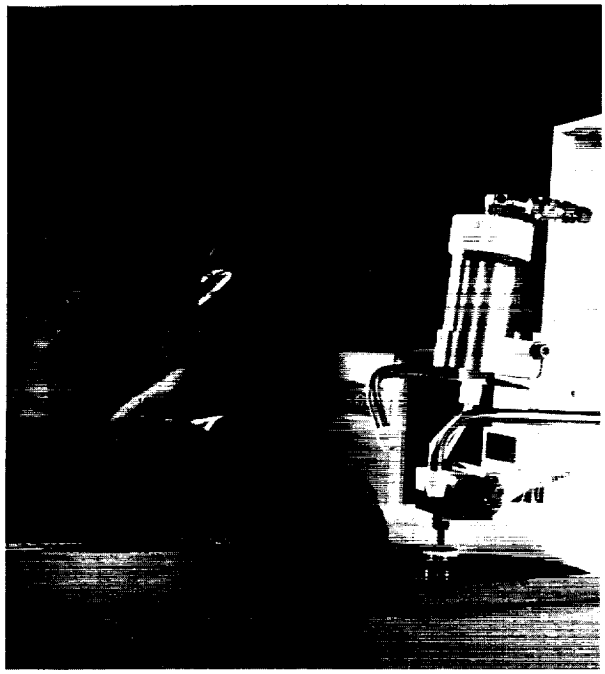
JPL Publication 93-27

Center for Space Microelectronics Technology

1992 Technical Report



November 1, 1993

NASA
National Aeronautics and Space Administration

Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

C S M T

Center for Space Microdevices Technology
Jet Propulsion Laboratory

In the Microdevices Laboratory, patterns are developed in photoresist after it has been deposited on a silicon wafer. Through electron-beam lithography, electrons are used to "expose" the photoresist, thereby creating microdevice structures as narrow as 10 nanometers in width.

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The research described in this publication was carried out by the Jet Propulsion Laboratory, California Institute of Technology, and was sponsored by the National Aeronautics and Space Administration, Ballistic Missile Defense Organization/ Innovative Science and Technology Office, Defense Advanced Research Projects Agency, U. S. Army, U. S. Navy, U. S. Air Force, and U. S. Department of Energy.

Abstract

The 1992 Technical Report of the Jet Propulsion Laboratory Center for Space Microelectronics Technology summarizes the technical accomplishments, publication, presentation, and patents of the center during the past year. The report lists 187 publications, 253 presentations, and 111 new technology reports and patents.

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Director's Report

The Center for Space Microelectronics Technology (CSMT) was founded in 1987 at the Jet Propulsion Laboratory (JPL) of the California Institute of Technology (Caltech). The National Aeronautics and Space Administration (NASA) and several Department of Defense agencies with space mission responsibilities established CSMT in order to create a critical-mass program in space microelectronics with world-class facilities, equipment, and staff.

The Center concentrates on innovative high-risk, high-payoff concepts and devices with the potential to enable future space missions and to significantly enhance current and planned missions. CSMT conducts research and development in four technical areas: solid-state devices, photonics, custom microcircuits, and advanced computing. Research and development are pursued through proof-of-concept demonstration, and successes are transferred to engineering development in government laboratories and industry.

CSMT focuses on those aspects of microelectronics and advanced computing that are unique to space applications. These areas of focus include sensors for those portions of the electromagnetic spectrum that are not accessible from Earth because the atmosphere is opaque; microinstruments and microelectronic systems for miniature spacecraft; and high-performance computing for mission data analysis and visualization.

After six years, CSMT has gained national recognition for its efforts in the following areas:

- Microsensors and microinstruments
- Electron tunneling
- Terahertz (submillimeter) technology
- Concurrent (massively parallel) computing
- Neural networks
- Silicon-compatible infrared detectors

CSMT also has significant programs in:

- Acousto-optical tunable-filter spectrometers
- Semiconductor lasers
- Long-wavelength infrared detectors

In addition, CSMT is investing in these areas for future applications:

- Nanometer devices
- Optoelectronic integrated circuits
- Innovative materials
- Sensor readout electronics
- Binary/diffractive optics
- Ultraviolet and X-ray CCDs

Policy guidance and program oversight for the Center are provided by the CSMT Board of Governors.

As of January 1993, the members of the CSMT Board of Governors were:

- Dr. Edward Stone, Director, JPL, Chairman
- Dr. Fenton Carey, Director, Office of Space, Department of Energy
- Dr. Gary Denman, Director, Defense Advanced Research Projects Agency
- Dr. Dwight Duston, Director, Ballistic Missile Defense Organization/Innovative Science and Technology Office
- Dr. Thomas Everhart, President, Caltech
- Dr. Lennard Fisk, Associate Administrator, Office of Space and Science Applications, NASA
- Col. David Jackson, Director, Army Space Technology and Research Office
- Dr. Paul Jennings, Vice President and Provost, Caltech
- Mr. Gregory Reck, Acting Associate Administrator, Office of Advanced Concepts and Technology, NASA
- Dr. Robert White, Undersecretary for Technology, U.S. Department of Commerce

The CSMT Scientific Advisory Board, comprised of seven world-renowned scientists, reviews the technical program and provides advice to the Board of Governors and CSMT Director. The remainder of this Director's Report summarizes the last year's achievements on the technical, programmatic, and institutional fronts.

TECHNICAL HIGHLIGHTS

The key accomplishments of CSMT scientists and engineers during the past years were as follows:

- **Ultraviolet CCD Detectors.** CSMT personnel extended the response of a commercial 512 x 512-pixel CCD to 100 nm in the ultraviolet. This was accomplished by using molecular beam epitaxy to incorporate a delta-doped layer, which prevents carrier recombination on the surface.

- **Ultrahigh-Frequency Capacitive Microseismometer**. CSMT staff developed a miniature seismometer that has nano-g sensitivity and weighs less than 200 grams. A prototype seismometer, which could be used on a Mars mission, has been installed and has successfully measured earthquakes.

- **Submillimeter Sensor Technology**. Niobium-based superconductor-insulator-superconductor mixers have been successfully demonstrated in quasi-optical receivers at 547 GHz and at 640 to 665 GHz using waveguides. The receiver noise temperatures of 120-250 K set new record lows in all these applications. The ground and airborne telescope-based receivers were used to acquire astrophysical data.

- **Submillimeter Flight Science**. The Microwave Limb Sounder flying on the Upper Atmosphere Research Satellite has mapped ozone depletion over Europe as well as Antarctica. The 205-GHz heterodyne receiver continues to operate without problems.

- **Semiconductor Lasers**. The world's first continuous-operation 1.43- and 2.1-μm semiconductor lasers were demonstrated. These InGaAs/ InGaAsP lasers are being developed for lidar and spectroscopy applications to detect CO_2 and N_2O gases.

- **Long-Wavelength Infrared Detectors**. A GaAs-based quantum well detector, developed jointly by AT&T, the U.S. Army Research Laboratory, and JPL, had a measured detectivity of 2×10^{10} at 15 μm and 60 K. This detector has potential application on NASA's Earth Observing System.

- **Space Environmental Effects**. Two flight experiment boxes were delivered to the Ballistic Missile Defense Organization (BMDO). The experiments, scheduled to fly on BMDO's Clementine mission in 1994, will measure the effects of space radiation on advanced CMOS circuitry, charge-coupled devices, and static random-access memory.

- **Micro-Weather Station**. CSMT demonstrated new micromachined silicon pressure, temperature, and wind sensors, in addition to a miniature hygrometer for measuring humidity. The level of miniaturization achieved will enable use of the micro-weather station on Mars and in Earth's troposphere.

- **High-Performance Computing**. The Intel Touchstone Delta parallel supercomputer was used to visualize Venus radar images from the Magellan Spacecraft, to study the solar wind and the structure of the Sun, and to perform complex electromagnetic scattering calculations. Sustained performance of up to 10 gigaflops was achieved.

- **Solid-State Memories**. A device built on garnet substrate was demonstrated to be capable of sustaining both bubble- and strip-shaped magnetic domains at the same bias field. This is an important precondition for building solid-state, nonvolatile memory chips with densities that may exceed one gigabit per square centimeter.

PROGRAMMATIC HIGHLIGHTS

CSMT hosted or sponsored the following technical workshops during 1992:

- Third Ballistic Electron Emission Microscopy Workshop held in Death Valley, California, on January 27, 1992.
- CMST New Technology Commercialization Workshop held in Newport Beach, California, on February 27 and 28, 1992.
- Innovative Long Wavelength Infrared Detector Workshop held at JPL in Pasadena, California, on April 7 - 9, 1992.
- Systems Software and Tools for High-Performance Computing Environments Workshop held in Pasadena, California, on April 14-16, 1992.
- Microtechnologies and Applications to Space Systems Workshop held in Pasadena, California, on May 27 and 28, 1992.
- NASA Binary Optics Workshop held in Vienna, Virginia, on July 28, 1992.
- Tunnel Sensors Workshop held at JPL in Pasadena, California, on July 29 and 30, 1992.
- Optoelectronic Semiconductor Modulators and Applications Workshop held in Santa Barbara, California, on August 12 and 13, 1992.

During the past year, highlights of CSMT defense-oriented technology applications programs include the following:

Simulation Technology. JPL's Parallel Geographically Distributed Simulation Framework Technology was delivered to the U.S. Air Force and the Advanced Research Projects Agency for use in the Warbreaker program and is being used in a series of demonstrations for BMDO's National Test Facility.

Multitargeting Tracking Workstation. Via a transition contractor, JPL's Advanced Multitarget Air-Breathing Integrated Tracking Workstation has been installed in the Air Defense Operations Center on Cheyenne Mountain, in Colorado Springs, Colorado, for an extended technology-insertion demonstration.

Automated Resource Scheduler. An artificial-intelligence-based automated resource scheduler has been developed, demonstrated, and selected for insertion into the U.S. Army's Block II All Source Analysis System (ASAS) Baseline. The scheduler automatically provides for optimum allocation and scheduling of oversubscribed assets among time-critical tasks.

CSMT personnel served on numerous panels and committees, including many technical conference organizing and program committees, as well as the following:

- Council of the American Physical Society.
- Joint Services Electronics Program, Technical Review Committee.
- NASA Space Terahertz Technology Center, University of Michigan, Technical Representative Committee.
- Concurrent Supercomputing Consortium Policy Board.
- Space Technology Interdependency Group (STIG).
- NASA Sensor Working Group.
- Air Force Scientific Advisory Board.
- Defense Intelligence Agency National MASINT Architecture Steering Committee.
- Executive and Technical Committee's NASA High-Performance Computing and Communications Program.
- National Science Foundation Program Advisory Panel for Advanced Scientific Computing.
- Institute of Electrical and Electronic Engineers (IEEE) Technical Advisory Committee on Parallel Processing.
- Department of Energy (DOE) Energy Research Supercomputing Users' Group Executive Committee.
- Army High-Performance Computing Research Center Advisory Committee.
- Advisory Panel for Scientific Computing Division of the National Center for Atmospheric Research
- Committee on Science Policy of the Society for Industrial and Applied Mathmatics.

A number of awards were presented to CSMT scientists and engineers. Most notable were the following:

- Three of the four 1992 **Lew Allen Awards** were presented to CSMT staff:
  - L. Doug Bell: For significant contributions leading to the development of innovative scanning tunneling microscopy-related technologies and their application to the elucidation of the electronic structure of advanced microelectronic materials structures.
  - Edward T. Chow: For pioneering work in the development of computer technology necessary to support the human genome effort leading to a new class of sequence alignment coprocessors called Biological Information Signal Processors.
  - Eric R. Fossum: In recognition of his research accomplishments in the fields of focal plane signal processing and high-performance image sensors.
- **NASA Medals** were awarded to the following CSMT staff members:
  - Carl Kukkonen - Exceptional Achievement
  - Joseph Perry - Exceptional Scientific Achievement
  - Kevin Hussey - Exceptional Engineering Achievement
  - James Janesick - Exceptional Engineering Achievement
  - Timothy Krabach - Exceptional Engineering Achievement
  - Jerry Solomon - Exceptional Engineering Achievement
- **Gordon Bell Award Finalists**
  - Four of the five finalists used the Intel Touchstone Delta Supercomputer at Caltech, including "Electromagnetic Scattering Calculations on the Intel Touchstone Delta," T. Cwik (JPL), J. Patterson (JPL), D. Scott (Intel SSD).
- **1992 "Federal 100" Award**
  - Paul Messina, one of 100 recipients of the 1992 "Federal 100" award, sponsored by Federal Computer Week magazine, was recognized for spearheading the acquisition of the Intel Delta for use by JPL, Caltech, and eleven other research organizations.

During 1992, CSMT staff published 187 papers, made 253 presentations, and submitted 111 new technology reports and patent applications.

CSMT again hosted several Distinguished Visiting Scientists. Participants were:

- **Dr. Anne Bagneres**
  Department of Electrical Engineering,
  Boston University

- **Prof. Hans Bozler**
  Department of Physics,
  University of Southern California

- **Prof. Floyd Humphrey**
  Department of Electrical, Computer, and Systems Engineering,
  Boston University

- **Prof. Linda Katehi**
  Department of Electrical Engineering and Computer Science,
  University of Michigan

- **Prof. Antti V. Raisanen**
  Helsinki University of Technology, Espoo, Finland

- **Prof. Michael G. Spencer**
  Department of Physics,
  Howard University

- **Dr. Pochi Yeh**
  Department of Electrical and Computer Engineering,
  University of California at Santa Barbara

INSTITUTIONAL HIGHLIGHTS

CSMT has been active in technology transfer and commercialization endeavors. The Center's efforts, which have benefited greatly from interactions with the successful programs at Stanford and Massuchusetts Institute of Technology, are highlighted below:

Visiting Industrial Fellows Program: The goal of this new program is to identify commercially important CSMT technologies and to develop joint JPL-industry programs to ensure effective transfer of these technologies to industry. Dr. William Vetterling from Polaroid Corporation was appointed as the first Fellow.

Computer Communications Switch: Unisys Corporation has licensed the Hyperswitch, a fast and integrated communications switch, developed by CSMT, to route messages in a parallel computer. Unisys plans to use the Hyperswitch in a new generation of transaction processing computers.

Microdevices Development: Innovative Research and Technology, a small business, is currently utilizing the unique facilities of the Microdevices Laboratory to develop millimeter- and submillimeter-wave devices.

Cray Parallel Applications Technology Program: Caltech Campus and JPL have been selected by Cray Research Inc. to be one of four sites for the company's new program. In late 1993, JPL will take delivery of a 256-node T3D, Cray's new parallel processor. Caltech Campus and JPL will work with Cray to bring up 25 applications programs on the T3D to conduct systems testing and help develop an applications software base.

I. Solid-State Devices

OVERVIEW

The Solid State Device Research Program is directed toward developing innovative devices for space remote and in-situ sensing, and for data processing. Innovative devices can result from the "standard" structures in innovative materials, such as low- and high-temperature superconductors or strained-layer superlattices. Innovative devices can also result from "innovative" structures achieved using electron tunneling or nanolithography in standard materials. A final step is to use both innovative structures and innovative materials. A new area of emphasis is the miniaturization of sensors and instruments using the techniques of electronic device fabrication to micromachine silicon into micromechanical and electromechanical sensors and actuators.

1992 MAJOR TECHNICAL ACHIEVEMENTS

Electron Tunneling

- **Demonstrated** feasibility of new microscopy; Tunneling Transmission Microscopy.
- **Demonstrated** new technique to measure electronic characteristics of pn junctions and heterojunctions (e.g., doping, uniformity, transport efficiency).
- **Observed** for first time the strain-induced conduction band-splitting in SeGe alloys.
- **Delivered** MicroGolay Cells to Goddard Space Flight Center for long-term testing. Performance estimated at factor of two better than state-of-the-art (pyroelectric) room-temperature IR sensor.
- **Demonstrated** operation of a prototype "compass needle" magnetometer at NRL.
- **Demonstrated** operation of a prototype all-silicon microaccelerometer.

Superconductivity

- **Fabricated** the first high-performance SNS weak links with ion-damaged barrier layers. These devices exhibit some of the best reported electrical characteristics at 77 K, and are expected to be useful for ultrahigh-speed, low-power flux quantum logic circuits, for Josephson mixers, and for sensitive magnetic field detectors.

- **Produced** high-quality epitaxial YBa2Cu3O7/Y2O3-ZrO2/Si structures. These structures will be used for fabrication of epitaxial YBCO bolometers and bolometer arrays on thermally isolated membranes. Such bolometers are expected to outperform other available IR sensors for wavelengths greater than 10 mm.

- **Delivered** Y-Ba-Cu-O films on Honeywell 7.6-cm Si wafers with readout transistors for bolometer array fabrication.

- **Demonstrated** growth of high-quality Y-Ba-Cu-O films on low-dielectric-constant insulators such as BaF2. These YBCO/insulator heterostructures are important for fabrication of high-speed superconducting interconnects for high-performance circuit and packaging applications.

- **Fabricated** and **delivered** for testing bandpass microwave filters. These filters will be incorporated into a low-noise receiver subsystem, similar to the front end of a Deep Space Network receiver, which will be submitted for launch on the NRL High-Temperature Superconductor Space Experiment II (HTSSE II). This project is being done in collaboration with section 336 and NASA Lewis Research Center.

Submillimeter (Terahertz) Receiver Technology

- **Demonstrated** very low SIS receiver noise: T_R = 370 K at 521 GHz. The waveguide mixer uses a niobium tunnel junction integrated with a specially designed superconductive microstrip transformer to resonate the junction capacitance. This is the best receiver result to date above 500 GHz.

- **Demonstrated** very-low-noise SIS mixer: T_m = 1130 K at 619 GHz. This is the best mixer result to date above 600 GHz.

- **Developed** an improved theoretical analysis of the dispersion in superconductive Nb-SiO_x-Nb microstrip transmission lines at submillimeter wave frequencies. The full frequency dependence of the complex propagation parameter and characteristic impedance has been properly incorporated into the calculations.

- **Demonstrated** for the first time a rectangular millimeter-wave waveguide fabricated using silicon micromachining techniques.

- **Made** first measurements on a 200-GHz tripler using planar back-to-back Barrier-N-N^+ (bbBNN) varactor devices. These devices were developed at JPL. More than 2% efficiency was observed in the first measurement. These planar devices show maximum efficiency at lower power levels. This is critical to the development of submillimeter-wave frequency multipliers.

- **Developed** a novel fabrication technique for back-to-back BNN varactor diodes, in which much of the processing is done from the back side of the wafer. Advantages of this technique over other techniques include greatly reduced front-side wafer damage because of reduced exposure to process chemicals, improved capability to integrate devices, and higher line yield.

- **Carried** out measurement on 200-GHz single-barrier varactor (SBV) triplers using a crossed waveguide mount. These devices were fabricated at Chalmers and Lincoln Laboratory. More than 5% efficiency has been achieved. **Characterized** the SBV diode performance over 180-to-210-GHz frequency range by varying output backshort positions to compare performance to our theoretical predictions. **Evaluated** loss in the crossed waveguide mount.

- **Measured** DC characteristic of bbBNN devices. Devices have symmetrical CV characteristic and very low leakage current (less than 10 nA at voltages 3 times that needed to deplete the varactor).

- **Developed** a new technique to measure series resistance and capacitance of the planar bbBNN devices using vector network analyzer. These devices do not have high series resistance like barrier-intrinsic-N (BIN) devices. Lower leakage current and smaller series resistance make these devices promising for submillimeter-wave applications.

- **Performed** scale-model measurements on 200 GHz-tripler and 810-GHz quintupler.

- **Demonstrated** new method of processing for submillimeter-wave multiplier diodes that greatly simplifies integration issues and reduces yield-limiting factors. BNN diodes fabricated using this method with integral antenna structures on low-dielectric substrates have been tested at low frequencies with excellent results. With minimal changes, the method also has been adopted as a means for fabricating submillimeter-wave mixer diodes.

- **Fabricated** and **tested** the world's first SIS planar array receiver at 230 GHz. All 10 receiver elements worked, and mixer noise temperatures between 90 and 235 K were obtained. Four elements had noise temperatures below 100 K, only two times higher than the best single-element waveguide receivers using similar superconducting detectors at the same frequency.

- **Developed** a novel technique for making a combined GaAs-on-quartz hybridized substrate. The procedure can be used to combine active GaAs semiconducting devices with passive transmission line circuitry to form low-loss planar integrated millimeter-wave circuitry. A subharmonically pumped antiparallel-diode-pair mixer was fabricated and tested with this approach at 200 GHz.

- **Developed** and fabricated the first series-array planar varactor-diode doubler (joint program with University of Virginia and University of Massachusetts). The novel array design allows a quadrupling of the usual input power level with little sacrifice in overall multiplication efficiency. More than 50 mW of output power was achieved at 170 GHz, five times higher than any other solid-state multiplier at this frequency.

Semiconducting Materials: Growth and Characterization

- **Discovered** a new selective etch procedure for preferentially converting SiGe epilayers to porous material without coverting adjacent Si layers. This etch has been exploited to fabricate amorphous/crystalline superlattices, and may also find application in superior electroluminescent devices based on porous Si, a superior SOI (Si on insulator) technology, and as a Si lift-off technology.

- **Demonstrated** a new method for preparation of TEM specimens from homoepitaxial diamond samples. This method relies on laser ablation rather than conventional techniques involving ion milling. Because of the slow milling rate of diamond, this process reduces specimen preparation time from ≈ 100 hours to ≈ 3 hours.

- **Demonstrated** a new technique for measuring porosities in porous Si and related materials. In this technique, energy dispersive analysis by x-rays is performed on a cross-sectional sample in a transmission electron microscope. By comparing the total x-ray yield from the porous layer to that in the bulk, the relative amounts of material from which x-rays are excited can be obtained, and hence the porosity. Using this technique, porosities can be determined at various points (i.e., as a function of depth) in the porous layer.

- **Performed** MBE growth and passivation of a 2.5-nm layer of delta-doped silicon on the back surface of a thinned EG&G Reticon 512x512 CCD array.

Electronic Device Technology

- **Developed** reproducible process for E-Beam lithography of T-gates.

- **Demonstrated** new method of processing for submillimeter-wave multiplier diodes that greatly simplifies integration issues and reduces yield-limiting factors. BNN diodes fabricated using this method with integral antenna structures on low-dielectric substrates have been tested at low frequencies with excellent results. With minimal changes, the method also has been adopted as a means for fabricating submillimeter-wave mixer diodes.

