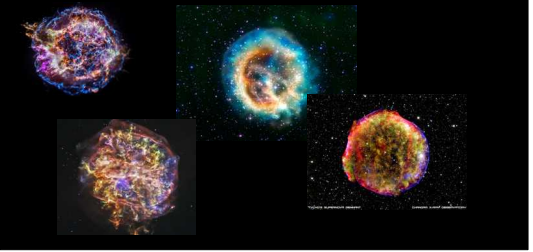
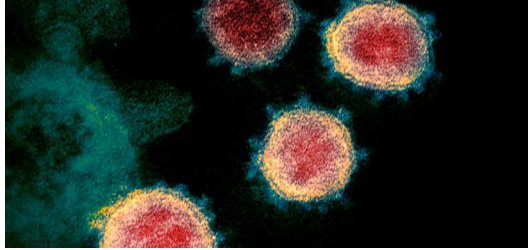
Highlights from H.E.S.S.

Stefan J. Wagner
LSW, U Heidelberg
H.E.S.S. observatory



The last 3 years



H.E.S.S. 1st extension started October 1, 2019

COVID restrictions starting Feb 2020.
Observers not allowed to leave Namibia in March 2020.
→ Operations with local observers/telescope operators.
→ H.E.S.S. continued to take data throughout the entire pandemic.

Initial test of moon observations in 2020,
Full integration as of January 2021.
Option: Remote observations from Zeuthen as of 2022

The last 3 years

New camera on 600 m^2-CT5 starting in 2019.
FlashCam-prototype and Nectar-chip based HESS1U cameras.
Changes to operational procedures and monitoring.

All telescopes, cameras, subsystems show high operational efficiency.

Average losses due to technical failures <2%/telescope and <5% full array.

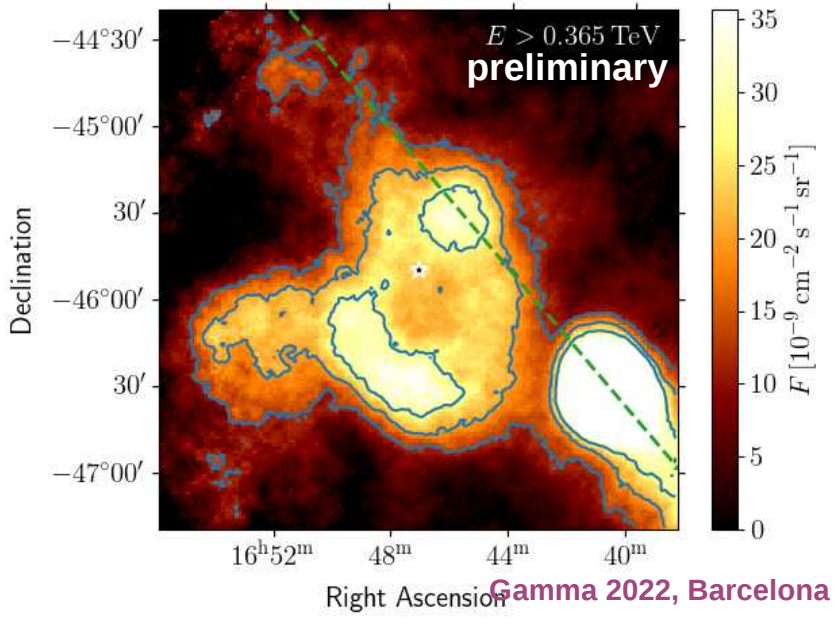
Low weather losses → >1200h darktime data,
~1500h incl. conservative moonlight/twilight.

