

# DM Gamma-Rays

Brandon Anderson  
EPS-HEP Meeting  
2013, July 18

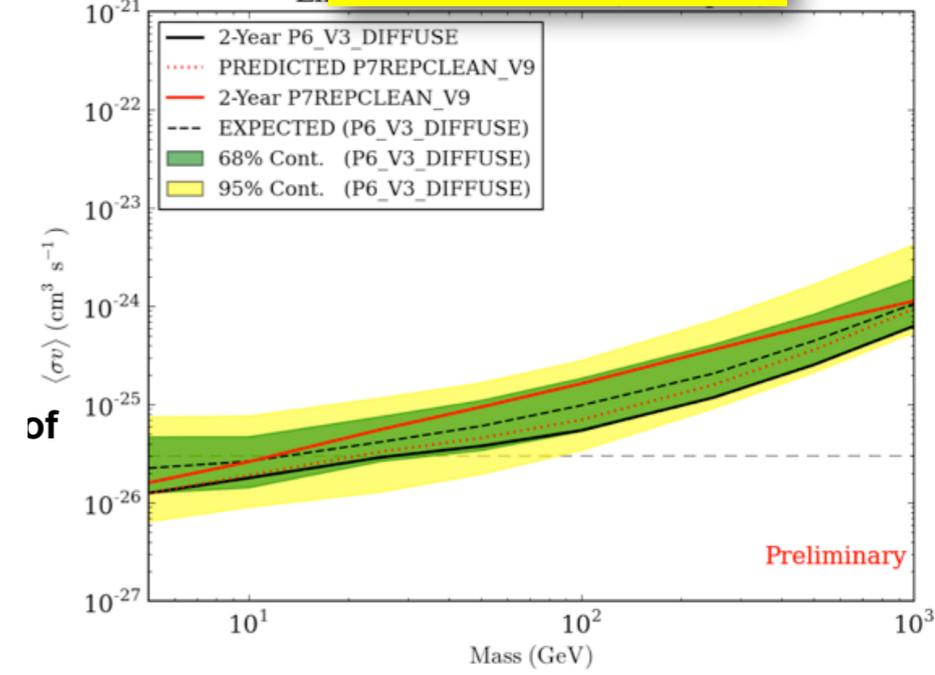
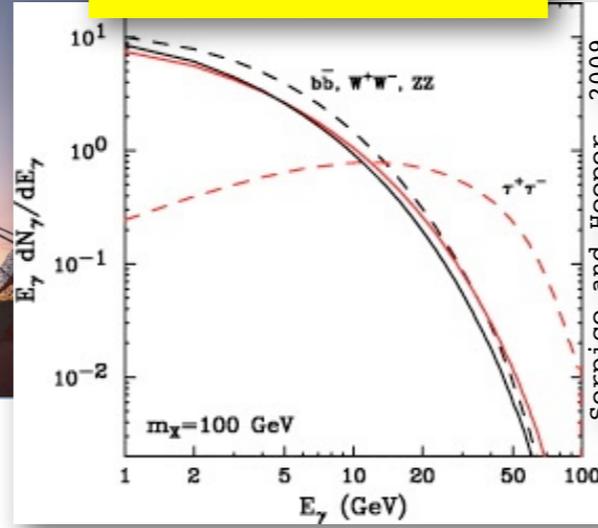


# Dark Matter

One Slide

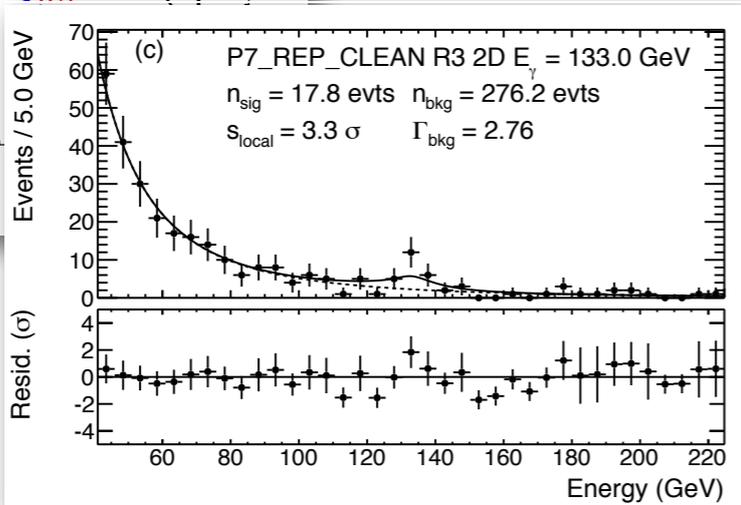
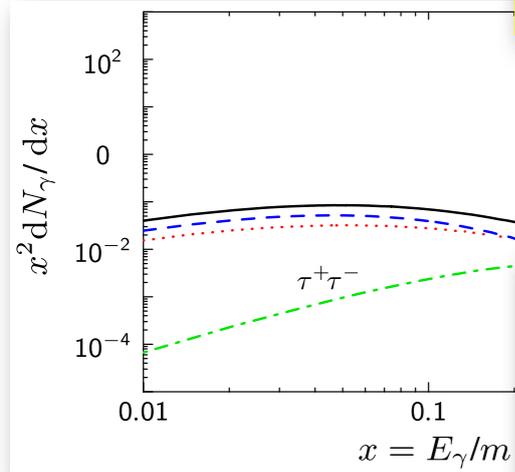
No continuum detection.

Best Limits

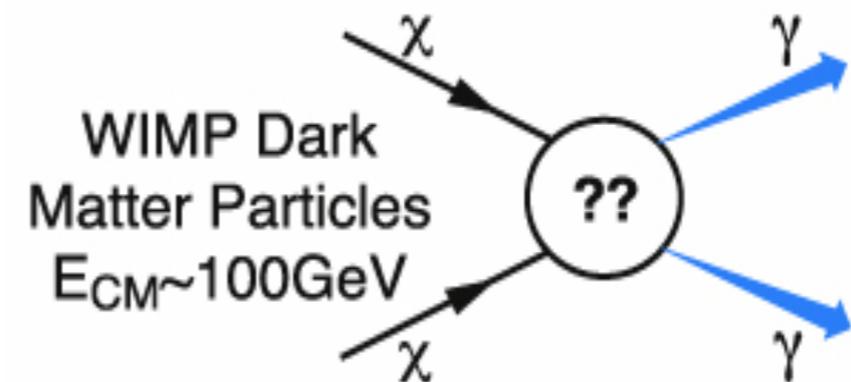
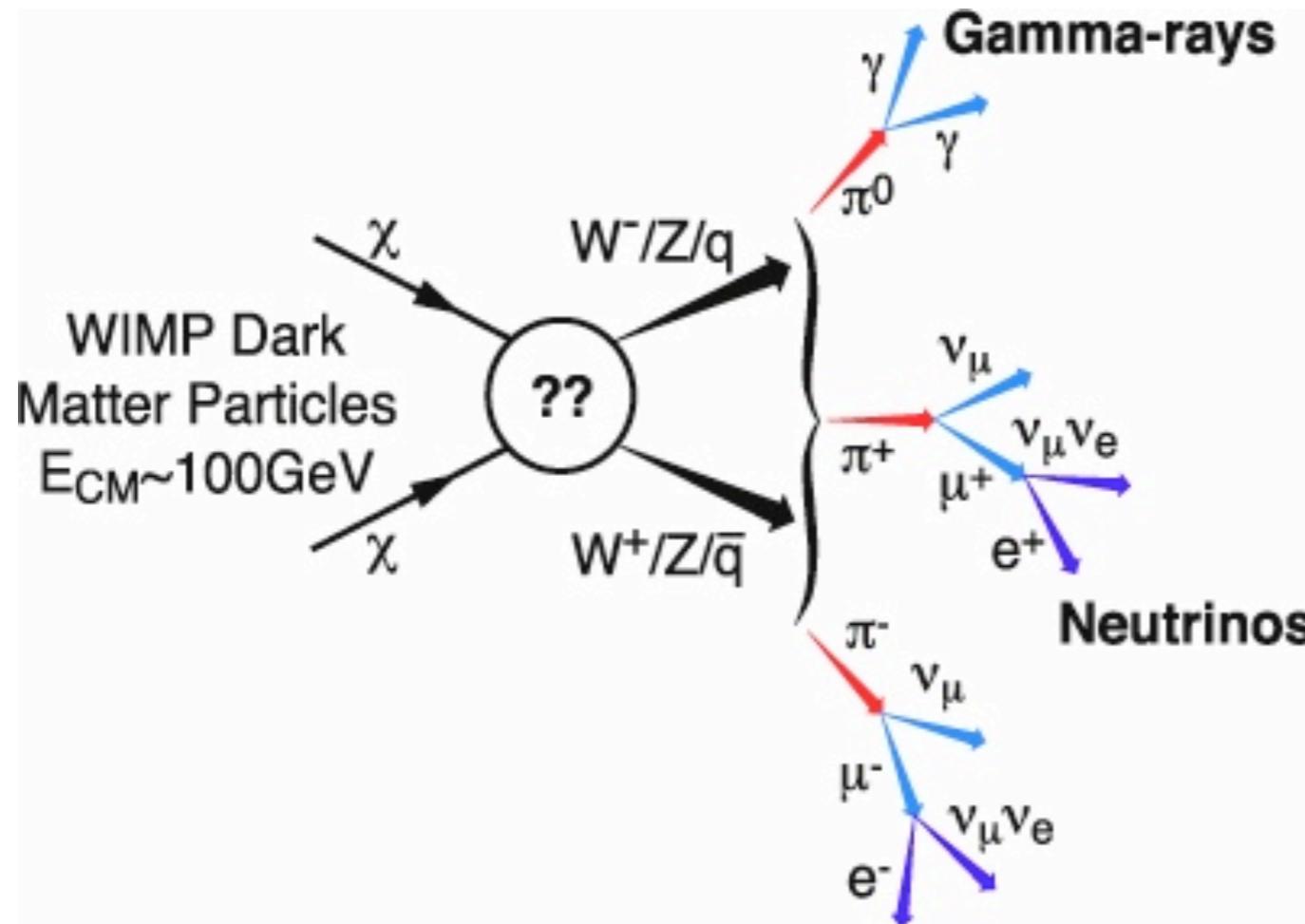


Possible line feature.

HESS II will say for sure.



# Gamma Production



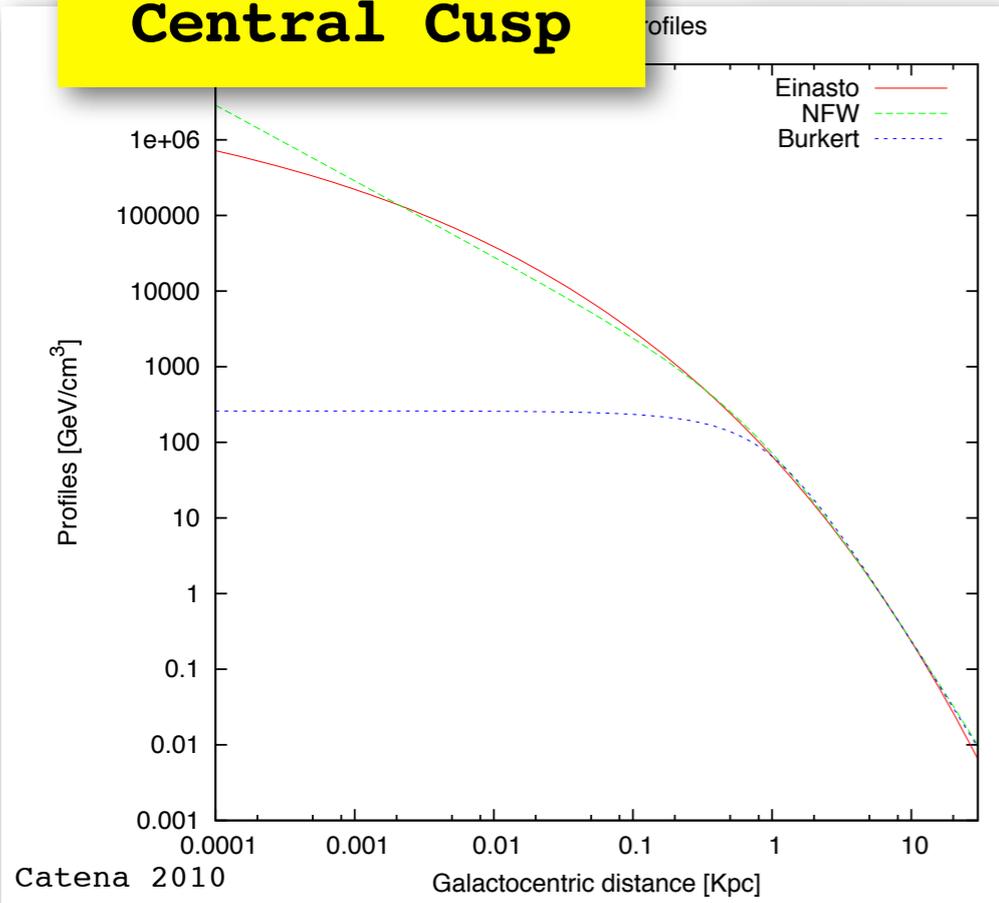
$$\frac{d\Phi_\gamma}{dE_\gamma} = \frac{1}{4\pi} \frac{\langle \sigma v \rangle}{2m_\chi^2} \sum_f \frac{dN_\gamma^f}{dE_\gamma} B_f$$

particle

astro

# DM Distribution

## Central Cusp



## Universal Profile

$$\rho(r) = \frac{\rho_0}{\frac{r}{R_S} \left(1 + \frac{r}{R_S}\right)^2}$$

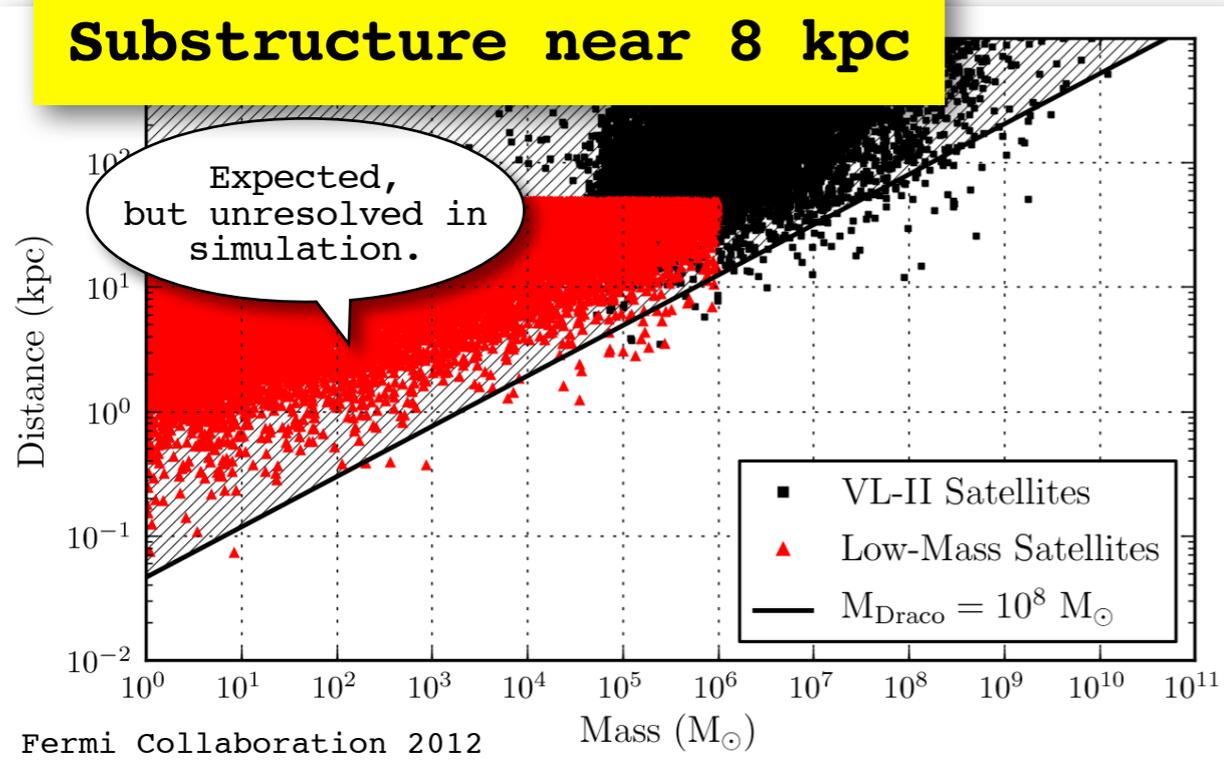
$$\frac{d\Phi_\gamma}{dE_\gamma} = \frac{1}{4\pi} \frac{\langle\sigma v\rangle}{2m_\chi^2} \sum_f \frac{dN_\gamma^f}{dE_\gamma} B_f \int_{\Delta\Omega} d\Omega \int_{l_{os}} \rho^2(l) dl(\psi) d\Omega$$

