

The **FUTURE** of America is the
RESEARCH of **TODAY**



U.S. House of Representatives Committee on Science, Space, and Technology

Subcommittee on Energy and Environment

**Hearing on Department of Energy User Facilities: Utilizing the Tools of Science to
Drive Innovation through Fundamental Research**

June 21, 2012

**Written Testimony Regarding the National User Facility Organization and the role
of DOE's user facilities in the U.S. scientific enterprise.**

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Senior Research Associate, The University of Chicago**

Written Testimony

Introduction

Chairman Harris, Ranking Member Miller and distinguished members of the Committee, I thank you for this opportunity to testify. My name is Antonio Lanzirotti, I am a Senior Research Associate at the University of Chicago's Center for Advanced Radiation Sources. It has also been an honor for me to serve this past year as the elected Chair of the National User Facility Organization and it is in that capacity that I am here today.

Founded in 1990, our organization was established in the hopes of facilitating communication among researchers that utilize our nation's scientific user facilities and facility administrators and stakeholders. We are a volunteer, non-profit entity and it is our hope that through these efforts we can educate our scientific peers and the American public of the availability, benefits and significance of research conducted at these facilities and provide a conduit for the scientific user community to disseminate recommendations of what we perceive are their operational needs.

Diverse Scientific User Community

Today the National User Facility Organization (NUFO) represents the almost 45,000 scientists who conduct research at the 46 largest federally funded user facilities in the United States. Of these, 36 facilities are managed by the Department of Energy, hosting almost 37,000 scientists each year.¹ These users reside in all 50 States, the District of Columbia, in our U.S. territories, and many are international scientists that travel here specifically to conduct their research using these tools.² They come from close to 600 universities in the U.S. and from more than 400 universities abroad. Roughly 7,000 of these users are students and postdoctoral researchers who depend on access to facilities to complete their education and train to be future scientists and engineers.³

Our community includes scientists from 400 unique companies including 45 Fortune 500 companies and 22 Fortune 100 companies. Companies such as General Electric, General Motors, Eli Lilly, IBM, Procter & Gamble, Boeing, Pfizer, Intel, Honeywell

¹ Complete listing of facilities at which users are NUFO members is available at <http://www.nufo.org/facilities.aspx>. We have also assembled posters highlighting each facility which is available at <http://www.nufo.org/posters.aspx>.

² Please see appended "Institutions that Conduct Research at U.S. National User Facilities". List was compiled by the National User Facility Organization (NUFO) through queries of Facility Administrators.

³ These metrics have been compiled by NUFO through queries of Facility Administrators. There are certainly differences in how each individual facility gathers these types of metrics and what and how often they require users to provide them. Additionally many scientists may utilize multiple facilities, so these values reported to us represent individual researchers at each individual facility.

International, DuPont, Abbott Laboratories, Northrop Grumman, and Hewlett-Packard have used multiple facilities in their industrial research.⁴

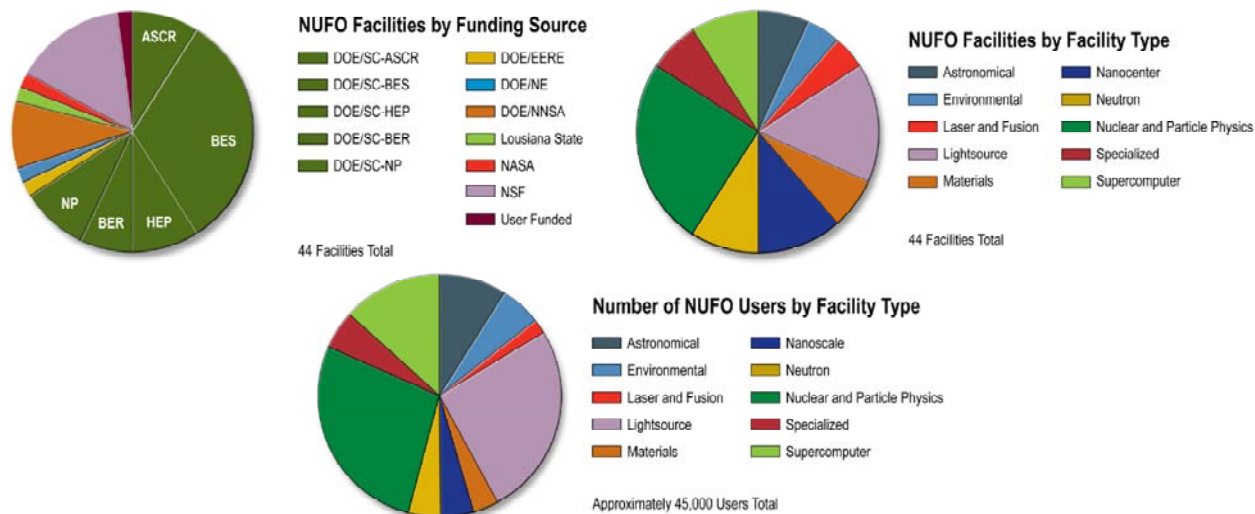


Figure 1: Demographics of the National User Facility Organization (NUFO) user community as of February 2012. Upper left denotes the primary funding agency for facility operations. Upper right denotes the type of facility and Bottom shows what fraction of our membership utilizes each facility type.

These facilities allow us to study our world and our universe in unprecedented detail with efficiencies orders of magnitude higher than what could be accomplished with smaller-scale instruments at our home institutions. It would simply be too costly and complex today for facilities such as these to be constructed and operated by universities or industry on their own.

These thousands of researchers also leverage their access to Office of Science User Facilities to maximize their productivity, research funded not only by the Office of Science but also NSF, NIH, NASA, DOD, DARPA, NNSA, EPA, NIST, DOA and private industry to name only a few.

Broad Scientific and Industrial Impact

The tremendously broad scope of science these facilities have allowed us to address is often underappreciated, impacting virtually every scientific field of study both in fundamental and applied sciences.

In the life sciences, for example, the high-brightness synchrotron X-ray facilities operated by the Office of Science have revolutionized the way that diffraction data from macromolecular crystals are being collected, as I am sure my colleague Dr. Wasserman will attest to. Macromolecular or Protein Crystallography using synchrotron X-ray

⁴ Data was compiled by NUFO again querying Facility Administrators. Compiled list is attached at end of this testimony and also available online at http://www.nufo.org/files/Fortune_500.pdf .

sources have allowed researchers to study biological molecules such as proteins, viruses and nucleic acids (RNA and DNA) to a resolution higher than $\sim 5 \text{ \AA}$. This high resolution has allowed life scientists to elucidate the detailed mechanism by which these macromolecules carry out their functions in living cells and organisms and the benefit of this research to the American people is tangible. As an example, scientists from Plexxikon, a Berkeley-based drug-discovery company⁵, used this technique to co-crystallize a BRAF mutated protein involved in the development of malignant melanoma along with small molecule lead candidates. Identifying the most promising lead then allowed them to identify potential drug candidates that could stop the disease's spread. This led to the development of a new drug, Zelboraf (Vemurafenib), that has been demonstrated to successfully treat patients with late-stage or inoperable forms of the disease, receiving FDA approval in August, 2011.⁶

Our material science community in particular is actively utilizing these tools to help develop methods that can ultimately be ported from one-of-a-kind technologies at a national user facility to broader adoption in private industry. For example, current lithography technology in production by semiconductor manufacturers can allow them to print circuits as small as 32 nanometers in width. Industry researchers today are using DOE scientific user facilities to develop new Extreme ultraviolet (EUV) lithography technologies⁷ that, when commercialized, will allow manufacturers to print circuit patterns onto computer chips with feature sizes smaller than 12 nanometers, providing factors of 10 improvements in speed and memory capacity compared to today's most powerful chips.⁸

⁵ **A. Pollack**, Studies Find Two New Drugs Effective Against Advanced Melanoma, The New York Times. (2011).; **Tsai J**, Lee JT, Wang W, Zhang J, Cho H, Mamo S, Bremer R, Gillette S, Kong J, Haass NK, Sproesser K, Li L, Smalley KS, Fong D, Zhu YL, Marimuthu A, Nguyen H, Lam B, Liu J, Cheung I, Rice J, Suzuki Y, Luu C, Settachatgul C, Shellooe R, Cantwell J, Kim SH, Schlessinger J, Zhang KY, West BL, Powell B, Habets G, Zhang C, Ibrahim PN, Hirth P, Artis DR, Herlyn M, Bollag G (2008) Discovery of a selective inhibitor of oncogenic B-Raf kinase with potent antimelanoma activity. Proc Natl Acad Sci USA 105:3041–3046

⁶ .FDA approval August 17, 2011. Work conducted at the Advanced Photon Source at Argonne National Laboratory, the Stanford Synchrotron Radiation Lightsource at SLAC National Accelerator Laboratory and the Advanced Light Source at Lawrence Berkeley National Laboratory.

