Fermi Gamma-ray Space Telescope

The Galactic Center : Issues and prospects with Fermi... and HESS

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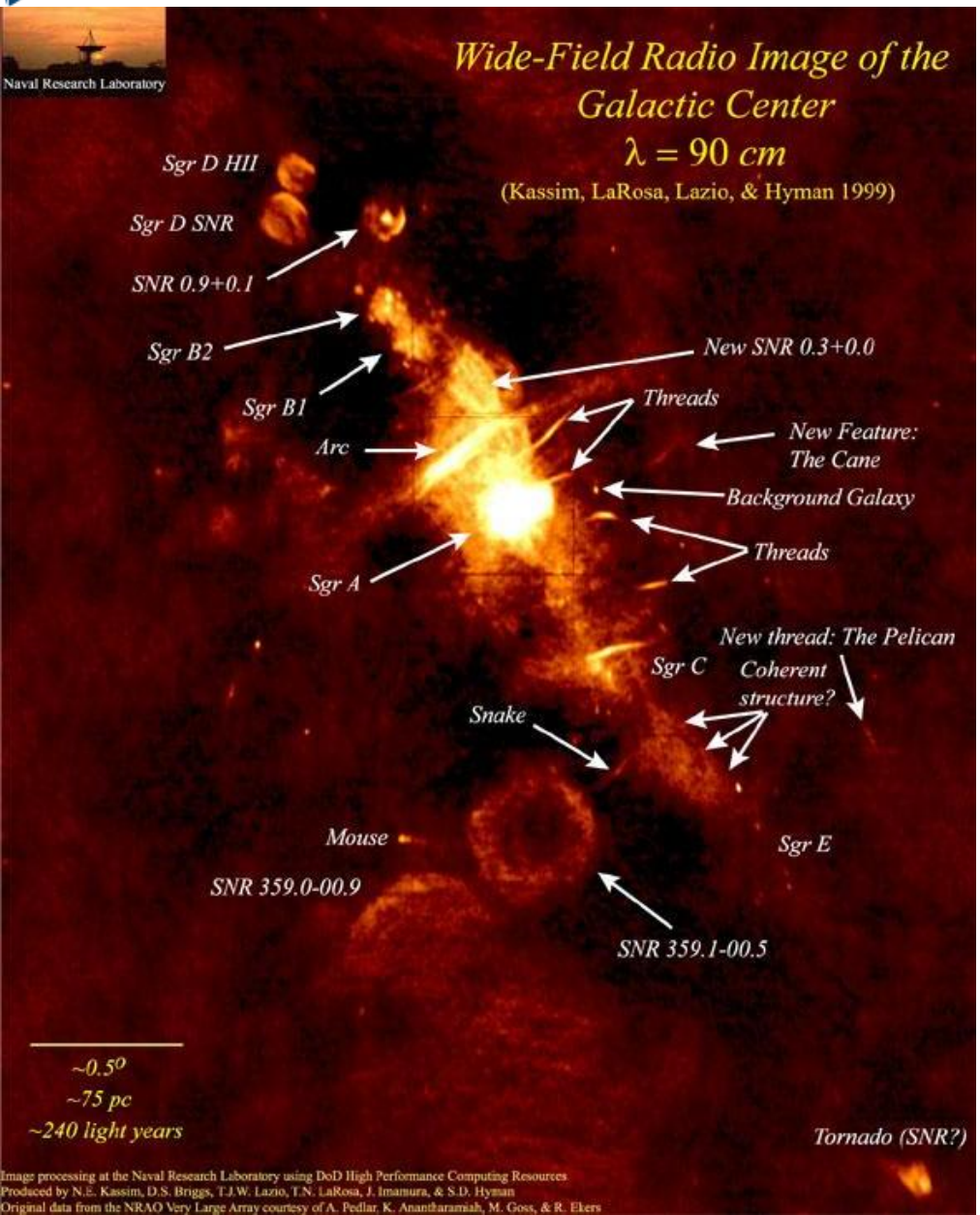
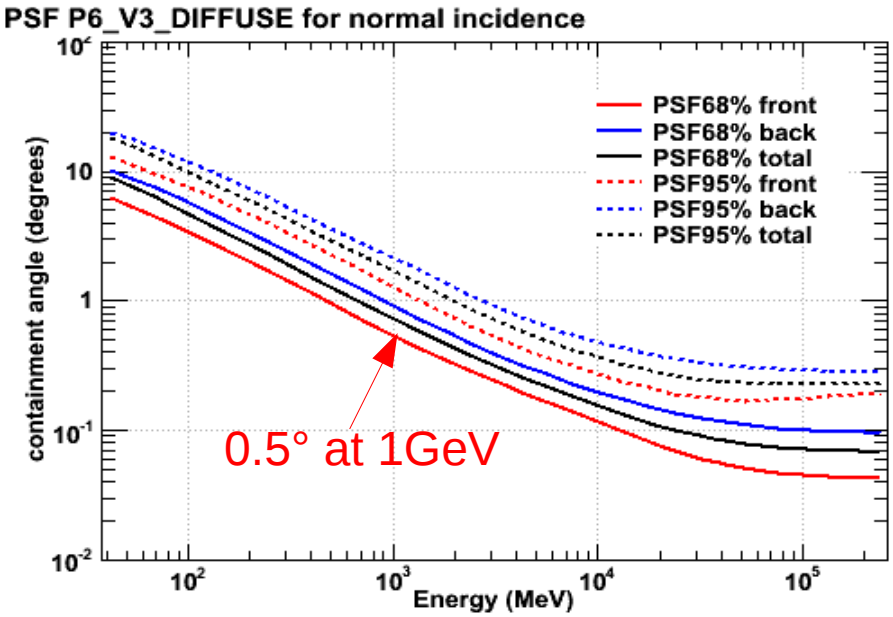
Atelier GeV-TeV
LLR, 16/09/09

