
VISITORS
PARKING

X-ray and TeV gamma-ray emission from the 50-year period binary system PSR J2032+4127/MT91 213

Jamie Holder for the VERITAS Collaboration

Bartol Research Institute/Department of Physics and Astronomy

University of Delaware

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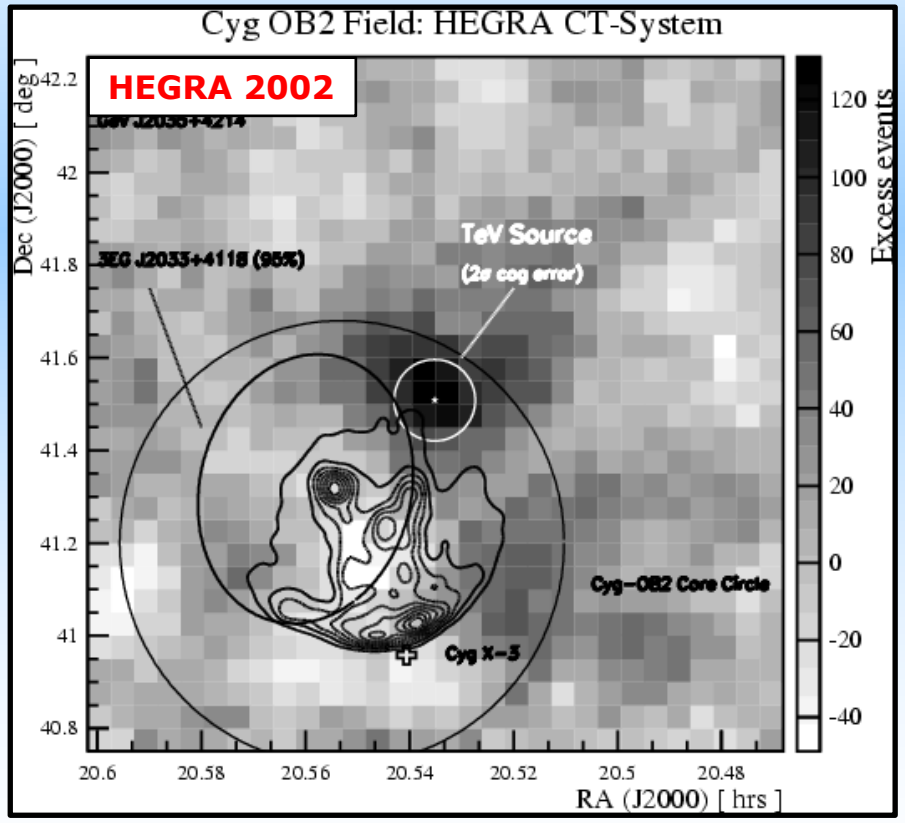
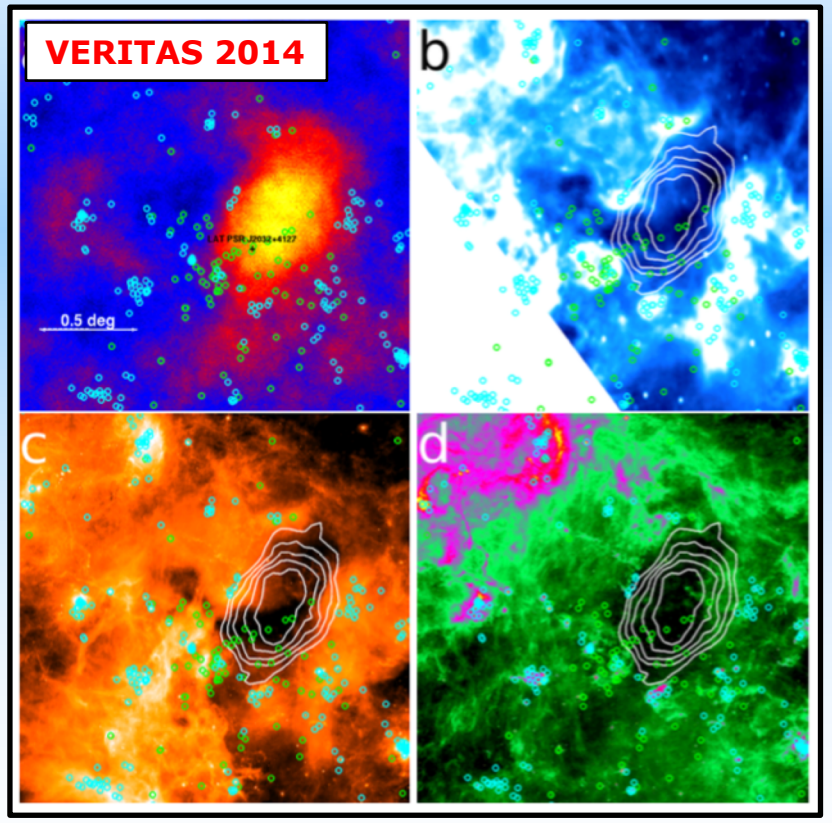
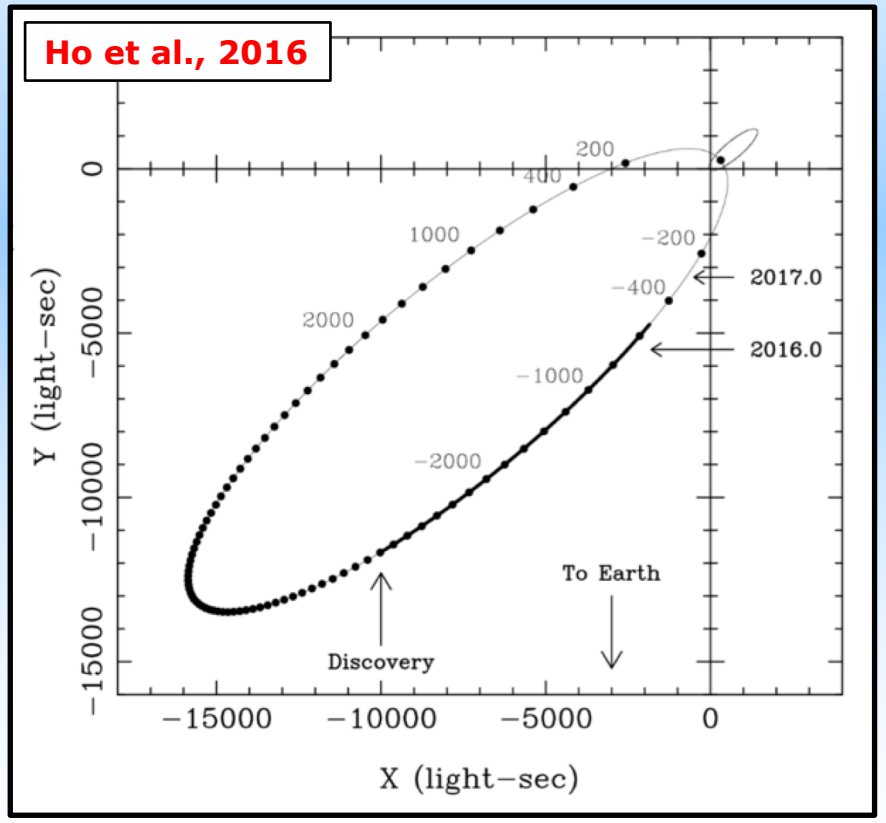
Some background: TeV J2032+4127

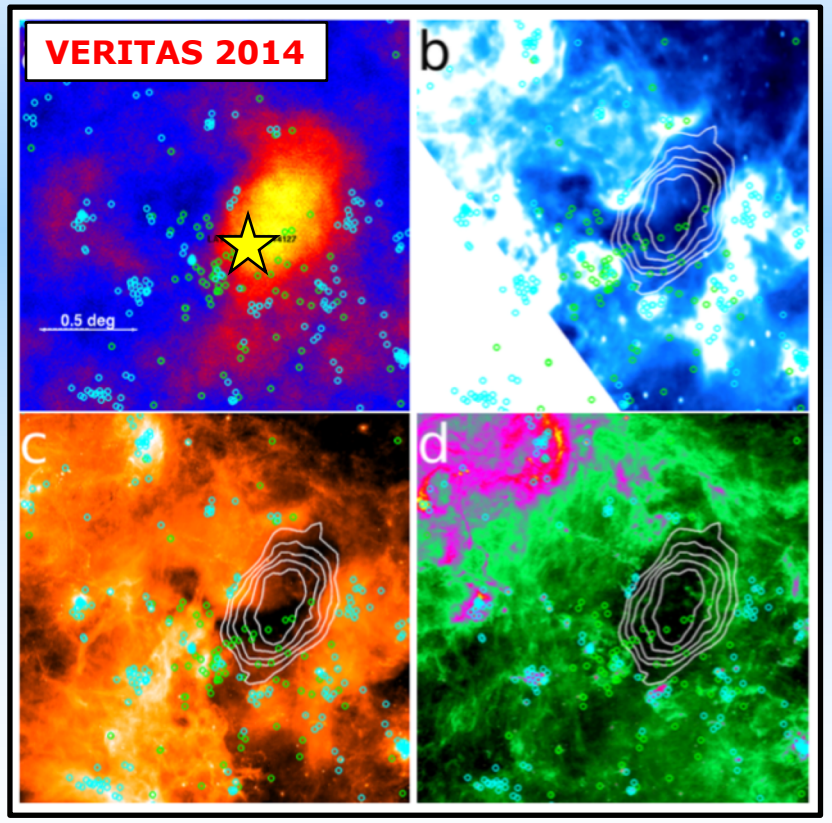
- TeV J2032+4127 was the first TeV source discovered with no obvious counterpart.
- VERITAS showed it to be an asymmetric, extended source, coincident with a radio/IR void.



