

**44TH ANNUAL
INTERNATIONAL
NUCLEAR AND SPACE RADIATION EFFECTS
CONFERENCE**

JULY 23 - 27, 2007

HONOLULU, HAWAII

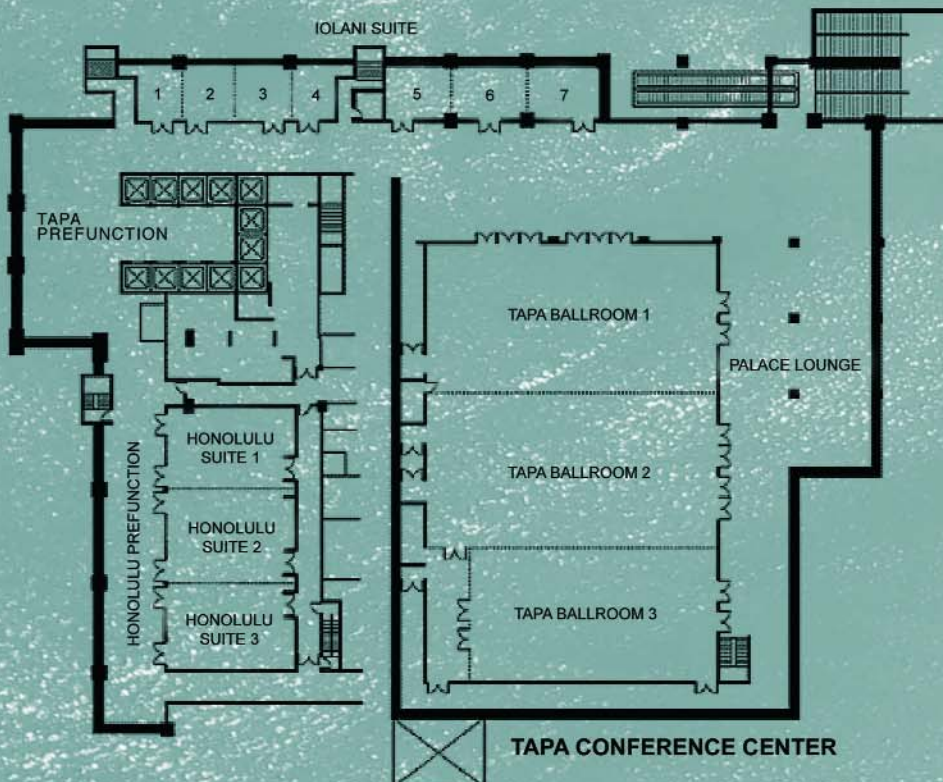
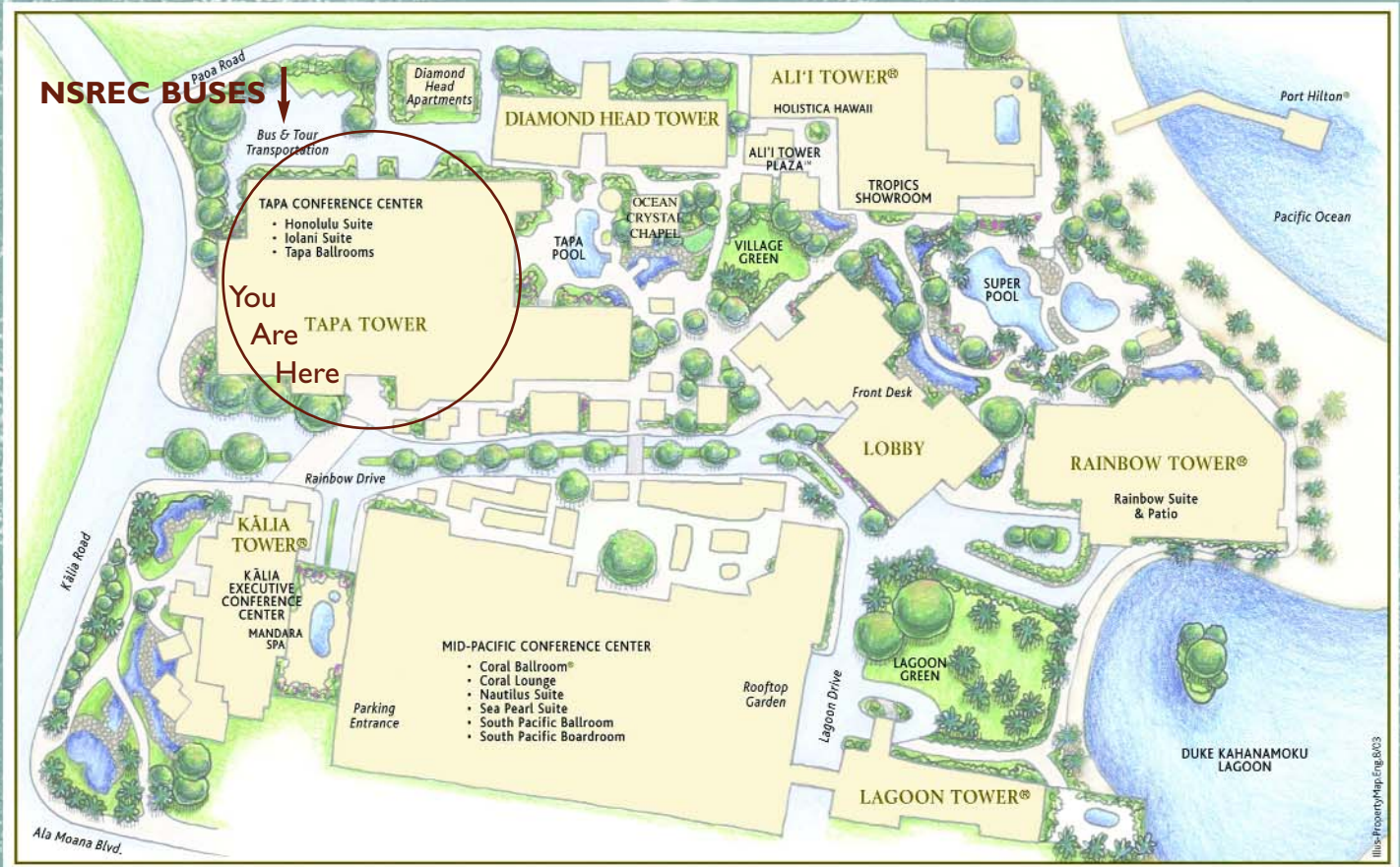


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Conference Facilities

Hilton Hawaiian Village (HHV)



Short Course and Technical Sessions -
Tapa Ballrooms 2, 3

Exhibits - Tapa Ballroom I
and Palace Lounge

Poster Papers -
Poster Setup: Iolani Suites 5, 6, 7
Poster Session: Tapa Ballroom I

Workshop - Honolulu Suites 1, 2, 3

AV Preview Room -
Iolani Suite 4

On-site Registration - Iolani Suite 2

Pre-Registration - Iolani Suites

Schedule

Time	Monday July 23	Tuesday July 24	Wednesday July 25	Thursday July 26	Friday July 27
7:30	[7:30] Continental Breakfast, Tapa Ballroom I	[7:30] Continental Breakfast, Honolulu Prefunction	[7:30] Continental Breakfast, Honolulu Prefunction	[7:30] Continental Breakfast, Honolulu Prefunction	[7:30] Continental Breakfast, Tapa Ballroom I
8:00	[8:00] Short Course Introduction Prof. Hugh Barnaby Tapa Ballrooms 2, 3				
8:15		[8:15] Conference Opening Tapa Ballrooms 2, 3	[8:15] Invited Talk Volcanism in Hawaii Dr. Patricia Fryer Tapa Ballrooms 2, 3	[8:15] Invited Talk Polynesian History, Mythology, and Culture Cy Bridges Tapa Ballrooms 2, 3	[8:15] Invited Talk Astronomy in Hawaii: Exploring Our Universe with the Largest Telescopes in the World Dr. Rolf-Peter Kudritzki Tapa Ballrooms 2, 3
8:30	[8:30] Part 1 – Process Technologies and Hardening Prof. Michael Alles				
9:00		[8:55] Session A Basic Mechanisms of Radiation Effects			
9:30			[9:25] Session F Radiation Effects in Devices and Integrated Circuits	[9:25] Session H Single-Event Effects: Mechanisms and Modeling	[9:25] Session J Single-Event Effects: Devices and Integrated Circuits
10:00	[10:00] Break, Palace Lounge				
10:30	[10:30] Part 2 – Radiation Effects and Mitigation Strategies on Digital ASICs and FPGAs Dr. Fernanda Lima Kastensmidt	[10:15] Break, Tapa Ballroom I and Palace Lounge [10:40] Session B Space and Terrestrial Environments	[10:30] Break, Tapa Ballroom I and Palace Lounge	[10:30] Break, Palace Lounge	[10:30] Break, Palace Lounge
11:00			[11:00] Session F (continued)	[11:00] Session H (continued)	[11:00] Session J (continued)
11:30		[11:45] Lunch			
12:00	[12:00] Short Course Luncheon, Tapa Ballroom I		[12:00] Lunch	[12:00] Lunch	[12:00] End of Conference
12:30					
1:00					
1:30	[1:15] Part 3 – Radiation Effects on Analog Integrated Circuits and Extreme Environment Design Prof. Benjamin Blalock	[1:10] Session C Hardness By Design	[1:25] Session G Dosimetry and Facilities	[1:25] Session I Photonic Devices and Integrated Circuits	
2:00					
2:30			[2:30] Data Workshop Honolulu Suites 1, 2, 3		
3:00	[2:45] Break, Palace Lounge	[2:45] Break, Tapa Ballroom I and Palace Lounge			
3:30	[3:15] Part 4 – Radiation Hardening at the System Level Dr. Ray Ladbury	[3:10] Session D Hardness Assurance		[3:00] Poster Session Tapa Ballroom I	
4:00					
4:30		[4:15] Session E Terrestrial and Atmospheric Radiation Environments and Effects	[4:15] End of Session		
5:00	[4:45] Wrap-up [4:55] Exam (for students requesting CEU credit only) [5:25] End of Short Course	[5:05] End of Session	[4:45 to 10:00] Conference Social Luau at Paradise Cove 5:30 Cocktails 7:15 Dinner 8:30 Show	[4:45] End of Session	
5:30	[5:30 to 7:30] All Conference Beach Bash Welcome – on the beachfront Ilima Lawn at the Hale Koa park next door to the Hilton Hawaiian Village Ali'i tower			[5:15 to 6:30] Radiation Effects Committee Open Meeting, Tapa Ballrooms 2, 3	
6:00		[6:00 to 10:00] Industrial Exhibits Reception 6:00 Cocktails 7:00 Buffet Tapa Ballroom and Palace Lounge			
6:30					
7:00					

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Chairman's Invitation



"Aloha and ho'olu komo la kaua (please join us) on nani (beautiful) Waikiki Beach on the Hawaiian Island of O'ahu. Mahalo nui (thank you very much) to all the volunteers, authors, exhibitors, supporters, and attendees who have contributed to NSREC 2007 in Honolulu, Hawaii. We anticipate an exceptional time of technical interchange and networking for those involved in radiation effects/electronics research, development, and marketing. A hui hou (see you soon) in Honolulu."

Lloyd W. Massengill
NSREC 2007 General Chairman

**Visit us on the web at:
www.nsrec.com**

Aloha! On behalf of the IEEE Nuclear and Plasma Sciences Society Radiation Effects Committee, I invite you to attend the 44th annual IEEE International Nuclear and Space Radiation Effects Conference (NSREC). This year's conference will be held July 23-27, 2007, at the Hilton Hawaiian Village Resort on beautiful Waikiki Beach in Honolulu, Hawai'i. We will continue the tradition of previous NSRE Conferences by offering an outstanding Technical Program, a one-day Short Course, a Radiation Effects Data Workshop, and an Industrial Exhibit. Engineers, scientists, managers, and other interested parties from around the world will attend.

The Technical Program Chairman, Prof. John Cressler (Georgia Tech), and his program committee, have assembled an outstanding set of contributed papers describing the latest information on nuclear and space radiation effects on electronic and photonic materials, devices, circuits, and systems, and the engineering of radiation-tolerant devices and integrated circuits. Presentations will include ten oral sessions and a poster venue. In addition, there will be a Radiation Effects Data Workshop consisting of poster presentations describing new radiation effects data and new simulation and test facilities. Three invited talks on local culture, geology, and technology are also planned.

Prof. Hugh Barnaby (Arizona State University) has organized this year's Short Course with a theme of "Hardened Electronics for Tomorrow's Radiation Tolerant Systems." This Short Course is an excellent learning opportunity for those who are new to the radiation effects community and need a quick introduction to the field, as well as those who want to stay abreast of current issues. The Short Course will start Monday morning with tutorials on "Process Technologies and Hardening" and "Radiation Effects and Mitigation Strategies on Digital ASICs and FPGAs." Monday afternoon will include tutorials on "Radiation Effects on Analog Integrated Circuits and Extreme Environment Design," and "Radiation Hardening at the System Level."

This year's Industrial Exhibits, organized by Barry Templeton (Vanderbilt/ISDE), will permit one-on-one discussions between conference attendees and exhibitors on the latest developments in radiation-hardened and radiation-tolerant electronics, engineering services, facilities, and equipment. On Tuesday evening, attendees and their companions are invited to a reception that showcases the Industrial Exhibit.

Social events have been planned to give Conference attendees and their guests many opportunities to informally discuss business and to become better acquainted. Susan Crain (The Aerospace Corporation), this year's Local Arrangements Chairman, has planned an extraordinary social program. The main conference social on Wednesday night will be an unforgettable visit to the Paradise Cove Luau. Attendees and guests will enjoy island activities, an oceanfront dinner, and a spectacular show on the leeward coast of O'ahu. In addition, we have planned two companion tours during the day on Tuesday and Thursday, each with its own Hawaiian Island theme.

Our hotel will be the Hilton Hawaiian Village Resort. I am quite confident you will have a 'olu'olu (wonderful) time at this world-renowned, award-winning resort situated directly on the beach in Waikiki. The city of Honolulu has something for everyone, from the history buff to the cultural connoisseur to those desiring dining and dancing after a busy conference day. The island of O'ahu is no less diverse, with eco regions ranging from sandy beaches to rocky volcanic mountains to tropical rainforests to lush agricultural plains – all within a short drive. There will be culture, history, and excitement for the whole family.

We are very excited about this year's conference and look forward to seeing you in Waikiki.

Short Course Program

HARDENED ELECTRONICS FOR TOMORROW'S RADIATION TOLERANT SYSTEMS

TAPA BALLROOMS 2, 3 – MONDAY, JULY 23

- 7:30 AM **REGISTRATION/CONTINENTAL BREAKFAST**
- 8:00 AM **SHORT COURSE INTRODUCTION**
Dr. Hugh Barnaby *Arizona State University*
- 8:30 AM **PART 1 – PROCESS TECHNOLOGIES AND HARDENING**
Dr. Michael Alles *Vanderbilt University Institute for Space and
Defense Electronics*
- 10:00 AM **BREAK (PALACE LOUNGE)**
- 10:30 AM **PART 2 – RADIATION EFFECTS AND MITIGATION
STRATEGIES ON DIGITAL ASICS AND FPGAS**
Dr. Fernanda Lima Kastensmidt *Universidade Federal do Rio
Grande do Sul (UFRGS)*
- 12:00 PM **SHORT COURSE LUNCHEON
(TAPA BALLROOM 1)**
- 1:15 PM **PART 3 – RADIATION EFFECTS ON ANALOG
INTEGRATED CIRCUITS AND EXTREME
ENVIRONMENT DESIGN**
Dr. Benjamin Blalock *The University of Tennessee*
- 2:45 PM **BREAK (PALACE LOUNGE)**
- 3:15 PM **PART 4 – RADIATION HARDENING AT THE
SYSTEM LEVEL**
Dr. Ray Ladbury *NASA Goddard Space Flight Center*
- 4:45 PM **WRAP-UP**
- 4:55 PM **EXAM (only for students requesting CEU credit)**
- 5:25 PM **END OF SHORT COURSE**

Short Course

COURSE DESCRIPTION

This one-day Short Course will provide a review of the radiation threats for electronics and the many techniques used to harden strategic and space-based systems. Case studies will be introduced in the first part of the course to show how mission requirements drive the analysis of environmental threats and the choice and implementation of hardening approaches. These approaches include the development of technologies that are hardened-by-process (HBP), integrated circuits (both digital and analog) that are hardened-by-design (HBD), and systems that utilize both HBP and HBD as well as system-level mitigation schemes. The course's four instructors will address these various aspects. Prof. Michael L. Alles, Vanderbilt University ISDE, will review the basic mechanisms of radiation effects and address process-level hardening. Radiation effects and mitigation schemes for digital ASICs and FPGAs will be presented by Dr. Fernanda Lima Kastensmidt, Universidade Federal do Rio Grande do Sul (UFRGS). Prof. Benjamin Blalock, University of Tennessee, will review radiation effects on analog applications and present advanced design techniques for analog electronics in extreme environments. Dr. Ray Ladbury, NASA Goddard Space Flight Center, will address the issues related to system design, from the identification of mission requirements to the implementation of hardening approaches at the system level.

The course is applicable to designers, radiation effects engineers, component specialists, and other technical and management personnel who are involved in developing systems designed to operate in harsh strategic and space environments. This course provides a unique opportunity for NSREC attendees to benefit from the expertise of the instructors as well as the in-depth coverage and perspective provided by the short course forum. Each instructor will develop the core content of their respective topics from background material largely found in the literature. As such, the course will benefit both new and experienced engineers, scientists, and managers.

CONTINUING EDUCATION UNITS (CEUS)

For those interested in Continuing Education Units (CEUs), 0.6 CEUs, endorsed by the IEEE and the International Association for Continuing Education and Training (IACET) will be available. The IEEE is an authorized CEU sponsor member of the IACET. IEEE guidelines for CEU credit will be followed. To qualify for CEU credit a person must be registered attendee of the Short Course and must pass a written examination with a score of 75% or better. The examination will be given immediately following the last segment of the course. It will be open book, consisting of approximately 20 multiple-choice questions covering only material presented in the Short Course. A certificate of completion will be mailed to all students who request and qualify for it.

SHORT COURSE CHAIRMAN



*Hugh J. Barnaby
Short Course Chairman*

Hugh J. Barnaby received his B.A. in mathematics and philosophy from the University of California, Berkeley, in 1992 and the M.S. and Ph.D. degrees in electrical engineering, from Vanderbilt University, Nashville, in 1999 and 2002. He is currently an Assistant Professor in the Department of Electrical Engineering at Arizona State University, where his primary research activities include modeling radiation effects in semiconductor devices and high performance integrated circuits and radiation-hardening-by-design. Dr. Barnaby has served as an active researcher in the radiation effects field for over 14 years in both industry and academics, presenting and publishing more than 60 papers during this time. He is a senior member of IEEE and has been involved in the NSREC community since 1996 serving as a Session Chairman in 2002, Short Course Instructor in 2005, and Poster Chairman in 2006.

Short Course Monday



Michael Alles is a Research Associate Professor and Senior Research Engineer with Vanderbilt's Institute for Space and Defense Electronics (ISDE) where he works in the area of radiation effects in microelectronics. He spent two years as a Business Unit Director for Silvaco International, 10 years with Ibis Technology Corporation in SIMOX-SOI technology and product development, and one year with Harris Semiconductor as a design engineer. Dr. Alles has served on the SIA ITRS starting materials working group since 1999, serving as chairman of the SOI materials group for the 2001 revision of ITRS, and has been a reviewer for Transactions on Nuclear Science three times. Dr. Alles received his Ph.D. in Electrical Engineering (12/92), M.S. in Electrical Engineering (8/90), and his B.E. in Electrical Engineering with a Double Major in Physics (5/87) all from Vanderbilt University.

PROCESS TECHNOLOGIES AND HARDENING

Dr. Michael L. Alles

Vanderbilt University Institute for Space and Defense Electronics

Michael L. Alles, Vanderbilt University Institute for Space and Defense Electronics, will review the response of materials and devices to ionizing radiation and discuss potential fabrication process modifications and device topologies to mitigate the effects of radiation. There is a desire to leverage the performance and density improvements of technology advancements for applications in radiation environments. Although thinner gate insulators in CMOS FETs have reduced the problematic threshold voltage shifts, edge leakage due to charge trapping in the isolation regions remains a consideration. Increased single event sensitivity with scaling and use of lightly doped substrates may require engineering of substrates or special device structures. While use of SOI-based technologies provides some relief; the total-ionizing-dose response of the buried oxide, parasitic bipolar effects, and a high angular dependence of the single event response must be considered.

Introduction

Review of Radiation Effects

- Single Event Effects
- Dose Rate Effects
- Total Ionizing Dose

Mitigation Approaches

- Radiation Hardening by Process
- Radiation Hardening by Design
- System Level Hardening

Technology Trends: Implications for Radiation Effects

- Scaling
- New Materials
- Substrates

Process Hardening

- Insulators
- Active Device Regions
- Technology Elements
- Impact of Overlayers

Summary



Fernanda Gusmão de Lima

Kastensmidt is a professor in the Applied Informatics Department at the Federal University of Rio Grande do Sul (UFRGS), located in Porto Alegre, Brazil. She received her BS in Electrical Engineering in 1997 and M. Sc. and Ph. D. degrees in Computer Science and Microelectronics in 1999 and 2003, respectively, from the Federal University of Rio Grande do Sul (UFRGS), Porto Alegre, Brazil. She worked in the Grenoble National Polytechnic Institute (INPG), France, in 1999 and Xilinx Corporation, San Jose, USA, in 2001. Her research interests include VLSI testing and design, fault effects, fault tolerant techniques and programmable architectures. She is a member of IEEE, and author of the book "Fault-Tolerance Techniques for SRAM-based FPGAs," published in 2006.

RADIATION EFFECTS AND MITIGATION STRATEGIES ON DIGITAL ASICS AND FPGAS

Dr. Fernanda Lima Kastensmidt

Universidade Federal do Rio Grande do Sul (UFRGS)

Fernanda Lima Kastensmidt, Universidade Federal do Rio Grande do Sul (UFRGS), will discuss radiation effects on digital integrated circuits and modern mitigation strategies for Application Specific Integrated Circuits (ASICs) and Field Programmable Gate Arrays (FPGAs). First, the mechanisms of charge collection in CMOS devices are explained as well as Single Event Effects (SEE). Single Event Upsets (SEU) and Single Event Transient (SET) effects are studied in synchronous and asynchronous logic. Next, the set of SEU and SET mitigation strategies based on hardware and time redundancy are presented and differentiated in terms of area and performance overhead and reliability. The radiation effects are then characterized for FPGA devices followed by a presentation of specific mitigation techniques for programmable devices based on hardware redundancy, placement and routing. By the end, the attendees will be acquainted with the design mitigation techniques that are currently being used to protect ICs (ASICs and FPGAs) against SEU, SET and MBU and their advantages and limitations.

