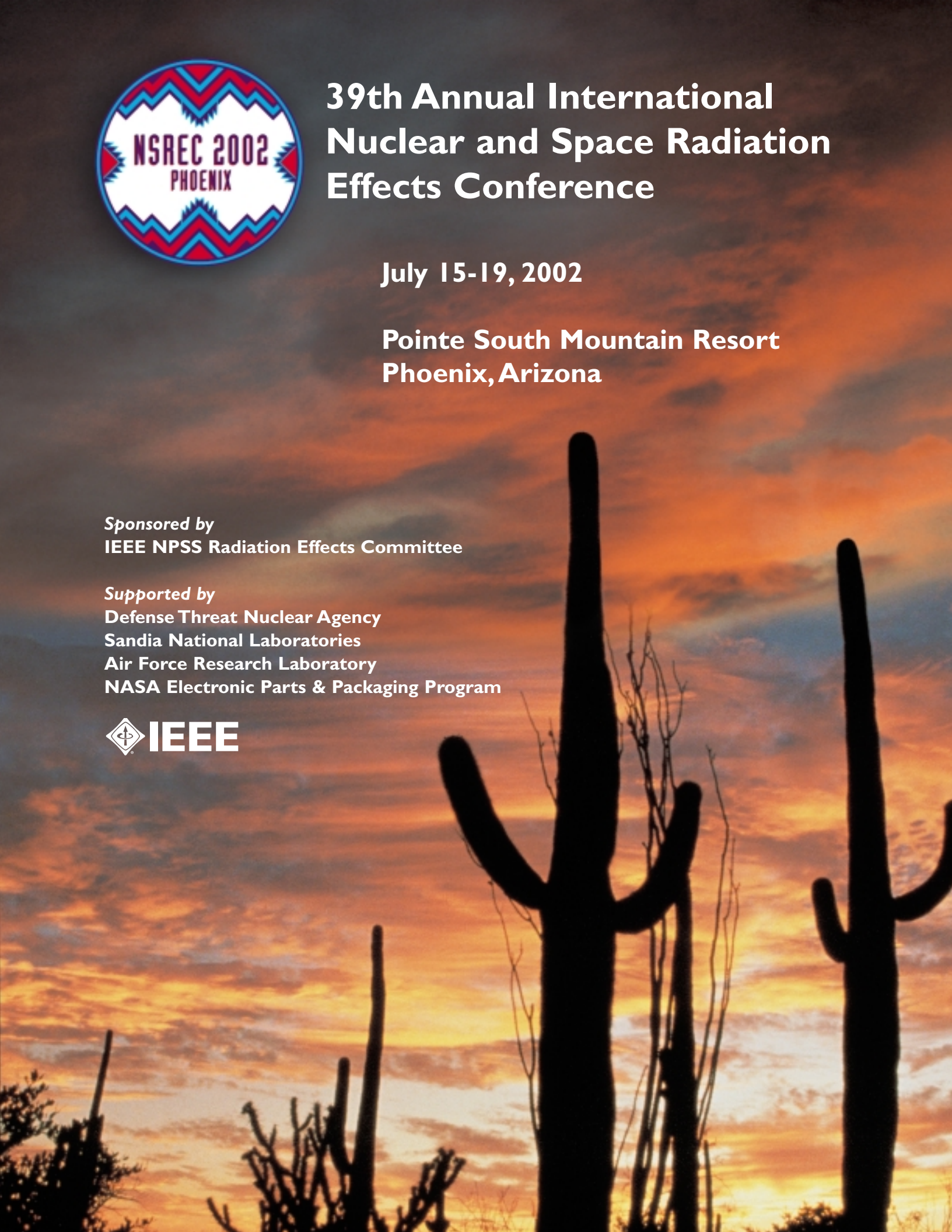

39th Annual International Nuclear and Space Radiation Effects Conference

July 15-19, 2002

Pointe South Mountain Resort
Phoenix, Arizona

Sponsored by
IEEE NPSS Radiation Effects Committee

Supported by
Defense Threat Nuclear Agency
Sandia National Laboratories
Air Force Research Laboratory
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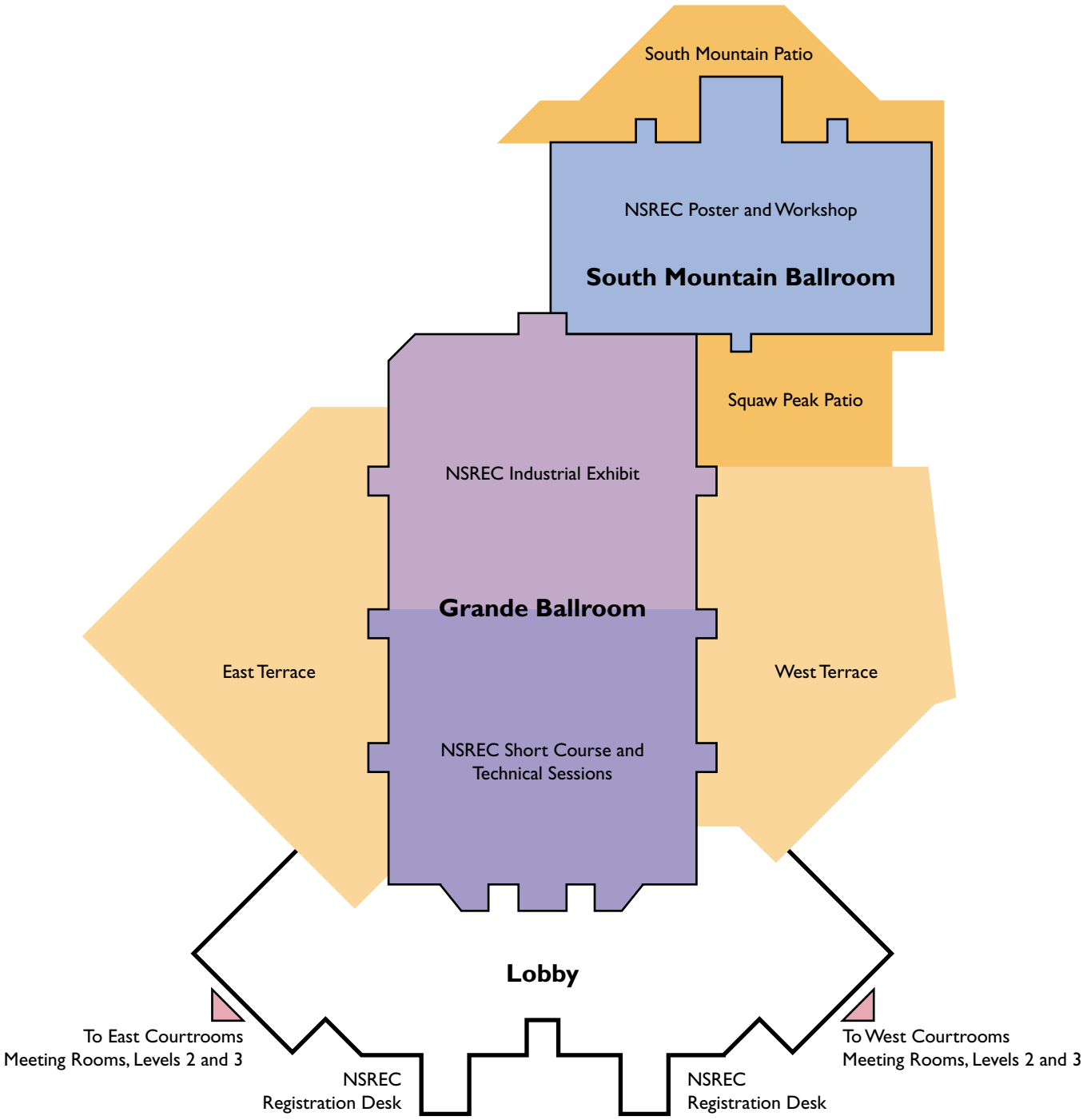
Conference Facilities



Schedule

Time	Monday July 15	Tuesday July 16	Wednesday July 17	Thursday July 18	Friday July 19
7:30	[7:30] Continental Breakfast	[7:30] Continental Breakfast	[7:30] Continental Breakfast Industrial Exhibits Area	[7:30] Continental Breakfast	[7:30] Continental Breakfast
8:15	[8:15] **Short Course Introduction** Paul V. Dressendorfer Grande Ballroom Front	[8:15] **Conference Opening** Grande Ballroom Front	[8:15] **Invited Talk** **Radiation Damage in Structured Silicon Semiconductor Detectors** Dr. Gerhard Lutz Grande Ballroom Front	[8:15] **Invited Talk** **Water and Ingenuity in the Semi-arid Southwest - What is the True Limit to Growth?** Dr. Soroosh Sorooshian Grande Ballroom Front	[8:15] **Invited Talk** **Living and Working in Space** Carl Walz Grande Ballroom Front
8:30	[8:30] **The Radiation Environment Outside and Inside a Spacecraft** Joe Mazur				
9:00		[8:55] **Session A** Basic Mechanisms	[9:15] **Session E** Radiation Concerns in High Energy Physics	[9:15] **Session H** Singel Event Effects, Mechanisms and Models	[9:15] **Session J** Devices and Integrated Circuits
9:30					
10:00	[10:00] Break	[9:50] Break	[10:25] Break Industrial Exhibits Area	[10:15] Break	[10:30] Break
10:30	[10:30] **Total Dose Effects in MOS Devices** Jim Schwank	[10:20] **Session A** (continued)	[10:45] **Session F** Isolation Technology	[10:40] **Session H** (continued)	[10:50] **Session J** (continued)
11:00					
11:30		[11:20] Lunch Note: Industrial Exhibits Open 11:45	[11:35] Lunch Note: Industrial Exhibits Close 3:30	[11:30] Lunch	
12:00	[12:00] Short Course Lunch Grande Ballroom Back				[12:05] End of Conference
12:30					
1:00		[1:00] **Session B** Space and Terrestrial Environments	[1:00] **Session G** Hardness Assurance	[1:00] **Session I** Singel Event Effects, Devices and Integrated Circuits	
1:30	[1:15] **From Carriers to Contacts, A Review of SEE Charge Collection Processes** Todd R. Weatherford				
2:00					
2:30	[2:45] Break	[2:25] **Session C** Dosimetry and Facilities	[2:25] **Data Workshop** South Mountain Ballroom	[2:40] **Poster Session** South Mountain Ballroom	
3:00		[3:00] Break Industrial Exhibits Area			
3:30	[3:15] **Radiation Hardness Assurance for Space Systems** Christian Poivey	[3:30] **Session D** Photonic Devices and Integrated Circuits			
4:00					
4:30	[4:45] Wrap-up		[4:30] End of Session		
5:00	[5:00] Exam (for students requesting CEU credit only)	[5:10] End of Session		[5:00] End of Session	
5:30	[5:30] End of Short Course			[5:15 to 6:45] Radiation Effects Committee Open Meeting Grande Ballroom Front	
6:00			[6:00 to 10:30] Conference Social **Corona Ranch Mexican Rodeo**		
6:30	[6:30 to 9:30] Conference Reception Entire Grande Ballroom				
7:00		[7:00 to 10:00] Industrial Exhibits Reception Entire Grande Ballroom			

Contents

Chairman's Invitation

"On behalf of the 2002 Conference Committee, I invite you to join us in Phoenix. We're putting on a great technical conference in a terrific venue; enjoy the great American Southwest!"

Ken Hunt
General Chairman

On behalf of the NPSS Radiation Effects Committee, it is my pleasure to invite you to attend the 39th Annual International Conference on Nuclear and Space Radiation Effects (NSREC) to be held July 15-19, 2002 at the Pointe South Mountain Resort in Phoenix, Arizona. As with previous NSRE Conferences, 2002 will offer an outstanding technical program, a one-day Short Course preceding the technical program, a Radiation Effects Data Workshop, and an Industrial Exhibit. We welcome attendance by engineers, scientists, managers and other interested persons from throughout the world. Highlights of the conference are given below, and you will find more complete details in this booklet. You can also access this information at http://www.nsrec.com.

The Technical Program Chairman, Tom Turflinger (NAVSEA Crane) and his program committee have put together an outstanding set of contributed papers that have been organized into ten sessions of oral and poster presentations and a Radiation Effects Data Workshop. In addition, there are three informative invited talks that should interest attendees and their families.

The Radiation Effects Data Workshop organized by Susan Crain (The Aerospace Corporation) and the Poster Session chaired by Robert Reed (NASA Goddard Space Flight Center) will be held adjacent to each other in the Resort's South Mountain Ballroom, providing a convenient venue for attendee and author discussions.

The theme of this year's Short Course, organized by Paul Dressendorfer (Sandia National Laboratories), is "Radiation Effects – From Particles to Payloads." The Short Course will be given on Monday, July 15th and will cover the issues involved in radiation effects for space systems, from the characteristics of the radiation environment continuing on through how one assures that a satellite will actually work as desired in that environment. It will lay a foundation of basic background material and build upon that to discuss some of the advanced technologies and approaches coming into use.

Starting with a reception on Tuesday evening, this year's Industrial Exhibit, organized by Chuck Tabbert (Peregrine Semiconductor) will provide an opportunity for conference attendees to discuss the latest radiation-resistant electronics, radiation analysis and testing equipment and facilities, and hardware and software simulation products and services.

The Pointe South Mountain Resort is an all-suites tennis and golf complex just south of the Phoenix Sky Harbor Airport. Nestled against South Mountain Park, the Pointe combines tremendous conference facilities, Mediterranean-style accommodations, and world-class recreation opportunities with Southwestern friendliness and hospitality. A variety of social events have been planned to give attendees and guests opportunities for informal interaction. Jeff Black (Mission Research Corporation), this year's Local Arrangements Chairman, assisted by Steve Clark (Air Force Research Laboratory), has put together a great social program. Companions will have the opportunity to enjoy High Tea in the Resort's famous Pointe In Thyme restaurant and a leisurely visit to the world-famous Heard Museum. The highlight of the social program will be a Mexican-style dinner and rodeo on Wednesday evening at near-by Corona Ranch. Attendees and their guests will enjoy a unique experience found only in the desert Southwest!

Your 2002 Conference Committee has worked hard to make sure that you enjoy both the technical and social aspects of this year's NSREC. We look forward to seeing you in Phoenix.

Short Course Program

RADIATION EFFECTS - FROM PARTICLES TO PAYLOADS

GRANDE BALLROOM - MONDAY, JULY 15

7:30 AM **REGISTRATION/CONTINENTAL BREAKFAST**

8:15 AM **SHORT COURSE INTRODUCTION**
Paul V. Dressendorfer
Sandia National Laboratories

8:30 AM **THE RADIATION ENVIRONMENT OUTSIDE AND INSIDE A SPACECRAFT**
Joe Mazur
The Aerospace Corporation

10:00 AM **BREAK**

10:30 AM **TOTAL DOSE EFFECTS IN MOS DEVICES**
Jim Schwank
Sandia National Laboratories

12:00 PM **SHORT COURSE LUNCHEON**

1:15 PM **FROM CARRIERS TO CONTACTS, A REVIEW OF SEE CHARGE COLLECTION PROCESSES**
Todd R. Weatherford
U.S. Naval Postgraduate School

2:45 PM **BREAK**

3:15 PM **RADIATION HARDNESS ASSURANCE FOR SPACE SYSTEMS**
Christian Poivey
NASA Goddard Space Flight Center

4:45 PM **WRAP-UP**

5:00 PM **EXAM** (only for students requesting CEU credit)

5:30 PM **END OF SHORT COURSE**

NOTE: All short course attendees will receive a special CD-ROM containing the complete notes from all previous NSREC short courses (1980-2002). The notes will be electronically searchable and will include all figures and text.

Short Course

COURSE DESCRIPTION

Beginning with the launch of Sputnik I in 1957, satellites have had a major impact on our lives. They have allowed advancements in areas as diverse as agriculture, forestry, mineral and land resources, water and marine resources, geology, geophysics, mapping, and earthquake prediction. They have enabled almost instant worldwide telecommunication, including telephone, television, and data services. They have greatly enhanced our ability to understand and predict meteorological events and even to know our location within a stone's throw anywhere on the earth's surface. They are an essential element of military reconnaissance. On a more far-reaching scale, much of what we know about the sun, moon, the planets in the solar system, and interplanetary space is a direct result of exploratory satellites.

The key enablers for this progress are the electronic and photonic devices and subsystems that provide many of the critical functions for satellite system operations. These devices and subsystems must survive and operate properly in the space radiation environment. The 2002 Short Course, "Radiation Effects - From Particles to Payloads", is a cohesive set of talks on the issues of concern for satellite systems. The morning will begin with an overview of the space radiation environment followed by a discussion of total dose effects in MOS devices. After lunch there will be a section covering single event effects. The final talk will tie all the earlier discussions together by detailing how one assures the satellite system will work as intended in the space environment.

Paul Dressendorfer of Sandia National Laboratories, the 2002 NSREC Short Course Chairman, has assembled a highly qualified team of experts to address these topics. The instructors are Joe Mazur of the Aerospace Corporation, Jim Schwank of Sandia National Laboratories, Todd Weatherford of the Naval Postgraduate School, and Christian Poivey of the NASA Goddard Space Flight Center. The four short course segments will be one hour and fifteen minutes each, with a fifteen minute question-and-answer period at the end of each segment. A luncheon will be served to all registered attendees.

CONTINUING EDUCATION UNITS (CEUs)

As in previous short courses, 0.6 CEUs endorsed by the IEEE and the International Association for Continuing Education and Training (IACET) will be available to qualified students. The IEEE is an authorized CEU sponsor member of the IACET. IEEE guidelines for offering CEU credit will be followed. Thus, to qualify for CEU credit a person must be a registered attendee of the Short Course and must pass a written examination with a score of 75% or greater. The examination will be given immediately after the last segment of the Short Course, will be open book, and will consist of approximately 20 multiple-choice questions covering the material presented in the Short Course. A certificate of completion will be mailed to all students who request and qualify for it.

