Observations of AGNs with the MAGIC Telescope

Daniel Mazin

on behalf of the MAGIC collaboration

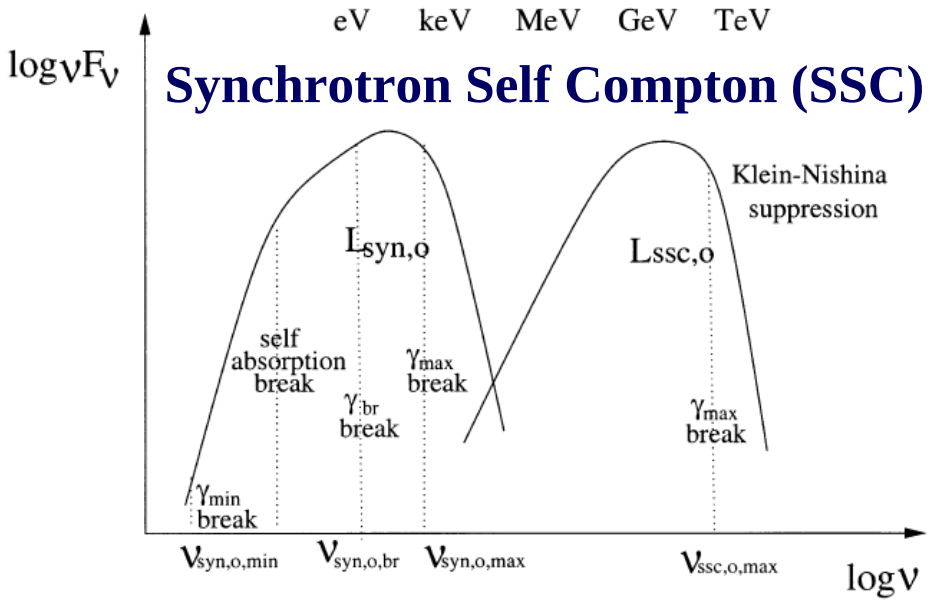
Max-Planck-Institut für Physik, Munich

Outline:

- Active Galactic Nuclei (AGN) and blazars
- Extragalactic Background Light (EBL)
- MAGIC
  - **Markarian 421, z=0.030**
  - **Markarian 501, z=0.034**
  - **1ES2344+514, z=0.044**
  - **Markarian 180, z=0.045**
  - **1ES1218+304, z=0.182**
  - **PG1553+113, z>0.09**
- Conclusions, outlook

TeV blazars

Kino et al, ApJ, 2002, 564, 97



- TeV blazars: non-thermal emission, highly variable
- All but one are HBL (high peaked BL Lacs)
- Models: **leptonic** vs. **hadronic** origin

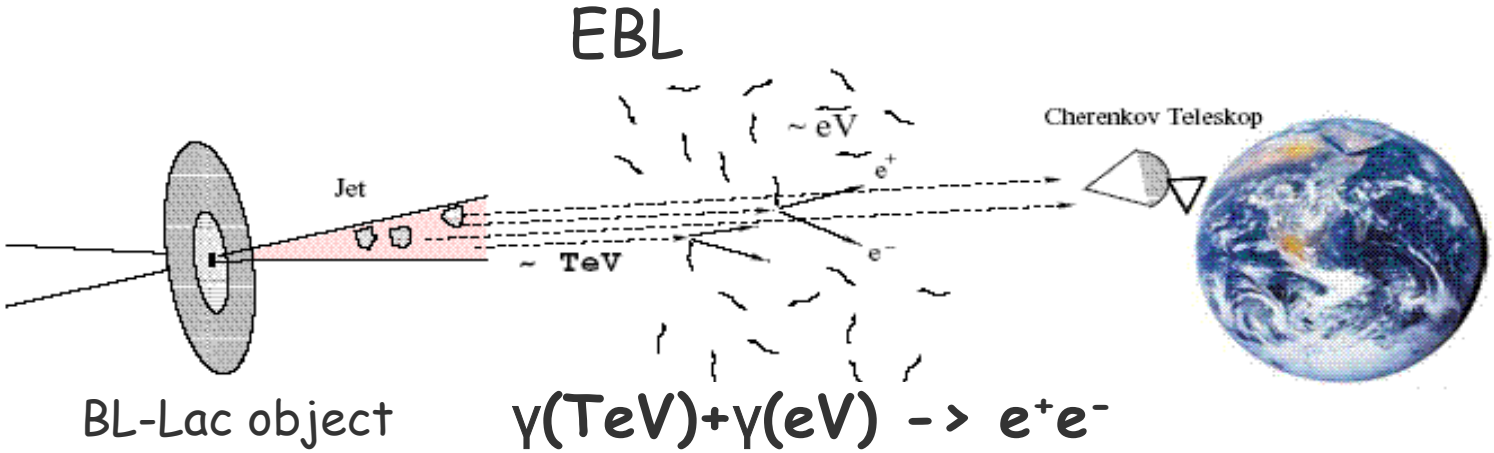
MAX-PLANCK-GESELLSCHAFT

Where are the sources?

