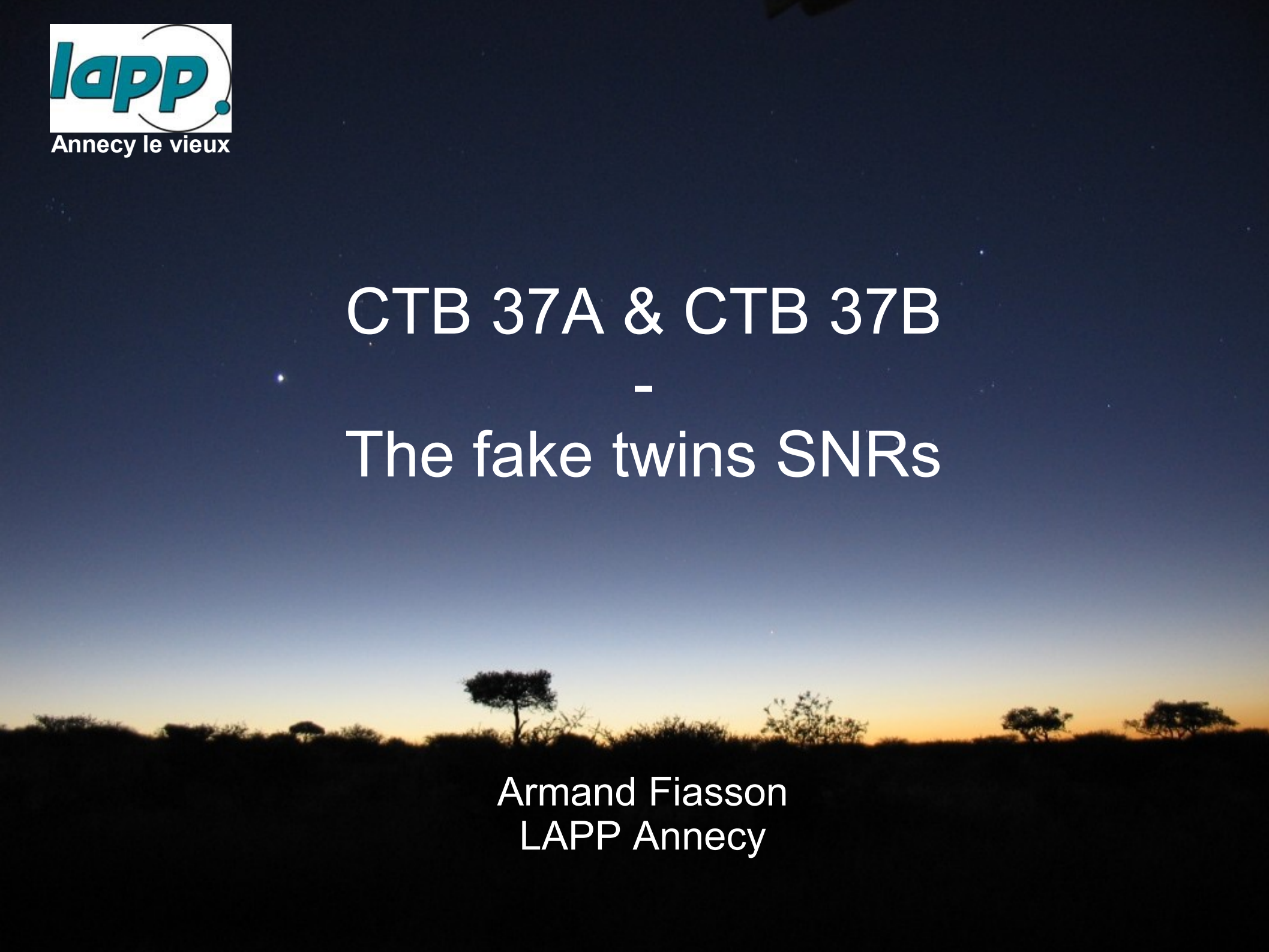
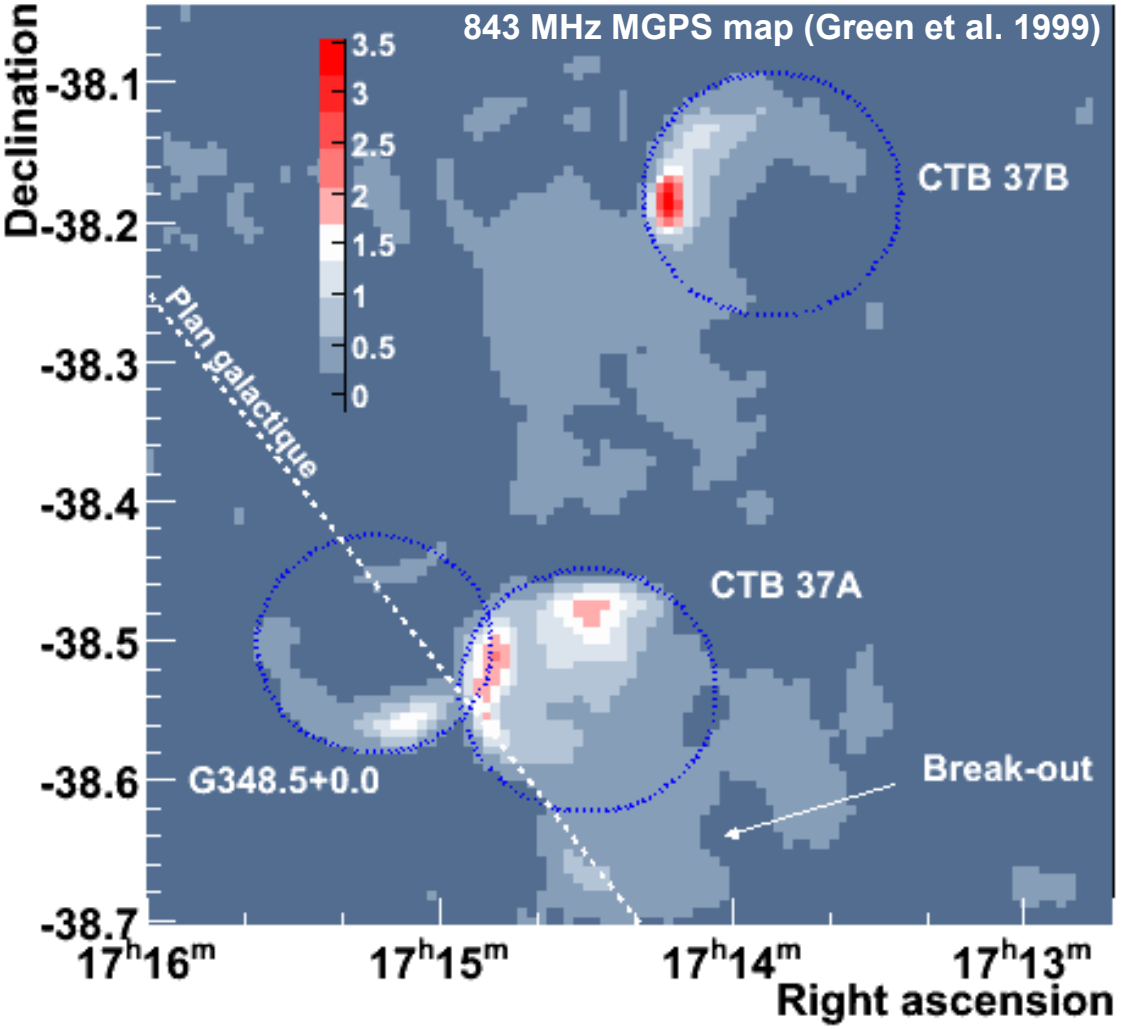


