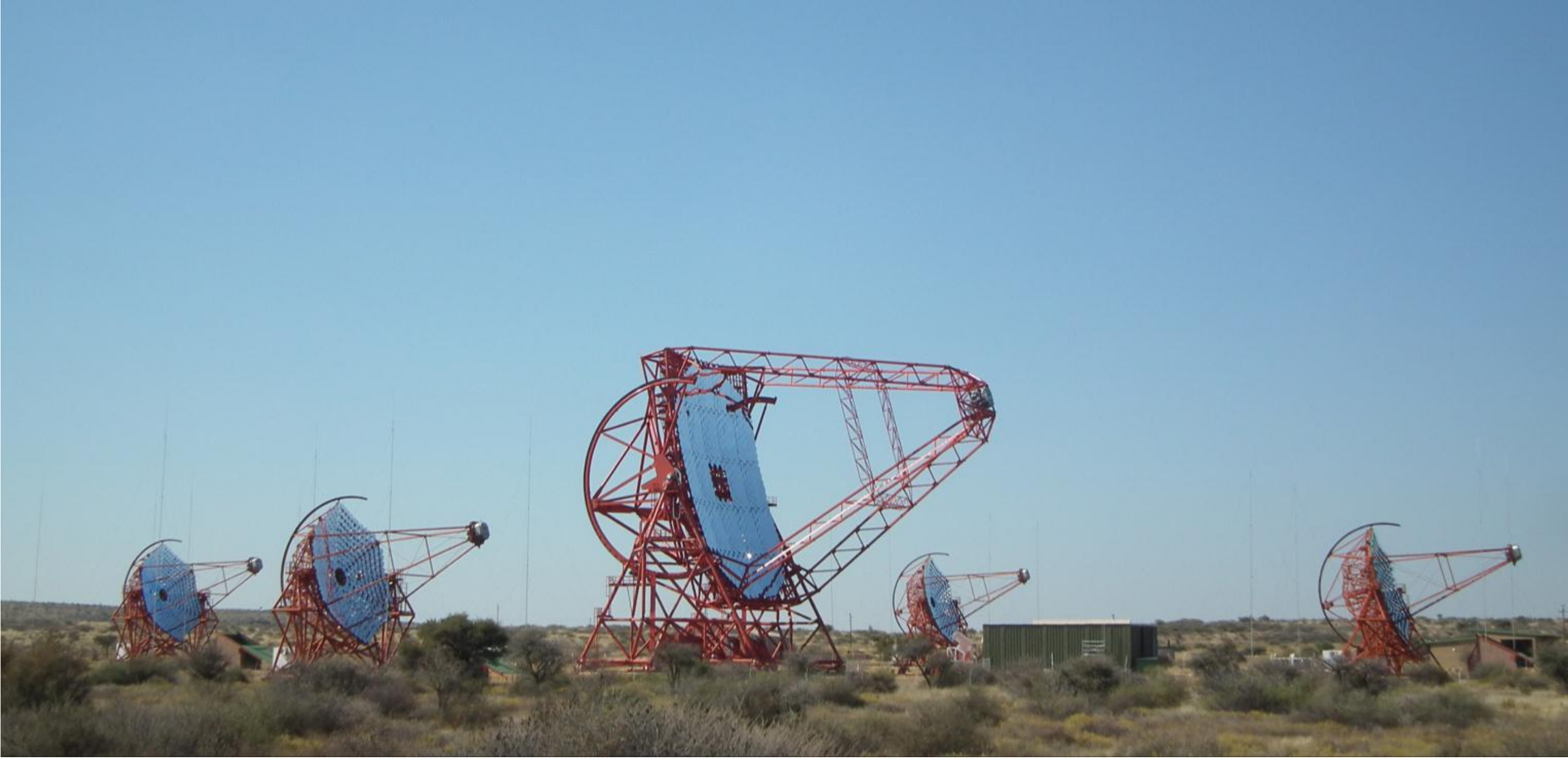


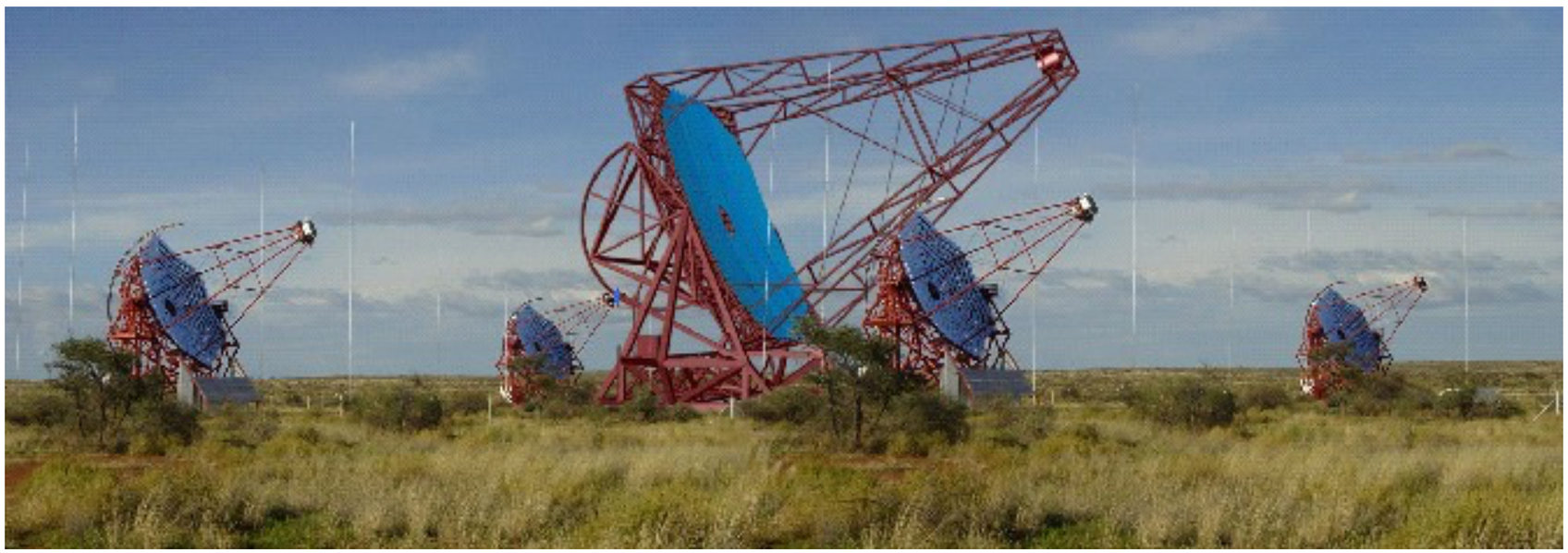
H.E.S.S. observations of pulsars

M. Spir-Jacob, A. Djannati-Ataï, L. Mohrmann, G. Giavitto, B. Khelifi, B. Rudak, C. Venter & R. Zanin for the H.E.S.S. collaboration

ICRC, Madison, July 2019

H.E.S.S. : High Energy Stereoscopic System

- **γ-ray ground based Cherenkov telescope** named after Victor HESS
- Two phases:
  - **HESS-I** since 2003: 4 telescopes of 12m of diameter used in stereoscopy **~ 100 GeV - 100 TeV**
  - **HESS-II** since 2012: 1 more telescope of 28m of diameter that lowers the threshold **~20 GeV**, can be used in mono or stereo
- **Monoscopic mode overlaps with Fermi-LAT**



