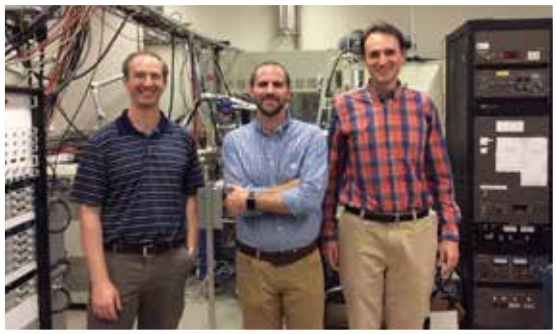
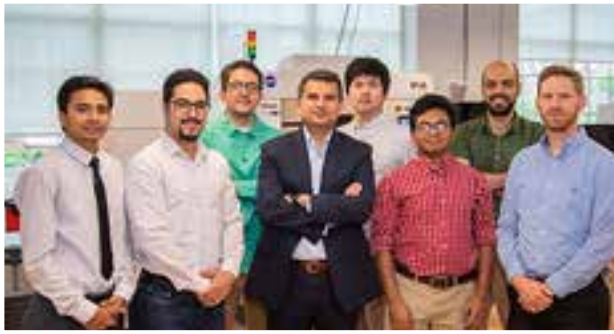
2018 – 2019
Annual Report to the Alabama Commission on Higher Education






Alabama EPSCoR

December 2019

NSF EPSCoR's primary goals are to provide strategic programs and opportunities for EPSCoR participants that stimulate sustainable improvements in the R&D capacity and competitiveness and to advance science and engineering capabilities in EPSCoR juridictions for discovery, innovation and overall knowledget-based properity

DOE EPSCoR's primary goals are, in designated states and territories, to improve the capability to conduct sustainable and nationally competitive energy-related research; jumpstart infrastructure development through increased human and technical resources, train scientists and engineers in energy-related areas, and build beneficial relationships with DOE laboratories

NASA EPSCoR seeks to contribute and promote the development of research infrastructure in areas of strategic importance to NASA, improve the capabilities of designated jurisdictions to gain support from sources outside the NASA EPSCoR program; develop partnerships between NASA research assets, academic institutions, and industry; and contribute to the jurisdiction's overall research infrastructure.

DOD EPSCoR, reauthorized in 2019, seeks to enhance the capabilities of institutions of higher education in designated eligible state and territories to develop, plan, and execute science and engineering research relevant to the mission of DOD, increase the number of university researchers capable of performing research responsive to the needs of DOD and increase the probability of being awarded federal financial assistance for research

USDA EPSCoR is designed to help institutions develop competitive research, education, and extension/outreach programs in high-priority areas of national need in agriculture, food, and environmental sciences. Alabama is currently ineligible for USDA EPSCoR

The NIH Institutional Development Award (IDeA) program enhances the competitiveness for research funding and low aggregate success ratesd for grant applications to NIH. Alabama is currently ineligible for IDeA funding.

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TO THE ALABAMA COMMISSION ON HIGHER EDUCATION

Alabama EPSCoR, Established Program to Stimulate Competitive Research, is dedicated to the advancement of economic development via scientific and engineering research through a collaborative effort among the State's research universities. The focus of activities is designed to attract and retain distinguished scientists and researchers for Alabama; to develop new cutting-edge technologies and high-tech industry; and to stimulate state competitiveness in medicine, biotechnology, engineering, and other applied sciences. Major achievements that stand out for 2018-2019 include Alabama State University joining the family of ALEPSCoR institutions; the development and launch of a searchable research capabilities map/database for the eight university research institutions with the inclusion of Southern Research and HudsonAlpha on the Alabama EPSCoR web site at https://alepscor.org/; and the initiation of Department of Defense EPSCoR programs with $12M allocated for EPSCoR jurisdictions.

The Research Capabilities Interactive Map/Database outlines Alabama expertise by each of eleven state research priorities including: Advanced Manufacturing, Agricultural Products/Food Production, Biosciences/ Biotechnology, Chemical/Petrochemical, Energy, Forestry Products, Information Technology and Cybersecurity, Metal and Advanced Materials, Nanotechnology, Plasma Sciences, and Transportation. Our hope is that this resource will be used by economic developers to show the great wealth and depth of expertise in our state and by researchers to locate knowledgeable collaborators.

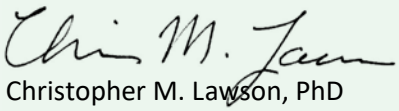
Major new awards for 2018-2019 include the following: NSF EPSCoR Research Infrastructure Improvement (RII) Track 4 awards (one in FY 2018 and 4 in FY 2019) and one NSF RII Track 2 award; fourteen (FY18) and seventeen (FY19) NSF Co-funded awards; a DOE State Laboratory Partnership Grant and DOE Early Career Award in FY18 and a DOE Implementation Grant in FY 19; two NASA Cooperative Agreement Notice (CAN) Awards, one each in FY18 and FY19 along with a FY19 Research Infrastructure Development (RID) Award, four NASA EPSCoR Rapid Response (R3) awards and one NASA EPSCoR International Space Station (ISS) Award. In FY18, these new federal EPSCoR awards totaled $9.1 M with $15.5M of estimated federal EPSCoR research expenditures (new and continuing awards).

State support for the ALEPSCoR program during FY 2019 included $343K for administration and $743K for the Graduate Research Scholars Program (GRSP) and this state investment led to a federal return in research expenditures of more than 14 to 1 for ALEPSCoR in FY 18. The GRSP has supported over 300 graduate students since 2006, leading to 65 Master's degrees and 187 Ph.D. degrees as of December 2019. During the fall of 2019, 42 students were awarded GRSP funding in Round Fourteen, 25 are new awardees. More information regarding the GRSP can be found in Volume 12 of the GRSP Booklet published December 2019.

The ALEPSCoR program continues to be a valuable contributor to scientific and engineering infrastructure, research capabilities, education, and economic development across the state. We look forward to continued investment for a stronger, more prosperous Alabama. We encourage you to review the many exciting EPSCoR research projects making an impact in our state.

Respectfully,

Christopher S. Brown, PhD
Chair, Alabama EPSCoR Steering Committee
Vice-President for Research
University of Alabama at Birmingham



Christopher M. Lawson, PhD
Executive Director, Alabama EPSCoR
Chair, Coalition of EPSCoR States
Professor, Department of Physics
University of Alabama at Birmingham

OVERVIEW & HIGHLIGHTS

The Established Program to Stimulate Competitive Research (EPSCoR), originally named *Experimental* Program to Stimulate Competitive Research was started by the National Science Foundation (NSF) in 1978 when Congress authorized the agency to create a new program in response to broad public concerns about the extent of geographical concentration of federal funding of research and development (R&D). Eligibility for EPSCoR participation is limited to those jurisdictions that historically received lesser amounts of federal R&D funding and demonstrated a commitment to develop their research bases and to improve the quality of science, technology and engineering research conducted at their universities and colleges.

The success of the NSF EPSCoR program during the 1980s subsequently prompted the creation of EPSCoR and EPSCoR-like programs that currently exist in five other federal agencies: the Department of Energy (DOE), the U.S. Department of Agriculture (USDA), the National Aeronautics and Space Administration (NASA), and the largest of all, the National Institutes of Health (NIH). In 2018, the Department of Defense EPSCoR was reauthorized and appropriated in FY19.

The mission of EPSCoR was originally designed to meet the NSF statutory function **"to strengthen research and education in science and engineering throughout the United States and to avoid undue concentration of such research and education."** During FY 2019, ALEPSCoR was eligible to receive new awards through EPSCoR programs associated with NSF, DOE, NASA and a new initiative at the Department of Defense EPSCoR or DEPSCoR. While ALEPSCoR has ongoing projects supported by the USDA AFRI/FASE program, Alabama became ineligible for new awards in 2016. Alabama is also ineligible for the NIH EPSCoR-like program called IDeA or the Institutional Development Award.

EPSCoR GOALS

- To provide strategic programs and opportunities for EPSCoR participants that stimulate sustainable improvements in their R&D capacity and competitiveness.
- To advance science and engineering capabilities in EPSCoR jurisdictions for discovery, innovation and overall knowledge-based prosperity.

EPSCoR OBJECTIVES

- To catalyze key research themes and related activities within and among EPSCoR jurisdictions that empower knowledge generation, dissemination and application.
- To activate effective jurisdictional and regional collaborations among academic, government and private sector stakeholders that advance scientific research, promote innovation and provide multiple societal benefits.
- To broaden participation in science and engineering by institutions, organizations and people within and among EPSCoR jurisdictions.
- To use EPSCoR for development, implementation and evaluation of future programmatic experiments that motivate positive change and progression.

OVERVIEW & HIGHLIGHTS

ALEPSCoR Specific Goals

- Increase R&D funding in Alabama to the national level.
- Increase competitiveness of all research institutions in the state by measured publications, patents, research faculty, research equipment, etc.
- Increase minority and under-represented group participation.
- Develop industry-government-university partnerships to contribute to technology development and economic growth in Alabama.
- Increase effectiveness of EPSCoR programs.

ALEPSCoR Plan for Achieving Goals

- Develop a coordinated plan for research within the state and aid in the development of consistent plans for each agency.
- Provide guidance in conducting competitions, where possible.
- Select programs which have the greatest potential for achieving national competitiveness and determine the resources required to reach that potential.
- Use strengths and focus areas identified in the review and selection process.
- Function as a liaison with the Alabama Commission on Higher Education.
- Participate in EPSCoR Foundation and Coalition activities, as well as other groups that have impact on federal funding agencies.

ALEPSCoR is a consortium of academic, government, and industrial organizations established in 1985. The core ALEPSCoR academic institutions in Alabama include the eight Ph.D. granting research universities: Alabama A&M University, Alabama State University, Auburn University, University of Alabama, University of Alabama at Birmingham, University of Alabama in Huntsville, Tuskegee University, and the University of South Alabama. Other academic institutions participate in and benefit from program activities through satellite or outreach efforts and NSF Co-funding.

The primary goal of the consortium is to establish the infrastructure needed to increase sustained national science and technology research competitiveness. This goal is accomplished by:

1. Supporting research clusters based on current Alabama research strengths.
2. Carefully planning major equipment purchases that significantly increase state capabilities.
3. Facilitating the hire of new faculty and research personnel in targeted areas.
4. Broadening participation of students in research cluster-related science and engineering fields.
5. Linking these clusters with higher education, government agencies, and the private sector.

OVERVIEW & HIGHLIGHTS

2018-2019 Alabama EPSCoR Notable Achievements

- The EPSCoR program at the Department of Defense (DEPSCoR) was reauthorized in FY2018 and appropriated with $12M in FY2019 to include a new mentor/mentee grant program called the Collaborative DEPSCoR Competition, the first solicitation was released in July 2019. Additional funds for EPSCoR jurisdictions were also allocated to support the existing Young Investigator Program and Defence University Research Instrumentation Programs
- In 2018, ALEPSCoR launched a searchable research capabilities database available at https://alepscor.org/
- Alabama State University became an AL EPSCoR institution in May 2018
- GRSP funded 42 students in Round 14 starting August 2019, 24 are new to the program
- Estimated research expenditures exceeded $15.5M in FY2018 and $16.1M in FY2019
- New EPSCoR awards exceeded $9.1M in FY2018 and $14M in FY2019
- In FY 2018, UA was awarded an EPSCoR Research Infrastructure Improvement (RII) Track 4 Award. In FY 2019 AL EPSCoR received four Track 4 awards, these were awarded to Dr. Kannatassen Appavoo at UAB, Dr. Jeffrey Krause at the Marine Environmental Sciences Corsortium and Dr. Saeed Latif and Dr. Scott Glaberman at USA. In FY 2019, Dr. Jeremy Schultz at HudsonAlpha was awarded a NSF EPSCoR Track 2 award.
- Fourteen new FY 2018 NSF Co-funded projects (total $6.7M) were awarded to AU, TU, UA, and UAB while seventeen new FY 2019 NSF Co-funded projects ($7.25M) were awarded to AAMU, ASU, AU, UA, UAB, UAH, and USA.
- DOE EPSCoR- In FY 2018 Alabama was awarded one State Laboratory Partnership Award (UAB) and one Early Career Award (UA). For the first time in several years, DOE EPSCoR announced the competition for the 2019 Implementation Grant. Nine awards were announced in July and the University of South Alabama's Dr. Kevin West was Alabama's recipient; other project team members include Drs. Heath Turner, Jason Bara, and Paul Rupar at UA; Dr. Michael Curry at TU; and Amanda Coffman at the University of North Alabama.
- NASA EPSCoR- In FY 2018, Alabama was awarded a new NASA EPSCoR Cooperative Agreement Notice (CAN) Award, the Science Investigator is Dr. Claudia Mewes at the University of Alabama. In FY 2019, Alabama NASA EPSCoR received at least one award from each of NASA EPSCoR's four funding mechanisms. These include one FY19 Cooperative Agreement Notice (CAN) Award, the Science Investigator is Dr. Kevin West at the University of South Alabama; a FY19 Research Infrastructure Development (RID) Award which is providing seed funding for projects at AAMU, Auburn, UA, UAB, and UAH; four EPSCoR Rapid Response (R3) awards went to Dr. Judy Schneider and Lingze Duan at UAH, along with Dr. Nima Shamsaei and Dr. Masatoshi Hirabayashi at Auburn University; and Dr. Michael Banish (UAH) was awarded an EPSCoR International Space Station award.

OVERVIEW & HIGHLIGHTS

The ALEPSCoR program is dedicated to the advancement of economic development via scientific and engineering research through a collaborative effort among the State's research universities. The focus of activities is designed to attract and retain distinguished scientists and researchers for Alabama; to develop new cutting-edge technologies, companies and opportunities; and to stimulate state competitiveness in medicine, biotechnology, engineering, plasma science, mathematics and other applied sciences.

ALEPSCoR seeks to increase Research and Development (R&D) competitiveness through the development and utilization of science and technology resources residing in Alabama's major research universities. It strives to achieve its objectives by stimulating sustainable infrastructure improvements at the state and institutional levels that significantly increase the ability of ALEPSCoR researchers to compete for federal and private sector R&D funding, and accelerate the movement of ALEPSCoR researchers and institutions into the mainstream of federal and private sector R&D support.

As a member of the EPSCoR program, Alabama receives federal funds to stimulate nationally competitive research and to increase the ability of its scientists to compete successfully for research funds from NSF and other federal agencies. The ALEPSCoR consortium of academic, government, and industrial organizations supports projects that establish an infrastructure within the state capable of developing and sustaining high-quality science and engineering research and education that can potentially contribute to statewide national competitiveness.

Over the long term, ALEPSCoR is enhancing valuable resources that can influence Alabama's research capacity in the 21st Century. Alabama depends on its colleges and universities to provide well educated workers that leading companies require if they are to compete in a knowledge-based global economy. A highly educated work force is the most critical factor in attracting and retaining the kind of leading companies that bring 21st century jobs to the state.

Increasing Alabama's scientific and technology research competitiveness is critical for the long term economic health of the state. Specifically, ALEPSCoR makes a difference to Alabama through education, outreach, increased diversity, partnerships, infrastructure building, economic benefit/jobs, business opportunities, and a system that encourages graduation and self-sustainability.

ALEPSCoR Develops Research Expertise Searchable Database

In FY 2019, Alabama EPSCoR updated the Science and Technology Capabilities database reflecting the expertise at Alabama A&M University, Alabama State University, Auburn University, Tuskegee University, University of Alabama, University of Alabama at Birmingham, University of Alabama in Huntsville, University of South Alabama, Southern Research and HudsonAlpha Institute for Biotechnology. This database was originally created in FY 2018 by AL EPSCoR, in response to a request by the Department of Commerce. Eleven research priority areas include: Advanced Manufacturing, Agricultural Products/Food Production, Biosciences/Biotechnology, Chemical/Petrochemical, Energy, Forestry Products, Information Technology and Cybersecurity, Metal and Advanced Materials, Nanotechnology, Plasma Sciences, and Transportation. Searchers on the web site enable one to access a list of research capabilities for each institution or drill down to specific areas within each research priority to discover the depth of research expertise in our state. Contacts at each institution are available for additional information, log onto: https://alepscor.org/

ALEPSCoR Improves Education

ALEPSCoR makes a difference through the state's colleges and universities, their science and engineering faculty, and students. A primary focus is preparing students for careers in engineering, materials sciences, biological sciences, physics, plasma science, energy, forestry, etc. Through mandates by NSF and other EPSCoR agencies, a portion of the agency investment goes to promote programs for K-12. Citizens of the state benefit by outreach efforts which includes basic community programs, teacher education

opportunities, and development of new science-based curricula. These efforts improve K-12 education without significant investments from the state.

ALEPSCoR Encourages Partnerships

ALEPSCoR cooperates with state leaders in government, higher education, and business to establish productive, long-term partnerships between universities, colleges, K-12 educational institutions, Alabama businesses, and other governmental agencies. These partnerships are designed to stimulate local action resulting in lasting improvements to the state's academic research infrastructure and increased national research and development (R&D) competitiveness.

ALEPSCoR Enhances Infrastructure

Human infrastructure is enriched by opportunities to establish relationships with national laboratories, to use equipment and collaborate with federal researchers, and hiring new faculty in targeted research "growth" areas which enables Alabama to achieve "critical mass" in these high growth research areas. Equipment infrastructure is improved by targeted equipment purchases which enable Alabama researchers to perform research in new cutting-edge technologies.

ALEPSCoR Provides Economic Benefits and Jobs

External EPSCoR funded grants support new faculty hires which provide salary for new research assistant professors, post-doctoral research associates, graduate student stipends and tuition, as well as undergraduate student support. These external grant funds provide jobs for hundreds of people in the state, helping to stimulate the state's economy. By establishing the research infrastructure in the state's targeted areas, Alabama researchers become competitive in obtaining federal non-EPSCoR grant funding. New external grant funds provide an additional economic benefit to the state by providing support for faculty and graduate students.

In FY 2018, NSF EPSCoR awarded Alabama researchers one new Research Infrastructure Improvement (RII) Track 4 award and fourteen new NSF Co-funded awards. DOE EPSCoR awarded Alabama one State Laboratory Partnership Grant and one Early Career Award. Alabama was also awarded a FY18 NASA Cooperative Agreement Notice (CAN) Award. New award totals for FY18 exceed $9.1M while research expenditures for the same period are estimated to be $15.5M.

In FY 2019, Alabama was awarded four new NSF ESPCoR RII Track 4 awards and one Track 2 Award, seventeen new NSF Co-funded awards, one DOE EPSCoR Implementation Award and from NASA EPSCoR- one Research Infrastructure Development Award, one Cooperative Agreement Notice, Award, four EPSCoR Rapid Response (R3) Awards and one EPSCoR International Space Station Award.

	FY 2018		FY 2019	
	New Awards	Estimated Research Expenditures	New Awards	Estimated Research Expenditures
NSF RII Tracks 1, 2, 3 and 4	250,956	5,244,812	2,218,665	5,835,644
NSF Co-funding	6,789,697	7,752,958	7,250,619	6,332,664
Dept of Energy	1,385,954	706,138	2,710,993	2,733,206
NASA	750,000	599,325	1,825,000	942,184
USDA	0	1,261,386	0	354,869
Dept of Defense	0	0	0	0
	9,176,607	15,564,619	14,005,277	16,198,567

Above: Former GRSP Awardee Dr. Karim Budhwani (Rounds 10 and 11) presents the CerFlux business plan to judges during EDPA's Launchpad Competition, February 28, 2019

Below: Christopher Krebs (CFO), Dr. Lisa Johnson (CO) and Dr. Karim Budhwani (CEO) of CerFlux (front row) with Launchpad judges. Photos by Bruce Nix

Dr. Karim Budhwani, a former GRSP recipient and CEO of CerFlux, competed in EDPA's (Economic Development Partnership of Alabama) Launchpad competition in early 2019. The Alabama Launchpad competition provides funding for Alabama entrepreneurs. CerFlux is a biotech company that has developed a test to identify the most effective first-line cancer treatment for personalized medicine. Compared to traditonal protocols, this method saves precious time and money and keeps patients from enduring side effects from ineffective treatments.

CerFlex is constructing a state-of-the-art lab in the historic Rush Hotel building in downtown Birmingham. The company will put the $50,000 Launchpad award toward its six-month roadmap, which will include:

- Completing renovations and construction of the lab.
- Refining the design and manufacturing process of the CerFlux platform for matching tumors with treatments.
- Gathering preliminary data required for national Small Business Innovation Research grants to underwrite subsequent research and development costs for translating the platform from "lab-2-life."

Dr. Budhwani was asked, "Why Birmingham, Alabama"? It comes down to the five P's essential for startup communities, Budhwani said—particularly for companies in the cancer biotech space. Those five P's are people, pillars, places, public policies and private investments.

"In Birmingham, we have a good mix of (1) people: researchers, scientists, entrepreneurs; and (2) pillars: O'Neil Comprehensive Cancer Center, Breast Cancer Research Foundation of Alabama, UAB grad school, drug discovery firms like Southern Research, health insurance firms like BCBS of Alabama and patient/survivor organizations like Forge Cancer Survivor Center. We have a growing option of (3) places, such as Innovation Depot, Dynamic Biosciences and Forge Coworking. Finally, we have an improving (4) policy landscape—EDPA, BHM small business council—and (5) private investment appetite for startups." For more information log onto http://cerflux.com.

Included with permission from Birmingham Now.

Dr. Karolina, Mukhtar, Associate Professor in the UAB Department of Biology was recognized as a recipient of the Presidential Early Career Award for Scientists and Engineers (PECASE) in July 2019. PECASE is the highest honor bestowed by the U.S. Government to outstanding scientists and engineers who are beginning their independent research careers and who show exceptional promise for leadership in science and technology. Dr. Mukhtar was nominated by the National Science Foundation. Dr. Muktar was awarded a NSF EPSCoR co-funded (NSF #1350244) CAREER award from August 2014 to July 2020 entitled, "Regulatory Mechanisms of Pathogen-Medicated Cellular Stress Signaling in Arabidopsis: Taking Plant Molecular Biology to the Urban Garden." This project is engaging minority students in citizen science to study cellular stress for more resistant crops.

Drs. Karolina Mukhtar and Kelvin Droegemeier (White House Office of Science and Technology Policy) during PECASE award ceremony, July 25, 2019, Washington, D.C.; DOE Photographer, Donica Payne

Alabama EPSCoR Steering Committee

The ALEPSCoR Steering Committee (AESC) is responsible for fiscal and programmatic aspects of ALEPSCoR activities. Members include representatives from eight research institutions: Alabama A&M University, Alabama State University, Auburn University, Tuskegee University, University of Alabama, University of Alabama at Birmingham, University of Alabama in Huntsville and University of South Alabama as well as the Alabama Commission on Higher Education and the Economic Development Partnership of Alabama. Alabama State University became an EPSCoR institution in May 2018.

