Long-term Gamma-Ray lightcurves and high-state probabilities of Active Galactic Nuclei

Martin Tluczykont, Maxim Shayduk, Oleg Kalekin & Elisa Bernardini
DESY, Helmholtz young investigator group (Multi-Messenger studies)

Introduction
Current neutrino experiments are approaching a sensitivity that allows to detect Active Galactic Nuclei (AGN) in their high-states. However, the expected signals might be too weak to result in a significant detection. One possibility to increase the detection chance is to focus the searches during states of high electromagnetic activity, especially in the very high energy (VHE) gamma-ray regime. In this context a good knowledge of the phenomenology of gamma-ray flux variability of the known VHE AGN is crucial.

Experiments shown:
- Pioneering imaging Cherenkov telescopes (used in this work)
- Next generation neutrino telescopes
- Pioneering imaging Cherenkov telescopes (used in this work)
- External & self triggering: possible bias towards high flux states (Fig. 4).

Available Data, Information extraction
- Mrk421, 1ES1959+650, Mrk501, PKS2155-304, ...
- Not electronically available data was extracted from publications using older data.
- Unknown observation durations are conservatively set to 1 hour.
- Energy normalization for pure power law: \( E^{1.3} \)
- Flux normalization for power law + exponential cutoff: \( E^{-\alpha} \exp(-E/\Lambda) \)
- Flux conversion to Crab (>1TeV) using corresponding observed spectra.
- Errors are statistical. Systematic errors: (1\%) for fluxes, <0.2 for indices.
- All collected data is available at http://veritas.sao.arizona.edu/VERITAS_whipple.html#lightcurves

Combined Lightcurves
Fig. 1: TeV Cross-normalized fluxes vs. modified Julian date (MJD) for Mrk421 from HEGRA, Whipple and CAT. Even without taking into account systematic errors and intrinsic short-term variations of the source, the cross-normalized fluxes agree remarkably well.

Fig. 4: Flux levels of Mrk421 (upper limits excluded), A significant bias towards high flux states is not visible here.

Fig. 5: Long-term lightcurve of 1ES1959+650

Conclusion & Outlook
A large amount of VHE gamma-ray data was collected, archived and converted to a common lightcurve format. An analysis of the data shows that it is possible to calculate an average observed high state (HS) rate with a reasonable error. The method used to estimate this error will be refined in order to calculate robust confidence intervals for the HS rate, under the assumption of a gamma-ray intensity distribution. The flux levels of AGN. Note that an upper limit derived from the considered data set might be overestimated due to the aforementioned bias to high fluxes. For more precise estimations of confidence intervals long total exposure times from random observations are desirable. In the future more data from VHE experiments will be available and with the launch of GLAST at the end of 2007, high energy gamma-ray data will be available with a very good time coverage.

Acknowledgements
In order to collect the data used in this work, many publications were used but also the authors were contacted directly. We wish to thank all those who have helped us with providing data and further information.

References
[5] E. Resconi, This conference