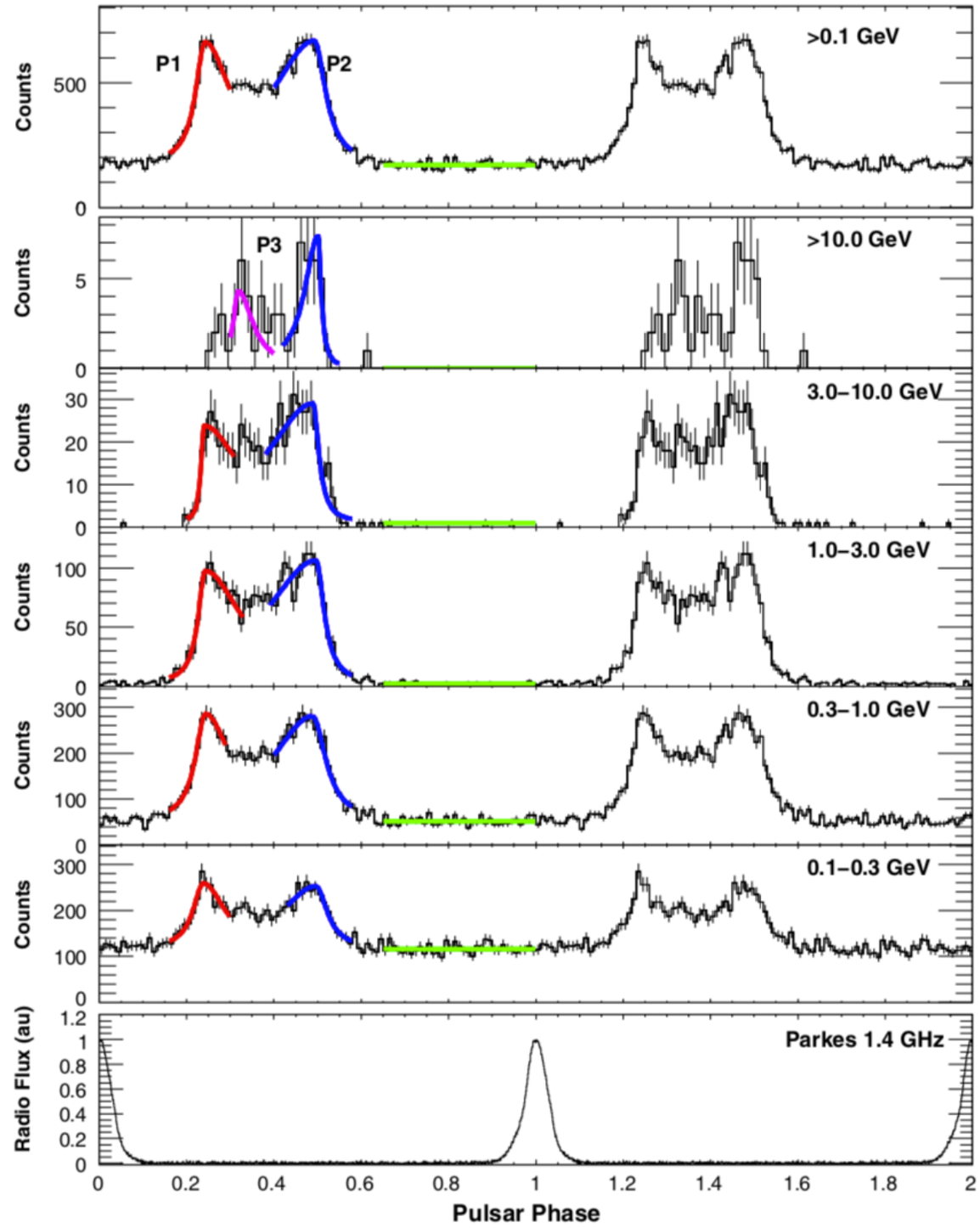
γ-ray emitting pulsars

- More than 2600 pulsars have now been discovered in radio
- Fermi-LAT detected more than 240 γ-ray emitting pulsars
- Component with a (sub-)exponential cut-off around the GeV
- Tail of that component accessible in HESS Mono
- 3 pulsars detected from the ground so far (the Crab, Vela and Geminga)
- **We announce the detection of PSR B1706-44 in the 10-80 GeV range**
- We discuss briefly the phenomenological implications of pulsars detections from the ground