MAGIC Major Atmospheric Gamma Imaging Cerenkov Telescope

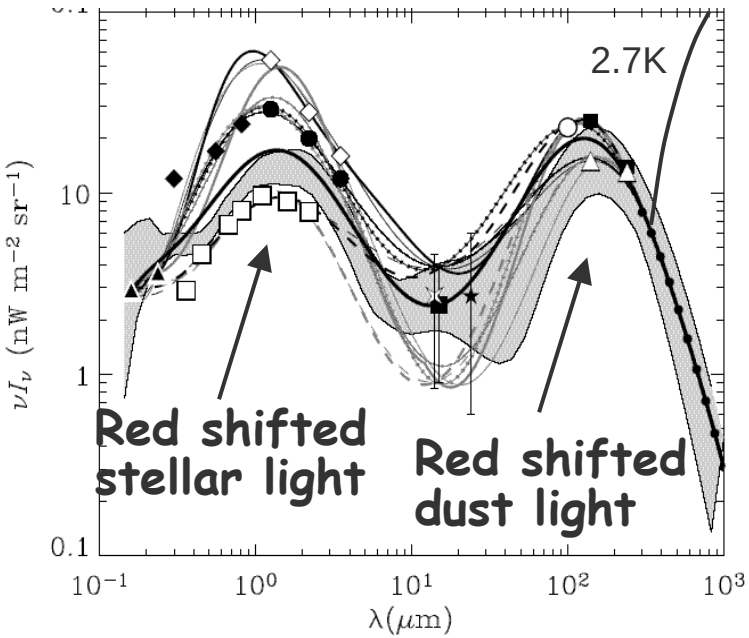
- In the Galactic plane, it starts to be crowded above 100 GeV. Expectations fulfilled.
- 16 extragalactic sources: 15 blazars and radio galaxy M87. The number is growing but slow.
- Expect many more if extrapolate from EGRET sources.
- Possible reasons:
  - Intrinsic cut-off
  - **Extragalactic absorption**
- GLAST will clarify

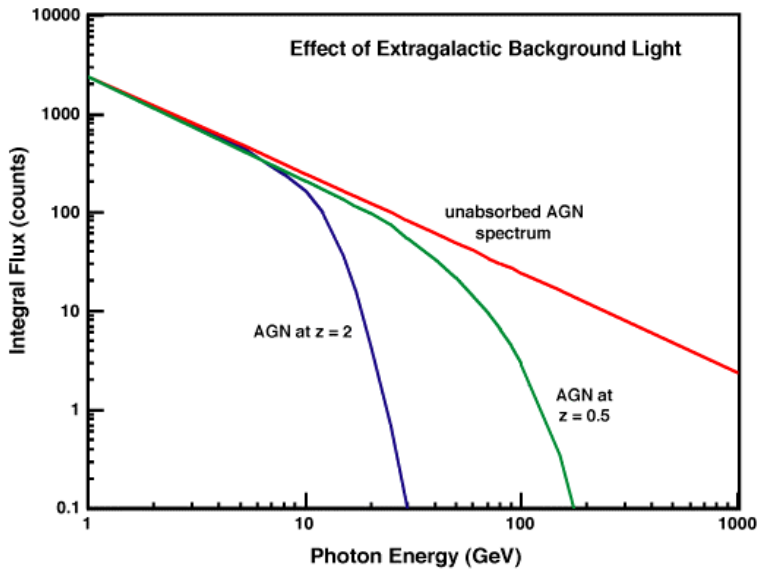
Attenuation of GeV-TeV photons



BL-Lac object

$\gamma(TeV)+\gamma(eV) \rightarrow e^+e^-$





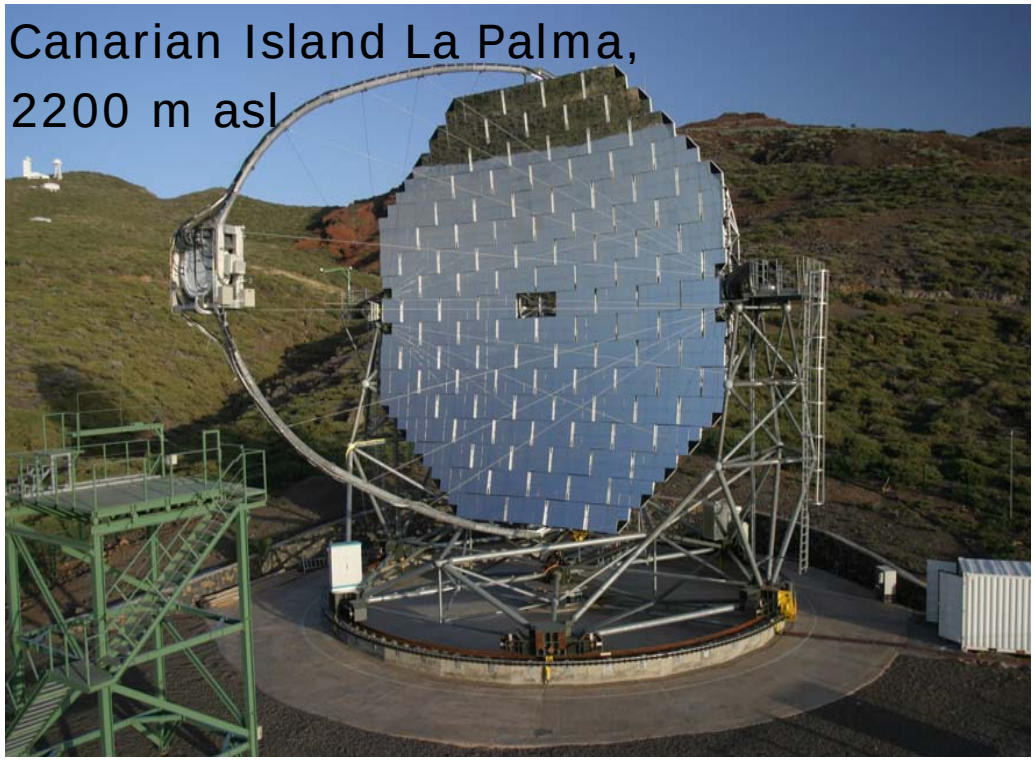
Daniel Mazin, MPI, Munich

MAX-PLANCK-GESELLSCHAFT

MAGIC

MAGIC
Major Atmospheric
Gamma Imaging
Cerenkov Telescope

- The largest imaging atmospheric Cherenkov Telescope with 17m mirror diameter
- 3.5° FoV Camera with 576 enhanced QE PMT's
- Trigger threshold: 50-60GeV
- Sensitivity: 2% Crab Nebula in 50 hours
- γ-PSF is about 0.1°
- Energy resolution: 30% at 150 GeV, 20% at 300 GeV

