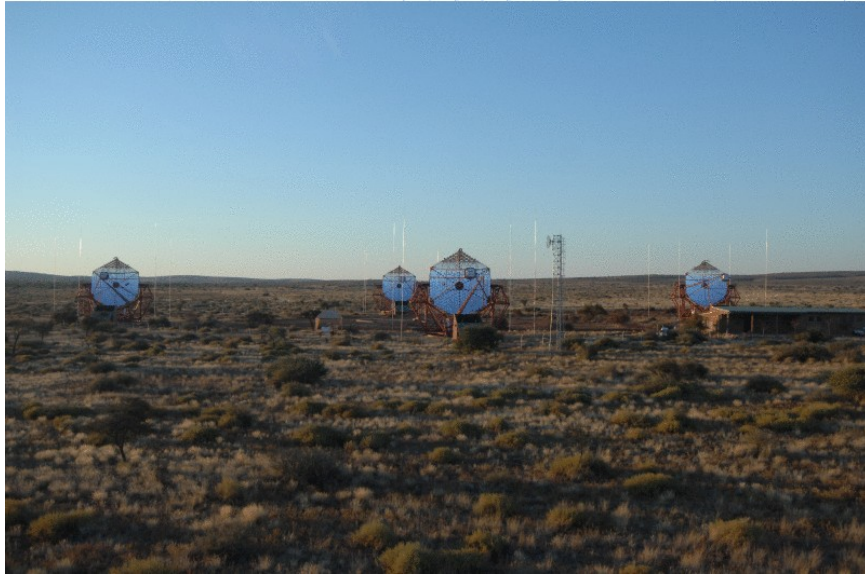


The H.E.S.S. view of our Galaxy in VHE gamma-rays

Armand Fiasson for the H.E.S.S. Collaboration

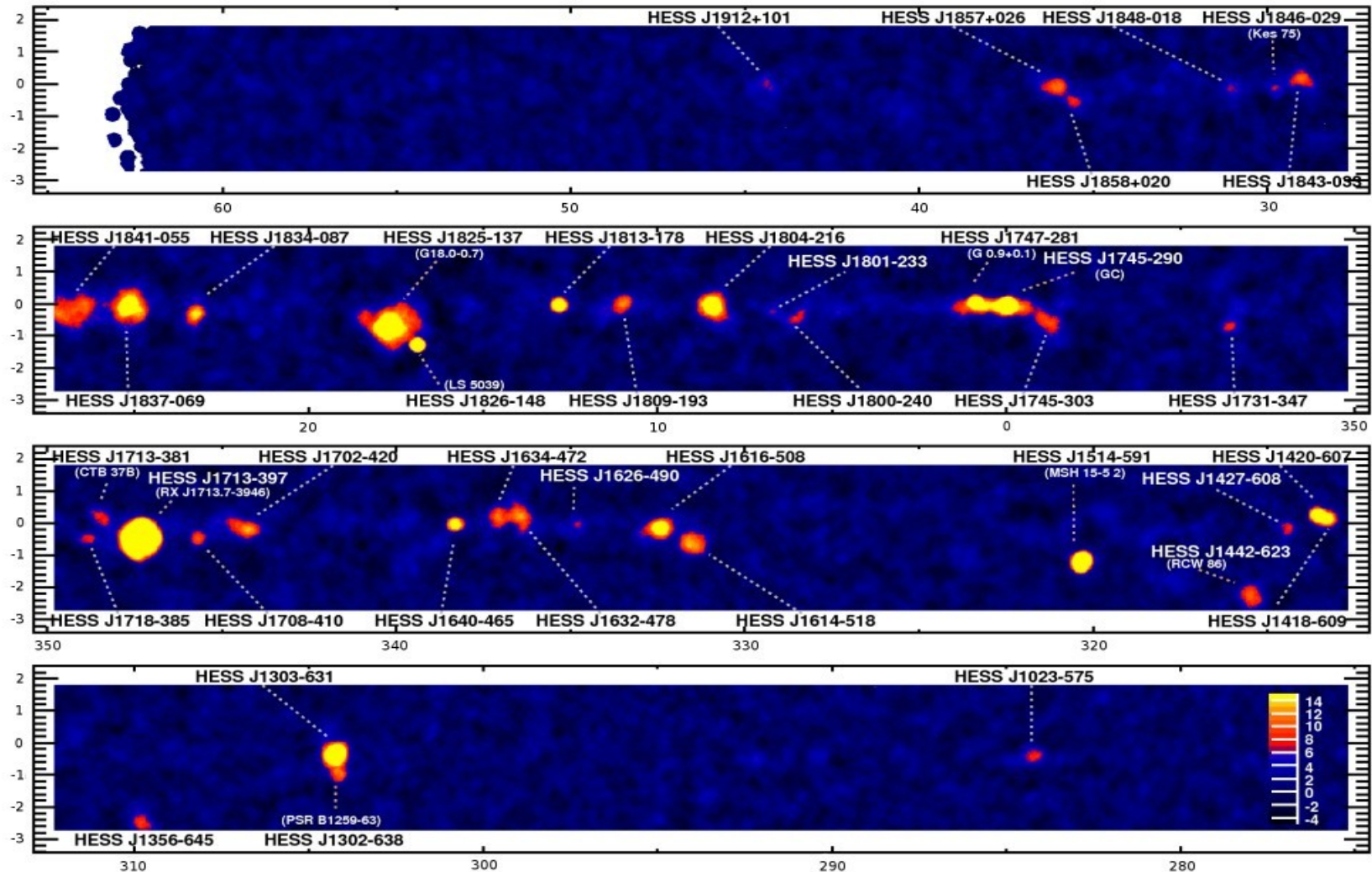
The High Energy Stereoscopic System (H.E.S.S.)



