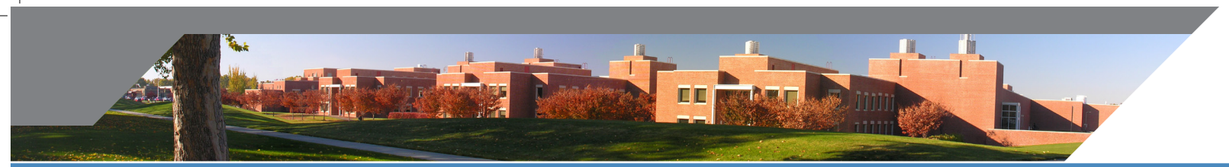


EMSL

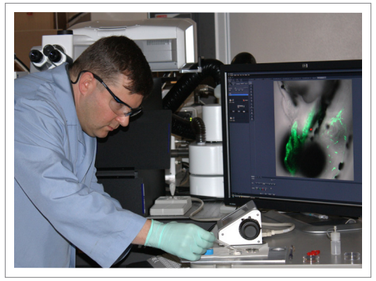
www.emsl.pnl.gov

Scientific Innovation Through Integration

PREPARING THE NEXT GENERATION

User facilities provide training ground for educating next generation of scientists

EMSL supports postdoctoral researchers, as well as graduate, undergraduate, and high school students from around the country. These students and early-career scientists have unique opportunities to build their expertise and to innovate while at EMSL. One such postdoctoral researcher is Joe Fisher, a bioenvironmental engineer from Oregon State University. As part of an effort to understand the potential toxic or biological consequences of nanoparticles—particles 100 times smaller than the width of a human hair—Joe was one of the first scientists to use EMSL's newest microscope, which allowed him to explore nanoparticle movements inside the embryo of a zebrafish and the potential impact to human health.

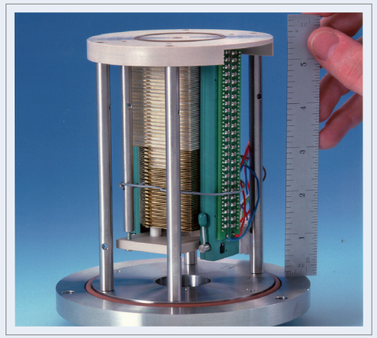


IMPACT TO INDUSTRY

Instrument Manufacturers

New technology benefits instrumentation industry

Six instrument manufacturing companies have licensed a technology developed at EMSL to improve the performance of analytical chemistry products essential for applications as varied as forensics, pharmaceutical testing, health biomarker identification, and the development of alternative fuels. As a result, those companies have enhanced their products and sold these new versions on the market. Pacific Northwest National Laboratory scientists at EMSL developed the Electrodynamic Ion Funnel to greatly improve detection capabilities of analytical chemistry instruments called mass spectrometers, which comprise approximately $2.6 billion in annual sales. All of the largest manufacturers of mass spectrometer instruments now incorporate some version of ion funnel technology in one or more of their products.



Automotive Companies

Enabling emission control for cleaner engines

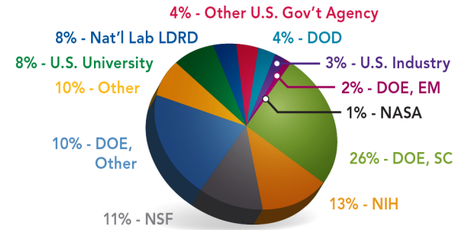
Several auto manufacturers, including Ford and GM, are leveraging advancements made by the Cummins Engine Company in collaboration with EMSL on catalyst solutions for low-emission engines. Based on research done at EMSL, Cummins had introduced a diesel engine for the Dodge Ram pickup in 2007 that—for the first time—met strict emissions standards to reduce noxious emissions and met the standards three years ahead of schedule—while maintaining outstanding fuel efficiency. Prior to this research, catalysts used in vehicle after-treatment systems weren't able to sufficiently reduce noxious emissions and therefore were unable to meet new EPA standards that came into effect in 2010. The EMSL-Cummins technological advancement paved the way for other manufacturers to use similarly improved exhaust treatment systems, such as new models of the diesel-powered Volkswagen Jetta.

PNNL-SA-79021

ACCELERATING INNOVATION ACROSS AMERICA

National asset for high-impact science

As a national scientific user facility, EMSL provides scientific solutions to scientists from universities, industry, and government who seek out our unique capabilities and scientific expertise for their most challenging research objectives. At EMSL, we collaborate with these scientists—our users—to enable discovery and innovative solutions for the nation's energy, environmental, and national security problems.



