

# Indirect Search for Dark Matter from the Galactic Center (with GLAST)

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# OUTLINE

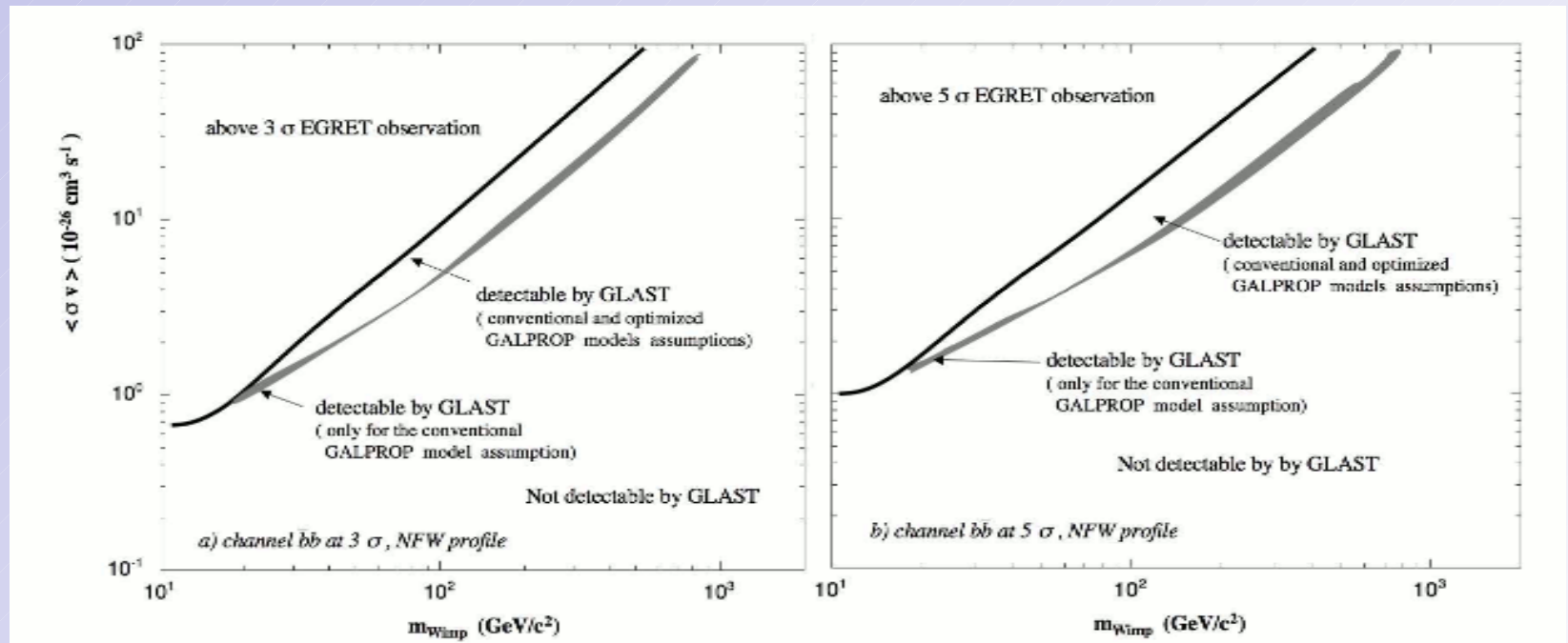
- Motivation and GLAST capabilities
- Astrophysical source in the GC and simulations
- DarkSusy simulation of DM spectra
- Region of Interest studies
- Counts from DM
- Likelihood analysis of simulations

Reports on the other DM searches with GLAST  
Overview - **J.Cohen Tanugi**  
Dwarf Spheroidal Galaxies - **E.Nuss**  
Annihilation Lines - **T.Ylinen**

# GC Dark Matter and GLAST

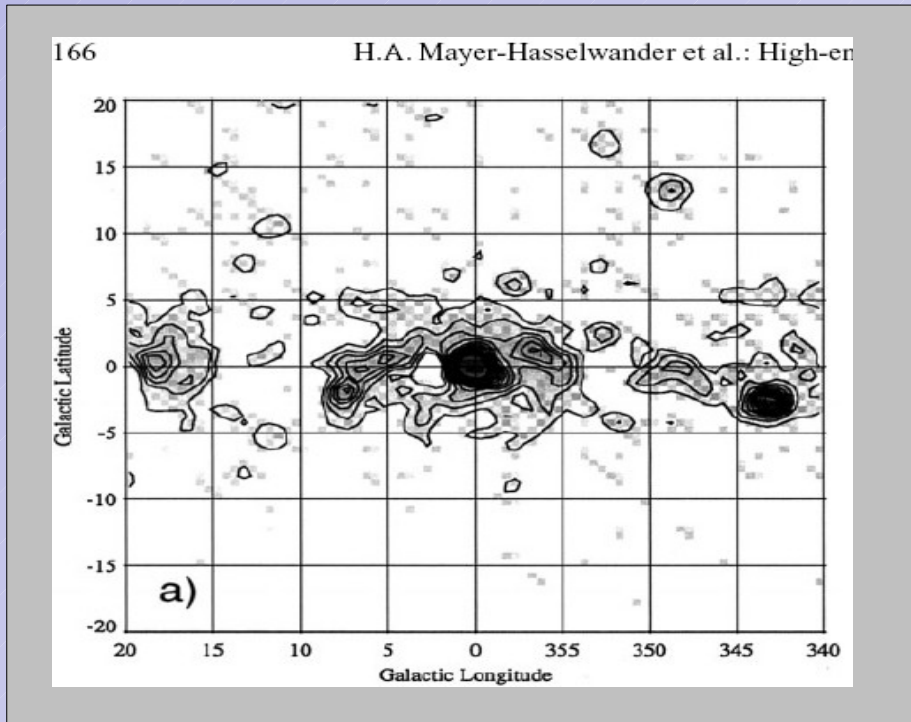
- Halos with central density cusps produced by DM
- Milky Way embedded in DM halo
- Galactic Center maybe detectable in  $\gamma$  ray (via annihilation prop. to  $\rho^2$ )
- **!! Major background contribution by astrophysical  $\gamma$  ray sources !!**

- Baltz et al. ArXiv 0806:2911
- Astrophysical sources subtracted
- Diffuse Background only
- Chi Square analysis

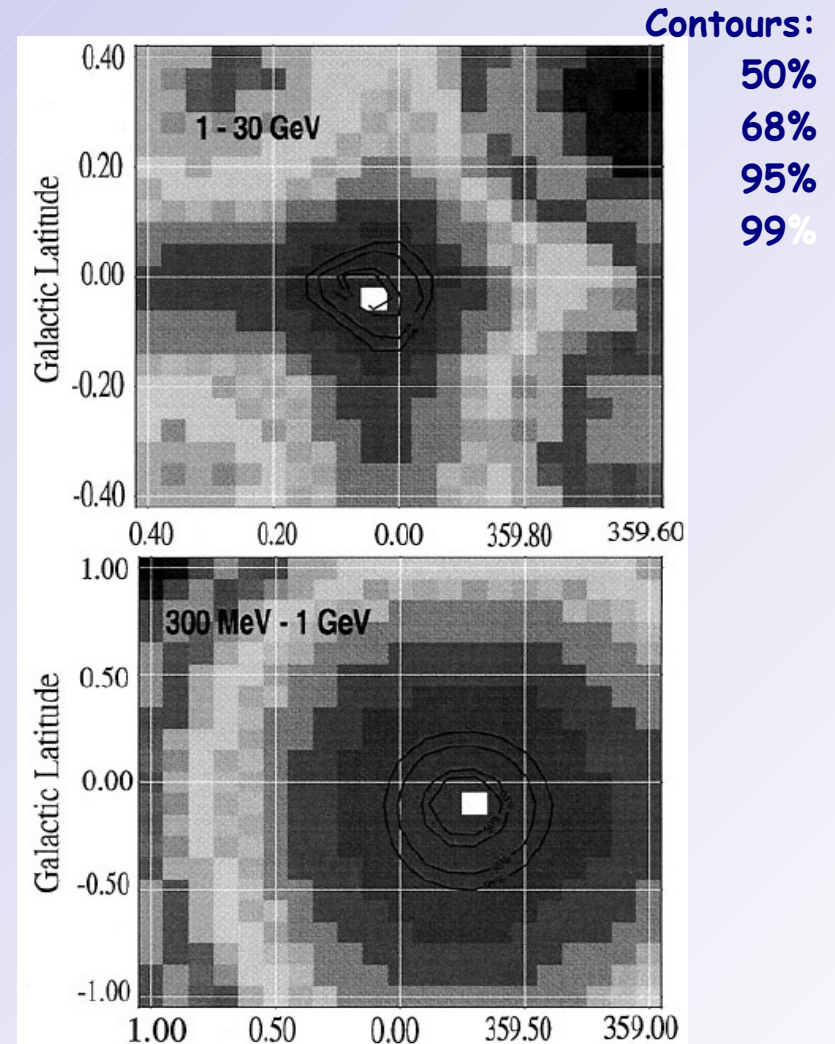


- Simulation of the known astrophysical sources and backgrounds
- Simulations of DM with DarkSusy
- Likelihood analysis