particle

astro

# DM Distribution

## Substructure near 8 kpc



## Universal Profile

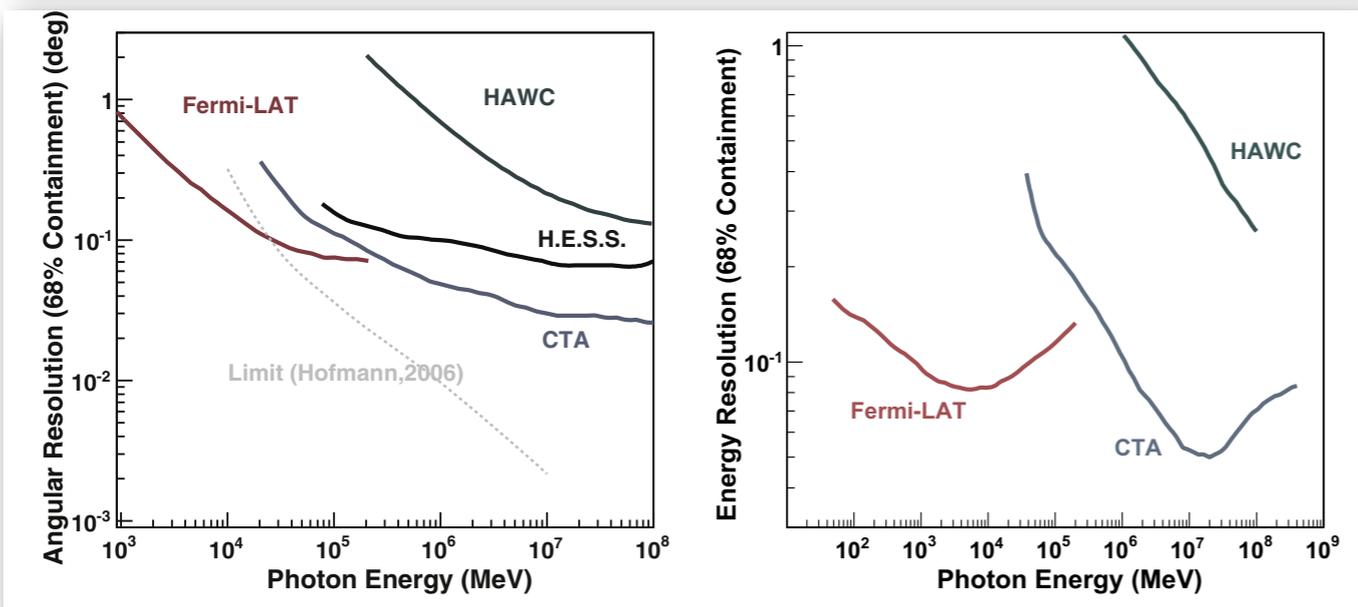
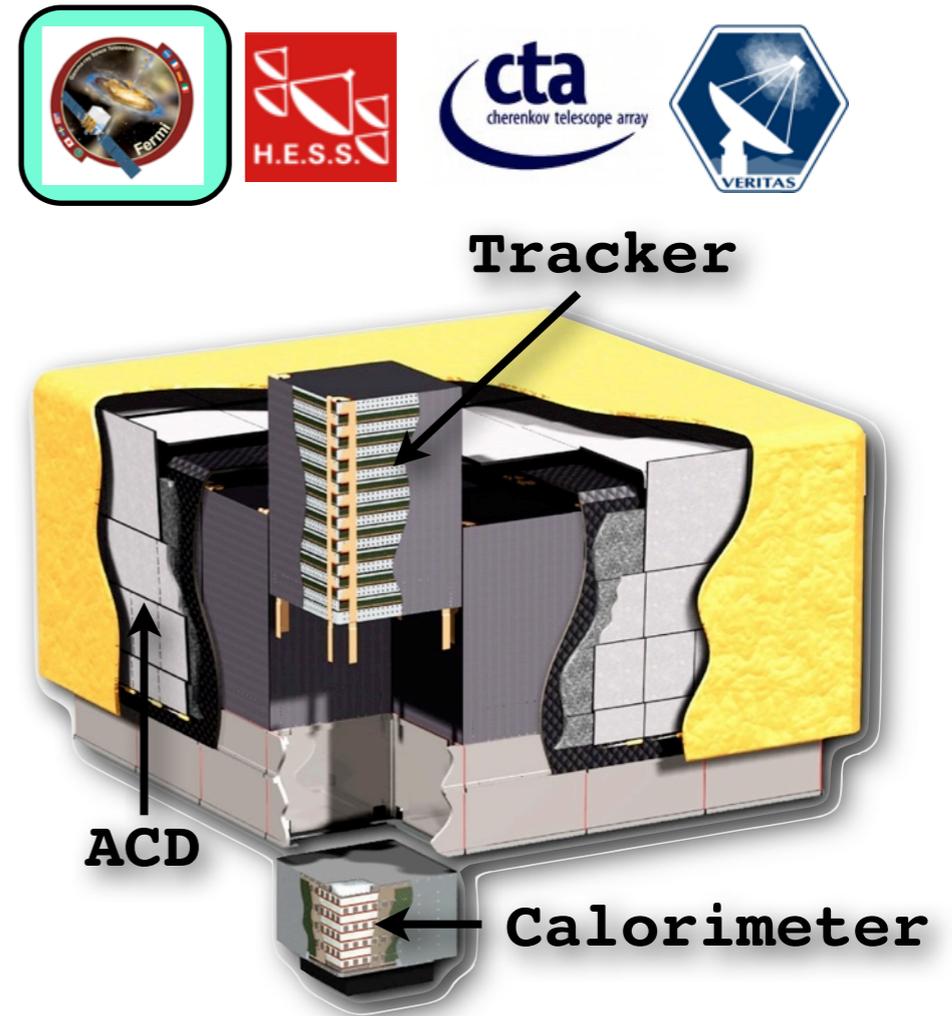
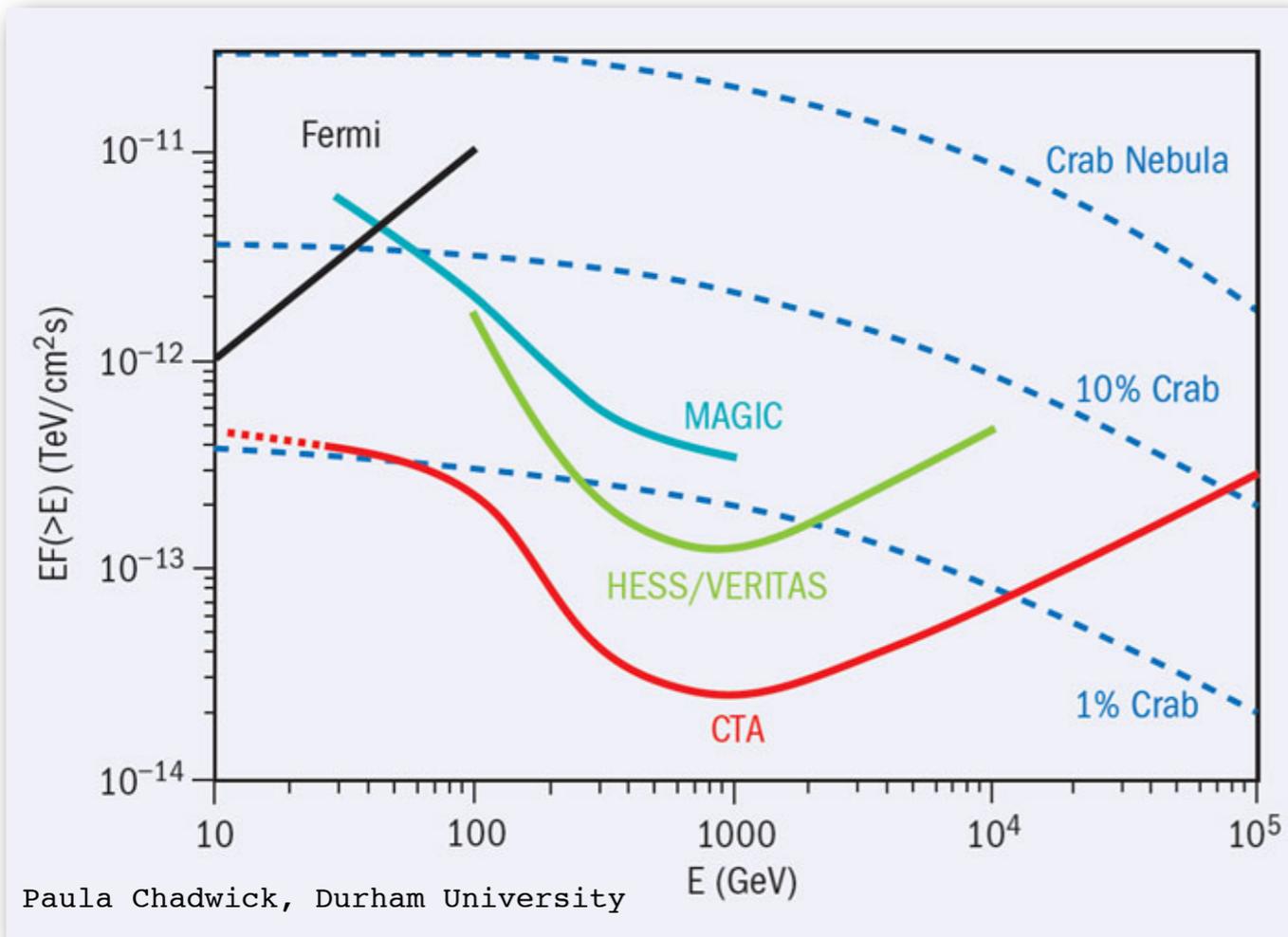
$$\rho(r) = \frac{\rho_0}{\frac{r}{R_S} \left(1 + \frac{r}{R_S}\right)^2}$$

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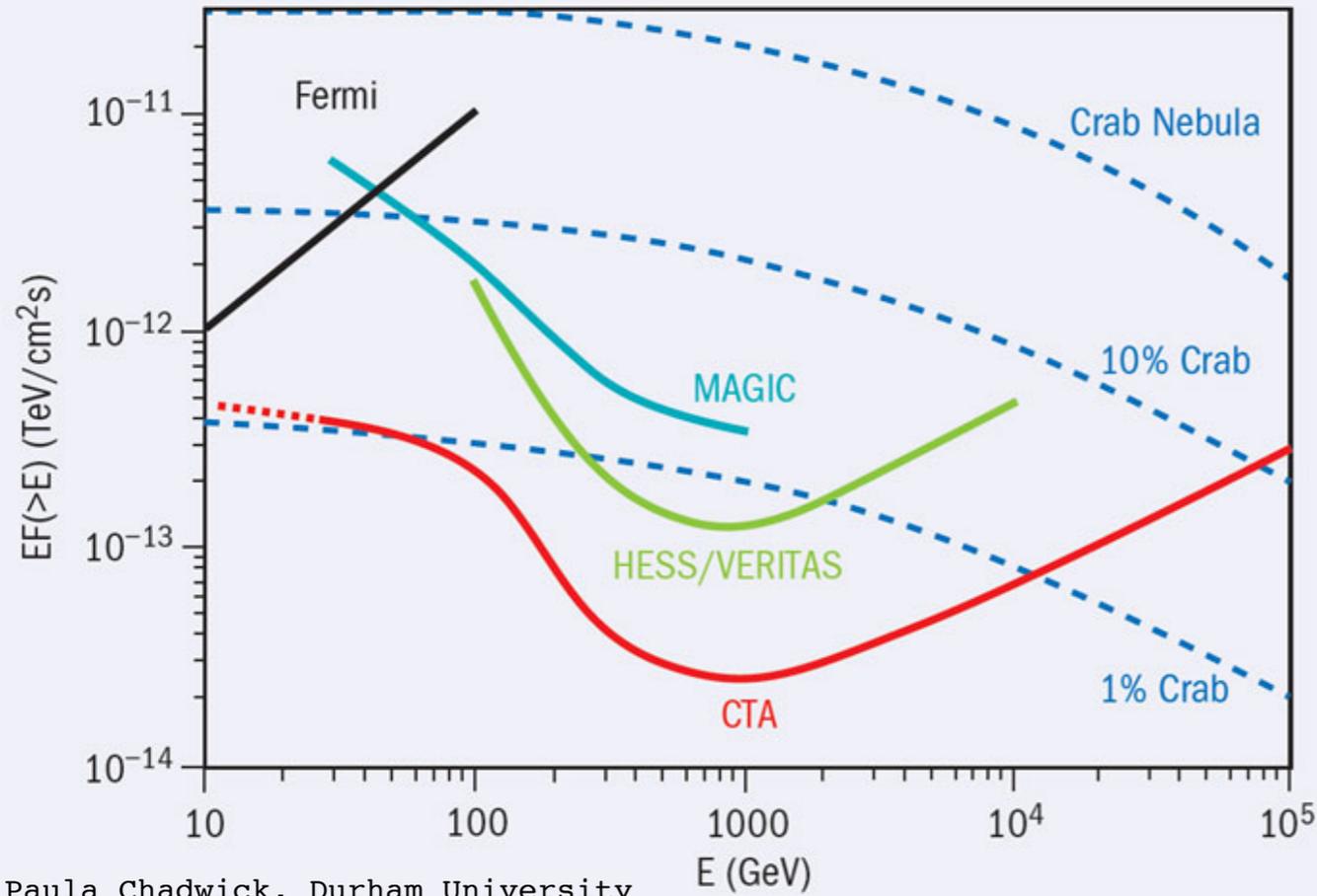
particle

astro

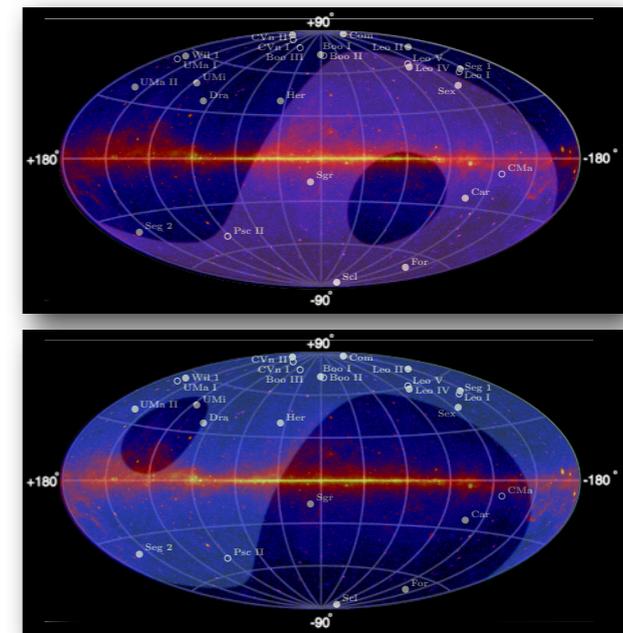
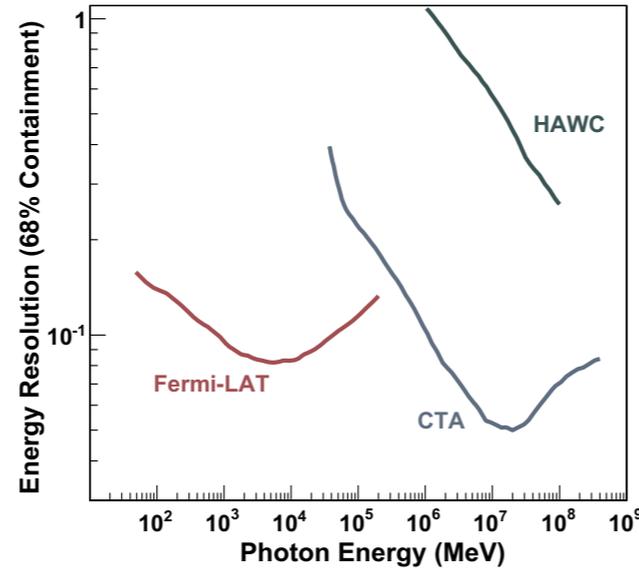
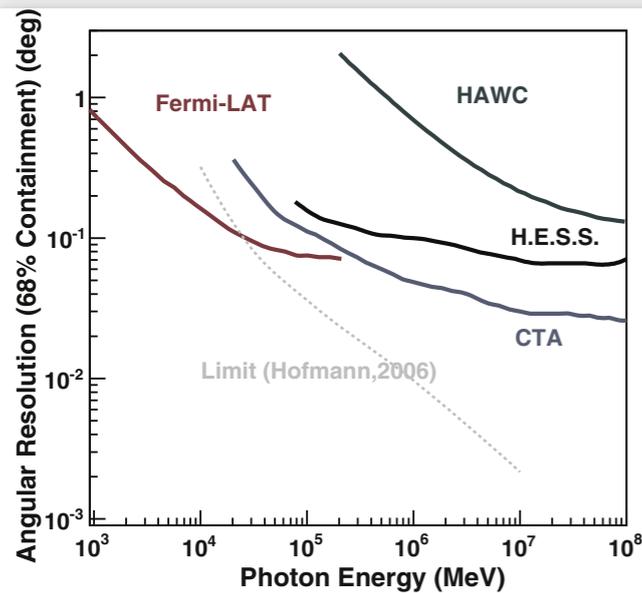
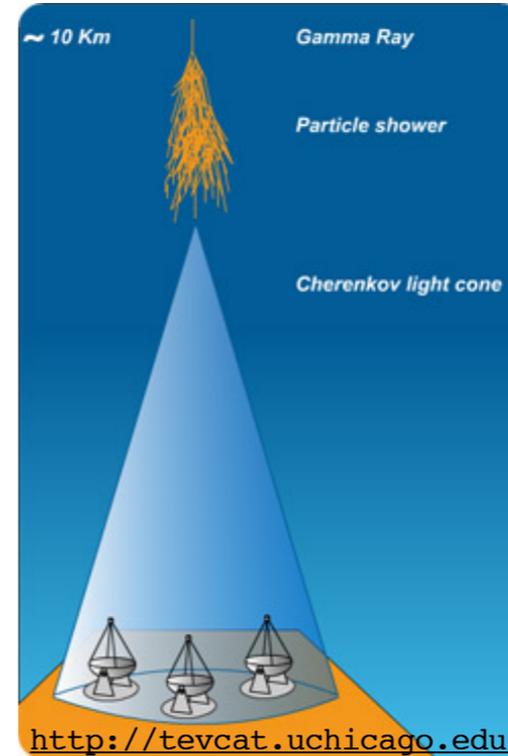
# Detector Overview



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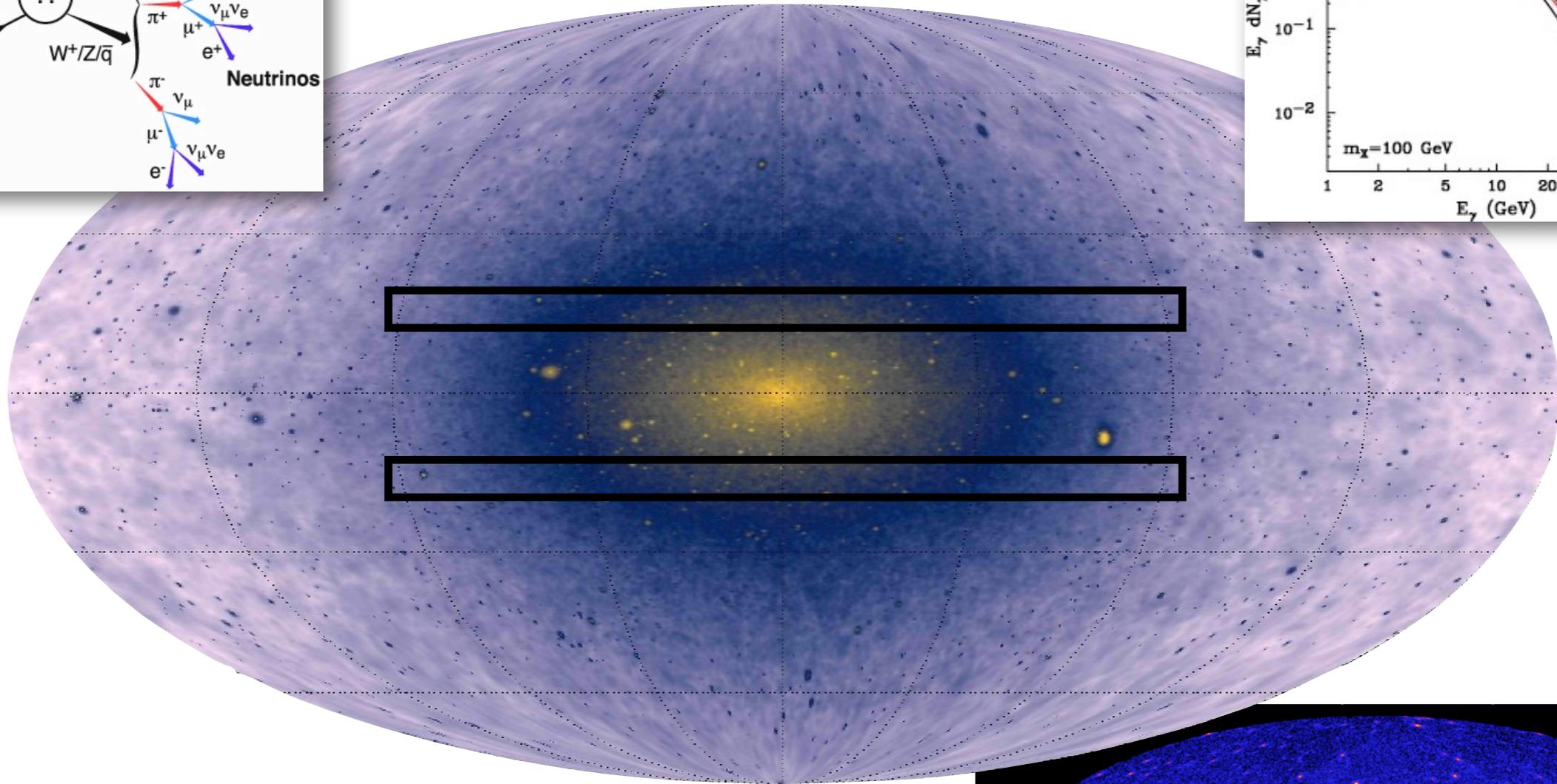
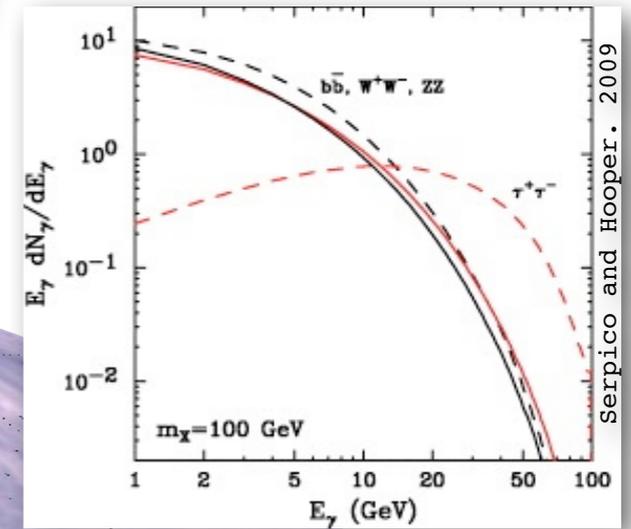
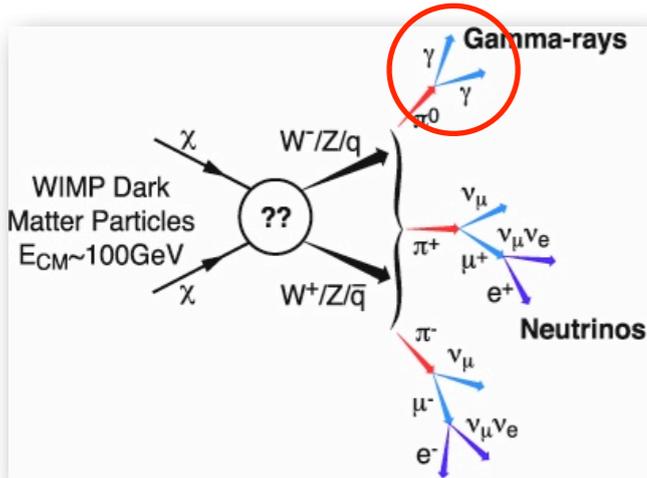
Paula Chadwick, Durham University