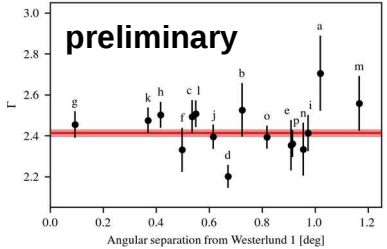
Galactic stellar clusters

The most massive open cluster in the local group,
but affected by significant (patchy) extinction: **Westerlund 1**

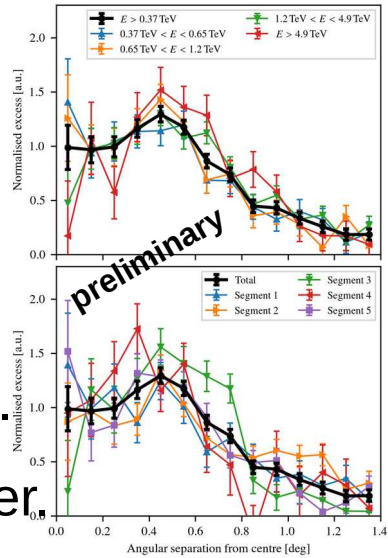
Discovery of coincident, degree-scale source
HESS J1646–458 centered on Wd1 in 2012.

New deep (164h) study (HESS coll., submitted)
Reveals shell-like structure, centered on cluster
and 4 sources on top of/adjacent to the shell.
HESS J1645−455, HESS J1647−465,
HESS J1649−460, and HESS J1652−462





Westerlund 1



Shell-like morphology (beyond Wd1) confirmed with high S/N.

The whole extended complex has remarkably homogeneous spectra.

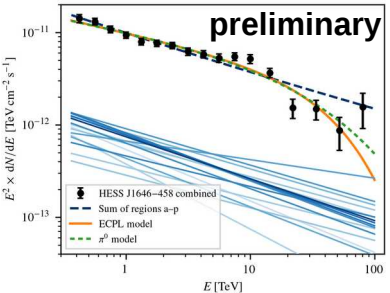
Individual ‘pixels’ in spectral map show no radial trend and little scatter.

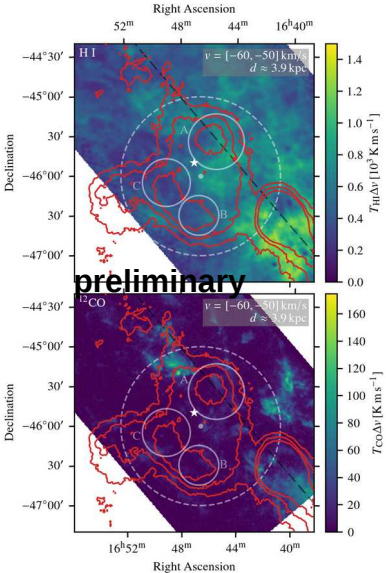
The overall emission may suggest (but does not require a cutoff).

No morphological match to neutral/molecular gas at 3.9 kpc (Wd1).

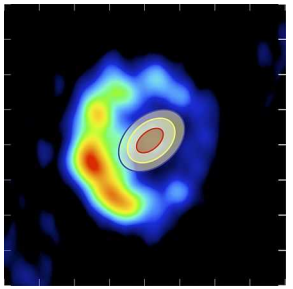
Conclusion: While not unique, CR acceleration at the cluster wind termination shock (size, morphology, energetics).

(L. Härer, poster)