- **Array of 4 Imaging Atmospheric Cherenkov Telescopes**
 - Detects the Cherenkov light from atmospheric showers in stereoscopic mode
 - Large field of view: 5°
 - 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 4 years in full operation mode

The H.E.S.S. Galactic Plane Survey

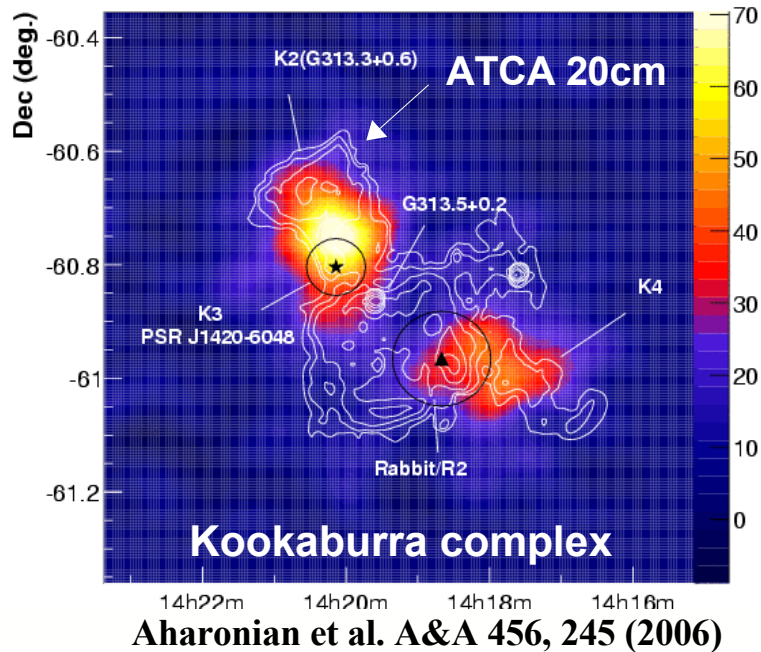
- Systematic survey of the inner galactic plane conducted since 2004
 - $-85^\circ < l < +60^\circ$ and $-3^\circ < b < +3^\circ$
- => successful: 8 new sources in 2004, > 15 new sources as of 12/2007