Annecy le vieux

CTB 37A & CTB 37B
-
The fake twins SNRs

Armand Fiasson
LAPP Annecy

CTB 37: a complex complex



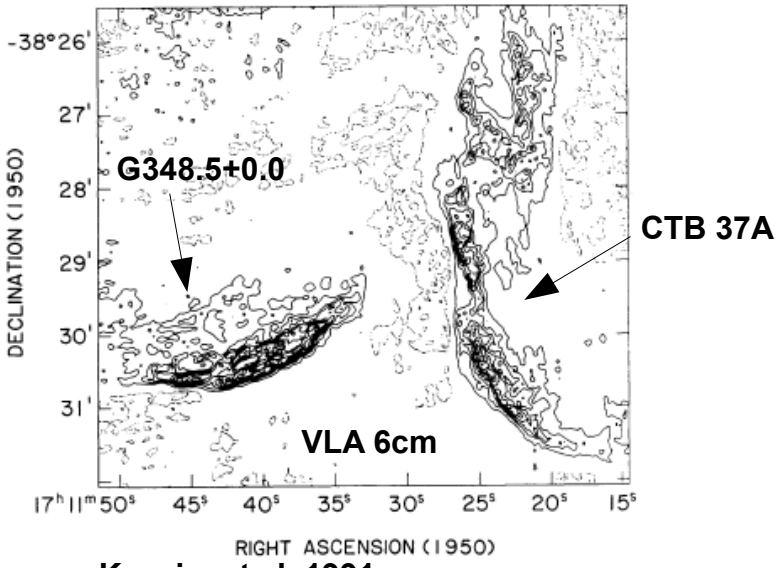
- **Bright region in radio emission**

  Thought to be 2 SNRs plus a bridge and a jet from CTB 37A

  => Now resolved as 3 partial SNR shells

- **Belong to the brightest radio shells**

  => Were thought to be younger than 2000 years but probably older

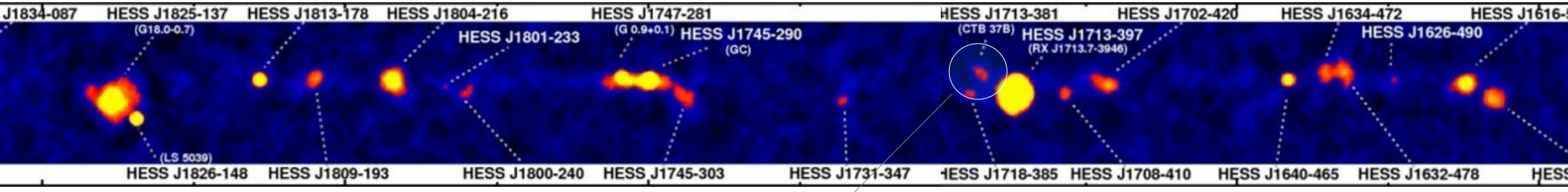


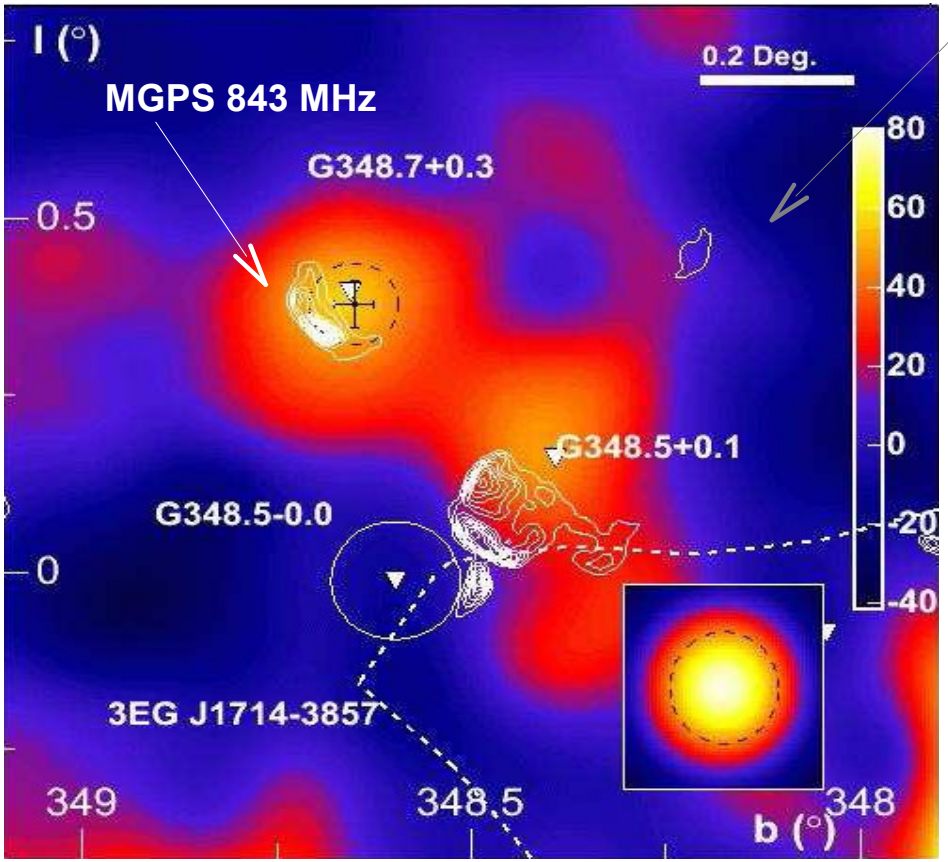
Kassim et al. 1991

- **CTB 37A: part well defined + break-out morphology**
- **CTB 37B: partial shell**

