2020 – 2021
Annual Report to the Alabama Commission on Higher Education

Alabama EPSCoR
December 2021

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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The Alabama Established Program to Stimulate Competitive Research (ALEPSCoR) 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 are 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 for 2020- 2021 include:

- thirty-four new FY2020 awards and thirty-four new FY2021 awards for two-year combined total of $30,552,567
- an update of the searchable research capabilities map/database for the eight Alabama Ph.D. granting institutions with Southern Research and HudsonAlpha on the Alabama EPSCoR web site at https://alepscor.org/
- development of the Alabama EPSCoR FY2021 Research Infrastructure Improvement (RII) Science and Technology (S&T) Plan
- completion of the down-select process of the single state-wide submission to the National Science Foundation $ 20M Track One grant program in August 2021

Major awards for FY2020 and FY2021 include:

- NSF EPSCoR Research Infrastructure Improvement (RII) Track 4 awards - (5 in FY 2020 and 3 in 2021)
- NSF RII Track 2 awards- (four in FY2020 – one as lead and three as a partnering institution)
- NSF Co-funded awards - nineteen (FY20) and 24 (FY21)
- DOE EPSCoR – two State Laboratory Partnership Grants in FY2020 and an extension to a DOE Implementation grant in FY2021
- NASA EPSCoR - during FY20, Alabama EPSCoR was awarded one NASA Cooperative Agreement Notice (CAN) Award, four Rapid Response Awards and in FY 2021, three NASA Rapid Response Research Awards, one International Space Station Award, one International Space Station Suborbital (new funding opportunity in FY21), and one NASA Cooperative Agreement Notice (CAN) award.

In 2020, new EPSCoR research awards exceeded $17M while estimated research expenditures exceeded $16M. In FY 2021, new awards exceed $13M while research expenditures estimated at $15.78M. State support for the ALEPSCoR program during FY 2020 included 1.2M to support administration (see ALEPSCoR staff members on pages 10-11) and the Graduate Research Scholars Program (GRSP) which led to a federal return in research expenditures for state funding of more than 13.7 to 1 for ALEPSCoR in FY 20. Since 2006, the GRSP has supported over 300 graduate students, leading to an estimated 73 Master's degrees and 221 Ph.D. degrees as of December 2021. During the fall of 2021, 36 students were supported with GRSP Round 16 funding, 17 are new awardees (see list page 15). Detailed information regarding GRSP Round 16 recipients is available in Volume 14 of the GRSP Booklet published December 2021.

The Research Capabilities Interactive Map/Database was updated to include Alabama expertise in eleven state research priorities; these include Plasma Science, Nanotechnology, Advanced Manufacturing, Agriculture/Food Production, Automotive and Aerospace Technologies, Biosciences/Biotechnology, Chemical/Petrochemical, Energy, Forestry Products/Natural Resources, Information Technology and Cybersecurity, and Metal and Advanced Materials. This resource can be used as a testament to the depth of expertise in our state and to encourage collaboration and economic development.

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

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 four 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).

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 2020-2021 ALEPSCoR was eligible to receive new awards through EPSCoR programs associated with NSF, DOE, NASA and a new ititiative at the Department of Defense EPSCoR or DEPSCoR. We became ineligible for new USDA AFRI/FASE 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.

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.

2020-2021 Alabama EPSCoR Notable Achievements

- Development of the Alabama EPSCoR FY2021 Research Infrastructure Improvement (RII) Science and Technology Plan for the state.

- Estimated research expenditures exceeded $16M in FY2020 and $15.7M in FY2021.

- New EPSCoR awards exceeded $17.4M in FY2020 and $13M in FY2021.

- The Graduate Research Scholars Program (GRSP) funded 36 students in Round 16, 19 are renewing awardees while 17 are new to the GRSP Program. Thirty-four awardees are pursuing a PhD while 2 are working towards a Master's. Funding began August 2021 for one year.

- ALEPSCoR updated the searchable research capabilities database available at https://alepscor.org/.

- NSF EPSCoR - In FY 2020, Alabama received five new RII Track 4 awards. These awardees include Dr. Biswajit Ray at UAH, Dr. William Jackson at USA, Dr. Steven Weinman at UA, and Dr. Majid Beidaghi and Dr. Xu Wang at Auburn. In addition, Dr. Prabhakar Clement (UA) is leading a NSF Track 2 Collaboration award between Alabama, Louisiana, and Mississippi. In 2021, Alabama EPSCoR received three new NSF EPSCoR Track 4 awards. Recipients include Dr. Wenli Bi at UAB and Drs. Siyuan Dai and Jakita Thomas at Auburn. Auburn University will also be partnering with the University of Idaho on a FY22 NSF EPSCoR Track 2 award.

- NSF Co-funding - In FY 2020, nineteen new co-funded projects were awarded to Auburn, Tuskegee, UA, UAH and USA totaling $7.6 M. In FY 2021, over $10M from twenty-four new awards is supporting research at AAMU, AU, TU, UA, UAB, UAH and Stillman College in Tuscaloosa.

- DOE EPSCoR- In FY2020, Alabama EPSCoR was awarded two State Laboratory Partnership awards for $1.5M. Recipients include Dr. Vladimir Kolobov at UAH and Dr. Suzanne Lapi at UAB. In FY2021, Dr. Kevin West (USA) was awarded a DOE EPSCoR Implementation Grant ($ 999,948) extension.

- NASA EPSCoR- In FY2020, Alabama institutions (Auburn, UAB, and UAH) were awarded four new NASA Rapid Response Research (R3) awards while in FY2021, Alabama NASA EPSCoR was awarded six new awards including an International Space Station Award, one International Space Station Suborbital (new funding program in FY2021), three new Rapid Response Research (R3) awards, and a large Cooperative Agreement Notice Award. Institutions involved include AAMU, ASU, AU, UA, and UAH.

- Completion of the down-select process for the single state-wide submission to the National Science Foundation $20M Track 1 program in August 2021.

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.

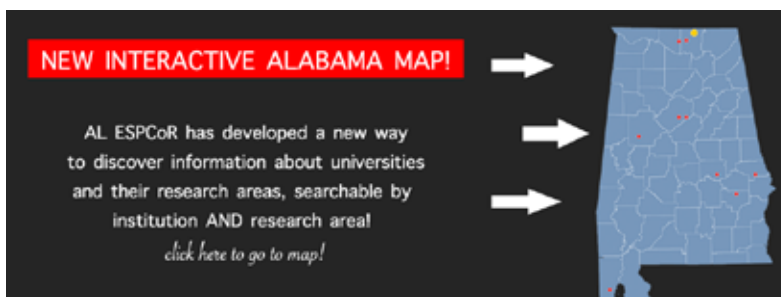Increasing Alabama's scientific and technology research competitiveness is critical for the long term economic health of the state. Specifically, ALEPSCoR makes a difference to Alabama through education, outreach, increased diversity, partnerships, infrastructure building, economic benefit/jobs, business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

ALEPSCoR Develops Research Expertise Searchable Database

In FY 2020 and 2021, 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. In 2021, research priority areas were updated to include: Plasma Science, Nanotechnology, Advanced Manufacturing, Agriculture/Food Production, Automotive and Aerospace Technologies, Biosciences/Biotechnology, Chemical/Petrochemical, Energy, Forestry Products/Natural Resources, Information Technology and Cybersecurity, and Metal and Advanced Materials. 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,

NEW INTERACTIVE ALABAMA MAP!

AL ESPCoR has developed a new way to discover information about universities and their research areas, searchable by institution AND research area!

click here to go to map!

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.

In FY 2020, Alabama was awarded portions of four new NSF RII Track 2 multi-jurisdictional awards, one as the lead and three as a collaborating institution; five new NSF RII Track 4 Awards, nineteen new NSF Co-funded awards; 2 DOE State Laboratory Partnership awards; and four new NASA Rapid Response Research (R3) awards. In FY2021, Alabama EPSCoR was awarded three NSF EPSCoR Track 4 awards, twenty-four NSF Co-funded awards, one DOE Implementation Award, and from NASA EPSCoR: three Rapid Response Research (R3) awards, one International Space Station (ISS) Award, one ISS Suborbital Award and one Cooperative Agreement Notice Award.

Agency	FY 2020		FY 2021	
	New Awards	Estimated Research Expenditures	New Awards	Estimated Research Expenditures
NSF RII	8,088,073	5,513,102	600,875	5,034,619
NSF Co funding	7,443,941	6,960,229	10,170,584	7,408,045
DOE EPSCoR	1,499,146	2,307,348	999,948	2,392,594
NASA EPSCoR	400,000	1,216,111	1,350,000	954,722
USDA EPSCoR	0	74,951	0	0
Dept of Defense EPSCoR	0		0	0
Total	17,431,160	16,071,741	13,121,407	15,789,980

ALABAMA EPSCoR 2021 Research Infrastructure Improvement Science and Technology Plan

<u>Executive Summary</u>

In 2017 Alabama EPSCoR (ALEPSCoR) worked with the Alabama Department of Commerce (DoC) to develop an economic development plan, "Accelerate Alabama 2.0". This State economic development plan contained an ALEPSCoR Science and Technology (S&T) plan describing the research and development (R&D) steps needed to achieve the economic goals of Accelerate Alabama 2.0.

More recently, in July of 2020, Alabama Governor Kay Ivey established, by Alabama Executive Order 720, the Alabama Innovation Commission (AIC), designed to stimulate economic growth in Alabama's innovation economy and tech-related industries. ALEPSCoR has developed a newly updated and modified ALEPSCoR's 2021 Research Infrastructure Improvement (RII) S&T Plan so that the new economic development goals and priorities of the Executive Order 720 inform and align with the R&D goals and steps of our new ALEPSCoR 2021 RII S&T plan. To this end, our new ALEPSCoR 2021 RII S&T plan will focus on developing new R&D technologies to support "Alabama's most prominent industries," listed in Executive Order 720 as: "automotive, aerospace, chemicals, agriculture, forest products, information technology, energy, metals, plastics, and bioscience."

The ALEPSCoR 2021 S&T plan establishes additional state-wide R&D priorities to develop additional emerging technologies where Alabama can develop future successful new industries and expand existing ones. Beginning in 2020 through 2021, ALEPSCoR performed a comprehensive analysis of the strengths and weaknesses of the Alabama R&D research enterprise, and each Alabama major research institution was asked to provide a comprehensive categorized list of current research capabilities and strengths at their institutions.

ALEPSCoR RII SCIENCE & TECHNOLOGY PLAN

APPROVED BY ALEPSCoR STEERING COMMITTEE, JULY 20, 2021

To determine the most promising future R&D technologies, a Request for White Papers / Pre-proposals was published in December of 2019 requesting proposed new research topics where Alabama could establish or strengthen national leadership. Nine pre-proposals on major research initiatives were received. National technical experts evaluated these submissions to determine the most promising areas for future Alabama leadership. These recommendations were considered by the full ALEPSCoR Steering Committee including the Vice Presidents for Research of the eight Alabama Ph.D. granting institutions and representatives from state government. The decision was made to make the primary focus of Alabama EPSCoR's RII resources in Plasma Science. Alabama is unique in its close linkage of industry, commercialization, national interest, and academia in plasma science, and it provides the most promising national leadership and new commercialization opportunities.

MANANAGEMENT
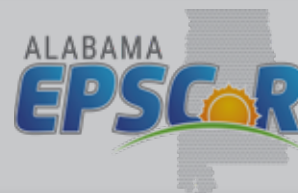
Alabama EPSCoR Steering Committee

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.

In March 2018 and again in August 2020, Dr. Chris Brown was elected Chair of the Alabama EPSCoR Steering Commitee while Dr. Shaik Jeelani was elected 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
Vice President for Research
University of Alabama at Birmingham

Dr. Robin McGill
Proxy for Dr. James Purcell
Deputy Director for Academic Affairs
Alabama Commission on Higher Education

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

Dr. Robert (Bob) Lindquist
Interim Provost and Executive VP for Academic Affairs
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 and Economic Development
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. Greg Barker
President
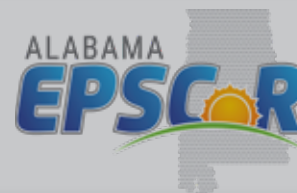Economic Development Partnership of Alabama

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

ALEPSCoR Executive Director

Dr. Christopher Lawson is a Professor of Physics at the University of Alabama at Birmingham. His research specialty is optical sensing and nonlinear optics and he has published over 60 peer-reviewed journal articles and 10 books or book chapters in these areas. During his research career, Dr. Lawson has been Principal Investigator (PI) of projects exceeding $23M in grant funding. In 2004 he established the NSF funded Center for Optical Sensors and Spectroscopies (COSS) and led this Center until becoming Executive Director of the Alabama Established Program to Stimulate Competitive Research (ALEPSCoR) in 2010.

Dr. Chris Lawson

ALEPSCoR (www.alepscor.org) is dedicated to the advancement of economic development via scientific and engineering research through a collaborative effort among the State's research universities. Overall, ALEPSCoR has brought in 268 federal EPSCoR grants for $165M from 2010-2020. 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 2020, GRSP support has resulted in 204 Ph.D. and 67 Master's degrees in high technology EPSCoR research areas.

As ALEPSCoR Executive Director, in 2016 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. In 2017, Dr. 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 lead to target economic growth areas and the creation of Alabama jobs. More recently, he supervised the development of a newly updated and modified ALEPSCoR 2021 Research Infrastructure Improvement (RII) S&T Plan. This plan outlines new economic development goals informed and aligned with Alabama Executive Order 720, established by Governor Ivey in 2020 for the Alabama Innovation Commission to define and stimulate Alabama's innovation economy and tech-related industries. The ALEPSCoR 2021 S&T plan establishes additional state-wide R&D priorities to develop additional emerging technologies where Alabama may develop future successful industries and expand existing ones. The S&T plan was unanimously approved by the ALEPSCoR Steering Committee on July 20, 2021.

Finally, from 2016-2021 Dr. Lawson served as the 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.

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 shortly thereafter joined Alabama EPSCoR as Program Coordinator II. She also plans to receive her MBA from UAB in Fall of 2021.

Ms. Briauna Perryman at the Alabama EPSCoR booth during the Economic Development Association of Alabama (EDAA) January 2020 Winter meeting in Montgomery. Alabama EPSCoR demonstrated how to access the Alabama web based research capabilities database.

Briauna Perryman, Charlotte Nix, and Dr. Chris Lawson met with Congresswoman Martha Roby (District 2) during Alabama EPSCoR's annual congressional delegation visits, February 2020.

MANAGEMENT

Alabama Commission on Higher Education (ACHE)

Dr. Robin McGill serves as Deputy Director for Academic Affairs at the Alabama Commission on Higher Education. She manages ACHE's instructional portfolio for Alabama's public colleges and universities, which includes program review, education and workforce policies, and student success initiatives. Prior to joining ACHE in May 2019, she worked as Director of Strategic Initiatives for the Rhode Island Office of the Postsecondary Commissioner. Dr. McGill has presented in local, regional, and national settings on higher education topics ranging from data integration to system-level governance and higher education funding. Dr. McGill earned her PhD in Classical Literature from Brown University, and she also holds baccalaureate degrees in Latin and Greek from the University of Georgia and an MLitt from the University of St. Andrews.

Margaret Pearson began a career in education in 2005 at the Alabama Commission on Higher Education. For the past 16 years, she played a key role in reviewing new academic programs in the Academic Affairs/Instruction and Special Projects unit. In June 2020, in her new role as Coordinator of Strategic Programs, Ms. Pearson began coordinating statewide programs associated with the Southern Regional Education Board (SREB), serving as the state coordinator of the Academic Common Market and Doctoral Scholars program. Ms. Pearson also provides staff support for the Alabama EPSCoR program.

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 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 awards from the USDA AFRI Program or NIH IDEA Programs.

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 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 Commendation, 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.

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.

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 2021, the Alabama Legislature continued the appropriation to ALEPSCoR through the Alabama Commission on Higher Education for the purpose of funding the Graduate Research Scholars Program (GRSP). Since its inception in 2006, the program has funded over 341 exceptional graduate students.

Round Sixteen had 73 applications, 36 were awarded. Funding for the nineteen renewing and seventeen new awardees will begin in the fall semester of 2021. These recipients are conducting research funded by EPSCoR (Established Program to Stimulate Competitive Research) programs at the National Science Foundation, National Aeronautics and Space Administration, and the U.S. Department of Energy Office of Science. Of the thirty-eight students, thirty-four (34) are pursuing a PhD while two (2) 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. 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 fifteen 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, and DOD 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 14 GRSP Booklet published December 2021.
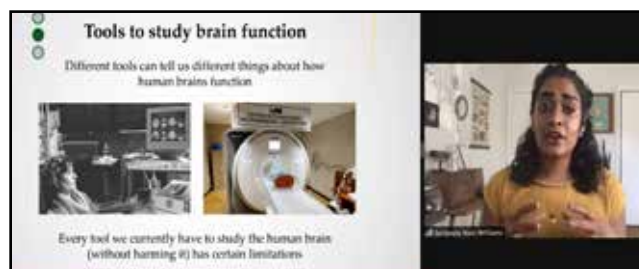
UAB GRSP awardee Sangeeta Nair presents her brain function research during the virtual ACHE Commissioner's meeting on December 12, 2020.

GRSP Campus Coordinators

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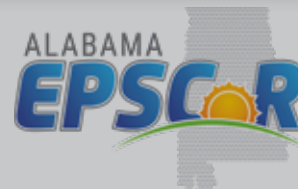
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GRADUATE RESEARCH SCHOLARS PROGRAM

	First Name	Last Name	Inst	Target Degree	EPSCoR grant
					Graduate Research Scholars Program (GRSP) Round 16 Awardees
1	Palwai	Sharvare	AAMU	PhD	NSF 1655280
2	Lam	Duong	AAMU	PhD	NSF 1655280
3	Mersaydes	Goodson	AAMU	PhD	NSF 1655280
4	Brennetta	Crenshaw	ASU	PhD	NSF 1900377
5	Ayodeji	Ipinmoroti	ASU	PhD	NSF 1900377
6	Wenqi	Cao	AU	PhD	NSF 1928770
7	Adam	Pfiefle	AU	PhD	NSF 1848344
8	Suresh	Thapa	AU	PhD	NSF 1809847
9	Jialing	Shen	AU	PhD	NSF 2005194; NSF 2033454
10	Andricus	Burton	AU	PhD	NSF 1809847
11	Lyndon	Smith	TU	PhD	NSF 1655280
12	Azizi	Turner	TU	PhD	NSF 1655280
13	Amber	Kinnebrew	TU	PhD	NSF 1655280
14	Richard	Harry	TU	MS	NSF 1655280
15	Erin-Nicole	Scott	TU	PhD	NSF 1655280
16	Irene	Sanchez-Gonzalez	UA	PhD	NSF 2019603
17	Sungyoon	Kim	UA	PhD	NSF 1856054
18	Sajid	Ahmed	UA	PhD	NSF 1655280
19	Shelby	Critcher	UA	PhD	NASA 80NSSC19M0051
20	Polina	Bombina	UA	PhD	NSF 2012554
21	Taiaba	Afrin	UAB	PhD	NSF 1350244
22	Guimu	Guo	UAB	PhD	NSF 1755464
23	John	Schoelz	UAB	PhD	NSF 1552586
24	Kallol	Chakrabarty	UAB	PhD	NSF 1655280
25	Md Raiful	Hasan	UAB	PhD	NSF 1642078
26	Bibek	Dhami	UAB	PhD	NSF 1832898
27	Nabil	Hoque	UAH	PhD	NASA 80NSSC19M0033
28	Tanzeela	Mitha	UAH	PhD	NSF 1653915
29	Md	Raquibuzzaman	UAH	PhD	NSF 1929099
30	Larissa	Langria	UAH	MS	NASA 80NSSC19M0051
31	Muntaseer	Bunian	UAH	PhD	NASA 80NSSC19M0051
32	Pavithra	Srinivas	USA	PhD	NSF 1655280
33	Jubaer	Alam	USA	PhD	NSF 1833016
34	Jeffrey	DeMeis	USA	PhD	NSF 2030080
35	Jon	Hastings	USA	PhD	NASA 80NSSC19M0147
36	William	Oswald	USA	PhD	NSF 1951488

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 FY2020 and FY2021. 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, and NASA see the following sections.

A strong commitment for EPSCoR is a sound investment for our State's future.

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.

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

NSF EPSCoR Eligible Jurisdictions

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

funding to recipients within a jurisdiction. In January 2020, new elibility criteria was announced which changed eligiblity from a 3-year average to a 5-year average. It also removed EPSCoR support from the elibility calulation and bases calculations on NSF Total award funding instead of only NSF Research Support. Eligibility in FY 2022 will be restricted to jurisdictions that recieve equal to or less than 0.75% of the total NSF budget. Jurisdictions that have been established in the program and whose share of total NSF funding is above 0.75% but less than 0.80% are allowed to remain EPSCoR-eligible for up to 5 years. Calculations are based on data from the NSF Office of Budget, Finance

	FY 2016 Research Support	FY 2017 Research Support	FY 2018 Research Support	FY 2019 Research Support	FY 2020 Research Support	2016- 2020 Total	EPSCoR Total	Federal Total	Adjusted $	% of Total $
	Amt $K	Amt $K	Amt $K	Amt $K	Amt $K	Amt $K	Amt $K		Amt $K	
Grand Total	$7,110,054	$7,016,546	$7,457,851	$7,734,408	$7,799,302	$37,118,161	$691,067	$790,984	$35,636,110	100%
Other	$26,715	$18,894	$23,354	$27,131	$21,735	$117,829				
US Total	$7,083,339	$6,997,652	$7,434,497	$7,707,277	$7,777,567	$37,000,332				
Alabama	$46,041	$51,155	$60,140	$58,987	$69,095	$285,418	$28,192		$257,226	0.72%

Alabama Eligibility for NSF EPSCoR (for FY 2022)

Source: https://www.nsf.gov/od/oia/programs/epscor/Eligibility_Tables/FY2022_Eligibility.pdf

A jurisdiction is eligible to participate in NSF EPSCoR if their most recent 5-year level of total NSF funding is equal to or less than 0.75% of the total NSF budget. Jurisdictions above 0.75% but less than 0.80% are allowed to remain EPSCoR-eligible for up to 5 years.

and Award Management and listed on NSF's Budget Internet Information System (http://dellweb.bfa.nsf.gov/). The FY 2020 and FY 2021 eligible tables remained the same and included twenty-four states, Guam, Puerto Rico and U.S. Virgin Islands, these juridctions receive approximately 10 percent of the NSF budget. The remaining ninety percent of NSF funding goes to non-EPSCoR jurisdictions.

