Blazar Observations with GLAST and the Upcoming Generation of Cherenkov Telescopes

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Contents:

(I) Cherenkov Telescopes:

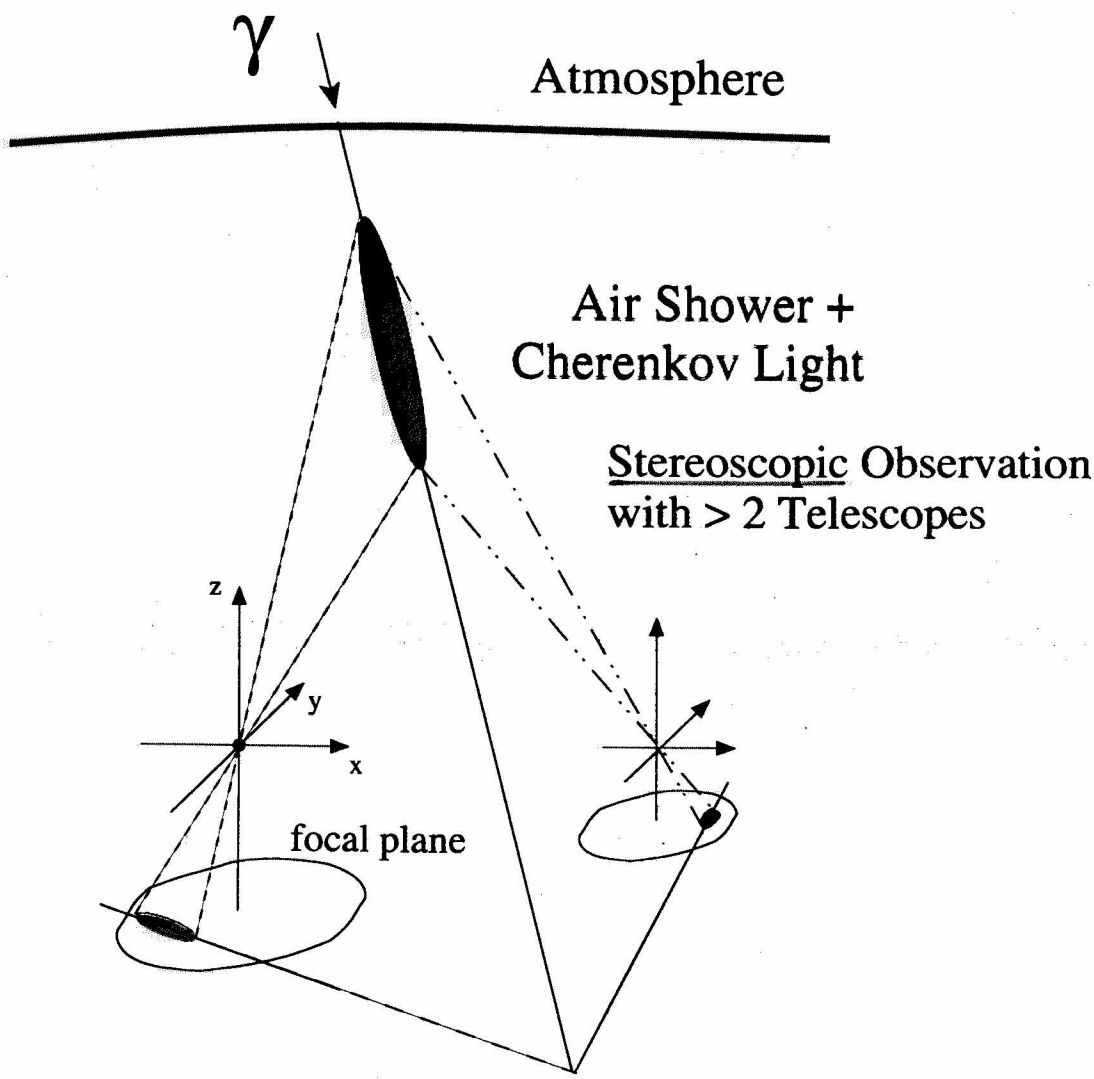
- Current Detectors
- Upcoming Detectors

(II) Complementarity of GLAST and Cherenkov Telescopes

- Key TeV Gamma Ray Observations
- Diffuse Extragalactic Background Radiation
- Prospects of Future Observations

(III) Summary and Wish-List

Imaging Atmospheric Cherenkov Telescopes



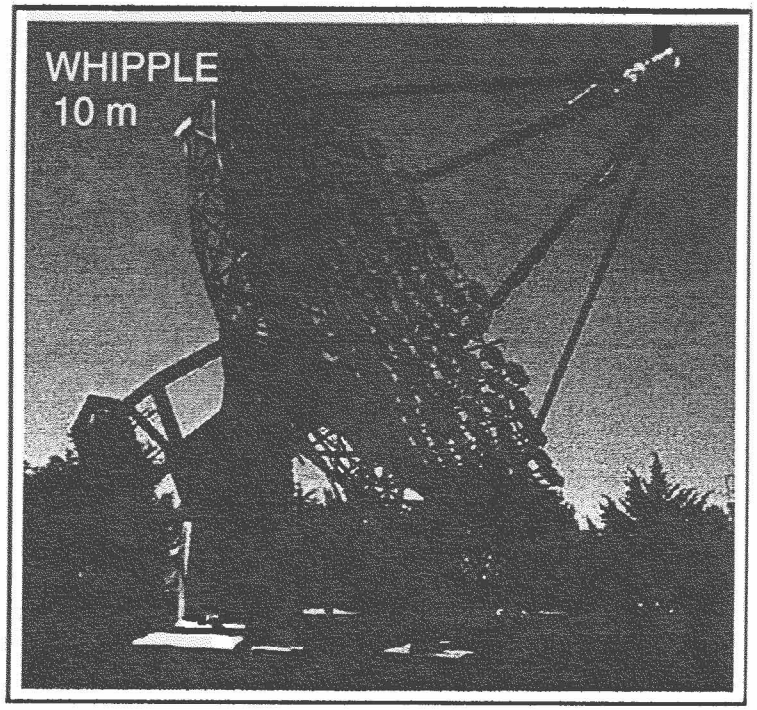
Strengths:

