

Office of the President

TO MEMBERS OF THE COMMITTEE ON OVERSIGHT OF THE DEPARTMENT OF ENERGY LABORATORIES:

DISCUSSION ITEM

For Meeting November 20, 2014

UPDATE ON THE DEPARTMENT OF ENERGY LABORATORIES AND PRESENTATION ON LAWRENCE LIVERMORE NATIONAL LABORATORY: SCIENCE AND TECHNOLOGY ON A MISSION

This discussion will review recent administrative matters and program accomplishments at the three University of California-affiliated DOE National Laboratories:

- Lawrence Berkeley National Laboratory (LBNL or Berkeley Lab)
- Lawrence Livermore National Laboratory (LLNL or Lawrence Livermore)
- Los Alamos National Laboratory (LANL or Los Alamos)

Lawrence Livermore National Laboratory: Science and Technology on a Mission

Lawrence Livermore National Laboratory (LLNL) Director William Goldstein will provide an overview of the frontier science and technology (S&T) conducted at LLNL to address national security problems. LLNL has a primary mission to ensure the safety, security, and effectiveness of the U.S. nuclear deterrent and to counter the spread and potential use of nuclear, radiological, chemical, and biological weapons. In its broader national security mission, LLNL conducts research and development (R&D) in energy technologies and systems, provides solutions to the nation's uniformed services, and engages in cooperative threat reduction activities around the world. The Laboratory works closely with academic institutions to advance fundamental research, support science, technology, engineering and math (STEM) education, and help train the S&T workforce needed to meet future national security challenges. Technology transfer and commercialization leverage industrial partnerships that translate Laboratory S&T solutions to end users and contribute to national security through enhancing U.S. economic competitiveness.

Frontier R&D underlies LLNL's ability to deliver cutting-edge solutions for its mission. Work at the forefront attracts and engages the best minds, drives innovation that leads to novel approaches to hard problems, and helps LLNL anticipate future technological developments around the world. Recent examples of pushing S&T boundaries and strengthening mission delivery include the discovery of element 116, Livermorium, the recreation of conditions approximating the center of Jupiter on the National Ignition Facility (NIF), and the application of additive novel manufacturing techniques to develop new classes of materials.

ADMINISTRATIVE UPDATES

Los Alamos National Laboratory largest site in Department of Energy (DOE)'s complex to attain DOE's highest achievement level safety and health recognition

In October LANL received Star-level recognition from the Department of Energy as part of DOE's Voluntary Protection Program (VPP). Star is a status for DOE contractors who have and continue to implement excellent safety programs that systemically protect employees. It is based on an assessment of management commitment, employee involvement, worksite analysis, hazard prevention and control, and safety and health training. Star recognition is the highest achievement level and recognizes outstanding safety and health programs. Los Alamos becomes the largest site in the DOE complex to receive VPP Star status.

LABORATORY HIGHLIGHTS

Lawrence Berkeley National Laboratory

Advanced Light Source user develops drug to help save lives of Ebola victims

With the Ebola virus outbreak worsening and the news of two Americans who recovered thanks to a cutting-edge drug treatment, structural biologist Erica Ollmann Saphire has been thrust into the news as a spokesperson for the scientific community. Saphire, who has been a Lawrence Berkeley National Laboratory (LBNL) Advanced Light Source user for the past 16 years, found herself in a new role as an Ebola virus researcher, whose Scripps Research Institute laboratory played a key part in understanding and fine-tuning the much-lauded Ebola treatment, ZMapp, which helped save an American doctor and nurse in September.

Saphire sees the experience as a way to shed light on the importance of public funding for basic research, stressing that without funding and access to synchrotrons like the Advanced Light Source at LBNL, drug development for diseases like Ebola would not move forward. She has also seen it as an opportunity to convey to people that structural biology is not as complicated as they might think, using visually compelling models to explain how viruses, and the drugs that target them, work.

Interactive map reveals rooftop reflectance for five California cities

Scientists from LBNL have created an interactive map that displays the solar reflectance (also known as albedo) of individual roofs in five California cities. The interactive map offers a bird's-eye view of rooftop albedo in San Francisco, Los Angeles, Long Beach, Bakersfield, and San Jose. The map gives viewers an ability to zoom in to see the albedo of an individual roof, and how it compares with the albedo of a white roof, the albedo of a cool-colored roof, and the average albedo of all the roofs in the city. The albedo map is intended to help homeowners and commercial property owners better understand their roof reflectance. It is also intended to help policymakers visualize the albedo of each city's current roofing stock, and inform the development of policies that could lead to cooler cities. Cool roof experts in LBNL's Heat Island Group, part of the Environmental Energy Technologies Division, developed the map with help

from LBNL's Public Affairs Department. The California Air Resources Board funded the research behind the map.

