

FLC NORTHEAST REGION NEWSLETTER – WINTER 2009

PPPL Team Receives Edison Award for Nuclear Detection System

Nuclear detection system inventors at the Department of Energy's (DOE) Princeton Plasma Physics Laboratory (PPPL) have received a 2008 Thomas Alva Edison Patent Award. Charles Gentile, Andrew Carpe and Stephen Langish, who developed the Miniature Integrated Nuclear Detection System (MINDS), received the honor from the Research and Development Council of New Jersey during a November 6 dinner in Basking Ridge.

The award, which fell under the homeland security category, notes the team's invention and patent of MINDS. The PPPL team was among nine overall winners.

"PPPL's Charlie Gentile, Andy Carpe, and Steve Langish are well deserving of the prestigious Thomas Alva Edison Patent Award for their patent on MINDS," said Mike Williams, PPPL Associate Director for Engineering and Infrastructure. "I congratulate them for their accomplishment, the distinction they have brought to Princeton University and PPPL, and the hope that the deployment of this technology will make the world a safer place."

The team, led by engineer Gentile, developed the antiterrorism device with applications in transportation and site security. MINDS can be used to scan moving vehicles, luggage, cargo vessels, and the like for specific nuclear signatures associated with materials employed in radiological weapons. It could be employed at workplace entrances, post offices, tollbooths, airports, commercial shipping ports, as well as in police cruisers, to detect the transportation of unauthorized nuclear materials.

Princeton Plasma Physics Laboratory, funded by the DOE and managed by Princeton University, is a collaborative national center for science and innovation leading to an attractive fusion energy source. Fusion is the process that powers the sun and the stars. In the interior of stars, matter is converted into energy by the fusion, or joining, of the nuclei of light atoms to form heavier elements. At PPPL, physicists use a magnetic field to confine plasma. Scientists hope eventually to use fusion energy for the generation of electricity.

Physicists Receive Patent for Improved Cancer Therapy Device

Four physicists at Brookhaven National Laboratory have been awarded U.S. Patent No. 7,432,516 B2 for the design of a “medical synchrotron” capable of delivering precision doses of proton radiation to cancerous tumors with minimal damage to surrounding healthy tissue. The new device would be more precise and less costly than existing proton-therapy systems, potentially increasing the availability and benefits of this treatment for cancer patients worldwide. The Brookhaven scientists are now seeking industrial partners to license and commercialize the technology.

“In the realm of cancer treatment, proton therapy is considered ‘surgery without a knife’ because proton beams can deliver cell-killing energy with extreme precision, unlike conventional x-ray radiation therapy,” said Brookhaven physicist Stephen Peggs, one of the project’s lead scientists. Peggs, while working at the Department of Energy’s (DOE) Fermi National Accelerator Laboratory, witnessed the completion of the nation’s first hospital-based proton-therapy synchrotron, installed at California’s Loma Linda University Medical Center in 1990.

“Almost as soon as the Loma Linda synchrotron went out the door, we started thinking about ways to build a better machine,” Peggs said. The current design—developed and refined as Peggs and other physicists worked on large-scale accelerators for physics experiments, including the relativistic heavy ion collider (RHIC) at Brookhaven—is the culmination of that effort.

“Our new design has improvements in beam-focusing technology to make the smallest possible beam size—that is, the sharpest possible ‘knife,’” said Peggs. Because smaller beams deliver radiation with increased precision, this improvement could have a significant impact by shortening the duration of treatment, increasing its effectiveness, or both. The new design also promises to be less costly and more reliable, which should increase its availability.

How it works

The idea behind radiation therapy is to deliver a lethal dose of radiation to cancerous cells. In conventional x-ray radiation therapy, many healthy surrounding cells are also exposed to the radiation because x-ray beams deposit their energy as they travel through tissue. In fact, most of the dose of x-rays is deposited near the surface of the body. Though cancerous cells tend to be more susceptible to the damaging effects of radiation (or less able to repair it), the collateral damage to healthy tissues limits the dose physicians can use to destroy the tumor.

FLC NORTHEAST REGION NEWSLETTER – WINTER 2009

Physicists Receive Patent for Improved Cancer Therapy Device (cont.)

