NASA SBIR 2022-II Solicitation

PROPOSAL NUMBER: 22-2- **S13.06-1962**

PHASE 1 CONTRACT NUMBER: 80NSSC22PB133

SUBTOPIC TITLE: In Situ Instruments/Technologies and Plume Sampling Systems for Ocean Worlds Life Detection

PROPOSAL TITLE: Methane Isotopes Analyzer for Enceladus Plume Flythrough

Small Business Concern

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Business Official:

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Summary Details:

Estimated Technology Readiness Level (TRL) :

Begin: 4
End: 5

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

We propose a low SWaP Capillary Absorption Spectrometer (CAS) which has general applicability to a range of NASA missions with specific development for methane analysis during an Enceladus plume flythrough. The system will contain a Plume Capture and Delivery System (PCDS) which transports plume molecules to the CAS to be analyzed for 13C/12C carbon and D/H hydrogen isotope ratios. The CAS utilizes laser absorption spectroscopy in a proprietary hollow fiber gas cell to enable high-precision measurements with minimal sample volume, making it ideal for a plume flythrough. This proposed effort will specifically design a PCDS and develop the CAS further to strengthen the D/H analysis with the constraints of relatively low-abundance of deuterated methane, along with the need to also measure 13C/12C isotopes jointly. In addition, the proposed technology will enable a general and significant upgrade to the core CAS technology (CAS V2.0) with the development of a higher performance, modular, multi-laser design.

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

Isotope-ratio analysis is a powerful tool to elucidate planetary systems. CAS is a novel technology that analyzes small sample amounts to produce high precision data enabling isotope measurement in a flythrough environment where the sample is extremely limited. For example, measurements of methene isotope ratios in a plume of Enceladus can provide insight into the possibility of life below the surface. In addition, the low sample-volume, sensitive, and low SWaP instrument can be appealing for a wide range of NASA lunar and planetary missions.

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

By expanding the CAS capability to measure D/H ratios in methane, the technology will be attractive for a range of environmental sensing and energy applications. In addition, the lower size, weight, power, AND cost is appealing as an alternative to isotope ratio mass spectrometry for commercial applications including pharmaceuticals, food provenance, and forensics.

Duration: **24**

PROPOSAL NUMBER: 22-2- **S16.08-2718**

PHASE 1 CONTRACT NUMBER: 80NSSC22PB169

SUBTOPIC TITLE: Atomic Quantum Sensor and Clocks

PROPOSAL TITLE: High-Sensitivity Isotopically-Purified All-Electrical Chip-Scale Atomic Magnetometers

Small Business Concern

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Summary Details:

Estimated Technology Readiness Level (TRL) :

Begin: 3
End: 5

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

All-electrical chip-scale atomic magnetometers based on spin-coherent transport effects through atomistic defects in semiconductors will have orders of magnitude improved sensitivity if the semiconductor hosts are isotopically purified and related device parameters optimized. Current all-electrical chip-scale atomic magnetometers have room-temperature sensitivities ~400 nT/root-Hz, and the proposed innovation we estimate conservatively to provide room-temperature sensitivities of 400 pT/root-Hz with possibilities as low as 100 pT/root-Hz. These are comparable to those achievable with NV-diamond chip-scale atomic magnetometers, but without the requirement for microwave fields or optical elements. These small-scale magnetometers would avoid the need to self-calibrate, compared to fluxgate magnetometers, and avoid challenges related to diffusion of gas through a glass cell and radiation damage of fiberoptics. They would thus be very well suited for NASA missions and nanosats as their size, power, and complexity restrictions are most severe.

In Phase II we plan to build a bench-top prototype based on microscopic- and device-level models of the spin-dependent dynamics in SiC-based all-electrical magnetometer developed in Phase I. Our Phase I results confirmed the dramatically improved sensitivity to magnetic fields in isotopically purified SiC. We will work with our partners to conduct further device design, epilayer growth, device fabrication and characterization in an iterative development cycle that will culminate in the second year where our objective is to demonstrate a magnetometer prototype that meets the targeted device performance in NASA-relevant environments as assessed by JPL's mu-house facility.

