

The J. Bennett Johnston Sr.

Center for Advanced Microstructures and Devices (CAMD)

EXCELLENCE IN SCIENCE AND ENGINEERING RESEARCH

LSU



Overview

LSU's **Center for Advanced Microstructures and Devices (CAMD)** provides researchers access to the **only synchrotron light source** in the southeastern United States. One of seven such facilities in the nation, more than 150 researchers, including LSU faculty, industrial users, local startup companies, and members of national research labs, use CAMD. It is also a key resource in attracting major center level grants to the university.

“Simply put, I don’t believe we would have received this funding without having a resource like CAMD in our backyard.”

—Jerry Spivey, Director of the Center for Atomic-Level Catalyst Design

Energy researchers employ CAMD technology to study green methods of energy generation. LSU faculty are studying the effects of the Deepwater Horizon oil spill on the **environment**. Researchers from LSU's Superfund Research Program, funded by the National Institute of Environmental Health Sciences (NIEHS), are studying the toxins produced during combustion that can be inhaled and transferred from the lungs to other internal organs and cause widespread damage.

Biomedical researchers are developing methods and therapies that more effectively diagnose and treat cancer, using structure-based drug design to fight against antibiotic resistant bacteria, and studying the triggers of inflammatory responses like asthma. **Advanced materials** researchers utilize CAMD for microfabrication, creating innovative new products and technologies from miniaturized analytical instrumentation to the radiators used in racecars.

The facility is an invaluable training tool, preparing undergraduate and graduate science, technology, engineering, and mathematics (STEM) students to participate in cutting-edge research on topics such as clean energy sources, reducing environmental contamination, drug discovery, and the creation of new advanced materials. CAMD also hosts tours and demonstrations for Louisiana middle and high school students.

Industry users from **15 local and national industries** utilize CAMD facilities and high-tech materials analysis and characterization services to solve production issues. These companies also partner with CAMD to develop new materials, pharmaceuticals, and other products. A number of Louisiana-based startup companies have emerged from discoveries made at CAMD.

Synchrotron Radiation

The CAMD facility houses an accelerator that produces and stores a beam of high-energy electrons. As the electrons orbit around the synchrotron, shaped like a ring, they are deflected by magnets. This results in the emission of synchrotron radiation, light invisible to the human eye. The light ranges from infrared (heat) to X-rays, with wavelengths that range in size from cells down to atoms.



The CAMD Experimental Hall

Synchrotron radiation is ideal for studying the arrangement of molecules and atoms, the interfaces where materials meet, biological materials like proteins and enzymes, and chemical processes. This research results in new energy solutions, advances in medical care and new drugs, the development of innovative materials with desirable purposes, and a better understanding of our environment.

Exciting Recent Developments

Facilities Upgrades: This year the CAMD facilities have undergone several updates. A **\$573,800 reroofing and exterior painting project** has been completed. The accelerator was upgraded to incorporate a multipole wiggler, funded by a **\$1.26 million National Science Foundation (NSF) grant** awarded to LSU professor Marcia Newcomer.

In addition, **2 new beamlines** have recently been moved to CAMD. The beamline previously operated by **Oak Ridge National Laboratory (ORNL)** scientists Steve Overbury and Dave Mullins at Brookhaven's National Synchrotron Light Source (NSLS) has moved to LSU and will expand the catalysis research of major LSU research centers, including the Energy Frontier Research Center, the NIEHS Superfund, and the Louisiana Consortium for Neutron Scattering.



Installation of the new Multipole Wiggler funded by a grant from the National Science Foundation.

The NSF funded the transfer of the **Wisconsin InfraRed ENvironmental Imaging (IRENI) Beamline**, designed and constructed by Carol Hirschmugl, to CAMD. This beamline produces high-resolution chemical images of living biological samples in minutes. The resulting world-class biomedical imaging allows for selective components such as fats or proteins in biological systems. This instrument is the only one of its kind in the world.

