The role of GLAST in multiwavelength observations of bright TeV blazars

David Paneque
on behalf of the GLAST/LAT collaboration

OUTLINE

1- Motivation to observe "the classical TeV blazars"

2-Expectations from GLAST/LAT observations

1- Motivation to observe (again) the classical TeV blazars

The physics related to TeV blazars (and AGNs in general) is not yet understood, despite some of these objects having been studied for >10 years.

Current experimental data allows for a big inter-model and intra-model degeneracy. ***More and "higher quality" data required to constrain models.***

- Leptonic vs hadronic emission models
- Intrinsic spectra vs EBL-affected spectra
- Production of flares (which are the shortest timescales)
- Acceleration/cooling in single or multi-zone; close or far from BH
- Role of external photon fields
- Time-resolve emission models
- etc,etc, etc …

1- Motivation to observe (again) the classical TeV blazars

Culprits for the relatively poor knowledge of these objects

1 - Time-evolving broad band spectra

Coordination of instruments covering different energies needed

2 - Poor sensitivity to study high-energy part (E>0.1 GeV)

Large observation times (with EGRET and “old” IACTs) were required for signal detection *Data NOT truly simulteneous*, and *most of our HBL knowledge relates to the high state*

Present and near future (two “performance jumps”):

New Generation of IACTs online (low E_{th}, high sensitivity)

GLAST operation in 2008 (~25 more sensitive than EGRET)

1- Motivation to observe (again) the classical TeV blazars

Mrk 421, Mrk 501, PKS 2155-304, 1ES1959+650

Excellent laboratory for studying High Energy blazar emission

Strong gamma ray sources (0.1-0.5 crabs in VHE "low state")
z <~ 0.1; low EBL absorption, we see "almost" intrinsic features

Knowledge acquired with those objects could (in principle) be applied to other objects (fainter and/or larger z)

Things we know about those blazars (and HBLs in general)

Dominant gamma-ray emission mechanism is believed to have a leptonic origin (SSC, EC) , at least in high (flaring) state

- **Fast variations (down to hours and sub-hours in VHE)**
- **X rays- Gamma-rays correlation (in general)**

2- LAT capabilities on the bright TeV blazars

For a detailed description of the performance of LAT:

- *See talks (this conf.) by Michelson and Longo*
- *Visit page*

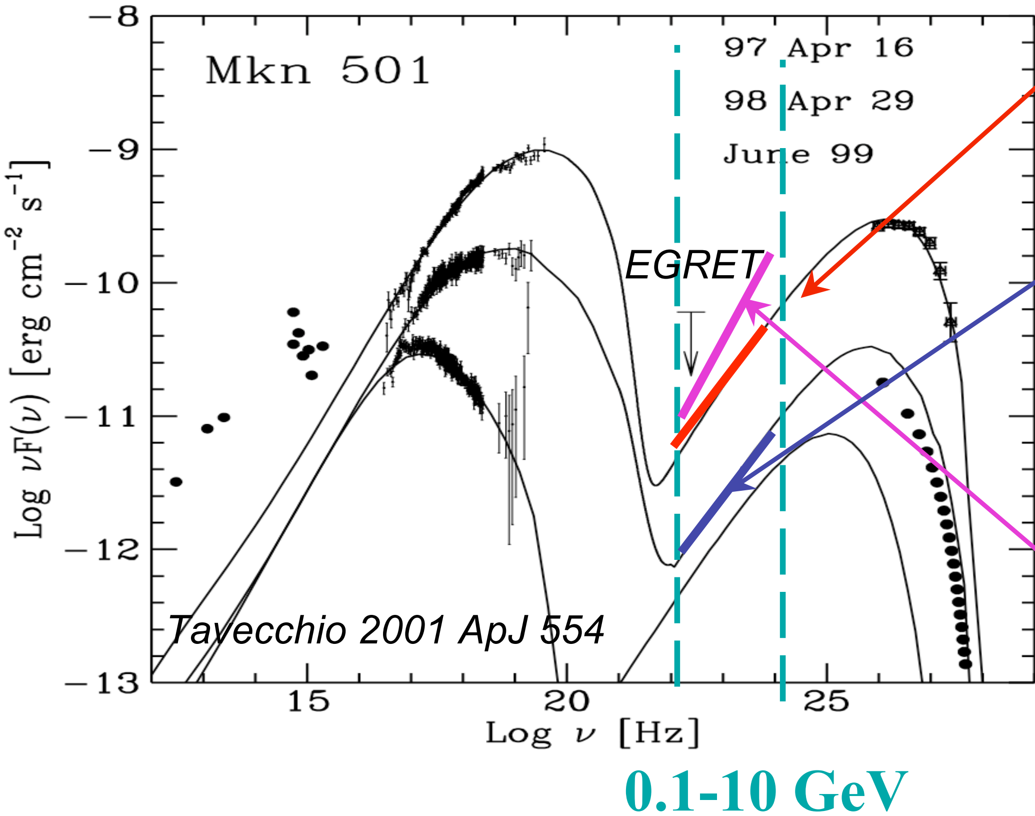
http://www-glast.slac.stanford.edu/software/IS/glast_lat_performance.htm

