Studies of the influence of the geomagnetic field on the sensitivity of gamma-ray observations

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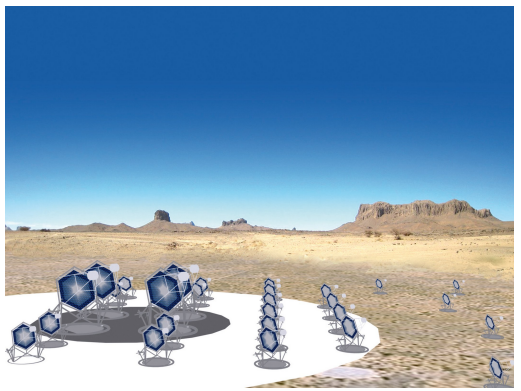
Structure

Cherenkov Telescope Array

High energy gamma-ray observatory which will study astrophysical sources

- Telescopes with different sizes: diameter of 12 m, 23 m and ~ 7 m
- Wide energy range from 10 GeV to greater than 100 TeV
- CTA Design Study and Research & Development-phase
  - Array Control Center
  - Camera electronics
  - Monte Carlo experiments

- Origin of cosmic rays
- Looking for dark matter
- Physics beyond the standard model



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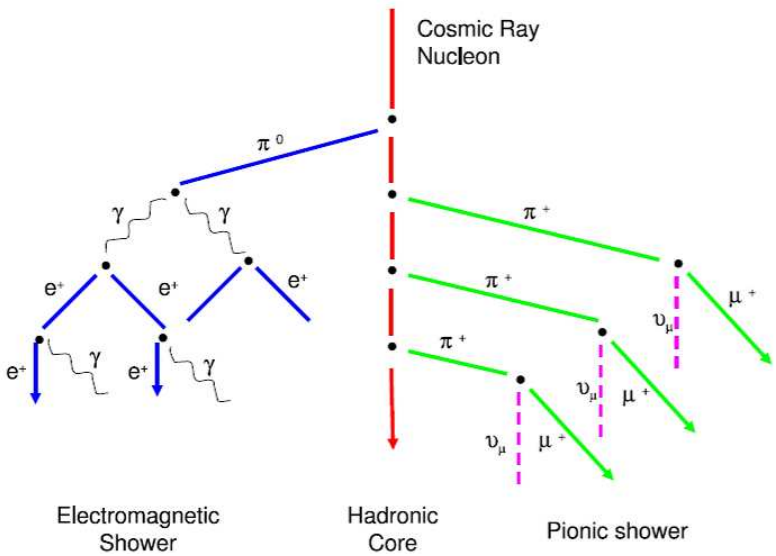
Extended Air Showers

- Photon can not penetrate the atmosphere
- EAS consists of charged particles (e^+, e^-)



- Pair production
- Coulomb scattering
- Detection of Cherenkov light which comes from the cascade of particles

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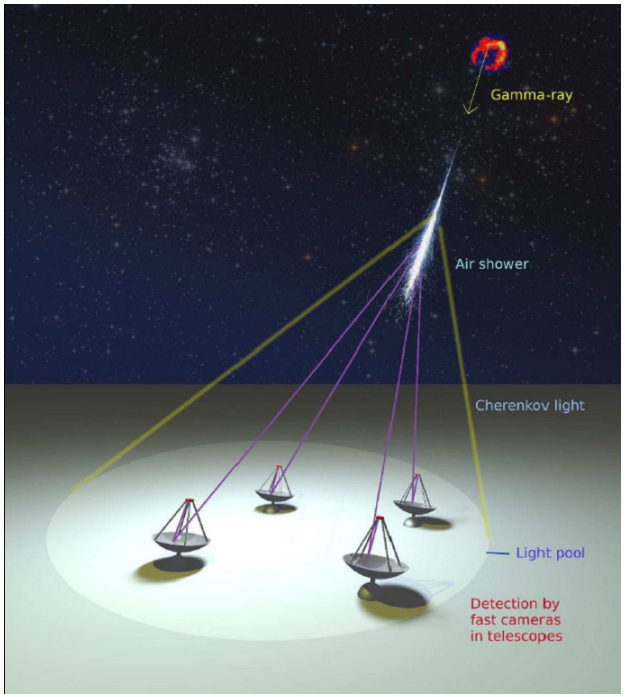
The problem

