

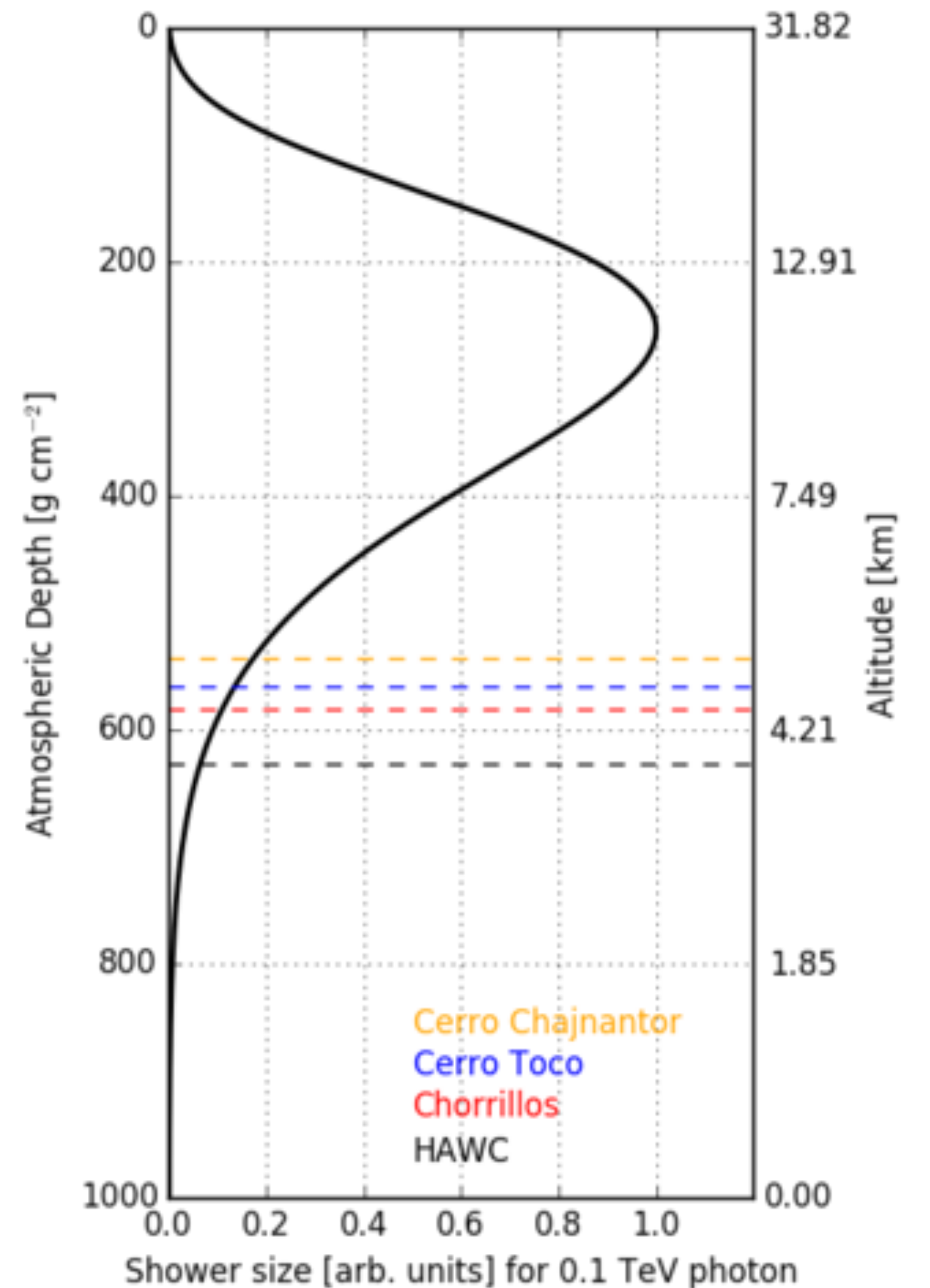
# Very-Extended Emission Structures with the Southern Gamma-Ray Survey Observatory