⁷ **P. Naulleau**, C. Anderson, L.-M. Baclea-an, D. Chan, P. Denham, S. George, K. Goldberg, B. Hoef, G. Jones, C. Koh, B. La Fontaine, B. McClinton, R. Miyakawa, W. Montgomery, S. Rekawa, and T. Wallow, "The SEMATECH Berkeley MET pushing EUV development beyond 22-nm half pitch," Proc. SPIE 7636, 76361J (2010); **P. Naulleau**, C. Anderson, L. Baclea-an, P. Denham, S. George, K. Goldberg, G. Jones, B. McClinton, R. Miyakawa, I. Mochi, W. Montgomery, S. Rekawa, and T. Wallow, "Using synchrotron light to accelerate EUV resist and mask materials learning," Proc. SPIE 7985, 798509 (2011).

⁸ Work conducted at the Advanced Light Source at Lawrence Berkeley National Laboratory.

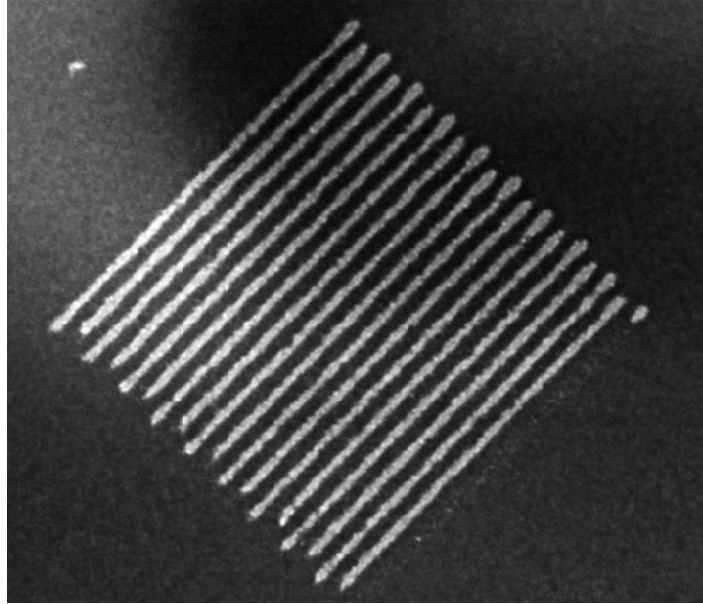


Figure 2: Using an experimental photosensitive spin-on inorganic ultrathin imaging film (photoresist) provided by Inpria Corporation, 16-nm lines and spaces were printed on the SEMATECH Berkeley Microfield Exposure Tool (MET) at the Advanced Light Source using a pseudo phase shift mask mode.

These smaller feature sizes also raise interesting issues with respect to technologies that can be used in chip verification, again an area where DOE scientific user facilities are playing an important and unique role. Consider that the vast majority of integrated circuits (ICs) are manufactured in commercial foreign foundries. Critical infrastructure and defense systems cannot afford the risk of untrusted electronic components embedded in them. For the U.S. DoD and Intelligence Communities to continue to have access to the highest performance possible in ICs, it is essential to continue use of overseas ICs, and not just those manufactured in U.S. trusted foundries⁹. DARPA's Integrated Circuits Integrity and Reliability of Integrated Circuits (IRIS) program and its recently concluded Trusted Integrated Circuits (TRUST) program are examples of government efforts to develop technology to determine unambiguously if an IC is free of malicious circuits inserted during the design or manufacturing process. A key approach for circuit evaluation is non-destructive imaging of its physical structure. However, as integrated-circuit process technologies become more complex (e.g., finer pitch dimensions, many layers of metallization, flip-chip packaging, multi-die stacks, etc.), nondestructive analysis becomes corresponding more challenging. Metallic interconnect and via structures range from micron to sub-micron dimensions and the technology node of critical dimensions for transistor components is projected to be 22 nanometers by 2015. The four DOE synchrotron facilities support modalities such as X-ray absorption and fluorescence Computed Micro- and Nano-Tomography that are proving critical for the development of new imaging methods for non-destructive chip estimation.

⁹ Defense Science Board Task Force on High Performance Microchip Supply, February, 2005. Available at <http://www.acq.osd.mil/dsb/reports/ADA435563.pdf>.

Such techniques are being developed today at these facilities (funded through DARPA) by companies such Xradia Inc. in collaboration with Southern California Information Sciences Institute¹⁰. These techniques may someday provide a component of a new reliability paradigm to protect U.S. systems against malware attacks.

Unique instruments available for catalysis research have also helped companies such as Cummins Inc., which designs, manufactures, distributes and services engines and related technologies, develop catalyst solutions for removing NO_x emissions from lean-burn engines. The emissions after-treatment system the company and user facilities helped develop based on this research increased the 2007 Heavy-Duty Dodge Ram's fuel efficiency by 25%.¹¹

Companies such as General Electric, represented by Dr. Ernie Hall here today, are utilizing Office of Science advanced supercomputing facilities to study the complex flow of air in wind turbine airfoils and jet exhaust nozzles and using simulations to understand and predict flow. Such information is critical in developing quieter, more fuel-efficient wind turbines and jet engines and improving engine life cycles in an extremely competitive global market.¹² For our U.S. industrial user community access to and partnerships with such user facilities are vital in helping U.S. industries maintain manufacturing excellence and technological leadership in a globally competitive environment.¹³

For many of these industrial researchers, prompt access to such facilities is critical in addressing problems of National importance. As an example, Intevac Photonics is a leading developer of night vision sensors and was contracted by the Army Night Vision Laboratory to develop a next-generation device called the Short Wavelength Infrared imager, or SWIR, for long-range identification of targets. It would use less energetic wavelengths of infrared light for illumination, which is safer for human eyes and provides greater sensitivity in unfavorable conditions. Such imagers are also quite small, so they can be used, for example, in unmanned aerial vehicles; and they work at distances of

¹⁰ Work conducted at Stanford Synchrotron Radiation Lightsource at SLAC National Accelerator Laboratory; **M. Bajura**, G. Boverman, J. Tan, G. Wagenbreth, C. M. Rogers, M. Feser, J. Rudati, A. Tkachuk, S. Aylward, P. Reynolds "Imaging Integrated Circuits with X-ray Microscopy" Proceedings of the 36th GOMACTech Conference, March 2011, Orlando, FL.

¹¹ <http://science.energy.gov/stories-of-discovery-and-innovation/127001/> ; Work conducted at the Environmental Molecular Sciences Laboratory, Pacific Northwest National Laboratory.

¹² <http://www.genewcenter.com/Press-Releases/GE-Global-Research-To-Partner-With-Livermore-National-Lab-and-Universities-On-Supercomputing-Project-3788.aspx> ; <http://www.alcf.anl.gov/articles/argonne-leadership-computing-facility-inspiring-innovation-industry-through-science> ; Testimony of Raymond L. Orbach, Director, Office of Science, U.S. Department of Energy, before the U.S. House of Representatives Committee on Science, July 16, 2003.; Work done at the Argonne Leadership Computing Facility, Argonne National Laboratory and the Oak Ridge Leadership Computing facility, Oak Ridge National Laboratory.

¹³ As an example, please see attached letter to Dr. Chu from Cosma International. Work done at the High Temperature Materials Laboratory, Oak Ridge National Laboratory

up to 20 kilometers. Based on a different semiconductor than previous devices – indium phosphide (InP), rather than gallium arsenide (GaAs) – when the completed device went through performance testing and a serious problem emerged. It quickly lost efficiency when kept at high temperatures for an extended period, as if sitting on a shelf during a desert deployment. With prompt access to photoemission spectroscopy instruments at one of our DOE user facilities, they discovered that the standard cleaning process used to prepare the surfaces of GaAs semiconductors was inadequate for the InP material. The researchers developed new surface cleaning procedures, and when Intevac incorporated them into the manufacturing process, the shelf-life problem went away. What’s more, the sensor’s sensitivity increased significantly.¹⁴

Our scientists have also used these facilities to make fundamental discoveries of the nature of our universe, discovering all elements of the sub-structure of visible matter in the universe from anti-protons to heavy quarks, from heavy leptons to neutrinos. Today these instruments are on the verge of helping us discover the sources of dark matter, dark energy and the generators of mass in the universe. For example, heavy ion collision experiments at these facilities have recently produced a liquid of strongly interacting quarks and gluons with a temperature 250,000 times hotter than the center of the Sun. Such discoveries have given us a surprising idea of what the universe was like just after the Big Bang some 14 billion years ago – a nearly perfect liquid with practically no viscosity, or resistance to flow.¹⁵

Community and Facility Needs

Whether we wish to study the history of our universe, isolate the subatomic building blocks of matter, visualize and manipulate matter at the atomic scale for industrial applications, develop new technologies to support U.S. security or understand the causes of disease and develop next generation drugs to combat them, there are DOE facilities that we increasingly rely on to help us conduct this research.

