

NSREC 2001



VANCOUVER BC

38th Annual International

NUCLEAR AND SPACE RADIATION EFFECTS CONFERENCE

*Vancouver,
British Columbia*

July 16 - 20, 2001

*Sponsored by
IEEE/NPSS Radiation Effects Committee*

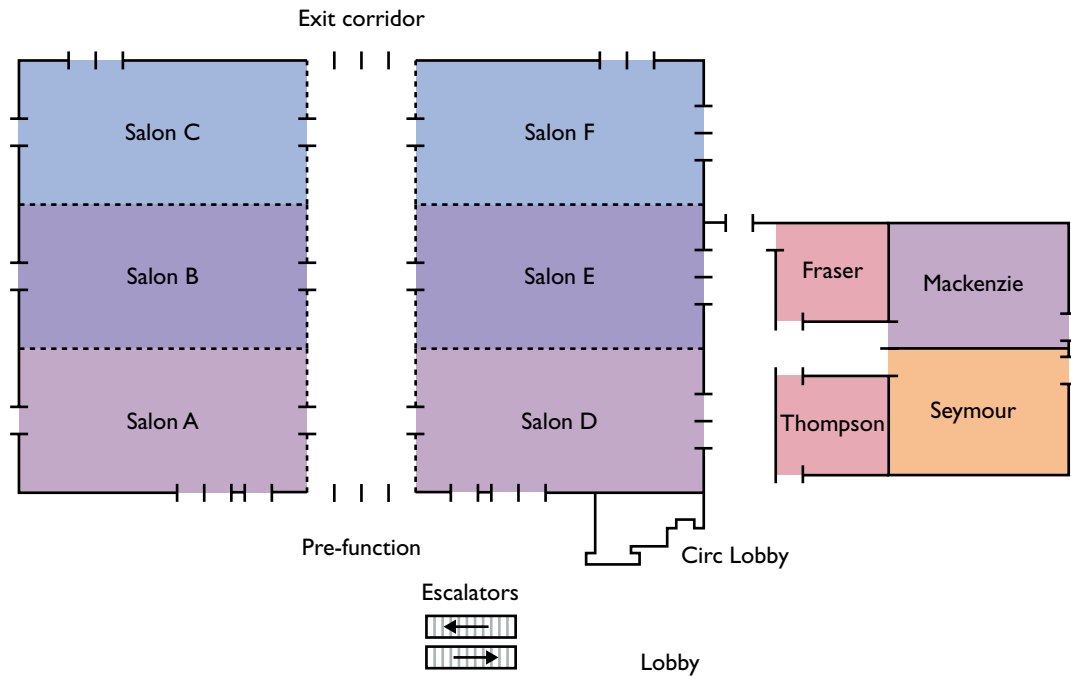
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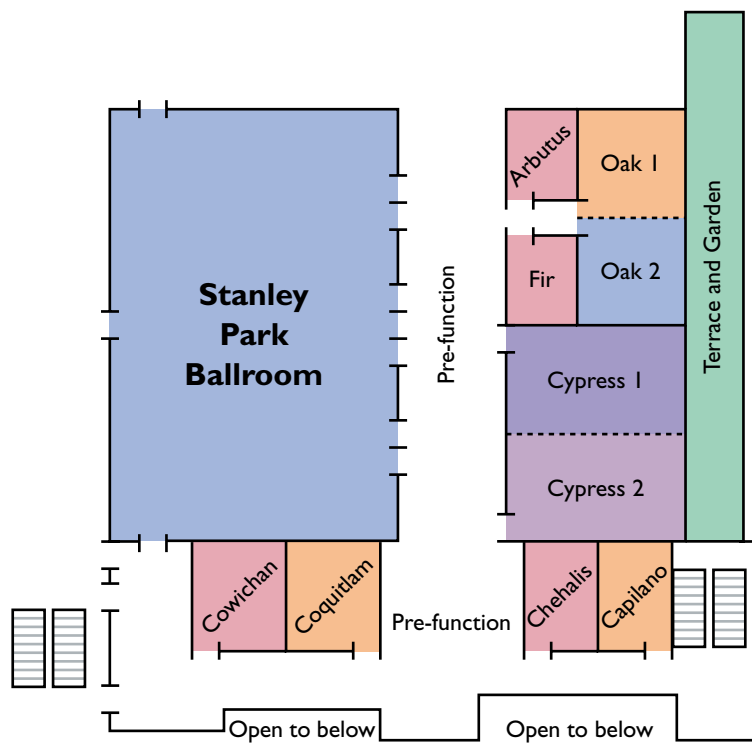
Conference Facilities

LEVEL ONE

Bayshore Grand Ballroom



LEVEL TWO



Schedule

Time	Monday July 16	Tuesday July 17	Wednesday July 18	Thursday July 19	Friday July 20
7:30	[7:30] Continental Breakfast Bayshore Grand Ballroom	[7:30] Continental Breakfast Stanley Park Ballroom	[7:30] Continental Breakfast Stanley Park Ballroom	[7:30] Continental Breakfast Bayshore Grand Ballroom	[7:30] Continental Breakfast Bayshore Grand Ballroom
8:15	[8:15] Short Course Introduction Paul Dodd Bayshore Grand Ballroom	[8:15] Conference Opening Bayshore Grand Ballroom	[8:15] Invited Talk Electric Power Grid Vulnerability to Space Weather John Kappenman	[8:15] Invited Talk Nuclear Astrophysics - Origin of the Elements Alan C. Shotton	[8:15] Invited Talk National Geographic Magazine - Anatomy of a Story Cary Wolinsky
8:30	[8:30] Silicon-On- Insulator Technology: Overview and Device Physics Jean-Pierre Colinge	[8:45] Session A Photonic Devices and Integrated Circuits			
9:00			[9:20] Session D Space and Terrestrial Environments	[9:20] Session F Basic Mechanisms	[9:20] Session H Hardness Assurance
9:30					
10:00	[10:00] Break	[9:50] Break Industrial Exhibits Area	[10:10] Break Industrial Exhibits Area	[10:10] Break	
10:30	[10:30] Silicon-On- Insulator Technology: Radiation Effects Olivier Musseau and Véronique Ferlet-Cavrois	[10:30] Session A (continued)	[10:50] Session D (continued)	[10:40] Session F (continued)	[10:25] Break
11:00					[10:45] Session I Devices and Integrated Circuits
11:30		[11:30] Lunch	[11:35] Lunch	[11:40] Lunch	
12:00	[12:00] Short Course Lunch Bayshore Grand Ballroom				
12:30					[12:20] End of Conference
1:00		[1:00] Session B Single Event Effects, Devices and Integrated Circuits			
1:30	[1:15] Physics and Hardness Assurance for Bipolar Technologies Ronald D. Schrimpf		[1:15] Session E Dosimetry and Facilities	[1:15] Session G Isolation Technologies	
2:00					
2:30					
2:45	[2:45] Break		[2:35] Data Workshop Bayshore Grand Ballroom		
3:00		[2:50] Break Industrial Exhibits Area			
3:30	[3:15] Single-Event Transients in Fast Circuits Steven P. Buchner and Mark P. Baze	[3:30] Session C Single Event Effects, Mechanisms and Modeling			
4:00					
4:30			[4:30] End of Session	[4:30] End of Session	
4:45	[4:45] Wrap-up				
5:00	[5:00] Exam (for students requesting CEU credit only)	[5:05] End of Session		[4:45 to 6:30] Radiation Effects Committee Open Meeting Bayshore Grand Ballroom	
5:30	[5:30] End of Short Course				
6:00			[6:00 to 9:30] Conference Social An Evening on English Bay		
6:30	[6:30 to 10:00] Industrial Exhibits Reception Stanley Park Ballroom and Pre-function Area				
7:00					

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Chairman's Invitation

NSREC 2001



VANCOUVER BC



"I would like to take this opportunity to thank all the volunteers who have donated their precious time to make this Conference one of the premier international Symposia on radiation effects in electronic materials, devices, circuits, and systems."

Marty Shaneyfelt
General Chairman

On behalf of the NPSS Radiation Effects Committee, it is my pleasure to invite you to attend the 38th Annual International IEEE Nuclear and Space Radiation Effects Conference to be held July 16-20, 2001, at the award-winning Westin Bayshore Resort and Marina in Vancouver, British Columbia, Canada. The 2001 Conference will continue the tradition of previous NSRE Conferences by offering an outstanding technical program, a one-day Short Course preceding the technical program, a Radiation Effects Data Workshop, and an Industrial Exhibit. We expect attendance by engineers, scientists, managers, and other interested persons from many nations. Highlights of the Conference are given below; complete details are provided in this booklet. For World Wide Web users, additional information on the conference can be obtained by directing your browser to <http://www.nsrec.com>.

The Technical Program Chairwoman, Janet Barth (NASA Goddard Space Flight Center), and her program committee have put together an exceptional set of contributed papers that have been arranged into nine sessions of oral and poster papers, and a Radiation Effects Data Workshop. The Radiation Effects Data Workshop consists of papers emphasizing radiation effects data on electronic devices and systems and descriptions of new simulation and radiation test facilities. In addition, there are three outstanding invited talks that should be of general interest to attendees and their companions.

The theme of this year's Short Course, organized by Paul Dodd (Sandia National Laboratories), is "Radiation Effects in Advanced Microelectronics: Issues for SOI, Bipolar, and CMOS Technologies." The Short Course will start with a morning devoted to silicon-on-insulator (SOI) technology. This important technology has been used in hardened systems for some time and is finally starting to emerge in the commercial marketplace. The afternoon will focus on radiation effects issues relevant to advanced bipolar and CMOS technologies.

This year's Industrial Exhibit, organized by Darrell Craig (Peregrine Semiconductor) will permit one-on-one discussions between conference attendees and exhibitors on the latest in radiation-hardened electronic devices, radiation analysis and testing services, and radiation test facilities and test equipment. We will kick-off the start of the Industrial Exhibit with a reception on Monday evening for attendees and their guests.

Social events have been planned to give Conference attendees and their guests opportunities to informally discuss radiation effects and to become better acquainted. Joe Benedetto (Aeroflex UPMC), this year's Local Arrangements Chairman, has put together a memorable social program. The highlight of the program will be the Wednesday evening social where attendees and their companions will have the opportunity to take a dinner cruise along English Bay. We strongly encourage you to register as early as possible for the social events as we are limited in the numbers we can accommodate.

Vancouver is situated amidst a magnificent natural harbor and the scenery is dominated by the North Shore Mountains. The weather in July is extremely pleasant. Vancouver and the surrounding area offer an unsurpassed assortment of recreational and cultural attractions for you and your family. As a result, Vancouver is an extremely popular place to visit in July. So do not delay, make your travel arrangements to attend this year's Conference today!

Your 2001 Conference Committee has been busy working to ensure that this Conference will continue to be regarded as one of the most technically beneficial and socially rewarding conferences. We are excited about this year's Conference and look forward to seeing you in Vancouver.

Short Course Program

RADIATION EFFECTS IN ADVANCED MICROELECTRONICS: ISSUES FOR SOI, BIPOLAR, AND CMOS TECHNOLOGIES

BAYSHORE GRAND BALLROOM - MONDAY, JULY 16

- 7:30 AM **REGISTRATION/CONTINENTAL BREAKFAST**
- 8:15 AM **SHORT COURSE INTRODUCTION**
Paul Dodd
Sandia National Laboratories
- 8:30 AM **SILICON-ON-INSULATOR TECHNOLOGY:
OVERVIEW AND DEVICE PHYSICS**
Jean-Pierre Colinge
University of California at Davis
- 10:00 AM **BREAK**
- 10:30 AM **SILICON-ON-INSULATOR TECHNOLOGY:
RADIATION EFFECTS**
Olivier Musseau and Véronique Ferlet-Cavrois
CEA-DIF France
- 12:00 PM **SHORT COURSE LUNCHEON**
- 1:15 PM **PHYSICS AND HARDNESS ASSURANCE FOR
BIPOLAR TECHNOLOGIES**
Ronald D. Schrimpf
Vanderbilt University
- 2:45 PM **BREAK**
- 3:15 PM **SINGLE-EVENT TRANSIENTS IN FAST CIRCUITS**
Steven P. Buchner, *SFA Inc.*
Mark P. Baze, *Boeing Phantom Works*
- 4:45 PM **WRAP-UP**
- 5:00 PM **EXAM** (only for students requesting CEU credit)
- 5:30 PM **END OF SHORT COURSE**
- 6:30 PM **INDUSTRIAL EXHIBITS RECEPTION**
Stanley Park Ballroom and Pre-function Area

Short Course

COURSE DESCRIPTION



"I believe we have an exceptional group of instructors for this year's short course. I encourage you to attend what I am sure will be a most interesting and rewarding day of instruction on radiation effects in advanced microelectronics."

Paul Dodd
Short Course Chairman

The title of the 2001 NSREC Short Course is "Radiation Effects in Advanced Microelectronics: Issues for SOI, Bipolar, and CMOS Technologies." As new technologies and processes are developed and become mainstream for terrestrial applications, insertion into spacecraft systems is desirable to take advantage of performance, power, and density improvements. Unfortunately, these new technologies can bring their own radiation hardness assurance challenges to the systems designer and parts engineer.

The 2001 NSREC Short Course will start with a morning devoted to silicon-on-insulator (SOI) technology. This important technology is finally starting to emerge in the commercial marketplace, with SOI microprocessors shipping today in high-end workstations, and SOI technology expected to be widely used in the near future. This exciting technology also has some unique advantages for operation in radiation environments. In the afternoon we will focus on radiation effects issues relevant to advanced bipolar and CMOS technologies. Enhanced radiation damage in low dose rate environments has been a very active area of research in recent years for bipolar technologies. In some bipolar integrated circuits, total dose failure levels measured at the low dose rate levels encountered in the space environment can be much lower than when measured at typical laboratory dose rates. The increased operating speeds of CMOS technologies may bring new radiation-induced failure modes, and a particular concern is the occurrence of single-event transients in high-speed digital and analog circuits.

Paul Dodd of Sandia National Laboratories, the 2001 NSREC Short Course Chairman, has assembled a highly-qualified team of instructors to address radiation effects in advanced microelectronics. The instructors for this year's short course are Jean-Pierre Colinge (University of California at Davis), Olivier Musseau and Veronique Ferlet-Cavrois (CEA/DIF), Ronald D. Schrimpf (Vanderbilt University), Steven P. Buchner (SFA/NRL), and Mark P. Baze (The Boeing Company). The four short course segments will be one-hour and fifteen minutes in duration, with a fifteen minute question-and-answer period at the end of each segment. A luncheon will be provided for all registered attendees.

CONTINUING EDUCATION UNITS (CEUs)

Attendees desiring to obtain continuing education credits may choose to take an exam following the Short Course. As in previous years successful completion of the Short Course exam will earn an attendee 0.6 CEUs endorsed by the IEEE and the International Association for Continuing Education and Training (IACET). The IEEE is an authorized CEU sponsor member of the IACET. IEEE guidelines for offering CEU credits will be followed. Thus, to qualify for CEU credit a person must be a registered attendee of the Short Course and pass a written examination with a score of 75% or more. The examination will be provided immediately after the last segment of the Short Course, be open book, and consist of about 20 multiple choice questions based on the material presented at the Short Course. A certificate of completion will be mailed to all who qualify.

Short Course Monday



Jean-Pierre Colinge was born in Brussels, Belgium, in 1956. In 1980, he received B.S. degrees in Philosophy and Electrical Engineering, and in 1984 he received a Ph.D. degree in Applied Sciences from the Université Catholique de Louvain, Louvain-la-Neuve, Belgium. From 1981 to 1985, he worked at the Centre National d'Études des Telecommunications (CNET), Meylan, France, the Hewlett-Packard Laboratories, Palo Alto, CA, and IMEC, Leuven, Belgium. In 1991, Dr. Colinge became a professor at the Université Catholique de Louvain, leading a research team in the field of SOI technology for low-power, radiation-hard, high-temperature and/or RF applications. He is presently a professor at the University of California at Davis and conducts research on sub-100 nm SOI devices. He has served on the committees of several conferences, including the IEDM and the SSDM, and was general chairman of the IEEE SOS/SOI Technology Conference in 1988. Dr. Colinge is a Fellow of the IEEE, and a member of the ECS. He has published over 220 scientific papers and three books on SOI.