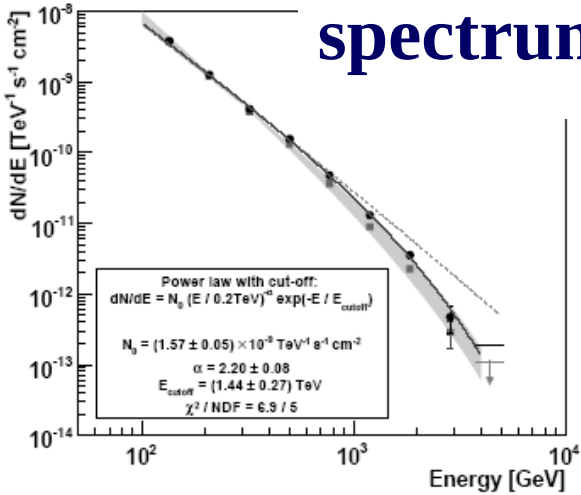


Mkn 421 (z=0.030)

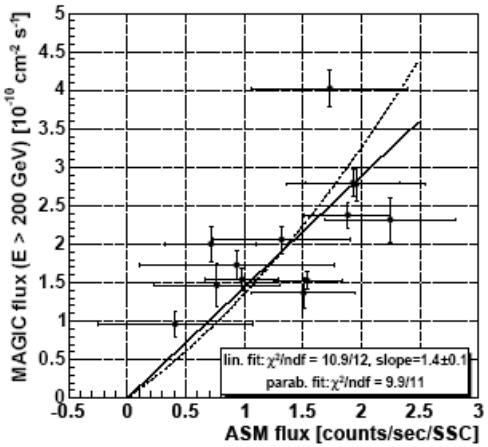
ApJ submitted, astro-ph/0603478

- Dec 2004 – Apr 2005
- 25.6 h, over 7000 excess events
- Energy threshold: 150 GeV