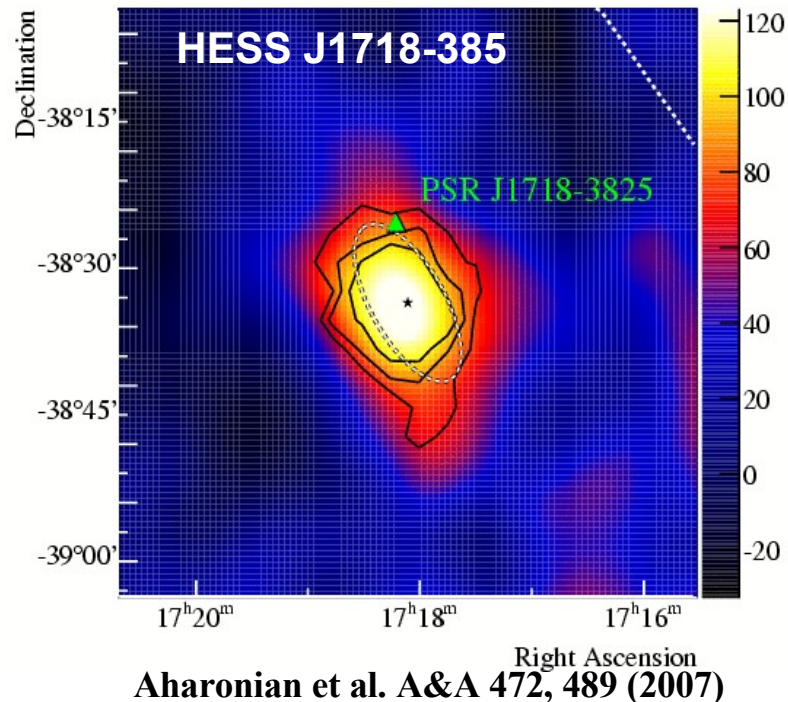
Which sources are detected?

- **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

Electron acceleration in PWN

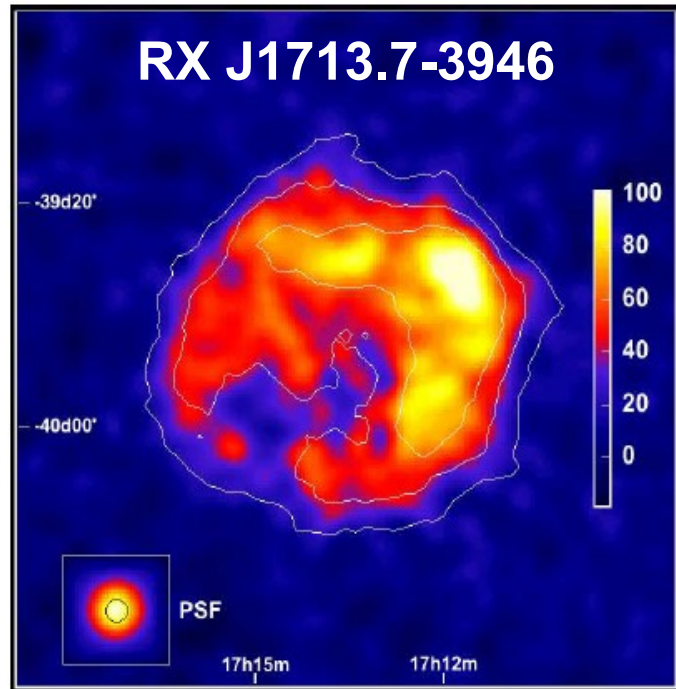


- An important fraction of the H.E.S.S. sources are associated with PWN
 - G0.9+0.1, Kookaburra complex, Vela X, MSH 15-52, HESS J1825-137, G21.5-0.9, Kes 75 ...
 - Plus others possibly associated with known pulsars
 - Or without detected pulsars
- => largest class of the H.E.S.S. Galactic sources

