CIESESE SUMMER RESEARCH 2017

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BENEFITS & REQUIREMENTS

(Does not apply to NETL or Sandia National Laboratories internships. For information on this progrmas refer to the corresponding section.)

Undergraduates – Associate's Degree

Benefits

$8,000 stipend
Airfare and lodging allowance
Participate in state-of-the-art research projects
Mentoring
Professional development seminars

Requirements

GPA: 3.0/4.0
Completed 1-year of STEM courses with lab: Chemistry, Biology, Physics
At most 2 semesters from completing degree requirements
Highly interested in scientific research
Good oral and written communication skills
Ability to contribute in a team environment
Knowledge of MS Office
Research statement and letter of recommendation from a faculty

Undergraduates – Bachelor's Degree

Benefits

$8,000 stipend
Airfare and lodging allowance

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Participate in state-of-the-art research projects
Mentoring
Professional development seminars

Requirements

GPA: 3.0/4.0
Science/Engineering majors must have completed at least sophomore year
Completed 1-year of STEM courses with lab: Chemistry, Biology, Physics
Programming skills
Depending on project, academic knowledge of upper division courses may be required.
Good oral and written communication skills
Ability to contribute in a team environment
Knowledge of MS Office
Research statement and letter of recommendation from a faculty

Graduates – MS/PhD Degree

Benefits

$8,000 stipend
Airfare and lodging allowance
Participate in state-of-the-art research projects
Mentoring
Professional development seminars

Requirements

GPA: 3.2/4.0
Completed at least 1 semester of graduate school by summer 2017
Highly interested in Energy Systems research

Programming skills
Literature research skills
Good oral and written communication skills
Ability to contribute in a team environment
Knowledge of MS Office
Research statement and letter of recommendation from a faculty

UNIVERSIDAD DEL TURABO

DEVELOPMENT OF LOW WIND SPEED VERTICAL WIND ENERGY TURBINE

Professor Héctor M. Rodríguez Dávila, Ph.D., P.E.

Department Mechanical Engineering

ENERGY MODELING OF RESIDENTIAL AND COMMERCIAL BUILDING CONFIGURATIONS

Professor Amaury Malavé, Ph.D., P.E.

Department Mechanical Engineering

DEVELOPMENT OF PHOTOVOLTAIC SYSTEMS NOVEL MATERIALS

Professor Amaury Malavé, Ph.D., P.E.

Department Mechanical Engineering

IMPROVING RESILIENCE ON ELECTRIC POWER INFRASTRUCTURE SYSTEMS VULNERABLE TO DISRUPTIONS

Understand and assess the impact of disruptions on electric power infrastructures performance as a first step towards developing and improving resilience of critical infrastructures of national interest.

Professor	José A. Santivañez Guarniz, Ph.D.
Department	Industrial Engineering
Preferred Majors	Industrial Engineering
Desirable Skills	Good understanding of basic principles of probability and operations research; good programming skills.

DEVELOPMENT AND TESTING OF AN UNMANNED AERIAL SYSTEM POWERED BY FUEL CELLS

Fuel cells-motor-propeller characterization and the particular aerodynamics and flight dynamics of the aircraft, to elucidate how the integration of fuel cells power energy sources affect flight performance, as well as to determine the effects of flight performance on the integrity of the fuel cells.

Professor	Bernardo Restrepo, Ph.D.
Department	Mechanical Engineering

SYNTHESIS AND CHARACTERIZATION OF NANO-COMPOSITE LAYERED CATHODE MATERIALS FOR LI-ION BATTERIES

Synthesis, characterization and electrochemical study of materials obtained from the optimization of the synthesis procedures to improve the electrochemical properties of composite materials cathodes for lithium ion batteries.

Professor	Santander Nieto Ramos, Ph.D.
Department	Chemistry
Desirable Skills	At least one year of STEM courses with lab (Chemistry, Biology and Physics)

SYNTHESIS, CHARACTERIZATION AND EFFICIENCY DETERMINATION OF CADMIUM SULFIDE-BASED PHOTOCATALYSTS FOR PRODUCTION OF HYDROGEN BY WATER SPLITTING

Develop new visible light sensitive photocatalytic materials for obtaining efficient and affordable water splitting for generating hydrogen using sunlight.

