TECHNICAL PROGRAM AND ACTIVITIES

34th Annual International

NUCLEAR AND SPACE RADIATION EFFECTS CONFERENCE

2nd International

CONFERENCE ON HIGH ENERGY BACKGROUND RADIATION IN SPACE

Snowmass Village, Colorado
July 21–25, 1997

Sponsored by
IEEE/NPSS Radiation Effects Committee

IEEE

Cosponsored by
Defense Special Weapons Agency, Sandia National Laboratories, Phillips Laboratory, NASA Goddard Space Flight Center, and Jet Propulsion Laboratory

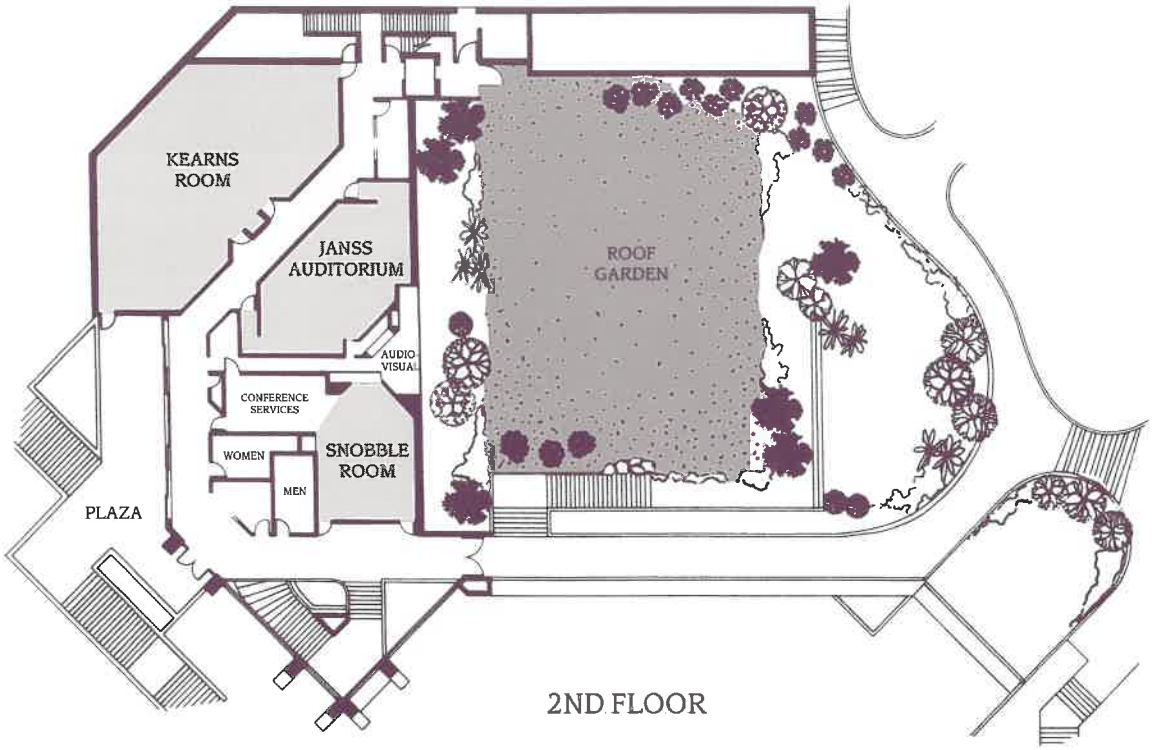
Schedule

Time	Monday July 21	Tuesday July 22	
		NSREC	CHERBS
7:30			
	[7:30] Continental Breakfast	[7:30] Continental Breakfast	
8:15	[8:15] **Short Course:** Introduction Nick van Vonno Snowmass Ballroom	[8:15] **Conference Opening** Awards Presentations Snowmass Ballroom	
8:30	[8:30] **Modeling Space Radiation Environments** Janet L. Barth		
8:45		[8:45] **Session A:** Basic Mechanisms of Radiation Effects	[8:45] **Memorial to Carl Rester**
9:00			[8:55] **Session CHA:** Induced Activity
10:00	[10:00] Break	[9:50] Break	[9:45] Break
	[10:30] **Radiation Transport Effects and Simulation** David E. Beutler and Leonard J. Lorence, Jr.	[10:20] **Session A** (cont.)	[10:20] **Session CHA** (cont.)
11:00		[11:05] **Session B:** Radiation Effects in Photonic Devices and Systems	[11:35] **Session CHB:** Analysis Methods and Models
12:00		[11:55] Lunch	
	[12:10] Short Course Luncheon		[12:10] Lunch
1:00			
	[1:30] **Single-Event Analysis and Prediction** Edward L. Petersen	[1:30] **Session C:** Radiation Effects in Devices and Integrated Circuits	[1:35] **Session CHB** (cont.)
2:00			
3:00		[2:50] Break	[2:50] Break
	[3:10] Break		
4:00	[3:40] **Design and Simulation of Hardened Integrated Circuits** James Swonger	[3:30] **Session D:** Hardness Assurance	[3:30] **Session CHC:** Detectors and Detector Systems
	[4:30] Wrap-up		
5:00	[4:45] Exam (only for students requesting CEU credit)	[4:50] End of Session	[5:05] End of Session
	[5:15] End of Short Course		
6:00			
7:00	[7:00-10:00] Conference Registration and Reception **Mozart in the Mountains** Roof Garden	[7:00-10:00] Industrial Exhibit Reception Bedford Ballroom	
8:00			

Cover photograph courtesy of Dennis di Cicco, *Sky & Telescope* Magazine.

Time	Wednesday July 23 — NSREC	Wednesday July 23 — CHERBS	Thursday July 24	Friday July 25
7:30				
	[7:30] Continental Breakfast		[7:30] Continental Breakfast	[7:15] Continental Breakfast
8:15	[8:15] **Invited Paper: CMOS Technology Scaling, 0.1 µm and Beyond** Dr. Bijan Davari		[8:15] **Invited Paper: Bootstrapping Intelligence** Dr. William Calvin	[8:00] **Invited Paper: Joint U. S./Russian Programs on the MIR Space Station** Dr. Ronald Sega
8:30				
8:45				
9:00				
	[9:15] **Session E:** Dosimetry	[9:15] **Session CHD:** Space Environment Background	[9:15] **Session G:** Spacecraft Environments and Effects	[9:00] **Session I:** Non-Destructive Single-Event Effects in Devices
10:00	[10:05] Break	[10:05] Break	[10:05] Break	[10:05] Break
	[10:45] **Session F:** Isolation Technologies	[10:45] **Session CHD** (cont.)	[10:35] **Session G** (cont.)	[10:25] **Session J:** Catastrophic Single-Event Effects
11:00				
12:00	[12:10] Lunch	[12:00] Lunch	[11:35] Lunch	[12:00] End of NSREC
1:00			[1:00] **Session H:** Single-Event Mechanisms and Charge Collection	
2:00	[1:45] **Poster Session** Poster Presentations Erickson, Carroll, and Sinclair Rooms	[1:45] **Session CHS** Summary and Discussion		
3:00		[2:45] End of CHERBS	[2:50] **Radiation Effects Data Workshop** Poster Presentations Kearns Room	
4:00				
	[4:30] End of Session		[4:30] Break	
5:00			[5:00-6:30] Radiation Effects Committee Open Meeting Snowmass Ballroom	
6:00	[6:00-10:30] Conference Social **Rock 'n' Roll Rodeo** Roof Garden			
7:00				
8:00				

Snowmass Conference Center



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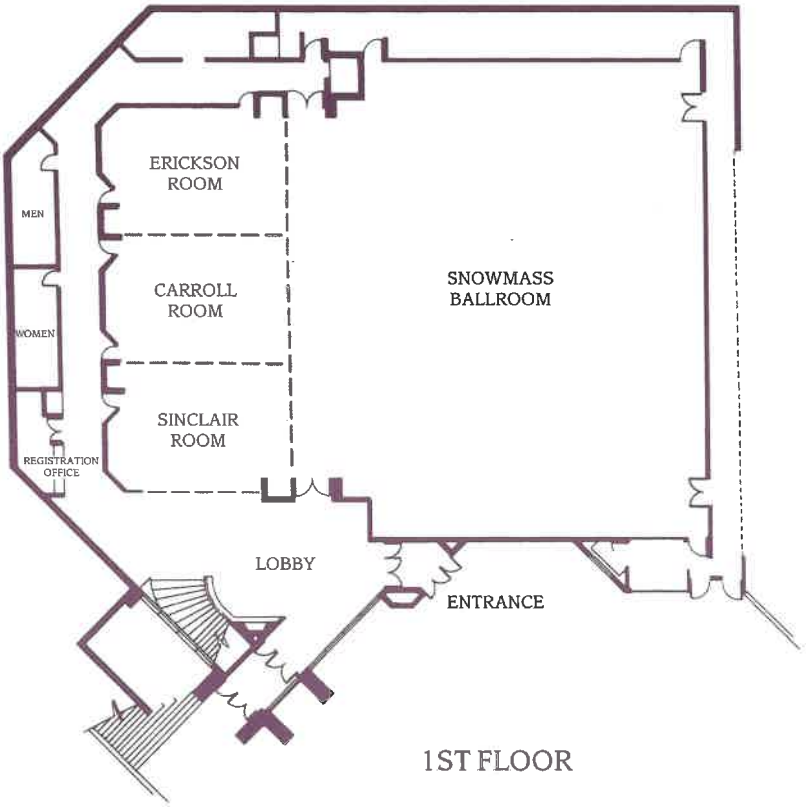

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Chairman's Invitation

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Poster Session
Robert D. Pugh
USAF Phillips Laboratory
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Data Workshop
Thomas L. Turflinger
Naval Surface Warfare Center
(812) 854–1670

Dear Colleague,

It is my pleasure to invite you to attend the 1997 IEEE Nuclear and Space Radiation Effects Conference. This 34th annual NSREC will be held July 21–25 at the Snowmass Conference Center, Snowmass Village, Colorado. This year's NSREC will be held in collaboration with the 2nd Conference on High Energy Radiation Background in Space. Snowmass was chosen as the site for this year's meetings for its outstanding conference facilities, beautiful site, local charm, and numerous available recreation opportunities. This will be the second time we have met at Snowmass. The last occasion was in 1987. It's a beautiful location and will, I am sure, be a wonderful site for a rewarding technical conference.

For World Wide Web users, additional information on the conference and on the Snowmass Village area can be obtained by directing your browser to **http://www.ieee.org/nps/nsrec/nsrec.html**.

The 1997 Conference will begin on Monday, July 21, with a one-day short course. Our short course chairman, Nick van Vonno, has assembled a series of tutorials focused on the topic "Applying Computer Simulation Tools to Radiation Effects Problems." Tutorial topics will include (1) modeling space radiation environments, (2) radiation transport effects and simulation, (3) single-event analysis and prediction, and (4) design and simulation of hardened integrated circuits. I believe that these lectures will provide background information and serve to generate a refreshing overview of a subject of interest to all attendees.

The 1997 Technical Program Chairman, Allan Johnston, has assembled a series of presentations which will be of interest to all persons concerned with radiation-induced effects on microelectronics. The technical program, held Tuesday, July 22, through Friday, July 25, will consist of contributed oral and poster papers. Also, we will have a radiation-effects data workshop dedicated to contributions which focus on providing a rich source of experimental data. In addition, there will be several invited talks in the program that will be of general interest to you (and to spouses, children, and companions attending with you).

The research papers presented at NSREC have been carefully evaluated by our session chairpersons and by numerous hard-working reviewers to ensure that only new and significant material has been accepted for presentation. The majority of the contributions will (after a separate rigorous reviewing process) be published in the December 1997 issue of the *IEEE Transactions on Nuclear Science* (for oral and poster papers) and in a *Radiation Effects Data Workshop Record* (for data workshop papers).

At the Industrial Exhibit, representatives from semiconductor vendors, wafer manufacturers, testing facilities, and equipment manufacturers will be available to discuss their latest products and technology developments. A highlight of the Industrial Exhibit will be the Industrial Exhibit Reception which will be held on the evening of Tuesday, July 22. A brochure, included with the registration packets, will provide preview information on all of the exhibitors.

As I have already mentioned, this year's NSREC will be held in collaboration with the Conference on High-Energy Radiation Background in Space. CHERBS will treat such subjects as space radiation background measurements, modeling of the space radiation background, space radiation environment data bases, and minimizing of radiation background effects in sensor systems. CHERBS will be held as a workshop on Tuesday and Wednesday. The CHERBS sessions will be held in parallel with the NSREC sessions. The majority of the CHERBS presentations will be published in an IEEE Conference Record. There will be a common registration for NSREC and CHERBS. Persons registered for the CHERBS workshop may freely attend all NSREC technical sessions or workshops, and persons registered for the NSREC may freely attend all CHERBS technical sessions or workshops. If space in any technical session or workshop becomes limited, attendees are encouraged to give preference for seating to the registrants of whichever conference is sponsoring that session. All attendees to NSREC and CHERBS will receive the publications from both conferences.

The conference will continue the tradition of providing opportunities for informal communication among attendees. We have planned a number of social events to facilitate both communication and relaxation. Our social program will be shared by both NSREC and CHERBS attendees.

As you page through this conference brochure, please take time to recognize the many engineers and scientists (all volunteers) who have donated their efforts to make this meeting one of the most prominent international symposia on radiation effects. My thanks to all of you who have worked so hard.

I'm looking forward to meeting you in Snowmass.

Dennis B. Brown
General Chairman

Short Course Program

APPLYING COMPUTER SIMULATION TOOLS TO RADIATION EFFECTS PROBLEMS

SNOWMASS BALLROOM
MONDAY, JULY 21
8:15 AM – 5:15 PM

7:30 AM	REGISTRATION/CONTINENTAL BREAKFAST
8:15 AM	SHORT COURSE INTRODUCTION Nick van Vonno *Harris Semiconductor*
8:30 AM	**MODELING SPACE RADIATION ENVIRONMENTS** Janet L. Barth *NASA Goddard Space Flight Center*
10:00 AM	BREAK
10:30 AM	**RADIATION TRANSPORT EFFECTS AND SIMULATION** David E. Beutler and Leonard J. Lorence, Jr. *Sandia National Laboratories*
12:10 PM	SHORT COURSE LUNCHEON
1:30 PM	**SINGLE–EVENT ANALYSIS AND PREDICTION** Edward L. Petersen *Consultant*
3:10 PM	BREAK
3:40 PM	**DESIGN AND SIMULATION OF HARDENED INTEGRATED CIRCUITS** James Swonger *Harris Semiconductor*
4:30 PM	WRAP–UP
4:45 PM	EXAM (only for students requesting CEU credit)
5:15 PM	END OF SHORT COURSE

Short Course

COURSE DESCRIPTION

The theme of the 1997 NSREC Short Course is **Applying Computer Simulation Tools to Radiation Effects Problems**. Several aspects of radiation effects will be discussed from a theoretical viewpoint as well as from a practical one. Examples of commercially–available software tools that can simulate and predict responses will be given.

The Short Course will start with a discussion of radiation environments in space and of the tools available for modeling these environments. Specific areas of interest will include trapped particles in the Earth environment, galactic and solar particles, and an overview of recent work on atmospheric particles. The second session will cover radiation transport phenomena and modeling. It will include material on radiation transport physics, numerical techniques and codes, and will discuss several applications such as x–ray, electron beam, and proton irradiation. In the third segment of the short course we will review the analysis and prediction of single–event effects (SEE). Here, we start off with a discussion of basic SEE concepts and the interaction of energetic particles with semiconductor device structures, followed by coverage of rate calculations and predictions and the available codes. The final session will discuss the design and simulation of hardened integrated circuits with emphasis on analog and mixed–signal applications. After a brief review of the natural space environment from the silicon technologist's viewpoint we discuss component degradation and modeling and circuit techniques used to improve the radiation tolerance of devices. Specific design examples in a practical simulation environment will be discussed.

Nick van Vonno of Harris Semiconductor is the 1997 Short Course Chairman. Instructors for this year's Short Course are Janet L. Barth of NASA Goddard Space Flight Center, David E. Beutler and Leonard J. Lorence, Jr. of Sandia National Laboratories, Edward L. Petersen, a private consultant, and James Swonger of Harris Semiconductor. Each Short Course segment will be followed by a fifteen–minute question and answer period. A Short Course Luncheon will be served to all registered attendees.

Continuing Education Units (CEUs)

This year, 0.6 CEUs endorsed by the IEEE and the International Association for Continuing Education and Training (IACET) will be made available to qualified students. The IEEE is an Authorized CEU Sponsor member of the IACET. IEEE guidelines for offering CEU credit will be followed. To qualify, a student must be a registered attendee of the Short Course and pass a written exam with a score of 75% or greater. The exam will be given immediately following the last segment of the Short Course (4:45 PM), will be open book, and will consist of approximately 20 multiple–choice questions covering the presented material. No CEU credit will be offered to students who have not taken and passed the written exam. A certificate of completion will be mailed to all qualified students.

Short Course Chairman

Nick van Vonno received his B. S. degree in electrical engineering from the University of Florida in 1966. Upon graduation, he joined Radiation, Incorporated (now Harris Corporation). Initial assignments in Reliability Engineering were followed by work in silicon process development and device engineering. Later work included hardened device development for key strategic and space programs. Specific interests included mixed–signal design, cryogenic CMOS process development, and SOI technology. Mr. van Vonno has been active in the NSREC, serving as a session chairman, Guest Editor for the 1992 conference, Awards Chairman in 1994, and a Short Course instructor in 1995. He has over 30 publications and conference presentations and currently holds eight U.S. patents. Mr. van Vonno is a senior member of IEEE.

MODELING SPACE RADIATION ENVIRONMENTS

Janet L. Barth
NASA Goddard Space Flight Center

Janet L. Barth will introduce her segment with a discussion of basic coordinate systems and field models. This will be followed by a discussion of trapped particles in the Earth and other planetary environments of galactic particles, solar particles in the Earth environment, and atmospheric (high-altitude) particles. For each of these environments, an overview of currently available simulation codes will be supplied, together with practical applications of predictions. Detailed discussion of particle motion, flux level variations, and spacecraft experimental data will provide a good background in the physics of these environments.