Where will CTA be located?
Studies of the influence of the geomagnetic field on the sensitivity of gamma-ray observations



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- Geomagnetic field calculation for 12 different sites
- Calculation of the influence of the geomagnetic field on shower parameters
- Run simulations of EAS of different sites

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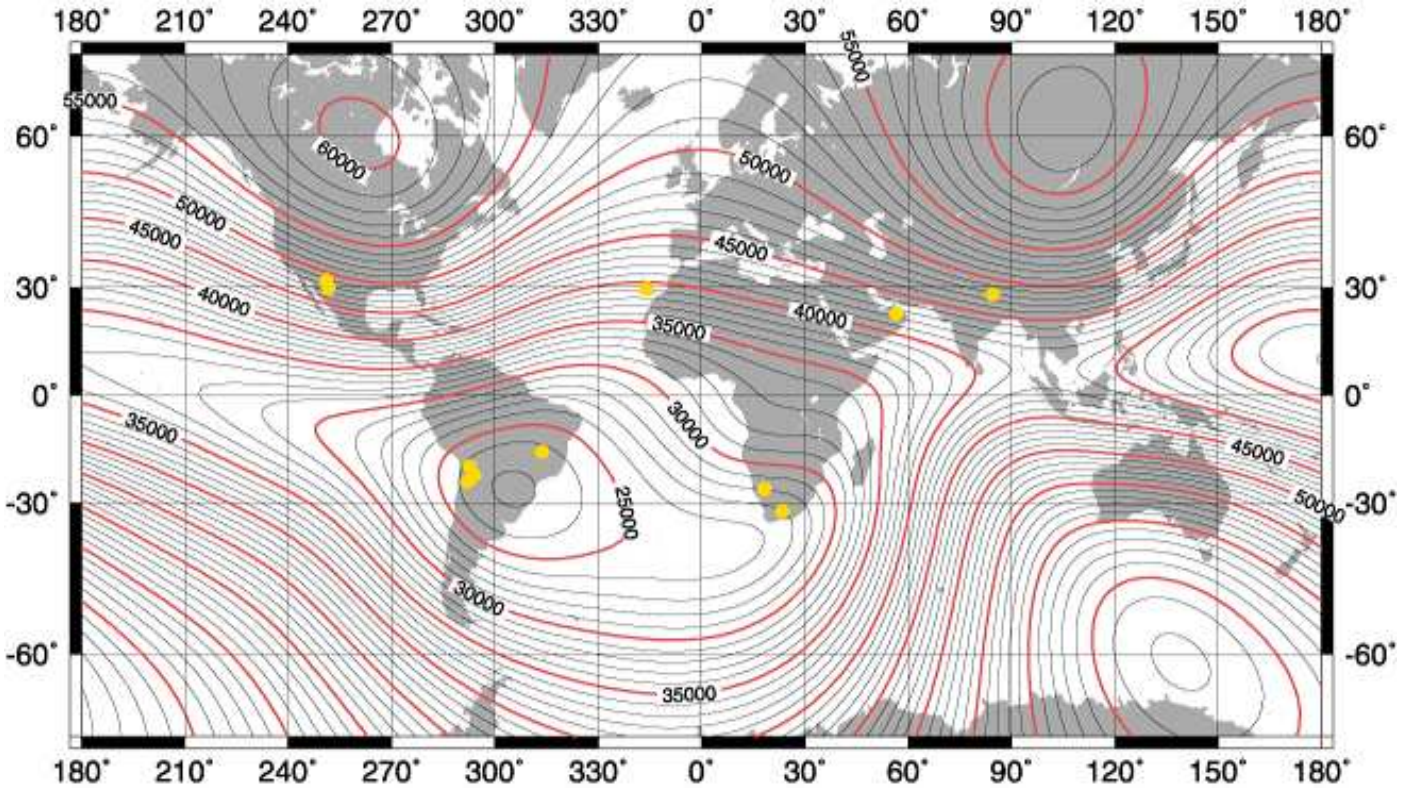
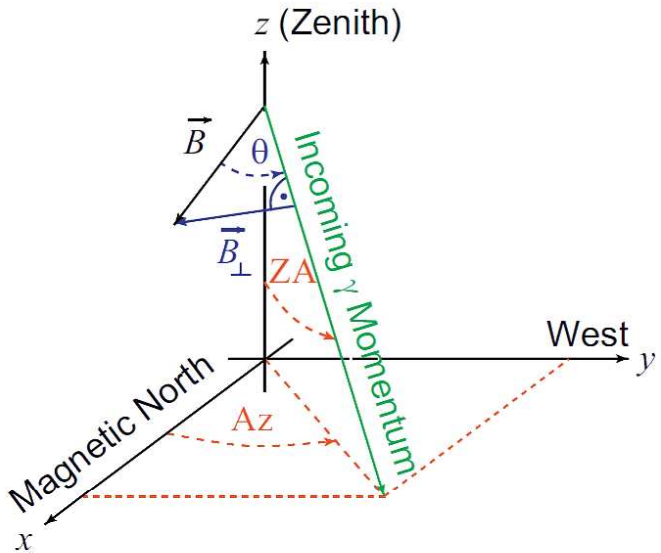
Map of candidate sites



