

# The gamma-ray view of the Galactic Centre region

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on behalf of the H.E.S.S. Collaboration  
Blois, May 30, 2012



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NATURWISSENSCHAFTLICHE  
FAKULTÄT



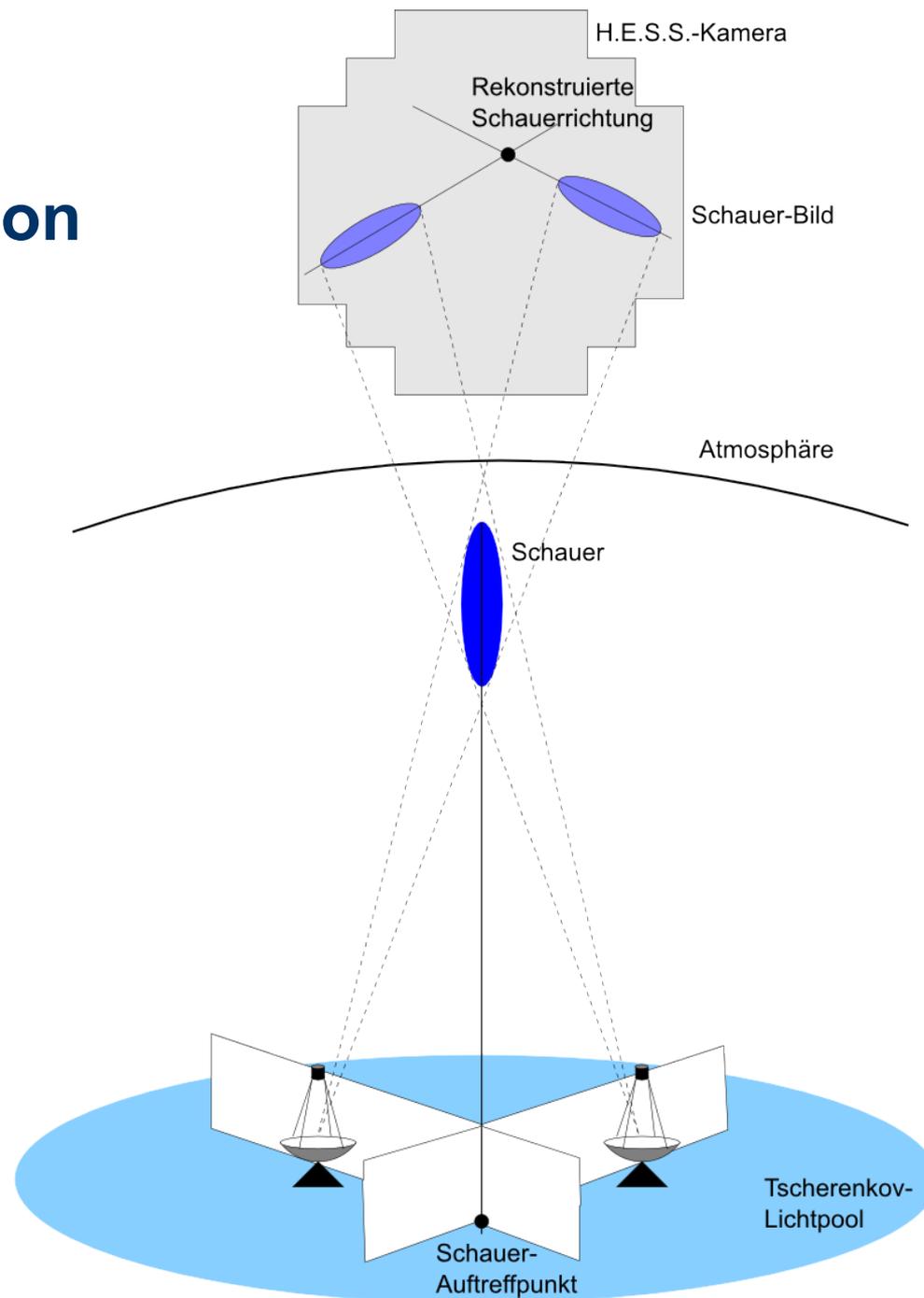
ERLANGEN CENTRE  
FOR ASTROPARTICLE  
PHYSICS

# H.E.S.S. (and soon H.E.S.S. II)

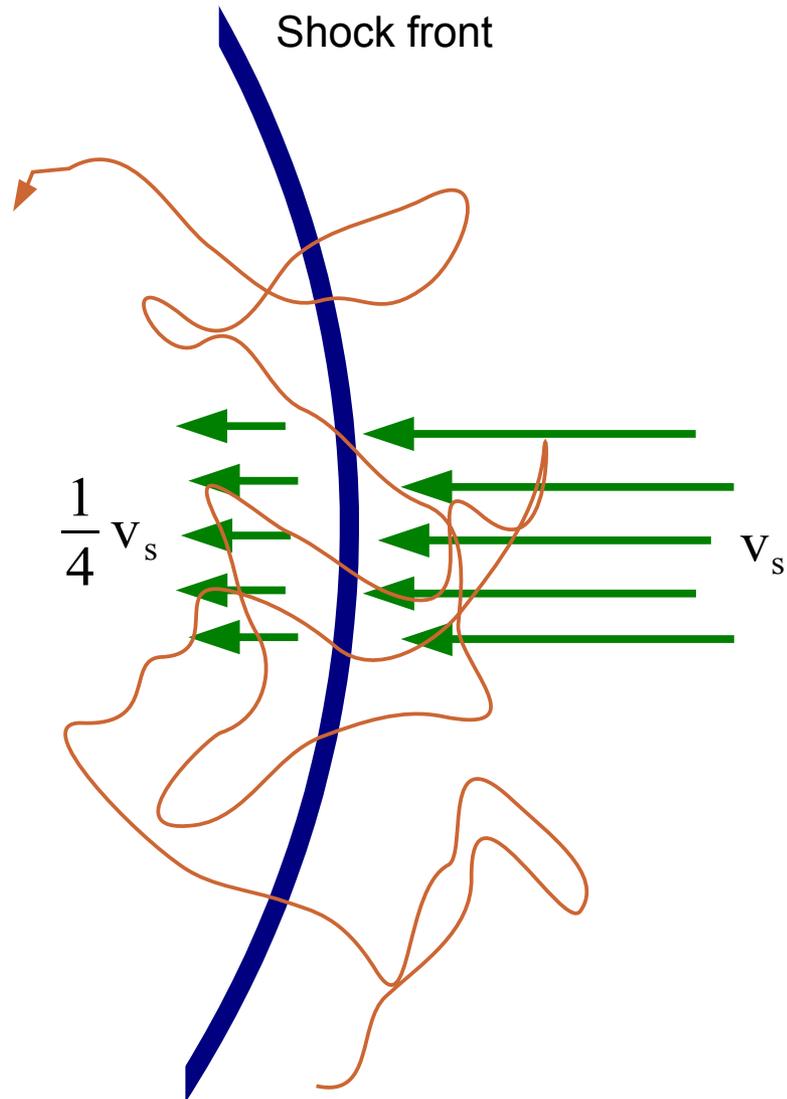


HESS I: Energy range 100 GeV-100 TeV • Sensitivity 1% Crab (25 h)  
Energy resolution 15% • Angular resolution  $< 0.1^\circ$

# Principle of Gamma-ray reconstruction



# Particle acceleration in strong shocks



- Shock front crossing for  $k$  times:

$$E = E_0 \beta^k, \quad \beta = 1 + \frac{v_s}{c}$$

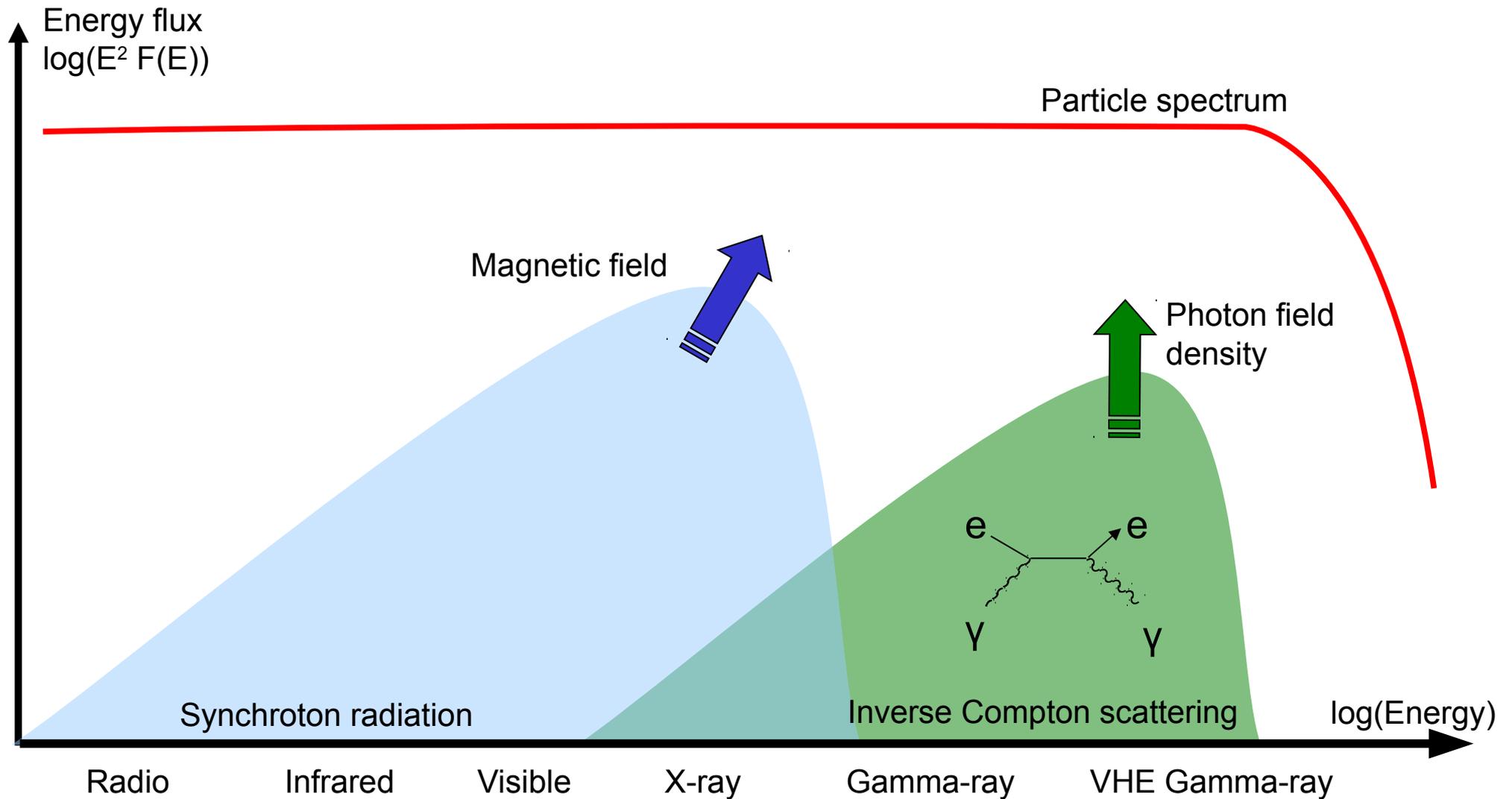
$$N = N_0 p^k, \quad p = 1 - \frac{v_s}{c}$$

- Particle energy distribution:

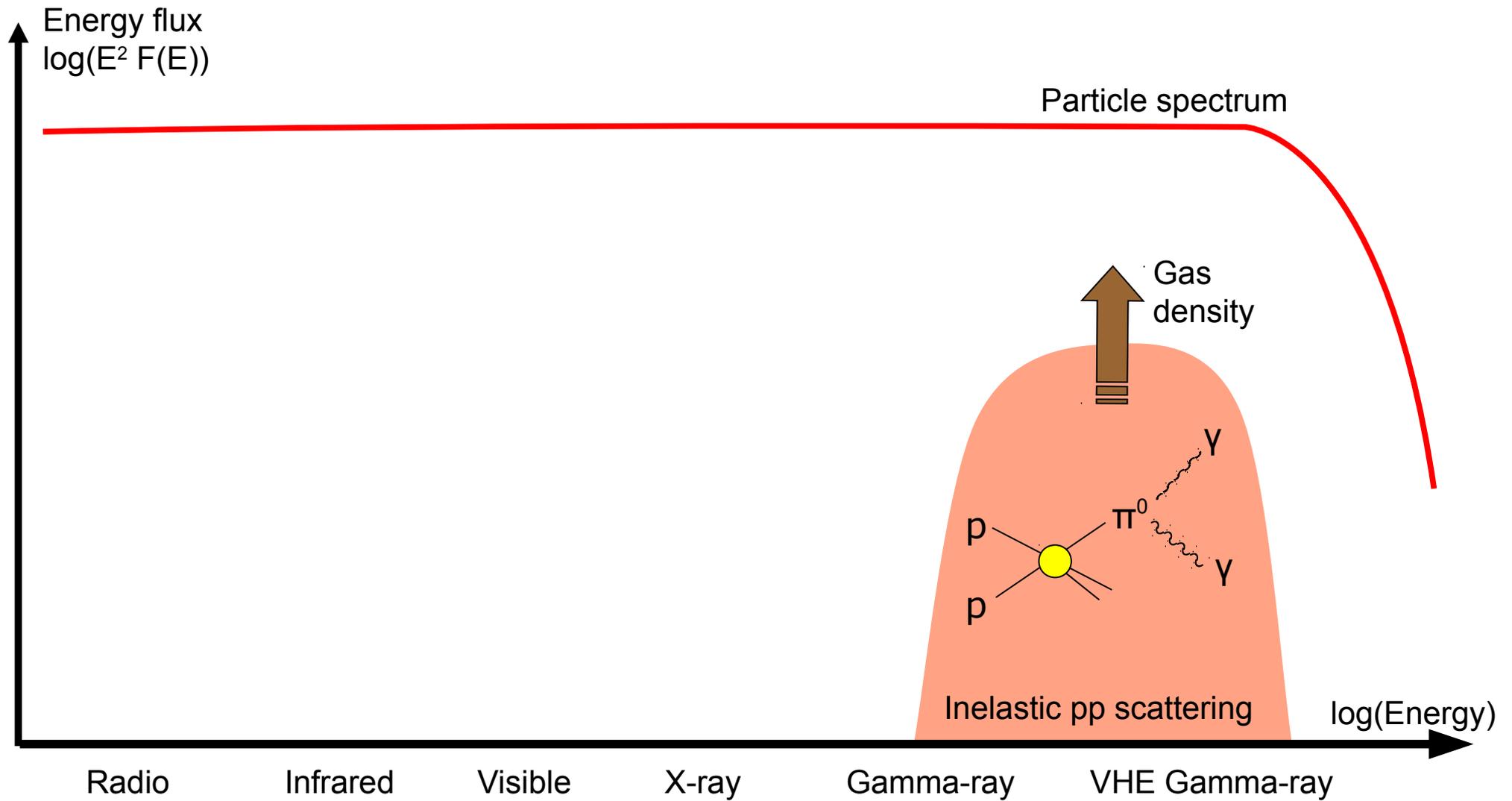
$$\begin{aligned} \rightarrow \frac{dN}{dE} &\propto E^{-1 + \frac{\ln p}{\ln \beta}} \\ &= E^{-1-1} = E^{-2} \end{aligned}$$

- Power-law with universal spectral index!
- Caution: modifications due to feedback, relativistic shock speeds...

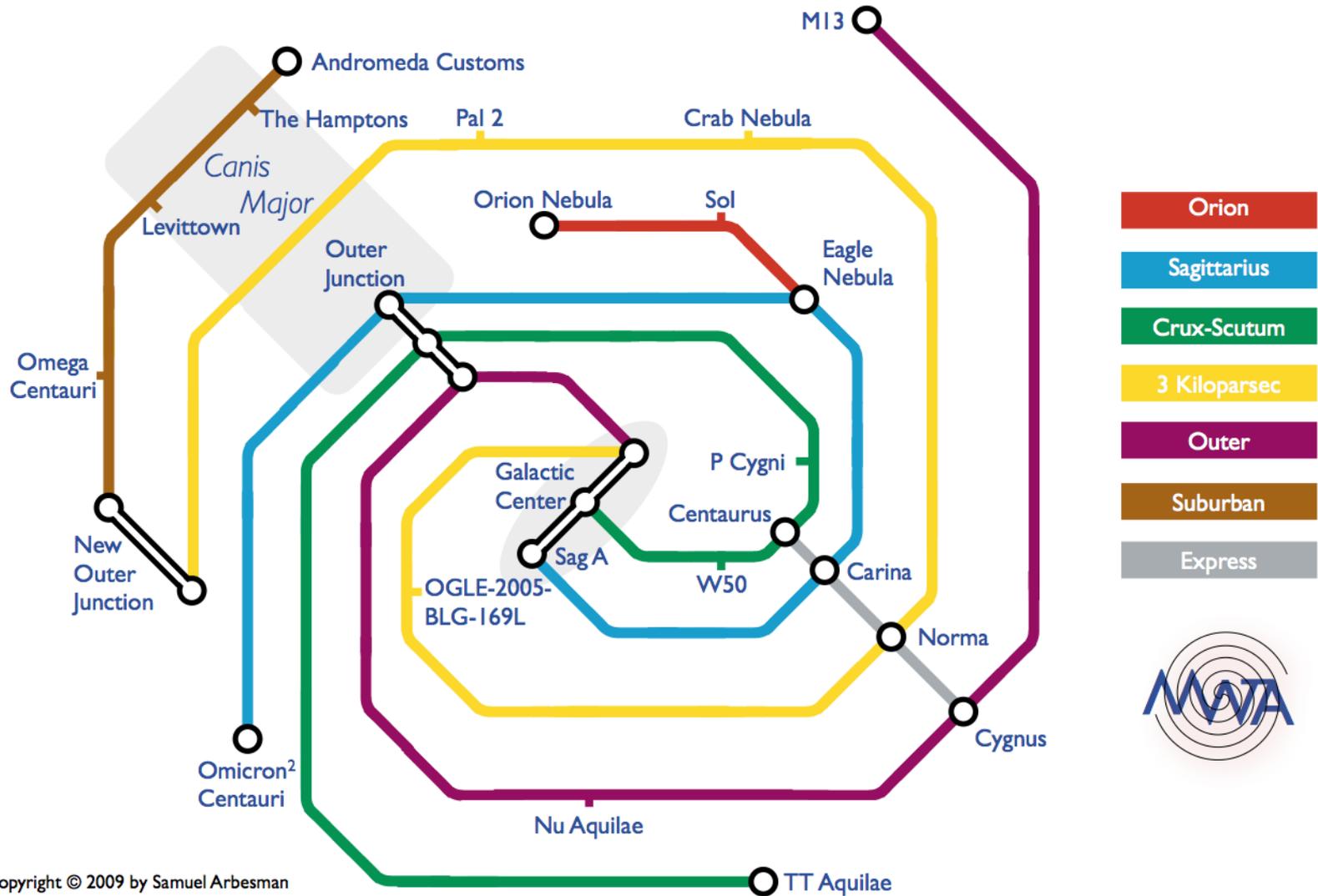
# From particles to radiation - electrons



