

# The vanishing of the primary emission region in PKS 1510-089



**Michael Zacharias**, J. Barnard, M. Böttcher, H. Schutte  
for the H.E.S.S. Collaboration

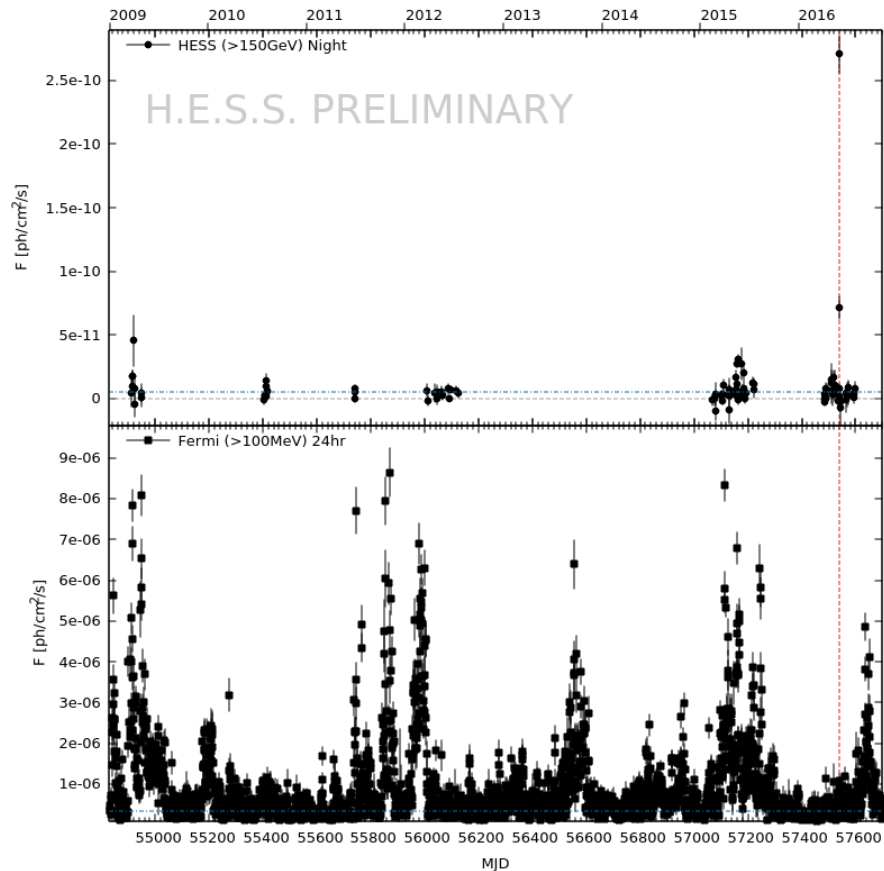


UNIVERSITÄT  
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*TeVPA 2023* — Naples