NOAA - National Geophysical Data Center

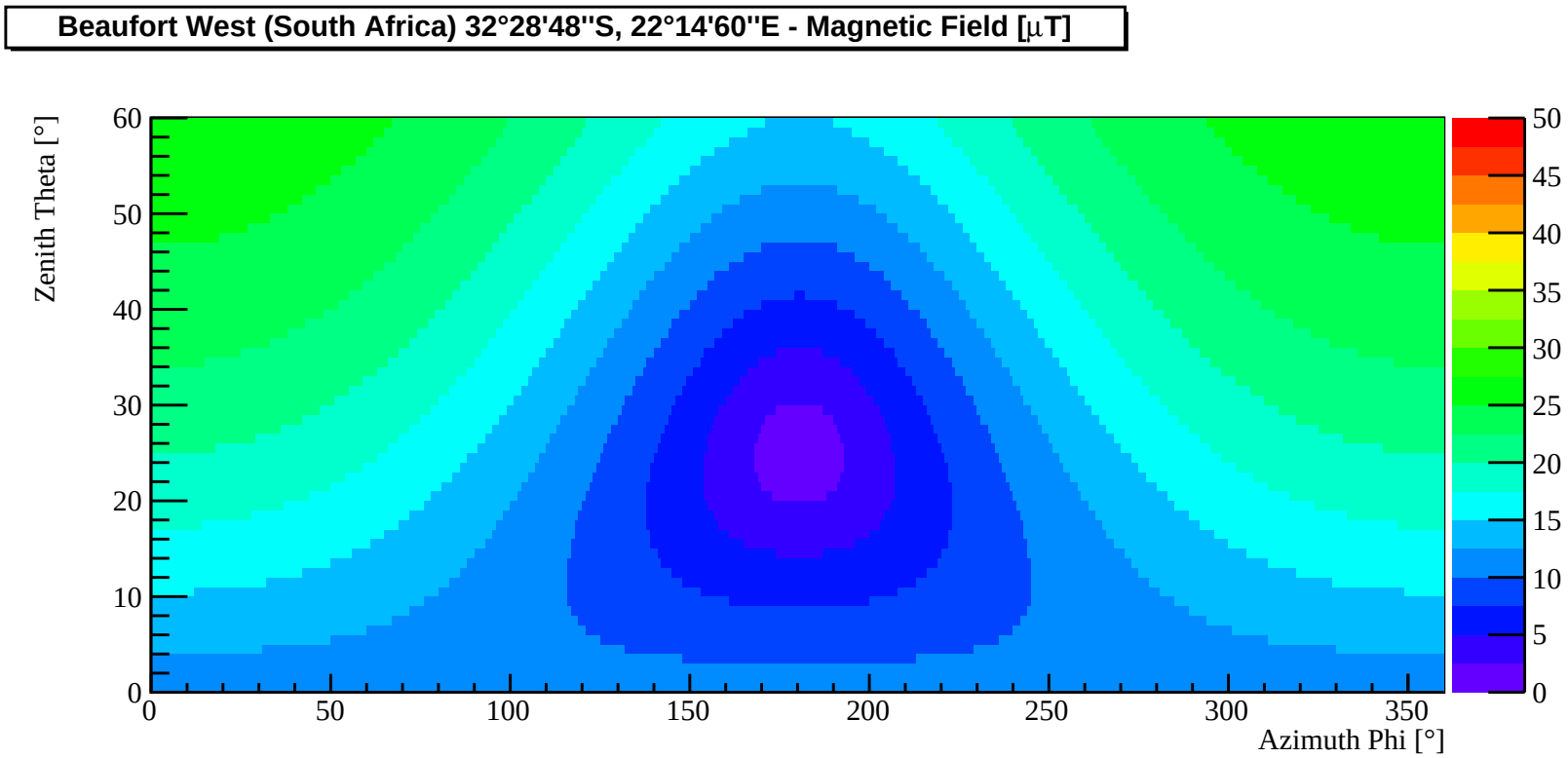
Geomagnetic field

- θ: angle between the direction of the EAS and the direction of the GF
- Azimuth angle: refers to the momentum of the incoming γ-ray (from the positive x-axis towards west)
- Telescope optical axis: parallel to the direction of the primary γ-ray