Here, only shown the **time required** by GLAST/LAT (*survey mode*) to get a **5 sigma detection** by assuming photon fluxes derived from past experimental data (X-rays/VHE) and extrapolations to the LAT energy range from reasonable/standard published SSC modelling

The uncertainties in flux and spectral index are also given for the observation time corresponding to this 5 sigma detection

2- LAT capabilities on the bright TeV blazars

Mrk 501



High

K = 1.4x10^{-8} GeV^{-1}cm^{-2}s^{-1} ; a = 1.45

F(>0.1GeV) = 9.0 x10^{-8} ph cm^{-2} s^{-1}

Time for 5 sigma detection: 0.9 days

$\Delta F_{>0.1GeV}$ ~ 68% ; Δa ~ 21%

Low

K = 2.3x10^{-9} GeV^{-1}cm^{-2}s^{-1} ; a = 1.45

F(>0.1GeV) = 1.42 x10^{-8} ph cm^{-2} s^{-1}

Time for 5 sigma detection: 9 days

$\Delta F_{>0.1GeV}$ ~ 74% ; Δa ~ 21%

EGRET high, Kataoka 1996, ApJ 514

This is the ONLY measurement of Mrk501 at these energies; it is a ~5 sigma detection

K = 2.7x10^{-8} GeV^{-1}cm^{-2}s^{-1} ; a = 1.3

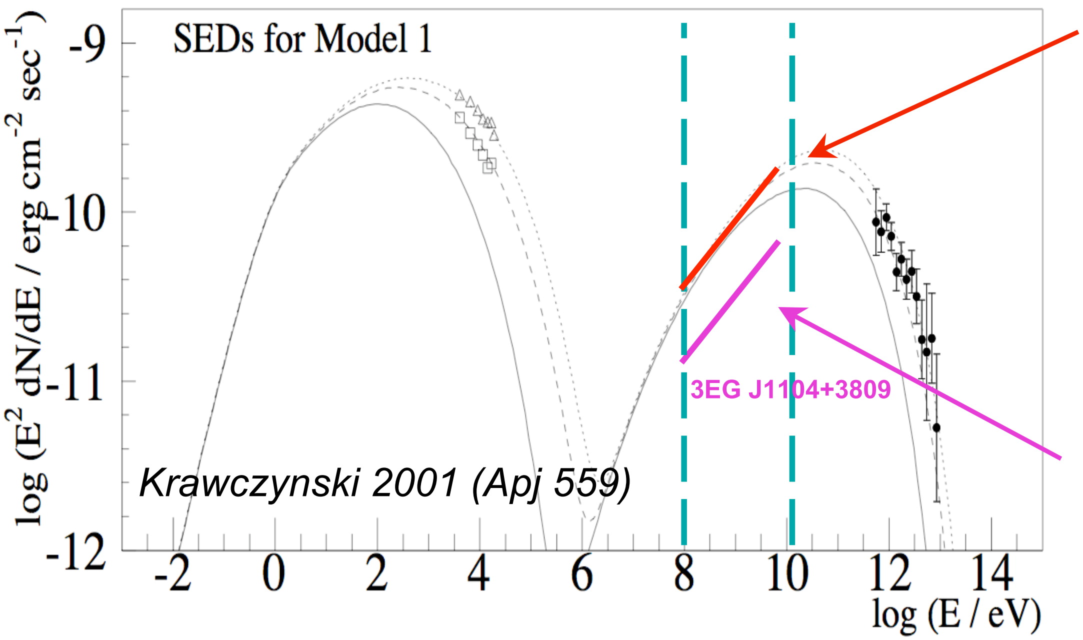
F(>0.1GeV) = 1.8x10^{-7} ph cm^{-2} s^{-1}