As users, we continuously ask for new state-of-the-art capabilities. New facilities invariably lead to higher efficiency in the long term, but they also lead us to tackle harder, more complex and time intensive research and development projects. In the last ten years we have entirely new classes of facilities available to us, such as the nanoscience centers and the Linac Coherent Light Source (LCLS), that are transforming our research. New facilities such as NSLS-II at Brookhaven, a synchrotron facility which will provide world leading X-ray brightness, and vital upgrades such as the planned LCLS-II upgrade at SLAC and the APS upgrade at Argonne are necessary steps in

¹⁴ Research conducted at the Stanford Synchrotron Radiation Lightsource at SLAC National Accelerator Laboratory and the Advanced Light Source at Lawrence Berkeley National Laboratory.

¹⁵ http://www.nytimes.com/2010/02/16/science/16quark.html?_r=1, “In Brookhaven Collider, Scientists Briefly Break a Law of Nature”, NY Times, February 15, 2010. Work conducted at Relativistic Heavy Ion Collider, Brookhaven National Laboratory.

ensuring we can improve efficiency and capacity and also deliver new capabilities to keep U.S. facilities world-leading. DOE's Office of Science in particular has become impressively adept at delivering new capabilities and facilities on time, on budget, and with performance that typically exceeds the original design specifications. Yet in building capacity and improving efficiency, historically it seems facilities have experienced funding shortfalls that often prevent them from operating at optimum levels, providing adequate number of staff to support user research and deploying upgrades as quickly as possible to maintain our Nation's leadership position. Providing operating budgets that allow these facilities to operate at their designed-for capacity and to hire and retain top scientific and technical talent should be a high priority.

Technological upgrades such as improved detectors, robotics, improved instrumentation, enabling remote computation and access to facilities all require sustained funding yet prove cost effective in the long term to improve efficiency and capacity. As new facilities come on-line and older facilities are retired, these types of efforts will be critical in meeting demand from the scientific community and keeping them competitive with the suite of new facilities being built abroad. Partnerships with academic institutions, industry and other federal research entities that enable new capabilities should be fostered. These types of partnership can provide tremendous leverage in funding that benefits all facility users, but aren't attractive for partner institutions if there is not a clear return on investment.

And as these facilities increasingly attract new user communities and reach out to industry to make them aware of how these facilities can be further utilized, more standardized requirements for access across the DOE complex are still needed that will make it easier for academia and industry to use these world-class research tools. However, it is important to recognize that a "one size fits all" approach to user access may not be optimal in some cases. For individual university PI's and smaller businesses in particular, which may not have large numbers of dedicated research staff, assistance and engagement from the facility can be a significant factor in ensuring their research experience is successful.¹⁶

Conclusions

In conclusion, national user facilities provide a broad research infrastructure that enables researchers to access specialized machines, instrumentation and capabilities as well as technical expertise from experienced facility scientists, engineers, and physicists that would otherwise be unavailable from their home institutions. Access to these facilities enables scientists to explore the frontier research questions of our time,

¹⁶ "Science for Energy Technology: Strengthening the Link between Basic Research and Industry A Report from the Basic Energy Sciences Advisory Committee", John C. Hemminger (chair), August, 2010. http://science.energy.gov/~media/bes/pdf/reports/files/setf_rpt.pdf .

leads to fundamental scientific discoveries and enables downstream technological developments for real-world industrial applications. The U.S. is unique in having such a large array of user facilities. Many countries have some subset, but no other country provides access to scientists to such a diverse group of facilities covering so many areas, giving U.S. academic and industrial scientists unequalled opportunities for research.

Institutions that Conduct Research at U.S. National User Facilities



2012



Scientists from 53 US States & Territories and ~1,200 Institutions Conduct Research at the National User Facilities

ALASKA

National Weather Service
University of Alaska Fairbanks

ALABAMA

Aegis Technologies Group
Alabama A&M University
Army Space & Missile Defense
Auburn University
AZ Technology
BAE Systems
CFD Research Corp
Hexcel Corp.
JE Sverdrup Technology
NASA Marshall Space Flight Center
New Century Pharmaceuticals, Inc.
Rolta
Southern Research Institute
U.S. Army Research, Development and
Engineering Command (RDECOM)
University of Alabama, Birmingham
University of Alabama, Huntsville
University of Alabama, Tuscaloosa
University of Montevallo
University of South Alabama
XNano Sciences Inc.

ARIZONA

A.T. Still University
Arizona State University
Embry-Riddle Aeronautical University
Gleicher Enterprises, LLC
Honeywell Space Systems
JNL Scientific
Midwestern University
National Energy Technology Laboratory
National Optical Astronomy Observatory
Northern Arizona University
Scientific Solutions, Inc.
Steward Observatory
University of Arizona

ARKANSAS

UALR
Arkansas State University
Harding University
University of Arkansas

CALIFORNIA

3DGeo
ACT
ActiveSight
Adelphi Technology Inc.
Advanced Micro Devices
Aerospace Corporation
Agouron Pharmaceuticals, Inc
Amgen, Inc.
Anadys Pharmaceuticals, Inc
Ardea Biosciences, Inc.
Area Detector Systems Corporation
ASML
Asylum Research
Azusa Pacific University

Boyd Technologies
Buck Institute for Age Research
California Department of Water Resource
California Department of Public Health
California Institute of Technology
California State University, Fresno
California State University, Fullerton
California State University, Chico
California State University, East Bay
California State University, Long Beach
California State University, San Marcos
California State University, Stanislaus
Capstone Turbine Corporation
Carl Zeiss SMT, Inc.
Celgene
Center for Molecular Structure
Chapman University
Chevron
Children's Hospital Oakland Research
Institute
City of Hope Medical Center
CoCrystal Discovery, Inc.
CombiChem, Inc.
CompX Group
ConfometRx, Inc.
Corvas International
Crystal Logic Inc.
Cytokinetics, Inc.
Duly Research
Eli Lilly
Eureka Scientific
European XFEL
Exelixis, Inc.
EZO Communications, Inc.
Fairchild Imaging
Fairview Associates
Far-Tech, Inc.
Fluidigm Corporation
FusionGeo Inc.
Genencor International
Genentech, Inc.
General Atomics
Gilead Sciences, Inc.
Graduate Theological Union
GSK X-Ray
Harvey Mudd College
Hewlett-Packard
Hitachi Global Storage
Honeywell, Inc.
IBM
ICON Consulting, Inc.
Illumina, Inc.
Information Sciences Institute
Intel Inc.
Intematix Corporation
Intrepid Tech Inc.
J. Craig Venter Institute
J. David Gladstone Institute
J. Paul Getty Museum
Jema Science, Inc.
Joint Bioenergy Institute
Joint Genome Institute
Kuzell Institute for Arthritis and Infectious
Diseases
La Jolla Institute for Allergy and Immunology

Los Angeles County Museum of Arts
Las Cumbres Observatory Global Telescope
Network
Lawrence Berkeley National Laboratory
Lawrence Livermore National Laboratory
Livermore Software Technology Company
Lockheed Martin Space Systems
Loma Linda University
Malcolm Pirnie
Mathematical Sciences Research Institute
MDC Vacuum Products
MellanoX Inc.
Metacomp Technologies, Inc.
Moore Tutoring
Morgan Technical Ceramics
MRC - Manta Ray Consulting
Nanosys, Inc.
NanoVasc
NASA - Ames Research Center
NASA Jet Propulsion Laboratory
National Security Technologies (NSTec)
National Energy Research Scientific
Computing Center
Northrop Grumman Aerospace Systems
Northwestern Polytechnic University
Novartis Corporation
Novartis Institute for Biomedical Research
Inc.
Novartis Vaccines and Diagnostics Inc.
NVIDIA Corp.
Oakland CDS
ONE-Nanotechnologies
OPAC Consulting Engineers, Inc.
Pacific Biosciences Inc.
Pacific School of Religion
Pacific Union College
Panoramic Technology Inc.
PerkinElmer
Pfizer Global Research and Development
Philips Lumileds Lighting Company
Photon Imaging, Inc.
Physical Optics Corporation
Plexikon, Inc.
Point Loma Nazarene University
Pomona College
Porifera Inc.
Radiabeam Technologies
Rand Corporation
Receptos, Inc.
Reciprocal Space Consulting
Roche
SAI San Diego
Salk Institute for Biological Studies
San Diego State University
San Diego Supercomputer Center
San Francisco State University
San Joaquin Valley Air Pollution Control
District
San Jose State University
Sandia National Laboratory
SAVEinc
Saxet Surface Science
Scaled Composites LLC
Scripps Institution of Oceanography
SensorMetrix



Scientists from 53 US States & Territories and ~1,200 Institutions Conduct Research at the National User Facilities

SGX Pharmaceuticals, Inc.
Shaheen Tonse
Shasta College Earth Science Department
Signal Pharmaceuticals
SII NanoTechnology USA, Inc.
Silicon Turnkey Solutions, Inc.
SLAC National Accelerator Laboratory
Solar Turbines Inc.
Spectrolab, Inc., A Boeing Company
SRI International
Stanford University
Structural GenomiX, Inc.
Structure Based Design, Inc.
Sun Pacific Farming
Syrrx, Inc.
Takeda San Diego, Inc.
Teledyne Scientific Co.
The Aerospace Corporation
The Burnham Institute
The Swiss Physical Society
Thios Pharmaceuticals
Tularik Inc.
U.S. Department of Agriculture
U.S. Geological Survey
University of California, Berkeley
University of California, Davis
University of California, Irvine
University of California, Los Angeles
University of California, Merced
University of California, Riverside
University of California, San Diego
University of California, San Francisco
University of California, Santa Barbara
University of California, Santa Cruz
University of San Francisco
University of Southern California
University of the Pacific
USDA-California State University Fresno
Vallejo High School
Ventura Photonics
Western Digital
Westmont College
XR Instruments
Xradia, Inc.
Zenobia Therapeutics, Inc.

