COSMIC-RAY ELECTRONS MEASURED WITH H.E.S.S.

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Outline

- The H.E.S.S. Experiment
- The H.E.S.S. Electron Measurement
  - Gamma-Ray Background
  - Hadronic Background
  - Spectrum Determination
- Results
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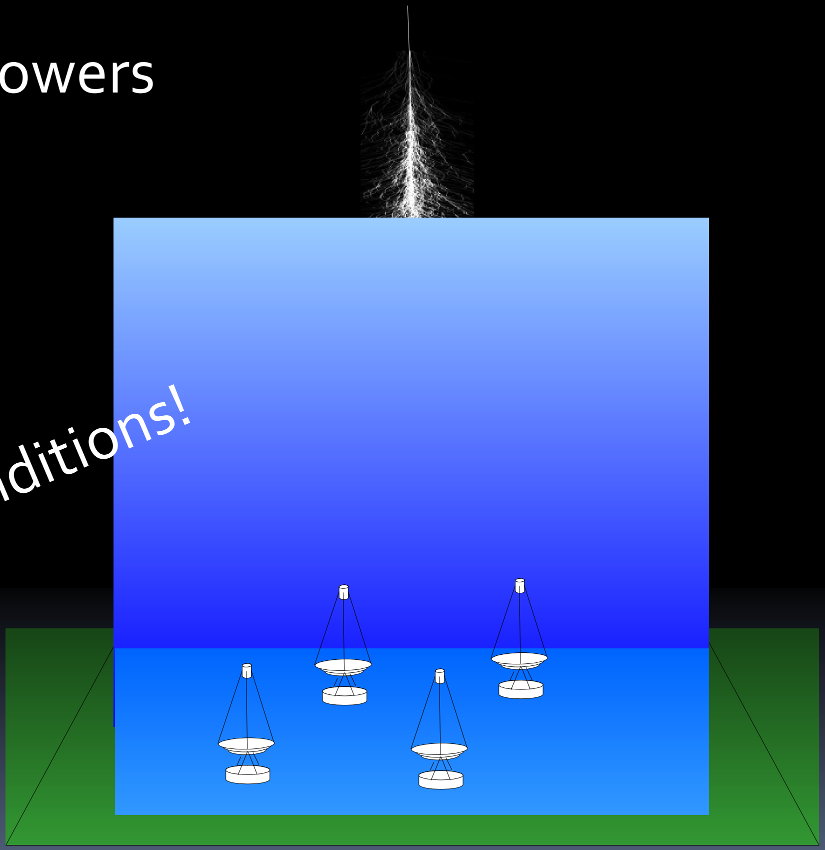
The High Energy Stereoscopic System

- Four Cherenkov telescopes in Namibia
- 13 m diameter mirrors (107 m^2)
- Cameras: 5˚ diameter field of view
- Energy threshold > 100 GeV
  (depending on event selection cuts and data set)

The H.E.S.S. Electron Measurement

- Indirect measurement via air showers in atmosphere
- Advantage:
  large collection areas (≈10^5 m²)