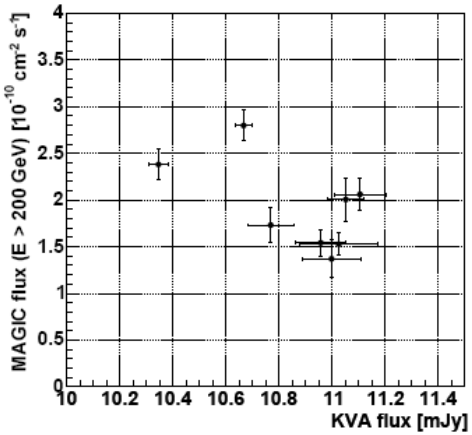
spectrum



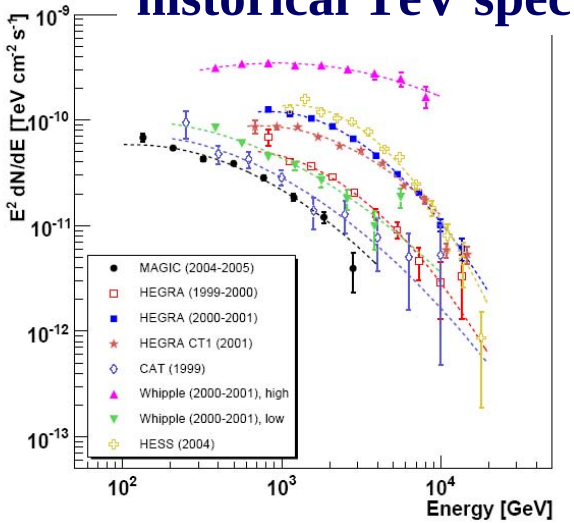
Clear TeV-X-ray correlation



Unclear TeV-optical correlation

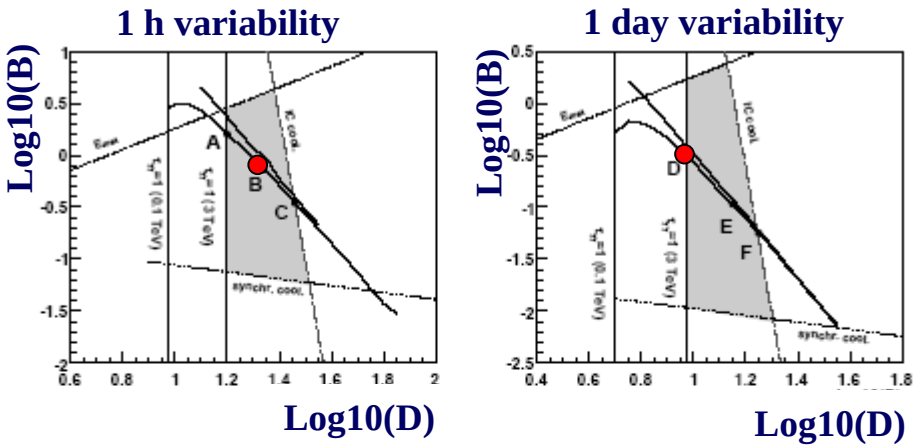


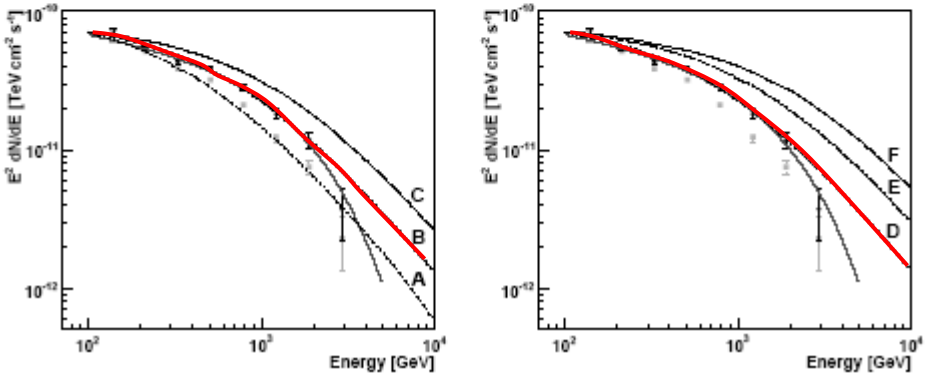
historical TeV spectra



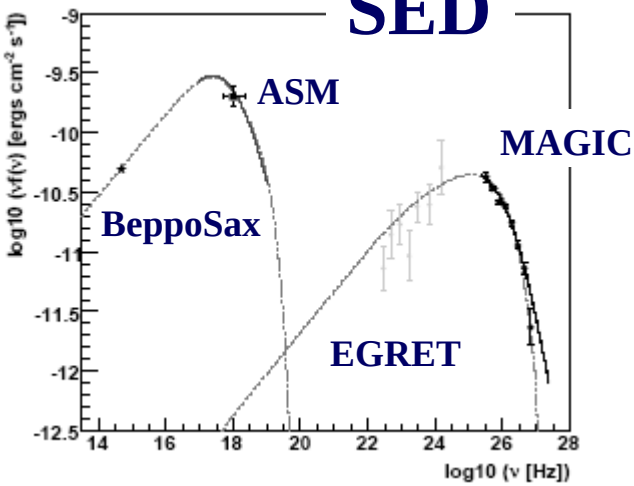
Mkn 421 (z=0.030)

SSC constraints





SED



In case of 1-day variability scale, the model provides the same parameters as from the 1997 flare (Whipple): different flux states only matter of electron population?

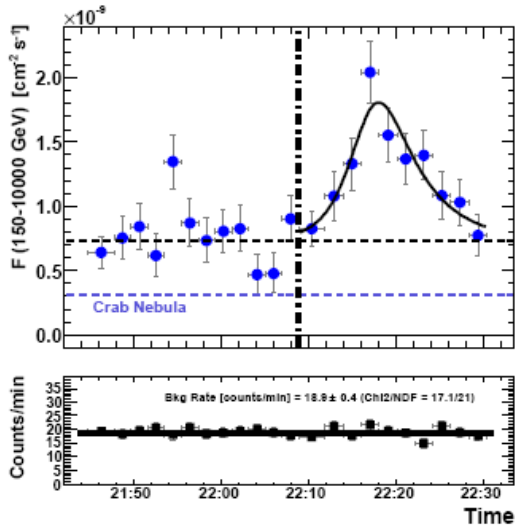
ApJ submitted, astro-ph/0603478

Mkn 501 (z=0.034)

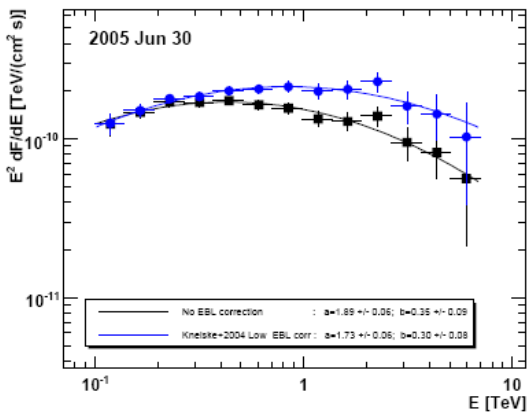
ApJ submitted, astro-ph/0702008

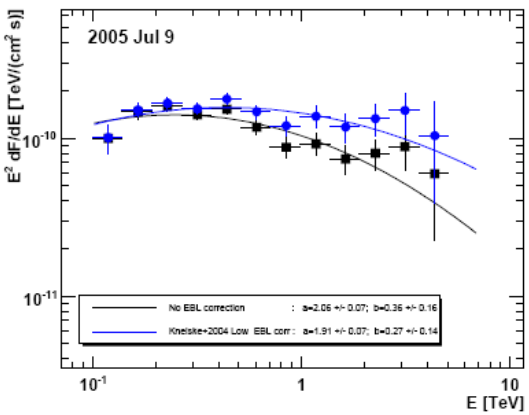
- June – July 2005
- 32.2 h, around 16 kevents above 100 GeV
- Energy threshold: 150 GeV
- Details: D. Paneque on Wednesday (P1.4)

Flux doubling times ~2 min

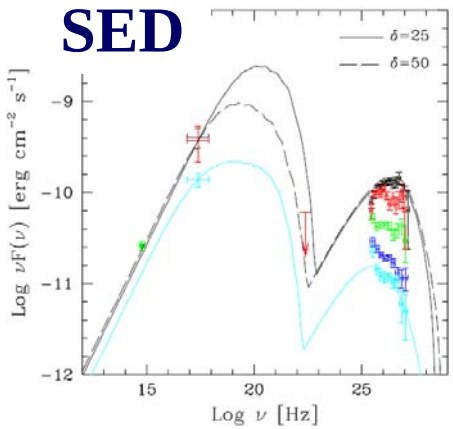


IC peak detected: measured and de-absorbed!





SED



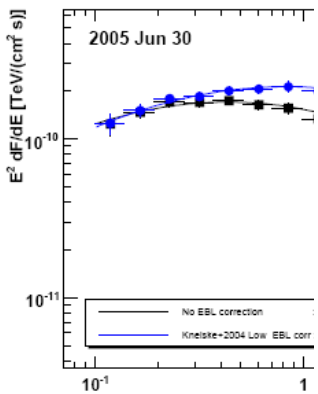
Mkn 501 (z=0.034)

