RECONSTRUCTION OF SHOWER PARAMETERS WITH KASCADE-Grande

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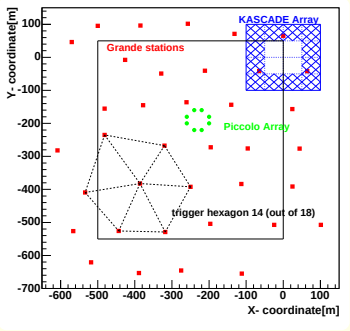
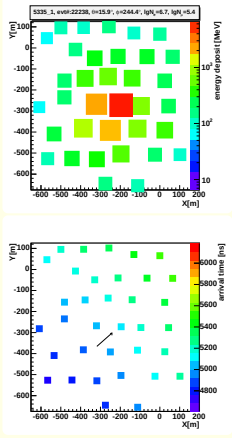
KASCADE-Grande Experiment



Layout of KASCADE-Grande experiment at Forschungszentrum Karlsruhe

KASCADE-Grande is the enlargement of the KASCADE experiment by an array of 37 stations covering an area of 0.5 km^2, enabling the measurement of air showers of primary energies up to 1 EeV. Its major goal is to measure the possible knee of the heavy component in the primary cosmic ray energy spectrum, expected at $\approx 10^{17}$ eV. In order to infer the energy spectra of the primary cosmic ray particles for different mass groups with unfolding techniques using the two dimensional electron-muon size spectrum, both total particle numbers have to be known.

- 700×700m^2 Grande array with 37 stations in 140m mutual distance
- each station houses 10 m^2 plastic scinitillator sensitive to charged shower component
- array divided in 18 trigger hexagons with 7/7 stations trigger condition
- Grande array 100% efficiency at $\approx 3 \times 10^{16}$eV
- provides Number of charged particles $\mathbf{N}_{ch}$
- Muon component is reconstructed from muon detectors of KASCADE array

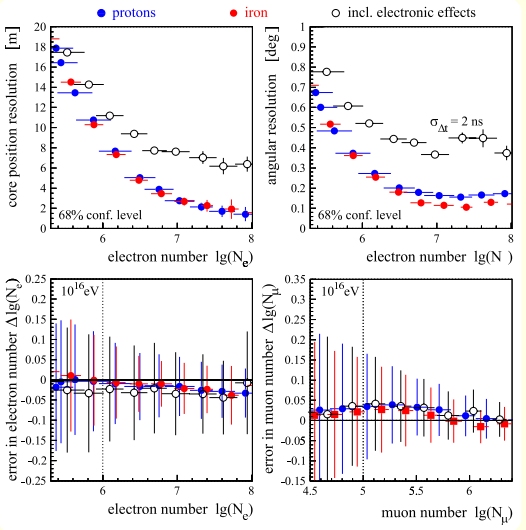


sample event measured with KASCADE-Grande

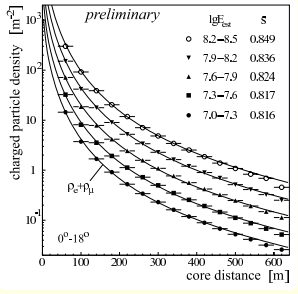
Reconstruction Accuracy

Reconstruction accuracy of core position (upper left) and shower direction (upper right) as function of electron number. Accuracy of reconstructed electron (lower left) and muon number (lower right) as function of the true electron and muon number. The error bars indicate the statistical error of a single reconstruction.

- systematics and uncertainties studied with CORSIKA/QGSJet (2001 version)
- simulation of installation with GEANT3.21
- output is analysed in same way as the measurements
- at 100% trigger efficiency ($N_e \approx 10^6$ or $N_\mu \approx 10^5$) resolution of 12m and 0.6°
- statistical uncertainty for both N_e and N_μ at trigger threshold at around 25%
- statistical uncertainty decreases to around 10% at higher energies
- systematic errors stay well below the statistical accuracy

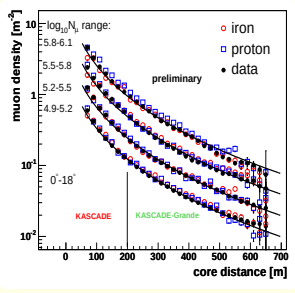


Measured Lateral Distributions



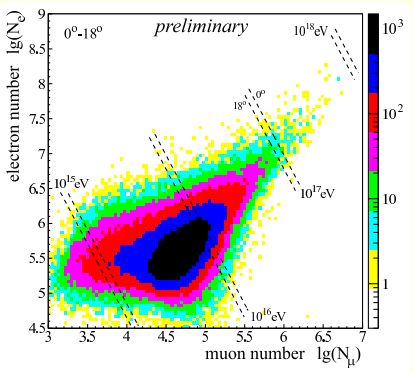
Measured lateral distribution of charged particles

- lateral distribution of charged particles for five energy bins
- energy estimated by linear combination of electron and muon numbers
- average age s increases with energy
- indication that composition gets heavier for higher energies
- muon lateral distributions agree relatively well with simulations
- iron and proton lie close to each other, as the shape of the muon lateral distribution is not very sensitive to the nature of the primary particle



Measured and simulated muon lateral distributions

Reconstructed Size Spectra



- more than 11 million events that triggered the Grande array recorded
- Figure left shows reconstructed particle numbers for zentih angle below 18°
- Figure right shows the comparison of muon size spectra of KASCADE and KASCADE-Grande
- good agreement between two measured fluxes in overlap area in both zenith angle ranges
- number of events comparable despite factor of nearly ten in exposure time
- shower sizes will be basis of sophisticated unfolding analyses, providing an insight into elemental composition above 10^{17}eV