Universidad de La Laguna

Archival search for Young Stellar Objects in the VERITAS data

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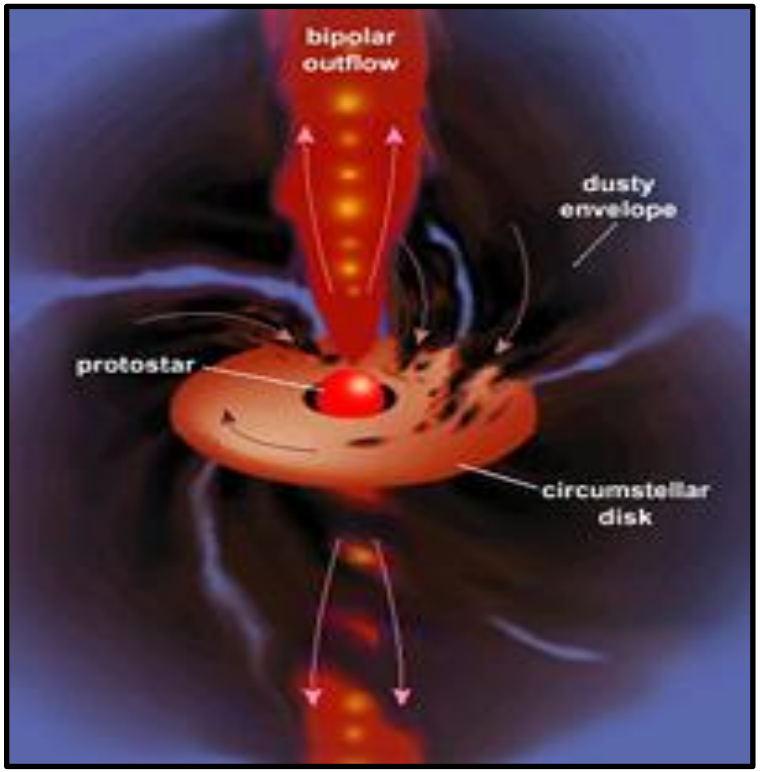
YSOs

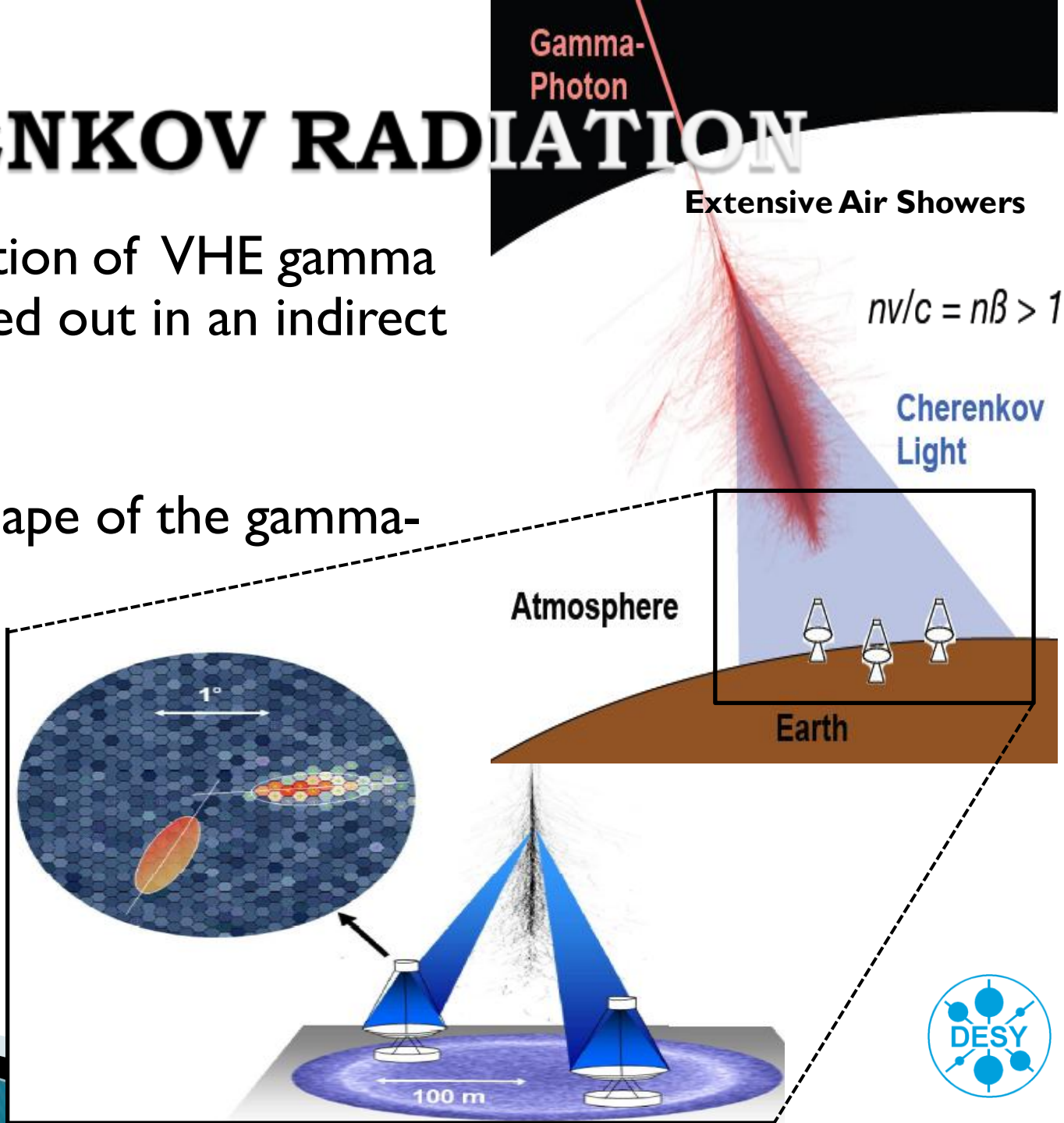
- Stars in the earliest stages of development, related with accretion, rotation and B-fields

- For some of them we can find jets
- There it possibly produces strong shocks -> Relativistic electrons and protons
- Could they produce gamma-ray emission?