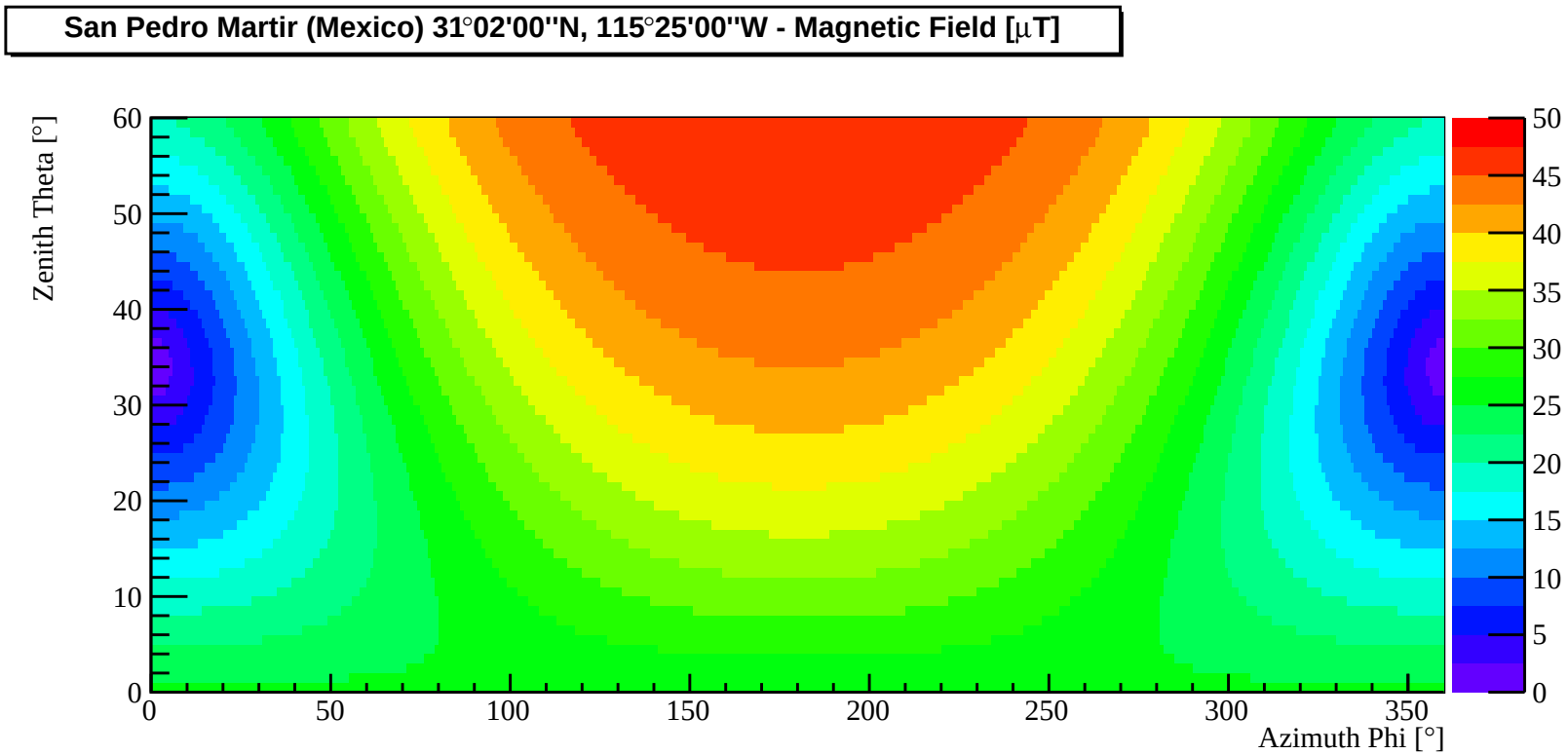


S.C. Commichau (2008)

Geomagnetic field

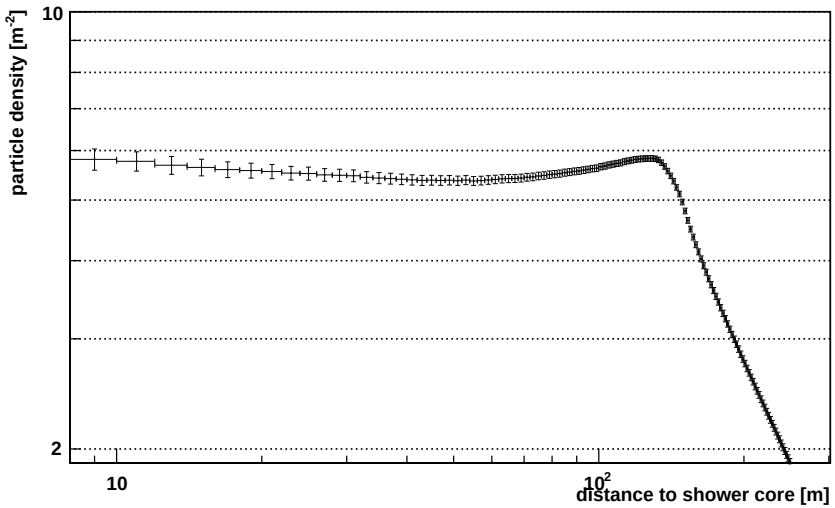


Geomagnetic field



Lateral distribution

- Shows the density of Cherenkov photons on the ground as a function of the impact parameters
- Influenced by the Cherenkov angle and Coulomb scattering angle