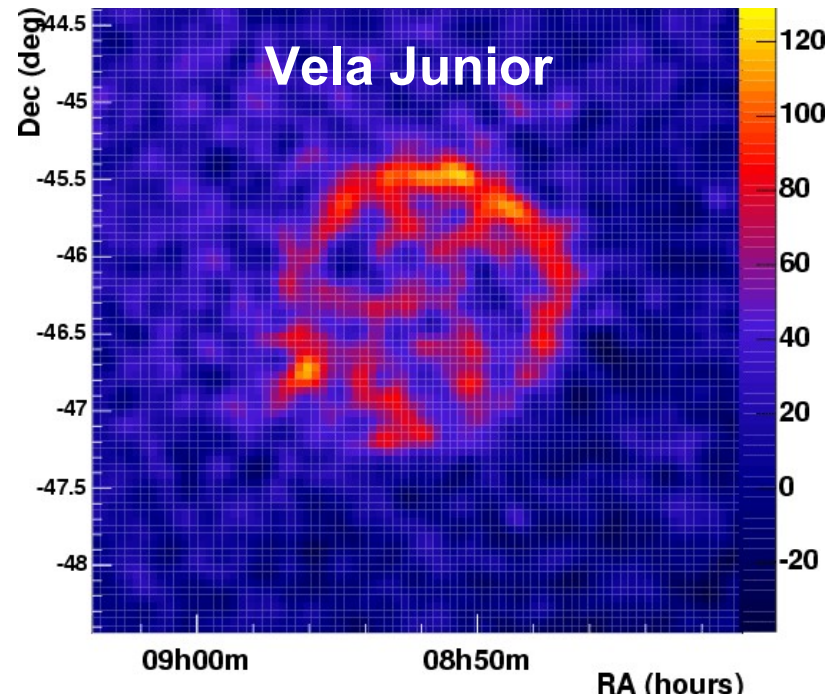


- Gamma-ray emission
 - Of order 1% of the total spin-down luminosity of known pulsars
 - Frequently offset from the pulsar position
- Comparaison to X-rays (synchrotron emission)
 - Implied magnetic field $\sim 10\mu\text{G}$ in these nebulae

Shell-type SNRs



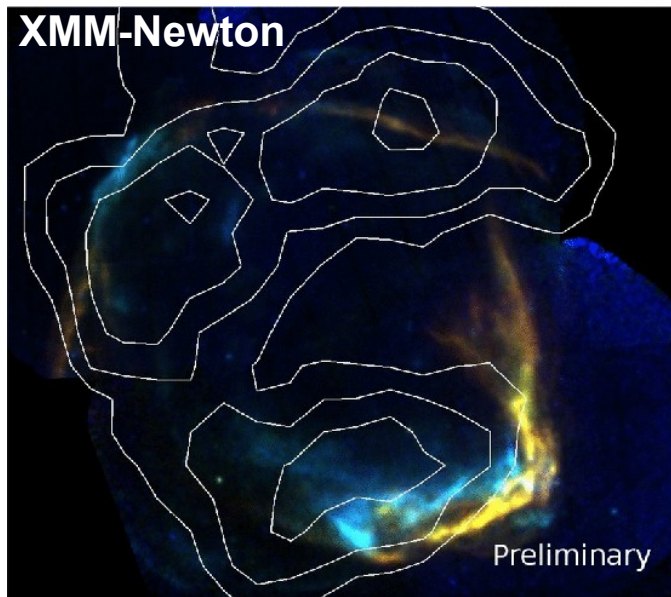
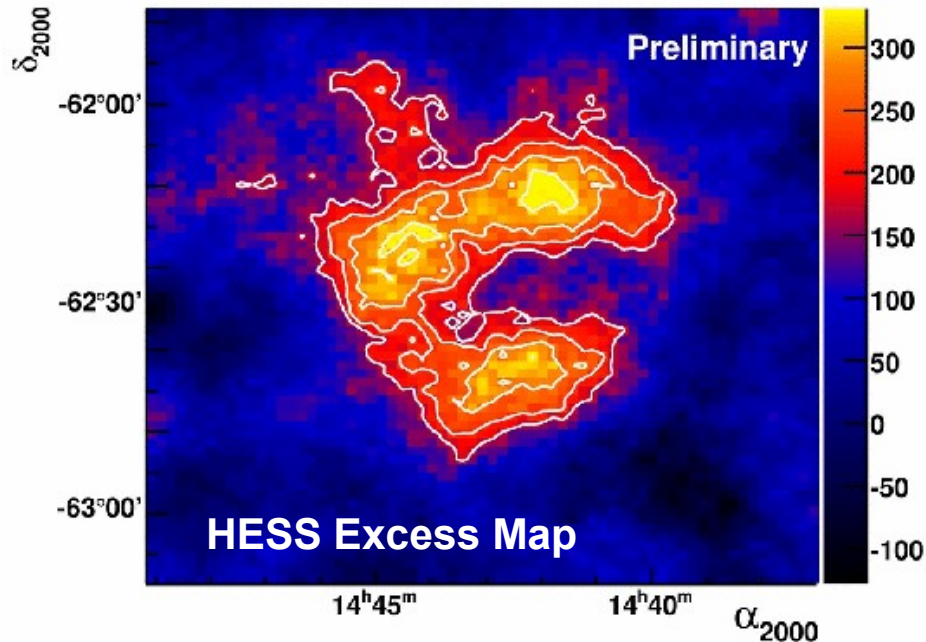
Aharonian et al. A&A 464, 235 (2007)



Aharonian et al. ApJ 661, 236 (2007)