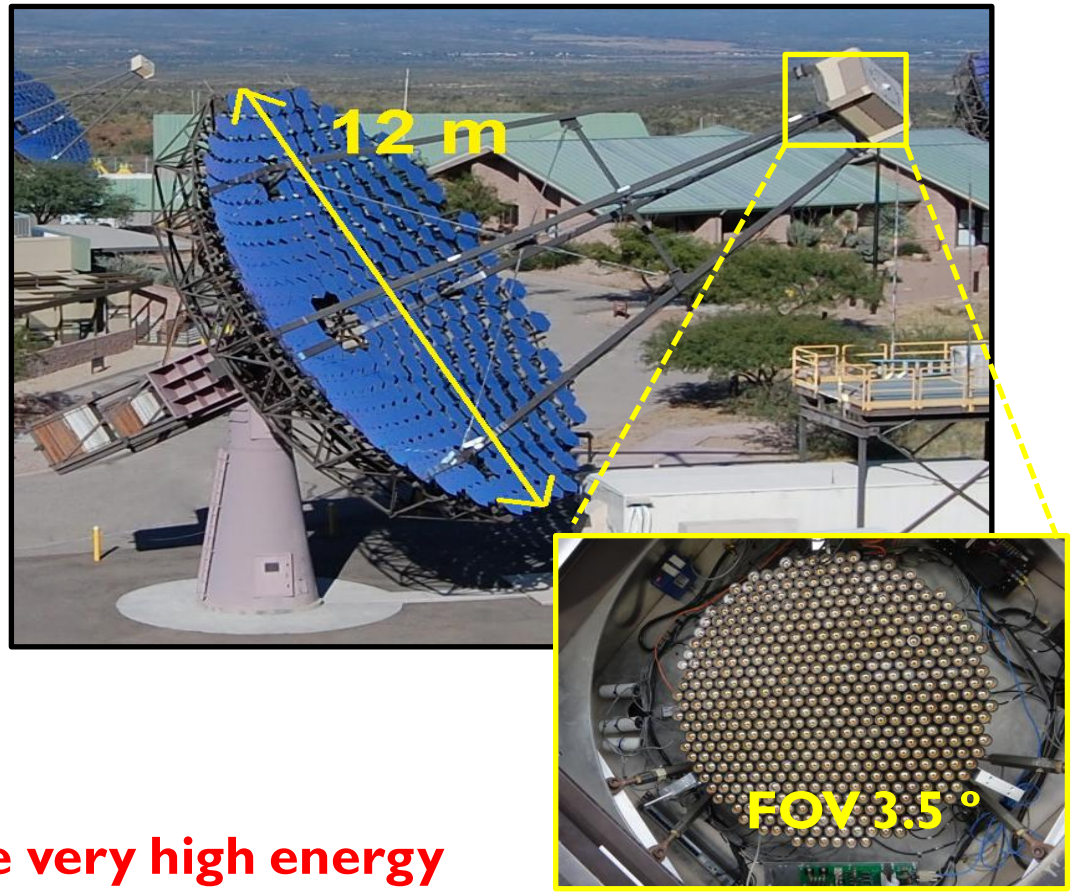


CHERENKOV RADIATION

- Reconstruction of VHE gamma rays is carried out in an indirect fashion
- Note the shape of the gamma-ray image



N° Telescopes	4 optical reflectors
N° Mirrors	350 on each one
N° Pixel camera	499 on each one
Energy Range	50 GeV – 50 Tev
Angular Resolution	0.1 ° (68% containment)



Gamma-ray astronomy in the very high energy

DESY

MOTIVATION

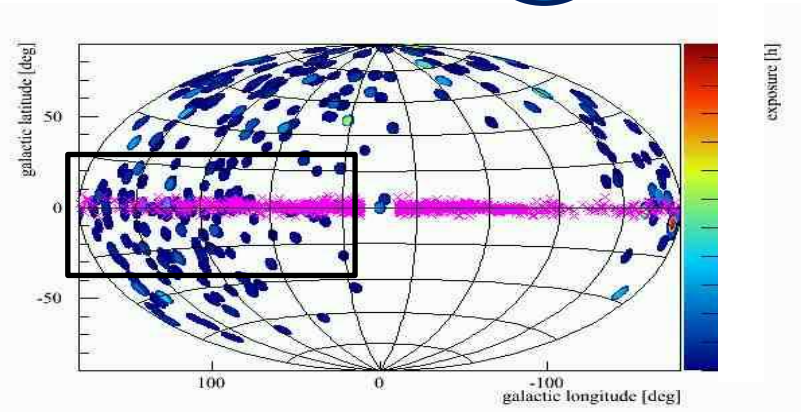
- Essential step toward deciphering the **origins of stars** (there are several open questions on star formation)
- Understand **particle acceleration processes** in the complex environment of massive molecular clouds
- Unravel the formation mechanism of astrophysical **jets in TeV.** (Jets are everywhere and little understood)

