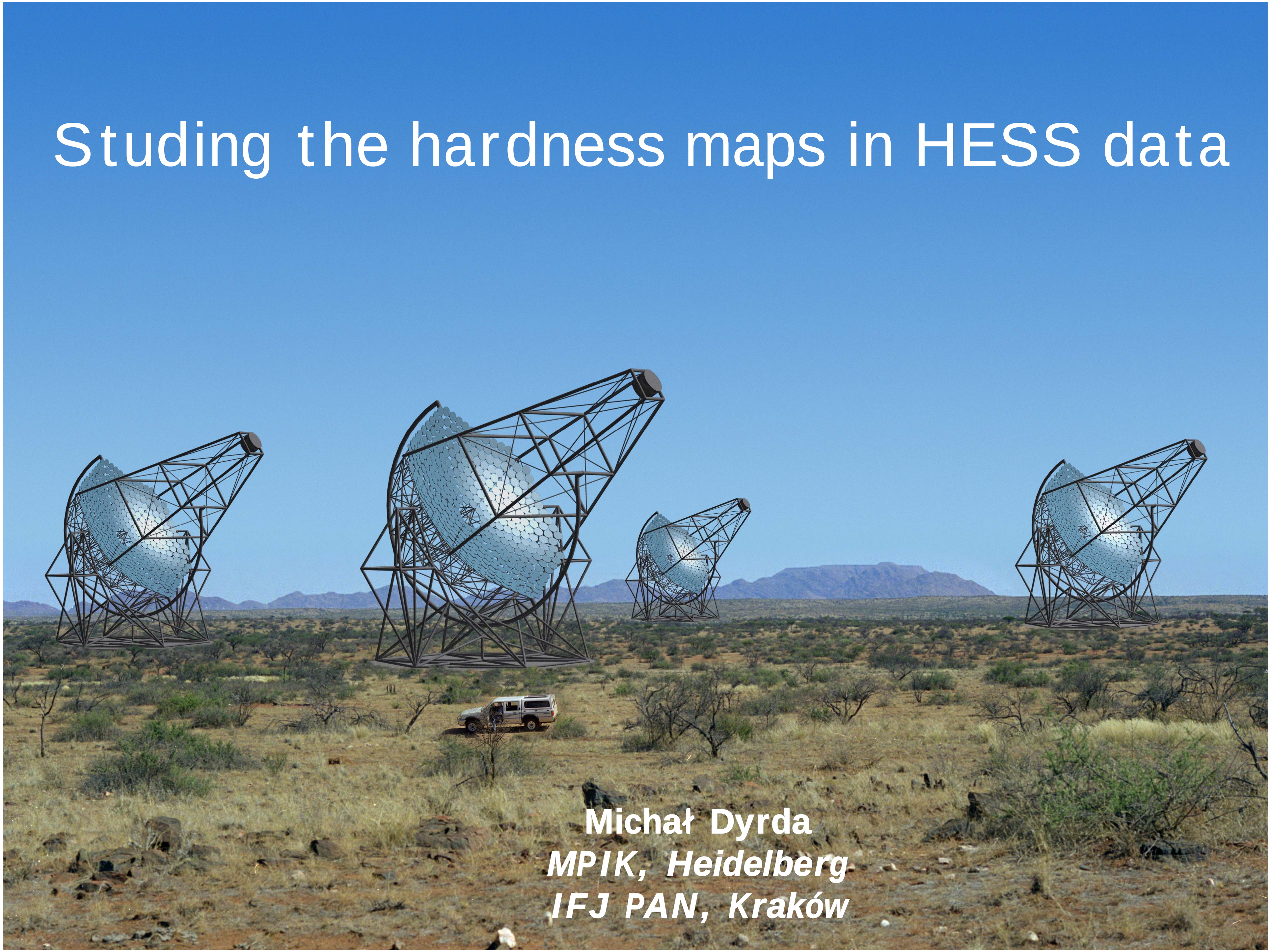
Studing the hardness maps in HESS data



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Heidelberg HESS analysis

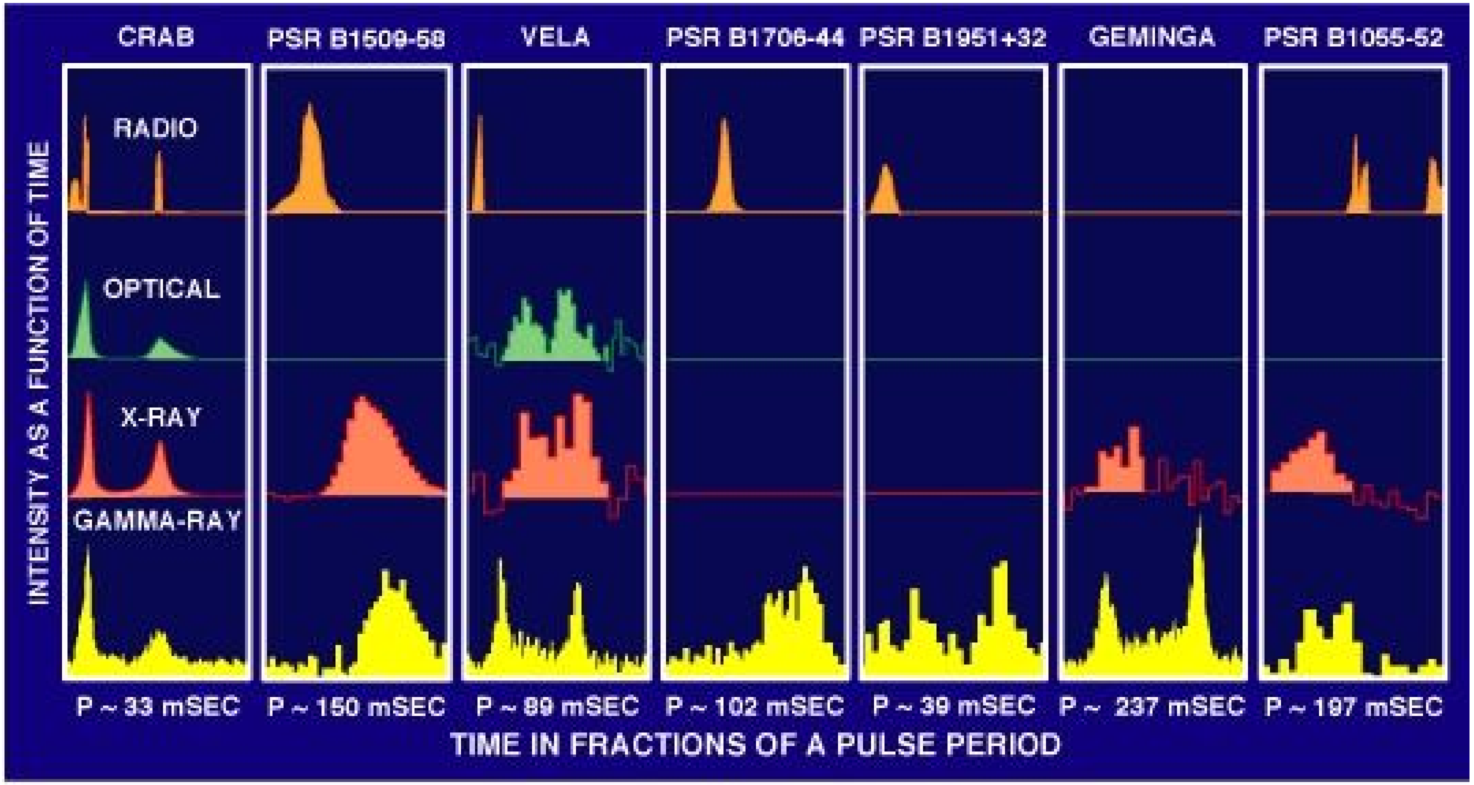
- wobble_chain – main program to analysis
- Searching for data – coordinates or name
- Choice – hard and/or standard cuts
- Software – C++ i ROOT
- Results – maps, spectrum, lightcurves

Standard vs. hard cuts

- Crab Nebula – „standard candle" of VHE gamma astronomy
- „selection cuts" – maximum σ for sources
- Optimalization – simulations + real background data
- With background σ growths proportionally to $\sqrt{t_{obs}}$
- Standard cuts – for sources with flux 10% Crab Nebula, with simillar spectrum - maximum $\sigma/\sqrt{t_{obs}}$
- Hard cuts – 1% of Crab Nebula flux, hard spectrum (Γ=2)
- Hard cuts – better for faint sources with rather hard spectrum
- Hard cuts give higher significance at the expense of energy threshold and cuts efficiency
- Hard cuts useful because of the reduction of systematic uncertainties –> background reduction relative to signal

Pulsar Wind Nebulae

- Pulsars - sources of powerful winds of highly relativistic particles
- Strong shocks - places of particle acceleration
- Inverse Compton scattering results in VHE gamma rays