Hell's Kitchen

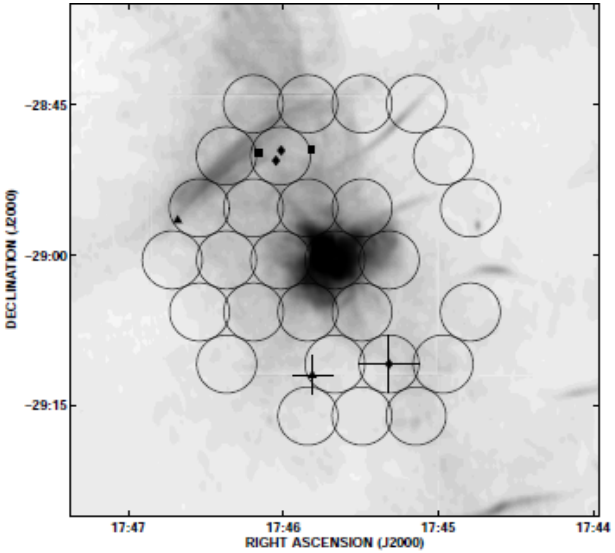


- One of the most complex regions in the sky!
- A huge pp emissivity due to CRs streaming through very dense clouds (CMZ)
- Many possible g-ray emitters (SNR, pulsars, binaries....)



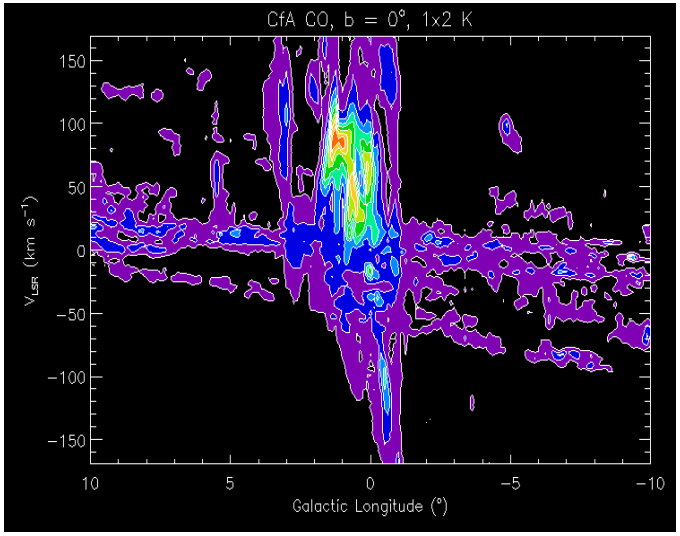
Local Source classes of possible interest

- Deneva et al. 09 : 3 pulsars detected in the close vicinity of SgrA*. Inferred population of ~2000 active radio pulsars!
- 2 famous star clusters (Arches and Quintuplet, squares in right figure)
- LMXBs around (see e.g. Del Santo et al. 2006)
- SNRs and PWNs...
- GAS!