Startup Companies: In 2014 two new startup companies were founded using technologies developed at CAMD:

Les Butler's Keck Grant has led to work with Louisiana Business & Technology Center (LBTC) to establish the **Grating Factory**, a startup focused on the production of gratings for phase-contrast imaging. This work will revolutionize X-ray imaging as it allows researchers to see soft tissue.

Millifluidica—founded by Challa Kumar, a former CAMD staff researcher—which produces off-the-shelf and custom lab-on-a-chip solutions for industrial applications.



The IRENI beamline focuses 12 beams of infrared radiation onto a single spot, which allows high-resolution chemical images of living biological samples.



Cancer researchers utilize CAMD to create treatments that target and destroy the DNA of malignant cancer cells and not that of healthy tissue.

Materials (CIMM). Project director Michael Khonsari and technical lead Wen Jin Meng, both LSU engineering professors, will guide the consortium’s work to advance applications in laser-based 3-D metal printing and multi-scale metal forming. CIMM—including co-principal investigators Guoqiang Li, LSU professor of engineering; Phillip Sprunger, LSU professor of physics; and Bala Ramachandran, Louisiana Tech—will coordinate advanced manufacturing research, education, and workforce development.

CAMD Funding

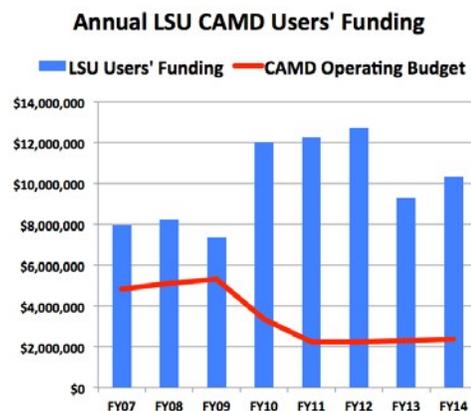
CAMD was originally established in 1988 with a \$25M grant from DOE and is operated by LSU through the Office of Research & Economic Development (ORED). CAMD was established as a state resource for advanced technology in microfabrication and synchrotron sciences, and multiple Louisiana and regional universities have invested more than \$150M in operations, beamlines, and infrastructure.

In the 2014 fiscal year (FY) CAMD’s operating budget was \$2,445,490. CAMD also received a \$967,047 supplement from ORED, which includes \$502,145 in overhead return from grant funding. In addition CAMD generates funds through its cost-center operations as well as several industrial grants and contracts that use the synchrotron X-ray facility.

CAMD receives funds from federal grants, the state, university consortia, and industry. Grants brought in by researchers who utilize CAMD facilities also bring in considerable overhead returns to the university. However, CAMD’s value should not be measured by its economics alone, but by the cutting-edge research facilitated by its synchrotron light source.

New Research Grants: Three new grants that rely heavily on CAMD’s cutting-edge research facilities were awarded in 2014: LSU chemistry professor Les Butler was awarded a **\$500,000 Keck Foundation grant** to develop laboratory-based tomography, imaging by sections, and phase-contrast X-ray imaging. Under the leadership of John DiTusa, an LSU physics professor, a collaborative group received a **\$4.61 million Department of Energy (DOE) Experimental Program to Stimulate Competitive Research (EPSCoR) award.**

In August 2015 the National Science Foundation awarded the Louisiana Board of Regents a **\$20 million** grant for the development of the **Consortium for Innovation in Manufacturing and**



The research funding brought in by CAMD users far exceeds its annual budget.

CAMD FY 2014 Budget	
CAMD Operating Budget	\$2,445,490
ORED Supplement*	\$967,047
Total	\$3,412,537
*The ORED Supplement includes approximately \$502,145 in overhead return that units typically receive from existing grant funds.	