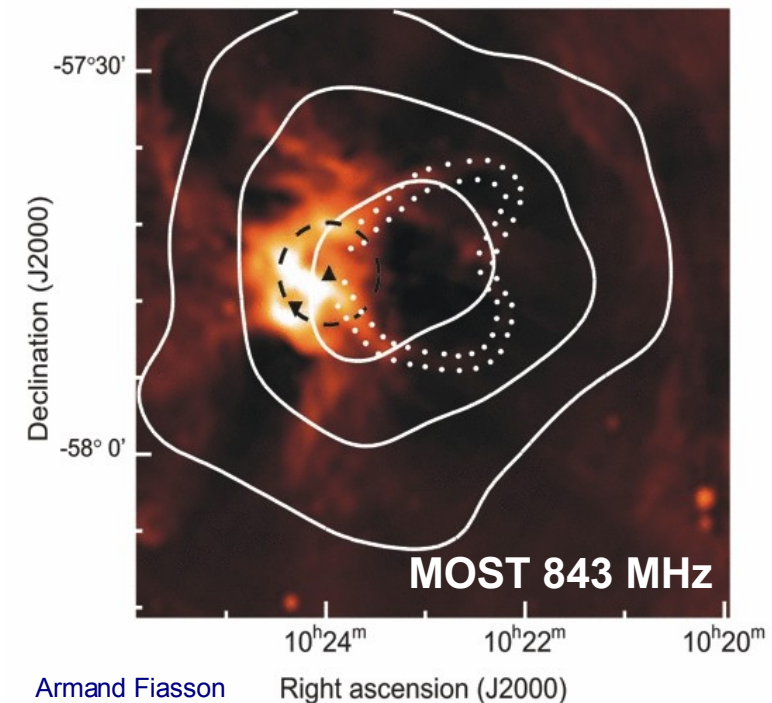
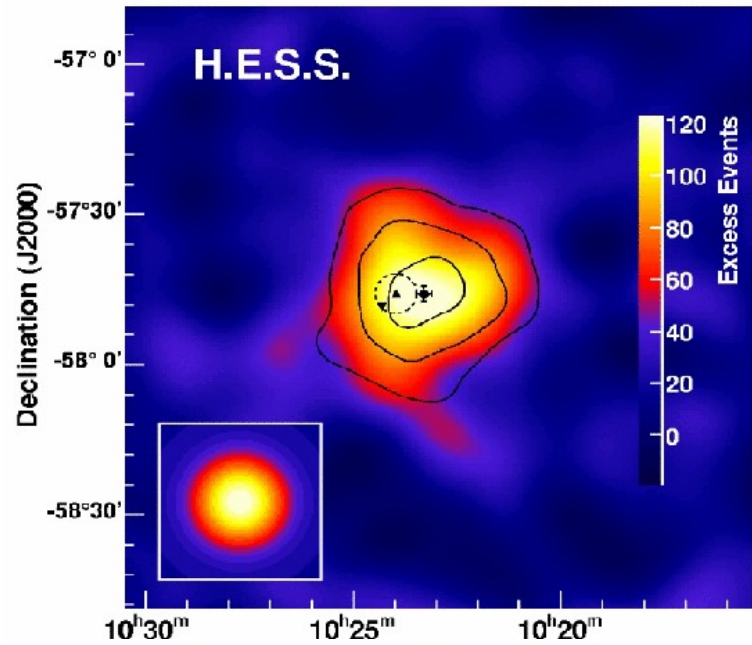
- **First shell morphology resolved in VHE gamma-rays**
 - Large angular size compared to the H.E.S.S. PSF
 - Powerlaw with spectral index close to 2 up to 30 TeV
 - => confirm the acceleration of particles with $E > 10^{14}$ eV
- **The nature of particle remains unidentified**
 - Electrons in a low intensity magnetic field ($\sim$ a few μ G)
 - Hadrons in a higher magnetic field ($\sim 100 \mu$ G, predicted by theoretical models)

Shell-type SNRs: new detection



- **RCW 86**
 - More recent discovery
 - The preliminary analysis compatible with partial shell
 - Looks like the X-ray morphology seen by XMM-Newton
- **Gamma -ray spectrum**
 - Compatible with a PL of index 2.5
 - 8% of the Crab Nebula in the range 1-10 TeV
 - Possible cut-off around 5 TeV with a spectral index of 1.9
- **Leptonic scenario**
 - Implies a magnetic field close 20 μ G
- **Hadronic scenario**
 - Imply a distance close to 1 kpc with $\Gamma=2.5$
 - Possible whatever the distance with $\Gamma=1.9$

