

Outreach and Education at CHESS

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Inspiring and training new scientists has always been important to the CHESS mission. With over 1000 people visiting CHESS each year, the Outreach and Education programs we support need to be multifaceted and flexible. The time people spend at CHESS covers the spectrum from a few minutes to a few years. During a visit of a few minutes, a CHESS staff scientist can attempt to explain what x-rays are, how this lab creates them and what we do with them. Through a summertime visit, high-school students, college undergraduates and even some courageous high school teachers might work closely with staff members on goal-oriented development projects. And at the far end of the spectrum, graduate students and post-doctoral scientists might become “temporary residents” at CHESS for several years’ time to help build beamlines, design equipment or develop techniques needed to complete their independent projects.

Beyond hosting visitors, though, the word “outreach” implies an active effort, by facility faculty and staff, to go out into the community to explain science and provide opportunities for young students to experience the excitement of science and technology. Although there has never been a formal, organized, outreach program at CHESS (more on this later), dedicated staff members Ken Finkelstein, Richard Gillilan and Marian Szebenyi have marched out on their own, volunteering in local elementary and middle schools and even developing long-term programs to bring hands-on instruction to youngsters. Formally written into its funding grant, the G-line faculty group has a dedicated outreach program and staff to organize the effort. They involve graduate student volunteers who bring their excitement for science to young students and they learn, at the same time, that outreach is both a valuable and rewarding personal experience.

Students in High School and College: Effective teaching requires an age-appropriate program and effective supervision. Students in high school and undergraduates in college are often interested in experiencing science and technology with an eye towards possible future careers. The staff at CHESS, MacCHESS and G-line supervise students for a number of reasons, including enjoyment and satisfaction as well as, sometimes, simple desperation to get some help to spark and motivate a long-needed project. This was certainly the case during the summer of 2002 when **Anton Kriksunov**, after his second year at

Ithaca High School, worked in my office to help expand our on-line user database by designing and building a new publications entry system. Anton had studied computer programming during his sophomore year. The project he undertook taught him several new programming languages, including the Javascript he used to build a web browser interface and the SQL language needed to enter data into the database. The system he built will allow both users and staff to enter information about publications and presentations they’ve made based on their work done at CHESS. The new system will be searchable and provide a means to upload and store electronic versions of papers and presentations. This will be a great timesaver for staff who need to be able to search for, download and print technical memoranda and use (and reuse!) presentation materials.



Soumendra Banerjee assembling the MedOptics CCD x-ray area detector and computer interface rack.

Soumendra Banerjee, a junior in the Cornell Applied and Engineering Physics department, worked on two x-ray imaging projects this past summer. His first project involved writing software to automate direct imaging of x-rays using a CCD area detector produced by the MedOptics Corporation. He wrote procedures under IDL that allowed the computer to take images in a “camera” mode by listening to external trigger signals to control the timing and duration of x-ray camera exposures. This camera will find

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many uses, ranging from recording small-angle scattering patterns from polymers and protein specimens to rapid large-area diffraction patterns taken during layer-by-layer crystal growth. He also worked with Rong Huang and Don Bilderback to collect x-ray fluorescence spectra using microscopic x-ray beams. They used a 10-micron x-ray beam to measure the location of zinc atoms in an ear stone of a Swedish Whitefish. These studies are used to understand the environmental conditions that the fish live in and their impact on the structure of the stone.

High School Teachers and RET: The National Science Foundation funds a program to provide Research Experiences for Teachers. Wilson Laboratory and Wayne State University have collaborated to host, at Cornell, several dozen teachers and students from inner-city schools in Detroit. CHESS has been fortunate to host two persons each year over the past few years. This past summer Richard Gillillan (MacCHESS) worked closely with **Michael Barclay** to customize 3D graphics software for processing x-ray data and for viewing molecular structures. The small-angle x-ray scattering data Michael analyzed provides a means of determining the shapes of protein molecules in solution. This will be

a significant tool for structural biology in the majority of situations where proteins do not form crystals needed for standard x-ray crystallographic techniques. His work involved using the OpenDX scientific visualization system that is a freely available software package used extensively in both research and education. In addition to creating graphics tools useful to research operations at CHESS and MacCHESS, Michael took home a general graphics package that can be used for instructional purposes.

Richard Gillilan and Michael Barclay with their visualization program shown on the computer monitor.



In a second project, **Doina Balceac** worked with Jim Savino, Brian Clasby and Tom Krawczyk on a systematic study of methods of joining two pieces of silicon crystal. Once bonded, these pieces form the water-tight and vacuum-tight first crystals for our x-ray optics monochromators on the high-intensity wiggler beamlines. These bonds need to be vacuum tight and strong without introducing strain into the silicon surface (which ruins the optical properties). She was given broad latitude in developing her own experimental direction, and worked in close conjunction with members of CHESS technical and scientific staff. Doina learned to carry out the metallurgical recipes for bonding two pieces of silicon and continued to test the mechanical, ultra-high vacuum and x-ray optical properties of her test specimens. She helped extend our engineering knowledge concerning silicon bonding and will return to teaching with a greatly improved ability to convey to her students what scientists and engineers actually do.

