



# SEARCHES FOR POINT-LIKE SOURCES OF COSMIC NEUTRINOS WITH 15 YEARS OF ANTARES DATA

G. Illuminati<sup>1</sup> & S. Alves<sup>2</sup> on behalf of the ANTARES Collaboration

<sup>1</sup> INFN - Sezione di Bologna, Viale Bertini-Pichat 6/2, 40127 Bologna, Italy

<sup>2</sup> IFIC - Instituto de Física Corpuscular (UV-CSIC), Calle Catedrático José Beltrán 2, 46980, Paterna, Valencia, Spain



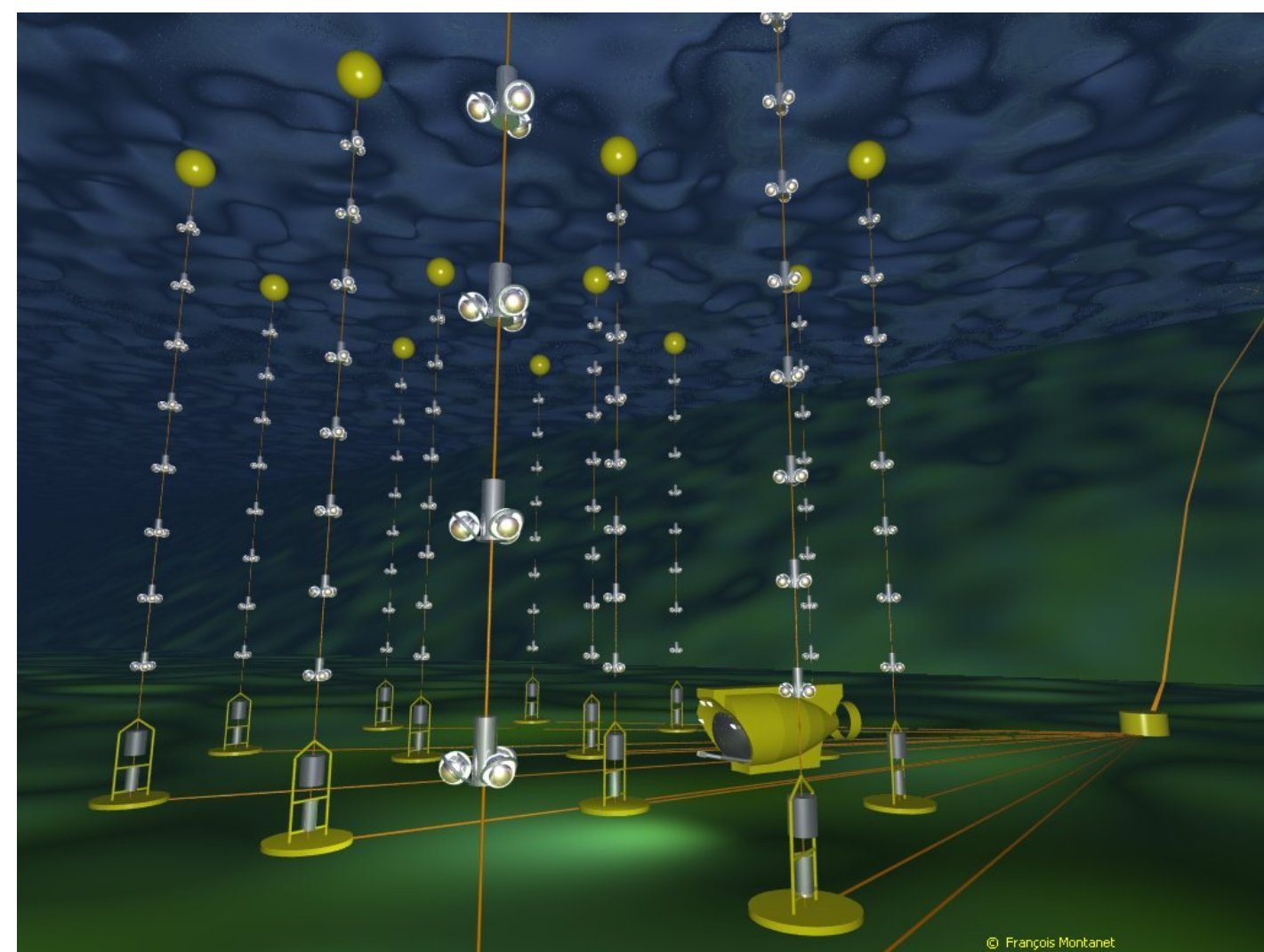
## ANTARES Telescope and Data Set

### ANTARES telescope:

- Three-dimensional array of **885 photomultiplier tubes**.
- 2500 m below the surface of the **Mediterranean Sea**.
- Completed in 2008, decommissioned in 2022.

