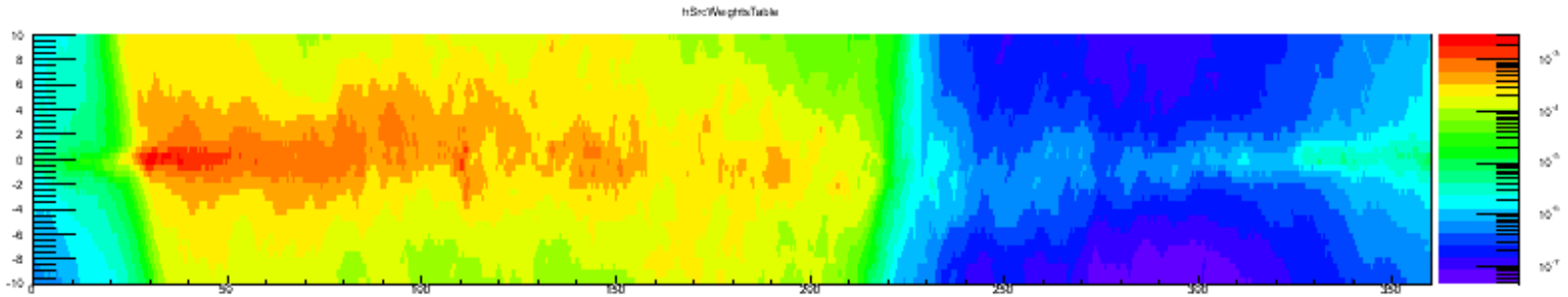
Expected Flux

X

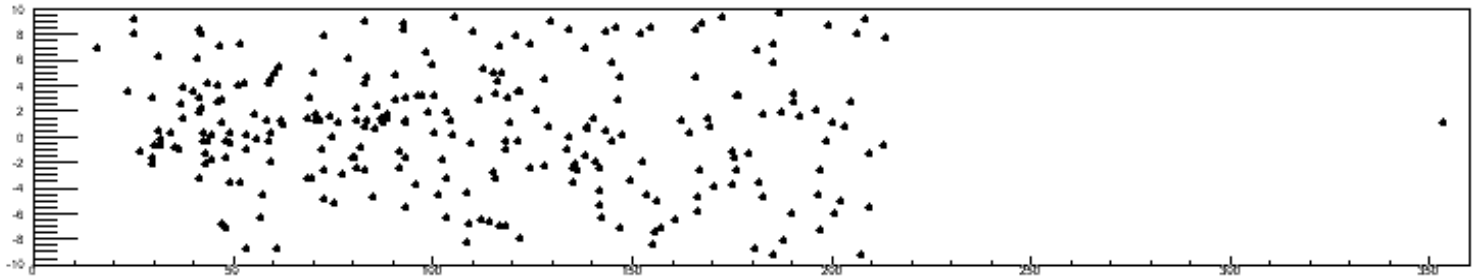


Detector Response

=



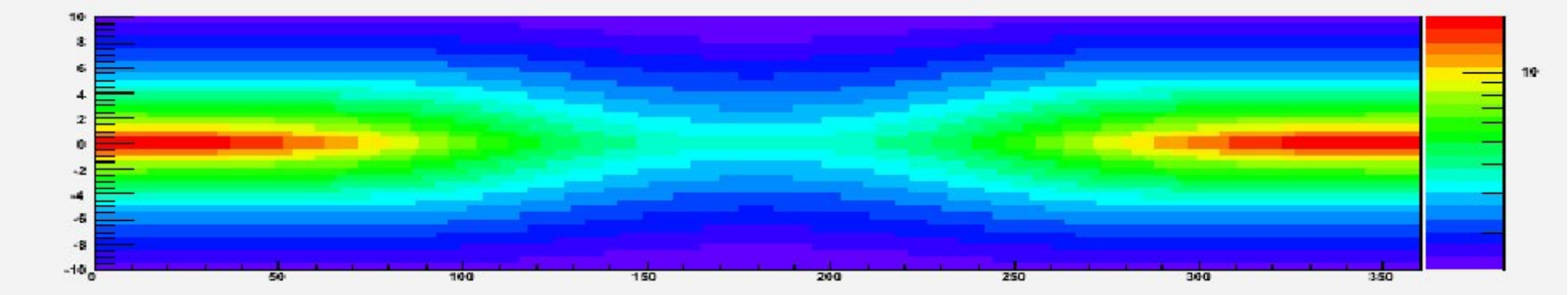
Where we expect to see signal



Model Prediction and Sensitivity

Preliminary!

