OG 2.03

AGN Observations by STACEE

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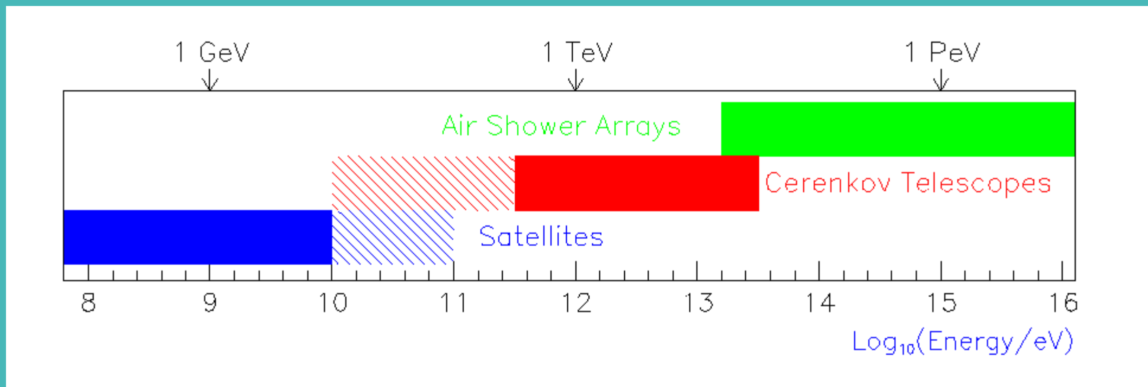
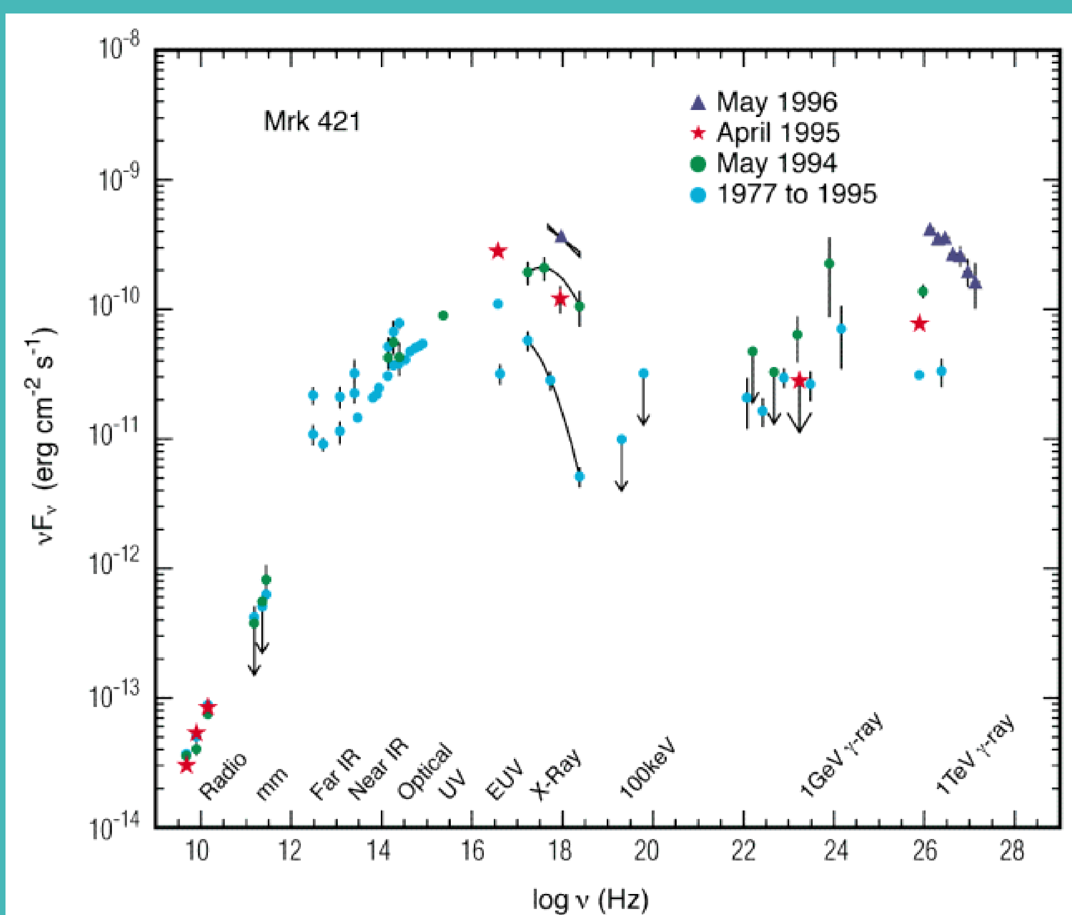
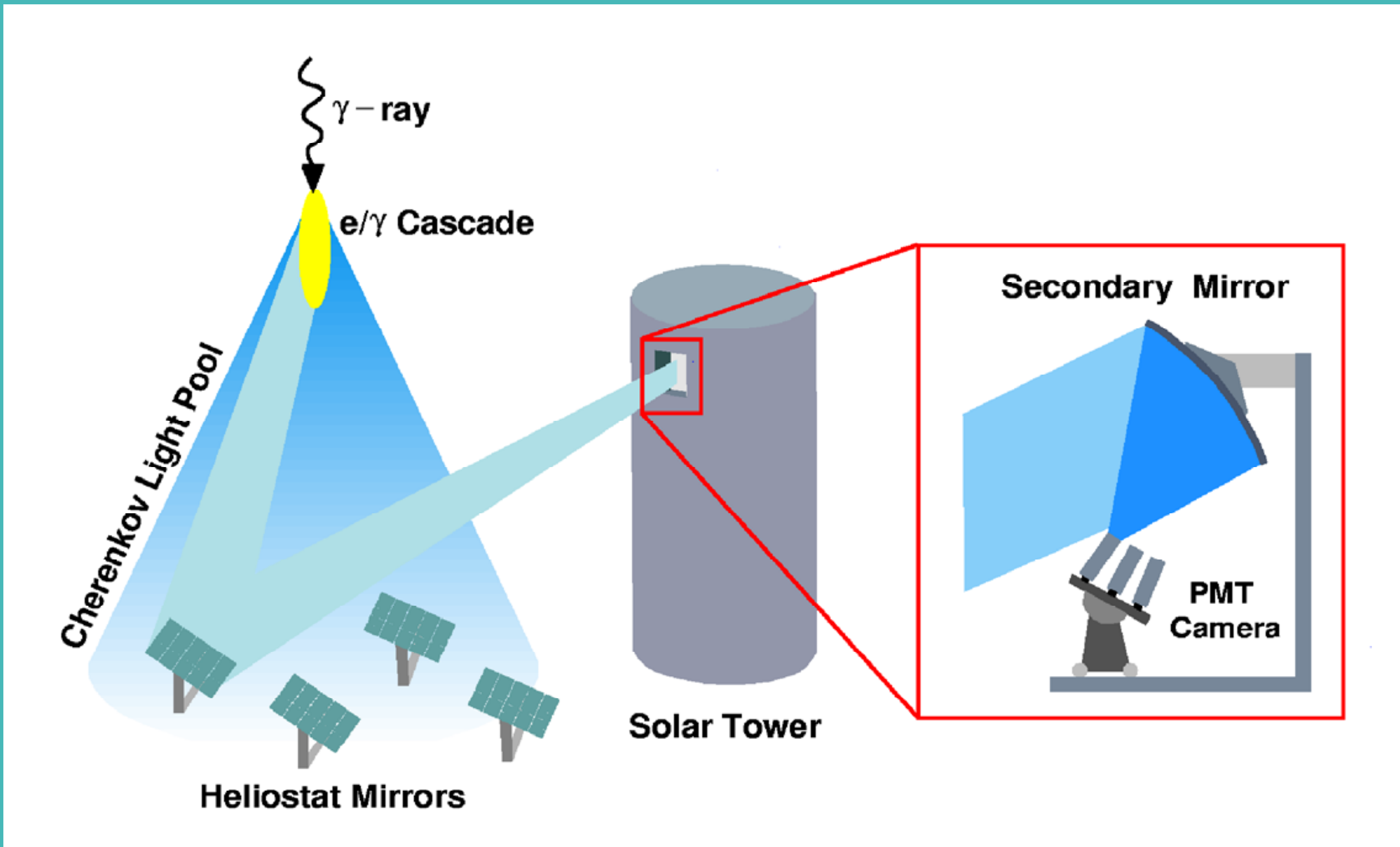


