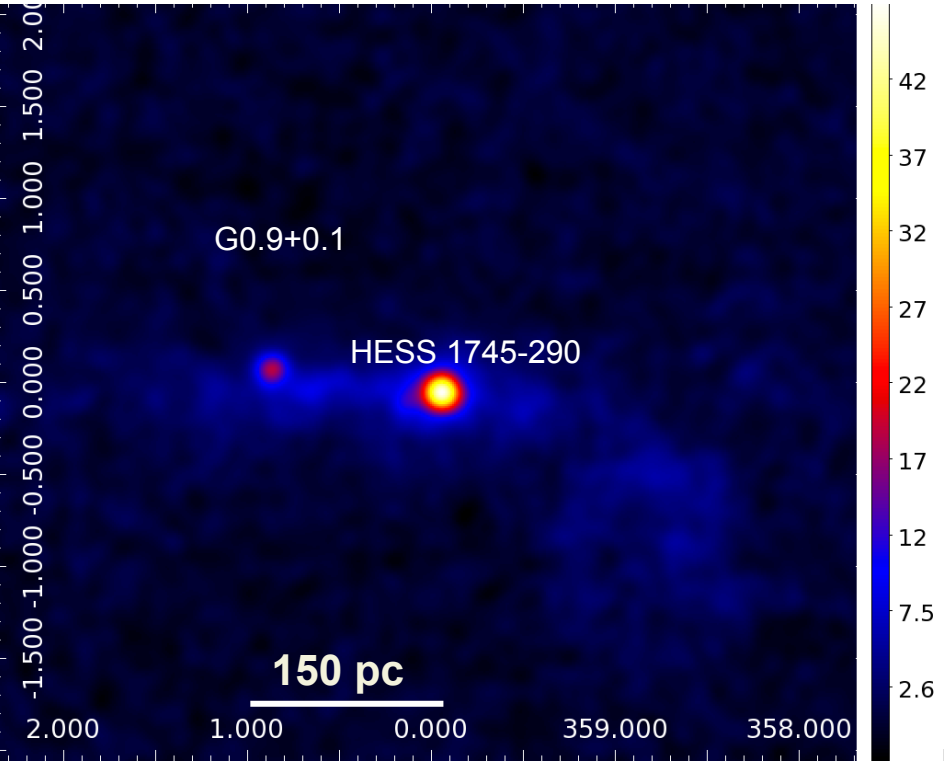
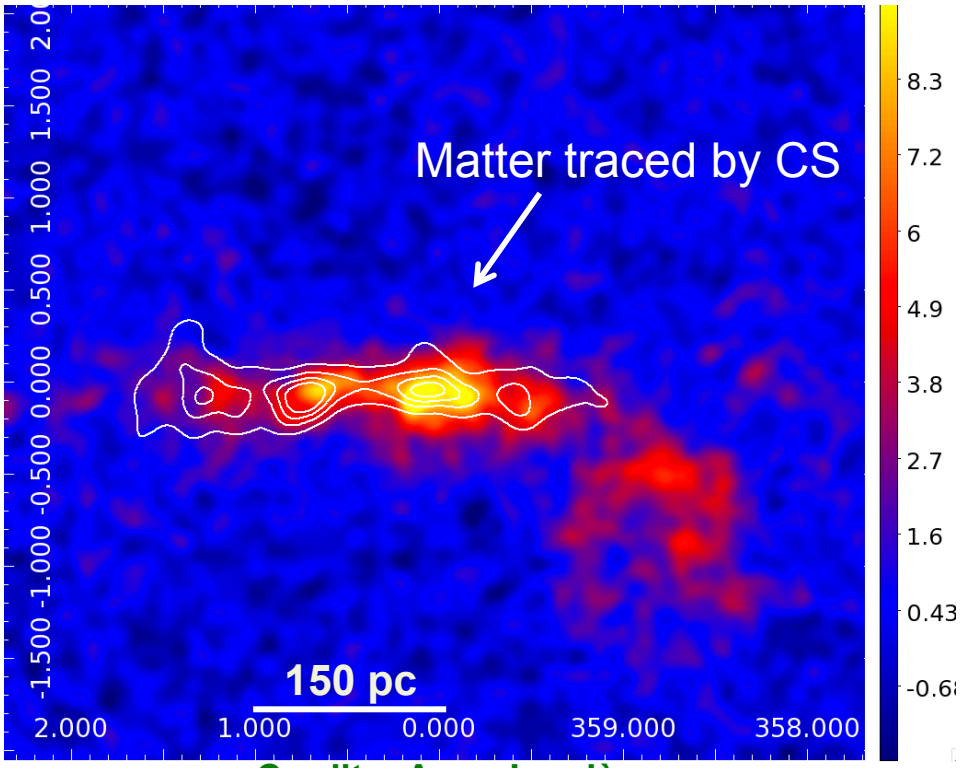
ORIGIN OF THE VHE COSMIC RAYS EXCESS IN THE CENTRAL 100PC OF THE MILKY WAY