- Energy of the primary photon: 100 GeV
- Altitude of all sites: 2000 m

  $\rightarrow$ Measurements of the geomagnetic effects on the showers

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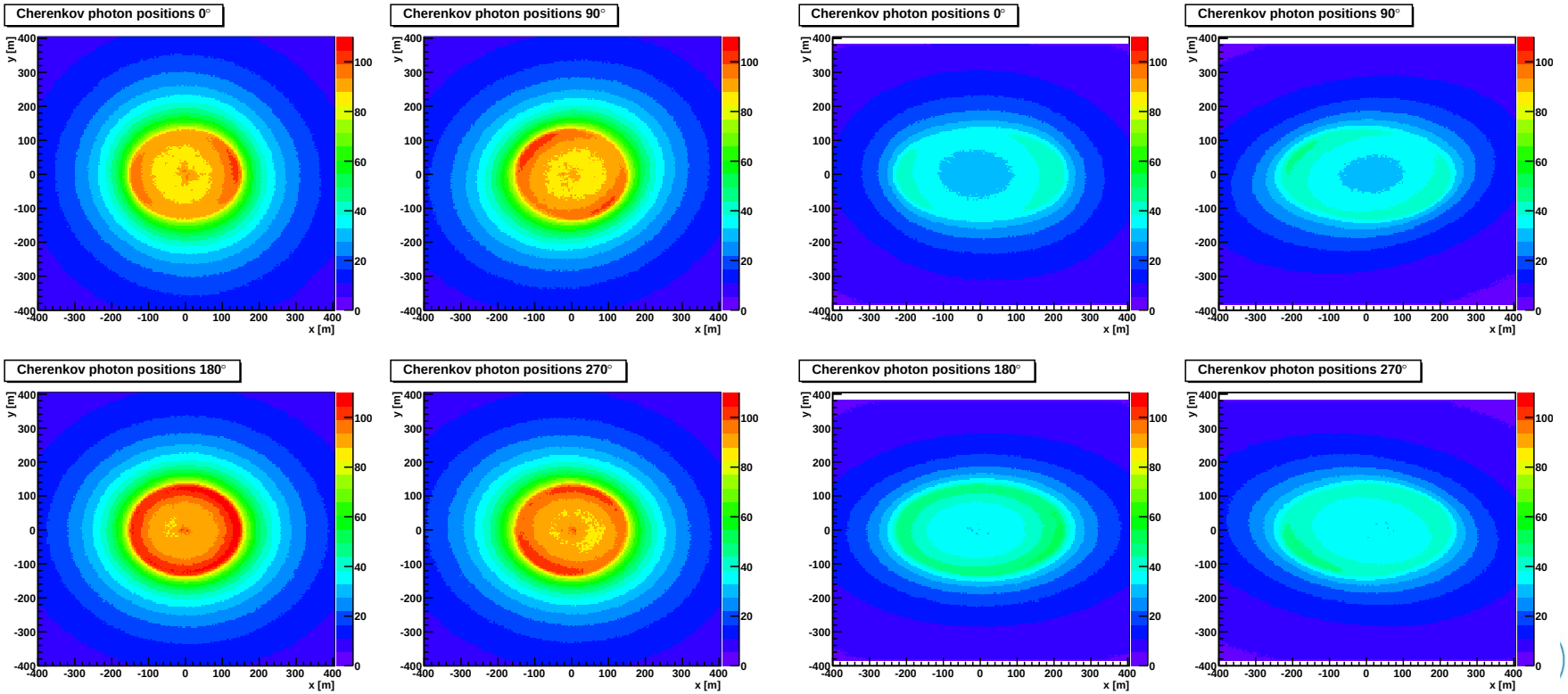