Introduction

Radiation Effects on Digital ICs

- Collection Charge in MOS devices
- Single-Event Effects

Radiation Hardening by Design: Strategies for ASICs

- Layout and Electrical Level Based Techniques
- Logic Level Based Techniques
- Architectural Level Based Techniques

Radiation Effects on FPGAs

- Permanent Single Event Effects
- Transient Effects

Radiation Hardening by Design: Strategies for FPGAs

- Hardware Redundancy
- Placement and Routing Issues
- Partial Reconfiguration

Conclusions



Benjamin J. Blalock received his B.S. degree in electrical engineering from The University of Tennessee, Knoxville, in 1991 and the M.S. and Ph.D. degrees, also in electrical engineering, from the Georgia Tech, Atlanta, in 1993 and 1996 respectively. He is currently an Associate Professor in the Department of Electrical and Computer Engineering at The University of Tennessee where he directs the Integrated Circuits and Systems Laboratory (ICASL). His research focus there includes analog integrated circuit design for extreme environments (both wide temperature and radiation) on CMOS and SiGe BiCMOS, multi-gate transistors and circuits on SOI, analog circuit techniques for sub 100-nm CMOS, mixed-signal/mixed-voltage circuit design for systems-on-a-chip, and biomicro-electronics. Dr. Blalock has co-authored over 80 refereed papers. He has also worked as an analog IC design consultant for Cypress Semiconductor Corp., Concorde Microsystems Inc., and XYZ Microsystems, LLC. Dr. Blalock is a senior member of the IEEE.

RADIATION EFFECTS ON ANALOG INTEGRATED CIRCUITS AND EXTREME ENVIRONMENT DESIGN

Dr. Benjamin Blalock
The University of Tennessee

Benjamin Blalock, The University of Tennessee, will discuss radiation effects on analog integrated circuits and design techniques for mitigating the combined impact of ionizing radiation and wide temperature variability on circuit functionality. The first part of the course will provide a basic overview of the analog circuits commonly found in space and strategic systems. These circuits include amplifiers, references, and regulators. Next, Dr. Blalock will review device- and circuit-level mechanisms for radiation-induced degradation and transient effects in commercial-off-the-shelf analog parts and the applications that use them. Special consideration will be placed on the enhanced-low-dose-rate sensitivity (ELDRS) in linear bipolar applications. The last part of the course will focus on strategies for designing analog integrated circuits targeted for use in harsh radiation and extreme temperature environments. The design of a CMOS quad operational amplifier on radiation hardened SOI will be presented, with special emphasis on achieving reliable operation over wide temperature range. A SiGe BiCMOS analog design for extreme environment will also be presented. These custom analog integrated circuits have been specially designed for Mars- and moon-based systems.

Introduction: Analog Circuits in Space Avionics

Radiation Effects in Analog ICs

- Total Dose and Dose Rate Effects
- Single Event Effects

Analog Integrated Circuit Design for Extreme Environments

- Motivation, Procedures and Methodologies
- Design of a Radiation Hardened SOI CMOS Op Amp
 - Sub-circuit design for reliability
 - Constant inversion coefficient biasing for wide temperature operation
- Extreme Environment SiGe BiCMOS Op Amp

Summary

Short Course Monday



Ray Ladbury is a radiation physicist in the Radiation Effects and Analysis Group (REAG) at NASA Goddard Space Flight Center where he is the Radiation Lead for the James Webb Space Telescope Mission. Prior to joining the REAG in 2000, he was a radiation physicist at Hughes Space and Communications (now Boeing Space and Information Systems), an editor at *Physics Today* Magazine, a physics professor at Pikeville College in Pikeville, Kentucky and a Peace Corps Science Teacher Trainer in the West African nation of Togo. He holds a Bachelor's degree in physics from Colorado State University and a PhD degree in experimental particle physics from the University of Colorado. He has published over 40 papers, over 30 of them in radiation effects and received the 2004 NASA Medal for Public Service.

RADIATION HARDENING AT THE SYSTEM LEVEL

Dr. Ray Ladbury

NASA Goddard Space Flight Center

Ray Ladbury, NASA Goddard Space Flight Center, will discuss system-level hardening approaches for space and strategic systems. System-level hardening seeks to develop a system that is demonstrably capable of fulfilling its required functions in the mission environment. Using case studies from actual space missions, the course will begin by examining how system requirements and parts selection determine the radiation vulnerabilities of the system. Next we look at the temporal, spatial and logical characteristics of radiation threats, how mitigation strategies capitalize on these characteristics and the limitations of traditional mitigation strategies. The final section of the course will consider how much mitigation is enough and how to prioritize radiation risks to facilitate the most efficient allocation of scarce resources.

Introduction

System and System Hardening

Case Studies

- Solar Dynamic Observatory
- Exploration Rovers

Threat Identification

Threat Assessment

- Probability Analysis
- Statistical Inference
- General Statistical Approach

Radiation Effects: Consequences and Propagation

- Single Event Effects
- Total Ionizing Dose and Displacement Damage
- Dose Rate Effects

Mitigation Strategies

Special Problems in System Level Hardening

Conclusions

Technical Program

TECHNICAL INFORMATION



"The 2007 NSREC had a record number of paper submissions, and the Technical Program Committee has assembled a truly exciting set of high-quality papers detailing the latest advances in nuclear and space radiation effects. Come and enjoy sunny Hawaii with us and help continue the wonderful tradition that is NSREC."

*John Cressler, Georgia Tech,
Technical Program Chairman*

The NSREC technical program will consist of contributed oral and poster papers, three invited papers, and a data workshop. All oral papers will be 12 minutes in length with an additional 3 minutes for questions and answers. The technical sessions and chairpersons are:

- **Basic Mechanisms of Radiation Effects**
Chair: Andrew Pineda, AFRL/University of New Mexico, Albuquerque, NM
- **Dosimetry and Facilities**
Chair: Anatoly Rosenfeld, University of Wollongong, Wollongong, Australia
- **Hardness Assurance**
Chair: Steve McClure, JPL, Pasadena, CA
- **Hardness By Design**
Chair: Tim Holman, Vanderbilt University, Nashville, TN
- **Photonic Devices and Integrated Circuits**
Chair: Cheryl Marshall, NASA-GSFC, Greenbelt, MD
- **Radiation Effects in Devices and Integrated Circuits**
Chair: Steve Bernacki, Raytheon/Draper Laboratory, Cambridge, MA
- **Single-Event Effects: Devices and Integrated Circuits**
Chair: Younes Boulghassoul, ISI/USC, Arlington, VA
- **Single-Event Effects: Mechanisms and Modeling**
Chair: Véronique Ferlet-Cavrois, CEA, Bruyeres Le Chatel, France
- **Space and Terrestrial Environments**
Chair: Tom Jordan, EMP Consultants, Gaithersburg, MD
- **Terrestrial and Atmospheric Radiation Environments and Effects**
Chair: Ken Rodbell, IBM, Yorktown Heights, NY

POSTER SESSION

Papers that are most effectively presented visually with group discussion will be displayed as posters from Tuesday, 2:00 PM through Wednesday, 5:00 PM in the Iolani Suites 5, 6, 7. Authors will be available to discuss their work during the Poster Session Thursday, 3:00 to 4:45 PM in the Tapa Ballroom 1. The Poster Session Chair is Dale McMorrow of NRL.

RADIATION EFFECTS DATA WORKSHOP

Papers in the data workshop are intended to provide radiation response data to scientists and engineers who use electronic and photonic devices and circuits in a radiation environment, and to designers of radiation-hardened systems. Workshop posters can be viewed from Tuesday, 12:00 PM through Thursday, 5:00 PM in the Honolulu Suites 1-3. Authors will be available to discuss their work during the Data Workshop Session Wednesday, 2:30 to 4:15 PM in Honolulu Suites 1-3. A copy of the Data Workshop Record will be mailed to all registered attendees after the conference. The data workshop chair is Christian Poivey of NASA-GSFC.

INVITED SPEAKERS

Dr. Rolf-Peter Kudritzki, the Director for the Institute for Astronomy at the University of Hawaii, will be speaking on "Astronomy in Hawaii"; Mr. Cy Bridges, the Director of Culture at the Polynesian Cultural Center, will be speaking on "Polynesian History, Mythology, and Culture"; and Dr. Patricia Fryer, Professor of Marine Geology and Geophysics in the School of Ocean and Earth Science and Technology at the University of Hawaii, will be speaking on "Volcanism in Hawaii."

LATE-NEWS PAPERS

A limited number of late news papers will be accepted and included in the Poster Session and the Radiation Effects Data Workshop. The deadline for submission is June 1, 2007. Detailed instructions for submitting a late-news summary to the technical program committee are available on the NSREC website at www.nsrec.com.

Technical Program Tuesday

TAPA BALLROOMS 2, 3

8:15 AM

OPENING REMARKS

Lloyd Massengill, Vanderbilt University, General Chairman

8:20 AM

AWARDS PRESENTATION

Tim Oldham, NASA-GSFC, Radiation Effects Steering Group Chairman

8:50 AM

TECHNICAL SESSION OPENING REMARKS

John Cressler, Georgia Tech, Technical Program Chairman

SESSION A

8:55 AM

BASIC MECHANISMS OF RADIATION EFFECTS

SESSION INTRODUCTION

Chair: Andrew Pineda, AFRL/University of New Mexico

A-1

9:00 AM

Radiation Induced Charge Trapping in Ultra-Thin HfO₂ based MOSFETs

S. K. Dixit, X. J. Zhou, R. D. Schrimpf, D. M. Fleetwood, S. T. Pantelides, L. C. Feldman, Vanderbilt University; G. Bersuker, R. Choi, SEMATECH Inc.

We investigate the radiation response of nMOSFETs with ultra-thin HfO₂ gate dielectrics. The radiation response is characterized as a function of dielectric thickness and irradiation bias.

A-2

9:15 AM

Nanoscale Electrical Characterization of Irradiated Ultra-Thin Gate Oxides

M. Porti, X. Aymerich, A. Cester, DEE - Universitat Autònoma de Barcelona; S. Gerardin, M. Nafria, A. Paccagnella, DEI - Padova University

We use different atomic force microscopy related techniques to analyze the electrical properties of irradiated ultra-thin gate oxides, gathering information on the number, size, position, and properties of conductive spots generated by impinging heavy ions.

A-3

9:30 AM

Oxide-Nitride-Oxide Capacitors Reliability Under Heavy-Ion Irradiation

A. Gasperin, A. Cester, A. Paccagnella, Padova University; G. Ghidini, ST Microelectronics

We investigate heavy ion irradiation effects on Oxide-Nitride-Oxide (ONO) capacitors. After irradiation we measure a leakage current that decreases with time. Electrical stresses demonstrate that irradiation does not reduce the time-to-breakdown of these devices.

A-4

9:45 AM

Quantum Mechanical Description of Displacement Damage Formation

M. J. Beck, R. Hatcher, R. D. Schrimpf, D. M. Fleetwood, S. T. Pantelides, Vanderbilt University

Using dynamical calculations of displacement damage formation conducted without recourse to energy partitions or threshold energies, we show that stable defect formation is a complex balance of electronic excitation, phonon emission, and metastable defect relaxation.

Technical Program Tuesday

A-5
10:00 AM

Mechanisms of Enhanced Radiation-Induced Degradation due to Excess Molecular Hydrogen in Bipolar Oxides

X.-J. Chen, H. Barnaby, B. Vermeire, Arizona State University; R. Pease, RLP Research; D. Platteter, G. Dunham, J. Seiler, NAVSEA Crane; S. McClure, JPL

Enhanced radiation-induced degradation in bipolar devices and circuits packaged in hermetically sealed packages with excess molecular hydrogen is proposed to result from H_2 dissociation reactions with defects in the oxide before and during radiation exposure.

POSTER PAPERS

PA-1

Evidence of Radiation Induced Dopant Neutralization in Partially-Depleted SOI NMOSFETs

K. Akarvardar, IMEP (now Stanford University); R. Schrimpf, D. Fleetwood, Vanderbilt University; S. Cristoloveanu, P. Gentil, IMEP; B. Blalock, University of Tennessee

Radiation-induced dopant passivation is demonstrated for the first time in partially-depleted SOI n-channel MOSFETs. The SOI four-gate transistor, inherently present in the partially-depleted MOSFET structure, is a very efficient tool for diagnosing dopant neutralization.

PA-2

Doping-Type Dependence of Damage in Silicon Diodes Exposed to X-Ray, Proton, and He⁺ Radiations

M. Caussanel, Université de Perpignan Via Domitia; A. Canals, TRAD; S. K. Dixit, M. J. Beck, R. D. Schrimpf, D. M. Fleetwood, S. T. Pantelides, Vanderbilt University; A. D. Touboul, Université Montpellier II

Different responses for n-Si and p-Si are observed after X-ray, H^+ , and He^+ irradiations. Recombination lifetime and forward I-V measurements made on abrupt junctions are compared to theory.

PA-3

Total Dose Response of HfSiON MOS Capacitors

D. Chen, R. D. Schrimpf, D. M. Fleetwood, K. F. Galloway, Vanderbilt University; S. Lee, H. Seo, G. Lucovsky, North Carolina State University; B. Jun, J. D. Cressler, Georgia Tech

We have performed the first total-dose irradiation experiments on $Hf_{0.6}Si_{0.2}ON_{0.2}$ and $Hf_{0.3}Si_{0.4}ON_{0.4}$ MOS capacitors. We observe reduced net oxide trap charge relative to Hf-silicate devices, and electron trapping in $Hf_{0.6}Si_{0.2}ON_{0.2}$ films with positive irradiation biases.

PA-4

Probing Radiation- and Hot Carrier-Induced Damage Processes in SiGe HBTs Using Mixed-Mode Electrical Stress

P. Cheng, B. Jun, A. Sutton, C. Zhu, A. Appaswamy, J. D. Cressler, Georgia Tech; R. D. Schrimpf, D. M. Fleetwood, Vanderbilt University

We report a new method of thermal annealing in modern bipolar transistors. Using this technique, we compare the damage processes associated with both X-ray irradiation-induced and hot carrier-induced damage in SiGe HBTs.

Technical Program Tuesday

PA-5 Trap Assisted Tunneling Induced Currents In Neutron Irradiated $\text{Al}_x\text{Ga}_{1-x}\text{N}/\text{GaN}$ HFETs

T. E. Gray, J. C. Petrosky, J. W. McClory, Air Force Institute of Technology; T. M. Uhlman, Defense Threat Reduction Agency

The gate leakage current in neutron irradiated $\text{Al}_{0.27}\text{Ga}_{0.73}\text{N}/\text{GaN}$ HFETs is investigated. A trap-assisted tunneling model is applied and fitted to experiment. The fitting indicates that increased trap density accounts for increased gate leakage after irradiation.

PA-6 An Analysis of the Effects of Low-Energy Electron Radiation on $\text{Al}_x\text{Ga}_{1-x}\text{N}/\text{GaN}$ HFETs

J. W. McClory, J. C. Petrosky, Air Force Institute of Technology; J. Sattler, Air Force Research Laboratory; T. Jarzen, Defense Threat Reduction Agency

The effects of low energy electron irradiation on $\text{Al}_{0.27}\text{Ga}_{0.73}\text{N}/\text{GaN}$ HFETs are investigated. Post-irradiation gate and drain currents increase due to increased carrier concentrations at the interface. Upon annealing, device parameters return to their pre-irradiation levels.

PA-7 Decrease of Charge Collection Due to Displacement Damage by Gamma Rays in 6H-SiC Diodes

S. Onoda, T. Ohshima, T. Hirao, S. Hishiki, T. Kamiya, JAEA; K. Mishima, N. Iwamoto, JAEA, UEC; K. Kawano, UEC

Charge Collection Efficiency (CCE) generated in 6H-SiC diodes by 15 MeV O is analyzed before and after gamma irradiation. We present the degradation of CCE and diffusion length, and discuss the utility of NIEL.

10:15 – 10:40 AM
TAPA BALLROOM I AND
PALACE LOUNGE

BREAK

SESSION B SPACE AND TERRESTRIAL ENVIRONMENTS

10:40 AM SESSION INTRODUCTION

Chair: Tom Jordan, EMP Consultants

B-1 Proton Flux Anisotropy in Low Earth Orbit

10:45 AM *B. K. Dichter, G. P. Ginet, D. Brautigam, M. J. Golightly, Air Force Research Laboratory; S. Easley, Air Force Institute of Technology; D. Madden, Boston College*

We measured proton flux anisotropy as a function of altitude in South Atlantic Anomaly. Results are applied to determining radiation doses to electronic components on three axis stabilized satellites in low Earth orbit.

B-2 Charging of Composites in Space Environment: Ground Test Data

11:00 AM *A. L. Bogorad, J. J. Likar, R. Herschitz, Lockheed Martin Commercial Space Systems*

Results of an extensive ground test routine, during which the charging characteristics of numerous composites commonly used in spacecraft design, are presented for plasmas representative of spacecraft exterior and shielded locations at GEO.

Technical Program Tuesday

B-3
11:15 AM **Galileo Giove-A Radiation Monitors, a Year in Orbit**
B. Taylor, C. Underwood, Surrey Space Centre, University of Surrey, UK; H.D.R. Evans, E. Daly, G. Mandorlo, M. Falcone, European Space Agency, ESTEC, NL; K. A. Ryden, P. A. Morris, QinetiQ Space Division, UK

A review of the radiation monitors on board the Galileo Giove-A satellite, CEDEX and Merlin, and their first year of data are presented. A comparison of the data with existing monitors and models is presented.

B-4
11:30 AM **New Statistical Solar Heavy Ion Model**
M. A. Xapsos, J. L. Barth, NASA-GSFC; C. Stauffer, MEI Technologies, Inc., NASA-GSFC; T. Jordan, EMP Consultants; R. Mewaldt, California Institute of Technology

A probabilistic model of cumulative solar heavy ion energy and LET spectra is developed for spacecraft design applications. Spectra are given as a function of mission time period, shielding thickness and level of confidence.

POSTER PAPERS

PB-1
Model for Estimating Directional Flux and Detector Response for Space Radiation Experiments

S. Huston, Huston Associates; J. Carsten, D. Cantwell, Advatech Pacific, Inc.

We present a model for estimating the directional flux of trapped radiation from standard models such as AP-8 or AE-8, and for determining the response of simple particle detectors to the directional flux.

PB-2
Bootstrap Surface Charging at Geosynchronous Earth Orbit: Modeling and On-Orbit Observations from the DSCSIII-B7 Satellite

L. H. Krause, C. L. Enloe, G. Font-Rodriguez, V. Putz, U. S. Air Force Academy; D. L. Cooke, K. P. Ray, Air Force Research Laboratory

We present an analysis of the charging interactivity between surrounding surface materials aboard a spacecraft at geosynchronous altitudes. With this study we examine bootstrap charging behavior with model data and with data collected on orbit.

11:45 AM – 1:10 PM LUNCH

SESSION C HARDNESS BY DESIGN

1:10 PM SESSION INTRODUCTION

Chair: Tim Holman, Vanderbilt University

C-1
1:15 PM **Ultra-Low Power Radiation Hardened by Design Memory Circuits**

T.-H. Chen, J. Chen, L. T. Clark, J. E. Knudsen, G. Samson, Arizona State University

A 0.13- μm memory operating at $V_{DD} = 0.5\text{ V}$ demonstrates post-500 krad(Si) I_{DD} 100x less than at 1.2 V. Register file readout and DICE cells allow operation at 204 mV and SEU immunity above 450 mV.

Technical Program Tuesday

C-2
1:30 PM **A Single-Event-Hardened Phase-Locked Loop Fabricated in 130nm CMOS**

T. D. Loveless, L. W. Massengill, B. L. Bhuvva, W. T. Holman, R. A. Reed, Vanderbilt University; D. McMorro, J. S. Melinger, Naval Research Laboratory

PLL circuits have been designed for RHBD SEE mitigation and tested for SET sensitivity. A voltage-based charge pump is shown to reduce the circuit vulnerability by more than two orders of magnitude over customary designs.

C-3
1:45 PM **Latch Design Techniques for Mitigating Single Event Upsets in 65nm SOI Device Technology**

A. J. Kleinosowski, E. H. Cannon, M. S. Gordon, D. F. Heidel, P. Oldiges, C. Plettner, K. P. Rodbell, R. D. Rose, H. H. K. Tang, IBM

This paper describes techniques for mitigating single event upsets in master-slave flip-flop latches in 65-nm SOI device technology. Techniques are explained, modeled, and measured with hardware experiments.

C-4
2:00 PM **Optimizing Radiation Hard By Design SRAM Cells**

L. T. Clark, K. C. Mohr, K. E. Holbert, X. Yao, J. E. Knudsen, Arizona State University

TID experiments using Co-60 accelerated testing on 130 and 90-nm transistors and SRAM arrays show that two-edge transistor SRAM cells with NMOS access transistors using reverse-body-bias are effective to mitigate TID in both generations.

C-5
2:15 PM **Domain Crossing Events: Limitations on Single Device Triple-Modular Redundancy Circuits in Xilinx FPGAs**

H. Quinn, K. Morgan, P. Graham, J. Krone, M. Caffrey, Los Alamos National Laboratory; K. Lundgren, Brigham Young University

This paper discusses the limitations of single-FPGA triple-modular redundancy (TMR) in the presence of multiple-bit upsets (MBUs). We estimate that 0.5-4% of all events could defeat single chip TMR implementations on orbit.

C-6
2:30 PM **An Evaluation of Transistor-Layout RHBD Techniques for SEE Mitigation in SiGe HBTs**

A. K. Sutton, J. P. Comeau, R. Krithivasan, J. D. Cressler, Georgia Tech; J. A. Pellish, R. A. Reed, Vanderbilt University; P. W. Marshall, Consultant NASA-GSFC; M. Varadharajaperumal, G. Niu, Auburn University; G. Vizkelethy, Sandia National Laboratories

We report heavy-ion microbeam results on layout-based RHBD techniques aimed at charge collection reduction in SiGe HBTs using an additional *pn* junction as a shunt collection path. Optimization strategies and design tradeoffs are discussed.

POSTER PAPERS

PC-1 **Differential Analog Layout for Improved ASET Tolerance**

A. T. Kelly, P. R. Fleming, W. T. Holman, B. L. Bhuvva, L. W. Massengill, A. F. Witulski, Vanderbilt University

An improved layout technique is presented that converts single event transients (SETs) in differential analog circuits into common mode signals, which are mitigated by the inherent common mode rejection (CMR) of differential amplifier topologies.

