Observations of Supernova Remnants with H.E.S.S.

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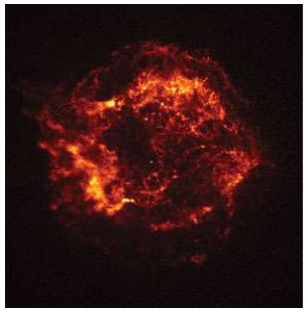
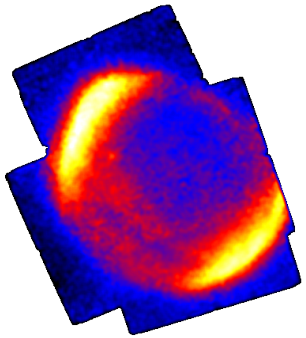
Outline

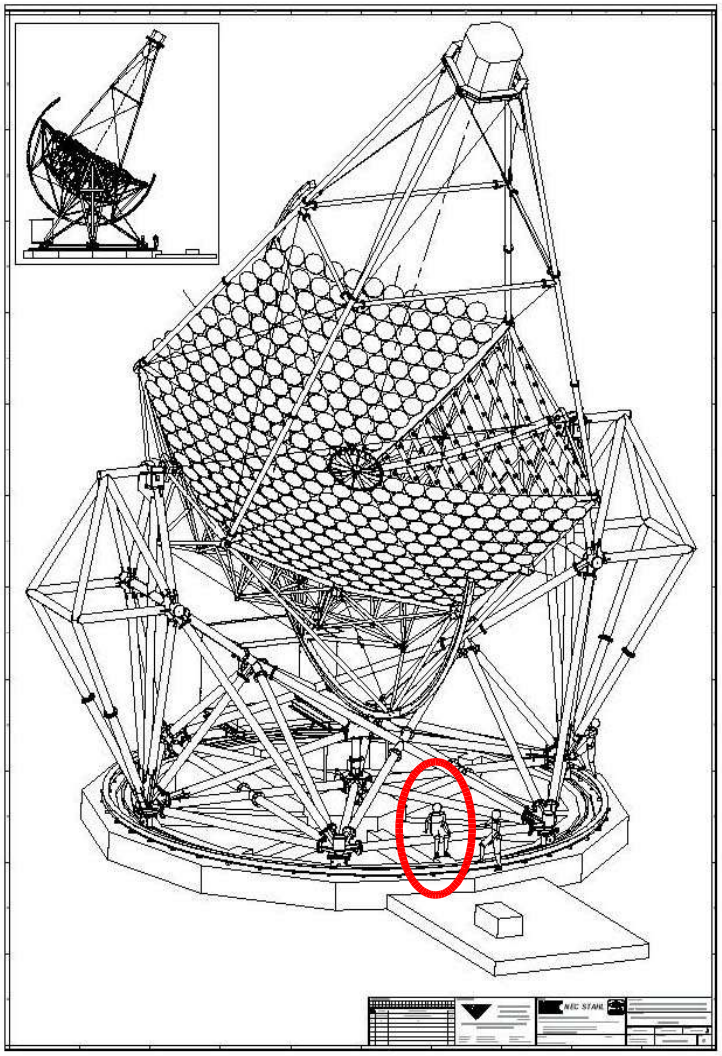
- Galactic Observations
  - Pulsars & pulsar nebulae
    - Crab nebula
    - PSR B1706
    - Vela
    - PSR B1259
  - Supernova remnants
    - SN1006
    - RX J1713-46
  - Galactic centre



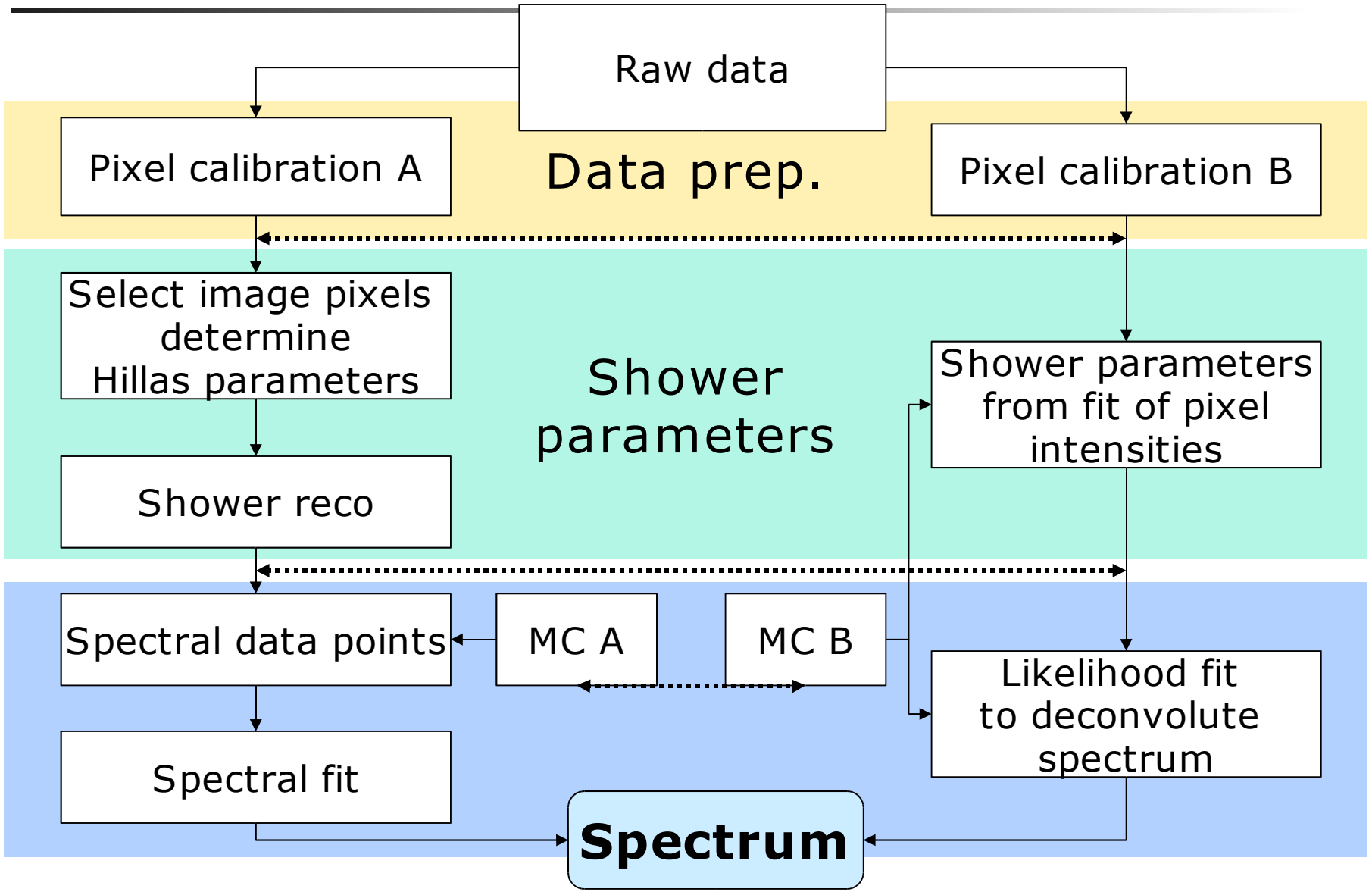


The H.E.S.S. Experiment

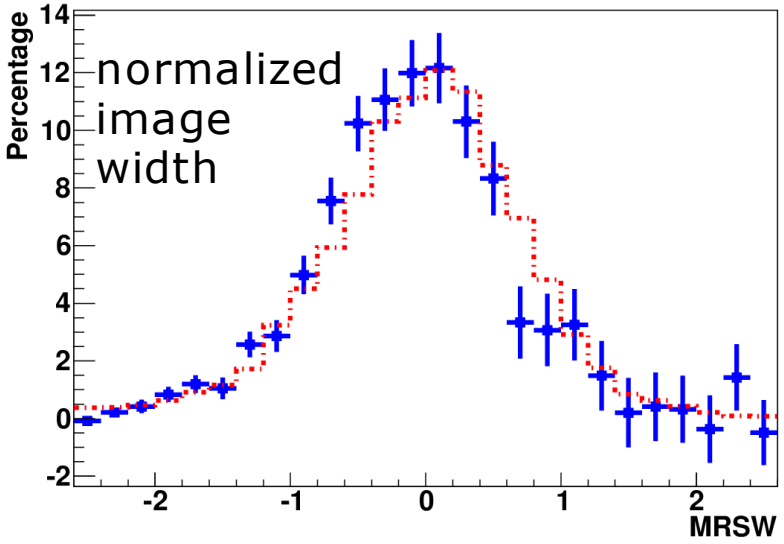
- Array of Cherenkov Telescopes
  - Situated in Namibia, southern Africa
  - 4 telescopes, 120 metre separation
- Telescope Structures
  - 4 x 106 m^2 reflector dish area
  - 15 metre focal length
- Camera
  - 960 photomultiplier tubes
  - Fast electronics
  - Wide field of view (5°)
- Performance
  - 100 GeV energy threshold
  - Sensitivity 1% of Crab flux in 25 hours
  - Energy resolution ~16%

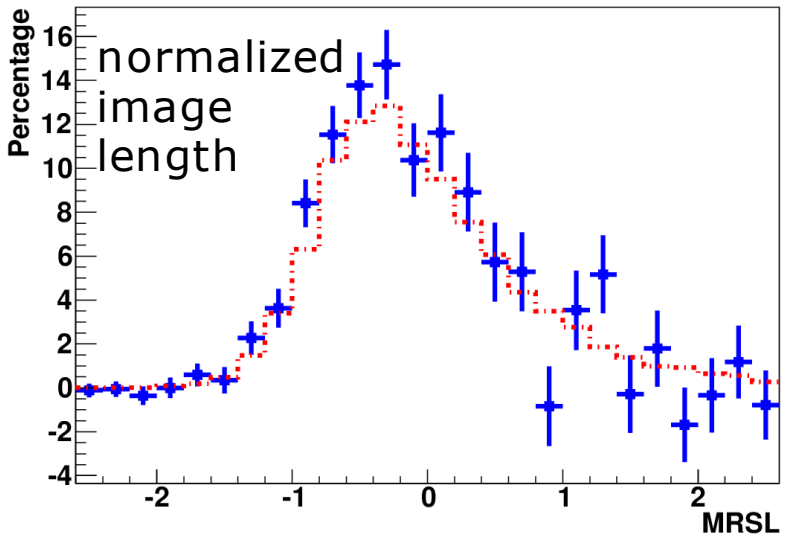


Data analysis with H.E.S.S.