Cherenkov photon position



zenith angle = 20°

zenith angle = 40°

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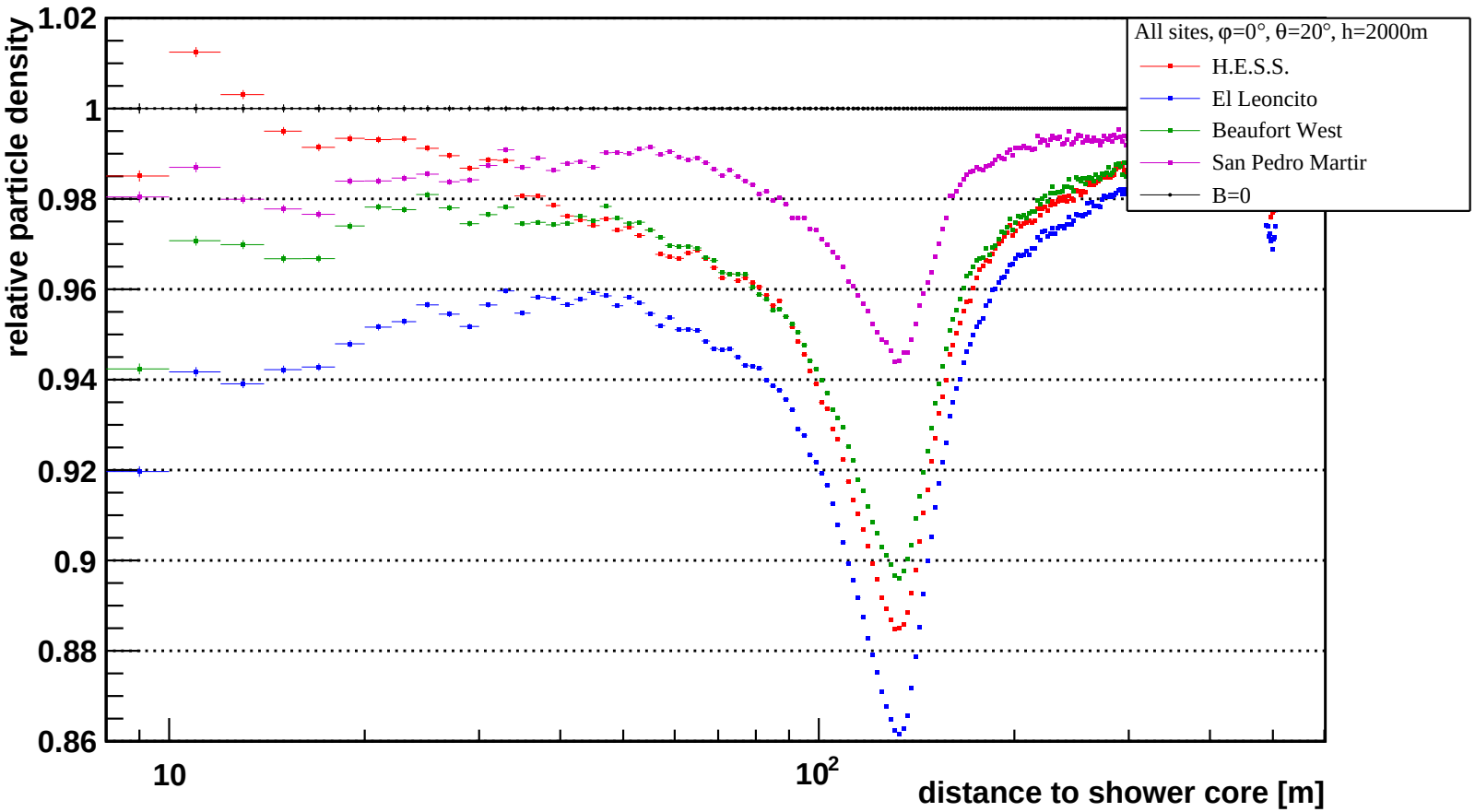
Lateral distribution relative to B=0



