Volume 2 • Issue 4 • 2004

Environmental Molecular Sciences Laboratory

William R. Wiley
EMSL NEWS
Environmental Molecular Sciences Laboratory

More Powerful New Magnet Installed

Eagerly anticipated 12-tesla magnet replaces lower-field instrument

EMSL recently installed a new state-of-the-art magnet that is expected to provide unprecedented "top-down" capability to the user facility for studying proteomics.

Manufactured by Magnex Scientific Ltd. for Bruker Daltonics, the 12-tesla, 110-mm bore superconducting magnet was set up in EMSL's High-Performance Mass Spectrometry Facility at the end of October 2004. It replaced a 9.4-tesla magnet previously equipped on one of the facility's Fourier-transform ion cyclotron resonance (FTICR) mass spectrometers.

Tesla—named for early twentieth century scientist Nikola Tesla—is a unit of magnetic flux density that describes the strength of a magnet. Thus, a 12-tesla magnet is 240,000 times more powerful than the Earth's magnetic field.

"With a higher field—such as that of a 12-tesla instrument—the user achieves increased precision and accuracy in their measurements," says Harold Udseth, Technical Group Leader of the High-Performance Mass Spectrometry Facility.

Udseth's facility provides researchers with a sizeable array of instruments—16 mass spectrometers in all—that target the study of proteomics, or the study of a collection of proteins that make up a cell under a specific set of conditions. Such research has become critically important to solving environmental challenges such as those related to carbon sequestering and waste tank cleanup. Research at the facility has historically focused on "bottom-up" proteomics, which allows researchers to use mass spectrometry to detect peptides—or pieces of a protein—leading to positive identification of the presence of particular proteins that comprise a cell.

However, "bottom-up analysis is a very good technique for identifying a protein's presence—especially for simple systems like microbes—but not necessarily for identifying the form of the protein present," says Udseth

Case in point—more complex higher-order organisms such as cells from mammals. In these cases, bottom-up analysis is difficult to impossible because the cells of these organisms make many modifications to their proteins.

(see ***New Magnet***, page 4)

Harold Udseth, Technical Group Leader, makes adjustments to the new magnet that the High-Performance Mass Spectrometry Facility recently installed.

Talented Students Attend CTY Workshop at EMSL

CTY attendees during the workshop at EMSL.

On Saturday, November 6, excitement and anticipation filled EMSL's hallways and laboratories as the user facility played host to some of the Pacific Northwest's brightest seventh-, eighth-, and ninth-grade students. More than 80 exceptional students—together with their parents—attended a day-long workshop to learn about the emerging field of nanotechnology.

Sponsored by Johns Hopkins University Center for Talented Youth (CTY), the workshop brought students together to interact with prominent nanotechnology experts from EMSL, Pacific Northwest National Laboratory (PNNL), the University of Idaho, University of Washington, and Washington State University. The workshop was one of only seven that CTY sponsored during the months of October and November at locations in Boston, New York, Virginia, Maryland, California, and Washington state.

This was the first time that PNNL was invited to host one of the Family Academic Conferences. CTY was established in 1979 after studies indicated that science and mathematics education in the United States is frequently inadequate. The studies found that bright students who are exposed to science/math courses that are not engaging, who are unable to advance through the courses at their own pace, or who do not see the relevance of the courses to their own lives too often lose interest in the sciences. To mitigate the lack of interest, capable young students need exposure to and interaction with scientists who bring mathematics and science to life.

Coordinated by EMSL user Don Baer—who also serves as deputy manager of PNNL's nanoscience and nanotechnology initiative, the workshop included a welcome speech from interim EMSL Director Allison Campbell and a keynote speech from PNNL nanotechnology expert Paul Burrows. Students broke into small-group sessions where they were immersed in subjects such as carbon nanotubes, nano robots, and nanoparticles and introduced to the user facility's state-of-the-art nanotechnology equipment. One group gained hands-on experience—each controlling EMSL's $150,000 electron microscope to view a computer microchip under 50,000-power magnification.

"It's nice to see the equipment and facilities of a federally run lab," said Tim Long, an eighth-grade student from Sedro-Woolley, Washington, who decided after his visit to add nanoscientist to his growing list of potential careers that include chemist, astrophysicist, and aerospace engineer.

"I've had a lot of fun—especially the session where we discussed nano robots," added 13-year-old David Grunzweig of Spokane, who agreed that the workshop stimulated his imagination. "It was fun to come up with our own ideas about how they would work."

Comments received from the student surveys following the workshop ranged from "This is cool" to "I learned a lot about nanotechnology." One student said the workshop will help her decide where she will attend college in a few years. Alix, a ninth-grade student at Wenatchee High School in Wenatchee, Washington, is considering a career in forensics and felt the knowledge gained at the event was relevant to her future plans.

Students who participate in the CTY program are first required to take a test before being accepted. More information about this important program is located on the Johns Hopkins website at http://cty.jhu.edu/.

EMSL Displays Robots at DOE Youth Expo

On October 14, U.S. Department of Energy Secretary Spencer Abraham hosted the "What's Next Expo" at downtown Chicago's Navy Pier. The event's purpose was to inspire young people to pursue mathematical and scientific careers and was attended by 500 Chicago-area seventh- and eighth-grade students.

Eric Choi explains the mechanics of the sumo robots to a group of students at the "What's Next Expo."

EMSL's mission involves multidisciplinary education of next-generation scientists and engineers. Furthering this mission and heeding Secretary Abraham's call to cultivate "the stars of DOE years down the road," EMSL Instrument Development Laboratory (IDL) research scientist Eric Choi attended the inaugural expo to introduce engineering in a form that young teenagers understand—sumo robots.