### Data set:

- **Complete coverage:** from January 29, 2007 to February 13, 2022 (4541 days of lifetime).
- **11029 track** and **239 shower** good-quality events.
- Tracks:  $\sim 0.4^\circ$  median angular resolution.
- Showers:  $\sim 3^\circ$  median angular resolution.

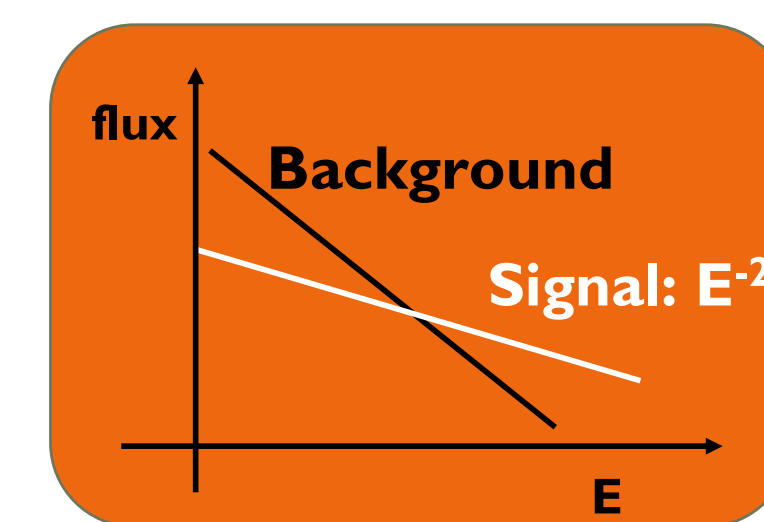
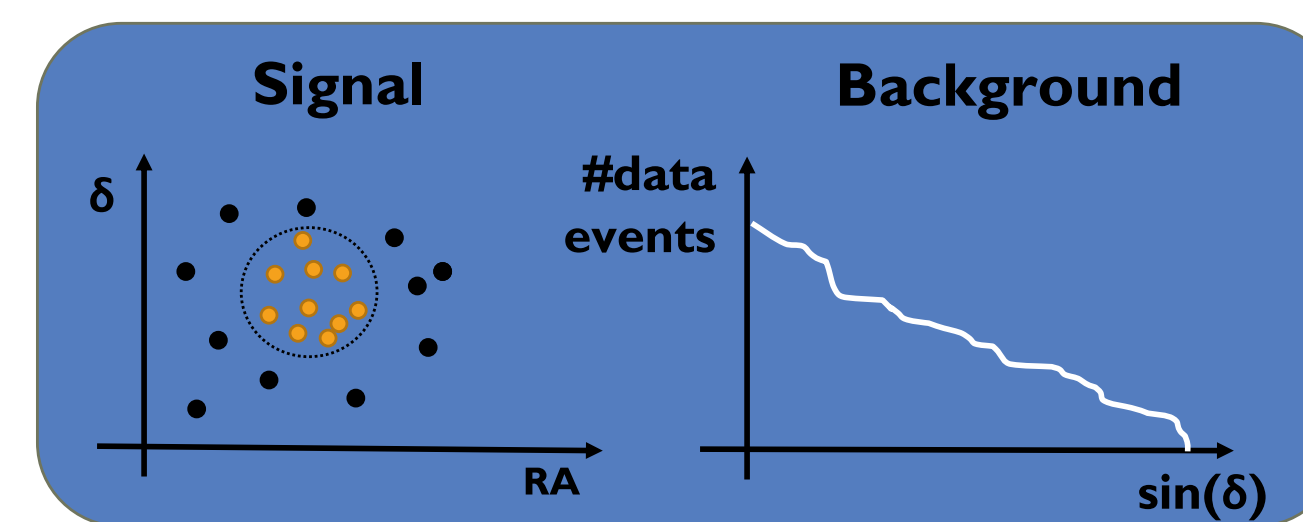