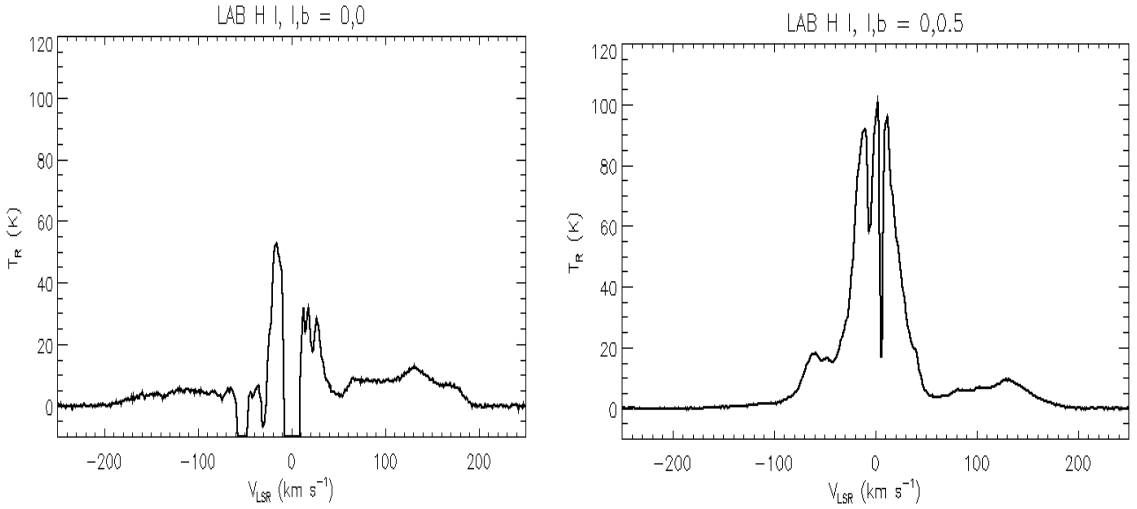


Diffuse Modeling

- **The GC region is perhaps the most difficult to model accurately, even if we understood the distribution of CR sources and cosmic-ray propagation**
- **The problem is the gas**
  - **Examples for H I and CO**
- **ISRF is reasonably uncertain as well!**



H I in absorption against Sgr A* (1.4 GHz)



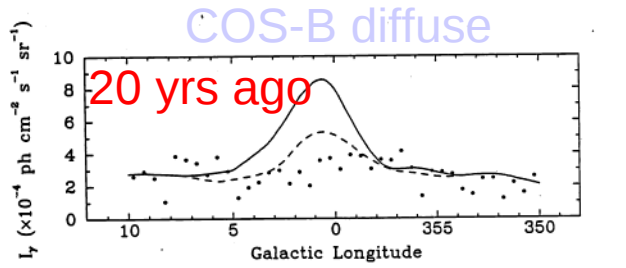
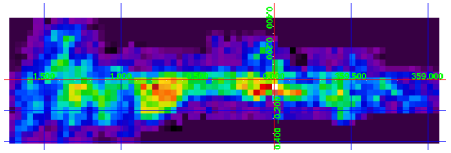


Figure 2. Profiles of observed and predicted γ-ray intensity in the Galactic center region, averaged over $|b| < 1°$. Points: observed COS-B γ-ray intensity (300–5000 MeV). Solid curve: predicted γ-ray intensity using the standard mass calibration ratio, N_{H_2}/W_{CO}, derived from Galactic disk observations. Dashed curve: predicted γ-ray intensity using the standard mass calibration ratio, but with the eight wide-line clouds indicated in Figure 1 removed from the analysis

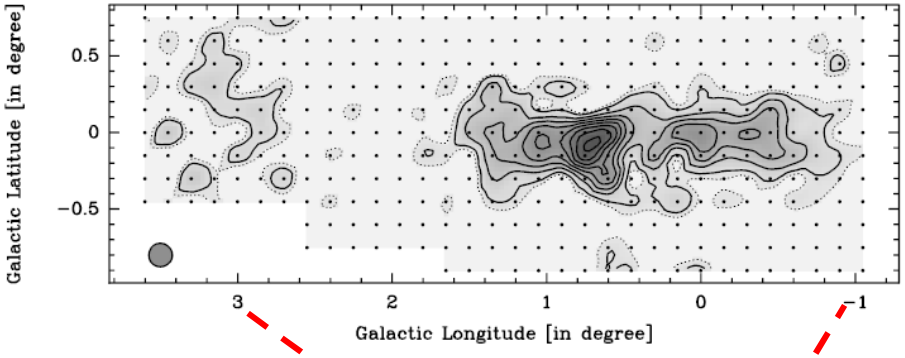
Stacy, Dame, & Thaddeus (1987)

Diffuse Modeling (2)

- **LAT collaboration currently working on characterizing the evaluation of N(H I) from the H I surveys**
- **Alternative tracers for molecular gas being tried**