- **Demonstrated** noise reduction of quantum well infrared photodetector (QWIP) by monolithically incorporating a low-noise filter.

- **Fabricated** circuits incorporating 0.1-μm pseudomorphic HEMTs (high-electron-mobility transistors) in differential pairs and **delivered** to collaborators at Caltech for incorporation into grid arrays (quasi-optically combined power amplifiers) for microwave operation.

- **Measured** ultraviolet quantum efficiency at the theoretical limit of an EG&G Reticon CCD array, modified at MDL by growth of a delta-doped silicon layer.

- **Demonstrated** first two-dimensional electron gas charge-coupled device (2DEG CCD) implemented in the InAlAs/InGaAs/InP lattice-matched system.

- **Developed** physical model for gate leakage in cryogenic complementary heterojunction field-effect transistors.

Microinstrument Technology

- **Fabricated** 16 phase-level, diffraction-limited Fresnel lenses having 83% efficiency by direct-write, variable-dose E-beam exposure of PMMA.

- **Fabricated** precision optical test reticules for calibration and alignment of Hubble corrector optics for the Wide Field Planetary Camera.

- **Fabricated** Ronchi Ruling for Toward Other Planetary Systems (TOPS) astrometrics

- **Designed**, fabricated, and demonstrated proof-of-concept micromachined electron energy filter less than 5 mm thick and compatible with large-area arrays.

- **Demonstrated** high-aspect-ratio (>20:1) fine grid structures (100-μm pitch) in silicon, gold, copper, and tungsten using technologies including chemical micromachining, precision sawing, electroforming, and chemical vapor deposition. Planned use on balloon flight (HEIDI) and proposed High Energy Solar Physics (HESP) mission

- **Demonstrated** prototype dew-point hygrometer, uncoated surface-acoustic-wave oscillators.

- **Demonstrated** prototype microbarometer.

- **Demonstrated** operation of an electrostatically deformable membrane 1 cm in diameter.

- **Demonstrated** Operation of 2.54-cm cube seismometer in 2286-m-deep borehole at China Lake. Sensitivity, estimated at better than 100 nG, exceeds all comparable underground devices.

TECHNICAL PROGRESS REPORTS

Electron Tunneling

Publications

"Probing Hot Carrier Transport and Scattering Using Ballistic-Electron-Emission-Microscopy"
A. M. Milliken, S. J. Manion, W. J. Kaiser, L. D. Bell, and M. H. Hecht,
Physical Review B, vol. 19, no. 19, p. 12826, November 15, 1992

"Ballistic Electron Emission Testing of Semiconductor Heterostructures"
G. N. Henderson, T. K. Gaylord, E. N. Glytsis, P. N. First, and W. J. Kaiser,
Solid State Communications, vol. 80, 59, 1991 (accepted)

"A Miniature High-Resolution Accelerometer Utilizing Electron Tunneling"
H. K. Rockstad, T. W. Kenny, J. K. Reynolds, W. J. Kaiser, T. R. VanZandt, and T. Gabrielson,
Micromechanical Systems, Proceedings ASME Winter Annual Meeting, DSC Vol. 40, 1992

"Electron Tunnel Sensors"
T. W. Kenny, W. J. Kaiser, J. K. Reynolds, J. A. Podosek, H. K. Rockstad, and S. B. Waltman,
Journal of Vacuum Science and Technology A, vol. 10, No. 4, Part 2, p. 2114 - 2118, July-August 1992

"Micromachined Electron Tunneling Infrared Sensors"
T. W. Kenny, W. J. Kaiser, J. A. Podosek, H. K. Rockstad, and J. K. Reynolds
Proceedings IEEE 1992 Solid State Sensors and Actuators Workshop, 174, 1992

"A Miniature High Resolution Accelerometer Utilizing Electron Tunneling"
H. K. Rockstad, T. W. Kenny, J. K. Reynolds, W. J. Kaiser, T. R. VanZandt, and T. B. Gabrielson,
Micromechanical Systems, Proceedings ASME Winter Annual Meeting, DSC, vol. 40-41, 1992

Invited Presentations

"Nondestructive Evaluation of Semiconductor Interfaces, Materials and Devices by Ballistic-Electron-Emission Microscopy"
W. J. Kaiser
Gordon Research Conference on Nondestructuve Evaluation, Oxnard, CA, January 20-24, 1992

"New Scanning Probe Microscopy of Surface and Subsurface Structures"
W. J. Kaiser
Nordic Surface Science Symposiom, Nyborg, Denmark, May 7-10, 1992

"Ballistic Electron Emission Microscopy of Semiconductor Structures"
L. D. Bell
Gordon Research Conference on Electron Spectroscopy, Wolfeboro, NH,
July 15, 1992

"Ballistic Electron Emission Microscopy"
M. H. Hecht
Workshop on Future Directions in Microscopy and Imaging, Southboro, MA,
August 13-16, 1992

"Ballistic Electron Emission Microscopy"
W. J. Kaiser
Caltech Electrical Engineering Department Seminar, Pasadena, CA,
February 7, 1992

"Ballistic Electron Emission Microscopy"
W. J. Kaiser
Wayne State Univ. Physics Department Colloquium, Detroit, MI,
March 12, 1992

"Measurement of the Electronic Structure of Interfaces Using Ballistic Electron Emission Microscopy"
S. J. Manion
Physics Department Seminar, San Jose State Univ., San Jose, CA,
March 12, 1992

"Ballistic Electron Emission Microscopy as a Probe of the Electronic Structure of Interfaces"
S. J. Manion
Southern California Society for Electron Microscopy Meeting, September 24, 1992

"New Technologies for Acceleration Measurements"
T. W. Kenny, T. R. Van Zandt, and W. J. Kaiser
U.S. Army Field Artillery Training School Seminar, Ft. Sill, OK, January 23, 1992

"Microsensors and Microinstruments"
W. J. Kaiser, T. W. Kenny, and T. R. VanZandt,
1992 JPL/Caltech Trustees Meeting, Pasadena, CA, March 15, 1992

"Principles, Performance and Applications of the Electron Tunneling Infrared Detector"
T. W. Kenny, W. J. Kaiser, H. K. Rockstad, J. K. Reynolds, and J. A. Podosek
1992 Microtechnology Workshop, Pasadena, CA, April 7, 1992

"Tunnel Sensors"
W. J. Kaiser, T. W. Kenny, J. A. Podosek, J. K. Reynolds, H. K. Rockstad, and S. B. Waltman
1992 Tunnel Sensors Workshop, Pasadena, CA, July 29, 1992

"Micromachined Electron Tunneling Infrared Sensors"
T. W. Kenny, W. J. Kaiser, J. A. Podosek, E. C. Vote, and J. K. Reynolds
1992 Tunnel Sensors Workshop, Pasadena, CA, July 29, 1992

"Tunneling Sensors: Recent Progress at JPL"
T. W. Kenny, W. J. Kaiser, J. A. Podosek, H. K. Rockstad, J. K. Reynolds, and E. C. Vote
U.C. Berkeley Electrical Engineering Department Seminar, Berkeley, CA, September 21, 1992

"Tunneling Sensors"
T. W. Kenny, W. J. Kaiser, H. K. Rockstad, and J. K. Reynolds
1992 Acoustical Society of America Annual Symposium, New Orleans, LA, November 3, 1992

"Tunneling Sensors"
T. W. Kenny, W. J. Kaiser, H. K. Rockstad, J. A. Podosek, and J. K. Reynolds
1992 American Vacuum Society Annual Symposium, Chicago, IL, November 1992

Presentations

"Investigation of Minority Carrier Transport Using BEEM"
L. D. Bell
Third Ballistic Electron Emission Microscopy Workshop, Death Valley, CA, January 27, 1992

"New Methods for Probing Electronic Structure and Carrier Transport in Semiconductor Heterostructures"
M. H. Hecht, Physics and Chemistry of Semiconductor Interfaces (PCSI), Death Valley, CA, January 31-February 2, 1991

"Probing Minority Carrier Transport with Ballistic Electron Emission Microscopy"
S. J. Manion
March Meeting of the American Physical Society, Indianapolis, IN, March 16-20, 1992

"Observation of Artificial Nanostructures with Ballistic Electron Emission Microscopy"
A. M. Milliken
March Meeting of the American Physical Society, Indianapolis, IN, March 16-20, 1992

"Microsensors and Microinstruments"
W. J. Kaiser, T. W. Kenny, and T. R. VanZandt,
1992 CSMT Board of Governors, Jet Propulsion Laboratory, Pasadena, CA,
January 16, 1992

"New Technologies for Acceleration Measurements"
T. K. Kenny, T. R. VanZandt, and W. J. Kaiser
Aerospace Corporation Internal Briefing, El Segundo, CA, February 27, 1992

"Electron Tunneling Sensors"
T. K. Kenny, W. J. Kaiser, H. K. Rockstad, J. K. Reynolds, and J. A. Podosek
1992 Microtechnology Workshop, Pasadena, CA, May 27, 1992

"An Electron Tunneling Infrared Sensor"
T. W. Kenny, W. J. Kaiser, J. A. Podosek, and J. K. Reynolds
1992 Solid State Sensors and Actuators Workshop, Hilton Head, SC,
June 24, 1992

"A Miniature High-Resolution Accelerometer Utilizing Electron Tunneling"
H. K. Rockstad, J. K. Reynolds, T. W. Kenny, and W. J. Kaiser
1992 Solid State Sensors and Actuators Workshop, Hilton Head, SC,
June 24, 1992

"Techniques for Preparation of Lithographically-Patterned Electrodes for Tunneling Sensors"
J. A. Podosek, E. C. Vote, T. W. Kenny, J. K. Reynolds, and W. J. Kaiser,
1992 Tunnel Sensors Workshop, Pasadena, CA, July 29, 1992

"Wide-Bandwidth Feedback Circuitry for Tunneling Sensors"
J. K. Reynolds, W. J. Kaiser, T. W. Kenny, and H. K. Rockstad
1992 Tunnel Sensors Workshop, Pasadena, CA, July 29, 1992

"A Miniature High-Resolution Accelerometer Utilizing Electron Tunneling"
H. K. Rockstad, T. W. Kenny, J. K. Reynolds, W. J. Kaiser, and T. R. VanZandt
1992 Tunnel Sensors Workshop, Pasadena, CA, July 29, 1992

"A Miniature High-Resolution Accelerometer Utilizing Electron Tunneling"
H. K. Rockstad, T. W. Kenny, J. K. Reynolds, W. J. Kaiser, and T. R. VanZandt
1992 American Society of Mechanical Engineers Annual Symposium, Anaheim,
CA, November 4, 1992

Patent and New Technology Reports

"Charge-Carrier Scattering Spectroscopy with BEEM"
M. Hecht, L. D. Bell, and W. J. Kaiser
NASA Tech Briefs, NPO-18411, vol. 16, no. 9, p. 58, September 1992

"Wide-Bandwidth Feedback Circuitry for Control of Tunneling Sensors"
W. J. Kaiser, T. W. Kenny, H. K. Rockstad, and J. K. Reynolds
New Technology Report, NPO-18866 (submitted)

"Technique for Preparing Lithographically-Patterned Tunneling Electrodes"
T. W. Kenny, J. A. Podosek, J. K. Reynolds, H. K. Rockstad, W. J. Kaiser, and E. C. Vote
New Technology Report, NTR-18865 (submitted)

"CCD with Backside Illumination and Charge Steering"
E. R. Fossum
NASA Tech Briefs, NPO-18387 vol. 16 (9) p. 30, September 1992

"Optical Link for Readout from Focal-Plane Array"
E. R. Fossum, A. G. Larsson, and J. Maserjian
NASA Tech Briefs, NPO-18481, vol. 16 (10), p. 30-31, October 1992

"Delta-Doped Buried Channels in Charge-Coupled Device"
E. R. Fossum
NASA Tech Briefs, NPO-18372, vol. 16, no. 12, p. 28, December 1992

"An Improved Uncooled Tunneling Infrared Sensor"
T. W. Kenny, W. J. Kaiser, J. A. Podosek, E. C. Vote, H. K. Rockstad, and J. K. Reynolds
New Technology Report, NPO-18560, June 15, 1992 (filed, U.S. Patent)

"Dual-Element Electron Tunneling Accelerometer"
W. J. Kaiser, T. W. Kenny, H. K. Rockstad, J. K. Reynolds, and T. R. VanZandt
New Technology Report, NPO-18862, October 28, 1992 (filed, U.S. Patent Pending)

Superconductivity

Publications

"X-Ray Photoelectron Spectroscopy Study of Inequivalent Oxygen Sites in High Temperature Superconductors"
R. P. Vasquez, B. D. Hunt, M. C. Foote, L. J. Bajuk, and W. L. Olson
Physica C, vol. 190, no. 3, p. 249-254, January 1, 1992

"Scaling of Vortex Transport Properties in High-Temperature Superconductors"
N.-C. Yeh, D. S. Reed, W. Jiang, U. Kriplani, F. Holtzberg, A. Gupta, B. D. Hunt, R. P. Vasquez, M. C. Foote, and L. J. Bajuk
Physical Review B, vol. 45, no. 10, p. 5654-5658, March 1, 1992

"A $YBa_2Cu_3O_7$ Epitaxial Thin Film by XPS"
R. P. Vasquez, M. C. Foote, and B. D. Hunt
Surface Science Spectra, vol. 1, no. 1, p. 31-42, June 1992

"The Semiconducting Tetragonal Phase of $YBa_2Cu_3O_{6+x}$ by XPS"
R. P. Vasquez, M. C. Foote, and B. D. Hunt
Surface Science Spectra, vol. 1, no. 1, p. 8-16, June 1992

"A $Bi_2Sr_{2-x}Ca_{1+x}Cu_2O_{8+d}$ Single Crystal by XPS"
R. P. Vasquez and R. M. Housley
Surface Science Spectra, vol. 1, no. 1, p. 50-57, June 1992

"A $Tl_2Ba_2CaCu_2O_{8+d}$ Epitaxial Thin Film by XPS"
R. P. Vasquez and W. L. Olson
Surface Science Spectra, vol. 1, no. 1, p. 58-67, June 1992

"SrF_2 by XPS"
R. P. Vasquez
Surface Science Spectra, vol. 1, no. 1, p. 24-30, June 1992

"$SrCl_2$ by XPS"
R. P. Vasquez
Surface Science Spectra, vol. 1, no. 1, p. 68-74, June 1992

"$SrBr_2$ by XPS"
R. P. Vasquez
Surface Science Spectra, vol. 1, No. 1, p. 43-49, June 1992

"SrI_2 by XPS"
R. P. Vasquez
Surface Science Spectra, vol. 1, no. 1, p. 17-23, June 1992

"$SrCO_3$ by XPS"
R. P. Vasquez
Surface Science Spectra, vol. 1, no. 1, p. 112-116, June 1992

"$SrSO_4$ by XPS"
R. P. Vasquez
Surface Science Spectra, vol. 1, no. 1, p. 117-121, June 1992

"$SrTiO_3$ by XPS"
R. P. Vasquez
Surface Science Spectra, vol. 1, no. 1, p. 129-135, June 1992

"$Sr(NO_3)_2$ by XPS"
R. P. Vasquez
Surface Science Spectra, vol. 1, no. 1, p. 122-128, June 1992

"X-ray Photoelectron Spectroscopy Characterization of a Nonsuperconducting Y-Ba-Cu-O SNS Barrier Material"
R. P. Vasquez, B. D. Hunt, M. C. Foote, and L. J. Bajuk
Journal of Vacuum Science and Technology, vol. 10, no. 4, p. 1511-1513, July/August, 1992

"Composition Variations in Pulsed-Laser-Deposited Y-Ba-Cu-O Thin Films as a Function of Deposition Parameters"
M. C. Foote, B. B. Jones, B. D. Hunt, J. B. Barner, R. P. Vasquez, and L. J. Bajuk
Physica C, vol. 201, no. 1, p. 176-182, October 10, 1992

"Highly Oriented Pyrolytic Graphite by XPS"
R. P. Vasquez
Surface Science Spectra, vol. 1, no. 2, December 1992 (in press)

"A Polycrystalline Diamond Film by XPS"
R. P. Vasquez
Surface Science Spectra, vol. 1, no. 2, December 1992 (in press)

"An Epitaxial C_{60} Film on Si (111) by XPS"
R. P. Vasquez, R. A. Brain, D. Ross, and N.-C. Yeh
Surface Science Spectra, vol. 1, no. 2, December, 1992 (in press)

"All-$YBa_2Cu_3O_{7-x}$ Edge-Geometry Weak Links"
B. D. Hunt, L. J. Bajuk, J. B. Barner, M. C. Foote, B. B. Jones, R. P. Vasquez
SPIE Proceedings, Progress in High Tc Superconducting Transistors and Other Devices II, vol. 1597, p. 108-117, 1992

"Chemical Modification of High-Temperature Superconductor Surfaces"
R. P. Vasquez
Chapter to appear in Synthesis and Characterization of High-Temperature Superconductors, Eds. J. J. Pouch, S. A. Alterovitz, R. R. Romanofsky, and A. Hepp, Trans Tech Publications Ltd., Aedermannsdorf, Switzerland, 1993

"Modeling of Planar Quasi-TEM Superconducting Transmission Lines"
D. Antsos, W. Chew, A. L. Riley, B. D. Hunt, M. C. Foote, L. J. Bajuk, D. L. Rascoe, and T. W. Cooley
IEEE Trans. on Microwave Theory and Techniques, 1992 (submitted)

"Growth of $YBa_2Cu_3O_{7-d}$ on Alkaline Earth Fluoride Substrates and Thin Films"
R. P. Vasquez, M. C. Foote, B. D. Hunt, and J. B. Barner
Physica C, 1992 (submitted)

Presentations

"YBCO/PBCO/YBCO Edge-Geometry Weak Link Devices"
J. B.Barner, M. C.Foote, B. D. Hunt, and R. P. Vasquez
March Meeting of the American Physical Society, Indianapolis, IN,
March 16-20, 1992

"Composition of Y-Ba-Cu-O Thin Films Deposited Using Pulsed Laser Deposition"
M. C.Foote, B. B. Jones, B. D. Hunt, J. B. Barner, R. P. Vasquez, and L. J. Bajuk
March Meeting of the American Physical Society, Indianapolis, IN,
March 16-20, 1992

"All-High-Tc SNS Weak Links Using Y-Ba-Cu-O Normal Metal Layers"
B. D. Hunt, M. C. Foote, J. B. Barner, and R. P. Vasquez
March Meeting of the American Physical Society, Indianapolis, IN,
March 16-20, 1992

"C_{60} Films on Si (111)"
R. A. Brain, W. Jiang, D. Ross, N.-C. Yeh, and R. P. Vasquez
Materials Research Society Spring Meeting, San Francisco, CA,
April 27-May 1, 1992

"Composition of Pulsed-Laser-Ablated Y-Ba-Cu-O Thin Films"
M. C. Foote, B. B. Jones, R. P. Vasquez, B. D. Hunt, and J. B. Barner
Applied Superconductivity Conference, Chicago, IL, August 23-28, 1992

"YBCO/PBCO/YBCO Edge-Geometry Josephson Devices for High Temperature Superconductive Electronics"
J. B. Barner, B. D. Hunt, M. C. Foote, T. W. Pike, and R. P. Vasquez
Applied Superconductivity Conference, Chicago, IL, August 23-28, 1992

"All-High-Tc Edge-Geometry Weak Links Using Y-Ba-Cu-O and Ion-Damaged Barrier Layers"
B. D. Hunt, J. B. Barner, M. C. Foote, B. B. Jones, R. P. Vasquez, and T. W. Pike
Applied Superconductivity Conference, Chicago, IL, August 23-28, 1992

"Epitaxial High Tc SNS Weak Links for Space Applications"
B. D. Hunt, J. B. Barner, M. C. Foote, B. B. Jones, and R. P. Vasquez
Third World Congress on Superconductivity, Munich, Germany,
September 14-19, 1992

"Low-Noise Receiver Downconverter Using High Critical Temperature Superconductor Films"
W. Chew, J. Barner, J. Bautista, K. Bhasin, C. Chorey, C. Cubbage, M. Foote, B. Fujiwara, B.Hunt, G. Ortiz, D. Rascoe, R. Romanofsky, and R. Vasquez
Third World Congress on Superconductivity, Munich, Germany,
September 14-19, 1992

"High Tc Thin Film Devices"
B.D. Hunt, J.B. Barner, M.C. Foote, B.B. Jones, and R.P. Vasquez
Westinghouse Science and Technology Center, Pittsburgh, PA,
November 23, 1992

Patent and New Technology Reports

"SNS Device Made with Edge-Defined Geometry"
B. D. Hunt and M. C. Foote
NASA Tech Briefs, NPO-18303, vol. 16, no. 6, p. 24, June 1992
(U.S. patent pending)

"SNS Heterojunctions with New Combinations of Materials"
R. P. Vasquez, B. D. Hunt, and M. C. Foote
NASA Tech Briefs, NPO-18483, vol. 16, no. 6, p. 24, October 1992
(U.S. patent pending)

"Superconductive Coplanar Waveguide Filters"
L. J. Bajuk, W. Chew, T. W. Cooley, M. C. Foote, B. D. Hunt, D. L. Rascoe, and A. L. Riley
NASA Tech Briefs, NPO-18424, vol. 16, no. 10, p. 26, October 1992

"Growth of $YBa_2Cu_3O_{7-x}$ on Alkaline Earth Fluoride Substrates and Thin Films"
R. P. Vasquez, M. C. Foote, B. D. Hunt, and J. B. Barner
New Technology Report, NPO-19030, November 1992 (submitted)

"Composition Variations in Pulsed-Laser-Deposited Y-Ba-Cu-O Thin Films as a Function of Deposition Parameters"
M. C. Foote, B. B. Jones, B. D. Hunt, J. B. Barner, R. P. Vasquez, and L. J. Bajuk
New Technology Report, NPO-18992 (submitted)

"An Improved SNS Superconducting Junction with Weak Link Barrier and Method of Producing"
B. D. Hunt
New Technology Report, NPO-18552, March 19, 1992 (filed)

"Method of Fabricating Superconducting Device"
M. C. Foote and B. D. Hunt
New Technology Report, NPO-18394, February 27, 1992 (filed)

