9. OUTREACH AND KNOWLEDGE TRANSFER

The NSEC has strong partnerships with researchers from the national laboratories, from industry, and from international institutions. During the past year, we worked closely with members of the Nanoelectronics Research Initiative (NRI) to put forward a successful supplemental proposal aimed at ultrasmall electronics. We also sponsored a workshop in San Francisco on the Frontiers of Nanoscale Science and Technology (FNST) that brought together leading researchers from industry as well as many of our national and international collaborators. We strengthened our international collaborations with new connections to Lund University (Sweden) and NEST (Italy). We continued to support visitor programs that allowed our postdoctoral fellows and graduate students to travel to our collaborators at the Universities of Tokyo, Delft and Lund. We helped plan and co-sponsor the Designing Biology Conference with the Radcliffe Institute for Science, participated in the annual Industrial Outreach Program on Bioengineering and Medicine, hosted several international delegations visiting the Center, continued to organize and sponsor the local NanoTechnology and Business Forum with Chinh Pham (Greenberg Taurig, LLP), and promoted community building within the Center through the postdoctoral fellow and graduate student coordinated research exchange seminars and courses. These activities are described in more detail below.

NSF-SIA Supplement in Nanoelectronics

The NSEC has maintained close ties with members of the Nanoelectronics Research Initiative (NRI). George Bourianoff (Fig. 9.1), for example, has been a member of our Advisory Committee. We had meetings with members of the NRI in 2004 and 2005. When a supplement was announced by the NSF-SIA for graduate student and postdoctoral fellow to NSF Centers in nanoelectronics, we intensified our discussions, focusing on the research vectors put forward by the NRI. A draft proposal was supported by the NRI and submitted to the NSF in September 2005. Our proposal to synthesize and characterize oxide nanostructures was funded in December 2005, led by new Assistant

Figure 9.1. George Bourianoff (*left*) highlights the new NSEC effort in nanoelectroincs; **Shriram Ramanathan** (*right*) discusses the research effort at the Frontiers of Nanoscale Science and Technology workshop, January 2006.

Professor **Shriram Ramanathan** (Fig. 9.1), who comes to Harvard from Intel. The effort will be jointly funded by NSF and by the SIA/NRI, extending over three years.

Other Industrial Interaction and Technology Transfer

We invited a number of leading experts from industry to the Frontiers in Nanoscale Science and Technology (FNST) workshop in San Francisco in January 2006. During the first day of the workshop, Robert Doering from Texas Instruments discussed the current strategic industry plan, George Bourianoff gave the industry view beyond CMOS devices, Phaedon Avouris from IBM spoke on carbon nanotube electronics and optoelectronics, and Pushkar Apte from the Semiconductor Industry Association presented the nanoelectronics challenge (Fig. 9.2). There was a lively question period and opportunities for students and researchers to interact with these experts from industry throughout the workshop.

Figure 9.2. Robert Doering (*left*), Pushkar Apte (*center)*; and George Bourianoff (*right*) speaking at the Frontiers of Nanoscale Science and Technology workshop, January 2006.

NSEC researchers also continue to work closely with industry and several patent applications have been filed in the fields of polymer science, optical memory, near-field laser antennas, and micro-manipulator arrays. These are reported in Table 1 on Center output.

Visitor Exchange Programs

The NSEC has a visitor exchange program between Center universities and the national laboratories to share facilities and carry out collaborative research. Visitors Program is managed by our administrative staff member to encourage collaborative research by supporting student travel. Leo Kouwenhoven oversees the student exchange with Delft, which has excellent facilities to make and test nanoscale structures as well as an outstanding graduate program. It is also possible for students to spend a few weeks or months visiting, to learn new skills and conduct research. Hiroyuki Sakaki and Seigo Tarucha look after similar visits with the University of Tokyo.