In March 2018, Dr. Chris Brown was elected Chair of the Alabama EPSCoR Steering Commitee while Dr. Shaik Jeelani became the Vice-Chair. Dr. Brown serves as the Vice President for Research at the University of Alabama at Birmingham. Dr. Jeelani serves as the Vice President for Research and Sponsored Programs as well as Dean of Graduate Studies at Tuskegee University.

Dr. Chris Brown
Chair, ALEPSCoR Steering Committee

Dr. Shaik Jeelani
Vice-Chair, ALEPSCoR Steering Committee

Alabama EPSCoR Steering Committee

Standing Committee

Dr. Christopher S. Brown
Chair, Alabama EPSCoR Steering Committee (elected 3/2018)
Vice President for Research
University of Alabama at Birmingham

Dr. Paul B. Mohr, Sr.
Proxy for Dr. James Purcell
Director of Special Programs
Alabama Commission on Higher Education

Dr. Shaik Jeelani
Vice-Chair, Alabama EPSCoR Steering Committee (3/2018)
Vice President for Research and Sponsored Programs
Dean of Graduate Studies
Tuskegee University

Dr. Robert (Bob) Lindquist
Interim Vice President for Research and Economic Development
The University of Alabama in Huntsville

Ms. Lynne U. Chronister
Vice President for Research and Economic Development
University of South Alabama

Dr. Daniel Wims
Provost and Vice-President for Academic Affairs
Vice-President for Research
Alabama A&M University

Dr. James "Jim" Weyhenmeyer
Vice President for Research
Auburn University

Dr. Russell Mumper
Vice President for Research and Economic Development
The University of Alabama

Dr. Christine Thomas
Associate Vice President for Institutional Effectiveness
Alabama State University

Mr. Steve R. Spencer
President, Economic Development Partnership of Alabama

Advisory Committee

Angela Till
Deputy Secretary and Proxy for
Greg Canfield, Alabama Department of Commerce

ALEPSCoR Executive Director

Dr. Chris Lawson

Dr. Christopher Lawson is a full Professor of Physics at the University of Alabama at Birmingham. His research specialty is optical sensing and nonlinear optics and he has published over 70 journal articles and 10 books or book chapters in these areas. Before coming to UAB, he led a group of 10 researchers first as Manager and then as Director/Principal Scientist at BDM International in McLean, Virginia. At UAB, Dr. Lawson has been Principal Investigator (PI) for numerous research grants awarded from the National Science Foundation (NSF), the Army Research Office (ARO), Army Research Labs (ARL), the Air Force Office of Scientific Research (AFOSR), DARPA and NASA. In 2004 he established the NSF funded Center for Optical Sensors and Spectroscopies (COSS) at UAB and led this Center until becoming Executive Director of Alabama Established Program to Stimulate Competitive Research (www.alepscor.org) in 2010.

Alabama EPSCoR is dedicated to the advancement of economic development via scientific and engineering research through a collaborative effort among the State's research universities. Overall, Alabama EPSCoR has brought in 235 federal EPSCoR grants for $152M from 2009-2018, including $39M over the last two years. As Alabama EPSCoR Executive Director, he oversaw the writing of Alabama's first Science and Technology (S&T) Plan/Roadmap endorsed by all major research institutions in the state, and formally adopted by Alabama Department of Commerce (DOC) Secretary Greg Canfield. Lawson worked with the Alabama DOC to incorporate this new S&T Roadmap into Alabama's Economic Development Plan, Accelerate Alabama 2.0, complementing it by identifying statewide research priorities and expertise that can provide target economic growth areas to create Alabama jobs.

Dr. Lawson also serves as the Director of the State funded Graduate Research Scholars Program (GRSP), designed to increase the pool of highly trained graduates available to Alabama industry. As of December 2019, GRSP support has resulted in 187 Ph.D. and 65 Master's degrees in high technology EPSCoR research areas.

Finally, Dr. Lawson serves as Chair of the Coalition of EPSCoR/IDEA States, which assumes a leadership role in coordinating national EPSCoR activities. He testified before the U.S. House Appropriations Committee on behalf of the EPSCoR Coalition in 2012 and 2013 and provided written expert witness testimony to the "Driving Innovation Through Federal Investments" full U.S. Senate Hearings in April 2014 and the House Appropriations Committee in 2019.

Loretta Moore, NSF EPSCoR Section Head and Dr. Chris Lawson at the EPSCoR Coalition meeting, February 25, 2019, Washington, D.C.

ALEPSCoR Staff

Charlotte Nix has been with Alabama EPSCoR since 2006 and serves as the Alabama EPSCoR Program Administrator at The University of Alabama. Ms. Nix is responsible for managing the Graduate Research Scholars Program, EPSCoR grant listings, EPSCoR reports, and Steering Committee coordination and communication. Ms. Nix earned her B.S. degree from The University of Alabama.

Ms. Briauna Perryman graduated from the University of Alabama at Birmingham in 2017 with a degree in Marketing and Marketing Management and plans to return for her MBA fall 2019. As of October 2017, she diligently serves as the Program Coordinator II for Alabama EPSCoR

Briauna Perryman, Charlotte Nix, and Dr. Chris Lawson met with Congressman Bradley Byrne (District 1) during Alabama EPSCoR's annual congressional delegation visits, February 2019

Agency Directors

The ALEPSCoR Agency Directors provide oversight responsibility for the day-to-day operations of federal EPSCoR research programs in Alabama, including responsibility for coordination, notification and supervision of all EPSCoR announcements and awards issued by the federal government. The ALEPSCoR Agency Director is the administrative officer for a designated EPSCoR program in Alabama. He/She is appointed by the ALEPSCoR Steering Committee (AESC) and is responsible for the administrative functions of the AESC, providing management, coordination and direction of the EPSCoR program in Alabama and for such other duties assigned by the Executive Director and AESC. ALEPSCoR currently has an EPSCoR Agency Director for NSF, DOE, and NASA. Currently, Alabama is not eligible for new awards from USDA AFRI Program.

MANAGEMENT

Alabama NSF EPSCoR State Agency Director

Dr. Gary Zank is the Alabama NSF EPSCoR Agency Director as well as Principal Investigator (PI) on the NSF-EPSCoR RII Track 1 grant entitled, RII Track-1: CPU2AL: Connecting the Plasma Universe to Plasma Technology in Alabama headquartered at the University of Alabama in Huntsville. Dr. Zank joined UAH in 2008 and currently serves as Director of the Center for Space Plasma and Aeronomic Research (CSPAR) and Chair of the UAH Department of Space Science. He was elected to the National Academy of Sciences in May 2016. Dr. Zank is currently the only member of the University of Alabama System to be a member of NAS. In recognition of Dr. Zank's global achievements in teaching, research, and innovation, he was named the University of Alabama Board of Trustees Trustee Professor, the highest award for a faculty member in The University of Alabama System, and he is also the Aerojet-Rocketdyne Chair in Space Science. Dr Zank has received numerous international and national awards, and is a Fellow of the American Physical Society (APS), the American Geophysical Union (AGU), the American Association for the Advancement of Science (AAAS), and and Honorary Member of the Asia, Oceania Geosciences Society(AOGS).

Dr. Zank earned his BS (1982) and PhD (1987) degrees at the University of Natal, South Africa and did Post-doctoral studies at the Max-Planck-Institut fuer Kernphysik and Max-Planck-Institut fuer Aeronomie (Germany) from 1987-1989 and Bartol Research Institute at the University of Delaware from 1989-1991. His research specialties include space and solar physics, plasma physics, and computational physics. Previous positions include Pei-Ling Chan Chair of Physics-and-Chair, Physics Department, University of Alabama at Huntsville; Chancellor's Professor of Physics and Astronomy, University of California, Riverside and Director, UCR Institute of Geophysics and Planetary Physics (IGPP) -and- System-wide Director, IGPP (July 2001 – June 2008). Dr. Zank can be reached at 256-961-7401 or garyp.zank@gmail.com.

Alabama DOE EPSCoR State Agency Director

Dr. John W. Steadman, P.E, serves as the Alabama Department of Energy (DOE) EPSCoR State Agency Director, Professor of Engineering at the University of South Alabama, and is a licensed professional engineer. Dr. Steadman previously served as Dean of Engineering at the Unviersity of South Alabama and Associate Dean and Head of the Department of Electrical Engineering at the University of Wyoming. He earned B.S. and M.S. degrees in electrical engineering from the University of Wyoming and the PhD degree from Colorado State University. Dr. Steadman was a research engineer for General Dynamics, Convair Division in San Diego, California before joining the faculty at the University of Wyoming and served as a Distinguished Visiting Professor at the United States Air Force Academy.

Dr. Steadman has received several awards, including the IEEE United States Activities Board Citation of Honor, the NCEES Distinguished Service Award with Special Commenation, the Wyoming Engineering Society Outstanding Engineer Award, and the AT&T Foundation Award for Excellence in Teaching. Professor Steadman was appointed to the Board of Registration for Professional Engineers and Professional Land Surveyors in Wyoming by three different governors serving on that board for more than sixteen years. He has also been active in the National Council of Examiners for Engineering and Surveying (NCEES), serving on several of the national committees, as treasurer, and as the national president in 1993-94.

In addition to his engineering education responsibilities, Dr. Steadman was 2004 President of IEEE-USA, Past Chair of the Board of Governors of the Order of the Engineer, and participates in accreditation of engineering programs for ABET. Dr. Steadman is the author of more than 60 journal publications, book chapters and patents. He has been honored with election to Fellow grade in the National Society of Professional Engineers and the American Society for Engineering Education. For more information, contact Dr. Steadman at 251.460.6206 or jsteadman@southalabama.edu.

MANAGEMENT

Alabama NASA EPSCoR State Agency Director

Dr. L. Dale Thomas was appointed as the Alabama Space Grant Director in August 2017. Dr. Thomas currently serves as a Professor and Eminent Scholar of Systems Engineering in the Department of Industrial and Systems Engineering and Engineering Management at the University of Alabama in Huntsville. He teaches system engineering students in the art and science of systems architecture and design, systems integration, test, and verification, and systems management. Dale also serves as director of the Alabama Space Grant Consortium and as deputy director of the UAH Propulsion Research Center.

Prior to his retirement from NASA in July 2015, Dale served as the Associate Center Director (Technical) for the NASA Marshall Space Flight Center (MSFC) in Huntsville, Alabama, providing technical leadership for all MSFC spaceflight projects. For more information, Dr. Thomas can be contacted at 256-824-4243 or dale.thomas@uah.edu.

Alabama USDA EPSCoR State Agency Director

While Alabama is not currently eligible for USDA EPSCoR, Dr. Frank F. (Skip) Bartol serves as the Alabama USDA EPSCoR State Agency Director, and is Alumni Professor of Reproductive Biology in the Department of Anatomy, Physiology and Pharmacology, Associate Dean for Research and Graduate Studies, and Interim Director of the Scott-Ritchey Research Center in the College of Veterinary Medicine at Auburn University (AU). Additionally, since its establishment in September 2014, Dr. Bartol serves with Dr. Greg Barsh of the HudsonAlpha Institute for Biotechnology, as co-Director of the HudsonAlpha/Auburn University Center for Comparative Genomics and Translational Research. A member of the AU faculty since 1983, Bartol obtained the BS degree from Virginia Tech and both MS and PhD degrees through the Interdisciplinary Reproductive Biology Program from the University of Florida. Additionally, he obtained advanced training in molecular biology as a Visiting Scientist and Scholar in the Center for Animal Biotechnology at Texas A&M University. In 2005, Bartol was honored by his doctoral alma mater when he was named a Donald Henry Barron Lecturer at the University of Florida in recognition of "outstanding research and scholarly activities in the field of reproductive biology." His research, which focuses on identification of mechanisms regulating development and function of female reproductive tract tissues in domestic ungulates, has been supported by competitive grants from the USDA National Research Initiative, the National Institute of Food and Agriculture (NIFA), the National Science Foundation, and private organizations in the U.S. and abroad, as well as by the Alabama Agricultural Experiment Station. Dr. Bartol served as Panel Manager for the U.S. NIFA Animal Reproduction program in 2014 and 2015. He is an active member of the Society for the Study of Reproduction (SSR), the American Society of Reproductive Immunology (ASRI), and the Society for Theriogenology (SFT), and was elected as an Honorary Member of the Society of Phi Zeta, the honor society of veterinary medicine, for "distinguished service in the advancement of science relating to the animal industry." For more information, contact Dr. Bartol at 334.844.3700 or bartoff@auburn.edu.

GRADUATE RESEARCH SCHOLARS PROGRAM

Graduate students who represent the next generation of researchers and innovators are critical to the advancement of Alabama's high-tech human resource capacity. To assist our institutions of higher education in training this next generation of scientists and engineers, investments are required to attract the brightest and best scholars who will contribute to the state's vision of economic growth and prosperity.

During FY 2019, the Alabama Legislature continued the appropriation to ALEPSCoR through the Alabama Commission on Higher Education for the purpose of funding the GRSP. Since its inception in 2006, the program has funded over 300 exceptional graduate students.

Round Fourteen began in the Fall of 2019 by funding 42 students with 25 new recipients conducting research funded by EPSCoR (Established Program to Stimulate Competitive Research) programs at the National Science Foundation, National Aeronautics and Space Administration, U.S. Department of Agriculture, and the U.S. Department of Energy Office of Science. Of the forty-two students, thirty-six (36) are pursuing a PhD while six (6) are working towards a Master's. Students are selected competitively by a team consisting of one campus coordinator from each of the PhD granting institutions in the ALEPSCoR Program. Renewals are granted each year subject to satisfactory progress in a given year and available funding. Alabama State University joined the AL EPSCoR program in May 2018 and participated fully in the GRSP during Round Fourteen with their first applicant.

The goal of the ALEPSCoR GRSP is to invest in Alabama universities to expand research output and attract eminent senior faculty and quality graduate students. The program's objective is to provide a highly trained workforce to fuel the growth of high technology companies in Alabama.

The quality of work generated as part of the first thirteen funding rounds was both cutting-edge and novel. Encouraged by the success of the program, researchers have leveraged state funds with other research based resources to supplement the GRSP and increase participation in the program. Students whose proposed research or field of study and career interests are congruent with the funded science and technology programs of the NSF, DOE, NASA, DOD, and USDA at Alabama EPSCoR universities are eligible to apply. The AESC created a GRSP Subcommittee to monitor and continually make revisions to improve the program.

Additional information regarding the GRSP can be found in Volume 12 GRSP Booklet published December 2019.

UAH GRSP awardee Ryan Gott presents his plasma-based system for water purification research during the Science and Technology Open House held in Mobile, April 4, 2019.

GRSP Campus Coordinators

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SUMMARY

In summary, the Alabama Established Program to Stimulate Competitive Research is dedicated to the development of scientific and engineering capabilities through state research university collaboration. Research performed by our universities represents a substantial industry in Alabama. Activities are designed to attract distinguished scientists, young investigators, and researchers from various fields, fostering economic development through investments that result in cutting-edge technologies and stimulate competitiveness in medicine, biotechnology, engineering, mathematics, and other applied sciences.

Alabama EPSCoR was successful in securing new funding from the NSF, DOE, and NASA during FY2018 and FY2019 Significant state commitment is necessary to sustain the ALEPSCoR activities and to provide concrete evidence to the NSF and other agencies that the State is willing to partially match the large federal research investment in these activities. Continued state support ensures EPSCoR federal funding will continue to be available for our scientists and demonstrates a willingness on the part of the State of Alabama to make a full commitment to building research capabilities to support state economic development. For more information on Alabama EPSCoR programs within the NSF, DOE, USDA, DOD, and NASA see the following sections.

NATIONAL SCIENCE FOUNDATION EPSCoR

The EPSCoR program was designed to fulfull the mandate of the National Science Foundation to promote scientific progress nationwide. The NSF EPSCoR program began in 1978 and is a federal-state partnership designed to help America maintain its global leadership by capitalizing on talents and resources available in all states of the union. The program promotes the intellectual and human development missions of NSF by supporting basic research activities which span a broad range of science, engineering and technology and by supporting training of future scientists and engineers. The NSF EPSCoR Office is located in the Office of the NSF Director where all EPSCoR awards are made through a rigorous merit review process.

NSF's EPSCoR Program is broadly set up as federal-jurisdiction partnerships. To participate in the program, an eligible jurisdiction is required to form its own EPSCoR steering committee and develop a science and technology (S&T) plan specific to the jurisdictions needs and goals. Each steering committee is expected to undertake "a recent comprehensive analysis of the strengths, barriers, and opportunities for further development of its institutions in support of overall objectives in research, education and innovation." Through these activities, steering committees work closely with partners in academia, government, and the private sector to build statewide networks.

NSF EPSCoR Eligible Jurisdictions

Guam	Nebraska
Virgin Islands	Oklahoma
Puerto Rico	Kentucky
South Dakota	Alaska
North Dakota	Hawai'i
West Virginia	Delaware
Vermont	Alabama
Wyoming	Louisiana
Nevada	Kansas
Mississippi	New Hampshire
Idaho	New Mexico
Maine	Rhode Island
Arkansas	Iowa
Montana	

Eligibility

Alabama first became eligible for EPSCoR funding in 1985. Eligibility to participate in the NSF EPSCoR program is based on the level of NSF research funding. Each year, NSF EPSCoR compiles annual summary data for NSF Research funding to recipients within a jurisdiction, this is averaged over the preceeding three-year period. Since 2003, eligibility has been restricted to jurisdictions that recieve 0.75% or less of the total NSF Research and Related Activities (R&RA) funds. Any EPSCoR jurisdiction no longer eligible for RII competitions complete any current grants. Eligibility continues for EPSCoR Co-funding and outreach opportunities for a period of three years. Eligibility

NSF EPSCoR Eligibility*

State	FY 2016 Research Support		FY 2017 Research Support		FY 2018 Research Support		FY 2016-18 Research Support		% of Total $
	Amt $K	Number of Awards	Amt $K	Number of Awards	Amt $K	Number of Awards	Amt $K	Number of Awards	
Grand Total	$5,490,618	18,214	$5,611,940	17,538	$5,802,723	17,398	$16,905,281	53,150	100%
Other	$26,804	30	$18,894	30	$23,354	31	$69,052	90	0.41%
US Total	$5,463,814	18,184	$5,593,046	17,506	$5,779,369	17,367	$16,836,229	53,057	99.59%
Alabama	$26,267	139	$33,202	153	$40,734	145	$100,203	437	0.59%

*Research support numbers were adjusted by NSF for large-scale logistical operations. Totals differ from those in BIIS due to adjustment for exemptions.

calculations are reported by the NSF office of Budget, Finance and Award Management and listed on NSF's Budget Internet Information System (BIIS). In FY 2019, eligible NSF EPSCoR jurisdictions included twenty-four states, Guam, Puerto Rico and U.S. Virgin Islands , these jurisdiction receive approximately 10 percent of the NSF budget. The remaining ninety percent of NSF funding goes to non-EPSCoR jurisdictions.

In FY 2018, the grand total of NSF awards distributed across the world was $7,457,851K while the US total was $7,434,497K. Alabama received $60,140K. NSF's Office of the Director awarded $17,283K directly to eight (AAMU, ASU, AU, TU, UA, UAB, UAH, and USA) PhD granting institutions for EPSCoR related research, major instrumentation awards, graduate research fellowships, and EPSCoR Co-funding.

NSF EPSCoR uses four major investment strategies to achieve its goal of improving the R&D competitiveness of researchers and institutions within EPSCoR jurisdictions. These strategies are:

Research Infrastructure Improvement (RII) Program: There are four RII investment strategies, these make up approximately 83% of the EPSCoR budget.

- **Track-1 (RII Track-1) Awards**

  RII Track-1 awards provide up to $4 million per year for up to five years. They are intended to improve the research competitiveness of jurisdictions by improving their academic research infrastructure in areas of science and engineering supported by the National Science Foundation and critical to the particular jurisdiction's science and technology initiative or plan. These areas must be identified by the jurisdiction's EPSCoR governing committee as having the best potential to improve the jurisdiction's future R&D competitiveness.

- **Track-2 (RII Track-2) Awards**

  Track-2 Focused EPSCoR Collaborations (RII Track-2 FEC) awards build interjurisdictional collaborative teams of

NSF Funding Rates FY 2012-2018

		2012	2013	2014	2015	2016	2017	2018
All NSF Directorates	No. of Proposals	48,717	49,150	48,206	49,630	49,306	49,425	48,334
	No. of Awards	11,628	10,981	11,120	12,016	11,893	11,457	11,716
	funding rate	24%	22%	23%	24%	24%	23%	24%
Alabama Portion (All NSF Directorates	No. of Proposals	670	648	666	583	607	656	672
	No. of Awards	111	95	103	85	102	116	113
	funding rate	17%	15%	15%	15%	17%	18%	17%
NSF Office of the Director O/D (includes EPSCoR)	No. of Proposals	992	579	755	671	420	416	444
	No. of Awards	344	269	336	312	217	249	119
	funding rate	35%	46%	45%	46%	65%	60%	27%
Alabama Portion (O/D) (includes EPScoR)	No. of Proposals	18	11	17	12	11	10	26
	No. of Awards	7	4	3	2	6	7	7
	funding rate	39%	36%	18%	17%	55%	70%	27%
All NSF Funding	Total*	6,730,420	6,548,925	6,766,552	6,967,463	7,110,054	7,016,546	7,457,851
Alabama (All NSF)	Total*	47,367	45,987	45,305	34,281	46,041	51,155	60,140
Overall NSF O/D Funding	Total*	496,472	343,784	385,949	460,863	462,073	454,777	503,917
Alabama NSF O/D	Total	7,945,231	5,262,194	4,797,819	2,611,006	4,486,653	9,151,080	17,283,205
Alabama EPSCoR	Total	7,579,458	4,851,399	4,239,226	2,420,866	4,017,754	9,140,280	15,189,507

*Amount shown in thousands

EPSCoR investigators in scientific focus areas consistent with NSF priorities. Projects must include researchers from at least two RII-eligible jurisdictions with complementary expertise and resources to tackle proposed projects. Funds provide up to $1 million per year for up to four years as collaborative awards between two EPSCoR jurisdictions or up to $1.5 million per year for up to four years to a consortia of three or more EPSCoR jurisdictions. Science, Technology, Engineering, and Mathematics (STEM) research and education activities should work to broaden participation though stategic inclusion and integration of different types of individuals, institutions and sectors. The project should have a comprehensive and integrated vision to drive discovery and build sustainable STEM capacity with diversity of all types (individual, institutional, geographical and disciplinary). Development of early-career faculty in a critial component.

- **Track-3 (RII Track-3) Awards**
  Piloted in FY 2013, RII Track-3 awards provide up to $750,000 for up to five years to support the strategic goal of broadening participation to improve future R&D competitiveness of EPSCoR jurisdictions. These awards are intended to broaden participation of underrepresented groups in STEM fields supported by NSF - underrepresented minorities, women, persons with disabilities and those in underserved rural regions of the country.

