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Characterization of a prototype imaging calorimeter for the Advanced Particle-astrophysics Telescope from an Antarctic balloon flight and CERN beam test

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We report the results and accompanying analysis methods from field-testing calorimeter prototypes for the Advanced Particle-astrophysics Telescope (APT) during the 2019 austral Antarctic balloon season and during a 2018 CERN beam test. The Advanced Particle-astrophysics Telescope is a proposed space-based gamma- and cosmic-ray instrument that utilizes a novel dispersed imaging calorimeter for both particle tracking and energy reconstruction. The imaging CsI calorimeter (ICC) consists of a CsI:Na scintillator read out by (WLS) fibers in both the x- and y-planes. To function both as a gamma-ray and cosmic-ray instrument APT must operate over a large dynamic range, from the single photon-election regime for low energy gamma-ray events to electronics-saturating cosmic-ray events. Analysis from a 150 mm x 150 mm calorimeter prototype accompanying the 2019 SuperTIGER-2.3 flight demonstrates successful event reconstruction from the long scintillation tail of saturating cosmic-ray events by utilizing the deep memory depth available to the TARGET readout electronics. Spatial reconstruction of events are performed using a two-sided Voigt profile and show position localization within the imaging calorimeter plane to less 3 WLS fiber widths. Charge resolution was evaluated on a 50 mm x 50 mm prototype placed in the 150 GeV/nuc, A/Z = 2.2 CERN SPS beam line. Nuclei were tagged using HNX silicon-strip detectors and allowed for fragmentation cuts in the data. The vastly saturating signals were reconstructed from the CsI:Na scintillation tail and show an APT charge resolution up to Z = 11 (with experimental limitations preventing full evaluation for Z larger 11) and linearity in the CsI:Na signal response up to lead.

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1. Overview

Placeholder

2. Planned detector Construction

Placeholder

3. Simulation

Placeholder

4. Performance

4.1 Bench testing

Placeholder

5. Summary

Placeholder

References

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