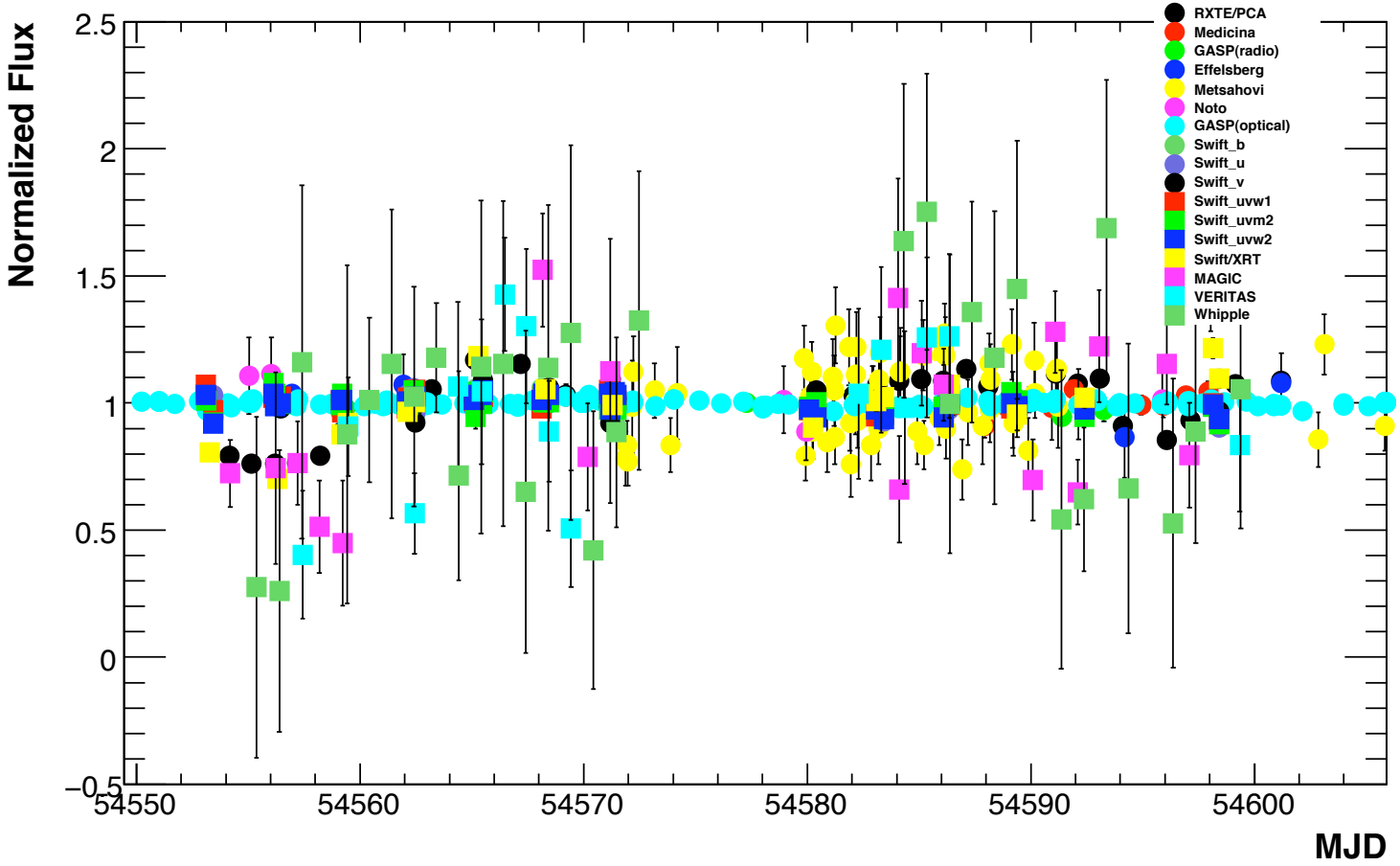
Quantification of the multi-frequency variability