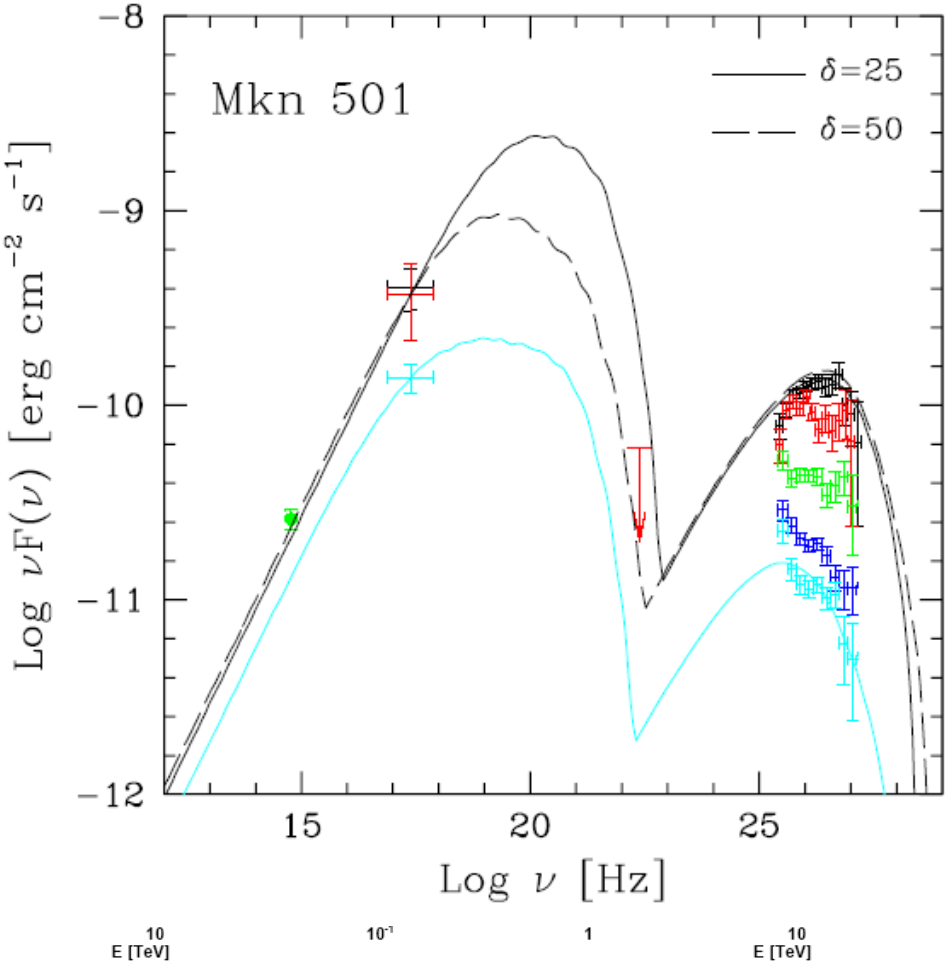
ApJ submitted, astro-ph/0702008

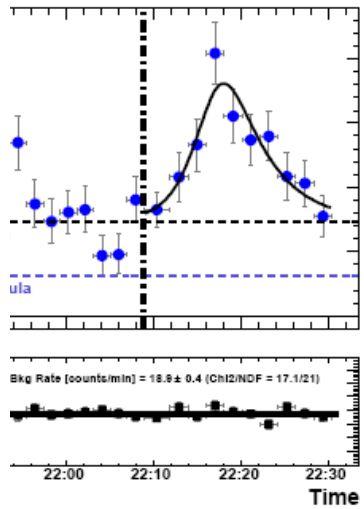
Flux doubling times ~2 min

- June – Ju
- 32.2 h, a
- Energy t
- Details:

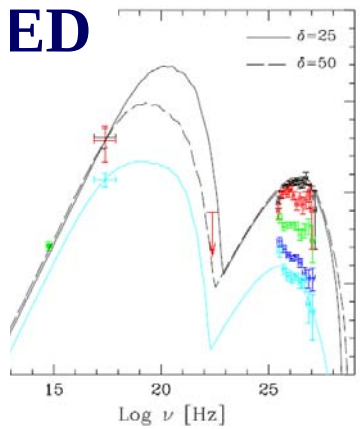
IC peak d







ED

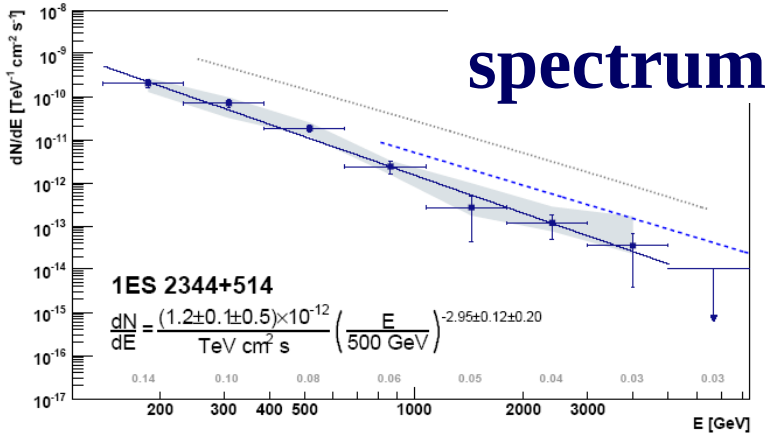


1ES2344+514 (z=0.044)

- Whipple: Flare (20-12-95),
  $F_{(>350GeV)}$ = 63% Crab, (*Catanese, 97*)
- Whipple later upper limits only,
  $F_{(>350GeV)}$ < 8% Crab in 96/97 (Schroedter, 05)
- HEGRA 1997-2002: 4.4 σ
  $F_{int(>970GeV)}$ = 3.3% Crab (*Tluczykont et al. 03*)
- MAGIC. Aug 05 – Jan 06, 27.4 h:
  8.1 σ; F(>350GeV) = 6% Crab, no variability; index: -2.96±0.12

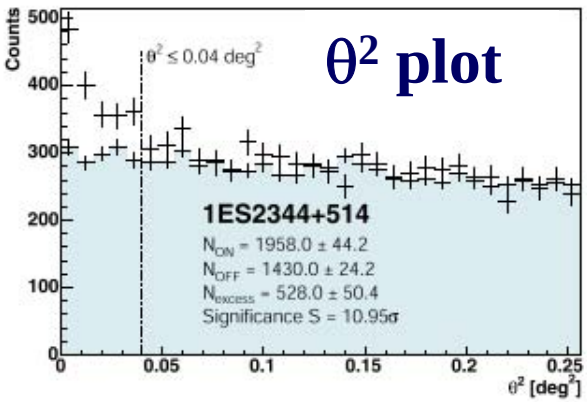
ApJ submitted, astro-ph/0612383

spectrum

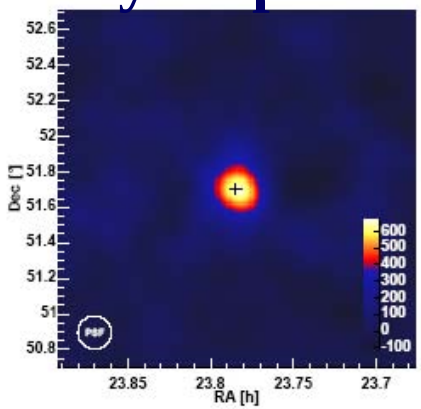


Clear detection!

