



Discovery of VHE emission from Mrk 180

Triggered by an optical outburst

E.Lindfors & D. Mazin on behalf of the MAGIC collaboration

ENIGMA Meeting, 8th September 2006, Otaaniemi

VHE emission from AGN

- The search for VHE ($>100\text{GeV}$) γ -ray emission has been one of the major goals for ground based γ -ray astronomy
- The number of reported γ -ray emitting AGN is currently 14
- Observed by MAGIC: Mrk 421, Mrk 501, 1ES 1959+650, 1ES 2344+514, 1ES 1218+304, PG 1553+113
- And new detection Mrk 180 in March 2006

AGN Variability

- AGN highly variable in all energy bands
- Correlations?
 - Optical-Gamma? Very little data on short time correlations (3c279 correlation with 2-3 days time lag), optical high states indicators of high gamma state?
 - X-ray to gamma, fast flares on X-ray often have GeV-TeV counterpart
 - High X-ray state, increased likelihood of GeV-TeV detection
- Target of Opportunity observations with MAGIC when sources are in high state in optical and/or X-rays

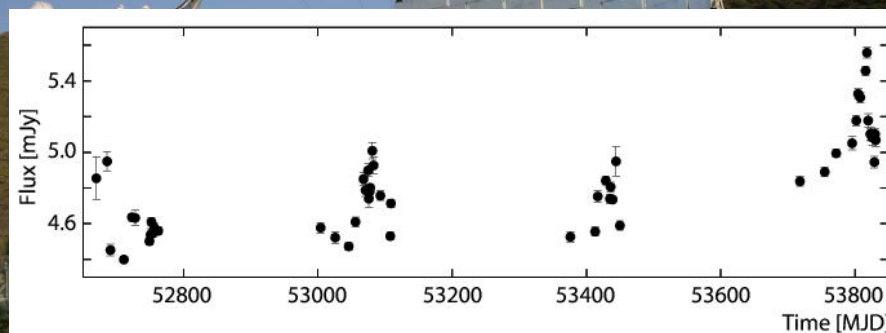
Alerts

- X-ray alerts: keep an eye on ASM weather map
- Optical alerts: Tuorla Observatory Blazar monitoring program:
<http://users.utu.fi/kani/1m/>

Mrk 180

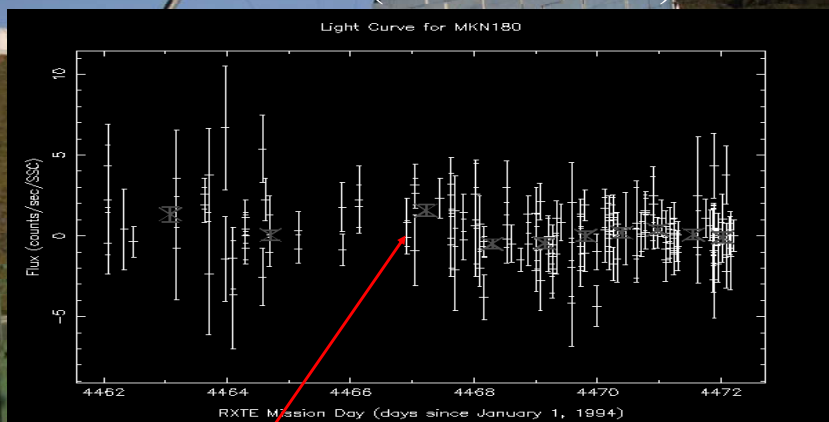
- Well-known HBL $z=0.045$
- Bright host galaxy ($R=14.17\pm 0.02$) much fainter core ($R=15.79\pm 0.02$) (Nilsson et al. 2003)
- Only upperlimits from EGRET, Whipple and HEGRA

Mrk 180 underwent an optical outburst in March 2006



Quasi-simultaneous UMRAO data shows no evidence of flaring

Mrk 180 (March 2006)



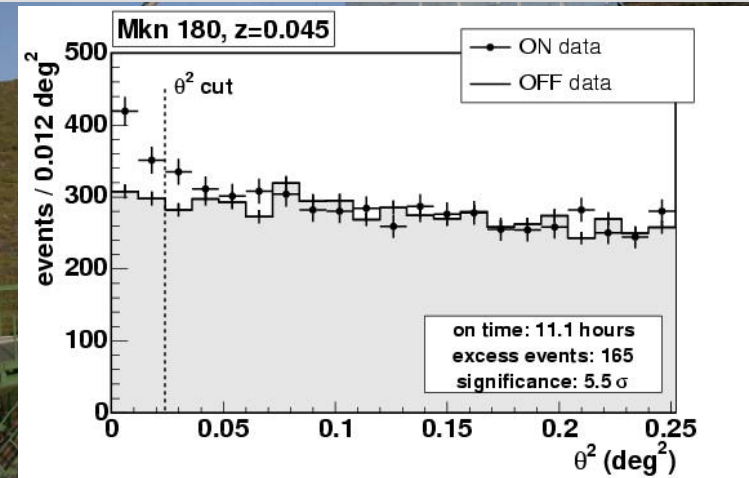
MAGIC Observations

- Started 23rd of March
- Observed from 23rd to 31st of March (scheduled telescope shutdown 1st of April)
- Total observation time 12.4 hours, observation conditions mostly good, but few nights there was some high clouds.
- Observations done in Wobble mode
- Runs with unusual trigger rates rejected => total observation time reduced to 11.1 hours
- $Z_A=39^\circ-44^\circ$

