SURF 2005

program and activities

summer undergraduate research fellowship

NSF

NIST

National Institute of Standards and Technology

Technology Administration, U.S. Department of Commerce

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The Summer Undergraduate Research Fellowship (SURF) Program at NIST

Looking for a great opportunity for your undergraduate students to get hands-on research career experience during the summer? Submit a proposal to participate in the National Institute of Standards and Technology (NIST) - National Science Foundation (NSF) Summer Undergraduate Research Fellowship (SURF) program for students majoring in science, mathematics and engineering.

The National Institute of Standards (NIST) and the National Science Foundation (NSF) are committed to the development of undergraduate students interested in exploring research careers. The Summer Undergraduate Research Fellowship (SURF) program is a NIST-NSF partnership that provides opportunities for students to actively participate in NIST research programs. The SURF program, which began in 1993 in NIST's Physics Laboratory (PL), has now expanded to include all seven of the NIST laboratories, i.e., Building and Fire Research Laboratory (BFRL), Electronics and Electrical Engineering (EEEL), Chemical Science and Technology (CSTL), Information Technology (ITL), Manufacturing Engineering (MEL), and Materials Science and Engineering (MSEL). SURF is a part of the NSF Research Experiences for Undergraduates (REU) Program.

The SURF program is designed to increase NIST's role in the training of future generations of scientists and engineers and to increase the involvement of women and minorities in science, mathematics and engineering. The goal of this program is to expose students to applied research procedures in a unique environment. In addition to the laboratory experience, several additional components of the program are designed to enhance the students' experience.

Citizenship Requirements
The program is open to all United States citizens or permanent residents.

Student Eligibility
Students should be undergraduate students with a scientific major, a G.P.A. of 3.0/4.0 or better, intend to pursue a Ph.D., and must be covered by a health insurance plan (either through school or family). Students with physics, material science, chemistry, applied mathematics, computer science, or engineering majors are always encouraged to apply. However, there may be research opportunities for students with other majors.

Living Arrangements
SURF students participate in the SURF program at the headquarters site of the National Institute of Standards & Technology (NIST). NIST is located in Gaithersburg, Maryland, about 25 miles (40 kilometers) from the center of Washington, D.C. Housing arrangements have been made with two local apartment complexes for the SURF students to share fully furnished apartments (*no pets allowed*). Transportation from these apartments to and from the NIST campus will be provided.

The Washington Metropolitan area is rich in cultural and recreational opportunities. The apartments are just a short commute from the nation's capital, theaters, movies, restaurants, evening entertainment, historical and cultural sites, museums, shopping, and many local universities.

Research Programs Available to Students
All seven of NIST's measurement and standards laboratories are participating in the SURF programs: Physics, Material Science and Engineering, Building and Fire Research, Information Technology, Electronics and Electrical Engineering, Chemical Science and Technology, and Manufacturing Engineering. Please see the application packet, the SURF website (http://www.surf.nist.gov/surf2.htm) or the general NIST website (http://www.nist.gov) for summaries of current research opportunities.

Financial Support
SURFers receive Research Fellowships funded jointly by NIST, NSF, and their school. Students receive a $4,000 stipend for the 12 weeks ($3000 for a limited number of 9-week slots), in addition to travel and housing allowances. Universities are encouraged to share in the program in such ways as providing student credits, travel or housing allowances. This may change in 2006 so be sure to check out website for details.

This is a competitive program that ranks and reviews both the university and student portion of the application to determine the final list of SURF awardees. In the past, the NIST SURF program has been able to support approximately 100 students.

Deadline
The deadline for receipt of applications is in February. Visit http://www.surf.nist.gov/surf2.htm for this years' exact date.

Application
Applications must consist of two parts: the student's university must submit a grant proposal that provides details about its academic program and nominating one (or more students). ***The university should submit just ONE application – regardless of the number or department from which the students are applying*.** Students must provide a copy of their transcripts, two letters of recommendation, and a letter of intent or personal statement. The letter should contain information that helps the review committee make an informed decision about the student such as why the student wants to participate in the NIST/NSF SURF program, and what areas of NIST research interest the student.

Specific program information and contact information for the Program Directors, and applications can be obtained from the NIST SURF website (http://www.surf.nist.gov/surf2.htm). You can find university contacts under the FAQ section. If your university would like to be added to the list, contact Anita Sweigert. To receive an application by mail, you may contact:

Anita Sweigert
NIST
100 Bureau Dr., Stop 8400 (Building 221, Room B160)
Gaithersburg, MD 20899-8400
Telephone: 301-975-4200
Fax: 301-975-3038
E-mail: sweigert@nist.gov

http://www.surf.nist.gov/surf2.htm

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2005 SURF Summer Seminars and Tours

May 23 First official work day and orientation for Session I SURF students

June 1 NIST Safety Orientation for Summer Students

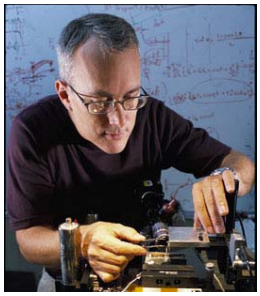
The session provided an overview, including how to report emergencies, use of personal protective equipment, general safety, office ergonomics, laboratory safety, and radiation safety. A session was also given later for Session II SURF students.

June 1 NIST Virtual Library (NVL) Demos and NIST Research Laboratory Tour

The sessions provided an overview and tour that included demonstrations of the Library facilities, both manual and computer based. This session was also repeated for Session II students.

June 2 Dr. Gordon Shaw
NIST Manufacturing Engineering Laboratory, Manufacturing Metrology Division

SI-Traceable Small Force Measurement at NIST



The international system of units (SI) is a coherent measurement system allowing the comparison of quantitative information. A brief explanation of the SI and SI-traceable measurement was given, followed by a discussion of small force measurement at NIST. Recent advances in small force metrology at NIST allow SI-traceable measurement of forces at the nanonewton level. This opens up many possibilities for mechanical testing of molecular to micro-scale materials, and also for systematically examining methods to join these materials. Recent efforts in development of small force standards and their application to the study of mechanical behavior of several inorganic and biologically-inspired micro- to nano-scale materials systems was discussed.

June 9 Dr. Wyatt Vreeland
NIST Chemical Science and Technology Laboratory, Analytical Chemistry
Division

Microfluidic Devices for Forensic DNA Analysis: Microfluidics, Electrophoresis and Optics

A new microfluidic DNA electrophoresis device with auxiliary optics, pneumatics, and software to enable rapid analysis of DNA "fingerprints" for forensic analysis and human identification was developed at NIST. The time required for analysis is reduced by nearly 90% when this device rather than the current method-of-choice for separations of this type – capillary electrophoresis – is used. The increased speed of analysis achieved when this microfluidic device is used as well as decreased cost will allow forensic case workers to address more rapidly the U.S. backlog of more than 0.5 million case samples.

June 13 First official work day and orientation for Session II SURF students

June 16 Jeffrey Bullard
Building and Fire Research Laboratory (BFRL) Seminar, Materials Construction Research Division

The Virtual Cement and Concrete Testing Laboratory

The Building Materials Division within BFRL, along with NIST's Information Technology Laboratory, has formed a NIST/industry consortium to develo a Virtual Cemtn and Concrete Testing Laboratory (VCCTL). The goal of the consortium is to deveop a web-based virtual laboratory for evaluating and optimizing cement-based matereials. Substantial savings in time, materials (purchase and disposal), human resources, and money can be achieved by reducing the number of physical concrete tests performed by private industry. The core of the virtual lab is a computer model for the hydration and microstructure develoment of cement-based systems that is based on 13 years of research at NIST.

June 16 Cynthia Howard Reed
BFRL Seminar, Building Environment Division

Ranking Interventions to Improve Inner-City Housing Indoor Air Quality

Measurement procedures are being developed and demonstrated to evaluate building ventilation and indoor pollutant concentrations. These procedures range from sophisticated tracer gas methods used predominantly in building research efforts to less involved procedures that can be employed by building operators. NIST researchers are continually developing new test procedures, and then demonstrating them in the field to evaluate their feasibility and reliability. The efforts in which these procedures are demonstrated in the field has resulted in the development of an important database of building ventilation and indoor air quality performance.

June 17 S. Shyam Sunder
BFRL Seminar, Deputy Director, BFRL

The Federal Building and Fire Safety Investigation of the World Trade Center Disaster

June 19 ***Making Choices***
Panel Discussion for SURF Students

Research track; management track; parent track? With so many possibilities to choose from, how do we decide on the smartest career path or the best time to start a family? Three NIST employees share their journeys, and talk about the choices, compromises, adventures, and twists of fate that took them to where they are today.

The panel was composed of: Barbara Goldstein, Frank Gayle, and Claire Saundry (NIST Staff). The facilitator and organizer was Kathryn M. Butler, NIST.

June 20 Professor Pietro G. Gambarova,
Milan University of Technology, Milan, Italy

BFRL Seminar: ***Thermal and Mechanical Characterization of a High-Performance Concrete for Heavy-Duty Roadways***

Dr. Liberato Ferrara,
Milan University of Technology, Milan, Italy

BFRL Seminar: ***Relationships Between Fiber Dispersion, Workability and the Mechanical Properties of SFRC Applied to Precast Roof Elements***

June 22 Mark W. Davis
BFRL Seminar, Building Environment Division

Parameters Affecting the Performance of a Residential-Scale Stationary Fuel Cell System

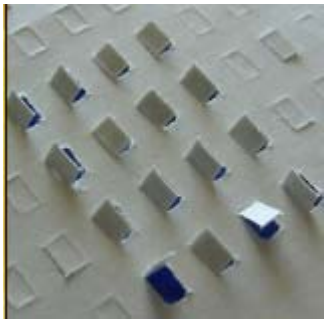
Fuel cells are being developed that produce both electricity and heat for residential applications. In order to facilitate the future commercialization of these systems, a rating methodology is being developed that will communicate their annual energy production and fuel consumption according to geographic location and intended use pattern. Factors such as ambient temperature, relative humidity, electrical power output, and thermal load are being considered. Several residential-scale stationary fuel cell systems have been tested to determine their response to these variables. Additionally, tests simulating a residential hot water and space heating load have been performed. The measured performance of two systems, a Plug Power Gensys 5c and an IdaTech EtaGen 5, will be discussed.

June 23 Dr. Sharon Laskowski
NIST Information Technology Laboratory, Information Access and User Interfaces Division

John Kelsey
NIST Information Technology Laboratory, Computer Security Division

Usability and Security of Voting Systems

The Help America Vote Act (HAVA) enacted by Congress in October 2002, gave NIST a key role in helping to realize nationwide improvements in voting systems by January 2006. The Information Technology Laboratory is coordinating HAVA efforts through its expertise in areas such as computer security and system usability. NIST supports the Election Assistance commission, chairing the Technical Guidelines Development Committee, which will recommend voluntary standards and guidelines in such important areas as: security of computers, computer



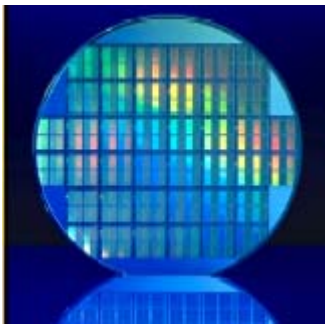
networks, and compute data storage used in voting systems; methods to detect and prevent fraud; protection of voter privacy; and the role of human factors in the design and application of voting systems, including assistive technologies for individuals with disabilities (including blindness) and varying levels of literacy.

June 28 Erica Kuligowski
BFRL Seminar, Fire Research Division

Evacuation Data Collection and Analysis

June 30 Dr. Eric Vogel
NIST Electronics and Electrical Engineering Laboratory, Semiconductor Electronics Division

The Future of Electronics: Moore's Law, Functional and Ubiquitous Electronics



Moore's law (the doubling of transistor density on integrated circuits approximately every 2 years) has provided smaller, faster and cheaper logic and memory for over 30 years. This has been driven by the ability to continue scaling the device dimensions of the Complementary Metal Oxide Semiconductor (CMOS) Field Effect Transistor (FET). Replacing or extending CMOS with emerging devices (Beyond CMOS) is an important aspect of continuing the acceleration of the rate of technical change. However, other electronic technology paradigms are becoming increasingly important. The concept of functional electronics or system-on-a-chip where optical, RF, MEMS and even molecular manipulation is performed on a CMOS platform is an increasingly important paradigm. The concept of ubiquitous electronics such as organic electronics in which electronics are cheaply incorporate din everyday items (clothes, packaging, etc.) is also an increasingly imortant paradigm. The talk provided a high-level overview of MOSFETscaling and discussed future technological paradigms (Beyond CMOS, Functional Electronics, Ubiquitous Electronics), which will continue to accelrate the rate of technical change.

June 30 ***National Science Foundation Physics REU Program Visit***

Dr. Beverly Burger, director of the Physics REU program at the National Science Foundation, visited the Physics SURFers. Dr. Burger evaluates our program and

gave us $100,000 towards supporting the Physics SURFers. She met with a number of Physics SURFers for 20-30 minutes who showed her where they work and chatted about their SURF experience.

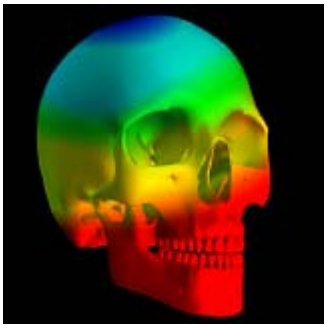
July 6 **Visit by University of Maryland Materials Research**

Ten students from a University of Maryland program similar to our SURF program toured a number of interesting labs (mammographic x-ray calibration range, Center for Neutron Research, and the weapons and protective systems lab) to get a feel for the science done at NIST.

July 7 Dr. Marc Desrosiers
NIST Physics Laboratory, Ionizing Radiation Division and PL SURF Director

Radiation Accidents: How Bones and Teeth Are Used to Measure Human Exposures

The how's and why's of radiation accidents were explained in t his presentation



on several accidents worldwide that included the former Soviet Union, Gaithersburg, and El Salvador. Electron Paramagnetic Resonance (EPR) spectrometry, also known as ESR, is sensitive to atoms/molecules with unpaired el ectrons (i.e. paramagnetic). EPR spectrometry is used to measure paramagnetic centers produced in materials after absorption of ionizing radiation (x-rays, gamma rays, high-energy particles). For bone, dentine and enamel tissue, ionizing radiation absorbed by the mineral component (hydroxyapatite) results in the formation of long-lived paramagnetic centers. This technique has been successfully used to quantify radiation overexposures to victims of radiation accidents and to assess the absorbed dose from internally-administered radiopharmaceuticals used in experimental medical therapy.

July 11 ***The Journal of Young Investigators (JYI)***

Contact: Heather Mispagel, Director of Public Relations (dpr@jyi.org)

The JYI recently launched a Resources Section, which features a Guide to Science Writing Manual. This 45-page manual is free for download at http://www.jyi.org/resources/rs.php. The manual can assist students in learnng the techniques of writing a resarch manuscript. Along with the manual, other JYI paraphernalia, such as JYI brochures and flyers, are also available for free download and distribution.

July 11 ***Annual Summer Horizons Program***

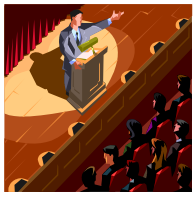
Contact: Lisa Portis Morgan (limorgan@umbc.edu)

SURF students were invited (and were provided transportation by UMBC) to attend the annual Summer Horizons program at the University of Maryland, Baltimore County (UMBC). Summer Horizons is the program whree the UMBC Graduate School takes a day to introduce students to graduate opportunities…some of the sessions dealt with how to get into graduate school, testing, decisions abut which program.

SURFers joined students from other summer research programs at UMBC, University of Maryland, College Park, University of Maryland at Baltimore, NASA, NSF, and NIH.

A continental breakfast, hot buffet lunch, and afternoon snacks were provided.

July 13 Mr. Donald Swenholt
Donald Swenholt Associates, Inc.



Giving Successful Presentations

Mr. Swenholt presented a few techniques and up-to-date procedures to assist the students in presenting their talks for the end-of-the-program SURF student symposium.

July 14 Dr. Andrew Persily
NIST Building and Fire Research Laboratory, Building Environment Division

Protecting Buildings from Airborne Chembio Agents

Concerns over airborne chemical and biological attacks have increased over recent years, prompting research, product development and programs to implement prevention, protection and response strategies. The vulnerability of buildings to airborne attacks depend on a number of factors related to building location, layout, and systems, and protective strategies strategies are increasingly being promoted and in some cases applied. The presentation addressed three key issues related to protecting buldings against airborne chembio agents: the threat, that is the agents and delivery mechanisms of concern; the vulnerabilities, building features that can increase occupant exposure in the event of an agent release; and, protective strategies, the engineering approaches being pursued to address these vulnerabilities. Special attention was given to activities occurring within the NIST's Indoor Air Quality and Ventilation group in terms of model development and application, development of guidance for building practitioners. In particular, the presentation spoke to current recommendations to protect buildings from outdoor releases through an outdoor air filtration and air cleaning in combination with building pressurization.

July 14 Peter Votruba-Drzal
BFRL Seminar

Nanomechanical Properties of Polymeric Coatings and Nanocomposites Through Instrumented Indentation

July 20 & July 27 ***NIST and the World Trade Center (Investigation Site Tour)***

The collapse of New York City's World Trade Center structures following the terrorist attacks of Sept. 11, 2001, was the worst building disaster in recorded history, killing some 2,800 people. More than 350 fire and emergency responders were among those killed, the largest loss of life for this group in a single incident.

In response to the WTC tragedy, the National Institute of Standards and Technology conducted a 3-year building and fire safety investigation to study the factors contributing to the probable cause (or causes) of post-impact collapse of the

WTC Towers (WTC 1 and 2) and WTC 7; expanded its research in areas of high-priority need such as prevention of progressive collapse, fire resistance design and retrofit of structures, and fire resistive coatings for structural steel; and is reaching out to the building and fire safety communities to pave the way for timely, expedited considerations of recommendations stemming from the investigation.

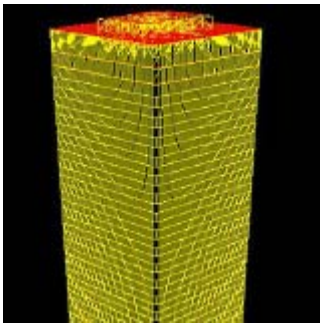
Forty SURFers (20 on each day) were able to tour the investigation site where much of the work that NIST has been involved with regarding the World Trade Center takes place.

July 20 & July 22 ***NIST Center for Neutron Research Tour*** (organized by 2nd Year SURFer Teresa Jacques, MSEL)

Neutron-based research covers a broad spectrum of disciplines, including engineering, biology, materials science, polymers, chemistry, and physics. The NCNR's neutron source provides the intense beams of neutrons required for these types of measurements. There are currently 29 experiment stations. The NCNR supports important NIST research needs, but is also operated as a major national user facility with merit-based access made available to the entire U.S. technological community. Each year, almost 2000 research participants from all areas of the country use the facility for measurements.

July 21 Dr. Frank Gayle
NIST Materials Science and Engineering Laboratory, Metallurgy Division

Aspects of the World Trade Center Disaster



In September 2002 the National Institute of Standards and Technology became the lead agency in an investigation of the World Trade Center (WTC) disaster of September 11, 2001. The investigation addressesd many aspects of the catastrophe, from occupant egress to factors affecting how long the Twin Towers stood after being hit by the airplanes, with the goal of gaining valuable information for the future.

A major part of the investigation was the metallurgical analysis of the structural steel from the Twin Towers. The analysis includes characterization of mechanical

properties, failure modes, and temperature excursions seen by the steel. In the overview of the metallurgical investigation, a description was presented of the structure of the towers, the steel recovered from the site, and special issues faced in the analysis of the steel.

July 21

Dr. William D. Phillips
NIST Physics Laboratory and 1997 Nobel Prize Laureate in Physics

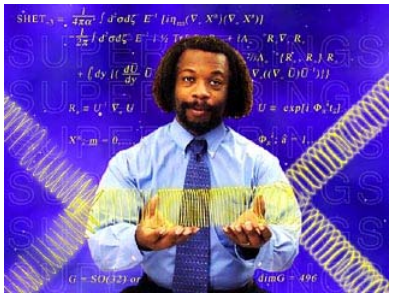
Time, Einstein, and the Coolest Stuff in the Universe

Being a SURF student at NIST affords one many benefits -- one of them being you just never know when you might run into one of our two Nobel Prize Laureates in Physics (Bill Phillips or Eric Cornell). Bill works at the Gaithersburg campus and Eric resides in Boulder. Bill wowed everyone on July 21 with a talk to celebrate the World Year of Physics.

What is time? Even Einstein had a hard time answering this question, but in spite of that, we can measure time more accurately than any other quantity. Atomic clocks are the most accurate timepieces ever made, and are essential for such features of modern life as synchronization of high speed communication and the operation of the Global Positioning System (GPS) that guides aircraft, cars, boats and backcountry hikers to their destinations. The limitations of atomic clocks come from the thermal motion of the atoms: hot atoms move rapidly and suffer from time shifts as predicted by Einstein's Theory of Relativity. Contrary to intuition, we can cool things by shining laser light on them. With laser cooling, we cool gases to less than one millionth of a degree above Absolute Zero. The slowly moving atoms in such a gas allow us to make even more accurate clocks, already so good that they would gain or lose only a second in 30 million years. Laser cooling has also made possible the observation of a long-standing prediction of Einstein: Bose-Einstein condensation hailed as one of the most important recent scientific developments.

What makes Bill so popular is many of his talks are aimed at people with no formal scientific training. His talks combine live demonstrations, video, and down-to-earth explanations with a bit of humour, but also discusses some of the most exciting recent developments in physics.

July 25 Professor Sylvester J. Gates, Jr.
John S. Toll Professor of Physics, University of Maryland's Center for String and Particle Theory Director



Superstrings: Einstein's Dream at the New Millennium

String theory was developed approximately 30 years ago by theoretical physicists who were uneasy with discrepancies between Einstein's theory of general relativity and quantum physics. In string theory, tiny open and closed strings are the most fundamental particles in the universe. The ability of these strings to spin has enabled physicists to make string theory consistent with both quantum mechanics and special relativity.

August 9 Final Presentations by SURF Students moderated by invited guests

August 9 Lunch: SURF Directors and special invited guests

August 10 Final Presentations by SURF students moderated by invited guests

August 11 Final Presentations by SURF students moderated by invited guests

August 12 Last Day for SURF students

2005 SURF Summer Activities

Finding a balance between work, play, and other activities isn't easy unless you're a SURF student. SURFers seem to have found the magic recipe, so look out when the 5 o'clock whistle blows because there's always fun and adventure when you get these SURFers together. Of course, it helps when you're in the DC Metro area where museums, baseball teams, and other entertainment opportunities abound. And, to get it all scheduled SURFers have their own forum for social and work-related SURF chatting.

SURF Forum

for social & work-related NIST SURF chat

SURF Forum Forum Index

Welcome

NIST News
- Seminars & Important Meetings

Now & the Future
- Does anyone know how to…?
- Graduate School
- Opportunities
- Anonymous Complaints

Activities
- After Work (get together for food & fun at home or around town)
- Take a Trip (explore Maryland, Virginia, New York & more)
- Our Global Community (leaving the world better than you found it)
- Sports (organize games and activities)
- Nature (take a hike, bike & more)
- Religion (find friends of your faith or share yours)
- Nightlife (clubs, etc.)
- Museums & the Arts (museums, performance arts, etc.)
- Dining (share a fave recipe, cheap eat or gourmet experience)
- Hobbies (your favorite pastimes, musical instruments, etc.)
- SURF T-Shirt Committee

Before you arrive…
- Getting Started
- How you get paid (know this before you leave school)
- What will happen on the first day (the schedule, transportation & more)
- Intro to NIST (dress codes & other fun stuff)
- Apartment Life (what to bring and what NOT to bring (like pets), the Internet, etc.)
- Summerfield Suites (chat with your new roommates)
- Oakwood Apartments (chat with your new roommates)
- The Locals (chat with other commuters, maybe carpool…)
- Air Travel Message Board (flying in at the same time? save $$ by sharing airport transportation)

SURF BBQ - NIST Picnic Grove

Food…food… did someone say food…OK, you'll find SURF students there. The SURF Directors provided the burgers, salads, desserts, and sodas. The students were the entertainment specialists providing Frisbees, music, etc. Check out a few pictures below

Is it Emeril -- BAM!
No, it's Chris White,
BFRL SURF Director

OK, no pushing,
there's plenty for all

Beauty and Brains --
Lady SURFers extraordinaire!

Is it the Wedding Crashers --
no, just a couple SURFer guys
mugging for the camera

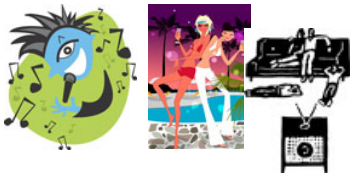
2005 SURF T-Shirt Design

And the tradition continues…each year the group designs a T-shirt during the summer. You don't have to be a student to want the T-shirt. Everyone from the NIST Director, the Physics Lab Director, to the niece of the SURF Administrative Coordinator wants one. Below is the design for the Summer 2005 -- what a creative group. Think you can outdo them next summer…

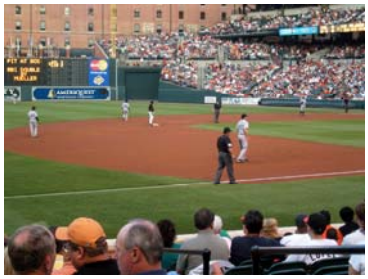
t-shirt front

t-shirt back

The Washington Metropolitan area is rich in cultural and recreational opportunities. NIST is just a short commute from the nation's capital, theaters, movies, restaurants, evening entertainment, historical and cultural sites, museums, shopping, and many local universities. Check out below some of the activities the SURF students took advantage of during the summer. They didn't wait for evening or weekends to have fun either since NIST boasts a fitness center, soccer, volleyball, softball, and many other activities to participate in during your lunch break. There were many other opportunities to have fun without spending a lot of cash because most college students watch their funds very closely. There were movie nights, poker parties, pool parties, a chance to show off your singing talents with karaoke, etc.



Camden Yards - Baltimore, MD ***RFK Stadium – Washington, DC***



Washington, DC finally has a baseball team again. The SURFers had their choice of seeing the Washington Nationals (Nats' -- sound like little bugs that bother me in the summer) or the Baltimore Orioles (Os) play the great game of baseball. What's summer without seeing your favorite home team play? Both teams were doing well this year so it should have been plenty of fun to see either team.

DC United Soccer

In 1996 the Nation's Capital because a charter member of Major League Soccer. They quickly set the standard for excellence in the league, on the field, and in the stands. In its short, nine-year history, DC United has earned more domestic and international honors than any other American side. The SURFers were able to attend some games and join the other soccer-hungry fans across the country.