SILICON-ON-INSULATOR TECHNOLOGY: OVERVIEW AND DEVICE PHYSICS

Jean-Pierre Colinge

University of California at Davis

Jean-Pierre Colinge will cover the basics of SOI transistor design, device physics, and substrate types to bring us all up to speed on what "makes SOI tick." This course will begin with an introduction and overview of current and soon-to-be available SOI integrated circuits. The different substrate materials that may be used for SOI technologies will be covered next, followed by SOI MOSFET structures and device considerations. Novel transistor structures will be discussed, and finally SOI circuits will be covered, including the unique performance and power advantages that are making SOI an attractive choice for advanced commercial technologies.

Introduction

SOI Substrates

- Silicon-on-Sapphire
- SIMOX
- Wafer Bonding and Etchback
- UNIBOND Material

The SOI MOSFET

- Source and Drain Capacitance
- Fully-Depleted vs. Partially-Depleted MOSFETs
- Threshold Voltage
- Body Effect
- Output Characteristics
- Reduced Transconductance
- Subthreshold Slope
- Microwave MOSFETs

Novel SOI MOSFET Structures

- Bipolar-MOS Hybrid Device
- Dual-Gate MOSFET
- Ground-Plane MOSFET
- Multiple-Gate and Wrapped-Gate MOSFETs

SOI Circuits

- High-Temperature Circuits
- Low-Voltage, Low-Power Circuits
- SRAMs and DRAMs

Conclusion



Olivier Musseau graduated from the Ecole Supérieure d'Electricité in 1985. In 1986 he joined the Commissariat à l'Energie Atomique (CEA) in the Centre d'Etudes de Bruyères le Châtel, and carried out research work on radiation effects on microelectronic devices. In 1991 he was awarded the degree of "Docteur en Science" from the University of Paris XI for his work on heavy ion effects in integrated devices. In 1994 he received the "Grand Prix de l'Electronique Général FERRIE", from the SEE, for his work on radiation hardening of electronic components. At CEA he manages a group in charge of R&D to ascertain radiation hardening of electronic and optoelectronic devices. His activities include research on the physical mechanisms of radiation interaction with insulating and semiconducting materials for the development of microelectronic CMOS/SOI technologies.



Véronique Ferlet-Cavrois graduated from l'Ecole Nationale Supérieure d'Electronique et de Radioelectricité de Grenoble (ENSERG, France) in 1990. She joined the Commissariat à l'Energie Atomique (CEA), Centre d'Etude de Bruyères-le-Châtel, in 1991, and worked on radiation effects on several generations of SOI technologies, from 0.8 μm to 0.25 μm , for military and space applications. She has been involved in dose, dose rate and heavy ion hardening of both commercial and radiation-hardened devices with simulation and experimental studies. She also works on high frequency modeling of CMOS/SOI technologies. Her current research interests are the electrical and hardening characterizations of an advanced 0.12-0.1 μm SOI technology dedicated to either low-power, low-voltage, or high performance digital applications, and the impact of device scaling on radiation effects. Véronique Ferlet-Cavrois is the author or co-author of more than 30 papers. She received the Outstanding Paper Award at the 1999 RADECS conference.

SILICON-ON-INSULATOR TECHNOLOGY: RADIATION EFFECTS

Olivier Musseau and Véronique Ferlet-Cavrois
CEA-DIF France

With a solid background on SOI operation in normal environments behind us, Olivier Musseau and Véronique Ferlet-Cavrois will cover the specifics of radiation effects in SOI devices and circuits. Over the last thirty years SOI technologies have been developed for the purpose of radiation-hardened military and space applications. Many efforts have been made to optimize these structures and very high levels of radiation hardness have been achieved. They will analyze the radiation hardness of various SOI technologies by taking into account the physical and the electrical structure of the elementary devices. It will be shown that some basic concepts of radiation hardness have to be revisited in order to deal with future nanometer-scale technologies.

Introduction

SOI Transistors

- Partially vs. Fully-Depleted
- Thick-Film SOI Transistors
- Other SOI Technologies

Total-Dose Effects

- Parasitic MOS Structures
- Lateral MOS Transistors
- DTMOS Transistors
- Fully-Depleted Transistors
- Total-Dose-Induced Latch
- The Buried MOS Transistor
- Sensitivity of the Buried Oxide
- A Design Solution: Body Ties
- Radiation Hardness Assurance

Dose-Rate Effects

- Comparison with SEE
- Comparison with CMOS/Bulk
- Behavior of BTS Transistors
- Dose-Rate Effects in SOI Circuits

Single-Event Effects

- Charge Collection in Transistors
- Modeling Single-Event Upset
- Review of SEU Data

Future Trends

- Scaling of SOI Technologies
- Dual Use of SOI Technologies
- Limits of Standard Concepts

Conclusion



Ron Schrimpf received his B.E.E., M.S.E.E., and Ph.D. degrees from the University of Minnesota in 1981, 1984, and 1986, respectively. He joined the University of Arizona in 1986, where he served as Assistant Professor, Associate Professor, and Professor of Electrical and Computer Engineering. Ron has been a Professor of Electrical Engineering at Vanderbilt University since 1996. His research focuses on radiation effects and reliability in semiconductor devices, including low-dose-rate effects in bipolar transistors, single-event effects in power devices, and development of TCAD tools for radiation effects and reliability. Ron is currently Executive Vice Chairman of the IEEE Radiation Effects Steering Group. He recently served as General Chairman of the 1999 IEEE Nuclear and Space Radiation Effects Conference (NSREC) and previously served the NSREC as Technical Program Chairman, Guest Editor, and Session Chairman. He also has served on the Technical Program Committees of the IEEE International Electron Devices Meeting (IEDM) and IEEE Bipolar/BiCMOS Circuits and Technology Meeting (BCTM). Ron was elected a Fellow of the IEEE in 2000; he received the IEEE Nuclear and Plasma Sciences Society (NPSS) Early Achievement Award in 1996; and he received the IEEE Nuclear and Space Radiation Effects Conference Outstanding Paper Award in 1991, 1996, and 1998.

PHYSICS AND HARDNESS ASSURANCE FOR BIPOLAR TECHNOLOGIES

Ronald D. Schrimpf
Vanderbilt University

The third session will cover radiation effects and hardness assurance issues for advanced bipolar technologies. This segment of the short course will begin with the motivation for usage of bipolar transistors and a quick glance at some recent issues with respect to radiation effects. The basic principles of bipolar junction transistor (BJT) operation will be presented, followed by a brief look at the characteristics of current bipolar technologies. Ron will then delve into the details of total-dose-induced gain degradation mechanisms in BJTs, and enhanced low-dose-rate sensitivity (ELDRS) effects in bipolar technologies. The session will conclude with a look at hardness assurance techniques and circuit-level issues specific to bipolar technologies.

Introduction

Basic Principles of BJT Operation

- Basic Structure and Bias Conditions
- Carrier Injection, Transport, and Transistor Action
- Current Components and Current Gain
- Gummel Number
- Heterojunction Bipolar Transistors
- Transconductance

Practical BJT Devices

- Conventional npn BJTs
- Vertical, Lateral, and Substrate pnp BJTs
- Advanced Devices

Total-Dose-Induced Gain Degradation

- Charge Generation, Transport, and Trapping
- Recombination and Excess Base Current
- Mechanisms and Models

Enhanced Low-Dose-Rate Sensitivity (ELDRS)

- Overview and Early Observations
- Base Current vs. Dose Rate
- Physical Models
- Space Effects

Hardness Assurance Methods

- Low-Dose-Rate Testing
- Elevated-Temperature Testing
- Two-Pulse Testing
- Test Recommendations

Circuit-Level Issues

- Transistor-Level vs. Circuit-Level Effects
- Compensating Effects

Conclusions

Short Course Monday



Steven P. Buchner is currently an employee of SFA Inc. and is assigned to the Naval Research Laboratory where he has been working in the field of radiation effects since 1993. His main interest is in understanding the origins of single event transients in electronic and optoelectronic circuits using tools such as ion accelerators, pulsed laser light, and circuit/device modeling programs. Prior to his current assignment, he was a senior research scientist at the former Martin Marietta Laboratories where he did research in the fields of radiation effects and infrared detectors. He has been a session chairman for both NSREC and RADECS and regularly reviews articles submitted to these conferences and to the IEEE Transactions on Nuclear Science. He holds physics degrees from Princeton University (A.B.) and the University of Pennsylvania (M.Sc. and Ph.D.).



Mark P. Baze received a Bachelor of Science in Physics in 1973 from Washington State University. He subsequently joined Boeing's Physics Technology Group. His work at Boeing has included radiation shield design, hardness assurance testing, development of laser simulation techniques for dose rate effects, total dose effects studies, single event modeling for large scale circuits, and single event hardening. He currently works in Boeing's ASIC design group specializing in radiation effects modeling hardening, and test structure design.

SINGLE-EVENT TRANSIENTS IN FAST CIRCUITS

Steven P. Buchner, *SFA Inc.*

Mark P. Baze, *Boeing Phantom Works*

This segment of the course will begin with a discussion of the mechanisms responsible for single-event transients (SETs) including their generation, propagation, attenuation, transmission and capture. Specific examples will be provided for digital, analog and optoelectronic circuits. The origins of the frequency dependence, a salient feature of single-event transients, will be discussed. Accelerator testing will be described with special emphasis on the unique approaches taken. In addition, the roles of laboratory tools, such as pulsed laser light and radioactive sources, for generating single-event transients will be discussed. Issues associated with modeling transients in large and complex circuits will also be covered. Attempts to harden circuits against single-event transients will be described. Finally, the instructors will use their cloudy crystal ball to take a peek at the future of single-event transient generation, testing, modeling and hardening.

Introduction

Background

- Definition of SETs
- Comparison with SEUs
- SETs in Digital and Analog Circuits

Mechanisms Leading to SETs

- Charge Generation
- Voltage Transients
- SET Propagation
- SET Sampling

Testing for SETs

- Accelerator and Pulsed Laser Testing
- Radioactive Sources
- Digital Circuits
- Analog Circuits

Modeling

- Commercial vs. Custom Tools
- Applications of Tools and Methods

Hardening Approaches for SETs

- Process Selection
- Circuit Level Hardening
- Error Tolerant Architectures
- Analog and Optoelectronics

Future Trends

- Technology and Scaling
- Testing
- Modeling
- Hardening

Conclusions

Technical Program

TECHNICAL INFORMATION



"NSREC 2001 authors will present oral and poster papers reporting on the most recent research results in the areas of nuclear and space radiation effects. Poster papers in our Data Workshop will also provide radiation response data and testing information for scientists, engineers, and system designers."

Janet Barth
Technical Program Chairwoman

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 three minutes for questions. The Technical Sessions and chairpersons are:

- **Space and Terrestrial Environments**
Chairs: Stuart Huston, Boeing Phantom Works and Kay Jobe, Boeing Satellite Systems
- **Photonic Devices and Integrated Circuits**
Chair: Joe Peden, SAIC
- **Isolation Technologies**
Chair: Ronald Smeltzer, Sarnoff Corporation
- **Single Event Effects, Mechanisms and Modeling**
Chair: Dale McMorrow, Naval Research Laboratory
- **Single Event Effects, Devices and Integrated Circuits**
Chair: Gary Lum, Lockheed Martin Missiles and Space Co.
- **Basic Mechanisms**
Chair: Dan Fleetwood, Vanderbilt University
- **Devices and Integrated Circuits**
Chairs: Ray Ladbury, Orbital Sciences Corporation and Eric Heijne, CERN
- **Hardness Assurance**
Chair: Tom Turflinger, NAVSEA Crane
- **Dosimetry and Facilities**
Chair: Laurent Dusseau, Université Montpellier II

POSTER SESSION

Papers that are most effectively presented visually with group discussion will be displayed from 12:00 PM Tuesday, July 17 through 12:00 PM Friday, July 20. Authors will be available to discuss their work during the Poster Session Thursday, July 19. The poster chair is Jim Schwank, Sandia National Laboratories.

RADIATION EFFECTS DATA WORKSHOP

Papers in the workshop are intended to provide radiation response data to scientists and engineers who use electronic devices in a radiation environment, and to designers of radiation-hardened systems. Workshop posters can be previewed from 12:00 PM Tuesday, July 17 through 12:00 PM Friday, July 20. Authors will be available to discuss their work during the Data Workshop Session Wednesday, July 18. A copy of the Workshop Record will be mailed to all registered attendees after the conference. The workshop chair is Nick van Vonno, Intersil Corporation.

INVITED SPEAKERS

Cary Wolinsky is a National Geographic author and photographer with over 30 years of experience. He will give a fascinating talk about the anatomy of a National Geographic story including photos from Australia and space. John Kappenman of METATECH Corporation will talk on solar storm effects on power grid systems and aircraft. Alan Shotter, the new director at Canada's TRIUMF Laboratory for Nuclear and Particle Physics, has tentatively agreed to give a stimulating technical presentation on the origin of elements.

LATE-NEWS PAPERS

A limited number of late-news papers will be accepted and included in the Poster Session or the Radiation Effects Data Workshop. The deadline for submitting late-news papers is June 1, 2001. Please submit late-news summaries using the 4-page summary and 35-word abstract format to the Technical Program Chairwoman, Janet Barth, NASA Goddard Space Flight Center, Code 562.1, Greenbelt, MD 20771, 301-286-8046. Additional information on submission of late-news summaries can be found at www.nsrec.com.

Technical Program Tuesday

8:15 AM BAYSHORE GRAND BALLROOM OPENING REMARKS
Marty Shaneyfelt, Sandia National Laboratories

8:20 AM AWARDS PRESENTATION
Dale G. Platteter, Radiation Effects Steering Group Chairman

8:40 AM TECHNICAL SESSION OPENING REMARKS
Janet Barth, NASA Goddard Space Flight Center

SESSION A PHOTONIC DEVICES AND INTEGRATED CIRCUITS

8:45 AM SESSION INTRODUCTION
Chair: Joe Peden, SAIC

A-1 Proton Damage in Advanced Laser Diodes
8:50 AM *A. H. Johnston, T. F. Miyahira, B. G. Rax, Jet Propulsion Laboratory*

Proton damage is investigated for six types of laser diodes with wavelengths ranging from 650 to 1550 nm, including a vertical-cavity surface emitting laser. Damage in internal monitor diodes is evaluated, along with recombination-enhanced annealing.

A-2 Correlation of Proton Radiation Damage in InGaAs/GaAs Quantum Well Light Emitting Diodes
9:05 AM *R. J. Walters, U.S. Naval Research Laboratory; S. R. Messenger, SFA Inc.; G. P. Summers, U.S. Naval Research Laboratory and University of Maryland; E. A. Burke, Consultant; S. M. Khanna, D. Estan, L. S. Erhardt, Defense Research Establishment Ottawa; H. C. Liu, M. Gao, M. Buchanan, Institute of Microstructural Sciences, National Research Council; A. J. SpringThorpe, Nortel Microelectronics, Nortel Networks; A. Houdayer, University of Montreal; C. Carlone, University of Sherbrooke*

The effects of proton irradiation at energies ranging from 1 up to 500 MeV on InGaAs/GaAs QW LEDs are studied. Degradation data are correlated to the nonionizing energy loss (NIEL), and the device damage mechanisms are studied.

A-3 2 MeV Proton Radiation Effects on the Spectrum of Blue Gallium Nitride Light Emitting Diodes
9:20 AM *F. Gaudreau, C. Carlone, University of Sherbrooke; A. Houdayer, University of Montreal; S. M. Khanna, Defense Research Establishment Ottawa*

The electroluminescence of CREE model C430-DH85 diodes is the sum of the band to band transition at 430 nm and a parasitic yellow band. The respective 2 MeV proton radiation damage constant is $(7 \pm 1) \times 10^{-14} \text{ cm}^{-2}$ and $(2.0 \pm 0.4) \times 10^{-14} \text{ cm}^{-2}$.

A-4 Response of 100% Internal Carrier Collection Efficiency Silicon Photodiodes to 1 keV to 60 keV Ions
9:35 AM *H. O. Funsten, S. M. Ritzau, R. W. Harper, Los Alamos National Laboratory; R. Korde, International Radiation Detectors Inc.*

Responsivity of silicon EUV photodiodes to 1-60 keV ions decreases with increasing mass and decreasing energy and is dependent on nuclear energy loss in the device. Detectors with nitrided oxide show 3.4 times the radiation hardness of non-nitrided detectors.

