

# Results from the VERITAS Collaboration

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The Universe viewed in Gamma-Rays  
ICRR, Kashiwa  
September 26, 2002

## VERITAS Collaboration:

*Collaboration members:*

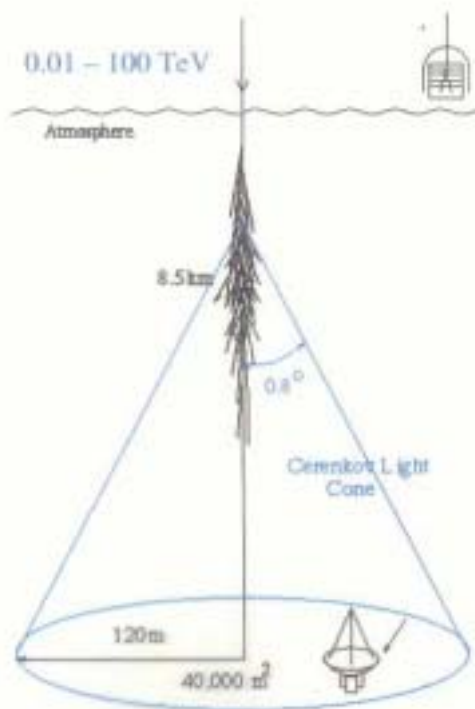
Iowa State U.  
Leeds U. (U.K.)  
McGill University (Canada)  
Purdue U.  
Smithsonian Astrophysical Observatory  
UCLA  
University College, Dublin (Ireland)  
U. of Chicago  
U. of Utah  
Washington U.

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for the VERITAS collaboration

# Topics

- Status of Whipple 10m
- Results from Blazars:
  - Mrk 421, Mrk501
  - H1426+428
  - 1ES1959+650
- Summary

## Whipple 10m

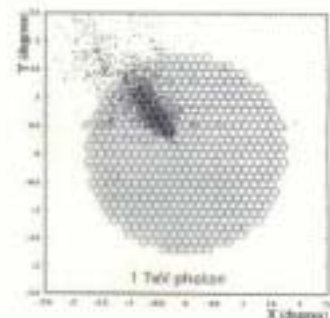


GRANITE-III Camera

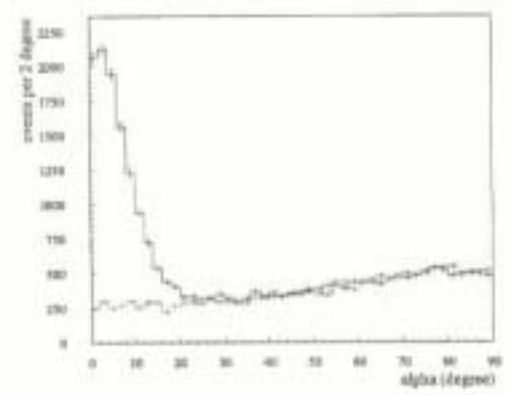
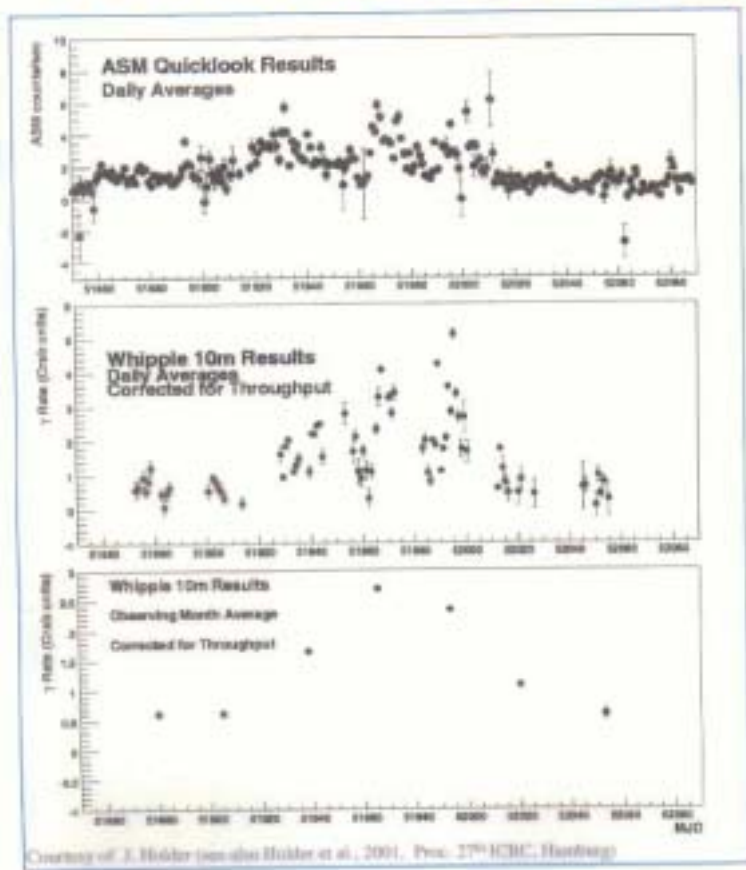