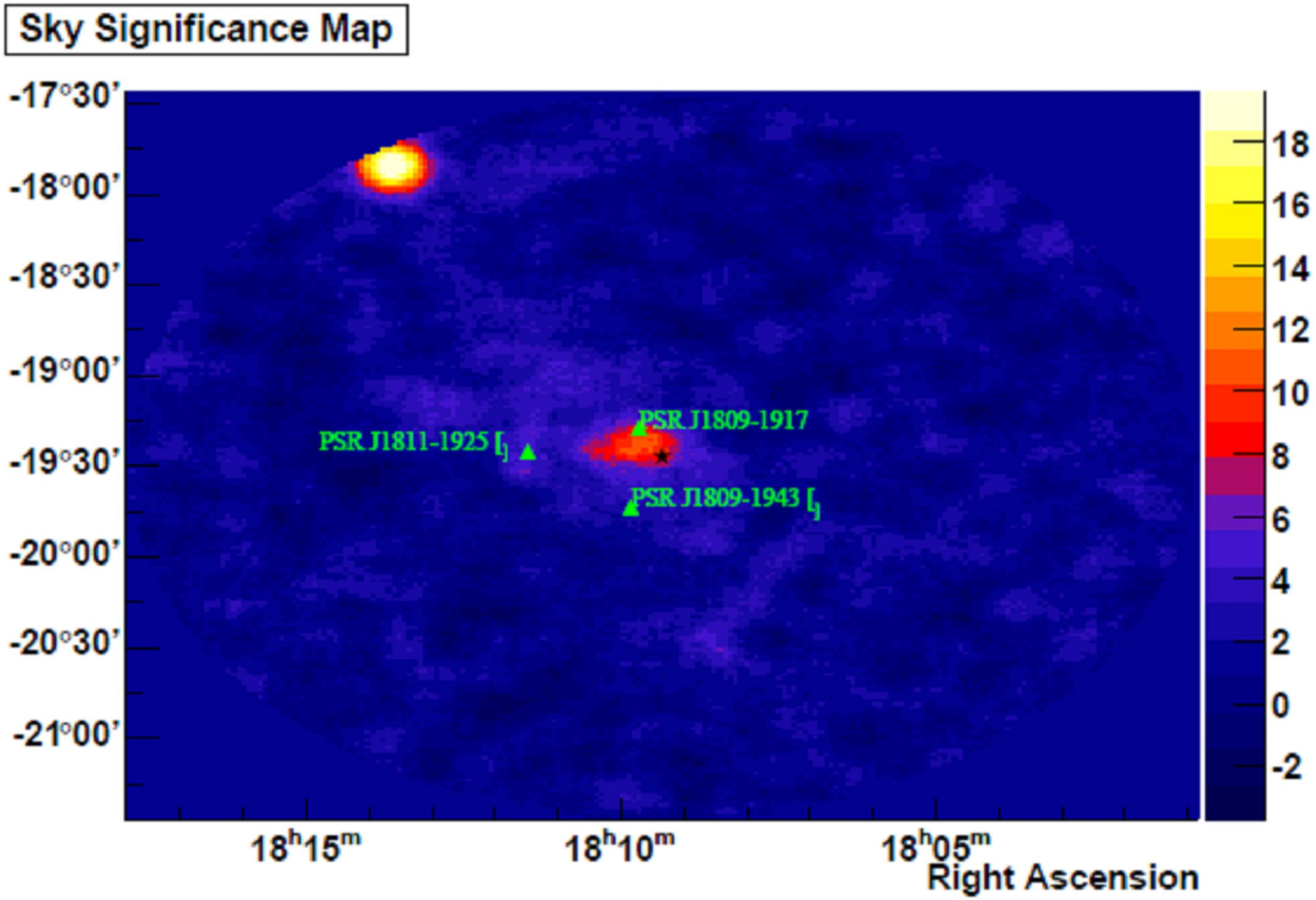


HESSJ1809-193

- Observations ~25 hours, 3600 gamma events
- Analysis – standard and hard cuts
- Pulsar PSR J1809-1917, P=83 ms (Vela type)
- Offset of the VHE emission from pulsar - due to pulsar proper motion ?
- Energy flux 1-10 TeV: $1.3 \cdot 10^{-11}$ erg/s•cm^2
- Hardness map – to study structure of the source in high and low energies
- Also - difference in photon hardness in the middle and near boundary
- HESS J1809-193 – PWN candidate

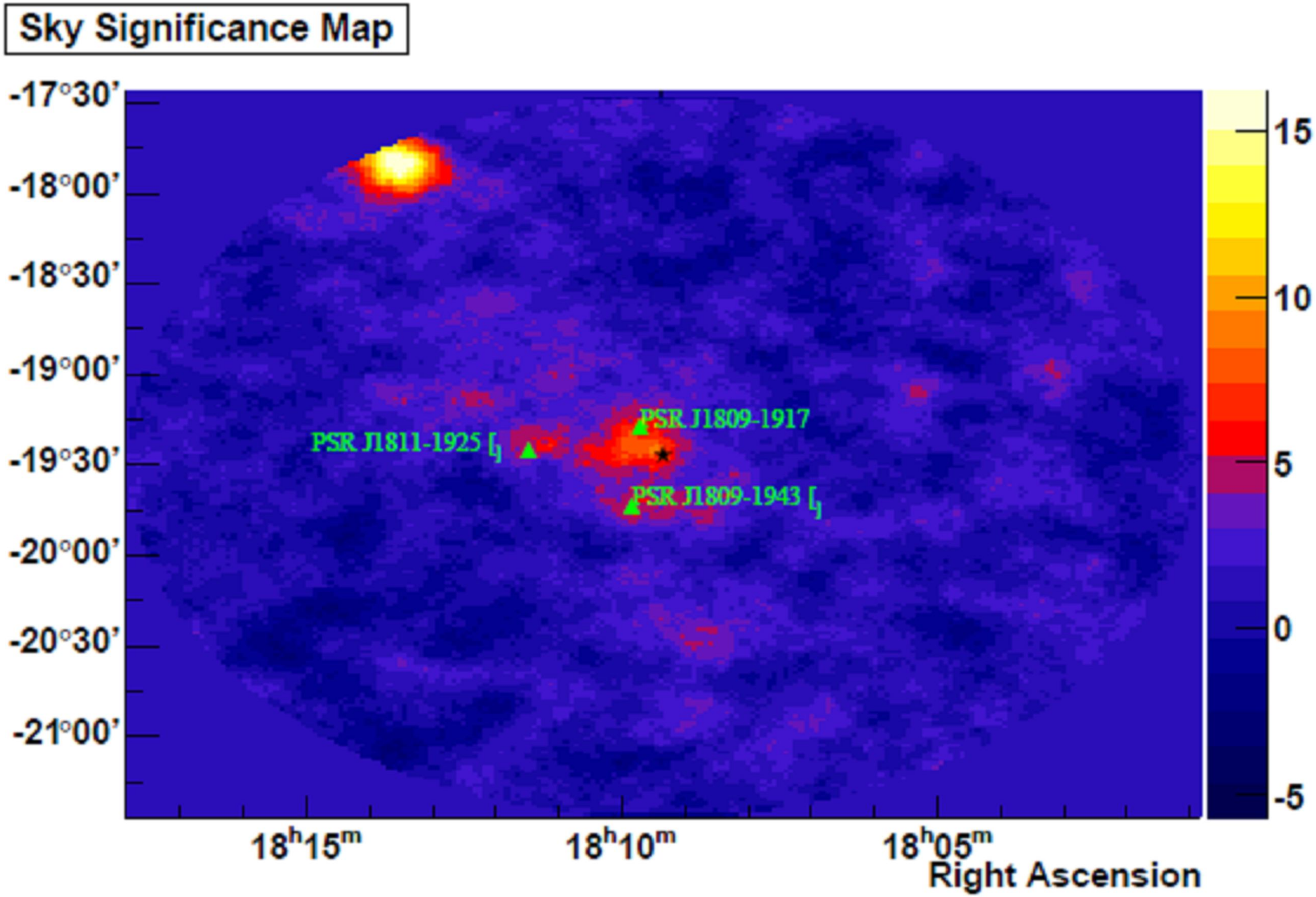
$$\varepsilon_\gamma \equiv L_\gamma / \dot{E} = 1.2$$

Hard cuts

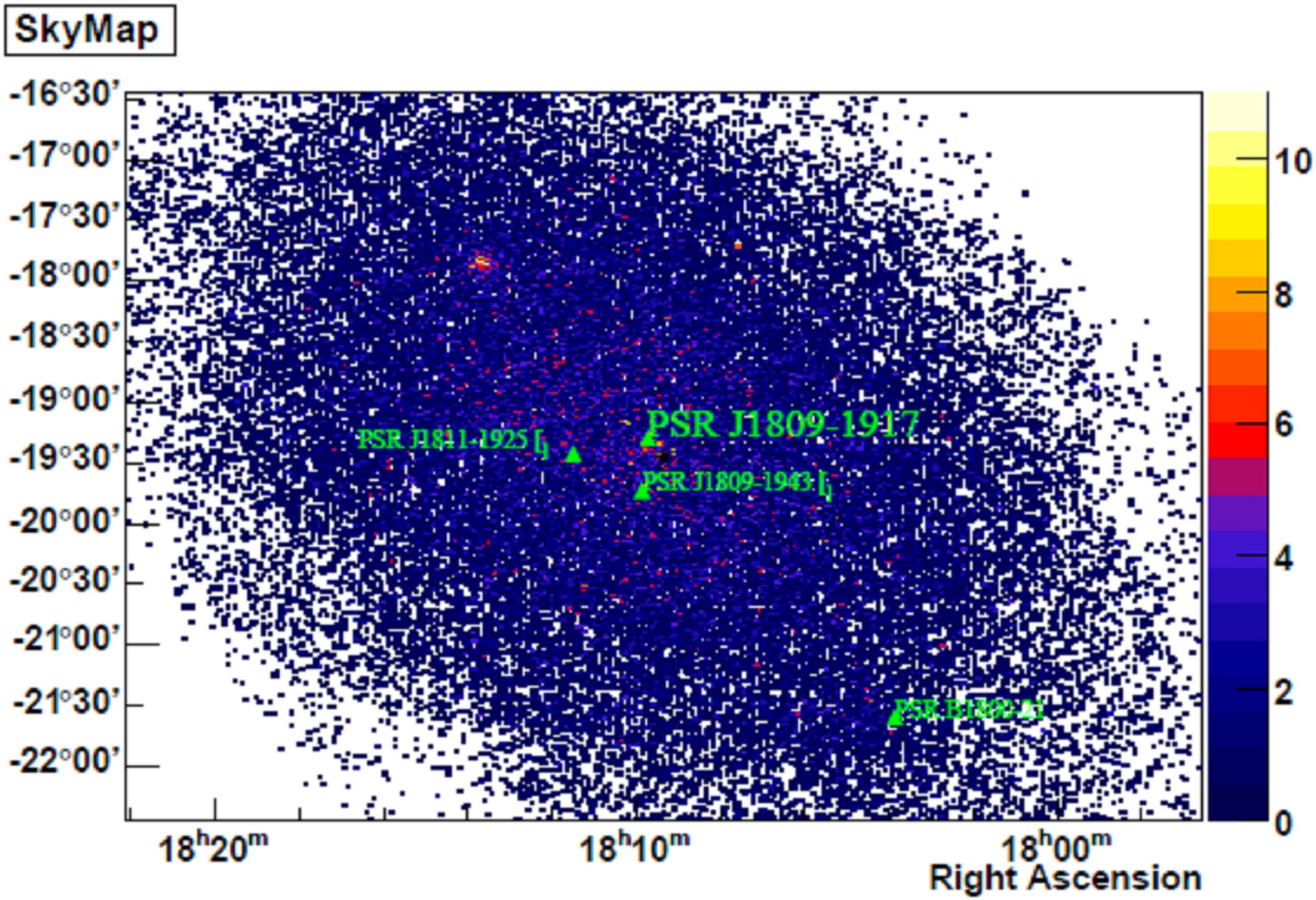


Sky Significance Map
-17°30'
-18°00'
-18°30'
-19°00'
-19°30'
-20°00'
-20°30'
-21°00'
PSR J1809-1917
PSR J1811-1925
PSR J1809-1943
18
16
14
12
10
8
6
4
2
0
-2
18^h15^m
18^h10^m
18^h05^m
Right Ascension