There were a number of visits by Center faculty, postdoctoral fellows and graduate students to use facilities and collaborate on research with scientists at other Centers and

National Laboratories. Xiaofeng Li, a graduate student working with **Donhee Ham** and **Robert Westervelt**, visited the University of Tokyo to collaborate with Seigo Tarucha and his group on terahertz applications of semiconductor nanostructures. Gary Steele, a member from **Raymond Ashoori**'s group at MIT, visited Delft University to discuss imaging transport resonances in the quantum Hall effect and the potential for applying their scanning probe techniques to the research performed at Delft. In addition, they also talked about the possibility of integrating the single-electron charge sensor used in the MIT group's experiments into the transport measurements performed on carbon nanotubes at Delft (Fig. 9.3)

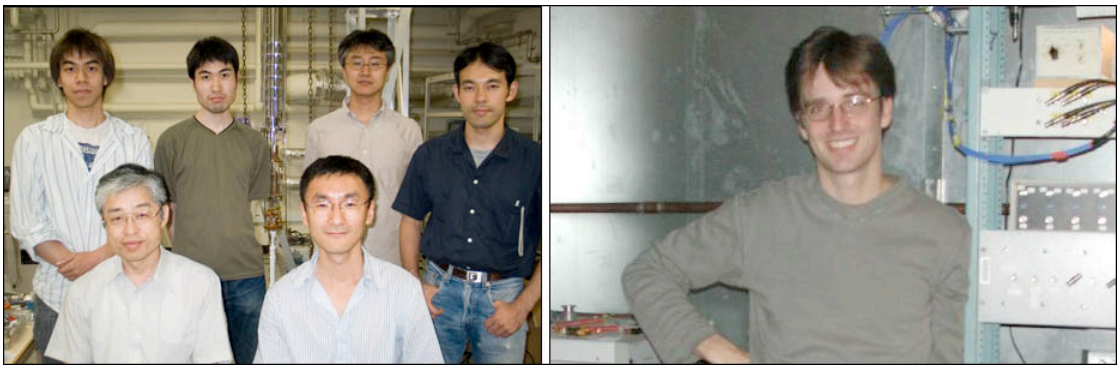


Figure 9.3. (*Left*) Seigo Tarucha (seated left) and Xiafeng Li (seated right) visiting Tarucha's group at the University of Tokyo; (*right*) Gary Steele visiting Delft University.

Fabio Beltram from the National Enterpise for nanoScience and nanoTechnology (NEST) Pisa, Italy visited the NSEC in February 2005 to discuss specific research collaborations with researchers in the Nanoscale Building Blocks and Imaging at the Nanoscale Clusters. Funding of collaborative projects by the Italian government has started during the past fiscal. Lars Samuelson also visited the NSEC in the summer of 2005. Samuelson is well known for his synthetic work in semiconductor nanostructures from Lund University in Sweden. He returned in the Fall of 2005 to give a seminar at Harvard and joint projects are now also underway with Lund. Ania Bleszynski, an NSEC graduate student, traveled to both Delft and Lund Universities where she worked with researchers to fabricate nanowire quantum dots of InAs and InAs/InP. Linus Froberg from Lars Samuelson's group traveled to Harvard to learn and perform transport measurements of these nanostructures using the custom-built scanning probe microscopes developed in the Center.

The NSEC has fostered a remarkable group of international collaborators who are not only outstanding scientists but leaders of preeminent research institutes for nanoscale science world-wide (Table 9.1). It is unfortunate that the international travel program for NSEC researchers was not included in the renewal award to the NSEC, despite positive reviews of the active international collaboration ongoing in the NSEC.

9.1 International Collaborators

Fabio Beltram	National Enterpise for nanoScience and nanoTechnology (NEST) Pisa, Italy
Leo Kouwenhoven	Kavli Institute of Nanoscience Institute Delft University of Technology The Netherlands
Daniel Loss	National Center of Competence in Research Nanoscale Science University of Basel Switzerland
Hiroyuki Sakaki	Institute of Industrial Science Japan
Lars Samuelson	Nanometer Structure Consortium Lund University Denmark
Seigo Tarucha	University of Tokyo Japan

International Workshops

In January 2005, we organized the Frontiers in Nanoscale Science and Technology (FNST) workshop held in San Francisco. This location was selected to draw both a national audience as well as allow participants and collaborators from Japan and Europe to attend. Over ninety researchers from industry, national laboratories, and academic institutions attended. Our NSEC provided student scholarships to graduate students and postdoctoral fellows from other NSECs (Wisconsin and Stanford) and from other U.S. universities who applied and presented their work during poster sessions. The first day of the workshop was devoted to challenges in nanoelectronics presented by members of industry (Fig. 9.2) described above. The second and third days focused on topics in nanophotonics, imaging, and information processing (Fig. 9.4). Additional support for