# From particles to radiation - protons



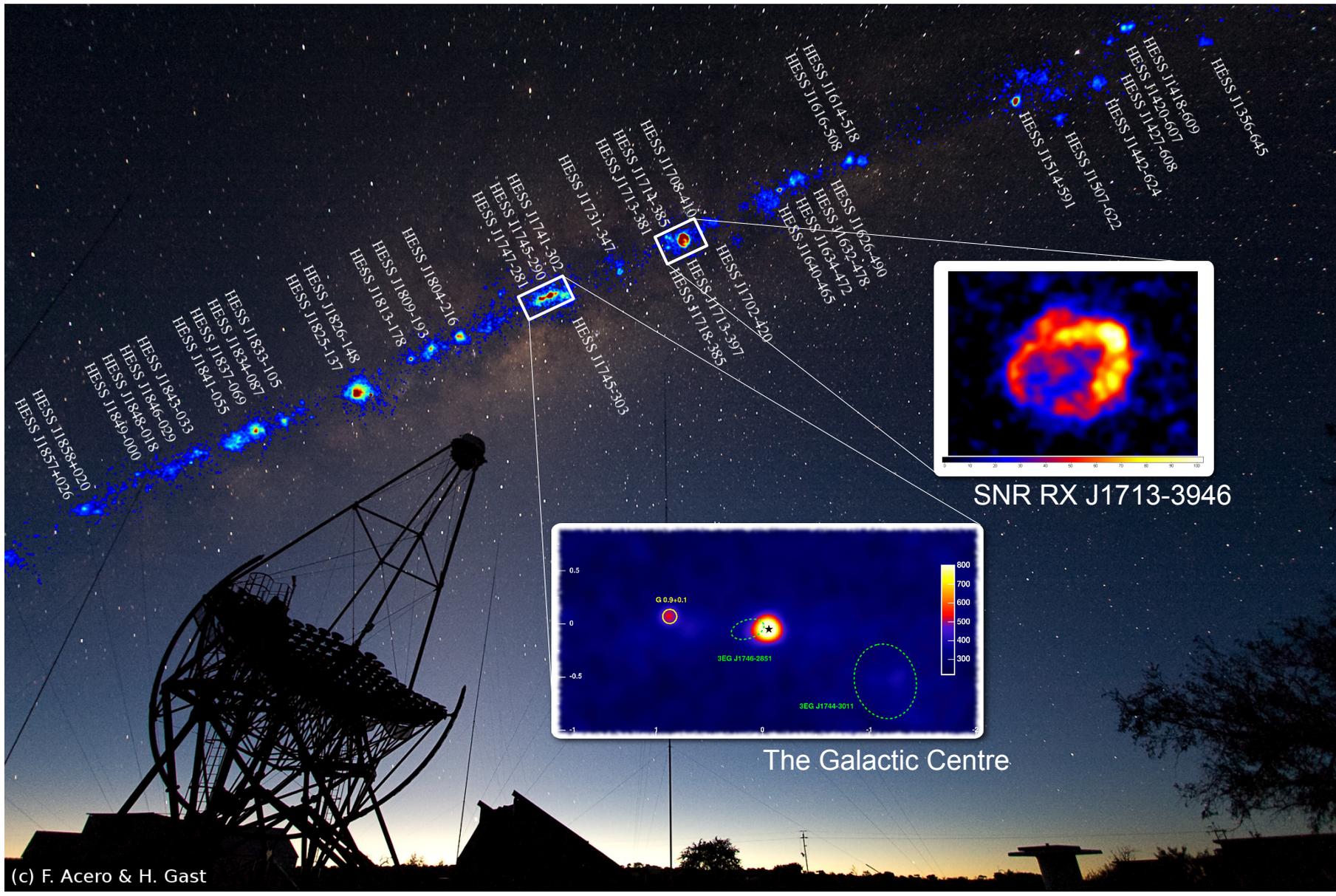
# The Centre of the Milky Way



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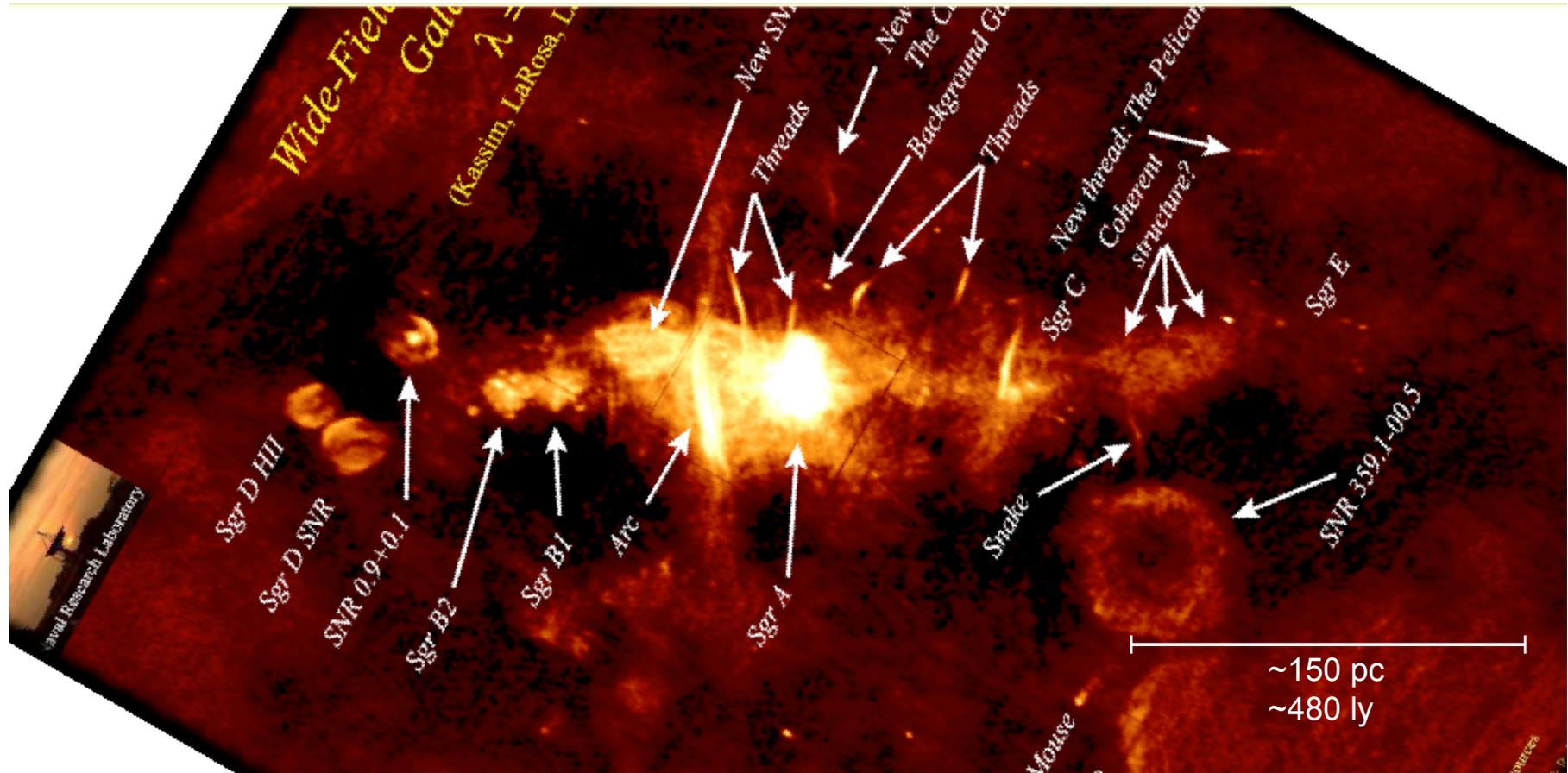


# The H.E.S.S. Galactic Plane Scan



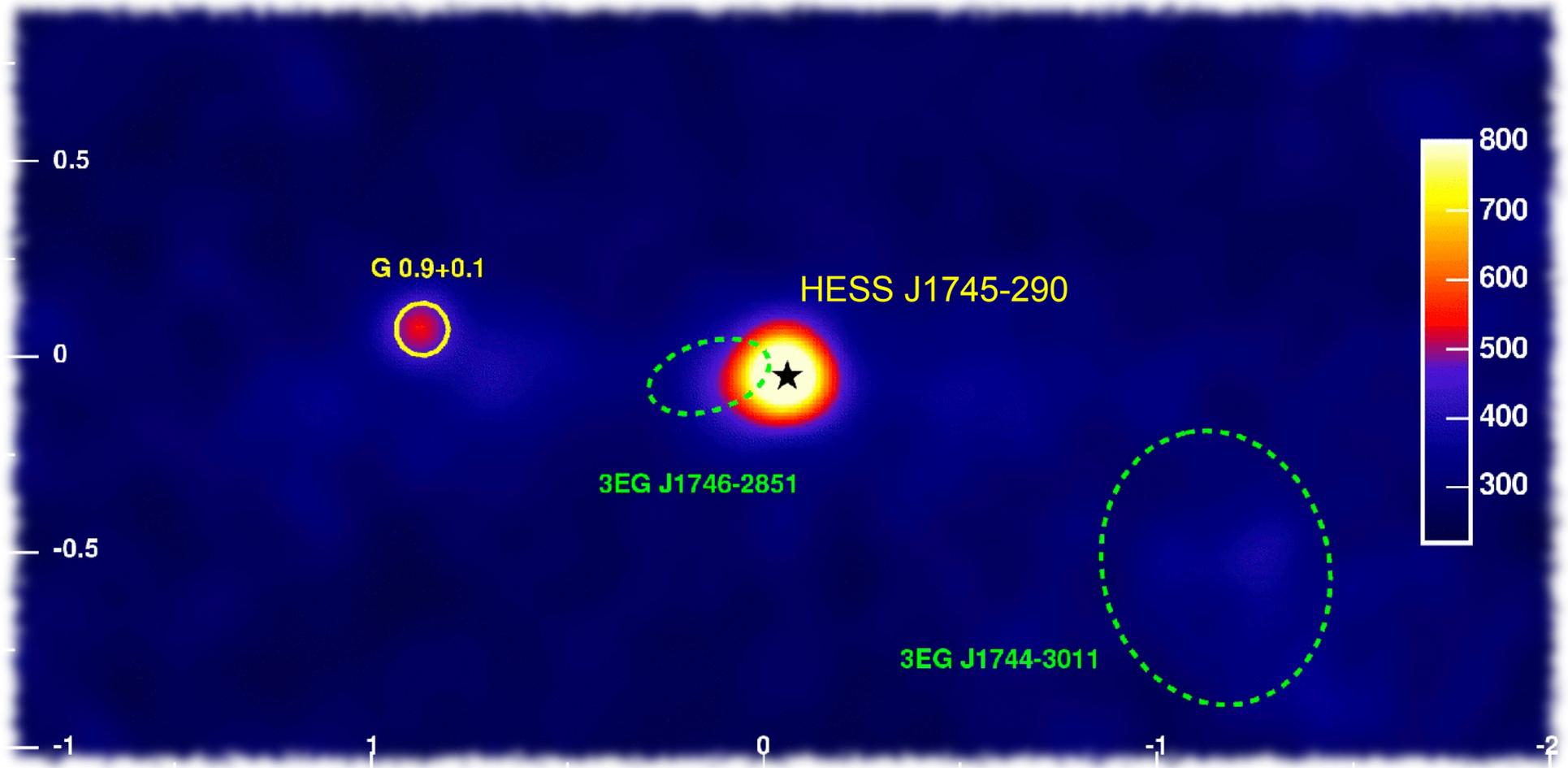
(c) F. Acero & H. Gast

# The Centre of the Milky Way: 90 cm radio view



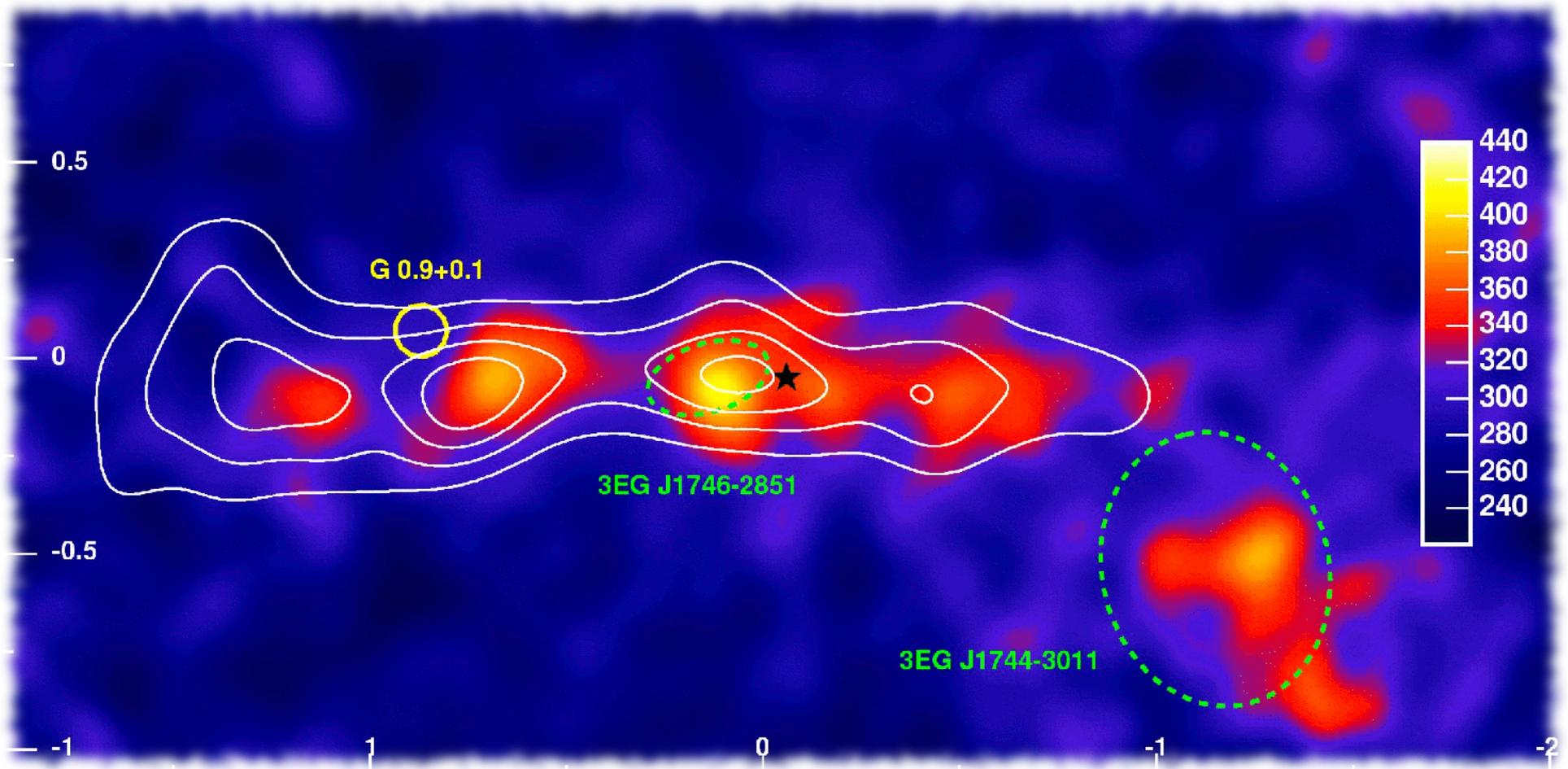
LaRosa et al. (2000)

# VHE Gamma-ray image ( $E > 380$ GeV, 55 h)



H.E.S.S. Coll. (2006)