Hugo Ayala



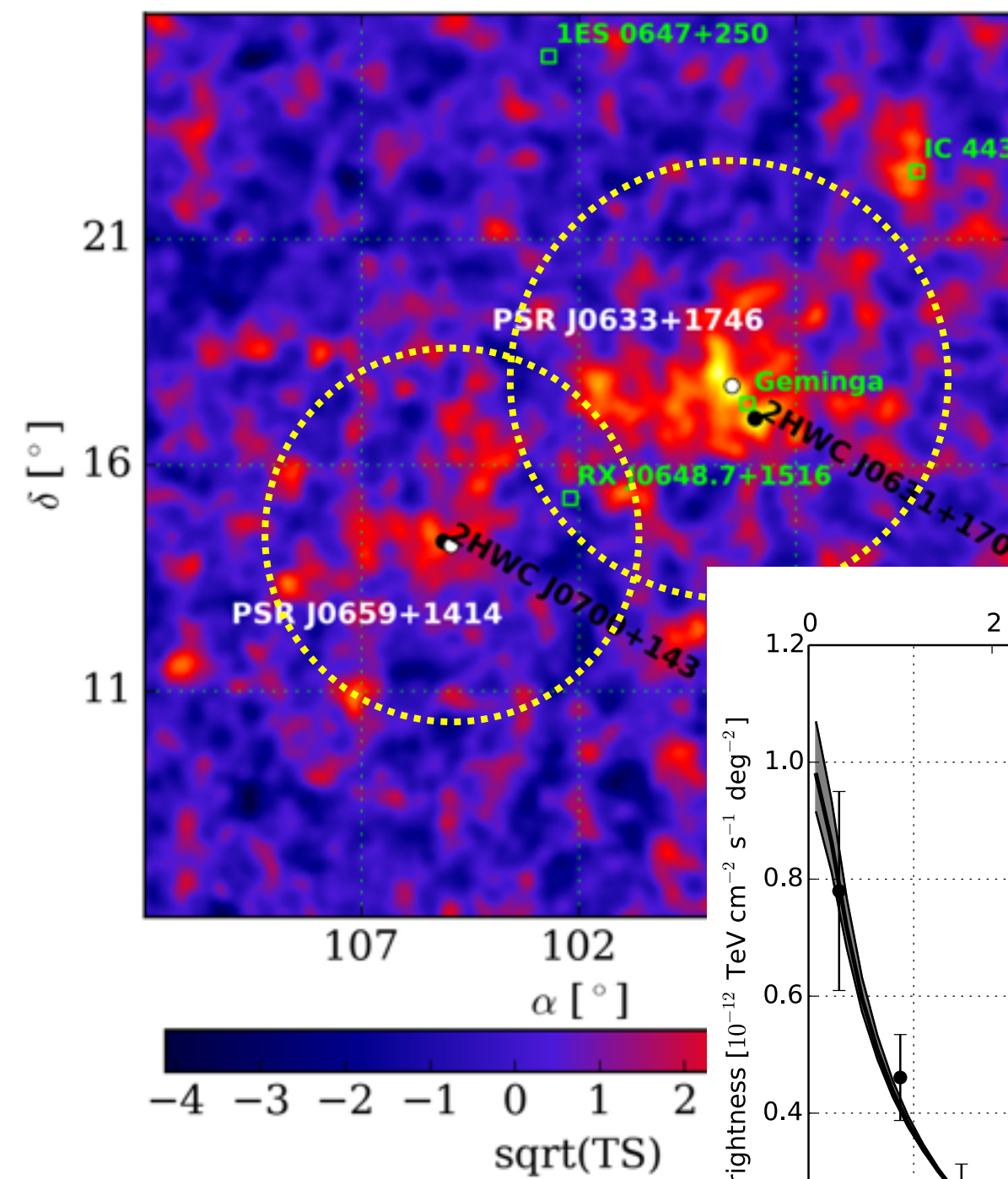
# The Southern Hemisphere

- Access to observations of the galactic center
- Telescope that has a **large field of view and high duty cycle**
- Observation and survey of **large extended sources**
- High Altitude: access to  $\sim 100$  GeV gamma rays