Janet L. Barth received the B. S. degree in Mathematics from the University of Maryland in 1978, and pursued graduate studies in computer science. She is an astrophysicist with the Radiation Physics Office at NASA's Goddard Space Flight Center, where she has worked since 1976. Her responsibilities are to develop spacecraft radiation hardening guidelines, and to lead research efforts to improve the accuracy of radiation environment definitions and the effectiveness of mitigation techniques. She began her career at NASA/GSFC by developing integration software for radiation environment models and codes. Later, she implemented the use of 3-dimensional ray trace methods for defining component level radiation exposures and developed techniques for optimizing mitigation procedures. She is principal investigator on an experiment to investigate the effect of composite materials on exposure levels, and is co-investigator on the Cosmic Ray Upset Experiment (CRUX). Ms. Barth has served the NSREC as a reviewer and session chair. She has co-authored papers on the space radiation environment, in-flight verification of single-event effect rate predictions, and system level radiation effects mitigation.

MODELING SPACE RADIATION ENVIRONMENTS

Overview
- Solar and galactic processes

Coordinate systems
- Geomagnetic
- Magnetic field models
- Atmospheric depth and rigidity

Trapped particles in the Earth environment
- Description of particles
- Trapped particle motion, isotropy, and flux levels
- Spacecraft measurements
- NASA AE8/AP8 and PL CRRES-series models
- Applications of predictions

Trapped particles on other planets

Galactic particles
- Description of particles
- Motion/propagation through magnetosphere and flux levels
- Spacecraft measurements
- CREME, CREME96, and CHIME models
- Applications of predictions

Solar Particles
- Description of particles
- Motion/propagation through magnetosphere and flux levels
- Spacecraft measurements
- SOLPRO, CREME, JPL, and NRL models
- Applications of predictions

Atmospheric particles
- Description of particles
- Wilson-Nealy and simplified models
- Applications of predictions

Conclusions and summary

RADIATION TRANSPORT EFFECTS AND SIMULATION

Leonard J. Lorence, Jr. and David E. Beutler
Sandia National Laboratories

Leonard Lorence, Jr. and David Beutler of Sandia National Laboratories will team teach the second course segment. This portion of the short course will present an overview of the theory of charged and neutral particle transport and numerical techniques used in current production computer codes together with code examples. This will be followed by a series of examples of how these codes can be used to calculate radiation spectra, dose, and charge deposition in electronics for a variety of common experimental and working conditions. These conditions include x-ray, electron beam, and proton irradiation.

David E. Beutler received his B. S., M. S., and Ph. D. degrees in Physics at Purdue University in 1980, 1983, and 1986, respectively. He joined Sandia National Laboratories in 1986 where he is a Senior Member of the Technical Staff. Dr. Beutler has been involved in a variety of studies of radiation effects in electronics and materials in strategic environments. These include: radiation source development and characterization, radiation transport code benchmarking, dose enhancement and upset in integrated circuits, radiation-induced conductivity, and thermostructural response in materials. He has served the NSREC as a session chairman and reviewer, and the Hardened Electronics and Radiation Technology (HEART) Conference as session chairman, guest editor, and reviewer. He is a member of the ASTM E10.07 committee for Radiation Dosimetry for Radiation Effects on Materials and Devices. He has authored many papers utilizing or benchmarking radiation transport codes.

Leonard J. Lorence, Jr. received his B. S. degree in Physics, and M. S. and Ph. D. degrees in Nuclear Science at the University of Michigan in 1976, 1979, and 1984 respectively. He joined Sandia National Laboratories in 1984 where he is a Senior Member of the Technical Staff. He is a coauthor of the CEPXS/ONELD code package. This was the first general-purpose discrete ordinates code for coupled electron-photon transport to be made available. Since its release in 1989, this one-dimensional code has been frequently used for radiation effects analysis. Dr. Lorence has authored many papers on the design of radiation transport codes and their use for radiation effects analysis.

RADIATION TRANSPORT EFFECTS AND SIMULATION

Transport physics
- Transport codes and their alternatives
- Particle interactions
- Boltzmann equation

Numerical transport techniques
- Monte Carlo
- Deterministic

Electron-photon transport codes
- Monte Carlo- ETRAN, ITS, MCNP, EGS
- Deterministic- CEPXS/ONELD
- Connection to BOXIEMP codes

Proton transport calculations

X-ray irradiation
- X-ray spectrum calculations
- Shielding calculations
- Dose in the dosimeter and the device

Electron beam irradiation
- Electron spectrum calculation
- Dose in the dosimeter and the device

Proton irradiation
- Proton spectrum
- Dose in the device

Conclusion

SINGLE–EVENT ANALYSIS AND PREDICTION

Edward L. Petersen
Private Consultant

Ed Petersen is currently a consultant in private practice and will introduce his segment with a discussion of device and space environment modeling. An overview of basic single–event effect (SEE) concepts will be followed by coverage of device and circuit effects and laboratory techniques. Cosmic ray and proton SEE calculation methods and codes will be discussed. The segment will conclude with an overview of test requirements and space SEE data.

Ed Petersen received his Ph. D. degree in Nuclear Physics from UCLA and his B. S. and M. S. degrees from Oregon State University. Dr. Petersen taught and conducted nuclear physics experiments from 1963 to 1969, and moved to the cyclotron branch of the Naval Research Laboratory in 1969 to continue in this field. In 1980, he was transferred to the Radiation Effects Branch at NRL. From 1983 to 1993 he was head of the Satellite Survivability Section in this branch. Since 1994 he has been a private consultant with NRL, SFA, SAIC, Myers & Associates, and others. He was DNA TREE program area reviewer for Single Event Effects Research from 1983 to 1993, and program chairman for the semi-annual SEU Symposium from 1982 to 1994. Dr. Petersen was guest editor of a single–event upset Special Issue and two issues of the HEART Conference proceedings in the Journal of Radiation Effects. He was co–chair of the DNA Upset Rate Committee in 1992 and 1993. Dr. Petersen has been active in the NSREC, serving as an elected member–at–large on the Radiation Effects Steering Group from 1990 to 1993, and as a Short Course instructor in 1983. He is a Senior Member of the IEEE with over 50 published technical papers.

SINGLE–EVENT ANALYSIS AND PREDICTION

Overview
- Modeling the space environment
- Modeling device charge collection

Single event concepts
- Single particle effects
- Effective LET and cross–section
- Ion track structure
- Interaction with semiconductors

Circuit errors
- Charge collection models
- Destructive and nondestructive errors

Laboratory techniques
- Ground–based SEE testing
- Laboratory sources

Cosmic ray SEE calculations
- The RPP approach to upset rates
- Cross–section, depth, and critical charge
- Evaluation of rate calculation approaches

Proton SEE calculations
- Nuclear reaction analysis
- Relationship of proton and heavy ion upsets

Test requirements

Observation and prediction of SEE rates in space
- Summary of results
- Multiple upsets

Conclusion and future trends

DESIGN AND SIMULATION OF HARDENED INTEGRATED CIRCUITS

James W. Swonger
Harris Corporation

Jim Swonger of Harris Semiconductor will present the final session of the Short Course. He will discuss the design and simulation of hardened analog and mixed-signal circuits for total-dose and SEE environments, including coverage of the design environment and simulation tools used. The importance of accurate post-radiation modeling will be discussed, as well as techniques for design requirements definition and design flow. Practical design examples will include both bipolar and MOS circuits.

James W. Swonger received his B. S. degree in Electrical Engineering from the University of Michigan in 1983. From 1983 to 1996, Mr. Swonger has been an IC design engineer with Harris Semiconductor, where he is currently a Senior Principal Engineer, IC Design. He has completed thirty commercial and radiation-hardened IC designs in bipolar, CMOS, and BiCMOS technologies, as well as providing radiation modeling, simulation, and design guidance for twenty space and military RH ASIC product developments. Mr. Swonger has published 12 papers on radiation-hardened, high-temperature, and custom integrated circuit design. He holds one patent for IC design and has several pending.

DESIGN AND SIMULATION OF HARDENED INTEGRATED CIRCUITS

Overview

Natural space environment radiation effects

- Major components of space radiation environments
- Effects of radiation on semiconductors

Relating component degradation to circuit performance

- Changes in operating point
- Changes in gain, impedance, and drive capability
- Changes in device isolation

Improving radiation tolerance of circuits

- Estimating performance
- Using simulation to predict circuit response
- Developing post-radiation models
- Developing design rules
- Design requirements definition
- Specifying environments of interest and design margins
- A design flow for a hardened IC
- Using simulation for design synthesis
- Using simulation for requirements compliance verification

Examples

- Bipolar differential pair input
- Bipolar gain stages
- Bipolar current reference
- MOS amplifier
- MOS sampled data filter

Conclusion and future technology trends

NSREC Technical Program

NSREC TECHNICAL INFORMATION

The NSREC technical session will consist of contributed oral and poster papers, three distinguished invited papers, and a data workshop. All NSREC oral sessions will be held in the Snowmass Ballroom at the Snowmass Conference Center. Oral papers will be 12 minutes in length with an additional 3 minutes for questions. The Technical Sessions and chairpersons are:

- **Basic Mechanisms of Radiation Effects**
  Peter Winokur, Sandia National Laboratories
- **Radiation Effects in Photonic Devices and Systems**
  Ken LaBel, NASA Goddard Space Flight Center
- **Radiation Effects in Devices and Integrated Circuits**
  Steve Clark, Naval Surface Warfare Center
  Olivier Musseau, CEA Bruyères le Châtel
- **Hardness Assurance and Testing Techniques**
  Mark Baze, Boeing Defense and Space Group
- **Dosimetry**
  Martin Beuhler, Jet Propulsion Laboratory
- **Isolation Technologies**
  Walter Shedd, USAF Phillips Laboratory
- **Spacecraft Environments and Effects**
  Richard Maurer, Johns Hopkins Applied Physics Laboratory
- **Single–Event Mechanisms and Charge Collection**
  Sophie Duzellier, ONERA–CERT/DERTS
- **Non–Destructive Single–Event Effects in Devices**
  Heather Dussault, Rome Laboratories
- **Catastrophic Single–Event Effects**
  Jim Pickel, Maxwell Technologies Incorporated

Poster Session

Papers that are most appropriate for visual presentation and group discussion will be displayed from 12:00 PM Tuesday through Thursday evening in the Erickson, Carroll, and Sinclair Rooms (located immediately adjacent to the technical sessions). Authors will be available to discuss their posters from 1:45 PM to 4:30 PM on Wednesday. The poster chairman is *Bob Pugh, USAF Phillips Laboratory.*

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 for designers of radiation–hardened systems. Workshop papers will be displayed as posters in the Kearns Room on the second floor of the Snowmass Conference Center from 12:00 PM Tuesday through Thursday evening. Authors will be available to discuss their work from 2:40 PM to 4:30 PM on Thursday. A copy of the Workshop Proceedings will be mailed to all registrants after the conference. The workshop chairman is *Tom Turflinger, Naval Surface Warfare Center.*

INVITED SPEAKERS

The 1997 NSREC is pleased to feature three invited talks. Bijan Davari, IBM Semiconductor Research & Development Center, will discuss ***CMOS Technology Scaling, 0.1 μm and Beyond*** on Wednesday. William Calvin, University of Washington, will discuss ***Bootstrapping Intelligence*** on Thursday. Ronald Sega, University of Colorado, will discuss ***Joint U. S./Russian Programs on the MIR Space Station*** on Friday.

LATE–NEWS PAPERS

A limited number of late–news papers will be accepted and included in the poster session. These papers will be listed on a separate addendum sheet at registration. The deadline for submitting late–news papers is June 5, 1997. Please submit late–news papers using the 4–page summary and 35–word abstract format, to the Technical Program Chairman, Allan Johnston, Jet Propulsion Laboratory, MS 303–220, 4800 Oak Grove Drive, Pasadena, CA 91109, (818) 354–6425. Authors must make a convincing case that late–news papers are newsworthy as well as technically sound in order to be accepted.

Tuesday, July 22

7:30 AM — REGISTRATION AND CONTINENTAL BREAKFAST
Roof Garden, Snowmass Conference Center

8:15 AM — OPENING REMARKS
SNOWMASS BALLROOM
Dennis B. Brown, Conference General Chairman
Teresa Farris, Local Arrangements Chairwoman

8:30 AM — AWARDS PRESENTATION
Peter S. Winokur, Steering Group Chairman

8:40 AM — TECHNICAL SESSION OPENING REMARKS
Allan H. Johnston, Technical Program Chairman

SESSION A — **BASIC MECHANISMS OF RADIATION EFFECTS**
8:45 AM — Session Introduction
Chairman: Peter Winokur, Sandia National Laboratories

A-1 — **Nonvolatile Field Effect Transistors Based on Protons and Si/SiO_2/Si Structures**
8:50 AM
W. L. Warren, K. Vanheusden, D. M. Fleetwood, J. R. Schwank, P. S. Winokur, and M. J. Knoll, Sandia National Laboratories

A novel nonvolatile memory effect involving H+ motion in SiO_2 is illustrated in bulk Si and SOI MOS devices. The technology is compatible with standard Si processing and is potentially radiation tolerant.

A-2 — **Quantitative Model of Radiation Induced SiO_2 Charge Trapping**
9:05 AM
J. F. Conley, Jr., Dynamics Research Corporation; P. M. Lenahan and B. D. Wallace, Pennsylvania State University; P. Cole, Naval Surface Warfare Center

A predictive model of radiation–induced oxide charging has been developed, based on statistical thermodynamics and ESR measurements of E′ centers. The model was successfully tested on MOSFETs irradiated with ^{60}Co gamma rays.

A-3 — **A Study of Charge Trapping in PECVD PTEOS Films**
9:20 AM
P. M. Lenahan and C. A. Billman, Pennsylvania State University; R. Fuller, H. Evans, W. Speece, D. Decrosta, and R. Lowry, Harris Semiconductor

We have studied charge trapping in tetraethylorthosilicate glass films using electron spin resonance. The films trap electrons and holes quite effectively in several traps, which include hydrocarbons and phosphorus.

A-4 — **Latent Interface Traps and 1/f Noise in Irradiated MOS Devices**
9:35 AM
D. M. Fleetwood and M. J. Johnson, Sandia National Laboratories

A delayed increase in 1/f noise is observed for pMOS transistors showing latent radiation–induced interface–trap buildup. The latent interface traps and increased noise appear to result from the same thermally activated process, likely involving hydrogen.

9:50 AM — BREAK

A-5
10:20 AM

Stress Induced Leakage Current (SILC) in Very Thin Gate Oxides after γ Irradiation

A. Scarpa, A. Paccagnella, and A. Artuso, Università de Padova; G. Ghiubaudo and G. Pananakakis, Laboratoire de Physique des Composants à Semiconducteurs/ENSERG; G. Ghidini, SFS-THOMSON Microelectronics

Stress induced leakage currents have been investigated for ultra-thin MOS gate oxides (44 Å), by γ radiation and/or current injection. The different natures of electrical and radiation SILC have been pointed out.

A-6
10:35 AM

Ultrafast Excitonic Nonlinearity in Neutron Irradiated Quantum Wells

S. Ten, J. G. Willams, P. T. Guerreiro, and N. Peyghambarian, University of Arizona

Sharp room temperature exciton features and complete recovery of the excitonic absorption with 21 ps time constant are demonstrated in neutron-irradiated (Ga,Al)As/GaAs multiple quantum wells. Physics of neutron generated defects responsible for the reduction of carrier lifetime is discussed.

A-7
10:50 AM

Time-Resolved Spectroscopy of Irradiated n-GaAs

M. Parenteau, D. Morrisand, and C. Carlone, Université de Sherbrooke; S. M. Khanna, Defence Research Establishment

Picosecond lifetime degradation constants are reported for GaAs irradiated with gamma, fission neutron, electron, proton, and oxygen ions. The degradation is attributed to non-radiative processes generated by radiation-induced defects.

POSTER PAPERS

PA-1

Microscopic Study of Eγ′ Center in Amorphous SiO_2: A First Principles Quantum Mechanical Investigation

J. R. Chavez, S. P. Karna, K. Vanheusden, C. P. Brothers, R. D. Pugh, and B. K. Singaraju, Phillips Laboratory; W. L. Warren, Sandia National Laboratories; R. A. B. Devine, France Télécom/CNET

We report the ab initio quantum mechanical investigation of the structure of the Eγ′ center in a-SiO_2. Our calculations suggest that the unpaired electron is shared by only two Si atoms, irrespective of the Si cluster size.

PA-2

Single Transistor Technique for Interface Trap Density Measurement in MOS Devices

V. S. Pershenkov, S. V. Cherepko, R. E. Ivanov, A. V. Shalnov, and V. V. Abramov, Moscow Engineering Physics Institute

The technique of interface trap density extraction is presented and discussed. It is based on the analysis of the linear region of device operation (strong and moderate inversion) and takes into account interface trap recharge during gate bias change.

PA-3

The Effect of Emitter Junction Bias on the Low Dose-Rate Radiation Response of Bipolar Devices

V. S. Pershenkov, V. B. Maslov, V. V. Belyakov, S. V. Cherepko, I. N. Shvetzov-Shilovsky, V. I. Rusanovsky, and A. V. Sogoyan, Moscow Engineering Physics Institute

Experimental results on the effect of emitter junction bias on the elevated temperature high dose-rate irradiation of bipolar devices and its application for low dose-rate response simulation are presented and discussed.

PA-4 **Hydrogen–Electron Model of Interface Trap Buildup**
A. B. Sogoyan, S. V. Cherepko, and V. S. Pershenkov, SPELS

A model of interface trap buildup is presented which utilizes both the hydrogen and conversion mechanisms. The experiment indicates that radiation–induced positive charge, substrate electrons, and hydrogen species are all required for interface trap generation.

PA-5 **The Effect of GeV Protons on Carrier Equilibrium in the Intrinsic Region of Large P–I–N Detector Diodes**
S. Watts, M. Solansky, J. Matheson, I. Hopkins–Bond, and A. Holmes–Siedle, Brunel University

An analysis of forward current–voltage characteristics in proton–irradiated silicon p–i–n diodes clarifies the unusual equilibria in the intrinsic region, which are caused by a deep acceptor trap level. Experimental data and a detailed computer model are presented.