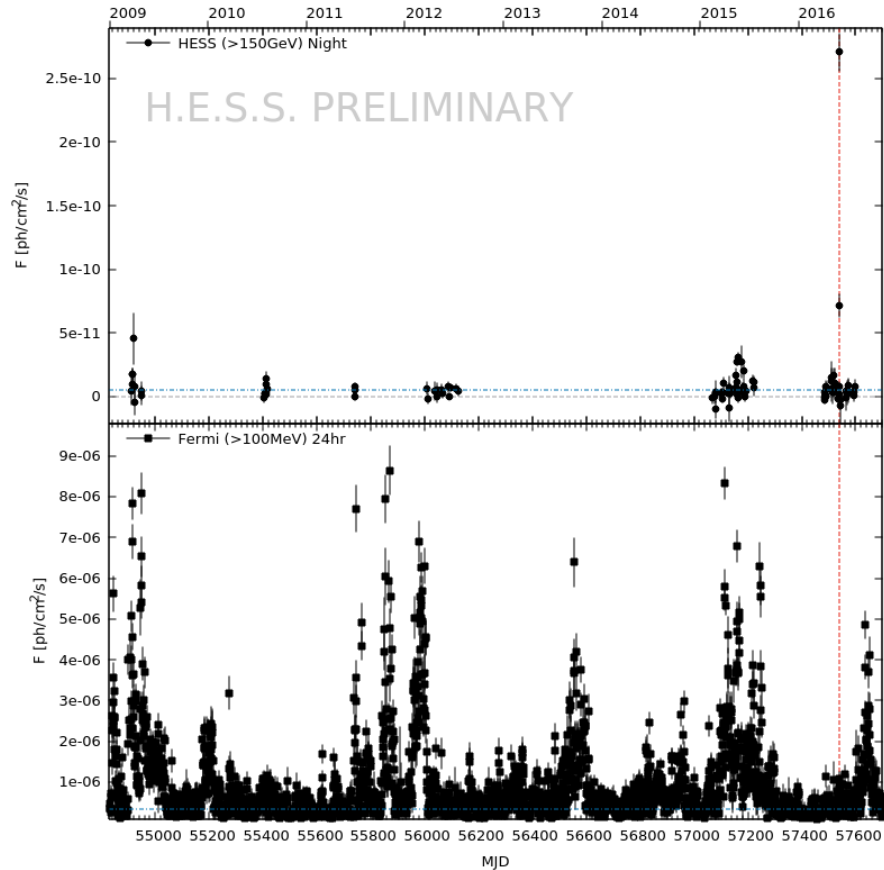
# PKS 1510-089 — a brief history



Light curves of PKS 1510-089 (FSRQ) from H.E.S.S. (top) and *Fermi*-LAT (bottom) (preliminary)

- FSRQ at redshift  $z = 0.361$  with a bright BLR
- Expect strong attenuation of VHE  $\gamma$  rays
- Detected with H.E.S.S. in 2009 (HESS+13)
- A deep monitoring campaign revealed...
  - VHE emission is persistent (MAGIC+18)
  - In May 2016, a bright almost orphan VHE flare occurred (HESS+21)
  - Another VHE flare took place in 2019

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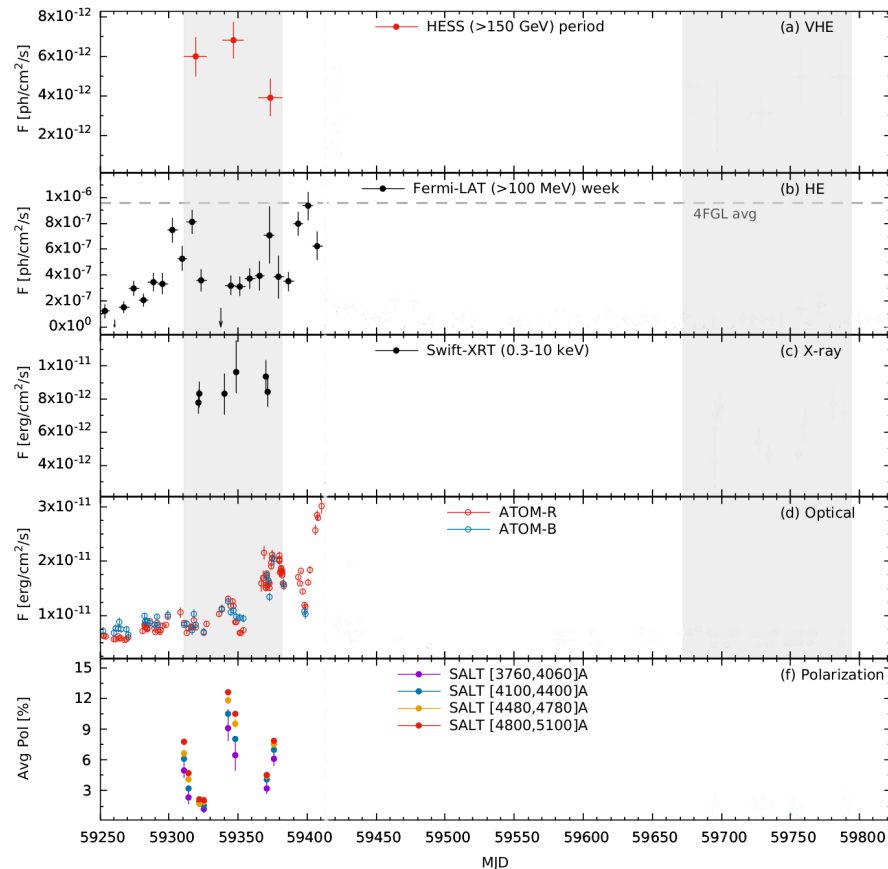