Lea Jouvin, Anne Lemière et Regis Terrier

Excess of VHE cosmic rays in the Galactic Center

H.E.S.S. (100 GeV -100 TeV)





Credits: Anne Lemière

After subtracting the brightest TeV sources:

-> diffuse hadronic emission

-> CRs energy density: 3-9 times higher than the local one and harder spectrum (Γ=2.3)

A unique accelerator in the central pc?

H.E.S.S. collaboration (2016): **stationary source** at the center

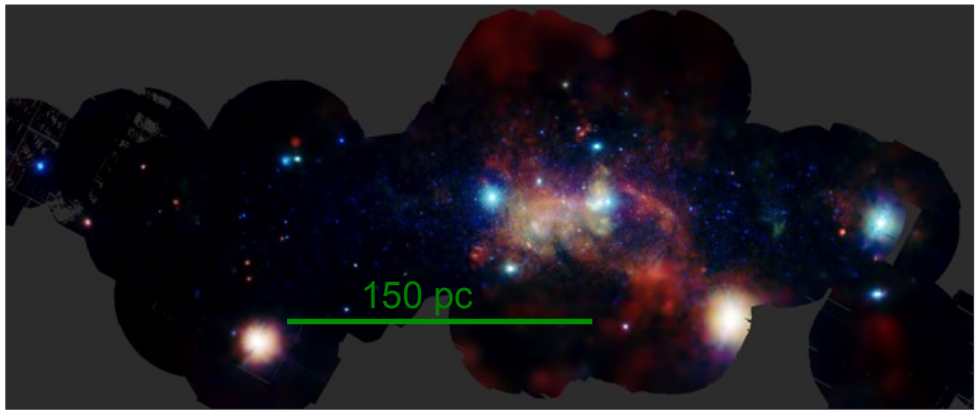
➔Require power: **10^{38} erg s^{-1}**

SgrA*: Dissipated power: 10^{39} erg s^{-1} (Wang et al ,2013)

➔ Good candidate for CR acceleration

Or Multiple CR impulsive injections

- Galactic Center:
  - High supernova (SN) rate: 10^{-4}-10^{-3} yrs^{-1}
  - **$\dot{E}_{SN}$=3.2×10^{39} – 3.2×10^{40} erg s^{-1}**



What is the impact of these SNRs on the CR density and VHE emission in the GC?

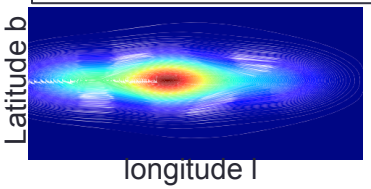
A simple time dependent 3D model CR injection and gamma-ray production

CRs injection (1)
(power law : $Q=N_oE^{-a}$)
Single stationary accelarator or multiple impulsive accelerators with a real spatial distribution

Propagation (2)
(Diffusion)

Production of γ-rays (3)
(Realistic 3D matter spatial distribution, cross section for p-p interaction)

