Characterizing the Isotropic Diffuse Gamma Ray flux (10–300 TeV) by the GRAPES-3 Experiment

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Isotropic Diffuse Gamma Rays

- By interaction of UHECRs with the CMB radiation via:
  - Pion photoproduction ($\mathrm{p} + \gamma_{CMB} \rightarrow \mathrm{p} + \pi^0$)
  - Bethe-Heitler pair production ($\mathrm{p} + \gamma_{CMB} \rightarrow \mathrm{p} + e^+ + e^-$)
- Secondaries further interact with the CMB radiation and undergo EM cascading.
- Final outcome is diffuse and isotropic flux of ultra-high-energy (UHE, $\sim$100 TeV) γ-rays.

Why Study Diffuse Gamma-Rays?

- Direct measurement of UHECRs is difficult:
  - Being charged get deflected by interstellar magnetic fields.
  - Extreme low flux (1 particle km^{-2} yr^{-1}).
- Possible probing through UHE γ-rays study.
- Provides significant information about sites of origin and acceleration mechanism.

GRAPES-3 Experiment

- Extensive air shower array at Ooty, India.
- 400 plastic scintillators over $25,000\ m^2$ area.
- Large area tracking muon telescope (560 m^2).
- Records $\sim$3 million showers per day from 1 TeV - 10 PeV.

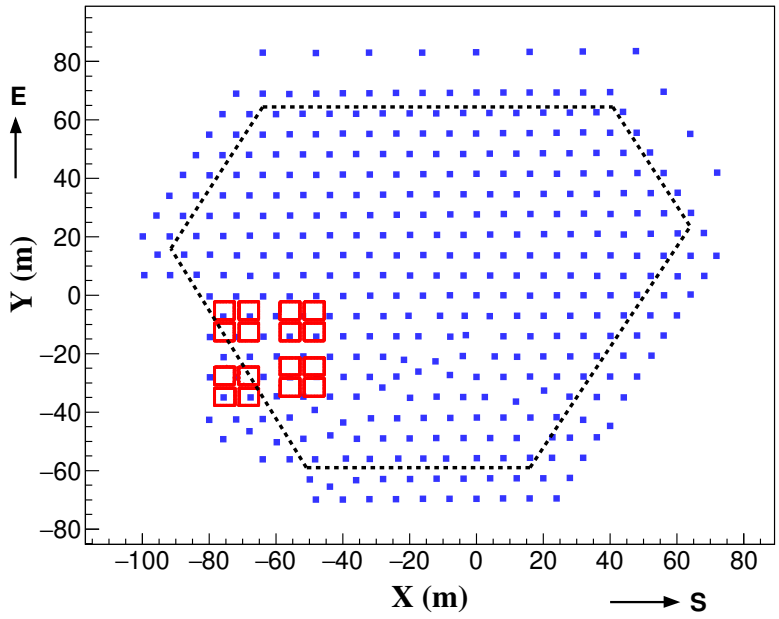


Figure: Schematic view of GRAPES-3 array

Gamma Hadron Discrimination

- Lesser muons in Gamma as in Hadronic showers.
- Showers with zero muons are considered as gamma-like (muon-poor).
- Muon telescope helps in efficiently rejecting charged cosmic ray background.

Gamma Selection Efficiency

- CORSIKA (ver 7.4) simulation is done for γ primaries.
- Selection efficiency $(\epsilon_\gamma) = \frac{N_{\mu=0}}{N_{tot}}$
- Calculated for each size bin and radial bin of 5 m from the muon telescope.

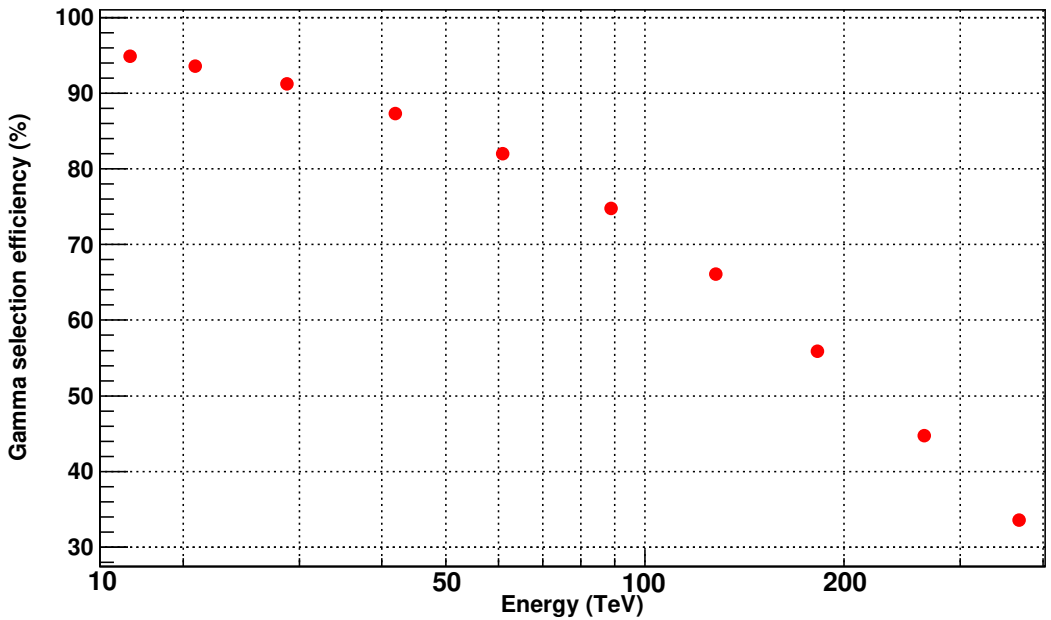


Figure: Variation of Gamma-ray selection efficiency with energy.