# Search Strategies

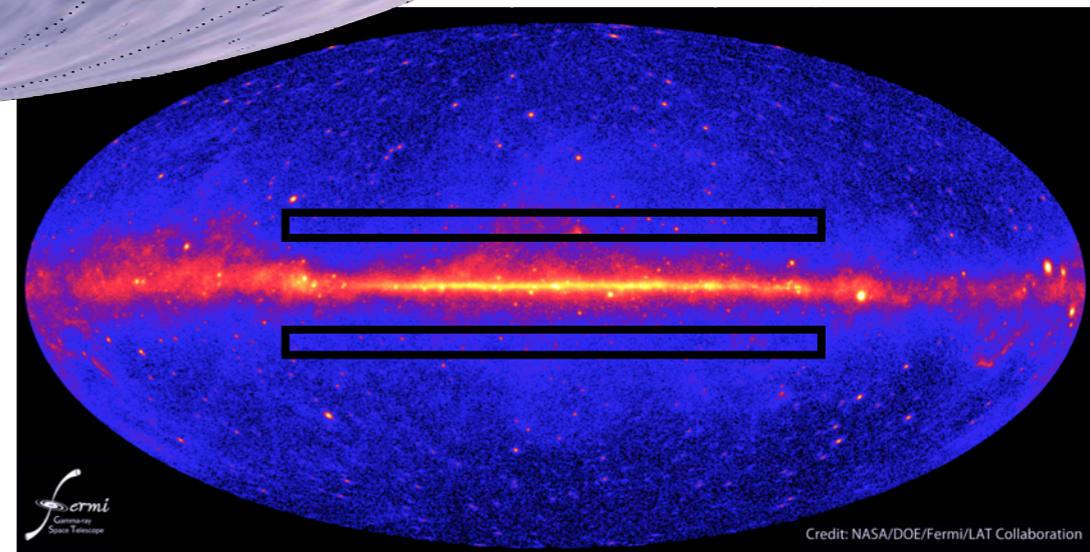
*Continuum Emission*

# Search Strategies

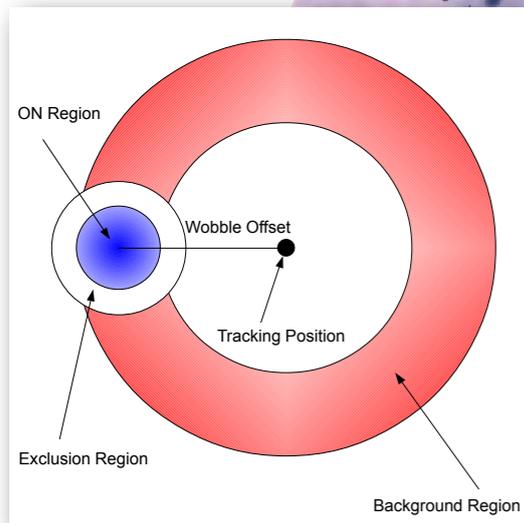
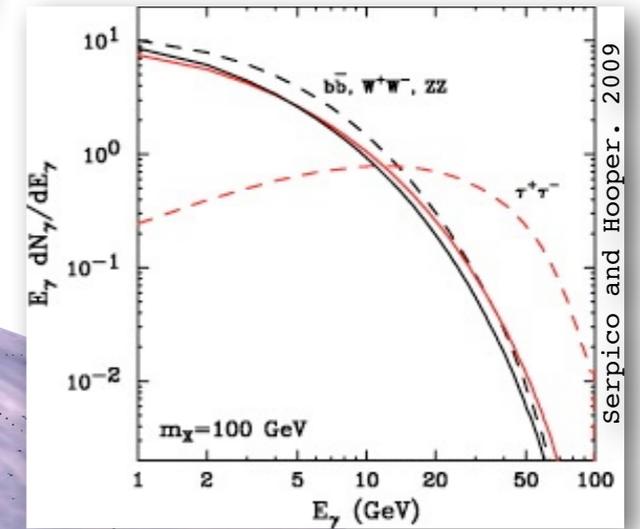
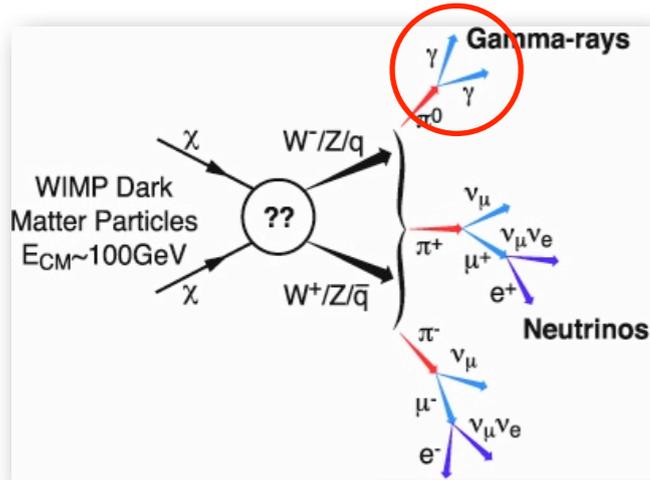


## Continuum Paradigm: Maximize S/N

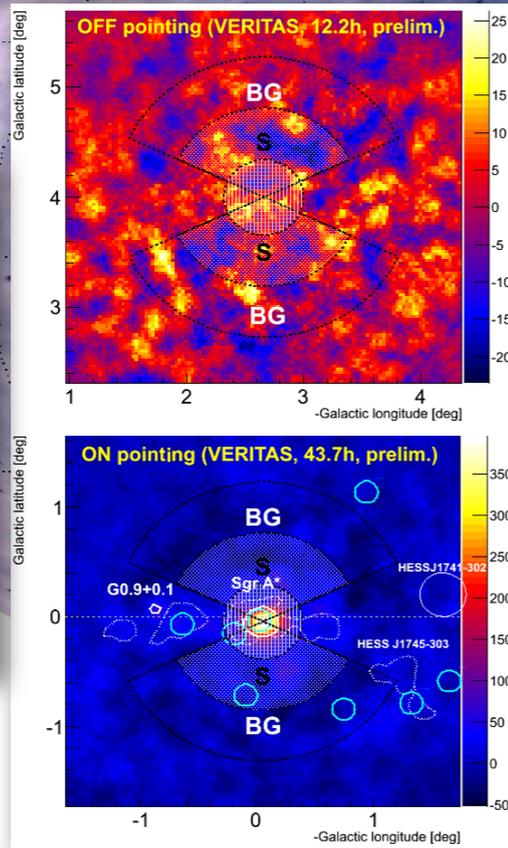
- Galactic Halo
- Galactic Center
- Known Objects (Dwarf Galaxies, Galaxy Clusters)
- Unknown Objects (Unassociated Subhalos)
- Isotropic (Unresolved: Both Local and Cosmological)



# Search Strategies

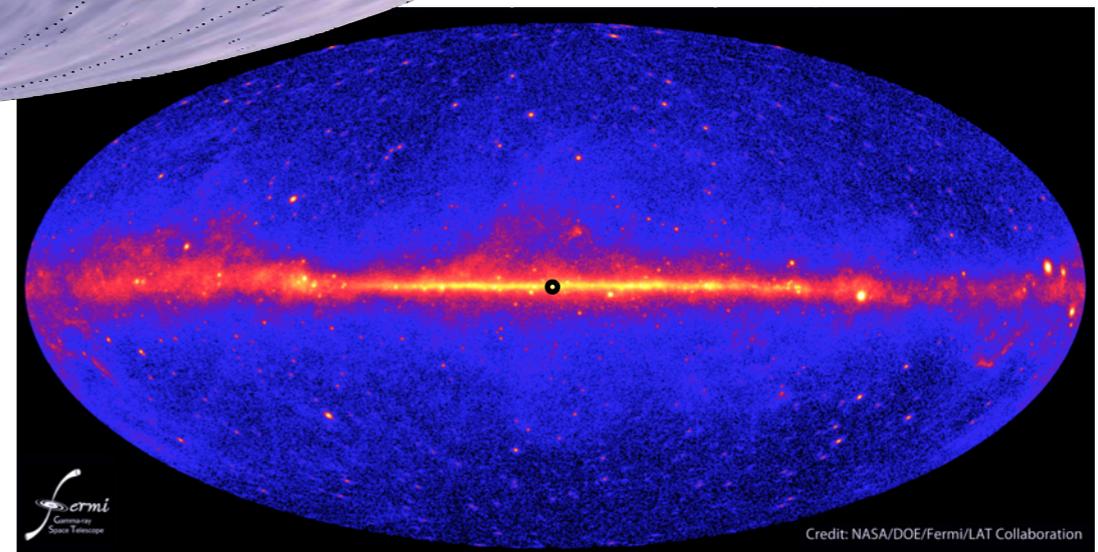


VERITAS Collaboration 2013

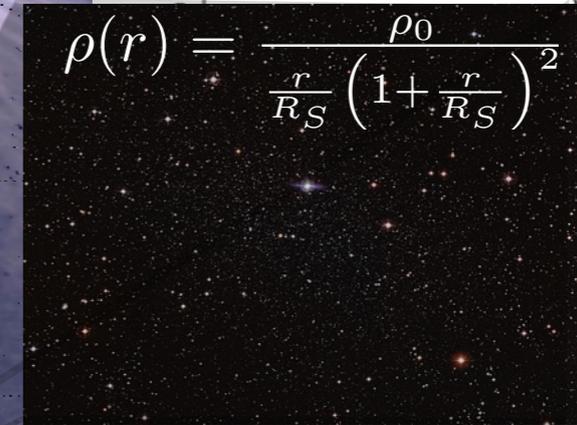
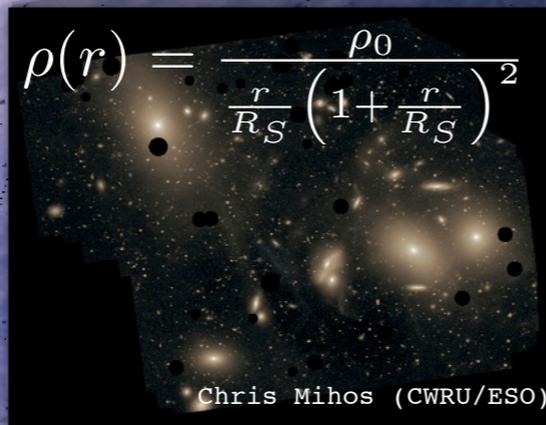
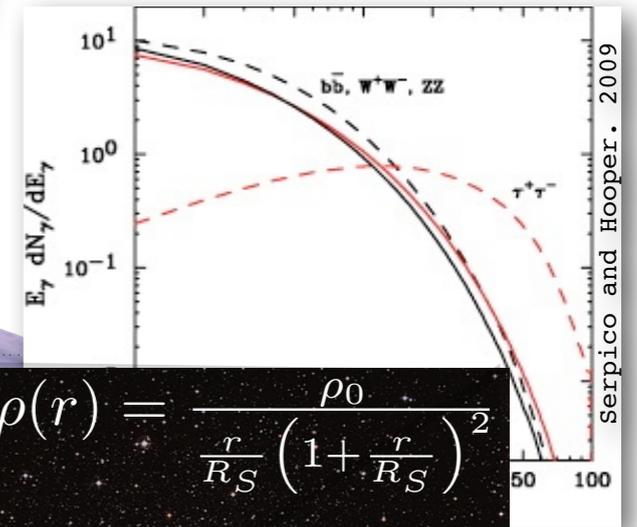
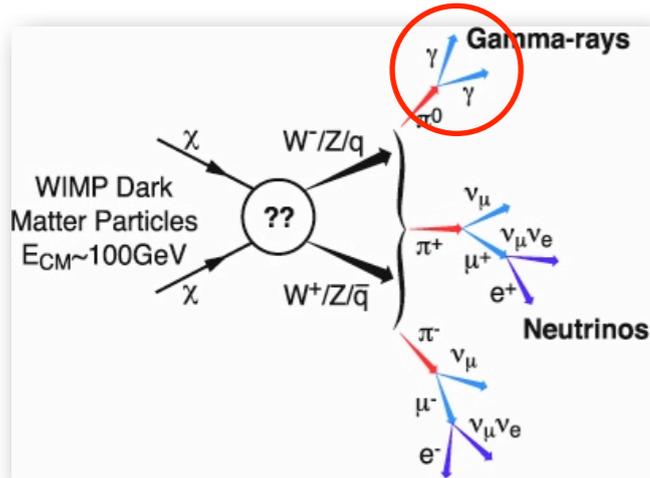


## Continuum Paradigm: Maximize S/N

- Galactic Halo
- **Galactic Center**
- Known Objects (Dwarf Galaxies, Galaxy Clusters)
- Unknown Objects (Unassociated Subhalos)
- Isotropic (Unresolved: Both Local and Cosmological)

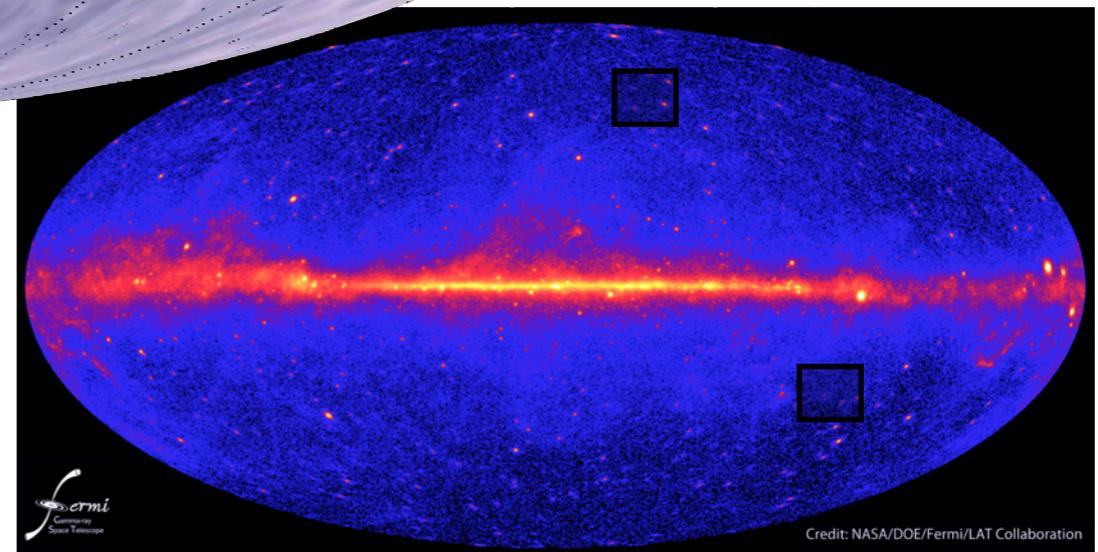


# Search Strategies

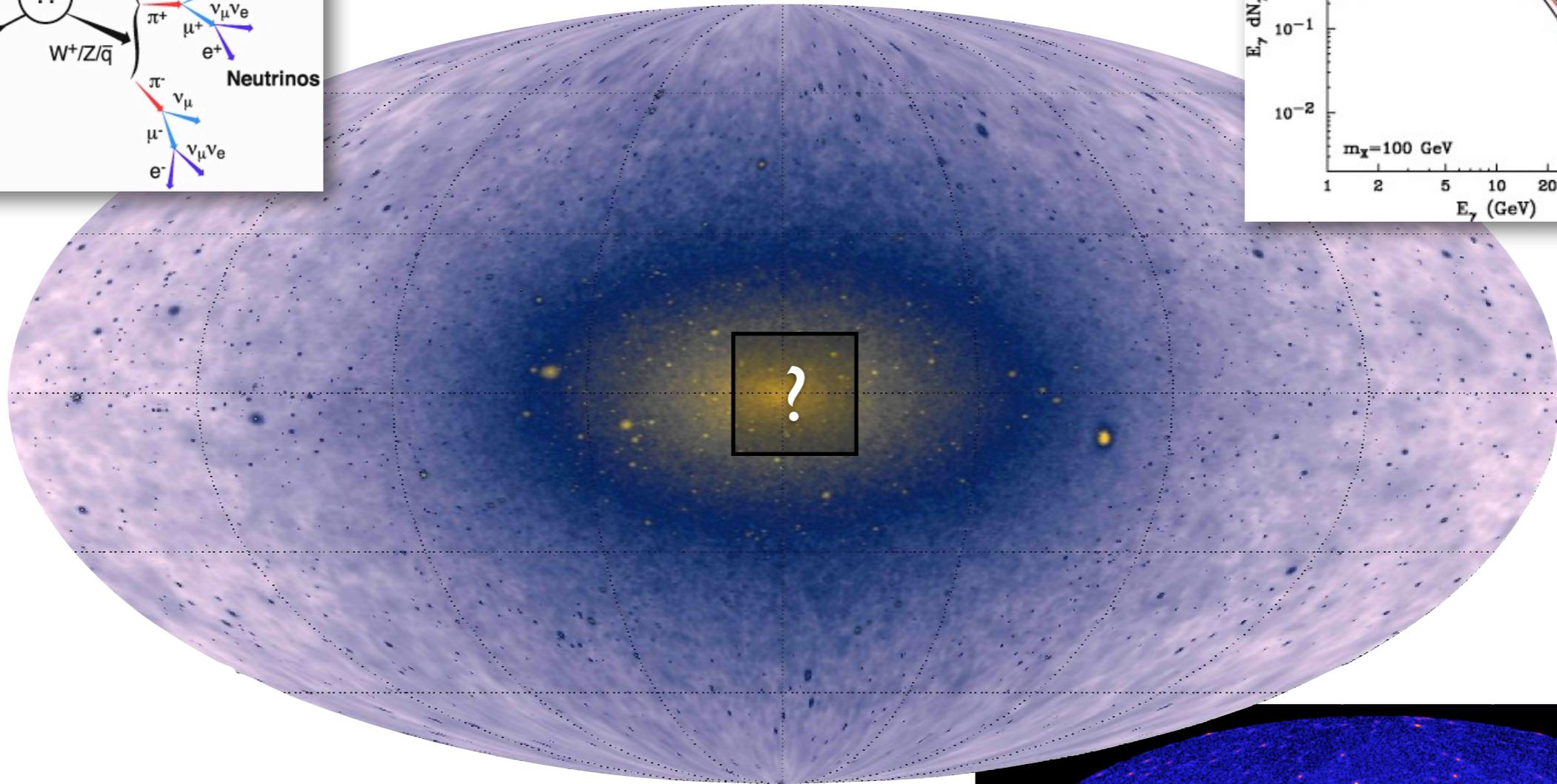
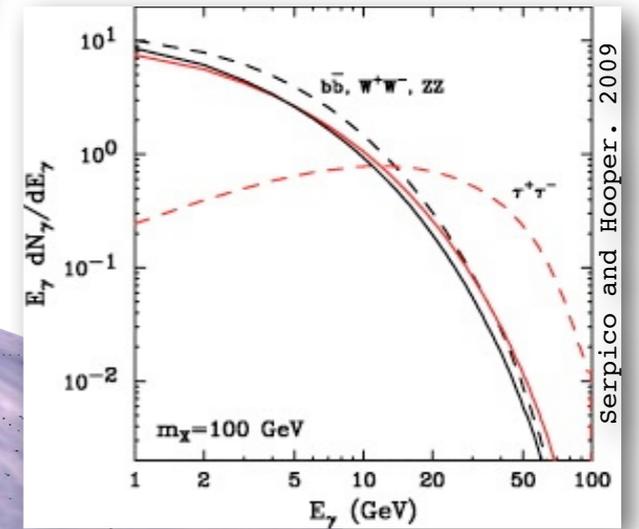
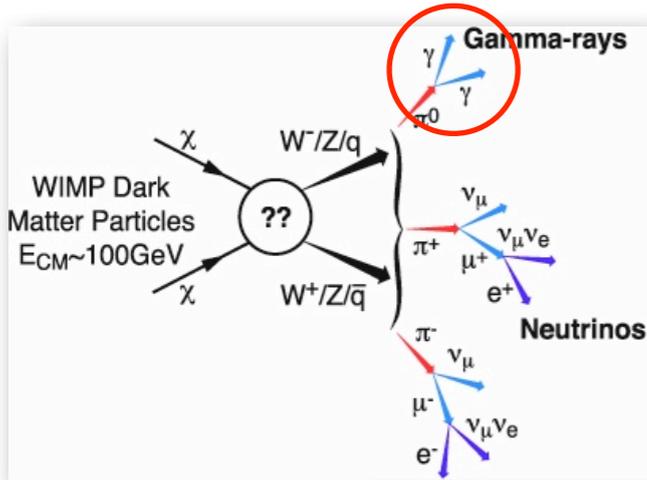


## Continuum Paradigm: Maximize S/N

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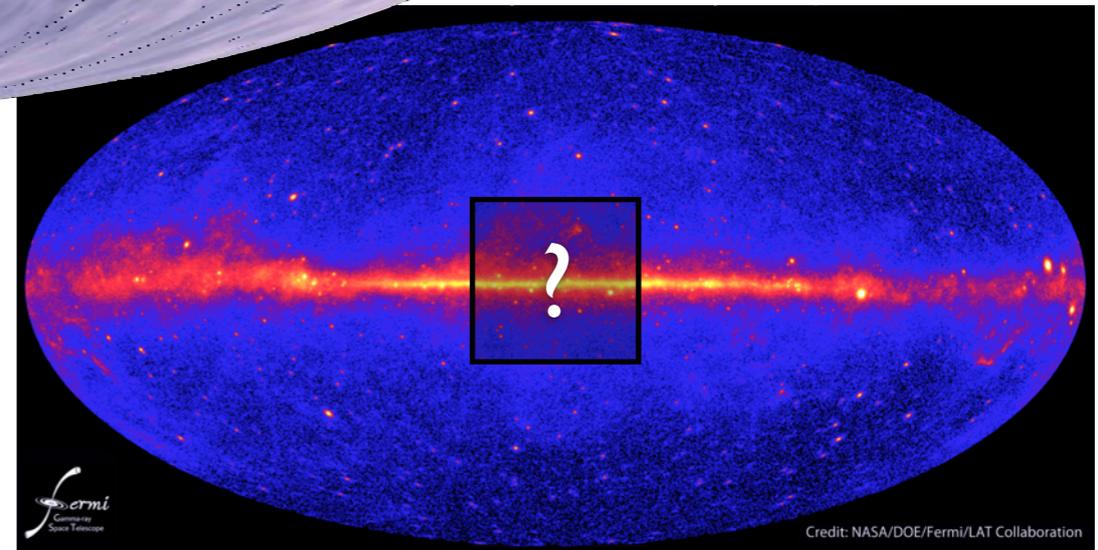