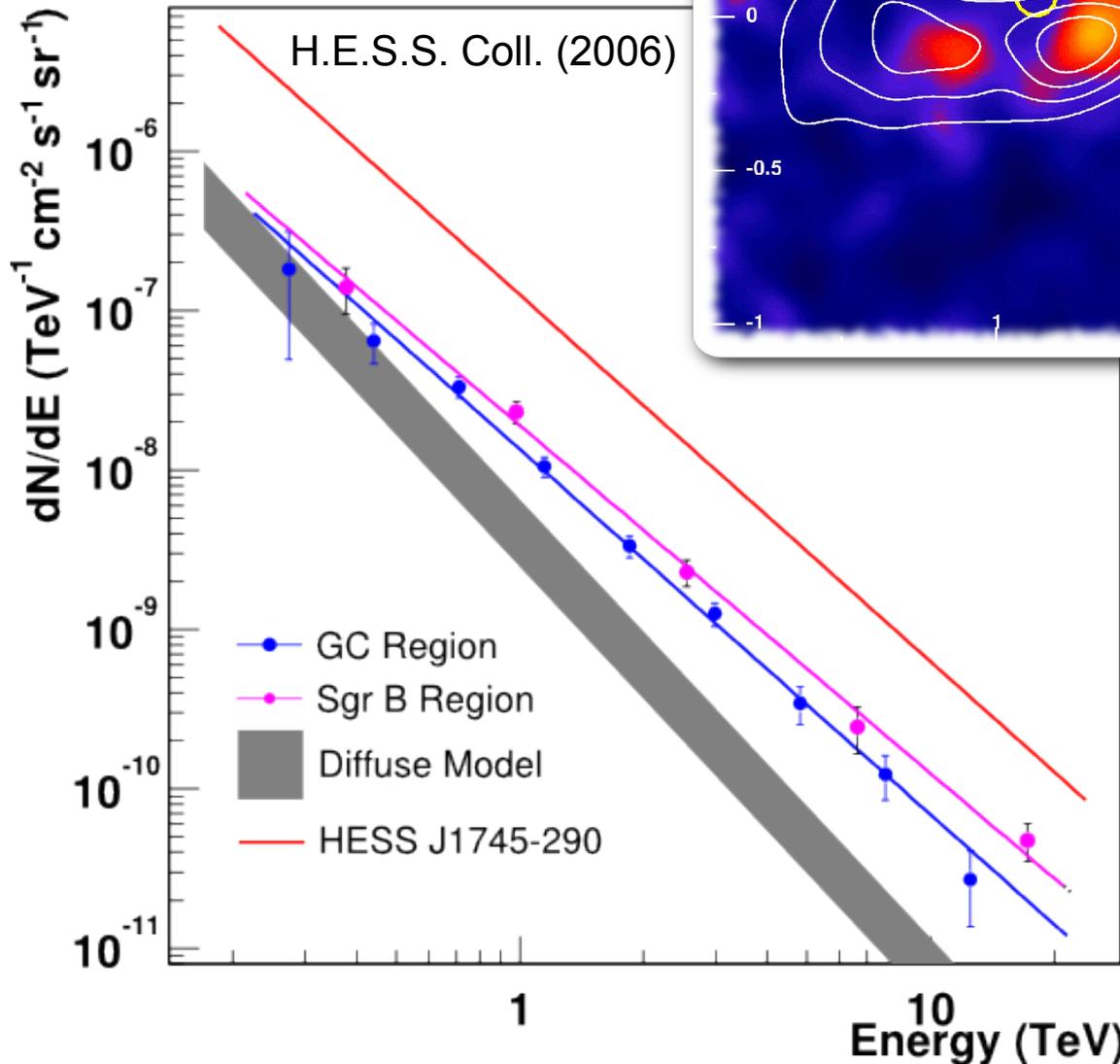
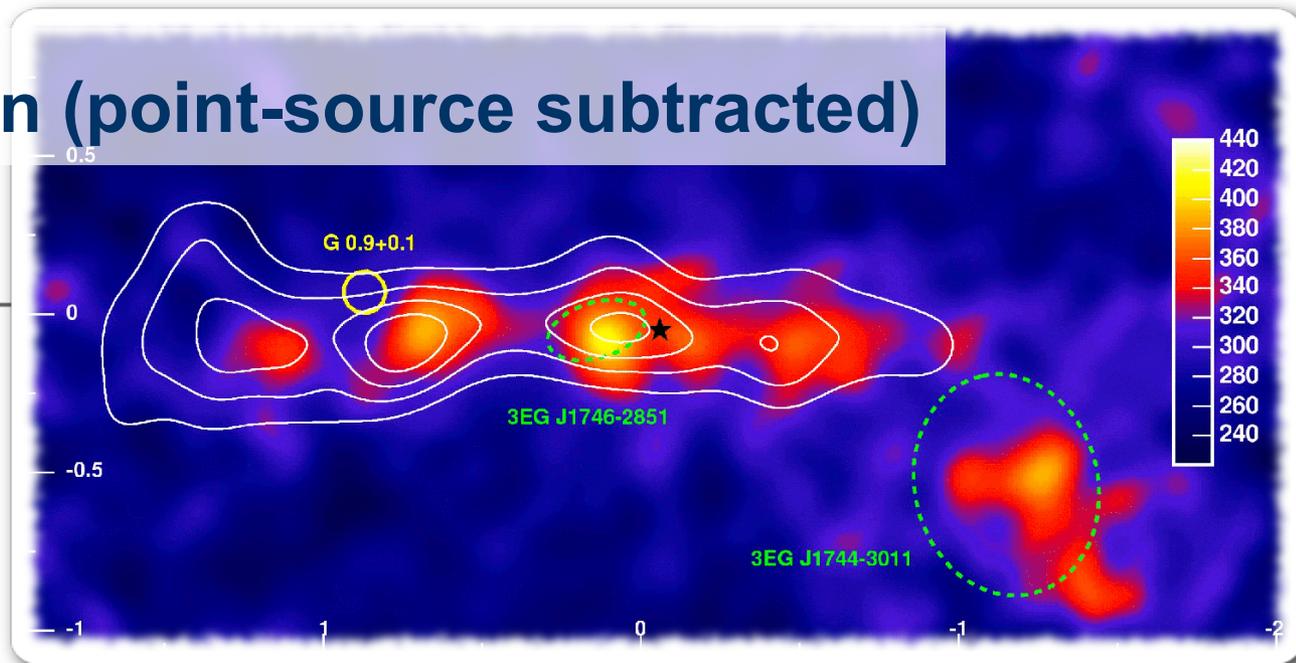
# Diffuse emission (point-source subtracted)



H.E.S.S. Coll. (2006)

- Protons interacting with molecular clouds?

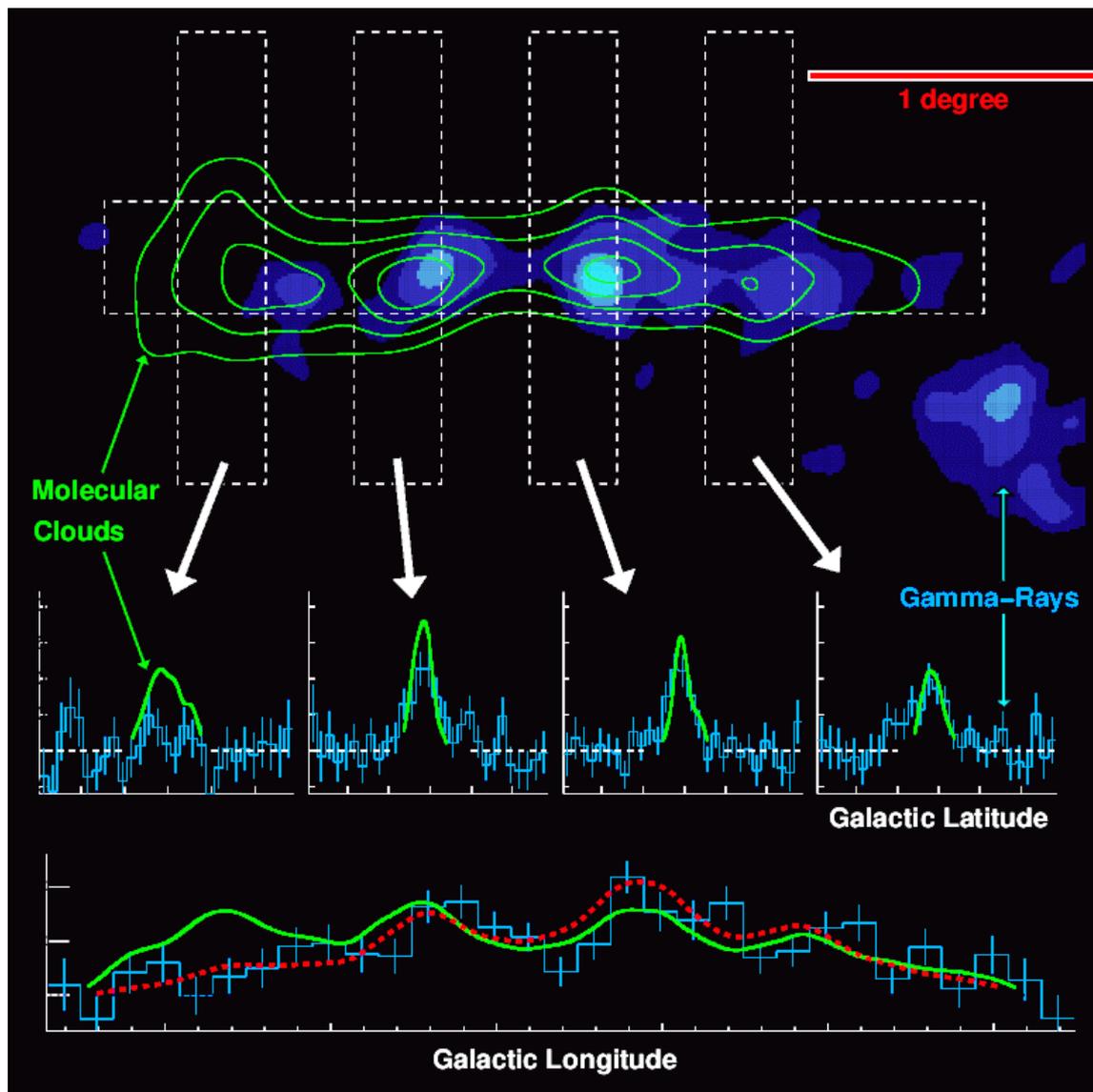
# Diffuse emission (point-source subtracted)