Graduate Student and Post-Doctoral Training: Student training has always been an integral part of the CHESS mission. CHESS is simultaneously a major national facility and a faculty-directed university laboratory. As a result there is constant, intense graduate and post-graduate student involvement at all levels, from design of new beamlines to the development of new instruments and experimental techniques. To date, we know of at least 449 graduate student thesis projects dependent on data acquired at CHESS. Each year nearly half of all the scientists who visit CHESS to carry out x-ray experiments are graduate students or post-doctoral fellows.

Building the new G-line stations has presented a rare opportunity to involve students in all aspects of x-ray laboratory construction and operations. Some of the front-end components and the majority of the experimental station hardware are being built by some dozen or so graduate students who expect, in the near future (we hope!) to perform their thesis research on these beamlines. Visit g-line.chess.cornell.edu for more details on the projects and the individuals involved. Because similar efforts mark much of CHESS' history, CHESS has been one of the most productive training centers in the U.S. for new beamline scientists who have gone on to populate other synchrotron facilities. As beamlines at national labs become more sophisticated and expensive, more of the design, construction and operations has turned to professional technicians, so there are fewer opportunities for students to obtain on-the-job training in these crucial skills. The continued training of beamline scientists has become an important



Ken Finkelstein, CHES Staff Scientist, is teaching children at the Varna Community Center how to build electromagnets.

part of the CHES mission and is consistent with the National Science Foundation mission of educational leadership.

K-12 and Public Education: Public education and outreach are integral to the broader mission of science in all aspects of Wilson Laboratory. With its impressive scale and sophisticated hardware, CHES and CESR are popular venues for secondary school visits and local college classes throughout the central New York region. An estimated 1,000-1,500 visitors each year see an educational video introducing basic concepts about high-energy physics and x-ray science before they take a walking tour of the facilities. Brochures describing the various scientific missions are handed out, including "The Science at Wilson Laboratory" and "If you had X-ray Vision what would you see?". And, of course, our various web sites disseminate information to an even wider audience (see www.ches.cornell.edu).

Several of the CHES, MacCHES and G-line staff have taken the initiative to participate in – or create – new programs in public outreach. Since Fall 1999, CHES staff scientist Ken Finkelstein has run an **After-school Science Club** to provide after school enrichment for kids in grades 3-8. Topics include electrical circuits, optics, microscopes, the night sky, and spectroscopy. Working in close association with local public schools and community associations, this program focuses on serving families with limited transportation options by bringing "hands-on" science activities to kids in their neighborhood. Each spring 9 weekly sessions have been offered free of charge and a total of 65 children have participated. Several staff scientists participate regularly in elementary and middle school **Science Days** - often because they have their own offspring attending the local schools. Richard Gillilan (MacCHES) participates regularly, giving demonstrations on liquid nitrogen, for example, to South Hill Elementary School (Spring 2001). Marian Szebenyi arranged various activities at the Newfield Middle

School's Science Day (1997-1999). Richard, Marian, and Irina Kriksunov graciously provide demonstrations of crystal mounting, data processing and structure solutions to visiting school groups. At Cayuga Heights Elementary School CHES hosts a yearly hands-on exhibit that introduces children to mineral crystals and their properties.

Joel Brock (G-line and Applied and Engineering Physics) has led an effort of numerous graduate students and other faculty who have worked, in collaboration with the **Sciencenter** of Ithaca, NY, to lead science topic sessions on X-ray Diffraction for home-schooled students from ages 8 to 16. The Sciencenter is a hands-on museum located in the city of Ithaca and is a great place for young and old to learn about and explore science. CHES and LEPP donated \$3,000 to help with their recent expansion project.

Organized Outreach and Education: As the scientific programs and staff at CHES, G-line and MacCHES have grown so too have the outreach and education efforts. Realizing that CHES could make good use of someone to help organize these various efforts, in the upcoming NSF proposal we've requested money to fund a part-time outreach coordinator. This person will work in concert with **Juliane Bauer-Hutchinson**, a full-time coordinator shared by G-line and CCMR (Cornell Center for Materials Research), and **Lora Hine**, a full-time Outreach Coordinator for the Wilson Laboratory program. We hope that the new coordinator can help facilitate events sponsored by CHES, evaluate the effectiveness of these activities, help train CHES staff to be effective presenters, and promote interdisciplinary efforts to connect our programs with others taking place on the Cornell campus.