In FY 2020, the grand total of NSF awards distributed across the world was $7,799,302K while the US total was $7,777,567K. Alabama recieved $69,095K. NSF's Office of the Director awarded $15,693,017 across Alabama including 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.

NSF Funding Rates FY 2014-2020								
		2014	2015	2016	2017	2018	2019	2020
All NSF Directorates	No. of Proposals	48,206	49,630	49,306	49,425	48,334	41,030	42,727
	No. of Awards	11,120	12,016	11,893	11,457	11,716	11,250	12,172
	funding rate	23%	24%	24%	23%	24%	27%	28%
Alabama Portion (All NSF Directorates)	No. of Proposals	666	583	607	656	672	525	549
	No. of Awards	103	85	102	116	113	98	137
	funding rate	15%	15%	17%	18%	17%	19%	25%
NSF Office of the Director O/D (includes EPSCoR)	No. of Proposals	755	671	420	416	444	605	891
	No. of Awards	223	312	217	249	119	136	227
	funding rate	45%	46%	65%	60%	27%	22%	25%
Alabama Portion (O/D) (includes EPSCoR)	No. of Proposals	17	12	11	10	26	13	28
	No. of Awards	3	2	6	7	7	2	10
	funding rate	18%	17%	55%	70%	27%	15%	36%
All NSF Funding	Total*	6,766,552	6,967,463	7,110,054	7,016,546	7,457,851	7,734,408	7,799,302
Alabama (All NSF)	Total*	45,305	34,281	46,041	51,155	60,140	58,987	69,095
Overall NSF O/D Funding	Total*	385,949	460,863	462,073	454,777	503,917	577,175	582,069
Alabama NSF O/D	Total	4,797,819	2,611,006	4,486,653	9,151,080	17,283,205	9,835,524	15,693,017
Alabama EPSCoR	Total	4,239,226	2,420,866	4,017,754	9,140,280	15,189,507	6,400,650	11,949,680

*Amount shown in thousands

Source: NSF Budget Internet Information System

NATIONAL SCIENCE FOUNDATION EPSCoR

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

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

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.

NSF 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 at 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 throughout Year 4 and approved by NSF EPSCoR in April of 2021, together with the previously approved versions from May of 2020

and from December 2018 was used to guide and direct the Year 4 effort and the allocation of resources to achieve the goals articulated in the proposal.

Research Thrusts 1, 2, 3, working groups, 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.

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, 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.
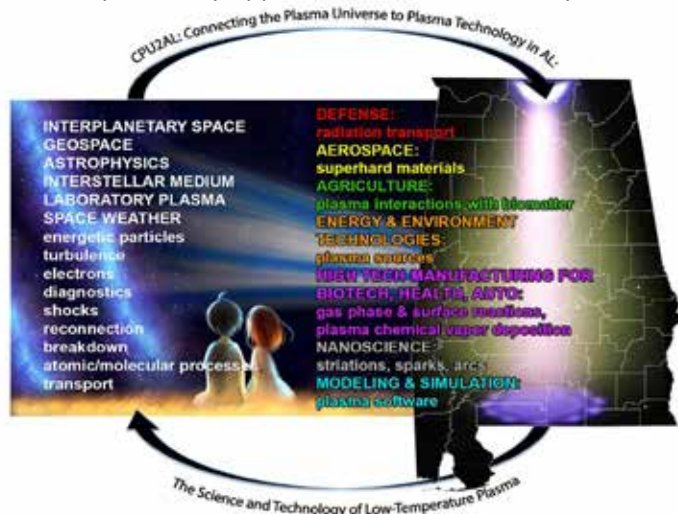
NSF RII Track 1 CPU2AL PI List

University of Alabama in Huntsville
Gary Zank (Project Director), Nick Pogorelov, Vladimir Kolobov, Jakobus Le Roux, Lingling Zhao, Haihong Che, Ying Zou, Gabe Xu, Gang Li, Gary Webb, Laxman Adhikari (postdoc), Haoming Liang (postdoc) Masaru Nakanotani (postdoc), Bofeng Tang (postdoc), Sarp Yalim (postdoc), Samira Tasnim (postdoc)

Alabama A&M University
Srinivasa Rao Mentreddy (AAMU Lead PI), Armitra Jackson-Davis, Ernst Cebert
Leopold Nyochembeng, Padmaja Guggilla

Alabama State University
Komal Vig

Auburn University
Edward Thomas (AU Lead PI), David Ennis
David Maurer, Stuart Loch, Uwe Konopka, Yu Lin, Emefa Monu, Yu Lin, Joe Perez, Kaijun Liu, Feng Si (postdoc)

Tuskegee University
Vijay Rangari (TU lead PI), Michael Curry, Maria Calhoun, Shaik Zainuddin

University of Alabama
Rich Branam (UA Lead PI), Gary Cheng, Mruthunjaya Uddi, Xiaowen Wang

University of Alabama at Birmingham
Yogesh Vohra (UAB Lead PI), Vinoy Thomas, Chen Cheng-Chien, Arron Catledge, Wenli Bi, Renato Camata, Gopi Samudrala, Paul Baker, Vineeth Vijayan (Postdoc)

University of South Alabama
Edmund Spencer

Oakwood University
Alexander Volkov

CFD Research Corporation
Robert Arslanbekov

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 cm^2) 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 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 overarching efforts are focused on using the LTP research thrusts above to:
- Build lasting collaborations between AL academic and 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

Measurable progress has been made on all of these fronts. In Year 4 CPU2AL participants published 46 publications (in 16 of those CPU2AL was the primary support for the publication), submitted 25 proposals to various funding agencies and garnered 12 awards for a total of $3,453,107.00.

Over the last four years of the grant award there has been a dramatic increase in the number and types of collaborations between the partner institutions. These cross-institutional collaborations have been achieved through a mix of programs and efforts. For example, our seed funding initiatives require the recipients to develop and run a cross-institutional program that engages faculty, students, and post-docs from different institutions, including available resource sharing. In year four there are eight active funded seed projects. These projects range from low temperature dusty plasma-based nanoparticles, the development of a cognitive RF plasma analyzer, to the study of the physics of collisional shock waves. The seed projects involve HBCUs, industry, and other members of the CPU2AL team.

Integrating HBCUs into the statewide research collaboration, has resulted in the CPU2AL HBCUs being fully involved in collaborations with UAH, UAB and AU. Three of the four HBCU institutions have received seed funding awards in Years 2 and 3 and in Year 4 two HBCUs received seed funding grants. In addition, we created a summer program for CPU2AL HBCU students called Alabama Research Experiences for Undergraduates (ALREU). This year three HBCU students participated in the ALREU Program.

Following the NSF Reverse Site Visit recommendation to strengthen interactions among Research Thrusts, three working groups were formed to address dedicated topics that cross the RTs. Initially, three different topics were selected and turned into working groups: Plasma Modeling, Diagnostics (electrical & optical) and Space Science in the Lab. In Year four a fourth working group was created for Food Safety and Plasma Agriculture. This group aims to enable networking and collaborative research to understand better plasma effects on seeds, plants, and meats using expertise across the three thrust areas, applications, diagnostics, and modeling. The purpose is to review the research progress at the partnering institutions and discuss current developments in plasma agriculture. The working group members discuss how diagnostics can quantify variables at the plasma – soft biomatter interphase, potentially leading to the development of empirical and mechanistic models to predict plasma effects on plants and meats.

Finally, in Year 4 we are now sharing and integrating resources across partner institutions. Specifically, we have acquired equipment for plasma processing and plasma diagnostics at AU (a Godyak-type Langmuir probe system and a scanning monochromator with backlit ICCD camera), a custom-built plasma treatment rotating chamber for powder samples/polymer pellets at TU, a large-area 30cm x 30cm plasma deposition system for manufacturing of superhard materials at UAB, and a Spectrometer detector and associated power supplies at UAH. These instruments are being shared among partner institutions to the extent needed to strengthen collaborations.

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 in order to inspire and train the next generation of (Low Temperature Plasma) scientists – involving activities aimed at K-12, undergraduates, graduate students, and postdocs. These activities are designed to link academic research activities to the Alabama LTP industry. During Year 4, the CPU2AL Team continued to recruit and appoint several participants at all levels, with the number of active participants increasing to 102, which is slightly up from about 99 in Year 3.

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. In particular, two new faculty hires in Year 4 were women and six of the fifteen CERIF Graduate Research Assistantships (GRAs) were women.

During the summer of 2021 we held our four summer programs: The International Space Weather Camp (ISWC) the Alabama Plasma Internship Program (ALPIP),

International Space Weather Camp

*The University of Alabama in Huntsville, Alabama A&M, ASU, Auburn, Oakwood University, Tuskegee University, The University of Alabama, UAB, The University of South Alabama

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• Travel Expenses to Huntsville AL Available
• Tuition Included
• GPA Requirement of 3.0

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the Alabama Research Experience for Undergraduates (ALREU) and the Corporate Internship Program on Plasma Technology Applications (CIPPTA). While the ISWC was not able to have the traditional international travel component in the program this year, due to the COVID-19 Pandemic, four students from Alabama attended the camp on the UAH campus and communicated with students in South Africa and Germany via various online communication platforms. We also had thirteen students participate in-person at some of the nine Alabama partner institutions for the ALPIP Internship Program and three students participate in-person for the ALREU Internship program. Lastly, five students spent the summer working at four companies in Alabama as part of their CIPPTA Internship.

In our continued effort to enhance the transfer of academic research to AL LTP industries we launched the first course in our Alabama Plasma Technology (APT) series, titled "Introduction to Spectral Diagnostics" in June 2018. This course gives an overview of non-invasive plasma spectroscopy techniques. The first was to have all the material accessed via self-paced online modules that the students work through. In Year 4 we created a second mode of the course where there are regular online lectures that accompany the course, online office hours, and a final exam. This course can be given for course credit at partner institutions and other institutes. In the summer of 2020, the course was taken by 22 Auburn graduate students and post-docs. To date 75 students have taken the course. During Summer 2021, the course was taken by 18 students and post-docs. Some of those students attended from the University of Tennessee - Knoxville, with those students getting course credit at their home institute.

The CPU2AL Program continues to work on broadening the participation of underrepresented students in K-12 STEM plasma-related activities through summer activities. Unfortunately, due to COVID 19, our efforts to increase URM K-12 participation was severely restricted during the summer of 2020. However, we were able to offer our At- Home STEM projects to past participants of our Fall Break camp via our website. Due to the continued hesitancy of institutions to host large events, we continued to offer these At-Home STEM projects during Summer 2021. We also provided tickets to small groups of students to attend the Exploreum in Mobile, Alabama and the Cook Science Museum in Decatur, Alabama.

CPU2AL Speaker Series

Dr. Ed Thomas
Dusty plasmas: Not Just the 4th State of Matter, but All States of Matter!

Communication and Dissemination

During Year 4, we have widely promoted the CPU2AL project 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) emails/meetings with industry partners, (vi) the CPU2AL speaker series, (vii) the CPU2AL virtual Annual Meeting, (viii) virtual presentations at national and international meetings, (ix) email blasts to internal and external audiences who subscribe on our website, and (x) social media such as Facebook, YouTube, TikTok and Instagram.

Management

The CPU2AL Management Team comprises representatives from eight campuses and the industrial partner, together with the 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 there are usually two in-person meetings of the Management Team. Unfortunately, due to the COVID-19 pandemic, there have been no in-person meetings, such as the Annual Retreat, this year. The Year 4 Annual Retreat was held virtually. We hope to resume in-person meetings in the near future. In January a new Project Manager, Indira Richardson, was hired to replace Patrick Hambloch, who resigned his position to move to Germany. There was a two month overlap of the Project Managers to enable adequate training of Ms. Richardson.

The 2020 COVID-19 Challenge

   Since March 2020, the CPU2AL project has faced an unprecedented challenge in managing a major research and workforce development program across 10 institutions spread throughout the State of Alabama. This became especially acute with the imposition of "stay-at-home" orders and the closure of university facilities. We have been fortunate in that many of our management activities already rely on telecommunications, including our monthly management meetings, and these have continued to be effective. For the last year our faculty and researchers who needed to be in the labs, including our students and post docs, have faced considerable challenges due to not having access to their laboratories, but all took the opportunity to work on publications, organize and analyze data, etc. For those engaged with more portable research activities (theory and data), the situation has been less difficult, and everyone continued to adapt quickly and readily as conditions changed. The PI's concern and emphasis has been that everyone's safety is paramount and that the participants should be judicious, smart, and adept enough to develop workarounds as the situation demands. This has been communicated in video conferences and via email to the CPU2AL family. This approach has allowed at least the research, management, and sustainability activities to proceed robustly.

   Far more challenging has been addressing the workforce development and enrichment programs at all levels. The project had to postpone the 2021 Spring Annual Retreat. However, we hope to resume the Annual Retreat next year. In addition, we had to cancel the 2021 Science and Technology Open House, as well as many other outreach activities, such as attending college and career fairs. Last summer our biggest regret was our inability to hold the student summer programs, such the International Space Weather Camp (ISWC) the Alabama Plasma Internship Program (ALPIP), the Alabama Research Experience for Undergraduates (ALREU) and the Corporate Internship Program on Plasma Technology Applications (CIPPTA). However, in May 2021 some Alabama universities began to reopen facilities to faculty, staff and students. Our laboratory researchers developed effective workspace utilization plans consistent with individual University and State guidelines that continue to include masks, social distancing measures, and the like in labs. This meant we were able to hold the ISWC and the three summer internship programs this year. It is our hope that, as things return to normal, we will again be able to attend recruitment career fairs and conferences and conduct open houses, science fairs and other outreach events.

NSF EPSCoR RII Track 2

In 2020, the NSF Track 2 research focus was "Harnessing the Data Revolution" to solve problems of national importance. In FY 2021, proposals to the Track 2 program were on "Advancing research towards Industries of the Future to ensure econonomic growth for EPSCoR jurisdictions."

In FY 2020, Alabama was awarded one Track 2 award as the lead and three others as a collaborator with another EPSCoR jurisdiction. Dr. Prabhakar Clement, at the University of Alabama, is leading a Track 2 Team investigating groundwater management across the Southeast. Other Alabama Track 2 investigators are collaborating with the South Dakota School of Mines and Tech; University of Kansas Center for Research and the University of Louisiana at Lafayette. In September 2021, nine FY 21 new NSF Track 2 awards were announced for a total of nearly $40M. Auburn University is serving as a partner with the University of Idaho, the start date is Oct. 1, 2021 and will be counted as a FY2022 award. From FY16-21, Alabama was awarded two NSF Track 2 awards as the lead and has served as a partner on ten.

NSF RII Track-2 FEC: IGM--A Framework for Harnessing Big Hydrological Datasets for Integrated Groundwater Management
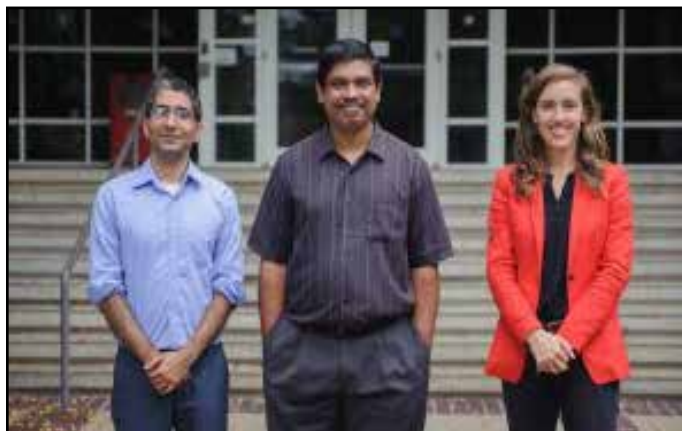Dr. Prabhakar Clement, UA

Groundwater depletion is a major water management problem that is of global concern. Locally, the Southeastern US has experienced increased water stress due to the mismanagement of its water resources, especially during drought periods. Rapid agricultural expansion and unplanned urbanization have further aggravated this problem. Given that water-related industries contribute to over 150 billion of US dollars in annual revenues, the long-term sustainability of freshwater resources is of paramount importance to this region. While mapping the availability

New NSF EPSCoR Track 2 Awards FY2020							
Award No	Title	Type	Lead Inst.	AL Inst./PI	Start date	End Date	AL Award Amt.
2019561	RII Track-2 FEC: IGM--A Framework for Harnessing Big Hydrological Datasets for Integrated Groundwater Management	EPSCoR Research Infrastructure	Lead Inst. UA: Dr. Prabhakar Clement (whole project over 4 years is $5,998,507;	University of Alabama	9/1/2020	8/31/2024	$4,126,634
2019511	RII Track 2 FEC: Precise Regional Forecasting via Intelligent and Rapid Harnessing of National Scale of Hydrometeorlogical Big Data	EPSCoR Research Infrastructure	Lead Inst.: Univ. of Louisiana at Lafayette, PI: Dr. Nian-Feng Tseng; whole project is $2,509,859	University of South Alabama: Dr. Sytske Kimball	9/1/2020	8/31/2024	780,485
2019597	RII Track-2 FEC: The IceCube EPSCoR Initiative (IEI) - IceCube and the Data Revolution	EPSCoR Research Infrastructure	Lead Inst.: South Dakota School of Mines and Tech for $3M;	University of Alabama: Juan Santander and Dawn Williams	9/1/2020	8/31/2024	921,659
2019603	RII Track 2 FEC: Aquatic Intermittency Effects on Microbiomes in Streams (AIMS)	EPSCoR Research Infrastructure Improvement Track 2	Lead Inst.: University of Kansas Center for Research, whole award is 2,999,199	University of Alabama: Carla Atkinson, Jon Benstead, and Charles (Nate) Jones	9/1/2020	8/30/2024	1,216,905

of water in topsoil, reservoirs, and rivers continues to receive much attention, mapping of groundwater storage changes at a fine spatiotemporal resolution over large areas is currently lacking. This is important because groundwater contributes around 40 percent of freshwater usage in the conterminous US, and its contribution in some Southeastern states, e.g., Mississippi, is over two-thirds. Groundwater also indirectly sustains surface water resources, and hence its actual contribution to freshwater usage is even larger than reported. The goal of this project is to harness the big data to implement an integrated groundwater management (IGM) framework that will provide new scientific insights and make useful groundwater predictions at an unprecedented fine spatiotemporal resolution. The IGM framework integrates hydrological, geological, and satellite datasets with machine learning tools and high-resolution simulation models. The information generated will be made available to a wide group of stakeholders through a web-based platform to help develop engineering and policy solutions. The research tasks and workforce development efforts will be jointly accomplished by a team of interdisciplinary researchers at five universities: The University of Alabama, Louisiana State University, University of Mississippi, Tuskegee University, and Southern University.

University of Alabama researchers on the ground-water project include, from left, Dr. Mukesh Kumar, Dr. Prabhakar Clement and Dr. Leigh Terry.

NSF RII Track-2 FEC: Precise Regional Forecasting via Intelligent and Rapid Harnessing of National Scale of Hydrometeorlogical Big Data

Sub: Dr. Sytske Kimball, USA
Lead: Dr. Nian-Feng Tseng, University of Louisiana at Lafayette

Global warming has emerged as a stark problem of national importance, as it results in more frequent extreme weather and climate events that cause rising economic loss and adverse societal impacts on numerous sectors, such as agriculture, transportation, water resource management, urban planning, among others. For better observations and numerical models on weather and climate parameters to improve forecasting accuracy, this project addresses precise regional forecasting via intelligent and rapid harness on national scale hydrometeorological Big Data. It aims to improve meteorological and hydrologic forecasts at target regions of interest by integrating massive atmospheric data sets with gathered surface data for finer temporal and spatial predictions, containing both fundamental research and

Dr. Sytske Kimball

experimental activities. Its solution approach is innovative by leveraging the actual gathered data as feedback to make prediction models generate better products with multiple near-term time horizons. Better regional prediction results from harnessing Big Data intelligently and rapidly via utilizing (1) a collection of proposed simple neural network models (called modelets) and (2) multiple accelerating methodologies developed or under development by the research team members. The modelet-based solutions for improving weather prediction spatially and temporally are applicable to all regions in the nation, with easy portability. They are being undertaken synergistically by jurisdictional collaboration across five universities in Louisiana, Alabama, and Kentucky, plus U.S. Geological Survey, enabling broad engagement at the frontiers of discovery and innovation in science and engineering related to accelerating data analytics, meteorology, and hydrology. Besides promoting the progress of science, this multidisciplinary project advances the national prosperity and welfare by curbing potential disruption due to global warming. The project also includes comprehensive efforts for (1) building future leadership through collaboration and supervision of junior investigators for their career advances, (2) enriching educational materials on the focused disciplines and strengthening student research to boost workforce development, and (3) aggressively recruiting and engaging underrepresented participants to support diversity.

NSF RII Track–2 FEC: The IceCube EPSCoR Initiative (IEI) – IceCube and the Date Revolution

Sub: Drs. Juan Marcos Santander and Dawn Williams, University of Alabama
Lead: Dr. Xinhua Bai Xinhua, South Dakota School of Mines and Technology

This Research Infrastructure Improvement Track-2 Focused EPSCoR Collaborations (RII Track-2 FEC) award brings together scientists from Alabama, Alaska, Delaware, Kansas, Nebraska and South Dakota to explore how Data Revolution can provide new insight into the Universe and its extreme phenomena: Where and how is the Universe producing microscopic particles that carry macroscopic

energies? Traditional astronomy has progressed from telescopes for visible light to include the full electromagnetic spectrum from radio to gamma-rays. Cosmic rays were discovered over a century ago, but the sources of these high energy particles from outer space remain mysterious. Recent discoveries by LIGO, Virgo, and IceCube have opened new windows on the Universe through gravitational waves and high energy neutrinos from deep space. Observations of these cosmic messengers have brought us into the era of Multi Messenger Astronomy (MMA). As one can imagine, multi-messenger observations with a network of a variety of detectors produce huge amounts of data with enormous complexity. Managing and analyzing the data pose a tremendous challenge to the science community, particularly those groups spread in EPSCoR states. This project will grow Big Data capability across six EPSCoR jurisdictions to address the challenge. Scientists with complementary skill sets will cooperate to make advances in MMA, beyond what could be done within a single jurisdiction. The project supports five early career faculty and trains postdoctoral scholars and college students. It also exposes secondary school students from underrepresented groups to IceCube and its Big Data challenges, which will help recruit young people into STEM fields and promote diversity and inclusion. The project?s vision is to establish a strong EPSCoR team that promotes new scientific ideas and innovates Big Data techniques to make discoveries in the era of MMA while preparing a high-tech workforce beneficial to all six participating EPSCoR states.