Area ~ 7,000 – 100,000 m<sup>2</sup>  
E ~ 0.2 – 20 TeV  
 $\Delta\theta/\theta \sim 0.2^\circ$

Calibration:  $3.31 \pm 0.15$  d.e./p.e.

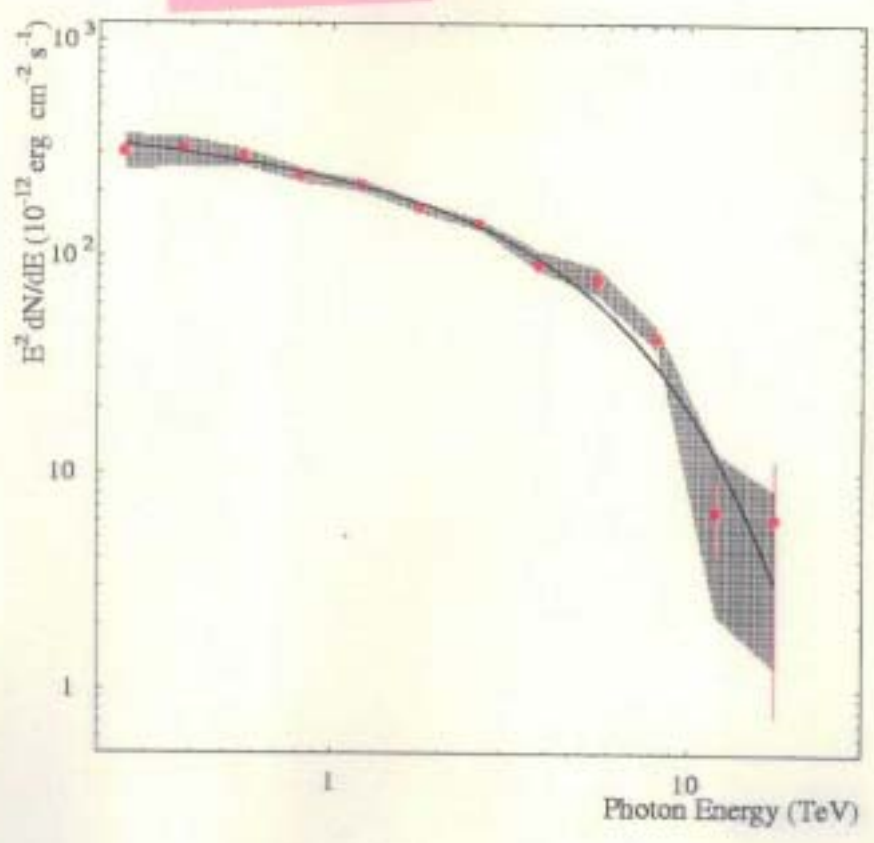


# Mrk 421 in 2000/2001:

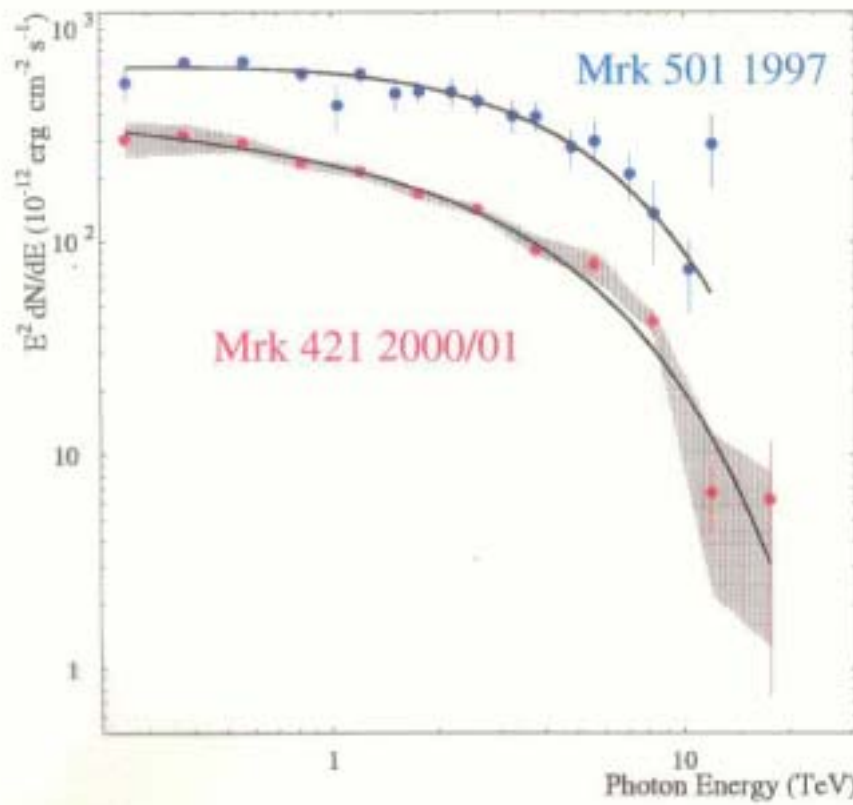


→ 23,000  $\gamma$ -rays at  $E > 300$  GeV