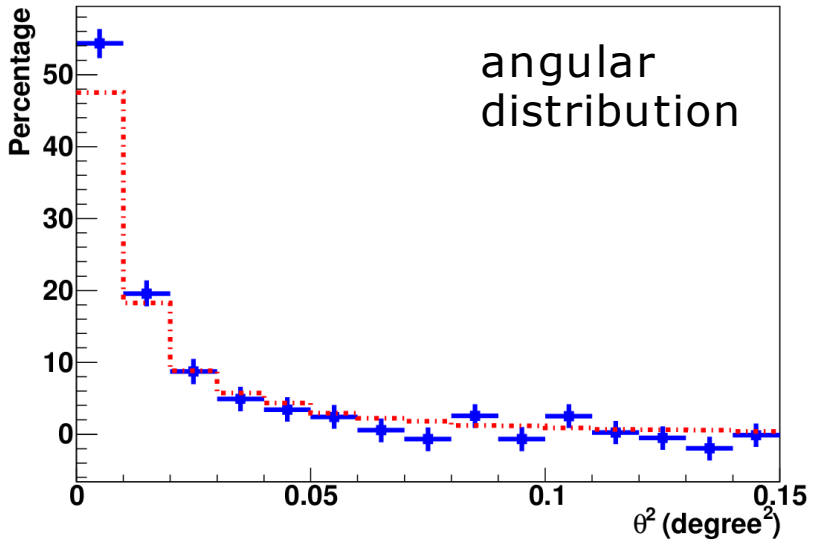


Comparison with Monte Carlo



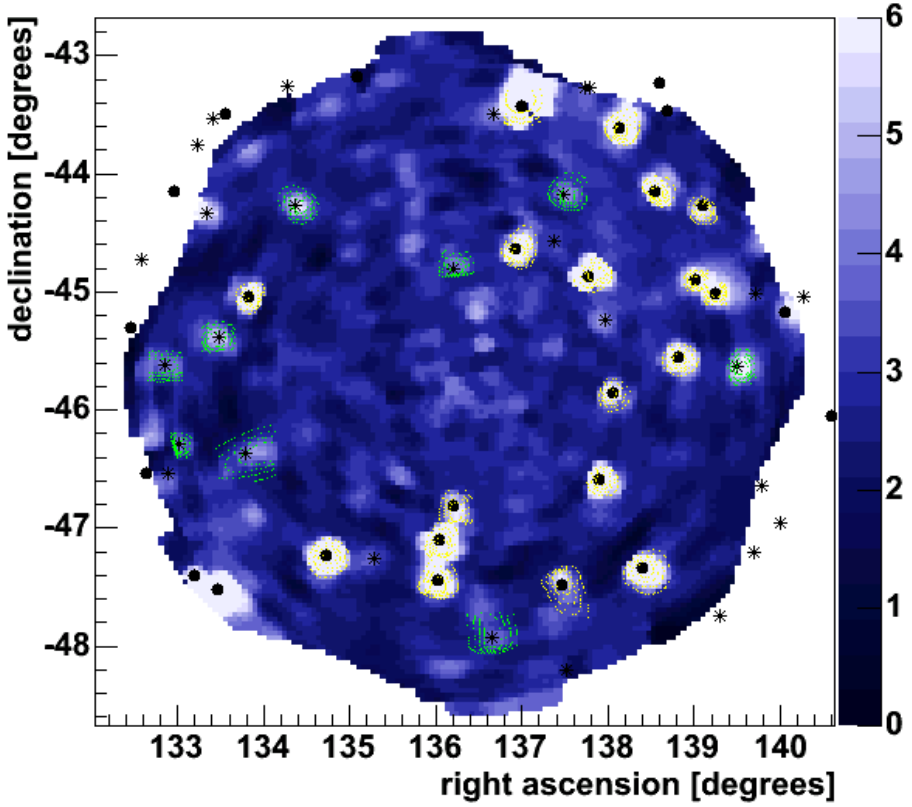


- Good agreement
  - MC simulations
  - γ ray excess events
- Narrow PSF
  - < 0.1°

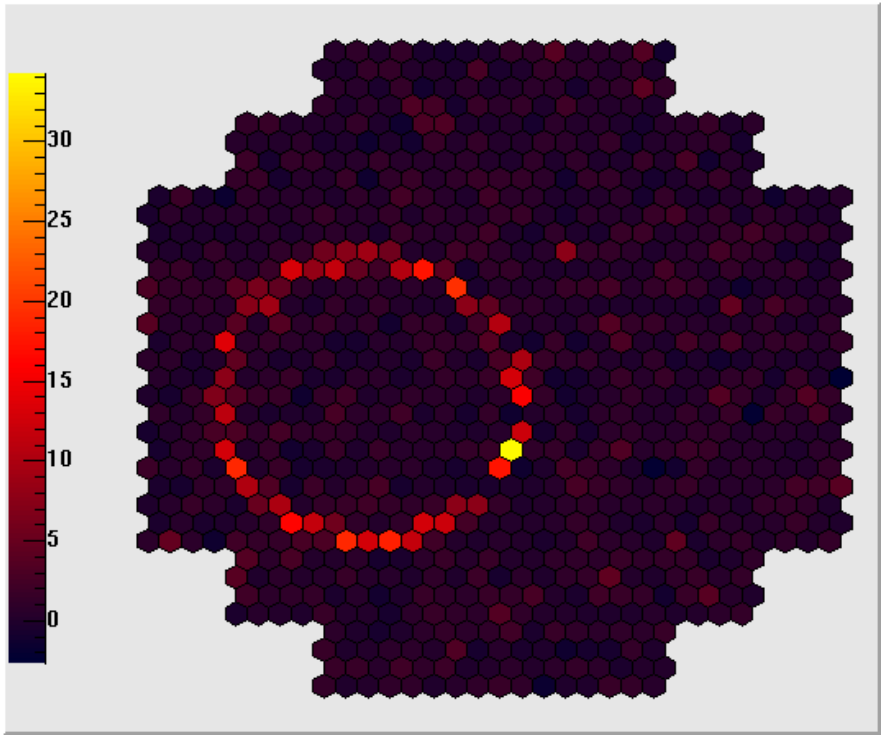


Data quality checks

PMT currents check pointing better than 20”

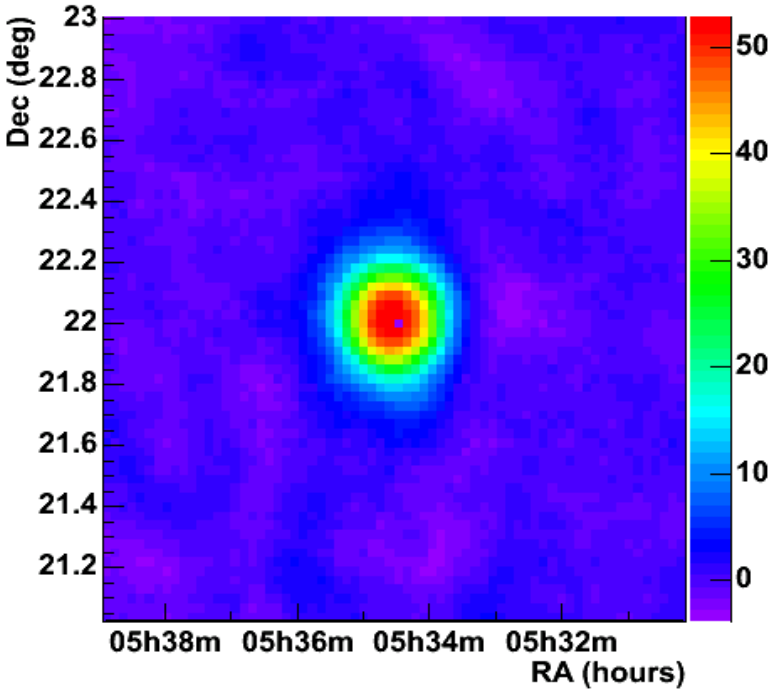


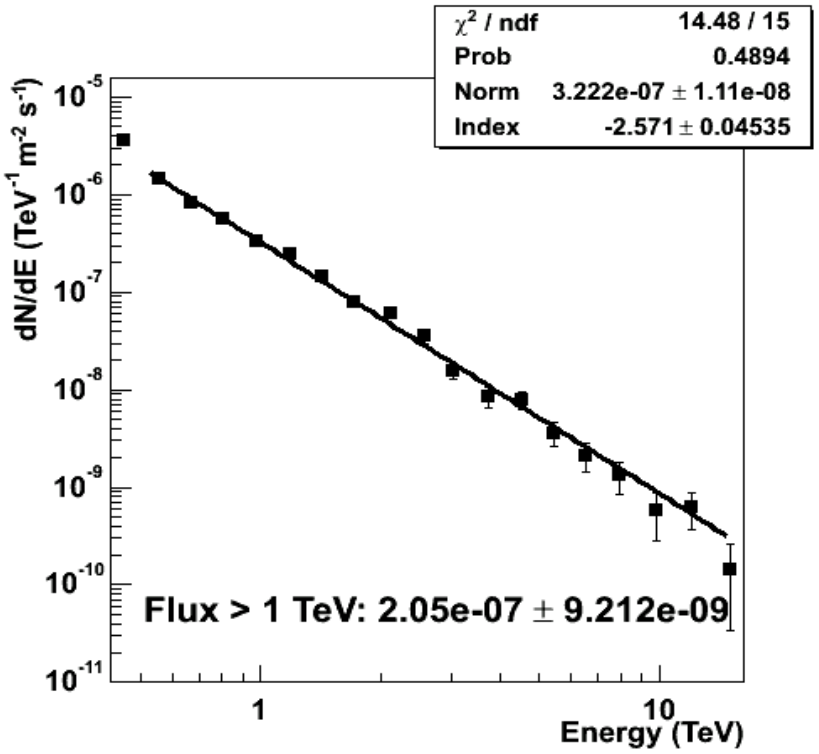
Imaging & absolute calibration: muon rings