9:50 - 10:30 AM BREAK - INDUSTRIAL EXHIBITS AREA

Technical Program Tuesday

A-5
10:30 AM **Proton-Induced CCD Charge Transfer Degradation at Low Operating Temperatures**

G. R. Hopkinson, Sira Electro-Optics Ltd

Measurements of CTI at CCD temperatures $\sim -100^{\circ}\text{C}$ show that proton-induced E-centers can be kept filled but other traps with energies 0.22-0.34 eV limit the achievable improvement in CTI. Implications for space borne astronomical instruments are discussed.

A-6
10:45 AM **Design and Characterization of Radiation Tolerant CMOS APS Image Sensors Up to 30 Mrad (Si) Total Ionizing Dose**

E. Eid, T. Chan, E. R. Fossum, Photobit Technology Corporation; R. H. Tsai, Photobit Corporation; R. Spagnuolo, J. Deily, NASA Goddard Space Flight Center; W. B. Byers Jr., J. C. Peden, Scientific Applications International Corporation

Radiation hardening design techniques were applied to a CMOS APS imager in a 0.35- μm standard process. The γ -ray irradiation data demonstrated that the imager is tolerant to Mrad (Si) total dose levels of ionizing radiation.

A-7
11:00 AM **A Comparison of Charge Transfer Efficiency Measurement Techniques on Proton Damaged n-Channel CCDs for the HST Wide Field Camera 3**

A. Waczynski, E. Polidan, S. D. Johnson, G. Delo, Global Science and Technology; P. Marshall, Consultant; R. Reed, NASA Goddard Space Flight Center; R. J. Hill, E. Wassell, Raytheon ITSS

We examine proton-damaged CCDs and compare the Charge Transfer Efficiency (CTE) degradation using the Extended Pixel Edge Response, First Pixel Response, and the ^{55}Fe x-ray measurements. CTEs measured on Marconi and BAE CCDs are compared.

A-8
11:15 AM **Low Angle Scattering of Protons on the XMM-Newton Mirror Shells and Effects on the On-Board CCD Detectors**

R. Nartallo, H. Evans, Rhea System SA and ESA-ESTEC; E. Daly, P. Nieminen, ESA-ESTEC; F. Lei, P. Truscott, Space Department, DERA

The propagation of protons through x-ray telescope mirrors by grazing incidence scattering processes has been modeled with Geant4. Protons reaching CCD detectors induce a radiation background the non-ionizing dose can cause degradation of the Charge Transfer Efficiency.

POSTER PAPERS

PA-I **Modeling of the Dark Signal Non Uniformity and Dark Signal Spikes in Proton Irradiated CCDs using Monte Carlo Techniques**

M. S. Robbins, B. Hadwen, Marconi, Applied Technologies Limited

Monte Carlo methods have been used to simulate the dark signal distribution in proton irradiated charge coupled devices, including field enhancement effects. Resultant distributions agree with measurement provided clustering of the generating centers is assumed.

11:30 - 1:00 PM LUNCH

Technical Program Tuesday

SESSION B SINGLE EVENT EFFECTS, DEVICES AND INTEGRATED CIRCUITS

1:00 PM SESSION INTRODUCTION

Chair: Gary Lum, Lockheed Martin Missiles and Space Co.

B-1 Single-Event Upset in the Power PC750 Microprocessor

1:05 PM *G. M. Swift, S. M. Guertin, F. Farmanesh, F. Irom, Jet Propulsion Laboratory;
D. G. Millward, Millward Associates*

Proton and heavy ion upset susceptibility has been measured for six types of storage elements in the Motorola Power PC750 using two test methods. Compared to earlier PPC603 results, the upset susceptibility has decreased.

B-2 Complex SEU Signatures in High-Speed Analog-to-Digital Conversion

1:20 PM *W. F. Heidergott, J. Hockmuth, N. Kha, C. Hammond, Motorola Inc.;
R. Ladbury, Orbital Sciences Corporation; P. W. Marshall, Consultant;
S. Buchner, SFA Inc.; A. B. Campbell, Naval Research Laboratory;
R. A. Reed, NASA Goddard Space Flight Center; C. Seidleck, Raytheon ITSS*

The complex single-event upset signatures produced by high-speed analog-to-digital converter devices are analyzed to establish magnitude, duration, and pattern characteristics. Event cross-section and histograms are used to support rate prediction and system effects analysis.

B-3 Modeling of Single Event Effects in Circuit-Hardened High-Speed SiGe HBT Logic

1:35 PM *G. Niu, R. Krithivasan, J. D. Cressler, Auburn University; P. Marshall, Consultant;
C. Marshall, R. Reed, NASA Goddard Space Flight Center;
D. L. Harame, IBM Microelectronics*

This paper presents SEE circuit modeling results in circuit-hardened SiGe HBT logic circuits. The SEE sensitivity of a D flip-flop is simulated as a function of LET, substrate doping level, and current path configuration.

B-4 Dependence of Comparator Single Event Transient Node Sensitivity on External Circuit Parameters

1:50 PM *A. L. Sternberg, L. W. Massengill, R. D. Schrimpf, Vanderbilt University;
P. Calvel, Alcatel Space Industries*

The nodes most sensitive to single event transients in linear bipolar circuits are not fixed. This paper describes a situation where the most sensitive transistor in the LM111 comparator is a function of external load capacitance.

B-5 Design and Testing of an SEE-Hardened LM139 Quad Comparator

2:05 PM *N. W. van Vonno, B. R. Doyle, Intersil Corporation*

We describe design considerations and SEE testing results of a hardened quad comparator equivalent to the standard LM139. The device uses redundancy and hardened process technology to achieve improved SET performance and elimination of SEL.

Technical Program Tuesday

- B-6** **Impact of Substrate Thickness on the SEU and SEL Response of ICs**
2:20 PM *P. E. Dodd, M. R. Shaneyfelt, F. W. Sexton, P. S. Winokur, Sandia National Laboratories;
E. Fuller, Novus Technologies*

The effects of substrate and epitaxial layer thickness on the SEU and SEL response of ICs are studied. Reducing substrate and epitaxial layer thickness can be an effective method for improving SEU and SEL immunity.

- B-7** **An Improved Stripe-Cell SEGR Hardened Power MOSFET Technology**
2:35 PM *M. Savage, J. L. Titus, NAVSEA Crane; D. Burton, J. Gillberg, Fairchild Corporation;
C. F. Wheatley, Consultant*

A new SEGR radiation-hardened, power MOSFET is reported here. It is based upon a well-established radiation-hardened technology described in 1996. The hexagonal cells used in prior work are replaced with a stripe-cell structure producing demonstrated performance improvements.

POSTER PAPERS

- PB-1** **Proton Effects of a Commercial Video Controller for ISS**
*G. K. Lum, L. Robinette, Lockheed Martin Missiles and Space Co.;
A. Howard, NASA Ames Research Center*

Results of proton single event effects of a commercial video controller and CCD and the possible hardening techniques to reduce the effects of catastrophic failure are discussed.

- PB-2** **Analog and Digital Single Event Effects Experiments in Space**
*S. H. Crain, R. Koga, The Aerospace Corporation;
R. B. Katz, NASA Goddard Space Flight Center*

Field programmable gate arrays and operational amplifiers experience single event upset (SEU) in ground-based testing. The data collected on these devices on two experiment boards on the Microelectronics and Photonics Test Bed (MPTB) are presented here.

- PB-3** **Latchup in CMOS Analog-to-Digital Converters**
T. F. Miyahira, A. H. Johnston, Jet Propulsion Laboratory

Latchup is evaluated in advanced A-D converters with many different latchup paths, some of which are catastrophic. Thermal imaging is used to measure surface temperature and determine sensitive regions. Revised test methods are made for characterization.

- PB-4** **An SEU-Hard Flip-Flop for Antifuse FPGAs**
*R. Katz, NASA Goddard Space Flight Center; J. J. Wang, J. McCollum, B. Cronquist,
R. Chan, D. Yu, Actel Corporation; I. Kleyner, Orbital Sciences Corporation*

An SEU-hardened flip-flop has been designed and developed for antifuse FPGA application. Design and application issues, testability, test methods, simulation and results are discussed.

2:50 - 3:30 PM **BREAK - INDUSTRIAL EXHIBITS AREA**

Technical Program Tuesday

SESSION C

3:30 PM

SINGLE EVENT EFFECTS, MECHANISMS AND MODELING

SESSION INTRODUCTION

Chair: Dale McMorrow, Naval Research Laboratory

C-1

3:35 PM

Heavy-Ion-Induced Breakdown in Ultra-Thin Gate Oxides

L. W. Massengill, B. K. Choi, D. M. Fleetwood, R. D. Schrimpf, Vanderbilt University; M. R. Shaneyfelt, T. L. Meisenheimer, P. E. Dodd, J. R. Schwank, Sandia National Laboratories; Y. M. Lee, R. S. Johnson, G. Lucovsky, North Carolina State University

We present experimental results on single-event-induced breakdown in sub-5 nm plasma-enhanced SiO₂ and Al₂O₃ dielectrics typical of current and next-generation commercial gate oxides. These advanced oxides are found to be quite breakdown resistant.

C-2

3:50 PM

Heavy Ion Induced Soft Breakdown of Thin Gate Oxides

J. F. Conley, Jr., A. H. Johnston, T. Miyahara, Jet Propulsion Laboratory; J. S. Suehle, E. M. Vogel, National Institute of Standards and Technology; B. Wang, University of Maryland

Heavy ion induced soft and hard breakdown are investigated in thin gate oxides as a function of LET, fluence, and voltage applied during irradiation. Post-irradiation oxide conduction is well described by the Suñé quantum point contact model.

C-3

4:05 PM

Ion Induced Stuck Bits in SDRAM Cells

L. D. Edmonds, S. M. Guertin, L. Z. Scheick, D. Nguyen, G. M. Swift, Jet Propulsion Laboratory

Experimental evidence of a linear trend in stuck bits in SDRAM memory cells justifies the use of traditional SEE rate calculation methods for this type of device.

C-4

4:20 PM

SEU Induced by Pions in Memories from Different Generations

S. Duzellier, D. Falguere, ONERA-DESP; M. Tverskoy, E. Ivanov, PNPI; R. Dufayel, M-C. Calvet, EADS Launch Vehicles

SEU cross-sections obtained with pions for a set of SRAMs/DRAMs from different generations are reported. An attempt to predict the device sensitivity to pions is made. The calculated rates are presented and discussed.

C-5

4:35 PM

SEE Analysis of Digital InP-based HBT Circuits at Gigahertz Frequencies

T. R. Weatherford, P. K. Schiefelbein, Naval Postgraduate School

Dynamic simulation of 10 GHz InP-based HBT devices is investigated for single event effects. Results provide an understanding where photocurrents exist and how the HBT saturates. A technique for single event hardening is demonstrated with computer simulation.

C-6

4:50 PM

First-Principles Calculations of the SEU Cross Section Curve for CMOS SRAMs

P. E. Dodd, M. R. Shaneyfelt, K. M. Horn, D. S. Walsh, J. R. Schwank, P. S. Winokur, Sandia National Laboratories

We present upset maps and cross section curves calculated directly from 3D simulations with no prior assumptions of the sensitive area. Soft error trends are compared for bulk-Si and SOI CMOS memories.

Technical Program Tuesday

POSTER PAPERS

PC-1 Analytical Microdosimetry Model for Proton Induced SEU in Modern Devices

J. Barak, Soreq NRC

Analytical expressions are derived for the probability of having a secondary ion with a given LET value following a p+Si nuclear event. Proton induced SEU cross sections are calculated by integrating this probability with the heavy ion cross section.

PC-2 Simulation of Multiple Upsets Rate Induced by Nucleons - Device Downscaling Effect

*F. Wrobel, J-M. Palau, CEM2, Université Montpellier II;
M-C. Calvet, EADS Launch Vehicles; O. Bersillon, H. Duarte, CEA*

A simplified 128 x 128 bit structure is used to derive soft error rates induced by high-energy nucleons (n/p). MBU and SEU rates are compared, and trends associated with downscaling are presented.

PC-3 Detailed Analysis of Secondary Ion Effect for the Calculation of Neutron-Induced SER in SRAMS

*G. Hubert, J-M. Palau, K. Castellani-Coulie, Université Montpellier II;
M-C. Calvet, EADS Launch Vehicles; S. Fourtine, EADS-Airbus*

A new method of neutron soft error rate (SER) calculation derived from device simulations and nuclear physics results is presented. Inputs are only a critical LET, a critical charge, and layout dimensions. No sensitive volume size is needed.

PC-4 Various SEU Conditions in SRAM Studied by 3-D Device Simulation

*K. Castellani-Coulie, J-M. Palau, G. Hubert, Université Montpellier II;
M-C. Calvet, EADS Launch Vehicles*

Various SEU conditions are studied by 3-D device simulation with the aim of going deeply into the sensitive region approach. The results suggest that some generally accepted notions must be revised.

PC-5 Single Event Charge Collection Simulations Using Passive Loads Extracted From Circuit-Level Modeling

J. K. Shreedhara, L. W. Massengill, Vanderbilt University

An engineering method for device-level single-event charge collection simulations using finite-element modeling and passive loading is presented. Composite passive loads are extracted from circuit-level simulations incorporating well-established compact models.

5:05 PM END TUESDAY SESSIONS

Technical Program Wednesday

INVITED TALK

8:15 - 9:15 AM

Electric Power Grid Vulnerability to Space Weather

John Kappenman, METATECH Corporation

Since the turn of the century, society has relied heavily on electricity for meeting essential needs. Three large, interconnected grids that span the North American continent provide rapid response to the diverse energy demands of users in the United States and Canada. This unique energy service requires coordination of electrical supply, demand, and delivery – all occurring at the speed of light. The sprawling North American grid resembles a large antenna, attracting electrical currents induced by giant solar storms. During severe space weather conditions, these solar storms have the potential to cause large-scale blackouts in North America by disrupting transmission grid operations. The disruptions can literally occur any time over the entire 11-year solar cycle. Mr. Kappenman will describe how accurate forecasts of a storm's onset, duration, and magnitude are achieved using satellite technology. Included will be a discussion on why power grids are increasingly vulnerable to economic and natural forces.

John G. Kappenman joined METATECH in 1998 as the Manager of their Applied Power Solutions Division. He directs the development of products, services, and consulting that are provided to clientele worldwide, primarily focusing on Lightning and Space Weather impacts on electric utilities. He has been an active researcher in power delivery technologies, and his primary engineering contribution has been his research work on lightning and magnetic storms and their disruptive effects on electric power systems. He led a utility industry effort to deploy a monitoring satellite that would provide advanced warnings of geomagnetic storms (launched by NASA in August 1997). He has also been a collaborator with EPRI and Global Atmospherics on the development and application of the Fault Analysis and Lightning Location System that will allow economic Location-Centered mitigation of lightning to transmission networks. He is a Senior Member of the IEEE and the Power Engineering Society, and is the Past Chairman of the Transmission and Distribution Committee (1994-1996). In February 1997, Mr. Kappenman provided presentations to the US Presidents' Commission on Critical Infrastructure Protection on the Potential Impact of Geomagnetic Storms on Electric Power System Reliability.

SESSION D

9:20 AM

SPACE AND TERRESTRIAL ENVIRONMENTS

SESSION INTRODUCTION

Chairs: Stuart Huston, Boeing Phantom Works and Kay Jobe, Boeing Satellite Systems

D-1

9:25 AM

Monte-Carlo Calculations of the Influence on Aircraft Radiation Environments of Structures and Solar Particle Events

C. S. Dyer, F. Lei, Space Department, DERA

Radiation transport codes are applied to calculate the influence of aircraft structure and loads on the internal environment from galactic cosmic rays. The importance of enhanced environments due to large solar particle events is also estimated.

D-2

9:40 AM

Correlation of Inflight Neutron Dosimeter Measurements with Atmospheric Neutron Model

E. Normand, Boeing Phantom Works

High altitude dosimeter measurements that have been calibrated with a TEPC detector compare well with the NASA-Langley atmospheric neutron model. The dosimeter can be used as an indicator of the SEU rates during a flight.

Technical Program Wednesday

D-3
9:55 AM **Initial On-Orbit Results from the Compact Environmental Anomaly Sensor (CEASE)**

B. K. Dichter, W. R. Turnbull, D. H. Brautigam, K. P. Ray, Air Force Research Laboratory; R. H. Redus, Amptek, Inc.

Data from the first nine months of operation of the Compact Environmental Anomaly Sensor (CEASE) are presented. The instrument's performance as a real-time space hazard warning device is analyzed. On-orbit particle data are presented.