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  - VHE emission is persistent (MAGIC+18)
  - In May 2016, a bright almost orphan VHE flare occurred (HESS+21)
  - Another VHE flare took place in 2019
- ... “but we’re not here to see any of that!”

(yt:TheTimTraveller)

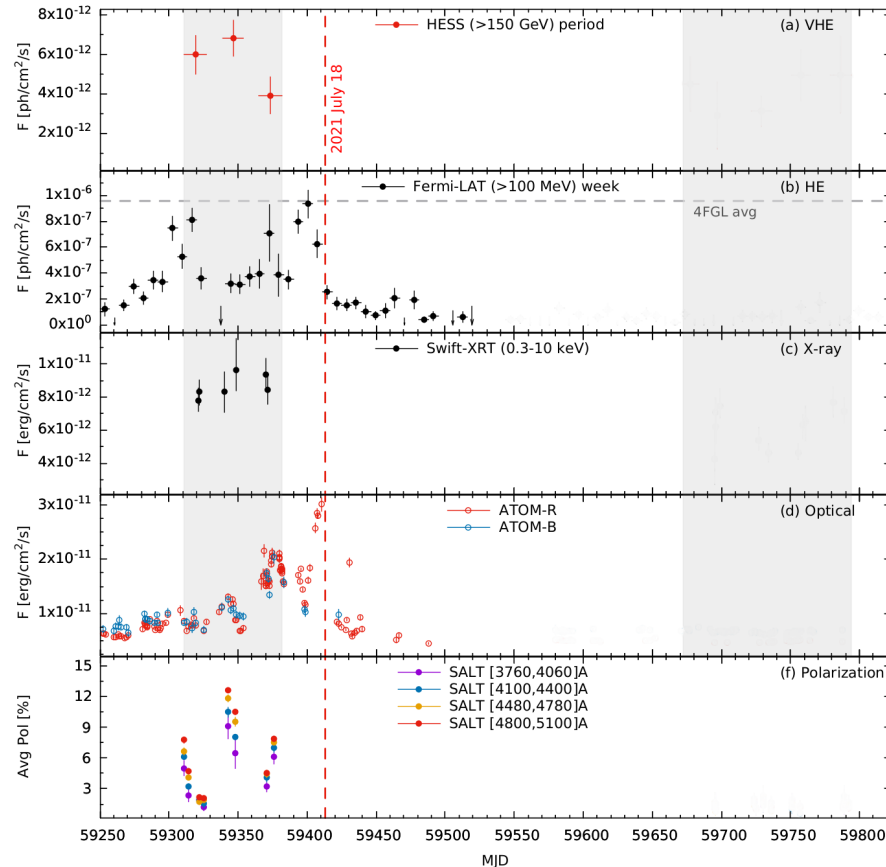
# PKS 1510-089 — Identity crisis of a blazar



MWL light curves of PKS 1510-089 (FSRQ) in 2021 from H.E.S.S., Fermi-LAT, Swift, and ATOM, as well as degree of polarization from SALT.

- MWL monitoring program since 2021:
  - H.E.S.S., Fermi-LAT, Swift, ATOM
  - SALT (spectro-polarimetry)