Crab Nebula

- Observations in 2003
  - 2.8 hours of data
  - 3 telescope stereo data
  - 46° Zenith Angle
  - 350 GeV energy threshold

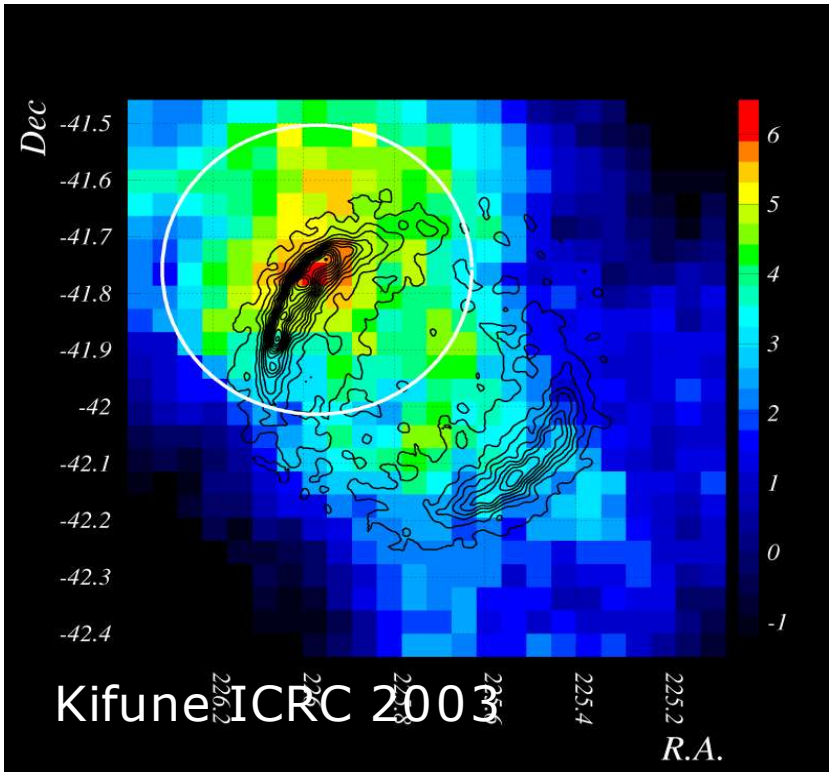




- Strong detection
  - 6.68 γ/min., 53 σ
  - Flux, spectrum consistent with other measurements
  - Consistent with point source

SN 1006

CANGAROO

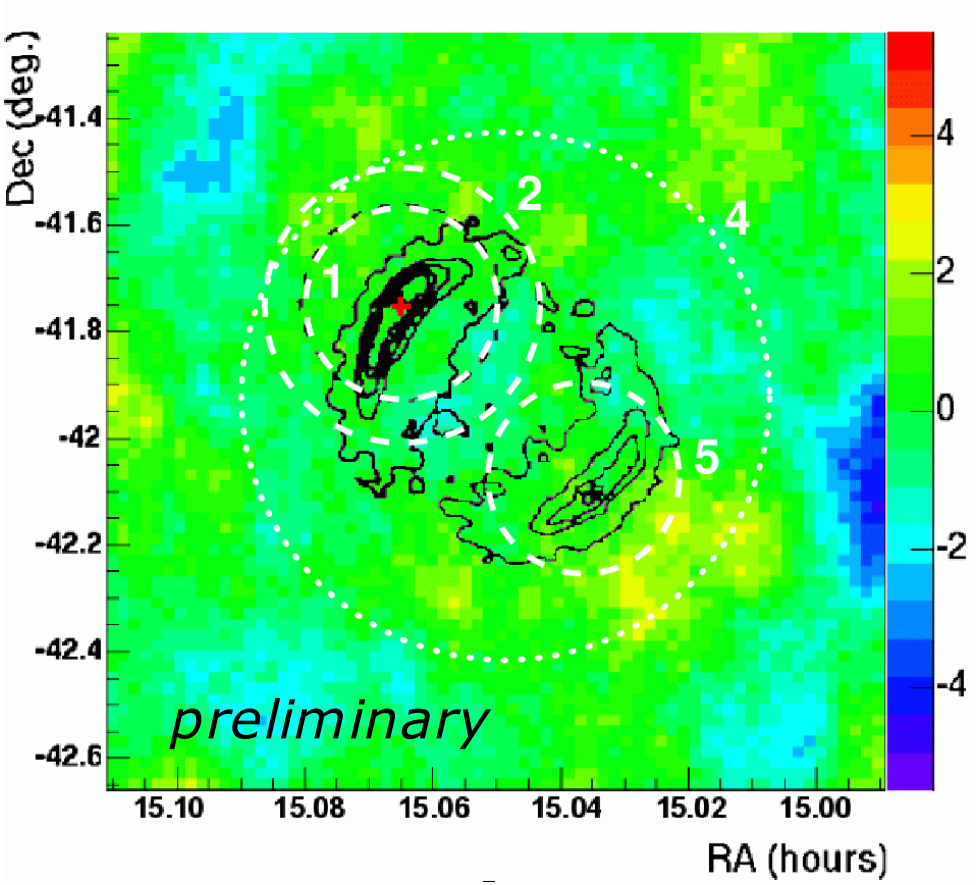


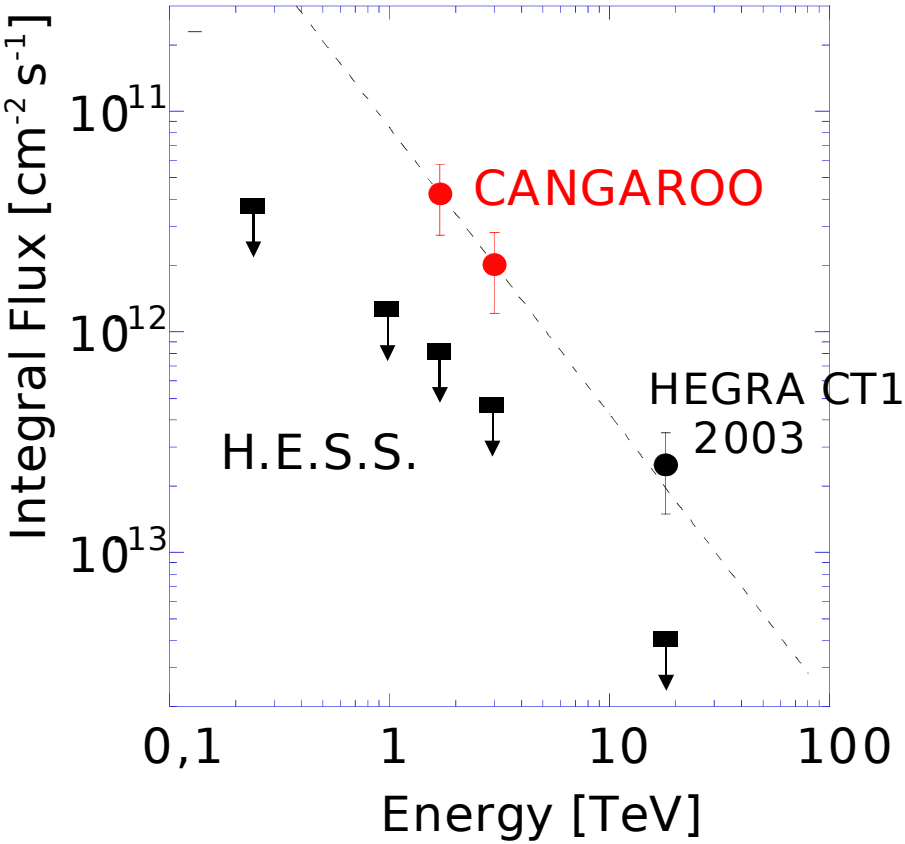
Kifune ICRC 2003

Tanimori et al., ApJ 497 (1988) L25
3.8 m telescope
+ conference proceedings

SN 1006

H.E.S.S.

