

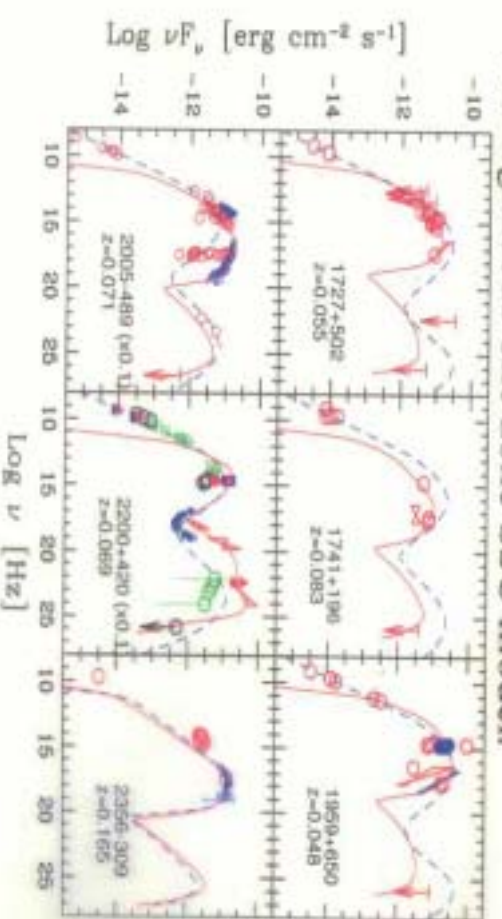
Observations of IES1959+650 with the Whipple 10m Telescope

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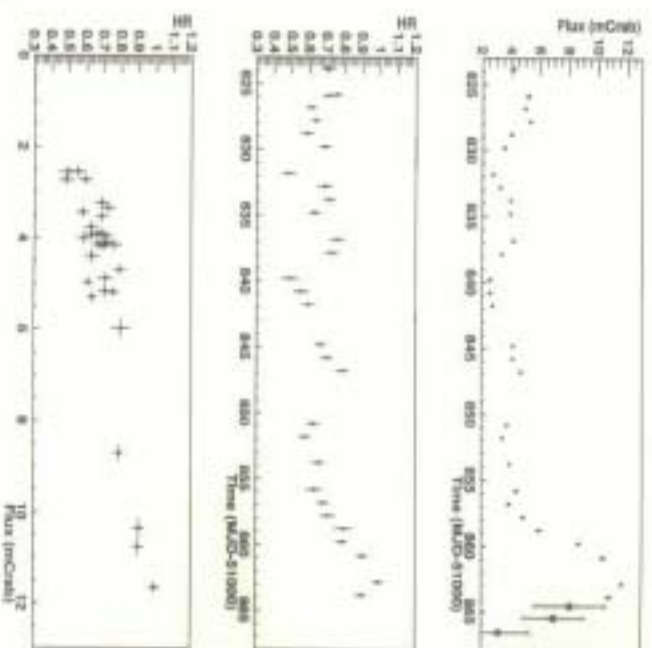
IES1959+650

- X-ray selected BL Lacertae object
- $z=0.048$
- Good TeV candidate
- Predicted by Stecker, de Jager & Salamon (1996) at $2 \times 10^{-11} \text{ cm}^{-2} \text{ s}^{-1}$ using simple scaling arguments

- Costantante and Ghisellini predict $8 \times 10^{-11} \text{ cm}^{-2} \text{ s}^{-1}$ using Fossati et al. (1998) phenomenological parameterization and $0.03 \times 10^{-11} \text{ cm}^{-2} \text{ s}^{-1}$ using homogeneous one-zone SSC model.



