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# Monitoring of the radio galaxy M87 with the MAGIC Telescope

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From January until April 2008 the MAGIC Telescope has been monitoring the radio galaxy M87 during several nights. A significant and variable signal has been detected. Following an agreement between the HESS/MAGIC/VERITAS Cherenkov Telescopes, additional observations have been triggered. We will give a short overview of the results from the campaign in January and February.

*Workshop on Blazar Variability across the Electromagnetic Spectrum*
*Palaiseau, France*
*April 22nd-25th 2008*

1 Speaker.
2 on behalf of the MAGIC Collaboration

 

## 1.Introduction

At the core of the giant radio galaxy M87 lies a super massive black hole with a mass of $10^9$ solar masses [1 and references therein] at a distance of about 16 Mpc from earth. Radio and X-ray observations have revealed an extended jet with a rich structure [2]. The angle between the jet and the line of sight is around 30 degrees. M87 has been established as TeV γ-ray emitter by the HEGRA collaboration [3] and was later confirmed by HESS [4] and VERITAS [1]. The energy spectrum is rather hard with a photon index of 2.3. A possible correlation between the X-ray flux and the VHE-γ-ray flux is under study. Both the core and the so called "HST-1" knot close to the core are experiencing variable fluxes, whereas either the core or the knot can be the brightest feature.

The HESS collaboration has reported variability on time scales of 2 days [4]. This constrained the size of the emission region to ~ 5 x $10^{15}$ cm d or 5 x $\delta$ $R_s$ and gave rise to the concept of monitoring the source at a more regular basis. The monitoring responsibilities are shared in an agreement between HESS, MAGIC and VERITAS. In case the measured flux exceeds a 4σ limit per night, the other observatories are informed and the monitoring is extended.

## 2.The MAGIC Telescope

The MAGIC Telescope is the world's largest Cherenkov Telescope with a 17m diameter mirror dish, reaching a trigger threshold of 60 GeV. Its camera consists of 576 PMTs with enhanced QE and a FOV of 3.5 degrees. The read-out system has recently been upgraded to 2 GSample/s FADCs. Using the shower time information for γ-hadron-separation, image cleaning and energy reconstruction, the sensitivity in 50h of observation corresponds to 1.6% of the Crab Nebula reaching an energy resolution of 20% [5].

## 3.Results and Discussion

Figure 1 shows the Alpha plot of the overall sample with a significance of about 10 standard deviations above the background. The position of the excess events is in agreement with the catalog position of M87.

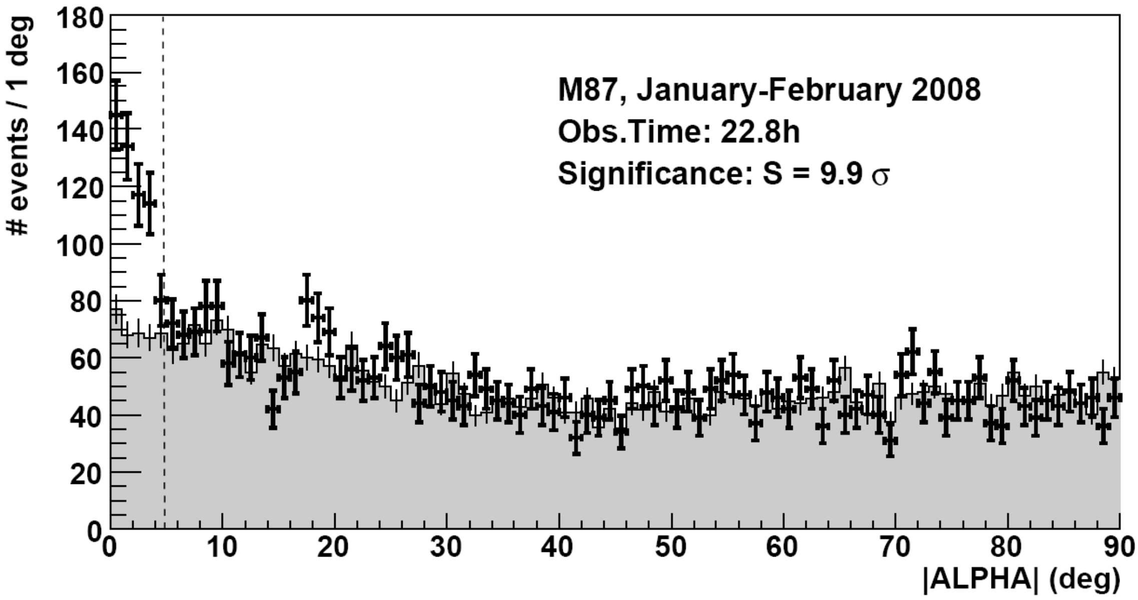


**Figure 1: |Alpha| distribution of the overall sample. The significance of the γ-ray excess is close to 10 standard deviations. More information about the observation mode and data analysis can be found in [6].**

