

Abstract

We report on an unidentified γ -ray signal found in the region around the BL Lac object 1ES 0229+200. It was recognized serendipitously in our analysis of 6.2 years of Fermi-LAT data at a distance less than 3° away from the blazar. The observed excess of counts manifests itself as an unexpected local maximum in the test statistic map. Although several Fermi-LAT sources have been identified in this area we were not able to link them to the position of this residual signal. A clear association with sources visible in other wavebands was not successful either. We briefly discuss characteristics of this unresolved phenomenon. Our results suggest a steep energy spectrum and a point-like nature of this candidate γ -ray emitter.

Source identification

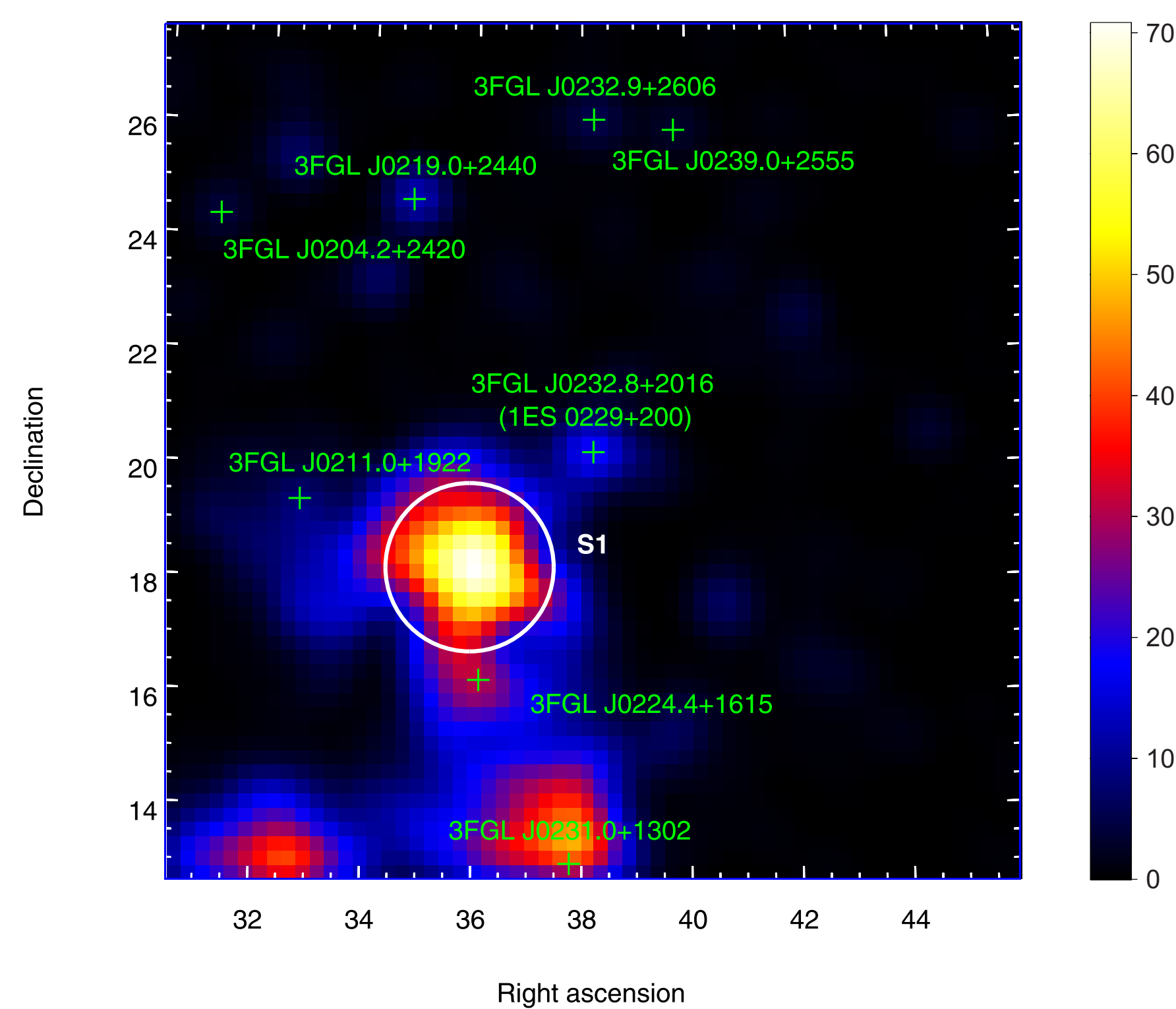


Figure 1 : A map of test statistic values in a region centred around the position of 1ES 0229+200. Only sources present in the 2FGL catalogue (*Fermi-LAT Coll., ApJS, 199, 46, 2012*) were assumed to contribute to the γ -ray signal in the shown region. Vertical bar at the right side represents colour encoding for different TS values. Labelled crosses denote sources present in the 3FGL (*Fermi-LAT Coll., arXiv:1501.02003, 2015*) but not in the 2FGL catalogue. White circle marks the unexpected signal labelled as S1 unattributable to any catalogue source.