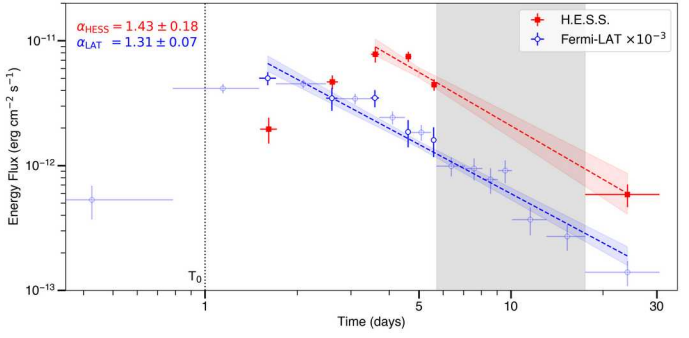


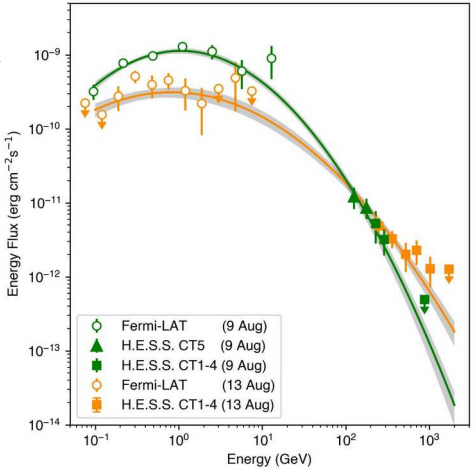
Recurrent Nova RS Ophiuchi



1st Galactic transient source: RS Ophiuchi – 2021 flare
A well-known recurrent nova at a distance of ~1.4 kpc.
Triggered by optical detection, VHE observations started with ~24h latency.
(2006 outburst in February restricted observing time for VHE follow-up.)
Lightcurve displays exponential rise and decay up to 40d past T_0.
VHE maximum off-set wrt to HE maximum by 2 days.
Energy-dependent rise, and corresponding spectral changes.
Conclusion: Hadronic scenario preferred; theoretical limit for E_{max} via diffusive shock acceleration reached → supports models for SNe accelerating PeV -CR.

S. Steinmaßl, Wednesday





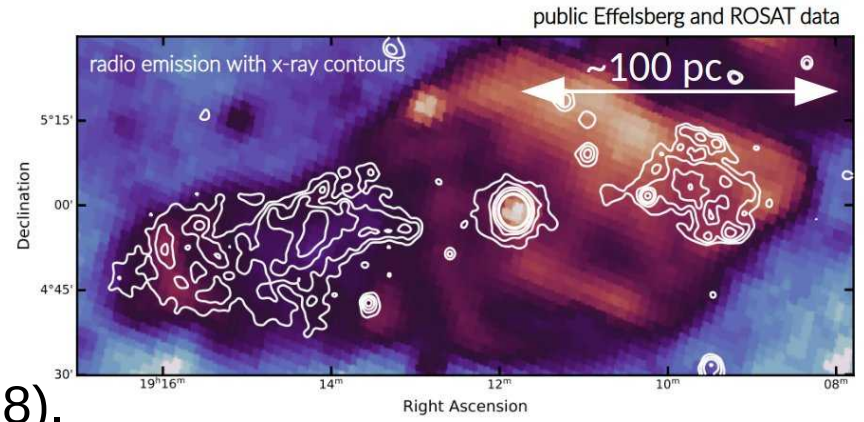
Microquasar SS433

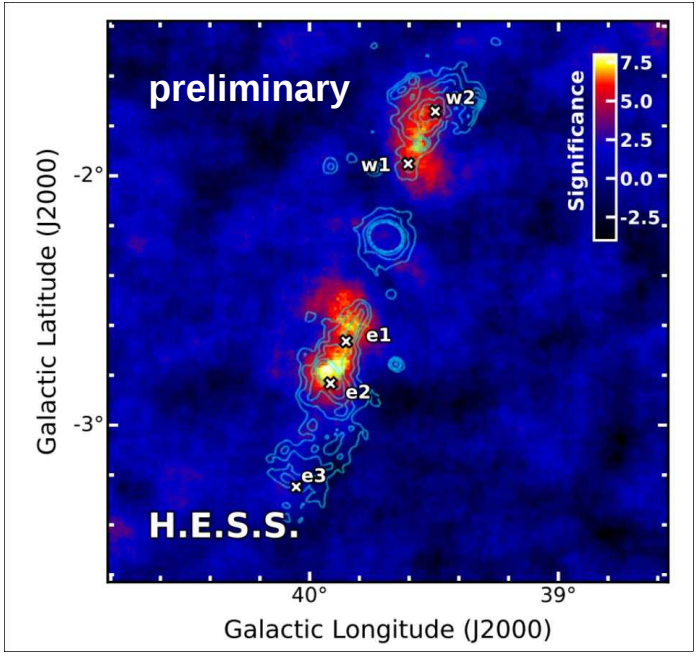
VHE upper limits in joint publication with MAGIC (2018) based on ~18h of data.
HAWC detection of emission from both jets (2018).

300h of H.E.S.S. observations reveal emission extended along jet direction on either side of SS433.

