

Project Overview: Year 1

Center for Radiation Engineering and Science for Space Exploration (CRESSE)

Dr. Richard Wilkins, Director



NASA Technical Review Committee

Reverse Site Visit Johnson Space Center August 13, 2009







CRESSE Year 1 Overview: Time of transition

Accomplishments over the past months:

- New equipment purchased:
 - Delivered: Computer cluster for interaction modeling (Aghara), Hydraulic press for composite fabrication (Zhou), Lunar Regoltih (350 kilograms!!), Computer controller for parametric analyzer for electronics (Wilkins).
 - Ordered: Tissue equivalent proportional counter (Gersey), NIM system for dosiemtry (Gersey).
 - In the process: Radfets for dosimetry and electronics (Wilkins & Gersey).
- Placed seven undergraduate student at JSC for summer interns; hired five graduate students.
- Graduate students for materials efforts working hard on lunar regolith composites.
- Hired 1 Post-doc (materials), hiring another (interaction modeling).
- Brad Gersey promotion application complete.
- Three refereed papers published or in press.
- CRESSE booth at the 2009 Nuclear and Space Radiation Effects Conference, along with attendance at four other international conferences.
- CRESSE Webpage published by PVAMU:
- Lab and office space renovations continue.









National Aeronautics and Space Administration



Sustainability Efforts during Year 1

• One successful NASA SBIR Phase I, Phase II submitted for \$188,000 for two years. Concerns composites for radiation shielding.

• Completed contract with Boeing Space Exploration for proton testing for the Constellation Program. K. Allums was helpful to us on this!

• Dr. Aghara has a three year contract with Langley Research Center to Monte Carlo perform radiation modeling.

• Dr. Zhou (PI) just received a grant from the Department of Education to integrate nanotechnology into the College of Engineering curriculum.

• Dr. Wilkins is collaborating with UT-Dallas and Purdue on proposal to the Defense Threat Reduction Agency on radiation effects on quantum circuits.





These activities will overlap for a time.

CRESSE Milestones and Performance Goals						
Research Phases:						
Expand Capabilities		Prove-in systems	000000	Radiation Experiments		
			\$\$\$\$\$	for Exploration		
Year 1	Year 2	Year 3	Year 4	Year 5		
Enhance capabilities in dosimetry and modeling: new equipment, new hardware/software	Enhance capabilities in materials and electronic testing	Conduct first radiation experiment with new detector system.	Conduct first experiment on detector system with rad-hard electronics.	Conduct a series of experiments with new detector system and modular target testhed		
Conduct first radiation experiment with detectors.	Model detector systems and experimental testbed during initial integration and testing.	Conduct initial experiments with Model 1 target testbed	Complete target testbed for both lunar and Martian simulation.	Integrate results from experimental testbed and radiation detector		
Design target testbed Hire post-doc	Conduct first radiation experiments on	Use modeling results to improve understanding of radiation detector	Complete modeling of experimental test bed. Use radiation detector results to improve detector	modeling into a virtual experiment model. Deliver/		
Attend 5 conferences, present at 2	Build first model of target testbed	Attend 6 conferences, present at 4, 2 student	characterization models. Attend 6 conferences,	demonstrate to NASA tested radiation detector system with high TRL.		
on prior data. Engage 7 undergraduates.	Hire post-doc Attend 5 conferences,	presentations Publish 6 refereed papers.	half student presentations. Publish 8 refereed papers.	Attend 8 conferences**, present at all, at least half student presentations.		
7 gřaðuate studěnts (at least one Ph.D. student)	present at 3, with 1 student presentation.	At least two new contracts and one research grant leveraged.	At least two new contracts and two research grants	Publish 10 refereed papers.		
	At least one new contract and one research grant leveraged.	New research staff added based on leveraged funds. Encace 7 undercraduates.	New research staff added based on leveraged funds.	At least three new contracts and three research grants leveraged.		
	Engage 7 undergraduates, 7 graduates (at least one	7 graduates (at least one additional Ph.D. student.)	Engage 9 undergraduates, 8 graduates (at least three* Ph.D.)	Engage 7 undergraduates, 7 graduates (3 Ph.D.)		
	2 undergrads into grad school, one master's degree graduates.	4 undergrads into grads, two master's degree graduates.	4 undergrads into grads, three masters and one Ph.D. student graduate.	four masters and two Ph.D. students graduate.		
Review by NASA Tech Review Committee and External Advisory Panel each year.						
** Leveraged funds will support additional travel to professional conferences.						