Short Course

SHORT COURSE CHAIRMAN

"This year's short course will provide a unique look into many of the considerations involved in putting together reliable satellite systems. We have an outstanding group of instructors presenting the material in what should be a very interesting and informative set of talks."

Paul V. Dressendorfer

Paul V. Dressendorfer received the B.S. degree from the California Institute of Technology in 1972, and the M.S., M.Phil., and Ph.D. degrees from Yale University in 1973, 1974, and 1978, respectively. Since joining Sandia National Laboratories in 1978, his research activities and publications have covered a wide range of areas including semiconductor device physics, basic radiation damage mechanisms, characterization of radiation effects, hardened technology development, hardness assurance, optoelectronic devices, multichip modules, advanced electronic and microsystem packaging, thermal management, frequency devices, sensors and transducers, and microsystem electronics. He has served the radiation effects community in a variety of roles at NSREC (including session chairman, short course instructor, and general conference chairman) and as vice-chairman of publications for the Radiation Effects Steering Group. He is the Editor of the IEEE TRANSACTIONS ON NUCLEAR SCIENCE, the Editor-in-Chief for the IEEE Nuclear and Plasma Sciences Society, and a Fellow of the IEEE.

Joe Mazur received degrees in physics from the University of Chicago (A.B. 1985) and the University of Maryland (M.S. 1987 and Ph.D. 1991). He became a member of the technical staff in the Space Sciences Department at The Aerospace Corporation in 1997. Dr. Mazur is now a research scientist at The Aerospace Corporation where he is active in the design and construction of advanced particle detectors and the analysis of space physics data from many spacecraft. He has studied the composition and energy spectra of solar energetic particles observed in interplanetary space as well as trapped heavy ions in the Earth's magnetosphere. Dr. Mazur's current research interests include solar flare particle composition and transport, source populations for particles accelerated at interplanetary and corotating shocks, and space environment effects on spacecraft. He is a co-investigator on the NASA Solar, Anomalous, and Magnetospheric Particle Explorer (SAMPEX) and the NASA/ESA Ulysses spacecraft, and an instrument investigator on the NASA Advanced Composition Explorer (ACE) spacecraft. He has authored or co-authored more than 40 scientific publications on interplanetary and trapped energetic particles. He is a member of the American Geophysical Union and an associate editor of *Geophysical Research Letters*.

THE RADIATION ENVIRONMENT OUTSIDE AND INSIDE A SPACECRAFT

Joe Mazur
The Aerospace Corporation

Joe Mazur will set the stage for the rest of the course by describing the environment of space. He will illustrate the hazards that exist and their impact on space systems. The sources of space radiation will be explained along with their variations caused by orbit and by space weather phenomena. Since when designing a system it is necessary to know the environment experienced by electronics inside the spacecraft, the effects of shielding and how to calculate those effects will be covered. Examples of the different phenomena and how they have impacted different satellite systems will be presented.

Introduction

Space Environment Hazards
- Known Hazards
- Examples of Impacts on Space Systems
- Single Event Effects and Total Dose

Sources of Space Radiation
- In Interplanetary Space
- In the Sun's Magnetic Field
- Within the Earth's Magnetosphere
- Radiation Environment in Typical Spacecraft Orbits

Space Radiation Measurement Techniques
- Fundamental Concepts
- Examples of Space Radiation Detectors and Spectrometers

Effects of Spacecraft Shielding
- Analogy with the Earth's Atmosphere
- Complexities
- Simulation Tools (e.g. EGS4)
- Relevance to Widely Different Missions
- Examples

Anomalies Due to Radiation Environment
- Difficulties in Establishing Cause in On-Orbit Events
- Examples

Variability of Radiation Environment and Significant Unknowns
- Infancy of the Field
- Examples from Current Research
- How Bad Can It Get?

Conclusion

James R. Schwank received his B.S., M.S., and Ph.D. degrees in Electrical Engineering from the University of California at Los Angeles. Jim joined Sandia National Laboratories in 1979, and is a Principal Member of the Technical Staff in the Radiation Technology, Simulation, and Assurance Department. At Sandia Jim has been involved in programs investigating the mechanisms of radiation effects in semiconductor devices (including the discovery of the rebound effect), developing radiation-hardened devices, and improving hardness assurance test methods. He is currently investigating SOI technology for radiation-hardened applications. For the NSREC, he has served as General Conference Chairman, Short Course Chairman, Short Course Instructor, Publicity Chairman, and is presently the Secretary of the Radiation Effects Steering Group. He was a Technical Program Chairman for the HEART Conference, Guest Editor for the Journal of Radiation Effects, and served on the IEEE SOI Conference Technical Program Committee. Jim is the author of more than 100 publications including papers that received the 1984, 1988, 1995, 1996, 2000, and 2001 NSREC and 1985, 1990, and 1995 HEART Conference Outstanding Paper Awards. He is also the recipient of an R&D 100 Award, an Industry Week Technology Award, and a Discover Magazine Technology Award. Jim is an IEEE Fellow and a member of the NPSS.

TOTAL DOSE EFFECTS IN MOS DEVICES

Jim Schwank
Sandia National Laboratories

Jim Schwank will discuss the effects of total dose on MOS devices. He will first provide an overview of the basics of radiation damage. This background will lead into a more detailed discussion of the limitations and issues for device response, including concerns for advanced technologies such as radiation-induced leakage current in ultra-thin oxides, damage in nitrided gate dielectrics, and leakage in trench isolated structures. The impact on specific devices such as SOI transistors, MEMS structures, and DRAMS will be illustrated. This section will conclude with a description of hardness assurance issues at the device level.

Introduction

Total Dose Effects - "The Basics"

- Interaction of Radiation with Materials
- Electron-Hole Yield
- Hole Transport
- Oxide Traps
- Interface Traps
- Border Traps
- Device Properties
- Measurement Techniques

Limitations and Issues for Device Response

- Gate Oxide
  - Thickness Dependence
  - Ultra-Thin Oxides
  - Nitrided Gates
- Field Oxide Leakage
  - LOCOS
  - Trench
- SOI devices
  - General
  - Buried Oxide-Induced Leakage
- Special Cases
  - MEMS
  - DRAMs

Hardness Assurance Issues

- Test Structure to IC Correlation
- Worst-Case Bias
- Burn-In Effects
- Optimum Radiation Sources for Hardness Assurance Testing

Conclusion

Todd Weatherford received a BSEE from Rutgers University in 1983 and the MSEE and PhD from North Carolina State University in 1986 and 1992, respectively. He has held positions at RCA's Broadcast Systems in camera design, and at RCA's Advanced Technology Laboratories designing CMOS/SOS and GaAs microprocessors. In 1984 he was a research assistant in the N.C. State University Solid State Laboratory studying Single Event Upset effects in GaAs ICs. In 1990 he joined SFA Inc. and worked as a contractor at the Naval Research Laboratory's Radiation Effects Branch where he investigated FET and HBT charge collection effects and conducted accelerator and space-based experiments. In 1995 he joined the faculty as an Assistant Professor at the Naval Postgraduate School (NPS) Department of Electrical and Computer Engineering where he teaches courses in semiconductor devices, reliability and radiation effects. Presently he is performing R&D in Group IV and III/V technologies. He has received several research and teaching awards while at NPS. Dr. Weatherford is a member of the IEEE Nuclear and Plasma Sciences Society, Solid State Circuits Society, and Electron Device Society and The Minerals, Metals and Material Society. He has served on various conference committees and reviewed for IEEE publications, has authored and co-authored over 50 publications, and has several patents pending.

FROM CARRIERS TO CONTACTS, A REVIEW OF SEE CHARGE COLLECTION PROCESSES

Todd R. Weatherford
U.S. Naval Postgraduate School

Single Event Effects are a major concern for satellite electronics, and Todd Weatherford will cover this important area. This session will examine the process from ionization to photocurrents. It will begin with a review of past Single Event Effects (SEE) short course material, and then will follow how energy transfers from the particle-semiconductor interaction to the current observed in the circuit. The discussion will include how these effects are modeled. Several different semiconductor technologies will be reviewed, with animations visualizing the transport process. Finally it will be shown that our understanding of these processes leads to useful predictions and solutions.

Introduction
- Overview of Previous SEE Short Courses
- Overall View of Energy Propagation of Single Event

SEE Carrier Transport Mechanisms
- Direct Carrier Ionization
- Indirect Ionization
- Recombination Processes
- Charge Transport in Semiconductors
- Charge Transport in Insulators
- Modeling Considerations

Displacement Damage Effects on Charge Collection
- Localized Defects
- Effect on Carrier Transport Properties

Examination of Example Technologies
- Silicon On Insulator (SOI)
- Silicon-Germanium
- III-V Based Technologies

Modeling Capabilities versus Testing
- SPICE versus Device Simulation
- Verification of Models

Hardening the Transistor
- Insulators
- Recombination Layers
- Efficient Removal of Charge

Future Considerations

Conclusion

Christian Poivey graduated from l'Institut des Sciences de l'Ingenieur de Clermont- Ferrand, France in 1985. Then he carried out research work on electrical simulation tools in the Commissariat à l'Energie Atomique (CEA), Centre d'Etudes de Bruyeres Le Chatel. In 1988 he was awarded the degree of "docteur ingenieur" from the University of Clermont-Ferrand II for this work. In 1988 he joined Matra Marconi Space. From 1988 to 1992, he worked as a parts engineer. His main task was the evaluation of parts for the SPOT5/HELIOS2 program. In 1992, he joined the Matra Marconi Space radiation group to perform R&D and testing on Single Event Effects. From 1995 to 2000 he was the radiation group leader. In 2000, he joined the radiation group of NASA Goddard Space Flight Center. He is the radiation lead on the ST5 and flight data analysis projects. He also conducts R&D studies on Single Event Transient effects on linear analog devices. Dr. Poivey is the author or co-author of more than 20 papers.

RADIATION HARDNESS ASSURANCE FOR SPACE SYSTEMS

Christian Poivey
NASA Goddard Space Flight Center

Christian Poivey will conclude the course by tying together the earlier talks in a discussion of how one assures a satellite system will work in the space environment. He will describe how one bounds the radiation response of devices through the use of data and testing and couples this information with knowledge of the radiation environment. Methods of dealing with the subsystem and system level impact of alterations in device response will be described. The course will end with his explanation of what is typically done to make assured, reliable space systems.

Introduction

Radiation Hardness Assurance Overview

Definition of Space Radiation Environment Specification

- External Environment
  - Recommended Models
- Environment Within Spacecraft
  - Available Computer Tools

Definition of System and/or Component Response

- Use of Existing Radiation Data
- Radiation Testing of Parts
- Analysis of Response at System/Subsystem Level
- Radiation Design Margin
- Parts Categorization

Definition and Implementation of Countermeasures

- Total Dose Design Hardening
- SEE Design Hardening

Management of Hardness Assurance

- Different Kinds of RHA Management
- The Radiation Requirements
- The Radiation Reviews

Conclusion

Technical Program

TECHNICAL INFORMATION

"NSREC 2002 will provide an excellent forum for authors to discuss the latest results of their research in radiation effects in microelectronics. Oral and Poster regular session presentations and Poster presentations in the Data Workshop will provide many opportunities for technical interchange and stimulating discussions."

Tom Turflinger, NAVSEA Crane
Technical Program Chairman

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

- **Space and Terrestrial Environments**
  Chair: Greg Ginet, Air Force Research Laboratory
- **Photonic Devices and Integrated Circuits**
  Chair: Dennis Thompson, Eastman-Kodak
- **Isolation Technologies**
  Chair: Reed Lawerence, SFA/NRL
- **Single Event Effects, Mechanisms and Modeling**
  Chair: Jeff Titus, NAVSEA Crane
- **Single Event Effects, Devices and Integrated Circuits**
  Chairs: Ron Pease, RLP Research and Satoshi Kuboyma, NASDA
- **Basic Mechanisms**
  Chair: Alessandro Paccagnella, Università di Padova
- **Devices and Integrated Circuits**
  Chair: Hugh Barnaby, University of Arizona
- **Hardness Assurance**
  Chair: Ron Lacoe, The Aerospace Corporation
- **Dosimetry and Facilities**
  Chair: Wendland Beezhold, Idaho State University
- **Radiation Effects in High Energy Physics**
  Chair: Martin Dentan, CERN

POSTER SESSION

Papers that are most effectively presented visually with group discussion will be displayed from 12:00 PM Tuesday, July 16 through 12:00 PM Friday, July 19. Authors will be available to discuss their work during the Poster Session Thursday, July 18. The poster chair is Robert Reed, NASA Goddard Space Flight Center.

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 16 through 12:00 PM Friday, July 19. Authors will be available to discuss their work during the Data Workshop Session Wednesday, July 17. A copy of the Workshop Record will be mailed to all registered attendees after the conference. The workshop chair is Susan Crain, The Aerospace Corporation.

INVITED SPEAKERS

Three stimulating and entertaining invited speakers are planned. The talks will be intellectually stimulating, and still be of interest to many family members.

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 May 31, 2002. Please submit late-news summaries by email in Acrobat (PDF) format, using the 4-page summary and 35-word abstract format to turflinger_t@crane.navy.mil. Paper submissions are also accepted at the address on the call for papers. Additional information on submission of late-news summaries can be found at www.nsrec.com.

Technical Program Tuesday

8:15 AM — OPENING REMARKS
GRANDE BALLROOM — *Ken Hunt, Vanderbilt University at Air Force Research Laboratory*

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

8:50 AM — TECHNICAL SESSION OPENING REMARKS
Thomas L. Turflinger, NAVSEA Crane

SESSION A — BASIC MECHANISMS
8:55 AM — SESSION INTRODUCTION
Chair: Alessandro Paccagnella, Università di Padova

A-1 — The Radiation Response of the High Dielectric Constant Hafnium Oxide/Silicon System
9:05 AM
A. Y. Kang and P. M. Lenahan, Pennsylvania State University; J. F. Conley Jr., Sharp Labs

We have investigated the radiation response of atomic layer CVD hafnium oxide films on silicon with electron spin resonance and capacitance vs. voltage measurements.

A-2 — Analytical Model for Proton Radiation Effects in Bipolar Devices
9:20 AM
H. J. Barnaby, University of Arizona; R. D. Schrimpf, D. M. Fleetwood, Vanderbilt University; R. L. Pease, RLP Research

Experiments show ionization-induced defects may moderate the effects of displacement damage in bipolar devices. A model is presented that analytically characterizes the combined effects of oxide-trapped-charge and bulk traps on bulk recombination.

A-3 — Physical Model for Enhanced Interface-Trap Formation at Low Dose Rates
9:35 AM
S. N. Rashkeev, C. R. Cirba, D. M. Fleetwood, R. D. Schrimpf, S. T. Pantelides, Vanderbilt University; S. C. Witczak, Sandia National Laboratories; A. Michez, CEM2 Université Montpellier II

We describe a model for enhanced interface-trap formation at low dose rates due to space charge effects in the base oxides of bipolar devices. Analytical modeling and numerical simulations are qualitatively consistent with experimental data.

9:50 - 10:20 AM — BREAK

A-4 — Comparison of Charge Yield in MOS Devices for Different Radiation Sources
10:20 AM
P. Paillet, V. Ferlet-Cavrois, O. Flament, CEA/DIF; J. R. Schwank, M. R. Shaneyfelt, R. A. Loemker, Sandia National Laboratories

NMOS transistors were irradiated using x-ray, Co-60 gamma, and proton radiation sources. The charge yield was estimated for protons of different energies, and compared to values obtained for x-ray and Co-60 irradiations.

A-5 10:35 AM

Si-SiO_2 Interface Trap Formation at 78 K Due to Boron-Oxygen-Hole-Centers

S. C. Witczak, J. R. Schwank, M. R. Shaneyfelt, H. P. Hjalmarson, Sandia National Laboratories; E. E. King, R. C. Lacoe, D. C. Mayer, The Aerospace Corporation; N. S. Saks, NRL

Irradiation at 78 K generates interface traps in n-channel, but not in p-channel, MOSFETs. Trap creation in the n-FETs is attributed to the activation of boron-oxygen-hole-centers in the near-interfacial oxide by radiation-induced holes.

A-6 10:50 AM

The Structure, Properties, and Dynamics of Oxygen Vacancies in Amorphous SiO_2

C. J. Nicklaw, Dynamics Research; Z.-Y. Lu, D. M. Fleetwood, R. D. Schrimpf, S. T. Pantelides, Vanderbilt University

A statistical analysis of oxygen vacancies in four amorphous SiO_2 structures shows a distribution of possible defect states exists due to different structural arrangement. The properties of Eγ′ and Eδ′ centers are related to local structure.

A-7 11:05 AM

Unified Model of Hole Trapping, Charge Neutralization, and *1/f* Noise in MOS Devices

D. M. Fleetwood, H. D. Xiong, R. D. Schrimpf, Z. Y. Lu, S. T. Pantelides, Vanderbilt University; C. J. Nicklaw, Dynamics Research

Striking similarities in capture cross sections strongly suggest that the $1/f$ noise of MOS devices is caused by the thermally activated capture and emission of carriers at O vacancy centers near the Si/SiO_2 interface.