STACEE is sensitive to the range of gamma−ray energies between 50 and 500 GeV. This region of the electro−magnetic spectrum lies beyond that currently explored by satellite experiments and below the threshold of existing Imaging Cherenkov Telescopes.

Target objects include pulsars, supernova remnants and active galaxies. For example, the active galaxy Mrk 421 has its peak energy output in this energy range.





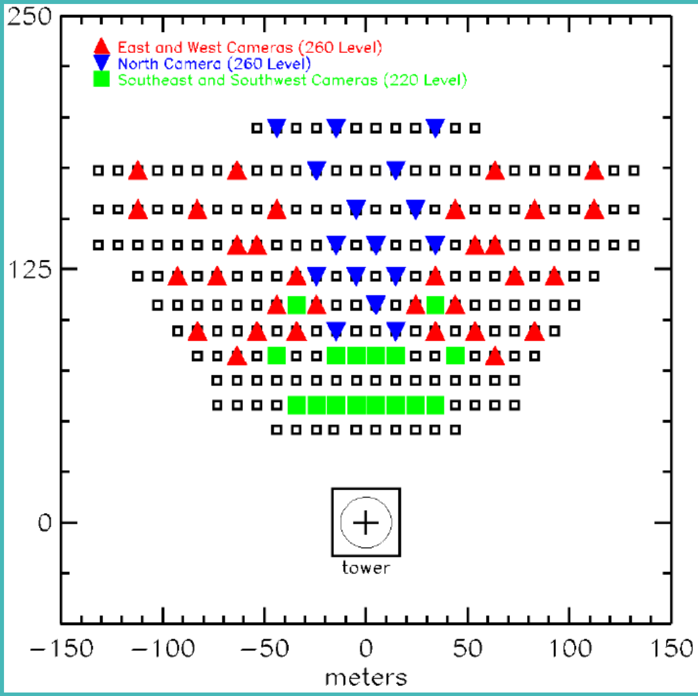
The Solar Tower technique is outlined above:

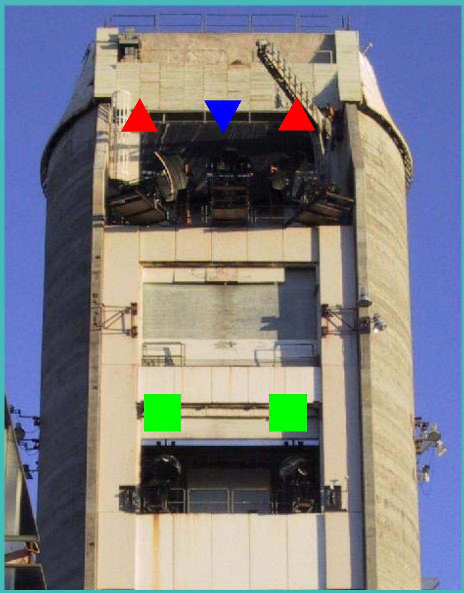
1) Cherenkov light is produced by a electromagnetic cascade in the upper atmosphere.

2) Heliostat mirrors are used to track an astrophysical source and reflect Cherenkov light onto the Solar Tower.

3) A secondary mirror in the tower focuses light from each heliostat on to a separate element in a photomultiplier tube camera.