PC-2 Design Techniques to Mitigate SET Pulse Widths in Deep-Submicron Combinational Logic

O. A. Amusan, L. W. Massengill, B. L. Bhuvu, S. DasGupta, J. R. Ahlbin, A. F. Witulski, Vanderbilt University

Analysis of 90-nm CMOS SET response quantifies the interaction between charge collection and charge redistribution in a matched-current-drive inverter chain. This interaction is exploited to optimize transistor layout for SET RHBD in combinational logic.

PC-3 A Comparison of TMR With Alternative Fault Tolerant Design Techniques for FPGAs

K. S. Morgan, Los Alamos National Laboratory; D. L. McMurtrey, B. H. Pratt, M. J. Wirthlin, Brigham Young University

This paper evaluates temporal redundancy, ECCs and quadded logic, well-known ASIC SEU mitigation techniques, as alternatives to TMR for FPGA SEU mitigation, demonstrating that they provide less reliability and are often more costly than TMR.

PC-4 Experimentally Measured Input Referred Voltage Offsets and Kickback Noise in RHBD Analog Comparator Arrays

N. Hindman, Z. Wang, L. T. Clark, D. R. Allee, Arizona State University

Fabricated 130-nm RHBD analog comparator arrays are measured to quantify input-referred offsets and kickback noise. Both are slightly larger than for an equivalent design using two-edge transistors. The kickback noise is shown to be systematic.

PC-5 A Heavy-Ion Tolerant Clock and Data Recovery Circuit for Satellite Embedded High-Speed Data Links

O. Mazouffre, B. Goumballa, H. Lapuyade, Y. Deval, J.B. Begueret, IMS Lab; M. Pignol, F. Malou, CNES; C. Neveu, Alcatel Alenia Space

A CDR circuit dedicated to satellite embedded high-speed data links is implemented in a 0.13- μm CMOS technology. Its design is based on an injection-locked oscillator. Its SET sensitivity is evaluated using heavy-ion irradiation.

PC-6 A Novel Circuit-Level SEU-Hardening Technique For Low-Voltage, Ultra-High-Speed SiGe HBT Logic Circuits

T. S. Mukherjee, K. T. Kornegay, A. K. Sutton, R. Krithivasan, J. D. Cressler, Georgia Tech; G. Niu, Auburn University; P. W. Marshall, Consultant NASA-GSFC

A new technique for SEU-hardening of SiGe HBT logic circuits is presented. Simulation results suggest that significant improvement in SEU immunity can be achieved compared to present state-of-the-art, with minimal power penalty.

PC-7 A 130-nm RHBD SRAM with High Speed SET and Area Efficient TID Mitigation

K. C. Mohr, L. T. Clark, Arizona State University

A RHBD 500-MHz 5kB SRAM includes EDAC support, dual-redundant control and decode logic SET mitigation, and row-by-row body bias modulation to mitigate TID induced leakage in two-edge transistor SRAM cells.

Technical Program Tuesday

PC-8 The Application of RHBD to n-MOSFETs Intended for Use in Cryogenic-Temperature Radiation Environments

B. Jun, A. K. Sutton, R. M. Diestelhorst, G. J. Duperon, J. D. Cressler, Georgia Tech; J. D. Black, T. Haeffner, R. A. Reed, M. L. Alles, R. D. Schrimpf, D. M. Fleetwood, Vanderbilt University; P. W. Marshall, Consultant NASA-GSFC

Proton and X-ray irradiation effects are investigated on n-MOSFETs exposed at both 300 K and 77 K. Annular and ringed-source RHBD transistors are shown to be immune to radiation-induced STI leakage at both temperatures.

2:45 – 3:10 PM
TAPA BALLROOM I AND
PALACE LOUNGE

BREAK

SESSION D HARDNESS ASSURANCE

3:10 PM SESSION INTRODUCTION

Chair: Steve McClure, JPL

D-1 Laser SEE Sensitivity Mapping of SRAM Cells

3:15 PM *A. Chugg, A. Burnell, M. Moutrie, R. Jones, MBDA UK Ltd; R. Harboe-Sørensen, ESA ESTEC*

It is shown that laser sensitivity mapping at the cell level can be used to reconstruct and analyze the SEE cross-section. It resolves such conundrums as data pattern variations in the SEE sensitivity of memories.

D-2 A Statistical Treatment of SEE Rate Calculation for Both Small and Large Event Counts

3:30 PM

R. Ladbury, NASA-GSFC

We develop a Maximum Likelihood method for bounding SEE rates at a desired confidence level. The method is useful for bounding SEE rates, test planning, reliability estimates and investigating lot-to-lot and part-to-part variability.

D-3 The Impact of Radiation-Induced Failure Mechanisms in Electronic Components on System Reliability

3:45 PM

D. C. Mayer, R. Koga, J. M. Womack, The Aerospace Corporation

A methodology is described to incorporate destructive radiation effects into the reliability estimation for a space system. Examples are presented to illustrate how on-orbit system reliability can be estimated from test data for radiation-sensitive parts.

D-4 Heavy-Ion SEE Test Concept and Results for DDR-II Memories

4:00 PM

R. Harboe-Sørensen, European Space Agency; F.-X. Guerre, G. Lewis, Hires Engineering

This paper addresses heavy ion SEE testing of DDR-II memories. In particular test approaches, sample preparation, physical error analysis and effective LET corrections will be covered and SEE data presented for 512 Mbit DDR-II memories.

Technical Program Tuesday

POSTER PAPERS

PD-1

Probabilistic Evaluation of Analog Single Event Transient Error

*A. Kauppila, Infoworks, Inc.; G. Vaughn, University of Alabama at Birmingham;
J. Kauppila, L. Massengill, Vanderbilt University*

We propose a procedure to estimate the consequences of an analog single event transient (ASET). The method qualifies ASETs based on their frequency domain signatures and determines the probability of a SET-induced error.

PD-2

Risk Reduction for Use of Complex Devices in Space Projects

*M. Berg, C. Poivey, MEI Technologies, Inc., NASA-GSFC; D. Petrick, K. LaBel,
M. Friendlich, S. Stansberry, NASA-GSFC*

We present guidelines to reduce risk to an acceptable level when using complex devices in space applications. Application to Virtex 4 Field Programmable Gate Array (FPGA) on Express Logistic Carrier (ELC) project is presented.

SESSION E

4:15 PM

TERRESTRIAL AND ATMOSPHERIC RADIATION ENVIRONMENTS AND EFFECTS

SESSION INTRODUCTION

Chair: Ken Rodbell, IBM

E-1

4:20 PM

Determination of Geometry and Absorption Effects and their Impact on the Accuracy of Alpha Particle Soft Error Rate Extrapolation

R. Baumann, Texas Instruments; D. Radaelli, Cypress Semiconductor

Extensive simulation and experimental results are presented demonstrating significant geometry and air absorption effects on alpha particle testing that must be comprehended to avoid substantial underestimation of product soft failure rates in the terrestrial environment.

E-2

4:35 PM

Single Event Upsets Induced by 1-10 MeV Neutrons in Static-RAMs Using Mono-Energetic Neutron Sources

*J. Baggio, V. Ferlet-Cavrois, P. Paillet, C. Marcandella, O. Duhamel, CEA-DAM/DIF;
D. Lambert, EADS Nuclétudes*

The latest version of JEDEC Standard JESD89A mentions that modern SRAM technologies could be more sensitive to terrestrial neutrons in the 1-10 MeV energy range. We investigate this possibility using mono-energetic neutron sources.

E-3

4:50 PM

A Quantitative Assessment of Charge Collection Efficiency of N+ and P+ Diffusion Areas in Terrestrial Neutron Environment

X. Zhu, X. Deng, R. Baumann, S. Krishnan, Texas Instruments

Using a detailed memory failure cluster analysis we demonstrate a novel direct measurement of the charge collection efficiency ratio of N+ and P+ diffusions for 90nm CMOS in the terrestrial neutron environment.

Technical Program Tuesday

POSTER PAPERS

PE-1

Bulk Charging of Dielectrics in Cryogenic Space Environments

J. I. Minow, V. N. Coffey, NASA-MSFC; W. C. Blackwell, Jr., L. N. Parker, Jacobs Engineering, ESTS Group; I. Jun, H. B. Garrett, JPL

We use a 1-D bulk charging model to evaluate dielectric charging at cryogenic temperatures relevant to space systems using passive cooling to <100K or extended operations in permanently dark lunar craters and the lunar night.

PE-2

Importance of BEOL Modeling in Single Event Effect Analysis

H. H. K. Tang, C. E. Murray, G. Fiorenza, K. P. Rodbell, M. S. Gordon, IBM T.J. Watson Research Center

Novel techniques have been developed to simulate particle transport in arbitrary complex back end of line topologies. They are shown to be critical for SEE analysis of new device structures for 65nm technologies and beyond.

5:05 PM END OF TUESDAY SESSIONS

Technical Program Wednesday

INVITED TALK

8:15 – 9:15 AM
TAPA BALLROOMS 2, 3

Volcanism in Hawaii

Dr. Patricia Fryer, Professor of Marine Geology and Geophysics, University of Hawaii, Honolulu, HI



Volcanism in Hawaii is a spectacular site, and fortunately most of the time is very approachable, making Kilauea, on the Big Island of Hawaii, the country's only "drive-in volcano." Eruptions there typically start with an inflation of the ground surface near the summit or along the rift zones of the volcano as magma rises from depth. A "curtain of fire" heralds the initial stages of the eruptions and is followed, a few hours to days later, by the growth of a primary vent that produces flows of variously *pahoehoe* or *aa* lava. At Kilauea, eruptions of this type have been on-going since 1983. Generally Hawaiian lava flows are approachable, but can be very damaging to property as they advance inexorably across sloping terrain. They can also provide an awe-inspiring spectacle for visitors and scientists from around the globe. There is evidence that the volcanoes of the Hawaiian Islands have had far more dangerous episodes in the past. Phreatomagmatic eruptions, in which ground water interacts with the magmas as they near the surface, have the potential to carry as much widespread destructive power and danger to life as those of the more familiar volcanoes of the Pacific "Ring of Fire." Fortunately, these more violent eruptions occur only rarely. The potential hazards from Hawaiian volcanoes are not confined to volcanic activity, however. The flanks of the islands are composed of fragments of the lavas that enter the sea upon eruption and the unbuttressed flanks are prone to mass wasting. Enormous landslides flank all of the islands and models for distribution of resultant tsunamis show the potential for widespread destruction. Each Hawaiian volcano is active for only a few million years before drifting away from its hot spot source. It then erodes to form a small volcanic remnant, subsides to form an atoll, and then sinks beneath the waves as a flat-topped *guyot* on its way northward with the Pacific plate toward Kamchatka. This process has been on-going for at least the last 80 million years.

Dr. Patricia Fryer is Professor of Marine Geology and Geophysics at the University of Hawaii's Manoa's School of Ocean and Earth Science and Technology. Beginning her graduate student career there in 1970, she has spent most of her research career learning about the complexities of volcanism and tectonics of the western Pacific island arcs. Her first taste of volcanism came at the age of 9, however, when her family, stationed at Pearl Harbor, sailed to the Big Island of Hawaii and visited Kilauea over the Easter Holiday, roaming the desolate trails around the caldera and across its floor. The intricate beauty of lava flows of all sorts, steaming vents, and sulfurous fumaroles has intrigued her ever since. In particular, she is fascinated by volcanism on the deep ocean floor. She has led numerous oceanographic expeditions and mapping surveys of the western Pacific. She served as chair of the Alvin Oversight Committee for UNOLS for 6 years, and has been heavily involved with the Ocean Drilling Program's and the Integrated Ocean Drilling Program's advisory panels over the past 20 years. She has dived in both the *Alvin* and the Japanese submersible *Shinkai 6500* and, together with numerous colleagues and students, has shared the delights of discovering never-before observed features of the ocean depths.

Technical Program Wednesday

SESSION F **9:25 AM** **RADIATION EFFECTS IN DEVICES AND INTEGRATED CIRCUITS** **SESSION INTRODUCTION**

Chair: Steve Bernacki, Raytheon/Draper Laboratory

F-1 **9:30 AM** **Total Ionizing Dose Effects in Shallow Trench Isolation Oxides** *F. Faccio, L. Gonella, CERN; H. J. Barnaby, M. McLain, Arizona State University; D. M. Fleetwood, R. D. Schrimpf, Vanderbilt University*

TID effects in STI oxides are studied using Field Oxide Transistors (FOXFETs). The evolution of charge trapped in the oxide and in interface traps is measured, and consequences for circuit reliability at low-dose-rates are discussed.

F-2 **9:45 AM** **The Effects of Hydrogen in Hermetically Sealed Packages on the Total Dose and Dose Rate Response of Bipolar Linear Circuits** *R. Pease, RLP Research; D. Platteter, G. Dunham, J. Seiler, NAVSEA Crane; S. McClure, JPL; H. Barnaby, X. J. Chen, Arizona State University*

It is demonstrated with test transistors and circuits that a small amount of hydrogen trapped in hermetically sealed packages can significantly degrade the total dose and dose rate response of bipolar linear microelectronics.

F-3 **10:00 AM** **Band-to-Band Tunneling (BBT) Induced Leakage Current Enhancement in Irradiated Fully Depleted SOI Devices** *P. C. Adell, Vanderbilt University/Arizona State University; H. J. Barnaby, B. Vermeire, Arizona State University; R. D. Schrimpf, Vanderbilt University*

We propose a model, validated with simulations, describing how BBT affects the leakage current degradation mechanism in irradiated FD-SOI devices. Drain current vs. gate voltage, including the transition to a high current regime, is explained.

F-4 **10:15 AM** **Power MOSFET Degradation in Space Radiation Environments** *J. A. Felix, M. R. Shaneyfelt, J. R. Schwank, S. M. Dalton, P. E. Dodd, J. B. Witcher, Sandia National Laboratories*

Large, unexpected changes in the I-V characteristics of commercial power MOSFETs irradiated with heavy ions and protons have been observed. Total dose effects alone cannot explain this enhanced degradation. Potential mechanisms are discussed.

10:30 – 11:00 AM
TAPA BALLROOM I AND
PALACE LOUNGE

BREAK

F-5 **11:00 AM** **The Effects of X-Ray and Proton Irradiation on a 200 GHz / 90 GHz Complementary (nnp + pnp) SiGe:C HBT Technology** *R. M. Diestelhorst, S. Finn, B. Jun, A. K. Sutton, P. Cheng, J. D. Cressler, Georgia Tech; P. W. Marshall, Consultant NASA-GSFC; R. D. Schrimpf, D. M. Fleetwood, Vanderbilt University; H. Gustat, B. Heinemann, G. G. Fischer, D. Knoll, B. Tillack, IHP, Frankfurt (Oder), Germany*

We investigate the effects of proton and X-ray irradiation on a novel 200GHz/90GHz (nnp/pnp) complementary SiGe:CHBT technology. Transistor radiation response and results for a current feedback operational amplifier fabricated in this technology platform are presented.

Technical Program Wednesday

- F-6**
11:15 AM **Displacement Damage Effects in Irradiated Silicon Carbide Devices**
S. C. Witzak, W. A. Martin, R. Koga, J. R. Srou, S. R. Nuccio, J. V. Osborn, The Aerospace Corporation; J. T. Torvik, R. Irwin, Microsemi Corporation

Radiation-induced degradation of SiC BJTs and MESFETs due to heavy ion and gamma-ray exposure is examined. Device degradation at total doses above 1 Mrad(SiC) results primarily from displacement damage and not from ionization damage.

- F-7**
11:30 AM **Radiation Tolerance of Nanocrystal-Based Flash Memory Arrays Against Heavy Ion Irradiation**
A. Cester, A. Gasperin, N. Wrachien, A. Paccagnella, Padova University; R. Portoghese, C. Gerardi, ST Microelectronics

We present new results on heavy-ion irradiation of nanocrystal non-volatile addressable memory arrays. An enhanced robustness with respect to floating gate memory is observed in terms of prompt charge loss after irradiation and retention characteristics.

- F-8**
11:45 AM **Electrostatic Discharge Effects in Irradiated Fully Depleted SOI MOSFETs with Ultra-Thin Gate Oxide**
S. Gerardin, A. Cester, A. Tazzoli, A. Griffoni, G. Meneghesso, A. Paccagnella, DEI - Padova University

We present new results on electrostatic discharges in FD SOI MOSFETs struck by heavy-ions. Irradiation is shown to reduce the ESD breakdown voltage and enhance the probability of generating source-drain filaments for gate ESD events.

POSTER PAPERS

- PF-1** **Enhanced TID Susceptibility in sub-100 nm Bulk CMOS I/O Transistors and Circuits**
M. McLain, H. Barnaby, H. Shah, K. Holbert, Arizona State University; M. Baze, A. Amort, J. Wert, Boeing Phantom Works; R. Schrimpf, Vanderbilt University

The radiation responses of 2.5V I/O transistors from a 90 nm commercial CMOS technology are evaluated. The data indicate enhanced TID susceptibility in I/O devices and circuits, which is attributed to the p-type body doping.

- PF-2** **Impact of Lateral Isolation Oxides on Radiation-Induced Noise Degradation in CMOS Technologies in the 100 nm Regime**
V. Re, M. Manghisoni, G. Traversi, University of Bergamo; L. Ratti, V. Speziali, University of Pavia

Degradation mechanisms associated with lateral isolation oxides are discussed to account for TID effects on the noise performance of 90 nm and 130 nm CMOS devices and for their dependence on geometry and operating conditions.

- PF-3** **Geometry and Strain Dependence of the Proton Radiation Behavior of MuGFET Devices**
S. Put, IMEC - SCKCEN; E. Simoen, N. Collaert, C. Claeys, IMEC; M. Van Uffelen, SCKCEN, the Belgian Nuclear Research Centre; P. Leroux, Katholieke Hogeschool Kempen

The effect of 60 MeV protons on N-MuGFET and P-MuGFET devices is studied. We discuss the influence of different geometries and a strained channel on the radiation behavior. DC characteristics and noise performance are investigated.

Technical Program Wednesday

PF-4 Site-Specific Catastrophic Latch-Up Conditions in Advanced VLSI ADCs

T. Miyahira, L. Scheick, F. Irom, J. Laird, A. Johnston, JPL

A catastrophic latch-up is dependent on the position of the single-event latch-up in an analog-to-digital converter. The device can survive when a noncritical site is latched. The damage can be traced to the configuration memory.

PF-5 Evaluation of the Proton Induced Bulk Damage in SDRAM Utilizing 90nm Process Technology

H. Shindou, S. Kuboyama, N. Ikeda, Y. Satoh, T. Tamura, Japan Aerospace Exploration Agency; T. Hirao, Japan Atomic Energy Agency

We describe proton induced bulk damage observed in 90nm process SDRAM. The degradation of the data retention ability was evaluated. The effect due to the difference of process technology and memory cell structure was discussed.

PF-6 A Comparison of the Effects of X-Ray and Proton Irradiation on the Performance of SiGe Precision Voltage References

L. Najafizadeh, B. Jun, J. D. Cressler, A. P. G. Prakash, Georgia Tech; P. W. Marshall, Consultant NASA-GSFC; C. J. Marshall, NASA-GSFC

A comparison is made between the effects of 10 keV X-Rays and 63 MeV protons on the performance of SiGe precision voltage references. Systematic differences in circuit response are observed and the origins are investigated.

PF-7 The Effects of Proton Irradiation on the DC and AC Performance of Complementary (nnp + npn) SiGe HBTs on Thick-Film SOI

M. Bellini, B. Jun, A. C. Appaswamy, P. Cheng, J. D. Cressler, Georgia Techn; P. W. Marshall, Consultant NASA-GSFC; B. El-Kareh, Consultant; S. Balster, H. Yasuda, Texas Instruments

The impact of proton irradiation on the DC and AC performance of complementary (nnp+npn) SiGe HBTs on thick-film SOI is investigated at 300K to 30K, and compared to results on SiGe HBTs on thin-film SOI.

PF-8 Radiation Tolerance of Si/SiGe n-MODFETs

A. Madan, B. Jun, R. M. Diestelhorst, A. Appaswamy, J. D. Cressler, Georgia Tech; R. D. Schrimpf, D. M. Fleetwood, Vanderbilt University; T. Isaacs-Smith, Space Research Institute, Auburn University; J. R. Williams, Auburn University; S. J. Koester, IBM

The radiation tolerance of Si/SiGe n-MODFETs is investigated for the first time, using both X-rays and low energy protons. A strong dependence on source-drain spacing is observed for both the DC and RF characteristics.

PF-9 Effects of Heavy-Ion Strikes on 65-nm Fully Depleted SOI MOSFETs with Strain-Inducing Techniques: New and Old Concerns

A. Griffoni, S. Gerardin, A. Cester, A. Paccagnella, DEI - Padova University; E. Simoen, C. Claeys, IMEC

We studied the immediate and long-term effects of heavy-ion strikes on 65-nm FD SOI MOSFETs. We highlighted new and old effects, analyzing the role of material and structure innovations in the response to heavy ions.

12:00 – 1:25 PM

LUNCH

Technical Program Wednesday

SESSION G

1:25 PM

DOSIMETRY AND FACILITIES

SESSION INTRODUCTION

Chair: Anatoly Rosenfeld, University of Wollongong

G-1

1:30 PM

Solid State Microdosimetry with Heavy Ions for Space Applications

A. Wroe, A. Rosenfeld, University of Wollongong; M. Reinhard, Australian Nuclear Science and Technology Organisation; V. Pisacane, J. Ziegler, M. Nelson, United States Naval Academy; F. Cucinotta, NASA; M. Zaider, Memorial Sloan Kettering Cancer Care Center; J. Dicello, Johns Hopkins University

This work provides valuable information pertaining to the performance and radiation hardness of Silicon-On-Insulator microdosimeters in heavy ion radiation fields and assesses their applicability to future deployments in space missions.

G-2

1:45 PM

LET-Measurements and Simulations of Heavy Ion Irradiation of Silicon and Tissue Micrometer Site Sizes

P. Beck, S. Rollet, Austrian Research Centers; M. Wind, Vienna University of Technology; H. Kitamura, National Institute of Radiological Science, Japan; M. Latocha, Polish Academy of Sciences; H. Böck, Vienna University of Technology

We describe exposure of micrometer silicon and tissue sites to heavy ion radiation fields for a wide range of LET. Geant4 and FLUKA Monte Carlo radiation transport simulations were performed and compared with experiments.

G-3

2:00 PM

Study of the Thermal Behavior of the OSL Integrated Sensor Response

P. Garcia, D. Benoit, F. Ravotti, L. Artola, B. Sagnes, L. Dusseau, IES UMR CNRS, Université Montpellier II; J. R. Vaillé, IES UMR CNRS, Université Montpellier II and Université de Nîmes; E. Lorfèvre, F. Bezerra, Centre National d'Études Spatiales

Temperature irradiation is shown to cause the fading of the OSL signal. The temperature dependence is modeled using an Arrhenius law. A simple method is proposed to correct this effect a posteriori.