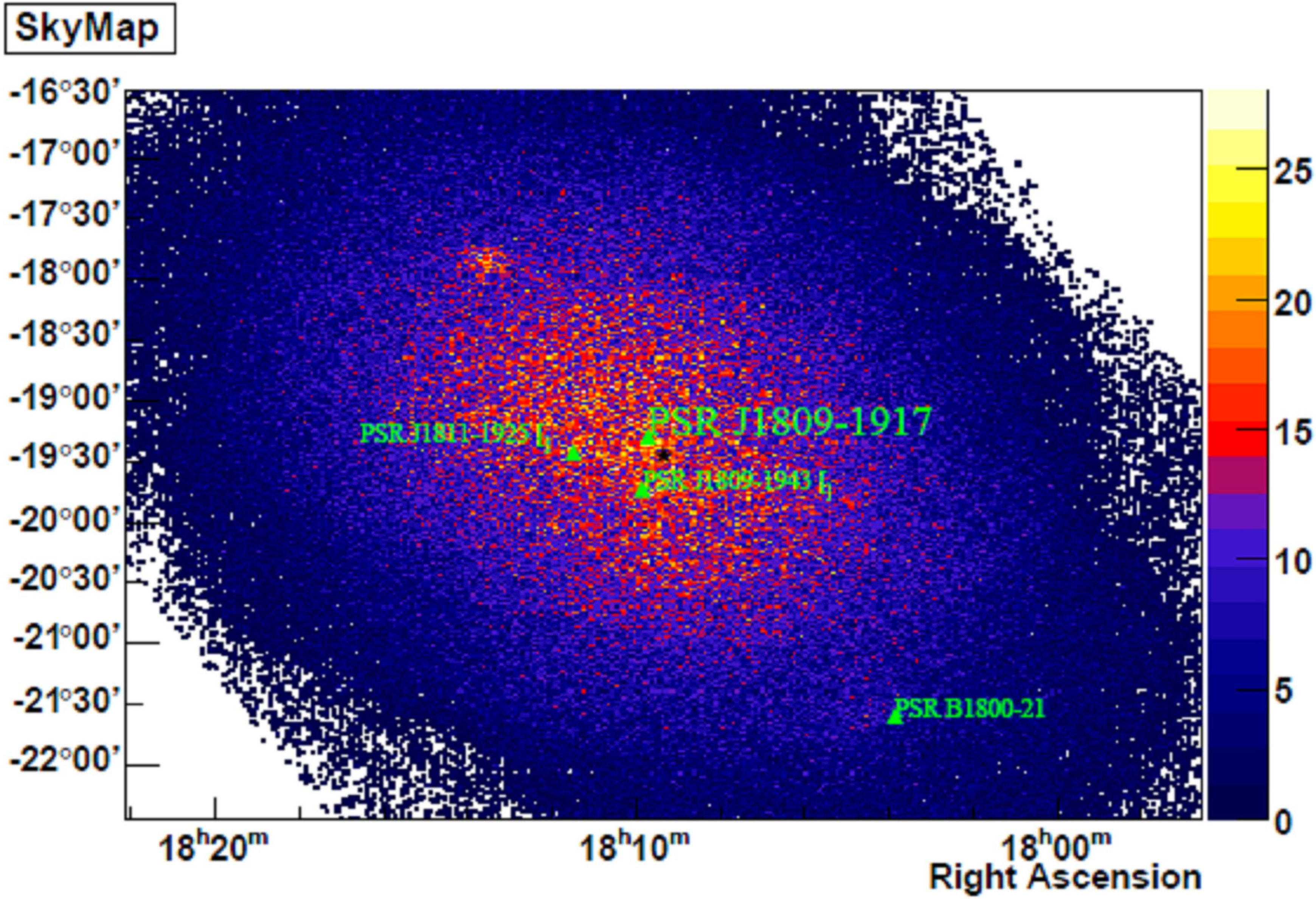
Standard cuts



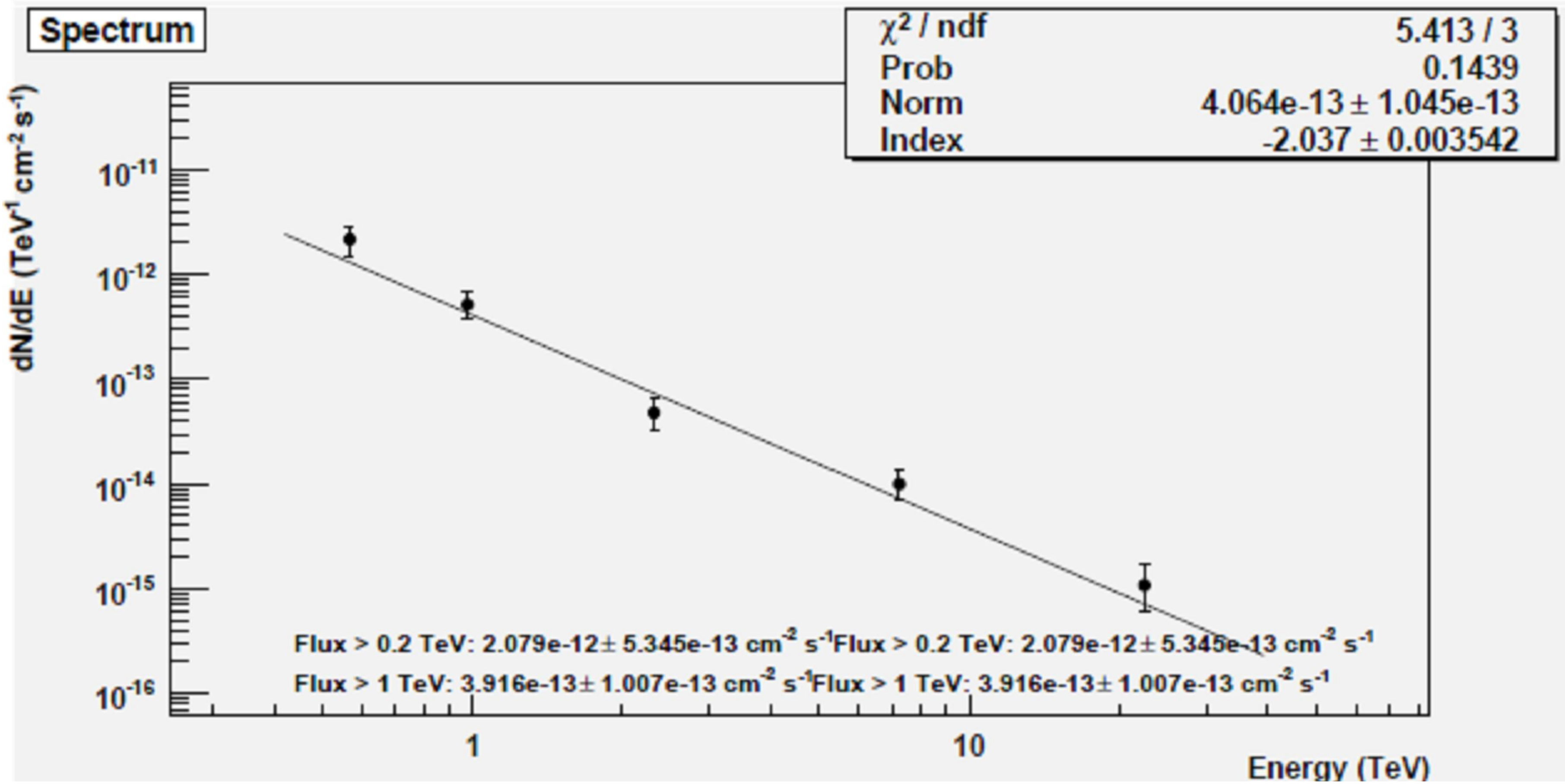
Hard cuts


SkyMap
-16°30'
-17°00'
-17°30'
-18°00'
-18°30'
-19°00'
-19°30'
-20°00'
-20°30'
-21°00'
-21°30'
-22°00'
PSR J1811-1925
PSR J1809-1917
PSR J1809-1943
18h20m
18h10m
18h00m
Right Ascension
10
8
6
4
2
0