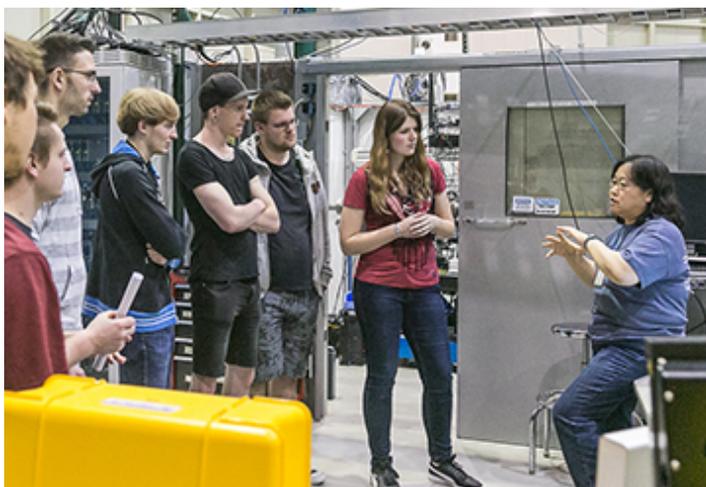
User Community

CAMD's state-of-the-art facilities are available to LSU faculty as well as regional, national, and international researchers. **In 2014 these users brought more than \$10.3 million in grant funding to LSU**, and the unique resources available to LSU faculty are a crucial advantage in grant proposals. **CAMD is utilized by more than 70 faculty from 19 departments across LSU**—including physics, chemistry, materials science, and geology—as well as national and international researchers.

CAMD is also a key **recruiting tool** for LSU. The center has played a key role in attracting world-renowned faculty such as Ward Plummer, a National Academy of Science member, and most recently well-known physicists and chemists such as William Shelton and Ye Xu. Faculty are drawn to LSU's advanced synchrotron capabilities, which offer much longer periods of access for complex experiments and applications than researchers may be able to obtain at other national synchrotron centers.



LSU graduate student Dawit Yemane works on the XRLM beamline.



Top left: Fulbright Scholars from Germany tour CAMD. Top right: A local student examines a beamline monochromator. Bottom: Elementary school students get a bird's-eye view of the experimental hall.

Major Research Projects

Center for Atomic-Level Catalyst Design

PI: Jerry Spivey

Agency: Department of Energy

\$12.5 million Energy Frontier Research Center

Consortium for Innovation in Manufacturing and Materials

PI: Michael Khonsari

Agency: National Science Foundation

\$20 million national consortium supporting advanced manufacturing research

Louisiana Alliance for Simulation-Guided Materials Applications (LA-SiGMA)

PI: Mark Jarrell

Agency: National Science Foundation

\$20 million materials science research and education program

Louisiana Consortium for Neutron Scattering

PI: John DiTusa

Agency: Department of Energy

\$4.9 million collaborative advanced materials research program

LSU Superfund Research Program

PI: Stephania A. Cormier

Agency: National Institute of Environmental Health Sciences

\$14.3 million research program on environmentally persistent free radicals

CAMD works closely with LSU faculty and Louisiana's other PhD-granting institutions to develop strong STEM programs in a wide range of fields including chemistry, physics, and electrical and mechanical engineering. From 2007 to 2012, **124 undergraduate**, **162 masters**, and **200 doctoral** students as well as **60 postdocs** used the facility. In addition CAMD hosts tours for the Baton Rouge community and provides demonstrations for local elementary and high school students.

Nobel Laureate David Wineland, who maintains the US atomic clock, uses CAMD microstructures in his research on cold atoms to develop new methods for quantum information storage. The **Army Corps of Engineers** utilizes CAMD X-rays to inspect environmental samples for contaminants and to characterize the toxicity of detected materials in order to develop techniques to clean the environment after military activity. The **Sandia and Argonne National Laboratories** produce a range of plastic and metal parts for motors and sensors using CAMD X-rays.

CAMD develops strong long-term collaborative efforts with external researchers. The Center has expanded its infrastructure and expertise through partnerships with eminent national and international scientists. Industrial users include **Albemarle, Exxon Mobil, and BASF**, the largest chemical producer in the world.

