MIRO

MUREP Institutional Research Opportunity

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NASA’s MUREP Institutional Research Opportunity

The mission of the National Aeronautics and Space Administration (NASA) Office of Education is to advance high-quality Science, Technology, and Engineering and Mathematics (STEM) education across the United States. To maximize these efforts, NASA has consolidated its education activities into the Minority University Research and Education Project (MUREP). MUREP supports training and development of students and faculty in STEM at targeted colleges and universities, and provides opportunities for research and education to inspire and prepare increasing numbers of students for STEM careers.

As an integral part of this mission, the MUREP Institutional Research Opportunity (MIRO), was established to strengthen and develop the research capacity and infrastructure of Minority Serving Institutions (MSIs) in areas of strategic importance and value to NASA’s mission and national priorities. Overall, MIRO awards aim to promote STEM literacy and to enhance and sustain the capability of institutions to perform NASA-related research and education, which directly supports NASA’s four Mission Directorates – Aeronautics Research, Human Exploration and Space Operations, Science, and Space Technology.

The goals of MIRO awards are to:

1. Expand the nation’s base for aerospace research and development by fostering new aerospace research and technology development concepts aligned with NASA research priorities as defined by NASA Mission Directorates.

2. Promote institutional advancement and enhanced research capacity through partnerships among MSIs, other academic institutions, NASA research assets, and industry.

3. Strengthen participation of faculty, researchers, and students at MSIs in the research programs of NASA’s Mission Directorates.

4. Facilitate mechanisms to ensure the diversity of workers at NASA and in undergraduate and graduate degrees awarded to students from MSIs in NASA-related fields reflects the diversity of our nation.
ALIGNMENT WITH NASA RESEARCH PRIORITIES
The Center for Applied Atmospheric Research and Education (CAARE) was established in 2015 at San Jose State University (SJSU), an AANAPISI and HSI serving institution. The goal is to expose undergraduate and graduate students to the various research projects associated with the field of atmospheric science.

In collaboration with NASA ARC and MSFC since 2016, CAARE summer interns are diving into projects to assist in areas such as tracking air pollution transport with space-borne lidars; utilizing remote sensing and GIS to analyze water resources and urban heat island effects; atmospheric rivers and precipitation distributions; climate change and variability in California crop production and wildfires; Puerto Rico coral reefs; developing training sets and input for a novel cloud classification algorithm, the relationship between California’s current system in the ocean and CO2; land cover and climate changes on water quality and quantity; and modeling radiative transfer through vegetation canopies.

BUILDING RESEARCH CAPACITY
The CAARE center is working closely with NASA researchers on selected research projects in addition to summer activities. Several NASA ARC scientists are serving as a thesis committee of CAARE grad students and teaching classes in the Department of Meteorology and Climate Science at SJSU. The goal is to broaden the Center research capacity and better align it with the NASA research activities in the Science Mission Directorate (SMD). To utilize our research capacity, CAARE and our partners utilize Air Quality Labs and High Performance Companies as our research facilities.

SUPPORTING STUDENTS
CAARE has supported more than 50 students including summer interns, undergrad and grad students at SJSU since 2015. In the summer of 2018, 14 bright summer interns (CAARE fellows) conducted research projects with mentors at NASA ARC and MSFC.

CAARE summer interns are also encouraged to collaborate with their mentors continuously during the regular academic year. CAARE supports students to present research work in professional conferences.

Many of our prior CAARE fellows are either pursuing M.S. or Ph.D. from different institutions or have found full-time positions in related fields.

PARTNERSHIP AND OUTREACH
Our critical partners, University of Alabama in Huntsville (UAH), Universities Space Research Association (USRA), and Fond du Lac Tribal and Community College (FDLTCC) influence a diverse environment in atmospheric-related disciplines in graduate and undergraduate levels. Our external partners, who support our program, are Air Resources Board, Santa Clara Valley Water District (SCVWD), Advanced Clustering Technologies Inc., and the Bay Area Quality Management District (BAAQMD).

For our outreach, our program is planning to create a summer camp to educate the younger generation about the importance of atmospheric-related disciplines in the search for a brighter future. This summer camp is designed for middle school students, who desire to learn about weather and climate.

FUTURE AND SUSTAINABILITY
In the next two years, our goal is to expand our program to provide more internships for college students, who desire to utilize their respected major in assisting with different projects for CAARE and NASA centers. In addition, we strive to further our outreach to the youth on the importance of atmospheric-related disciplines and its effect on Earth.