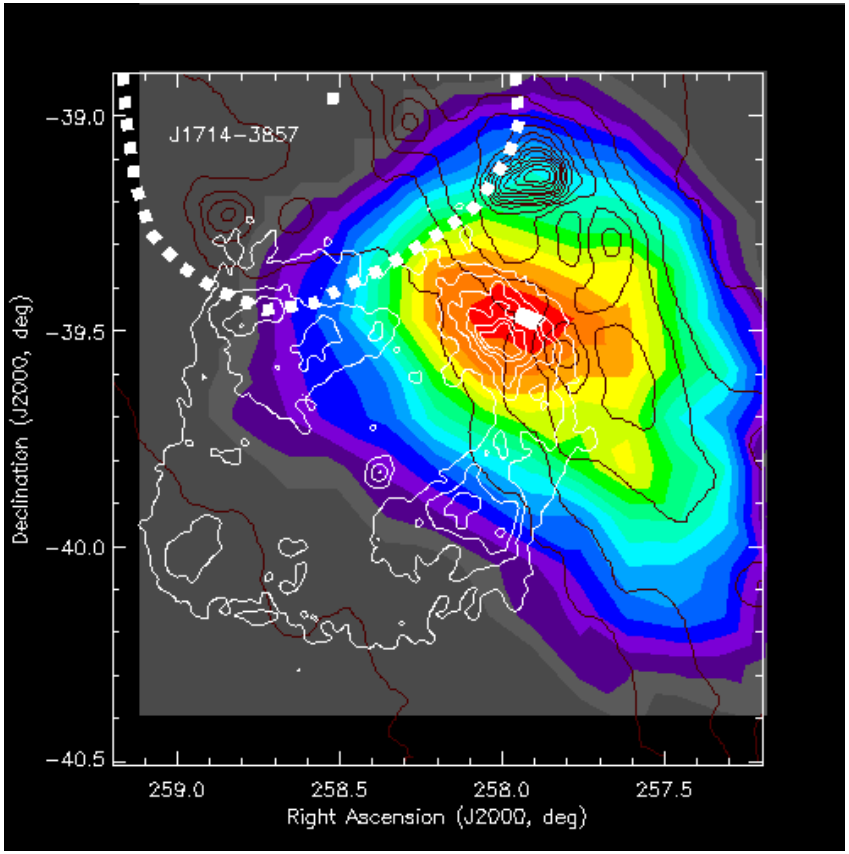




18 hours 2 Telescope data, 2003
No signal seen

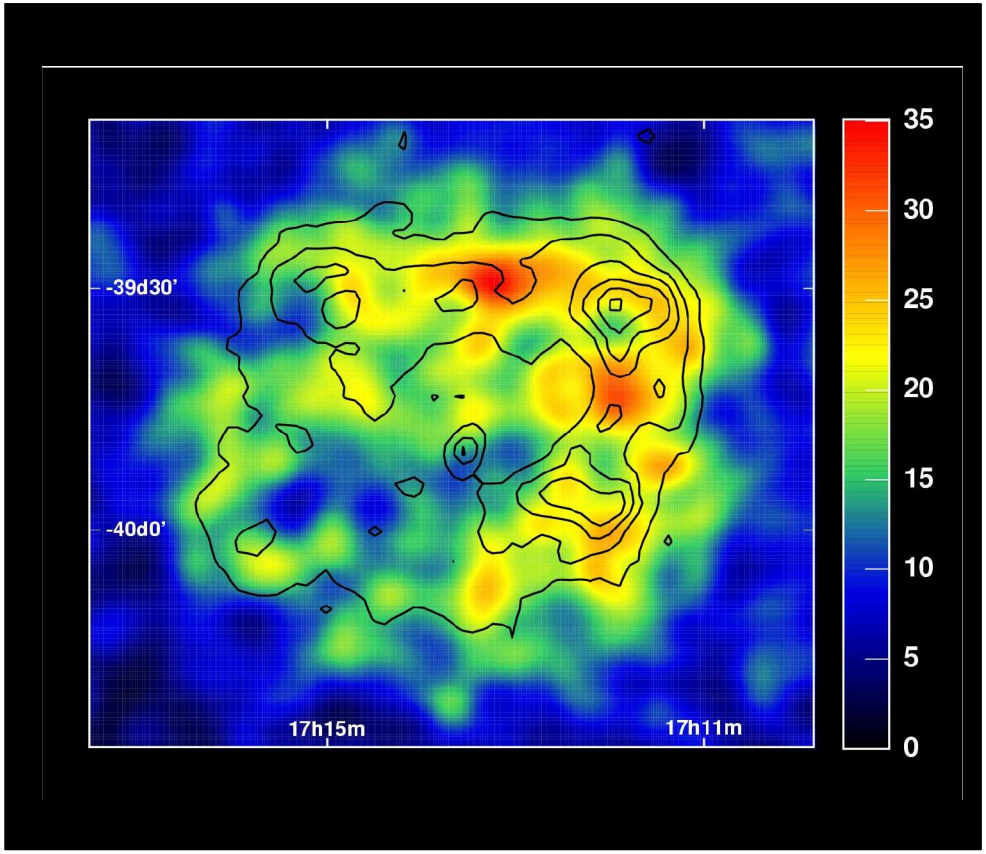
RXJ 1713.7-3946

CANGAROO

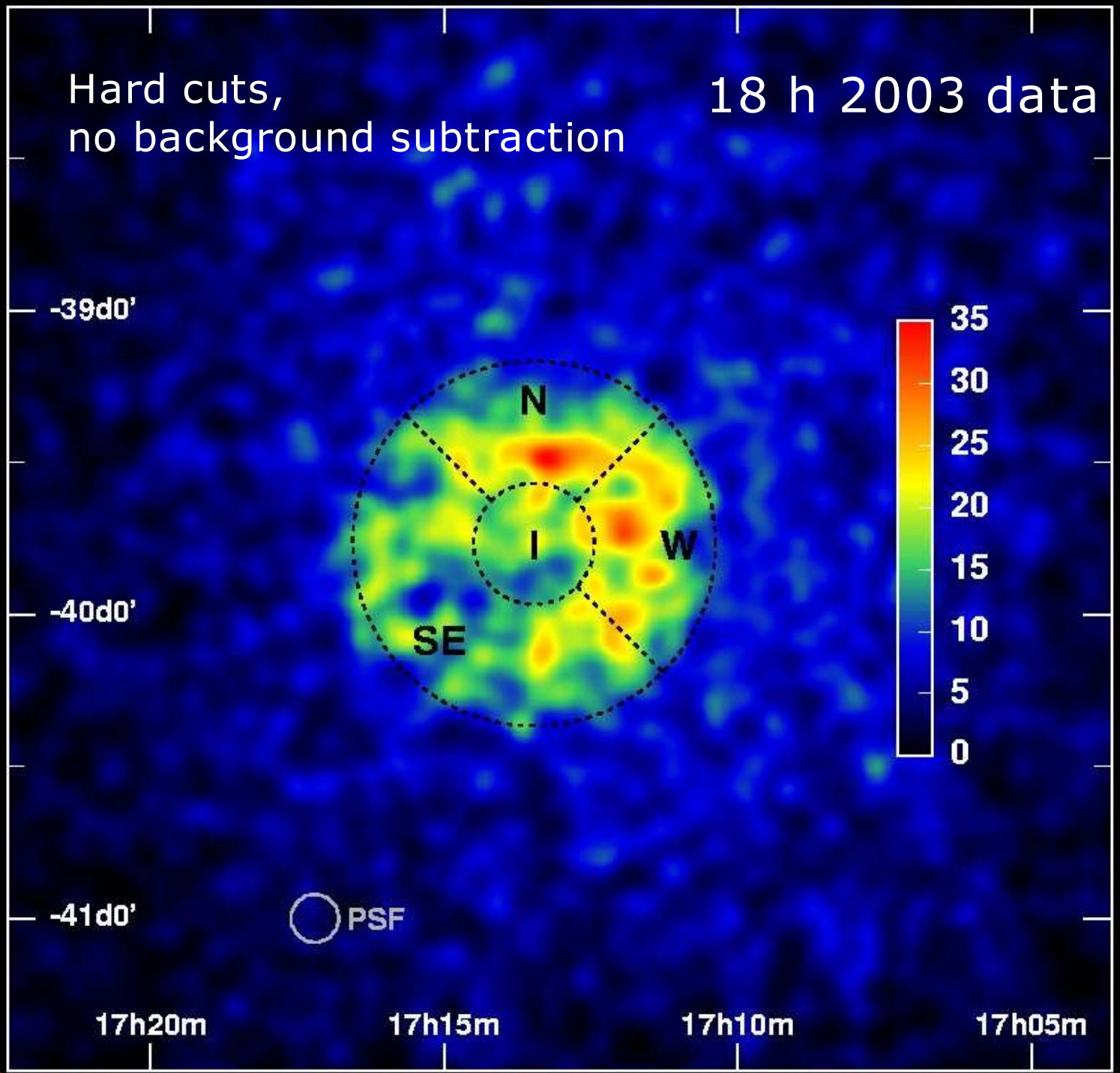


Kifune ICRC 2003

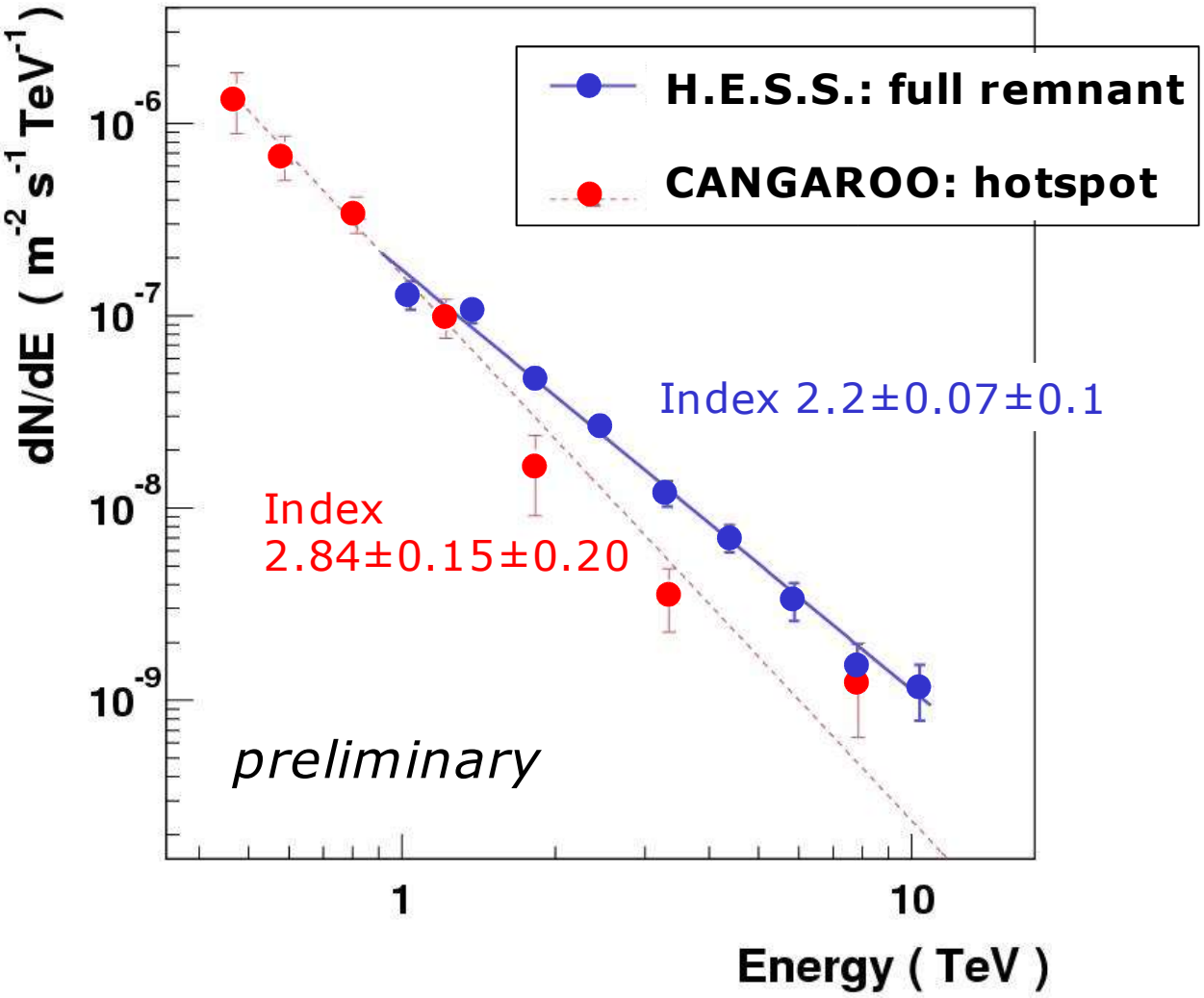
H.E.S.S.