11:20 - 1:00 PM LUNCH

POSTER PAPERS

PA-1

Consistency of Bulk Damage Factor and NIEL for Electrons, Protons and Heavy Ions

S. Kuboyama, T. Aburaya, S. Matsuda, National Space Development Agency of Japan; T. Hirao, Japan Atomic Energy Research Institute

There are substantial differences between defects introduced by electrons and those introduced by protons and heavy ions. The consistency of displacement damage factor and NIEL for electrons, protons and heavy ions was clearly explained by the differences.

PA-2

Application of Displacement Damage Dose Analysis to Low Energy Protons on Silicon

S. R. Messenger, SFA/NRL; E. A. Burke, Consultant; G. P. Summers, R. J. Walters, NRL

A simple method is described for using NIEL to determine relative damage produced by protons that terminate in the active region of a device.

PA-3 Characterization of Proton Irradiated AlGaN/GaN Modulation Doped Field-Effect Transistor Structures by Low Energy Electron-Excited Nanoscale Luminescence

B. D. White, M. Bataiev, L. J. Brillson, Ohio State University; B. K. Choi, D. M. Fleetwood, R. D. Schrimpf, S. T. Pantelides, Vanderbilt University; R. W. Dettmer, Air Force Research Laboratory; U. K. Mishra, University of California Santa Barbara

We have examined AlGaN/GaN modulation-doped field effect transistors that display degraded source-drain current characteristics after 1.8 MeV proton irradiation. We have correlated these changes with defect and/or compositional changes measured spectroscopically with nanometer-scale depth resolution.

PA-4 Effects of Proton Irradiation on the Transport Properties of a AlGaN/GaN 2-Dimensional Gas System

S. Khanna, Defence Research Establishment Ottawa; F. Gaudreau, P. Fournier, C. Carlone, Université de Sherbrooke; H. Tang, J. Webb, NRC of Canada; A. Houdayer, Université de Montréal

Using 2 MeV protons, a fluence as high as $3x10^{15}/cm^2$ is necessary to drive a metal to insulator transition for a two dimensional gas formed at a AlGaN/GaN interface. The corresponding mobility has also been measured.

PA-5 Radiation Induced Interface Traps in MOS Devices: Capture Cross Sections and the Density of States of P_{b1} Silicon Dangling Bond Centers

P. M. Lenahan, N. A. Bohna, J. P. Campbell, Pennsylvania State University

New results compare the capture cross-section and electronic density of states of two radiation induced Si/SiO_2 P_{b0} and P_{b1} centers. The additional P_{b1} results provide a much more nearly complete picture of the Si/SiO_2 interface radiation damage.

PA-6 Intrinsic Defects in Amorphous SiO_2

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

We use first-principles calculations to show that the prominent radiation-induced defect in SiO_2 that has a characteristic luminescence at 1.9 eV is not a non-bridging oxygen-hole center but an OH group attached to a network Si atom.

PA-7 Temperature Dependence and Irradiation Response of 1/*f* Noise in MOSFETs

H. D. Xiong, D. M. Fleetwood, B. K. Choi, A. L. Sternberg, Vanderbilt University

A detailed comparison of the temperature and frequency dependence of the $1/f$ noise of MOS transistors shows the importance of thermally-activated charge exchange between the Si channel and defects in the oxide.

PA-8 Radiation Effects in Low-Dielectric-Constant Methyl-Silsesquioxane Films

M. P. Petkov, Jet Propulsion Laboratory; K. G. Lynn, Washington State University; K. P. Rodbell, W. Volksen, R. D. Miller, IBM

Low-k methyl-silsesquioxane films were irradiated by a 3 keV low-current (~30 fA) positron beam. Bond-breaking was observed at <1 Gy cumulative doses, implying more significant effects upon electron irradiation in space or by electron microscope.

PA-9 **Radiation-Induced Charge Trapping and Rebound in Low K Silsesquioxane-based Inter-metal Dielectric Films**
R. A. B. Devine, J. W. Tringe, J. R. Chavez, Air Force Research Laboratory

Electric field dependence of radiation induced buildup of fixed oxide charge in the spun-on inter-metal dielectric FOx 15 has been studied. A field sensitive rebound effect is observed in the flat-band voltage shift.

SESSION B **SPACE AND TERRESTRIAL ENVIRONMENTS**
1:00 PM SESSION INTRODUCTION
Chair: Gregory Ginet, Air Force Research Laboratory

B-1 **The Radiation Effects on Galileo Spacecraft Systems at Jupiter**
1:10 PM *P. D. Fieseler, S. M. Ardalan, R. A. Frederickson, Jet Propulsion Laboratory*

The Galileo spacecraft has been subjected to the charged particle environment around Jupiter since 1995. There have been numerous system failures attributable to radiation effects. We summarize those failures, their causes and any associated fixes.

B-2 **On-Orbit Measurement of JFET Leakage Current and Its Annealing as Functions of Dose and Bias at Jupiter**
1:25 PM *A. R. Frederickson, J. M. Ratliff, G. M. Swift, Jet Propulsion Laboratory*

Controlled bias vs. dose is being used to induce radiation-annealing, minimize charge in depletion zones, and thereby keep a JFET within acceptable operating limits during flight.

B-3 **Characteristics of the Hubble Space Telescope's Secondary Radiation Environment Inferred from Charge-Collection Modeling of Near Infrared Camera and Multi-Object Spectrometer**
1:40 PM *R. Ladbury, Orbital Sciences; J. Pickel, PR&T; G. Gee, B. Fodness, SGT; T. Jordan, EMP Consultants; L. Bergeron, B. Rauscher, D. Figer, STScI; R. A. Reed, NASA Goddard Space Flight Center; P. Marshall, Consultant*

Dark frames from orbiting infrared detector arrays are analyzed using a model of detector charge collection to investigate the effects of secondary and primary particle environments in infrared detectors and related electronics.

B-4 **Observation of Solar Particle Events from CREDO and MPTB During the Current Solar Maximum**
1:55 PM *C. S. Dyer, D. Rodgers, S. Clucas, K. Hunter, QinetiQ; A. B. Campbell, Naval Research Laboratory*

New data, since July 2000, show additional solar particle events and are correlated with single event effects and compared with standard models. The event of 5-6 November 2001 rivals those of July 2000 and October 1989.

B-5 **Probabilistic Model for Low Altitude Trapped Proton Fluxes**
2:10 PM *M. A. Xapsos, J. L. Barth, E. G. Stassinopoulos, NASA Goddard Space Flight Center; S. L. Huston, Boeing*

Trapped proton fluxes are calculated as a function of confidence level for low earth orbits. This will be especially useful for planning future space missions.

POSTER PAPERS

PB-1 **In-Flight Observations of the Radiation Environment and its Effects on Devices in the SAC-C Polar Orbit**

D. Falguere, D. Boscher, T. Nuns, S. Duzellier, S. Bourdarie, ONERA/DESP; R. Ecoffet, S. Barde, J. Cueto, CNES; C. Alonzo, C. Hoffman, CONAE

The ICARE instrument associates a set of particle flux measurements with the associated effects on electronic components. This paper presents a full set of data obtained on the SAC-C orbit (707 km, 98.2 degrees) for more than one year.

PB-2 **MULASSIS: A Geant4 Based Multi-Layered Shielding Simulation Tool**

F. Lei, P. R. Truscott, C. S. Dyer, QinetiQ; P. Nieminen, E. Daly, ESA-ESTEC

Radiation shielding analysis is crucial to spacecraft development. We report on the features of a multiple-layered shielding simulation software tool (MULASSIS), based on Geant4. It is integrated to the ESA SPENVIS system.

PB-3 **Evaluation of Energy-Angle Spectra of Secondary Neutrons from p+Al-27 and p+Pb-208 Reactions for Space Shielding Applications**

Y. O. Lee, J. Chang, Korea Atomic Energy Research Institute; M. H. Kim, Kyunghee University

For space system shielding, energy-angle spectra of secondary neutrons produced from the p+Al-27 and p+Pb-208 reactions for energies below 400 MeV are evaluated utilizing optical, statistical, and pre-equilibrium models with available experimental data.

PB-4 **Modeling of Secondary Neutron Production from Space Radiation Interactions**

L. W. Townsend, G. S. Braley, University of Tennessee; F. A. Cucinotta, NASA/JSC; L. H. Heilbronn, Lawrence Berkeley National Laboratory

Reliable methods of estimating secondary neutron production cross sections from nuclear interactions of high energy cosmic rays are presented. Estimates of spectral and angular distributions are in good agreement with experimental data.

SESSION C — DOSIMETRY AND FACILITIES

2:25 PM SESSION INTRODUCTION

Chair: Wendland Beezhold, Idaho State University

C-1 2:30 PM **Improvement of SOI Microdosimeter Performance Using Pulse Shape Discrimination**

I. Cornelius, A. Rosenfeld, University of Wollongong; R. Siegele, D. Cohen, Australian Nuclear Science and Technology

We measured the rise time of current pulses generated by heavy ions in 10 micron size SOI volumes. The pulse shape discrimination technique allows for better identification of the charge collection volume of SOI microdosimeters.

C-2 2:45 PM
Dose Measurement Based on Threshold Shift in MOSFET Arrays in Commercial SRAMs
L. Scheick , G. Swift, Jet Propulsion Laboratory

A new method, using an array of MOS transistors in a SRAM, is described for measuring dose absorbed from ionizing radiation. The dosimeter is digital in nature, and thus easily accessible remotely.

POSTER PAPERS

PC-1
Model-Data Comparison of Total Dose Experiment on KITSAT-1
S.-J. Kim, K.-W. Min, KAIST; Y.-H. Shin, Komed Co. Ltd.; J.-H. Seon, SaTReC i Co. Ltd.

We analyze the results of KITSAT-1 total dose experiments using the model developed for temperature dependent irradiations. The model reproduces the observed threshold voltage changes including the peculiar oscillations caused by temperature variations.

3:00 - 3:30 PM BREAK - INDUSTRIAL EXHIBITS AREA

SESSION D 3:30 PM
PHOTONIC DEVICES AND INTEGRATED CIRCUITS
SESSION INTRODUCTION
Chair: Dennis Thompson, Eastman-Kodak Company

D-1 3:40 PM
Radiation-Induced Charge Collection in Infrared Detector Arrays
J. C. Pickel, PR&T; R. Reed, NASA Goddard Space Flight Center; R. Ladbury, Orbital Sciences; B. Rauscher, STScI; P. Marshall, Consultant; T. Jordan, EMP Consultants; B. Fodness, G. Gee, SGT

A model is presented for predicting charge collection in space-based infrared detector arrays due to ionizing particle radiation. The model development is described and predictions are compared to experimental data on modern IR focal plane arrays.

D-2 3:55 PM
Evaluation and Prediction of the Degradation of a COTS CCD Induced by Displacement Damage
R. Germanicus, L. Dusseau, J. Fesquet, J. Gasiot, Université Montpellier II; S. Barde, G. Rolland, R. Ecoffet, CNES; C. Barillot, P. Calvel, Alcatel; F. Saigné, Université de Reims

Proton irradiation results ranging to 17.5 MeV to 63 MeV are presented for a silicon COTS CCD. Mean and extreme dark currents are analyzed. A method to determine parameters required by the Marshall method prediction is proposed.

D-3 4:10 PM
Proton Irradiation Tests of the Rosetta ROLIS CCD Detector Electronics
A. Denker, H. Homeyer, J. Opitz-Coutureau, Hahn-Meitner-Institut; H. Grothues, M. Tschentscher, H. Michaelis, DLR Institute of Space Sensor Technology & Planetary Exploration

Proton irradiation tests were performed at Ionenstrahllabor with the complete CCD detector electronics of the Rosetta Lander ROLIS-D camera system, and special electronic parts like (non radiation-hardened) FPGAs and LEDs of the ROLIS illumination device.

D-4 4:25 PM
Heavy Ion Induced Charge Collection Mechanisms in CMOS Active Pixel Sensor
J.-P. David, X. Belredon, ONERA/DESP; D. Lewis, T. Beauchene, V. Pouget, IXL, Université Bordeaux; S. Barde, CNES; P. Magnan, SUPAERO-CIMI

CMOS APSs can easily be designed for specific applications. This paper presents experimental and simulation results of heavy ion charge collection. These results demonstrate the important role of charge diffusion for spectrometry applications of APSs.

D-5 4:40 PM
Effects of Proton Irradiation on Luminescence Emission and Carrier Dynamics of Self-assembled III-V Quantum Dots
R. Leon, Jet Propulsion Laboratory; S. Marcinkevicius, J. Siegert, Royal Institute of Technology; B. Magness, W. Taylor, California State University; C. Lobo, University of Cambridge

Comparisons of III-V quantum dots with equivalent quantum wells after 1.5 MeV proton irradiation showed that photoluminescence intensities and carrier lifetimes are much less affected by radiation in the quantum dots.

D-6 4:55 PM
Origin of the Radiation-Induced OH Vibration Band in Polymer-Coated Optical Fibres Irradiated in a Nuclear Fission Reactor
B. Brichard, A. Fernandez Fernandez, F. Berghmans, M. Decréton, SCK-CEN Belgian Nuclear Research Centre

We observed the growth of the 1.39 μm OH vibration band in polymer-coated fiber exposed to nuclear fission radiation. The parameters governing the mechanism have important implications for the design of a fast-neutron fiber optic monitor.

POSTER PAPERS

PD-1
Gamma Radiation Studies on Optical Materials
J. Spencer, E. Colby, SLAC; T. Plettner, Stanford University; G. Lum, Lockheed Martin

We present results of the effects of gamma radiation on the optical transmission properties of materials relevant for a new generation of laser driven particle accelerators. Various forms of Si, optical, and laser materials are studied.

PD-2
Trends in Optocoupler Radiation Degradation
T. F. Miyahira, A. H. Johnston, Jet Propulsion Laboratory

Proton damage is investigated in optocouplers with LED input current specifications as low as 40 μA. Damage mechanisms are compared with the 4N49 optocoupler. The new devices are more than a factor of ten better in a proton environment.

PD-3
1.8 MeV Proton Damage Effects on the Threshold Current and Operating Wavelength of Vertical Cavity Surface Emitting Lasers
M. A. Neifeld, A. Kalavagunta, University of Arizona; R. D. Schrimpf, B. K. Choi, Vanderbilt University

We investigate the effect of 1.8 MeV protons on high-speed oxide-confined vertical cavity surface emitting lasers. Threshold current degraded linearly with fluence but the wavelength shifted non-monotonically, exhibiting a maximum $\Delta\lambda/\lambda$ of ~0.3%.

PD-4 **Towards the Development of Radiation-Tolerant Instrumentation Data Links for Thermonuclear Fusion Experiments**

A. Fernandez Fernandez, F. Berghmans, B. Brichard, M. Decréton,
SCK-CEN, Belgian Nuclear Research Centre

Thermonuclear reactors will require permanent monitoring under high gamma dose rates and high neutron fluence. We propose to implement an analog fibre optic link based on direct-modulated VCSELS for highly radioactive environments.

PD-5 **Dose-rate Dependencies in Gamma-Irradiated In-fibre Bragg Gratings**

A. Fernandez Fernandez, B. Brichard, F. Berghmans, M. Decréton,
SCK-CEN, Belgian Nuclear Research Centre

We gamma-irradiated fibre Bragg grating filters at several dose rates. We present evidence that the dose rate does not affect the FWHM of the Bragg peak and that the saturating Bragg peak shift remains.

5:10 PM END OF TUESDAY SESSIONS

INVITED TALK 8:15 - 9:15 AM

Radiation Damage in Structured Silicon Semiconductor Detectors

Dr. Gerhard Lutz, Max Planck Institut-Halbleiterlabor

Radiation damage has been studied extensively in the frame of electronics. It is also a subject of elaborate investigations in the context of semiconductor detectors. This is the case in particular in the context of particle physics where detectors have to withstand the harsh radiation environment of high luminosity particle colliders. Radiation damage at much lower dose is of relevance in space based X-ray observatories where detectors are exposed to cosmic radiation and in particular to the radiation belt. This high vulnerability with respect to radiation is due to the sophisticated structures of the detectors which have to provide simultaneously precision images and spectral information. The mechanisms responsible for deterioration of detector properties differ in many ways from those being important in electronic devices. Thus the methods of improving radiation hardness of detectors also deviate from those used in electronics. Dr. Lutz will review the mechanisms of radiation damage in silicon radiation detectors taking as a basis the observed and well parameterized changes in the material properties of silicon and silicon dioxide under exposure to radiation. Particular emphasis will be given to structured semiconductor detectors such as silicon strip detectors and X-ray CCDs for which device simulations and experimental results will be presented.

Gerhard Lutz joined the Max-Planck-Institut fuer Physik, Munich, in 1972. He developed and introduced in 1980 the first silicon strip detectors in particle physics experiments along with a variety of new detector principles. Dr. Lutz established the MPI Semiconductor Detector Laboratory in 1992 and is currently the project leader of this laboratory. He has developed detectors for particle physics and x-ray astronomy. He has also conducted several particle physics experiments at CERN. Dr. Lutz received his Ph.D. at Hamburg University, 1967 where his thesis was "Coherent Bremsstrahlung and Pair Production on Diamond." He was an assistant and associated Prof. at Northeastern University, Boston 1967-1972 along with a visiting scientist at CERN. Dr. Lutz has more than 350 scientific publications, a large fraction concerning semiconductor detectors. He has authored a book on semiconductor radiation detectors. He received the Roentgen Award 1966 for the "Production of Highly Polarized Photons in the GeV region."