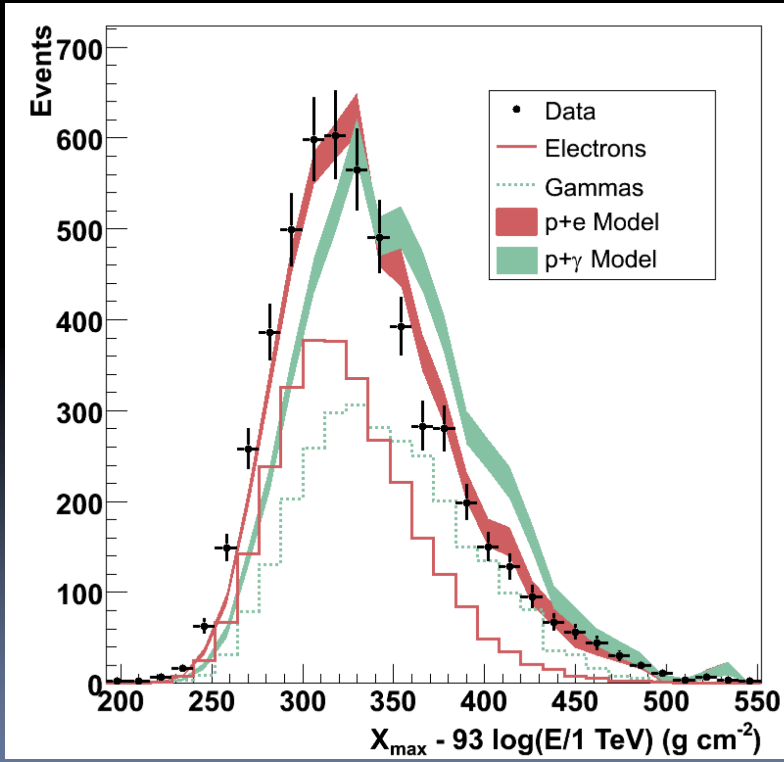
Dependence on atmospheric conditions!



- Background contributions:
  - Gamma rays
  - Hadrons

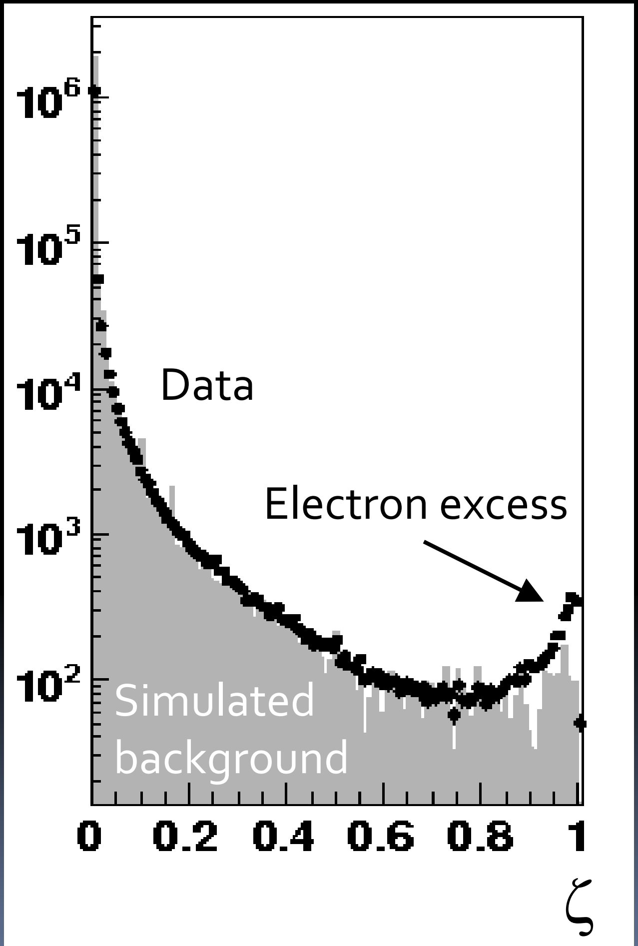
Gamma-Ray Background

- Very similar air showers
- Avoided by choice of data set:
  Galactic plane and potential gamma-ray sources are excluded
- Remaining background:
  diffuse extragalactic gammas
  - Very low fluxes are expected due to pair creation on radiation fields
  - Experimental discrimination: X_{max}
    - Occurs ½ radiation length higher for electrons
    - Cannot exclude maximum of 50% gamma contamination



