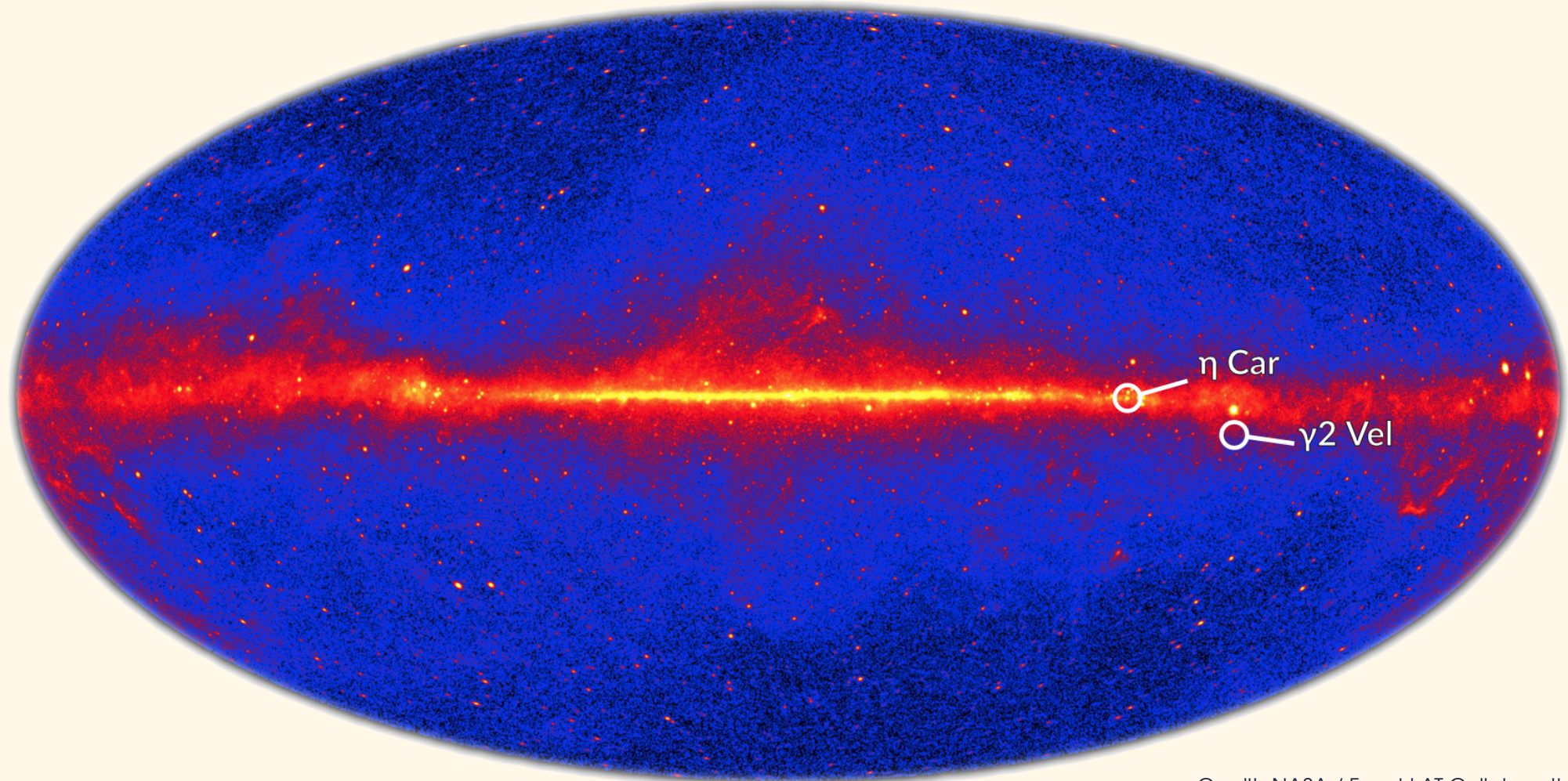


The 2020 periastron of Eta Carinae at high-energies

Guillem Martí-Devesa and Olaf Reimer
On behalf of the *Fermi*-LAT Collaboration
Gamma 2022 – 06.07.2022

Detected HE CWB



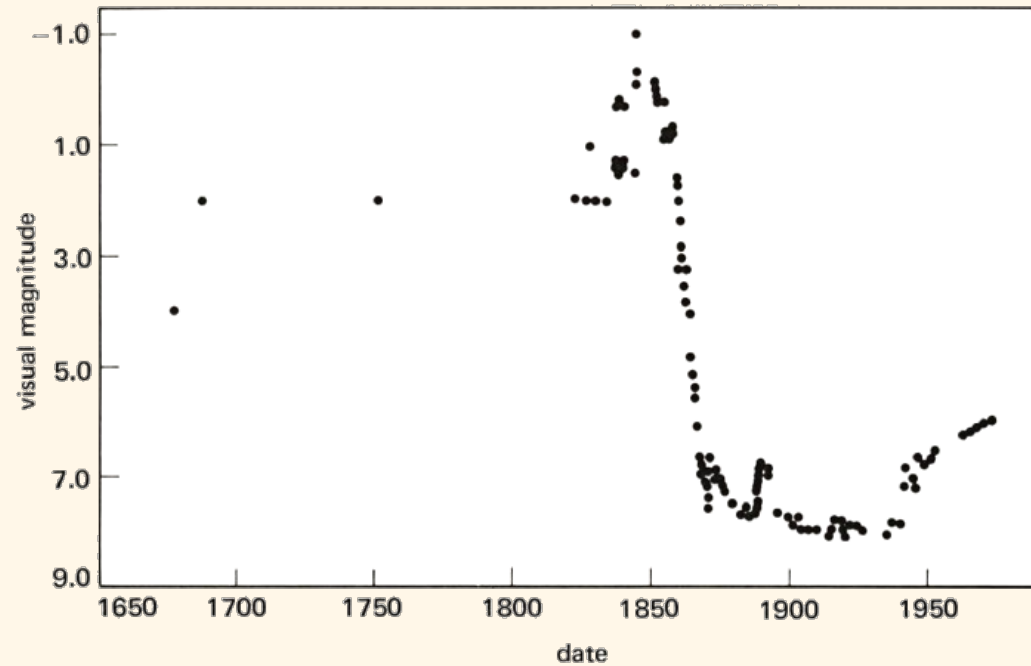
Credit: NASA / Fermi-LAT Collaboration / D. Huber