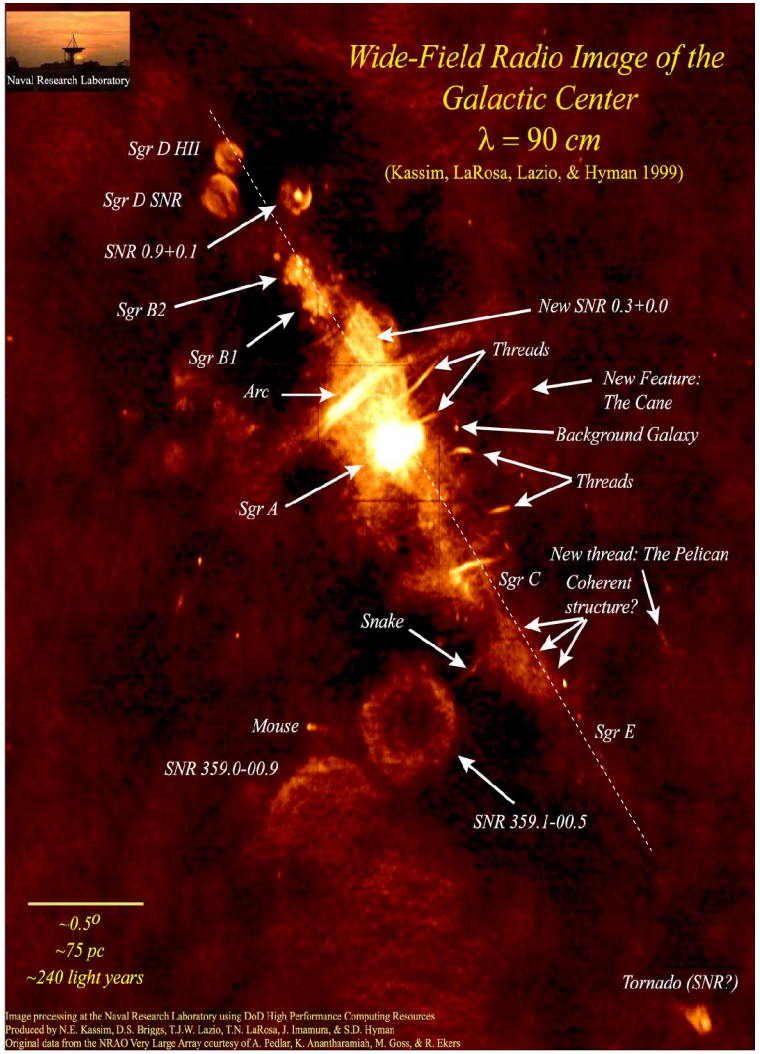
18 hours 2 telescope data 2003
>20σ, clearly extended

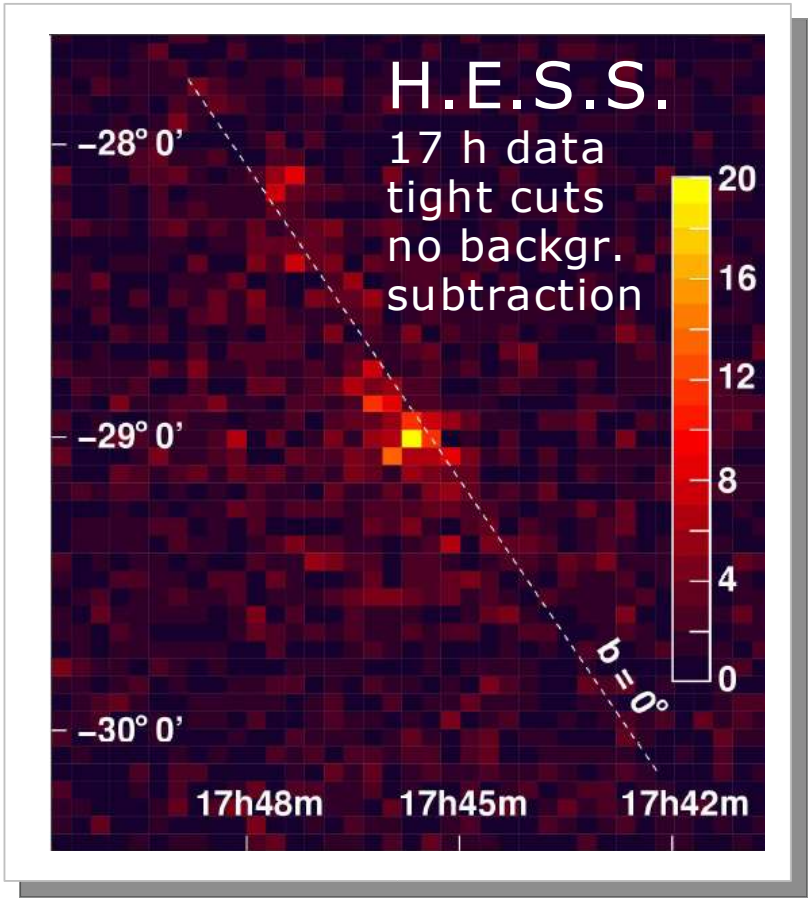

Hard cuts,
no background subtraction
18 h 2003 data
-39d0'
-40d0'
-41d0'
N
I
W
SE
PSF
35
30
25
20
15
10
5
0
17h20m
17h15m
17h10m
17h05m

