Fiscal Year:	FY 2005	**Task Last Updated:**	FY 10/25/2005
PI Name:	Pisacane, Vincent L. Ph.D.		
Project Title:	Lunar EVA Dosimetry: MIcroDosimeter iNstrument (MIDN) System Suitable for Space Flight		
Division Name:	Human Research		
Program/Discipline:	NSBRI Teams		
Program/Discipline--Element/Subdiscipline:	NSBRI Teams--Technology Development Team		
Joint Agency Name:		**TechPort:**	Yes
Human Research Program Elements:	(1) **SR**:Space Radiation		
Human Research Program Risks:	(1) **ARS**:Risk of Acute Radiation Syndromes Due to Solar Particle Events (SPEs)		
Space Biology Element:	None		
Space Biology Cross-Element Discipline:	None		
Space Biology Special Category:	None		
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City:	Annapolis	**State:**	MD
Zip Code:	21402-1314	**Congressional District:**	3
Comments:	PI retired October 2011 (Ed., 2/29/2012; information from NSBRI)		
Project Type:	GROUND	**Solicitation / Funding Source:**	2003 Biomedical Research & Countermeasures 03-OBPR-04
Start Date:	08/01/2004	**End Date:**	07/31/2008
No. of Post Docs:	1	**No. of PhD Degrees:**	0
No. of PhD Candidates:	0	**No. of Master' Degrees:**	0
No. of Master's Candidates:	0	**No. of Bachelor's Degrees:**	8
No. of Bachelor's Candidates:	2	**Monitoring Center:**	NSBRI
Contact Monitor:		**Contact Phone:**	
Contact Email:			
Flight Program:			
Flight Assignment:	Note: title changed per NSBRI info (12/08)		
Key Personnel Changes/Previous PI:			
COI Name (Institution):	Cucinotta, Francis (NASA JSC) Dicello, John (Johns Hopkins Cancer Center") Rozenfeld, Anatoly (University of Wollongong) Ziegler, James (USNA) Nelson, Martin (USNA) Zaider, Marco (Memorial Sloan-Kettering Cancer Institute)		
Grant/Contract No.:	NCC 9-58-TD00407		
Performance Goal No.:			
Performance Goal Text:			

Task Description:	A microdosimeter is perhaps the only active detector capable of directly determining the radiation quality of a mixed or unknown radiation field, and, therefore, the dose equivalent and effective dose from which the radiation risk can be assessed in real time. The objectives of this research project are to develop a rugged, portable, low power, low mass, solid-state microdosimeter suitable for spaceflight and verify its performance through radiation source and beam tests. The original objectives were expanded to include development of an instrument for the MidSTAR-I spacecraft to be launched in September 2006. This flight will provide evaluation of a preliminary version of the instrument in the space environment. The first-year objectives of the research plan were: (1) prepare computer models of the space environment and radiation transport codes for use in year 2, (2) develop a bench-top set of equipment matched to the sensor, (3) with the bench-top system carry-out preliminary tests with simulated pulses and limited radiation sources, and (4) develop the engineering model of the MIDN-MidSTAR instrument and begin integration of the flight instrument. We are ahead of our objectives for the first year. We now have operational computer models that simulate the near-earth environment and two radiation transport code, GEANT4 and MCNP. As a consequence, the USNA has agreed to be a beta site for the Los Alamos MCNPX version which includes improvements to the algorithms for parallel processing computing. We have made preliminary assessments of the natural radiation environment for the MidSTAR orbit and the effect of the housing on the energy levels and count rates expected during the mission. We have developed a bench-top instrument which includes state-of-the-art laboratory equipment without regard to power and mass that is used for benchmarking the development of the microdosimeter system. We have preliminarily explored the sensor response to assess noise, sensitivity, resolution, linearity, and dynamic range as well as collected data with alpha particles, neutrons, protons, and simulated pulses. We have completed an engineering model with space qualifiable electronics for the MIDN-MidSTAR instrument. The engineering model has gone through several iterations to converge to a final design. Based on the engineering model, a three sensor instrument has been designed for the MIDN-MidSTAR mission. There will be one sensor near the exterior of the spacecraft, one inside, and one encased in polyethylene. The flight boards and parts have been delivered and assembly of the MIDN-MidSTAR instrument is in progress. Integration and initial testing should be completed in approximately one month. This will be followed by vibration and thermal vacuum tests and integration into the spacecraft over the next year. Our schedule is consistent with the spacecraft schedule. We planned originally to use the bench–top instrumentation for radiation beam tests well into the second year before developing the flight qualifiable system. However, because of the success of the engineering model, a MIDN instrument suitable for radiation beam tests will be developed in the early part of the second year. Thus we will be able to compare the performance of the bench-top systems with the flight qualifiable instrument. Our plan for next year is to: 1. Complete qualification of the MIDN-MidSTAR instrument through vibration and thermal vacuum testing and integrate it into the MidSTAR spacecraft supporting efforts at the launch site, Cape Canaveral. 2.Continue development of the engineering and bench-top models to explore reductions in noise, power, and mass and increase sensitivity. 3.Develop the first version of the MIDN instrument to be used for beam tests in year 2. 4. Carry out preliminary testing at the Naval Academy with radiation sources and simulated pulses and carry out two trips to Brookhaven National Laboratory for additional beam tests. 5.Finalize implementation of the GEANT4 and MCNPX radiation transport codes and use the codes to help interpret the radiation test data.