η Carinae: a brief review

The Great Eruption

A large mass ejection created the **Homunculus Nebula** around ~ 1850



Credit: M. Diodati / AVVSO

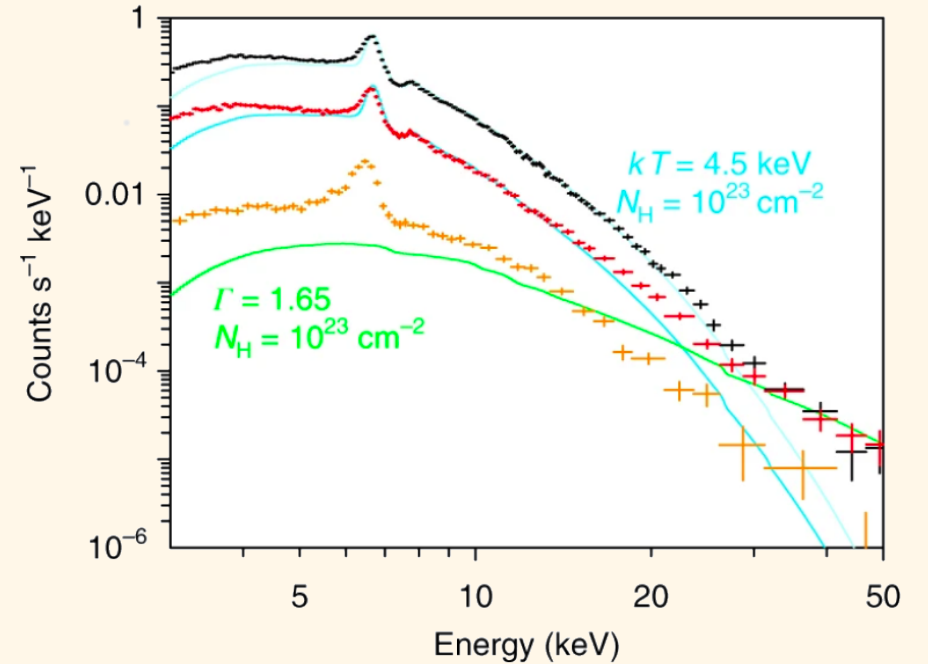
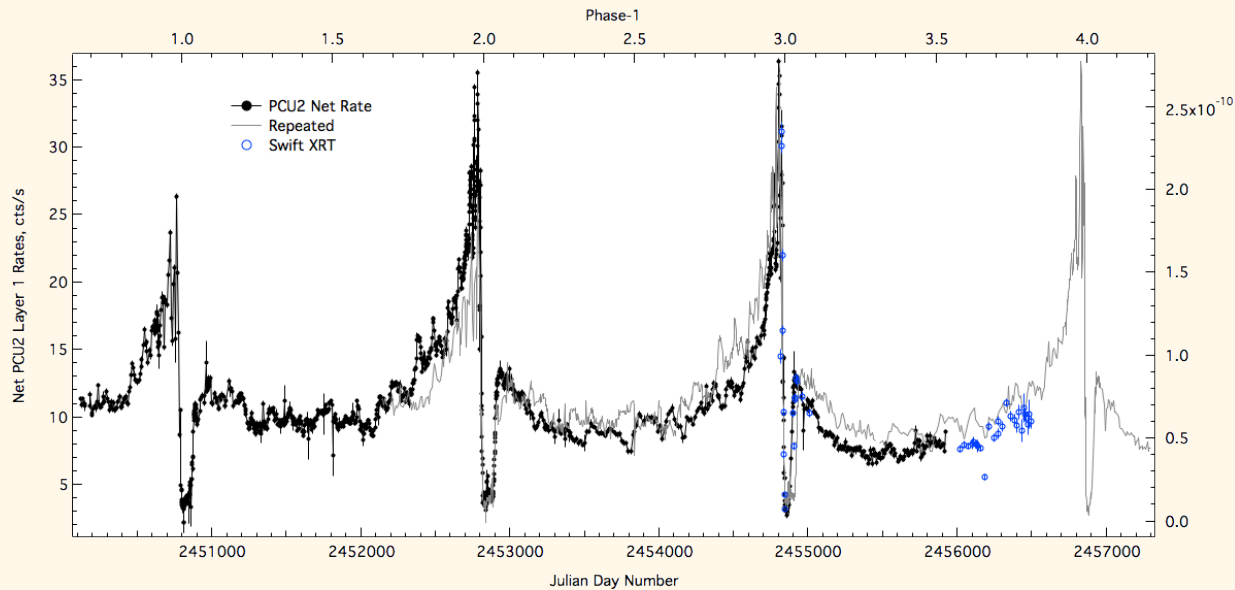


Credit: NASA, ESA, N. Smith, and J. Morse

Soft and hard X-rays

X-ray maximum right **before** periastron.

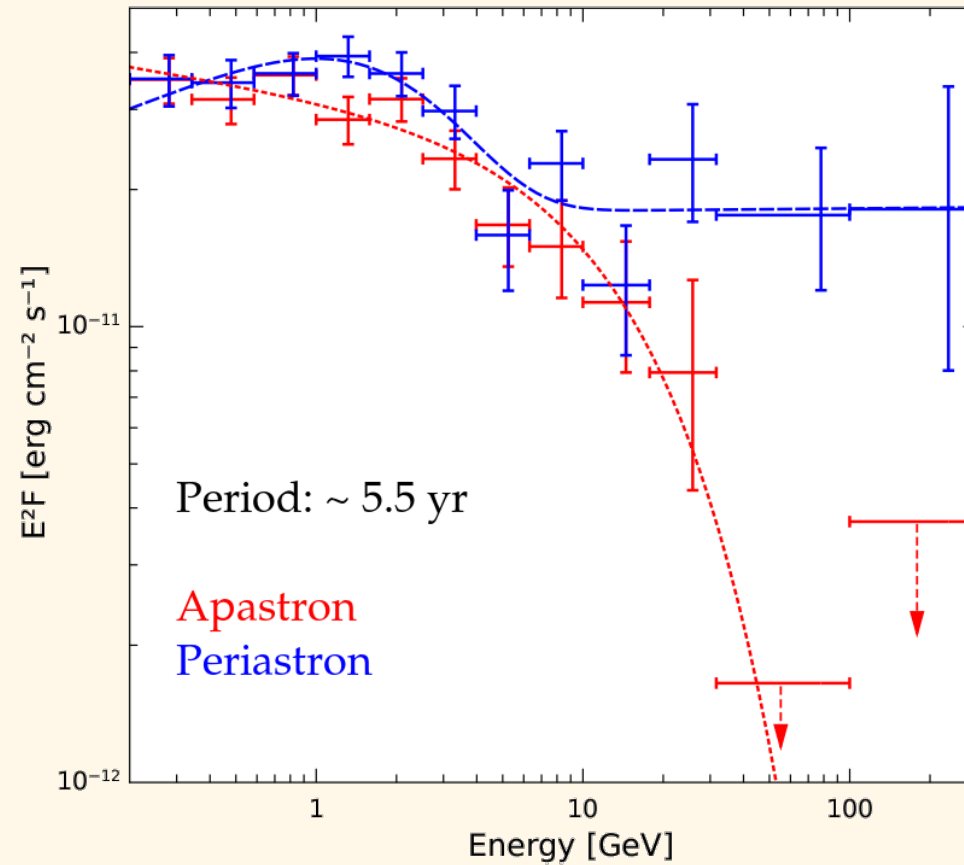
Hard X-ray PL component identified (but no radio synchrotron!)