PA-6 **Photoluminescence Study of Gallium Vacancy Defects in Gallium Arsenide Irradiated by Relativistic Protons**
C. Carlone and M. Parenteau, Université de Sherbrooke; A. Houdayer and P. Hinrichsen, Université de Montréal; J. Vincent, TRIUMF

The introduction rate of the gallium vacancy defect in n–type GaAs has been measured for 200, 350, and 500 MeV protons. The results are compared with the relativistic theory of the scattering cross section and with NIEL.

PA-7 **Integrity of III–V Heterojunction Interfaces under Gamma Irradiation**
S. Subramanian and L Ungeir, Oregon State University; S. M. Goodnick, Arizona State University

Reliability of modern III–V heterostructure devices meant for strong radiation environment operation depends on the integrity of the hetero–interfaces under radiation. We present results on the influence of gamma radiation on heterojunction structures probed by Hall, C–V, and photoluminescence.

PA-8 **Proton Irradiation Effects on Critical Current of Single Crystal Superconducting YBCO Wire**
S. M. Khanna, Defence Research Establishment, Ottawa; A. M. Figueredo, Industrial Materials Institute

Critical current density J_c of 10–MeV proton irradiated single–crystal superconducting YBCO wire filaments was investigated. Record J_c values $\approx 1.4 \times 10^5$ A/cm^2 at 77 K and $\approx 1.3 \times 10^6$ A/cm^2 at 30 K in a magnetic field of 1 T were observed.

SESSION B **RADIATION EFFECTS IN PHOTONIC DEVICES AND SYSTEMS**
11:05 AM Session Introduction
Chairman: Ken LaBel, NASA Goddard Space Flight Center

B-1 **Damage from Proton Irradiation of Vertical–Cavity Surface Emitting Lasers**
11:10 AM
A. H. Paxton, H. Schöne, and E. W. Taylor, Phillips Laboratory; R. F. Carson, K. D. Choquette, H. Q. Hou, K. L. Lear, and M. E. Warren, Sandia National Laboratories

Vertical–cavity surface–emitting lasers were irradiated with 4.5 MeV protons. The light output decreased by 10% to 20% at the nominal operating current for proton fluence ranging from 1.1×10^{13} to 2.8×10^{13} protons/cm^2.

B-2 11:25 AM

MPTB Radiation Effects Study on the DR1773 Fiber Optic Data Bus

G. L. Jackson, K. A. LaBel, and M. Flanegan, NASA Goddard Space Flight Center; P. W. Marshall, SFA, Inc.; C. J. Marshall, Naval Research Laboratory

We present a description of the Microelectronics and Photonics Test Bed (MPTB) Dual–Rate 1773 (DR1773) Fiber Optics Experiment, the radiation hardening techniques utilized, as well as the associated radiation ground test results and analysis.

B-3 11:40 AM

Single–Event Test Methodology and Radiation Test Results of Commercial Gigabit per Second (Gbps) Fiber Optic Data Links

P. W. Marshall and M. A. Carts, SFA, Inc.; C. J. Marshall, Naval Research Laboratory; K. A. LaBel, M. Flanegan, and J. Bretthauer, NASA Goddard Space Flight Center

We present a detailed description of the novel single event test methodology utilized to evaluate high–speed fiber optic data, along with results of proton irradiation of commercially available fiber channel components.

POSTER PAPER

PB-1

Total Dose Radiation Characterization of 850 nm and 1300 nm PM Fiber for Application to Fiber Optic Gyroscopes in Space Environments

B. A. Posey and G. J. Sexton, Orbital Sciences Corp.; J. A. Hammond and M. A. Domaszewicz, Fibersense Technology Corp.

We present data on attenuation losses induced by gamma radiation in 850 nm and 1300 nm polarization–maintaining fibers. The 1300 nm fiber appears suitable for use in fiber optic gyroscopes for most space environments while attenuation in the 850 nm fiber limits its application.

11:55 AM LUNCH

SESSION C 1:30 PM

RADIATION EFFECTS IN DEVICES AND INTEGRATED CIRCUITS

Session Introduction

Chairmen: Steve Clark, Naval Surface Warfare Center
Olivier Musseau, CEA Bruyères le Châtel

C-1 1:35 PM

Low Dose Rate Effects on Linear Bipolar ICs: Experiments on the Time Dependence

R. K. Freitag and D. B. Brown, Naval Research Laboratory

The time dependence of radiation–induced damage to bipolar microcircuits has been studied. It is found that both time–dependent effects and "true" dose–rate effects must be considered.

C-2 1:50 PM

Radiation–Induced Gain Degradation in Lateral PNP BJTs with Lightly and Heavily Doped Emitters

A. Wu, University of Arizona; R. D. Schrimpf, Vanderbilt University; R. L. Pease, RLP Research; D. M. Fleetwood, Sandia National Laboratories; S. L. Kosier, VTC Inc.

Radiation–induced gain degradation is compared as a function of dose rate and emitter doping. Devices with lightly doped emitters degrade more rapidly with dose, but the damage mechanisms are otherwise similar.

C-3 2:05 PM

Degradation of Precision Reference Devices in Space Environments

B. G. Rax, C. I. Lee, and A. H. Johnston, Jet Propulsion Laboratory

Test results for precision references are compared with degradation expected for a basic bandgap reference circuit. The results show that displacement damage from protons causes substantially more damage than ionization damage for most devices.

C-4 2:20 PM

Charge Pumping Analysis of Radiation Effects in LOCOS Parasitic Transistors

O. Flament and O. Musseau, CEA/Centre d'Etudes de Bruyères; J. L. Autran, INSA de Lyon; P. Roche, Université Montpellier II; C. Chabrerie, Thomson CSF Communication; O. Faynot and R. Truche, CEA/DTA/LETI

The electrical behavior of LOCOS parasitic transistors has been investigated by combining charge pumping measurements and simulations. The creation of interface and border traps induced by irradiation has been analyzed along the LOCOS–silicon interface.

C-5 2:35 PM

Radiation Effects on Current Field Programmable Gate Array Technology

R. B. Katz and K. A. LaBel, NASA Goddard Space Flight Center; G. M. Swift, Jet Propulsion Laboratory; J. J. Wang, Actel Corporation

FPGAs are increasingly popular as they fill a critical technology niche. Manufacturers take different approaches to the technology and architectural features. This paper analyzes FPGA technology, evaluates radiation effects, and includes performance data.

POSTER PAPERS

PC-1

Neutron Radiation Tolerance of Advanced UHV/CVD SiGe HBT BiCMOS Technology

J. M. Roldán, W. E. Ansley, and J. D. Cressler, Auburn University; S. D. Clark, Naval Surface Warfare Center; D. Nguyen-Ngoc, IBM Microelectronics

The effects of 1–MeV neutron irradiation on SiGe HBTs and silicon CMOS transistors from an advanced UHV/CVD SiGe BiCMOS technology are examined for the first time over the temperature range of 300K to 84K.

PC-2

Total Dose Testing of a CMOS Charged Particle Detector

B. R. Hancock and G. A. Soli, Jet Propulsion Laboratory

CMOS charged particle spectrometer chips, fabricated with a standard commercial process, have been tested to 10 krad(Si). The chips still perform well, but the dark current increases and an excess noise is observed.

PC-3

Implementation of Total Dose Effects in the BJT Gummel–Poon Model

X. Montagner, P. Fouillat, R. Briand, and A. Touboul, Université Bordeaux; S. Witczak, The Aerospace Corporation; R. D. Schrimpf and K. F. Galloway, Vanderbilt University; M. C. Calvet, Aérospatiale; P. Calvel, Alcatel Espace

A method of including total-dose effects in the Gummel–Poon model for BJTs is described. Adding an additional term related to low-level base current allows good agreement with experimental data.

2:50 PM BREAK (Bedford Ballroom)

SESSION D — HARDNESS ASSURANCE

3:30 PM — Session Introduction

Chairman: Mark Baze, Boeing Defense and Space Group

D-1 — 3:35 PM — Evaluation of Temperature–Enhanced Gain Degradation of Vertical npn and Lateral pnp Bipolar Transistors

S. C. Witczak, R. C. Lacoe, and D. C. Mayer, The Aerospace Corporation; R. D. Schrimpf and K. F. Galloway, Vanderbilt University; D. M. Fleetwood, Sandia National Laboratories; J. M. Puhl and J. S. Suehle, NIST; R. L. Pease, RLP Research

The effect of dose rate on radiation-induced gain degradation is compared for vertical npn and lateral npn bipolar transistors. High dose-rate irradiations at elevated temperatures are more effective at simulating low dose-rate degradation in the lateral pnp transistors.

D-2 — 3:50 PM — A Promising Attempt to Define Conservative Conditions for Total Dose Evaluation of Bipolar ICs

L. Bonora and J. P. David, ONERA-CERT/DERTS

This paper investigates the influence of parameters such as temperature, dose rate, and bias upon the deterioration of irradiated bipolar ICs. A specific set of high dose-rate irradiations seems promising for being conservative in comparison with low dose rate.

D-3 — 4:05 PM — A Proposed Hardness Assurance Test Methodology for Bipolar Linear Circuits and Devices in a Space Ionizing Radiation Environment

R. L. Pease, RLP Research; D. B. Brown, Naval Research Laboratory; L. Cohn, Defense Special Weapons Agency; D. M. Fleetwood, Sandia National Laboratories; A. H. Johnston, Jet Propulsion Laboratory

A hardness assurance test approach has been developed for bipolar linear circuits and devices in space. It consists of a screen for dose-rate sensitivity and a characterization test method to develop the conditions for lot acceptance at high dose rate.

D-4 — 4:20 PM — Experimental Validation of the Long Term Thermal Effect Prediction of Metal Oxide Semiconductor Devices Based on an Accelerated Method of Oxide Trap Characterization

F. Saigné, L. Dusseau, J. Fesquet, and J. Gasiot, Université Montpellier II; R. Ecoffet, CNES; J. P. David, ONERA-CERT/DERTS; R. D. Schrimpf, Vanderbilt University

Experiments have been run for three different devices from three manufacturers to confirm a new method which allows one to predict in a short time the long-term thermal effect on devices in a space environment.

D-5 — 4:35 PM — Effectiveness of IC Shielded Packages Against Space Radiation

J. P. Spratt, B. C. Passenheim, and R. E. Leadon, Full Circle Research; S. Clark, Phillips Laboratory; D. Strobel, Space Electronics, Inc.

IC shielded package design equations were extended to include all important shield parameters (thickness, Z, edge effects, secondary emission). Dose profiles calculated using forward and adjoint Monte Carlo were verified using new methods simulating omnidirectional radiation.

POSTER PAPERS

PD-1 **Physical Oxide Properties as a Hardness Assurance Screen for Bipolar Devices**

C. I. Lee, A. H. Johnston, and B. G. Rax, Jet Propulsion Laboratory

Oxides over emitter–base junctions are examined for pnp transistors in linear bipolar ICs. The results indicate that physical oxide properties can be used as a screening tool to distinguish between devices with low and high sensitivity to dose-rate effects.

PD-2 **Isothermal and Isochronal Annealing Methodology to Study Post–Irradiation Temperature Activated Phenomena**

C. Chabrerie and J. C. Boudenot, Thomson CSF Communications; J. L. Autran, INSA de Lyon; P. Paillet, O. Flament, and J. L. Leray, CEA, Centre d'Etudes de Bruyères

We model the oxide trapped charge evolution to predict post–irradiation behaviors for arbitrary anneal conditions. Our methodology consists of using the experimental data of one single isochronal anneal to calculate this oxide trapped charge evolution.

PD-3 **Worst–Case Test Vectors for Functional Failure Induced by Total Dose in CMOS Microcircuits with Transmission Gates**

A. A. Abou–Auf, US Army Research Laboratory; D. F. Barbe, University of Maryland; M. M. Rushdi, George Mason University

A fault model for total–dose induced functional failure in CMOS microcircuits containing transmission gates has been developed for the automatic generation of worst–case test vectors.

PD-4 **A Step Towards Risk Management in Space Vehicles by Combining Destructive Single Event Effects with Reliability Requirements**

N. P. Goldstein and W. E. Willing, Northrop Grumman ESSD

Destructive SEE effects are combined with reliability failure rates to quantify program risk. This is used to derive realistic acceptance criteria for devices with low destructive SEE rates in a satellite system.

PD-5 **SEU Hardening Approaches in Spaceborne Applications Using COTS**

G. K. Lum, Lockheed Martin Missiles and Space

The combination of space radiation models that characterize the satellite environment and a careful interpretation of upset parameters allow one to design with affordable COTS. Various hardening techniques for space applications will be discussed.

PD-6 **Single Event Latchup Threshold Estimation Based on Laser Diode Dose Rate Test Results**

A. I. Chumakov, A. N. Egorov, O. B. Mavritsky, A. Y. Nikiforov, and A. V. Yaneko, Specialized Electronic Systems

Latchup research and simulation was performed at various laser wavelengths, pulse durations and spot sizes. Single event to dose rate correlation was found, providing the possibility of SEL threshold energy prediction based on laser dose rate tests.

4:50 PM End of Tuesday Sessions

7:30 AM **REGISTRATION AND CONTINENTAL BREAKFAST**
Roof Garden, Snowmass Conference Center

INVITED PAPER
8:15 AM

CMOS Technology Scaling, 0.1 μm and Beyond

Dr. Bijan Davari, IBM Semiconductor Research and Development Center

A projection of CMOS technology scaling and the expected performance, density, and power improvements are presented. Technology for scaling to sub-0.1 micron effective channel length (L_{eff}) is discussed. The key scaling barriers; namely, the non-scalability of device threshold voltage, interconnect RC delays, increased power-density and soft error rate are examined and some possible ways to circumvent them are presented. It is shown that device speed enhancement in excess of 3X, circuit density improvement of 8X, and 20-40X improvement in power-delay product (mW/MIPS) will be achieved by scaling the CMOS technologies down to the sub-0.1 micron regime, operating in the 1 V range, as compared with today's high performance 0.35-micron devices at 3.3 V. Therefore, although the device performance improvement will not keep pace with the miniaturization rate due to the various non-scalable elements, there will still be significant improvements in the silicon chip performance which will continue to fuel the growth of the semiconductor industry for the next decade.

Bijan Davari received his M. S. and Ph. D. degrees in electrical engineering from Rensselaer Polytechnic Institute, Troy, NY, in 1984. He then joined IBM research division, Thomas J. Watson Research Center, Yorktown Heights, NY. Since then he worked on various aspects of scaled CMOS and BiCMOS technologies, including device scaling and process integration. He defined and developed a selectively scaled 0.25-μm CMOS technology at 2.5 V, demonstrating significant performance and power reduction improvement over CMOS technologies at 3.3 V. This work has set the direction and the supply voltage for the post 3.3 V CMOS generations. Dr. Davari was appointed IBM Fellow in 1996 for "His leadership in CMOS technology scaling. His work has profoundly influenced both the logic technology in current IBM systems and the direction of ongoing CMOS research, leading the way to high-performance and low-power." He is presently the senior manager of the Advanced Logic and SRAM Development in IBM's Semiconductor Research and Development Center (SRDC) at Hopewell Junction, NY. His department's activities include the development of CMOS technologies down to sub-0.1 micron for logic and SRAM products, Silicon On Insulator (SOI), and Non Volatile RAM (NVRAM). He has authored and coauthored over 60 publications in various aspects of semiconductor devices and technology.

SESSION E
9:15 AM

DOSIMETRY

Session Introduction

Chairman: Martin Buehler, Jet Propulsion Laboratory

E-1
9:20 AM

Radiation Monitoring Systems for the Space Environment

G. F. MacKay and I. Thomson, Thomson & Nielson Electronics, Ltd.; A. Ng and N. Sultan, Canadian Space Agency

The MOSFET dosimeter has a thin active area which can measure absorbed dose to material, electronic, and biological specimens. Total dose results from three missions, BION-10, BION-11, and MIR are presented, along with the development of a MOSFET dosimeter.

E-2
9:35 AM

Dose Enhancement in a Room Cobalt-60 Source

M. Simons, Research Triangle Institute; R. L. Pease, RLP Research; D. M. Fleetwood and J. R. Schwank, Sandia National Laboratories; M. Krzesniak, Naval Surface Warfare Center

A room cobalt-60 source was characterized using TLDs and pMOS RADFETs. Dose enhancement was measured using RADFETs with and without gold-flashed kovar lids. A method was developed to predict dose enhancement vs. position and test configuration.

E-3 9:50 AM

Application of Reactors for Testing Neutron–Induced Upsets in Commercial SRAMs

P. J. Griffin, T. F. Luera, P. J. Cooper, and S. G. Karr, Sandia National Laboratories; E. Fuller, NOVUS Technology

Reactor neutron environments can be used to test/screen the sensitivity of unhardened commercial SRAMs to low–LET neutron–induced upset. Tests indicate both thermal and fast neutrons can cause upsets in unhardened parts.

POSTER PAPERS

PE-1

Gamma–Ray Transport through Thin Layers

J. C. Garth and J. R. Turinetti, Phillips Laboratory

CEPXS/ONELD calculations of energy fluence and dose vs. distance in Al, Ag, and Pb for several cobalt–60 spectra were performed. Results are compared with predictions using an attenuation law recommended in ASTM Standard E666–91.

PE-2

Least Squares Analysis of Fission Neutron Standard Fields

P. J. Griffin, Sandia National Laboratories; J. G. Williams, University of Arizona

A least squares analysis of fission neutron standard fields is performed using the latest dosimetry cross sections. Discrepant nuclear data are identified and adjusted spectra for ^{252}Cf spontaneous fission and ^{235}U thermal fission fields are presented.

PE-3

Determination of Low Energy (<160 keV) X–Ray Spectra and Verification of Transport Calculations through Silicon

J. R. Turinetti, K. L. Critchfield, J. R. Chavez, and W. T. Kemp, Phillips Laboratory; R. D. Bellem, Embry–Riddle Aeronautical University; D. E. Beutler, Sandia National Laboratories

Low energy (<50 keV) discrepancies are shown through ITS detector response calculations to be caused by escape peak losses. Accounting for this detector response, CEPXS/ONELD transport calculations through silicon agree well with measurements.