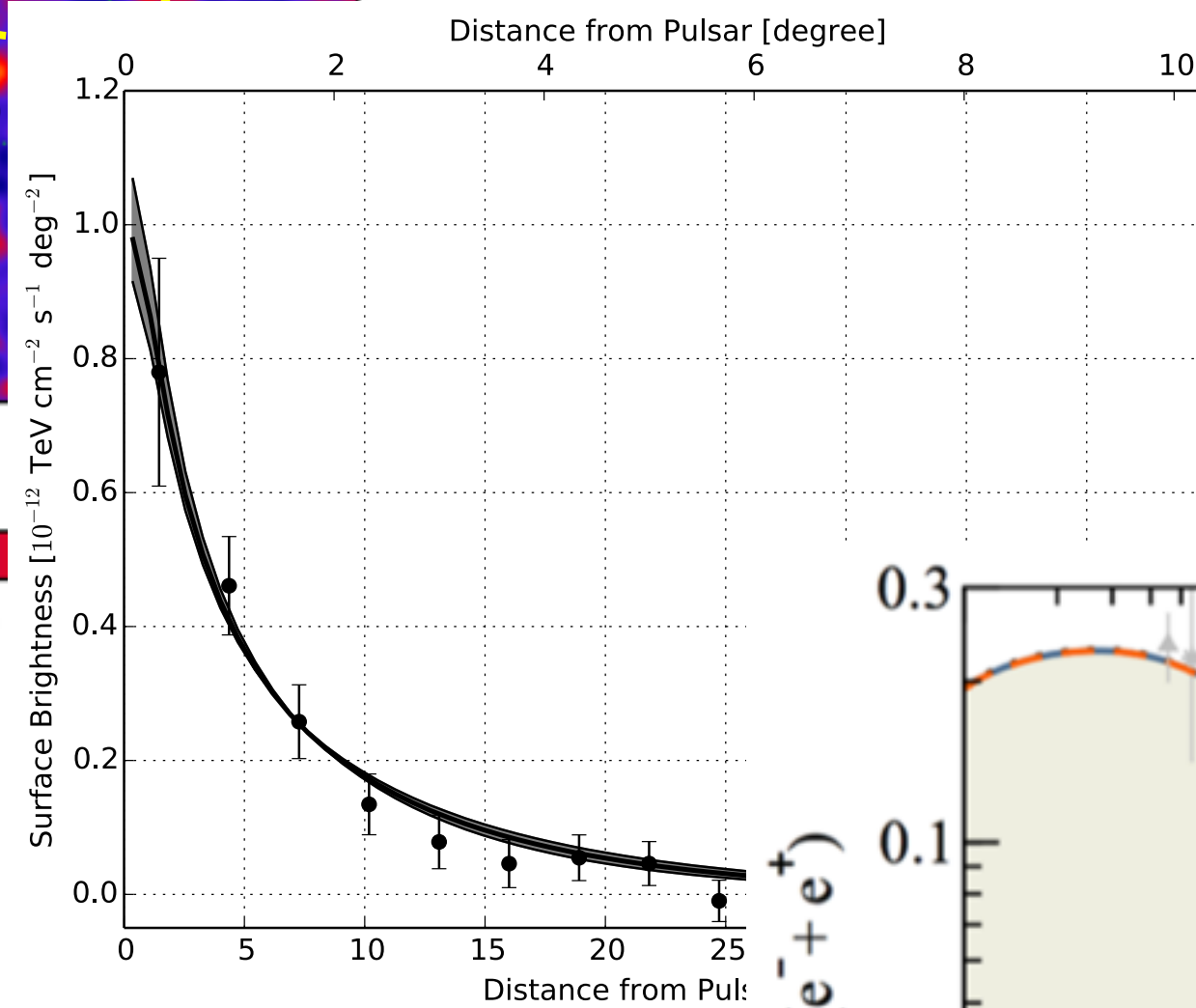


By Chad Brisbois

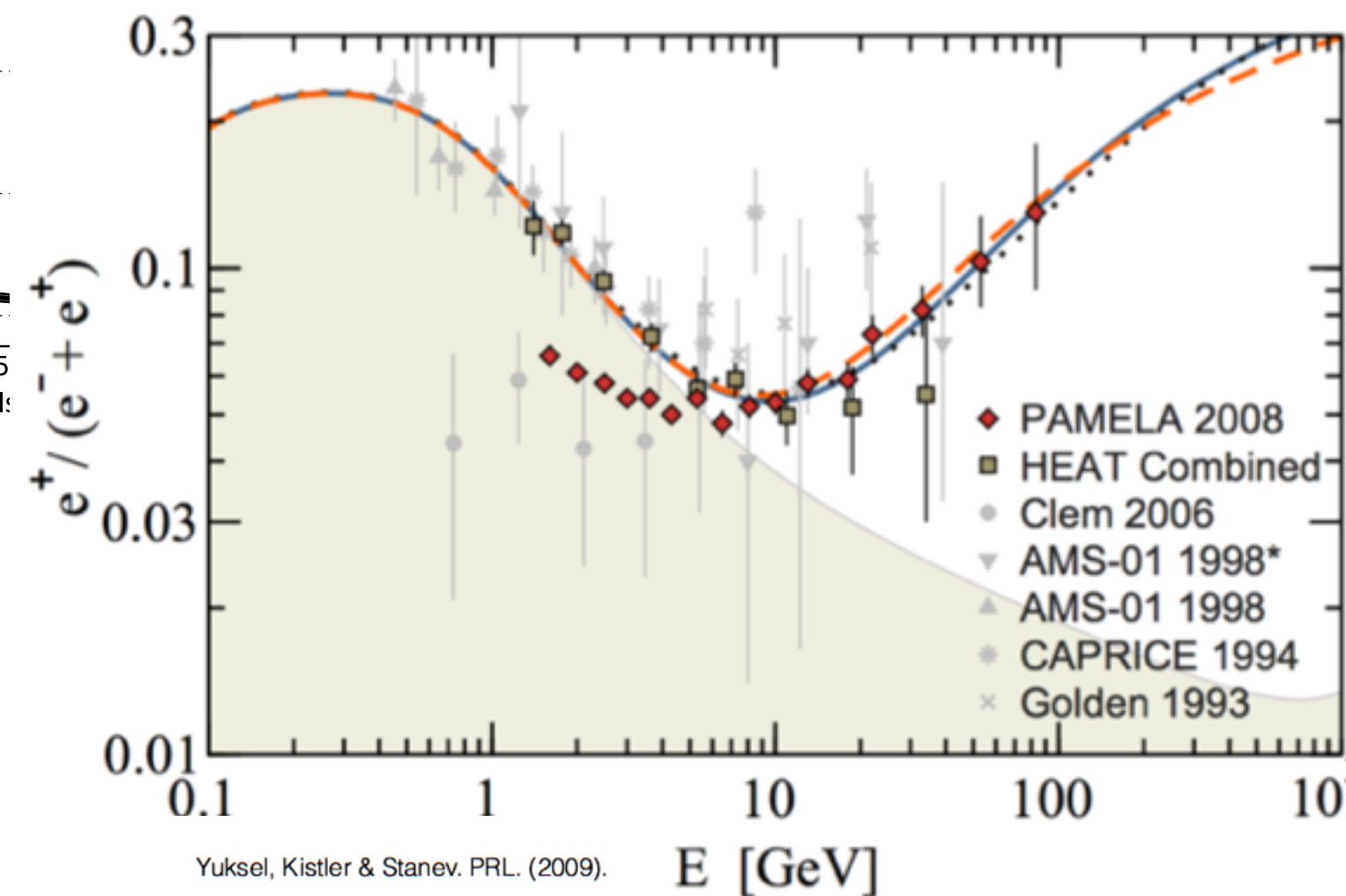
# Extended Sources Analysis on Nearby PWNe



- Geminga & PSR B0656+14
- Nearby mid-aged pulsars
- Very extended



- Radial profile
- Likelihood fit with diffusion model
- Constrain diffusion coefficient in the ISM



- Study particle diffusion in ISM
- Study contribution to local CR flux
- Positron excess: pulsar or DM?