# EGRET Sources

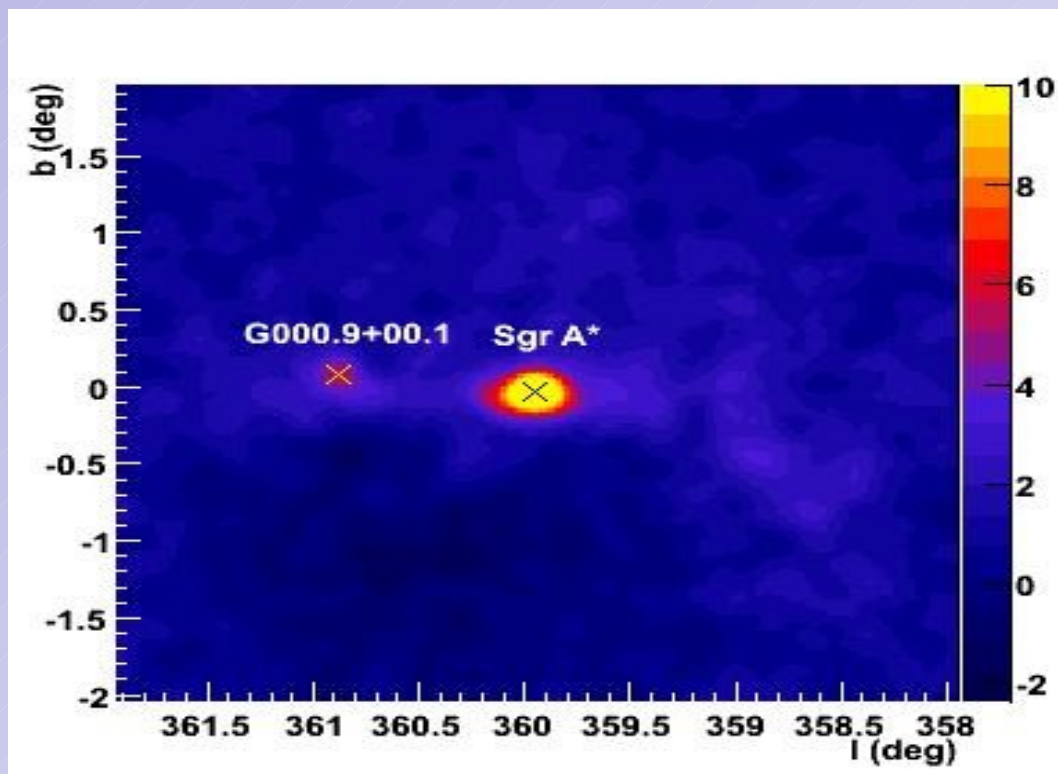


- 3EG J1746-2851
- $F_{GC}(>1 \text{ GeV}) = (49 \pm 3) \times 10^{-8} \text{ cm}^{-2} \text{ s}^{-1}$
- Unidentified
- Source as DM emission (A. Morselli et al. *Astrop.Ph.* (2004), 21, 267)



Plots from Mayer-Hasselwander et al. *A&A* 335, 161 (1998)

# TeV Sources



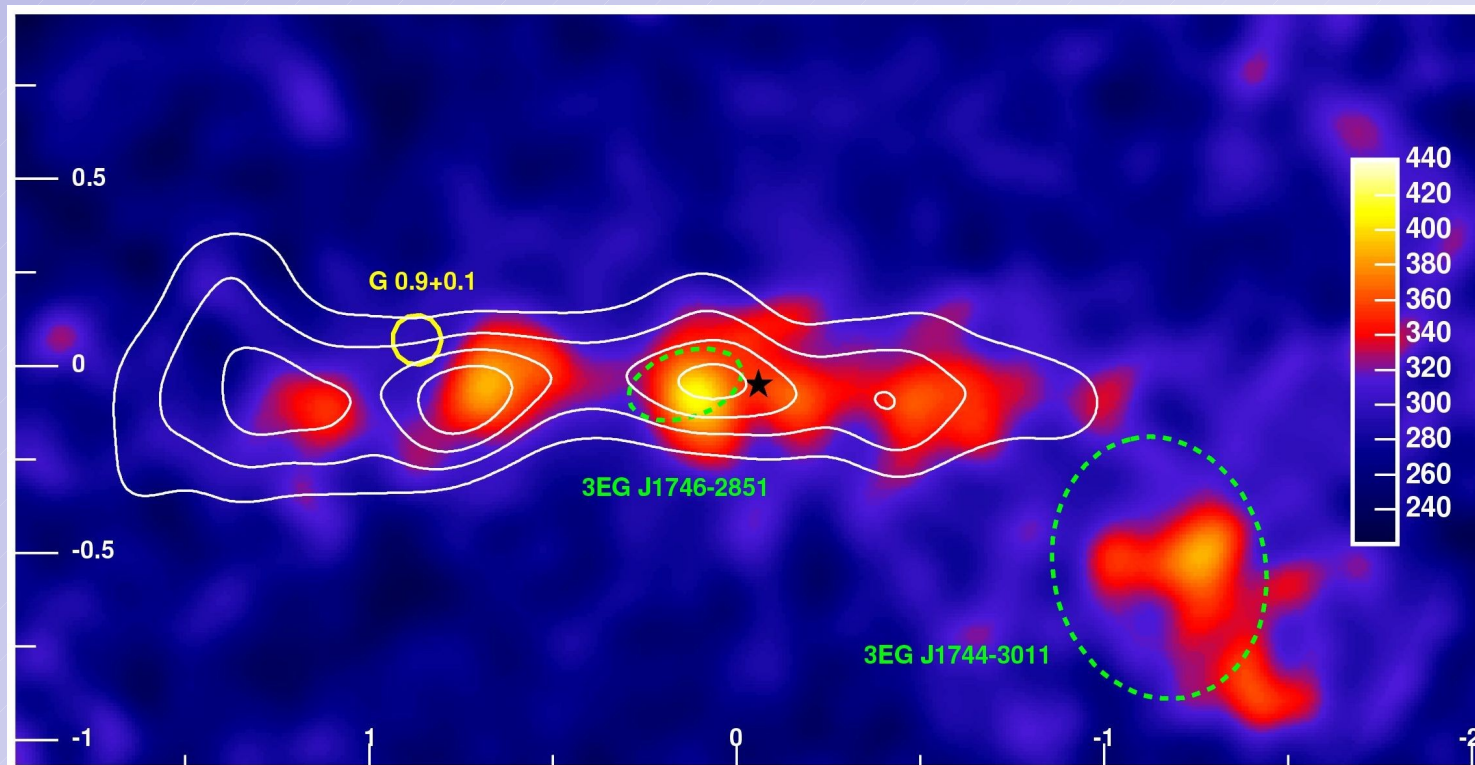
- G 0.9+0.001
- Detected by HESS (Aharonian et al. A&A 432, L25)
- TeV emission coincident with a SNR
- PL Spectrum with  $\text{ph.in.} = 2.39 \pm 0.07$

- TeV Galactic Center Source
- Detected by: CANGAROO coll. ApJ 606, L 115; VERITAS coll. ApJ 608, L97; HESS coll. A&A 425, L13; MAGIC coll. ApJ 639, 761
- Steady flux - PowerLaw  $\text{ph.in.} = 2.25 \pm 0.04$
- HESS data disfavour DM emission ( $\sim 10\text{TeV}$ , Phys.Rev.Lett. 97,221102)
- SgrA East excluded (van Eldik et al. ArXiv0709.3729)
- PWN G359.95-0.04 (Chandra, Wang et al. MNRAS 367, 936) possibly associated with GC TeV emission