HESS J1023-575 & Westerlund 2

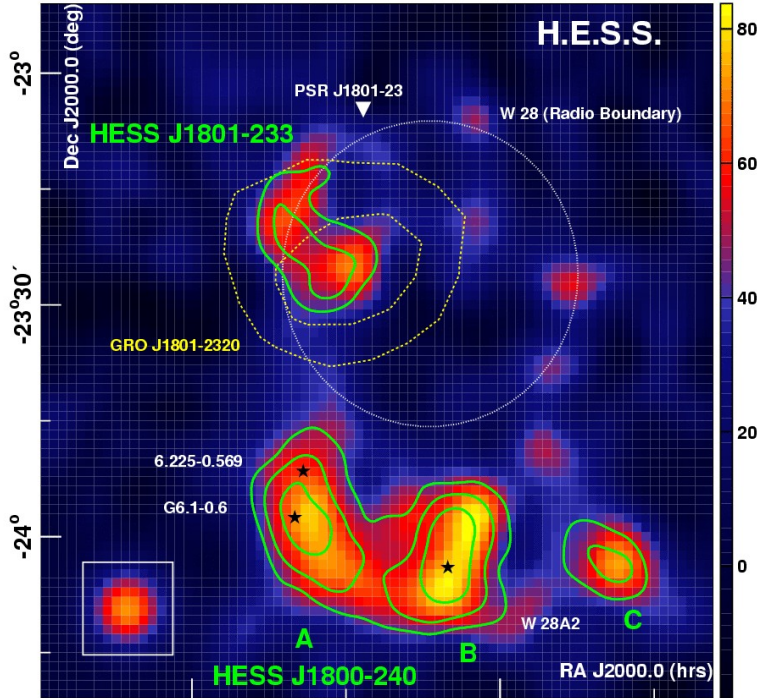


- **New class of VHE gamma ray emitter?**
 - Open young stellar cluster
 - Blister seen in radio: rapid expansion in a low density medium
- **HESS J1023-575**
 - Extended emission $\sigma \sim 0.18^\circ \pm 0.02^\circ$
 - Compatible with a PL of index 2.51 ± 0.16
- **The stellar cluster and the blister are in good positionnal coincidence**
 - Supershell are expected to accelerate efficiently particles

=> collective effects of stellar winds

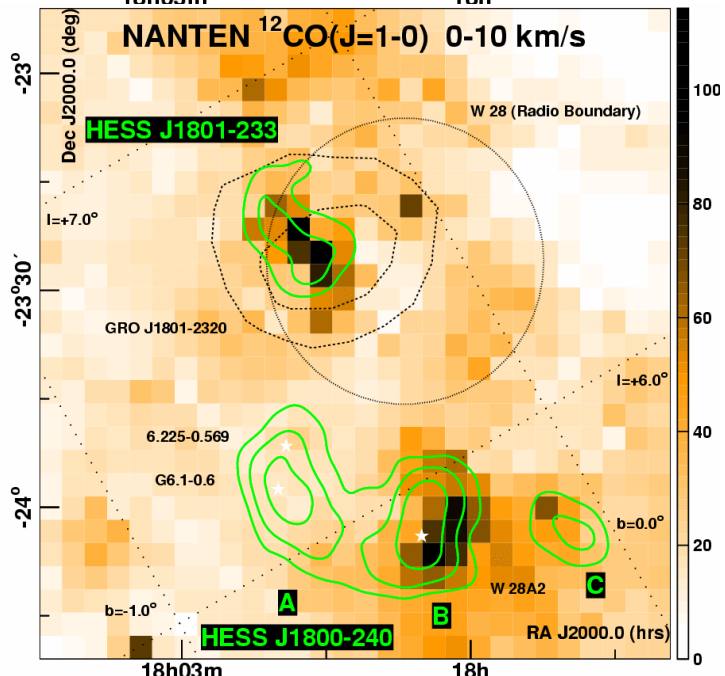
Aharonian et al. A&A 467,1075 (2007)