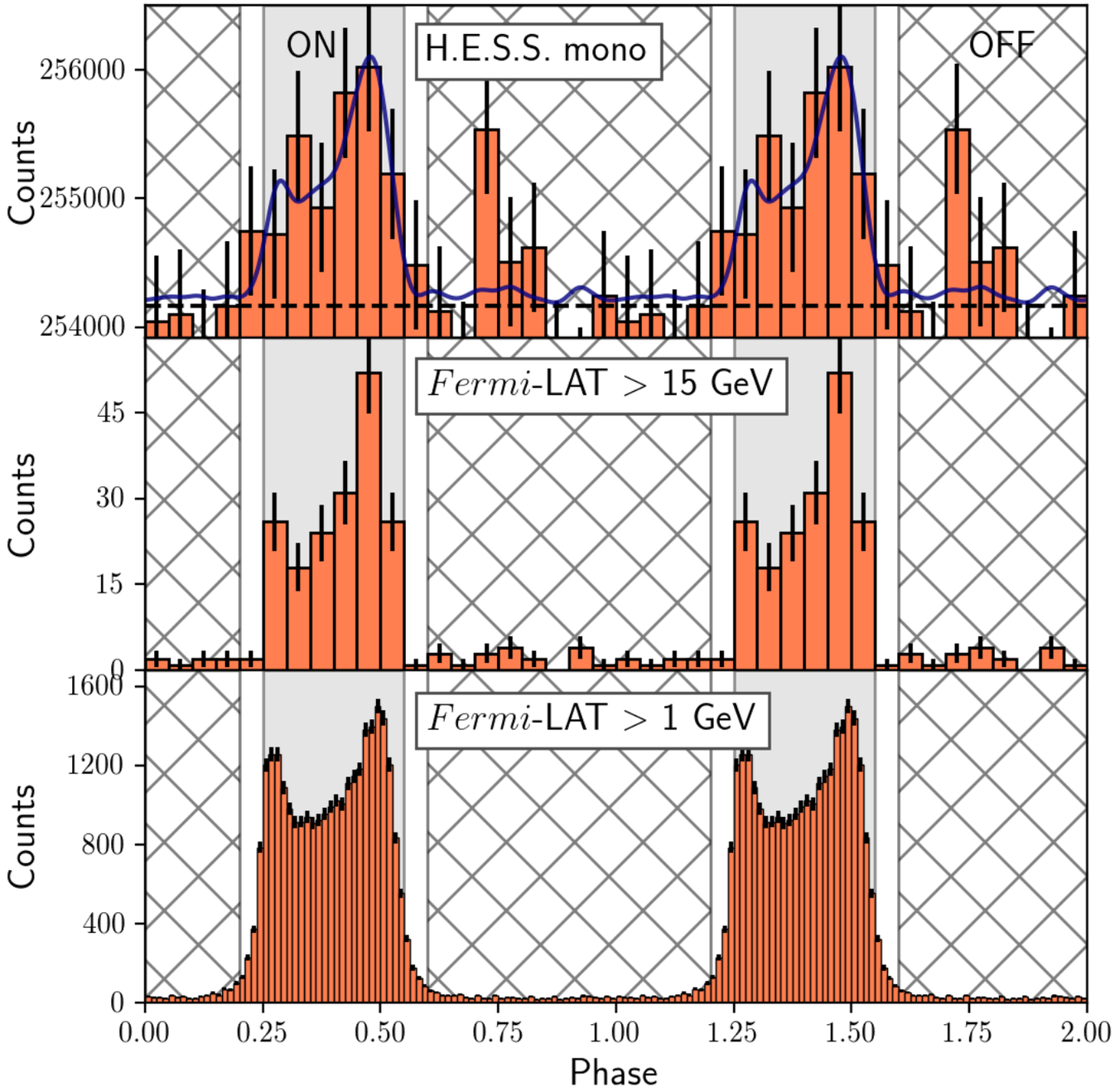
PSR B1706-44

- Discovered in 1992
- Flux: 10^{-9} erg/s/cm^2 (3rd in Fermi catalog)
- Period: 102 ms
- Age: 1.7x10^4 years
- Distance: 2.3 kpc

The positions of P1 and P2 do not evolve with energy while the ratio P1/P2 slowly diminishes with increasing energy