# Mrk 421 Lynchburg 2/1/01 $\kappa$ 501:



# Mrk 421 vs. Mrk 501 spectrum:



$$dN/dE \sim E^{-1.95 \pm 0.07} e^{-(E/E_0)}$$

$$\text{with } E_0 = 4.6 \pm 0.8 \text{ TeV}$$

data from Samuelson et al. 1998, ApJ, 501, L17

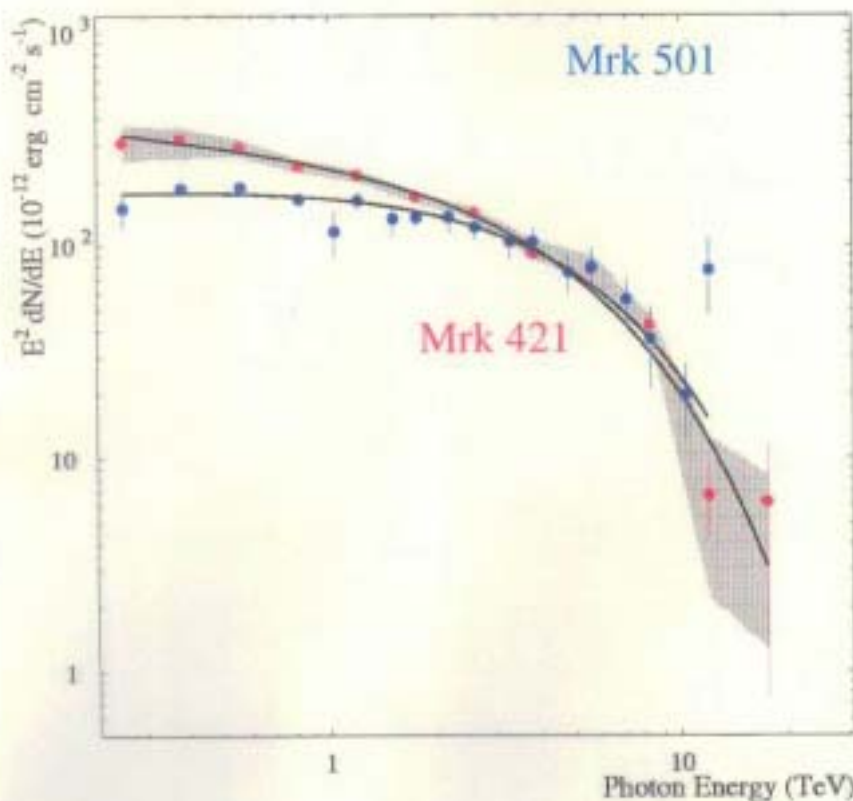
$$dN/dE \sim E^{-2.14 \pm 0.03} e^{-(E/E_0)}$$

