



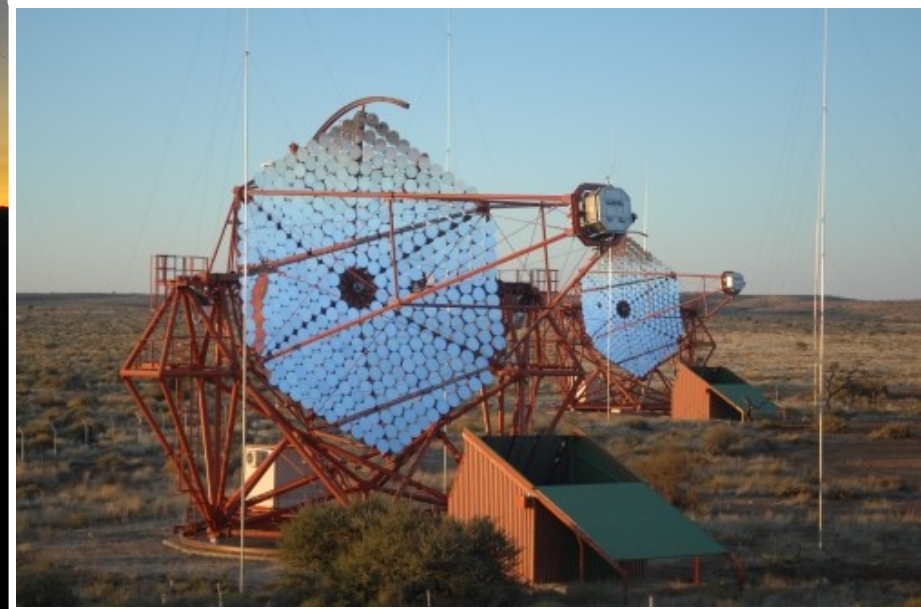
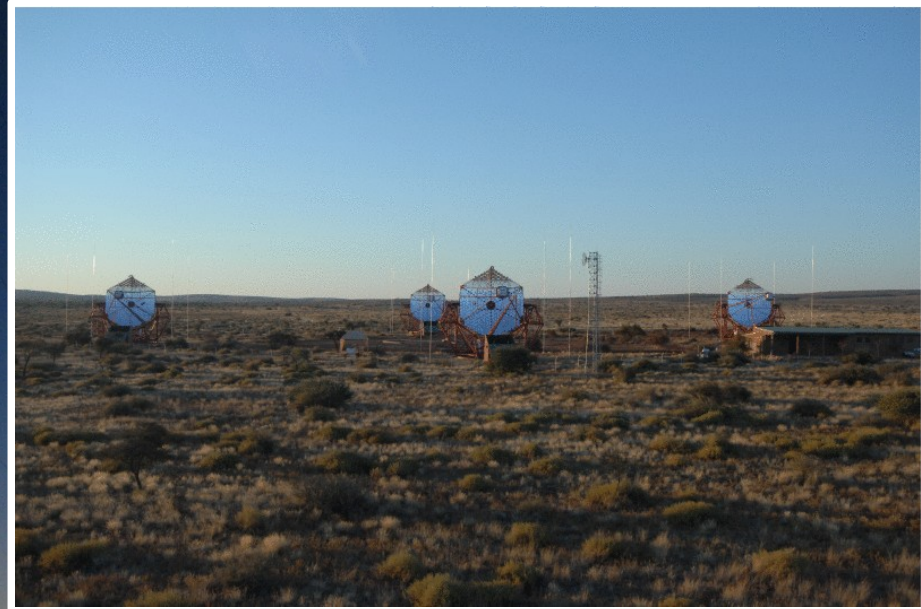
# The VHE gamma-ray sky by H.E.S.S.

Armand Fiasson  
Post-doc LAPP



# The High Energy Stereoscopic System (H.E.S.S.)

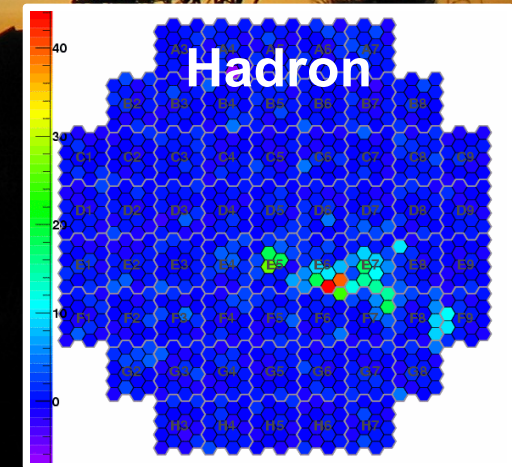
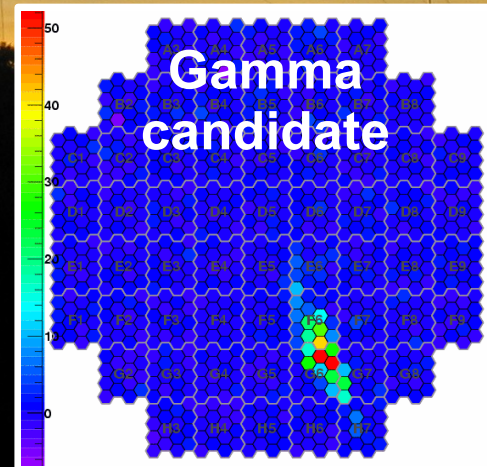
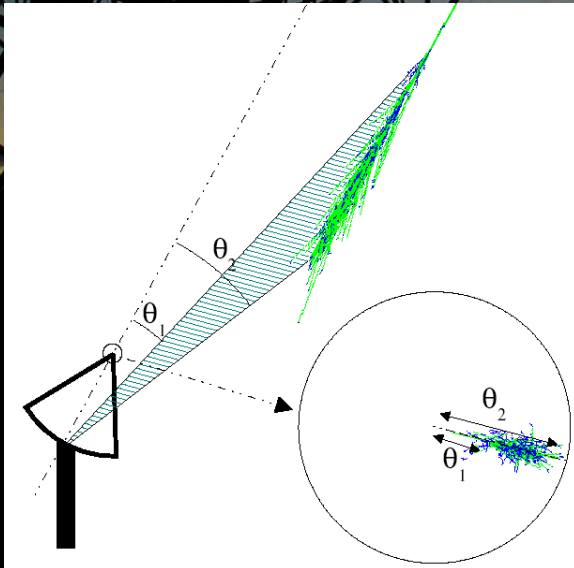
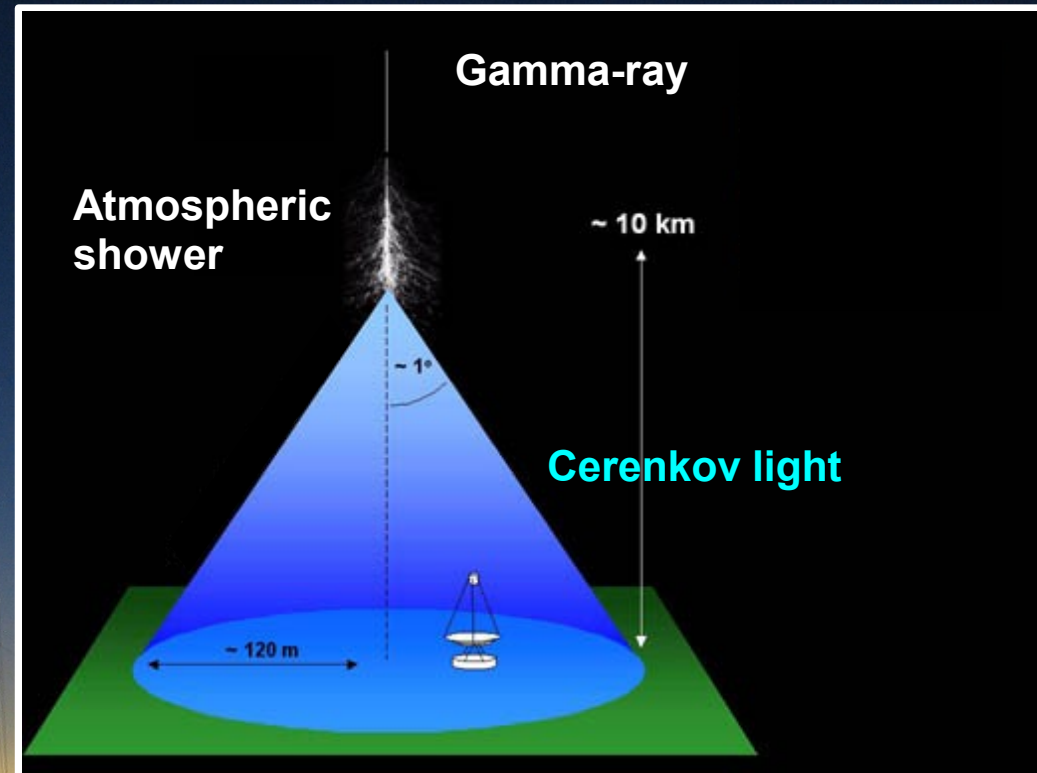
- **Array of 4 Imaging Atmospheric Cherenkov Telescopes**
  - Detects the Cherenkov light from atmospheric showers
  - Stereoscopic mode
  - Large field of view:  $5^\circ$
  - Energy range: 100 GeV to a few 10 TeV
  - Résolution:  $\Delta\theta \sim 0.1^\circ$  and  $\Delta E/E \sim 16\%$
- **Located in the Khomas Highlands of Namibia**
  - Southern hemisphere
    - => Ideal position to observe the inner Galactic plane
- **Construction completed in December 2003**
  - => more than 5 years in full operation mode