Submillimeter (Terahertz) Receiver Technology

Publications

"Dispersion of Niobium Transmission Lines at Terahertz Frequencies"
H. H. S. Javadi, W. R. McGrath, B. Bumble, and H. G. LeDuc
Proceedings of the Third International Symposium on Space Terahertz Technology, p. 362, Univ. of Michigan, Ann Arbor, MI, March 24-26, 1992

"A 200 GHz Tripler using a Single Barrier Varactor"
D. Choudhury, M.A. Frerking, and P.D. Batelaan
IEEE Trans. on Microwave Theory and Tech., March 1993 (accepted)

"Silicon Micromachined Waveguides for Millimeter and Submillimeter Wavelengths"
M. Yap, Y. C. Tai, W. R. McGrath, and C. Walker
Proceedings of the Third International Symposium on Space Terahertz Technology, p. 316, Univ. of Michigan, Ann Arbor, MI, March 24-26, 1992

"Analysis of a Novel Noncontacting Waveguide Backshort"
T. M. Weller, L. P. B. Katehi, and W. R. McGrath
Proceedings of the Third International Symposium on Space Terahertz Technology, p. 298, Univ. of Michigan, Ann Arbor, MI, March 24-26, 1992

"Current Saturation in Submillimeter Wave Varactors"
E. Kollberg, T. Tolmunen, M. Frerking, and J. East
IEEE Trans. on Microwave Theory and Tech., vol. 40, no. 5, p. 831-838, May 1992

"Design of Planar Varactor Frequency Multiplier Devices with Blocking Barriers"
U. Lieneweg, T. J. Tolmunen, M. A. Frerking, and J. Maserjian
IEEE Trans. on Microwave Theory and Tech., vol. 40, no. 5, p. 839-845, May 1992

"A Noncontacting Waveguide Backshort for Submillimeter Wave Applications"
T. M. Weller, L. P. B. Katehi, and W. R. McGrath
22nd European Microwave Conference Proc., Helsinki Univ. of Technology, Espoo, Finland, August 25-27, 1992

"A Fixed Tuned Broadband Matching Structure for Submillimeter SIS Receivers"
T. H. Büttgenbach, H. G. LeDuc, P. D. Maker, and T. G. Phillips
IEEE Trans. of Applied Superconductivity, vol. 2, no. 3, p. 165-175, September 1992

"Dispersion in Nb Microstrip Transmission Lines at Submillimeter Wave Frequencies"
H. H. S. Javadi, W. R. McGrath, H. G. LeDuc, and B. Bumble
Applied Physics Letters, vol. 61, no. 22, p. 2712-2714, November 30, 1992

"Heterojunction Varactors"
M. A.Frerking and J. East
Proceedings of IEEE, vol. 80, no.11, November 1992

"A New Fabrication Technique for Back-to-Back Barrier-N-N^+ (bbBNN) Varactor Diodes"
R. P. Smith, D. Choudhury, S. Martin, and M. A. Frerking
IEEE Trans. on Electron Device Letters, 1992 (submitted)

"Anomalous Capacitance of Quantum Well Double-Barrier Diodes"
O. Boric, T. Tolmunen, E. Kollberg, and M. Frerking
International Journal of Infrared and Millimeter Waves, vol.13, no. 6, p. 799-814, 1992

"Measurements on a 215 GHz Subharmonically Pumped Waveguide Mixer Using Planar Back-to-Back Air Bridge Schottky Diodes"
P. H. Siegel, R. J. Dengler, I. Mehdi, J. E. Oswald, W. L. Bishop, T. W. Crowe, and R. J. Mattauch
IEEE Trans. on Microwave Theory and Techniques, 1992 (accepted)

"A Planar Quasi-Optical SIS Receiver"
P. A. Stimson, R. J. Dengler, S. Cypher, H. G. LeDuc and P. H. Siegel
IEEE Trans. on Microwave Theory and Techniques, 1992 (accepted)

Invited Presentations

"Instruments for Future NASA Missions"
M. A. Frerking
22nd European Microwave Conference, Helsinki University of Technology, Helsinki, Finland, August 1992

"Design and Performance of a 640-GHz Subharmonically Pumped Mixer Using Planar GaAs Schottky Diodes"
P. H. Siegel, I. Mehdi, W. L. Bishop, and T. W. Crowe
1992 Joint IEEE AP-S/URSI International Symposium, Session RA12, Chicago, IL, July 23, 1992

"A Planar SIS Receiver for Array Applications"
P. A. Stimson, R. J. Dengler, P. H. Siegel, and H. G. LeDuc
1992 Joint IEEE AP-S/URSI International Symposium, Session RA12, Chicago, IL, July 23, 1992

Presentations

"Dispersion of Niobium Transmission Lines at Terahertz Frequencies"
H. H. S. Javadi, W. R. McGrath, B. Bumble, and H. G. LeDuc
Proceedings of the Third International Symposium on Space Terahertz Technology, p. 362, Univ. of Michigan, Ann Arbor, MI, March 24-26, 1992

"Silicon Micromachined Waveguides for Millimeter and Submillimeter Wavelengths"
M. Yap, Y. C. Tai, W. R. McGrath, and C. Walker
Proceedings of the Third International Symposium on Space Terahertz Technology, p. 316, Univ. of Michigan, Ann Arbor, MI, March 24-26, 1992

"A 200-GHz Tripler using Single Barrier Varactor"
D. Choudhury, M. A. Frerking, and P. D. Batelaan
Proceedings of the Third International Symposium on Space Terahertz Technology, Univ. of Michigan, Ann Arbor, MI, March 24-26, 1992

"A New Fabrication Technique for Back-to-Back Barrier-N-N+ Varactor Diodes"
R. P. Smith, D. Choudhury, S. Martin, M. A. Frerking, J. K. Liu and F. A. Grunthaner
Proceedings of the Third International Symposium on Space Terahertz Technology, Univ. of Michigan, Ann Arbor, MI, March 24-26, 1992

"Analysis of a Novel Noncontacting Waveguide Backshort"
T. M. Weller, L. P. B. Katehi, and W. R. McGrath
Proceedings of the Third International Symposium on Space Terahertz Technology, p. 298, Univ. of Michigan, Ann Arbor, MI, March 24-26, 1992

"A New Fabrication Technique for Back-to-Back Varactor Diodes"
R. P. Smith, D. Choudhury, S. C. Martin, and M. A. Frerking
Third Symposium on Space Terahertz Technology, Univ. of Michigan, Ann Arbor, MI, March 24-26, 1992

"Development of a 630 GHz SIS Mixer and Superconductive Circuit Elements"
H. H. S. Javadi, W. R. McGrath, M. Salez, J. P. Clarke, H. G. LeDuc, J. A. Stern, and B. Bumble
Applied Superconductivity Conference, Chicago, IL, August 24-28, 1992

"A Noncontacting Waveguide Backshort for Submillimeter Wave Applications"
T. M. Weller, L. P. B. Katehi, and W. R. McGrath
22nd European Microwave Conference, Helsinki Univ. of Technology, Espoo, Finland, August 25-27, 1992

"Characterization and Analysis of Back-to-Back Barrier-N-N+ (bbBNN) Varactor Devices for mm- and Submm-Wave Frequency Multipliers"
D. Choudhury, R. P. Smith, A. V. Raisanen, M. A. Frerking, and S. Martin
1993 IEEE International Microwave Symposium (submitted)

"A Back-to-Back Barrier-N-N+ (bbBNN) Diode Tripler at 200 GHz"
D. Choudhury, R. P. Smith, A. V. Raisanen, M. A. Frerking, and S. Martin
Fourth International Symposium on Space Terahertz Technology (submitted)

"A 200-GHz Planar Diode Subharmonically Pumped Waveguide Mixer with State-of-the-Art Performance"
P. H. Siegel, R. J. Dengler, I. Mehdi, W. L. Bishop, and T. W. Crowe
1992 IEEE MTT-S International Microwave Symposium, Paper O-5, p. 595-598, June 3, 1992

"Design and Measurements of a 210 GHz Subharmonically Pumped GaAs MMIC Mixer"
P. H. Siegel, S. Weinreb, S. Duncan, W. Berk, A. Eskandarian, and D. W. Tu
1992 IEEE MTT-S International Microwave Symposium, Paper O-7, p. 603-606, June 3, 1992

"A Planar Quasi-Optical SIS Receiver Suitable for Array Applications"
P. A. Stimson, R. J. Dengler, P. H. Siegel, and H. G. LeDuc
1992 IEEE MTT-S International Microwave Symposium, Paper MM-4, p. 1421-24, June 4, 1992

"A Planar Quasi-Optical SIS Receiver for Array Applications"
P. A. Stimson, R. J. Dengler, P. H. Siegel, and H. G. LeDuc
Third Int. Sym. Space Terahertz Tech.,Univ. of Michigan, Ann Arbor, MI, March 24-26, 1992

Patent and New Technology Reports

"RF Tuning Element"
W. R. McGrath and V. Lubecke
U.S. Patent No. 5,115,217, May 19, 1992

"Noncontacting Waveguide Backshort"
W. R. McGrath
U.S. Patent No. 5,138,289, August 11, 1992

"Onset of Dispersion in Nb Microstrip Transmission Lines at Submillimeter Wave Frequencies"
H. H. S. Javadi, W. R. McGrath, H. G. LeDuc, and B. Bumble
New Technology Report, NPO-18905, August 12, 1992 (filed)

"Silicon Micromachined Waveguide for Millimeter Wave and Submillimeter Wave Frequencies"
W. R. McGrath, Y. C. Tai, M. Yap, and C. Walker
New Technology Report, NPO-18903, May 19, 1992

"A New Fabrication Technique for Back-to-Back Barrier-N-N+ Varactor Diodes"
R. P. Smith, D. Choudhury, S. Martin, and M. A. Frerking
NASA Tech Briefs, NPO-18800, March 24, 1992 (accepted)

"A 200 GHz Tripler Using Single Barrier Varactor"
D. Choudhury, M. A. Frerking, and P. D. Batelaan
NASA Tech Briefs, NPO-18962 (accepted)

"Rugged Noncontact Backshorts for Waveguides"
W. R. McGrath
NASA Tech Briefs, NPO-18091, vol. 16, no. 5, p. 26-28, May 1992

"Composite GaAs-on-Quartz Substrate for Integration of Millimeter-Wave Passive & Active Device Circuitry"
P. H. Siegel, I. Mehdi, and B. Wilson
New Technology Report, NPO-83771, U.S. Patent Application, JPL No. C-18809, February 1992

Semiconducting Materials: Growth and Characterization

Publications

"Surface Morphology of Molecular-Beam Epitaxy Grown $Si_{1-x}Ge_x$ Epitaxial Layers on (100) and (110) Si"
W. T. Pike, R. W. Fathauer, and M. S. Anderson
Journal of Vacuum Science and Technology B, vol. 10, no. 4, p. 1990-1993, July/August 1992

"Microstructural Investigations of Light-Emitting Porous Si Layers"
T. George, M.A. Anderson, W.T. Pike, T.L. Lin, R.W. Fathauer, K.H. Jung, and D.L Kwong
Applied Physics Letters, vol. 60, no. 19, p. 2359-2361, May 11, 1992

"Growth Parameters Affecting the Formation of Buried $CoSi_2$ by Endotaxy of Co on Si(111)"
R.W. Fathauer and T. George
Journal of Vacuum Science and Technology A, vol. 10, no. 4, Part 3, p. 2404-2406, July/August 1992

"Co Diffusion and Growth of Buried Single-Crystal $CoSi_2$ in Si(111) by Endotaxy"
R.W. Fathauer, T. George, and W.T. Pike
Journal of Applied Physics, vol. 72, no. 5, p. 1874-1877, September 1, 1992

"New Class of Si-Based Superlattices: Alternating Layers of Crystalline Si and Porous Amorphous $Si_{1-x}Ge_x$ Alloys"
R.W. Fathauer, T. George, E.W. Jones, W.T. Pike, A. Ksendzov, and R.P. Vasquez
Applied Physics Letters, vol. 61, no. 19, p. 2350-2352, November 9, 1992

"Epitaxial Growth of p+ Silicon on a Backside-Thinned CCD for Enhanced UV Response"
Michael E. Hoenk, Paula J. Grunthaner, Frank J. Grunthaner, R. W. Terhune, Masoud Fattahi
SPIE Proceedings, vol. 1656, p. 488, 1992

"Growth of a Delta-Doped Silicon Layer by Molecular Beam Epitaxy on a Charge-Coupled Device for Reflection-Limited Ultraviolet Quantum Efficiency"
Michael E. Hoenk, Paula J. Grunthaner, Frank J. Grunthaner, R. W. Terhune, Masoud Fattahi, and Hsin-Fu Tseng
Applied Physics Letters, vol. 61, no. 9, p. 1084-1086, August 31, 1992

Invited Presentations

"Growth and Properties of Three-Dimensionally-Confined Nanometer CoSi2/Si Heterostructures"
R.W. Fathauer, T. George, E.W. Jones, A. Ksendzov, and W.T. Pike
19th Conference on the Physics and Chemistry of Semiconductor Interfaces, Death Valley, CA, January 28-30, 1992

"Cross-Hatched Surface Morphology in SiGe Epitaxial Layers on (100) Si"
W.T. Pike, R.W. Fathauer, and M. Anderson
19th Conference on the Physics and Chemistry of Semiconductor Interfaces, Death Valley, CA, January 28-30, 1992

"Columnar and Subsurface Silicide Growth with Novel Molecular Beam Epitaxy Techniques"
R.W. Fathauer
Applied Physics Seminar Series, Caltech, Pasadena, CA, March 10, 1992

"Growth and Properties of Si with Embedded CoSi2 particles"
R.W. Fathauer
March Meeting of the American Physical Society, Indianapolis, IN, March 16-20, 1992

"Columnar and Subsurface Silicide Growth with Novel Molecular Beam Epitaxy Techniques"
R. W. Fathauer, T. George, A. Ksendzov, and W. T. Pike
Spring Meeting of the Materials Research Society, San Francisco, CA, April 27-May 1, 1992

"Microdiffraction and its Applications"
W. T. Pike
Birkbeck College, London University, London, UK, July 29, 1992

"Epitaxial Growth of Metal Silicide/Silicon Structures"
Robert W. Fathauer
Materials Science Department seminar, University of Southern California, Los Angeles, CA, November 20, 1992

Presentations

"Energy-Filtered Microdiffraction in a Dedicated Scanning Transmission Electron Microscope"
W. T. Pike
Frontiers in Electron Microscopy and Materials Science, Berkeley, CA, April 21-24, 1992

"Strain Relief in $Si_{1-x}Ge_x$ Epitaxial Layers Grown on (110) Si Substrates"
W. T. Pike, T. George, and R. W. Fathauer
Frontiers in Electron Microscopy and Materials Science, Berkeley, CA,
April 21-24, 1992

"Amorphous Si Formation by the Etching of Single-Crystal Si Substrates"
T. George, R. W. Fathauer, T. L. Lin, W. T. Pike, and R. P. Vasquez
Spring Meeting of the Materials Research Society, San Francisco, CA,
April 27-May 1, 1992

"Si Surface Chemistry and Low Temperature MBE Growth of a Delta-Doped Si Layer on a Commercial Charge-Coupled Device for Reflection-Limited UV Quantum Efficiency"
F. J. Grunthaner, Michael E. Hoenk, Paula J. Grunthaner, R. W. Terhune, Masoud Fattahi, and Hsin-Fu Tseng
7th International Conference on Molecular Beam Epitaxy, Schwäbisch Gmünd, Germany, August 24-28, 1992

Patent and New Technology Reports

"Growth of Delta-Doped Layers on Silicon Charge-Coupled Devices"
Michael. E. Hoenk, Paula J. Grunthaner, Frank J. Grunthaner, Robert Terhune, and Michael Hecht
NASA Tech Briefs, NPO-18688, June 26, 1992 (filed)

"Silicon Sample Holder for Moleuclar Beam Epitaxy"
Michael E. Hoenk, Paula J. Grunthaner, and Frank J. Grunthaner
NASA Tech Briefs, NPO-18687, June 26, 1992 (filed)

"Method for Fabrication of Buried Porous Silicon-Germanium Alloy Layers in Single-Crystal Silicon Substrates"
R. W. Fathauer and T. George
New Technology Report, NPO-18836 (submitted)

"Polarized Cathodoluminescence Study of Uniaxial and Biaxial Stress in GaAs/Si"
C. H. Rich, A. Ksendzov, R. W. Terhune, F. J. Grunthaner, and B. A. Wilson
NASA Tech Briefs, NPO-18353, June 1992 (filed, patent pending)

Electronic Device Technology

Publications

"Epitaxial Growth of p+ Silicon on a Backside-Thinned CCD for Enhanced UV Response"
Michael E. Hoenk, Paula J. Grunthaner, Frank J. Grunthaner, R. W. Terhune, and Masoud Fattahi
SPIE Proceedings, vol. 1656, p. 488, 1992

"Growth of a Delta-Doped Silicon Layer by Molecular Beam Epitaxy on a Charge-Coupled Device for Reflection-Limited Ultraviolet Quantum Efficiency"
Michael E. Hoenk, Paula J. Grunthaner, Frank J. Grunthaner, R. W. Terhune, Masoud Fattahi, and Hsin-Fu Tseng
Applied Physics Letters, vol. 61, no. 9, p. 1084, August 31, 1992

"CCD Focal-Plane Image Reorganization Processors for Lossless Image Compression"
S. E. Kemeny, H. Torbey, H. Meadows, R. Bredthauer, M. LaShell, and E. R. Fossum
IEEE Journal Solid-State Circuits, vol. 27, no. 3, p. 398-405, March 1992

"An Analysis of the Temperature Dependence of the Gate Current in Complementary Heterojunction Field-Effect Transistor"
T. J. Cunningham, E. R. Fossum, and S. M. Baier
IEEE Electron Device Letters, vol. 13, no. 12, p. 645-647, 1992

"Gallium Arsenide-Based Readout Electronics"
T. J. Cunningham and E. R. Fossum
NASA/JPL Workshop Proceedings on Innovative LWIR Detectors, Pasadena, CA, April 1992

"Noise and Current-Voltage Characterization of CHFET Structures Below 8 K"
T. J. Cunningham and E. R. Fossum
Infrared Readout Electronics, SPIE Proceedings vol. 1684, p. 84-92, 1992

"Real-Time Processor for Staring Receivers"
B. R. Hanzal, A. Peczalski, J. C. Schwanabeck, R. Sanderson, and E. R. Fossum
Infrared Readout Electronics, SPIE Proceedings vol. 1684, p. 257-266, 1992

"Infrared Readout Electronics"
E. R. Fossum, ed.
SPIE Proceedings, vol. 1684, 1992

"A Resistive-Gate InAlAs/InGaAs/InP 2DEG CCD"
D.V. Rossi, A. Cheng, H. Wieder, and E. R. Fossum
Proceedings 1992 IEEE International Electron Devices Meeting, San Francisco, CA December 1992

"Study on High-Speed Imaging Technology for the Microgravity Containerless Processing Facility"
E. R. Fossum
JPL Project Document, September 1992

"Concurrent Processor ASIC for High Speed Path Planning"
S. E. Kemeny, T. J. Shaw, R. H. Nixon, T. Daud, and E. R. Fossum
Proceedings GOMAC '92, Las Vegas, NV, November 1992

"Current Switching and Modulation Based on Electron Interference in Electron Waveguides: A Zero Gap Electron Wave Coupler"
M. Thomas, N. Dagli, J. Waldman, A. Gossard, E. Yuh, E. Gwinn, R. Muller, and P. Maker
Trans. of Electron Devices, vol. 39, no. 11, p. 2643, November 1992

Presentations

"A New Fabrication Technique for Back-to-Back Varactor Diodes"
R. P. Smith, D. Choudhury, S. C. Martin, and M. A. Frerking
Space Terahertz Meeting, Ann Arbor, Michigan, March 1992

"Si Surface Chemistry and Low-Temperature MBE Growth of a Delta-Doped Si Layer on a Commercial Charge-Coupled Device for Reflection-limited UV Quantum Efficiency,"
F. J. Grunthaner, Michael E. Hoenk, Paula J. Grunthaner, R. W. Terhune, Masoud Fattahi, and Hsin-Fu Tseng
7th International Conference on Molecular Beam Epitaxy, Schwäbisch Gmünd, Germany, August 24-28, 1992

"Gallium Arsenide-Based Readout Electronics"
T. J. Cunningham and E. R. Fossum
NASA/JPL Workshop on Innovative LWIR Detectors, Pasadena, CA, April 1992

"Noise and Current-Voltage Characterization of CHFET Structures Below 8 K"
T. J. Cunningham and E. R. Fossum
SPIE Conference on Infrared Readout Electronics, Orlando, FL, April 1992

"Real-Time Processor for Staring Receivers"
B. R. Hanzal, A. Peczalski, J. C. Schwanabeck, R. Sanderson, and E. R. Fossum
SPIE Conference on Infrared Readout Electronics, Orlando, FL, April 1992

"A Resistive-Gate InAlAs/InGaAs/InP 2DEG CCD"
D. V. Rossi, A. Cheng, H. Wieder, and E. R. Fossum
1992 IEEE International Electron Devices Meeting, San Francisco, CA, December 1992

Patent and New Technology Reports

"A New Fabrication Technique for Back-to-Back Varactor Diodes"
R. P. Smith, D. Choudhury, S. C. Martin, and M. A. Frerking
NASA Tech Briefs, NPO-18800, July 1992 (accepted)

"Growth of Delta-Doped Layers on Silicon Charge-Coupled Devices"
Michael. E. Hoenk, Paula J. Grunthaner, Frank J. Grunthaner, Robert Terhune, and Michael Hecht
NASA Tech Briefs, NPO-18688 (submitted)

"Silicon Sample Holder for Molecular Beam Epitaxy"
Michael E. Hoenk, Paula J. Grunthaner, and Frank J. Grunthaner
NASA Tech Briefs, NPO-18687 (U.S. patent pending)

"Active Pixel Cosmic Ray Sensor"
E. R. Fossum, T. J. Cunningham, and M. J. Holtzman,
New Technology Report, NPO-18975/8558 (submitted)

"Active Pixel Sensor Structure Using Junction Field-Effect Devices"
E. R. Fossum, T. J. Cunningham, T. Krabach, and C. Staller
New Technology Report, NPO-18978/8562, (submitted)

"CCD with Backside Illumination and Charge Steering"
E. R. Fossum
NASA Tech Briefs, NPO-18387, vol. 16, no. 9, p. 30, September 1992