$$\text{with } E_0 = 4.3 \pm 0.3 \text{ TeV}$$

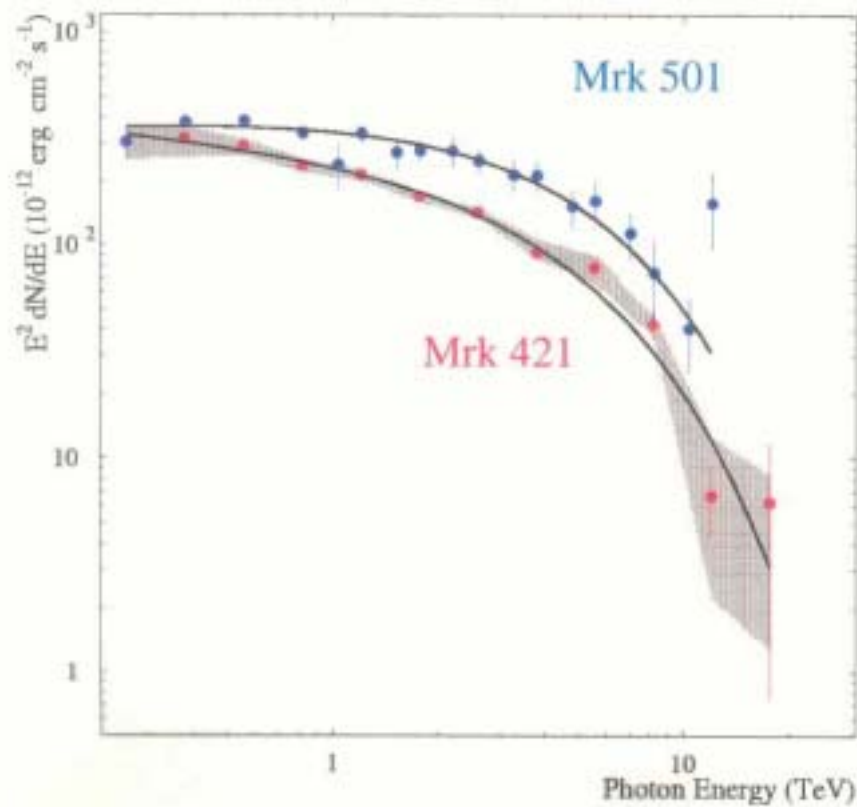
$$(-1.4 + 1.7 \text{ TeV})_{\text{sys}}$$

from Kottarich et al. 2001, ApJ, 560, L45

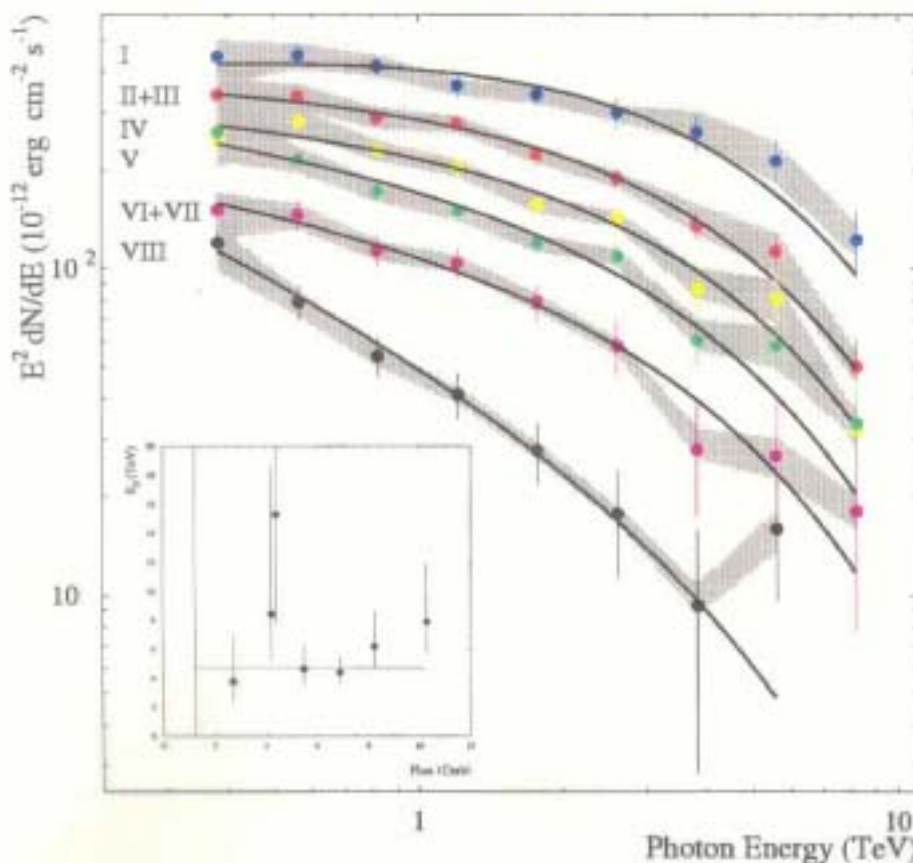
# Mrk 421 vs. Mrk 501 spectrum:



# Mrk 421 vs. Mrk 501 spectrum:



# Mrk 421 spectral variability:



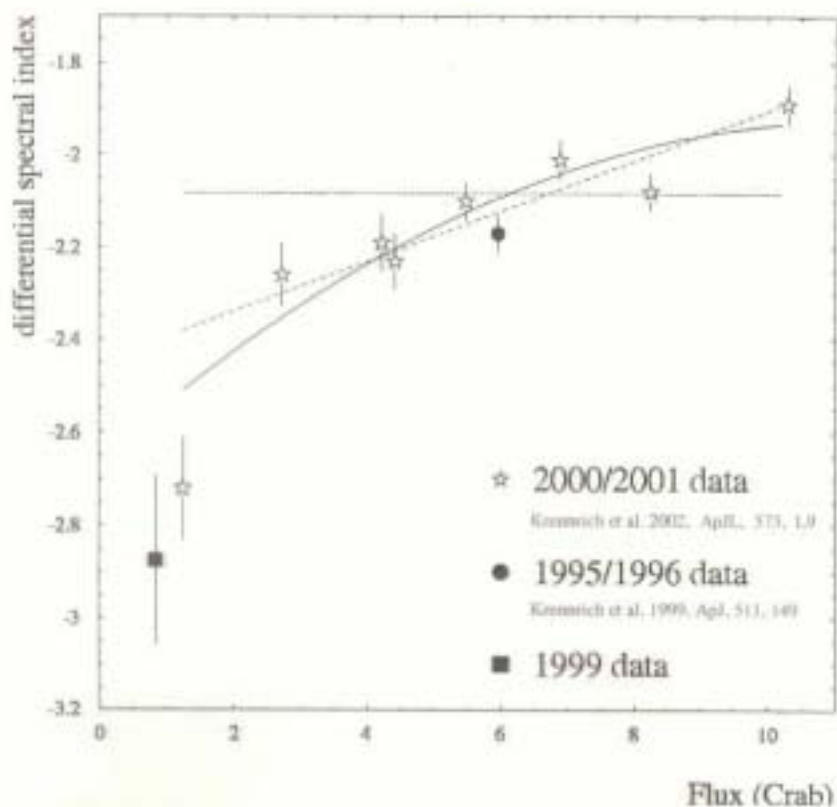
$$dN/dE \sim E^{-\alpha} e^{-(E/E_0)}$$

$$\alpha = 1.89 \pm 0.04 \text{ (set I)}$$

⋮

$$\alpha = 2.72 \pm 0.11 \text{ (set VIII)}$$

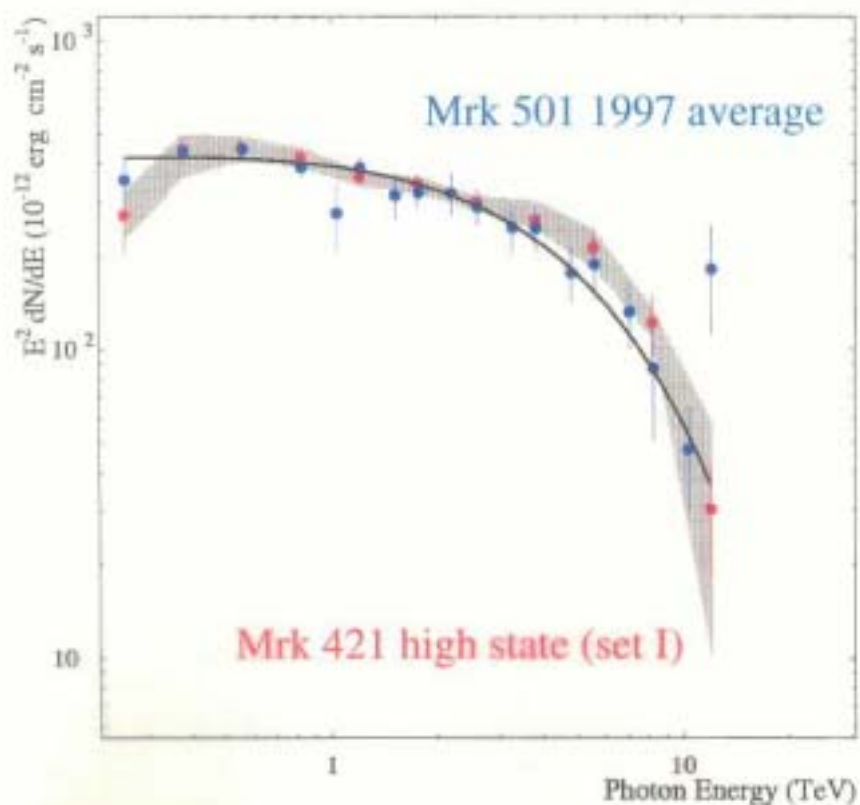
# Mrk 421: spectral variability:



$\alpha(\text{flux})$  over 6 years!