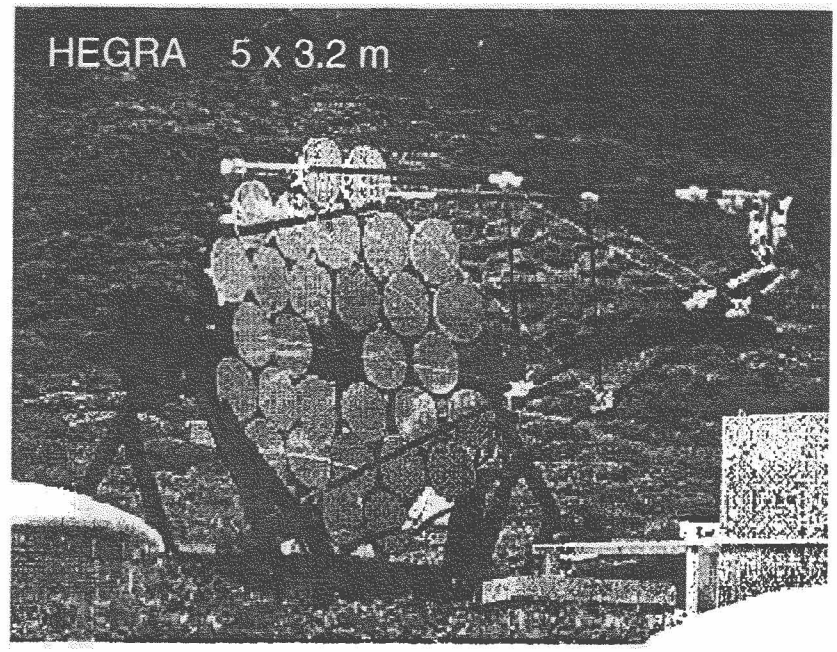
Detection Area	10^5 m²
Angular Resolution	0.1 Degree
Energy Resolution	10%

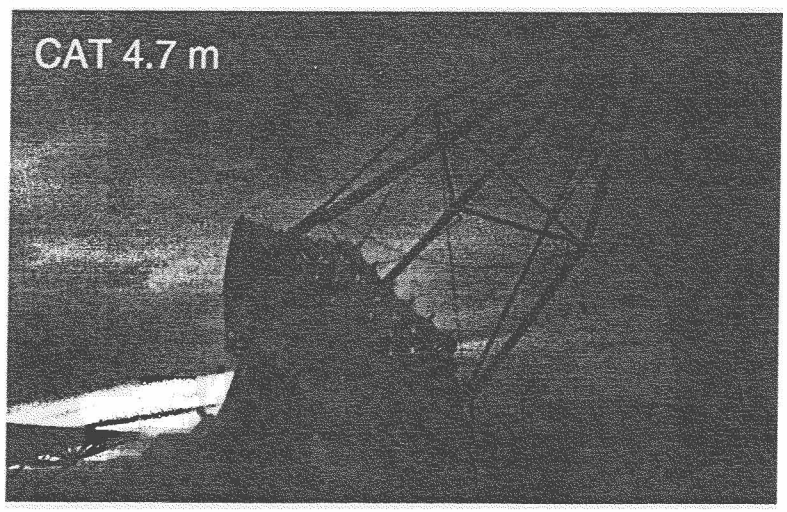
Weaknesses:

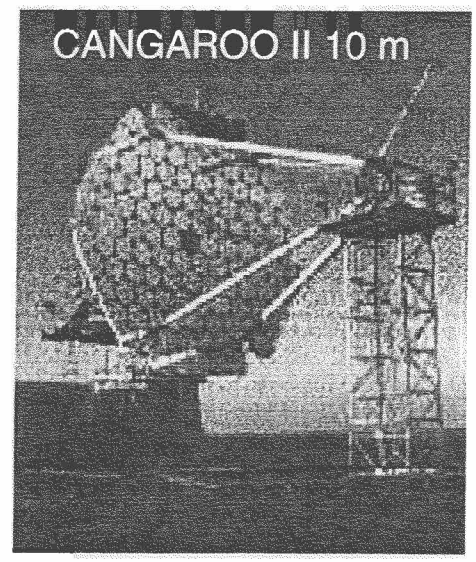
Field of View	4 msr (4 Degree Diameter)
Background of Cosmic Rays	

Imaging Atmospheric Cherenkov Telescopes









Energy Thresholds:
200 GeV – 500 GeV

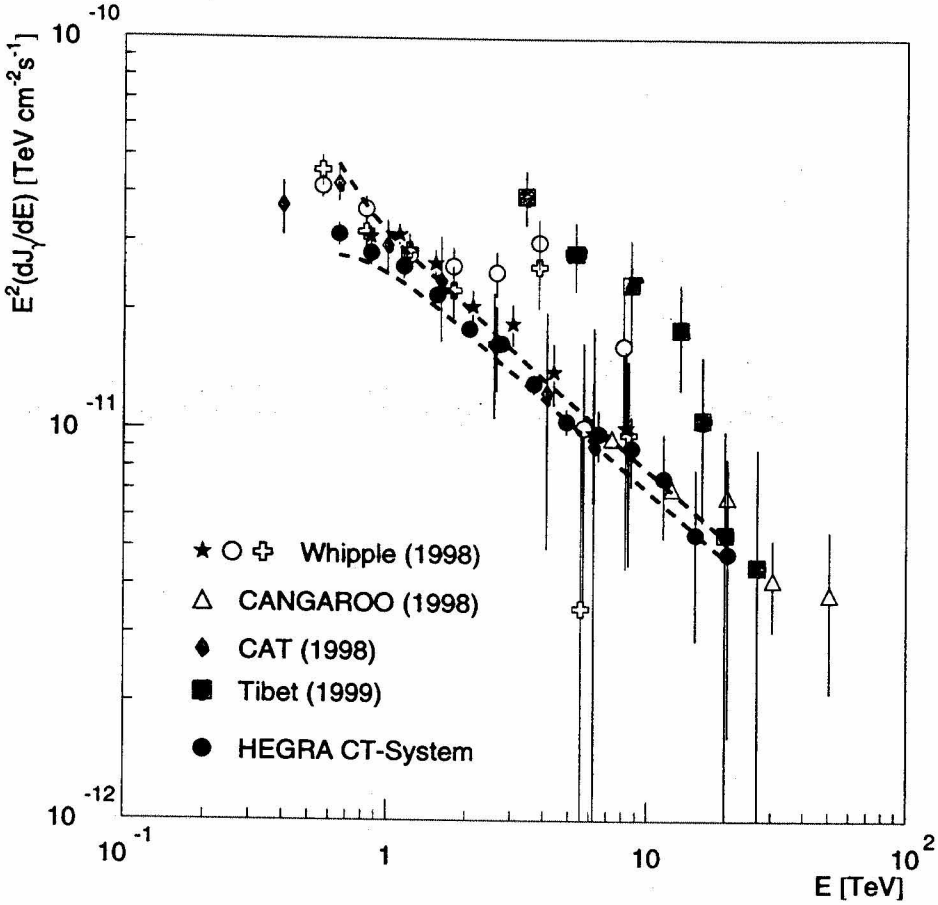
Sensitivities:
30% Crab in 1 hr, 3% Crab in 100 hrs
(1E−11 erg / cm² s and 1E−12 erg / cm² s @ 1 TeV)

Crab Observations
Crosscalibration of TeV Telescopes

Detection Rates:

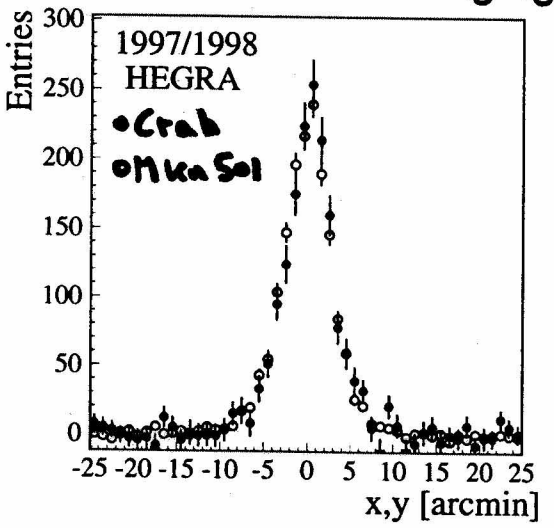
~ 60-180 γ/hr

Energy Spectrum:



=> Excellent Agreement Between Experiments!