"Optical Link for Readout From Focal-Plane Array"
E. R. Fossum, A. G. Larsson, and J. Maserjian
NASA Tech Briefs, NPO-18481, vol. 16 , no. 10, pp. 30-31, 1992

"Delta-Doped Buried Channels in Charge-Coupled Device"
E. R. Fossum
NASA Tech Briefs, NPO-18372, vol. 16, no. 12, p. 28, December 1992

Microinstrument Technology

Publications

"Phase Holograms in PMMA"
P. D. Maker and R. E. Muller
Journal of Vacuum Science and Technology B, vol. 10, no. 6, p. 2516-2519, November/December 1992

"A Fixed Tuned Broadband Matching Structure for Submillimeter SIS Receivers"
T. H. Buttgenbach, H. G. LeDuc, P. D. Maker, and T. G. Phillips
IEEE Trans. of Applied Superconductivity, vol. 2, no. 3, September 1992
(Invited Presentation)

"Smart Focal-Plane Technology for Microinstruments and MicroRovers"
E. R. Fossum
Proceedings 1992 NASA/OAST Workshop on Microtechnologies and Applications to Space Systems, Pasadena, CA, May 1992

"Microinstruments and Microsensors for Space Science"
W. J. Kaiser, G. Varsi, M. Chrisp, R. Jones, T. R. VanZandt, T. W. Kenny, W. Vanerdt, E. Hui, and D. Crisp
World Space Congress, Publication 1-M.3.04, Washington, DC, August 28 - September 5, 1992 (in press)

Invited Presentations

"Development of a Microseismometer at JPL"
T. R. VanZandt, T. W. Kenny, W. J. Kaiser, and B. Banerdt
Seismology Seminar, Caltech, Pasadena, CA, February 1992

"Microsensors and Microinstruments: New Measurement Principles and New Applications"
W. J. Kaiser, T. R. VanZandt, T. W. Kenny, W. B. Banerdt, and D. Crisp
1992 Microtechnology Workshop, Jet Propulsion Laboratory, Pasadena, CA, May 27, 1992

"Probing the Electronic Structure of Semiconductor Interfaces"
M. H. Hecht
JPL Technology Board Seminar, Jet Propulsion Laboratory, Pasadena, CA, September 14, 1992

Presentations

"Phase Holograms in PMMA"
P. D. Maker and R. E. Muller
36th International Symposium on Electron, Ion and Photon Beams, Orlando, FL, May 26, 1992

"Binary Optics at JPL"
Binary Optics Workshop, Sponsored by NASA Office of Aeronautics and Space Technology, GRC, Vienna, VA, July 28, 1992

"Development of a Microseismometer for Earth and Mars Applications"
W. J. Kaiser, T. R. VanZandt, W. B. Banerdt, and P. E. Malin
American Geophysical Union, San Francisco, CA, December 1992

"Novel Position Sensor Technologies for Micro Accelerometers"
T. R. Van Zandt, T. W. Kenny, and W. J. Kaiser
SPIE meeting, Orlando, FL, April 1992 (in press)

"Development of a Microseismometer at JPL"
T. R. VanZandt, T. W. Kenny, W. J. Kaiser, and B. Banerdt
Joint IRIS/Seismological Society of America Meeting, Santa Fe, NM, April 1992

"Current Switching and Modulation Based on Electron Interference in Electron Waveguides: A Zero Gap Electron Wave Coupler"
M. Thomas, N. Dagli, J. Waldman, A. Gossard, A. Yuh, E. Gwinn, R. Muller, and P. Maker
Device Research Conference, Cambridge, MA, June 1992

"Smart Focal-Plane Technology for MicroInstruments and MicroRovers"
E. R. Fossum
NASA/OAST Workshop on Microtechnologies and Applications to Space Systems, JPL & Pasadena Convention Center, Pasadena, CA, May 1992

Patent and New Technology Reports

"Phase Holograms in PMMA"
P. D. Maker and R. E. Muller
New Technology Report, NPO-18791/8359, June 1992 (filed)

"A Miniature, High Performance Hygrometer"
T. R. VanZandt, W. J. Kaiser, and T. W. Kenny
New Technology Report, NPO-19028, March 1993 (filed, patent pending)

"A Miniature, Wide-Bandwidth, Capacitive Motion Sensor"
T. R. VanZandt, W. J. Kaiser, and T. W. Kenny
New Technology Report, NPO-18794, May 5, 1992 (filed, patent pending)

"Single-Crystal Spring Mechanical System for Low-Mass Motion Sensors"
T. R. Van Zandt, W. J. Kaiser, and T. W. Kenny
New Technology Report, NPO-18795, May 5, 1992 (filed, patent pending)

"An Ultra-High Frequency Capacitive Position Sensor"
T. R. Van Zandt, T. W. Kenny, and W. J. Kaiser
New Technology Report, NPO-18675, May 5, 1992 (filed, patent pending)

"High-Performance Circuit for Capacitance Measurement in Sensors"
W. J. Kaiser, T. W. Kenny, and T. R. Van Zandt
New Technology Report, NPO-8599 (submitted)

"A Low-Mass Accelerometer Employing an Ultra-High Frequency Capacitive Position Sensor"
T. R. Van Zandt, T. W. Kenny, and W. J. Kaiser
New Technology Report, NPO-18795, NPO-18675, NPO-18794
May 5,1992 (filed, patent pending)

II. Photonics

OVERVIEW

This section concentrates on optoelectronic materials and devices. Optical processing is included in the section on Advanced Computing. Optoelectronic devices that generate, detect, modulate, or switch electromagnetic radiation are being developed for a variety of space applications. The program includes spatial light modulators, solid-state lasers, optoelectronic integrated circuits, nonlinear optical materials and devices, fiber optics, and optical networking photovoltaic technology and optical processing.

1992 MAJOR TECHNICAL ACHIEVEMENTS

Lasers

- **Patterned** gratings incorporating /4 phase shift for DFB lasers.
- **Demonstrated** a mode-locked erbium doped fiber optic ring laser, which can produce tunable, 500-femtosecond pulses with 1-kW peak power in the 1.55-micrometer regime.
- **Demonstrated** the world's first continuous operation of InGaAs/InP lasers up to 2.0 micrometers in wavelength. These lasers are essential for LIDAR and spectroscopy applications.
- **Developed** state-of-the-art single-mode lasers at 940 nm for spectroscopy and computer interconnects.

Optoelectronic Materials and Characterization

- **Examined** thick porous SiGe alloy samples with a range of Ge content. Upon stain etching of MBE grown layers, the samples are found to become much more Ge rich. Photoluminescence measurements of these samples show that the luminescence intensity decreases dramatically with increasing Ge content, without significant shifts in the peak position.

Optoelectronic Integrated Circuits

- **Designed** state-of-the-art low-damage chemical-assisted ion etching system, which is going to be used for the fabrication of submicrometer OEIC structures.
- **Patterned** growth of high-quality GaAs for fabrication of quantum dot and quantum wire structures.

Infrared Detectors

- **Fabricated** stacked (multiple layer) HIP SiGe/Si IR detectors. For initial study, two stacked detectors (2 periods of 100Å-$Si_{0.7}Ge_{0.3}$ (p^+)/Si and 4 periods of 50Å-$Si_{0.7}Ge_{0.3}$ (p^+)/Si) and a single-layer detector (200 Å-$Si_{0.7}Ge_{0.3}$ (p^+)/Si) were fabricated. The idea is to improve the internal quantum efficiency (collection efficiency of photo-generated carriers at the collector) by using multiple SiGe layers. TEM micrographs showed good crystalline quality of the SiGe/Si multilayers. Similar current-voltage characteristics were observed for the stacked devices compared to the single-layer device.

- **Demonstrated** the first LWIR PtSi infrared detectors by incorporating a 1-nm-thick p^+ doping spike at the PtSi/Si interface. Three doping-spike PtSi infrared detector samples with boron doping concentrations of 2 $x10^{19}$ to 2 x 10^{20} cm^{-3} were fabricated by growing the doping spikes at 400°C using MBE. The effective PtSi Schottky barrier heights of these samples decrease with increasing boron doping concentrations. Doping spike PtSi detectors with cutoff wavelengths of 6.5, 9, 11, 14, 18, & 22 μm have been demonstrated. Furthermore, QE @ 5 μm has been improved by more than two orders of magnitude compared to that of the conventional PtSi detector.

- **Carried out** ground-based radiation test results of the SiGe HIP detectors by exposing these devices to 1 Mrad of Co-60/Am-241 and 1 Mrad of 8.5-MeV protons. No increase in the device dark current was observed after the radiation. The current-voltage characteristics of the detectors were measured at temperatures ranging from 70 to 140 K. The activation energy analysis of these devices showed that the Richardson constant was increased by a factor of two, and the potential barrier was increased by less than 5% compared to those of the unradiated devices. The increased potential barrier indicates that the strain SiGe layer does not relax after radiation.

- **Developed** an antireflection coating technology for SiGe HIP detectors operating at 8-12 μm. The antireflection coating consists of 1.7 μm thick ZnS. FTIR measurement of a Si substrate with antireflection coating indicated an improvement in absorption of more than 30% in the LWIR region.

- **Used** a new amorphous Ge deposition technique for the optical cavity formation of SiGe HIP detector arrays.

- **Developed** a subpicosecond pulse detection and optical thresholding system for performing real-time detection of correctly decoded CDMA pulses.

- **Demonstrated** germanium blocked impurity band far-infared (80-200 μm) detector arrays in small formats (2x8) with good quantum efficiency and low dark current.

Nonlinear Optics and Optical Processing

- **Demonstrated** motion-enhanced correlation using degenerated four-wave mixing in photorefractive CdTe, which shows both optical correlation and novelty filtering phenomena.
- **Demonstrated** high-speed pattern correlation using photodiffractive effect in Cr-doped GaAs/AlGaAs semi-insulating multiple-quantum wall structure. (Collaboration with the Bell Laboratories)
- **Developed** nonlinear optical dyes with unprecedented nonlinear polarizability, a factor of 20 larger than conventional molecules such as Disperse Red 1.
- **Demonstrated** twelvefold increase in electro-optic coefficient for a polymer film containing new JPL-developed nonlinear optical dyes as compared to polymer containing conventional Disperse Red 1 dye.
- **Developed** a model for polar packing of molecules in two-component layered crystal systems that provides a strategy for development of noncentrosymmetric nonlinear optical materials.
- **Demonstrated** factor of two enhancement in optical limiting performance for Pb and In containing phthalocyanine dyes as compared to previous state-of-the-art phthalocyanines, resulting in performance in the range needed for eye protection.
- **Developed** sol-gel and polymeric solid-state nonlinear absorptive limiter materials containing phthalocyanine dyes with energy-handling capability in excess of 1 J/cm^2, which meets the requirement for limiter devices for eye protection.
- **Developed** new theoretical procedure that uses geometry optimization in the presence of electric fields to probe the relationships between molecular structure and nonlinear polarizability of organic compounds.
- **Demonstrated** a relationship between bond length alternation in conjugated linear chain molecules and their nonlinear polarizability, which gives for the first time a systematic strategy for the optimization of the nonlinear polarizability of molecules of a given length.

- **Demonstrated** the tuning of the third-order polarizability of donor/acceptor polyene molecules by variation of solvent polarity and acceptor strength, allowing maximization, sign reversal, and a crossing through zero of the third-order polarizability.

- **Developed** a UV-transparent bio-organic nonlinear optical crystal capable of optical second-harmonic generation of 1064-nm light with an efficiency exceeding that of conventional KD^*P crystals.

Fiber Optics

- **Showed** that performance of fiber cables in orbit on LDEF is consistent with laboratory measurements of radiation damage.

- **Demonstrated** a fiber-based system for demonstrating code-division multiple-acess (CDMA) all-optical networking.

Space Environmental Effects on Materials

- The mechanism for the atomic oxygen erosion of perfluorinated polymeric materials (Teflon™) has been further elucidated. The bombardment of virgin Teflon™ with hyperthermal atomic oxygen yielded no reaction products as a result of the impact, while similar material recovered from the trailing edge of LDEF-emitted CO_2 when exposed to the same beam. This suggests that in space the photolyzed or photo-oxidized layer that forms on fluorinated polymers is reactive to atomic oxygen and gives rise to degradation observed in these materials.

- The direct erosion of Kaptan™ thermal blanket material by atomic oxygen was confirmed by the detection of CO and CO_2 reaction products during O-atom bombardment. Observation of a bimodal product distribution in the time-of-flight spectra for the CO product suggests that several different mechanisms are involved in the erosion process.

- The installation and characterization of the straggled proton beam hardware at Caltech's Kellogg Radiation Laboratory has been successfully completed. The proton beam produced compared favorably with theoretical predictions, and studies on the broadband radiation of multilayer structures have been initiated.

Photonics Systems

- **Demonstrated** feasibility of optical readout of a focal plane array using a MQW waveguide modulator

- **Designed** and **built** a thermoelectric cooler (TEC) controller. Using this controller, the operating temperature of a laser diode can be stabilized to within 0.02 degree Celsius, in the 0-to-50-degree-Celsius range. Furthermore, it can be used to perform temperature tuning of the laser's wavelength.

Remote Sensing Technology

- **Designed** and **assembled** an acousto-optic tunable filter (AOTF) polarimetric and hyperspectral imaging prototype system for remote sensing applications from ground platform. Tests of its performance are in progress.

- **Completed** a preliminary design on development of real-time, programmable, AOTF hyperspectral imaging systems to be used from Learjet and space-shuttle platforms.

TECHNICAL PROGRESS REPORTS

Spatial Light Modulators

Publications

"Project Management: A Multimedia Perspective"
S. Shen
9th International Conference on Data Engineering, September 1992

"Object-Oriented Classification for Software Reuse: Knowledge Base Overview"
B. Beckman and M.K. Summers
Submitted for publication in IEEE Software, August 1992

Patent and New Technology Reports

"All Optical Photochromic Spatial Light Modulators Based on Photoinduced Electron Transfer in Rigid Matrices"
D. N. Beratan and J. W. Perry
U. S. Patent No. 5.062,693, November 5, 1991

Lasers

Publications

"InGaAs/InGaAsP/InP Strained-Layer Quantum Well Lasers at ~2 μm"
S. Forouhar, A. Ksendzov, A. Larsson, and H. Temkin
Electron. Letters, vol. 28, no.15, p. 1431-1432, July 1992

"Room-Temperature Operation of MOCVD-Grown GaInAs/InP Strained-Layer Multiquantum Well Lasers in 1.8-μm Range"
S. Forouhar, A. Larsson, A. Ksendzov, R.J. Lang, N. Tothill, and M.D. Scott
Electron. Letters, vol. 28, no. 10, p. 945-947, May 7, 1992

Patent and New Technology Reports

"Safety Enclosure for a MOCVD Process Chamber"
J. Singletery, J. Warner, and H. Velasquez
New Technology Report, NPO-18872 (submitted)

"Hyperbolic Grating Unstable Resonator Oscillator Amplifier Laser Diode"
R. J. Lang, M. Mittelstein, R. C. Tiberio, S. Forouhar, and D. Crawford
New Technology Report, NPO-18804 (patent pending)

"Strained Layer InGaAs/InP Quantum Well Lasers"
S. Forouhar, A. G. Larsson, A. Ksendzov, and R. J. Lang
C-18827, April 2, 1993 (filed)

Optoelectronic Materials and Characterization

Publications

"Visible Luminescence from Silicon Wafers Subjected to Stain Etches"
R. W. Fathauer, T. George, A. Ksendzov, and R. P. Vasquez
Applied Physics Letters, vol. 60, no. 8, p. 995-997, February 24, 1992

"Electronic Structure of Light-Emitting Porous Si"
R. P. Vasquez, R. W. Fathauer, T. George, A. Ksendzov, and T. L. Lin
Applied Physics Letters, vol. 60, no. 8, p. 1004-1006, February 24, 1992

"The Use of Ultraviolet Radiation at the Congruent Sublimation Temperature of Indium Phosphide to Produce Enhanced inp Schottky Barriers"
J. Singletery and J. R. Shealy
Journal of the Electrochem., vol. 9, p. 2961, 1992

"Temperature Dependence of the Property of the DBR Mirrors Used in Surface Normal Optoelectronic Devices"
J. J. Dudlery, D. L. Crawford, and J. E. Bowers
IEEE Photonic Tech. Lett. vol. 4, no. 4, p. 311-314, April 1992

Invited Presentations

"Strained layer semiconductor lasers"
D. L. Crawford
Invited talk for the ECE Department, UCSB, May 1992

Presentations

"Study of Interband Optical Transitions between Confined States in $In_xGa_{1-x}As$ Single Quantum Wells and Continuum States in GaAs Barrier"
A. Ksendzov, W. T. Pike, and A. Larsson
March Meeting of the American Physical Society, Indianapolis, IN,
March 16-20, 1992

"Low Threshold Continuous Operation of InGaAs/InGaAsP Multiquantum Well Lasers at ~ 2.0 μm"
S. Forouhar, S. A. Keo, A. Ksendzov, A. Larsson, and H. Temkin
13th IEEE International Semiconductor Laser Conference, Takamatsu, Kagawa, Japan, September 1992

"Room-Temperature Operation of MOCVD-Grown GaInAs/InP Strained-Layer Multiquantum Well Lasers in the 1.8-μm Range"
S. Forouhar, A. Larsson, A. Ksendzov, and R. J. Lang
IEEE 50th Annual Device Research Conference, Cambridge, MA, June 1992

Patent and New Technology Reports

"Method for Selective Formation of Light-Emitting Porous Silicon on Silicon Substrates"
R. W. Fathauer and E. W. Jones
New Technology Report, NPO-18735 (submitted)

"Fabrication of Nanometer Single-Crystal Metallic CoSi2 Structures on Si"
K.-W. Nieh, T.-L. Lin, and R.W. Fathauer
U. S. Patent No. 5,075,243, February 1992

Optoelectronic Integrated Circuits

Publications

"The Use of Ultraviolet Radiation at the Congruent Sublimation Temperature of Indium Phosphide to Produce Enhanced Inp Schottky Barriers"
J. Singletery and J.R. Shealy
Journal of the Electrochem., vol. 9, p. 2961, 1992

"Temperature Dependence of the Property of the DBR Mirrors Used in Surface Normal Optoelectronic Devices"
J.J. Dudlery, D.L. Crawford, and J.E. Bowers
IEEE Photonic Tech. Lett. vol. 4, no. 4, p. 311-314, April 1992

Presentations

"Low Threshold Continuous Operation of InGaAs/InGaAsP Multiquantum Well Lasers at ~ 2.0 μm"
S. Forouhar, S.A. Keo, A. Ksendzov, A. Larsson, and H. Temkin
13th IEEE International Semiconductor Laser Conference, Takamatsu, Kagawa, Japan, September 1992

"Room-Temperature Operation of MOCVD-Grown GaInAs/InP Strained-Layer Multiquantum Well Lasers in the 1.8-μm Range"
S. Forouhar, A. Larsson, A. Ksendzov, and R.J. Lang
IEEE 50th Annual Device Research Conference, Cambridge, MA, June 1992

Infrared Detectors

Publications

"Elemental Boron-Doped p+-SiGe Layers Grown by Molecular Beam Epitaxy for Infrared Detector Applications"
T. L. Lin, T. George, E. W. Jones, A. Ksendzov, and M. L. Huberman
Applied Physics Letters, vol. 60, no. 3, p. 380-382, January 20, 1992

"SiGe/Si Camel-Barrier Heterojunction Internal Photoemission LWIR Detector"
T. L. Lin, S. Dejewski, E. W. Jones, and A. Ksendzov
IEEE Trans. Electron Devices, vol. 38, no. 12, p. 2696, December 1991

Patent and New Technology Reports

"Technique for Preparing High Purity Gallium Doped Germanium (Ge:Ga) Epitaxy"
T. Krabach (JPL) and J. E. Huffman (Rockwell International)
NASA Tech Briefs, NPO-18961 (submitted)

"Technique for Depth Profiling Carrier Density in High Purity Narrow Band Gap Materials"
T. Krabach (JPL) and J. E. Huffman (Rockwell)
NASA Tech Briefs, NPO-18962 (submitted)

Nonlinear Optical Materials

Publications

"Optical Processing with Photorefractive Compound Semiconductors"
L.-J. Cheng, D. T. H. Liu, and K. L. Luke
International Journal Nonlinear Optical Physics, vol.1, p. 609, 1992

"GaAs-Based Photorefractive Time-Integrating Correlator"
D. T. H. Liu, K. L. Luke, and L.-J. Cheng
Optical Pattern Recognition III, SPIE Proceedings vol. 1702, p. 205, 1992

"Novelty Filtered Optical Correlator Using Photorefractive Crystal"
D. T. H. Liu, T.-H. Chao, and L.-J. Cheng
Hybrid Image and Signal Processing III, SPIE Proceedings, vol. 1701, p. 105, 1992

"The Synthesis and Spectroscopic Properties of Organometallic Cyanine Analogues"
J. M. Spotts, W. P. Schaefer, and S. R. Marder
Advanced Materials, vol. 4, no. 2, p. 100-102, February 1992

"The First Molecular Electronic Hyperpolarizabilities of Highly Polarizable Organic Molecules: 2,6-Di-tert-Butylindoanilines"
S. R. Marder, L.-T. Cheng, and B. Tiemann
Journal Chemical Society (London) Section D Chemical Communications, vol. 9, pp. 672-674, 1992

"Second-Order Nonlinear Optical Properties of Diiron Alkenylidyne Complexes"
J. A. Bandy, H. E. Bunting, M. H. Garcia, M. L. H. Green, S. R. Marder, M.E. Thompson, D. Bloor, P.U. Kolinsky, R.J. Jones, and J.W. Perry
Polyhedron, vol. 11, p. 1489, 1992

"The Synthesis of Ferrocenyl Compounds with Second-Order Optical Nonlinearities"
M. L. H. Green, S. R. Marder, M. E. Thompson, D. Bloor, P. U. Kolinsky, and R. J. Jones
Polyhedron, vol. 11, p. 1489, 1992

"Direct Measurements of Nonlinear Absorption and Refraction in Solutions of Phthalocyanines"
T. H. Wei, D. J. Hagan, M. J. Sence, E. W. Van Stryland, J. W. Perry, and D. R. Coulter
Applied Physics B, vol. 54, no. 1, p. 46-51, January 1992