David Paneque and Diego Tescaro

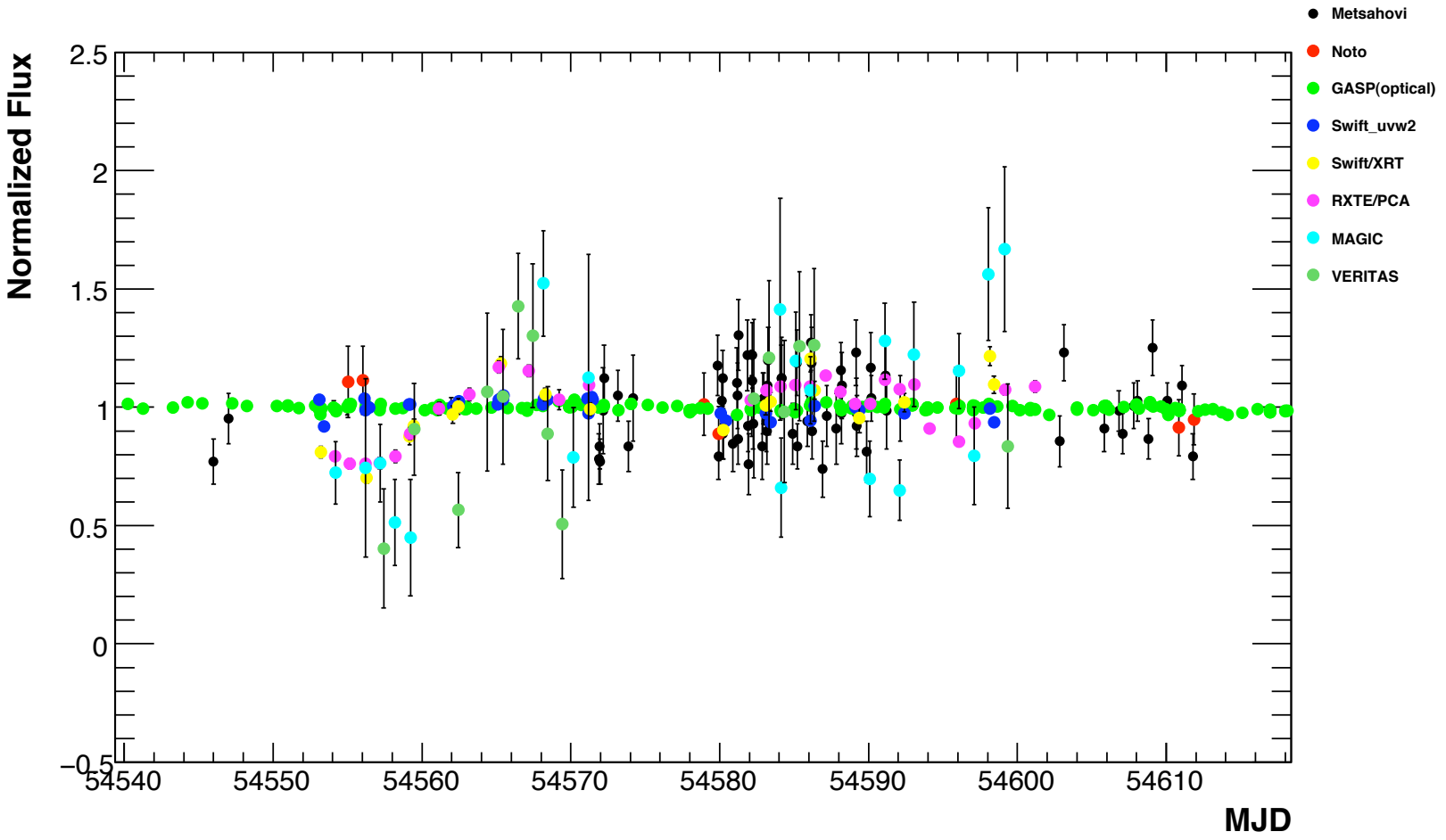
Normalized Light Curves



Very busy plot. Many instruments.
Many instruments have large relative errors

Normalized Light Curves

Few instruments were removed



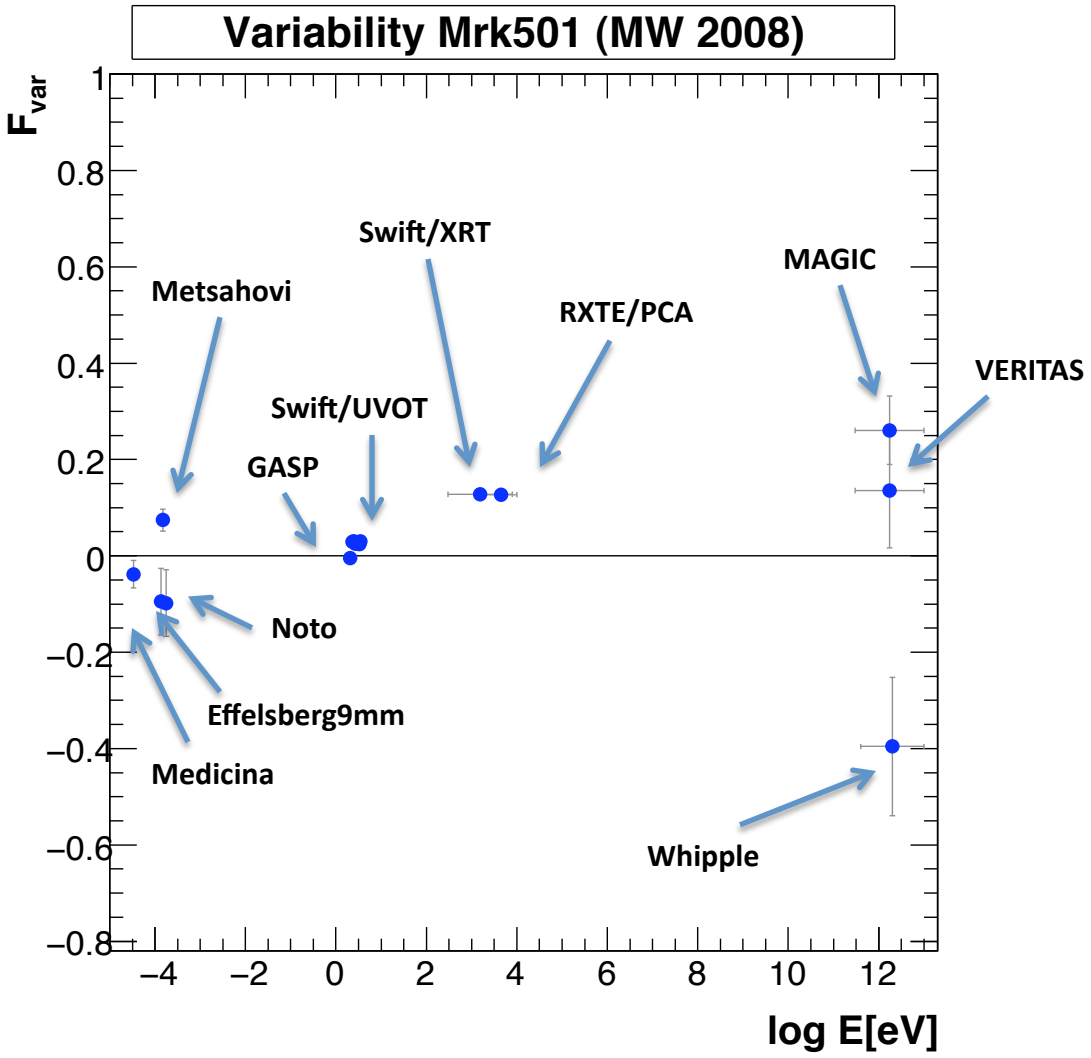
Measured fluxes at VHE were low (big relative errors)
In general No big flux variations (little variability)

Quantification of the Variability

Quantification following prescription given in *Vaughan et al. 2003*

Journal-ref: Mon. Not. Roy. Astron. Soc. 345 (2003) 1271
astro-ph/0307420 (July 2003)