- ◆ Weak EGRET source $1.8 \times 10^{-7} \text{ cm}^{-2} \text{ s}^{-1}$ for $E > 100 \text{ MeV}$
- ◆ Optical variability: 0.28 mags in 4 days (Villata et al. 2000)
- ◆ X-ray variability (Giebels et al. 2002) :



- ◆ Previous TeV observations inconclusive:
 - ◆ Utah 7 telescope array 57 hours, 3.9σ , $E_{\text{threshold}} > 6000 \text{ GeV}$ (Nishiyama et al 1999)
 - ◆ HEGRA preliminary detection $\sim 5\sigma$ (Konopelko et al. 2002 April APS meeting)
 - ◆ Whipple upper limits

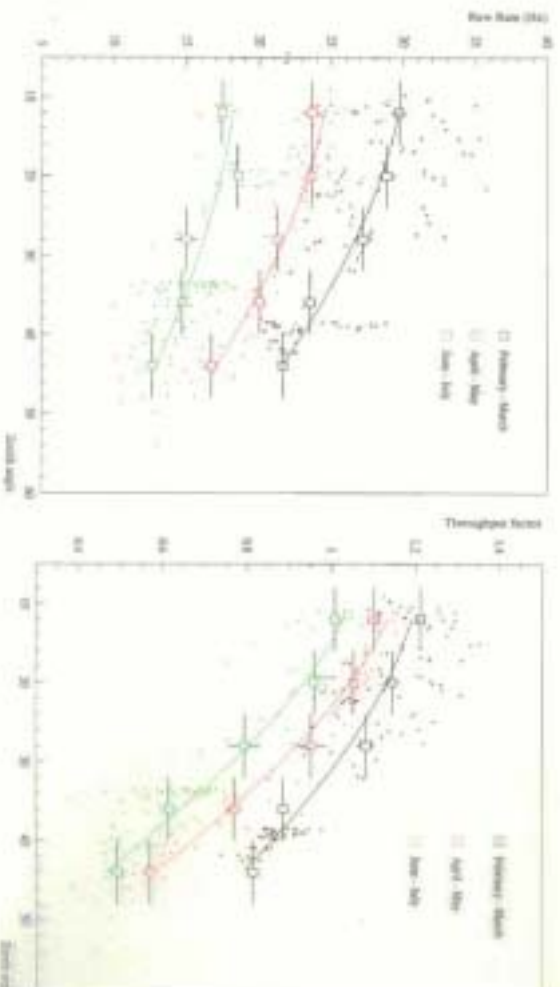
Whipple 10m Telescope

- ◆ 10 m diameter reflector. Mirror realigned in February 2002 - sensitivity 6σ for 1 hour on the Crab.
- ◆ 490 PMT camera (only used high resolution PMTs for this analysis - 0.12 deg. Spacing)



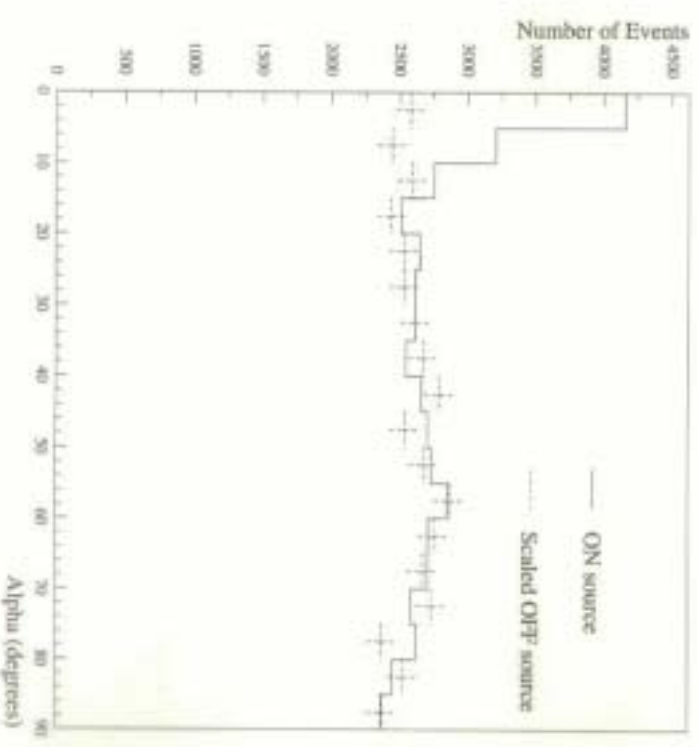
Atmospheric Pollution

- Dramatic **reduction in background rate** observed over February - July 2002.
- Use response to cosmic ray background spectrum to measure effect: 20% at zenith, 40% at 45 degrees.
- Efficiency decrease is **ZA dependent** therefore probably atmospheric and related to massive **forest fires in Arizona**.