"Enhanced Nanosecond Optical Limiting in Metallophthalocyanine Solutions"
J. W. Perry, K. Mansour, E. T. Sleva, K. J. Perry, S. R. Marder, and D. Alvarez
Conference on Lasers and Electro-Optics, OSA Technical Digest, vol. 12, p. 120, Optical Society of America, Washington, DC, 1992

"Structure Property Relationships for Molecular Second-Order Nonlinear Optics"
S. R. Marder, D. N. Beratan, and L.-T. Cheng
American Institute of Physics Conference Proceedings, 272: Molecular Electronics Science and Technology, A Aviram, Ed., p. 252, American Institute of Physics, New York, 1992

"Nonlinear Polarizabilities of Symmetric and Nonsymmetric Polyene and Cyanine-Like Molecules"
J. W. Perry, S. R. Marder, G. Bourhill, K. Mansour, C. B. Gorman, and B. G. Tiemann
Nonlinear Optics: Materials, Fundamentals and Applications, OSA Technical Digest, vol. 18, p. 476, Optical Society of America, Washington, DC, 1992

"Organic Materials for Nonlinear Optical Devices"
J. W. Perry, and S. R. Marder
Space Microelectronics, Issue 4, pp. 36-43, Jet Propulsion Laboratory, Pasadena, CA, Summer 1992

"4-N-Methylstilbazolium Tosylate Salts with Large Second-Order Optical Nonlinearities"
S. R. Marder, J. W. Perry, and W. P. Schaefer
Journal of Materials Chemistry, vol. 2, p. 985, 1992

"Optimizing the Second-Order Optical Nonlinearities of Organic Molecules: Asymmetric Cyanines and Highly Polarized Polyenes"
S. R. Marder,C. B. Gorman, L. T. Cheng, and B. G. Tiemann
SPIE Proceedings, 1775, 1992 (in press)

"Synthesis and Nonlinear Optical Properties of Sol-Gel Materials Containing Phthalocyanines"
P. D. Fuqua, K. Mansour, D. Alvarez, S. R. Marder, J. W. Perry, and B. S. Dunn
SPIE Proceedings, 1992 (in press)

"Photorefractive Image Processing Using Compound Semiconductors"
L.-J. Cheng, D. T. H. Liu, and K. L. Luke
International Journal of Optical Computing, 1992 (accepted)

Presentations

"Optimization of the First Hyperpolarizability of Organic Molecules"
S. Risser, D. Beratan, and S. Marder
American Physical Society National Meeting, March 1992

"Enhanced Nanosecond Optical Limiting in Metallophthalocyanine Solutions"
J.W. Perry, K. Mansour, E.T. Sleva, K.J. Perry, S.R. Marder, and D. Alvarez
Conference on Lasers and Electro-Optics, Anaheim, CA, April 1992

"Optimizing the Second-Order Optical Nonlinearities of Organic Molecules: Asymmetric Cyanines and Highly Polarized Polyenes"
S.R. Marder
SPIE National Meeting, San Diego, CA, July 1992

"Synthesis and Nonlinear Optical Properties of Sol-Gel Materials Containing Phthalocyanines"
P.D. Fuqua, K. Mansour, D. Alvarez, S.R. Marder, J.W. Perry, and B.S. Dunn
SPIE National Meeting, San Diego, CA, July 1992

"Nonlinear Polarizabilities of Symmetric and Nonsymmetric Polyene and Cyanine-Like Molecules"
J. Perry, S.R. Marder, G. Bourhill, K. Mansour, C.B. Gorman, and B.G. Tiemann
Nonlinear Optics: Materials, Fundamentals and Applications, Optical Society of America International Meeting, Maui, HI, August 1992

"Optical Limiters Based on Excited State Absorption in Phthalocyanine Complexes"
J.W. Perry
Fourth Annual Review of the Advanced Laser Protection Program,
Washington, DC, August 1992

"GaAs-Based Photorefractive Time-Integrating Correlator"
D.T.H.Liu, K.L. Luke, and L.-J. Cheng
SPIE Conference on Optical Pattern Recognition III, Orlando, FL, 1992

"Novelty Filtered Optical Correlator Using Photorefractive Crystal"
D.T.H.Liu, T.-H. Chao, and L.-J. Cheng
SPIE Conference on Optical Pattern Recognition III, Orlando, FL, 1992

Invited Presentations

"Optical Limiters Based on Excited State Absorption in Macrocyclic Dye Complexes"
J. W. Perry
Hughes Research Laboratory, Malibu, CA, January 1992

"Organic Materials for Nonlinear Optical Devices"
J. Perry
Optical Sciences Section, Jet Propulsion Laboratory, Pasadena, CA,
February 1992

"Optimization of Organics for Nonlinear Optics"
S. Marder
IBM, Almaden, CA, and Lockheed, Palo Alto, CA, March 1992

"Organic Materials for Nonlinear Optical Devices"
J. Perry
Canadian Forces School of Aerospace Studies, Jet Propulsion Laboratory, Pasadena, CA, March 1992

"Structure-Property Relationships for Nonlinear Optical Materials"
S. Marder
American Chemical Society Workshop: "Organic Optoelectronic Materials," Monterey, CA, April 1992

"Structure-Property Relationships for Second-Order Nonlinear Optical Polarizabilities"
S. Marder
Raychem, Inc., Menlo Park, CA, May 1992

"Structure-Property Relationships for Second-Order Nonlinear Optical Polarizabilities"
S. Marder
Stanford Univ., Palo Alto, CA, May 1992

"Design and Fabrication of Organic Nonlinear Optical Materials and Devices"
J. W. Perry and S. R. Marder
JPL/Caltech Administration Quarterly Management Meeting, California Institute of Technology, Pasadena, CA, June 1992

"Bond Alternation and Nonlinear Optical Properties of Organic Compounds"
S. R. Marder
Progress in Nonlinear Optics: Organic and Polymeric Materials, Pullman, WA, July 1992

"Structure-Property Relationships for Second-Order Nonlinear Optical Polarizabilities"
S. Marder
Du Pont, Wilmington, DE, August 1992

"Basic Design Strategies for Nonlinear Optical Materials"
S. R. Marder
American Chemical Society National Meeting, Washington, DC, August 1992

"Design and Fabrication of Organic Nonlinear Optical Materials and Devices"
J. W. Perry and S. R. Marder
Director's Topical Research Seminar, Jet Propulsion Laboratory, Pasadena, CA, September 1992

"The Relationship Between Bond Length Alternation and Nonlinear Hyperpolarizabilities"
S. R. Marder, G. H. Bourhill, L.-T. Cheng, A. Friedli, S. Gilmour, C. B. Gorman, K. Mansour, J. W. Perry, and B. G. Tiemann
US-France Workshop on Optical Materials, Maubaisson, France, September 28 - October 3, 1992

"A Chemist's View of Nonlinear Optical Materials"
S. R. Marder
National Academy of Sciences Frontiers in Science Conference, Irvine, CA, November 5-7 1992

"Optimizing the Nonlinear Optical Properties of Organic Materials"
S. R. Marder
Ultrafine Particles in Glassy Matrices Conferences, Sponsored by Nippon Sheet Glass, Osaka, Japan, November 10-13, 1992

"Nonlinear Polarizabilities of Symmetric and Nonsymmetric Polymethine Dyes"
J. W. Perry
Chemistry Department, Univ. of Pittsburgh, PA, November 1992

Patent and New Technology Reports

"Real-Time Edge-Enhanced Optical Correlator"
T.-H. Liu and L.-J. Cheng
U.S. Patent No. 5,150,228, September 22, 1992

Fiber Optics

Publications

"Radiation and Temperature Effects on LDEF Fiber Optic Samples"
A. R. Johnston, R. Hartmayer, and L. A. Bergman
Proceedings, Second LDEF Post-Retrieval Symposium, San Diego, CA,
June 2-4, 1992

Presentations

"Space Exposure of Fiber Optics on LDEF"
A. R. Johnston
SPIE International Symposium on Optical Engineering Photonics and Aerospace Sensing, Orlando, FL, April 22, 1992

"Radiation and Temperature Effects on LDEF Fiber Optic Samples"
A. R. Johnston, R. Hartmayer, and L. A. Bergman
Proceedings, Second LDEF Post-Retrieval Symposium, San Diego, CA,
June 2-4, 1992

"Optical Protocols for Terabit Netwoks"
P. Chua, J. Lambert, J. Morookian, and L. Bergman
1992 LEOS Conference, Santa Barbara, CA, p. 43-44, July 29-August 12, 1992

Patent and New Technology Reports

"Optical Protocols for Terabit Networks"
P. Chua, J. Lambert, J. Mookian, and L. A. Bergman
U.S. Patent Pending, October 21, 1992 (filed)

Space Environmental Effects on Materials

Publications

"Vacuum-Ultraviolet Radiation/Atomic Oxygen Synergism in FEP Teflon Erosion"
A. E. Steigman, D. E. Brinza, Eric G. Laue, M. S. Anderson, and R. H. Liang
Journal of Spacecraft and Rockets, vol. 29, no. 1, p. 150, January-February 1992

"Probing the Microscopic Corrugation of Liquid Surfaces with Gas-Liquid Collisions"
M. E. King, G. M. Nathanson, M. A. Hanning-Lee, and T. K. Minton
Physics Review Letters, v. 70, p. 1026, 1993

"UV-VUV Degradation of Spacecraft Materials"
A. E. Stiegman and R. H. Liang
Proceedings of the NATO ASI conference on Space Environment and Effects (in press)

Remote Sensing Technology

Publications

"Acousto-optic Tunable Filter Multispectral Imaging System"
L.-J. Cheng, T.-H. Chao, and G. Reyes
AIAA Space Programs and Technologies Conference, paper no. 92-1439, March 24-27, 1992

Presentations

"Acousto-optic Tunable Filter Multispectral Imaging System"
L.-J. Cheng, T.-H. Chao, and G. Reyes
AIAA Space Programs and Technologies Conference, March 24-27, 1992

III. Advanced Computing

OVERVIEW

Advanced concepts in hardware, software, and algorithms are being pursued for application in next-generation space computers and for ground-based analysis of space data. The research program focuses on massively parallel computation and neural networks, as well as optical processing and optical networking, which are discussed in the Photonics Section. Also included are theoretical programs in neural and nonlinear science, and device development for magnetic and ferroelectric memories.

1992 MAJOR TECHNICAL ACHIEVEMENTS

Parallel Computation

- **Demonstrated** parallel rendering of Landsat images using Compositional C++ as part of IBM announcement of their new parallel machine at Supercomputing '92, Minneapolis, MN, November 1992.
- **Developed** 3D Coupled Integral Equation Finite Element Electromagnetics Code for analysis of inhomogeneous electromagnetic structures.
- **Analyzed** structures requiring solution of systems of linear equations with over 48,000 unknowns on the Intel Touchstone Delta System.
- **Developed** new techniques for performing parallel proximity detection for parallel discrete event simulations in the SPEEDES (Synchronous Parallel Environment for Emulation and Discrete Event Simulation) operating system.
- **Demonstrated** the feasibility of new hybrid techniques for synchronizing parallel and distributed simulations using the SPEEDES operating system.
- **Developed** and **demonstrated** a new synchronization strategy for parallel simulations in the SPEEDES environment called "Breathing Time Warp." This new approach combines the best of both "Time Warp" and "Breathing Time Buckets" into one system while eliminating the potential problems that each of these might have by themselves.
- **Designed** and **implemented** the Advanced Simulation Framework (ASF) to support parallel discrete-event simulation on heterogeneous network of workstations and parallel computers.

Neural and Analog Computing

- **Designed, fabricated, and demonstrated, for the first time,** an application-specific 40 x 40 resource allocation processor chip based on parallel processing neural net concept. This is a fully integrated embodiment of an asynchronous analog network with multidimensional feedback, solving a computation-intensive problem of dynamic assignment, orders of magnitude faster than even the state-of-the-art digital parallel machines such as a hypercube. The information processing speed of this chip is potentially equivalent to 2.56 trillion operations per second.

- **Developed, implemented, and demonstrated** the first high-speed reconfigurable neuroprocessor on a PC card. This processor easily interfaces with any PC (e.g., 486, 386). Its versatility (architectures of feedforward, feedback, cascade correlation, etc., and different input, hidden and output nodes) has been demonstrated by applying it to problems ranging from feature extraction (feedforward net) in a map-knowledge base for cartographic data analysis to resource allocation (dynamic assignment) under dynamically changing cost conditions (feedback configuration). This card clearly demonstrates the significant speed enhancement with the use of fully parallel hardware. In addition, incorporation of direct memory access (DMA) interface, currently under way, would further increase the processing speed by over an order of magnitude.

- **Developed and fabricated** a 15 x 15-order binary-optic Dammann grating using the e-beam lithography system, and **tested first such** grating as a laser beam replication device. This grating has the advantages of high orders, high efficiency, and high uniformity for applications to enhance connectivity in optical processing.

- **Designed, fabricated, and tested** a neuron-synapse chip as a class D device package to be flown in a geo-transfer orbit on board a British satellite, for research of space environmental effects on neural net hardware, training and performance, and evaluation and improvement of current device designs. The chip will be programmed to learn and perform a number of input-output mapping functions as well as a character recognition operation.

- **Developed and demonstrated,** using an acousto-optic tunable filter (AOTF), successful discrimination of a blue-green laser line embedded in an intense white light with a better than 30-dB improvement in the signal-to-noise ratio (SNR). This demonstrates a potential for use of an AOTF in blue-green laser radar (LIDAR) applications.

- **Experimentally demonstrated** an innovative approach to generate an inhibitory synaptic-weight Fourier hologram using an electronically controlled liquid-crystal light valve. Such a hologram would be useful for dense optical memory schemes for high-speed pattern recognition.

- **Designed and fabricated** a chip based on a neural net architecture for diagnostics for high-speed autonomous vehicle health management (VHM). This chip would be demonstrated for diagnostic analysis of an auxiliary power unit (APU) used by a space shuttle. The scheme is generic to similar high-speed applications in any plant operation health monitoring and management.

- **Designed and fabricated** a novel vector array processor for use in real-time and ultralow-power image compression applications. This custom processor is based on the vector quantization image encoding algorithm, and this hardware fully exploits the inherent parallelism of the algorithm. The processor can handle code-book sizes up to 128 vectors of dimensionality 16.

- **Developed,** in collaboration with Penn. State University, a novel concept for a real-time optical joint transform correlator based on large holographic memory. This correlator would compare a two-dimensional input image with a large bank of images. This system would be particularly useful for real-time ID check by characteristics such as face or fingerprint. The system would take advantage of the architecture for parallel retrieval of and large storage capability of photorefractive memory.

- **Developed** a simulator, as a precursor to a new path-planning processor chip implementation. The chip would provide high-speed determination of "lowest cost" path from one or multiple origination points on a given terrain to all the points of the terrain, when the mobility "costs" of traversing individual pixels in 8 directions (North, South, East, West and NE, NW, SE, and SW) are known. In addition, the design permits vector costs as inputs, thereby allowing, e.g., up-slope and down-slope speeds on a hill to be different. This design will expand our already demonstrated 7-MHz path-planning chip, interfaced with a PC, for computation and display, for example, of the simultaneous advance of a "red" and a "blue" team on any constrained terrain, display isocost contours for different movers, and determine the best path to reach any point on the terrain with over four orders of magnitude speed enhancement (over that with conventional sequential digital techniques). This chip will have applications not only in the defense arena, but also for better earthquake and emergency preparedness, and for traffic congestion control.

Neurocomputing Theory and Nonlinear Science

- **Constructed** a novel neural network associative model based on the concept of terminal attractor in nonlinear dynamic theory. The terminal attractor has an infinite attracting power in phase space. With the assistance of the terminal attractor, it can be proven through computer simulation that the storage capacity can reach at least 4N, where N is the total number of neurons without any spurious or oscillation states. With a small number of neurons, exhaustive search simulation shows that total convergence can be achieved. With 256 neurons, it can be shown that perfect convergence with an adaptive threshold can be accomplished with 1024 stored states. An optical implementation of the model with inner-product architecture is devised.

- **Developed** and **validated** radically new algorithmic approaches and analytical tools for tactical intelligence fusion in the areas of: (a) probabilistic force structure characterization and ranking; (b) constrained geolocation prediction of critical relocatable targets with high accuracy. Currently working on technology transfer to NSWC, ETL, PM ASAS, and PM IEW. U.S. Army APO TECHBASE PROGRAM.

- **Developed** and **demonstrated** *novel neural learning theory* in terms of non-Lipschitzian dynamics and adjoint operators. The new methodology enables computation of the gradient of an objective functional with respect to the various parameters of the network architecture in a highly efficient manner. Specifically, it combines the advantage of dramatic reductions in computational complexity inherent in adjoint methods with the ability to solve, for temporal (i.e., trajectory) learning, the adjoint equations forward in time. Not only is a large amount of computation and storage saved, but the handling of real-time applications becomes also possible.

  Learning time is reduced by one to two orders of magnitude in comparison to the best previously published benchmark results, while trajectory tracking is also significantly improved.

  This work also lays the foundations for new approaches to nonlinear system identification, and efficient spatio-temporal pattern processing. The methodology was transferred both outside JPL (e.g., to NSA) and within the laboratory, e.g., to the JPL Technology Thrust on Control of Robot-Environment Interaction, and to the Precision Segmented Reflector space application.

- **Discovered** new method for *global optimization of multiextremal functions* based on the novel concept of "Terminal Repeller Unconstrained Subenergy Tunneling". The new method was demonstrated to be over 100 times faster than competing state-of-the-art approaches on the standard SIAM benchmarks. It should be highly valuable for many space, energy, and defense applications.

- **Developed** methodology enabling the *solution of certain classes of partial differential equations on synchronous neural hardware.* The corresponding algorithms were implemented and benchmarked (in simulation) on the Kortewegde Vries (soliton) equations. In view of the projected computational capabilities of neural optoelectronic hardware, this breakthrough approach is expected to have a profound, long-term impact on modeling complex phenomena in geophysics, space science, and aeronautics, of relevance to NASA, DOD, and DOE.

- **Developed** a *new generation of time-parallel algorithms for solution of parabolic partial differential equations*, which are suitable for implementation on emerging massively parallel MIMD architectures such as the Caltech/JPL Delta.

- **Developed** the *NEIMO method for high-speed molecular dynamics simulations.* Currently collaborating with Goddard group at Caltech to use the method for material and biomolecular simulation applications.

- **Initiated** a focused program, with significant near- and long-term potential, for development of "*Intelligent Neuroprocessors for Launch Vehicle Health Monitoring* (VHM)". The program is intended to: (i) fulfill a very high-priority technology need for User Codes NASA/OSF and NASA/OSE; (ii) represent the first aggressive effort to transition and adapt neuroprocessor hardware building blocks developed at JPL to support the agency's mainline activities; (iii) serve as a major vehicle for transitioning and validating neural devices and algorithms for interfacing of analog neuroprocessor hardware to existing flight (digital) systems under very stringent performance conditions; (iv) establish JPL as a primary foundry for neural systems and advanced neural and analog computing devices within NASA; and (v) foster synergistic technical and programmatic collaborations with NASA centers and industry in the area of neural networks.

- **Developed** a *new generation of parallel algorithms* which achieve the time lower bound of O(logN) in solving various *multibody system problems* with application to spacecraft and robot manipulator dynamics simulation.

- **Completed** the implementation of parallel/vector algorithms and architectures for real-time hardware in-the-loops simulation of the *Cassini* Project.

- **Completed** the delivery of the *DARTS real-time dynamics simulator* for the Cassini spacecraft to the Cassini project.

- **Designed** and **implemented** an end-to-end, state-of-the-art computational testbed to conduct real-time experiments in high-performance sensor-based neurocontrol for robotic applications in rock coring, RAEVA, and microsampling.

Optical Processing

- **Invented** a self-amplified angularly multiplexed beam formation technique for programmable electronic interconnection and neural optical computing applications. The technique utilizes an electrically-addressed spatial light modulator for the dynamic writing of specific computer-generated holographic (CGH) gratings and the two-beam coupling energy transfer effect in photorefractive crystals for self-amplification of optically retrieved beam patterns. These memorized beam patterns serve as basis functions from which a variety of complicated beam patterns can be formed in parallel to satisfy specific functional requirements in designated applications. For example, 24 basis patterns can generate 10^7 different beam patterns via the control of a digital PC.

- **Discovered** a novel modified signed-digit (MSD) high-speed and high-data-throughput optical computing technique. The technique is based on an operation in which spatially encoded input matrices are multiply imaged using optical fan-out elements and correlated selectively with a set of specifically designed spatial filters. Subtraction can be converted into addition by means of a complement code.

Data Storage

- **Demonstrated** successful bias field matching between minor loop storage areas and input/output and read/write gate areas in Vertical Bloch Line memories.

- **Demonstrated** magnetic domain and domain wall imaging using tunneling-stabilized magnetic force microscopy in Vertical Bloch Line memory material.

- **Demonstrated** a magnetic gallium arsenide random-access memory test cell.

Software Engineering and Computer Science

- **Increased** the focus of the task from software components (algorithms) to include all forms of information. The system has been ported from the Macintosh environment to a UNIX X-windows environment supporting remote operations.

- **Developed** and **simulated** a simulation model for a multiring shufflenet with permutation engine switching nodes at 100% of I/O capacity with routing latency of 1.5 times the theoretical minimum.

Advanced Networking

- **Developed** a simple distributed control structure to realize a switching node with constant routing latency for packet asynchronous optical data. The control structure is designated as a permutation engine.

- **Devised** a superset network (supernet) architecture using existing network topologies and routing algorithms with multiple, dynamically interconnected routing planes to result in a high-bandwidth, low-latency communication network.

Communications

- **Designed** and **laid out** a high-speed networking HIPPI Extender card. The card has full-duplex communication capabilities and will provide a 1.2- GHz input signal to a laser diode, which is part of a four-LD array transmitter developed in house.