Localization and Imaging:

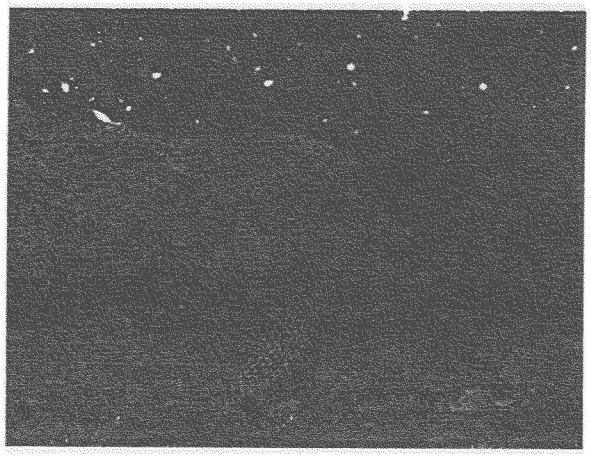


Localization Accuracy:
~35 arcsec

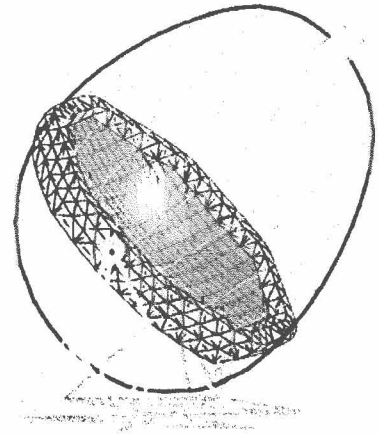
Future:
< 10" !

Angular Extension:
< 1.5 arcmin

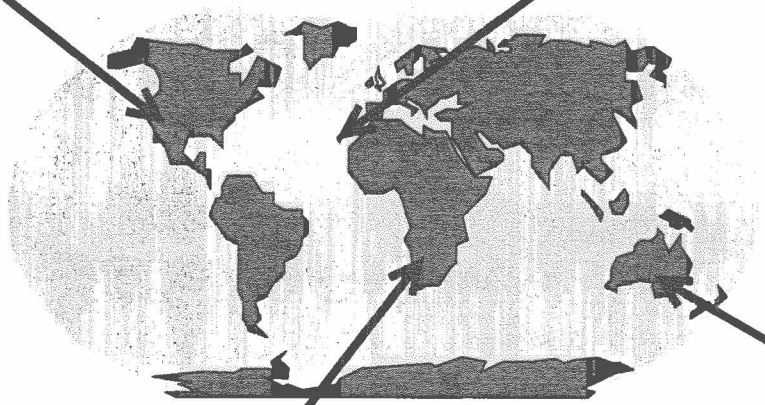
Upcoming Cherenkov Telescope Installations



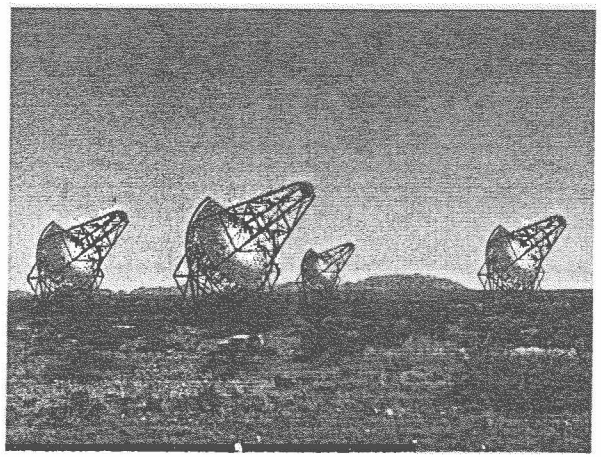
VERITAS
7 x 10 m
(3 in 2003)



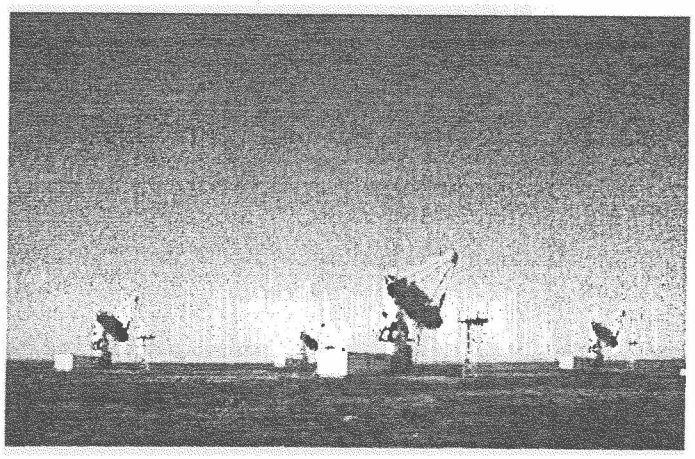
MAGIC
1 x 17 m
(2001)