Top: Dr. Santander
Below: Dr. Williams

NSF RII Track–2 FEC: Aquatic Intermittency Effects on Microbiomes in Streams (AIMS)

Sub: Drs. Carla Atkinson, Jon Benstead, and Charles (Nate) Jones, University of Alabama

Lead: Dr. Amy Burgin, University of Kansas Center for Research

Understanding of links among microbial communities (microbiomes), stream health, and water quality relies on studies of perennially flowing streams. However, more than half of global stream-miles do not flow continuously. These intermittent streams occur across the entire country--from western deserts to eastern forests. Despite their ubiquity, research on intermittently flowing streams is impeded by a lack of: 1) physical infrastructure designed to measure intermittency, and 2) scientific training that straddles aquatic and terrestrial ecology. The Aquatic Intermittency effects on Microbiomes in Streams (AIMS) project will address the first obstacle by creating a network of instrumented sites designed to generate "Big Data" to quantify flow intermittency, stream microbiomes, and water quality. AIMS will confront the second obstacle by using its network to provide training in collaborative science and interdisciplinary methods to study intermittent streams, and by providing workforce training in environmental "Big Data" tools through a new On Ramps to Data Science program, which will focus on data generated by microbiome sequencing, environmental sensors, and Geographic Information Systems (GIS). This infrastructure and training will support a team of 18 investigators, including nine early career scientists spanning five EPSCoR jurisdictions (AL, ID, KS, MS, OK). To build capacity in team science, 11 graduate students and two postdoctoral associates will be recruited using a cohort model that will provide cross-jurisdictional training in scientific communication, inclusive mentoring, data management and collaboration. Students will be trained through AIMS Undergraduate Program (AIMS UP), which will recruit participants from regional partners, such as Haskell Indian Nations University, Alabama A&M, and the Shoshone-Bannock Summer Youth Program. Our overarching objective is to create research infrastructure and training capable of integrating big data sources needed to address water quality at the critical nexus between intermittent and perennial streams.

Top to Bottom: Drs. Atkinson, Benstead, and Jones

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.
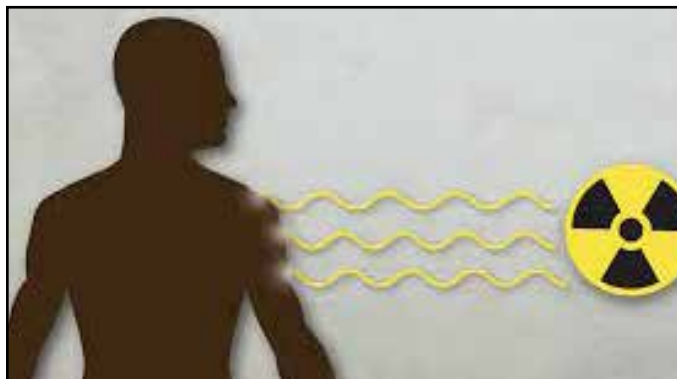
In FY 2020, Alabama EPSCoR was awarded five new NSF RII Track 4 Awards. Awardees include Dr. Majid Beidaghi at Auburn University; Dr. Xu Wang from Auburn University; Dr. Steven Weinman from The University of Alabama; Dr. Biswait Ray from the University of Alabama in Huntsville and Dr. William Jackson from the University of South Alabama. In FY 2021, Alabama EPSCoR was awarded three new NSF Track 4 awards. Awardees include: Dr. Wenli Bi at the University of Alabama at Birmingham and Drs. Siyuan Dai and Jakita Thomas at Auburn University.

NSF RII Track-4 Real-Time Radiation Dosimetry Using Flash Memory
Dr. Biswajit Ray, UAH

Throughout the world, radiation exposure has been on the rise due to the increased use of nuclear power, medical procedures, nuclear weapons and natural disasters affecting power plants such as in Fukushima, Japan. Increased exposure to radiation has both short- and long-term detrimental effects on the human body and rapid diagnosis (triage) of an absorbed dose of radiation is critical for survivability. Thus, it is critical to have a fast, cost-effective and field-deployable personal dosimetry solution without the overhead of additional hardware or processing equipment. The project will develop a handheld, real-time radiation dosimetry solution using commercially available flash memory chips. Since memory chips are widely used in many embedded systems (e.g., smartphones) and wearable devices (e.g., fitness belts), this project's concept could provide a paradigm shift in radiation dosimetry through distributed smart devices, which will be very useful for health monitoring, remote sensing, military applications, nuclear-reactor safety and space applications. In addition, the project has a strong educational component that includes the training of underrepresented students, the involvement of undergraduate students in research and the incorporation of the project's research findings into coursework.

For more information log onto Dr. Ray's website at:] https://sites.google.com/a/uah.edu/ray_biswajit/

NATIONAL SCIENCE FOUNDATION EPSCoR

	New NSF EPSCoR RII Track 4 Awards - FY2020 and FY 2021						
Award Number	Title	Type of Grant	Principal Investigator	Inst.	Start Date	End Date	Amount of Award to date
FY 2020 Awards							
1929195	RII Track-4: Electrochemical Modulation of Permeability and Selectivity of Conductive MXene Membranes	NSF EPSCoR RII Track 4	Majid Beidaghi	AU	12/01/2019	11/30/2022	183,801
1928770	RII Track-4: Transcriptome Profile and X Chromosome Dosage Compensation in the Zonary Placenta	NSF EPSCoR RII Track 4	Xu Wang	AU	12/01/2019	11/30/2021	245,298
1928812	RII Track-4: Use of Positron Annihilation Lifetime Spectroscopy to Engineer Membrane Selective Layers	NSF EPSCoR RII Track 4	Steven Weinman	UA	12/01/2019	11/30/2022	233,463
1929099	RII Track-4: Real-Time Radiation Dosimetry Using Flash Memory	NSF EPSCoR RII Track 4	Biswajit Ray	UAH	12/15/2019	11/30/2021	233,345
1929117	RII Track-4: Using Zircon (U-Th)/He Thermochronology to Explore a Link Between Mesozoic Tectonism and Nonmarine Sedimentation in the Eastern Tibetan Plateau	NSF EPSCoR RII Track 4	William Jackson	USA	12/15/2019	11/30/2021	146,483
							$1,042,390
FY 2021 Awards							
2033131	RII Track-4: Pressure Tuning of Magnetic Topological Insulators using Synchrotron X-ray Techniques	NSF EPSCoR RII Track 4	Wenli Bi	UAB	01/01/2021	12/31/2022	212,530
2033454	RII Track-4: van der Waals polaritonics for mid-infrared light emitters	NSF EPSCoR RII Track 4	Siyuan Dai	AU	02/01/2021	01/31/2023	228,110
2033452	RII-Track 4 - Experiencing The Matrix of Power Dynamics For Undergraduate And Graduate Black Women In Computing to Understand their Intersectional Experiences	NSF EPSCoR RII Track 4	Jakita Thomas	AU	6/1/2021	5/30/2023	160,235
							$600,875

NSF RII Track–4 Using Zircon (U–th)/ He Thermochronology to Explore a Link Between Mesozoic Tectonism and Nonmarine Sedimentation in the Eastern Tibetian Plateau

Dr. William Jackson, USA

Dr William Jackson

The Tibetan Plateau, the largest and highest plateau on Earth, is a product of the India-Asia continent-continent collision. Because collision is ongoing, geologic processes can be observed and measured, making the Tibetan Plateau an ideal natural laboratory for tectonic investigations. While modern observations and measurements provide details pertaining to active tectonics of the plateau, studies show that ancient, inherited crustal features are a primary control for how the plateau is currently developing. In the eastern Tibetan Plateau, sedimentary and igneous rocks are exposed at the surface that provide a record of these ancient, pre-India-Asia tectonic events; however, these rocks remain largely unstudied. Therefore, the goal of this proposal is to investigate the age and geologic relationships of sedimentary and igneous rocks in the eastern Tibetan Plateau. This study will utilize field and laboratory methods to determine the timing and rates of pre-India-Asia geologic processes. By integrating field data with modern age dating techniques, the ability to quantify when and how these rocks were exhumed to the Earth?s surface will be possible. Advancing our knowledge in this region will allow us to better understand the Tibetan Plateau, as well as older mountain belts and large plateaus on Earth.

Modern observations and measurements of Tibetan Plateau provide insights into active tectonic processes during plateau development. However, to fully incorporate these data a better understanding of inherited, Mesozoic tectonic fabrics must be established. In the eastern Tibetan Plateau, the northern Yidun terrane contains Mesozoic sedimentary and igneous rocks that record contractional deformation and exhumation; thereby, providing an opportunity to understand the spatial and temporal development of deformation in the Tibetan Plateau prior to the Cenozoic India-Asia collision. The goal of this proposal is to investigate a link between the exhumation of the Late Triassic Ganzi Pluton and development of two nonmarine sedimentary basins that are in stratigraphic and structural contact with the pluton. To approach this goal, the Principal Investigator (PI) proposes to use bedrock and detrital zircon (U-Th)/He thermochronology, working in collaboration with the Basin Analysis and Helium Thermochronology Laboratory (BAHTL) at the University of Connecticut, directed by Dr. Julie C. Fosdick. The proposed work is designed to address two main objectives, train the PI in zircon (U-Th)/He techniques and interpretations, and collect thermochronology data to explore a link between Mesozoic tectonism and nonmarine sedimentation. Results from this project will advance our understanding of Mesozoic tectonics in the eastern Tibetan Plateau, providing initial crustal input parameters for mechanical models. Advancing our knowledge of geologic processes that develop high-elevation (> 4 km) mountains and plateaus will help us better integrate large data sets that seek to understand global-scale natural processes.
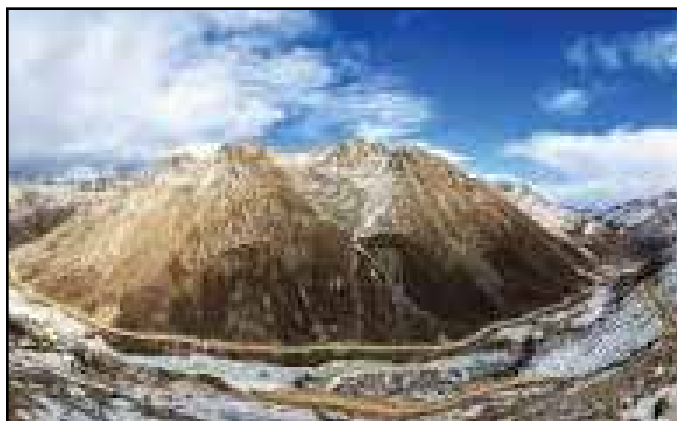
NSF RII Track–4 Use of Positron Annihilation Lifetime Spectroscopy to Engineer Membrace Selective Layers

Dr. Steven Weinman, UA

This project seeks to build on the water research at The University of Alabama at Tuscaloosa (UA). With a wealth of natural water sources and access to the Gulf of Mexico, Alabama is an ideal location for research in water treatment processes. As such, UA has made water one of its four research pillars to provide better water quality for all people. Polyamide membranes, often called reverse osmosis or RO membranes, are commonly used for seawater desalination. However, their molecular level properties are not well understood. This project will allow researchers from UA to conduct studies at the National Institute of Standards and Technology (NIST) to learn a new technique to characterize the molecular-level properties of water treatment polymer membranes. This research seeks to understand how synthesis conditions affect membrane performance at the molecular level, specifically those involved in seawater desalination. The polymer characterization technique will be of great benefit to make these membranes more energy-efficient and cost-effective. This work will initially provide training for one graduate student, and results will be integrated into undergraduate curriculum and research. The research collaboration formed through this project will help develop capacity at UA to characterize polymers using cutting-edge technology, providing additional opportunities to educate and train graduate and undergraduate students.

Dr. Weinman's research group logo. Representing water membranes, the "W" has contaminated water on the left side and clean water on the right side, the middle part of the letter W acts as a membrane (specialized filter) to clean the water.

NSF RII Track–4 Electrochemical Modulation of Perameability and Selectivity of Conductive MXene Membranes

Dr. Mejid Beidaghi, Auburn University

The development of efficient membrane-based water desalination and purification technologies is essential for addressing the global challenges of water scarcity and pollution. An ideal separation membrane should show high permeance (transport of desired species) and high selectivity (rejection of undesired species), two properties that are often inversely correlated. In processes such as water desalination and removal of heavy metals from water, charged ions are separated from water by size exclusion or electrostatic interactions with a membrane. Two-dimensional (2D) materials are crystalline materials consisting of one or few layers of atoms and have attracted much interest in recent years for the fabrication of efficient membranes. Nanoporous or lamellar membranes based on 2D materials can potentially separate ionic species from water at higher rates and more efficiently compared to current membranes. The main goal of this project is to understand the effects of applied electrochemical potential on the separation performance of conductive membranes based on 2D transition metal carbides (MXenes). To achieve this goal, the PI will partner with researchers at Northeastern University to fabricate nanoporous and lamellar MXene membranes and study their separation properties. In addition, this project will provide opportunities to train graduate students in advanced membrane materials synthesis and characterization methods and will establish a long-term collaboration between Auburn University and Northeastern University. The PI will also integrate the result of this research into a recently developed course focused on applications of 2D materials.

RII Track–4 Transcriptome Profile and X Chromosome Dosage Compensation in the Zonary Placenta
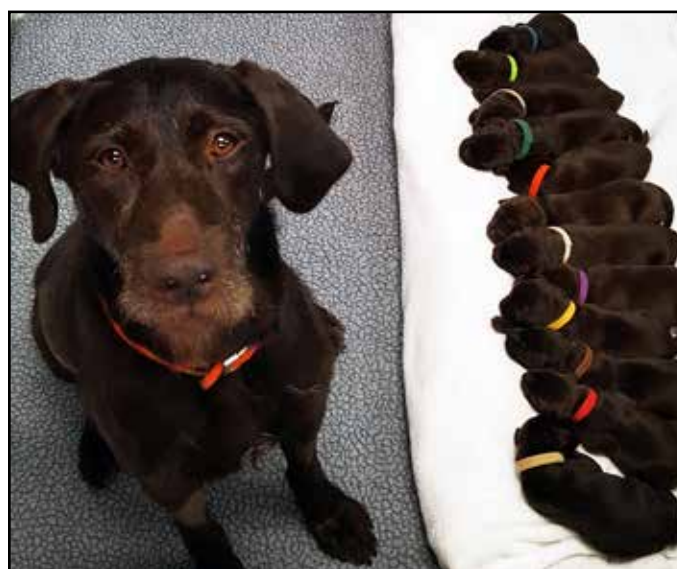
Dr. Xu Wang, Auburn University
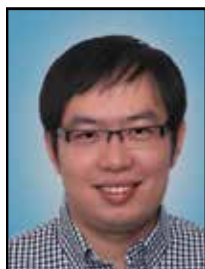
Prenatal development of mammalian fetuses relies on an important organ known as the placenta. Despite its critical function in gas exchange, nutrient transport and immunity at the maternal-fetal interface, the placenta is the most morphologically diverse organ in mammals, with at least five different forms. One of these forms include the zonary placenta, which has a unique belt-like structure that wraps around the fetus. The zonary placenta consists of multiple tissues in three major zones: the transfer zone, the pigmented zone and the allantochorion. The function of each of these zones remains poorly understood. Female dogs have two X chromosomes and males only have one, resulting an unequal dose of X-linked genes. Dosage compensation is achieved by inactivating one X chromosome in females through a process called X chromosome inactivation. Different strategies, including random and imprinted X chromosome inactivation, are observed in mammalian placentae. The mechanism of X chromosome inactivation in canine placenta is unknown. To fill in these gaps, we propose to characterize gene expression profiles and regulation of X chromosome inactivation in different canine placental tissues. This proposed research will lead to comprehensive understanding of regulated gene expression and a comparative analysis of dosage compensation across different types of animals.

The goal of this research is to understand the gene expression and epigenetic control of X chromosome dosage compensation in the zonary placenta. The mammalian placenta is a key evolutionary innovation that dramatically improves the reproductive success through in utero development of the embryos. Despite its critical function, placenta is the most morphologically diverse organ with five major placentation forms. Zonary placenta is observed in carnivores including companion animals such as cats and dogs. The band shaped placenta encircles the fetus with three distinct zones: the transfer zone, the pigmented zone and the allantochorion. Their functions and transcriptome profiles are still poorly understood. In therian mammals, females and males have unequal dose of X-linked genes, and this is solved by a mechanism called dosage compensation (DC). In somatic tissues of eutherian mammals, DC is achieved by random X chromosome inactivation (XCI) in females, in which one of the two X chromosomes is inactivated and the choice is random. In the extraembryonic tissues that give rise to placenta, imprinted XCI was observed in rodents, in which it is always the paternal X that is inactivated. The XCI status remains to be characterized in zonary placenta. This project will achieve the following objectives: 1) Characterize the full-length transcriptomes and functional enrichment of gene networks in the transfer zone, pigmented zone and allantochorion of the canine placenta, 2) Investigate the form, status, escaping profile and epigenetic regulation of XCI in the zonary placenta. This proposed research will lead to comprehensive understanding of the profile and epigenetic regulation of XCI in zonary placenta through single-cell RNA sequencing, which opens the door to comparative phylogenomic analysis of dosage compensation.
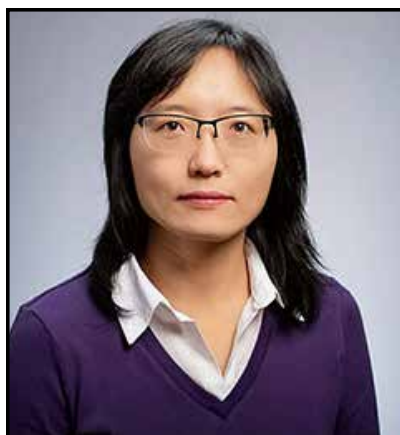

An adult Vapor Wake detection dog and her puppies at Auburn University's College of Veterinary Medicine Canine Performance Science Program. Vapor Wake dogs are trained to detect explosives and other illicit substances on moving targets in crowded areas.

RII Track 4– Tuning of Magnetic Topological Insulators using Synchrotron X–ray

Dr. Wenli Bi, UAB

Quantum technology, such as quantum computing and spintronics, transitions quantum mechanical properties into practical applications. The key to accelerate this technology is to understand the fundamental physical properties governed by quantum mechanics in novel materials. This EPSCoR project aims to develop a new experimental approach to advance the fundamental understanding of quantum magnetic materials. Specifically, modern synchrotron X-ray techniques combined with external pressure, a controllable degree of freedom, will be used to reveal the complex and exotic quantum phenomena in newly discovered materials incorporating intrinsic magnetism with non-trivial electronic structure. The microscopic insights gained in this project will guide the material design for desired functional properties. This support will strengthen the collaborative efforts between University of Alabama at Birmingham (UAB) and Advanced Photon Source (APS) at Argonne National Laboratory (ANL). It allows the PI's group to gain full exposure to the state-of-the-art synchrotron facilities at APS and develop new techniques that will expand the research capability at UAB.

The goals of the proposed research are to unravel the intriguing interplay of magnetic properties with the Dirac fermions and reveal rich quantum phases by applying external pressure. The proposed research will develop a novel experimental approach to study the interplay of magnetic order and nontrivial topology and provide feedback to synthetic design of novel quantum materials. Using pressure as a tuning knob, interplay of crystal structure and magnetism will be established. The proposal adopts a combined experimental approach using the state-of-the-art synchrotron spectroscopy, X-ray diffraction, transport, and diamond anvil cell technology. Magnetic, transport, and structural properties of two model magnetic topological insulators, $EuSn_2Pn_2$ and $EuMnBi_2$ will be investigated systematically. This EPSCoR project will enable PI's research group to perform collaborative research at the Advanced Photon Source (APS), Argonne National Laboratory (ANL). These activities will offer invaluable learning experience on the frontier synchrotron techniques through extensive interactions with the well-established experts at ANL, thus promoting the career development of next-generation scientists.

RII Track−4 van der Waals polaritronics for mid−infrared light emitters

Dr. Siyuan Dai, Auburn University

The mid-infrared (mid-IR) is part of optical spectrum that is invisible to the naked eye but important for a wealth of technologies, including biochemical sensing, gas monitoring, thermal illumination and energy control, security and defense, and many others. Despite these vital applications, research and development in the mid-IR have been stymied due to the sparsity of efficient light sources in this wavelength range. This fellowship project aims to develop bright mid-IR light sources by coupling nanometer scale material dots (quantum dots) with propagating nanoscale optical waves (polaritons). By controlling the properties of the polaritons in layer materials, the research team plans to enhance the intensity of light emitted from quantum dots. The PI will collaborate with researchers at the University of Texas at Austin (UT Austin) to synthesis quantum dots-polariton structures and to perform the mid-IR optical characterizations. This fellowship project is expected to develop useful mid-IR light sources that will benefit a broad range of applications listed above. The project will also broaden the research capabilities of the PI and Auburn University in IR optoelectronics and quantum-engineered material synthesis, as well as establish long-term collaborations between Auburn University and other institutions including UT Austin.

The primary goal of the project is to develop bright and controllable light emitters for the technically important mid-IR spectra range where light wavelength spans from 3 to 20 μm. For this purpose, the PI proposes to incorporate current quantum dots mid-IR emitters with polaritonic van der Waals (vdW) materials. Polaritons in vdW materials are highly confined and relatively low-lossy, therefore possess high photonic density of states to enhance the mid-IR light emission by increasing the radiative recombination rate of electrons in quantum dots. The PI and his collaborators will grow mid-IR semiconductor quantum dots using the state-of-the-art molecular beam epitaxy at UT Austin. The research team will then fabricate vdW polaritonic materials on top of the quantum dots and fine tune the top surface structure to optimize light emission into the free space. Graphene and configurable vdW heterostructures will be involved to implement dynamic tunability for the light emitters. The quantum dot-polariton emitters will finally be characterized by mid-IR photoluminescence spectroscopy to test the light emission performance. The successful demonstration of this project will deliver bright and dynamically tunable mid-IR light sources and complement current knowledge in light-matter interactions with a better understanding of quantum dot – polariton interactions.

RII Track–4 Experiencing The Matrix of Power Dynamics for Undergraduate and Graduate Black Women in Computing to Understand their Intersectional Experiences

Dr. Jakita Thomas, Auburn University

Understanding the experiences of Black women in computing, who experience racism and sexism at the same time, provides insights that can help support Black women more effectively. This research will study Black women's unique perspectives in Computer Science (CS) education and computing, including the trials and triumphs experienced as Black women navigate various computing spaces (academic, professional, personal, etc.). Additionally, this research will explore just and equitable approaches to communicating those experiences to CS educators and those outside of the community of Black women. This fellowship will take place at the Constellations Center for Equity in Computing at Georgia Tech, working with an internationally recognized researcher in equity in CS education. The fellowship will provide training to the PI and a graduate student in approaches to designing, enacting, and assessing more equitable computing spaces that can better support Black women. By coupling those approaches with the PI's approach to describing the unique perspective into computing that Black women provide through their lived experiences, the proposed research will develop theory and practice that can be used to create spaces that broaden and deepen the engagement of Black women in the field, bringing the nation closer to CS For All.