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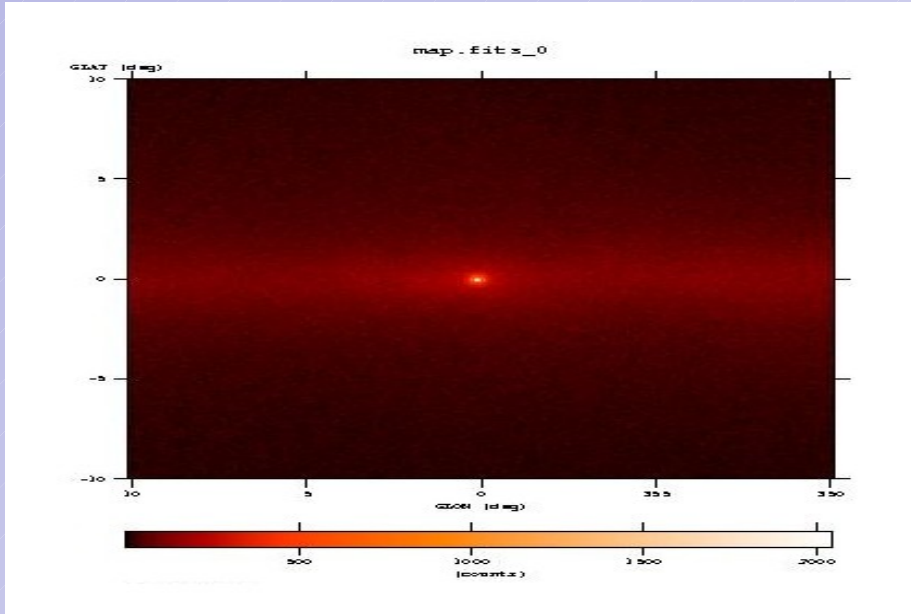


# TeV Sources II



- TeV Diffuse Emission
- Detected by HESS (Aharonian et al. NATURE 439, 695)
- Associate to a dense Molecular Clouds region (Molecular Clouds-G.C.R. Interaction ?)

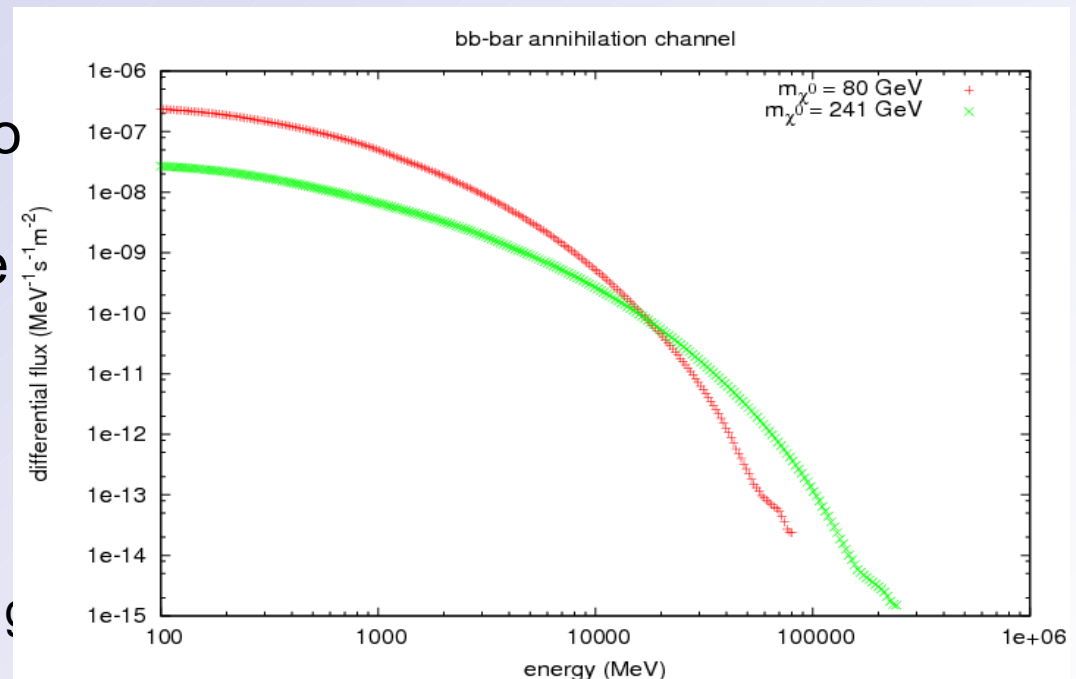
# Simulated GC



- Diffuse Galactic emission
- Total flux 20.74 /m<sup>2</sup>s [.01-655GeV]
- Galprop 6002029RB emission map
- 3EG J1746-2851 (assumed astroph)
- Int.Flux=0.0369/m<sup>2</sup>s
- Ph.Ind.=1.7
- TeV GC (HESS1745)
- Int.Flux =0.00187/m<sup>2</sup>s, Ph.Ind =2.25

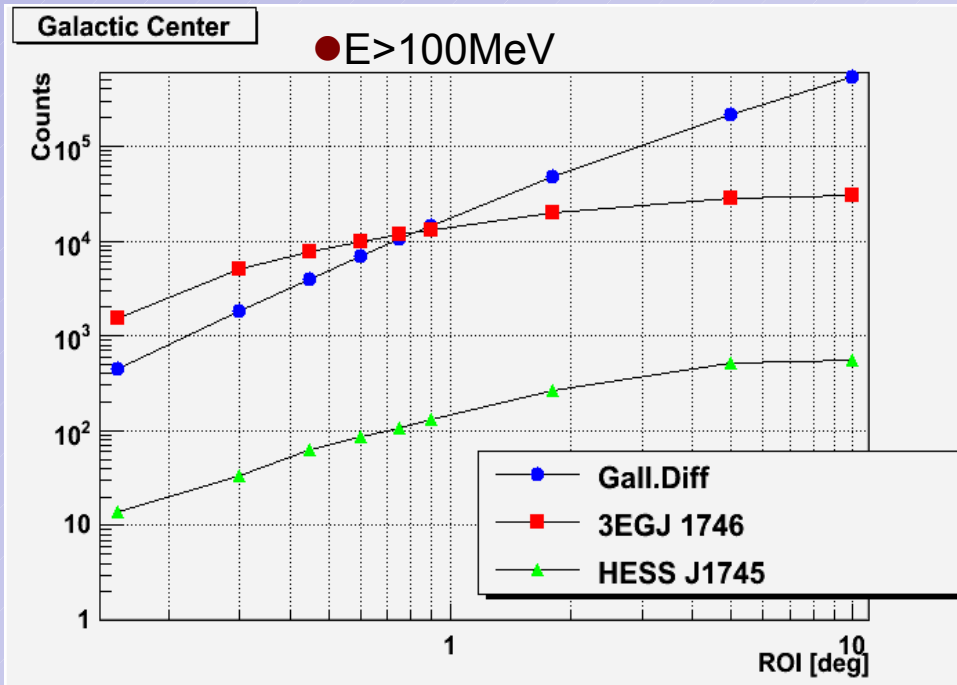
## ● DarkSusy

- DM particle mass: 50, 241, 500
- Halo Profiles: NFW, ADB( Navarro et al. MNRAS 349, 1039. Adiabatically contracted NFW, close to Moore profile)
- $\sigma v = 3 \cdot 10^{-26} \text{ cm}^3 \text{ s}^{-1}$
- Ann. Channel b-anti b (tau- anti tau)



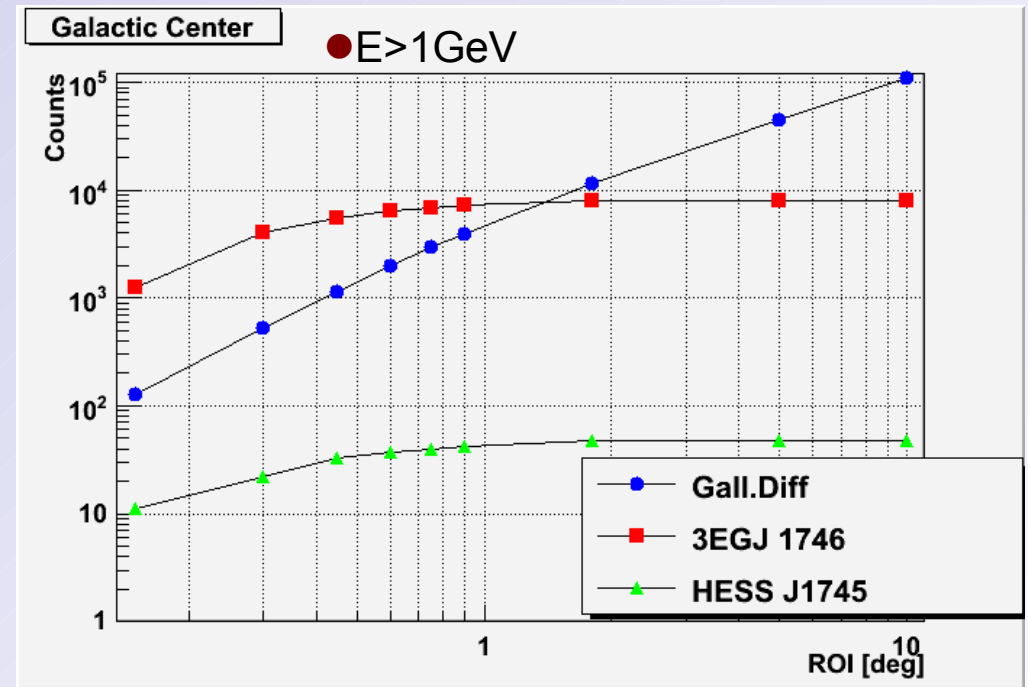
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# Counts vs ROI