Professor	María del C. Cotto-Maldonado, Ph.D.
Department	Chemistry
Preferred Majors	Chemistry (GPA no less than 3.50, but not indispensable)
Desirable Skills	General Chemistry (1 year of chemistry) approved; able to work in group and independently; knowledge of Word, Excel

and similar computer programs; bilingual; be responsible; good attitude to laboratory work

ROTATING DISK SLURRY ELECTRODEPOSITION OF PLATINUM ON ONION-LIKE INNER CORE PARTICLES: A NOVEL MATERIAL FOR CATALYST LAYER FOR PROTON EXCHANGE MEMBRANE FUEL CELLS

Contribute in the development of a durable, cost-effective membrane electrode assembly by working on the improvement of the catalysts layer materials, specifically by presenting a novel catalyst support material.

Professor	Ileana González-González, Ph.D.
Department	Chemistry

UNIVERSITY OF NEW MEXICO

OPTIMIZATION OF ENERGY RETROFITTING STRATEGIES FOR BUILDINGS

Professor	Vanessa Valentin
Department	Civil Engineering
Minimum Knowledge Required	Matlab

THERMAL AND ELECTRICAL CONTROLS FOR MICROGRIDS

Professors	Ramiro Jordan Manel Martinez-Ramon Andrea Mammoli
Department	Electrical Engineering Mechanical Engineering (Mammoli)
Minimum Knowledge Required	C, C++, Python, MatLab or LabVIEW

BATTERY AND THERMAL ENERGY STORAGE

Professor	Andrea Mammoli
Department	Mechanical Engineering
Minimum Knowledge Required	Basic Programming skills; basic chemistry or heat transfer and thermodynamics

THE UNIVERSITY OF TEXAS AT EL PASO

AUTOMATION OF A HIGH PRECISION STAGE FOR X-RAY GRAZING INCIDENCE SMALL-ANGLE SCATTERING (GI-SAXS) AND REFLECTIVITY (XR) STUDIES

GI-SAXS and XR are experimental techniques for characterizing the nanoscale structure and composition of thin film materials: GI-SAXS gives information about the in-plane lateral structure of nanotextured films, and XR gives information about how nanostructure changes as a function of depth. This project consists of programming and testing a sample stage that is able to precisely control the incidence angle of an x-ray beam for use in GISAXS and XR measurements on the Xeuss 2.0 HR SAXS system in the department of physics at UTEP. Test measurements will be carried out on novel photovoltaic materials, metal vapor-deposited thin films, as well as preliminary measurements for a new solid-liquid interface energy storage research project.

Professor	Jose Banuelos, Ph.D.
Department	Physics

Preferred Majors	Physics, Computer Science/Engineering, Materials Science and Engineering, Chemistry

THE INTERACTION BETWEEN WATER AND ROOM TEMPERATURE IONIC LIQUIDS CONFINED IN MESOPOROUS CARBON

Supercapacitors rely on the reversible adsorption of electrolyte ions on a porous high-surface-area carbon electrode. The presence of water as a contaminant in these devices has been linked to degradation of the supercapacitor over time, but new studies suggest that, present in the right amount, water can improve the performance of a supercapacitor. To shed light on this problem, this project involves studying the interaction of either imidazolium or pyrrolidinium-based ionic liquid electrolyte water mixtures with the pore surfaces of an 8nm-pore size mesoporous carbon material. Sample preparation, SAXS measurements, and data analysis will be carried out to learn about the nanostructure of this system.

Professor	Jose Banuelos, Ph.D.
Department	Physics
Preferred Majors	Physics, Chemistry, Materials Science and Engineering, Mechanical Engineering

DESIGN OF A HIGH PRESSURE OXY-COMBUSTION SYSTEM

Directly Heated Supercritical Carbon Dioxide (DH-SCO2) power cycles have the potential to achieve high thermal efficiencies and provide options for more than 90% CO2 capture. A DH-SCO2 combustor burning Natural Gas/Oxygen at 100 bar requires significant CO_2 recirculation and the flame temperatures below 1400 K. Participants in this project will assist in the systematic design of a high-pressure oxy-combustion system using ASPEN and FLUENT softwares, assist senior team members in the experimental development and testing of a high pressure oxy-combustor, and become familiar with combustion and heat transfer fundamentals.