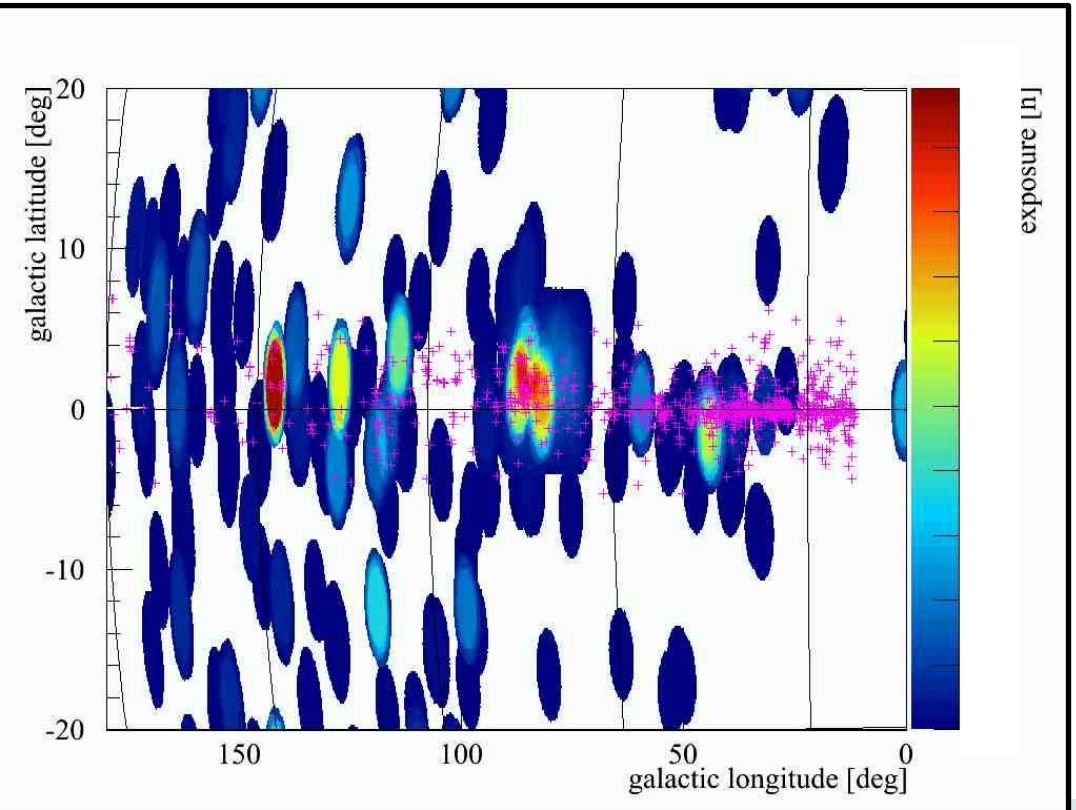
RMS Survey

- RMS → ~ 700 MYSOs
- VERITAS observations

The Red MSX Source (RMS) survey

Multi-wavelength program to distinguish between (MYSOs) and other objects





118 source candidates

10 hours *of observation*

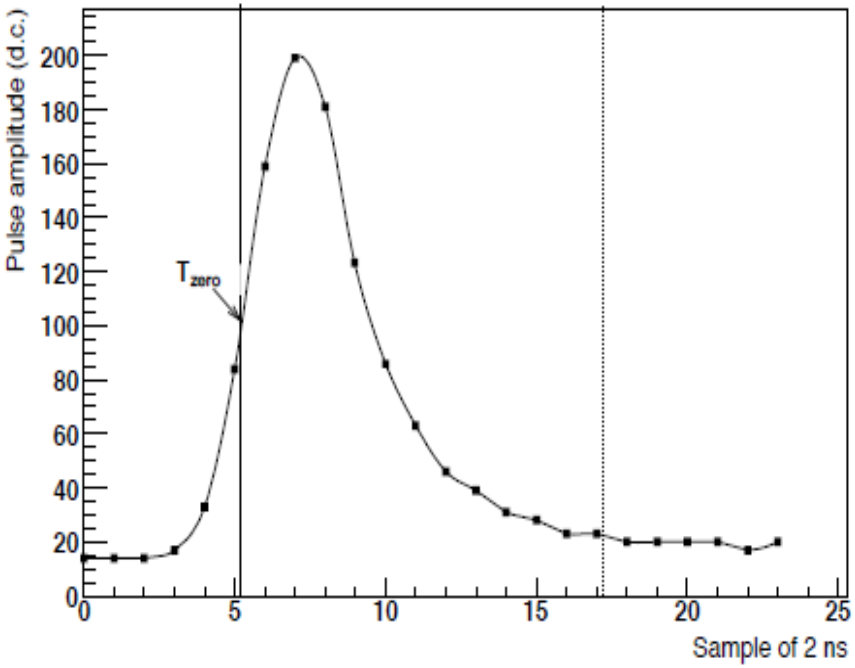
at least

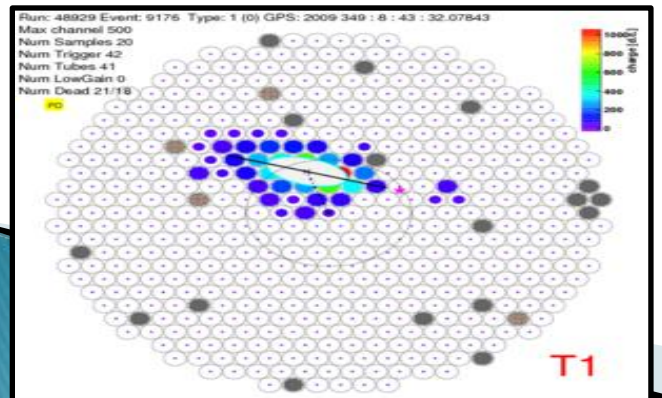
1.5 degrees

maximum radius from the camera center.