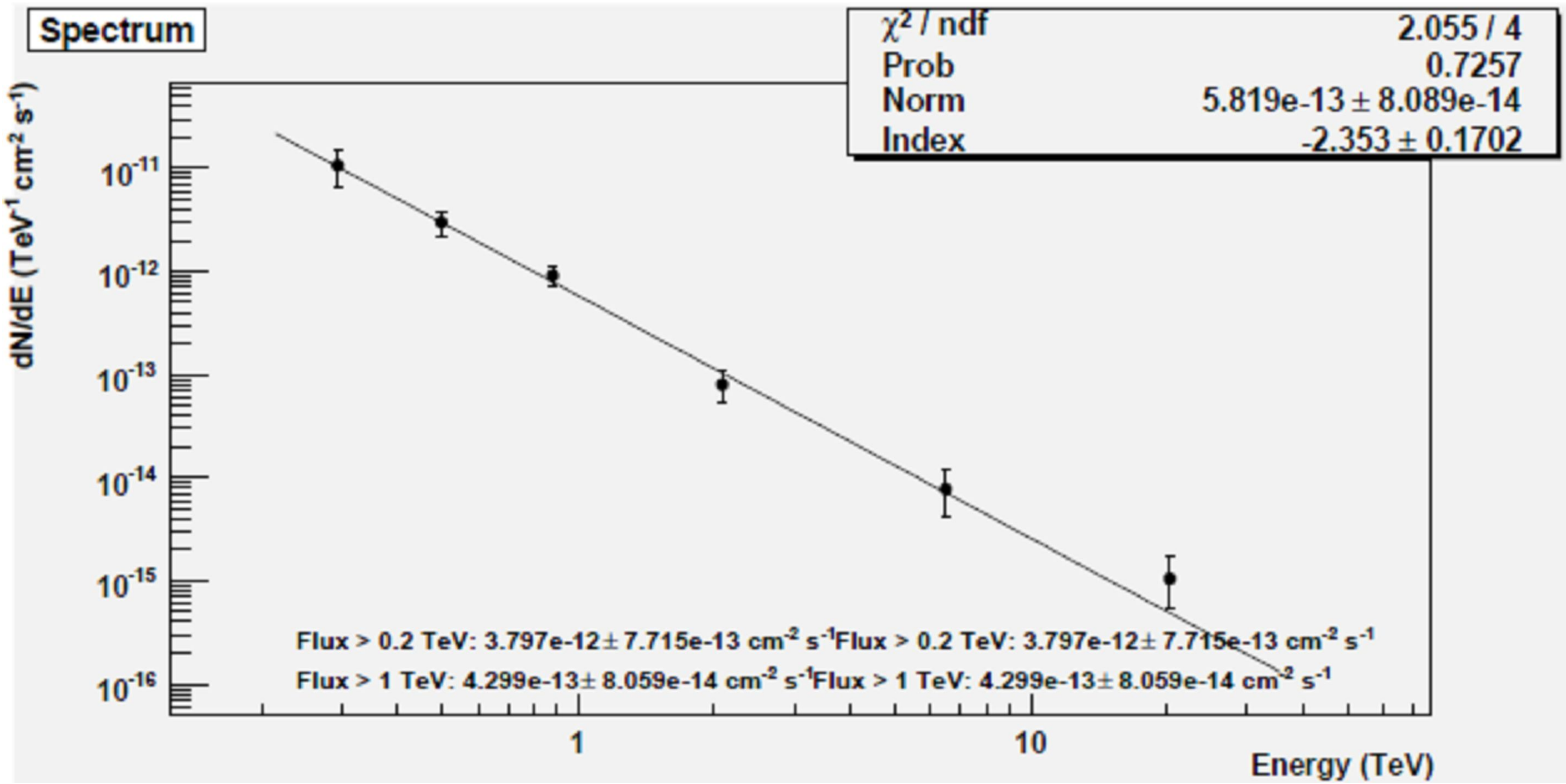
Standard cuts



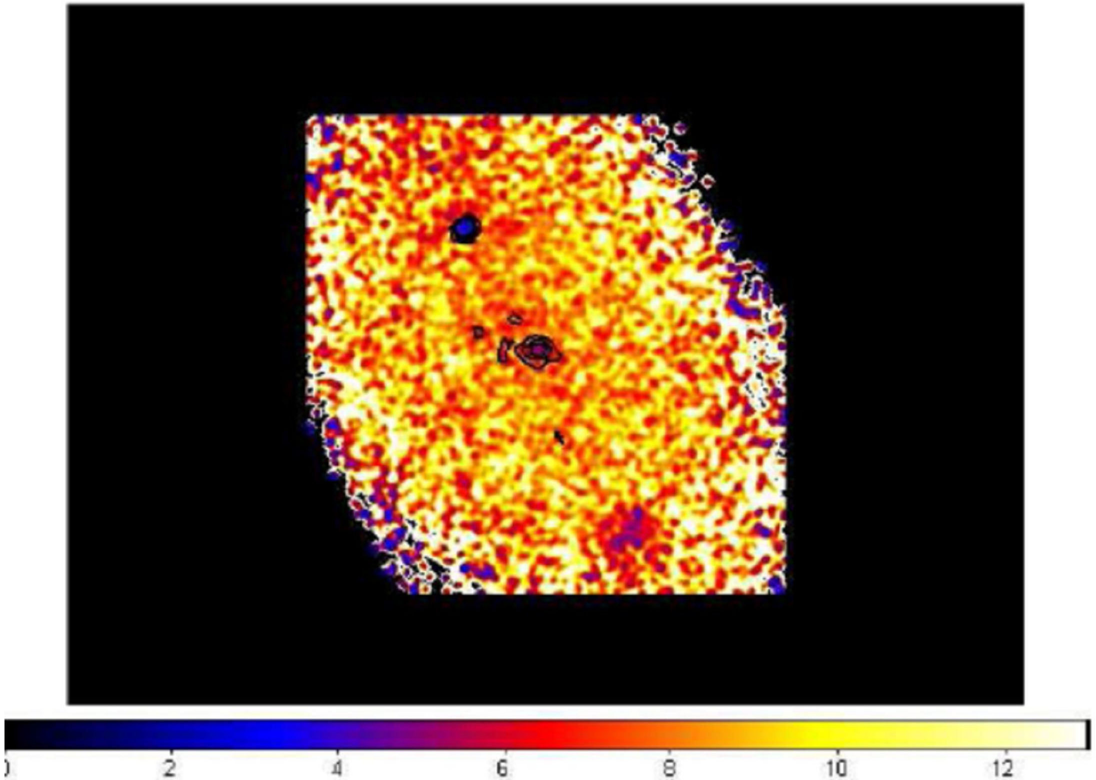
Spectrum - hard cuts



Spectrum - standard cuts



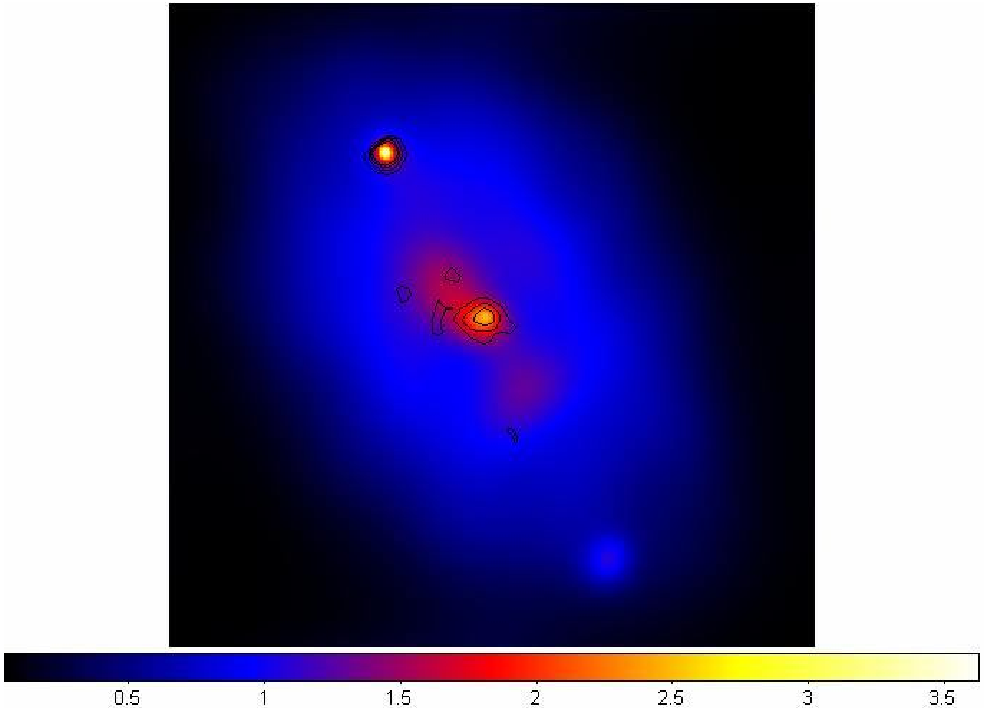
Hardness map – non standard approach



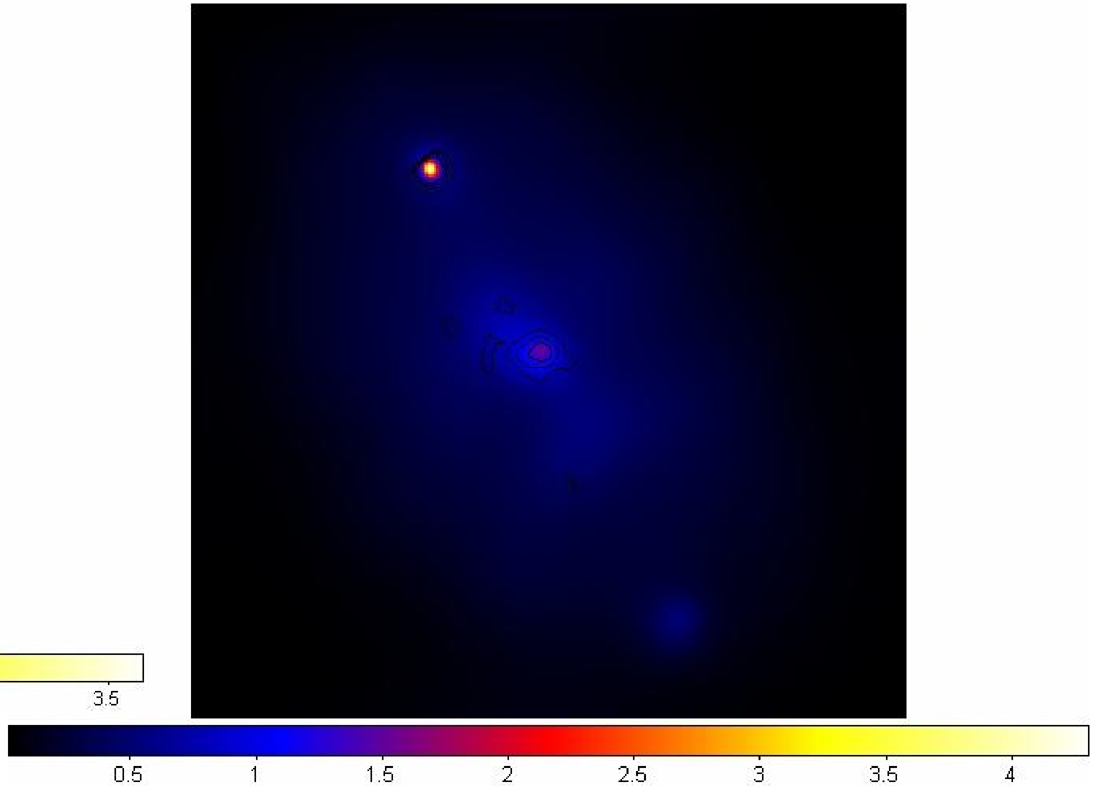
- For standard and hard cuts different energy cut-off