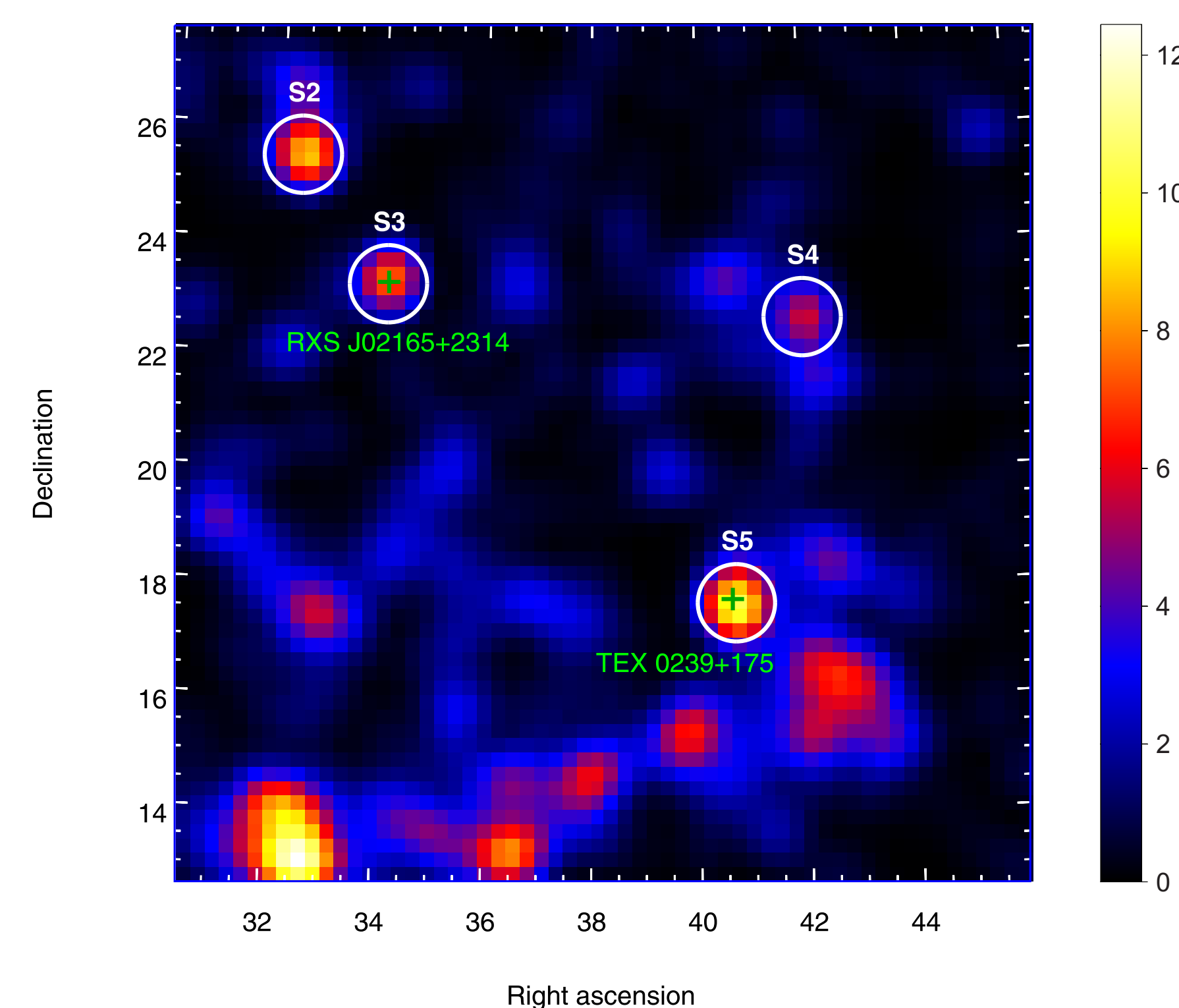