DATA ANALYSIS

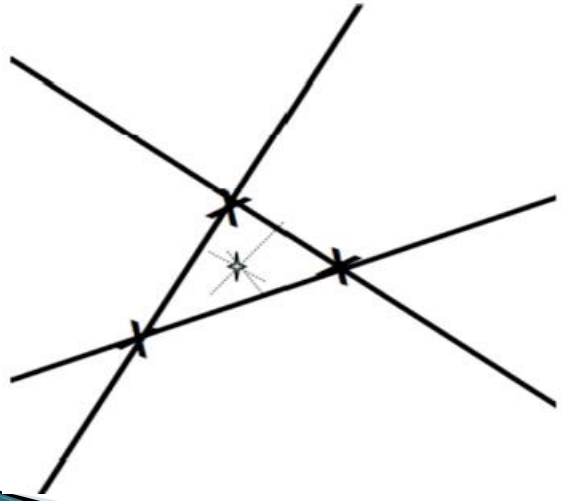
- Calibrations to have an uniform response across the camera: *Flatfielding* (5 minutes calibration, diode flasher is at 300 Hz, each night).
- Integration to obtain the total charge in each pixel when we get an event. (Selected time window: 12 samples of 2 ns)

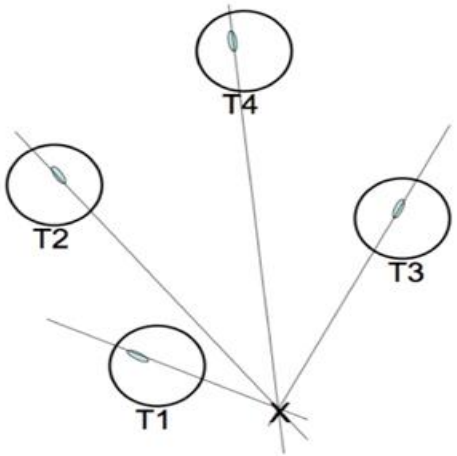


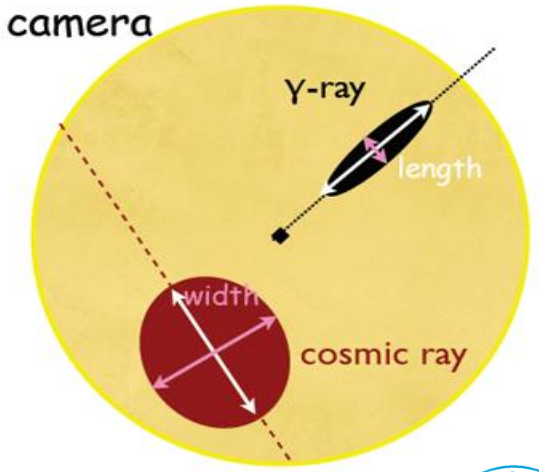


PRIMARY PARTICLE GEOMETRY

- Length and the width of the shower images.
- The source position
- The core location
- Differentiate cosmic-ray from the gamma-ray images
- The primary particle energy