Hadronic Background

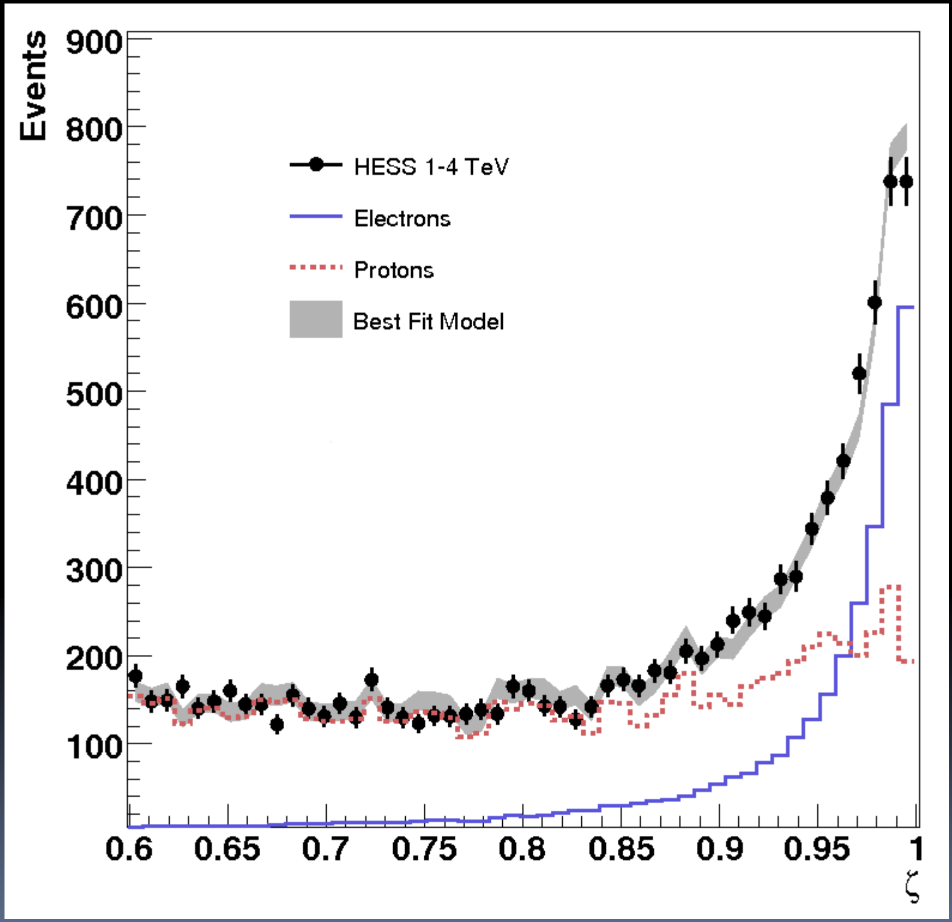
- Electron-hadron separation with the machine-learning algorithm **Random Forest** (RF)
- RF converts image parameters into output parameter $\zeta \in [0,1]$:
  - ζ=1: electron-like
  - ζ=0: background
- ζ describes *electron-likeness* of an event
- Cut ζ>0.6 is applied for a 98-99.5% background suppression



Hadronic Background

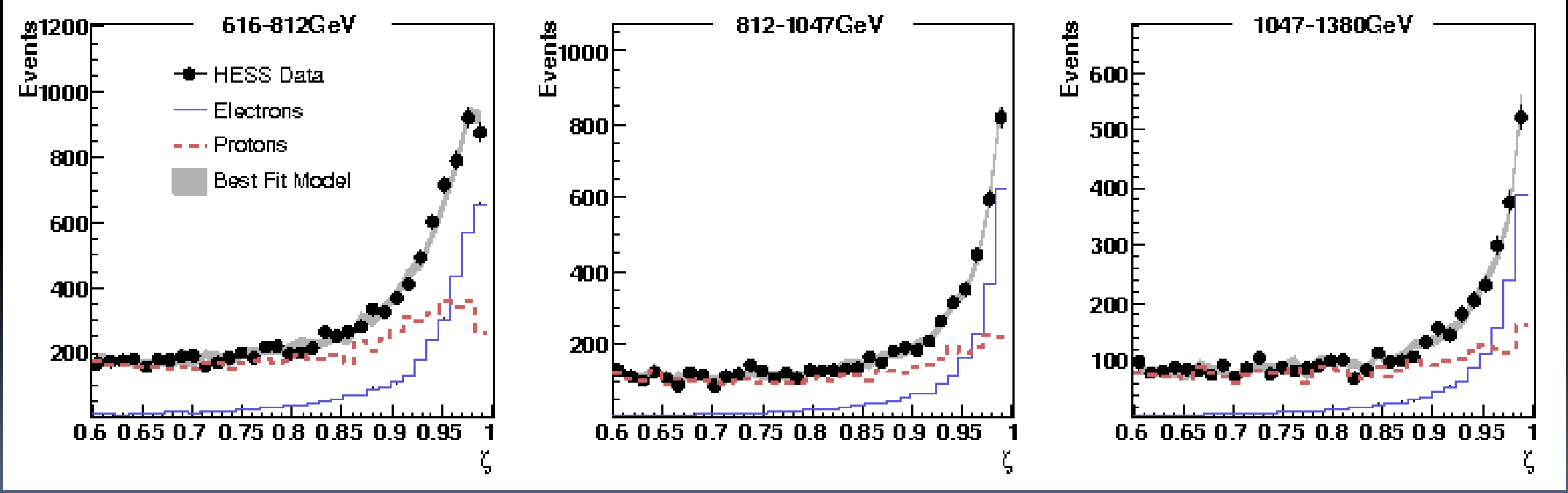
- Remaining background level determined by a fit in ζ with electron and proton simulations
- The hadronic background can be modelled with protons only because heavier nuclei are sufficiently suppressed by ζ cut