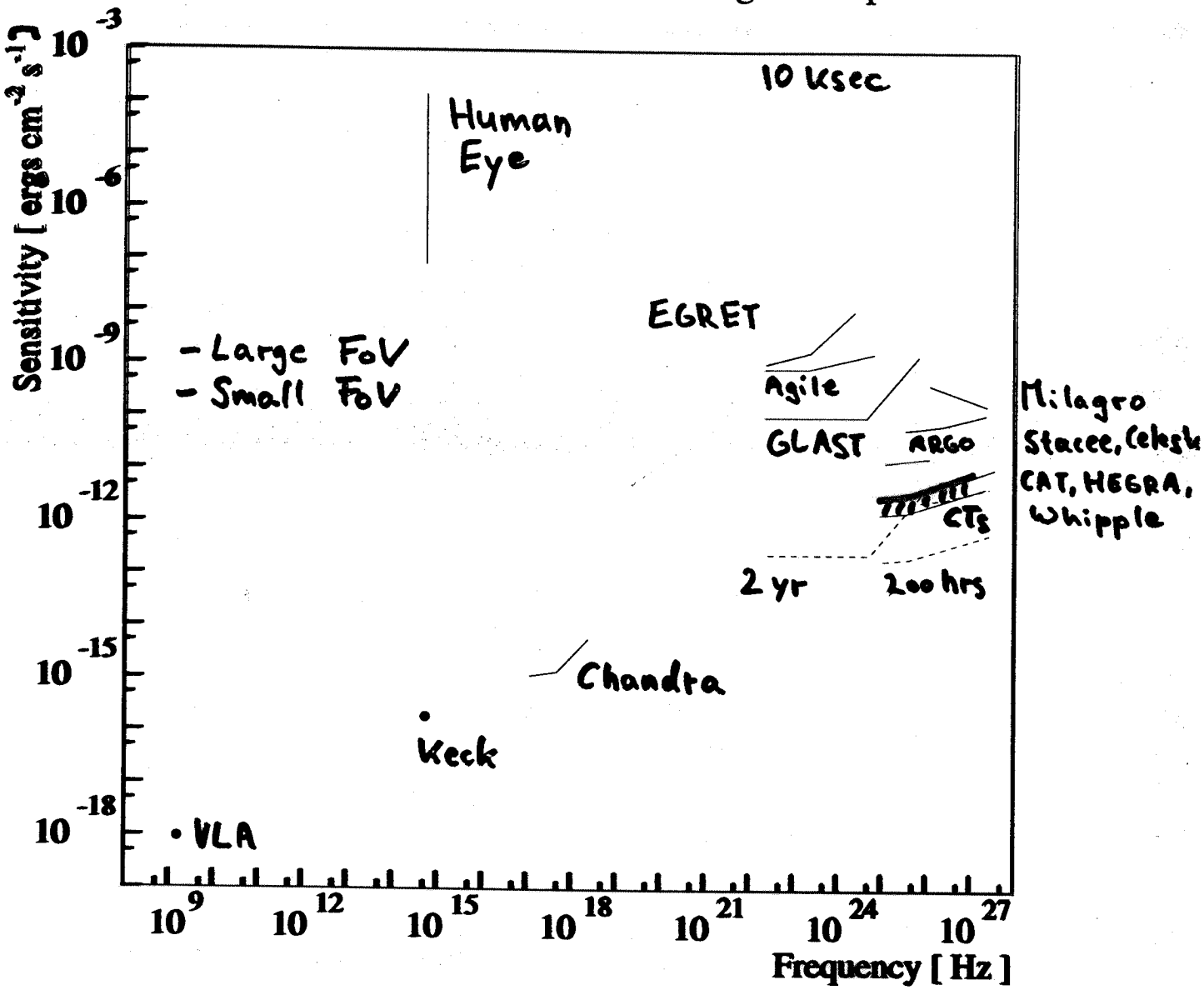
H.E.S.S.
4 (16) x 12 m
(4 in 2002)



CANGAROO III
4 x 10 m
(4 in 2004)



Telescope Sensitivities Over the Electromagnetic Spectrum



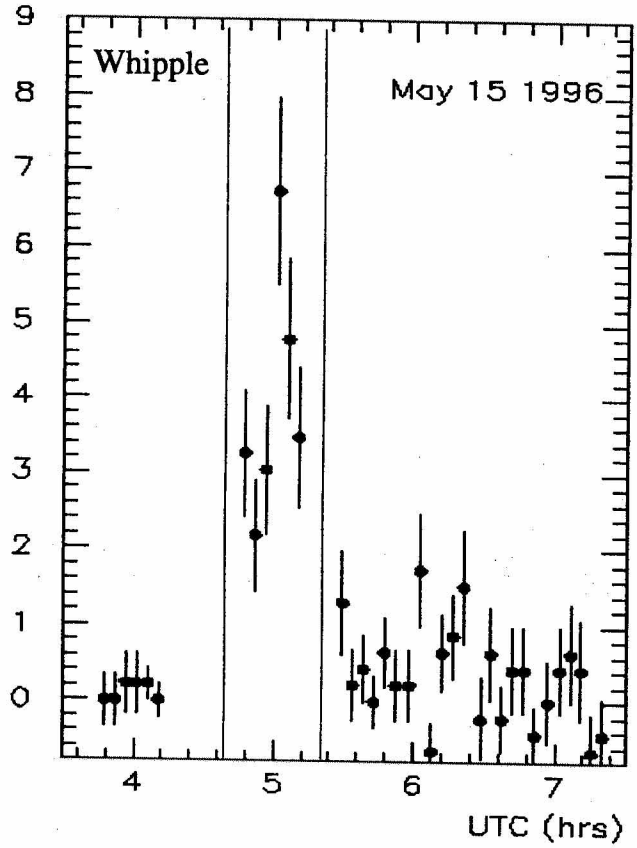
Cherenkov Telescopes:

– Best for Observation of (Sub–) Hour Variability

– Caveats:

- Diurnal Observations ~5 hrs
- 1 Week Moon–Pause for Every 3 Weeks of Observations
- ≳ 1