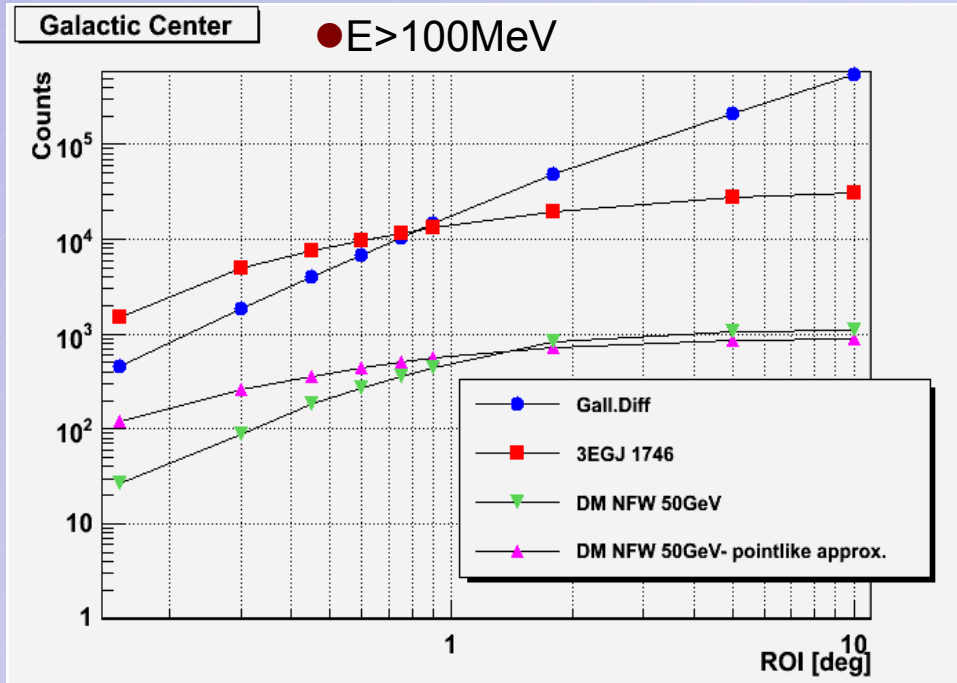
● Astrophysics sources integral counts profile

- Best ROI for HESS J1745: 5deg E>100MeV, 1.8deg E>1GeV
- opt. function:  $SGN/\sqrt{SGN+bck}$



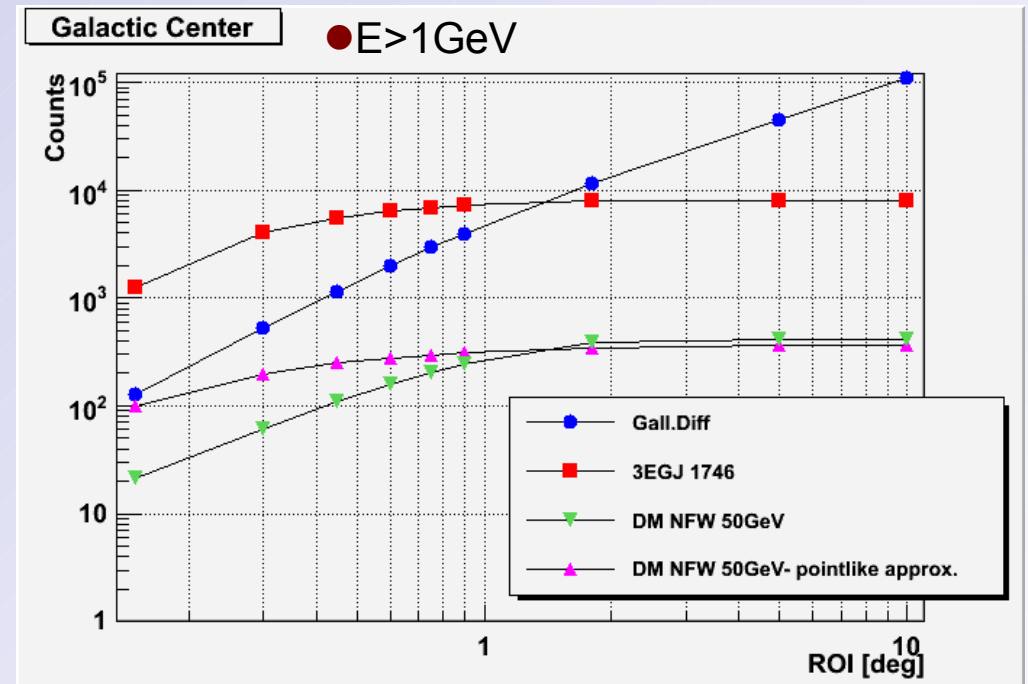


# Counts vs ROI

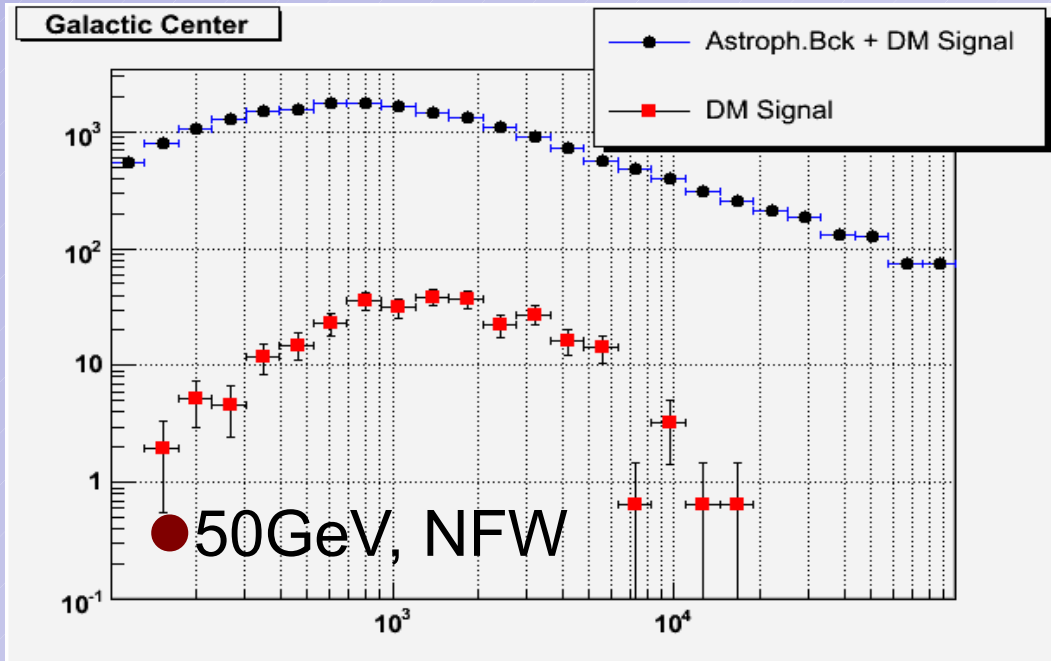


- Best ROI for NFW=1.8 both for E>100MeV and 1GeV
- Best ROI for point-like = 0.75deg E>100MeV, 0.6deg E>1GeV
- opt. function:  $DM/\sqrt{DM+bck}$