Credit: M. Corcoran

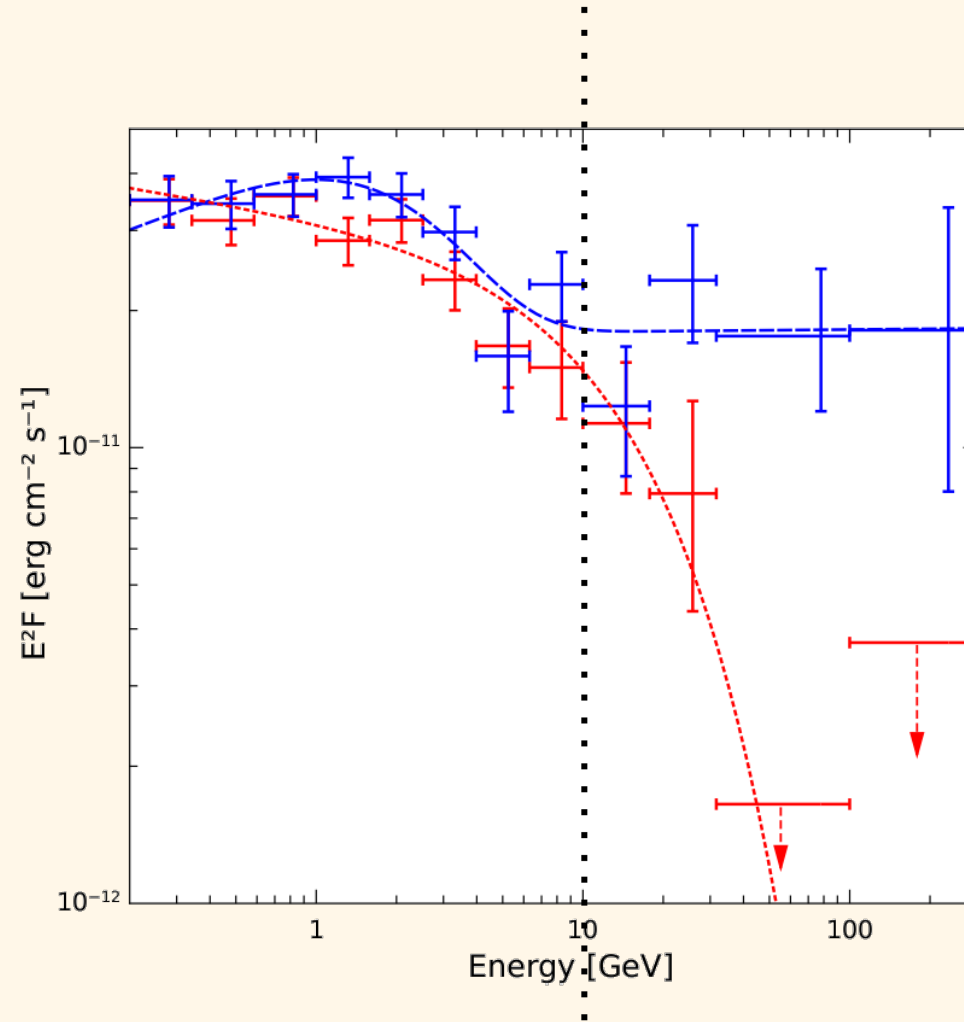
Credit: K. Hamaguchi et al. 2018

A known binary with known HE emission



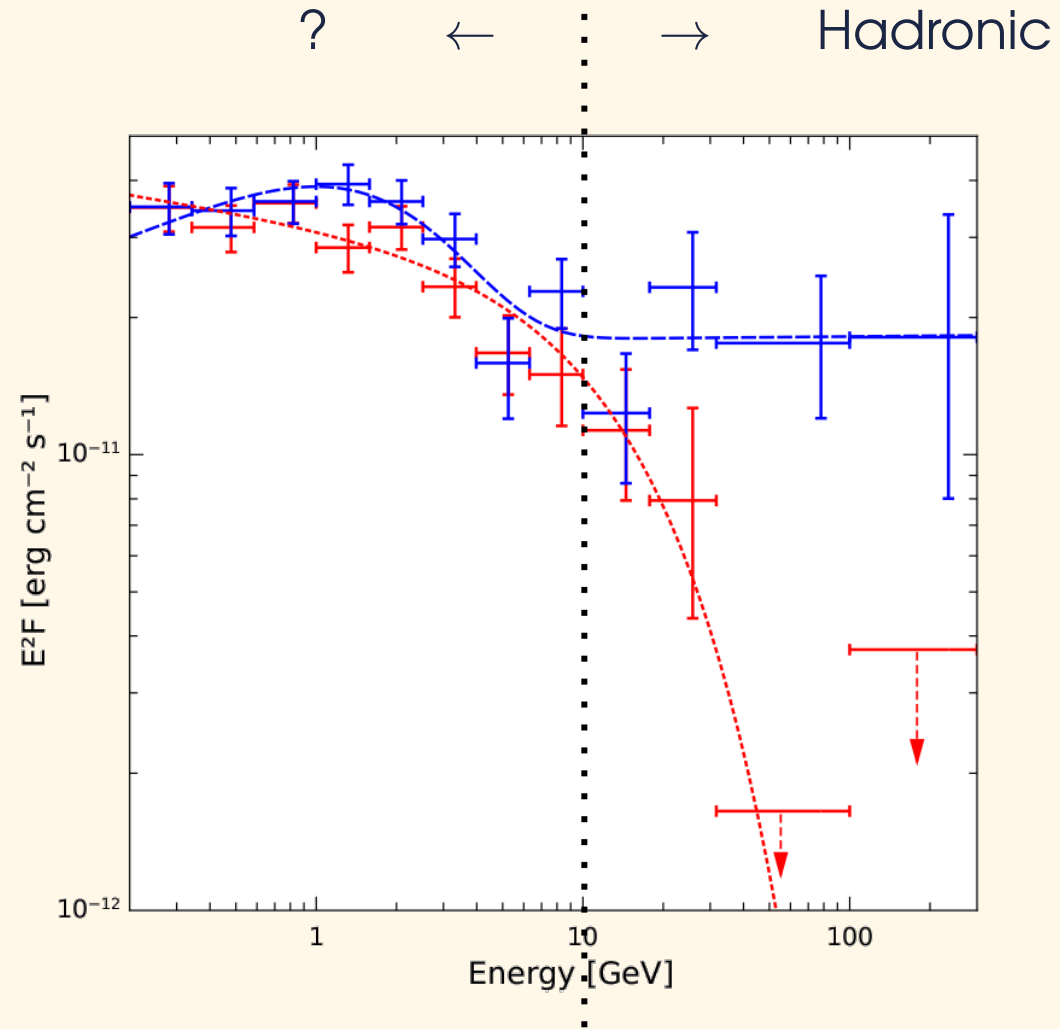
Reitberger et al. 2015

A known binary with known HE emission



Reitberger et al. 2015

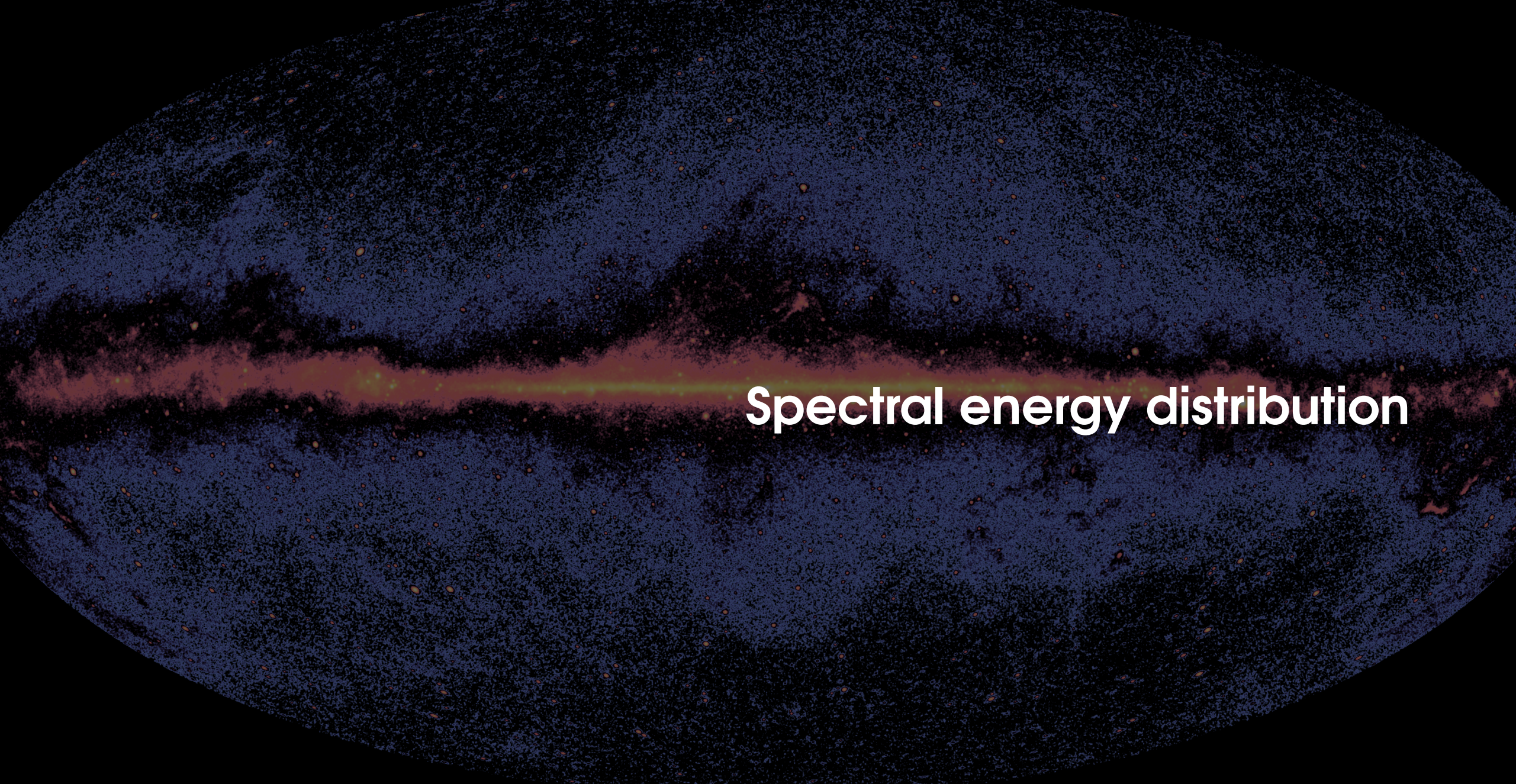
A known binary with known HE emission



Reitberger et al. 2015

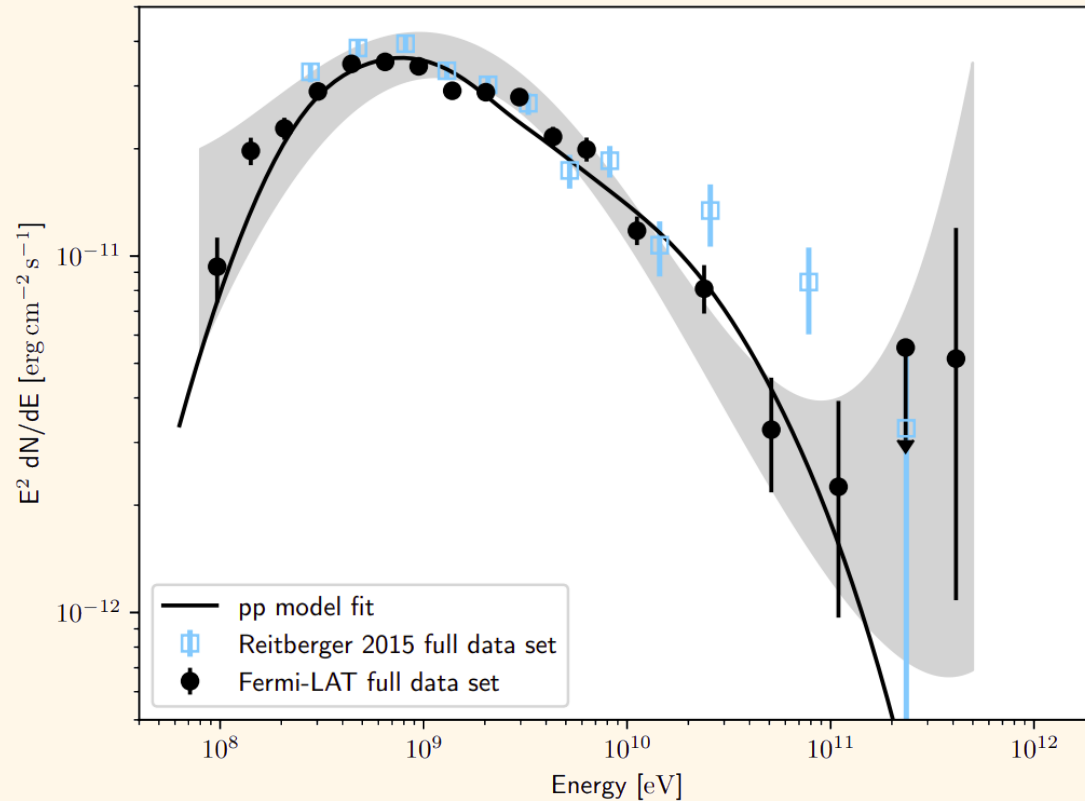