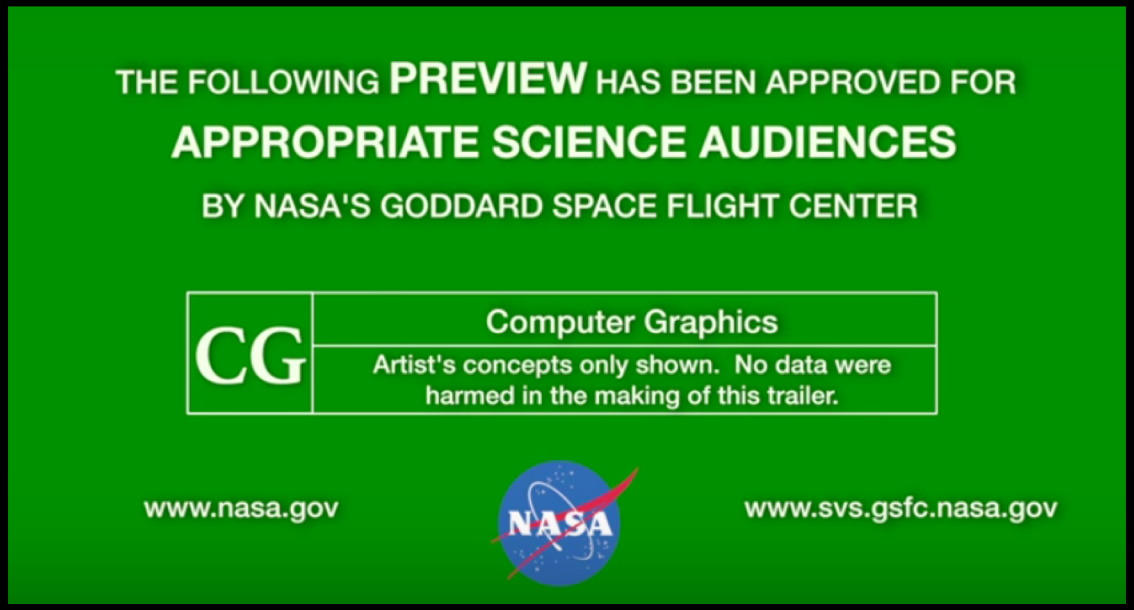


- In 2009, Fermi discovered the likely power source: PSR J2032+4127.
- In 2015, Lyne et al. showed that the pulsar is in a long period binary system with MT91 213.
- Further monitoring gave an orbital period of 45-50 years, with periastron in fall 2017.



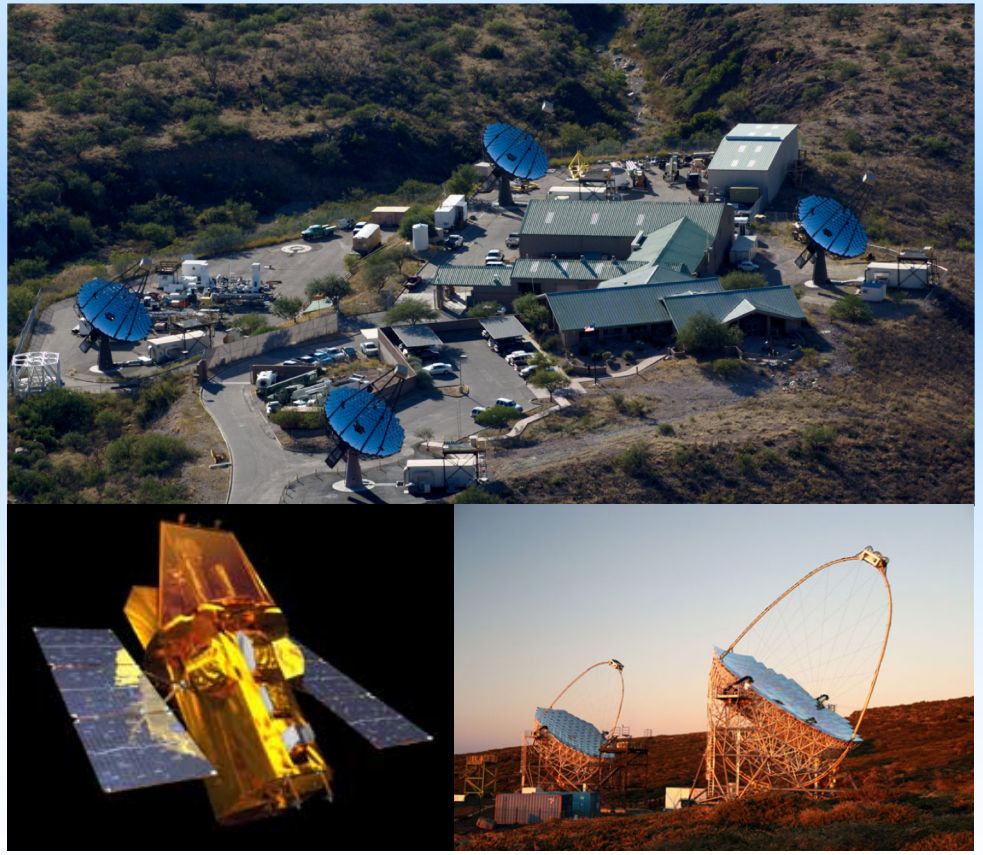


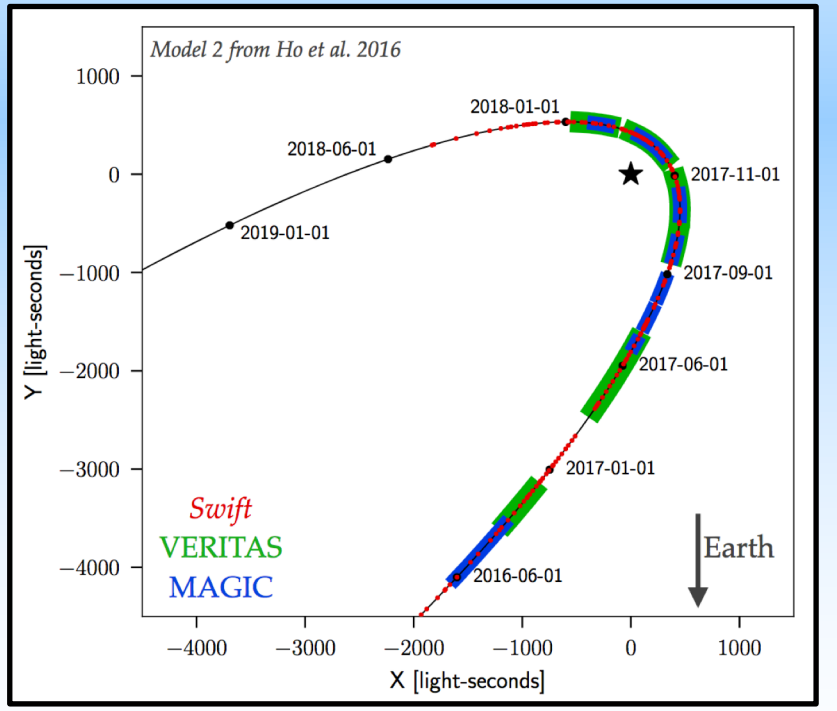
The Fermi team gently encouraged observations.