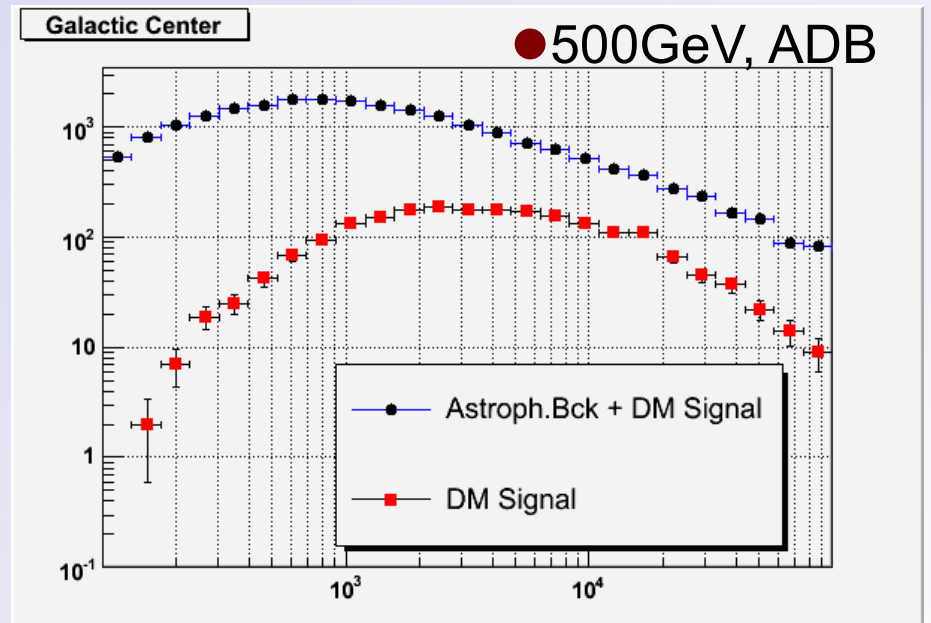
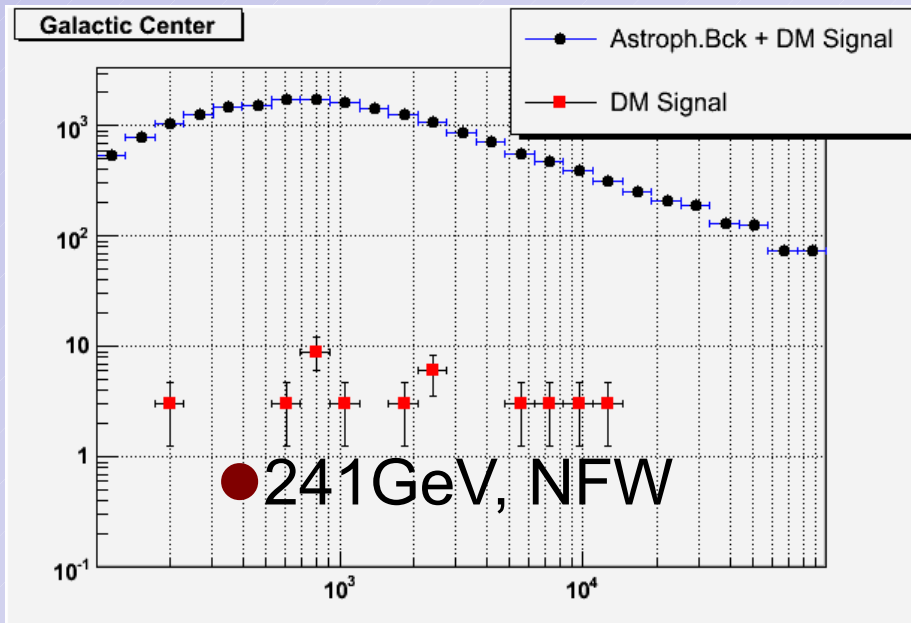
- Comparison of DM profiles
- NFW spatial model vs point-like approx.
- Major differences below 1.8deg



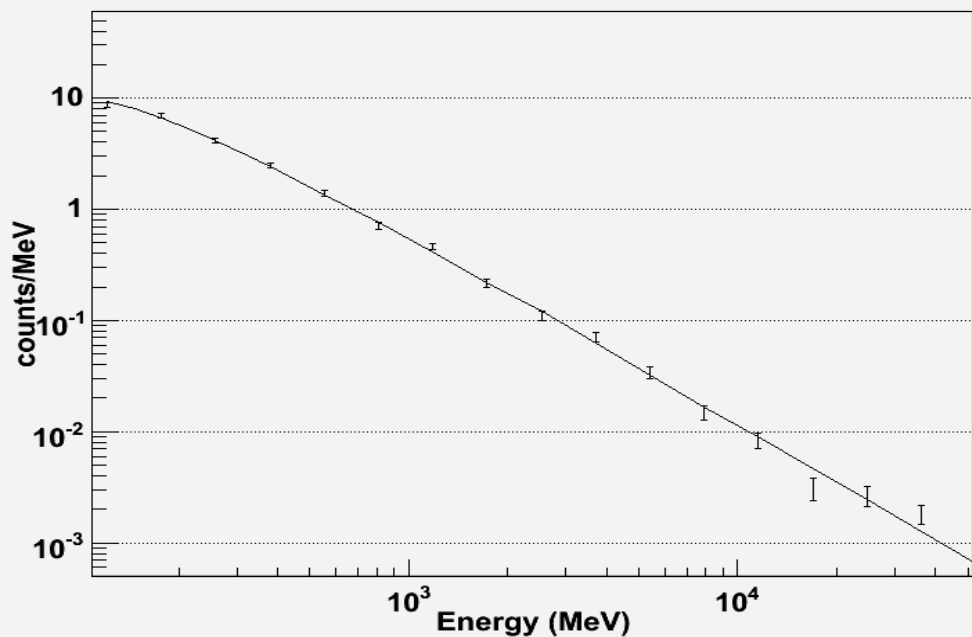
# Counts from DM



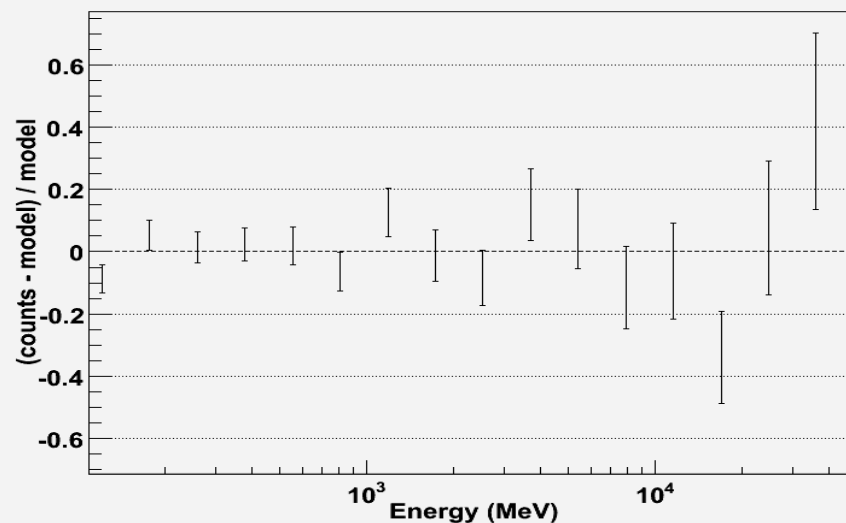
- Counts from DM simulations
- 30Ms, ROI = 0.6deg
- DM 50 = 280, Sum 19990
- DM241 = 39, sum = 19749
- DM500ADB = 2136, sum = 21846



# Isolated Source Analysis I

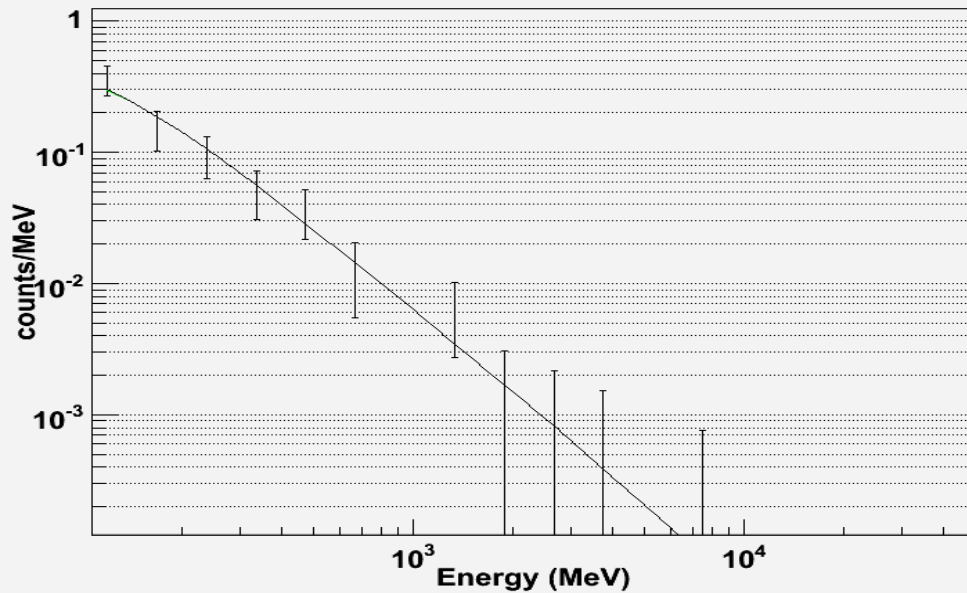


- 3EG J1746-2851
- 3Ms, ROI =5deg
- Integral:  $0.99 \pm 0.02$
- Index:  $-1.70 \pm 0.01$
- Nevts: 2960
- TS 19259