TECHNICAL PROGRESS REPORTS

Parallel Computation

Publications

"CC++ Run-Time Library Interface"
J. George and M. Pomerantz
Computer Science Department, California Institute of Technology,
Pasadena, CA, February 10, 1992

"SPEEDES: A Unified Approach To Parallel Simulation"
J. Steinman
Parallel and Distributed Simulation (PADS), Vol. 24, No. 1, p. 75-84, January 1992

"Predicted Performance of On-Board Software Algorithms on Space-Qualified Computers"
E. Upchurch, J. George, and B. Eng
Remote Exploration and Experimentation Project, HPCCI, NASA, Final Report, August 30, 1992

"High Performance Flight Computer Developed For Deep Space Applications"
R. Bunker, E. Upchurch, J. George, and B. Eng
Spacecomputing, Paris, France, November 1992

"Hypercube Matrix Computation Task, Research in Parallel Computational Electromagnetics, Report for January 1, 1991 - March 31, 1992"
T. Cwik, R. Ferraro, N. Jacobi. V. Jamnejad, P. Liewer, P. Lyster, J. Mc Comb, J. Parker, J. Partee, J. Patterson, and B. Zimmerman
JPL Project Document, July 1, 1992

"Comparing 3D Finite-Element Formulations Modeling Scattering from a Conducting Sphere"
J. Parker, R. D. Ferraro, and P. C. Liewer
IEEE Trans. on Magnetics (to appear October 1993)

"SPEEDES: A Unified Approach to Parallel Simulation"
J. Steinman
Proceedings of the SCS Multiconference on Advances in Parallel and Distributed Simulation, Newport Beach, vol. 24, no. 1, p. 75-84, January 1992

"SPEEDES: A Multiple-Synchronization Environment for Parallel Discrete-Event Simulation"
J. Steinman
International Journal in Computer Simulation, vol. 2, p. 251-286, 1992

"Synchronization of Parallel Simulations"
J. Steinman
NASA Tech Briefs, Vol. 16, No. 9, September 1992

"The Event Horizon"
J. Steinman
Internal JPL document, JPL D-10029, November 1992

"Parallel 3-D Perspective Rendering"
P. P. Li
DDF Annual Report - FY 1991, JPL D-9387, p. 309-318, June 1992

"Parallel Three-Dimensional Perspective Rendering"
P. P. Li and D. W. Curkendall
Proceedings of the Second European Workshop on Parallel Computing,
p. 320-331, March 1992

Invited Presentations

"Electromagnetic Scattering Analysis on the Intel Touchstone Delta"
J. Patterson and T. Cwik
37th Annual IEEE International Computer Conference, Spring Compcon '92,
San Francisco, CA, February 25-27, 1992

"Electromagnetic Scattering on Massively Parallel Processing Systems"
T. Cwik
EMCC Presentation, Redstone Arsenal, AL, April 14-15, 1992

"Electromagnetic Scattering and Radiation Analysis on High Performance Parallel Processors"
J. Patterson and T. Cwik
Computational Electromagnetics, Computer-Aided Design and Supercomputing Conference, McLean, VA, July 30-31, 1992

"Electromagnetic Scattering Calculations on the Intel Touchstone Delta"
T. Cwik, J. Patterson, and D. Scott
Supercomputing '92, Minneapolis, MN, November 1992

"Hybrid Simulations of the Effects of Interstellar Hydrogen Pick-up Ions on the Solar Wind Termination Shock"
P.C. Liewer, B.E. Goldstein, and N. Omidi
Journal Geophysical Research, 1993 (to be published)

"Two-Dimensional Plasma PIC Simulations of Plasma Heating by the Dissipation of Alfveń Waves, in Solar Wind Seven"
P.C. Liewer, T.J. Krucken, R.D. Ferraro, V.K. Decyk, and B.E. Goldstein (E. Marsch and R. Schwenn, eds.)
COSPAR, Pergamon, Oxford, p. 481, 1992

"Interactive SPEEDES and Proximity Detection"
J. Steinman
New Technologies for Interactive Military Parallel Simulations Discussion, Aerospace Corporation, El Segundo, CA, November 1992
(guest speaker)

Presentations

"Numerical Convergence of Various Edge Elements for Three-Dimensional Scattering"
J. Parker
Union Radio Scientifique International (URSI), Boulder, CO, January 1992

"Solving Large-Scale Method of Moments Electromagnetic Problems"
T. Cwik and J. Patterson
Delta Applications Workshop, Pasadena, CA, February 11-12, 1992

"Finite Elements for Electromagnetic Scattering"
J. Parker, R. Ferraro, J. McComb, and S. Araki
Concurrent Supercomputing Consortium Delta Science Fair, Caltech, Pasadena, CA, May 27, 1992

"Electromagnetics Scattering Calculations on the Intel Touchstone Delta"
T. Cwik, J. Patterson, and D. Scott
Concurrent Supercomputing Consortium Delta Science Fair, Caltech, Pasadena, CA, May 27, 1992

"The Solution and Numerical Accuracy of Large MoM Problems"
T. Cwik and J. Patterson
IEEE Antennae and Propagation Society/Union Radio Scientifique International (APS/URSI), Chicago, IL, July 1992

"EMLIB: An Internet Server for Electromagnetics Software"
T. Cwik and S. Ray
IEEE Antennae and Propagation Society/Union Radio Scientifique International (APS/URSI), Chicago, IL, July 1992

Coupling Finite Elements and Integral Equations to Model Three-Dimensional Scattering and Radiating Structures"
T. Cwik and V. Jamnejad
IEEE Antennae and Propagation Society/Union Radio Scientifique International (APS/URSI), Chicago, IL, July 1992

"The Use of Distributed Memory Parallel Computers for Electromagnetic Computation"
T. Cwik and R. Ferraro
1-day Course for IEEE Antennae and Propagation Society/Union Radio Scientifique International (APS/URSI), Chicago, IL, July 1992

"On Using Del-Squared Plus Boundary Constraints Instead of Curl-Curl for Vector Scattering Problems"
J. Parker, R. D. Ferraro, and P. C. Liewer
IEEE Antennae and Propagation Society/Union Radio Scientifique International (APS/URSI), Chicago, IL, July 1992

"Distributed Memory Tangential Finite Elements for Inhomogeneous Scatterers in Free Space"
J. Parker, R. Ferraro, and P. C. Liewer
IEEE Antennae and Propagation Society/Union Radio Scientifique International (APS/URSI), Chicago, IL, July 1992

"Finite Element Mesh Generation on MIMD Computers for EM Scattering Problems"
R. D. Ferraro and B. A. Zimmerman
IEEE Antennae and Propagation Society/Union Radio Scientifique International (APS/URSI), Chicago, IL, July 1992

"Comparing 3D Finite Element Formulations Modeling Scattering from a Conducting Sphere"
J. Parker, R. D. Ferraro, and P. C. Liewer
IEEE Conference on Electromagnetic Field Computation, Claremont, CA, August 3-5, 1992

"Comparing 3D Finite Element Formulations Modeling Scattering from a Conducting Sphere"
J. Parker, R. D. Ferraro, and P. C. Liewer
IEEE Conference on Electromagnetic Field Computation, Claremont, CA, August 3-5, 1992

"Coupling Finite Elements and Integral Equations to Model Three-Dimensional Scattering and Radiating Structures"
T. Cwik and L. Epp
IEEE Conference on Electromagnetic Field Computation, Claremont, CA, August 3-5, 1992

"Combined Parallel Finite Element Mesh Refinement and Mesh Partitioning Algorithm for Numerical Modeling of Electromagnetic Scattering Problems"
K. Tembekjian, S. Araki, J. McComb, and R. Ferraro
Supercomputing '92, Minneapolis, MN, November 1992

"A Network Express Demonstration of Distributed Supercomputing for the CASACALCRUST Project"
P. M. Lyster, L. Bergman, R. Blom, R. Crippen, P. Li, D. Okaya, C. Pardo, and D. Stanfill
CASA Gigabit Jamboree, San Diego Supercomputer Center (SDSC), La Jolla, CA, December 19, 1991

"A Network Express Demonstration of Distributed Supercomputing for the CASA-CALCRUST Project"
P. M. Lyster, L. Bergman, R. Blom, R. Crippen, P. Li, D. Okaya, C. Pardo, and D. Stanfill
Third Gigabit Testbed Workshop, SDSC, La Jolla, CA, January 13-15, 1992

"CASACALCRUST Distributed Supercomputing"
P.M. Lyster
Delta Applications Workshop for the Concurent Supercomputing Consortium, California Institute of Technology, Pasadena, CA, February 12, 1992

"CASA Gigabit Supercomputing Network: CALCRUST 3D real-time multi-dataset rendering"
P. M. Lyster, L. Bergman, P. Li, D. Stanfill, R. Blom, R. Crippen, R. Crippen, C. Pardo, and D. Okaya
Supercomputing '92, Minneapolis, MN, November 16-20, 1992

"Particle-in-Cell Calculations on Massively Parallel Computers"
P. M. Lyster, P.C. Liewer, R. D. Ferraro, and V. K. Decyk
International Sherwood Fusion Theory Conference, Santa Fe, NM, April 6-8, 1992

"Three-Dimensional Electrostatic General Concurrent Particle-In-Cell (GCPIC) Calculations on Intel Touchstone Delta"
P. M. Lyster, P. C. Liewer, R. D. Ferraro, and V.K. Decyk
Supercomputing '92, Minneapolis, MN, November 16-20, 1992

"Particle Simulation on Distributed Memory Parallel Computers"
V. K. Decyk, F. S. Tsung, P. C. Liewer, P. M. Lyster, and R. D. Ferraro
Institute of Plasma and Fusion Research, University of California at Los Angeles, Report PPG-1446, July 1992

"Particle Simulation on Distributed Memory Parallel Computers"
V. K. Decyk, F. S. Tsung, P. C. Liewer, P. M. Lyster, and R. D. Ferraro
IAEA Technical Comittee Meeting on Advances in Simulation and Modeling Thermonuclear Plasmas, Montreal, Quebec, Canada, June 15-17, 1992

"SPEEDES: A Unified Approach to Parallel Simulation"
J. Steinman
Proceedings of the SCS Multiconference on Advances in Parallel and Distributed Simulation, Newport Beach, CA, vol. 24, no. 1, p. 75-84, January 1992

"Parallel 3-D Perspective Rendering"
P. P. Li
First Delta Applications Workshop, Pasadena, CA, February 12, 1992

"Planetary Scientific Visualization Using the Intel Delta Parallel Supercomputer"
D. W. Curkendall, P. P. Li, and E. DeJong
International Conference on Earth and Space Science Information Systems, Pasadena Convention Center, Pasadena, CA, February 1992

Patent and New Technology Reports

"Hyperswitch Communication Network"
J. Peterson, E. Upchurch, and E. Chow
NASA Tech Briefs, NPO-18588 (submitted)

"Synchronous Parallel Environment For Emulation and Discrete Event Simulation (SPEEDES)"
J. Steinman
NASA Tech Briefs, NPO-18414, vol. 16, no. 9, p. 129, September 1992
(U.S. patent pending)

"Synchronization of Parallel Simulations"
J. Steinman
NASA Tech Briefs, NPO-18414 (U.S. patent pending)

Neural and Analog Computing

Publications

"Bifurcating Neuromorphic Optical Pattern Recognition in Photorefractive Crystals"
H.-K. Liu
Optical Society of America 1992 Technical Series, v. 18, p. 447-449, 1992

"VLSI Implemented Building-Block Neural Network Chips For Classification/ Detection Applications"
T. Daud, S. P. Eberhardt, T. X. Brown, M. Tran, and A. P. Thakoor
Proceedings of the NeuroNimes Conference on Neural Networks and Their Applications, Nimes, France, p. 565, November 2-6, 1992

"Cascaded VLSI Neural Network Chips: Hardware Learning for Pattern Recognition and Classification"
T. X. Brown, M.D. Tran, T. Duong, T. Daud, and A. P. Thakoor
Simulation, Special Issue: Neural Networks: Model Development for Applications, v. 58, p. 340, May 1992

"Analog VLSI Neural Networks: Implementation Issues and Examples in Optimization and Supervised Learning"
S. P. Eberhardt, R. Tawel, T. X. Brown, T. Daud, and A. P. Thakoor
IEEE Trans. Industrial Electronics, v. 39, p. 552, 1992

"Learning in Analog Neural Network Hardware"
R. Tawel
Accepted for publication in a special issue of Computers and Electrical Engineering on Parallel and Distributed Computing for Intelligent Systems (in press)

"Optical Implementation of a Feature-Based Neural Network with Application to Automatic Target Recognition"
T-H. Chao and W.W. Stoner
Applied Optics, Special Issue: Optical Implementation of Neural Networks, Ed: D. Psaltis and K. Wagner, March 1993 (in press)

"Electronic Neural Networks for On-Board High-Performance Computing"
R. Tawel
An invited paper, Proceedings of the NASA Langley Conference on High-Performance Computing for Flight Vehicles, Washington, DC, December 1992 (in press)

Invited Presentations

"Bifurcating Optical Information Processing in a Nonlinear Gain Saturation Memory Medium"
H.-K. Liu
International Symposium on Optoelectronics in Computers, Communications, and Control, Hsinchu, Taiwan, December 14-18, 1992

"High-Speed Analog Neuroprocessors for Event Tagging and Data Management"
R. Tawel
International Space Year Conference on Earth and Space Information Systems, Pasadena, CA, February 1992

"A 40 x 40 Neuroprocessor for Solving Competitive Assignment Problems"
R. Tawel
Workshop on Neural Networks: Hardware, Optical and Electronic, Lake Louise, Canada, March 1992

"Electronic Neural Networks: MOSIS Experiments - What Next?"
A. P. Thakoor
DARPA's Topical Workshop on Neural Network Hardware, Arlington, VA, October 1992

Presentations

"Bifurcating Neuromorphic Optical Pattern Recognition in Photorefractive Crystals"
H.-K. Liu
Optical Society of America Nonlinear Optics: Materials, Fundamentals, and Applications Topical Meeting, Lahaina, Maui, HI, July 17-21, 1992

"Multilayer Holographic Bifurcative Neural Network for Real-Time Adaptive EOS Data Analysis"
H.-K. Liu
NASA OSSA Applied Information System Research Program Workshop, Laboratory for Atmospheric and Space Physics, University of Colorado, Boulder, CO, August 11-13, 1992

"Optical Implementations of Terminal Attractor-Based Neural Networks"
H.-K. Liu
National Taiwan Univ. Optoelectronic Engineering Graduate Institute Seminar, Taipei, Taiwan, China, December 14, 1992

"VLSI Neuroprocessor for 40 x 40 Resource Allocation"
S. P. Eberhardt, S. Kemeny, T. Daud, R. Tawel, and A. P. Thakoor
Proceedings of the Government Microcircuit Applications Conference (GOMAC), Las Vegas, NV, p. 265, November 9-12, 1992

"Cascaded VLSI Neural Network Building-Block Chips for Map Pixel Classification"
T. A. Duong, T. X. Brown, M. D. Tran, S. P. Eberhardt, and A. P. Thakoor
Proceedings of the Government Microcircuit Applications Conference (GOMAC), Las Vegas, NV, p. 145, November 9-12, 1992

"Concurrent Processor for High Speed Path Planning"
S.E. Kemeny, T.J. Shaw, R.H. Nixon, T. Daud, and E.R. Fossum
Proceedings of the Government Microcircuit Applications Conference, Las Vegas, NV, p. 191, November 9-12, 1992

"Optical Implementation of a Feature Based Shift-Invariant Multilayer Neural Network"
T.-H. Chao
IEEE International Joint Conference on Neural Networks (IJCNN), Beijing, China, vol. III, p. 376, November 3-6, 1992

"Analog VLSI Neural Network Building Block Chips for Hardware-in-the-Loop Learning"
T. Duong, T. Brown, M. Tran, H. Langenbacher, and T. Daud
International Joint Conference on Neural Networks (IJCNN), Beijing, China, vol. III, p. 264, November 3-6, 1992

"Dynamically Reconfigurable Optical Morphological Processor"
T.-H. Chao
Proceedings of the SPIE International Symposium, San Diego, CA, vol. 1703, July 20-24, 1992 (in press)

"Optical Implementation of a Shift-Invariant Neocognitron"
T.-H. Chao, W. W. Stoner, and W. J. Miceli
Proceedings of the SPIE International Symposium, San Diego, CA, vol. 1773, July 20-24, 1992 (in press)

"Parallel Processor Array for High-Speed Path Planning"
S. E. Kemeny, T. J. Shaw. R. H. Nixon, and E. R. Fossum
Proceedings of the IEEE Custom Integrated Circuits Conference, Boston, MA, p. 6.5.1, 1992

"Learning and Optimization with Cascaded VLSI Neural Network Building-Block Chips"
T. Duong, S. P. Eberhardt, M. Tran, T. Daud, and A. P. Thakoor
Proceedings of the IEEE International Joint Conference on Neural Networks (IJCNN), Baltimore, MD, vol. I, p.184, June 1992

"A Radial Basis Function Neurocomputer Implemented with Analog VLSI Circuits"
S. Watkins, P. M. Chau, and R. Tawel
Proceedings of the IEEE International Joint Conference on Neural Networks (IJCNN), Baltimore, MD, vol. II, p. 607, June 1992

"Nonlinear Functional Approximation with Networks Using Adaptive Neurons"
R. Tawel
Proceedings of the IEEE International Joint Conference on Neural Networks (IJCNN), Baltimore, MD, vol. III, p. 491, June 1992

"Automatic Target Recognition Using a Feature Based Optical Neural Network"
T.-H. Chao
Proceedings of the SPIE: Aerospace Sensing Symposium, Orlando, FL, vol. 1701, p. 276, April 1992

"Optical Hazard Detection and Avoidance Sensor for NASA's Planetary Landers"
T.-H. Chao
Proceedings of the SPIE Aerospace Sensing Symposium, Orlando, FL, vol. 1702, p. 132, April 1992

"Acousto-optic Tunable Filter Multispectral Imaging System"
L.-J. Cheng, T.-H. Chao, and G. Reyes
Proceedings of the AIAA Space Programs and Technologies Conference, vol. 1439, March 1992

"Optical Implementation of a Feature-Based Multiple Layer Neural Network"
T.-H. Chao
Optical Society of America Annual Meeting, Albuquerque, NM, September 1992

"Dynamically Reconfigurable Optical Morphological Processor"
T.-H. Chao
Optical Society of America Annual Meeting, Albuquerque, NM, September 1992

"Neural Net for Vehicle Health Management"
S. Gulati and R. Tawel
Third International Conference on Fuzzy Systems and Neural Networks, Johnson Space Center, TX, June 1992

"Fast Classifier Training"
T. X. Brown
Conference on Neural Networks for Computing, Snowbird, UT, April 1992

Patent and New Technology Reports

"Optical Implementation of Terminal-Attractor-Based Associative Memory"
H.-K. Liu, Jacob Barhen, and Nabil H. Farhat
NASA Technical Report, NPO-18790-1-CU (submitted)

"The Optical Implementation of Inner Product Neural Associative Memory"
H.-K. Liu
NASA Tech Briefs, NPO-18491-1-CU, vol. 17, no. 3, p. 45, March 1993
(U.S. patent pending)

"Trinary Associative Memory Would Recognize Machine Parts"
H.-K. Liu, A. Awwal, and M. Karim
NASA Tech Briefs, NPO-17850, vol. 15, no. 3, p. 93, September 1991
(U.S. patent pending)

"Inner-Product Trinary Associative Memory
H.-K. Liu, A. A. S. Awwal, and M. A. Karim
JPL Case No. C-17850-CIT 2050, October 14, 1992 (U.S. patent pending)

"Analog Delta-Backpropagation Neural Networks Circuitry"
S. Eberhardt
U.S. Patent No. 5,101,361, March 31, 1992

"A Network of Dedicated Processors Would Find Best Paths on Map"
S. Eberhardt
U.S. Patent No. 5,072,379, December 10, 1991

"Simplified Learning Scheme for Analog Neural Networks"
S.P. Eberhardt
U.S. Patent No. 5,056,037, October 8, 1991

"Traveling Salesman and Similar Global Optimization Problems"
T. Duong, S. Eberhardt, and A.P. Thakoor
NASA Tech Briefs, NPO-18390, Integrated with NPO-178071, November 8, 1991
(patent appl. filed)

"Real-Time Imaging Spectrometer"
T.-H. Chao, J. Yu, and L.-J. Cheng
NASA Tech Briefs, NPO-18410, December 9, 1991 (patent appl. filed)

"Nonvolatile, Programmable Neural Network Synaptic Array"
R. Tawel
NASA Tech Briefs, NPO-18578, July 8, 1992 (patent appl. filed)

"Cascaded VLSI Neural Network Architecture for On-Line Learning"
T. Duong, T. Daud, and A. P. Thakoor
NASA Tech Briefs, NPO-18645, September 4, 1992 (patent appl. filed)

"Ferroelectric/optoelectronic memory/processor"
S. Thakoor and A.P. Thakoor
NASA Tech Briefs, NPO-18222, vol. 16 , no. 4, p. 29, April 1992

"Optical Correlator with Complex Holographic Filter"
T.-H. Chao
NASA Tech Briefs, 16(10), NPO-18464, October 1992

"Calculating Necessary Neuron Gains for Winner-Take-All Networks"
T. X. Brown
New Technology Report, NPO-18640, August 7, 1991 (filed)

"Analog Processor to Solve Optimization Problems"
T. Duong, S. Eberhardt, and A. P. Thakoor
New Technology Report, NPO-18390, vol. 17, no. 2, p. 56, February 1993

"Digital Parallel Processor Array for Path Planning"
S. E. Kemeny, E. R. Fossum, and R. H. Nixon
New Technology Report, NPO-18727, March 1992 (filed)

"Demonstration of AOTF Imaging Spectrometer"
T.-H. Chao, J. Yu, and L.-J. Cheng
New Technology Report, NPO-18410, vol. 17, no. 1, p. 56, January 1993

Neurocomputing Theory and Nonlinear Science

Publications

"Optical Implementation of Terminal-Attractor-Based Associative Memory"
H.-K. Liu, J. Barhen, and N. Farhat
Applied Optics, vol. 31, no. 23, p. 4631-4644, August 10, 1992

"Bifurcating Neuromorphic Optical Pattern Recognition in Photorefractive Crystals"
H.-K. Liu
Optical Society of America 1992 Technical Series, vol. 18, p. 447-449, 1992

"Random Interactions in Higher-Order Neural Networks"
P. Baldi and S.S. Venkatesh
IEEE Trans. on Information Theory, 1992 (in press)

"Neural Networks for Fingerprint Recognition"
P. Baldi and Y. Chauvin
Neural Computation, 4, 1992 (in press)

"How Delays Affect Neural Dynamics and Learning"
P. Baldi and A. Atiya
IEEE Trans. on Neural Networks, 1992 (in press)