G-4

2:15 PM

Comparison of a Tissue Equivalent and a Silicon Equivalent Proportional Counter Microdosimeter to High-Energy Proton and Neutron Fields

B. B. Gersey, J. Wedeking, R. Wilkins, S. Aghara, R. Dwivedi, Prairie View A&M University

A tissue equivalent and a silicon equivalent proportional counter microdosimeter were exposed to eight progressively hardened neutron energy spectra at the LANSCE ICE House facility and to 70 MeV protons. Selected dosimetric results are compared.

POSTER PAPERS

PG-I

Metrics for Comparison Between Displacement Damage Due to Ion Beam and Neutron Irradiation in Silicon BJTs

E. Bielejec, G. Vizkelethy, R. Fleming, D. B. King, Sandia National Laboratories

We report on a series of metrics used to determine damage equivalence between ion and neutron irradiated silicon BJTs. Included are late time gain degradation, deep level transient spectroscopy (DLTS) results, and early-time transient annealing.

Technical Program Wednesday

PG-2 Considerations on the Relationship Between Dosimetry Metrics and Experimental Conditions

P. J. Griffin, D. W. Vehar, P. J. Cooper, D. B. King, Sandia National Laboratories

This paper captures cases where subtle differences in how dosimetry metrics are reported have significant effects on interpretation of data. Examples are presented and suggestions made on ways to minimize the chance the data misinterpretation.

PG-3 Simultaneous Evaluation of Neutron Spectra and 1-MeV-Equivalent (Si) Fluences at SPRIII and ACRR

J. G. Williams, T. Schnauber, University of Arizona; P. J. Griffin, D. B. King, D. W. Vehar, S. M. Luker, K. R. DePriest, Sandia National Laboratories

Simultaneous least-squares adjustment of calculated neutron spectra in the central cavity of SPRIII and in the Pb-B bucket at ACRR is described and the resulting 1-MeV-equivalent fluences are compared with damage measurements in 2N2222 transistors.

DATA WORKSHOP

2:30 – 4:15 PM

HONOLULU SUITES 1, 2, 3

INTRODUCTION



Chair: Christian Poivey, NASA-GSFC

W-1 Energetic Proton Maps for the South Atlantic Anomaly

G. P. Ginet, B. K. Dichter, D. Brautigam, Air Force Research Laboratory; D. Madden, Boston College

Proton flux intensity maps, boundary contours and worst-case spectra have been computed for the South Atlantic Anomaly between 400 - 1650 km using data from the CEASE detector for the epoch 2000-2006.

W-2 Radiation Damage in Hubble Space Telescope Detectors

M. Sirianni, ESA/STScI; M. Mutchler, R. Gilliland, J. Biretta, R. Lucas, STScI

The Hubble Space Telescope has been orbiting since April 1990. It is a unique laboratory for radiation damage studies for different detectors. We present some of the most interesting findings still looking for an explanation.

Technical Program Wednesday

W-3 Flight SEU Performance of the Single Board Computer (SBC) Utilizing Hardware Voted Commercial PowerPC Processors On-board the CALIPSO Satellite

B. Peters, D. Lahti, A. Wardrop, H. Herzog, General Dynamics - AIS; T. O'Connor, Ball Aerospace & Technology Corp.; R. DeCoursey, NASA Langley

603r-PowerPC single board computer SEU rate predictions are compared to on-orbit CALIPSO data. Upset mitigation includes hardware voting 3 or 4 processors with transparent system upset monitoring and recovery. G4-PowerPC SEU performance is also reported.

W-4 Influence of Solar Cell Shape, Interconnect Shape, and Coverglass Coatings on Solar Array Arcing Parameters

J. J. Likar, A. L. Bogorad, Lockheed Martin Commercial Space Systems; B. V. Vayner, Ohio Aerospace Institute; J. T. Galofaro, NASA-GRC

Arc inception voltage studies have been performed on several common solar cell types. Results yielded quantitatively significant findings indicating specific designs are susceptible to arc inception at bias voltages readily achievable at near Earth orbits.

W-5 A Continuously Variable Water Beam Degradar for the Radiation Test Beamline at the Francis H. Burr Proton Therapy Center

E. W. Cascio, S. Sarkar, Francis H. Burr Proton Therapy Center, Massachusetts General Hospital

A continuously variable water beam degrader is described. The advantages of this system are discussed, and the equivalence of this system to the standard plastic degraders is shown by measurements of the proton energy spectrum.

W-6 "Super" Cocktails for Heavy Ion Testing

M. B. Johnson, M. A. McMahan, M. Galloway, D. Leitner, Lawrence Berkeley National Lab

The 4.5A MeV heavy-ion cocktail at the 88-Inch Cyclotron has been expanded. The super-cocktail is available by special request when only normal incidence between the beam and the device under test is possible or desirable.

W-7 Upgrades for the RADEF Facility

A. Virtanen, A. Javanainen, H. Kettunen, H. Koivisto, I. Riihimäki, University of Jyväskylä; R. Harboe-Sørensen, ESA/ESTEC

RADEF includes heavy-ion and proton beam lines for irradiation of space electronics. A special beam cocktail for rear face irradiations has been developed. Also, experimental LET values of its two heaviest ions have been determined.

W-8 The Dosimetric Performance of RADFETs in Radiation Test Beams

A. Holmes-Siedle, REM Oxford Ltd; F. Ravotti, IES - Université Montpellier II; M. Glaser, Department PH-DT2-SD, CERN

The response of different kinds of RADFETs to a variety of test beams - gamma-ray, neutron, MV and KV X-ray, electron, proton and pion is presented: threshold voltage shift, dose/bias dependence, annealing, and temperatures coefficients.

Technical Program Wednesday

W-9 Gamma Radiation Effects in Er- and Yb-Doped Optical Fibers

W. J. Thomes, Jr., Sandia National Laboratories; K. Simmons-Potter, B. P. Fox, Z. V. Schneider, University of Arizona

Gamma radiation induced photodarkening was observed in Er- and Yb-doped optical fibers and amplifiers. Presented data show the optical transmission from 1.0 to 1.7 μm as a function of dose and dose rate.

W-10 Catastrophic SEE Mechanisms and Bias Dependence in SiC Diodes

L. Scheick, J. Laird, R. Harris, JPL

A MOSFET driver rated to 18 V exhibits a destructive single-event effect. Data exclude single-event latch-up and intimate SEB as the mechanism. The device design that optimizes high current density may cause the SEB sensitivity.

W-11 SiC vs. Si for High Radiation Environments

R. D. Harris, JPL

Commercial SiC and Si Schottky diodes have been irradiated with protons. Comparison of degraded I-V characteristics suggests that the radiation resistance of Si Schottky diodes is as good as, or better than, SiC Schottky diodes.

W-12 Total-Dose Effects in InP Devices

D. L. Hansen, M. J. Robinson, F. Lu, Boeing Satellite Development Center

Total dose testing was performed on InP heterojunction bipolar transistors and photodiodes using a high and low dose rate 60-Co source. Devices showed little degradation, indicating that InP technology is robust to total dose effects.

W-13 Proton Radiation Effects on Medium/Large Area PIN Si Photodiodes for Optical Wireless Links for Optical Wireless Link for Intra-Satellite Communications (OWLS)

J. J. Jiménez, J. Sánchez-Páramo, M. T. Álvarez, J. A. Domínguez, J. M. Oter, I. Arruego, R. Tamayo, H. Guerrero, Laboratorio de Optoelectrónica (ACUI), Dpto. de Ciencias del Espacio y Tecnologías Electrónicas, Instituto Nacional de Técnica Aeroespacial - INTA

Photodiodes were irradiated with ~30 to ~60 MeV protons. Electrical and optoelectronic parameters were characterized during the test. Results on degradation and post-annealing are reported. Preliminary results on the lattice effects are also given.

W-14 Pulsed and Steady State Radiation Effects on Si and GaAs Single Junction Photovoltaic Devices

J. Shelton, W. Thomes, Jr., D. Stein, Sandia National Laboratories

Single Si junction photovoltaic devices manufactured at Sandia National Laboratories MDL were tested in a pulsed high dose mixed radiation environment as well as a long-term steady-state high and low dose gamma environment.

Technical Program Wednesday

W-15 Bipolar Phototransistors Reliability Assessment for Space Applications

G. Quadri, O. Gilard, French Space Agency (CNES); P. Spezzigu, French Space Agency (CNES) and Università degli Studi di Cagliari ; J.-L. Roux, Università degli Studi di Cagliari

Life test, total dose and proton irradiations were performed on silicon-based bipolar phototransistors. Based on the obtained results a new device selection method for space application is proposed.

W-16 SEU Testing of a Multi-Gbps Fiber Optic Transceiver Operating Over Parallel Ribbon Fiber

C. Kuznia, J. Ahadian, R. Pommer, R. Hagan, Ultra Communications

We present a multi-Gbps parallel fiber optic transceiver based on 850 nm GaAs VCSEL and PIN optoelectronic devices and silicon-on-sapphire integrated circuitry. We present the results of heavy ion single event upset testing.

W-17 Cost Effective Hybrid DC-DC Converter Radiation Performance

D. Sable, G. Skutt, VPT Inc.; S. Rainwater, Suntronics

This paper presents design information, verification methodology, and test data to achieve good radiation performance for hybrid DC-DC converters with low cost. A new radiation-hardened point-of-load power converter design is presented.

W-18 Low Dose Rate Testing of the Intersil IS1009RH Voltage Reference and the ISL72991RH Negative Low-Dropout Voltage Regulator

N. van Vonno, J. S. Gill, Intersil Corporation

We summarize results of baseline 60-Co low dose rate testing of the Intersil IS1009RH Voltage Reference and ISL72991RH Low-Dropout Voltage Regulator. Irradiation was performed under bias. Data showed specification-compliant performance for both parts after 100krad(Si).

W-19 ELDRS Study of the LT-1078 for Multiple Applications

D. P. Love, J. Faul, C. Peterson, D. Behrens, Northrop Grumman; J. B. Parkinson, Private Contractor

Five flight biases of LT1078 Op-Amps, including zero during irradiation to mimic unpowered backup redundancy, have their ELDRS data vs. application-unique electrical parameters PSPICE modeled vs. dose predictions of each application vs. shielding are examined.

W-20 SEU Characterization of GHz ADCs at Full Clock Frequency and with Dynamic Inputs using a Beat Frequency Test Method

K. Kruckmeyer, R. Rennie, National Semiconductor; V. Ramachandran, Vanderbilt University

We describe a test method and present data for characterizing single event upsets (SEU) of ultra high-speed (gigahertz) analog to digital converters at full clock frequency and with a dynamic input at 2x Nyquist.

Technical Program Wednesday

W-21 SEE Testing of the DDC BU-61583 Advanced Communication Engine

J. George, R. Koga, The Aerospace Corporation

The DDC BU-61583 is a complete, hardened, hybrid interface solution for a MIL-STD-1553 spacecraft communications bus. We present SEE ion data for the embedded RAM, host processor interface, and the 1553 bus interface.

W-22 Radiation Hardness Characterization of a 130nm Technology

C. Hafer, M. Lahey, H. Gardner, D. Harris, A. Jordan, T. Farris, Aeroflex Colorado Springs; M. Johnson, NASA-GSFC

Intrinsic and Radiation Hard-by-Design hardness characterization has been performed on a 130nm process. Hardness results from test chips produced in phases one and two of a NASA Goddard Space Flight Center contract are presented.

W-23 Total Ionizing Dose and Single Event Effect Studies of a 0.25 μ m CMOS Serializer ASIC

C. Xiang, T. Liu, J. Ye, P. Gui, C.-A. Yang, W. Chen, J. Zhang, P. Zhu, R. Stroynowski, Southern Methodist University

A 0.25 μ m CMOS serializer ASIC, designed using radiation tolerant layout practice, was exposed to proton beam at various flux levels and accumulated 100 Mrad(Si) total dose. The ASIC survived this test and data are presented.

W-24 Compendia of Radiation Test Results

P. Layton, E. Patnaude, L. Longden, Maxwell Technologies

TID and SEE data was taken to qualify and evaluate IC devices for radiation susceptibility in the natural space environment. A summary of the test data is presented and discussed.

W-25 Results of Recent 14 MeV Neutron Single Event Effects Measurements Conducted by the Jet Propulsion Laboratory

F. Irom, T. F. Miyahira, D. N. Nguyen, I. Jun, JPL; E. Normand, Boeing Defense and Space Group

14 MeV neutron single-event effects results are presented for a variety of microelectronic devices: ADC, operational amplifiers, flash memory, SRAM, and SDRAM. Data was collected to evaluate these devices for possible use in NASA spacecraft.

W-26 Compendium of Current Total Ionizing Dose Results and Displacement Damage Results for Candidate Spacecraft Electronics for NASA

D. J. Cochran, M. V. O'Bryan, C. Poivey, MEI Technologies, Inc., NASA-GSFC; S. P. Buchner, QSS Group Inc., NASA-GSFC; K. A. LaBel, NASA-GSFC

Vulnerability of a variety of candidate spacecraft electronics to total ionizing dose and displacement damage is studied. Devices tested include optoelectronics, digital, analog, linear bipolar devices, and hybrid devices.

Technical Program Wednesday

W-27 Compendium of Current Single Event Effects Results for Candidate Spacecraft Electronics for NASA

*M. V. O'Bryan, C. Poivey, J. W. Howard, MEI Technologies, Inc., NASA-GSFC;
K. A. LaBel, R. L. Ladbury, NASA-GSFC; S. P. Buchner, T. R. Oldham, QSS Group Inc., NASA-GSFC*

Vulnerability of a variety of candidate spacecraft electronics to proton and heavy-ion induced single event effects is studied. Devices tested include digital, linear bipolar, and hybrid devices.

W-28 Single Event Effects Hardening and Characterization of Honeywell's Pass 3 RHPPC Processor Integrated Circuit

J. P. Lintz, L. F. Hoffmann, M. J. Smith, R. T. Van Cleave, R. R. Cizmarik, Honeywell

We describe a single event effects evaluation of Honeywell's radiation-hardened Pass 3 RHPPC Processor, which is functionally and pin-compatible with the commercial PowerPC 603e™. Results support an upset rate of 1×10^{-5} upsets/chip-day in geosynchronous orbit.

W-29 Upset Characterization and Test Methodology of the PowerPC405 Hard-Core Processor Embedded in Xilinx Field Programmable Gate Arrays

G. Allen, G. Swift, JPL; G. Miller, Xilinx

Results from heavy-ion and proton SEU for the Xilinx Virtex-II Pro and Virtex-4 PPC405 processor cores are presented. Test methodologies for pseudo-static and dynamic approaches are discussed.

W-30 Dose Rate Upset Investigations on the Xilinx's Virtex IV Field Programmable Gate Arrays

A. Vera, D. Llamocca, M. Pattichis, University of New Mexico; W. Kemp, W. Sheed, D. Alexander, J. Lyke, Air Force Research Laboratory

We describe the results of an investigation on the upset, latch-up, and burn-out susceptibility of the Xilinx's XC4VFX12 to ionizing dose rate exposure. Evaluations are performed on a commercial version of the device.

W-31 Static Proton and Heavy Ion Testing of the Xilinx Virtex-5 Device

H. Quinn, K. Morgan, P. Graham, J. Krone, M. Caffrey, Los Alamos National Laboratory; K. Lundgren, Brigham Young University

This paper presents proton and heavy-ion static results for the latest Xilinx field programmable gate arrays (FPGAs). The paper analyzes static bit cross-sections, resources, multiple-bit upsets (MBUs) and angular effects.

W-32 Neutron Induced Micro-SEL Events in COTS SRAM Devices

J. Tausch, D. Sleeter, JD Research; D. Radaelli, H. Puchner, Cypress Semiconductor

This paper provides experimental details of micro-latchup occurrences in SRAM circuitry caused by exposure to neutron irradiation similar to that seen at sea level (terrestrial neutrons). Design enhancements are identified that eliminated the problem.

Technical Program Wednesday

W-33 Multigenerational Radiation Response Trends in SONOS-Based NROM Flash Memories with Neutron Latch-Up Mitigation

J. Tausch, T-Squared Research; S. Tyson, SES Consultants; T. Fairbanks, LANL

Radiation testing was performed on three generations of SONOS-based NROM Flash memory products fabricated at technology nodes of 220nm, 110nm, and 90nm. Neutron irradiation was investigated for mitigating latch-up. NROM appears attractive for space applications.

W-34 Total Ionizing Dose (TID) Tests of Non-Volatile-Memory: Flash and MRAM

D. N. Nguyen, JPL

We report on TID tests of MRAM and advanced 4Gbit flash memories from three manufacturers. Both in-situ and biased interval irradiations measurements were used to characterize the response of the total accumulated dose failures.

W-35 Proton and Heavy Ion Induced Semi-Permanent Upsets in Double Data Rate SDRAMs

R. Koga, P. Yu, S. Crain, J. George, The Aerospace Corporation

Semi-permanent upset sensitivity in DDR SDRAMs is examined. A technique to reduce the sensitivity is presented. The reduction extends to high LET regions for heavy ion induced upsets.

W-36 Radiation Characterization of 512Mb SDRAMs

R. Lawrence, BAE Systems

Radiation effect sensitivity of two single data-rate 512 Mb SDRAMs has been characterized. The SDRAMs were not from the same manufacturer. Total ionizing dose, single event latch-up, and single event upset results are presented.

W-37 Dynamic Single Event Upset Characterization of the MT48LC4M32B2TG-6 SDRAM Using Proton Irradiation

D. M. Hiemstra, MDA Space Missions; F. Pranajaya, UTIAS Space Flight Laboratory

Dynamic single event upset characterization of the MT48LC4M32B2TG-6 SDRAM using proton irradiation is presented. The device's upset rate in the space radiation environment is estimated.

W-38 Guide to the 2006 IEEE Radiation Effects Data Workshop Record

D. M. Hiemstra, MDA, Space Missions

The 2006 Workshop Record has been reviewed and a table prepared to facilitate the search for radiation response data by part number, type, or effect.

4:15 PM END OF WEDNESDAY SESSIONS

Technical Program Thursday

INVITED TALK

8:15 – 9:15 AM

TAPA BALLROOMS 2, 3



Polynesian History, Mythology, and Culture

Cy Bridges, Director of Culture, Polynesian Cultural Center, Hau'ula, HI

Take a mystical and magical journey through the enchanting islands of Polynesia. Hawai'i, the land of Aloha, is located at the northern most point of the apex of the Polynesian Triangle formed with Aotearoa, the 'land of the long white cloud' (New Zealand) at the southern border, and Rapa Nui (Easter Island) in the east. Hawaii's sets the framework and foundation for the family of Polynesia. Polynesia: many islands, filled with legends, excitement, beauty, enchantment, history, enticing dances, and haunting music that will beckon you! Learn, come to know and understand its people and history, and feel their special spirit. I will share insights of history, migration, and its settlement, as well Polynesian's love, relationship, and respect for land, sea, and the universe around them. Polynesians are an island people, located in the largest ocean on earth, separated by many generations of time as well as thousands of miles of open ocean. As a Polynesian, our differences are unique, and yet our striking similarities verify that we are in fact of one people.

Mr. Cy Bridges currently serves as the Director of Culture for the Polynesian Cultural Center. The Cultural Center is Hawaii's number one paid cultural visitor attraction. Since it's opening in 1963 the center has hosted over 32 million guests. Cy's main responsibility is to oversee the cultural authenticity, training and presentations of the Cultural Center. He has been with the Cultural Center for over 35 years and has been involved in every aspect of cultural presentation, from: research, planning, developing, choreography, implementation, and evaluation reviews. He is a noted Kumu Hula or Hula master and has taught workshops in Hawai'i, the continental U.S., Mexico and Japan. He has participated competitively in cultural dance festivals and has also served often as a judge, including at the Merrie Monarch Festival, which is Hawaii's premier Hawaiian cultural event, and which is also given the distinction as the Olympics of Hula. Aside from his involvement in many other cultural and community organizations, Cy is the president of the Native Hawaiian Hospitality Association (NaHHA), whose mission is to encourage the preservation and perpetuation of Hawaiian values, customs, language, and artifacts, as well as to promote research in support of the economic value of Hawaiian culture in the hospitality industry. He is a member of the Oahu Island Burial Council of the State Historical Preservations Department. Its purpose is to advise the Department of Land and Natural Resources on all matters pertaining to sacred and historic burial sites more than 50 years old which are located on private, state, and county properties. Cy is also a composer, a chanter, and a musician, but feels his most important calling and responsibility as Honey, Dad, and especially Papa!

SESSION H

9:25 AM

SINGLE-EVENT EFFECTS: MECHANISMS AND MODELING

SESSION INTRODUCTION

Chair: Véronique Ferlet-Cavrois, CEA

H-I

9:30 AM

Impact of Heavy Ion Energy and Nuclear Interactions on Single-Event Upset and Latchup in Integrated Circuits

P. E. Dodd, J. R. Schwank, M. R. Shaneyfelt, J. A. Felix, G. L. Hash, S. M. Dalton, Sandia National Laboratories; P. Paillet, V. Ferlet-Cavrois, J. Baggio, CEA-DIF; R. A. Reed, Vanderbilt University; K. Hirose, H. Saito, Institute of Space and Astronautical Science

The impact of heavy ion energy on the SEU and SEL response of commercial and radiation-hardened CMOS ICs is explored. The role of nuclear interactions and implications for hardness assurance and rate prediction are discussed.

Technical Program Thursday

H-2
9:45 AM **Impact of Ion Energy and Species on Single Event Effects Analysis**
R. A. Reed, R. A. Weller, R. D. Schrimpf, J. A. Pellish, L. W. Massengill, M. H. Mendenhall, K. M. Warren, Vanderbilt University; N. F. Haddad, R. Lawrence, J. Bowmam, BAE Systems

Experiments on radiation hardened SRAMs confirm the contribution of heavy ion induced nuclear reactions to SEU. The observed on-orbit rate is underestimated by classical methods. Simulations that include proper physics correctly estimate the SEU response.

H-3
10:00 AM **On-Orbit Event Rate Calculations for SiGe HBT Shift Registers**
J. A. Pellish, R. A. Reed, R. A. Weller, M. H. Mendenhall, R. D. Schrimpf, K. M. Warren, B. D. Sierawski, Vanderbilt University; P. W. Marshall, Consultant NASA-GSFC; A. K. Sutton, R. Krithivasan, J. D. Cressler, Georgia Tech; G. Niu, Auburn University

Event rate calculations for IBM SiGe HBT digital logic are presented. The heavy ion GCR event rates for two different shift register designs are compared and the effects of the radiation environment are analyzed.