COLORADO

AMEC - Earth and Environmental
Array Biopharma, Inc.
Ball Aerospace & Technologies Corp.
Bede Scientific Incorporated
Btech Corp.
Colorado Research Associates
Colorado School of Mines
Colorado State University
Fiberforge
Geomega
High Altitude Observatory
KromaTiD Inc.
Lodestar Corp.
National Center for Atmospheric Research
National Jewish Medical & Research Center
National Renewable Energy Laboratory
NOAA Earth System Research Laboratory

NOAA Forecast Systems Laboratory
NSF Research Experience for Teachers
Radiometrics Corp
Solar Consulting Services
Solmirus Corporation
SPEC Inc.
Symetrix Corp.
Tech-X Corporation
University Corporation for Atmospheric
Research
University of Colorado (CIRES)
University of Colorado, Boulder
University of Colorado, Colorado Springs
University of Colorado, Denver
University of Denver
University of Northern Colorado
U.S. Bureau of Reclamation
U.S. Geological Survey
Zeus Analytics

CONNECTICUT

Advanced Fuel Research
Advanced Solid State Analysis, Inc.
Bayer Corporation
Boehringer Ingelheim Pharmaceuticals, Inc.
Canberra Industries, Inc.
Dura Cell Technical Center
Fuji Medical Systems
Inframat Corporation
MannKind Corporation
Pfizer Global Research and Development
Pratt & Whitney
Rib-X Pharmaceuticals, Inc.
Sonalysts, Inc.
Southern Connecticut State University
Trinity College
United Technologies Research Center
University of Connecticut
University of Connecticut Health Center
Warner Lambert
Wesleyan University
Western Connecticut State University
Yale University

DELAWARE

Delaware State University
DuPont Pharmaceuticals Company
E.I. DuPont de Nemours & Company
GE Solar
Incyte Corporation
INVISTA, Inc.
University of Delaware

FLORIDA

ACES QC
Beam Engineering for Advanced
Measurements Co.
Broward College
ENSCO, Inc.
Florida A&M University
Florida Atlantic University
Florida International University
Florida Southern College
Honeywell Space Systems

Mayo Clinic
National High Magnetic Field Laboratory
Rollins College
Synchrotron Research, Inc.
TECO Energy
Teraflux Corp.
The Scripps Research Institute
University of Central Florida
University of Florida
University of Miami
University of North Florida
University of South Florida
University of West Florida
Xstream Systems, Inc.

GEORGIA

Agnes Scott College
Berry College
BP Global
Center for Disease Control & Prevention
Clark Atlanta University
Dalton State College
EMC Engineers, Inc.
Emory University
Fourth Generation Partners Inc.
Georgia Institute of Technology
Georgia Southern University
Georgia State University
Medical College of Georgia
Skidaway Institute of Oceanography
University of Georgia
University of West Georgia
Valdosta State University
Virkaz Technologies, LLC

HAWAII

The Nature Conservancy
University of Hawaii at Manoa

IDAHO

Idaho National Engineering & Environmental
Laboratory
Idaho State University
Shin-Etsu MicroSi, Inc.
University of Idaho

ILLINOIS

Adler Planetarium & Astronomy Museum
Advanced Diamond Technologies Inc.
Alion Science and Technology
Argonne National Laboratory
Arryx Inc.
Augustana College
Aviex LLC
Benedictine University
BP Global
Buehler Ltd.
Bytestream Information Technologies
Cabot Microelectronics
Caterpillar Inc.
Chicago Botanic Garden
Chicago High School for Agricultural Sciences
Chicago State University
College of DuPage



Scientists from 53 US States & Territories and ~1,200 Institutions Conduct Research at the National User Facilities

College of Lake County
Containerless Research, Inc.
Creatv Micro Tech, Inc.
Crown Cork and Seal
DePaul University
Dominican University
Dover Industrial Chrome, Inc.
Eastern Illinois University
Electric Power Research Institute
Engineering & Management Specialists, Inc.
EPIR Technologies Inc
EXAFS Analysis
Fermi National Accelerator Laboratory
Field Museum of Natural History
FLASH
Governors State University
Grumman/Butkus Associates
HD Technologies, Inc.
Health Research Institute
IC Gomes Consulting
IIT Research Institute
Illinois Aviation Museum
Illinois Institute of Technology
Illinois Mathematics & Science Academy
Illinois State University
Illinois Tool Works
INEOS USA LLC
Innovations High School
IRI/CEPCO Engineering, Inc.
ITW - Industrial Finishing
JEOL USA Inc.
John Deere
Katten Muchin Rosenman
Kenwood Academy High School
L'Oreal USA
Letco
Lewis University
Illinois State Water Survey
Loyola University Chicago
Lyons Elementary School District 103
Magnesium-Elektron USA
Mar USA, Inc.
MassThink LLC
Materials Development, Inc.
McCrone Associates, Inc.
MediChem Life Sciences
Millikin University
Molecular Biology Consortium
Monmouth College
Morgan Park High School
Mother McAuley High School
Muons
Nalco
NanoSonix Inc.
Nastrx, Inc.
National Center for Food Safety & Technology
NCSA
North Central College
Northeastern Illinois University
Northern Illinois University
Northrop Grumman
Northwestern University
Oakton Community College
Oregon High School
Packer Engineering, Inc.

Poly Crystallography Inc
Powermation
Rayonix LLC
Reinders, Inc.
Rend Lake College
Richard J. Daley College
Roosevelt University
Rosalind Franklin University
Rubicon Technology, Inc.
Rush University
Shamrock Structures
Southern Illinois University, Carbondale
Southern Illinois University, Edwardsville
Spectragen, Inc.
St. Xavier University
Sterling Engineering
Streiffer Consulting
Technisource
The Art Institute of Chicago
The HDF Group
The University of Chicago
Toshiba Medical Research Institute USA, Inc.
TUSC
U.S. Environmental Protection Agency
University of Illinois, Chicago
University of Illinois, Urbana-Champaign
University of Rennes
UOP LLC
Viva Biotech (USA) Inc.
Walter Payton College Prep
Wilbur Wright College

INDIANA

Anderson University
Bloomington High School North
Butler University
Cummins, Inc.
DePauw University
Earlham College
Fort Wayne Metals Research Products
Corporation
Goshen College
Hans Tech, Inc.
Haynes International
Indiana State University
Indiana University, Bloomington
Indiana University, South Bend
ITT SSD
NuVant Systems Inc.
Purdue University
Rolls-Royce Corporation
Rose Hulman Institute of Technology
SSCI Inc.
Taylor University
University of Notre Dame
Valparaiso University
Vitha Labs of Indiana, Inc.
Wabash College

IOWA

Ames Laboratory
Coe College
Grinnell College
Iowa State University

Krell Institute
Pioneer Hi-Bred International, Inc.
St Ambrose University
University of Iowa
University of Northern Iowa

KANSAS

Fort Hayes State University
Kansas State University
KPS Technology & Engineering
NanoScale Corporation
National Weather Service
Skywarn
University of Kansas, Lawrence
University of Kansas
Wichita State University

KENTUCKY

Eastern Kentucky University
Logan Aluminum, Inc.
University of Kentucky
Western Kentucky University

LOUISIANA

ExxonMobil
Grambling State University
Louisiana State University
Louisiana Tech University
Southeastern Louisiana University
Southern University and A&M College
Southern University of New Orleans
University of Louisiana, Lafayette

MAINE

Bigelow Laboratory for Ocean Sciences
University of Maine

MARYLAND

Army Research Laboratory
Artep Corporation
BSI Proteomics Corporation
Center for Research on Environment and
Water (CREW), IGES
Creatv Micro Tech, Inc.
DataDirect Networks
Dynamic Science, Inc.
Glenelg High School
Global Defense Technology and Systems, Inc.
(GTEC)
Goucher College
Johns Hopkins University
Morgan State University
Muniz Engineering, Inc
NASA Goddard Space Flight Center
National Cancer Institute (NCI)
National Center for Research Resources
(NCRR)
National Institute of Advanced Industrial
Science and Technology (NIAIST)
National Institute of Allergy and Infectious
Diseases (NIAID)
National Institute of Diabetes and Digestive
and Kidney Diseases (NIDDK)



Scientists from 53 US States & Territories and ~1,200 Institutions Conduct Research at the National User Facilities

