ATIC EXPERIMENT: PRELIMINARY RESULTS FROM THE FLIGHT IN 2002

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Abstract

The Advanced Thin Ionization Calorimeter (ATIC) has been flown on a Long Duration Balloon (LDB) flight in 2000, and again after refurbishment in 2002. The instrument consists of a silicon matrix for charge measurement, a flared graphite target to induce nuclear interactions, scintillator strip hodoscopes for triggering and helping reconstruct trajectories, and a Bismuth Germanate (BGO) calorimeter to measure the energy of incident particles. In this paper, we discuss the second flight, which lasted 20 days, starting on 12/29/02. Preliminary results from the on-going analysis of the data, including proton and helium spectra, are reported.

1. Introduction

ATIC is a balloon borne experiment to measure individual elemental spectra of cosmic rays from hydrogen to iron over the energy range $\sim$ 30 GeV - 100 TeV. ATIC collected 65 GB of science data during its second LDB flight in Antarctica from 12/29/02 to 01/18/03. An overview of the ATIC-2 experiment and the second balloon flight are presented in reference [3]. In this paper we present preliminary results from the on-going analysis of ATIC-2 data, including proton and helium spectra.

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2. ATIC Instrument

The ATIC instrument combines three major detectors with a total of 6248 channels: 1) a silicon matrix, comprised of 80 × 56 pixels, to determine incident particle charge, 2) a graphite target to force nuclear interactions: the target is interleaved with a set of plastic scintillator hodoscopes (S1, S2 and S3 from the top down) with a 2-range PMT readout on each side to provide pre-trigger and improve trajectory reconstruction, and 3) a calorimeter, comprised of eight layers of 40 BGO crystals each, with a 3-range PMT readout, to measure shower energy from nuclear interactions [2]. Fig. 1 shows the ATIC event display of a typical cosmic ray, which traversed a Si pixel and S1 strips, probably interacted between S2 and S3, and developed a shower in the BGO calorimeter.

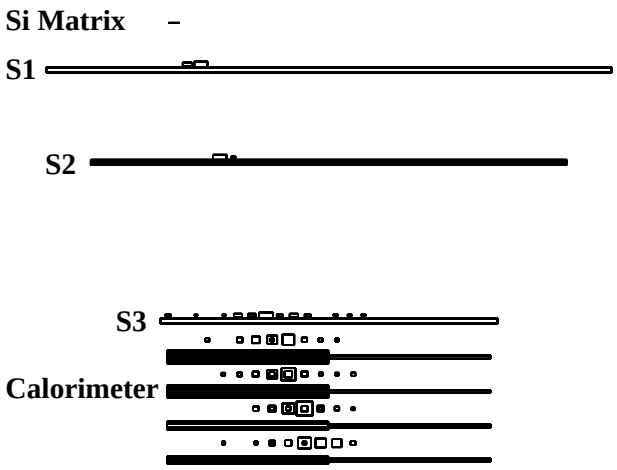

Fig. 1. ATIC event display shows each detector component's response to an incident cosmic ray. Box size is proportional to the corresponding signal size.

3. Calibration

The calorimeter and hodoscopes have multi-range readouts using dynode pick-offs to cover the required dynamic range. The lowest range calibration for these was performed for several days before the flight using the ionization signal from muon data collected in a pre-trigger mode (S1 and S3 on). Fig. 2(a) shows a distribution of the total energy deposit in the calorimeter from the same muon data after gain correction. It shows a clear peak with a contribution from side-exit events. The higher range calibration was performed using cosmic ray showers collected during the flight. Fig. 2(b) shows a distribution of the total energy deposit

in the BGO after gain correction, but without any data cuts. Below $\sim$ 30 GeV, the effect of trigger efficiency threshold is apparent.