## Search Method: Unbinned Likelihood

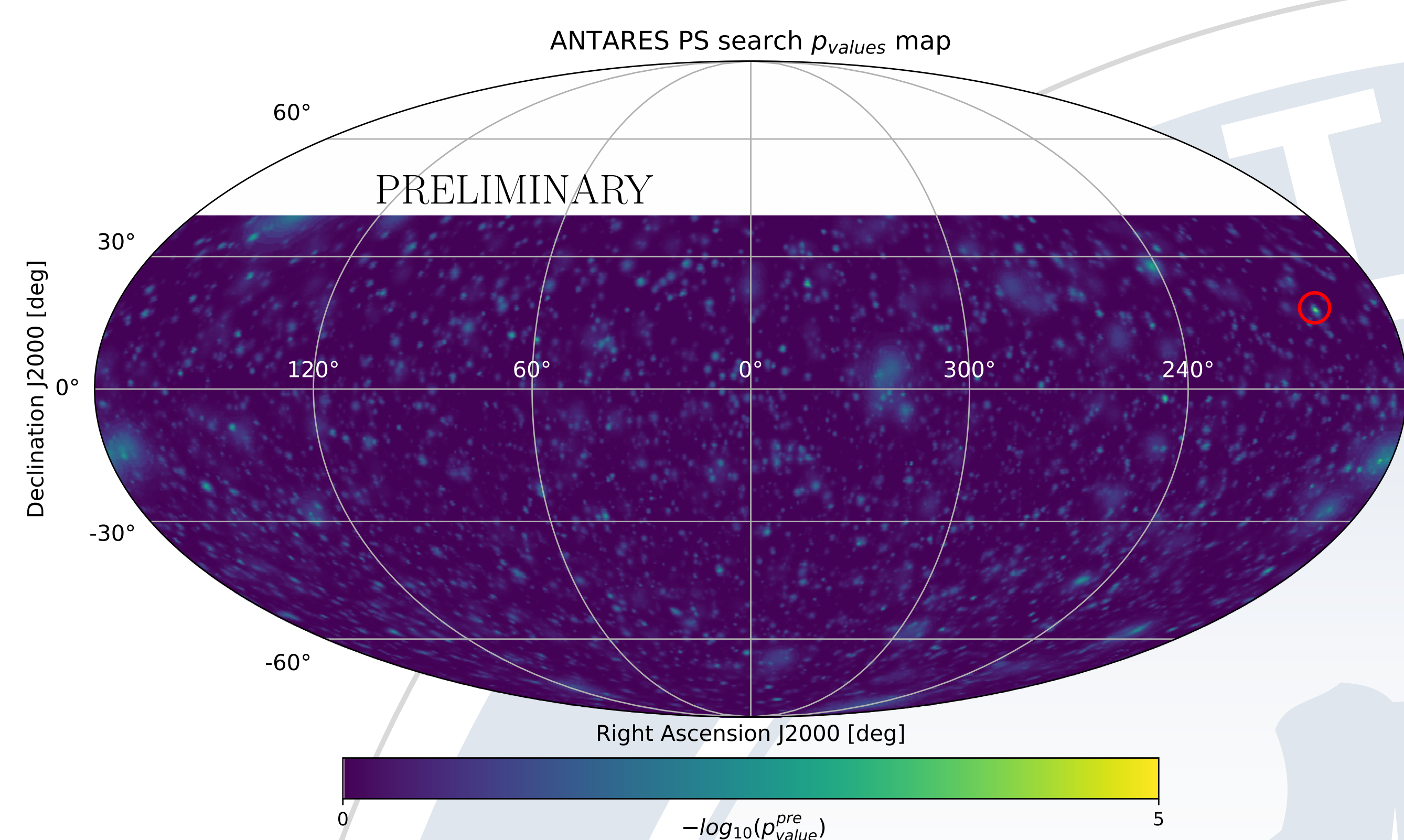
$$L(n_s) = \prod_{j \in \{tr, sh\}} \prod_{i \in j} \left| \frac{n_s^j}{N_j} S_i^j + \left(1 - \frac{n_s^j}{N_j}\right) B_i^j \right|$$