# The H.E.S.S. experiment

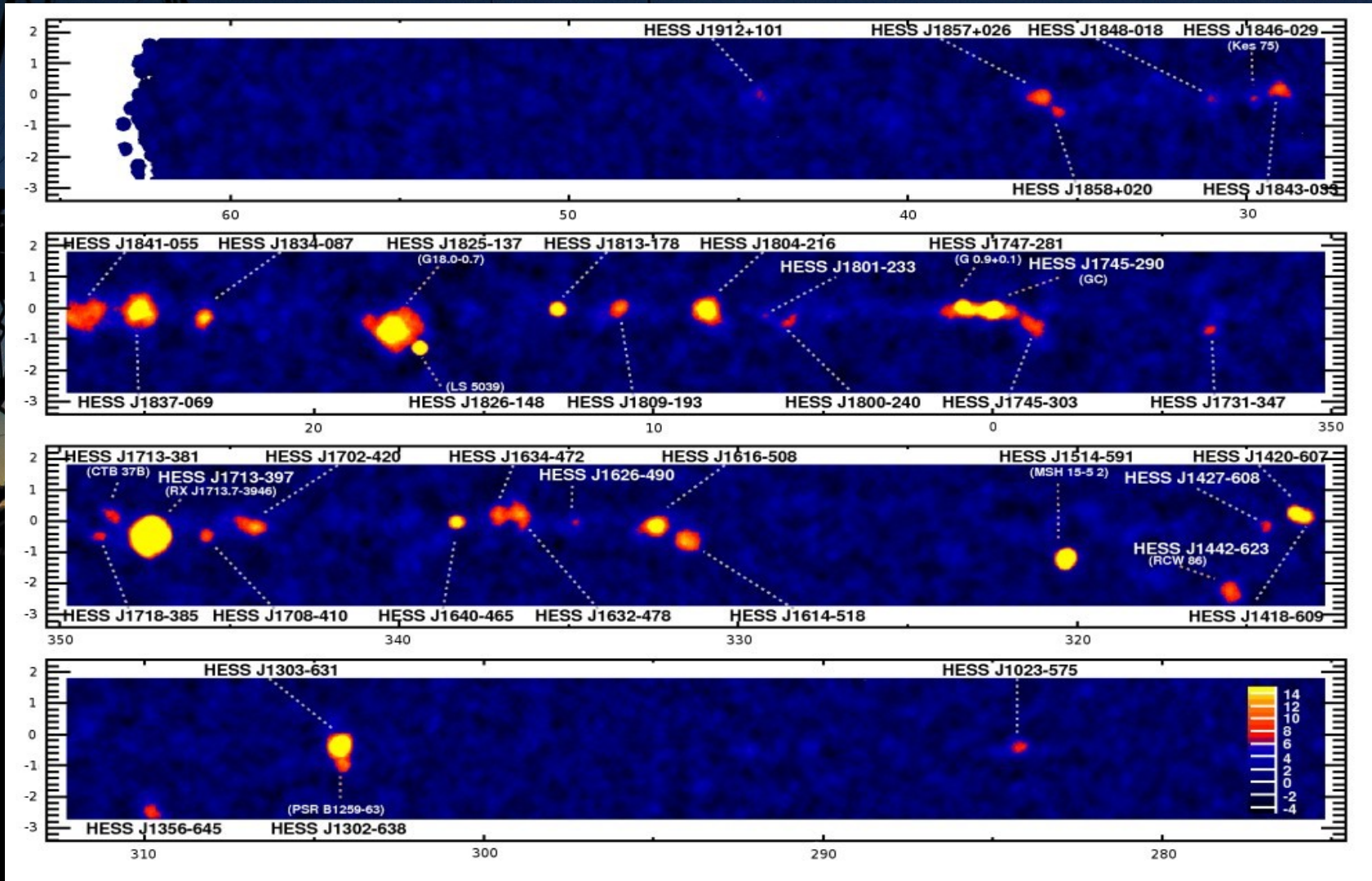
- **Ground based telescopes**
  - Atmosphere as a calorimeter
  - Shower Cerenkov light visible from the ground
- **Imaging Atmospheric Cerenkov Telescope:**
  - Shower image at the focal plane





# The VHE gamma-ray sky by H.E.S.S.

- Systematic survey of the inner galactic plane conducted since 2004
  - Almost half of the Galactic disc surveyed between  $-3^\circ$  and  $+3^\circ$  of latitude





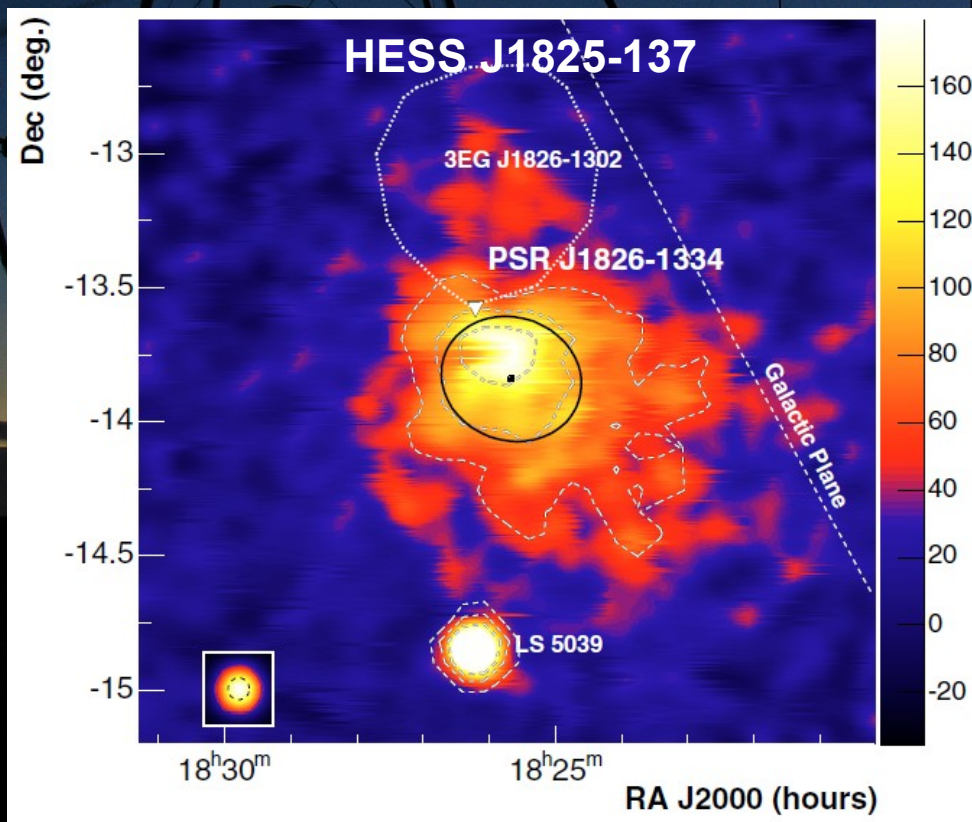
# Which sources are detected?