Our sustainability efforts will also improve by developing long term collaborative research work with ARC and MSFC as well as NASA Digital Earth Virtual Environment and Learning Outreach Project (NASA DEVELOP) program. This will add more future workforce to the research needed to accomplish goals for each program. In addition to continue our collaboration with NASA research activities, CAARE will collaborate and seek funding opportunities from other federal or local agencies to further sustain the CAARE activities in research and education.
ALIGNMENT WITH NASA RESEARCH PRIORITIES
In 2009, the University of Texas at El Paso (UTEP), a Hispanic-serving institution, established the MIRO Center for Space Exploration and Technology Research (MIRO cSETR). The MIRO cSETR supports NASA's vision of space exploration by focusing on advanced capabilities in the areas of chemical propulsion and small spacecraft. The MIRO cSETR vision is to establish a sustainable minority university center of excellence in aerospace research through strategic partnerships and to educate a diverse future aerospace workforce.

BUILDING RESEARCH CAPACITY
MIRO cSETR has approximately 16,000 square feet of on-campus laboratory space, a 400-acre airport and flight test range, and 8,000 acres of land for development of off-campus test facility in Fabens, Texas. On-campus research facilities houses research involved in small satellite development, green-propellant and small spacecraft propulsion development, unmanned aerial systems, fundamental combustion research, reactive material testing, material characterization, and computer-modeling capabilities (CFD & FEA). Off-campus facility houses research activities for testing of cryogenic propulsion systems and high-pressure combustion devices. UTEP, industry and local government partners have supported research capacity development effort by providing more than 6 million dollars for physical infrastructure and equipment fund. Since 2009, cSETR has received more than 11 million dollars from other federal agencies through competitive grant funding.

Currently, MIRO cSETR supports research and professional development of more than 120 faculty, staff, and student researchers. Research teams have published over 40 articles, presented over 100 posters and papers at over 20 national conferences, and received 2 patents during the 2015 project cycle.

SUPPORTING STUDENTS
The center has institutionalized its research and education mentoring pedagogy by contributing to UTEP’s Engineering Programs through expansive student engagement in projects and curriculum developments. Since 2009, cSETR has supported more than 600 students and 150 internships. MIRO cSETR trained graduates to move on to employment with agencies and companies such as NASA, Lockheed Martin, Raytheon, the Department of Defense, Intel, Blue Origin, General Electric, and others. During the 2015 project cycle, 40 undergraduates and 25 graduates have been supporting the development of cryogenic propulsion systems, small satellite development, and green propellant research at internships in NASA Johnson Space Center (JSC), Marshall Space Flight Center (MSFC), Glenn Research Center (GRC), and Kennedy Space Center (KSC). Students within the center have been awarded the Harriett G. Jenkins Graduate Fellowship, the Space Technology Research Fellowship, and were collaborating authors in 2017 Best Paper by the American Institute of Aeronautics and Astronautics’ Liquid Propulsion Technical Committee.

PARTNERSHIPS AND OUTREACH
The center has forged a long-term strategic partnership with NASA JSC, NASA MSFC, NASA WSTF, and Lockheed Martin Corporation (LMC). The LMC partnership, which encompasses all business units of LMC, includes infrastructure development fund, internships, curriculum development, adjunct teaching, and research and development projects.

Through the cSETR MUREP Aerospace Academy for the Southwest, our goal is to inspire, engage, and educate students, parents, and communities. MAA Southwest services K-12 with age-appropriate NASA, provided curriculum enhancement activities in school, after-school models, and through campus sessions at UTEP, that conceptually enriched with science and engineering concepts. We have engaged 9 regional school districts, training over 200 teachers to teach NASA based curriculum, and involved over 7,000 students through events, summer camps, seminars, and outreach activities since 2009.

FUTURE GOALS AND SUSTAINABILITY
In the next two years, the Center expects to receive more than 5 million dollars of infrastructure development funds from UTEP and other industry partners to expand its research capabilities in small spacecraft, cryogenic propulsion systems, and unmanned aerial vehicles. MIRO cSETR will continue to maintain its excellent track record of securing competitive research funding from other federal agencies. The cSETR is also expanding its small business partnerships through the support from the Economic Development Administration (EDA) and the County of El Paso. The MIRO cSETR has received two Phase I and one Phase II NASA SBIR/STTR funding this year.
Data Intensive Research and Education Center for STEM (DIRECT-STEM)

California State University, Los Angeles
MUREP INSTITUTIONAL RESEARCH OPPORTUNITY (MIRO)
CYCLE 6 MID-PROJECT UPDATE, SUMMARY, AND FUTURE PLANS

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ALIGNMENT WITH NASA RESEARCH PRIORITIES
In 2015, California State University Los Angeles, a Hispanic-serving institution, established the DIRECT-STEM to recruit and train students from under-represented groups and inspire them to become future leaders in STEM-related professions with strong NASA science competence. In collaboration with the Jet Propulsion Laboratory (JPL), the center has been contributing to NASA's research priorities of Earth Science (Atmospheric Sciences, Water & Carbon Cycles) and Astrophysics & Space Sciences (Origins of Stars and Planets), and JPL’s Center for Data Science and Technology (Cloud computing). Our research and training are closely in alignment with missions of AIRS, GRACE, GPM, MODIS, SMAP, TES, Hubble Space Telescope, Herschek & Spitzer Space Observatory, Atacama large Millimeter Array (ALMA), etc.