Can we conclusively identify the radiative scenario from current data?

What did occur during the last periastron in 2020?



Spectral energy distribution

Proposed scenarios below 10 GeV



White et al. 2020

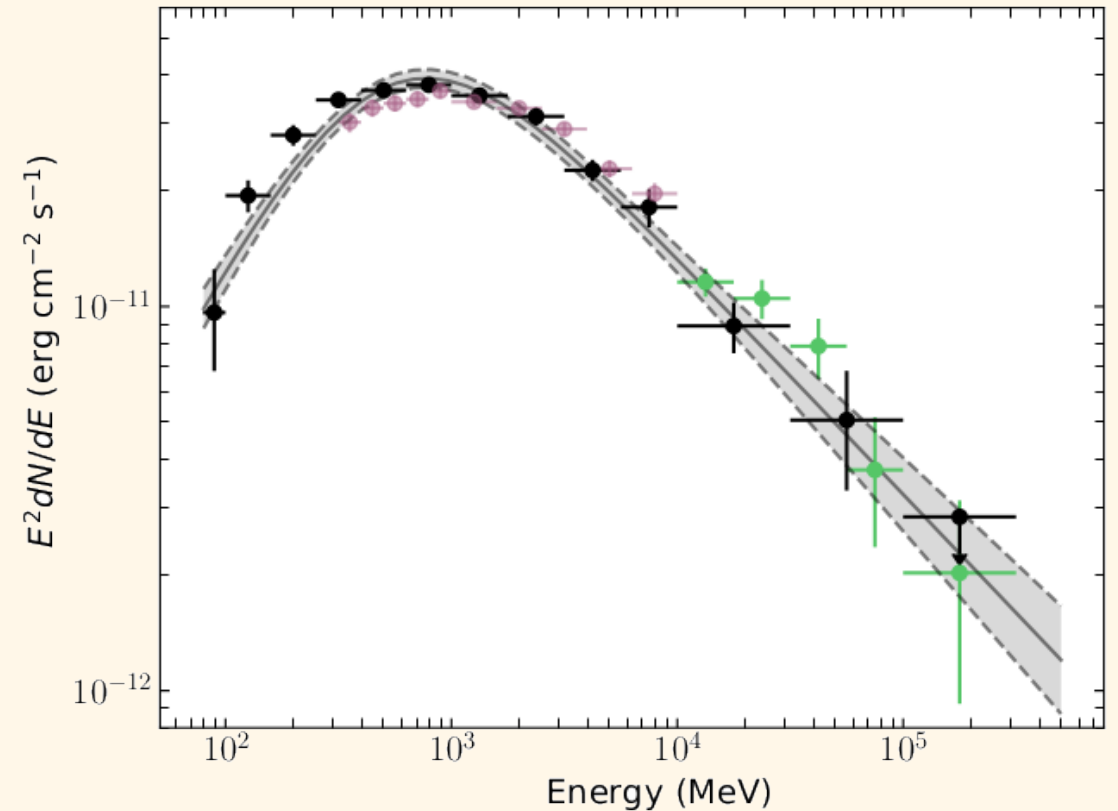
- **Hadronic scenario:** would likely imply the existence of a very hard spectrum at ~ 100 MeV
- **Leptonic scenario:** probably would connect hard X-ray component with LE gamma ($\Gamma \sim 1.65$)