Ingelman & Thunman (1996)



Simplified model of the galactic plane

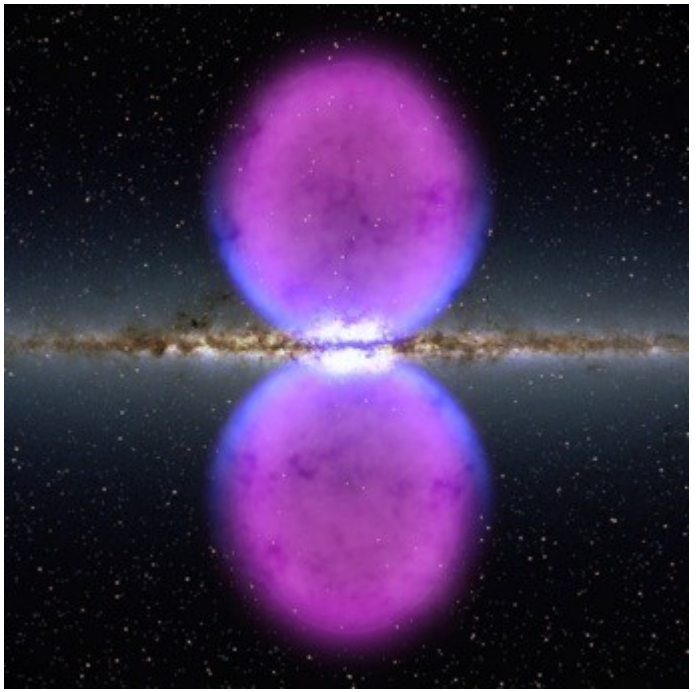
- ρ_{ISM}=1 nuclei/cm^3 * exp(-h/0.26kpc)
- CR flux throughout galaxy same as at Earth

21 Events Expected (IC40+IC59) from this model

To see an over-fluctuation (P-value<50%) 90% of the time

→ **90% Sensitivity: 1.7 x 10^{-4} $(E/GeV)^{2.7}$ [$GeV^{-1}cm^{-2}s^{-1}$]**

*Integrated Flux, 155 events



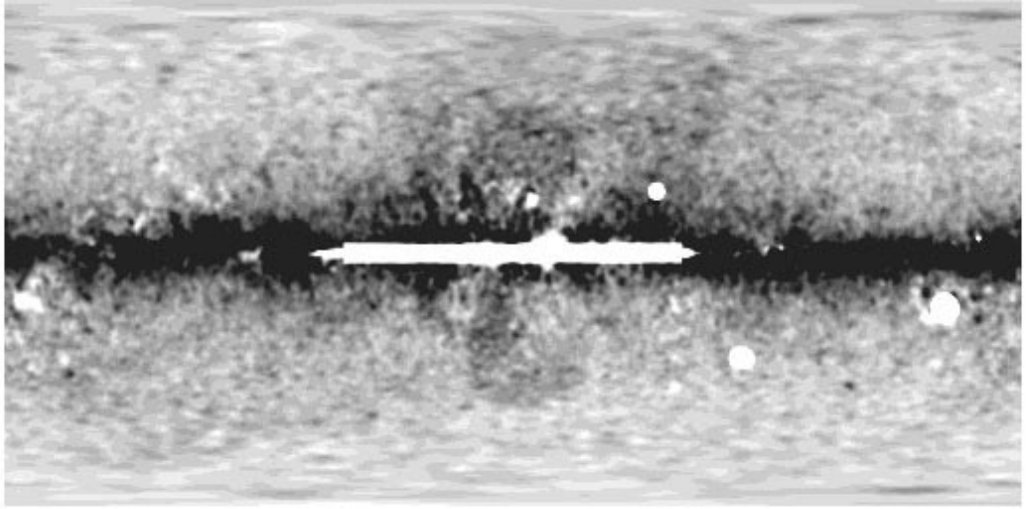
Fermi Haze/Bubbles

Claims of a very extended region of gamma-ray emission

Electron IC and synchrotron?
Meng Su *et al.* 2010 *ApJ* **724** 1044
But how do you get the HE electrons?