National Institute of Standards & Technology (NIST)
National Institutes of Health (NIH)
National Oceanic and Atmospheric Administration (NOAA)
Naval Research Laboratory
Orbital Sciences Corporation
Science Applications International Corp. (SAIC, Inc.)
Space Telescope Science Institute
StormCenter Communications, Inc
The Henry M. Jackson Foundation for the Advanced Military Medicine, Inc
Topographix
Towson University
U.S. Food and Drug Administration
U.S. Army Research Laboratory
U.S. Naval Academy
Uniformed Services University of the Health Sciences
University of Maryland, Baltimore
University of Maryland Biotechnology Institute
University of Maryland Center for Environmental Science
University of Maryland, College Park
W. L. Gore & Associates

MASSACHUSETTS

Abbott Bioresearch Center, Inc.
Abbott Laboratories
Aerodyne Research Inc
Amherst College
ARIAD Pharmaceuticals Inc.
ArQule Inc.
Assurance Technology Corp.
AstraZeneca Pharmaceuticals LP
Atmospheric and Environmental Research (AER), Inc.
Aurora Flight Sciences
AXSUN Technologies, Inc
Beam Power Technology
Beth Israel Deaconess Medical Center
Boston Biomedical Research Institute
Boston College
Boston University
Brandeis University
Bridgewater State College
Brigham and Women's Hospital
Cabot Corporation
Center for Astrophysics
Certified Scientific Software
Children's Hospital
Dana-Farber Cancer Institute
Digital Equipment Corporation
Forsyth Institute, The
Genzyme Corporation
Graphene Laboratories Inc.
Hanscom AF Base
Harvard University
ICF Consulting /Systems Applications Inc. Intl.
International Supercomputing
International Rectifier
Joslin Diabetes Center and Joslin Clinic

Massachusetts General Hospital
Massachusetts Institute of Technology
Microlytic North America Inc.
Millennium Pharmaceuticals
Mount Holyoke College
MWRA
Northeastern University
Novartis Institutes for Biomedical Research Inc.
NuOrtho Surgical Inc
Osram Sylvania Inc.
Physical Sciences, Inc.
Procter & Gamble Co.
Program in Cellular and Molecular Medicine and Immune Disease Institute
ProSensing Inc
Radiation Monitoring Devices, Inc.
Radiation Science, Inc.
RMD - Radiation Monitoring Devices, Inc
Rogue Wave Software, TotalView Technologies
Schlumberger-Doll
Sirtris Pharmaceuticals, Inc.
Smithsonian Astrophysical Observatory
The CBR Institute for Biomedical Research
Triton
Tufts University
U.S. Geological Survey
University of Massachusetts, Dartmouth
University of Massachusetts, Amherst
University of Massachusetts, Worcester
Visidyne, Inc.
Volpe Center
Whatman Nuclepore
Whitehead Institute for Biomedical Research
Williams College
Woods Hole Oceanographic Institution
Worcester Polytechnic Institute
WSI Corporation
Xtal BioStructures Inc.

MICHIGAN

Beaumont Hospital at Royal Oak
Calvin College
Central Michigan University
Dow Chemical Company
Fac 4 Rare Isotope Bms
Ford Motor Company
General Motors Corporation
Grand Valley State University
Henry Ford Health System
Hope College
Kalamazoo College
Kettering University
Michigan Molecular Institute
Michigan State University
Michigan Technological University
NOAA/NWS Forecast Office
Parke-Davis Pharmaceuticals
Pharmacia & Upjohn, Inc.
Rigaku Innovative Technologies
Toyota Motor Engineering & Manufacturing North America Inc.
University of Michigan

Van Andel Research Institute
Visteon Corporation
Wayne State University
Western Michigan University
William Beaumont Hospital

MINNESOTA

3M
aixACCT Systems, Inc.
Carleton College
Concordia College
Diagnostic Biosensors, LLC
Gustavus Adolphus College
Hysitron Inc.
IBM
Krell Institute
Mayo Clinic
Medtronic, Inc.
Orono High School
Saint Cloud State University
Seagate Technology
The Hormel Institute
University of Minnesota, Minneapolis
University of Minnesota, Twin Cities

MISSISSIPPI

Alcorn State University
Army Engineer Center
Engineering Research Development Center, Waterways Experiment Station
Jackson State University
Mississippi State University
Naval Research Laboratory
The University of Southern Mississippi
U.S. Army Corps of Engineers
U.S. Engineer Research and Development Center

MISSOURI

Brewer Science, Inc.
DOC/NOAA/NWS/NCEP Aviation Weather Center
Donald Danforth Plant Science Center
Honeywell Federal Manufacturing & Technologies, LLC
Incident Response Training Department
Kansas City Plant
Midwest Biomed Research Foundation
Missouri University of Science and Technology
Monsanto Company
Parkway South High School
Saint Louis University
Southwest Missouri State University
The Washington University
Truman High School
Truman State University
University of Missouri, Columbia
University of Missouri, Kansas City
University of Missouri, St. Louis
Veterans Administration Medical Center
Washington University

MONTANA



Scientists from 53 US States & Territories and ~1,200 Institutions Conduct Research at the National User Facilities

Carroll College
Montana State University
The University of Montana

NEBRASKA

Air Force Weather Agency
Creighton University
University of Nebraska, Omaha
University of Nebraska, Lincoln

NEVADA

Desert Research Institute
National Weather Service
Nevada Cancer Institute
Sable Systems International
The EXAFS Company
TUI
University of Nevada, Las Vegas
University of Nevada, Reno

NEW HAMPSHIRE

AmberWave Systems Corporation
Dartmouth College
Neslab Instruments, Inc.
Photonis
Plymouth State University
TotalView Technologies
University of New Hampshire
USACE - Cold Regions Research and
Engineering Laboratory (CCREL)

NEW JERSEY

AZ Electronic Materials US Corp.
BASF Catalysts LLC
Bell Laboratories
BioDelivery Sciences International
Bristol-Myers Squibb
Continuum Dynamics Inc.
ExxonMobil
Geophysical Fluids Dynamics Lab
Hamamatsu Corporation USA
High Performance Technology Inc.
Hoffmann-LaRoche, Inc.
Institute for Advanced Study
Merck & Co., Inc.
Montclair State University
Nanonex Corporation
Nanopowder Enterprises, Inc.
National Oceanic and Atmospheric
Administration (NOAA)
NEC Research Institute
New Jersey Institute of Technology
Princeton University
Rudolph Technologies, Inc. - Metrology
Business Unit
Rutgers, the State University of New Jersey
Sanofi-Aventis
Schering-Plough Research Institute
Seton Hall University
Stevens Institute of Technology
U.S. Army
Unilever Research, U.S.
University of Medicine and Dentistry of New
Jersey

X-Ray Instrumentation Associates

NEW MEXICO

Anemometry Specialists
Center for Orthopedic Sports
Eastern New Mexico University
JD Instruments LLC
Los Alamos National Laboratory
Motorola
NanoMR Inc.
National Security Technologies, LLC @ Los
Alamos Operations (LAO)
New Mexico Institute of Mining and
Technology
New Mexico State University
Sandia National Laboratories
Senior Scientific
Sensplex Inc.
Star Cryoelectronics Inc.
Voss Scientific

NEW YORK

Adapco Group
Advanced Design Consulting, Inc.
Akzo Nobel Chemicals, Inc.
Alfred University
American Museum of Natural History
AWS Truewind, LLC
Bard College
Binghamton University
Brookhaven National Laboratory
Brooklyn College of The City University of
New York
Cara Therapeutics, Inc.
CD-Adapco
Chromalloy
City College of New York
City University of New York (CUNY)
Clarkson University
Cold Spring Harbor Fish Hatchery
Cold Spring Harbor Laboratory
Columbia University
Cornell University
Corning, Inc.
Courant Inst
Delphi Automotive Systems
Dow Chemical Company
Eastman Kodak Company
Fordham University
GE Global Research Center
Gene Network Sciences
General Electric Company
Global Foundries
Hamilton College
Hauptman-Woodward Medical Research
Institute
Hofstra University
Hunter College, CUNY
IBM
Iona College
John Jay College
Kitware, Inc.
Knolls Atomic Power Laboratory
Lucent Technologies

Marymount Manhattan College
Memorial Sloan-Kettering Cancer Center
MESO Inc.
MiTeGen
Moldflow Corporation
Mount Sinai School of Medicine
NASA Goddard Institute for Space Studies
Nassau Community College
New York Medical College
New York State College of Ceramics
New York State Department of Health
New York Structural Biology Center
New York University
NYC Dept. of Environmental Protection
Philips Research
Photonics Industries International, Inc.
Polytechnic Institute of New York University
Queens College of the The City University of
New York
Queensborough Community College of CUNY
R. Browning Consultants
Rensselaer Polytechnic Institute
Research Foundation of SUNY
Reservoir Labs
Rochester Institute of Technology
Roswell Park Cancer Institute
Sarah Lawrence College
SGK Nanostructures, Inc.
Siemens Corp
St. John's University
St. Joseph's College
State University of New York, Albany
State University of New York, Binghamton
State University of New York, Buffalo
State University of New York, Farmingdale
State University of New York, Geneseo
State University of New York, Old Westbury
State University of New York, Onconta
State University of New York, Oswego
State University of New York, Plattsburgh
State University of New York, Stony Brook
State University of New York, Syracuse
Suffolk Community College
SUNY Upstate Medical University
SVC
Syracuse University
T&V Services, Inc.
Tech-X Corp Williamsville
The Graduate Center, CUNY
The River Project
University of Albany
University of Rochester
Vassar College
Wadsworth Center, New York State
Department of Health
Weill Cornell Medical College
Yeshiva University