Proposed scenarios below 10 GeV

Proposed analysis: take advantage of
PSF-quality reconstruction quartiles

We find $\Gamma \sim 1.2$, slightly less pronounced
than the expected π^0 -decay, but also
inconsistent with a smooth X-ray
connection

Consistent with results from the Fermi-LAT
Collaboration on low-energy breaks
(yesterday's talk!)

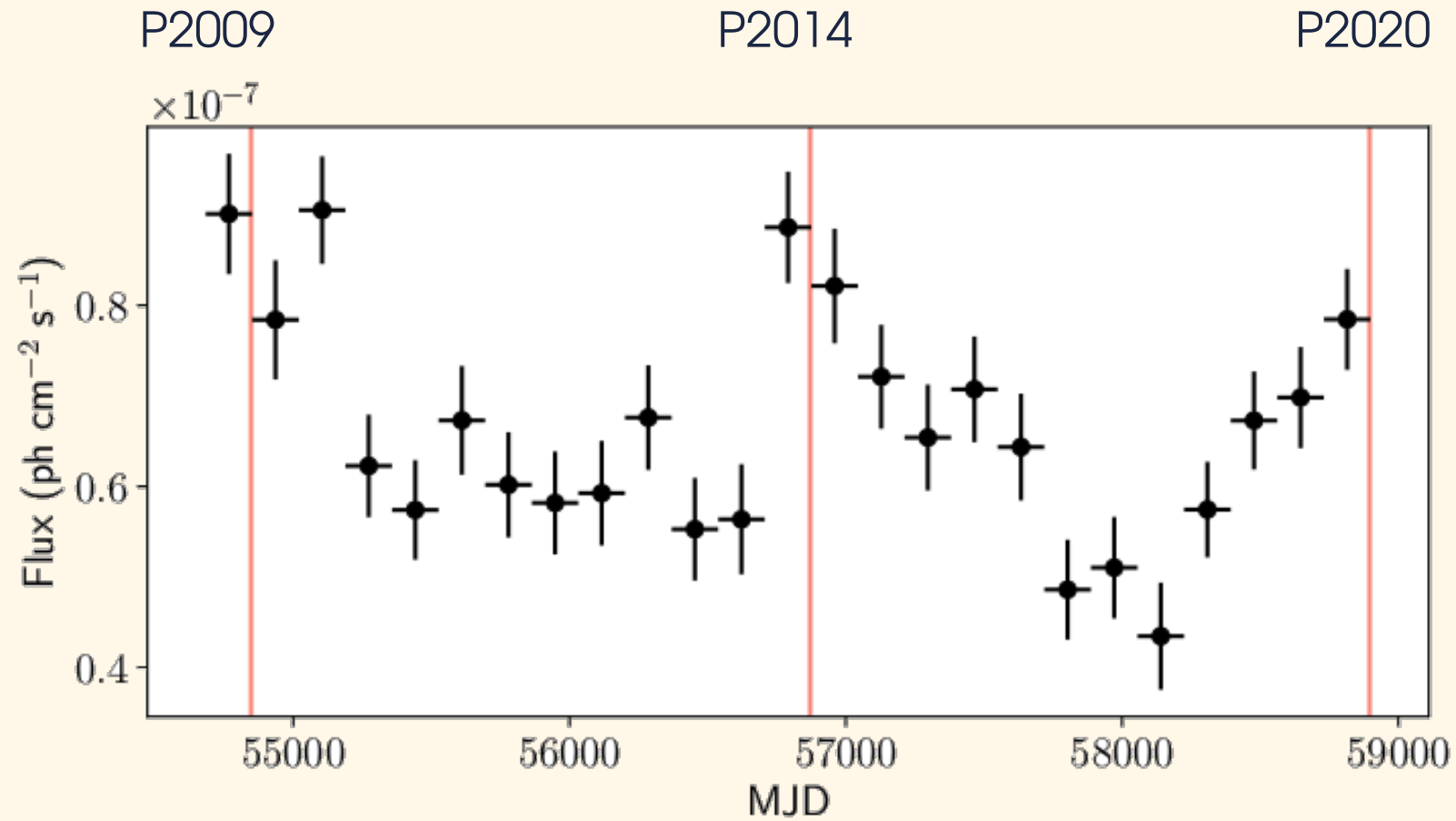