The W28 field



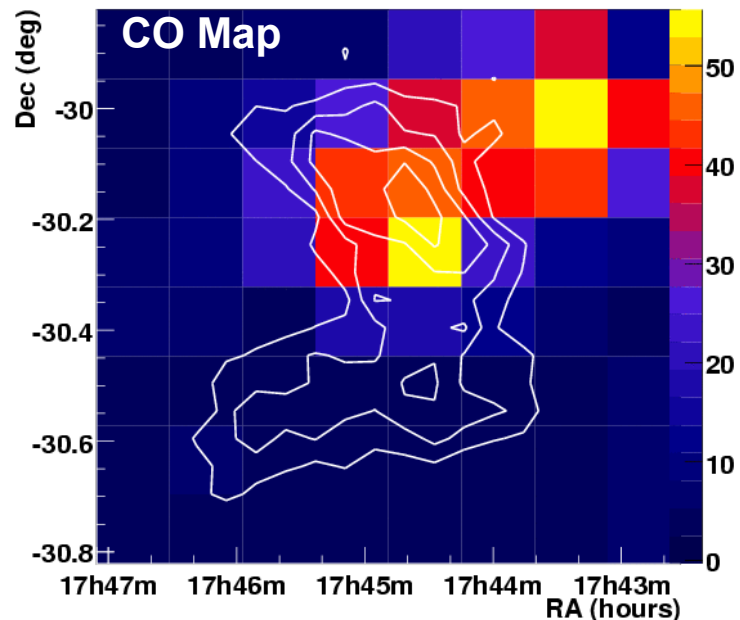
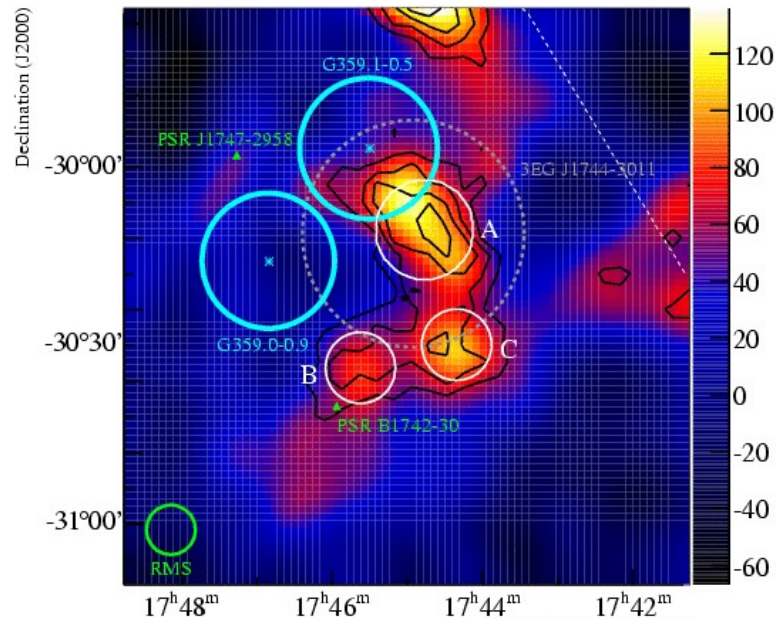
- **Several VHE gamma-ray sources close to the SNR G6.4-0.1**
 - 3 of them are extended emissions
 - Photon index $\Gamma \sim 2.5 - 2.7$
 - One coincident with an EGRET source (within W28)
- **Interaction of the remnant with a dense molecular cloud seen in NANTEN CO (J=1 $\rightarrow$ 0) observations**
 - Presence of OH masers (1720 MHz)
 - Northern gamma-ray emission coincident

=> Energetics compatible with CRs accelerated within the SNR and interacting with the cloud
- **Molecular clouds seen also in coincidence with the southern excesses**
 - Distances compatible with the SNR
 - Hadronic scenario also possible
- **Alternative scenario possible for the southern emissions**
 - Others SNRs, young stars, open stellar cluster