Observations

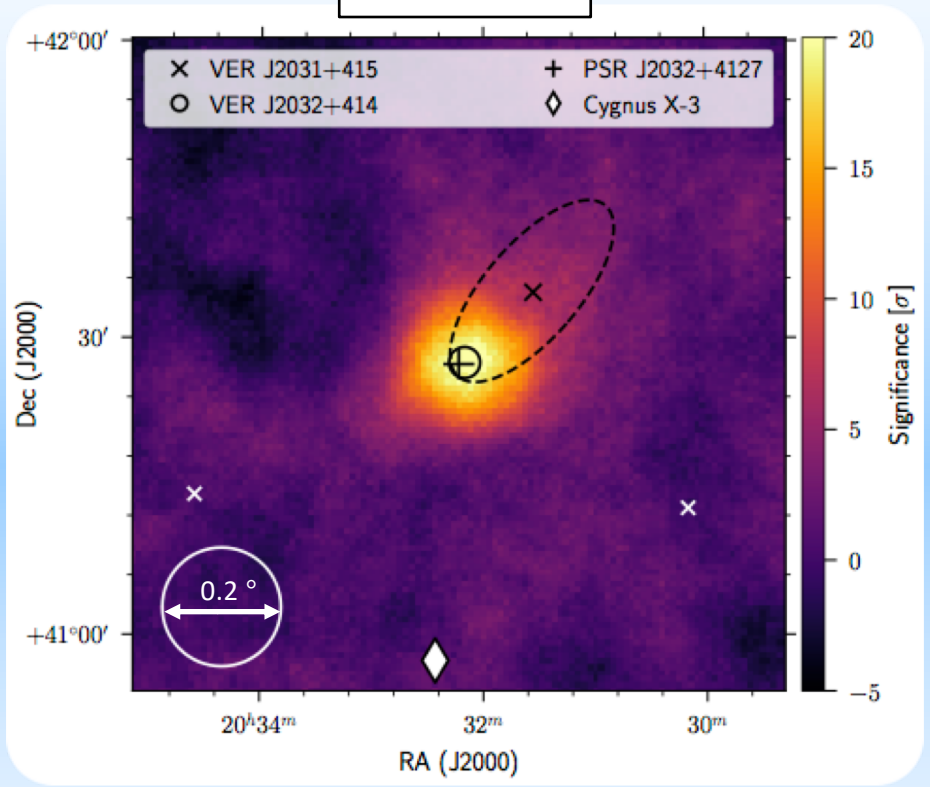
- VERITAS was happy to oblige! Collected 140 hours from 2016-2018.
- Part of a coordinated campaign with *Swift* (136 hours) and MAGIC (88 hours).



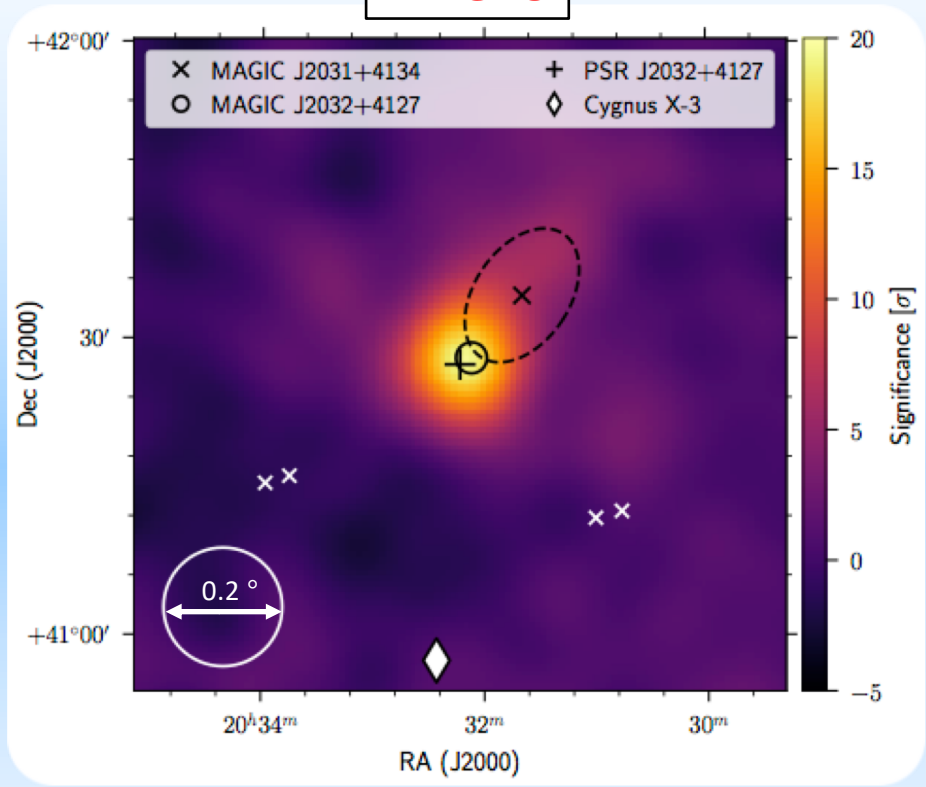


Detection

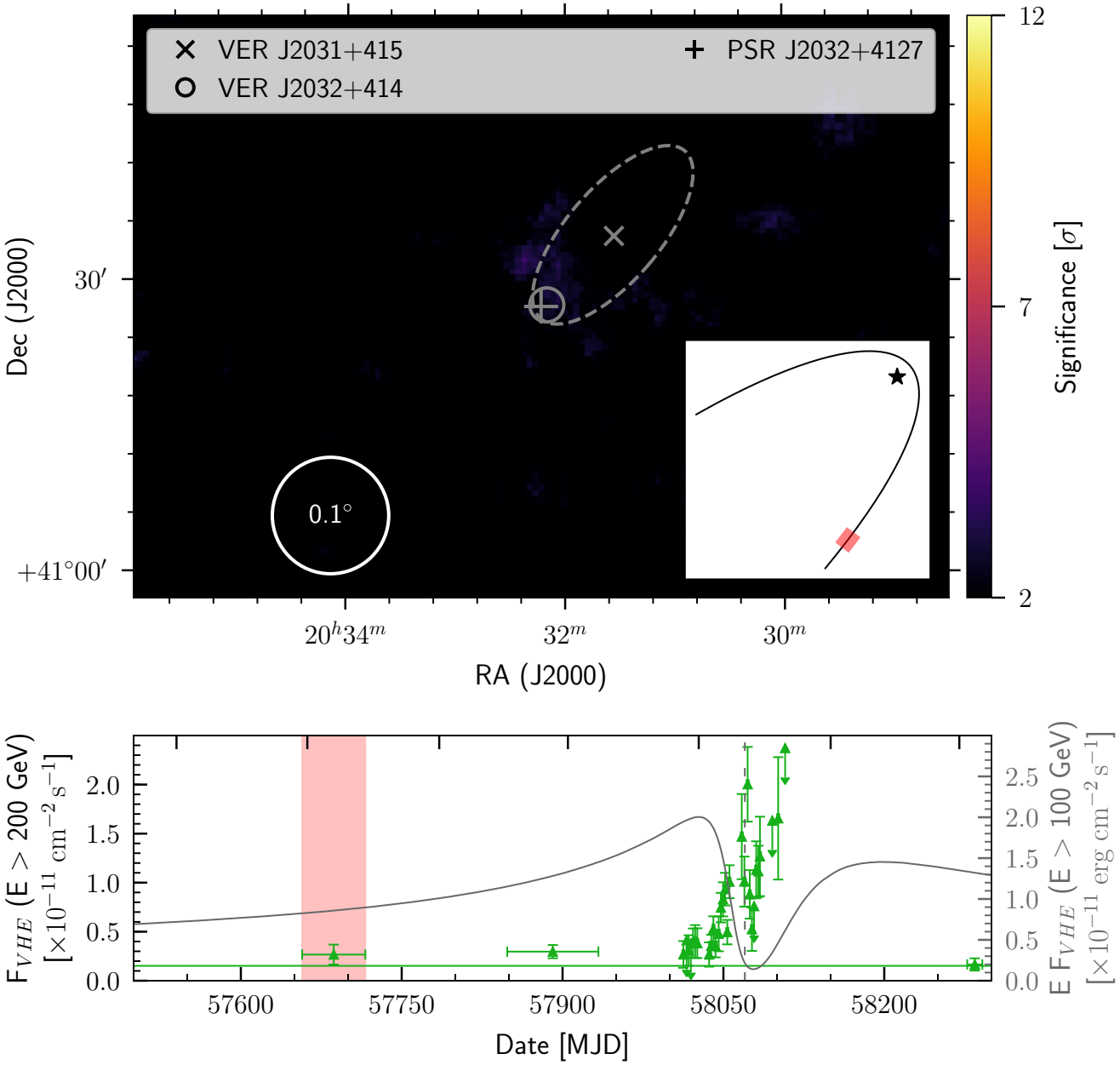
VERITAS



MAGIC



- A new, point-like TeV source was detected early in fall 2017, consistent with the location of the binary system.
- The TeV flux is time variable, peaking close to periastron, providing a firm association.