SESSION E 9:15 AM

RADIATION CONCERNS IN HIGH ENERGY PHYSICS

SESSION INTRODUCTION

Chair: Martin Dentan, CEA Saclay/CERN

E-1 9:25 AM

Influence of Scintillation Crystals Radiation Hardness on Electromagnetic Calorimeter Performance

G. Y. Drobychev, M. V. Korjik, V. Moroz, Institute for Nuclear Problems;
P. Lecoq, P. Rebecchi, CERN; J.-P. Peigneux, D. Sillou, LAPP

Characteristics of about 5000 PWO crystals for CMS electromagnetic calorimeter (ECAL) are analyzed. A method for the evaluation of the ECAL energy resolution accounting for a distribution of individual scintillation crystals radiation hardness is proposed.

E-2 9:40 AM

Radiation Effects in the Readout Chip for the ATLAS Semiconductor Tracker

I. Mandic, Jozef Stefan Institute

The readout chip for silicon strip detectors of the ATLAS Semiconductor Tracker is described. Results of irradiations up to 100 kGy and $2x10^{14}$ n/cm^2 (1 MeV neutron NIEL equivalent) done with various sources are presented.

E-3 9:55 AM

Radiation Tolerance of Prototype BTeV Pixel Detector Readout Chips

G. Chiodini, J. A. Appel, G. Cardoso, D. C. Christian, B. Hall, J. Hoff, S. W. Kwan, A. Mekkaoui, R. Yarema, S. Zimmermann, Fermilab; L. Uplegger, INFN

We present the radiation tolerance of prototype pixel detector readout chips, fabricated in standard 0.25 micron CMOS processes, for use in BTeV at Fermilab. Total dose (to ~100 Mrd(Si)) and single event effects are reviewed.

E-4 10:10 AM

Radiation Hardness Perspectives for the Design of Analog Detector Readout Circuits in the 0.18 µm CMOS Generation

V. Re, Universita di Bergamo; V. Speziali, L. Ratti, Universita di Pavia; M. Manghisoni, ST Microelectronics

This paper presents a study of the ionizing radiation tolerance of analog parameters of 0.18 μm CMOS transistors for application to the design of front-end integrated circuits for detectors in high energy physics experiments.

POSTER PAPERS

PE-1

Predicting the Radiation Environment at High-luminosity Hadron Colliders

I. Dawson, C. Buttar, University of Sheffield; M. Shupe, University of Arizona

Future hadron-collider experiments are designed to operate in intense radiation environments. Presented will be the methods used for predicting radiation background levels in the Atlas experiment at CERN, with particular emphasis on the reliability of such predictions.

PE-2

The Effect of Oxygenation on the Radiation Hardness of Silicon Studied by Surface Photovoltage Method

E. Tuovinen, J. Härkönen, E. Tuominen, K. Lassila-Perini, S. Nummela, J. Nysten, Helsinki Institute of Physics; P. Heikkilä, V. Ovchinnikov, M. Palokangas, M. Yli-Koski, Helsinki University of Technology; L. Palmu, S. Kallijärvi, University of Oulu; T. Alanko, P. Laitinen, A. Pirojenko, I. Riihimäki, G. Tiourine, A. Virtanen, University of Jyväskylä

The suitability of the Surface Photovoltage (SPV) method for characterizing irradiated silicon samples was proven. Adding oxygen to silicon was found to improve the radiation hardness, i.e. the minority carrier diffusion lengths of silicon.

PE-3 **I-V and C-V Curves for Irradiated Prototype Silicon Pixel Sensors for BTeV**

M. R. Coluccia, J. A. Appel, G. Chiodini, D. C. Christian, S. W. Kwan, G. Sellberg, Fermilab; L. Uplegger, INFN

We present I-V and C-V curves for irradiated prototype $n^+/n/p$ (p-stop and p-spray isolation) silicon pixel sensors, intended for use in BTeV at Fermilab. Results are based on exposures with 200 MeV protons to ~$10^{15}/cm^2$.

PE-4 **Radiation Studies of Silicon Microstrip Detectors for use in ATLAS, SCT**

L. G. Johansen, B. Stugu, University of Bergen; L. Andricek, G. Lutz, H. G. Moser, R. Richter, Max Planck Institut; D. Robinson, Cambridge University

Silicon detectors, designed for use in ATLAS at CERN's LHC, are shown to operate satisfactorily after irradiation with $3x10^{14}$ (24 GeV/c protons)/cm^2. No breakdown effects are seen with the detectors biased up to 500 volts.

10:25 - 10:45 AM BREAK - INDUSTRIAL EXHIBITS AREA

SESSION F **ISOLATION TECHNOLOGY**

10:45 AM SESSION INTRODUCTION

Chair: Reed Lawrence, SFA Inc/ NRL

F-1 **Proton Radiation Effects in 0.35 micron Partially-Depleted SOI**
10:50 AM **MOSFETs Fabricated on UNIBOND**

Y. Li, G. Niu, J. D. Cressler, M. J. Palmer, Auburn University; J. Patel, Jet Propulsion Laboratory; P. W. Marshall, Consultant; R. Reed, NASA Goddard Space Flight Center; H. S. Kim, Jackson and Tull; S. T. Liu, Honeywell SSEC

We investigate the radiation hardness of a 0.35 micron SOI Technology on UNIBOND under proton irradiation and propose a mechanism for the positive threshold voltage shift and subthreshold swing degradation in the front channel nFET.

F-2 **Anomalous Charge Collection from SOI Substrates and Its Effect on**
11:05 AM **SEU Hardness**

J. R. Schwank, P. E. Dodd, M. R. Shaneyfelt, G. Vizkelethy, B. L. Draper, T. A. Hill, D. S. Walsh, G. L. Hash, Sandia National Laboratories

Increased SEU sensitivity from drain strikes in SOI devices is shown to result from heavy-ion induced charge generation in the substrate. The mechanisms for charge collection and methods for mitigating their effects are discussed.

F-3 **Insights on the Parasitic Bipolar Transistor of Fully and Partially**
11:20 AM **Depleted SOI Technologies Under Heavy Ion or Dose Rate Irradiations**

V. Ferlet-Cavrois, C. Marcandella, C. D'Hose, G. Gasiot, O. Flament, CEA/DIF; O. Faynot, CEA/DRT/LETI

The parasitic bipolar amplification of SOI devices is analyzed for both fully and partially depleted SOI technologies. The bipolar gain is extracted on heavy ion and dose rate irradiations, and compared to static measurements.

POSTER PAPERS

PF-1 **Study of Transient Current Induced by Heavy-Ion in NMOS/SOI Transistors**

T. Colladant, A. L'Hoir, Université Paris; V. Ferlet-Cavrois, C. D'Hose, CEA-DAM/DIF; J. du Port de Pontcharra, CEA/DRT/LETI

The parasitic bipolar transistor of NMOS/SOI transistors is a key element to determine the SEU sensitivity. Parasitic bipolar transistor response has been investigated through transient current measurements induced by high energy heavy ions.

11:35 - 1:00 PM LUNCH

SESSION G **HARDNESS ASSURANCE**

1:00 PM SESSION INTRODUCTION

Chair: Ron Lacoe, The Aerospace Corporation

G-1 1:10 PM **Probing the Charge Collection Sensitivity Profile Using a Picosecond Pulsed Laser at a Range of Wavelengths**

A. Chugg, R. Jones, M. Moutrie, MBDA; C. Dyer, C. Sanderson, A. Wraight, QinetiQ

A new empirical methodology is defined and demonstrated in which the charge collection sensitivity of SEE-susceptible nodes in microcircuits is calculated from laser pulse measurements of the upset threshold at a range of wavelengths.

G-2 1:25 PM **Backside SEU Laser Testing for Commercial-Off-The-Shelf SRAM**

F. Darracq, H. Lapuyade, P. Fouillat, Université Bordeaux; N. Buard, F. Mounsi, B. Foucher, EADS-CCR; M.-C. Calvet, R. Dufayel, EADS-LV

This paper presents a new methodology for single event laser tests of COTS SRAM. It describes the possibility of backside laser testing with a new dedicated laser test bench.

G-3 1:40 PM **Gamma Enhancement of Proton-Induced SEE Cross Section in a CMOS SRAM**

L. S. Erhardt, D. S. Haslip, T. Cousins, R. Buhr, Defence Research Establishment Ottawa

An increased proton-induced SEE cross section has been observed in SRAMs previously exposed to gamma radiation. The magnitude of this effort depends upon both the total dose and dose rate of the gamma irradiation.

G-4 1:55 PM **Model to Evaluate the High Temperature Irradiation Effect for Different Doses at a Given Dose Rate on NPN Bipolar Junction Transistors**

F. Saigné, J. Boch, T. Maurel, Université de Reims Champage-Ardenne; F. Giustino, CERN; R. D. Schrimpf, K. F. Galloway, Vanderbilt University; L. Dusseau, J. Fesquet, J. Gasiot, Université Montpellier II; R. Ecoffet, CNES

A model is proposed to evaluate the degradation induced by high temperature irradiation at a given dose rate on NPN bipolar junction transistors. The model and experimental results, presented for two different devices, are in good agreement.

G-5 2:10 PM

Single Event Upset Simulation for Field Programmable Gate Arrays

M. Wirthlin, E. Johnson, Brigham Young University;
M. Caffrey, Los Alamos National Laboratory

FPGAs provide advantages for space-based remote sensing. However, FPGAs are susceptible to singe-event upsets. We describe a single-event upset simulator used to simulate the effects of SEUs within the FPGA configuration memory.

POSTER PAPERS

PG-1

Effect of Emitter-Base Bias during Pre-Irradiation Infrared Illumination on Radiation Response of Bipolar Transistors

V. S. Pershenkov, A. Y. Bashin, G. I. Zebrev, S. V. Avdeev,
V. V. Belyakov, Moscow Engineering Physics Institute;
V. N. Ulimov, V. V. Emelianov, Research Institute of Scientific Instruments

Increase and suppression of radiation-induced current gain degradation has been experimentally observed after pre-irradiation infrared illumination of NPN and PNP bipolar transistors under respectively reverse and forward emitter-base bias during IR treatment.

PG-2

Cold Temperature SEE Experiments on Advanced CMOS Memory Technology

L. E. Selva, L. Z. Scheick, Jet Propulsion Laboratory

A novel method of testing electronics at extremely cold temperature is presented. The SEE response of state-of-the-art memories are shown at ~100 K. An analysis of the correlation between amplified SEE effects and cold temperature effects is presented.

DATA WORKSHOP

2:25 - 4:30 PM
SOUTH MOUNTAIN BALLROOM

INTRODUCTION

Chair: Susan Crain, The Aerospace Corporation

W-1

SEE In-Flight Data for two Static 32 KB Memories on High Earth Orbit

S. Duzellier, S. Bourdarie, ONERA/DESP;
R. Velazco, B. Nicolescu, TIMA; R. Ecoffet, CNES

SEE in-flight measurements are presented for two 32 KB SRAMs in the MPTB orbit. Accelerator testing of flight spares allows for prediction of event rates using the standard CREME model. The predicted and observed rates are compared.

W-2 Radiation Effects Predicted, Observed, and Compared for Spacecraft Systems

B. E. Pritchard, A. H. Johnston, G. M. Swift, Jet Propulsion Laboratory

This paper documents radiation effects observed in spacecraft at the system and subsystem levels, and where possible, relates them to predicted radiation effects in parts. Comparisons are also made as a function of design paradigm, including part vintage, system complexity, and design assurance philosophy.

W-3 Solar Flare Proton Environment for Estimating Downtime of Spacecraft CCDs

E. Mikkelson, Boeing Satellite Systems; W. Baba, TRW

A solar flare proton environment is presented that includes both flux and duration. This environment can be used to estimate maximum CCD downtime.

W-4 A Radiation Tolerant Video Camera for High Total Dose Environments

G. R. Hopkinson, M. D. Skipper, B. Tailor, Sira Electro-Optics Ltd.

The design and performance of a solid state video camera, tolerant to > 6 Mrd(Si), is described. The camera uses a CMOS active pixel sensor (APS) and is suitable for high total dose applications in the nuclear industry.

W-5 Radiation Effects Data on Commercially Available Optical Fiber: Database Summary

M. N. Ott, NASA Goddard Space Flight Center

Presented here are the results of a survey on radiation data for commercially available optical fiber. This database will serve as a tool for engineers when selecting optical fiber for space applications.

W-6 Radiation Hardness Studies for the ATLAS SCT Optical Links

P. K. Teng, Academia Sinica

The radiation hardness of opto-electronics (VCSELs and PIN diodes) and the associated ASICs for SCT optical links has been extensively studied in gamma, neutron, and proton beams. The results will be reviewed.

W-7 Irradiation Tests on Optical Gigabit Ethernet Components

J. Ye, G. Evans, R. Stroynowski, Southern Methodist University; M. Chu, S.-C. Lee, P. K. Teng, Academia Sinica; B. Dinkespiler, F. Rethore, Cernre de Physique des Particules de Marseille; L. Gallin-Martel, M.-L. Gallin-Martel, Institut des Sciences Nucleaires; M. Pearce, Royal Institute of Technology

We performed irradiation tests on components of an optical gigabit Ethernet. We identified a radiation resistant link. Error rate is measured. Methods to convolve the test results to a given neutron spectrum are developed.

W-8 Proton Single Event Effects (SEE) Testing of the Myrinet Crossbar Switch and Network Interface Card

J. W. Howard Jr., Jackson and Tull; K. LaBel, NASA Goddard Space Flight Center; M. Carts, R. Stattel, C. Rogers, Raytheon ITSS; T. Irwin, QSS

The Myricom Myrinet crossbar switch and network interface card have been evaluated for proton single event effects. No evidence of latchup was observed, but several modes of upsets and functional interrupts were noted.

W-9 Ionizing Radiation Effects in FLEX 10K50E Programmable Logic Devices

D. M. Gingrich, N. J. Buchanan, L.Chen, Centre for Subatomic Research, University of Alberta

We have measured the effects of total ionizing dose in Altera FLEX 10K50E embedded programmable logic devices. An average total dose of 470 Gy(SiO_2) was observed before the power supply current increased.

W-10 Ion Beam Testing of ALTERA APEX FPGAs

M. Ceschia, A. Paccagnella, M. Bellato, A. Kaminski, J. Wyss, Università di Padova; S-C. Lee, C. Wan, Institute of Physics, Academia Sinica; M. Menichelli, A. Papi, INFN

Altera Apex SRAM-based FPGAs with 400,000 equivalent gates have been tested under heavy ion irradiation. Single Event Functional Interruption is the main radiation failure, likely due to single event upset in the configuration memory.

W-11 Single Event Upset Characterization of the Pentium 4, Pentium III and Low Power Pentium MMX Microprocessors using Proton Irradiation

D. Hiemstra, S. Yu, M. Pop, MDRobotics

Experimental single event upset characterization of the Pentium 4, Pentium III and Low Power Pentium MMX microprocessors using proton irradiation is presented. Results are compared with previous tests on other Pentium microprocessors.

W-12 Single Event Effects and Prompt Dose Hardness of a Deep Sub-micron Commercial Process

J. M. Benedetto, Aeroflex UTMC

A single event effect and prompt dose hardened 0.25 μm CMOS process has been developed using the WaferTech commercial foundry. The hardness was achieved solely using design-hardening techniques.

W-13 SEE and TID of Emerging Non-Volatile Memories

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

We report on the SEE and TID tests of higher density flash memories. Both normal and irregular SEFI were observed, indicating upsets from complex control circuitry. TID results are compared with tests from previous generations.

W-14 Single Event Transients (SET) Sensitivity of Advanced BiCMOS Technology (ABT) Buffers and Transceivers

R. Koga, P. Yu, S. Crain, K. Crawford, The Aerospace Corporation;
K. Chao, Johns Hopkins Applied Physics Laboratory

Heavy ion induced single event transients for various Advanced BiCMOS Technology (ABT) buffers and transceivers are presented. For our test samples, there is a wide variation in the transient sensitivity. No test samples underwent single event latchup.

W-15 Variations in SET Pulse Shapes in the LM124A and LM111

M. W. Savage, T. L. Turflinger, J. L. Titus, H. F. Barsun, NAVSEA Crane; Y. Boulghassoul, L. W. Massengill, A. L. Sternberg, Vanderbilt University; R. L. Pease, RLP Research

We present a paper that shows remarkable variation in the transient pulse signal shape of the LM124A and LM111 in a heavy ion environment. In the paper, both the data and test methods are presented.

W-16 Current Single Event Effects and Radiation Damage Results for Candidate Spacecraft

M. V. O'Bryan, C. M. Seidleck, M. A. Carts, Raytheon; K. A. LaBel, R. A. Reed, C. J. Marshall, D. K. Hawkins, A. B. Sanders, S. R. Cox, NASA Goddard Space Flight Center; R. Ladbury, S. D. Kniffin, M. R. Jones, T. Sciarini, C. Palor, Orbital Sciences; J. W. Howard, H. S. Kim, J. D. Forney, Jackson and Tull; C. Poivey, SGT; S. P. Buchner, T. Irwin, Z. Kahric, QSS/NASA Goddard Space Flight Center; P. W. Marshall, Consultant; J. P. Bings, J. L. Titus, NAVSEA Crane

We present vulnerability data of candidate spacecraft electronics to proton and heavy ion induced SEE, TID and proton-induced damage. Devices tested include optoelectronics, digital, analog, linear bipolar, hybrid devices, ADC, DAC and DC-DC converters.

W-17 Single Event Testing of DC/DC Converters for Space Flight

K. Warren, D. Roth, J. Kinnison, R. Pappalardo, Johns Hopkins Applied Physics Laboratory

Hybrid DC/DC converters from two major manufacturers were tested for single event transient and catastrophic failure. The converters were evaluated under a range of loading conditions and input voltages. Transients and catastrophic failures were observed during irradiation.