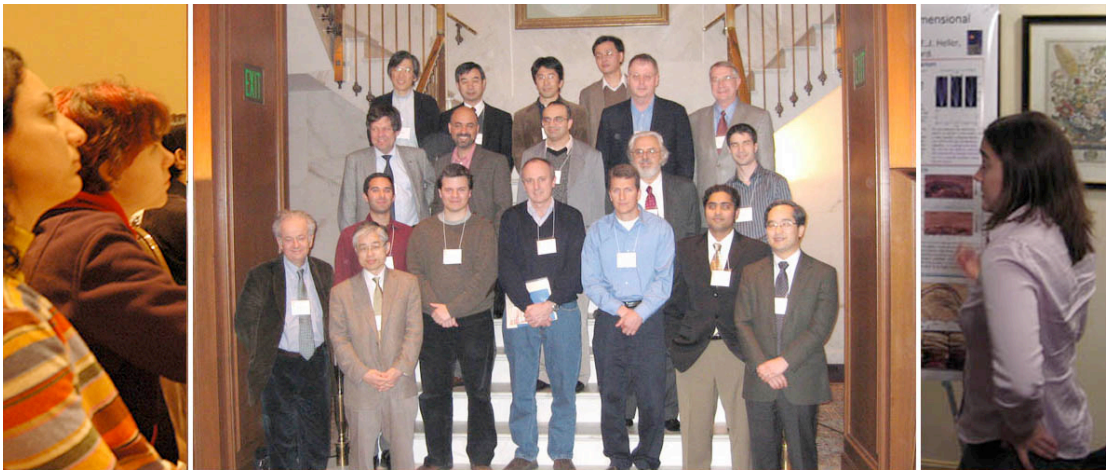


Figure 9.4. (a) Frontiers of Nanoscale Science and Technology (FNST) Workshop in San Francisco, January 2006.

Figure 9.4. (b) Frontiers of Nanoscale Science and Technology (FNST) Workshop in San Francisco, January 2006.

the workshop was provided by ICORP-JST, SORST-JST, IT-MEXT [from Japan]; Greenberg Traurig, LLP; and the Center for Nanoscale Systems [Harvard University]. The FNST workshop was the fourth international workshop since the beginning of the NSEC in 2001. Again this year, the workshop served to bring together the many postdoctoral fellows and graduate students who began collaborations through the visitor exchange program. The workshop is an opportunity to learn what progress has been made since those visits and explore new areas of exploration. The next international workshop is tentative planned in Europe in 2007. The Center also hosted several international groups during the past year including delegations from Denmark, France, Germany, Italy, Switzerland, and Japan.

Special Workshops

In May 2005, the NSEC co-sponsored a conference on Designing Biology at the Radcliffe Institute. **Westervelt** and **Whitesides** served on the organizing committee that featured Joanna Aizenberg, Linda Buck, Angela Belcher, Vicki Colvin, Drew Endy, and Ellen Williams. The conference drew over 300 to the daylong program of talks, poster sessions and a panel discussion about bringing these research results to technology featuring Myra Hart and William Sahlman from the Harvard Business School; Lita Nelsen from the MIT Licensing Office, and Bryan Roberts from Venrock Associates. The conference attendees included researchers, scholars, students, industry professionals and interested members of the public. More information is found at the Radcliffe Institute website: http://www.radcliffe.edu/events/conferences/designing_biology

Fig 8.5. Robert Westervelt speaking at the *Designing Biology* conference.

Industrial Outreach Program (IOP)

In April 2005, NSEC members participated in the annual meeting of the Industrial Outreach Program (IOP) Workshop sponsored by Harvard's Division of Engineering and Applied Sciences (DEAS). The IOP Workshop is directed by Assoc. Dean Fawwaz Habbal and is aimed at strengthening external collaborations by facilitating mutually beneficial relationships between outside groups and DEAS interdisciplinary research groups. The workshop on *Bioengineering and Medicine: A Confluence of Innovation* (www.deas.harvard.edu/industry/Conference2005/agenda.htm) was heavily subscribed (Fig. 12.6). With nearly 200 participants, a video and sound feed to a second room was set up. **George Whitesides** spoke on physical tools for cell biology and examples of technology transfer to large companies and smaller, startup ventures. Dale Larson from the Biophysics Department based at the Medical School spoke on nanohole array surface plasmon devices and their applications. **Robert Westervelt**, Chinh Pham (Greenberg Traurig, LLP), Mark Brandt (Maple Fund) and Rick Rogers (Imaging Group, School of Public Health) participated in a roundtable discussion on forging collaborations with industry. Following the roundtable discussion there was a poster session with NSEC postdoctoral fellows and graduate students to allow for more detailed interaction between the NSEC researchers and attendees.