10:05 AM BREAK (Bedford Ballroom)

SESSION F 10:45 AM

ISOLATION TECHNOLOGIES

Session Introduction

Chairman: Walter Shedd, Phillips Laboratory

F-1 10:50 AM

Irradiation Response of Mobile Protons in Buried SiO_2

K. Vanheusden, S. P. Karna, and R. D. Pugh, Phillips Laboratory; J. R. Schwank, W. L. Warren, and D. M. Fleetwood, Sandia National Laboratories; R. A. B. Devine, France Télécom/CNET

Trapping of mobile protons is observed in various SOI materials, but only upon irradiating under a positive top–Si bias. Thermal detrapping shows that the proton traps are shallow and located near the substrate Si/SiO_2 interface.

F-2 11:05 AM

The Radiation Response of Capacitors Fabricated on Bonded Silicon–on–Insulator Substrates

P. J. McMarr, SFA, Inc.; B. J. Mrstik, Naval Research Laboratory; R. K. Lawrence, ARACOR

The effect of X–ray irradiation on bonded silicon–on–insulator substrates has been studied. The results of this study show that the macroscopic properties of the insulator are responsible for the radiation sensitivity of the substrates.

F-3 11:20 AM

Radiation–Induced Charge in SIMOX Buried Oxides: Lack of Thickness Dependence at Low Applied Fields

R. K. Lawrence, ARACOR; B. J. Mrstik and H. L. Hughes, Naval Research Laboratory; P. J. McMarr, SFA, Inc.

SIMOX wafers prepared using a variety of conditions were exposed to 10 keV X–rays. At low applied fields the amount of radiation–induced charge in the buried oxide was found to be independent of oxide thickness.

F-4 11:35 AM

Charge Collection in Submicron CMOS/SOI Technology

O. Musseau, V. Ferlet–Cavrois, CEA Bruyères le Châtel; A. B. Campbell, W. J. Stapor, and P. T. McDonald, Naval Research Laboratory; J. L. Pelloie and C. Reynaud, CEA–LETI

The analysis of charge collection in submicron CMOS/SOI technology emphasizes the importance of the bipolar mechanism, and the limits of the usual SEU concepts (LET threshold and cross section) for scaled down devices.

F-5 11:50 AM

Total–Dose and SEU Characterization of Low–Power CMOS/SOI Integrated Circuit Memory Technologies

C. Brothers, R. Pugh, P. Duggan, and J. Chavez, Phillips Laboratory; D. Schepis, D. Yee, and S. Wu, IBM Semiconductor R&D Center

Total–dose and single event effect radiation characterizations of 0.25 micron memories fabricated at IBM's research foundry in bulk and partially depleted SOI, implemented in 2.5 V 64k and 1.8 V 144 k test SRAMs are reported.

POSTER PAPERS

PF-1

Electron and Hole Trapping in Unibond Wafers

R. E. Stahlbush, Naval Research Laboratory

Electron and hole trapping in X–ray irradiated Unibond wafers are studied. The trap concentrations of electrons and holes in the buried oxide are less than in SIMOX but more than in thermally grown oxide.

PF-2

Reducing Radiation–Induced Back Channel Threshold Shifts in Partially Depleted SIMOX CMOS Devices by Using ADVANTOX Substrates

S. T. Liu, Honeywell, Inc.; L. P. Allen and M. J. Anc, Ibis Technology Corp.; W. Jenkins and H. Hughes, Naval Research Laboratory; R. Lawrence, ARACOR

Excessive total dose radiation induced back channel threshold shifts often observed in partially depleted NMOS transistors fabricated in full dose SIMOX wafers can be greatly reduced by the use of low dose ADVANTOX substrates.

12:05 PM **Poster Session Introduction**
Poster Chairman: Bob Pugh, USAF Phillips Laboratory

12:10 PM **LUNCH**

1:45 PM – 4:30 PM
ERICKSON, CARROLL, AND SINCLAIR ROOMS

POSTER SESSION

Poster Chairman: Bob Pugh, USAF Phillips Laboratory

Authors will be present during this session to answer questions. Posters will be displayed for individual viewing from noon Tuesday to Thursday evening. Abstracts for posters are listed in this brochure under the oral sessions with which they are associated.

4:30 PM End of Wednesday Sessions

7:30 AM **REGISTRATION AND CONTINENTAL BREAKFAST**
Roof Garden, Snowmass Conference Center

INVITED PAPER
8:15 AM

Bootstrapping Intelligence

Dr. William Calvin, University of Washington

The way that thought processes and intelligence function in the human brain is an area of extensive research. Evolving something new "on the fly" involves a lot of creative trial-and-error inside the brain, mostly in the last second before speaking aloud. Starting from themes as disjointed and unrealistic as those of a dream, humans are capable of making something of quality out of the subconscious morass. This talk will discuss human thought processes, and how new ideas develop and evolve. The bootstrapping of new ideas works much like the immune response or the evolution of a new animal species—except that the brain can turn the "Darwinian crank" a lot faster, on the time scale of thought and action. Newly cloned firing patterns are tacked onto a temporary mosaic. But cloning may "blunder slightly" or overlap several patterns— and this variation makes us creative. Variant hexagonal mosaics compete with one another for territory in the association cortex, their success biased by memorized environments and sensory inputs. Eventually, as quality improves, we become conscious of our new invention.

Dr. William H. Calvin is a neurophysiologist on the faculty of the University of Washington in Seattle. He was originally trained in physics at Northwestern University, was converted to brain research by graduate work at MIT and Harvard Medical School, and did a combined theoretical and experimental Ph. D. in physiology and biophysics at the University of Washington in 1966. His interest in evolutionary mechanisms has led him to investigate both the ape-to-human big brain problem and the milliseconds-to-minutes Darwinian mechanism for shaping up sentences to speak, and evolving plans for tomorrow. The more recent of his nine nonfiction books are *How Brains Think*, and *The Cerebral Code*.

SESSION G
9:15 AM

SPACECRAFT ENVIRONMENTS AND EFFECTS

Session Introduction

Chairman: Richard Maurer, Johns Hopkins Applied Physics Laboratory

G-1
9:20 AM

Probability Distributions of High-Energy Solar-Heavy-Ion Fluxes from IMP-8: 1973-1996

W. F. Dietrich, LASR/Enrico Fermi Institute; A. J. Tylka and P. R. Boberg, Naval Research Laboratory

We present probability distributions for the fluences of high-energy solar energetic He, CNO, and Fe, based on the data accumulated by the University of Chicago's cosmic ray telescope on IMP-8 in 1973-1996.

G-2
9:35 AM

CREME96: A Revision of the Cosmic Ray Effects on Micro-Electronics Code

A. J. Tylka and J. H. Adams, Jr., Naval Research Laboratory; P. R. Boberg, Universities Space Research Association; B. Brownstein, Software Technology, Inc.; W. F. Dietrich, University of Chicago; E. O. Flueckiger, University of Bern; E. L. Petersen, Consultant; M. A. Shea and D. F. Smart, Phillips Laboratory; E. C. Smith, Consultant

CREME96, now available at http://crsp3.nrl.navy.mil/creme96/, contains significant improvements in ionizing-radiation environment modeling and single-event upset calculation techniques. We report these improvements and compare CREME96 to on-orbit particle flux and SEU data.

G-3 9:50 AM

APEXRAD: Low Altitude Orbit Dose as a Function of Inclination, Magnetic Activity and Solar Cycle

M. S. Gussenhoven, E. G. Mullen, and J. T. Bell, Phillips Laboratory; D. Madden and E. Holeman, Boston College

A computer utility called APEXRAD was developed to examine orbital dose for low altitude spacecraft such as Space Station. Orbit–dependent and other space radiation considerations will be discussed.

10:05 AM BREAK

G-4 10:35 AM

Proton Displacement and Ionizing Damage Dose for Shielded Devices in Space

S. R. Messenger and E. A. Burke, SFA, Inc.; M. A. Xapsos, Naval Research Laboratory; G. P. Summers, Naval Research Laboratory and University of Maryland

The sensitivity of displacement and ionizing damage dose calculations to both the incident proton energy spectrum and that transmitted through shields is calculated down to 100 eV for trapped radiation and solar proton events.

G-5 10:50 AM

Predictions and Observations of SEU Rates in Space

E. L. Petersen, Consultant

This report analyzes the latest flight data and examines the state–of–the–art of space upset rate predictions.

G-6 11:05 AM

An Autonomous Charge Control System at Geosynchronous Altitude: Flight Results for Spacecraft Design Consideration

E. G. Mullen, A. R. Frederickson, and G. P. Murphy, Phillips Laboratory; K. P. Ray, E. G. Holeman, and D. E. Delorey, Boston College; R. Robson, Hughes Research Laboratories; M. Farar, Assurance Technology Corporation

Geosynchronous spacecraft have a history of charging anomalies. Conventional passive protection measures are often complex and costly. Results from an alternative approach, an autonomous charge control system as flown on DSCS, will be discussed.

G-7 11:20 AM

Arc Rate Measurements Observed by the Photovoltaic Array Space Power Plus Diagnostics (PASP Plus) Experiment

K. P. Ray and D. E. Delorey, Boston College; D. A. Guidice, Phillips Laboratory; R. C. Adamo and D. R. Dana, SRI International; J. D. Soldi and D. E. Hastings, Massachusetts Institute of Technology

This paper presents results from the PASP Plus experiment. Comparisons in arc rate between ten solar arrays are made. Correlations of arc rate versus plasma density, ram angle, altitude, array temperature, and bias voltage are shown.

POSTER PAPERS

PG-1

Analysis of Large Solar Proton Events for Radiation Effects Applications

M. A. Xapsos and G. P. Summers, Naval Research Laboratory; E. G. Stassinopoulos, NASA Goddard Space Flight Center; E. A. Burke, Consultant

Extreme value statistics are used to predict the maximum solar proton event fluence and peak flux that spacecraft in geosynchronous orbit can expect to receive during a mission. Convenient graphical results and expressions are presented.

PG-2 **In–Flight ESD Anomalies Triggered by Photoemission, Micrometeoroid Impact and Pressure Pulse**

L. Levy, R. Reulet, J. C. Mandeville, J. M. Siguier, and D. Sarrail, CERT–ONERA; J. P. Catani, CNES; L. Gerlach, ESA–ESTEC

The paper reviews different means to trigger discharges on electron–bombarded dielectrics. At least two in–flight ECEMP anomalies are related to events like photoemission and sudden local pressure increase. Other mechanisms are also studied at the laboratory.

11:35 AM LUNCH

SESSION H **SINGLE–EVENT MECHANISMS AND CHARGE COLLECTION**

1:00 PM Session Introduction

Chairwoman: Sophie Duzellier, CERT–ONERA/DERTS

H-1 **Single Event Upset Induced by Pions in 16Mb DRAM Chips**

1:05 PM *C. J. Gelderoos and R. J. Peterson, University of Colorado, Boulder; M. E. Nelson, U. S. Naval Academy; J. F. Ziegler, IBM Research Division*

Measurements of pion–induced single event upset cross sections were made as functions of pion energy and chip architecture. Cross sections exhibit proportionality to π–^{28}Si reaction cross sections, and significant differences are seen to exist between manufacturers.

H-2 **Comparisons of Error Rates in Logic and Registers: Theory and Experiment**

1:20 PM *S. Buchner, SFA, Inc.; D. McMorrow and J. Melinger, Naval Research Laboratory; M. Baze, Boeing Defense and Space Group*

The frequency dependence of error rates in a circuit containing both logic elements and registers was investigated using a pulsed laser. The dependence on frequency and pulse energy is presented.

H-3 **Attenuation of Single Event Induced Pulses in CMOS Combinatorial Logic**

1:35 PM *M. P. Baze, Boeing Defense and Space Group; S. P. Buchner, SFA, Inc.*

Results are presented of a study of SEU pulse attenuation in combinatorial logic structures built using common digital CMOS design practices. SPICE, heavy ion, and pulsed laser results reveal characteristics useful for estimating error rates.

H-4 **Charge–Collection Mechanisms of AlGaAs/GaAs HBTs**

1:50 PM *D. McMorrow, J. S. Melinger, and A. B. Campbell, Naval Research Laboratory; S. Buchner, SFA, Inc.; W. R. Curtice, W. R. Curtice Consulting*

AlGaAs/GaAs HBTs are investigated via time–resolved and time–integrated charge–collection measurements and by two–dimensional computer simulation, providing new insights into the mechanisms of charge collection in heterojunction bipolar transistors.

H-5 **SEU Design Considerations for MESFETs on LT GaAs**

2:05 PM *R. Radice, D. Eskins, T. R. Weatherford, and D. J. Fouts, Naval Postgraduate School; P. W. Marshall, SFA, Inc.; C. J. Marshall, H. Dietrich, and M. Twigg, Naval Research Laboratory; R. Milano, Vitesse Semiconductor*

We report on wafer design and modeling of single event charge collection in the Vitesse H–GaAsIII process fabricated above LT GaAs epitaxial layers. We discuss the tradeoffs in SEU immunity and transistor design.

H-6
2:20 PM

Origins and Quantification of the SEU Critical Charge in a Submicron CMOS Technology

C. Detcheverry, D. Dachs, E. Lorfevre, C. Sudre, G. Bruguier, J.-M. Palau, and J. Gasiot, Université Montpellier II; R. Ecoffet, CNES

This work quantifies the influence of the parasitic bipolar structure inherent to a MOS transistor in a submicron technology. Its effect is shown to be important in SEU occurrence and modifies the sensitive volume notion.

H-7
2:35 PM

Comparison of Single Event Phenomena for Front/Back Irradiations

O. Musseau and V. Ferlet-Cavrois, CEA Bruyères le Châtel; A. B. Campbell, W. J. Stapor, and P. T. McDonald, Naval Research Laboratory

For devices irradiated from the front and the back, where the same amount of charge is deposited in sensitive volumes, the SEU sensitivities and charge collection spectra are different. We present new data about this phenomenon and suggest an interpretation.

POSTER PAPERS

PH-1

Heavy Ion and Proton–Induced Single Event Multiple Upsets

R. A. Reed, M. A. Carts, S. Buchner, P. J. Marshall, and P. T. McDonald, SFA, Inc.; C. J. Marshall, Naval Research Laboratory; O. Musseau, CEA Bruyères le Châtel; D. R. Roth and P. J. McNulty, Clemson University; T. Corbière, Matra MHS

Proton–induced spallation reactions and ionizing heavy ion events are shown to cause multiple upsets in a high density SRAM. Monte–Carlo simulations of proton–induced single event multiple upsets are presented.

PH-2

Charge Collection and SEU from Angled Ion Strikes

P. E. Dodd, M. R. Shaneyfelt, and F. W. Sexton, Sandia National Laboratories

Charge collection and SEU from angled ion strikes are studied using three–dimensional simulation. The inverse cosine scaling law for angled strikes is shown to be of limited usefulness. Impacts on SEU test methodology are discussed.

PH-3

Correlation of Single–Event Phenomena in GaAs Circuits with Carrier Lifetime in LT GaAs Buffer Layers

D. McMorrow, J. S. Melinger, H. Dietrich, and A. B. Campbell, Naval Research Laboratory; A. R. Knudson and S. Buchner, SFA, Inc.; K. Ikossi-Anastasiou, Louisiana State University; S. C. Moss, The Aerospace Corporation; D. Engelhardt and T. Childs, TLC Precision Wafer Technology

Femtosecond transient reflectivity measurements on multilayer structures incorporating LT GaAs buffer layers measure carrier lifetimes directly and permit correlation of the results with SEU measurements on devices incorporating LT GaAs buffer layers.

PH-4

Proton Upset Rate Simulation by a Monte Carlo Method: Importance of the Elastic Scattering Mechanism

C. Inguimbert, S. Duzellier, and J. Bourrieau, ONERA–CERT/DERTS; R. Ecoffet, CNES

This paper describes the calculation of the proton upset cross–section by a Monte Carlo method. The computation combines heavy–ion experimental data and modeling of the inelastic (NUREAC) and elastic (ELASTIC) proton/silicon reactions.

PH-5 **Low LET Cross–Section Measurements Using High Energy Carbon Beam**

R. Ecoffet, CNES; S. Duzellier, D. Falguère, L. Guibert, and C. Inguimbert, ONERA–CERT/DERTS

30 to 300 MeV/n SEU results are presented for memories from 256K SRAM to 64M DRAM. Devices are sensitive at low LET and the cross sections reach a plateau. Analysis is made using an adapted diffusion model.

2:50 PM – 4:30 PM
KEARNS ROOM

RADIATION EFFECTS DATA WORKSHOP

Data Workshop Chairman: Tom Turflinger, Naval Surface Warfare Center

Authors will be present at posters during this session to answer questions. Workshop posters will be displayed for individual viewing from noon Tuesday to Thursday evening.

W-1 **Device SEE Susceptibility from Heavy Ions (1995–1996)**

D. K. Nichols, J. R. Coss, T. F. Miyahira, H. R. Schwartz, and G. M. Swift, Jet Propulsion Laboratory; R. Koga, W. R. Crain, K. P. Crawford, and S. H. Penzin, The Aerospace Corporation

A seventh set of heavy ion single event effects (SEE) test data have been collected since the last IEEE publications. SEE trends are indicated for several functional classes of ICs.

W-2 **Single Event Effect Test Results for Candidate Spacecraft Electronics**

K. A. LaBel, A. K. Moran, E. G. Stassinopoulos, and J. M. Barth, NASA Goddard Space Flight Center; C. M. Seidleck, Hughes/ST Systems Corporation; P. Marshall and M. Carts, SFA, Inc.; C. Marshall, Naval Research Laboratory; J. Kinnison and B. Carkhuff, Applied Physics Laboratory

We present both heavy ion and proton single event ground test results for candidate spacecraft electronics. A variety of digital, analog, and fiber optic devices were tested, including DRAMs, FPGAs, and fiber links.

W-3 **Radiation Single Event Effects Results of COTS–Based Space Microcircuits**

D. J. Strobel, P. L. Layton, J. Parkinson, H. Anthony, and R. Boss, Space Electronics, Inc.; J. Spratt and B. Passenheim, Full Circle Research

Single–event effects radiation test results of COTS microcircuits are presented in tabulation form. The data are from heavy ion radiation tests conducted for space environment suitability.