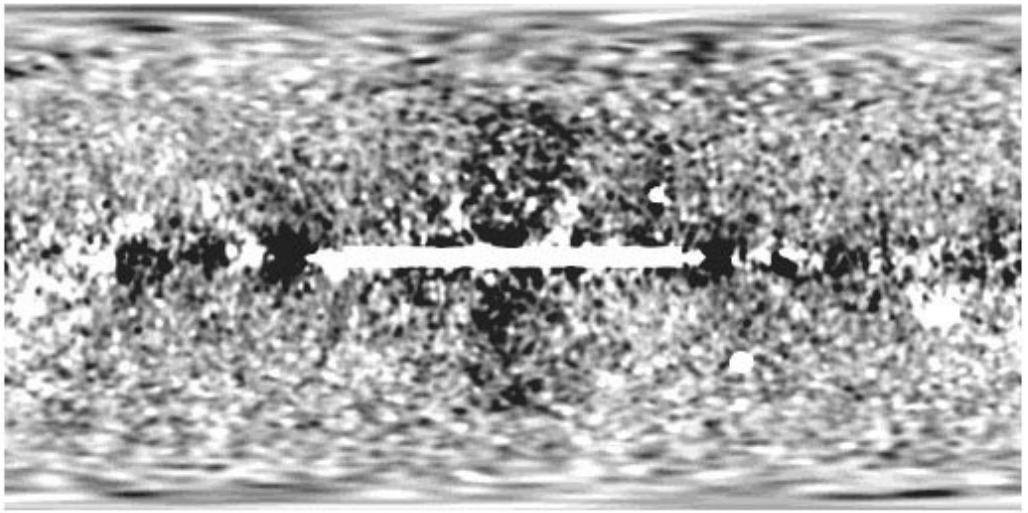
vs

Or pion decay?
Crocker & Aharonian, *Phys.Rev.Lett.106:101102,2011*
Slow and steady proton injection?



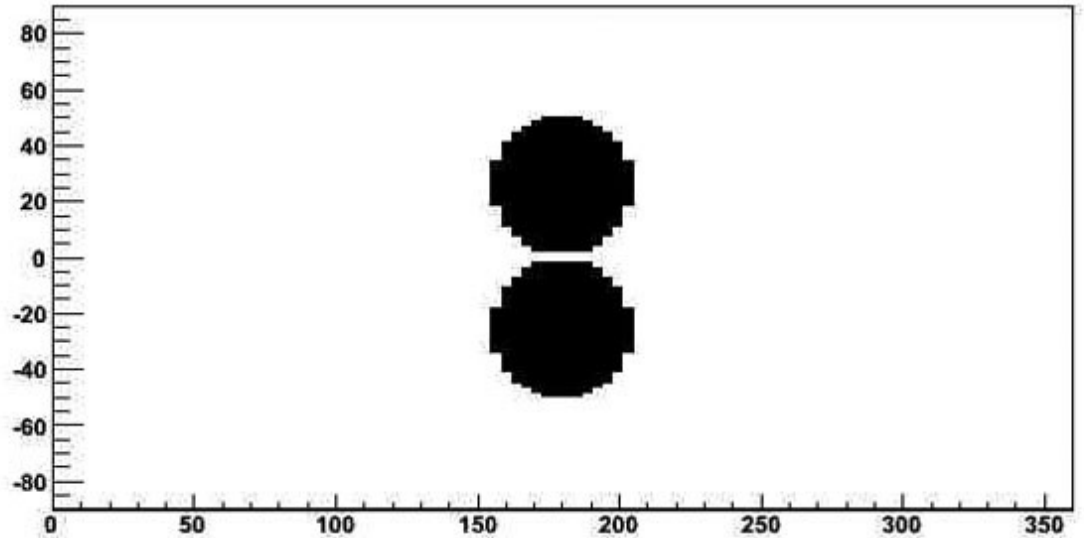
Subtraction Maps:
Meng Su *et al.* 2010 *ApJ* **724** 1044

