NASA SBIR 2021-II Solicitation

PROPOSAL NUMBER: 21-2- **H6.23-2564**

PHASE 1 CONTRACT NUMBER: 80NSSC21C0411

SUBTOPIC TITLE: Spacecraft Autonomous Agent Cognitive Architectures for Human Exploration

PROPOSAL TITLE: ADAPtive agenT Architecture

Small Business Concern

Firm: **TRACLabs, Inc.**
Address: **100 Northeast Interstate 410 Loop #520, San Antonio, TX 78216**
Phone: **(281) 461-7886**

Principal Investigator:

Name: **Ernest Cross II**
E-mail: **vince.cross@traclabs.com**
Address: **100 North East Loop 410, Suite 520, TX 78216 - 4727**
Phone: **(856) 887-1791**

Business Official:

Name: **David Kortenkamp**
E-mail: **korten@traclabs.com**
Address: **100 Northeast Interstate 410 Loop #520, TX 78216 - 4727**
Phone: **(281) 461-7886**

Summary Details:

Estimated Technology Readiness Level (TRL) :

Begin: 3
End: 4
Technical Abstract (Limit 2000 characters, approximately 200 words):

The focus of the Phase 2 effort is to expand the Intelligent Machine Learning (IML) approach taken in Phase 1 to develop a Human-Centered Intelligent Virtual Agent (IVA). IML is an approach that moves the development of machine learning models away from engineers and puts the development of the model in the hands of the end-user. A Human-Centered IVA is focused on continuously improving the Machine Learning (ML) models while also providing effective communication between the human crewmembers and the IVA. Human-centered IVA is a perspective on artificial intelligence and ML that algorithms must be designed with awareness of being part of a larger system that includes end-users. This approach allows the IVA to incorporate the knowledge, insight, and feedback of the end-users allowing for tuning and refinement of the ML models. The Human-centered IVA will assist crewmembers in various tasks e.g., crew scheduling, procedure creation, and anomaly detection and resolution during a long-duration mission. ADAPT's Human-Centered IVA will provide the computationally heavy-lifting while still receiving inputs and insights from the crewmembers. This allows for the expansion of processes and information to a larger scale without compromising data integrity or mission success due to a lack of ground assistance.

To provide crewmembers with a Human-Centered IVA this effort leverages the supervised learning algorithms Decision Tree, Random Forest, Ada Boost, Gradient Boost, Extreme Gradient Boost, Categorical Boost, and Associative Rule Models which were shown in Phase I to be succesful within an IML approach. Additionally, this phase will focus on providing an explainable interface that allows the end-user to query the IVA for the reason behind its prediction. This will be accomplished using an interactive visualization Graphical User Interface.

Potential NASA Applications (Limit 1500 characters, approximately 150 words):

We expect the Human-centered Intelligent Virtual Agents (IVA) approach to improving model predictions throughout all phases of a long-duration mission will be of interest to several groups within NASA. The ARTEMIS program for example could make use of IVAs to assist the crew in similar scenarios used during the development. Additionally, this work will be of interest to the EVA Exploration Office, the EVA Strategic Planning and Architecture group, and the Exploration Mission Planning Office.

Potential Non-NASA Applications (Limit 1500 characters, approximately 150 words):

The proposed cognitive architecture will benefit several TRACLabs commercial customers. We expect the ability of end-users to direct the adaptation of the system will be of interest. For example, Baker Hughes has already expressed interest in licensing some of the new capabilities being developed in previous cognitive agent efforts, particularly the ontology and anomaly management aspects.

Duration: **24**

PROPOSAL NUMBER: 21-2- **S2.04-1261**

PHASE 1 CONTRACT NUMBER: 80NSSC21C0317

SUBTOPIC TITLE: X-Ray Mirror Systems Technology, Coating Technology for X-Ray-UV-OIR, and Free-Form Optics

PROPOSAL TITLE: Polishing of X-Ray Optics

Small Business Concern

Firm: **OptiPro Systems, LLC**
Address: **6368 Dean Parkway, Ontario, NY 14519**
Phone: **(585) 265-0160**

Principal Investigator:

Name: **Franciscus Wolfs**
E-mail: **fwolfs@optipro.com**
Address: **6368 Dean Parkway, NY 14519 - 8970**
Phone: **(585) 265-0160**

Business Official:

Name: **Matthew Carlson**
E-mail: **mcarlson@optipro.com**
Address: **6368 Dean Parkway, NY 14519 - 8970**
Phone: **(585) 265-0160**

Summary Details:

Estimated Technology Readiness Level (TRL) :

Begin: 2
End: 7
Technical Abstract (Limit 2000 characters, approximately 200 words):