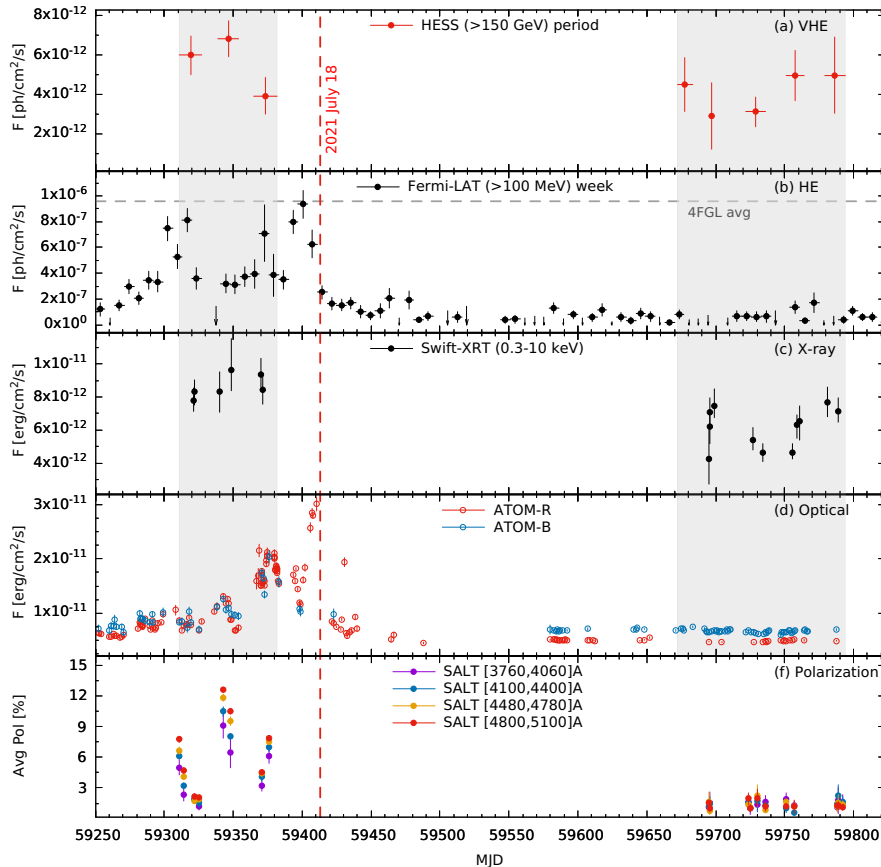
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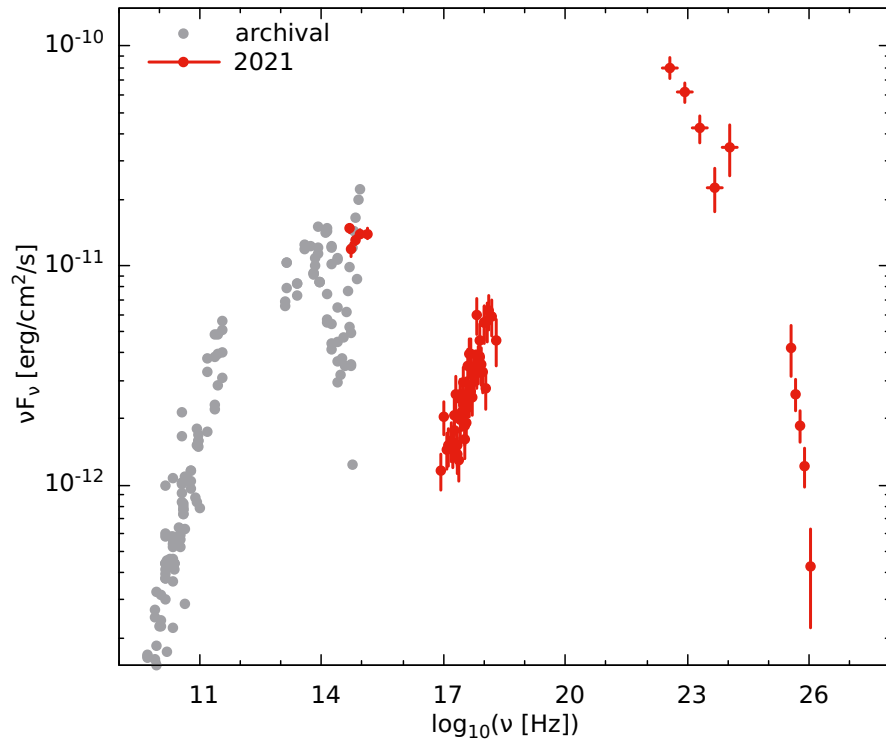
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- MWL monitoring program since 2021:
  - H.E.S.S., Fermi-LAT, Swift, ATOM
  - SALT (spectro-polarimetry)
- For the rest of 2021, HE  $\gamma$ -ray and optical fluxes went down
- And have stayed down since
- Additionally, the degree of polarization has dropped to 0%
- But VHE  $\gamma$ -rays and X-rays have remained almost unchanged

MWL light curves of PKS 1510-089 (FSRQ) in 2021 & 2022 from H.E.S.S., Fermi-LAT, Swift, and ATOM, as well as degree of polarization from SALT.

