HASP Student Payload Application for 2008

Payload Title:
Micro Scale Space Radiation Detectors

Payload Class: (circle one)	Institution:	Submit Date:
Small Large	Louisiana Tech University	18 Dec 2007

Project Abstract

Micro scale scintillator based space radiation detectors are being developed under an REA previously granted by the Louisiana Space Consortium to investigators at Louisiana Tech University. La Tech Engineering students have developed a prototype device which is near completion and will be ready for testing by the early spring of 2008. The main components include four scintillator detectors, four photomultiplier tubes, a DC/DC converter, and a microcontroller. Two detectors will be configured for neutron radiation detection and two will be configured for high energy charged particle radiation detection. In order to assess the design and operability of the space radiation detectors, we desire to test them at high altitudes under actual cosmic radiation bombardment. Negotiations and coordination are currently underway with the NASA Aircraft Operations Division at Ellington Field in Houston TX. The plan is to conduct a flight test of the prototype on board a NASA WB-57 high altitude research aircraft. This flight will be conducted at altitudes of 60,000 feet and above which should expose the detectors to significant and measurable amounts of cosmic radiation. The next logical step is to flight test the prototype detectors at the higher altitudes available through the High Altitude Student Payload program.

Team Name: Chester's Boys

Team or Project Website:

	Student Team Leader Contact Information:	Faculty Advisor Contact Information:
Name:	Scott Pellegrin	Dr Scott Forrest
Department:	Institute for Micromanufacturing	Institute for Micromanufacturing
Mailing Address:	2402 East Georgia Avenue	9307 Belden Drive
City, State, Zip code:	Ruston LA 71270	Shreveport LA 71118
e-mail:	smp019@latech.edu	sforrest9123@yahoo.com
Office telephone:		
Cell:	(318) 278-7110	(318) 458-4210
FAX:		

Payload Team Management and Structure

The technology involved in the development of this prototype is the result of research already in progress under a previously awarded LaSpace Research Enhancement Award (REA). Dr Scott Forrest, research associate at the Institute for Micromanufacturing (IFM) and Principal Investigator for this REA, will serve as the main advisor for Chester's Boys payload team. This team is being assembled for the purpose of flight testing this technology at the altitudes available with the High Altitude Student Platform (HASP) program. Dr Davis Harbour of the La Tech Electrical Engineering Department will serve as secondary advisor.

Chester's Boys payload team will initially consist of three engineering students. It is anticipated that more students will become involved as the project develops. These students will do all the prototype development, integration and testing necessary to prepare for the HASP balloon launch in September of 2008. Scott Pellegrin, an engineering student with the IFM, will serve as the team leader and will be the main student point of contact.

Chester's Boys Contact Information

Student Team Leader:
Scott Pellegrin
Cell Phone: (318) 278-7110
Email: smp019@latech.edu

Main Team Advisor:
Dr Scott Forrest
Cell Phone: (318) 458-4210
Email: sforrest9123@yahoo.com
scott.forrest@barksdale.af.mil

Secondary Team Advisor:
Dr Davis Harbour
Office Phone: (318) 257-4715
Email: dharbour@latech.edu