Free parameter: total number of signal events

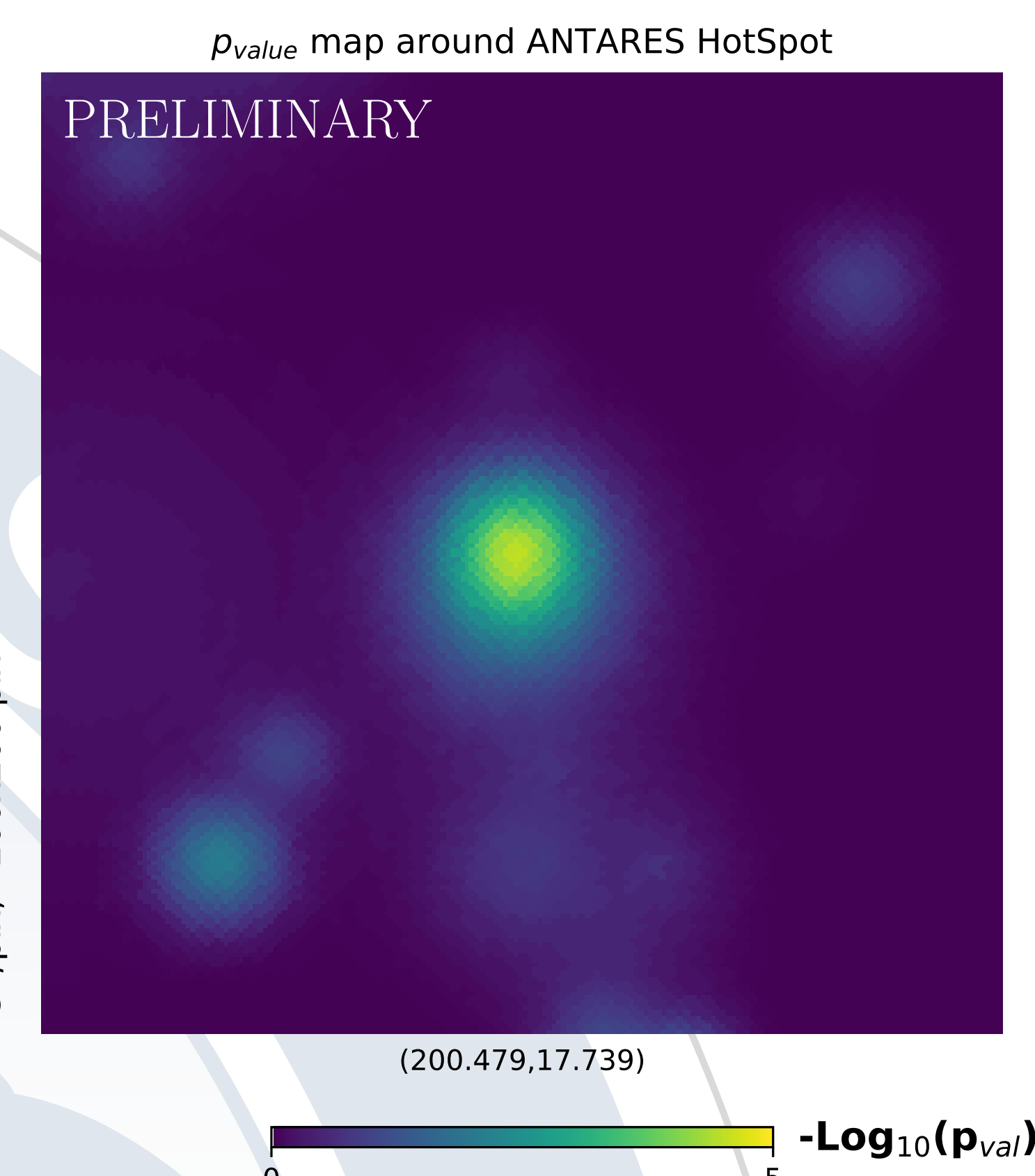
$$S_i = S^{space} \cdot S^{energy} \quad B_i = B^{space} \cdot B^{energy}$$