Manufacturing grazing incidence x-ray mirrors costs between $4 to $6 million per square meter of optical surface area. To reduce the cost of making x-ray mirrors, NASA is seeking manufacturing solutions to aid in cost reduction factors of 5 to 50 times. One cost driver is the mandrel-based polishing process that impacts the inside surface of an X-ray mirror shell. Current shells are created through a replication process utilizing an aluminum mandrel. OptiPro is proposing to enhance process solutions to reduce costs required for polishing both the mandrel and the outside shell surface by maintaining constant force during polishing, developing new polishing tools, and optimizing the polishing algorithm. The target platform for these improvements will be on an OptiPro's polishing platform. These improvements will be directly applicable to the polishing being done at Marshall Space Flight Center on various equipment including OptiPro's UltraForm Finishing platform.

OptiPro's Phase II will focus on prototyping hardware and software solutions to provide a cost effective deterministic solution when combined with an optimized polishing process. A rotisserie part A-Axis and a new dual tool polishing head will be updated to an existing bridge polishing platform. A force feedback system will be prototyped and integrated into a polisher to provide in-situ adjustments during polishing. Prototype polishing tools will be further refined and optimized. The polishing algorithms are being enhanced for more efficient polishing and achieving tighter tolerances through improvements to correction algorithms and new adaptive learning routines. The software will be upgraded to incorporate all of these changes. All innovations will be tested

on a demonstrator mandrel and processing will be refined to improve surface quality as efficiently as possible. The results of this Phase II will enhance fabrication at MSFC and become commercially available solutions at OptiPro.

Potential NASA Applications (Limit 1500 characters, approximately 150 words):

The proposed system will benefit all projects using x-ray shells and mandrels, both cylindrical and segments that fit within the working envelope that the proposed hardware is installed on. Missions including Lynx and the IR/O/UV space telescope would be among those that would benefit from the technology being developed. These improvements will be applicable to polishing being done at Marshall Space Flight Center on various equipment including OptiPro's UltraForm Finishing platform and polishing being done at Goddard Space Flight Center.

Potential Non-NASA Applications (Limit 1500 characters, approximately 150 words):

The proposed polishing system and hardware improvements would benefit all types of part geometries including the following:

- Rotationally Symmetric Geometries - Aspheres, Spheres, and Ogive Missile Domes
- Cylindrical Optics
- Freeform and Conformal Optics Optics

The processes being developed to work with nickel will provide ground work for working on other metal materials, including aluminum.

Duration: **24**

PROPOSAL NUMBER: 21-2- **Z5.04-1958**

PHASE 1 CONTRACT NUMBER: 80NSSC21C0288

SUBTOPIC TITLE: Technologies for Intravehicular Activity Robotics

PROPOSAL TITLE: Collaborative Sensing and Mapping for IVA Robots

Small Business Concern

Firm: **Metis Technology Solutions, Inc.**
Address: **2309 Renard Place Southeast, Suite 200, Albuquerque, NM 87106**
Phone: **(505) 299-1509**

Principal Investigator:

Name: **Walter Harper**
E-mail: **walter.k.harper@nasa.gov**
Address: **2309 Renard Place Southeast, Suite 200, 87106 - 4284**

Phone: **(650) 210-6184**

Business Official:

Name: **Joy Colucci**
E-mail: **joy.colucci@metis-tech.com**
Address: **2309 Renard Place Southeast, Suite 200, NM 87106 - 4284**
Phone: **(650) 207-9378**

Summary Details:

Estimated Technology Readiness Level (TRL) :

Begin: 3
End: 6
Technical Abstract (Limit 2000 characters, approximately 200 words):

Metis Technology Solutions proposes to further mature its online, bi-directional, and robust collaborative SLAM and sensor co-registration technology known as Astrobee Localization and Collaborative Multi-layered Mapping (A-LCMM). The technology allows any Intra-Vehicular Activity (IVA) robot to collect data about its surrounding environment and share it with other robots via a central server to perform localization and mapping tasks. Sensors equipped to each IVA robot can be co-registered and fused with a collaboratively generated physical map of an environment which is stored on a central server. This fused multi-layered map of the environment consists of layers in which individual sensor data is registered with the physical map of the environment. The system is sensor and camera agnostic, meaning that any sensor and camera can be ingested by the system. This system not only eliminates the need for a ground team to manually update Astrobee maps, but also enables autonomous state assessment operations in space habitats which fills technical gaps identified in the Integrated System for Autonomous and Adaptive Caretaking (ISAAC) project. Developed hardware prototypes are to be used for validation in real-world environments by integrating the hardware and the software components of the system together. Beyond NASA, applications outside of Astrobee are not only feasible, but desirable. Improvements to the current state-of-the-art for collaborative SLAM not only impact Astrobee, but any system that uses multiple robots or SLAM in general. With the recent emergence of commercial space stations, autonomous cars, augmented reality (AR), and autonomous unmanned aerial vehicles (UAVs), there are many opportunities in which the technology can penetrate the market and make a ground breaking difference in the world of robot autonomy for years to come.
Potential NASA Applications (Limit 1500 characters, approximately 150 words):