VER J2031+415
VER J2032+414
PSR J2032+4127
0.1°
Dec (J2000)
30′
+41°00′
20h34m
32m
30m
RA (J2000)
Significance [σ]
12
7
2
FVHE (E > 200 GeV) [×10−11 cm−2 s−1]
2.0
1.5
1.0
0.5
0.0
57600
57750
57900
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58200
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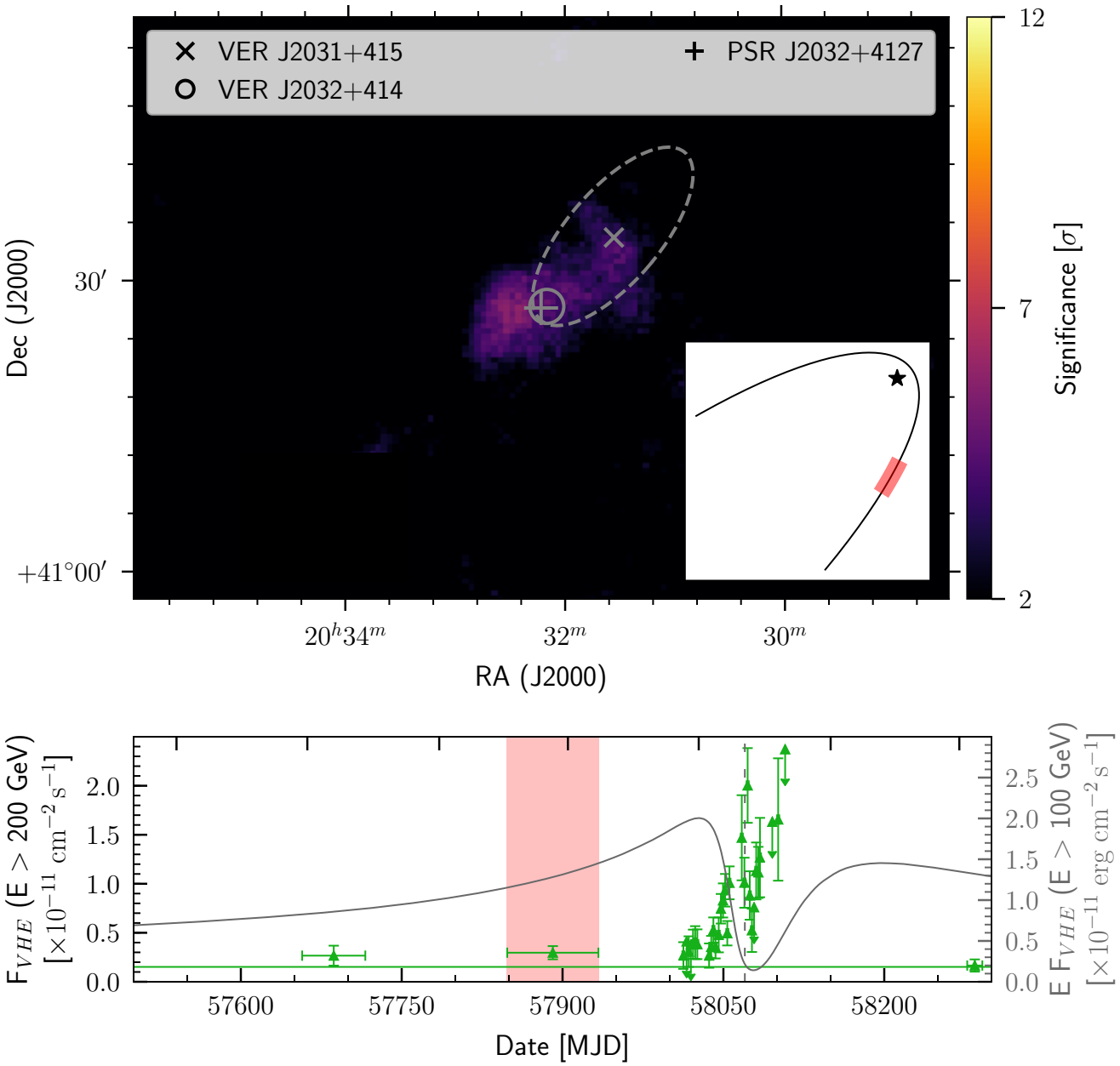