Mrk 421 – Variability on Sub–Hour Time Scale

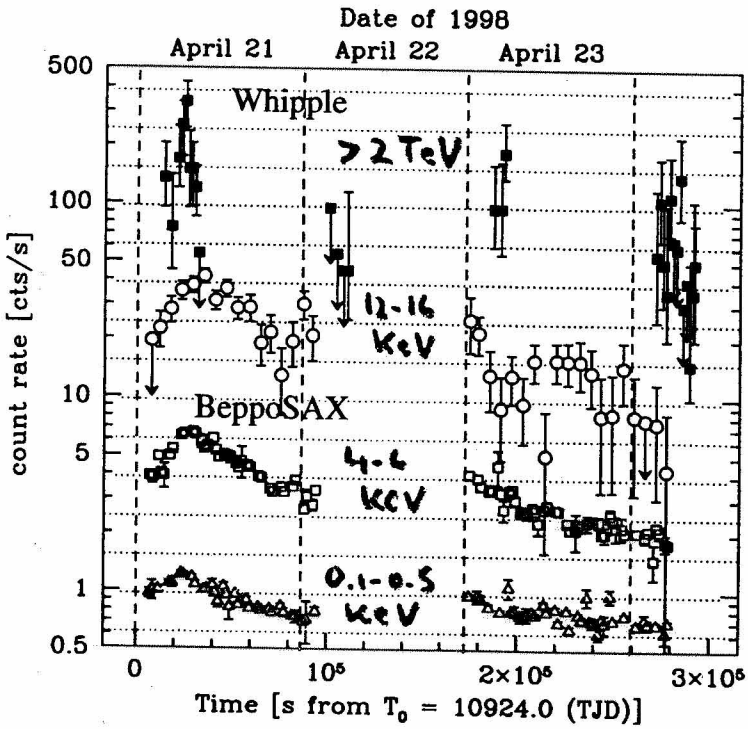


Gaidos et al., 1996

TeV Flux Variability on 15 min Time Scale

⇒ Simultaneous Multiwavelength Observations Required

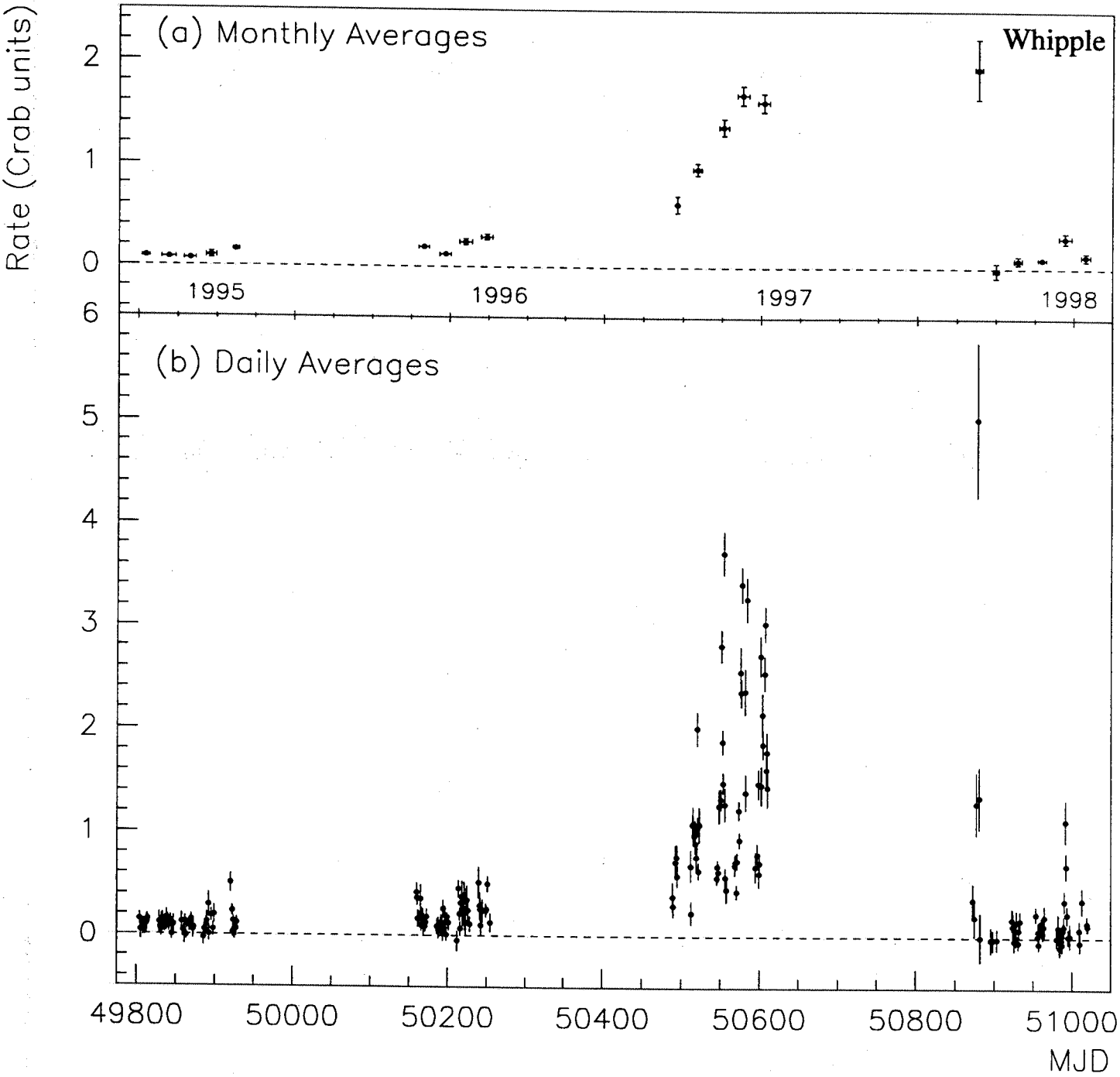
• true time not much smaller



Maraschi et al., 1999

TeV Flare Shorter Than X–Ray Flare

Markarian 501

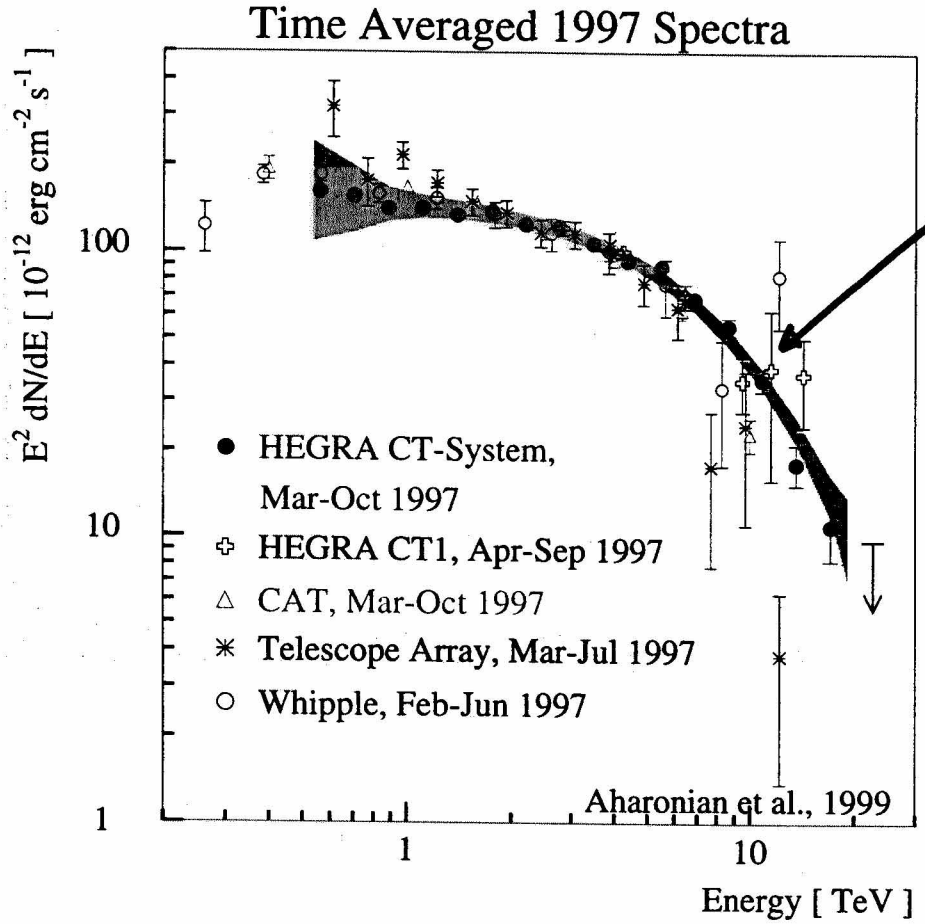


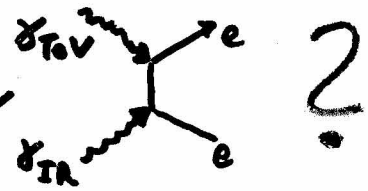