BUILDING RESEARCH CAPACITY
We have a computer server, housed at the college of ECST, that meets our data storage and computational needs for research and training. Our research has focused on (1) Earth’s hydrological cycle and its changes, especially related to precipitation, water vapor, soil moisture through data computation and modeling; (2) Large scale data analysis and machine learning based data processing and neutral networks based reinforced deep learning models in data analyzing; (3) Understanding the origin of solar system using Spitzer Space Telescopes.

To date, DIRECT-STEM Center faculty and student scholars have published 23 peer-reviewed manuscripts and presented 53 posters and papers (including 14 invited talks) at 23 local, regional, national, international conferences, and institutes. Faculty has published in high-impact journals including Science Advances, Geophysical Research Letters, Environmental Research Letters, etc.

SUPPORTING STUDENTS
To enhance student knowledge and research skills, the Center has developed and conducted 18 mathematics, statistics, computation, and research training workshops for 143 STEM students from Cal State LA, community colleges, and other local universities, hosted 12 multi-disciplinary research seminars, and modified 4 undergraduate and graduate level courses to introduce NASA's products into classroom lectures/activities/student projects. GEOG5100: Graduate Seminar in Physical Geography Research (Dr. Ye); CS 5940: System Engineering (Dr. Guo); CS2800: Numerical Methods for Engineers (Dr. Lopez); and GEOL5700: Remote Sensing in Hydrology (Dr. Li).

We have provided 43 students with support for intensive hands-on research development. Nine undergraduates and 23 graduates have interned at JPL and Goddard during the last 3 summers; among these, 12 graduate students have year-round internships/research jobs for 1-2 academic years or additional summer internship with JPL mentors. One student became a full-time employee at JPL and 5 undergraduate students advanced to a master degree program at UCLA, UCSD, and Cal State LA. Seven students have advanced (or will start) Ph.D. programs at R-1 universities including UCI, UCLA, UCSB, Vanderbilt, U of Washington, and IMPRS in Heidelberg, Germany. One graduate student interned at Cooperative Institute for Climate Science, Princeton Univ. One graduating undergraduate student won a National GEM Fellowship and the NSF Graduate Research Fellow award and is going on to UCLA for a Ph.D. this fall.

PARTNERSHIPS AND OUTREACH
A critical partner of the Center has been the University of California, Irvine (UCI). UCI’s data science center and its team have delivered week-long workshops to our research students that include an introduction to data science and coding, research practice projects, lab tours, and information sessions on how to apply for Ph.D. programs. Many of our collaborators have very close relationships with our faculty and have assisted in our student research project development, served as seminar speakers, provided internships, and accepted our students into their doctoral programs.

We have also engaged in outreach to K-12 educators and their middle to high school students through annual Satellite and Education Conferences at Cal State LA. The teachers participated in many workshops and training sessions on NASA data, educational material development, research discoveries, etc.

FUTURE GOALS AND SUSTAINABILITY
The Center expects to continue recruiting and training our students through well-constructed and effective activities. Sustainability efforts include strengthening our expertise in data science through recruitment of new faculty members and revising student training to include Python coding and applications on concepts in mathematics/statistics. Faculty will continue to create/modify more courses at both undergraduate and graduate levels to incorporate NASA data into lecture and class projects.

External funding efforts include a recent award of NSF proposal of Establishing Spokes to Advance Big Data Applications (BD Spokes). This proposal focuses on curricular development across disciplines to bring big data into classrooms through service learning engagements with local communities, 3 years’ award totaling $950,587.
Fellowships and Internships in Extremely Large Dataset (FIELDS)

UNIVERSITY of California, Riverside
MUREP INSTITUTIONAL RESEARCH OPPORTUNITY (MIRO)
CYCLE 6 MID-PROJECT UPDATE, SUMMARY, AND FUTURE PLANS

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ALIGNMENT WITH NASA RESEARCH PRIORITIES
In 2015, University of California, Riverside, a MSI serving institution, established the FIELDS Project through the NASA MIRO grant to train and educate students (mainly minorities) in Big Data analysis techniques. FIELDS offers activities at multiple levels:

• High school students attend a summer academy at UCR where they complete college courses in STEM fields and are made aware of FIELDS opportunities;
• Undergraduate students complete 10-week summer internships at JPL and academic year research internships at UCR;
• Graduate students are eligible for multi-year graduate student fellowships to work on data intensive topics of interest to NASA; and
• Post-Doctoral fellows conduct research in areas covering future NASA missions.