Due to the low energy threshold of MAGIC spectral features and light curves can be explored in a new energy range (>100 GeV). The day by day light curve is shown in Figure 2. Flux variability between 3% to 15% of the Crab Nebula flux is detected above 350 GeV, where MAGIC achieves its best sensitivity. However for the energy range between 150 to 350 GeV no significant variability is detected. The spectrum has been divided into a low and a high state, taking note of the variability seen in the light curve above 350 GeV. February 1$^{st}$ and 8$^{th}$ are used in the “high state” sample, while the rest of the observations is referred to as “low state”. The corresponding spectra are both shown in Figure 3. A marginal spectral hardening with the higher flux state is evident. It should be noted that the spectrum of M87 has been measured from 100 GeV to 10 TeV for the first time during the high state without hints for a cut off at higher energies or a bending towards lower energies. Over the entire energy range the spectrum can be perfectly described by a power law (the corresponding fit values can be found in the Figure).

During our observations the core of M87 was bright in X-rays (D. Harris, priv. communication), while the HST-1 knot was in a low state.

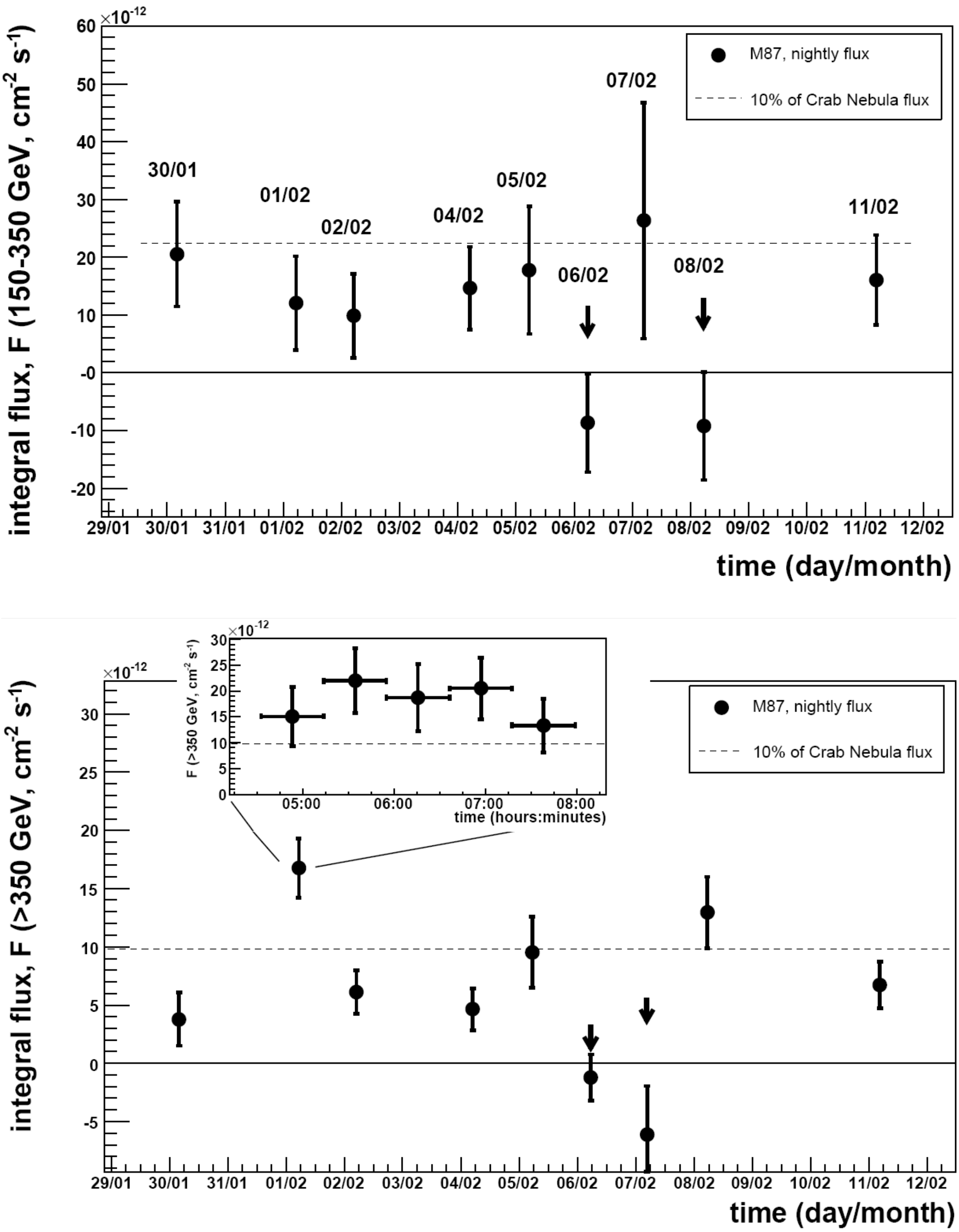


**Figure 2: Daily light curve from 150-350 GeV (upper panel) and above 350 GeV (lower panel) respectively. The inlay shows the intra night light curve of the day with the strongest signal.**

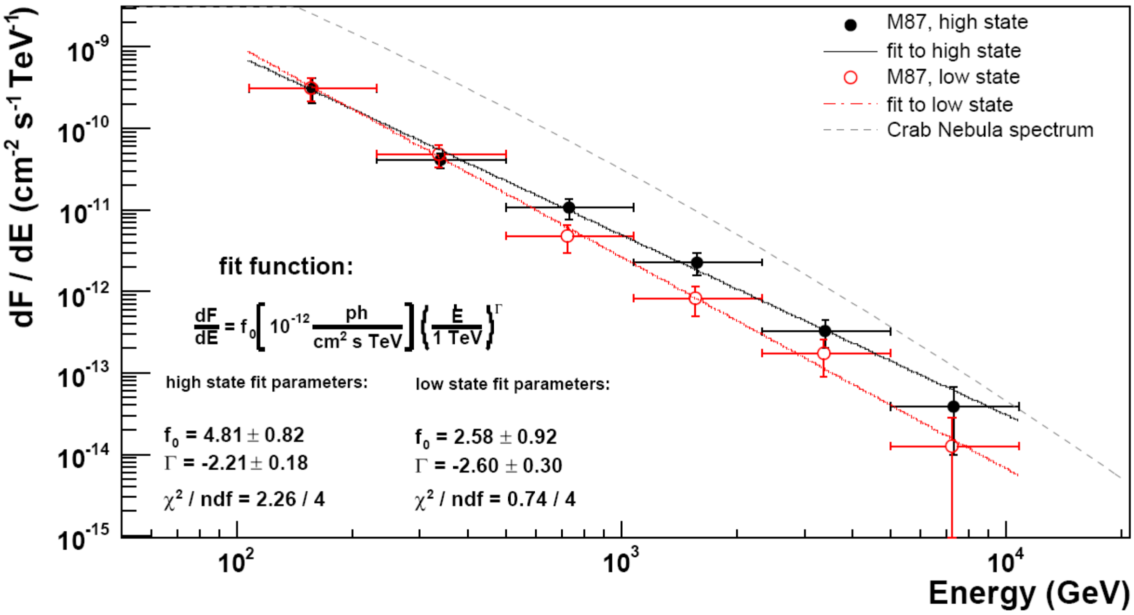