Lawrence Livermore National Laboratory

Lawrence Livermore National Laboratory researchers develop a method for making strong, ultra-low density materials

In a paper featured on the cover of the journal *Advanced Materials*, Lawrence Livermore National Laboratory (LLNL) researchers reported on their synthesis of low-density, high-strength materials that make use of a novel interconnected “nanotubular” geometry that they developed. Unlocking the full potential of these materials requires the researchers to build structures with precise microscopic control over the manufacturing using a method that builds on a substrate of nanoporous gold that controls the density, pore size, and composition of the material. The resulting interconnected networks overcome the decrease in strength and stiffness often found in low-density materials, yielding products that are stable over wide ranges of temperature and about ten times stronger and stiffer than traditional materials. The LLNL approach opens new opportunities in wide-ranging fields including energy, catalysis, sensing, and filtration. This work was supported by LLNL's Laboratory Directed Research and Development (LDRD) Program.

A “molecular movie” of photosynthesis

In a paper published by the journal *Nature*, an international team that includes LLNL reports on light-induced changes in one of the two large protein complexes that catalyze photosynthetic reactions. The team used the x-ray free-electron laser at the Stanford Linear Accelerator to collect data that show for the first time how the structure changes in time. They determined the molecular structure of the protein in its dark and light-affected states, showing how specific molecular regions of the complex change shape as photosynthesis proceeds. LLNL's participation in this work was funded through the UC Laboratory Fee Research Program. Foundational work on developing this capability was funded by the Laboratory's LDRD Program.

Los Alamos National Laboratory

Breakthrough antibacterial approach could resolve serious skin infections

In a recent groundbreaking manuscript appearing in the *Proceedings of the National Academy of Science*, researchers in a multi-institutional effort between Los Alamos National Laboratory (LANL), the University of California Santa Barbara, Dixie State University, and Northern Arizona University explored exploiting ionic liquids in a concerted effort to combat antibiotic-resistant bacterial biofilms in skin, as well as for topical transdermal drug delivery. Effective treatment of skin-based bacterial biofilms has been identified as a serious and unmet medical need.

Like a protective tent over a colony of harmful bacteria, biofilms make the treatment of skin infections especially difficult. Biofilms often persist in the periphery of an actual wound, beneath an intact, healthy skin layer. Microorganisms protected in a biofilm pose a significant health risk because of their antibiotic resistance and recalcitrance to treatment. Biofilm-protected bacteria account for some 80 percent of total bacterial infections in humans and are 50 to 1,000 times more resistant to antibiotics than simpler bacterial infections. They are a major cause of chronic wounds and wound degeneration.

Of the materials examined by the research team, choline-glycerate emerged as a multipurpose ionic liquid with excellent antimicrobial activity, minimal toxicity to epithelial cells as well as skin, and effective permeation enhancement for drug delivery. This work could have especially useful applications for military medical treatments where soldiers in the field can be exposed to bacterial infections that are particularly difficult to treat. Topical application as a prophylaxis or direct treatment to an open wound could provide enough time to reach the proper medical facilities when in an austere environment. Importantly, ionic liquids can be derived from inexpensive starting materials that are Food and Drug Administration approved and are extremely stable to high temperatures and pressures, which are necessary traits for commercialization in real-world applications. This research was supported by funds from the UC Laboratory Fees Research Program, UC Office of the President, Grant Number 12-LR-237080.

Agreement with Allied Minds to license LANL's wide-scale, quantum key distribution technology for truly secure commerce, banking, communications, and data transfer

The largest information technology agreement ever signed by LANL brings the potential for truly secure data encryption to the marketplace after nearly 20 years of development at one of the nation's premier national security science laboratories. By harnessing the quantum properties of light for generating random numbers, and creating cryptographic keys with lightning speed, the technology enables a completely new commercial platform for real-time encryption at high data rates. For the first time, ordinary citizens and companies will be able to use cryptographic systems that have only been the subject of experiments in the world's most advanced physics and computing laboratories for real-world applications. If implemented on a wide scale, quantum key distribution technology could ensure truly secure commerce, banking, communications, and data transfer.

The technology at the heart of the agreement is a compact random-number-generation technology that creates cryptographic keys based on the truly random polarization state of light particles known as photons. Because the randomness of photon polarization is based on quantum mechanics, an adversary cannot predict the outcome of this random number generator. This represents a vast improvement over current "random-number" generators that are based on mathematical formulas that can be broken by a computer with sufficient speed and power. Any attempt by a third party to eavesdrop on the secure communications between quantum key holders disrupts the quantum system itself, so communication can be aborted and the snooper detected before any data are stolen.

The technology transfer agreement is between LANL and Whitewood Encryption Systems, Inc. of Boston, Mass., a wholly owned subsidiary of Allied Minds. The agreement provides exclusive

license for several LANL-created quantum-encryption patents in exchange for consideration in the form of licensing fees. The LANL technology is simple and compact enough that it could be made into a unit comparable to a computer thumb drive or compact data-card reader. Units could be manufactured at extremely low cost, putting them within easy retail range of ordinary electronics consumers.

Key to Acronyms

DOE	United States Department of Energy
LANL	Los Alamos National Laboratory
LBNL	Lawrence Berkeley National Laboratory
LDRD	Laboratory Directed Research and Development
LLNL	Lawrence Livermore National Laboratory
NIF	National Ignition Facility
R&D	Research and Development
S&T	Science and Technology
STEM	Science, technology, engineering, and mathematics
VPP	Voluntary Protection Program