EMSL user projects by funding source in FY11.

EMSL enables efficiencies across federal agencies. Users from across the country use our specialized capabilities instead of developing their own. Without access to EMSL, these scientists would have to invest in similar—and often less powerful and less impactful—capabilities, which would be duplicative and most likely cost prohibitive.

Millions of dollars of research and multiple agencies depend upon access to EMSL capabilities and scientific expertise. Annually, our users conduct research for the following entities:

- Department of Energy
- National Science Foundation
- National Institutes of Health
- Department of Defense
- Department of Homeland Security
- Industry.

User access and support is enabled by funding from the DOE Office of Science's Office of Biological and Environmental Research.

Speeding innovation

EMSL takes a distinctive approach in enabling high-impact science. We believe that by integrating multiple scientific capabilities, innovation and discovery can be accelerated. EMSL helps users integrate across supercomputing capabilities and more than 150 experimental instruments. These instruments are often one of a kind or not available anywhere else in the United States.

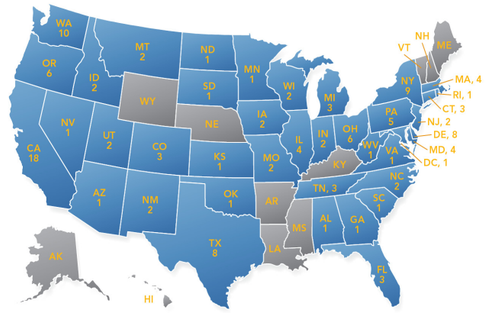
Combining all of these capabilities, methods, and minds under one roof speeds the cycle of science. Scientists can conduct experiments, quickly verify those results computationally, and then refine their experimental approach. This 'feedback loop' accelerates the innovation cycle.

Proven to deliver impact

For more than 15 years, more than 10,000 scientists have benefited from collaborating with EMSL. Annually, EMSL supports more than 700 individual scientists who produce on average 350 peer-reviewed publications—which adds considerable knowledge and impact to the global science community. Additionally, EMSL innovations have been awarded 79 patents.

Working with industry

Industry benefits from EMSL's capabilities and investments in two specific ways: either as a user institution or by licensing technology developed at EMSL. Over 20 Fortune 500 companies have conducted research using EMSL capabilities, including GE, GM, Boeing, and Motorola working in areas such as improved materials for semiconductors and catalysis characterization for biomass conversion to biofuels. EMSL also collaborates with small businesses and helped Innovatek develop an advanced processor for hydrogen generation.



EMSL users come from a variety of research institutions across the nation (shown by the number of user institutions per state in FY11) and from 35 countries.

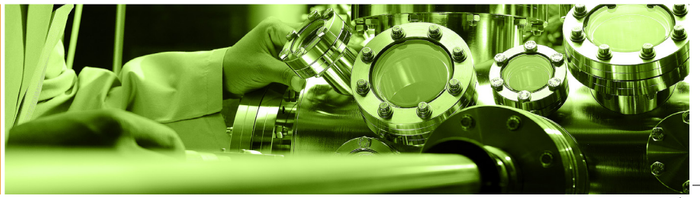
ALLISON A. CAMPBELL
Director
allison.campbell@pnnl.gov
509-371-6000

EMSL | Pacific Northwest NATIONAL LABORATORY

Proudly Operated by Battelle Since 1965

U.S. DEPARTMENT OF ENERGY

EMSL has helped develop materials that reduce automobile emissions, discovered biomarkers for diseases, shaped legacy waste cleanup approaches, and contributed to the nation's defense.



DELIVERING NATIONAL IMPACT

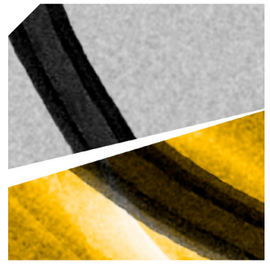
Clean Transportation

Increasing efficiency while reducing emissions

Consumers are demanding more efficient, lower emission cars and EMSL is making these vehicles a reality. Since infrastructure and vehicle sales heavily favor gasoline engines, a near-term gain in fuel efficiency needs next-generation gas engines. However, current prototypes of these engines may release higher concentrations of harmful particulate matter known to cause lung and respiratory damage into the air. To address this, scientists from General Motors Research, Pacific Northwest National Laboratory, and the University of Wisconsin are using a one-of-a-kind EMSL instrument called SPLAT to examine exhaust from the new engines, one particle at a time. Understanding these particles allows manufacturers to create new filters to meet strict particulate emissions guidelines.