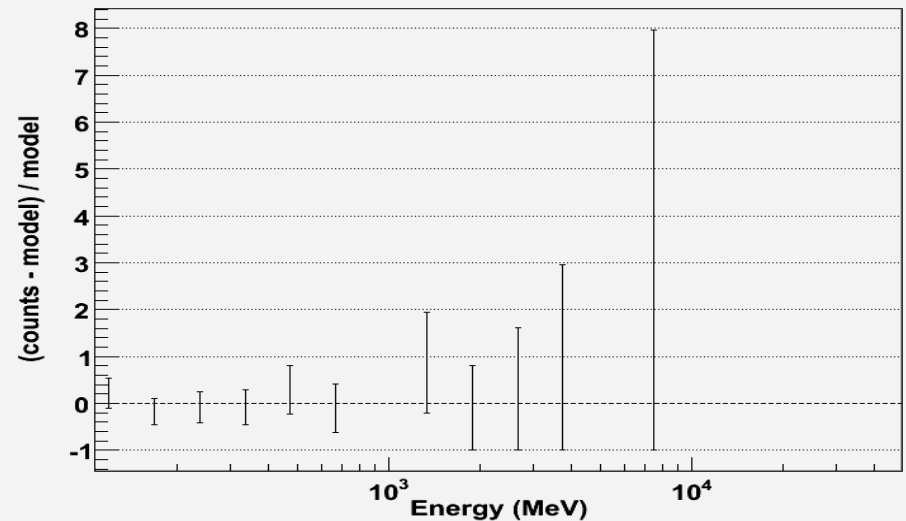
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# Isolated Source Analysis II

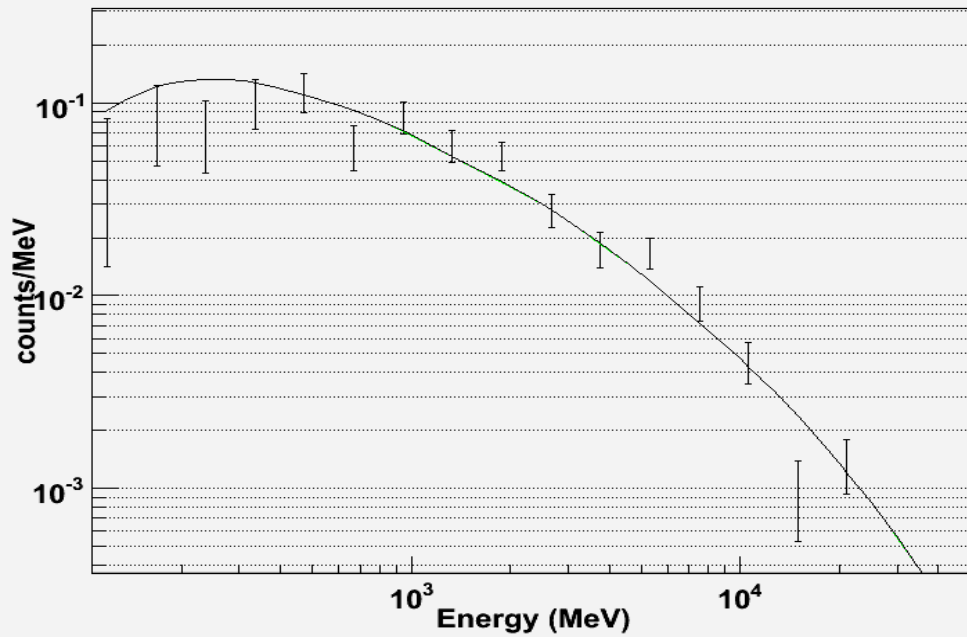


- HESS J1745-2851
- 3Ms, ROI = 5deg
- Integral:  $0.20 \pm 0.03$
- Index:  $-2.16 \pm 0.14$
- Nevts: 54
- TS : 242

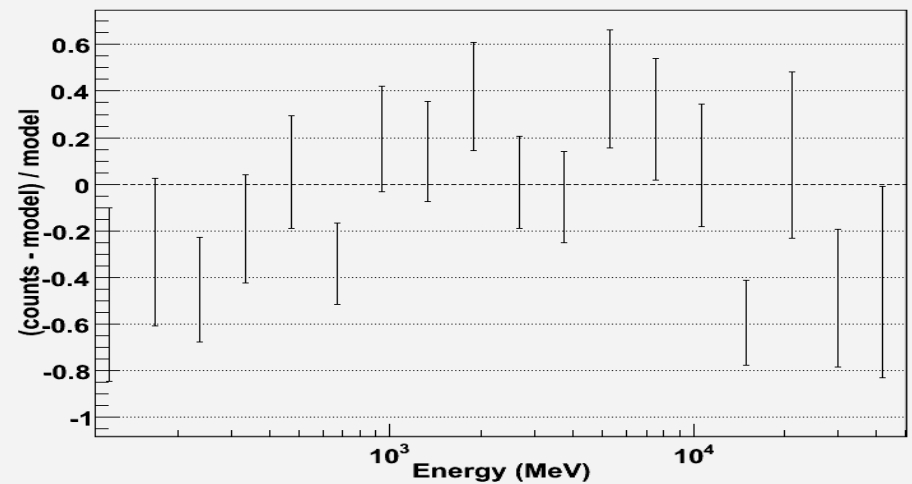
● Residuals



# Isolated Source Analysis III

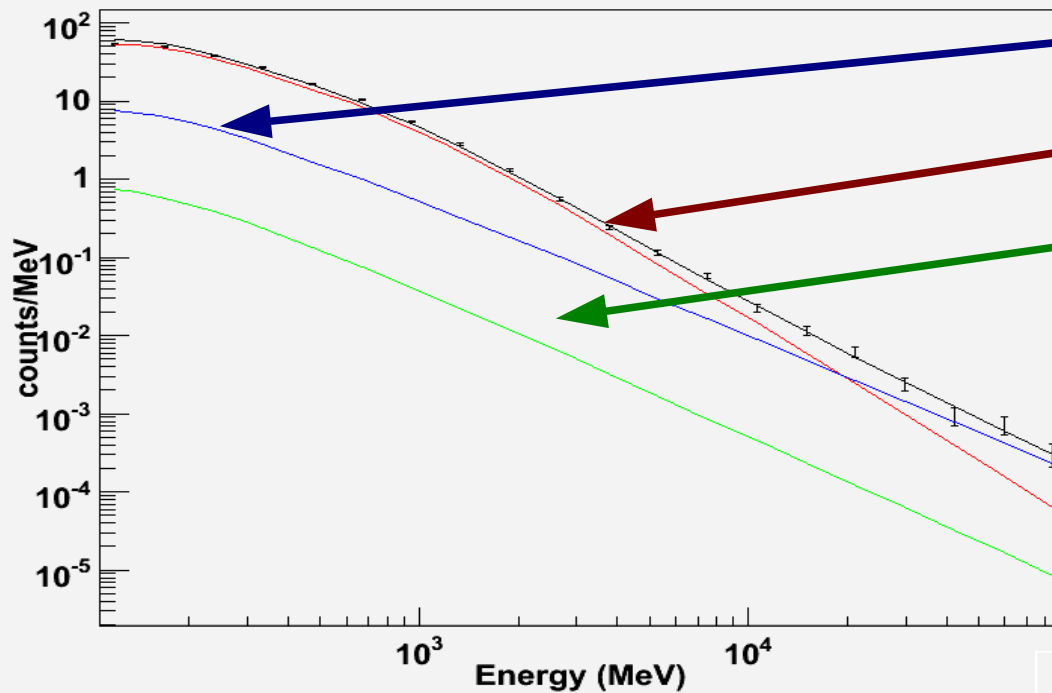


- 500GeV, ADB profile
- ROI 5deg, 3Ms
- Norm  $8.2 \pm 0.4 \cdot 10^{-6}$
- Nevents = 288
- TS = 5710