NORTH CAROLINA

American Barmag Corporation
Army Research Office
Atrix Components, Inc.
Duke University
International Technology Center



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Magnequench Technology Center
National Institute of Environmental Health
Sciences (NIEHS)
NOAA, NESDIS, NCDC
North Carolina A&T State University
North Carolina State University
Renaissance Computing Institute
RTI International
Syngenta Biotechnology Inc.
University of North Carolina, Asheville
University of North Carolina, Chapel Hill
University of North Carolina, Charlotte
Wake Forest University

NORTH DAKOTA

North Dakota State University
University of North Dakota

OHIO

Air Force Research Laboratory
Applied Sciences, Inc.
Battelle Columbus
Berea City School District
Bowling Green State University
Byrd Polar Research Center
Case Western Reserve University
City of Cleveland
Cleveland Clinic Foundation
Cleveland State University
Cuyahoga Valley Space Society
Denison University
Diamond Innovations, Inc.
Edison Welding Institute, Inc.
Equistar Chemicals
Givaudan Inc.
GrafTech International Holdings
Innovative Scientific Solutions Inc.
Kent State
Kenyon College
Lake Shore Cryotronics, Inc.
Medical College of Ohio at Toledo
Miami University
NASA Glenn Research Center
Norcold Inc.
Oberlin College
Ohio State University
Ohio University
Ohio Wesleyan University
Pegasus Technical Services, Inc.
Procter & Gamble
Shepherd Chemical Company
Taitech, Inc.
The Timken Company
Third Millennium Metals, LLC
U.S. Air Force
UES, Inc.
Universal Technology Corporation
University of Akron
University of Cincinnati
University of Dayton Research Institute
University of Toledo
Wright State University
Youngstown State University

OKLAHOMA

3D Icon
Frontier Electronic Systems Corp.
Halliburton Energy Services
Johnson & Associates
National Severe Storms Laboratory
Northern Oklahoma College (NOC)
Oklahoma State University
Oklahoma Wind Power Initiative
Rogers State University
The Samuel Roberts Noble Foundation, Inc.
The University of Tulsa
U.S. Army Corps of Engineers - Tulsa District
University of Oklahoma
University of Oklahoma Health Sciences
Center
University of Oklahoma, Cooperative
Institute for Mesoscale Meteorological
Studies (CIMMS)
U.S. Department of Agriculture, Agricultural
Research Service
Warning Decision Training Branch

OREGON

Concordia University
FEI Company
Intel Corporation
Lane Community College
National Energy Technology Laboratory
Oregon Health Sciences University
Oregon State University
Portland State University
Reed College
SpectraWatt
TOK America
University of Oregon

PENNSYLVANIA

3-Dimensional Pharmaceuticals
Air Products and Chemicals, Inc.
Arcadis G&M, Inc.
Arkema, Inc.
Bechtel Marine Propulsion Corporation
Bettis Atomic Power Laboratory
Bloomsburg University
Bryn Mawr College
Bucknell University
Carnegie Mellon University
Children's Hospital of Philadelphia
Clarion University of Pennsylvania
Collegiate Academy
Dickinson College
Drexel University
Duquesne University
Eastern University
First Solar, Inc.
Fox Chase Cancer Center
Franklin & Marshall College
Gettysburg College
GlaxoSmithKline
Haverford College
II-VI Incorporated
Indiana University of Pennsylvania
Johnson & Johnson

Johnson Matthey, Inc.
Kutztown University of Pennsylvania
Lafayette College
Lehigh University
Lockheed Martin Space Systems
Merck Sharp & Dohme Corporation
Morphotek, Inc.
Muhlenberg College
National Energy Technology Laboratory
Naval Surface Warfare Center
Olympus America Inc.
Rhodia, Inc.
SCHOTT North America, Inc.
SmithKline Beecham Pharmaceuticals
Swarthmore College
Temple University
The Fox Chase Cancer Center
The Pennsylvania State University
The Wistar Institute
Thomas Jefferson University
University of Pennsylvania
University of Pittsburgh
University of Scranton
Ursinus College
Villanova University
Vitae Pharmaceuticals
Westinghouse
Wobblimind Media

RHODE ISLAND

Brown University
University of Rhode Island

SOUTH CAROLINA

Clemson University
College of Charleston
Francis Marion University
Furman University
Medical University of South Carolina
Savannah River National Laboratory
University of South Carolina
Westinghouse Electric Company LLC
Westinghouse Savannah River Company
Wofford College

SOUTH DAKOTA

Black Hills Institute
South Dakota School of Mines and
Technology
South Dakota State University
University of South Dakota

TENNESSEE

Austin Peay State University
East Tennessee State University
Eastman Chemical Company
EDP Biotech Corporation
Fisk University
Information International Associates, Inc.
Middle Tennessee State University
Myricom, Inc.
National Institute for Computational Sciences
Oak Ridge Associated Universities



Scientists from 53 US States & Territories and ~1,200 Institutions Conduct Research at the National User Facilities

Oak Ridge Institute for Science and Education (ORISE)
Oak Ridge National Laboratory
Rhodes College
St. Jude Children's Research Hospital
Tennessee State University
Tennessee Technological University
The Orion Foundation
University of Memphis
University of Tennessee, Knoxville
Vanderbilt University
Y-12 National Security Complex

TEXAS

Abilene Christian University
Amarillo College
Austin College
Baker Hughes Incorporated
Baylor University
ChevronTexaco Inc.
El Paso Community College
ExxonMobil
Four State Research
Freescale Semiconductor, Inc.
Frito-Lay North America
GSI Environmental, Inc.
Innovar Scientific, Inc.
INTECSEA
Lamar University, Beaumont
Marlow Industries, Inc.
MechanOptics Engineering
Molecular Structure Corp.
Nalco
NASA
National Space Biomedical Research Institute
Plano Senior High School
Prairie View A&M University
Raytheon IIS, Garland Division
Rice University
Rigaku Americas Corporation
SAIC - Houston
Sam Houston State University
SEMATECH
Southwest Foundation for Biomedical Research
Southwest Research Institute
Texas A&M University
Texas Christian University
Texas Instruments Inc.
Texas Southern University
Texas State University
The Dow Chemical Company
The Methodist Hospital Research Institute
Trinity University
Universities Space Research Association
University of Houston
University of North Texas
University of Texas M. D. Anderson Cancer Center
University of Texas, Arlington
University of Texas, Austin
University of Texas, Brownsville
University of Texas, Dallas
University of Texas, El Paso

University of Texas, Pan American
University of Texas, San Antonio
University of Texas, Houston
Wyle Laboratories, Inc.

UTAH

EDAX-TSL
ATK Launch Systems
Boeing Company
Brigham Young University
MOXTEK, Inc.
NOAA NWS CBRFC
University of Utah
US Synthetics Corporation
Utah State University
VIRGINIA
Analytical Services & Materials (AS&M), Inc.
BAE Systems
College of William and Mary
Defense Threat Reduction Agency
Eastern Virginia Medical School
Ecopulse, Inc.
Federal Highway Administration
George Mason University
Hampton University
Howard Hughes Medical Institute
ITT
James Madison University
Metalsa Roanoke Inc.
MITRE Corporation
NASA Langley Research Center
National Geospatial-intelligence Agency
National Institute of Aerospace
National Radio Astronomy Observatory (NRAO)
National Science Foundation
Naval Surface Warfare Center Dahlgren Division
Norfolk State University
Old Dominion University
SAI McLean
SAIC
Science Systems and Applications, Inc. (SSAI)
Synthonics, Inc.
Thomas Jefferson National Accelerator Facility
University of Virginia
Virginia Commonwealth University
Virginia Polytechnic Institute & State University
Virginia State University
Washington and Lee University
Washington University

VERMONT

Middlebury College
University of Vermont

WASHINGTON

Bernard Walter Consulting
Boeing Commercial Airplanes
Children's Hospital and Regional Medical Center
Cray, Inc.