- **Track-4 (RII Track-4) EPSCoR Research Fellows**
  Track 4 awards provide opportunities for non-tenured investigators to further develop their individual research potential through extended collaborative visits to the nation's premier private, governmental, or academic research centers. Through these visits, the EPSCoR Research Fellows will be able to learn new techniques, benefit from access to unique equipment and facilities, and shift their research toward transformative new directions. The experience gained through the fellowship is intended to provide a foundation for research collaborations that span the recipient's entire career. These benefits to the Fellows are also expected to in turn enhance the research capacity of their institutions and jurisdictions.

Co-Funding of Disciplinary and Multidisciplinary Research:

EPSCoR co-invests with NSF Directorates and Offices in the support of meritorious proposals from individual investigators, groups, and centers in EPSCoR jurisdictions that are submitted to the Foundation's research and education programs, and crosscutting initiatives. These proposals have been merit reviewed and recommended for award, but could not be funded without the combined, leveraged support of EPSCoR and the Research and Education Directorates. Co-funding leverages EPSCoR investment and facilitates participation of EPSCoR scientists and engineers in Foundation-wide programs and initiatives. Co-funding is approximately 16% of the EPSCoR budget.

Workshops and Outreach:

The EPSCoR Office solicits requests for support of workshops, conferences, and other community-based activities designed to explore opportunities in emerging areas of science and engineering, and to share best practices in planning and implementation in strategic planning, diversity, communication, cyberinfrastructure, evaluation, and other areas of importance to EPSCoR jurisdictions. The EPSCoR Office also supports outreach travel that enables NSF staff from Directorates and Offices to work with the EPSCoR research community regarding NSF opportunities, priorities, programs, and policies. Such travel also serves to more fully acquaint NSF staff with the science and engineering accomplishments, ongoing activities, and new directions and opportunities in research and education in the jurisdictions. Workshops and Outreach utilize approximately 1% of the EPSCoR budget.

Ongoing NSF EPSCoR RII Awards							
Award No	**Title**	**Type**	**Inst**	**AL PI**	**Collaborators**	**Period of Performance**	**AL award**
1348368	STEM-IQ: Science, Technology, Engineering and Mathematics Inquiry-Enhancing Science Education in Southeast Alabama	NSF RII Track 3	AU	Allen Landers		3/15/2014 - 2/29/2020	742,711
1539034	RII Track-2 FEC: Bridging Cognitive Science and Neuroscience Using Innovative Imaging Technologies	NSF RII Track 2 FEC	UAB	Paul Gamlin and Lawrence Sincich	Medical Univ. of S. Carolina (lead inst), Furman Univ., Univ of S. Carolina, Baufort Campus	8/1/2015 - 7/31/2019	1,600,000 of $6M
1539035	RII Track 2 FEC: Feeding and Powering the World - Capturing Sunlight to Split Water and Generate Fertilizer and Fuels	NSF RII Track 2 FEC	UA	Shanlin Pan and Elizabeth Papish	Univ. of Miss. (Lead Inst.), Miss. State, Tulane Univ.	8/1/2015 - 10/31/2019	828,000 of $6M total
1632825	RII Track-2 FEC: Emergent Polymer Sensing Technologies for Gulf Coast Water Quality Monitoring	NSF RII Track 2 FEC	UA and UAB	UA- Marco Bonizzoni and Natasha Dimova; UAB- Eugenia Kharlampieva	Univ. of S. Miss. (Lead Inst.) with Univ. of Miss., and UAB	8/1/2016 - 7/31/2020	1,044,526 of $4M total
1632891	RII Track-2 FEC: Probing and Understanding the Brain: Micro and Macro Dynamics of Seizure and Memory Networks	NSF RII Track 2 FEC	UAB	Jerzy Szaflarski, Sandipan Pati, Timothy Gawne, and Roy Martin	Louisiana Tech (Lead Inst.) and Univ. of Arkansas	9/1/2016 - 8/31/2020	1,392,528 of $6M total
1632881	RII Track-2 FEC: The Creation of Next-Generation Tools for Neuroscience - Noninvasive Radioluminescence Approaches to Optogenetics	NSF RII Track 2 FEC	UAB	Lori McMahon, Gary Gray, Lynn Dobrunz, Mark Bolding, and Kazu Nakazawa	Clemson Univ. (Lead) and Univ. of New Mexico	9/1/2016 - 8/31/2020	2,020,926 of $ 6M total
1655280	RII Track-1: CPU2AL: Connecting the Plasma Universe to Plasma Technology in Alabama	NSF RII Track 1	UAH	Gary Zank	AAMU, USA, AU, TU, UA, UAB, UAH, USA, and Oakwood University	9/1/2017 - 8/31/2022	20,000,000
1738497	RII Track-4: Selection of methylxanthine-responsive aptamers	NSF RII Track 4	UA	Ryan Summers		09/15/2017 - 8/31/2020	258,968
1738564	RII Track-4: Quantifying Muscle Assembly in Live C. elegans Using Super-Resolution Light Microscopy	NSF RII Track 4	USA	Ryan Littlefield		9/1/2017 - 8/31/2020	128,020
1736150	RII Track-2 FEC-Genome to fitness: An Analysis of the Stress Response in Peromyscus	NSF RII Track 2	AU	Wendy Hood and Andreas Kavazis	Univ. of S. Carolina at Columbia (Lead inst.)	8/1/2017 - 7/31/2021	1,348,649

RII Track-1: CPU2AL: Connecting the Plasma Universe to Plasma Technology in Alabama

The NSF EPSCoR CPU2AL project is an integrated, statewide collaborative effort that seeks to understand, predict, and control the transfer of power from electromagnetic fields to electrons, ions, atoms, molecules, and surfaces, and chemical reactions in plasma and on surfaces in low-temperature plasma (LTP) environments. The project is led by the University of Alabama in Huntsville (UAH) and engages a consortium of nine Alabama (AL) universities including Auburn University (AU), the University of Alabama in Birmingham (UAB), Tuskegee University (TU), the University of Alabama (UA), Alabama A&M University (AAMU), the University of South Alabama (USA), Alabama State University (ASU), and Oakwood University together with an industrial partner, Computational Fluid Dynamics Research Corporation (CFDRC). The collaboration combines theory, modeling, and experimental validation of LTP and applies these to industrial applications with the goal of realizing the extraordinary potential of LTP science for transformative technological solutions that address societal grand challenge problems, advanced manufacturing and materials, biomedicine, agriculture, and food safety.

The revised Strategic Plan developed in the Fall 2018 and approved in December 2018 was used to guide and direct the Year 2 effort and the allocation of resources to achieve the goals articulated in the proposal.

Project elements in Year 2 include three research thrusts, research equipment acquisition, workforce development, diversity, communication and dissemination, sustainability, and project management.

Thanh Dang, a UAH student interning at CPU2AL's industrial partner CFD Research Corporation

Research Thrusts 1, 2, 3, and infrastructure improvements

The three cross-institutional research thrusts (RTs) launched in Year 1 are now fully engaged in addressing the major challenges facing LTP science today: (i) basic understanding of plasma kinetics and diagnostic techniques (RT 1), (ii) collective processes (RT 2), and (iii) plasma interactions with solid, liquid, and soft matter (biomaterials) and bio-matter (seeds and food) surfaces (RT 3). Conceptually, RT 2, i.e., the basic plasma physics and diagnostic program, is the glue that draws together RT 1 in its formulation of plasma kinetics that enables theory and diagnostics and RT 3, which addresses plasma applications. An example highlighting the role of RT 2 as the "glue" is the use of high-resolution spectroscopy to diagnose plasmas used for plasma-treatment of polymers for biomaterial applications. The new aspect of the study was the role of a magnetic field in processing polymers. This collaboration was both cross-institutional, engaging B. Tucker, Y. Vorha, V. Thomas from UAB, and T. Hall, I. Arnold, E. Thomas from AU, and crossed research thrusts, being a mix of research thrusts RT 3, RT 1.2b, RT 2.1b.

RT 1 addresses the prediction, control, and diagnostics of LTP kinetics through two goals. The first goal is to develop the capability to accurately model the properties of LTP in order to understand naturally occurring plasma environments or to tailor a plasma state to accomplish a particular industrial task. Four objectives are pursued that address the development of theoretical and computational models from a physical kinetics perspective, including a focus on modeling the charged-particle kinetics in the presence of electromagnetic (EM) fields, collisions,

NSF RII Track 1 CPU2AL PI List

University of Alabama in Huntsville
Gary Zank (Lead PI), Nick Pogorelov, Vladimir Kolobov, Kunning Gabe Xu

Alabama A&M University
Srinivasa Rao Mentreddy, Armitra Jackson-Davis, Ernst Cebert
Leopold Nyochembeng, Padmaja Guggilla

Alabama State University
Komal Vig

Auburn University
Edward Thomas (Co-PI), David Ennis
Kaijun Lui, David Maurer, Joe Perez, Stuart Loch, Uwe Konopka, Yu Lin, Emefa Monu

Tuskegee University
Vijay Rangari, Michael Curry, Maria Calhoun, Zainuddin Shaik

University of Alabama
Gary Cheng, Mruthunjaya Uddi,
Rich Branam

University of Alabama at Birmingham
Yogesh Vohra (Co-PI), Vinoy Thomas,
Chen Cheng-Chien, Arron Catledge, Wenli Bi

University of South Alabama
Edmund Spencer

Oakwood University
Alexandre Volkov

CFD Research Corporation
Robert Arslanbekov

and turbulence. The second goal of RT 1 is to design and develop diagnostics capable of measuring plasma properties in LTPs far from equilibrium and their initial formation through steady-state conditions. It is crucial to perform high-quality measurements of plasma properties with sufficient temporal and spatial resolution to enable validation of theoretical models. Three objectives are pursued to (i) develop plasma diagnostic tools based upon emission spectroscopy and laser-induced fluorescence to measure line-integrated basic plasma parameters such as the plasma density and electron temperature, (ii) acquire and develop in-situ diagnostics that can provide localized measurements of plasma parameters, and (iii) develop fast diagnostic systems that can measure the time evolution of a variety of plasma structures.

RT 2 addresses electron kinetics and collective phenomena through two goals. The first goal is to study the temporal and spatial ordering of plasma systems, and investigate fundamental properties of waves, instabilities, nonlinear processes, and self-organization in LPT. Two objectives are pursued focusing on the physics of dusty plasmas and understanding and controlling plasma stratification. The second goal of RT 2 is to develop a state of the art computational tool to simulate high-frequency EM field interactions with plasma, validate the tool for selected benchmark problems, and apply it to problems of interest to the CPU2AL Team.

RT 3 addresses plasma interfaces (solid, liquid, bio-matter) through two goals. The first goal is the LTP synthesis of novel superhard materials, specifically to study the formation of superhard materials from C, N, O, and B (CNOB) in LTPs and develop an understanding of the formation process and resulting material properties. Two objectives are pursued: (i) to synthesize novel superhard materials based on CNOB using existing LTP systems and carry out plasma treatment of graphitic carbon synthesized from renewable waste sources for incorporation into polymer composites and (ii) to develop large-area (> 100 cm2) plasma systems required for synthesis of superhard materials for applications in automotive, biomedical, and aerospace industries. The second goal of RT 3 is related to plasma interactions with

Vincent Hembrick-Holloman, a TU Ph.D. Candidate and GRSP Recipient (Rounds 11,12, and 13) interned at Enonik Industries.

soft matter and biomatter, specifically to understand the effect of LTP on biomaterials, plants, seeds, and agricultural products, and the fundamental processes responsible for their bioactivity. Two objectives are pursued: (i) to study effects of LTP on scaffold biomaterials and (ii) to investigate seed and food decontamination and protection, and electrical and biophysical responses of plants.

Our big-picture efforts are focused on using the research thrusts above to:

- Build lasting collaborations between AL academic and certain industry institutions;
- Integrate historically black colleges and universities (HBCUs) into the statewide research collaboration;
- Build shared infrastructure as a statewide resource, and
- Expand the faculty.

The second effort, i.e., integrating HBCUs into the statewide research collaboration, has resulted in the CPU2AL HBCUs being fully involved in collaborations with UAH, UAB, AU, and the CFDRC. Two of three seed funding awards were given to HBCUs and the only CERIF GRA application received from an HBCU was funded (ASU). In addition, during Year 2, a summer program exclusively for CPU2AL HBCU students was created.

Workforce Development and Diversity

The workforce development (WD) goal of CPU2AL is to make diverse, measurable, and long-lasting improvements in the Science, Technology, Engineering, and Mathematics (STEM) pipeline and workforce in Alabama that will link academic research activities to the Alabama LTP industry. During Year 2, the CPU2AL Team continued to recruit and appoint numerous participants at all levels, now numbering 120 participants.

Whenever possible, the appointment of women and underrepresented minority (URM) participants was prioritized and special efforts were devoted to recruit and retain such groups of participants.

Communication and Dissemination

During Year 2, the CPU2AL project was widely promoted through (i) the CPU2AL website, (ii) email campaigns with program announcements (iii) postings at career centers of all partner institutions, (iv) postings in national job search engines for students and URMs, (v) STEM outreach events, (vi) emails/meetings with industry partners, (vii) CPU2AL colloquia, (viii) the Science and Technology Open House (STOH), (ix) the CPU2AL Annual Meeting, (x) a comprehensive Newsletter, and (xi) presentations at national and international meetings.

Management

The CPU2AL Management Team comprises representatives from eight campuses and the industrial partner, together with a Project Manager (PM). Since its inception, the CPU2AL Management Team ensures that communication lines remain open and efficient and that cross-campus activities (scientific, academic, workforce, and diversity) are on schedule and achieving their specific goals. Communications include monthly virtual meetings and two in-person meetings of the Management Team. The CPU2AL Education, Outreach, and Diversity (EOD) Specialist plays an integral part in the coordination of project activities and participates in all meetings of the Management Team.

During Year 2, a second retreat was held to continue building cross-campus scientific and social relationships. Unlike the Year 1 retreat, which helped establish the basic management and planning tools and the allocation and management of resources, particularly the Central Education, Recruitment, and Impact Fund (CERIF), the Year 2 retreat focused more on collaborative research brain-storming and discussion with industry partners in

the Birmingham area. This led to a revised project timeline where responsible parties for each task in the strategic plan were identified along with monthly milestones for each task.

2019 CPU2AL Annual Meeting / Science and Technology Open House

The 2019 CPU2AL Annual Meeting was held in conjunction with the Science and Technology Open House from Wednesday, April 3 through Friday, April 5, 2019. During the STOH, undergraduate and graduate students and post-docs presented their research posters. Awards were given to the top three student posters in physical and biological science at each academic level. The annual meeting served as a dress rehearsal for the CPU2AL members presenting at Reverse Site Visit with the NSF.

The K-12 outreach event was held on Wednesday, April 3, brought in upwards 200 local students. The open house included full access to the Gulf Coast Exploreum Science Center, hands-on science demonstrations, and an IMAX presentation.

Science demonstrations were provided Auburn University, Bishop State Community College, The Dauphin Island Sea Lab, The University of Alabama, The University of Alabama at Birmingham, and The University of Alabama in Huntsville.

Above: UAB graduate student demonstrating plasma science experiment to students and NSF Program Manager.

Above: AU Professor Ed Thomas demonstrates the forces of nature using ping-pong balls, Science & Technology Open House, April 3, 2019.

Above & Below: Science experiments provided by Auburn University, Bishop State Community College, The Dauphin Island Sea Lab, The University of Alabama, The University of Alabama at Birmingham, and The University of Alabama in Huntsville at the Science and Technology Open House on April 3, 2019.

NATIONAL SCIENCE FOUNDATION EPSCoR

New Alabama NSF EPSCoR RII Awards FY2018 and FY2019							
Award No	**Title**	**Type**	**Inst**	**AL PI**	**Collaborators**	**Period of Performance**	**AL award**
FY 2018							
1832993	RII Track-4: EASE - Functional Electrical Stimulation and Mechanical Actuation of Soft Exoskeletons	NSF RII Track 4	UA	Vishesh Vikas		09/01/2018 - 08/31/2020	250,956
FY 2019							
1832898	RII Track-4: Designing Solution-Processed Hybrid Metamaterials via DNA Self-Assembly	NSF RII Track 4	UAB	Kannatassen Appavoo		10/01/2018 - 09/30/2020	246,292
1833065	RII Track-4: A Functional Genomics Approach to Explain the Evolution of Large Bodies and Long Life Spans	NSF RII Track 4	USA	Scott Glaberman		10/01/2018 - 09/30/2020	134,930
1833016	RII Track-4: Investigating 3-D Dispersed Smart Antenna Arrays for Nearly Full Spherical Scanning by New Radios (NRs)	NSF RII Track 4	USA	Saeed Latif		10/01/2018 - 9/30/2020	170,046
1833053	RII Track-4: Peering into Nature's Glass Boxes - using nano-Raman Spectroscopy to answer Novel Questions in Diatom-focused Environmental Research	NSF RII Track 4	Marine Environmental Sciences Consortium	Jeffrey Krause		10/01/2018 - 09/30/2020	121,325
1826781	RII-Track 2 FEC: Functional Analysis of Nitrogen Responsive Networks in Sorghum	NSF RII Track 2	HudsonAlpha	Jeremy Schmutz	University of Nebraska	10/1/2018-9/30/2022	1,972,373

NSF EPSCoR RII Track 2

In 2018, the NSF Track 2 FEC (Focused EPSCoR Collaboration) grant research focus was "Understanding the Relationship between Genome and Phenome" and in 2019, the research focus was "Harnessing the Data Revolution to solve problems of national importance".

In FY 2018, Alabama recieved no new Track 2 awards, but several previously awarded Track 2 awards were ongoing. In FY 2019, HudsonAlpha Institute for Biotechnology was awarded a NSF RII Track 2 award to investigate plant genomics to better understand how nitrogen affects plant growth and development.

RII Track-2 FEC: Functional Analysis of Nitrogen Responsive Networks in Sorghum

Dr. Jeremy Schmutz
HudsonAlpha Institute for Biotechnology

The high yields typical of modern agriculture rely upon nitrogen fertilizer, yet the manufacture of synthetic nitrogen fertilizer is extremely energy intensive and represents a major cost for farmers. Additionally, fertilizer runoff produces many secondary problems such as aquatic dead zones with low oxygen contents, and reduced water quality, increasing the costs of providing safe drinking water in agricultural regions of the country. Genetic gains in nitrogen use efficiency (NUE) by plants will aid in protecting yield while mitigating both costs and negative environmental impacts associated with high rates of fertilizer application in agriculture. Through this Track-2 Focused EPSCoR Collaborations (RII Track-2 FEC) project, researchers at the HudsonAlpha Institute for Biotechnology in Alabama and the University of Nebraska will partner to conduct cutting-edge plant genomics research to better understand how nitrogen affects plant growth and development. HudsonAlpha Institute for Biotechnology will bring its biotechnology education and agricultural genomics research expertise to the collaborative project while the University of Nebraska-Lincoln will contribute its expertise in plant transformation and automated phenotyping with their state-of-the-art automated greenhouse system for imaging large plants. Researchers will collect information of how plants respond to nitrogen levels through a variety of genetic, biotechnological, and observational methods in the widely-used grain crop sorghum. Sorghum thrives in climates where many food crops struggle and is more efficient at utilizing resources such as water and nitrogen. It is an ideal crop to target for improvement to meet the predicted doubling of global food demand by 2050. In addition, the project will include an educational component, which will train and inspire students to pursue genetic and biotechnology-based research for agriculture. To accomplish this, HudsonAlpha will develop a three-week summer course for advanced high school students called the "AgriGenomics Academy." Additional activities include the recruitment of three undergraduate students who will complete summer internships at both HudsonAlpha and University of Nebraska-Lincoln to learn advanced techniques, and support for the Launching Aspiring Biotechnology Students (LABS) program, which introduces low and moderate-income students to biotechnology. The project will also mentor four early career faculty. In addition to nitrogen use efficacy, the combined efforts of these two institutions will make significant progress toward understanding the biology of other complex agronomic crop traits.

Research Principal Investigator Jeremy Schmutz (left) and co-Investigator Kankshita Swaminathan (right) with a sorghum plant growing in HudsonAlpha's plant growth chamber".

NSF EPSCoR RII Track 4

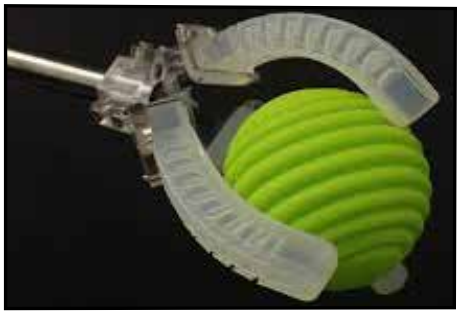
NSF EPSCoR RII Track 4 - EPSCoR Research Fellows funds non-tenured faculty to further develop their individual research potential through extended visits to learn new techniques, benefit from state-of-the-art equipment and facilities and shift their research toward transformative new directions to benefit the research capacities of their institutions and jurisdictions. Experiences gained through fellowships are intended to provide benefits impacting the recipient's career for years to come and in turn enhance the research capabilities of their institutions and jurisdictions. Any research topic that fits within NSF's overall portfolio is available for support. There is a limit of three proposal submissions per eligible jurisdiction.

During FY 2018-2019, Alabama was awarded five new NSF RII Track 4 awards. The list includes Dr. Vishesh Vikas at the University of Alabama, Dr. Kannatassen Appavoo at the University of Alabama at Birmingham, one award each to Drs. Scott Glaberman and Saeed Latif at the University of South Alabama and one to Jeffrey Krause, (University of South Alabama) at the Marine Environmental Sciences Consortium at Dauphin Island Sea Lab.

RII Track-4 EASE- Functional Electric Stimulation and Mechanical Actuation of Soft Exoskeletons

Dr. Vishish Vikas, UA

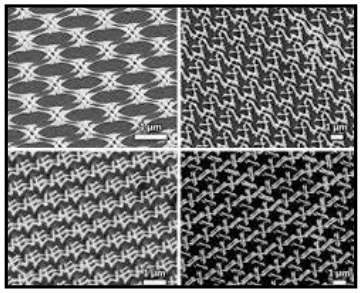
Soft material robotics is envisioned to be the future of robotics that combines the concepts of the Internet of Things (IoTs), wearable sensors, material science and artificial intelligence to fabricate robots that can assist and collaborate with humans. This field is of special interest to roboticists and engineers as it has multiple fundamental challenges and there are tremendous benefits for applications to fields such as agriculture, disaster robotics to assistive rehabilitation. This project will enable researchers from the University of Alabama to enhance their capabilities to develop next-generation soft material exoskeletons (exosuits) stimulated by mechano-neuromuscular actuators through a collaboration with researchers at the University of Pittsburgh. Mechanically and electrically actuated soft exosuits are envisioned to have an impact on the fields of assistive robotics, rehabilitation robotics, and elder care. The research will result in the development of design and control principles for mechano-neuromuscular actuated soft wearable exosuits, thus greatly enhancing life and reducing rehabilitation cost for individuals who suffer from paralysis, stroke, and spinal cord injuries. The applied nature of this research will play an instrumental role in attracting students to STEM fields that include computer science, electrical engineering, mechanical engineering and biomedical engineering.