Property of a specific blazar or emission mechanism?

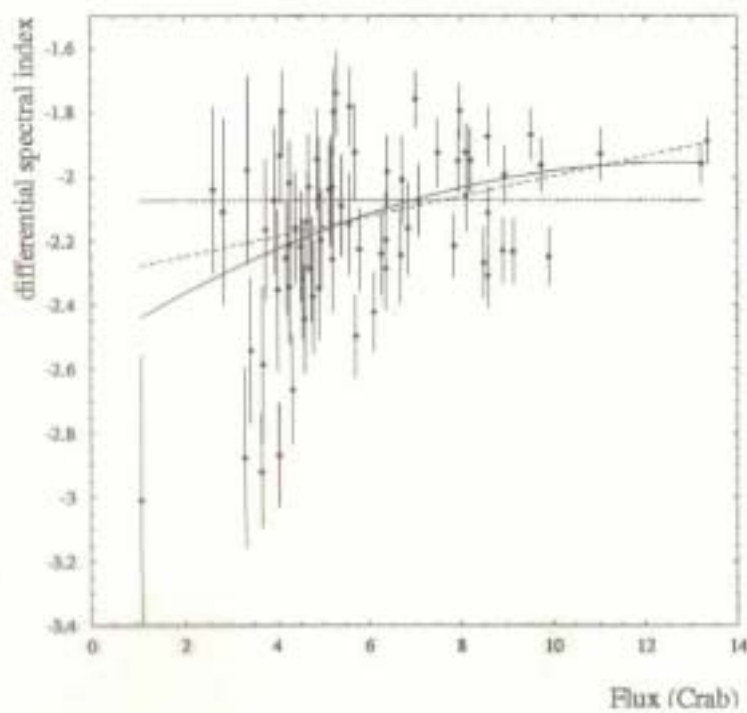
# Mrk 501 1997 vs. Mrk 421 high state:



# 1/2 Hourly Spectral Variability:

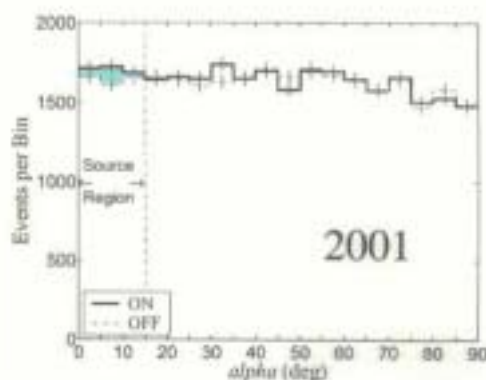
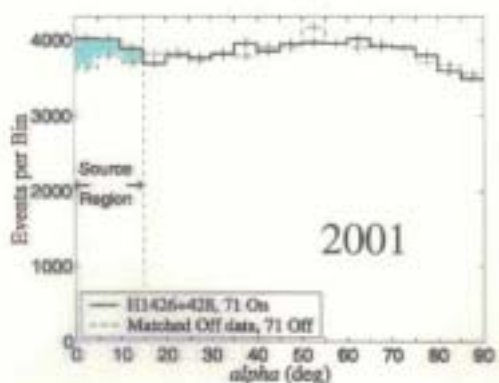
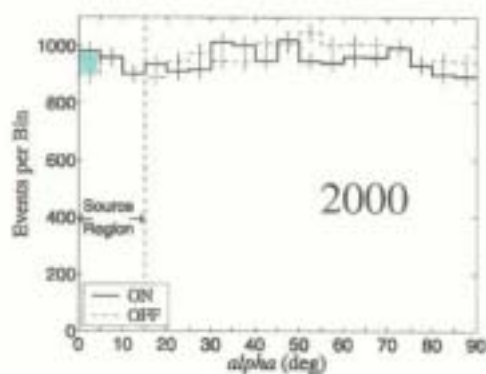
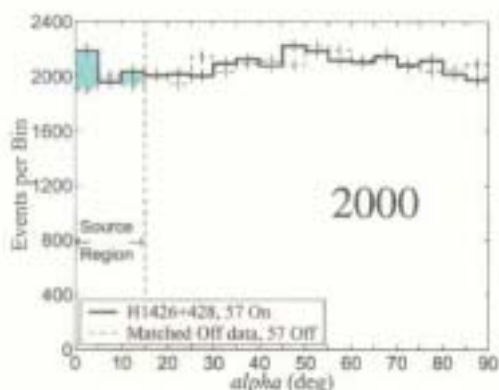