W-18 Low Dose Failures of Hardened DC-DC Power Converters

J. Lehman, C. Yui, B. G. Rax, T. F. Miyahira, M. Weideman, P. Schrock, G. M. Swift, A. H. Johnston, Jet Propulsion Laboratory

Radiation exposure of Interpoint DC-DC converters, guaranteed to 100 krd(Si), began showing failures as low as 4 krds(Si) weeks prior to spacecraft launch. Total dose testing confirmed failure modes and posed possible design solutions.

W-19 Radiation Performance of the L4913 Voltage Regulator

F. Faccio, N. Boetti, P. Jarron, B. Kisielewski, CERN

The radiation-hard voltage regulator L4913, developed by ST Microelectronics in collaboration with CERN, has been extensively tested using x-rays, CO-60, and hadron beams. The radiation performance of the component is excellent.

W-20 Proton Radiation Effects on Dry Lithium Metal Polymer (DLMP) Battery

Y. Choquette, D. Lessard-Déziel, Institut de recherche d`Hydro-Québec;
S. Khanna, L. Varga, Defence Research Establishment Ottawa;
A. Houdayer, Université de Montréal; M. Giray, G. Brassard, Canadian Space Agency

Proton irradiation of a dry lithium metal polymer battery with dose equivalent to 1, 5, 10 and 20 years in low earth orbit indicates that these batteries are not much affected in space radiation environment.

W-21 Proton Response of Low-frequency Noise in 0.20 micron 90 GHz f_T UHV/CVD SiGe HBTs

Z. Jin, J. D. Cressler, G. Niu, Auburn University; P. W. Marshall, Consultant;
H. S. Kim, Jackson and Tull; R. A. Reed, NASA Goddard Space Flight Center;
A. J. Joseph, IBM

We investigate the influence of proton exposure on low-frequency noise in aggressively scaled 90 GHz SiGe HBT technology. The observed noise degradation is explained by our previously proposed theory, and compared to first generation SiGe technology results.

W-22 Total Dose Dependency and ELDRS Effects on Bipolar Linear Devices

C. C. Yui, S. S. McClure, B. G. Rax, T. D. Minto, Jet Propulsion Laboratory

Total dose tests of several bipolar linear devices show sensitivity to both dose rate and bias during exposure. All devices exhibited Enhanced Low Dose Rate Sensitivity (ELDRS). Behavior of critical parameters is compared and discussed.

W-23 Updated Responses of Radiation-Hardened Power MOSFETs to 1-MeV Equivalent Neutrons

J. E. Gillberg, D. I. Burton, Fairchild Semiconductor; J. L. Titus,
N. Hubbard, NAVSEA Crane; C. F. Wheatley, Consultant

This paper is an update of a previous workshop paper providing test results of neutron irradiations performed on an additional six types of radiation-hardened power MOSFETs manufactured by Fairchild Semiconductor.

W-24 Evolution of Characteristics of Operational Amplifiers Originated by the Neutron Radiation Damage

F. J. Franco, J. Lozano, J.A. Agapito, Universidad Complutense de Madrid

The determination of the parameters of operational amplifiers under irradiation of fast neutrons has been done. The results accurately predict the properties of the operational amplifiers when irradiated with low doses of neutrons.

W-25 **Nuclear Dose Rate, Total Dose, and Neutron Radiation Testing of COTS Devices**

S. G. Mulford, Raytheon

Nuclear radiation testing has been performed on a variety of COTS devices including memories, microprocessor family devices, linears, and discretes for the prompt narrow dose rate, total dose gamma, and neutron environments.

W-26 **Use of COTS Components for High Dose Rate Measurement**

P. Chambaud, C. Brisset, CEA; G. Beuzelin, COGEMA

This document describes an apparatus hardened for use in gamma radiation dose rate measurement. The basic assembly comprises a silicon detector associated with a COTS amplifier. It is supplemented by a drift compensation system.

W-27 **Radiation Effects Testing Facilities in PSI During Implementation of the PROSCAN Project**

W. Hajdas, A. Zehnder, F. Burri, Paul Scherrer Institut; R. Harboe-Sorensen, ESA-ESTEC

Using three cyclotrons, proton irradiation facilities at PSI are available with a wide range of proton energies for radiation effects studies. These facilities are designed in a similar, portable, and user-friendly manner.

4:30 PM END OF WEDNESDAY SESSIONS

CONFERENCE SOCIAL
6:00 PM CORONA RANCH MEXICAN RODEO
(For more information, see Social Program section.)

INVITED TALK
8:15 - 9:15 AM

Water and Ingenuity in the Semi-Arid Southwest - What is the True Limit to Growth?

Dr. Soroosh Sorooshian, University of Arizona

Effective management of water resources is critical in today's world, particularly in the arid and semi-arid regions of the world, which constitute nearly 1/3 of the world's land mass. Three issues place special stress and added uncertainties on water resources in semi-arid regions.

The first issue is the rapid population growth in almost all of the semi-arid regions of the world. The second issue is the impact of prosperity on per capita water consumption rates. As we make the transition from an industrial economy to a new, information-based economy, water diversions for industrial and agricultural needs are declining. However, prosperity is increasing the demand for landscape and turf irrigation, water-based recreation, and other in-stream uses. The third complication arises from the additional uncertainty resulting from global climate change and, hence, the potential intensification of the hydrologic cycle. Therefore, there is no doubt that both population growth and climate variability will have a great impact on regional water resources and the way they should be managed.

An overview of the recent observational technologies (such as NASA's Earth Observing System (EOS) satellites), modeling advances, and analysis tools will be provided in this presentation. The potential impact on management of water resources in the southwest U.S. will be discussed, with particular emphasis placed on the Colorado River basin, which supplies water to nearly 30 million people.

Dr. Sorooshian is a Regents Professor in both the Dept. of Hydrology and Water Resources and the Dept. of Systems and Industrial Engineering at the University of Arizona. His primary research is in surface hydrology, with particular emphasis on precipitation runoff modeling utilization of remote-sensing information in hydrology of arid/semi-arid regions, as well as water resources management issues. His expertise on water resource issues is recognized at both the national and international levels. He is the director of the NSF Science and Technology Center on "Sustainability of Semi-Arid Hydrology and Riparian Areas" (SAHRA). He's currently the Chair of the World Climate Research Program's (WCRP) Global Energy and Water cycle EXperiment (GEWEX) Science Steering Group, Director of the World Laboratory Center in Hydrologic Sciences and Water Resources, and a member of the NOAA Science Advisory Board to the Undersecretary of Commerce and NOAA Administrator. He has served on several National Research Council (NRC) committees. Dr. Sorooshian has testified to both the U.S. House and Senate Committees on water resources issues.

Dr. Sorooshian has two Ph.D. degrees from UCLA, the first in Systems Engineering in 1977, and the second in Engineering of Water Resources and Hydrologic Systems Analysis in 1978. He has served as Editor for many of the most prestigious technical journals in his field. He received the Japan Society for the Promotion of Science (JSPS) Award in 1989 and 1998. Dr. Sorooshian is a Life Fellow of the Indian Association of Hydrologists and a Fellow of the American Association for the Advancement of Science (AAAS), American Geophysical Union (AGU), American Meteorological Society (AMS), and the International Water Resources Association (IWRA).

SESSION H **SINGLE EVENT EFFECTS, MECHANISMS AND MODELS**

9:15 AM SESSION INTRODUCTION

Chair: Jeffery Titus, NAVSEA Crane

H-1 **Differences in Charge Removal from FGMOS Floating Gates by**
9:30 AM **Electrons and Heavy Ions**

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

The unusual dependence on LET exhibited by FGMOS devices exposed to heavy ions can be explained in terms of recombination and annealing of the charge trapped in the oxide and the structure of heavy-ion tracks at low incident energies.

H-2 **Ion Track Structure and Its Effects in Small Size Volumes of Silicon**
9:45 AM *A. Akkerman, J. Barak, Soreq NRC*

A model for ion-energy-deposition in silicon, based on experimental data of the optical energy loss function is presented. The model yields ion-track spatial structure. It estimates the influence of track structure on deposition in submicron devices.

H-3 **Comparison of Bulk and SOI Technology Sensitivities to**
10:00 AM **14 MeV Neutrons**

G. Gasiot, P. Roche, P. Flatresse, ST Microelectronics;
V. Ferlet-Cavrois, J. Baggio, CEA/DAM; J. du Port de Poncharra, CEA/DRT/LETI

This paper investigates the effects of 14 MeV neutron irradiation on bulk and SOI technologies. Experimental results on both technologies are presented as well as a study of the effect of the irradiation angle.

10:15 - 10:45 AM BREAK

H-4 **Effects of Proton Beam Angle-of-Incidence on Single-Event**
10:45 AM **Upset Cross-Section**

R. Reed, B. Fodness, H. Kim, NASA Goddard Space Flight Center;
P. W. Marshall, Consultant; P. J. McNulty, Clemson University;
R. Reedy, G. Wuo, J. Swonger, C. Tabbert, Peregrine Semiconductor

Experimental and simulation evidence is presented that shows a significant effect on the single event upset cross-section when the angle-of-incidence of the proton beam is varied.

H-5 **Accelerated Wear-out of Ultra-thin Gate Oxides After Irradiation**
11:00 AM *A. Cester, S. Cimino, A. Paccagnella, Università di Padova;*
G. Ghibaudo, LPCS/ENSERG; G. Ghidini, ST Microelectronics

We investigate how ultra-thin gate oxides, subjected to heavy ion irradiation, react to subsequent electrical stresses. In irradiated devices, the time-to-breakdown (soft or hard) is reduced in comparison with unirradiated samples.

H-6 11:15 AM

Long-Term Reliability Degradation of Ultra-Thin Dielectric Films Due to Heavy-Ion Irradiation

B. K. Choi, R. D. Schrimpf, D. M. Fleetwood, L. W. Massengill, K. F. Galloway, 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

High-LET ion irradiated 3.3 nm oxynitride film MOS capacitors show premature breakdown during subsequent electrical stress. The reliability degradation is explained with a simple model based on the increased log slope of the gate leakage current.

POSTER PAPERS

PH-1

Anomalous Charge Loss from Floating-Gate Memory Cells Due to Heavy Ion Irradiation

G. Cellere, A. Paccagnella, Università di Padova; J. Wyss, A. Candelori, INFN; L. Larcher, Modena University; P. Pellati, A. Chimenton, Ferrara University; A. Modelli, P. Caprara, ST Microelectronics

We investigated experimentally and theoretically charge loss phenomena from non-volatile-memory floating gates produced by heavy ion irradiation. Results are inconsistent with existing models and new explanations are proposed for the enhanced charge loss.

PH-2

Wavelength Dependence of Transient Laser-Induced Latchup in Epitaxial CMOS Test

S. D. LaLumondiere, R. Koga, J. V. Osborn, D. C. Mayer, R. C. Lacoe, S. C. Moss, The Aerospace Corporation

We report thresholds for laser-induced latchup on epitaxial CMOS test structures for 600 and 815 nm excitation. We analyze the differences observed in terms of different latchup triggering mechanisms and discuss particle-induced latchup.

PH-3

The Contribution of Diffusion to Device Upset Cross Sections

J. D. Patterson, L. D. Edmonds, Jet Propulsion Laboratory

A novel technique incorporating carrier recombination for determining the charge collection efficiency is applied to a realistic memory device to obtain the upset cross section, as a function of LET and orientation. The theoretical predictions show agreement with experiment.

PH-4

Charge-Collection in InAlAs/InGaAs High Electron Mobility Transistors. Experiment and Simulation

D. McMorrow, J. S. Melinger, D. P. Yang, J. B. Boos, Naval Research Laboratory; A. R. Knudson, SFA

Time resolved charge-collection measurements and two-dimensional device simulations, performed on InAlAs/InGaAs HEMTs with pulsed laser excitation, address the mechanisms of charge collection and enhancement in these heterostructure devices.

11:30 - 1:00 PM LUNCH

SESSION I — SINGLE EVENT EFFECTS, DEVICES AND INTEGRATED CIRCUITS

1:00 PM — SESSION INTRODUCTION

Chairs: Ronald Pease, RLP Research and Satoshi Kuboyama, National Space Development Agency of Japan

I-1 — Single-Event Transients in High-Speed Comparators

1:10 PM

A. H. Johnston, T. F. Miyahira, F. Irom, Jet Propulsion Laboratory

Single-event transients are evaluated in three high-speed comparators, including one BiCMOS device. Regions well removed from the gain stage contribute to the cross section of the BiCMOS device, but not for the two bipolar comparators.

I-2 — Circuit Modeling of the LM124 Operational Amplifier for Single-Event Transient Prediction

1:25 PM

Y. Boulghassoul, L. W. Massengill, A. L. Sternberg, Vanderbilt University; R. L. Pease, RLP Research; S. P. Buchner, QSS/NASA Goddard Space Flight Center; J. W. Howard, Jackson and Tull; D. McMorrow, NRL; M. W. Savage, NAVSEA Crane; C. Poivey, NASA Goddard Space Flight Center

We present a calibrated LM124 circuit model for analog Single-Event Transient analyses. We rely heavily on datasheet specifications and experimental laser data for dc and transient calibration. The resulting model is suitable for broad-beam SET predictions.

I-3 — Single Event Burnout of NPN Bipolar Junction Transistors in Hybrid DC/DC Converters

1:40 PM

K. Warren, D. Roth, J. Kinnison, R. Pappalardo, Johns Hopkins Applied Physics Laboratory

Single event induced failure of the AMF2805S DC/DC converter has been traced to burnout of an NPN transistor, while in the inhibit mode only. A discussion of the failure mechanism and consequences for DC/DC converter testing is presented.

I-4 — Impact of Scaling on Soft Error Rates in Commercial Microprocessors

1:55 PM

X. Zhu, L. Massengill, Vanderbilt University; N. Seifert, Compaq Computer

We analyze the impact of technology scaling and internal logic design on the soft error rate (SER) in 0.35 μm and 0.25 μm Alpha 21164 and 21264 microprocessors at the device, circuit and system levels.

I-5 — A Comparison of SEU Tolerance in High-Speed SiGe HBT Digital Logic Designed with Multiple Circuit Architectures

2:10 PM

G. Niu, R. Krithivasan, J. D. Cressler, Auburn University; P. A. Riggs, B. A. Randall, Mayo Foundation; P. Marshall, Consultant; R. Reed, NASA Goddard Space Flight Center

We compare the SEU tolerance in high-speed SiGe HBT digital logic designed with multiple circuit architectures using simulation. One circuit architecture shows significantly better SEU tolerance than others.

I-6 2:25 PM

Analysis of the Effects of SEUs on the Hidden Parts of a Pipelined Microprocessor: A Case Study

F. Faure, R. Velazco, TIMA-CMP; M. Violante, M. Rebaudengo, M. Sonza Reorda, Politecnico di Torino

A method for estimating the sensitivity to transient errors of a pipelined-cached processor when executing a given program is proposed. Preliminary results show good agreement between predicted and measured figures.

POSTER PAPERS

PI-1 The Role of Parasitic Elements in the Single-Event Transient Response of Linear Circuits

A. L. Sternberg, L. W. Massengill, Y. Boulghassoul, Vanderbilt University; S. P. Buchner, QSS/NASA Goddard Space Flight Center; R. L. Pease, RLP Research; M. W. Savage, NAVSEA Crane

Parasitic elements are key contributors to single-event transients in analog circuits. The identification of these parasitics with a pulsed laser and an ion microbeam, and the effects on observed SET are discussed.

PI-2 Laser-Induced and Heavy Ion-Induced Single Event Transient (SET) Sensitivity Measurements on LM139 Comparators

S. D. LaLumondiere, S. C. Moss, R. Koga, The Aerospace Corporation; M. C. Maher, National Semiconductor

We have measured single event transients (SET) on LM139 comparators with differing topologies. We report both pulsed laser-induced and heavy ion-induced measurements. We discuss the effects of different device topologies on SET sensitivity.

PI-3 Test Methodology for Characterizing the SEE Sensitivity of a Commercial IEEE 1394 Serial Bus (FireWire)

C. Seidleck, Raytheon; H. Kim, Jackson and Tull; S. Buchner, QSS/NASA Goddard Space Flight Center; P. W. Marshall, Consultant; K. LaBel, NASA Goddard Space Flight Center

The SEE responses of two FireWire serial buses, based on the IEEE 1394 standard, were tested with heavy ions and protons. A unique approach to testing and categorizing the Single-Event Effects (SEEs) is presented.

PI-4 Comparison of Heavy Ion and Proton Induced Single Event Effects (SEE) Sensitivities

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

Proton induced single event effects of a set of microcircuits are compared with effects due to heavy ions. Even though some microcircuits show a relatively high sensitivity to heavy ions, they do not have a corresponding sensitivity to protons.

PI-5 **Frequency Related Effects of Analog Single-Event Transients in Linear Circuits**

Y. Boulghassoul, L. W. Massengill, T. Holman, Vanderbilt University

Investigations in the frequency domain show a tight dependence of ASET response on the high frequency components of current stimuli and the impulse response of downstream circuit elements. Benefits gained from frequency compensation are evident.

PI-6 **Single-Event Upset in the PowerPC7400 (G4) Microprocessor**

F. Irom, G. M. Swift, F. Farmanesh, Jet Propulsion Laboratory;
D. G. Millward, Millward Research

Proton and heavy-ion single-event upset susceptibility has been measured for the Motorola PowerPC7400. The results show that this advanced device has low upset susceptibility, despite the scaling and design advances.

PI-7 **Validation of an SEU Simulation Technique for a Complex Processor: PowerPC7400**

S. Rezgui, R. Velazco, TIMA; G. M. Swift, Jet Propulsion Laboratory

A methodology for error rate prediction of a complex processor running applications by a software-based fault injection technique is presented. The methodology is validated through comparison with heavy ion data obtained on advanced PowerPC processors.