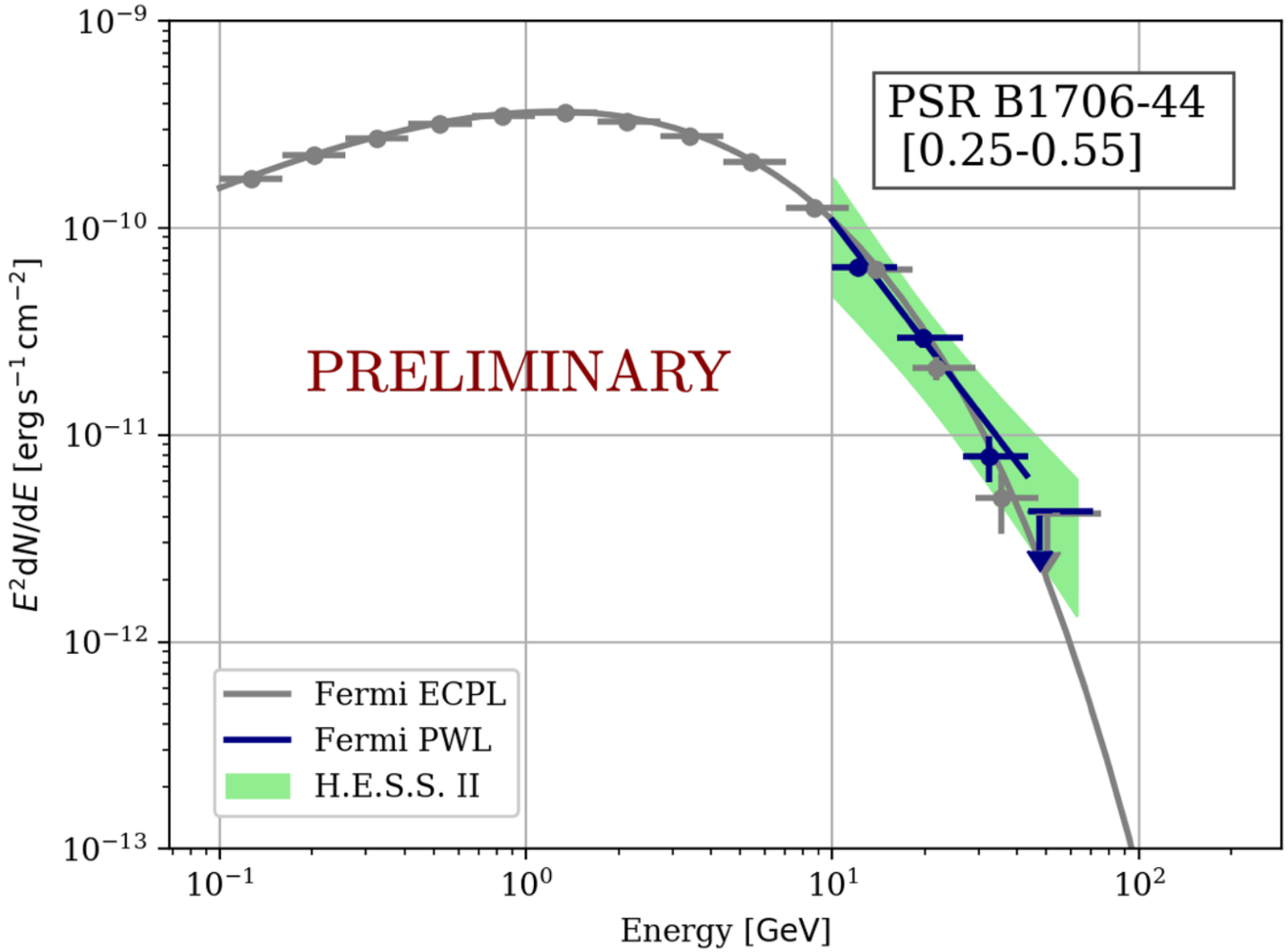
PSR B1706-44 phasogram



Li&Ma test:
ON: 0.25-0.55
OFF: 0.6-0.2
N: 5 091 420
N_{ON}: 1 532 177
N_{OFF}: 3 050 011
α: 0.5
4.74σ(>4σ: PSR detection threshold)
pulsed excess: 7171 +- 1515

Maximum likelihood ratio using Fermi-derived PDF:
4.6σ with 8139 signal events

PSR B1706-44 spectrum



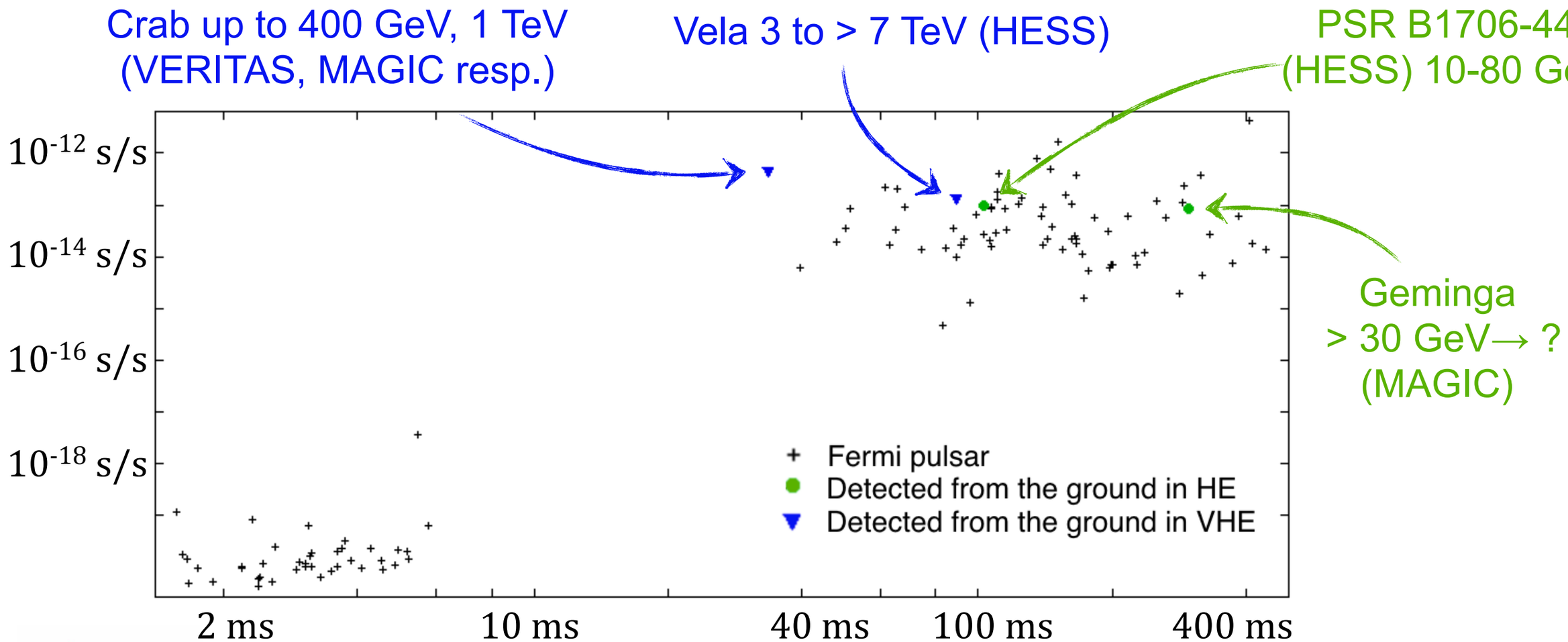
Phase-resolved spectrum on Fermi-LAT and HESS data

	Energy range	Index	Flux at 20 GeV [/TeV/cm^2/s]
Fermi	>10 GeV	3.9 +- 0.1	(4.4+-0.3)×10^{-8}
Hess	10-80 GeV	3.76 +- 0.36	(4.3+-0.9)×10^{-8}