Proton therapy offers an advance over conventional x-rays because proton beams deposit most of their energy where the beam stops. The original proton therapy synchrotrons were designed to deliver cell-killing doses of radiation to tumors in three dimensions by aiming proton beams from multiple directions to stop at the depth of the tumor tissue. That precision targeting allows doctors to deliver higher doses to the tumor cells while sparing healthy surrounding tissue.

But accelerators are often costly to build and difficult to maintain, which explains why the design principles for hospital-based accelerators must be radically modified and why relatively few hospitals have them. The new accelerator design developed by the Brookhaven team offers two main advantages: rapid cycling and strong focusing. Rapid cycling allows proton beams to be injected and extracted from the synchrotron in just one turn around the circular particle accelerator. Unlike the earlier machines, which required multiple turns, this eliminates the need for sensitive feedback systems to control the beam currents.

“This makes the machine more robust and reliable to operate. It’s more of a turnkey operation,” Peggs said. “Turn it on and it consistently starts up like a transformer, rather than booting up like a PC.”

Strong focusing refers to the ability to shape the proton beam and keep it focused to pinpoint dimensions. In contrast to the Loma Linda machine, where beams measure up to a centimeter across, the new design can achieve beams as narrow as one millimeter. Pinpoint accuracy reduces collateral damage and allows physicians more flexibility in the doses they use. Higher doses could yield more effective therapy, possibly in fewer treatments.

Compact beam size has other benefits as well: smaller components (beam pipes, magnets, etc.) for the whole device. That makes everything lighter, and less expensive, according to Peggs. A smaller size will also eliminate the need to water-cool most magnets; air-cooling will be sufficient. That adds up to even more cost savings. “Our biggest challenge now is to find partners in an industrial consortium to help us build one of these new machines,” said Peggs. “It’s part of our mission as a national laboratory to put together teams and serve national needs in terms of technology transfer. We would help to build the first specialized, high-tech items, but most of an accelerator is made from conventional technology, and that can be done by industry. So we are looking for a consortium to see this move into the commercial sector—and hospitals across the country,” he said.

In addition to Peggs, Michael Brennan, Joseph Tuozzolo, and Alexander Zaltsman, all in Brookhaven’s Collider-Accelerator Department, collaborated on the project. Their ideas and designs stem directly from their experience working on particle accelerators for physics experiments. “It’s the fact that we do the science for accelerators like RHIC that allows us to do this for medical applications,” Peggs said.

FLC NORTHEAST REGION NEWSLETTER – WINTER 2009

Aviation Research and Technology Park Lease Signing Advances Key NextGen-related Venture

The Federal Aviation Administration's (FAA) William J. Hughes Technical Center has entered into a lease and Memorandum of Understanding with the South Jersey Economic Development District to build an Aviation Research and Technology Park adjacent to the Technical Center, near Atlantic City, N.J. The lease transfers control of 55 acres of Technical Center property for construction of the complex. The agreement was signed October 31.

The park, which will be built at no direct cost to the FAA, will be a high-technology, integrated, dynamic aviation facility that provides the infrastructure for national and international leadership in aviation research and technologies. The park will offer a central location for the FAA's partners to perform research, development, testing, integration and verification of the technologies, concepts and procedures required by the Next Generation Air Transportation System (NextGen).

By 2025 U.S. air traffic is predicted to more than double, and the current air traffic control system will not be able to manage this growth. NextGen is a transformation of the National Airspace System (NAS), including the national system of airports, which uses 21st century technologies to ensure that future safety, capacity and environmental needs are met. NextGen will be realized through coordinated efforts by the Departments of Transportation, Defense, Homeland Security, and Commerce, as well as the FAA, NASA, and the White House Office of Science and Technology Policy. The NextGen vision was developed by the Joint Planning and Development Office, which facilitates interagency cooperation.

The Aviation Research and Technology Park, Inc., was created as a nonprofit corporation and includes representatives of state and local government agencies, academia, and the private sector. With several direct participants and even more stakeholders in this project, the New Jersey Economic Development Authority and the South Jersey Economic Development District were co-applicants on a \$2.5 million grant from the U. S. Economic Development Administration to build the infrastructure of the research park.

The South Jersey Economic Development Division received the grant and secured a \$5 million bank loan to develop the infrastructure. As lessee of the 55 acres from the FAA, the Economic Development Division prepared an aggressive schedule, with construction scheduled to begin in April 2009 and completion planned for April 2011.