Current IVA robot programs such as Astrobee have the potential to directly benefit from this technology. IVA robots must be able to perform autonomous state assessment activities such as surveillance, reconnaissance, and leak identification which future orbiting facilities such as Lunar Gateway will require. The developed technology will allow for Astrobee to advance its localization and mapping capabilities as well as provide real-time sensor data of the environment from multiple robots simultaneously.

Potential Non-NASA Applications (Limit 1500 characters, approximately 150 words):

Commercial space habitats like Axiom Station would directly benefit from this technology. IVA robots will play a critical role in automating tasks onboard commercial space habitats. With the ability to perform autonomous state assessment, surveillance, and reconnaissance of a space habitat, it significantly reduces the required human and financial resources required to maintain a space station.

Duration: **24**

PROPOSAL NUMBER: 21-2- **A1.01-3185**

PHASE 1 CONTRACT NUMBER: 80NSSC21C0127

SUBTOPIC TITLE: Aerodynamic and Structural Efficiency - Integration of Flight Control with Aircraft Multidisciplinary Design Optimization

PROPOSAL TITLE: Integrated Flight Control Design and Multidisciplinary Optimization

Small Business Concern

Firm: **Bechamo, LLC**
Address: **701 Ellicott St, Buffalo, NY 14223**
Phone: **(617) 470-6840**

Principal Investigator:

Name: **Michael Piedmonte**
E-mail: **mike@bechamo.com**
Address: **22327 19th Ave SE, WA 98021 - 8450**
Phone: **(617) 470-6840**

Business Official:

Name: **Michael Piedmonte**
E-mail: **mike@bechamo.com**
Address: **22327 19th Ave SE, WA 98021 - 8450**
Phone: **(617) 470-6840**

Summary Details:

Estimated Technology Readiness Level (TRL) :

Begin: 3
End: 5

Technical Abstract (Limit 2000 characters, approximately 200 words):

Multi-disciplinary optimization has emerged as a key technology required to make increasingly more sophisticated electric and hybrid-electric aircraft that require advanced CONOPS such as urban air mobility and cargo delivery. Current MDO design results may take into account many disciplines in the design resulting in an optimized aircraft, only to discover controller limitations

post-aircraft configuration lock related, resulting in less efficient, less capable and ultimately less safe aircraft.

After decades of designing and flying flight controllers for new and existing types of hybrid and distributed propulsion aircraft, our goal is to get add a controllability component to aircraft multidisciplinary design optimization. Our controllability assessment tools can be used individually or together in an MDO/MDA framework to ensure the airplane is optimized for both aircraft performance and flight control control requirements. We leverage open-source software from OpenMDAO and can import models form OpenVSP and other sources.

New UAM and UAS configurations provided significant advantages and are being pursued by the aerospace industry. Our software allows us to partner with aircraft makers to help develop their aircraft and then provide flight control solutions as a secondary output from our controllability assessment tools.

Far too often, we've seen the aircraft OML locked and much later discovered aircraft flight envelope and CONOPS restrictions due to inability to control the aircraft. By co-designing the aircraft and the flight controller, we optimize both simultaneously, resulting in a design that closes for performance, CONOPS, failure conditions, and controllability within a significantly reduced timeline.

Potential NASA Applications (Limit 1500 characters, approximately 150 words):

RVLT concepts or slight modifications to the current concepts will allow RVLT to provide NASA with additional key critical technical areas to focus on in the future. New concepts can be quickly iterated and evaluated.

AAM can use the controllability tools to understand what closed-loop performance is achievable to be able to form new CONOPS and infrastructure plans.

ARMD can use the controllability assessment tools to optimizing the use of motors, rotors and propulsion system powertrain with respect to controller use and limitations.

Potential Non-NASA Applications (Limit 1500 characters, approximately 150 words):

UAM and UAS markets have received significant investments on concept aircraft that may not be able to meet the proposed CONOPS or safety requirements. These tools can be used to evaluate designs and pivot into plausible, but inadequate designs. Technical due diligence could use the tools to compare and evaluate concepts for feasibility.