Figure 9.6. Industrial Outreach Program (IOP) Workshop: (left) **Robert Westervelt** introduces **George Whitesides**; (R) interactions during the student poster session.

NSEC members also participate regularly in meetings of the Massachusetts Nanotech Exchange Summit (http://www.nanotechexchange.org/). The mission of the Nanotech Exchange is to create partnerships among public companies, state agencies, and academic institutions. They are dedicated to supporting economic development, entrepreneurship and innovation in technology in New England. Ranch Kimball, MA State Secretary of Economic Development, spoke at the May 2005 meeting at the Museum of Science, Boston on the activities to support nanotechnology ongoing in Massachusetts. Greg Schmergel (Nantero), Greg Shelton (Raytheon), and Jim Lynch (Agilent Technologies) spoke about their industrial experiences and Matthew Nordan (Lux Research) gave perspectives on nanotechnology entrepreneurship based on case studies from their extensive field research.

Nanotech Business Forum

Westervelt worked with Chinh Pham (Greenberg Taurig, LLP) to initiate the NanoTechnology Business Forum in the Fall of 2004. The NanoTechnology business forum brings together leaders from local business, industry, government and academics for monthly networking meetings. The monthly meetings rotate to different venues in the Boston area. The March 2005 meeting, for example, was held at Harvard (Fig. 9.7). **Charles Marcus** spoke about activities ongoing at Harvard in nanoscale science and Mark Brandt (Maple Fund) spoke on Trends and Opportunities in Nano-electronics. The Nanotech and Business Forum was instrumental in bringing together Rick Rogers (School of Public Health) and Giannoula Klement (Children's Hospital) along with Dale Larson (Biophysics) who have become collaborators on the research in *Cluster I: Tools for Integrated Nanobiology* through continued discussion in the Spring of 2005.

Figure 9.7. NanoTechnology & Business Forum meeting at Harvard, March 2005.

Community Building

During the past two years, the Center sponsored the Research Exchange Seminar run by NSEC Postdoctoral Fellows. The seminar is held biweekly on Tuesday at lunchtime during the academic year to encourage NSEC postdoctoral fellows and graduate students

Figure 9.8. Research Exchange Seminar (*left*, *center*) and a meeting of the Imaging group (*right*).

to learn about each other's research. The Exchange Seminar has blossomed into a venue where graduate students can get the advice of the postdoctoral fellows on preparation for oral presentation and then give their talk at the Exchange. On occasion, outside speakers are invited and the seminar is hosted by students at Harvard and MIT to emphasize both locations of NSEC activities in Cambridge.

With the realignment of research activities for the renewal effort a major theme of new tool development emerged last year. We have initiated a bi-monthly series of meetings for graduate students, postdoctoral fellows and faculty members involved in imaging tool development. These meetings help promote the exchange of best practices and technical expertise among members of the NSEC (Fig. 9.8).

In the Spring of 2005, the NSEC sponsored the course *AP298r: Interdisciplinary Chemistry, Engineering, and Physics*, which covered fundamental concepts in nanoscale research as well as possible applications in a series of lectures by twenty NSEC faculty members (Fig. 9.9). Topics for the course were organized in six sections: NanoBio and Microfluidics, Nanoparticles and Nanowires, Nanofabrication and Electron Microscopy, Nano-optics, Imaging Electrons, and Coherent Electronics. A paper and oral presentation on one of the topics was required. Twenty-five students took the course for credit and another fifteen researchers and staff members regularly attended the class as auditors. The lectures are available on the NSEC website: http://www.nsec.harvard.edu/AP298.htm.

Figure 9.9. Hongkun Park gives his AP298r lecture.