Year 1 assessment according to goals and milestones in the original proposal:

Enhance capabilities in dosimetry and modeling: new equipment, new hardware/ software.

✓ Status: New cluster purchased and installed; TEPC and NIM systems ordered. <u>Plan</u>: New detector hardware expected Fall 2009, beam time reserved at Loma Linda, to be proposed at NSRL for Spring-Summer 2010.

Conduct first radiation experiment with detectors.
Status: First beam experiment to take place next week at LANSCE.
<u>Plan</u>: LANSCE experiment will conduct experiments on prototype discussed below. Loma Linda experiment to use "Mark I" standard BERT & ERNIE.

Design target testbed.

 ✓ Status: Prototype design complete, initial lunar regolith plates and CO₂ (simulate Martian atmosphere) scheduled to be part of the LANSCE experiment.
Design of "Mark I" standard BERT & ERNIE underway.
Plan: Complete Mark I by end of year (2009).





Year 1 assessment according to goals and milestones in the original proposal (cont.):

 \succ Hire post-doc.

✓ Status: Dr. Pendleton hired to supervise materials group regolith composite fabrication.
<u>Plan</u>: New Ph.D. level researcher (Dr. Hu) to be hired for interaction modeling (September 2009 start).

> Attend 5 conferences, present at 2.

Status: More than 5 international conferences were attended. Drs. Zhou and Saganti presented at two of the conferences. Dr. Wilkins also presented at Texas Academy of Science, March 2009. <u>Plan</u>: Students and Dr. Pendleton to present papers at the NSBE Aerospace Conference in Fall 2009.

Publish 2 refereed papers on prior data.

✓ Status: At least three papers published or in-press in *Radiation Research*, *Nuclear Instruments* and *Methods B*, and *Journal of Physical Chemistry C*.

<u>Plan</u>: At least one paper to be submitted to IEEE Transactions in Nuclear Science by end of September 2009.

Engage 7 undergraduates, 7 graduate students (at least one Ph.D. student)
Status: 7 undergraduates hired to participate in JSC internships for Summer 2009; five graduate students currently working in materials and dosimetry.
Plan: Recruit Ph.D. student(s) ASAP.





Refereed Papers

"Biological effects of high-energy neutrons measured in vivo using a vertebrate (Oryzias laptipes) model", W. Kuhne, B. Gersey, R. Wilkins, H. Wu, S. Wender, and W. Dynon, accepted for publication in Radiation Research, May 2009. In collaboration with Honglu Wu at JSC.

"Real-time nanotube-based proton radiation sensors", P. Boul, K. Turner, J. Li, M. X. Pulikkathara, R. Dwivedi, E. Sosa, Y. Lu, O. Kuznetsov, P. Moloney, R. Wilkins, M. O'Rourke, V. Khabasheshu, S. Arepalli, L. Yowell, accepted for publication in Journal of Physical Chemistry C, June 2009.

In collaboration with a number of investigators at JSC.

➢ "Evaluation of Multi-functional Materials for Deep Space Radiation Shielding", K. Rojdev, W. Atwell, R. Wilkins, B. Gersey and F. Badavi, National Space and Missile Symposium, Henderson, NV, 22-26 June 2009.

In collaboration with the Boeing Company and JSC.

* "Monte Carlo Analysis of Pion Contribution to Absorbed Dose from Galactic Cosmic Rays," S.K. Aghara, S. R. Blattnig, J. W. Norbury and R. C. Singleterry *Nucl. Insrtum. Meth. B*, 267 (2009) 1115–1124

In collaboration with Langley Research Center.

These show a strong integration with NASA and NASA contractors.





BERT & ERNIE Update

≻Lunar regolith delivered.

>Prototype lunar regolith panels fabricated.

≻New hydraulic press delivered and being installed.



>Prototype experiments to be conducted at Los Alamos next week.