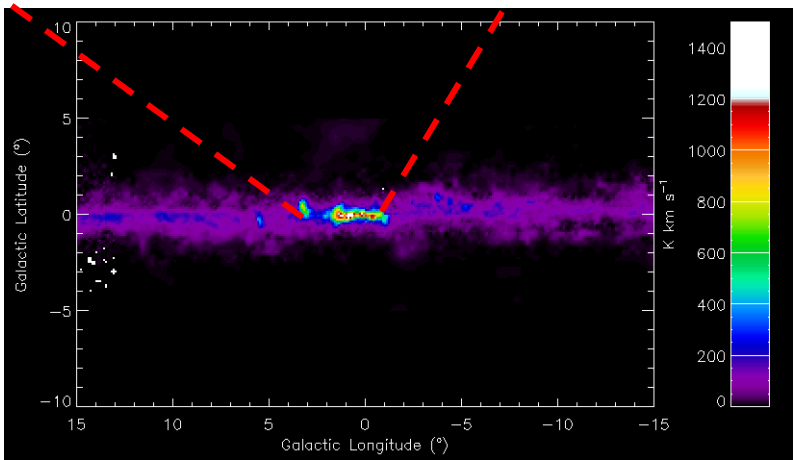


CS (1-0) Tsuboi et al. (1999) NRO 45-m



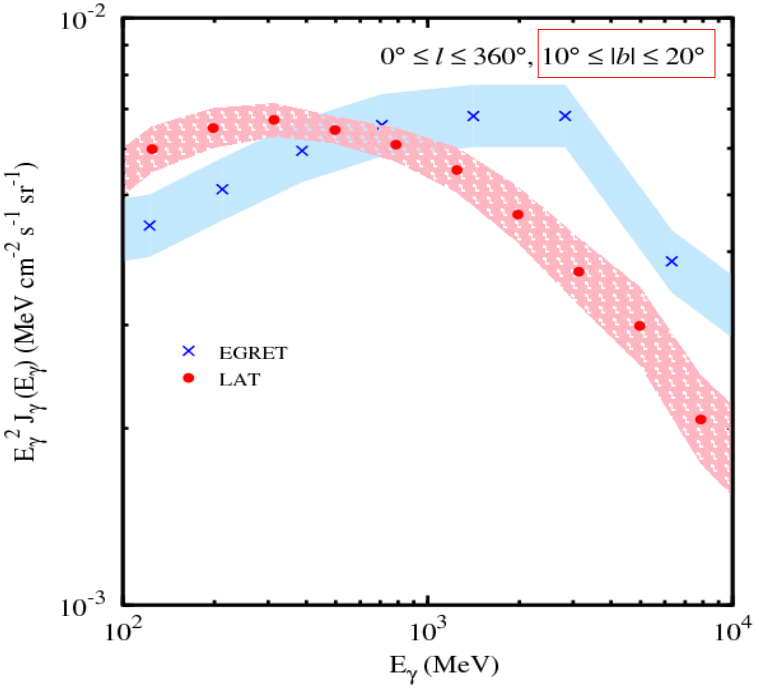
$C^{18}O$ (1-0) Dahmen et al. (1997) Southern 1.2-m

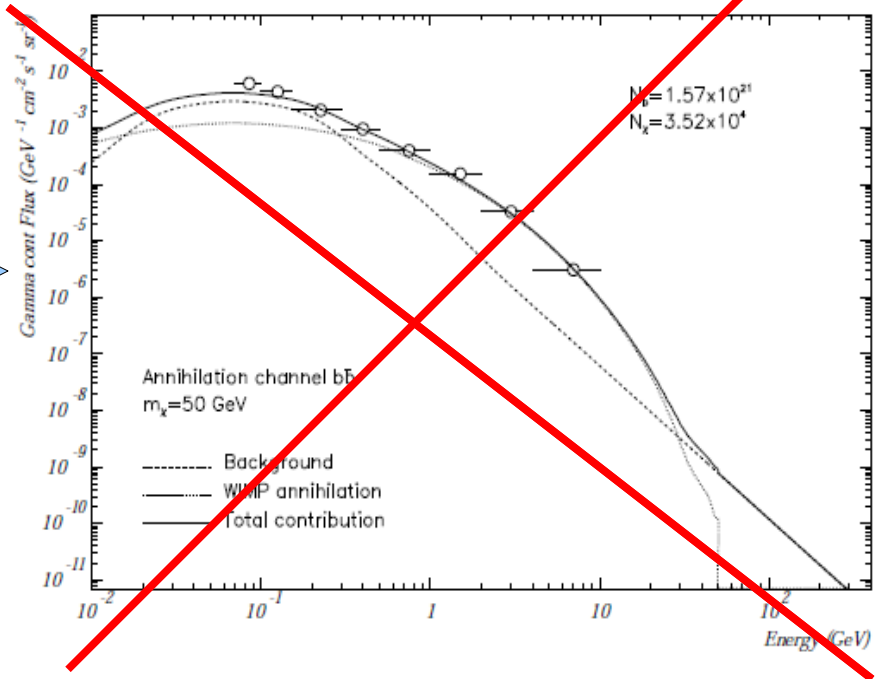
- **May have a 'diffuse' component from unresolved pulsars (Deneva et al. 2009) in a not so distant future (important impact on source fit quality)**