Research from the NSEC also has been woven into undergraduate courses. The new engineering course, ES 122: *Cellular Engineering*, taught by **Parker** this past spring was a laboratory course designed to give students a cutting-edge research experience and one selection was taken from NSEC-related work. The undergraduate class was broken down into research teams with a graduate student as the team leader. There was one lecture a week (1.5 hrs) and one lab demonstration. Then the students had 10–20 hours of laboratory access a week to work towards defined milestones. In the laboratory, the students learned cell tissue culture, cell motility assays, light, fluorescent, and video microscopy, immunohistochemistry, and microcontact printing. They met milestones with written and oral reports, were held to high standards in that they kept a detailed and graded lab notebook. The final project presentation incorporated all they have learned, plus other techniques that they taught one another.

10. SHARED AND OTHER EXPERIMENTAL FACILITIES

The shared facilities are operated to encourage both hands-on research by experienced and qualified users, and as educational tools for students and researchers from other disciplines who can benefit from their use. A broad-range of facilities teaches students the skills of nanofabrication, imaging, and synthesis that they will need after graduation, and open new avenues of investigations for all disciplines. The shared experimental facilities play a special role in fostering interdisciplinary exchanges. The facilities are the natural meeting places where students from all parts of the Center learn from one another and share technical expertise.

Figure 10.1. Construction underway at Harvard University (left) on the new Laboratory for Integrated Science and Engineering (LISE), April 2006. Computer aided design of the completed LISE building (right) that will be the new home of the shared experimental facilities.

New Laboratory Construction

Harvard University is supporting the construction of a new, 135,000 sq. ft. Laboratory for Integrated Science and Engineering (LISE). The Faculty Planning Committee viewed the construction of LISE, in close proximity to other science buildings in the north Yard, as a singular opportunity to create a research environment that will centralize major experimental facilities and foster cross-disciplinary research. The principal architect of LISE is Jose Rafael Moneo who served as Chairman of the Architecture Department of the Harvard Graduate School of Design (1985–1990). The building will include extensive vibration free space to house the shared facilities including major cleanroom and nanofabrication facilities, advanced imaging laboratories, and facilities for materials synthesis. The building will also have space for new faculty (Interdisciplinary Research Laboratories) to advance cross-disciplinary research. A third programmatic element will be common spaces to promote collaborative exchanges. The project is now entering the final construction phase (Fig. 10.1). LISE is scheduled to open in June 2007.

Harvard University also supported the construction of a new building in the North Yard at 60 Oxford Street (Fig. 10.2). The top two floors, along with one floor in the adjacent Engineering Sciences Laboratory (ESL) at 40 Oxford Street are now home to faculty in Bioengineering. **Parker'**s laboratories have been finished in this space which has been an impetus to work in the Tools for Integrated Nanobiology Cluster, for example. These recent buildings and those that will be completed soon will continue to pull the science community together, across traditional departmental boundaries and be spaces where researchers can interact in common experimental facilities.

Figure 10.2. New building at 60 Oxford Street; the top two floors are dedicated to Bioengineering.

Integrated Management of Facilities and Technical Staff

In January 1999 Harvard announced the commitment to launch several new interdisciplinary research centers in the sciences. The faculty had identified a strong scientific and technological need for the understanding and development of mesoscale materials and structures. This new challenge would require sophisticated facilities for imaging, nanofabrication, synthesis, and growth. The Center for Imaging and Mesoscale Structures (CIMS) was born from this vision. **Halperin**, co-PI of NSEC, was the first Scientific Director of CIMS. Harvard University supports the Center for Imaging and Mesoscale Structures (CIMS) to support research and education in the area of nanotechnology and mesoscale science. A main mission of CIMS is the provision, operation and maintenance of complex facilities for imaging and fabrication. CIMS began to purchase equipment and hire technical staff as well as construct a second cleanroom in the basement of the Gordon McKay Laboratory. The management of the shared facilities at Harvard from CIMS, MRSEC and NSEC were integrated in 2002; the management boards of these Centers work closely together. Importantly, instrumentation for new CIMS facilities are open to all students, research associates, staff and faculty of the NSEC (regardless of institution), and to all NSEC collaborators.

Figure 10.3. Erin Boyd, NSEC graduate student, uses the new JEOL JSM 7000F high-current, e-beam writing instrument in McKay Laboratory.