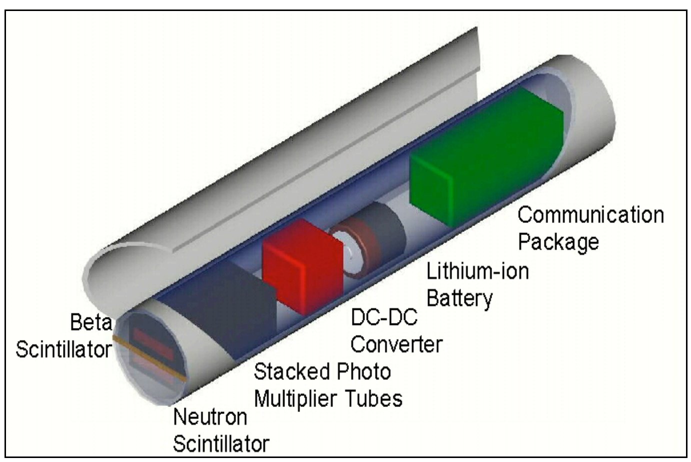
Payload Description

Background

Investigators at La Tech University and members of NASA's Space Radiation Analysis Group (SPRAG) have been exchanging information on current radiation detection technology. This group has expressed the need to upgrade their current stock of passive radiation dosimeters with a new generation of active radiation dosimeters. Passive radiation dosimeters take cumulative readings of astronaut exposure to space radiation during the length of a particular space mission. The data collected is analyzed by ground based radiation experts after the astronauts return to Earth. Active radiation dosimeters are designed to detect, measure, and communicate the amount and type of radiation exposure in real time. The development of this technology is crucial if NASA is to realize its goal of launching manned missions back to the Moon and eventually to Mars. These devices will need to have low mass, low volume and low power characteristics and should possess a wide range of sensitivity to particular forms of radiation. Figure 1 depicts an active space radiation dosimeter of the type being developed which is designed to detect beta and neutron radiation.

Figure 1. Active Space Radiation Dosimeter

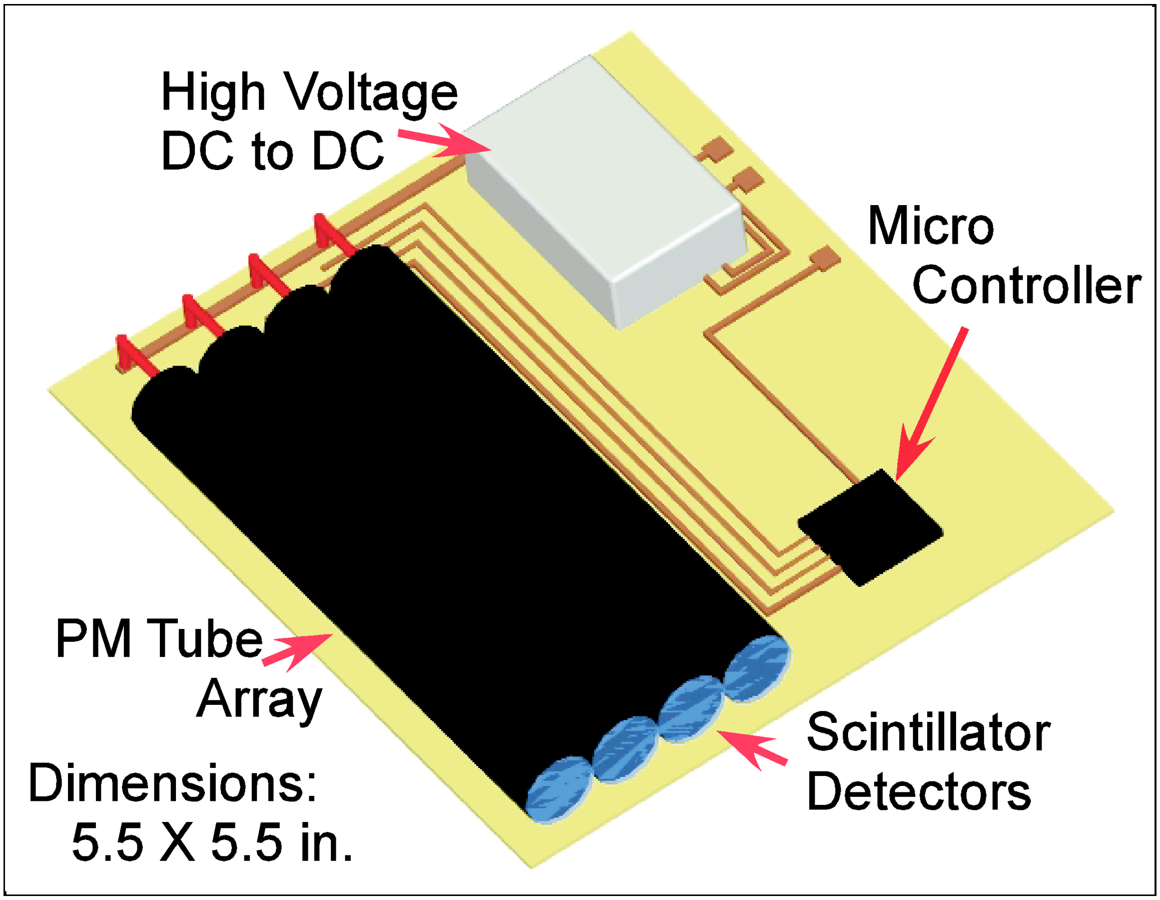
Major components include beta and neutron scintillators, stacked photomultiplier tubes, lithium-ion battery, DC-DC converter, and communications package. This dosimeter can be made about the size of a common fountain pen and can be easily attached to clothing or common areas in a space environment.