W-4 **Common–Source TLD and RADFET Characterization of Co–60, Cs–137, and X–Ray Irradiation Sources**

M. Simons and J. Buaron, Research Triangle Institute; R. L. Pease, RLP Research; D. M. Fleetwood, J. R. Schwank, and L. C. Riewe, Sandia National Laboratories; M. Krzesniak and T. Turflinger, Naval Surface Warfare Center; W. T. Kemp and P. W. C. Duggan, Phillips Laboratory; J. M. Puhl, National Institute of Standards and Technology; A. H. Johnston and M. Wiedeman, Jet Propulsion Laboratory; R. E. Mills, Hughes Electronics; A. G. Holmes–Siedle, Radiation Experiments and Monitors; L. M. Cohn, Defense Special Weapons Agency

Dose enhancement and dose rate were measured in more than a dozen gamma sources using pMOS RADFETs and TLDs from two independent sources. ARACOR X–ray dose rates were calibrated using single– and dual–dielectric RADFETs.

W-5 **Radiation Hardness Assurance Categories for COTS Technologies**

G. L. Hash, M. R. Shaneyfelt, F. W. Sexton, and P. S. Winokur, Sandia National Laboratories

A comparison of the radiation tolerance of three commercial and one radiation hardened SRAM is presented for four radiation environments. Burn–in is shown for the first time to reduce functional failure levels.

W-6 **Thin–Film Thermo–Resistor Radiation Hardness Experimental Results**

A. Y. Nikiforov, V. A. Telets, and V. S. Figurov, Specialized Electronic Systems

Tests of thin–film thermo–resistors were carried out in the temperature range of –60 to +125 °C. Deviations from initial values did not exceed 2% until after the dose rate 2.7×10^{10} rad(Si)/s, total dose 1.8×10^{5} rad(Si), and neutron fluence 2.4×10^{12} n/cm^2.

W-7 **Radiation Hard Bulk CMOS ROM Dose Rate Upset Detailed Analysis Technique and Results**

A. Y. Nikiforov, V. N. Guminov, and V. A. Telets, Specialized Electronic Systems

Dose rate investigation of a radiation hard bulk CMOS ROM family is performed with a pulsed laser. The dose rate upset level is determined by the preamplifier. The dependence of upset duration on frequency is obtained and analyzed.

W-8 **Single Event Upset Characteristics of the 486–DX4 Microprocessor**

C. K. Kouba, NASA Johnson Space Flight Center; G. Choi, Texas A&M University

The 486–DX4 microprocessor has been tested for single event upset susceptibility. A cyclotron experiment using heavy ions was used to test processors from two vendors. Results include error modes and cross sections.

W-9 **Investigation of Non–Independent Single Event Upsets in the TAOS GVSC Static RAM**

R. Hosken and R. Koga, The Aerospace Corporation; B. Wilson, J. Marcelli, and L. Laird, GTE Government Systems

Operation of the two TAOS Honeywell GVSC flight computers has been monitored over three years. SEUs in the Micron 32Kx8 static RAM chips were characterized and some were found to have a common primary event.

W-10 **Single Event Effect Neutron Test Results for Various SRAM Memories**

D. Thouvenot, P. Trochet, R. Gaillard, and F. Desnoyers, Nuclétudes

This paper presents the results of a SEE neutron evaluation carried out on five SRAM types.

W-11 **Neutron SEU Trends in Avionics**

N. Kerness and A. Taber, Lockheed Martin Federal Systems

Accelerator measurements of 38 memory device vintages, along with 13 years of avionics processor experience, indicate that DRAMs rather than SRAMs may become the future memory of choice for protection against atmospheric neutron single event upset.

W-12 **The SEU in Pulse Width Modulation Controllers with Soft Start and Shutdown Circuits**

S. H. Penzin, W. R. Crain, K. B. Crawford, S. J. Hansel, and R. Koga, The Aerospace Corporation

A study was done of single event upset pulse width modulation controllers which feature either soft start or shutdown circuits. Upsets occurring in the soft start circuit of these devices greatly affect the external circuit.

W-13 **Total Dose Performance of a Commercial Off the Shelf Ultra–Low Noise Precision Bipolar Operational Amplifier During Irradiation**

D. M. Hiemstra, SPAR Environmental Systems

The performance in a dose rate environment of an ultra–low noise bipolar operational amplifier during irradiation with respect to total dose is presented. Comparisons to previously reported results are made.

W-14 **Total Dose Response of Maxim Analog Multiplexers at Two Dose Rates**

R. Pease, RLP Research, Inc.; W. Kemp, N. Islam, and J. Chavez, Phillips Laboratories

Samples of MAX338CPE and MAX358CMPE CMOS analog multiplexers were irradiated at 90 and 0.01 rad(SiO_2)/s to 16 krad(SiO_2). Both parts showed increase in on–resistance and leakage current with total dose, but did not show significant dose rate sensitivity.

W-15 **Characterization of Commercial High Density Memories under Low Dose Rate Total Ionizing Dose (TID) Testing for NASA Programs**

A. K. Sharma, NASA Goddard Space Flight Center; K. Sahu, Unisys Corporation

This paper reports low dose rate total ionizing dose testing [0.04 to 0.08 rad(Si)/s] on different types of high density memories such as DRAMs, SRAMs, EEPROMs, and Flash memories. Most were commercial parts in plastic packages.

W-16 **Total Ionizing Dose Effects on 64–Mb 3.3–V DRAMs**

C. I. Lee, D. N. Nguyen, and A. H. Johnston, Jet Propulsion Laboratory

Total dose tests were done on 64–Mb DRAMs from two manufacturers. These scaled DRAMs are about twice as hard as 16–Mb commercial DRAMs. Retention time distributions were used to examine on–chip uniformity of the total dose response.

W-17 **Ionizing Radiation Response of an Amorphous Silicon Based Antifuse**

J. M. Benedetto and C. C. Hafer, UTMC Microelectronic Systems

Ionizing radiation response of Ti/W metal electrode amorphous silicon (a–Si) antifuses is examined. The resistance of unprogrammed antifuses increases with increasing total dose, and fully programmed antifuses are insensitive to total dose.

4:30 PM End of Thursday Sessions

5:00 PM **Radiation Effects Committee Open Meeting**

7:15 AM — REGISTRATION AND CONTINENTAL BREAKFAST
Roof Garden, Snowmass Conference Center

INVITED PAPER
8:00 AM

Joint U. S./Russian Programs on the MIR Space Station

Dr. Ronald Sega, University of Colorado at Colorado Springs

The 1990's marked the beginning of several cooperative programs between the United States and Russia in space. Professor Sega flew on the third scheduled docking of the Space Shuttle with the MIR Space Station in 1996, as well as on other cooperative missions between the U. S. and Russia on the Space Shuttle. In this talk he will discuss his experiences in space, providing details about the MIR Space Station and the challenges that need to be overcome in order to perform such missions. He will also discuss the future International Space Station, and the problems that occur during extended stays in the space environment.

Professor Ronald Sega received a B. S. in Math and Physics from the U. S. Air Force Academy, an M. S. in Physics from Ohio State University, and the Ph. D. in Electrical Engineering from the University of Colorado. His earlier experience was as an Air Force flight instructor. Following this, he held an academic position at the U.S. Air Force Academy, and then served as Operations Plans Officer for the 302 Tactical Airlift Wing of the U. S. Air Force. He served as Technical Director of the Laser and Aerospace Mechanics Directorate at the U. S. Air Force Academy, and as an adjunct professor of physics at the University of Houston before being selected as an astronaut. He participated in two Space Shuttle flights, including the third docking flight with the MIR Space Station. During his career he has done extensive scientific research in addition to his duties as a pilot and astronaut, with more than 100 publications in scientific journals. His research areas include high-power microwaves, growth of semiconductor materials in space, and infrared measurements of electromagnetic fields. He is currently Dean of the College of Engineering and Applied Science at the University of Colorado at Colorado Springs.

SESSION I
9:00 AM

NON-DESTRUCTIVE SINGLE-EVENT EFFECTS IN DEVICES

Session Introduction

Chairwoman: Heather Dussault, Rome Laboratories

I-1
9:05 AM

Low Energy Proton-Induced SEE Effects in Memories

S. Duzellier, D. Falguère, T. Nuns, and L. Guibert, ONERA-CERT/DERTS; R. Ecoffet, CNES; M. C. Calvet, Aérospatiale

This paper presents data obtained on memories from various generations. Highlight is set on component response down to 8.89 MeV incident protons. Implications of the low-energy part of the proton sensitivity curve on calculated SEE rates are discussed.

I-2
9:20 AM

Single-Event Upset in Flash Memories

H. R. Schwartz, D. K. Nichols, and A. H. Johnston, Jet Propulsion Laboratory

SEU tests show that soft errors in the internal controller cause functional interruption to occur with an approximate LET threshold of 7 MeV-cm^2/mg. A high-current failure mode was also observed during sequencing after the heavy-ion beam was turned off.

I-3
9:35 AM

Artificial Neural Network Robustness for On-Board Satellite Image Processing: Results of SEU Simulations and Ground Tests

R. Velazco and Ph. Cheynet, LSR IMAG; J. D. Muller, CEA; R. Ecoffet, CNES

ANNs (Artificial Neural Networks) have been proved as having potential fault tolerance properties. We present the architecture of an ANN designed to process satellite images. Soft simulations and ground tests performed on a digital implementation of this ANN prove its SEU robustness.

I-4
9:50 AM

Predicting Heavy Ion Susceptibility of Parts Tested with Protons

P. M. O'Neill, G. Badhwar, and W. X. Culpepper, NASA Johnson Space Flight Center

A method based on internuclear cascade–evaporation codes was developed and used to estimate the heavy ion upset cross section from the measured proton cross section. Its accuracy and limitations are demonstrated with proton and heavy ion measurements.

POSTER PAPERS

PI-1

Space SEE Risk for a Commercial Digital TV Receiver

R. Ecoffet, M. Sarthou, and M. Labrunée, CNES; L. Gasc and A. Dubreuil, COMATLAS

Commercial digital TV reception ASICs were heavy ion tested. Bit error rate degradation, loss of synchronization, loss of functionality, and latch-up were observed. Estimations are made showing that the set can be used in most space environments.

PI-2

Effects of Low Temperature Buffer Layer Thickness and Growth Temperature on the SEE Sensitivity of GaAs HIGFET Circuits

P. W. Marshall, SFA, Inc.; C. J. Marshall, Naval Research Laboratory; T. R. Weatherford and D. J. Fouts, Naval Postgraduate School; B. Mathes and M. LaMacchia, Motorola Government Systems

Heavy ion test results reveal the roles of growth temperature and buffer layer thickness in the use of a low temperature grown buffer layer for suppressing SEE sensitivity in GaAs HIGFET circuits.

PI-3

Single Event Upset (SEU) Sensitivity Dependence of Linear Integrated Circuits (ICs) on Bias Conditions

R. Koga, S. H. Penzin, M. D. Looper, K. B. Crawford, and W. R. Crain, The Aerospace Corporation

The single-event upset (SEU) sensitivity of certain types of linear microcircuits is strongly affected by bias conditions. For these devices, a model of upset mechanism and a method for SEU control have been suggested.

10:05 AM BREAK

SESSION J

10:25 AM

CATASTROPHIC SINGLE-EVENT EFFECTS

Session Introduction

Chairman: Jim Pickel, Maxwell Technologies Incorporated

J-1
10:30 AM

Single Event Gate Rupture in Thin Gate Oxides

F. W. Sexton, D. M. Fleetwood, M. R. Shaneyfelt, P. E. Dodd, and G. L. Hash, Sandia National Laboratories

The dependence of single event gate rupture (SEGR) critical field on oxide thickness is examined for thin gate oxides. Critical field for SEGR increases with decreasing oxide thickness, consistent with an increasing "intrinsic" breakdown field.

J-2
10:45 AM

Heavy Ion Induced Failures in a Power IGBT

E. Lorfevre, C. Dachs, C. Detcheverry, J.-M. Palau and J. Gasiot, Université Montpellier II; F. Roubaud, Université des Antilles-Guyanne; M. C. Calvet, Aérospatiale; R. Ecoffet, CNES

For the first time, heavy ion induced destructive failures are reported in IGBTs. An experimental and 2D simulation investigation shows that latchup is involved in the triggering of the device.

J-3 11:00 AM

Investigations into the Power MOSFET SEGR Phenomenon and Its Physical Mechanisms

G. M. Swift, L. D. Edmonds, T. Miyahira, D. K. Nichols, and A. H. Johnston, Jet Propulsion Laboratory

SEGR is investigated for power MOSFETs with different voltage ratings. Latent failures occurred for several devices when voltage was applied to the gate after irradiation with heavy ions. This suggests that SEGR may be a two–step process.

J-4 11:15 AM

Neutron–Induced Single Event Burnout in High Power Electronics

E. Normand, J. L. Wert, D. L. Oberg, and P. Majewski, Boeing Defense and Space Group; P. Voss, Eupec; S. A. Wender, Los Alamos National Laboratory

Energetic neutrons, which were demonstrated to induce single–event burnout in power MOSFETs, have been shown to induce burnout in high power (>3000 V) electronics when operated at voltages as low as 50% of rated voltage.

J-5 11:30 AM

Determination of Latch–Up Sensitive Volume Dimensions Using High Angle Inclination Heavy Ion Beams

R. Ecoffet, CNES; S. Duzellier, ONERA–CERT/DERTS

We present a method for determining the sensitive volume thickness by varying energy deposition conditions using high inclination beams and by fitting energy losses with cross–section measurements. A latch–up example is discussed.

J-6 11:45 AM

Latchup in Integrated Circuits from Energetic Protons

A. H. Johnston, G. M. Swift, and L. D. Edmonds, Jet Propulsion Laboratory

Proton and heavy–ion latchup cross sections are compared for devices with bulk and epitaxial substrates. A revised approach for proton latchup is developed that takes well geometry into account.

12:00 PM End of Conference

CHERBS Technical Program

CHERBS TECHNICAL INFORMATION

The CHERBS technical program will consist of oral papers and a one–hour summary and discussion at the end of the conference. All CHERBS oral sessions will be held in the Max Park Room of the Wildwood Lodge. Oral papers will be 12 minutes in length with an additional 3 minutes for questions. The Technical Sessions and chairpersons are:

- **Induced Activity**
  Jack Trombka, NASA Goddard Space Flight Center
- **Analysis Methods, Models, Catalogs, and Data Bases**
  Jim Ryan, University of New Hampshire
- **Detectors and Detector Systems**
  Jeff Schweitzer, University of Connecticut and University at Albany – SUNY
- **Space Environment Background**
  George Lasche, Constellation Technology Corporation

INVITED SPEAKERS

The 1997 NSREC is pleased to feature three invited talks which CHERBS registrees are encouraged to attend. Bijan Davari, IBM Semiconductor Research & Development Center, will discuss ***CMOS Technology Scaling, 0.1 μm and Beyond*** on Wednesday morning prior to CHERBS session CHD. William Calvin, University of Washington, will discuss ***Bootstrapping Intelligence*** on Thursday. Ronald Sega, University of Colorado, will discuss ***Joint U. S./Russian Programs on the MIR Space Station*** on Friday.

Tuesday, July 22

TECHNICAL PROGRAM

7:30 AM — **REGISTRATION AND CONTINENTAL BREAKFAST**
Roof Garden, Snowmass Conference Center

8:15 AM
SNOWMASS BALLROOM — **OPENING REMARKS**
Dennis B. Brown, NSREC General Chairman
Teresa Farris, NSREC Local Arrangements Chairwoman

8:45 AM
MAX PARK ROOM
(WILDWOOD LODGE) — **MEMORIAL TO A. CARL RESTER**
George Lasche, Constellation Technology Corporation

SESSION CHA — **INDUCED ACTIVITY**
8:55 AM — Session Introduction
Chairman: Jack Trombka, NASA Goddard Space Flight Center

CHA-1
9:00 AM — **AXAF Detector Backgrounds Produced by Cosmic Ray Protons**
T. W. Armstrong and B. L. Colborn, SAIC; K. L. Dietz, S. L. O'Dell, and M. C. Weisskopf, NASA Marshall Space Flight Center

Backgrounds expected for x-ray detectors on the Advanced X-ray Astrophysics Facility from cosmic-ray proton bombardment have been determined by Monte Carlo simulations. Results include the time dependence of prompt and activation backgrounds.

CHA-2
9:15 AM — **Induced Radioactivity Measured in a Germanium Detector after a Long Duration Balloon Flight**
R. Starr, Catholic University; L. G. Evans, Computer Sciences Corporation; S. R. Floyd and J. I. Trombka, NASA Goddard Space Flight Center; D. M. Drake and W. C. Feldman, Los Alamos National Research Laboratory; S. W. Squyres, Cornell University; and A. C. Rester, Constellation Technology Corporation

A 13-day long duration balloon flight carrying a germanium detector was flown from Williams Field, Antarctic in December 1992. After recovery of the payload the activity induced in the detector was measured.

CHA-3
9:30 AM — **The Prompt Cosmic-Ray-Induced Background in the Orbiting Compton Telescope COMPTEL**
J. M. Ryan, S. Kappadath, M. McConnell, and D. Morris, University of New Hampshire; V. Schönfelder, M. Varendorff, and G. Weidenspointner, Max-Planck Institute; W. Hermsen, Space Research Organization Netherlands-Utrecht; K. Bennett, ESTEC

To perform a measurement of the cosmic diffuse gamma-ray flux one must overcome the background generated locally by cosmic rays. We report on the spectrum of the prompt component of this background.

9:45 AM — **BREAK**

CHA-4
10:20 AM — **Charged Particle Induced Radiation Damage of Germanium Detectors in Space: Two Mars Observer Gamma-Ray Detectors**
J. Brückner and M. Koenen, Max-Planck Institut fur Chemie; L. G. Evans, Computer Sciences Corporation; R. Starr, Catholic University; S. H. Bailey and W. V. Boynton, University of Arizona

Charged particle bombardment induces radiation damage in germanium crystals. The Mars Observer gamma-ray HPGe detector suffered energy resolution degradation in space. These data are compared with accelerator based results of a similar HPGe detector.

CHA-5
10:35 AM

Analysis of Activation Effects in Space–Borne and Proton Beam Irradiated Gamma–Ray Detectors

P. R. Truscott, C. S. Dyer, H. E. Evans, and M. Cosby, DERA–Farnborough; C. E. Moss, Los Alamos National Research Laboratory

Results are presented from Space Shuttle and proton beam (0.3 and 1 GeV) experiments in which BaF_2, GSO, and LSO gamma–ray detector materials were irradiated. These are compared with predicted effects of activation and detector response.