STACEE Configuration



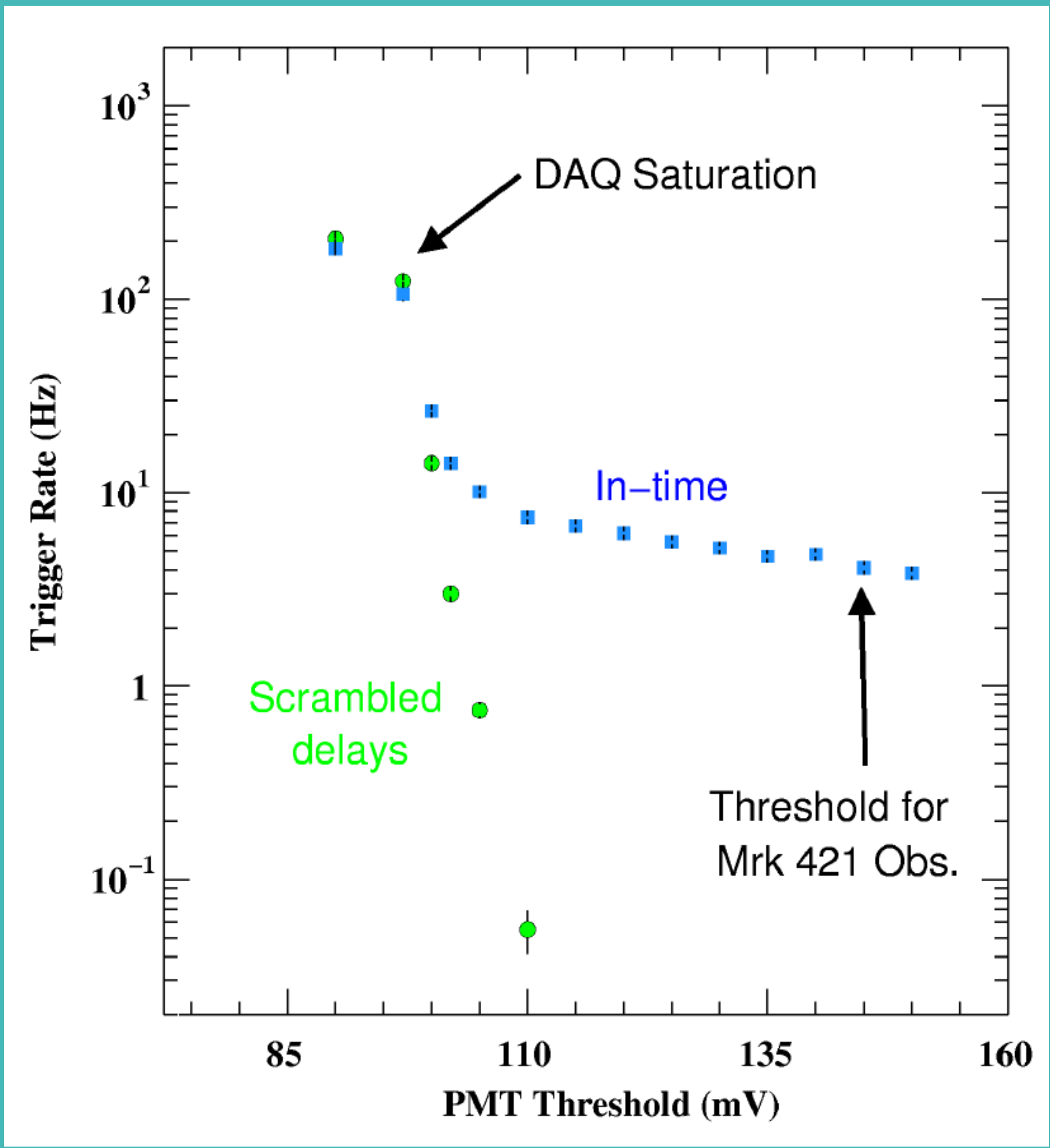


STACEE Configuration:

- 2000−2001 48 Heliostats (37 m^2 each)
- 2001− 64 Helisotats
- Five secondary mirrors focus light onto photomultiplier cameras.
- Timing and FADC information.
- Digital delay and trigger.

See, also: Covault et. al OG2.05 (poster 225)

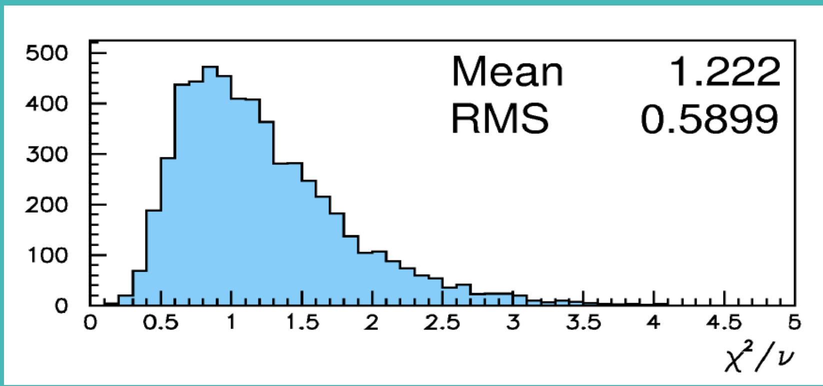
Rate vs. Threshold (STACEE−48)



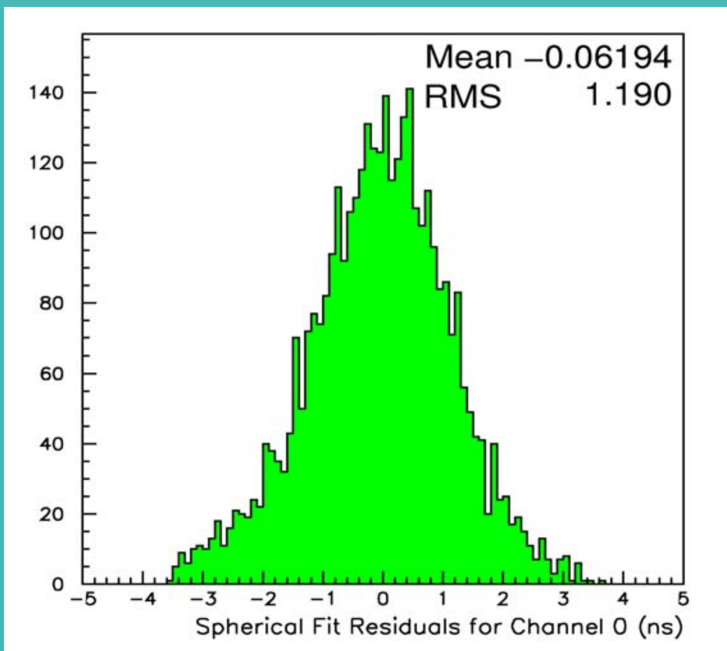
Night Sky background triggers negligable above 110 mV (4.5 pes/PMT)

Very conservative operating threshold at 145 mV (6 pes/PMT)