# Search Strategies

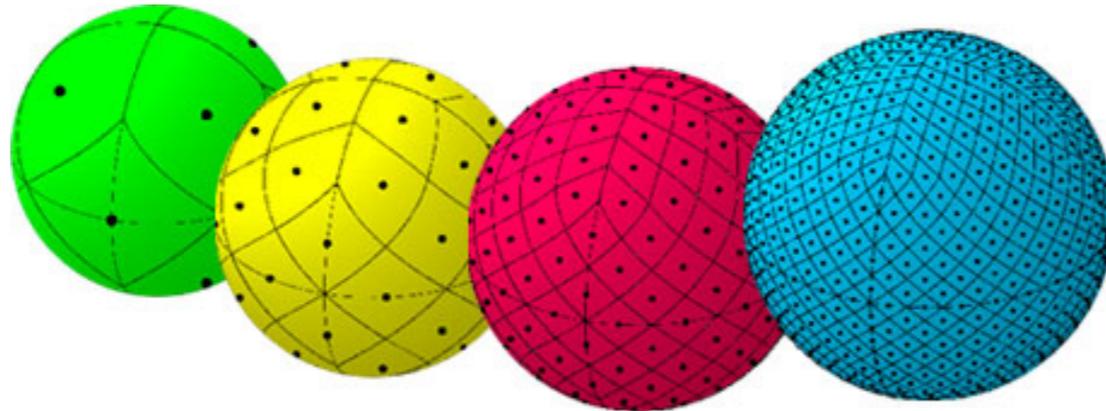
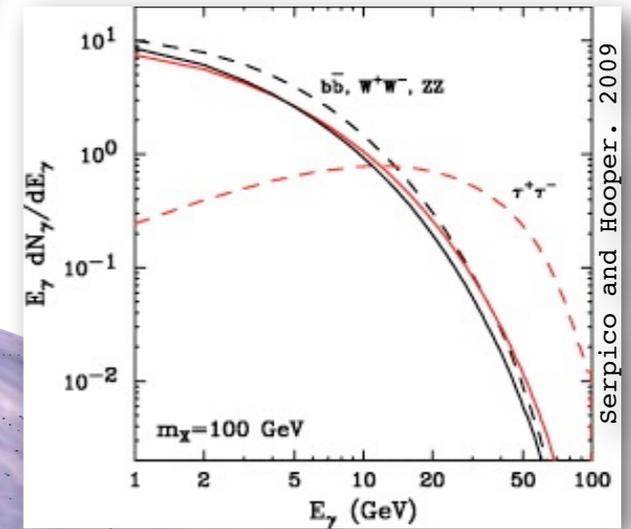
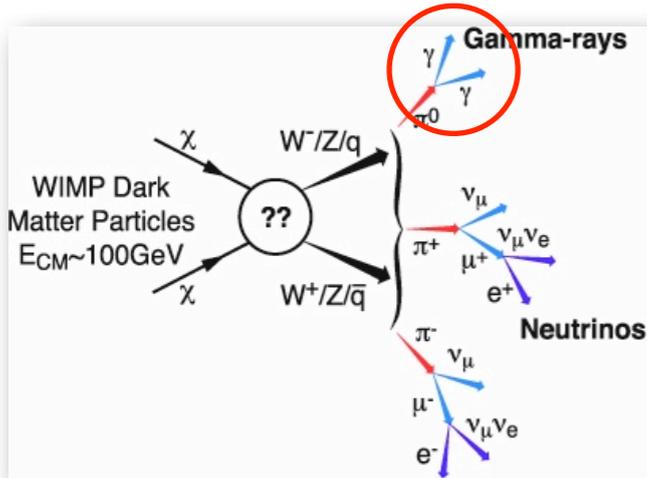


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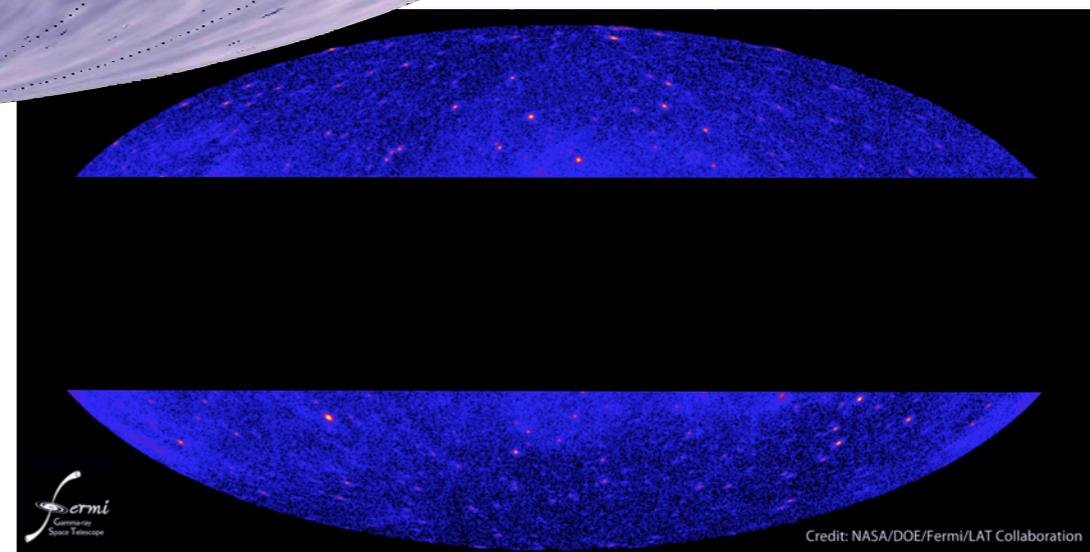
# Search Strategies



Spatial Fourier  
 Decomposition  
 (Stacking).

## Continuum Paradigm: Maximize S/N

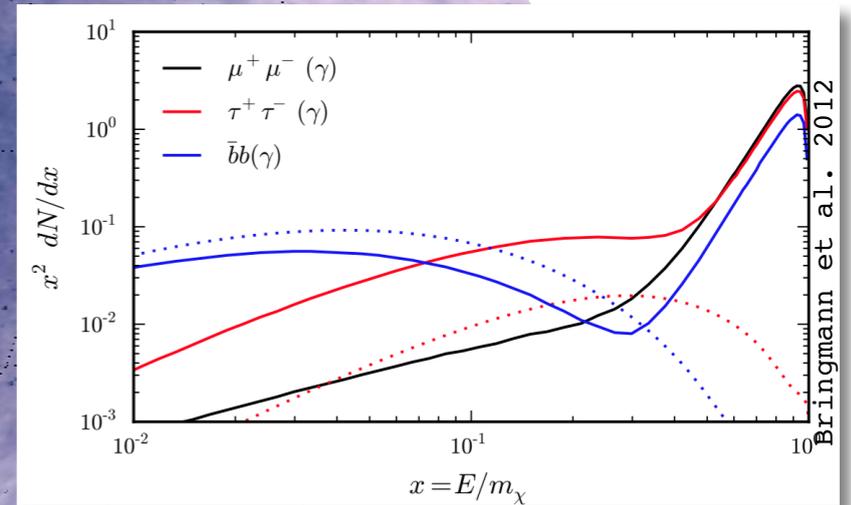
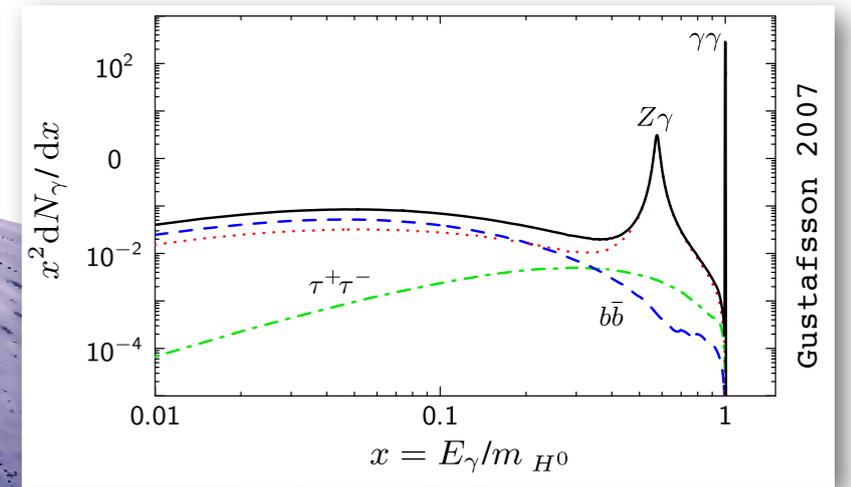
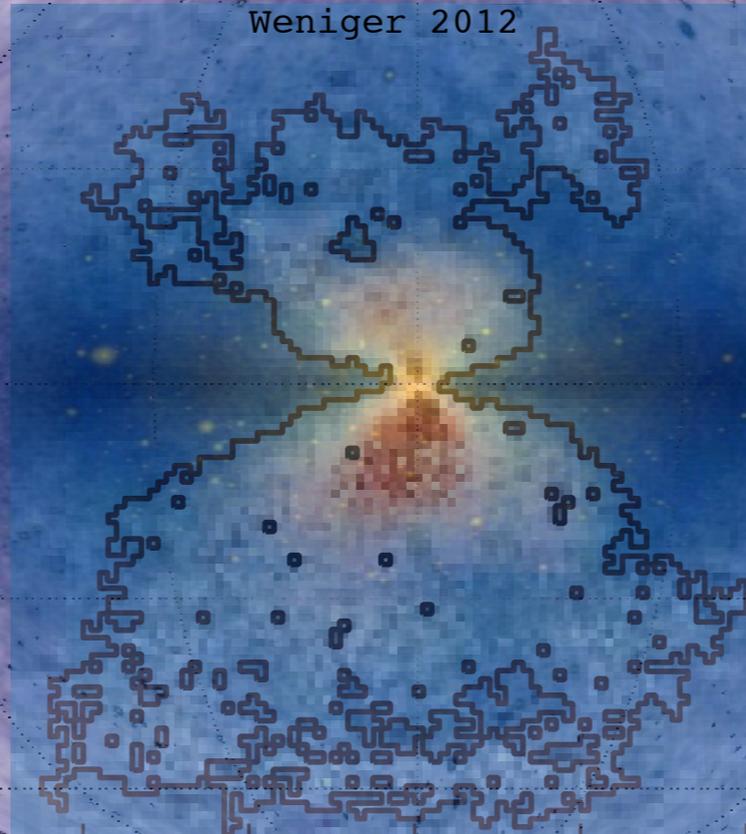
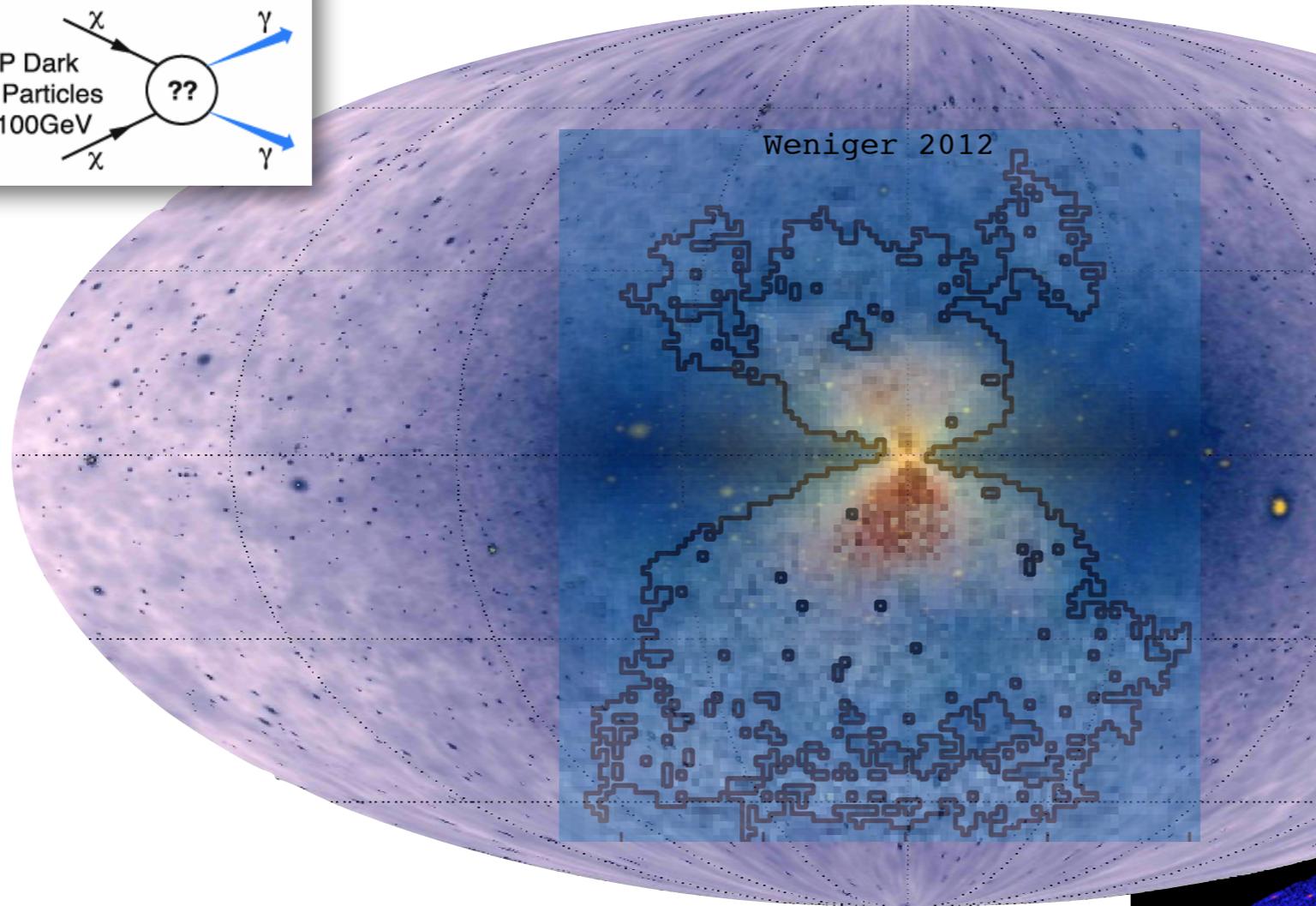
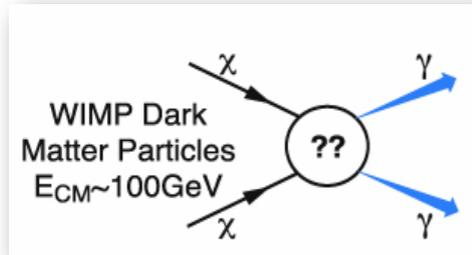
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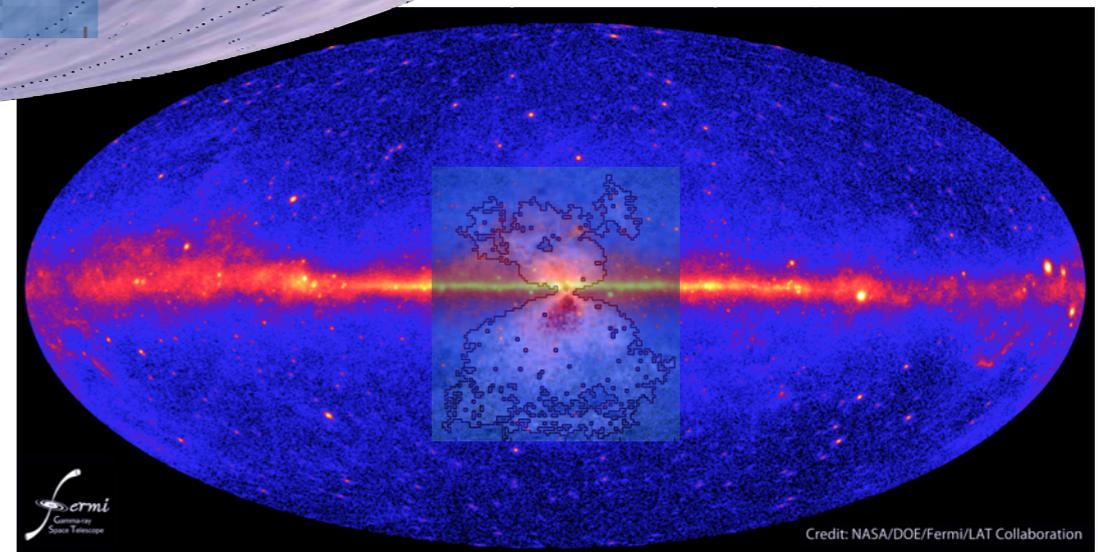
*Spectral Features*

# Search Strategies

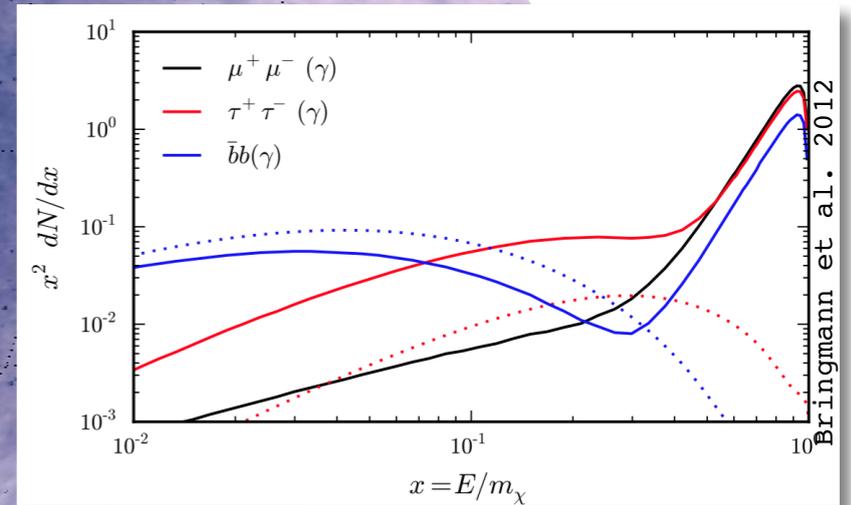
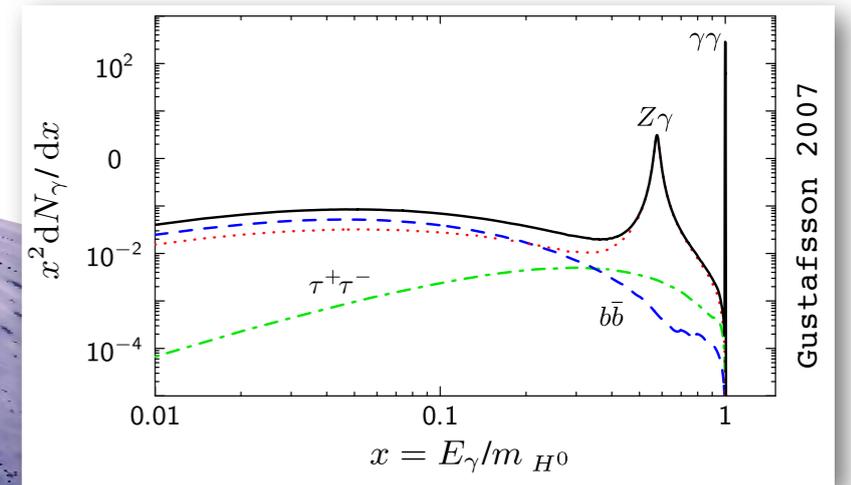
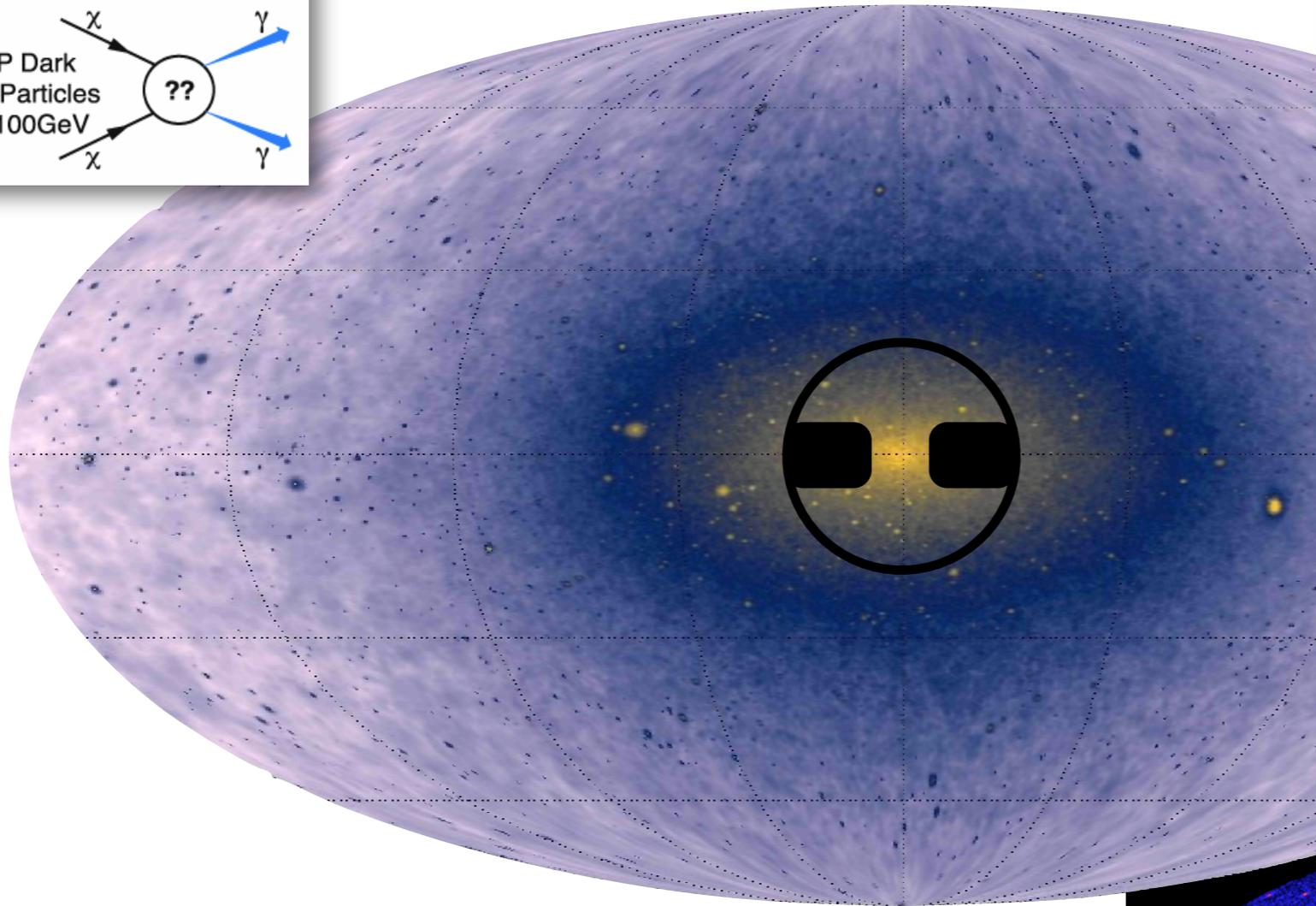
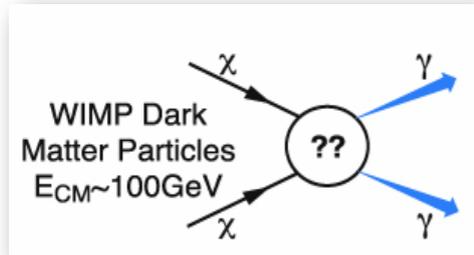