A new, self-supporting, online Master of Science and Engineering program in Data Science was established in 2017, and currently brings in about $500K per year in tuition fees. With a focus on big data this degree is designed for staff from NASA and other federal agencies who work in data analysis, processing, and statistics.

BUILDING RESEARCH CAPACITY
Through FIELDS, we have established a Data Science Center. The university provided a new and modern building to house the Center and five new faculty lines to support research efforts. New faculty cover a wide range of disciplines, including astrophysics, computer science, statistics and genomics. Through FIELDS, we are also building a visualization lab. Our new Astrobiology Center at UCR works directly with other NASA centers. FIELDS faculty have developed expertise in analyzing data from Euclid and WFIRST (two future NASA missions) and are training graduate students to lead parts of Euclid and WFIRST projects. Overall, scholars supported by the FIELDS Project produce 10-15 papers per year in refereed STEM journals.

SUPPORTING STUDENTS
To enhance student knowledge and research skills, the FIELDS Project has provided research fellowships for graduate students in all the STEM disciplines. UCR has contributed funds to complement NASA-MIRO grant supporting graduate students. The students in the FIELDS program study in their selected area with a serious concentration on big data and visualization. When they graduate, they will be an expert in their field, making them very much in demand on the job market. The undergraduate students are supported by FIELDS MIRO to perform summer internships at NASA centers as well as academic year internships at UCR through Chancellor’s funds. Every year we support 15 graduate students, 30 UG summer interns, 40 high school students and 2 post-doctoral scholars.

PARTNERSHIPS AND OUTREACH
We are engaged in outreach to approximately 30 K-12 public schools in seven different districts (Riverside, Perris, Moreno Valley, Corona, San Jacinto, Oxnard and Santa Monica). We have already reached over 30,000 people since the beginning of the NASA MIRO FIELDS program.

Engagement and public outreach innovative activities and resources have been created exclusively for the FIELDS Project, including the development of a virtual reality demonstration of big data in astronomy, new multi-sensory STEM activities that cater to underrepresented groups, massive STEM events delivered in Spanish, and a web-based educational interactive that uses big data to educate users on wildfire spread.

Outreach covers subjects in astrophysics, cosmology, planetary sciences, suborbital programs, robotics, biology and heliophysics, in line with NASA priorities.

FUTURE GOALS AND SUSTAINABILITY
In the next two years, the NASA MIRO FIELDS program will continue the education and training of minority students while working to further sustain the program by achieving the following goals: (1) Increase course offering in the online Masters in Data Science; (2) Establish a complementary program for the Riverside Unified School District (RUSD) to support minority high school students to attend colleges during summer to take courses in STEM fields; (3) Establish the NASA MIRO Visualization Center at UCR; (4) Develop an online course in “Origins” that includes modules on the origins of the universe; (5) Initiate a Data Science consultancy; (6) Implement FIELDS virtual reality tools in K-12 classrooms; (7) Establish a new Center for Origins and Deep Time (CODT) that aligns with NASA priorities; (8) Continue an active role in data science aspects of the Euclid and WFIRST NASA missions; (9) Provide leadership parts in ground-based observational efforts for calibration of Euclid data; and (10) Initiate free annual workshops on data science techniques for students, staff, and community members.

Currently, we have submitted proposals to NASA for a program (Launchpad from High School to NASA) that will engage students in STEM from high school to careers; to the University of California to establish the CODT; and to private foundations for data science related research and training.
Hampton University Center for Atmospheric Research and Education, HU:CARE

MUREP INSTITUTIONAL RESEARCH OPPORTUNITY (MIRO)
CYCLE 6 MID-PROJECT UPDATE, SUMMARY, AND FUTURE PLANS

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ALIGNMENT WITH NASA RESEARCH PRIORITIES
In 2015, Hampton University, an HBCU, established the Center for Atmospheric Research and Education to develop multiple research efforts in atmospheric sciences using remote-sensing, in-situ, and laboratory techniques, and creating educational programs in atmospheric science, Earth system science, and science communication. In collaboration with NASA Langley Research Center, the Center has contributed to NASA Strategic Objective 1.1: Understand the Sun, Earth, Solar System, and Universe [NASA Strategic Plan, 2018], particularly the goal of “Safeguarding and Improving Life on Earth.” Our work is aligned primarily with the Science Mission Directorate and its Earth Science programs, although we are pursuing some development work relevant to the Space Technology Mission Directorate.

BUILDING RESEARCH CAPACITY
To build institutional research capacity, we have deployed a Satellite Direct Broadcast Receiving System as well as upgraded our optical research facility. The University/College has supported this effort by providing space for the DBRS antenna. We have leveraged support from DoD and NSF to add complementary facilities including an AERONET Sun Photometer, meteorological and ozone sondes, and a state-of-the-art massively parallel computer.