=> SNRs evolving into inhomogeneous and probably dense medium

The complex as seen by HESS - 2004





HESS excess map - Aharonian et al. ApJ 636, 777 (2006)

- **CTB 37 is located close to the Galactic centre and RX J1713.7-3946**

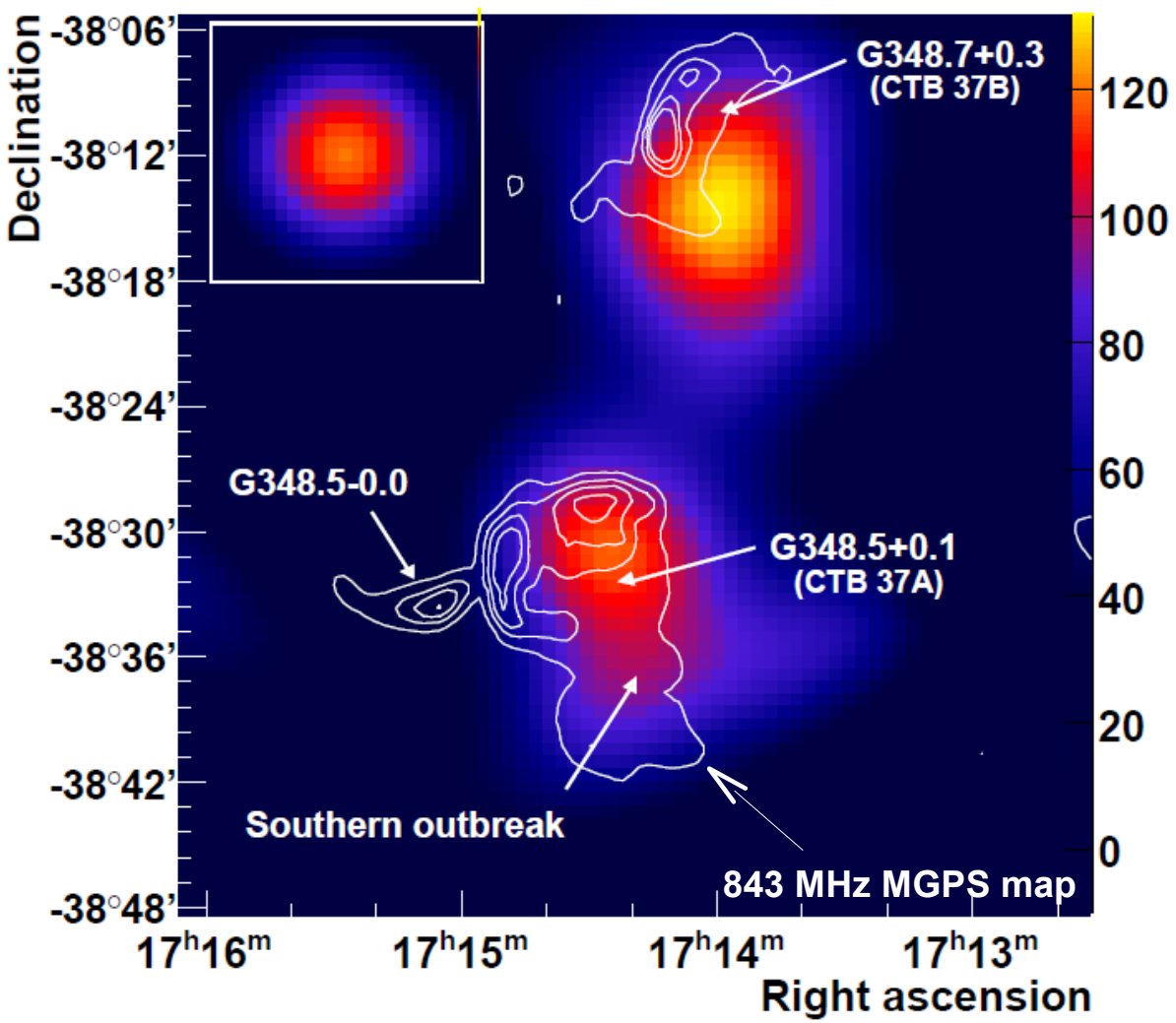
  => Deeply covered by HESS in 2004

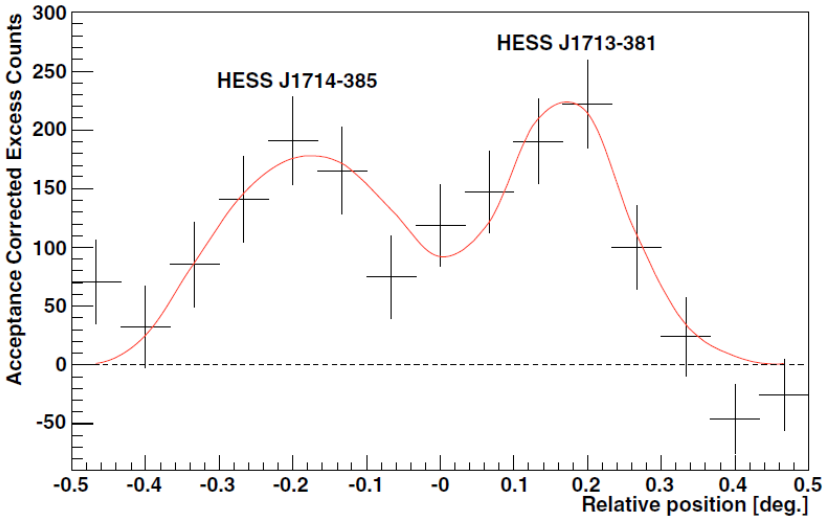
- **One VHE gamma-ray source detected**
  - HESS J1713-381
  - No significant extension
    - $\sigma = 3.6' \pm 2.4'$
  - Power-law with $\Gamma = 2.3 \pm 0.5$ and normalisation eq. 1.8% Crab