Memorial Day in the Nation's Capital

PBS's National Memorial Day Concert remembered the sacrifices of American's veterans and the SURFers were on hand to view it live. The concert commemorated the 60th anniversary of Iwo Jima and honored our troops in Iraq and Afghanistan.

Of course, when you get a group of college kids together on a holiday, you're sure to find food, drink, and fun (and maybe the latest swim fashions).

United States Holocaust Memorial Museum

The United States Holocaust Memorial Museum is America's national isntitution for the documentatiion, study, and interpretation of Holocaust history. The SURFers went to learn about the unprecedented tragedy. The museum encourages its visitors to reflect upon the moral and spiritual questions raised by the events of the Holocaust as well as their own responsibilities as citizens of a democracy.

2005 Smithsonian Folklife Festival

More than 1 million visitors attended the 39th annual Smithsonian Folklife Festival on the National Mall between June 23-June 27 and June 30-July 4. Festival-goers enjoyed a variety of music, crafts and food in the four featured programs: "Food Culture USA," "Forest Service, Culture and Community," "Oman: Desert, Oasis and Sea" and "Nuestra Música: Music in Latino Culture." Not being a group to waste an opportunity, the SURFers were among the 1 million to check out things.

The Meaning of the Fourth of July

On the Fourth of July, we pause to remember and celebrate the values of liberty and justice that make our country great, and to be thankful for the remarkable freedoms that we enjoy in the United States of America.

The significance of this day has inspired speeches, literary works, and musical compositions. It is also an opportunity for each of us to ponder the meaning of our nation's heritage and to celebrate it in our own unique way. SURFers were able to celebrate "live" on the National Mall and not only enjoy the fireworks but ponder why this holiday is special to each of them.

WICKED

As with many others, the SURFers probably grew up on the story "The Wizard of Oz," but long before Dorothy dropped in, two other girls meet in the Land of Oz. One, born with emerald-green skin, is smart, fiery and misunderstood. The other is beautiful, ambitious and very popular. How these two unlikely friends end up as the Wicked Witch of the West and Glinda the Good Witch makes for a most spellbinding story. If you were an Oz fan, it was a necessity to see the "rest of the story."

Medieval Times Dinner and Tournament

You can count on the SURFers to find the ususual. Medieval Times is an adventure unlike anything you have ever experienced before or will ever experience again. During each live performance, guests enjoy an authentic medieval feast while valiant knights on horseback do battle to the death. Brilliant costumes, authentic in every detail add to the splendor of your visit. Cheer your brave knight to victory as he competes in games of skill, hand to hand combat and of course, the joust. Who will rise victorious and have his chance to select the queen of love and beauty? Only the strongest and bravest knight who hears the support of the loyal subjects will win.

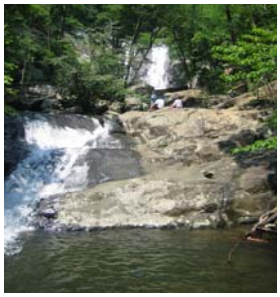
Twins Jazz Lounge

SURFers went to check out Twins Jazz Lounge, which was voted one of AOL's City Guides best live music clubs for 2005.

Another tradition continues… the trip to Kings Dominion!

It started way back in 1993 when the first group of SURFers came to NIST. A chance to get the whole group together to enjoy hair-raising rides, the wettest water park, sizzling stage shows, and tons of other cool stuff. What more could a "SURFer" want when the forecast calls for a **H**azy, **H**ot, and **H**umid Washington summer day.

Hike, Mountain Bike, Camping, and White Water Rafting



After a hot day at Kings Dominion, it was great to cool off at Great Falls Park, located in McLean, Virginia, which is 800 acres in size and has 15 miles of trails. Five miles of these trails are multiple use trails for mountain biking and horseback riding. The trail system offers a wide variety of environments for exploration. The river trail follows the Potomac river from the falls overlooks downstream along the scenic Mather Gorge; the Patowmack Canal trail follows the ruins of this historic canal and the ruins of the canal town of Matildaville; the Old Carriage Road trail, the Ridge trail and Mine Run trail follow upland oak forests; the Swamp trail follows along a unique swamp habitat and lowland forest.

Steven F. Udvar-Hazy Center

Never ones to miss an opportunity so close at hand, the SURFers visited the relatively new Steven F. Udvar-Hazy Center near Washington Dulles International Airport The Center is the companion facility to the National Air and Space Museum on the National Mall. The building opened in December, 2003, and provides enough space for the Smithsonian to display the thousands of aviation and space artifacts that cannot be exhibited on the National Mall. The two sites together showcase the largest collection of aviation and space artifacts in the world.

The Center was named in honor of its major donor, and features a large aviation hangar in which aircraft are displayed on three levels. The SURFers were able to walk among aircraft and small artifacts in display cases located on the floor, and view aircraft hanging from the arched ceiling on elevated skywalks. Many engines, helicopters, ultra-lights, and experimental flying machines are on display in a museum setting for the first time. Among the aviation artifacts on display are the Lockheed SR-71 Blackbird, the fastest jet in the world;

the Boeing Dash 80, the prototype of the 707; the Boeing B-29 Superfortress Enola Gay; and the deHavilland Chipmunk aerobatic airplane.

On the following pages you will get a glimpse of all the hard work the SURFers put in over the summer with an abstract from each telling of their work.

We hope you will join us next summer and experience all SURF has to offer!

Student Abstracts
2005 SURF Program

American University

Seamless Mobility and Bandwidth Allocation in Wireless Communications Networks

Allison W. Gaul

A growing number of consumers use handheld devices such as laptops and PDAs which can use the IEEE 802.11 protocol to communicate when the user is on the go. Although 802.11 access points are appearing in more public places such as libraries and coffee shops, the users can only get network access within a small area near the access point, within which they can reliably use wireless devices. The bandwidth of the 802.11 hotspot is divided as needed amongst the existing users until the hotspot is full, and maximum bandwidth load is reached. At this point any new users attempting to connect will be blocked, and denied access, until bandwidth is freed up. On the other hand, cellular (UMTS) networks span the globe, and also provide access to services such as email, media transfer, and web browsing, yet they are only beginning to support devices such as those used in 802.11 hotspots. Applications such as streaming video and online gaming require the greater bandwidth of 802.11 access points, but Voice over IP (VOIP) users in densely populated areas can find their calls being terminated unexpectedly as they travel in and around the hotspot. New technologies are being developed to allow efficient handovers from one access technology to another. At this time there is an increasing amount of research being done on the design of such networks, and on the problem of finding the optimal time to initiate and execute a handover.

To establish a theoretical model for vertical handovers in a heterogeneous wireless network, we examined a hypothetical isolated IEEE 802.11 hotspot which is situated inside a larger cellular network cell. Through the use of both mathematical analysis and computer simulations we were able to determine blocking probabilities for users attempting to enter the hotspot or cell, given an arrival/departure rate, type of application, bandwidth allocation/availability, and geometry of the hotspot and cell. The resulting model provides us with the ability to suggest optimal user load and bandwidth allocation methods for a hotspot that lies within a cell, so that its users can handover to the cellular network instead of dropping their connections upon getting too far from the access point. The model can easily be expanded to encompass other factors, which makes the model very useful for designing networks that utilize new handover technologies.

Appalachian State University

Affinity of Surfaces for Binding Specific Proteins

Carolyn A. Kitchens

Carbohydrates are involved in a variety of cell-cell mediated processes including recognition events, cell growth, infectivity (of bacteria), and the immune response. As such, there is significant interest in developing biosensors based on the rapid and specific recognition of oligosaccharides cell surfaces. Proteins such as Concanavalin A (Con A) express two sites specific for the selective binding of glucose. Con A uses these binding receptors to bind molecules of glucose and can be used to immobilize glycoproteins or carbohydrates containing glucose groups. Utilizing patterning methods such as microcontact printing, the selectivity of thiol derivatized oligosaccharide compounds on Au surfaces can be used to bind proteins such as Con A. These patterns are formed by surrounding the saccharide molecules with a resist, such an alkanethiol, for which Con A does not have an affinity. This allows for patterns to be formed affording easy detection of the binding of glucose specific compounds. Using these techniques, more efficient bioassays and smaller testing devices can be developed. To take these assays to even smaller scales, scanned probe based fabrication methods using atomic force microscopy (AFM) are being tested to evaluate the ability to generate nanoscaled patterns of glucose thiols on Au surfaces and determine their efficacy for binding.

Using Inorganic Nanoparticles as Biological Contrast Agents

Stephanie Marie Moore

Immunological assays are generally applied for pharmacogenomic research and drug discovery, infectious and genetic disease and cancer diagnostics. These bioassays are tests used to determine the strength or biological activity of a substance, such as a drug or hormone. The most common detection method used for these bioassays is through fluorescence. However, the traditional organic fluorophores that take part in this detection technique can undergo photodegradation. Since fluorescence miscroscopy applies intense light sources, photodegradation can inhibit the organic fluorophores widespread application. Inorganic silicon nanoparticles, with their reasonable photoluminescence quantum yields and high chemical stability, have become popular possibilities for the next acceptable fluorophores. These highly luminescent silicon nanoparticles offer high photostability and exhibit size-dependent emission in a wide spectral range. In a previous article, applying luminescent Si nanoparticles for DNA tagging was performed.[1] Overall, the Si nanoparticles must first react with a suitable crosslinker, which will then connect the particle to a protein through this crosslinking bridge. The final product can be detected in the aqueous phase by the fluorescence of the silicon nanoparticle. The purpose of this project was to determine which crosslinker,

SANPAH, Sulfo-SANPAH or TDBA-Osu, was a suitable crosslinker for the conjugation to the protein. The crosslinker that enabled the greatest fluorescence in the final product was TDBA-Osu.

[1]Wang, L., Reipa, V., and Blasic, J. (2004) Silicon Nanoparticles as a Luminescent Label to DNA. *Bioconjugate Chem. 15*, 409 –412.

Brigham Young University

Spectrally Tunable Light Source for Remote Ocean-Color Sensing

Jacqualine D. Jackson

Properties of the Earth's oceans, such as chlorophyll concentration are important in atmospheric and climatic studies of the Earth. The measurement of such properties is necessary to study the relationship between the oceans' productivity and the Earth's climate. Such measurements are made through a combination of (1) satellite sensors, (2) calibration sensors, and (3) bioptical instruments that relate physical properties of the ocean to radiometric measurements. The integration of the various measurements does help eliminate uncertainty, but it also allows more room for uncertainty as the final measurement is based on not one, but three components. Uncertainty in any of the measurements significantly affects the validity of the final data product.

There are two types of uncertainty in such measurements: random and systematic (bias). Random uncertainty due to changing environmental conditions can be reduced by additional measurements. However, systematic uncertainty cannot be reduced this way, and will give rise to large bias in remotely sensed global ocean color data products. A common systematic error is faulty calibration. Instruments involved in ocean color measurements are typically calibrated against incandescent sources which have very different spectral distributions than the distribution of the light leaving the Earth's oceans. Such differences make these measurements susceptible to systematic bias introduced by stray light. The effects of stray light can be reduced and even removed in a system in which the calibration source distribution approximates a measured ocean color.

Other tunable sources have been developed for such purposes, but still fail to accurately match the spectral distribution of ocean color. Tunable LED sources match ocean color spectra better than incandescent sources, but around 550 nm, a wavelength found in ocean color, LED sources do not have good spectral coverage. In this work, development of a radiometrically stable, spectrally tunable, solid-state calibration source for ocean color is described. This unique source can approximate spectral distributions for a variety of ocean color and atmospheric conditions. It will be used to characterize and correct instruments' responsivities for ocean color radiometry.

Bucknell University

Proton Transfer Ionic Liquids as Green Solvents

Daniel J. Miller

Room temperature ionic liquids exhibit a variety of interesting physical properties including low volatility, thermal stability, and good solvation ability. Ionic liquids (IL) are organic salts that are liquid at ambient temperatures. They have experienced increased use in organic synthesis and in polymer systems as a result of their unique properties. Chemical advantages of using an ionic liquid solvent often include improved stereo- and regio- selectivity in reaction products and enhanced rates of reaction. Because of the large number of possible organic ion pairs, IL solvents can be "tuned" to exhibit solvent properties desirable of a chemical system. Such variability permits the selection of a solvent that will make product or catalyst recovery easier, allowing for re-use of solvent and/or catalyst. Ionic liquids are often termed "green solvents" because of their recyclability and because of their low vapor emission, both advantages over conventional organic solvents.

Ten n-propylammonium ionic liquids were synthesized by proton transfer from organic and mineral acids. The ionic liquids were characterized by proton nuclear magnetic resonance spectroscopy. Conductivity and vapor pressure measurements suggest that the ionic liquids prepared with organic acids show incomplete proton transfer, whereas those prepared with a mineral salt (nitric acid) demonstrate nearly complete conversion to the ion pair. Acid/base combinations that result in total proton transfer are termed "strong" ionic liquids, and are characterized by high conductivity and extremely low vapor pressure. "Weak" ionic liquids, which are mixtures of the organic salt and the parent acid and base, showed higher vapor pressure and conductivity roughly two orders of magnitude lower than the strong IL. The thermal behavior of the synthesized liquids was measured by thermal gravimetric analysis and differential scanning calorimetry.

Small-angle neutron scattering (SANS) is useful for detecting microstructures of 1-100 nanometers in size. Surfactants in solution typically form micelles in this size range, clusters of surfactant molecules arranged to minimize the unfavorable energetic nature of surfactant-solvent contact. Micelle formation of didodecyldimethylammonium bromide, cetyltrimethylammonium bromide, and Triton X-100 were investigated by SANS in n-propylammonium acetate, n-propylammonium nitrate, and deuterium oxide at several temperatures. Surfactant aggregates were clearly visible in the deuterium oxide solutions, some aggregation was observed in strong ionic liquid at high surfactant concentrations (greater than 10 mass percent surfactant), and no microstructure was detected in the weak ionic liquid/surfactant mixtures.

Carnegie Mellon University

Optimization of a Self-Assembly Monolayer Releasing Layer for Nanoimprint Lithography

Kate Hollabaugh

Nanoimprint lithography (NIL) has emerged as a new technology with the ability to pattern features smaller than ten's of nanometers. Nanoscale features in a hard (Si, quartz, etc.) master are imprinted or reproduced by stamping the master into a soft resist film. Typically the imprints are done at elevated temperatures and pressures where the resist material can flow and fill the mold. To prevent the resist from sticking to the mold surface a releasing layer is required. It has been found that self-assembled monolayers (SAMs) of fluorinated trichlorosilanes provide a hydrophobic coating to improve mold release during the imprinting process. Trichlorosilanes, however, are highly reactive, especially in the presence of ambient water vapor, and it difficult to avoid polymerization of trichlorosilane and multilayer adsorption. Such multilayer adsorption is detrimental to high resolution NIL applications as the trichlorosilane will effectively fill in to the nanoscale features of the mold. In this study tridecafluoro-1,1,2,2 (tetrahydroctyl)trichlorosilane (FOTS) is applied to both smooth and patterned silicon oxide surfaces through the vapor phase. By controlling the level of moisture in the environment, the propensity for multilayer can be controlled. A quartz crystal microbalance (QCM) is used to monitor the mass of the adsorbed trichlorosilane in-situ and indicate the degree of coverage. The performance of the coatings in terms of surface energy is evaluated through water contact angle measurements. Atomic Force Microscopy and ellipsometry are also employed to correlate the surface topology and thickness, respectively, of the adsorbed layer with the surface energy and the degree of coverage. Together this suite of measurement techniques enables an effective optimization of the trichlorosilane deposition conditions for high resolution nanoimprint lithography molds.

Case Western Reserve University

Techniques for Measuring the Particle Size Distribution (PSD) of a Single Component in a Multi-Component Powder

Sarah E. Langhorst

Mixed powders are used in the processing of a wide range of products, from pharmaceutical applications to the processing of materials such as cements and ceramic composites. In such applications, the particle size distributions (PSDs) of the different powder components strongly influence the powder's chemical reactivity, packing efficiency, and rheological properties. When the mixing or grinding process used to create the mixed powder can irreversibly change the PSD of one or more of the components, it is difficult to assess the PSD of the components individually. In this project, a novel approach was examined for isolating the PSDs of the components, based on differences in their optical properties. Two-component powders were suspended in a liquid, and a standard laser diffraction technique was used to determine the

PSD. By closely matching the complex refractive index of the dispersing liquid to that of one of the components, the diffraction method should, in principle, sample only particles of the other component. This presentation will describe the method used, will analyze the various sources of uncertainty that can influence the measurements, and will demonstrate the use of the method to determine the particle size distribution of gypsum in a cement powder.

Colgate University

Evaluation of a Semi-empirical Approach to Model the Efficiency of HPGe Detectors for Applications in Gamma Ray Spectrometry Using the Software Program ANGLE

Benjamin J. Reschovsky

High purity germanium detectors are widely used for gamma ray spectrometry, including applications in the fields of natural science, medicine, and homeland security. In order to measure the activity of an "unknown" sample, the efficiency of the detector must be known. Since the efficiency of these detectors varies with energy, detector-source geometry, and also sample composition, an efficiency curve must be generated for every geometry and sample composition to generate an accurate calibration curve for activity measurements of unknown samples. The process for preparation and characterization of efficiency standards for all geometries and sample compositions can be time consuming and costly. Thus, practitioners of gamma spectrometry have pursued other approaches (such as computer modeling techniques) for generating efficiency curves for HPGe detectors.

One popular approach to efficiency curve determination is a purely mathematical model known as the Monte Carlo method. While in some cases this approach is effective, there has been some concern that a purely mathematical approach does not provide the user with traceability to national standards. A second popular approach is known as the "semi-empirical" approach, in which mathematical calculations are also performed, but which also include reference efficiency curve(s) traceable to national standards as inputs. A number of computer programs have been developed based on this approach. One such program, known as ANGLE, uses the concept of the effective solid angle to calculate an efficiency curve for a desired geometry (point, disk, cylindrical, and Marinelli source geometries at any distance). The program requires information about the geometry of the detector and source holders and a reference efficiency curve (using a traceable point source at a known distance from the end-cap of the detector). The program calculates the effective solid angle of both the reference point source and the unknown source. The ratio of these two solid angles, multiplied by the reference point source efficiency, yields the calculation of the new efficiency of the unknown source.

In this project an evaluation of the performance of the ANGLE software has been conducted. A point source with known activity was measured at several distances from the detector and used to generate an efficiency curve, which was then compared to corresponding calculations made using the ANGLE software. The same comparison was also done for a solution in a Marinelli beaker. The effects of true coincidence summing have been observed and are taken into

consideration. Accuracy and reproducibility of the ANGLE calculations are discussed. Suggestions for improvements to the approach are presented.

College of William and Mary

Message Maker Testing Framework Promotes HL7 Compliance

Justin Manweiler

According to the Institute of Medicine (IOM), there are approximately 98,000 deaths in the U.S. each year attributable to medical errors. In an effort to reduce the risk of human mistakes, strong informatics standards are necessary for improved communication between diverse healthcare systems.

In the U.S., Health Level Seven (HL7) is the prevailing standard. When fully employed, it allows disparate systems to exchange key sets of clinical and administrative data. Widespread compliance would lead to superior quality of care, improved patient safety, and reduction of costs. The expansion of its use is vital to the realization of a National Health Information Infrastructure, connecting distributed health data nationwide.

Due to its universal nature, designed to accommodate the whole of the healthcare industry, the HL7 standard is overwhelmingly large in its entirety. Message communication profiles are used to limit the scope of the specification to the needs of a particular implementation. This necessitates extensive profile-specific conformance testing to ensure interoperability and correct behavior. Currently, this testing must be performed manually, as each particular profile requires a customized testing suite.

At NIST, under lead scientist Rob Snelick (Division 897), work is being done to simplify the process of validation. The Message Maker tool produces a set of test messages based on a system's specific profile. Personally, I have developed an automated system of validation for the generated testing suite. By comparing the messages to their profile and a description of their expected contents, my work helps to ensure that the tests will simulate the expected conditions when transmitted into a real system.

With the completion of the Message Maker conformance-testing framework, the difficulty associated with system implementation and subsequent debugging will be reduced. HL7 compliance will be thereby promoted, further realizing the potential of healthcare IT.

Cornell University

Poking Jell-O on a Tine Scale: The Structure-Property Investigation of Polymeric Nanocomposites and Gels

Kevin Huang

While robust, versatile coatings are ubiquitous in everyday life, a chief aim of many manufacturers is to develop scratch- and mar-resistant coatings that still retain their desired, application-specific properties. Naturally, then, recent research has focused on nanomaterial-based fillers for such coatings. Popular among these has been the dispersion of inorganic nanoparticles in transparent gel or polymer matrices to form easily tunable nanocomposites. In the current study, the structure-property correlation of thermoreversible triblock copolymer gels and nanocomposites was investigated. A well-characterized ABA triblock copolymer was dissolved in a midblock-selective alcohol to yield a solvated, physically cross-linked polymer network. The physical properties of the resulting gel can be intuitively understood by comparison with a common edible gel system, Jell-O gelatin. Structural characterization of the gel was achieved through dynamic light scattering (DLS), a complex method allowing for the extraction of characteristic decay times and length scales as well as various kinetic factors. From these results, details on the gel architecture, critical dynamics, and non-ergodicity of the system were obtained. Nanoindentation on dried thin films of the gel was conducted to relate these structural findings to the nanomechanical response of the material. Accordingly, traditional mechanical quantities such as hardness and elastic modulus were acquired. This type of characterization is akin to poking a material in a highly controlled and quantitative manner. Finally, to examine the effect of nanoparticle addition to the gel system, titanium dioxide nanospheres were dispersed into the gel and subsequently characterized by both DLS and nanoindentation. The resultant nanocomposite can be thought of as the nanoscale equivalent of fruit dispersed in Jell-O. The structure-property relationships derived from the nanocomposite were correlated with those for the pure polymer gel and fundamental physical mechanisms were ultimately proposed. This research represents the first comprehensive attempt at forming such associations between gel and nanocomposite structural dynamics and their related nanomechanical response, a critical step towards the development of scratch-resistant coatings.

The Limit of Nearly Touching Gold Nanoparticles
Christopher Kakovitch

Understanding coupling between metallic nanooparticles is critical for exploiting plasmon nanooptics in sensors, for nanooptical communication, and in new metamaterials. Using the boundary element method in modeling chains of metallic nanoparticles, the classical plasmonic response of coupled nanoparticles in the limit of very strong coupling can be calculated. These results help probe the singular limit when the nanoparticles are nearly touching or just overlapping.

To fully understand the limit of nearly touching nanoparticles that exhibit cylindrical symmetry, we have also developed a density functional theory for the quantum mechanical response of these particles. A jellium model is used for coupled gold nanoparticles. I will discuss the development and execution of the jellium model and density functional theory. Initial results will be presented to understand where the classically separated nanoparticles with an interparticle gap are shorted out by quantum mechanical electronic interparticle tunneling. This defines a cutoff for the singular limit.

Terahertz Spectroscopy on Crystals of Small Peptides
Andrew Schwarzkopf

Terahertz radiation lies between the IR and microwave bands. Terahertz (THz) spectroscopy is a relatively young field, and recent advances in THz generation have opened up new possibilities. There is interest in applications of THz technology in many areas, including semiconductor physics, imaging, and spectroscopy of biomolecules.

THz spectroscopy is particularly interesting for biological applications because it probes the energy range corresponding to large-scale vibrations of biomolecules. These vibrations are important in conformational changes of biomolecules, of which protein folding is an extremely important example. At present, no reliable theory exists for this difficult-to-model region of the spectrum. In order to fundamentally understand the important factors affecting THz absorption spectra, as a first step toward complex proteins and solutions, we study smaller, computationally manageable systems. These include the crystalline forms of amino acids and short peptide chains. Using these systems, we can further refine the theories to more closely match our experimental spectra.

We find that an important factor affecting THz absorption spectra is hydrogen bonding. Because the involved vibrational modes are nonlocal, hydrogen bonds among the peptide molecules within a crystal have a strong impact on these modes. In our experimental tests of this we have put much effort into recrystallizing particular amino acids and peptide chains. Spectroscopic studies of these samples suggest that a strong three-dimensional hydrogen bonding network gives sharper spectral peaks than a one-dimensional network. In other work it was found that changing the hydrogen bond structure, by removing water from lattice sites in

the crystal, drastically changes the spectrum. Finally, the importance of hydrogen bonding in Thz spectra is underscored by the results of experiments investigating changes in the size of crystalline nanopores. In this study, pore size was changed by using different cocrystallized solvents, resulting in frequency shifts of the THz absorption peaks.

Drexel University

Image Quality Metric for Tissue Scaffolds
Craig Schroeder

Tissue scaffolds form an important component of cutting edge bioengineering research. Tissue scaffold engineering promises the capability of designing, fabricating, and implanting artificial tissue scaffolds to replace damaged, diseased, or removed organs and tissues. The need to mimic natural tissue leads to the need to accurately mimic properties like porosity and permeability. Yet measuring directly can be expensive and inaccurate. An alternative is to obtain a 3D image instead, as by a CT scan or an MRI scan. Properties can then be computed from the image. This also opens the door for a host of other analysis that may be easily performed.

The problem with the latter approach is that multiple sources of errors are incurred. Hardware resolution, sampling density, and noise in images can all significantly affect computed properties. This research consists of developing a metric for tissue scaffolds to get an idea not only of how poor the image is, but the affects of this noisiness on the properties at hand. This would permit one to compute not only porosity and permeability but also obtain some estimate of how accurate those computations are likely to be.

As part of this project, I designed an approach for analyzing the relationship between noise, filters, and porosity that permits the knowledge gained to be used to assign quality estimates to images based on porosity. I designed and ran tests to analyze the behavior and sensitivity of this approach under a range of images, noise, filters, and porosity. I developed a simple theory that predicts the behavior observed empirically under two of the filters and can be used to simplify the resulting metric. I also evaluated other metrics and worked with other NIST researchers in applying their research to this project.

Franklin and Marshall College

Diagramming the Phase Relationships of the BiCoNbO System
Margaret C. Yeager

Ceramics have contributed greatly to the modern lifestyle. Aside from pottery and esthetics, they are used in various electronics as both insulators and capacitors in objects such as televisions and cell phones. It is these electronic capabilities that are particularly interesting for dielectric and piezoelectric ceramics and new forms of both are being constantly searched for.

By researching the phase relationships of the BiCoNbO system, potential dielectrics could be found.

Determining the phase diagram requires that the compounds be at equilibrium, first by calcining the compounds at low temperatures (700-800^{o} C) and then heating at higher temperatures (700-1400^{o} C) to speed up the equilibration process. During these heatings it is important to remain constantly below the ceramics' melting points. Between heatings the compounds are ground with a mortar and pestle to further induce equilibrium. The final components and ratios of these compounds are found by analysis of the equilibrated ceramic's x-ray diffraction pattern. Compounds found to be pure pyrochlore are analyzed for dielectric and magnetic properties.