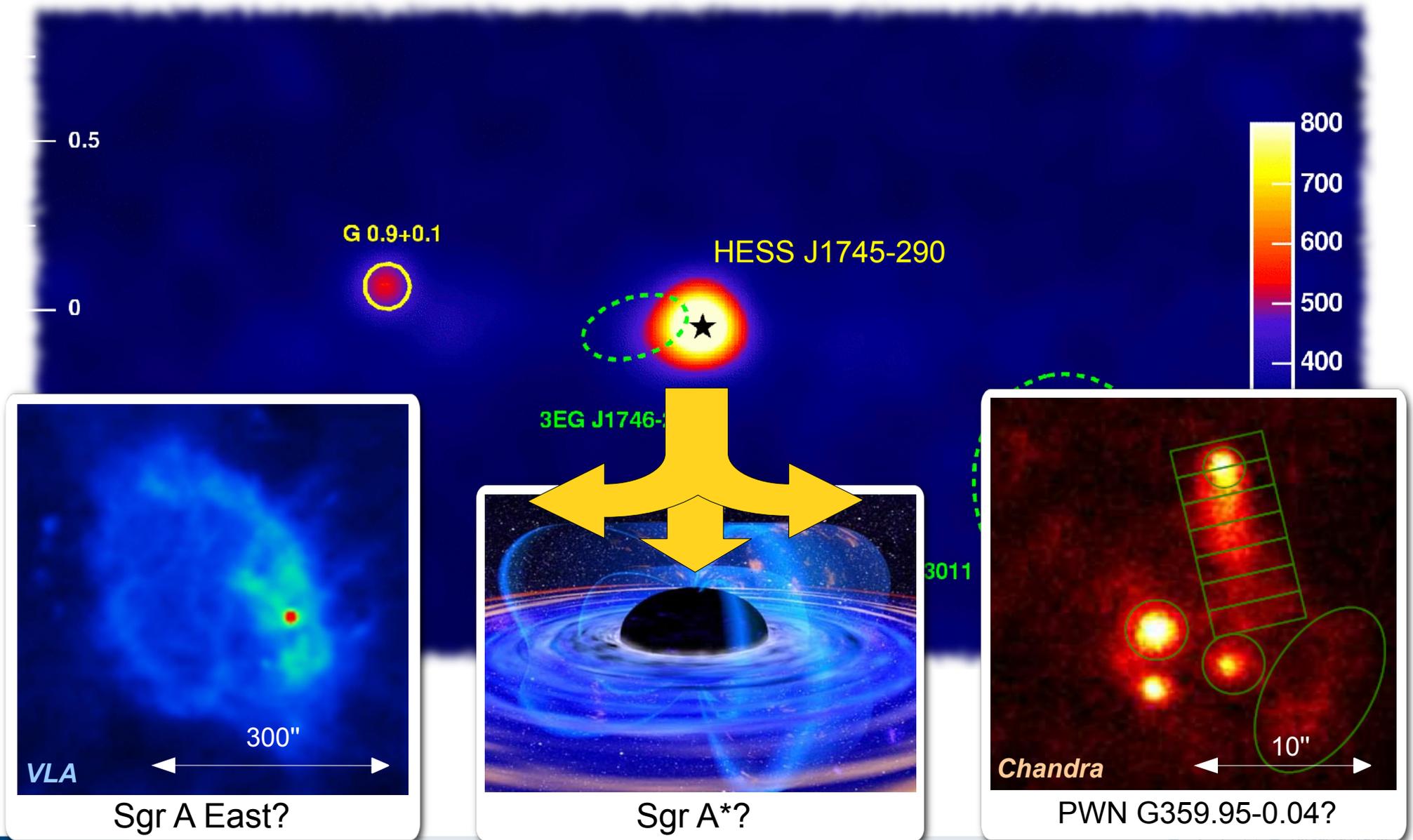
- Emission not explained by passive cosmic ray illumination  
→ need local accelerator
- Photon index similar to central source  
→ accelerator identified?

# Correlation with molecular clouds

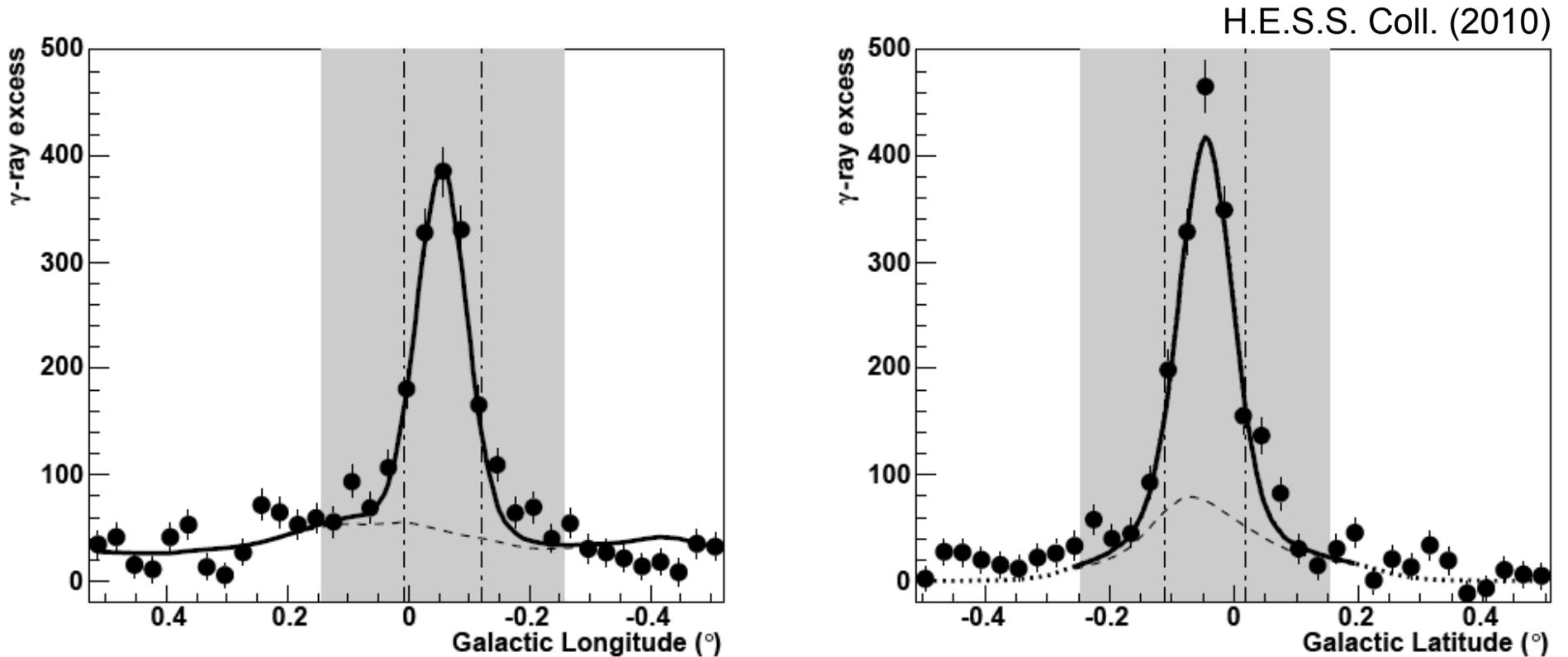
- No emission seen at longitudes  $> 1^\circ$
  - Protons injected by central source?
  - Assume diffusion coefficient of  $k = \sim 3 \text{ kpc}^2 \text{ Myr}^{-1}$
- Injection started  $10^4$  years ago



# The nature of the central source



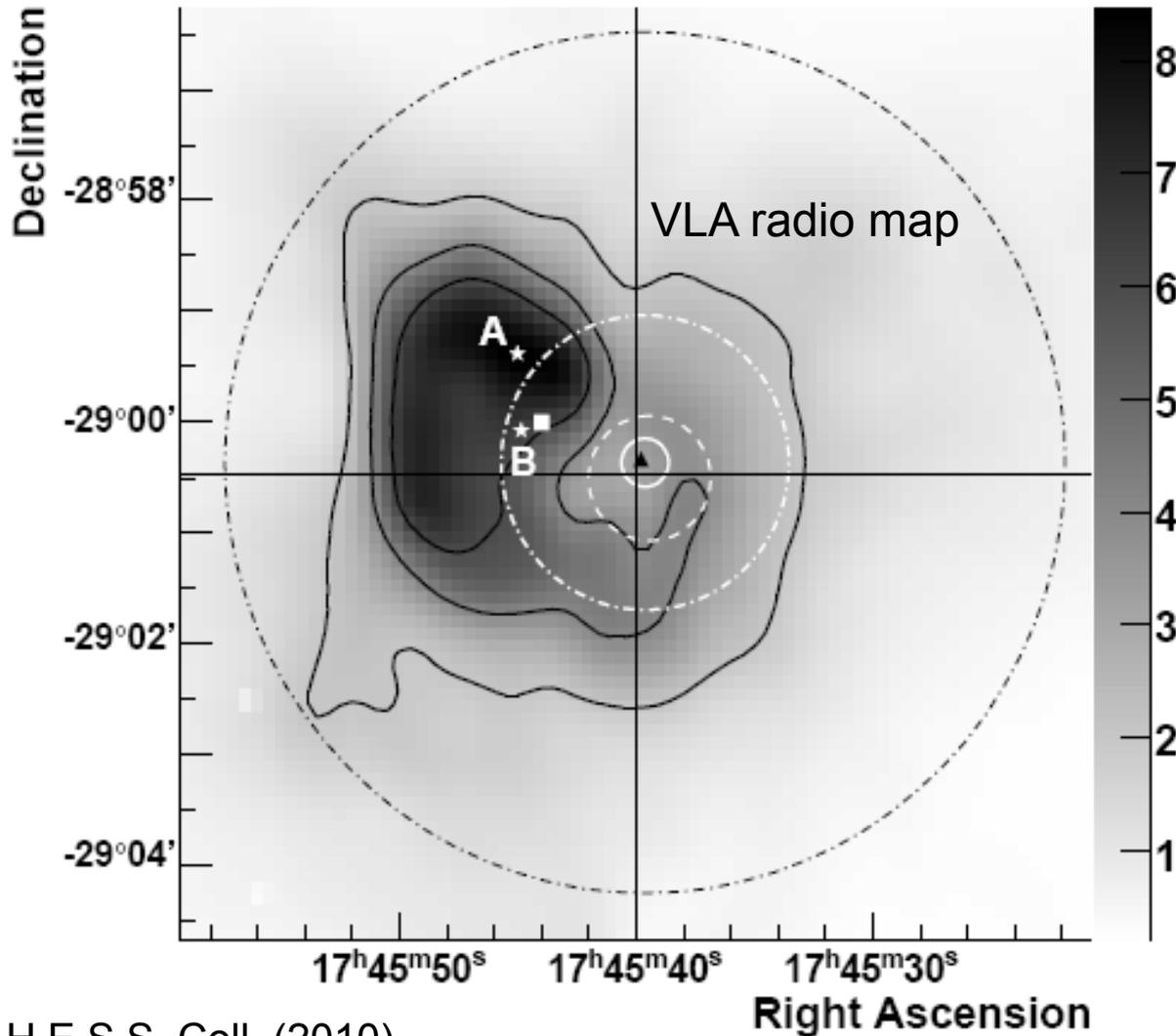
# Position of HESS J1745-290



- 2D source fit to gamma-ray excess map  
Source model: point source + underlying diffuse emission

→ Position well compatible with Sgr A\*

# SNR Sgr A East discarded

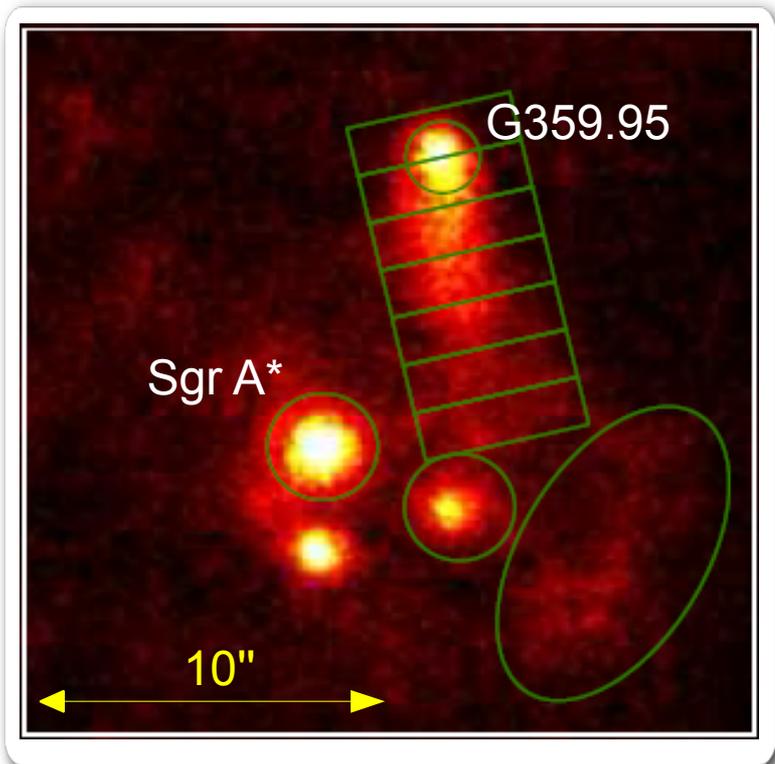


H.E.S.S. Coll. (2010)

- Best fit position coincident with Sgr A\* (and PWN 359.95)
  - 9'' error circle on position (68% containment, including systematics)
  - Probability of random coincidence:  $9 \times 10^{-5}$  ( $3.9 \sigma$ )
- Sgr A East not the main source of gamma-ray emission

