

CHES Assistant Director's Report

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Some sort of "rough waters" analogy is needed to describe activities at CHES over the past year. The CHES staff kept as even a keel as possible despite two external forces. First, uncertainty about science funding affected the laboratory (as well as researchers across the United States). Budget constraints heavily throttled capital spending we had planned for the 2008-2011 renewal period. This slowed – but did not stop – progress to improve x-ray user facilities, as the reader can learn from other articles in this magazine. Second, CHES was directly impacted by the end of the High-Energy Physics (HEP) data collection program and the start of an accelerator physics program called CESR-TA – or CESR Test Accelerator. The CESR-TA project is a jointly-funded NSF-DOE project to use the Cornell accelerator (CESR) as a test development model for the damping rings that will ultimately be part of the International Linear Collider (ILC). Alterations to CESR caused some loss of x-ray running days, though the hardware improvements resulting from the project will yield long-term benefits to x-ray users in terms of better reliability, better alignment and better stability of x-ray beams.

The quality of the CHES facilities and depth of user support depend critically on the staff. This past year saw three longtime staff members depart from the CHES team. Jeff White took an early retirement and was excited to dedicate himself to upgrading his own home to be a model of environment-friendly energy efficiency. Jeff had worked at CHES for over 23 years in many formative roles, among them leading the operations team, liaison to the accelerator staff, developer of the E-line diagnostic beamline, and head of the CHES and ERL safety committees. Holly Manslank was a CHES operator for 4 years and moved on to a technical position closer to her new home in Geneva NY. Holly brought to CHES a keen sense of organization and logic that helped the staff see the benefits of well-organized and documented

procedures for chemical room use, signal monitoring, cable mapping and labeling. And last but certainly not least, Virginia Bizzell retired after 30 years as CHES business manager and staff "memory." Virginia served both CHES Directors, Batterman and Gruner, and all the CHES and MacCHES staff and users with sincere respect, nurturing and care over the entire life of the facility. Her service is sorely missed and we wish her, Jeff, and Holly all the best.

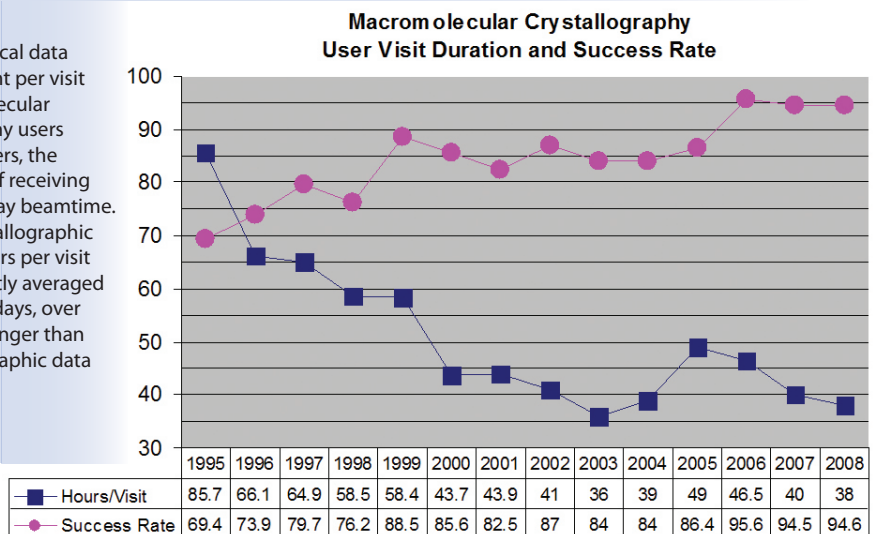
The CHES staff strives to constantly improve the quality of the x-ray user facility and user support at CHES. Those who visit CHES periodically have noticed that the running modes of the facility have changed dramatically over the past few years. From its inception, x-ray users had always collected data while the HEP program was running the accelerator and collecting particle physics data. While in this "parasitic mode," the accelerator needed considerable performance tuning and the x-ray beam positions and stability were sometimes compromised. This running mode changed over the past few years so that CHES users now have a dedicated machine during "x-ray running." With dedicated running, accelerator conditions can be optimized for the best combination of small source size, long-term stability, and long beam lifetime. Our goals are to realize as few interruptions as possible during x-ray

data collection. We have seen that when the machine is well conditioned – a process we improve upon each day – interruptions for re-injections should be limited to once every 8-12 hours or more. We expect this to improve in the future. To hasten these improvements, we have formed a study group of both x-ray and accelerator experts who will identify and tackle issues related to beam alignment and stability.

The reliability and use of CHES have changed over time. Figure 1 shows historical trends for the amount of time that each visiting research group has spent collecting x-ray data. Also shown is the reliability during those visits. Among the many conclusions that can be drawn the most obvious is that the reliability of user beamtime has grown – at or above 95% - which is similar to other state-of-the-art synchrotron facilities across the United States. This is quite an accomplishment given that the Cornell accelerator was designed to serve the HEP program and continues to store both electrons and positrons simultaneously. The flexible design of the CESR source affords some benefits, though, allowing the laboratory to explore creative accelerator physics development programs such as CESR-TA and also test novel undulator designs.