POSTER SESSION
2:40 - 5:00 PM
SOUTH MOUNTAIN BALLROOM

INTRODUCTION

Chair: Robert Reed, NASA Goddard Space Flight Center

5:00 PM END THURSDAY SESSIONS

5:15 - 6:45 PM
GRANDE BALLROOM

RADIATION EFFECTS COMMITTEE OPEN MEETING

INVITED TALK
8:15 - 9:15 AM

Living and Working in Space

Carl Walz, NASA Astronaut

Carl Walz, U.S. Air Force officer and career astronaut, will describe his experiences on the most recent team to work aboard the International Space Station (ISS). He will discuss his intensive training in Russia and the U.S., the mission itself and the recovery process after more than 4 months in space. We will have a unique opportunity to learn the latest status of the Station and the growing understanding of man's place in space.

Colonel Walz began his Air Force career as a nuclear research officer responsible for analysis of radioactive samples from the Atomic Energy Detection System. He took his first step toward being an astronaut by graduating as a Distinguished Graduate Flight Test Engineer from the USAF Test Pilot School, after which he served as a Flight Test Engineer working on a variety of F-16C airframe avionics and armament development programs.

Selected by NASA in January 1990, Colonel Walz is a veteran of four space flights and logged over 34 days in space by 1996. In 1993 he served as a mission specialist on STS-51, where he was one of a five-member crew that deployed the U.S. Advanced Communications Technology Satellite and the Shuttle Pallet Satellite with NASA and German scientific experiments aboard. During this mission he participated in his first spacewalk, spending seven hours evaluating tools for the Hubble Space Telescope servicing mission. His second flight opportunity was in 1994 as the Orbiter flight engineer on STS-65. The crew of seven flew the second International Microgravity Laboratory spacelab module and conducted more than 80 experiments focusing on materials and life sciences research in microgravity. In 1996 he was a mission specialist on STS-79 where the six-member crew aboard Atlantis docked with the Russian MIR station, delivered food, water, U.S. scientific experiments and Russian equipment and exchanged NASA long duration crewmembers.

In 1998 Colonel Walz began training in both the U.S. and Russia for his latest mission of living and working aboard the International Space Station. On December 7, 2001 he arrived aboard STS-108 Endeavour as part of the Expedition-4 crew of three (one Russian cosmonaut and two American astronauts) that stayed on the station for approximately four months. They will perform flight tests of the station hardware, conduct internal and external maintenance tasks and several spacewalks, and develop the capability of the station to support the addition of science experiments. He will return to earth in early May.

SESSION J
9:15 AM

DEVICES AND INTEGRATED CIRCUITS

SESSION INTRODUCTION

Chair: Hugh Barnaby, University of Arizona

J-1
9:30 AM

Elimination of Enhanced Low-Dose-Rate Sensitivity and Thermal-Stress Effects in Linear Bipolar Devices

M. R. Shaneyfelt, J. R. Schwank, S. C. Witczak, G. L. Hash, P. E. Dodd, L. C. Riewe, Sandia National Laboratories; R. L. Pease, RLP Research; D. M. Fleetwood, Vanderbilt University; M. C. Maher, National Semiconductor

Passivation layers are shown to have major impact on the total dose hardness of bipolar technologies. Selecting the correct passivation layers can eliminate the PETS and ELDRS effects in at least some bipolar technologies.

J-2 9:45 AM

Total Dose Hardening of a Bipolar Voltage Comparator

R. L. Pease, RLP Research; M. C. Maher, National Semiconductor;
M. W. Savage, P. R. Baker, J. F. Krieg, T. L. Turflinger, NAVSEA Crane;
M. R. Shaneyfelt, Sandia National Laboratories

A radiation-tolerant bipolar voltage comparator experienced severe degradation in hardness when process, wafer size, and mask changes were made. The reasons are identified. Design layout modifications re-established the hardness.

J-3 10:00 AM

Separation of Ionization and Displacement Damage Using Gate-Controlled Lateral PNP Bipolar Transistors

D. R. Ball, R. D. Schrimpf, Vanderbilt University; H. J. Barnaby, University of Arizona

Ionization and displacement effects in lateral PNP bipolar transistors can be separated and analyzed using gate-controlled devices. Experiments and simulations based on this approach help to explain proton-induced BJT degradation.

J-4 10:15 AM

Analysis of Schottky Diode Dose-Rate Failure Mechanisms Using Enhanced TCAD Simulation

R. J. Graves, J. Ralston-Good, Dynamics Research; J. L. Titus, NAVSEA Crane;
J. E. Smith, Raytheon; M. Boden, International Rectifier

Numerical process and device simulations are applied to identify the mechanisms that govern the dose-rate response of power Schottky diodes and to visualize the dynamics of catastrophic failure due to large current densities and thermal runaway.

10:30 - 10:50 AM BREAK

J-5 10:50 AM

Total Dose Radiation Response of Hafnium Oxide Capacitors

J.A. Felix, D. M. Fleetwood, R. D. Schrimpf, Vanderbilt University;
J. G. Hong, G. Lucovsky, North Carolina State University;
J. R. Schwank, M. R. Shaneyfelt, Sandia National Laboratories

The total-dose response of HfO_2 capacitors has been investigated for devices irradiated with 10-keV x-rays. The radiation-induced oxide-trapped charge is significantly greater than that observed in high-quality thermal SiO_2 of equivalent electrical thickness.

J-6 11:05 AM

Radiation Effects in Micromechanical Systems (MEMS): RF Relays

S. McClure, J. Lehman, C. Yui, P. Alonzo, Jet Propulsion Laboratory;
R. E. Mihailovich, J. F. DeNatale, Rockwell; T.-Y. Hsu, HRL Laboratories

Micromechanical RF relays, fabricated by surface micromachining techniques, are characterized for their response to total ionizing dose. Changes in switch activation voltage and device failure to activate at moderate dose levels are noted.

J-7 11:20 AM

An Investigation of the Origins of the Variable Proton Tolerance in Multiple SiGe HBT BiCMOS Technology Generations

J. D. Cressler, R. Krithivasan, G. Zhang, G. Niu, M. J. Palmer, Auburn University; P. W. Marshall, Consultant; H. S. Kim, Jackson and Tull; R. A. Reed, NASA Goddard Space Flight Center; A. J. Joseph, IBM

We investigate the physical origins of the variable proton tolerance in multiple SiGe HBT BiCMOS technology generations. We use a combination of new proton data, 2-D simulations, and electrical stress results to shed light on the damage mechanisms.

J-8 11:35 AM

Investigation of Proton Energy Effects in SiGe HBT Technology

S. Zhang, J. D. Cressler, G. Niu, T. Isaacs-Smith, J. R. Williams, Auburn University; S. Subbanna, R. Groves, IBM; H. Bakhru, State University of New York; P. W. Marshall, Consultant; H. S. Kim, Jackson and Tull; R. A. Reed, NASA Goddard Space Flight Center

We present the first investigation of low energy (1.75 MeV) proton irradiation in SiGe HBTs and discuss proton energy effects in SiGe technology.

J-9 11:50 AM

Proton-Induced Degradation in AlGaAs/GaAs Heterojunction Bipolar Transistors

X. Hu, B. K. Choi, D. M. Fleetwood, R. D. Schrimpf, R. A. Weller, Vanderbilt University; H. J. Barnaby, University of Arizona; K. McDonald, Sandia National Laboratories; R. Dettmer, Air Force Research Laboratory

The effects of proton irradiation on AlGaAs/GaAs Heterojunction Bipolar Transistors (HBTs) are reported. The devices exhibit little degradation when irradiated with 105 MeV protons, but significant gain degradation occurs at 1.8 MeV.

POSTER PAPERS

PJ-1

Total Dose and Single Event Effects in Switching DC/DC Power Converters

P. C. Adell, R. D. Schrimpf, B. K. Choi, C. R. Cirba, Vanderbilt University

Radiation effects in switching DC/DC power converters are examined using a combination of total dose experiments and a simple electrical technique for studying SEE. Effects in the power MOSFET switch and the control circuitry are considered.

PJ-2

Carrier Removal Rate and Mobility Degradation in Heterojunction Field Effect Transistor Structures

B. Jun, S. Subramanian, Oregon State University

In this paper, we report experimental results and theoretical investigations of neutron irradiation-induced carrier removal rate and mobility degradation in AlGaAs/GaAs heterojunction field effect transistor (HFET) structures.

PJ-3 **DCI-V and Charge Pumping Analyses of Gamma-Ray Irradiated Power VDMOSFET Devices**

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

We clarify and further explain the DC I-V data of the gamma-irradiated VDMOSFET samples. This work indicates the DCIV technique may be useful to characterize the near-midgap interface traps for VDMOSFET devices.

PJ-4 **Dose Rate Effects in Gamma-Irradiated Ferroelectric PZT Capacitors**

G. Zhang, P. Sun, Q. Zou, H. E. Ruda, Center for Advanced Nanotechnology;
Q. Guo, X. Yu, D. Ren, R. Yan, Xinjiang Institute of Physics

We report on dielectric properties of PZT capacitors, gamma-irradiated at different dose rates. The dielectric properties exhibited distinct radiation dose rate dependence with the worst-case degradation occurring at the lowest dose rate.

12:05 PM END OF CONFERENCE

RESG NEWS

Dale G. Platteter
Chairman

Ronald D. Schrimpf
Executive Vice Chairman

The IEEE Radiation Effects Steering Group (RESG) held its annual fall business meeting in Phoenix, Arizona, at the site of our upcoming Nuclear and Space Radiation Effects Conference (NSREC). The RESG chose Phoenix for the 2002 Conference because of its family-friendly location and outstanding technical facilities. The main technical session, poster session, data workshop, and industrial exhibits all have excellent spaces. In addition, all guest rooms at the resort are two-room suites, so the underlying message is, "bring the family to Phoenix this year."

The South Pointe Mountain Resort is an all-suite tennis and golf complex with six swimming pools. The resort is located in the middle of a golf course and directly across the street from Fry's Electronics Superstore. For those who have never visited Fry's, it is a "heavenly shopping experience" for an electronic engineer. A few blocks down the street is a huge shopping mall, a "heavenly shopping experience" for the rest of the family.

We recently published an updated version of the CD-ROM archive of Radiation Effects Short Course Notebooks, adding the past four years of Short Course notebooks to our previous collection. The updated CD spans the entire period from 1980-2002 and includes a full text search engine. NSREC will provide a complimentary copy of this new CD-ROM to all those who register for the 2002 Short Course.

Next year's conference is scheduled for 21-25 July 2003 at the DoubleTree Hotel in Monterey, California. Allan Johnston of Jet Propulsion Laboratory, Conference General Chairman, has been working for two years on the details for this meeting. Allan's committee is planning to observe the 40th anniversary of NSREC with a special issue of the Transactions on Nuclear Science. The issue will include 20-25 invited papers, from some of NSREC's most distinguished authors, summarizing the significant technical findings of this community over the past 40 years.

Dan Fleetwood of Vanderbilt University was appointed as 2004 Conference General Chairman. Dan is currently looking at locations in the eastern US and has visited several sites. He is giving strong consideration to the city of Atlanta. Dan will be negotiating contracts and forming his technical committees soon.

Please visit our NSREC web site at *www.nsrec.com* for the most up-to-date conference information, on-line registration materials, author preprint requests, reviewer schedules, award nomination forms, history of the NSREC, web links to our exhibitors, and more.

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

RESG NEWS

ARE YOU A MEMBER OF IEEE?

Now is the time to join the Institute of Electrical and Electronics Engineers (IEEE) and the Nuclear Plasma Sciences Society (NPSS). Why? First of all, you get to be a member of the largest professional engineering society in the world. 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 *Radiation Effects Data Workshop Record* and one issue of the *IEEE Transactions on Nuclear Science* (December 2002) will be mailed to each technical session attendee. A copy of the NSREC *Archive of Radiation Effects Short Course Notebooks 1980-2002* CD-ROM will be given to each Short Course attendee.

NSREC has three publications each year:

- **IEEE Transactions on Nuclear Science**. This IEEE journal is the official archive of research papers presented at the NSREC Conference. A six issue/year subscription is $775 (only $15 IEEE/NPSS members).

- **Radiation Effects Data Workshop Record**. Published each year in October, this IEEE proceedings has become the source for radiation test data on semiconductor components. A copy of the Workshop Record is available for $154 ($77 IEEE members).

- **NSREC Short Course Notebook**. Published each July, this notebook contains tutorial presentations on the basic physics of radiation effects in circuits and systems. It includes the instructor's notes and text, given to participants of the annual Radiation Effects Short Course. The CD-ROM *Archive of Radiation Effects Short Course Notebooks 1980-2002* is available for $200 ($160 IEEE members).

To obtain individual copies, please visit the IEEE *on-line Catalog and Store* at http://shop.ieee.org/store/ or contact IEEE Service Center at 732-981-1393.

RADIATION EFFECTS COMMITTEE OPEN MEETING

You are invited to attend the IEEE Radiation Effects Committee's Annual Open Meeting on Thursday, July 18, from 5:15 – 6:45 PM in the Grande Ballroom Front. 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. We will also elect four IEEE/NPSS members to serve as a *nominating committee*, to help us select a slate of candidates for the upcoming RESG elections. This committee will present its recommendations for potential candidates for the RESG Vice-Chairman and RESG Secretary positions. Nominations will be taken from the floor. All IEEE NPSS members present are eligible to vote. Refreshments will be provided.

Awards

2001 OUTSTANDING CONFERENCE PAPER AWARD

SEU-Sensitive Volumes in Bulk and SOI SRAMs from First-Principles Calculations and Experiments

Paul Dodd, Marty Shaneyfelt, Kevin Horn, Dave Walsh, Gerald Hash, Tom Hill, Bruce Draper, Jim Schwank, Fred Sexton and Peter Winokur of Sandia National Laboratories

2001 MERITORIOUS CONFERENCE PAPER AWARD

Heavy-Ion-Induced Breakdown in Ultra-Thin Gate Oxides and High-k Dielectrics

Lloyd Massengill, Bo Kyoung Choi, Dan Fleetwood, Ron Schrimpf and Ken Galloway of Vanderbilt University, Marty Shaneyfelt, Tim Meisenheimer, Paul Dodd and Jim Schwank of Sandia National Laboratories and Yi-Mu Lee, Robert Johnson and Gerry Lucovsky of North Carolina State University

2001 DATA WORKSHOP PAPER AWARD

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

Martha O'Bryan, Christina Seidleck and Martin Carts of Raytheon ITSS, Ken LaBel, Robert Reed, Janet Barth, Cheryl Marshall, Donald Hawkins, Anthony Sanders and Steve Cox of NASA Goddard Space Flight Center, James Howard, Jr., Hak Kim, James Forney and Curtis Dunsmore of Jackson and Tull Chartered Engineers, Steve Buchner and Paul Marshall of SFA, Inc., and Christopher Palor, Ray Ladbury and Scott Kniffin of Orbital Sciences Corporation

IEEE FELLOWS

Two distinguished members of the radiation effects community were elected to the grade of IEEE Fellow on January 1, 2002.

Allan H. Johnston
Jet Propulsion Laboratory

Marty R. Shaneyfelt
Sandia National Laboratories

Allan H. Johnston's citation reads, "For contributions to the understanding of space radiation effects in optoelectronics."

Marty R. Shaneyfelt's citation reads, "For contributions to the understanding of radiation effects in semiconductor devices and to the development of radiation-hardened technologies."

EARLY ACHIEVEMENT AWARD

Paul E. Dodd of Sandia National Laboratories will receive the 2001 NPSS Early Achievement Award at the 2002 NSREC. Paul has authored or co-authored more than 40 peer-reviewed publications, including papers that won the 1997, 2000, and 2001 NSREC Outstanding Conference Paper Awards. Paul Dodd has served the radiation effects community as Publicity Chairman, Session Chairman, Awards Committee member, Short Course Instructor, and Short Course Chairman for the NSREC, and has been a Session Chairman for the Single-Event Effects Symposium and the European RADECS Conference. He will serve as Technical Program Chairman of the 2003 NSREC. Paul's citation reads: "For contributions to the understanding and simulation of physical mechanisms responsible for single-event effects in spaceborne microelectronics."

Awards

2001 RADIATION EFFECTS AWARD

The 2001 Radiation Effects Award was presented to Dr. Andrew Holmes-Siedle, Brunel University of West London and REM Oxford Ltd., during the opening ceremonies of the 2001 conference. Dr. Holmes-Siedle received this honor for contributions to the field of radiation dosimetry and his encouragement of young researchers in the field of radiation effects. He is well known for his invention of the RadFET solid-state pMOS dosimeter, which has seen wide application in space, medical, and high-energy physics research.

2002 RADIATION EFFECTS AWARD

The winner of the 2002 Radiation Effects Award will be announced Tuesday morning, July 16.

2003 RADIATION EFFECTS AWARD

Nominations are currently being accepted for the 2003 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 2003 IEEE NSREC at Monterey, California in July 2003. 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 David Hiemstra, Member-at-Large for the Radiation Effects Steering Group. David can be reached at 905-790-2800 x4733, dhiemstr@mdrobotics.ca.

Industrial Exhibits

"The co-location of the exhibits and the technical sessions along with all the planned "festivities" make this year's exhibit a must see! See you there."

Chuck Tabbert
Industrial Exhibits Chairman

The 2002 exhibit will be held at the Pointe South Mountain Resort, Grand Ballroom, Phoenix, Arizona on July 16 and 17, 2002. We are looking forward to another well-attended conference and excellent traffic through the exhibit booth area. As you'll see in the enclosed floorplan, the exhibits are next door to all the technical sessions. We're looking to have all the breaks and hopefully a lunch in the exhibits area during the event. Also, for your convenience, a stage will be set up with public address capability for vendor-sponsored raffles during the exhibit hours.

