Simulation Studies Of MACE γ Ray Telescope

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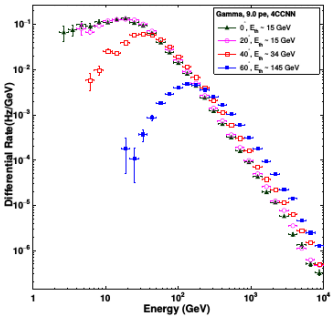
Introduction

The ***MACE*** (Major Atmospheric Cherenkov Experiment) is a Very High Energy γ – ray telescope located at Hanle, in cold desert of Ladakh region, India. The telescope will detect γ rays in energy of 30 GeV – 20 TeV. The altitude of the MACE location is 4270 m above asl, highest for any Imaging Atmospheric Cherenkov Telescope (IACT) in the world. The MACE is largest Asian IACT with reflector size of 21 m. The high altitude and large size empower MACE to maintain the energy threshold within narrow range of 30 GeV – 50 GeV over wide zenith angle range of 0° – 40°. MACE has integral flux sensitivity of ~ 2 % of Crab and it will collect high quality temporal and spectral data for many VHE γ ray sources. Here, we present the results of the simulation studies for estimation of performance parameters of MACE, namely Integral flux sensitivity, energy resolution and angular resolution.

Details of Simulation

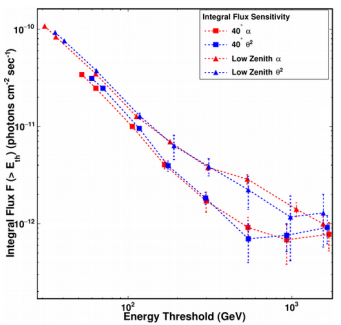
The telescope response to extensive air showers induced by proton, alpha, electrons and γ rays in energy range of 10 GeV to 20 TeV was simulated. We have generated air shower library comprising of ~1.2 billion showers using EAS simulation package CORSIKA. The atmospheric absorption,reflectivity and PMT quantum efficiency were simulated using IACT/ATMO package provided with CORSIKA. We have developed C+/ROOT based framework to simulate reflector, light of night sky, camera geometry and electronics, trigger and data analysis chain. We estimated variation of average performance parameters as a function of energy for low zenith angle range of 0° – 30°. The variation of performance against energy was also evaluated for zenith angle of 40°.

Differential Trigger Rate



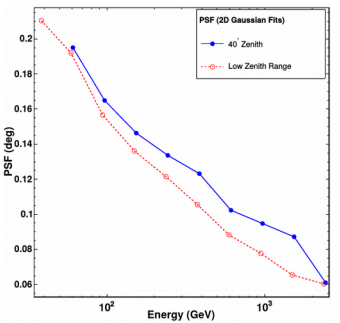
- Effective area of order of ~10^5 m^2
- Crab spectrum $\frac{dF}{dE} \propto \left(\frac{E}{1\,TeV}\right)^{-2.59}$ $photons/TeV/cm^2/sec$
- For 0°-20° zenith angle range, the trigger energy threshold is ~15 GeV
- For 40° zenith the trigger energy threshold is ~34 GeV
- At zenith angle of 60°, energy threshold is ~145 GeV.

Integral flux sensitivity



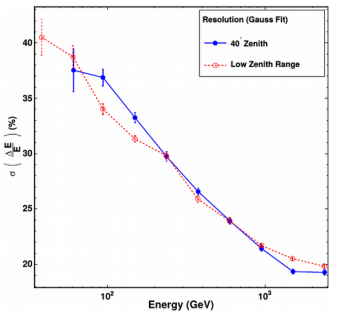
- The minimum integral flux for point source with Crab spectrum which can be observed in 50 Hrs of observation with at least 10 γ rays
- MACE can detect integral flux of ~2% of Crab above energy of ~31 GeV in zenith angle range of 0° – 30°.
- At 40° zenith, The energy threshold increases to ~52 GeV with sensitivity of ~1.6 % of Crab

Angular Resolution



- The standard deviation of a 2D Gaussian function fit to distribution of reconstructed arrival directions in camera plane
- Angular resolution of ~0.20° near energy threshold.
- Improves with increasing energy to ~0.06° in energy range of 2-3 TeV

Energy Resolution



- The standard deviation of Gaussian fit to distribution of fractional change in reconstructed energy relative to true energy of the γ ray.
- Energy resolution of ~40% near energy threshold.
- Resolution improves with increasing energy to ~20% in energy range of 2-3 TeV

MACE Performance at 40° zenith is comparable with performance at low zenith angle range