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Data Acquisition with the Transition Radiation Detector of the AMS-02 Experiment

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The Alpha Magnetic Spectrometer (AMS-02) will measure primary cosmic ray particle and gamma ray spectra on board the International Space Station. A transition radiation detector (TRD) provides the capability to identify positrons and antiprotons. Space qualified electronics, developed for the TRD, supply its 5248 proportional counter tubes with high voltage and read out all channels running on board data reduction routines. Flight hardware and electronics integrated into AMS-02 passed tests in a particle beam and a space simulator in 2010. Structure of the flight control and readout system as well as the performance of data acquisition is presented.

Summary

INTRODUCTION
The Alpha Magnetic Spectrometer 02 (AMS-02) is a large acceptance spectrometer for high energy charged particles and gamma rays in cosmic radiation. It is designed for maintenance-free operation on board the International Space Station (ISS) with a duration of the lifetime of the station. A transition radiation detector (TRD) provides the capability for the experiment to distinguish positrons and antiprotons in the background of protons and electrons in the energy range 10-300 GeV. This will lead to a significant contribution to indirect dark matter search, since excess signal from annihilation is expected to be discovered.
In 2010 the final assembly of the detector takes place at CERN with the TRD on top of AMS-02.

DATA ACQUISITION WITH THE TRD
The AMS-02 TRD uses production of transition radiation in its fleece radiator layers to suppress the proton signal against positrons. It is built out of 5248 Xe/CO2 filled proportional counter tubes in 20 layers and contributes to dE/dx measurement. The TRD octagon is mounted in an aluminum and carbon fiber support structure on top of AMS-02. A recirculating gas system controls absolute pressure and the 4:1 mixture of Xe:CO2 gas in the TRD.
Two Crates mounted on the main radiators of AMS-02 house the DAQ and slowcontrol electronics. Frontend boards digitize analog signal and are powered and read out by a data reduction board's sequencer digitally. To cope with the huge amount of date with a limited bandwidth from ISS to ground control each subdetector has it own data reduction boards, where the data is buffered and processed.
All components passed an extensive space qualification procedure before flight production with qualification models and acceptance tests during flight production in order to assure fully functional hardware for space application.

STATUS
The transition radiation detector as well as the entire AMS-02 detector has proven readiness for flight in early 2010. In January a test in a particle beam provided by CERN showed physics performance of the detectors but also the reliability of the readout system and data processing routines of AMS-02 and its subdetectors. In April a thermal-vacuum-test at ESTEC in the Netherlands was conducted to test compatibility with ISS regulations and space qualification. The test was succesfully passed with all components of the experiment.
Results of current cosmics data recorded during integration and testing periods and data recorded during the testbeam with the flight detector show excellent homogeneity of detector properties.
Before shipment to Kennedy Space Center and launch to the ISS onboard the last Space Shuttle in second half of 2010 the decision was made to take advantage of the extended lifetime of the International Space Station by replacing the superconducting magnet of the silicon tracker subdetector limited by three years of operation with a permanent magnet. The integration is beeing carried out without major modifications to the subdetectors.
The final configuration and status of the detector focusing the TRD subdetector and its electronics can be presented in september 2010.

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