H-4
10:15 AM **3D Simulation of SEU Hardening of SiGe HBTs Using Shared Dummy Collector**
M. Varadharajaperumal, G. Niu, X. Wei, Auburn University; J. D. Cressler, Georgia Tech; R. A. Reed, Vanderbilt University; P. W. Marshall, Consultant, Brookneal

We present 3-D simulations of SEU hardening of SiGe HBTs using shared dummy collector. The shared dummy collector suppresses diffusive charge collection and simultaneous charge collection in adjacent HBTs for both normal and angled deep strikes.

10:30 – 11:00 AM
PALACE LOUNGE BREAK

H-5
11:00 AM **New Measurement Techniques of Voltage Transients in Inverters and Chains of Inverters Under Pulsed Laser Irradiation**
V. Ferlet-Cavrois, P. Paillet, J. Baggio, CEA; D. McMorro, J. S. Melinger, NRL

New techniques are developed to measure voltage transients induced by irradiation of CMOS logic cells. The shape of voltage transients is analyzed with respect to the transient response of single transistors and technology characteristics.

H-6
11:15 AM **Feasibility Study of a Table-Based SET-Pulse Estimation in Logic Cells From Heavy-Ion-Induced Transient Currents Measured in a Single MOSFET**
D. Kobayashi, K. Hirose, ISAS/JAXA and The Graduate University for Advanced Studies; H. Ikeda, ISAS/JAXA; H. Saito, ISAS/JAXA and The University of Tokyo

A table look-up modeling technique estimates SET-pulse waveforms comparable to those in mixed-mode simulations in bulk and SOI technologies at low-computational cost. Approaches to reduce estimation errors and experimental costs for modeling are also presented.

Technical Program Thursday

H-7
11:30 AM

Transient Radiation Response of Single- and Multiple-Gate FD SOI Transistors to Pulsed Laser Irradiation

M. Gaillardin, S. Cristoloveanu, IMEP-ENSERG; P. Paillet, V. Ferlet-Cavrois, J. Baggio, CEA-DIF; D. McMorrow, Naval Research Laboratory; O. Faynot, C. Jahan, L. Tosti, CEA-LETI

Direct measurements of transient currents under pulsed laser irradiation are performed on FDSOI transistors, and for the first time on non-planar triple-gate transistors. The sensitivity of advanced SOI devices to SEU and SET is discussed.

H-8
11:45 AM

Radiation Performance of Capacitor-Less Floating Body DRAM (Z-RAM) Cell

N. Butt, M. Alam, Purdue University

We have modeled the radiation performance of capacitor-less DRAM. For alpha particle fluence of 0.01/cm²-hr, soft error rates are less than 1000 FIT/Mb. A physical model with initial results is introduced for ionization dose effects.

POSTER PAPERS

PH-1

Angular Dependence of Heavy Ion Effects in Floating Gate Memory Arrays

G. Cellere, A. Paccagnella, DEI, Padova University; A. Visconti, M. Bonanomi, ST Microelectronics; R. Harboe-Sørensen, ESA/ESTEC; A. Virtanen, Accelerator Laboratory, University of Jyväskylä

FG arrays were irradiated at tilted angles with high energy ions, which left “traces” in the array. Important implications on effects of LET and tilt angle on the radiation effects in state-of-the-art technologies are discussed.

PH-2

Single-Event Burnout of Silicon Carbide Schottky Barrier Diodes Caused by High Energy Protons

S. Kuboyama, C. Camazawa, Y. Satoh, N. Ikeda, JAXA; T. Hirao, JAEA; H. Ohyama, Kumamoto National College of Technology

It was demonstrated that single-event burnout was observed in the silicon carbide schottky barrier diodes with high energy proton irradiation. The behavior was successfully explained with a failure density function based on the binomial distribution.

PH-3

The Role of Track Structure on High-Injection Carrier Dynamics in III-V Devices Measured Using Ion and Laser Microbeams

J. S. Laird, JPL; S. Onoda, T. Hirao, T. Ohshima, T. Kamiya, JAEA

Low ambipolar diffusivities in Si means charge collection depends on ion track structure. Here, we examine the role of ambipolar diffusion in charge collection in III-V materials using an ion microbeam and laser to cover a wide range of initial track conditions.

PH-4

Using Sub-Threshold Heavy Ion Upset Cross Section to Calculate Proton Upset Cross Section

C. Inguimbert, S. Duzellier, T. Nuns, ONERA; F. Bezerra, CNES

This paper reports SEU proton calculations using the very low LET heavy ion upset cross section. Sub-threshold events are due to nuclear fragments produced by ion/matter nuclear interactions, similar to the proton induced upset mechanism.

Technical Program Thursday

PH-5 Effects of Random Dopant Fluctuations (RDF) on the Single Event Vulnerability of 90 nm and 65 nm CMOS Technologies

A. Balasubramanian, P. R. Fleming, B. L. Bhuva, L. W. Massengill, Vanderbilt University

Random Dopant Fluctuation (RDF) induced threshold voltage (V_t) variations, increase the distribution of SET pulse width and critical charge required for SEUs. Monte-Carlo simulations show this can affect the hardness characterization in 90nm and 65nm processes.

PH-6 Single Event Pulse Shapes and Impact On N-Hit Pulse Modeling in Deep Submicron CMOS

S. DasGupta, O. A. Amusan, J. R. Ahlbin, A. F. Witulski, B. L. Bhuva, M. L. Alles, L. W. Massengill, R. D. Schrimpf, R. A. Reed, Vanderbilt University

Deep submicron CMOS SETs show a current waveform plateau not accounted for by the double exponential model, which significantly affects voltage pulse width. A device mechanism and a different compact model current waveform are proposed.

PH-7 Innovative Simulations of Heavy Ion Cross-Sections in a 130nm CMOS SRAM. Influence of the Passivation Layers and PMOS Contribution

V. Correas, F. Saigné, B. Sagnes, J. Boch, IES UMR UM2-CNRS; G. Gasiot, D. Giot, P. Roche, ST Microelectronics, France

A simulation tool to predict the heavy ion cross section is proposed. A 20% average error between experimental and simulated results is shown for a SRAM in a commercial 130nm CMOS technology.

12:00 – 1:20 PM LUNCH

SESSION I PHOTONIC DEVICES AND INTEGRATED CIRCUITS

1:25 PM SESSION INTRODUCTION

Chair: Cheryl Marshall, NASA-GSFC

I-I Proton- and Gamma-Induced Effects on Erbium-Doped Optical Fibers

1:30 PM

S. Girard, J. Baggio, P. Paillet, V. Ferlet-Cavrois, CEA; B. Torteche, Y. Ouerdane, A. Boukenter, J. P. Meunier, Laboratory Hubert Curien; E. Regnier, Draka Comteq France; M. Van Uffelen, A. Gusarov, F. Berghmans, SCK-CEN; J. R. Schwank, M. R. Shaneyfelt, J. A. Felix, Sandia National Laboratories; E. W. Blackmore, TRIUMF; H. Thienpont, Vrije Universiteit Brussel

The behavior of three erbium-doped fibers with different Er and Al_2O_3 concentrations are compared during proton and γ -ray exposures. Mechanisms of radiation-induced attenuation around the pumping wavelength and the Er^{3+} emission spectrum are discussed.

Technical Program Thursday

I-2
1:45 PM **Gamma-Ray Irradiation Effects on CMOS Image Sensors and Finger Gated-Diodes in Deep Sub-Micron Technology**

P. R. Rao, X. Wang, A. J. P. Theuwissen, Delft University of Technology; A. J. Mierop, DALSA

This work focuses on estimating the radiation hardness of 4-T active pixel sensors and technological evaluation of the Philips' 0.18- μm process utilizing finger gated-diodes (FGDs) as a radiation sensitive tool.

I-3
2:00 PM **Lateral Diffusion Length Changes In HgCdTe Detectors in a Proton Environment**

J. E. Hubbs, M. Gramer, D. Maestas, J. Garcia, G. Dole, Ball Aerospace & Technology Corp.; A. Anderson, Air Force Research Laboratory; P. Marshall, Consultant NASA-GSFC; C. Marshall, NASA-GSFC

Changes in the lateral diffusion length in HgCdTe detectors was studied at proton energies of 7, 12, and 63 MeV. Data analysis suggests that the atomic Coulombic interaction is the primary mechanism for these changes.

I-4
2:15 PM **Measurement and Simulation of the Variation in Proton-Induced Energy Deposition in Large Silicon Diode Arrays**

C. L. Howe, R. A. Weller, R. A. Reed, R. D. Schrimpf, B. D. Sierawski, M. H. Mendenhall, Vanderbilt University; P. W. Marshall, Consultant NASA-GSFC; C. J. Marshall, NASA-GSFC;

The proton induced charge deposition in a well characterized silicon diode array is analyzed with Monte Carlo based simulations. These simulations include all physical processes, together with pile up, to describe the experimental data accurately.

I-5
2:30 PM **Proton Irradiations Effects on Al-Free Laser Diodes Emitting at 852 nm for Caesium Atomic Clocks Applications**

M. Boutillier, C. Barquin, X. Dollat, O. Gauthier-Lafaye, S. Bonnefont, F. Lozes-Dupuy, LAAS-CNRS; V. Ligeret, M. Calligaro, M. Lecomte, O. Parillaud, M. Krakowski, Alcatel-Thales III-V Lab; O. Gilard, CNES

852 nm emitting Al-free laser diodes and layers constituting the device are irradiated with 31 MeV protons with fluences from 10^{10} to $5 \cdot 10^{12} \text{ p}^+/\text{cm}^2$. Threshold damage coefficients are derived before and after forward bias annealing.

I-6
2:45 PM **LED Technologies for Optocouplers: Fundamental Issues and Hardness Assurance**

A. Johnston, T. Miyahira, JPL

Physical properties and radiation degradation mechanisms of LEDs used in optocouplers are discussed. Hardness assurance methods are evaluated, including reverse-recovery time measurements that are effective in determining the first-order sensitivity to radiation damage.

Technical Program Thursday

POSTER PAPERS

PI-1

Radiation Induced Damage and Recovery in RR-P3HT:PCBM Based Organic Photocells

R. A. B. Devine, C. Mayberry, AFRL/VSSE, Kirtland AFB; G. Li, Y. Yang, UCLA

Organic photocells have been characterized during and post- X-irradiation. The open circuit voltage, dark current and power conversion efficiency show degradation consistent with the generation of defect states in the semiconductor. Some recovery is observed.

PI-2

Accuracy of Analog Fiber-Optic Links for Inertial Confinement Fusion Diagnostics

E. K. Miller, G. S. Macrum, National Security Technologies, LLC; H. W. Herrmann, J. M. Mack, S. E. Caldwell, C. S. Young, T. J. Sedillo, S. C. Evans, Los Alamos National Laboratory; C. J. Horsfield, D. Drew, Atomic Weapons Establishment, U.K.

Interferometric fiber-optic links used in pulsed power experiments are evaluated for accuracy in the presence of radiation fields which alter fiber transmission. Amplitude-modulated formats (e.g., Mach-Zehnder) and phase-modulated formats are compared.

PI-3

Radiation Test Results for a MEMS Microshutter Operating at 60 K

D. A. Rapchun, Global Science & Technology; S. Buchner, QSS Group Inc., NASA-GSFC; H. Moseley, NASA-GSFC

The results of radiation testing of a MEMS Microshutter operating at low temperature (30 K) are presented. The results show that after a dose of 200 krad(Si), the part is still able to function properly.

POSTER SESSION

3:00 – 4:45 PM

TAPA BALLROOM I

INTRODUCTION



Dale McMorrow, NRL

4:45 PM

END OF THURSDAY SESSIONS

5:15 – 6:30 PM

TAPA BALLROOMS 2, 3

RADIATION EFFECTS COMMITTEE OPEN MEETING

Technical Program Friday

INVITED TALK
8:15 – 9:15 AM
TAPA BALLROOMS 2, 3



Astronomy in Hawaii: Exploring Our Universe with the Largest Telescopes in the World

Dr. Rolf-Peter Kudritzki, Director of the Institute for Astronomy, University of Hawaii, Honolulu, HI

Astronomy, like no other science, has revolutionized our thinking about the world and our human existence. With every new generation of technology, more and more powerful telescopes have contributed to extending our knowledge of the universe. Today, the largest and most powerful telescopes in the world are located in Hawaii on the summit of Mauna Kea (14,000 feet). The many spectacular and fundamental discoveries made with these new facilities are the subject of this presentation. We will discuss the detection of new worlds such as planets orbiting around other stars, proto-planetary disks forming new planetary systems, the black hole in the center of our galaxy, dark matter and dark energy and the accelerated expansion of the universe, and the detection of galaxies 13 billion light years away from us. We will also discuss the scientific potential and scope of the coming next generation telescopes, which will take us even further in this breathtaking endeavor to understand the cosmos we live in.

Dr. Rolf-Peter Kudritzki has been the Director of the University of Hawaii's Institute for Astronomy since October of 2000. Dr. Kudritzki was formerly a Professor of Astronomy and Director of the Institut für Astronomie und Astrophysik at the University of Munich. Since the summer of 1999, he has been Dean of the Faculty of Physics at the University of Munich. He has also been a director of the Max-Planck-Institut für Astrophysik. Dr. Kudritzki's research activities and international collaborations have led to his participation and membership in a wide range of international committees. For many years he has been a member and chair of the advisory Visiting Committee for the Hubble Space Telescope Science Institute, located at the Johns Hopkins University. In addition, he was chair of the European Southern Observatory Advisory Committee, and is a member of the Board of Directors of the Association of Universities for Research and Astronomy (AURA). AURA manages U. S. national observatories located in Arizona, New Mexico and Chile; the two international Gemini observatories which are located in Chile and Hawaii; and the Hubble Space Telescope Science Institute. He is also the chair of the National Science Working group for the Next Generation Giant Segmented Mirror Telescope. In addition to his administrative responsibilities, Dr. Kudritzki has continued to pursue a career as an active researcher. His recent research has been in the area of the investigation of the physics of stars and galaxies, and in particular their evolution. For the past ten years, he has been involved in the development of new telescopes and telescope instrumentation. He has published more than 100 publications in refereed journals and has been invited frequently to give presentations at international science conferences. He has supervised more than 30 Ph.D. students, many of whom now are professors themselves. Since January 2003, Dr. Kudritzki has held the title of Interim Vice Chancellor for Research and Graduate Education at the University of Hawaii. Dr. Kudritzki holds a diploma in Physics and a Ph.D. in Astronomy from the Technische Universität, Berlin.

Technical Program Friday

SESSION J SINGLE-EVENT EFFECTS: DEVICES AND INTEGRATED CIRCUITS

9:25 AM

SESSION INTRODUCTION

Chair: Younes Boulghassoul, ISI/USC

J-1
9:30 AM

Multiple Cell Upsets as the Key Contribution to the Total SER of 65nm CMOS SRAMs and its Dependence on Well Engineering

G. Gasiot, D. Giot, P. Roche, ST Microelectronics

The key contribution of MCUs to the total SER of 65 nm CMOS SRAMs is studied through experiments and 3D-TCAD simulations. The triple well and well contact frequency both drive the magnitudes of MCU and SER.

J-2
9:45 AM

Low Energy Proton Induced Single Event Upsets in 65 nm Silicon-on-Insulator Latches and Memory Cells

K. P. Rodbell, M. S. Gordon, D. F. Heidel, H. H. K. Tang, C. Plettner, P. Oldiges, IBM T. J. Watson Research Center

Experimental data are presented showing that low energy (< 2 MeV) proton irradiation can upset exploratory 65 nm Silicon-On-Insulator (SOI) circuits. Alpha particle SER data, modeling and simulation results provide a plausible mechanism.

J-3
10:00 AM

The Effect of the ADE Resistance on Limiting Heavy-Ion SEU Upset Cross-Sections of SOI/ADE SRAMs

M. S. Liu, D. K. Nelson, J. C. Tsang, Honeywell; H. Y. Liu, Seagate Technology; P. J. McMarr, H. L. Hughes, NRL

This paper discusses the limiting heavy-ion induced single-event upset cross section of radiation-hardened SOI SRAM using an active delay element and its relation with the resistance of the active delay element.

J-4
10:15 AM

Mapping of Single Event Burnout in Power MOSFETs

A. Haran, J. Barak, D. David, N. Refaeli, Soreq NRC; B. E. Fischer, M. Heiss, K. O. Voss, G. Du, GSI

Direct mapping of single event burnout (SEB) in power MOSFETs is presented for the first time utilizing the GSI heavy ion microprobe. SEB and charge-collection mapping uncover the MOSFET areas most sensitive to ion strikes.

10:30 – 11:00 AM
PALACE LOUNGE

BREAK

J-5
11:00 AM

The Effect of Voltage Fluctuations on the Single Event Transient Response of Deep Submicron Digital Circuits

M. J. Gadlage, Vanderbilt University and NAVSEA Crane; R. D. Schrimpf, B. Narasimham, B. L. Bhuvu, Vanderbilt University; P. H. Eaton, J. M. Benedetto, Micro-RDC

In this paper, we demonstrate how small voltage variations across an integrated circuit can affect the digital single event transient response. For technologies with supply voltages near 1 V, the potential drop may produce unexpected vulnerability.

Technical Program Friday

- J-6**
11:15 AM **Impact of VCO Topology on SET Induced Frequency Response**
W. Chen, N. Varanasi, B. Vermeire, H. J. Barnaby, T. Copani, Arizona State University; V. Pouget, P. Fouillat, University Bordeaux; P. Adell, Vanderbilt University

Laser experiments performed on two SiGe VCO circuit topologies show different output spectra. Analytical models demonstrate that the spectral response is determined by design features impacting the modulated amplitude or frequency characteristics of transient signals.

- J-7**
11:30 AM **Characterization of Digital Single Event Transient Pulse Widths in 130 nm CMOS**
B. Narasimham, B. L. Bhuvva, R. D. Schrimpf, L. W. Massengill, M. J. Gadlage, O. A. Amusan, W. T. Holman, A. F. Witulski, W. H. Robinson, J. D. Black, Vanderbilt University; J. M. Benedetto, P. H. Eaton, Micro-RDC

The distribution of SET widths in a 130 nm CMOS technology is measured experimentally. The average pulse width for LETs up to 100 MeV-cm²/mg is below 800 ps, with most pulses shorter than 600 ps.

- J-8**
11:45 AM **New Methodologies for SET Characterization and Mitigation in Flash-Based FPGAs**
S. Rezgui, J.-J. Wang, E. C. Tung, B. Cronquist, J. McCollum, Actel Corporation

New SET characterization and mitigation techniques unique for non-volatile FPGA are investigated. Their implementation on a flash-based FPGA and evaluation in-beam show their efficacy with little area overhead but high time penalty for high-scaled technologies.

POSTER PAPERS

- PJ-1**
Correlation of Prediction to On-Orbit SEU Performance for a Commercial 0.25 mm CMOS SRAM
D. L. Hansen, K. Jobe, J. Whittington, M. Shoga, D. A. Sunderland, Boeing Satellite Development Center

Comparison between performance in a geosynchronous orbit and predictions based on ground testing for a digital signal processor will be presented. Performance during flare peaks will be shown.

- PJ-2**
Impact of TID Effect on the Analog SET Sensitivity of Linear Bipolar Integrated Circuits
M. F. Bernard, L. Dusseau, J. Boch, IES - UMR CNRS, Université Montpellier II; S. Buchner, QSS Group Inc., NASA-GSFC; D. McMorow, Naval Research Laboratory; R. Ecoffet, Centre National d'Etudes Spatiales; R. Schrimpf, Vanderbilt University; K. LaBel, NASA-GSFC

Total ionizing dose is shown to affect the single-event transient sensitivity of the LM139. Circuit analysis is used to correlate the degradation of the amplifier stages with the shape of the transient output signal.

Technical Program Friday

PJ-3 The Effects of Angle of Incidence and Temperature on Latchup in 65nm Technology

J. M. Hutson, J. D. Pellish, R. A. Reed, R. D. Schrimpf, R. A. Weller, L. W. Massengill, Vanderbilt University; G. Boselli, R. Baumann, Texas Instruments

Single event latchup (SEL) in 65nm CMOS devices is examined with respect to strike angle of incidence. Variation in device characteristics with temperature is considered.

PJ-4 Single Event Effect Characterization of High Density Commercial NAND and NOR Nonvolatile Flash Memories

F. Irom, D. N. Nguyen, JPL

This paper reports single-event effects results for a variety of high density commercial NAND and NOR flash memories. Three SEE phenomena were investigated: bit upsets, SEFIs, and catastrophic loss of ability to erase the device.

PJ-5 Effects of Buffer Layer on Single-Event Burnout of Power DMOSFETs

S. Liu, M. Boden, International Rectifier Corp.; J. L. Titus, NAVSEA Crane

We have proven, both experimentally and theoretically, that adding a buffer layer improves a device's SEB survivability. We present simulation results showing that the choice of buffer is important in achieving the best device performance.

PJ-6 Mitigation and Modeling of Single-Event Transients in Voltage-Controlled Oscillators

T. D. Loveless, L. W. Massengill, W. T. Holman, B. L. Bhuva, Vanderbilt University

RHBD techniques to mitigate SETs in current-starved VCOs are presented. Additionally, an analytical model is presented that can be used to develop SEE-tolerant VCO designs.

PJ-7 Effect of Dose History on SEE Properties of Power MOSFETS

L. Selva, L. Edmonds, J. Laird, L. Scheick, R. Harris, JPL

We present data showing that dose levels seen in harsh mission or in nuclear environments can influence the single-event effects of a power metal-oxide semiconductor. The typical metric of single-event gate rupture, the drain-to-gate threshold, drops when a critical dose is reached.

PJ-8 Experimental Validation of a Tool for Predicting the Effects of Soft Errors in SRAM-based Field Programmable Gate

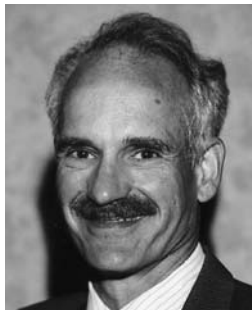
L. Sterpone, M. Violante, Politecnico di Torino; R. Harboe-Sørensen, D. Merodio, F. Stuesson, R. Weigand, European Space Agency; S. Mattsson, Saab Ericsson Space

Radiation testing was used to measure the cross-section of a design implemented on SRAM-based FPGA. Experimental data closely match predictions obtained through a tool for computing the impact of soft errors in such devices.