- **VHE gamma-rays are tracers of non-thermal particle acceleration within our Galaxy**
  - Neutral pions decay after deep inelastic proton-proton scattering
  - Inverse Compton of electrons (CMB, dust radiation, stellar radiation fields...)
- **Most of the identified new sources are related to supernova remnants**
  - Pulsar wind nebulae
    - Acceleration of the electron wind from the pulsar accelerated within its terminal shock
  - Shell type supernova remnants
    - Particle acceleration through Fermi mechanism
- **Some of the new sources remains unidentified**
  - Mostly extended sources along the Galactic plane
  - No obvious counterparts at other wavelengths
  - No candidate from where VHE gamma-ray emission is expected

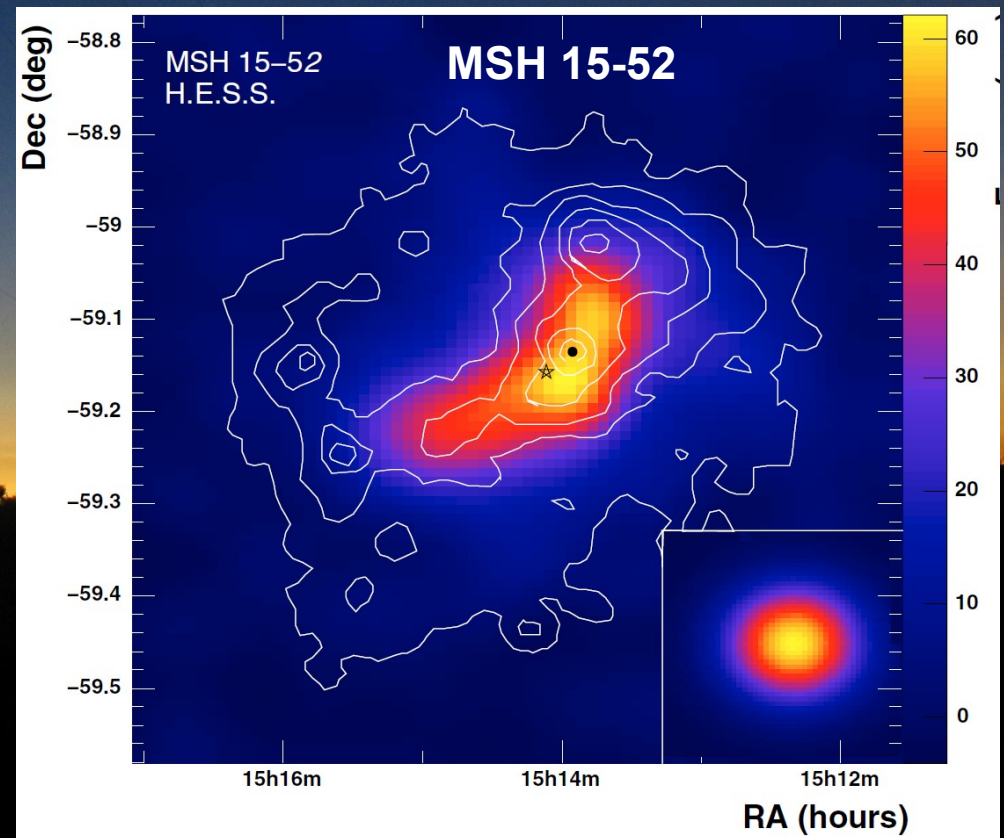


# Pulsar wind nebulae

- An important fraction of the H.E.S.S. Sources are associated with PWN  
G0.9+0.1, Crab Nebula, MSH 1552, VelaX ...
- Association with known pulsars or PWN without pulsars detected  
=> the largest class of the HESS Galactic sources



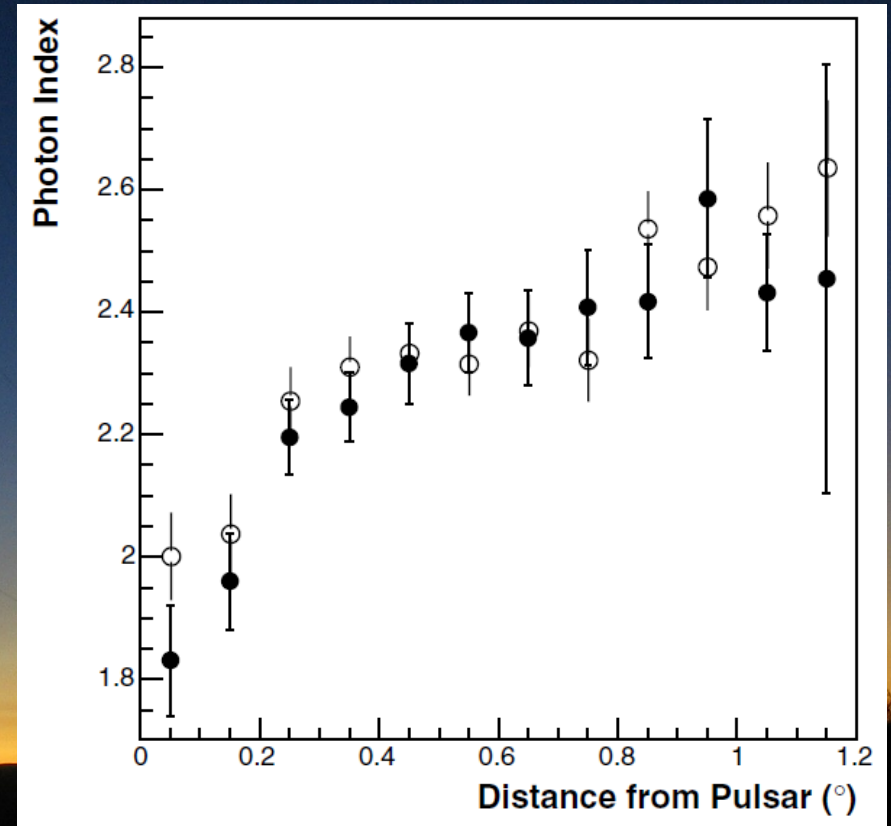
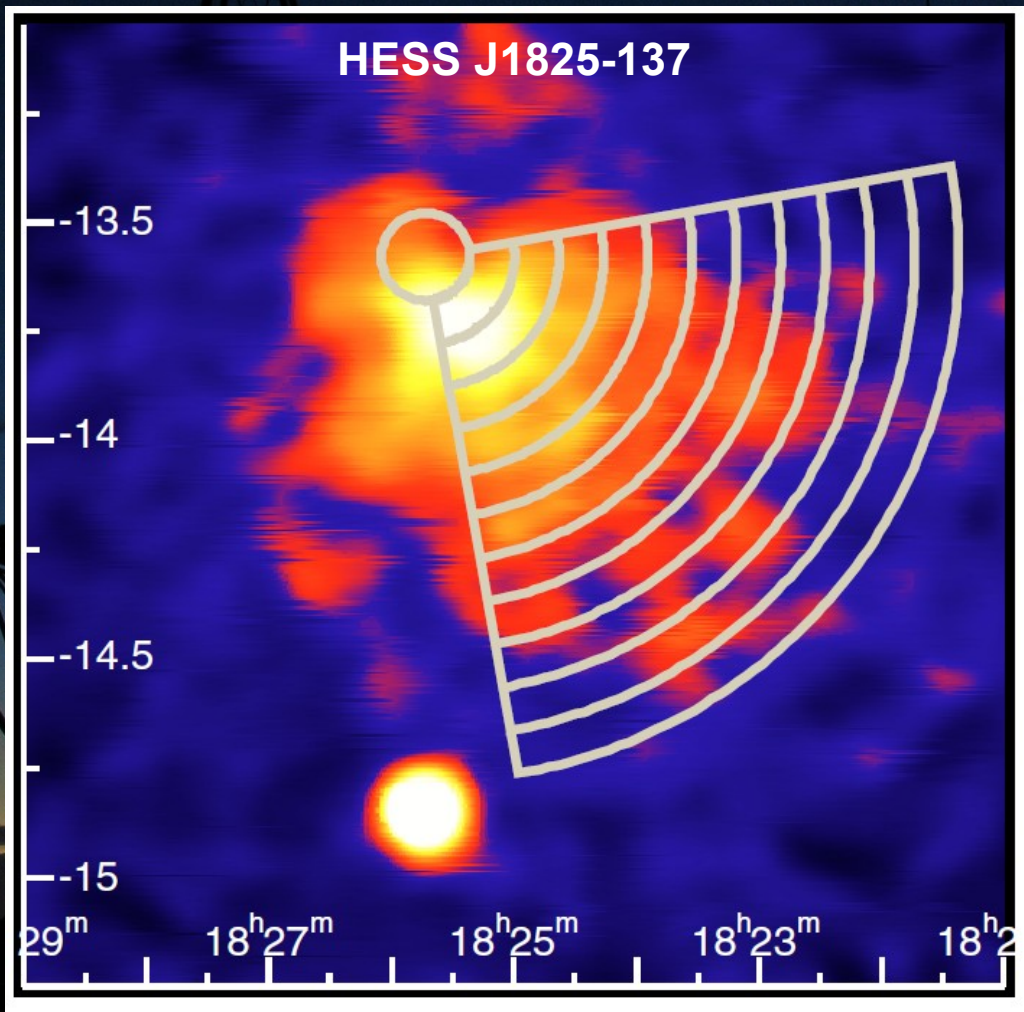
[Aharonian et al. A&A 460 365A 2006]