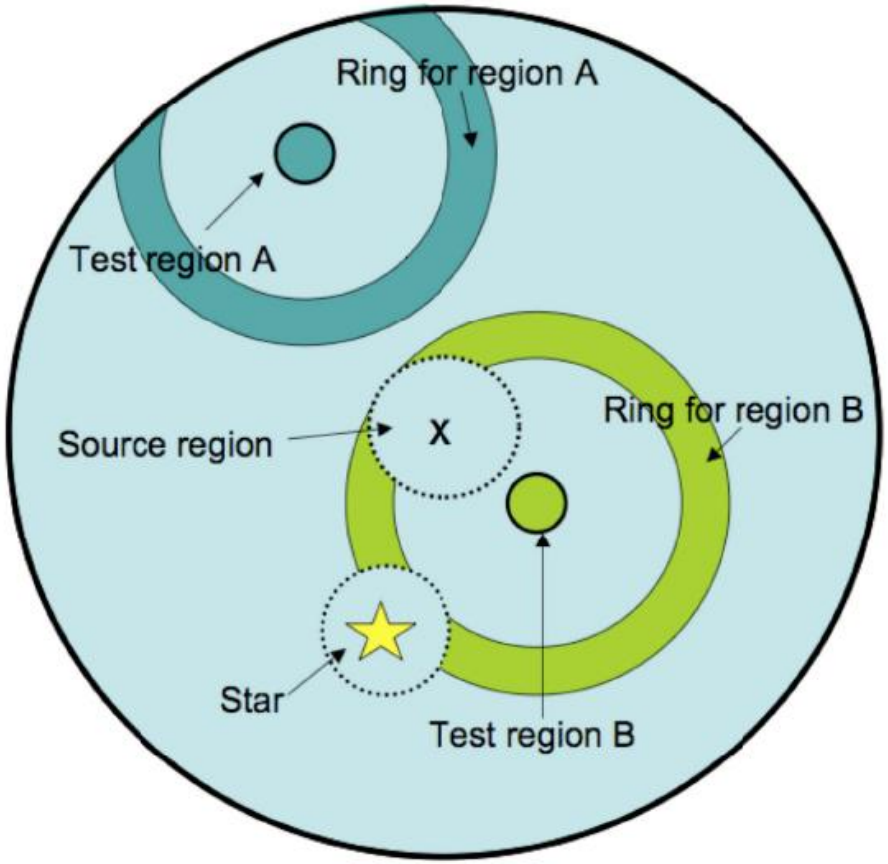






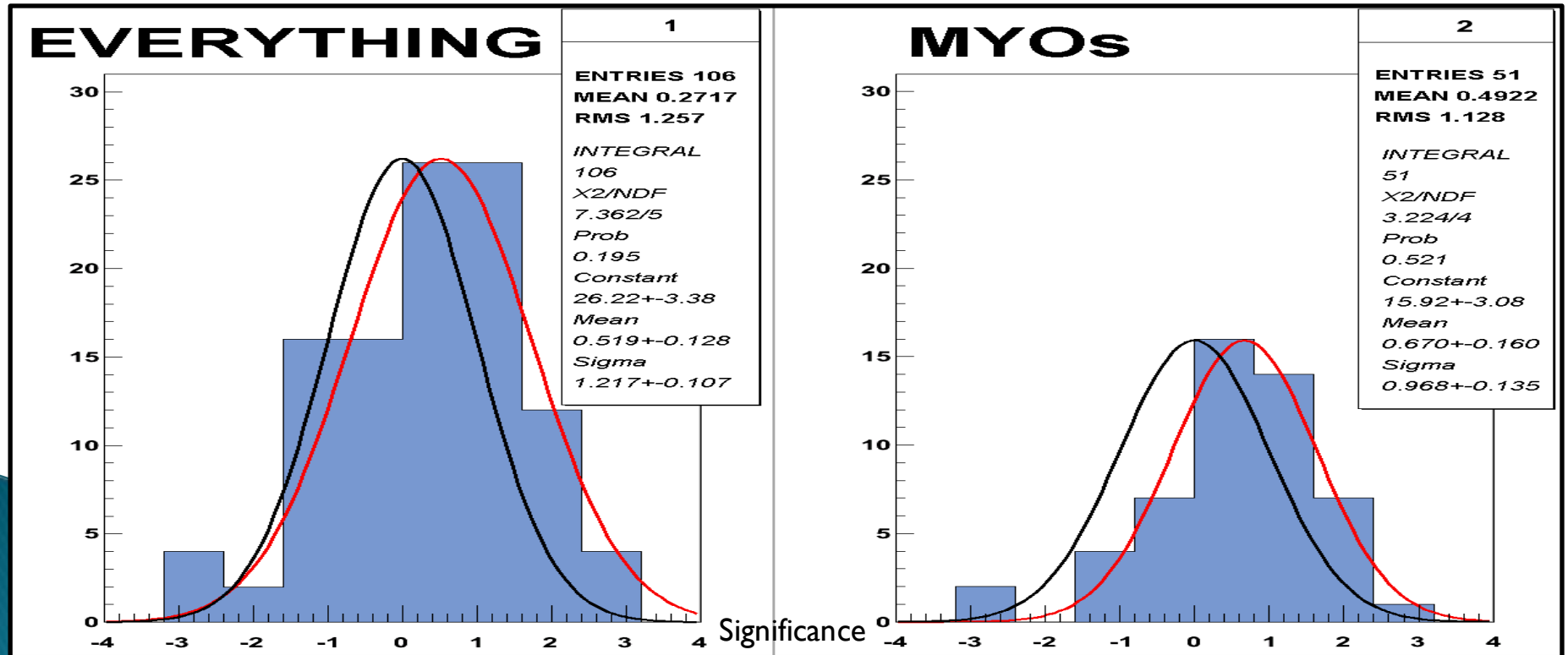
Background estimation

- Gamma-ray source or bright stars (magnitude < 6) in the FOV be excluded from the background estimation region. The gamma-ray source at the center of the field of view is also excluded from the background estimation.