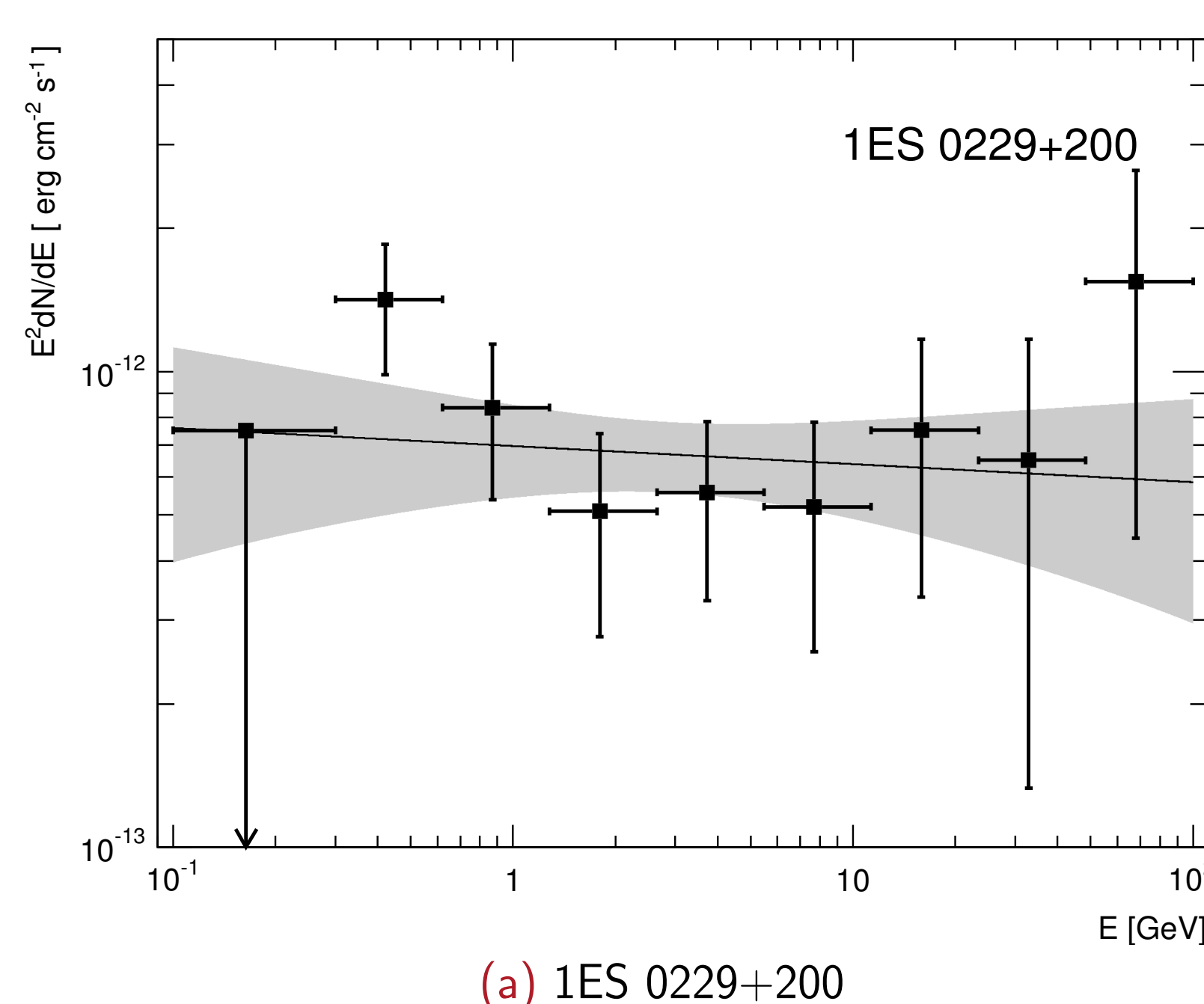