RX J1713 Spectrum



TeV gamma rays from GC

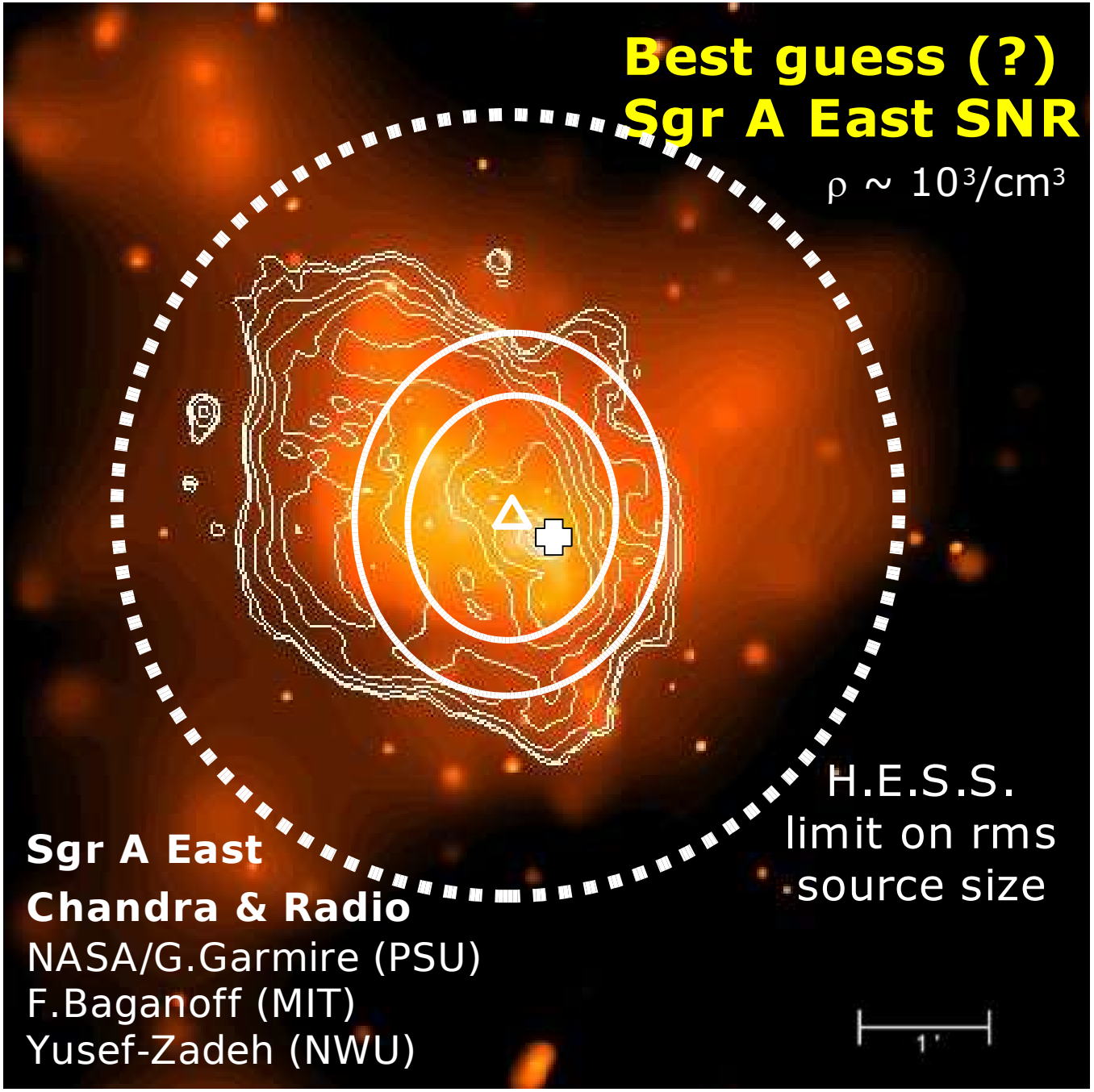




17 hours 2 telescope data

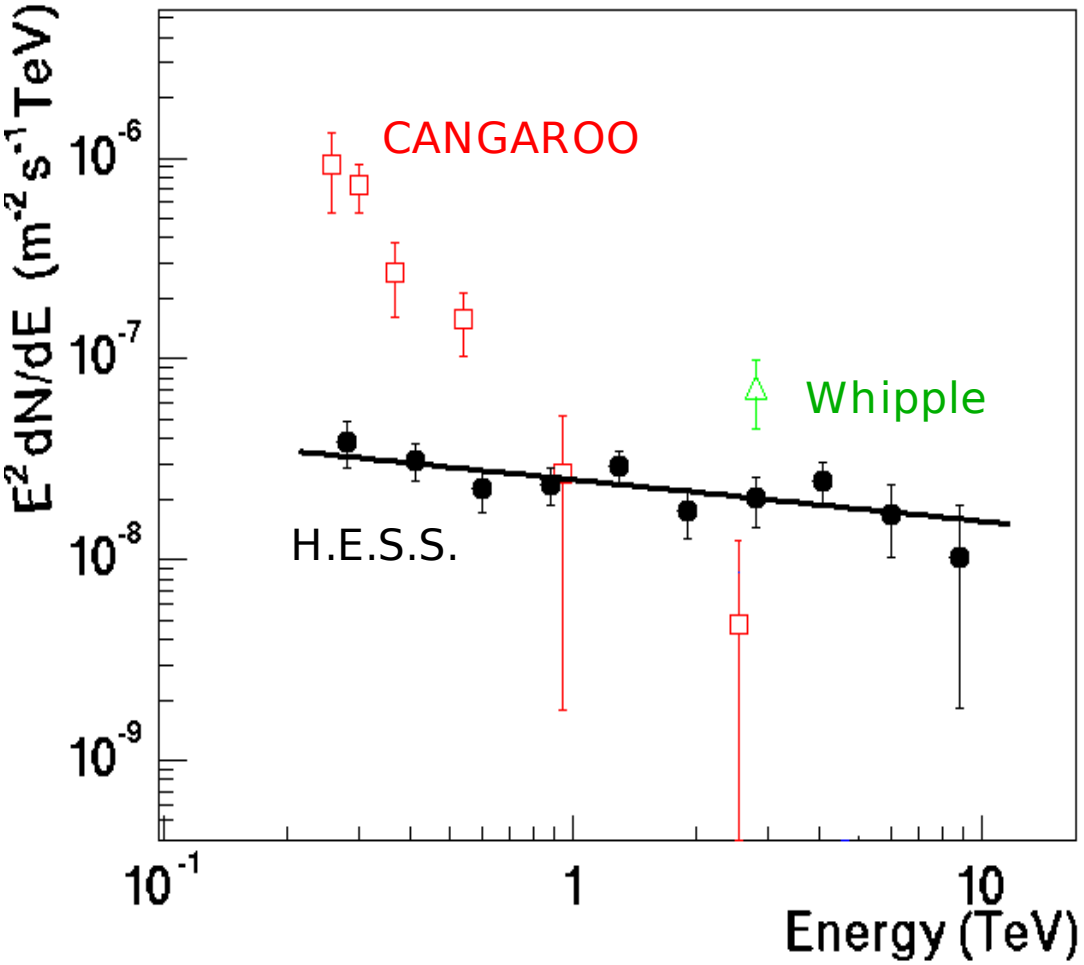
> 10σ

Point source (size < 3' or 7 pc)

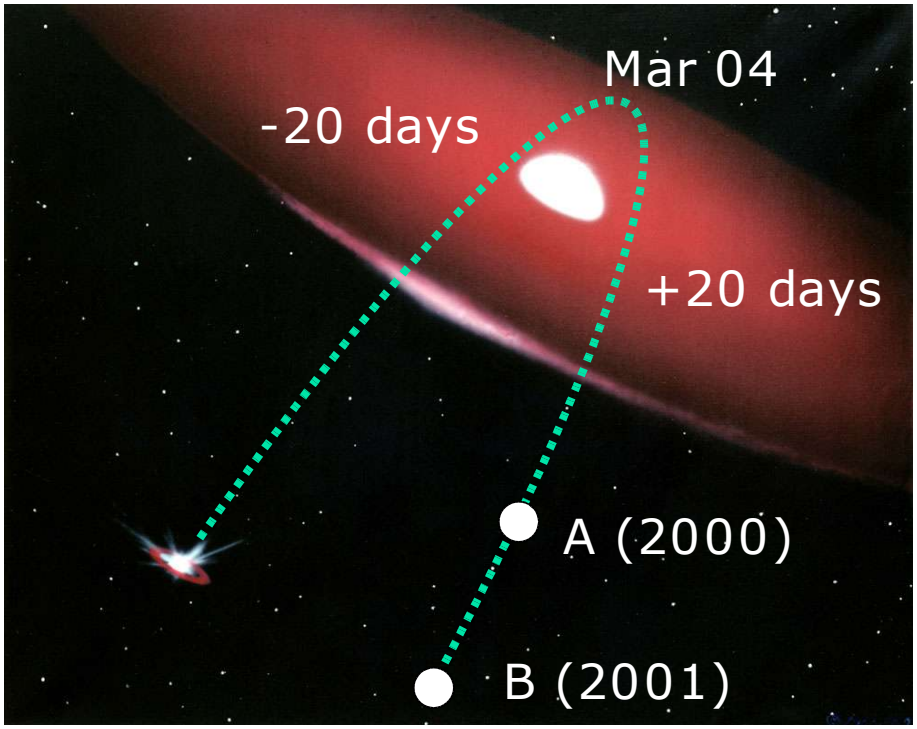

Best guess (?)
Sgr A East SNR
ρ ~ 10³/cm³
H.E.S.S.
limit on rms
source size
Sgr A East
Chandra & Radio
NASA/G.Garmire (PSU)
F.Baganoff (MIT)
Yusef-Zadeh (NWU)
1'

Galactic center spectra

- CANGAROO
  - Slope -4.6 ± 0.5
  - Flux ~ 1 Crab!
  - H.E.S.S. should see it in minutes
- H.E.S.S.
  - Slope -2.2 ± 0.09
  - Flux 6% Crab
- Whipple
  - Flux marginally consistent