Data Analysis

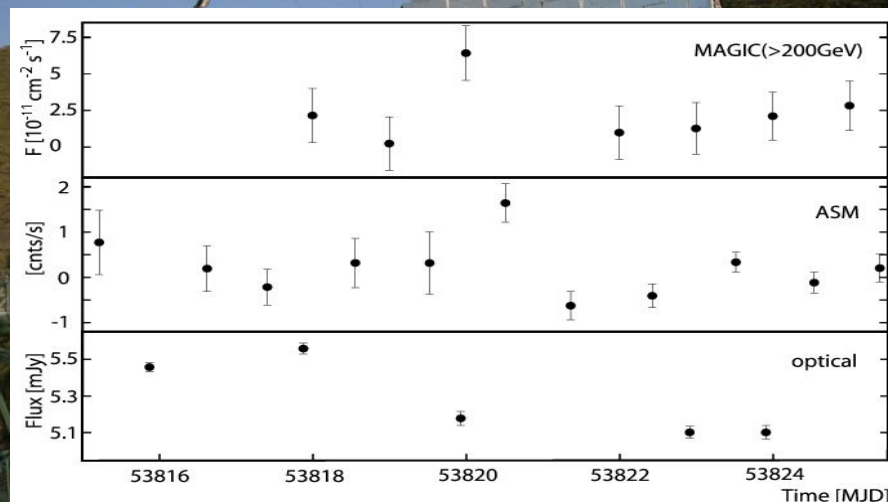
- Done by D.Mazin
- Using standard analysis and calibration programs for the MAGIC telescope.
- γ /hadron separation was done using random forest
- Number of excess events : difference between the source and background region in θ^2 distributions, three background regions

θ^2 distribution

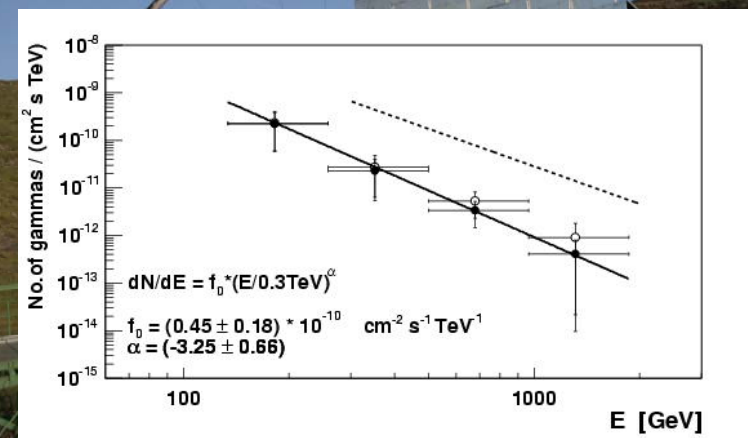


θ =angular distance between the source position in the sky and the reconstructed arrival position of the shower

No evidence of flux variability, the fit to the nightly integrated flux is consistent with a constant emission: $\chi^2/\text{ndf} = 7.1/6$



The measured and the de-absorbed energy spectrum of Mrk 180



The observed integral flux above 200 GeV is $1.27 \cdot 10^{-11}$ ergs / cm^2/s (or 11% of Crab flux)

-Errors statistical only: The systematic error about 50% for the absolute flux level and 0.2 for the spectral index

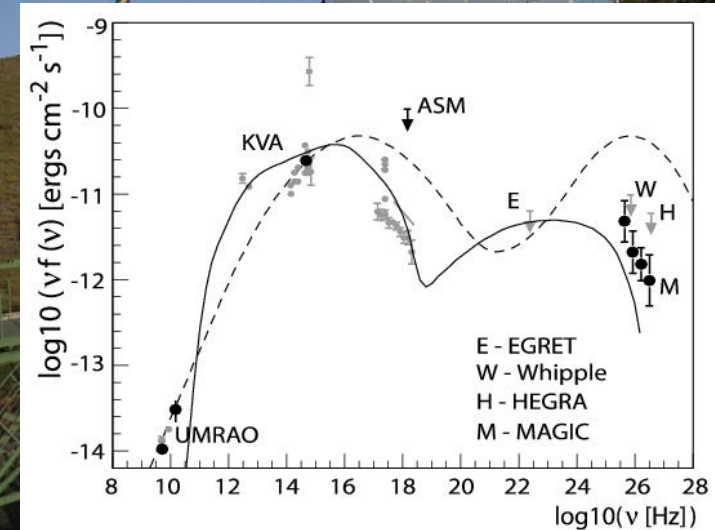
-Results of independent cross-check analysis were in good agreement with the numbers reported here.

-VHE gamma-rays partially absorbed by low energy photons of the evolving extragalactic background light, the effect is small for photons with energies below 1TeV

-Used the best-fit model of Kneiske et al. 2004

-The deabsorbed spectrum has slope -2.8 ± 0.7

The spectral energy distribution of Mrk 180



Does the detection present a flaring state?

- Flare in optical, hint of flare in X-rays
- Observed flux factor of 30 above the prediction of Costamante and Ghisellini model, their model calculation is based on quiescent synchrotron spectrum

But...

- The source has not been observed in low optical state with MAGIC and we are below the upper limits from other experiments, so we have nothing to compare to.
- Although MAGIC lightcurve can be considered suggestive it is statistically consistent with constant emission.

Conclusions

- This would be very interesting source for MW campaign!