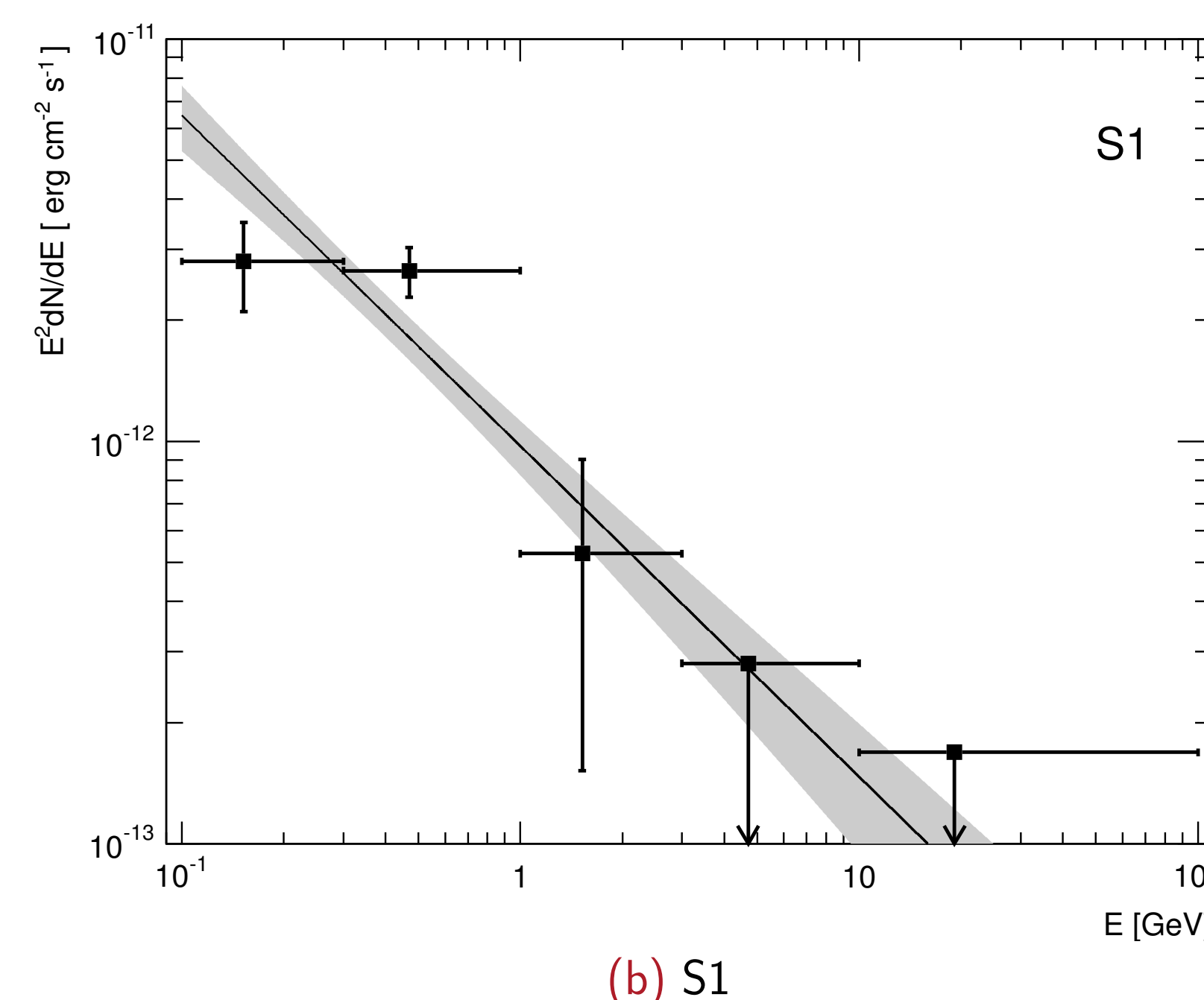