## Feature Paradigm: Maximize Signal Photons

- Use highest signal regions, despite complex background.
- Select control regions to check instrumental effects:
  - Off-Source
  - Galactic Plane
  - Earth Limb

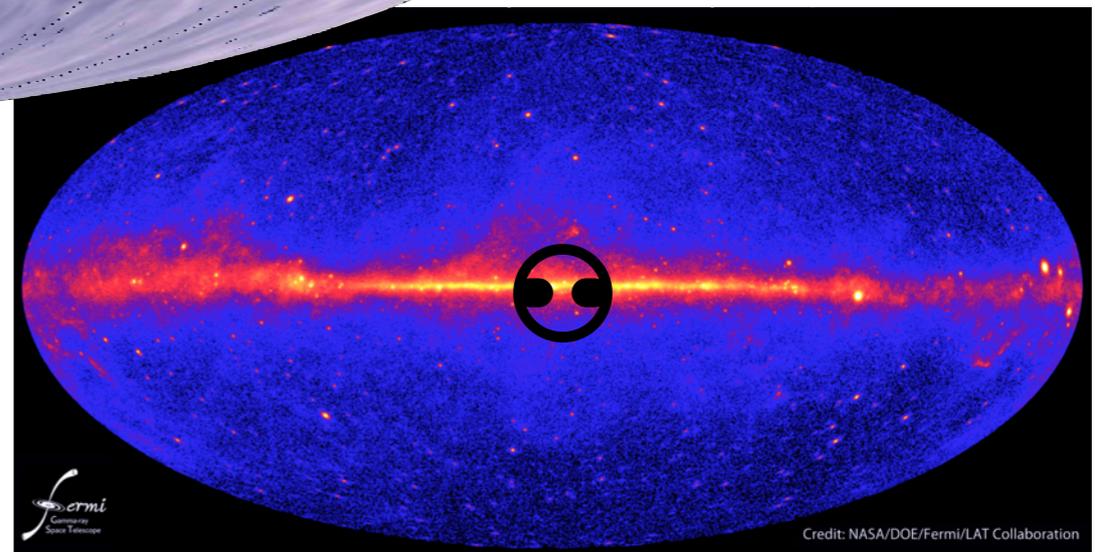


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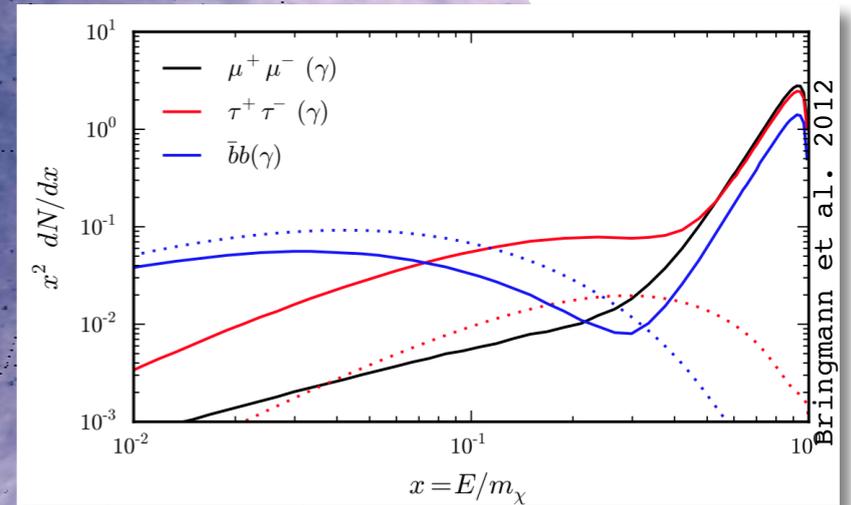
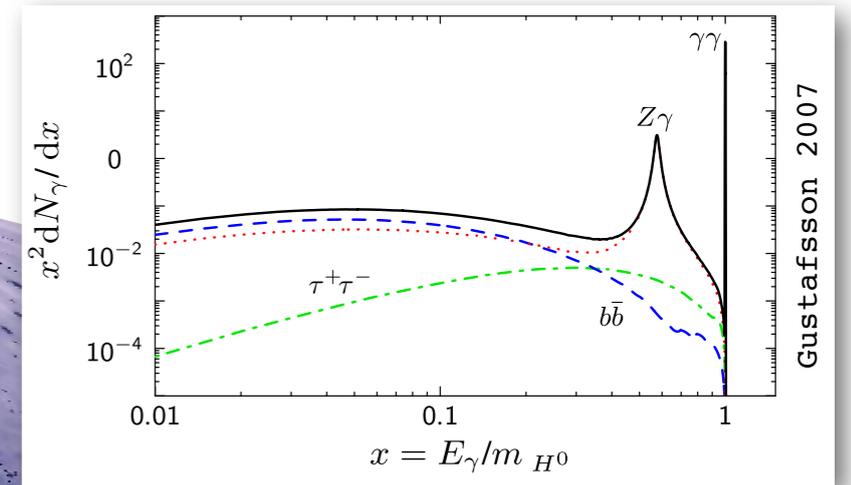
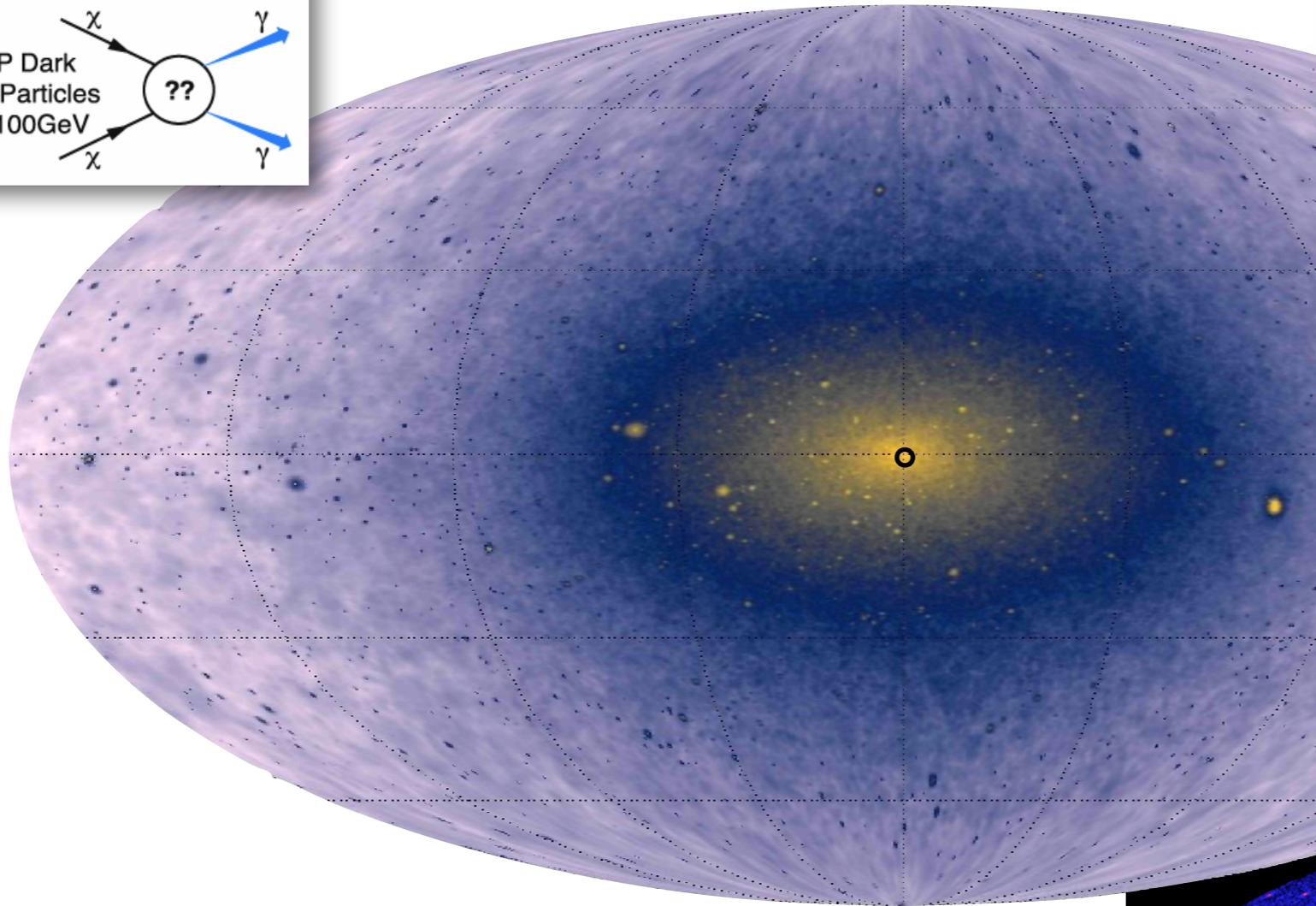
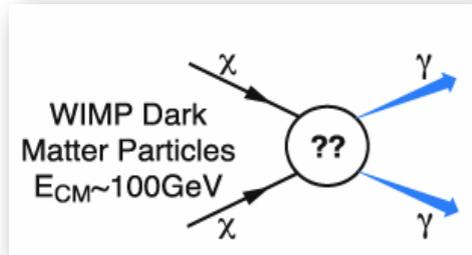


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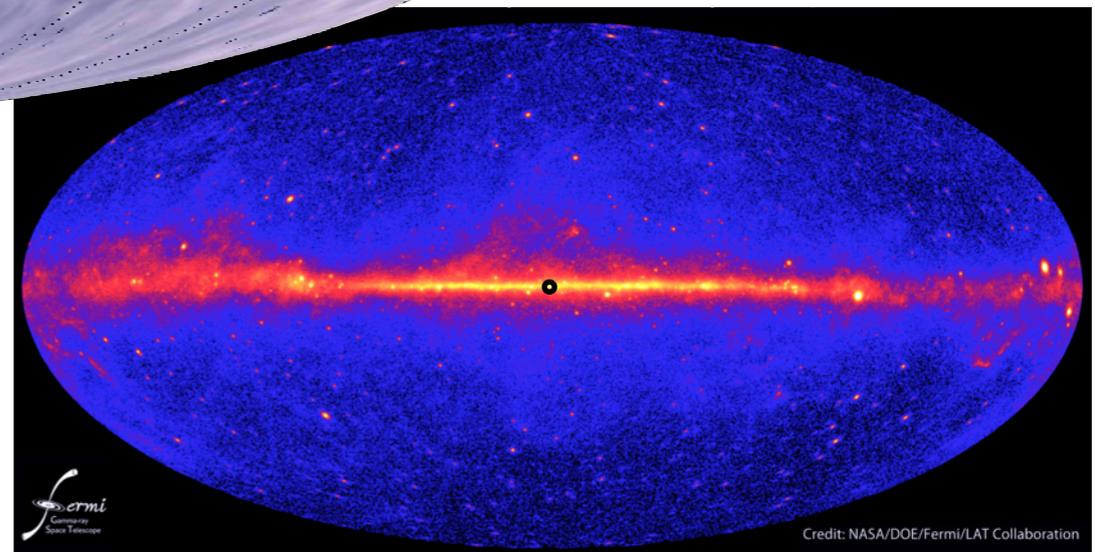


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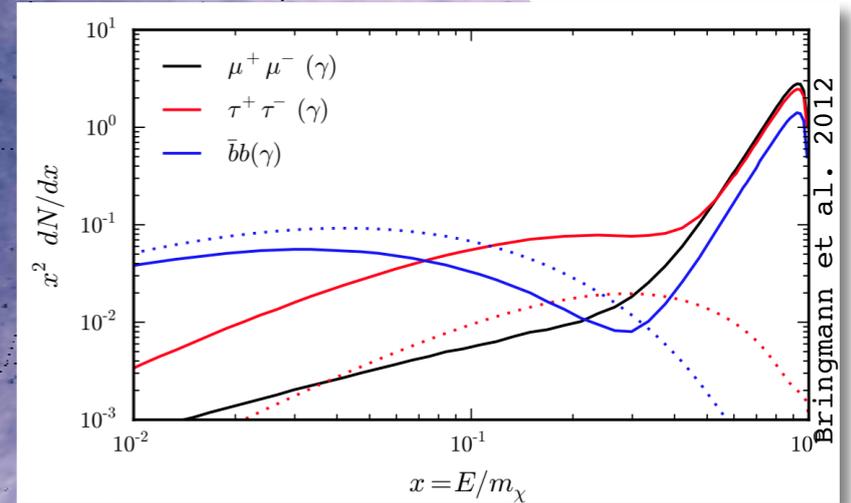
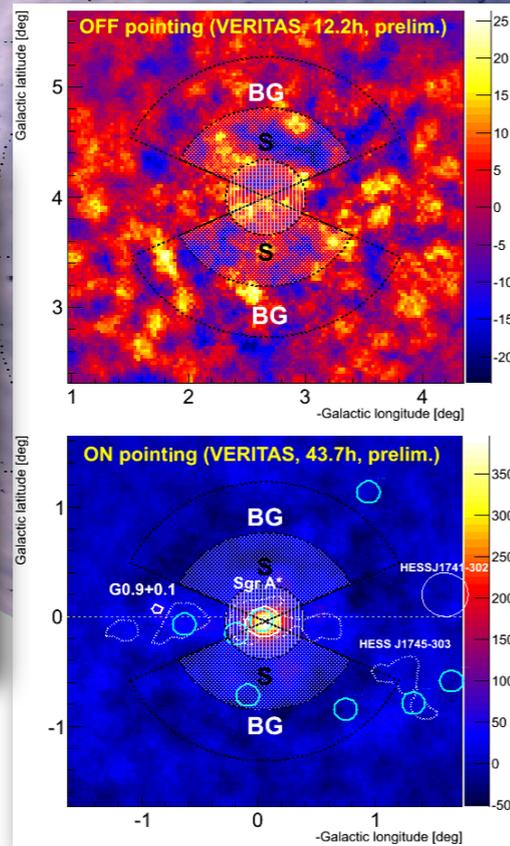
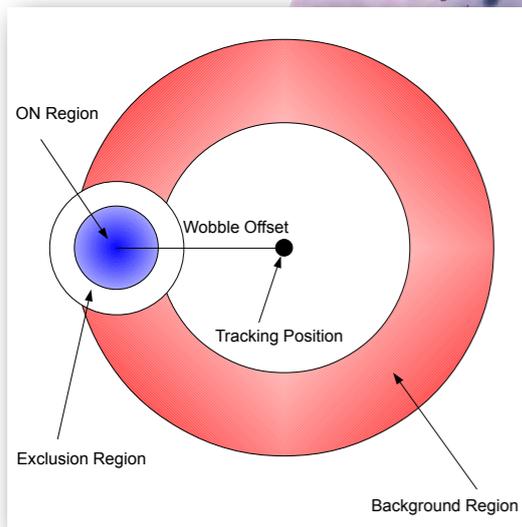
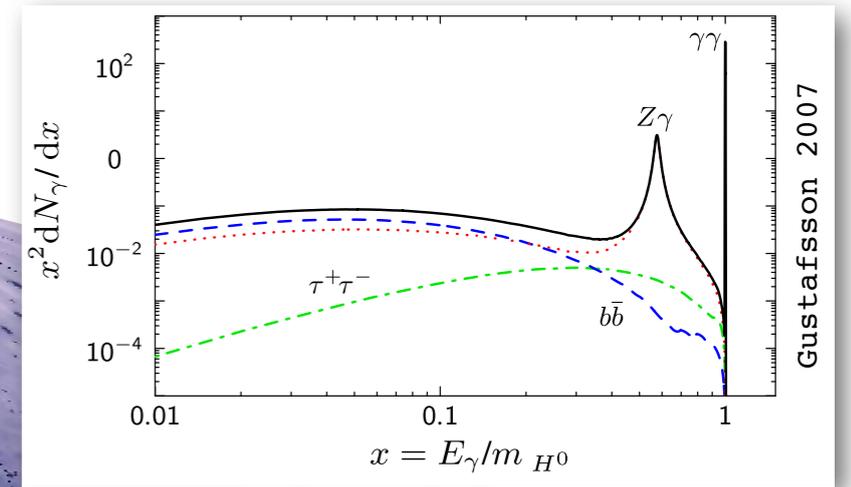
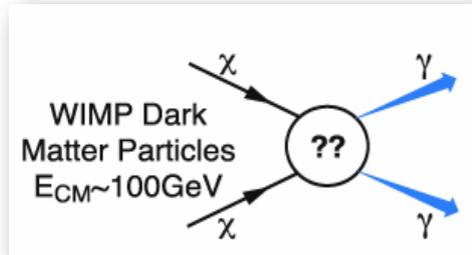


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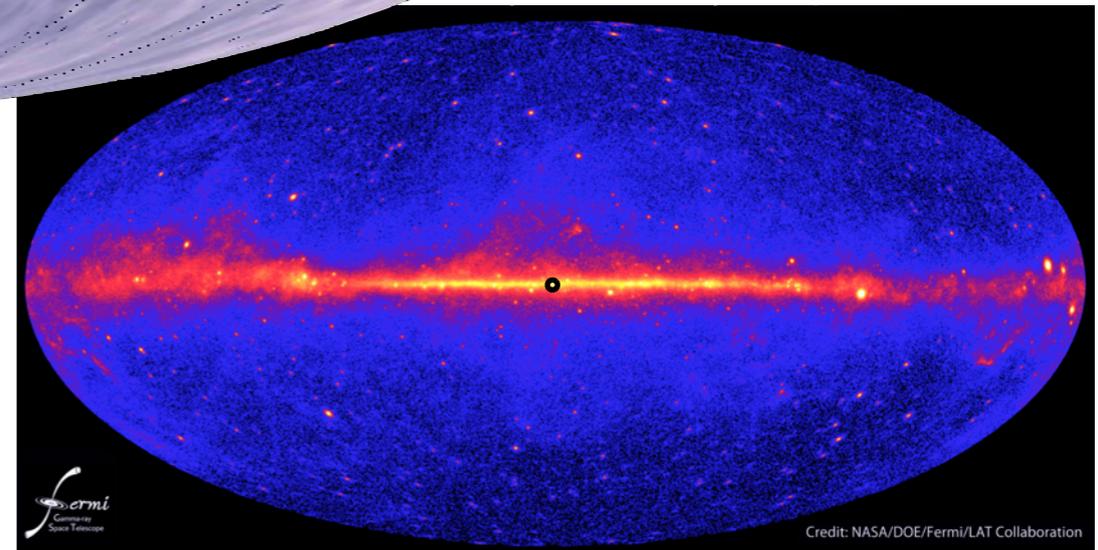