Time for 5 sigma detection: 0.3 days

$\Delta F_{>0.1GeV}$ ~ 62% ; Δa ~ 25%

2- LAT capabilities on the bright TeV blazars

Mrk 421

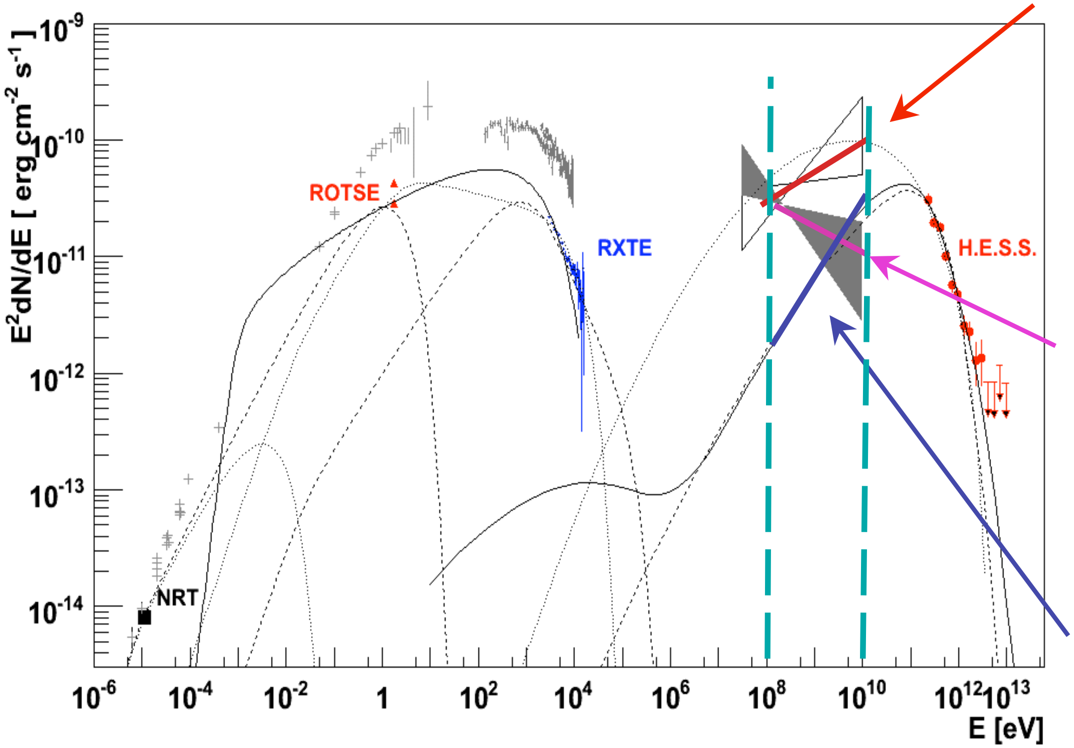


High
K = 6.0 x10^{-8} $GeV^{-1}cm^{-2}s^{-1}$; a = 1.60
F(>0.1GeV) = 3.9 x10^{-7} ph cm^{-2} s^{-1}
Time for 5 sigma detection: 0.2 days
$\Delta F_{>0.1GeV}$ ~ 63% ; Δa ~ 20%