The lease authorizes construction and maintenance of the facilities, and the creation and operation of the Aviation Research and Technology Park, a research institution to perform aviation research and development; aviation security and safety; research, development, and testing of air traffic control systems; and research and development for airports and airport operations. The memorandum of agreement supplements the terms and conditions of the lease and clarifies use of the land.

FLC NORTHEAST REGION NEWSLETTER – WINTER 2009

Aviation Research and Technology Park Lease Signing Advances Key NextGen-related Venture (cont.)

The Aviation Research and Technology Park will complement Florida's NextGen demonstration capabilities at Daytona International Airport. Advanced NextGen technologies developed and tested at the Technical Center will be demonstrated in an operational environment at Daytona, then returned to the Technical Center for integration with the current NAS and other components of NextGen.

NOAA Fisheries Research Ship Retired

The National Oceanic and Atmospheric Administration's (NOAA) research ship *Albatross IV* was decommissioned on November 20, 2008, ending her distinguished 45-year career serving the nation. The vessel sailed over 655,000 miles on 453 research cruises, primarily fisheries surveys off the northeastern coast of the United States. These surveys created the world's longest continuous study of fish population data.

NOAA's new fisheries survey vessel, *Henry B. Bigelow*, is replacing the *Albatross IV*, ensuring that the collection of important ecological data goes uninterrupted. "*Albatross IV* is the grand old lady of the NOAA fleet," said William J. Brennan, Ph.D., acting Under Secretary of Commerce for oceans and atmosphere and acting NOAA administrator. "I am proud to be one of the scientific crew members who sailed aboard this vessel that contributed significantly to our extensive knowledge about important fishery stocks and the marine environment off the Northeast."

Albatross IV is the last of four vessels sharing the same name that have sailed from Woods Hole since 1883. The original *Albatross* was the first to be built exclusively for marine research by any government. Built in 1962, *Albatross IV* was the first vessel in the modern shipbuilding era, and continued the long scientific tradition established by the first three *Albatross* vessels.

"More than 2,400 people sailed aboard *Albatross IV*, some working their entire careers with the vessel," said Rear Admiral Jonathan W. Bailey, director of the NOAA Corps, one of the nation's seven uniformed services, and director of NOAA's Office of Marine and Aviation Operations. "We are sad to see her go, but look forward to continuing this important work with *Henry B. Bigelow*, a ship that is as much a quantum leap forward in capability for us now as was *Albatross IV* when she entered service back in 1963."

For most of her service life, the 187-foot *Albatross IV* conducted sampling and research cruises across the Northeast Continental Shelf in support of NOAA's Northeast Fisheries Science Center. Her key projects included annual spring and autumn groundfish and sea scallop trawls.

FLC NORTHEAST REGION NEWSLETTER – WINTER 2009

NOAA Fisheries Research Ship Retired (cont.)

The magnitude of information collected by a ship like *Albatross IV* can be overwhelming. During each cruise, fish and invertebrates were sorted on deck by species. The data about each fish, such as its sex, weight, length and stomach contents, was recorded. Oceanographic data are also collected by sensors, both shipboard and deployed. A typical fishery resource survey cruise takes about 45 days.

Albatross IV was also a “school” for software engineers, who developed a computerized system for fisheries data collection with scientists from NOAA’s Northeast Fisheries Science Center during the annual trawls. The ship then served as the test platform in 2001 for the automated system that signaled the end of nearly four decades of pencil and paper data recording aboard NOAA fisheries ships in the Northeast. The successful tests aboard *Albatross IV* led to the installation of the system across the NOAA fisheries fleet.

As part of the fleet of NOAA research and survey ships and vessels, *Albatross IV* was operated, managed, and maintained by officers of the NOAA Corps, masters and wage mariners under NOAA’s Office of Marine and Aviation Operations. Her last captain was Master Stephen Wagner, a resident of Woods Hole, Mass.

Hope for Treating Relapse of Methamphetamine Abuse

A new study at Brookhaven National Laboratory suggests that vigabatrin (a.k.a. gamma vinyl-GABA, or GVG) blocks drug-seeking behavior in animals previously trained to associate methamphetamine with a particular environment. Specifically, animals pretreated with vigabatrin lost interest in spending time in a location where they previously had been given methamphetamine. The results will appear in the February 2009 issue of *Synapse*.