Figure 2 : A map of test statistic values based on a source model including sources from the 3FGL catalogue and the hypothetical object S1. Circles encompass the unknown sources of HE γ -rays. Green crosses pinpoint the positions of two known BL Lac objects (*Veron-Cetty, Veron, A&A, 518, A10, 2010*).

Spectral energy distributions



(a) 1ES 0229+200



(b) S1

Figure 3 : Spectral energy distributions of 1ES 0229+200 and S1. Upper limits on the flux at a 95% confidence level denoted by arrows are stated in those bins where TS < 1. Solid lines represent the spectral shapes given by maximum likelihood estimates of the relevant parameters. Grey areas are defined by uncertainties on the differential fluxes. The error bars denote the statistical uncertainties at a 1σ confidence level.

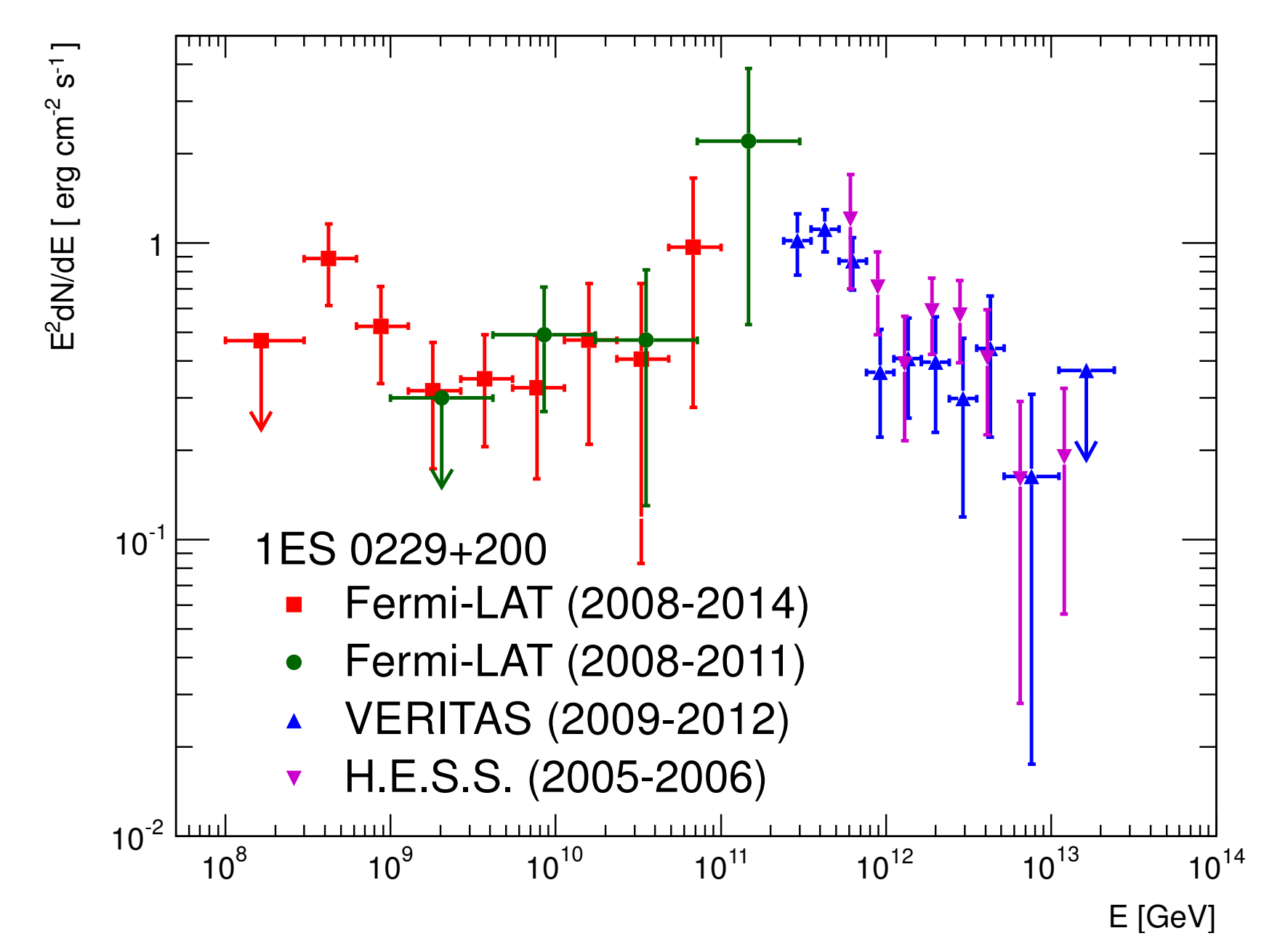
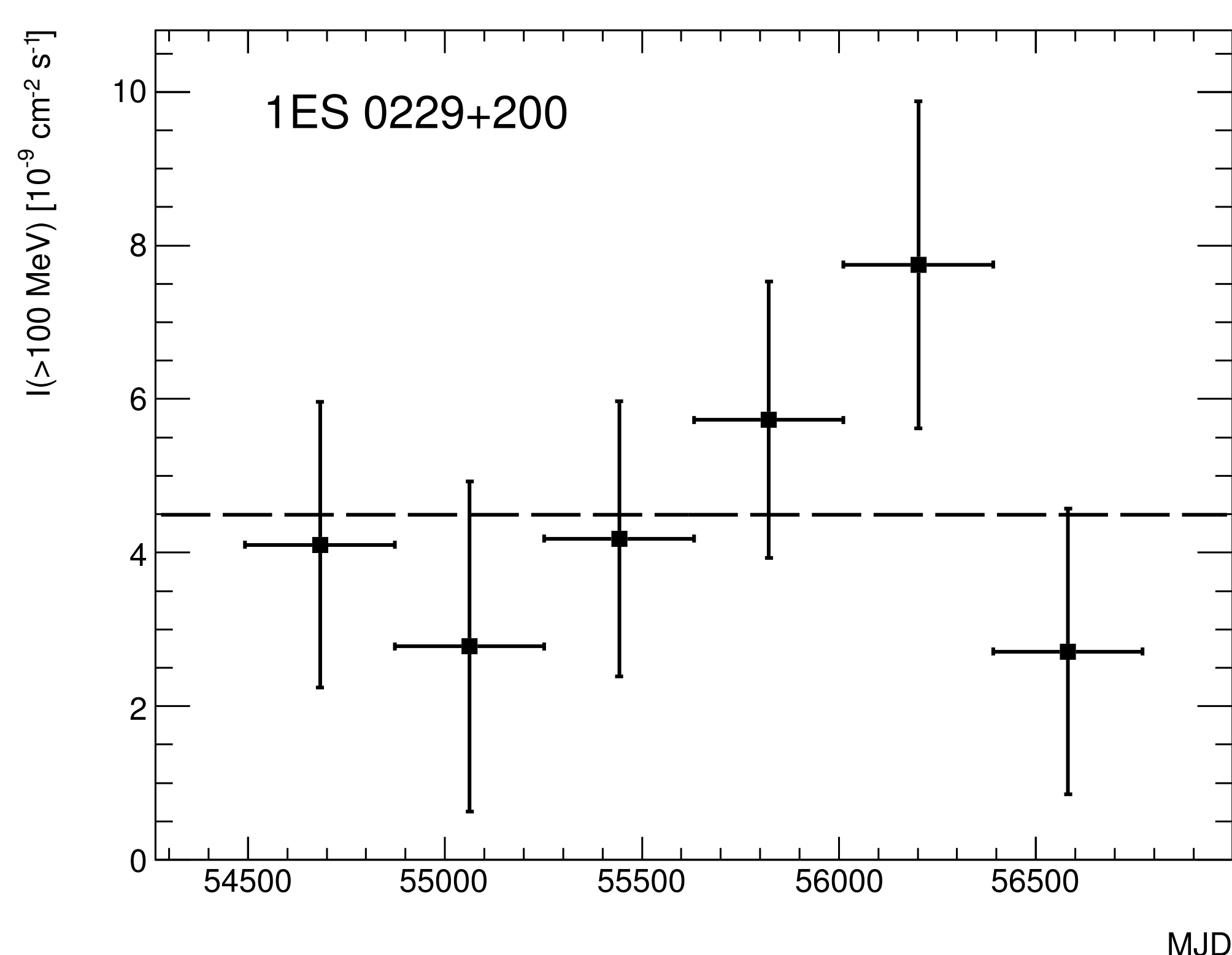
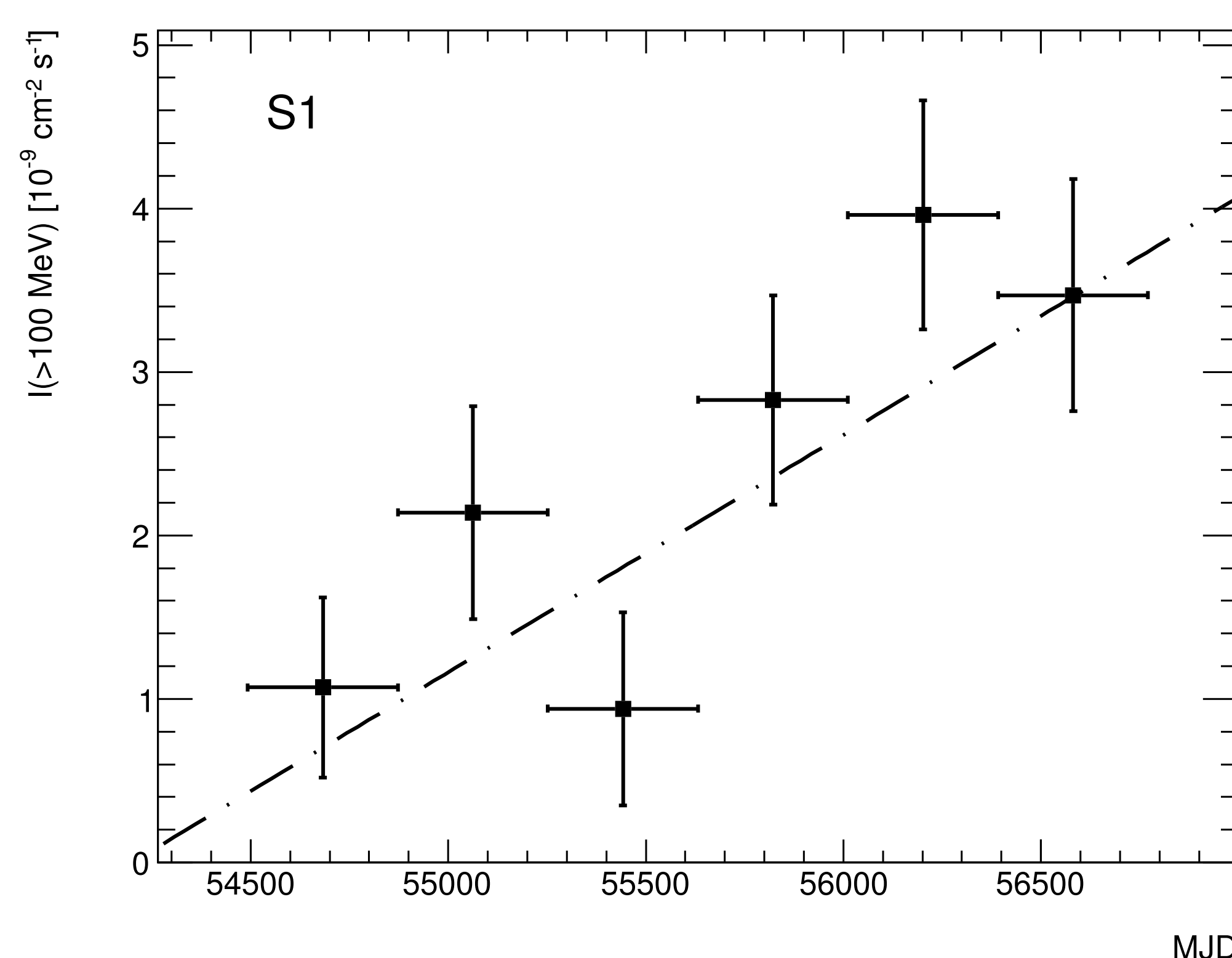