This fellowship will provide training for the PI and a graduate student to understand the matrix of power dynamics that Black women encounter in computing as well as the forms of agency they acquire and develop to persist. The work will focus on examining the experiences of Black women in different computing contexts at various stages to articulate a Black women's standpoint as they contend with racism and sexism, simultaneously, in computing. This research will identify design principles that can be applied to create more equitable spaces that are more inclusive, welcoming, and supportive for Black women. Finally, this research will explore the affordances of approaches to communicate those experiences in ways that authentically portray and honor the complexities and range of experiences while also developing empathy for and action around promoting equity and sustained engagement in computing. The development of methodologies for articulating the matrix of power dynamics in computing will be transformative for the PI's research program. The fellowship will generate new theories that can help the field better understand the experiences of other marginalized groups, new principles for designing equitable spaces for these groups, and non–traditional approaches for communicating those experiences to others inside and outside of the field. The proposed project will establish a collaboration between leaders in the fields of intersectional computing and equity in computing education, as well as provide actionable insights that will support the commitment to create and enact more equitable computing spaces taken up by the PI's department at the PI's home institution.

Attendees at the 2018 #BlackComputeHER.org conference, a non-profit co-founded by Dr. Jakita Thomas

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.
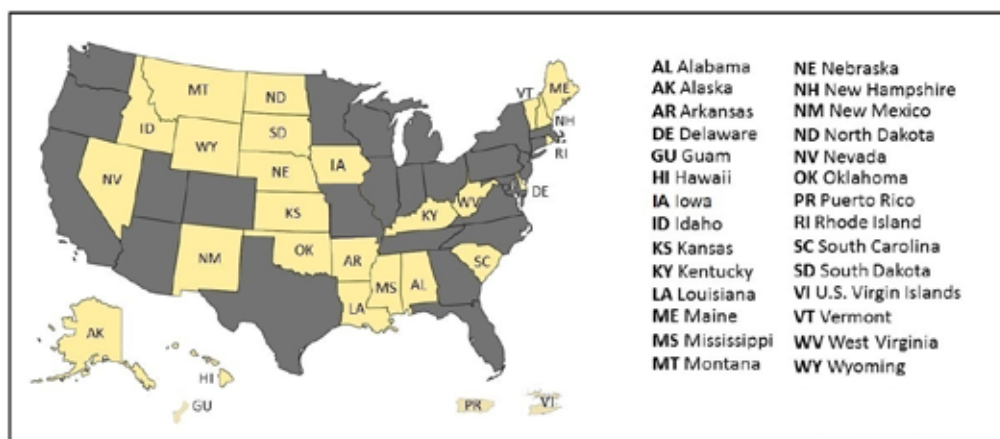
For such proposals, the managing Program Officer first decides whether to make an award recommendation and the amount and duration to be recommended for the award. The decision to recommend an award or declination rests with the managing program. Once these decisions are made, a request for partial support 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 FY 2020, Alabama was awarded 19 new NSF Co-funded awards, which include four CAREER awards (1 at UAH, 2 at

NSF EPSCoR FY 2021 Eligibility

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

EPSCoR states and other U.S. jurisdictions eligible for EPSCoR during FY 2021

This includes twenty-five states, Guam, Puerto Rico, and the U.S. Virgin Islands.

NATIONAL SCIENCE FOUNDATION CO-FUNDED EPSCoR

UA and 1 at AU); one RAPID (Rapid Response Research) award to study the COVID-19 pandemic, one MRI award, and three REU sites. culty Early In 2021, Alabama was awarded 24 new NSF Co-funded awards which include six CAREER awards (3 at UAH, and one each at Auburn, UA, and UAB). In addition, FY2021 NSF Co-funded awards include one REU site at Auburn University and an EAGER or Early-Concept Grants for Exploratory Research at UAH.

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. 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. REU (Research Experiences for Undergraduates) supports active participation by undergraduates in research projects. RAPID (Rapid Response Research) awards respond to a severe urgency with regard to availability of, or access to, facilities or specialized equipment, including quick response research on natural or anthropogenic disasters and similiar unanticipated events.

NSF CAREER: Geometric and Electronic Contributions to Bio-Inspired Reactivities of Heme-superoxide Intermediates

Dr. Gayan Wijeratne, University of Alabama at Birmingham

With support from the Chemistry of Life Processes Program in the Division of Chemistry and the Established Program to Stimulate Competitive Research (EPSCoR) Dr. Gayan B. Wijeratne at the University of Alabama at Birmingham will investigate the chemistry of small molecules with heme iron centers such as the ones that activate oxygen in human biology. These model systems can be extremely versatile, yet straightforward probes for comprehending the complicated mechanistic details that govern oxygen mediated reactivities in biology. Dr. Wijeratne and his team will utilize these powerful tools in shedding light on yet unknown knowledge that can lead to pathways for efficient syntheses of complex molecules, and the discovery of catalysts that can enhance the efficiency of catalysts of oxygen reduction benefiting alternative energy applications. This work will involve bio-inspired design and synthesis of fresh model systems that combine organic and inorganic synthetic toolkits, and analyses of reactivities that draw parallels to biological functionalities. As well, a broad variety of cryogenic spectroscopic tools will be employed, offering a uniquely specialized skillset to contributing high-school, undergraduate, graduate, and postdoctoral researchers. Outreach and educational aspects of this project will involve the orientation of Birmingham City high school students toward Regional Science Fair via a newly designed Science Club program. Proposed efforts will strive to bridge the gap of scientific literacy of youngsters in the City of Birmingham, which is one of the most income-segregated school districts in the country.

FY 2020 NSF Co-funded Awards

Award Number	Title	Principal Investigator	INST	Start Date	End Date	Awarded Amount To Date
1932547	CPS: Small: Collaborative Research: RF Sensing for Sign Language Driven Smart Environments	Sevgi Gurbuz	UA	10/01/2019	09/30/2022	$366,252
1942956	CAREER: Investigating the mechanistic basis of host adaptation in close and distant relatives within Xanthomonas species complex	Neha Potnis	AU	02/15/2020	01/31/2025	$849,698
1950563	REU Site: Research Experience for Undergraduates in Algebra and Discrete Mathematics at Auburn University	Overtoun Jenda	AU	04/01/2020	03/31/2023	$259,200
1950304	REU Site: Collaborative Approaches among Scientists and Engineers	Kimberly Mulligan	AU	04/15/2020	03/31/2023	$404,476
1950855	REU Site: Interdisciplinary Convergence to Advance the Biotechnological and Bioscience Workforce	Ryan Summers	UA	05/15/2020	04/30/2023	$428,647
2030080	RAPID: Exosomal tRNA fragments may constitute an innate viral defense against SARS-CoV-2 and other respiratory RNA viruses.	Glen Borchert	USA	05/15/2020	04/30/2022	$231,020
1950488	Concurrent Multiscale Moving-Window Scheme for Shock Wave Interaction with Material Microstructure	Vinamra Agrawal	AU	06/01/2020	05/31/2023	$408,164
1944374	CAREER: Photovoltaic Devices with Earth-Abundant Low Dimensional Chalcogenides	Feng Yan	UA	07/01/2020	06/30/2025	$516,000
2042683	CAREER:Hybrid Data-driven Synthesis by Design of Atomically Thin Quantum Materials	Kasra Momeni	UA	07/27/2020	02/28/2025	$509,509
2005194	Twist and route canalized polariton nano-light in MoO3 microstructures	Siyuan Dai	AU	08/01/2020	07/31/2023	$217,928
2042786	Cluster Algebras, Quiver Representations, and Rigid Curves	Kyungyong Lee	UA	08/01/2020	10/31/2022	$72,139
2012081	Catalyst Award: TU CURES	Deloris Alexander	TU	08/15/2020	07/31/2022	$199,990
2012554	When Can We Cluster Data? Improved Conditions for Perfect Recovery and Numerical Methods	Brendan Ames	UA	08/15/2020	07/31/2022	$129,374
1943465	CAREER: Understanding the Combined Effect of Microstructure and Topology on the Mechanical Behavior of Additively Manufactured Lattice Structures	Kavan Hazeli	UAH	08/15/2020	07/31/2025	$540,001
2051356	CRII: CIF: Fundamental Research on Energy Efficiency and Security of RF Energy Harvesting Wireless Networks	Lina Pu	UA	08/17/2020	06/30/2022	$114,922
2019120	MRI: Acquisition of a 3.0 Tesla Magnetic Resonance Imaging Scanner	Rajesh Kana	UA	09/01/2020	08/31/2022	$1,605,115
2007013	Collaborative Research: The Circumgalactic Dictionary: An Interpretation Guide For Circumgalactic Medium Observations	Jeremy Bailin	UA	09/01/2020	08/31/2023	$385,219
1951488	IRES Track I:Collaborative Research:Application-Specific Asynchronous Deep Learning IC Design for Ultra-Low Power	Na Gong	USA	09/01/2020	08/31/2023	$99,996
1951552	IRES Site: Fractional-Order Circuits and Systems Research Collaboration with EU COST Action	Todd Freeborn	UA	09/01/2020	08/31/2023	$299,861
						$7,637,511

NATIONAL SCIENCE FOUNDATION CO-FUNDED EPSCoR

	FY2021 NSF Co-funded Awards					
Award Number	Title	Principal Investigator	INST	Start Date	End Date	Award
1951974	SCC-PG: Planning Live, Sustainable Community Asset Mapping for a Dementia e-Friendly Alabama	Nicole Ruggiano	UA	10/01/2020	09/30/2022	$150,000
2008973	III: Small: Spatial Deep Learning from Imperfect Volunteered Geographic Information	Zhe Jiang	UA	10/01/2020	09/30/2023	$500,000
2017553	The effects of markers of shared identity on inflammation and stress	Christopher Lynn	UA	05/01/2021	04/30/2024	$204,055
2044633	CAREER: Fast, Energy Efficient Irregular Kernels via Neural Accerlation	Joshua Booth	UAH	04/01/2021	03/31/2026	$283,488
2044733	PFI-TT: Scalable Thermal Spray Deposition of Surface-Engineered Washcoat Catalysts for Vehicle Emission Control Systems	Ruigang Wang	UA	02/15/2021	01/31/2023	$250,000
2045005	CAREER: Geometric and Electronic Contributions to Bio-inspired Reactivities of Heme-superoxide Intermediates	Gayan Wijeratne	UAB	05/01/2021	04/30/2026	$426,000
2047251	CAREER: A roadmap to atomically ordered complex materials via control of entropic mixing	Adam Hauser	UA	06/01/2021	05/31/2026	$309,087
2047484	CAREER: Taming Wireless Devices Cross-Layer Errors with Assistive Networked Edges	Jianqing Liu	UAH	03/15/2021	02/28/2026	$412,276
2047762	CAREER: Unlocking the potential of natural polymers for efficient removal of emerging contaminants from drinking water.	Maria Peresin	AU	04/01/2021	03/31/2026	$358,850
2047939	CAREER: Diversity in the darkness: Integrating environmental genetics, comparative genomics, and citizen science to shed light on groundwater biodiversity	Matthew Niemiller	UAH	09/01/2021	08/31/2026	$604,000
2048884	Partnership to Provide Technology and Cyber-security Experiences to Alabama Black Belt through Mobile Application Development	Jay Bhuyan	TU	05/15/2021	04/30/2025	$999,995
2050742	REU Site: Research experience through collaborative teams in bioprocessing for conversion of waste into products of value	Brendan Higgins	AU	09/01/2021	08/31/2024	$391,099
2051747	Upgrade of an Isotope Ratio/Mass Spectrometer for Compound-Specific Isotope Analysis in Organic Biogeochemical Research	Ann Ojeda	AU	07/01/2021	06/30/2023	$110,081
2100980	Excellence in Research: PAH1-mediated regulation of lipid synthesis in the model oleaginous yeast Yarrowia lipolytica	Stylianos Fakas	AAMU	09/01/2021	08/31/2024	$534,963
2105165	Collaborative Research: Revealing Strengthening and Toughening Mechanisms in Coconut Endocarp through Integrated Multiscale Modeling and Characterization	Ning Zhang	UA	08/15/2021	07/31/2024	$130,000
2105525	The Topology of Contact Type Hypersurfaces and Related Topics	Bulent Tosun	UA	07/01/2021	06/30/2024	$156,405
2107325	IRES Track 1: Innovative Macromolecular & Polymer Research Experience in San Sebastian (IMPRESS)	Jason Bara	UA	07/01/2021	06/30/2024	$300,000
2107631	Catalyst Project: Investigating Adaptive Hybrid Learning in College Algebra to Improve STEM Engagement and Persistence for HBCU Students	Lisa Gary	Stillman College	08/15/2021	07/31/2024	$175,000
2112610	EAGER: Acquisition of a Tomographic Particle Image Velocimetry System for Fluid-Structure Interaction Investigation of Active Blowing on Deformable Surfaces	Konstantinos Kanistras	UAH	02/15/2021	01/31/2022	$89,720
2119902	NSF INCLUDES Alliance: The Alliance of Students with Disabilities for Inclusion, Networking, and Transition Opportunities in STEM (TAPDINTO-STEM)	Overtoun Jenda	AU	08/01/2021	07/31/2026	$2,673,839
2121215	CCSS: Collaborative Research: Quality-Aware Distributed Computation for Wireless Federated Learning: Channel-Aware User Selection, Mini-Batch Size Adaptation, and Scheduling	Xiaowen Gong	AU	08/15/2021	07/31/2024	$220,000
2124877	COLLABORATIVE RESEARCH: Identifying the Dielectric Properties of Liquid-Metal Polymer Composites to Ensure the Dielectric Integrity of Deformable Electronic Applications	Amanda Koh	UA	09/01/2021	08/31/2024	$198,324
2129879	Probing novel phases of matter in van der Waals magnet Fe5-xGeTe2	Wencan Jin	AU	08/15/2021	07/31/2024	$194,640
2134689	FMSG: Cyber: Federated Deep Learning for Future Ubiquitous Distributed Additive Manufacturing	Jia Liu	AU	09/01/2021	08/31/2023	$498,762
						$10,170,584

NSF CAREER: Taming Wireless Devices Cross-Layer Errors with Assistative Networked Edges

Dr. Jianquing Liu, UAH
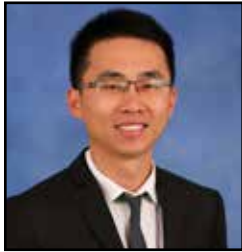
Wireless devices such as smart phones, computers and sensors are ubiquitous in our daily life and modern society, creating unprecedented benefits in work efficiency, healthcare, automation control and many more. Due to the imperfect electronics and noisy environments, wireless devices are inherently faulty which can result in multifaceted data errors in computing, caching, and communications (C3). These errors have been widely deemed harmful, so the state-of-the-art on error control mainly target for absolute error removal. Yet, data errors can be benign or even beneficial (e.g., introducing errors to gradients may help the machine learning models to escape local optima), while existing research that are reactive and non-functional fail to turn data errors into good. Hence, the research objective of this project is to proactively harvest, render, and control data errors across C3 of wireless devices for significant performance gains in energy efficiency, throughput, data privacy, etc. Moreover, the research efforts will be coupled with educational innovations through the development of new laboratories, lecture contents, outreach demos and a novel undergraduate/graduate co-learning pedagogy. The successful completion of this project will enhance diversity in the wireless workforce in the nation, promote community outreach and create fundamental innovations of wireless technologies that are transformative to future wireless applications (e.g., AI and smart health).

This project is jointly funded by the Division of Electrical, Communications and Cyber Systems, Directorate of Engineering, and the Established Program to Stimulate Competitive Research (EPSCoR).

NSF CAREER: Fast, Energy Efficient Irregular Kernels via Neural Accerlation

Dr. Joshua Booth, UAH

High-performance computing suffers from a performance bottleneck that wastes computation time, money, and energy, as processing cores on multicore systems sit idle waiting for memory accesses from irregular kernels. These irregular kernels normally accomplish little computational work despite the high cost of accessing memory. These costly bottlenecks must be remedied by a new approach to high-performance computing. But, at the same time, computing is evolving and is becoming less dependent on the low-level programming languages that cause these bottlenecks and more dependent on learning algorithms such as neural networks to attain the necessary efficiency. This project builds the foundation for accelerating irregular kernels by replacing them with neural networks that run on accelerators optimized for neural networks. These neural networks offer better performance and energy consumption. Additionally, these networks are tuned in high-level programming languages (e.g., Python) that are easier for novice users to learn. This allows more computer scientists to aid the scientific and high-performance computing communities. This project also builds a new curriculum such as adding neural accelerators and expanding neural network algorithm materials into traditional undergraduate courses. This project, in both its research and educational aspects, significantly reduces the development time and costs of high-performance computing while simultaneously reducing performance bottlenecks. Furthermore, this project will support graduate and undergraduate students as they engage in cross-disciplinary involvement to match accuracy and performance constraints from the scientific-modeling and big-data-analysis communities that currently depend on irregular kernels for areas such as climate modeling, large scale circuit design, and drug analysis on infectious diseases.

This project is jointly funded by CAREER Software and Hardware Foundations HPC program and the Established Program to Stimulate Competitive Research (EPSCoR).funded by the Cyber Physical Systems Program and the Established Program to Stimulate Competitive Research (EPSCoR).

NSF CAREER: Unlocking the potential of natural polymers for efficient removal of emerging contamininants from drinking water

Dr. Maria Peresin, Auburn University

In this project, Dr. Maria Soledad Peresin aims to unlock the potential of certain components of plant or animal biomass to design biomaterials by advancing the fundamental understanding of naturally occurring systems to address critical issues of societal concern, such as the removal of emerging contaminants from drinking water.

Polymers are natural or man-made chemicals that are composed of building blocks of smaller repeating molecules, as one would picture individual Legos® within a larger structure. Natural polymers, such as cellulose (from wood, soybean hulls, cotton, etc.), chitosan (from the outer shell of shellfish) and alginates (from algae) are sustainable and renewable resources that are an essential component of a circular economy, aimed at minimizing waste. Combining properties of different natural polymers is a way to develop a new generation of products that may replace traditional, non-renewable fossil fuel-based materials.

This project will focus on understanding, developing and using renewable, natural polymers to design efficient and sustainable adsorbents, which are highly porous structures for the removal of contaminants. Dr. Peresin proposes an extensive study of a variety of polymer systems to maximize their potential adsorption capacity for removing contaminants from water bodies in different environmental conditions. Adsorption capacity of the polymers' assemblies and their performance will be assessed using three model emerging aquatic contaminants, tetracycline (an antibiotic), ibuprofen (an analgesic) and sulfamethoxazole (an antibiotic).

Dr. Peresin will use this research program as a platform for education with an impactful contribution to improving science literacy in the State of Alabama while contributing to local, national and global efforts to provide a sustainable method for cleaning drinking water. Younger generations have an increased environmental concern and awareness of the need to decrease our impact on the planet. Through her research and mentorship, Dr. Peresin hopes to advance career opportunities within the forest industry for environmentally conscience students with the development of novel processes and new products that contribute to the sustainable use of resources and economic benefit of society. This project is jointly funded by the Biomaterials Program in the Division of Materials Research, and the Established Program to Stimulate Competitive Research (EPSCoR).

NSF CAREER: A roadmap to atomically ordered complex materials via control of entropic mixing

Dr. Adam Hauser, UA

The ability to atomically order crystalline materials is central to advancing technology. In the 1980s, 99% atomic ordering in two-element materials was developed, wherein two elements alternate nearly perfectly in their atomic site occupations. This enabled high-frequency transistors, which led to the cell phone revolution and high-efficiency solar panel technologies. Theoretical predictions tout revolutionary new material properties in complex (3+ elements) materials that will make possible new devices with broad application in information technology, solar cells, lighting, microwave communications, thermoelectrics, and power electronics. However, achieving the 99% atomic ordering required to realize those properties has remained elusive. The goal of this project is to systematically gain an

understanding of the fundamental ordering mechanisms in complex materials. This research integrates computational theory and experimental results to create a set of criteria that can be used to design materials of sufficiently high atomic ordering (99%) to realize their intrinsic properties. This research directly integrates educational activities to impact underrepresented minorities, women, and underserved rural communities in STEM fields, and ensure that undergraduate education includes research experience. This mentor-based strategy focuses on elevating science, technology, engineering and mathematics (STEM) educators in underrepresented communities in rural Alabama and Mississippi. K-12 educators gain access to university faculty and specialists at the Alabama Science in Motion program to plan classes and laboratory sessions, and through the Alabama Math, Science and Technology Summer Institute receive training to qualify their rural school district for program/equipment funding. Undergraduate summer researchers are recruited from local Historically Black Colleges and Universities, minority-serving institutions and the American Physical Society's Conferences for Undergraduate Women in Physics. Undergraduate students will also work as research assistants during each school year.

This project is jointly funded by the Electronic and Photonic Materials Program and the Established Program to Stimulate Competitive Research.

The effects of markers of shared identity on inflammation and stress
Dr. Christopher Lynn, UA

Identity transcends individuals, shaping social interactions and senses of shared belonging. Despite their importance as signifiers of social belonging, visible markers of identity have received limited attention in terms of their attendant impacts on health. This study will thus investigate how consonance with cultural values around specific markers of identity impacts health. The researchers will measure a series of biological markers of endocrine and immune function among individuals with and without visible markers of identity who report varying degrees of shared identity. The project will train students from backgrounds underrepresented in the sciences. Additional outputs will serve the public, including free online teaching modules, museum exhibits, a book and a documentary film identity markers and health.

The goals of this 3-year project are to investigate identity markers as important facets of shared belonging, testing the degree to which expressing belonging can influence health. The first phase of research involves developing a culturally valid questionnaire about the relative importance of social signifiers of identity to participants' senses of belonging. The second phase correlates results of the questionnaire to measures of health, including immunoglobulin A, interleukin-1, interleukin-6, C-reactive protein, alpha-amylase, and cortisol derived from saliva samples. The biocultural approach taken utilizes a mixture of proven methods for empirically measuring the internalization and impact of culture and advanced field techniques for assessing immune and endocrine response, providing a holistic sense of how signifiers of identity contribute to or depart from shared belonging and in turn impact health. The results will contribute to theories of embodiment and cultural consensus theory. This project is jointly funded by Cultural Anthropology and the Established Program to Stimulate Competitive Research (EPSCoR).