  => Coincident with CTB 37B

- **Excess toward CTB 37A but not significant**

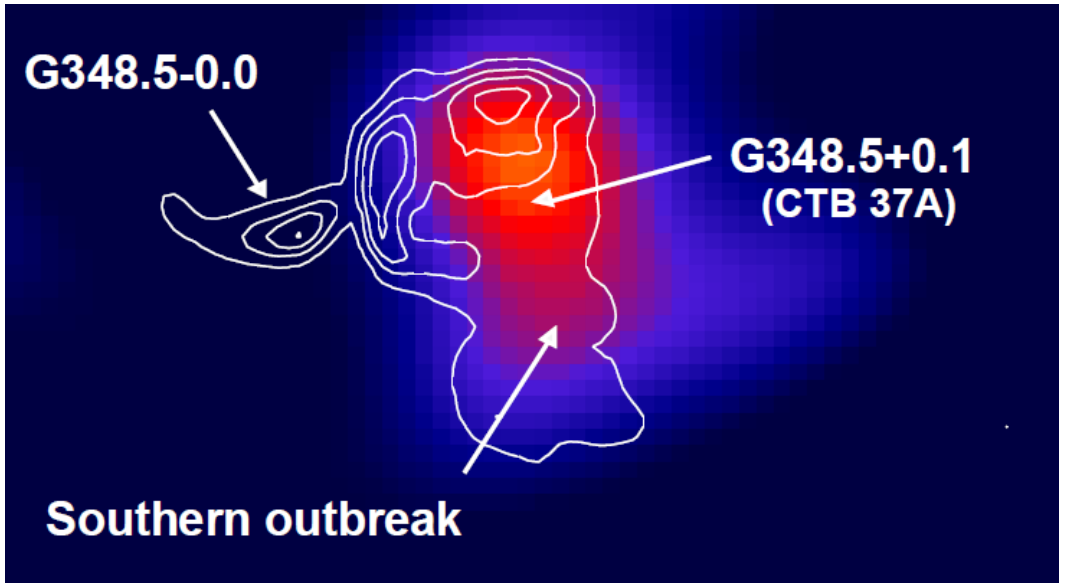
The complex as seen by HESS - 2008





- **Follow-up observation performed between 2004 and 2008**
  - Live-time almost x 2
- **Excess toward CTB 37A is now significant: HESS J1714-385**
  - 8.7σ post-trials
  - Distinct from the other source
- **Both gamma-ray emissions are coincident with a SNR**

HESS J1714-385 & CTB 37A



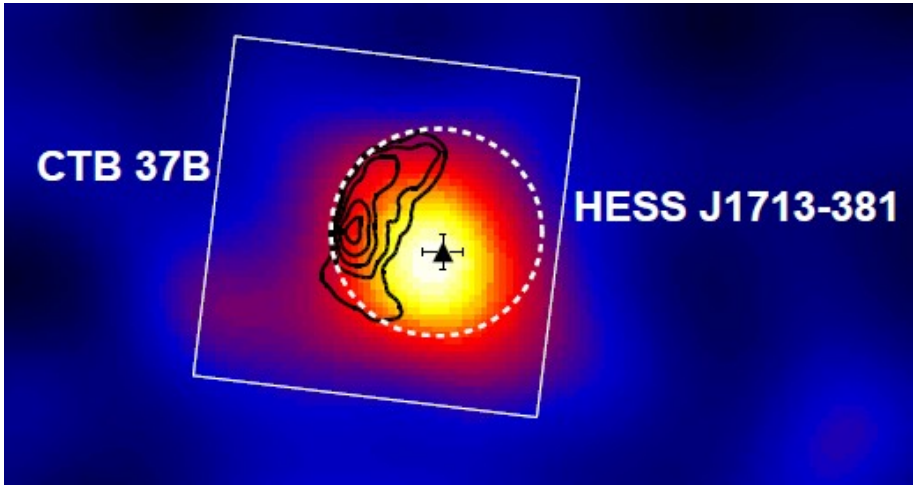
Aharonian et al. A&A, 490, 685A (2008)

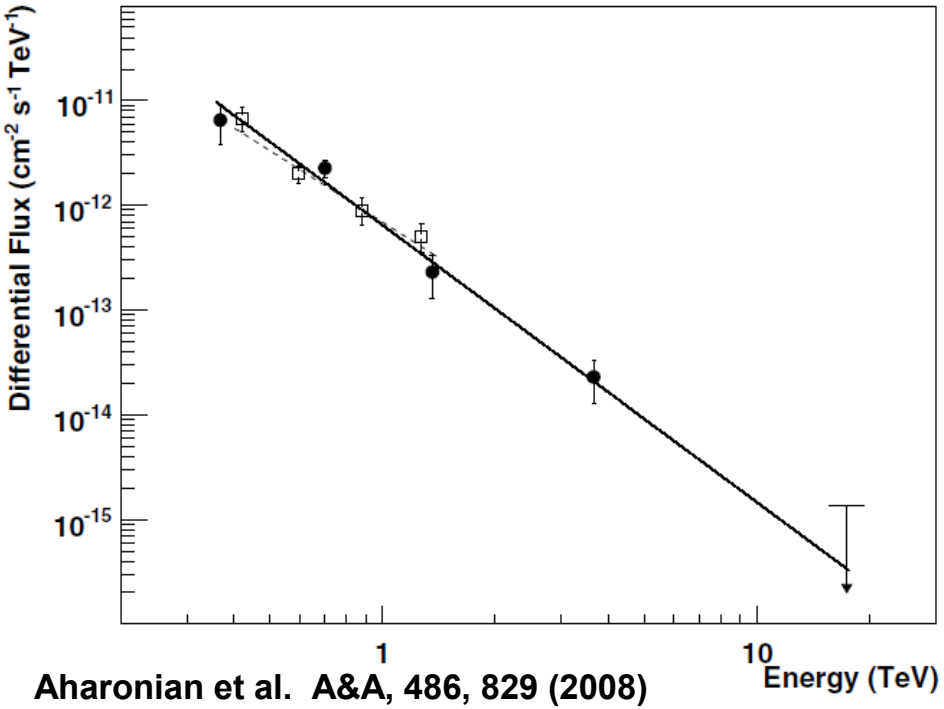
- **HESS J1714-385**
  - 975 counts using hard cuts
  - Significance 8.7 σ post-trials
- **Extended source**
  - σ = 4' ± 1' assuming a Gaussian profile
  - No significant asymmetry

