H.E.S.S. Highlights

Pierre Brun for the H.E.S.S. collaboration
August 2014, Quy Nhon Vietnam
The H.E.S.S. collaboration

- MPI Kernphysik, Heidelberg, Humboldt Univ. zu Berlin, Ruhr-Univ. Bochum, Univ. Erlangen-Nuremberg, Univ. Hamburg, LSW Heidelberg, Univ. Potsdam, Univ. Tübingen, DESY
- Polish Academy of Sciences; Jagiellonian University, Cracow; Nicolaus Copernicus University, Torun; University of Warsaw, Warsaw
- Univ. Adelaide, North-West Univ., Potchefstroom, Wits Univ., Johannesburg, Univ. of Namibia, Windhoek
The H.E.S.S. experiment

- **H.E.S.S. phase I**
  - Four 12 m telescopes
  - FoV 5 deg
  - Energy threshold 100 GeV
  - Angular resolution < 0.1 deg

- **H.E.S.S. phase II**
  - Four 12 m telescopes
  - One 28 m telescope (FoV 3.5 deg)
  - Energy threshold O(30 GeV)
  - Angular resolution from 0.4 deg to less than 0.1 deg
The H.E.S.S. experiment

- H.E.S.S. phase I
  - More than 10000 hours of data
  - Discovered over 80 new VHE gamma ray sources
  - Published over 100 scientific papers, plus numerous conference contributions
- H.E.S.S. phase II
  - Towards lower threshold and transients

H.E.S.S. phase I  H.E.S.S. phase II
H.E.S.S. I Highlights:
The Galactic Plane Scan

- Pre-trials significance map, correlation radius $0.1^\circ$
- Blue-red transition corresponds to $\sim 5\sigma$ post trial

- **Blue lines**: H.E.S.S. horizons for 1% and 10% Crab
- **Dots**: H.E.S.S. Galactic sources
  - Red: PWNes
  - Yellow: SNRs
  - Black: other sources

Pierre Brun - H.E.S.S. Highlights - VHEPU, Vietnam 2014
H.E.S.S. I Highlights: A selection

- Diffuse emission
  - After subtraction of sources

- Extreme SNR
  - HESS J1640: The brightest (Stefan Ohm)
  - G349.7+0.2: The farthest

- Pulsar wind nebulae population

- AGN limits

- Many more
H.E.S.S. phase 2

- Operation of the first mixed system of Cherenkov telescopes

- Trigger
  - All configurations simultaneously

- Analysis
  - CT5 mono: presented here
  - Full H.E.S.S. array analysis under study
Single telescope reconstruction

- Template (model) based photon reconstruction
  - Adapted from de Naurois et al APh 32, 231 (2009)
- Standard analysis
  - Optimized for source observations
- PSR/GRB analysis
  - Optimized for low E detections
- Template (MC) based photon reconstruction
  - ImPACT, Dan Parsons
Collection area

H.E.S.S. Preliminary

Effective area [m^2]

log_{10}(E_{true} [TeV])

-1.8 -1.6 -1.4 -1.2 -1.0 -0.8 -0.6 -0.4 -0.2 0

-10^4 -10^5

HESS28m mono (trigger)
HESS28m mono (standard analysis)
HESS28m mono (pulsar/GRB analysis)
HESS12m full array (standard analysis)
MAGIC I mono (Albert et al. (2008))
### Energy and angular resolution

<table>
<thead>
<tr>
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<th>Energy resolution</th>
<th>Angular resolution</th>
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<tbody>
<tr>
<td>Standard analysis</td>
<td>30%</td>
<td>0.2 deg</td>
</tr>
<tr>
<td>Pulsar/GRB analysis</td>
<td>30% - 40%</td>
<td>0.3 - 0.4 deg</td>
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**Energy bias**

![Energy bias graph](graph1.png)

**Angular resolution**

![Angular resolution graph](graph2.png)
Sensitivity

- Standard analysis
  - 5σ in 100 h
  - 5% background systematics

- Pulsar analysis
  - 5σ in 100 h
  - No background systematics
The Crab with H.E.S.S. II

- \( <\text{zenith}> = 48 \text{ deg} \)
- Standard analysis
  - Photon rate = \(12.6 \pm 0.1 \, \gamma/\text{mn} \)
  - MC expectation = \(13 \, \gamma/\text{mn} \)
AGN seen with HESS 28m

<table>
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<tr>
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<th>Live time</th>
<th>Excess</th>
<th>Sign.</th>
<th>Rate</th>
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<tr>
<td>PKS 2155-304</td>
<td>35.7 h</td>
<td>3669 γ</td>
<td>29 σ</td>
<td>1.71 ± 0.06 γ/mn</td>
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<tr>
<td>PG 1553+113</td>
<td>15.4 h</td>
<td>2358 γ</td>
<td>25 σ</td>
<td>2.55 ± 0.11 γ/mn</td>
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The Galactic Center

- The Galactic Center is one of the most complicated regions
- Observation and analysis
  - Live time 68.8 h
  - Signal with 25 $\sigma$
  - Extended emission
- Background needs to be further studied
- More from H.E.S.S. I observations
The Vela pulsar

- Observation
  - Livetime 20 h
  - Zenith angle: 27 deg – 35 deg

- PSR analysis
  - Optimized cuts for low energies

- Data samples
  - data sample 1
  - data sample 2
  - 10 h
  - 7 h
  - 3 h

Fermi-LAT, arXiv:1002.4050
The Vela pulsar seen with H.E.S.S. phase 2 data sample 2

- Significance 9.5 $\sigma$
- $N_{\text{excess}} = 6059 \pm 640$
Pulsar physics (not only Vela)
- What is the spectrum above 20 GeV?
- Constraining the cut-off?
The Vela pulsar spectrum

Fermi-LAT arXiv:1002.4050

H.E.S.S.
The Vela pulsar seen with H.E.S.S.

- For H.E.S.S.
  - Calibration source at the threshold in standard observation mode
  - Well prepared for GRB search
Transients with H.E.S.S. phase 2

Adapted from Funk & Hinton
Summary

- H.E.S.S. phase 2, including the 28 m telescope is
  - Measuring point sources and extended sources
  - Filling the gap between Fermi-LAT and IACTs

- Exciting times ahead
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