Duration: **24**

PROPOSAL NUMBER: 21-2- **S3.01-2261**

PHASE 1 CONTRACT NUMBER: 80NSSC21C0072

SUBTOPIC TITLE: Power Generation and Conversion

PROPOSAL TITLE: Pushing Radiation Hardness and Qualification of Ultrathin Silicon Solar Cells

Small Business Concern

Firm: **Regher Solar, LLC**
Address: **7700 South River Parkway, Tempe, AZ 85284**
Phone: **(520) 838-9404**

Principal Investigator:

Name: **Dr. Alex Fedoseyev**
E-mail: **alex.fedoseyev@gmail.com**
Address: **7700 South River Parkway, AZ 85284 - 1808**
Phone: **(256) 694-3056**

Business Official:

Name: **Stanislau Herasimenka**
E-mail: **sh@regher.com**
Address: **7700 South River Parkway, AZ 85284 - 1808**
Phone: **(520) 838-9404**

Summary Details:

Estimated Technology Readiness Level (TRL) :

Begin: 5
End: 8
Technical Abstract (Limit 2000 characters, approximately 200 words):

Regher Solar proposes this SBIR project to mature ultrathin silicon (UT-Si) solar cell technology to achieve TRL 7 and quickly transition to TRL 8 followed by injection into both NASA and commercial missions. At present UT-Si cells manufactured by Regher Solar have a 20% Beginning-of-Life (BOL) efficiency which is exactly in between Copper-Indium-Gallium-Selenide (CIGS) and Epitaxial Lift Off Inverted Metamorphic (ELO-IMM) thin film solar cells that are currently considered for making flexible solar blankets. With several practically attainable improvements UT-Si solar cells will reach 22% BOL efficiency in 2 years. However, the End-of-Life (EOL) efficiency of UT-Si cells drops substantially when exposed to space radiation making them less attractive for the use in space. If radiation damage is mitigated, UT-Si cells can achieve EOL efficiency of ELO-IMM cells while being as inexpensive as CIGS cells making them the optimum choice for flexible solar arrays among all thin film technologies.

This project will leverage an improved understanding of radiation-induced defects in c-Si that was developed in the last 3 years within the effort to fabricate more radiation hard Si detectors for the Large Hadron Collider. The main proposed innovations include: (1) using defect engineering to passivate radiation induced defects, (2) further reducing solar cell thickness from 20 to 10 microns to improve the effectiveness of passivation, and (3) utilizing active defect elimination methods that can be periodically applied to the solar cells in space.

Phase II of this project will demonstrate the feasibility of the proposed innovations and will conduct comprehensive electron and proton irradiation testing. We will collaborate with blanket manufacturers to package UT-Si solar cells in CICs and blankets and conduct complete qualification to achieve TRL 7. Phase II will also work with development partners to integrate UT-Si cells into ongoing missions and achieve TRL 8.

Potential NASA Applications (Limit 1500 characters, approximately 150 words):

UT-Si solar cells can be integrated into novel flexible solar array deployment systems to meet NASA solar array specific power (250 W/kg) and stowed volume efficiency (50 kW/m^3) goals. At the same time UT-Si solar cells have a potential to also meet NASA goals for the long-term operation in high radiation environment (1 MeV 6e15 e/cm2). Together this will make UT-Si solar cell technology an ideal choice for several NASA projects including LISA solar array, Vertical Lunar Solar Arrays and large scale solar arrays for Solar Electric Propulsion.

Potential Non-NASA Applications (Limit 1500 characters, approximately 150 words):

The main advantage of UT-Si technology is compatibility with high volume manufacturing and a low manufacturing cost. Production of UT-Si solar cells can be quickly scaled to 100 MW/year to meet the demand of the growing space industry. The example applications include satellite mega constellations and space based solar power that will need tens of MW of affordable space-stable solar cells.

Duration: **24**

PROPOSAL NUMBER: 21-2- **S1.10-1555**

PHASE 1 CONTRACT NUMBER: 80NSSC21C0081

SUBTOPIC TITLE: Atomic Quantum Sensor and Clocks

PROPOSAL TITLE: Low SWaP UHV chamber for atom interferometer

Small Business Concern

Firm: **Q-Peak, Inc.**
Address: **135 South Road , Bedford, MA 01730**
Phone: **(781) 275-9535**

Principal Investigator:

Name: **Dr. Vladyslav Ivanov**
E-mail: **vivanov@qpeak.com**
Address: **135 South Road , MA 01730 - 2307**
Phone: **(781) 271-1838**

Business Official:

Name: **B. David Green**
E-mail: **green@qpeak.com**
Address: **135 South Road, MA 01730 - 2307**
Phone: **(978) 689-0003**

Summary Details:

Estimated Technology Readiness Level (TRL) :

Begin: 4
End: 6

Technical Abstract (Limit 2000 characters, approximately 200 words):

The development and maturation towards space applications of atomic systems are needed to meet NASA's interest in advancing quantum sensing technologies. Atom interferometers have unmatched precision for in-situ measurements of local gravity acceleration. The Size, Weight, and Power consumption (SWaP) of existing atom interferometers is a major obstacle for employing them in NASA missions. One of the main components of an atom interferometer is an ultra-high vacuum (UHV) system. UHV systems are typically the heaviest components of atom interferometers. A light, compact, and energy-efficient UHV system will be highly beneficial for NASA missions.