10:10 - 10:50 AM **BREAK - INDUSTRIAL EXHIBITS AREA**

D-4
10:50 AM **The Charge Control Experiment on DSCS: From MIN to MAX**

K. P. Ray, B. K. Dichter, Air Force Research Laboratory; D. E. Delorey, Boston College; E. G. Mullen, Assurance Technology Corporation

The authors report on a five year study of differential and frame charging as measured by the Charge Control Experiment (CCE) on a DSCS III satellite operating during both solar minimum and maximum.

D-5
11:05 AM **Solar Cycle Variation of Outer Belt Electron Dose at Low Earth Orbit**

D. H. Brautigam, B. K. Dichter, K. P. Ray, W. Turnbull, Air Force Research Laboratory; D. Madden, Boston College; A. Ling, Radex, Inc.; R. Redus, Amptek, Inc.

The solar cycle dependence of the LoLET dose rates in the low altitude 'horns' of the outer zone electron belt is examined using data from TSX5/CEASE (solar maximum) and APEX/PASP+ (solar minimum).

D-6
11:20 AM **Neutron Production from Polyethylene and Common Spacecraft Materials**

R. H. Maurer, D. R. Roth, J. D. Kinnison, The Johns Hopkins Applied Physics Laboratory; L. H. Heilbronn, J. Miller, C. J. Zeitlin, Lawrence Berkeley National Laboratory

Experimental measurements of neutron production from collisions of neutron beams with polyethylene blocks simulating tissue at LANSCE and 1 GeV/amu iron nuclei with spacecraft shielding materials at the AGS are reported.

POSTER PAPERS

PD-1 **Predicting Dose-Time Profiles of Solar Energetic Particle Events Using Bayesian Forecasting Methods**

J. S. Neal, L. W. Townsend, The University of Tennessee

Bayesian inference techniques, coupled with Markov Chain Monte Carlo sampling methods, are used to predict dose-time profiles for energetic solar particle events. Inputs into the predictive methodology are dose measurements obtained early in the event.

PD-2 **Fluxes of Relativistic Electrons in Low-Earth Orbit During the Decline of Solar Cycle 22**

W. D. Pesnell, Nomad Research, Inc.

Measurements from the High Energy Particle Spectrometer (HEPS) on the Upper Atmosphere Research Satellite (UARS) were used to develop a database of the pitch-angle and energy-resolved electron fluxes with energies between 30 keV and 5 MeV.

Technical Program Wednesday

PD-3 On-Orbit Fractional Frequency Shifts of Precision Quartz Crystal Oscillators

W. J. Stapor, B. G. Henson, M. D. Frank, P. T. McDonald, Innovative Concepts Inc.; J. Nelson, Welkin/CSC

Frequency shifts of orbiting precision crystal oscillators are correlated with periods of increased solar proton flux over three years. The data and direct radiation correlation contribute to understanding actual performance for precision oscillator space applications.

PD-4 Displacement Damage in Silicon Due to Secondary Neutrons, Pions, Deuterons, and Alphas from Proton Interactions with Materials

I. Jun, W. McAlpine, Jet Propulsion Laboratory

The enhancement of displacement damage energy deposition due to secondary neutrons, pions, deuterons, and alphas resulting from high energy proton interactions with aluminum and tungsten shielding are examined in this paper.

11:35 - 1:15 PM LUNCH

SESSION E DOSIMETRY AND FACILITIES

1:15 PM SESSION INTRODUCTION

Chair: Laurent Dusseau, Université Montpellier II

E-1 Neutron and Proton Dosimetry with Improved Silicon Diodes

1:20 PM *A. B. Rosenfeld, M. L. F. Lerch, M. Reinhard, G. I. Kaplan, University of Wollongong; I. E. Anokhin, O. S. Zinets, Institute for Nuclear Research; S. Mao, Stanford University*

A silicon p-i-n diode with improved dynamic range of NIEL dosimeter has been studied theoretically and experimentally in neutron and proton fields. A new sensor for simultaneous measurements of NIEL and IEL has been developed.

E-2 Application of FGMOS Arrays for Dosimetry

1:35 PM *M. N. Martin, D. R. Roth, A. G. Darrin, Johns Hopkins University Applied Physics Laboratory; P. J. McNulty, Clemson University; A. G. Andreou, Johns Hopkins University*

We present a radiation dosimeter based on the erasure of floating-gate MOS transistors. We will provide background theory and analysis to describe the operation of the sensor.

E-3 Feasibility Study for On-Line Dosimetry on the Synchrotron Microbeam Field at ESRF

1:50 PM *A. B. Rosenfeld, M. L.F. Lerch, University of Wollongong; T. Kron, Mater Hospital Newcastle University; E. Brauer-Krisch, A. Bravin, ESRF; A. Holmes-Siedle, REM OXFORD*

Microbeam on-line dosimetry with quadruple MOSFET detectors and automatic beam profile deriving has been investigated. Micron spatial resolution has been achieved.

Technical Program Wednesday

E-4
2:05 PM **Floating Gate Dosimetry Based on Measurement of Incremental Charge Injection**

L. Z. Scheick, Jet Propulsion Laboratory; P. J. McNulty, Clemson University

We describe a new method for enhancing the precision of the floating gate based dosimeter. Methods and results of directly measuring the charge on the floating gate and the removal of charge due to ionizing radiation are presented.

E-5
2:20 PM **High Energy Particle Irradiation of Optically Stimulated Luminescent Films at CERN**

L. Dusseau, G. Polge, S. Mathias, J. R. Vaillé, R. Germanicus, J. Fesquet, J. Gasiot, CEM 2 Université Montpellier II; R. Broadhead, B. Camanzi, Brunel University; F. Saigné, Université de Reims Champagne-Ardenne

For the first time, Optically Stimulated Luminescent dosimetric films and sensors have been irradiated at CERN with 500 MeV electrons, 23 GeV protons, and 3.66 GeV negative pions. The first results are presented and discussed.

POSTER PAPERS

PE-1 **Compact Energetic Light Particle Detector and Spectrometer**

H. Matsumoto, H. Koshiishi, T. Goka, Y. Kimoto, National Space Development Agency of Japan; B. D. Green, G. E. Galica, T. Nakamura, Physical Sciences Inc; T. Abe, S. Badono, S. Murata, Mitsubishi Electric Company; J. D. Sullivan, Boston University Center for Space Physics

We have developed an Energetic Light Particle Monitor (LPM) that can discriminate electrons, protons, alphas and heavy ions. LPM's unique characteristics, the design approach, and response during exposure to protons, electrons, alphas, and carbon ions are presented.

PE-2 **Linear Dependence of the Radiation-Induced Absorption in Ultra High Mixed Gamma-Neutron Irradiation Field**

B. Brichard, P. Borgermans, A. Fernandez Fernandez, K. Lammens, M. Decréton, SCK•CEN, Belgian Nuclear Research Centre

Fiber-optics technology is expected to play an important role in fiber-optic plasma diagnostics. Their survivability must be assessed under very strong mixed neutron-gamma irradiation. We report the on-line optical absorption measurement of various fibres in a nuclear fission reactor.

Technical Program Wednesday

DATA WORKSHOP

2:35 - 4:30 PM

BAYSHORE GRAND BALLROOM

INTRODUCTION



Chair: Nick van Vonno, Intersil Corporation

W-1 Total Dose Performance of Radiation Hardened Voltage Regulators and References

S. S. McClure, B. G. Rax, Jet Propulsion Laboratory; J. L. Gorelick, Boeing Space Systems

Total dose test results of commercially available radiation hardened bipolar voltage regulators and references are presented. Behavior of critical parameters in different conditions is compared and the impact to hardness assurance methodology is discussed.

W-2 Permanent Single Event Functional Interrupts (SEFIs) in 128- and 256-Megabit Synchronous Dynamic Random Access Memories (SDRAMs)

R. Koga, P. Yu, K. Crawford, S. Crain, V. Tran, The Aerospace Corporation

Permanent Single Event Functional Interrupts (SEFIs) have been observed in several high density Synchronous Dynamic Random Access Memories (SDRAMs). Affected devices often lose both Read and Write functions.

W-3 Simultaneous Cryogenic Temperature (77K) and Total Dose Ionizing Radiation Effects on COTS Amplifiers

D. Guckenberger, Cornell University;

D. M. Hiemstra, MacDonald Dettwiler Space and Advanced Robotics Ltd.

COTS CMOS and bipolar amplifiers were subjected to gamma radiation at room temperature and 77K to observe the relationship between cryogenic temperature and ionizing radiation effects. Frequency Response, THD and Noise Voltage results are presented.

W-4 Comparative Testing of ADSP-21020 DSPs from Multiple Vendors

P. Duggan, S. Sampson, R. Burnell, Air Force Research Laboratory; R. Koga, The Aerospace Corporation; S. McEndree, J. Tausch, D. Sleeter, D. Alexander, Mission Research Corporation

Total ionizing dose, ionizing dose rate, and single event effects test results are reported on the ADSP-21020 by Analog Devices Inc., the RH21020 by BAE Systems/Manassas, and the TSC21020F by TEMIC Semiconductors.

W-5 Characterization of Various SEE Hardened Power Management ICs

B. P. Alaskiewicz, B. R. Doyle, W. H. Newman, J. W. Swonger, Intersil Corporation

Single event effects test results are reported for several power management devices that have been specifically SEE-hardened by design. Single event transient, as well as single event latch-up data are presented and discussed.

Technical Program Wednesday

- W-6 Single Event Upset Characterization of the Pentium®MMX and Low Power Pentium®MMX Microprocessors Using Proton Irradiation**
D. M. Hiemstra, S. Yu, M. Pop, MacDonald Dettwiler Space and Advanced Robotics Ltd.

Experimental single event upset characterization of the Pentium®MMX and Low Power Pentium®MMX microprocessors using proton irradiation is presented. Results are compared with previous tests on the Pentium®MMX, Pentium®II, and Celeron®.

- W-7 Total Dose and Single Event Effects Testing of the Intel Pentium® III (P3) and AMD K7 Microprocessors**

J. W. Howard Jr., Jackson and Tull Chartered Engineers; K. A. LaBel, E. Webb, NASA Goddard Space Flight Center; M. A. Carls, R. Stattel, C. E. Rogers, Raytheon ITSS

To understand the radiation sensitivity and radiation response, Intel Pentium® III and AMD K7 microprocessors were tested for total dose and single event effects.

- W-8 Total-Dose and Single-Event-Upset (SEU) Resistance in Advanced SRAMs Fabricated on SOI Using 0.2-Micron Design Rules**

*K. Hirose, H. Saito, Institute of Space and Astronautical Science;
M. Akiyama, M. Arakaki, Institute for Unmanned Space Experiment Free Flyer;
Y. Kuroda, S. Ishii, K. Nakano, Mitsubishi Heavy Industries, LTD*

We measured total dose and single event upset (SEU) resistance in advanced 128-Kbit SRAMs fabricated on SOI using 0.2-micron design rules. Our results indicate that the 128-Kbit SRAMs can be used in specific space technologies.

- W-9 SEE Tests for Commercial Off-the-Shelf DSPs To Be Used in a Space Experiment**

M. Menichelli, B. A. Alpat, R. Battiston, M. Bizzarri, S. Blasko, D. Caraffini, A. Papi, Universita' di Perugia; J. Burger, T. Dai, A. Kounine, M. Steuer, Massachusetts Institute of Technology; E. Cortina Gil, University of Geneva; P. Egelhof, R. Scharth, R. Simon, Gesellschaft fur Schwerionenforschung; C. Haller, V. Plyaskine, CERN; O. Maris, University of Bucharest

DSPs from Analog Devices were tested for single event effects for use in a Space Station particle physics experiment. The tests were performed at GSI (Darmstadt) with high-energy (200 to 800 MeV/nucleon) Xenon, Gold, and Uranium ions.

- W-10 Total Ionizing Dose Testing of Ferroelectric Nonvolatile RAM**

D. N. Nguyen, L. Z. Scheick, Jet Propulsion Laboratory

The total ionizing dose test results of two different sizes of ferroelectric RAM (FeRAM), Ramtron 64Kb FM1608 and 256Kb FM1808, suggest that the commercial CMOS based sense amplifiers and reference voltage generators are the most sensitive.

- W-11 SEE Evaluation of Digital Analog Converters for Space Applications**

L. Z. Scheick, Jet Propulsion Laboratory

Single event effects cross-sections were obtained for three different Digital to Analog Converters (DACs): the Analog Devices DAC8420, the Analog Devices AD768, and the Xicor X9C503.

Technical Program Wednesday

W-12 High-Speed Data Transmission for Spaceborne Applications

J. M. Benedetto, A. Oliver, Aeroflex UTM

Total dose and single event effect data are presented for low voltage differential signaling (LVDS) components. LVDS is finding its way into many spacecraft applications and may become a *de facto* standard for data transmission in satellites.

W-13 Total-Dose Tolerance of the Commercial Taiwan Semiconductor Manufacturing Company (TSMC) 0.35- μ m CMOS Process

*R. C. Loe, J. V. Osborn, D. C. Mayer, S. Brown, The Aerospace Corporation;
J. Gambles, Microelectronics Research Center*

Radiation measurements on transistor test structures fabricated using the TSMC 0.35- μ m CMOS process showed minimal off-state leakage up to approximately 50 krad(Si) and small threshold voltage shifts up to 70 krad(Si). Additional data are presented.

W-14 UC Davis Crocker Nuclear Laboratory (CNL) Radiation Effects Measurement and Test Facility

C. M. Castaneda, Crocker Nuclear Laboratory, University of California

The radiation effects facility at the Crocker Nuclear Laboratory provides medium energy protons and beams of deuterons and ^4He to perform radiation effects measurements and tests on materials and devices used in aerospace applications.

W-15 Recent Radiation Damage and Single Event Effect Results for Candidate Spacecraft Electronics

M. V. O'Bryan, C. M. Seidleck, Raytheon ITSS; K. A. LaBel, R. A. Reed, J. L. Barth, NASA Goddard Space Flight Center; J. W. Howard Jr., Jackson and Tull Chartered Engineers; R. L. Ladbury, S. D. Kniffin, Orbital Sciences Corporation; P. W. Marshall, Consultant

We present data on the vulnerability of candidate spacecraft electronics to proton and heavy-ion induced single-event effects and proton-induced damage. Devices include digital, analog, linear bipolar, hybrid devices, Analog-to-Digital Converters (ADCs), Digital-to-Analog Converters (DACs), and DC-DC converters.

W-16 Single Event Latchup and Total Dose Testing of Spacecraft Electronic Components

K. Warren, D. Roth, J. Kinnison, B. Carkuff, Johns Hopkins Applied Physics Laboratory

Single event latchup (SEL) and total dose test results for candidate spacecraft electronic components are presented. Devices tested were analog, digital, and mixed signal integrated circuits under consideration for spacecraft electronics.

W-17 Device Susceptibility Update: 1999-2000

J. R. Coss, Retired

This ninth biennial compendium continues the previous work of Nichols, et al., on single event effects (SEEs) on microcircuits first published in 1985. The paper summarizes data collected and published in 1999 and 2000.

Technical Program Wednesday

W-18 An Updated Data Compendium of Enhanced Low Dose Rate Sensitive (ELDRS) Bipolar Linear Circuits

R. L. Pease, RLP Research; S. McClure, A. H. Johnston, Jet Propulsion Laboratory; J. Gorelick, Boeing Satellite Systems; T. L. Turflinger, M. Gehlhausen, J. Kreig, NAVSEA Crane; T. Carriere, ASTRIUM; M. Shaneyfelt, Sandia National Laboratories

Total dose data on ELDRS bipolar linear circuits, presented in 1996, have been updated. The new data include 36 data sets at high and low dose rate on 27 part types from nine manufacturers.

W-19 A Compendium of Single Event Transient Data

M. W. Savage, T. L. Turflinger, NAVSEA Crane; J. W. Howard, Jackson and Tull Chartered Engineers; S. Buchner, SFA, Inc.

We present a compendium on observed Single Event Transients on analog and digital circuits. Both the data and the test methods used are presented.