NSF INCLUDES Alliance: The Alliance of Students with Disabilities for Inclusion, Networking, and Transition Opportunities in STEM (TAPDINTO–STEM)
Dr. Overton Jenda, Auburn University

Persons with disabilities are one of the most significantly underrepresented groups in STEM education and employment, comprising a disproportionately smaller percentage of STEM degrees and jobs compared to their percentages in the U.S. population. The NSF INCLUDES Alliance of Students with Disabilities for Inclusion, Networking, and

Transition Opportunities in STEM, also known as the NSF INCLUDES TAPDINTO-STEM Alliance, will employ a collective impact approach with dozens of partnering organizations to increase the number of students with disabilities (SWDs) who complete associate, baccalaureate and graduate STEM degrees and enter the STEM workforce. Auburn University is leading this NSF INCLUDES Alliance's primary partnerships with five institutions of higher education (IHE) that will direct regional hubs of collaborating IHEs to address this national need. The hubs will be championed by Auburn University (Southeastern Hub), Northern Arizona University (Mountain Hub), The Ohio State University (Northeastern Hub), the University of Hawaii-Manoa (Islands Hub), the University of Missouri-Kansas City (Midwest Hub) and the University of Washington (West Coast Hub). The NSF INCLUDES Alliance partners include 27 IHEs with three professional organizations: The Association of University Centers on Disability, the Association on Higher Education And Disability and the Learning Disabilities Association of America. The partners will expand the NSF INCLUDES TAPDINTO-STEM Alliance to include over 50 IHEs to address the broadening participation vision of increasing the education of SWDs in STEM at the post-secondary academic levels and their transitions to STEM employment. The University of Missouri-Kansas City serves as the backbone organization, led by Alexis Petri, to support communication, engagement, networked systems, data collection and analyses, sustainability, scaling and dissemination. An internal evaluation will be led by Auburn University personnel, and a team of external evaluators will be led by Linda P. Thurston, who is a professor emerita at Kansas State University.

This NSF INCLUDES Alliance is primarily funded by NSF Inclusion across the Nation of Communities of Learners of Underrepresented Discoverers in Engineering and Science (NSF INCLUDES), a comprehensive national initiative to enhance U.S. leadership in discoveries and innovations by focusing on diversity, inclusion and broadening participation in STEM at scale. The Alliance is jointly funded by the NSF Established Program to Stimulate Competitive Research (EPSCoR) program.

NSF SCC-PG: Planning Live, Sustainable Commumity Asset Mapping for a Dementia e-Friendly Alabama

Dr. Nicole Ruggiano, UA

Among the 5.7 million Americans with Alzheimer's disease or related dementia (ADRD), most reside in the community and receive care from unpaid family caregivers. ADRD caregiving is complex and caregivers often report having a lack of support and barriers to services, which often results in feelings of depression, burden, and isolation. At the same time, primary care providers report being unaware of local supportive services that they can refer patients and caregivers to for support. There is particular urgency to address issues of ADRD care in Alabama, where there is an expected 17% increase in cases of ADRD over the next six years and patient/caregiver populations that are geographically isolated, vulnerable, and unaware of local support services and resources.

To better support ADRD caregivers and link them to needed services, this planning project will engage community stakeholders in four regions of Alabama to initiate the development of a community asset mapping (CAM) technology that: (a) utilizes volunteered geographic information (VGI) and data mining; (b) is self-monitoring for data accuracy and quality; and (c) can be used by community residents and providers to connect families

with supportive resources that address their ADRD needs. To inform the development of this technology, the planning project will collect data from a variety of stakeholders (people with ADRD, caregivers, providers, policymakers) through interviews, focus groups, and surveys. The data collected will address a number of conceptual issues in developing the proposed technology and promoting its adoption and engagement by stakeholders. The project will also explore and evaluate approaches to managing data that takes into account both space and time, available data sources for data mining, and data mining algorithms for the proposed technology. Overall, the planning project will explore how new crowd sourcing protocols may drive community engagement with a VGI technology that aims to address issues of ADRD care and caregiving. More importantly, the project can potentially transform *social science research o*n ADRD care and caregiving from existing technology approaches that are used in isolation (e.g., internet searches) or by small groups (e.g., virtual support groups) towards a connected community approach that facilitates social and mutual support and is driven by local needs to improve care and quality of life.

This project is jointly funded by Smart and Connected Communities and the Established Program to Stimulate Competitive Research (EPSCoR).

Partnership to Provide Technology and Cyber–security Experiences to Alabama Black Belt through Mobile Application Development

Dr. Jay Bhuyan, Tuskegee University

While job growth in STEM fields, specifically in information technology and cybersecurity, has been consistently on the rise, diversity in these workforce fields has not grown at a comparable pace. This Developing and Testing Innovations (DTI) project will advance efforts to better understand and promote practices that increase minority high school students' motivations and capacities to pursue STEM careers. This project will engage students in hands-on field experience, laboratory/project-based entrepreneurship tasks and mentorship experiences in fields of computing, specifically in cybersecurity. This project, based on the use of a Project Based Learning (PBL) environment with high school students, is a partnership between Tuskegee University, Auburn University, a rural and an urban school district in the historic Black Belt region of the state of Alabama, Tuskegee University Engineering and Computer Science Alumni Associations, and the Alabama State Department of Education. The focus of the partnership is to recruit annually a cohort of forty ethnically and racially diverse high school students from the partnering school districts for immersion in a STEM intensive PBL four-week STEM Summer Academy hosted by Tuskegee University, followed by one semester in-school training. The Academy is designed to provide 40 rising 10th and 11th grade students and ten high-school teachers annually (150 over the life of the three-year grant) with far-reaching technological experiences through the exciting exploration of secured mobile application development under a PBL framework.

This project is co-funded by the Innovative Technology Experiences for Students and Teachers (ITEST) program, which supports projects that build understandings of practices, program elements, contexts and processes contributing to increasing students' knowledge and interest in science,
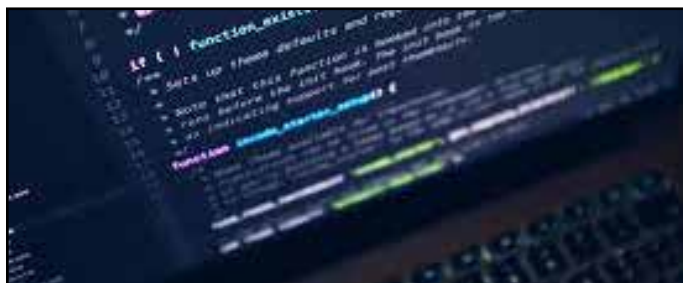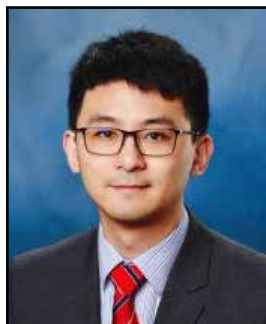
technology, engineering, and mathematics (STEM) and information and communication technology (ICT) careers. This project is also jointly co-funded by the Established Program to Stimulate Competitive Research (EPSCoR).

Probing novel phases of matter in van der Waals magnet Fe5–xGeTe2

Dr. Wencan Jin, Auburn University

Van der Waals materials have atomically thin layers that are vertically stacked and have weak interlayer bonds. Graphite is one example. They can be fabricated into two-dimensional forms, which are of tremendous interest for the next generation nanometer-scale electronics. Recently, intrinsic magnetic order was demonstrated in two-dimensional van der Waals materials opening up new opportunities in data storage and information processing. Van der Waals magnetic materials are also of interest in fundamental condensed matter physics, because they possess appreciable interactions between the crystal structure, electronic states, and magnetic order that could lead to novel phases of matter with unique properties. This project will establish the relationships between the structural, electronic, and magnetic properties of a new van der Waals magnetic material with a high magnetic transition temperature and complex magnetic order. Understanding these properties will help in the design of high-efficiency electronic devices. The research goals are accomplished through comprehensive investigations combining multiple state-of-the-art experimental techniques. The research activities involve collaboration with scientists from different disciplines, which provides extensive training for graduate and undergraduate students at Auburn University. The experiments to be carried out at the national laboratories will promote the students' professional development. The principal investigators will integrate the research topics into two existing courses and will continue to participate in the K-12 education under established local outreach programs.

This project is jointly funded by the Electronic and Photonic Materials program in the Division of Materials Research and the Established Program to Stimulate Competitive Research (EPSCoR).

NSF EAGER: Acquisition of a Tomographic Particle Image Velocimetry System for Fluid–Structure Interaction Investigation of Active Blowing on Deformable Surfaces

Dr. Konstantinos Kanistras, UAH

Active blowing methods have shown tremendous improvements in delay separation, lift enhancement and noise reduction over the years, however a major roadblock associated with high mass flow requirements has restricted their use on aircraft platforms. One potential method to resolve this issue is to synthesize and utilize two seemingly unique active flow control methods, a deformable flap providing a continuous wing contour and active upper-surface blowing, to develop a more efficient active flow control system that can enhance aircraft performance and control. The primary aim of this project is to investigate and determine the key factors governing the performance of active blowing on deformable surfaces. The project will also support the integration of research with graduate and undergraduate education and it will attract, educate and help retain a diverse pool of scientists/engineers including underrepresented minorities from partner institutions.

This project is jointly funded by the Fluid Dynamics and the Established Program to Stimulate Competitive Research (EPSCoR) programs.

NSF PFI-TT: Scalable Thermal Spray Deposition of Surface-Engineered Washcoat Catalysts for Vehicle Emission Control Systems

Dr. Ruigang Wang, UA

The broader impact/commercial potential of this Partnerships for Innovation - Technology Translation (PFI-TT) project is to develop an emission control prototype product with novel, surface-engineered catalysts for exhaust abatement. Clean air represents a signific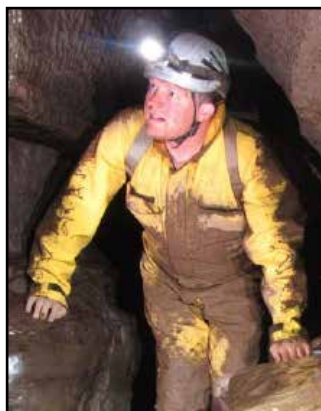ant societal benefit. Various mobile and stationary emission control systems are included in current solutions to reduce adverse environmental and health impacts. The adoption of support-promoted and surface-engineered catalysts with low temperature activity can have a global impact for the industrial applications in automotive catalytic converters and many industrial operations including electrical power plants, refineries and chemical plants, and surface coating facilities. Personnel involved in this project includes one graduate student and undergraduate students, who will gain innovation, technology transfer, and entrepreneurship experience.

This project is jointly funded by Partnerships for Innovation (PFI) and the Established Program to Stimulate Competitive Research (EPSCoR).

NSF CAREER: Diversity in the darkness: Integrating environmental genetics, comparative genomics, and citizen science to shed light on groundwater biodiversity

Dr. Matthew Niemiller, UAH

Many organisms are found in subterranean water (groundwater), yet the diversity and relationships of these organisms are poorly known, in part because caves and other subterranean habitats are particularly challenging to access and study. However, new sampling and emerging environmental genetic approaches, such as environmental DNA (eDNA), offer great promise for studying biodiversity in challenging ecosystems. Environmental DNA is DNA that is left in the environment by the organisms that live there. With modern techniques it is possible to isolate and sequence this DNA to identify, monitor, and study the organisms living in many different habitats. This project will harness traditional, eDNA, and genomic approaches to identify patterns and drivers of biodiversity within and among cave groundwater habitats in the central and eastern United States. In addition, this project will explore how aquatic cave organisms have responded to changes to their habitats that are associated with human impacts on groundwater both spatially and over time. Best practices for employing eDNA and its integration with genomic approaches in the study of aquatic cave ecosystems will be developed. Research will directly involve K-12 students and educators, undergraduate and graduate students, postdoctoral researchers, and community scientists, with an emphasis on groups that are grossly underrepresented in caving and science through several educational and outreach programs, including a student-focused community-science initiative for aquatic cave biodiversity monitoring, grades 3–5 educational summer camps, an undergraduate student research and training program, and teacher workshops. Finally, this project will support the development of an online data portal for groundwater and cave biodiversity data and resources for future research and support conservation and management efforts.

This project will harness a large, existing specimen and tissue collection and integrate traditional and eDNA sampling with genomic approaches, such as ultraconserved elements and restriction site-associated DNA sequencing, to compare levels of species and genetic diversity at different scales within and among three diverse karst biogeographic regions in the central and eastern

United States to better understand spatial patterns and the underlying processes that shape them. In addition, the effects of human impacts in land use on spatial and temporal patterns of biodiversity in groundwater populations and communities will be examined using population genomic approaches. Finally, the integration of eDNA with genomic approaches will be studied to explore the application of eDNA in providing insights into the spatial and temporal dynamics of groundwater species and communities using time-series analysis of sediment cores in caves. Groundwater ecosystems are particularly attractive for such studies, as the lack of UV radiation, stable temperatures, and generally low microbial activity in groundwater habitats may promote long-term eDNA persistence.

This project is jointly funded by the Systematics and Biodiversity Science program and the Established Program to Stimulate Competitive Research (EPSCoR).

NSF REU Site: Research experience through collaborative teams in bioprocessing for conversion of waste into products of value

Dr. Brendan Higgins, Auburn University

Closing the loop on biological wastes is a critical global challenge given the expectation that the Earth will support roughly 9 billion people by 2050. Biological wastes are rich resources that contain a range of nutrients as well as water. Many of the molecules found in bio-waste can be transformed into products of value to society – fertilizers, protein, energy, clean water, medicine, and advanced biomaterials. This project promotes scientific progress and advances the health, prosperity, and welfare of the nation, consistent with the NSF's mission. It does this by engaging cohorts of budding researchers into research projects aimed at converting biological waste materials back into products of value. At the same time, it trains student participants on how to conduct research and, of equal importance, how to communicate that work to the broader community. Participant students will be recruited from populations that are underrepresented in technical fields, as well as populations who currently lack access to research opportunities. The outcome will be a better-trained, diverse scientific workforce, which will help deliver solutions that benefit both people and the environment.
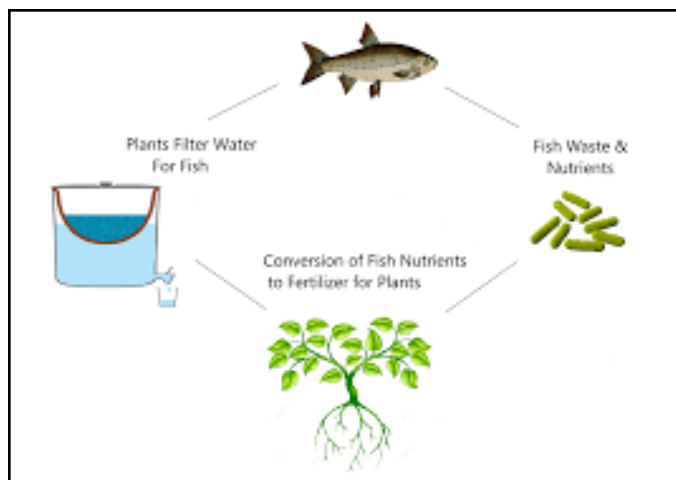
The objective of this project is to establish a new REU site that integrates undergraduate students in team-based research projects focused on converting biological wastes into products of value. The proposed REU site will provide a 10-week summer research experience for ten students each year, over a 3 year period. REU students will be paired with faculty teams working in four different areas: 1) use of fish waste for sustainable aquaponics vegetable production, 2) upgrading wastewater nutrients into zooplankton fish feed, 3) transforming cellulose into sensors for infectious disease detection, and 4) conversion of lignin into adhesives and carbon fiber. As the most

abundant biopolymers on Earth, cellulose and lignin are widely available in a range of waste biomass resources. REU student participants will not only gain research experience through this project, they will also receive training on teamwork and communication best practices through a suite of professional development opportunities. These efforts will yield two major outcomes: 1) a cohort of young researchers, many from underrepresented groups, who have strong understanding of interdisciplinary team-based research, and 2) publications showcasing the work of these students to the broader research community.

This project is jointly funded by the Division of Engineering Education and Centers (Directorate for Engineering), and the Established Program to Stimulate Competitive Research (EPSCoR).

COLLABORATIVE RESEARCH: Identifying the Dielectric Properties of Liquid-Metal Polymer Composites to Ensure the Dielectric Integrity of Deformable Electronic Applications
Dr. Amanda Koh, UA

Bioelectronics and soft robotics require electronic materials that function while being stretched or compressed. Composites of soft polymers with metals that are liquid at, or near, room temperature, have recently gained extensive attention from the scientific community for such applications. They have shown impressive performance as stretchable electronic components and for physiological sensors. Prior research has focused on expanding the promise of these composite materials, but relatively little has been done to understand their electrical aging and failure mechanisms. The lack of knowledge could lead to premature failure and may put future technologies utilizing liquid metal polymer composites at risk. This project combines experimental analysis and numerical modeling to identify the key characteristics that lead to the unique electrical performance and breakdown of liquid metal polymer

composites. With the understanding established through this project, future soft electronic technologies can be developed with application-specific performance and long-term durability in mind. The novel findings of this project will be utilized to promote underrepresented minority student intertest in STEM. Building on the existing relationship with the Girl Scouts and by taking advantage of the world-class high-voltage lab, a series of polymer, capacitor, and high voltage-related experiments will be designed for young women and K-12 students. Furthermore, short courses on high-voltage engineering and dielectrics with use cases on deformable dielectrics will be delivered at community colleges to promote university recruitment in Alabama and Mississippi. This project is jointly funded by the Electronic and Photonic Materials (EPM) program of the Division of Materials Research (DMR), the Established Program to Stimulate Competitive Research (EPSCoR), and the Metals and Metallic Nanostructures (MMN) program of DMR.

III: Small: Spatial Deep Learning from Imperfect Volunteered Geographic Information
Dr. Zhe Jiang, UA
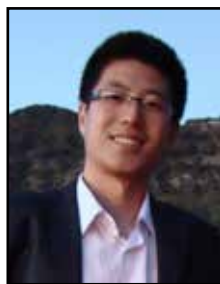
This project aims to investigate novel spatial machine learning algorithms based on imperfect volunteered geographical information as ground truth for applications at the intersection of machine learning and geographic information science. The rapid growth of geospatial and spatiotemporal data being collected from space, airborne, and terrestrial platforms provides scientists, farmers, and first responders critical information they need about the surface of the Earth. This emerging area that intersects machine learning, especially deep learning, with geographic information science is called GeoAI. GeoAI can potentially transform society by addressing grand challenges such as rapid disaster response, water resource management, and transportation. One major obstacle, however, is that deep learning heavily relies on a large number of training labels, which are often not easily available for geographic

applications due to slow and expensive field surveys. Existing research on semi-supervised learning could not fully resolve the issues due to the complex nature of geographic data such as spatial heterogeneity. This project will fill the gap by exploiting large scale, low-cost, and near real-time volunteered geographic information. The project will contribute towards the next generation water resource management for the U.S. in the 21st century. This research can not only improve the situational awareness for disaster response agencies but also enhance the flood forecasting capabilities of the National Water Model. Planned algorithms will be implemented into open source tools that will enhance the research infrastructure for disaster management and hydrology communities. Educational activities include curriculum development, K-12 computer science education at Alabama Computer Science Summer Camps. The principal investigator has a past record in mentoring undergraduate students from a historically black university and will continue the efforts at the University of Alabama, which has a reputation for producing African American researchers.

Upgrade of an Isotope Ratio/Mass Spectrometer for Compound– Specifid Isotope Analysis in Organic Biogeochemical Research

Dr. Ann Ojeda, Auburn University

This award supports the upgrade of specialized instrumentation at Auburn University that can help answer research questions about the sources, transformations, and cycling of carbon-based compounds in the natural environment. The upgrade will allow an existing isotope-ratio mass spectrometer (IRMS) to perform carbon and hydrogen compound-specific isotope analysis (CSIA) of organic molecules. The upgrade will boost cutting-edge research in geosciences, biology, ecology, and engineering at Auburn. The upgrade will also enable interdisciplinary collaborations across diverse research fields. For example, CSIA can link isotope signatures to sources and transformations of organic compounds in industrial and oil spills, which in turn, informs remediation efforts. CSIA of organic molecules in the sediment and rock record can help reconstruct Earth's past climate and help pinpoint regional and global changes in vegetation in response to climate change. The upgrade will also have broader impacts on Auburn and the larger scientific community in several ways. First, the upgrade will enhance the infrastructure at Auburn, fostering new connections between Auburn and other institutions in the southeast. In addition, the instrument upgrade will support undergraduate and graduate thesis work, providing students with technical knowledge and skills that are transferrable to the workforce. Finally, the award supports an isotope workshop at Auburn providing stipends for underrepresented students to acquire data using the instrument and learn analytical and laboratory skills.

This award received co-funding from the Established Program to Stimulate Competitive Research (EPSCoR) office.

The Topology of Contact Type Hypersurfaces and Related Topics

Dr. Bulent Tosun, UA

This project, jointly funded by Topology and the Established Program to Stimulate Competitive Research (EPSCoR), centers around the geometry and topology of 3- and 4-dimensional spaces, mathematical objects known as symplectic and contact structures, and interactions between these. Symplectic and contact geometries are not just a natural language for some aspects of classical physics, but also naturally arise and find applications in many areas of modern mathematics and mathematical physics. The techniques spring from gauge theory, Floer theory, holomorphic curve techniques, and the theorems and conjectures find applications and connections in several fields, such as: smooth manifold topology, hyperbolic geometry, dynamics, complex analysis in several variables, and complex algebraic geometry. Building on his extensive and collaborative research, the PI aims to study many unique questions and conjectures that sit at the intersection

of symplectic/contact topology and smooth manifold topology in low dimensions, and complex analysis. The proposed research and its outcomes will greatly impact our current understanding of geometric topology in low dimensions. As an integral part of this project, the PI will help mentor graduate students and postdoctoral fellows in his research area, maintain an active topology group at the University of Alabama by organizing seminars, workshops and conferences, and devote time to initiate a math circle in Tuscaloosa. Electronic and Photonics Materials Program in the Division of Materials Research and the Established Program to Stimulate Competitive Research (EPSCoR).