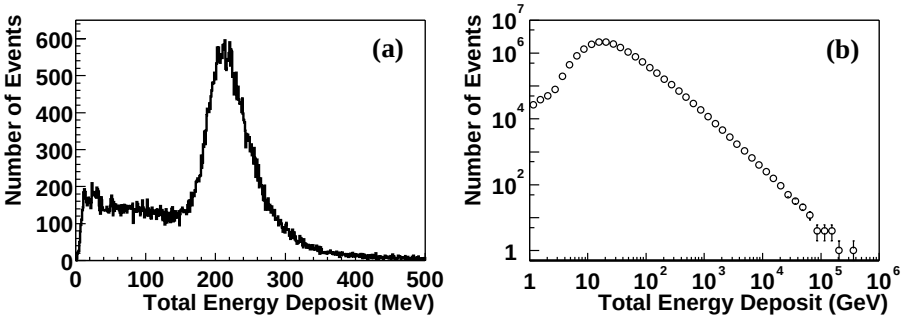

Fig. 2. Distributions of total energy deposit measured by the BGO calorimeter from (a) pre-flight muon data and (b) ATIC-2 flight data.

The calibration for the Si matrix was performed using helium candidates from the flight data. Fig. 3 shows charge distributions after gain correction for protons, helium, and the CNO group, and heavier elements. The effect of electronics non-linearity is yet to be corrected.

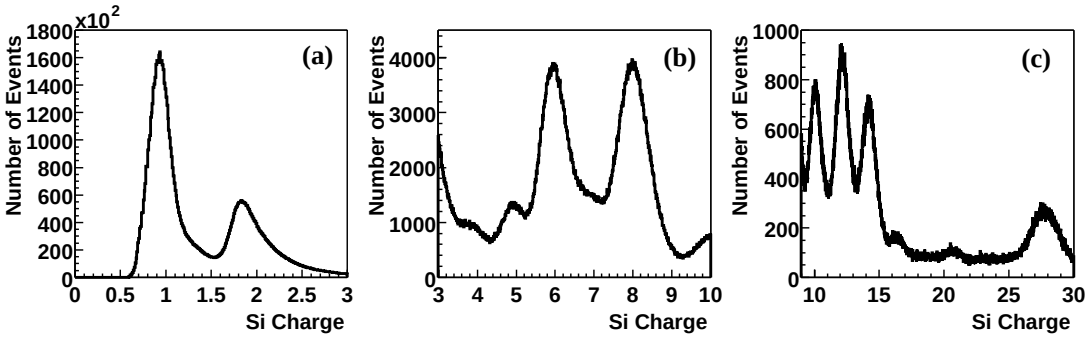

Fig. 3. Distributions of charge measured by the Si matrix: (a) proton and helium, (b) the CNO group and (c) heavier elements.

The calibration for hodoscopes are still in progress due to significant gain change during the flight. ATIC-2 had a problem of unstable high voltage in one layer of S1 and one layer of S3, so more careful corrections are needed. More details of the calibration procedures are described in [1].

4. Preliminary Results

The same event selection criteria of the ATIC-1 data [1] were applied to get the preliminary results from ATIC-2. Fig. 4 shows the preliminary all-particle spectrum, along with proton and helium spectra. Above 100 GeV, all three exhibit an apparent power law. The roll off below $\sim$ 30 GeV is due to the trigger efficiency threshold, which will be corrected to obtain the final spectra. Despite the very preliminary calibration used here, the results show great promise for the ATIC-2 data analysis in the near future.

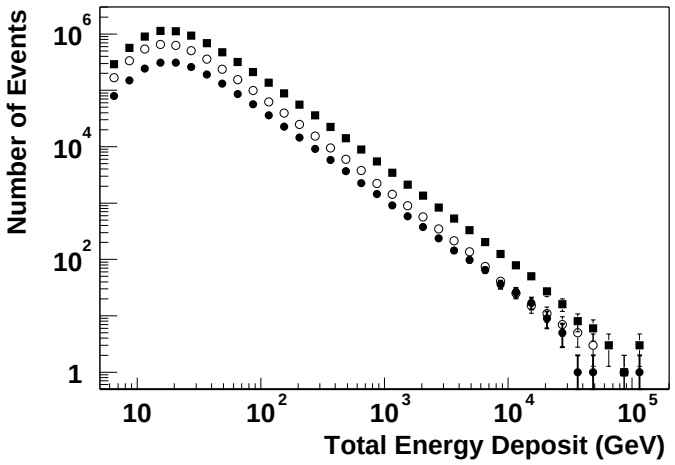

Fig. 4. Preliminary results of total BGO energy deposit spectrum from ATIC-2 data: All particles (filled squares), proton candidates (open circles), and helium candidates (filled circles).

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References

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