[Aharonian et al. A&A 435 17 2005]



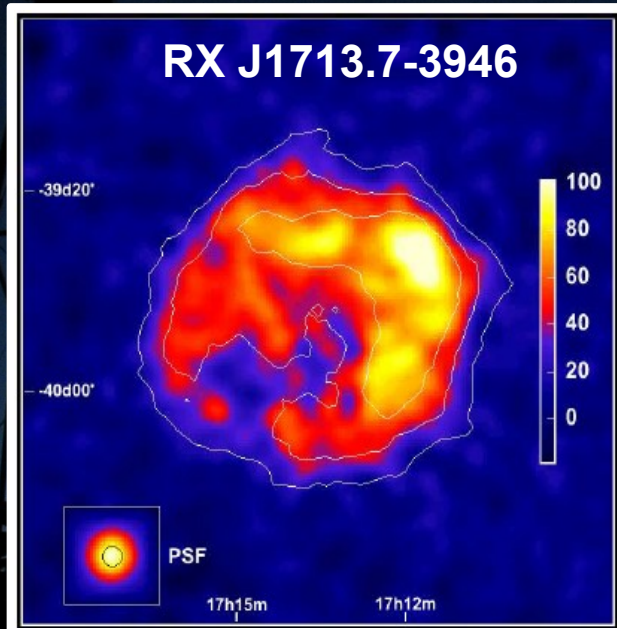
# Leptonic accelerators



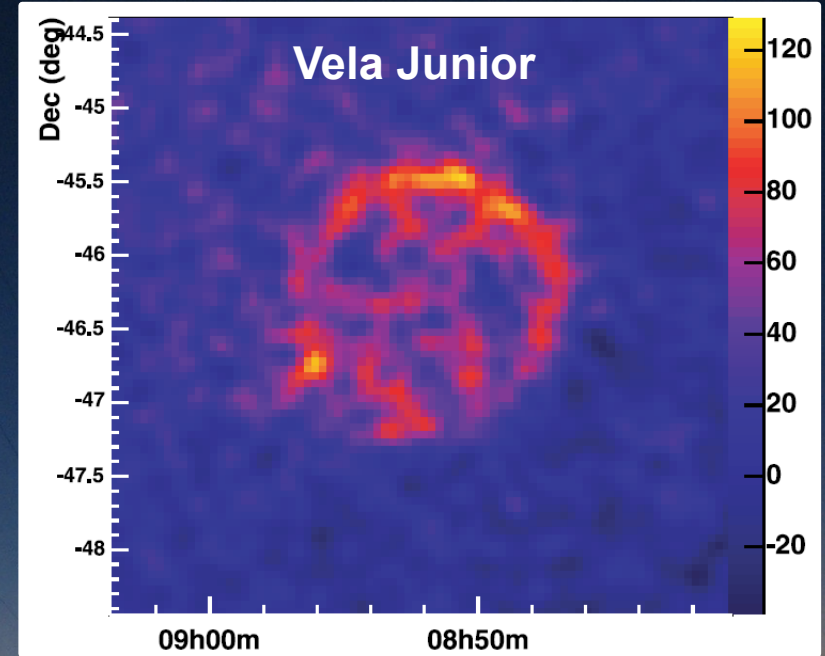
- Radiation losses of the accelerated electrons deduced from the gamma-ray flux  
=> steepening spectrum with increasing distance to the pulsar
- Gamma-ray flux of order of 1% of the spin-down luminosity of the pulsar



