Searching for >177 TeV Gamma Rays in the Vicinity of Mrk 501

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HAWC has recently developed 2 new analysis techniques that reconstructs the energy of each gamma-ray event. With this new analysis HAWC has detected several Galactic sources with emission above 100 TeV. Additionally the HAWC Collaboration has developed new event reconstruction algorithms called "Pass 5". Using the energy estimators and Pass 5 we search for >177 TeV emission in the vicinity of Mrk 501. High-energy emission from Mrk 501 could, for example, be evidence of Axion Like Particles, a theoretical dark matter candidate. We find a hint of a high-energy lobe within 0.5° of Mrk 501 using both energy estimators.
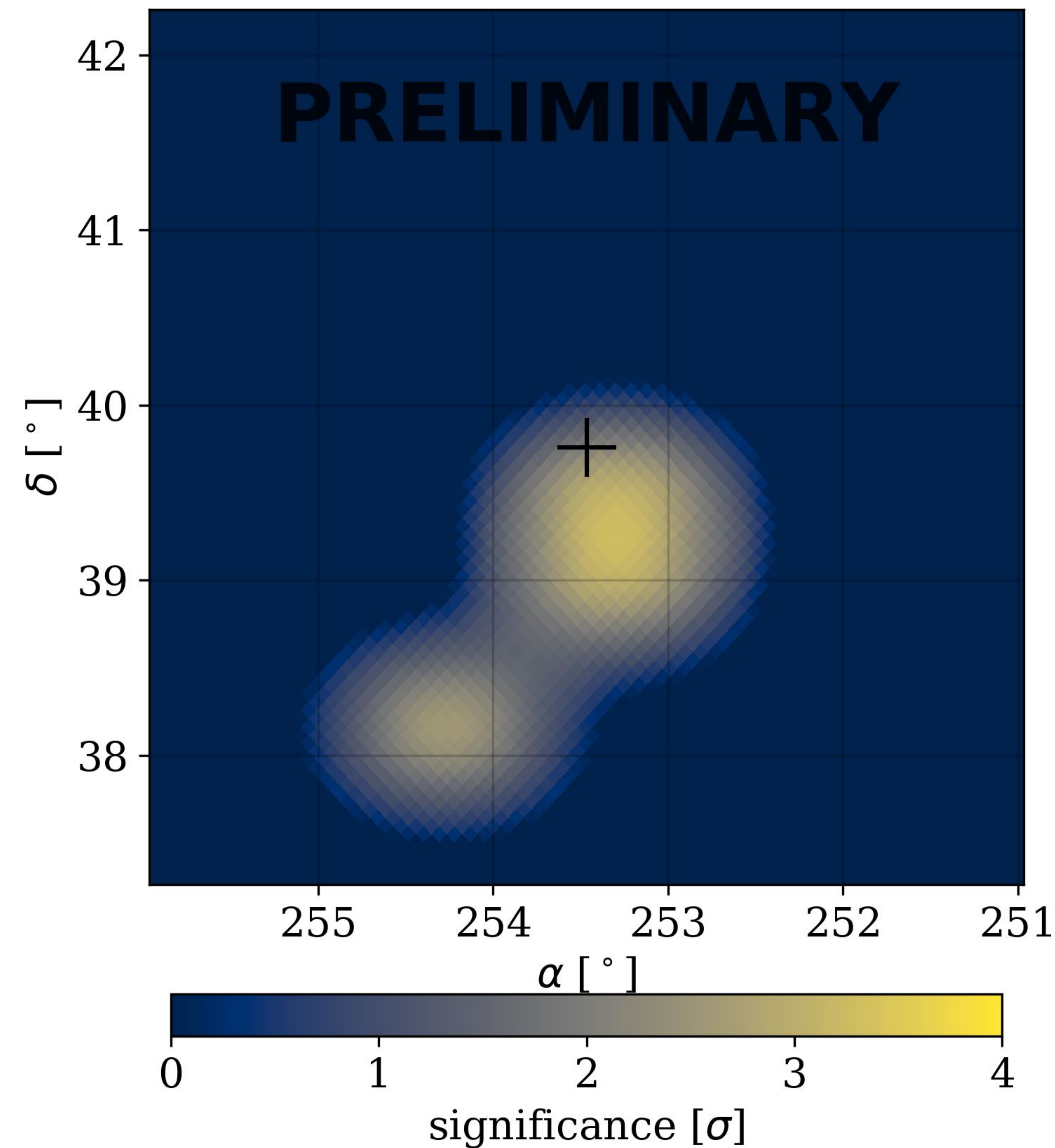
Figure 1: HAWC >177 TeV significance map around Mrk 501 (cross) using the Pass 5 Ground Parameter dataset

- The High Altitude Water Cherenkov (HAWC) Observatory is an array of 300 water tanks equipped with 4 PMTs each that measure extensive air showers from gamma rays.
  - Which PMTs are hit, when they were hit, and how much charge is deposited tells us the direction and energy of the initial gamma ray