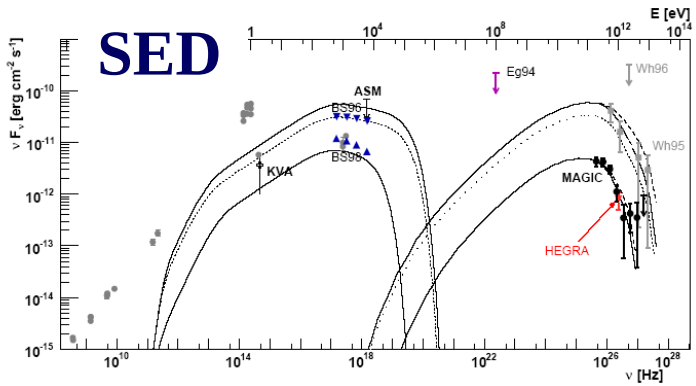
θ² plot



sky map



SED

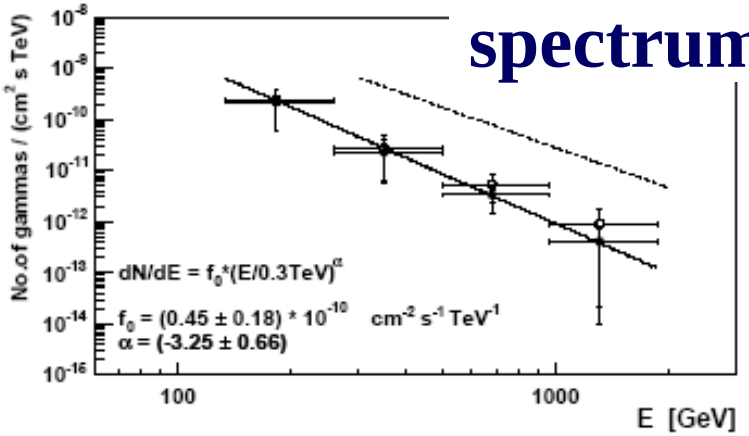


Mkn 180 (z=0.045)

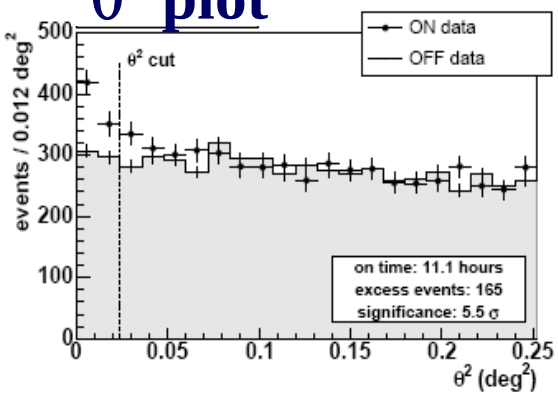
- Whipple: $F_{(>300GeV)}$<10.5% Crab units
- HEGRA: $F_{(>1.5TeV)}$<12% Crab units
- MAGIC: **DISCOVERY!**
- March 2006, 11.1 h
- Triggered by optical flare
- 5.5 σ, $F_{(>200GeV)}$ = 11% Crab units
  index: -3.3 ± 0.7