# Multiple Source Fit



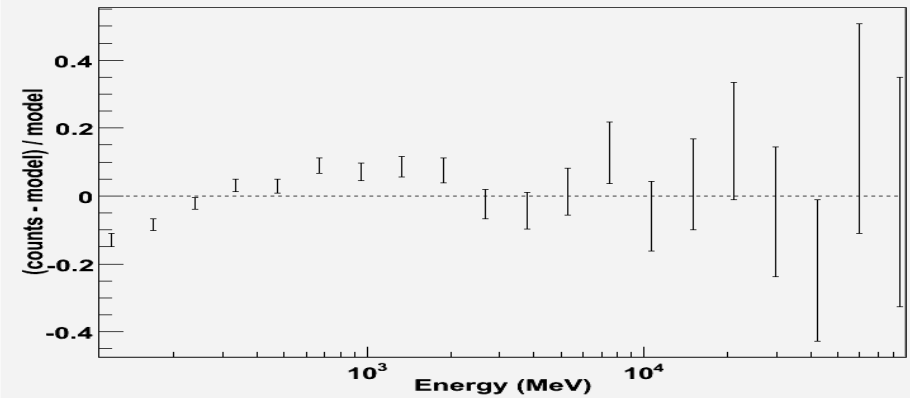
3EGJ1746

Diffuse Gal.

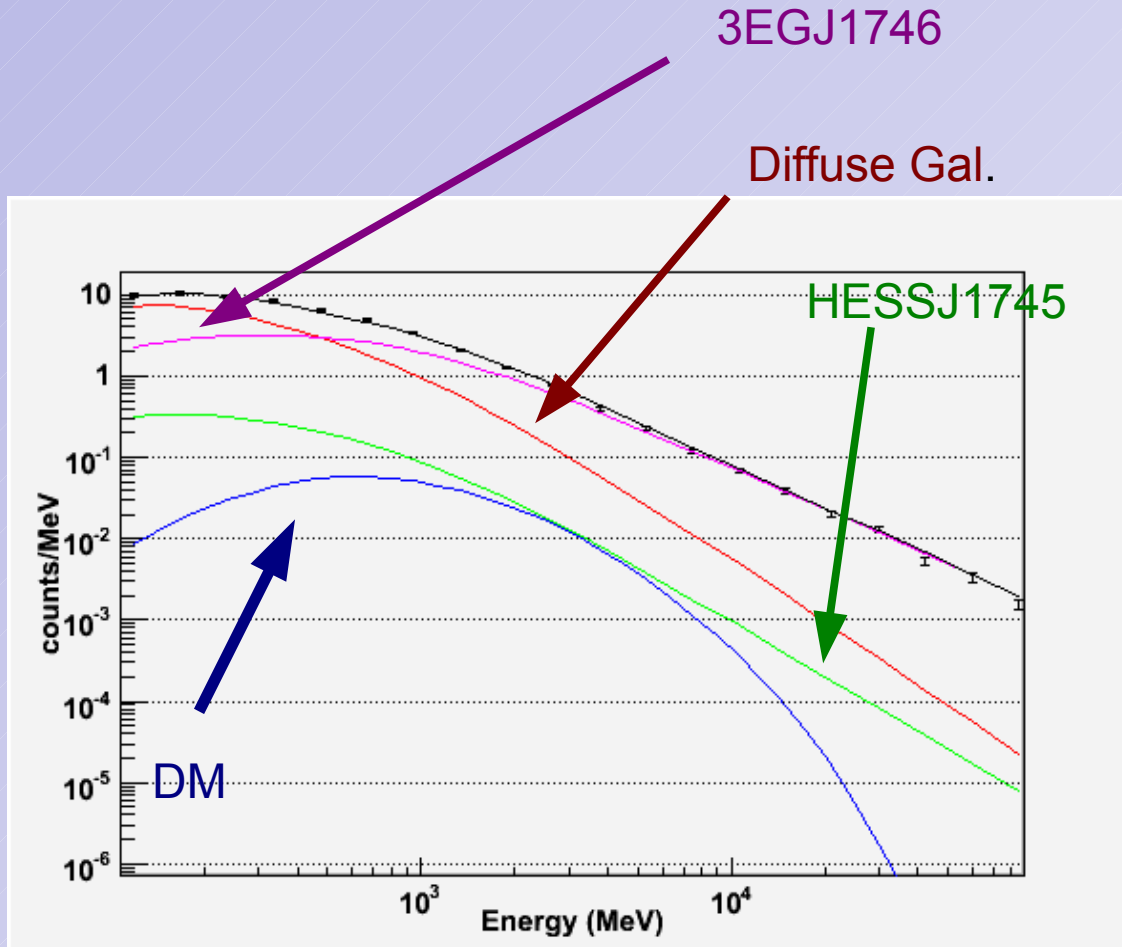
HESSJ1745

● Residuals

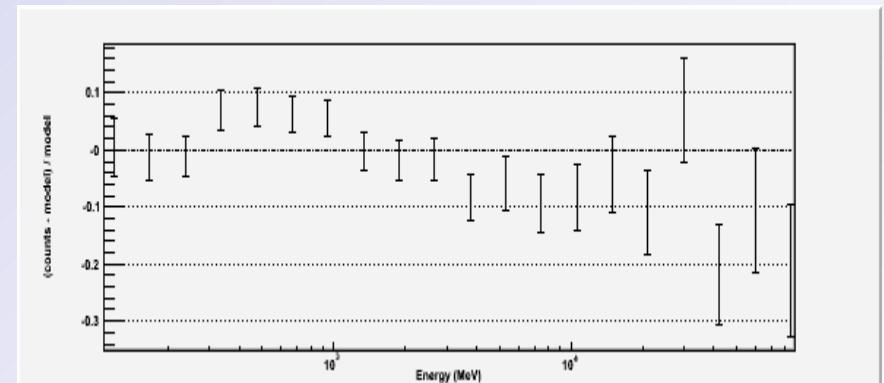
- Astrophysical Sources only
- 3Ms, ROI=5deg
- 3EG J1746-2851, TS=1912
- HESS J1745, TS=2.5, not detected, likely detected in 1 year