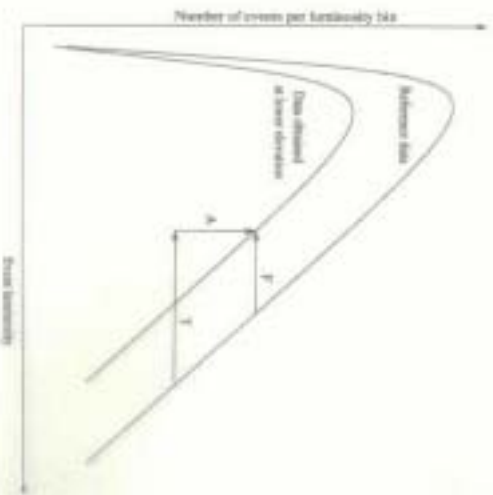
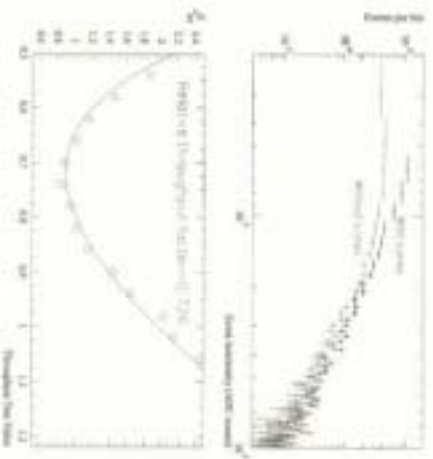
Observations of IES1959+650

- 39.3 hours **ON** source, 7.6 hours **OFF** source between May 16 and July 8, 2002.
- Standard supercuts analysis
- Mean rate = 1.08 ± 0.05 gammas/minute



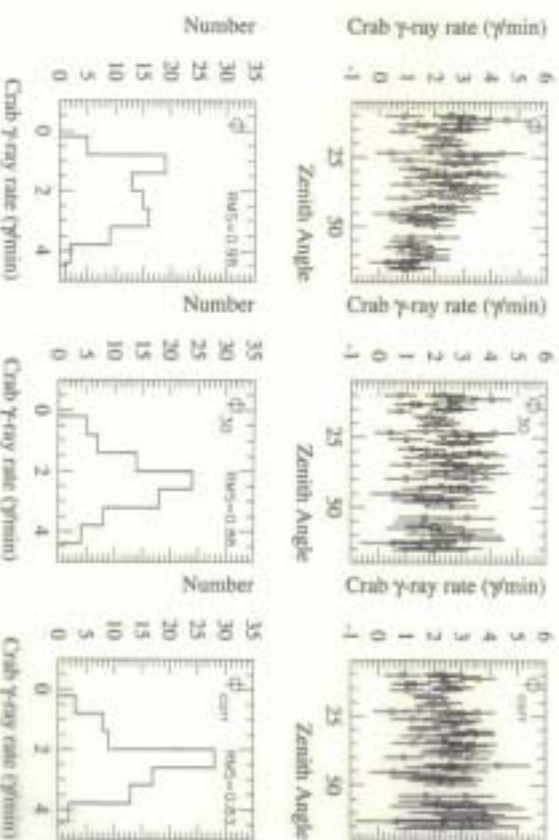
Zenith Angle/ Throughput Corrections

- ◆ les1959 culminates at a zenith angle of **33.5°**
- ◆ Measured Gamma Ray rates must be **corrected** for large Zenith angle and variability of atmospheric attenuation.
- ◆ Make Zenith angle correction based on simple geometrical arguments
- ◆ Correct for atmospheric absorption by measuring response to **cosmic ray spectrum**