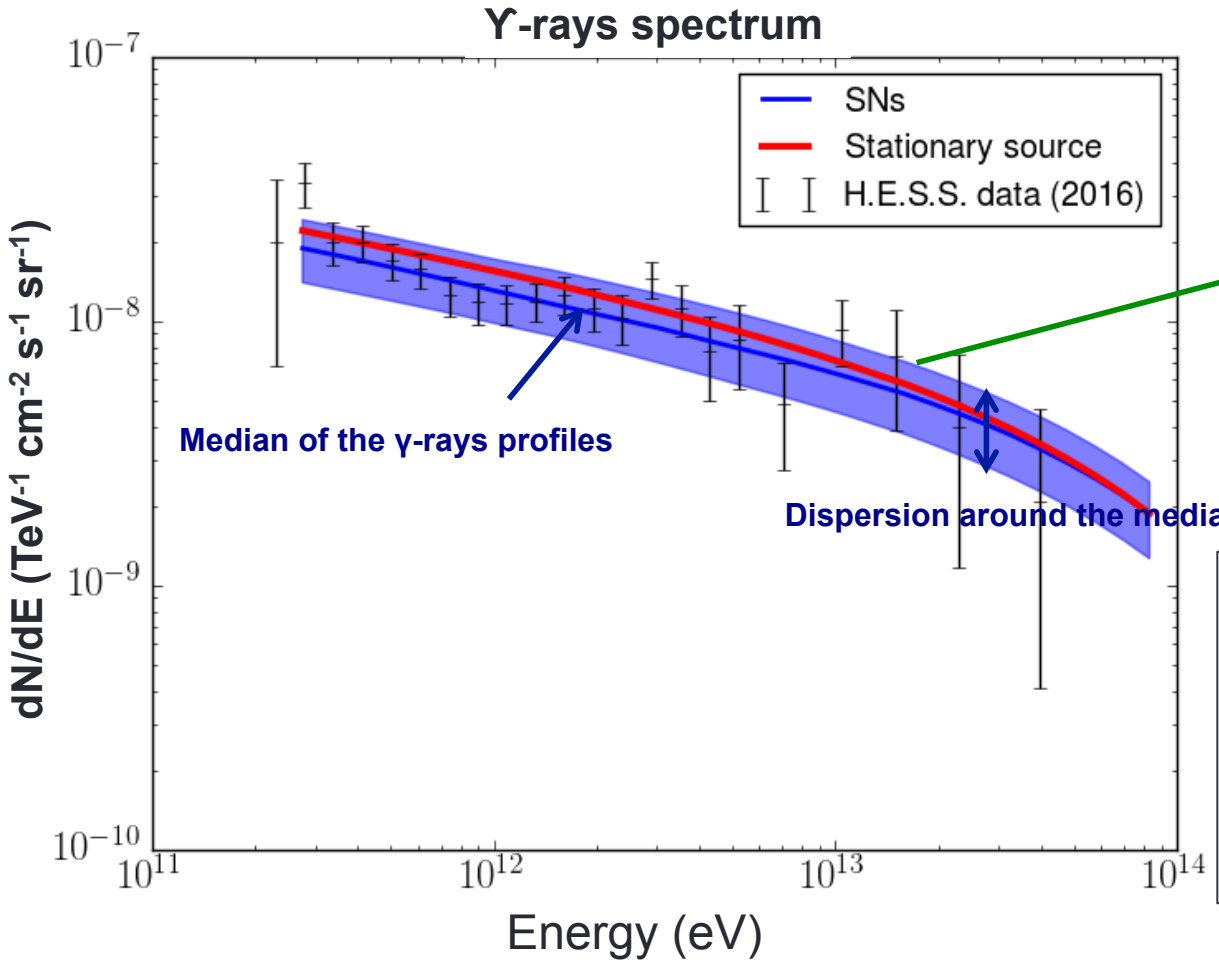
Spectrum and map of the resulting diffuse emission