Energy Storage Solutions

A twisting turn for battery materials



In countless applications, better batteries will play a key role in our global energy future. In search of fundamental knowledge of why batteries succeed or fail, scientists at EMSL pioneered a new concept: building a working lithium-ion battery using a single nanowire as an electrode. When placed in EMSL's high-powered microscopes, this tiny battery enables researchers to observe the nanowire's most intricate structural changes during battery use. This research set the stage for more recent work with a DOE Energy Frontier Research Center, which captured high-resolution video observations of a nanowire electrode twisting and contorting as it was charged. The video uncovered new details on how rechargeable batteries wear out over time. EMSL scientists are now working with GM and Applied Sciences Inc. to study silicon and carbon fiber nanocomposites to improve batteries for electric vehicles.

Understanding Biological Systems

Discoveries to fight disease

Scientists from the U.S. and Sweden teamed up at EMSL to vastly enhance knowledge of proteins in spinal fluid, setting the stage for unprecedented research into neurological disorders. To be exact, they discovered 2,630 new proteins in the clear fluid that protects the brain and spinal cord—nearly tripling the previously known database. Armed with this information, researchers and clinicians can close in on indicators and root causes of diseases like Alzheimer's and Parkinson's, which will lead to more efficient diagnostic tests and treatments. The team integrated several custom-built and one-of-a-kind capabilities EMSL offers in the area of proteomics: the large-scale study of proteins in biological systems. In the months that followed this initial work, the team rapidly took the next step by finding over 700 spinal fluid proteins to be uniquely linked to chronic fatigue syndrome—a disease that afflicts several million Americans.

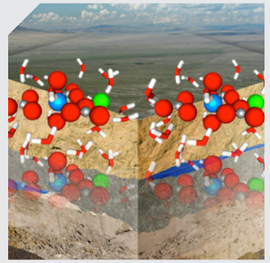
Improving Explosives Detection

Combating explosives as terrorist weapons

Understanding whether canine noses detect the chemical compounds of explosives themselves or of the materials associated with packaging the explosives could lead to more efficient use of canine detection, as well as the development of new automated detection systems. Using a special mass spectrometry technique, EMSL scientists have made significant progress on differentiating between compounds identified. They analyzed samples identified as 'positive' for explosives by dogs—and were able to improve the detection of specific compounds by 100 times. The analysis techniques are automated and transportable, and detect nitrates like TNT, as well as compounds in liquid explosives.

Meeting Legacy Waste Obligations

Predicting contaminant movements



Scientists at EMSL are building a better understanding of how uranium contaminants diffuse underground—critical knowledge for protecting people and ecosystems. At Hanford, a former plutonium production site in Washington state, uranium-contaminated groundwater is moving toward the Columbia River. But how fast? New research at EMSL shows previous studies may have overestimated the rate by as much as 40 percent. Using EMSL's capabilities, Pacific Northwest National Laboratory scientists accounted for uranium's unique properties to revise old predictions. Findings like these provide a more accurate prediction of uranium migration, helping policymakers and engineers make informed cleanup decisions.

A Clean Energy Campaign

Real Solutions

The Joint BioEnergy Institute has drawn on EMSL's unique suite of analytical instrumentation to identify enzymes that can break down biomass for more effective and efficient biofuels development. At EMSL, scientists are studying enzymes from rainforest floors, compost and the Arctic to determine which are more effective at degradation and how they break down biomass. With this knowledge, JBEI plans to engineer enzymes to deconstruct biomass such as switchgrass into individual sugars or alcohol, which could then be fermented to make biofuels.

NEW TOOLS PUSH FRONTIERS OF SCIENCE

Scientific advancements cannot be made without similar advances in the instrumentation used to make discoveries. New tools being developed at EMSL will enable researchers to greatly enhance how they view chemical and biological systems. EMSL houses nearly 150 instruments, of which 85 represent major capabilities or offerings to the global scientific community. In the past few years, the suite of instruments grew in capability and uniqueness with the addition of nearly 30 systems funded by the American Recovery and Reinvestment Act. Some of EMSL's most unique instruments include:

- A new microscope dedicated to environmental studies at the nanoscale. It can be used to study catalytic processes in real-world conditions with the goal of helping build more effective catalysts for biofuel production.
- An xray system that images the microstructure of materials, such as plants to study the interaction of roots and soil for understanding how climate changes impact these natural resources.
- An instrument that captures 3D images of materials such as ceramics and semiconductors, and already has been used to study next-generation light-emitting diode materials.