IRES Track 1: Innovative Macromolecular and Polymer Research Experience in San Sebastian (IMPRESS)

Dr. Jason Bara, UA

This IRES Site (Track 1) proposal will recruit seven undergraduate students pear year for three years (21 students total) from The University of Alabama (UA) to participate in an 8-week summer research experience focused on polymers and macromolecules at the POLYMAT Institute at the Universidad de Pais Vasco (University of the Basque Country, POLYMAT/UPV) in San Sebastian, Spain. With the advent and proliferation of synthetic polymers in the mid-20th Century, these materials have impacted all aspects of modern life and will continue to be critically important in nearly every scientific discipline in the future, ranging from batteries and fuel cells to tissue engineering and drug delivery. Additionally, managing plastic waste through improved recycling and/or "upcycling" (i.e., value-added) processes is a critical environmental need for improving sustainability. Although ubiquitous in daily life, only a fraction of undergraduate science and engineering students become directly acquainted with polymer science (outside of perhaps a senior-level elective course), and it is uncommon for students to be exposed to advanced applications of polymers beyond general principles introduced in chemistry courses. We will introduce undergraduate researchers to polymers early in their careers and provide these students with opportunities to work on the use of polymers in batteries, corrosion prevention, catalysis, and biological applications. The chosen host location (POLYMAT/UPV) is uniquely suited to host this IRES Site based on its high level of polymer research activity within the EU and the concentration of leading international researchers in polymers at their institution.

This project is jointly funded by the International Research Experience for Students program and the Established Program to Stimulate Competitive Research (EPSCoR).
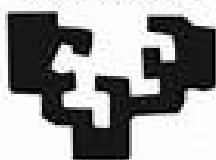
Collaborative Research: Revealing Strengthening and Toughening Mechanisms in Coconut Endocarp through Integrated Multiscale Modeling and Characterization
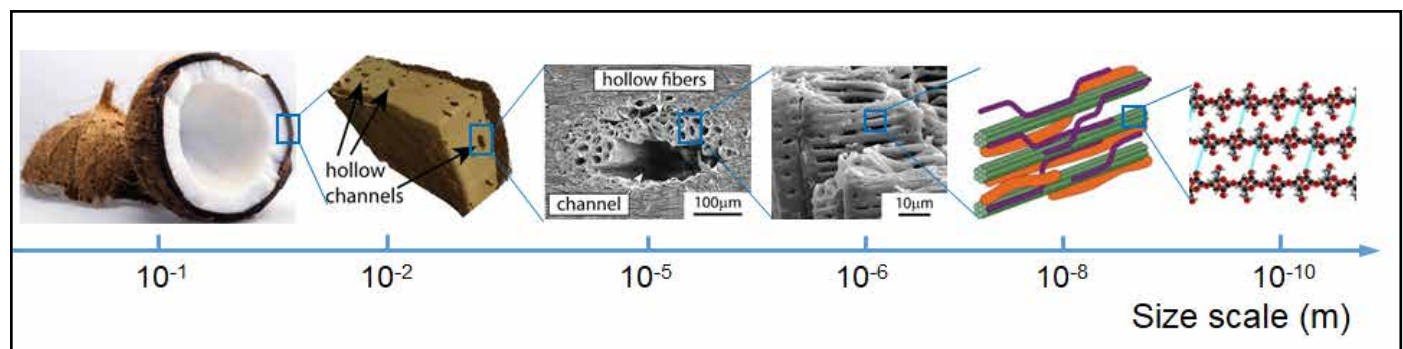
Dr. Ning Zhang, UA

The hard shell of the coconut, called endocarp, is a lightweight material with impressive strength, toughness, and hardness. As with many biological materials, this outstanding behavior is due to a highly complex structure. When studied at increasing magnifications, the endocarp reveals different structures at each magnification level. At the largest level, a porous network can be seen, consisting of bundles of hollow channels. Larger magnifications reveal a graded cellular structure, where larger cells are found toward the inside of the coconut, and smaller cells toward the outside. The cells themselves feature walls consisting of many layers, and each of these layers consists of tiny fibrils. Understanding comprehensively how all of these elements work together to make the coconut so strong and tough is a significant challenge, especially because of their disparity in size. This project will develop novel computer simulation techniques with the capability of treating these different elements simultaneously at the relevant sizes. This project will also develop new experimental techniques to measure and visualize directly how the different elements inside the coconut endocarp interact, to test and calibrate the computer models. This integrated computational and experimental approach will provide unprecedented insights into how the coconut's structure gives rise to its outstanding performance. These insights and methods can then be used to engineer coconut-inspired lightweight applications that are strong and tough, for instance to improve helmets. This project will provide research opportunities to undergraduate students. For instance, computational and experimental training series will be offered to undergraduate students during the summer. Underrepresented students including female and minority students will participate in this research project. This project will also provide opportunities to students with disabilities to work on computational modeling remotely. Presentations and seminar talks will be offered to middle and high school students to attract them to participate into biomaterial research.

This project is jointly funded by the Biomaterials progam (BMAT) in the division of materials research (DMR) and the Established Program to Stimulate Competitive Research (EPSCoR).

Catalyst Project: Investigating Adaptive Hybrid Learning in College Algebra to Improve STEM Engagement and Persistence for HBCU Students

Dr. Lisa Gray, Stillman College

Catalyst Projects provide support for Historically Black Colleges and Universities (HBCU) to work towards establishing research capacity of faculty to strengthen science, technology, engineering, and mathematics (STEM) undergraduate education and research. It is expected that the award will further the faculty member's research capability, improve research and teaching at the institution, and involve undergraduate students in research experiences. Stillman College outlines an interdisciplinary approach to investigate the combination of Self-Regulated Learning theory, Adaptive Learning Technology, and Culturally Relevant Pedagogy to promote student success in college algebra. Specifically, the major activities include the design of a theory-driven hybrid adaptive college algebra course. The anticipated outcomes are to advance persistence and success in STEM for underrepresented students as HBCUs.

This project is jointly funded by the Historically Black Colleges and Universities Undergraduate Program and the Established Program to Stimulate Competitive Research (EPSCoR).

Excellence in Research: PAH1-mediated regulation of lipid synthesis in the model oleaginous yeast Yarrowia lipolytica

Dr. Stylianos Fakas, AAMU

Biofuels are renewable fuels that can replace nonrenewable fossil fuels and thus decrease US dependency on oil. Microorganisms such as yeasts produce lipid-based biofuels that are considered a viable alternative to oil. However, the large-scale production of microbial biofuels has lagged because the low yields make the economics unfavorable. The project aims to study the catalysts that convert raw materials to lipid biofuels in yeast cells. This knowledge is important for increasing the yields of lipid-based biofuels. The next step will be to use this knowledge to design more efficient production processes for biofuels. In addition, this research will provide training opportunities for African-American graduate and undergraduate students. Specifically, first-generation African American undergraduate students will be the focus of the project because they have lower graduation rates and lower graduate enrollment rates compared to white peers. The hands-on training and intensive mentoring that the PIs will provide will increase these students' retention and graduation rates and prepare them for graduate programs.

This project is jointly funded by the Historically Black Colleges and Universities - Excellence in Research Program (EiR), the Established Program to Stimulate Competitive Research (EPSCoR), and the Historically Black Colleges and Universities - Undergraduate Program (HBCU-UP) of the Division of Human Resource Development.

FMSG: Cyber: Federated Deep Learing for Future Ubiquitous Distributed Additive Manufacturing

Dr. Jia Liu, Auburn
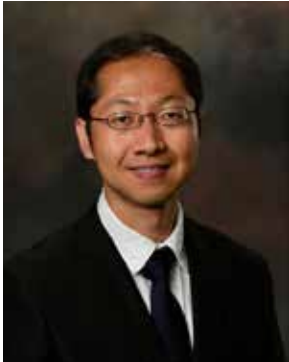
Distributed additive manufacturing has promising potential to connect and coordinate individual manufacturers for efficient, on-demand production. It can leverage the freeform fabrication of numerous additive manufacturers to form a flexible and robust supply chain and achieve reconfigurable mass customization in the future. However, product quality, consistency and privacy concerns among those distributed manufacturers pose a grand challenge to fully unleashing the potential of distributed additive manufacturing. This Future Manufacturing Seed Grant (FMSG) CyberManufacturing project will support fundamental research to provide needed knowledge for developing a unified algorithmic and training framework. The new framework, named FEDMDL, will lay a solid foundation to enable consistent and reliable production in a privacy-preserving, insight-sharing manufacturing network. This will further promote the adoption of additively manufactured parts in various industries, such as aerospace, automobile, healthcare, and will boost the participation of small-and-medium-sized manufacturers in the national supply chain. Therefore, results from this research will benefit the competitive advantages of US manufacturing and economy. This research provides manufacturing companies with the synergy of novel machine learning and federated computing techniques. The multi-disciplinary approach will help broaden the participation of underrepresented groups in research and positively impact engineering education.

This project is jointly funded by the Division of Civil. Mechanical and Manufacturing Innovation, the Established Program to Stimulate Competitive Research (EPSCoR), and the Division of Electrical, Communications, and Cyber Systems.
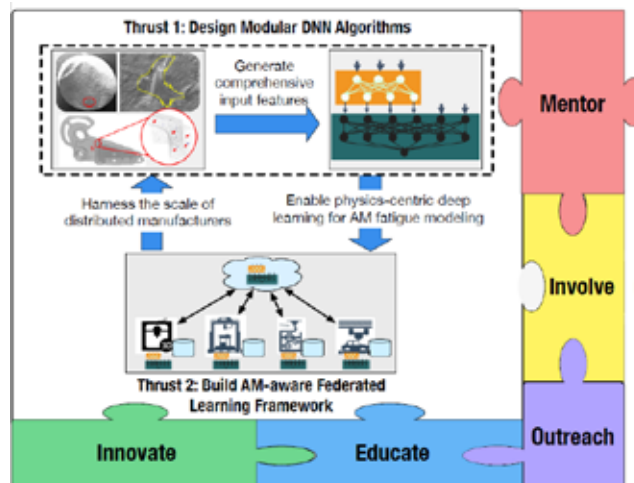
- An integrated research, education and outreach plan to design a unified algorithmic and training framework for future distributed AM. Two tightly-coupled research thrusts are proposed: (1) design modular deep neural networks for nondestructive qualification of complex AM geometry; (2) build an AM-aware, federated learning framework to enables elastic, collaborative training for deep learning.

CCSS: Collaborative Research: Quality-Aware Distributed Computation for Wireless Federated Learning: Channel-Aware User Selection, Mini-Batch Size Adaptation and Sheduling
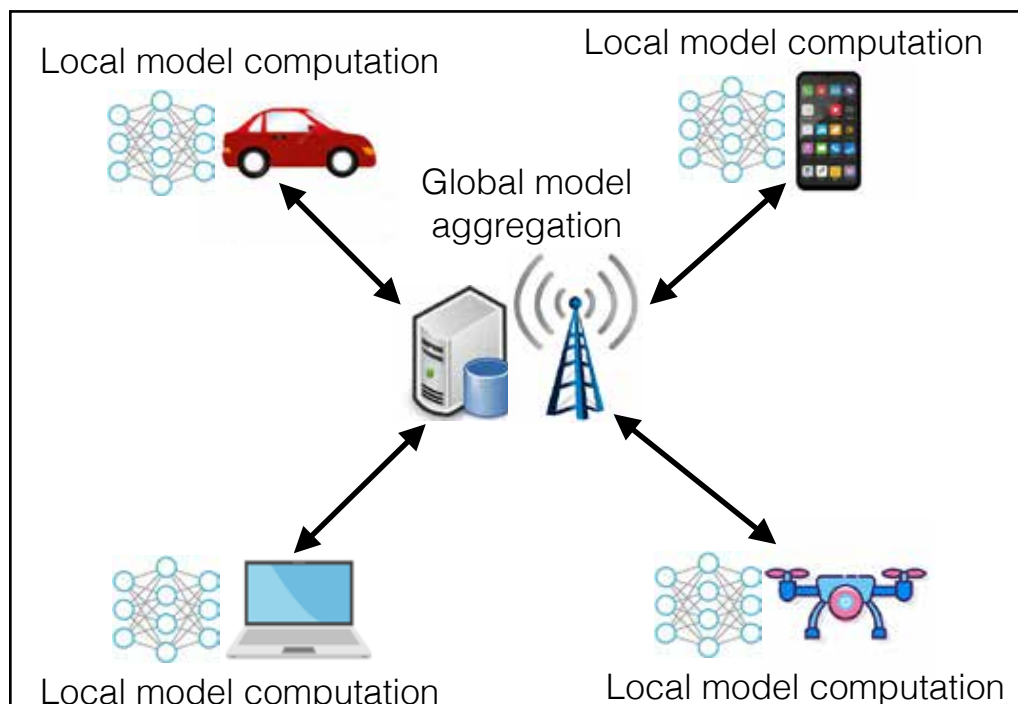
Dr. Xiaowen Gong, Auburn University

With the explosive growth of machine learning/ artificial intelligence (ML/AI) technologies, there is enormous potential to advance networking technologies to enable distributed ML/AI data analytics over networked systems. This project will explore innovative cross-disciplinary research at the intersections of wireless networking and machine learning, and study wireless federated learning (FL) for achieving collaborative intelligence in wireless networks. It will advance the fundamental understanding of quality-aware dynamic distributed computation and computation-communication co-design for wireless FL. This project will spur a new line of thinking and provide new insights to support various emerging ML/AI applications over wireless networked systems, such as collaborative robotics, multi-user mixed reality, and intelligent control and management of wireless networks. The proposed research will also be integrated with education activities at the PIs' institutions for graduate, undergraduate, and K-12 students via curriculum development, research experiences, and outreach. The PIs will make conscientious effort to recruit minority graduate students.

This project is jointly funded by the Division of Electrical, Communications and Cyber Systems (ECCS), and the Established Program to Stimulate Competitive Research (EPSCoR).

Local model computation

Local model computation

Global model aggregation

Local model computation

Local model computation

Wireless federated learning exploits wirelessly connected devices to perform machine learning in a distributed and collaborative manner.

DEPARTMENT OF ENERGY EPSCoR

The DOE EPSCoR Program was established by the Energy Policy Act of 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-five states, the Commonwealth of Puerto Rico, Guam, 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).

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

DOE EPSCoR eligibility map

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.
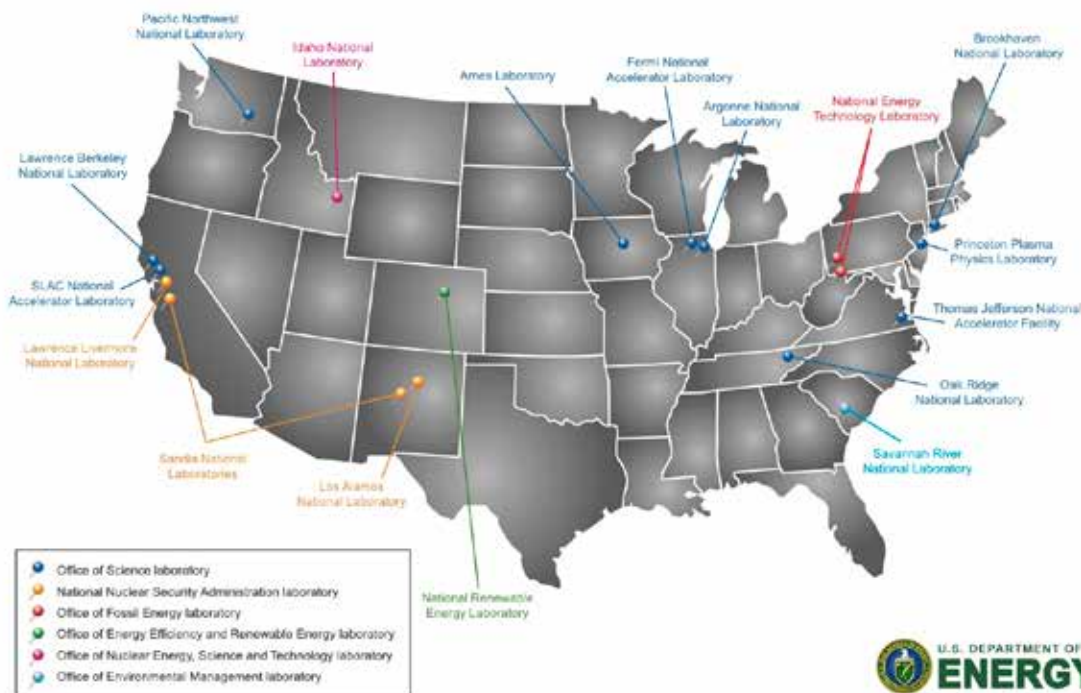
In 2020, DOE announced $21 million in awards for thirty-one DOE EPSCoR State Laboratory Partnership Grants. Alabama was awarded two projects which include principal investigators Dr. Vladimir Kolobov at UAH and Dr. Suzanne Lapi at UAB.   Dr. Kolobov will be collaborating with Sandia National Lab while Dr. Lapi will collaborate with Los Alamos National Lab.

In June 2021, DOE EPSCoR announced awards totalling $22M in support of nine projects coveing a range of energy research topics from grid integrations, solar energy, wind energy, and advanced manufacturing. These projects will be located in EPSCoR jurisdictions and are intended to improve geographical distribution of federal R&D funding, strengthen underserved regions of the country and enable those research institutions to compete for federal R&D funding. Awards are being provided to Boise State University, Montana State University, University of Nebraska-Lincoln, University of Alaska at Fairbanks, University of Nevado at Reno, University of Rhode Island, University of South Alabama, and West Virginia University.

Dr. Kevin West (USA) will serve as Principal Investigator on this multi-institutional project investigating molecular-level interactions between ionic liquids and molecular species.

Department of Energy National Laboratories

NEW FY20 and FY21 DOE EPSCoR Awards				
Award No.	Type	Title	PI	Inst
2020				
DE-SC0021391	DOE EPSCoR State Lab Partnership	Self Organization of Plasma-Material Interfaces	Vladimir Kolobov; co-PI: Gabe Xu	UAH
DE-SC0021279	DOE EPSCoR State Lab Partnership	Production, Purification and Characterization of Radioisotopes via Neutron Spallation	Suzanne Lapi	UAB
2021				
DE-SC0020282	DOE EPSCoR Implementation Grant	Expanding knowledge of specialized liquids to enhance plastic recycling and reuse in advanced manufacturing processes	(lead) Kevin West, Matthew Reichert, James Davis, Christy Wheeler West, Brooks Rabideau	USA
			Paul Rupar, Jason Bara, Heath Turner	UA
			Michael Curry	TU
			Amanda Coffman	Univ. N. Alabama

Expanding the Understanding the Molecular-level Interactions Between Ionic Liquids and Molecular Species : AASC Phase II

Dr. Kevin West, University of South Alabama

Dr. Kevin West, University of South Alabama

This project aims to advance the understanding of how molecular-level interactions between ionic and molecular species affect macroscopic properties related to the three topic areas described below, and of how these interactions can be leveraged to develop energy efficient and environmentally benign processes. The three topic areas are (I) aromatic/aliphatic hydrocarbon separations, (II) reactions in thermally-robust ionic liquids and (III) ionic liquid high-performance polymers. Complementary sets of experiments and simulations are employed to connect observed phenomena, such as phase behavior and reaction rates, to molecular-level interactions in the mixtures.

In Topic I, thermophysical property and phase behavior measurements are coupled with molecular dynamic simulation 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 are examined in Topic II, where nucleophilic aromatic substitution reactions and alkylation are studied. Additionally, a preliminary kinetic analysis of the degradation kinetics of the salts at elevated temperatures is conducted. Reactive Monte Carlo simulations are used to elucidate key solvent characteristics which promote the reactions. In Topic III, studies on two areas related to high performance polymers include: the synthesis of ultra-high performance-ionene hybrid polymers inspired by ionic liquid anions (including the 3D-printing of these species) and anionic polymerization in ionic liquids.

State Laboratory Partnership Awards

Self-Organization of Plasma-Material Interfaces
Dr. Vladimir Kolobov, University of Alabama in Huntsville

Low-temperature plasma (LTP) physics, chemistry and engineering offer breakthroughs and transformative technological solutions that address grand societal challenges. The subject of the proposed research – understanding LTP-induced self-organization at gas-solid-liquid interfaces – has been identified by DOE as one of the top priorities in the field. Two Plasma Research Facilities (PRFs) have been recently established at DOE's Sandia National Laboratories (SNL) and Princeton Plasma Physics Lab (PPPL). The proposed collaborative research between the University of Alabama in Huntsville (UAH), an Alabama small business - CFD Research Corporation (CFDRC), and the Plasma Research Facility at Sandia National Laboratories focuses on the interactions of LTP with solid and liquid surfaces, transport phenomena and heterogeneous chemical reactions at interfaces, and self-organization and pattern formation in non-equilibrium reactive plasmas. The collaboration will enable the development of theory, computational tools and experimental studies of LTP to control plasma stratification and filamentation, plasma-induced processes at gas, liquid and solid interfaces for applications in material synthesis, nanoelectronics, biomedicine and food safety. The project will a) improve the understanding of transport processes, chemical reactions and plasma-driven self-organization such as stratification and filamentation, formation of anode spots, liquid droplets ejection from cathodes, and plasma electrolysis, b) utilize and share among the project participants computational tools developed by the participants to understand plasma-based surface functionalization and plasma-enabled pattern nucleation in a wide range of scales from nano- to millimeters, and c) use experimental methods and facilities available at UAH and SNL to understand and control plasma processes, reaction pathways and the electric nature of self-organization of the plasma-exposed interface structures. A combination of theory, computer simulations and dedicated experiments will be applied to selected DC/AC discharges in noble gases and plasma jets in air to clarify and control surface functionalization and plasma-assisted self-organization at material interfaces over a wide range of spatial scales.

Successful completion of the proposed research will result in an improved understanding of gaseous plasma interfaces with metal/semiconductor electronic structures, electric surface charging, electron emissions from nano-tips, and nanoparticle synthesis that can be applied for the design of electronic structures, plasma transistors, metamaterials, plasma-aided printing and additive manufacturing. The proposed collaboration of Alabama institutions with SNL will enable sharing expertise and resources to develop theory, perform computational studies, and conduct targeted experiments for clarifying fundamental processes at plasma-material interfaces for validation and fine-tuning of the models. Graduate students and post-doctoral researchers will participate in the research and collaboration with SNL. The project will complement and leverage the ongoing NSF EPSCoR project "CPU2AL: Connecting the Plasma Universe to Plasma Technology in Alabama". The proposed partnership will help establish a sustainable research partnership of Alabama researchers with SNL devoted to understanding and controlling LTP environments, strengthening the research capacity and building an inclusive workforce in plasma science and technology in the State of Alabama.

Production, Purification and Characterization of Radioisotopes via Neutron Spallation

Dr. Suzanne Lapi
University of Alabama in Birmingham

This collaborative proposal between the University of Alabama at Birmingham (UAB, PI Suzanne Lapi), and Los Alamos National Laboratory (LANL, collaborator Michael Fassbender) aims to develop novel techniques for isotope production. This proposal takes advantage of complementary techniques available at the UAB cyclotron facility and LANL isotope production facility (IPF) and will involve UAB faculty, postdocs, graduate students and undergraduates as well as LANL scientists and staff. Specifically, we aim to develop methods for isotope production that make use of the high energy neutrons generated at the LANL IPF high energy beam line. This project will involve the development of separation techniques for radioisotope production at UAB, using radiotracer analogues produced using the TR24 cyclotron, which would directly translate to separations of the desired isotopes produced at LANL via neutron spallation. Extended visits to LANL by UAB students involved in this initiative are also envisioned.