# Search Strategies

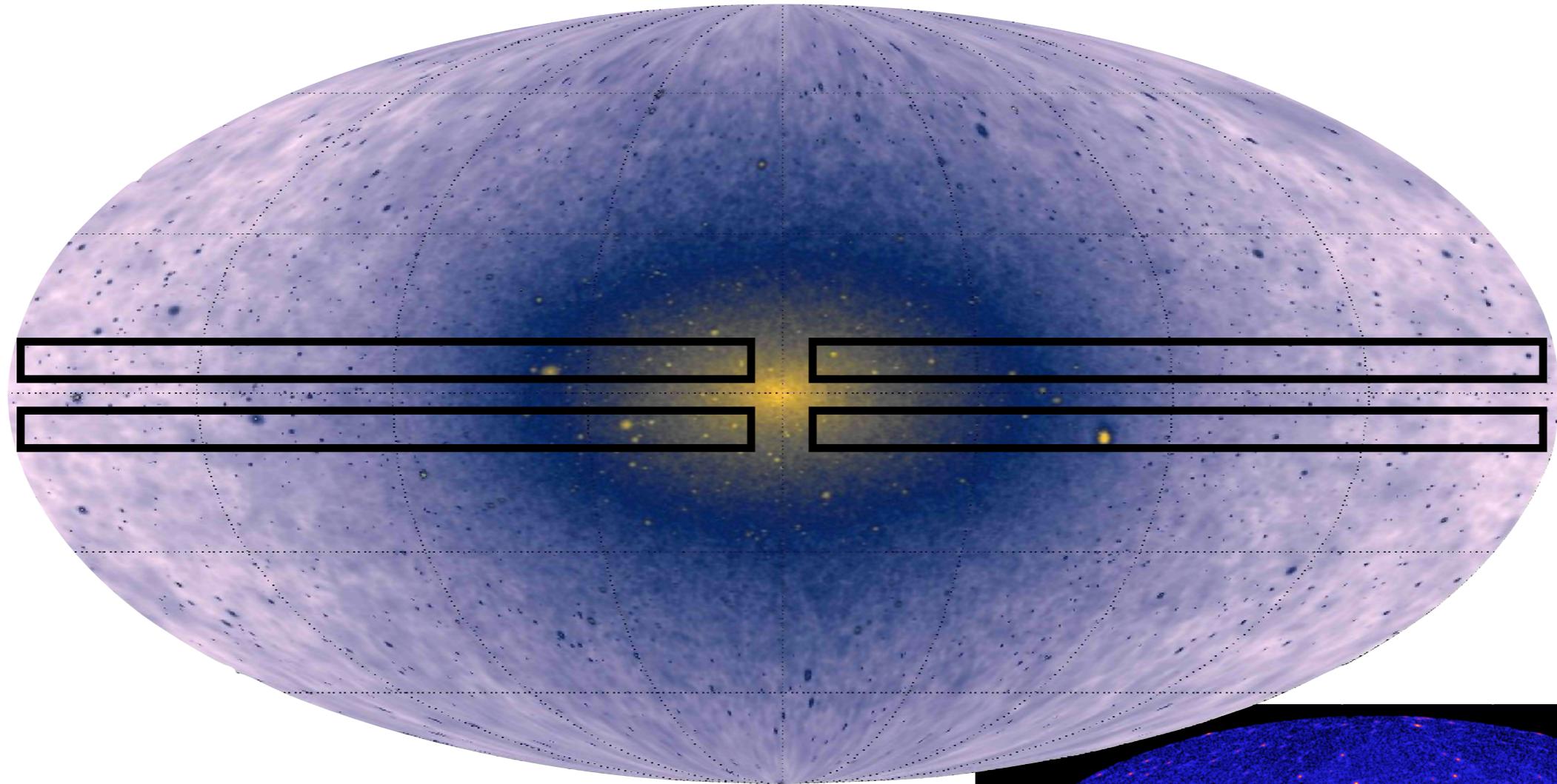


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- Use highest signal regions, despite complex background.
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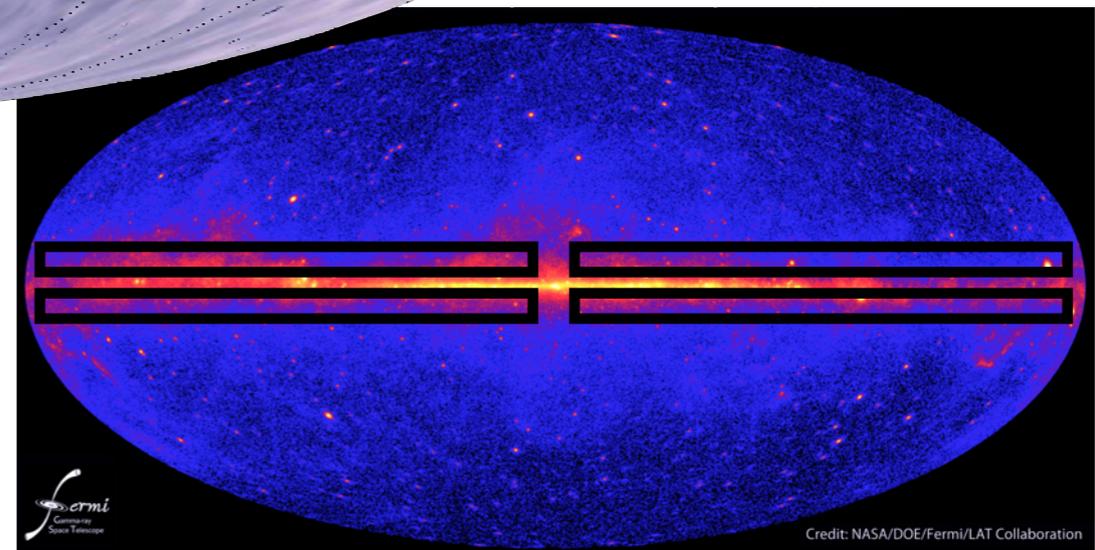


# Search Strategies



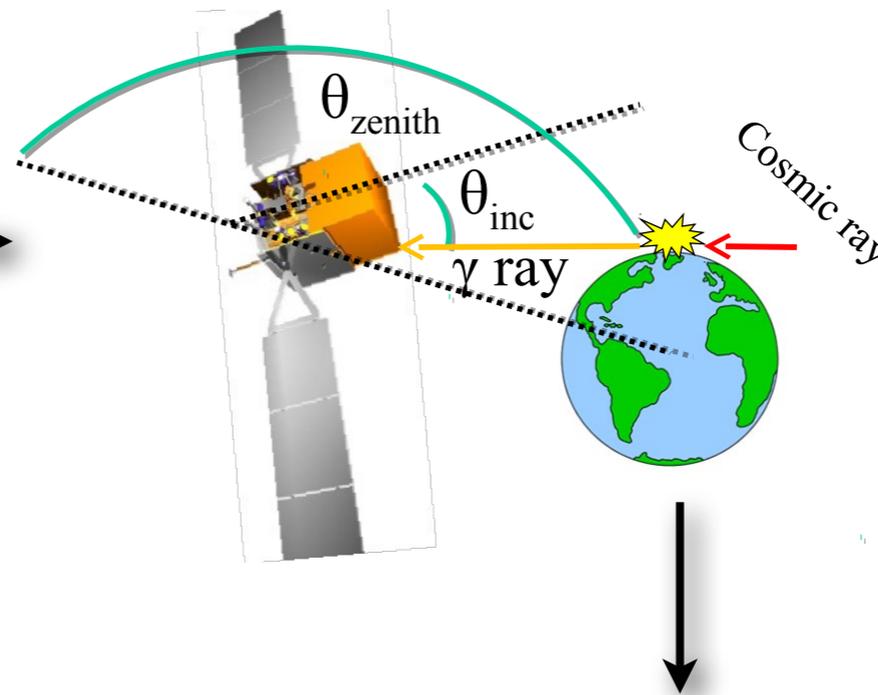
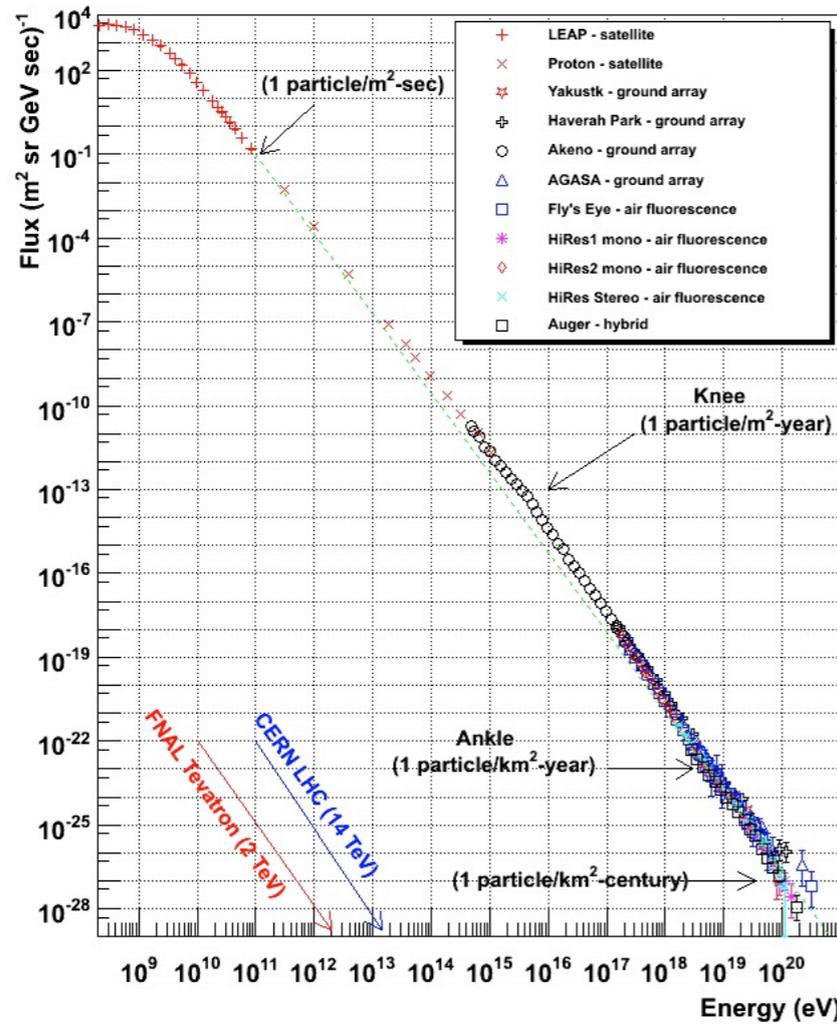
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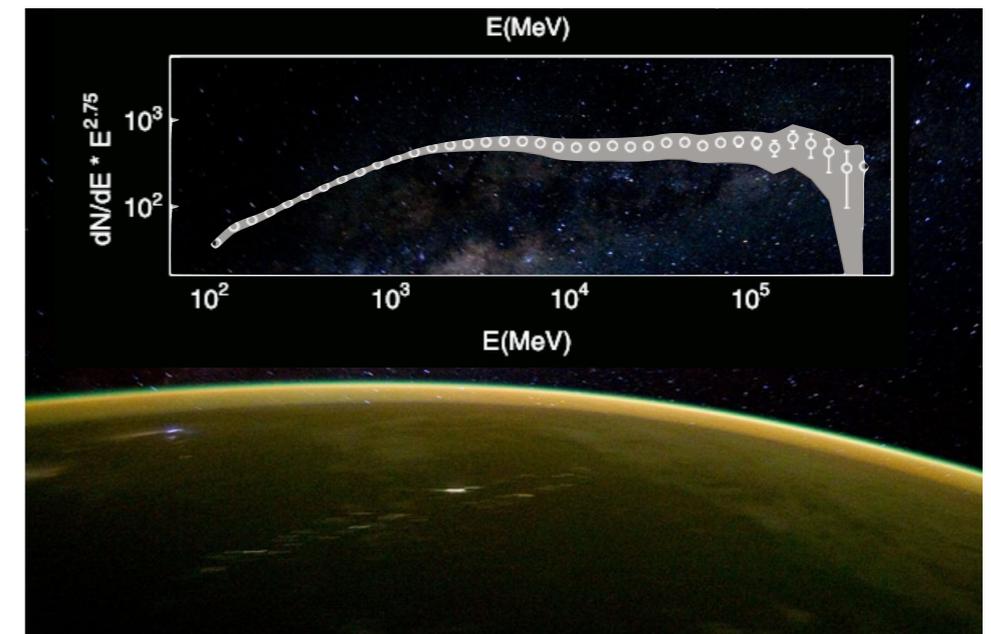
# Search Strategies

Cosmic Ray Spectra of Various Experiments



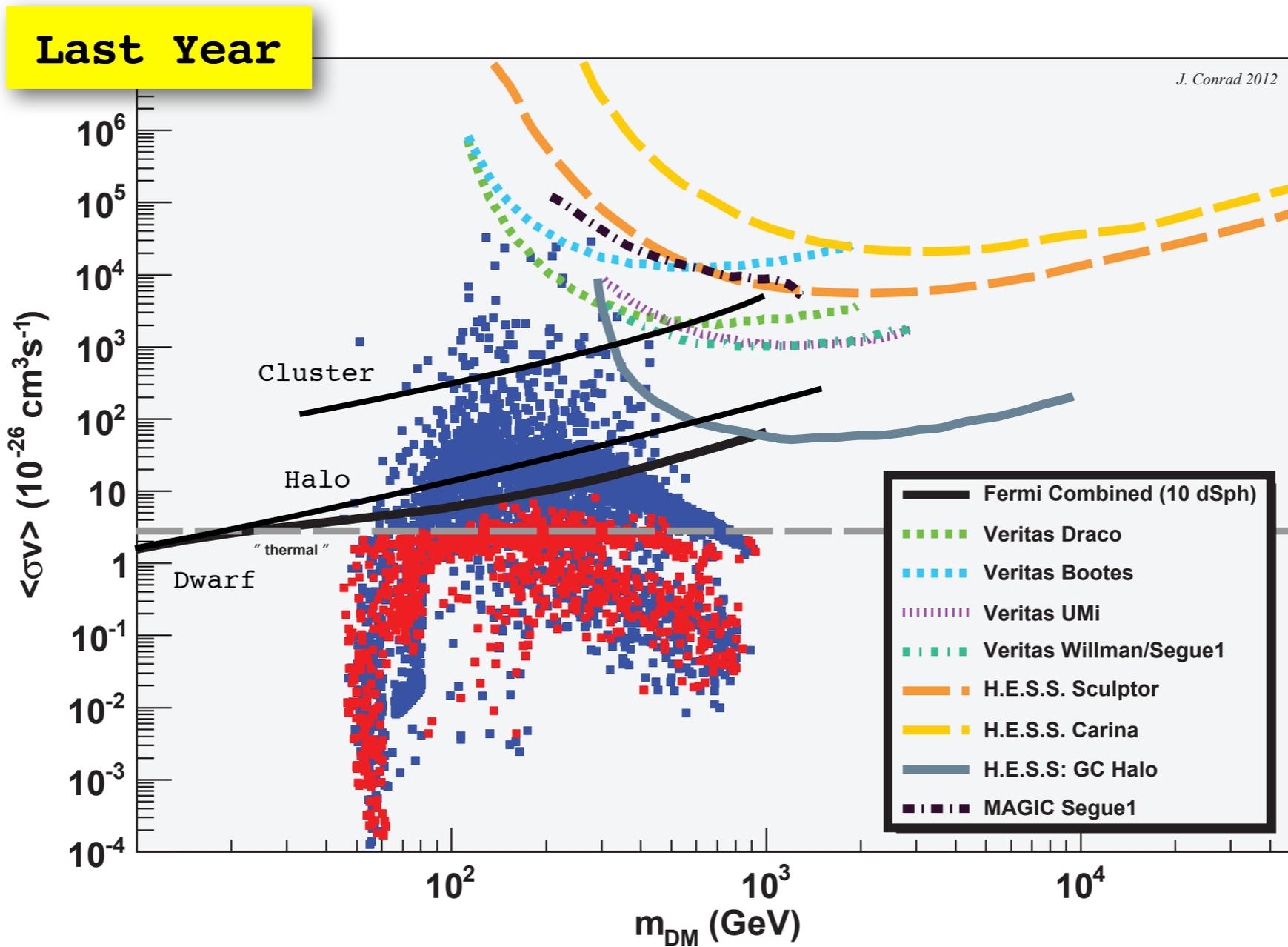
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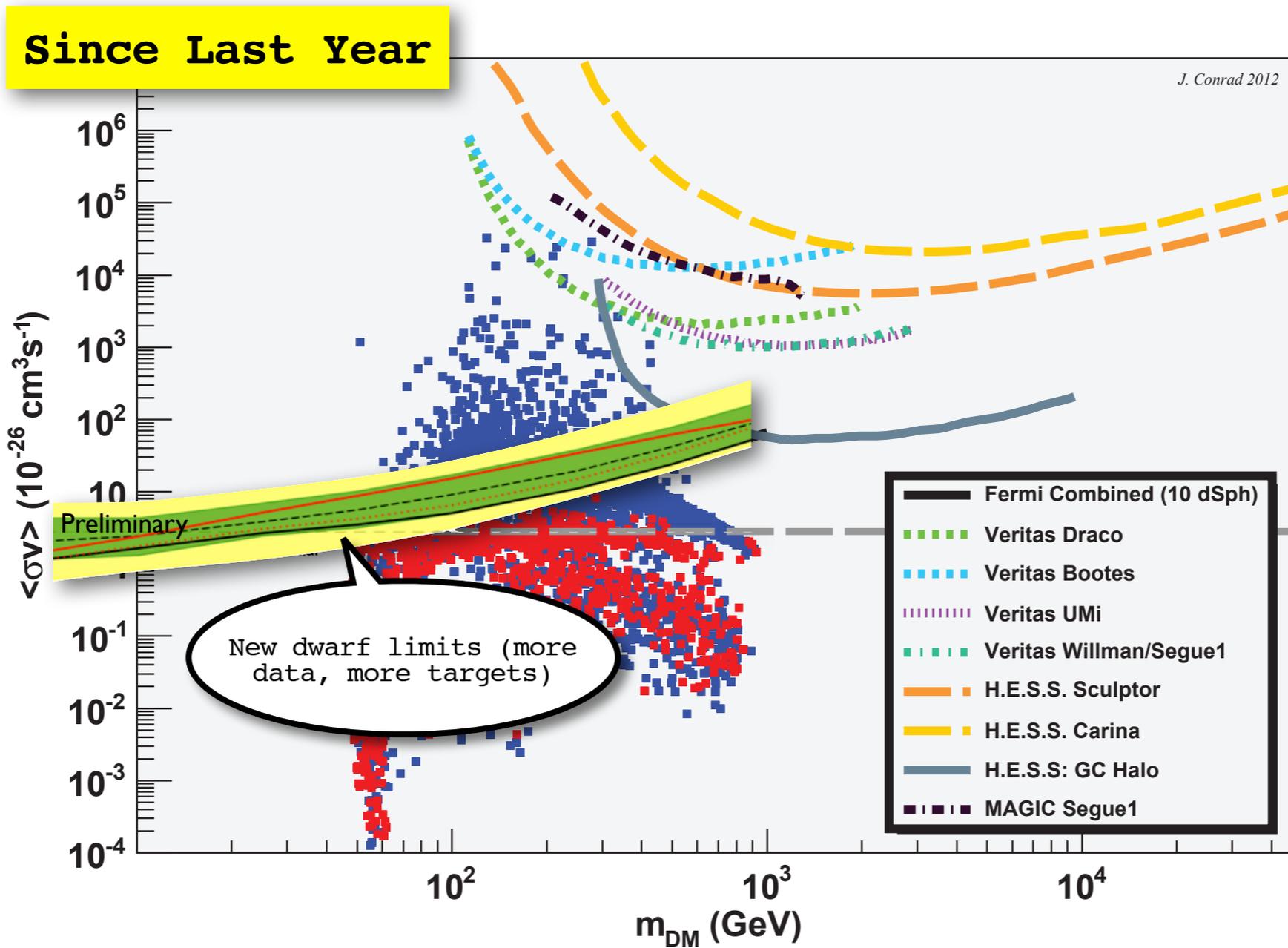