12:00 PM END OF CONFERENCE



IEEE



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The 2007 IEEE Nuclear and Space Radiation Effects Conference will be held July 23-27, 2007 in Waikiki Beach, Honolulu, Hawaii at the Hilton Hawaiian Village Resort. The conference hotel is located on Waikiki Beach in Honolulu on the southern side of the Hawaiian island of Oahu. This magnificent hotel is truly a village with over 22 beachfront acres and almost 3000 guest rooms. Enjoy the perfect mix of world-class conference facilities for our technical meetings and a relaxed, beach village atmosphere for unhurried networking and unwinding. Lloyd Massengill and his 2007 conference committee have put together a strong technical program, as well as social events that will provide frequent opportunities for discussing radiation effects with friends, old and new.

Supporters of the conference include the Defense Threat Reduction Agency, Sandia National Laboratories, Air Force Research Laboratory, the NASA Electronic Parts and Packaging Program, NASA Living With a Star Program, and the Jet Propulsion Laboratory and the following new corporate supporters BAE Systems, Micro-RDC, Honeywell, ST Microelectronics, Boeing, and Aeroflex Colorado Springs.

The 2008 NSREC will be held in Tucson, AZ at the new Starr Pass J. W. Marriott Hotel, July 14-18. The conference site is a spectacular desert location in the mountains above the city. The Conference Chairman is Paul E. Dodd, of Sandia National Laboratories. The 2009 NSREC will be held in Quebec City, Canada at the Quebec City Hilton and the Quebec Conference Center, July 20-24. The conference site overlooks the St. Lawrence River and the walled city of Quebec. The Conference Chairman is Mark A. Hopkins, of The Aerospace Corp. The 2010 NSREC is still in the site selection process. Conference Chairman is Joseph M. Benedetto, of Micro-RDC.

As always, papers presented at the NSREC are eligible for publication in the December issue of the *IEEE Transactions on Nuclear Science*. This year we will continue the fully electronic submission and review process inaugurated last year. It is particularly important for authors to upload their papers prior to the conference for consideration for publication in the December TNS Special Issue. Detailed instruction can be found at <http://www.nsrec.com/editmsg.htm>.

Keep visiting our web site at www.nsrec.com for author information, paper submission details, vendor links, on-line registration, and the latest NSREC information.

To provide consistent reviews of papers throughout the year, the *IEEE Transactions on Nuclear Science* has made structural changes in its editorial process. This year, we are aligning the review process for the December issue of the Transactions to be consistent with this process. The new editorial structure will rely on the year-round editorial board that now manages reviews for submissions throughout the year to the Transactions in the area of radiation effects. The review process is managed by a Senior Editor, Dr. Jim Schwank, and six assistant editors who are technically knowledgeable in one or more specializations and are experienced in the publication process. The year-round editorial board is not directly associated with the annual conference, so they will not be included in the conference committee. We thank Jim Felix and Steve Buchner, the remaining guest editors, for their service to the community. The December issue of the *Transactions on Nuclear Science* has been the official record of refereed papers for the conference. The Radiation Effects Steering Committee is committed to retaining the feel of the December issue as the "conference record." To ensure this, the Steering Committee has asked the Vice-Chair of Publications to closely monitor the review process and to work closely with the Senior Editor. If you have questions or comments I can be reached via email at sextonfw@sandia.gov, while Jim's email address is schwanjr@sandia.gov.

RESG NEWS

ARE YOU A MEMBER OF IEEE?

Now is the time to join the Institute of Electrical and Electronics Engineers (IEEE) and the Nuclear Plasma Sciences Society (NPSS). Why? First of all, you get to be a member of the largest professional engineering society in the world. **About 60% of NSREC attendees are IEEE members.** Full membership in IEEE costs \$156. NPSS membership is \$20. NPSS members receive a free subscription to *NPSS News* and have an opportunity to purchase a subscription to the *IEEE Transactions on Nuclear Science* for \$65 (print) or \$25 (on-line).

NPSS members get to vote in our NSREC elections, held at the annual open meeting on Thursday of the conference. If that is not enough, **members receive a significant discount on registration fees** for the NSREC and Short Course. With a subscription to IEEE Xplore, members can search and view digital copies of NSREC papers (published since 1988) from an on-line web-based database. What are you waiting for? Apply for membership at <http://www.ieee.org> or visit the IEEE registration desk.

NSREC PUBLICATIONS

NSREC has three publications each year:

- **IEEE Transactions on Nuclear Science.** This IEEE journal is the official archive of research papers presented at the NSREC Conference. A six issue/year subscription is \$1140 (only \$65 for IEEE/NPSS members).
- **Radiation Effects Data Workshop Record.** Published each year in October, this IEEE proceedings has become the source for radiation test data on semiconductor components. A copy of the Workshop Record is available for \$180 (\$90 IEEE members).
- **NSREC Short Course Notebook.** Published each July, this notebook contains tutorial presentations on the basic physics of radiation effects in circuits and systems. It includes the instructor's notes and text, given to participants of the annual Radiation Effects Short Course. The *Archive of Radiation Effects Short Course Notebooks 1980-2007* is available on CD-ROM for \$200 (\$160 IEEE members). To obtain individual copies of this CD, please visit <http://www.nsrec.com/editor.htm>.

A complimentary copy of the 2007 *IEEE Radiation Effects Data Workshop Record* and one issue of the *IEEE Transactions on Nuclear Science* will be mailed to each NSREC technical session attendee.

RADIATION EFFECTS COMMITTEE ANNUAL OPEN MEETING

You are invited to attend the IEEE Radiation Effects Committee's Annual Open Meeting on Thursday, July 26, from 5:15 PM in Tapa Ballrooms 2, 3. All conference attendees and spouses are encouraged to attend. We will discuss the 2007 conference and future IEEE Nuclear and Space Radiation Effects Conferences. There will be an election for the Junior Member-at-Large on the Radiation Effects Steering Group. Nominations will be taken from the floor. All IEEE NPSS members present are eligible to vote. Refreshments will be provided.

Awards

2006 OUTSTANDING CONFERENCE PAPER AWARD

Statistical Analysis of the Charge Collected in SOI and Bulk Devices under Heavy Ion and Proton Irradiation – Implications for Digital SETs

V. Ferlet-Cavrois, P. Paillet, M. Gaillardin, D. Lambert, J. Baggio, J. R. Schwank, G. Vizkelethy, M. R. Shaneyfelt, K. Hirose, E. W. Blackmore, O. Faynot, C. Jahan, and L. Tosti

2006 OUTSTANDING STUDENT PAPER AWARD

Single-Event Tolerant Latch Using Cascode-Voltage Switch Logic Gates

Megan C. Casey, Bharat L. Bhuvra, Jeff D. Black, Lloyd W. Massengill, Oluwole A. Amusan, and Arthur F. Witulski

2006 DATA WORKSHOP PAPER AWARD

Total Dose and Dose Rate Response of Low Dropout Voltage Regulators

R. L. Pease, G. Dunham, and J. Seiler

RICHARD F. SHEA DISTINGUISHED MEMBER AWARD

Paul V. Dressendorfer received the B.S. degree in Physics from the California Institute of Technology in 1972, and the M.S., M.Phil., and Ph.D. degrees in Solid State Physics from Yale University in 1973, 1974, and 1978, respectively. He recently retired from Sandia National Laboratories as the manager of the Biomolecular Interfaces and Systems Department at Sandia National Laboratories. This group focused on the science of integration of biomolecular processes, biological principles, biomimetic materials, and biomolecular function into nano- and micro-scale systems. His earlier research activities and publications have covered a wide range of areas including semiconductor device physics, basic radiation damage mechanisms, characterization of radiation effects, hardened technology development, hardness assurance, optoelectronic devices, multichip modules, advanced electronic and microsystem packaging, thermal management, frequency devices, sensors and transducers, and microsystem electronics. He has been active in a variety of IEEE activities, including positions such as general chair of the Nuclear and Space Radiation Effects Conference (NSREC) and of the Semiconductor Interface Specialists Conference (SISC), short course instructor and chair of the NSREC, technical program chair of the SISC, IEEE Section Membership chair, IEEE Standards Committee member, and member of the NPSS AdCom, Radiation Effects Steering Group, and Radiation Instrumentation Steering Committee. He is a Fellow of the IEEE and a recipient of the IEEE Third Millennium Award. He has been the Editor-in-Chief of the IEEE *Transactions on Nuclear Science* since 1993, is currently the Editor-in-Chief (Chair of the Publications Committee) of the NPSS, and is the NPSS Liaison to the TAB Transactions Committee. He recently reorganized the Editorial Board and review processes for the *Transactions on Nuclear Science*; a similar structure is also being implemented in the *Transactions on Plasma Science*.

Dr. Dressendorfer has been awarded the Richard F. Shea Distinguished Member Award. His citation for this award is "In appreciation of 14 years as editor for NPSS. Special recognition as Editor-in-Chief for reorganizing and implementing an effective operating structure for the *Transactions on Nuclear Science*."

Awards

IEEE FELLOWS

One distinguished member of the radiation effects community was elected to the grade of IEEE Fellow on January 1, 2007.

Ron Pease

RLP Research

Ron's citation reads, "for contributions to the radiation response of microelectronic devices circuits and systems."

2006 RADIATION EFFECTS AWARD

The 2006 Radiation Effects Award was presented to Dennis Brown from the National Reconnaissance Office during the opening ceremonies of the 2006 conference.

Dr. Brown's citation reads "For contributions to the dissemination and advancement of radiation effects research and by his leadership in all aspects of the IEEE Nuclear and Space Radiation Effects Conference and the Radiation Effects Steering Group."

2007 RADIATION EFFECTS AWARD

The winner of the 2007 Radiation Effects Award will be announced Tuesday morning, July 24. Nominations are currently being accepted for the 2007 IEEE Nuclear and Plasma Sciences Society (NPSS) Radiation Effects Award. The purpose of the award is to recognize individuals who have had a sustained history of outstanding and innovative technical and/or leadership contributions to the radiation effects community but who may not have been honored by being elected Fellows of the IEEE or receiving other IEEE awards such as a Merit Award, the Shea Award, or an IEEE Medal.

2008 RADIATION EFFECTS AWARD

Nominations are currently being accepted for the 2008 IEEE Nuclear and Plasma Sciences Society (NPSS) Radiation Effects Award. The purpose of the award is to recognize individuals who have had a sustained history of outstanding and innovative technical and/or leadership contributions to the radiation effects community.

The basis of the award is for individuals who have: (1) a substantial, long-term history of technical contributions that have had major impact on the radiation effects community. Examples include benchmark work that initiated major research and development activities or a major body of work that provided a solution to a widely recognized problem in radiation effects; and/or (2) a demonstrated long-term history of outstanding and innovative leadership contributions in support of the radiation effects community. Examples include initiation or development of innovative approaches for promoting cooperation and exchange of technical information or outstanding leadership in support of the professional development of the members of the radiation effects community.

A cash award and plaque will be presented at the 2008 IEEE NSREC in Tucson, Arizona in July 2008. Nomination forms are available electronically in PDF Format or in Microsoft Word format at <http://www.nsrec.com/nominate.htm>. Additional information can be obtained from Wayne Abare, Member-at-Large for the Radiation Effects Steering Group. Wayne can be reached at 321-729-7224, wabare@harris.com.

Conference Information

ALOHA!! The 2007 IEEE NSREC will be held at the Hilton Hawaiian Village (HHV) Beach Resort in Honolulu, Hawaii. We will enjoy the perfect mix of world-class conference facilities for our technical meetings and a relaxed, beach village atmosphere for unhurried networking and unwinding. With our meeting rooms in the on-site Tapa Conference Center, surrounded by numerous excellent restaurants, park-like grounds with fascinating wildlife and ample activities for all ages, you won't need to leave the conference site! But you will... Honolulu is alive with daytime and evening activities and the Waikiki Beach area is set in the middle of the action. You can take a quiet walk along the beach or venture into town amidst all the activity... it's yours to explore.



ROOMS FOR SIDE MEETINGS

Several meeting rooms are available for use by any registered conference attendee at the Hilton Hawaiian Village on a first come, first served basis. *NSREC encourages side meetings to be scheduled at times other than during technical sessions.* Contact ETC Services at 720-733-2003 or send an e-mail to etcservices@qwest.net to make side meeting reservations **before** the conference. To make a side meeting reservation **during** the conference, see the NSREC Registration Desk staff.

Notes: *You must register for the conference before a side meeting room can be reserved!* All audio/visual equipment and refreshments must be coordinated through the hotel and are the responsibility of the attendee.

MESSAGES

808-947-7936
ASK FOR THE NSREC
REGISTRATION DESK
FAX: 808-951-5458

A message board for incoming messages will be located in the pre-function area outside the conference room during the NSREC. Faxes can be received through the hotel's guest fax but there must be a cover sheet stating the recipient's name, noting the NSREC conference, and advising the total number of pages being sent. There is a fee for incoming faxes, chargeable to your guest room and thus, faxes can be accepted for hotel guests only.

CONTINENTAL BREAKFAST AND COFFEE BREAKS

The 2007 IEEE NSREC will provide continental style breakfasts and refreshments at breaks during the NSREC Short Course and Technical Sessions. Breakfast every day will begin at 7:30 AM for *registered conference attendees only*.

BUSINESS CENTER

The Hilton Hawaiian Village has a Business Center located on the ground floor of the Diamond Head Tower which is open and staffed 24 hours a day. Services available are: incoming and outgoing faxes, computer stations with internet access, laptop internet access outlets, courier shipping, cell phone rental, office supplies, and printers. Costs associated with the Business Center services may be charged to your room or paid by cash or credit card. This location is also a "contract" U.S. Post Office but is allowed to handle postal matters during specified hours only.

Registration and Travel

CONFERENCE REGISTRATION

To pre-register for NSREC, complete the conference registration form enclosed in this booklet, or register on-line at www.nsrec.com. **Please note that registration fees are higher if payment is received after June 22, 2007.**

**ETC SERVICES, INC.
2254 EMERALD DRIVE
CASTLE ROCK, CO 80104**

**720-733-2003
FAX: 720-733-2046
ETCSERVICES@QWEST.NET**

Mail the conference registration form with your remittance to ETC Services, Inc. The registration form, **with payment**, should be mailed to arrive no later than seven days prior to the conference, or arrangements should be made to hand carry fees for on-site registration. Faxed registrations will be accepted with credit card payment. Telephone registrations will not be accepted. You can also register via the internet, provided all of the credit card information is included. Go to the NSREC web site for on-line registration at www.nsrec.com.

Registration fees should be made payable to the "IEEE NSREC" and must be in U.S. funds only. There are three ways to remit advanced payment of registration and activity fees: 1) check made out in U.S. dollars and drawn on a U.S. bank, 2) U.S. Money Order, or 3) Mastercard, VISA, or American Express credit card.

On-site conference registration will take place at the Iolani Suite #2. For everyone who has pre-registered, your packets can be picked up at the Iolani Suites #5-7 on Sunday - Monday and Iolani Suite #1 after that. The following is the schedule for registration:

ON-SITE REGISTRATION HOURS

Sunday, July 22	5:00 PM – 9:00 PM
Monday, July 23	7:30 AM – 4:00 PM 6:00 PM – 9:00 PM
Tuesday, July 24	7:30 AM – 5:30 PM
Wednesday, July 25	7:30 AM – 3:00 PM
Thursday, July 26	7:30 AM – 3:00 PM
Friday, July 27	7:30 AM – 10:00 AM

CONFERENCE CANCELLATION

A \$25 processing fee will be withheld from all refunds. Due to advance financial commitments, refunds of registration fees requested after June 22, 2007 cannot be guaranteed. Consideration of requests for refunds will be processed after the conference. To request a refund, you must notify ETC Services by fax at 720-733-2046 or e-mail at etcservices@qwest.net.

Registration and Travel

HOTEL RESERVATIONS AND INFORMATION

HILTON HAWAIIAN VILLAGE BEACH RESORT AND SPA

2005 KALIA ROAD
HONOLULU, HAWAII 96815
USA

808-949-4321
TOLL FREE: 800-445-8667
FAX: 808-951-5458

WWW.HILTONHAWAIIAN
VILLAGE.COM



Photo: courtesy of Hilton Hawaiian Village.

Our conference hotel will be the HILTON HAWAIIAN VILLAGE (HHV) on Waikiki Beach in Honolulu, Oahu, Hawaii. This magnificent 22-acre oceanfront resort is truly a village paradise, with over 20 wonderfully-international restaurants and lounges, five pools, 90 shops, a health club and spa, water sports, children's program, and even a branch of the Bishop Museum. The hotel towers are situated among lush botanical gardens with exotic wildlife and tropical waterfalls, all adjoining Waikiki's widest stretch of sandy beach.

The government rate for a standard garden-view room is \$140.00 + tax and the NSREC group rate for a standard garden-view room is \$190.00 + tax for single and double occupancy. Additional adults are \$45.00 + tax per person. Children 18 years of age and younger are free when sharing a room with their parents, with a maximum of 4 people in the room. Partial-ocean-view rooms are offered (on request) at \$205.00 per night plus tax, single/double and full-ocean-view rooms are offered (on request) at \$220.00 per night plus tax, single/double. The current tax is 11.41%.

MAKING RESERVATIONS

All rooms must be guaranteed with a credit card or deposited by check. The cut-off for IEEE NSREC reservations is **June 22, 2007**. Once the room block has been filled OR after the cut-off date (whichever comes first!), room accommodations will be confirmed on a space available basis and the room rate will be higher.

Reservations can be made by calling the Hilton Hawaiian Village directly at **808-949-4321** or call Hilton general reservations at **800-445-8667**. There are two blocks of rooms and a group code is needed to access either. For those who are eligible for the government rate, use the code **SRP-C-AUG**. For those looking for the NSREC group rate, use code **SRP-C-AUF**.

In addition, reservations can be made on-line at the Hilton Hawaiian Village website. In this case, go to the website, click on Reservations (at the top), enter your dates and in the "group/convention" section, enter either **AUG** (government rate) or **AUF** (group rate), then follow the prompts.

Website: <http://www.hiltonhawaiianvillage.com>

GOVERNMENT RATE

All government rate attendees will be asked to provide a government ID upon registration at the Hilton. If you do not have an official government ID, then you may provide documentation that you are traveling on government business. One of these forms of ID will be necessary to guarantee "government rate" check in.

ROOM AVAILABILITY

Due to the popularity of this resort, it is possible that the NSREC room block will fill – especially on dates prior to or after the conference proper dates. The conference committee is working with the hotel to add additional rooms on an as-needed basis. If you have difficulty obtaining the NSREC room rates, or if you are told that the block is "sold out," please contact ETC Services (720-733-2003) for assistance.

Registration and Travel

AIRPORT AND TRANSPORTATION INFORMATION

Honolulu International Airport (airport code HNL) is approximately eight miles from the Hilton Hawaiian Village. Taxis are readily available. The average one-way taxi fare is about \$35.00.

AIRPORT SHUTTLE

Roberts Hawaii offers a scheduled service approximately every 20 minutes from the Honolulu Airport to downtown and Waikiki area hotels. Reservations are not required on the airport-hotel transfer but they ARE required on the hotel-airport transfer. Rates are \$9.00 per person one way and \$15.00 per person roundtrip. Reservations can be made by calling toll free 1-866-898-2519 or, when on the island, 808-954-8652. You can also visit their website at: www.robertshawaii.com.

Charley's Taxi & Tours, located at the Hilton Hawaiian Village, offers general taxi service and specially-arranged VIP shuttle service to/from Honolulu International Airport and around town. Call in advance and arrange for arrival pickup service at the airport. Shuttle service to Honolulu Airport – 7 AM to 7 PM (every hour on the hour). Airport Shuttle Rates – \$12.00 per person. Please call ahead for reservations. Telephone: 808-947-0077 (at the resort). Web site: www.charleystaxi.com.

DRIVING DIRECTIONS

From Honolulu International Airport (HNL): depart Honolulu Airport via Airport Exit to Hwy H1 East. Hwy H1 East to Exit 23 (6.3 mi). Exit 23 to Punahau St.(0.2 mi). South (right) on Punahau to S. Beretania St. (0.2 mi). West (right) on S. Beretania St. to Kalakaua Ave (175 yards). South (left) on Kalakaua Ave to Ala Moana Blvd (1.0 mi). South (bear right) on Ala Moana Blvd to Kalia Rd (0.2 mi.) South (left) on Kalia Rd to HHV entrance (25 yards). Hilton Hawaiian Village entrance is on the right.

PARKING

Parking is at a fee for all hotel guests. The current self-park rate is \$20 per day and valet parking is \$26 per day, chargeable to your room account.

GETTING AROUND WHILE AT THE HHV

Walking. There are many attractions, shops, and restaurants both on site and within a very short walk from the Hilton Hawaiian Village, and public transportation is also readily available. A rental car won't be necessary while attending NSREC, unless you plan island sightseeing (see Local Activities section). The center of Waikiki Beach township is within a 10 minute walk (either by surface streets or along the beach) from the HHV.

Public bus transportation. Oahu Transportation Services offers "The Bus" public bus transportation routes to all parts of Oahu. For information on routes, times and fares please call 808-848-5555 or visit the web site at www.thebus.org.

The Waikiki Trolley. This unique mode of transportation offers different tours and conveniently stops at the Hilton Hawaiian Village. Contact the Hotel Activities Desk for trolley-route booklets and all-day passes: 808-949-4321 Ext. 29.

Registration and Travel

RENTAL CAR DISCOUNT HERTZ

HERTZ NUMBER
CV #03S20002 IEEE NSREC

There are many attractions, shops and restaurants within walking distance of the Hilton Hawaiian Village and public transportation is also readily available. Although a rental car won't be necessary in many cases, you may want one for island sightseeing.

Hertz has been selected as the official car rental agency for the 2007 NSREC and will be offering discounted rates for conference attendees. For reservations and information, call Hertz at 800-654-2240 and mention CV #03S20002 or use the Hertz website at www.hertz.com. The special conference rates will be available from July 16, 2007, to August 3, 2007. The rates are valid at any Honolulu Hertz location as long as pick-up/return are at the same location.

Class	Car type	Daily (per day)	Weekend (per day)	Weekly (5 - 7 days)
A	Economy	\$44.00	\$44.00	\$229.00
B	Compact 2/4-door	\$48.00	\$48.00	\$250.00
C	Midsize	\$51.00	\$51.00	\$260.00
D	Standard	\$54.00	\$54.00	\$276.00
F	Fullsize 4-door	\$56.00	\$56.00	\$281.00
G	Premium	\$64.00	\$90.00	\$387.00
I	Towncar	\$92.00	\$98.00	\$459.00
L	4WD/AWD SUV	\$92.00	\$98.00	\$459.00
R	Minivan 2WD	\$92.00	\$98.00	\$459.00
U	Convertible	\$92.00	\$98.00	\$438.00

Rental cars are subject to availability so advance reservations are recommended. When making reservations, the agent will check to see if this is the best rate for you at the time. Government surcharges, taxes, airport related fees, vehicle licensing fees and optional items, such as refueling or additional driver fees, are extra. Renters must meet Hertz age, driver and credit requirements. Additional restrictions, terms and conditions may apply.

