CHESS Director’s Report

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Cornell was awarded $8M Phase 1a funds for a 4-year effort to prototype critical components of a next generation ERL X-ray source. We are enormously proud and pleased that the NSF was convinced by the community and review committee’s assessment that an ERL source opens an enormous number of science opportunities in numerous areas. It is telling that the Foundation decided to proceed on the ERL project even though this year’s overall NSF budget is arguably the most constrained in decades. The goal of ERL Phase 1a is to build the critical injector and demonstrate that it has the brilliance and temporal performance characteristics for a continuous duty coherent hard X-ray source with very short X-ray pulse capability. It is Cornell’s intention to submit a Phase 2 proposal for a full-scale ERL project by 2008. A Phase 2 ERL would be a full scale hard X-ray user facility without peer in the world. More information on the ‘ERL Developments’ can be found on page 9.

For the last year and a half CHESS has been operating in a new mode with alternating periods of dedicated use of the CESR storage ring for high energy physics and for X-ray science. Modifications of CESR for the high energy physics experiment were completed in early Fall 2004, resulting in essentially a new, and highly complex, CESR machine lattice. Since that time there have been three dedicated X-ray run periods. It has taken time to work out bugs in the machine. Particularly irksome was a failure of one of the electrostatic separators, due to an internal clog in the cooling system, at the start of the second user run. Replacement of the separator involves opening a large portion of the ring to atmosphere. Restoration of the ultrahigh vacuum required to run a storage ring is a very unforgiving operation that would have required several weeks to bake out and complete and would have required aborting much of the scheduled user run. Instead, the LEPP and CHESS staffs worked very hard to implement on-the-spot modifications to the separator cooling to baby it through to the end of the second user run. By the 3rd run period the separator had been repaired (it was later replaced) and the machine behaved beautifully.

We’re very pleased to report that last May Rick Cerione assumed the role of MacCHESS Principal Investigator. Rick holds a dual appointment as professor in both Cornell’s College of Veterinary Medicine and the Department of Chemistry and Chemical Biology. He is a long time MacCHESS user and a highly respected member of the biological community. We look forward to his long term guidance of MacCHESS. Quan Hao continues his competent role as MacCHESS Director.

The national budget situation is a concern. The NSF Physics Division budget was particularly hard hit in 2005, which resulted in significant funding cuts to LEPP for operation of the ring. Fortunately, wise management by LEPP Director Maury Tigner avoided layoffs or reduction of run time, but required deferring needed expenditures. The flexibility to do this is now gone and another bad budget year will likely result in reduced operations. We are hopeful that the Congress recognizes that NSF science is important for the well-being of the nation and improves the budget appropriation. We are told by our contacts in Congress that the scientific community is much less effective than other groups in communicating opinions about national priorities. We strongly encourage you to write to your Congress people to express your opinion on matters of scientific funding.

I can’t help but close with comments on some scientific accomplishments of which I am particularly proud, some of which are highlighted in this newsletter issue:

• A collaboration between CHESS, the Winterthur Museum in Delaware and the University of Delaware has resulted in a confocal X-ray fluorescence instrument that allows the nondestructive analysis of the composition of works of art. It’s been a great deal of fun to see a series of works of art, some dating back to the 17th century, come to CHESS for analysis. This work has garnered a great deal of attention and has already resulted in user awards (see page 41 for
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more information).

• A MacCHESS graduate student has demonstrated a high pressure protein freezing method that obviates the need for cryoprotectants. This will greatly simplify the preparation of crystals for diffraction and could have a large impact on high-throughput methods (more details on page 60).

• A Los Alamos/CHESS collaboration has found a new phase of carbon by squeezing carbon nanotubes in a diamond anvil cell. The diamonds were scored by the resultant material, suggesting that it may be harder than diamond!

• CHESS and the APS were used to demonstrate an inelastic scattering method to resolve charge rearrangements in matter with a world-record 41 attosecond time resolution. To appreciate how short a time interval this is, consider that 41 attoseconds is to one second as 1 second is to 1.5 billion years.

• A Cornell/Berkeley team has developed a pulsed laser deposition system to watch the molecular layer-by-layer growth of complex inorganic materials, such as perovskites. The results are changing the way people think about pulsed laser deposition growth mechanisms and could result in better electronic materials.

• A Columbia University team has elucidated the structural basis for modulation and agonist specificity of HCN pacemaker channels, with important implications for heart therapies.

• A CHESS/MacCHESS/Osmic Corp. collaboration has demonstrated high reflectivity artificial multilayer monochromators with ten times the energy bandpass of silicon (111). This relatively inexpensive mono increases the available X-ray flux on many beamlines while preserving sufficient energy resolution for the majority of diffraction experiments. This development will have a big impact on synchrotron sources around the world (see page 30 for more information).

The best part is that I could go on for pages with more user accomplishments. I never cease to be amazed at the imagination and productivity of CHESS staff and users.