George Washington University

SANS Investigation of the Mechanism and Kinetics of Membrane Protein Crystallization in Self-Assembled Cubic Lipidic Mesophases

Atiq Chowdhury

Knowing the structure of proteins is essential to understanding their function and the mechanisms of their actions. While many structures are known, few of them are membrane proteins due to the difficulty of crystallizing them. Crystallization of membrane proteins allows for the collection of structural data, but very little is understood about the forces producing these crystals.

One crystallization method, in cubo, which has had limited success, consists of mixing a protein with a lipid solution to form a cubic phase, then adding a precipitant (usually a salt) and incubating until crystals form. This process is poorly understood—hence, a systematic approach has been under taken to understand this process. Insights gained from this research will lead to improved techniques for producing high quality membrane proteins crystals needed for structural determination. First the effects of a precipitant, salt, on the structure of the cubic lipid mesophase were studied. Next, Gramicidin (a simple membrane protein), was inserted in this mesophase to investigate lipidic structural changes and protein distribution.

Small-angle neutron scattering (SANS) is used as the main structural probe to understand the details of the structures of various components and their interactions at various stages in the crystallization process. SANS is able to investigate structural features in materials ranging from 1 to 500nm, which is perfectly suited for the cubic lipidic mesophase pore size unit of 6 nm. By manipulating specific ratios of D_2O and H_2O within the mesophase, the scattering from the lipids in the solution can be "matched out"—this ratio of was found and only the protein distribution within the mesophase was detected, which showed that Gramicidin remained in a monomer state even with a high protein and salt concentration.

Factors Affecting the Quality of Electronic Fingerprint Collection
Peter S. May

Interest in biometric access control—the use of one or more of a person's inherent biological properties (formations and shapes in retinas, irises, fingerprints, hands and faces, et cetera)—is rapidly growing within the government as well as the private sector. Biometric access has attractive advantages over other modes of access control. Unlike token-based control (e.g., physical key access), there is no physical artifact to misplace or to have stolen, and unlike knowledge-based control (e.g., password access), there is no secret phrase to forget or to pass on to an unauthorized party. However, even as many major entities (including the federal government and immigration programs) consider biometrics for their access-control needs, certain problems inherent in these methods have yet to be properly scrutinized.

Electronic fingerprint collection is a natural first step into biometric control, since the use of fingerprints as identification is already well-established, its first uses dating back over a century. In modern systems, in addition to the traditional fingerprint images, a database is used to store information about the crucial parts (the minutiae) of a particular print. The minutiae indices can later be used to locate a manageable set of close possibilities within an extremely large set of prints. To speed the electronic processing of fingerprints, the minutiae of a print may be determined by a computer program, but, for various reasons, sometimes the quality of an image is not sufficient to determine the minutiae of the print therein.

This study aims to determine, through repeated trials, the effects of various external factors on the quality and usability of prints collected by an electronic reader. These factors include age, skin condition, general attitudes toward security and privacy, and the absence (the first of two phases of this experiment) or presence (the second phase) of instant feedback. Another factor is habituation: The user's behavior could potentially change as a result of acclimatization; one's input might increase in quality as one learns how to use the system better, or decrease in quality since comfort with the system could translate into carelessness.

For this experiment, I have developed a questionnaire for each phase, as well as FingerGrabber, a program which collects fingerprints using a USB fingerprint scanner. The first-phase FingerGrabber allows an administrator to collect one sample for the index finger on each hand. The second-phase FingerGrabber was developed to be used by the test subject, who may sample his or her own prints and is given a feedback rating on each (based on NFIQ, Elham Tabassi et al.). Subsequent statistical analysis on the series of prints and their associated questionnaires will be examined for trends and possible correlations.

Coplanar Waveguides Test Structures for Critical Dimension Metrology
Chidubem Arthur Nwokoye

Metrology of the dimensions of features on photomasks is a continuing issue in IC fabrication. These photomasks are clear quartz substrates with chrome features that are 4x or 5x the

intended on-wafer dimensions. Current technologies for measuring these dimensions include optical and atomic force microscopy, each of which suffers from time or resolution limitations. In this work, we investigated whether these dimensions can be determined from the electrical properties of the features. In particular, at high frequency the lines behave as co-planar waveguides (CPWs). In modern integrated circuits, CPWs are used as transmission line elements for device connection and signal distribution to retain the signal fidelity.

Therefore, to measure the critical dimensions (CDs) of features on photomasks, we modeled test structures based on a CPW made up of three chromium strips lines (two grounds and one signal) that lie on an infinite dielectric material (silicon-dioxide) in the presence of air. Our approach in trying to measuring the transmission line parameters of the CPW was to assume that it supports a quasi-TEM slotlike mode where by exact or approximate conformal mapping techniques could be used. We found that the line capacitance increases logarithmically with the signal-line width at high frequencies for CPWs of line thickness 0.1 μm, line spacing 0.5 μm – 0.8 μm, and signal-line width 0.4 μm – 1.0 μm. Interestingly, the line capacitance results from the conformal mappings were similar to results obtained when we modeled the same CPW dimensions with a computer software program called Maxwell© 2D which simulates the CPWs at low frequencies. Thus, the quasi-TEM slotlike mode is also valid for low frequencies. Furthermore, a decaying effect was observed when a graph of line inductance against signal-line width is plotted for the same dimensions in the line capacitance case. We observed that the characteristics impedance decays with increasing signal-line width when modeling with conformal mappings. The extracted CD sensitivity for the characteristic impedance, line inductance and line capacitance with respect to signal-line width was 45.7 Ω/m per μm, 0.324 μH/m per μm, and 22 Pf/m per μm respectively for an application.

Based on these results, future work will involve additional theoretical studies followed by fabrication and electrical testing of CPWs on photo-masks and other substrates. Finally, the possibility of extending this work to the determination of dimensions using stand-off (non-contact) measurements of transmission-line parameters of a feature on the photomask will be investigated.

Damping in Thin Doped-Permalloy Films
Deepthi Pulugurtha

We seek to optimize the magnetodynamic properties of magnetic devices by varying the damping of permalloy thin films by doping them with transition elements from group IVB to IB. Long samples with length between 10cm to 14cm with concentration gradients of dopants were prepared by DC magnetron sputtering. The concentration of the dopants, c, varied along the length of the sample as the target to substrate distance increased, but was typically less than 10%.

The damping was measured with FMR spectroscopy. The FMR linewidth varies as the sample is rotated out of plane from its easy axis and is used to separate damping from line broadening

from extrinsic sources. From each of the sample measurements, we obtained information about the variation of the Gilbert damping parameter, α, quantity dα/dc. A typical result from the Permalloy sample doped with Tantalum, had a Gilbert damping parameter variation of dα/dc = .0009.

Georgetown University

Graphical Analysis and Statistical Evaluation of Chemical Sensors

Nancy Houdek

NIST scientists in the Chemical Science and Technology Lab (CSTL) have devised sensors, or microhotplates, that can detect trace amounts of chemical warfare (CW) agents in the atmosphere. These sensors react to the conductivity change when a gas crosses a film coating. However, atmospheric interference, such as humidity or diesel fumes, affects the accuracy of the sensors.

Our objective is to build predictive models that yield improved accuracy in the presence of these interferences. To accomplish this, graphical tools are used to gain insight into the data through exploratory data analysis, and we hope to use this insight to improve the statistical models, based on machine learning techniques such as artificial neural networks and support vector machines. This will lead to sensors that are more capable of correctly detecting CW agents in the presence of interference.

Optimization of Ethylene Oxide on Silicon for Biorepellant Applications

Priscilla M. Lui

The reduction of nonspecific protein adsorption at surfaces has become increasingly important in many biological areas as protein adsorption poses problems for applications including medical inserts, bioassays, biomedical devices, and biosensors. Nonspecific adsorption of proteins may interfere with medical techniques that require specific interactions between proteins and surface-bound molecules as well as increase biofouling, potentially causing harmful biological reactions or infections to occur. This presents a major obstacle in the field of biomedical devices as it limits both the efficacy and functional life of such devices.

Poly(ethylene glycol) is a nontoxic and nonimmunogenic polymer that has been shown experimentally to resist protein and cell adsorption. Many theories surround the polymer's ability to resist proteins, which may be attributed to the effects of steric repulsion and chain mobility produced by the highly conformational molecules within the monolayer. Self-assembled monolayers consisting of smaller ethylene oxide units on gold have shown interesting patterns of nonspecific adsorption of proteins as a function of coverage. However, silicon should prove a more ideal substrate due to the strong covalent bonds exhibited by the attachment of ethylene oxide molecules in comparison to the relatively weak linkages and

increasing instability of monolayers on gold as a function of time. Also, silicon's use as a semi-conductor provides more options in the areas of biosensors and microelectronics.

The goal of the project was to optimize the protein resistance of silicon using custom synthesized molecules of ethylene oxide terminating in alkene, aldehyde, alcohol, and thiol functional groups. The various reactivities of the functional groups allowed for tailoring of surface coverage. Differing attachment schemes of the surface functionalization reaction were also used to optimize molecular coverage including UV light and heat. The ethylene oxide monolayers were characterized by using FTIR, spectroscopic ellipsometry, and contact angle measurements. After attaching ethylene oxide molecules to the surface of silicon, protein adsorption was also analyzed using fluorescence microscopy, FTIR, and spectroscopic ellipsometry to determine the ability of the monolayer to resist proteins.

Non-Linearity of InGaAs Photodiodes

Nicholas Penha Malaya

The linear response of an experiment's measurement devices is a critical element of any precise test. A measure of linearity is in effect a classification of the range over which the detector output is directly proportional to the input signal. This range of constant response is the linear region of the detector. Characterization of this range and the location of significant deviation from linearity will improve the accuracy of the data gathered from the measurement device.

This talk will be a discussion of our methods and procedure to experimentally determine the linearity of InGaAs photodetectors. We have focused on InGaAs detectors because we believe that the current linear range of 10^{-8} Amperes can be extended by as much as three decades through the use of passive cooling. We will explain our method for determining the linearity using a combination of beam-flux addition and different filters. With proper characterization of the linear region within the dynamic range of the detector, a nonlinear correcting term can be added to enhance precision in increasingly nonlinear regions. Finally, we will discuss the Labview program developed to more fully automate control of series of rotation stages used in the NIST Beamconjoiner III to perform measurements on various photodiodes.

This research is useful in optical standards and calibrations as well as a variety of industrial applications such as optical networks. The testing of these InGaAs detectors could result in their possible use in future satellite telescope sensors, such as the NIR array on the Supernova/Acceleration Probe (SNAP).

Gettysburg College

Temperature Corrections in Industrial Irradiation Processing

Tanya B. Ostapenko

In the routine operation of a radiation processing facility, the dose measurements with the product at regular intervals document dosimetric quality control of the process for the facility operator and regulatory authorities. It is important that this dosimetry be suitably accurate and traceable to a national primary standard. The most widely recognized and best available methods for relative high-dose measurements is the alanine – Electron Paramagnetic Resonance (EPR) dosimetry technique. This technique is based on relative EPR measurements of the ceoncentrations of stable free radicals by radiation in alanine. The concentration is related to the absorbed dose and this is comparred to identical dosimeters irradiated to precisely known doses with a standard source.

At present, the procedure of calibrating a source for a coustomer comprises sending unirradiated alanine from NIST to the customer, who irradiates then with the industrial source to be calibrated. The irradiated dosimeters are returned to NIST, the EPR signals are measured at NIST and compared with the signals from dosimeters irradiated with the NIST standard calibration source. Subsequently, the dose values are calculated. The only unknown factor is the temperature during irradiation; this is not controlled and varies greatly during the irradiation. The dosimeter response has a dependence on temperature, for which is compensated by applying a correction factor to the dosimeter response in order to compute the absorbed dose. Moreover, there is no standard protocol on how to estimate the irradiation temperature and apply this correction. This work involves simulating industrial temperature profiles using a Co-60 source, for which estimations of the relative benefits for the different industrial methods of correcting for temperature variations will be evaluated.

Terahertz Spectroscopy on Crystals of Small Peptides

Candace M. Pfefferkorn

In recent years, advances in techniques for generating terahertz radiation have allowed exploration of this rich spectral region which bridges the gap between the microwave and far infrared sections of the electromagnetic spectrum. New applications of THz technology to vibrational spectroscopy of biomolecules have generated much interest since THz radiation is well-suited for probing the large amplitude low frequency vibrational modes relevant to the dynamics of conformational change.

In this work, a low-temperature epitaxially grown GaAs photomixer is used to generate THz radiation via difference frequency mixing. This continuous wave radiation is used for absorption spectroscopy of cooled crystalline samples of amino acids and dipeptides prepared in polyethylene. A cryogenically cooled sensitive bolometer is used to detect transmitted THz radiation. Unlike lower resolution time-resolved methods of THz generation, our broadly

tunable CW system has a high resolution of 0.04 wave numbers, and has enabled us to obtain well-resolved spectra with clear spectral features.

Experimental spectra from crystalline samples with well-documented crystal structures are compared to predictions from computational modeling programs in order to investigate the sensitivity of THz modes to hydrogen bonding networks in small peptide crystals and amino acids. In particular, the crystalline dipeptide L-alanyl-L-valine has been studied because its nanotube diameter and hydrogen bonding structure can be varied by altering the conditions of recrystallization. For different crystallizations with different hydrophobic pore sizes, shifts in the terahertz absorption spectrum were observed. Observed shifts to characteristic THz peaks can be attributed to the small differences in strength and configuration of the hydrogen bonds surrounding the pores. Since temperature variation can also cause shrinking or expansion of hydrogen bonds, our result supports previous work which found that fits to spectra of room temperature tripeptides based on applying the anharmonicity factors determined for lower temperature spectra were greatly improved by allowing a central frequency shift. Identifying and characterizing these vibrational modes are an important step to understand protein folding and its effects.

Grove City College

Quantifying the Deprotection Kinetics of Next Generation Photoresists

M. Patrick Hourigan

Photolithography is the driving technology used by the microelectronics industry to fabricate integrated circuits with current feature sizes below 100-nm. In this process, photoresist materials are used as the imaging template allowing pattern transfer into the underlying semiconductor substrates. In order to understand current limitations of these polymeric based materials, it is critical to understand the basic chemistry necessary that allows for the imaging in these thin films. An acid catalyzed chemical reaction facilitates patterning of sub-100nm features by cleaving (deprotecting) functional groups on the polymeric photoresist in selected regions exposed to UV radiation. A critical parameter of this mechanism is the deprotection extent of the photoresist material. The deprotection trends of several model next generation photoresists of the 193-nm regime were characterized with Fourier transform infrared spectroscopy and scanning probe microscopy as a function of reaction time, exposure dose, and temperature. During the deprotection process, acid diffuses within the thin film; this is often undesirable and leads to uncontrolled feature sizes. Attempts to limit the acid diffusion include using lower processing temperature and using base additives. We include results on the affect of added base quencher to the photoresist which serves to reduce the deprotection extent. In this talk we describe the photolithographic process and the basic chemistry of these modern 193-nm photoresist materials.

Gustavus Adolphus College

A Framework for Parameter Study Applications in Distributed Computing Environments

Justin D. Haaheim

Distributed computing systems leverage the power of many physically dispersed computers to perform computation. Existing architectures for distributed computing are often restricted to a single computational task. Screen Saver Science (SSS), a distributed computing platform developed by William George at NIST, is designed to accept any type of computation and distribute it to a dynamic network of computers on a local area network for processing. SSS is written in Java, and utilizes Jini and JavaSpaces technologies for its dynamic networking and shared memory needs.

Screen Saver Science is based on the client-server model. A central server hosts a JavaSpace, which acts as shared memory between the server and clients. Client computers run the client portion of the SSS software which, when the computer begins idling (i.e. when the screen saver starts), retrieves a task from the SSS JavaSpace, runs it, and sends back the results.

My research this summer has focused on the parameter study style of computation in distributed computing environments. In the parameter study paradigm, a single program is run many times with different input parameters. The results of these runs are then analyzed together. Each execution of the program, however, is independent of the other runs, which makes parameter studies particularly well-suited for distributed computing environments such as SSS. The difficulty is in specifying, dividing and assigning parameter ranges, and in the bookkeeping associated with these large quantities of tasks being generated. Fortunately, these things are common to all parameter studies in distributed computing environments, which have allowed me to develop an application-program interface (API) that offloads work from the application programmer. My talk will discuss some of the functionality and implementation of the API.

In-situ Radiation Force Measurement of High Frequency Ultrasound

Dorea R. Ruggles

High frequency (3 MHz-30 MHz) ultrasound is used extensively in medical and industrial applications as an effective, non-invasive measuring and imaging tool. Ultrasound waves impart a mechanical radiation force-which can be measured to determine the ultrasound power incident on an object. Determining the power radiated from a source requires knowledge of the attenuation of the ultrasound as it travels from source to object. Ultrasonic attenuation in a medium is dependent on the spatial distribution of ultrasonic energy as well as the properties of the medium itself. In a radiation force balance (RFB), at least two media – the water between source and target, and the material composing the target – are involved, and the spatial distribution is complicated by the shape of the target which intercepts the ultrasound beam.

These factors combine to confound RFB power measurements sufficiently to require empirical, rather than purely theoretical, corrections for *in-situ* attenuation. The purpose of this project was to obtain and apply the experimental data required for *in-situ* attenuation corrections for an available RFB.

The bulk of the presentation will focus on the spatial and material considerations of measuring ultrasound attenuation. Attention will be given to the relative advantages and disadvantages of the six targets that were constructed during the course of the project. The results of the attenuation study will be presented. It will be shown that the classical attenuation theory is not sufficient for characterizing *in-situ* ultrasonic power because the *in-situ* attenuation correction is heavily dependent on the characteristics of the propagation medium and target.

Hamilton College

Polarized ^{3}He

Gregory Armstrong

Because of it's strongly spin dependant neutron absorption cross section, polarized ^{3}He is an ideal neutron spin filter. ^{3}He can be polarized by a variety of different methods. We focused on spin exchange (SEOP) and metastable exchange (MEOP) optical pumping. In SEOP rubidium vapor is polarized with circularly polarized light. The Rb then transfers it's polarization to the ^{3}He nucleus through the hyperfine interaction during collisions with ^{3}He atoms. In MEOP metastable ^{3}He atoms are produced using an RF discharge. The metastable atoms are polarized by pumping with circularly polarized light. The polarization is transferred to the nucleus by the hyperfine interaction. Once the ^{3}He is polarized it is very sensitive to magnetic field gradients. In order to protect the ^{3}He from magnetic fields while being used on the neutron beam a small shielded solenoid was built. The magnetic field homogeneity was optimized based on magnetic field maps and relaxation time measurements.

Harvey Mudd College

Polarized Neutron Reflectometry Studies of Spin Valves with Pico-Scale Antiferromagnetic Layers

Stephanie M. Moyerman

The current era in science and technology marks a time when devices that manipulate the spin of an electron, known as spintronic devices, may possibly replace today's semiconductor electronics. Specifically, Giant Magnetoresistance (GMR) is a spin-dependent effect that is already being utilized for hard-drive read heads. One magnetic recording device that exploits GMR is known as a spin-valve, which consists of two ferromagnetic (FM) layers separated by a non-magnetic spacing layer. One ferromagnetic layer is free in orientation, causing it to align with an external magnetic field. The other ferromagnetic layer is locked in place by an adjacent antiferromagnetic (AFM) layer through a pinning mechanism known as exchange bias. The

hallmark of exchange bias is the shift in the magnetic hysteresis loop, yielding asymmetry about zero applied fields. The magnitude of this shift is known as the exchange field. Microscopic models of the origin of the exchange field focus on the formation of magnetic domains in the antiferromagnet or the ferromagnet, or on a small induced moment in the antiferromagnet [1]. Insight into these microscopic models can be gained by investigating the dependence of exchange biasing in spin-valves with AFM layer thicknesses in the pico-scale regime. Previous low temperature GMR measurements have verified the existence of exchange bias in spin valves with AFM layers as thin as 2 Å [2].

A comparable set of spin valves with structure Si/50Å Ta/30Å NiFe/10Å CoFe/30Å Cu/30 Å CoFe/ X IrMn/16 Å Ta /10 Å Cu /50 Å Ta with X= 4 – 16 Å were produced by DC magnetron sputtering and measured using Polarized Neutron Reflectivity (PNR). For the samples with X= 4 and 16 Å, PNR studies were performed at 6 and 20 K respectively at several points along the magnetic hysteresis curve to provide a depth profile of the vector magnetization and to probe separately the free and pinned CoFe layers. Fits to the data for X=16 Å confirm that in saturating fields, the ferromagnetic CoFe layers are aligned in parallel as expected. In intermediate fields we achieve near antiparallel alignment, though the pinned layer appears to be canted relative to the applied field. Significant changes in this antiparallel magnetic structure are observed during the second field sweep, showing that high field saturation alters the nature and effectiveness of the pinning in our sample. This effect is known as "training." Comparable PNR results are achieved for the X=4 Å sample, though the changes in the magnetic structure of the individual layers after training are more pronounced. These results support the characterization of exchange biasing as an interfacial effect, potentially originating from pinned spins with a net moment in the antiferromagnet.

[1] A. Hoffmann, J. W. Seo, M. R. Fitzsimmons, H. Siegwart, J. Fompeyrine, J.-P. Locquet, J. A. Dura and C. F. Majkrzak, "Induced magnetic moments at a ferromagnet-antiferromagnet interface," Phys. Rev. B. vol. 66, pp. 220406I, Dec. 2002.
[2] K. L. Perdue, M. J. Carey, P. D. Sparks, and J. C. Eckert, "Exchange Bias and Giant Magnetoresistance in Spin Valves with Angstrom-Scale Antiferromagnetic Layers at 5 K," IEEE Trans., (In Press).

Illinois Wesleyan University

Techniques of Reaching Extreme Low Temperatures for Making Measurements in Single Electron Tunneling Devices

Brian J. Simonds

This talk will discuss the development of low temperatures in a dilution refrigerator for taking sensitive electrical measurements of single electron tunneling devices. In order to achieve a base temperature of 0.025 Kelvin it was necessary to analyze the DR for heat loads which we found to be caused by two coaxial cables inside the insert. Also, time permitting I will discuss measurements taken at low temperature of actual SET devices.

James Madison University

A Comparison of Charged Particle Detectors Using Neutron Depth Profiling

Michael E. Peretich

Neutron Depth Profiling (NDP) is a unique nondestructive analytical technique that uses neutron-induced charged particle reactions to probe the concentration versus depth distribution of light elements in real time. The measurements are limited by noise and energy resolution. Lower noise assists in obtaining deeper, more accurate profiles, whereas improved energy resolution decreases the uncertainty in depth resolution. Recently a Canberra* passivated implanted planar silicon (PIPS©) detector was compared to an Ortec* silicon surface-barrier (SSB) detector to determine their relative effectiveness in charged particle detection for NDP use. PIPS detectors typically exhibit higher energy resolution than SSB detectors. PIPS detectors have notably less of a dead layer than SSB detectors and are more sensitive in the low energy region where electronic and radiation background often overtakes the charged particle spectrum. Furthermore, PIPS detectors are generally less expensive than SSB detectors, so a comparison of the two types of detectors was undertaken. This study presents initial results comparing the two types of charge particle detectors for analyses of actual NDP applications.

Samples of polyvinylidene chloride, aluminum nitride, helium-3 implanted into tungsten, and borosilicate glass were analyzed using NDP to determine which detector performed better for specific charged particle detection. To evaluate the collection efficiency of low energy x-ray and gammas on the detector, both detectors were exposed to Barium-133 and Europium-152 radioisotope sources without the neutron beam present.

The PIPS detector has a good spectrum in the higher energy region as well as good energy resolution; however, as the energy decreases the background noise increases exponentially. On the other hand, the SSB detector was able to measure much further down the energy spectrum providing the capability to probe deeper beneath the sample surface. Two features contribute to the high background noise observed in the PIPS detector. First, it has virtually no dead layer to attenuate the abundance of low energy x-ray and gamma radiation produced from prompt and short lived activities during the neutron irradiation. Second, the thickness of the PIPS detector (300 μm) is nearly six times that of the SSB detector (50 μm). The thickness of the PIPS is excessive for the collection of the charged particle ionization. The extra volume serves to contribute noise collected from the ionization created by the penetrating betas and photons emitted by the sample during NDP analysis. Although thinner PIPS detectors are commercially available, PIPS detectors of comparable thickness of the SSB detectors are not currently commercially available due to manufacturing limitations.

The PIPS detector used in this work has better energy resolution than the SSB detector, and performs better at charged particle energies used by NDP for boron and lithium analyses. However, at lower energies, the detector collects significant background, making it unsuitable for NDP when determining low concentrations of chlorine, nitrogen, or helium. Additional

studies with thinner PIPS detectors are in progress to assess the appropriate use of the two types of detectors for NDP applications.

*Identification of commercial products does not constitute endorsement by NISTor by the authors.

Johns Hopkins University

Wind Load Factors for Tall Buildings

Amelia P. Wright

For a structure to function safely, the strength or capacity must be greater than the demand induced by the loads acting on the structure. The probability that a structure will fail is the probability that the demand exceeds the capacity. Although the probability of failure of a structure can never be zero (e.g., the structure can be hit by a meteorite), it can be reduced enough to ensure a societally acceptable safety level in a cost-effective manner. The load and resistance values are defined in statistical terms, rather than being deterministic. To assure that the design is safe, nominal design values of the loads must be multiplied by load factors larger than unity, and nominal resistance values must be multiplied by resistance factors smaller than unity.

The ASCE 7-05 Standard specifies the same load factor for all buildings, regardless of whether they are rigid or flexible. Tall buildings are flexible, that is, they are dynamically active, and their response depends upon the damping inherent in their motion. Because damping values are affected by large uncertainties, the actual value of the damping as experienced during the building motion can differ significantly from the nominal damping value used in design. The safety margin inherent in the load factor must therefore account for these uncertainties. It follows that load factors must be larger for tall buildings than for rigid buildings, since the latter's response is not a function of damping.

The goal of this project is to develop wind load factors appropriate for tall building design, and to compare them with load factors specified in the ASCE Standard on the basis of estimates of rigid building response. The development of load factors entails the use of information on uncertainties inherent in the various parameters that determine structural response, The talk will include a description of the dynamic and statistical elements of the methodology used to estimate load factors for tall buildings. It is anticipated that this work will provide a basis for recommendations to the ASCE 7 Wind Loads Committee on load factor values for tall building design.

Lebanon Valley College

Monte Carlo Simulation of a Single Photon on Demand Source Using a Multiplexed PDC Scheme

Katherine E. Myers

The creation of a single photon on demand source has potential uses in quantum computing and quantum cryptography. Creating a secure link based on the physical laws of quantum mechanics relies on single photons and would be a significant achievement and one of the motivations for this research. Currently, single photon on demand sources can only be approximated to varying degrees by a number of different schemes. This is because the probability of creating more than one photon, P(>1), is generally coupled to the probability of creating a single photon, P(1), in that P(>1) is roughly proportional to $P(1)^2$.