2 GeV < E < 5 GeV



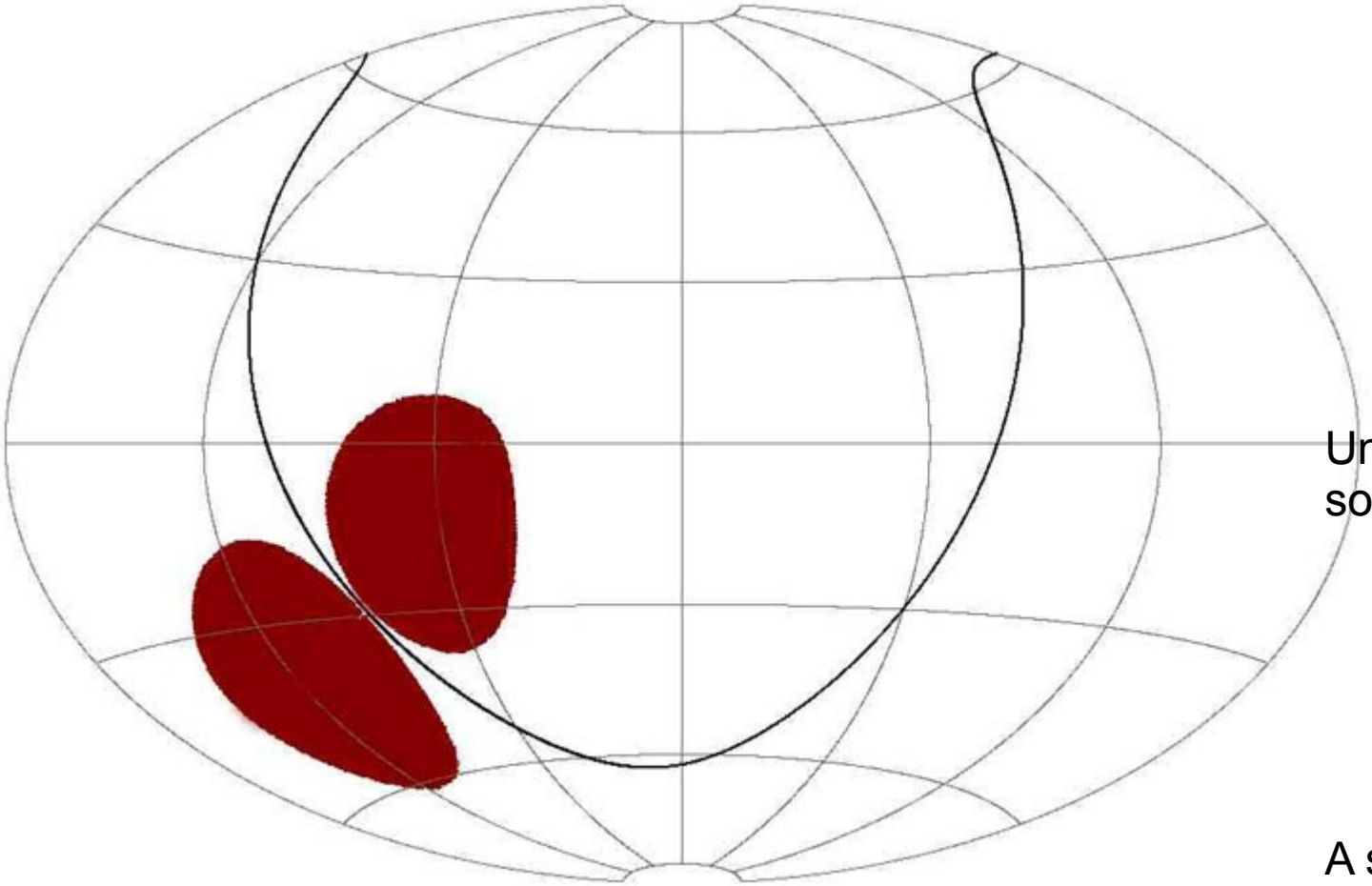
Everything is a circle to first order
(especially when it's hazy)