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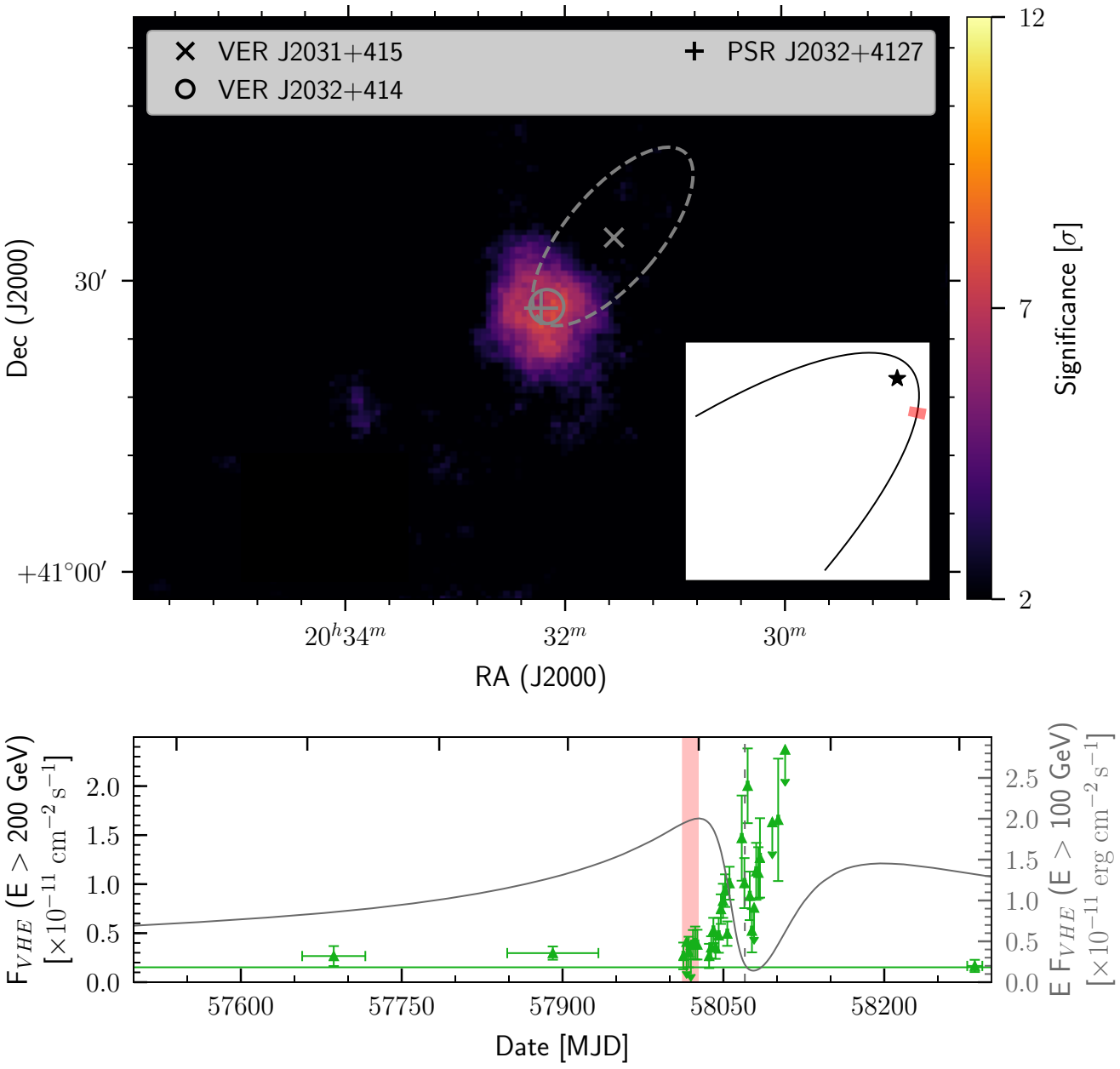
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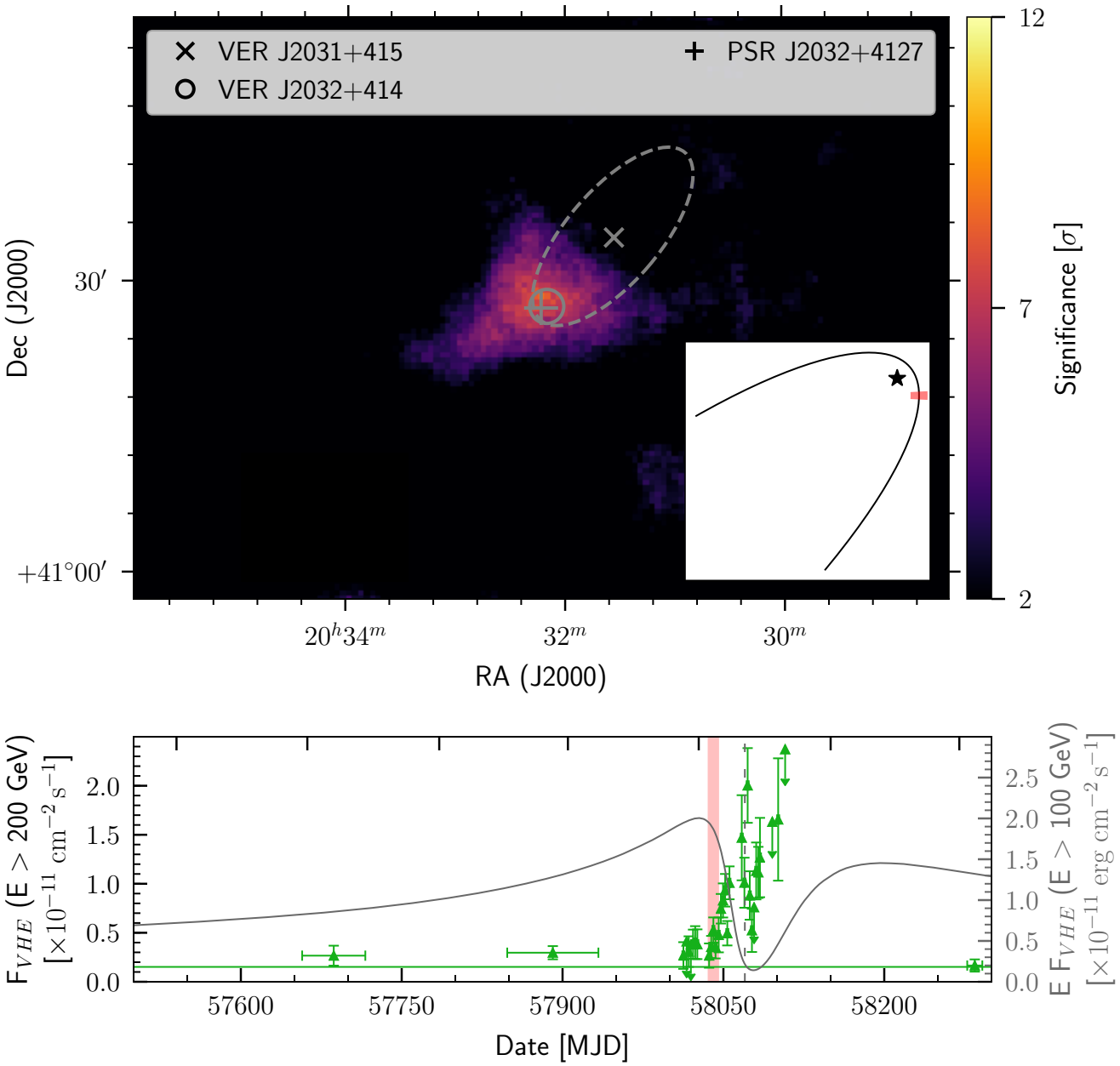
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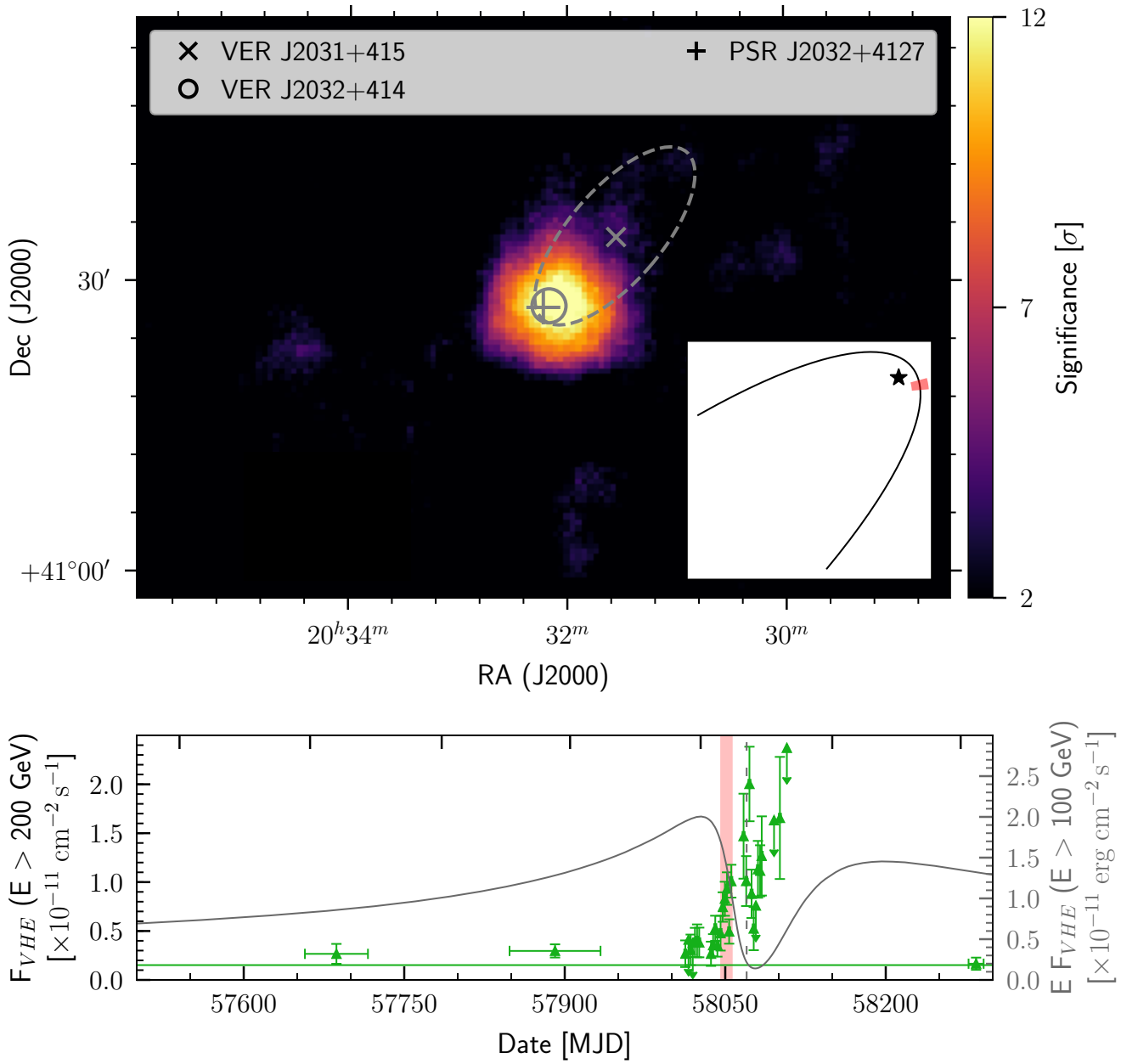