RII Track-4: Designing Solution-Processed Hybrid Metamaterials via DNA Self-Assembly

Dr. Kannatassen Appavoo, UAB

With increasing demands to build devices that have a smaller footprint but operate at greater speeds, it is critical to develop materials with never-before-seen properties. These demands in performance are tied with developing nanofabrication techniques that are cheap and scalable in order to rapidly deploy these advanced materials into novel energy, communication and medical technologies. Metamaterial, a class of material that does not occur in nature, can possess exotic properties as determined by their periodic, organized structures rather than the intrinsic material properties of their



individual units. However, fabricating metamaterials is often costly and time-consuming, thus requiring sophisticated tools to create periodic arrays of nanostructures with high precision. In this project, the Principal Investigator will partner with experts at Brookhaven National Laboratory to develop a low-cost solution-process technique to fabricate three-dimensional metamaterial (BNL). The goal is to use self-assembly, the natural process by which complex structures are put together, to arrange subunits of different nanostructures into a three-dimensional metamaterial, providing real-time insights on the environmental factors that modify this process. This highly interdisciplinary project provides education and training opportunities in the fields of photonics, nanofabrication and high-resolution microscopy, and enables graduate and undergraduate students from Alabama to conduct research at BNL. If successful, this project will offer a strategy to create metamaterial on a large scale, aligning with the Materials Genome Initiative's vision to discover, manufacture, and deploy advanced materials in half the time and at a fraction of the cost.

RII Track-4 A Functional Genomics Approach to Explain the Evolution of Large Bodies and Long Life Spans

Dr. Scott Glaberman, USA

We use reptiles, specifically giant tortoises, to study the processes behind aging and cancer. Mammals, including humans, have long been used to study these topics, with obvious applications for improving health. However, it is becoming clear that all kinds of animals -not just mammals- have evolved ways of delaying aging and avoiding cancer. Thus, focusing

on mammals limits our arsenal for understanding how biology has solved these major physiological challenges. In this project, we will investigate which genes have allowed giant tortoises to mitigate cancer and other biological processes in order to grow so big and live so long. Specifically, we will use cells from long-lived, giant tortoises and their small tortoise relatives to see whether certain genes related to aging and cancer behave differently in these two types of tortoises. This work will not only expand how we look at the importance of animal diversity for meeting challenges in human health, but will also shed light on why we see such amazing diversity in animal life spans and body sizes in nature. The project also has a large outreach component including the development of high school learning modules to teach students cutting-edge technologies in genetics.

RII Track 4: Investigating 3-D Dispersed Smart Antenna Arrays for Nearly Full Spherical Scanning by New Radios (NRs)

Dr. Saeed Latif, USA

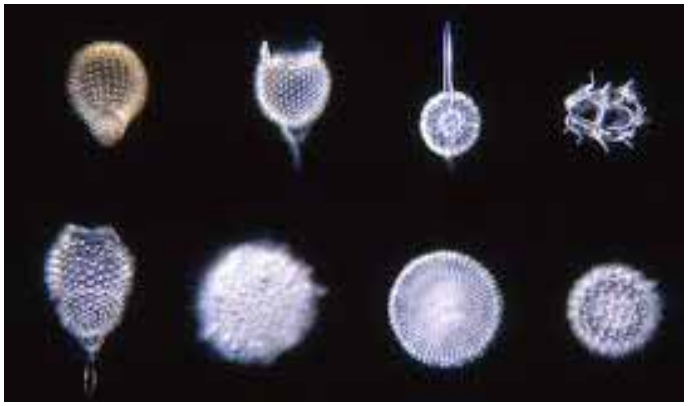
The existing 4G cellular systems have stretched their capabilities to a limit that they can no longer be extended or incrementally improved to meet the mounting demand for high bandwidth-consumptive mobile services. As the demand for large bandwidth and high data rate for mobile applications is at all-time high, future 5G (5th Generation) mobile terminals must operate at unused millimeter wave (mmWave) bands. It is also

expected that existing lower frequency 4G bands will continue to be needed for wide area coverage. In this project, it is proposed to investigate the performance of a new generation of smart dispersed array antenna architecture for future 5G new radios (NRs). The mmWave arrays will be integrated into recently designed 4G/LTE multi-slot antennas for interoperability between cells of 4G networks and future 5G heterogeneous cells. This will provide a unified connectivity platform for existing and emerging connected services. This fellowship will be a unique opportunity for the PI and a graduate student to access state-of-the-art facilities and advanced fabrication equipment. The project outcomes will be utilized to attract members of minority and underrepresented groups to engineering education in the Gulf Coast region. This will also boost the University of South Alabama's recruiting effort to attract outstanding undergraduate students, and drive up new mobile-based economic development opportunities in the Gulf Coast and in the State of Alabama.

RII Track-4: Peering into Nature's Glass Boxes - using nano-Raman Spectroscopy to answer Novel Questions in Diatom-focused Environmental Research

Dr. Jeffrey Krause
Marine Environmental Sciences Consortium

Diatoms are abundant microscopic oceanic 'plants' which have a protective shell made of glass. Despite their small size, diatoms' collective importance in marine ecosystems is immense. They produce as much oxygen globally as all the rain forests combined. Their glass shell (i.e. diatomaceous earth) also has many industrial applications. Unlike land plants which grow relatively slow, diatom biomass accumulates fast and is rapidly recycled in seawater. The recycling of diatom biomass releases 5-10 billion metric tons of carbon back into the ocean annually -a quantity of carbon which exceeds global fossil-fuel emissions. This project will use state-of-the-art technology to examine the properties of the glass shell and determine how they affect diatom-biomass recycling. This technology uses single-cell analysis, instead of traditional methods which require thousands of cells, thereby enabling new understanding and insight of single-cell material composition and structure. This project will help entrench this technology into diatom-based research and provide training for a Ph.D. student. The project collaboration with Stony Brook University based scientist will help researchers at the Alabama-based Dauphin Island Sea Lab personnel to emerge as leaders in their subfields. Also considering the vast industrial application for diatomaceous earth, these approaches may be useful for industry. This expertise will enable future work to serve the unique environmental research needs in the northern Gulf of Mexico (Alabama, Mississippi, Louisiana).



NATIONAL SCIENCE FOUNDATION CO-FUNDED EPSCoR

NSF Co-funding

To accelerate the movement of EPSCoR researchers and institutions into the mainstream of NSF support, EPSCoR Co-funding is available to provide support for proposals submitted to NSF's research, education and cross-cutting competitions. The objectives of the EPSCoR Co-funding mechanism are:

- To increase the number and competitiveness of EPSCoR jurisdiction investigators and institutions who participate in NSF research, technology, and education programs;
- To increase the participation of EPSCoR jurisdiction researchers and institutions in regional alliances and national collaborations;
- To broaden participation in science and engineering by institutions, organizations and people within and among EPSCoR jurisdictions.

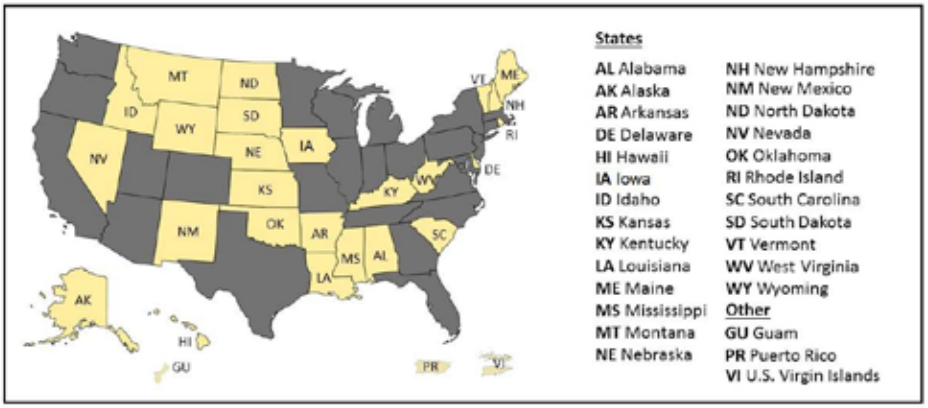
NSF Co-funding is not a program that can be applied to directly but works internally at NSF to provide joint support for certain meritorious proposals submitted to NSF's research, education, and cross-cutting Directorate competititions. The EPSCoR Co-funding mechanism focuses on those "Fund-if-Possible" proposals, which the NSF merit review process finds to lie at or near the cutoff for funding by the programs to which they were submitted. EPSCoR co-funds meritorious proposals that would otherwise not be supported due to availability of funds or other overriding program priorities.

For such proposals, the managing Program Officer first decides whether to make an award recommendation and the amount and duration to be recommended for the award. The decision to recommend an award or declination rests with the managing program. Once these decisions are made, a request for partial support via EPSCoR Co-funding can be forwarded to the EPSCoR for consideration. NSF EPSCoR Co-funding Mechanism is dependent on the number and quality of proposals submitted from EPSCoR jurisdictions and the availability of EPSCoR funds for Co-funding.

Proposal characteristics that will enhance the likelihood of EPSCoR co-funding are: (a) researchers who have not previously received NSF awards or researchers whose awards ended three or more years ago; (b) requests reflecting collaborative efforts within and across participating jurisdictions and at regional, national and/or international levels; (c) projects submitted to cross-discipline or cross-directorate programs; (d) projects that are synergistic with NSF investment and funding priorities in the current fiscal year; (e) projects that increase participation of members of underrepresented groups and/or institutions; (f) requests for instrumentation that build research capacity at the institutional or jurisdictional level; (g) student programs that will significantly enhance institutional research capability and competitiveness or provide training opportunities for K-12 students and professional development for K-12 teachers; and (h) programs that exemplify NSF's commitment to the integration of research and education.

In 2018, Alabama researchers were awarded fourteen new NSF Co-funded awards. These include three CAREER awards; one GOALI award, three Collaborative Research awards, one EAGER and one RCN-UBE award. In FY 2019, Alabama was awarded seventeen NSF Co-funded awards which include three CAREER awards and four MRI awards.

NSF EPSCoR FY19 Co-funding Eligibility



States

AL Alabama, AK Alaska, AR Arkansas, DE Delaware, HI Hawaii, IA Iowa, ID Idaho, KS Kansas, KY Kentucky, LA Louisiana, ME Maine, MS Mississippi, MT Montana, NE Nebraska, NH New Hampshire, NM New Mexico, ND North Dakota, NV Nevada, OK Oklahoma, RI Rhode Island, SC South Carolina, SD South Dakota, VT Vermont, WV West Virginia, WY Wyoming

Other

GU Guam, PR Puerto Rico, VI U.S. Virgin Islands

EPSCoR states and other U.S. jurisdictions eligible for EPSCoR co-funding during FY 2019
This includes twenty-five states, Guam, Puerto Rico, and the U.S. Virgin Islands.

NATIONAL SCIENCE FOUNDATION CO-FUNDED EPSCoR

CAREER awards are a Foundation-wide funding mechanism and is NSF's most prestigious award in support of junior faculty who exemplify the role of teacher-scholars through outstanding research, excellent education, and the integration of education and research within the mission of their institution. GOALI (Grant Opportunities for Academic Liason with Industry) awards seek collaboration between academic research institutions and industry. The Major Research Instrumentation (MRI) Program's goal is to increase access to shared scientific and engineering instruments for research and training in U.S. institutions of higher education, not-for-profit museums, science centers, and scientific/engineering research organizations. EAGER awards fund exploratory work in its early stages on untested, but potentially transformative research ideas of approaches, this is often considered high-risk, high payoff. RCN-UBE (Research Coordination Networks in Undergraduate Biology Education) awards, RCN awards seek to advance a field or create new directions in research or education by supporting groups of investigators to communicate and coordinate their research, training, and educational activities across disciplinary, organizational, geographic and international boundaries.

NEW Alabama EPSCoR NSF Co-funded Awards FY2018

Award No	Title	Lead Principal Investigator	Inst.	Period of Performance	Award
1809847	Exploration of Electronic and Catalytic Behavior in Epitaxial Complex Oxide Films and Nanocomposites	Ryan Comes	AU	07/01/2018 - 6/30/2021	531,981
1752654	CAREER: Secondary Amine Selective Petasis (SASP) Bioconjugation	Monika Raj	AU	07/01/2018 - 6/30/2023	650,000
1751296	CAREER: Uncovering mechanisms that shape variation in how males and females differ in their gene expression	Rita Graze	AU	08/01/2018 - 7/31/2023	392,665
1761675	GOALI: Prediction and Mitigation of Undesirable Acoustic Phenomena in Combustors and Power Generation Systems	Joseph Majdalani	AU	9/1/2018 - 8/31/2021	386,553
1827690	Partnership for Research and Education in Multiferroic Polymer Nanocomposites Between Tuskegee University and University of Nebraska-Lincoln	Vijaya Rangari	TU	09/01/2018 - 8/31/2024	1,288,750
1826775	Embodying Emotion in Interaction: A Biocultural-Linguistic Study of Communication and Physiology	Sonya Pritzker	UA	07/15/2018 - 6/30/2021	315,859
1800214	Collaborative Research: Atomistic Switches on Pyridinol Based Pincer Ligated Catalysts for Carbon Dioxide Reduction	Elizabeth Papish	UA	07/15/2018 - 6/30/2021	357,919
1748371	Implicit Biases and Discretionary Prosecutorial Decision Making	Jennifer Cox	UA	8/1/2018 - 7/31/2020	284,959
1812930	Collaborative Research: A Regularized Poisson Boltzmann Model for Fast Computation of the Ensemble Average Polar Solvation Energy	Shan Zhao	UA	08/15/2018 - 7/31/2021	230,000
1749837	CAREER: Engineering biomimetic environments to elucidate mechanisms of dormancy in brain metastatic breast cancer cells	Shreyas Rao	UA	9/1/2018 - 8/31/2023	407,524
1831512	Dimensions: Collaborative Research: Processes that Generate and Maintain Phylogenetic, Genetic, and Functional Diversity of the Freshwater Mussel Holobiont across Multiple Scales	Carla Atkinson	UA	09/01/2018 - 8/31/2022	977,466
1837698	EAGER: ISN: Anticipatory Interdiction in Narco-Trafficking Networks	Nicholas Magliocca	UA	9/1/2018 - 8/31/2020	295,656
1755464	CRII: OAC: Scalable Cyberinfrastructure for Big Graph and Matrix/Tensor Analytics	Da Yan	UAB	06/01/2018 - 5/31/2020	170,941
1826988	RCN-UBE: The Research on STEM Education Network: Improving Research Inclusivity through a Grassroots Culture of Scientific Teaching	James Morris	UAB	08/01/2018 - 7/31/2023	499,424
					6,789,697

NATIONAL SCIENCE FOUNDATION CO-FUNDED EPSCoR

NEW Alabama EPSCoR NSF Co-funded Awards FY2019					
Award No	Title	Lead Principal Investigator	Inst.	Period of Performance	Award
1828729	MRI: Acquisition of an X-Ray Photoelectron Spectrometer for Advancing Multidisciplinary Research and Education in Quantum Mechanics, Nanotechnology, Biosensors, and Energy Storage	Stephen Egarievwe	AAMU	10/01/2018 - 9/30/2020	628,558
1848344	CAREER: Modulation of the Interlayer Coupling in Heterostructures based on Two-Dimensional Materials	Marcelo Kuroda	AU	07/01/2019 - 6/30/2024	322,699
1850117	CRII: RI: Testing and Interpreting Image-based Computer Vision Models in 3D Space	Anh Nguyen	AU	06/01/2019 - 5/31/2021	175,000
1828232	MRI: Acquisition of an Atomic Force Microscope for Materials Research and Education	Eugenia Kharlampieva	UAB	10/01/2018 - 9/30/2020	314,912
1828678	MRI: Development of an Underwater Mobile Testbed Using a Software-Defined Networking Architecture	Aijun Song	UAB	10/1/2018 - 9/30/2021	300,000
1848154	CAREER:Laser Cooling and Trapping of Beryllium: Frozen Plasmas and Precision Measurements	Clayton Simien	UAB	04/01/2019 - 3/31/2024	336,325
1849264	S&AS:INT:COLLAB: Aerodynamic Intelligent Morphing System (A-IMS) for Autonomous Smart Utility Truck Safety and Productivity in Severe Environments	Vladimir Vantsevich	UAB	05/01/2019 - 4/30/2023	651,260
1850241	CRII: SaTC: Rowhammer Attack on Fresh and Recycled Memory Chips: Security Risks and Defenses	Tauhidur Rahman	UAH	03/01/2019 - 2/28/2021	175,000
1855646	IRES Track 1: USA-China: International Research Experience for Native American Students in IoT Enabled Environmental Monitoring Technologies	Jinhui Wang	USA	10/1/2018 - 8/31/2021	299,920
1900377	Excellence in Research: InnovAtive Methods and Advanced Science at Alabama State University (IAM-ASU)	Qiana Matthews	ASU	8/1/2019 - 7/31/2022	499,968
1848418	CAREER: Exploration and Controllability of Excitonic Behaviors in Conjugated Polymer Single Isolated Chains and Chain Aggregates	Paulo Araujo	UA	8/1/2019 - 7/31/2023	360,000
1853467	Collaborative Research: Population Dynamics in Random Environments: Theory and Approximation	Hai Dang Nguyen	UA	7/1/2019 - 6/30/2022	105,047
1908195	Hyperbolic-Parabolic Balance Laws with Applications	Yanni Zeng	UAB	7/1/2019 - 6/30/2022	151,361
1856054	Track-1- (INFEWS) Food-Energy-Water Nexus in the Deep South: A Latent System Primed for Transition From Rain-fed to Irrigation-fed Agriculture	Hamid Moradkhani	UA	07/15/2019 - 6/30/2023	1,300,000
1919906	MRI: Acquisition of a Cryoprobe Equipped Nuclear Magnetic Resonance Spectrometer for Studying Macromolecules, Bioactive Isolates, and Dynamic Processes	Paul Rupar	UA	09/01/2019 - 8/31/2022	532,871
1856729	Nano-ceria shape effects on non-equilibrium plasma-catalysis for chemical looping CO2 reuse	Ruigang Wang	UA	8/15/2019 - 7/31/2022	440,071
1919952	MRI: Development of a Non-Equilibrium Plasma Coupled Rapid Compression Machine	Nicholas Tsolas	AU	9/1/2019 - 8/31/2022	657,627
					7,250,619

NATIONAL SCIENCE FOUNDATION CO-FUNDED EPSCoR

CAREER: Modulation of hte Interlayer Coupling in Heterostructures based on Two-Dimensional Materials

Dr. Marcelo Kuroda, Auburn University

This CAREER award supports computational and theoretical research and education on materials which are composed of stacked two-dimensional layers and exhibit novel properties and phenomena. Each layer consists of few-atom-thick crystals, which are particularly interesting due to the differences between their in-plane and out-of-plane properties, and the capability to stack them. These properties can be tuned through external mechanical, electrical, or magnetic fields. Theoretical descriptions of the properties of these materials do not include atomic-scale details; this makes it difficult to identify underlying principles to control their behavior and to devise corresponding control mechanisms. Elucidating the interplay among weak interactions, structure, and function in these materials called layered heterostructures is key to the discovery of novel physical phenomena. The PI will use computational methods to study these materials with the aim to help accelerate the deployment of functional high-performance materials and energy-efficient platforms that can revolutionize electronic and sensing device technologies.

Inspired by recent experiments demonstrating the modulation of electron tunneling in heterostructures based on two-dimensional materials, the PI will combine theoretical models and state-of-the-art computation to describe novel physical phenomena emerging in these systems. In particular, this project is aimed to investigate how interlayer coupling can be tuned by using external fields in two-dimensional materials. Understanding the quantitative relationship between interlayer coupling and the atomistic details of these material systems will enable a data-driven search for other complex structures where key properties are enhanced, and guide design and experimental realization of new materials with promising properties.

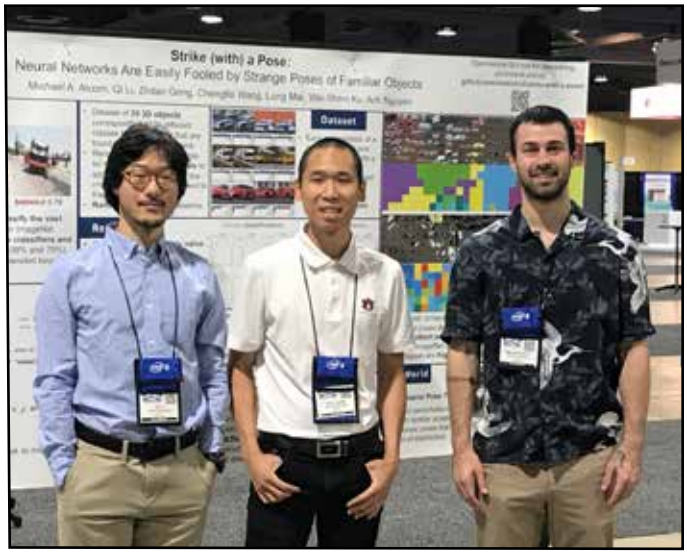
This research will be coupled to education and outreach activities to be carried out at Auburn University and in the Southeastern US region. The PI will create a webinar series on various areas of physics targeting broad undergraduate student audiences in universities and colleges throughout the Southeastern US region. In these webinars, faculty from different institutions will discuss current directions of their research areas and disseminate potential opportunities for graduate studies or research experiences. The PI and his group will be actively involved in two existing and successful outreach programs at Auburn University for middle and high school students: The Summer Science Institute and the Semiconductor Day. The PI will develop student-centered course curricula pertaining to novel physics emerging at the nanoscale and electronic structure.

CRII: RI: Testing and Interpreting Image-based Computer Vision Models in 3D Space

Dr. Anh Nguyen, Auburn University

From autonomous vehicles to cancer detection to speech recognition, artificial intelligence (AI) is transforming many economic sectors. While being increasingly ubiquitous, AI algorithms have been shown to easily misbehave when encountering natural, unexpected, never-seen inputs in the real world. For example, when a car on autopilot failed to recognize a white truck against a bright-lit sky, it crashed into the truck, killing the driver. To avoid such costly and unsafe failures, this project develops a framework for rigorously and automatically testing AI algorithms, specifically computer vision systems, in a 3D environment. In addition, via the framework, the project attempts to uncover why an algorithm makes a given decision. Providing explanations understandable by humans for decisions made by machines is crucial in gaining users' trust, advancing AI algorithms, and complying with the current and future legal regulations on the use of AI with sensitive human data.