Current Space Radiation Detector Prototype

The current space radiation detector prototype is designed to be a flying test bed for components of the planned active space radiation dosimeter. Figure 2 depicts the prototype which consists of four scintillator detectors attached to four photomultiplier tubes, a DC-DC converter, and a microcontroller all attached to a circuit board. The prototype components and the circuit board will be protected by a payload housing currently under development. The payload housing will include thermal insulation and will expose only the scintillator detectors to the ambient conditions.

Figure 2. Space Radiation Detector Prototype



When incoming radiation particles impact the scintillator detectors, light pulses are produced which are channeled into the photomultiplier tubes (PMT). The PMT convert the light energy into amplified electrical pulses. This data is collected and stored by the microcontroller. The type and intensity of radiation can be determined by the characteristic pulses that are generated.

The components of interest in the planned flight test are the scintillator detectors. Two detectors will be configured for neutron radiation detection and two will be configured for high energy charged particle radiation detection. One of the neutron detectors will contain a scintillator doped with nanoparticles and the other will contain a scintillator which is human skin equivalent. One of the charged particle detectors will contain a scintillator which is doped with nanoparticles and the other will contain a scintillator which is human skin equivalent. All scintillators will be configured for pulse height and for energy spectroscopy.

The purpose of the flight test is to assess the performance of the scintillators in detecting neutrons and high energy charged particles at altitude under actual cosmic radiation bombardment. The data collected will be analyzed to compare the performance and sensitivities of the scintillators which are nanoparticle doped with those that are human skin equivalent. Additionally, the data will be compared with data collected during flight tests of the prototype conducted on board a NASA WB-57 high altitude research aircraft.

Payload Integration

It is anticipated that payload integration with HASP will be relatively easy. Below is a summary of planned integration with the EDAC 516 and with the DB9 Connector.

EDAC 516 Connector

We will design the payload for power input and for analog and discreet interface via the EDAC 516. The device will be configured for an input power of 30 volts and a current draw well under .5 amps. We have selected a DC-DC converter with design temperature limits appropriate for the extremely cold conditions that will be encountered during the HASP flight. Although the payload will be thermally insulated within the payload housing, we will desire to monitor payload temperature via one of the analog downlink commands. The only payload command we anticipate requiring is the discreet on/off command to turn the power on prior to flight and to turn it off after the flight.

DB9 Connector

We will design the payload for serial communications interface with the DB9 Connector. Data will be transmitted to the DB9 for on board data archiving and for telemetry. Back up data archiving will be accomplished via an integrated microcontroller.

Payload Weight and Footprint

We anticipate that the prototype with payload housing will have approximate dimensions of 5.5 x 5.5 x 1.0 (inches) and will weigh less than a kilogram.

Dr. Scott Forrest 6/27/2007
Institute for Micromanufacturing
La Tech University

Dear Dr. Forrest,

I am writing to indicate support for your work in small active, scintillation based detectors for high energy charged particle and neutron dosimetry. To support long term human presence in space, we are in need of radiation detection systems with low mass/volume/power characteristics and a wide dynamic range/sensitivity for the particles of interest.

With the upcoming Shuttle retirement and continued development of the next generation vehicle to return explorers to the moon, radiation detector systems of the type you are investigating are highly desirable.

Specifically, I hope to see the further development and use of micro scale photomultiplier tubes currently being developed as integral components of an active radiation dosimeter for spaceflight.

Best regards,

Eddie Semones
Spaceflight Dosimetry Lead
Space Radiation Analysis Group
Johnson Space Center
Mailcode SF2
2101 Nasa Parkway
Houston, Texas 77058