# Nearby PWN Candidates in Southern Sky

Nearby mid-aged/old pulsars (simple criteria):

- In southern sky (Geminga and PSR B0656+14 for comparison)
- Out of inner Galaxy ( $|b| > 5$  or  $90 < l < 270$ )
- $\dot{E}/D^2 > \text{Geminga} * 0.1$
- Age  $> 10000$  years: size of 10 TeV nebula is not limited by age

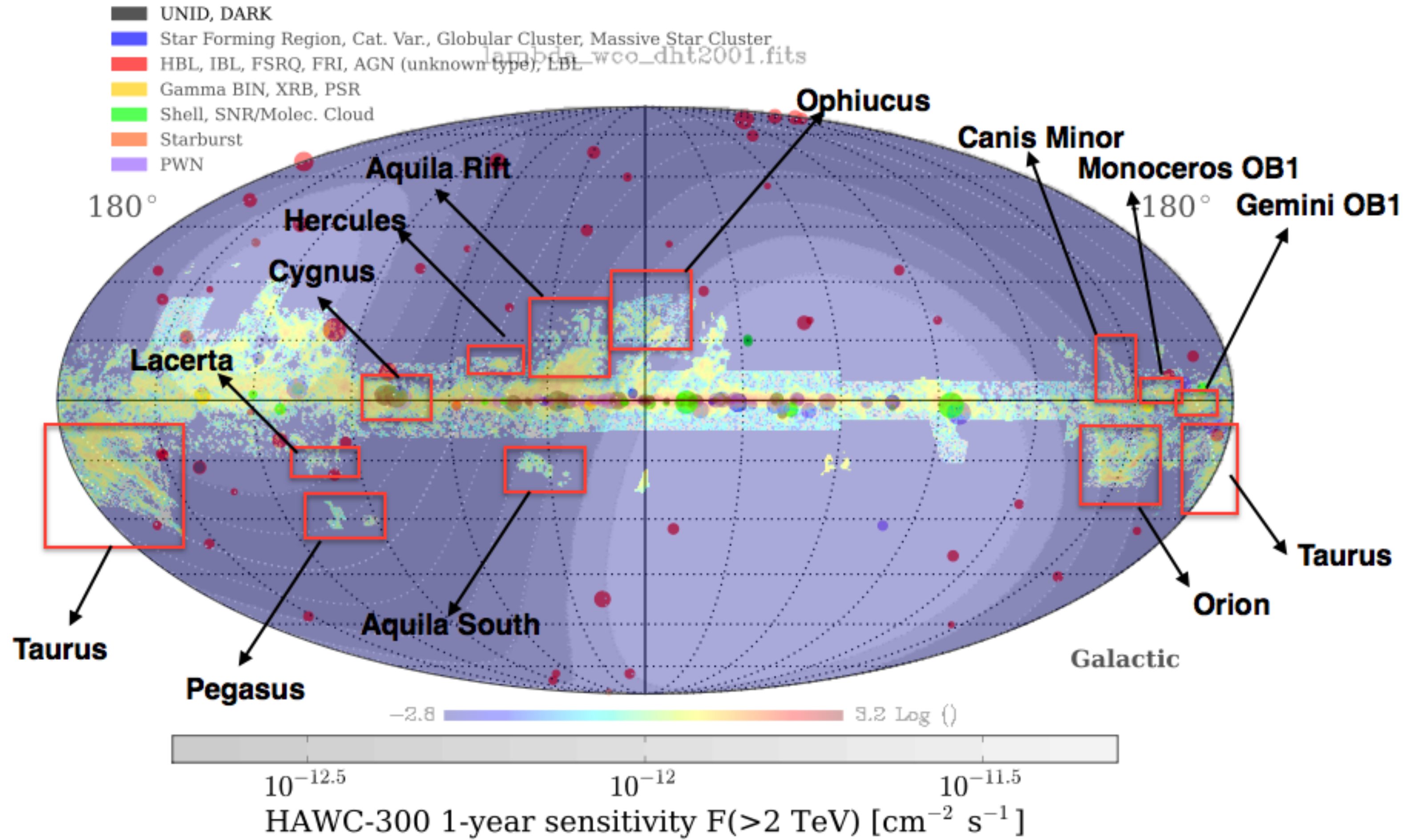
Vela! →  
 Geminga →  
 PSR B0656+14 →

| # | G1<br>(deg) | Gb<br>(deg) | RAJD<br>(deg) | DECJD<br>(deg) | DIST<br>(kpc) | AGE<br>(Yr) | EDOT<br>(ergs/s) | $C1 \dot{E}/D^2$ |
|---|-------------|-------------|---------------|----------------|---------------|-------------|------------------|------------------|
| 1 | 263.55      | -2.79       | 128.83588     | -45.17635      | 0.28          | 1.13e+04    | 6.9e+36          | 8.8010e+37       |
| 2 | 195.13      | 4.27        | 98.47564      | 17.77025       | 0.25          | 3.42e+05    | 3.2e+34          | 5.1200e+35       |
| 3 | 201.11      | 8.26        | 104.95056     | 14.23931       | 0.28          | 1.11e+05    | 3.8e+34          | 4.8469e+35       |
| 4 | 253.39      | -41.96      | 69.31623      | -47.25253      | 0.16          | 1.59e+09    | 1.2e+34          | 4.6875e+35       |
| 5 | 291.56      | -12.55      | 154.46387     | -71.94490      | 0.26          | 1.67e+10    | 6.9e+33          | 1.0207e+35       |
| 6 | 295.53      | 48.39       | 187.79714     | -14.19545      | 0.45          | 2.56e+09    | 1.8e+34          | 8.8889e+34       |
| 7 | 337.46      | -54.93      | 340.42508     | -52.61006      | 0.68          | 5.22e+09    | 2.5e+34          | 5.4066e+34       |