Dependence on hadronic model!



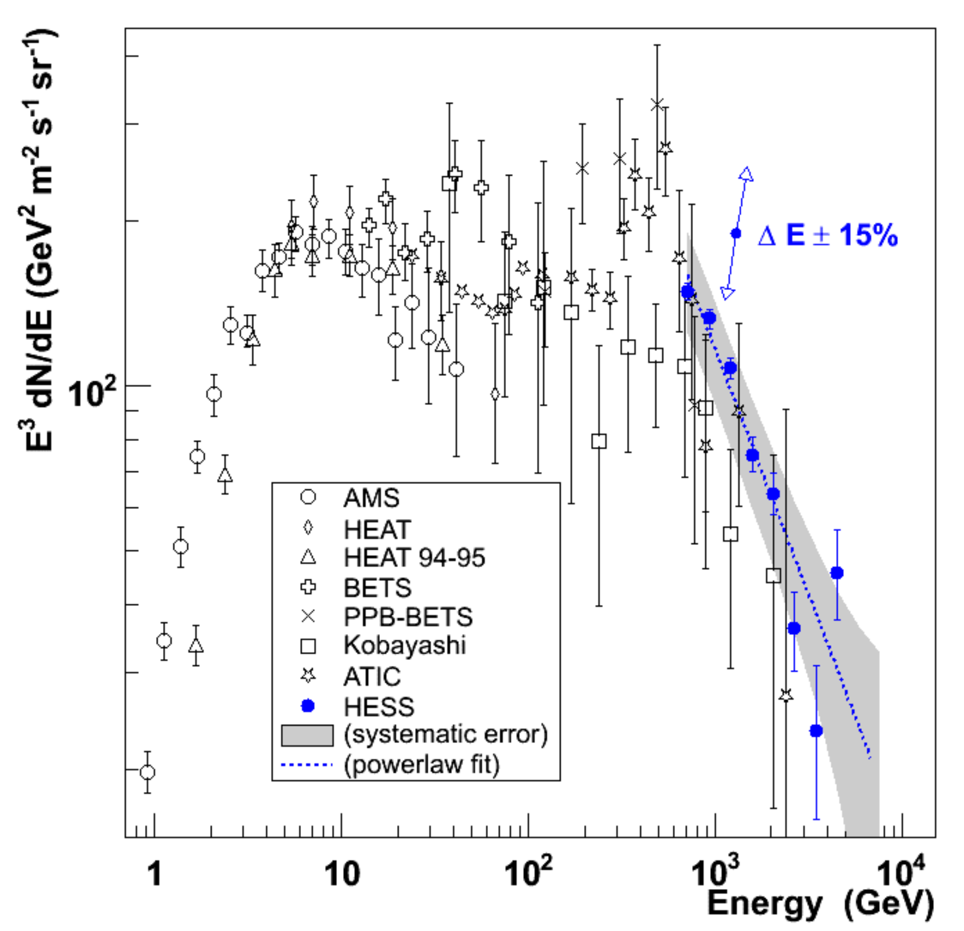
Spectrum Determination

- Fit in ζ in independent energy bands
  $\Rightarrow$ determine number of electrons in each band



