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Simulation Studies for Optimizing the Trigger Field of View of the TACTIC Imaging Element

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Abstract. Simulation studies, for the Imaging Camera of the TACTIC γ-ray telescope have been carried out to optimize its trigger field of view for a point γ-ray source. The results indicate that a trigger field of 9×9 pixels should improve the sensitivity of the telescope.

Keywords : TACTIC telescope, Monte-carlo simulation, Trigger field of view

1. Introduction

The Imaging Element (IE) of the 4-element TACTIC array of γ-ray telescope at Mt.Abu, Rajeshtan (24.6°N, 72.7°E, 1300 m asl) has successfully detected the TeV γ-ray candle, the Crab Nebula (Bhatt et al, 2002), and the BL-Lac object Mkn-421 (Kaul et al, 2002) during the Jan-March, 2001, observation period. The paper presents results obtained from simulation studies to improve the present system sensitivity level of ~6.3σ in 40 hrs for the Crab Nebula, at E_γ >1.0 TeV, by optimising its trigger field.

2. Simulation Methodology

CORSIKA air-shower code, Version 5.62; (Heck et al, 1998) has been used to generate a databases of about 22,000 showers initiated by γ-rays as well as cosmic ray protons between the energy ranges 0.5TeV - 20.0TeV and 1.0TeV - 40.0TeV respectively. Bacup-software developed inhouse, allows to pickup a shower from the TACTIC array placed on the ground, randomly within the distance of 200m. The cerenkov-photons from each shower, are then ray-traced to the imaging camera after accouting for wavelength dependent atmospheric absorption, mirror

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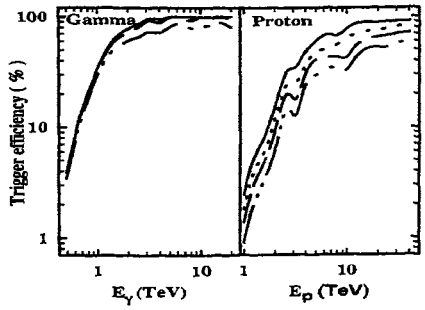

Table 1. 5-σ Crab signal recovery time estimates for Imaging Element.

Trigger Field	5-σ time in hrs.
(15 X 16)	16.20 (2.30)
(11 X 11)	6.20 (1.20)
(9 X 9)	4.50 (1.13)
(7 X 7)	3.27 (1.13)

Figure 1. Trigger efficiency for γ-ray and proton events as seen by 4-different trigger fields (i) 15×16 solid line (ii) 11×11 dotted line (iii) 9×9 dashed line and (iv) 7×7 dash dotted line.

reflection and photo-cathode quantum efficiency. An event is recorded when three non-collinear triplet pixels record ≥ 6pe within the trigger field of view. The various trigger field configurations considered here are 15×16, 11×11, 9×9 and 7×7 pixels.

3. Results and Conclusions

The two panels of Figure 1, show the trigger efficiency of the γ-ray and cosmic-ray proton initiated events at zenith angle of 20°, for the above mentioned 4-trigger fields. While one sees an obvious monotonic decrease in the trigger efficiency for protons, the corresponding situation for γ-rays indicates that the trigger efficiency decreases (for E_γ >1.5 TeV) only in the 7×7 case as compared to the other configurations, indicating 9×9 to be the optimum trigger field of view. Table 1 gives the 5σ retrival time T for a Crab-like γ-source obtained from the following equation:

$$T = \frac{25(f_\gamma R_\gamma + 2 f_p R_p)}{3600(f_\gamma R_\gamma)^2} \text{hrs.} \qquad (1)$$

where f_γ and f_p are accepted fraction of γ-ray and proton events, and R_γ & R_p are the rates obtained for the two progenitors with their appropriate spectra. The sensitivity estimates given in Table 1 (with a representative value of f_p = 0.01(0.001) and f_γ = 0.5) also suggest that 9×9 trigger field should be preffered as against the other configurations to attain improved sensitivity. Sensitivity estimate calculations, with actual values of f_γ and f_p, obtained after applying standard image parameter cuts are in progress.

References

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