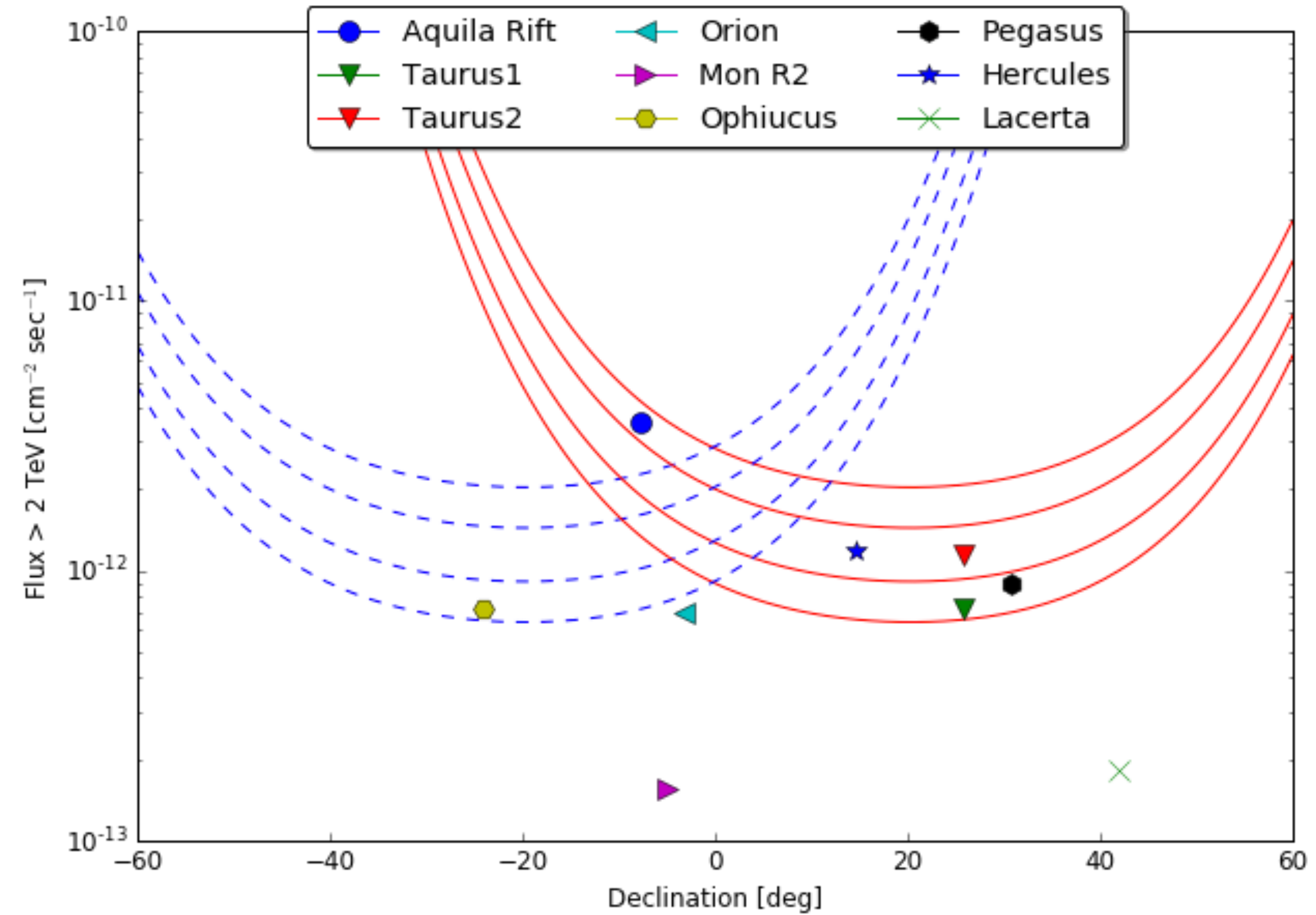
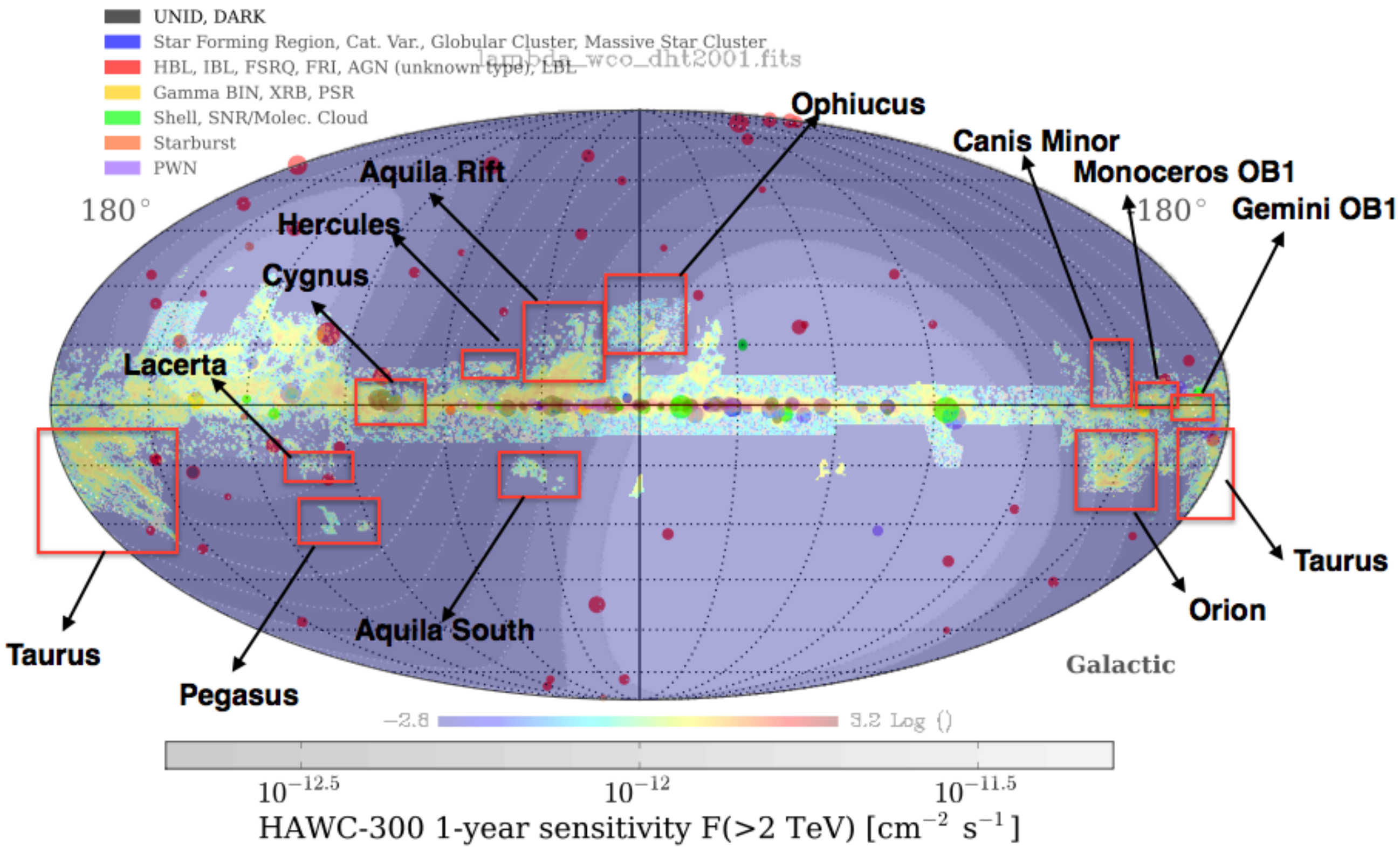
# Study of Large Structures