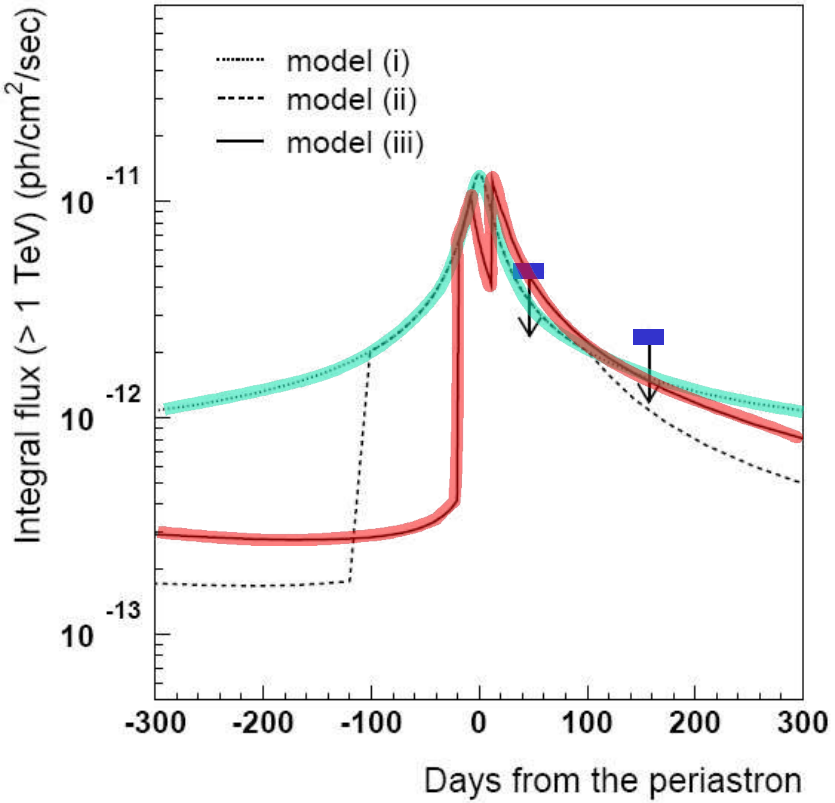
PSR B1259-63



Model: Ball & Kirk 2000

CANGAROO

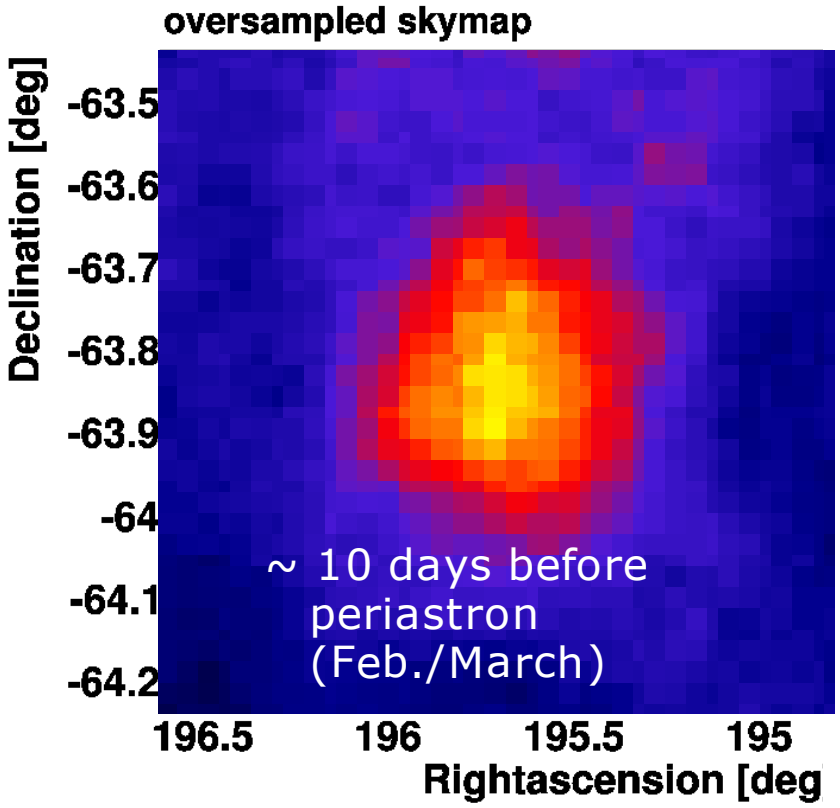
Kawachi et al. 2004



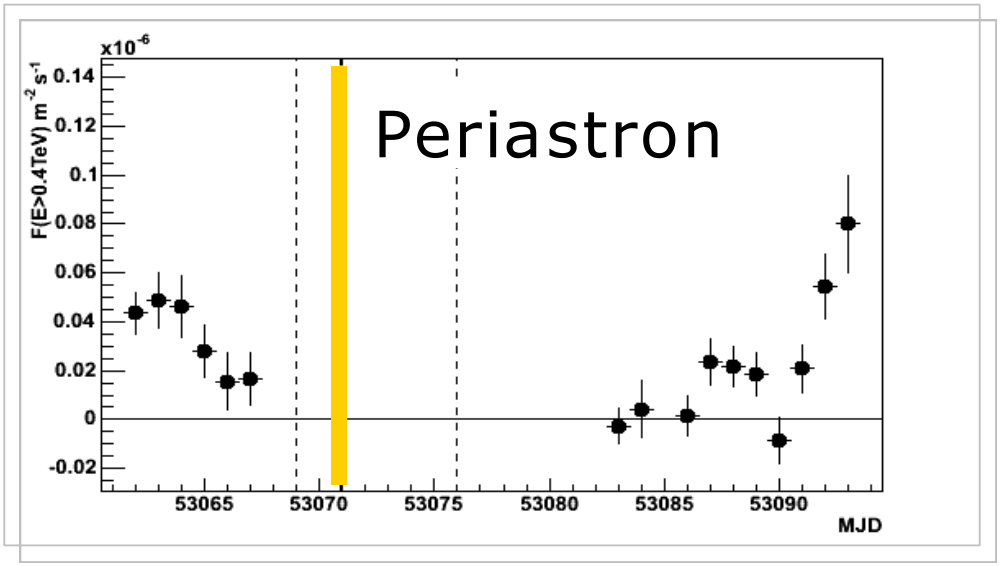
Complex time dependence depending on alignment of pulsar and stellar wind

PSR B1259-63

H.E.S.S. preliminary

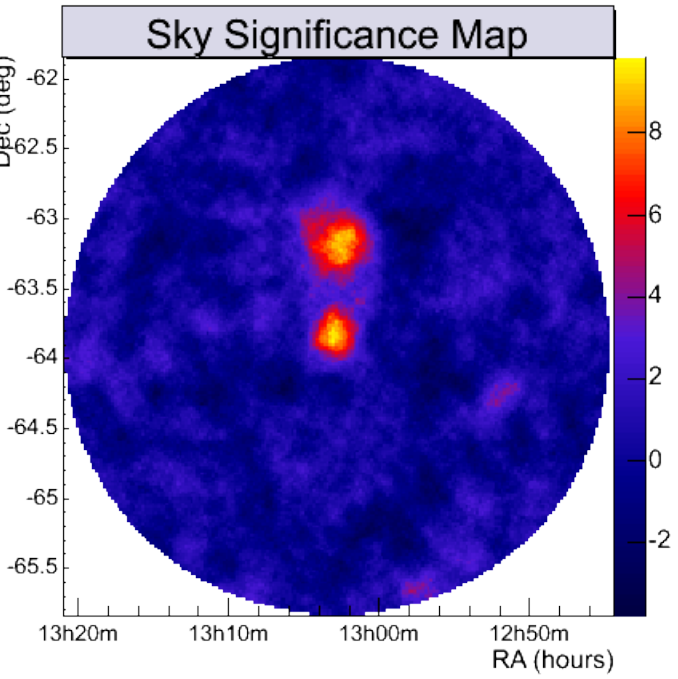


- Strong detection
  - ~ 9 σ pre-periastron
  - ~ 6 σ post-periastron
  - Flux ~5% Crab
  - Spectral Index 2.8±0.3 (stat)