The central binary is not detected.

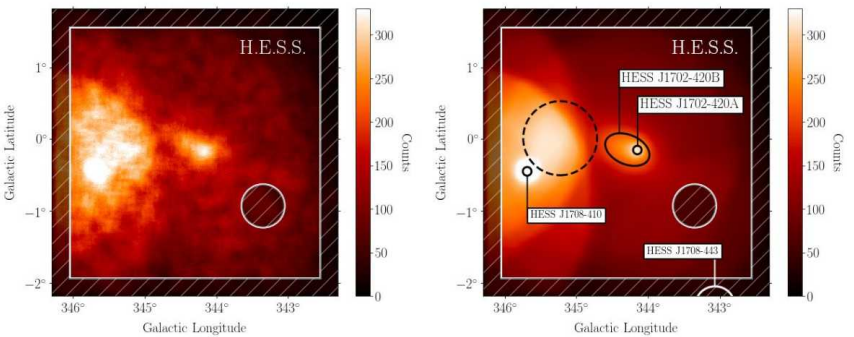
Spectra on both sides are similar and extend beyond 40 TeV. L. Olivera-Nieto, Monday



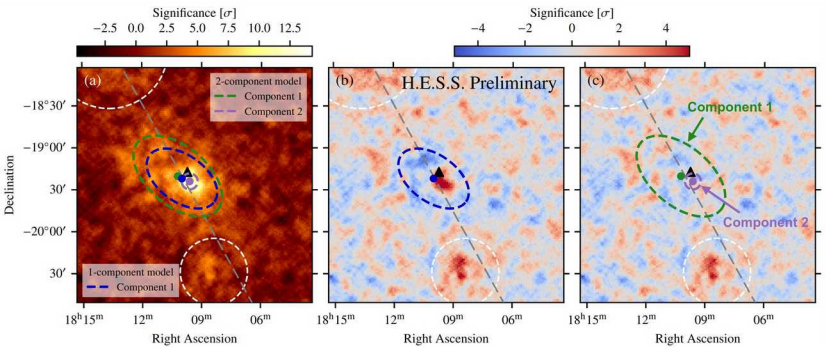


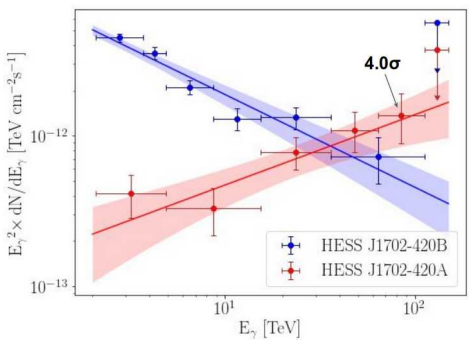
PeVatrons and candidates

HESS J1702-420
HESS collaboration, A&A, 653, A152 (2021)

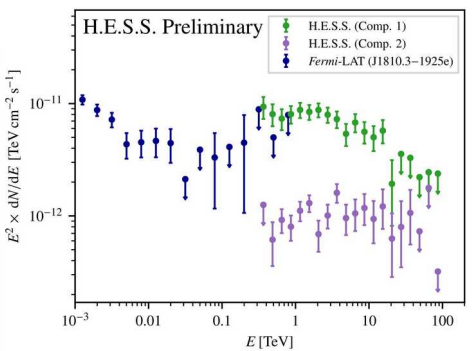


HESS J 1809-193
L. Mohrmann, Monday





While scenarios differ both PeVatron candidates reveal spectral substructure.