Professor	Norman Love, Ph.D.
Department	Mechanical Engineering
Preferred Majors	Mechanical Engineering, Materials Science and Engineering, Chemistry, Physics

INVESTIGATION OF NANOCOMPOSITES FOR ENHANCED ENERGY STORAGE

This project is aimed at testing the hypothesis that using aligned ceramic nanowires in a polymer matrix could lead to higher energy in dielectric capacitors. In details, the specific objectives are to: A) Establish multi-scale micromechanics models to predict the overall dielectric energy densities of nanocomposites with aligned or random ceramic inclusions, B) Originate fabricating techniques for oriented nanowires polymer matrix composites toward intensifying their capability, and C) Determine dielectric properties of the composites, guiding the modification of models to improve their predictability if necessary. The research will combine both modeling and experimental approaches to test the hypothesis of using aligned inclusions would lead to higher energy densities.

Professor	Yirong Lin, Ph.D.
Department	Mechanical Engineering
Preferred Majors	Mechanical Engineering, Materials Science and Engineering, Chemistry, Physics

ADDITIVE MANUFACTURING OF ENERGY HARVESTING MATERIAL SYSTEM FOR ACTIVE WIRELESS MEMS SENSORS

Wireless sensors can be operated in a variety of environments to provide distributed sensing compared with wired sensors. Unlike passive wireless sensors, active wireless sensors provide higher signal strength and longer communication range. However, an active wireless sensor requires its own power source to perform sensing activities. Therefore, this proposed work will be focused on the development of an energy harvesting material system capable of working in harsh environment to harvest both vibrational and thermal energy. Using a combined modeling-fabrication-testing approach, we will understand the fundamental aspects of how to design a ceramic-graphene structure for optimized thermal and vibration energy harvesting.

Professor	Yirong Lin, Ph.D.
Department	Mechanical Engineering
Preferred Majors	Mechanical Engineering, Materials Science and Engineering, Chemistry, Physics

UNIVERSITY OF PUERTO RICO - MAYAGUEZ

POWER ELECTRONICS APPLIED TO RENEWABLE ENERGY APPLICATIONS

Renewable energy sources are one of the key enabling technologies for future energy economy. It is the purpose of this project to research renewable energy technologies (solar panels, fuel cells, thermoelectric generators) with its integration to the electrical engineering education. The students will have the opportunity to do simulations, experiments, and acquire theory for an enriched electrical engineering research experience. The interested students will have the chance to study renewable energy technologies and the feasibility of these technologies as a substitute to traditional fossil fuels.

Professor	Eduardo Ortiz-Rivera, Ph.D.
Department	Electrical Engineering
Preferred Majors	Electrical Engineering; Aerospace Engineering; Engineering Education; Computer Engineering with emphasis on embedded systems; Mathematics; Physics; Industrial Engineering with emphasis in robotics

A SMALL-SCALE MICROGRID: SETUP, STABILITY AND CONTROL

This project proposes to run a small-scale, real-world, Microgrid setup at the University of Puerto Rico-Mayagüez (UPRM) working in closed loop. This project will focus on the installation and the integration of renewable energy and distributed generation systems. The primary goal of the microgrid setup is to increase the integration of intermittent supply and end-use, thus supporting higher penetration levels of intermittent renewables in distributed systems.

Professor	Fabio Andrade, Ph.D.
Department	Electrical Engineering
Preferred Majors	Electrical Engineering; Computer Engineering with emphasis on embedded systems

DESIGN AND CONSTRUCTION OF A HYDROFOIL-BASED SOLAR POWER BOAT

UPRM's Solar Boat Team is currently developing a hydrofoil-based solar power boat with adjustable angle of attack. The hydrofoil technology will allow the boat's hull to be out of the water. In the "flying mode" the drag force produced by the water on the hull will be minimized, allowing the motor to operate with less energy and more efficiently. Nontheless, lifting the boat with the hydrofoils turns the typically stable vehicle into an unstable and nonlinear system. The dynamic system is comparable to the well-known problem of the inverted pendulum. Therefore, the performance gain expected under the hydrofoil technology is matched by increased complexity of the system.

Professor	Eric Aponte, Ph.D.
Department	Electrical Engineering
Preferred Majors	Electrical Engineering; Computer Engineering with emphasis on embedded systems

CONTROLLER AND POWER ELECTRONICS CONVERTER DESIGN AND IMPLEMENTATION FOR SOLAR POWER BOATS

The objective is to develop a control system that will enable proper roll, pitch and height stabilization of the solar boat while cruising above water and using the minimum amount of energy. Desirable skills for the students: The students will be required and will agree to participate on different outreach activities related to energy systems for teachers and students..