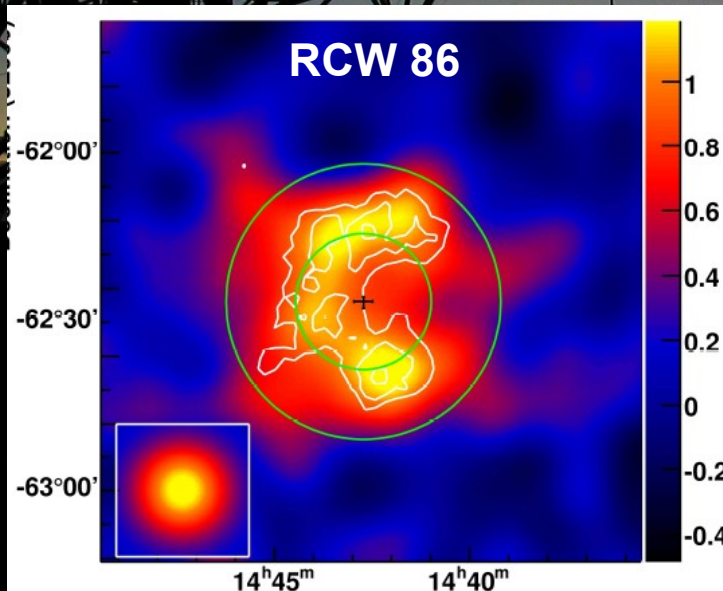
# Shell-type supernova remnants



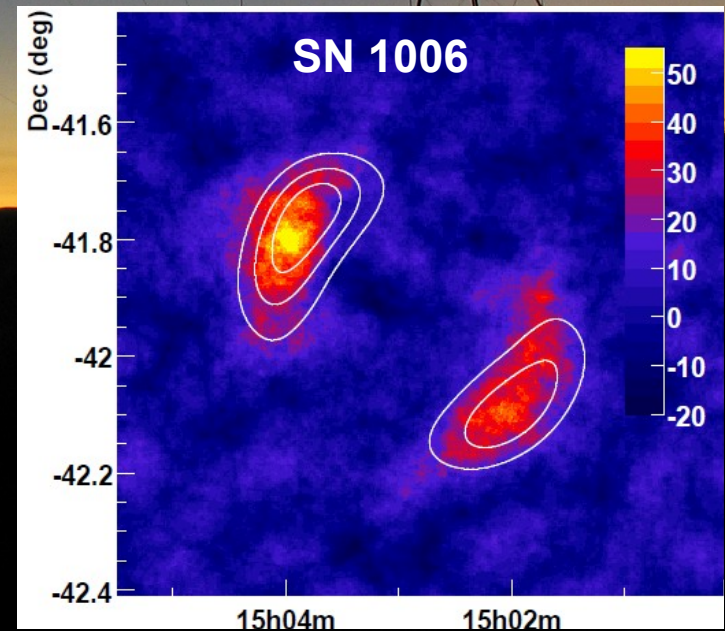
[Aharonian et al. A&A 464, 235 2007]



[Aharonian et al. ApJ 661, 236 2007]



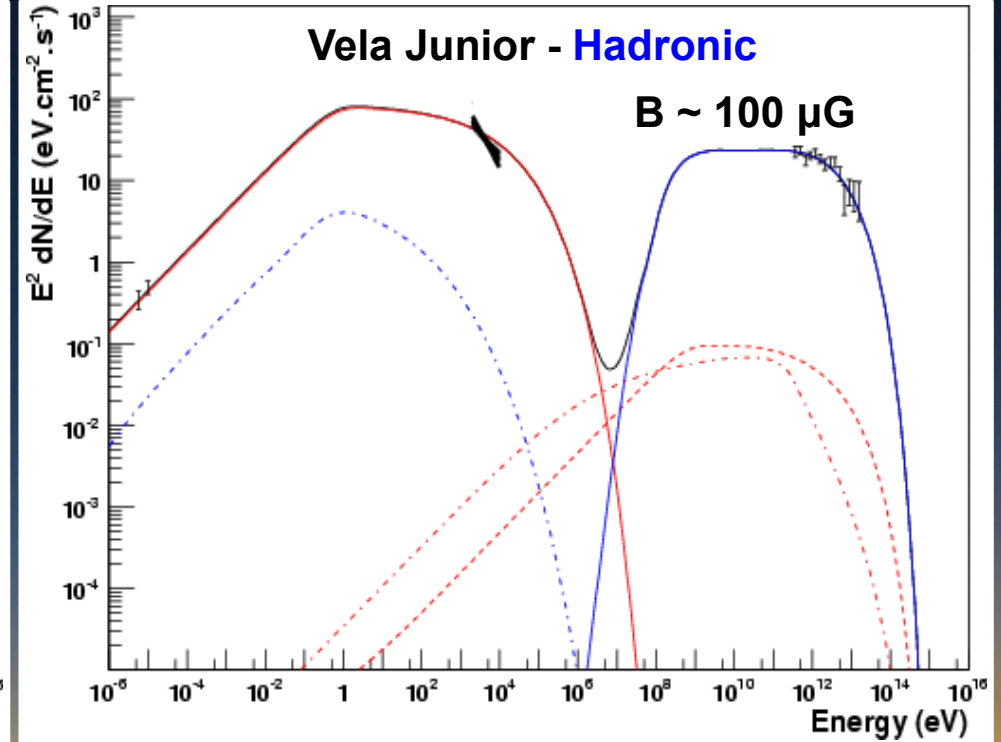
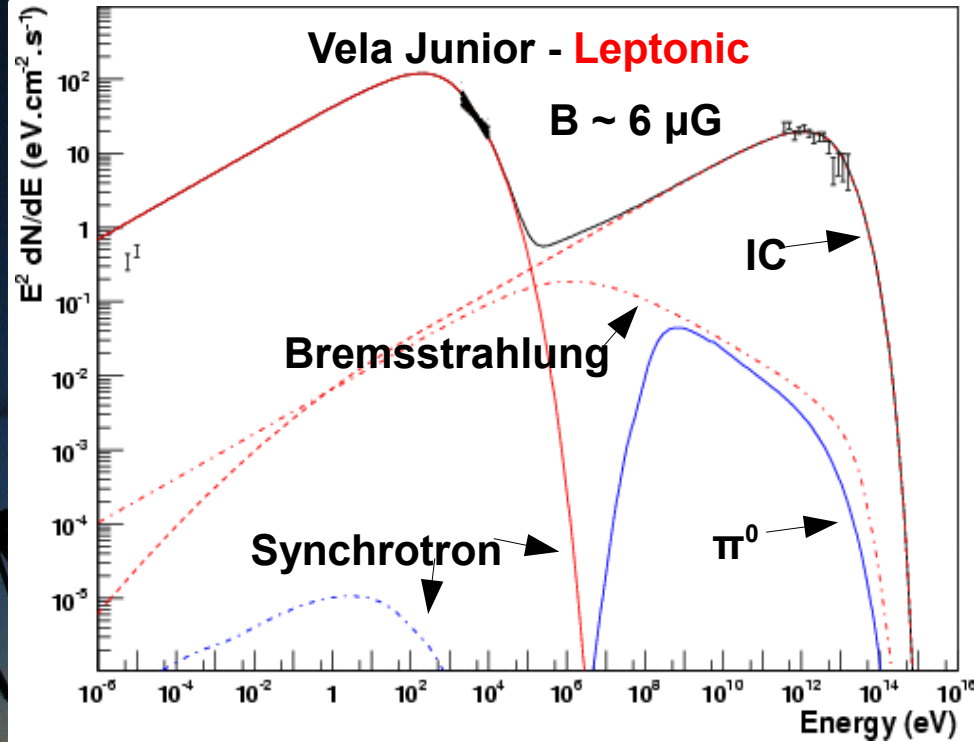
[Aharonian et al. ApJ 692, 1500A 2009]



[M. Naumann-Godo et al. 2009]



# Hadronic accelerators?



[Aharonian et al. ApJ 661, 236 2007]