$$F_{var} = \sqrt{\frac{S^2 - < \sigma_{err}^2 >}{< F_\gamma >^2}}$$



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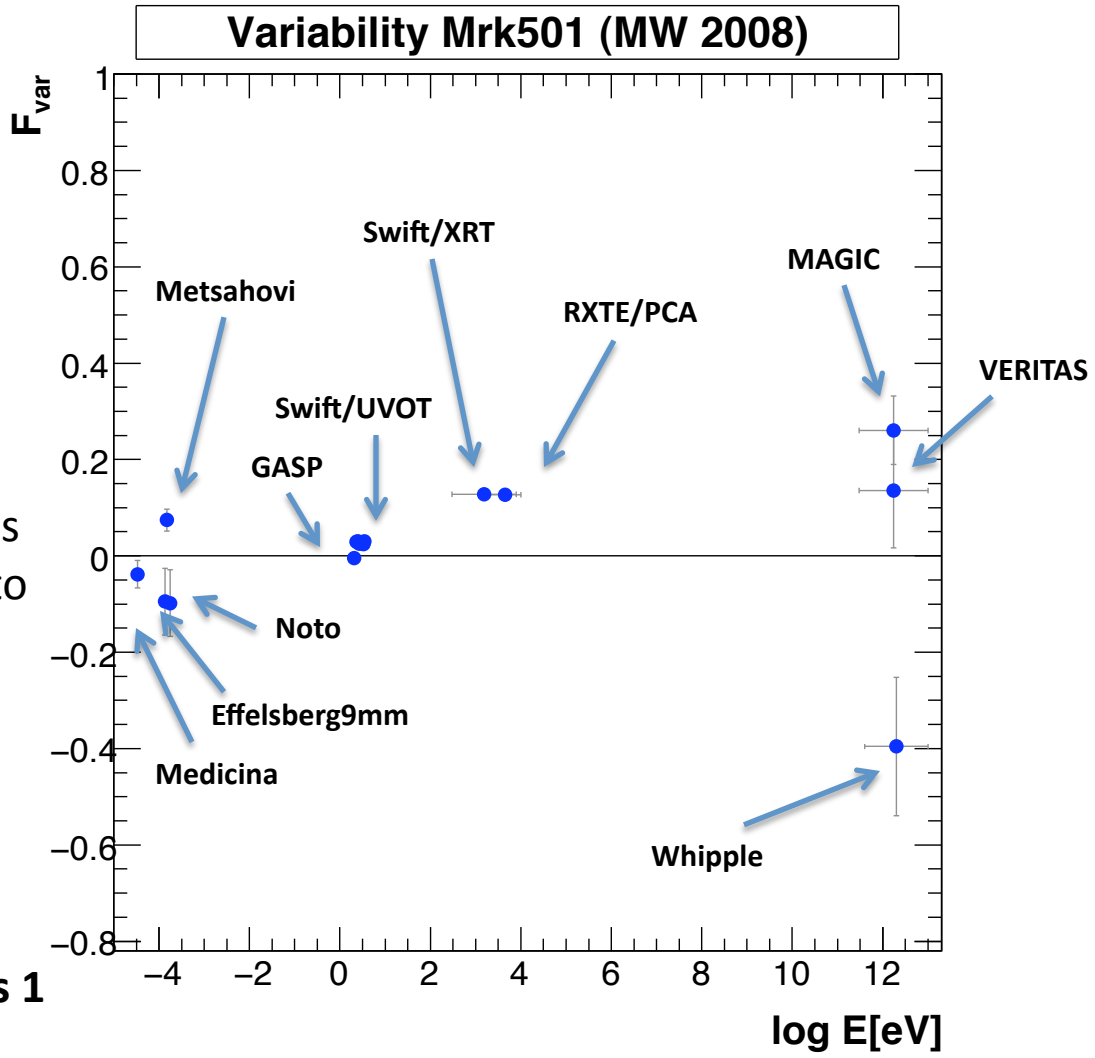

Negative fluxes produced when there is a "lack" of flux fluctuations according to errors.

This could happen:

1 – By chance. Specially if few points

2 – Errors over-dimensioned

All negative values compatible with zero… thus consistent with hypothesis 1

Quantification of the Variability

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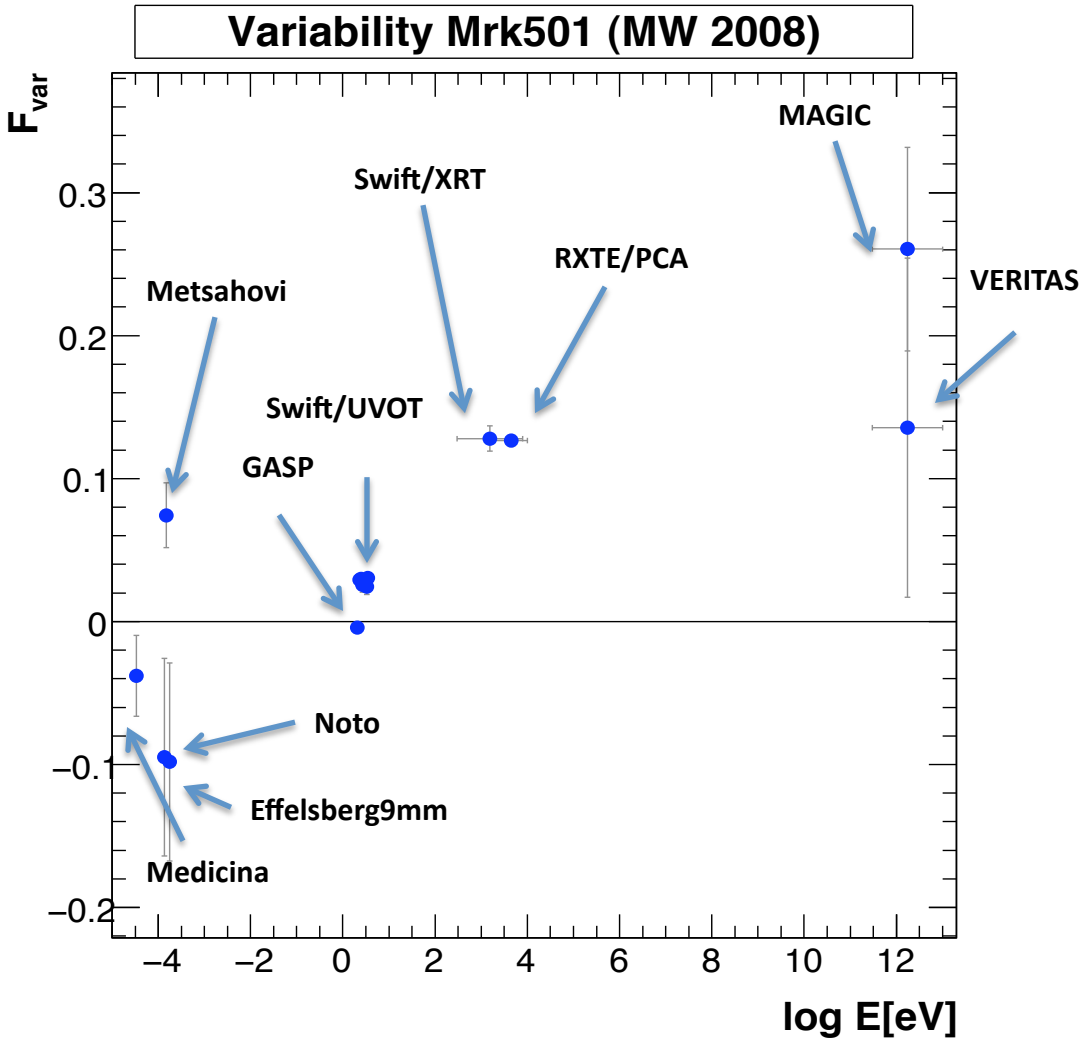
***F_{var}* increases with energy**