ApJ, 648 (2006) L105-L109

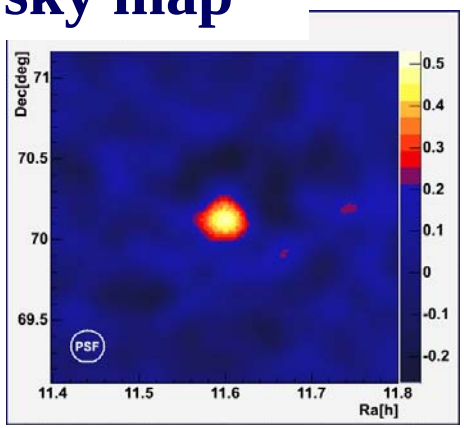
spectrum



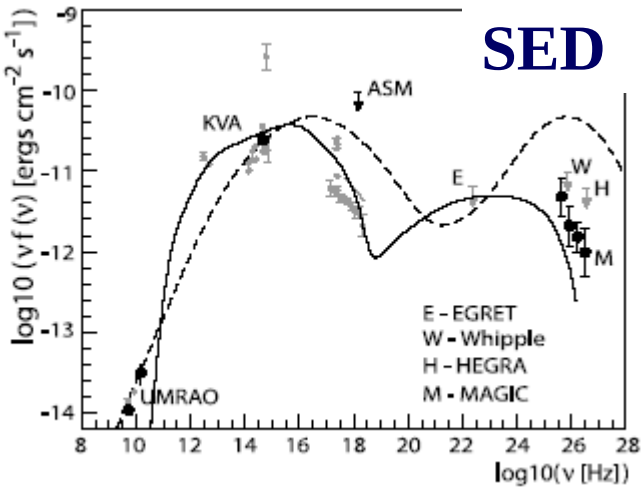
θ² plot



sky map



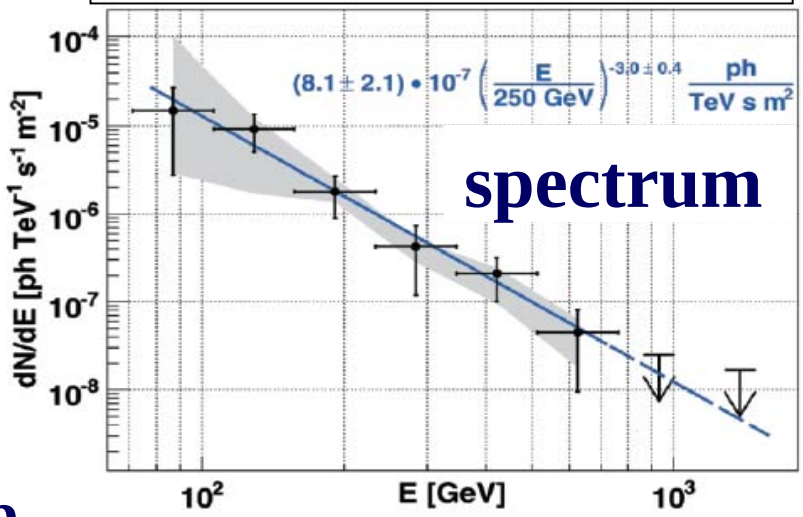
SED

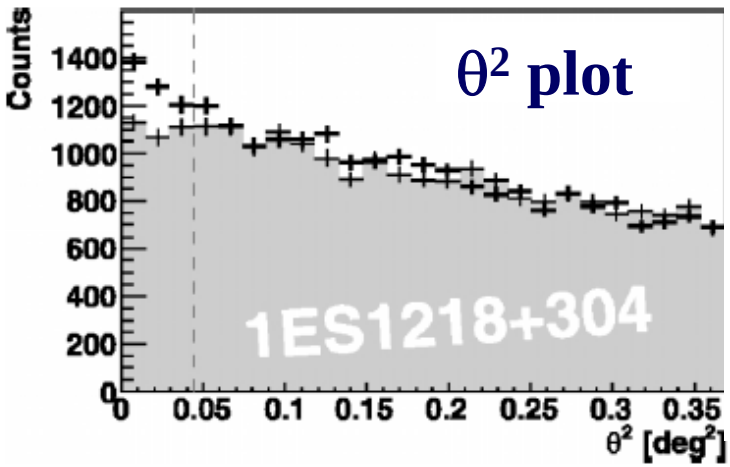


1ES1218+304 (z=0.182)

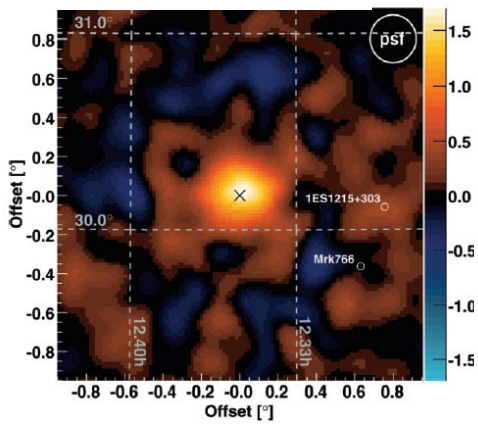
- Whipple: $F_{(>350GeV)}$<8% Crab units.
- HEGRA: $F_{(>750GeV)}$<12% Crab units
- MAGIC: **DISCOVERY!**
- Jan 2005, 8.2 h
- 6.4 σ, $F_{(>120GeV)}$ = 13% Crab units
  index: -3.0 ± 0.4

ApJ, 642 (2006) L119-L122

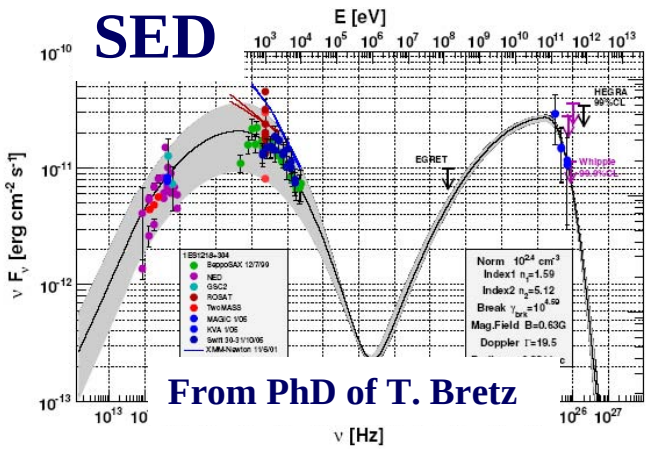




sky map



SED



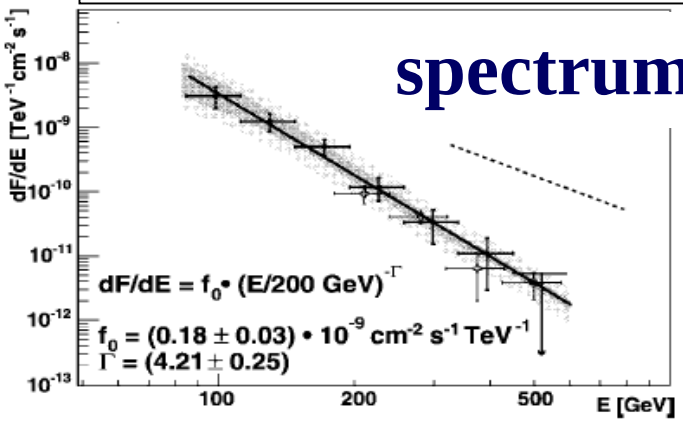
From PhD of T. Bretz

PG1553+113 (z>0.09)

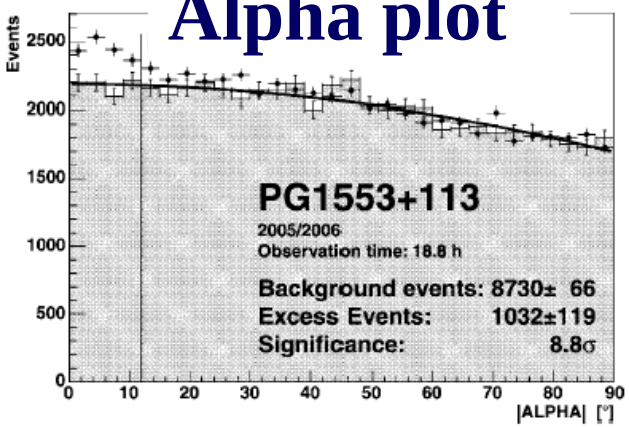
- Observed 18.8h in 2005-06
- H.E.S.S.: 4.0σ evidence
  (A&A 448L (2006), 43)
- MAGIC: ApJL 654, L119-L122 (2007)
- 8.8σ, firm detection.