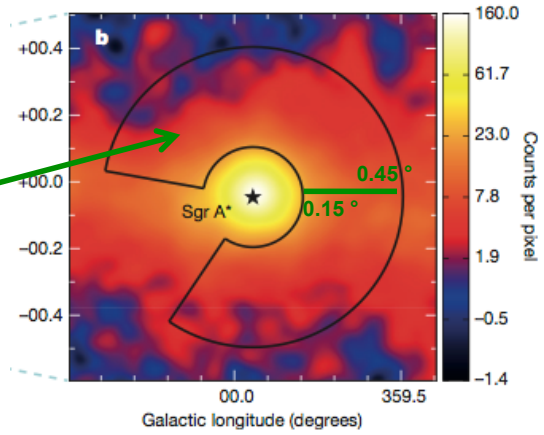


H.E.S.S. published data

Contrains on the CR injection and propagation in the GC

γ-rays: spectral distribution





SNs:

E_{SN}: 10^{51} erg

Efficiency for CR acceleration: 2%

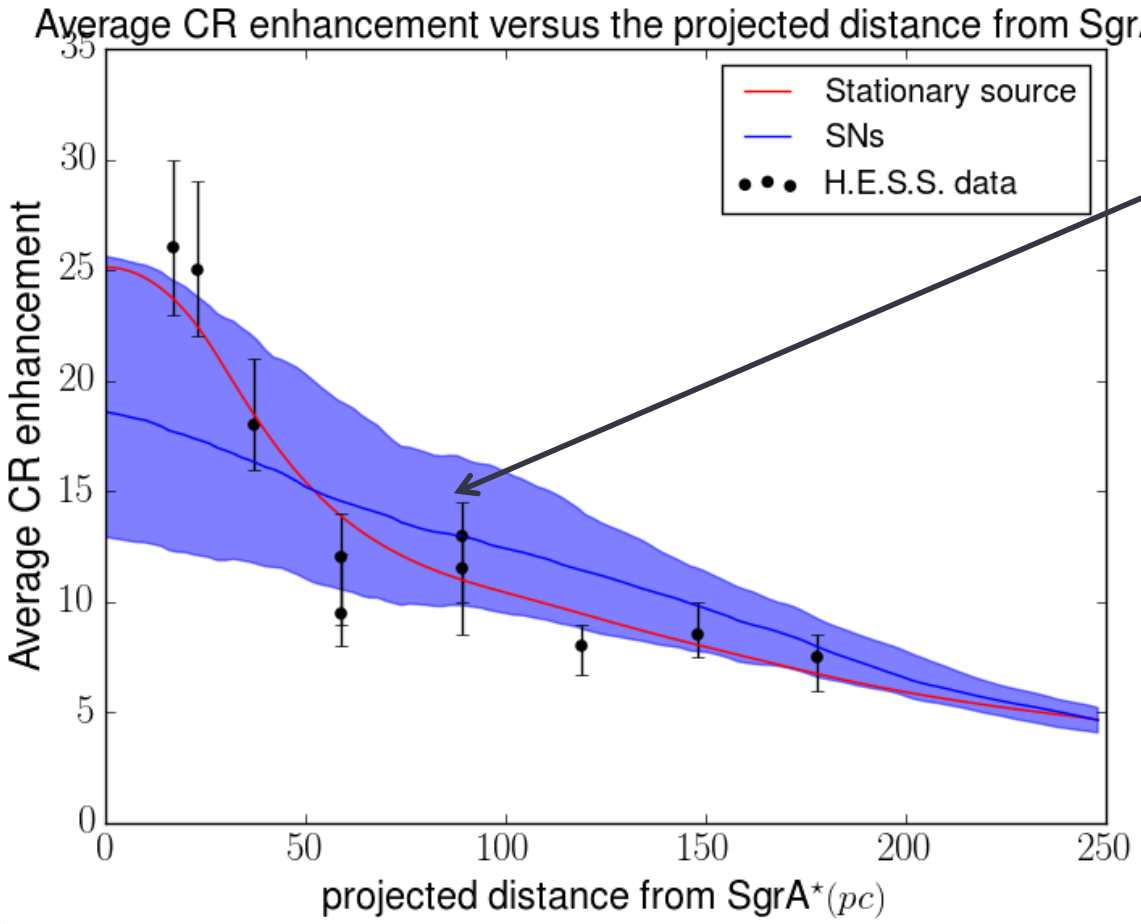
Stationary source:

Require power: **10^{38} erg s^{-1}**

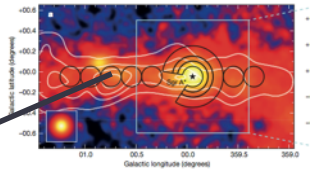
Credits: Jouvin et al 2016, submitted

Even with low acceleration efficiency: SNs alone can reproduce the total spectrum

CR density profile



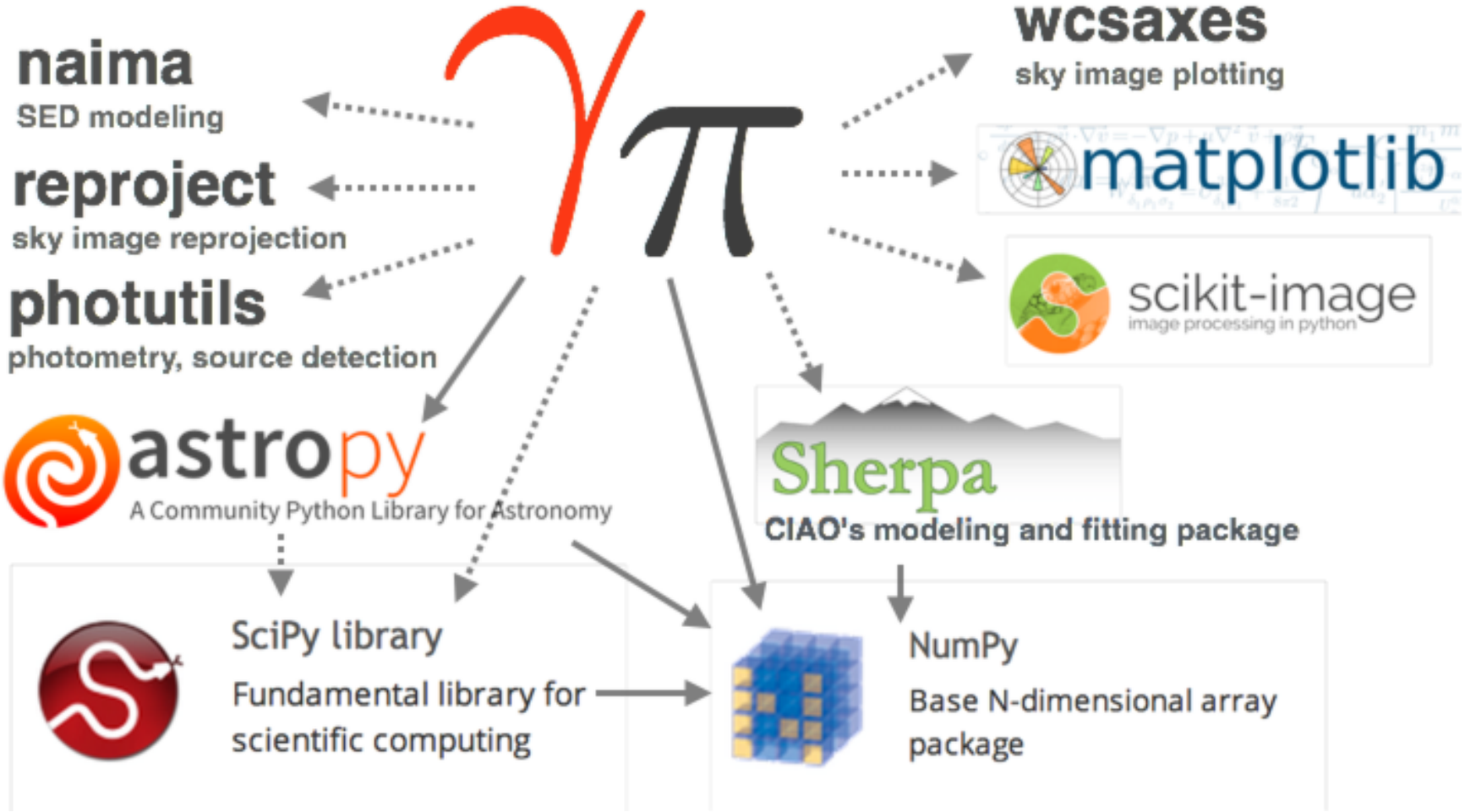
Credits: Jouvin et al 2016, submitted



Credits: H.E.S.S. collaboration
Abramowski **et al., 2016**

- At distance >30pc: *both model can explain the data*
- Central excess seems difficult to be reproduced by the SNRs alone
- Stationary source alone*: why SNRs doesn't accelerate CR in the GC?*