## Recent Results

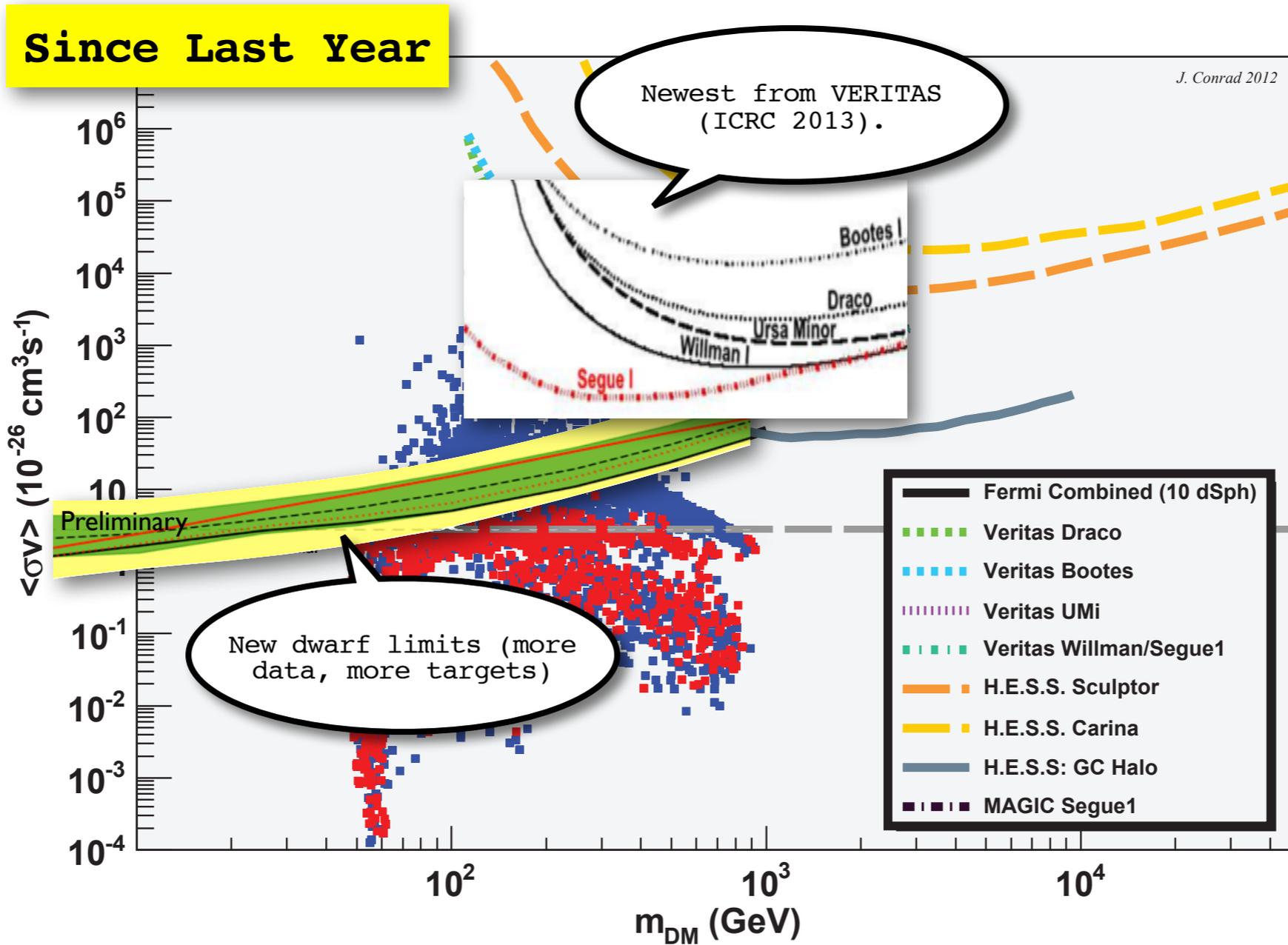
# Continuum Results



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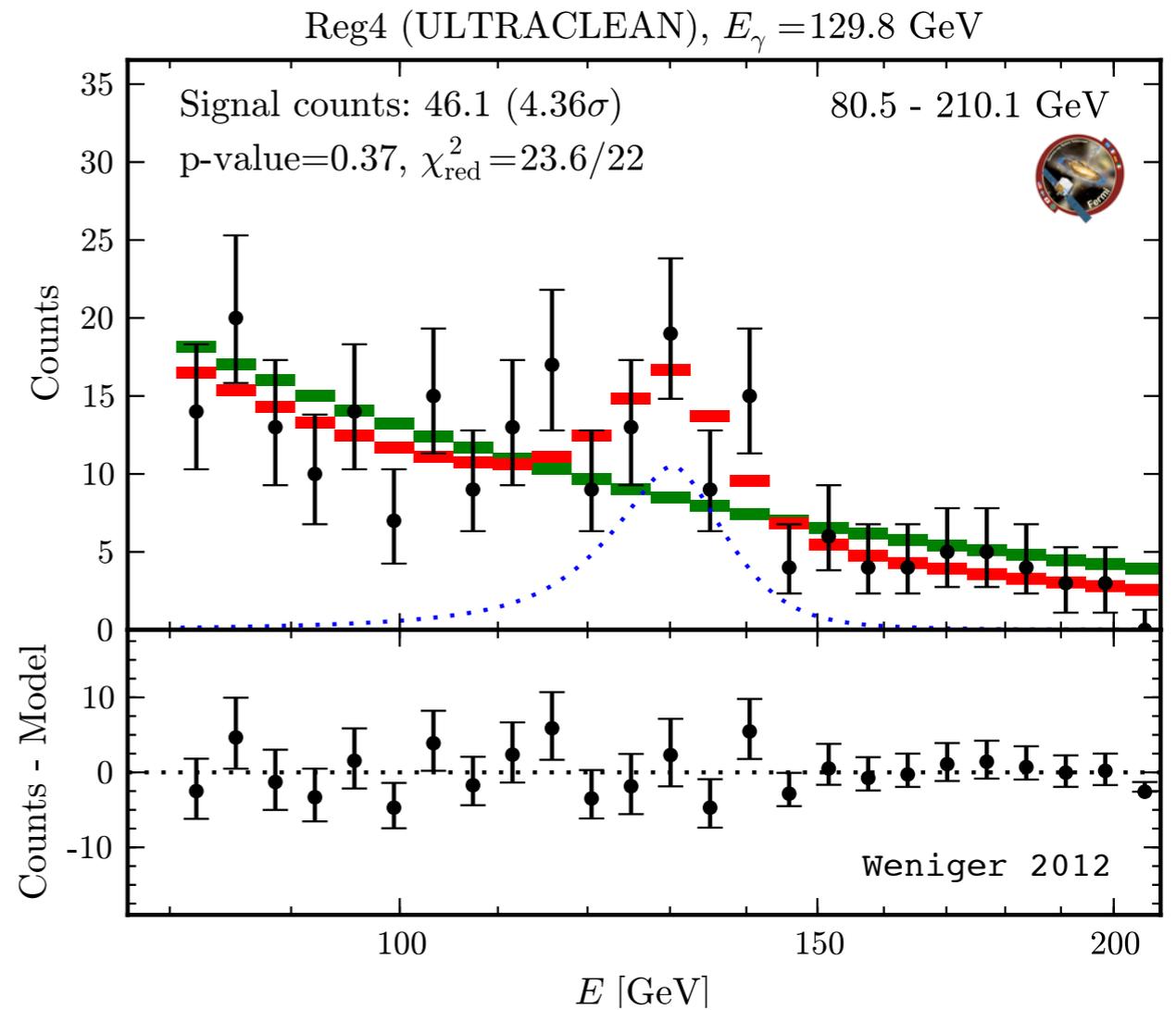
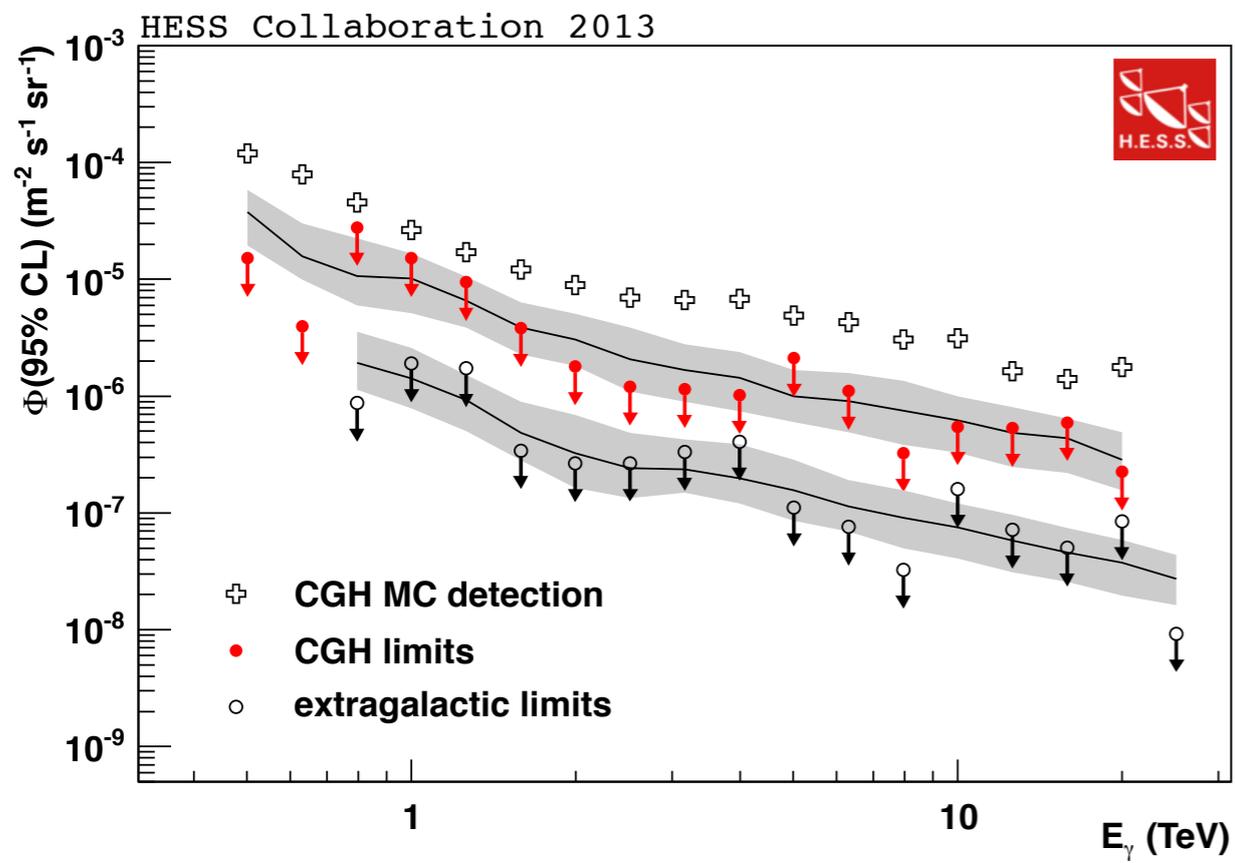


# Continuum Results



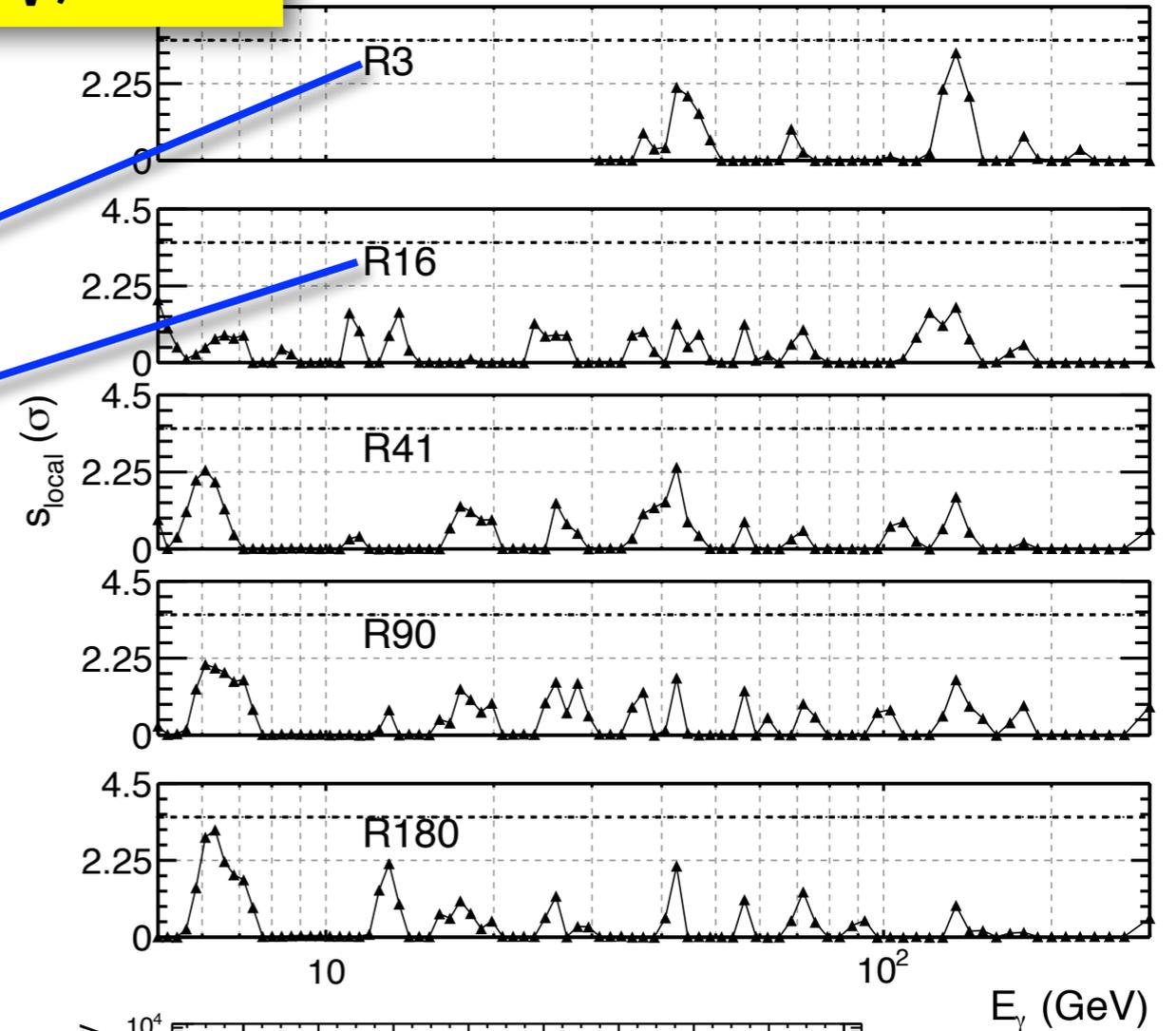
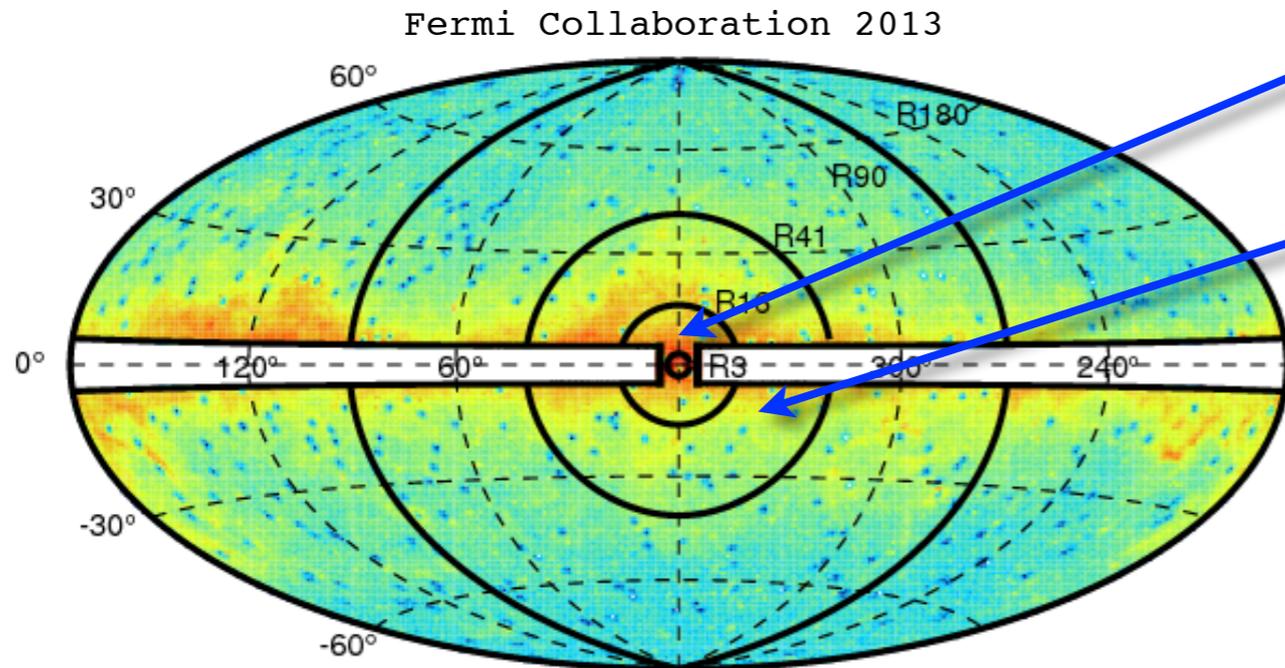
# Feature Results

**XX- $\rightarrow$ YY, HY, etc.**

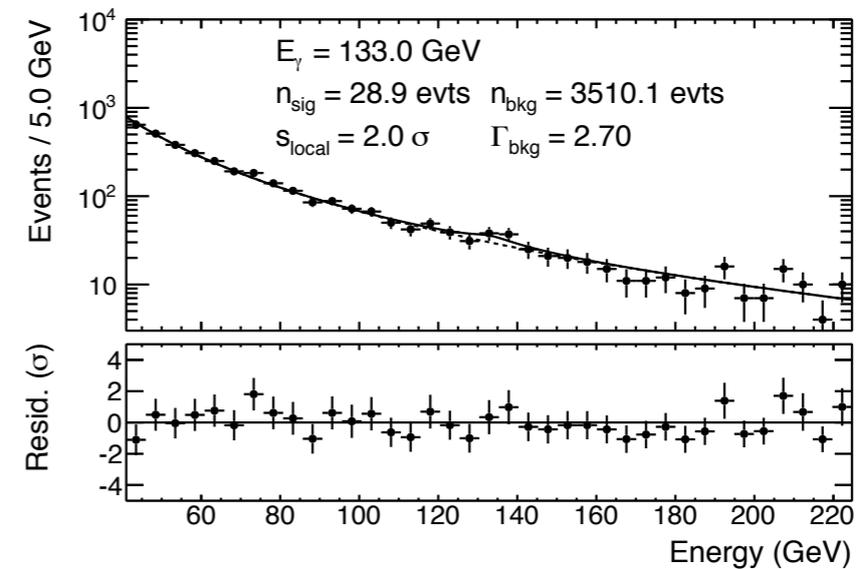
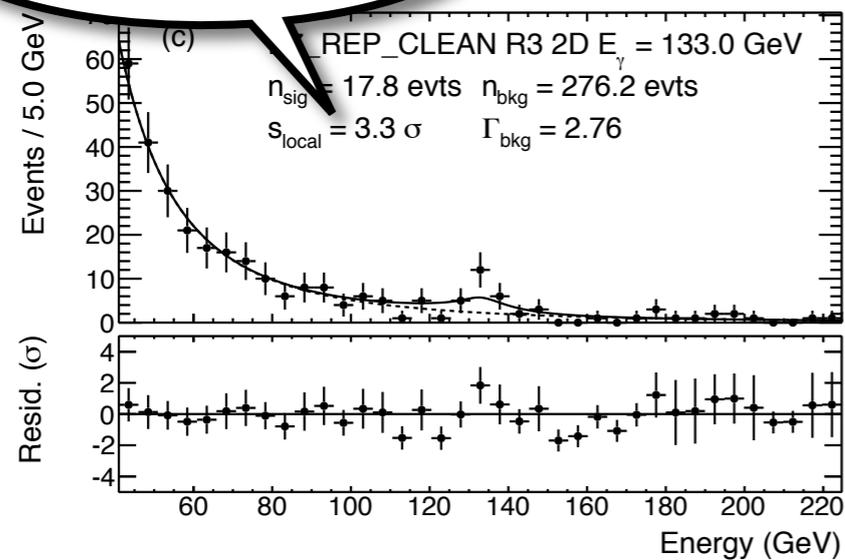