$$\mathrm{HR} = \frac{\mathrm{standard}}{\mathrm{hard}}$$

1 TeV threshold



Below 1 TeV

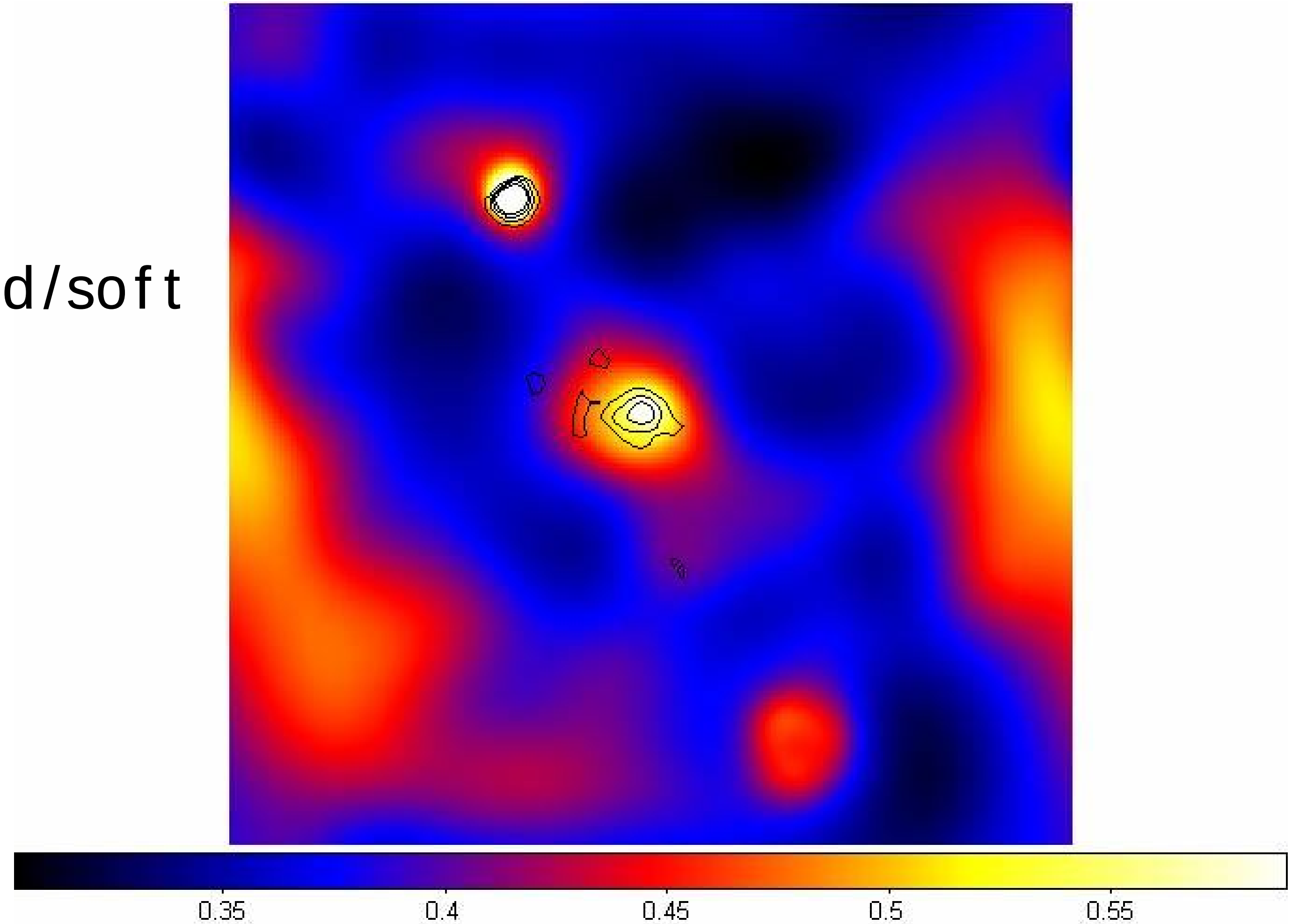


Above 1 TeV

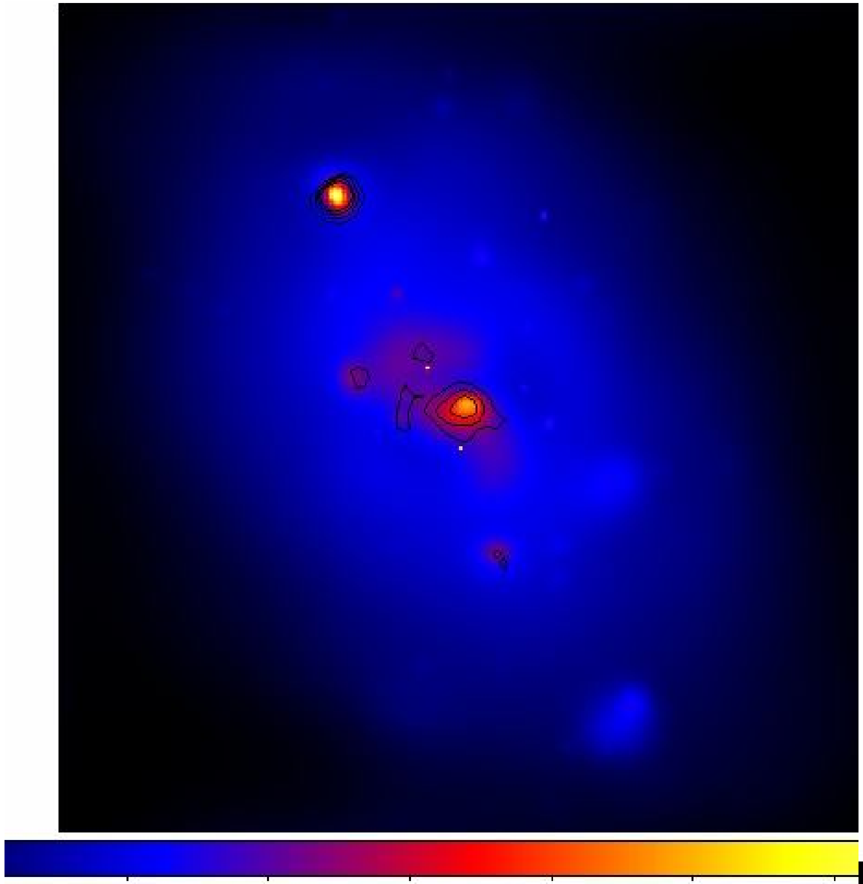
Maps smoothed with ASMOOTH algorithm with parameter sigmin=4