10 GeV < E < 20 GeV



25 degree radii circular characterization

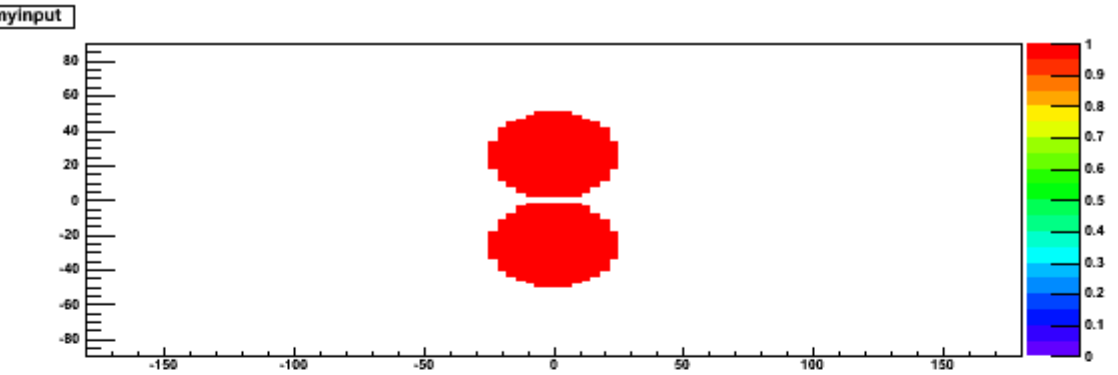
My Fermi Haze Characterization in Equatorial Coordinates