"Gradient Descent Learning Algorithms: A General Dynamical Systems Perspective"
P. Baldi
IEEE Trans. on Neural Networks, 1992 (in press)

"Backpropagation and Unsupervised Learning"
P. Baldi, Y. Chauvin, and K. Hornik
in Linear Networks, Back-Propagation: Theory, Architectures and Applications, Y. Chauvin and D. E. Rumelhart, Editors, Lawrence Erlbaum Associates, 1992 (in press)

"Gradient Descent Learning Algorithms"
P. Baldi
in Back-Propagation: Theory, Architectures and Applications, Y. Chauvin and D. E. Rumelhart, Editors, Lawrence Erlbaum Associates, 1992 (in press)

"A Modular Hierarchical Approach to Learning"
P. Baldi
Proceedings of the Second International Conference on Fuzzy Logic and Neural Networks, p. 72-77, May 1992

"When Neural Networks Play Sherlock Holmes"
P. Baldi and Y. Chauvin
in Back-Propagation: Theory, Architectures and Applications, Y. Chauvin and D. E. Rumelhart, Editors, Lawrence Erlbaum Associates, 1992 (in press)

"Application of Adjoint Operator Fast Neural Learning to Nonlinear System Identification in Robotics"
J. Barhen, S. Gulati, N. Toomarian, and S. T. Venkataraman
IEEE Trans. on Neural Networks, 1992 (in press)

"Computational Chaos in Massively Parallel Neural Networks"
J. Barhen and S. Gulati
International Journal of Computer and Electrical Engineering, 1992 (in press)

"New Directions in Massively Parallel Neurocomputing"
J. Barhen, N. Toomarian, A. Fijany, A. Yariv, and A. Agranat
in Neural Networks and Their Applications, J.C. Rault, Editor, EC2 Publishers, Paris, France, p. 543-554, 1992

"Terminal Repeller Unconstrained Sub-Energy Tunneling for Fast Global Optimization"
B. Cetin, J. Barhen, and J. Burdick
Journal of Optimization Theory and Applications, 1992 (in press)

"Global Descent Replaces Gradient Descent to Avoid Local Minima Problems in Learning with Artificial Neural Networks"
B. Cetin, J. Burdick, and J. Barhen
ICNN'93 1992 (in press)

Parallel Computation Systems for Robotics: Algorithms and Architectures
A. Fijany and A. K. Bejczy (Editors)
World Scientific Publishers, September 1992

"Fast Parallel Preconditioned Conjugate Gradient Algorithms for Robot Manipulator Dynamic Simulation"
A. Fijany and R. E. Scheid
Journal of Intelligent Robotic Systems: Theory and Applications, 1992 (in press)

"ASPARC: An Algorithmically Specialized Parallel Architecture for Robotics Computations"
A. Fijany and A. K. Bejczy
in Parallel Computation Systems for Robotics: Algorithms and Architectures, A. Fijany and A.K. Bejczy Editors, World Scientific, p. 95-191, September 1992

"Recursive Flexible Multibody System Dynamics Using Spatial Operators"
A. Jain and G. Rodriguez
Journal of Guidance, Control and Dynamics, vol. 15, no. 6, p. 1453-1466, November-December 1992

"Linearization of Manipulator Dynamics Using Spatial Operators"
A. Jain and G. Rodriguez
IEEE Trans. on Systems, Man and Cybernetics, 1992 (in press)

"A Fast Recursive Algorithm for Molecular Dynamics Simulations"
A. Jain, N. Vaidehi, and G. Rodriguez
Journal of Computational Physics, 1992 (in press)

"An Analysis of the Kinematics and Dynamics of Under-Actuated Manipulators"
A. Jain and G. Rodriguez,
IEEE Trans. on Robotics and Automation, 1992 (in press)

"Recursive Dynamics Algorithm for Multibody Systems with Prescribed Motion"
A. Jain and G. Rodriguez,
Journal of Guidance, Control and Dynamics, 1992 (in press)

"Recursive Formulation of Operational Space Control"
K. Kreutz-Delgado, A. Jain, and G. Rodriguez
The International Journal of Robotics Research, vol. 11, no. 4, p. 320-328, August 1992

"Self-Amplified Optical Pattern-Recognition Technique"
H.-K. Liu
Applied Optics, vol. 31, no. 14, p. 2568-2575, May 10, 1992

"Optical Implementation of Terminal-Attractor-Based Associative Memory"
H.-K. Liu, J. Barhen and N. Farhat
Applied Optics, vol. 31, no. 23, p. 4631-4644, August 10, 1992

"Bifurcating Neuromorphic Optical Pattern Recognition in Photorefractive Crystals"
H.-K. Liu
Optical Society of America 1992 Technical Series, 18, p. 447-449, 1992

"Spatial Operator Algebra for Multibody System Dynamics"
G. Rodriguez, A. Jain, and K. Kreutz-Delgado
Journal of the Astronautical Sciences, 40, p. 27-50, 1992

"Multitarget Tracking in Dense Threat Environments"
N. Toomarian and M. Zak
International Journal of Computer and Electrical Engineering, 1992 (in press)

"Learning a Trajectory Using Adjoint Functions and Teacher Forcing"
N. Toomarian and J. Barhen
Neural Networks, vol. 5, no. 3, p. 473-484, 1992

"Neural Networks for Real-Time Robotic Applications"
N. Toomarian, J. Barhen, and S. Gulati
in Parallel Computation Systems for Robotics: Algorithms and Architectures,
A. Fijany and A.K. Bejczy, Editors, World Scientific, p. 213-247, 1992

"Pattern Classification Using the Phase Velocity Field Approach"
N. Toomarian
Pattern Recognition Letters, vol. 13, no. 1, p. 13-17, January 1992

"Fast Neural Solution of a Nonlinear Wave Equation"
N. Toomarian and J. Barhen
International Joint Conference on Neural Networks, vol. 5, p. 10-15, 1992

"Compliance Control with Neural Networks Identification of Uncertain Environment Dynamics"
N. Toomarian
Conference on Decision and Control, 1992 (in press)

"Learning Trajectories with a Hierarchy of Oscillatory Modules"
N. Toomarian and P. Baldi
1993 IEEE International Conference on Neural Networks, 1992 (in press)

"Actuator Tuning for Static Shape Correction of Truss Structures with Nonlinear Joints"
N. Toomarian and M. Salama
34th AIAA SDM Conference, 1992 (in press)

"Terminal Slider Control of Nonliner Systems"
S.T. Venkataraman and S. Gulati
ASME Journal of Dynamic Systems, Measurement and Control, 1992 (in press)

"Compliance Control of Robots in Unknown Environments Using Neural Networks"
S.T. Venkataraman, S. Gulati, J. Barhen, and N. Toomarian
IEEE Trans. on Robotics and Automation, 1992 (in press)

"Terminal Slider Approach to Robust Robot-Environment Interactions"
S.T. Venkataraman and S. Gulati
Journal of Intelligent and Robotic Systems, 1992 (in press)

Perceptual Robotics
S.T. Venkataraman and S. Gulati
Springer-Verlag, 1992 (in press)

"Parameter Learning and Compliance Control Using Neural Networks"
S.T. Venkataraman
in Neural Networks in Robotics, G. Bekey and K. Goldberg, Editors, Kluwer Publications, 1992 (in press)

"Parameter Learning with Avalanching Neural Networks"
S.T. Venkataraman
IEEE Control Systems Magazine, 1992 (in press)

"The Problem of Irreversibility in Newtonian Dynamics"
M. Zak
International Journal of Theoretical Physics, vol. 31, no. 2, p. 333-342, February 1992

"Terminal Model of Newtonian Dynamics"
M. Zak
International Journal of Theoretical Physics, 1992 (in press)

"Irreversibility and Creativity in Neurodynamics"
M. Zak
International Journal of Computer and Electrical Engineering, 1992 (in press)

"Neurodynamical Model of the Collective Brain"
M. Zak
International Joint Conference on Neural Networks, vol. 5, no. 4, p. 115-121, 1992

Invited Presentations

"Unpredictability in Newtonian Dynamics"
M. Zak
Invited presentation, Fifth International Symposium on the Bellman Continuum, Hawaii, January 1993

"Nonlinear Dynamics and Neural Network Information Processing"
J. Barhen
Invited seminar at University of Paris/ESPCI, France, February 1992

"Advances in Optoelectronic Neurocomputing"
J. Barhen
Invited France-Telecom University/ENST seminar, Paris, France, November 1992

"Bifurcating Optical Information Processing in a Nonlinear Gain Saturation Memory Medium"
H.-K. Liu
International Symposium on Optoelectronics in Computers, Communications, and Control, Hsinchu, Taiwan, December 14-18, 1992

Presentations

"Neural Networks Research in the Former Soviet Union"
J. Barhen
CIA/FASAC Briefing on Soviet Nonlinear Science, January 1992

"The Newton-Euler Inverse Mass Operator Method for Internal Coordinate Molecular Dynamics Simulations"
A. Jain, G. Rodriguez, N. Vaidehi, A. Mathiowetz, and W. A. Goddard
Workshop on High-Performance Computing and Grand Challenges in Structural Biology, January 1992

"Dynamical Approach to the Collective Brain"
M. Zak
USA-Mexico Symposium on Artificial Intelligence, January 1992

"Applicability of Neurocomputing Technology to Earth-Based Atmospheric Remote Sensing"
J. Barhen
NSF/NCAR Symposium, February 1992

"Collective Brain as a Dynamical System"
M. Zak
USC Center for Geo-engineering, March 1992

"Fast Neural Algorithms for Detecting Moving Targets in Highly Noisy Environments"
N. Toomarian, J. Barhen, and M. Zak
SPIE's OE/Aerospace Sensing Symposium, April 1992

"A Modular Hierarchical Approach to Learning"
P. Baldi
Second International Conference on Fuzzy Logic and Neural Networks, Iizuka, Japan, May 1992

"Contact Control of Robot Manipulators with Neural Network Identification of Environment Dynamics"
S.T. Venkataraman, S. Gulati, J. Barhen, and N. Toomarian
Seventh Yale Workshop on Adaptive and Learning Systems, May 1992

"A Unipolar Terminal-Attractor-Based Associative Memory with Adaptive Threshold and Perfect Convergence"
C.-H. Wu and H.-K. Liu
International Joint Conference on Neural Networks, Baltimore, MD, June 7-11, 1992

"Hybrid Robot Control with Neural Network Identification of Uncertain Environments"
S.T. Venkataraman and S. Gulati
American Control Conference, June 1992

"Control of Nonlinear Systems Using Terminal Sliding Modes"
S.T. Venkataraman and S. Gulati
American Control Conference, June 1992

"Intelligent Neuroprocessors for In-Situ Launch Vehicle Propulsion Systems Health Management"
S. Gulati and R. Tawel
Third International Workshop on Neural Networks and Fuzzy Logic,
NASA Johnson Space Center, June 1992

"Dynamic Self-Amplified Photorefractive Optical Beam-Array Generation"
S. M. Zhou, P. Yeh, and H.-K. Liu
SPIE's 1992 International Symposium on Optical Applied Science and Engineering, July 1992

"Multilayer Holographic Bifurcative Neural Network for Real-Time Adaptive EOS Data Analysis"
H.-K. Liu
NASA OSSA Applied Information System Research Program Workshop,
Laboratory for Atmospheric and Space Physics, University of Colorado, Boulder, CO, August 11-13, 1992

"Real-Time Dynamic Simulation of the Cassini Spacecraft Using DARTS: Part II, Parallel/Vector Real-Time Implementation"
A. Fijany, J. Roberts, A. Jain, and G. Man
Fifth Annual Conference on Computational Control, August 1992

"Parallel O(logN) Algorithms for Open- and Closed-Chain Rigid Multibody Systems Based on a New Mars Matrix Factorization Technique"
A. Fijany
Fifth Annual Conference on Computational Control, August 1992

"Multilayer Holographic Bifurcative Neural Network for Real-Time Adaptive EOS Data Analysis"
H.-K. Liu
NASA OSSA Applied Information System Research Program Workshop,
August 1992

"Recursive Flexible Multibody Dynamics Using Spatial Operators"
A. Jain and G. Rodriguez
Eighth International Conference on CAD/CAM: Robotics and Factories of the Future, August 1992

"Real-Time Simulation of the Cassini Spacecraft Using DARTS: Part I, Functional Capabilities and the Spatial Algebra Algorithm"
A. Jain and G. Man
Fifth Annual Conference on Aerospace Computational Control, August 1992

"Real-Time Simulation of the Cassini Spacecraft Using DARTS: Parallel/Vectorized Real-Time Implementation"
A. Jain, A. Fijany, J. Roberts, and G. Man
Fifth Annual Conference on Aerospace Computational Control, August 1992

"Spatial Operator Algebra for Flexible Multibody Dynamics"
A. Jain and G. Rodriguez
Fifth Annual Conference on Aerospace Computational Control, August 1992

"New Directions in Massively Parallel Neurocomputing with Applications to Signal Processing"
J. Barhen
National Security Agency COGSCI Seminar, August 1992

"Advances in Nonlinear Science Applications to Target Detection"
J. Barhen
DARPA Warbreaker Symposium, September 1992

"Adaptive Invariant Optical Pattern Recognition"
H.-K. Liu
Optical Society of America Annual Meeting, September 1992

"Space Invariant Automatic Target Recognition"
H.-K. Liu
DARPA Warbreaker Symposium, September 1992

"Unpredictable Dynamics Approach to Neural Intelligence"
M. Zak
USC Center for Applied Mathematics, September 1992

"New Directions in Massively Parallel Neurocomputing"
J. Barhen, N. Toomarian, A. Fijany, A. Yariv, and A. Agrarat
Fifth International Conference on Neural Networks and their Applications, Nimes, France, November 1992

"Shape Estimation From Incomplete Measurements: A Neural Networks Approach"
N. Toomarian, M. Salama, and R. Bruno
Third International Conference on Adaptive Structures, November 1992

"Unpredictability in Newtonian Dynamics"
M. Zak
Caltech Seminar on Mechanics, Pasadena, CA, November 1992

"Totally Retrievable and Perfectly Convergent Neural Associative Memory System"
C.-H. Wu and H.-K. Liu
International Symposium on Optoelectronics in Computers, Communications, and Control, Hsinchu, Taiwan, December 14-18, 1992

"Optical Implementations of Terminal-Attractor-Based Neural Networks"
H.-K. Liu
National Taiwan University Optoelectronic Engineering Graduate Institute Seminar, Taipei, Taiwan, December 14, 1992

"Neural Network Principles and Optical Implementations"
H.-K. Liu
SPIE Half-Day Short Course SC-6, Hsinchu, Taiwan, December 15, 1992

"Stochastic Attractors in Terminal Neurodynamics"
M. Zak
International Conference on Engineering Sciences, Hong Kong, December 1992

"Parameter Learning and Compliance Control Using Neural Networks"
S.T. Venkataraman, S. Gulati, J. Barhen, and N. Toomarian
Conference on Decision and Control, Tucson, AZ, December 1992

"NASA Neuroprocessing Devices and Analog Computing Program"
S. Gulati, P. Hunter, J. Barhen, R. Tawel, and A. Thakoor
Symposium on High-Performance Computing for Flight Vehicles, Washington, DC, December 1992

Patent and New Technology Reports

"Real-Time Predetection Dynamic Range Compression"
H.-K. Liu
U.S. Patent No. 5,130,530, issued July 14, 1992

"Inner-Product Trinary Associative Memory"
H.-K. Liu, A. A. S. Awwal, and M. A. Karim
JPL Case No. C-17850-CIT 2050, October 14, 1992 (U.S. patent pending)

"Neural Networks Training by Integration of Adjoint System of Equations Forward in Time"
J. Barhen and N. Toomarian
JPL and NASA Case No. NPO-18586-1-CU, 1992 (U.S. patent pending)

"Controlling Flexible Robot Arms Using a High-Speed Dynamics Process"
A. Jain and G. Rodriguez
JPL and NASA Case No. NPO-18499-1-CU, 1992 (U.S. patent pending)

"Controlling Under-Actuated Robot Arms Using a High-Speed Dynamics Process"
A. Jain and G. Rodriguez
JPL and NASA Case No. NPO-18498-1-CU, 1992 (U.S. patent pending)

"A Self-Amplified Optical Pattern Recognition System"
H.-K. Liu
JPL Case No. C-18009; CIT Case No. 2088, 1992 (U.S. patent pending)

"Fast Temporal Neural Learning Using Teacher Forcing"
N. Toomarian and J. Barhen
JPL and NASA Case No. NPO-18553-1-CU, 1992 (U.S. patent pending)

"Terminal Slider Control of Nonlinear Systems"
S.T. Venkataraman and S. Gulati
JPL and NASA Case No. NPO-18584-1-CU, 1992 (U.S. patent pending)

"The Optical Implementation of Inner Product Neural Associative Memory"
H.-K. Liu
NASA Tech Briefs, NPO-18491-1-CU, vol. 17, no. 3, pg. 45, March 1993
(U.S. patent pending)

"Trinary Associative Memory Would Recognize Machine Parts"
H.-K. Liu, A. Awwal, and M. Karim
NASA Tech Briefs, NPO-17850, vol. 15, no. 9, pg. 93, September 1991
(U.S. patent pending)

"Accelerating Learning by Neural Networks"
N. Toomarian and J. Barhen
NASA Tech Briefs, NPO-18553, vol. 16, no. 11, p. 110, November 1992

"Optical Implementation of Terminal-Attractor-Based Associative Memory"
H.-K. Liu, Jacob Barhen, and Nabil H. Farhat
NASA Technical Report, NPO-18790, June 15, 1992

"Adjoint Functions and Temporal Learning Algorithms in Neural Networks"
J. Barhen and N. Toomarian
NASA Tech Briefs, NPO-18586, 1992 (in press)

"Adjoint-Operator and Nonadiabatic Learning Algorithms in Neural Networks"
J. Barhen and N. Toomarian,
NASA Tech Briefs, NPO-18352, 1992 (in press)

"Fast Serial and Parallel Conjugate Gradient Algorithms for Rigid Multibody Dynamics"
A. Fijany and R. E. Scheid
NASA Tech Briefs, NPO-18567, 1992 (in press)

"High-Precision Computing with Charge Domain Devices"
J. Barhen and N. Toomarian
NASA Tech Briefs, NPO-18972, 1992 (in press)

"Neural Networks with Creative Dynamics"
J. Barhen and M. Zak
NASA Tech Briefs, NPO-18125, 1992 (in press)

"Optical Implementation of Terminal-Attractor-Based Associative Memory"
H.-K. Liu, J. Barhen, and N. Farhat
NASA Tech Briefs, JPL NPO-18790, 1992 (in press)

"Optical Pattern Recognition With Self-Amplification"
H.-K. Liu
NASA Tech Briefs, JPL NPO-18648, 1992 (in press)

"Parallel Algorithms and Architectures for Computation of Manipulator Forward Dynamics"
A. Fijany and A.K. Bejzcy
NASA Tech Briefs, NPO-18706, 1992 (in press)

Optical Processing

Publications

"Self-Amplified Optical Pattern-Recognition Technique"
H.-K. Liu
Applied Optics, vol. 31, no. 14, pp. 2568-2575, May 10, 1992

"MSD Optical Computing Using Fan-Out Element"
S.-M. Zhou, S. Campbell, P. Yeh, and H.-K. Liu
Optics Letters, vol. 17, pp. 1996-1998, 1992

"Adaptive Invariant Optical Pattern Recognition"
H.-K. Liu
Optical Society of America 1992 Technical Digest Series, vol. 12, p. 60, 1992

Invited Presentations

"Advanced Self-Amplified Optical Pattern Recognition"
H.-K. Liu
Electrical and Computer Engineering Department, Auburn University, Auburn, AL, October 5, 1992

"Advanced Optical Computing Techniques for Future Space Exploration"
H.-K. Liu
Physics Department, Alabama A&M University, Huntsville, AL, October 6, 1992

"Using Optical Computers for Scientific Data Reduction and Display"
H.-K. Liu
The DataLab at Jet Propulsion Laboratory, Pasadena, CA, October 22, 1992

Presentations

"Self-Amplified Dynamic Space-Invariant Optical Pattern Recognition"
H.-K. Liu
DARPA Optics Review (published by Booz, Allen & Hamilton Inc.), Melbourne, FL, January 7-10, 1992

"Adaptive Invariant Optical Pattern Recognition"
H.-K. Liu
Conference on Lasers and Electro-Optics, Anaheim, CA, May 10-15, 1992

"Complex Reconfigurable Free-Space Optical Interconnections Via Phase CGH in Spatial Light Modulators"
H.-K. Liu and S.-M. Zhou
SPIE's 1992 International Symposium on Optical Applied Science and Engineering, San Diego, CA, July 19-24, 1992

"Dynamic Self-Amplified Photorefractive Optical Beam-Array Generation"
S.-M. Zhou, P. Yeh, and H.-K. Liu
SPIE's 1992 International Symposium on Optical Applied Science and Engineering, San Diego, CA, July 19-24, 1992

"Adaptive Invariant Optical Pattern Recognition"
H.-K. Liu
Optical Society of America 1992 Annual Meeting, Alburquerque, NM, September 20-25, 1992

"Space Invariant ATR"
H.-K. Liu
DARPA Workshop on Sensor Data Interpretation, George Mason University, Fairfax, VA, September 30-October 2, 1992

Patent and New Technology Reports

The Caltech Patent Manager, Mr. Lu Speck, stated in the attached letter to JPL Section 347 Office that Dr. Hua-Kuang Liu is "In...optical correlators and other optical devices probably in the 100th percentile of JPL's inventors.... Few, if any, JPL inventors have achieved such a high percentage of their cases selected for patenting."