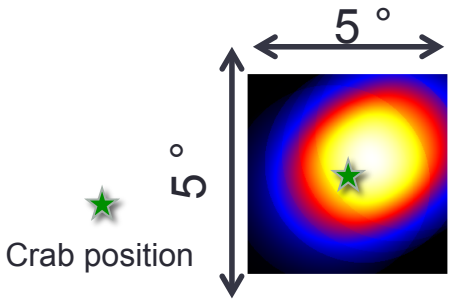
3D spectral analysis



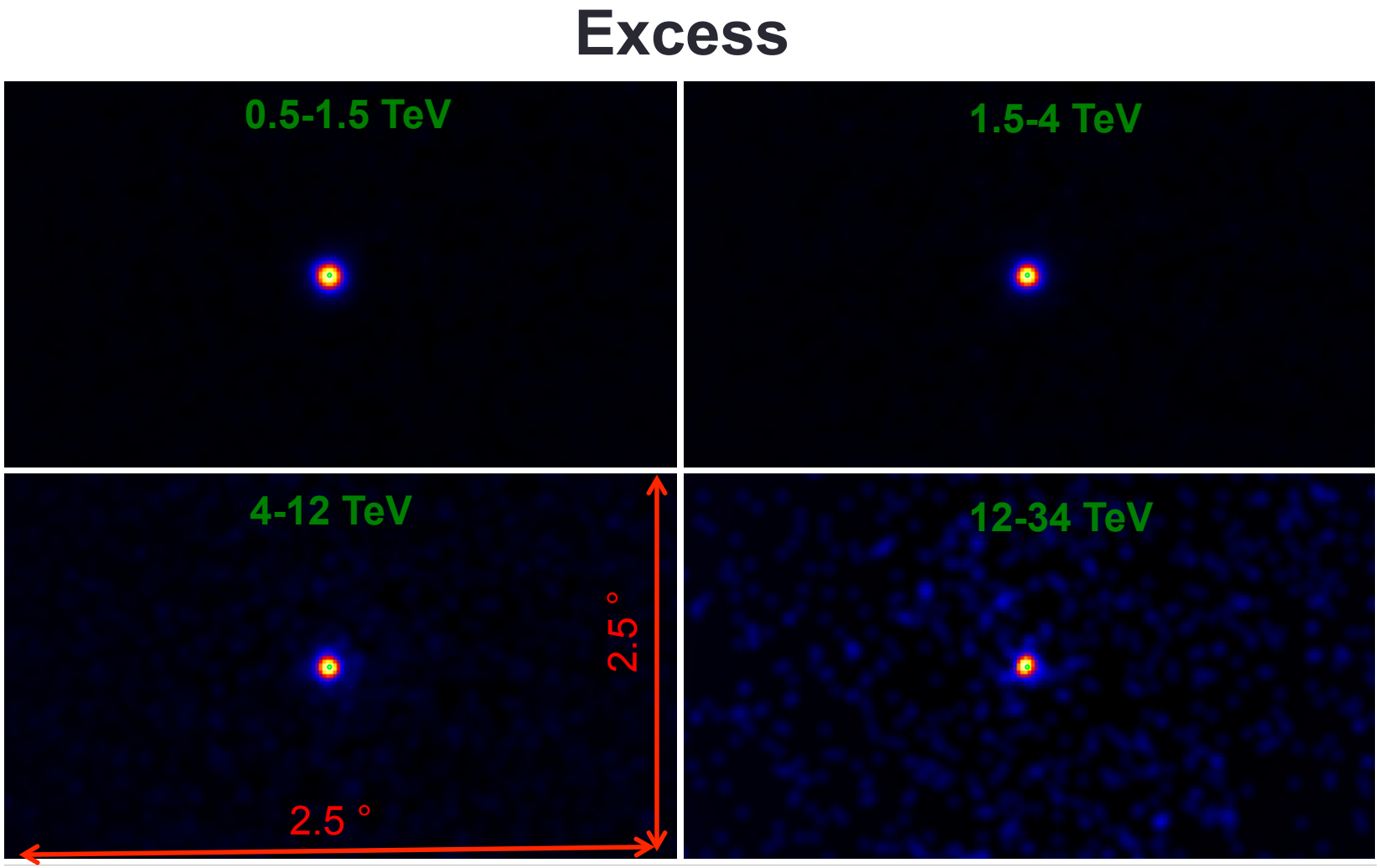
Is the ridge emission morphology energy dependent?