Martí-Devesa & Reimer 2021



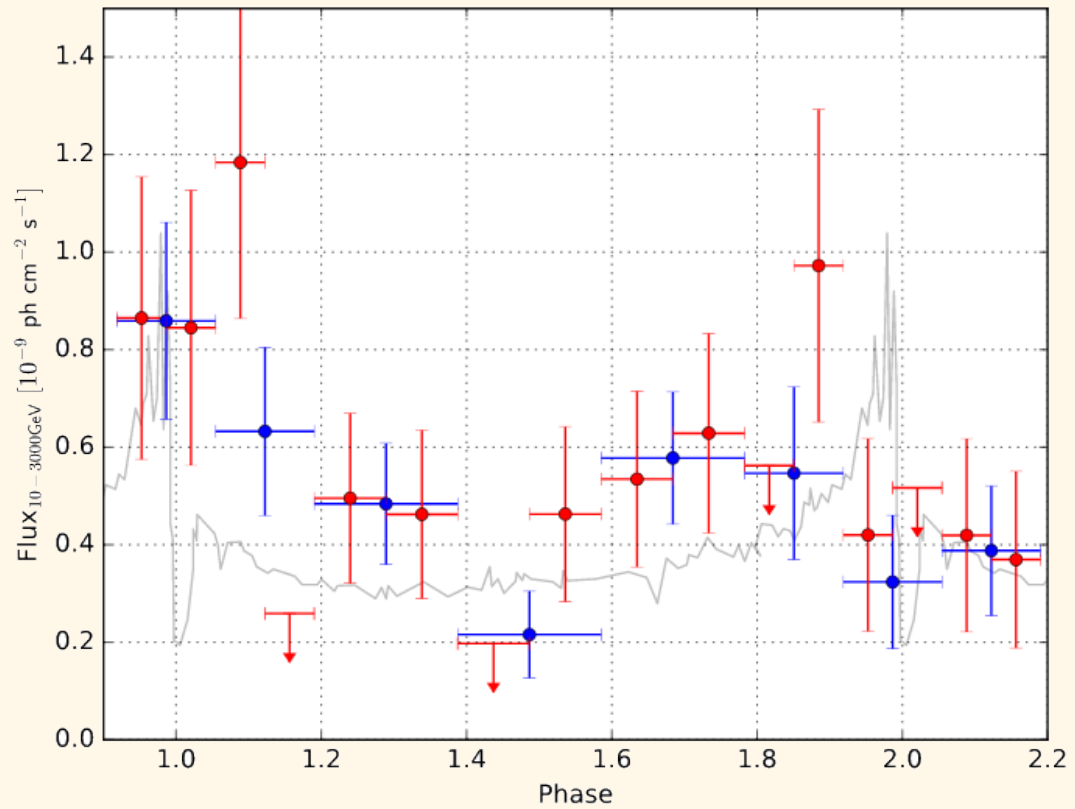
Orbital variability

Two orbits below 10 GeV



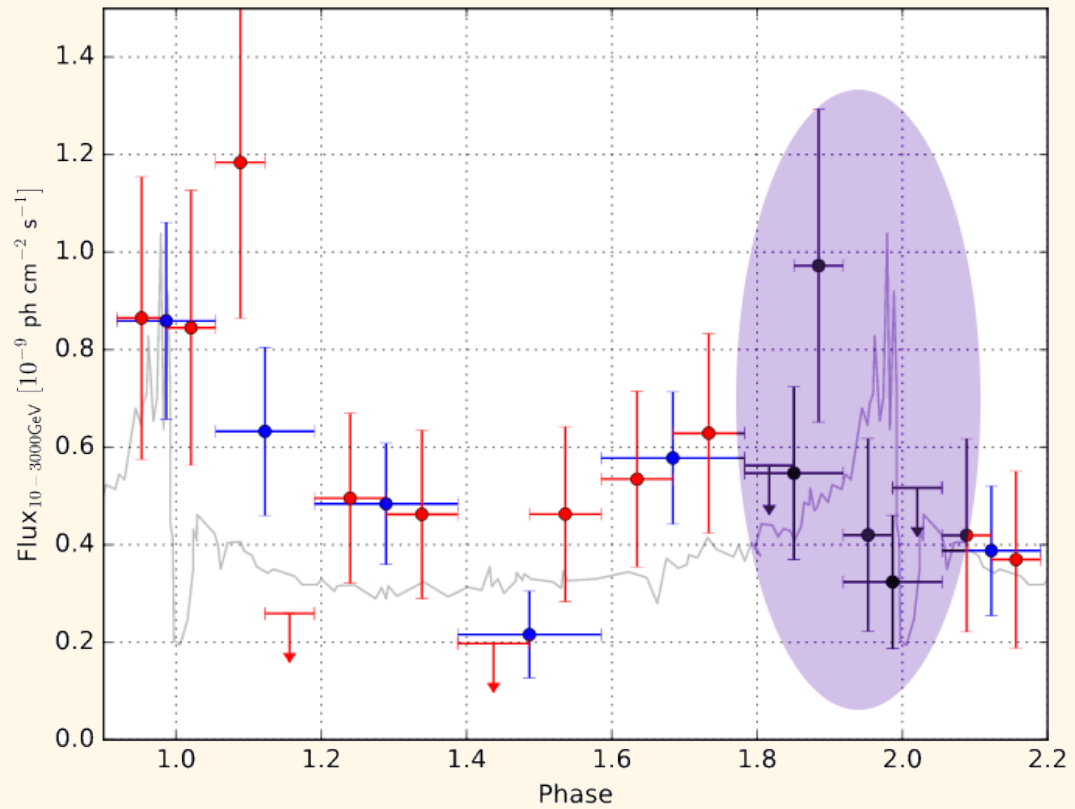
Martí-Devesa & Reimer 2021

Two orbits above 10 GeV



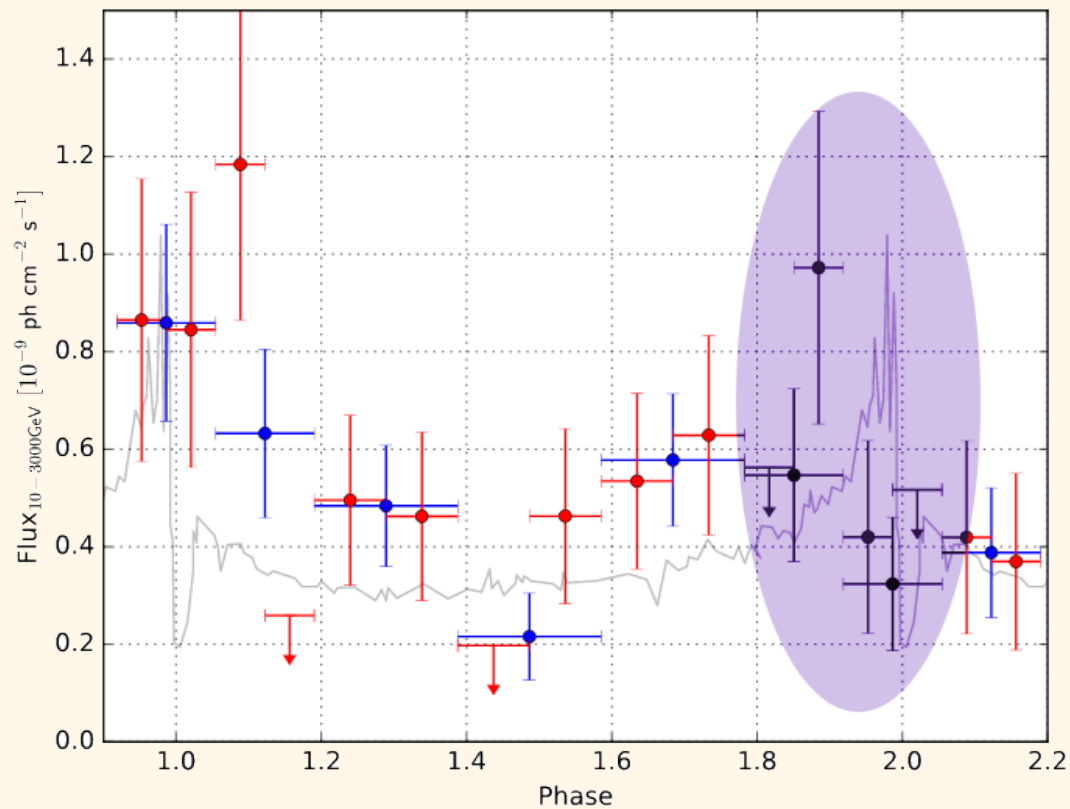
Balbo & Walter 2017

Two orbits above 10 GeV

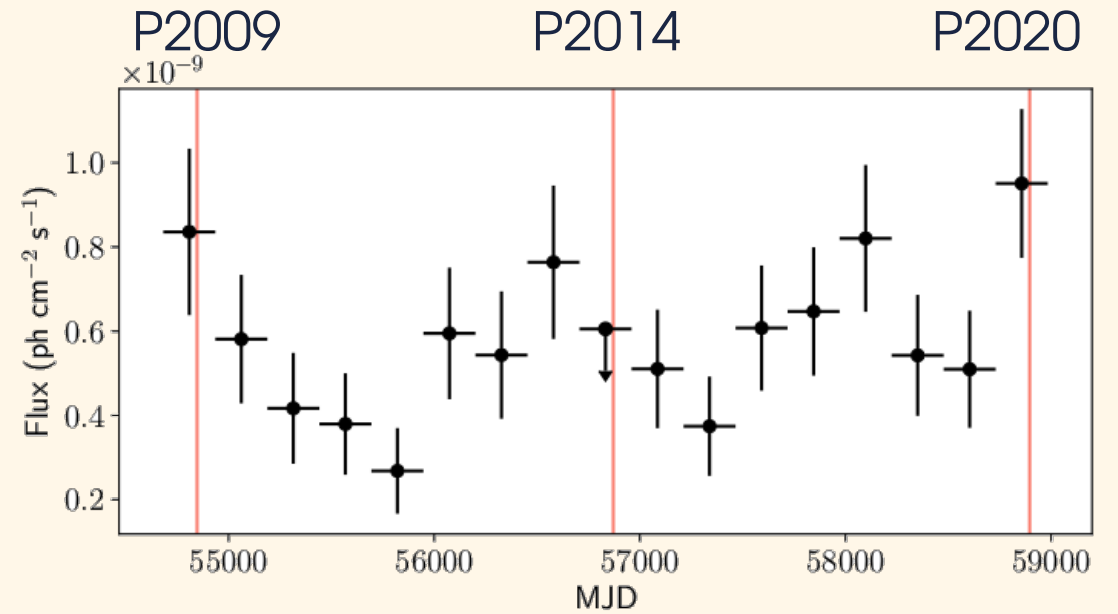


Balbo & Walter 2017

Two orbits above 10 GeV

