Analysis optimisation for more than 10 TeV gamma-ray astronomy with IACTs

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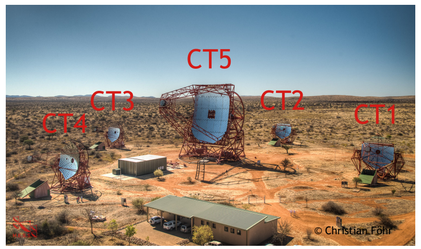
High Energy Stereoscopic System — H.E.S.S.

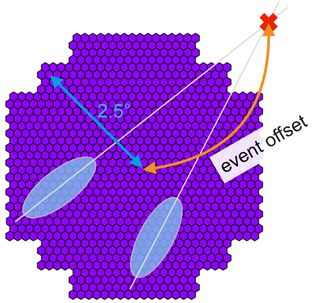


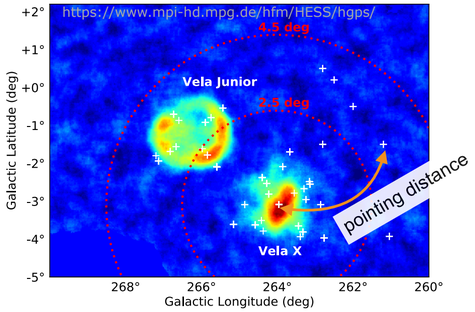
- CT1-4: ⌀12m, 5° FoV, energy threshold ~100 GeV
- CT5: ⌀28m, 3.2° FoV, energy threshold tens of GeV

Sensitivity degradation at high energies due to:
- limited gamma-ray statistics (steeply falling source spectra)

Analysis optimisation:
- event selection
- **reconstruction**
- **gamma/hadron separation**

Large-offset-angle events





standard analysis:
max. event offset ≈ max. pointing distance ≈ 2.5°

Allowance for large-offset events (> 2.5°) in the analysis →
- **larger effective field of view** (up to ~8-9 deg)
- **increase in gamma-ray statistics** at highest energies

Closely located sources in the Galactic Plane — perfect targets for the approach

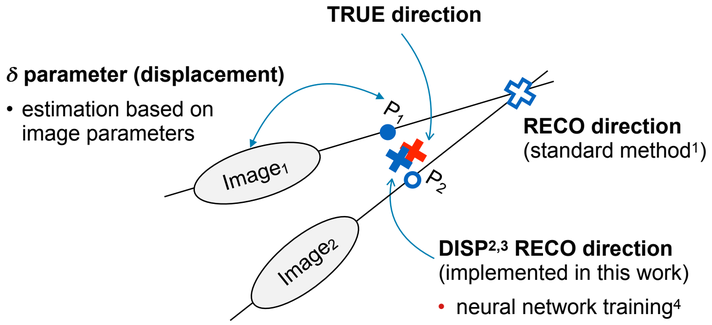
Challenges of large-offset event analysis

Standard direction reconstruction[1]:
- intersection of image major axes →

Large offset angles:
- angles between images are small ⇒
- small error in image direction = large inaccuracy in shower direction ⇒
- **reconstruction accuracy decreases**

+ **increase in background rate**

Improved direction reconstruction (DISP method)



Improved gamma/hadron separation

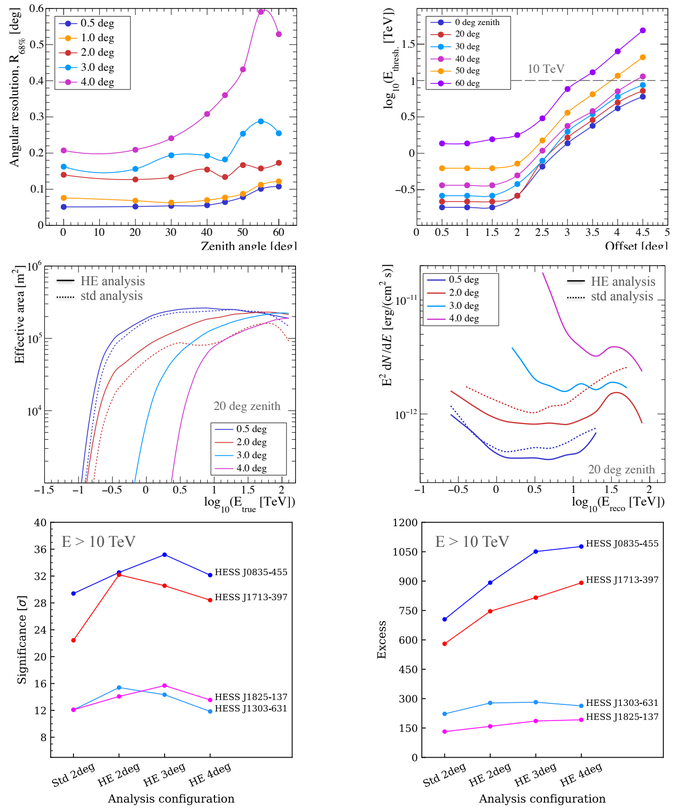
Based on standard g/h separation[5] (BDT training[4])
- standard training variables + **shower core distance**
- training bands:
  - 1 offset band → **9 bands** (between 0.5° & 4.5°)
  - 1 high energy band 5-100 TeV → **5 bands** (between 5 & 150 TeV)

Summary

- Large-offset events in the analysis — promising way to increase
  - source exposure and statistics at high energies
  - an effective field of view up to 9°
- Challenges — addressed using
  - DISP direction reconstruction
  - improvements in g/h separation

  → **high-energy optimised analysis**
- Results:
  - 5-10% improvement in angular resolution & 10-20% in sensitivity for standard offset angles
  - sensitivity to events at large offset angles (was not accessible before!)

Performance



Acknowledgements:

We thank the H.E.S.S. Collaboration for allowing us to use H.E.S.S. data and analysis software package for this contribution.

https://www.mpi-hd.mpg.de/hfm/HESS/pages/publications/auxiliary/HESS-Acknowledgements-2021.html

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