HR map – 1 TeV

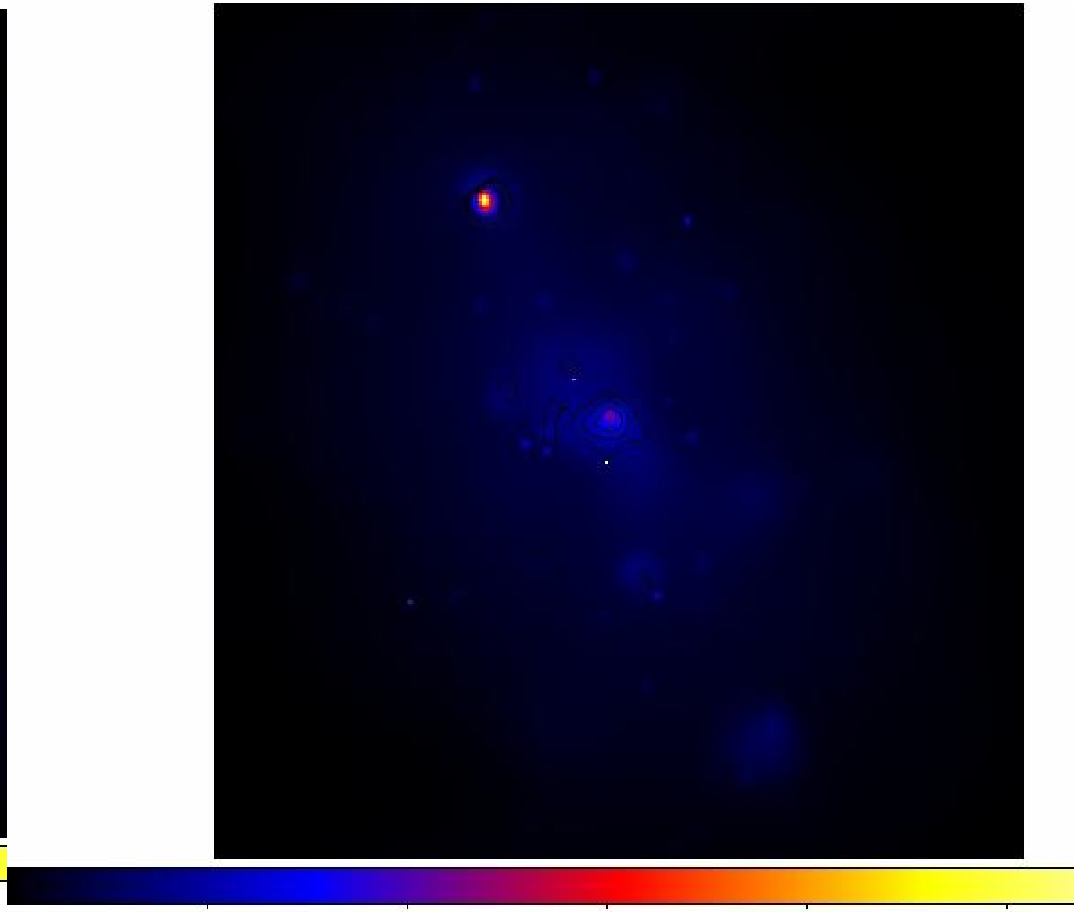
HR = hard/soft



1 TeV Threshold



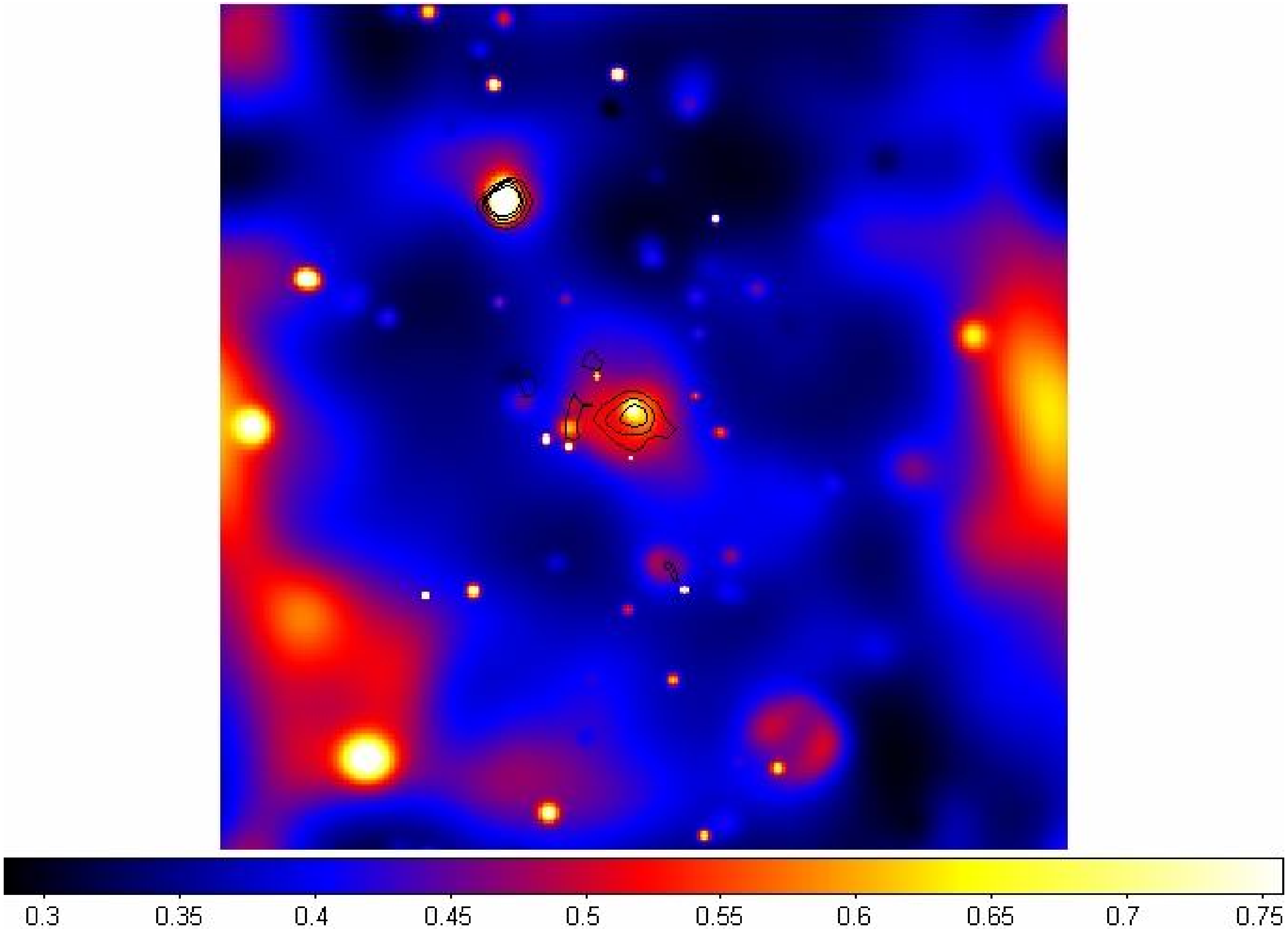
Below 1 TeV



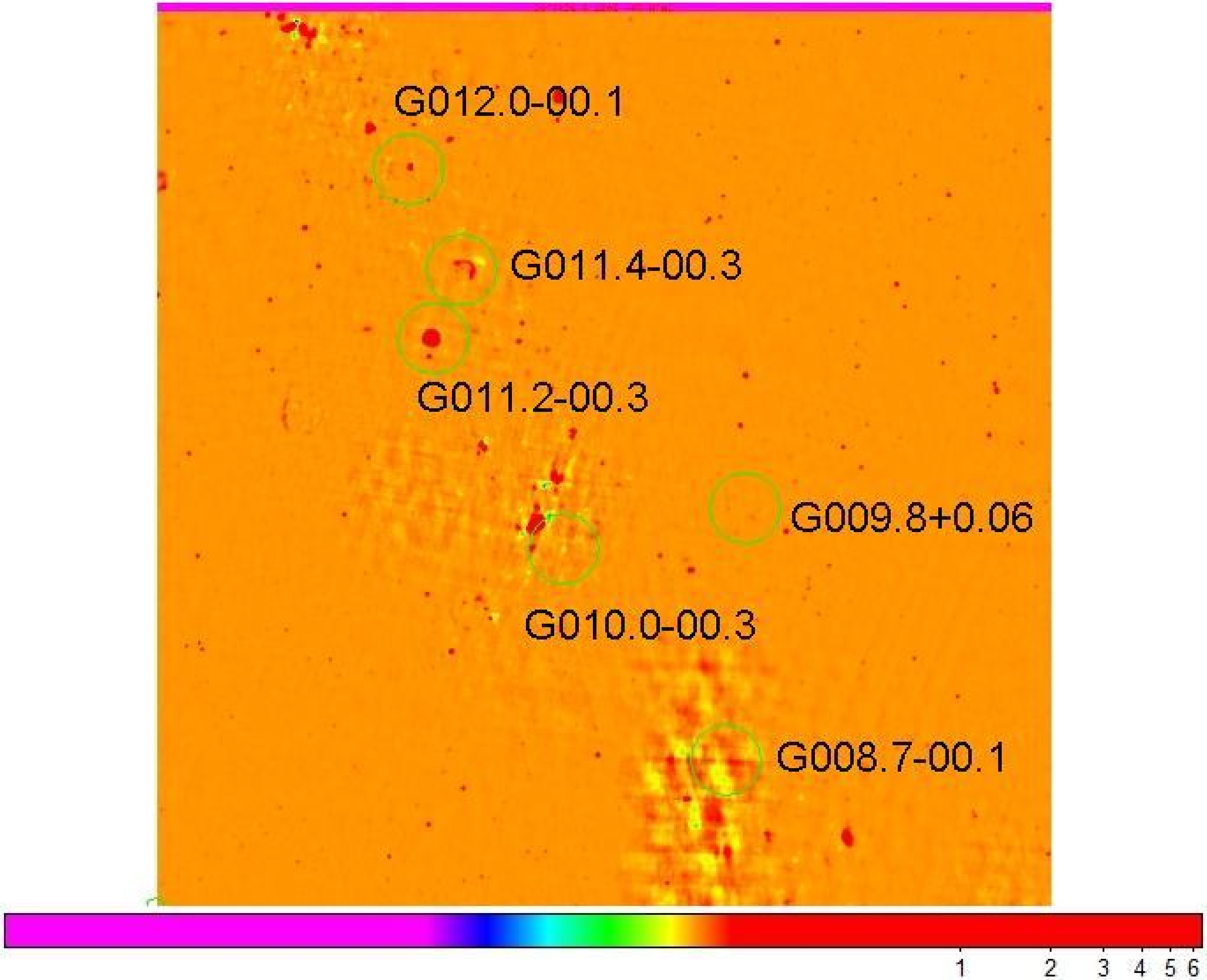
Above 1 TeV

Maps smoothed with ASMOOTH algorithm with parameter sigmin=2

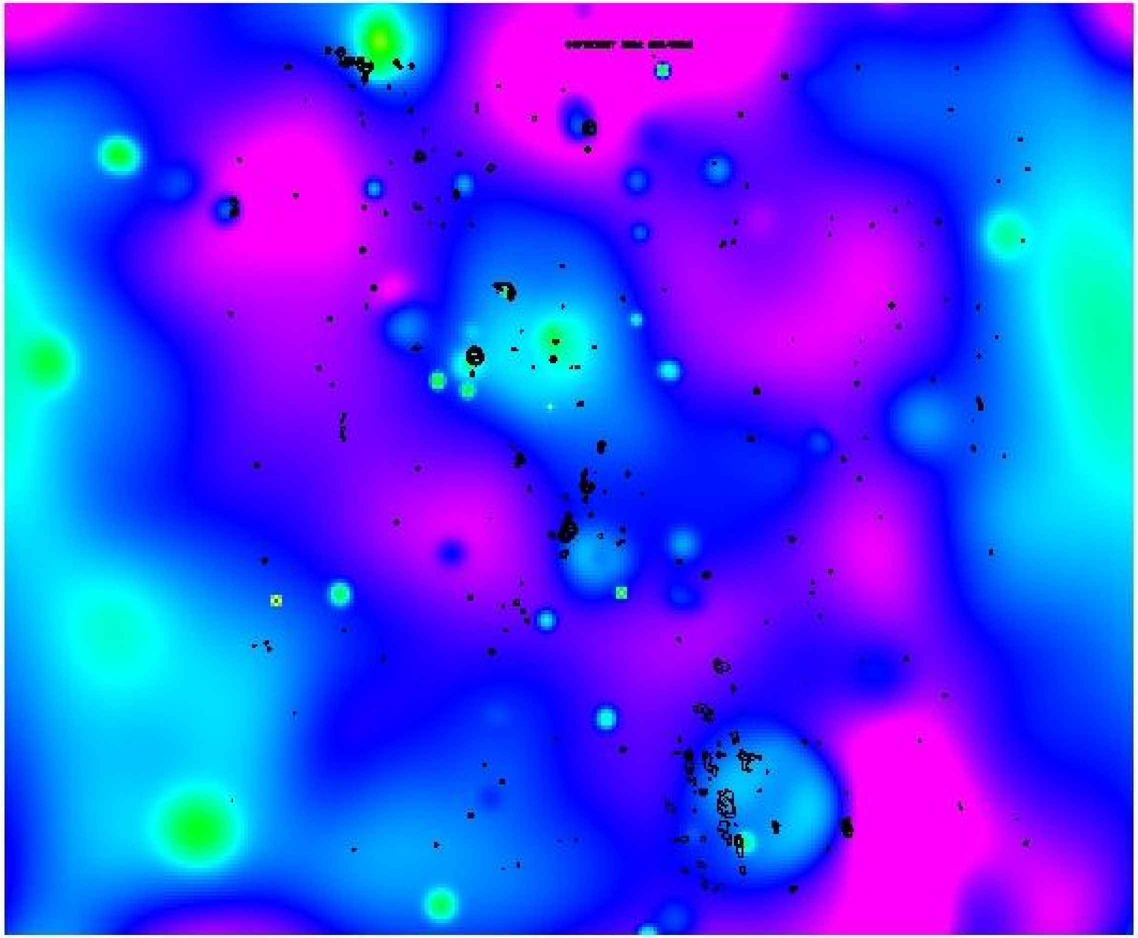
HR map – 1 TeV

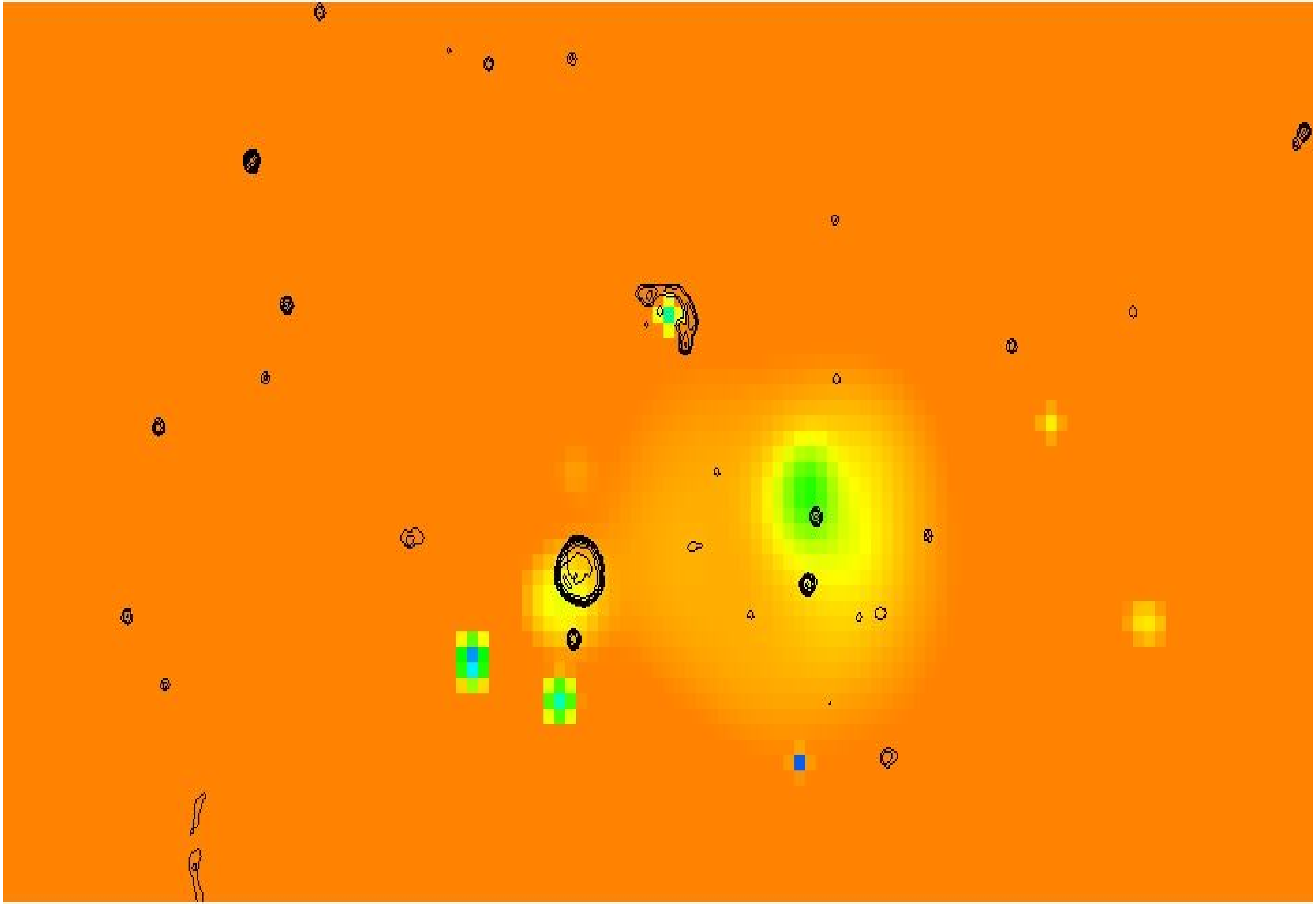


Sources identification



HR map with radio intensity contours



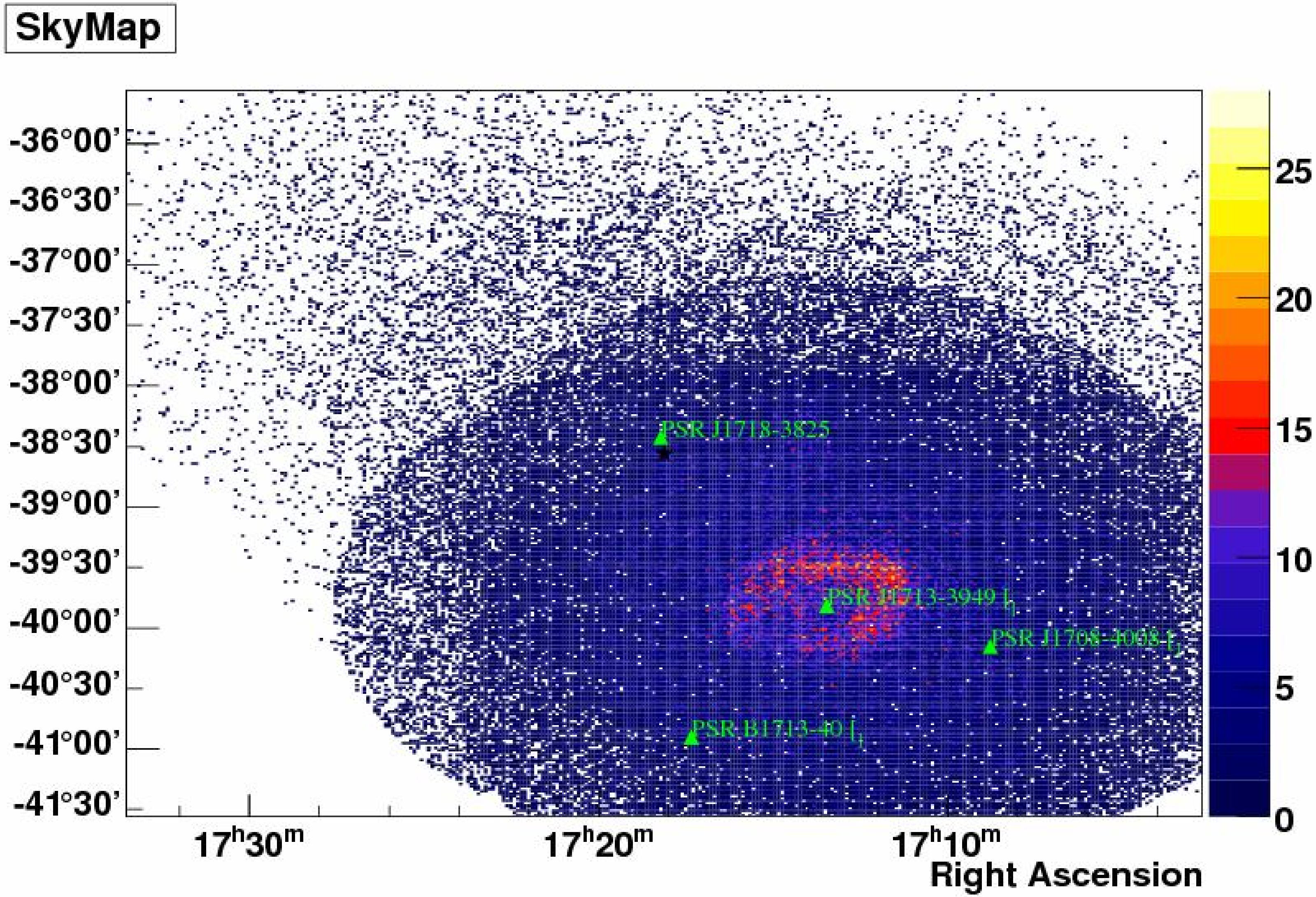


SNR RX J1713.7-3946 and HESS J1718-385