Sumo robots tangle like their human counterparts, but "fight" to push each other off the robotic version of a wrestling mat—a circular black wooden board with a white line around the perimeter. These compact and lightweight robots are engineered by their developer with a programmable circuit board that operates a motor within desired parameters and optical sensors that "see" the white line and keep the robot from driving itself off the board.

Groups of expo attendees, including Secretary Abraham himself, watched Choi's four sumo robots—code-named Omega, Blockhead, The Borg, and Bob—grapple and asked questions about how they work.

"The kids really loved the robots; many wanted to know if they could build the robots themselves," says Choi, who encouraged his audience in the engineering principles during the three-hour event.

Choi is extensively involved with the effort of IDL staff to bring an interest in engineering to local high schools and statewide colleges. Researchers from several national laboratories, including the Pacific Northwest National Laboratory—on whose campus EMSL resides—presented in their areas of expertise. Next year's expo will be held in Albuquerque, New Mexico.

EMSL User Experience Rekindles Passion for Science

Being the only physicist at a small private liberal arts college for women can be an isolating experience professionally, so to be able to rub shoulders with other physicists and scientists and work at a national research laboratory was a dream come true for Peggy Perozzo, a professor at Mary Baldwin College in Virginia.

Perozzo spent four weeks at EMSL working with scientist Ken Beck and his team using EMSL's state-of-the-art equipment to conduct research in optics and photonics. "The equipment at EMSL and the collaboration with other scientists enabled me to carry out my experiments successfully," Perozzo continues. "The project I was involved in with Ken's group was very lucrative in terms of results, and we were able to publish a paper. This will reflect very favorably for me as I undergo my fourth year review."

Using a tunable light from a Nd:YAG pumped frequency-doubled dye laser at EMSL, Perozzo and her colleagues measured the photo-stimulated neutral bromine atom yields from KBr, NaCl, and KCl single crystals as a function of time-delay between two ultraviolet laser pulses. Two-laser excitation experiments specifically excite laser-generated transient centers with the bulk crystal. Such secondary excitation leads to enhanced Br and Br* neutral emission. A time-of-flight mass spectrometer determined the mass of the products and the amplified output was sent to a 500-MHz video amplifier and a digital oscilloscope. Velocity profiles of the yields were transformed into kinetic energy distributions.

"The experiments were important because they verified the generality of the excitonic model of surface excitation," says Perozzo.

Perozzo learned a lot during her time at EMSL and made new collaborative links. "It was a wonderful experience to be in a research lab again," she says. "I spent the past 7-8 years teaching physics at three liberal arts colleges and did not have the opportunity to engage in research. Though I was constantly aiming to perfect my classes and stay informed of new advances in the sciences, teaching the same introductory courses year after year can make one a bit stale. Working with Ken's group was refreshing for me professionally. Being in a one-person department, I don't often get the opportunity to discuss scientific research, at least not in my field. So to be able to participate in brainstorming sessions and data analysis, and tweaking lasers and taking data was an exciting opportunity, and it rekindled my passion for science and the joy of investigation."

New Magnet (continued from page 1)

Enter EMSL's new 12-tesla magnet, which enables top-down analysis—an innovative method for helping researchers understand the role, function, structure, and changing nature of cellular proteins within these more challenging organisms. Coupled with an FTICR mass spectrometer, the magnet provides the researcher with a unique tool complementary to historically repetitive bottom-up methods—resulting in not only a scientific understanding of the protein, but potential application to environmental challenges as well.

"During bottom-up analysis, you have to repeat the experiments enough times to obtain the statistics the researcher requires; it's a lengthy process, but we're the only facility I'm aware of that can complete each experiment in four hours," says Udseth. "With a targeted list of proteins of interest determined through bottom-up analysis, researchers can further their research using the top-down capabilities of the 12-tesla magnet to devise experiments for actually understanding the role and function of a protein."

Very few mass spectrometers of this strength are in existence; the Mayo Clinic installed a 12-tesla FTICR for their proteomics research in 2003. Now, Udseth and his staff are eagerly working to make the system available to their users by next summer.

"During the upcoming year, we will be developing as much capability for use of this instrument as possible so that it can be incorporated into EMSL's user program," says Udseth.

Udseth is also overseeing continued expansion of EMSL's already-expansive and sought-after mass spectrometry capabilities, including the addition of 800 square feet of new laboratory space that will house a new FTICR mass spectrometer and three new linear ion trap mass spectrometers.

"The inclusion of this new magnet to our robust collection of mass spectrometry instrumentation, along with a set of support procedures that address sample preparation and data analysis, make it practical and effective to investigate critical biological challenges," says Udseth. "We are among the premier research facilities capable of stepping up to these challenges."

William R. Wiley
EMSL NEWS
Environmental Molecular Sciences Laboratory

EMSL User Services
W.R. Wiley Environmental Molecular Sciences Laboratory
Pacific Northwest National Laboratory
P.O. Box 999
MS K8-84
Richland, WA 99352

The William R. Wiley Environmental Molecular Sciences Laboratory (EMSL) is a Department of Energy national scientific user facility located at Pacific Northwest National Laboratory (PNNL) in Richland, Washington. The EMSL is operated by PNNL for the DOE Office of Biological and Environmental Research.

For additional details about the capabilities and research being performed at EMSL, please visit our web site at http://www.emsl.pnl.gov or call us at 509-376-2553.