- Improved energy estimation methods have recently been developed
  - Detailed in "Measurement of the Crab Nebula Spectrum Past 100 TeV with HAWC" The Astrophysical Journal, Volume 881 (2019)
  - The "Ground parameter" is based on a fit of the PMT charge profile; The other is calculated with a "Neural Network"
  - Both estimators have an energy resolution of 30% at 177 TeV

- An excess of gamma-rays with energy >177 TeV is within 0.5° of Mrk 501
  - Ground Parameter: 3.31σ
  - Neural Network: 2.35σ

- We have found a pointing systematic error that is up to 0.5° depending on the zenith angle of the event.
  - Future analyses will account for the systematic uncertainty and will elucidate if these events are coming from Mrk 501
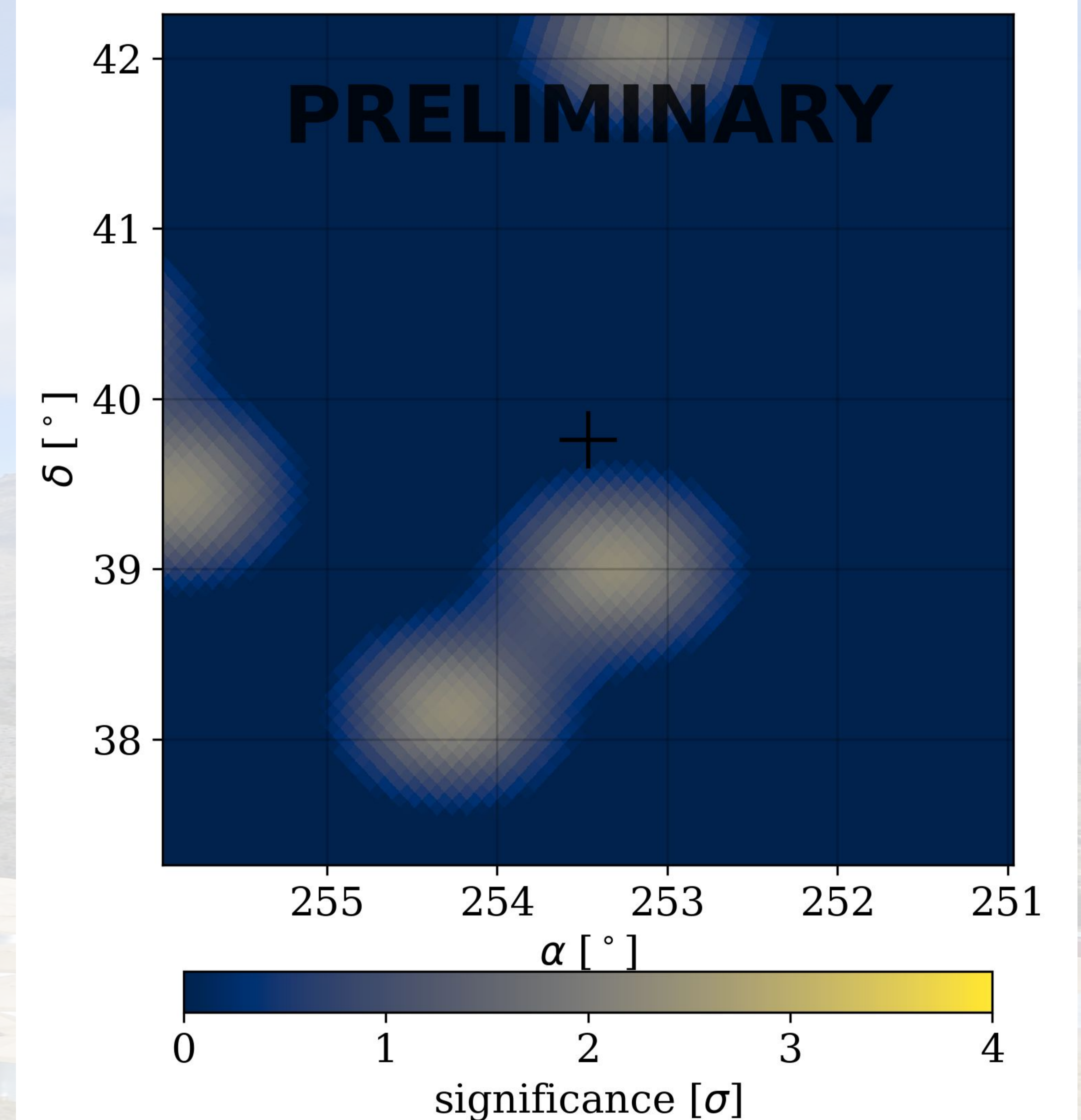

Figure 2: HAWC >177 TeV significance map around Mrk 501 (cross) using the Pass 5 Neural Network dataset