Professor	Guillermo Serrano, Ph.D.
Department	Electrical Engineering
Preferred Majors	Mechanical Engineering; Electrical Engineering; Aerospace Engineering; Computer engineering with emphasis on embedded systems; Mathematics; Physics; Industrial Engineering with emphasis in robotics
Desirable Skills	Interest on renewable energy applications, fluid dynamics, control systems, finite-analysis, basic programming skills.

DEVELOPMENT OF NOVEL AND INNOVATIVE TECHNOLOGIES FOR ADVANCED WATER PURIFICATION USING THE MINIMUM ENERGY

To develop novel and innovative technologies for advanced water purification by the expansion of fundamental science in biological and physico-chemical processes. Research Team interests are motivated by the need for safe and clean water. Access to fresh water sources is becoming limited while the world population continues to grow and global climate changes have shifted the balance of available fresh water. The team is looking to answer: Is it possible to develop new technologies for water purification using the minimum energy?

Professor	Pedro Tarafa-Vélez, Ph.D.
Department	Civil Engineering
Preferred Majors	Material Science and Engineering; Chemical Engineering; Chemistry; Environmental Engineering; Civil Engineering; Industrial Engineering; Physics
Desirable Skills	Proactive and self-motivated; willing to learn and to do work with minimal supervision; well-familiarized with databases to conduct literature reviews; basic knowledge in Water Quality and engineering processes for water treatment, specifically for Filtration; knowledge and experience in conducting bacteriological analyses; basic knowledge working with UV/Vis spectrometers; fluorescence and TOC analyses; basic knowledge in general and organic chemistry

NATIONAL ENERGY TECHNOLOGY LABORATORY

NETL is the Department of Energy's (DOE) preeminent Fossil Energy Laboratory with the mission to conduct R&D to promote the cleanest and most efficient power systems in the world.

To apply for NETL's summer research internships go to http://www.orau.gov/netl/applicants/how-to-apply.html and complete your application by March 1, 2017. Before you submit your application, below you can learn about NETL's principal investigators and the projects they are working on.

PRINCIPAL INVESTIGATORS AND RESEARCH AREAS

Investigator	David Tucker
Research Topics	Cyber-Physical Systems, Hybrids, System Identification, Controls, Electrochemistry, Gasification, Fuel Processing
Investigator	Larry Shadle

Research Topics	Cyber-Physical Systems, Hybrids, Multiphase Flow, Gasification, Circulating Fluidized Beds, Chemical Looping
Investigator	Danylo Oryshchyn
Research Topics	Systems Analysis, Thermodynamics, Hybrids, Renewable Energy
Investigator	Rigel Woodside
Research Topics	Magneto-hydrodynamics, Plasma Physics, Design of Experiments
Investigator	Farida Harun
Research Topics	Cyber-Physical Systems, Hybrids, System Identification, Real-Time Modeling
Investigator	Valentina Zaccaria
Research Topics	Cyber-Physical Systems, Hybrids, Real-Time Modeling, Component Degradation
Investigator	Paolo Pezzini (Ames Laboratory)
Research Topics	Cyber-Physical Systems, Controls, System Integration

PROJECTS

ON LINE RECURSIVE SYSTEM IDENTIFICATION AND ADAPTIVE CONTROL OF HYBRID POWER SYSTEMS

This project consists of running the Hybrid Performance project facility to obtain dynamic data in real time while simultaneously run the algorithms of on-line system identification to obtain a recursive model (state spaces models). The models obtained will be utilized for real-time adaptive control. The outcome of this project would facilitate the application of linear controls in the complete bounded fuel cell turbine hybrid power system envelope. The linear identification and control could be obtained for any operating point of the system and work with several actuators at the same time.

RAMAN GAS ANALYZER FOR CONTROL IN ADVANCED POWER SYSTEMS

With the purpose of studying advanced hybrid power systems utilizing gasifier technology, the effect of fuel composition changes on the system dynamics must be addressed. Outlet syngas compositions from different gasifiers vary depending on the type of coal. Small changes in composition can cause significant variations in turbine speed and other system parameters if no control strategy is applied. Without a direct measurement of composition system stability could be a significant issue, especially during transient conditions.

The Raman Gas Analyzer was designed and constructed at NETL to provide a fast (real-time) measurement of the major components of a fuel gas, to design novel control algorithms based on advanced power systems under sudden variation of fuel compositions. Two RGA prototypes have been constructed. Installation and testing in the Hyper facility provides the opportunity to demonstrate new control strategies applied to a gas turbine recuperated cycle designed for hybrid configuration. To demonstrate a rapid change in fuel composition, in a short-term test, the approach selected is to blend bottled nitrogen into the natural gas supply line. The dilution will be adequate to change the combustion conditions (reduce the heat produced) in the turbine combustor, and controls can be developed.