Pulsars detected in ground-based γ-ray telescopes

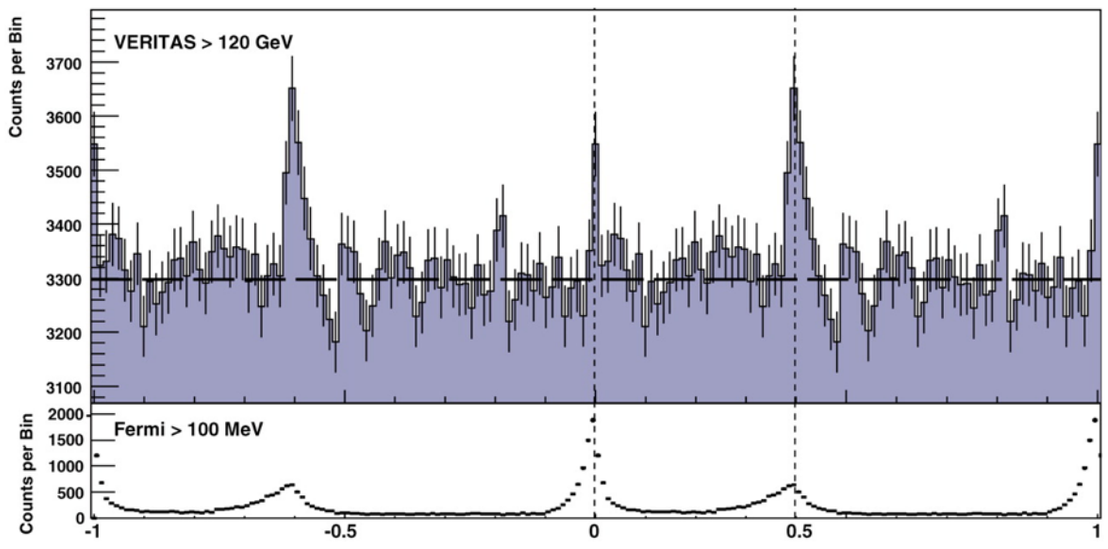
Four detections:

- 2 in the HE (<100 GeV) range only: PSR B1706-44 and Geminga
- 2 in the HE and VHE range: the Crab and Vela