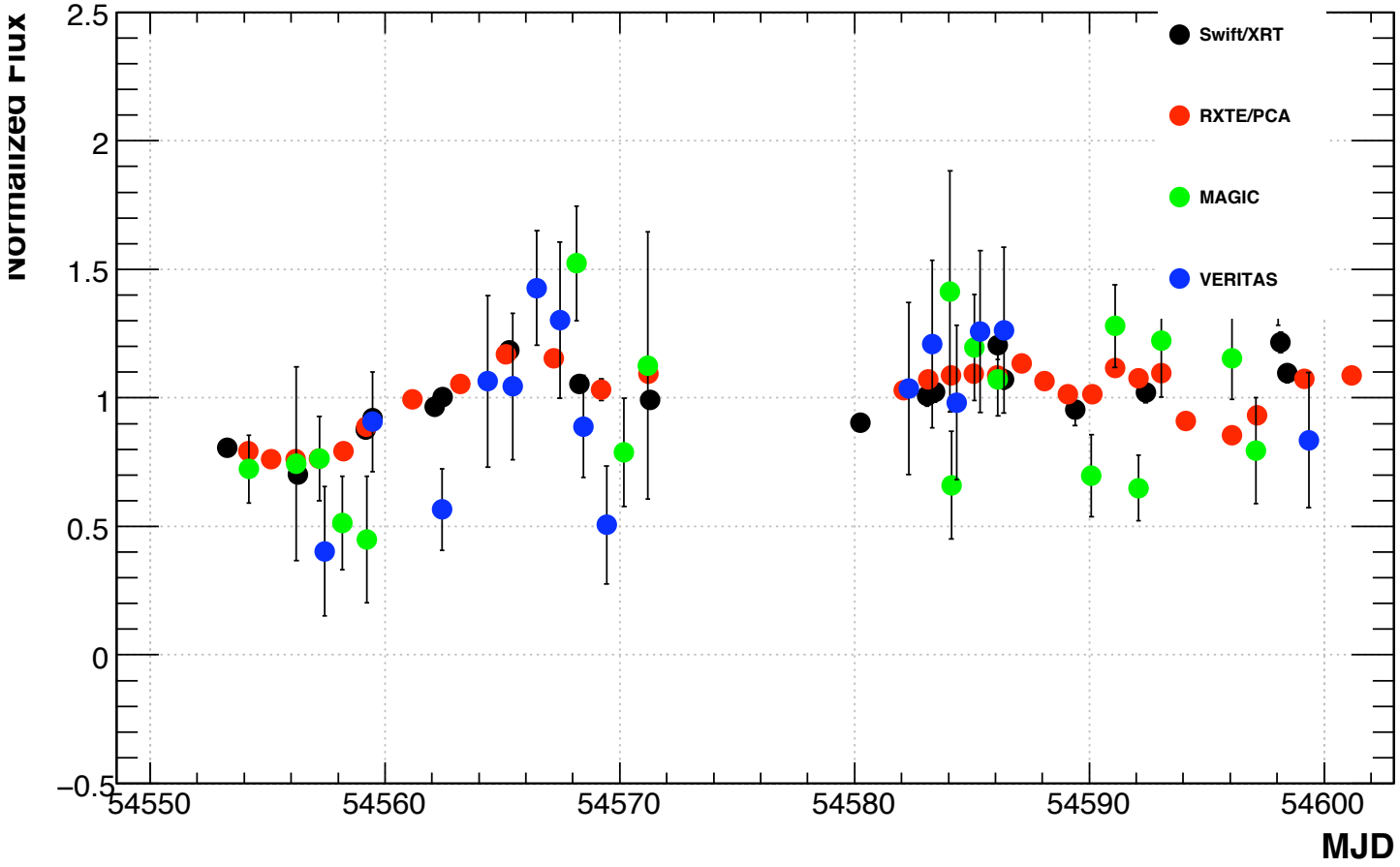
Metsahovi could be the exception.
Still … errors are large….