Unfortunately mostly in southern hemisphere

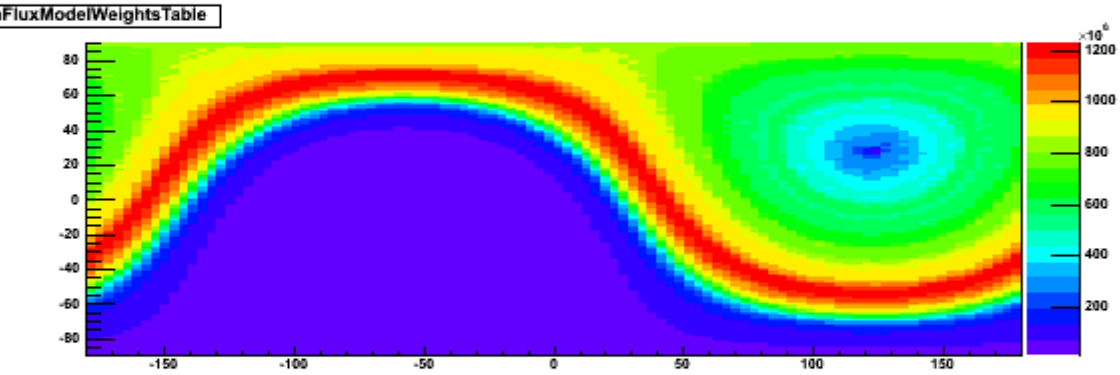
A similar game to Galactic Plane

IC59+IC40



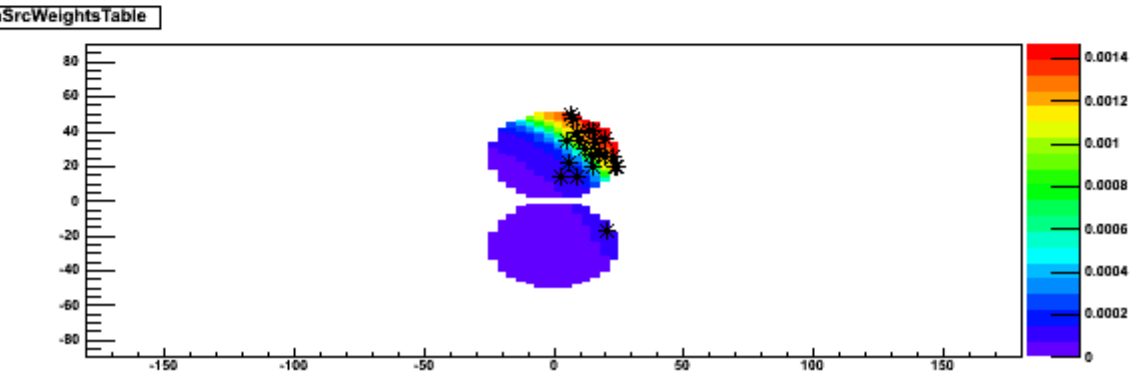
Expected Flux

X



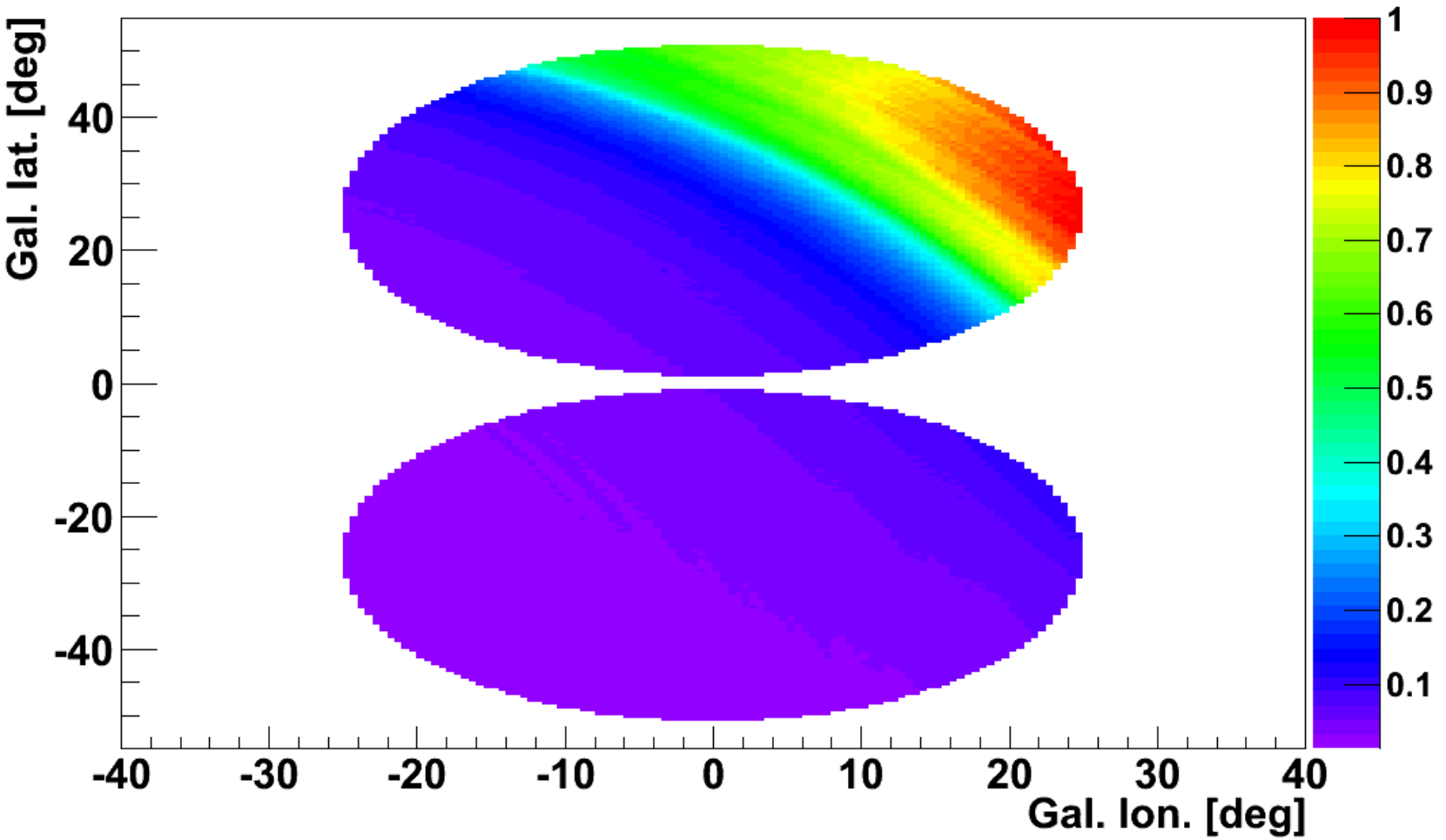
Detector Response

=



Where we expect to see signal

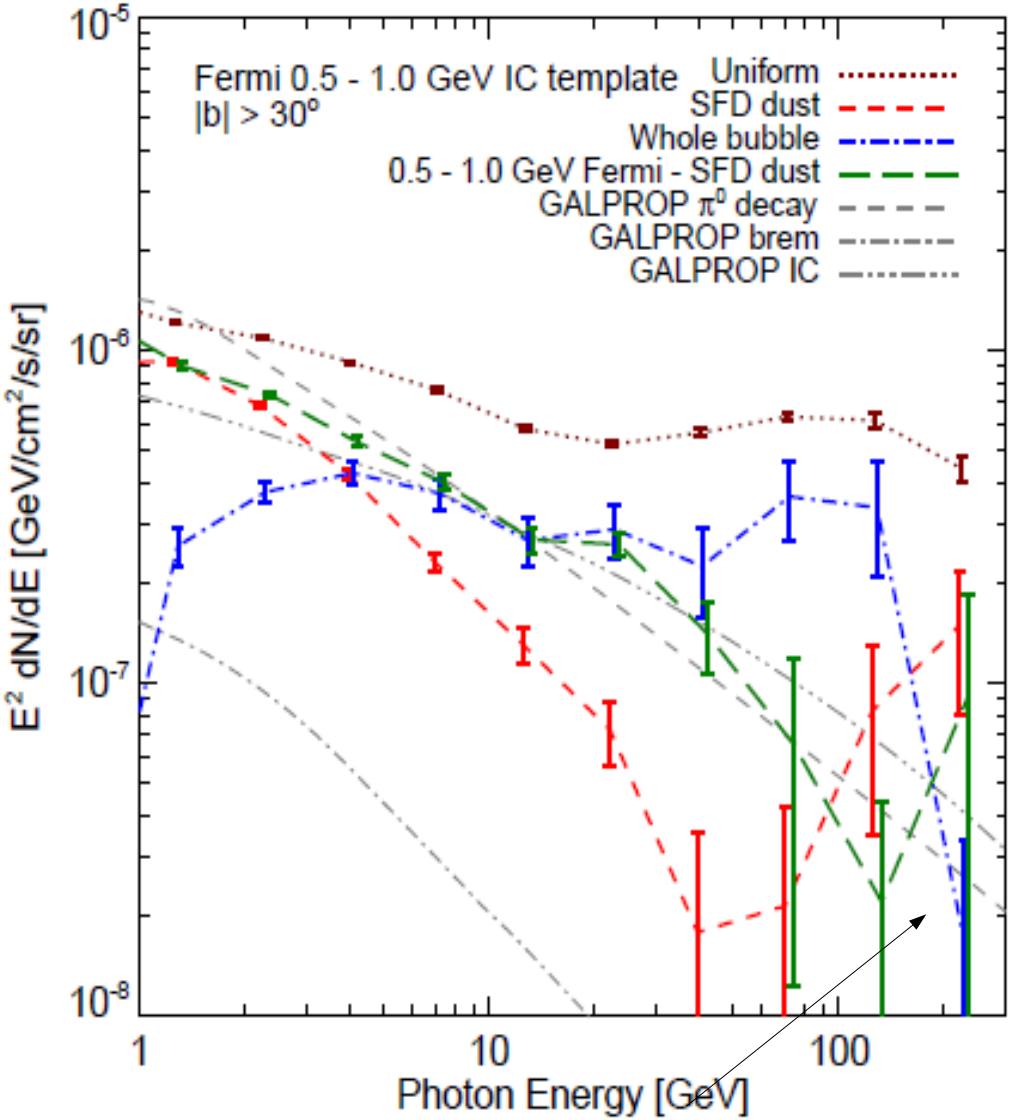
IC59+IC40


Gal. lat. [deg]
40
20
0
-20
-40
-40
-30
-20
-10
0
10
20
30
40
Gal. lon. [deg]
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1

(Naïve) Model Prediction and Sensitivity

Preliminary!

Model: 1/2 γ emission = neutrino emission



164 Events expected from model

$1.8 \times 10^{-7}\ E^2$ [GeV cm^{-2} s^{-1} sr^{-1}] with no cutoff

➡ **90% UL Sensitivity:**

$6.4 \times 10^{-8}\ (E/GeV)^2$ [GeV^{1}cm^{-2}s^{-1}sr^{-1}]

*Flux is per solid angle, 60events

arXiv:1005.5480v3 cutoff at high E

arXiv:1008.2658v4 no cutoff $3.5 \times 10^{-7}\ E^2$ [GeV cm^{-2} s^{-1} sr^{-1}]

Some Observations

- Possible to start excluding very optimistic hadron models

- Unfortunately, somewhat high dependance on spacial characterization

- Many γ-flux models and spacial characterization models (subtraction dependent)

Plan is to make the analysis result as general of a statement as possible.

A likelihood analysis is planned for the Galactic Plane & Fermi Bubbles using the combined IC59+IC40 data

Other extended sources search (3 deg ES all sky search, Milagro extended source regions A &B) also planned and underway

IceCube
SOUTH POLE NEUTRINO DETECTOR