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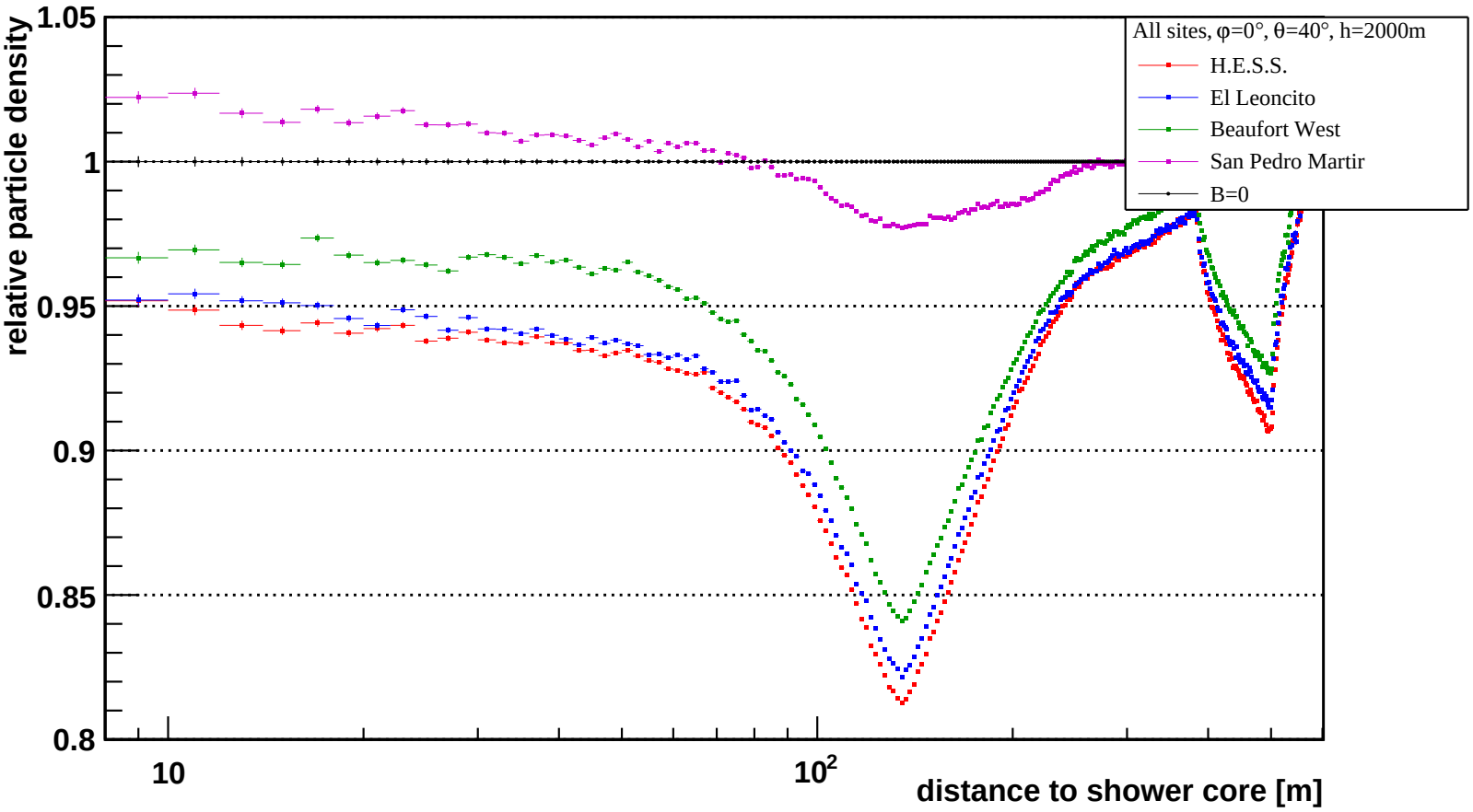