This could indicate that flux variations are produced by injection of fresh (high energy) electrons



Normalized Light Curves

Only instruments with the largest variability are shown



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Variability during this campaign is very low:

X-rays (Gliozzi etal 2006)

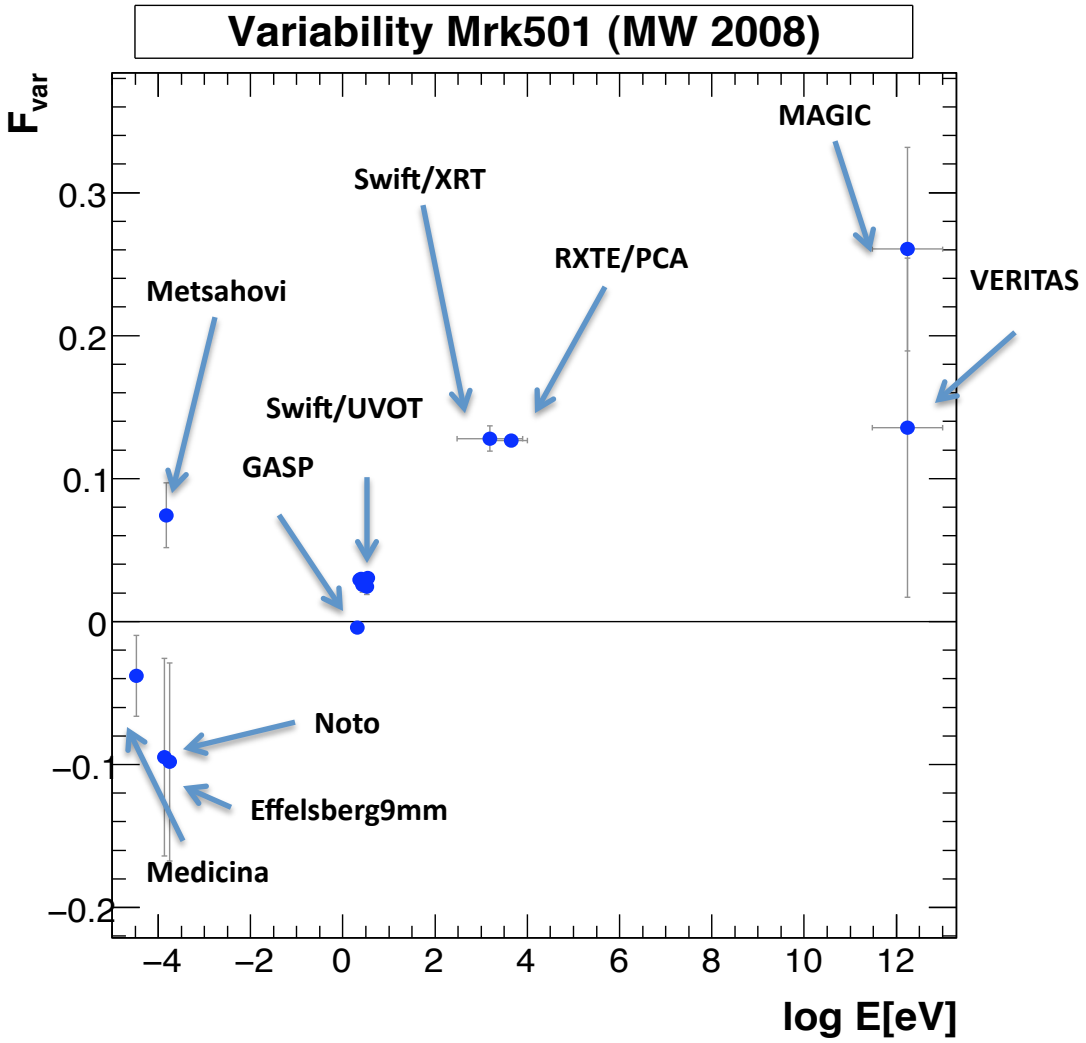
In X-rays, typically Fvar ~ 0.3

Fvar ~ 0.1 Only in July 2008, and May 2008

Gamma-rays (J. Albert et al., ApJ 669 (2007) 862))