EGRET flux, Hartman 1999, ApJS 123
K = 2.13x10^{-8} $GeV^{-1}cm^{-2}s^{-1}$; a = 1.60
F(>0.1GeV) = 13.9 x10^{-8} ph cm^{-2} s^{-1}
Time for 5 sigma detection: 0.8 days
$\Delta F_{>0.1GeV}$ ~ 63% ; Δa ~ 19%

2- LAT capabilities on the bright TeV blazars

PKS 2155-304



EGRET flux HIGH

$K = 3.4 \times 10^{-8}$ GeV^{-1}cm^{-2}s^{-1} ; a = 1.70

F(>0.1GeV) = 2.4 $\times 10^{-7}$ ph cm^{-2} s^{-1}

Time for 5 sigma detection: 0.6 days

$\Delta F_{>0.1GeV}$ ~ 55% ; Δa ~ 9%

EGRET flux LOW Hartman 1999 , ApJS 123

$K = 8.0 \times 10^{-9}$ GeV^{-1}cm^{-2}s^{-1} ; a = 2.35

F(>0.1GeV) = 13.2 $\times 10^{-8}$ ph cm^{-2} s^{-1}

Time for 5 sigma detection: 6 days

$\Delta F_{>0.1GeV}$ ~ 34% ; Δa ~ 10%

Low

$K = 3.6 \times 10^{-9}$ GeV^{-1}cm^{-2}s^{-1} ; a = 1.40

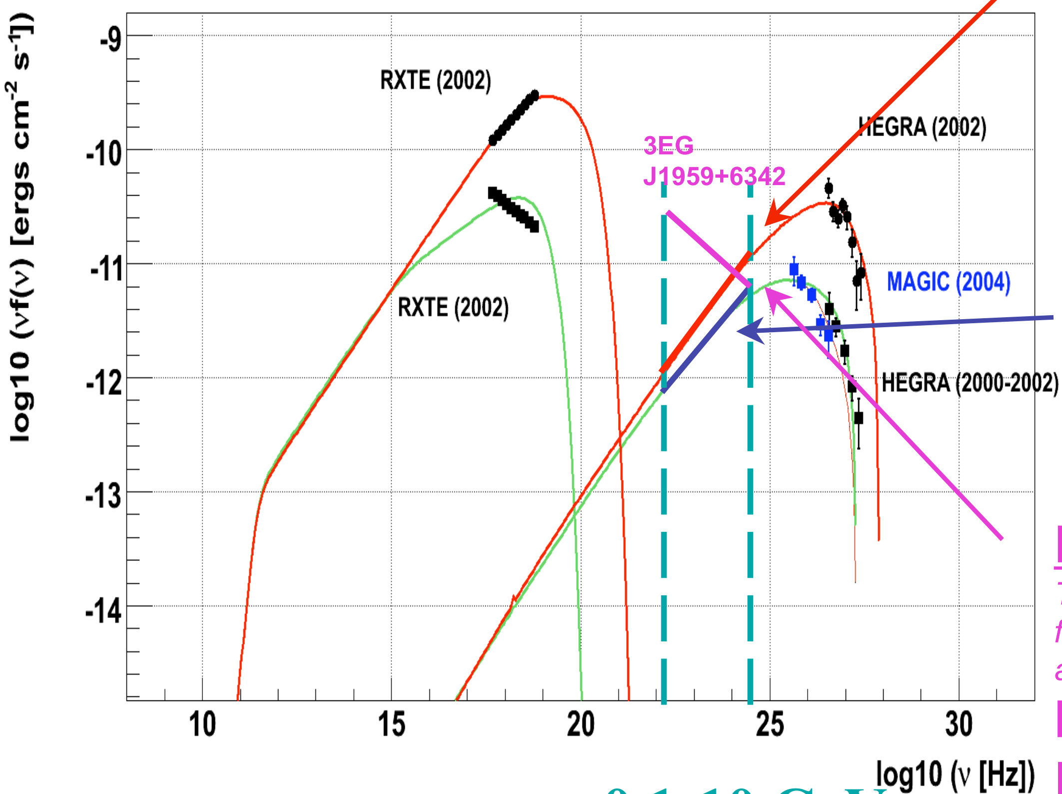
F(>0.1GeV) = 2.3 $\times 10^{-8}$ ph cm^{-2} s^{-1}