=> An emission by the shell (9.5' x 8') is not excluded

- **HESS J1714-385 spectrum**
  - Compatible with a power law
    - Γ = 2.30±0.13
    - Normalisation ~3% Crab

HESS J1713-381 & CTB 37B



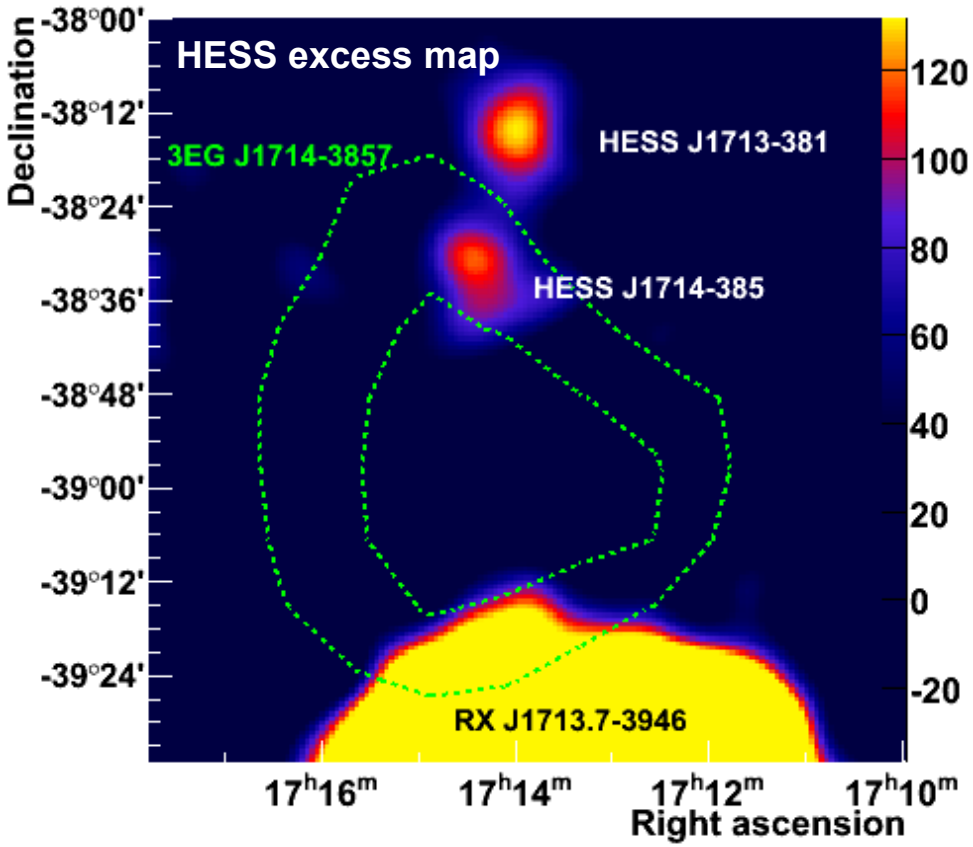


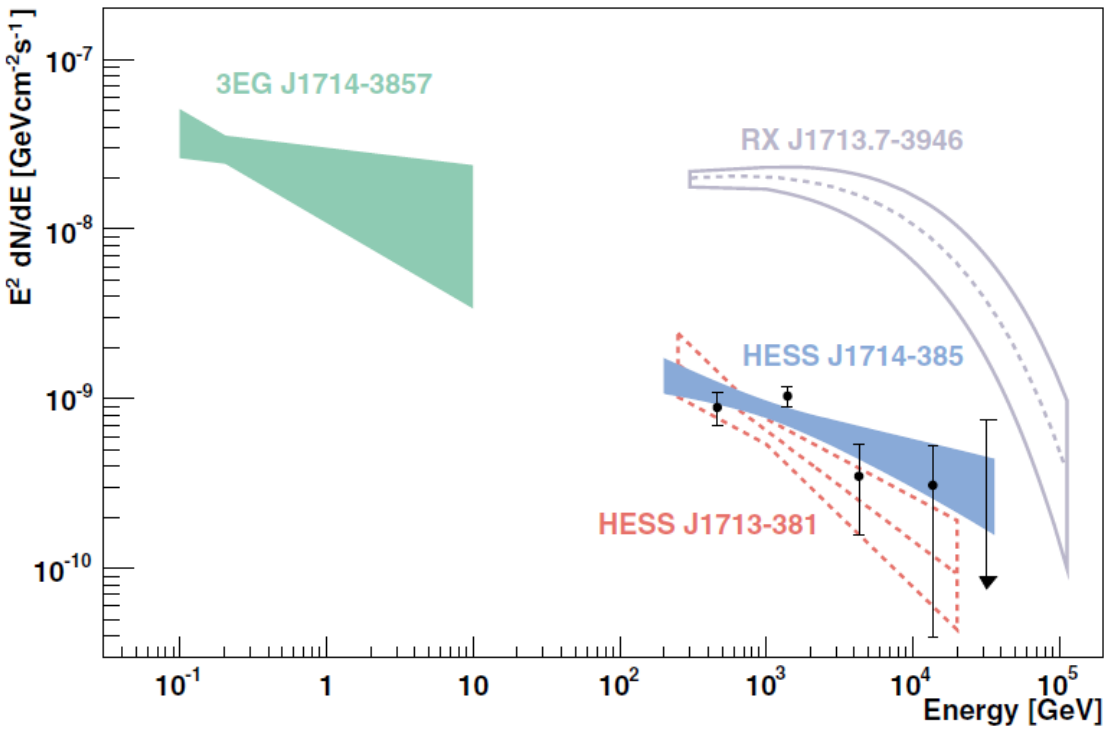
Aharonian et al. A&A, 486, 829 (2008)