# 1/2 Hourly Spectral Variability:



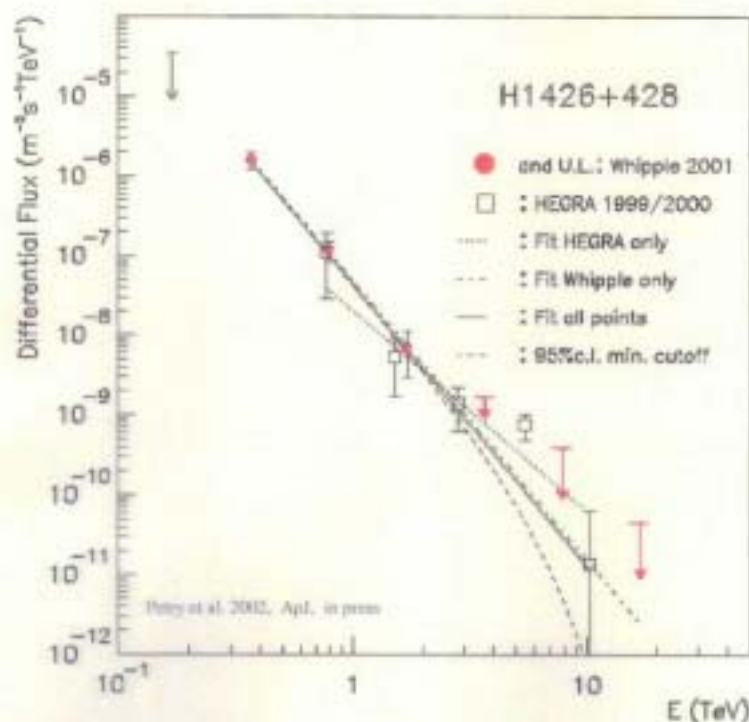
# H1426+428:

weak signal ~ 80 mCrab



from Horan et al. 2002, ApJ, 571, 733

# H1426+428 spectrum:



**Whipple 2001:**  
 $dN/dE \sim E^{-3.50 \pm 0.35 \pm 0.05}$

Petry et al. 2002, ApJ, in press

**HEGRA 2001:**  
 $dN/dE \sim E^{-2.60 \pm 0.6 \pm 0.05}$

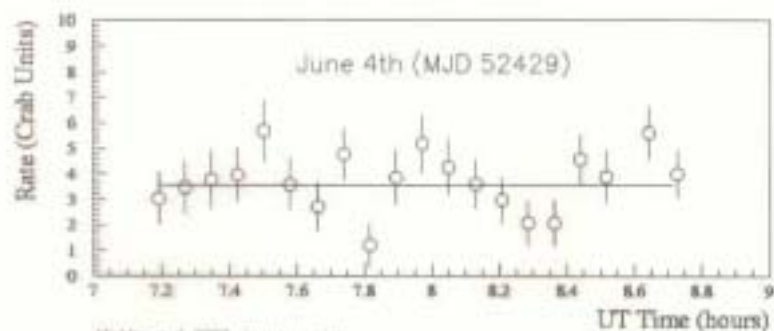
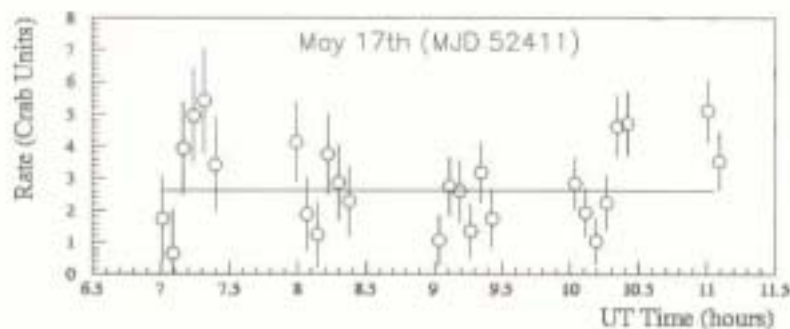
Akarsou et al. 2002, A&A, 394, L23