Figure 4 : SED of 1ES 0229+200. Red squares are the results of our analysis. Green circles represent the results of the analysis of the Fermi-LAT data obtained by *Vovk et al., ApJL, 747, L14, 2012*. Blue and magenta triangles denote the very high energy data gathered by the VERITAS (*Aliu et al., ApJ, 782, 13, 2014*) and H.E.S.S. (*Aharonian et al., A&A, 475, L9-L13, 2007*) experiments, respectively.

Temporal evolution



(a) 1ES 0229+200



(b) S1

Figure 5 : Lightcurves of 1ES 0229+200 and S1. The dashed line represents the χ^2 fit of the data to a constant (χ^2/NDF is 4.4/5, $p = 0.5$). The dash-dotted line denotes the linear fit of S1 data (χ^2/NDF is 6.1/4, $p = 0.2$).

Conclusions

We analysed 6.2 years of high energy γ -ray data gathered by the Fermi-LAT experiment from a region surrounding the BL Lac 1ES 0229+200. The features of the source were found to be consistent with older findings (*Fermi-LAT Coll., arXiv:1501.02003, 2015; Vovk et al., ApJL, 747, L14, 2012*). We noticed a possible break in the spectrum around the energy of 2 GeV. No increase of the source activity in the periods of the VHE enhancement was observed.

We found an unexpected significant signal near 1ES 0229+200. Additional four fainter unknown sources were recognized in the studied region. None of the revealed objects have been previously reported. Spectral shapes and fluxes of new sources of a γ -ray excess were recorded. Possible correlation of two signal areas with BL Lacs RXS J02165+2314 and TEX 0239+175 was found. The brightest of the unknown signals was studied in detail. No support for the extended nature of this candidate source has been established. Its emission is variable and can be described by a steep power law.