HESS J 1831-098

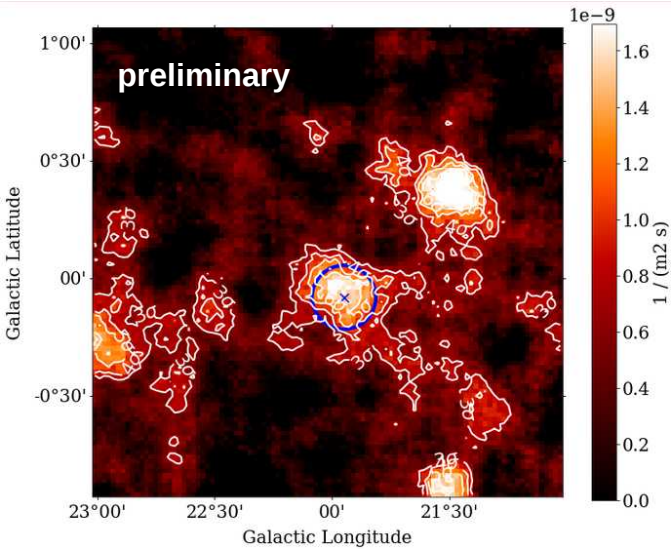
Data obtained beyond HGPS now reveals that emission from HESS J 1831-098 extends beyond 40 TeV.

No indication for spectral cutoff.
Extended morphology fit by a single component.

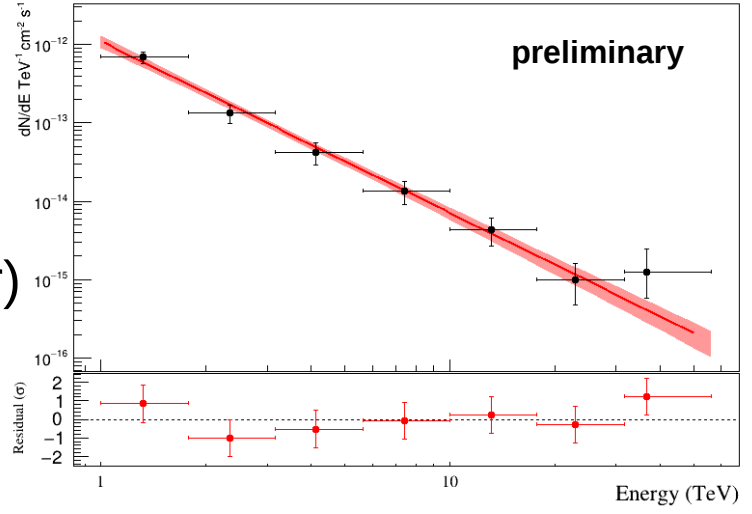
Proximity but offset from 3HWC J1831-095.

Rather old (130 kyr), low-power PSR J1831-0952 and/or
Cloud illuminated by G21.8+0.2 and/or G21.6-0.8

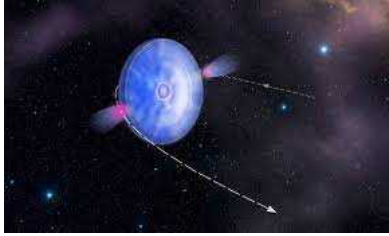
also: PeV candidate J2019+368 (D. Kostunin, poster)