- RX J1713.7-3946 – supernovae remnant, shell type, shock – place of particle acceleration
- Observations: ~63 h, 6702 events
- 1.6^0 in the direction South–West -> HESS J1718-385 – PWN candidate
- Observations: ~82 h. First only for RX J1713.7-3946
- Gamma ray source: ~0.14^0 on south from pulsar PSR J1718-3825 – type Vela, τ=90 kyr, P=75 ms
- Energy flux of HESSJ1718-385: (1-10) TeV = $2.9 \cdot 10^{-12}$ erg s^{-1} cm^{-2}
- PSR J1718-3825: d~4 kpc, $\dot{E} = 1.3 \cdot 10^{36}\, ergs^{-1}$

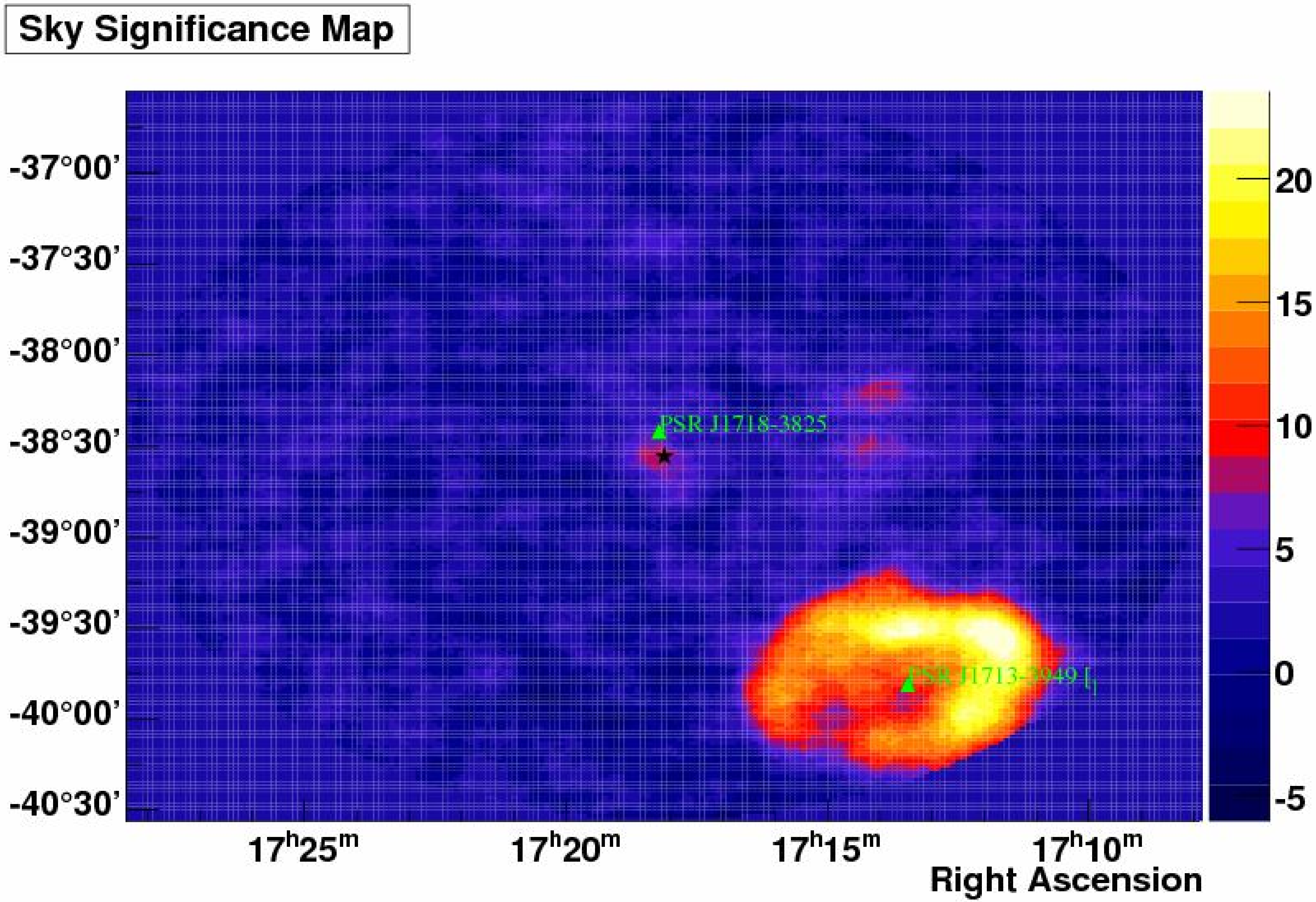
$$\varepsilon_\gamma \equiv L_\gamma / \dot{E} = 0.5$$