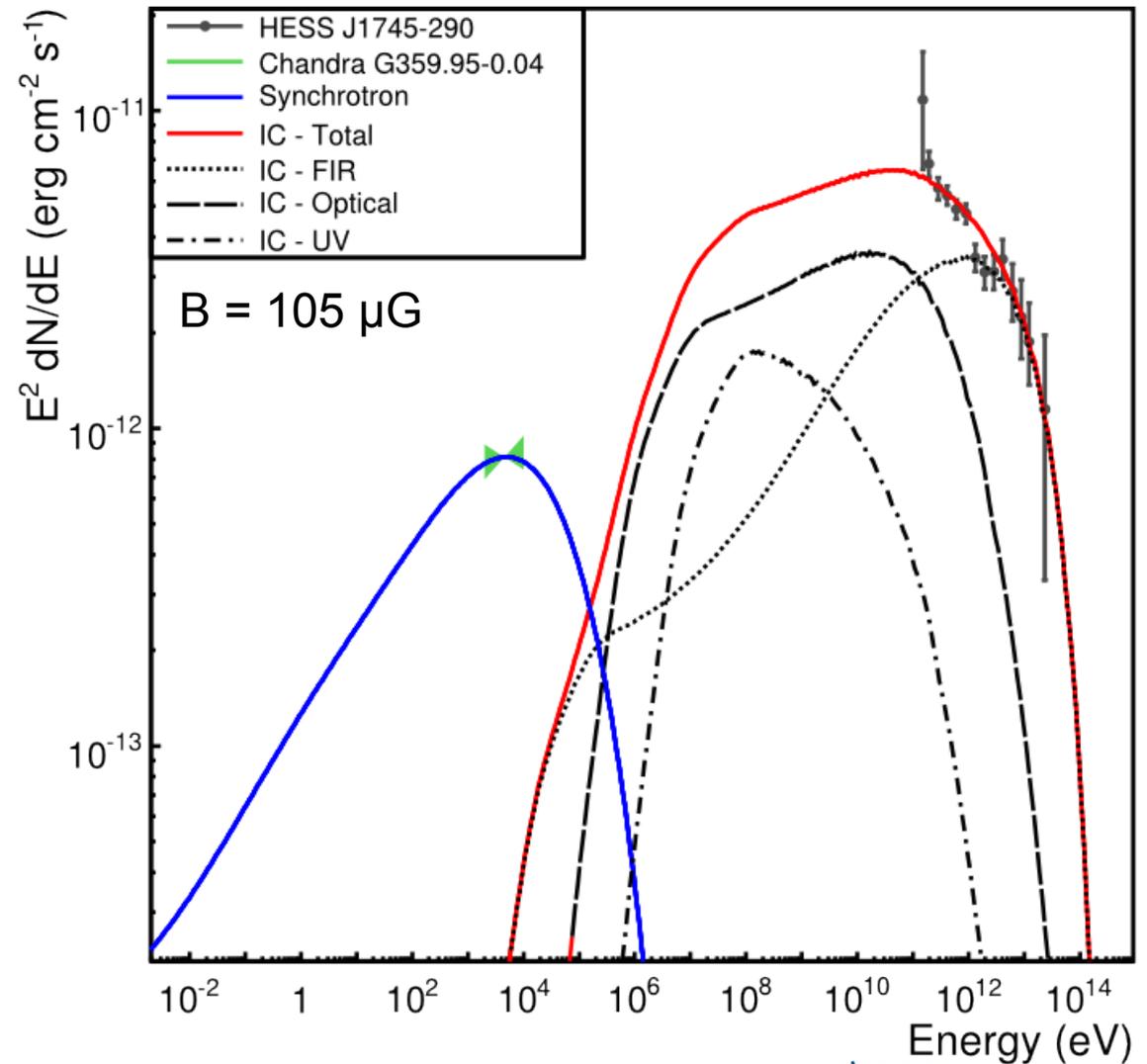
# HESS J1745-290: a pulsar wind nebula?

Aharonian + Hinton (2007)

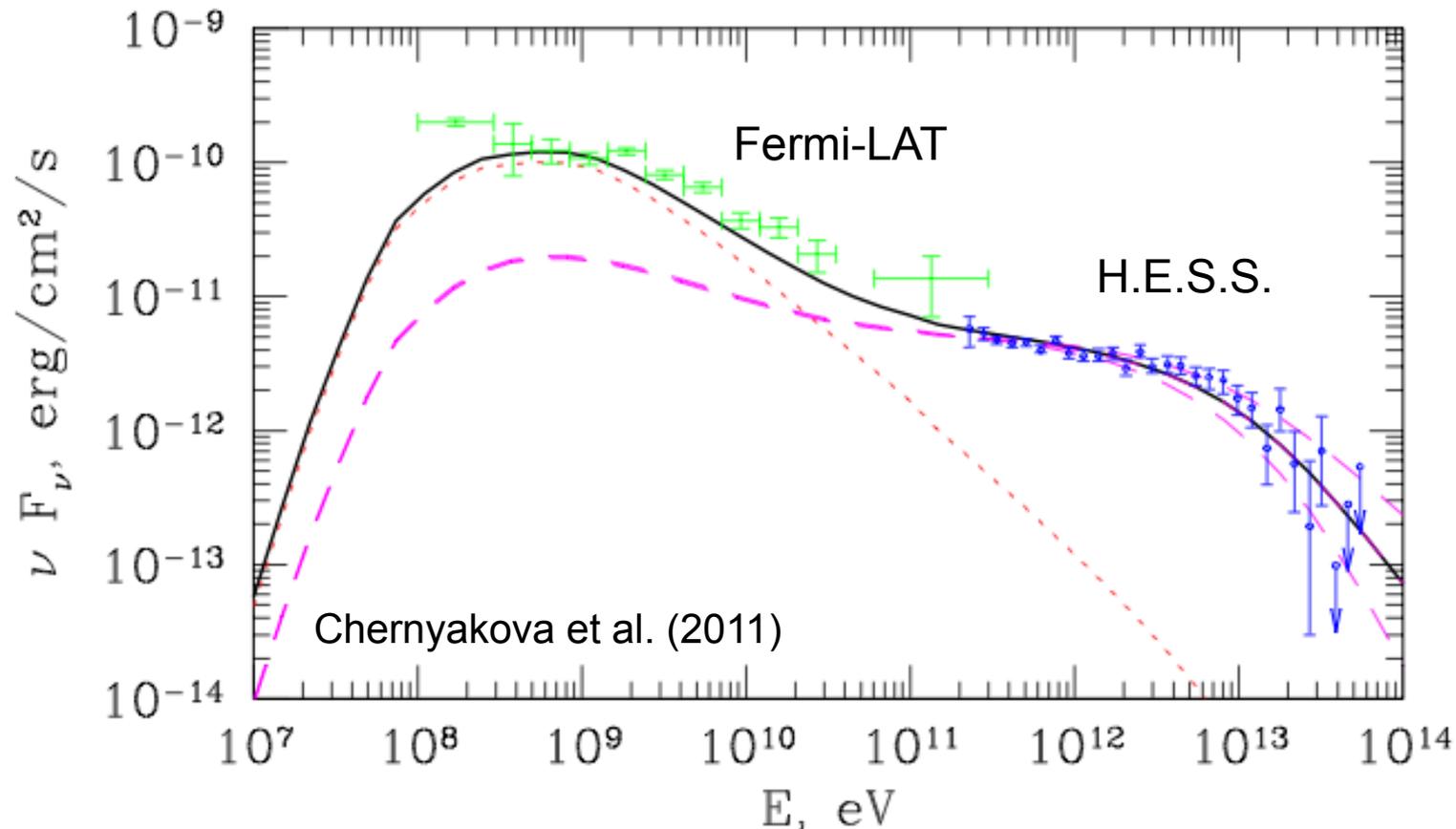


Wang et al. (2005)

- Dense radiation fields around Galactic Centre  
 → source potentially IC dominant  
 → plausible candidate

