THE AMS SILICON MICROSTRIPS TRACKER

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The AMS tracker collaboration

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The Alpha Magnetic Spectrometer is a detector designed to search for anti-matter and dark matter by the analysis of cosmic rays in space. Its installation is scheduled on the International Space Station (ISS) for an operational period of 3 years. A precursor flight on a Space Shuttle occured in 1998 with a silicon surface of 2.1 m^2. The construction of the 7 m^2 second phase is starting. The AMS silicon tracker has a large dynamic range of up to 100 MIPS for dE/dx measurement. We discuss the design, construction and performance of the detector.

1 Introduction

Results from the STS91 precursor flight of AMS were presented at this conference [1] and in references [2,3,4].

2 The AMS-01 Tracker design

The design of the detector was guided by the very severe conditions of space such as mechanical stress at launch, large temperature range and relatively low electrical power available ($\sim$ 1 kW) for the whole experiment. Detailed descriptions are available in [5,6].

The tracker consists of 6 layers of double sided silicon microstrip detectors mounted on very light supporting disks made of carbon fiber and Al honeycomb (X_o = 0.65 % per layer). Four inner layers of 1 m diameter are in a magnetic field of 0.14 Tesla provided by a permanent magnet and two, with a diameter of 1.25 m, are placed outside of the field. The AMS-01 tracker was equipped with 38 % of the total number of sensors (2.1 m^2 and 58,368 channels) for the precursor flight.

The sensors ($40 \times 72 \times 0.3$ mm^3) have a strip pitch of 27.5 μm (110 for read-out) on the p-side (bending coordinate). The pitches of the n-side (non-bending) are 26 and 208 μm. Sensors are organized in 57 *ladders* (see fig 1) connecting up to 15 wafers to the front-end electronics (TFE hybrids) described in ref [7]. The routing of lines is made by kapton (upilex) microstrip cables directly glued on the silicon. The connections are made by microbonds. The mechanical rigidity is provided by a reinforcement made of Airex foam and carbon fiber. A thin EMI shielding is wrapped around the ladder.

The cooling of the front-end electronics is provided by Al bars filled with a highly thermo-conductive material (TPG).

3 Performance

Prototypes were tested with 50 GeV electrons at CERN [8] and with C ions at GSI [9,10] for dE/dx studies. We obtained position resolutions of $\sim$10 μm for p-side and $\sim$30 μm for n-side and a *signal/noise* $\simeq$ 8 for MIPs.

This performance was confirmed for the whole tracker during the STS91 shuttle flight of 1998 [5,6] and by subsequent tests with particle and ion beam at CERN and GSI. No failure occured during the 10 days of mission in space.

The momentum resolution for ^4He is shown in figure 2. Good agreement is seen between the expected resolution for flight data (histogram) and from ^4He beam of known momentum (points).

Figure 3 shows the quality of the dE/dx measurement for the identification of cosmics with Z>2.

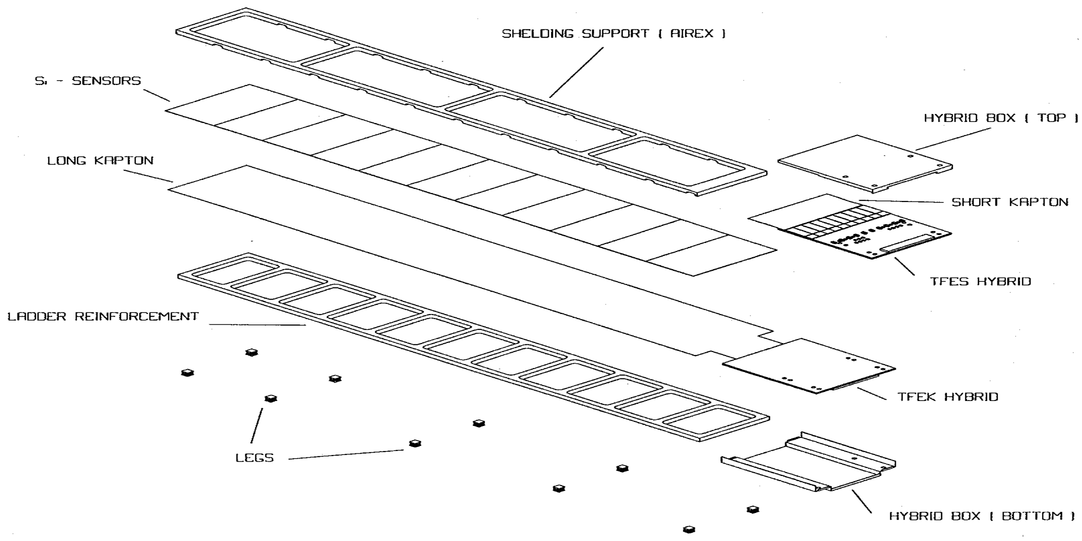

Figure 1. Exploded view of an AMS silicon ladder

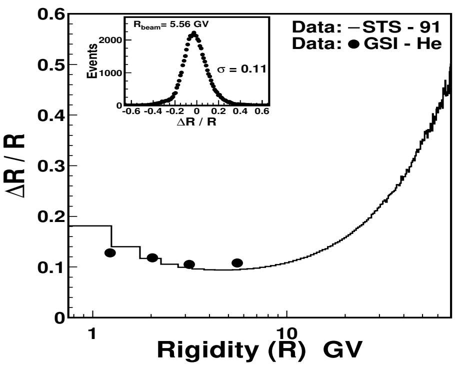

Figure 2. Rigidity resolution for ^{4}He

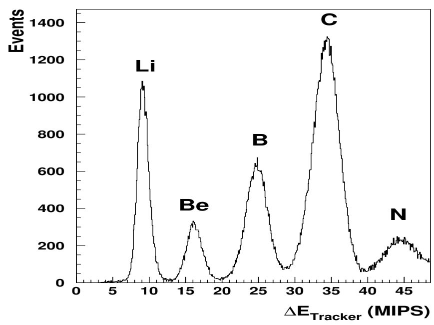

Figure 3. dE/dx spectrum from the AMS tracker

4 The tracker for AMS-02

AMS is being significantly upgraded (e.g. with a superconducting magnet) for its installation on ISS scheduled for fall 2003. The tracker is improved keeping the same concept, with a complete coverage reaching a total silicon surface of 7 m^2 (192 ladders) and organized in 8 layers for better redundancy. Electronics and cooling will be improved, read-out strips on n-side modified and the silicon wafers surface passivated.

References

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