Q-Peak is addressing the need for lighter, compact, energy-efficient UHV systems suitable for an atom interferometer. Within a successful Phase I program, Q-Peak experimentally proved the suitability of the Aluminum alloy (AlSi10Mg) as housing material for the UHV chamber. Aluminum alloy (AlSi10Mg) housing is capable of maintaining residual gas pressure well below 5×10^{-10} Torr. The AlSi10Mg alloy is 30% lighter than stainless steel.

Q-Peak proposes to build a complete UHV chamber suitable for atom interferometry out of the AlSi10Mg alloy. The ability to machine AlSi10Mg using a 3D printing process removes the constraint of traditional manufacturing considerations that can further decrease the SWaP of the UHV system. Special attention will be devoted to the development of an energy-efficient and reliable alkali-atom source.

Potential NASA Applications (Limit 1500 characters, approximately 150 words):

Keeping track of the actual spacecraft position is a key part of navigation for any spacecraft. Accurate in situ gravimetry based on atom interferometry can be used for satellite-based global gravity field mapping. Atom interferometry is a potential technology to gather the type of data currently produced by NASA's Gravity Recovery and Climate Experiment Follow-On mission. Europa Clipper can use an atom interferometer for determining the most likely locations to gain access to subsurface material.

Potential Non-NASA Applications (Limit 1500 characters, approximately 150 words):

Stable and precise accelerometers and gyroscopes are required for navigation and can be used for ships and planes. They are especially advantageous in situations when a GPS signal is absent and high accuracy is required. Such devices are of great value to the US Navy.

Duration: **24**

PROPOSAL NUMBER: 21-2- **Z8.09-2218**

PHASE 1 CONTRACT NUMBER: 80NSSC21C0198

SUBTOPIC TITLE: Small Spacecraft Transfer Stage Development

PROPOSAL TITLE: High Performance Pump-fed Transfer Stage for Venture Class Cislunar & Deep Space Missions

Small Business Concern

Firm: **Flight Works, Inc.**
Address: **17905 Sky Park Circle, Suite F, Irvine, CA 92614**
Phone: **(949) 387-9552**

Principal Investigator:

Name: **Christopher Bostwick**
E-mail: **chris.bostwick@flightworksinc.com**
Address: **17905 Sky Park Circle, Suite F, CA 92614 - 6707**
Phone: **(949) 387-9552**

Business Official:

Name: **Eric Besnard**
E-mail: **eric.besnard@flightworksinc.com**
Address: **17905 Sky Park Circle, Suite F, CA 92614 - 6707**
Phone: **(949) 387-9552**

Summary Details:

Estimated Technology Readiness Level (TRL) :

Begin: 4
End: 5
Technical Abstract (Limit 2000 characters, approximately 200 words):

Flight Works is proposing to continue the development and demonstration of a low cost, compact, high performance transfer stage which enables dedicated missions to cislunar and deep space (such as Mars rendezvous) with small launchers like Virgin Orbit's LauncherOne and ABL's RS-1. More than a stage, the system features a full set of avionics creating a bus with extensive propulsion capabilities. The avionics is based on flight-proven large CubeSat avionics from partner Astro Digital. The high performance is enabled by Flight Works' micropump-fed

propulsion technology matured over the last few years for small spacecraft combined with the high density-specific impulse (Isp) provided by the green monopropellant ASCENT. The green propellant can be stored cold to minimize heating power and a low-power pumped loop can be used to slightly warm the propellant prior to use. The result is ***a simple, versatile, cost-effective stage with full bus functionality and with performance capabilities similar to that of a traditional bipropellant pressure-fed stage*** and which can be configured for cislunar and even Mars missions.

Other benefits include scalability; use of green propellants and low-pressure tanks minimizing range safety operations and costs; high thrust for rapid, efficient transfer (compared with electric propulsion systems which have to be launched at higher orbits to avoid low altitude drag and which can require months to reach the targeted orbit while exposing the system to the damaging radiation of the Van Allen belts); minimized size provided by a high performance propulsion system; and attitude control system for long term operations.
Potential NASA Applications (Limit 1500 characters, approximately 150 words):

A stage providing over 4.3 km/s delta-V to a nanosat payload can be an enabler for many NASA lunar and interplanetary missions. These include missions similar to the NASA Cislunar Autonomous Positioning System Technology Operations and Navigation Experiment (CAPSTONE), or follow-ons to NASA's Mars CubeSat missions MarCO-A and -B, and unlike MarCO, could enable Mars Orbit Insertion. It can also be used for NASA LEO and GEO nanosat missions, whether launched as dedicated or as secondary payloads.