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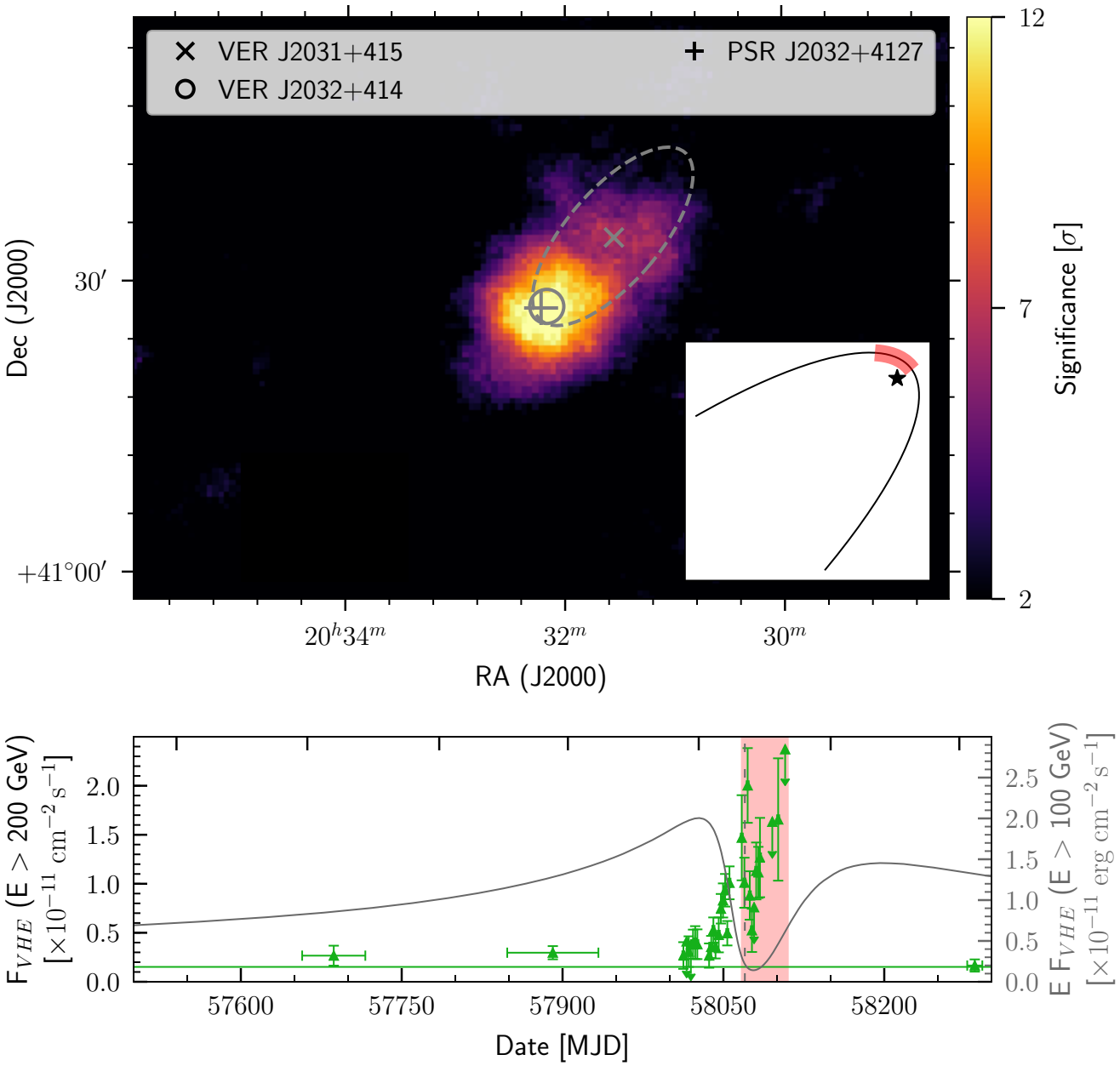
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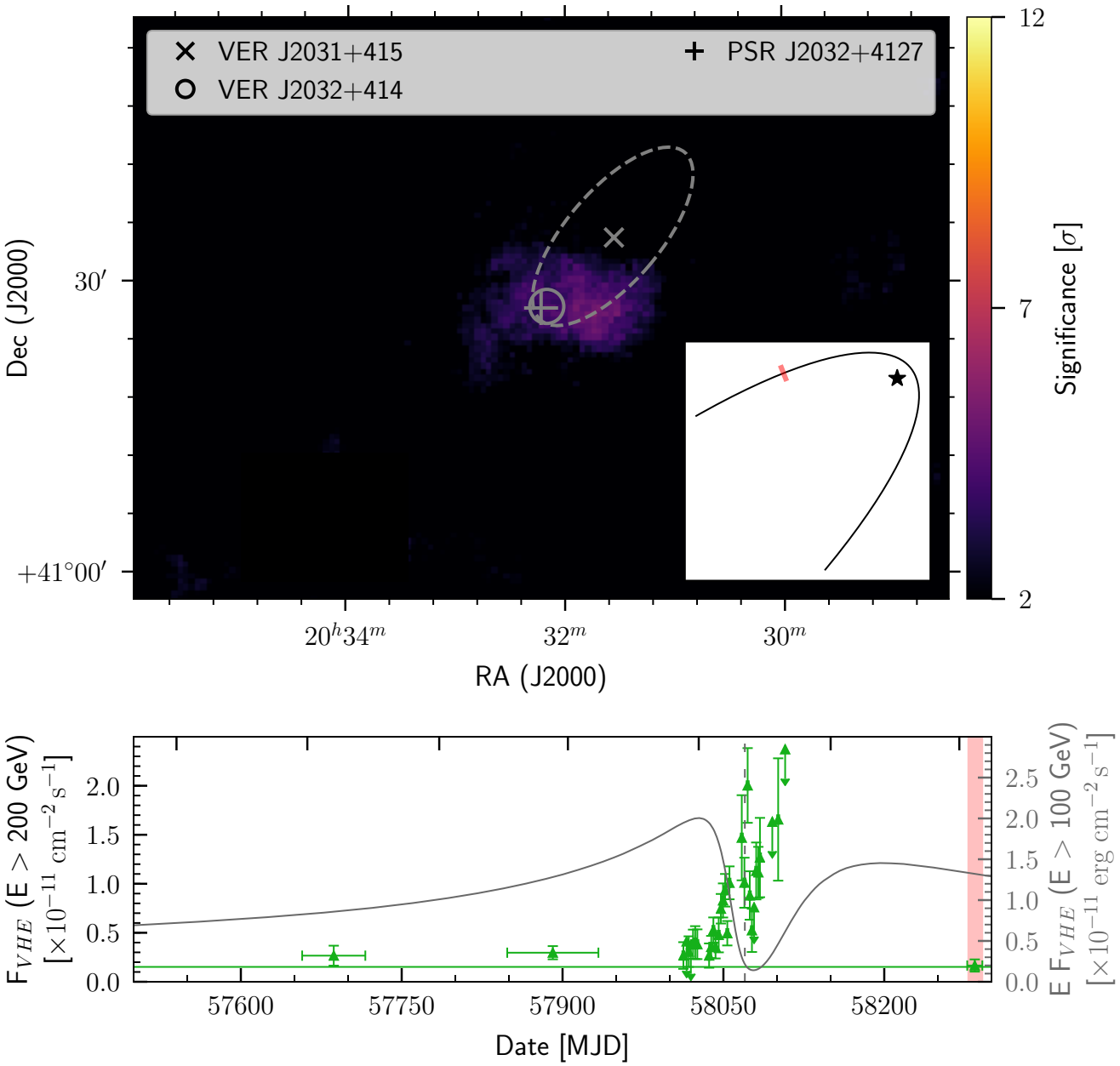
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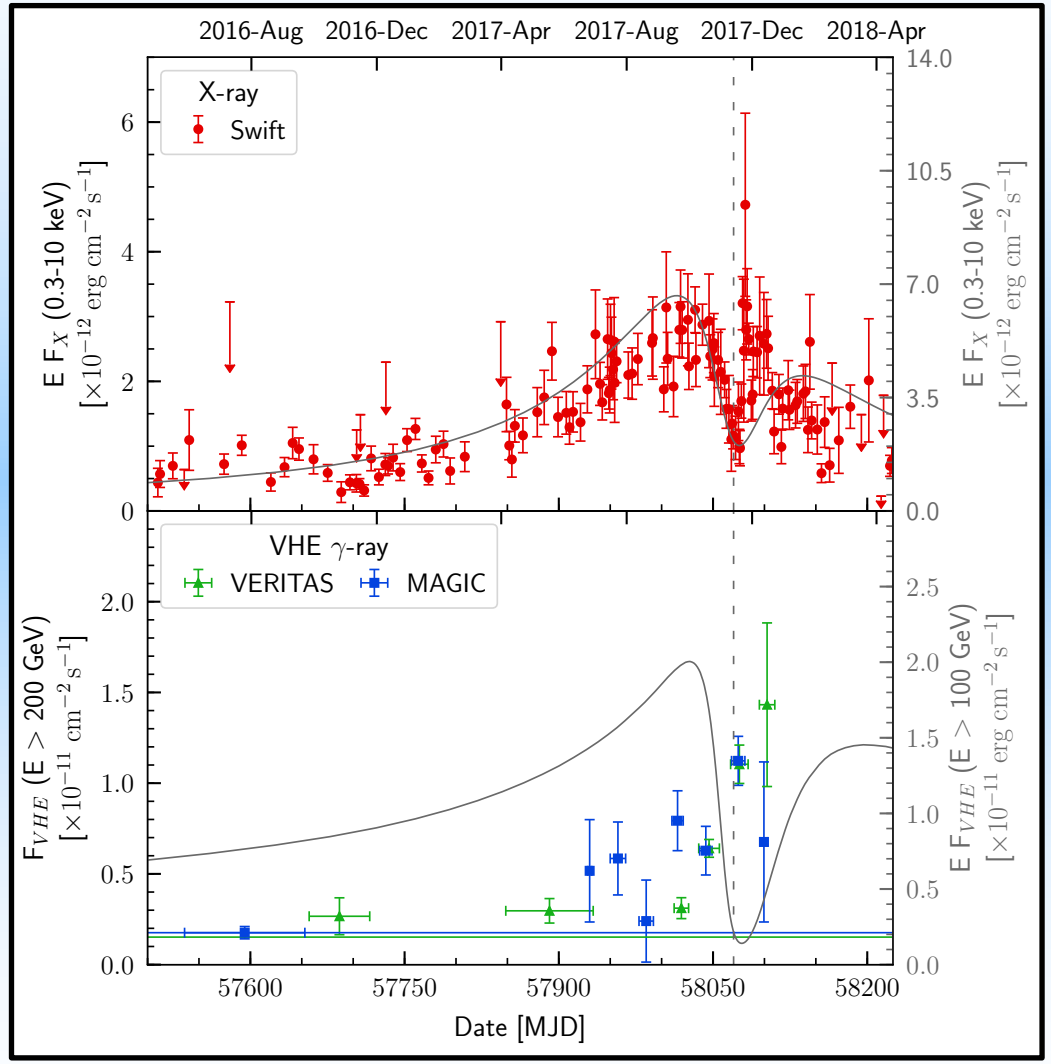
Lightcurve