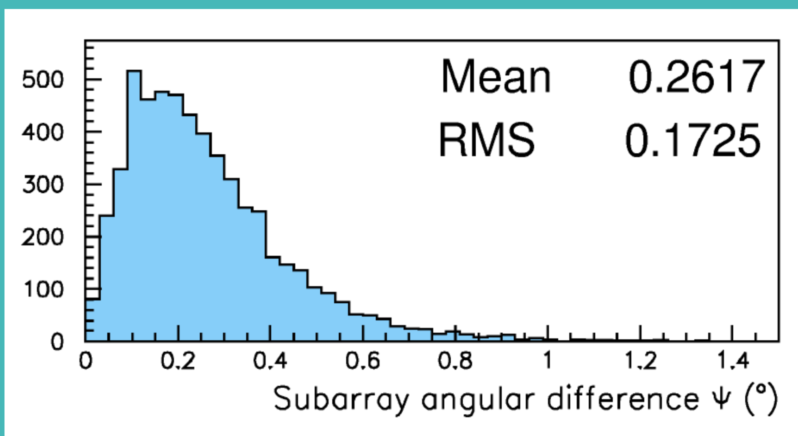
Shower Reconstruction



χ^2 from shower fit

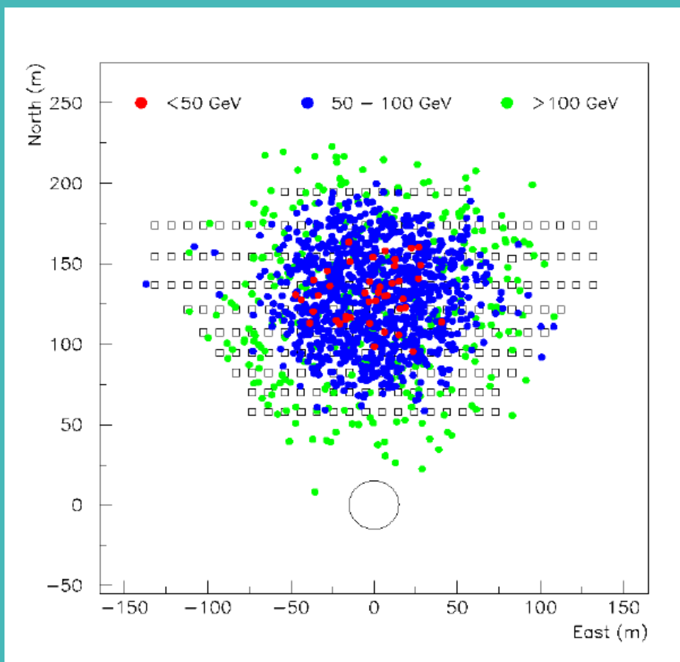


Fit residuals

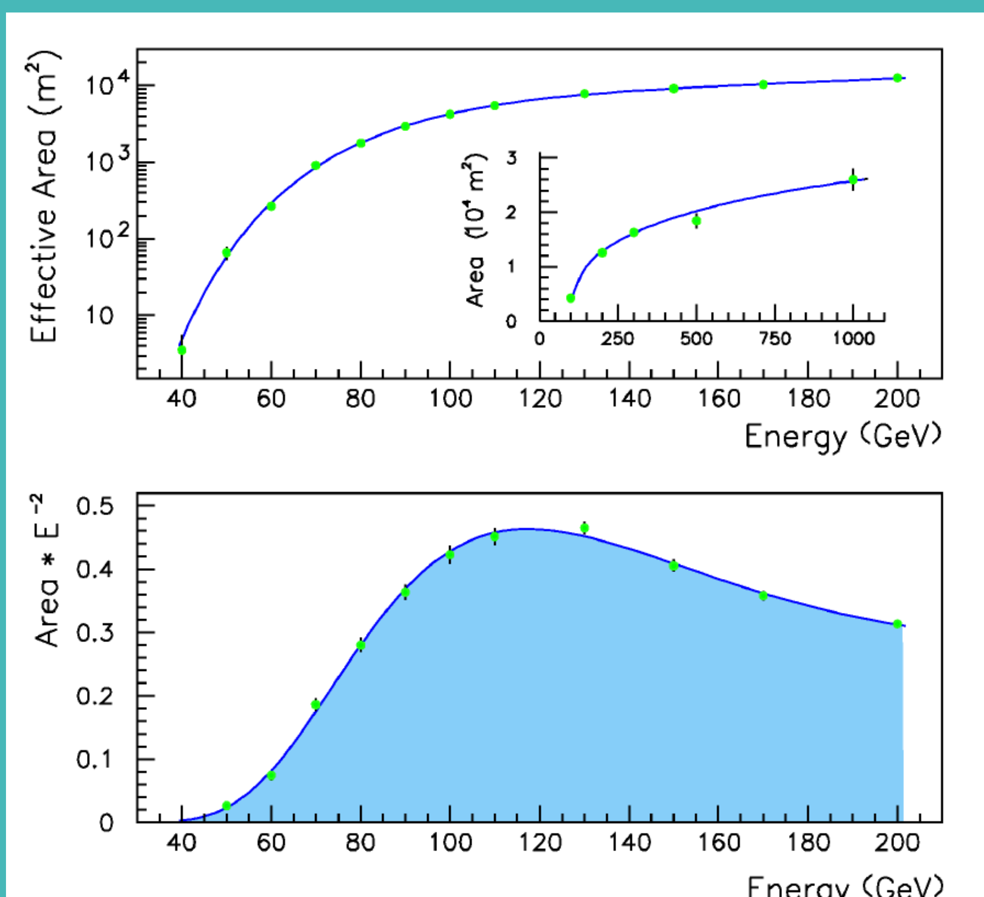


Angular resolution from split array.

Simulations



The triggering probability of simulated showers is used to calculate the effective collecting area of the array. Convolving this area with an assumed source spectrum of E^{-2} yields an energy threshold of ~ 115 GeV for a source at zenith



Mrk 421 Observations

Early 2001:

Observations by RXTE and HEGRA early in 2001 show that Mrk 421 is in a very active state.

Feb−Apr 2001:

STACEE−48 Observations of Mrk 421.

- ON/OFF observing mode (30 min pairs)
- 45h on−source data acquired.
- 26h after quality cuts based on sky conditions and PMT cluster rate stability.
- Raw significance ON−OFF is 12 σ.