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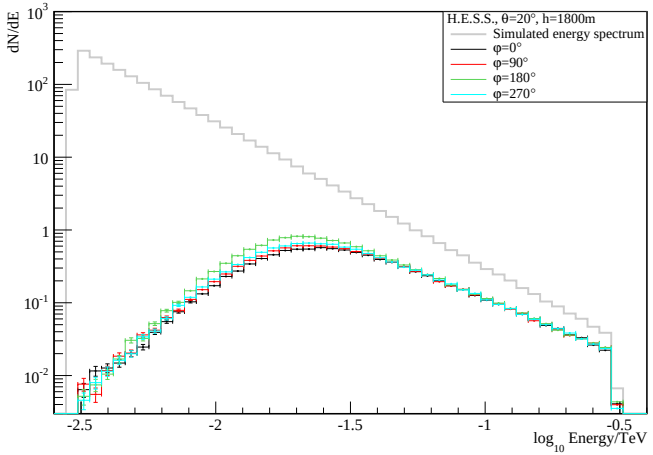
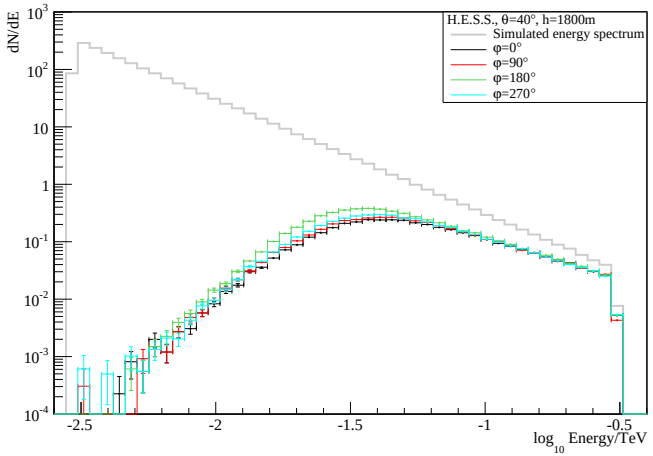
Energy spectrum and energy threshold

- Energy spectra of the detected showers
- 9 telescopes with a diameter of 23 m, separated by 80 m
- Energy threshold = Maximum
- $E_T = 20 GeV (ZE = 20°)$
- $E_T = 38 GeV (ZE = 40°)$





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Results

- Intensity of the geomagnetic field on the Earth's surface: $20\mu T$ to $70\mu T$

  $\rightarrow$ Location with a low absolute value of the Earth's magnetic field

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- Altitude of the site

  $\rightarrow$ Number of photons depends on the density the shower travels through the atmosphere

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  $\rightarrow$ $h \leq 4000\ m$

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