- **HESS J1713-381**
  - 292 ± 36 counts using hard cuts
  - Significance 8.6 σ post-trials
- **Extended source**
  - σ = 2.6' ± 0.8' assuming a Gaussian profile

  => An emission by the whole shell (4'-6') is here also not excluded
- **HESS J1713-381 spectrum**
  - Compatible with a power law
    - Γ = 2.65 ± 0.19
    - Normalisation ~2.6% Crab

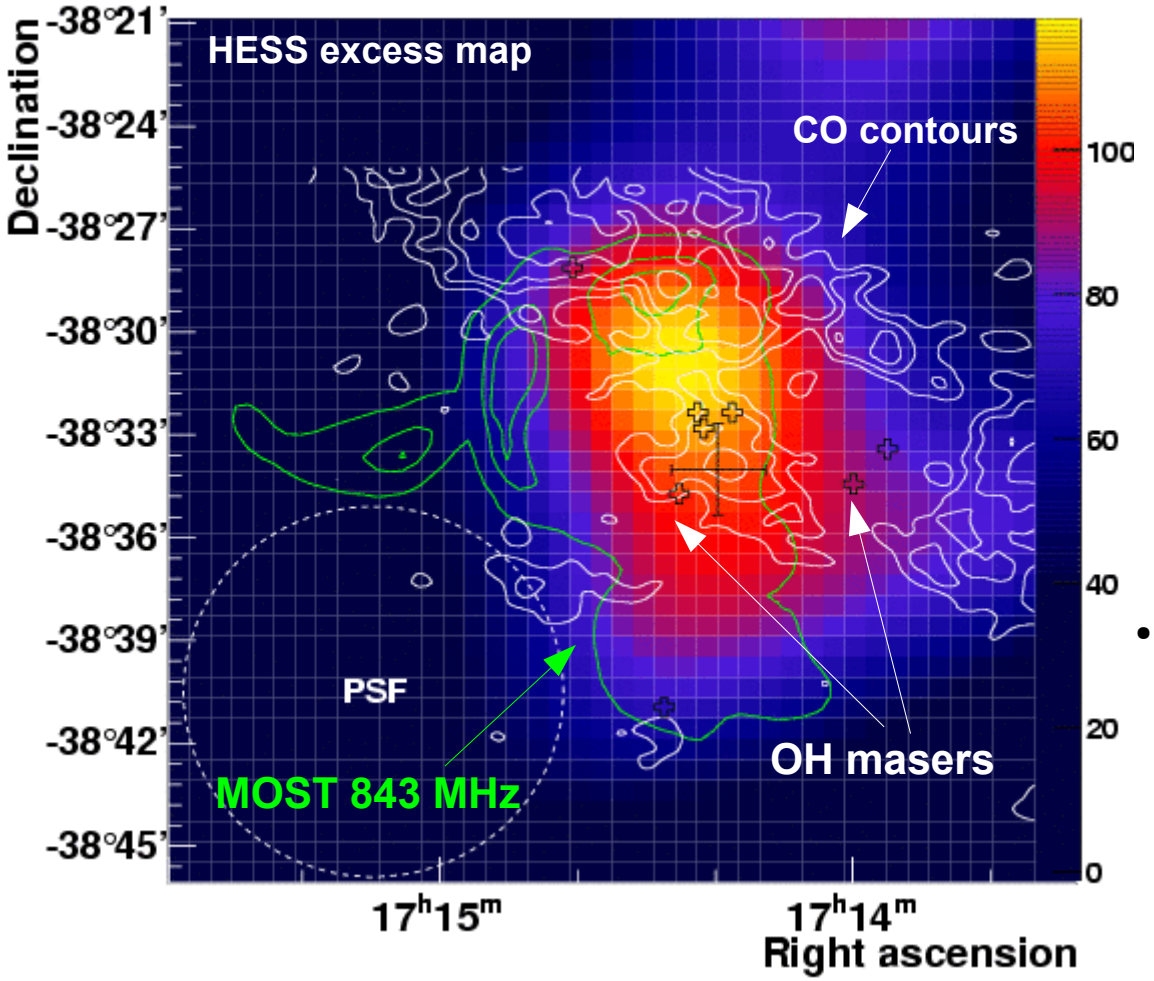
Association with an EGRET source?





- **The EGRET source 3EG J1714-3857 lies in this region**
  - Two dense molecular clouds in the vicinity of RX J1713.7-3946 are though to be the origin of the source
- **The HESS sources are two competitive counterpart candidates**
  - Between the 68% and 99% CL contours
  - Spectral compatibility between sources (although it is expected by chance)

CTB 37A: γ-rays from molecular clouds?



Aharonian et al. A&A, 490, 685A (2008)

- **SNR interacting with several molecular clouds**
  - OH masers (1720 MHz)
  - Dense molecular clouds detected in CO observations