HERTZ LOCATION ON SITE

Note that Hertz has a rental office conveniently located on the Hilton Hawaiian Village property at the front of the Tapa Tower.

Industrial Exhibits



Barry Templeton
Industrial Exhibits Chairman

The **NSREC 2007 Industrial Exhibits** will be located in the Tapa Ballroom 1 and the Palace Lounge adjacent to the technical sessions all day on Tuesday and until noon on Wednesday. It will feature the leading suppliers of radiation-hardened products, related materials, and services. The exhibit offers companies the opportunity to showcase their products, technologies, and services to key technical and management personnel associated with electronics used in space vehicles, military electronics, and applications requiring radiation tolerance in harsh environments. Attendees are encouraged to stop by and visit the vendors. Breaks will be held in the exhibitor areas on Tuesday and Wednesday.

A reception, hosted by the exhibitors and open to all conference attendees and their guests, will be held Tuesday evening and will feature complimentary beverages followed by a full dinner buffet.

NOTE: Children under 16 must be accompanied by an adult in the Exhibits.

For additional information, contact:

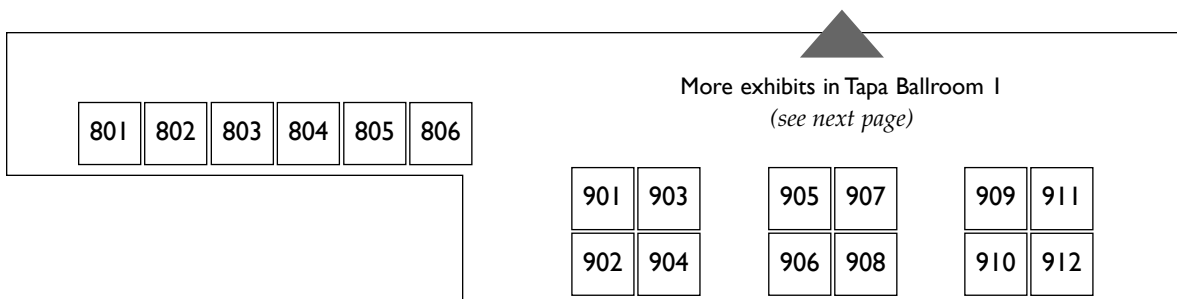
Barry Templeton	Phone: 615-322-3833
ISDE	Fax: 615-343-9550
	Email: Barry.templeton@vanderbilt.edu

Or contact us through the internet at: www.nsrec.com/exhibit.htm

EXHIBIT HALL HOURS

Tuesday, July 24	10:15 AM - 3:30 PM 6:00 PM - 10:00 PM 10:15 AM - 10:40 AM (conference break) 2:45 PM - 3:10 PM (conference break) 6:00 PM - 10:00 PM (exhibitor reception) 6:00 PM cocktails, 7:00 PM buffet
Raffle drawing	9:00 PM
Wednesday, July 25	7:30 AM - 2:45 PM 7:30 AM - 8:15 AM (continental breakfast) 10:30 AM - 11:00 AM (conference break)

NSREC INDUSTRIAL EXHIBITS – PALACE LOUNGE



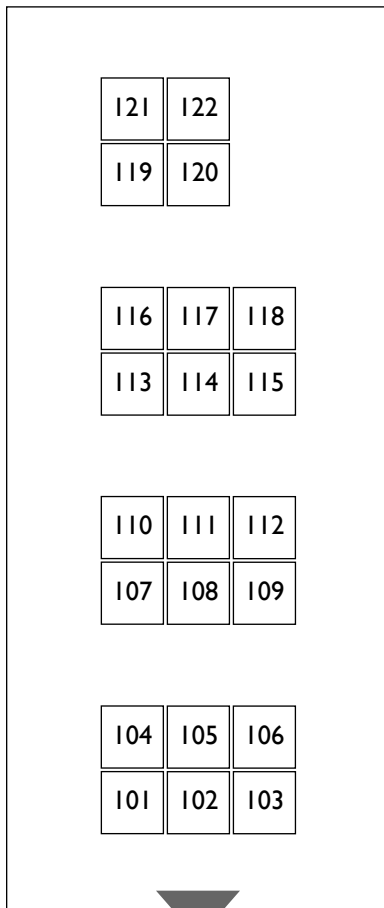
Industrial Exhibits

EXHIBITORS

Please check our web site (www.nsrec.com) for a current listing of companies exhibiting at 2007 NSREC.

NSREC INDUSTRIAL EXHIBITS

TAPA BALLROOM I



More exhibits in Palace Lounge
(see previous page)

Company	Internet Site	Booth #
3D Plus - USA	www.3d-plus.com	122
Actel Corporation	www.actel.com	105, 106
Aeroflex Colorado Springs	www.aeroflex.com/radhard	805, 806
BAE Systems	www.eis.na.baesystems.com	101
Boeing - Phantom Works	www.boeing.com/ssed	801
Crane Aerospace & Electronics	www.craneae.com	104
Cyclotron Institute, Texas A & M University	http://cyclotron.tamu.edu/ref	114
Defense Microelectronics Activity (DMEA)	www.dmea.osd.mil	102
Honeywell	www.honeywell.com	118
ICS Radiation Technologies	www.icsrad.com	121
Idaho Accelerator Center	http://iac.isu.edu	111
Indiana Univ. Cyclotron	http://www.iucf.indiana.edu/rerp/index.php	119
International Rectifier	http://hirel.irf.com	804
Intersil Corporation	www.intersil.com	103
Jazz Semiconductor	www.jazzsemi.com	802
JD Instruments	www.jdstruments.net	911
J.L. Shepherd & Associates	www.jlsheperd.com	910
Maxwell Technologies	www.maxwell.com	907
MBDA	www.mbda.co.uk	905
Micro-RDC	www.micro-rdc.com	113
Modular Devices Inc.	www.mdipower.com	108
NASA Living with a Star	http://lws-set.gsfc.nasa.gov	904
NASA - NEPP	nepp.nasa.gov	903
National Semiconductor	http://www.national.com	117
Northrop Grumman Corporation	http://www.northropgrumman.com	116
Orora Design Technologies, Inc.	www.orora.com/home	909
Peregrine Semiconductor Corp.	www.psemi.com	115
Prarie View A&M - NASA Center for Applied Rad Research	www.pvamu.edu/carr	902
Radiation Assured Devices	http://radiationassureddevices.com	120
Sandia National Laboratories	www.sandia.gov	109
Silvaco International	http://www.silvaco.com/	912
Survivability, Vulnerability, & Assessment Directorate	www.wsmr.army.mil/capabilities/datts/testing	901
Synopsys	www.synopsys.com	908
Synplicity, Inc.	www.synplicity.com	110
US Semiconductor Corp.	www.us-semi.com	906
Vanderbilt University - Institute for Space and Defense Electronics	www.isde.vanderbilt.edu	803
VPT, Inc.	www.vpt-inc.com	112
Xilinx	www.xilinx.com	107

2007 IEEE NSREC Technical Sessions and Short Course Registration Form



Name _____
Last Name First Name Middle Initial

Name to appear on badge _____

Company/Agency _____

Mailing Address _____

City _____

State _____ Zip Code _____

Country _____

Telephone Number _____

Fax Number _____

E-mail Address _____

IEEE MEMBERSHIP

☐ I am an IEEE Member. _____
Membership Number

☐ I am not a Member, but I wish to join the IEEE.
Non-members must register at the non-member rate.

CANCELLATIONS

A \$25 processing fee will be withheld from all refunds. Due to advance financial commitments, refunds of registration fees requested after June 22, 2007 cannot be guaranteed. Consideration of requests for refunds will be processed after the conference.

**Mail or Fax this form and your remittance
 (payable to IEEE NSREC) to:**

**ETC Services, Inc.
 2254 Emerald Drive
 Castle Rock, CO 80104**

720-733-2003 Fax: 720-733-2046

REGISTRATION FEES (in U.S. dollars)

Late fee REQUIRED if payment received after June 22, 2007.

Early Late

IEEE Member *

Short Course	\$250	\$300	\$ _____
Technical Sessions	\$400	\$480	\$ _____

Non-IEEE Member

Short Course	\$310	\$360	\$ _____
Technical Sessions	\$500	\$600	\$ _____

Full-Time Students who are IEEE Members *

Short Course	\$115	\$300	\$ _____
Technical Sessions	\$115	\$480	\$ _____

TOTAL AMOUNT ENCLOSED: \$ _____

PAYMENT OF FEES

☐ Enclosed is a check or money order in **U.S. DOLLARS ONLY**, drawn on or payable through a U.S. bank. Payable To: **IEEE NSREC**

☐ Charge registration fees to my credit card (U.S. dollars):

☐ American Express ☐ Master Card ☐ Visa

Card No. _____ Expiration Date _____

Printed Name _____

Address _____

Address _____

Signature _____

If your company or agency is going to pay by check at a later date, **please do not complete the credit card portion of this form. Only one form of payment is needed.**

* To obtain IEEE rates, you must provide your IEEE number on this form.

2007 IEEE NSREC Activities Registration Form



Conference
Participant _____

Company/Agency _____

Address _____

City _____

State _____ Zip Code _____

Country _____

Telephone Number _____

Fax Number _____

Accompanying
Persons _____
Name

Please list ages for children under age 21 only

Name Age

Name Age

Name Age

Name Age

CANCELLATIONS

To encourage advanced registration for conference social activities, we will refund all activity fees for conference attendees and/or their companions who for any reason are unable to attend the conference. If your plans change after this form is submitted and you would like to request a refund, you must notify ETC Services by email at etcservices@qwest.net or FAX at 720-733-2046 no later than July 13 or notify the conference registration desk when picking up your registration materials **(but no later than 24 hours before the scheduled activity)**.

**Mail or Fax this form and your remittance
(payable to IEEE NSREC) to:**

**ETC Services, Inc.
2254 Emerald Drive
Castle Rock, CO 80104**

720-733-2003 Fax: 720-733-2046

ACTIVITY FEES (in U.S. dollars)

Late fee REQUIRED if payment received after June 22, 2007. We strongly encourage early registration; the number of tickets available for each event is limited. Children must be accompanied by an adult during all tours and social events.

	Early	Late	Number Attending	Total Cost
Conference Reception: Monday night, July 23				
Adult	\$0	\$0	_____	_____
Waimea Valley/Dole Plantation: Tuesday, July 24				
Adult	\$60	\$70	_____	\$_____
Child (age 4-12)	\$35	\$45	_____	\$_____
Child (age 0-3)	\$0	\$0	_____	_____
Industrial Exhibits Reception: Tuesday night, July 24				
Adult/child	\$0	\$0	_____	_____
Child (age 0-12)	\$0	\$0	_____	_____
Luau at Paradise Cove: Wednesday night, July 25				
Adult	\$45	\$65	_____	\$_____
Child (age 4-18)	\$20	\$45	_____	\$_____
Child (age 0-3)	\$0	\$0	_____	_____
Iolani Palace/Lunch at Dukes: Thursday, July 26				
Adult/child	\$60	\$70	_____	\$_____

TOTAL AMOUNT ENCLOSED: \$_____

PAYMENT OF FEES

- ☐ Enclosed is a check or money order in **U.S. DOLLARS ONLY**, drawn on or payable through a U.S. bank. Payable To: **IEEE NSREC**
- ☐ Charge registration fees to my credit card (U.S. dollars):
- ☐ American Express ☐ Master Card ☐ Visa
- Card No. _____ Expiration Date _____
- Printed Name _____
- Address _____
- Address _____
- Signature _____

Social Program

HONOLULU, HAWAII



"Aloha! This is Hawaii so I know you'll have fun – especially if you join us for some great tours and phenomenal luau. May your experience here in Waikiki be unforgettable!"

Susan Crain, The Aerospace Corporation, Local Arrangements Chairman

NSREC 2007 will be held at the Hilton Hawaiian Village Beach Resort on amazing Waikiki Beach, Honolulu, on the island of Oahu, Hawaii. The resort spans 22 acres, offering the widest stretch of beach on Waikiki, a beachfront lagoon, waterfalls, five pools, gardens, an exquisite art collection, exotic wildlife, a full-service spa, and nightly entertainment. There are more than 20 restaurants and lounges on site and the Village also boasts more than 90 shops. Beyond the Village property is Waikiki – synonymous with vitality – where there is a fascinating blend of eastern, western, and Polynesian cultures. The greater city of Honolulu stretches out further, from Diamond Head to Pearl Harbor. The rest of the island of Oahu, also known as "The Gathering Place," offers something for everyone, from the majestic cliffs of the Ko'olau Mountains (mauka) to the crystal-blue waters of the Pacific Ocean (makai). Conference attendees can enjoy pristine beaches with turquoise waters for snorkeling and swimming, razor-edged mountains and lush rainforests for hiking (with no snakes!), famous north shore beaches for world-class surfing, museums and botanical gardens for touring, and of course "battleship row."

Children must be accompanied by an adult during all tours and social events.



Photo: courtesy of Hilton Hawaiian Village.

**SUNDAY, JULY 22
5:00 PM TO 9:00 PM
REGISTRATION OPEN**

The registration desk will be open from 5:00 PM to 9:00 PM in the Iolani Suites.

Social Program

**MONDAY, JULY 23
5:30 PM TO 7:30 PM
ALL CONFERENCE
BEACH BASH WELCOME**

Shake off the jet lag and catch up with colleagues and friends in a wonderful, open air venue. The 2007 Conference Chairman Lloyd Massengill and his entire conference committee welcome you to Waikiki! Come join us for refreshments on the beachfront Ilima Lawn at the Hale Koa park next door to the Hilton Hawaiian Village Ali'i tower. Open to all conference attendees and their guests.

Please remember to wear your badge!

**TUESDAY, JULY 24
9:00 AM TO 4:00 PM
WAIMEA VALLEY
AUDUBON CENTER AND
DOLE PLANTATION**



*Photo: courtesy of Joe Solem
Photography.*

Beyond the high energy pace of Waikiki lies the peaceful natural beauty of Oahu.

Experience this aspect of the island as we travel to the North Shore (home of the legendary waves of the Banzai Pipeline) to enjoy a gentle hike along the cool trails of the beautiful Waimea Valley Audubon Center. This 1800 acre park located in a picturesque valley above Waimea Bay has over 6,000 plant species including native Hawaiian plants, as well as plants from other regions. Stroll through the gardens and walk up to the Waimea Falls for a swim. The pace is relaxing and the environs are mesmerizing. Plant enthusiasts, bird lovers, history buffs, and anyone who longs for a true Hawaiian island experience will find what they are seeking in Waimea Valley.



*Photo: courtesy of Hawaii
Tourism Japan.*

Lunch will be supplied at the Waimea Grill, a small restaurant on the park grounds. It will include a choice of sandwich, chips, a cookie and a drink. After lunch, we'll continue on a short driving tour through Haleiwa, the North Shore's classic surf town.

Then it's off to the Dole Plantation. The "Pineapple Experience" is one of Hawaii's favorite visitor attractions offering a fun and educational experience for the entire family. Home to the world's largest maze, Dole has an entertaining way of educating people about Hawaii's unique agricultural industry. We will take a ride on the "Pineapple Express," a 2-mile, 20 minute fully narrated train tour that promises to be quite enthralling. And there will still be time to make a stop at the country store and cool down with an original, world famous Dole Whip before returning to the HHV.

Meet the buses at the HHV designated bus pickup area beside the Tapa Tower (shown on your hotel map). Dress comfortably and wear walking shoes. Bring swimming attire and a towel if you wish to swim in the falls. (There are changing facilities at the falls.) Space is limited – please reserve early. (Wikiwiki!)

**TUESDAY, JULY 25
6:00 PM TO 10:00 PM
INDUSTRIAL EXHIBITS
RECEPTION**

**6:00 PM COCKTAILS
7:00 PM BUFFET**

A Tuesday night reception will be hosted by the NSREC exhibitors. Along with meeting representatives from leading companies in the radiation-hardening industry, NSREC attendees and their guests can enjoy complimentary food and drinks. Visit the exhibits and any registered technical attendee can participate in the booth raffles. **NOTE: Children under 16 must be accompanied by an adult in the Exhibits.**



Social Program

WEDNESDAY, JULY 25
4:45 PM TO 10:00 PM
LUAU AT PARADISE COVE

5:30 PM COCKTAILS
7:15 PM DINNER
8:30 PM SHOW



Photo: courtesy of Lloyd Massengill.

The luau is the quintessential Hawaiian social event and Paradise Cove is one of the largest and most respected luau shows in Hawaii. Located on the leeward coast of O'ahu, it features brilliant sunset views from 12-oceanfront acres. NSREC has contracted exclusive use of Paradise Cove for our Wednesday night main conference social event.

Try your hand at the unique games of Hawaii as you compete against your friends and colleagues at 'O'o ihe (spear throwing, but not at each other we hope!), 'Ulu maika (rolling stone disks), or Moa pahe'e (dart sliding). If traditional arts and crafts are more to your liking, there is lei making, basket weaving, and traditional Hawaiian quilting (a Hawaiian tradition first brought to the islands by missionaries that has evolved into a unique island craft featuring innovative, colorful designs and intricate stitchery.)



Photo: courtesy of Lloyd Massengill.

How about an authentic Polynesian tattoo reminiscent of the South Pacific culture before the arrival of the Europeans? Have no fear, this version is only temporary. Take part in a traditional hukilau, pulling giant fish nets from the sea to the rhythms of a conch shell and island chants. Then, stroll among the Island craftsman displaying their wares, some of which can be purchased as a souvenir of your memorable visit to Paradise Cove.

The luau is the island combination of a feast and a picnic, and in keeping with that tradition, we will have a wonderful outdoor dinner against the backdrop of the glorious Hawaiian sunset. Follow the Royal Court Procession to the Imu (underground pit oven) Amphitheater for the ceremony to unearthing the luau's traditional roasted pig. We will then feast on all-you-can-eat kalua pig direct from the imu, chicken, and fresh fish, along with the traditional Hawaiian fruits and complements, even poi for the brave among us.

As dinner is concluded, the Paradise Cove Main Stage will explode with the excitement of traditional songs and dances of Hawaii and Polynesia as the Paradise Cove Extravaganza dazzles you. It's the perfect show for a perfect evening: a little comedy, a little audience participation, plus lots of outstanding singing and dancing under the wonderful Hawaiian night. The unforgettable show, considered the best on the island, will conclude with one of Polynesia's greatest fire-knife dances. Don't forget to BRING YOUR CAMERA!

Buses will begin departing the HHV bus pickup area (shown on your hotel map) on Wednesday at 4:45 PM, and will continue until 5:15 PM. Arts/Crafts/Games/Cocktails will take place before dinner, which will begin at 7:15 PM. The Polynesian Show will begin at 8:30 PM and conclude at 9:15 PM. Buses will begin departing for the HHV immediately following the show and will continue until 9:45 PM. After 9:45, you're on your own getting back! Note: Strollers can be taken on the bus and Paradise Cove is stroller friendly. Dress is very casual.

ALOHA SHIRT CONTEST

Wear your favorite Aloha shirt and you may win our "Wildest Aloha Shirt" contest!

Social Program

**THURSDAY, JULY 26
9:00 AM TO 2:30 PM
IOLANI PALACE AND
LUNCH AT DUKE'S**

Recognizable to most of us haoles (mainlanders) as Police Headquarters in Hawaii Five-O, the 'Iolani Palace is, in reality, a Hawaiian national treasure and the only official state residence of royalty in the United States.

Visiting the palace will be the center of this cultural tour of Honolulu. As we head out from the HHV for some downtown sight-seeing with a guide to point out the highlights, our destination will be the 'Iolani Palace, which was the official residence of the Hawaiian Kingdom's last two monarchs – King Kalakaua, who built the Palace in 1882, and his sister and successor, Queen Lili'uokalani. During the monarchy period, the Palace was the center of social and political activity in the Kingdom of Hawaii. We will enjoy the beauty and grandeur of the palace as we learn the history of the monarchy and hear the stories and experience the culture of the Hawaiian people.



Photo: courtesy of Hawaii Tourism Japan.

Changing gears from the bygone culture of the monarchy to the modern culture of the hip surfing scene, we will have lunch in Waikiki at Duke's Restaurant. Duke's of Waikiki, named in honor of surfing legend Duke Kahanamoku, is a seafood restaurant located on the site of the original Outrigger Canoe Club, overlooking the spot where Duke rode the biggest wave of his life.

The restaurant is reminiscent of a gentler and younger Waikiki, when canoeing and surfing were in their heyday, beachboys ruled, and Duke was the undisputed "king of the ocean." A virtual museum and a well respected restaurant, Duke's features an extensive collection of Duke memorabilia and a menu full of fresh island fare and traditional fare with a Hawaiian twist. Enjoy a delicious lunch in this relaxing atmosphere while checking out the photos, koa outrigger canoe, and surfboards.

Meet the buses at the HHV designated bus pickup area beside the Tapa Tower (shown on your hotel map). Please reserve early – space will be limited. (Wikiwiki!)

Note: there is a dress code at the palace – no midriff, tank, strapless tops, bathing suits, or brief shorts. Also, children under 5 cannot be accommodated.

AEROBICS

Get a healthy start on your day with Dave Bushmire, our own certified aerobics instructor. These sessions will take place in South Pacific 4 meeting room located in the Mid-Pacific Conference Center at 6:30 - 7:30 AM, Tuesday, Wednesday, and Thursday.

ACTIVITIES CANCELLATION POLICY

To encourage advance registration for conference social activities, NSREC will refund all activity fees for conference attendees and companions who for any reason are unable to attend the conference. If your plans change after your activities registration form is submitted, simply request a refund by notifying ETC Services by fax or e-mail no later than July 13, 2007. Fax: 720-733-2046. E-mail: etcservices@qwest.net.

Local Activities

WAIKIKI, HONOLULU, AND OAHU BEYOND

The trouble you will have when visiting the Island of Oahu will not be, “What is there to do?” but rather “What do I pick?” Whether you prefer excursions that include snorkeling, scenic views, museums, surfing, culture, geology, shopping or being entertained, your choices are numerous. Here are just a few to get you started.

BATTLESHIP ROW, PEARL HARBOR

USS ARIZONA MEMORIAL

USS MISSOURI MEMORIAL



Photo: courtesy of Lloyd Massengill.