W-20 Characterization of Transient Error Cross Sections in High Speed Commercial Fiber Optic Data Links

C. J. Marshall, R. A. Reed, K. A. LaBel, NASA Goddard Space Flight Center; P. W. Marshall, Consultant; M. A. Carts, Raytheon ITSS; S. Baier, Honeywell Technology Center

The proton single event transient response of several gigabit per second commercial optical links is characterized versus optical power, data rate and incident proton angle. The links are quite robust for many on-orbit applications.

W-21 Results of Single Event Effects Testing of a Commercial Optical Time-Domain Reflectometer

J. L. Wert, E. Normand, D. Oberg, M. Vallejo, Boeing Phantom Works

A program was carried out to quantify the susceptibility of a commercial Optical Time-Domain Reflectometer (OTDR) to single event effects (SEEs). The responses of the single board computer and the entire OTDR to proton exposures are compared.

W-22 Proton Radiation Damage of Si APD Single Photon Counters

X. Sun, NASA Goddard Space Flight Center; H. Dautet, Perkin Elmer Optoelectronics Canada

Proton radiation damage of Si avalanche photodiodes were measured at 53 to 189 MeV proton energy. The annealing rates were monitored at -10°C, room temperature, and 55°C. The results are compared with the previously published data.

W-23 Photon and Neutron Responses of Optical Absorption Dosimeters Used at SLAC

X. S. Mao, J. C. Liu, Stanford University; G. Lum, Lockheed Martin Missiles and Space Co.

This paper reports the photon and neutron responses of four types of optical absorption dosimeters used at SLAC. The neutron responses are about 50% of their photon responses when expressed as tissue dose responses.

4:30 PM END OF WEDNESDAY SESSIONS

CONFERENCE SOCIAL

6:00 PM

AN EVENING ON ENGLISH BAY

(For more information, see Social Program section.)

Technical Program Thursday

INVITED TALK

8:15 - 9:15 AM

Nuclear Astrophysics - Origin of the Elements

Dr. Alan C. Shotter

Dr. Alan Shotter, one of Europe's top researchers in the field of nuclear physics using accelerated beams of exotic ions, will speak about using radioactive beams to explore reactions which take place on stars, in particular explosive burning in supernova, to produce the elements above helium. He leads investigations at the Tri-University Meson Facility's (TRIUMF's) new world-class facility called ISAC (Isotope Accelerator) which produces radioactive beams of 3,000 isotopes to study the types of reactions that take place in the stars. As the new Director of the TRIUMF facility, Dr. Shotter will lead the Canadian effort to exploit the ISAC.

Dr. Shotter is currently a professor of experimental physics at the University of Edinburgh where he served as the Head of Physics Department 1988 to 1990 and the Head of Physics and Astronomy Department from 1990 through 1994. In November 2000 he was named the new director of TRIUMF, Canada's national laboratory for nuclear and particle physics which is located at University of British Columbia in Vancouver. Dr. Shotter received his PhD in nuclear physics at Oxford University and was named a Fellow of the Institute of Physics in 1984 and a Fellow of the Royal Society of Edinburgh in 1988. He has served as a member of numerous British and International scientific bodies and committees. He leads research in Experimental Nuclear Physics, specializing in nuclear reactions, nuclear instrumentation, and nuclear astrophysics and leads scientific programs at world-class nuclear physics facilities in Belgium, USA, Canada, Germany, Switzerland, and Sweden. He initiated a European wide activity in the public understanding of science which is linked to the European Physical Society and the European Science Foundation. He is also the Chairman of the Board of Trustees for the Murdock Trust, an independent charitable trust that supports retired scientists in financial need.

SESSION F

9:20 AM

BASIC MECHANISMS

SESSION INTRODUCTION

Chair: Dan Fleetwood, Vanderbilt University

F-1

9:25 AM

Influence of Interface and Bulk Defect Interaction on Proton Radiation Response of Bipolar Devices

H. J. Barnaby, R. D. Schrimpf, Vanderbilt University; R. L. Pease, RLP Research

The degradation due to ionizing-radiation-induced interfacial damage and displacement-induced bulk defects is coupled in bipolar junction transistors. This mechanism is a significant factor in the proton radiation response of bipolar transistors and circuits.

F-2

9:40 AM

The Effect of Network Topology on Proton Trapping in Amorphous SiO₂

A. C. Pineda, University of New Mexico; S. P. Karna, W. M. Shedd, R. D. Pugh, Air Force Research Laboratory; H. A. Kurtz, University of Memphis

First-principles quantum chemical calculations suggest that the binding and stability of protons in amorphous SiO₂ strongly depend on the topology of the interacting network.

Technical Program Thursday

F-3 Proton-Induced Defect Generation at the Si-SiO₂ Interface

9:55 AM

*S. N. Rashkeev, D. M. Fleetwood, R. D. Schrimpf, Vanderbilt University;
S. T. Pantelides, Vanderbilt University and Oak Ridge National Laboratory*

We report first-principles calculations of interface-trap formation in MOS structures. It is shown that H⁺ arriving at a Si-SiO₂ interface cannot be neutralized and that depassivation of dangling bonds occurs via the reaction $\text{SiH} + \text{H}^+ \Rightarrow \text{D}^+ + \text{H}_2$.

10:10 - 10:40 AM

BREAK

F-4 Noise Characteristics of Radiation Induced Soft Breakdown Current in Ultra-Thin Gate Oxides

10:40 AM

*A. Cester, L. Bandiera, M. Ceschia, A. Paccagnella, Università di Padova;
G. Ghidini, ST Microelectronics*

Heavy ion irradiation of ultra-thin gate oxides produces a soft-breakdown gate current, affected by a multilevel Random Telegraph Noise, whose time constants depend on temperature. An original model of the noise characteristics is proposed.

F-5 Radiation Induced Leakage Currents: Atomic Scale Mechanisms

10:55 AM

*P. M. Lenahan, J. J. Mele, J. P. Campbell, A. Y. Kang, The Pennsylvania State University;
S. T. Liu, Honeywell; R. K. Lowry, D. Woodbury, Intersil Corporation;
R. A. Weimer, Micron Technologies*

We identify atomic scale defects involved in radiation induced leakage currents in metal oxide silicon devices; these defects are oxygen deficient silicon dangling bond centers in the oxide near the Si/SiO₂ interface.

F-6 Comparison of Charge Trapping in Undoped Oxides Made by Low and High Temperature Deposition Techniques

11:10 AM

*B. J. Mrstik, H. L. Hughes, Naval Research Laboratory;
R. K. Lawrence, P. J. McMarr, SFA Inc; P. Gouker, MIT Lincoln Laboratory*

Hole and electron trapping in deposited oxides made by low-temperature silane processes and by high temperature TEOS processes are compared. TEOS oxides are found to have electron traps with a large, strongly field-dependent cross section.

F-7 Effects of Alternating Bias Exposure on Radiation-Induced Defects in MOS Devices

11:25 AM

*J. A. Felix, D. M. Fleetwood, Vanderbilt University;
L. C. Riewe, M. R. Shaneyfelt, P. S. Winokur, Sandia National Laboratories*

MOS trapped-charge densities were characterized after AC bias irradiation over a wide frequency range using the thermally stimulated current technique. The dependence of electron trapping on bias frequency is discussed.

Technical Program Thursday

POSTER PAPERS

PF-1 **Revised Calculation of High Energy Proton Damage in Gallium Arsenide**

*S. R. Messenger, SFA Inc.; E. A. Burke, Consultant;
G. P. Summers, M. A. Xapsos, R. J. Walters, Naval Research Laboratory*

A longstanding discrepancy between proton NIEL calculations and experimental measurements at high energies has been eliminated by incorporating the damage efficiency function used in neutron displacement kerma calculations.

PF-2 **Photoluminescence Due to Boron-Related Defect in Solar Cell Silicon Irradiated with 1 MeV Electrons**

M. Tajima, M. Warashina, Institute of Space and Astronautical Science; T. Hisamatsu, SHARP Corporation; S. Matsuda, National Space Development Agency of Japan

We investigated a new photoluminescence line at 0.87 eV in B-doped Si irradiated with 1 MeV electrons and identified its origin as the interstitial defect of boron and oxygen which causes the degradation of space solar cells.

PF-3 **Direct Experimental Evidence for Atomic Scale Structural Changes Involved in the Interface-Trap Transformation Process**

*P. M. Lenahan, T. D. Mishima, J. Jumper, The Pennsylvania State University;
T. N. Fogarty, R. T. Wilkins, Prairie View A&M University*

Several groups have reported changes in the interface trap energy distribution over (many) hundreds of hours after irradiation. We present the first direct experimental observation of atomic scale changes involved in these phenomena.

PF-4 **Atomic Structure Characterization of P Centers in Phosphorus Doped α -SiO₂**

H. A. Kurtz, University of Memphis; S. P. Karna, Air Force Research Laboratory

We present the first *ab initio* quantum mechanical calculations of the atomic structure and spin properties of P₁, P₂, and P₄ centers in amorphous SiO₂. The calculations support the atomic structure assignments made from ESR experiments.

PF-5 **The Role of O₂ and H₂O Molecules in Irradiated SiO₂**

T. Bakos, S. N. Rashkeev, S. T. Pantelides, Vanderbilt University

We report first-principles calculations for the diffusion, stability and reactions of O₂ and H₂O in SiO₂, accounting for observed differences in the E' center generation under high-dose irradiation of different oxides.

PF-6 **Detection of Trap Activation by Ionizing Radiation in SiO₂ by Spatially Localized Cathodoluminescence Spectroscopy**

B. D. White, L. J. Brillson, The Ohio State University; D. M. Fleetwood, R. D. Schrimpf, S. T. Pantelides, Vanderbilt University

Thick Al gate oxide structures exposed to x-ray irradiation exhibit spatially-localized optical emissions characteristic of multiple deep level traps. Irradiation under gate bias produces a gradient change of these defect densities across the oxide thickness.

Technical Program Thursday

11:40 - 1:15 PM LUNCH

SESSION G ISOLATION TECHNOLOGIES

1:15 PM SESSION INTRODUCTION

Chair: Ronald Smeltzer, Sarnoff Corporation

G-1 Modification of H⁺ Transport in Buried Oxides by X-Ray Irradiation

1:20 PM

P. J. Macfarlane, R. E. Stahlbush, Naval Research Laboratory;

A. H. Edwards, Air Force Research Laboratory

Radiation induces or modifies near interface defects that affect the detrapping-based transport of H⁺ ions in buried oxides. This may account for discrepancies between transport characteristics of protons created by irradiation and by hydrogen annealing.

G-2 Gated-Diode Characterization of the Back-Channel Interface on Irradiated SOI Wafers

1:35 PM

R. K. Lawrence, SFA Inc.; D. E. Ioannou, George Mason University;

W. C. Jenkins, Naval Research Laboratory; S. T. Liu, Honeywell, SSEC

A gated-diode technique is used to characterize the radiation-induced back-channel interface state concentration in SOI devices fabricated on a SIMOX wafer.

G-3 Anomalous Radiation Effects in Fully-Depleted SOI MOSFETs Fabricated on SIMOX

1:50 PM

Y. Li, G. Niu, J. D. Cressler, M. J. Palmer, Auburn University; J. Patel, Jet Propulsion

Laboratory; C. J. Marshall, R. A. Reed, NASA Goddard Space Flight Center;

P. W. Marshall, Consultant; H. S. Kim, Jackson and Tull Chartered Engineers

We investigate the radiation hardness of fully-depleted SOI MOSFETs on SIMOX under proton exposure. An anomalous kink in the back-gate linear I_D - V_{GS} curve at high radiation dose and unusual self-annealing effects in devices cooled to 77K are described.

POSTER PAPERS

PG-1 An Assessment of SIMOX Substrates for Deep Submicron CMOS Devices

S. T. Liu, Honeywell International; W. C. Jenkins, Naval Research Laboratory

CMOS devices on SIMOX substrates with buried oxide thicknesses from 120 nm to 380 nm were made. The assessment of the pass-gate radiation response showed that the thinner buried oxides provide better cost and performance.

Technical Program Thursday

POSTER SESSION

2:05 - 4:30 PM

BAYSHORE GRAND BALLROOM

INTRODUCTION



Chair: Jim Schwank, Sandia National Laboratories

4:30 PM

END THURSDAY SESSIONS

4:45 - 6:30 PM

BAYSHORE GRAND BALLROOM

RADIATION EFFECTS COMMITTEE OPEN MEETING

Technical Program Friday

INVITED TALK

8:15 - 9:15 AM

National Geographic Magazine - Anatomy of a Story

Cary Wolinsky

Cary Wolinsky, an author and photographer for National Geographic, will give us a behind-the-scenes look at the process of producing those amazing National Geographic Magazine stories and breathtaking photographs. He will discuss where the ideas come from, what really goes on during the field trips, and how a story works its way through the National Geographic article-making apparatus toward ink on paper. He will share with us his experiences and inspirations to get that one photograph that "tells the story". Along the way we will visit Russia, Australia, and Space through his marvelous photography.

Cary Wolinsky began working as a news and magazine photographer for the Boston Globe in 1968 while completing a degree in journalism at Boston University's School of Communications. By 1972, he was providing freelance photo stories to many national magazines, including *Natural History*, *National Geographic*, *Smithsonian*, *Newsweek*, and *International Wildlife*. After becoming a contract photographer with National Geographic in the mid 1980s, Mr. Wolinsky came to specialize in historical and cultural assignments that require in-depth research and well-managed, global coverage. His numerous stories published by National Geographic include; *Silk*, *The Queen of Textiles*, *Sichuan: Where China Changes Course*, *Inside the Kremlin*, *Sir Joseph Banks*, *The Greening of the Empire*, *The Quest for Color*, *The Power of Writing*, *Australia- A Harsh Awakening*, *New Eyes on the Oceans*, and *Surviving Space*.

Mr. Wolinsky has taken a leading role in introducing quality photography in electronic publishing. He co-founded Picture Network International, an on-line, photography database system designed to serve established and emerging publishing markets. In 1997 PNI was sold to Kodak and continues marketing photography on-line under the name Picture Quest. Mr. Wolinsky's photographs have been licensed for advertising and editorial use in hundreds of publications throughout the world. His photographic prints have been exhibited and acquired by museums and private collections in the United States, Europe, Australia and Asia. An extensive collection of Mr. Wolinsky's work is available online at www.carywolinsky.com. His field notes are regularly posted on the National Geographic web site where he describes the "Best", "Worst", and "Quirkiest" moments of his field assignments.

SESSION H

9:20 AM

HARDNESS ASSURANCE

SESSION INTRODUCTION

Chair: Tom Turflinger, NAVSEA Crane

H-I

9:25 AM

Comparison of X-Ray, Gamma, and Proton Irradiation for Space Hardness Assurance Testing

J. R. Schwank, M. R. Shaneyfelt, D. E. Beutler, B. L. Draper, R. A. Loemker, P. E. Dodd, F. W. Sexton, Sandia National Laboratories; P. Paillet, V. Ferlet-Cavrois, CEA/DIF

SOI transistors were irradiated using x-ray, Co-60 gamma, and proton radiation sources. The radiation-induced back-gate threshold voltage shift was used to determine the optimum laboratory radiation source for simulating the proton environment of space.

Technical Program Friday

H-2
9:40 AM **Aging and Baking Effects on the Radiation Hardness of MOS Capacitors**
A. Karmarkar, B. K. Choi, R. D. Schrimpf, D. M. Fleetwood, Vanderbilt University

A decrease in oxide-charge trapping efficiency of Al-gate MOS capacitors was observed after 15 years of storage. This difference decreases after baking, and so far has not been observed in poly-Si gate capacitors.

H-3
9:55 AM **Evaluation of MOS Devices Total Dose Response Using the Isochronal Annealing Method**
F. Saigné, LAM, Université de Reims; L. Dusseau, J. Fesquet, J. Gasiot, CEM2, Université Montpellier II; R. Ecoffet, Centre National d'Etudes Spatiales; R. D. Schrimpf, K. F. Galloway, Vanderbilt University

The use of the isochronal annealing method to minimize the failure risk when evaluating an irradiated device is discussed. It is shown how experimental isochronal annealing under bias allows detection of the rebound effect in devices.

H-4
10:10 AM **Comparison of Heavy-Ion-Induced and Laser-Induced Single Event Charge Collection**
X. W. Zhu, B. L. Bhuva, L. W. Massengill, Vanderbilt University

Device-level simulations are used to establish a relationship between heavy ion and laser charge collection. Simulation results support single event upset hardness assurance of circuits using focused laser testing.