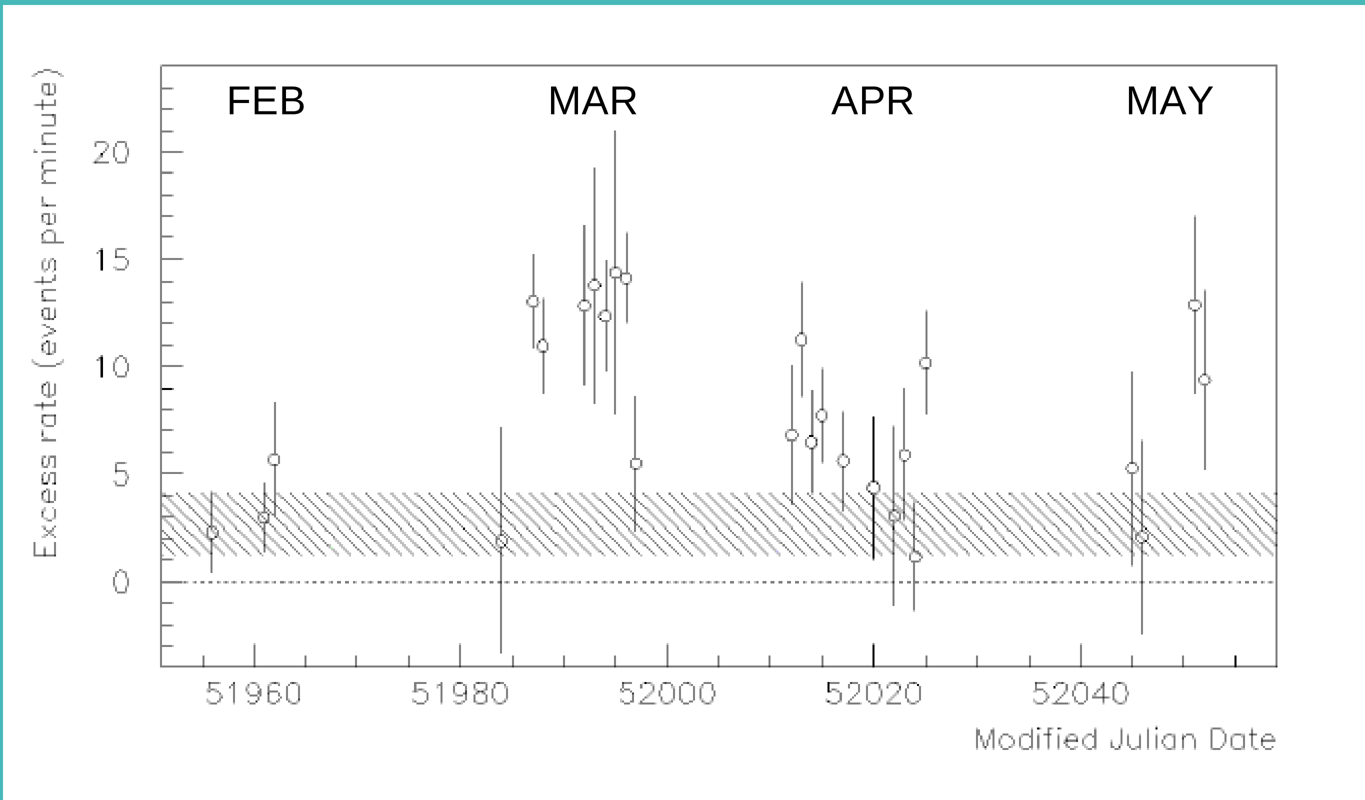
- 6^{th} magnitude star in on−source FOV
- Some additional 'noise promoted' triggers
- Observations of an 'empty' field with similar stars to quantify this effect.

Mrk 421 Analysis Procedure

- Channel cuts from heliostat logging and PMT monitoring − remove bad channels software
- Software reimposition of trigger.
- Keep 99% of events when all channels good.
- Calculate ON/OFF livetimes.
- Reconstruct shower directions

- Timing uncertainties are increased in the absence of pulse height information: hence, we do not use a goodness−of−fit cut.
- Mean reconstructed direction is <0.05º fromMrk 421 position