Quinn et al. 1999

Large Variation Of Emission Strength
On Time Scales of Several Months

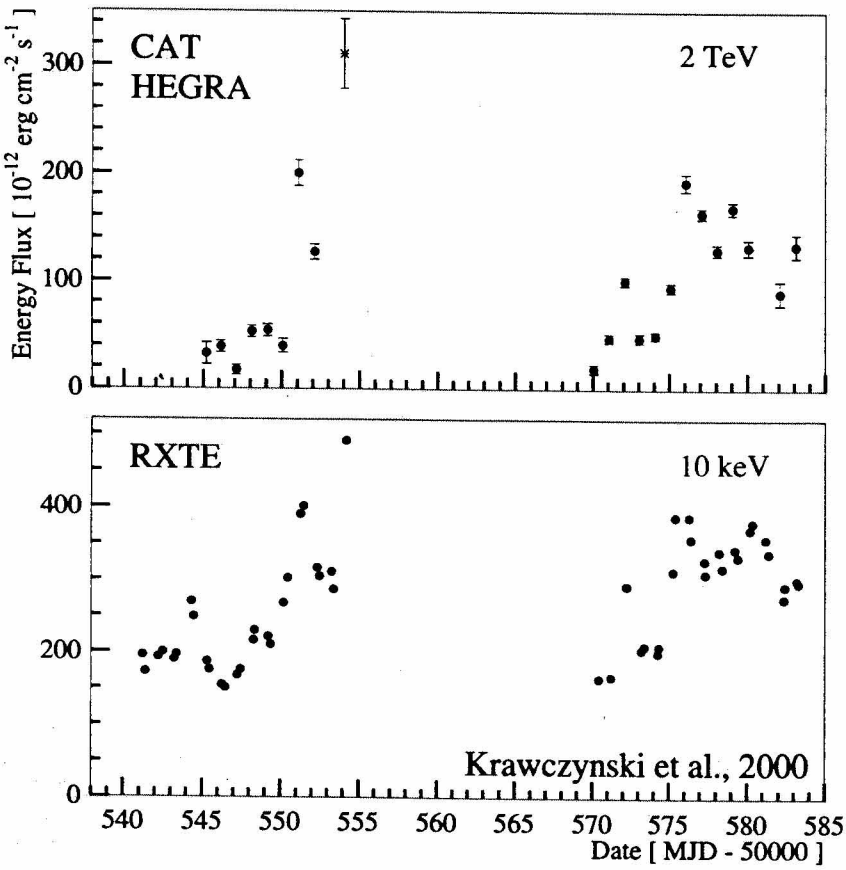
=> Rapid Alerts Needed (a la BACODINE, RXTE ASM) !

Markarian 501





Emission
Up To 16 TeV

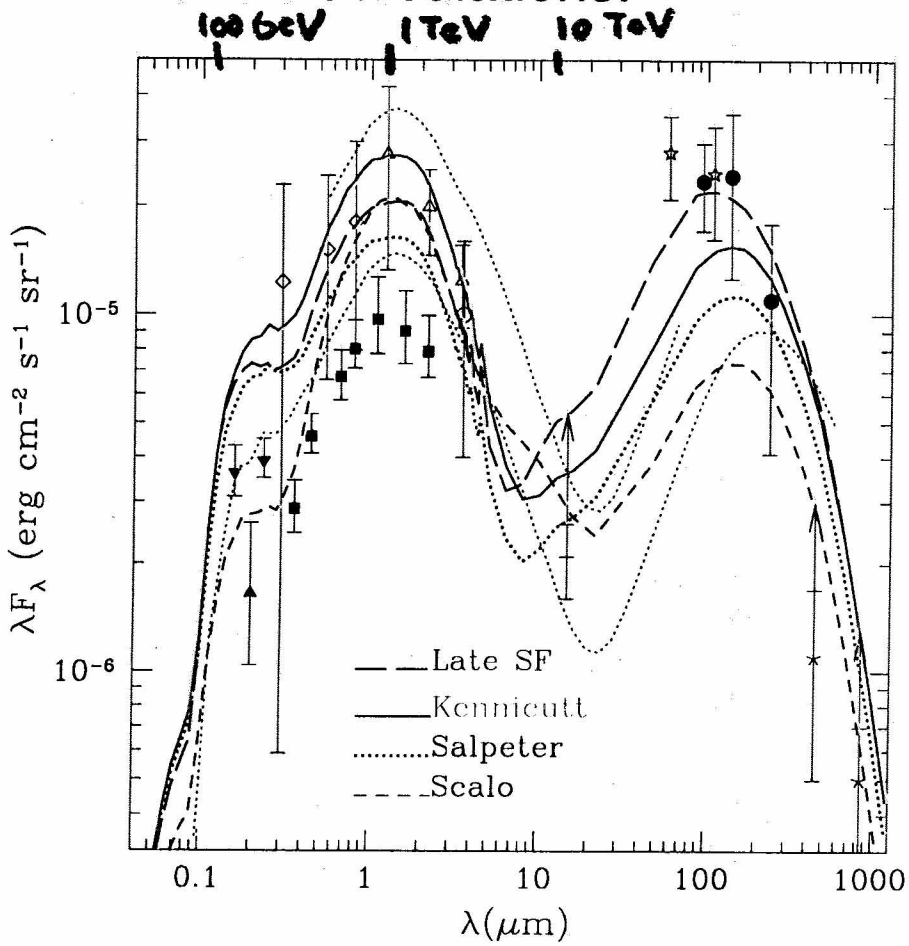


Spectral Indices: 0.1 (2hrs)
Required: 0.03 (2hrs)

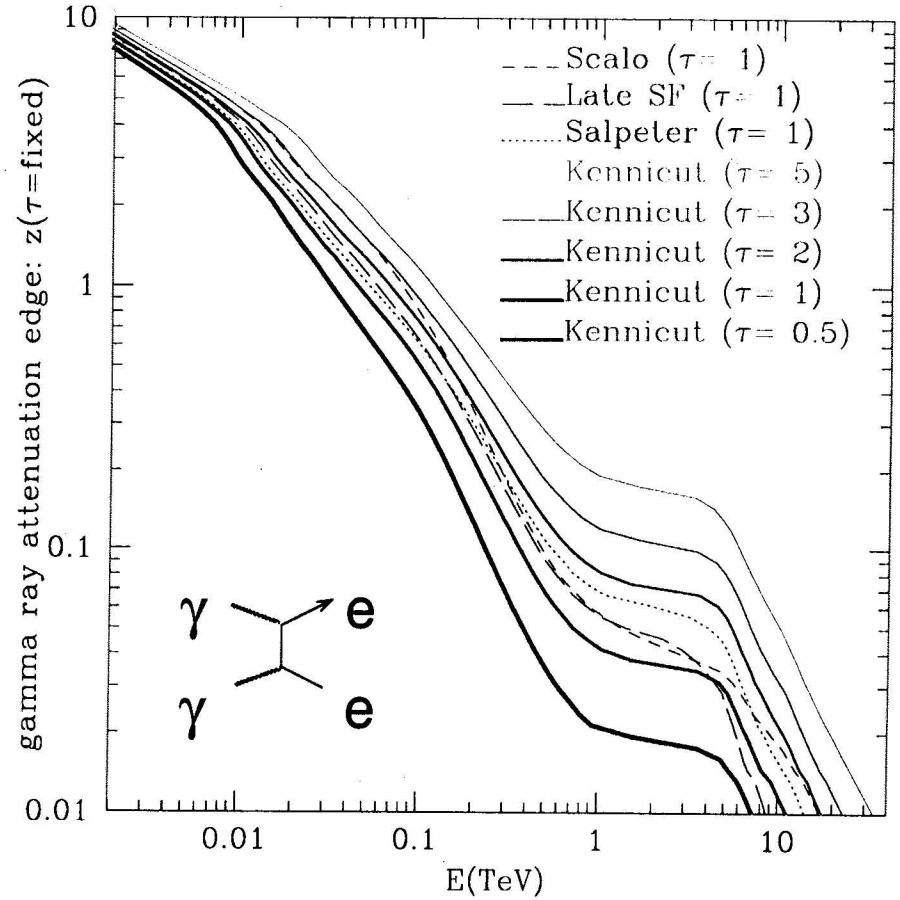
Tight X–Ray / TeV
Correlation

The Extragalactic Infrared Background

Model Calculations:



Extragalactic Extinction:



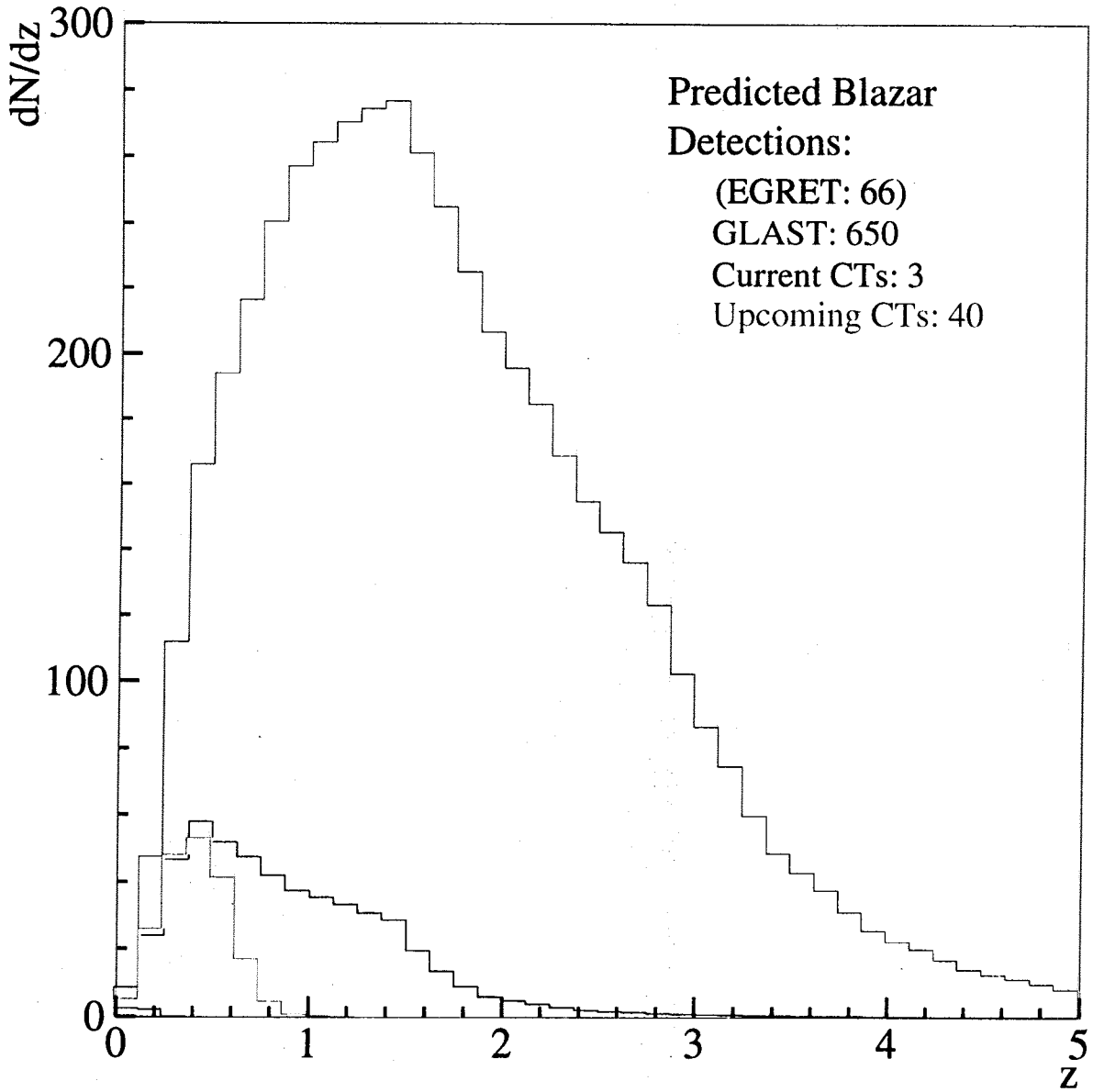
Primack et al., 2000

Infrared Background:

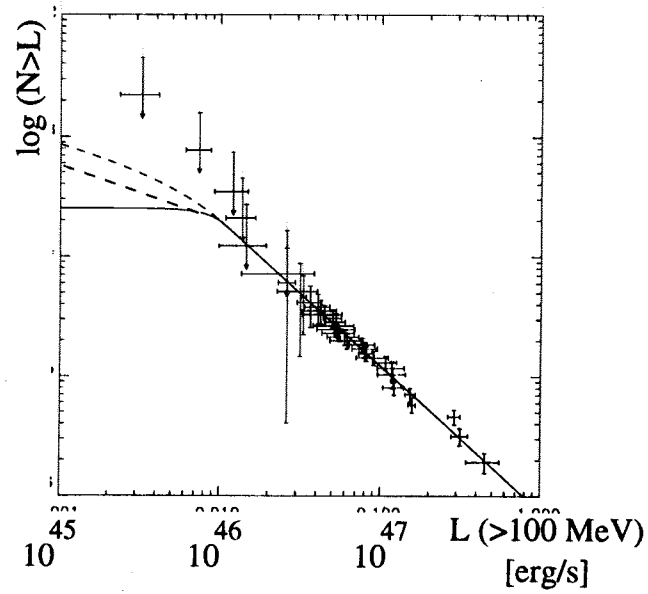
- Depends on Star Formation History and Cosmological Parameters

- Limits Accessible Volume
- Can Be Determined from GeV/TeV Observations

Predicted Number of Blazar Detections



Luminosity Function from Chiang & Mukherjee 1998:



Luminosity Evolution:

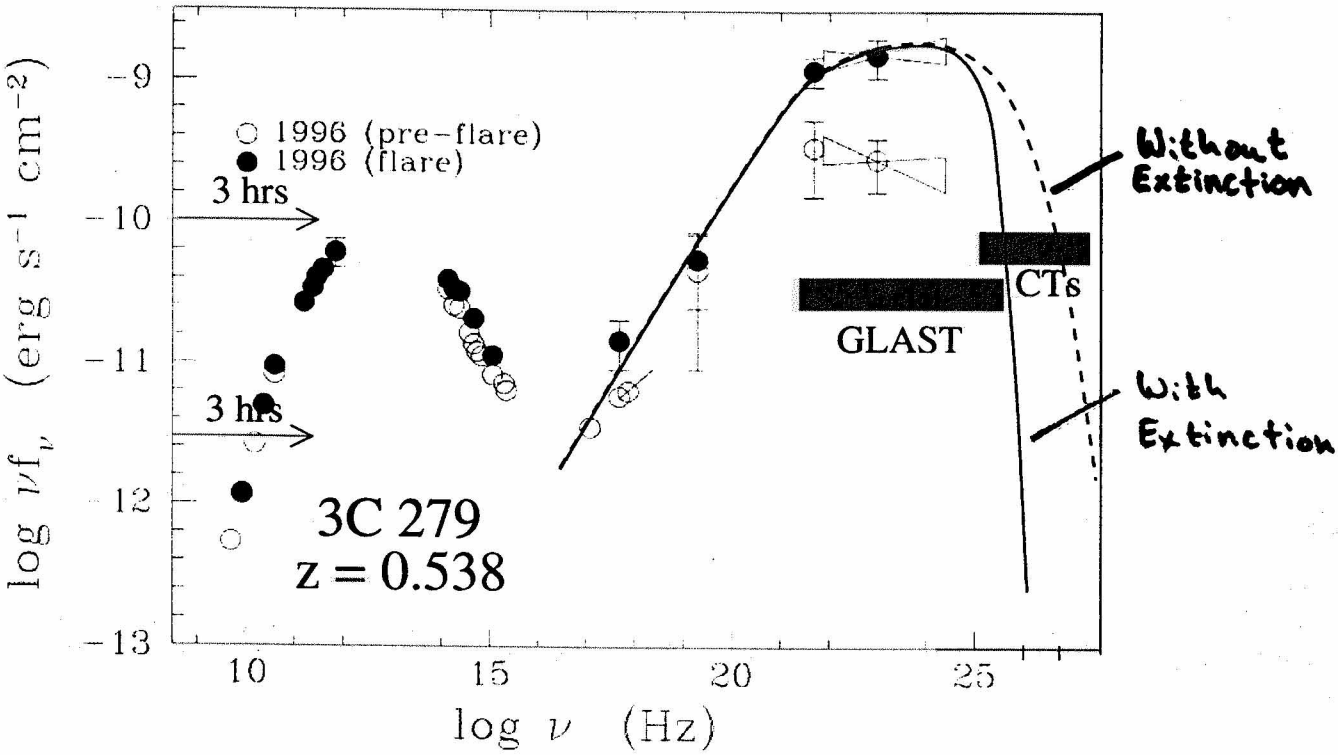
$\rho \propto (1+z)^{2.7}$ with Exponential Cutoff at $z > 1.5$

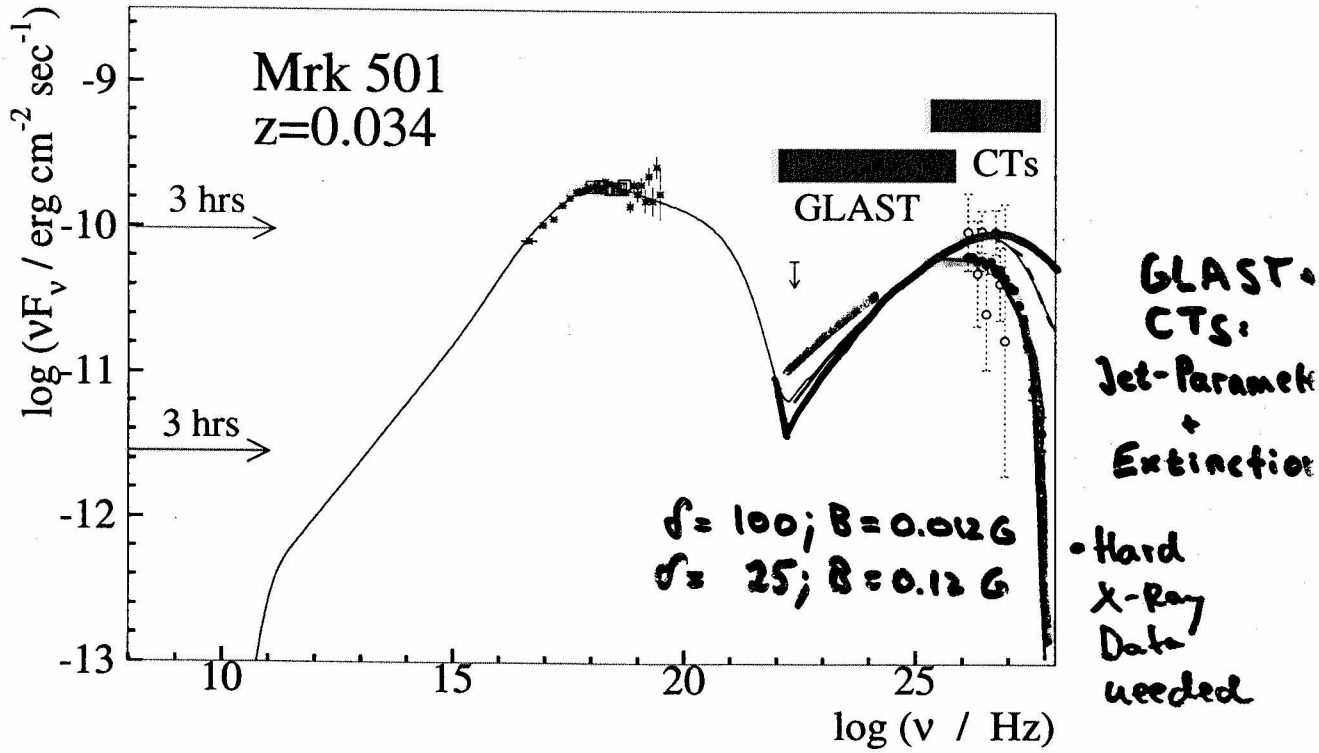
Spectral Index:

$\alpha = -1.1$ for 100 MeV < E < 1 GeV

$\alpha = -1.5$ for E > 1 GeV

Coordinated GLAST / VHE Observations





GLAST and Cherenkov Telescopes:

- Inverse Compton Component Over 6 Orders of Magnitude in Frequency
- Most Promising: Strong Sources with $z < 0.5$

Summary And Conclusions

GLAST:

- Large Data Sample of Blazars With Redshifts Up To 5
  => New Classes of <Weak> or <Distant> Sources?
  Diffuse Extragalactic Gamma–Ray Background?
- Blazar Cosmology
- Correlation With Low Frequency Properties
- Time Resolved Studies: Bright EGRET Quasars

Cherenkov Telescopes:

- Sources With Redshifts Up to ~1
- Determination of IR–BG As Function of Redshift
- Time Resolved Studies: Strong + "Blue" Objects

Joint Observations:

High Sensitivity Observations from 10 MeV to 20 TeV

Wish List – GLAST:

- Rapid Email Alerts: Blazar Flares, Spectral Changes
- Uninterrupted Coverage for Duration of
  Typical Multiwavelength Campaigns (~2 Weeks)

- List of Nearby, "Blue" Sources

• X-Rays : 0.1keV - 200keV