Industrial users are able to receive training on all CAMD equipment and to contract with CAMD staff for full-service data acquisition, interpretation, and final reports.



Dr. Orhan Kizilkaya tests catalysts for environmentally-friendly ways to generate fuels from waste gases.

Economic Development

CAMD plays a vital role in Louisiana's economic development. **Research and development personnel from fifteen industries, local and national, utilize CAMD X-rays** for their research and to solve production problems. Multiple local startup companies have emerged from research performed at CAMD, and many continue to use the facilities as they grow their operations. **One-fourth of all patents generated by LSU research are from CAMD researchers.**

A 2010 economic impact report showed that spending by CAMD and its researchers directly creates new sales in the community. Area businesses that benefit from those expenditures in turn hire additional workers. Spending by those businesses and their employees then creates another round of sales for other businesses.

The report indicated that in a single year through the injection of new funds into the local economy CAMD supported **146 total jobs**. This translated into the creation of \$4.1 million in direct Louisiana earnings and a total of \$5.7 million in earnings. A total of \$13.9 million of Louisiana sales can be attributed to the federal grant funding attracted by CAMD and its researchers in 2010 alone.

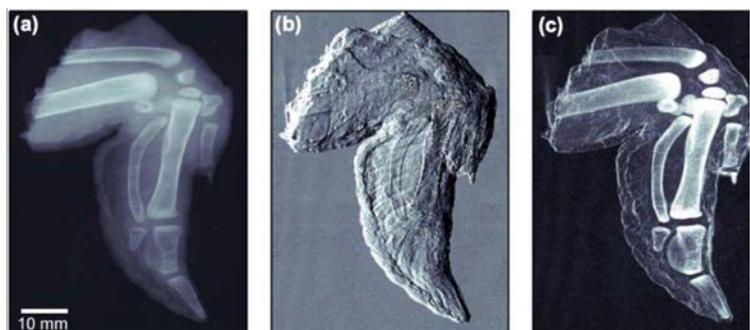
While impressive, the economic impact report provides an incomplete picture of the importance of CAMD to Louisiana's economy. **Six startup companies** have emerged from CAMD, including Mezzo Technologies, Analytical Specialists Inc., and Biofluidica. New research and technological innovations will result in the continued growth of industry partnerships and the number of startups that emerge. In addition researchers continue to generate millions of dollars in federal grants for research projects that would not be possible without CAMD's state-of-the-art facilities. The long-term impact of CAMD has the potential to continue to grow exponentially.



Analytical Specialists Inc. developed a cutting-edge portable gas chromatograph, used in the Gulf of Mexico after the Deepwater Horizon oil spill to measure environmental contaminants.



Using technologies developed at CAMD, Louisiana startup **Mezzo Technologies** supplies racecars with advanced heat exchangers that make cars run cooler, allowing increases in horsepower.



The **Grating Factory**, which emerged from research funded by a Keck grant, uses CAMD facilities to produce gratings for phase-contrast X-ray imaging. Phase-contrast Imaging: (a) Standard X-ray; (b) Phase-contrast image; (c) Dark-field image.

CAMD Quick Facts

- One of only 7 synchrotron radiation facilities in the US, and the only one in the Southeast
- LSU User Community
 - More than 150 researchers from LSU, industry, and national labs utilize CAMD
 - 73 LSU faculty from 19 departments
 - 124 undergraduate, 162 masters, and 200 PhD students as well as 60 postdocs
- 2014 Research Funding
 - LSU users held \$52.3 million total in active grants
 - CAMD users received \$10.3 million in research funding
- Industrial users from more than 15 companies
- 6 local startups emerged from CAMD research, including 2 new companies in 2014
- One-fourth of LSU's patents awarded to CAMD users
- 2 new beamlines from the Oak Ridge National Laboratory and the University of Wisconsin relocated to CAMD in 2015



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LIVE GOLD

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