- The X-ray flux has increased steadily since at least 2013.
- Short timescale fluctuations may indicate interactions with a clumpy stellar wind.

- The TeV flux increases more rapidly (a factor of 10 within days), reaching maximum at periastron.
- TeV emission is not well-fit by existing models

Model from Takata et al, 2017, with parameters from Li et al 2017.



Petropoulou, M., *et al.* 2018, MNRAS, 474, L22; Ho, W., *et al.* 2017, MNRAS, 554 464, 1211; Li, K. L., *et al.* 2018, ApJ, 857, 123 566

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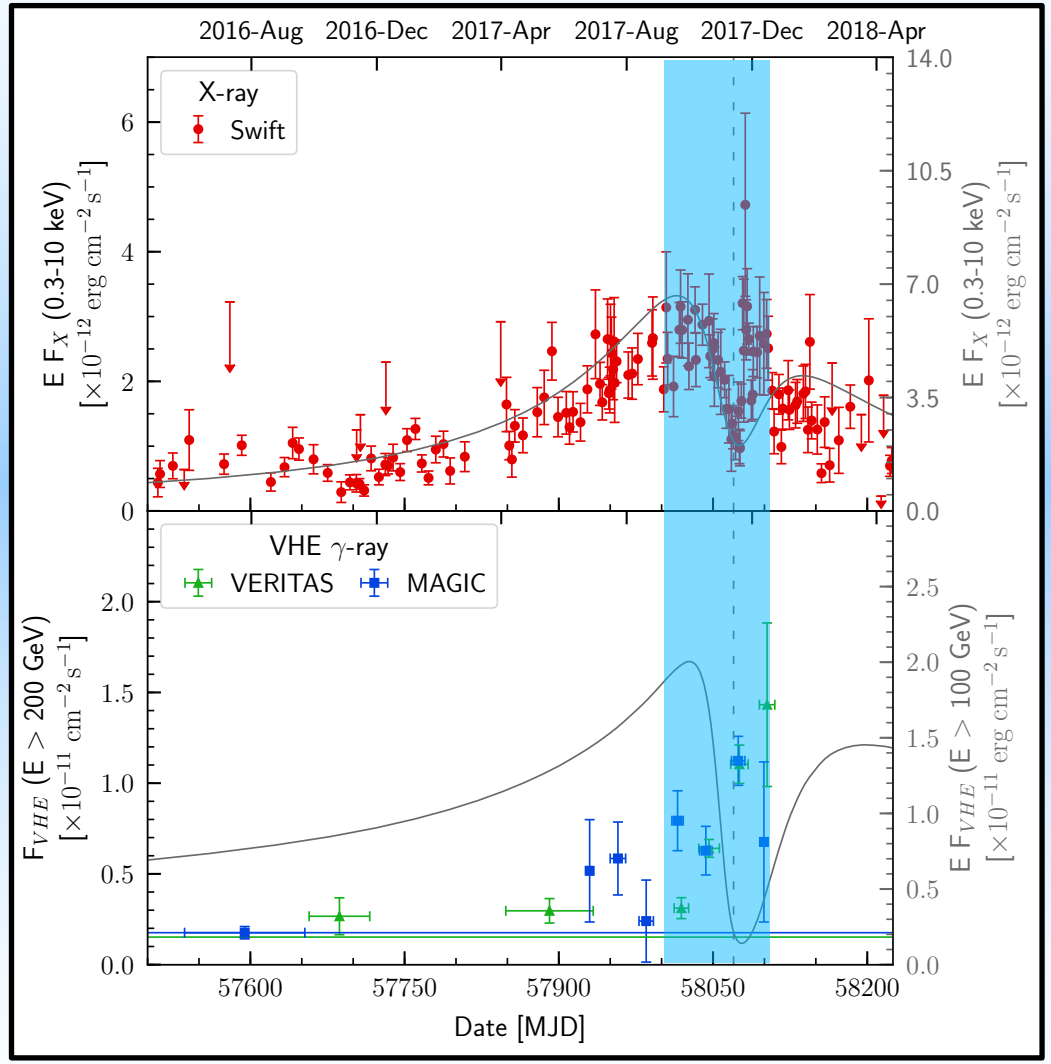

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Lightcurve

- Asymmetric modulation of the X-ray flux may be due to Doppler boosting of the post-shocked flow.
- Post-periastron X-ray flare may indicate disk crossing.

- TeV flux suppression after periastron (around superior conjunction) may be due to gamma-gamma absorption.

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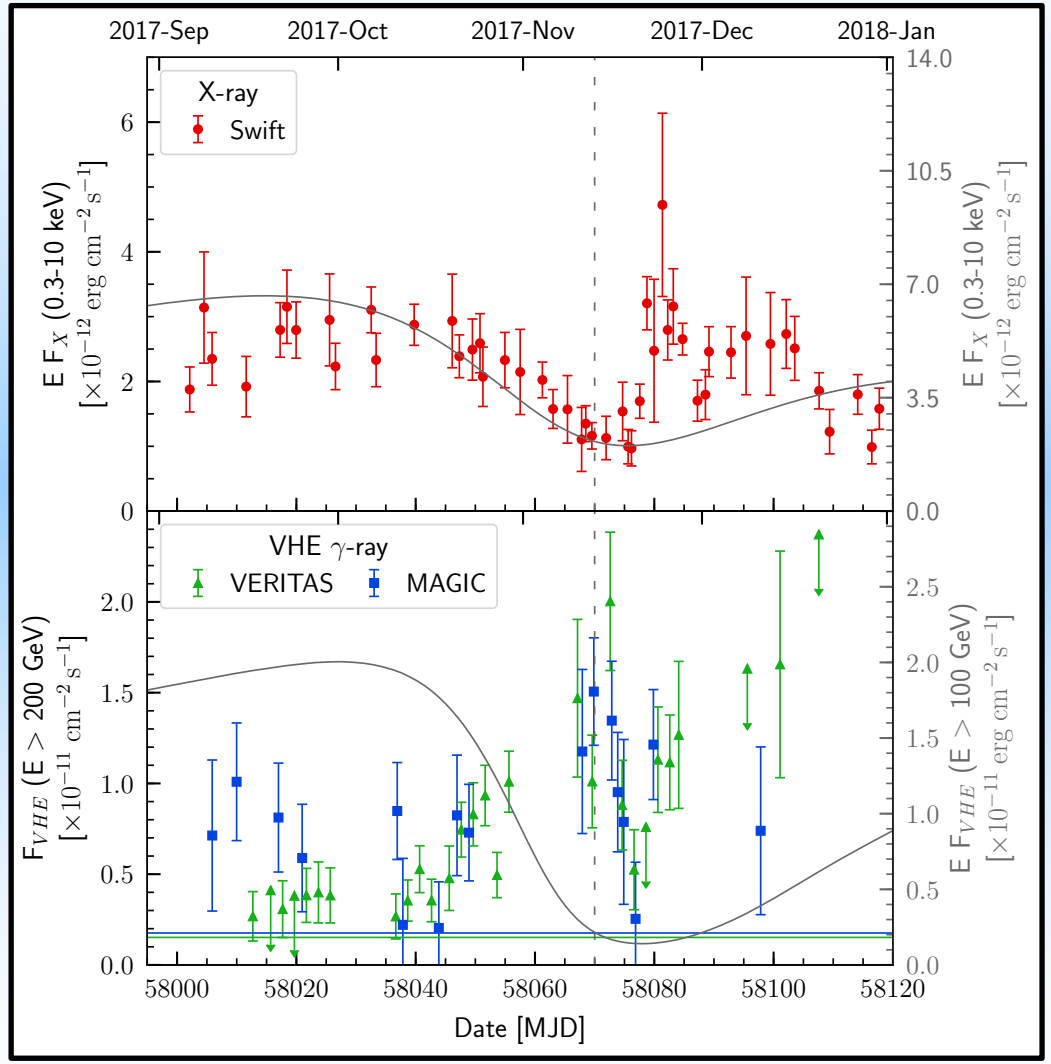

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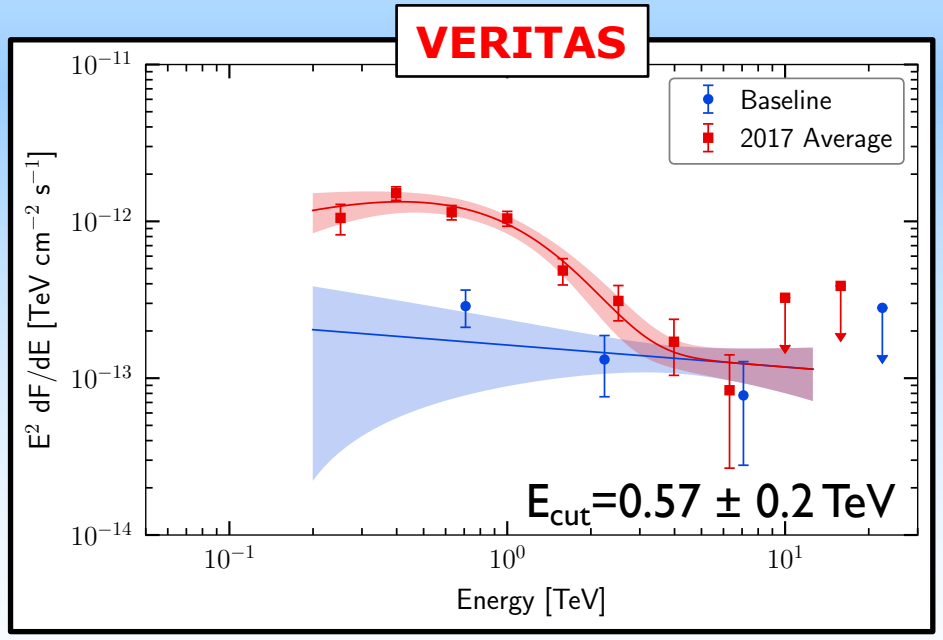
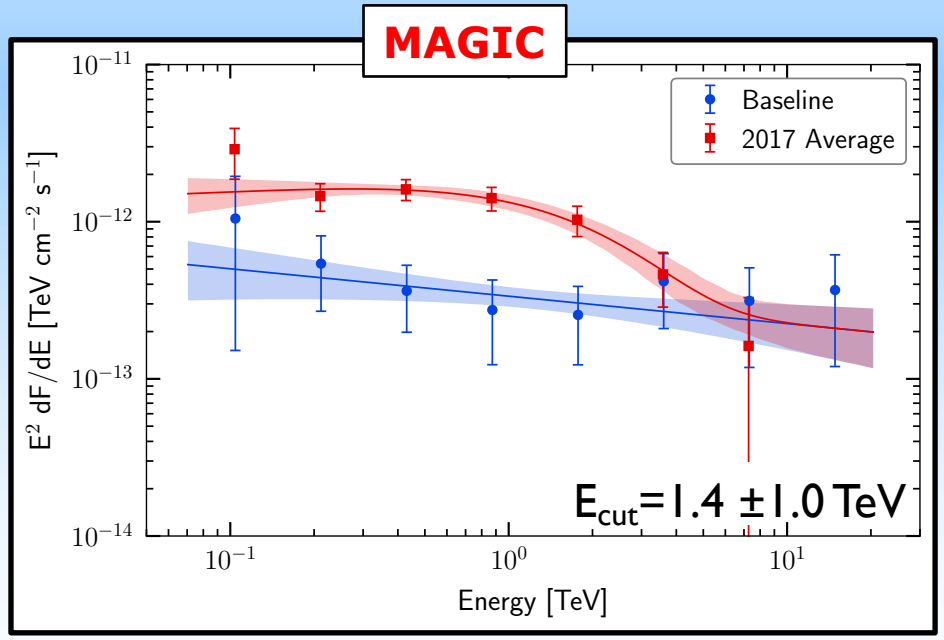
Spectra