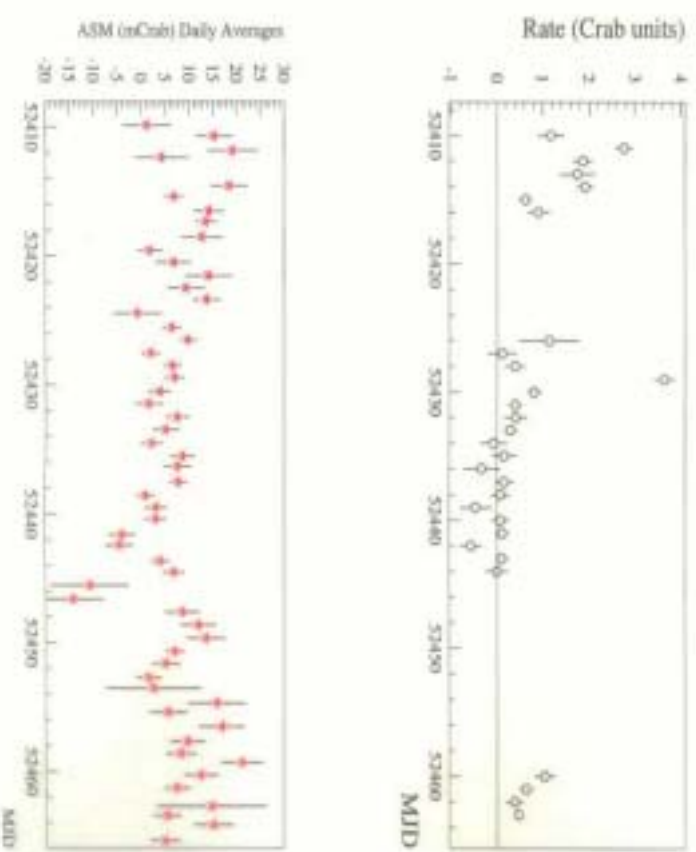
Crab Nebula Test

- ◆ Have observations of **Crab Nebula** over a wide range of Zenith angle and weather conditions
- ◆ Applying the Zenith angle/ throughput correction should **reduce** the dispersion in the measured Crab rate (assuming Crab is steady)



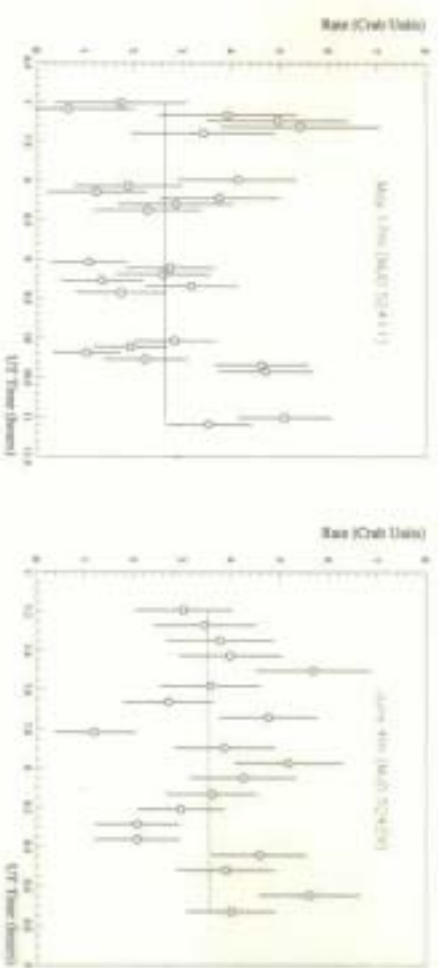
Flux Variability

- ◆ Strong **night-to-night** variability
- ◆ MJD 52428 - 52429: doubling timescale of **7 hours**
- ◆ Implies jet **Doppler factor > 9**.
- ◆ Emission region < 60 light hours.
- ◆ Also active in X-rays (cf overall mean rate = 3.7 mCrab)



Short-term Variability

- ◆ No strong evidence for shorter timescale variability
- ◆ MJD 52411 chi-square prob of constant emission = **1%**
- ◆ MJD 52429 chi-square prob of constant emission = **8%**