Researchers previously attempted to achieve the two main goals of (1) testing and (2) interpreting computer vision systems by synthesizing a 2D input image that fails a target image recognition model. However, the existing methods operate at the pixel level, generating special patterns that (a) are hard to explain; (b) might not transfer well to the physical world; and (c) may rarely be encountered in reality. Instead of optimizing in the 2D image space, the research objective of this project is to harness 3D graphics engines to create a 3D scene where the factors of variations (e.g. lighting, object geometry and appearances, background images) can be controlled and optimized to cause a target computer vision system to misbehave. This research effort will (1) reveal systematic defects via automatically testing the target model across many controlled, disentangled settings; and (2) improve the existing interpretability methods by incorporating 3D information. The developed methods attempt to provide explanations for the decisions made by computer vision models and create new insights into their inner functions. The project will improve the safety, reliability, and transparency of AI algorithms. This project is jointly funded by the Robust Intelligence (RI) and the Established Program to Stimulate Competitive Research (EPSCoR) programs.



Dr. Anh Nguyen and graduate students presenting first NSF paper at CVPR (Computer Vision and Pattern Recognition) Conference in Long Beach, California, June 2019

CAREER: Laser Cooling and Trapping of Beryllium: Frozen Plasmas and Precision Measurements

Dr. Clayton Simien, UAB

This CAREER award supports investigation of berillium (Be) as a new candidate element for the next generation of optical atomic clocks, as well as for producing an ultracold neutral plasma -- an ultracold gas of ions and electrons. Atomic clocks have been instrumental in the advancement of science and technology in the twentieth century, leading to innovations such as global positioning, advanced communications, and tests of fundamental theories of particle physics. A next generation optical atomic clock would extend the capabilities of these systems and will enable enhanced security for data routing and communications, advanced earth and space time-based navigation, and ever more precise testing of Einstein's Theory of General Relativity. Ultracold neutral plasmas (UCNPs) are laser produced plasmas that stretch the boundaries of traditional plasma physics. However, studies of these table-top ultracold systems are promising to greatly improve our understanding of much hotter and denser plasmas thought to occur in many astrophysical systems. The goal of this project is to laser cool, trap and photo-ionize neutral atomic beryllium for its potential use as an optical frequency standard, and to produce a UNCP at a sufficiently low temperature for ionic crystals to form inside the system, virtually freezing the plasma. This award will also make it possible to attract and retain more

underrepresented minority students to physics studies. The project will involve minority graduate, undergraduate, and high school students via existing Univ. of Alabama - Birmingham programs to participate in research projects in the Simien Spectroscopy and Laser Cooling group. Additional outreach activities will aim to get K-12 students interested in science and engineering by performing physics and chemistry demonstrations at local schools in the region.

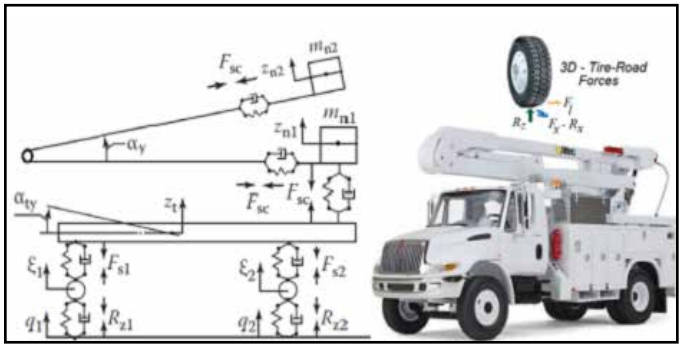
This project is jointly funded by the Plasma Physics program, the Atomic, Molecular and Optical Experimental Physics program, and the Established Program to Stimulate Competitive Research (EPSCoR).

S&AS: INT: COLLAB: Aerodynamic Intelligent Morphing System (A-IMS) for Autonomous Smart Utility Truck Safety and Productivity in Severe Environments

Dr. Vladimir Vantsevich, UAB

Utility trucks are the first responders in areas of extreme weather situations for tasks such as rescuing people from disaster areas, cutting trees to restore traffic, and repairing electric posts and restoring power. This study establishes a scientific framework for maintaining the productivity and safety of emergency response vehicles while eliminating accidents. This is implemented via a novel integrated framework to monitor and predict weather conditions and feed that information into intelligent mechanisms that autonomously shape the aerodynamic surfaces of utility trucks. This potentially transformative framework for A-IMS will: (1) bring new perspectives of learning to enhance the adaptability and intelligence in natural-engineering systems that leverage physical and information processes; (2) establish an integrated design framework for hazardous environments to achieve resilience, and productivity through integrated adaptation of morphological properties while also mitigating the effects of potentially adversarial learning agents that can exist in the cloud; (3) investigate the interactive physical components of the A-IMS, that will simultaneously operate in two different mediums of multi-phase fluids, and solids (i.e., the air/fluid and road).

The A-IMS framework will be evaluated through hardware/software implementation, as well as in real-world conditions in the unique test conditions available at Wall of Wind at Florida International University. The project's education and outreach component include integrated research and education plans that will lead to technology transfer and summer camps to integrate high-school students, as well as students from multiple cultures, and disciplines into autonomy research. This project is expected to contribute new scientific knowledge and engineering techniques for next generation transportation infrastructure resiliency, and to facilitate economic growth in the state of Alabama.



above: Dr. Vantsevich will conduct A-IMS tests on this utility vehicle from Altec, Inc. in the Wall of Wind facility at Florida International University.

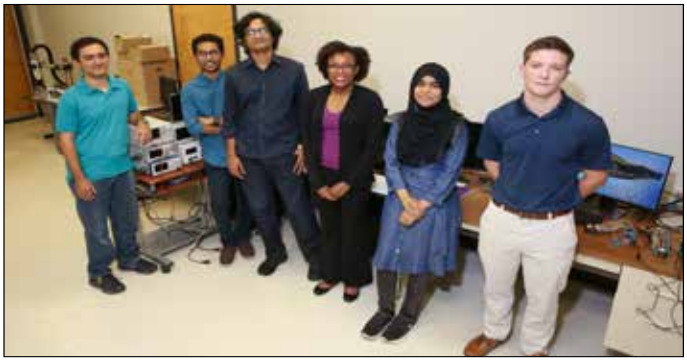
CRII: SaTC: Rowhammer Attack on Fresh and Recycled Memory Chips: Security Risks and Defenses

Dr. Tauhidur Rahman, UAH

Rowhammer is a software-assisted cyber-attack that causes malicious changes to the target memory cells of dynamic random-access memory (DRAM) due to charge leakage, by crafting memory access patterns which rapidly access the same row multiple times. This research focuses on proper hardware characterization towards a Rowhammer-resistant memory system. This characterization will also inform whether Rowhammer susceptibility increases with aging, and if so, will enable a method for detecting recycled chips.

The research will (i) identify the Rowhammer-prone memory cells through hardware characterization, (ii) develop a low-cost system-level technique to build a Rowhammer-resistant memory system, (iii) experimentally study the vulnerability of counterfeit (especially recycled) DRAM chips to Rowhammer, and (iv) develop a framework that identifies recycled DRAM chips, if a relationship between Rowhammer effectiveness and aging is found.

The research findings and tools will be of high interest to the individual consumers, federal agencies, data centers, healthcare, enterprise, and automobile systems, that are the targets of Rowhammer attacker. The cross-cutting nature of this research will broaden the advancement of knowledge in the field of computer systems, security, and reliability and will enable collaboration between various communities (systems/device/reliability/hardware-security/algorithms). The graduate and undergraduate students working on this project will receive training and grow expertise in the related fields. The research findings will also be used in existing and new graduate/undergraduate courses on hardware-security for training and education.



Rahman's team at UAH

All publicly released data, source codes, and peer-reviewed research articles will be made available during the period of performance and afterward, and will be posted at https://www.trust-hub.org/data and http://webpages.uah.edu/~mtr0011.

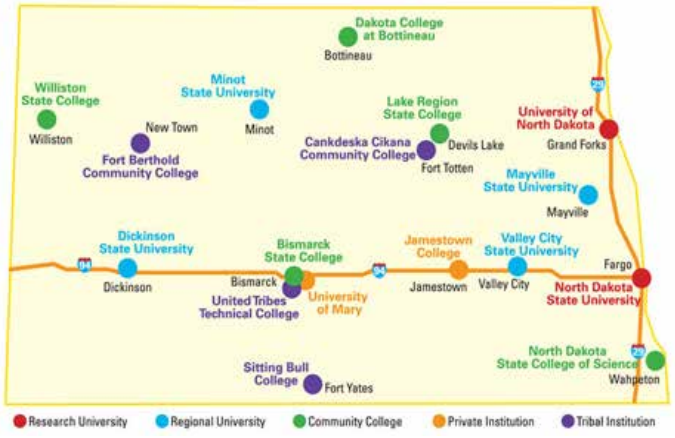
IRES Track 1: USA-China: International Research Experience for Native American Students in IoT Enabled Environmental Monitoring Technologies

Dr. Jinhui Wang, University of South Alabama

Twelve Native American students from five Tribal Colleges in the state of North Dakota will participate in a six-week summer program over the course of three years. Each year, four students will form a cohort and participate in pre-training in the U.S. and then visit and study at the host University in Beijing, China for five weeks. All three student cohorts will focus on one unifying topic - building and testing an Internet of Things (IoT)-enabled environmental monitoring system. During the course of the research training and after the project is finished, a deep and comprehensive evaluation will be conducted to assess three key aspects of the program: 1) instructional training and research experience, 2) global professional and cultural experience; and 3) student mentoring. This program will greatly benefit participating students. This is an international learning experience that may be the key highlight of student participants' academic careers, which may be especially true for Native American students, as they have less chances

for performing research abroad. The program will provide participating students with unique opportunities to become globally-engaged scientists and to build their international scientific networks. There are five Tribal Colleges in the state of North Dakota that represent historic tribal nations. The recruitment of this program from these Tribal Colleges will ensure a regionally diverse student group will receive international mentoring and research-based education. In many large cities of U.S., there are environmental problems similar to Beijing, so the monitoring technology learned by participating students will provide valuable reference and an essential technology reserve. The participating students will build peer-mentoring skills and learn about the unique culture and traditions of China from Beijing, the culture center of China.

Student participants will learn to design advanced environmental monitoring systems that integrate energy harvest and remote control, which can track all four categories of environmental contaminants including metals, radioisotopes, volatile organic contaminants, and biological contaminants. In this project, tasks for student participants include sensor developments, interface circuits designs, wireless sensor network designs for Internet of Things (IoT)-enabled systems to realize environmental monitoring, testing the proposed monitoring system on laboratory and field sites, and making reliability-based lifetime analyses. The proposed system is a much-needed technology for environmental decision-making that will help substantially reduce ecological and human-health threats from environmental problems, and the implemented prototype and test data will be a significant reference for the other academic researchers and industrial developers. Evaluation data collection will occur sequentially using a combination of qualitative and quantitative data measurements to assess the effectiveness of the program. The primary goals of this program are to: 1) provide students with training and mentoring in international-based engineering applications that will create a positive effect in their professional and personal lives, 2) create Native American experts in environmental monitoring and protection, and 3) improve specialized environmental management in the remote areas.



North Dakota University System

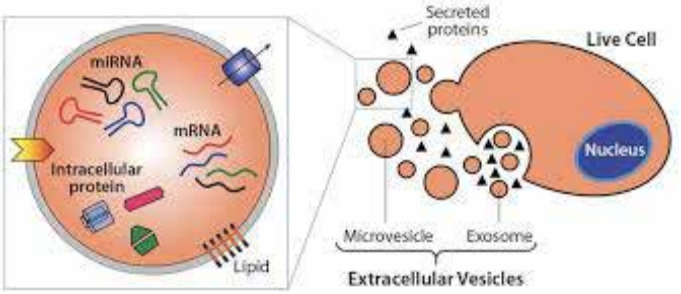
Excellence in Research: InnoAtive Methods and Advanced Science at Alabama State University

Dr. Qiana Matthews, ASU

Exosomes are small vesicles that are released from donor cells and internalized by a recipient cell. These vesicles carry proteins, DNA and RNA. It is thought that they are important for cell-to-cell communication, and may be important for development of disease. Some viruses will use exosomes to spread infections. In other cases, exosomes from virus-infected cells can trigger anti-viral responses to help combat virus infections. Adenovirus is a virus that causes the common cold. The goal of this proposal is to examine how adenovirus infection alters the formation and composition of exosomes by comparing exosome formation in uninfected and infected cells in vitro. In addition, work will be performed to ask if there is a connection between altered exosome formation and severity of adenovirus infection. These studies will provide new information on the interaction between the host cell and viruses, and will lead to a greater understanding of exosome biogenesis and virus infections. This promotes the NSF mission because it promotes the progress of science. This project will also support the education of undergraduate and graduate students. Therefore, it fulfills the mission of the NSF to support education and diversity in science.

NATIONAL SCIENCE FOUNDATION CO-FUNDED EPSCoR

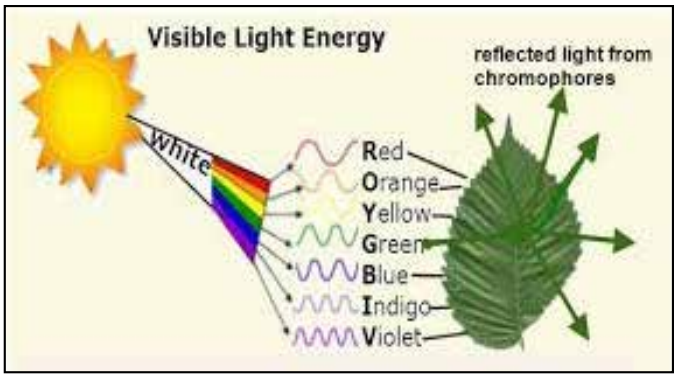
This project is jointly funded by the Integrative Organismal Systems (IOS) Symbiosis and Self-Defense (SDS) program, the Established Program to Stimulate Competititve Research (EPSCoR),the Historically Black Colleges and Universities Undergraduate Program (HBCU-UP) and Historically Black Colleges and Universities Excellence in Research (HBCU-EiR) programs.



CAREER: Exploration and Controllability of Excitonic Behaviors in Conjugated Polymer Single Isolated Chains and Chain Aggregates

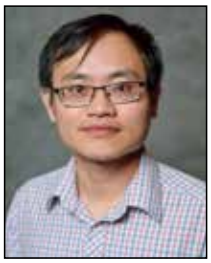
Dr. Paulo Araujo, UA

Many molecules have a group of atoms, called a chromophore, that absorb light and give the molecule its color. All molecules of the same type have the same atom grouping and the same color. At least that is the case when the molecules are far apart. Move two molecules close together and their chromophores interact with each other, changing their color. This interaction plays a central role in the properties of conjugated polymers, which are formed by linking many chromophores together into long chains of molecules, like beads on a necklace. With support from the Macromolecular, Supramolecular and Nanochemistry Program in the Division of Chemistry and the Established Program to Stimulate Competitive Research (EPSCoR), Professor Paulo Araujo at the University of Alabama Tuscaloosa is studying the interactions between chromophores in conjugated polymers. Professor Araujo and his students are combining sophisticated optical microscopies with methods to manipulate polymer structures to understand how local arrangements of chromophores in individual polymer chains affects their optical properties. Their discoveries could have important implications for the design and control of polymers used in a wide variety of emerging technologies, including light-emitting diodes and solar energy conversion applications. The team is documenting their progress -- from the generation of the ideas to the publication of the work -- through a series of online videos produced in multiple languages. In addition, close collaboration with students and faculty at Brazilian universities is promoting the integration of minority groups and international students into top-notch scientific programs.



Collaborative Research: Population Dynamics in Randon Environments: Theory and Approximation

Dr. Hai Dang Nguyen, UA



This project will formulate and analyze a general mathematical framework to facilitate understanding the persistence and extinction of species affected by random environmental fluctuations. Global climate change models predict increasing temporal variability in temperature, precipitation and storms in the next century. Random environmental fluctuations have been shown to drive populations

extinct, promote persistence, change genetic diversity, and modify the spread of infectious diseases. It is therefore urgent to develop tools for understanding the effects of random temporal fluctuations in environmental conditions on species. The PIs will develop mathematical theory, in conjunction with analytical and numerical approximation methods, to help theoretical ecologists pinpoint how environmental fluctuations affect the long-term dynamics of ecological communities. In collaboration with the Gore lab at Massachusetts Institute of Technology the PIs will test theoretical results by comparison with microbial ecology experiments. The investigators plan to involve high school and undergraduate students in projects allowing them to develop programming skills and diversify their mathematical and ecological knowledge. For outreach, the investigatprs will organize seminars and conferences and promote the participation of women and members of traditionally underrepresented minorities within the sciences.

This project is jointly funded by the Division of Mathematical Sciences Mathematical Biology Program the Established Program to Stimulate Competitive Research (EPSCoR).

Hyperbolic-Parabolic Balance Laws with Applications

Dr. Yanni Zeng, UAB

This project aims to study a general system of partial differential equations called hyperbolic-parabolic balance laws, with two specific applications in mind: one in bio-medicine and another in gas dynamics. There is a variety of gas-dynamic phenomena that can be described mathematically by hyperbolic-parabolic balance laws. The swirl of complicated gas flows surrounding a space vehicle reentering the Earth's atmosphere is probably one of the most spectacular examples for which these balance laws serve as a (simplified) mathematical description. The second application motivating this research is chemotaxis, the movement of micro-organisms in response to a chemical stimulus. The mechanism of chemotaxis is ubiquitous in biology and medicine, from migration of bacteria or leukocytes to cancer metastasis. Arising from the physical world, the parabolic-hyperbolic systems do not fit exactly into the traditional classification in the theory of partial different equations, and the solutions' behavior is governed by both hyperbolicity and parabolicity, plus a chemical reaction. Integrated into the research activities of the project there is an educational component. It includes curriculum development of hands-on modeling of real-world problems by partial differential equations, one-on-one research mentorship to undergraduate students, and direct participation of research by Ph.D. students. The project encourages the participation of students at all levels, especially students from under-represented groups.

This project is jointly funded by the Applied Mathematics Program of the Division of Mathematical Sciences and by the Established Program to Stimulate Competitive Research (EPSCoR).

Track-1-(INFEWS) Food-Energy-Water Nexus in the Deep South: A Latent System Primed for Transition From Rain-fed to Irrigation-fed Agriculture

Dr. Hamid Moradkhani, UA

The Deep South states, including Alabama, Mississippi, Louisiana and Georgia, continue to experience one of the highest poverty rates in the nation. As agriculture plays a significant role in the economies of these states, one potential option for their economic resurgence is through a drastic increase in agricultural productivity. This project considers such an option based on a scenario of a transition from rain-fed to irrigation-fed (RFtoIF) agriculture. The project is conducted in the Mobile River Basin encompassing portions of Alabama, Georgia and Mississippi. Given that food, energy and water (FEW) systems are intricately linked within the basin, the study will evaluate the impacts of RFtoIF agriculture transition on the distribution-of and interactions-between these three

resource systems. Through established relationships and collaboration with the stakeholders in Alabama, the project provides an opportunity for the investigators and relevant stakeholders to facilitate identification of the barriers and incentives needed to spur RFtoIF transition in the Deep South, as well as to discuss the significance of findings, identify ways for improving their impacts, and enabling informed decision making influences on prosecutors when rendering decisions in IPV cases. As well, by offering a more comprehensive understanding of prosecutorial discretion, it has the potential to guide reform and improve practice.

This project is jointly funded by INFEWS and the Established Program to Stimulate Competitive Research (EPSCoR); and managed by the GeosciencesS Directorate.

MRI: Acquisition of a Cryoprobe Equipped Nuclear Magnetic Resonance Spectrometer for Studying Macromolecules, Bioactive Isolates, and Dynamic Processes

Dr. Paul Rupar, UA

This award is jointly funded by the Chemical Research Instrumentation (CRIF) program, the Established Program to Stimulate Competitive Research (EPSCoR), and the Major Research Instrumentation (MRI) program. Professor Paul Rupar from the University of Alabama Tuscaloosa and colleagues Elizabeth Papish, Jason Bara, Marco Bonizzoni and Lukasz Ciesla are acquiring a 500 MHz NMR spectrometer equipped with a cryoprobe. Nuclear magnetic resonance (NMR) spectrometers measure the interaction of radio waves with a sample's atomic nuclei in the presence of a strong magnetic field. The information provided by NMR spectrometers allows researchers to identify unknown substances, determine the structure of molecules, macromolecules, and biomolecules, and monitor reaction dynamics in solution. Because of its versatility, ease of use, and non-destructive nature, NMR spectroscopy supports much of modern chemical-based research and is critical to the fields of organic chemistry, inorganic chemistry, biology, chemical engineering, biochemistry and materials science. The cryogenic probe provides a significant increase in sensitivity relative to standard NMR probes. The instrument is also used to train undergraduate and graduate students in the use of this powerful tool. The spectrometer is available for use by researchers at other institutions including Tuskegee University and Samford University.

Nano-ceria shape effects on non-equilibrium plasma-catalysis for chemical looping CO2 reuse

Dr. Ruigang Wang, UA

Non-equilibrium plasmas, also known as low-temperature plasmas, are highly reactive and can be used in catalytic chemical processes. Chemical looping processes can convert natural gas into electricity, liquid fuels, hydrogen, or chemicals while providing capture of carbon dioxide (CO2). The use of non-equilibrium plasma-catalysis (NEPC) for chemical looping and methane processing can have a global impact on energy conversion infrastructure such as small-scale reactors for chemical synthesis, power plants, gas-to-liquid technology, oil exploration, and fuel cells, etc. This project will study the shape effects (such as rods, cubes, octahedra, and fibers) of ceria-supported catalysts (CuOx and RuOx) on performance and selectivity in non-equilibrium low-temperature plasma-enhanced chemical looping hydrogen production from water, using CO2, water and natural gas as feedstock. The proposed research could lead to economically viable approaches for synthesis of sustainable fuels from CO2 obtained directly from power plants, water and natural gas feedstock, thus providing alternatives to fossil fuels while mitigating greenhouse gas emissions.

The proposed research will test the hypothesis that gaseous non-equilibrium low temperature plasma containing vibrationally and electronically excited species/radicals/hot electrons etc. together with the metal oxide catalysts supported on different ceria nano-shapes can synergistically enhance heterogeneous reactions leading to low temperature performance and selectivity in products which can include syngas (CO+H2) and larger hydrocarbons (C2H4, C2H6, C2H2) during the reduction cycle and H2 during the oxidation cycle. The plasma-catalysis synergy can enhance the yield at low temperatures and also lead to understanding towards catalyst design for product selectivity. For example, the plasma can dissociate CH4 to CH3+H at low temperatures. With the right docking sites on catalysts or interfaces, two CH3 radicals can combine to form C2H4 after losing H2. The RF discharge plasma can by sustained using solar energy or wind energy and novel high efficiency surface discharge techniques can be developed. The proposed outreach program will be aimed at teachers and students in rural Alabama to increase participation of underrepresented minority students in science and engineering research.