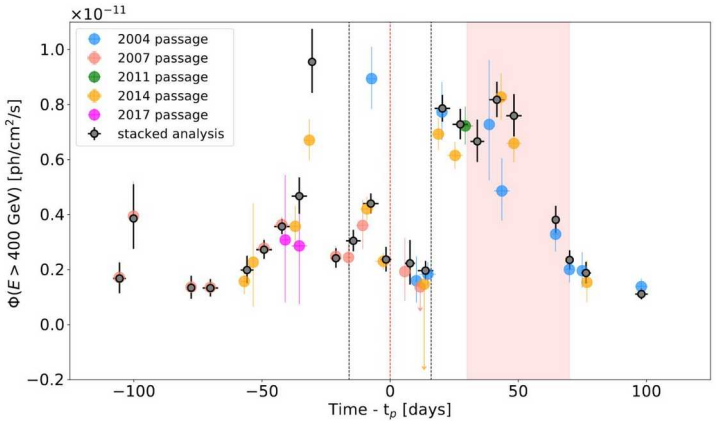
I. Lypova, Monday

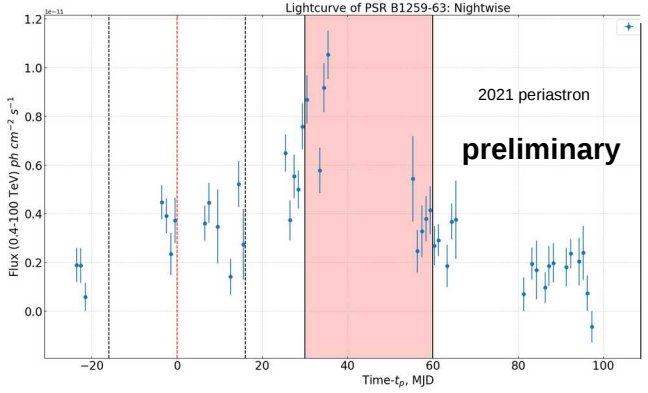


PSR B1259-63



Pulsar orbiting Oe9.5V star in 3.4 year cycle.
6th periastron covered with H.E.S.S. in 2021.



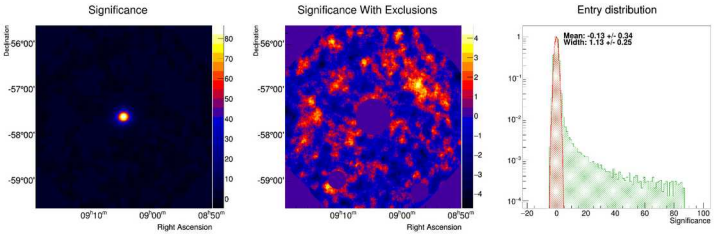


Clear confirmation of secular variations in gamma-emission during periastron.
Changes in GeV-TeV behavior.
Detection beyond 80d after periastron.

C. Thorpe-Morgan, Wednesday

AGN flares

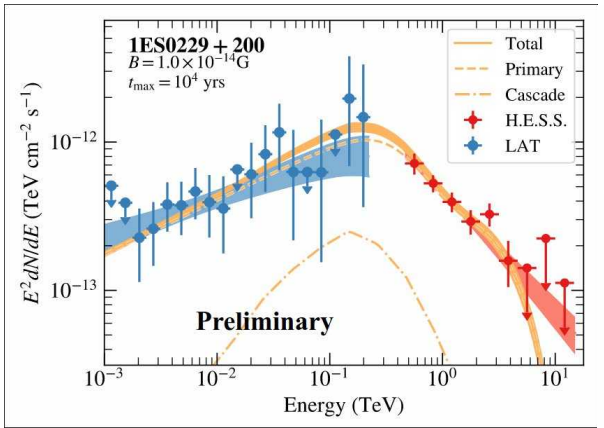
Flares detected with new CT5 camera in PKS 0903-57, ATEL #13632
Redshift quoted in literature almost certainly wrong.

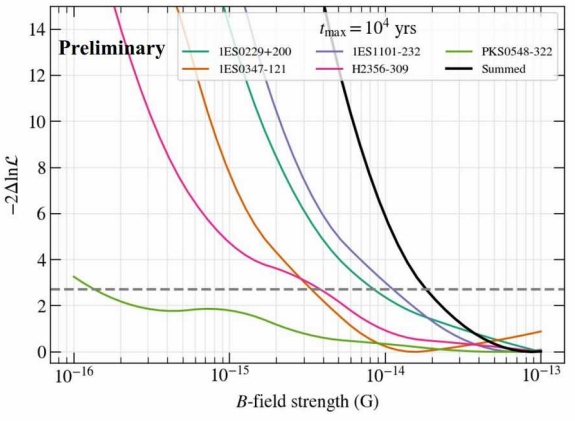


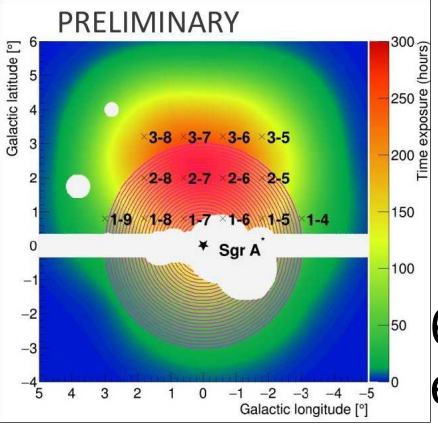
High-redshift flare in PKS 0346-27 @ z = 0.991
(ATEL #15092) → EBL extinction (see also M87).