For additional information, contact:

Chuck Tabbert	Phone: 321-951-4524
Peregrine Semiconductor	Cell Phone: 321-432-9380
13 E Melbourne Ave	Fax: 321-951-7972
Melbourne, Fl 32901	Email: ctabbert@peregrine-semi.com

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

Booth Spaces: $2,000 per 10′ x 10′ area. Included in this cost is:

- A link to your company's web page on the NSREC exhibitor page
- One (1) complimentary conference registration per 10 x 10 space rented
- Two (2) complimentary exhibitor badges granted to the exhibit area for booth staffers (additional exhibitor badges $100 each)
- Exhibitor Social July 16th, 2002

As of this writing, several booth spaces are available but as in past years, the exhibit area is filling quickly.

EXHIBIT HALL HOURS

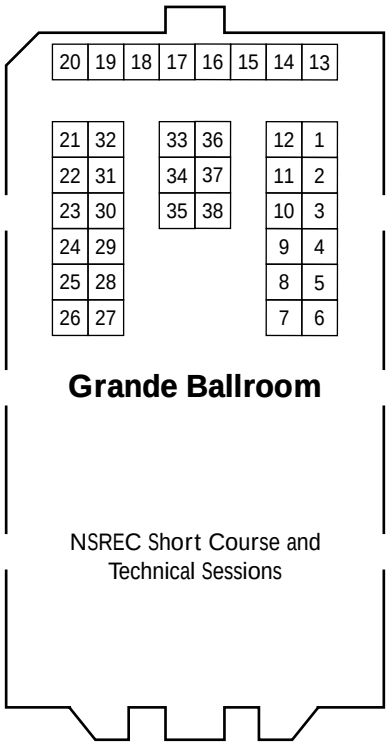
Set-Up:	Tuesday, July 16	8:00 AM – 11:45 PM
Show Hours:	Tuesday, July 16	11:45 PM - 5:00 PM 7:00 PM - 10:00 PM (exhibitor reception)
	Wednesday, July 17	7:30 AM - 3:30 PM
Tear-down:	Wednesday, July 17	3:30 PM – 6:00 PM

Industrial Exhibits

EXHIBITORS

Please check our web site (www.nsrec.com) for a current listing of companies exhibiting at 2002 NSREC.

NSREC Industrial Exhibit



Company	Internet Site	Booth(s) #
Actel	www.actel.com	26
AEM	www.aem-usa.com	17
Aeroflex UTMC	www.utmc.com	27, 28
Atmel	www.atmel.com	38
BAE Systems	www.iews.na.baesystems.com	29
Boeing Rad Effects Lab	www.boeing.com/assocproducts/radiationlab/data	20
Brookhaven National Lab	http://tvdg10.phy.bnl.gov	19
Defense Microelectronics Activity	www.dmea.osd.mil	9
DPA Components International	www.dpalabs.com	36
Honeywell SSEC	www.myspaceparts.com	10
Integrated Systems Engineering	www.ise.com	11
International Rectifier	hirel.irf.com	8
Intersil	www.intersil.com	5
iRoC Technologies	www.iroctech.com	22
JD Instruments	www.jdinstruments.net	15
J.L. Shepherd Associates / ICS Radiation Technology	www.jlshepherd.com	16
Maxwell Technologies Inc	www.maxwell.com	3
MeltroniX / US Semiconductor Corp	www.meltronix.com	21
Micropac	www.micropac.com	12
Modular Devices Inc	www.mdipower.com	31
MRC Microelectronics	www.mrcmicroe.com	32
NASA Applied Radiation	www.pvamu.edu/carr	30
NASA Goddard Space Flight Center	lws.gsfc.nasa.gov	35
NASA Marshall Space Flight Center	see.msfc.nasa.gov	33, 34
Northrop Grumman	www.sensor.northgrum.com/essd/atc/	25
Peregrine Semiconductor	www.peregrine-semi.com	7
Sandia National Labs	www.sandia.gov	18
Silvaco	www.silvaco.com	2
Spectrum Astro	www.specastro.com	37
Texas A&M Cyclotron	http://cyclotron.tamu.edu/ref/	1
White Sands Missile Range	www.wsmr.army.mil	4
Xilinx	www.xilinx.com	6

Conference Information

ROOMS FOR SIDE MEETINGS

Several meeting rooms are available for use by NSREC attendees during the conference week at the Pointe South Mountain Resort. 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

602-453-5568
FAX: 602-431-6535

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 2002 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

602-438-9000 x 4391
FAX: 602-431-6535

The Pointe South Mountain Resort has a Business Center located to the east of the 2nd floor lobby near the East Courtrooms and Gift Shoppe. The Center's hours of operation are 7:00 AM to 5:00 PM Monday to Friday. Services available from the Business Center include black and white and color copying, fax transmission and receiving, computer usage, scanning, internet access, equipment rental, and secretarial services. Costs associated with the Business Center services are the responsibility of the attendee. Business Center access can be arranged beyond the basic hours, but additional charges will apply.

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 13, 2002.

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 "2002 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 lower lobby near the Grande Ballroom in the Pointe South Mountain Resort. The following is the schedule for on-site registration:

Sunday, July 14	**5:00 PM – 9:00 PM**
Monday, July 15	**7:30 AM – 4:00 PM** **6:00 PM – 9:00 PM**
Tuesday, July 16	**7:30 AM – 5:30 PM**
Wednesday, July 17	**7:30 AM – 3:00 PM**
Thursday, July 18	**7:30 AM – 3:00 PM**
Friday, July 19	**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 13, 2002 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

The 2002 IEEE NSREC will be held at the Pointe South Mountain Resort. The Pointe South Mountain Resort is the largest all-suite resort in the American Southwest with ideal conference meeting space for the NSREC. Located adjacent to the South Mountain Park and ten miles from the Phoenix Sky Harbor airport, the Pointe has many scenic courtyards, six swimming pools, a large spa and fitness center, and world-class tennis and golf facilities.

POINTE SOUTH MOUNTAIN RESORT

7777 SOUTH POINTE PKWY
PHOENIX, ARIZONA 85044

602-438-9000
TOLL-FREE: 800-876-4683

Photo courtesy of Pointe South Mountain Resort

The Pointe South Mountain Resort has recently completed a redesign of its 640 guest suites. Connecting guests with the resort's South Mountain desert experience, the hacienda-style, one-bedroom suites feature many of the desert's natural tones and textures, yet use dramatic color, much like a cactus in bloom. The rooms' artwork and accessories have a personal, hand-collected quality portraying the surrounding South Mountain range, designed from photographs and drawings from several artists who hiked the area. The room redesign was just one part of Pointe South Mountain's enhancements. The first to be unveiled was the Paseo in November of 2000, an outdoor event venue and public promenade lined with fountains, botanical collections and landscaped sitting areas.

The conference room rate is $90.00 per night plus tax, double occupancy. There is a $15.00 per person charge for each additional person over the age of 18. A block of rooms has been set aside at the Government per diem rate for U.S. Government attendees. Proof of Government employment is required. A $5.00 per night resort fee will also be charged to your suite. The fee provides unlimited local calls and access for credit card, toll free, and collect phone calls; daily use of in-suite coffee; daily newspaper; fitness center admittance; and shuttle to the Arizona Mills Mall.

Please call the Pointe South Mountain Resort and ask for the **"IEEE NSREC"** block of rooms. Reservations must be guaranteed. The cut-off date for room reservations is June 11, 2002. After that date, room accommodations will be confirmed on a space available basis and the conference room rate is not guaranteed.

EARLY CHECK-OUT FEE

The Pointe South Mountain Resort has an early check-out fee of $50 if you depart earlier than your reservation states. In order to avoid this fee, please provide the hotel at least 24 hours notice of an early check-out. This is performed easiest by verifying your departure date at check-in and notifying the hotel when your plans change.

Registration and Travel

AIRPORT INFORMATION

Phoenix Sky Harbor International Airport is served by 21 airlines, which provide nonstop service from Phoenix to approximately 104 cities in the U.S., and around the world. America West Airlines and Southwest Airlines have major hub operations in Phoenix providing convenient connections to virtually any city in the U.S. The airport is approximately 10 miles from the Pointe South Mountain Resort.

TRANSPORTATION AND DIRECTIONS

Upon arrival in Phoenix, you have a choice of transfers. You can pay for shuttle service or a taxi to take you from the airport to the hotel. Or you can choose to rent a car from the many agencies that operate out of the Phoenix Sky Harbor International Airport. If you are driving from the airport, it is very easy to get to the resort. The most difficult portion of the drive is getting from your rental car lot onto I-10 South. The rental car companies are at different locations around the airport and it is best to ask them for the easiest route to I-10 South. Take I-10 South to the Baseline Road exit, approximately 4-5 miles. Exit at Baseline Rd/Guadalupe, exit number 155. Turn right onto Baseline Rd. Then, turn left at the first traffic light, South Pointe Pkwy.

AIRPORT SHUTTLE DISCOUNT

Super Shuttle is offering a discount for attendees for shuttle service from Phoenix Sky Harbor Airport to the Pointe South Mountain Resort. The service costs $9.00 + 15% gratuity per person one-way (double that for roundtrip). Reservations are not needed for the airport-to-hotel transfer; simply claim luggage and exit at the door that says "Shared Ride Van Service." A Guest Service Representative will meet each party at the designated pick-up location and arrange Super Shuttle service to the hotel. Each person then advises the Super Shuttle driver that he/she is eligible for the IEEE NSREC group rate. All payments must be in cash (U.S. dollars) as credit cards and checks are NOT accepted. Reservations are required for the transfer from the hotel to the airport; those must be made at least 24 hours in advance by calling 1-800-BLUE-VAN (800-258-3826) or booking online at www.supershuttle.com. Again, advise the driver of the IEEE NSREC group rate.

PARKING

There is ample free parking at the Pointe South Mountain Resort. Upon arrival at the resort, you should park temporarily at Guest Registration. Once you have obtained your room, a guest services person will be happy to direct you to an appropriate parking lot.

Registration and Travel

RENTAL CAR DISCOUNT
800-331-1600

AWD NUMBER A606096

Avis has been selected as the official rental car agency for the 2002 NSREC and is offering discounted rates for the conference attendees. For reservations and information, call Avis at 800-331-1600 and mention AWD Number A606096. The rates below are the conference rates, however, should a lower qualifying rate become available, Avis is pleased to present a 5% discount on that rate.

NOTE: Weekend daily rates apply for rentals between 12 noon Thursday and 11:59 PM Monday.

Car type	Daily (per day)	Weekend (per day)	Weekly (5-7 days)
sub-compact	$32.99	$22.99	$147.99
compact	$36.99	$23.99	$158.99
intermediate	$40.99	$24.99	$171.99
fullsize 2-dr	$41.99	$25.99	$180.99
fullsize 4-dr	$43.99	$26.99	$190.99
premium	$47.99	$29.99	$203.99
luxury	$77.99	$71.99	$338.99
minivan	$77.99	$71.99	$338.99
sport utility	$77.99	$71.99	$338.99
convertible	$77.99	$71.99	$338.99

2002 IEEE NSREC and Short Course Registration Form

Name _____
Last Name *First Name* *Middle Initial*

Name to appear on badge _____

Company/Agency _____

Mailing Address _____

_____

City _____

State _____ Zip Code _____

Country _____

Telephone Number _____

Fax Number _____

E-mail Address _____

IEEE MEMBERSHIP

☐ I am an IEEE Member. _____
Membership Number

☐ I am not a Member, but I wish to join the IEEE.

Non-members must register at the non-member rate, 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 13, 2002 cannot be guaranteed. Consideration of requests for refunds will be processed after the conference.

Mail or Fax this form and your remittance (payable to 2002 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 13, 2002.

	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	$280	$_____
Technical Sessions	$105	$410	$_____

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: **2002 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.**

* All short course attendees will receive a special CD-ROM containing the complete notes from all previous NSREC short courses (1980-2002). The notes will be electronically searchable and will include all figures and text.

2002 IEEE NSREC
Activities Registration Form

Conference Participant _____

Company/Agency _____

Address _____

City _____

State _____ Zip Code _____

Country _____

Telephone Number _____

Fax Number _____

Accompanying Persons _____
Name

Please list ages for children under age 21 only

_____
Name *Age*

_____
Name *Age*

_____
Name *Age*

Mail or Fax this form and your remittance (payable to 2002 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 13, 2002. **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 Reception: *Sunday, July 14*				
Adult/child	$0	$0	_____	
Conference Reception: *Monday, July 15*				
Adult/child	$0	$0	_____	
Heard Museum Tour/Lunch: *Tuesday, July 16*				
Adult	$30	$35	_____	$_____
Child (age 0-12)	$20	$25	_____	$_____
Exhibitor Reception: *Tuesday, July 16*				
Adult/child	$0	$0	_____	
Corona Ranch Mexican Rodeo: *Wednesday, July 17*				
Adult	$35	$40	_____	$_____
Child (age 0-12)	$20	$25	_____	$_____
High Tea: *Thursday, July 18*				
Adult	$25	$30	_____	$_____

TOTAL AMOUNT ENCLOSED: $_____

CANCELLATIONS

To encourage advanced registration for conference social activities, we will refund all activity fees for conference attendees and/or their companions who for any reason are unable to attend the conference. If your plans change after this form is submitted and you would like to requst a refund, you must notify ETC Services by email at etcservices@qwest.net or FAX at 720-733-2046 no later than July 9 or notify the conference registration desk when picking up your registration materials (**but no later than 24 hours before the scheduled activity**).

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: **2002 IEEE NSREC**.

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

☐ American Express ☐ Master Card ☐ Visa

Card No. _____

Expiration Date _____

Signature _____

Social Program

Photograph courtesy of Greater Phoenix Convention and Visitors

The 2002 NSREC Committee has made arrangements for everyone to enjoy the cultural diversity of a dynamic city that is Phoenix 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. Late fees apply if payment is received after June 13, 2002.

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

SUNDAY, JULY 14
6:00 TO 9:00 PM
SHORT COURSE RECEPTION

Please join us for refreshments in the back half of the Grande Ballroom (Sections F, G, I, and J). The registration desk will be open from 5:00 to 9:00 PM and refreshments will be served from 6:00 to 9:00 PM. Dress is casual.

MONDAY, JULY 15
6:30 TO 9:30 PM
CONFERENCE RECEPTION

In the Grande Ballroom, conference attendees and their guests are invited to renew old acquaintances and make new ones. The registration desk will be open from 6:00 to 9:00 PM and refreshments will be served from 6:30 to 9:30 PM. Dress is casual.

Jeff Black
Local Arrangements Chairman

Steve Clark
Assistant Local Arrangements

Social Program

TUESDAY, JULY 16
10:30 AM TO 3:00 PM
HEARD MUSEUM TOUR AND LUNCH

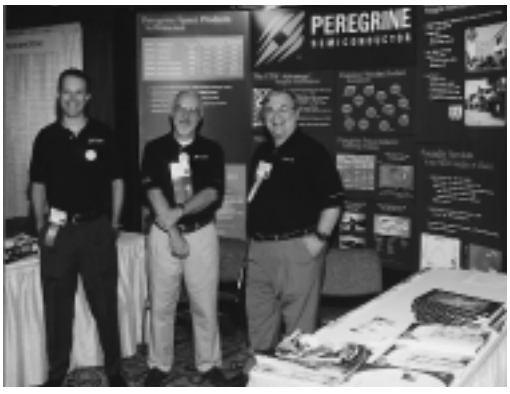
The internationally acclaimed Heard Museum is one of the best places to experience the myriad cultures and art of Native Americans of the Southwest. The museum's 10 spacious exhibit galleries, one being an interactive display for children, and beautiful outdoor courtyards feature outstanding traditional and contemporary Native American art. The Heard Museum was founded in 1929 by Dwight and Marie Heard to house their personal collection of cultural and fine art. The mission and philosophy of the Heard today is to educate the public about the heritage and the living cultures and arts of Native peoples, with an emphasis on the peoples of the Southwest.

Photograph courtesy of Jeff Black

Buses will depart the Pointe South Mountain Resort at 10:30 AM for the 30 minute ride to the Heard Museum. Tour guides will meet the NSREC companions and split into smaller groups for a guided tour of the museum. The guided tour will last until approximately 12:00 noon when all groups will meet at the Monte Vista Room for lunch and a demonstration of Native American artwork. Following lunch, NSREC companions will be free to tour the museum at their own pace, visit the museum store, or socialize in the Monte Vista Room. Buses will leave the Heard Museum at 2:30 PM and return to the Pointe South Mountain Resort at 3:00 PM. The Heard Museum is mostly indoors, but there is some walking outdoors between buildings, so dress appropriately for the heat.

TUESDAY, JULY 16
7:00 TO 10:00 PM
INDUSTRIAL EXHIBITS RECEPTION

The NSREC exhibitors will host a reception in the Grande Ballroom. Along with meeting the leading companies of the radiation hardened industry, there will be complimentary food and drink to NSREC attendees and their guests. Dress is casual.



Photograph courtesy of Dave Bushmire

Social Program

WEDNESDAY, JULY 17
6:00 TO 10:30 PM
CORONA RANCH
MEXICAN RODEO

Please join us as we visit the Corona Ranch Mexican Rodeo Grounds. We start the evening meeting the buses outside the lower lobby departing at approximately 6:00 PM. The short bus ride will take us to the front of the rodeo grounds, where we will be met with a mariachi band, drinks, and appetizers. We will continue to socialize in an air conditioned tent until 7:00 PM when dinner will be served. At 8:30 PM we will be entertained outdoors by a rodeo show put on by the staff of Corona Ranch. Following the rodeo, the social will continue until about 10:30 PM when the last bus departs.

