Radio emission in extensive cosmic ray air showers
LOPES30

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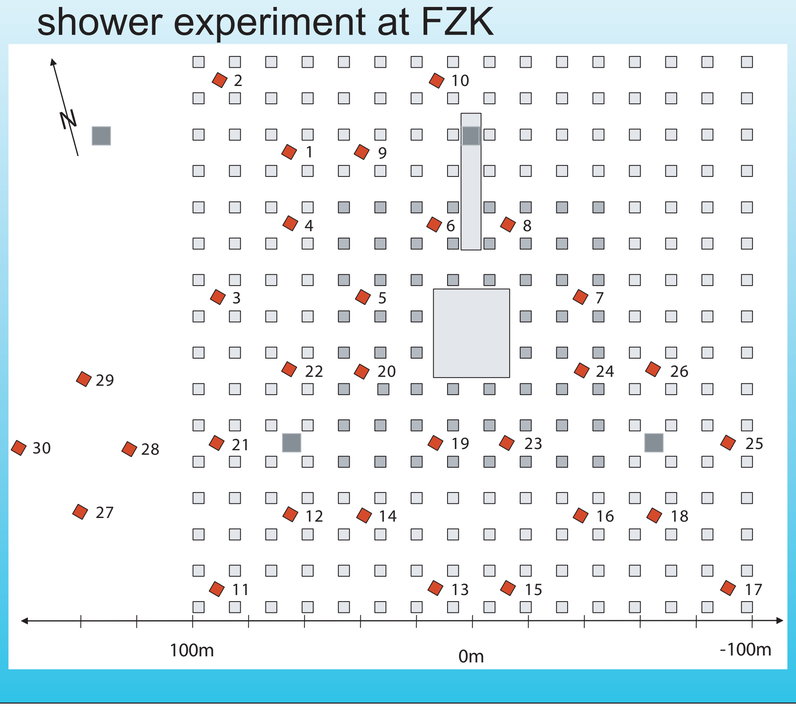
LOPES30 – antenna field for the detection of high-energy cosmic rays

- 30 antennas installed in coincidence with the KASCADE-Grande air shower experiment at FZK



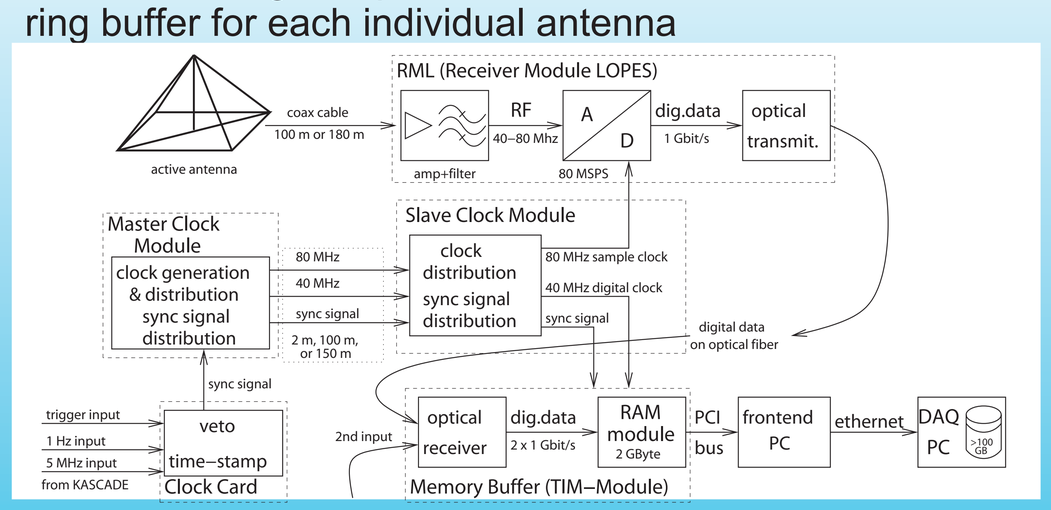
threshold of radio detection: primary energy $E_0 \sim 10^{16}$ eV

inverted-V dipole antennas, maximum baseline ~ 270 m

consists of 3 clusters with 10 antennas each

4 antennas placed outside the KASCADE array to avoid noise from the particle detectors of the array