Data Selection

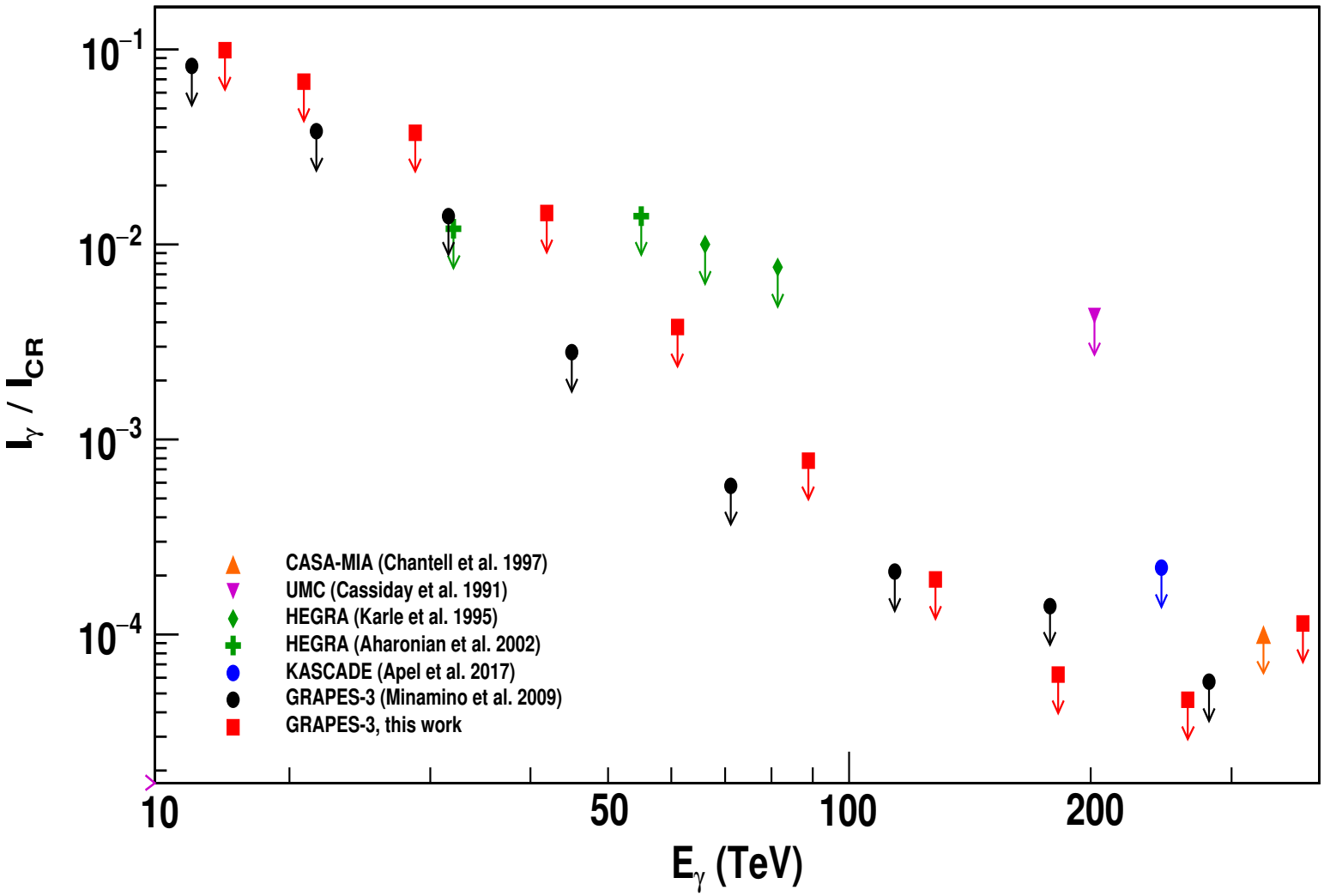
- One year : January 2014 - December 2014.
- Quality cuts:
  - Reconstructed cores must lie inside the fiducial area.
  - Shower age restricted to $0.12 \leq s \leq 1.8$.
  - Zenith angle $< 25^{\circ}$.

Upper limit of I_γ/I_{CR}

$$I_\gamma/I_{CR} \leq \frac{N^{\mu=0}_{90\%C.L.}}{N_{tot}} \frac{1}{\epsilon_\gamma} \frac{1}{1 - n_{chance}} \tag{1}$$

- Integral flux for different threshold values of shower size and radial distance of 30 m from the muon telescope is calculated.

Plot of Upper limit of I_γ / I_{CR}



ICRC 2021 session details

- Date and time (Berlin) of ZOOM-Meeting : 16 July 2021 - 18:00
- Presenter-forum number: 221

Thank You!