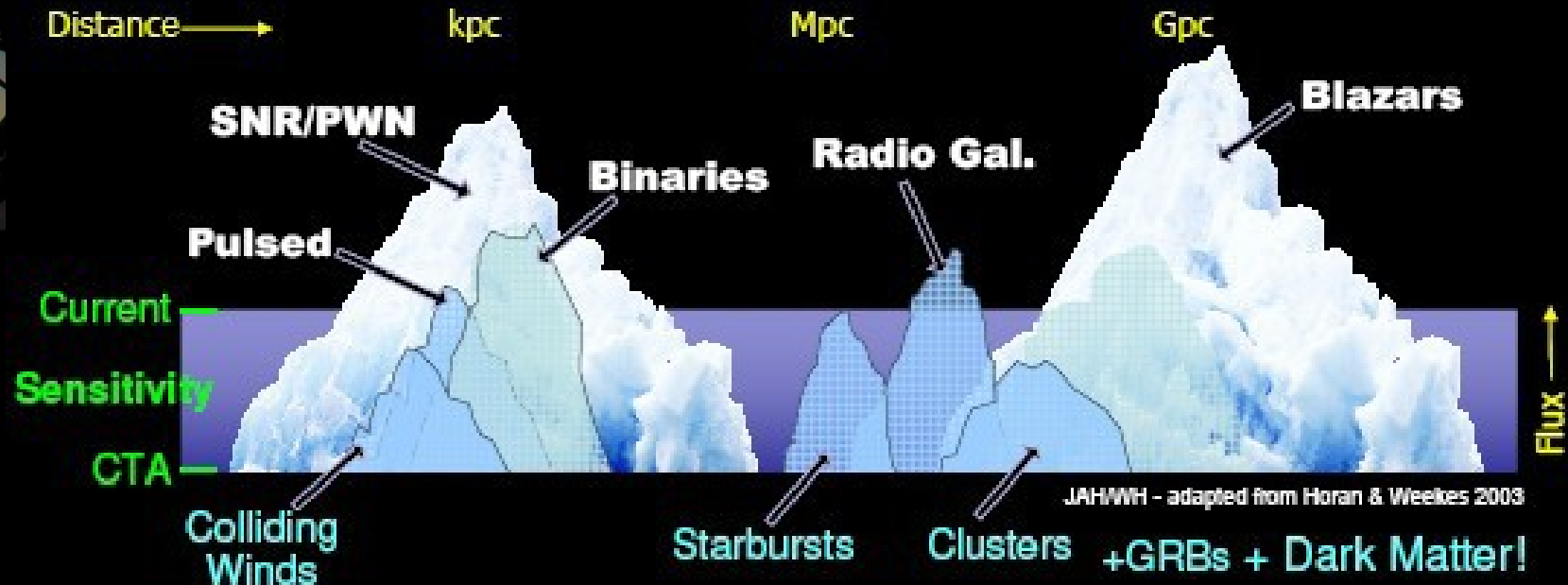
- **Spectrum = Powerlaw with spectral index close to 2 up to 30 TeV**  
=> confirm the acceleration of particles with  $E > 10^{14}$  eV
- **The nature of particle remains unidentified**
  - Electrons in a low intensity magnetic field ( $\sim$  a few  $\mu\text{G}$ )
  - Hadrons in a higher magnetic field ( $\sim 100 \mu\text{G}$ , predicted by theoretical models)



# What about diffuse emission with HESS?

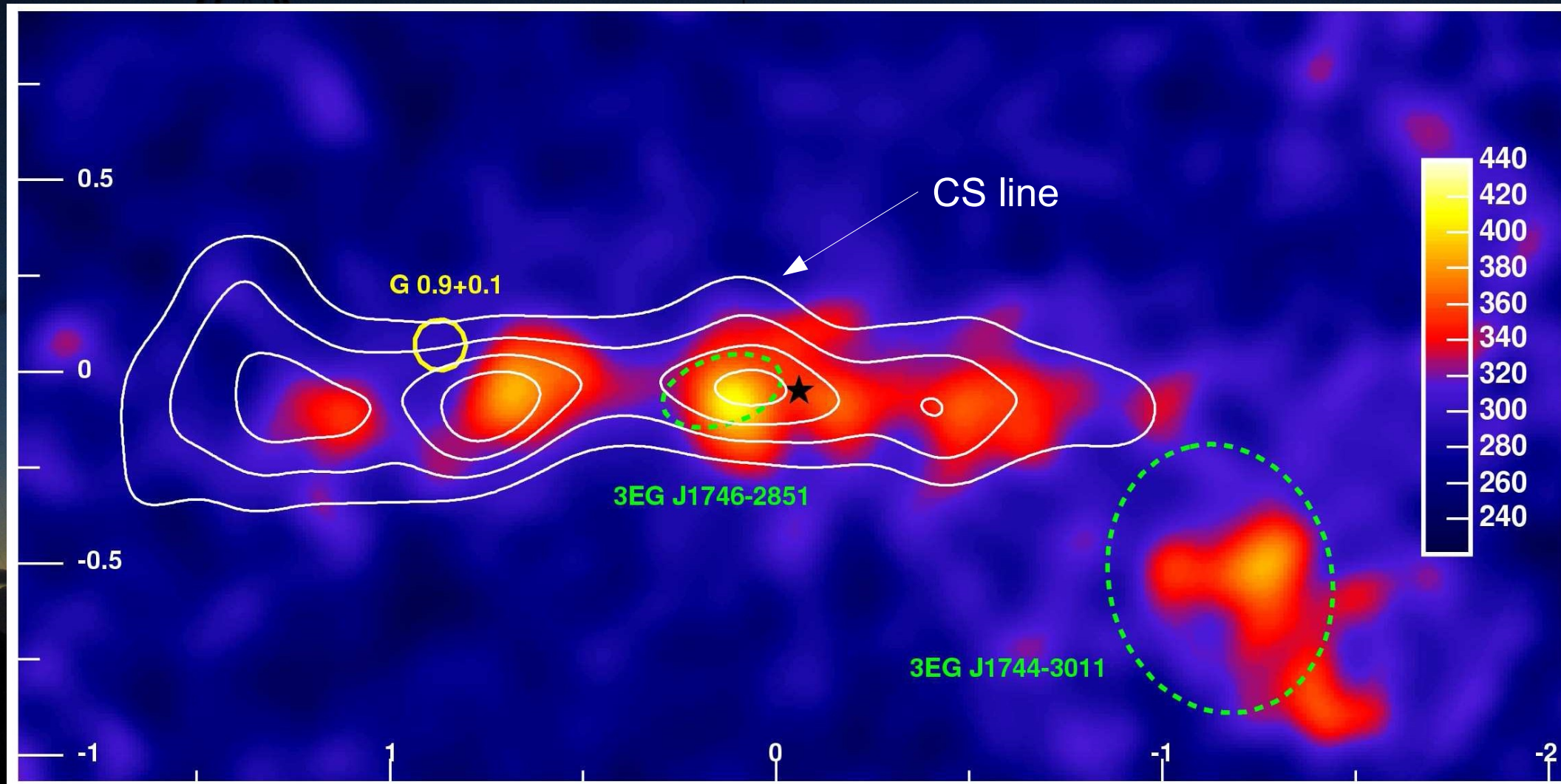
Chaves et al. HESS (2008)

- The current sensitivity and energy threshold of HESS-I do not allow to access to the diffuse emission  
=> We detect only the top of the iceberg
- However some premisses of diffuse emission can be found within HESS observations