“Reinstatement of drug-seeking behavior after an extended period of abstinence is the number-one cause of drug-addiction relapse,” said Brookhaven neuroanatomist Stephen Dewey, who led the research team. “This animal study suggests that vigabatrin could potentially prevent human methamphetamine addicts from relapsing.”

According to the National Institute on Drug Abuse, methamphetamine is a very addictive stimulant that is quickly becoming an American public health epidemic. Currently, no effective treatment for methamphetamine addiction exists.

Vigabatrin is a pharmaceutical agent first tested as a possible treatment for a variety of addictions in animal studies led by Dewey at Brookhaven. It is the only drug that has been shown to block any behavior associated with methamphetamine use, and it is currently being tested by Catalyst Pharmaceutical Partners for safety and efficacy against cocaine and methamphetamine addiction in humans in Phase II clinical trials across the U.S.

FLC NORTHEAST REGION NEWSLETTER – WINTER 2009

Hope for Treating Relapse of Methamphetamine Abuse (cont.)

“In human drug abusers, many things can cause relapse—exposure or access to drugs, environmental cues that trigger thoughts of the drug, or stress,” said Dewey. “If vigabatrin can prevent relapse, it could have a huge impact by helping drug abusers regain control over their lives.”

In the current study, rats were first put through a series of conditioning tests that taught them to expect methamphetamine in one chamber of a three-chamber apparatus and saline solution in another. The researchers then allowed the rats to roam freely among the three chambers. If the rats spent the majority of their time in the chamber where they had been given methamphetamine, the scientists knew they had established a “conditioned place preference.”

Once this preference was established, the researchers extinguished it by giving the rats saline injections in both chambers, again allowing the animals free access to all chambers until the rats had no preference for the previously methamphetamine-associated chamber for at least six consecutive days.

Once extinguished, however, it is possible for a conditioned preference to be reinstated—just as it is possible for a recovered drug addict to relapse. To reinstate the place preference in this experiment, Brookhaven scientists injected the rats with methamphetamine in the neutral chamber. Immediately, rats went to the chamber where they had received methamphetamine and remained there for the duration of the exposure period.

Then, once the reinstatement of a preference was clearly demonstrated, researchers tested vigabatrin’s effectiveness blocking it. They pretreated animals with vigabatrin two-and-one-half hours before giving them another priming dose of methamphetamine followed by free access to all three chambers. When pretreated with vigabatrin, the rats no longer showed any preference for one chamber over another.

Dewey’s group is now conducting studies to examine whether GVG will also block an environmental cue previously shown to produce a relapse of drug-seeking behavior. “These studies have wide implications for addressing the number-one cause of relapse to drug-seeking behavior. If we can successfully block drug-induced reinstatement, then our ability to block environmental cue-induced relapse is significantly enhanced,” Dewey said.

FLC NORTHEAST REGION NEWSLETTER – WINTER 2009

Hope for Treating Relapse of Methamphetamine Abuse (cont.)

Collaborators on this study included: Amy DeMarco, now an M.D./Ph.D. student at Stony Brook University, who conducted the research while working in Dewey's lab at Brookhaven last summer and is lead author on the paper; Reema Dalal, Jessica Pai, and Jonathan Brodie of New York University; Stefanie Aquilina of Cornell University; Uma Mullapudi of Dartmouth College; Shiva Kothari of Duke University; Milan Kahanda of Rensselaer Polytechnic Institute; and Crystie Hammel, Courtney Liebling, Vinal Patel, and Wynne Schiffer of Brookhaven Lab. The research was funded by the National Institute on Drug Abuse and the Office of Biological and Environmental Research of the Department of Energy's (DOE) Office of Science.

Brookhaven has a world-renowned research program aimed at understanding the neurological mechanisms and consequences of drug addiction and other addictive behaviors. This program is fueled, in part, by DOE's longstanding support of brain-imaging technologies developed as a direct outgrowth of its commitment to basic physics and nuclear chemistry research.