Time for 5 sigma detection: 5 days

$\Delta F_{>0.1GeV}$ ~ 68% ; Δa ~ 21%

2- LAT capabilities on the bright TeV blazars

1es1959+650



0.1-10 GeV

High

K = 2.1 x10^{-9} GeV^{-1}cm^{-2}s^{-1} ; a = 1.60

F(>0.1GeV) = 1.3 x10^{-8} ph cm^{-2} s^{-1}

Time for 5 sigma detection: 20 days

$\Delta F_{>0.1GeV}$ ~ 81% ; Δa ~ 19%

Low

K = 1.5x10^{-9} GeV^{-1}cm^{-2}s^{-1} ; a = 1.65

F(>0.1GeV) = 1.0 x10^{-8} ph cm^{-2} s^{-1}

Time for 5 sigma detection: 40 days

$\Delta F_{>0.1GeV}$ ~ 75% ; Δa ~ 16%

EGRET flux, Hartman 1999, ApJS 123

The EGRET source 3EG J1959+6342 is located ~1.5 degrees away from 1ES1959+650, and can be considered as an upper limit for the average emission of this blazar

K = 6.8x10^{-9} GeV^{-1}cm^{-2}s^{-1} ; a = 2.45

F(>0.1GeV) = 13.3 x10^{-8} ph cm^{-2} s^{-1}

Time for 5 sigma detection: 10 days

$\Delta F_{>0.1GeV}$ ~ 29% ; Δa ~ 9%

2- LAT capabilities on the bright TeV blazars

Complement TeV obs. to cover entirely (and “close-to-simultaneously”) the high-energy peak in the SED

Together with simultaneous observations at X-ray frequencies, these new data will permit to study:

- *Evolution of spectra with time, displacement of peaks …*

GLAST/LAT will be “always” watching !!!

Notify the community when things get hot

LAT data (<10 GeV) will not be affected by the EBL, which will permit disentangling the intrinsic spectra of the sources. This will help to rule out/confirm emission models, as well as EBL models

3- Concluding remarks

The LAT instrument has been assembled and working for >1 year. Currently being characterized/validated. **LAT operation (beginning 2008) will boost our current capabilities to study blazars.**

LAT will bring key data from a poorly sampled energy range (0.02-100 GeV). However, **simultaneous MW observations are needed to understand the broad spectra of these objects**.

Campaigns on these four bright TeV blazars are being planned for 2008; ***agreements with instruments covering radio to TeV energies are currently being made.*** Campaigns on other non-HBL AGNs (like BLLac and 3C279) will be also performed. *Do not hesitate to contact us if you are interested in participating*. More information on multiwavelength campaigns with GLAST/LAT on these and other objects can be obtained at ***http://glast.gsfc.nasa.gov/science/multi/***

Backup

LAT Performance

http://www-glast.slac.stanford.edu/software/IS/glast_lat_performance.htm

Single-energy-bin sensitivity plot

5-sigma sensitivity to a high-latitude source whose spectrum is integrated over 1/4 decade in energy centered on the energy shown on the horizontal axis.