This proposal also responds directly to the critical shortage of highly qualified scientists in the field of radiochemistry and radionuclide production in the United States. This proposal intrinsically encompasses a multidisciplinary training program that will include undergraduate students, graduate students, postdoctoral research fellows and other early career scientists. We strive to foster the development of a new generation of young scientists in isotope production and radiochemistry. Thus, while the grant will fund experimental supplies and support students and scientists, it is clear that the impact on the scientific program and workforce development in the state of Alabama from the support of this project will extend far beyond the scope of the work proposed.

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 equally 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.

- EPSCoR ISS Suborbital is a new program in FY2021 and is an amendment to the ISS Flight Opportunity Solicitation. Awards are up to $200,000 (plus the cost of the flight) for a three-year period of performance. NASA intends to announce yearly, pending funding availability.

- NASA Rapid Response Research Solicitation (R3) is a 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 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. Dr. Thomas serves as the managing Principal Investigator on all NASA EPSCoR grants while a Science Investigator manages the research aspects of the award.

In FY 2020, new NASA EPSCoR awards included four Rapid Response Research (R3) awards. In FY 2021, Alabama was awarded one International Space Station (ISS) award, one ISS Suborbital award, three Rapid Response Research (R3) awards, and a Cooperative Agreement Notice Award. See lists in this section.

Grant Number	Type of Award	Role	Name	Title	Inst.	Amount	Period of Performance
80NSSC20M0135	NASA FY20 R3 Award	Principal Investigator	Dale Thomas	SiC Zener diode and Voltage References for extended operation (>1000 hr.) at 500 degrees C: SMD Planetary Division, High- Temperature Subsystems and Components for Long-Duration (months) Surface Operations	UAH	100,000	6/1/2020-5/31/2021
		Science Investigator	Ayayi Ahyi, Sarit Dhar		AU		
80NSSC20M0134	NASA FY20 R3 Award	Principal Investigator	Dale Thomas	Low-pressure plasma/photocatalytic nanofibrous membrane reactor system for harvesting fuel components from Martian atmosphere: KSC Partnership Office/Conversion of Co2 into Fuel.	UAH	100,000	4/15/2020-4/14/2021; extended to 8/31/2021
		Science Investigator	Andrei Stanishevsky		UAB		
80NSSC20M0131	NASA FY20 R3 Award	Principal Investigator	Dale Thomas	Physical Sciences Program / Dusty Plasmas	UAH	100,000	9/1/2020-8/31/2021 (ext 8/31/2022)
		Science Investigator	Uwe Konopka and Ed Thomas		AU		
80NSSC20M0136	NASA FY20 R3 Award	Science Investigator	Judy Schneider, UAH	Characterization of Bi_metallic Joints Formed by Different Processes	UAH	100,000	4/15/2020-4/14/2021; ext to 7/14/2022
						400,000	

SiC Zener diode and Voltage References for extended operation (>1000 hr.) at 500 degrees C: SMD Planetary Division, High-Temperature Subsystems and Components for Long-Duration (months) Surface Operations

Science PI: Dr. Ayayi Ahyi, AU

SiC and GaN are the materials of choice for High temperature electronics because of their wide bandgap and high chemical stability at high temperature and also because these technologies have recently seen a considerable development leading to commercialization on the consumer market. Although they both have acceptable thermal conductivity, SiC is exceptional in that regard, which prevents the occurrence of hot spots in the device when used at high power and high current densities. Several teams have been developing electronics devices for Venus like conditions. Power conditioning for these devices will be needed both for protection and for accuracy. In modern electronics, power conditioning is done using complex integrated circuits. However, GaN or SiC technology are not at the stage where these types of ICs are easily manufactured and tested within a reasonable amount of time. Therefore, discrete Zener diodes, which have been extensively used in earlier Si electronics (and are still used although less commonly) to stabilize voltages, shape signals and protect electronics from overvoltage events have a huge potential for SiC high temperature electronics.

We propose the fabrication and investigation of high temperature (500°C) SiC Zener diodes using ion implantation and evaluate their long term degradation at high temperature. Two main configurations will be pursued: (i) a vertical device, for high power applications and (ii) a lateral device that can be integrated into SiC ICs that are being developed by other groups. The different elements necessary to make the high temperature device will come from expertise developed by the Auburn group in their ongoing and previous studies of devices such as 500°C MOSFET transistors and high temperature integrated circuits. A measurement setup was developed for our ongoing interest in high temperature electronics and will also be used in this case for study of the device behavior over time. The device will be stressed at high temperature (typically 500°C) for over 1000 hours and the characteristics of the device will be monitored during the test. Of interest are the capacity of the devices to regulate power with minimal drift over time. For such precision devices, contact degradation and the effect of passivation layers will have an important effect on the device performance. The effect of using ion-implanted doped layer as opposed to the conventional way of using epitaxially doped material will also be investigated. Our study therefore will give to other groups involved in the development of devices for NASA missions, the recipes to incorporate Zener diodes into their designs with established properties over time. The difficulties of the project reside in the presence of crystal defects in SiC such as basal plane and threading edge dislocations that are known to grow over time especially at high temperatures. Unfortunately these defects are more prominent in highly doped layers. They are known to reduce the performance of diodes and may result in faster degradation of the devices at high temperatures. The study proposes both the fabrication and the long- term study of the devices in a set up that allows the parallel biasing of several devices simultaneously at high temperature. Devices will be characterized in situ while at high temperature and be characterized after 1000 hours stress to observe the presence of dislocations and their extent.

Low–pressure plasma/photocatalytic nanofibrous membrane reactor system for harvesting fuel components from Martian atmosphere: KSC Partnership Office/ Conversion of Co2 into Fuel.

Science PI: Dr. Andrei Stanishevsky, UAB

This project aims at the developing of a light-weight ceramic nanofiber-based, glow discharge enhanced, photocatalytic membrane reactor system operating at reduced pressures to support efficient in-situ resource utilization in future Mars missions. Current processes designed for Mars in situ resource utilization (ISRU) include Sabatier, steam/dry reforming, reverse water/gas shift, electrolysis, Fischer-Tropsch, methanol synthesis and several others. All these and related processes rely on relatively heavy and energy-thirsty equipment and frequently need the temperatures >150 oC and pressures e1bar (up to 50 bar). Several other approaches have been proposed to utilize the Martian atmosphere for fuel components, water and oxygen. Those include solid oxide electrolysis (MOXIE), photocatalysis, and glow-discharge plasma. Photoreduction of CO_2 to CO and O2, or to other compounds through the reactions with H2 and H2O is possible due to reasonable solar irradiance (<300 W/m2) on Mars. Plasma technology is also gaining increased interest for the reduction of CO_2 to CO and O2. Although some interesting results have been obtained, both plasma and photocatlytic approaches are still in their infancy.

To advance these promising technologies to the next level, the proposed study will explore the potential of plasma/photocatlytic conversion of CO_2 into the fuel components by using a light-weight and scalable nanofibrous ceramic (NFC) membrane catalytic reactor system operating under simulated Martian atmospheric conditions. The proposed reactor incorporates the staked flat gas separation membrane, catalytic membrane, and metal mesh electrode system capable of operating at low pressures and down to cryogenic temperatures.

The research objectives include the design, fabrication, and tests of NFC membranes for (1) CO2/N2 and CO/O2 separation, (2) CO_2 splitting to CO and O2 in glow discharge and under visible light, and (3) CO_2 and CO reactions with H2 and CH4 in glow discharge and under visible light at low pressures and temperatures. The feasibility of completion of the proposed tasks is based on the availability of the efficient process to fabricate NFC membranes with different composition and microarchitectures and total porosity up to 99.5%. The process involves a high-yield, free-surface alternating field electro-spinning (AFES) to prepare nanofibrous ceramic precursors, followed by calcination and sintering procedures to fabricate the membranes. This allows the fabrication and screening, in reasonable time, of a variety of prospective membrane compositions and structures. Targeted materials primarily include the nanofibrous transition metal oxides (TiO2, ZrO2, ZrxTi1-xO2) doped with Ni, Mn, Ru, Cu, Fe, and Co, and incorporating, in some cases, carbon nanostructures. Significant research findings on gas transport and catalytic performance of NFC membranes and entire reactor system under targeted environmental conditions are expected upon completion of these tasks.

Dusty Plasmas: Space Life and Physical Sciences and Research Apps

Science PI: Dr. Uwe Konopka, AU

Dusty plasmas are four-component plasma systems consisting of the standard plasma constituents of electrons, ions, and neutral atoms, with the addition of a fourth component: charged, solid, nanometer-to-micrometer-sized particulates (i.e, the dust particles). In both laboratory and space environments, the dust particles become charged through the acquisition of electrons and ions from the background plasma as well as various ionizing processes such as thermionic emission or photoelectron emission. Regardless of the charging processes, the dust particles are coupled to and become part of the plasma through their charge. However, the small charge-to-mass

ratio of the dust grains (relative to the electrons or ions) means that the plasma process of the dust component is slowed to time (~10-2 s) and space (~10-3 m) scales that enable simultaneous studies of plasma dynamics in both the kinetic (particle) and fluid (collective) regimes. Moreover, the small charge-to-mass ratio also allows the thermal state of the dust component to be experimentally tuned over a range of Coulomb-coupling parameters (i.e., G, ratio of electrostatic-to-thermal energy) from the weakly-coupled (G << 1) to strongly-coupled (G >>1) regimes. This provides opportunities to explore regimes of plasma behavior that are generally difficult to achieve in standard plasmas.

This proposed project seeks to perform a new investigation of controlled dusty plasma particle transport from weakly-coupled to strongly-coupled regimes. This work leverages the extensive expertise and experimental capabilities of the Auburn Dusty Plasma research group in laboratory and microgravity studies of dusty plasmas. In this work, two main activities are proposed for this one-year activity: (a) demonstration of passively-driven, long-range dust particle transport (i.e., transport distances >> collision mean free path) using biased electrodes to establish cyclical particle motion between several suspended dust clouds and (b) development of a programmable, segmented electrode with the ability to provide steady-state or periodic control of particle transport over long distances in a plasma. The long-term goals of this work are to develop a comprehensive understanding of dust particle transport over a broad range of experimental conditions that can lead to scaled studies of charged dust transport in environments relevant to lunar and Martian conditions. From these studies, it will be possible to provide a scientific basis for the next generation of remote and manned missions on airless and plasma exposed bodies throughout the solar system.

Characterization of Bi_metallic Joints Formed by Different Processes

Science PI: Dr. Judy Schneider, UAH

Development of the Space Launch System (SLS) vehicle at the NASA- Marshall Space Flight Center (MSFC) supports the Artemis Mission to the moon, Mars and beyond [1]. To sustain these missions, there is a need for fabrication of landers as well as reusable, reliable materials and processes for extraterrestrial fabrication and repair. Thus, the materials and fabrication processes must be suitable for a multitude of components as well as environments. Terrestrially, to support the SLS vehicle fabrication, upgrades are underway to improve the performance and reliability of the RS-25 liquid rocket engine (LRE) [2]. While this provides an opportunity to insert new materials and manufacturing processes, such as additive manufacturing (AM) into the RS-25 production upgrade, it is urgent to develop material property databases to ensure designers have relevant information for designing robust and reliable engine components.

A regeneratively cooled, RS-25 combustion chamber consists of a Copper (Cu) liner joined to a structural jacket [3, 4]. Heritage hardware initially used stainless steels (Fe based) whose coefficient of thermal expansion (CTE) closely matched that of the Cu liner [5]. Eventually, the Fe base material was replaced by higher strength nickel (Ni) based superalloys such as Inconel 625. While Inconel 625 provided improved strength, there was a trade off in increased CTE mismatch that affected the fatigue life of the combustion chamber. More recently, the NASA developed an advanced Ni based superalloy called NASA HR-1 that decreased the CTE mismatch [6]. The current evaluation of manufacturing methods, such as AM, provides an opportunity to evaluate improved materials to retain the high strength of the Ni based superalloy while minimizing the CTE mismatch to improve reliability. Of the various AM processes being evaluated for the RS-25 LRE, direct energy deposition (DED) processes offer the best approach

toward fabrication of bi-metallic combinations without size restrictions [7]. Improved reliability can be obtained if the resulting bi-metallic interface has adequate strength and microstructural stability at elevated temperatures during hot fire operation. This requires quantification of the properties of the AM materials in parallel with the development of AM processes for LREs. Thus quantifying the material properties from AM processing also must include those of the resulting interface between different families of materials encountered in regeneratively cooled LREs. Prior research has observed significant differences in the interface of samples obtained using different materials, processes and vendors [8-12]. Since there are no current standards or specifications for production of this hardware, the vendors currently apply their best practices, which can widely vary. This means that there is no consistency in the feedstock supplier or equipment settings, factors known to affect the melt pool formation and mixing between materials. Within the liquid metal of the melt pool, Marangoni currents influence the intermixing as influenced by atmospheric contaminations, injection velocity, heat source power density, and elemental composition, resulting in vastly different properties at the interface [13-15]. Since DED is of interest for the bi-metallic structures, characterization of two processes involving blown powder are proposed: blown powder deposition versus cold spray. Thus understanding how variations in DED processing affect the overall properties of the bi-metallic joint will contribute toward increasing the overall technical readiness level (TRL) of an AM RS-25 LRE. This is of relevant interest to both NASA and the commercial space companies [16-19]. Using the unique capabilities at UAH, this proposal will leverage mini-samples from actual hardware [12] in collaboration with NASA and commercial space to characterize and disseminate data.
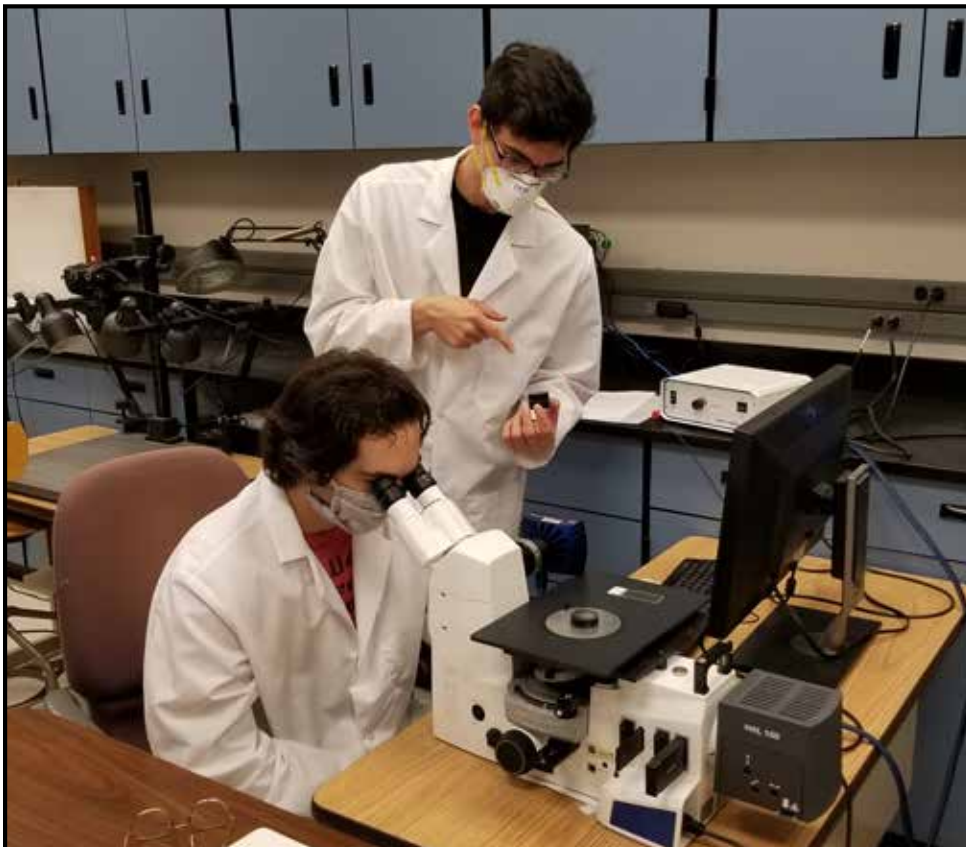
Noah Nadan (front) and Giancarlo Puerto, Dr. Schneider's graduate students, working in the laboratory.

NATIONAL AERONAUTICS & SPACE ADMINISTRATION EPSCoR

FY21 NEW NASA EPSCoR Awards							
Grant Number	**Type of Award**	**Role**	**Name**	**Title**	**Inst.**	**Amount**	**Period of Performance**
80NSSC20M0141	NASA FY 2021 ISS Award	Principal Investigator	Dale Thomas	In-Space Manufacturing of Assembled Lightweight Flexible Carbon-based Perovskite Thin Film Solar Cells with Radiation Stability in ISS	UAH	100,000	10/1/2020 - 9/30/2023
		Science Investigator	Feng Yan		UA		
80NSSC21M0230	NASA FY21 ISS Suborbital	Principal Investigator	Dale Thomas	Appendix G - Three-Dimensional Plume-surface Interaction and Crater Formation Dynamic Measurements in Reduced Gravity Environments	UAH	200,000	9/1/2021 - 8/31/2024
		Science Investigator	David Scarborough, Vrishank Raghav, Masatoshi Hirabayashi, and Brian Thurow		AU		
80NSSC21M0139	FY21 NASA R3	Principal Investigator	Dale Thomas	Improved drought tolerance of mustard green with atmospheric pressure plasmas	UAH	100,000	6/1/2021- 5/31/2022
		Science Investigator	Kunning Xu (UAH), Komal Vig (ASU), Srinivasa Rao Mentreddy (AAMU)		UAH, ASU, AAMU		
80NSSC21M0138	FY21 NASA R3	Principal Investigator	Dale Thomas	Application of Machine Learning to High-Resolution Earth System Model Data	UAH	100,000	6/1/2021- 5/31/2022
		Science Investigator	Di Tian		AU		
80NSSC21M017	FY21 NASA R3	Principal Investigator	Dale Thomas	Machine Learning Accelerated Discovery, Testing, and Characterization of Light-weight Refractory High Entrophy Alloys for Space Application	UAH	100,000	5/1/2021- 4/30/2022
		Science Investigator	Lin Li, Feng Yan, Jiaqi Gong		UA		
80NSSC21M0361	FY21 NASA CAN Award	Principal Investigator	Dale Thomas	Synergistic Effects of Defects and Microstructure on Mechanical Behavior of LB-LBF Metallic Materials	UAH	750,000	9/1/2021 - 8/31/2024
		Science Investigator	Shuai Shao (Sci-I), Jeffrey Suhling, Lukami Baker, Nima Shamsaei; Hareesh V. Tippur, Mr. Mike Ogles		AU		
		Co-PIs	Dr. J. Brian Jordan, Dr. Paul Allison, Dr. Steven R. Daniewicz		UA		
						1,350,000	

FY21 Cooperative Agreement Notice (CAN)– Synergistic Effects of Defects and Microstructure on Mechanical Behavior of LB–LBF Metallic Materials

Science PI: Dr. Shuai Shao, Auburn University

The overarching goal of the proposed research is to enable prediction of mechanical properties of additively manufactured (AM) metallic materials by considering the characteristics of defects and their surrounding microstructure. To achieve this goal, this project investigates the synergistic effects of defects and their surrounding microstructure on the mechanical properties of laser beam powder bed fused (LB-PBF) metallic materials, including IN718 and SS 316L. This research ad-dresses the main hindrance of adopting AM metallic materials in flight critical applications, i.e., their compromised and hard-to-predict mechanical behavior due to the presence of volumetric defects, including pores (gas-entrapped pores and key holes) and lack-of-fusions. Indeed, the mechanical performance (such as fatigue resistance and high strain rate response) is associated with significant scatter due to the stochastic nature of these defects and their surrounding microstructure. The central objectives of this research are to: 1. Assess the effects of defect size/shape and microstructure on the fatigue behavior of AM IN718, 2. Based on the fatigue data on AM IN718, incorporate the synergistic effects of defects and microstructure on fatigue performance into a predictive model, 3. Validate this developed predictive model against the fatigue data of SS316L, and 4. Assess the effects of defects/microstructure on the high strain rate behavior of AM IN718. To achieve these objectives, a rigorous research program integrating AM fabrication, fatigue and high strain rate experiments, analysis, and numerical simulations —both conventional linear elastic finite element method and crystal plasticity— will be carried out by a team of researchers at The National Center for Additive Manufacturing Excellence (NCAME) at Auburn University, University of Alabama-Tuscaloosa, and University of Alabama-Huntsville. The experimental effort serves to provide foundational data as well as initial knowledge on the defect-microstructure synergy. The design of experiments (DoE) is devised to achieve independent control of the AM alloys' microstructural features and to evaluate the individual/synergistic effects of these features on the fatigue and high strain rate behaviors of AM alloys. The combined effect of defects/micro-structure on the high strain rate behavior of LBPBF materials is currently not well understood, and the knowledge generated in this project serves to fill this gap. In addition to the experiments, a more complete picture regarding the defect/microstructure synergy on the fatigue behavior of these materials will be provided by parametric numerical simulations. The collective findings regarding the interrelationship between defect/microstructure and fatigue performance will then be cast into a predictive model. Such a model can enable the prediction of fatigue performance of LB-PBF components based on the most critical volumetric defect and the microstructure of the material. It can also be later extended to capture the stochastic effects of both volumetric and surface defects and/or other types of loading, such torsion and multiaxial. Key components of this research not only align well with several of NASA interest areas under the 2020 NASA Taxonomy, but they also address many technical gaps identified in both the AMSC and NIST roadmaps. In fact, this research has already attracted significant interest from several NASA research centers as witness by the NASA support letters. In addition, this research led by NCAME is also highly aligned with the Alabama EPSCoR State Science & Technology Roadmap and the "Strong Start, Strong Finish" initiative on advanced manufacturing, as noted by the support letter from Governor Ivey. Through this project, not only the team's relevant technical capabilities will be enhanced, but also the collaboration within the multi-university team will be strengthened, preparing the team for future opportunities.