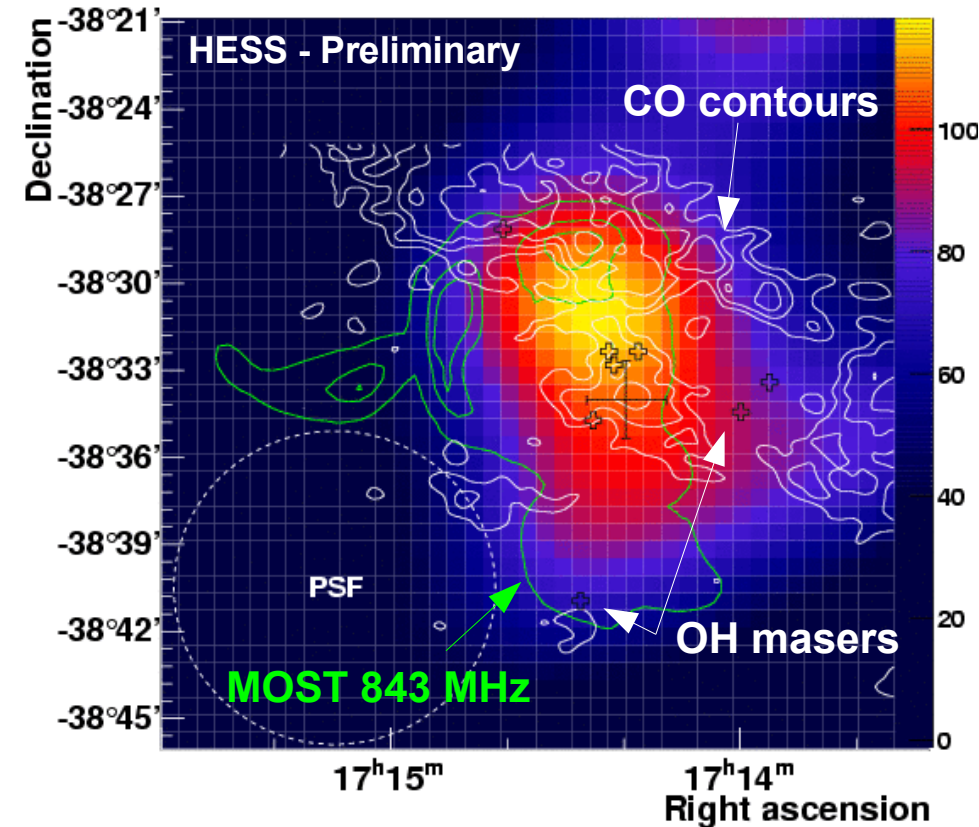
HESS J1745-303

HESS J1745-303



- **New analysis of this unidentified H.E.S.S. source**
 - Discovered in the galactic scan in 2004
 - Statistic increased in 2005 – 2007
 - => complex morphology, possibly multiple
 - Powerlaw of index $\Gamma = 2.71 \pm 0.11$
- **Still no obvious counterpart for the whole emission**
- **Pulsar wind nebula powered by PSR B1742-30**
 - Could only explain a fraction of HESS J1745-303
- **A hadronic scenario could explain the northern part**
 - Interaction of the SNR G359.1-0.5 blast wave with a matter ring (OH masers 1720 MHz)
 - CO observations reveals a coincidence of a fraction of this ring with the gamma-ray source
 - Energetics compatible with CRs from the SNR interacting with the cloud
 - => $\sim 32\%$ of the SN explosion energy into CRs

HESS J1714-385 & CTB 37A



Aharonian et al. submitted to A&A

- **Recently discovered by H.E.S.S.**
 - Coincident with SNR G348.5+0.3 (CTB 37A)
 - Powerlaw with spectral index $\Gamma = 2.30 \pm 0.13$
 - Extended source: $\sigma \sim 4'$
 - Possible association with 3EG J1714-3857
- **Hadronic scenario**
 - SNR interacting with several molecular clouds (OH masers 1720 MHz)
 - Gamma-ray energetics compatible with CRs accelerated by CTB 37A

=> [4% - 33%] of the SN explosion energy into CRs
- **Leptonic scenario**
 - PWN candidate discovered in X-rays (Chandra & XMM-Newton)
 - Possibly associated with CTB 37A
 - $\sim 0.1\%$ conversion of the implied spin-down luminosity in gamma-rays

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 sources discovered
- **Several supernova remnant have been detected**
 - Shell-type SNRs resolved for the first time at TeV energies
 - Electron acceleration within PWNe
- **Several binaries system have been also detected with different periods (not discussed in this talk)**
- **New classes of objects have been more recently detected in the TeV range by H.E.S.S.**
 - Young stellar cluster
 - Molecular clouds in the vicinity of particle accelerators
- **A significant number of gamma-ray sources are still unidentified**
- **Continuation of this survey seems promising**
 - HESS phase II will increase resolution and sensitivity to the current system