SUPERVISORY CONTROL FOR LOAD FOLLOWING

The purpose of this project is to develop a supervisory control scheme for load following in a hybrid system. The objective is to divide power generation between the fuel cell and the turbine during power demand changes, i.e. responding faster with the gas turbine and then adjusting the fuel cell load over a sufficient time in order to avoid excessive temperature oscillation in the fuel cell. Temperature variation represents a constraint in the control problem. In the first stage, the control architecture will be implemented and tested on a numerical model.

COMPONENT DEGRADATION IN FUEL CELLS

As part of the Hybrid Performance project, single input-single output controllers have been designed to regulate variables that directly affect fuel cell degradation in a hybrid system. A required work is to test the complete control strategy (all the controllers simultaneously) on the HyPer facility and characterize the system in a broad range of operating conditions while the cell is degrading. This will give a better understanding of long-term operations of the system.

STARTUP AND ELECTROCHEMICAL LIGHTOFF

Hybrid fuel cell turbine power systems (FC/GT) represent an opportunity to double the efficiency of standard pulverized coal power generation technology and reduce harmful emissions associated with power generation by 50%. To reach this level of efficiency, the complexities of the highly coupled FC/GT cycles must be resolved. This project will examine all stages of operation but focus primarily on turbine startup and fuel cell heating. This will be accomplished through a cyber-physical approach to study direct-fired, recuperated hybrid systems.

One inherent complexity of the FC/GT hybrid system comes from wide discrepancies in the individual component response times. It is well known that the mismatch between fuel cell and balance of plant time constants make the control task arduous for all operating regimes. This is most noticeable during the startup process of direct-fired hybrid cycles, where the compressor airflow feeds directly into the cathode side of the fuel cell. For synchronous operating speed, both the turbine and fuel cell must commence operations simultaneously under a coupled (fuel cell and turbine) hybrid configuration. This requires careful coordination of the turbine's startup ramp rate, and the cathode airflow input to avoid spatial and time dependent temperature gradients within the fuel cell material.

MISO + SISO OR FEED FORWARD MISO

The design of a baseline control strategy is essential to evaluate the controllability of advanced hybrid power systems. The coupling of diverse devices into advanced hybrids represents one of the most important advantages to increase the efficiency of future power technologies. Hybrid power systems currently being considered for development and deployment include coupled fuel cell-gas turbine; concentrated solar power (CSP)-gas turbine; thermal energy storage-gas turbine hybrids; and CSP-geothermal systems. In many cases, these coupled hybrid systems present significant controllability challenges because of the tight nonlinear coupling between two or more systems, each with different time scales, dynamics, and thermal energy needs. Specifically, the most challenging aspect is represented by the strong variability in the thermal energy source from upstream devices during transient operations, such as sunlight unpredictability or load following operations. As a result, new control strategies are needed that can timely provide turbine speed stable operation under sudden thermal source variability using one or more actuators.

This project will focus on a multi-input single-output (MISO) control strategy to control the turbine speed using a simultaneous control of the auxiliary fuel valve and the bleed-air valve in a fuel cell-turbine hybrid system. A non-linear programming procedure based on the state-space concept was developed in the simulation environment. Turbine electric load perturbations will be used to test the algorithm.

CYBER-PHYSICAL CHEMICAL LOOPING REACTOR OBSERVER

NETL has pioneered the use of cyber-physical systems to develop promising advanced technologies. This approach has provided a new paradigm when integrating complex processes and its utility has been demonstrated on concepts even before a process concept reaches full maturity, as in the case of the fuel-cell – turbine hybrid power system demonstrated as part of the HyPer project. NETL now wants to extend this approach to another developing technology: Chemical Looping Systems. Chemical Looping is a process that converts fossil fuels using a solid oxygen carrier, enabling highly efficient clean-up of the products of combustion. Using a cyber-physical observer, a multi-stage, fluidized bed (FB), chemical looping reactor (CLR) is being developed to control and speed the development of this technology. This concept uses an ambient temperature or cold-flow transparent reactor to enable direct observation of the granular oxygen carrier particles to establish the process state in the hot CLR. In this way, unstable solids flow conditions and process upsets can be avoided and process improvements can be evaluated. Existing cold-flow test apparatus must be adapted, system identification studies conducted, real-time models and controls developed, and performance validated by running both the cold-flow test facility and the pilot scale hot test rig. There are ample opportunities to contribute to this exciting new approach combining real-time computational modeling with operational physical hardware and to publishing the results in scientific and engineering journals.