POSTER PAPERS

PH-1
Early Lethal SEGR Failures of VDMOSFETs Considering Non-Uniformities in the Rad-Hard Device Distribution
T. H. Wheatley, Consultant; C. F. Wheatley, Consultant; J. L. Titus, NAVSEA Crane

SEGR failures of VDMOSFETs for many parameters for a VDMOSFET universe of like devices have been studied. Non-uniform components are now considered. Time-to-failure is studied using Monte Carlo methods. Bounds are ascribed using an empirical equation.

PH-2
Development of a Test Methodology for Single Event Transients (SET) in Linear Devices
J. W. Howard Jr., J. D. Forney, H. S. Kim, Jackson and Tull Chartered Engineers; C. Poivey, SGT Inc.; K. A. Label, NASA Goddard Space Flight Center

We present SET test data on linear devices under many operational conditions in an attempt to understand the SET generation and characteristics and to define a low-cost, conservative test methodology to characterize these effects.

PH-3
Non-Damage Beam Blanking SEM Test Method and Its Application to Highly Integrated Devices
N. Nemoto, A. Makihara, S. Kuboyama, S. Matsuda, National Space Development Agency of Japan; H. Ohtotmo, K. Furuse, S. Baba, T. Hirose, RYOEI Technica Corporation

The origin of damage caused by Beam Blanking SEM (BBSEM) was clarified and completely removed for SEU testing. The improved BBSEM was successfully used to locate SEU sensitive areas for highly integrated devices.

Technical Program Friday

PH-4 Backside Laser Testing of ICs for SET Sensitivity Evaluation

*D. Lewis, V. Pouget, H. Lapuyade, P. Fouillat, A. Touboul, IXL Université Bordeaux;
F. Beaudoin, P. Perdu, Centre National d'Etudes Spatiales*

An experimental approach combining backside laser testing and analog mapping is presented. A technique of ICs backside preparation is evaluated. The methodology is applied to the study of SET sensitivity of a linear IC.

PH-5 Assessing the Impact of the Space Radiation Environment on Parametric Degradation and Single Event Transients in Optocouplers

*R. A. Reed, C. J. Marshall, J. L. Barth, K. A. LaBel, NASA Goddard Space Flight Center;
C. Poivey, SGT Inc; P. W. Marshall, Consultant; S. Kniffin, Orbital Sciences Corporation;
C. Seidleck, Raytheon ITSS*

We present techniques developed to assess the performance of optocouplers when used in the space radiation environment. This includes a discussion of how ground testing issues and estimates of in-flight performance can be used to assess impact.

PH-6 Effect of Aging on Radiation Response of Bipolar Transistors

*V. S. Pershenkov, A. Y. Slesarev, A. V. Sogoyan, V. V. Belyakov, V. B. Kekukh,
A. Y. Bashin, D. V. Ivashin, V. S. Motchkine, Moscow Engineering Physics Institute;
V. N. Ulimov, V. V. Emelianov, Research Institute of Scientific Instruments*

Thermally activated aging process is investigated by experimental evaluation of the change in radiation response of test PNP and NPN transistors at wide range of emitter-base bias after pre-irradiation elevated-temperature stress and infrared illumination.

PH-7 New Instrumentation, Patterns and Their Effects on TID Testing of Antifused-Based FPGAs

I. Kleyner, Orbital Sciences Corporation; R. Katz, NASA Goddard Space Flight Center

Techniques and methods traditionally utilized for TID performance evaluation of FPGAs were recently modified and expanded. As a result, some significant and previously undetected characteristics of TID-related degradation process of antifuse-based FPGAs were observed and studied.

10:25 - 10:45 AM BREAK

SESSION I DEVICES AND INTEGRATED CIRCUITS

10:45 AM SESSION INTRODUCTION

Chairs: Ray Ladbury, Orbital Sciences Corporation and Eric Heijne, CERN

I-I Radiation Effects on Floating-Gate Memory Cells

10:50 AM *G. Cellere, J. Wyss, A. Paccagnella, Università di Padova;
P. Pellati, P. Olivo, University of Ferrara*

Heavy ion irradiation of 4Mb floating-gate cell arrays produces threshold voltage shifts in programmed transistors. Specially designed devices and instrumentation allow, for the first time, the detection of threshold variation between 40mV and more than 2V.

Technical Program Friday

- I-2**
11:05 AM **The Effects of High-Dose Gamma Irradiation on High-Voltage 4H-SiC Schottky Diodes and the SiC/SiO₂ Interface**
D. C. Sheridan, G. Chung, J. D. Cressler, Auburn University; S. Clark, NAVSEA Crane
- The effects of high-dose gamma radiation on the characteristics of high-voltage 4H-SiC Schottky diodes for use in extreme environment electronics are investigated for the first time. Results are correlated with SiC MOS capacitor irradiation experiments and numerical simulation.
- I-3**
11:20 AM **The Effects of Proton Irradiation on SiGe:C HBTs**
S. Zhang, G. Niu, J. D. Cressler, Auburn University; H.-J. Osten, D. Knoll, The Institute for Semiconductor Physics (IHP); C. J. Marshall, R. A. Reed, NASA Goddard Space Flight Center; P. W. Marshall, Consultant; H. S. Kim, Jackson and Tull Chartered Engineers
- The effects of 63 MeV proton irradiation on SiGe:C HBTs are reported the first time. The DC characteristics and neutral base recombination of these SiGe:C HBTs are investigated for proton fluences up to 5×10^{13} p/cm².
- I-4**
11:35 AM **Proton Radiation Response of SiGe HBT Analog and RF Circuits and Passives**
J. D. Cressler, M. C. Hamilton, R. Krithivasan, G. Niu, S. Zhang, Z. Jin, M. J. Palmer, Auburn University; H. Ainspan, IBM Research Division; R. Groves, A. J. Joseph, D. L. Harame, IBM Microelectronics; C. J. Marshall, R. A. Reed, NASA Goddard Space Flight Center; P. W. Marshall, Consultant; H. S. Kim, Jackson and Tull Chartered Engineers
- We present the first results concerning effects of 63 MeV proton irradiation on SiGe HBT analog and RF circuits and passive elements. Results suggest that the SiGe HBT technology is robust for tested circuit applications.
- I-5**
11:50 AM **1/f Noise in Proton Irradiated SiGe HBTs**
Z. Jin, G. Niu, J. D. Cressler, Auburn University; C. J. Marshall, R. Reed, NASA Goddard Space Flight Center; P. W. Marshall, Consultant; H. S. Kim, Jackson and Tull Chartered Engineers; D. L. Harame, IBM Microelectronics
- This paper investigates the impact of proton irradiation on the 1/f noise in UHV/CVD SiGe HBTs. The relative degradation of 1/f noise shows a strong dependence on device geometry. An analytical 1/f noise model is developed.
- I-6**
12:05 PM **Neutron Radiation Effects in High Electron Mobility Transistors**
B. Jun, S. Subramanian, Oregon State University; A. Peczalski, Honeywell Sensor Laboratory
- Neutron radiation effects on the I-V characteristics of AlGaAs/GaAs HEMTs and AlGaAs/InGaAs Heterostructure Insulated Gate FETs (HIGFETs) are studied. Physical mechanisms responsible for the observed degradation of the device parameters are discussed.

Technical Program Friday

POSTER PAPERS

PI-1 Correlation Between Non-Ionizing Energy Loss (NIEL) and the Offset Voltage Shift in InP/InGaAs HBTs Caused by Neutron, Electron and Gamma Radiation

A. Shatalov, S. Subramanian, A. Klein, Oregon State University

Non-ionizing energy loss (NIEL) calculations are reported for the neutron, electron and gamma radiation interaction in InGaAs. Correlation between the calculated NIEL values and the experimentally observed offset voltage shift in InP/InGaAs HBTs is presented.

PI-2 Proton, Pion and Neutron Irradiation Effects on Standard and Oxygenated Silicon Diodes

D. Bisello, N. Bacchetta, A. Candelori, A. Kaminski, D. Pantano, R. Rando, I. Stavitski, University of Padova; J. Wyss, University of Cassino

Silicon diodes on standard and oxygenated silicon substrates were irradiated by protons, pions and neutrons to determine the starting material and processing which improve the radiation hardness for high energy physics detector applications.

PI-3 Simulation of Heavy Ion Induced Failure Modes in nMOS Cells of ICs

J. G. Loquet, J. P. David, S. Duzellier, D. Falguère, T. Nuns, ONERA-Toulouse

Simulation results show leakage current induced by impacts of individual heavy ions in an nMOS-FET's bird's beak can account for experimentally observed stuck bits. Parametric extrapolation shows dramatic sensitivity increase for recent LOCOS technologies.

PI-4 Measurements of Interface Recombination Currents by DCIV in γ -Ray Irradiated Power VDMOSFET

M-S. Park, C. R. Wie, State University of New York at Buffalo

Direct-current current-voltage (DCIV) measurement was used for the first time to monitor interface recombination currents in annealed, γ -ray irradiated power VDMOSFETs. The data are correlated with subthreshold I-V data.

PI-5 Radiation Behavior of Irradiated MOSFETs at Various Operation Temperatures

G. I. Zebrev, S. S. Lomakin, D. V. Ivashin, Moscow Engineering Physics Institute

It was shown experimentally that above threshold transconductance in investigated n-MOSFETs degrade after irradiation only in the moderate inversion region. Mechanisms responsible for above threshold transconductance degradation are discussed.

12:20 PM END OF CONFERENCE

RESG NEWS



The Radiation Effects Steering Group (RESG) is elected by the membership of the IEEE NPSS Radiation Effects Committee to provide guidance, policy, and a 'corporate memory' for the annual IEEE Nuclear and Space Radiation Effects Conference. The RESG seeks to promote the dissemination of information in the field of radiation effects, as well as maintain high scientific and technical standards among its members. A complete listing of RESG members appears on one page, near the end of this brochure.

At the core of the RESG, we have seven elected (voting) members. We also have several members appointed by the Chairman and three elected IEEE AdCom members. All of these people are volunteers. All have served in one or more major positions at NSREC. Over the years, RESG has developed a set of operating guidelines, documenting the "how to" for just about every volunteer position at the conference. When good things are done at NSREC (or mistakes made), we update these guidelines. Nothing is left to chance.

In the spring each year, RESG meets at the proposed site for the (year +2) conference. This gives the conference general chairman and RESG an opportunity to discuss specific issues with each new location, before a contract is signed. The RESG summer meeting is held at the NSREC, on the day before the Short Course. In the fall, we always meet at the site of next year's conference.

Not every facility can host the NSREC, as we are pretty demanding. We look for locations that have acceptable room rates in 'resort' settings, along with first-class space for technical sessions, posters, and exhibits. We ask for high-tech audio/visual, gourmet food (at discount prices), easy travel access for international guests, and scenic geographic areas to encourage attendees to bring their families. We ask for no rain in July. Needless to say, we actually find some of these places!

About a year and a half before each NSREC, the technical program chairman, session chairs, guest editors, short course speakers, and awards committee chairs begin the job of organizing every aspect of the technical program. From the call for papers, publicity, paper selection, finding reviewers; to testing the audio/visual, planning socials, selecting menus, making financial predictions; nothing is left to chance. The chairs do it. They also solicit more than 150 volunteers each year, to help with every aspect of the program and publishing. If you have not been asked to serve on one of the 2002 or 2003 conference committees, please raise your hand. You will make 10 new friends - instantly.

As you know, IEEE had difficulty publishing the first all-digital issue of the Transactions on Nuclear Science (TNS) in December 2000. It arrived almost 2 months late, with many typo errors and some fuzzy-looking graphics. RESG has been working with the Nuclear and Plasma Sciences Society (NPSS) Administrative Committee (AdCom) to correct these problems. We made some changes to our graphics submission process. In addition, NPSS has recently upgraded the TNS editorial services from "mid-level" to a "fully edited service" for this coming year. Authors will be pleased to know that they will get a chance to review final proofs of their manuscript, before printing.



Dale G. Platteter
Chairman



Ronald D. Schrimpf
Executive Vice Chairman

RESG NEWS

If you are looking for the NSREC pre-print room, it has moved. It is now a virtual-reality on the web. We hope this change makes it easier to request preprints, directly from each author.

The digital projection system at NSREC 2000 was a success. Over 75% of the authors used it, with very few glitches. Be prepared for even more PowerPoint presentations this year.

We promise to keep you very busy this week. Best of all, we will provide quality opportunities to interact with the authors and volunteers who make NSREC happen. Their names are listed on every page of this brochure. Be sure to thank them.

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. Full membership in IEEE/NPSS offers a one-year subscription to the *IEEE Transactions on Nuclear Science*, a subscription to *IEEE Spectrum* magazine, *NPSS News*, and *IEEE Institute*. 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 25% 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 1989) from an on-line web-based database. What are you waiting for? Talk to Vern Price at the IEEE registration desk.

NSREC PUBLICATIONS

A complimentary copy of the 2001 *Data Workshop Record* and December 2001 issue of the *Transactions on Nuclear Science* will be mailed to each technical session attendee. If you would like to order these NSREC publications, please contact IEEE at 732-981-1393.

A copy of the 2001 *Short Course Notes* will be provided to each Short Course attendee. A very limited number of 2001 *Short Course Notes* are available for \$100 at the registration desk. Our digital *Archive of Radiation Effects Short Course Notebooks* (1980-1998) can be purchased on CD-ROM for \$200 (\$160 IEEE members) by visiting the IEEE *on-line Catalog and Store* at www.ieee.org.

RADIATION EFFECTS COMMITTEE OPEN MEETING

You are invited to attend the IEEE Radiation Effects Committee's Annual Open Meeting on Thursday, July 19, from 4:45 – 6:30 PM in the Bayshore Grand Ballroom. All conference attendees are encouraged to attend. We will discuss this 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

2000 OUTSTANDING PAPER AWARD

Single-Event Upset and Snapback in Silicon-on-Insulator Devices

Paul Dodd, Marty Shaneyfelt, Dave Walsh, Jim Schwank, Gerald Hash, Rhonda Loemker, Bruce Draper, and Peter Winokur, Sandia National Laboratories

2000 MERITORIOUS CONFERENCE PAPER AWARD

Universal Damage Factor for Radiation-Induced Dark Current in Silicon Devices

Joe Srour and Daniel Lo, TRW

2000 DATA WORKSHOP PAPER AWARD

Two poster presentations were selected for the Award.

Radiation Damage and Single Event Effect Results for Candidate Spacecraft Electronics

Martha O'Bryan, Christina Seidleck and Martin Carts, Raytheon; Kenneth LaBel, Robert Reed, Janet Barth, Cheryl Marshall, Donald Hawkins and Anthony Sanders, NASA Goddard Space Flight Center; James Howard, Jr., Hak Kim and James Forney, Jackson and Tull; Ray Ladbury and Scott Kniffin, Orbital Sciences Corporation; Paul Marshall, Consultant; David Roth, James Kinnison and Elbert Nhan, Applied Physics Laboratory; and Kusum Sahu, QSS

A Compendium of Recent Optocoupler Radiation Test Data

Kenneth LaBel, Robert Reed and Cheryl Marshall, NASA Goddard Space Flight Center; Scott Kniffin and Ray Ladbury, Orbital Sciences Corporation; Hak Kim and James W. Howard, Jr., Jackson and Tull; Jerry Wert, Dennis Oberg and Eugene Normand, Boeing; Allan Johnston, JPL; Gary Lum, Lockheed Martin; Rocky Koga and Susan Crain, Aerospace Corporation; James Schwank and Gerald Hash, Sandia National Laboratories; Steve Buchner, James Mann and Larry Simpkins, NRL; Mary D'Ordine, Ball Aerospace; and Martha O'Bryan, Christina Seidleck, Loc Nguyen and Martin Carts, Raytheon

IEEE FELLOWS

Two distinguished members of the radiation effects community were elected to the grade of IEEE Fellow on January 1, 2001.

Timothy Oldham

Army Research Laboratory

John Cressler

Auburn University

Dr. Oldham's citation reads, "For contributions to the understanding of complex time-dependent radiation response of MOS electronic devices." He will be presented with his Fellow certificate during the conference opening on Tuesday, July 17.

Dr. Cressler was presented with his IEEE Fellow Certificate earlier this year. His citation reads, "For contributions to the understanding and optimization of silicon and silicon-germanium bipolar transistors."