"A Self-Amplified Optical Pattern Recognition System"
H.-K. Liu
JPL Case No. C-18009; CIT Case No. 2088 (U.S. patent pending)

"Photorefractive Crystal Compresses Dynamic Range of Images"
H.-K. Liu
NASA Tech Briefs, NPO-18098, vol. 15, no. 10, pg. 37, October 1991

"Optical Computation of Matrices from Vectors"
H.-K. Liu
NASA Tech Briefs, NPO-17512, vol. 15, no. 2, pg. 70, February 1991
(U.S. patent pending)

"Real-Time Predetection Dynamic Range Compression"
H.-K. Liu
U.S. Patent No. 5,130,530, Issued July 14, 1992

"Optical Pattern Recognition with Self-Amplification"
H.-K. Liu
NASA Technical Report, NPO-18648, October 29, 1992

"Reconfigurable Optical Interconnections via Dynamic Computer-Generated Holograms"
H.-K. Liu and S.-M. Zhou
Patent to be filed by JPL November 3, 1992

Data Storage

Publications

"Domain Imaging in Magnetic Garnets Using Tunneling-Stabilized Magnetic Force Microscopy"
R. R. Katti, P. Rice, J. C. Wu, and H. L. Stadler
IEEE Trans. on Magnetics, vol. 28, no. 5, p. 2914-2916,
September 1992

"Partial Grooving in Vertical Bloch Line Memory"
J. C. Wu, R. R. Katti, and H. L. Stadler
IEEE Trans. on Magnetics, vol. 28, no. 5, p. 2338-2340, September 1992

Invited Presentations

"Vertical Bloch Line Storage Technology"
R. R. Katti
Datatape Corporation, Pasadena, CA, September 2, 1992

"Onboard Memory and Storage Technology"
R. R. Katti
NASA/ARTS Committee Meeting for Data Systems Technology, Pasadena, CA,
October 15, 1992

"Vertical Bloch Line Storage"
R. R. Katti
Polaroid Corporation, Cambridge, MA, November 3, 1992

"Vertical Bloch Line Storage Technology Update for VBL Consortium Planning"
R. R. Katti
Integrated System Assemblies Corporation, Woburn, MA, November 5, 1992

"Vertical Bloch Line Storage Chips"
R. R. Katti
Interactive Meeting on Magnetic Recording," Lake Arrowhead, CA,
November 11, 1992

Presentations

"Partial Grooving in Vertical Bloch Line Memory"
J. C. Wu, R. R. Katti, and H. L. Stadler
1992 International Magnetics Conference, St. Louis, MO, April 13, 1992

"Domain Imaging in Magnetic Garnets Using Tunneling-Stabilized Magnetic Force Microscopy"
R. R. Katti, P. Rice, J. C. Wu, and H. L. Stadler
1992 International Magnetics Conference, St. Louis, MO, April 15, 1992

"Analysis of the Degradation of a Spaceflight Tape Recorder"
R. R. Katti, J. P. Slonski, O. Short, and K. Starnes
1992 International Magnetics Conference, St. Louis, MO, April 15, 1992

"Vertical Bloch Line Storage Technology"
H. L. Stadler, R. R. Katti, and J. C. Wu
National Media Laboratory, St. Paul, MN, July 28, 1992

Patent and New Technology Reports

"Partial Grooving in Vertical Bloch Line Memory"
J. C. Wu, R. R. Katti, and H. L. Stadler
NASA Tech Briefs, NPO-18749

"Half-State Readback in Vertical Bloch Line Memory"
J. C. Wu, R. R. Katti, and H. L. Stadler
NASA Tech Briefs, NPO-18644, June 29, 1992 (filed, U.S. patent pending)

"Domain Imaging in Magnetic Garnets Using Tunneling-Stabilized Magnetic Force Microscopy"
R. R. Katti, J. C. Wu, and H. L. Stadler
NASA Tech Briefs, NPO-18726

"Nonvolatile Gallium Arsenide Random-Access Memory"
R. Katti, J. C. Wu, and H. L. Stadler
NASA Tech Briefs, NPO-18529, June 29, 1992 (filed, U.S. patent pendingt)

"An Improved Vertical Bloch Line Memory"
J. C. Wu, H. L. Stadler, and R. R. Katti
JPL Case No. C-18615, June 29, 1992 (filed, U.S. patent pending)

"An Improved Nonvolatile Magnetic Random-Access Memory"
J. C. Wu, H. L. Stadler, and R. R. Katti
C-18529, June 29, 1992 (filed, U.S. patent pending)

Software Engineering and Computer Science

Publications

"Automation and Hypermedia Technology Applications"
J. H. Jupin, E. W. Ng, and M. L. James
Soar Conference, Houston, TX, August 1992

Presentations

"Performance Engineering of Complex Systems"
E. Upchurch
Keynote Address at 4th International Conference on Synergetics,
Bangkok, Thailand, February 4, 1992

"Parallel Database Benchmarking and Tactical Intelligence Applications Support"
E. Upchurch
ASAS Techbase Semiannual Review, JPL, Pasadena, CA, April 1992

"SPEEDES: A Unified Approach to Parallel Simulation"
J. Steinman
PADS, Newport Beach, CA, January 1992

"Simulated Operational Scenarios for a Planetary Mini-Rover Executive Running on the MAX"
J. George
TOOLS, Paris, France, August 1992

"High-Performance Flight Computer Developed for Deep Space Applications"
R. Bunker, E. Upchurch, J. George, and B. Eng
Spacecomputing, France, November 1992

"ASAS Parallel Database Server"
E. Upchurch, P. Springer, D. Lockman
ASAS Techbase Semiannual Review, U. Penn., Philadelphia, PA, October 1992

"ASAS and Parallel Oracle on the Ncube"
P. Springer
Oracle Users' Group Meeting, Foster City, CA, November 16, 1992

"Automation and Hypermedia Technology Applications"
J.H. Jupin, E.W. Ng, and M.L. James
Soar Conference, Houston, TX, August 1992

Patent and New Technology Reports

"Encylopedia of Software Components"
L. V. Warren and B. C. Beckman
JPL Case No. 18435, NASA Case No. NPO-18435-1-CU, Attorney Docket No. JPL/015-91

Advanced Networking

Publications

"Advanced Networking Detailed Migration Plan - Technical Approach"
L. A. Bergman, D. T. H. Liu, and S. P. Monacos
Report to Sponsor, April 30, 1992

"Advanced Networking Migration Plan - Executive Summary"
L. A. Bergman, D. T. H. Liu, and S. P. Monacos
Report to Sponsor, May 14, 1992

Invited Presentations

"A Permutation Engine for Interfacing to Future 50-Gbit/sec WDM All-Optical Networks"
S. P. Monacos
Advanced Networking Seminar, Jet Propulsion Laboratory, Pasadena, CA, September 10, 1992

"Simulation of Hot-Potato Networking Using SES"
S.P. Monacos
Advanced Network Subsystem Design Review, University of Colorado, Boulder, CO, September 29, 1992

"A Permutation Engine as a Scalable WDM Interface to High-Capacity Networks"
S.P. Monacos
Advanced Network Subsystem Design Review, University of Colorado, Boulder, CO, September 29, 1992

Presentations

"CASA Supercomputer Network - CALCRUST 3D Seismic Profiling"
L.A. Bergman
SDI BioMed Workshop, Los Angeles Airport Hilton, Los Angeles, CA, January 17, 1992

"WDM HIPPI Multiplexer - Application of IST Technology for High-Performance NTB Computing"
L.A. Bergman
NTB Technology Insertion Kickoff Meeting, Washington, DC, June 9-10, 1992

Patent and New Technology Reports

"Permutation Engine"
S.P. Monacos
JPL and NASA Case No. NPO-18864-1-CU, March 27, 1992 (U.S. Patent Pending)

"Supernet"
S.P. Monacos
JPL and NASA Case No. NPO-18983-1-CU, September 11, 1992 (U.S. Patent Pending)

IV. Custom Microcircuits

OVERVIEW

The goals of this program are to develop custom microcircuit technology, also known as application-specific integrated circuit (ASIC) technology, for use in flight and ground programs. Supporting this effort are activities to investigate the effects of the space environment, and particularly ionizing radiation, on microcircuits and to develop a space qualification methodology. Another aspect of the program emphasizes innovative applications of custom microcircuit technology to image and signal processing and communications.

1992 MAJOR TECHNICAL ACHIEVEMENTS

Space Qualification Methodology

- **Observed** the March 1991 solar flare in the JPL p-FETs on board the CRRES (Combined Release and Radiation Effects Satellite) and presented the results at the 1992 Nuclear and Space Radiation Effects Conference in New Orleans (July 1992)

- **Designed** a test coupon for the Honeywell 1060 Gate Array to be used to assess the reliability of flight gate arrays.

- **Developed** the RADMON (radiation monitor) for the STRV (Space Technology Research Vehicle) to be launched in December 1993.

- **Installed** a wafer-level parametric test system (hp4062) to be used in testing microelectronic test chips.

- **Began** development of a reliability tester to be used to evaluate the reliability of microelectronic test chips fabricated along with integrated circuits and sensors (CCDs).

TECHNICAL PROGRESS REPORTS

Custom Microcircuits

Publications

"Parallel processor array for high-speed path planning"
S. E. Kemeny, T. J. Shaw, R. H. Nixon, and E. R. Fossum
Proceedings 1992 IEEE Custom Integrated Circuits Conf., Boston, MA, May 1992

"Concurrent processor ASIC for high-speed path planning"
S. E. Kemeny, T. J. Shaw, R. H. Nixon, T. Daud, and E. R. Fossum
Proceedings GOMAC '92, Las Vegas, NV, November 1992

Presentations

"Parallel processor array for high-speed path planning"
S. E. Kemeny, T. J. Shaw, R. H. Nixon, and E. R. Fossum
IEEE Custom Integrated Circuits Conf., Boston, MA, May 1992

"Concurrent processor ASIC for high-speed path planning"
S. E. Kemeny, T. J. Shaw, R. H. Nixon, T. Daud, and E. R. Fossum
GOMAC '92, Las Vegas, NV, November 1992

Patent and New Technology Reports

"Digital Parallel Processor Array for Path Planning"
S. E. Kemeny, E. R. Fossum, R. H. Nixon
New Technology Report, NPO-18727/8286 (1992)

Space Qualification Methodology

Publications

"Proton-Sensitive Custom SRAM Detector"
G. A. Soli, B. R. Blaes, and M. G. Buehler
IEEE Trans. on Nuclear Science, Vol. 39, no. 5, pp. 1374-1378, October 1992

"CMOS-ASIC Life-Predictions from Test Coupon Data"
M. G. Buehler, N. Zamani, and J. A. Zoutendyk
Proceedings IEEE 1992 International Conference on Microelectronic Test Structures, vol. 5, pp. 4-11, March 1992

"CRRES Microelectronic Test Chip Orbital Data II"
G. A. Soli, B. R. Blaes, M. G. Buehler, K. Ray, and Y.-S. Lin
IEEE Trans. on Nuclear Science, vol. 39, pp. 1840-1845, December 1992

Presentations

"CMOS-ASIC Life Predictions from Test Coupon Data"
M. G. Buehler
UCLA EE201 Electrical Engineering Graduate Student Seminar,
February 24, 1992

"CMOS-ASIC Life Predictions from Test Coupon Data"
M. G. Buehler
Space Parts Working Group Meeting, Torrance, CA, March 24, 1992

"CMOS-ASIC Life Predictions from Test Coupon Data"
M. G. Buehler
Reliability Engineering Section Seminar, JPL, Pasadena, CA, September 10, 1992

CMOS-ASIC Life Predictions from Test Coupon Data"
M. G. Buehler
LSI Logic, Sunnyvale, CA, October 2, 1992

"GaAs Integrated Circuit Reliability"
W. Yamada, K. MacWilliams, M. Buehler, N. Zamani, and B. Blaes
DARPA Digital GaAs Insertion Workshop, Reston, VA, November 20, 1992

"CRRES Microelectronic Test Chip Orbital Data II"
G. A. Soli, B. R. Blaes, M. G. Buehler, K. Ray, and Y.-S. Lin
Nuclear and Space Radiation Effects Conference, New Orleans, LA, July 15, 1992

Patent and New Technology Reports

"Particle Sensor Array"
M. G. Buehler, B. R. Blaes, and U. Lieneweg
NASA Tech Briefs, NPO-18322, March 19, 1992 (filed, U.S. patent pending)

"Alpha-Sensitive D-Latch"
M. G. Buehler, B. R. Blaes, and R.H. Nixon
NASA Tech Briefs, NPO-187614, October 5, 1992 (filed, U.S. patent pending)

"Barrier/n/n+ Varactor Frequency Multipliers"
U. Lieneweg and J. Maserjian
NASA Tech Briefs, NPO-18428, vol. 16, no. 8, p. 28, August 1992

V. Appendix

CSMT-CALTECH CAMPUS COLLABORATIONS

J. Bower	Neural oscillations in cognitive neuroscience
J. Burdick	Global optimization with application to robotics
K. M. Chandy	Porting SPEEDES to Compositional C++
W. Goddard	Large-scale molecular simulations and high-performance computing
R. H. Grubbs	Nonlinear optical polymers
V. Lubecke	Planar backshort for integerated circuits
R. Mewalt	Interdigitated pixel sensor
D. Psaltis, D. Marx	Subwavelength optical patterns
D. B. Rutledge	Computer-aided design; Planar backshort for integrated circuits
M. Segev	Terabyte volume holographic space science data storage
K. Vahala	Patterned growth of GaAs for quantum dots and wires
A. Yariv	Large-scale processors and algorithms for neurocomputing
N.-C. Yeh	HTS high-field magnetic properties

CSMT-OTHER COLLABORATIONS

H. Abarbanel (UCSD)	Chaos
A. Agranat (Hebrew U.)	Electroholographic neural networks
D. Andes (Naval Weapons Center)	Neurocomputing algorithms for target detection in cluttered backgrounds
A. Bagneres (U. of Grenoble)	Micromagnetic supercomputer simulations
B. Beckman (Microsoft, Inc.)	Knowledge base software
D. Beratan (U. of Pittsburgh)	Theory of optical nonlinearities and electron transfer
H. Bozler (USC) P. Echternach	Single-electron transistor
J. L. Bredas (U. of Mons, Belgium)	Theoretical studies of conjugated organic molecules
R. Buhrman (Cornell U.)	Noise measurements of HTS junctions
D. Casasent (Carnegie Mellon U.)	Optical Processing
Y. Chauvin (Stanford)	Fingerprint recognition
L. T. Cheng (Dupont)	Hyperpolarizabilities of organics
R. Colton (NRL)	Magnetometer
T. Crowe (U. of VA) R. J. Mattauch	Planar diodes
N. Dagli (UCSD) M. Thomas	Electron waveguides
D. Dapkis (USC)	DFB gratings, HDWDM components in photonic integrated circuits
R. van de Geijn (U. of TX, Austin)	High-performance in-core parallel direct solver
S. P. DenBaars (UCSD)	MOCVD growth and characterization
B. Dunn (UCLA)	Sol-gel nonlinear optical materials
J. East (U. of MI)	Submillimeter-wave mixer analysis

N. Erickson (U. of MA)	Submillimeter-wave multipliers
N. Farhat (U. of PA, Phil.)	Optical neural nets
M. Fattahi & (EG&G Reticon) H.-F. Tseng	Charge-coupled device technology
M. Forrester (Westinghouse Science and Technology Center)	HTS device development
T. Gabrielson (NAWC)	Accelerometer
A. M. Glass (Bell Labs) A. Partovi	Nonlinear optics
D. Glenar (GSFC)	Infrared sensor
A. Gmitro (U. of AZ) B. Velasquez	Optical interconnects
R. Graham (Arizona State U.)	Analytical electron microscopy
J. Green (Oxford U.)	Photoelectron spectroscopy of organic and organometallic nlo materials
J. Hardy (National Test Facility)	Parallel simulation
J. Herring (Hughes)	256 x 256 LWIR focal plane array
M. Hopkins (U. of Pittsburgh)	Third-order nonlinear optical properties of organometallic compounds
F. Humphrey (Boston U.)	Vertical bloch line memory simulations and experiments
K. Hwang (USC)	Digital optical computing
R. Iltis (UCSB)	Tracking algorithms
S. S. Iyengar (LA State U.)	Tactical intelligence fusion
B. Johnson (Honeywell)	HTS bolometers
L. P. B. Katehi (U. of MI)	Novel waveguide backshorts: theoretical analysis
C. Krafft (Naval Air Development Center)	Magnetic material characterization
A. Kussmaul (MIT Lincoln Laboratory)	High-temperature superconductors

D. L. Kwong (U. of Texas)	Porous Si
A. G. Larsson (Chalmers U.)	MBE growth and semiconductor lasers
B. F. Levine (AT&T Bell Laboratories)	Infrared detectors
K. L. Luke (CSU Long Beach)	Nonlinear optics
J. Mahan (Colorado State U.)	Analysis of epitaxial $FeSi_2$
P. Malin (Duke U.)	Borehole seismometers
L. Mawst (TRW)	DFB gratings
S. Narathong (U. of WI-Platteville)	Neuro-chip designs
S. Palfrey (David Sarnoff Research Center)	Monolithic LWIR focal plane array
P. Pellegrini (Rome Laboratory)	PtSi infrared detector
A. Persoons (U. of Leuven, Belgium)	Hyper-Raleigh scattering technique
B. Pierce (Hughes Aircraft Company)	Theoretical studies of conjugated organic molecules
J. Posthill (Research Triangle Institute)	Analysis of epitaxial diamond films
P. Rice (NIST-Boulder, CO)	Tunneling-stabilized magnetic force microscopy in magnetic garnets
J. Sanderson (Los Alamos National Laboratory)	Parallel simulation
L. Schowalter (Rensselaer Polytechnic Inst.)	Rutherford backscattering analysis
G. Stegeman (U. Cent. FL)	Third-order nonlinear optical properties of organic materials
A. Stubberud (UC Irvine)	Neural nets for control
M. K. Summer (Sangamon State U.)	Knowledge base software
H. Temkin (CO State U.)	Gas source MBE and semiconductor lasers
W. Tomasch (Notre Dame U.)	Microwave measurements of HTS

E. Van Stryland (U. Cent. FL)	Passive optical limiters; nonlinear optics of phthalocyanines
S. Velsko (Livermore Nat. Lab)	Nonlinear optics of bio-organic crystals
J. Villareal (NASA-JSC)	STS-APU health-monitoring
H. Wieder (UCSD)	InGaAs detectors
T. Weller (U. of MI)	Novel waveguide backshorts: theoretical analysis
J. Weiss (McDonnell Douglas)	Fuzzy state classification for VHM applications
A. White (AT&T Bell Laboratories)	Epitaxy of $CrSi_2$
I. Williams (Hong Kong University of Science and Technology)	Nonlinear optics of bio-organic crystals
J. Wu (Auburn U.)	Neural networks and applications
C. Yakymyshyn (G.E. CR&D)	Electro-optic organic salt crystals
P. Yeh	Advanced optical processing and neurocomputing
F. Yu (PA State U.)	Image processing
S. Zhou (UCSB)	Photorefractive material and holography

DISTINGUISHED VISITING SCIENTISTS

- Dr. Anne Bagneres, Department of Electrical Engineering, Boston University
- Prof. Hans Bozler, Department of Physics, University of Southern California
- Dr. Floyd B. Humphrey, Department of Electrical, Computer, and Systems Engineering, Boston University
    - IEEE Magnetics Society Award Winner for Contributions to Magnetics
    - Magnetic materials and device research
- Prof. Linda Katehi, Electrical Engineering, University of Michigan
- Professor Walter Kosonocky, New Jersey Institute of Technology
    - Advanced Imager Technology
- Dr. Venkatesh Narayanamurti, Dean, College of Engineering, University of California at Santa Barbara
    - Ballistic Electron Emission Microscopy
- Dr. Dimitris Pavlidis, NASA Center for Terahertz Technology, University of Michigan
- Prof. Antti V. Raisanen, Senior Research Fellow, National Research Council, Helsinki University of Technology, Espoo, Finland
    - Head, Radio Laboratory
- Prof. Michael G. Spencer, Department of Physics, Howard University
    - MBE of High Electronic Mobility Devices
    - Laser-Assisted Molecular Beam Epitaxy
- Dr. Roland Stalder, ETH Zurich
    - Charged Particle Detection

Dr. James Tillman, University of Washington

- Micro-Weather Station

- Prof. Pochi Yeh, Department of Electrical Engineering and Computer Engineering, University of California at Santa Barbara

HONORS AND AWARDS

Lew Allen Awards

L. Doug Bell: For significant contributions leading to the development of innovative scanning tunneling microscopy-related technologies and their application to the elucidation of the electronic structure of advanced microelectronic material structures

Edward T. Chow: For pioneering work in the development of computer technology necessary to support the human genome effort leading to a new class of sequence alignment coprocessors called Biological Information Signal Processor

Eric R. Fossum: In recognition of his research accomplishments in the fields of focal plane signal processing and high-performance image sensors

NASA Medals

Carl Kukkonen: Exceptional Achievement

Joseph Perry: Exceptional Scientific Achievement

Kevin Hussey: Exceptional Engineering Achievement

James Janesick: Exceptional Engineering Achievement

Timothy Krabach: Exceptional Engineering Achievement

Jerry Solomon: Exceptional Engineering Achievement

Gordon Bell Award Finalists

"Electromagnetic Scattering Calculations on the Intel Touchstone Delta"
T. Cwik (JPL), J. Patterson (JPL), D. Scott (Intel SSD)

1992 "Federal 100" Award

Paul Messina: One of 100 recipients of the 1992 "Federal 100" award, sponsored by Federal Computer Week. Messina was recognized for spearheading the acquisition of the Intel Delta for use by JPL, Caltech, and eleven other research institutions

CONFERENCES AND WORKSHOPS SPONSORED AND/OR HOSTED BY CSMT

- Ballistic Electron Emission Microscopy Workshop, Death Valley, CA, February 1992
- CMST New Technology Commercialization Workshop, January 1992
- Third International Symposium on Space Terahertz Technology, February 1992
- Innovative Long-Wavelength Infrared Detectors Workshop, April 1992
- Systems Software and Tools for High-Performance Computing Environments Workshop, April 1992
- Microtechnologies and Applications to Space Systems Workshop, May 1992
- NASA Binary Optics Workshop, Sponsored by NASA Office of Aeronautics and Space Technology, GRC, Vienna, VA, July 28, 1992
- Tunnel Sensors Workshop, Jet Propulsion Laboratory, July 7, 1992
- Optoelectronic Semiconductor Modulators and Applications Workshop, August 1992

TECHNICAL REPORT STANDARD TITLE PAGE

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12. Sponsoring Agency Name and Address NATIONAL AERONAUTICS AND SPACE ADMINISTRATION Washington, D.C. 20546		14. Sponsoring Agency Code RE 159 BK-582-03-11-21-00

15. Supplementary Notes

16. Abstract

The 1992 Technical Report of the Jet Propulsion Laboratory Center for Space Microelectronics Technology summarizes the technical accomplishments, publications, presentations, and patents of the center during the past year. The report lists 187 publications, 253 presentations, and 111 new technology reports and patents.

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