**Figure 3: Spectra of the high and low state as observed with MAGIC. A marginal spectral hardening during the high state is evident.**

## 4.Summary

We confirm the E > 730 GeV short-time variability of M87 reported by [4]. The observed variability timescale is in the order of or even below one day, restricting the emission region to a size of $R \leq \Delta\, t\, c\delta = 2.6 \times 10^{15}$ cm or 2.6 $\delta R_s$.

The complex structure of the light curve with several flares during our observations shows that a trigger to extend observational coverage can be highly successful. In the new energy window opened by MAGIC the flux stays constant within our sensitivity. Further observations are required to test the marginal hardening that was detected during the high state.

With the coming inauguration (18/19. September) of the second MAGIC telescope yielding a projected increase in sensitivity of a factor 2-3 [7], future monitoring capabilities of the MAGIC telescope system will be greatly improved.

## References

[1] V. A. Acciari (the VERITAS coll.), et al. 2007, preprint: arxiv:0802.1951

[2] D. Harris, et al. 2007, preprint: arxiv:0707.3124

[3] D. Harris, et al. 2007, preprint: arxiv:0707.3124

[4] F. Aharonian, et al. (HESS coll.) 2006A, Science, 314, 142

[5] D. Tescaro (the MAGIC coll.), et al. 2007, proceedings of the 30th ICRC.

[6] J. Albert (the MAGIC coll.), et al. 2008, submitted to ApJ letters, preprint: arxiv: 0806.0988

[7] E. Carmona (the MAGIC coll.), et al. 2007, proceedings of the 30th ICRC