Awards

2000 RADIATION EFFECTS AWARD

The 2000 Radiation Effects Award was presented to E.G. Stassinopoulos of the NASA Goddard Space Flight Center during the opening ceremonies of the 2000 conference. Dr. Stassinopoulos received this honor for his pioneering work in the areas of test facility and methodology development, his leadership as a liaison between the US and European radiation effects communities and his notable contributions to the understanding and modeling of the radiation environment with emphasis on practical engineering applications.

2001 RADIATION EFFECTS AWARD

The winner of the 2001 Radiation Effects Award will be announced Tuesday morning, July 17.

2002 RADIATION EFFECTS AWARD

Nominations are currently being accepted for the 2002 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 2002 IEEE NSREC at Phoenix, Arizona in July 2002. 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 Fred W. Sexton, Member-at-Large for the Radiation Effects Steering Group. Fred can be reached at 505-844-3927, sextonfw@sandia.gov.

Industrial Exhibits



"I am happy to once again serve as the Exhibits Chairman for NSREC. As always, the conference committee has chosen not only a functional site, but one of great beauty as well."

*Darrell Craig
Industrial Exhibits Chairman*

The 2001 NSREC's Industrial Exhibit again features the leading worldwide 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 management personnel associated with electronics used in space vehicles, military electronics, and applications requiring radiation tolerance in harsh environments.

The Industrial Exhibit will be held Monday, July 16, Tuesday, July 17 and Wednesday, July 18 at the Westin Bayshore Resort and Marina in beautiful Vancouver, BC, Canada. This year exhibits will have increased conference attendee traffic made possible by several food/social functions held in the exhibit area, of course including the very popular vendor hosted evening social on July 16.

At this writing, several booth spaces are still available, but as in past years, the exhibit area is quickly filling. For additional information regarding the 2001 NSREC Industrial Exhibit, please see: www.nsrec.com, or contact:

Darrell Craig
2001 NSREC Exhibits Chairman
(representing Peregrine Semiconductor)
321-773-3701 fax: 321-773-5884
dcraig@peregrine-semi.com

NSREC – CANADA BOUND

Canada is very receptive to having the 2001 NSREC's Industrial Exhibit in Vancouver. However, Canada is a foreign country and has its own border crossing rules and laws. Please plan ahead and allow extra time prior to the conference to complete the required paperwork.

A Canada Customs Invoice **MUST** accompany every shipment into Canada.

Mendelssohn-Commercial in Vancouver has been selected as our official customs broker. As an exhibitor you are not obligated to use their services, but the conference committee suggests that you do so to facilitate your show needs. Please visit their web site at : www.mend.com, or call Mr. Robert Parker at 604-687-5535. Their free book "Canada Bound" will answer all of your questions about textiles, plants, radio frequency emitting devices, and radiation emitting devices, which include laser pointers, monitors, CD players etc.

The advantage of using a broker such as Mendelssohn is that they post the required bonds and securities with Canada Customs and clear all incoming shipments upon arrival in Canada, or at the show site. They will also expedite your clearance through U.S. Customs via their offices in the United States.

If you are transporting your display material into Canada via commercial carrier, as hand baggage, by air, or in a rental or personal vehicle, **YOU WILL NEED** to complete appropriate Customs forms and have these in place at least a week prior to your border crossing date.

The bottom line for Canada is "they want our conference and trade show business at NSREC 2001." Our bottom line is "we want to comply with their laws and regulations."

Industrial Exhibits

EXHIBIT HALL HOURS

Set-Up:	Monday, July 16	noon – 5:00 PM
Show Hours:	Monday, July 16	6:30 PM - 10:00 PM (reception)
	Tuesday, July 17	7:30 AM - 5:00 PM
	Wednesday, July 18	7:30 AM - 11:00 AM
Tear-down:	Wednesday, July 18	11:00 AM – 5:00 PM

EXHIBITORS

Please check our web site (www.nsrec.com) for a current listing of companies exhibiting at 2001 NSREC.

Actel www.actel.com

Aeroflex UTMC www.utmc.com

AFRL/USBX www.vs.afrl.af.mil

Amptek Inc. www.amptek.com

ATMEL www.atmel-wm.com

BAE Systems www.baesystems.com

Boeing www.boeing.com/defense-space/space/

Cyclotron (Texas A & M) <http://cyclotron.tamu.edu/ref>

Defense Microelectronic Activity (DMEA) www.dmea.osd.mil

Honeywell www.myspaceparts.com

Integrated Systems Engineering, Inc. www.ise.com

International Rectifier hirel.irf.com

Intersil Corporation www.intersil.com

iROC www.iroctech.com

J. D. Instruments www.jdinstruments.net

J. L. Shepherd www.jlshepherd.com

Mission Research Corporation www.mrcmicroe.com

NASA Goddard Space Flight Center sec.gsfc.nasa.gov/lws_set.htm

Northrop Grumman www.northgrum.com

Peregrine Semiconductor Corporation www.peregrine-semi.com

Sandia National Laboratories www.sandia.gov

Xilinx, Inc. www.xilinx.com

Conference Information

ROOMS FOR SIDE MEETINGS

Several meeting rooms are available for use by NSREC attendees during the conference week at the Westin Bayshore Resort and Marina Vancouver. Contact ETC Services at 720-733-2003 or send an e-mail message to etcservices@qwest.net to make meeting reservations in advance of the conference.

To make a meeting room reservation during the conference, see the NSREC registration desk. All audiovisual equipment and refreshments must be coordinated through the hotel and are the responsibility of the attendee.

MESSAGES

604-633-6406
FAX: 604-687-3102

A message board will be located in the lobby just outside the conference room for all incoming messages during the NSREC Short Course and Technical Sessions. Faxes can be sent and received through the hotel's business center. Costs associated with faxes are the responsibility of the attendee.

CONTINENTAL BREAKFAST AND COFFEE BREAKS

The 2001 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 attendees only*.

BUSINESS CENTER

604-687-3377
FAX: 604-687-3102

The Westin Bayshore Resort and Marina has a Business Center located in the lobby adjacent to Stanley Perks snack bar. The Center's hours of operation are 8:00 AM to 4:00 PM Monday to Friday. Services available from the Business Center include computer time, photocopying, fax, and secretarial services. Costs associated with the Business Center services are the responsibility of the attendee. Should conference participants have fax and/or copy needs beyond those hours, the Westin Bayshore Resort and Marina staff will be happy to assist.

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 15, 2001.

**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. Faxed registrations will be accepted with credit card payment. 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. 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 "2001 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 REGISTRATION HOURS

On-site registration for the Conference will be located in the Coat Room near the Grand Ballroom of the Westin Bayshore Resort and Marina. The following is the schedule for on-site registration:

Sunday, July 15	5:00 PM – 9:00 PM
Monday, July 16	7:30 AM – 4:00 PM 6:00 PM – 9:00 PM
Tuesday, July 17	7:30 AM – 5:30 PM
Wednesday, July 18	7:30 AM – 3:00 PM
Thursday, July 19	7:30 AM – 3:00 PM
Friday, July 20	7:30 AM – 10:00 AM

REGISTRATION CANCELLATION POLICY

A \$25 processing fee will be withheld from all refunds. Due to advance financial commitments, refunds of registration fees requested after June 15, 2001 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

WESTIN BAYSHORE RESORT AND MARINA VANCOUVER, BC

604-682-3377

The 2001 IEEE NSREC will be held at the Westin Bayshore Resort and Marina. Situated on Coal Harbour, this waterfront resort is conveniently located between the lively action of downtown Vancouver and the beauty of the thousand-acre Stanley Park. The great shopping and dining of Robson Street and historic Gastown are only minutes away. And complete with its own marina, health club, and indoor and outdoor pools, this resort is an exceptional meeting site.

A \$50 million dollar redevelopment recently refurbished all 320 rooms in the Main Building, equipping them with the latest in technology. Meeting and convention facilities have doubled to almost 48,000 square feet, including 23 meeting rooms and the largest hotel ballroom in Western Canada, the Bayshore Grand Ballroom. The lobby has been entirely redesigned and offers expansive views of the mountains, harbor, city skyline and the seawall - a scenic walkway between Stanley Park and the Vancouver Convention and Exhibition Centre.

New restaurants include: Currents Restaurant & Lounge, Seawall Bar & Bistro (with wrap-around decks over the marina) and Stanley Perks snack bar. The new Marina includes expanded facilities to accommodate transient moorage and yacht charters for dinner cruising, fishing, sightseeing or overnight adventures.

Room amenities include TV with cable, in-room movies, coffee maker, hair dryer, iron and ironing board, complimentary coffee and bottled water, use of Bayshore bathrobes and umbrellas, data port, dual-line telephones, and Kid's Club Activities.

The conference room rate for either single or double occupancy is \$240.00 CAD (Canadian dollars) per night plus tax (or ~\$153.00 USD plus tax based on the March 30, 2001 exchange rate). Triple occupancy is \$265.00 CAD, and quad occupancy is \$290.00 CAD. Children 18 years of age and under are free. The Westin Bayshore Resort and Marina rates are applicable from Friday, July 12, 2001 through Saturday, July 22, 2001. The current exchange rate as of March 30, 2001 is \$1.00 CAD = \$0.636 USD. The current exchange rate can be found at <http://finance.yahoo.com/m3?u>.

In addition, there is an optional "Resort Services Fee" of \$10.00 CAD that you can accept or reject upon check-in. Acceptance of this fee gives all parties in your room: 1) daily admission to the health club and indoor pool, 2) access to unlimited local, credit card calls and 800 toll free numbers (up to 30 minutes per call), and 3) a daily newspaper delivered to your room.

To make reservations, call the Westin Bayshore Resort and Marina at 604-682-3377. Be sure to reference the "IEEE NSREC" when you call to make reservations. Reservations must be guaranteed with a credit card. The cut-off date for room reservations is June 15, 2001. After that date, room accommodations will be confirmed on a space-available basis, and the conference rate will not be guaranteed. However, Vancouver will be in the midst of high-season and rooms will likely sell out very far in advance. **PLEASE BOOK MUCH EARLIER THAN USUAL!!**

EARLY CHECK-OUT FEE

Because this is high-season in Vancouver, hotel space is at a premium. Upon check-in, each guest must reconfirm their check-out date with the hotel. If after doing this, a guest opts to leave early, there is a \$50.00 CAD "early departure" fee added to the hotel bill. So please pay close attention to this detail when asked to verify your hotel departure date.

Registration and Travel

PARKING

The current parking charge (charged to the room) for registered guests is \$18.00 CAD for self-parking and \$18.50 CAD for valet parking. These rates are per car, per day and include “in and out” privileges.

AIRPORT INFORMATION

Vancouver International Airport is served by more than 40 airlines, operating 17 international and 22 U.S. scheduled flights daily. Located ten miles south of the city, the trip to the hotel normally takes from 25 - 40 minutes, depending on traffic. Rental cars are readily available at the airport; reservations are strongly recommended in July by all of the major car rental companies.

The “Vancouver Airporter” is a coach shuttle company offering transfers from the airport to downtown Vancouver hotels. Departing from the arrivals level (Level 2) of both the International and Domestic Terminals, tickets can be purchased at their ticket office on Level 2. For more information call 800-668-3141 (toll free), 604-946-8866, or visit their web site at www.yvrairporter.com.

Sea-Tac International Airport (Seattle, WA) should also be considered since airfares are frequently much lower than those to Vancouver. Approximately three to three and a half hours south of Vancouver, you can rent a car (as long as the vehicle is also returned back to a U.S. location) or utilize the coach shuttle service to Vancouver. Call “Quick Shuttle” at 800-665-2122 (toll free), 604-940-4428, or visit their web site at www.quickcoach.com. Please leave plenty of time for driving as you may encounter delays at the border.

AIRLINE DISCOUNT 800-521-4041

I.D. CODE 527NF

United Airlines is the sole official airline for the 2001 NSREC and is offering special discounted fares for conference attendees. Fares can be purchased for United, United Shuttle, or United Express.

- Travel dates are between July 12 - 22, 2001.
- Destinations are Vancouver, BC, Canada and Seattle, Washington.
- Discounts are from the United States, Canada and Puerto Rico.
- A 5% discount off any published fare, including First Class.
- A 10% discount off applicable BUA or “M” class of service purchased three days in advance.
- A 15% discount off applicable BUA or “M” class of service purchased 60 days in advance.
- These discounts are valid provided all rules and restrictions are met. These discounts cannot be combined with other discounts or promotions.

NOTE: The discount is available for the conference attendee, family member or traveling companions.

ENTRY INTO CANADA

United States citizens (including adults and children) entering Canada **MUST** have a valid passport or birth certificate (with valid photo I.D. such as a driver’s license) with them. Custom officials at the Vancouver International Airport and at the border **WILL** request to see your passport or birth certificate. You may be denied entry into Canada if you do not have the proper identification! Please visit www.cic.gc.ca and follow the prompts for Visitors for Canada for the most current information on entry requirements from all countries.

2001 IEEE NSREC and Short Course Registration Form

NSREC 2001



VANCOUVER BC

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, but if you join during the conference, you will receive a complimentary half-year membership in IEEE and in the IEEE Nuclear and Plasma Sciences Society.

CANCELLATIONS

A \$25 processing fee will be withheld from all refunds. Due to advance financial commitments, refunds of registration fees requested after June 15, 2001 cannot be guaranteed. Consideration of requests for refunds will be processed after the conference.

**Mail or Fax this form and your remittance
(payable to 2001 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 15, 2001.

Early Late

IEEE Member

Short Course	\$230	\$280	\$ _____
Technical Sessions	\$340	\$410	\$ _____

Non-IEEE Member

Short Course	\$290	\$345	\$ _____
Technical Sessions	\$425	\$510	\$ _____

Full-Time Students who are IEEE Members

Short Course	\$105	\$105	\$ _____
Technical Sessions	\$105	\$105	\$ _____

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: **2001 IEEE NSREC**.

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

☐ American Express ☐ Master Card ☐ Visa

Card No. _____

Expiration Date _____

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.**

2001 IEEE NSREC Activities Registration Form

NSREC 2001



VANCOUVER BC

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

Child care, up to age 12, will be available to NSREC attendees participating in the Wednesday Social at no charge for those who pre-register their children by June 15, 2001 (names and ages must be included on this Conference registration form). If you do not pre-register, we cannot guarantee there will be space for your child. For those who wish to arrange for child care at other times during the Conference, contact the Westin Bayshore Resort and Marina at 604-682-3377 and ask for the concierge.

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 your activities registration form is submitted, to receive a refund you must notify ETC Services by fax at 720-733-2046 no later than July 10 (do not fax changes after Thursday, July 12). 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 2001 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 15, 2001. **We strongly encourage early registration; note that the number of tickets available after pre-registration for each event is limited.** Children must be accompanied by an adult during all tours and social events.

	Early	Late	Number Attending	Total Cost
Short Course Conference Reception: Sunday, July 15				
Adult/child	\$0	\$0	_____	
Exhibitor Reception: Monday, July 16				
Adult/child	\$0	\$0	_____	
Granville Island Lunch and Shopping: Tuesday, July 17				
Adult/child (age 4 up)	\$20	\$27	_____	\$_____
Child (age 0-3)	\$0	\$0	_____	
An Evening on English Bay: Wednesday, July 18				
Adult	\$30	\$37	_____	\$_____
Child (age 0-12)	\$15	\$20	_____	\$_____
Child care (age 0-6)	\$0	\$0	_____	
Child care (age 7-12)	\$0	\$0	_____	
Grouse Mountain Tour, Logging Show: Thursday, July 19				
Adult	\$16	\$21	_____	\$_____
Child (age 7-12)	\$5	\$7	_____	\$_____
Child (age 0-6)	\$0	\$0	_____	

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: **2001 IEEE NSREC**.

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

☐ American Express ☐ Master Card ☐ Visa

Card No. _____

Expiration Date _____

Signature _____

Social Program



"We hope you will enjoy the social program which reflects the food and landscape of Vancouver."

*Joe Benedetto
Local Arrangements Chairman*

The 2001 IEEE NSREC Committee has made arrangements for everyone to enjoy the many facets of Vancouver through the various social events planned. We strongly encourage you to register as early as possible for the social events as we are limited in the numbers we can accommodate. While last minute accommodations can be made, transportation concerns and preparations are necessary to guarantee the arrangements.