Cosmological studies are also pursued with extreme Blazars
New sources: MRC 0910-208 and 1RXS J195815.6-301119 (arXiv:2108.02232)

… and established ones (60-160h)
5 sources → Limits on IGM
M. Meyer, Wednesday

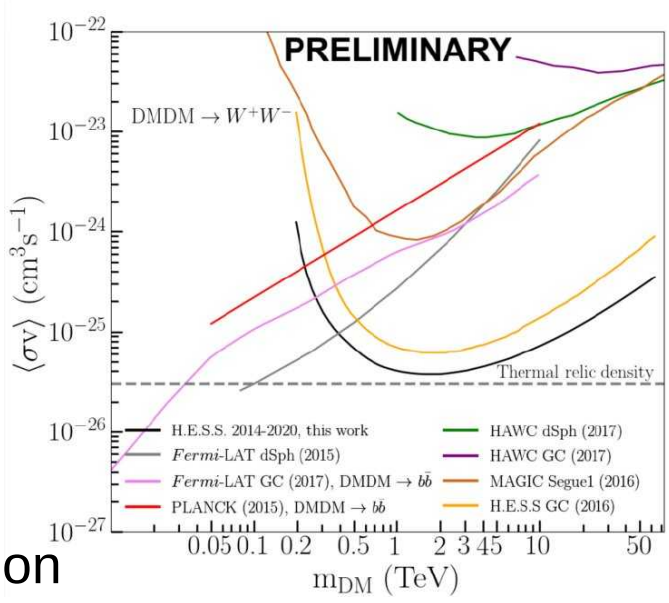






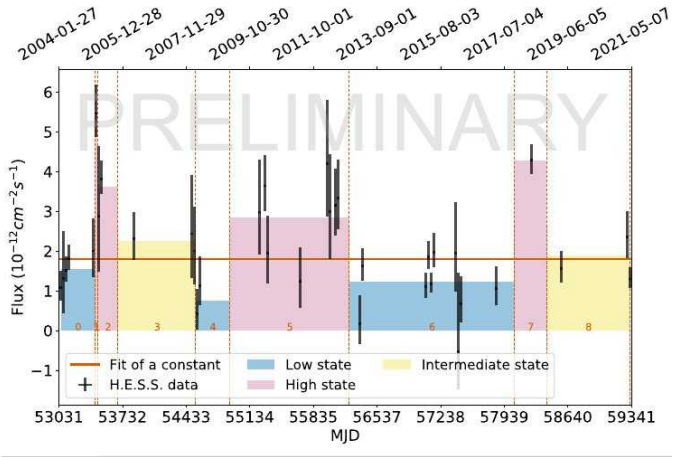
Pointers:

600h on Inner Galaxy Survey (2014-2020) extends previous DM studies down to thermal relic (A. Montanari, poster)



Data also contribute to deeper study of the diffuse emission in the Galactic Centre. J. Devin, Monday

- Pulsar Wind Nebula candidates (P. Chambery, poster)
- Limits on TDE event (I. Lypova, poster)
- M87: morphology V. Barbosa-Martins, Wednesday
- spectra&EBL (P. Zilberman, poster), lightcurve (Hahn)



New challenges

Many studies combine very extended data sets (600h+), obtained over many years with changing camera/telescope combinations, mapping extended structures beyond single fov and/or source confusion.

Challenges in treating systematics, background estimation and - rejection as well as separation of sources (3D modeling).
→ Extensive work improving calibration, background, and high-level analysis
e.g. choice of gammapy as high-level tool (borne out of 1HGPS)

See, e.g. presentations on MC validation (F. Leuschner, poster)
and background rejection (L. Olivera-Nieto, poster)

Starting H.E.S.S.-XX

Approaching its 20th anniversary (1st telescope inauguration and start of stereoscopic observations in 2002) the HESS observatory still improves its operational performance and enables fascinating research.