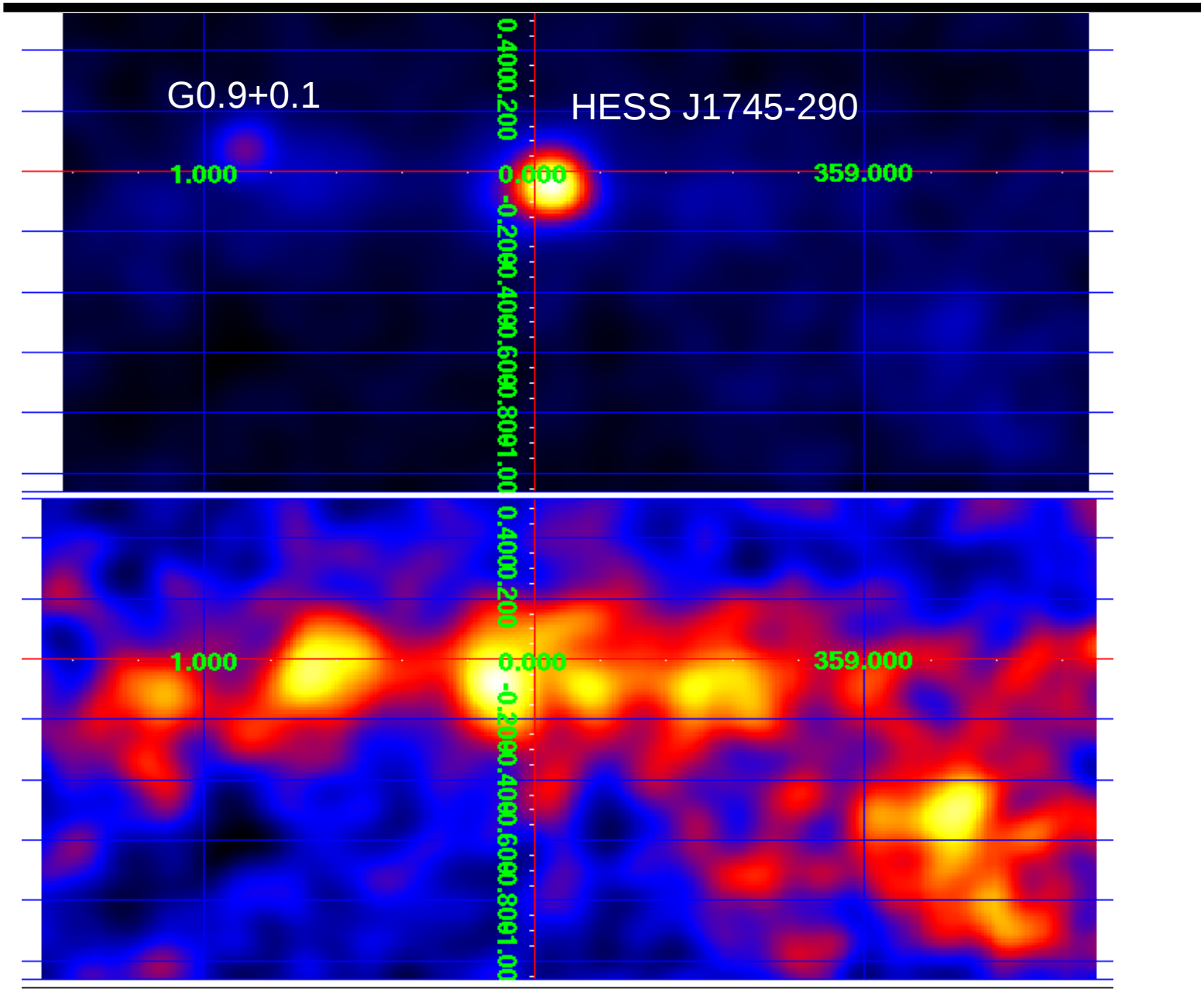
Dark Matter

- Galactic center is well-known as a potential source of gamma-rays related to decay of dark-matter particles
- DM is one of the hottest topics around....
- For the LAT data, we need a very accurate background model to assess upper limits, and a very strong case to discard other possible astrophysical sources in case of detection....
- .... especially now that the 'GeV excess' is not there anymore:

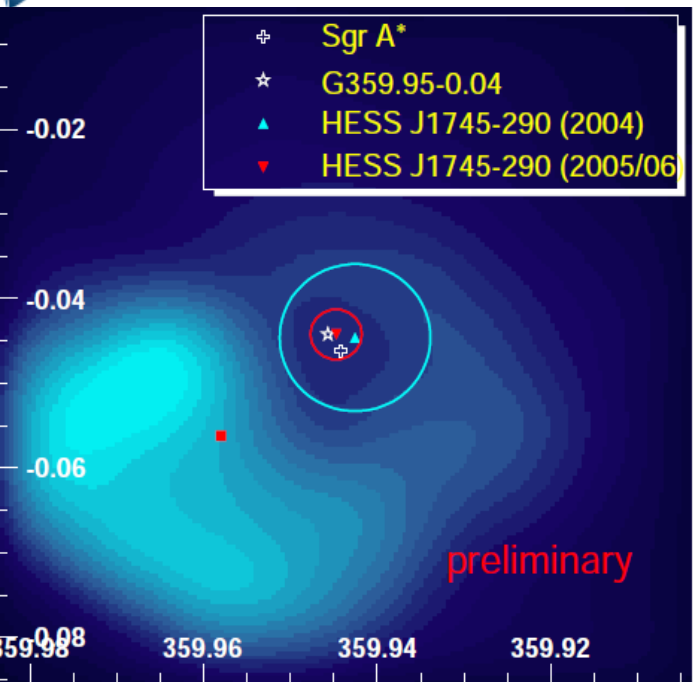




H.E.S.S view of the GC



Recent H.E.S.S. results

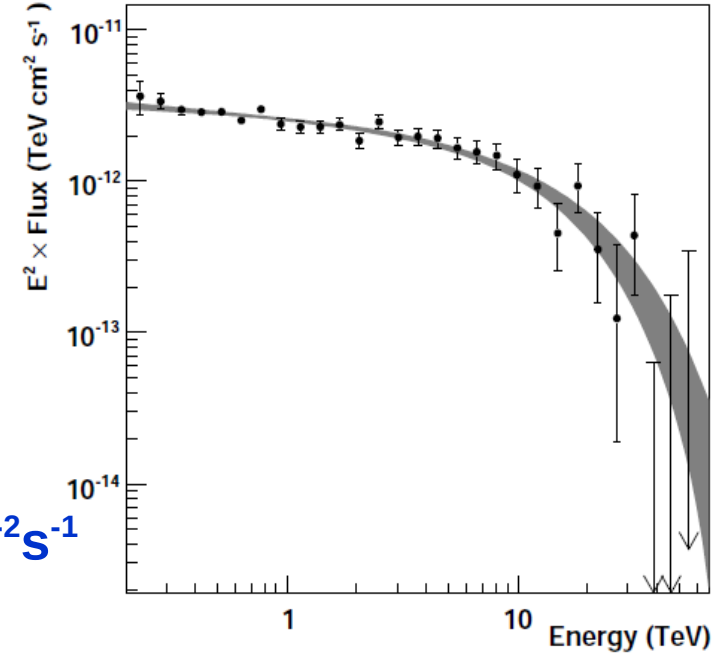


- **VanEldik et al. 2007**
  - **Improved pointing analysis : 30''->6''**
  - **Sgr A East excluded at 95% C.L.**
- **Remaining candidates**
  - **SgrA***
  - **PWN cand. G359.95-0.04 (Wang et al. 06)**
  - **others....**

- **Aharaonian et al. 2009**
  - **3 year analysis shows cutoff**
  - **No variability found**

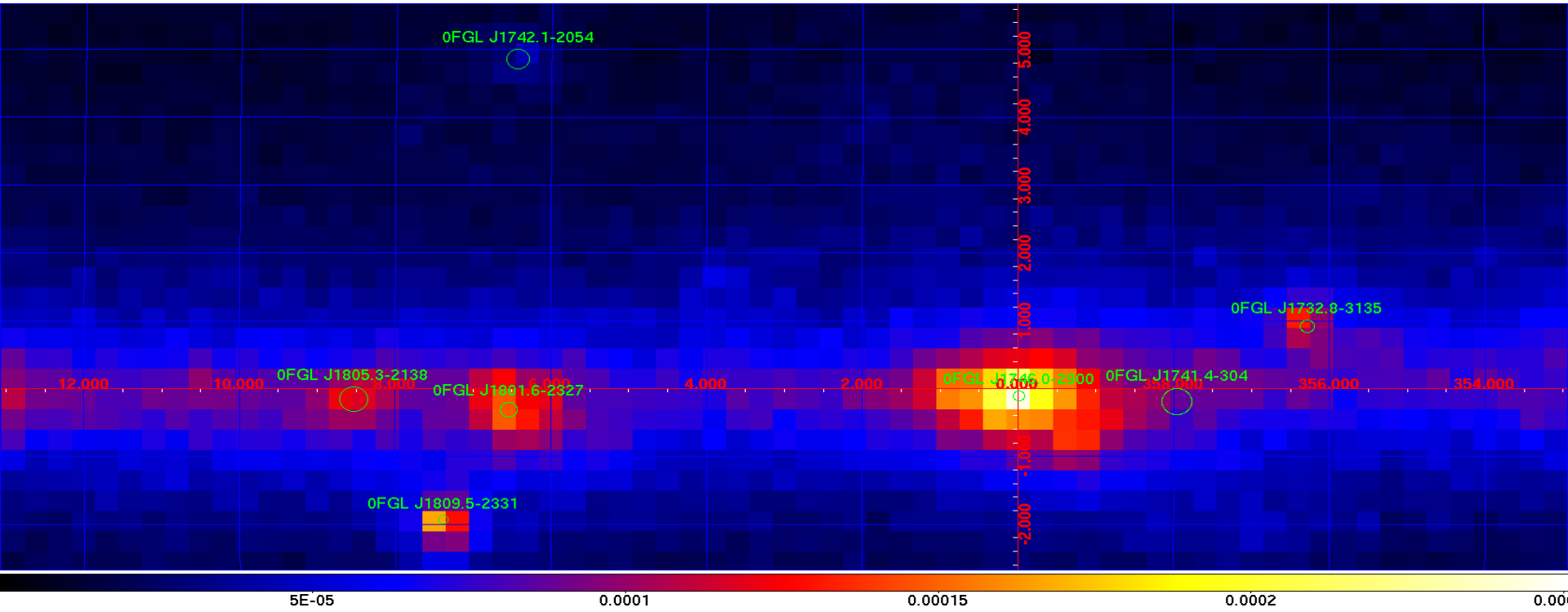
$$\frac{dN}{dE} = \Phi_0 \times \left(\frac{E}{1\mathrm{TeV}}\right)^{-\Gamma} \times e^{-\left(\frac{E}{E_{\mathrm{cut}}}\right)}$$