- full digitization of the radio signal between 40 - 80MHz
- detected voltage amplitude can be stored for ~ 6 sec in a 1 GB ring buffer for each individual antenna



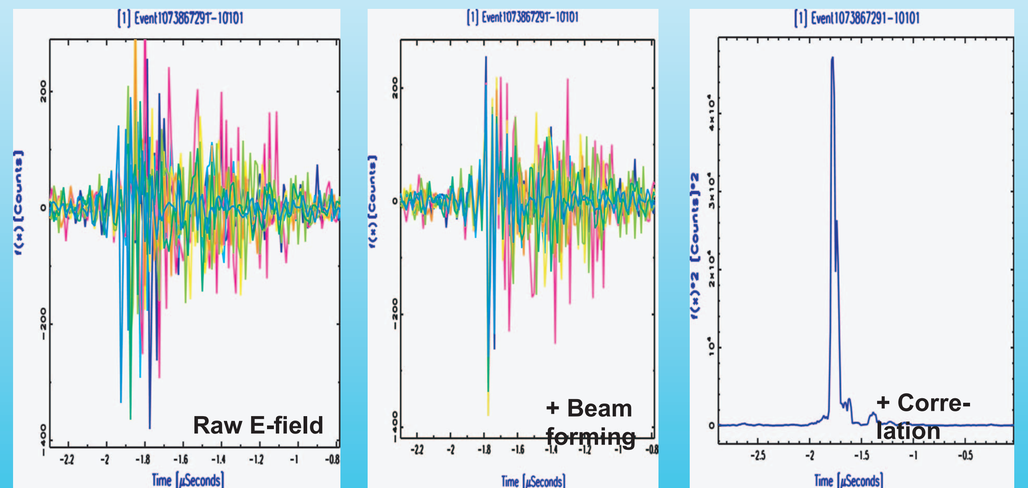
- 12 bit ADC (80 MHz clock), effective signal filtered between 43-73 MHz
- trigger condition for LOPES30: high particle multiplicity in KASCADE array
- EAS with primary energy $E_0 > 10^{16}$ eV can be investigated

EAS investigations with a radio antenna system - Status

- Radio emission in EAS is dominated by geo-synchrotron effect, i.e. synchrotron emission of electron-positron pairs defelected in the earth's magnetic field
- theoretical predictions on field strength are based on Monte-Carlo simulations (Huege, Falcke 2003)

Detection of short time coherent radio pulses in the MHz - frequency range

- Analysis of LOPES10: proof of principle (Falcke et al. 2005) detailed analysis of 7 months data set ongoing
- calibration of electronic chain in April 2005 completed; amplification factor determined
- full DAQ of LOPES30 since May 2005
- absolute calibration with reference antenna in July 2005:
  - antenna gain by simulations
  - electronic amplification using calibrated reference antenna
- KASCADE and KASCADE-Grande provide LOPES30 with shower information (arrival direction, core position, primary energy)