This project is jointly funded by Process Systems, Reaction Engineering and Molecular Thermodynamics and the Established Program to Stimulate Competitive Research (EPSCoR).

MRI: Development of a Non-Equilibrium Plasma Coupled Rapid Compression Machine

Dr.Nicholas Tsolas, Auburn University

Development of next generation high-efficiency, low-emission engines require extending the pressure and temperature operation ranges beyond current limits. A novel approach known as the plasma-assisted combustion (PAC) has recently demonstrated considerable promise, which can play an important role in enhancing the basic combustion process. However, the details of exact chemical enhancement mechanisms remain largely unknown. The main goal of this project is to design, fabricate and assemble a unique plasma coupled experimental apparatus that will enable the scientific investigation of PAC at engine relevant conditions. Additionally, additive manufacturing techniques will be leveraged to fabricate customized metallic components of complex geometries not possible with traditional subtractive methods. This project will also include educational and workforce development activities to train a new generation of engineers and scientists with the interdisciplinary technical skills. These efforts will ultimately reduce fuel consumption, ensure energy security, mitigate the environmental impact of next generation engines, and position the US as a leader in the development of innovative technologies for transportation/energy applications.

This MRI program will allow a multi-disciplinary group of researchers to develop a unique plasma coupled rapid compression (PRCM), that is capable of compressing a gaseous fuel and oxidizer mixture to instigate combustion while under the effects of a non-equilibrium plasma. Taking advantage of additive manufacturing, the modularity of this device will allow a variety of different diagnostic measurements to be performed in order to accurately observe plasma formation, and ultimately interpret auto-ignition chemistry and physical-chemical interactions with and without the influence of a plasma. The device also provides well-defined boundary conditions to compliment experimental studies with numerical modelling approaches. Based on this instrument, the project aims to elucidate the following scientific investigations: a) understand the kinetic oxidation scheme of low-temperature combustion (cool flame chemistry) of hydrocarbon fuels, practical fuels, and surrogate fuels; b) understand the combustion characteristics of new generation biofuels derived from algae and non-food source terrestrial biomass; c) understand the role of plasma chemical effects on the kinetic oxidation scheme of cool flame chemistry of fuels; and d) demonstrate PAC as a means to enable advanced compression ignition strategies. Experimental data derived from this device will be used to develop and validate accurate plasma-specific and low-temperature chemical kinetic models for use in predictive simulations tools, thus enabling the design of future engines and improved combustion systems.

This project is jointly funded by CBET-MRI Program and the Established Program to Stimulate Competitive Research (EPSCoR).

Workshops and Outreach

EPSCoR solicits requests for support of workshops, conferences, and other community-based activities designed to explore opportunities in emerging areas of science and engineering, and to share best practices in planning and implementation in strategic planning, diversity, communication, cyberinfrastructure, evaluation, and other areas of importance to EPSCoR jurisdictions.

NSF EPSCoR Regional Outreach Meeting

The NSF EPSCoR Regional Outreach: All About Research Center Programs meeting was held on April 2, 2019, in Mobile, Alabama. It drew over 80 attendees from the southeastern US.

This event was also attended by NSF Center Program Officers and Center Directors. Each provided extensive information about the various centers sponsored by the NSF. It featured breakout sessions where attendees can ask questions about centers and speak with program officers and center directors.

DEPARTMENT OF ENERGY EPSCoR

The DOE EPSCoR Program was established by Section 2203 in 1992 and is positioned in the Office of Science and is the single largest supporter of basic research in the physical sciences. It supports both basic and applied research and development across a wide range of interdisciplinary program areas that including:

Advanced Scientific Computing Research
Basic Energy Sciences
Biological and Environmental Research
Fusion Energy Sciences
High Energy Physics, and Nuclear Physics

The goals of the DOE EPSCoR program are to:

- Improve the capacity of designated states and territories to conduct sustainable and national competitive energy-related research
- Jumpstart infrastructure development through increased human and technical resources, training scientists and engineers in energy-related areas
- Build beneficial relationships with ten world class laboratories in designated states and territories, leverage DOE national user facilities, and take advantage of opportunities for intellectual collaboration across the DOE system.

DOE uses NSF EPSCoR eligibility criteria. Twenty-seven states, the Commonwealth of Puerto Rico and the U.S. Virgin Islands are currently eligible for DOE EPSCoR. DOE EPSCoR provides funding support through three types of awards including the Implementation Grant, National Laboratory Partnership Grants, and the Early Career Research Program, each are described below.

The Implementation Grant is for a maximum period of six years with an initial period of three years. Maximum funding for Implementation Grants is $2,500,000 per year and until recently only one active implementation grant per state or territory was permitted at a time. Now any EPSCoR state or territory can apply when there is an open Funding Opportunity Announcement (FOA). An Implementation Grant solicitation was issued in November 2018, the first in several years. Pre-applications were due December 20, 2018, requested full proposals were due March 27, 2019. Nine awards were announced July 1, 2019.

The EPSCoR-State/National Laboratory Partnership Grant is for a maximum period of 3 years. Maximum funding for

DOE EPSCoR eligibility map

DEPARTMENT OF ENERGY EPSCoR

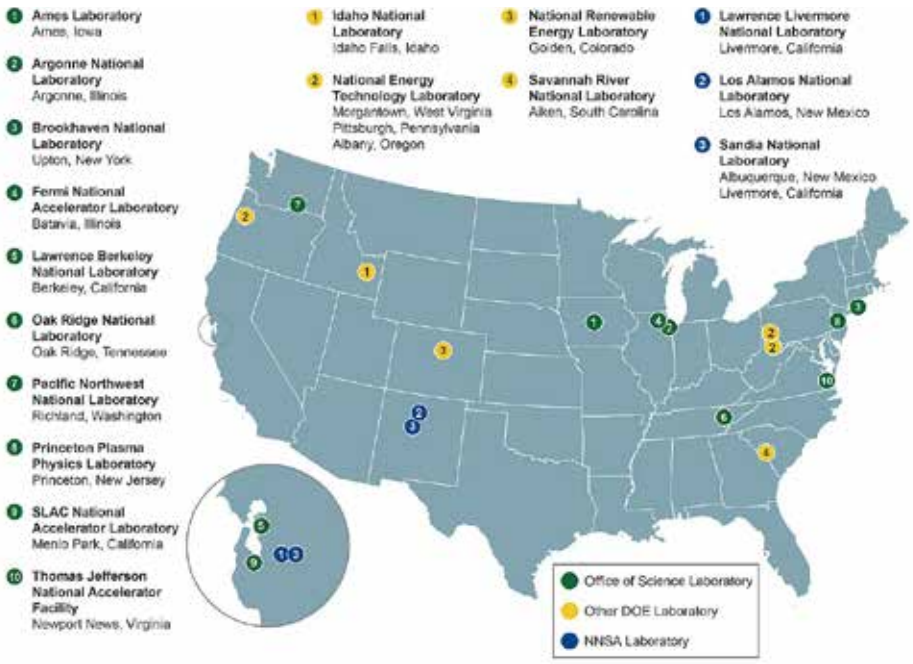
these grants is $200K per year with no state matching funds required. PIs on current DOE grant awards are not eligible to serve as PIs on Partnership Grant applications. Grants allow EPSCoR researchers to work closely with DOE National laboratories to conduct collaborative research and train students. Multiple submissions per state and laboratory are permitted and expected. There is no limit to the number of state or laboratory submissions per year. All funding resides within the EPSCoR state and no EPSCoR funds are permitted to support DOE National Laboratory activities.

DOE Office of Science Early Career Research Awards are limited to applications received from academic institutions in EPSCoR jurisdictions. A particular DOE Program Area/ Office many nominate meritorious applications that would not have been otherwise considered for joint consideration by multiple program areas on a funds available basis.

In FY 2018, Alabama was awarded one State Lab Partnership Award and one Early Career Award. Dr. David Hilton, University of Alabama at Birmingham Associate Professor of Physics was awarded a State Laboratory Partnership grant while Physics Assistant Professor, Dr. Wang-Kong Tse at The University of Alabama was awarded the DOE Early Career Award.

In July 2019, the Department of Energy announced $17 million in funding for nine energy research projects under the federal Established Program to Stimulate Competitive Research (EPSCoR) Implementation Grant Program. Selected projects cover a range of topics energy research, including fundamental science in chemistry and materials as well as research to advance fusion energy, grid integration/solar energy, fuel cells, and advanced manufacturing. The projects will improve research capabilities in the host institutions through the support of groups of scientists and engineers, including graduate students and post-doctoral fellows, working together on common research topics.

Nine DOE Implementation awards were made to Alabama, Alaska, Hawaii, Idaho, Maine, Montana, Nebraska, West Virginia, and Wyoming. Drs. Kevin West and James Davis at University of South Alabama were our state's recipient of the DOE Implementation Grant. Dr. Kevin West is a Professor in the Chemical Engineering Department while Dr. James Davis is a Professor of Chemistry.



Department of Energy National Laboratories Map

Active Alabama DOE EPSCoR Awards					
Inst	PI	Award	Title	Funding	POP
2016					
UA	Lin Li	DE-SC0016164 (DOE Lab Partnership)	Multiscale Modeling of Shear Banding in Metallic Glasses	420,756	9/1/2016 - 8/31/2019
2017					
UA	Jared Allred	DE-SC0018174 (Early Career Award)	Investigation of Short-Range Ordering in Transition Metal Compounds by Diffuse Scattering	750,000	9/1/2017- 8/31/2022
AU	Steven Mansoorabadi	DE-SC0018043 (Early Career Award)	Mechanistic Studies of a Primitive Homolog of Nitrogenase Involve in Coenzyme F430 Biosynthesis	750,000	9/1/2017 to 8/31/2022
AU	Eduardus (Evert) Duin	DE-SC0018011	Expression of recombinant methyl-coenzyme M reductase in the methanogenic archaeon Methanococcus maripaludis for the examination of activation and the role of post-translational modifications	303,333	9/1/2017- 8/31/2020
AU	Guillaume Laurent	DE-SC0017984	Real-time Observation of Multi-electron Processes in Atoms and Diatomic Molecules	441,328	8/15/2017 to 8/14/2020
2018					
UAB	David Hilton	DE-SC0019137 (State Laboratory Partnership)	Ultrafast Spectroscopy of Pnictides in High Magnetic Field: Stongly Nonequilibrium Physics in the 25 Tesla	635,954	9/1/2018 to 8/31/2021
UA	Wang-Kong Tse	DE-SC0019326 (DOE Early Career Award)	Interaction and Transport Effects in Driven Magnetic and Topological Materials	750,000	9/1/2018- 8/31/2023
2019					
USA	USA: Kevin West (Lead PI)	DE-SC0020282 (DOE Implementation Grant)	Understanding the molecular-level interactions between ionic liquids and molecular species to design and develop novel solvent systems for environmental and energy applications	2,710,993	8/15/2019 - 8/14/2021

Ultrafast Spectroscopy of Pnictides in High Magnetic Field: Stongly Nonequilibrium Physics in the 25 Tesla

Drs. David Hilton and Ilias Perakis, UAB


Dr. David Hilton


Dr. Ilias Perakis

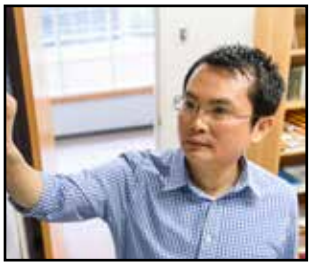
The main goal of this proposal is to study the optical and electronic properties of a novel class of iron-based superconductor when they are driven far from equilibrium. A detailed understanding of these properties is essential for their use in future applications as well as to increase our understanding of superconductivity and spin density waves in these materials. The research proposes to use a combination of intense ultrafast laser pulses with durations of <50 femtoseconds (1015 femtoseconds are in 1 second) in the optical, infrared, and terahertz frequencies to drive the material far away from equilibrium. The PI's instrument takes advantage of recent advances in ultrashort pulse generation that have substantially increased the available terahertz power and frequency range of operation (0.3 THz to 10 THz). Multiple laser pulses will be tailored to control the electronic and optical properties of these materials so that they

can steered into technologically useful states, including transient quantum states that are not normally accessible at equilibrium. The research will also employ the 25 Tesla Split Florida-Helix magnet at the National High Magnetic Field Laboratory at Florida State to control the spin fluctuations and magnetic phase of these materials, which the PIs hypothesize are the primary factor controlling their electronic and optical properties. The theory component of this program will be a joint effort with the experimental team and will be used to guide experiments over the term of this proposal. This will be used to describe non-thermal properties and metastable phases of quantum materials initiated by femtosecond laser pulses. To do so, the PIs propose to develop numerical computer models of the underlying materials physics. If successful, the research will demonstrate a new way to discover, design, and control exotic correlated materials phases.

This research program directly supports recent Department of Energy reports on Grand Challenges and on Basic Research Needs for Materials under Extreme Environments which note the need to understand the properties of materials under high-magnetic field and in high laser fluence, among many other extreme conditions, to enhance energy efficiency technologies. The Materials in Extreme Environments Grand Challenge targets the development of novel experimental techniques that "combine two or more of these characterization tools to permit so-called 'multi-dimensional' analysis of materials and surfaces in situ", which will be a significant focus of our research. This research is also compatible with the BES program's desire to "support fundamental research to understand, predict, and ultimately control matter and energy at the electronic, atomic, and molecular levels" by elucidating the origins of the quantum critical points in these novel pnictide superconductors. This program will also seek to answer the question: "Will the materials formed under these conditions have unique ... physical (electronic, magnetic, and superconducting) properties?" by developing the experimental tools needed to study the electronic, magnetic, and structural properties under external magnetic field on a femtosecond timescale and in high laser fluence.

Interaction and Transport Effects in Driven Magnetic and Topological Materials

Dr. Wang-Kong Tse, UA



Quantum materials, when driven by light into highly non-equilibrium conditions, can exhibit novel and non-trivial properties not available in equilibrium. Understanding driven quantum matter could enable efficient photovoltaic applications and powerful quantum information technology. An important class of quantum materials is comprised of van der Waals crystals (e.g. graphene), which are characterized by their atomically thin structure and bonding through the van der Waals force. While there has been much progress in the investigation of van der Waals crystals and heterostructures due to their novel magnetic and topological properties, their non-equilibrium behavior is not fully understood. Bridging the two fields of van der Waals materials and non-equilibrium matter, the planned research aims to firmly understand and demonstrate the possibility to control van der Waals materials under strongly non-equilibrium conditions. This project will involve studies of three key interwoven topics: (1) exploring the effects of strong electromagnetic fields on magnetic van der Waals trilayer structures; (2) understanding the effects of electronic interaction in strongly driven van der Waals systems; (3) investigating nonlinear transport properties in strongly driven van der Waals systems. Developments in these three key areas are expected to bring significant progress in finding novel strategies to control the magnetic, interaction and transport properties in non-equilibrium quantum materials.

Understanding the molecular-level interactions between ionic liquids and molecular species to design and develop novel solvent systems for environmental and energy applications

Dr. Kevin West, University of South Alabama

Dr. Kevin West, University of South Alabama

Project Objectives: To develop an understanding of how the molecular-level interactions in ionic liquid/molecular species mixtures affect macroscopic properties related to chemical reactions and separation, and how these interactions can be leveraged to develop energy efficient processes.

Project Description and Methods: Three topic areas will be explored: (I) aromatic/aliphatic hydrocarbon separations, (II) reactions in thermally-robust ionic liquids and (III) ionic liquid high-performance polymers. The PIs will use a complementary set of experiments and simulations to connect observed phenomena, such as phase behavior and reaction rates, to molecular-level interactions in the mixtures. In Topic I, the PIs will use thermophysical property and phase behavior measurement coupled with molecular dynamics simulations to understand factors that influence the partitioning behavior of model aromatic and aliphatic hydrocarbons in thermally-robust, perarylsulfonium- and perarylphosphonium-based ionic liquids. High temperature (ambient to 250°C) reactions in these same ionic liquids will be examined in Topic II, where nucleophilic aromatic substitution reactions, alkylation and cumene hydroperoxide decomposition will be examined. The latter two reactions are acid-catalyzed, with the acid provided by dissociation of phenolic hydroxyls at high temperature. Reactive Monte Carlo simulations will elucidate key solvent characteristic which promote the reactions. In Topic III, two areas related to polymerization are studied: the synthesis of ultra-high performance-ionene hybrid polymers inspired by ionic liquid anions and anionic polymerization in ionic liquids, again coupling experiment and simulation to understand solvent environment and its effects on materials synthesis.

Potential Impacts: The work funded through this proposal has the potential to have transformative effects on the design of chemical reaction and separations processes. Developing an understanding of how the molecular-level interactions in ionic liquid solvent systems affect the behavior of solutes will enable the rational design of ionic liquids and processes which exploit them to decrease energy usage in industrial chemical reactions and separations. The importance of this understanding is echoed in the Department of Energy – Office of Energy Efficiency & Renewable Energy's areas of interest for advanced manufacturing technologies: "integrated reactor and separation technologies that improve both reactions and separations together, especially using non-thermal processes like reactive distillation, membrane reactors and ionic reaction media to result in simplified processes," and develop a "better understanding of molecular interactions between ionic liquids and other fluids in order to develop better separation methods to get pure and more stable ILs."

FY2019 DOE Implementation Grant Team	
Institution	PI(s)
University of South Alabama	Kevin West (Lead PI)
	W. Matthew Reichert (Project Director and Co-PI)
	James Davis
	Christy Wheeler West
	Brooks D. Radieau
University of Alabama	Heath Turner
	Jason Bara
	Paul Rupar
Tuskegee University	Michael Curry
University of North Alabama	Amanda Coffman

NATIONAL AERONAUTICS & SPACE ADMINISTRATION EPSCoR

The NASA EPSCoR program began in 1994, uses NSF eligibility criteria, and works to strengthen the research capabilities of 27 jurisdictions that have in the past not participated equably in competitive aerospace and aerospace-related research activities and to develop a more competitive research base within their jurisdiction and member academic institutions. NASA EPSCoR objectives are to:

- Contribute to and promote the development of research infrastructure in EPSCoR jurisdictions in areas of strategic importance to the NASA mission.
- Improve the capabilities of the jurisdictions to gain support from sources outside the NASA EPSCoR program.
- Develop partnerships between NASA research assets, industry, and EPSCoR jurisdictions' academic institutions.
- Contribute to the overall research infrastructure, science and technology capabilities, higher education, and/or economic development of the jurisdiction.

NASA EPSCoR Jurisdictions

Alabama	**Nevada**
Alaska	**New Hampshire**
Arkansas	**New Mexico**
Delaware	**North Dakota**
Guam	**Oklahoma**
Hawaii	**Puerto Rico**
Idaho	**Rhode Island**
Kansas	**South Carolina**
Kentucky	**South Dakota**
Louisiana	**Vermont**
Maine	**U.S. Virgin**
Mississippi	**Islands**
Montana	**West Virginia**
Nebraska	**Wyoming**

The primary funding opportunities of NASA EPSCoR are:

- Research Cooperative Agreement Notice (CAN) Grant, which solicits topic-specific proposals addressing high-priority NASA research and technology development needs. Awards are up to $750,000 for a three-year performance period. NASA intends to announce the EPSCoR Cooperative Agreement Notice, or CAN, for Research Awards yearly, pending funding availability; 50% cost share is required.
- EPSCoR Research Infrastructure Development awards, or RID. This component enables jurisdictions to build and strengthen relationships with NASA researchers. The RID has a three-year base period of performance with a potential one-year no cost extension. Awards are $125,000 per year and requires 100% cost share by the awardee. NASA intends to announce the RID opportunity every three to five years, pending funding availability.
- EPSCoR International Space Station, or ISS, Flight Opportunity Awards provide opportunities to launch mature research projects to the space station. Awards are up to $100,000 for a three-year performance period with no cost share obligations. NASA intends to announce the EPSCoR CAN for ISS Flight Opportunity Awards yearly, pending funding availability.
- NASA Rapid Response Research Solicitation (RRR) is a new funding opportunity from NASA for quick turn-around of research needs by NASA for one year period of performance, no cost share for the $100,000 award is required. Proposals are limited to three pages for the technical section, these proposals are submitted quarterly pending funding and topic availability.

The Alabama NASA EPSCoR program builds upon existing strengths within the State, using facilities and personnel at the Space Grant Universities and at the NASA Marshall Space Flight Center (MSFC) but extending these to a new set of teachers, researchers, students, and industrial collaborators. The Alabama NASA EPSCoR Program Director also serves as the Alabama Space Grant Consortium Director. The goals of Alabama NASA EPSCoR

are to (1) effect a permanent increase in the national competitiveness of Alabama's basic research programs in targeted areas; (2) enhance research areas which already have strength and which are closely related to the special needs of Alabama; and (3) provide the basis for continuing expansion of basic research in Alabama in the post-EPSCoR era.

Dr. Dale Thomas (p.13) serves as the Alabama NASA Agency Director as well as the Alabama Space Grant Director, and is a Professor and Eminent Scholar of Systems Engineering in the Department of Industrial and Systems Engineering and Engineering Management at the University of Alabama in Huntsville.

During FY 2018, Alabama was awarded a new CAN award entitled, "Micro-Magnetic Driven Design of Multi-Component Magnetic Alloys for Advanced Electric Propulsion" in May 2018. Dr Claudia Mewes at UA is the Science Investigator.

In FY 19 Alabama NASA EPSCoR recieved at least one award in each of the four NASA EPSCoR funding mechanisms.