All research involving laboratory animals at Brookhaven National Laboratory is conducted under the jurisdiction of the Lab's Institutional Animal Care and Use Committee in compliance with the Public Health Service Policy on Humane Care and Use of Laboratory Animals, the U.S. Department of Agriculture's Animal Welfare Act, and the National Academy of Sciences' Guide for the Care and Use of Laboratory Animals. This research has enhanced understanding of a wide array of human medical conditions, including cancer, drug addiction, Alzheimer's and Parkinson's diseases, and normal aging, and has led to the development of several promising treatment strategies.

FLC NORTHEAST REGION NEWSLETTER – WINTER 2009

Navy Divers Chill in Army Chambers

Researchers from the Naval Submarine Medical Research Laboratory (NSMRL) in Groton, Conn., used the Doriot Climatic Chambers at the U.S. Army Soldier Systems Center (SSC) in Natick, Mass., to begin an evaluation of two different designs of submarine escape immersion equipment (SEIE) suits. Participating in the study are four volunteer Navy divers divided into groups of two; each group is in the SEIE in an inflatable pool within the chambers. "They are trying to simulate an emergency evacuation from a disabled submarine and waiting for rescue," said Josh Bulotsky, an SSC electrical engineer.

According to Lt. Jon Vanderweele, NSMRL undersea medical officer, the Navy is looking at two competing designs of SEIE to possibly replace the current generation aboard submarines. Both consist of a dry suit with inflatable hood and air pockets that also have an inflatable raft attached. The idea is to evaluate the two different designs to see the pros and cons of each, including which design provides the best thermal protection.

"Rescue is always preferable to escape, but if the crew on a disabled submarine is forced to escape by swimming out the escape trunk, this equipment is designed to keep them afloat on the surface until they are picked up. We want to evaluate its ability to keep them warm in an arctic sea environment," Lt. Venderweele said. "After escaping, the submariners may end up scattered over a large area, and they may be waiting a day or two before rescue. We want to prevent hypothermia while they are waiting."

In test conditions, the chambers are kept at 35 degrees Fahrenheit with a constantly blowing 15 mile-per-hour wind. In addition, the water in the pools is chilled to 37 degrees Fahrenheit, and water is periodically poured on the volunteers to simulate waves or rain. "We want to see if heat gets pulled away from the SEIE suit," noted Lt. Venderweele.

Eleven different sensors monitor the volunteers' core and skin temperatures. Although the idea was to have the volunteers sit in the pools for 24 hours straight, the divers needed to stop this first test after approximately eleven and one-half hours. Even after about three and one-half hours, the divers said their hands and feet were beginning to get cold. The goal is to have five iterations of the test.

"We will take the data and evaluate it to see if one design is better than the other or if there is some combination that might be best," Lt. Venderweele said. "For instance, based on the hands and feet comment, maybe there is a need for better gloves or booties."

FLC NORTHEAST REGION NEWSLETTER – WINTER 2009

Navy Divers Chill in Army Chambers (cont.)

After learning about the test, the Combat Feeding Directorate (CFD) provided some rations for evaluation. They supplied shortbread bars, a previously approved ration component, and the volunteers are going to evaluate the packaging and ease of use in a wet, cramped environment. The bars are a current component of the food packet survival package and have a proven shelf life beyond the current requirement of five years. The Navy has expressed the need for a product with a seven-year shelf life, she said. The participants will eat one shortbread bar every six hours during the study and, after testing, divers will be asked to complete a brief questionnaire to gather information on product acceptability.

For upcoming iterations of the testing, Lt. Vanderweele is working with the CFD to investigate the possibility of evaluating reverse osmosis water purification systems to convert sea water into potable water for inclusion in the SEIE system. CFD will be providing NSMRL some information on these types of systems.

Both Bulotsky and Lt. Vanderweele agree that this collaboration between the Army and the Navy has been beneficial. Lt. Vanderweele pointed out that testing with manikin simulations is not the same as human volunteers; and although the original thought was to do this testing at sea, the Doriot Climatic Chambers provides more controlled test conditions and is safer for the volunteers.

Save the Date: Spring 2009 Regional Meeting

The next Northeast regional meeting will take place March 16-18, 2009, at the Newport Undersea Warfare Center, Division Newport, located in Newport R.I. Join us for three days of networking, discussions about technology transfer issues, laboratory tours, and entertaining social events.

More information on the meeting, including an agenda and hotel information, will soon be available online at www.flcnortheast.org.