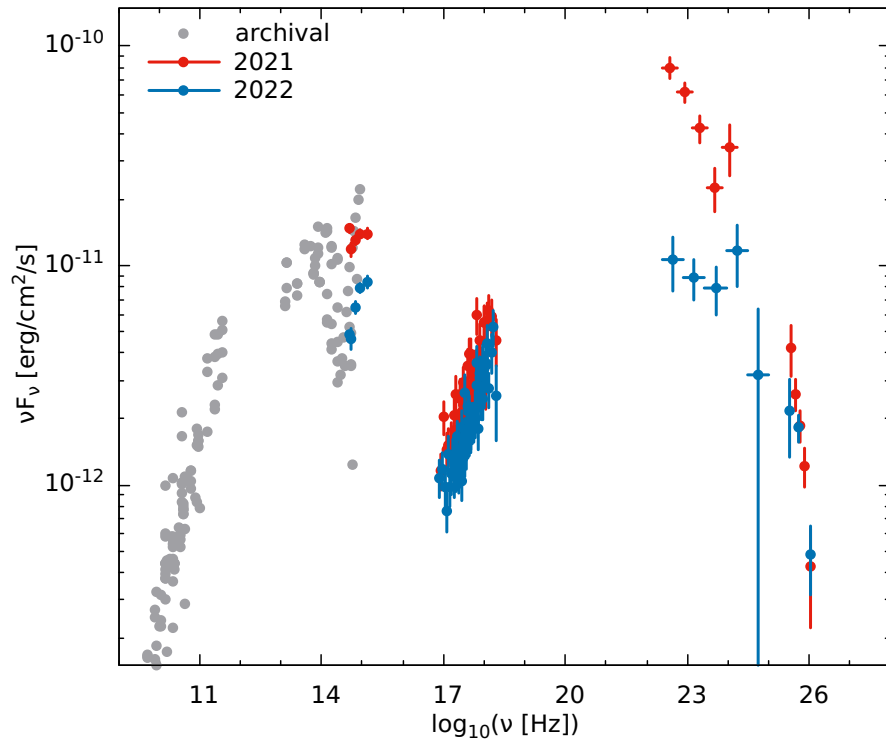
# PKS 1510-089 — Identity crisis of a blazar



MWL spectrum of 2021 (red) with archival data (gray)

- Spectra averaged during H.E.S.S. observation windows
  - In 2021, this is before the drop!

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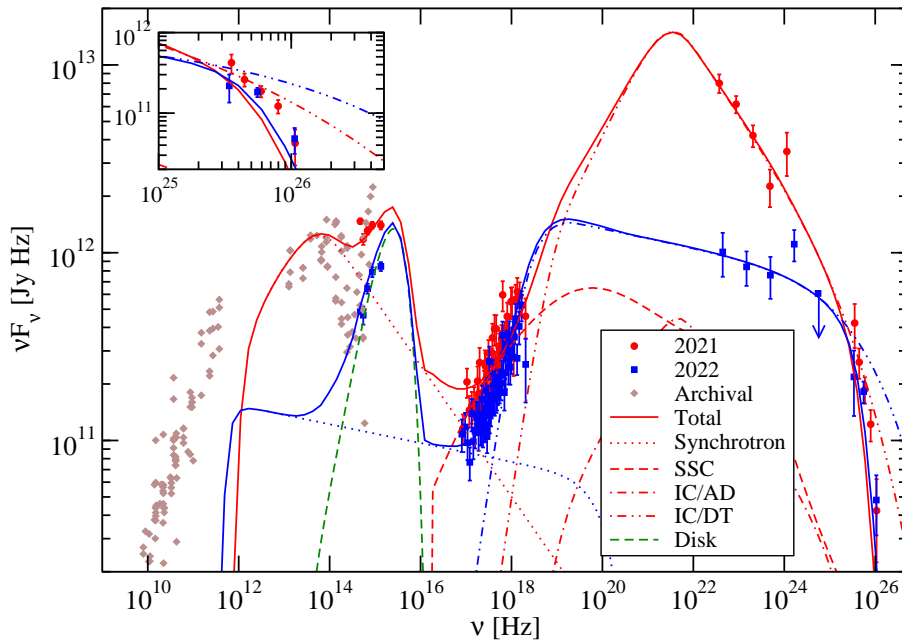