- Both VERITAS and MAGIC observe a cut-off close to 1 TeV.
- The only other gamma-ray binary to display a spectral cutoff in the TeV regime is LS 5039, with a cutoff at 8.7 ± 2.0 TeV in the VHE high state, close to inferior conjunction
- Possible explanations include cascade emission and/or Klein-Nishina effects (e.g. Bednarek & Sitarek, 2018).
- Is it always there?





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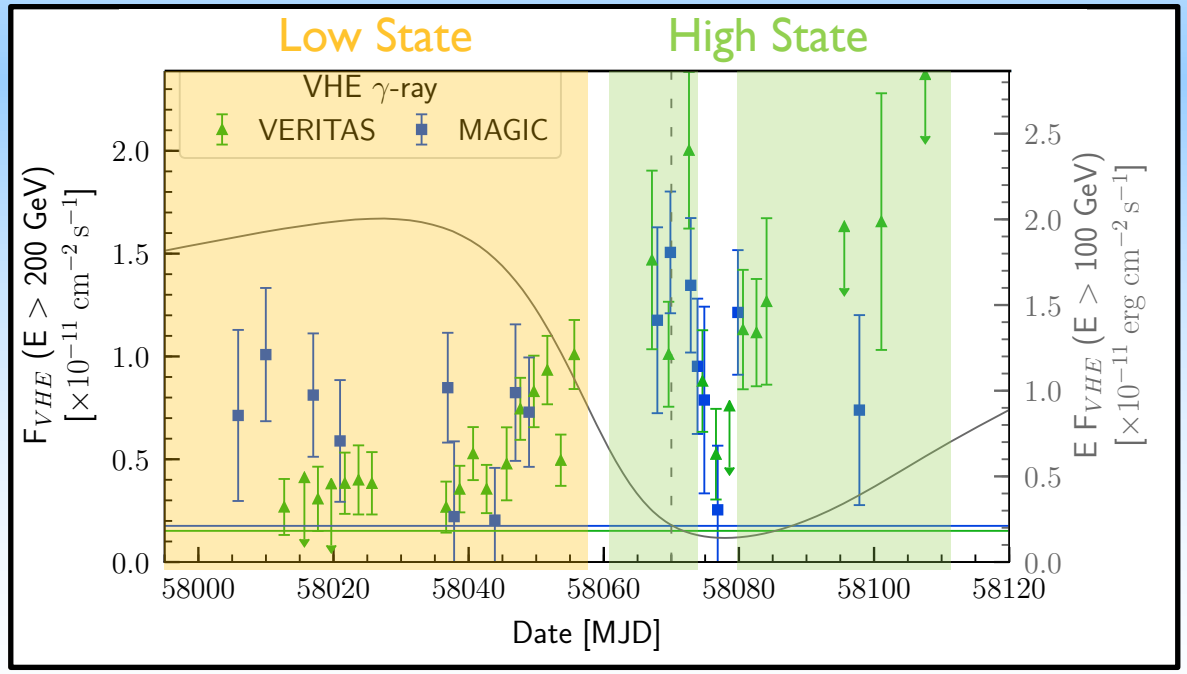
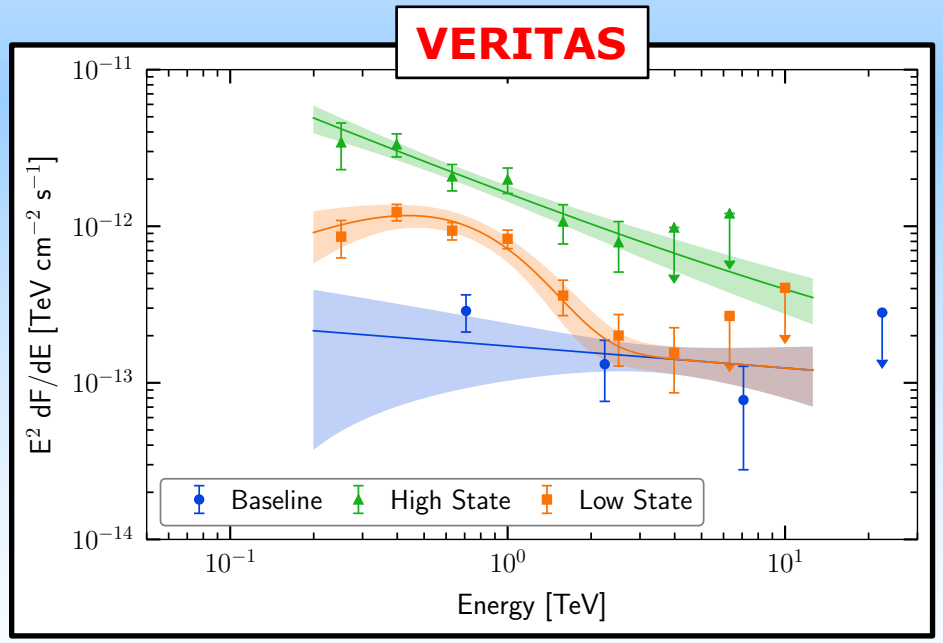
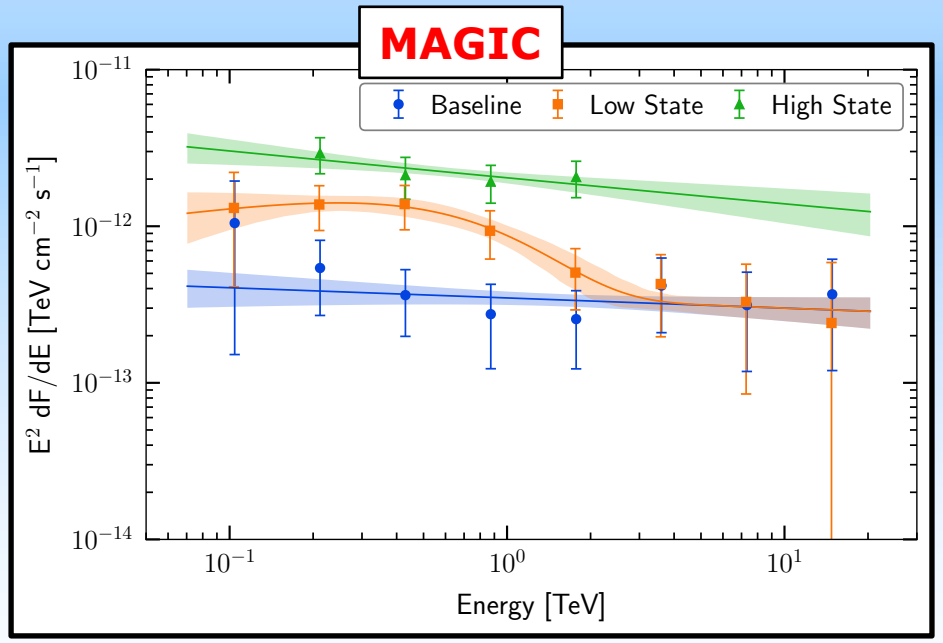


Spectra

- The cut-off is clearly present in the low-state, before periastron.
- High-state spectrum is well fit with a power-law – but we cannot formally exclude a cut-off.





Summary

- VERITAS and MAGIC have clearly detected a new TeV binary.
- Only the second system in which the nature of the compact object is firmly established.
- The TeV luminosity is similar to that of PSR B1259-63 (~1% of the pulsar spin-down energy) – while the GeV luminosity seems to be significantly lower.
- The emission shows day-scale variability, which is not well-described by existing models.
- Detailed temporal and spectral analysis reveals several distinctive features in the TeV observations.
- Combining the TeV with multiwavelength results will provide exceptionally strong model constraints.

- See ApJ Letter (arXiv:1810.05271) for full details.