Current HU:CARE faculty, researchers, and student scholars have published 24 articles and presented 58 posters and papers at a dozen national conferences. Our team is developing new methods of combining satellite weather data for improved forecasting of severe thunderstorms and tornadoes, participating in studies of ozone around the Chesapeake bay, and creating new ways of using light to measure and understand the atmosphere.

SUPPORTING STUDENTS
To enhance student knowledge and research skills, the Center has developed a joint course in satellite meteorology with our partner, the University of Wisconsin Madison. In addition, we have developed the Virginia Earth Systems Science Scholars program for high-school and junior college students to give students an Earth-science advanced placement option and to inspire them to study the complex and interdependent web of systems that make our planet work.

Through this project, we have provided students with support for their students and internships at NASA centers. Currently, 6 undergraduates and 2 graduates have been contributing to projects across the Science Directorate at NASA Langley Research Center. Students supported by this program have contributed to airborne atmospheric science campaigns, field campaigns to study ozone, severe weather monitoring, and orbital measurement of air quality.

PARTNERSHIPS AND OUTREACH
This center has been a successful partnership between four-year universities (UW and UMBC), non-profit companies (NIA), the Virginia Space Grant Consortium, and Hampton University.

We have also developed a unique outreach program in which Hampton University journalism and communication students work with the outreach professionals at the National Institute of Aerospace to create science communication materials for the public and students at all levels.

FUTURE GOALS AND SUSTAINABILITY
In the next two years, the Center expects to increase our involvement in research at Langley Research Center by placing more students working directly with NASA mentors. We have also leveraged HU:CARE support to bring in over $1M in additional external funding to continue to build out our atmospheric science infrastructure.
Langston University NASA Advanced Research in Biology Center (LUNAR-BC)

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Alignment with NASA Research Priorities
In 2015, Langston University, a Historically Black College and University, established the Langston University NASA Advanced Research in Biology Center to develop natural countermeasures to the dysregulated immune system affecting crewmembers under extended spaceflight conditions. In collaboration with NASA Johnson Space Center, the LUNAR-BC program has contributed to the NASA Human Research Roadmap in the area of Human Health Countermeasures for risk of adverse health event due to altered immune response.

Building Research Capacity
To build institutional research capacity, we have equipped the newly created Science Research Institute with advanced instrumentation for high impact biomedical research. Langston University has supported this effort by providing an entire building on campus to house the NASA MIRO research center. A QToF mass spectrometer, cell sorter and an Illumina sequencer was acquired to conduct an in-depth study of immune cells and natural countermeasures under micro-gravity conditions.

Currently, LUNAR-BC faculty, researchers, and student scholars have presented four posters and papers at two national conferences. One of the LUNAR-BC students won first place for his oral presentation at the Annual Biomedical Research Conference for Minority Students (ABRCMS) in the fall of 2017. A LUNAR-BC student presented a poster at the Harvard Medical School New England Science Symposium and won first place for the poster presentation. During the Oklahoma EPSCoR Research Day at the Capitol, one of the LUNAR-BC students won second place for a poster presentation.

Supporting Students
To enhance student knowledge and research skills, the Center has contributed to NB 1114 Natural Science Biology I course. Students taking NB 1114 participate in the LUNAR-BC NASA challenge award, where they develop proposals for a NASA human health countermeasure. The winning team receives a stipend and a trip to NASA JSC. Through this project, we have provided students with support for their internships at NASA centers and on campus. Currently, eight undergraduates have participated in biomedical research at NASA Johnson Space Center during summer terms.

Partnerships and Outreach
Critical partners of the Center are NASA Johnson Space Center, University of North Texas Health Science Center, Harvard Medical School and Stanford University. These critical partners have assisted greatly with the research and student training. The director of the UNTHSC animal facility is helping to set up a small animal model facility in the Science Research Institute at LU. This will allow LU to scale up the NASA studies from the test tube to small animal models. We have also engaged in outreach to Rose State College (RSC), a local community college. Students from RSC have participated in summer research internships with LUNAR-BC over the last three summers.

Future Goals and Sustainability
In the next two years, the Center expects to engage additional agencies and new partners with the LU Science Research Institute. To that end, we have started working with our partners on collaborative research proposals. We currently have one of our faculty team members funded with a Department of Agriculture research award. The research with the LUNAR-BC program will lead to a needed increase in the understanding of natural compound formulations to enhance the immune system in humans. This will allow for low cost natural treatments for immune related diseases in humans and sustaining the immune system for astronauts on extended space missions.
Merced Anomaterials Center for Energy and Sensing (MACES)

University of California at Merced
MUREP INSTITUTIONAL RESEARCH OPPORTUNITY (MIRO)
CYCLE 6 MID-PROJECT UPDATE, SUMMARY, AND FUTURE PLANS

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ALIGNMENT WITH NASA RESEARCH PRIORITIES
In collaboration with Langley, Ames and Glenn, Merced nanomaterials Center for Energy and Sensing (MACES) was established in fall 2015 at Merced, the University of California’s newest campus. We have been continuously cultivating MACES into a research institute that is not only known for conducting excellence in materials-based research for high performance energy and sensing devices for space exploration (Space Technology Mission Directorate and Human Exploration and Operations Mission Directorate), but also for offering a multidisciplinary and supportive education environment to promote STEM education at the Merced campus, where over 55% of students are from underrepresented groups.