NASA Rapid Response Research (R3): Machine Learning Accelerated Discovery, Testing, and Characterization of Light-weight Refractory High Entropy Alloys for Space Application

Science PI: Dr. Lin Li, UA
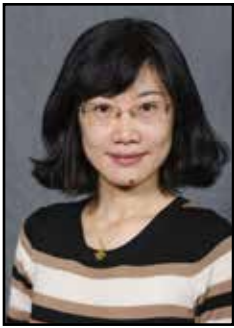
The goal of this proposal is to accelerate the discovery of light-weight refractory high entropy alloys (RHEAs) with enhanced mechanical performances by integrating first-principles material simulations, data-driven machine learning (ML) models, and experimental validation. Advanced metals and alloys with superior mechanical properties at elevated temperatures remain in high demand for aeronautical applications. Recently, a new category of RHEAs has shown great promise as the potential materials for the high-temperature structural application. The RHEAs usually contain four or five elements from the nine elements in Group IV (Ti, Zr, and Hf), Group V (V, Nb, and Ta), and Group VI (Cr, Mo, and W) with the additions of non-refractory elements such as Al, Si, Co, or Ni. The refractory elements allow the RHEAs to function as load-bearing components at a temperature even higher than that for Ni-based superalloys. However, the traditional RHEAs suffer from limited room-temperature ductility and heavyweight, significantly hindering their manufacturing and applications. To design lightweight RHEAs with balanced specific strength and ductility is of urgency and yet poses remarkable challenges in the complex multicomponent system. Firstly, considering the potentially vast number of alloys with the complexity of mpositional space, the typically used sequential trial-and-error experiments are daunting. Secondly, the feasibility of the empirical or semi-empirical rules developed for dilute alloys confronts fundamental issues due to unknown physics coming from many-body interaction. The proposed project will employ a computationally aided aterials discovery (CAMDIS) approach, and deploy multiscale ML models to data-mine the connection between electronic and thermodynamic properties of multicomponent alloys with their mechanical properties for the rapid design of light-weight RHEAs. Specifically, we will explore the compositional space of Group IV, V, and VI multicomponent alloys using first-principles based density functional theory (DFT) calculations to compute the defect energetics and identify the alloy compositions that process intrinsic ductile propensity. Multiscale neural network ML models will be developed to integrate heterogeneous simulation and experimental data and learn features and representation in the scale of relevance. The parameters of ML models will be optimized to uncover physical-based mechanisms thus enabling decision-making capabilities in precision experimentation planning. The predicted alloys will be synthesized using high-throughput magnetron co-sputtering, and then characterized to obtain structural, chemical, thermal, and mechanical properties. The new experimental data will be supplied into the dataset to train next-generation ML models for accuracy improvement. ML approaches are well suited to this problem because they can (1) operate with an incomplete understanding of the underlying physics in the novel HEA alloys but still take chemical, physical, and thermodynamic parameters to accelerate learning; and (2) find patterns in observed data, making it possible to model relationships that are unavailable in theory.

We envision the proposed ML approaches will significantly accelerate the search of multiphase multi-principal component alloys, providing novel alloy systems to tailor the mechanical performance. The created dataset and the developed ML will allow the promising alloy composition for future computational and experimental investigation towards the design of novel RHEAs for aeronautical applications
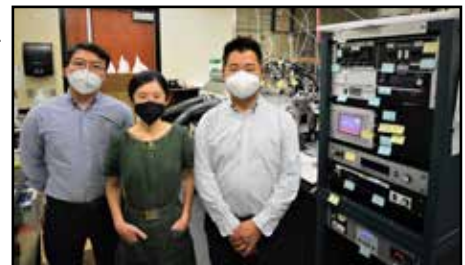
From left to right: Drs. Feng Yan and Lin Li (Metallurgical and Material Engineering) and Dr. Jiaqi Gong (Computer Science) at the University of Alabama are working on the AI enabled discovery of lightweight novel alloys for aerospace application.

NASA Rapid Response Research (R3): Application of Machine Learning to High-Resolution Earth System Model Data

Science PI: Dr. Di Tian, Auburn University
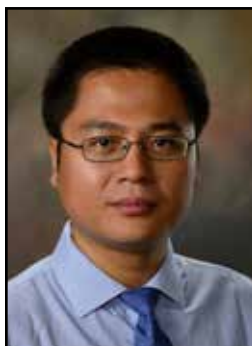
The NASA Global Modeling and Assimilation Office (GMAO) uses Goddard Earth Observing System (GEOS), a Global Climate Model (GCM), to produce high resolution atmospheric data, such as weather forecast, subseasonal to seasonal forecasts, and climate reanalysis. High quality GEOS-based precipitation estimates are fundamental to improving land surface estimates and for forecasting initial conditions from the GMAO models. In this project, we will adapt a novel deep learning architecture: super resolution deep residual network (SRDRN) to be used by the GMAO for downscaling and bias correcting GEOS-based precipitation estimates. The SRDRN algorithm was constructed by the Co-I Di Tian's team, which was inspired by a novel super scaling deep learning approach in computer vision field. The SRDRN algorithm deeply exploited full spatio-temporal dependencies of large- and local-scale climate data and therefore better captured local-, small-scale features such as extreme precipitation events compared to the classic downscaling methods. Through transfer learning the trained SRDRN algorithm in one region could also be applied to a different region without additional training. The algorithm was validated through synthetic downscaling experiments and is ready to be adapted for both downscaling and bias correcting real world earth system data. We will downscale hourly MERRA-2 precipitation data using the SRDRN algorithm with the stage IV radar 4-km hourly precipitation observations. The algorithm will be trained and evaluated over different periods and regions in the contiguous United States (CONUS). Given the results found in our synthetic downscaling experiments, we expect the SRDRN algorithm will show outstanding performance on downscaling MERRA-2 precipitation at hourly, daily, and monthly timescale. The trained SRDRN algorithm can be directly used to downscale any GEOS-based precipitation estimates in real time during historical or future periods, and can be used to produce high-resolution, radar observation-corrected GEOS-based precipitation products over any region of the globe without radar observations. Building our existing efforts in deep learning applications for high resolution earth system data, the proposed activities are expected to significantly improve the MERRA-2 precipitation as well as any GEOS-based precipitation and other land surface or near surface estimates in terms of data accuracy, resolution, and latency.

ISS Suborbital: Three-Dimensional Plume-surface Interaction and Crater Formation Dynamic Measurement in Reduced Gravity Environments

Science PI: Dr. David Scarborough, Auburn University

This 2021 Suborbital Flight Opportunity project seeks to investigate the effect of reduced and lunar gravity on the dynamic crater evolution process. To this end, the main research objectives will be: 1. Develop a new research facility for testing and evaluating current and future NASA technology 1. Explore and test the capabilities of the 3D, time-resolved stereo imaging system under development at AU 2. Non-intrusively measure 3D, time-resolved crater evolution in a full-domain experiment under (1) reduced gravity conditions obtained using the proposed drop tower and (2) lunar gravity conditions obtained during parabolic flight experiments. The project is innovative in that for the first time, we propose to use novel non-intrusive stereo imaging currently under development at Auburn to measure the time-resolved, 3D crater formation process in a full-domain, reduced and lunar gravity environment.

NASA Rapid Response Research (R3): Improved drought tolerance of mustard green with atmospheric pressure plasmas

Science PI: Dr. Kunning (Gabe) Xu, UAH

As NASA advances human space exploration, crop plants will play an important role in sustained human presence in space, on the moon, and on Mars. Crop plants such as leafy greens and fresh vegetables provide nutrients, varied texture, and flavor, and contribute to astronauts' mental health. However, growing plants in the engineered environment of space habitats can introduce multiple abiotic stresses that can impact the plant's growth and nutritional value. Drought stress is one of the important abiotic stresses. This project aims to study drought stress on 'Amara' mustard greens and if and how treatment with atmospheric pressure plasma (APP) can improve the plant's drought tolerance.

In plants, water deficiency can impair seed germination, crop yield, and the resulting nutritional content. Plants can naturally produce antioxidants and enzymes to combat the oxidative stress caused by drought. Research has shown that plasma treatment can further increase a plant's production of enzymes and proteins associated with combatting oxidative stress. This project seeks to study the effect of room-temperature APP on 'Amara' mustard greens' drought tolerance and nutrition. This project will be a collaboration among investigators at University of Alabama in Huntsville (UAH), Alabama A&M University (AAMU), and Alabama State University (ASU). The team combines expertise and lab capabilities in plasma science and technology (UAH), agriculture (AAMU), and microbiology and genetics (ASU). The project is relevant to NASA's Space Biology Program and Human Exploration Program.

The research will use a low temperature APP to treat 'Amara' mustard green seeds at different exposure times and different plasma gases. The longer exposures result in more plasma produced reactive species on the seeds, and the different gases (He and Ar) produce different amounts of reactive species. The treated seeds will then be observed for germination rate under drought and no-drought conditions to determine if the plasma affects the drought tolerance of the seed. After germination, the seeds will be plants and the resulting plant growth under drought and no-drought conditions will be studied. Physical and nutritional analyses including color, texture, nutrients such as ascorbic acid and carotenoids, antioxidant activity, and lipid oxidation will be done. Genetic analysis will be done to understand how the plasma changed the plant to produce different characteristics and nutrients. RNA will be extracted from the roots and shoot of hte plant and processed to determine the gene expression of the control and treated plants.
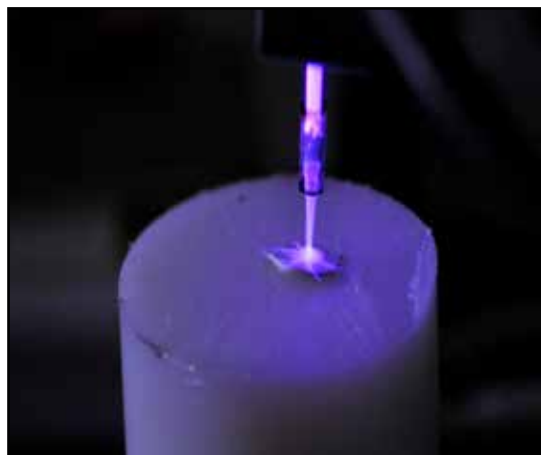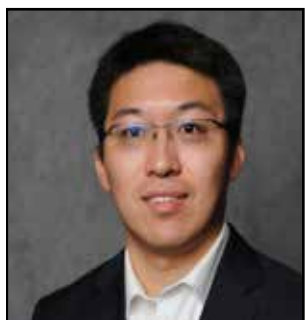

Atmospheric Pressure Plasma (APP) treatment of a pumpkin seed

NATIONAL AERONAUTICS & SPACE ADMINISTRATION EPSCoR

ISS: Evaluation on In-space manufacturing of carbon-based perovskite solar cells

Science PI: Dr. Feng Yan, UA

In-space manufacturing of highly efficient and scalable carbon-based perovskite thin film solar cells and characterize its space radiation hardness in International Space Station (ISS) is in high demand. Particularly, long-duration space missions require novel design and in-space manufacturing (ISM) to realize on-demand fabrication, repair, and recycling for the space application. In particular, the power of the entire ISS is provided by the solar panel which was manufactured on the earth.However, damage or break of the solar panel could generate severe power loss or accident for the ISS. Thus, it is desired to get fast repair and replace the solar panel through the ISM. The manufacturing process is very complicated and not suitable for the ISM due to the limited facilities, earth-independent, and microgravity conditions in the ISS. Therefore, to realize the ISM of the solar panel, an easy way to fit the limitation of the space working environment is needed. Particularly, a lightweight, stable, high efficient, and flexible solar cell ISM is highly expected to repair or replace the broken or damaged solar panel in ISS.

Nowadays, the perovskite thin film solar cell becomes a new solar cell technology with high performance with power conversion efficiency >25%, and ultralow-cost per watt photovoltaic materials, and demonstrated radiation resistance. These advantages of perovskite solar cell technology promise the space application with affordable and sustainable solar energy during space exploration and ISS. However, conventional manufacturing of perovskite solar cells still suffers from the stabilities, degradation and short term durability. In this work, we evaluate the carbon-based perovskite solar cells for the space application by integrating the carbon electrode to prevent the space radiation and suitable for printing in space to demonstrate the in-space manufacturing of highly efficient and stable carbon-based perovskite for space application. The materials structure including the free-standing carbon electrode, perovskite absorber will be analyzed to understand the stabilities in the space environment. The device performance including the parameters of the solar cell will be tested under various conditions, including the vacuum, cyclic temperature. This evaluation will pave the way for the in-space manufacturing of large scale solar cell for the future ISS and space travel to provide continuous power.
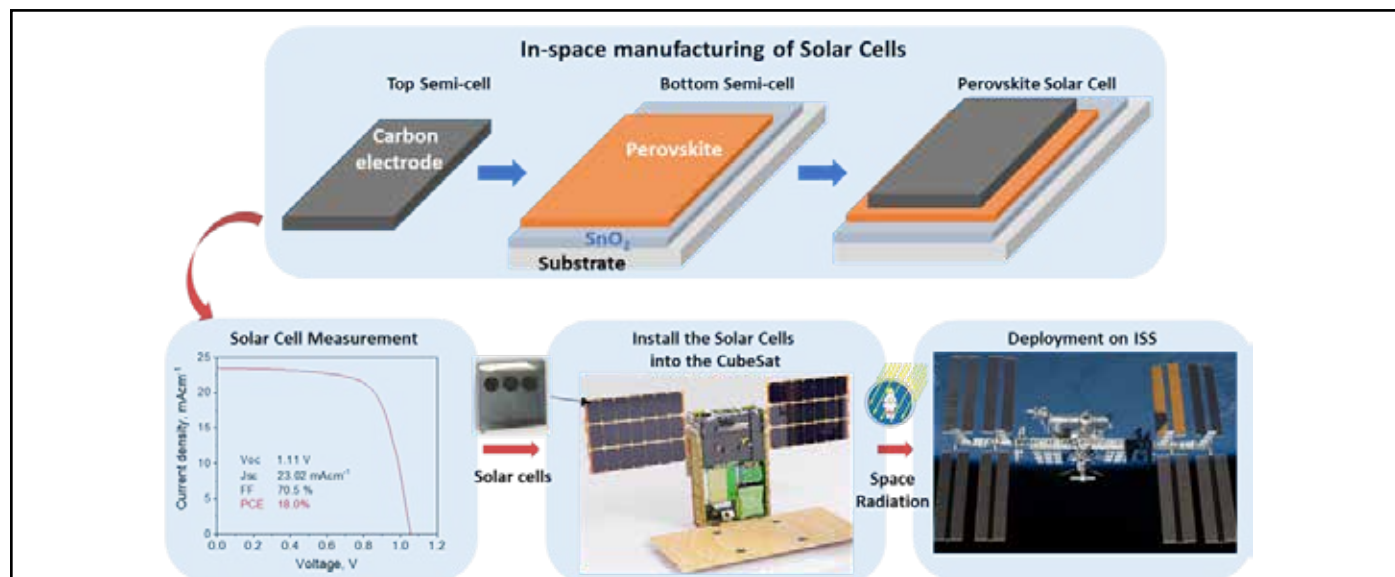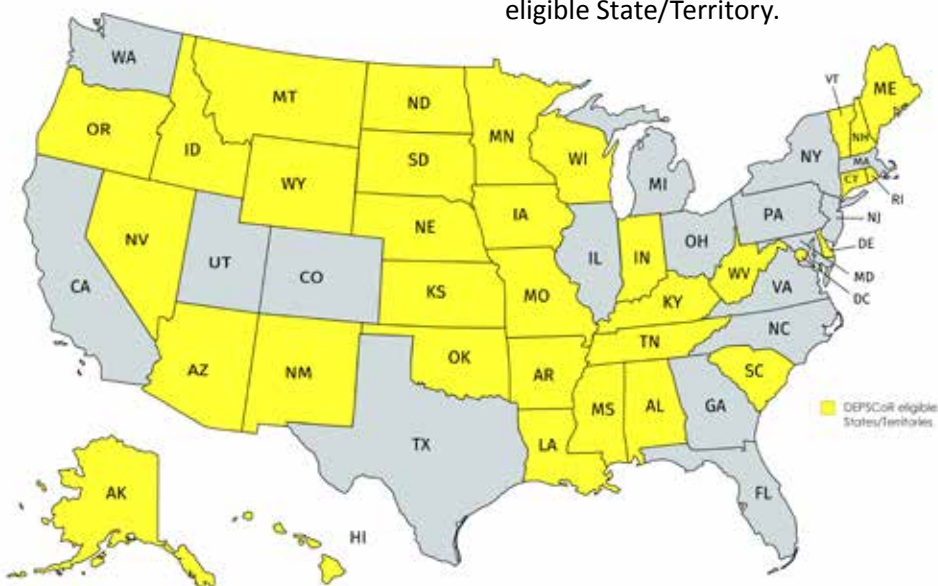
US DEPARTMENT OF DEFENSE EPSCoR

The Department of Defense EPSCoR program was legislatively authorized in 1994. It was reauthorized in 2017 and appropriated $12M in FY 2019 and FY 2020 to fund DEPSCoR. In FY 2021, Congress tasked the Basic Research Office to manage the $17M Defense Established Program to Stimulate Competitive Research (DEPSCoR). The capacity building program is designed to strengthen the research infrastructure at institutions of higher education in underutilized States and Territories. There are three major objectives for DEPSCoR:

1. Enhance the capabilities of institutions of higher education (IHE) in eligible State/Territories to develop, plan, and execute science and engineering (S&E) research relevant to the mission of the DoD and competitive under the peer-review system used for awarding Federal reearch assistance

2. Increase the number of university researchers in eligible States/Territories capable of performing S&E research responsive to the needs of the DoD

3. Increase the probability of long-term growth in the competitively awarded financial assistance that IHE in eligible States/Territories recieve from the federal government for S&E 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."

Three Key Componenets of DEPSCoR include:
Thrust 1. Collaborative DEPSCoR Competition encourages collaborations on basic research projects of interest to the Department of Defense and is structured to form a two-person team between 1) a researcher who has never served as a principal investigator on a prior DoD funded award, and 2) an investigator who will provide mentorship and has served as a principal investigator on a DoD-funded research award between Oct. 1, 2014 and September 30, 2021. U.S. Citizenship nor a security clearance is required. A collaborator may partner with more than one applicant. Both the applicant and the collaborator must be tenured or tenure-track faculty members with appointments at an IHE in a DEPSCoR eligible State/Territory.

Thrust 2. Capacity Building DEPSCoR Competition works to jumpstart capability development in the State/Territory through increased human, technical, and management resources to achieve excellence in a DoD-relevant research areas through funding to support equipment, education, research, and relevant activities. Grants awarded are intended to support the strategic objectives of Institutes of Higher Education in DEPSCoR States/Territories to achieve basic research excellence in areas of high relevance to the DoD. This award is $500K/year for 2 years.   An IHE's executive officer is required to serve as the Team Lead, the Vice President for Reseach can apply.   Each institution is limited to one application.   Applications must present the opportunities for enhanced academic research and development competitiveness and, if appropriate, industrial or economic competitiveness. A strategic plan to sustain the investment after the award must be discussed. Applications must present a management plan for coordinating multiple thrusts working on a common basic research theme. These thrusts could include, but are not limited to, purchasing new equipment, supporting new hires, and support for graduate student and post-doctoral fellows. Adequate provision for substantive commitment by the IHE's executive offices and appropriate administrative support is an important factor contributing to the success of this Capacity Building effort.
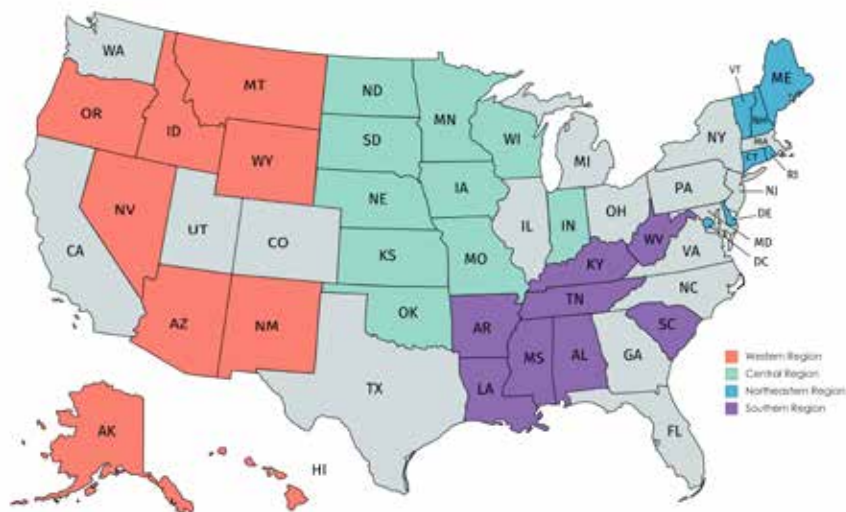
FY21 DoD Research Collaboration Funding Opportunity Announcement		
Topic Number	Service	Topic Area
1	AFOSR	Physics of Sensing
2	AFOSR	Space Propulsion and Power
3	AFOSR	Complex Networks
4	AFOSR	Atomic and Molecular Physics
5	ARO	Modeling of Complex Systems
6	ARO	Biomathematics
7	ARO	Solid Mechanics
8	ARO	Environmental Chemistry
9	ARO	Electronic Sensing
10	ONR	Nanoscale Computing Devices and Systems
11	ONR	Marine Mammals and Biology
12	ONR	Additive Manufacturing
13	ONR	Social Networks and Computational Social Science
14	ONR	Hypersonic Aerothermodynamics

Thrust 3. DEPSCoR Education and Outreach will provide information and encourage increased participation in the Department of Defense's initiatives to support national security functions.   Regional workshops were planned in the northeast, southern, central and western parts of the country but were suspended due to the ongoing COVID-19 pandemic. (see regional workshop map below)

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.

USDA Established Program to Stimulate Competitive Research (EPSCoR) States FY2007-FY2021

State	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Alabama	yes	yes	yes	yes	yes	yes	yes	yes	yes	-	-	-	-	-	-
Alaska	yes	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	yes	yes
Delaware	yes	yes	yes	yes	-	-	-	-	-	-	-	-	-	-	-
Hawaii	yes	yes	yes	yes	yes	-	-	-	-	-	-	-	yes	yes	yes
Idaho	yes	yes	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	yes	yes

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

EPSCoR/IDeA Funding Chart

Agency	FY17 Enacted	FY18 Enacted	FY19 Enacted	FY20 Enacted	FY21 Enacted	FY22 Budget Request
NIH	$333.4	$351.0	$361.6	$386.6	$396.6	TBD
NSF	$160.0	$170.7	$175.6	$190.0	$200.0	TBD
DOD	-	-	$12.0	$12.0	$17.0	TBD
DOE	$15.0	$20.0	$20.0	$25.0	$25.0	TBD
NASA	$18.0	$18.0	$21.0	$24.0	$26.0	TBD
USDA	$56.25*	$60*	$62.3*	$63.8*	$65.3*	TBD
	$526.4	$559.7	$590.2	$637.6	$664.6	TBD

(amounts in millions)

*Represents 15 percent of the Agriculture and Food Initiative (AFRI) budget