This integration made CIMS the main source for centralized user facilities in the Oxford Street science campus. In September 2004, **Marcus** became the Scientific Director of CIMS. In April 2005, CIMS was renamed to the Center for Nanoscale Systems and they launched their new website (www.cns.fas.harvard.edu). In January 2006, Eric Martin (Fig. 10.4) joined CNS from Avici Systems (North Billerica, MA) as its new Technical Director. CNS presently has thirteen full-time technical staff members. Instrumentation available is organized in three areas: Imaging and Analysis; Nanofabrication (including

cleanroom operation); and Materials Synthesis. The complete list of instrumentation and equipment is listed on the facilities web page (www.cns.fas.harvard.edu/facilities/). CNS continues through direct equipment matching to the NSEC. The support and operation of the shared experimental facilities are the responsibility of CNS, with the only recharge to CNS from the NSEC in the form of user fees. The CNS support of technical staff and operating costs of the shared facilities represents substantial leveraging of our NSF/NSEC funding.

Figure 10.4. (Left) Eric Martin, Technical Director of CNS; (right) National Nanotechnology Infrastructure Network (NNIN).

National Nanotechnology Infrastructure Network (NNIN)

UC Santa Barbara and Harvard University are two of the thirteen members of the National Nanotechnology Infrastructure Network (NNIN), which began in March 2004. CNS is also responsible for managing the Harvard portion of the NNIN activity (www.nnin.org) that further reaches out to a national user base. The areas of focus at Harvard are soft lithography and the assembly of nanoparticle and molecular electronics; theoretical simulations of electron states and transport in nanoscale systems. These areas have significant overlap with research in the NSEC.

Michael Stopa is leading the coordination of the computational initiative in NNIN (Fig. 10.5). **Stopa** was previously at NTT in Japan and gave several seminars as past of the international exchange programs of the NSEC. Like the NNIN experimental

program, NNIN/C is a multi-university initiative, the object of which is to establish a national computing resource that provides hardware resources and simulation tools dedicated to nanoscience research for the academic and industrial research communities. The software tools include commercial software packages for design and analysis, of nanometer scale devices as well as some of the latest academic advances in nanoscale modeling and simulation software. A workshop *Synergy Between Experiment and Computation in Nanoscale Science* is planned for May 31–June 3, 2006 (see below).

Figure 10.5. Michael Stopa (right) works with Nick Schiarizzi (seated) at Harvard in the computing initiative of the NNIN.

NNIN/C Conference

Synergy Between Experiment and Computation in Nanoscale Science

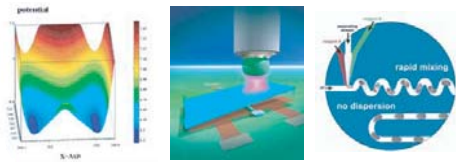
NNIN COMPUTATION

synergy

May 31 - June 3, 2006

Harvard University, Cambridge, MA

In this workshop, we will discuss a varied assortment of nanoscale systems and phenomena with an emphasis on computation. The main theme of the conference, the synergy between experiment and computation, will be explored in focused presentations from experimentalists who will describe the impact of computation on their research and what their desiderata might be for future computation. Correspondingly, computational researchers will focus on the outstanding experimental puzzles that their computations address and their desiderata from the experimental world.



Conference Topics:

I. Ab Initio Electronic Structure of Nanoscale Systems
II. Correlated Electrons in Low-Dimensional Nanoscale Systems
III. Casimir Effect
IV. Microfluidics
V. Photonics