NEW FY 2019 Alabama NASA EPSCoR Awards

NASA EPSCoR Award	Lead PI	Science Investigator(s)	Title	Science Investigator Institution	Amount	Period of Performance
FY19 Cooperative Agreement Notice (CAN)	Dale Thomas, AL NASA EPSCoR, UAH	Kevin West (lead PI) James David, Grant Glover, William Reinhert	Development of CO2-Capturing Ionic Liquid Solutions for Spacecraft Air Revitalization Systems	USA	750,000	8/15/19 to 8/14/2022
FY19 Research Infrastructure Development (RI) (3 year) #80NSSC19M0051	Dale Thomas, AL NASA EPSCoR, UAH	Yu Lei	Development for Advanced Fuel Coatings	UAH	375,000	6/1/19 to 5/31/2022
		Todd Freeborn	Evaluating localized electrical impedance myography to quantify segmental fluid shifts induced by simulated micro-gravity conditions	UA		
		Raziq Yaqub	Cyber Security for Decentralized Aero-vehicle Control Systems	AAMU		
		Nicholas Tsolas	The Next Frontier in Space Exploration - Cubesats: Investigating the combustion characteristics of imidazole-based ionic liquids and HAN bipropellants to enable dual-mode propulsion systems	AU		
		Kannatassen Appavoo	Effect of Space Radiation Environment on Emerging Photonic Technologies	UAB		
EPSCoR Rapid Response (R3) award # NNH18ZHA005C	Dale Thomas, AL NASA EPSCoR, UAH	Judy Schneider	EPSCoR R3 - FY18 Alabama NASA EPSCoR Rapid Response: Characterization of Bi_metallic Joints Formed by Different Processes	UAH	100,000	11/19/18-11/18/19
EPSCoR Rapid Response (R3), award # NNH18ZHA005C		Lingze Duan	EPSCoR R3 - FY18 Alabama NASA EPSCoR Rapid Response: Development of Fiber-Optic High-Temperature Heat Flux Sensors for Venus Exploration	UAH	100,000	11/30/18-11/29/19
EPSCoR Rapid Response (R3)		Nima Shamsaei	Characterization of Inconel 625 Blown Powder Freeform Deposition Material	AU	100,000	6/6/2019-6/5/2020
EPSCoR Rapid Response (R3)		Masatoshi Hirabayashi	Investiate Potential Mars or Lunar Resources	AU	100,000	7/1/2019-6/30/2020
EPSCoR ISS, award # NNHi8ZHA004C	Dale Thomas, AL NASA EPSCoR, UAH	Michael Banish	EPSCoR ISS: FY18 NASA ISS Flight Opportunity: Silicon-Cobalt Alloy Properties	UAH	300,000	11/30/18-11/29/21

FY 2019 NASA EPSCoR Awards		
Awarding Mechanism	NASA EPSCoR Awarded	awarded to Alabama NASA EPSCoR
Cooperative Agreement Notice (CAN)	28	1
Research Infrastructure Development (RID)	16	1
Rapid Response Research (R3)	24	4
International Space Station (ISS) Flight Opportunity	5	1

ALABAMA NASA EPSCoR COOPERATIVE AGREEMENT NOTICE (CAN) AWARD

Development of CO2 - Capturing Ionic Liquid Solutions for Spacecraft Air Revitalization

Science PI: Dr. Kevin West, USA

This proposal addresses the development of CO_2-capturing ionic liquid solutions for spacecraft air revitalization systems. Air revitalization in closed environments is a mission critical task for NASA, with the chief technical challenge being the removal of CO2 from the recirculating air supply. Specifically, efficient removal of CO2 from closed space craft environments is a NASA research and development priority as stated in the NASA Technology Roadmap Technical Area (TA) 6: Human Health, Life Support, and Habitation Systems document. The practical significance of this requirement was recently illustrated in a NASA study that showed that 7% of the genes changed their expression during spaceflight, which was attributed to metabolic stress on the body due to elevated CO_2 exposure in the spacecraft.Additionally, NASA is concerned with cognitive and behavior effects on humans exposed to increased levels of CO2. 3. On the international space station, CO2 removal is currently accomplished using a thermally regenerable solid zeolite, Grace 13X. While effective, the solid zeolite has a number of logistical problems including the production of dust from the absorbent bed and sensitivity to ambient humidity. A similar separations challenge exists on submarines, where closed environment CO2 removal is a crucial part of the life support system. On submarines, CO2 is removed via chemical capture with an aqueous ethanolamine solution. This is also an effective process, but with significant disadvantages; chiefly, the volatilization of the amine, which creates a foul odor, can damage electronics and presents long term heath effects. Furthermore, regeneration of the solution (desorption of the CO2) is somewhat energy intensive as the large thermal mass of the solution (often 70 mass % water) must be heated to promote desorption. While the energy requirement is moot on a nuclear submarine, power consumption is a key concern for spacecraft.

Dr. T. Grant Glover, seated, demonstrates an early-stage prototype of the next-generation carbon dioxide scrubber being developed for the International Space Station. Colleagues standing from left to right are Drs. Matthew Reichert, James Davis and Kevin West.

NATIONAL AERONAUTICS & SPACE ADMINISTRATION EPSCoR

ALABAMA NASA EPSCoR RESEARCH INFRASTRUCTURE DEVELOPMENT (RID)

Alabama NASA EPSCoR Research Infrastructure Development FY19

Dr. Dale Thomas, UAH

The purpose of the Alabama NASA EPSCoR RID program is to build core capabilities at Alabama's universities and other collaborative institutions. We shall build competitive research and technology development capabilities in areas of interest to both NASA and the State of Alabama. The interests of NASA are defined in the CAN (pages 6,7 and 8),in the 2014 NASA Strategic Plan, and by the 3 strategic goals of the Office of Education's ARCD. The interests of the State of Alabama in this regard are defined by the Alabama State EPSCoR Committee (SEC), which oversees all EPSCoR programs within the state. The PI of this proposal is Dr. L. Dale Thomas, the Alabama NASA EPSCoR Director, the Alabama Space Grant Consortium Director, and a professor at the University of Alabama in Huntsville.

Development for Advanced Fuel Coatings

Science PI: Dr. Yu Lei, UAH

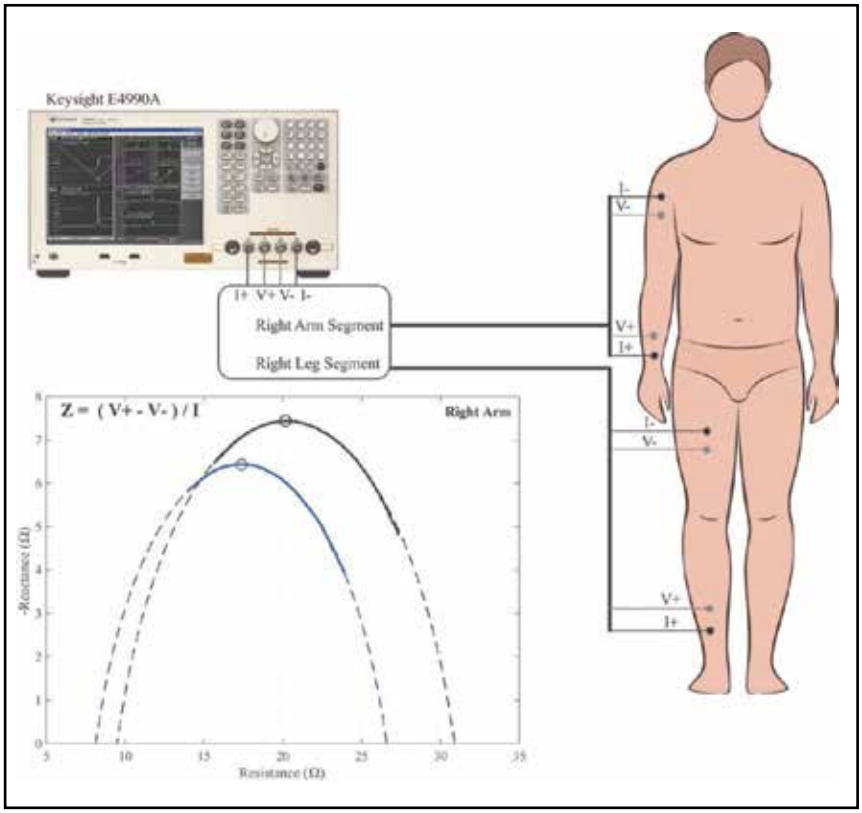
The success in developing nuclear thermal propulsion (NTP) can be a game changer for deep space exploration. However, the development of the NTP system is hindered by considerable fuel loss due to the cermet fuels losing mechanical integrity at high temperature in hydrogen flow. Our goal is to significantly improve the thermal and chemical stability of UO2 fuel with the use of protecting layers which will be the key to prevent hydrogen embrittlement in the NTP system.

The proposed project will engage the use of advanced manufacturing techniques and state-of-the-art characterization techniques available at the University of Alabama in Huntsveill (UAH) and national user facilities to meet the challenges for accomplishing this goal. The techniques utilized are a network of material sciences, chemistry, solid state physics, chemical and mechanical engineering. The PI for the project, Dr. Yu Lei, will direct a team of highly motivated, multidisciplinary UAH graduate and undergraduate research team in coating development, characterization, and performance evaluation. Advances will be made in this one-year project, and become a source of attraction for external funding opportunities as the project develops. If successful, it will benefit the NASA strategic goal on deep space exploration.

Evaluating localized electrical impedance myography to quantify segmental fluid shifts induced my simulated micro-gravity conditions

Science PI: Dr. Todd Freeborn, University of Alabama

Dramatic changes in body fluid distribution occur in microgravity environments, with an overall headword fluid shift observed in astronauts. This shift of fluid towards the head affects the eye and impacts astronauts' vision, both during and after spaceflight. Approximately 23% of astronauts experienced reduced near sight within a few days exposure to microgravity, with 48% reporting near sight vision reduction after returning from long-duration space flight aboard the International Space Station (ISS). This highlights only one of the health problems that occurs due to fluid-shifts induced by microgravity, though this phenomenon also impacts the cardiovascular system, reflex mechanisms, and endocrine mechanisms. To further understand the effects of fluid shifts on human physiology, researchers need tools to quantify the amount and time-course of change of fluids within different body compartments (trunk, legs, arms, head) throughout exposure to microgravity environments. These tools can support quantifying the rate and amount of fluid shifts, investigate the efficacy of interventions



aimed at modifying fluid shifts and improve computational models to predict performance and medical needs. This research proposal aims to address this need by evaluating localized electrical impedance measurements of segmental tissues as a method to monitor fluid shifts in the body from exposure to conditions that simulate microgravity environments.

Localized electrical impedance measurements (L-EIM) of a biological tissue quantify the passive electrical properties of the tissue under study. This impedance is dependent on cell populations, cell volumes, cellular membrane integrity, and the intra- and extracellular fluids. L-EIM have been used to assess fluid shifts in patients during dialysis and also to measure nutritional status in simulated microgravity environments (head-down tilt bed-rest). However, this technique has not yet been evaluated to quantify fluid shifts at minutes/hours timescales in simulated micro-gravity environments

Based on the headword fluid shift observed during astronauts' exposure to microgravity environments, we hypothesize that these fluid shifts will cause an increase in the resistance component of the electrical impedance of the arms and legs segments of the human body and a decrease in the resistance of the trunk and neck. To test this hypothesis, this project will collect localized electrical impedance measurements from six body segments (right/left legs, arms, trunk) during head-down tilt bed-rest to simulate the fluid-shifts typical of micro-gravity exposure. The specific aims of this research are to:

i) Quantify the time-course of L-EIM and volume changes of segmental body compartments (e.g. legs, arms, trunk) in human participants throughout an 8-hour, head-down tilt best rest protocol;

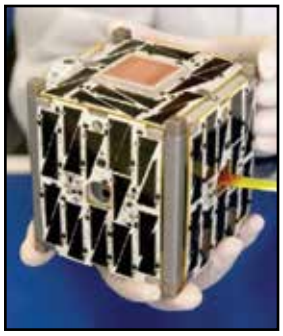
ii) Quantify the magnitude of limb movement during a bed-rest protocol and identify if the magnitude of L-EIM changes observed during the study protocol are impacted by overall movement.

The Next Frontier in Space Exploration - Cubesats: Investigating the combustion characteristics of imidazole-based ionic liquids and HAN bipropellants to enable dual-mode propulsion systems

Science PI: Dr. Nicholas Tsolas, Auburn University

For the most part, unmanned space exploration and satellite installations have been reserved for government agencies and large private entities with leveraged financial backing. The high cost of reaching Earth's orbit has always been a major factor in preventing new-entrants from entering space. However, that soon may change due to a little box not measuring more than 10 cm in length, width and height, known as a CubeSat. Initially conceived as a university experiment for educational purposes, CubeSats have ushered in a new era to gain access to space with lower risk, and development costs. Unfortunately, due to their inherently simple design architecture, their in-space capabilities are currently quite limited. CubeSat missions thus far have only been deployed into low-Earth orbit, and can perform minimal (if any) in-space maneuvers and tasks due to no onboard propulsion systems and limited payload capacities. Despite these limitations, immense potential exists, and it is evident that the demand and attractiveness for CubeSats will continue to grow in the immediate future. The next iteration of CubeSat missions sees them potentially being used to explore planetary objects in deep-space, but in order to meet the demands of such rigorous missions, current CubeSat propulsion technologies need to evolve and advance.

Providing propulsive capabilities in order to perform orbit change, formation flying, proximity operations, fine attitude control, or drag-make-up and de-orbit are crucial for increasing the capabilities of future CubeSats missions. However, developing a simple propulsion system suitable for CubeSats has its inherent challenges, since it would need to operate within the restrictions of current CubeSat architectures. Currently, established propulsion technologies, which have been developed for larger spacecraft with an emphasis on reliability, performance and versatility, are often discarded simply because the they are costly, and are difficult to scale down. The proposed concept herein looks to investigate the feasibility of a dual-mode propulsion system for CubeSat applications as a means to potentially extend their mission versatility. To achieve this, dual-mode systems look to combine the advantages of high-thrust chemical and high-Isp electric modes into a single system. A single common propellant used in both modes would reduce system hardware, mass and volume, which makes this concept highly attractive for CubeSats. The possibility of using imidazole-based ionic liquids as a fuel component in a binary monopropellant with readily used HAN oxidizer is proposed to assess their efficacy as a propellant for dual-mode micro-propulsion systems. In order to assess the feasibility of such propellants, and in turn design an experimental thruster, it is critical to understand their fundamental combustion and ignition characteristics. Over the course of the proposed one-year project, the Combustion and Energy Laboratory (CEL) at Auburn University led by Dr. Nicholas Tsolas (see Fig. 2) will look to investigate i) the thermal auto-ignition characteristics of these propellants, but also their ignition characteristics via facilitated catalysis and electrolytic means to enable more efficient combustion; and ii) how microscale combustion effects influence overall flame propagation and sustainment. Critical understanding of such effects are necessary to optimize micro-thrusters designs specific to CubeSat applications, but also use this knowledge as a stepping stone to demonstrate proof-of-concept designs and systems that utilize the dual-mode technology and begin implementing initiatives to transition this concept to TRL 4.



CubeSat photo credit: Dominic Hart, NASA Ames Research Center

Effect of Space Radiation Environment on Emerging Phototonic Technologies

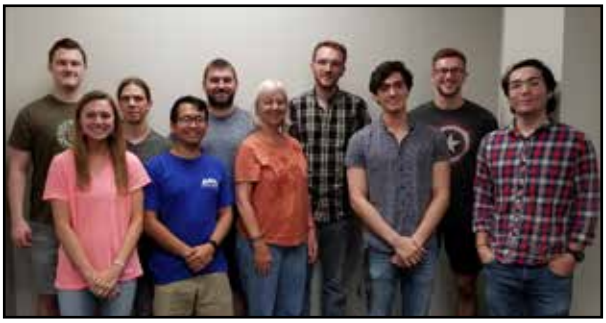
Dr. Kannatassen Appavoo, UAB

With a growing space sector, there is an increased need to reduce costs and make new missions such as flying solar blimps, powering unmanned aerial vehicles, and launching probes to explore exoplanets more economically affordable. In order to do so effectively, understanding what material can be integrated into devices for space applications is of great importance. Of major relevance to space missions conducted by NASA is device degradation due to radiation from charged particles, such as incident protons and electrons, with particle energies that range from near-zero to several hundred of million eVs. Here, we propose to study the effect of radiation on hybrid perovskite, a novel promising material for technological applications that has recently proven to be resistant to radiation. Since there have only been a handful of studies on this material, our goal is to develop a research program to understand how radiation affect the ultrafast carrier dynamics of hybrid perovskite, an important parameter that dictates the overall performance of various devices like photovoltaics, sensors and detectors. This research is well aligned with NASA's overall mission and discussed at various instances in the 2018 strategic plan, namely (i) Strategic Objective 2.1 that will "enable space-based low Earth orbit economy by transitioning ISS operations and maintenance to commercial and international partners, while continuing to leverage ISS for research, technology development, and to extend human presence in space;" (ii) Strategic Objective 2.2 that create "resilient architecture featuring multi-use, evolvable space infrastructure, minimizing unique developments, with each mission leaving something behind to support subsequent missions;" and Strategic Objective 3.1 to "develop and transfer revolutionary technologies to enable exploration capabilities for NASA and the Nation." With this initial funding from the NASA EPSCoR, we hope to develop a research program centered around effects of radiation on novel photonic technologies, providing insights about changes in the structure of the active semiconductor changes device performance on the microscopic and ultrafast timescales.

Alabama NASA EPSCoR Rapid Response: Characterization of Bi_ metallic Joints Formed by Different Processes

PI: Dr. Judy Schneider, UAH

The family of Cr-Cu alloys is used as the liner in high heat flux applications. Alloying considers the addition of Zr, Nb, Co, and Ag to improve the properties. C-18150 is based on Zr additions which promote age hardening to strengthen the alloy. However, subsequent operation at elevated temperatures can result in Ostwald ripening of the precipitates thereby reducing strength. In contrast GRCop-84 is strengthened by Cr2Nb dispersoids which form during solidification. The formation of these dispersoids leaves an almost pure Cu matrix which increases the thermal conductivity. Nickel based superalloy 625 will be evaluated along with the lower strength 300 series stainless steel alloys (SS). Inconel 625 can be operated up to 1500Â° F (816Â° C) while SS alloys are generally limited to 900Â° F (482Â° C). Although short term operation can extend the use of SS alloys upwards of 1500Â° F (816Â° C). Although Ni and Cu form a single-phase alloy, the influence and stability of the alloying elements must be evaluated for operation in a high flux environment. This project has three objectives designed to fully characterize SLM fabricated GRCop 42:1) Baseline the interfaces of the as-fabricated material combinations by characterizing the microstructure in two orientations using optical microscopy (OM) and scanning electron microscopy (SEM).2) Evaluate the effectiveness of various heat treatments on NASA supplied samples. Trade off in temperature between the two alloys will be evaluated due to the limitations of the lower melting temperature Cu alloys. After heat treatment, hardness profiles across the interface will be conducted. Miniature specimens will be machined and tested before and after heat treatments.3) Evaluate stability of the interface following long term exposureto high temperatures simulating the operational environment. As diffusion is expected to occur in Ni-Cu interfaces, elevated temperature tests will be conducted and specimens characterized microscopically and in tension following exposure to evaluate potential Kirkendall effects.



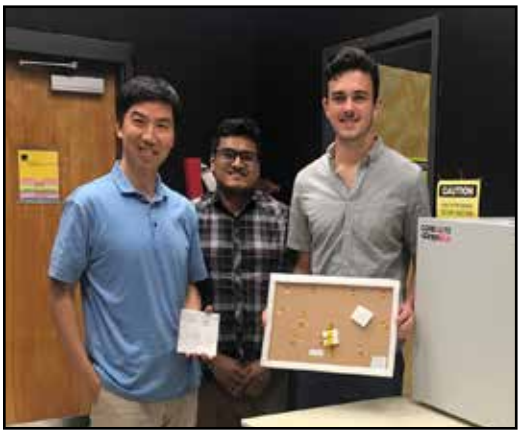
Dr. Schneider's research group: front row (L to R): Laura Farris, MS; An Nguyen, undergraduate, Judy Schneider, Giancarlo Puerto, undergraduate; Noah Nadden, undergraduate; back row: Will Robinson, undergraduate; Swinson Terry, undergraduate; Jared Stone, MS; Zack Perrin, undergraduate; Myles Fullen, MS. Two PhDs and one MS student not pictured.

Alabama NASA EPSCoR Rapid Response: Development of Fiber-Optic High-Temperature Heat Flux Sensors of Venus Explorations

PI: Dr. Lingze Duan, UAH

The objective of this research project is to develop a fiber-optic heat flux sensor (HFS) that is able to operate at an ambient temperature as high as 500 ˚C with a 10-mW/m2 heat flux sensitivity. The innovation of the work is three-fold: a) There has been very little prior research on fiber-optic HFS, so the intended work represents a new concept in heat flux sensing; b) Unlike traditional optical fiber thermal sensors, the new design uses gold-coated high-temperature fiber Bragg gratings (FBG) as the sensing elements, which can withstand temperatures above 500 ˚C.; and c) To improve the survivability of the interrogation-detection system under extreme conditions, an innovative scheme based on FBG wavelength discriminators is proposed, which allows the use of broadband light sources (e.g., LED) and direct power measurement.

The project will serve as a case study to verify the potential of high-T fiber-optic sensing in addressing the



L to R: Dr. Lingze Duan, Graduate student Nabil Hogue, and undergraduate student Owen Thome with the special high-temperature fiber-optic sensor they are testing with NASA EPSCoR R3 grant funding.

challenges in Venus exploration. It also carries additional implications to a broader scope within NASA's core scientific interest in planetary and solar missions as well as geophysical research on earth (e.g. volcanoes, deep sea vents, etc). A number of educational opportunities will be created as a result of this work, including graduate research assistantships and undergraduate summer research projects.

Alabama NASA EPSCoR Rapid Response: Characterization of Inconel 625 Blown Powder Freeform Deposition Material

PI: Dr. Nima Shamsaei, AU

There is a plethora of commercialized, metal-based Additive Manufacturing (AM) techniques with the most commonly used being the Powder Bed Fusion (PBF) and Directed Energy Deposition (DED) methods. Laser Engineered Net Shaping (LENS™), one common laser-based DED, or Direct Laser Deposition (DLD), used for fabrication and repair of parts, uses a laser to melt a spot on a metal substrate while blowing metal powder into the molten pool. Under normal operation, the substrate, attached to a Computer Numerical Control (CNC) controlled stage, is moved in a user defined pattern to create a single layer, and upon completion, the deposition head, containing the laser focusing lens and the power nozzles, are moved up to begin another layer, with this process repeating until the part is done. Though AM techniques offer many advantages over traditional manufacturing techniques, many of the process-structure-property-performance relationships are not yet fully understood. Certification and qualification of AM processes, as well as standardization of various post-processing or quality checks, is required for AM technology to further mature and be adopted. Resultant microstructures of DED Inconel 625 parts have been shown to differ drastically from those of their wrought counterparts6-7-8. The DED process is conducive for epitaxial and elongated grain growth, with strong texture depending on build and major thermal gradient directions, resulting in anisotropy in the mechanical properties of the resulting part9. Therefore, the production of application-worthy parts becomes problematic, as both process and feedstock-driven defects, as well as inconsistencies in part microstructure, can lead to unpredictable mechanical behavior, especially in its fatigue response.

Dr. Nima Shamsaei (center) with research team in Auburn's Additive Manufacturing Lab.