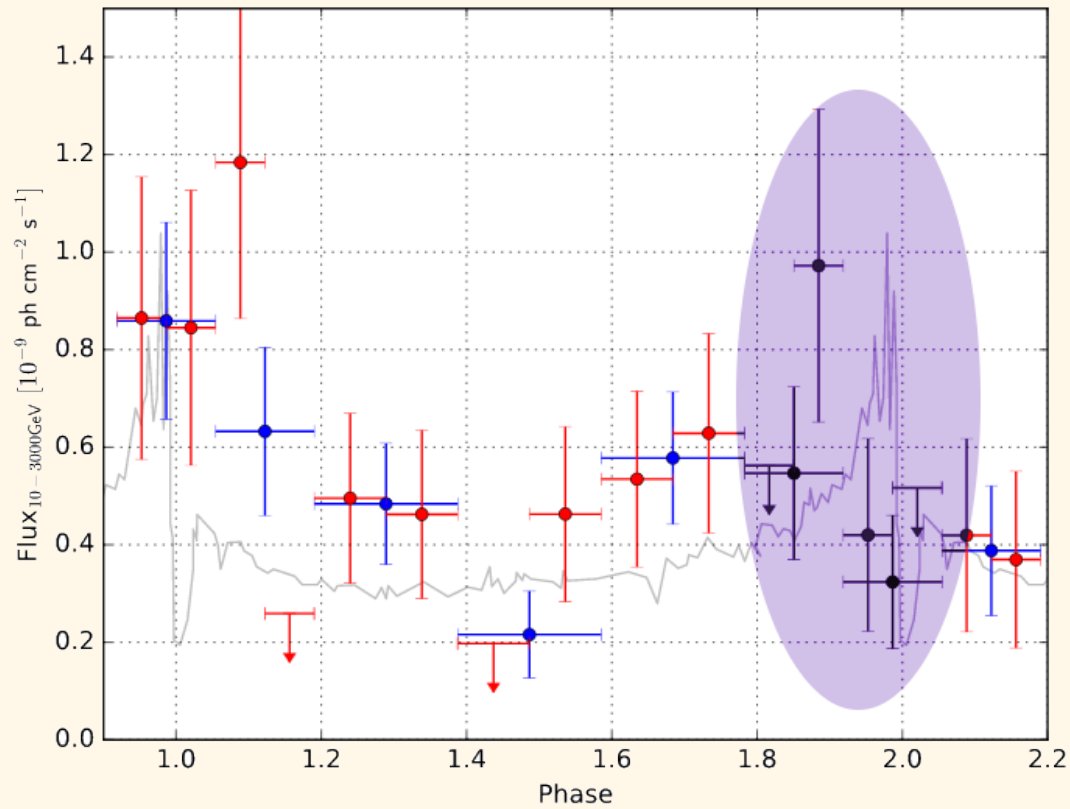


Balbo & Walter 2017

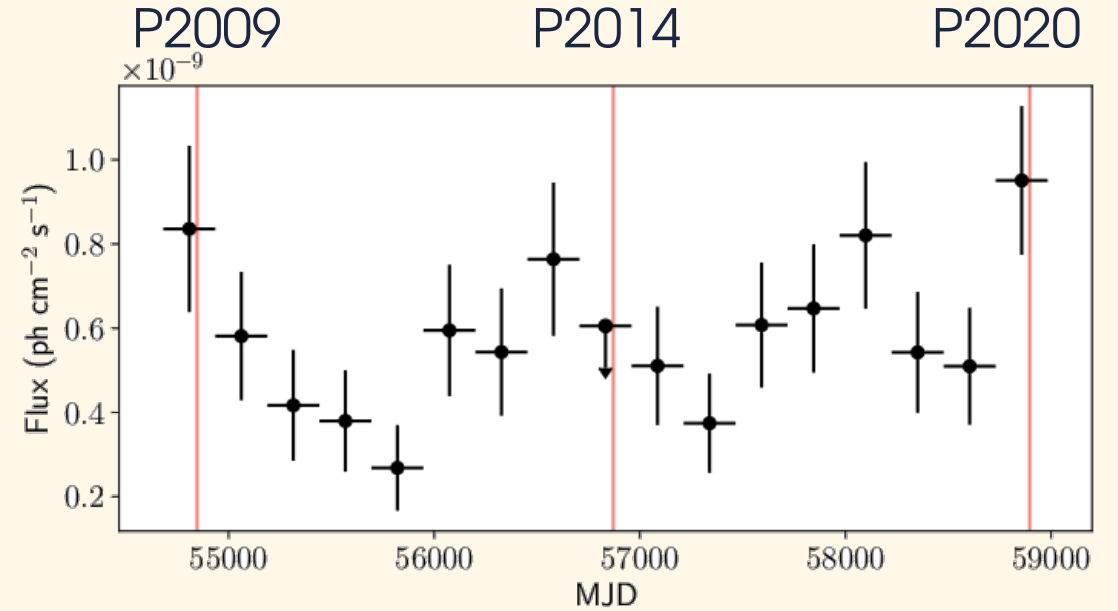


Martí-Devesa & Reimer 2021

Two orbits above 10 GeV



Balbo & Walter 2017



Martí-Devesa & Reimer 2021

$$F_{P2020} = (10.34 \pm 2.08) \times 10^{-10} \text{ ph cm}^{-2} \text{ s}^{-2}$$

VS

$$F_{P2014} = (3.69 \pm 1.54) \times 10^{-10} \text{ ph cm}^{-2} \text{ s}^{-2}$$