The USS *Arizona* Memorial is the final resting place for many of the battleship's 1,177 crew members who lost their lives on December 7, 1941. The national memorial commemorates the site where World War II began for the United States. Experience history through the national memorial's program tour, museum, and wayside exhibits. The park is open 7 days a week, 7:30 AM - 5:00 PM. The earliest program begins at 7:45 AM; the last starts at 3:00 PM. Admission is free and tickets are issued on a first-come-first-served basis. Expect large crowds. Security is very strict. Strollers are permitted in the visitor center but not in the theaters or the water taxi. No purses, handbags, backpacks, fanny packs, diaper bags, or camera bags are permitted. However, you may take your camera or camcorders (without the bag). www.nps.gov/usar/index.htm

The battleship USS Missouri, “Mighty Mo,” is now docked in Pearl Harbor. The Missouri has served her nation proudly in World War II, the Korean Conflict and most recently in the Gulf War. It was on the USS Missouri that the document of surrender was signed by representatives of the allied nations and the government of Japan. The Memorial is open daily, 9:00 AM - 5:00 PM. The ticket window closes at 4:00 PM. www.ussmissouri.com

POLYNESIAN CULTURAL CENTER

Welcoming over one million visitors annually, this 42-acre park features Polynesian village settings from ancient Hawaii, Samoa, the Marquesas, Tahiti, Fiji, Tonga and New Zealand. Demonstrations of their daily lives and indigenous crafts are featured. Traditional and modern dance from each part of Polynesia is featured in a spectacular evening show. The Polynesian Cultural Center is located in Laie on Oahu's North Shore. For more information, visit www.polynesia.com

HANAUMA BAY



Photo: courtesy of Lloyd Massengill.

Known for its beauty and serenity, Hanauma Bay Nature Preserve is a paradise's paradise. Home to some of the most colorful and unique marine life in the world and designated as Hawaii's first Marine Life Conservation District, meeting some of this marine life face-to-face is an experience rarely matched worldwide. Whether you are snorkeling for the first time or the 100th you won't be disappointed at Hanauma Bay. Outstanding marine life is not the only thing you will find here. Hanauma Bay was formed by geologic activity and has lots to offer in the way of geology. Also, keep an eye opened for the many unique species of coastal plants and migrating species of birds. www.co.honolulu.hi.us/parks/facility/hanaumabay/welcome.htm

Local Activities

BISHOP MUSEUM

This is a wonderful museum about Hawaii and other Pacific island cultures located right in Honolulu and very convenient to the HHV. It was founded in 1889 by Charles Reed Bishop in honor of his late wife, Princess Bernice Pauahi Bishop, the last descendant of the royal Kamehameha family. Full of family royal heirlooms and Hawaiian artifacts, it features several galleries such as the Polynesian hall, the Kaahili room, and the Science Adventure Center. The roots of Hawaii in Polynesian culture are beautifully detailed, especially in the Kaahili room where the feather standards of the ali'i are displayed. And the Science center focuses on the Hawaiian natural environment in an interactive style. You can walk through the heart of a volcano or put muscle into making it erupt. If the timing is right, you might see the feeding of the scorpions. There is also a Hawaii Sports Hall of Fame where the history of sports in Hawaii is recorded. www.bishopmuseum.org

DIAMOND HEAD CRATER & SCENIC LOOKOUT

Explore one of Hawaii's most distinctive natural landmarks. Just minutes from central Waikiki is the Diamond Head Crater & Lookout offering views of Molokai and Lanai on a clear day. Hike to the summit, which is 763 feet high, and enjoy one of the most breathtaking views of Waikiki.



Photo: courtesy of Lloyd Massengill.

SEA LIFE PARK

At Sea Life Park, Hawaii's marine life comes alive for you and your family in a unique and fun setting, between mountains and the sea and just 15 minutes from Waikiki. From the moment you arrive, you don't have to be a bystander – Sea Life Park offers you and your family the opportunity to get right in the water with some of the most interesting creatures of the sea. You can swim with the dolphins; hug the sea lions; pet the incredibly gentle sting rays; and waddle with the penguins. It's an amazing opportunity for you to really interact with these gentle creatures, and only Sea Life Park can bring it to you. Sea Life Park is also home to the world's only "Wholphin," a cross between a whale and a dolphin. And if you wish to stay dry, you can just enjoy the park and its ocean-based shows and activities. Advanced reservations are required for all "Swim with the Dolphins" and other "wet" activities. www.sealifeparkhawaii.com

THE INTERNATIONAL MARKETPLACE, WAIKIKI

With over 130 carts, shops and artisan stands, this open-air market in the heart of Waikiki remains a must-see-and-do for bargain hunters and souvenir seekers. Enjoy a vast array of international and local cuisine while you shop from the International Food Court or make your visit during the evening and attend one of their free Hawaiian Entertainment Shows. Open 10:00 AM - 10:00 PM daily. www.internationalmarketplacewaikiki.com

BYODO-IN TEMPLE

The Byodo-In Temple showcases a replica of a 900-year-old Japanese temple, a detailed architectural treasure, situated against the backdrop of the majestic Ko'olau mountains. Here in the Valley of the Temples Memorial Park, you can enjoy beautiful Japanese gardens, tranquil koi ponds, flowing streams and a garden gazebo. Built in 1968, the Temple was created to celebrate the 100th anniversary of the first Japanese immigrants to Hawaii. It is located on Oahu's windward coast in Kaneohe. www.nightstarhawaii.com

Local Activities

PALI LOOKOUT

The Nuuanu Pali Lookout is a favorite stop among visitors to Oahu. Overlooking the 985-foot cliffs of the Koolau Mountain Range, the Pali (which means cliffs) offers beautiful panoramic views of the windward side of the island. This is the historic site of one of the most famous battles in Hawaiian history. When Kamehameha I and his army invaded Oahu in 1795, he conquered his opponents here in the Nuuanu Valley, pursued them up into the higher regions, and drove them over the cliffs. Don't stand too close to the edge! And don't let the wind blow you over unless you are feeling very adventurous. The trade winds blow through the valley between the high mountains on either side creating a natural windtunnel of sorts. On an extra windy day, you can lean into the winds and let them hold you up.

<http://oahu.aloha-hawaii.com/tours/pali+lookout/>

HAWAI'I MARITIME CENTER

This museum celebrates the rich maritime history of Hawaii and chronicles the arrival of whalers, traders, missionaries, plantation workers and other visitors to Hawaii. Here, you will find ocean vessel history ranging from ancient Polynesian sailing canoes to a waterfront display of a square rigger – the Falls of Clyde.

HONOLULU ZOO

Located between the slopes of Diamond Head and Waikiki, the Honolulu Zoo offers an educational experience with lots of fun thrown in. Learn about tropical ecosystems and meet a true Bird of Paradise, visit the Children's Zoo and pet Lani Moo the cow, have a picnic on the grounds, or choose a Twilight Tour or a Vacation Adventure. www.honolulu zoo.org

WAIKIKI AQUARIUM

You can get close up views of reef sharks, living corals, endangered Hawaiian monk seals, graceful sea jellies, myriads of colorful reef fish, and much more at the Waikiki Aquarium. Located next to a living reef on the Waikiki shoreline, their main focus is the aquatic life of Hawaii and the tropical Pacific. Visit at your leisure or plan to attend one of their special family classes. Choose between "Marine Munchies" which centers on feeding time or search for crabs, shrimp, eels, and octopus in "Exploring the Reef at Night" or another one of the enticing classes.

www.waquarium.org

WEATHER AND CLOTHING

The weather in Hawaii is warm and delightful, with the average temperature in Honolulu during July in the mid-80's (Fahrenheit) during the day and mid-70's at night. We can expect very little rain, low humidity, and warm tropical breezes. You might need a light-weight jacket for breezy evenings on the beach or visits to higher elevations.

Island living is laid back and casual. Conference attire will be business casual (the air-conditioned rooms may be cool)... aloha shirts are, of course, always appropriate. Attire for roaming about the beach, hotel, shops, and restaurants during the day is "resort casual:" tee/sport shirts, shorts, and sandals/flipflops. In the evenings, attire can move up a notch to "evening resort casual" at many of the more up-scale restaurants: dresses or blouse and slacks for the ladies and sport/aloha shirts and slacks for the men.

Bring your surf wear, flip flops, snorkeling gear, surfboard, and of course your Aloha shirts. And don't forget your camera!!

Be prepared, we will have a "Wildest Aloha Shirt" competition at the Wednesday night social.

2007 Conference Committee



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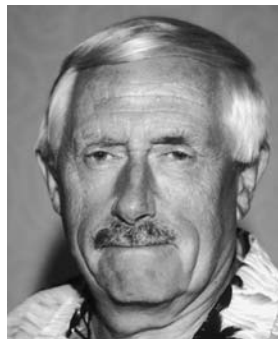
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2008 IEEE NUCLEAR AND SPACE RADIATION EFFECTS CONFERENCE Short Course and Radiation Effects Data Workshop

July 14 - 18, 2008

**JW Marriott Starr Pass Resort & Spa
Tucson, Arizona**

The 2008 IEEE International Nuclear and Space Radiation Effects Conference will be held July 14 - 18 in Tucson, Arizona at the JW Marriott Starr Pass Resort & Spa. The Conference features a technical program consisting of eight to ten sessions of contributed papers describing the latest observations in radiation effects, an up-to-date Short Course on radiation effects offered on July 14, a Radiation Effects Data Workshop, and an Industrial Exhibit. The technical program includes oral and poster sessions.

Papers describing nuclear and space radiation effects on electronic and photonic materials, devices, circuits, sensors, and systems, as well as semiconductor processing technology and design techniques for producing radiation-tolerant (hardened) devices and integrated circuits, will be presented at this meeting of engineers, scientists, and managers. International participation is strongly encouraged.

We are soliciting papers describing significant new findings in the following or related areas:

Basic Mechanisms of Radiation Effects in Electronic Materials and Devices

- Ionizing Radiation Effects
- Materials and Device Effects
- Displacement Damage
- Single-Event Charge Collection Phenomena and Mechanisms
- Radiation Transport, Energy Deposition and Dosimetry
- Processing-Induced Radiation Effects

Radiation Effects on Electronic and Photonic Devices and Circuits

- MOS, Bipolar and Advanced Technologies
- Isolation Technologies, such as SOI and SOS
- Optoelectronic and Optical Devices and Systems
- Methods for Hardened Design and Manufacturing
- Modeling of Devices, Circuits and Systems
- Particle Detectors and Associated Electronics for High-Energy Accelerators
- Cryogenic or High Temperature Effects
- Single-Event Effects
- Novel Device Structures, such as MEMS and Nanotechnologies

Space, Atmospheric, and Terrestrial Radiation Effects

- Characterization and Modeling of Radiation Environments
- Space Weather Events and Effects
- Spacecraft Charging
- Soft Error Rates (SER)

Hardness Assurance Technology and Testing

- Testing Techniques, Guidelines and Hardness Assurance Methodology
- Radiation Exposure Facilities
- Dosimetry

New Developments of Interest to the Radiation Effects Community

PAPER SUMMARY DEADLINE: FEBRUARY 1, 2008

PROCEDURE FOR SUBMITTING SUMMARIES

Authors must conform to the following requirements:

1. Prepare a single Adobe Acrobat file (maximum 5 pages) consisting of (a) an abstract no longer than 35 words on the first page, followed by (b) an informative **two to four page summary** describing results appropriate for 12-minute oral or a poster presentation. On the first page, please include title, name and company affiliation of the authors, and company address (city, state, country). Identify the author presenting the paper and provide telephone, fax, and email address.
2. The summary must include sufficient detail about the work to permit a meaningful technical review. In the summary, clearly indicate (a) the purpose of your work, (b) significant new results with supporting technical material, and (c) how your work advances the state of the art. Show key references to other related work. The summary must be **no less than two and no more than four pages** in length, including figures and tables (one additional page is allowed for the 35-word abstract). *All figures and tables must be large enough to be clearly read. Note that this is more than an abstract, but do not exceed four pages.*
3. Prepare your summary in single-column format, using 11 point or greater font size, formatted for either U.S. Standard (8.5 x 11 inch) or A4 (21 x 29.7 cm) page layout, with 1 inch (2.5 cm) margins on all four sides.
4. Obtain all corporate, sponsor, and government approvals and releases necessary for presenting your paper at an open-attendance international meeting.
5. Summary submission consists of an Author Information Form and a PDF-format copy of the four-page summary. Submission is electronic only, through **www.nsrec.com**. Details on the submission process may be found at **www.nsrec.com**. *Authors are requested to state their preference for presentation (oral, poster, or data workshop poster) and for session.* However, the final category of all papers will be determined by the Technical Program Committee, which is responsible for selecting final papers from initial submissions.

**Summaries must be received by
February 1, 2008**

**Detailed submission and
formatting instructions
will be available after
January 4, 2008
at www.nsrec.com**

Papers accepted for oral or poster presentation at the technical program will be eligible for publication in the Conference issue of the *IEEE Transactions on Nuclear Science* (December 2008), based on a separate submission of a complete paper, and subject to an independent review after the Conference. Further information will be sent to prospective authors upon acceptance of their NSREC summary. It is not necessary to be an IEEE member to present a paper or attend the NSREC. However, we encourage IEEE membership of all NSREC participants.

RADIATION EFFECTS DATA WORKSHOP

The Radiation Effects Data Workshop is a forum for papers on radiation effects data on electronic devices and systems. Workshop papers are intended to provide radiation response data to scientists and engineers who use electronic devices in a radiation environment, and for designers of radiation-hardened systems. Papers describing new simulation or radiation facilities are also welcomed. **The procedure for submitting a summary to the Workshop is identical to the procedure for submitting NSREC summaries.** Radiation Effects Data Workshop papers will be published in a Workshop Record and are not candidates for publication in the Conference issue of the *IEEE Transactions on Nuclear Science*.

TUCSON, ARIZONA

NSREC 2008 will be held at the JW Marriott Starr Pass Resort cradled in the Tucson Mountains just west of Tucson, Arizona. The resort is Tucson's premier convention destination, featuring a newly redesigned 27-hole Arnold Palmer signature golf facility offering views of the city and a majestic landscape of towering Saguaros and the Sonoran Desert. A fitness center, hiking the mountain desert terrain, swimming and whirlpools, and the Hashani Spa may be followed by dining at one of the five restaurants located at Starr Pass. Exploring the region by horseback, Jeep, hiking, or bicycling, and trips to nearby Kitt Peak National Observatory, Arizona-Sonora Desert Museum, Saguaro National Parks, Old Tucson Studios, Nogales, Mexico, San Xavier del Bac mission, the Pima Air & Space Museum, the Presidio de San Ignacio de Tubac, the mission at Tumacacori National Historical Park, Tombstone, and Kartchner Caverns or Colossal Cave are but a few of the sight-seeing, shopping and dining opportunities during our stay in Tucson. In addition to the luxurious accommodations of the Starr Pass Resort, the natural beauty and diverse culture of the Old Pueblo provide a perfect backdrop for the NSREC 2008 conference. For more information on Tucson and Southern Arizona, visit **www.visittucson.org**, for additional information on the JW Marriott Starr Pass Resort & Spa, visit **www.jwmarriottstarrpass.com**.



Photo: courtesy of JW Marriott Starr Pass Resort.

Hilton Hawaiian Village



You
Are
Here

You
Are
Here

You
Are
Here



TRAVEL VIA AIR

Directions from Honolulu

International Airport (HNL)

Depart Honolulu Airport via

Airport Exit to Hwy H1 East.

Hwy H1 East to Exit 23 (6.3 mi).

Exit 23 to Punahau St.(0.2 mi).

South (right) on Punahau to

S. Beretania St. (0.2 mi).

West (right) on S. Beretania St.

to Kalakaua Ave (175 yards).

South (left) on Kalakaua Ave

to Ala Moana Blvd (1.0 mi).

South (bear right) on Ala Moana Blvd

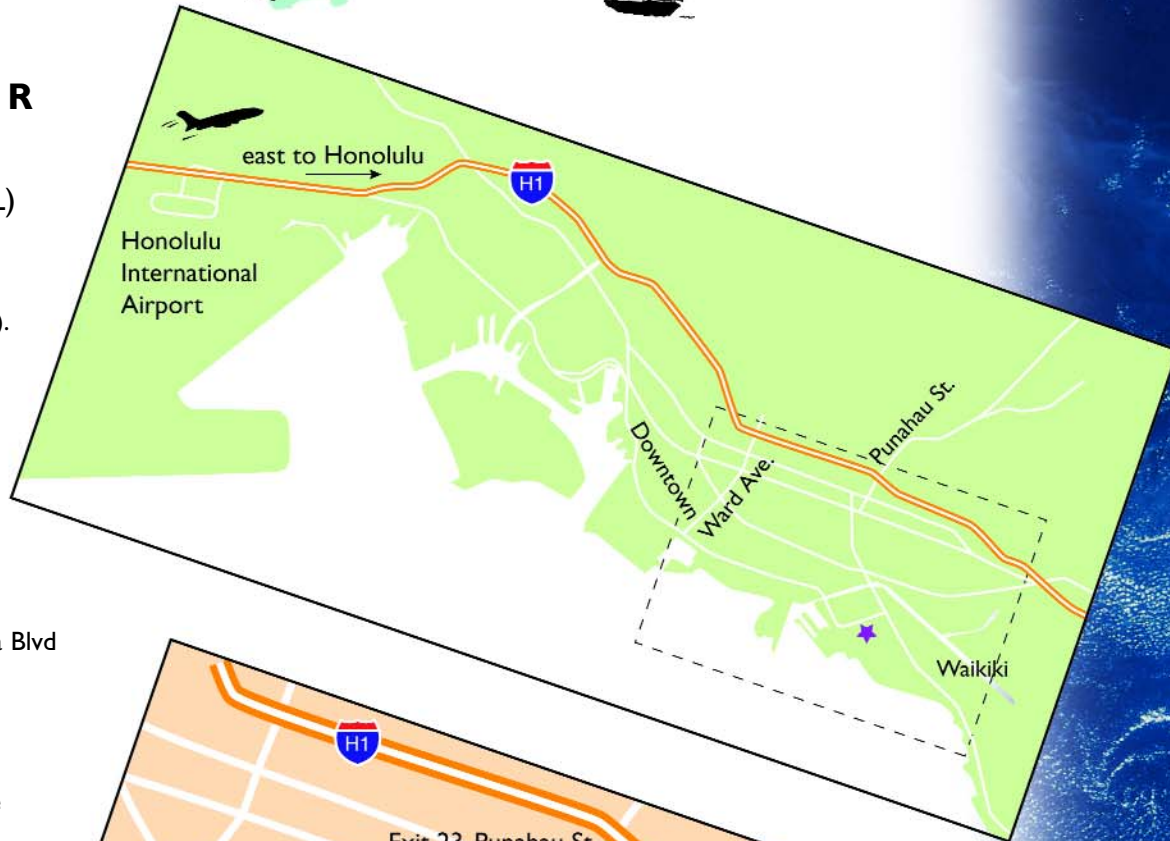
to Kalia Rd (0.2 mi.)

South (left) on Kalia Rd

to HHV entrance (25 yards).

Hilton Hawaiian Village entrance

is on the right.



GPS COORDINATES

For Hilton Lobby:

N 21.282421497 degrees

W 157.837518454 degrees

TRAVEL VIA YACHT

Depart Los Angeles Harbor.

Sail West toward Oahu (2556 mi).

Circle south around Diamond Head (2 mi).

Arrive Ala Wai Boat Harbor next to the Hilton Lagoon.

Walk to lobby (100 yards).

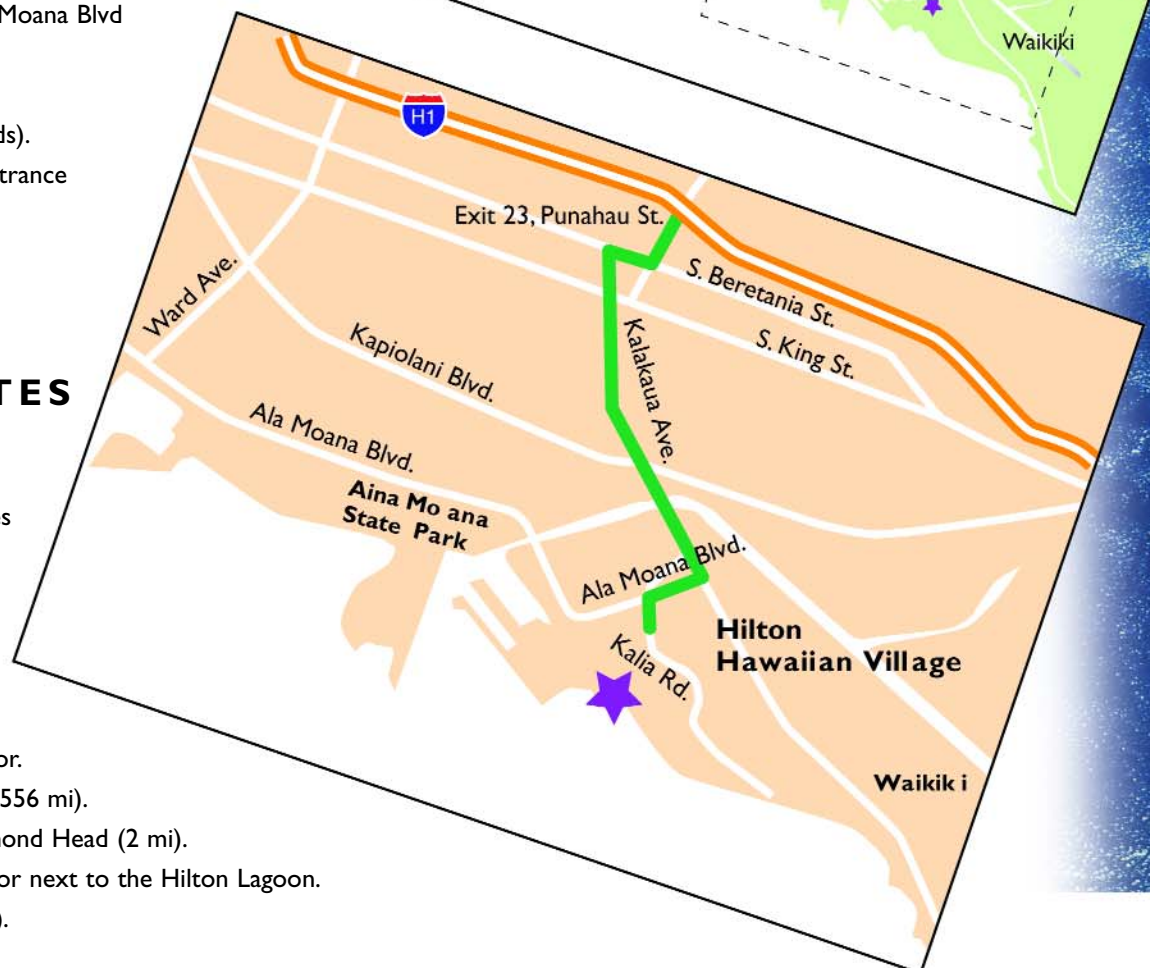


Photo Courtesy of NASA Earth Observatory