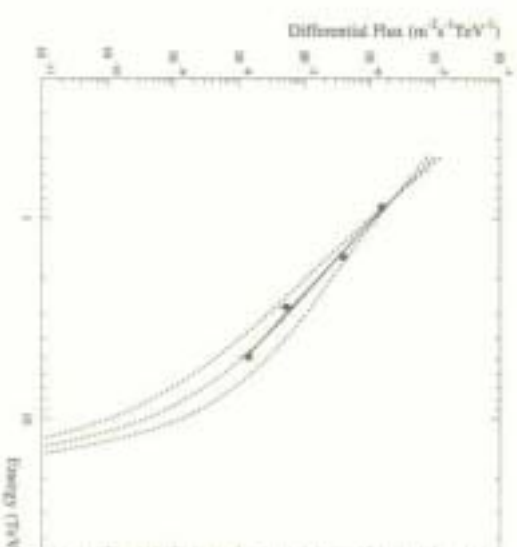
Spectral Analysis

- ◆ Follows procedure used for H1426+428 Petry (2002)
- ◆ Generate MC events using "kascade" simulation code
- ◆ Derive "extended cuts": cuts on LENGTH, WIDTH and ALPHA which vary with log(SIZE)
- ◆ Also apply software trigger cuts to avoid trigger region
- ◆ Derive analytical expression based on log(SIZE) and DISTANCE to estimate primary energy
- ◆ Calculate (spectral index dependent) A_{eff} for each energy bin.
- ◆ Calculate differential fluxes in each bin using A_{eff} for an initial spectrum $\alpha=2.5$
- ◆ Fit power law to the resulting values then reiterate using A_{eff} for spectral index of fit. Repeat until convergence.
- ◆ Test on Crab Nebula data from 2002:

$$dN/dE = 10^{(-6.49 \pm 0.030 \pm 0.15)} E^{(-2.71 \pm 0.082 \pm 0.05)} \text{ m}^{-2} \text{ s}^{-1} \text{ TeV}^{-1}$$

Preliminary Spectrum

- ◆ Initial spectral analysis concentrates on high Zenith Angle (34° - 40°) ON-OFF observations during high state May 16th - May 21st.
- ◆ 88 minutes ON and OFF source.
- ◆ Attenuation factor included in MC based on measurements of cosmic ray background.
- ◆ Spectral index similar to Crab $\alpha = 2.81 \pm 0.16_{\text{stat}} \pm 0.05_{\text{sys}}$
- ◆ Lots of work remains: Two groups are working independently on spectral reconstruction. Results have important implications for EBL models.

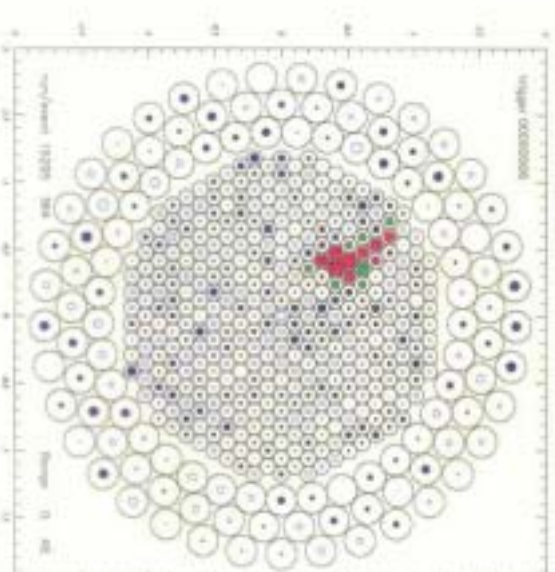


Conclusions and Future Work

- ◆ Further **verification** of close **XBLs** as **TeV sources** (Mkn421, Mkn501, H1426, 1ES2344, PKS2155)
- ◆ Many good southern hemisphere candidates - PKS2155 awaiting confirmation!
- ◆ Spectral analysis of May-July 2002 data ongoing - checking for:
 - ◆ Spectral **shape** (curvature?)
 - ◆ Spectral **features** (cut off?)
 - ◆ Spectral **variability**
- ◆ Multiwavelength observations planned for September - November 2002.

Analysis Procedure

- ◆ Standard **supercuts** analysis:
 - ◆ Calibrate with pedestal and nitrogen flasher events
 - ◆ Select Image/Border pixels at $4.25/2.25\sigma$
 - ◆ Calculate Hillas parameters
 - ◆ Gamma ray selection cuts optimized on Crab nebula data: "Supercuts 2000"



Crab Nebula Test