MWL spectrum of 2021 (red) & 2022 (blue) with archival data (gray)

- Spectra averaged during H.E.S.S. observation windows
  - In 2021, this is before the drop!
- Significant change in HE  $\gamma$ -ray spectrum
  - Flux drop and hardening
  - Spectral continuation to VHE domain unchanged
  - Spectral change coincides with flux drop taking place within a few days
- Significant change in optical spectrum
  - (explored using Schutte+22)
    - 2021 is a mix of synchrotron, AD and BLR
    - 2022 fully explained by (constant) AD and BLR
    - Derived upper limit on synchrotron spectrum



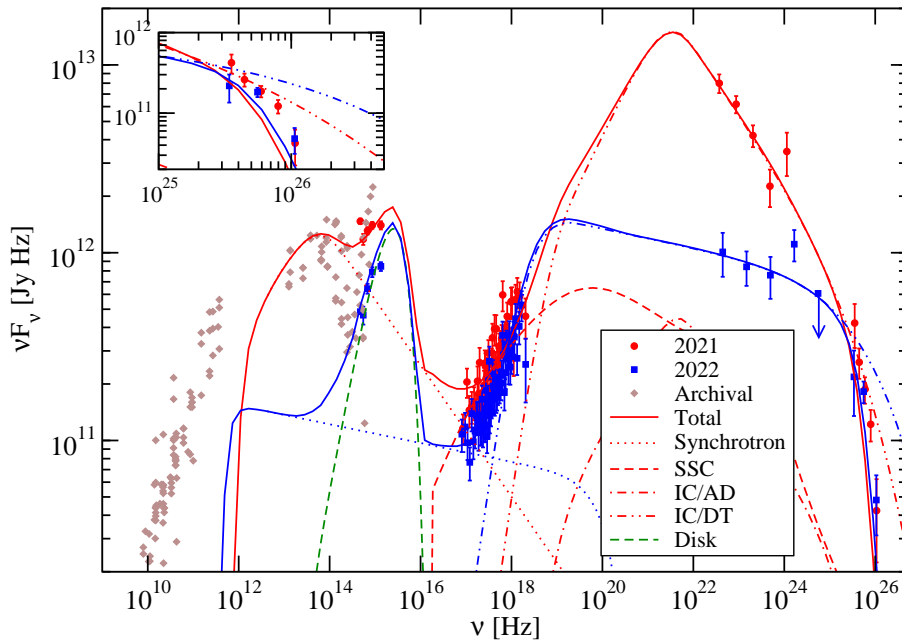
# PKS 1510-089 — One-zone modeling



One-zone modeling of the 2021 & 2022 data sets.

- Using a leptonic steady-state one-zone code (Böttcher+13)
- One-zone modeling of both states possible
  - Requires significant changes to electron distribution function (normalization, index)
  - Must be located relatively far away from the black hole ( $\gtrsim 10\text{pc}$ )
  - Changes not likely to happen on such a short time scale
  - Fit to VHE data not so good