  - **E_{cut}~20TeV Φ_0=(2.55+/-0.06)e^{-12} $TeV^{-1}cm^{-2}s^{-1}$**
  - **Γ=2.1 +/- 0.04**

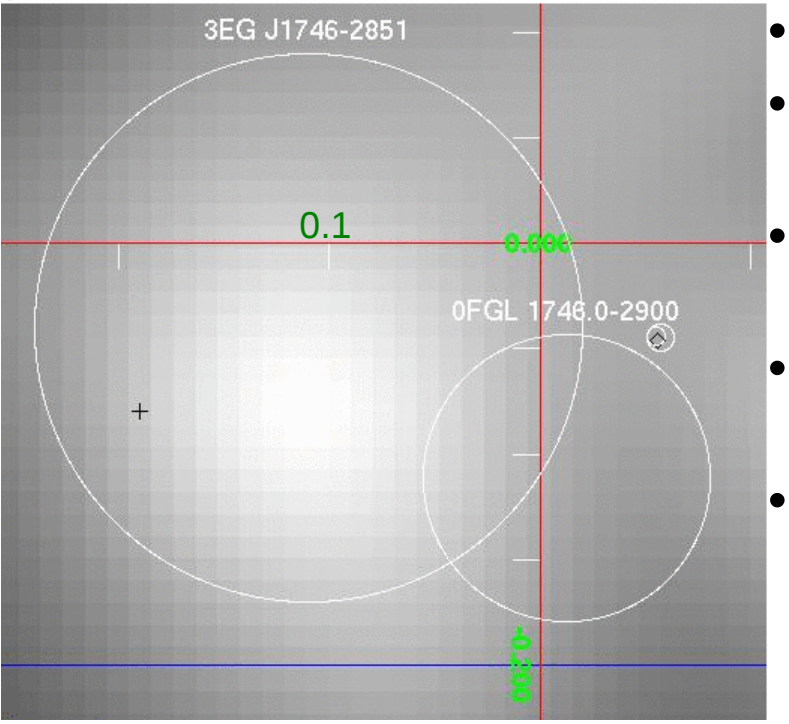


The LAT BSL sources within 10° of the GC

- **Bright Source List : 3 month LAT catalog of highly significant sources (TS>100) : Abdo et al., ApJS 183, 46-66, 2009**
- **9 month skymap in cts/s/pixel with 95% C.L. error circles on BSL sources (0.3° pixel)**
- **We are contemplating a vastly more inhabited landscape after 12 mths and TS>25...**
- **0FGLJ1746.0-2900 detected at 36σ, position=(266.506, −29.005,0.068)**