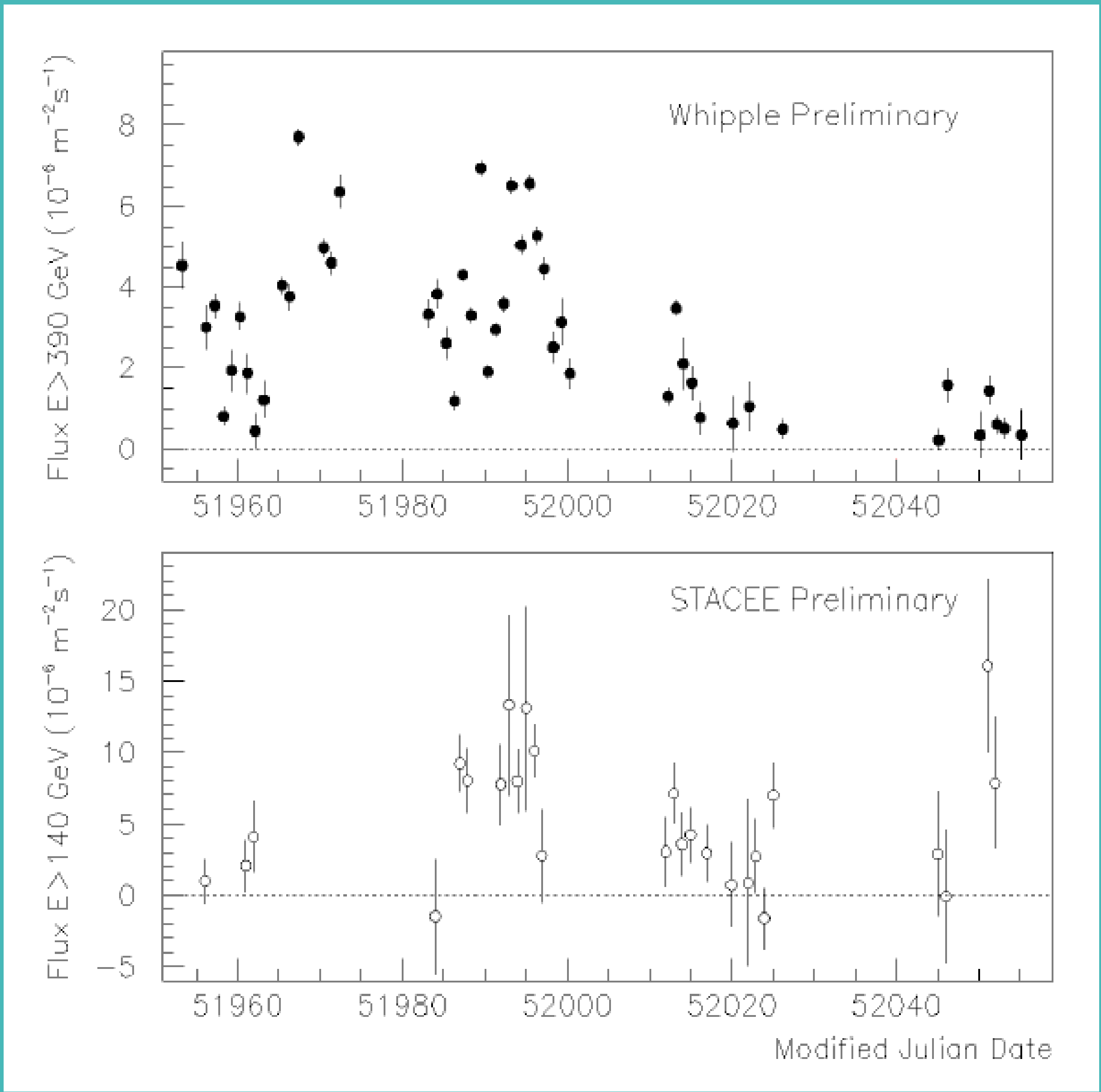
Mrk 421 Excess



There is clearly a large and variable excess.
However part of the excess may be due to ’the star’.

The hatched band shows the range ($\pm 1\ \sigma$) of possible contamination deduced from on−off observations of an ’empty’ FOV containing similar stars (1.1 ± 0.6 %)

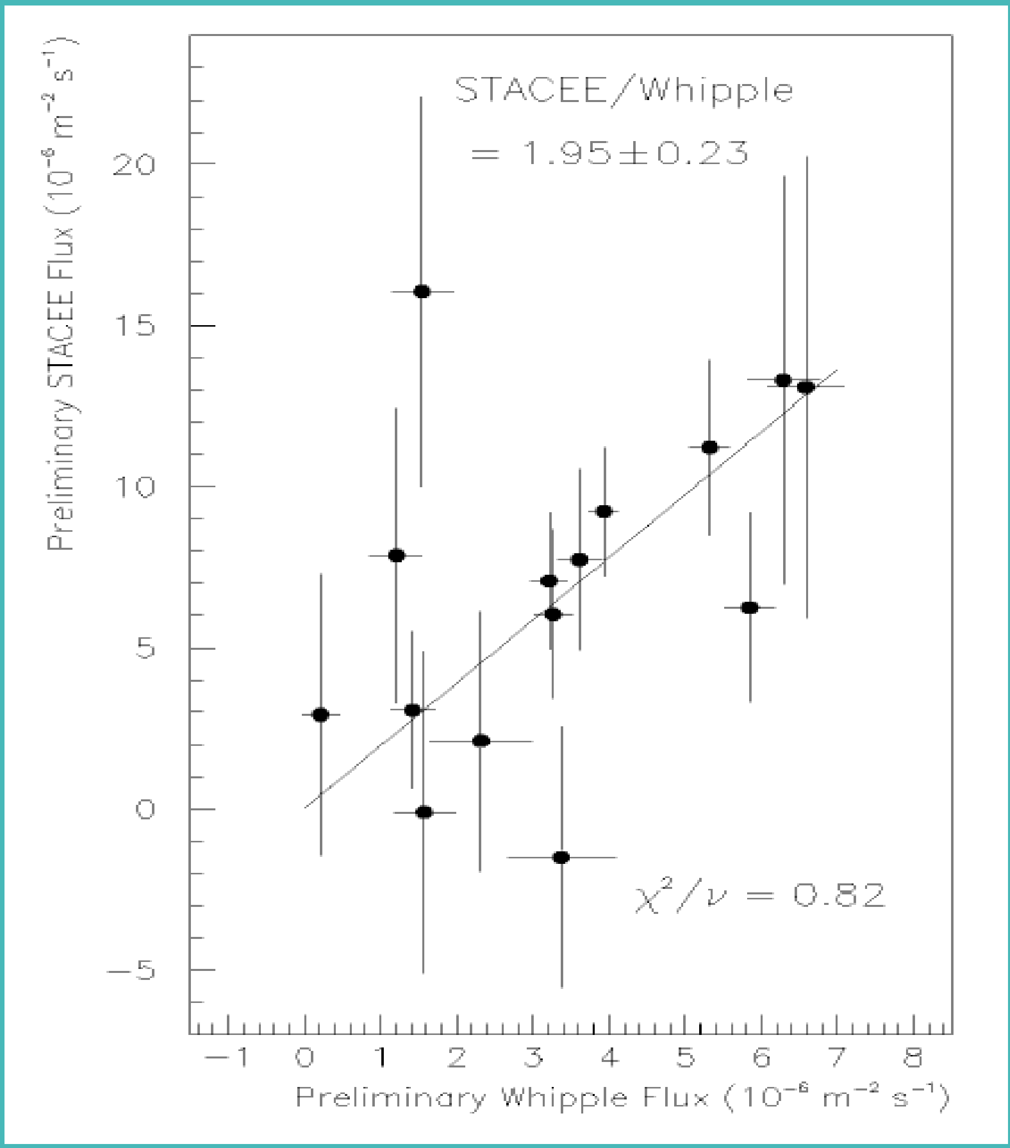
Mrk 421 Light Curve



Uncertainty in star subtraction = 1.4×10^{-6}

Highly variable source – need to use simultaneous data for comparison.