Potential Non-NASA Applications (Limit 1500 characters, approximately 150 words):

Non-NASA applications include commercial and DoD missions requiring high orbital maneuver capabilities. These include dedicated missions on small launch vehicles where additional delta-V is required, as well as commercial space-tug applications, e.g. on Falcon-9 rideshare launches. The stage can also be modified for other applications such as orbital inspectors from LEO to cislunar operations.
Duration: **24**

PROPOSAL NUMBER: 21-2- **H3.02-2497**

PHASE 1 CONTRACT NUMBER: 80NSSC21C0319

SUBTOPIC TITLE: Microbial Monitoring for Spacecraft Cabins

PROPOSAL TITLE: Fluorescence Imager for Microbial Monitoring of Habitat Surfaces

Small Business Concern

Firm: **Nanohmics, Inc.**
Address: **6201 East Oltorf Street, Suite 400, Austin, TX 78741**
Phone: **(512) 389-9990**

Principal Investigator:

Name: **Dr. John Sarik**
E-mail: **jsarik@nanohmics.com**
Address: **6201 East Oltorf Street, Suite 400, TX 78741 - 7509**
Phone: **(832) 293-3906**

Business Official:

Name: **Mike Mayo**
E-mail: **mmayo@nanohmics.com**
Address: **6201 East Oltorf Street, Suite 400, TX 78741 - 7509**
Phone: **(512) 389-9990**

Summary Details:

Estimated Technology Readiness Level (TRL) :

Begin: 4
End: 6
Technical Abstract (Limit 2000 characters, approximately 200 words):

As next generation lunar missions and interplanetary human spaceflight grow closer, the ability to assess habitat surface microbial content quickly and accurately has become increasingly significant. Current state of the art technology relies on astronaut swabbing of surfaces and subsequently performing molecular analysis on the samples to determine the microbial burden. To alleviate this burden, Nanohmics Inc., proposes to continue advanced development of an autonomous, fluorescence imaging detector (AFID) for microbial mapping demonstrated during the Phase I program. The key components of the unmanned, aerial, 3D-sensing AFID system are a custom fluorescence detector with excitation sources controlled by embedded image acquisition and processing that uses spectral fingerprints and machine learning to differentiate between bacteria, fungi, and other organic material. The goal of the Phase II program will be design, optimization, and performance demonstration of the AFID system ability to generate a microorganism map of the total bioburden on simulated habitat surfaces relevant to future human spaceflight. The final AFID prototype will be advanced to TRL 5-6 over the course of the Phase II program with the ability to distinguish bacteria (detection threshold > 500 CFU/100 cm2) and fungi (detection threshold > 10 CFU/100 cm2) which meet the pre-flight and in-flight microbial mapping microbial monitoring requirements as defined by the International Space Station Medical Operations Requirements Documents (ISS MORD).

Potential NASA Applications (Limit 1500 characters, approximately 150 words):

Numerous NASA applications benefit from ensuring proper disinfection of surfaces, particularly habitat protection applications. This technology would enable in-situ measurement of spacecraft, lander, rover, and instrument cleanliness.

Potential Non-NASA Applications (Limit 1500 characters, approximately 150 words):

A fluorescence imager has multiple applications in the medical, defense, and industrial markets. This technology could be applied to ultraviolet (UV) light disinfection systems used in hospitals to reduce healthcare-associated infections (HAIs) to ensure proper disinfection and identify pathogens in the hospital. This technology could also be used for bio-agent sensing for defense applications.

Duration: **24**

PROPOSAL NUMBER:	21-2- **Z2.01-1280**
PHASE 1 CONTRACT NUMBER:	80NSSC21C0211
SUBTOPIC TITLE:	Spacecraft Thermal Management
PROPOSAL TITLE:	Advanced Cooling System for Modular Power Electronics

Small Business Concern

Firm: **Advanced Cooling Technologies, Inc.**
Address: **1046 New Holland Avenue, Lancaster, PA 17601**
Phone: **(717) 205-0628**

Principal Investigator:

Name: **Dr. Kuan-Lin Lee**
E-mail: **kuan-lin.lee@1-act.com**
Address: **1046 New Holland Avenue, PA 17601 - 5688**
Phone: **(717) 205-0631**

Business Official:

Name: **William Anderson**
E-mail: **Bill.Anderson@1-act.com**
Address: **1046 New Holland Avenue, PA 17601 - 5688**
Phone: **(717) 205-0602**