Rationale for HRP Directed Research:	
Research Impact/Earth Benefits:	Experimental microdosimetric techniques are perhaps the only experimental methods for actively determining the radiation quality of mixed or unknown radiation fields and their dose equivalent. The radiation quality and the corresponding dose equivalent and/or effective doses form the basis of regulatory dose limits both in the U.S. and internationally as well as the basis for the evaluation of potential overexposures. Generally, in radiation fields with average quality factors greater than one, those radiation components with the highest quality may represent a component of the dose comparable to the dose uncertainty. For example, as the energy of x-ray therapy machines increases to accommodate intensity modulated radiotherapy and other new techniques, the contributions of secondary neutrons produced in the shielding materials to the whole-body exposure of the clinical personnel as well as the patients themselves increase. With a quality factor as high as twenty, a one or two percent neutron component can contribute as much as twenty to thirty percent of the dose equivalent. Likewise, in radiation storage and clean-up, it is the dose equivalent or effective dose, not the physical absorbed dose, that determines the need and level of clean up, yet it is the physical dose that is usually measured because of the difficulty in measuring dose equivalent in the field by personnel who are not experts in microdosimetry. Finally, the detection of radiation emitted by nuclear materials that may be used in terrorist activities requires cheap, reliable, and rugged microdosimeters that can determine small changes in the radiation environment and issue reliable alerts in real time. The use of prior methods is limited in part because of the complexity, sensitivity, and lack of reliability of the most commonly used instruments, gas proportional counters. The compact system that we have developed for space applications would likewise be applicable for the situations and measurements described in the previous paragraph.
Task Progress:	There has been significant progress over this first year of the project. Accomplishments include: 1. Characterization of the radiation environment for the MidSTAR-I orbit using the SPENVIS suite 2. Determination of the species and flux that the MIDN-MidSTAR should observe using shielding curves and preliminary CRÈME simulations 3. Installation of the MCNP transport code and acceptance of the USNA as a beta site for the MCNPX code 4. Installation of the GEANT4 code on a standalone and multiprocessor computers 5. Initial design of the MIDN and MIDN-MidSTAR instruments 6. Completed integration of the bench-top system, and it has been used in benchmarking important parameters for the space qualifiable design 7. Iterative development of a single channel breadboard instrument to confirm the design of the flight qualifiable microdosimeter system 8. Procurement of the flight parts, printed circuit boards, and housings for the MIDN-MidSTAR instrument and flight parts and printed circuit boards for the MIDN instrument 9. Initial testing of the MIDN bench-mark system using alphas, neutrons, protons, and simulated pulses.
Bibliography Type:	Description: (Last Updated: 07/24/2015)
Presentation	Dicello, J. F. and Pisacane, V. L. "Rugged, compact microdosimeters and the applicability of such measurements for assessing the risk of cancers from exposures to radiation" N/A Feb-2005
Presentation	Pisacane, V. L., Nelson, M. E., Ziegler, J. F., Dolecek, Q., Veade, T. N., Heyne, J. A., Cucinotta, F. A., Rosenfeld, A. B., Zaider, M., Dicello, J. F. "MIcroDosimeter iNstrument (MIDN) system scheduled for launch in 2006" N/A May-2005

Presentation	V. L. Pisacane, J. F. Ziegler, M. E. Nelson, T. N. Veade, J. A. Heyne, Q. E. Dolecek, A. B. Rosenfeld, F. A. Cucinotta, J. F. Dicello "The USNA MIDN MIcrodosimeter Instrument" N/A Jan-2005
Presentation	Wroe, A., Rosenfeld, A. B., Cornelius, I. M., Pisacane, V. L., Ziegler, J. F., Nelson, M. E., Cucinotta, F. A., Zaider, M., Dicello, J. F. "Microdosimetry simulations of solar protons within a spacecraft" N/A Jun-2005