Fvar ~ 0.6 (without big flares)
Fvar ~ 1.2 (with big flares)

See backup slides for further details



Conclusions

Variability quantified for all frequencies (instruments)

Many instruments showed fluxes compatible with being constant (no-variability)

Instruments with variable flux

- **Metsahovi**
- **Swift/UVOT**
- **Swift/XRT and RXTE/PCA**
- **MAGIC and VERITAS**

Flux variations during this campaign are substantially lower than in past campaigns

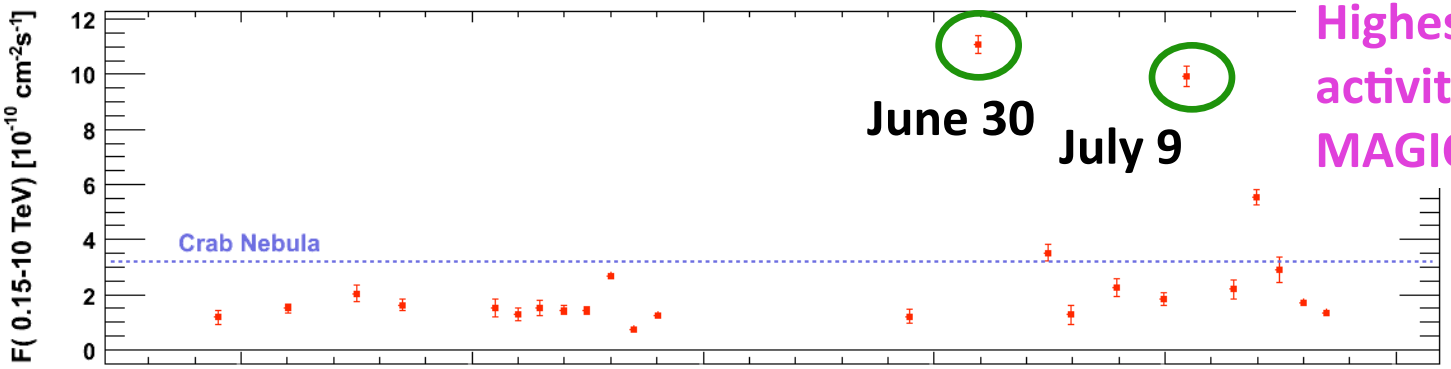
Variability seems to increase with energy; largest flux variations observed at the highest energies. This would be consistent with flux variations being produced by injection of fresh (high energy) electrons.

Backup slides

Quantification of the Variability

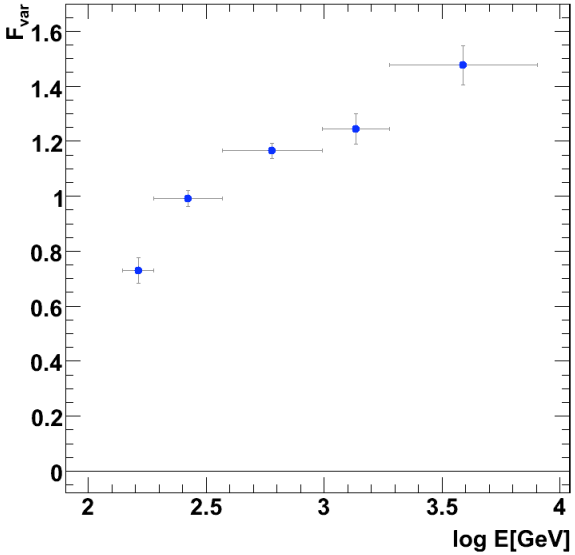
Comparison of variability at gamma-ray energies with previous campaigns

Mrk501 observations with MAGIC during 2005 (J. Albert et al., ApJ 669 (2007) 862)

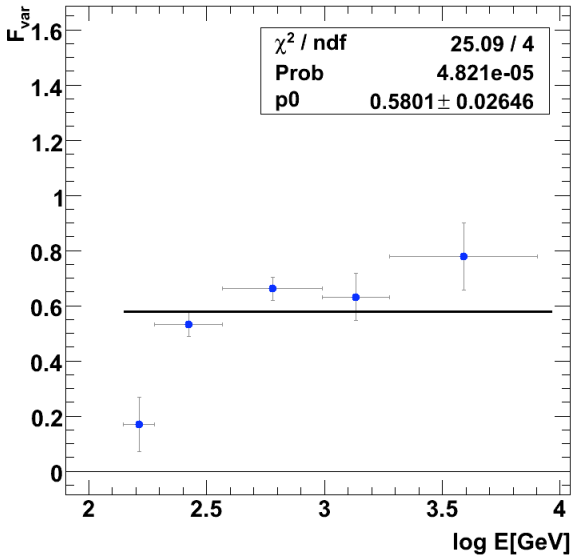


Highest VHE activity during MAGIC obs.