Summary Details:

Estimated Technology Readiness Level (TRL) :

Begin: 4
End: 6

Technical Abstract (Limit 2000 characters, approximately 200 words):

Advanced Cooling Technologies, Inc. (ACT) proposes to develop and mature a compact and effective cooling system for standardized modular power electronics aiming for future space missions. In Phase I, ACT performed a trade study and developed two advanced heat spreaders for 3U electronics cooling: (1) Hi-K™ plate and (2) pulsating heat pipe (PHP) thermal plane. Both heat spreaders outperform the conventional heat spreader (conduction only aluminum plate), and can operate in both vertical and horizontal orientations. PHP is 10% lighter than Hi-K™ plate

and aluminum plate. In Phase II, ACT will continue to mature the PHP heat spreader technology and develop the complete cooling system of a Modular Electronics Unit (MEU) for space missions. The thermal performance of the PHP from theoretical models and manufacturability will be evaluated to yield an optimum design applicable for various electronics in Space VPX platforms. To characterize the heat spreader performance under various conditions, both transient and steady-state operation will be tested for high and low heat fluxes, as well as in vacuum, and at system level. The performance of PHPs and Hi-K™ plate will be compared in relevant Space VPX environments. An advanced enclosure with embedded cooling will also be developed to minimize the overall system thermal resistance from the cards to the ultimate heat sink on a spacecraft. The final deliverable will be a flight-like MEU cooling system, consisting of down-selected PHP heat spreaders, enhanced conduction card retainers, and an embedded cooling chassis.

Potential NASA Applications (Limit 1500 characters, approximately 150 words):

The proposed cooling system can effectively remove the waste heat from electronics cards to the heat sink. This will allow for a long duration operation of high-power electronics in space. Many NASA applications will benefit, including human landing systems, cis-lunar Gateway, Electric propulsion to Mars and Planetary habitat, etc. The two-phase thermal plane and embedded chassis cooling concepts are also applicable for high-performance CubeSat thermal management.

Potential Non-NASA Applications (Limit 1500 characters, approximately 150 words):

High-power-density electronics (e,g, MOSFETs, GTOs, IGBTs, IGCTs) and Space VPX systems will be the major market for the proposed cooling solutions. The “plug-and-play” components developed under this program are adaptable for many terrestrial applications, including MIDS communication systems for military, electronics in missile and radar systems, electric vehicles, data center cooling, etc.

Duration: **24**

PROPOSAL NUMBER: 21-2- **H12.03-1100**

PHASE 1 CONTRACT NUMBER: 80NSSC21C0253

SUBTOPIC TITLE: Portable Spatial Disorientation Simulator - Trainer

PROPOSAL TITLE: Advancing and Validating Galvanic Induced Disorientation Simulation Trainer (GIST)

Small Business Concern

Firm: **Soterix Medical, Inc.**
Address: **237 West 35 Street, 1401, New York, NY 10001**
Phone: **(888) 990-8327**

Principal Investigator:

Name: **Abhishek Datta**
E-mail: **adatta@soterixmedical.com**
Address: **237 W 35 ST, 1401, NY 10001 - 1950**
Phone: **(888) 990-8327**

Business Official:

Name: **Abhishek Datta**
E-mail: **adatta@soterixmedical.com**
Address: **237 W 35 ST, 1401, NY 10001 - 1950**
Phone: **(888) 990-8327**

Summary Details:

Estimated Technology Readiness Level (TRL) :

Begin: 4
End: 7

Technical Abstract (Limit 2000 characters, approximately 200 words):

We developed a functional laboratory disorientation trainer prototype. The end deliverable is a system that astronauts will regularly use to simulate landing and recovery type tasks and that is used to develop sensorimotor standards to gage suitability to perform tasks. We adapted an existing portable constant current stimulation design (that incorporates an in-built IMU) into a first functional version of a galvanic vestibular stimulation (GVS) disorientation trainer that fully meets the stated deliverables of the solicitation. The early prototype was single channel, wirelessly charged, had data logging capability, ~5 hour run time, 1 mA current limit, and provided full control via a bluetooth connected smartphone app. We adapted it into a 2 channel version to allow simulating pitch and roll tilt, increase current limit to 5 mA and related voltage compliance, provide option for user-adjustable manual gain, emergency on-off switch, incorporate user-switchable rechargeable batteries, and external /manual event triggering. Phase-1 established a laboratory version of the disorientation trainer culminating in pilot testing with 3 participants.

Potential NASA Applications (Limit 1500 characters, approximately 150 words):

Upon successful completion of Phase-2, we will have validated our device for inducing spatial

disorientation using a range of simulated operational tasks. We envision our technology being used by NASA JSC to train all crew-members. In the future, there is potential for NASA to use the same technology to treat space sickness.