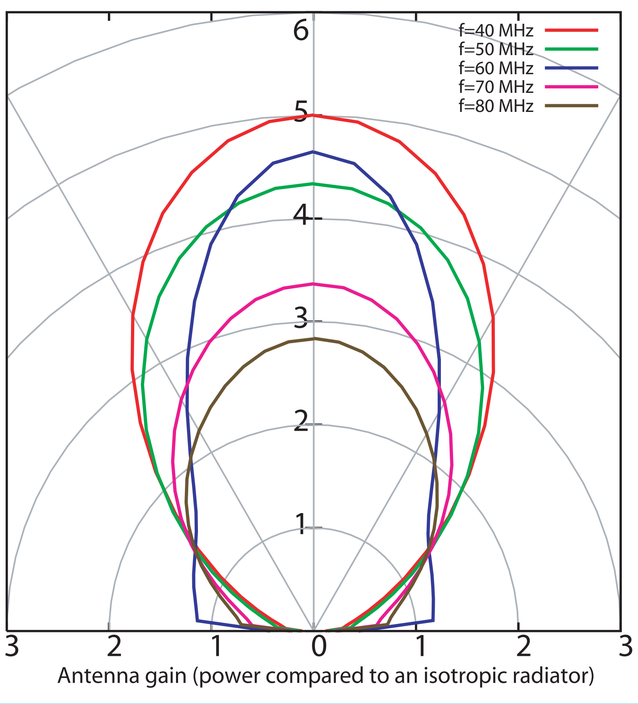


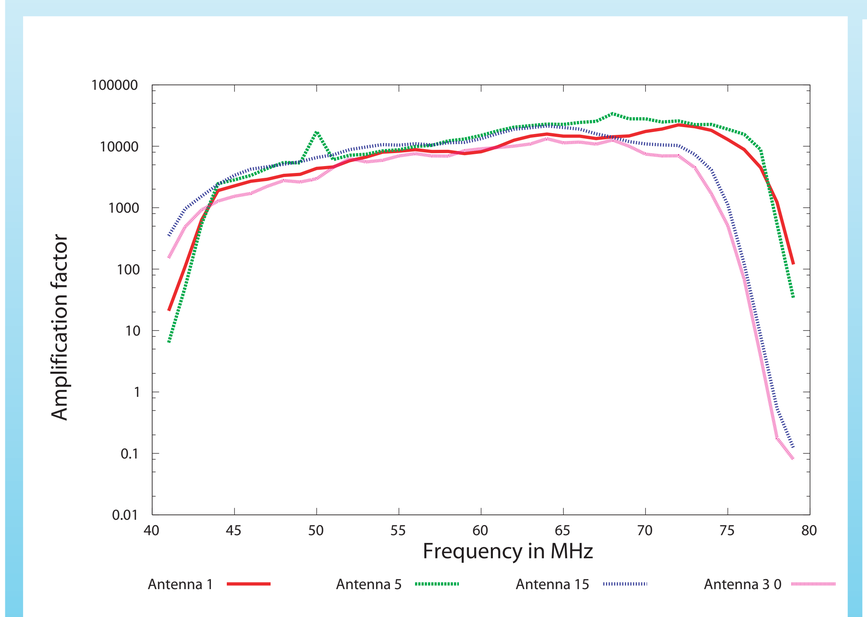
Reconstruction of short pulse radio emission in EAS

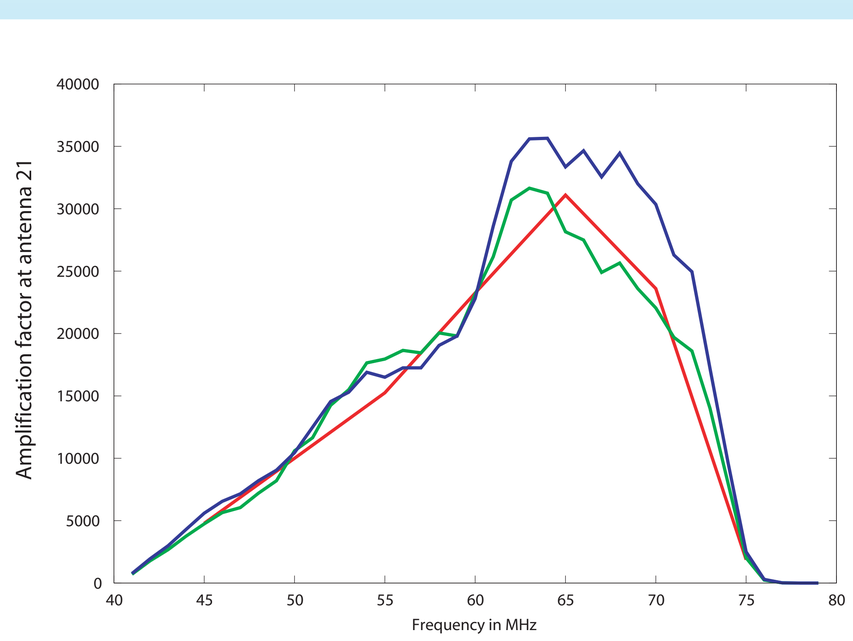
Absolute calibration of LOPES30

- antenna gain obtained by detailed simulations of the antenna response pattern
- electronic amplification factor determined by using a biconical reference antenna mounted above

LOPES antenna in the KASCADE array at the Forschungszentrum Karlsruhe







- frequency dependent response pattern determines the antenna gain
- simulated directional diagram of the LOPES antennas including the steel base plate (largest influence at 60 MHz)

- calibrated sine wave is emitted by reference antenna yielding a known field strength
- measurement of the frequency dependent amplification factor, including full influence of both, antenna position and environmental conditions
- amplification factor corrected for the antenna geometry