BUILDING RESEARCH CAPACITY
Our collaborative research projects are focused on creative applications of nanomaterials to produce power systems that are efficient, durable and lightweight for space exploration, to enable development of sensing devices for monitoring human health and environment. These new systems can perform well in a variety of extreme environments, not only in space but also on Earth.

To build institutional research capacity, MACES has developed and implemented a proposal call that encourages and supports research projects that are innovative, collaborative, build ties with NASA, and have potential for long-term growth. We have also made coordinated efforts to improve research infrastructure. With the support of the MIRO award and the University, we have purchased a high-end Zeiss Gemini 500 scanning electron microscope, which has filled a long-standing gap in UC Merced’s capacity in imaging nanomaterials. Center resources and collaborative opportunities have enhanced the ability to compete for additional funding to sustain our efforts in research and education. In less than three years, MACES faculty have secured extramural support in excess of $4.3 million. The total includes $1.8 million in instrumentation funding from Department of Defense (DOD) and National Science Foundation (NSF) in molecular characterization and nanomaterial structural imaging, and $2.1 million in research grants, including major grants from NSF and DOE. We have published over 40 peer-reviewed papers in the area of nanomaterials enabled power and energy systems. Among them, 12 papers are joint publications from 2-3 faculty groups. Moreover, a number of them were published in prestigious journals in materials research. Students have presented MACES sponsored research at national conferences 20 times during the last 2 years.

SUPPORTING STUDENTS
We have implemented a multipronged and vertically integrated approach to attract and train students. Over the 2.5 years, we have offered 90 fellowship awards to both undergraduate students at UC Merced and local non-UC Merced students and around 90 fellowship positions to our graduate students. Currently, we are supporting fourteen underrepresented PhD students. The percentage of underrepresented students participants is significantly higher than the national average. We have further expanded our research collaboration with NASA by growing from two NASA Center affiliations to four NASA Center partnerships. We have tripled the number of students sent to NASA Centers for conducting summer internship experiences from year 1 to year 3. These new exciting developments have provided more opportunities for students working with NASA scientists and engineers. Significant student accomplishments are exemplified by six NASA awards and three external fellowship awards.

PARTNERSHIPS AND OUTREACH
We have further aligned our research projects with NASA Mission Directorates. These projects include new polymer-based energy transducers (NASA-Langley); Nanomaterial enabled biosensors for monitoring crew health (NASA-Ames); Power management (JPL) and battery-based energy storage and solar cell stability (NASA-Glenn, UCSC). To attract more students from underrepresented groups into STEM fields, a multi-pronged approach has been taken. This includes an annual Open House to introduce the general public to our Center’s research and educational programs and research projects, high-school to NASA-Ames field trips and an annual summer REU program that provides local college students with research experience and help them prepare for graduate studies. MACES faculty and graduate students have designed 6 nanotechnology modules which have been demonstrated to over 1500 local high school students. All of these programs have received extremely positive reviews from the participants.

FUTURE GOALS AND SUSTAINABILITY
MACES is becoming a significant, multi-disciplinary research center that serves as a focal point for the participating faculty to apply for and acquire federal grants. In addition, we are also establishing strong educational and outreach programs that our faculty can leverage when applying for funding. We will continue to foster core research competences in energy materials and sensing materials by facilitating additional collaborations within UC Merced and with other institutions, NASA and industry, and committing new resources to help faculty improve grant writing. In parallel, we will recruit and train graduate students who can tackle complex and high impact problems in nanomaterials. With strong research capacities, we will become a major contributor to the development of nanomaterials that enable space missions. Moreover, MACES will also be positioned to obtain major center grants from federal funding agencies such as NSF, DOD and DOE.
ALIGNMENT WITH NASA RESEARCH PRIORITIES
In 2015, Delaware State University, a Historically Black College and University, established the Optics for Space Technology & Applied Research (O*STAR) to conduct research on applications of optical sciences on space explorations. In collaboration with Goddard Flight Space Center, the Center has contributed to the mission of NASA's Science Mission Directorate (SMD) and Space Technology Mission Directorate (STMD) in the research areas—laser-induced breakdown spectroscopy investigations for planetary science, development of sodium-LIDAR altimetry, development of mid-infrared integrated sensing and imaging systems, and design and fabrication of uncooled infrared detectors.