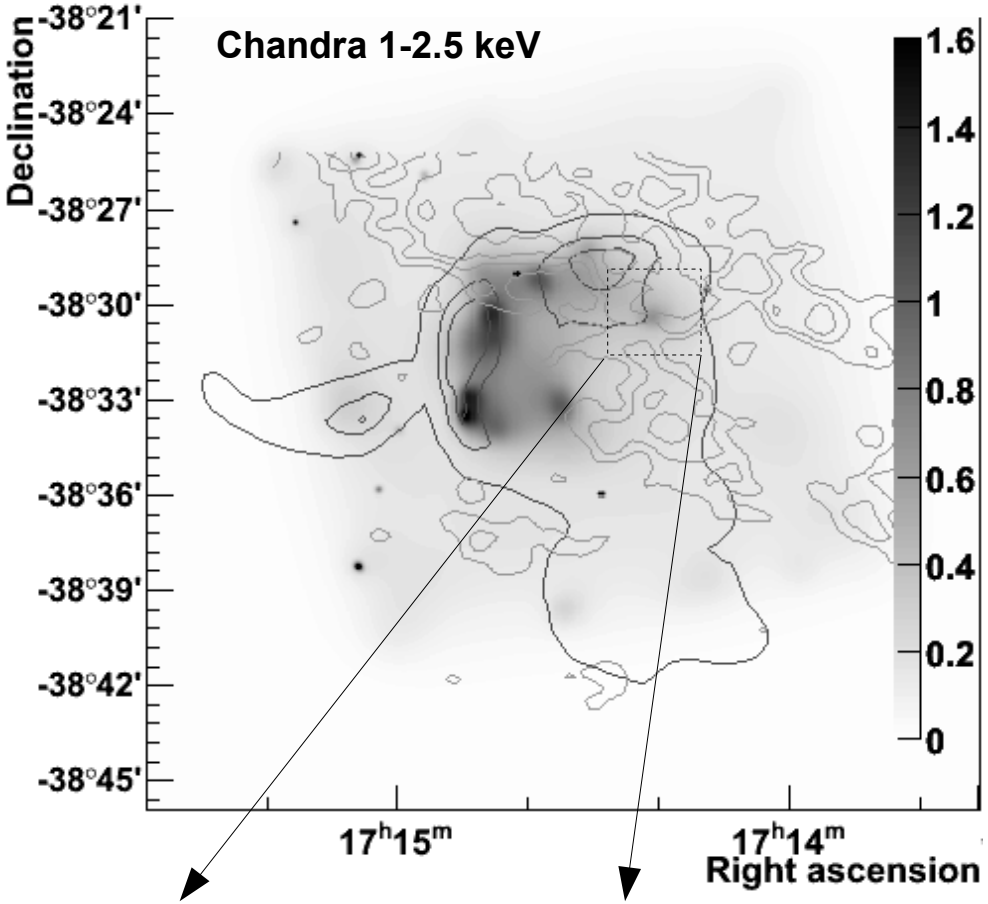
    =>Radial velocities match the masers

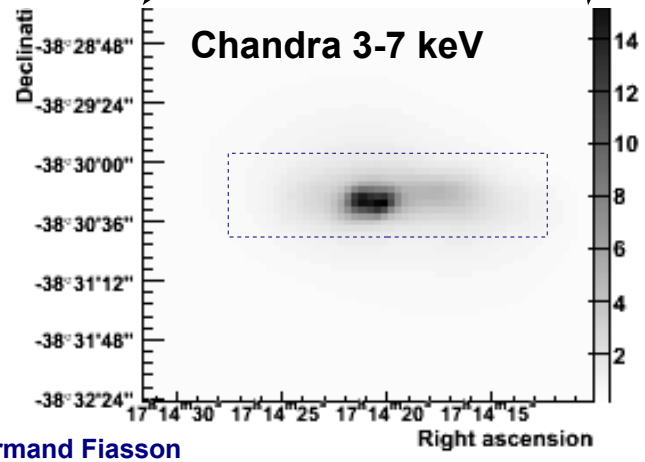
  => Probe for hadron CR acceleration

- **Hadronic scenario?**
  - Gamma-ray energetics compatible with CRs accelerated by CTB 37A

    => [4% - 30%] of the SN explosion energy into CRs

Or from a PWN?

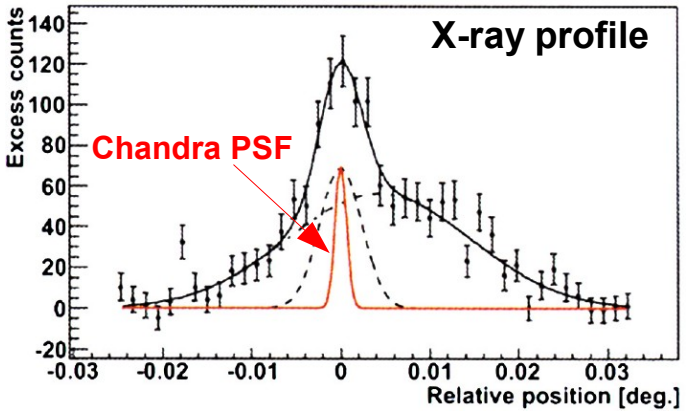




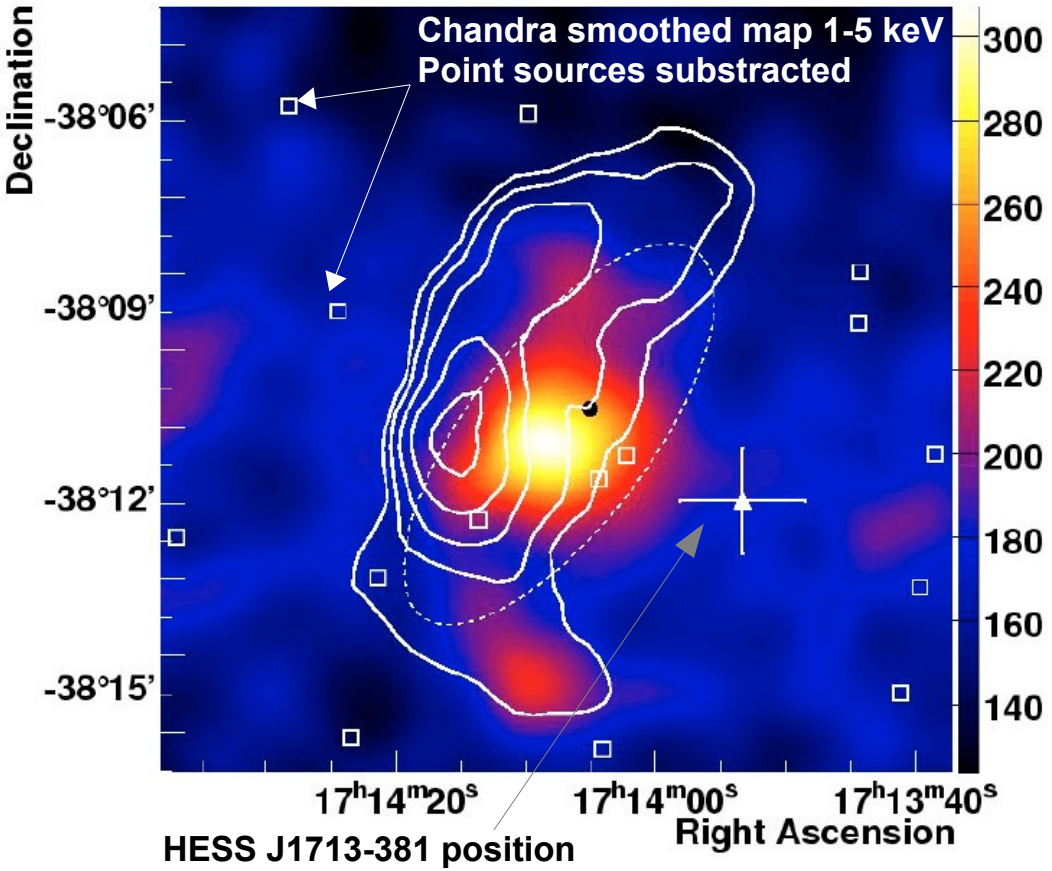
- **Recent X-ray observations**
  - Chandra & XMM-Newton