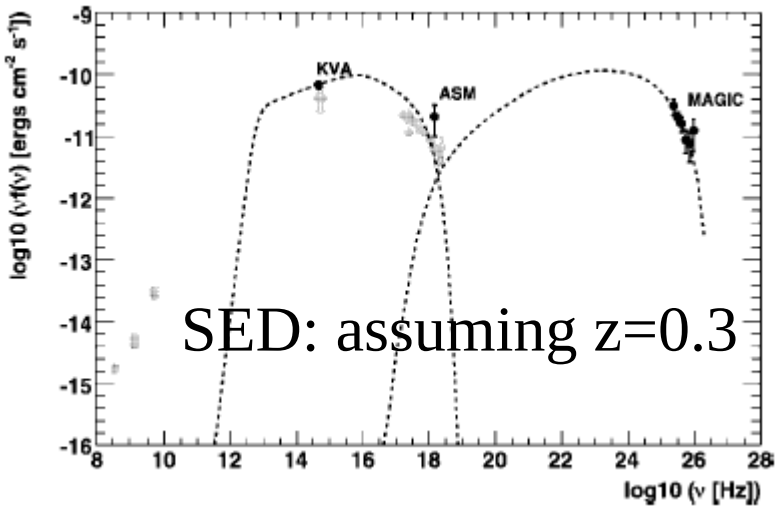
ApJ, 654 (2007) L119-L122

spectrum



Alpha plot



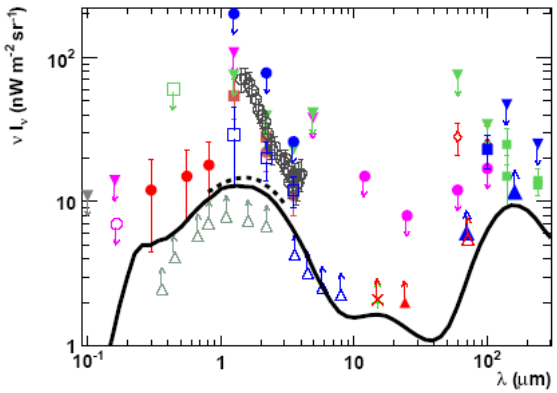


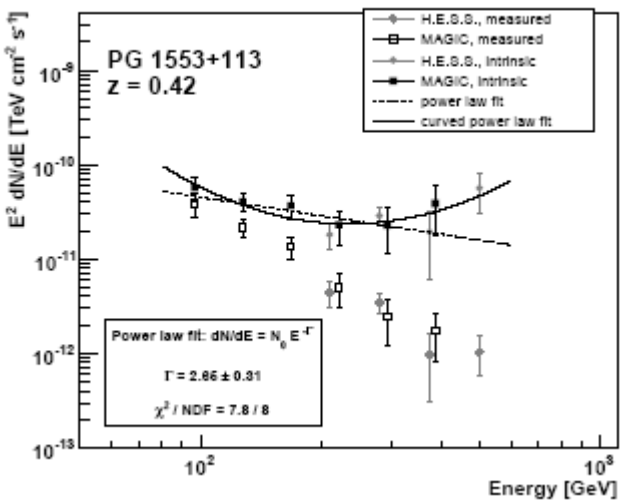
SED: assuming z=0.3

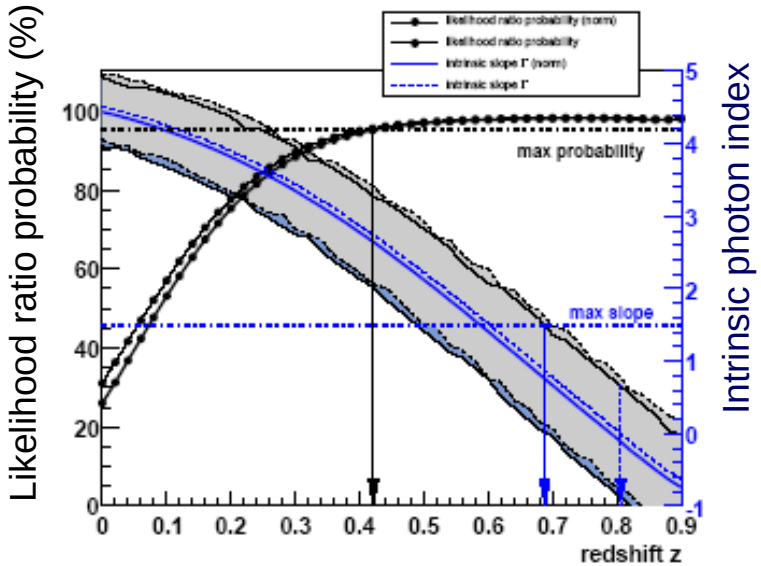
PG1553+113 (z<0.42?)

- Used H.E.S.S+MAGIC spectrum
- Assumed there is no break in the intrinsic spectrum of PG1553+113
- Assumed minimum evolving EBL (Kneiske et al. 2004)
- ⇒ $z < 0.42$

ApJ, 655 (2007) L13-L16







Conclusions / Outlook

- There are 15 blazars above 100 GeV established
  (discovered by Whipple, Durham, TA, CANGAROO, H.E.S.S., and MAGIC)
- MAGIC detected 7 of them; 2 of them discovered by MAGIC, 1 co-discovered with H.E.S.S.
- GeV-TeV sources up to redshift z=0.2. Possible detections up to z=1 with HESS, MAGIC, CANGAROO, and VERITAS
- Simple leptonic emission models usually work
- Hard constraint on the redshift for PG1553+113 of $z<0.42$ in case there is one peak above 100 GeV. If $z>0.42$, first detection of multipeak structure of a blazar above 100 GeV.
- TeV blazars constrain EBL: see Mazin on Wednesday (P5.2)

More new MAGIC sources in the pipeline! Stay tuned!