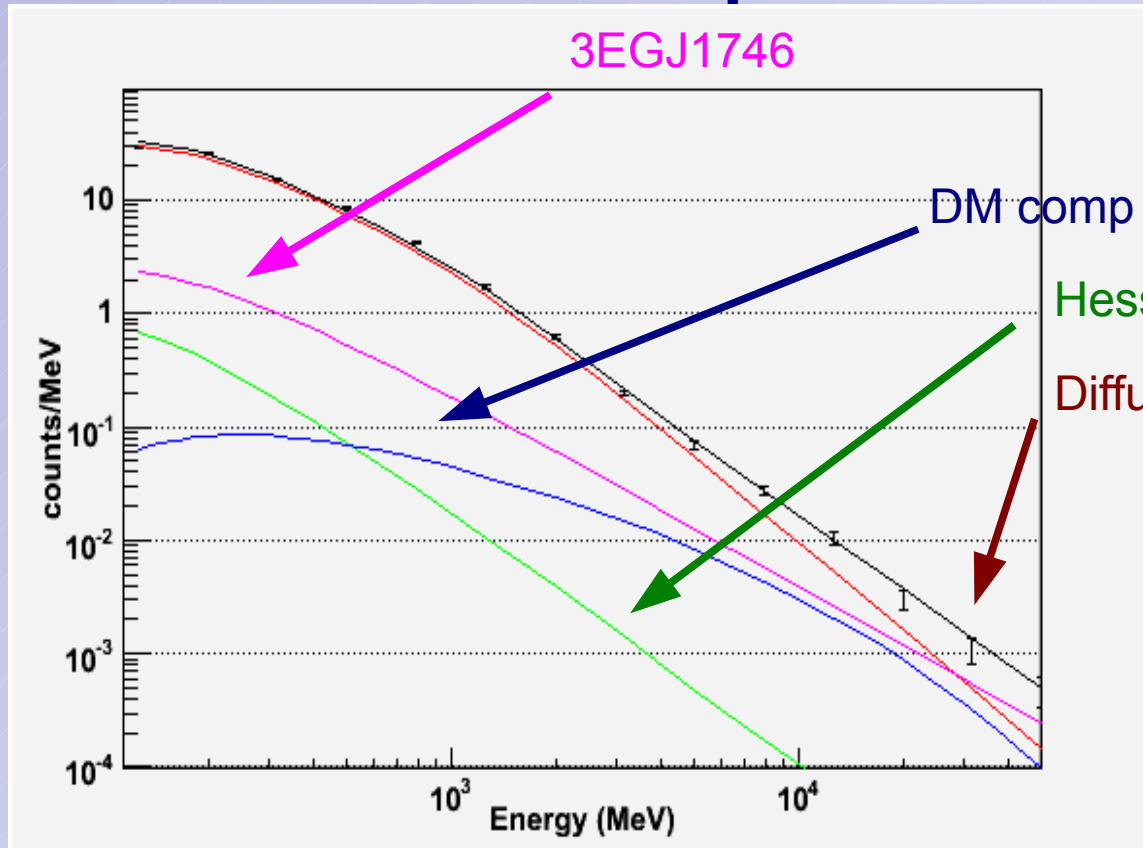
# Multiple Source Fit



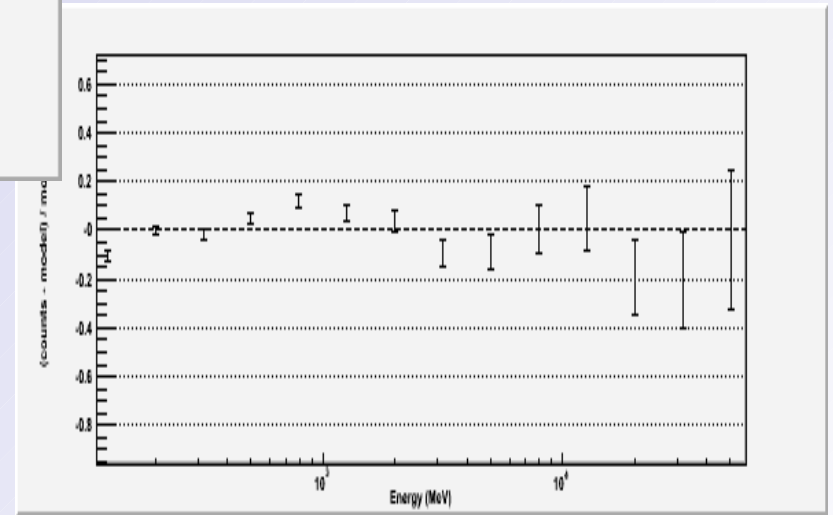
- Astrophysical Sources & DM
- Mass 50GeV, NFW
- 15Ms,
- $4\sigma$ ,  $> 5\sigma$  in 1year



# Multiple Source Fit



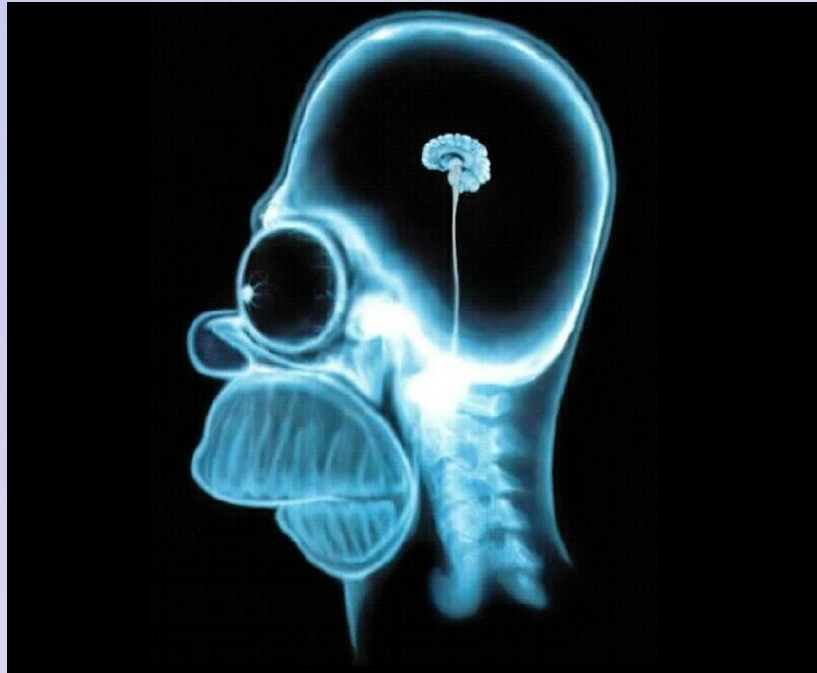
- Astrophysical Sources & DM
- Mass 500GeV, ADB
- 6Ms,  $9\sigma$



# Summary

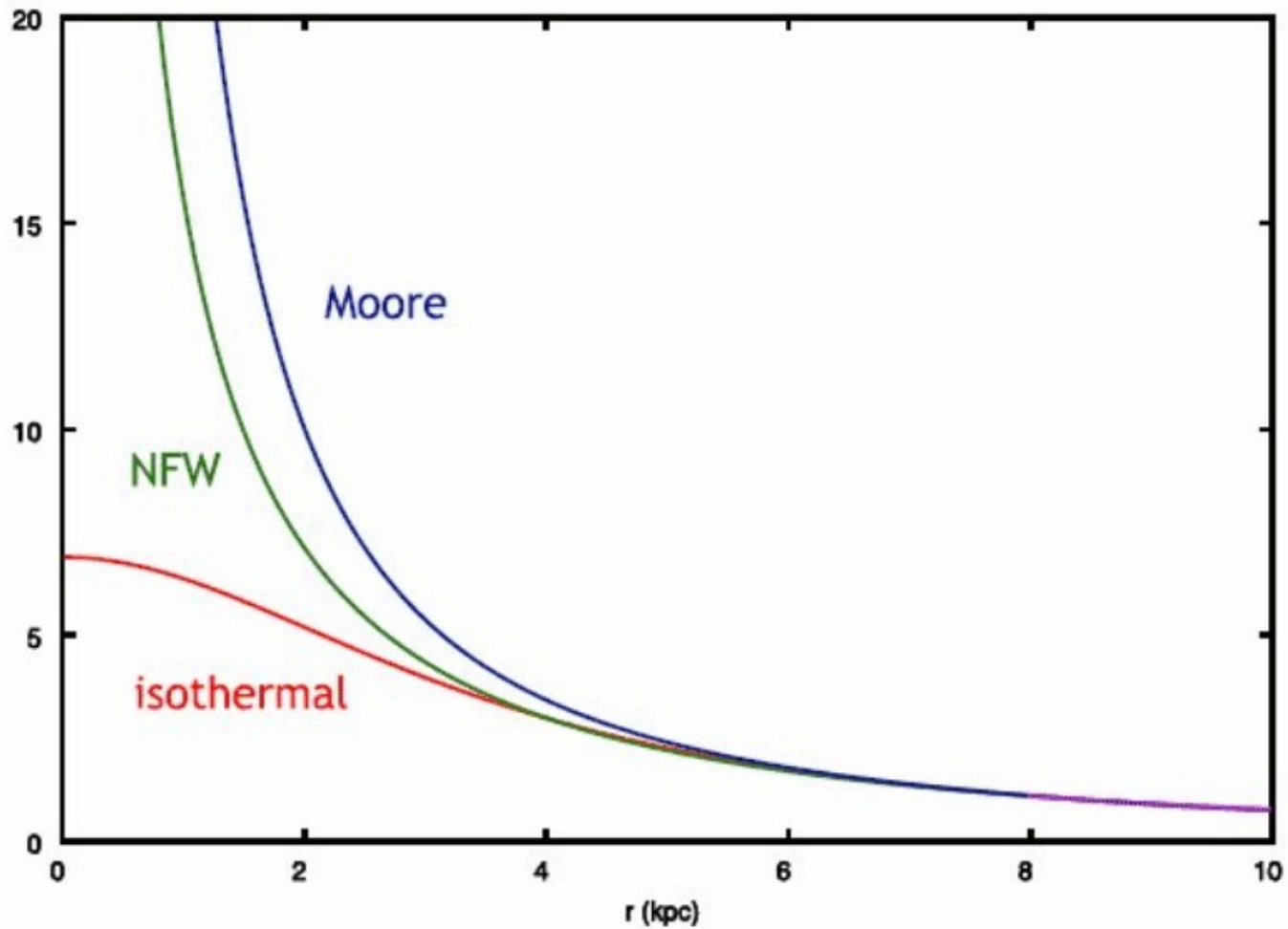
- GC as a major target for the indirect search for DM
- Most sensitive gamma ray study of GC to be performed with GLAST (already in orbit and delivering data)
- Likelihood analysis well suited for gamma satellites
- Detailed modelling of the background needed
- Signal enhancement with optimal ROI study
- DM spectral analysis
- First model constrains with 1 year data

# BACKUP



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From Conrad 2007

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