Alabama NASA EPSCoR Rapid Response: Investigate Potential Mars or Lunar Resources

PI: Dr. Masotoshi Hirbayashi, AU

The objective of this project is to map the thickness of a dust/water ice layer in the Permanently Shaded Regions (PSRs) in the lunar polar regions by considering mixing processes. Water is a key element of future resource in planetary explorations. Signs of water ice have been detected on the Moon by different techniques. Their sources may result from impacts of asteroids and comets, volcanism, or implantation by the solar wind. Classical theories discuss that the accumulation of water ice on the lunar surface is related to heat transfer. Water ice particles in the surface layer can be sublimated (or melted) by various processes such as impact cratering and solar heating. Then, they may be transported at low attitude but trapped by cold spots including the PSRs. However, this explanation is incomplete because lunar surface materials are mixed by impacts and electromagnetic forces. The present project will investigatehow material mixing affects the thickness of a dust/water ice layer. The current project will explore the mixing depth of a dust/water ice layer on the floors of three craters, Amundsen, Cabeus B, and Lovelace. The first two craters are located in the south pole region while the third one is in the north pole region. Thus, the investigations of these craters allow us to infer the contrast of the water ice distribution in the PSRs at the north and south poles. We will divide a PSR within each crater into two locations. The first location is a PSR region far from the sunlit-shadow boundary (SSB), or Area 1. The second region is at the SSB, defined as Area 2. We consider that mixing in Area 1 is only controlled by impact bombardment, while that in Area 2 is influenced by both impact cratering and electromagnetic forces. To accomplish this goal, we employ data analysis, statistical modeling, and experiments. Following are the planned tasks. Task A will conduct data analysis by using archived data in NASA/PDS from Lunar Reconnaissance Orbiter (LRO)s the Lyman-Alpha Mapping Project (LAMP) instrument and its camera system (LROC). We will use data from the LROC and LAMP instruments archived in the Planetary Data System. LROC images will be used to develop the crater production function and analyze the crater conditions. LAMP images will be used to analyze the amount of water ice in the SPRs. Task B will quantify the impact-driven mixing depth on the floor of the target craters by using an established statistical model. This model will provide the statistical distribution of the impact-driven mixing depth of a dust/water ice layer in Areas 1 and 2 for each crater, given the CSFD from Task A. In this task, we will assume that the CSFDs of the PSR and the sun-lit regionare similar within a crater. Task C will experimentally measure the total amount of dust/water ice transported at the SSB. Experiments will be performed in the Magnetized Plasma Research Laboratory (MPRL) in the Auburn University Physics Department. Task D will integrate all the results in these tasks to give constraints on the effect of material mixing on the thickness of a dust/water ice layer in the PSRs. The present call seeks research of potential for resources including near surface lunar ice with high H2O concentration. Based on the expected results, our project fits the calls goal by providing ideas for water ice sampling technologies.

NASA ISS Flight Opportunity: Silicon-Cobalt Alloy Properties

PI: Dr. Dale Thomas, UAH;

Science Investigator: Dr. Michael Banish, UAH

This proposal addresses research emphasis to enable the eventual production of high-silicon-transition metal alloys. The thermophysical property measurements will use the Japan Aerospace Exploration Agency Electrostatic Levitation Furnace. The casting simulation requires precise and accurate thermophysical and physical properties during the entire solidification process. Among

the required thermophysical properties are the viscosity, surface tension, density, and heatcapacity, among others. Metals and metallic alloys often have high melting temperatures and highly reactive liquid states. Thus, processing these liquids in containers leads to significant contamination and uncontrolled under-cooling behavior. The above is especially true for molten silicon and its alloys. Thermophysical properties of these reactive materials can be determined by using an electrostatic levitator (ESL) which levitates and suspends a sample between two electrodes and subsequently analyzing (high-speed) video and temperature (pyrometer) data of the molten levitated samples, rather than using traditional contact techniques. This measurement technique eliminates many sources of experimental error, due to the inherent non-contact nature of the ESL. There is minimal contamination between the sample and its container, due to the levitation, and the experiments are done under vacuum, limiting the effects of surrounding gases. The ESL also offers the advantages that a single sample can be heated and cooled multiple times between a wide range of temperatures; samples can be under-cooled to a high degree; viscosity and surface tension can both be obtained from a single transient signal; and with a single axisymmetric oscillation induced in the sample, the data analysis becomes clear and relatively straightforward. Density and heat capacity are performed as a separate but paired set of experiments. Silicon-transition metal alloys maintain the lower density, high compressive strength, and mitigate the brittleness of pure silicon. While silicon itself is corrosion resistant, it wets and dissolves all but a few materials; molten silicon is commonly called â€œthe universal solventâ€•. The development of low-density (low-mass), high strength, compression alloys for space missions would enable lower mass components resulting in less vehicle mass and higher durability. The wetting ability of molten silicon coupled with its high melting point makes the determination of its thermophysical properties experimentally challenging. Silicon and silicon-transition metal alloys are systems that can take advantage of the benefits of container-less processing, or levitation facilities in a low gravity environment. Silicon is a semiconductor or semi-metal depending on the temperature. The levitation and melting of silicon in terrestrial Electrostatic Levitator systems requires close attention and adjustment of the sample size, heating and levitation parameters. Off-eutectic alloys are particularly difficult to process sinceduring melting there is a mixture of liquid and solid. The determination of thermophysical properties such as viscosity, surface tension, density, and heat capacity of silicon alloys is well-suited to electrostatic levitation in a low gravity environment due to the lower electrostatic forces required for sample.

US DEPARTMENT OF DEFENSE EPSCoR

Congress reauthorized the Department of Defense EPSCoR (DEPSCoR) in FY 2018 and appropriated $12M in FY 2019 to fund DEPSCoR. DEPSCoR's objectives include:

- enhance the capabilities of institutions of higher education in eligible states and territories to develop, plan, and execute science and engineering research relevant to the DOD mission and competitive under the peer-review systems used for awarding federal assistance
- increase the number of university researchers in eligible states/territories capable of performing science and engineering research responsive to the needs of the Department of Defense
- increase the probability of long-term growth in the competitively awarded financial assistance the institution of higher education in eligible states and territories recieve from the federal government for science and engineering research.

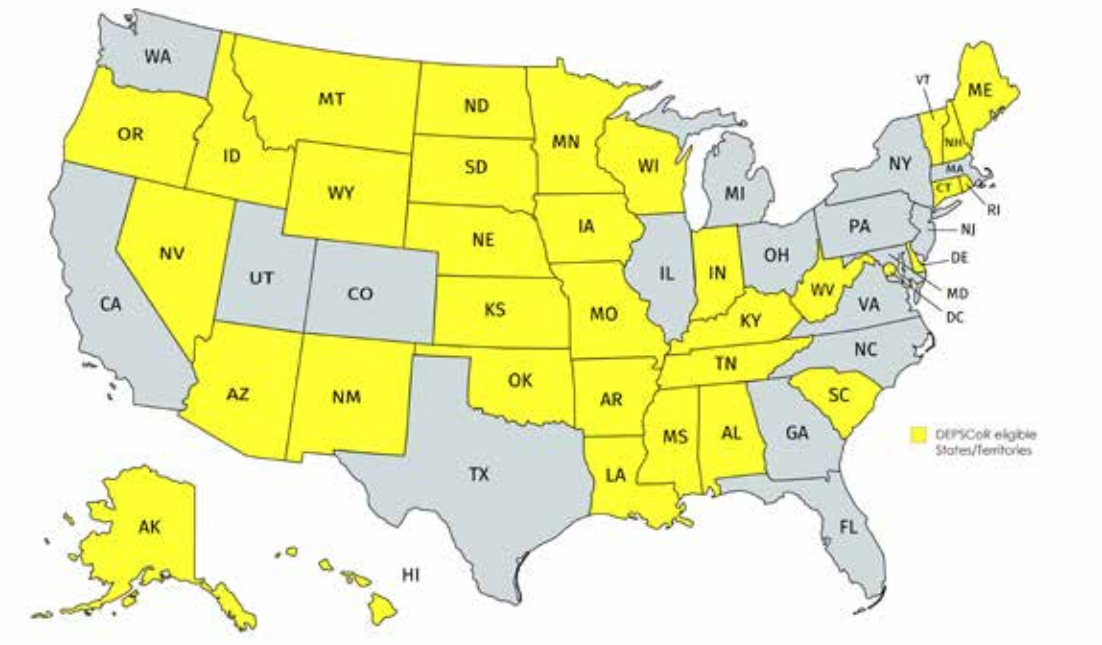
The authorization for DEPSCoR included a formula for determining elibility for a state or territory, it was based on the amount of Department of Defense Research and Development funds obligated to institutions of higher education with a state/territory over a three-year average. Thirty-four states, the Commonwealth of Puerto Rico, Guam, and the U.S. Virgin Islands are eligible. "States that received less than 60% of 1/50th of the total Science and Engineering (S&E) research obligations to the U.S. Institutions of Higher Education are eligible if a commitment to developing S&E research is demonstrated."

The DEPSCoR Program has three general thrusts:

- increase funding to programs in the Services
- solicit applications for a stand alone competition
- host outreach meetings to educate researchers about DOD funding programs.

Collaborative DEPSCoR Competition is a new program and will be managed by the Basic Research Office, awarded by the Air Force Office of Scientific Research (AFOSR) and administered through the Office of Naval Research (ONR). The first Funding Opportunity Announcement (FOA) was published in July 2019 with white papers due in October 2019. It will support a mentee/mentor group with up to six awards totaling $3.6M at $600K each ($200K for 3 years). White papers are due by Oct. 25, 2019, notification of white paper selection is estimated to be around December 2019, with proposals (by invitation only) due Feb. 14, 2020.

Augment Exising Programs - Existing programs within DOD, the Young Investigator Program (YIP) and the Defense University Research Instrumentation Program (DURIP) will



US DEPARTMENT OF DEFENSE EPSCOR

be enhanced with $8.4M in additional funds to benefit EPSCoR jurisdictions. It is estimated that an additional nine YIPs and three DURIPs will be awarded to DEPSCoR-eligible researchers compared to the yearly average of five.

The YIP is available through the U.S. Navy, U.S. Army, and the U.S. Air Force. There will be 3 additional YIP awards and one DURIP award per Service (ARO, ONR, and AFOSR) set aside for DEPSCoR-eligible jurisdictions.

The Office of Naval Research YIP supports new researchers who received their doctorate (or equivalent) on or after January 1, 2012. Awards are $510K over a 36-month period. Additional funding may be requested (up to $250K) for equipment.

Army YIP has no fixed due date, and is continuously open until 31 March 2022. The Army YIP is a prestigious award and supports Strategic Land Power Dominance for the Army of 2030 and beyond which includes seven Core Technical Competencies: Computational Science, Ballistic Sciences, Materials and Manufacturing Sciences, Protection Sciences, Propulsion Sciences, Network and Information Sciences, and Human Sciences in ten scientific divisions. These include: Physical Sciences (chemical, physics, and life); Engineering Sciences (mechanical, electronics, materials sciences, and earth sciences); Information Sciences (computing sciences, mathematical sciences, and network sciences). White papers covering a 3-year period and sent to the appropriate technical contact are strongly encouraged to conserve valuable applicant and Government resources. YIP awards will not exceed $150K per year for three years.

The Air Force YIP seeks to support young-in-career scientists and engineers who received PhD or equivalent degrees by 1 April 2012 or later. The program objective is to foster creative basic research in science and engineering; enhance early career development of outstanding young investigators, and increase opportunities for young investigators to recognize the Air Force mission and related challenges in science and engineering. No cost share required, award ceiling: $450K ($150K for 3 years).

The DURIP supports university research infrastructure essential to high-quality Navy relevant research. DURIP funds are used for the purchase of major equipment in support of DOD-relevant research. It is estimated that there will be on DURIP award in each of the three services each at the $300K level.

DEPSCoR Education and Outreach will host regional meetings to inform researchers about DOD programs and opportunities. Alabama is included in the Southern Region. The Southern Regional meeting will be held at Louisiana State University on Feb. 20, 2020.

As of October 1, 2019, no DEPSCoR awards have been made with FY 2019 funds.

US DEPARTMENT OF AGRICULTURE EPSCoR

ALABAMA USDA EPSCoR

The National Institute of Food and Agriculture's (NIFA's) Food and Agricultural Science Enhancement (FASE) Grants are designed to help institutions develop competitive projects and to attract new scientists and educators into careers in high-priority areas of national need in agriculture, food, and environmental sciences. FASE Grants consist of New Investigator Grants, Pre- and Postdoctoral Fellowship Grants, and Strengthening Grants. Strengthening Grants are further divided into Sabbatical Grants, Equipment Grants, Seed Grants, Strengthening Standard Grants, Strengthening CAP (Coordinated Agricultural Project) Grants, and Strengthening Conference Grants.

Strengthening Grants are available during each funding cycle to ensure researchers at institutions and states underrepresented in terms of Federal research, education, and/or extension funding receive a portion of AFRI funds. Strengthening Grants are limited to: (1) small and mid-sized or minority-serving degree-granting institutions that previously had limited institutional success for receiving Federal funds; or (2) State Agricultural Experiment Stations or degree-granting institutions eligible for USDA Established Program to Stimulate Competitive Research (EPSCoR). When determining eligibility for these grant types, the following definitions apply:

- Small and mid-sized academic institutions with a current total enrollment of 17,500 or less including graduate and undergraduate and full- and part-time students.
- Accredited academic minority-serving institutions whose enrollment of a single minority group or a combination of minority groups exceeds 50% of the total enrollment, including graduate and undergraduate and full- and part-time students.
- Limited institutional success means institutions not among the most successful universities/colleges for receiving federal funds for science and engineering research.

Every year, NIFA determines the states eligible for USDA EPSCoR funding. This list includes states having a funding level no higher than the 38th percentile of all states based on a 3-year rolling average of AFRI funding levels, excluding FASE Strengthening funds granted to EPSCoR states and small-mid-sized and minority-serving, degree-granting institutions, see table below. In FY 2016, Alabama became ineligible for USDA EPSCoR funding. A list of ongoing USDA EPSCoR projects can be found on the next page.

USDA Established Program to Stimulate Competitive Research (EPSCoR) States FY2007-FY2019

State	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Alabama	yes	yes	yes	yes	yes	yes	yes	yes	yes	-	-	-	-
Alaska	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Arizona	-	-	-	-	-	-	-	-	yes	-	-	-	-
Arkansas	yes	yes	-	-	-	-	-	-	-	-	-	yes	-
Connecticut	-	-	yes	yes	yes	yes	yes	yes	yes	yes	-	-	yes
Delaware	yes	yes	yes	yes	-	-	-	-	-	-	-	-	-
Hawaii	yes	yes	yes	yes	yes	-	-	-	-	-	-	-	yes
Idaho	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Kentucky	yes	yes	yes	yes	yes	yes	yes	yes	yes	-	-	-	
Louisiana	yes	yes	yes	yes	yes	-	-	-	-	-	-	yes	yes
Maine	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Mississippi	-	-	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Montana	-	-	-	-	yes	yes	yes	yes	yes	yes	yes	yes	yes
Nevada	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	-
New Hampshire	-	-	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
New Jersey	yes	yes	-	-	-	-	-	-	-	yes	yes	yes	yes
New Mexico	yes	yes	-	-	yes	yes	yes	yes	yes	yes	yes	yes	yes
North Dakota	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Oklahoma	yes	yes	-	-	-	yes	yes	yes	-	yes	yes	yes	yes
Rhode Island	-	-	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
South Carolina	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes

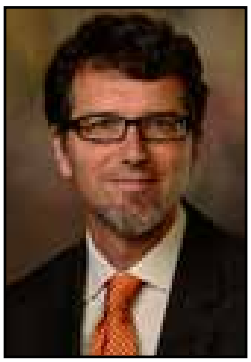
Available on https://nifa.usda.gov/resource/history-usda-epscor-states

US DEPARTMENT OF AGRICULTURE EPSCoR

Ongoing USDA (AFRI Program) EPSCoR awards during FY2019						
Grant No	Title	PD Name	INST	Start Date	End Date	Award Amount
2016-68008-25030	Breaking the Cycle: Amending Aquafeeds to Mitigate Aeromonas hydrophilia outbreaks	Terry Hanson	AU	3/15/16	3/14/2018; extended to 3/14/2019	199,832
2015-67015-23285	Xenogenesis To Improve Artificial Spawning of Reproductively Difficult Catfish	Rex Dunham	AU	3/15/15	3/14/2018; extended to 3/14/2019	450,000
2016-65615-25539	Tools and Planning for Migration of Agriculture as as Sustainable Path for Agricultural Production	Richard McNider	UAH	9/1/16	8/31/2018; extended to 8/31/2019	162,667
2014-67016-21570	Identification of Inhibitors for Essential Phopholipid Biosythetic Enzymes in Haemonchus contortus	William H Witola	TU	12/1/13	11/30/18	150,000
2013-68004-20357	Identifying gaps between knowledge and practice in production and distribution of local and regional foods for a more secure food supply chain	Christy Bratcher	AU	12/15/12	12/14/18	2,407,836
2015-67014-23085	Calcium regulation of interactions between a xylem-inhabiting pathogenic bactrerium and host plants	Leonardo De La Fuente	AU	1/15/15	1/14/19	377,214
2013-67016-20523	Maternal Lactocrine Programming of Female Productive Tract Development	Frank Bartol	AU	2/1/13	1/31/19	700,000
2017-67020-26398	Systems Modeling of Nitrogen Recycling in Multi-Trophic Aquaculture Production	David M Blersch	AU	2/15/15	2/14/20	499,350
2015-69006-22927	Securing the Land for Agricultural and Community Development: Addressing Heir Property as as Asset Building Strategy	Robert Zabawa	TU	2/15/15	2/14/20	499,998

Systems Modeling of Nitrogen Recycling in Multi-Trophic Aquaculture Production

Dr. David Blersch, Auburn University



Production of food-grade products using multi-trophic aquatic ecological processes such as aquaponics promises efficient and low-emission production at the large scale. The intensificaiton of production at this scale requires careful management of nutrient flows between components of the multi-trophic system, and near-complete knowledge of materials and energy flows among all the components. Improvements in this type of production can be achieved through increasing yield and nutrient use efficiency at each of the production unit processes, and the overall system production might then be increased through minimizing losses of key nutrients such as nitrogen and phosphorus. The goal of this research is to understand nutrient use efficiencies in large-scale multi-trophic finfish aquaculture by developing a systems modeling approach to nitrogen and phosphorus flows within the system. The approach is to develop nutrient use computational models for individual unit processes within a multi-trophic production system using standard reactor process models based on growth kinetics. The model will be calibrated to data collected from a large-scale multi-trophic production system in operation at Auburn University, and for which multiple seasons of data will be collected. The expected results are the development of a new model for multi-trophic production based upon a modular unit-process modeling approach that allows alternative scenario analysis for competing candidate production unit processes and approaches. The potential impact is the development of a knowledge base for optimized operation of nutrient-closed multi-trophic production systems informing a modeling tool that can be used for planning new and efficient installations of nutrient-conservative aquaculture production systems.

Securing the Land for Agricultural and Community Development: Addressing Heir Property as an Asset Building Strategy

Dr. Robert Zabawa, Tuskegee University

Heir property causes land loss among African American farmers, ranchers, and forestland owners and constrains wealth creation within African American communities of the South. Heir property refers to land and improvements on land owned collectively by heirs of an owner who has died without a probated will; traditionally, African American landowners have been reluctant to write wills. Heir property has limited collateral value, and we estimate that there are tens of billions of dollars in asset value that cannot be used as collateral for business ventures or agricultural investments. Additionally, heir property owners are not eligible for important USDA programs to farmers and homeowners, representing another obstacle to African American wealth creation. The objectives of our integrated project (research, Extension, teaching) combine the faculty and graduate students at Tuskegee and Auburn Universities with two leading non-profit organizations, Land Loss Prevention Project and Alabama Appleseed, which have made major contributions addressing heir property. This project will compare four African American New Deal Resettlement Communities established to provide farmland, and four neighboring communities, to examine the impact of heir property on asset building, cultural continuity, and community development. The project will identify strategies to address heir property that impede asset building, use research findings to develop Extension and outreach publications and programs to serve heir property owners and communities, and establish a course taught jointly at Tuskegee and Auburn Universities that focuses on heir property and land loss in the context of asset building and community development in Alabama and the South.

APPENDIX

EPSCoR/IDeA Funding Overview

amounts in millions

	FY17 Enacted	FY18 Enacted	FY19 Enacted	FY20 President's Budget Request	FY 20 EPSCoR/IDeA Coalition Goals	FY20 House Approved
NSF	$160.00	$170.70	$175.60	$151.20	$190.00	$177.70
NIH	$333.40	$351.00	$361.60	$311.20	$400.00	$381.60
DOE	$15.00	$20.00	$20.00	$7.70	$25.00	$25.00
USDA	$56.25*	$60.0*	$62.3*	n/a	15% Language	$66.8*
NASA	$18.00	$18.00	$21.00	$0	$28.00	$25.00
DOD	-	-	$12.00	$0	$25.00	$10.50
Totals	**$582.65**	**$619.00**	**$652.50**			**$686.60**

*Represents 15% of Agriculture and Food Research Initiative

EPSCoR and EPSCoR-like program budgets, by agency: FYs 2002–16

(Millions of dollars)

Agency	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
All agencies	288.9	358.0	353.3	367.4	367.1	363.1	418.9	437.2	460.1	436.0	483.4	461.0	488.6	508.8	562.0
DOD	15.7	15.7	8.4	11.4	11.5	9.5	17.0	14.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DOE	7.7	11.7	7.7	7.6	7.3	7.3	14.7	16.8	21.6	8.5	8.5	8.4	10.0	10.0	14.8
EPA	2.5	2.5	2.5	2.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
NASA	10.0	10.0	10.0	12.0	12.5	12.8	15.5	20.0	25.0	25.0	18.0	18.0	18.0	18.0	18.0
NIH[a]	160.0	210.0	214.0	222.0	220.0	218.0	223.6	224.3	228.8	226.5	276.5	261.6	273.3	273.3	320.8
NSF	79.3	88.8	93.7	93.4	97.8	101.5	120.0	133.0	147.1	146.8	150.9	147.6	158.2	165.5	160.0
USDA	13.7	19.3	17.0	18.6	18.0	14.0	28.1	29.0	37.6	29.2	29.5	25.4	29.1	42.0	48.4

[a] NIH has an EPSCoR-like program known as the Institutional Development Award program.

DOD = Department of Defense; DOE = Department of Energy; EPA = Environmental Protection Agency; EPSCoR = Established Program to Stimulate Competitive Research; NASA = National Aeronautics and Space Administration; NIH = National Institutes of Health; NSF = National Science Foundation; USDA = Department of Agriculture.

Note(s):
EPA and DOD discontinued issuing separate EPSCoR program solicitations in FYs 2006 and 2010, respectively. USDA's reported budget in FY 2012 included $6.8 million in unobligated funds. NASA made minor revisions to prior-year data in 2014.

Source(s):
Data are provided by agency EPSCoR representatives and are collected by the National Science Foundation Office of Integrative Activities, Office of EPSCoR, January 2017.

Science and Engineering Indicators 2018