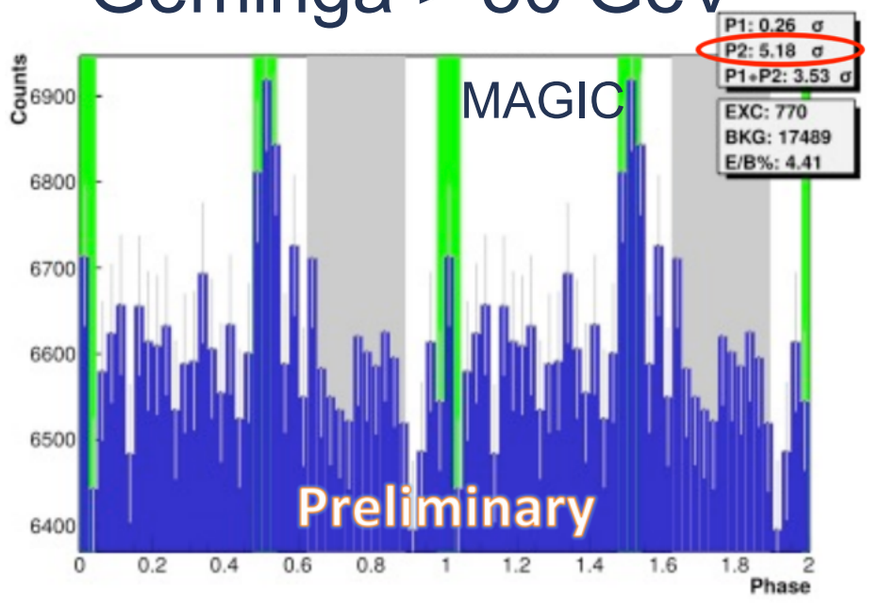


Phasograms of these four pulsars

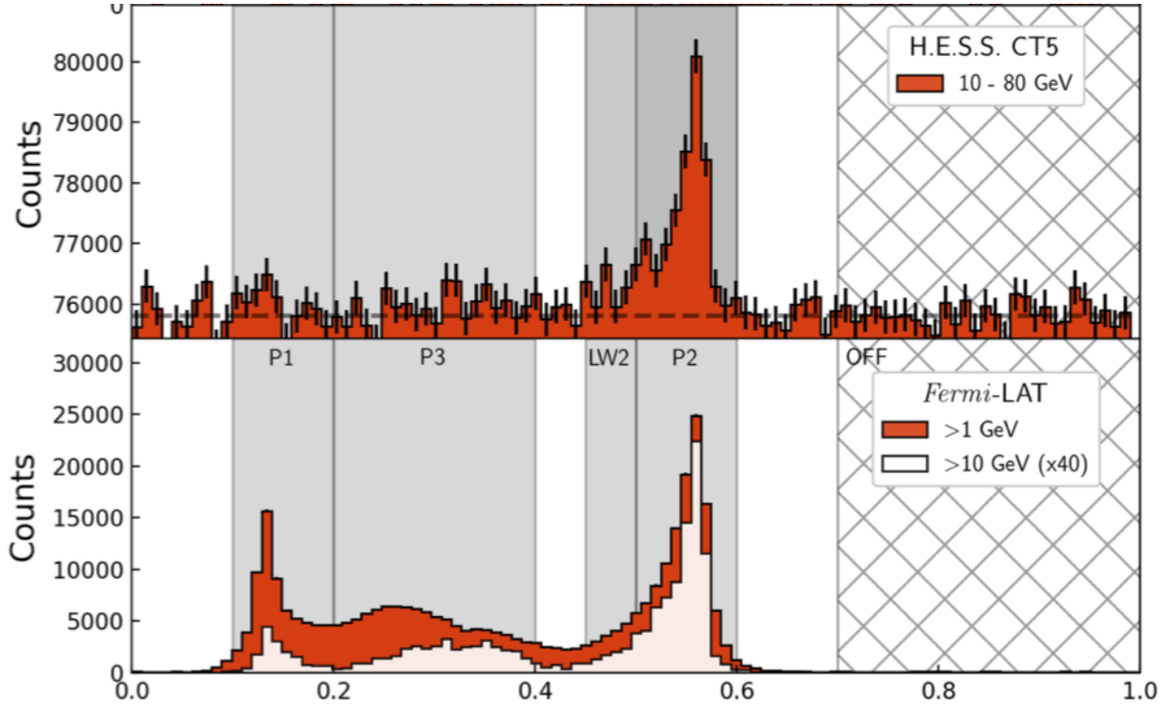
The Crab > 100 GeV



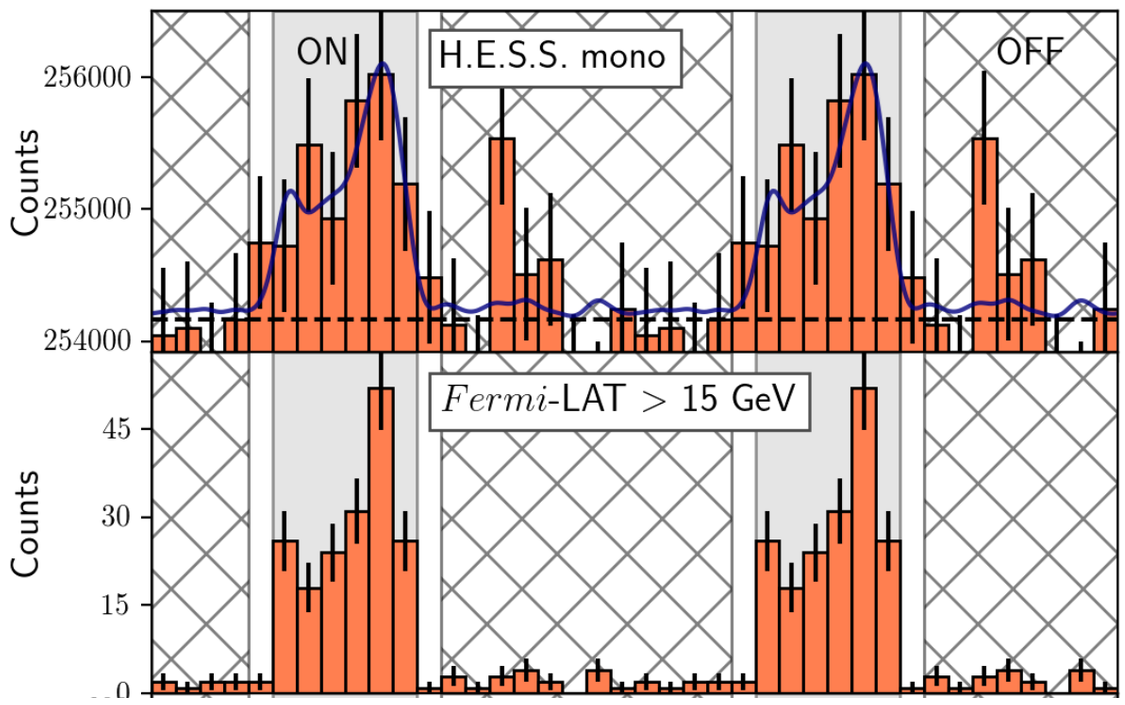
Geminga > 30 GeV



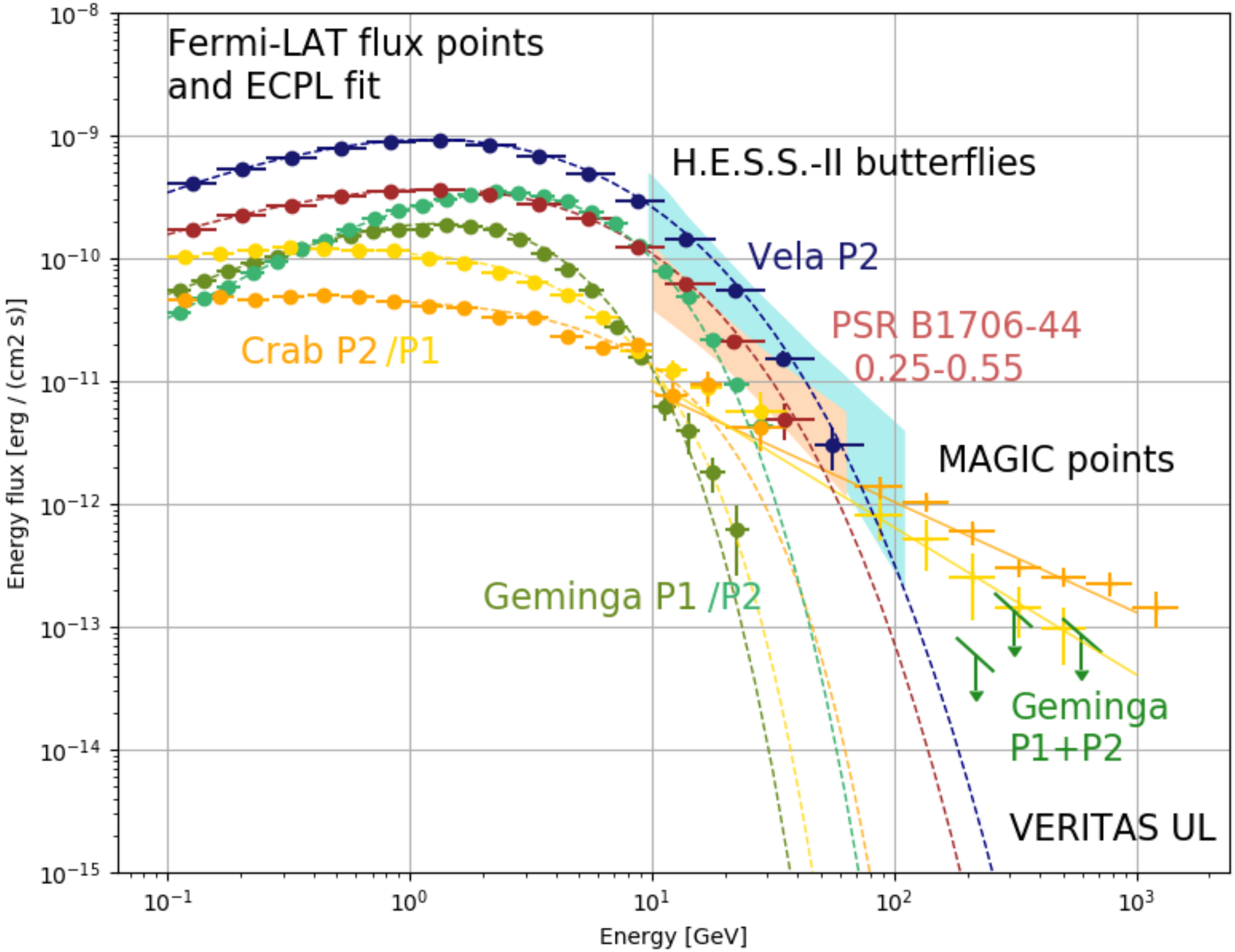
Vela 10-100 GeV



PSR B1706-44 10-80 GeV



Spectra of these four pulsars



The Crab and Vela PSRs exhibit important differences

Two different light curve and spectral behaviours

Crab

- Both pulses P1 and P2 are observed from the GeV to the TeV, bridge also detected from the ground
- The spectrum connects smoothly for both pulses from the GeV to the TeV with a power-law

Vela

- The amplitude P1/P2 changes more with energy and only P2 is detected from the ground
- The HE component shows a curvature / cutoff at few GeV with > 3σ for both Fermi and HESS
- Distinct spectral multi-TeV component

Do PSR B1706-44 (+Geminga and others) behave like the Crab or Vela in the 10-100 GeV range ?

Summary and conclusions

- We have detected pulsations from PSR B1706 with HESS-II in monoscopic mode in the 10-80 GeV range using 28.3h of observation
- It is the fourth detection from the ground of a pulsar
- Its light curve and spectrum in HESS are compatible with those of *Fermi*-LAT
- Steep spectrum with index -3.8+-0.4 similar to Vela (-4.1+-0.2)
- Lack of statistics prevents a conclusion on the curvature : as for Geminga, question whether it is Crab-like or Vela-like remains open
- Deeper observations should bring insight into gamma-ray pulsed emission:
  - On the location: cavities in the magnetosphere (OG/SG), current sheet in the striped wind, near or far beyond the LC
  - On the acceleration mechanism : $E_{//}$ or magnetic reconnection
  - Radiation processes : curvature, synchrocurvature, synchrotron for the HE component and IC, SSC for the VHE component