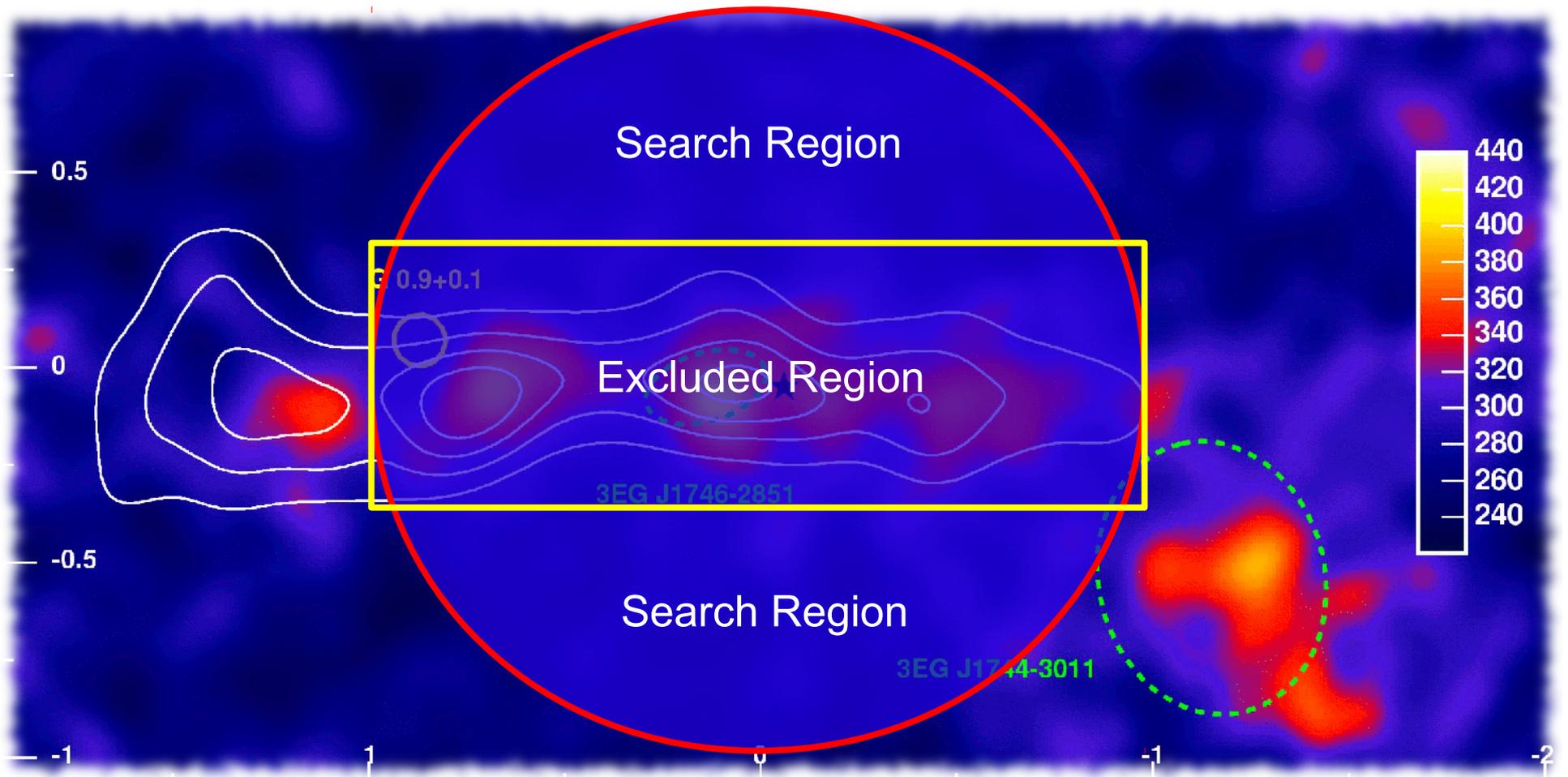


# A combined model for the GeV-TeV range

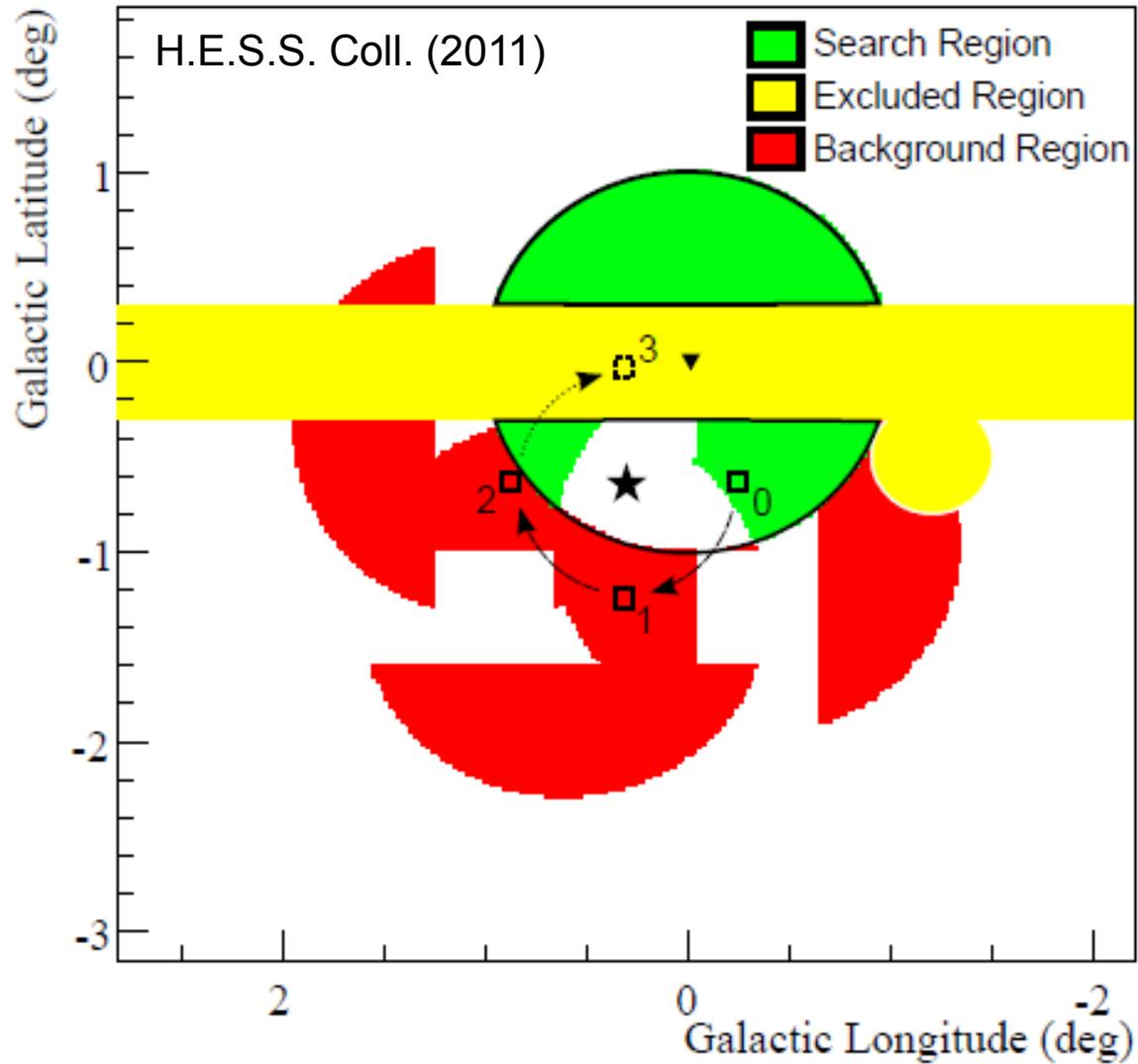


- GeV Flux too large for IC model  
→ PWN scenario unlikely
- Model: energy dependent diffusion of protons  
→ needs steady injection since  $10^4$  years + flare

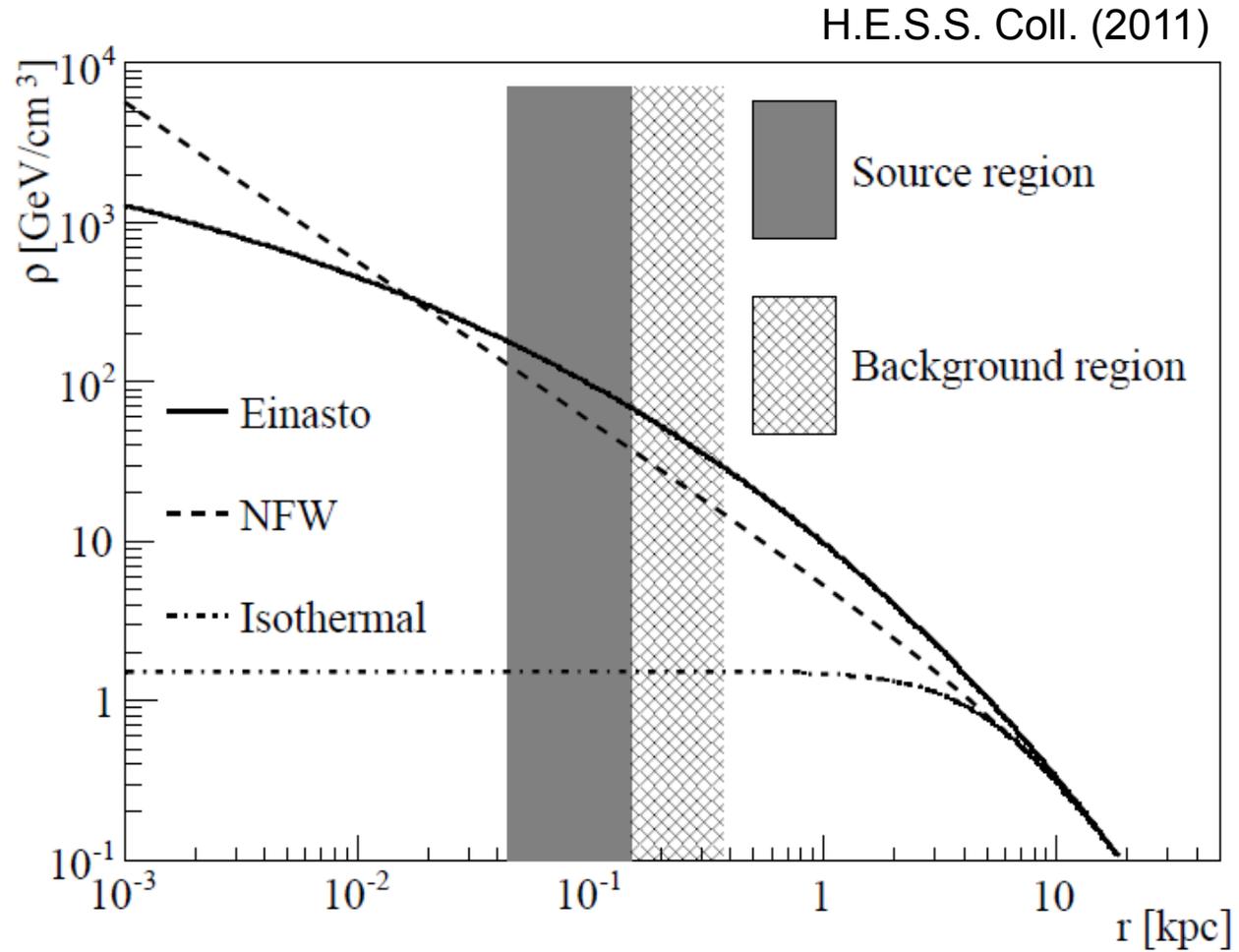
# Dark Matter annihilations in the Galactic Halo?



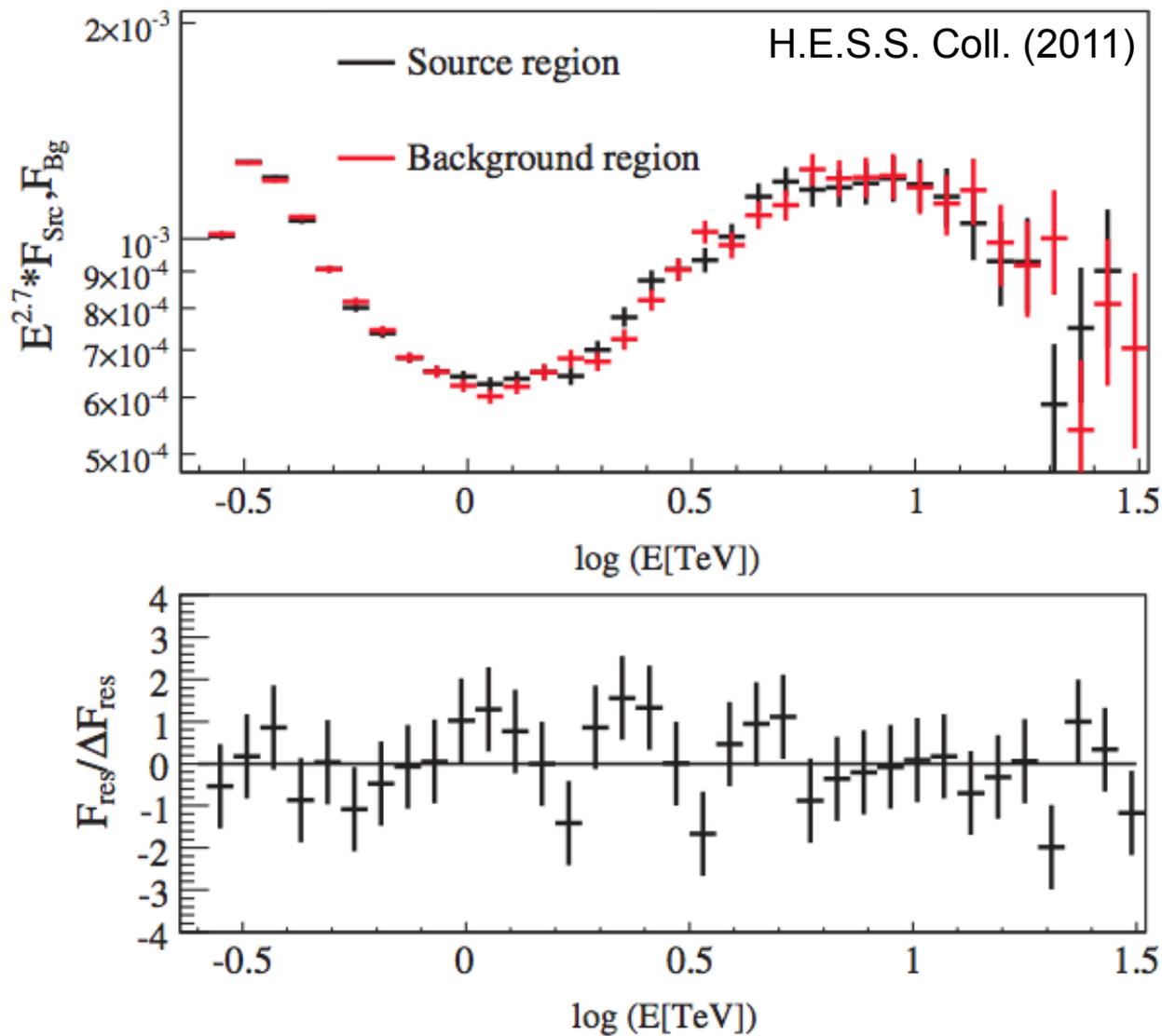
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# Dark Matter annihilations in the Galactic Halo?