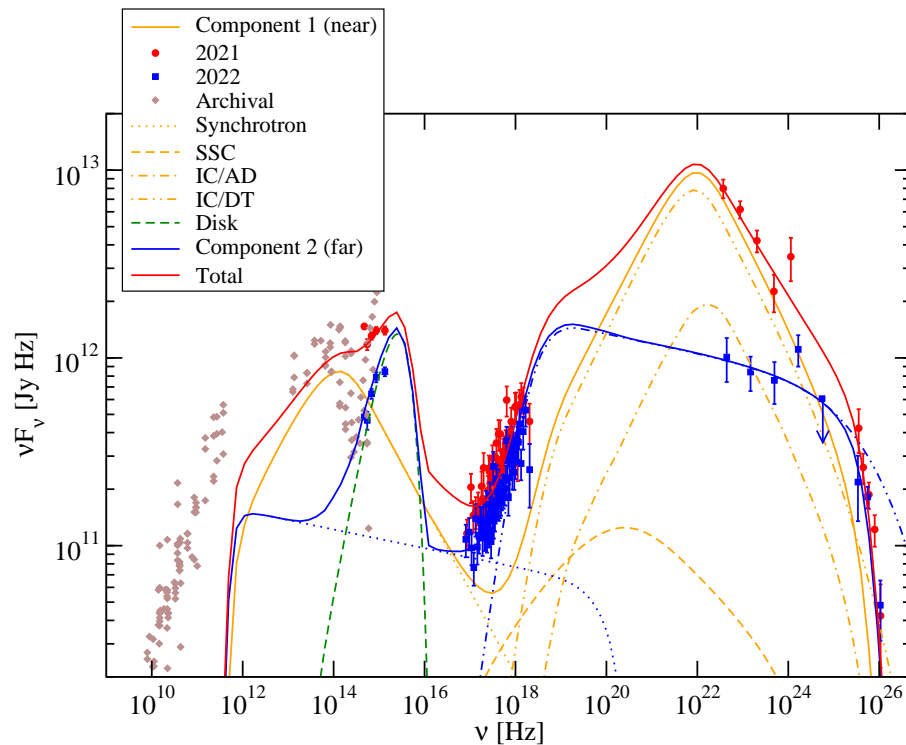
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- What if it were two zones?

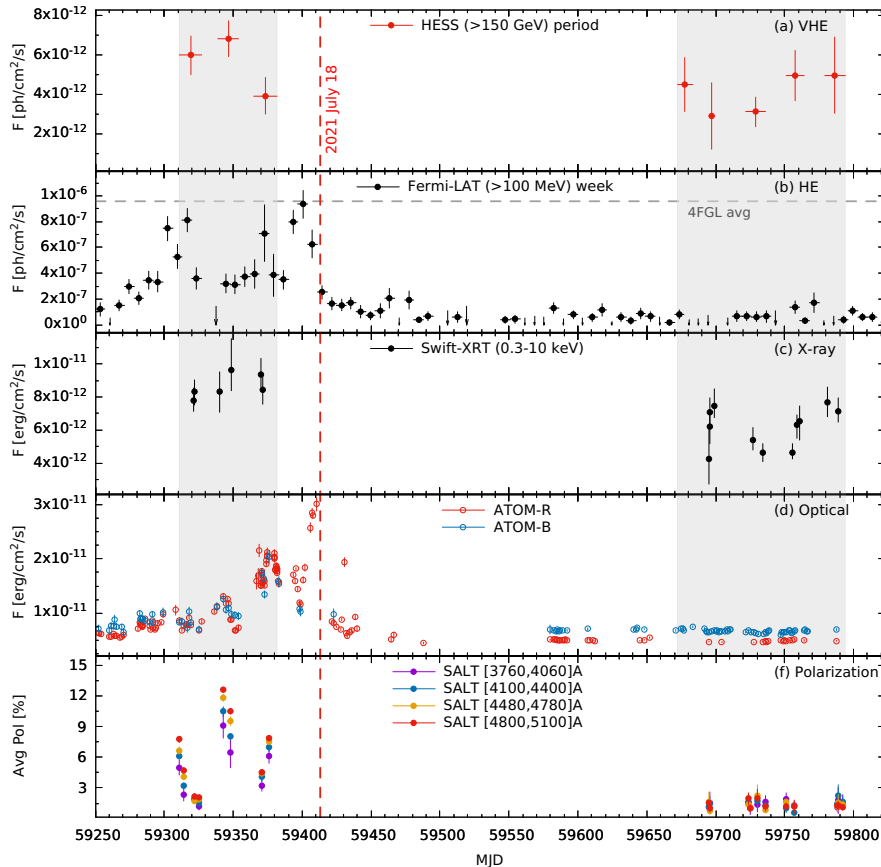
# PKS 1510-089 — Two-zone modeling



Two-zone interpretation of the data with a near zone (yellow), a far zone (blue) and the total (red).