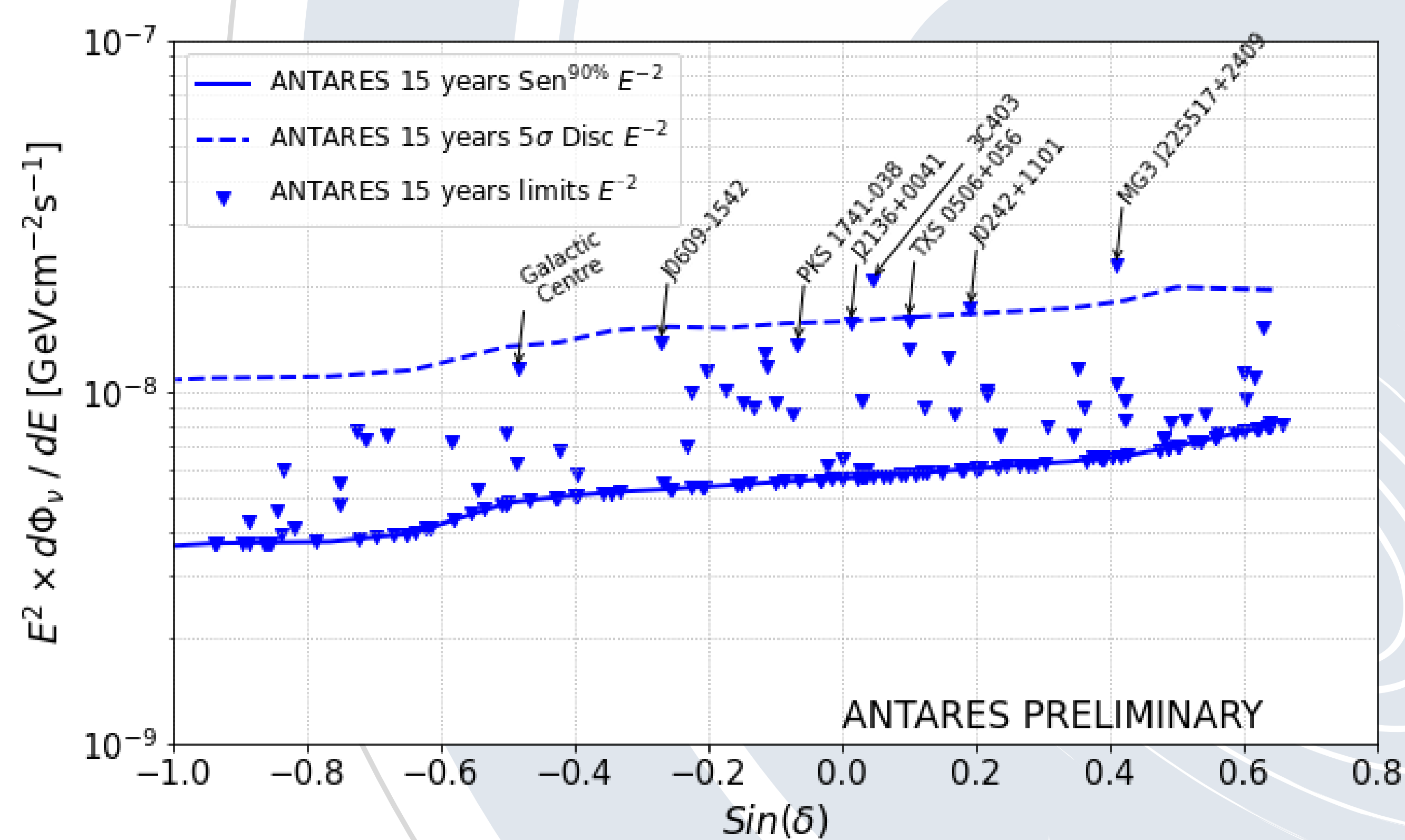
## Full-Sky Search



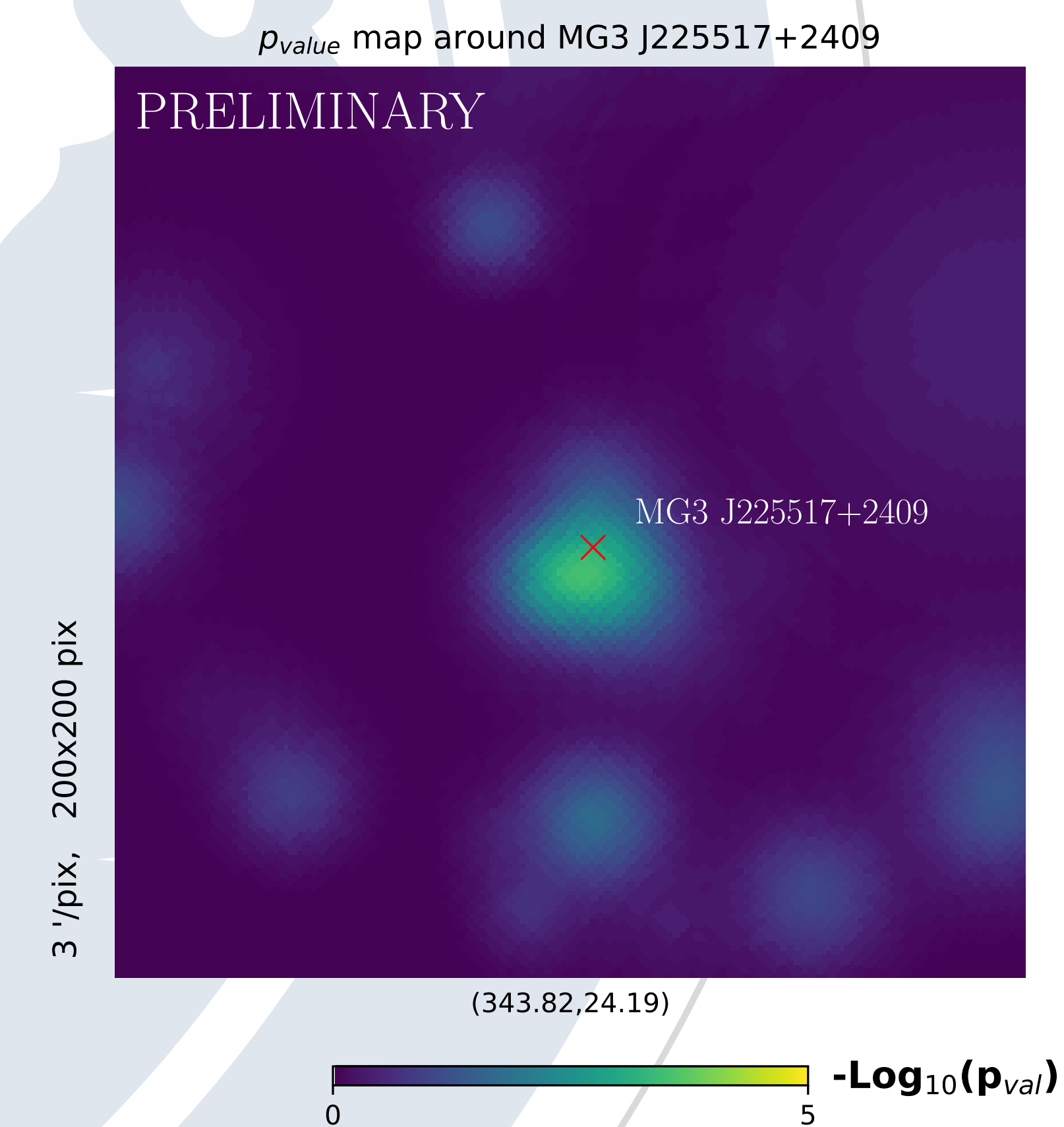
- **Sky** divided in  $\sim 0.11^\circ \times \sim 0.11^\circ$  pixels using a HEALPix grid with NSIDE=512. Each pixel direction is investigated.
- **Left:** sky map of pre-trial p-values found at each investigated direction. White region is outside ANTARES visibility.
- **Most significant cluster** found at (RA = 200.73°,  $\delta = 17.46^\circ$ ), with  $4\sigma$  pre-trial ( $1.2\sigma$  post-trial) significance. Second most significant cluster at (RA = 183.16°,  $\delta = -16.10^\circ$ ) with  $3.7\sigma$  pre-trial.
- **Right:** sky map of pre-trial p-values centered at the location of the full-sky hotspot. Find at the end of the poster the event distribution around this point.