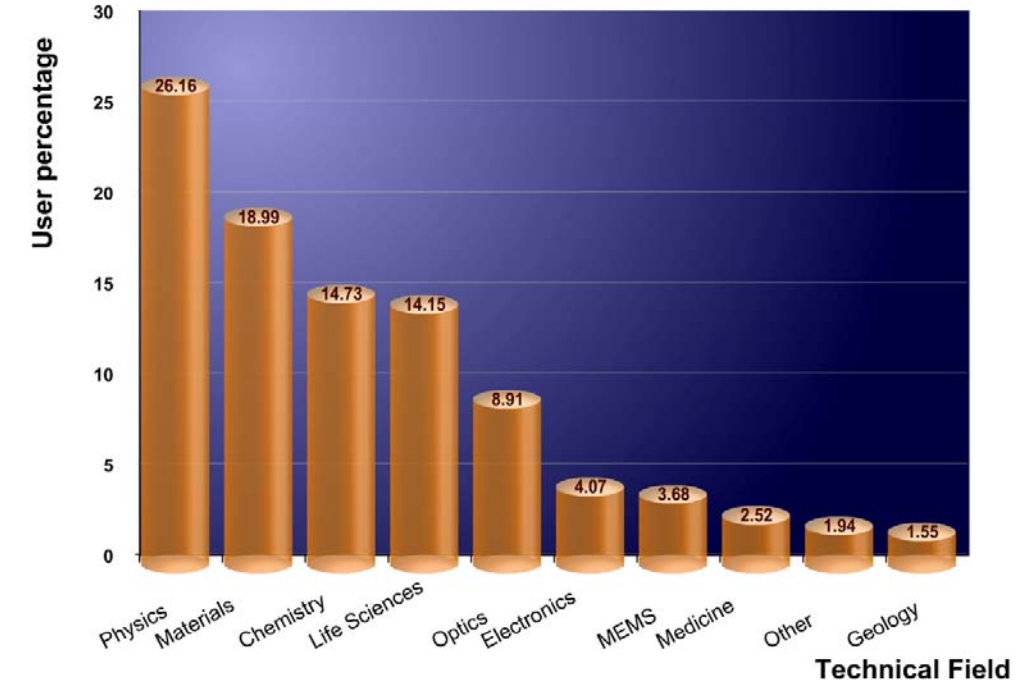
Confirmed Speakers:

Sadasivan Shankar, Intel Corporation
Gerhard Klimeck, Purdue University
Normand Modine, Sandia Laboratories
George Whitesides, Harvard University
David Goldhaber-Gordon, Stanford University
John Joannopoulos, M.I.T.
Sauro Succi, Istituto per le Applicazioni del Calcolo
Charles Marcus, Harvard University
John Shumway, Arizona State University
Federico Capasso, Harvard University
Derek Stewart, Cornell University
Eric Heller, Harvard University
Howard Stone, Harvard University

http://cns.fas.harvard.edu/nanobynumbers

User Statistics

The shared facilities are heavily subscribed with more than 500 users from March 2005 through February 2006. Users came from many different institutions and varied



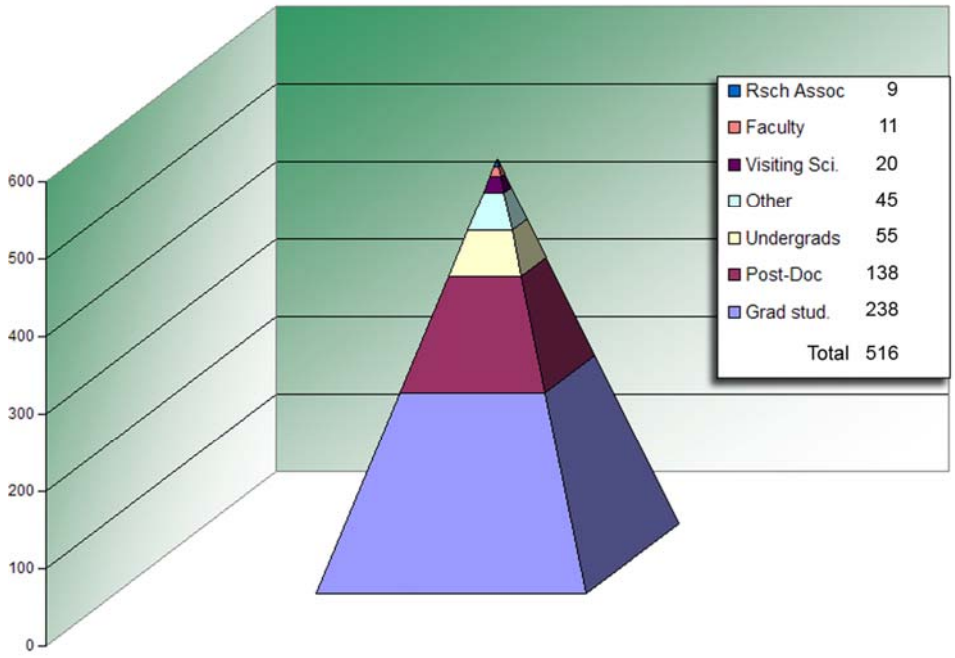


Figure 10.6. Shared Facilities user statistics from March 2005 to February 2006.

technical fields. Below (Fig. 10.6) is statistical information of the shared facility users. Note that the Other categories in the Institution Type chart includes small and large corporations, state and federal agencies, and international institutions. Also, most projects cut across many technical fields. In fact, it is part of the mission of CNS and NNIN to promote such interdisciplinary research. However, for the sake of tracking trends, users must select only one technical field when applying to the CNS/NNIN User Program.