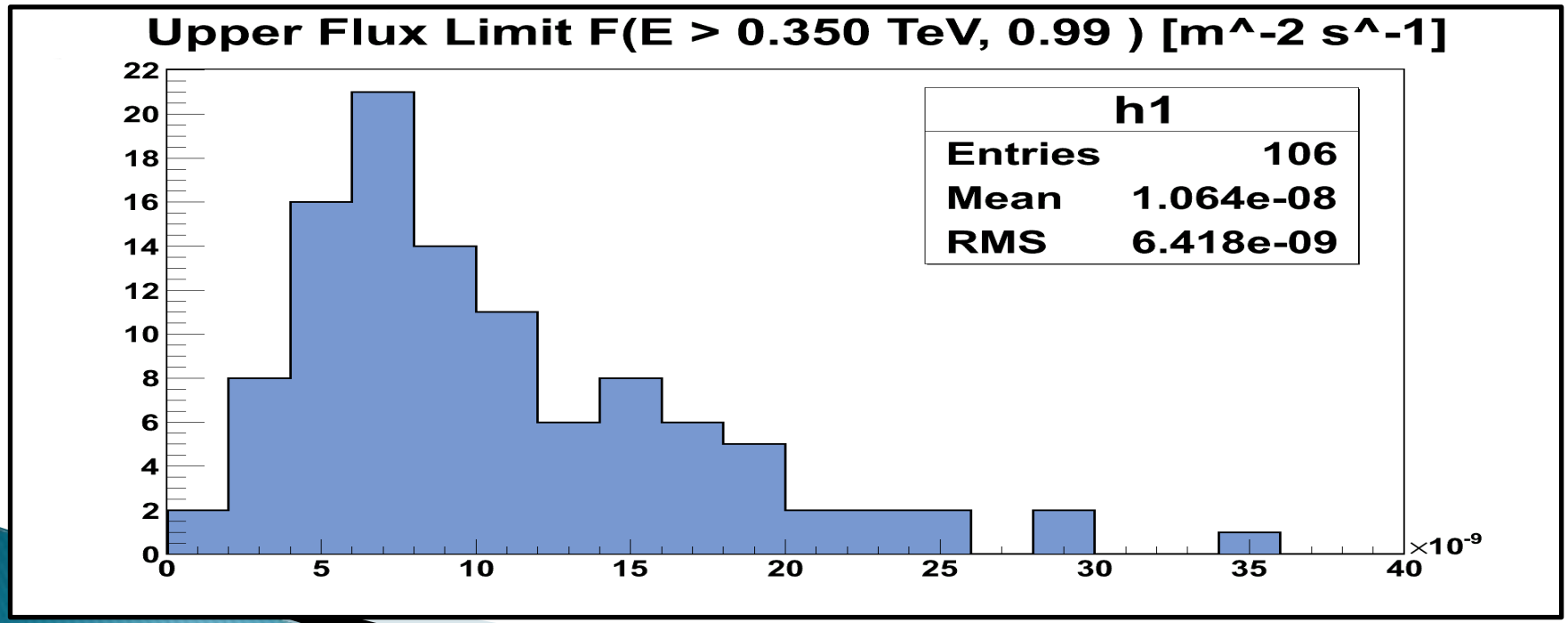
RESULTS

- 106 objects: 51 MYSOs + HII regions, OH/IR stars,…
- Excess gamma-flux, upper limits, significance and sky-maps
- No results with ≥ 5σ

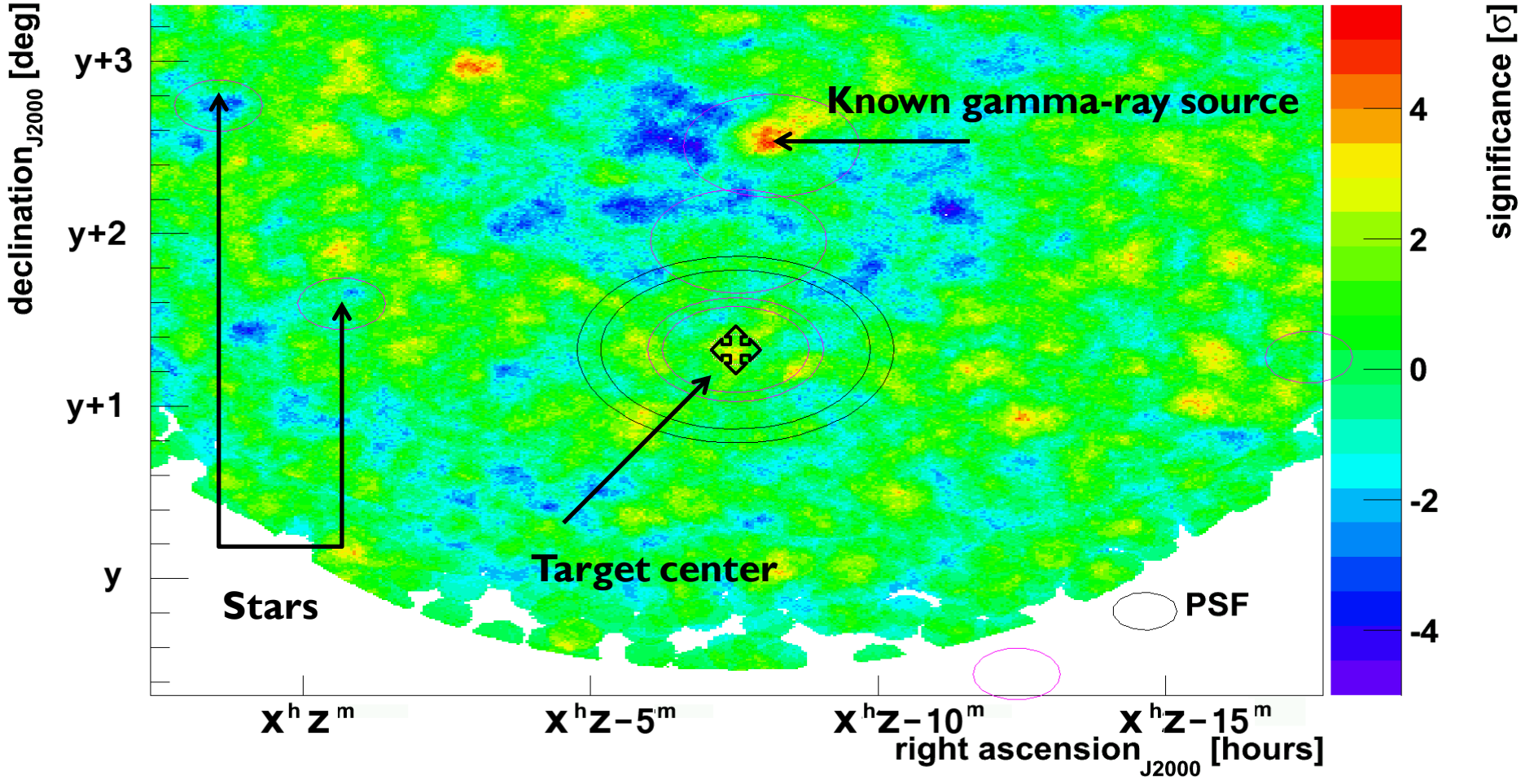


RESULTS

- No results with ≥ 5σ,… but
- Excess flux ⟶ Target flux – Background flux
- Upper limit flux ⟶ Excess flux + 3σ