Proton experiments planned in December 2009 for student thesis work (Loma Linda).

> Martian and Lunar regolith systems called: **B**ioastronautics **E**xperimental **R**esearch **T**estbeds for **E**nvironmental **R**adiation **N**ostrum **I**nvestigations and **E**ducation (**BERT** and **ERNIE**)





External Advisory Committee (as appeared in the original proposal):

EAC Member	Title/Affiliation	CRESSE Contribution	
Dr. Kimberly Allums	Radiation Effects Engineer, ERC,	Radiation testing for the NASA	
	Inc., NASA Johnson Space Center.	Constellation Program, former	
		student researcher at CARR, minority	
		pipelines to advanced degrees.	
Dr. William Atwell	Boeing Technical Fellow, The	Expertise on radiation modeling and	
	Boeing Company, Space	its application to space exploration.	
	Exploration, Houston, TX		
Dr. Thomas Borak	Professor, Department of	Extensive expertise in radiation dose	
	Environmental and Radiation	and dosimetry instrumentation.	
	Health, Colorado State		
Dr. Les Braby	Research Professor, Department of	Radiation instrumentation for over 30	
	Nuclear Engineering, Texas A&M	years; built dosimetry instruments for	
		human flights.	
Dr. Yves Chabal	Chair, Department of Material	Pipelines for advanced STEM	
	Science and Engineering;	degrees; new materials and devices	
	Professor, Department of Electrical	for space exploration.	
	Engineering, University of Texas -		
	Dallas.		
Dr. Mark Shavers	Radiation Scientist, Space	Radiation risk assessment for	
	Medicine Group, Wyle &	astronauts; radiation instrumentation;	
	Associates, Houston, TX	future workforce planning	

Changes:

- Kim Allums now a member of the TRC.
- Tom Borak has retired.
- Have invited Dr. Dan Davis at TAMU to participate. Aerospace engineer in materials, interested in minority pipelines in engineering and science.
- Invited Dr. Ellie Blakely, Berkley National Labs, to broaden expertise in the life sciences. (Accepted)
- Need new "electronics" member.0





External Advisory Committee (EAC):

Duties & Expectations:

Members will be asked to review CRESSE activities and provide feedback to the investigators on:

- Progress and quality of CRESSE research.
- Relevance of the research to NASA missions.
- Relevance of the research to the aerospace community.
- Trends in engineering, science and technology that may impact the CRESSE research and mission.
- Student pipelines to advanced degrees of importance to NASA.

The members will receive CRESSE reports and be invited to participate either personally or electronically in an annual meeting where investigators will brief EAC members on CRESSE activities and plans.

The first annual meeting is being planned for September 2009 at PVAMU.

Dr. Wilkins is working with Dr. Shavers (current *de facto* chair) on arrangements for the meeting.





CRESSE Electronics Research

Primary Investigator: Wilkins

- Guiding principle: Assure mission reliability & safety
- Goal: Maximize TRL level of CRESSE research instruments
- Objective: Provide NASA & contractors with radiation effects data from realistic environments

Mechanism for maximizing TRL:

Input from Allums et. al. **External Inputs:** Process: Existing literature Outputs: •Selection of devices for testing. Databases Radiation data on relevant •Radiation experiments with Personnel in ESMC devices. CRESSE testbeds. Higher TRL for CRESSE Integration of devices in electronic Internal Inputs: researched instruments. systems developed for CRESSE •Environmental & instruments. interaction models Instrumentation requirements Feedback based on data from experiments.





Starting point for electronics effort: RadFETS:

> Devices DESIGNED for radiation sensitivity – Appropriate first choice device to be used with BERT & ERNIE.

- ➢ Radiation response well characterized.
- Excellent research opportunity for tissue and silicon dosimetry.
- Excellent candidate for personal space dosimeters for astronauts.





Experimental Plan for DUTs with BERT & ERNIE:

1.RadFET and Si proportional counter. – Radiation effects on RadFETs understood, comparisons of Si and tissue dosimetry.

- 2. Prior tested discrete devices chosen to avoid lot to lot variations.
- 3. Prior tested integrated circuits.
- 4. Prior tested system

5.New devices of interest to NASA.



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Input from Allums

others at

NASA

and