DyNuSim
Emerald Biostructures, Inc.
Fred Hutchinson Cancer Research Center
Hummingbird Scientific
Infinitia Corporation
MediChem Research, Inc./AXAS
Pacific Northwest National Laboratory
Seattle Biomedical Research Institute
Seattle Children's Research Institute
Seattle Pacific University
Sienna Technologies, Inc.
STI Optronics, Inc.
The Boeing Company
Thyen-med
U.S. Environmental Protection Agency
University of Washington, Seattle
Washington Closure Hanford
Washington State University
Washington State University, Tri-Cities
Western Washington University
Whitman College
Woodruff Scientific LLC

WEST VIRGINIA

Marshall University
Morgantown ETC
National Energy Technology Laboratory
ProLogic, Inc.
West Virginia University

WISCONSIN

ARL Inc
Bruker AXS, Inc.
General Electric Medical Systems
Marquette University
Medical College of Wisconsin
Promega Corporation
Union Semiconductor Technology Corporation
University of Wisconsin, La Crosse
University of Wisconsin, Madison
University of Wisconsin, Stout
University of Wisconsin, Whitewater
University of Wisconsin, Milwaukee
University of Wisconsin, Platteville
University of Wisconsin, Stevens Point

WYOMING

University of Wyoming

DISTRICT OF COLUMBIA

Embassy of Australia
Carnegie Institution of Washington
Catholic University of America
Children's National Medical Center
George Washington University
Georgetown University
Howard University
NASA - Headquarters
National Museum of Natural History
National Oceanic and Atmospheric Administration
Naval Research Laboratory
Office of Management and Budget

The **FUTURE** of America is the
RESEARCH of **TODAY**



Scientists from 53 US States & Territories and ~1,200 Institutions Conduct Research at the National User Facilities

Office of Science and Technology Policy
(OSTP)
Smithsonian Institution
U.S. Department of Energy

PUERTO RICO

Arecibo Observatory
Infotech Aerospace Services
Interamerican University de Puerto Rico
National Astronomy and Ionosphere Center
(NAIC)
University of Puerto Rico, Cayey
University of Puerto Rico, Humacao
University of Puerto Rico, Rio Piedras
University of Puerto Rico, San Juan

VIRGIN ISLANDS

University of the Virgin Islands

The **FUTURE** of America is the
RESEARCH of **TODAY**



NATIONAL
USER
FACILITY
ORGANIZATION

The Fortune 500 and National User Facilities

47 of the Fortune 500 companies, with research and development facilities in 27 states, use 17 National User Facilities operated by the United States Department of Energy Office of Science and 1 by the National Science Foundation. The research undertaken by these corporations is wide-ranging, encompassing biology, chemistry, physics, material science and computing. The experiments performed at the facilities support the creation of diverse products, including new pharmaceuticals, advanced materials for semiconductors and vehicular batteries, telecommunications satellites, and consumer goods.

The User Facilities provide an effective way for industrial organizations to leverage the cutting-edge capabilities offered by modern science. The results enable advances in technological development and permit the United States to remain competitive in a global economy.

Facilities Used

ACRF – ARM Climate Research Facility

ALS - Advanced Light Source, Lawrence Berkeley National Laboratory

APS - Advanced Photon Source, Argonne National Laboratory

ALCF - Argonne Leadership Computing Facility, Argonne National Laboratory

CFN - Center for Functional Nanomaterials, Brookhaven National Laboratory

CNM - Center for Nanoscale Materials, Argonne National Laboratory

EMSL - Environmental Molecular Sciences Laboratory, Pacific Northwest National Laboratory

HFIR - High Flux Isotope Reactor, Oak Ridge National Laboratory

HTML - High Temperature Materials Laboratory, Oak Ridge National Laboratory

LANSCE - Los Alamos Neutron Science Center, Los Alamos National Laboratory

Molecular Foundry, Lawrence Berkeley National Laboratory

NERSC - National Energy Research Scientific Computing Center, Lawrence Berkeley National Laboratory

NHMFL – National High Magnetic Field Laboratory, Florida State University

NSLS - National Synchrotron Light Source, Brookhaven National Laboratory

OLCF - Oak Ridge Leadership Computing Facility, Oak Ridge National Laboratory

SNS - Spallation Neutron Source, Oak Ridge National Laboratory

SSRL - Stanford Synchrotron Radiation Laboratory, SLAC National Accelerator Laboratory

TANDEM - Tandem Van de Graaff Accelerator Facility, Brookhaven National Laboratory

Summary of Research

Company	Fortune 500 Rank	Locations	User Facilities	Research
Exxon Mobil	2	Baton Rouge, LA Annandale, NJ Baytown, TX	APS NSLS	Characterization of feedstocks for the petroleum refining industry (NSLS) Polymer composites (NSLS) Microporous materials (NSLS) Transformation of sulfur in fuel materials (APS, NSLS) Operates four X-ray analysis beamlines (NSLS)

Company	Fortune 500 Rank	Locations	User Facilities	Research
Chevron	3	Mountain Pass, CA Richmond, CA Houston, TX	ALS APS	Structural transformations of minerals (APS) Proprietary research (ALS, APS)
General Electric	4	Niskayuna, NY W. Milwaukee, WI	ALCF ALS APS LANSCE NERSC NSLS OLCF	Nanoscale gas sensors (ALS) Computational modeling of engines (NERSC) Computational modeling of wind turbines and jet engines (ALCF, OLCF) Computational modeling of gasification (OLCF) Catalyst characterization (APS) Isotope production (LANSCE) Characterization of advanced materials – transportation batteries, ceramic coatings in gas turbines, industrial gas sensors, solar panels (NSLS)

Company	Fortune 500 Rank	Locations	User Facilities	Research
Ford Motor	8	Dearborn, MI	ALS APS EMSL	Fuel combustion (ALS) Characterization of fuel sprays in engines (APS) Catalysts for control of automotive exhaust (EMSL)
Hewlett-Packard	10	Palo Alto, CA Corvallis, OR	CNM EMSL LANSCE SSRL	New materials for electronic paper (SSRL) Properties of memory resistive devices (CNM) Test of weather modeling software (EMSL) Failure mechanisms of semiconductors (LANSCE)
General Motors	15	Flint, MI Warren, MI	APS EMSL HFIR HTML NERSC SNS	Analysis of fuel cells (APS) Hydrogen storage for fuel cells (HFIR, SNS) Conversion of heat to electricity in vehicles (HFIR, HTML) Efficiency and emissions of gasoline engines (NERSC) Mitigation of particulates from engine exhaust (EMSL)

Company	Fortune 500 Rank	Locations	User Facilities	Research
International Business Machines	20	San Jose, CA Yorktown Heights, NY Austin, TX	ALCF ALS APS CFN CNM EMSL LANSCE Molecular Foundry NSLS SSRL	Strain in electronic materials (APS, CNM, SSRL) Microelectronic connections and photovoltaics (SSRL) Properties of nanoparticles and nanoparticle/polymer composites (Molecular Foundry) Lithographic materials for semiconductors (ALS) Semiconductors (APS) Characterization of materials for the manufacture of computer chips (NSLS) Magnetic materials (EMSL) Control of environmental contamination (EMSL) Computer disk drives (LANSCE) Supercomputer design (ALCF) Operates X-ray analytical facility (NSLS)

Company	Fortune 500 Rank	Locations	User Facilities	Research
Procter & Gamble	22	Needham, MA Cincinnati, OH Fairfield, OH Mason, OH	ALCF APS EMSL HFIR NSLS SNS	Computation modeling for consumer goods, foods, fire control materials (ALCF) Fuel cell and battery materials (NSLS) Pharmaceutical development (APS) Biocompatible nanoparticles (EMSL) Medical materials, including drug delivery and human tissue replacement (HFIR, SNS)
Boeing	28	Albuquerque, NM Kirkland, WA Renton, WA Seattle, WA	ALCF APS EMSL LANSCE OLCF	Computational modeling of turbulence in aircraft, wind turbines, heat exchangers, buildings (ALCF) Aerodynamic modeling of airplanes (OLCF) Analysis of semiconductor failures (LANSCE) Evaluation of contaminant removal devices (EMSL) Materials research (APS)

Company	Fortune 500 Rank	Locations	User Facilities	Research
Johnson & Johnson	33	Exton, PA Spring House, PA	APS	Pharmaceutical development (APS)
United Technologies	37	East Hartford, CT South Windsor, CT	NERSC NSLS OLCF	Design of new catalysts (OLCF) Modeling of fire-fighting foams (OLCF) Catalysts for fuel cells (NSLS) Simulation of fuel flow in jet engines (NERSC)
Pfizer	40	Groton, CT San Diego, CA South San Francisco, CA	ALS APS NHMFL NSLS SSRL	Pharmaceutical development (ALS, APS, NSLS, SSRL) Protein separation (NHMFL)
Lockheed Martin	44	Sunnyvale, CA Newtown, PA	TANDEM	Effect of cosmic rays on spacecraft performance (TANDEM)
Dow Chemical	46	Albany, NY	ALS APS NSLS	Materials for semiconductor lithography (ALS) Polymers for building materials (APS) Characterization of polymers (NSLS)