RX J1713.7-3946, HESSJ1713-385



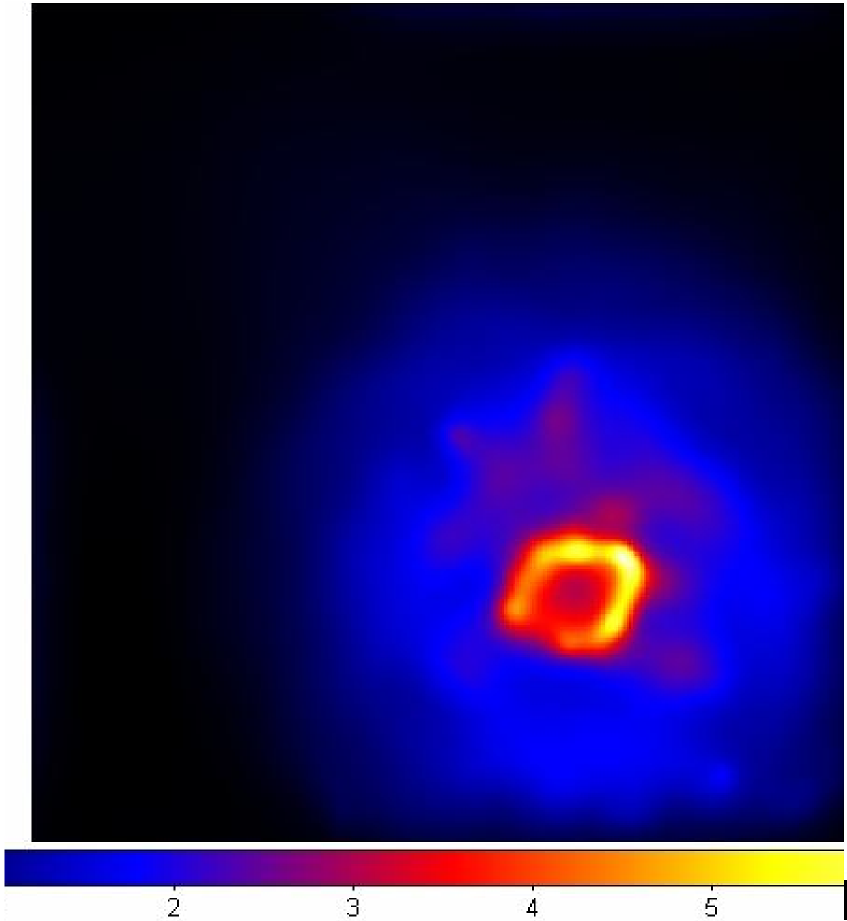
Hard cuts

RX J1713.7-3946, HESSJ1713-385

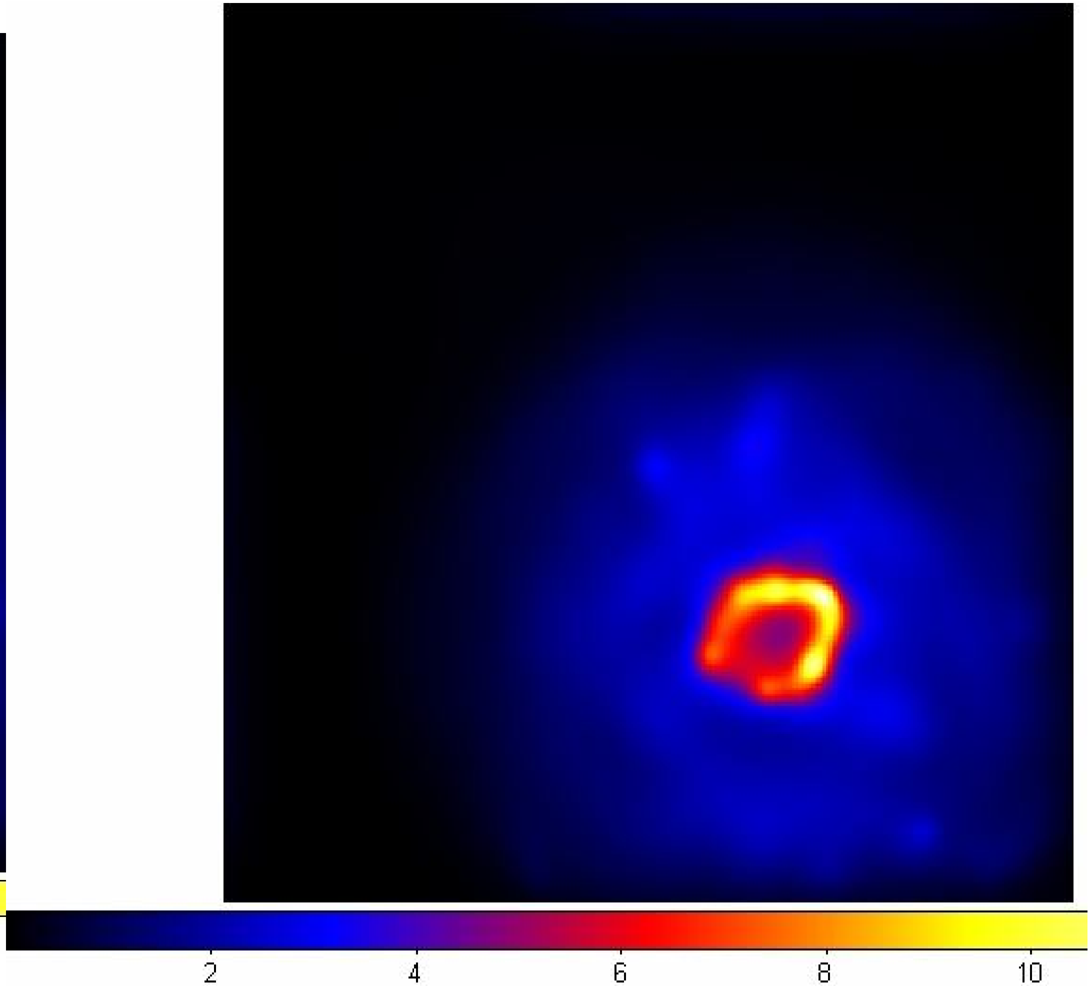


Hard cuts

1 TeV threshold



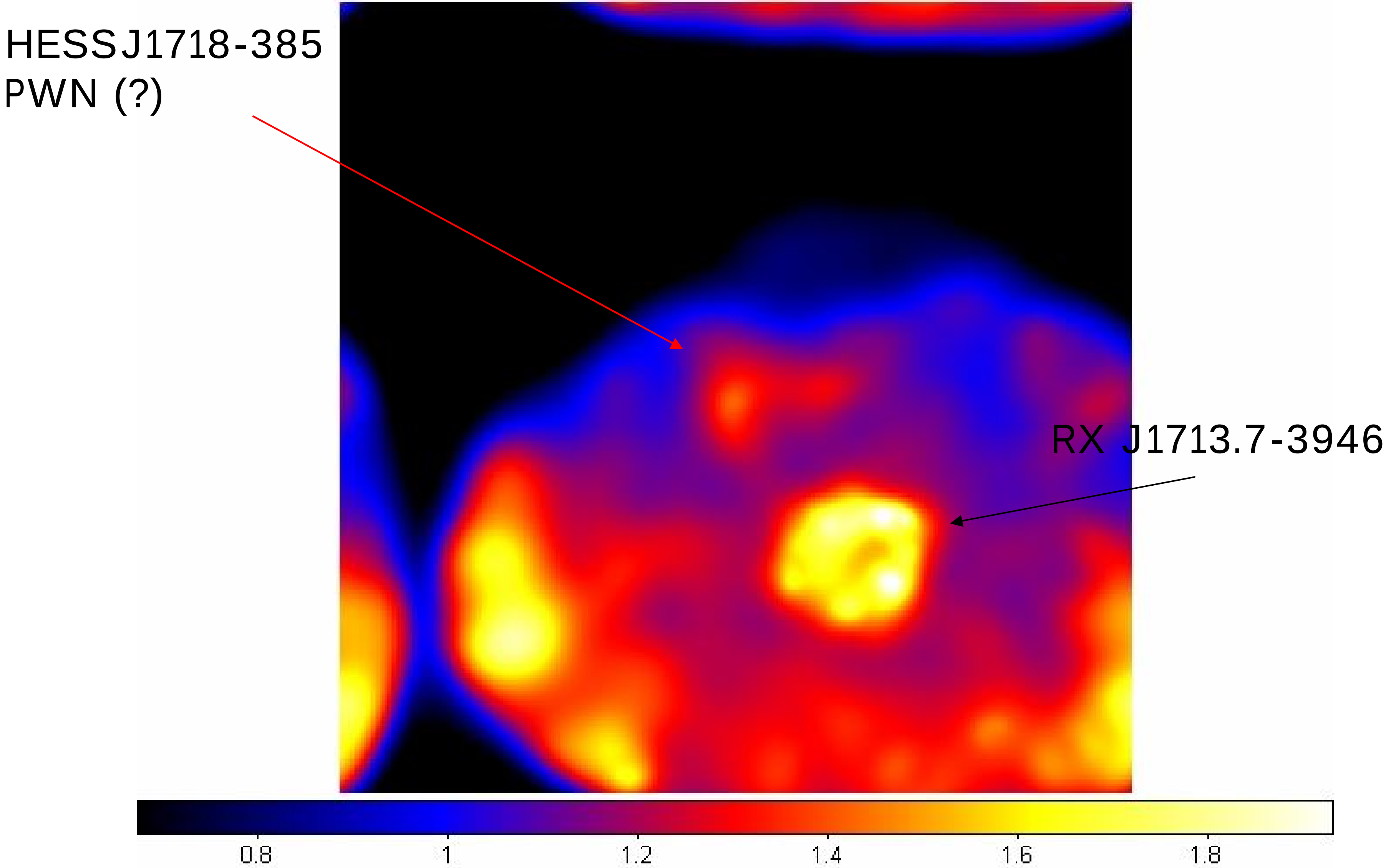
Below 1 TeV



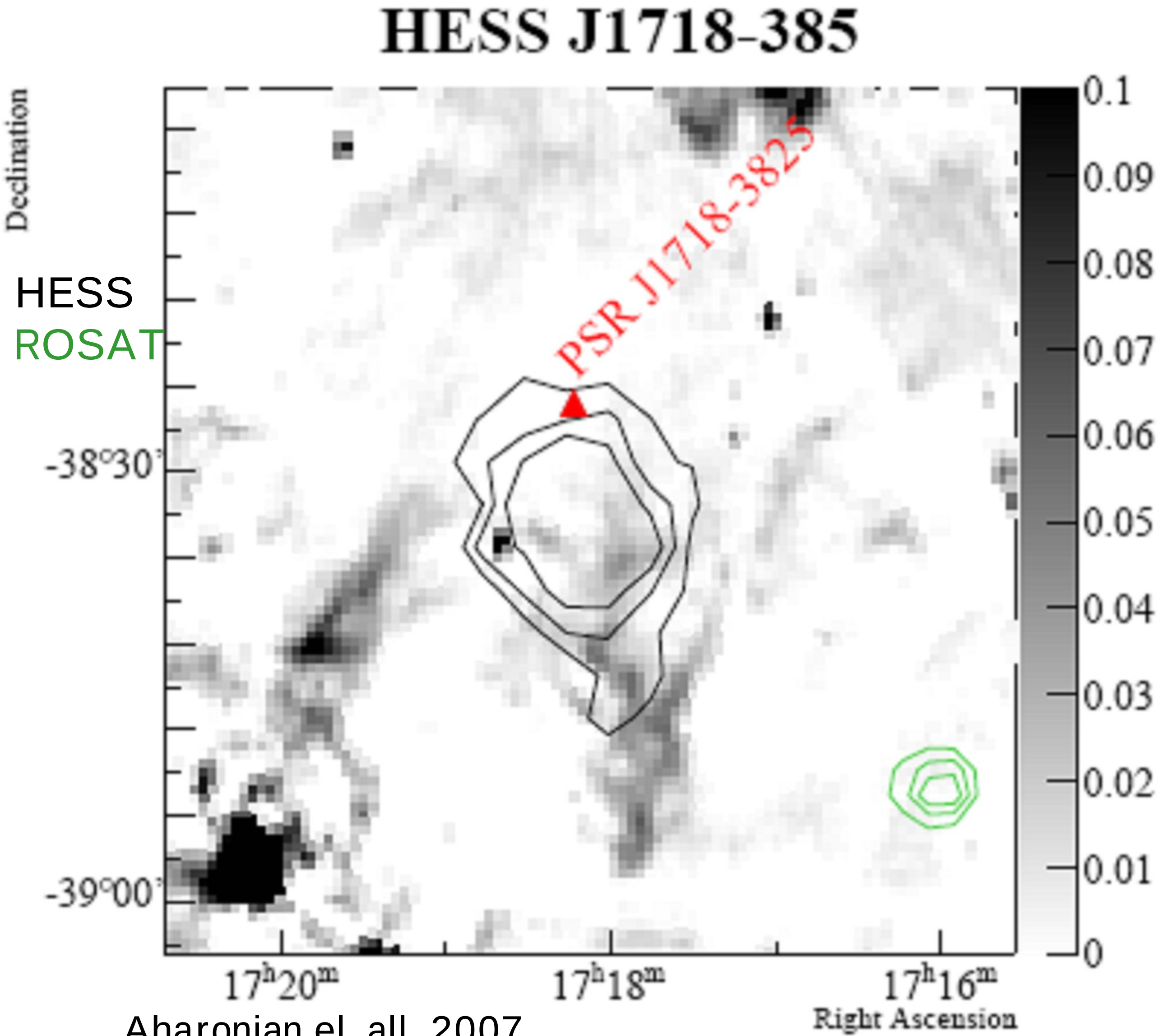
Above 1 TeV

Maps smoothed with ASMOOTH algorithm with parameter sigmin=4

Hardness map – 1 TeV



Different wavelength



HESS
ROSAT

Aharonian el. all, 2007

Radio emission colerated with IRAS Sky Survey, which suggests termal source

Radio map from Molonglo Galactic Plane Survey at 843 MHz

Conclusions

- HR maps can be additional useful tool in analyzing gamma ray observations
- Basic difficulty - small photon statistics
- All effects on HR maps must be always verified with respect to original data