Localization and variability of the BSL source

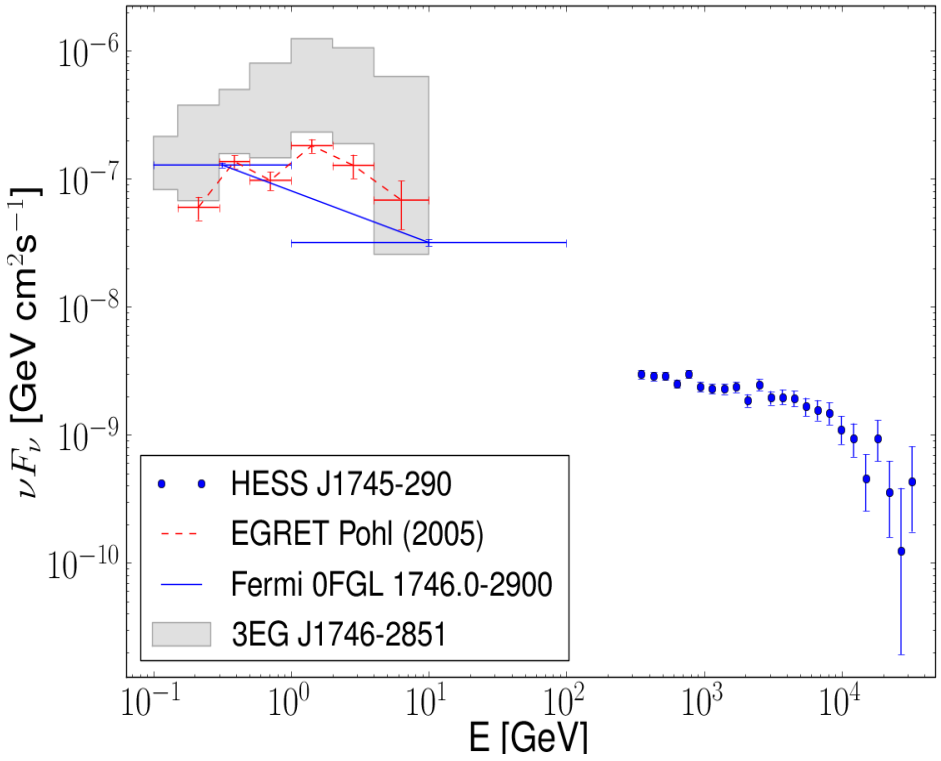


- Image is H.E.S.S. after source removal
- Diamond is SgrA*, with the 2 most recent H.E.S.S. Localizations
- Formally inconsistent with the BSL position
- EGRET reanalysis (Dingus&Hooper 04) not consistent either with BSL!
- Still need more data to understand systematic biases....

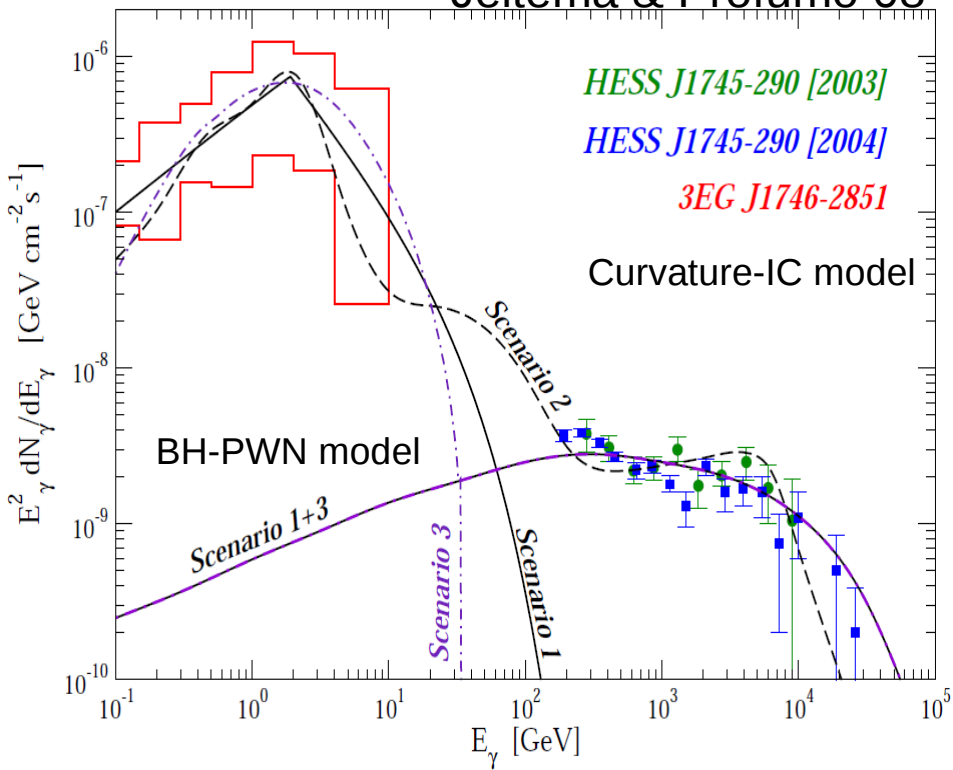
- Variability studies in the BSL paper finds marginal variability
  - Chi^2 based, PWL flux (200MeV to 100GeV) computed per week
  - Threshold=24.7, (alpha error=1% ~ 2 false positives in the 205 BSL sources)
  - Key to association and interpretation of the GC source (think DM....)

Spectral considerations

- **BSL fitted flux (1-100 GeV)=(7.9+/-0.5)x10^{-8} cm^{-2} s^{-1}**
  - **Significantly lower than EGRET analysis (Mayer-Hasselwander)**
  - **Matches better the reanalysis in Pohl 05 (but for localization....)**
- **H.E.S.S. Extrapolation : ~4.6x10^{-9} cm^{-2} s^{-1}**
- **Unless Galactic Diffuse underestimated by ~10**
  - **Not detecting a GeV spectral break would be interesting....**



Jeltema & Profumo 08



Summary of Status

- **LAT analysis on the 1-year dataset is ongoing**
  - **Galactic Diffuse modeling improved**
  - **Digging out as many distinct excess emissions as possible**
  - **Instrument response functions much improved but still not as accurate as we would like for such a region...**
- **Expect news at the Fermi Symposium :**

  http://fermi.gsfc.nasa.gov/science/symposium/2009/