**Whipple+HEGRA:**  
 $dN/dE \sim E^{-3.54 \pm 0.27 \pm 0.05}$

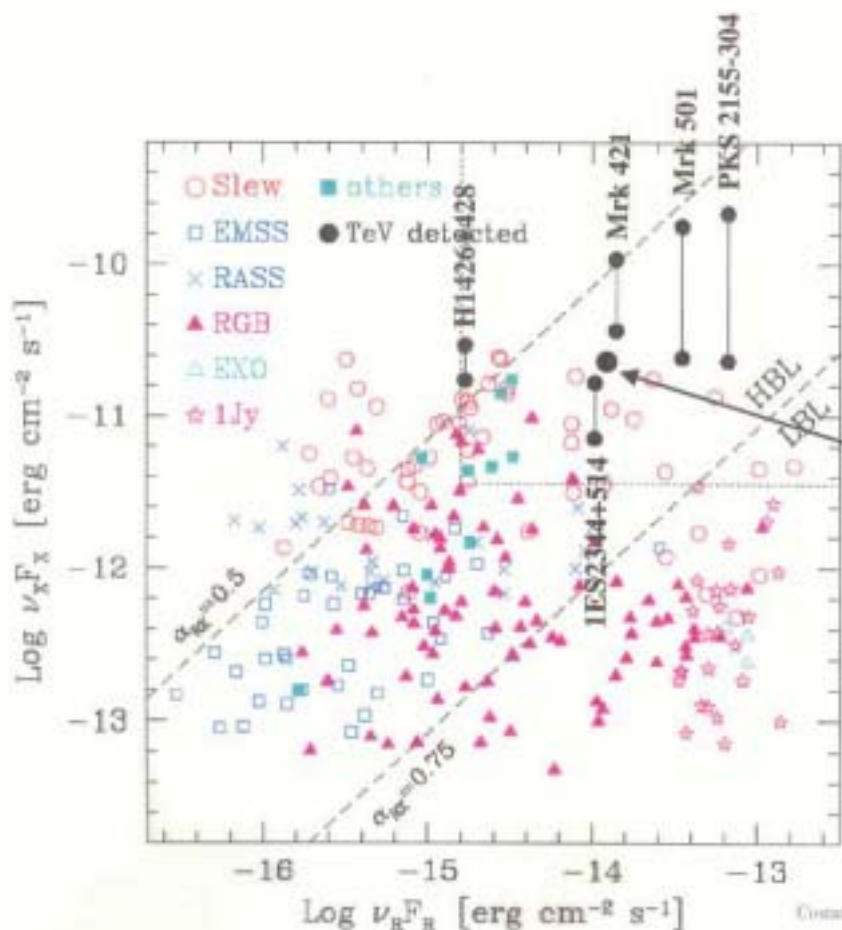
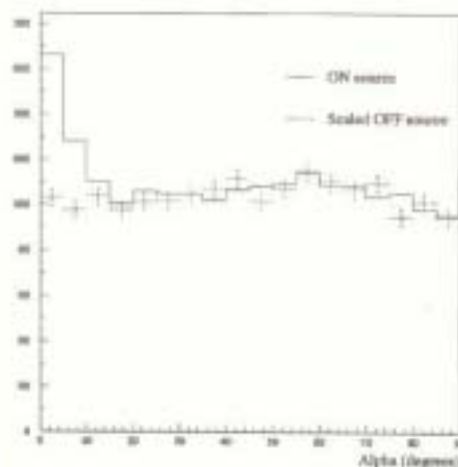
Petry et al. 2002, ApJ, in press



# 2002 Flares from 1ES1959+650:



Hobbs et al. 2002, in preparation



## Search for new TeV Blazars:

1ES1959+650

# Summary

- Cutoff in Mrk421, Mrk501 spectra at  $\sim 4$  TeV
- Spectral variability for Mrk 421 established
- $\frac{1}{2}$  hourly spectral variability (preliminary)
- Index-flux correlation for average Mrk 421 below 2 TeV
- H1426+428 ( $z = 0.129$ ) shows steepest spectrum below 2 TeV
- 1ES1959+650 exhibits strong flares  $\sim 5$  Crab  
→ spectrum (see J. Holders talk)
- 4 TeV blazars with redshifts  $z = 0.033 - 0.129$  detected and spectra derived
- All TeV blazars fall into the high X-ray & radio flux region of Costamante's catalog for prospective TeV sources!