- Key point:
  - Is stationary source dominant at all energies? Are there other contributions?
  - Are there variations of the spectrum with position in the region?

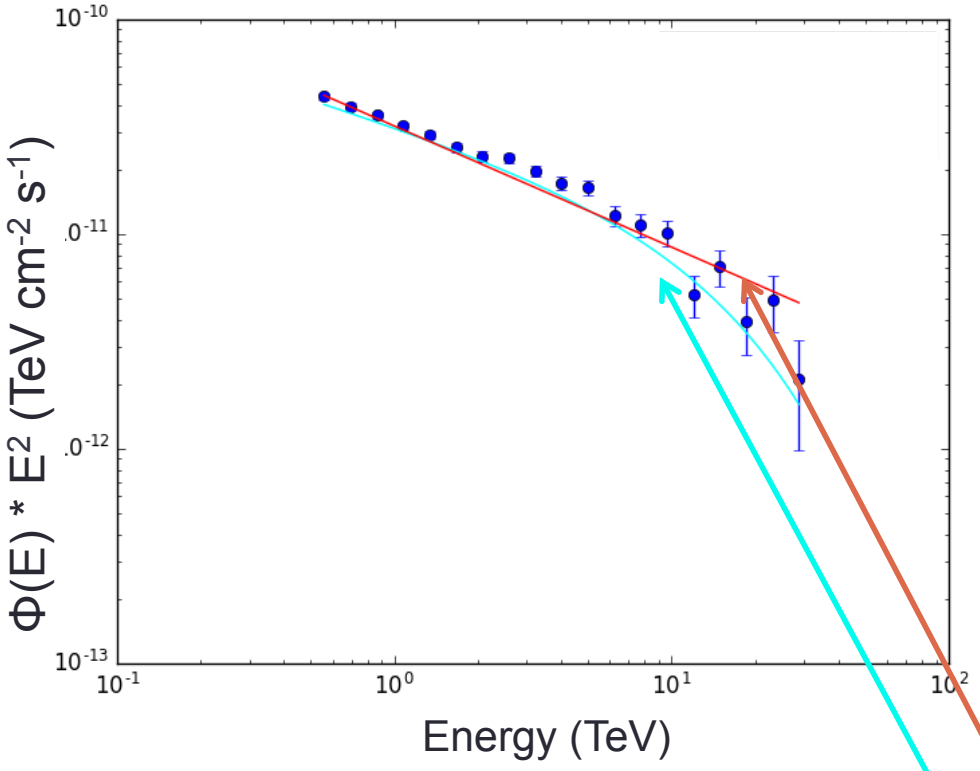
- Approach:
  - Open source tool (GAMMAPY)
  - Develop background model whatever the energy band based on AGN runs:



Crab images (≈18 h)



Crab: 0.5-40 TeV, 20 images



3D analysis;

For a point like source image:

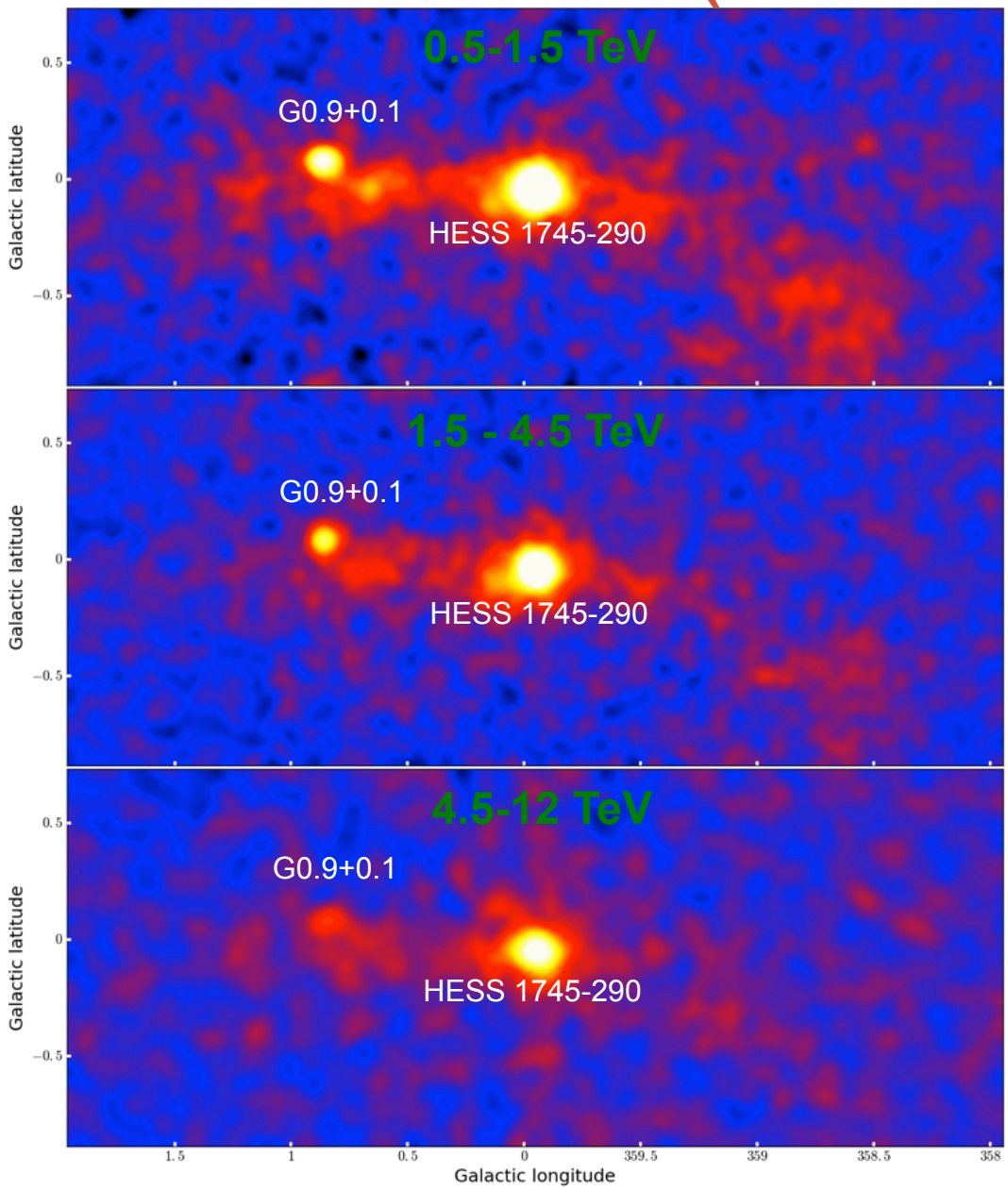
On=OFF + (exposure*($\mathbf{a_1}S_1$))*PSF***$\Phi(E)$**

Spectral component:

-$\Phi(E)=\Phi_0 (E/E_0^{-a})$

-$\Phi(E)=\Phi_0 (E/E_0^{-a}) * \exp(-E/E_c)$

Galactic Center (≈240 h)



GC ridge emission: Residual Map

Subtraction of the GC source + G0.9