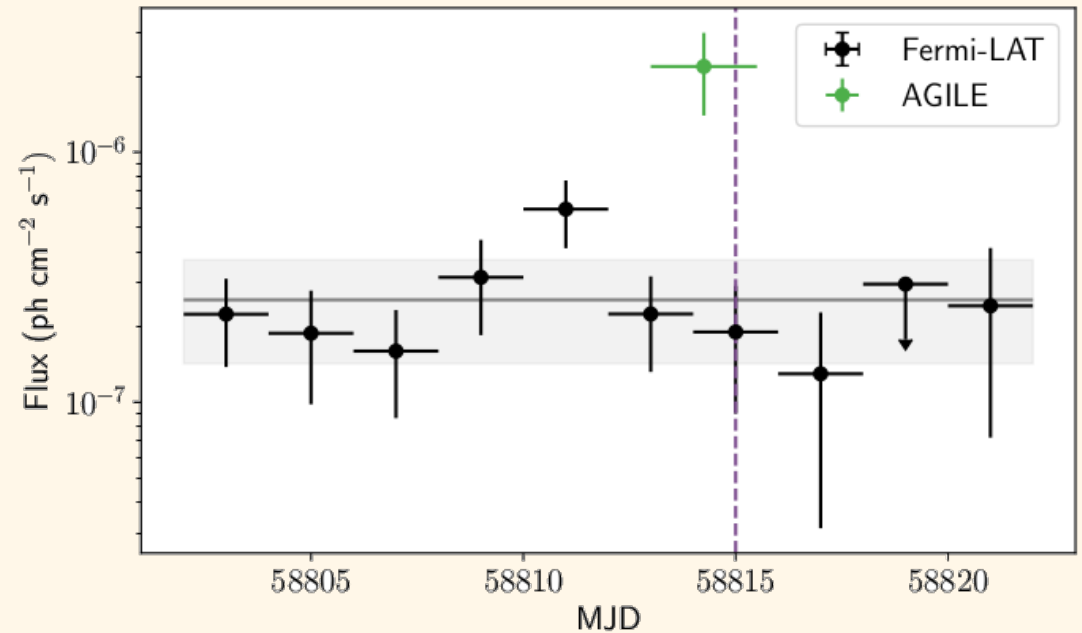
A flare during the last periastron?

Enhanced gamma-ray activity from Eta Carinae

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Piano, G. ; Tavani, M. ; Verrecchia, F.  ; Pittori, C. ; Lucarelli, F.  ;
Cardillo, M. ; Casentini, C. ; Ursi, A. ; Bulgarelli, A.  ; Fioretti, V. ;
Parmiggiani, N.  ; Donnarumma, I. ; Vercellone, S. ; Gianotti, F. ;
Trifoglio, M. ; Giuliani, A. ; Mereghetti, S. ; Caraveo, P. ; Perotti, F. ; Chen, A. ; ...

AGILE is detecting gamma-ray emission above 100 MeV from a source positionally consistent with the colliding wind binary Eta Carinae. Integrating from 2019-11-26 UT 00:00:00 to 2019-11-28 UT 12:00:00 (MJD: 58813.0 - 58815.5), a preliminary multi-source likelihood analysis yields a detection at coordinates $(l, b) = (288.3, -0.7) \pm 0.7$ deg (99% C.L. stat.) ± 0.1 deg (syst.), with a significance above 4 sigma and a gamma-ray flux $F(> 100 \text{ MeV}) = (2.2 \pm 0.8) \times 10^{-6}$ photons/cm²/s.



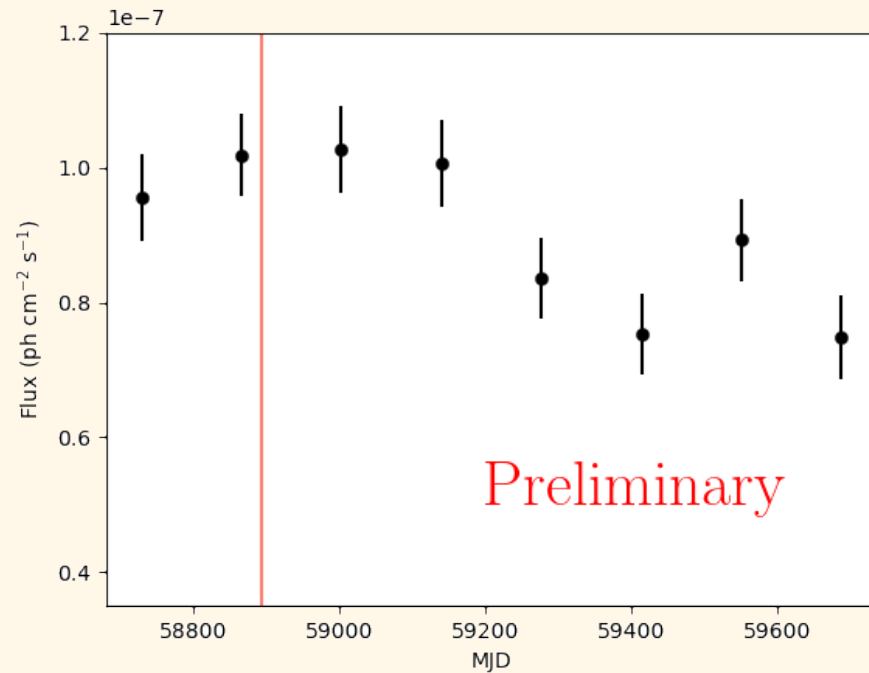
Martí-Devesa & Reimer 2021



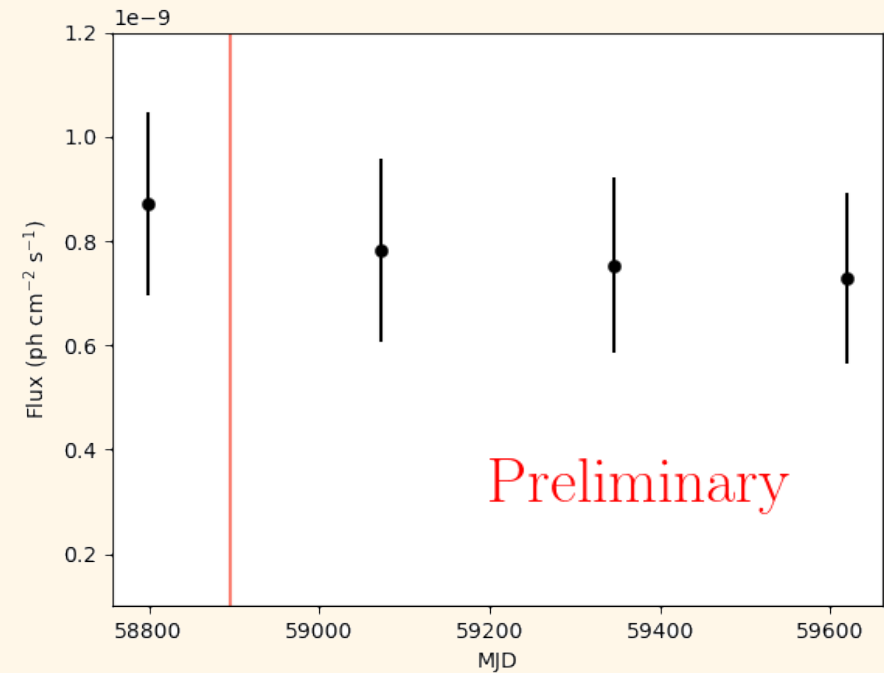
And since then, what?

Preliminary follow-up analysis

Low energy component



High energy component





Summary

Summary

- Low energy component seemingly **too hard** for X-ray connection, but can't confirm nor deny π^0 bump
- Clear **variability between orbits**: evidence of different spatial distribution of 2 particle populations?
- η Carinae still surprising. Detailed simulations required, and we'll see what comes next!