Speaking of novelty, other articles in this magazine highlight exciting upgrades to CHES beamlines and instruments over

Fig. 1: Historical data for hours spent per visit for macromolecular crystallography users and, for all users, the success rate of receiving scheduled x-ray beamtime. For non-crystallographic users, the hours per visit has consistently averaged between 4-5 days, over three times longer than for crystallographic data collection.



the recent past. Updating the x-ray beamline front-ends and optics helps improve x-ray performance and add new capabilities that users should appreciate. For instance, both the F3 and C1 beamlines have newly-installed 800 millimeter-long white beam mirrors. These help collimate and/or focus x-ray beams in the vertical direction, while at the same time reducing heat loads and higher-order harmonic content of downstream monochromator optics. The downstream optics for both stations are still not ready to reap the full benefits, but this will improve as our budget and resource situation improve over the next year. D-line is the first-ever CHESS beamline that can now operate without any beryllium windows. Traditionally, beryllium windows serve to separate downstream x-ray optics environments, typically helium volumes, from the delicate ultra-high vacuum of the accelerator storage ring. Adding a new vacuum optics box to D-line and removing the windows makes it possible for researchers to use high-intensity, low-energy x-ray beams when needed.

Looking forward to continued funding from the NSF, we have plans for scientific and technical initiatives that will benefit users in many ways. The next year should show progress on many fronts, including designing and building new high-energy, vertical focusing optics to increase the x-ray intensity by a factor of forty or so for high-pressure research at the upgraded B2 station. This will dramatically decrease exposure times for angle-dispersive diamond-anvil high-pressure experiments. We would also like to roll out horizontal-focusing synthetic multilayer optics at a few stations. Best of all would be to engineer a flexible, tunable substrate for multilayers that would provide a very rare capability – the ability to adjust and optimize the horizontal focus of a wide-energy-bandpass x-ray beam. The corresponding x-ray intensity increase would enable much more rapid scanning x-ray fluorescence imaging at the F3 station, for example. We also expect to see many new applications of fast pixel-array detectors, in collaboration with developments from the Gruner laboratory.

Sol Gruner - CHESS Director

Sol M. Gruner was raised on a farm in Southern New Jersey. He received his undergraduate physics degree from M.I.T. and his Ph.D., also in physics, from Princeton University. Following receipt of his Ph.D. in 1977, Sol remained in Princeton as a member of the physics department faculty. He moved to Ithaca in 1997 as Director of the Cornell CHESS facility and as a faculty member in the physics department and the Laboratory of Applied and Solid State Research (LASSP). He presently holds the post of The John L. Wetherill Professor of Physics. In addition to his work at CHESS, he has an active, independently funded research group in the physics department. He is a member of the graduate fields of Physics, Applied Physics, Biophysics, and Materials Science and Engineering.

Sol characterizes himself as working across the continuum between biological and condensed matter physics, with a heavy emphasis on instrumentation and technique development. Areas of particular interest include the biophysics of lipid membranes, the effects of pressure on biomacromolecules and assemblies, the physical properties of block copolymers and the development of x-ray instrumentation and methods. He has been involved in the introduction of liquid crystal methods to the study of membrane lipid phases, and the discovery of a number of block copolymer phases. His group develops x-ray detectors, and much of the technology for the CCD detectors now used at synchrotrons throughout the world has come from this effort. The group is presently developing silicon-based detectors for time-resolved x-ray experiments.

Don Bilderback - CHESS Associate Director

After receiving his PhD in physics (with R. Collella, Purdue, 1975) Don Bilderback came to Cornell and shortly thereafter became the first CHESS employee under Bob Batterman, the first CHESS director. He has pursued a career in x-ray research, developing x-ray sources (CHESS and now the Energy Recovery Linac), x-ray detectors (first real-time back-reflection Laue camera when in Materials Science and Engineering, see www.multiwire.com), the first transmission x-ray mirror and the first bendable mirror with table legs underneath that you push apart to accomplish the bending. In 1993, he was a co-winner of an R&D 100 Award, an honor given annually to the one hundred most significant technical innovations of the year, in recognition of the development of tapered capillaries for producing micron-sized x-ray beams. The capillary work is ongoing and last year resulted in the excellent thesis by Sterling Cornaby (Applied and Engineering Physics PhD,

2008) entitled "The Handbook of X-ray Single-bounce Monocapillary Optics".

Don has also been concerned with high-heat-load x-ray optics over the last 20 years. His idea of cryo-cooling the silicon optics has been widely adopted by other synchrotron laboratories and resulted in the Compton Award of 1998 to Don Bilderback, Andreas Freund, Gordon Knapp and Dennis Mills. Don recently set the goal (from the backdrop of ERL development) of making x-ray optics reach a one nanometer hard x-ray beam size. The APS/NSLS II community has picked up this goal and is rapidly developing Laue lenses that might be one of the first kinds of optical component that might reach this goal. This is very exciting!

Don is a member of the ACA, the AAAS, and is a fellow of the American Physical Society. He often serves as a consultant to APS, ESRF and other synchrotron sources. He is a member of the Photon Science

Committee for the Deutsches Elektronen-Synchrotron (DESY) and of the Nanoprobe Beam-line Advisory Committee at the NSLS II project. And Don is currently the Cornell University correspondent for *Synchrotron Radiation News* and a Co-editor for World Publishing Co. for a book series on Synchrotron Radiation.

Don Bilderback is married to Becky, his wife and sweetheart of 39 years. He has one son, Doug, and a 2½ year-old grandson, Ian, who live in Seattle. Don loves to travel, commute to work on his bicycle, swim, and cross-country ski. He recently was involved (with many other Ithacans) in settling 53 refugees from Burma in the Ithaca area. One young lady from the group, Wimber Pha, lived with the Bilderbacks five days a week, where she received tutoring in English, math, driving a car, etc and moved up to English as a Second Language in her studies. Don also enjoys discussing science and faith issues.