- Galactic Diffuse Emission: Interaction of cosmic rays with the interstellar media and radiation fields
- Understand the **propagation, diffusion and distribution** of cosmic rays in the galaxy
- Giant Molecular Clouds
  - Search for gamma-ray emission from Molecular Clouds and **probe the flux of cosmic rays** in distant parts of the galaxy.
  - Compare it to the flux of cosmic rays measured at Earth
  - **Measure the gas mass column density** distribution of molecular clouds for a known CR intensity. (Ackermann et al. 2012)

# CO Survey



# CO Survey



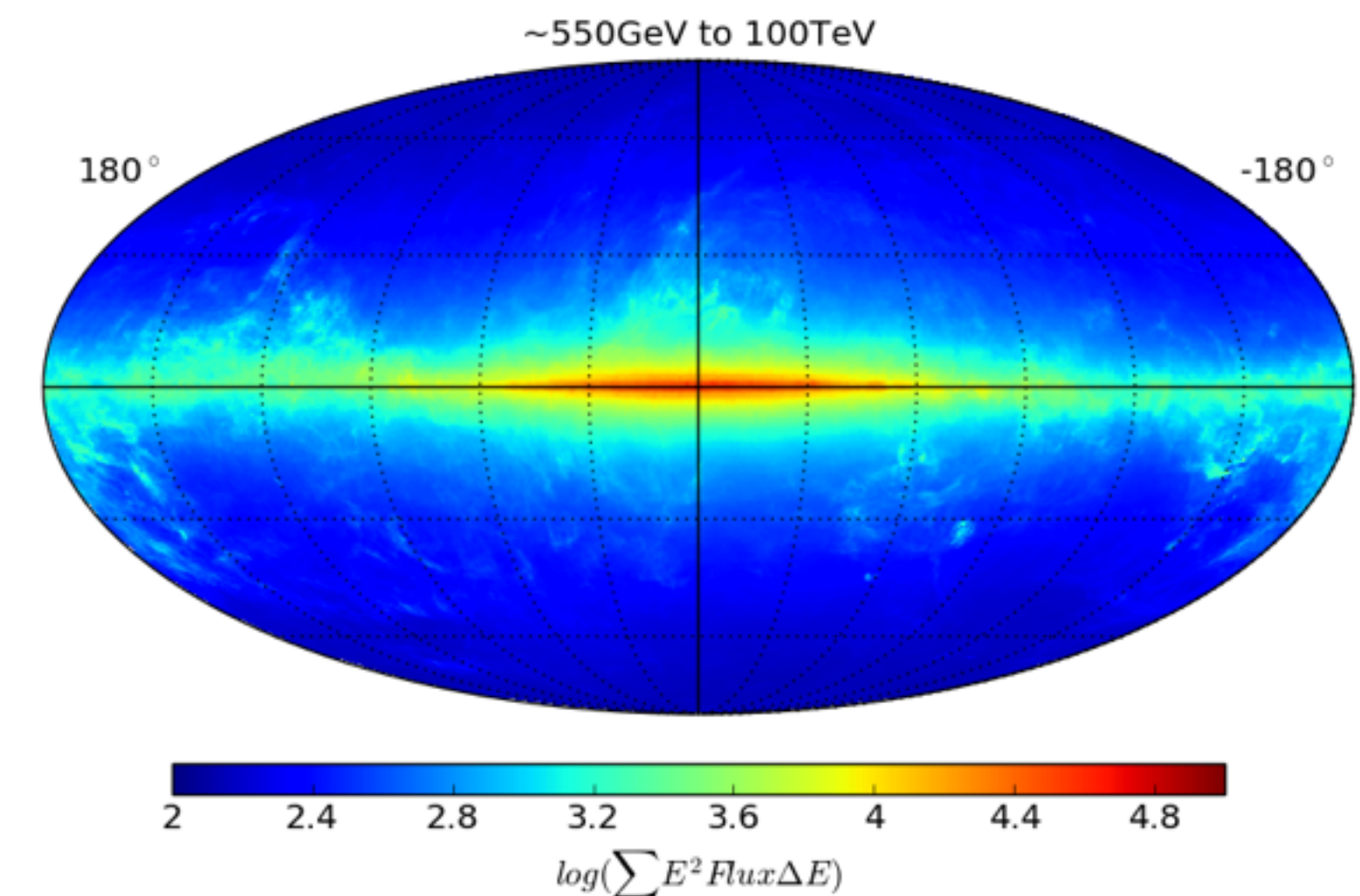
$$F_{\gamma}(\geq E_{\gamma}) = \begin{cases} 1.45 \times 10^{-13} E_{\text{TeV}}^{-1.75} (M_5/d_{\text{kpc}}^2) & \text{cm}^{-2} \text{ s}^{-1}, \text{ above } E_{\gamma} > 100\text{MeV}, \\ 2.85 \times 10^{-13} E_{\text{TeV}}^{-1.6} (M_5/d_{\text{kpc}}^2) & \text{cm}^{-2} \text{ s}^{-1}, \text{ above } E_{\gamma} > 1\text{TeV}. \end{cases}$$