BUILDING RESEARCH CAPACITY
To build institutional research capacity, we have enhanced the research capabilities of Optical Sciences of Applied Research (OSCAR) labs. Significant progress was made in areas of developing novel systems, novel materials and technologies for space application e.g. laser-based sensors and LIDAR systems for extra-terrestrial exploration, MARS rover 2020 program. The University has supported this effort by providing a new building for doing research on optical sciences and applications. 45 Center faculty, researchers, and student scholars have published 30 refereed journal and conference proceedings and more than 30 Conference & Technical Presentations. Two patent applications had been submitted on uncooled infrared detection by Dr. Rana where students were listed as co-applicants.

SUPPORTING STUDENTS
To enhance student knowledge and research skills, the Center has contributed to offer PhD in Optics degree (only to be offered at an HBCU). This degree includes academic curriculum with specialization in optical technologies, photonic materials and research areas integrated with all-year round internships to prepare future workforce for NASA. 25 students completed their Bachelor of Science, four students completed their Master of Science in Applied Optics; another six students completed their PhD in Optics degree. One of the graduating students was awarded with presidential award for a perfect GPA.

Through this project, we have provided students with support for their students and internships at NASA centers. Currently, 12 undergraduates and 2 graduates have completed internships at NASA Goddard Flight Space Center.

PARTNERSHIPS AND OUTREACH
A critical partner of the Center has been the University of Delaware, Los Alamos National Laboratory, NASA Goddard Flight Space Center, University of Massachusetts at Lowell for research collaboration and student internship. We have also engaged in outreach to Delaware Aerospace and Educational Foundation, local school districts and Dover Public Library through activities related to our research on applications of optical sciences.

FUTURE GOALS AND SUSTAINABILITY
In the next two years, the center expects to enhance the research infrastructure and capabilities. O*STAR Center efforts will be sustained through new and diversified course offering e.g. new integrated MS-PhD program, diversifying our research portfolio to include new federal agencies, foundations and industry partners. To that end, O*STAR Center scientists have already secured more than $2M funding from other sources than NASA to add sustainability to the center since January 2017. We hope to collaborate with industries to sustain our center in addition to federal funding.
Physics and Astronomy with Authentic Research Experience (PAARE Center)

University of Virgin Islands St. Thomas

MUREP INSTITUTIONAL RESEARCH OPPORTUNITY (MIRO)
CYCLE 6 MID-PROJECT UPDATE, SUMMARY, AND FUTURE PLANS

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Physics and Astronomy with Authentic Research Experience (PAARE Center)
University of Virgin Islands St. Thomas

ALIGNMENT WITH NASA RESEARCH PRIORITIES
The University of Virgin Islands St. Thomas, a Historically Black College and University, established the Physics and Astronomy with Authentic Research Experience (PAARE) Center in 2015. The PAARE degree program is designed to focus on enhancing students’ university STEM education through increased opportunities to engage in research. In collaboration with NASA’s Goddard Space Flight Center (GSFC), PAARE efforts connect our students to research opportunities throughout the astrophysics community and, ultimately, connect our graduates to employment opportunities in the United States Virgin Islands (USVI) and throughout the country.

BUILDING RESEARCH CAPACITY
UVI now offers a 4-year Bachelor of Science degree in physics with an astronomy research application. Two newly hired physics faculty have joined the university in support of this effort. In the first year of the official UVI-Physics B.S. program, three students have declared majors. UVI is on track to graduate its first class of physics B.S. students by 2019.

An X-ray detector test stand at UVI has been built and actively engages UVI students in detector development activities associated with the GSFC X-ray detector lab. Substantial refurbishment and upgrades to the Etelman Observatory began during the Fall 2016. These upgrades and refurbishments make the facility better capable to house students during research projects, to support faculty research activities, and to welcome visitors to Etelman Observatory outreach and education activities.

SUPPORTING STUDENTS
UVI students are involved in operations and calibrations at the Etelman Observatory, and many participate in NASA/GSFC internships and projects each summer. Undergraduate and graduate students continue to participate in Research Assistant and Teaching Assistant opportunities. A Peer-Led-Team-Learning (PLTL) concept has been implemented as a regular component of the physics curriculum. Peer-Led Team Learning (PLTL) is a nationally recognized research-based model of teaching and learning for university STEM courses. In PLTL, students who have done well in a course are recruited to be peer-leaders, who meet with a small group of students to engage in problem solving and discussion of course material.

PARTNERSHIPS AND OUTREACH
Outreach has been successful through a combination of K-12 school and public visits to the Etelman Observatory, presentations by UVI faculty to local high schools to promote the UVI physics program, and public lectures given by visiting researchers. A partnership with Orangewave Innovative Science (OWIS) has expanded opportunities for research in solar physics and climate change. Together with NASA/KSC, the Etelman Observatory USVI Regional Educator Resource Center (ERC) has been established to provide educational outreach and resources in astrophysics.