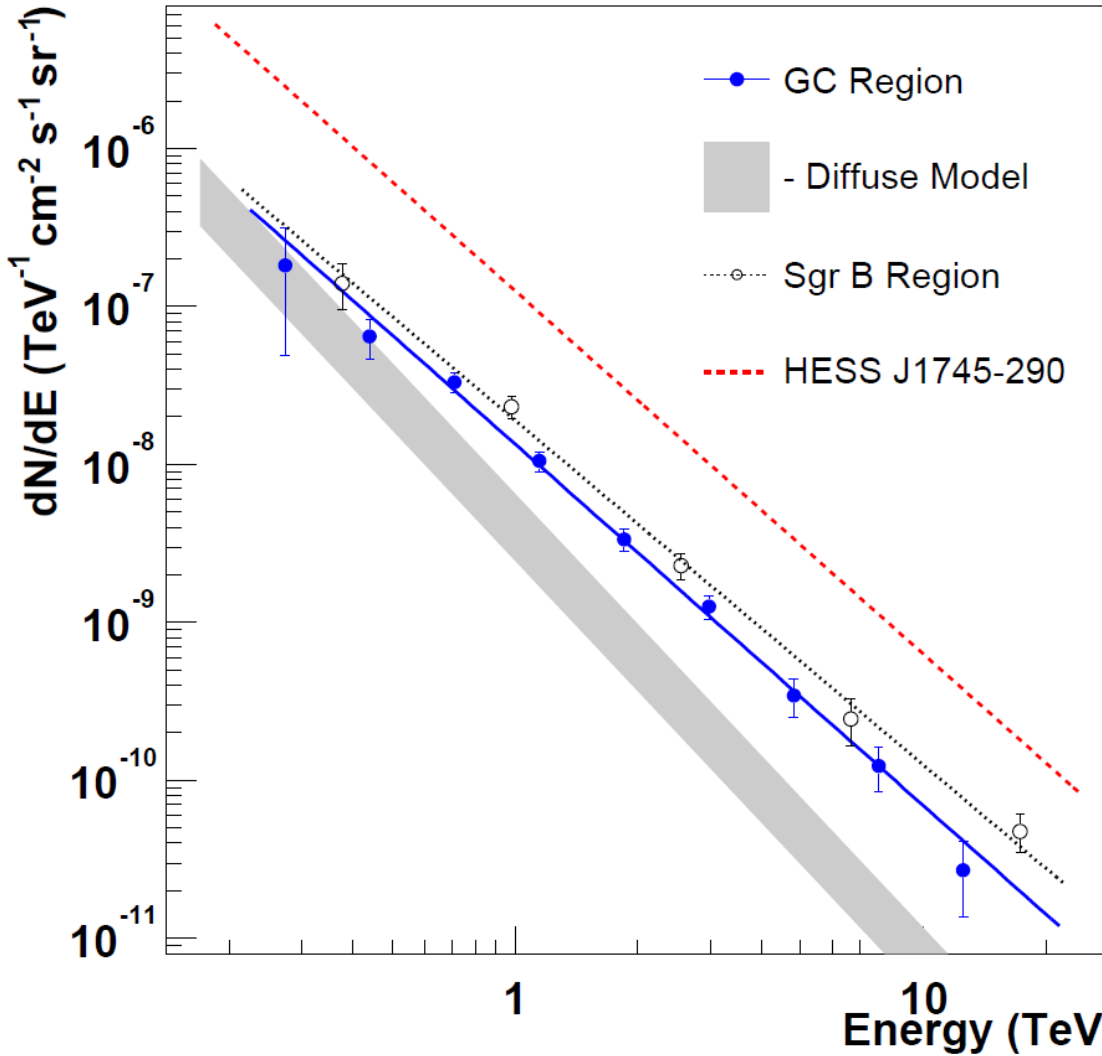
# The Galactic center ridge



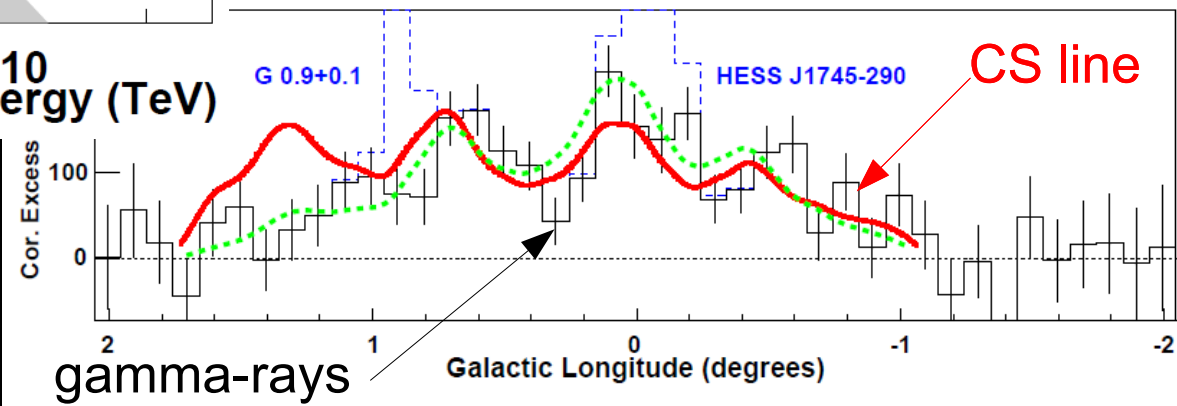
[Aharonian et al. Nature 439 695 2006]



# The Galactic center ridge

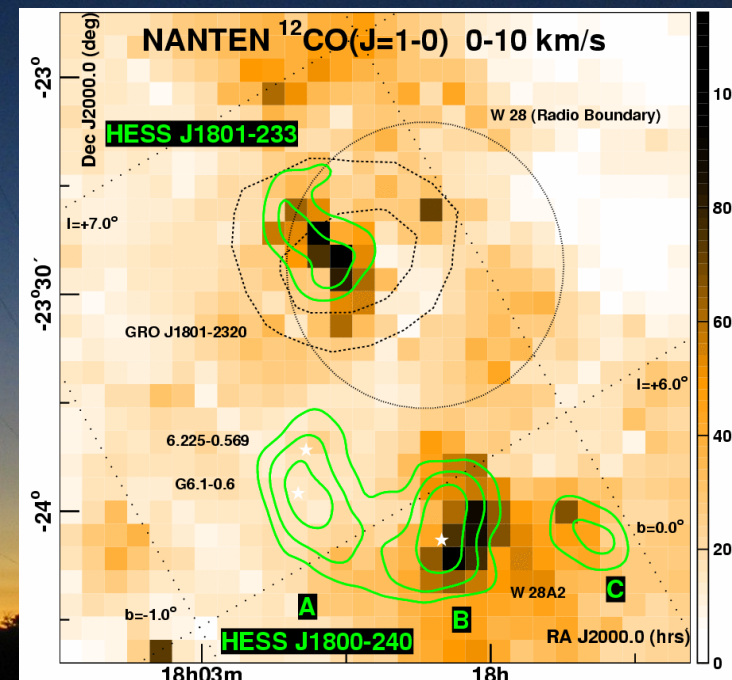
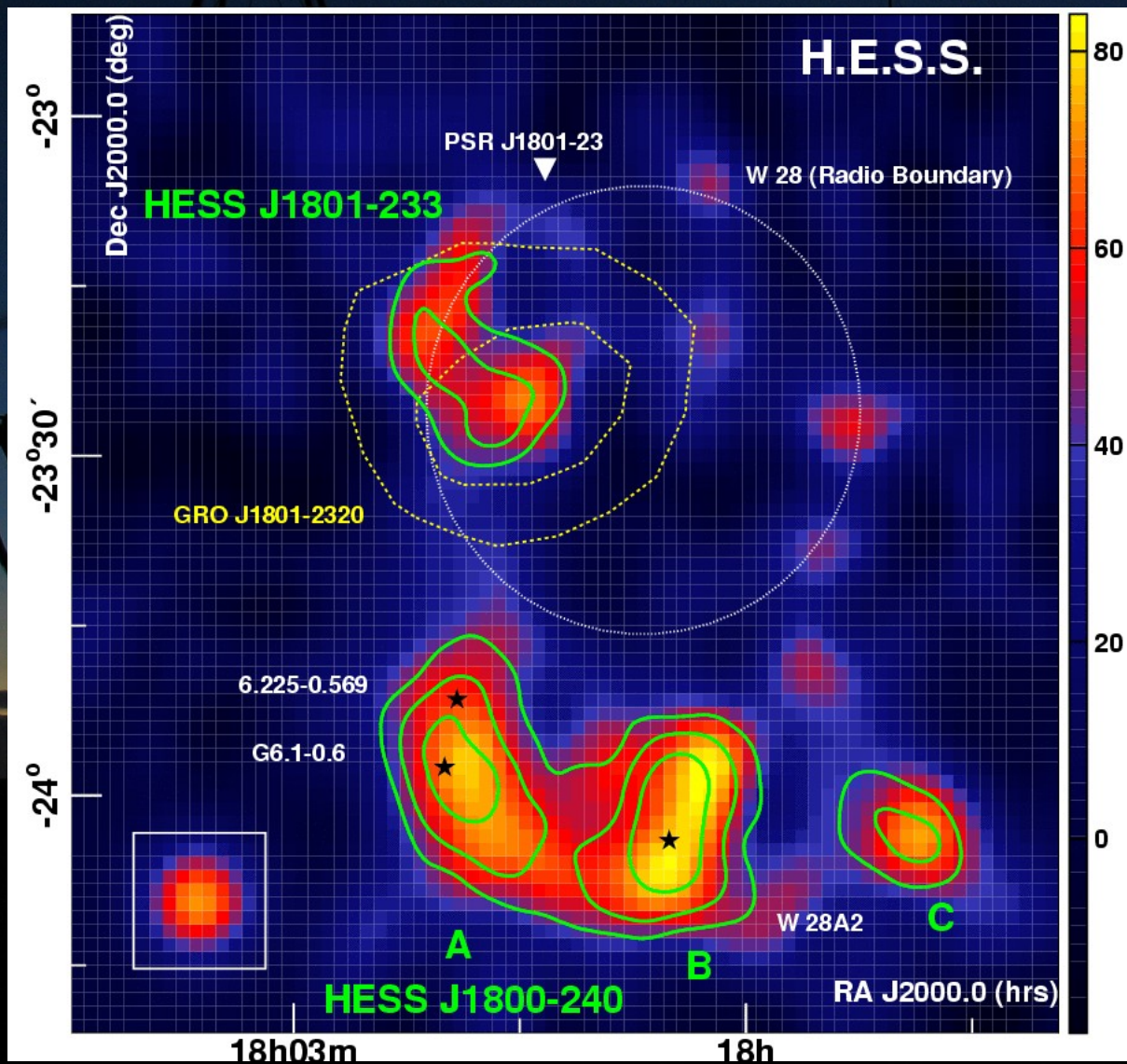