CHA-6
10:50 AM

Activation in the COMPTEL Double–Scattering Gamma–Ray Telescope

D. J. Morris, M. L. McConnell, and J. M. Ryan, University of New Hampshire; V. Schönfelder, M. Varendorff, and G. Weidenspointner, Max–Planck Institut; H. Aarts, Space Research Organization Netherlands–Utrecht; K. Bennett, ESTEC

Comparison of spectra from the COMPTEL double–scattering telescope for different orbits and epochs during six years since launch of the Compton Gamma–Ray Observatory shows evidence of activation on a range of time scales.

CHA-7
11:05 AM

Induced Background in the Mars Observer Gamma–Ray Spectrometer

W. V. Boynton, University of Arizona; L. G. Evans, Computer Sciences Corporation; R. Starr, Catholic University; J. Brückner, Max–Planck Institut für Chemie; S. H. Bailey, University of Arizona; and J. I. Trombka, NASA Goddard Space Flight Center

The Mars Observer gamma–ray spectrometer has provided data on background lines due to natural and cosmic–ray induced radioactivity. These data will help determine, for future missions, the detection sensitivity of gamma–ray lines of interest that are at or near the energy of background lines.

CHA-8
11:20 AM

Cosmic Ray Induced Degradation in X–Ray Detectors on Board the NEAR Spacecraft

S. R. Floyd and J. I. Trombka, NASA Goddard Space Flight Center; J. O. Goldsten and E. M. Fiore, Johns Hopkins University/APL

The x–ray detectors on board the Near–Earth Asteroid Rendezvous (NEAR) spacecraft are argon gas filled proportional counters. Their resolution is checked periodically with an Fe–55 radioactive source. Low energy tailing and broadening of the 6 keV line is observed.

SESSION CHB
11:35 AM

ANALYSIS METHODS, MODELS, CATALOGS, AND DATA BASES

Session Introduction

Chairman: Jim Ryan, University of New Hampshire

CHB-1
11:40 AM

Radiation Threats from Huge Solar Particle Events

R. C. Reedy, Los Alamos National Research Laboratory

One of the greatest radiation hazards away from the Earth's magnetosphere is solar energetic particles. Modern and ancient SEP measurements are reviewed and used together to set limits on possible huge solar particle events.

CHB-2
11:55 AM

Long–Term Energetic Particle Databases from Geosynchronous and GPS Orbits

R. C. Reedy, R. D. Belian, T. E. Cayton, J. C. Ingraham, M. G. Henderson, M. M. Meier, G. D. Reeves, and L. A. Weiss, Los Alamos National Research Laboratory

Los Alamos has had energetic–particle instruments on many Global Positioning System and geosynchronous satellites for about 2 decades. Databases for electrons and ions measured by these instruments have been created to study space weather.

12:10 PM LUNCH

CHB-3
1:35 PM

Spectral Analysis in High Radiation Space Backgrounds with Robust Fitting

G. P. Lasche, R. L. Coldwell, J. A. Nobel, and A. C. Rester, Constellation Technology Corporation; J. I. Trombka, NASA Goddard Space Flight Center

Spectral analysis software is tested for its ability to fit spectra from space. The approach, which emphasizes the background shape function, is uniquely suited to identifying weak–strength nuclides in high–radiation background environments.

CHB-4
1:50 PM

Comparison Between Predictions & Observations of Induced Radioactive Background in Interplanetary Missions

C. Dyer, P. Truscott, and H. Evans, Space Department, DERA Farnborough; L. Evans, Computer Sciences Corporation; J. I. Trombka, NASA Goddard Space Flight Center

Predictions have been made of the cosmic–ray induced radioactivity in germanium, bismuth germanate and sodium iodide and are compared with data obtained from the Mars Observer and Near Earth Asteroid Rendezvous missions.

CHB-5
2:05 PM

A Monte–Carlo Ray–Tracing Program for Modeling Scintillators

V. Gerrish, Constellation Technology Corporation

A new Monte–Carlo ray–tracing program useful for designing active scintillator shielding to reduce radiation background effects in space is described. Results are presented for a BGO anti–Compton shield and a CsI(Na) active collimator.

CHB-6
2:20 PM

Simulation of HEAO 3 Background

B. L. Graham, George Mason University; B. F. Phlips, Naval Research Laboratory/USRA; J. D. Kurfess and R. A. Kroeger, Naval Research Laboratory

Gamma–ray background in the High Resolution Gamma–Ray Spectrometer on HEAO 3 has been Monte Carlo modeled. Decay of nuclei produced by spallation of cosmic rays, trapped protons and their secondaries was included.

CHB-7
2:35 PM

The INTEGRAL Mass Model and GGOD Monte Carlo Simulation Suite

F. Lei, A. R. Green, A. J. Bird, C. Ferguson, and A. J. Dean, Physics Dept., University of Southampton

A detailed ESA INTEGRAL gamma–ray satellite mass model is being built and is used as input to the Monte Carlo program GGOD. We present the preliminary background evaluations for the two main gamma–ray instruments and discuss the background minimisation.

2:50 PM BREAK (Bedford Ballroom)

SESSION CHC
3:30 PM

DETECTORS AND DETECTOR SYSTEMS

Session Introduction

Chairman: Jeff Schweitzer, University of Connecticut and University at Albany – SUNY

CHC-1
3:35 PM

SONTRAC – A Low Background, Large Area Solar Neutron Spectrometer

C. B. Wunderer, University of New Hampshire; D. Holslin, SAIC; J. R. Macri, M. McConnell, and J. M. Ryan, University of New Hampshire

SONTRAC will measure neutrons from solar flares using scintillator fibers viewed by CCD cameras to track neutron–proton scatters. SONTRAC rejects all background radiation except neutrons from the solar direction. A prototype is operational.

CHC-2
3:50 PM

Ceramic Mercuric Iodide Semiconductor Particle Counters

M. Schieber, Hebrew University of Jerusalem and Sandia National Laboratories; A. Zuck, M. Braiman, and J. Nissenbaum, Hebrew University of Jerusalem; R. Turchetta, W. Dulinski, D. Husson, and J. L. Riester, LEPSI (ULP/IN2P3)–Strasbourg

Mercuric iodide ceramic radiation detectors, which can act as nuclear particle counters, have been fabricated with single continuous and with linear strip electrical contacts and tested with different kinds of gamma and beta sources and a high energy beam at CERN.

CHC-3
4:05 PM

Neutron Induced Backgrounds in the MIXE X–Ray Detector at Balloon Altitudes

T. W. Armstrong and B. L. Colborn, SAIC; K. L. Dietz and B. D. Ramsey, NASA Marshall Space Flight Center

The MIXE X–ray astronomy detector has experienced high backgrounds on balloon flights although well shielded against atmospheric gamma–rays and charged particles. Monte Carlo simulations show that this is due to neutron–induced backgrounds from cosmic–ray and albedo sources.

CHC-4
4:20 PM

Estimate of Brittle Fracture Effects in Sensor Systems Exposed to Heavy Cosmic Ray Ions

P. Vasilyev, A. I. Kalinichenko, and S. V. Vasilyev, Kharkiv, Ukraine

A mechanism of brittle fracture in sensor system materials from powerful thermoelastic waves generated in a heavy ion track is studied. The probability of spacecraft sensor system damage is analyzed based on the concept of a damaged zone around the ion trajectory.

CHC-5
4:35 PM

The Effectiveness of a Proportional Counter with a Specially Designed Filter as a Solar X–ray Monitor on the NEAR Mission

P. E. Clark, Catholic University; S. R. Floyd and J. I. Trombka, NASA Goddard Space Flight Center

A proportional counter with a specially designed mask/filter (PCF) to enhance sensitivity at higher energies, and a Si PIN detector (SPD), are being used to measure solar flux on the Near Earth Asteroid Rendezvous (NEAR) mission. The complementary nature of their performances is considered.

CHC-6
4:50 PM

Perspectives on Mercuric Iodide as a Radiation Detector Material for Space Measurements

V. Gerrish and L. Van den Berg, Constellation Technology Corporation

Mercuric iodide is a semiconductor detector material that operates at room temperature, has high detection efficiency, and exhibits good energy resolution over the range 5 keV to 5 MeV. Low power requirements and radiation damage resistance make it well suited for space measurements.

5:05 PM End of Tuesday Sessions

7:30 AM — REGISTRATION AND CONTINENTAL BREAKFAST
Roof Garden, Snowmass Conference Center

INVITED PAPER
SNOWMASS BALLROOM
8:15 AM

CMOS Technology Scaling, 0.1 µm and Beyond
Dr. Bijan Davari, IBM Semiconductor Research and Development Center

(see NSREC technical program for abstract and speaker biography)

SESSION CHD
MAX PARK ROOM
9:15 AM

SPACE ENVIRONMENT BACKGROUND
Session Introduction
Chairman: George Lasche, Constellation Technology Corporation

CHD-1
9:20 AM

Continuum Background in Space–Borne Gamma–Ray Detectors
L. G. Evans, Computer Sciences Corp.; J. I. Trombka, NASA Goddard Space Flight Center; R. Starr, Catholic University; W. V. Boynton and S. Bailey, University of Arizona

Measurements of the gamma–ray continuum background made during the cruise portion of a number of planetary missions are compared. The effectiveness of different shield designs in reducing background is evaluated.

CHD-2
9:35 AM

Solar Cycle Variation in the Inner Zone Proton Belt Configuration
A. L. Vampola, University Research Foundation; M. Lauriente, NASA Goddard Space Flight Center

SEU data show an inward motion of the inner zone energetic proton flux from solar maximum to minimum. This change, which is due to the change in atmospheric scale height, is not present in the AP8MIN/MAX models.

CHD-3
9:50 AM

Measurements of the Radiation Belts from MIR and STRV 1994–1997
P. Buhler, A. Zehnder, L. Desorgher, and W. Hajdas, Paul Scherrer Institute; E. Daly and L. Adams, ESA/ESTEC

Environment monitors were launched in 1994, in GTO and on MIR. GTO samples the equatorial regime; MIR the near atmospheric cut–off. The electron belt has had many injection events, including January 1997. MIR data show strong asymmetry. Results are compared with models.

10:05 AM — BREAK (Bedford Ballroom)

CHD-4
10:45 AM

New High Energy Electron Component of Earth Radiation Belt
V. V. Dmitrenko, A. M. Galper, V. M. Gratchev, V. G. Kirillov–Ugryumov, S. E. Ulin, and S. A. Voronov, Moscow Engineering and Physics State Institute

The charge ratio, spatial, pitch–angle and energy distribution of the high energy ($E_e > 10$ MeV) electron–positron component of trapped particles in Earth's radiation belt are presented. The probable mechanisms of particle generation and trapping are considered.

CHD-5
11:00 AM

Using Cross–Correlations of SEUs and AP8 as a Diagnostic Tool
A. L. Vampola, University Research Foundation; M. Lauriente, NASA Goddard Space Flight Center

We demonstrate that spurious effects (SEUs, anomalies, noise in satellite systems) can be used in a 2–D (longitude and latitude) cross–correlation to evaluate AP8 and to indicate the energy of the protons that are producing the effects.

CHD-6
11:15 AM

Gamma–Radiation Background on Board Russian Orbital Stations

V. V. Dmitrenko, A. M. Galper, V. M. Grachev, V. G. Kirillov–Ugryumov, S. V. Krivov, A. A. Moiseev, S. E. Ulin, Z. M. Uteshev, K. F. Vlasik, and Yu. T. Yurkin, Moscow Engineering and Physics State Institute

Gamma-ray background measurements on board Russian orbital missions "Salyut-6," "Salyut-7," "Mir," "Soyuz," and "Progress" have been made since 1979. The dependence of background intensity, in the energy intervals 0.1–8 MeV and 30–600 MeV, on a mission's mass, telescope orientation, and rigidity cut off are presented. The background from man–made sources on the missions was investigated.

CHD-7
11:30 AM

The Gamma–Ray Background of the Spacecraft with RTG Components Aboard

I. G. Mitrofanov, D. A. Ushakov, A. L. Alisov, and A. K. Tonshev, Space Research Institute; C. Moss and R. Reedy, Los Alamos National Research Laboratory; L. Evans, Computer Sciences Corporation

High energy background was measured on the Russian Mars '96 spacecraft which had plutonium generators. Energy spectra up to 2 MeV are presented with high spectral resolution. Main nuclear peaks are resolved, and their photon fluxes are estimated.

CHD-8
11:45 AM

Outer Zone Energetic Electron Environment Update

A. L. Vampola, Space Environmental Effects

Under ESA auspices, CRRES MEA data were used to train neural networks to predict energetic electron flux levels using 65 years of the Kp magnetic index as the input variable. A replacement environment for AE8 has been produced.

12:00 PM LUNCH

SESSION CHS
1:45 PM

SUMMARY AND DISCUSSION

G. P. Lasche, Constellation Technology Corporation; J. M. Ryan, University of New Hampshire; J. I. Trombka, NASA Goddard Space Flight Center; J. S. Schweitzer, University of Connecticut and University at Albany – SUNY

2:45 PM End of Conference

Conference Information

INDUSTRIAL EXHIBIT

This year's Industrial Exhibit will feature the leading suppliers of radiation-hardened products, related materials, and services. The exhibit will be held in the Bedford Ballroom, which is located one village level below the Snowmass Conference Center. The exhibit will be open from noon to 5:00 PM on Tuesday, July 22, and again that evening from 7:00 PM to 10:00 PM. During the Tuesday evening session, refreshments will be provided for attendees and their guests. The exhibits will be open again during the continental breakfast on Wednesday morning, July 23. The exhibits will close at 1:00 PM Wednesday. Companies wanting additional information regarding exhibits should contact Trish Snyder at (612) 954-2495 or send E-mail to snyder_trish@mn14.ssec.honeywell.com. Late registration for exhibit booth space will be accepted.

PRE-REGISTERED EXHIBITORS

Boeing Radiation Effects Laboratory
Boeing Solid-State Electronics Development
Experimental & Mathematical Physics Consultants
Harris Semiconductor
Honeywell Solid State Electronics Center
Honeywell Space Systems Division
J. L. Shepherd & Associates
Lockheed Martin Federal Systems
NASA Space Environments & Effects
NSA Microelectronics
Oerlikon-Contraves AG Space
Space Electronics Incorporated
Temic
Union Carbide Crystal Products
UTMC Microelectronic Systems

ROOMS FOR SIDE MEETINGS

Several meeting rooms are available for use by NSREC/CHERBS attendees during the conference week at The Silvertree Hotel, Wildwood Lodge, Mountain Chalet, and Stonebridge Inn. Please contact the conference registration desk adjacent to the Snowmass Ballroom to reserve a room for a side meeting. Arrangements for audiovisual equipment, refreshments, etc., can be made through the properties and are the responsibility of the attendee. Contact ETC Services, Inc. at (303) 770-2055 or send an e-mail message to ETCSVC@aol.com to make a meeting reservation in advance of the conference.

MESSAGES

(970) 923-2000 ext. 278

A message board will be located in the lobby area outside the Snowmass Ballroom for all incoming messages during the Short Course and NSREC/CHERBS Technical Sessions. Faxes can be sent and received through your hotel property. Costs associated with faxes are the responsibility of the attendee. The Silvertree Hotel has a business center.

CONTINENTAL BREAKFAST & COFFEE BREAKS

The 1997 NSREC/CHERBS will provide continental breakfast and refreshments at breaks during the Short Course and NSREC/CHERBS Technical Sessions for registered short course and technical attendees only. Continental breakfasts will begin at 7:30 AM Monday through Thursday and at 7:15 Friday in the Snowmass Conference Center Roof Garden.

RADIATION EFFECTS COMMITTEE OPEN MEETING

The IEEE Radiation Effects Committee will hold its Open Meeting in the Snowmass Ballroom from 5:00 PM to 6:30 PM on Thursday, July 24. All conference attendees are encouraged to attend the Open Meeting to 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 Committee. Nominations will be taken from the floor. All NPSS members present are eligible to vote. The newly-elected officers of the Radiation Effects Committee will be installed.

Steering Group

Chairman
Peter S. Winokur
Sandia National Laboratories

Executive Vice-Chairman
Klaus G. Kerris
Army Research Laboratory

Secretary
David W. Emily
Naval Surface Warfare Center

Treasurer
Walter M. Shedd
Phillips Laboratory

Senior Member-at-Large
James P. Frank
Honeywell, Inc.

Member-at-Large
Kenneth A. LaBel
NASA/GSFC

Junior Member-at-Large
Stephen E. Bernacki
Raytheon Company

Past Chairman
Kenneth F. Galloway
Vanderbilt University

Vice-Chairman, Publications
Daniel M. Fleetwood
Sandia National Laboratories

Vice-Chairman, Publicity
Kenneth K. Hunt
Vanderbilt University

Special Publications Assignment
Paul V. Dressendorfer
Sandia National Laboratories

RADECS Liaison
Philippe M. Calvel
Alcatel Espace

Vice-Chairman, 1996 NSREC
Charles J. Utrias
Lockheed Martin Federal Systems

Vice-Chairman, 1998 NSREC
James R. Schwank
Sandia National Laboratories

Vice-Chairman, 1999 NSREC
Ronald D. Schrimpf
Vanderbilt University

AdCom Members:

Burr C. Passenheim
Full Circle Research, Inc.

James R. Coss
Jet Propulsion Laboratory

James P. Spratt
Full Circle Research, Inc.

News from the Radiation Effects Steering Group (RESG)

The RESG welcomes Steve Bernacki of Raytheon as its newly elected Member-at-Large and Dave Emily (NSWC-Crane) as Secretary to serve a one-year term. In addition, the Chairman has appointed Ron Schrimpf of Vanderbilt University as the 1999 Nuclear and Space Radiation Effects Conference (NSREC) General Chairman. A complete listing of RESG members appears at the back of this brochure. A Nominating Committee, chaired by Kenneth Galloway of Vanderbilt University, has prepared a written ballot for the election (this Spring) of an Executive Vice-Chairman and Secretary to serve from 1997 to 2000. Klaus Kerris will become the new Chairman of the Radiation Effects Committee for that same period. The new slate of officers will be installed during the Open Meeting on Thursday evening of the conference.