FUTURE GOALS AND SUSTAINABILITY
UVI faculty and students now regularly collaborate with researchers from NASA/GSFC, CofC, and USAF Academy throughout the year and over the summer. In addition, we have now also begun new collaborations with the Harvard–Smithsonian Center for Astrophysics, University of Wisconsin-Madison, University of Texas-Austin, US Department of Agriculture and the Environmental Protection Agency.

IMAGES
Caption: The UVI Observatory, located at 1325 ft atop Crown Mountain on the island of St. Thomas in the US Virgin Islands, houses a research-grade 0.5 m automated Cassegrain telescope. (image found at https://observatory.uvi.edu/)
Solid High Energy Lithium Battery (SHELiB)

Xavier University of Louisiana
MUREP INSTITUTIONAL RESEARCH OPPORTUNITY (MIRO)
CYCLE 6 MID-PROJECT UPDATE, SUMMARY, AND FUTURE PLANS

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ALIGNMENT WITH NASA RESEARCH PRIORITIES
In 2015, Xavier University of Louisiana, a MSI serving institution, established the SHELiB Center to develop high energy density lithium battery in collaboration with the NASA Glenn Research. The Center has contributed to the NASA Technology Area 3 (TA 3): Space Power and Energy Storage. For example our work on lithium sulfide batteries, Li2S, which is a very high energy cathode materials, will produce power with a much lower mass and therefore enable NASA to plan longer missions deeper into space. This project aligns extremely well with research at the NASA Glenn Center. Another area of focus at the SHELiB Center at Xavier is the development of gel polymer electrolytes that are stable against lithium metal anode. These electrolytes will replace highly flammable solvent currently in use in lithium ion battery. Since safety is the number one priority in any NASA mission, these gel electrolytes will significantly allow NASA to achieve safe and affordable deep space exploration.

BUILDING RESEARCH CAPACITY
To build institutional research capacity, we have acquired three state-of-the-art lithium ion battery glove boxes equipped with a lithium evaporation system, ultraviolet light, and spin-coater using funds obtained from NSF. In addition, we have used NASA funds to purchase a high energy vertical planetary Ball Mill, 6T hydraulic Lamination Hot Press, 250 C Vacuum Oven with programmable controller and flowmeter, and Coin Cell battery maker. The center is equipped with various other equipment, including a low pressure chemical vapor deposition (LP-CVD) system, automated RF double Magnetron gun sputtering system, potentiostats, and Arbin battery tester. We have access to common instrumentation including Hitachi SEM with EDAX capability, Hitachi Field-emission SEM, Hitachi transmission electron microscope. The University/College has supported this effort by providing high achieving students with full or partial tuition and some students receive a full ride. In addition, the University has higher faculty with expertise in materials science or polymer chemistry.

Currently, the center has three faculty, one research scientist and twelve student scholars. We have published ten articles and presented 15 posters at national conferences.

SUPPORTING STUDENTS
To enhance student knowledge and research skills, the Center has contributed to the General Chemistry Courses and created a new Polymer course.

Through this project, we have provided students with support during the academic school while performing research in the SHELiB Center and during the summer whether they had internships at NASA centers or performed research at GATech or Auburn University. Currently, the center has 12 undergraduate scholars and they are doing research in the SHELiB Center. In addition, the scholars have had several accomplishments. Kobi Jones, a scholar, has recently had his research paper published in MRS Advances (DOI: 10.1557/adv. 2018.520). Natalie Hughes, another scholar, has had her paper published in the MRS Advances (DOI: 10.1557/adv. 2017.637). Also, scholars, Jere’ Williams and Kayla Strong’s research papers have been accepted by ECS Transactions and MRS Advances respectively. Additionally, there have been nine scholars that have gone on to graduate schools to pursue advanced degrees.

PARTNERSHIPS AND OUTREACH
We have also engaged in outreach to K-12 educators by organizing a well-received teacher’s workshop at the SHELiB Center annually. The teachers bring their students with them to participate in lab experiments at the Center and are introduced to the NASA funded research projects. We are also engaged in outreach to five local high schools where our Xavier students engage with the classrooms by teaching ‘hands-on’ experiments to the high school students. In contrast to other outreach initiatives, the six week long program (per semester) is designed to provide partner schools with a cohesive laboratory component that enhances their science/chemistry curriculum within the classroom.

FUTURE GOALS AND SUSTAINABILITY
The SHELiB Center will continue to collaborate with the partner institutions and further the objectives of the project. To that end, we have recruited faculty with overlapping research goals that will contribute to the sustainability efforts. Additionally, we have applied for and received NSF funding to increase the infrastructure capabilities of the Center. Dr. Meda and his collaborators at the University of Nebraska submitted a proposal to NSF last year. Currently, Dr. Meda and Dr. Daniel Scherson have a white paper pending at the Department of Energy.
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