## Candidate-List Search

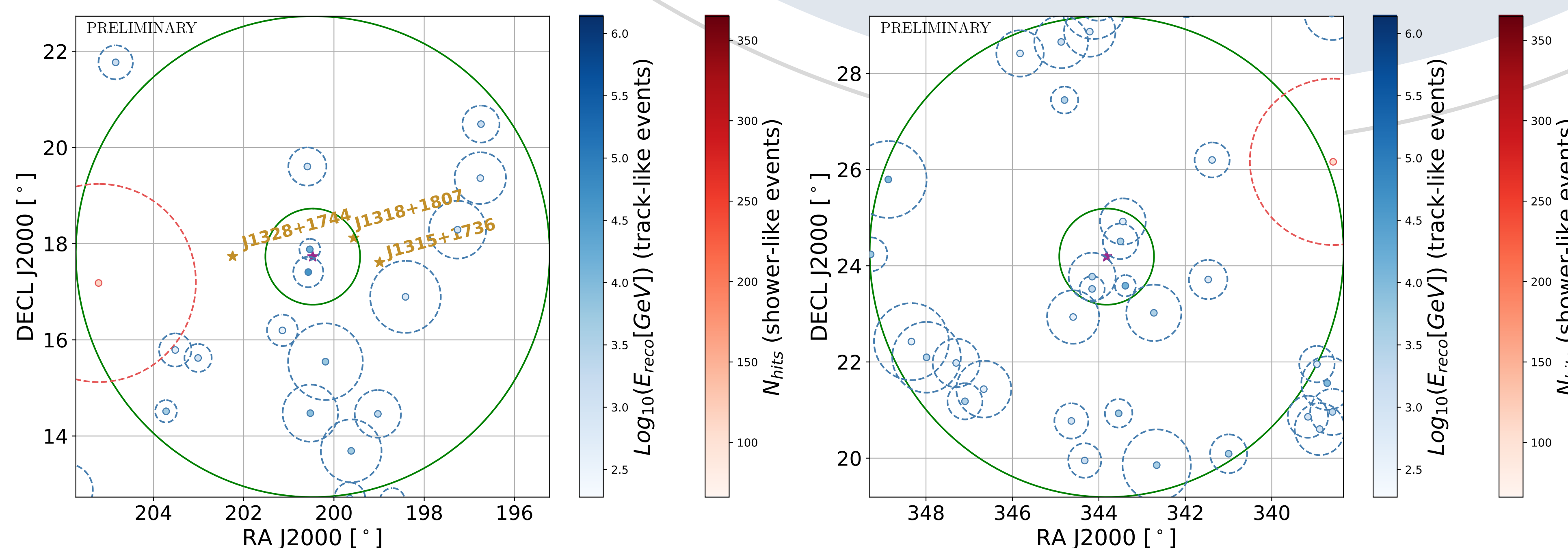


- **163 sources investigated.** No significant evidence of cosmic neutrino sources found (list available at contribution proceeding).
- **Highest significant source: blazar MG3 J225517+2409**,  $3.4\sigma$  pre-trial ( $1.6\sigma$  post-trial) significance.
- **Other significant sources:** 3C403 ( $3.4\sigma$ ), J0242+1101 ( $2.6\sigma$ ), J2136+0041 ( $2.4\sigma$ ), TXS 0506+056 ( $2.4\sigma$ ), J0609-1542 ( $2.3\sigma$ ) and the Galactic Centre ( $2\sigma$ ).
- **Left:** 90% C.L. limits on the one-flavour neutrino flux normalization.
- **Right:** sky map of pre-trial p-values centered at the location of MG3 J225517+2409.



## ANTARES Event Locations

**Left:** ANTARES events close to the full-sky hotspot. **Right:** ANTARES events close to blazar MG3 J225517+2409 (Both as purple stars). Green circles indicate the  $1^\circ/5^\circ$  distance from the centre. Blue dots represent tracks and red dots, showers; with an outer circumference indicating the estimated angular uncertainty. Darker shades of red and blue indicate higher value of the energy estimator.



## Acknowledgements

Grant PRE2019-087798 funded by MCIN/AEI/10.13039/501100011033 and by ESF Investing in your future.



Grant of the Generalitat Valenciana, Pla GenT: references CIDEAGENT/2018/034 & 2020/049