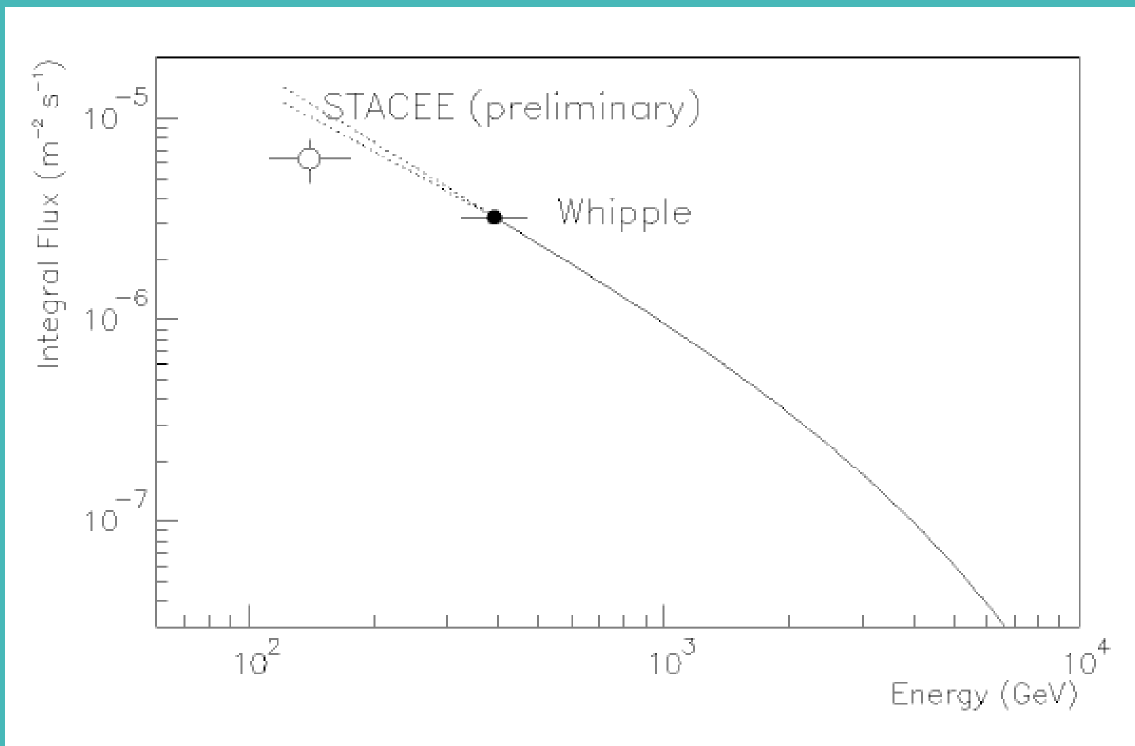
Comparison with Whipple



Using 28 nearly simultaneous runs from STACEE & Whipple data.

Consistent with a constant flux ratio of ~ 2.

Integral Spectrum



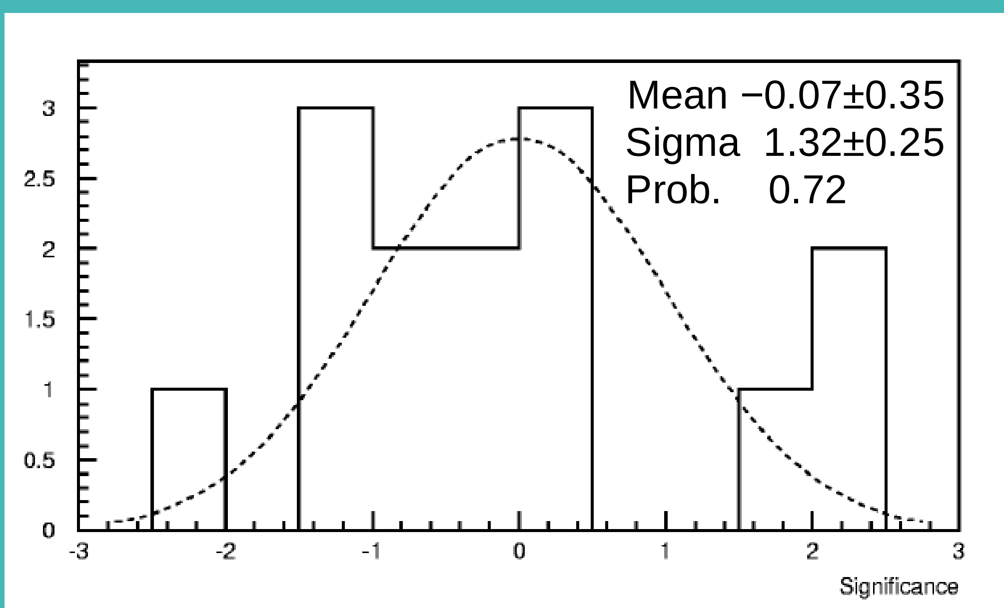
- STACEE flux is marginally consistent with extrapolation of Whipple spectrum (including systematic errors on both experiments)
- Expect peak of high energy (IC) component somewhere between 10 and 100 GeV:
  - EGRET spectral index 1.57 $\pm$ 0.15.
  - Whipple spectral index= 2.14 $\pm$ 0.03 (with exponential cut−off at 4 TeV).

Mrk 501 Observations

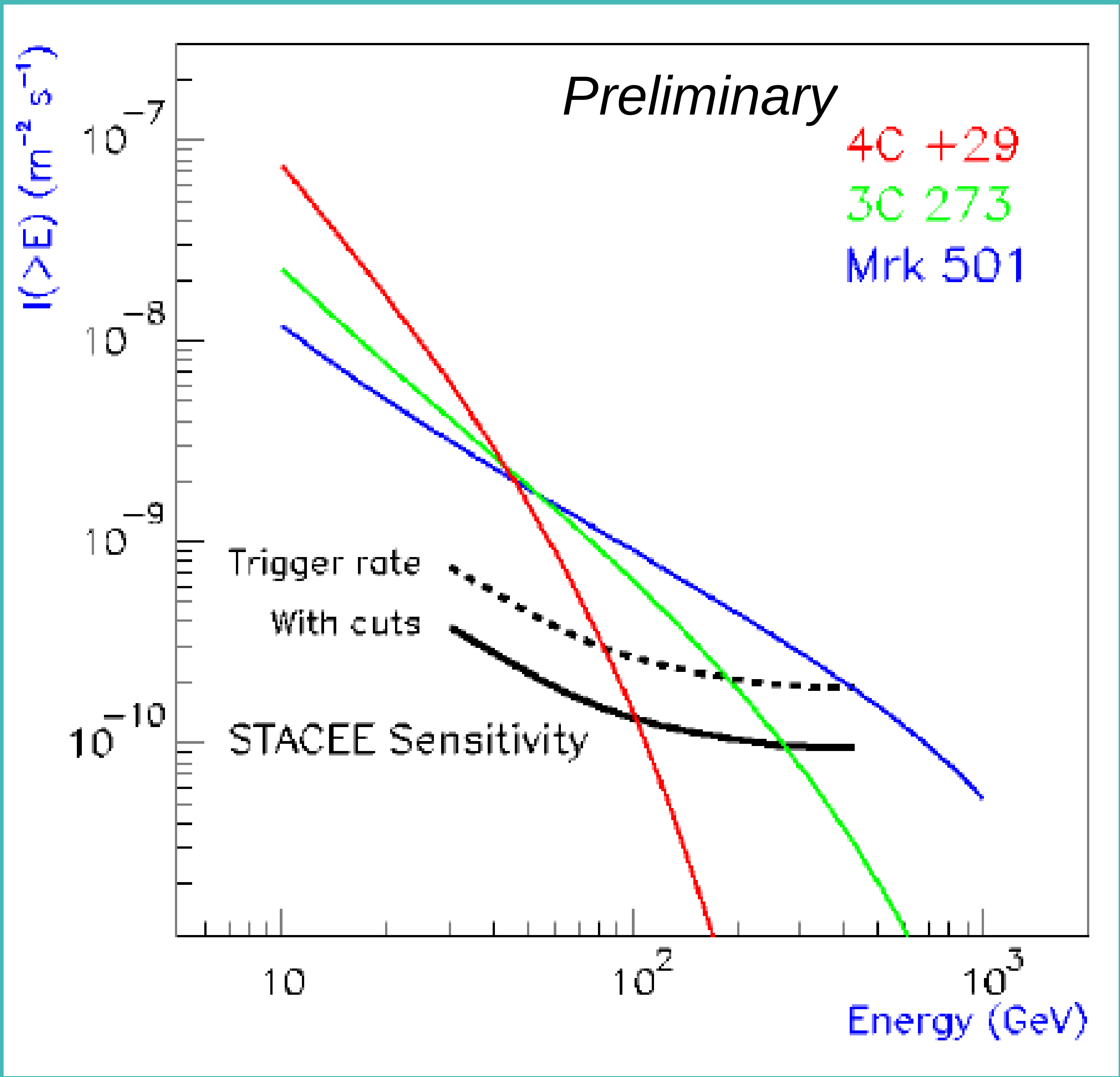
- 27 Mar 2001 − 24 May 2001
- 14.2 hr of ON−source data acquired
- 12.3 hr pass cuts
- Total excess = −0.23 σ.
- Mean energy = 130 GeV
- Flux limit:

$$\Phi < 7.0 \times 10^{-11}\ \gamma / cm^2 / s$$

Day by day significance:

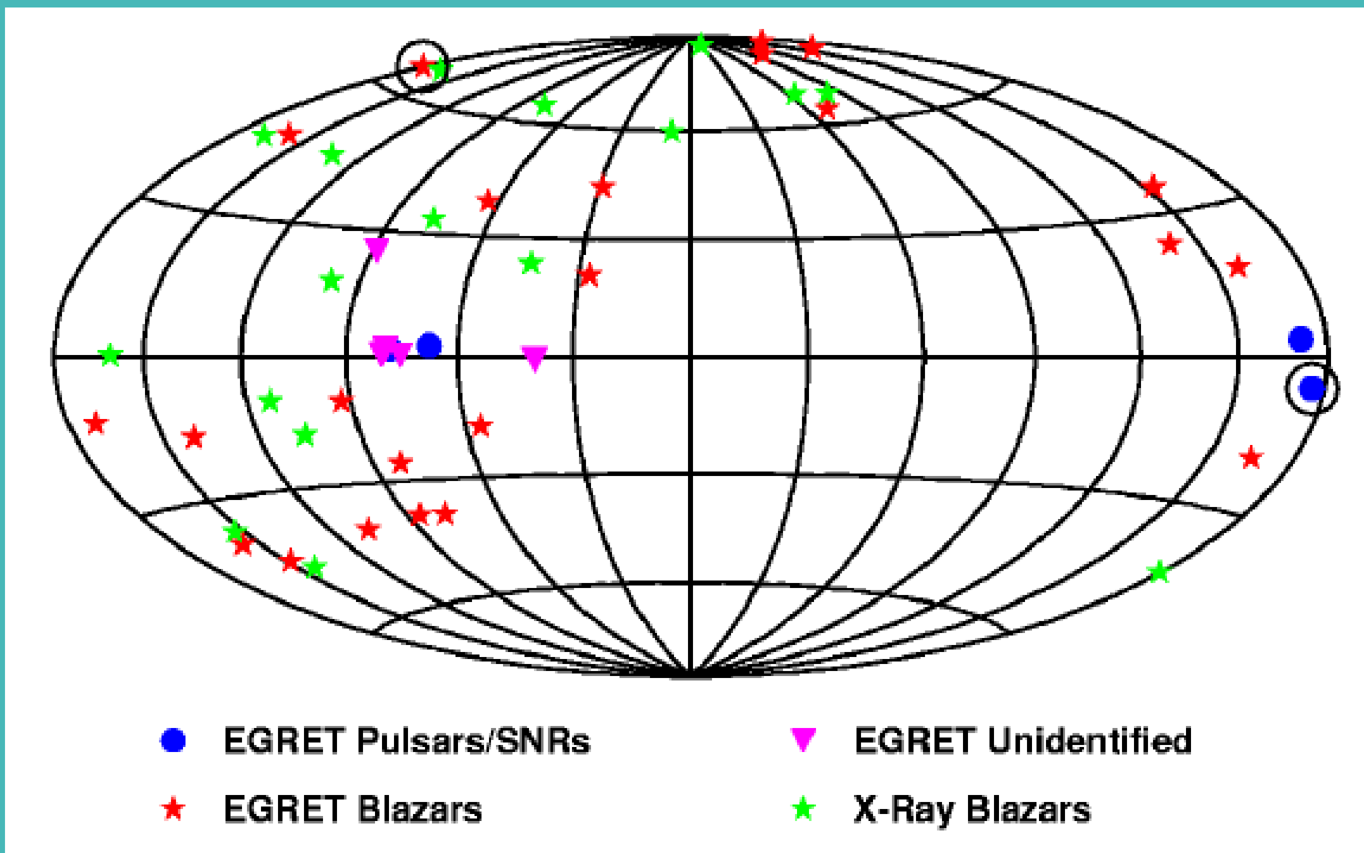


AGN Sensitivity



A sensitivity estimate for the completed STACEE experiment is shown above. Extrapolated EGRET spectra (with estimated extagalactic absorption) for sample sources are also shown.

Target Sources



Third EGRET Catalog:

Pulsars: The Crab, PSR1951+32 ...

Supernova Remnants: W44, γ−Cygni...

Blazars: Mrk 421, Mrk 501, 3C 66A, W−Comae

3C 273,4C +29.45, 3EG 0509+056...

Unidentified Sources with X−ray counter−parts

+ X−ray Selected Blazars