FUEL FLEXIBILITY IN HYBRID SYSTEMS

NETL has made a significant progress in understanding the dynamics of a solid-oxide fuel cell/gas turbine (SOFC/GT) hybrid power system. One particular research interest is exploring the capability of this hybrid technology under a fuel flexible environment. With the potential to run SOFC systems using many different types of fuel, NETL believes that transitioning one fuel composition to another can be advantageous for load following or cycling mode operations to vary output products, such as liquid fuels and electricity for polygeneration plants. As such, this system can offer a greater flexibility to improve the availability of power infrastructure and economic viability. The fuel flexibility is also beneficial to handle fuel cell thermal management, as an example of using high methane content fuel. To date, the actual range of fuel flexibility that could be implemented in the SOFC/GT hybrid system under different transient circumstances is still unknown. As there are high coupling issues between the SOFC/GT components, system identification is very critical to understand the transient response in the system to fuel types and fuel processing units. Controls for thermal management and fuel cell degradation for fuel flexible SOFC/GT systems are also not yet available.

ANODE RECYCLE

The aim of this project is to fully characterize the system at different anode recycle rates, with the final goal of adding a degree of freedom to the present control strategy. Anode recycle rate (ARR) will be considered an additional manipulated variable to increase the flexibility of the system, and a control strategy will be implemented to exploit this new flexibility. Possibly, ARR will be used to mitigate cell degradation over time and/or maintain fuel cell performance during degradation.

COMPRESSOR SURGE AND STALL

The aim of this project is to fully characterize the system at different anode recycle rates, with the final goal of adding a degree of freedom to the present control strategy. Anode recycle rate (ARR) will be considered an additional manipulated variable to increase the flexibility of the system, and a control strategy will be implemented to exploit this new flexibility. Possibly, ARR will be used to mitigate cell degradation over time and/or maintain fuel cell performance during degradation.

MODELING THE NETL MICROGRID

In order to showcase advanced power technologies, NETL researchers have developed a concept for a microgrid to provide electric power to the Morgantown campus. This microgrid will assure continuity of power to safeguard equipment, resiliency to effectively serve as a refuge for the federal government in the event of evacuation of Washington DC, and meet the Net Zero Energy government wide operational goals, while also providing infrastructure to demonstrate new technologies. Preliminary designs are required to define the size and scope of this microgrid, defining the features needed and to model the manner in which it will operate. Of particular interest is the desire to incorporate cyber physical research approach that promises to reduce technology development time and assure that NETL retains our leadership in a quickly evolving electric power generation and supply network. This work will help to define the environmental footprint of a microgrid and well as provide the basis for “greening” our power system.

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MAGNETO HYDRO DYNAMICS

NETL's Direct Power Extraction Laboratory is located at the Albany, Oregon site. In this lab, we perform experiments dealing with magnetohydrodynamic (MHD) power generation. Experiments cover material response to the MHD environment (magnetic field, supersonic velocity, temperatures too high for current power-conversion technologies), and characteristics of the plasma jet and its ability to supply sustained power. The proposed project for the summer of 2017 is to work with the principal investigator to design and execute experiments which show how conductivity of the plasma-jet varies and what impacts arise from the boundary layer surrounding the jet. This will include design-adjustments to the channel which encloses the jet (built to both contain the plasma and allow sensors to read the jet without interfering with it); designing experiment campaigns; executing experiments; presenting results internally; submitting an article for publication in a peer-reviewed journal.

SANDIA NATIONAL LABORATORIES

Sandia National Laboratories is operated and managed by Sandia Corporation, a wholly owned subsidiary of Lockheed Martin Corporation. Sandia Corporation operates Sandia National Laboratories as a contractor for the U.S. Department of Energy’s (DOE) National Nuclear Security Administration (NNSA) and supports numerous federal, state, and local government agencies, companies, and organizations.

Committed to science with the mission in mind, Sandia creates innovative, science-based, systems-engineering solutions to our nation's most challenging national security problems.

To learn more and apply for Sandia’s summer research internships go to http://www.sandia.gov/careers/ps-forward.html and complete your application by February 15, 2017.