The Rodeo Show highlights the most exciting portions of both Western Rodeo and Mexican Charreada. The Charreada (Mexican Rodeo) consists of several different feats of horsemanship including riding, roping, accuracy, courage and style. The Western portion showcases the two most exciting events that made Rodeo great: bull and bronco riding. A six-piece Mariachi Band, adding to the flavor of Rodeo Days accompanies the event. The event-filled Rodeo is professionally announced and designed for 45 minutes of "edge-of-the-seat" excitement!

As it is likely to be hot in Phoenix, even in the evening, please dress very comfortably. Some of the area will be cooled, but the rodeo stands are not. The Corona Ranch will have plenty of water and other drinks served the entire evening; please plan to take advantage and enjoy the show.

Social Program

THURSDAY, JULY 18
1:00 TO 3:00 PM
HIGH TEA

NSREC companions are invited to enjoy an elegant afternoon tea service at the Pointe South Mountain Resort in the A Pointe in Tyme restaurant.

Prior to the introduction of tea into Britain, the English had two main meals - breakfast and dinner. It was no wonder that Anna, the Duchess of Bedford (1788 - 1861) experienced a "sinking feeling" in the late afternoon. Adopting the European tea service format, she invited friends to join her for an additional afternoon meal. The menu centered around small cakes, bread and butter sandwiches, assorted sweets, and, of course, tea. The practice of inviting friends to come for tea in the afternoon was quickly picked up by other social hostesses and a common pattern for service soon merged. The first pot of tea was made in the kitchen and carried to the lady of the house who waited with her invited guests. Food and tea was then passed among the guests. So join us for an afternoon of food, drink, and conversation.

Photograph courtesy of Jeff Black

AEROBICS

Work off the previous day's stress and start your morning off with Dave Bushmire, our own certified aerobics instructor, Tuesday, Wednesday, and Thursday mornings at 6:30 AM. The sessions will be held at the Phantom Horse Exercise Facility in their aerobics room. Good quality exercise shoes are recommended.

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 9, 2002.

Local Activities

GENERAL INFORMATION

Phoenix is the capital city of Arizona and is located on the Salt River in the south central part of the state. The city sits on the eastern edge of the Sonoran Desert. Phoenix was founded on the site of ancient Native American canals; hence its name, signifying a new town which had risen from the ruins of an old civilization. Several factors have contributed to the city's spectacular growth, including its temperate, dry, sunny climate during much of the year, its recreational opportunities, and its diversified industries.

Photograph courtesy of Greater Phoenix Convention and Visitors

Almost two-thirds of Arizona's population lives in the Greater Phoenix area. The expanding metropolitan area includes the suburbs of Mesa, Scottsdale, Tempe, and Glendale, all of which are among the fastest-growing cities in the United States. Also in the area are a number of Native American communities and reservations, national monuments, and state parks.

Phoenix is an important center for research and development, electronics, telecommunications, and the aerospace industry. Production of aircraft parts, electrical appliances, agricultural chemicals, and leather goods remains central to its manufacturing base. Government operations, tourism, research and development concerns, and construction are also important to the city's economy. Agricultural products include cotton, alfalfa, durum wheat, vegetables, citrus and other fruits, and beef and dairy cattle.

In its early years, Phoenix became popular as a haven for winter visitors from North America's colder climates. Many people with health problems, particularly respiratory ailments, visited the area for its dry and relatively pollen-free air. In the second half of the 20th century developers created near Phoenix huge planned retirement communities such as Sun City and Leisure World. Today Phoenix is a popular destination for vacationers and conventioneers.

Phoenix has garnered well-earned praise as one of the world's top five golf destinations. As the sixth-largest city in the United States, with nearly 1.3 million residents, 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, fine dining, horseback riding and outdoor activities.

Local Activities

SOUTH MOUNTAIN PARK/MYSTERY CASTLE

The 16,500-acre park is the largest municipal park in the world, sheltering more than 300 plant species. The resort is located near the park. The quirky Mystery Castle (800 E. Mineral Road, 602-268-1581) was built by a man with a dream and a great imagination. It is an odd three-story castle built out of stone, adobe, automobile parts and petroglyphs. The resulting 18-room fantasy has 13 fireplaces, a wedding chapel, parapets, and many other unusual touches. This castle is a must for fans of folk-art constructions. Admission Fee.

OLD TOWN SCOTTSDALE

Hitchin' posts and wood-front shops are reminiscent of the days when sheep were herded down Scottsdale Road, and the whole place was known as The West's Most Western Town. A laidback grid of wood and faux adobe with covered walkways, Old Town has ditched its utilitarian past to become a community of stores and restaurants. Its eastern end leads to the more-sophisticated architecture of Scottsdale Center for the Arts, city government buildings, and a row of restaurants and bars. West of Old Town, across Scottsdale Road, are arts districts where galleries sell works. Old Town Scottsdale is a 30 minute drive from the Pointe South Mountain Resort. Free.

CAMELBACK MOUNTAIN

The city's most famous landmark is a crouching dromedary. In the mountain's Echo Canyon recreation area, sheer red cliffs and hiking paths attract outdoor lovers. Summit elevation is 2714 ft (827 m) — the peak rises around 1600 ft (488 m) above the elevation of downtown Phoenix. The Camelback Mountain is located about 30 minutes north of the Pointe South Mountain Resort. Free.

BANK ONE BALLPARK

Home of the Arizona Diamondbacks, you can arrange to tour the retractable-roof stadium by calling 602-462-6799. This architectural marvel features more than 49,000 seats, a retractable roof that can open or close in less than five minutes, air conditioning and a natural-turf field. Bank One Ballpark, affectionately known to locals as "BOB," is one of the world's top stadium facilities offering the latest in technology. The Diamondbacks are playing out-of-town during the week of our conference, but the tour of the facility is worth seeing. Admission Fee.

Photograph courtesy of Jeff Black

Local Activities

HALL OF FLAME MUSEUM OF FIREFIGHTING

The Hall of Flame Fire Museum and the National Firefighting Hall of Heroes, located in Phoenix, Arizona, has almost an acre of fire history exhibits, with over 90 fully restored pieces of fire apparatus on display, dating from 1725 to 1969. Most of the exhibits are American, but there are also pieces from England, France, Austria, Germany, and Japan. The Hall of Flame sponsors the National Firefighting Hall of Heroes, which honors firefighters who have died in the line of duty or who have been decorated for heroism. 6101 E. Van Buren St., 602-275-3473. Admission Fee.

SEDONA, ARIZONA

Located in the high southwestern desert under the rim of the Colorado Plateau 90 minutes north of Phoenix, Sedona is home to numerous resorts, golfing, and artistic events year round. The City of Sedona is one of Arizona's premier tourism, recreation, resort, retirement, and art centers. Featuring the wonder of what Native Americans consider the spiritual vortex of the Southwest and absolutely sublime red rock formations, Sedona and Oak Creek Canyon challenge many national parks in their beauty. Its beauty became known through the motion picture industry with such classic films as John Wayne's "The Angel and the Badman," and Robert Mitchum's "Blood on the Moon." Today, many commercials and television shows are filmed in the rural area surrounding the city, and the community plays host to over four million tourists from around the world.

THE GRAND CANYON

The Grand Canyon of the Colorado River is one of the seven natural wonders of the world and one of our planet's most astounding accomplishments. The sheer majesty and beauty of the scenery found here is beyond belief. No picture has ever done it justice. To really appreciate it, you have to see it with your own eyes, whether you explore the Rim for a day or take more time to trek down into the Canyon. 130 miles north of Phoenix.

Photograph courtesy of Greater Phoenix Convention and Visitors Bureau

Local Activities

GOLFING

Photograph courtesy of Pointe South Mountain Resort

With more than 200 golf courses, Greater Phoenix offers abundance of challenging links. So you can see, Phoenix golf is quite popular. Greater Phoenix has added more golf courses than any place in the United States over the past six years. Since 1992, 585 holes have been added to the local golf inventory with 522 more in the planning stage or under construction. Arizona has more golf courses per capita than any state west of the Mississippi River.

Golfing is possible in Phoenix in the summer with early sunrise (5:30 AM) and reduced green fees that change by the hour. Care must be taken in the heat, but the resort golf courses are prepared to aid golfers in such weather. The Pointe South Mountain Resort has the Phantom Horse Golf Course located on property.

SHOPPING

When visiting Greater Phoenix, you owe it to yourself to check out the area's fabulous shopping malls, unique boutiques, antique shops and the terrific deals available at regional outlet centers. As you shop at palatial Scottsdale Fashion Square, enjoy the upscale ambiance of Biltmore Fashion Park, peruse antique stores in Glendale or explore galleries and boutiques in Scottsdale, you'll see why shopping is such a popular activity in Greater Phoenix.

Arizona Mills: Located at I-10 and U.S. 60, Arizona Mills is the state's largest value and entertainment mega-mall. Complementary shuttle service from the Pointe South Mountain Resort.

Arizona Center: Downtown Phoenix dining marketplace. Enjoy nine restaurants with varying cuisine, four night clubs, specialty shops, 24-screen AMC Cineplex and acres of gardens, fountains and pools.

Scottsdale Fashion Square: The Southwest's largest and most distinctive center, Scottsdale Fashion Square offers 225 stores including four upscale department stores, nearly 50 exclusive retailers, two luxury theatres and virtually 30 restaurants and eateries.

Biltmore Fashion Park: World-class shopping in a beautiful outdoor park setting. Saks Fifth Avenue, Gucci, Cartier, Cheesecake Factory, Christopher Gross' Fermier Brasserie.

Local Activities

SHOPPING

The Borgata of Scottsdale reflects the spectacular atmosphere of northern Italy's Tuscany region. Scottsdale's popular shopping village mirrors what can be found in San Gimignano, Italy, complete with turrets and towers, thick stone walls and bubbling fountains. Shoppers can purchase everything from fresh fruits and vegetables at the seasonal Farmers Market, to children's clothing and fine jewelry. With its international flair and romance, The Borgata of Scottsdale offers a trendsetting experience for everyone.

el Pedregal is a "Festival Marketplace" nestled in the shadows of a 250-foot boulder formation. This Sonoran Desert oasis is modeled after "Old Morocco" and features a sub-saharan tent structure and a massive watch tower. Numerous high-end specialty shops and galleries make this a truly unique shopping experience.

WEATHER AND CLOTHING

Phoenix averages a high of 105° F (40° C) and a low of 80° F (26° C) during the month of July. Phoenix also averages 300 days of sunlight and only 8" of yearly rainfall. Be prepared for hot days and temperate nights. Inside temperatures can seem overly cool by comparison, so you may wish to include a light sweater or wrap. Please dress appropriately, and be prepared to drink plenty of water if staying outside for any extended period of time.

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The 2003 IEEE International Nuclear and Space Radiation Effects Conference will be held July 21 - 25 in Monterey, California at the DoubleTree Hotel. 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 21, 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 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 7, 2003

PROCEDURE FOR SUBMITTING SUMMARIES

Authors must conform to the following requirements:

1. Electronically submit a single Adobe Acrobat file consisting of (a) an abstract no longer than 35 words on the first page, followed by (b) an informative two to four page summary (appropriate for a 12-minute oral or poster presentation). The summary must include sufficient detail about the work to permit a meaningful scientific review. In the summary clearly indicate (a) the purpose of your work, (b) significant new results with supporting technical material, and (c) how your work advances the state of the art.
2. The summary must be no less than two nor more than four pages in length, including figures and tables (one additional page is allowed for the abstract). *All figures and tables must be large enough to be clearly read.* Note that this is more than an abstract, but do not exceed four pages.
3. Detailed submission and formatting instructions will be available after October 1, 2002 at www.nsrec.com.
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.

Summaries must be received by February 7, 2003

Detailed submission and formatting instructions will be available after October 1, 2002 at www.nsrec.com

Papers accepted for oral or poster presentation at the technical program will be eligible for publication in the Conference issue of the IEEE Transactions on Nuclear Science (December 2003), 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.

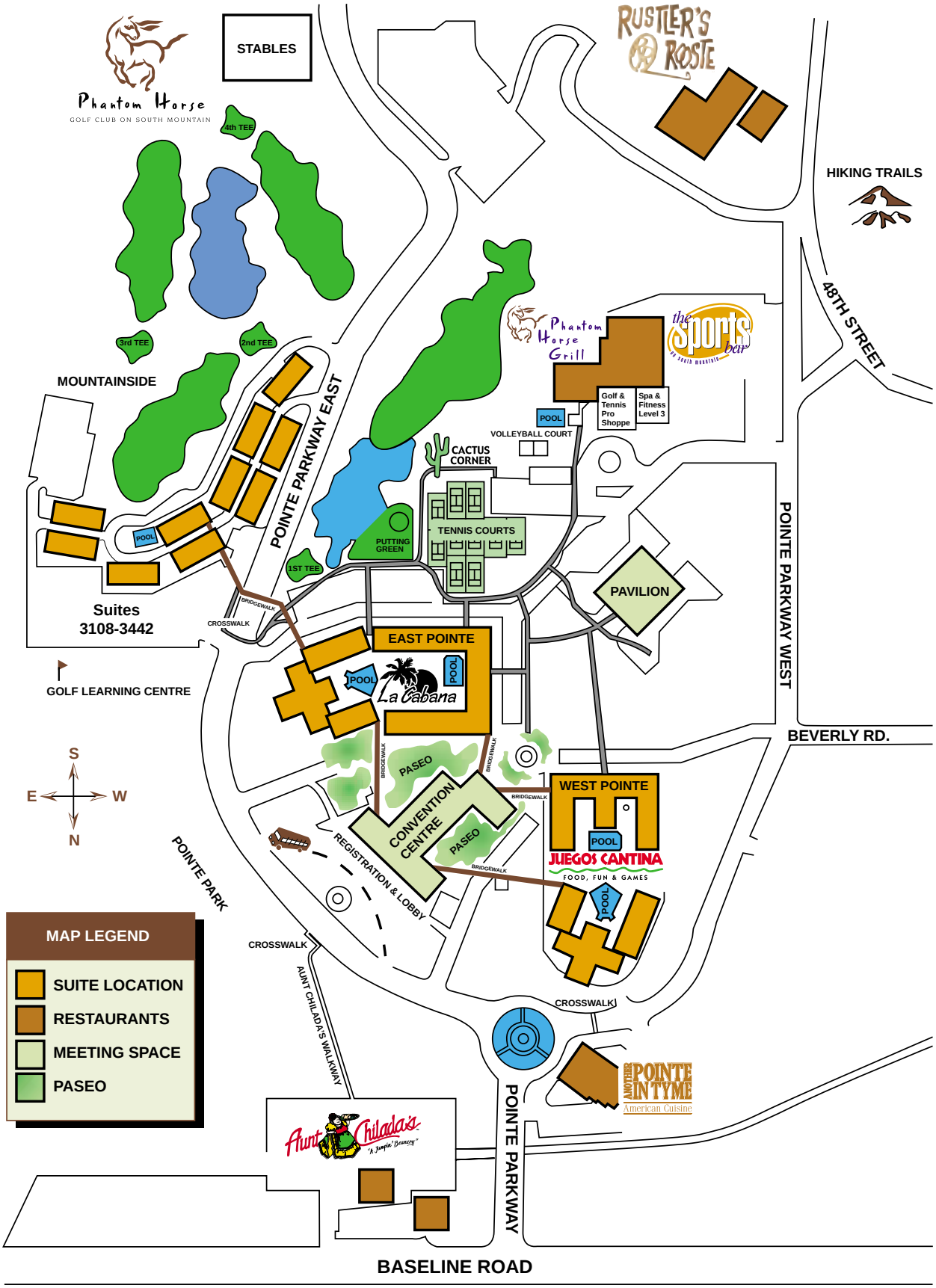
MONTEREY, CALIFORNIA

The picturesque city of Monterey is located on Monterey Bay. It is the site of the renowned Monterey Aquarium, as well as the location of Cannery Row, made famous by the novelist John Steinbeck. The nearby 17-mile drive contains some of the most beautiful scenery in the United States and was photographed by Ansel Adams during the 1940s. Monterey is a small city with an intimate feel, with many local attractions and activities. Sea lions, seals and otters abound in Monterey Bay. Beaches, hiking, historical sites, kayaking, sailing, golf, and nearby wineries in the Carmel Valley are among the many attractions in this unique site.

Photograph courtesy of DoubleTree Hotel

The Conference, to be held at the DoubleTree Hotel and the Monterey Conference Center (which are contiguous), is located in the center of the main attractions. A three-minute walk to the north of the Conference Center takes you to the Monterey Pier and marina area with restaurants and maritime attractions, as well as the Maritime Museum. An even shorter walk to the south puts you in downtown Monterey, where there are numerous shops and restaurants within a ten-block area that invite exploration by the visitor. Conference attendees and their families will have numerous activities and attractions to choose from in one of the most popular vacation sites in California.

Conference Facilities



TO THE POINTE SOUTH MOUNTAIN RESORT

From Phoenix International Sky Harbor Airport (PHX)

Exit airport or rental car lot onto I-10 SOUTH (toward Tucson)
Proceed 4.5 mi/~7 km to EXIT NUMBER 155 - towards Baseline Road/Guadalupe
Keep RIGHT at the fork in the ramp for 0.5 mi/0.8 km
Turn RIGHT onto WEST BASELINE ROAD, proceed 0.2 mi/0.3 km
Turn LEFT onto SOUTH POINTE PARKWAY WEST, bear left at roundabout

www.nsrec.com