A new method of creating single photons involving a multiplexed system that decouples P(1) and P(>1) has been developed based on parametric down conversion (PDC). PDC uses a nonlinear crystal which takes single input photons and creates photons two at a time. The probability of creating a state with n photons with the PDC system follows the Bose-Einstein distribution. At a very small mean photon rate, μ, this distribution is governed by μ^n. Therefore, a small mean photon rate ($\mu < 1$) is typically used to limit the probability of having an n larger than 1. However, using a small μ in turn yields a low probability of creating any photons at all.

In the multiplexed scheme, the nonlinear crystal creates many photon pairs in each pulse. The photons created two at a time are correlated, one of which acts as a herald photon for the other which is sent to a switch that directs it to the output. To increase P(1), there are four single mode fibers that collect the potential herald photons and direct them to a single detector. When a herald photon is detected, it is known that its twin exists in the output. The herald fibers are delay lines, allowing for the determination of which channel caused the detector to fire based on the timing of the detection. A which path signal is sent to the switch directing it to connect the appropriate input channel known to contain a photon to the output. Using a system of four PDC sources increases P(1), while allowing the use of a smaller mean photon rate per channel, therefore keeping P(>1) low. Overall, there is a greater likelihood that one and only one photon is emitted in this system than from the traditional single input setup.

A Monte Carlo approach was used to simulate the experiment, with a goal of finding the optimal operating parameters. Development of this computer program allowed for a deeper understanding of these parameters; mean rate, detector dark counts, and losses in the system. This presentation will outline the details of the experimental setup and the computer simulation. An overview of the results will be given, including a discussion of the effectiveness of the PDC system in creating single photons on demand.

Lehigh University

Evolution of Strain-Induced Microstructure and Texture in Commercial Steel Sheet Under Balanced Biaxial Stretching

Brian F. Gerard

An increasingly popular method used to improve the fuel economy of automotive vehicles is to make them lighter. This can be accomplished in many ways, one of these being the replacement of the heavy conventional steel sheets used for the exterior body panels with lighter, higher strength materials of thinner sheets. The processing technique to make these body panels involves stamping the sheet between numerous die sets (two large, mating dies) to achieve the desired shape. These dies cost upwards of $500k to produce, and thus it becomes necessary to model the die design and resulting behavior of materials prior to fabricating the dies as this will reduce the die tryout period and associated costs. As this stamping process imposes various types and levels of strain on the sheet which will affect the behavior of the material (wrinkling/tearing of the sheet, surface appearance, tolerance of the final shape), databases of material performance is critical for accurate finite element analysis. Currently, this information is limited and largely undocumented in the newer replacement materials, thus making it difficult to predict the behavior. In this study, the evolution of crystallographic texture, surface morphology, and microstructure was investigated under balanced biaxial stretching (equal stretching in all directions) in sheets of Drawing Quality Special Killed (DQSK) steel. The resulting data and constitutive equations will be useful as inputs for finite element models that predict mechanical behavior.

Massachusetts Institute of Technology

Using Optical Tweezers to Create Zinc Oxide Nanowire-Based Devices

Melis N. Anahtar

Despite the ability to fabricate and characterize nanowires of varied materials and dimensions, there are very few mechanisms to directly manipulate and assemble these wires to create nanoscale components. One such mechanism is a laser tweezer-based system that uses the force of light to move and position nanowires. Using this technology we can prototype and test nanodevices that can act as LEDs, sensors, and circuits. This project used a scanning Optical Tweezer (OT) instrument to trap and arrange zinc oxide (ZnO) nanowires in solution. To prepare the samples, semiconducting ZnO wires grown using the vapor-liquid-solid (VLS) growth process were placed in water and sonicated to remove the wires from the chip and disperse them in solution. The chips were imaged in a Scanning Electron Microscope (SEM) to determine the optimal sonication time and observe the effect of water on the morphology of the wires. After samples that met the criteria of wire length and density were obtained, the OT setup was used to arrange the wires into junctions and arrays on a chemically treated coverslip. The coverslips were treated by dipping them in 5% 3-aminopropyltrimethoxysilane in methanol and rinsing in water. They were then dried and imaged in the SEM to verify the integrity of the

structures. The results show that OT is an effective tool for prototyping nanodevices and creating basic nanocomponents.

Observing Electo-osmotic Flow in Glass and Fluorinated Polymer Microchannels
Christopher J. Russell

Current research in micro- and nanofluidics is aimed at miniaturizing macroscopic chemical and biological analysis equipment. Fluid transport in microscale channels requires unique pumping strategies, which exploit the high surface-to-volume ratio of microchannels. One such approach, electro-osmotic flow (EOF), uses an electric field to transport an electrolyte solution through a channel. EOF has primarily been performed by applying an electrical bias to a buffer solution in a glass microchannel, and observing flow toward the cathode (i.e., negative electrode). Decreasing channel dimensions to sub-micron scale provides even higher surface-to-volume ratios, but introduces challenges in device fabrication, channel filling, and EOF behavior. This contribution reports (1) the effect of multidirectional electric fields on EOF in glass microchannels, (2) the performance of polymer microchannel fabrication techniques, and (3) the measurement of EOF inside fluorinated polymer microchannels. In particular, the flow rate and direction of EOF were measured when parallel and perpendicular electric fields were applied to the channel. EOF proceeds at approximately 0.2 mm/s with 100 V bias of a 5 Mm KH_2PO_4 buffer. The gate voltage has the effect of slowing EOF, and making changes in conductivity lower in magnitude. Fluorinated polymer microchannels were prepared by ultraviolet (UV) embossing. A 200 □m thick fluorinated monomer solution was cast onto a microchannel template and exposed to various doses of UV radiation. Then, channels were assembled by sealing the polymer film to a glass surface, and EOF experiments, identical to those of the glass microchannels, were performed. The fluorinated polymer microchannels facilitate EOF; however a flow rate was not determined due to conductivity measurements from incomplete channel sealing. This work is the first step in using fluorinated polymer channels as an alternative to glass channels in microfluidic flow-control, separations, and/or analyte focusing. Furthermore, this work provides a foundation for ongoing development of EOF pumping in sub-micron polymer channels.

Mercer University

Laser Frequency Control in Four-Wave Mixing
Jeremy B. Clark

Atom optics is a new field presenting new opportunities for research using laser cooling techniques and Bose-Einstein Condensates (BEC's). By allowing correlated photons to interact with a BEC, we could create correlated atom beams to perform a number of experiments where more massive coherent particles would prove suitable.

Current correlated photon sources are not suitable for interacting with cold atoms. In this experiment, entangled correlated photons will be created using four-wave mixing in rubidium

vapor so that they can then be passed through a BEC to create entangled atom beams. In order to probe the response time of the mixing process, it is of interest to control the relative frequency between the probe and pump beams with high precision. To this end, we use the Dichroic Atomic Vapor Laser Lock (DAVLL) as developed by Corwin et al. Stabilizing the frequency with the DAVLL provides the necessary flexibility to lock the pump lasers off resonance where nonlinear effects dominate. Probe detuning can then be controlled using a variety of techniques using the frequency control of the pump as a reference.

Miami (Ohio) University

Developing a World Model Ontology for the Autonomous Vehicle Project

Tom Walters

Any autonomous robot must be able to understand and make decisions in response to its environment. There are three important parts to this process. They are: 1) the ability to effectively sense the environment, 2) the existence of a well-defined and functional internal knowledge representation of the world, and 3) a set of tasks that can be executed, in response to the previous two items, in order to accomplish a specified goal. This research focuses on the second of these three parts by building a well-defined world model for the autonomous vehicle project. My contribution to this world model is an ontology.

In an ontology, similar to a knowledge base, information is structured in a hierarchy. However, an ontology will represent concepts as well as their properties and set relationships, rules, and constraints. An autonomous robot can use this type of knowledge representation to make decisions or reason based on its external observations.

Our intelligent systems (IS) ontology is built in a software package called Protégé 2000, which is an open source ontology editor developed at Stanford University. This package is particularly useful for the work being done not only because of its ability to support relationships such as class and property, but also for the active development of plug-in utilities. These utilities offer versatile functionality like setting up visualizations of the class structure to implementing different methods of creating constraints and rules.

Our autonomous vehicle operates in an outdoor environment where it encounters both man-made and natural obstacles. In this talk, I will describe how my work focused on developing environmental concepts in the context of military definitions and documentation. In doing so, I will describe the three main parts of the ontology development process: a) Leveraging an online, open source ontology called Opencyc to build the more general, upper-level concepts in the IS ontology; b) Adding event specific concepts; and c) Establishing rules and constraints that give the vehicle the ability to reason within the ontology.

A Route to a Room Temperature, Effusive Atomic Beam
Morgan J. Welsh

Conventionally, effusive atomic beams of alkali metals are created using an oven that heats an atomic source to create a non-directional atomic beam. The out-going atoms pass through a constriction that collimates the atoms into a narrow beam. A phenomenon, known as Light-Induced Atomic Desorption (LIAD), can be applied to this system to increase the density of rubidium atoms. LIAD is a non-thermal process using non-resonant, ultraviolet light incident on the inside surfaces of the chamber. The UV light modifies the surface properties and releases atoms that were bound to the surface. These desorbed atoms are at room temperature, and therefore have relatively low velocities, which facilitates more efficient laser cooling apparatus. I investigated the effects of LIAD on a rubidium vapor cell, and subsequently extended the experiment to detect a LIAD enhanced rubidium beam.

Millersville University of Pennsylvania

Computer-Aided Camera Placement for Facial Recogntion
Daniel S. Blanchard

For computer vision systems requiring a rig of multiple cameras aimed at a target object, such as for redundant facial recognition, it is often useful to determine quantitatively what arrangement of cameras yields the most acceptable images over the largest area. Currently, there are no widely available programs that can be used to calculate this. This talk will describe a piece of software that utilizes a realistic camera model to aid in the design of camera rigs for facial recognition applications. The talk will outline the model in detail, propose results that verify accuracy, present how the "operating envelope" is calculated, and conclude with a discussion of an optimal (application-specific) camera rig. The application may be easily customized for other multiple-camera applications.

Materials Informatics Tools and Crystallographic Databases
Brian M. Nolan

Three-dimensional crystal structures are used throughout science to identify unknown compounds, in much the same way that fingerprints are used to identify persons. Today crystal structures are an integral part of designing and predicting new materials and their behaviors. For example, models of crystal structures have been used in the research that ultimately led to the shrinking of cell phone sizes and the introduction of Flash memory devices. Now research is just beginning at NIST on how to build databases that will use the emerging power of the Semantic Web, the next generation of the Internet.

When someone searches for information on Google^{tm} they have two choices, "Google Search" or "I'm Feeling Lucky." Unless this person feels extremely confident about their search criteria they probably won't press the "I'm Feeling Lucky" button. Instead they will proceed with a normal search and then scan their results for what appears to be the correct page. However,

what if it could be guaranteed that the first result in the search was the one being sought after and several useful pages of results where they all were related to what the user was looking for? This potential search power is real and the technology behind it is being developed by a collaboration of scientists in all fields of research here at NIST.

The technology bringing about this future is all part of the Semantic Web. NIST's Crystal Structure Databases are ideal test examples because they are large scientific databases and highly mathematical. The math and theory behind crystallography is used in all areas of computer science. For example data compression algorithms and encryption algorithms use many of the same theories.

This new Internet will harness the power of the Resource Description Framework (RDF) templates, creating a well defined, Internet database where high-end research, commerce, entertainment, and communication will flow intelligently. What the Resource Description Framework will do is allow scientists and web developers to create open databases that are built to be understood by machines as opposed to the current Internet that is built to be understood by humans.

This presentation will cover both the human aspect of the Internet and the computational aspect of the Semantic Web. Information and examples will be presented on how both entities view and understand the Internet that is presented to them currently and the one that will be accessible in the near future.

Mississippi State University

Characterizing the Capacitive-Voltage Relationships of Silicon Carbide Power Devices

Aaron J. Wright

The emergence of silicon carbide (SiC) semiconductor power devices has the potential to revolutionize power distribution and conversion systems. SiC, well known for its high frequency and high power potentials in power electronics, has produced switching speeds greater than the widely used silicon (Si) by a factor of 100. SiC technology is expected to extend high frequency power conversion to the 10Kv to 25Kv range. In addition, the excellent operation of SiC devices at high temperature makes the material suitable for extreme conditions such as uses in military, space and aircraft electronics, nuclear power, and power utility industries.

System Simulators and measurement systems are needed by circuit designers to characterize commercial power devices. The Hefner IGBT(Insulated Gate Bipolar Transistor) model developed at NIST is used in the IGBT Model Parameter ExtrACtion Tools (IMPACT) software to extract IGBT parameters including the temperature dependent properties of SiC materials and the capacitance-voltage characteristics. Recently, IMPACT has been enhanced and extended to include SiC MOSFET (Metal Oxide Semiconductor Field-Effect Transistor) models.

This project is a part of the expanding IMPACT software by developing a measurement system that characterizes the capacitance-voltage relationships of MOSFETs. This measurement system generates CV(capacitance-voltage) curves to portray the behavior of the substrate capacitances as voltage is varied. An LCR meter is interfaced with varying gate and drain voltage supplies and the system controller via GPIB bus. This new system will assist in determining the behavior of SiC semiconductors at high voltages.

Mount Saint Mary's University

Preparation and Characterization of Gold Nanoshells

Ryan C. Cleary

There are many applications that use optical detection techniques, such as sensing DNA hybridization and a simple home pregnancy test. The ability to make simple, lost cost nanoscale sensors that have highly tunable optical properties will aid in these areas. Our strategy involves preparing metal covered silica nanoparticles, termed metal nanoshells. Metal nanoshells are well known for the ability one has to tune their optical properties from the infrared to ultraviolet wavelengths. By coating silica with a nanometer thick metal shell and varying this shell thickness, the plasmon resonance can be adjusted. Gold was used to create the shell because it is inert, its surface can be readily functionalized, and it has a plasmon band in visible wavelengths. Once demonstrated, we aim to prepare nanoshells with magnetic properties. This will allow us to control both the particle's optical properties and its position in three dimensions.

Murray State University

Application of the Programmable Josephson Voltage Standard in Voltage Metrology

Aaron M. Cowan

There are three Josephson Voltage standards used in the Quantum Voltage Metrology Lab: a traveling standard (compact JVS), a 10V Windows-based system (NIST10), and a programmable standard (PJVS). The U.S. legal volt is maintained and disseminated by these quantum voltage standards. We will describe the characteristics of the different types of Josephson junction arrays and the working principle of these voltage standards in DC voltage metrology.

One important application of the PJVS is for high precision array to array direct comparisons. We recently upgraded the NIST10 from the DOS operating system to Windows along with a part of the system's electronics. To verify the performance of the upgraded NIST10, we have used the PJVS as a stable voltage source and carried out a series of comparisons between the NIST10 and the PJVS at different voltage levels. We have achieved a few parts in 10^{10} uncertainty at 2.5 V in such comparisons and established a confidence for NIST10 performance after modification in it hardware and software.

An application of the compact JVS is for interlaboratory comparisons performed across the country. Four ILCs were made as part of the NCSLI JVS ILC 2005. This involved the system being shipped back and forth from NIST. Therefore, it was necessary to ensure that the CJVS was properly functioning after each shipment, that is operating within a few part in 10^9. The PJVS was applied in another array to array direct comparison this time involving the CJVS. Testing at the 2.5 V level again, an uncertainty of a few parts in the 10^9 was achieved verifying the performance of the CJVS.

Northwestern University

Control of Cell Adhesion and Morphology on Oligo(ethylene oxide) Surfaces of Various Packing Densities

Mark A. Rocco

The structure of self-assembled monolayers (SAMs) of $[S(CH_2CH_2O)_6CH_3]_2$ and $HS(CH_2)_3O(CH_2CH_2O)_xM$, where x = 5 or 6 and M = H or CH_3, on Au were studied with spectroscopic ellipsometry (SE) and reflection-adsorption infrared spectroscopy (RAIRS). Ordered and disordered SAMs of these compounds exhibit very different protein adsorption properties, which are important to the biocompatibility of devices, such as, catheters, implants, cardiac pacemaker leads, contact lenses, etc., as well as cell biology. Within the realm of biomaterials and biotechnology, the ubiquitous concern among scientists and bioengineers is the concept of biocompatibility. This term pertains to a certain acceptable tolerance of the human body's natural immune response to the introduction of a foreign material into the body or biological fluids. When foreign materials are placed within a biological environment, the process of biofouling, the deposition of proteinaceous or glycoproteinaceous films on metal or oxide surfaces, begins almost instantaneously. Thus, the control of non-specific protein adsorption possesses significant economic importance for a wide variety of medical, biotechnological, tissue engineering, maritime, and energy industries.

By means of SE and RAIRS data, we have shown that film growth of the $[S(CH_2CH_2O)_6CH_3]_2$ SAMs terminates at ~ 60% of a monolayer, which corresponds to the onset of self-rejection and the onset of high protein resistance. Moreover, for the first time ever we have shown that by adjusting the assembly conditions, highly ordered SAMs of $HS(CH_2)_3O(CH_2CH_2O)_6H$, with the oligo(ethytlene oxide) [OEO] segment in a 7/2 helical conformation, can be prepared. These highly ordered, helical SAMs are the most monodisperse OEO surface prepared thus far, and coupled with the ability to control surface structure, afford a new platform for understanding protein adsorption and cell adhesion at the molecular level.

However, before one can ultimately control this non-specific protein absorption, it is of utmost importance to understand the structural basis of not only the individual molecules and assembly they form, but also the microscopic-macroscopic structure-property relationship responsible for this protein resistance/adsorption. Currently, the most promising means of

study stem from the analysis of self-assembled monolayers, due to the convenience, stability, and control that their molecules provide. Thus, through analysis of the cellular response of murine aortic smooth muscle cells to fibronectin-coated SAMs of $HS(CH_2)_3O(CH_2CH_2O)_5CH_3$ we intend to help elucidate the mystique surrounding this complex structure-property relationship.

Ultimately, if we can determine the behavior of cells on SAMs and can control how they behave based on the manipulation of the cellular environment, then we may be able to develop innovative techniques for tissue engineering and biomaterials.

Oberlin College

Layered Double Hydroxides: A Novel Additive for Flame Retardant Polymeric Nanocomposites

Michael C. Moore

Adding Layered Double Hydroxides (LDHs) to polymers has been shown to increase the thermal stability of polymeric materials and acts to increase the flame retardancy. While effective as a micro-dispersion, nano-dispersed LDHs have the added FR benefits of both inorganic hydroxides and layered crystal nanocomposites. Through the use of organic ions, LDHs can be intercalated to increase the gallery spacing and then swelled with various polymers to obtain a uniform nanocomposite. Overall flame retardancy of a material is influenced by the organic ion used and LDHs can be used in conjunction with traditional FR additives. Our tests of LDH nanocomposites in epoxy and polyurea systems have shown LDHs to be an effective flame retardant through multiple mechanisms. Our focus is to continue to develop high-throughput methods for producing effective flame retardant formulations as an alternative to environmentally harmful halogenated materials.

Ohio University

Surface Potential Measurements of Organic Interfaces by Scanning Kelvin Probe Microscopy

Aaron Katzenmeyer

The drastic down-scaling of electronic devices has seen two basic approaches: the traditional refinement of prior techniques to achieve smaller scales and more radically the assembly of devices from atomic elements. The molecular approach to electronics offers much in regards to construction and size; however, more information is required concerning the electrical properties of molecules. Since a molecule used in this sense must have electrical contacts, we start there. How does it change our contact properties? The work-function (applied energy required to conduct) for a metal may be altered by chemisorption or by variance of the surface structure. This study quantified the effects induced by attaching organic monolayers and employing different techniques for metal deposition. The methodology of this experiment

involved scanning Kelvin probe microscopy to directly obtain the contact potential difference between the probe tip and the sample which allowed the work-function to be readily calculated.

Developing Libraries for Portable Raman Spectrometers

Seth L. Marquard

Raman spectroscopy is a technique, which relies on the excitation of an electron. When a laser illuminates a sample, an electron moves into a virtual energy state which is below the first electronic transition. Relaxation of the electron to the ground state emits a photon of a different color. However Raman is inefficient and only 1 in a million photons are scattered as a different color. Raman is a useful analytic technique in that the spectra are compound specific and there is little sample preparation necessary.

Currently, Raman spectrometers are becoming smaller, more portable, and easier to use. Because these devices are small and require little sample preparation they are gaining popularity among fire and police departments as well as the military. While a Raman spectrum is an inherent property of the material, biases in the spectrometer and the exact wavelength of the laser can influence the shape of the spectra. This causes a problem in that each spectrometer must rely upon a device specific library. These libraries are not compatible between instrument companies or even spectrometers built by the same company.

NIST is currently trying to develop a protocol by which the spectrum of a compound would only need to be measured once. Some steps in this direction have already been accomplished. First is the development of SRM-2241, a chromium doped glass is used to calibrate the Y-axis (intensity) of Raman spectrometers. The use of this standard allows the inter-comparison of Raman spectra acquired with 785nm laser excitation.

The work conducted this summer focused on four Raman systems; a Fourier Transform Raman (operating at 1064nm), a research grade Raman microscope system and two commercially available portable Raman systems (all operating with 785nm lasers). Spectra were taken of the ASTM standard shift reagents, white powders supplied by the FBI, common inorganic ions, and several pesticide samples. Libraries were compiled with the spectra from the two portable systems and the spectra from one instrument were searched in the library of the other. A hit quality index was recorded for each spectral search and a model generated to observe trends in identification performance. A comparison of hit quality before and after correction with SRM-2241 was performed. Future work will involve including resolution, spectral coverage, and Raman shift calibration into an algorithm that would modify the spectrum in a predictable way and eliminate the need to develop individual libraries for individual Raman spectrometers.

Pennsylvania State University

Spin Transistors: Enforcing Moore's Law
Alexander U. Adler

In 1965, Gordon Moore, a founder of Intel, observed that the number of transistors per square inch on integrated circuits had doubled every year since the integrated circuit was invented. In the late 1980's, this rate had since slowed down to doubling approximately every 18 months. Now, experts believe it might be in danger of hitting a brick wall without significant new developments in technology. One potential new technology is spintronics – electronics that deal with the individual spins of carrier as well as the charge. In particular, the concept of a spin transistor that operates like a Bipolar Junction Transistors with added functionality may reduce the number of transistors required by a factor of five.

This presentation will focus on the technology and creation of spin transistors with silicon as the base. It will cover the lithography process involved in creating these devices, comparisons of spintronic transistors to Bipolar and Magnetic Bipolar Junction Transistors using analogies to the Ebers-Moll model, preliminary data for the characterization of the tunneling barriers and an outline for future research and applications of these transistors.

Pepperdine University

Delving into the Fiery Realm of Ceramics—Developing Phase Diagrams for the $BaTiO_3$-$BaMnO_{3-x}$ Binary and BaO-TiO_2-MnO_x Ternary Systems
Tiffany Ellise Asche

Much of the technology that enables cellular communications is based upon the unusual and distinctive properties of dielectric ceramics that are currently used as resonators and filters. The implementation of $Ba_2Ti_9O_{20}$-based dielectric ceramics as resonators in the 1970's brought about a major breakthrough in the communications industry. The characteristic high dielectric constants and low dielectric losses of this class of ceramics allowed for miniturization of resonator components, and enhanced stability. Since that time, the search continues for refining ceramic structure in order to optimize performance and minimize cost for a variety of applications. In order to tackle structural and thermodynamic properties of complex systems for use in industry, a foundation must be laid that adequately describes the behavior of more basic systems. Determining the equilibrium phase diagrams for binary and ternary systems provides a wealth of information that is useful in both academic and industrial endeavors.

This specific project focused upon the determination of the binary phase diagram for the $BaTiO_3$-$BaMnO_{3-x}$ system, as well as further investigation into the phase diagram for the ternary system BaO-TiO_2-MnO_x through solid-state reactions. X-ray powder diffraction was utilized to identify the equilibrium phases that occur at varying compositions and high temperatures. The $BaTiO_3$-$BaMnO_{3-x}$ binary system was found to contain a variety of polymorphs at varying

compositions, including 2L, 6L, 8L, 9R, 10L, 12R and 15L hexagonal and rhombohedral phases. The binary phase diagram is relatively simple for compositions of $BaTi_{1-x}Mn_xO_{3-y}$ with lower Mn content in which $0.4 > x > 0$. In this compositional range, specimens are single-phase, namely the 6L hexagonal phase from 1250-1450°C. Compositions for which $0.7 > x > 0.4$ are single-phase (rhombohedral 12R) from 1000- 1250°C; both 6L and 12R phases are present from 1250- 1450°C. The binary phase diagram becomes much more complex at higher manganese content. A relatively narrow compositional band from $0.9 > x > 0.8$ is single-phase (rhombohedral 9R) at 1150°C; this band narrows further at higher temperatures and at 1450°C, a 10L hexagonal phase is present. Compositions for which $x > 0.9$ contain the greatest number of polymorphs in this system. At 1150°C, 2L, 8L, and 15L hexagonal phases are present. At 1450°, both 8L and 9R phases have been found in this compositional range.

Given the complexity of the system, particularly for compositions with higher manganese content, further experiments are needed in order to pinpoint the phase boundaries. While relatively little time was invested into the $BaO\text{-}TiO_2\text{-}MnO_x$ ternary system, there have been clear indications of the presence of phases that are distinct from any of the three binary subsystems. Although additional investigations must be completed, particularly on the ternary system, the data collected this summer aids in shedding light on the system as a whole.

Princeton University

Traces of Tragedy: The Explosive Signatures of Landmines in Soil

Bryan R. Cockrell

Current US defense policy both domestic and foreign has given rise to the need for an improved understanding of the impacts of explosives on soils among geochemists. First, a number of domestic military bases have been decommissioned, raising the necessary question of how easily the residues of explosives tested at those bases could seep into groundwater. Second, in the US-Iraq conflict, soldiers are routinely killed when landmine detectors fail to identify explosive traces. In addition, the problem of unexploded landmines continues to fester in historically war-ravaged countries, resulting in catastrophically high numbers of civilian casualties. As one means of alleviating this situation, landmine detectors should be designed to more readily recognize the explosive compounds of which the landmines consist, many of which leave their signatures in nearby soil through leakage out of the landmine device.

To acquire an appreciation for the explosive traces present in soil, four soils from different areas at a military detonation site in the Washington, DC area were analyzed for their explosive content using High Performance Liquid Chromatography (HPLC). UV detection and Mass Spectrometry (MS) helped to elucidate the composition of each soil. Compounds such as TNT, RDX, HMX, 2,4-DNT, 2,6-DNT, and 2-A-4,6-DNT were discovered in the soils at concentrations ranging from tens of nanograms per gram of soil to over a milligram per gram of soil.