All nights included

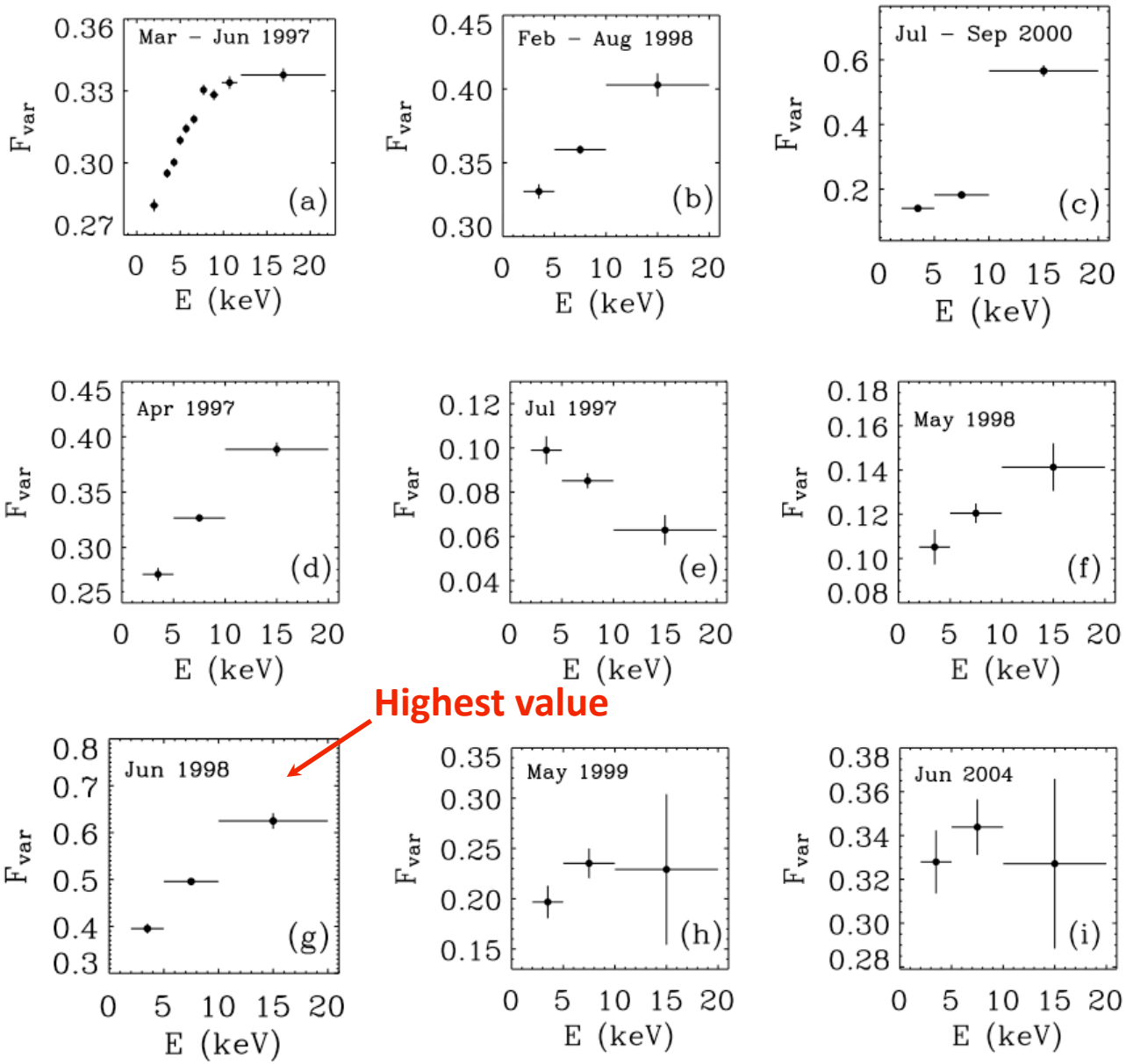


Flare nights excluded



In 2008 the Fvar value at VHE (E>0.3 TeV) is ~ 0.2

Comparison with Fvar at X-rays (Gliozzi et al. 2006, ApJ, 646)



In general, F_{var} increases with energy

Highest F_{var} value was not obtained in 2007, when X-ray (and gamma) flux was highest

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