Student Training and Safety

Equally important to the acquisition of state-of-the-art instrumentation in the pursuit of our research program, is the availability of talented technical staff that provides training through regularly scheduled courses and hands-on laboratory instruction. The technical staff ensures that environmental health and safety procedures are followed and guidance is provided until researchers are certified as self-users. The staff also helps researchers develop new fabrication processes and measurements techniques, and upgrade equipment in response to changing research needs.

These cutting-edge instruments also are used in many of the Research Experience for Undergraduate (REU) and Teacher (RET) projects and, in many cases, are resources that are not available to many participants in these summer research programs back at their

Figure 10.7. (left) Dr. Steve Cronin and Sasha Stolyarov (REU, Univ. Texas Dallas) working in one of the cleanrooms; (right) Jeremy Munday, **Federico Capasso**, and Rachel Hillman (REU, Univ. of Illinois), during the summer research experience program, 2005.

home institutions (Fig. 10.7). This is an important illustration how the NSEC brings together talented researchers, who serve as mentors for undergraduates and teachers, technical staff with expertise, and essential (and often sophisticated) experimental facilities. Both of the REU students shown above are or will be pursuing graduate degrees in science; Sasha Stolyarov returned to Harvard after finishing his undergraduate degree at the Univ. of Texas at Dallas and entered Harvard in Physics as a graduate student in the Fall of 2005.

Other Facilities

Center participants have access to other imaging, clean room, and synthesis facilities at MIT and UC Santa Barbara. With the installation of three new systems (Fig. 10.8), there are now a total of eight different MBE machines available for sample growth at UC Santa Barbara (www.materials.ucsb.edu/~mbe/lablayout.html). The NSEC has supported exchanges through the travel program by students who are expert in materials growth (UC Santa Barbara) to meet with students working in transport measurement (Cambridge). It is been very valuable in moving research forward for these different groups to gain an understanding of each others' approaches and capabilities. The National Laboratories have excellent capabilities that also help NSEC researchers, particularly those in micro-electromechanical structure (MEMS) fabrication facilities at Sandia (www.cint.lanl.gov). **Westervelt** serves on the Advisory Board of CINT.

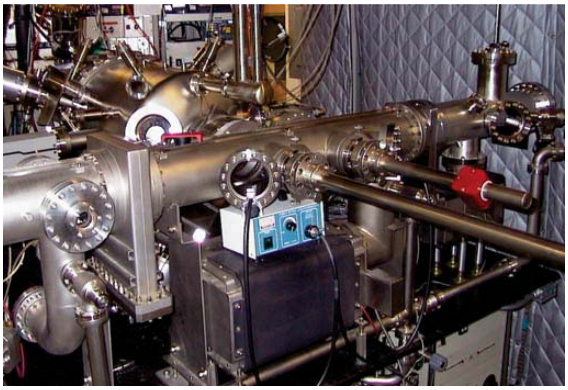


Figure 10.8. Molecular beam epitaxy facilities at UC Santa Barbara.

Center participants also benefit strongly from international collaborations with Delft University of Technology in The Netherlands, and the University of Tokyo, the Institute for Industrial Research and NTT in Japan. These institutions are world leaders in mesoscopic science and engineering. **Leo Kouwenhoven** has created a visiting program with Delft to exchange students and share facilities for collaborative research. **Hiroyuki Sakaki** and **Seigo Tarucha** are also coordinating visits with the University of Tokyo, the Institute for Industrial Research, and NTT for the design and fabrication, and testing of nanoscale structures (see also NSEC International Workshops in 12. Outreach and Knowledge Transfer, above). Our international collaborators have contributed to the travel support for student exchanges and to support joint workshops.