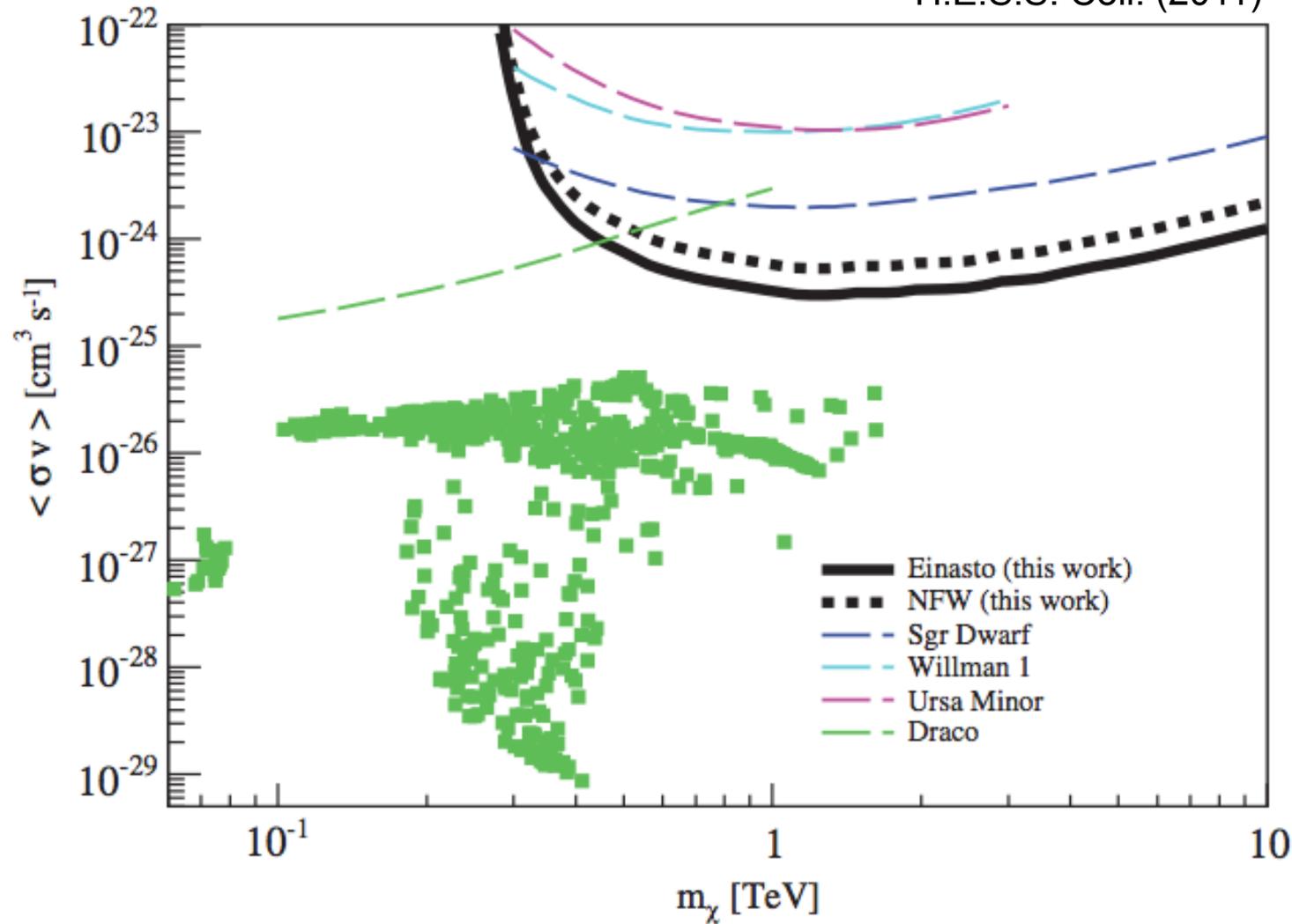


# Signal and background flux spectra



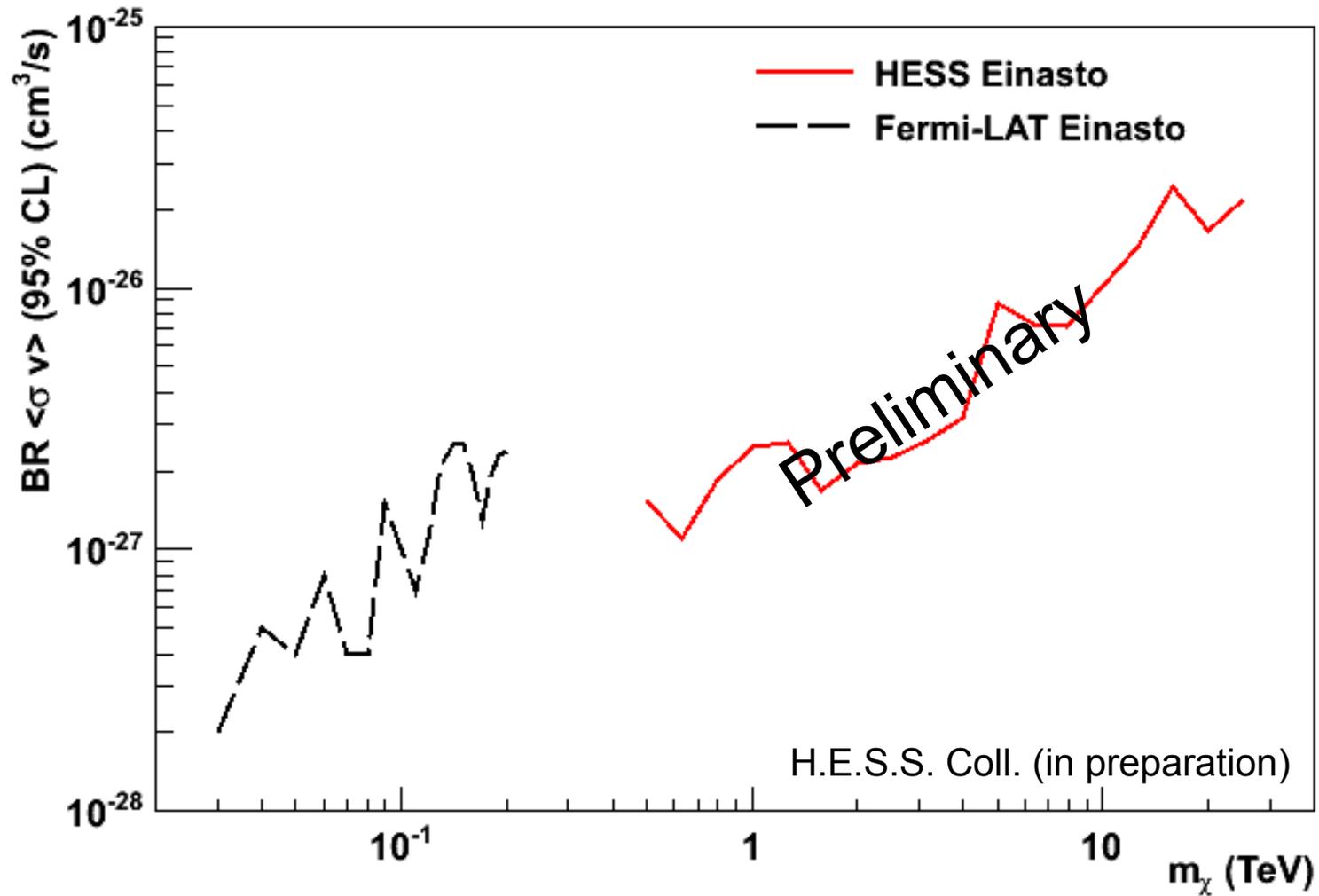
# Limits for $\chi\chi \rightarrow q\bar{q}$

H.E.S.S. Coll. (2011)



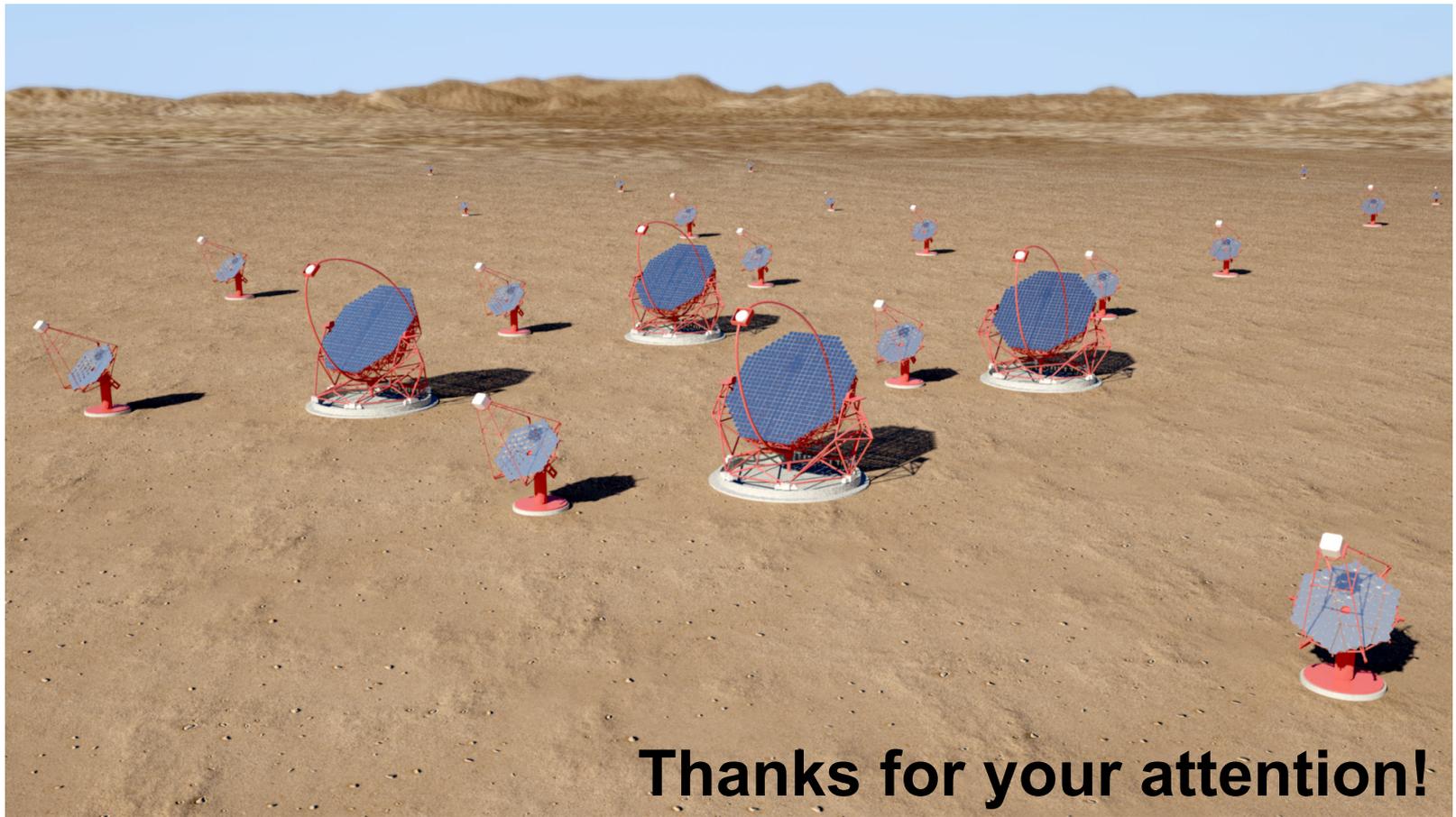
- Currently best limits for masses in the TeV regime

# Limits for $XX \rightarrow YY$



- First line limits in the TeV mass range
- Limits on IB-like features soon

# CTA – improved sensitivity from 2015 on



GEFÖRDERT VOM



Bundesministerium  
für Bildung  
und Forschung



HELMHOLTZ  
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Alliance for Astroparticle Physics



EMERGING  
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