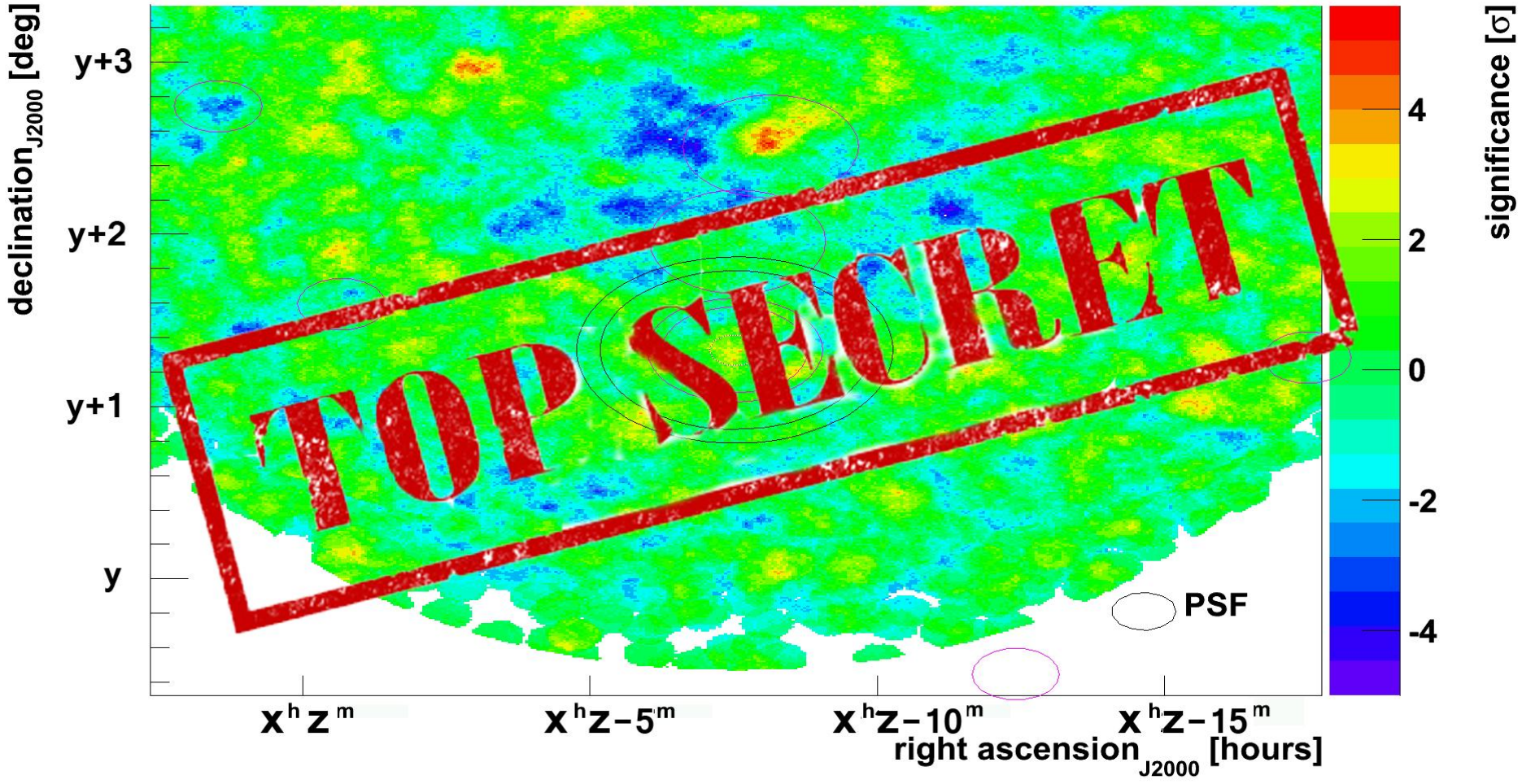


RESULTS: *THE SOURCE A*



Source A: Most significant MYSOs: 2.8 σ

RESULTS: *THE SOURCE A*

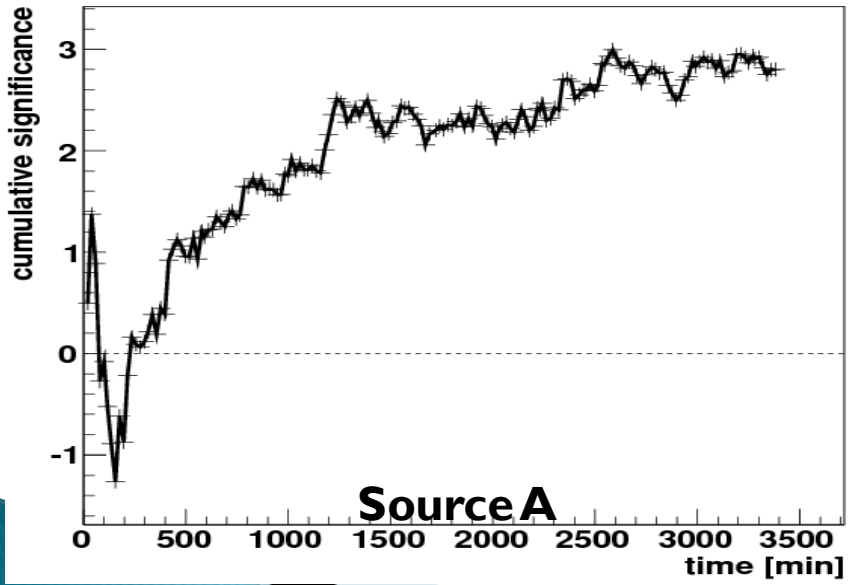


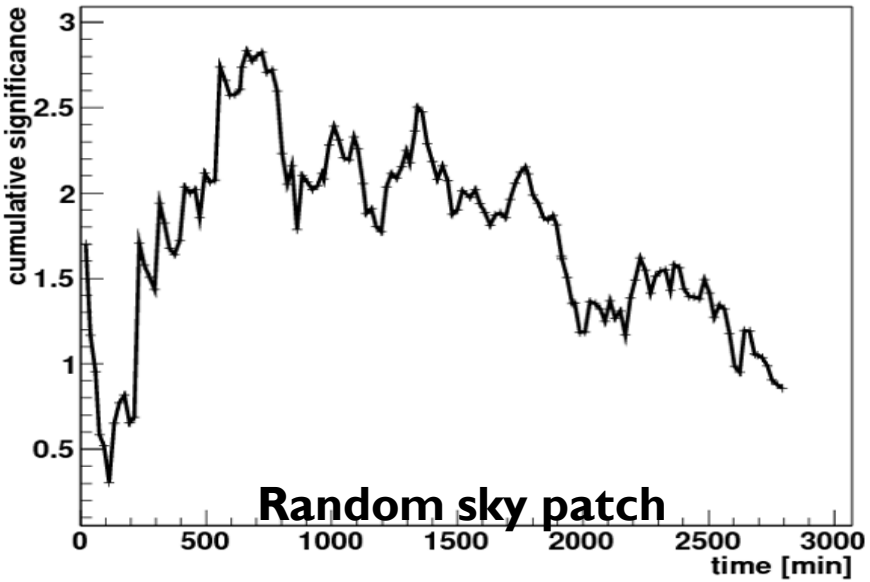
RESULTS: *THE SOURCE A*

- Cumulative significance ⟶ the way significance changes with time

$$\sigma \propto \sqrt{t}$$

- Theoreticians predicted that combined effect of several protostars deeply embedded in giant clouds might be responsible for GeV−TeV sources[1]





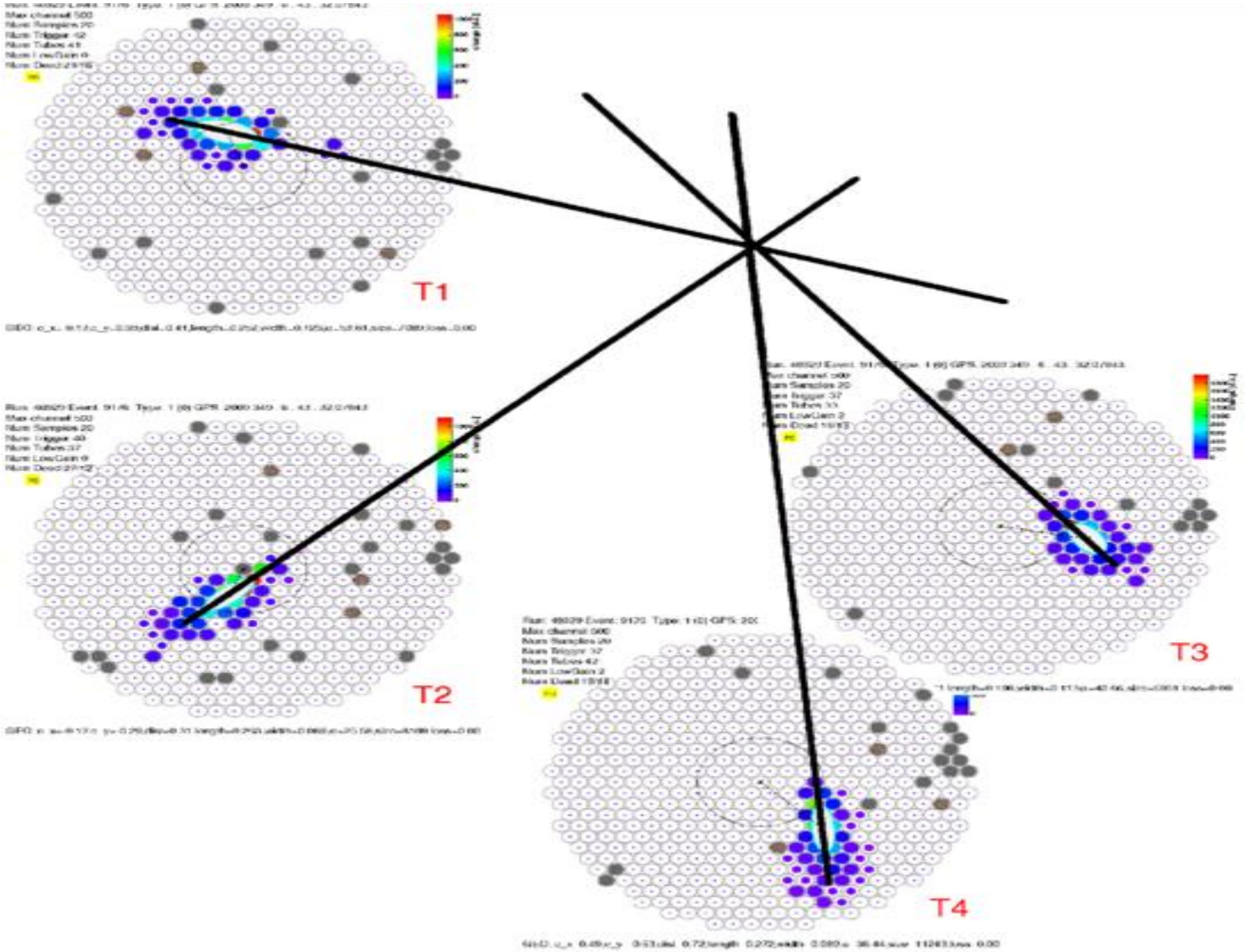
V. Bosch-Ramon, G. E. Romero, A. T. Araudo, and J. M. Paredes (2009)

CONCLUSIONS

- **106 Analyzed sources!**. More than anyone at DESY.
- **Increasing significance on source A!**. An extra 10 hours in order to confirm the significance behavior with time.
- **Upper limit fluxes** ⟶ Protostellar modeling ⟶ Maximum value for gamma-ray emission.
- **Future generations of Cherenkov telescopes:** Better results for lower observation times, e.g. CTA.

QUESTIONS?


Hamburg
Berlin
Potsdam
Zeuthen
Poznan
Polska
(Poland)
Wroclaw
Deutschland
(Germany)
Leipzig
Dresden


T1
T2
T3
T4