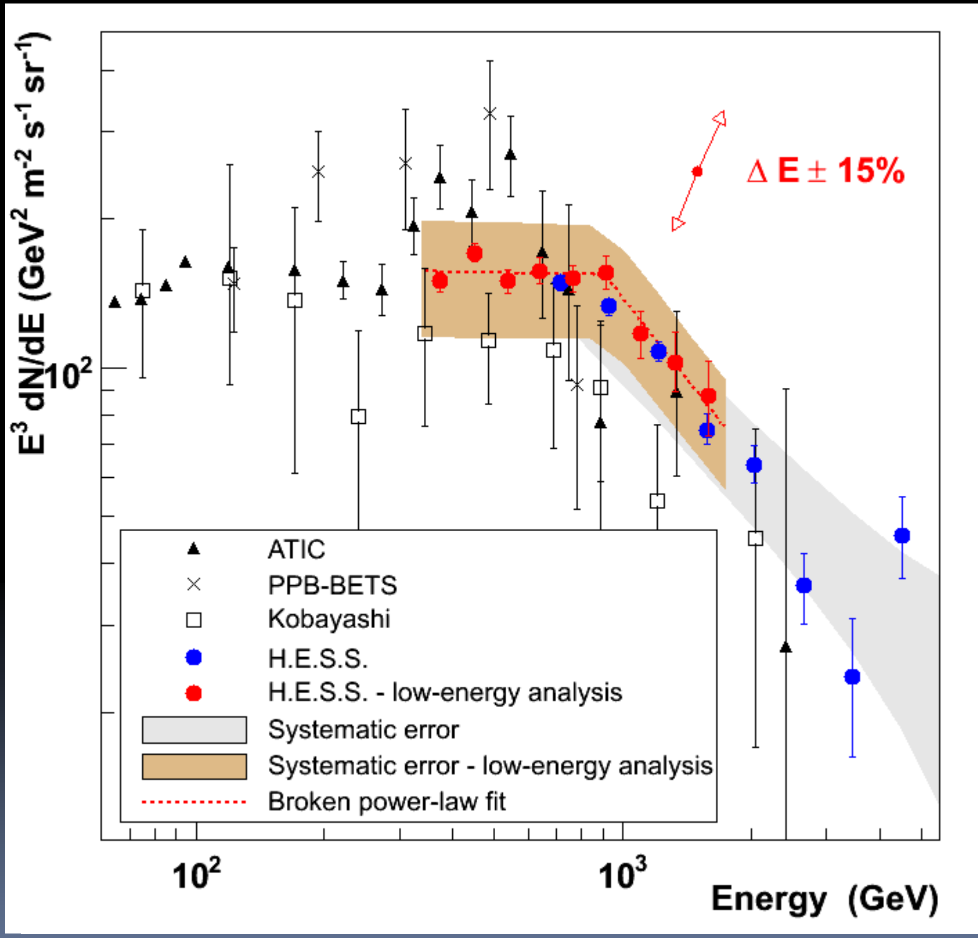
Results: High-Energy Spectrum

- Cuts:
  - impact distance < 200 m
  - image size in each camera > 200 photo electrons
- Syst. uncertainty: atmospheric variations + model dependence of proton simulations (SIBYLL vs. QGSJET-II)
- H.E.S.S. energy scale uncertainty of 15%
- Spectral index: 3.9±0.1(stat)±0.3(syst.)