# Feature Results

**XX  $\rightarrow$   $\gamma\gamma$ ,  $H\gamma$ , etc.**

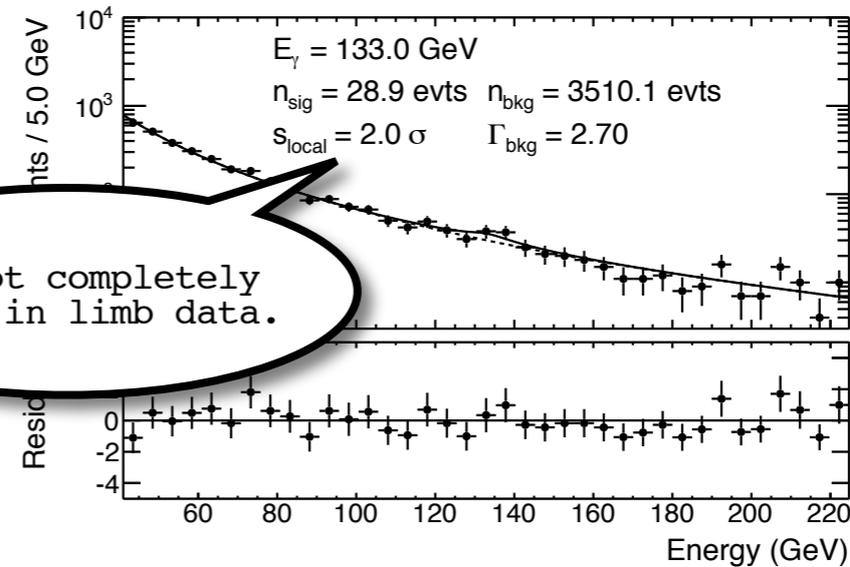
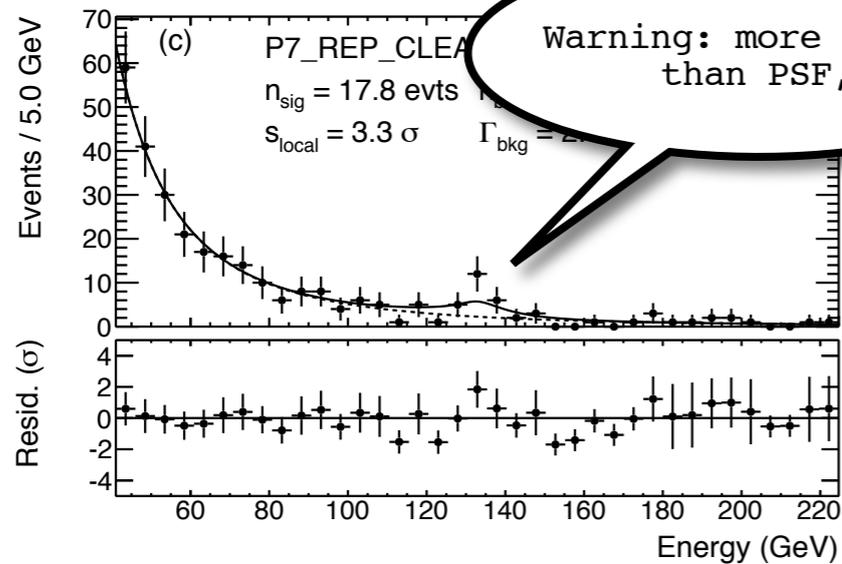
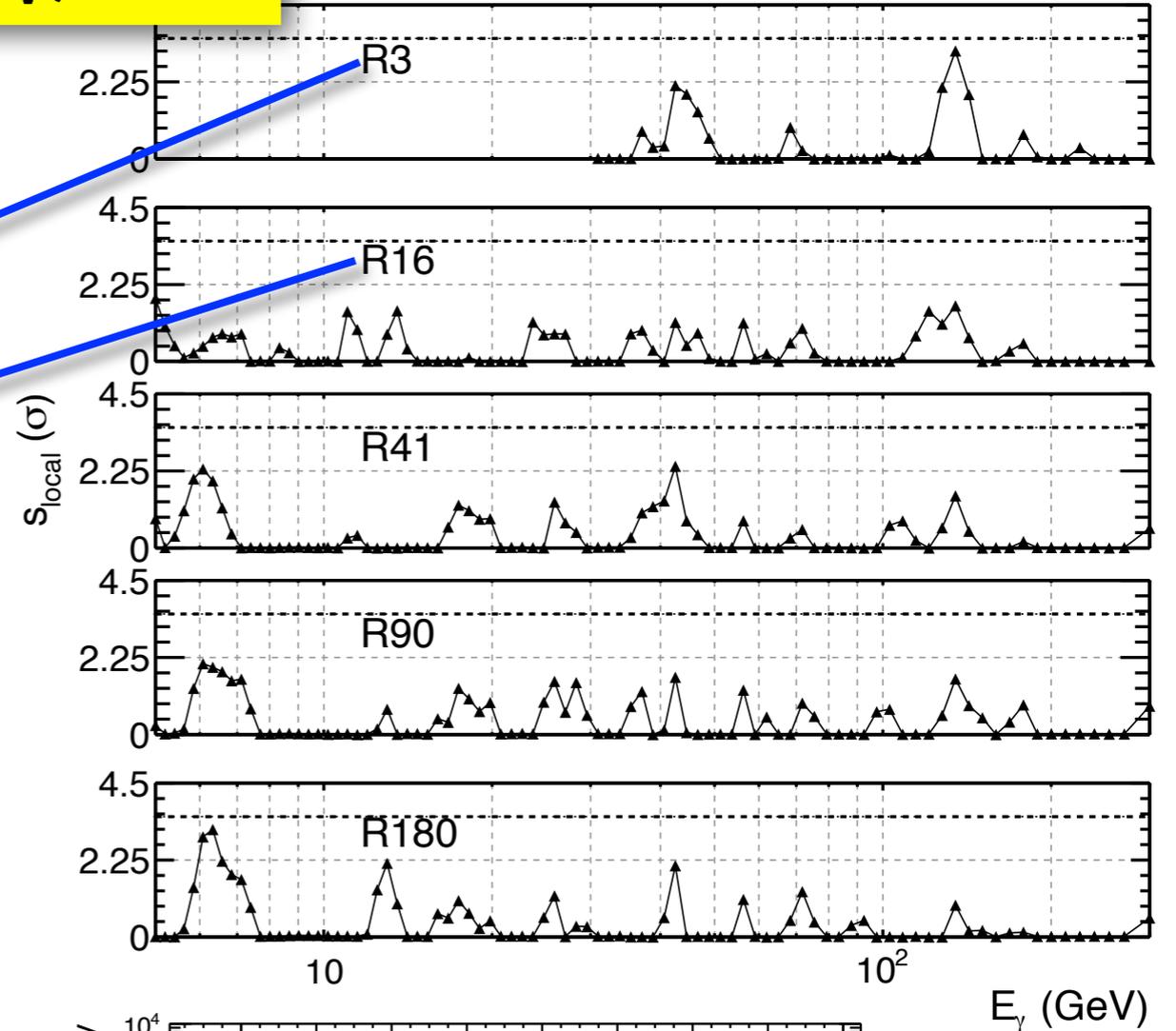
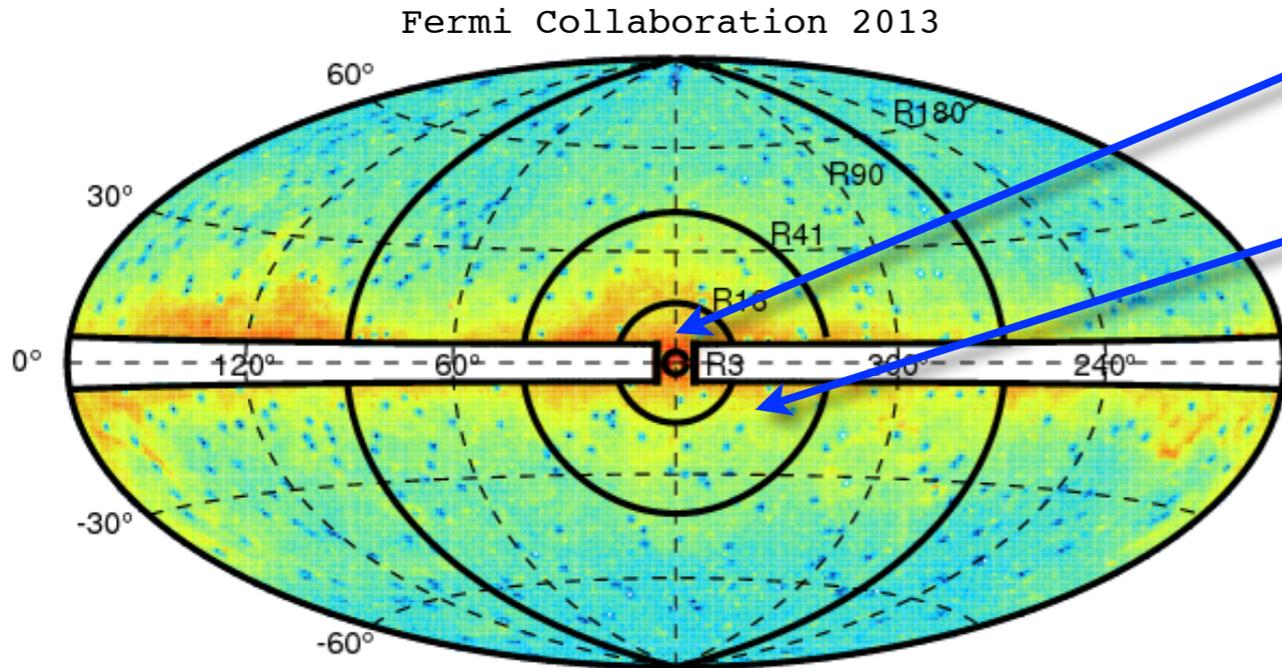


Highest significance  
w/ 2D PSF.



# Feature Results

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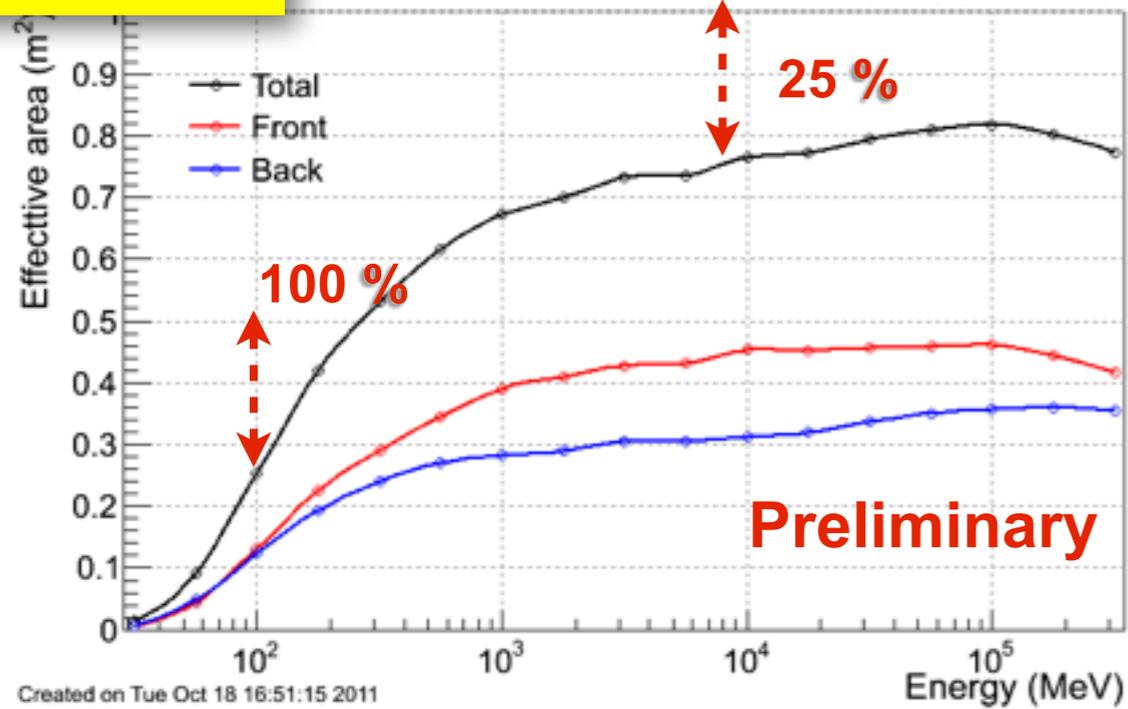


Looking Forward

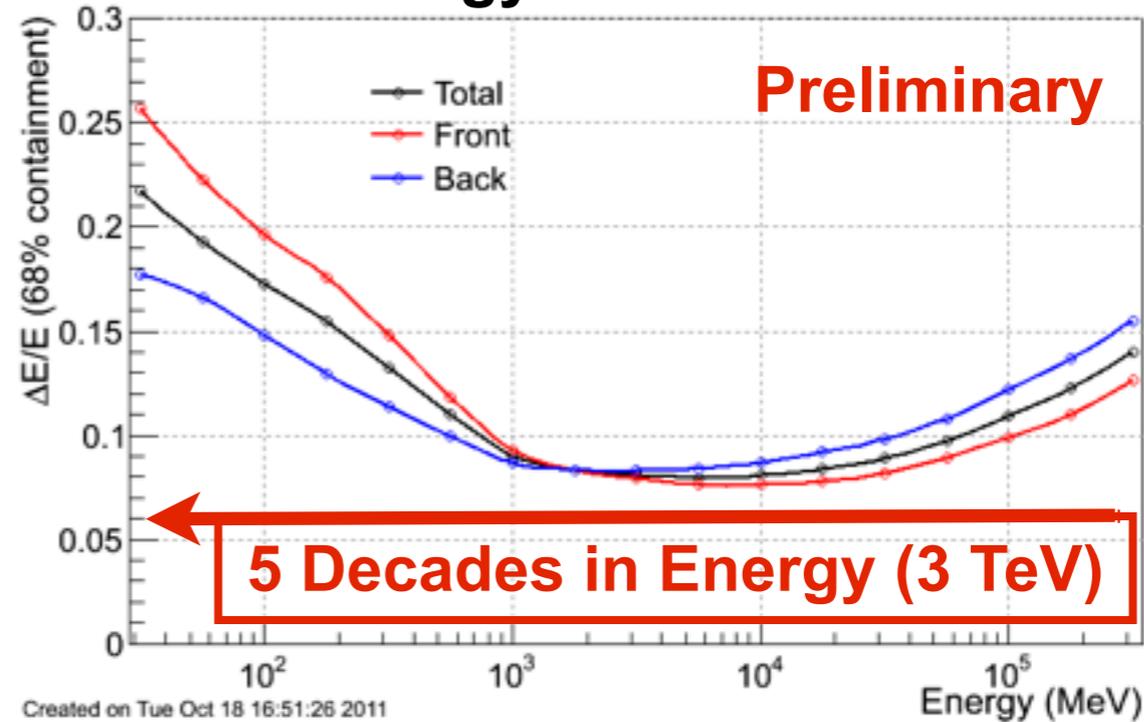
# Instrument Changes

Pass 8

## Effective Area

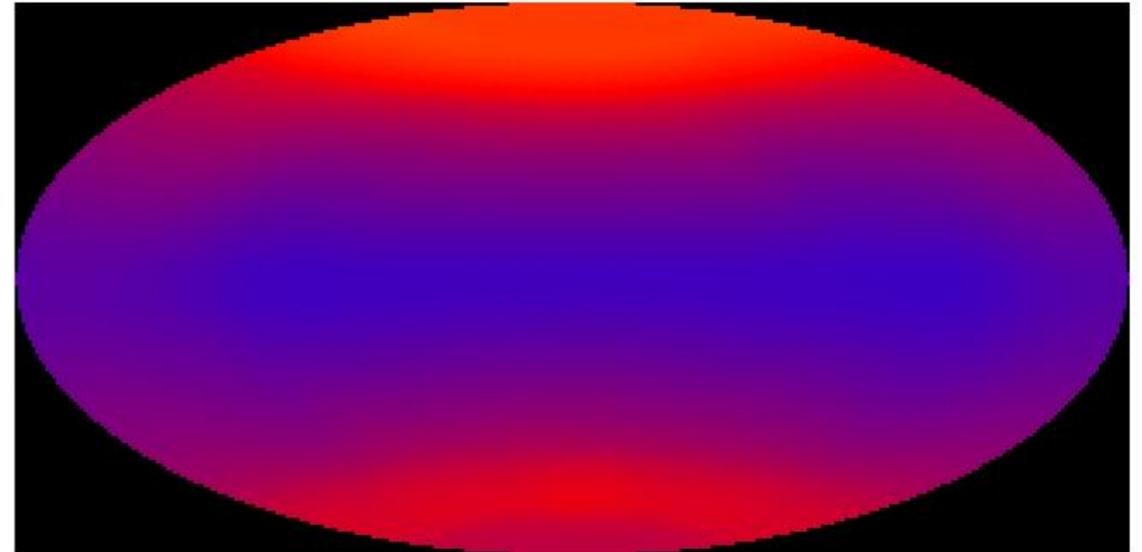
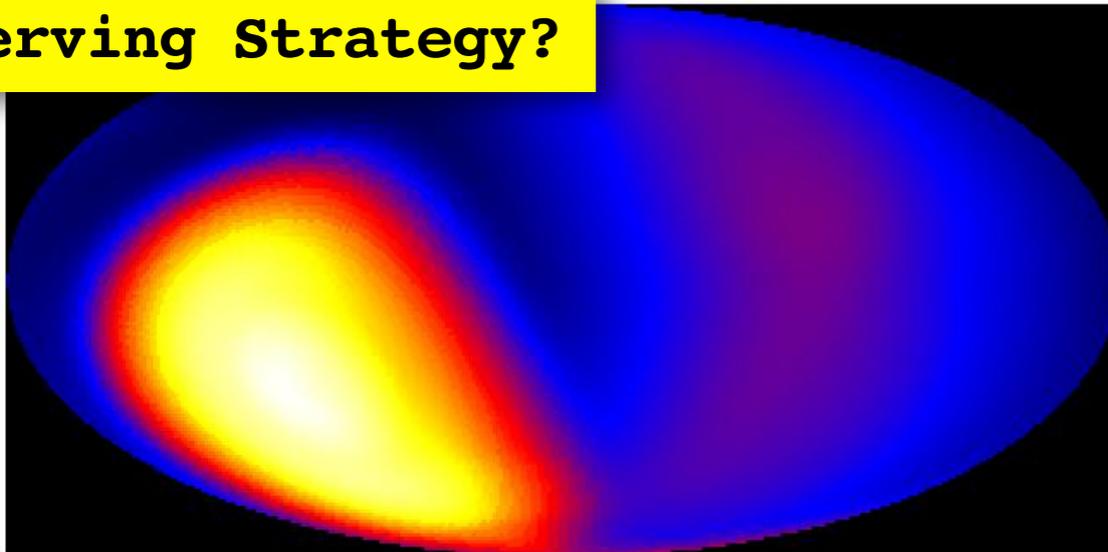


## Energy Resolution



"To help guide future observation plans, the Fermi Project is soliciting "white papers" from the scientific community. These should detail specific alternative observing strategies and discuss, in a quantitative way, the scientific benefits. We emphasize that this solicitation differs from a call for proposals, in that it is not a competitive peer review. Multiple ideas, or combinations thereof may ultimately be implemented. Continuing dialogs between any groups involved and the Fermi Project are also encouraged."

## Observing Strategy?

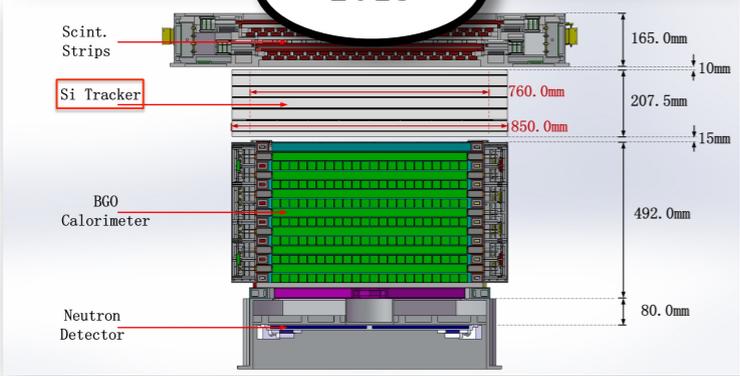


# New Additions

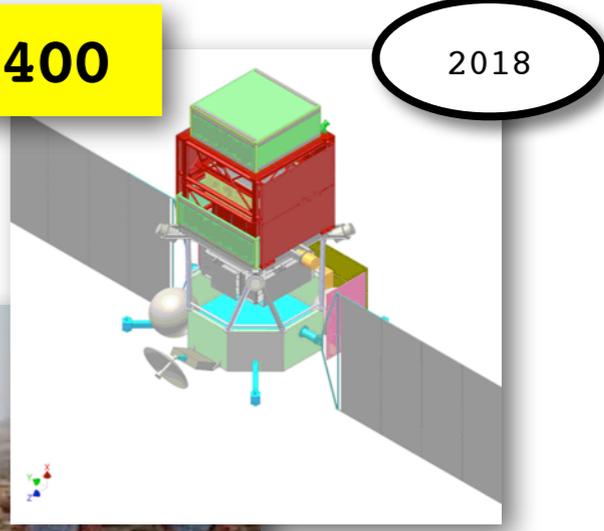
## DARk Matter Particle Explorer



2015



## GAMMA-400



2018

## HESS II NOW!



## Cherenkov Telescope Array Soon



	FERMI-LAT	GAMMA-400	DAMPE	VERITAS	MAGIC	HESS II	CTA
<b>Energy Range (GeV)</b>	0.02 - 300	0.1 - 3x10 <sup>3</sup>	5 - 10 <sup>4</sup>	>100	>50	>30	>20
<b>Energy Res. (100 GeV, %)</b>	10	1	1.5	15	20	15	20
<b>Angular Res. (100 GeV, deg)</b>	0.1	0.01	0.1	0,1	0,07	0,07	0,1