Two models of the explosives-contaminated soil were prepared in order to gain an understanding of the interaction of explosive compounds with soil particles and groundwater. Humic acid, a predominating component of the organic matter in soil, was incorporated into montmorillonite clay, which was later coated with five of the previously studied explosive compounds. The acid was added at levels consistent with those of the organic matter found in the soil of Angola's Malange province, a region that has long been beset with incidental landmine explosions. After characterizing the model soil through extraction of the explosive compounds, a series of leeching experiments were performed using water and then glucose as modifiers for the migration of the explosives. In sum, this investigation, while only scratching the surface of the experimentation needed to develop improved landmine detectors, hints at the importance of explosive signatures as mechanisms for identification.

Rice University

Grain Size and Composition of Doped Permalloy

Matt Connors

It is of interest when considering a magnetic film to determine how its magnetic properties vary according to grain size and composition. To accomplish this, thin film samples of a $Ni_{80}Fe_{20}$ permalloy on a silicon substrate, each with a different dopant and with increasing dopant concentration along the length of the sample, were investigated using an atomic force microscope (AFM) to look at how grain size changed along the length of the samples. Also, energy dispersive spectroscopy (EDS) on a scanning electron microscope (SEM) was used to look at how composition changed along the length of the samples.

The grain size results from AFM did not demonstrate any correlation between grain size and dopant concentration. However, from the EDS results, the atomic percentage of the dopant rose from about 2% at one end of the sample to about 16% at the other end. This indicates that there might exist a relationship between composition of dopant and dopant concentration.

Saint Joseph's University

Characterizing Thin Films of Organic Electronic Materials on Functionalized Silicon Using Polarized Spectroscopic Techniques

Devlin Murdock

Alkylthiophenes, particularly poly(3-hexylthiophene) (P3HT), are of great interest as organic semi-conducting materials due to the high field effect mobilities available from these solution-processable systems. The performance of these systems has been shown to be affected by the nature of the polymer/substrate interface, yet there is little understanding of the effect of these interfacial interactions on the ordering of the polymer. Variable Angle Spectroscopic Ellipsometry (VASE) and Brewster's Angle transmission Fourier Transform Infrared spectroscopy (FTIR), polarized spectroscopic techniques, were used to characterize the surfaces

of silicon wafers after functionalization with octadecyltrichlorosilane (OTS) and other self-assembled monolayers (SAMs). Polymer thin films were spin-coated from different solvents at various spin speeds. The combined optical investigation was used to determine the effect of these different fabrication conditions on the thickness, absorbance, and ordering of the P3HT films. These results are discussed in the context of previous literature investigations of the morphology and electrical properties of similar systems.

Smith College

Structure and Dynamics of Ammonia Borane Using Neutron Scattering

Teresa L. Jacques

Due to the depletion of fossil fuel resources and the need for a cleaner energy source, hydrogen is at the forefront of possible alternatives. Since hydrogen is combustible and liquefies at an extremely low temperature, better techniques for efficient and safe storage and transport are needed. Many candidates for new hydrogen storage materials are being investigated in the form of metal hydrides (e.g. NaAlH4), carbon-based materials (such as nanotubes and metal organic frameworks or MOFs), and chemical hydrides. One particular class of chemical hydrides that are of interest is the amineboranes, of which H_3BNH_3 is thbvve simplest. These compounds typically liberate hydrogen gas when heated to a reasonably low temperature, which is a desirable characteristic of a storage material. Enhancements of the kinetics and reduction of the activation energy for this process (the mechanism is unknown) has been observed if ammonia borane is confined in a mesoporous silicate host. In order to understand this process and further pursue the possibility of amineboranes being considered as candidate materials, their behavior and structure over a range of temperatures and in both the neat solid and confined must be understood.

Neutron scattering is a powerful tool for characterizing materials since neutron energies and wavelengths are on the order of molecular rotational and vibrational energy levels and interatomic spacing, respectively. Because of this, we can use neutrons to probe the dynamics and structure of a wide variety of materials. Additionally, we can benefit form the isotopic dependence of the neutron scattering cross-section by isotopically labeling with H/D. We have examined crystalline, partially deuterated ammonia borane ($H_3{}^{11}BND_3$) using three neutron instruments: neutron diffraction (on BT1) to confirm its crystal structure, quasielastic neutron scattering (on the Disc Chopper Spectrometer, DCS) to determine its rotational dynamics, and inelastic neutron scattering (on the Filter Analyzer Neutron Spectrometer, FANS) to identify its vibrational modes.

Geometry Effects on Dose Calibrator Response Function for ^{211}At and ^{90}Y in 5Ml and 10Ml Becton-Dickinson Syringes

Samantha Elizabeth Leland

One important aspect in the development of new radiopharmaceuticals is ensuring that accurate measurement protocols are introduced that will ensure that the prescribed activity is

administered to the patient for therapy. The first part of this presentation will address the geometric considerations of the administration of ^{211}At, an alpha-emitter recognized as an attractive radionuclide for use in targeted radiotherapy applications. Though still in trials, Alpha-emitters are considered advantageous for applications where specific localization of ionizing radiation to cancer cells is required for delivery of cytotoxic dose to cancerous tumors, while minimizing damage to surrounding tissue. Specific localization is achieved as a result of the characteristic combination of high energy (5 to 8 MeV) and charge of massive (when compared to beta particles) alpha particles. This combination results in relatively high linear energy transfer (LET) of alpha particles in human tissue — maximizing dose to pathogenic tissue, while minimizing destruction of healthy cells. Astatine-211 is particularly attractive by virtue of a half-life (7.2 h), which is long enough to enable targeted delivery, while short enough to minimize radioactive waste consideratons. In addition, a branching decay scheme yields alpha-emissions of 5.78 MeV and 7.45 MeV (^{211}Po daughter), and K x-ray emissions, which may provide for not only convenient counting of ^{211}At activity levels, but also for external imaging of ^{211}At tissue distributions. Although the use of alpha-emitting radionuclides is considered advantageous, the geometric effects of the different dose containment devices for these radionuclides, including ^{211}At, has not be adequately addressed.

The second part of this talk will address the same considerations for ^{90}Y, a beta-emitter currently on the market in the form of radiopharmaceuticals like Zevalin™, used to treat cancerous tumors. For each of these radionuclides, radioactivity measurements of radiopharmaceuticals made prior to administration of these drugs to patients are carried out using re-entrant type ionization chambers known as radionuclide calibrators (or "dose calibrators"). These detection systems comprise a "well" for lowering the contained activity dose (in a suitable administration device, such as a hypodermic syringe or reaction vial), an ionization-type volumetric detector (filled with a suitable gas mixture), electronics for measuring the resulting current, an electrometer for measuring the resulting current and (typically) and computer or other readout device for display/archive of the results. In this project, calibrated activity is dispensed to pertinent geometries and a range of volumes are introduced to several dose calibrators that are in use in the radiopharmaceutical industry today. The goal of the research is an understanding of the response of these systems to variations in the volume (geometry) of solutions of ^{211}At and ^{90}Y for the range of measurement containment vessels investigated in order to give guidance to clinical researchers for clinical trials that are currently underway, and to ensure that NIST has a complete understanding of important factors for making accurate and precise measurements of this radionuclide when clinical trials have been completed and the new drugs are introduced into the marketplace for routine use.

Southern Methodist University

Developing a Computational "Basic Reference Model" for Second Language Learning

Emma Y. Wu

Human language acquisition remains one of the greatest mysteries of the mind, labored over and debated by linguists and cognitive scientists for decades. How is it that every child can successfully learn a first language without a need for formal lessons? Computer scientists have approached the question with computational programs, hoping to simulate and thus explain the human faculties of language. Today there is more empirical data than ever before, but still not a good theory.

The project attempts not a full computational theory but rather creates a "reference model." The Basic Reference Model (BRM), available via the Web, is aimed at second language acquisition; first language learning involves a child's simultaneous discovery of the technicalities of language (phonetics and phonemics, words, syntax, meaning) and a conceptual ontology. The BRM assumes the learner is already equipped with a full set of ontological relationships. The second language learning is further constrained to written language. The project's particular example is teaching Spanish to an English speaker, but the BRM can be modified to explain other language learning phenomena, which thereby allows more complex reference models to be produced.

The BRM is based on a sample corpus of Spanish, derived largely from pictorial information. Lexical information was applied to the learner's pre-existing ontology, using Stanford's ontology software, *Protégé*. From there, a sentence generator was created to address the two prongs of language acquisition, grammar and semantics. Unfortunately, due to time constraints, the generator is more theoretical than actual. This part of the project focuses less on grammar and more on how ontological relationships between words affect sentence generation.

Stanford University

Characterization of Performance of Thermoelectric Cooling Devices

Mariana Meyer

Thermoelectric cooling is based on the Peltier effect, which occurs when a current flows through two dissimilar conductors and heat is transferred from one side of the junction to the other. Thermoelectric coolers (TEC's) are solid-state devices that utilize multiple junction semiconductors arranged in an array to produce a cooling effect on one face of the TEC. TEC's are currently used in electronics cooling applications as well as in commercial products such as beverage coolers. Advantages provided by TEC's are that they contain no moving parts and therefore need little maintenance, and that they are small and non-position dependent. However, the efficiency of TEC's is much lower than that of the vapor compression systems

most commonly used in refrigeration. The coefficient of performance (COP) of TEC's usually ranges between 0.4 and 1, while the COP of vapor compression systems can be 3 or greater.

Since the fabrication methods and resulting products vary between TEC manufacturers, it is difficult to compare the performance of TEC's. We sought to understand the factors affecting the performance of TEC's, with the goal of better characterizing their performance. Using a liquid-cooled heat exchange system, the COP of several TEC's was calculated under varying operating conditions, such as operating temperature and power supplied to the device. With this data, not only can the performance of TEC's be characterized, but the effectiveness and efficiency of our experimental design and method can also be evaluated.

State University of New York, Binghamton

Improvements to the Residual Stress Diffractometer
Andrew Gardner

The residual stress diffractometer (BT8) is an instrument that uses a monochromatic beam of thermal neutrons to make measurements on lattice strains and preferred orientation (texture). These measurements are used to study both residual and applied stress in various materials. Several examples of what the instrument is useful for will be discussed, including residual stress measurements in both railroad tracks and in gas pipelines.

My project this summer has been to design improvements in the BT8 instrument and generate detailed drawings of any changes so that the new parts can be machined at the NIST shop. The design considerations that drove the changes will be discussed. These factors included weight, performance, cost, and shielding to reduce background noise. This is the first major change in the design of the instrument in five years with an anticipated three-fold performance increase. The most significant change was to modify the housing to accommodate three position sensitive neutron detectors as opposed to the old design which only held one detector. This modification will allow for a more efficient counting of neutrons, which translates to lower counting times (resulting in faster measurements) and/or smaller beam sizes (resulting in better resolution). Other changes include the complete redesign of both the primary and secondary aperture systems. Both will allow complete control over beam dimensions and divergence of the primary and reflected neutron beams. This results in much improved definition of the gage volume both over a larger range of aperture-to-sample distances and aperture openings.

Bulletproof Vests Don't Last Forever: Service Life Prediction of PBO-Based Body Armor
Maureen Gundlach

Today, many bulletproof vests are made of poly (p-phenylene benzobisoxazole) (PBO) fiber. PBO (trade named Zylon) is used because it is more flexible and up to twice as strong as its better-known cousin, Kevlar. However, problems with the performance of Zylon became apparent in the summer of 2003, when a PBO-based vest was penetrated by a bullet, only 8

months after manufacture. Previous studies have shown that the tensile strength of Zylon decreases after exposure to moisture, UV light, and mechanical damage but there are currently no non-destructive methods for determining if a vest is degraded. Previous work at NIST involved exposure of new Zylon vests to high temperature and high relative humidity. Yarns removed from these vests and tested showed a 40% decrease in tensile strength over 160 days of exposure. Testing of individual PBO fibers extracted from these same vests reinforced the existing data. The effect of mechanical damage on tensile properties was assessed by developing a tool to impose bending and abrasion onto fibers. This tool was designed to reproduce the repeated bending that occurs at the waist of a vest as an officer sits and stands. This work will contribute to the overall goals of the study, which are to develop a testing method that can be conducted on a small amount of material, and to predict the service life of PBO-based body armor. It is hoped that in the future, officers can monitor the effectiveness of their vests and replace them in time to ensure their safety.

Finite Element Analysis of Small-Scale Theta-Like Specimens
David Henann

As modern components and devices scale down to micron and sub-micron sizes, accurate mechanical property measurements of the materials and interfaces in these devices are crucial for their design and for an assessment of their mechanical reliability. Accordingly, we are developing standardized testing configurations and methodologies with wide applicability that can be used for localized measurements of strength and fracture toughness of materials and interfaces at the micro- to nanometer length scale. A particularly promising test configuration is that of a theta-like geometry loaded vertically in compression, thereby subjecting the horizontal ligament to uniaxial tension. Finite element analysis is used to elucidate the stress distribution in these specimens. In particular, we investigate various external (e.g., circular or hexagonal) and internal hole geometries with the objective of maximizing the gauge-section stress and minimizing the maximum principal stress elsewhere. Moreover, as it is difficult to load uniformly a small-scale structure with an articulating load platen, alternative loading schemes (e.g., spherical tips on a flat and flats with compliant layers) are explored via three-dimensional finite element analysis.

Production and Joining Techniques for Template Synthesized Nano-Wires
Jordan Peck

Template synthesized nanocompontents of various Ni, Co and Pt alloys have been fabricated and characterized. These components are grown in the pores of an aluminum-oxide membrane which is then dissolved leaving free standing high aspect ratio wires 200 nm in diameter and up to 50 μm long. The morphology, composition, structure, and mechanical properties of these wires were studied using scanning electron microscopy, atomic force microscopy, and instrumented indentation. Electrochemical deposition is utilized to pursue joining the nanowires to macroscopic wires as well as atomic force microscope tips. Once understood, this joining technique can then be used in the creation of functional nanodevices.

State University of New York, Geneseo

Creation of Efficiency Curve Calibrations for High Purity Germanium Detectors and Testing of Spectroscopic Portal Monitors Against ANSI Standard N42.38

Christopher G. Wahl

In order to accurately determine the activity of an unknown radioactive sample using high purity germanium detectors, full-energy efficiency curves as a function of the gamma-ray energies are needed for different source geometries. The detection efficiency strongly depends on the gamma-ray energy, as well as the sample geometry and the source-to-detector distance. Using a wide variety of standard reference materials, efficiency curves for six detector geometries have been created for a range of gamma-ray energies from 25 keV to 1.8 MeV. These curves have been used to calibrate sources with unknown activities for many uses, such as in testing portal monitors for future homeland security uses.

Spectroscopic portal monitors are currently being developed for future deployment at important sites around the nation to monitor pedestrian, vehicular, and cargo container traffic for radioactive sources. These instruments are capable of detecting and identifying gamma-ray and neutron emitting radioactive material. In order to set a standard for these monitors, the ANSI N42.38 standard is being developed to specify the instrument performance necessary for homeland security uses. As a final part of the development process for this standard, validation tests were performed to ensure that the standard's tests are appropriate and the testing descriptions are accurate. The results of this validation will be described, along with a comparison between gross counting (plastic scintillator) and spectroscopic (NaI, Ge, and Xe) portal monitors.

Syracuse University

Calibration of Prostate Brachytherapy Sources

Regina M. Kennedy

NIST created the primary standard for the measurement of prostate brachytherapy source ("seed") strength, which is currently applied to a variety of seed types, 32 in all, from 18 manufacturers. A number of methods are employed to maintain a standard that is accurate, and to ensure continued traceability of secondary standards maintained by source manufacturers and accredited calibration laboratories. Each seeds' strength was measured using the WAFAC (Wide-Angle Free-Air Chamber), which directly realizes the quantity air-kerma strength. The WAFAC results were compared with those from emitted x-ray spectrum measurements, anisotropy measurements and three different well-chamber results to study general similarities and differences within and between the various seed types. Radiochromic film was also used to image the distribution of radioactive material within the seed. Along with these methods,

measurements of absorbed dose rates were accomplished with a plastic scintillator using a water phantom. The reproducibility of the plastic scintillator instrument was studied and the results were compared with consensus data sets published by the American Association of Physicists in Medicine (AAPM).

Tougaloo College

Media Health, Degradation, and Lifetime Measurement

Ka'Reshia Ousley

The National Software Reference Library (NSRL) is a project designed to collect software stored on optical media from various sources and incorporate file profiles computed from this software into a Reference Data Set (RDS) of information. The RDS is a collection of digital signatures of known, traceable software applications, which can be used by law enforcement, government, and industry organizations to review files on a computer by matching file profiles in the RDS.. This collection is stored completely on optical discs.

Optical disks have become the standard medium for distributing large quantities of high quality information in a reliable and convenient package. They are used to hold music, movies, computer software, and data of all kinds, for both personal and commercial use. CDs and DVDs have become the medium of choice due to their practicality in the reproduction of information and their presumed ability to repeatedly transmit data without deterioration. Although they have been marketed to the public as durable and convenient storage solution, optical discs may be a lot less long-lived than first thought. Current research findings have established that these media are not as durable or reliable as previously believed. Various environmental factors, such as heat humidity, light contribute to the deterioration of this media.

The focus is primarily on the influence of Ultraviolet light on the degradation of optical media, specifically CD-Rs and CD-RWs. Research has proven that exposure to sunlight exacerbates media degradation tremendously. This is an attempt to specify which kinds of light cause this acceleration in degradation.

This venture is an effort to determine the health of and track the degradation of specific optical media using a technique called hashing, which generates a unique value, serving as an identifier, for each disk. Each piece of media is exposed to some form of typical stressor or damage and the degradation of the media is traced until the end of life of the media.

This research gives the NSRL project a sound basis for its handling, storage, and preservation of media for its on-going, long-term operations. It may also aid in providing law enforcement with a means of determining the longevity of evidentiary data stored on optical media and can provide them with the capabilities to test and quantify the state of the integrity of their media as well as track and determine the rate of degradation given specific factors. This research will also

fill a void in the common awareness and understanding regarding the physical side of digital forensics.

Tulane University

Neutron Tomography of Corn Kernels Inoculated with Aspergillus flavus

Thomas E. Cleveland

Neutron imaging is a technique which is conceptually similar to imaging with x rays. Our facility uses neutrons to image macroscopic objects, typically at a resolution of about 100–200 μm. A neutron beam is passed through the object to be imaged and onto a detector, where its transmission through the object forms the image. This detector is usually a combination of a scintillator screen, which "converts" the neutrons into visible light, and a CCD camera or amorphous silicon panel for detecting this light. If many 2D transmission images of an object are taken at different angles using this technique, it is possible to mathematically reconstruct the object in 3D; this process is called neutron tomography.

The most important difference between neutron and x-ray imaging is that atoms have different cross-sections for neutrons than for x-rays. X-ray cross-sections of atoms increase fairly regularly with atomic number: iron has a larger x-ray cross-section than carbon, which has a larger cross-section than hydrogen. This is a familiar property of x-rays; it is why we use lead shielding for x-rays instead of some lighter material. Neutron cross-sections of atoms, however, vary in an irregular way with atomic number. To neutrons, for example, iron has a larger cross-section than carbon, but hydrogen has a larger cross-section than either iron or carbon. In fact, many light atoms have large neutron cross-sections, and are more easily imaged with neutrons than with x-rays. Perhaps most significantly, neutrons are useful for imaging materials which contain hydrogen. For instance, imaging the distribution of water in hydrogen fuel cells is a major application of neutron imaging at our facility.

Since many biological objects are rich in hydrogen-bearing materials, but poor in material that could be imaged well with x-rays, neutron imaging and tomography should, in principle, be ideal techniques for viewing their internal structure. In this study, the ability of neutron tomography to distinguish different tissues in corn kernels is examined. Additionally, we attempt to use neutron tomography to observe the differences in internal structure between kernels infected with *Aspergillus flavus* and uninfected controls. This technique could be useful for analyzing different corn varieties for breeding purposes; for instance, the spread of a pathogen in corn kernels of different varieties could be quickly imaged, and the resistance of the different varieties could be compared. Finally, the technique's use in analyzing corn kernels could serve as a model for how neutron tomography might be used to analyze other biological objects.

The Search for Radiative Beta Decay of the Free Neutron
Isaac Kremsky

Beta decay of a neutron occurs when a neutron decays into a proton, an electron, and an electron antineutrino. In addition, the Standard Model predicts that photons will be emitted during the decay, a process that is called radiative beta decay. However, this process has never been experimentally verified. My research this summer was devoted to measuring radiative decay definitively for the first time, thus confirming the Standard Models prediction of the process. My efforts involved participating in the data run and calculating the expected ratio of triple coincidence of electron, proton, and photon detections to double coincidence of electron and proton detections. The calculation gives experimentally measurable parameters that allow a direct comparison with the predictions of the Standard Model. I will be presenting a brief description of radiative beta decay and its motivation, an overview of the experiment, and some of the details and results of my calculation.

University of California, Berkeley

Simulating Wireless Ad-Hoc Networks with Mnet
Yakov Y. Ivanov

Even though there is number of applications for mobile wireless ad-hoc networks, some of which include sensor networks, vehicle safety, military reconnaissance, first responder assistance, smart homes, and factory automation, most are still in research, and are far from yielding practical value. The problem is that most studies of Ad-Hoc networks are conducted by either simulating the whole infrastructure of the network directly in software, or by using expensive equipment together with GPS, to simulate various mobility scenarios. Both of the approaches are quite at their extremes, as the software simulations are not as accurate, while real simulations are rather expensive. Mnet suite strives to bridge the divide between the two extreme approaches by simulating mobility scenarios using a combination of hardware and software, achieving the cost that is much lower than that of the real node GPS simulations, while yielding results more accurate than that of the pure software simulations.

University of California, Irvine

Developing a Testing Environment for User Interfaces for Urban Search and Rescue
Hrayr Artunyan

First responders to a disaster site, man-made or natural, are often met with unpredictable and hazardous environments. In situations where survivors may be found, it is critical to quickly deploy an Urban Search and Rescue (USAR) team. Often the disaster site is too dangerous or even inaccessible to humans. To address this issue, researchers are developing robots that can assist first responders in searching these high risk environments. The robots typically contain multiple sensors to locate victims and construct maps of the environment.

Teleoperation is the main way of controlling current USAR robots. A big issue is providing the operator with situation awareness of a complex, remote and unfamiliar environments. This necessitates testing the effectiveness of human-robot interaction (HRI) of USAR Robots. That is, testing the effectiveness of how the human commands the robot and how feedback is presented. One way in which these experiments have been carried out is by using the physical NIST USAR test arenas. A problem with a physical environment is replication of the robots paths and real world conditions such as communication disruptions. Moreover, developing user interfaces for robots is time consuming and limits the number of interfaces that can be tested. A more efficient way of performing experiments is by using simulators, where researchers have complete control over the environment.

USARSim, a simulator based on the unreal game engine, was developed to model the NIST test arenas. Presently, this simulator has only a simple user interface and requires extensive programming to test variations. I am developing a modularized user interface for this simulator, such that researchers can quickly set-up and experiment with different user interactions and different presentations of information. Additionally, I am developing a method that allows the experimenter to degrade the simulator video signal, to simulate different levels of video distortions. This allows for testing sensor representations that can compensate for and complement less than ideal video data. The goal of this project is to build a testing environment for USAR user interfaces.

Hadamard Transform Time of Flight Mass Spectrometry

Alejandro G. Lichtscheidl

Time of Flight Mass Spectrometry (TOF-MS) and Time of Flight Secondary Ionization Mass Spectrometry (TOF-SIMS) are techniques commonly used to determine the mass values corresponding to gas samples and deposited solid samples respectively. The relatively inexpensive cost of a TOF mass spectrometer, compared to other kinds of mass spectrometers, makes it a good investment in most laboratories where mass measurements are a routine. One disadvantage; however, is the low efficiency of the TOF, providing information on only a small fraction of the total sample used, giving a total count efficiency of 2% while losing all the rest of the information. Fortunately, one can improve the efficiency count of the TOF up to 50% when Hadamard mathematics is used to control the firing of ions through the TOF. In our case, we use a factor of a Hadamard matrix known as a simplex matrix; which is composed entirely by +1's and 0's. Using the simplex matrix, one can prescribe the data acquisition process of the instrument to measure more than one molecule at a time while keeping the intrinsic error the same, thus gathering more information per unit time, improving the count efficiency of such a measurement and yielding a more robust technique for measuring gas or deposited solid molecules of lower concentration. The data initially obtained from this technique can be misleading since it looks not any different than noise, but when the data is multiplied with the simplex inverse, also referred to as Hadamard transform, one recovers the mass spectrum. Simplex matrices of sizes 43 through 2027, which have proven to be true simplex matrices, have

been obtained using computer programming and will be experimentally coupled with the TOF-MS and the TOF-SIMS to improve the count efficiency of the instrument.

University of Florida

Cell Adhesion on Aged Biodegradable Polymers

Ruby Ibeth Chen

Polymers have a promising future in facilitating the healing process of major wounds. In trauma or disease situations where an extensive amount of bone tissue has been damaged, scaffolds can serve as a template for bone growth. Initially, scaffolds provide support by bridging the area where bone is found to be missing. Constructed out of biodegradable polymers, such as poly(D,L-lactic acid) (PDLLA) and poly(lactic-co-glycolic acid) (PLGA), scaffolds provide surfaces on which new bone cells can adhere and grow. The cells use the scaffold to support them while they synthesize new bone. As the fractured area recovers, the scaffold degrades leaving behind new bone tissue.

Conditions in vivo can have a large impact on a polymer. As growing cells infiltrate the wound, the polymer degrades at a rate dependant on Ph, temperature, and other properties of the surrounding medium. When a polymer is placed in an aqueous environment, it will swell as solvent begins to permeate it. Due to its amphoteric nature, protein in serum is absorbed on the surface of polymers. Cell interaction with protein may facilitate the ability of the cell to bind to the polymer. Changes in degradation, swelling and protein absorption affect the surface properties of the polymer scaffold, which, in turn, can affect cell adhesion and growth. Thus, we have studied the effect of polymer aging in aqueous media on cell adhesion to biodegradable polymers.

As a model for conditions of bone growth on scaffolds, we cultured MC3T3-E1 cells on PDLLA films that had been aged in cell media for various times. MC3T3-E1 cells are a cell line originally isolated from mouse *Calvaria* (skull). These cells assume a fibroblastic morphology during their growth and differentiate into osteoblasts in vitro. Using phase contrast and fluorescence microscopy, we observed cell morphology, adhesion, and growth on various aged polymers. Our results indicate that aging polymers affect the efficiency of cell adhesion. Further research in cell adhesion can lead the way to improving scaffolds, modifying them in such a way as to enhance cell growth and reduce the length of recovery.