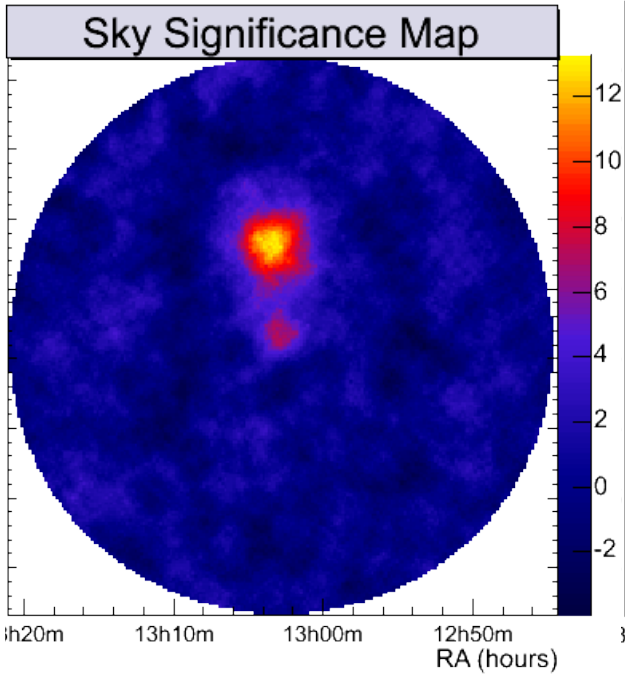


VHE J1303-63

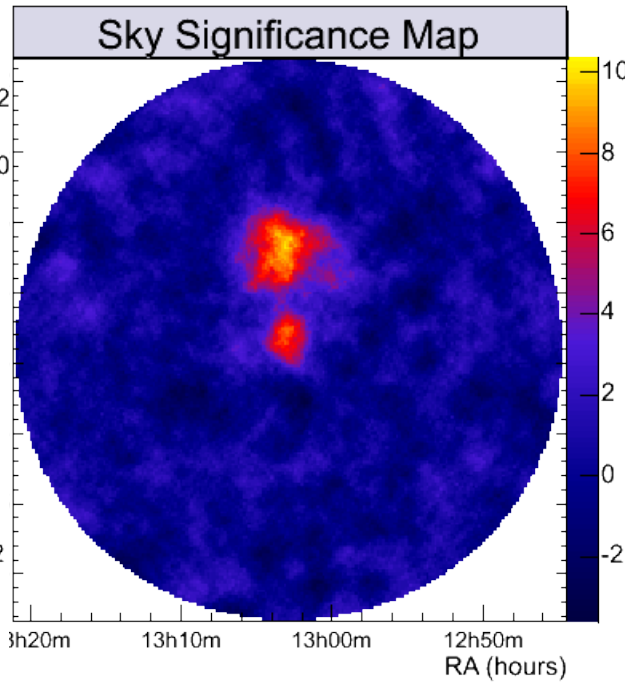
Feb. 04



March 04



Apr./May 04



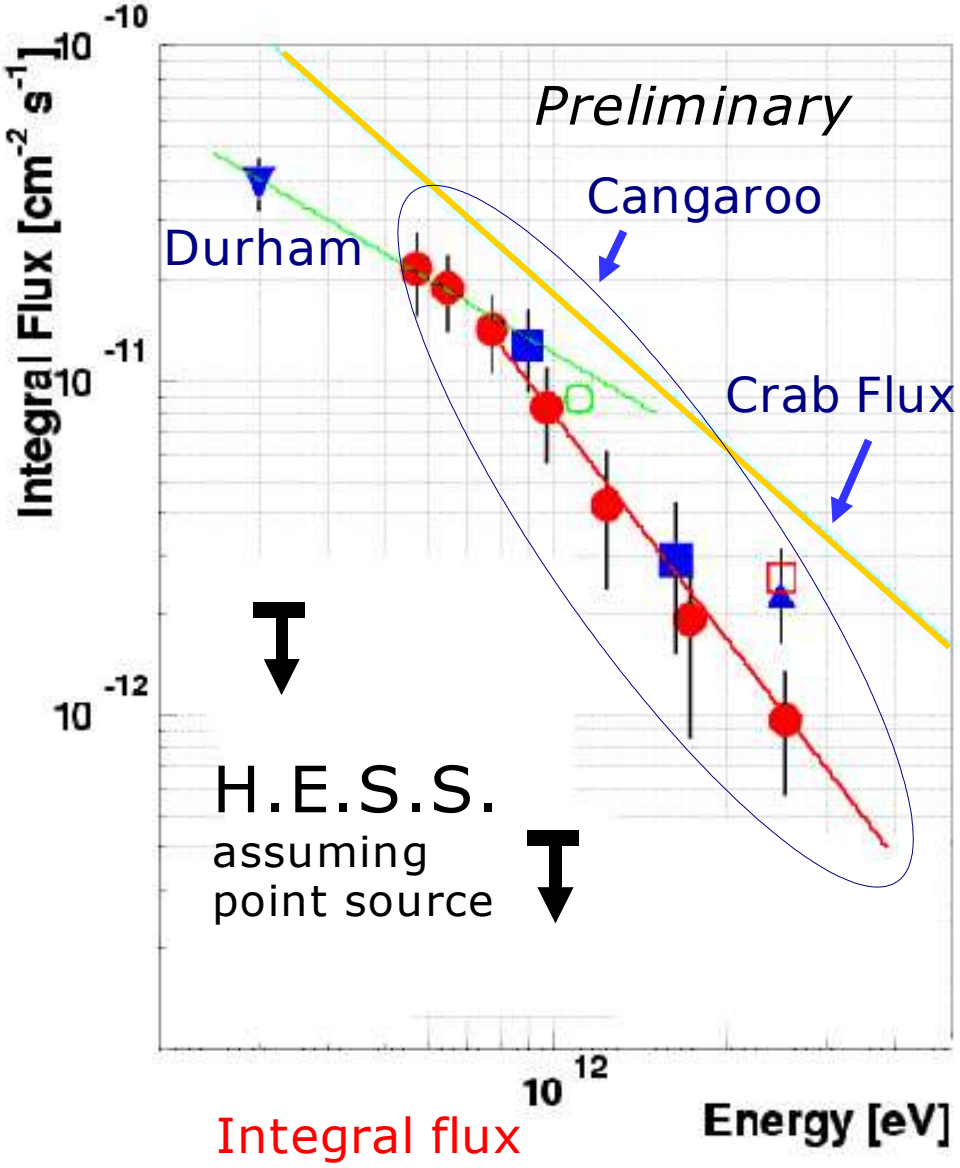
- New unidentified TeV source
  - 39 hours, >13 σ detection
  - Looks extended at 0.2° level, steady flux
  - Index ~2.2, ~10% Crab

Galactic sources with H.E.S.S.

Object	Previous Detection	H.E.S.S. Observations
Crab nebula	Whipple, HEGRA, CAT	> 50 σ
SN 1006	CANGAROO, 70% Crab	Upper limit, 10% Crab
Vela	CANGAROO, 60% Crab	Upper limit, 7% Crab
PSR 1706-44	CAN, Durham, 50%	Upper limit, 3% Crab
RX J1713	CANGAROO, ~1 Crab	20 σ, 50% Crab
Gal. center	CANGAROO, ~1 Crab	11 σ, 6% Crab
PSR B1259		10 σ, 5% Crab
VHE J1303		13 σ, 10% Crab

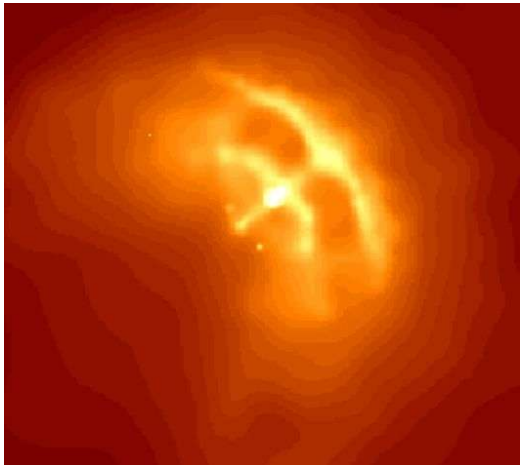
PSR 1706-44

- Detected by Durham and CANGAROO-I,II
  - Kifune et al. 1995
  - Chadwick et al. 1998
  - Kushida et al., ICRC 2003
- H.E.S.S.
  - 14 h 2-telescope data
    - Commissioning phase
  - No signal seen
    - Upper limit 3% of Crab flux



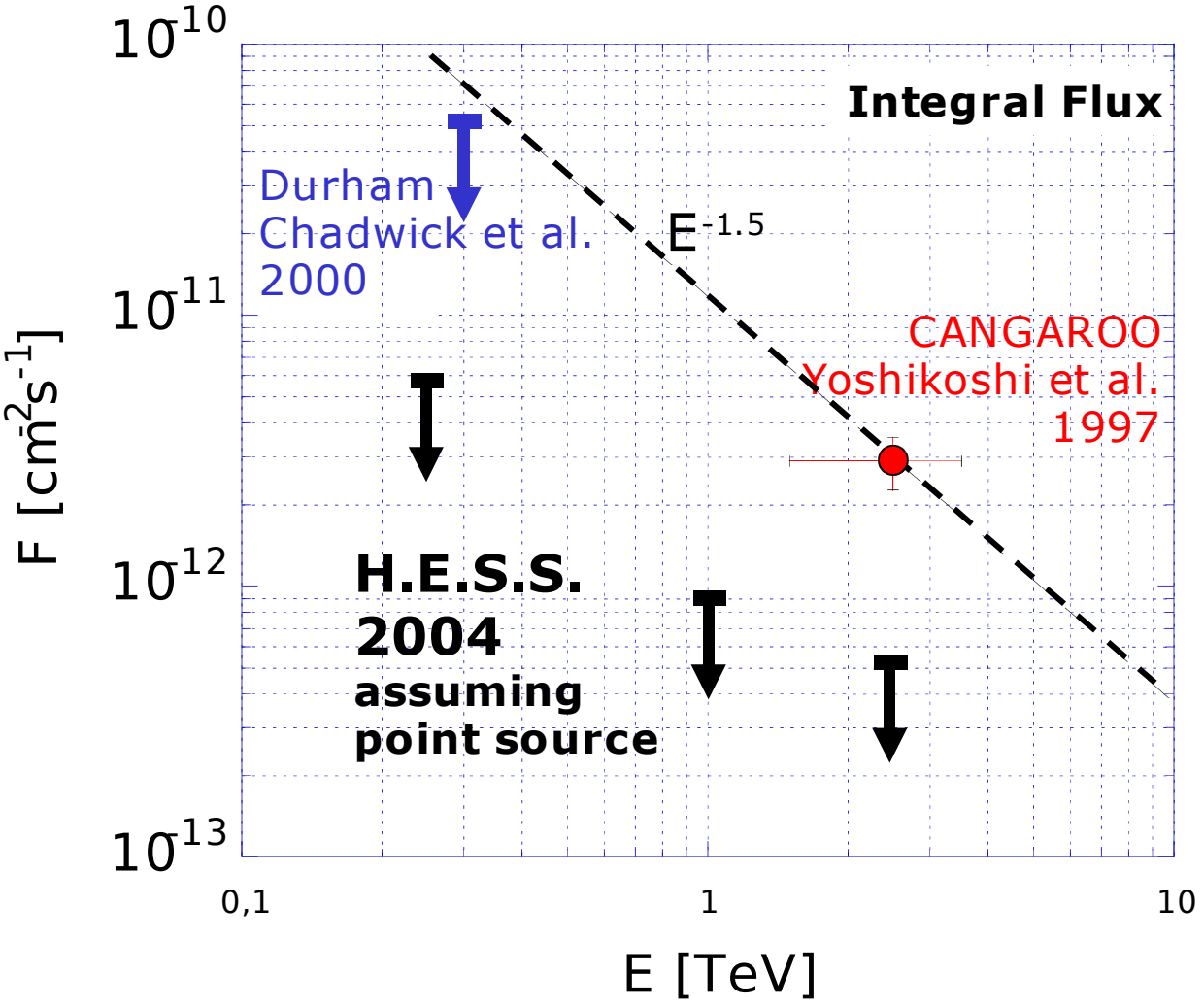
VELA

preliminary



Chandra

- CANGAROO source 0.13° off pulsar
- H.E.S.S. limits similar for both CANGAROO and pulsar location



Galactic center: PMT currents