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Preliminary results from the first flight of ATIC: $Z > 8$Z spectra

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Abstract. The Advanced Thin Ionization Calorimeter (ATIC) is designed to measure individual elemental spectra from protons to Fe for energies from 10 GeV to near 100 TeV. Preliminary results are presented for 8 < Z ≤ 26 spectra from the maiden flight of ATIC in Antarctica that acquired 360 hours of data.

1 Introduction

The energy spectra of individual elements with Z>8 have been well measured at low energies. It is important to extend these measurements into the energy region where supernova acceleration of charged particles begins to fail. This is being done by the Advanced Thin Ionization Calorimeter (ATIC) experiment (Wefel et al., 2001). The results from this experiment will allow us to determine whether spectral differences exist between the elements at high energies. The ATIC instrument is designed to measure the composition and energy spectra of Z = 1 to 28 cosmic rays over the energy range ~10 GeV - 100 TeV. This provides overlap with previous experiments including CRN (Swordy, 1993).

2 The ATIC Balloon Flight

ATIC was launched from the Ross Ice Shelf in Antarctica on 28 December 2000 and it flew around Antarctica, landing just beyond the Trans-Antarctic mountain range on 13 January 2001. The average atmospheric overburden during the flight was 6 g/cm^2.

The ATIC experiment (shown in figure 1) measures the energy with an ionization calorimeter made of BGO crystals that is located under a graphite target. The purpose of the target is to induce the first interaction of the incident cosmic ray. For heavy ions, the first interactions do almost always occur in this target. There are three scintillator hodoscopes (S1, S2, and S3) located on top, within and beneath the target that serve to create a fast trigger. This trigger is used to capture the analog signals from all the detectors. In addition, the scintillators give an indication of the location of the interaction within the target. The scintillator on top of the target also contributes to the charge measurement, but the principle means of determining the charge is the silicon matrix detector located on top of ATIC.

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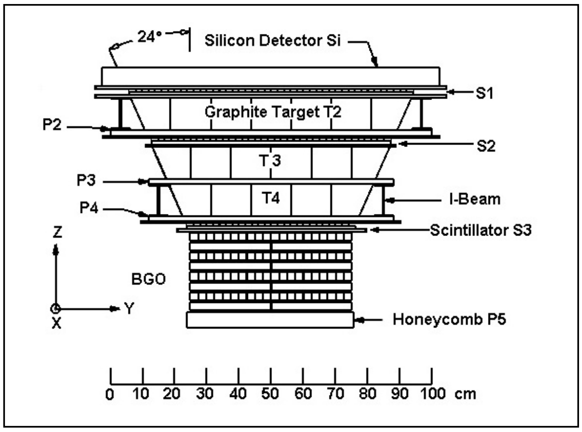

Fig. 1 The ATIC instrument configuration

3 The Preliminary Results

The ATIC flight collected approximately 25 million events. We have begun the task of analyzing this data. The first point we examined in the data analysis was to determine whether the Z>8 data sample was not contaminated by backscatter.

The interaction and subsequent shower development in the calorimeter produces backscattered radiation, mostly low energy electrons, gamma ray and neutrons. This radiation induces signals in the top scintillator hodoscope and the silicon matrix that can be confused with the signal of the incident cosmic ray primary. Our simulations have led us to expect confusion with cosmic ray protons and helium nuclei, but not with heavier ions. To check this, we have examined the frequency of multiple signals above a threshold of Z>5.5 in the silicon matrix. We found that, 81% of the events had only one hit in the matrix and 97% of the events had no more than 2 hits.

To get 100% coverage at all incidence angles, it was necessary to organize the silicon detectors into four planes with some overlap between adjacent detectors (see Adams et al, 1999). The active area of the matrix is 99.21 cm by 107.86 cm. Each pixel is 1.945 cm by 1.475 cm. Altogether there are 4480 pixels for a total area of 12852.6 cm^2, so the fractional overlap is 20%. Because the pixels are arranged in four planes of 1120 pixels per plane, we expect that cosmic rays arriving at off vertical incidence will see, on average, almost the same fractional overlap as those that arrive vertically. We then estimate that, in the absence of backscatter, we would expect ~80% of the events to have one hit and almost all of the remaining events to have only two hits. This is very close to the experimental results. This shows that backscatter signals are rarely large enough to be confused with Carbon and heavier cosmic rays.

For the Z>8 nuclei, we can be sure there will be no competing backscatter events in the matrix. This has allowed us to locate heavy ion hits without knowledge of the shower axis. However, we cannot determine the charge resolution without correcting for the angle of incidence. To do this, the shower axis in the calorimeter must be fit. As of this writing, we have not fit the showers in the calorimeter to extract this angle.

In our analysis we are combining data from 4480 individual silicon detectors. Each must be individually calibrated. We have made calibrations of these detectors in the lab, but as of this writing these calibrations have not been applied to the data. We plan to complete some additional analysis steps in time to present preliminary results on the charge resolution at the conference.

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