For a detector in latitude  $-20^\circ$   
**HAWC**

$$M_5 = \frac{M_{\text{Cloud}}}{10^5 M_{\odot}} \quad d_{\text{kpc}} = \frac{d}{1 \text{ kpc}}$$

# Study of Large Structures

- Galactic Diffuse Emission: Interaction of cosmic rays with the interstellar media and radiation fields
- Understand the **propagation, diffusion and distribution** of cosmic rays in the galaxy
- Part of the Southern Hemisphere has been measured by H.E.S.S at TeV energies (Abramowski, A. et al. 2014)
  - No more measurements in the Southern Hemisphere!!



GalProp model between  
550 GeV and 100 TeV.  
Contains gamma-rays from  
pion decay, bremsstrahlung  
and inverse Compton

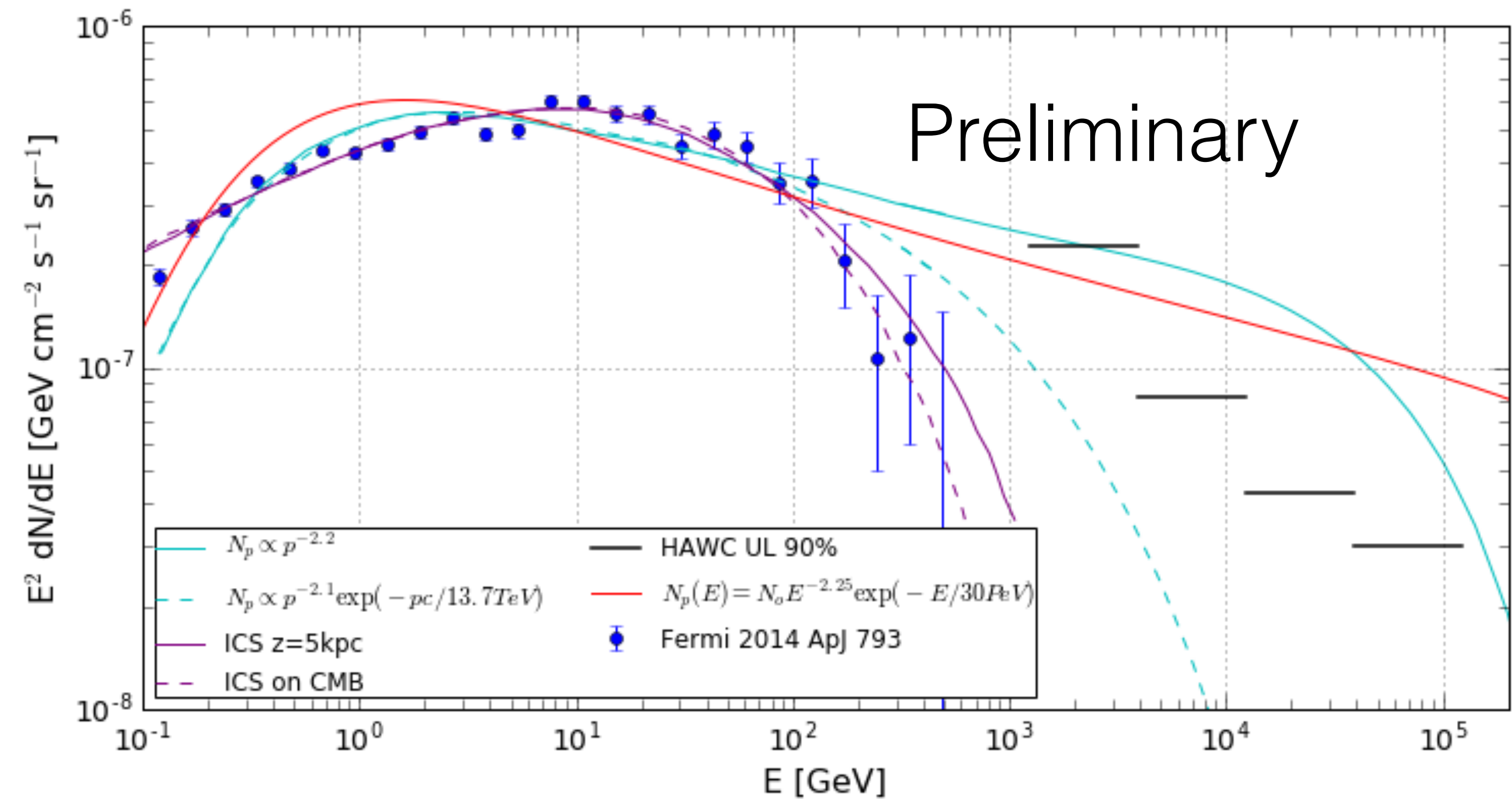
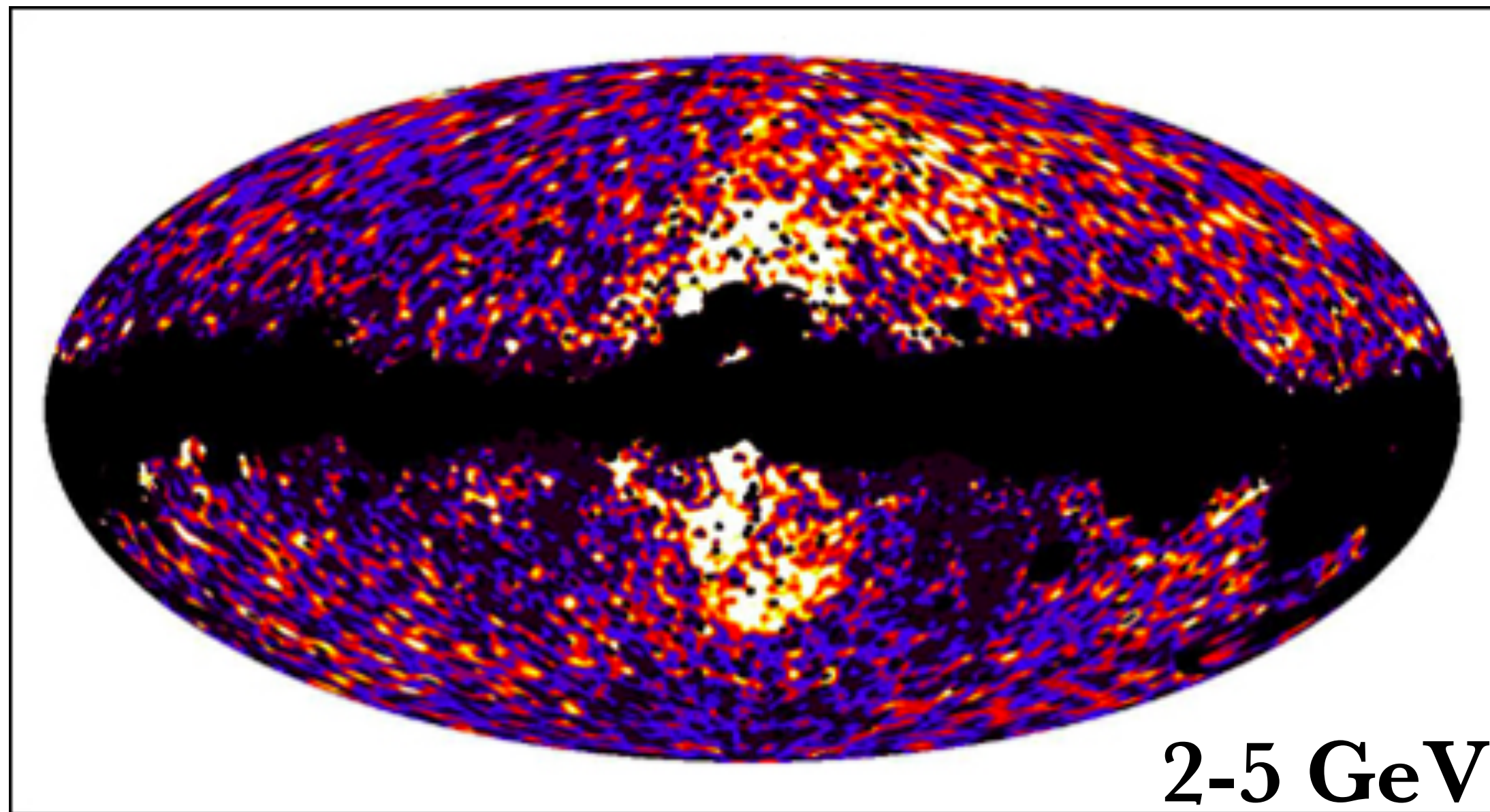


# Study of Large Structures

- Galactic Diffuse Emission: Interaction of cosmic rays with the interstellar media and radiation fields
- Understand the **propagation, diffusion and distribution** of cosmic rays in the galaxy
- Southern Fermi Bubble: not accessible to HAWC

# Fermi Bubbles

- **High energy gamma-ray data** ( $>500\text{GeV}$ ) desirable to constrain the spectrum and hence to shed more light on *the origin* of the Fermi bubbles.
- HAWC data constrains some hadronic models



Images taken from [http://www.outerspacecentral.com/mw\\_haze\\_page.htm](http://www.outerspacecentral.com/mw_haze_page.htm)

# Summary

- Build a detector in the southern hemisphere
- **Large field of view and high duty cycle**
- Access to Galactic Center
- Measure Diffuse Emission in the southern sky
- Measure/Detect the Southern Fermi Bubble at very high energies