The SPHERE - Service Life Prediction of Polymeric Construction Materials

Michelle Kinahan

The NIST SPHERE (Simulated Photodegradation by High Energy Radiant Exposure) was designed to revolutionize the service life prediction of high performance construction polymers. Over long periods of service, paints, coatings and adhesives degrade with use and weather exposure. The SPHERE is being utilized to establish a correlation between outdoor exposure

and accelerated, indoor testing, which would cut back on the time and money required to test the properties and performance of materials as they degrade. 32 chambers attached to the SPHERE house samples under carefully controlled conditions. Four of the chambers are equipped with additional components to facilitate motion of the samples. Variables such as temperature, humidity, amount of movement, and UV radiation received are monitored for comparison to outdoor conditions, with the hope of linking field and laboratory results.

The mechanical motion within the chambers of the SPHERE is a main concern. Precise straining of the samples and accurate analysis of the response are integral to a reliable correlation. Multiple factors including malfunctioning motors and indexers, dead load cells, bent rods, and unwanted friction were causing the system to move in an undesired pattern and preventing accurate data collection. Much time was spent investigating the sources of these problems and replacing components of the mechanical system in an attempt to alleviate them. The motion within the chambers was improved greatly over the past two months and further work is being done to allow precise motion. LabVIEW programs were also created to facilitate the collection of field data.

Once the motion is corrected, the SPHERE will be reassembled and resume taking sample data. Experiments with different materials, temperatures, humidity levels and amounts of motion will be carried out, and the results analyzed. The ultimate goal of proving a correlation between outdoor field and indoor laboratory experiments will hopefully be attained.

Look Mom, No Hands! The Traceable AFM Calibration Becomes Hands-free

Lee M. Kumanchik

We present a non-contact approach for calibrating atomic force microscope (AFM) cantilevers using measurements traceable to NIST standards. Current calibration methods such as thermal calibration are not traceable and require contact with a surface to calibrate the optics. Other methods require manually aligning a probe, such as a reference cantilever, over the AFM which is ill-suited for calibrating multiple AFMs simultaneously. In addition, we have found that in some cases the mechanics of the contact surface can produce large errors in the measured stiffness. The presented technique utilizes electrostatics to calibrate AFM cantilevers based on SI traceable measurements of voltage, capacitance, and displacement. The approach can be automated which will facilitate the calibration of an entire array of cantilevers by making the process fast and accurate.

University of Maryland, Baltimore

Attribution of Absorption Spectral Features to Phonon Self – Energies

D'Vone Jackson

To understand the infrared absorption of a material like gallium phosphide (GaP), the examination of the dielectric function is necessary. The dielectric function for GaP contains

contributions because of the phonon self-energy. In order to relate the absorption of GaP to the phonon self-energy, the dielectric function must vary linearly with the self-energy.

It turns out that in fact, the phonon self-energy is very small. Therefore, we are able to Taylor expand the dielectric function with respect to the self-energy and proceed with our investigation of the phonon self-energy to interpret the features of the absorption spectrum.

To further pinpoint the causes of the spectral features in the absorption spectrum, the phonon self energy has been divided into two terms: the part that results from sum processes, characterized by an infrared photon being absorbed and emission of two phonons whose momenta sum to zero and whose energies sum to that of the photon, and the part that results from difference processes, characterized by an infrared photon being absorbed, emission of one phonon, and absorption of a different phonon.

Using 3-D rendering of the irreducible Brillouin-zone wedge, the crystal momenta corresponding to considerable contributions to the self-energy which can be correlated to large peaks in the absorption spectrum are identified.

University of Maryland, College Park

Automatic Polarization Compensation and Timing Alignment for Quantum Key Distribution System

Garth Boyst

In a combined effort, the Information Technology and Physics Laboratories have implemented Quantum Key Distribution (QKD) systems. Quantum Key Distribution is a secure method for two parties to exchange encryption keys using certain phenomena of quantum physics. By encoding information onto a single photon, one can guarantee that if intercepted by an eavesdropper, the intended receiver will be able to detect perturbation to the system. These photons can be sent over free-space or over optical fiber. NIST has implemented both, using polarization encoding on these single photons.

Implementation of a fiber-based QKD system is different from a free-space QKD system in that there is a change in polarization state due to birefringence caused by stress, shape, and temperature of the optical fiber. My work was to write software to implement an active-feedback polarization alignment system to compensate for these polarization changes and for recovery of the initial polarization states.

Both free-space and fiber implementations introduce timing delays due to different lengths between the classical and quantum transmission paths and the added circuitry for quantum detection. I wrote multi-threaded software to implement automatic timing alignment between the transmitted quantum data pulse and the classical data channel on the receiving PCI board.

Thermal Imaging of Heated Carbon Dioxide
Meredith H. Brenner

A new trace explosive detection technology utilizing walk-through portals requires air to be puffed through a series of nozzles onto passengers, then recollected and analyzed for particles of explosives. However, little is known about the gas flow out of the nozzles being used. Capturing a picture of the gas jet as it leaves the nozzle would allow for a better understanding of the nozzle's properties, as well as answering questions about the number of nozzles needed and where they should be placed. However, there are numerous difficulties involved with visualizing gas flow dynamics. The jet diffuses quickly, making it difficult to maintain or identify characteristics such as temperature and concentration. Also, the flow dynamics change rapidly, making a fast shutter speed necessary.

This project investigated a new method of imaging gas flow dynamics using an infrared (thermal) camera. The camera used was a liquid nitrogen-cooled Indium Antimonide camera; it operates in mid-infrared wavelengths (1.5-5 microns) with a resolution of 320 x 256 pixels. To capture the images, carbon dioxide gas was heated and ejected from the nozzle. Carbon dioxide was used because of its strong emission around 4.2 microns, and a filter in the camera optics blocked other wavelengths. In addition, the camera was calibrated against a water-bath blackbody at various temperatures; this data was later used to perform a non-uniformity correction on the pictures obtained from the nozzle to remove noise from the images. Results include several pictures of the carbon dioxide plume at various distances from the nozzle; an annular nozzle was used primarily but images were also obtained for other nozzle types. It is possible that information about the temperature and concentration of a gas plume could be determined from such pictures.

PSPICE Circuit Modeling of Electronic Devices Comprised of PEDOT: PSS Films
Ran Kathryn Chang

Molecular electronics, or the use of molecules in place of present solid-state silicon technology, is speculated to be the keystone that could lead to an integral breakthrough in scientific technology. A part of research at NSIT has been devoted on Poly (3, 4-ethylenedioxythiophen): poly (styrenesulfonic acid) (PDOT: PSS), a transparent and conductive polymer that is widely used as a top electrical contact in semiconductor devices. The study of this material is of great interest because it can also be employed as fundamental units for electronic components. Exploring the physical characteristics of PEDOT: PSS through probe-station investigation, we found that the hysteretic current-voltage (I-V) curve of PEDOT: PSS contains a negative differential resistance region. More importantly, we found that the hysteretic I-V curve of PEDOT: PSS exhibits the characteristics an electrical bi-stable latch. In this project at the Semiconductor Electronics Division of NIST, I aided in the development of circuit modeling, simulated in PSPICE, to characterize the I-V curve exhibited by PEDOT: PSS.

Reducing the Quantity of Data Manually Analyzed in Digital Forensic Investigations by Block Hashing

Inaqui Raynaud Delgado

Digital forensic investigators use collections or reference data sets of digital fingerprints of known, traceable software applications to determine which files are important as evidence. Data that is identified through automatic processes reduces the amount of manual effort needed by a digital forensic investigator.

The National Software Reference Library (NSRL) is a government-sponsored program at the National Institute of Standards and Technology. It provides law enforcement agencies with a data reference set of more than 10 million digital file fingerprints from commonly used commercial software.

Currently, file hashing is the most common method of comparing digital file signatures between data sets. File hashing allows investigators to exclude files with matching signature, leaving unidentified data to be further examined.

A motivation to further automate detection of known traceable data has sparked interest in examining the effectiveness of block hashing as an identification method of data sets. Block hashing involves hashing digital signature chunks or blocks of data of known, traceable software applications and comparing them to foreign data sets.

My research attempts to show the effectiveness of block hashing as a feasible forensic tool by testing controlled installation block hashing, and raw block hashing. Controlled installation block hashing consists of comparing block hashes of an installed operating system against block hashes of the media from which it was installed. Raw block hashing consists of block hashing a foreign data set and comparing block hashes of the operating system media from which it was installed. This research attempts to apply the strength of cryptographic hashes to statistical identification of data.

Polyelectrolyte Multilayers as a Novel Dielectric for Organic Thin Film Transistors

Nathan T. Fisher

Fabricating high-performance organic thin film transistors (OTFTs) using low-cost techniques is critical to their commercial adoption. To realize high performance, the OTFT gate dielectric must be smooth and pinhole-free, exhibit a high dielectric constant, and have a tunable surface chemistry. Polymer films created by polyelectrolyte layer-by-layer (LbL) assembly can meet or exceed these specifications. In LbL assembly, an ionized substrate is alternately exposed to aqueous solutions of oppositely charged polyelectrolytes. Upon each exposure, polyelectrolyte deposition overcompensates for the surface ionization, and the surface charge is reversed. A reproducible amount of polyelectrolyte is deposited every exposure step.

We constructed a robot to produce multilayer films. The mechanical design and algorithms of the robot were optimized to reproducibly create high-quality films with tunable thickness. We used a model system consisting of a polyanion, polystyrenesulfonate (PSS) and a polycation, poly(diallyldimethylammonium chloride) (PDAC). We established a linear trend in PSS/PDAC film thickness with the number of layer pairs using robotic assembly for fabrication and spectral ellipsometry for measurement. The film thickness per layer pair was increased from 1.1nm/bilayer to 6.8nm/bilayer with the addition of 0.1M NaCl into the aqueous solutions containing the polyelectrolytes.

This model system was employed as a gate dielectric in OTFTs that used regioregular poly(3-hexylthiophene) (P3HT) as the semiconductor. The transport properties of the transistors were measured. Because the charge and chemical functionality of the top surface of LbL films can be easily reversed, these films may provide a research platform for investigating carrier trap formation at the dielectric / semiconductor interface.

Finding the Breaking Point of New Medical Diagnostics
Eitan Halper-Stromberg

DNA microarrays, sometimes called "genechips," are relatively new devices for doing genome-wide measurements, with tens of thousands of sensors for particular nucleic acid sequences that correspond to particular genes. The most common use for these arrays is to measure the messenger RNA population in a cell, the "gene expression profile." Messenger RNA is used to specify the proteins produced in the cell, which give rise to the biological activity.

Statistical inference is used heavily when interpreting microarray results, in part because of the complexity of the measurement process, the large number of sensors on the array, and because signal-to-noise is limited. The large number of sources of variability in microarray results include some related to the sensor measurements themselves, which are determined from an imaging process.

My project therefore explores the relationship between sensor variability as captured by the image artifact and microarray image results, the output of statistical inference techniques that use expression quantities obtained from the image artifact. The sensor variability that I am introducing is actually quite specific, and can be conceptualized as a distortion of the pre-existing image artifact expression measures. The distortions are set both by area specification and depth specification (the intensity by which the existing expression measures are scaled). The image results, and consequently, our ability to determine which genes are being expressed in a cell, are directly related to the expression measures from the image artifact, and therefore, a distorted image artifact affects skewed image results. The acceptability threshold for skewed results comes from comparing results from image artifacts that have been distorted at designated intervals and ones that have not been distorted at all. The results will be to discover the robustness of the statistical inference devices under conditions of controlled distortion. The

devices designed to be robust will probably have a higher tolerance for distortion before the integrity of the results are forfeited than those not designed to be robust.

Discovering the acceptable range of sensor variability due to error is something the medical community, and therefore the population at large, cannot afford to forego. A single microarray test sample is precious because diseased patients do not have the time or money to do multiple tests. Lives literally depend on our ability to interpret microarray results with as few samples as possible just as they depend on a doctor's ability to interpret a single MRI, not ten, to diagnose cancer.

Chemical Informatics in Chemical Kinetic Model Databases
James Hong

The problem of data management in science presents a considerable challenge to many researchers. Data management has been an increasing problem today due to the amount and rate at which information being produced, especially in combustion chemistry. In addition to the sheer volume of data produced in combustion chemistry, these problems are also compounded by standard naming conventions, which are very often not used. Considerable time and effort is also spent collecting, formatting, and verifying chemical data before any further work is possible making it very difficult and time consuming for scientists to read these databases and extract useful information. By applying modern chemical informatics and web technologies we are be able to expedite, improve, and cross-reference these files with other databases to create a relational database. By using techniques to create this web application, users will be able to upload combustion simulation files in an industry-standard format, view the uploaded data in various representations, and contribute the uploaded information to an online database. A brief demonstration of some of the unique features of this web application will be given.

Aerosols have become vital to many aspects of modern society ranging from the biomedical and pharmaceutical industries to modern inkjet and fuel injection technology. The pharmaceutical industry specifically is interested in researching aerosols for their applications within medicinal spray devices such as inhalers. These sprays must transport chemical species into designated areas in the body via the lungs to help protect the health of the user. The efficacy of the medicinal spray is dependent on individual droplet characteristics such as size, velocity, and composition. Pharmaceutical companies have become increasingly aware of the need to optimize these sprays in order to improve dosing consistency. Although new aerosol generators have been able to produce and distribute droplets at a higher efficiency, characterizations and standard models for these generators typically only consist of droplet size and velocity distributions and droplet number density. There is no quantitative data collected on the spatial composition and drop-to-drop variation of therapeutic or chemical agents throughout these aerosols. If scientists can determine how a therapeutic agent is distributed within an aerosol, they can evaluate the transport efficiency of a substance or agent to its designed region of delivery.

Development of Calcium Phosphate Biopolymer Composites with Chitosan and Casein

Jesse W. Hwang

This study was performed to further investigate and enhance the development of a biomaterial composed of calcium phosphate in combination with an organic biopolymer. Three organic biopolymers were evaluated: gelatin, chitosan, and casein. Gelatin dissolves the most in calcium solutions and is an ideal medium to deliver calcium phosphate. Gelatin is biocompatible, biodegradable, cheap, and can be injected without open surgery. Chitosan is a derivative of chitin which is mainly found in insects, cell walls of fungi, and marine invertebrates. Chitosan dissolves the most in organic acid and has minimal foreign body reaction, a natural antibacterial character, and the ability to be shaped into various forms such as porous structures. Casein, the main protein component of milk, dissolves the most at high Ph and stabilizes the colloidal calcium phosphate. Casein is widely used in research for its ability to incorporate and transport large amounts of calcium and phosphates, which plays an essential role in the mineralization of bone and teeth in mammals. The interaction of calcium and phosphate with each biopolymer was studied through solubility tests, titration, and precipitation to determine the chemical interactions. The calcium phosphate/biopolymer composites were characterized by chemical analysis, x-ray powder diffraction, and infrared spectroscopy. A calcium phosphate biopolymer composite has the potential to be used as an injectable bone substitute that would not require invasive surgery. The organic biopolymer would act as the delivery system and binder for calcium phosphate.

Aerosols and the Development of a Reference Aerosol Generator

Bradley S. Johnson

One of the first steps in achieving a quantifiable standard for the chemical distribution of a therapeutic agent within an aerosol is setting up a controlled experiment that couples a reference aerosol generator with the proper spray visualization techniques that allows one to see individual droplets within an aerosol or jet. We tried two different droplet-array generators, which allowed us to vary the spray droplet size by changing the orifice diameter. With this approach, we were able to develop a collection of well-controlled droplets sizes in the micron-diameter range of interest. Many atomizers use ultrasonic vibrations produced by a piezo-electric device within an atomizer to create an aerosol with well-defined droplet sizes and distributions. If an aerosol generator is equipped with a piezo-electric device and a transducer, it can achieve atomization at much lower pressures compared to regular atomizers that don't employ additional ultrasonic energy. Once atomization is achieved through a piezo-electric atomizer, individual droplets can be analyzed for their chemical content. To first test this approach, we sent a fluorescent dye through one of the atomizers that would fluoresce droplets when they came in contact with laser light. Our current approach is to use a pulsed laser in combination with two far-distance microscopes to image the individual droplets through each

telescope and separate those that contain the dye from those that do not contain the dye. This will be accomplished by using appropriate filters ahead of one microscope to only detect droplets that fluoresce, and the other will be setup to detect all the unfiltered droplets in the region of interest. By comparing the two simultaneous images, we can observe what percentage of droplets contain fluorescent dye. The next step in this project will be to use actual substances that fluoresce in place of water and dye, and analyze these sprays quantitatively at different positions downstream from the nozzle.

Microfluidic Mixing
Prasad Kutty

Microfluidics is becoming an area of increasing interest to scientists because of its ability to create a highly developed system to carry out many tasks in an efficient manner. One such task is mixing, an important component of many chemical and biological applications. In this work, a microfluidic mixer, which is driven by oscillatory electro-osmotic flow, was studied both computationally and experimentally. Numerical solutions for fluid flow in the geometry were obtained by solving the Navier-Stokes equations using the commercial finite element package FEMLab. To evaluate the ability of the flow configuration to produce chaotic motion, the deformation of material lines composed of passive tracer particles were simulated using MATLAB scripting codes, in a manner analogous to flow experiments using tracer dyes. In addition, a scheme in which the tracer particles were allowed to undergo random walks was used to evaluate the effects of simultaneous chaos and diffusion on the mixing. In order to validate the numerical results, a flow experiment was designed. The desired geometry was constructed by casting with a PDMS substrate. Gold electrodes to drive the EOF were deposited onto a glass slide. In order to achieve oscillatory flow, a signal splitter was made to output a sine and cosine wave from a single sine wave. The PDMS substrate was placed on the glass slide and a power source, function generator, and signal splitter were connected to the mixing device. Buffer solutions with and without dye were mixed in order to analyze the EOF mixing process and compare it with our numerical analysis. Through this project, I was able to connect the computational and experimental analyses in advancing this area of research.

An Analysis of Anti-Virus Software and Its Interaction with Industrial Control Systems
Michael B. Lochner

Control systems have an important role in industrial production and distribution. Delivering water and electricity to our houses, packaging food products, assembling cars, monitoring sewage flow, and operating chemical plants are examples of industrial networks that utilize control systems. For both economic and safety reasons, it is important that the computers which govern these manufacturing systems maintain a level of security. The current systems in industry were initially designed for performance, reliability, and safety. When these control systems are integrated with various Information Technology solutions such as remote access capabilities, security vulnerabilities arise and must be addressed. The vulnerability issues are

typically resolved by using security software; however, many of the computers in the control networks are not capable of handling the additional computations required by the security software. Industrial control systems carry out time-critical operations, which are dependant upon the computer's processor being available for calculations. By burdening the computers in a control network with additional computational loads, one risks delaying the time-critical calculations and disturbing the manufacturing process. This action can lead to a variety of problems such as a service outage, failed product, or an industrial accident.

NIST is working to establish a set of guidelines and a performance test strategy for industry to use when deploying commercial off-the-shelf (COTS) antivirus products with industrial control systems. This presentation describes testing being performed on the NIST Industrial Control Security Testbed to analyze the adverse effects of anti-virus software on control system performance and to validate the performance test procedures. The testing consists of various modes of antivirus software execution and control system configurations. A portion of the data obtained from the experiments will be included in this presentation to demonstrate use of the test strategy and provide example performance data.

Mass Calibration Graphical User Interface

Jeff Meister

The Mass & Force Group at NIST uses their advanced balances in a climate-controlled laboratory to calibrate weights submitted from industry against the national standard. To do this, they use a Fortran program that was developed in the 1970s and is showing its age. Alan Heckert has modernized the code to Fortran 90, but the program still runs from the command line, making it difficult for inexperienced users to operate. The Mass & Force Group wishes to export this program to other laboratories across the country so that they can do their own calibrations, but these users will have widely varying computer experience.

My task was to develop a graphical user interface for the mass calibration software to make it easier to use for people of all skill levels. I used the Visual Basic .NET language to do this, including such features as a guided wizard-style interface, informative labeling, error checking and notification, and tables for data entry. These features make the GUI a significant improvement on the old style of Fortran data input, which required the user to painstakingly space out unlabeled, raw numbers in a strict column format emulating that of punch cards. I had to develop a method of communicating between the VB and Fortran code to accomplish this.

Future additions to the GUI will include formatting of the output report in more than just ASCII text (such as Word files or TeTeX), and possibly more documentation for the GUI in Microsoft Help format. In addition, the Mass & Force Group desires that the GUI be integrated with automated tools that they use in their laboratory, requiring me to communicate between VB and LabVIEW. Work on this has already begun, with help from Vincent Lee of MEL.

Getting into the BOMAB Head
Matthew Mille

In the event of a radioactive disaster, one of the biggest tasks is to estimate the radiation dosage received by people to determine the actions of emergency response teams. As part of these radiation dosage calculations, accurate measurements of the contaminated people require an estimated geometrical efficiency based on the measuring equipment of the human body. This implies that there is a need for a large number of human body standards (phantoms) to meet the quality criteria of the measurement. The purpose of this project is to find a reliable way to estimate the efficiency of gamma systems using the Monte Carlo computation, and to validate that efficiency by making measurements of a standard geometry. The final scope of the project is to create a standard human body phantom, to validate its theoretical efficiency based on a comparison of the Monte Carlo computation with the experimentally measured efficiency, and to calibrate existing phantoms.

A Bottle Manikin Absorption (BOMAB) phantom head spiked with Ga-67 was used for this project as a standard geometry. The radioactive BOMAB head is measured at a number of distances from HPGe detector, and the experimental efficiency for our gamma spectrometry system is determined. The same set of experiments is then modeled using the Monte Carlo N-Particle Transport Code (MCNP). The main task for the MCNP calculations is to create an accurate and realistic description of the measuring system (detector, source, and the environment). In this project, a method is proposed to define the object's geometry by using its CT scan data. A computer program called Scan2MCNP was used to convert CT scan data of the BOMAB head into a very accurate 3-dimensional computer model to be included into the MCNP input file (Figure 1). The project output will make it possible to measure similar geometries with unknown activity using the estimated efficiency by MCNP based on its CT images.

The theoretical and experimental results will be compared. The projected results are as follows: 1) results between computations and measurements are consistent to better than 4 percent, 2) the uncertainties for both computations and measurements are better than 4 percent (k=1), 3) the major uncertainty for the MCNP computations was the description of the geometry of head-detector system, and 4) the major uncertainty for the measurements was the emission probability of the gamma-rays.

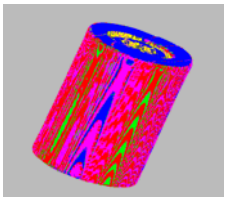


Figure 1- Computer Model of the BOMAB head

The Coordinate Measuring Machine: A Widely Used Geometric Measuring Machine in Manufacturing

Raymond S. Nelson, III

An introduction to the Coordinate Measuring Machine (CMM) along with the performance evaluation of one experimental CMM will be given in this presentation. The Coordinate Measuring machine is used to inspect fabricated parts to assure that geometric design tolerances are achieved. They increase the thought output of the inspection process by decreasing the need for specialized measuring fixtures and gauges. A CMM is controlled by a computer, which can be programmed to inspect a multitude of various shapesand geometries with a high degree of accuracy and repeatability.

Implementation of a Subset of Capabilities of e-FITS Using Java Applet

Svetlana Rabinovich

e-FITS is a web application for generating graphs, tables, and random numbers and for performing distributional modeling for approximately 50 univariate statistical distributions that is being developed by the NIST Statistical Engineering Division. The initial motivation for the project was to generate graphs and tables to complement the statistics chapter in the NIST Digital Library of Mathematical Functions. Additional motivation was provided by Ken Inn of the Ionizing Radiation Division who requested that the project be extended to include distributional modeling. e-FITS is currently available to NIST staff and it is anticipated that it will be available to the public within the next year.

e-FITS is currently implemented using Perl/CGI scripts. Dataplot serves as the underlying computational engine. The advantage of this approach is that allows us to leverage the significant distributional capabilities in Dataplot (e.g., Dataplot currently supports 90+ distributions). The disadvantage of this approach is that the computations are performed on the server machine rather than the user's local machine.

My contribution to the project was to write a java applet that provides the user with a subset of the most critical capabilities of e-FITS (graphs, tables, and some distributional fitting) for a subset of the supported distributions. The main advantage of the java applet is that the computations are performed on the user's local platform rather than on the server. This provides fast response and eliminates traffic load on the server. The primary disadvantage is that only a subset of the features in the Perl/CGI/Dataplot approach is available in the java applet. The next step for the java applet is to support additional distributions and to implement additional features, such as the fitting capabilities can be extended to include maximum likelihood estimation, confidence intervals for distribution parameters and percentiles, and bootstrap analyses.

Performance Evaluation of UWB Indoor Localization Equipment
Haris A. Raja

Interest in location-aware application has substantially grown over the past decade. As a result, technologies that find the location of mobile users inside a building are becoming an attractive area of research and development. A significant application of such technologies is in emergency situations where it is important to be able to track the movements of the first responders inside closed environments. More commercial, public safety and military applications are also emerging every day.

While GPS does an excellent job of providing such capability outdoors, where one has line-of-sight propagation paths to GPS satellites, it cannot be used in an indoor environment where ceilings obstruct view of the satellites and one encounters much harsher propagation environment caused by walls and obstacles such as furniture and other objects found in buildings. Therefore, the problem of finding locations of mobile sources inside buildings presents special challenges.

Ultra Wide Band (UWB) technology is emerging as a suitable approach to deliver high accuracy location estimation. Several vendors are using this technology to develop indoor positioning systems. Our objective in this project was to use such state-of-the-art equipment and design a proper series of tests to evaluate the performance and investigate the accuracy of the achieved localization delivered by the selected products under various conditions.

My role in this project was to learn and understand the operation of the selected ranging/localization equipment, assist in designing specific test scenarios for performance evaluation and documentation of the results for further post-processing.

Generating Film Thickness Gradients using Flow Coating
Kristen Roskov

Combinatorial methods is an exciting new area of science that allows the efficient collection of large data sets exploring one, or multiple, variables. One branch of combinatorial science involves the use of continuous gradients to probe material response. In this project, we examine continuous thickness gradients of polymer films on silicon wafer substrates using a flow coating methodology. The goals are two-fold: first, to systematically generate a library of data from which future users can estimate the parameters necessary to produce films of a desired thickness; second, to provide insight into the underlying polymer physics that govern flow coating (solvent density, solution viscosity, surface tension, etc.). The creation of thickness gradients in polymer films using flow coating is accomplished using a motorized stage and an angled blade that is accelerated across a substrate. Flow coating input parameters include acceleration, terminal velocity, blade height, and blade angle, and we are focusing on the first two. These input parameters are systematically varied to compare film thickness as a function of polymer molecular weight, mass fraction of polymer in solution, solvent, and acceleration of

the stage. Once the films are created, reflective interferometry is used to map the thicknesses (ranging from 50nm to 4μm) across an x and y grid. This process enables screening of thickness dependent phenomena in thin films, while permitting scientists to focus on regions of interest for detailed investigation.