- 2022 “one-zone model” fits X-rays and VHE  $\gamma$  rays in a “far zone” ( $\gtrsim 10\text{pc}$ )
- Another “near zone” (close to the BH) added for 2021 data explaining optical and HE  $\gamma$ -ray data
- “Near zone” disappeared in July 2021
  - Inner jet became inefficient
  - Inner jet has swung away from the line-of-sight
- It would explain
  - ... rapid change of state
  - ... persistent VHE flux (MAGIC+18)
  - ... unclear correlation patterns (Zacharias+19)
  - ... most of “ancient” variability in near zone

# PKS 1510-089 — Summary

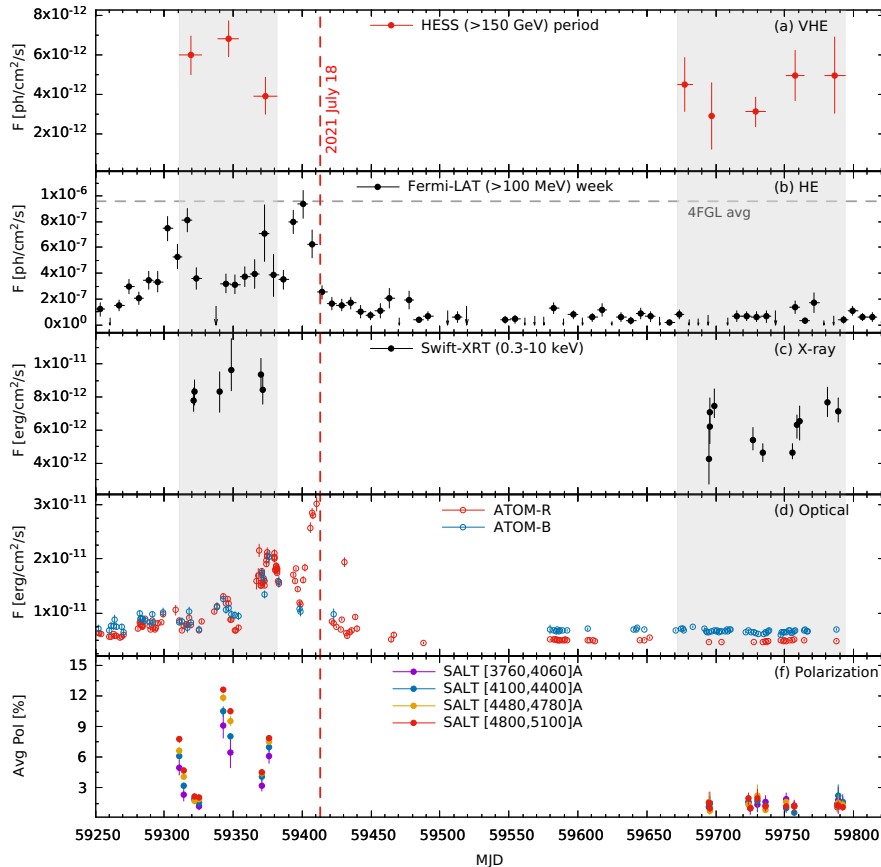


MWL light curves of PKS 1510-089 (FSRQ) in 2021 & 2022 from H.E.S.S., Fermi-LAT, Swift, and ATOM, as well as degree of polarization from SALT.

- Historically, 2 zones were active at the same time
- In July 2021, the near-zone emission region disappeared
- Only the far-zone emission region is still active
- Radio (and far-IR) data may shed light on the cause of this identity crisis

All details: HESS+23, ApJL, 952, L38

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**Thank you!**