    => Complex region in X-rays
- **Thermal emission discovered from the interior of the remnant**
- **PWN candidate coincident with the remnant**
  - Possibly associated with CTB 37A
  - X-ray luminosity implies a spin-down luminosity around 10^{37} erg/s at 11.3 kpc

  => ~0.1% conversion in gamma-rays

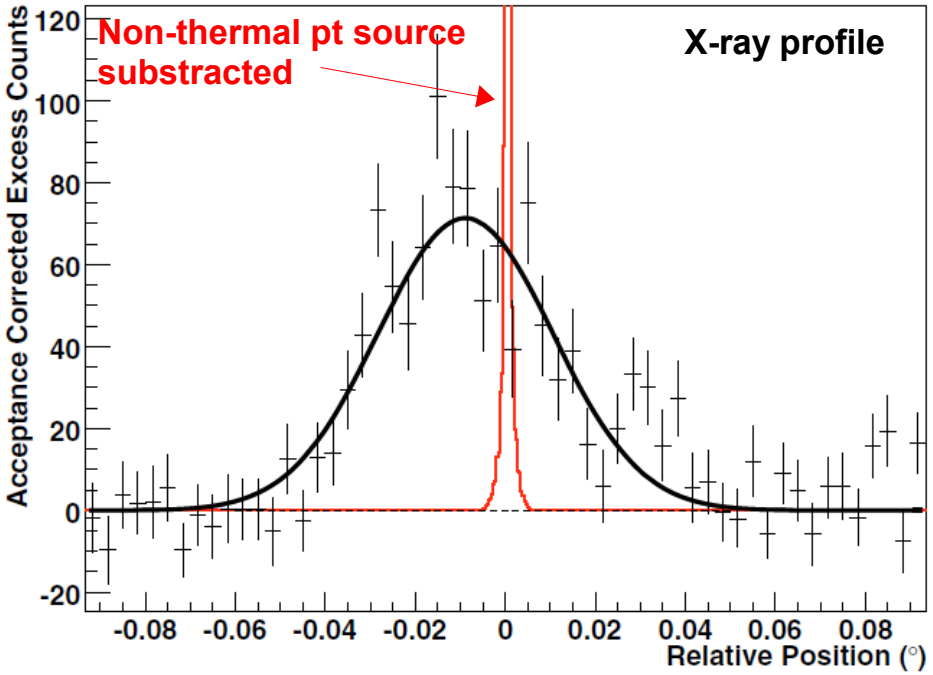


CTB 37B: Chandra's view of the remnant



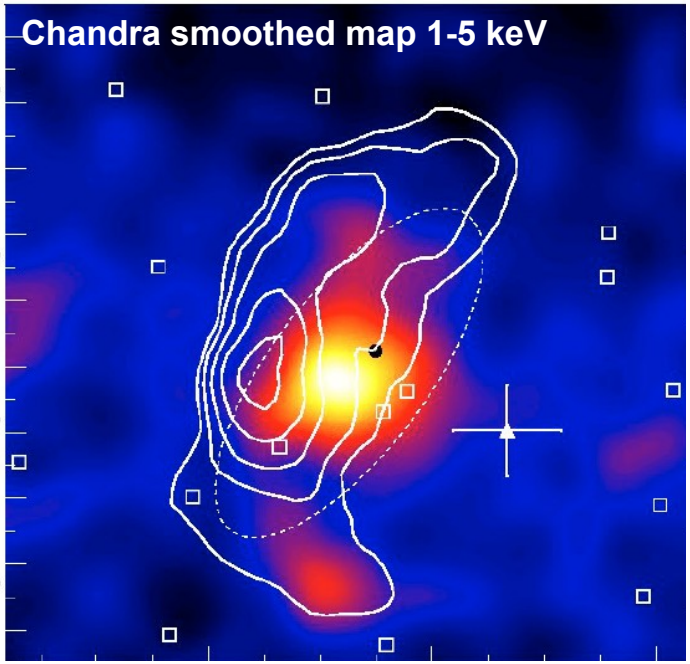
- **Recent observations by Chandra**
- **Extended thermal emission within radio shell**
  - σ = 1.2'±0.1' assuming a Gaussian profile

=> Imply an SNR age of a few 1000 years evolving in a medium with average density close to 0.5 cm^{-3}



- **One strong non-thermal point source**
  - Could be associated with the SNR
- **No extended non-thermal emission**

CTB 37B: hadronic or leptonic scenario?



- **Gamma-rays from the non thermal X-ray point source?**
  - Could be a neutron star belonging to CTB 37B
  - But lack of non thermal extended source coming from a PWN

    => Scenario unlikely

- **Gamma-rays from the SNR shell?**
  - **From an electron population**
    - But lack of non thermal X-rays from the shell

      => implies a low magnetic field ~1μG or an electron cut-off around 40 TeV
  - **From a hadron population**
    - Density deduced from X-rays ~ 0.5 cm^{-3}

      => CR acceleration efficiency implied ~40%

    => most natural scenario

Summary

- **A new light have been brought over the CTB 37 complex these last years**
  - HESS detected two VHE gamma-ray sources coincident with the SNRs
  - Chandra & XMM-Newton have completed the MWL view

- **HESS J1714-385 & CTB 37A**
  - Shocked molecular clouds in the vicinity of the SNR + an EGRET source
    => argue for a hadronic scenario
  - CR acceleration efficiency compatible with expected values
  - But PWN scenario very competitive

- **HESS J1713-381 & CTB 37B**
  - A leptonic scenario does not seem likely
    - No X-ray PWN associated with the non thermal X-ray point source
    - No non thermal X-ray from the SNR shell
  - CR acceleration efficiency in a hadronic scenario seems plausible