At its Fall Meeting in Snowmass Village, CO, the RESG reviewed the 1996-1999 NSRECs. The 1996 IEEE NSREC was extremely successful. The conference was attended by 454 engineers, scientists, and industry business professionals from throughout the world representing 15 countries. Due to proximity to the LA/San Diego area, industrial participation increased by 50 and overall attendance was up by 75! Over one hundred papers presented at the conference were published in the December Issue of the *IEEE Transactions on Nuclear Science*. We are indebted to our Guest Editors (Editor: Art Campbell, Naval Research Laboratory; Associate Editor: Lloyd Massengill, Vanderbilt University; Assistant Editor: Fred Sexton, Sandia National Laboratories) who worked tirelessly with reviewers and authors to produce this high-quality journal. A Radiation Effects Data Workshop, chaired by Scott Tyson (Mission Research Corporation), was held during the conference. Sixteen data-intensive papers were published in the *1996 IEEE Radiation Effects Data Workshop Record* which is available from the IEEE Service Center (1-800-678-IEEE). Additional highlights of the 1996 NSREC include: (1) 67 registrants joined IEEE and NPSS, (2) advertisement of conference programs, planning, and activities on the WWW, and (3) an unforgettable "Evening With The Phantom."

Dennis Brown, General Chairman of the 1997 NSREC, reviewed final plans for the upcoming Snowmass Village (at Aspen) Conference. Many details of the 1997 NSREC are contained in this program booklet. The 1997 NSREC will be co-located with CHERBS, the Conference on High-Energy Radiation Background in Space, with an expected CHERBS attendance of 50-60. CHERBS is focused on radiation background effects interfering with weak spacecraft signals and planetary radiation environments. The subject matter will no doubt be of interest to NSREC attendees and the schedules of the two conferences have been arranged to provide ample time for technical discussions and informal gatherings. We welcome the organizers of CHERBS — namely, Jack Trombka and Pam Solomon of NASA GSFC, Jeff Schweitzer of the University at Albany - SUNY, and George Lasche of Constellation Technology Corporation — and look forward to continued interactions.

Jim Schwank, General Chairman of the 1998 NSREC, discussed preliminary plans for his conference which will be held in Newport Beach, CA, on July 20-24, 1998. Jim is joined by Lloyd Massengill as Technical Program Chairman, Gary Lum as Local Arrangements Chairman, and Marty Shaneyfelt as Finance Chairman.

Please visit our Web site at http://www.ieee.org/nps/nsrec/nsrec.html. This is the best place to get information about this year's and future NSRE conferences. The site gets 300 hits a month! Our thanks to Dale Platteter, who is our very own webmeister.

The Steering Group is dedicated to sustaining NSREC as a high quality technical conference that offers attendees many opportunities for technical interchange, both formal and informal. We believe that the NSREC has been an important and valuable event for the radiation effects community and continues to be the premier radiation effects conference in the U.S. We welcome your input and suggestions.

Peter S. Winokur
Chairman

Klaus G. Kerris
Executive Vice Chairman

Awards

1996 OUTSTANDING PAPER AWARD

Radiation Effects at Low Electric Fields in Thermal, SIMOX, and Bipolar–Base Oxides

D. M. Fleetwood, L. C. Riewe, and J. R. Schwank, Sandia National Laboratories; S. C. Witczak and R. D. Schrimpf, University of Arizona

1996 MERITORIOUS PAPER AWARDS

Enhanced Damage in Bipolar Devices at Low Dose Rates: Effects at Very Low Dose Rates

A. H. Johnston, C. I. Lee, and B. G. Rax, Jet Propulsion Laboratory

Accelerated Tests for Simulating Low Dose Rate Gain Degradation of Lateral and Substrate PNP Bipolar Junction Transistors

S. C. Witczak, R. D. Schrimpf, K. F. Galloway, and D. M. Schmidt, University of Arizona; D. M. Fleetwood, Sandia National Laboratories; R. L. Pease, RLP Research; W. E. Combs, NSWC–Crane; J. M. Puhl and J. S. Suehle, NIST

1996 DATA WORKSHOP PAPER AWARDS

Radiation Effects in Analog CMOS Analog–to–Digital Converters

T. L. Turflinger, M. V. Davey, and J. P. Bings, NSWC–Crane

A Compendium of Recent Total Dose Data on Bipolar Linear Microcircuits

R. L. Pease, RLP Research; W. E. Combs, NSWC–Crane; A. H. Johnston, Jet Propulsion Laboratory; T. Carrière, Matra Marconi Space; S. McClure, Hughes Space and Communications

IEEE FELLOW

One member of the radiation effects community was elected to the grade of IEEE Fellow on January 1, 1997.

Daniel M. Fleetwood
Sandia National Laboratories

A certificate will be presented to Dr. Fleetwood during the conference opening on Tuesday, July 22.

RADIATION EFFECTS AWARD

Nominations are currently being accepted for the 1998 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 IEEE NSREC at Newport Beach, California in July 1998. Nomination forms or additional information can be obtained from Ken LaBel, Senior Member–at–Large for the Radiation Effects Steering Group. Mr. LaBel can be contacted at (301) 286–9936, facsimile (301) 286–1718, or E–mail: ken.label@gsfc.nasa.gov.

Registration and Travel

NSREC/CHERBS CONFERENCE INTEGRATION

This year's NSREC is being held in collaboration with the 2nd Conference on High Energy Radiation Background in Space (CHERBS). CHERBS will be held as a workshop on Tuesday and Wednesday in parallel with the first two days of NSREC technical sessions. There will be a common registration for NSREC and CHERBS. Persons registered for the CHERBS workshop may freely attend all NSREC technical sessions or workshops, and persons registered for the NSREC may freely attend all CHERBS technical sessions or workshops. If space in any technical session or workshop becomes limited, attendees are encouraged to give preference for seating to the registrants of whichever conference is sponsoring that session. The NSREC Short Course on Monday, July 21, has been designed to be useful to both NSREC and CHERBS attendees, and the technical programs of the conferences have been scheduled to minimize overlap on topics of mutual interest. The majority of the CHERBS presentations will be published in an IEEE Conference Record. All attendees to NSREC and CHERBS will receive the publications from both conferences. The conferences will share a common social program and Industrial Exhibit.

CONFERENCE REGISTRATION

To pre-register for NSREC or CHERBS, complete the conference registration form enclosed in this booklet. Please note that the registration fees are higher if payment is received after June 20, 1997.

ETC Services, Inc.
7731 South Cove Circle
Littleton, CO 80122
(303) 770–2055
Fax: (303) 741–5890

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 7 days prior to the Conference, or arrangements should be made to hand carry fees for on-site registration. Telephone registrations will not be accepted.

Registration fees should be made payable to the "1997 IEEE NSREC" and must be in U. S. funds only. Advance payment of registration and activity fees should be by one of the following: (1) check made out in U. S. dollars and drawn on a domestically-located bank, (2) U. S. Money Order, or (3) Mastercard, VISA, or American Express credit card. An additional 5% charge will be added to the registration and activity fees for credit card payments.

On-site registration for the Conference will be conducted at the Registration Office on the first floor of the Snowmass Conference Center on the following schedule:

Sunday, July 20	4:00 PM – 9:00 PM
Monday, July 21	7:30 AM – 5:00 PM
	7:00 PM – 10:00 PM
Tuesday, July 22	7:30 AM – 5:00 PM
Wednesday, July 23	7:30 AM – 3:00 PM
Thursday, July 24	7:30 AM – 3:00 PM
Friday, July 25	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 July 1, 1997, 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 (303) 741-5890.

HOTEL RESERVATIONS

(800) 598–2004
or (970) 923–2010
FAX: (970) 923–4260

The 1997 IEEE NSREC will be held at the Snowmass Conference Center in Snowmass Village, Colorado. NSREC attendees have the choice of four different properties, while CHERBS attendees have one conference hotel. In most of the properties, a block of rooms is available at the prevailing Government rate plus tax for U. S. government attendees. The rate is available only for U. S. Government civilian or military personal *with proof of Government employment*. All hotels are extending conference rates from July 17 through July 27. Reservations must be guaranteed and accompanied by a deposit prior to arrival. Please read the descriptions below, as the deposit policy varies by property. All properties have a common cancellation policy. If you cancel 14 days prior to arrival, you will receive a full refund, less a $25 cancellation fee. If you cancel less than 14 days prior to arrival, you forfeit your entire deposit, however, if the room is re–rented you forfeit only the $25 cancellation fee.

To make reservations for any of the conference properties, call 1–800–598–2004 and ask for the "NSREC" or "CHERBS" block of rooms. **The cut–off date for room reservations is June 17, 1997. After June 17, room accommodations will be confirmed on a space–available basis only, and the conference rate cannot be guaranteed.** Please book early!

NSREC PROPERTIES

The Silvertree Hotel

Located adjacent to the Conference Center, The Silvertree Hotel offers an unforgettable mountain getaway! Offering three restaurants and a nightclub, it has two pools and hot tubs, a sauna, steam room, and a full service health club. All rooms include coffee makers, mini–refrigerators, and hair dryers. RATE: $98.00 plus tax, double–occupancy. Children under 12 are free, $25.00 each additional person (no Government rate offered). One night's lodging is due 14 days from reservation; 150 rooms are available.

Wildwood Lodge

Located adjacent to the Conference Center, the Wildwood Lodge offers a pool and hot tub nestled amongst the aspens. All rooms include coffee makers and mini–refrigerators. RATE: $85.00 plus tax (Corporate), $82.00 plus tax (Government per diem), double–occupancy. Children under 12 are free, $25.00 each additional person. One night's lodging is due 14 days from reservation; 100 rooms are available.

Mountain Chalet

Centrally located near the Village Mall and across from the NSREC Exhibits, Mountain Chalet extends the warmth and comfort of a mountain ski lodge. Full hot complimentary breakfasts are served daily, and all rooms have mini–refrigerators and coffee makers. The hotel also has a pool and hot tub. RATE: $83.00 plus tax (Corporate), $82.00 plus tax (Government per diem), double–occupancy. Children under 12 are $5.00, $10.00 each additional person. One night's lodging is due upon booking; 45 rooms are available.

Stonebridge Inn

Within a short walk from the Conference Center, the Stonebridge Inn's newly remodeled lobby, restaurant, and lounge will be a welcome spot to greet fellow attendees. Complimentary continental breakfasts are served daily, and all rooms have mini–refrigerators and coffee makers. The hotel has a pool and hot tub. RATE: $82.00 plus tax, double–occupancy. Children under 12 are free, $10.00 each additional person. $50.00 is due upon booking; 80 rooms available.

CHERBS PROPERTY

Wildwood Lodge

Located adjacent to the Conference Center, the Wildwood Lodge offers a pool and hot tub nestled amongst the aspens. All rooms include coffee makers and mini–refrigerators. RATE: $85.00 plus tax (Corporate), $82.00 plus tax (Government per diem), double–occupancy. Children under 12 are free, $25.00 each additional person. One night's lodging is due 14 days from reservation; 50 rooms are available.

The Silvertree Hotel

Wildwood Lodge

Mountain Chalet

Stonebridge Inn

Photographs courtesy of Snowmass Resort Association

TRANSPORTATION TO SNOWMASS

The Sardy Field Aspen Airport accommodates the needs of recreational and business travelers to the Aspen/Snowmass valley area. Nonstop air service is currently available through the Denver, Colorado Springs, and Dallas/Fort Worth airports. Check with your travel agent as flight availability varies seasonally. The Aspen Airport is located approximately 8 miles from Snowmass.

You can help the NSREC control costs by having your travel agent include the conference discount codes when making reservations with United Airlines. Note that it is not necessary to use the conference negotiated rates to have your travel agent include the reference number.

Airline Discount

United Airlines, in cooperation with the IEEE NSREC, is offering special discounts to the conference. Rates are based on published round-trip fares within the United States and Canada.

- Travel dates are between July 17 and July 27, 1997. Destinations are Aspen, Denver, and Colorado Springs airports.
- A 5% discount off any United/United Express published fare in effect when tickets are purchased, subject to all applicable restrictions.
- A 10% discount off any United/United Express "BUA" fares in effect when tickets are purchased.

To take advantage of these discounts, call United, or have your travel agent call, at (800) 521-4041 for reservations between 7:00 AM and 1:00 AM EST daily. **Reference ID# 565UR for IEEE/NSREC**.

Transportation from Aspen Airport

All NSREC/CHERBS properties (The Silvertree Hotel, Wildwood Lodge, Mountain Chalet, and Stonebridge Inn) have complimentary airport transportation to and from the Aspen Airport. Please call your property from the airport courtesy phone to make arrangements.

Driving Directions from Denver/Glenwood Springs

From Denver, take I-70 West to Glenwood Springs (about 160 miles), and then take Highway 82 East to Aspen/Snowmass. Basically, from Glenwood Springs to the Snowmass Village turn (Brush Creek Road), you follow Highway 82 East all the way. Follow Highway 82 East signs all the way through Glenwood Springs, Carbondale, El Jebel, and Basalt. After passing Basalt (about 25 miles), you will pass "Old Snowmass" (on your right you will see a Conoco gas station). When Highway 82 East becomes two lanes, stay in the right lane and follow to the stop light. Take a right turn at the stop light onto Brush Creek Road. The total distance from Glenwood Springs is about 30 miles.

Follow Brush Creek Road all the way into Snowmass Village. When entering the Village, you'll see signs for "Upper Village" and the Conference Center – this is the road you want. When pulling into the Upper Village, stay right (you'll see signs for lots 7, 8, and 9). The Silvertree is located on the left on Elbert, next to the Conference Center.

For your assistance, maps of the area are located inside the front cover and on both sides of the back cover of the brochure.

1997 IEEE NSREC/CHERBS 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 _____

HOTEL INFORMATION

At which hotel will you be staying?
(for information only, registrees must make their own arrangements)

☐ Silvertree Hotel ☐ Mountain Chalet ☐ Stonebridge Inn
☐ Wildwood Lodge ☐ Other _____

IEEE MEMBERSHIP

☐ I am an IEEE Member. _____
Membership Number

Nonmembers must register at the nonmember 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 July 1, 1997, cannot be guaranteed. Consideration of requests for refunds will be processed after the conference.

Mail or FAX this form and your remittance (payable to 1997 IEEE NSREC) to:

ETC Services, Inc.
7731 South Cove Circle
Littleton, CO 80122
Telephone: (303) 770-2055
FAX: (303) 741-5890

REGISTRATION FEES

(Late fee REQUIRED if payment received after June 20, 1997)

For which conference are you registering? (check only one)

☐ **NSREC** ☐ **CHERBS**

	Early	Late	
IEEE Member			
Short Course	$225	$250	$ _____
Technical Sessions	$275	$350	$ _____
Non-IEEE Member			
Short Course	$275	$300	$ _____
Technical Sessions	$375	$450	$ _____
Full-Time Students who are IEEE Members			
Short Course	$100	$100	$ _____
Technical Sessions	$100	$100	$ _____

Total Amount Enclosed for Registration: $ _____
Add 5% if Credit Card Payment: $ _____
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: **1997 IEEE NSREC**

☐ Charge registration fees plus 5% to my credit card using one of the following credit cards:

☐ American Express ☐ Master Card ☐ Visa

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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.**

1997 IEEE NSREC/CHERBS 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 _____

HOTEL INFORMATION

At which hotel will you be staying?
(for information only, registrees must make their own arrangements)

☐ Silvertree Hotel ☐ Mountain Chalet ☐ Stonebridge Inn
☐ Wildwood Lodge ☐ Other _____

IEEE MEMBERSHIP

☐ I am an IEEE Member. _____
Membership Number

Nonmembers must register at the nonmember 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 July 1, 1997, cannot be guaranteed. Consideration of requests for refunds will be processed after the conference.

Mail or FAX this form and your remittance (payable to 1997 IEEE NSREC) to:

ETC Services, Inc.
7731 South Cove Circle
Littleton, CO 80122
Telephone: (303) 770-2055
FAX: (303) 741-5890

REGISTRATION FEES

(Late fee REQUIRED if payment received after June 20, 1997)

For which conference are you registering? (check only one)

☐ **NSREC** ☐ **CHERBS**

	Early	Late	
IEEE Member			
Short Course	$225	$250	$ _____
Technical Sessions	$275	$350	$ _____
Non-IEEE Member			
Short Course	$275	$300	$ _____
Technical Sessions	$375	$450	$ _____
Full-Time Students who are IEEE Members			
Short Course	$100	$100	$ _____
Technical Sessions	$100	$100	$ _____

Total Amount Enclosed for Registration: $ _____
Add 5% if Credit Card Payment: $ _____
TOTAL AMOUNT ENCLOSED: $ _____

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Social Program

The 1997 NSREC Committee will provide a program that gives you and your companions a taste of the history, natural beauty, and entertainment found in the Snowmass/Aspen area. We strongly encourage early registration for the social events; note that the number of tickets available for each event is limited. **Late fees apply if payment is received after June 20, 1997.** Children must be accompanied by an adult during all tours and social events.

Sunday, July 20
6:00 PM – 8:00 PM
Short Course Reception

Please join us for light refreshments in the Snowmass Conference Center Roof Garden. Enjoy the panorama of the Snowmass valley while renewing old acquaintances. The registration desk will be open from 4:00 PM to 9:00 PM, so take advantage of this opportunity to register early! Feel free to explore the Conference Center.

Monday, July 21
7:00 PM – 10:00 PM
Mozart in the Mountains
Conference Reception

In the Snowmass Conference Center Ballroom, conference attendees and their families and guests will be transported to 18th century Europe to enjoy the melodies of Mozart. From 7:00 PM to 10:00 PM enjoy a complimentary buffet of Italian pasta, salads, vegetables, and rich desserts. Guests will enjoy the views of the mountains from the Conference Center's Roof Garden, where a classical trio will play. We're sure Mozart would be pleased to hear his music in the splendor of the Rocky Mountains and would encourage your attendance. A child care program will be provided in The Silvertree Hotel for pre-registered children, adjacent to the Conference Center (see below for details). Dress is casual.