Thermal Imaging Camera Effectiveness for Fire Fighter Applications
Justin Rowe

Thermal imaging cameras are becoming a valuable tool for the fire fighting community. Smoke in a burning building can limit visibility making it more difficult for a fire fighter to efficiently and safely perform their jobs. Thermal imagers can distinguish between various heat sources allowing fire fighters to navigate through thick smoke to locate victims and fire fighters in need of assistance, analyze the most effective plan of fire attack, and evaluate the potential for reignition after a fire has initially been extinguished.

There are a variety of sensor technologies being used by different thermal imaging camera manufacturers and each type produces very unique results. Research is ongoing as to how different fire environments limit the camera performance levels for different camera models and technologies. Tests involving various heat and smoke levels, as well as the effects of fuel, dust, and water are being analyzed. Preliminary results show distinctive trends in the performance of different thermal imagers as a function of environmental conditions.

With a better understanding of how thermal imagers can perform in a fire, thermal imaging technology and production can be applied specifically to the needs of the fire fighting community, advancing the way we can fight fire in the future.

Autonomous Vehicles: Designing In-lane Maneuvering Software for Vehicle Trajectories
Alba Serrano

The task of developing an autonomous vehicle is extremely complex. Using a hierarchical methodology, the intricate process of driving is broken down into smaller more understandable modules: Destination Manager, Route Segment Manager, Driving Behaviors, Elemental Maneuvers, Vehicle Trajectory, Steering Servo and Speed Servo. At each of these steps basic driving controls are responsible for a certain element within the driving process. Starting from the highest-level module, the destination manager, trickling all the way down the steering and speed servos, each sub module has particular knowledge that is pertinent for the preceding module.

I was responsible for the knowledge within the Vehicle Trajectory procedure. This step consisted mainly of in-lane movements, mainly static obstacle avoidance. Using initial and final positions and velocities, the vehicle determines a feasible and safe trajectory. In-lane movements are broken down into four real world situations: a straight path with a straight trajectory, a

straight path with a constant curvature arc trajectory, a curved path with a straight trajectory, and finally a curved path with a constant curvature arc trajectory. All of the situations are translated from real space into lane space in order to simplify the computation of the trajectory. Once the trajectory is calculated it must then be translated back into its respective real world situation, and then finally warped to obtain the accurate trajectory for each particular situation. The trajectory calculations are programmed and tested in Mathematica, a foreign language to the vehicle. Thus the program must be translated into C language, which the vehicle is able understand and can execute.

The trajectory process is one that is constantly being re-evaluated since driving conditions often can change quickly, thus forcing the vehicle to determine another safe route. Using this technique the vehicle most of the knowledge necessary to determine trajectories for every possible driving situation it encounters. With this type of technology, vehicles will soon reach a level of autonomy that few thought possible.

Facilitating Structure-based Drug Design: Three Dimensional Visualization of Inhibitor-HIV Protease Interactions

Deborah M. Sweet

The HIV/AIDS epidemic, with a startling 39.4 million cases worldwide, has mobilized scientists to come together to find a cure for this devastating virus. With recent advances in structural biology, structure-based drug design has become one of the most powerful ways to develop new HIV treatments. In particular, many drugs target HIV protease, an enzyme that plays a key role in the replication of the virus. Using three-dimensional visualizations of this complicated protein, researchers design drugs to fit the active site, thus inhibiting the enzyme's normal function. These inhibitors must not only be a good fit, but must have high bioavailibilty, low toxicity and a low risk of side effects. Several drugs including indinavir, ritonavir and squinavir, have been moderately successful at treating HIV, but no cure has been found as of yet.

In order for researchers to meet the challenges of designing an effective HIV protease inhibitor, they must have access to structural data. The HIV Structural Database (HIVSDB) at NIST seeks to provide drug developers worldwide with access to a repository of HIV protease inhibitors, both published and unpublished. The database is a means to collect, to organize and to annotate previous results so that they can be used to spur further drug development. Although the database contains a lot of valuable information for researchers, it lacks sufficient visualization tools for the interactions between protease and inhibitor, which are critical in structure-based drug design.

The goal of this project was to supplement the current database with three-dimensional animations and images showing the interactions of the approximately 250 collected inhibitors with HIV protease. The images were created using Pymol (http://pymol.sourceforge.net/), a molecular visualization software, and they provide a "molecular tour" of the inhibitor,

highlighting the interactions between chemical fragments of the inhibitor and particular residues of HIV protease. These images will allow researchers to compare inhibitors directly and to build on existing inhibitors to make new drugs, which could have better pharmacokinetic properties. Since these images focus on Van Der Waals interactions, the next step in this project is to generate similar images showing hydrogen bonding, as well as to expand the database to other enzymes such as reverse transcriptase

In addition to the work on HIVSDB, I also worked on the enzyme thermodynamics database.

A Survey of the Computation and Applications of Theta Functions
Gaurav Thakur

The Theta functions, a class of four mathematical functions of two variables, are a central tool in various branches of physics and engineering. Mathematical models of spinning tops, pendulums and ocean waves for example all frequently involve the Theta functions and in applied problems, numerical calculation of these functions is usually necessary to obtain definite results.

An effective computational algorithm for the functions, implemented in a computer program that was developed for the Digital Library of Mathematical Functions (DLMF) project at NIST, will be described in this presentation. The third Theta function, in some sense the simplest one, will be considered exclusively as the other three functions are just minor variations of it. It is defined by the following infinite series, where x and q are complex numbers and q is restricted to have an absolute value less than 1.

$$\theta_3(x,q) = 1 + 2\sum_{k=1}^{\infty} q^{k^2} \cos(2kx)$$

For most choices of the arguments x and q, this sum converges extremely rapidly and is quite efficient for computations, requiring the evaluation of only the first couple of terms to get a very accurate result. However, if x has a large imaginary part or $|q|$ is close to 1, the convergence can be very slow and direct summation is no longer a practical approach. However, it is often possible to employ a group of transformation equations for this Theta function to effectively change the function's arguments into values that are more suitable for summing the series. The usage of these equations will be explained as well as some of the difficulties that can arise when utilizing them.

Several two and three-dimensional graphs of the Theta functions, created for DLMF purposes using point data from the calculation program, will also be presented.

Developing an Online Sparse Matrix Repository for Testing and Comparing Linear Algebra Algorithms
Benjamin J. Zoller

Testing numerical software requires running it against test matrices. However, simply generating random matrices is not sufficient; one often needs to compare the software against

specific kinds of sparse matrices. The Matrix Market online library of sparse matrices serves to provide the scientific and educational community with a repository of almost 500 matrices to test linear algebra algorithms. Organized by matrix sets within matrix collections, each matrix in the library has its own summary web site which describes the different properties of the matrix, shows different visual representations, and provides access to downloadable matrix files in fixed formats that can be easily used by other software. The Matrix Market also includes matrix generators, such as Java applets, which produce matrices which adhere to specifications set by the user.

This particular project was focused on updating the Matrix Market library to meet current web standards. The previous version of Matrix Market relied on old style database files with information about the matrices in the library, a few complicated Perl scripts that generated HTML, and several hard-coded web pages. By unifying all the matrix data and converting it to XML, the matrix files were made easier to process. Next, instead of generating pages with Perl, XSLT stylesheets were created. XSLT stylesheets make it easier for a web programmer unfamiliar with the Matrix Market to quickly understand how data is being displayed so he or she can quickly and easily make revisions if necessary. Among the navigation tools available to the user, the search tool is the most convenient. To process search data, the previous version of Matrix Market used a C program, which is not a method as commonly used today. The version under development uses a Common Gateway Interface written in Perl to process the search form data. All of these changes serve to make the Matrix Market a more flexible tool that is easier to update and change.

University of Massachusetts, Amherst

Fishing for Answers: What Happens to Pharmaceuticals After They Go Down the Drain?

Catherine M. Goodrich

Pharmaceuticals are increasingly being recognized as an environmental threat. As a result of their prevalent usage, they have been detected in surface, drinking and waste waters throughout the world. So far, studies have shown adverse effects of pharmaceuticals on aquatic life, but there are many aspects of this issue yet to be studied. Waste water treatment processes such as chlorination and dechlorination (commonly used processes for water treatment in America) are not always effective in removing these pharmaceuticals from the water and may in fact be transforming reactive pharmaceutical compounds. Using a liquid chromatographic evaluation, the reactivities of three commonly used pharmaceuticals diclofenac, fluoxetine, and metoprolol have been investigated. By simulating chlorination and dechlorination conditions, the effects of these processes on these pharmaceuticals has been demonstrated and verified with waste water sampled from a local water treatment facility. All three of the pharmaceuticals tested were transformed to new products in the chlorination and dechlorination processes. The reactivity and apparent transformation of these pharmaceutical compounds lead to further questions about the quality of our water and the potential these compounds have to cause adverse health effects.

Developing a Reference Dataset for Software Security Vulnerabilities
Michael A. Sindelar

Computer security has become an increasingly important field. By exploiting preexisting security vulnerabilities in software, malicious users can trigger crashes, access protected files, and even take control of systems. These security vulnerabilities are often difficult to find, and manual code review is costly and time intensive. Many companies are developing professional tools to scan software for potential vulnerabilities, reducing the amount of time needed for software auditing.

Standard methods for evaluating the performance of software vulnerability detection tools would help users compare tools and developers find real advances. One part of a standardized method is a large corpus of software to test tools for detection and false-positive rates. To better understand software vulnerability and detection, a taxonomy of Software Security Flaws and a taxonomy of Software Assurance Functions and Techniques are being developed for the SAMATE (Software Assurance Metrics and Tool Evaluation) project. These taxonomies can be used to analyze the breadth and depth of vulnerabilities represented in the database.

The talk will cover some basic security vulnerabilities, such as buffer overflows and SQL injection attacks, and an early version of the taxonomy of vulnerabilities. I will also show an early prototype of the reference dataset, which uses an XML schema and PHP/Xquery front-end I wrote, and contains C and Java code samples that I coded to demonstrate these vulnerabilities. I will also discuss some of the issues that were considered for finding appropriate content for the reference dataset, such as sources, size, and complexity of the source code.

In the future, the dataset will hopefully become a large-scale effort, collecting code from many different sources. It can then be used by industry and research institutions to test software assurance tools and identify the most appropriate tool for their projects.

University of Nevada, Reno

Microfluidic Interfacial Tensiometry
Danielle C. Ramos

The interfacial (surface) tension between two immiscible liquids is a fundamental quantity in physical chemistry that affects the processing/end use of emulsions. A microfluidic approach of rapidly measuring the interfacial tension is described. This method involves the production of emulsion droplets of prescribed dimensions and spacing inside a microfluidic device, which are then accelerated and deformed under extensional flow produced in a contraction in the device. The drop shape in the two-phase flow is analyzed to determine the interfacial tension. Good

agreement is found between our measurements and values reported in the literature, as determined by standard measurement techniques.

University of North Carolina, Charlotte

Measurement Standards for Transport-Related Light Emitting Diodes
Casey C. Burkhart

The advancement of Light Emitting Diode (LED) technology has allowed rapid integration of such devices into the marketplace especially in the transportation sector. Low energy consumption combined with the long-term durability exhibited by light emitting diodes has made them ideal for warning and signaling situations. Currently there is not an accepted international photometric measurement protocol for these unique light sources. For this reason it has become of critical importance to develop standards and reliable metrics. Previously established guidelines are not applicable due to the fact LED properties differ drastically from traditionally implemented strobe or beacon lamps. In support of NCHRP Project 13-02 the photometric characterization of several LED products were studied in the Center for High Accuracy Retro-Reflectance Measurement (CHARRM) facility. Additional work was completed in the NIST Photometric Bench Laboratory where the unit for flashing light, luminous exposure (lx-s), is maintained. This analysis yielded information regarding the spatial profile, average chromaticity, and the luminous exposure of each product. From this data a measurement methodology was developed to assist manufacturers in rating their equipment and provide consumers a way to compare various devices.

Measurement of Wide-Bandgap Semiconductors Using Scanning Capacitance Microscopy
Nathan Conrad

Dopant profiles of wide-bandgap semiconductor (GaN, GaAs, and SiC) devices were measured using scanning capacitance microscopy (SCM). SCM, a type of atomic force microscopy, is a technique where a small conductive tip is swept across a small area (on the order of 100 nm). During the sweep, electrical capacitances are measured. These capacitance measurements are analyzed to create a two-dimensional map of the sample. This technique works well for analyzing Silicon-based semiconductors, but is not as well suited for wide-bandgap semiconductors. SCM sample preparation involves mounting the device on a metal disc, cross-sectioning the device, cleaning the exposed cross-section, and growing an oxide layer. The SCM images are transformed into semiconductor dopant profiles using FASTC2D. SCM performance evaluation was also explored. The dopant profiles measured using SCM match up with the expected profiles (based on other measurements and on sample fabrication).

Characterization of Sub-micron Microhotplate Platform for Embedded Sensor (ES) Virtual Component (VC) for System-on-a-Chip (SoC)
Daniel J. Jakubisin

In this talk a MEMS (Micro-Electro-Mechanical Systems)-based embedded gas-sensor Virtual Component (VC) for a System-on-a-Chip (SoC) will be described. One of the key components of this system is a microhotplate structure fabricated with standard sub-micron CMOS technology. GPIB-based instrument automation was developed and used with LabWindows/CVI programming to characterize the microhotplate structure. The resistance and TCR (Temperature Coefficient of Resistance) of the polysilicon material used in the microhotplate heater and temperature sensor was measured. The Kelvin four-wire configuration was used for these measurements. Other properties of the microhotplate, including the thermal time constant and thermal efficiency were also measured. These microhotplate characterization results will be presented and discussed.

University of Puerto Rico, Mayaguez

Laser Trapping in Single Molecules Studies
Melvin E. Irizarry-Gelpi

Previous studies of single molecules (SMs) relied on attaching molecules to surfaces to immobilize them so they can be observed over a long time period. This method causes perturbations of the dynamics of the molecules and can even denature some proteins. Because of the necessity of surface attachment, the scope of molecules that can be studied is small. An alternative aproach is to encapsulate SMs in liposomes or hydrosomes. These containers can be optically trapped manipulated and fused to initiate chemical reactions between molecules. By immobilizing dye-labeled proteins using this technique, one can observe Fluorescence Resonance Energy Transfer (FRET) and study the dynamics (e.g., unfolding or folding) of the protein. For this purpose we have set up a confocal microscope with an optical trap and photon counting devices that can collect and anlayze FRET from a single pair of dye molecules.

Electron Backscatter Diffraction Measurements on Tetragonal Material for Applications in Ferroelectric Random Access Memory
William Neris

Ferroelectric Random Access Memory (FRAM) shows numerous advantages over conventional semiconductor technology memories, which makes it a great prospect to replace this technology in the not-too-distant future. FRAM is a non-volatile random access memory, which is faster than other non-volatile memories such as EEPROM or Flash and works with a relatively low power supply. Lead Zirconate Titanate (PZT) is a ceramic that displays great ferroelectric properties, which are being used in the creation of FRAM. Ferroelectric materials s how a spontaneous polarization that can be reversed by applying a sufficiently strong electric field. PZT has a tetragonal crystal structure; it has a mobile atom in its center, and applying an electric field can move the direction of the atom in the direction of the field. The atom is displaced either

upwards or downwards from the center of the crystal unit cell and its position is stable, thus it keeps its polarization in the absence of an electric field. To find this mobile atom it is important to know the crystal orientation of the material to find the elongated axis (c-axis) in which it is located. Electron Backscatter Diffraction (EBSD) is one of the most commonly used techniques to obtain crystallographic information using the Scanning Electron Microscope (SEM). It consists of exposing a crystalline sample tilted at an angle of 65° to 70°, to a scanning electron beam. The electrons undergo various interactions with the atoms, the most important of which captures the electrons that escape from the specimens' surface. By scanning the beam over the sample surface, a series of patterns can be recorded containing crystal orientation information at points in a grid on the sample surface. HKL Channel 5 technology software is used to analyze these patterns and make orientation maps of the crystal structure for a better understanding of the orientation of the PZT grains in the thin film. Initial results show that there are two types of grain, oriented either (111) or (100)/(001). Experiments to improve the accuracy of the techniques and confirm the orientation of the c-axis will be reported.

Phase Behavior of Mixed Lipid Bilayered System

Veronica Rodriguez-Rivera

Lipid mixtures of short and long amphiphile chains self-assemble in water to form a wide variety of structures. The morphology of these structures include phases composed of extended flexible bilayer membranes that may display order by stacking in a lamellar phase with a periodicity on the order of hundreds of Angstroms. They may also form bilayered micelles (or bicelles), which are bilayered disks formed of a long lipid chain with their edges stabilized by short chain lipid, with diameter of a few hundred Angstroms.

The lipid mixtures have a great potential in the study of membrane proteins and peptides. These mixtures imitate the physical properties of biological membranes and they are stable over a wide range of temperatures, Ph and ionic strength. A detailed description of the morphology of the lipid mixtures and an understanding of their phases will help increase their use in various structural biology techniques.

SANS (Small – Angle Neutron Scattering), reflectometry, and crossed polarizers were use to study the transition from the bicelle to lamellar phase. Our studies focused on a 10% total lipid mixture consisting of the long chain lipid, DMPC, and the short chain lipid, DHPC. The goal was to study the effect on the transition between the bicelle to lamellar phase by changing the Q value of the mixture, which is defined as the molar ratio of the DMPC with respect to the DHPC. The Q values used were 3, 5, and 7. A charged lipid (POPG or DMPG) was also added to the system in various molar ratios with respect to the DMPC. We found that the transition temperature of the solution is dependent on the Q value. Also, the amount of the charged lipid affects the phase diagram. With these results, the structure of the phase boundary between the bicelles and lamellar morphology was better understood and characterized.

University of Rochester

Mobile Ad-Hoc Networks: What, Why, and How

David J. Ganzhorn

Mobile Ad-Hoc Networks are an emerging technology that enable a new generation of connected devices. Unlike traditional networks, they do not rely upon a fixed infrastructure, and are capable of dynamically forming and optimizing a working network. This robustness allows for mobile ad-hoc networks to be used in situations where traditional networks are impossible or impractical, due to frailness or expensiveness.

NIST has been developing a test bed to enable researchers to experiment and test mobile ad-hoc networks in a more realistic environment than pure computer simulation, without requiring researchers to deal with the expense of a full mobile ad-hoc network deployment, or the difficulty in creating their own test bed.

This talk gives background information on mobile ad-hoc networks, their purposes, and current research issues, as preparation for the subsequent talk on NIST"s test bed for experimentation and research, and the software tool we are developing to simplify its use.

The Use of Collodion Films to Shield Solid State Alpha Detectors from Heavy Ion Recoils

Edward M. Hall

Alpha-recoil contamination of solid state alpha spectroscopy systems leads to inaccurate measurements and wear on the detector. This contamination results in increased and variable backgrounds, larger measurement uncertainty, increased detection limit and eventual costly replacement of the device. Historically, in order to prevent recoil contamination, the use of 12µg / cm^2 air thickness and a six volt negative bias was used to control alpha recoil contamination (Sill and Olson, Analytical Chemistry, 42, 1596 (1970)). As an alternative, we have developed and tested thin collodion polymer films as a mechanism to improve the reduction of heavy recoil ion contamination. A nitrocellulose based collodion in iso-amyl acetate solution was prepared into a 12µg / cm^2 film and irradiated by a ^{238}Pu source under a ten volt negative bias below a detector. Particle counts on the detector show a decrease in several orders of magnitude of recoil contamination when these films are used, even well after 10^9 alpha-particles are detected. The mechanism by which these films stop recoil ions was shown to be impact energy loss, which then creates free carbon bonds in the nitrocellulose structure. Atomic Force Microscopy (AFM) was used to plot surface topography and impact damage on the films while infrared spectroscopic composition mapping was used to chart the chemical degradation of the film structure. It was found that thin single-use Collodion films do successfully shield solid state alpha detectors from wear and damage due to recoil contamination, improving detection limits and reducing the need for expensive replacements.

Real-World Traffic Simulation for Disaster Response Scenarios
David C. Walker

In the event of a disaster, natural or otherwise, emergency response teams depend largely on dispatchers for coordination of rescue, evacuation, and medical treatment efforts. The Department of Homeland Security is currently evaluating the possible use of large-scale integrated simulations for aid in training dispatchers. These simulations would incorporate natural phenomena, such as the spread of fire and gasses, along with human phenomena, such as mob behavior and vehicular traffic, to achieve the maximum possible level of realism. This talk will discuss the work done by the Manufacturing and Modeling Simulation Group towards developing such an integrated simulation. I will give particular focus to high-level traffic simulation, and the use of real-world geographic data to achieve greater accuracy in modeling the flow of traffic.

University of Southern California

Creating a Centralized Database for Combustion of Real Transportation Fuels
Chris Winterowd

My work this summer at NIST in the SURF program was a part of the "Real Fuels" project at NIST. The NIST Real Fuels project is directed at developing computer infrastructure to support chemical kinetic modeling of the combustion of real fuels (e.g., gasoline, diesel, jet fuel). This project allows those in academia and industry to access the chemical kinetics database for reference as well as upload new entries to the database. As the project grows, it will create a standard source for chemical data encompassing models, reactions, species, and references for data used in combustion of real fuels. One of the first tasks was becoming familiar with standard classification schemes and structural representations for chemical species. This involved drawing structures for molecules commonly employed in detailed chemical kinetic combustion models. Quantum calculations are often employed in this field to determine the structures and energies of molecules where experimental data is limited or not available. I assisted in populating a database employed in the NIST Chemrate program which utilizes molecular geometries and vibrational frequencies to compute thermochemical functions for the molecules. The current reaction sets used in modeling are largely text-based files. I worked on several programs, which import species and reactions contained in chemical kinetic models and translates them into information to populate a chemical kinetic model database. These programs are used take the "flat file" listings and put them into relational databases where they are displayed in meaningful form on the kinetics web interface. One aspect of this was to develop a Java based graphing program to display thermochemical and chemical kinetic data contained in these models.

University of Southern Mississippi

Doppler Cooling of Rubidium-87 in a Zeeman Slower
Carrie Walker

This summer I was involved in the construction and testing of a Zeeman slower. A Zeeman slower is an apparatus that uses doppler cooling to slow a beam of hot rubidium-87 atoms (thermal velocities of approximately 300 m/s) down to velocities of a few tens of m/s. In this talk I will describe my contributions to this project, which include the construction and testing of the slower's magnetic field profile, the frequency stabilization of the laser which will be used to slow the atoms, and the design and implementation of a probe laser which will be used to diagnose the thermal beam. The ultimate goal of my project is to cool the Rb-87 atoms and measure their doppler-shifted absorption spectrum.

University of Tennessee, Knoxville

Capabilities of FDS in Modeling Low Gravity Fires as well as Small Scale Steady State Materials
Scott Rockwell

As NASA embarks on longer duration missions to the international space station and to Mars or the Moon, the risk of accidental fires increases. In addition, the oxygen generator fire in the Russian Mir space station in 1997 has heightened interest in the behavior of low gravity combustion. Hence, there is a need to understand the behavior of fires in reduced gravity. This project applies the NIST Fire Dynamics Simulator to describe fires in microgravity and examine the behavior of the fires (and model) for a large range of situations.

Parallel improvements to the code's accuracy in normal gravity are pursued as well. For example, fires in a vitiated condition (product gases mixed with incoming air) act very differently from fully ventilated fires. Consequently, this project also examined FDS's capability to model vitiated fires of PE and ABS samples that were burned in a cone calorimeter in normal gravity, with and without nitrogen dilution of the air supply. Modeling was also performed for normal gravity cone calorimeter experiments designed to mimic the low-stretch conditions of microgravity fires. In all calculations, accurate results depend upon having the correct thermal properties for the materials. Consequently, the thermal properties of various plastics were found experimentally using a Thermogravimetric Analyzer along with a Differential Scanning Calorimeter, and these physical parameters were related to those typically found using the cone calorimeter.

University of Texas, Austin

Modeling Study of Strategies to Reduce the Spread of Airborne Infections in Hospitals

David Heinzerling

Control of airborne infectious agents in hospitals is critical both to effective health care and to the control of direct and indirect health care costs. Current hospital design guidelines focus on room pressure control and air filtration to control the spread of airborne contaminants. Studies indicate, however, that there is little consistency in hospital design strategies used by engineers in the field to control airborne pathogens. This presentation will highlight a number of questions concerning current hospital design practices and provide an overview of the tools and methods that can be used to answer some of these questions. Additionally, this talk will summarize how infectious agents are generated, transmitted, and removed, as well as detail preliminary CONTAM simulations of intriguing airborne infection case scenarios. CONTAM is a multizonal, well-mixed reactor model that provides a highly configurable framework for analyzing indoor air quality issues. Design issues associated with room pressurization, filtration, and ultraviolet germicidal irradiation (UVGI) will be reviewed.

Modeling and Comparison of Copper-based and Aluminum Deep-Sub-micrometer On-Chip Interconnects at High-Frequencies

Vaishal J. Shah

Copper is displacing aluminum as the material of choice for IC interconnects in high-speed VLSI integrated circuits because, in quasi-DC applications, a copper feature has lower resistance than an aluminum one of equal dimensions. However, in order to prevent chemical poisoning of the dielectric material in which the copper interconnects are embedded, the IC fabrication process features copper cladding with thin metallic films. One problem is that materials that are chemically suitable for this function are typically five to ten times as electrically resistive as copper. Because, in addition, copper-interconnect manufacturing is complex and costly relative to that of aluminum-based interconnect fabrication, we have undertaken a broad-based analysis of the electrical performance of copper conductors that are clad with films of a selection of commonly used metals, these metallic films having a range of thicknesses typical of those used in IC manufacturing. The copper cores of the conductors have diameters in the range 100 nm to 200 nm. The performance of each dimensional/material configuration is reported as s-parameter sets, transmission loss, characteristic impedance, and circuit-simulation inputs such as resistance and capacitance per unit length. The results are being generated by electromagnetic modeling of strip-line test structures. The need for such modeling is driven by the so-called skin effect. This is the increase in overall feature resistance at high frequencies caused by current-density depletion in the central region of the conductor. Our approach involves simulation of various dimensional/material configurations with Ansoft HFSS software at frequencies up to 30 GHz. We observed, for example, the impact of increasing the tantalum nitride cladding thickness on the overall resistance. This result has important implications for fabrication-process optimization and is supported by published measurements. Based on these

encouraging results, our future work will involve simulating other configurations having the more irregular geometries produced by processes that are currently used by the semiconductor industry.

Virginia Polytechnic Institute and State University

Evaluation of the Z-Axis Piezoceramic Motor in the Molecular Measuring Machine

Lindsay M. Low

Nanomanufacturing is steadily becoming an essential process to the technological world as commercial items are becoming smaller. To address this issue, the Manufacturing Engineering Laboratory is developing the Molecular Measuring Machine (M^3), which uses a scanned probe microscope (SPM) and Michelson interferometry. This instrument is designed to attain point-to-point measurements over a 50 mm by 50 mm area with nanometer accuracies. The high accuracy measurements will be completed, in part, using a probe controlled by a piezoceramic driven motor. Certain aspects of the motor were studied including the effects on its range of motion and resonant frequency using several different approaches. Also studied was the tilt of the probe during its motion so that the error can be corrected during use. These attributes of the motor were measured using a linear variable displacement transducer, capacitance displacement gage, a Michelson laser interferometer, and an autocollimator. It was found that the maximum range of the fine motion is around 3 micrometers. This range decreases with the addition of spring washers to the back plate screws. The resonant frequency occurs at 4.6 kilohertz and is not affected by the tightening of the motion coupling. These measurements provide a better understanding of how the probe will move in the machine.

