An Undergraduate Low-Mass Balloon-Borne Cosmic Ray Experiment

Robert Walch*, R. D. Dietz*, Patricia Mills, Julie Smith, Ryan Marshall*, Levi Ellis, Cynthia Galovich*, Kendall Mallory***

***University of Northern Colorado**

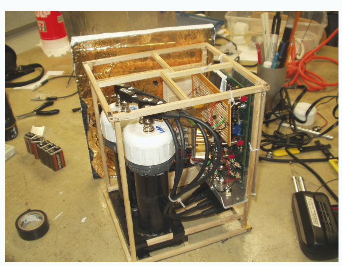
****University of New Mexico**

Background

In 2003 the Colorado Space Grant Consortium (COSGC) received a NASA grant for a project called “DemoSat” to support balloon launches of undergraduate-built payloads. As a member of the COSGC, the University of Northern Colorado has participated in five launches. Our payloads, which reach an altitude of around 100,000 feet, have to survive near-vacuum conditions, external temperatures below -70 °F, and high g-forces during balloon burst and landing. Launch considerations imposed a total mass limit of only 2.5 kg. In 2004 we flew an experiment to detect cosmic ray secondaries.

The Experiment

The goal of the experiment was to measure charged particle count as a function of altitude. The charged particles (mostly muons and some pions) are secondary and tertiary products from primary cosmic ray collisions with air molecules. Our detector consisted of organic scintillator material, two photomultiplier tubes (PMTs), a coincidence counting circuit and a data logger. When a charged particle passed through the scintillator material (donated by the University of Minnesota) photons were produced that were detected by the PMTs. Two PMTs were used to distinguish real signals from noise. The output from each PMT went to one input of a coincidence counting circuit (designed by Lawrence Berkeley Laboratory which also donated the blank circuit board). Input signals had to arrive within 800 nsec of each other to cause the circuit to send a signal through an amplifier to a data logger. The entire experiment including a resistive heater was powered by five 9-V batteries.



The interior of the payload box before launch showing the PMTs sealed in PVC tubes that kept the pressure at 850 millibars during entire flight. This novel approach prevented possible coronal discharge.

Students Ryan Marshall and Levi Ellis with the payload after recovery.

Results

The data presented is the number of coincident counts registered in one-second bins over a period of roughly 3.3 hours. Data collection began just before the release of the balloon, and the expected rise in secondary particle flux is evident. The peak in secondary flux occurred at a pressure of about 120 mb and was followed by a gradual decline in counts as the balloon rose to its peak altitude and the air density decreased. A rapid parachute descent of the payload after the balloon burst took it again through the altitude of maximum secondary flux. The instrument package survived impact and continued to record a constant flux until it was recovered and powered down.