Tuesday, July 22
9:00 AM – 2:00 PM
Brunch at the Hotel Jerome
Companion Event

Jerome Wheeler, Aspen's most famous gold miner, invites you to brunch at his Hotel – the Jerome. Built in 1889, the Hotel Jerome has been restored to its Victorian splendor. Brunch will be served in the stately appointed Century Room and we promise you a rich and elegant experience. After brunch, feel free to shop in Aspen's many boutiques and galleries. The bus will depart from the Snowmass Conference Center front entrance at 9:00 AM and will leave the Hotel Jerome at 2:00 PM. Shorts are not recommended. Adults/Children (Ages 0–12): $22 (Early)/$25 (Late).

Photograph courtesy of the Hotel Jerome

Wednesday, July 23
6:00 PM – 10:30 PM
Rock 'n' Roll Rodeo
Conference Social

The West is famous for its rodeos! Be at the Snowmass Conference Center and Roof Garden to see rodeo, rock 'n' roll style. There will be a trick roper, who will give lessons to the cow-poke at heart, and a magician to entertain. Refreshments will start at 6:00 PM in the Roof Garden. A sit-down dinner of elegant Cowboy chow (salad, steak and shrimp, and vegetables) will be served at 7:00 PM in the Snowmass Ballroom. Children 12 and under will dine on jello salad, a hot dog, veggies, and chips. The finale is Colorado Mud Pie! After dinner, dance to a rock 'n' roll band until the cows come home, or 10:30 PM, whichever is first! Retire to the Roof Garden for an after-dinner drink. Dress is casual. Adults: $25 (Early)/$28 (Late), Children (Ages 4–12): $5 (Early)/$5 (Late). Children under 4 years old are free.

Thursday, July 24
9:15 AM – 2:00 PM
Redstone Castle Tour
Companion Event

Redstone's Castle, Cleveholm Manor, is set in the majestic Crystal River Valley. You will be transported by bus (45 minutes) to this turn-of-the-century 42-room mansion. The Manor was completed in 1900 and offers the chance to experience the great life of a grand era. The tour of the castle will be first, followed by an opportunity to stroll through the town of Redstone. There are galleries, shops, and restaurants to explore. Lunch is on your own. The bus will depart from the Snowmass Conference Center front entrance at 9:00 AM and will depart for Snowmass at 2:00 PM. Casual dress and shoes recommended. Adults: $22 (Early)/$25 (Late), Children: (Ages 4–12) $15 (Early)/$18 (Late). Children under 4 years old are free.

Photograph copyright John McEvoy

WEATHER AND CLOTHING

"If you don't like the weather, wait 5 minutes and it will change" is the adage in the Rocky Mountains! Temperatures are about 75 degrees Fahrenheit (24 degrees Celsius) in July, but remember you are at an elevation of 8300 feet (2500 meters). The sun is stronger so remember your hat, sunblock, and chapstick. Expect daily afternoon rain showers. Dressing casual in layers is best. Please drink plenty of water and go easy on caffeine and alcohol until you are acclimated to the elevation.

CHILD CARE

Child care will be provided for the "Mozart in the Mountains" Conference Reception on Monday, July 21 for children ages 0–10. This will be available at no charge for those who pre-register their children by June 20, 1997, and will be held in the Elbert Room on the lower level of the Silvertree Hotel from 7:00 PM to 10:00 PM. A pizza dinner will be provided; please bring infant food and accessories. Space is limited, so register early. Please contact your hotel's front desk for child care referrals at other times during your stay.

ACTIVITIES CANCELLATION POLICY

To encourage advance 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. To receive a refund if your plans change after your activities registration form is submitted, you must notify ETC Services by FAX at (303) 741-5890 (do not FAX changes after Thursday, July 17) or notify the conference desk when picking up your registration materials **(but no later than 24 hours before the scheduled activity)**.

Local Activities

Free Activities

Snowmass Village offers the following activities. Meeting sites will be announced and posted at NSREC/CHERBS.

Guided nature hikes – 10:00 AM daily
Anderson Ranch tour (Art and photography studio/school) – 4:00 PM Monday
Fly fishing clinic – 5:00 PM Monday
Arts & Imagination workshop for children – 3:00 PM Tuesday/Thursday/Friday
Mountain bike clinic – 1:00 PM Wednesday

Chairlift rides are available daily between 8:30 AM and 4:30 PM at a cost of $8.00.

Events

Saturday, July 19: Snowmass Porsche Festival at the Snowmass Village Mall
Thursday, July 24: Snowmass Summer of Music will present a free evening concert at the Fanny Hill Amphitheater, Snowmass Village Mall. Performers to be announced.
Saturday, July 26: Snowmass Rocky Mountain Brewer's Festival, Snowmass Village Mall

Shopping

Snowmass is reminiscent of a European village, even though it is only 30 years old. The Snowmass Village Mall has over 50 shops and restaurants. Located nearby, Aspen offers a myriad of upscale shopping opportunities.

Outdoor Activities

Enjoy the Rocky Mountains while in Snowmass and see the beautiful backcountry landscape. River rafting, hiking, jeep tours, horseback rides, ballooning, fishing, and mountain biking – there are numerous ways to take in the scenery! Call (800) 759–3939 to obtain further information on tours.

Photograph courtesy of Snowmass Resort Association

Maroon Bells

The famous Maroon Bells of the Rockies are located 15 miles from Snowmass. The most photographed peaks in Colorado have trails for the novice to experienced hiker. You may drive to the Bells before 8:00 AM and after 5:30 PM. Between 8:30 AM and 4:00 PM, the Bells can only be reached by catching buses in Aspen.

Aspen Historical Society

From hunting territory to mining city, through the "Quiet Years" as an agricultural center, to the present, the history of Aspen can be seen at the Aspen Historical Society at 620 West Becker Street.

Aspen Center for Environmental Studies

Experience the wild side of Aspen at the Hallam Lake Nature Preserve. See free lectures, captive owls, eagles and hawks, and the "Little Naturalist" program. Walk around Hallam Lake and watch birds. The preserve is located behind the Aspen Post Office at 100 Puppy Smith Street. (970) 925–5756.

Aspen Music Festival

The internationally renowned summer Festival and School present the 50th summer season with nine weeks of daily events ranging from orchestra, operas, and chamber music to jazz and children's concerts. For more information call (970) 925–3254.

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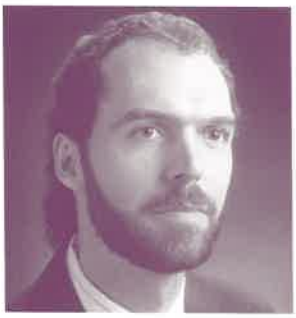

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ANNOUNCEMENT AND FIRST CALL FOR PAPERS

1998 IEEE NUCLEAR AND SPACE RADIATION EFFECTS CONFERENCE

Short Course and Radiation Effects Data Workshop

NSREC

July 20–24, 1998

Newport Beach Marriott Hotel and Tennis Club

Newport Beach, California

The 1998 IEEE International Conference on Nuclear and Space Radiation Effects will be held July 20–24 in Newport Beach, California at the Newport Beach Marriott Hotel and Tennis Club. The Conference features a technical program consisting of eight to ten sessions of contributed papers describing the latest observations in radiation effects, an up-to-date Short Course on radiation effects offered on July 20, a Radiation Effects Data Workshop, and an Industrial Exhibit. The technical program includes oral and poster sessions. In order to allow maximum participation by attendees, no parallel sessions will be scheduled.

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
- Radiation transport, energy deposition, and dosimetry
- Processing-induced radiation effects

Radiation effects on electronic and photonic devices and circuits

- MOS, bipolar, and III-V technologies
- SOI and SOS technologies
- Optical and optoelectronic sensors and transmitters
- Methods for hardened design and manufacturing
- Modeling of devices, circuits, and systems
- Particle detectors and associated electronics for high-energy accelerators
- Cryogenic temperature effects
- Novel device structures

Space radiation effects

- Single-event phenomena in devices and circuits
- Modeling of space radiation environments
- Spacecraft charging

Hardness assurance technology and testing

- Testing techniques, guidelines, and hardness assurance methodology
- Radiation exposure facilities

New developments of interest to the radiation effects community

Papers in the areas of "Commercial Space Systems & Environments" and "Radiation Effects in Emerging Technologies" are especially encouraged.

IEEE

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PAPER SUMMARY DEADLINE: FEBRUARY 4, 1998

Procedure for Submitting Summaries:

Authors must conform to the following requirements:

1. Send 12 copies (no facsimile or e-mail submissions, please) of (a) an abstract no longer than 35 words attached to (b) an informative summary (appropriate for a 12-minute presentation). The summary must furnish sufficient details to permit a meaningful review and clearly indicate (a) the purpose of your work, (b) significant results, and (c) how your work advances the state of the art.

2. The summary should be no less than two nor more than four pages in length, including figures and tables. *All figures and tables must be large enough to be clearly read.* Note that this is more than an abstract, but *do not exceed four pages.*

3. Type your summary using 11 point or greater type on either U. S. Standard, 8.5 in. (21.6 cm) x 11 in. (27.9 cm), or A4, 21 cm x 29.7 cm, white paper, with 1 in. (2.5 cm) margins on all four sides. Please include title, names and company affiliations of the authors, and company address (city and state). Underline the name of the author presenting the paper.

Summaries (12 copies) must be received by February 4, 1997.

Address them to:

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IEEE/NSREC Technical Chairman

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Department of
Electrical and Computer Engineering
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Nashville, Tennessee 37212
(615) 343-~~6018~~ 6771

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, and telephone and FAX numbers 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.

Papers accepted for oral or poster presentation at the Conference will be eligible for publication in the Conference issue of the *IEEE Transactions on Nuclear Science* (December 1998), 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 Proceedings and are not candidates for publication in the Conference issue of the *IEEE Transactions on Nuclear Science*.

Newport Beach: Possessing a charming and relaxing atmosphere, Newport Beach is located along the beautiful Pacific Ocean in Orange County, California. The city is nestled south of Los Angeles, north of San Diego and southwest of Disneyland in Anaheim, and adjacent to John Wayne/Orange County Airport. The Mediterranean climate of balmy days and cool evenings provides a perfect year-round backdrop for an exciting IEEE NSREC conference and a family vacation. Surrounded by one of the largest small-boat harbors in the world and lazily stretching itself along more than six miles of scenic Pacific coastline, you'll soon discover why Newport Beach is called "The Colorful Coast."

Orange County and the Greater Los Angeles Area provide an unsurpassed assortment of recreational and educational opportunities for you and your family. The weather in July is extremely pleasant, and the area offers a variety of ways to enjoy the sun and the sea. Disneyland, Universal Studios, and other theme parks are located nearby, as are many museums (Huntingdon and the Nixon Libraries). The California Angels and Los Angeles Dodgers baseball teams make the area their home, and there are various movie and television studios, superb shopping centers, and countless fine restaurants. Fashion Island, a veritable shopper's paradise, is located immediately adjacent to the Conference Hotel.

The Newport Beach Marriott Hotel and Tennis Club, our conference hotel, is approximately fifteen minutes from the Orange County Airport, and about one hour from the Los Angeles International Airport. Rental cars, public transportation, and airport shuttle-buses make Newport Beach easily accessible for both domestic and international travelers. More extensive information on attractions, entertainment possibilities, and transportation can be found at Newport Beach's excellent World Wide Web location:

http://newportbeach.com/nb_home.html

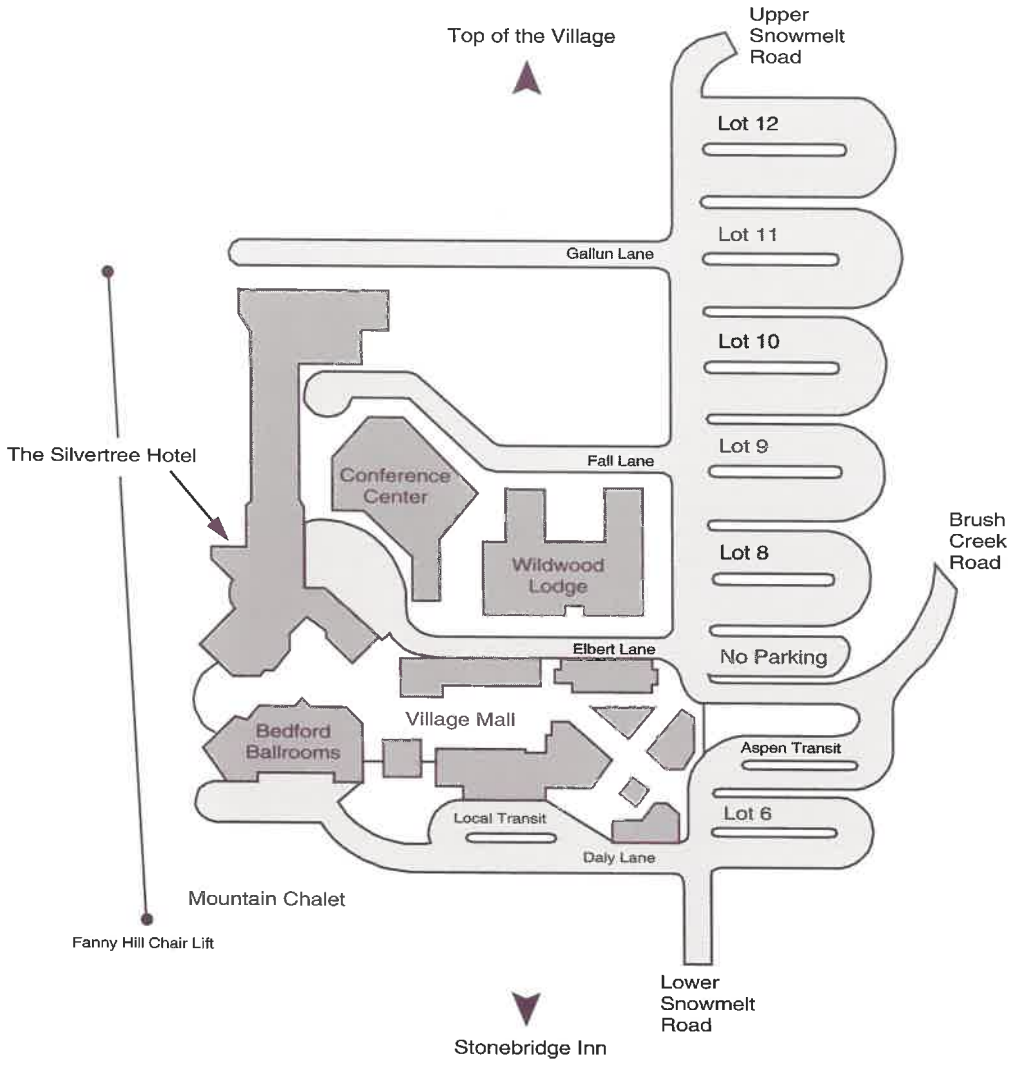
Come to NSREC '98 and make your visit to Newport Beach an extended vacation for your entire family!

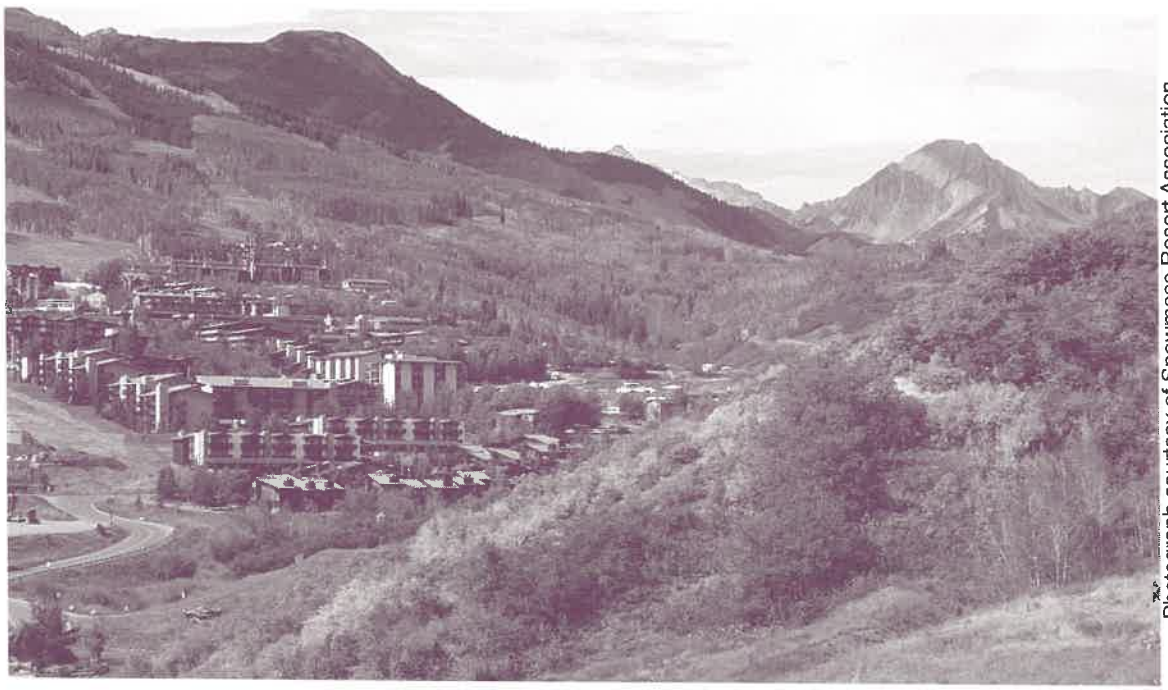
For the latest information on the 1998 NSREC as it becomes available, visit our site on the World Wide Web:

http://www.ieee.org/nps/nsrec/nsrec.html

Photograph courtesy of the Newport Beach CVB

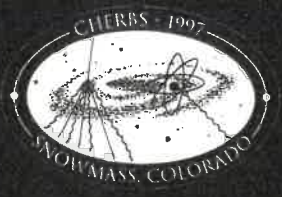
Snowmass Village





Photograph courtesy of Snowmass Resort Association

Snowmass Village



Snowmass Conference Center
Wildwood Lodge
Parking
The Silvertree Hotel
Bus Station
Parking
Mountain Chalet
Stonebridge Inn
Snowmelt Road
Brush Creek Road
Parking
Parking
Wood Road
Snowmass Medical Center
Conoco Station
Snowmass Center
Far Away Road
Owl Creek Road
Brush Creek Road
To Highway 82, Aspen