Results: Low-Energy Spectrum

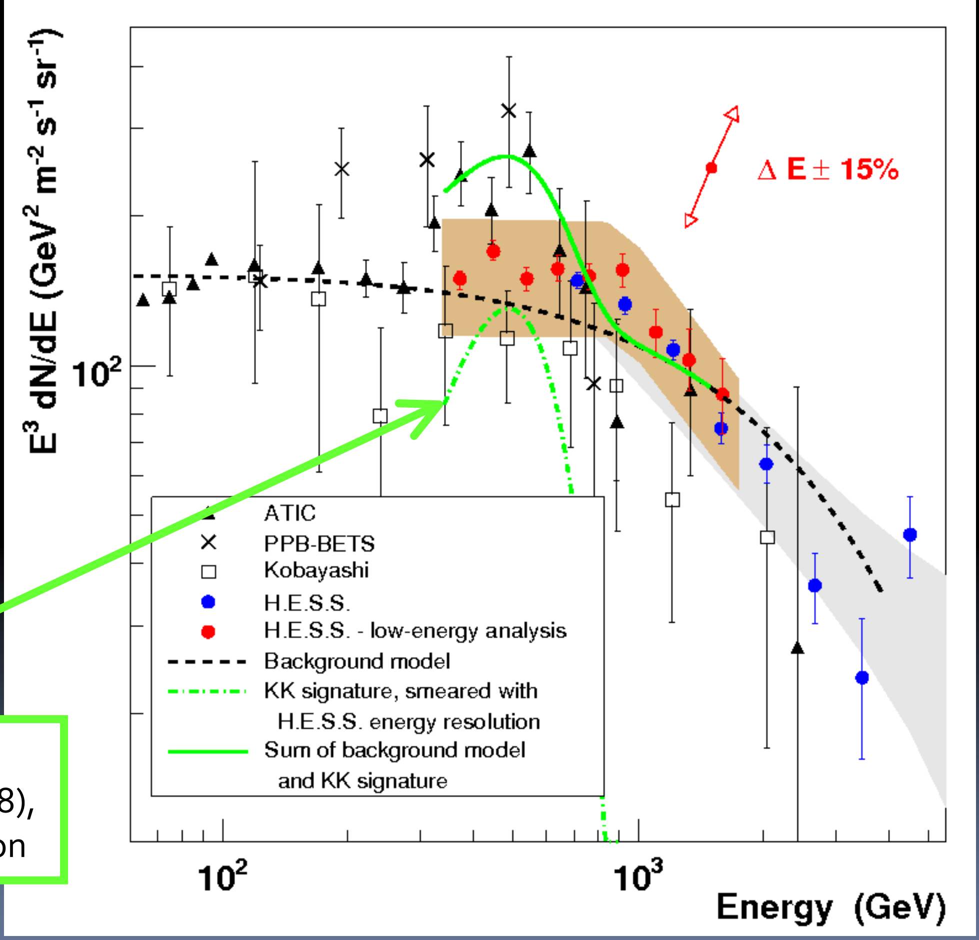
- Cuts:
  - impact distance < 100 m
  - image size in each camera > 80 photo electrons
  - Data set of 2004/2005
- Syst. uncertainty: atmospheric variations + model dependence of proton simulations (SIBYLL vs. QGSJET-II)
- Spectral index:
  $\Gamma_1 = 3.0 \pm 0.1(\text{stat}) \pm 0.3(\text{syst.})$
  $\Gamma_2 = 3.9 \pm 0.1(\text{stat}) \pm 0.3(\text{syst.})$



Results: Low-Energy Spectrum

- No contradiction to ATIC data due to H.E.S.S. energy scale uncertainty
- No indication of a bump in the spectrum
- Compatible with electron acceleration in astrophysical objects

How would a KK signature look like in the H.E.S.S. data?



620 GeV KK with flux matching the ATIC data (J. Chang et al., Nature, 456, 362, 2008), smeared out with H.E.S.S. energy resolution

Conclusion

- H.E.S.S. has measured cosmic-ray electrons between 340 GeV and 5 TeV
- Systematic uncertainties include atmospheric variations, uncertainties in hadronic interaction models and H.E.S.S. energy scale uncertainty
- Smooth spectrum that steepens at about 1 TeV