Washington University, St. Louis

Comparison of Computer Simulation and Experimental Data in National Radiation Standard

Joe Freedman

Radiation dosimetry studies the amount of energy deposited by ionizing radiation on a finite amount of mass. The US standard for the SI unit of dose, the Gray (J/kg), is established and distributed here at NIST. The standard for radiation accumulated in biological applications uses water dosimetry, partly because it is the reproducible material most similar to human tissue. The absorbed dose is found by irradiating a calorimeter and measuring the increase in temperature. Then, calculations can be done to find the dose from the increase in temperature.

While this standard is well established, there are still minor complications involving conduction and convection effects from different parts of the calorimeter being heated to different temperatures during the irradiation. Computer simulations are compared to experimental data to gain insight on this problem. Effects from each part of the calorimeter – glass walls,

thermometers, and water – are explored separately in order to explain this heat transfer problem.

Image Analysis of MEMS-Based Nanopositioning Stages
Leah Pike

Several micro-scale motion stages based on microelectromechanical systems (MEMS) technology have been designed and fabricated at NIST. These MEMS-based nanopositioners have been developed for applications in nanomanipulation and scanning probe microscopy. This presentation will concentrate on the initial characterization of these devices using imaging analysis. The main objective of the image analysis is to determine the relationship between the input voltage to the nanopositioner and the output displacement. In addition, data from several different stages of the same design will be presented and compared, thus analyzing the consistency of the fabrication process. In addition, the effects of different design variables for each stage will be discussed.

Thermal actuators are used to drive the nanopositioners, which are known to be nonlinear. Therefore, a careful calibration of the input-output relationship is necessary for high-precision motion. In addition, a better qualitative understanding of the overall motion of the nanopositioner mechanism is required. These nanopositioners are compliant mechanisms which have a monolithic design with flexure hinges for generating rotational motion. Therefore, as a voltage is applied to the thermal actuator, the entire structure deforms. The image analysis has been used to verify that the structure deforms as predicted by finite element analysis. Future plans for the use of image analysis in the characterization of these devices will also be presented.

Wellesley College

Illuminating Quantum Dots
Merideth A. Frey

Quantum dot nanocrystals (NCs) appear to offer remarkable solutions to numerous limitations of conventional fluorescent organic dyes used for biochemical and biomedical assays. With such characteristics as long fluorescence lifetimes, narrow emission spectra, and excellent photostability, scientists have become increasingly interested in using quantum dot NCs for the quantitative metrology in a variety of real-world applications. However, optical properties of NCs appear to be strongly dependent on the local environment of NCs such as local ionic concentration and packing density in aggregated NCs. In this study, we measured dynamic photoluminescence of clustered NCs in an effort of developing reference measurement. This measurement can be useful in understanding optical properties of clustered NCs probing molecular assemblies in real biological systems. For this end, we developed a measurement platform by combining a confocal laser beam illuminator and real-time total internal reflection fluorescence microscopy.

Creating a Reliable Controlled Source of Hydrosomes
Christina Willis

A hydrosome is a small droplet of water in a background fluid, similar to water in oil. When the background fluid is a fluorocarbon with an index of refraction less than that of water, it is possible to trap and manipulate individual droplets using optical tweezers. In this manner a hydrosome may serve as a nanoscale container for performing small volume chemistry and single-molecule studies. Hydrosomes are currently created by sonicating a small amount of aqueous solution in a fluorocarbon, but this produces a large number of hydrosomes with a wide size distribution. What is desirable, for most applications, is to produce on demand an individual hydrosome with a volume on the order of a femtoliter. Recently, researchers in China have reported the reliable production of micron-sized water droplets in oil by longitudinally shaking a glass micropipette tip so that water is expelled from the tip. The droplets are formed as the tip accelerates quickly backwards, such that the inertia of the water overcomes the adhesion between the water and the glass. I will be discussing my efforts to implement the accelerating-tip scheme in a way that will permit optical trapping of the hydrosomes produced.

Western New England College

Tracking for Performance Evaluation of Urban Search and Rescue Robots
Andrew J. Lutz

In the devastating wake of the Oklahoma City bombings and the 9/11 attacks, it was realized that the time-critical and dangerous task of urban search and rescue could be made more efficient through the use of robots. While many academics and industrialists have been called upon to develop these practical systems, NIST was tasked with developing an environment dedicated to their performance testing. Three arenas ranging in difficulty through the presence of various obstacles have been developed by NIST and proliferated throughout the world in order to objectively test and evaluate these robots. It is imperative to determine the location of the robot at all times within the testing environment in order to validate its position against any map the system (or human operator) may generate. A tracking system is required to gather baseline robot position/path data.

NIST employs an ultra-wideband (UWB) positioning system to localize and track robots. A UWB system appears to be optimal for this environment because of its reliability in measuring precise and accurate location data points in both cluttered and uncluttered environments when compared to other wireless positioning/tracking technologies. The accuracy and precision of this locating system is determined by comparing data collected at various positions within cluttered and uncluttered environments. Subsequently, a data parsing code was created which is able to read the raw data and output in a useful, human-consumable format.

Worcester Polytechnic Institute

Analyzing and Expanding a Mathematical Model of a Fluorometry Experiment

Brian G. Cordes

In a fluorescence reaction, fluorophores are bombarded with electromagnetic radiation at a specific frequency exciting them to a higher energy level. In the process of returning to the ground state, an excited fluorophore will emit a photon which causes the observed fluorescence effect. However, not all excited fluorophores will return to the ground state in this manner. An excited fluorophore may undergo certain photochemical reactions which transform the molecule to a non-reactive species, in effect destroying its ability to fluoresce. Hence, after time, the fluorescence response will diminish and ultimately disappear as the fluorophores are rendered non-reactive. This is the process of fluorescence photodegradation.

Fluorophores are of particular importance to biologists because they can be used to enhance the visibility of cell regions and other biological materials when viewed under a microscope. The common problem when using this technique is that the region of interest will become illuminated for only a short period of time due to the fluorescence photodegradation. Hence, it is difficult to record sufficient amounts of qualitative or quantitative data that could be useful in understanding any localized behavior within the biological system.

Significant work has been done by Dr. A.K. Gaigalas (NIST, Biotechnology Division) to better understand the effects of fluorescence photodegradation as a function of the wavelength of the incident light. In addition, he developed a simplified mathematical model to describe the fluorescence response in a phase modulation fluorometry experiment.

In this project, a model based on first principles was developed, which justifies Gaigalas' simplifications. An in-depth qualitative analysis of the generalized fluorescence model was performed using MATLAB, focusing on the evolution of the fluorophore population over time as a function of the wavelength of the incident light and parameters of the fluorescence photodegradation reaction. In addition, analytic techniques were used to both simplify many of the calculations and more efficiently approximate the fluorescence response.

Evaluating Virtual Cement and Concrete Testing Laboratory Measurements

Mary E. Desrosiers

Concrete is the second most widely consumed resource on the planet. Because of its importance in building, highway, tunnel, runway, etc construction, research is continuously performed to produce newer cements with improved strength and durability characteristics. The testing processes are costly and lengthy and scientists are exploring ways to decrease both cost and time.

The Building and Fire Research Laboratory (BFRL) in collaboration with the cement industry developed a concrete testing and evaluation platform called the Virtual Cement and Concrete Testing Laboratory (VCCTL). VCCTL is a software product, i.e. a computer model that mimics the chemistry and physics involved in concrete formation using virtual measurements. The VCCTL software supplies researchers and industry with a useful tool that is cost-effective and less time-consuming for assuring the quality of concretes, while also providing a more efficient tool for experimenting to create new and improved cements. VCCTL is also useful for predicting cement properties.

I worked with a group in the Statistical Engineering Division and with Dr. Edward Garboczi (BFRL), who are jointly analyzing the statistical uncertainty of VCCTL measurements. I tested nine different Portland cements through the VCCTL system to examine their properties. I focused on the ASTM standard test methods C186 Heat of Hydration, C109 Compressive Strength, C191 Vicat Time of Set, and C266 Gillmore Time of Set. I then compared the generated VCCTL results with the corresponding data previously obtained from physical laboratory testing. Each of the nine cements had been tested by a worldwide group of laboratories via an inter-laboratory comparison and test results are collected in a database by the Cement and Concrete Reference Laboratory (CCRL). My work involved familiarizing myself with the VCCTL, calibrating input parameters in order to make the comparisons more realistic, running the tests, and calculating statistical confidence intervals for the CCRL data. The confidence intervals were used to compare the two sets of results, physical vs. virtual. The data and results I gathered will be used by the Statistical Engineering Division of ITL to analyze statistical uncertainty and to conduct a sensitivity study on virtual measurements.

Yale University

What A Coincidence: Developing a Rapid LSC Screening Method for ^{90}Sr Contamination in Urine

Evan B. Crawford

Strontium-90 is one of the most insidious fallout products of nuclear fission. Radioactive but difficult to detect due to its characteristics as a pure beta emitter, it is relatively long-lived with a ~29-year half-life. Its daughter yttrium-90 is another pure beta emitter, further complicating the detection of ^{90}Sr. Strontium is chemically analogous Ca; thus, in the body ^{90}Sr is deposited in bones and teeth, its radioactive isotopes causing long-term complications such as leukemia in humans. Current ^{90}Sr bioassay methods require a few days to several weeks per sample and involve time- and labor-intensive chemical separations. This time frame is unacceptable for mass human screening in the event of the release and environmental dispersion of considerable quantities of ^{90}Sr.

A rapid (~1-2 hours or less) method has been developed to screen human urine samples for ^{90}Sr contamination via parallel Cerenkov and cocktail liquid scintillation counting. Determination is complicated by chemical and color quenching varying with different urine samples.

Mathematical corrective quench curves can be quickly and simply generated on a sample-by-sample basis by splitting the sample and spiking one fraction with a radioactive isotope for comparison against an unquenched sample, reducing or eliminating the necessity of chemical separation processes. Alternatively, a ~10 min. activated charcoal chemical process can be used to decolorize the sample in order to reduce quenching effects. Due to its relatively low maximum beta energy, only ~0.5% of ^{90}Sr activity will be counted via Cerenkov LSC, while >90% is counted via cocktail LSC. A calibration constant is calculated to allow for the comparison of these two measurements and thus the ^{90}Sr fraction in the urine is resolved. The method also allows for the resolution of ^{89}Sr and ^{90}Y from the energy spectra. This method is robust and flexible, allowing for rapid mass screening of the population affected by the dispersion of radiostrontium.

APPENDIX A. A QUICK CROSS-REFERENCE – SURF 2005

STUDENT (Last Name, First Name)	UNIVERSITY	TITLE	OU	PAGE
Adler, Alexander	Pennsylvania State University	Spin Transistors: Enforcing Moore's Law	MSEL	55
Anahtar, Melis	Massachusetts Institute of Technology	Using Optical Tweezers to Create Zinc Oxide Nanowire-Based Devices	MEL	46
Armstrong, Gregory	Hamilton College	Polarized ^{3}He	PL	41
Artunyan, Hrayr	University of California, Irvine	Developing a Test Environment for User Interfaces for Urban Search and Rescue	ITL	66
Asche, Tiffany	Pepperdine University	Delving into the Fiery Realm of Ceramics—Developing Phase Diagrams for the $BaTiO_3$-$BaMnO_{3-x}$ Binary and BaO-TiO_2-MnO_x	MSEL	55
Blanchard, Daniel	Millersville University of Pennsylvania	Computer-Aided Camera Placement for Facial Recognition	ITL	49
Boyst, Garth	University of Maryland, College Park	Automatic Polarization Compensation and Timing Alignment for Quantum Key Distribution System	ITL	70
Brenner, Meredith	University of Maryland, College Park	Thermal Imaging of Heated Carbon Dioxide	PL	71
Burkhart, Casey	University of North Carolina, Charlotte	Measurement Standards for Transport-Related Light Emitting Diodes	PL	86
Chang, Ran	University of Maryland, College Park	PSPICE Circuit Modeling of Electronic Devices Comprised of PEDOT: PSS Films	EEEL	71
Chen, Ruby	University of Florida	Cell Adhesion on Aged Biodegradable Polymers	MSEL	68
Chowdhury, Atiq	George Mason University	SANS Investigation of the Mechanism and Kinetics of Membrane Protein Crystallization in Self-Assembled Cubic Lipidic Mesophases	MSEL	33
Clark, Jeremy	Miami (Ohio) University	Laser Frequency Control in Four-Wave Mixing	PL	47
Cleary, Ryan	Morgan State University	Preparation and Characterization of Gold Nanoshells	CSTL	51
Cleveland, Thomas	Tulane University	Neutron Tomography of Corn Kernels Inoculated with *Aspergillus flavus*	PL	65
Cockrell, Bryan	Princeton University	Traces of Tragedy: The Explosive Signatures of Landmines in Soil	CSTL	56
Connors, Matt	Rice University	Grain Size and Composition of Doped Permalloy	MSEL	57
Conrad, Nathan	University of North Carolina, Charlotte	Measurement of Wide-Bandgap Semiconductors Using Scanning Capacitance Microscopy	EEEL	86
Cordes, Brian	Worcester Polytechnic Institute	Analyzing and Expanding a Mathematical Model of a Fluorometry Experiment	ITL	96
Cowan, Aaron	Murray State University	Application of the Programmable Josephson Voltage Standard in Voltage Metrology	EEEL	51
Crawford, Evan	Yale University	What A Coincidence: Developing a Rapid LSC Screening Method for ^{90}Sr Contamination in Urine	PL	97
Delgado, Inaqui	University of Maryland, College Park	Reducing the Quantity of Data Manually Analyzed in Digital Forensic Investigations by Block Hashing	EEEL	72
Desrosiers, Mary	Worcester Polytechnic Institute	Evaluating Virtual Cement and Concrete Testing Laboratory Measurements	ITL	96
Fisher, Nathan	University of Maryland, College Park	Polyelectrolyte Multilayers as a Novel Dielectric for Organic Thin Film Transistors	MSEL	72
Freedman, Joseph	Washington University, St. Louis	Comparison of Computer Simulation and Experimental Data in National Radiation Standard	PL	93

STUDENT (Last Name, First Name)	UNIVERSITY	TITLE	OU	PAGE
Frey, Merideth	Wellesley College	Illuminating Quantum Dots	PL	94
Ganzhorn, David	University of Rochester	Mobile Ad-Hoc Networks: What, Why, and How	ITL	89
Gardner, Andrew	State University of New York, Binghamton	Improvements to the Residual Stress Diffractometer	MSEL	61
Gaul, Allison	Appalachian State University	Seamless Mobility and Bandwidth Allocation in Wireless Communications Networks	ITL	23
Gerard, Brian	Lehigh University	Evolution of Strain-Induced Microstructure and Texture in Commercial Steel Sheet Under Balanced Biaxial Stretching	MSEL	46
Goodrich, Catherine	University of Massachusetts, Amherst	Fishing for Answers: What Happens to Pharmaceuticals After They Go Down the Drain?	CSTL	84
Gundlach, Maureen	State University of New York, Binghamton	Bulletproof Vests Don't Last Forever: Service Life Prediction of PBO-Based Body Armor	BFRL	61
Haaheim, Justin	Gustavus Adolphus College	A Framework for Parameter Study Applications in Distributed Computing Environments	ITL	39
Hall, Edward	University of Rochester	The Use of Collodion Films to Shield Solid State Alpha Detectors from Heavy Ion Recoils	PL	88
Halper-Stromberg, Eitan	University of Maryland, College Park	Finding the Breaking Point of New Medical Diagnostics	CSTL	72
Heinzerling, David	University of Texas, Austin	Modeling Study of Strategies to Reduce the spread of Airborne Infections in Hospitals	BFRL	90
Henann, David	State University of New York, Binghamton	Finite Element Analysis of Small-Scale Theta-Like Specimens	MSEL	61
Hollabaugh, Kate	Carnegie Mellon University	Optimization of a Self-Assembly Monolayer Releasing Layer for Nanoimprint Lithography	MSEL	27
Hong, James	University of Maryland, College Park	Chemical Informatics in Chemical Kinetic Model Databases	CSTL	72
Houdek, Nancy	George Washington University	Graphical Analysis and Statistical Evaluation of Chemical Sensors	ITL	35
Hourigan, Patrick	Grove City College	Quantifying the Deprotection Kinetics of Next Generation Photoresists	MSEL	38
Huang, Kevin	Cornell University	Poking Jell-O on a Tiny Scale: the Structure-Property Investigation of Polymeric Nanocomposites and Gels	BFRL	30
Hwang, Jesse	University of Maryland, College Park	Development of Calcium Phosphate Biopolymer Composites with Chitosan and Casein	MSEL	75
Irizarry-Gelpi, Melvin	University of Puerto Rico, Mayaguez	Laser Trapping in Single Molecules Studies	PL	87
Ivanov, Yakov	University of California, Berkeley	Simulating Wireless Ad-Hoc Networks with mNET	ITL	66
Jackson, D'Vone	University of Maryland, College Park	Attribution of Absorption Spectral Features to Phonon Self-Energies	PL	69
Jackson, Jacqualine	Brigham Young University	Spectrally Tunable Light Sources for Remote Ocean-Color Sensing	PL	25
Jacques, Teresa	Smith College	Structure and Dynamics of Ammonia Borane Using Neutron Scattering	MSEL	58
Jakubisin, Daniel	University of North Carolina, Charlotte	Characterization of Sub-micron Microhotplate Platform for Embedded Sensor (ES) Virtual Compoennt (VC) for System-on-a-Chip (SoC)	EEEL	87
Johnson, Bradley	University of Maryland, College Park	Aerosols and the Development of a Reference Aerosol Generator	CSTL	75
Kakovitch, Christopher	Cornell University	The Limit of Nearly Touching Gold Nanoparticles	PL	31

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Katzenmeyer, Aaron	Ohio University	Surface Pontential Measurements of Organic Interfaces by Scanning Kelvin Probe Microscopy	EEEL	53
Kennedy, Regina	Syracuse University	Calibration of Prostate Brachytherapy Sources	PL	63
Kinahan, Michelle	University of Florida	The SPHERE-Service Life Prediction of Polymeric Construction Materials	BFRL	68
Kitchens, Carolyn	Appalachian State University	Affinity of Surfaces for Binding Specific Proteins	CSTL	24
Kremsky, Isaac	Tulane University	The Search for Radiative Beta Decay of the Free Neutron	PL	66
Kumanchik, Lee	University of Florida	Look Mom, No Hands! The Traceable AFM Calibration Becomes Hands-free	MEL	69
Kutty, Prasad	University of Maryland, College Park	Microfluidic Mixing	MSEL	76
Langhorst, Sarah	Case Western Reserve University	Techniques for Measuring the Particle Size Distribution (PSD) of a Single Component in a Multi-Component Powder	BFRL	27
Leland, Samantha	Smith College	Geometry Effects on Dose Calibrator Response Function for ^{211}At and ^{90}Y in 5 mL and 10 mL Becton-Dickinson Syringes	PL	58
Lichtscheidl, Alejandro	University of California, Irvine	Hadamard Transform Time of Flight Mass Spectrometry	CSTL	65
Lochner, Michael	University of Maryland, College Park	An Analysis of Anti-Virus Software and Its Interaction with Industrial Control Systems	MEL	76
Low, Lindsay	Virginia Polytechnic Institute & State University	Evaluation of the Z-Axis Piezoceramic Motor in the Molecular Measuring Machine	MEL	93
Lui, Priscilla	Georgetown University	Optimization of Ethylene Oxide on Silicon for Biorepellant Applications	EEEL	36
Lutz, Andrew	Western New England College	Tracking for Performance Evaluation of Urban Search and Rescue Robots	MEL	95
Malaya, Nicholas	Georgetown University	Non-Linearity of InGaAs Photodiodes	PL	37
Manweiler, Justin	College of William & Mary	Message Maker Testing Framework Promotes HL7 Compliance	ITL	29
Marquard, Seth	Ohio University	Developing Libraries for Portable Raman Spectrometers	CSTL	54
May, Peter	George Washington University	Factors Affecting the Quality of Electronic Fingerprint Collection	ITL	34
Meister, Jeffrey	University of Maryland, College Park	Mass Calibration Graphical User Interface	ITL	77
Meyer, Mariana	Stanford University	Characterization of Performance of Thermoelectric Cooling Devices	BFRL	60
Mille, Matthew	University of Maryland, College Park	Getting into the BOMAB Head	PL	78
Miller, Daniel	Bucknell University	Proton Transfer Ionic Liquids as Green Solvents	MSEL	26
Moore, Michael	Oberlin College	Layered Double Hydroxides: A Novel Additive for Flame Retardant Polymeric Nanocomposites	BFRL	53
Moore, Stephanie	Appalachian State University	Using Inorganic Nanoparticles as Biological Contrast Agents	CSTL	24
Moyerman, Stephanie	Harvey Mudd College	Polarized Neutron Reflectometry Studies of Spin Valves with Pico-Scale Antiferromagnetic Layers	MSEL	41
Murdock, Devlin	Saint Joseph's University	Characterizing Thin Films of Organic Electronic Materials on Functionalized Silicon using Polarized Spectroscopic Techniques	CSTL	57
Myers, Katherine	Lebanon Valley College	Monte Carlo Simulation of a Single Photon on Demand Source Using a Multiplexed PDC Scheme	PL	45

STUDENT (Last Name, First Name)	UNIVERSITY	TITLE	OU	PAGE
Nelson, III, Raymond	University of Maryland, College Park	The Coordinate Measuring Machine: A Widely Used Geometric Measuring Machine in Manufacturing	MEL	79
Neris Diaz, William	University of Puerto Rico, Humacao	Electron Backscatter Diffraction Measurements on Tetragonal Material for Applications in Ferroelectric Radom Access Memory	MSEL	87
Nolan, Brian	Millersville University of Pennsylvania	Materials Informatics Tools and Crystallographic Databases	MSEL	49
Nwokoye, Arthur	George Washington University	Coplanar Waveguides Test Structures for Critical Dimension Metrology	EEEL	34
Ostapenko, Tanya	Gettysburg College	Temperature Corrections in Industrial Irradiation Processing	PL	38
Ousley, Ka'Reshia	Tougaloo College	Media Health, Degradation, and Lifetime Measurement	ITL	64
Peck, Jordan	State University of New York, Binghamton	Production and Joining Techniques for Template Synthesized Nano-Wires	MEL	62
Peretich, Michael	James Madison University	A Comparison of Charged Particle Detectors Using Neutron Depth Profiling	CSTL	43
Pfefferkorn, Candace	Gettysburg College	Terahertz Spectroscopy on Crystals of Small Peptides	PL	38
Pike, Leah	Washington University, St. Louis	Image Analysis of MEMS-Based Nanopositioning Stages	MEL	94
Pulugurtha, Deepthi	George Mason University	Damping in Thin Doped-Permalloy Films	MSEL	35
Rabinovich, Svetlana	University of Maryland, College Park	Implementation of a Subset of Capabilities of e-FITS Using Java Applet	ITL	79
Raja, Haris	University of Maryland, College Park	Performance Evaluation of UWB Indoor Localization Equipment	ITL	80
Ramos, Danielle	University of Nevada, Reno	Microfluidic Interfacial Tensiometry	MSEL	85
Reschovsky, Benjamin	Colgate University	Evaluation of a Semi-empirical Approach to Model the Efficiency of HPGe Detectors for Applications in Gamma Ray Spectrometry Using the Software Program ANGLE	PL	28
Rocco, Mark	Northwestern University	Control of Cell Adhesion and Morphology on Oligo(ethylene oxide) Surfaces of Various Packing Densities	CSTL	52
Rockwell, Scott	University of Tennessee, Knoxville	Capabilities of FDS in Modeling Low Gravity Fires as well as Small Scale Steady State Materials	BFRL	91
Rodriguez, Veronica	University of Puerto Rico, Mayaguez	Phase Behavior of Mixed Lipid Bilayered System	MSEL	88
Roskov, Kristen	University of Maryland, College Park	Generating Film Thickness Gradients Using Flow Coating	MSEL	80
Rowe, Justin	University of Maryland, College Park	Thermal Imaging Camera Effectiveness for Fire Fighter Applications	BFRL	81
Ruggles, Dorea	Gustavus Adolphus College	*In-situ* Radiation Force Mesurement of High Frequency Ultrasound	MEL	40
Russell, Christopher	Massachusetts Institute of Technology	Observing Electo-osmotic Flow in Glass and Fluorinated Polymer Microchannels	CSTL	47
Schroeder, Craig	Drexel University	Image Quality Metric for Tissue Scaffolds	ITL	32
Schwarzkoph, Andrew	Cornell University	Terahertz Spectroscopy on Crystals of Small Peptides	PL	31
Serrano, Alba	University of Maryland, College Park	Autonomous Vehicles: Designing In-lane Maneuvering Software for Vehicle Trajectories	MEL	81
Shah, Vaishal	University of Texas, Dallas	Modeling and Comparison of Copper-based and Aluminum Deep-Sub-micrometer On-Chip Interconnects at High-Frequencies	EEEL	92

STUDENT (Last Name, First Name)	UNIVERSITY	TITLE	OU	PAGE
Simonds, Brian	Illinois Wesleyan University	Techniques of Reaching Extreme Low Temperatures for Making Measurements in Single Electron Tunneling Devices	EEEL	42
Sindelar, Michael	University of Massachusetts, Amherst	Developing a Reference Dataset for Software Security Vulnerabilities	ITL	85
Sweet, Deborah	University of Maryland, College Park	Facilitating Structure-based Drug Design: Three Dimensional Visualization of Inhibitor-HIV Protease Interactions	CSTL	82
Thakur, Gaurav	University of Maryland, College Park	A Survey of the Computation and Applications of Theta Functions	ITL	83
Wahl, Chris	State University of New York, Geneseo	Creation of Efficiency Curve Calibrations for High Purity Germanium Detectors and Testing of Spectroscopic Portal Monitors Against ANSI Standard N42.38	PL	63
Walker, Carrie	University of Southern Mississippi	Doppler Cooling of Rubidum-87 in a Zeeman Slower	PL	91
Walker, David	University of Rochester	Real-World Traffic Simulation for Disaster Response Scenarios	MEL	90
Walters, Thomas	Miami (Ohio) University	Developing a World Model Ontology for the Autonomous Vehicle Project	MEL	48
Welsh, Morgan	Miami (Ohio) University	A Route to a Room Temperature, Effusive Atomic Beam	PL	49
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