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

**SUNDAY, JULY 15
6:00 TO 9:00 PM
SHORT COURSE
RECEPTION**

You are invited to join us for refreshments and renew old acquaintances in the Stanley Park Ballroom. Food and drink will be served from 6:00 to 9:00 PM. The registration desk will be open from 5:00 to 9:00 PM for conference registration. Dress is casual.

**MONDAY, JULY 16
6:30 TO 10:00 PM
INDUSTRIAL EXHIBITS
RECEPTION**

A reception will be hosted by the NSREC exhibitors in the Stanley Park Ballroom and pre-function area. Along with meeting the leading companies of the radiation-hardened industry, there will be a large buffet of salads, vegetables, meats, seafood and desserts to enjoy. Dress is casual.



Photograph courtesy of Dave Bushmire

Social Program

**TUESDAY, JULY 17
11:00 AM TO 3:00 PM
GRANVILLE ISLAND
SHOPPING TRIP AND
LUNCH AT BRIDGES
RESTAURANT**

Nestled in the center of Vancouver is a friendly little oasis. An island that seduces the senses, Granville Island is a paradise filled with an unbelievable assortment of seafood, fruit, vegetables, plants, flowers, and almost everything imaginable. It is laden with restaurants, theatres, galleries, and studios occupied by both artists and craftspeople. It is the place to go to sample the offerings of the 200+ shops in the public market or watch as artisans work on their creations. More than 8 million visitors travel and shop at Granville Island each year!



Photograph courtesy of Tourism Vancouver

Buses will depart the Westin Bayshore Resort and Marina at 11:00 AM for the 30 minute ride to Granville Island. First stop will be Bridges Restaurant where NSREC companions will lunch in a private room. With a view of False Creek, you will dine on salad, pasta with baby shrimp, and dessert. Lunch will conclude at 12:30 PM, and visitors will have ample time to visit the shops. Buses will leave Granville Island promptly at 2:30 PM for the return ride to the resort. This is a casual event, shorts/slacks are appropriate, and good walking shoes are recommended. Strollers can be placed on the bus.

**TUESDAY, JULY 17
EVENING**

There are no scheduled NSREC events for Tuesday evening. Please take this time to visit the many sights of Vancouver and enjoy the fine restaurants. The Westin Bayshore Resort and Marina concierge can give you many recommendations for dining, theatre, and shopping. Enjoy!

Social Program

**WEDNESDAY, JULY 18
6:00 TO 9:30 PM
AN EVENING ON
ENGLISH BAY
CONFERENCE SOCIAL**

Mountains and water - both salt and fresh - create Vancouver's dramatic setting. Vancouver and its neighboring communities contain hundreds of miles of shoreline. Most locals agree that the best way to see Vancouver is with a sunset cruise around the city and along some of the vast rugged Coast Mountains that stretch north to Alaska.

Please join us as we set sail in style for three hours on "*An Evening on English Bay*". We will enjoy fine dining and spectacular scenery aboard the Westin Bayshore Resort and Marina yachts as we travel from the Burrard Inlet around Stanley Park under the Lions Gate Bridge and out onto English Bay. A sit-down dinner will be held inside the yachts starting at 7:30 PM. A delicious menu, including an appetizer, salad, twin entrée of steak and salmon, and dessert, will be as enjoyable as the scenery.



Photograph courtesy of Tourism Vancouver

The Westin Bayshore Resort and Marina Yachts are moored within easy walking distance from the Westin Bayshore Resort and Marina Tower entrance. Signs or personnel will mark the way. Please plan on arriving at the Westin Marina at 6:00 PM to board the yachts. We will set sail at approximately 6:30 PM and return at 9:30 PM.

Please wear comfortable shoes and clothing and bring a light jacket or sweater, as the summer evening air on English Bay can become somewhat cool. Don't forget your camera! Strollers are NOT recommended on the yachts.

CHILD CARE

Child care, up to age 12, will be available to NSREC attendees participating in the Wednesday Social at no charge for those who pre-register their children by June 15, 2001 (names and ages must be included on the Conference registration form). If you do not pre-register, we cannot guarantee that there will be space for your child. For those who wish to arrange for child care at other times during the Conference, contact the Westin Bayshore Resort and Marina at 604-682-3377 and ask for the concierge.

Social Program

**THURSDAY, JULY 19
11:00 AM TO 4:30 PM
GROUSE MOUNTAIN -
THE PEAK OF VANCOUVER
AND WEST COAST
LOGGING SHOW**

Everything that makes Vancouver great comes together at Grouse Mountain. This wilderness paradise is a short 30 minute drive from the Westin Bayshore Resort and Marina, through Stanley Park and across the Lion's Gate Bridge. Once at the top of the mountain plateau, there's a wealth of things to see and do. Get in touch with nature on one of Grouse Mountain Adventure Center's guided walking tours, or tour an extraordinary collection of 16-foot tall wooden sculptures carved by internationally renowned chain saw artist Glen Greensides. Enter Grouse Mountain's mile high Theatre in The Sky, Canada's first high-definition video presentation, "Born to Fly". While on Grouse Mountain, don't forget to take the Peak Chairlift to the spectacular 4100' summit with its 360 degree panoramic view. Also, make sure to see the West Coast Logging Show.

Buses will depart the resort at 11:00 AM. Upon arrival at Grouse Mountain, attendees ascend to the top of Grouse Mountain by way of an Aerial Skyride (ten minutes). This is the **ONLY** way to the top on this tour! The Skyride will take companions on a scenic one-mile journey high above the second growth forests and between



Photograph courtesy of Tourism Vancouver

the mountain peaks. Lunch on the mountain is on-your-own. You can choose from a fabulous array of restaurants with the finest and freshest in West Coast and seafood dishes. From fine dining in The Observatory to casual fare in Bar 98, there is a menu to please any palate. A listing of times for the events on Grouse Mountain are posted in the main lodge. The buses will leave the Grouse Mountain parking lot to return to the resort promptly at 4:00 PM (make sure to leave enough time for the skyride down to the parking lot!) Be sure to wear comfortable shoes and clothing (you'll probably find yourself walking quite a bit during the visit). Also bring a light jacket since it can be quite cool on a cloudy or windy day. Strollers can be stored on the bus and the Skyride, but Grouse Mountain is primarily gravel and dirt trails.

AEROBICS

Work off the previous day's stress and start your morning off with Dave Bushmire for some aerobic exercise. Dave will lead various exercise routines Tuesday, Wednesday, and Thursday. A good quality exercise shoe is recommended. Times and locations will be posted and available at the NSREC registration desk.

WESTIN'S KID'S CLUB

The Westin's Kid's Club has many activities and will be enjoyed by all NSREC Kids! Please ask for a Kid's Club registration packet at the Westin Front Desk when you register.

ACTIVITIES CANCELLATION POLICY

To encourage advance registration for conference social activities, NSREC 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 your activities registration form is submitted, request a refund by notifying ETC Services by fax at 720-733-2046 but no later than July 10.

Local Activities

GENERAL INFORMATION

In 1858 thousands of Americans led the gold rush on the Fraser River and stirred the British to establish the colony of British Columbia. In 1871 British Columbia joined Canada, and Vancouver was incorporated 15 years later on April 6th, 1886. Vancouver's ocean and mountain views, and the easy availability of sailing, skiing, seawall walks, and sandy beaches make it an international tourist attraction.

The lushness of this city is evidence that it does rain in Vancouver. While weather patterns generate weeks of gray skies in the winter, summer is filled with long warm sunny days, with July being the driest month all year. The Nuclear and Space Radiation Effects Conference will be held at the award winning Westin Bayshore Resort and Marina. The Westin Bayshore is Vancouver's only downtown resort and marina. It overlooks the famous 1000-acre Stanley Park with breathtaking views of the Coastal Mountains. Between conference sessions, early in the morning, or during an evening stroll, be sure to take in the scenery along the Sea Wall.

CAPILANO SUSPENSION BRIDGE AND PARK

The Capilano Suspension Bridge is a world-famous suspension footbridge and is Vancouver's oldest tourist attraction. Originally built in 1889, today's bridge is the 4th bridge at this location, and measures 450 feet (140 meters) across and 230 feet (70 meters) above the Capilano River. The park offers guided tours, native carving center, award winning gardens, and restaurants. The park is located on the North Shore, 10 minutes from the Lions Gate Bridge. Admission fee. 3735 Capilano Road, North Vancouver, BC, 604-985-7479.



Photograph courtesy of Tourism Vancouver

VANCOUVER AQUARIUM IN STANLEY PARK

More than 35,000 animals from around the world are kept at the Vancouver Aquarium in Stanley Park. The aquarium is just minutes from the Westin Bayshore Resort and Marina in Stanley Park and offers many special events and interactive programs. Admission fee. 604-659-3400.

CANADA PLACE

Take a short walk along the Sea Wall to Canada Place; the huge Teflon-coated sails have become Vancouver's most recognized landmark. Spend an hour or so touring this usually busy area and watching the cruise ships getting ready for their next voyage. Along the Sea Wall, you can watch the seaplanes coming in and out of Coal Harbor. Free.

Local Activities

PACIFIC SPACE CENTER

Showcasing state-of-the-art technology with presentations about space, the center contains several interactive exhibits and simulations as well as a full motion simulator and multi-media presentations. Located in Vanier Park near Granville Island. Admission fee. 1100 Chestnut St., Vancouver, BC, 604-738-7827.



Photograph courtesy of Tourism Vancouver

UNIVERSITY OF BRITISH COLUMBIA MUSEUM OF ANTHROPOLOGY

This museum houses one of the world's finest collections of Northwest Coast and First Peoples art in an award-winning building overlooking the mountains and sea. The museum is located on the University of British Columbia campus. Admission fee. 6393 NW Marine Drive Vancouver, BC, 604-822-5087.

SCIENCE WORLD AND ALCAN OMNIMAX THEATRE

There are hundreds of hands-on exhibits at Science World, including Canada's first 3D laser theatre and spectacular OMNIMAX films on the world's largest dome screen. Science World is located at the end of False Creek. Admission fee. 1455 Quebec Street, 604-443-7474.

VANCOUVER ART GALLERY

This gallery features visual art exhibitions and elegant spaces with contemporary regional and international exhibitions in Western Canada's largest public art gallery. The Vancouver Art Gallery is located close to the Westin Bayshore Resort and Marina. Admission fee. 750 Hornby St., 604-662-4714.

Local Activities

SHOPPING

Shopping in Vancouver can be a full time occupation! Vancouver offers tremendous variety from Robson Street, Granville Island, Gastown, Yaletown and Commercial Drive. Vancouverites can shop with the best of them. Whether you're searching for designer labels or retro furniture, ceramic mugs or Cartier jewelry, hand-blown glass sculptures or salt water taffy, Italian shoes or organic green tea, Vancouver has it all.



Photograph courtesy of Tourism Vancouver

Robson Street shopping begins at Robson and Denmen (a short two blocks from the Westin Bayshore Resort and Marina) and continues for almost a full mile. The busiest shopping area on Robson Street is approximately a half mile from Denmen. Gastown, the oldest part of Vancouver, offers its own shopping experience. Most of the shopping in Gastown can be found along Water Street (also the site of Vancouver's steam powered clock). The center of Gastown is slightly more than one mile from the Westin Bayshore Resort and Marina.

WEATHER AND CLOTHING

Vancouver enjoys warm, comfortable summers with daytime high temperatures in July just above 70 degrees F (20 degrees Celsius). Evenings are a bit cooler, particularly if you venture out onto the water, so be sure to pack a light jacket and sweater. July is also the driest month in Vancouver averaging only 1.4 inches of rain and a full 24 days without any measurable precipitation.

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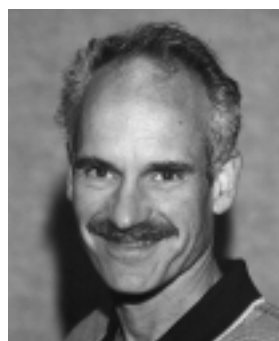
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ANNOUNCEMENT and FIRST CALL FOR PAPERS



2002 IEEE NUCLEAR AND SPACE RADIATION EFFECTS CONFERENCE

Short Course and Radiation Effects Data Workshop



July 15 - 19, 2002
Pointe South Mountain Resort
Phoenix, Arizona

www.nsrec.com

Sponsored By

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The 2002 IEEE International Nuclear and Space Radiation Effects Conference will be held July 15 - 19 in Phoenix, Arizona at the Pointe South Mountain Resort. 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 offered on July 15, 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 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
- SOI and SOS Technologies
- 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 Temperature Effects
- Single-Event Effects
- Novel Device Structures, such as MEMs

Space, Atmospheric, and Terrestrial Radiation Effects

- Characterization and Modeling of Space and Terrestrial Radiation Environments
- Space Weather Effects
- Spacecraft Charging

Hardness Assurance Technology and Testing

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

Commercial Space Systems

New Developments of Interest to the Radiation Effects Community

PAPER SUMMARY DEADLINE: FEBRUARY 1, 2002

PROCEDURE FOR SUBMITTING SUMMARIES

Authors must conform to the following requirements:

1. Mail two paper copies or electronically submit one Adobe Acrobat PDF file of (a) an abstract no longer than 35 words attached to (b) an informative summary (appropriate for 12-minute oral or a poster presentation). The summary must furnish sufficient details to permit a meaningful review and clearly indicate (a) the purpose of your work, (b) significant results, and (c) how your work advances the state of the art.
2. The summary should be no less than two nor more than four pages in length, including figures and tables. *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. Type your summary using 11 point or greater type on either U. S. Standard, 8.5 in. (21.6 cm) x 11 in. (27.9 cm), or A4, 21 cm x 29.7 cm, white paper, with 1 in. (2.5 cm) margins on all four sides. Please include title, names and company affiliations of the authors, and company address (city and state). Underline the name of the author presenting the paper.
4. Obtain all corporate, sponsor, and government approvals and releases necessary for presenting your paper at an open-attendance international meeting.
5. Include a cover letter giving (a) the names, complete addresses, telephone and FAX numbers, and e-mail addresses of all authors, and (b) the session that you prefer for presentation (if you have a preference). *Authors are also encouraged to state their preference for an oral or poster presentation in the conference, or a poster at the data workshop.* 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.

Paper or PDF Summaries must be received by February 1, 2002

Address paper summaries (2 copies) to:

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Electronic submissions to:

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will be accepted as Adobe Acrobat PDF attachments only

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 2002), 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.

PHOENIX, ARIZONA

Located along the banks of the Salt River, where early Hohokam Indians first settled, Phoenix is saddled between dramatic mountain ranges to the north, south and east. Greater Phoenix is comprised of 2.8 million residents living in 22 incorporated cities - including Scottsdale, Tempe and Mesa - that cover the 9,127 square miles of Maricopa County.

Phoenix offers a multitude of cultural and recreational activities. Greater Phoenix gives visitors the opportunity to enjoy countless activities ranging from outstanding museums, galleries, performing arts and fine dining, to horseback riding and cowboy shoot-outs. The climate makes outdoor activities, such as desert jeep tours, hot-air ballooning, and water recreation a way of life. And, Phoenix has garnered well-earned praise as one of the world's top five golf destinations.



Photograph courtesy of Jeff Black

The Pointe South Mountain Resort (www.pointesouthmtn.com) is the largest all-suite resort in the Southwest with 640 suites, ideal conference meeting space for NSREC, and four dining establishments - all located on 600 acres adjoining South Mountain Park. Six swimming pools, located in scenic courtyards, provide convenience and variety to sunbathers and recreational swimmers. The Phantom Horse Spa and Fitness Club offers aerobics and aqua-aerobic classes, a complete range of cardiovascular equipment, weight machines and free weights, as well as a variety of massage therapies and diagnostic services. World-class tennis and golf facilities round out your recreational opportunities at the Pointe.

Conference Facilities



WESTIN BAYSHORE LOBBY



TO THE WESTIN BAYSHORE RESORT AND MARINA

From Vancouver International Airport (YVR)

Depart airport via main exit onto Grant McConachie Way
 Cross the Arthur Lang Bridge, take Granville Street exit
 Remain on Granville Street (~6 km/3.8 miles)

From Seattle (US Interstate 5)

US Interstate 5 becomes Canada Highway 99
 Highway 99 merges with Granville Street ~40 miles from
 the US and Canada border

From Granville Street, cross the Granville Street Bridge, take Seymour Street exit
 From Seymour Street, turn left onto W Georgia Street
 From W Georgia Street, turn right onto Cardero Street
 The Westin Bayshore Resort and Marina is straight ahead