- **Additional component to a diffuse model**  
 => freshly accelerated particles
- **More likely protons**  
 => 1 SNR could explain the gamma-ray flux





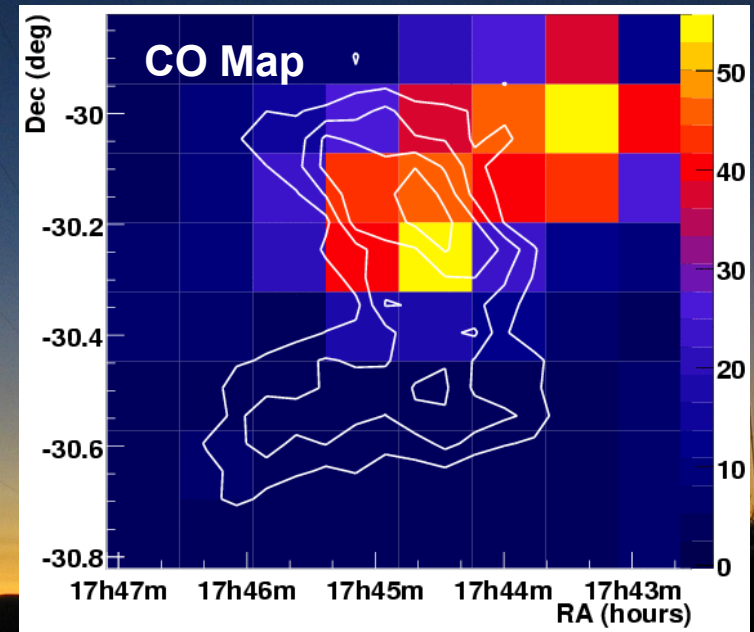
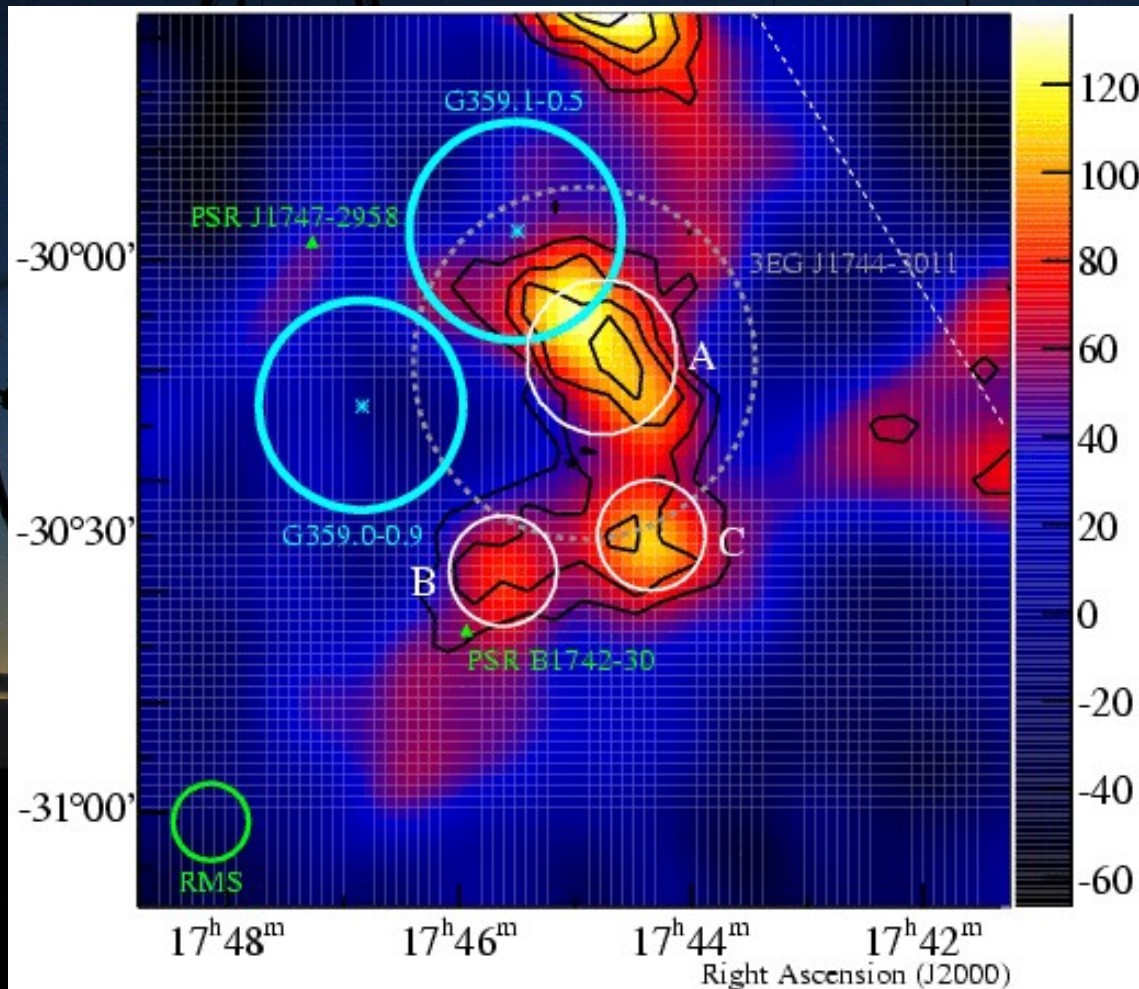
# Cloud with identified accelerator: W28



[Aharonian et al. A&A 481 401 2008]



# A second example: HESS J1745-303



[Aharonian et al. A&A 483 509 2008]

- **Growing class** => HESS J1714+385 and the recently discovered source HESS J1923+141 could be associated with a molecular cloud



# Summary

- **The H.E.S.S. Experiment, with its high sensitivity, is ideally located to observe the inner part of the Galactic plane**
- **The Galactic plane survey, conducted since 2004, is successful**
  - => more than 20 point-like or slightly extended sources discovered
- **Several supernova remnant have been detected**
  - Shell-type SNRs resolved for the first time at TeV energies (hadrons?)
  - Electron acceleration within PWNe
  - => **Other classes also detected in our Galaxy: binaries, stellar clusters ...**
- **Class of VHE emitting molecular clouds is increasing**
  - => CR overdensity due to a local accelerator
- **The future looks promising for the search of diffuse emission**
  - => HESS-II and CTA => Combination of a lower energy threshold and an increased sensitivity