Company	Fortune 500 Rank	Locations	User Facilities	Research
Northrup Grumman	61	Redondo Beach, CA Rolling Meadows, IL Chantilly, VA	APS TANDEM OLCF SSRL	Efficiency of DNA delivery in cells (APS) Climate models and projections (OLCF) Characterization of nanoparticles (SSRL)
Intel	62	Chandler, AZ Lacey, CA Santa Clara, CA Windsor, CO Hudson, MA Northborough, MA Albuquerque, NM Aloha, OR Hillsboro, OR Portland OR	APS LANSCE Molecular Foundry SSRL	Creation and characterization of new polymers (Molecular Foundry, SSRL) Heat removal in integrated circuit packages (Molecular Foundry, SSRL) Development of new semiconductor structures (APS) Failure rates in semiconductors (LANSCE)

Company	Fortune 500 Rank	Locations	User Facilities	Research
Caterpillar	66	East Peoria, IL Mossville, IL	APS EMSL HTML	Characterization of stress in materials (APS) Mechanism of corrosion in bearings (HTML) Catalysts for treatment of diesel exhausts (EMSL)
Honeywell International	74	Glendale, AZ Peoria, AZ Phoenix, AZ Tucson, AZ Sunnyvale, CA Clearwater, FL Des Plaines, IL Coon Rapids, MN Eden, MN Fridley, MN Minneapolis, MN Kansas City, MO	APS CFN HTML LANSCE NSLS SSRL TANDEM	Materials for semiconductor manufacturing (APS) Effect of cosmic rays on microelectronic components (TANDEM) Failure rates in semiconductors and electronics (LANSCE) Characterization of catalysts and adsorbents (APS, CFN, HTML, NSLS, SSRL) Proprietary research (ALS)

Company	Fortune 500 Rank	Locations	User Facilities	Research
		Hopewell Junction, NY Pleasant Valley, NY Essex Junction, VT Redmond, WA Sammamish, WA Brampton, Ontario Mississauga, Ontario		
Abbott Laboratories	75	North Chicago, IL Worcester, MA	ALS APS NHMFL NSLS	Pharmaceutical development (ALS, APS, NSLS) Antibody recognition in human immune system (NHMFL)
Merck	85	Rahway, NJ West Point, PA	ALS APS	Pharmaceutical development (ALS, APS)
DuPont	86	Wilmington, DE	APS EMSL HFIR Molecular Foundry	Properties of polymer nanocomposites (APS, HFIR, SNS, Molecular Foundry) Computational modeling of intermolecular forces (EMSL)

Company	Fortune 500 Rank	Locations	User Facilities	Research
			SNS	
Oracle	105	Santa Clara, CA Redwood Shore, CA	LANSCE	Failure rates in semiconductors and electronics (LANSCE)
3M	106	Minneapolis, MN	APS	Fuel Cells (APS)
Deere	107	Moline, IL	APS	Studies of strain in materials (APS)
Motorola	110	Tempe, AZ Austin, TX Tel-Aviv, Israel	EMSL LANSCE	Failure testing of semiconductors (LANSCE) Materials for improved semiconductors (EMSL)
Eli Lilly	112	Indianapolis, IN San Diego, CA	ALS APS SSRL	Pharmaceutical development (ALS, APS, SSRL)
Bristol-Myers Squibb	114	Lawrenceville, NJ Princeton, NJ	APS EMSL NSLS	Pharmaceutical development (APS, EMSL, NSLS)
Halliburton	158	Duncan, OK	APS	Properties of cement (APS)
Amgen	159	South San Francisco, CA Thousand Oaks, CA	ALS APS	Pharmaceutical development (ALS, APS)
Medtronic	160	Brooklyn Center, MN	APS	Batteries for medical applications (APS)

Company	Fortune 500 Rank	Locations	User Facilities	Research
Monsanto	197	Chesterfield, MO	APS	Proteins characterization for agricultural biotechnology (APS)
Sun Microsystems	204	Mountain View, CA Redwood City, CA San Jose, CA Sunnyvale, CA	LANSCE	Failure rates in semiconductors and electronics (LANSCE)
ITT	214	Fort Wayne, IN Herndon, VA	ACRF APS NERSC	Studies on anesthetics (APS) Development of scientific visualization software (NERSC)
SAIC	215	Frederick, MD Maclean, MD	APS NERSC	Characterization of proteins from coral (APS) Analysis of wind energy technology (NERSC)
Cummins	218	Columbus, IN	EMSL HTML	Control of diesel exhaust (EMSL) Composition and mechanical properties of steels and filters for engines (HTML)
Texas Instruments	223	Dallas, TX Plano, TX	APS EMSL	Films for microelectronic fabrication (EMSL) New microstructures for transistors (APS)

Company	Fortune 500 Rank	Locations	User Facilities	Research
		Sherman, TX Stafford, TX	LANSCE	Failure rates of semiconductors (LANSCE)
Thermo Fisher Scientific	234	Bremen, Germany	EMSL	Technology for improved characterization of large molecules and mixtures (EMSL)
Boston Scientific	279	Natick, MA St. Paul, MN	EMSL LANSCE	Failure rates in semiconductors (LANSCE) Computational modeling of human lungs (EMSL)
Eastman Kodak	297	Rochester, NY	EMSL NSLS	Mechanism of image generation in medical radiography (NSLS) Conducting polymers (EMSL)
Western Digital	304	San Jose, CA	SSRL	Thin films for computer disk drives (SSRL)
Ball	307	Boulder, CO	TANDEM	Resistance to radiation of semiconductors for spacecraft and military (TANDEM)
Advanced Micro Devices	390	Santa Clara, CA Sunnyvale, CA Fort Collins, CO Boxborough, MA	LANSCE	Failure rates of semiconductors (LANSCE)

Company	Fortune 500 Rank	Locations	User Facilities	Research
		Austin, TX		
Corning	391	Corning, NY	EMSL HTML	Ceramics of diesel exhaust filters (HTML) Rheological dynamics of particle suspensions (EMSL)
Applied Materials	421	Boise, ID	EMSL	Magnetic devices for medical, military and data storage (EMSL)
Micron Technology	432	Boise, ID Star, ID	LANSCE	Failure rates in semiconductors and electronics (LANSCE)
Agilent Technologies	461	Santa Clara, CA	NHMFL	Ultra-high resolution optical imaging (NHMFL)
Rockwell Collins	462	Tustin, CA Melbourne, FL Cedar Rapids, IA Ely, IA	LANSCE	Failure rates in semiconductors and electronics (LANSCE)



Dr. Steven Chu
Secretary of Energy
S/Forrestal Building
1000 Independence Ave, SW
Washington DC 20585-0121

March 6th, 2012

RE: Oak Ridge National Laboratory's High Temperature Materials Laboratory User Program

Dear Mr. Secretary:

The Body & Chassis Systems Division of Cosma International, a subsidiary of Magna International (Magna), manufactures hot-stamped components for vehicular structures at its Eagle Bend facility in Clinton, Tennessee, which employs 750 people. These components are subsequently supplied to OEMs for incorporation into bodies in white. Some of these components are made with advanced high-strength steels, which enable the use of thinner components to achieve significant weight reductions and improved fuel efficiency without sacrificing safety.

We are writing to you today to express our deepest appreciation for the technical support provided to Cosma and Magna by Dr. Edgar Lara-Curzio and his research team at the High Temperature Materials Laboratory (HTML) at the Oak Ridge National Laboratory. We contacted Dr. Lara-Curzio in late November last year requesting urgent assistance to identify the mechanisms responsible for the failure of components manufactured at Eagle Bend during assembly of bodies in white at an OEM's plant. We turned to ORNL's High Temperature Materials Laboratory for:

- its wide array of powerful tools for materials characterization;
- the expertise of the staff in operating these instruments;
- most importantly the staff's understanding of the relationships between manufacturing processes and the microstructure and physical and mechanical properties of materials;
- the opportunity to work side-by-side with the HTML research team.

Even more significant were the virtually instantaneous HTML response to our call for help, and the staff's "can do" attitude in working late and during the Thanksgiving holidays. Such rapid turn-around is critical to solving industrial manufacturing problems and allowed both Eagle Bend and the OEM to determine a solution and continue production.

Eagle Bend's experience working with ORNL's High Temperature Materials Laboratory demonstrates the wisdom and value of Federal investments in user facilities at the National Laboratories. These facilities make available capabilities and expertise that industry cannot afford to acquire and/or maintain, and their collaborative environment facilitates innovation and helps accelerate the commercialization of technologies. Furthermore, in situations like the one we just experienced, they have the expertise to assist industry in solving problems that affect productivity and competitiveness.

Magna International and its subsidiaries will continue to look to the High Temperature Materials Laboratory for our future characterization needs and recommend it as a partner to help U.S. industries maintain manufacturing excellence and technological leadership in a globally competitive environment.

Sincerely,

Steve Esman (General Manager)



Allan Navarro (Quality Manager)



cc: Dr. Henry C. Kelly, Acting EERE Assistant Secretary
Patrick B. Davis, Vehicle Technologies Program Manager
Dr. Carol L. Schutte, Lead, Vehicle Technologies Program, Materials Technology Team Lead
Dr. Thom Mason, Director, Oak Ridge National Laboratory
Dr. Leo Christodoulou, Advanced Manufacturing Office, Manager