Potential Non-NASA Applications (Limit 1500 characters, approximately 150 words):

We have begun discussions with private space companies on incorporating our technology. In addition, technology can be used as a countermeasure for space sickness. Further commercial applications include medical (e.g. correction of balance impairment in Traumatic Brain Injury) and virtual / augmented reality in training and entertainment.

Duration: **24**

PROPOSAL 21-2- **Z3.04-2593**

NUMBER:

PHASE 1 CONTRACT NUMBER: 80NSSC21C0281

SUBTOPIC TITLE: Autonomous Modular Assembly Technology for On-Orbit Servicing, Assembly, and Manufacturing (OSAM)

PROPOSAL TITLE: CrossLink

Small Business Concern

Firm: **Motiv Space Systems, Inc.**
Address: **350 North Halstead Street, Pasadena, CA 91107**
Phone: **(626) 737-5988**

Principal Investigator:

Name: **Michael Hagman**
E-mail: **Michael.Hagman@motivss.com**
Address: **350 North Halstead Street, CA 91107 - 3122**
Phone: **(626) 421-7687**

Business Official:

Name: **Tom McCarthy**
E-mail: **tom.mccarthy@motivss.com**
Address: **350 North Halstead Street, CA 91107 - 3122**
Phone: **(626) 389-5783**

Summary Details:

Estimated Technology Readiness Level (TRL) :

Begin: 3
End: 5
Technical Abstract (Limit 2000 characters, approximately 200 words):

Motiv Space Systems (Motiv) proposes a transformative robotic solution, CrossLink, for On-Orbit Servicing, Assembly, and
Manufacturing (OSAM). Crosslink is a fusion of existing and emerging technologies under development at Motiv. For OSAM
activities to realize their full potential, robotic systems of the future must improve in a number of key areas. CrossLink will
enable future OSAM activities through:

- Low-Cost, Mobile, Modular Robotic Manipulation System
    - The CrossLink robotic system will be architected utilizing the xLink robotic arm architecture as its basis. xLink is designed to be a highly modular, easy to re-configure system, and as such the previously designed components can be shared across both xLink and CrossLink.
- High Bandwidth, Open Architecture, Plug-and-Play Connectivity (SpacECAT)
    - Based upon Motiv's ground robotics products, an EtherCAT communication architecture will be developed and prototyped on direct path to flight hardware utilizing Motiv's Flight DELTA motor controller. This new SpaceECAT architecture will provide high speed and bandwidth communication across the CrossLink Robotic Arm tools, mobility, and tasks as well as any other on orbit SpaceECAT enabled devices. Furthermore, this will enable the use of Motiv's ROS control tools to be used for flight systems.
- Robotic Mobility and Generalized Tool Utilization
    - The grappling end-effector will enable the mobility and tool use of the CrossLink system. The end-effector acts as both a structural and electrical connection for passing power and communication signals to the spacecraft and other SpacECAT enabled tools/devices.

Potential NASA Applications (Limit 1500 characters, approximately 150 words):

NASA's OSAM programs are developing ever sophisticated robotic technologies and tools. An emphasis on modularity, scalability and affordability is growing within the community. The CrossLink addresses each of these points of emphasis and provides options for NASA in its pursuit of assembly activities on orbit. Specific mission concepts include the In-Space Assembled Telescope, aggregated instrument payloads assembled on truss systems for complex science gathering, assembly of 3D printed structures, Internal Gateway Robotics, etc.

Potential Non-NASA Applications (Limit 1500 characters, approximately 150 words):

As NASA and other government agencies create mission roadmaps for OSAM related activities, commercial entities are building business plans to create an industrial operated sector complete with services. The CrossLink can support mission services including space tugs, material transfer between depots, and on-orbit construction of integrated systems following multiple launches.

Duration: **24**

PROPOSAL NUMBER: 21-2- **Z1.06-3130**

PHASE 1 CONTRACT NUMBER: 80NSSC21C0236

SUBTOPIC TITLE: Radiation-Tolerant High-Voltage, High-Power Electronics

PROPOSAL TITLE: Rad-Hard Ga2O3 Diodes

Small Business Concern

Firm: **Kyma Technologies, Inc.**
Address: **8829 Midway West Road, Raleigh, NC 27617**

Phone: **(919) 789-8880**

Principal Investigator:

Name: **Dr. Jacob Leach**
E-mail: **leach@kymatech.com**
Address: **8829 Midway West Road, NC 27617 - 4606**
Phone: **(919) 789-8880**

Business Official:

Name: **Dr. Heather Splawn**
E-mail: **splawn@kymatech.com**