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

Using an all-electrical readout these highly stable small-scale all-electrical SiC-based magnetometers do not require high-frequency microwave elements or optical components. Their improved size, weight and power consumption make them ideal for sensor redundancy, nanosats and cancellation of magnetic distortions due to spacecraft stray fields. Implications include search for life (water vapor, subsurface oceans), crustal anomalies for planetary magnetic history, studies of atmospheric loss by solar wind and space mining of metal-rich asteroids.

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

All-electrical chip-scale magnetometers have applications in aerospace, health, geological prospecting and noninvasive materials monitoring. Examples include magnetic navigation for

GPS-denied airborne applications, magnetocardiography, underground/underwater anomalies, planetary probing and solar weather monitoring, and high-resolution crack detection.
Duration: **24**

PROPOSAL NUMBER: 22-2- **S11.02-2135**

PHASE 1 CONTRACT NUMBER: 80NSSC22PB116

SUBTOPIC TITLE: Technologies for Active Microwave Remote Sensing

PROPOSAL TITLE: Coupled Resonator Power Combiner (COREPOWER)

Small Business Concern

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Summary Details:

Estimated Technology Readiness Level (TRL) :

Begin: 2
End: 4
Technical Abstract (Limit 2000 characters, approximately 200 words):

Building on the successful prototype 5-way coupled resonator combiner demonstrated during Phase I, NuWaves will leverage the COREPOWER combiner technology to develop a L-band, 1 kW solid state power amplifier (SSPA) with greater than 60% power added efficiency (PAE). During the development of the SSPA, the COREPOWER combiner will be modeled and NuWaves will utilize proprietary simulation methods to gain confidence that the design will not experience Multipaction mission conditions. The prototype SSPA will be manufactured and tested in a laboratory environment with inputs from NASA on mission representative radio frequency (RF) signals.

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

The SSPA developed during the COREPOWER Phase II effort is targeted for synthetic aperture radar (SAR) satellites.

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

Small spacecraft ion thrusters, unmanned systems payloads, electronic warfare systems

Duration: **16**

PROPOSAL NUMBER: 22-2- **S13.03-2074**

PHASE 1 CONTRACT NUMBER: 80NSSC22PB214

SUBTOPIC TITLE: Extreme Environments Technology

PROPOSAL TITLE: In-Circuit Energy Storage Device for Extreme Environments

Small Business Concern

Firm: **TDA Research, Inc.**
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Principal Investigator:

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Summary Details:

Estimated Technology Readiness Level (TRL) :

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

Future NASA missions will require system operation at extreme environmental conditions, with temperatures as low as -180°C. Current state-of-practice is to place the hardware in bulky and power-inefficient environmentally protected housings. Hence, NASA is seeking systems that can operate in these extreme environments without needing environmental protection systems.

TDA Research, Inc. is developing hybrid supercapacitors that can operate in extremely cold temperatures (-180°C). The supercapacitor electrodes will use our patented carbon structures to provide high areal capacitance and power in a small package with high power and energy density. On-chip supercapacitors provide the unique capability to store electrical energy and deliver it very quickly and efficiently, enhancing peak-load performance, and offer excellent cycling capability (1-2 orders of magnitude better than batteries).

In Phase I project, we fabricated and tested chip-sized supercapacitors (both 2D and 3D) with superior relative powers (avg. of 28.4-34.1 W/g) and relative energies of 4.6-5.6 Wh/kg (when mass is added for a commercial fully packaged device). We cycled over capacitors over 5,000+ charge/discharge cycles showing good stability. In the proposed Phase II work, we will continue the development of structured electrochemical capacitors for extreme environments, optimizing the carbon structures and (electrode formulations), the low temperature electrolytes used and the capacitor design to maximize the areal capacitance and its power and energy density. We will then fabricate, test, and deliver functional prototype cells to NASA at the end of Phase II.
Potential NASA Applications (Limit 1500 characters, approximately 150 words):

TDA's ultracapacitors can withstand extreme low temperature environments found on Titan, the Moon. Mars, asteroids, comets and other small bodies, and can be used during the descent through kilometers of cryogenic ice expected in these planetary survey missions. The applications include supplementing batteries during high power transients: powering precision actuators and sensors, high-torque force actuators, radio-frequency (RF) electronics, guidance and navigation avionics and instruments.
Potential Non-NASA Applications (Limit 1500 characters, approximately 150 words):

Micro and chip-based supercapacitors can also be used to supplement batteries, enhancing peak-load performance. Other commercial applications could include energy storage and high power in various low temperature applications: (i) Polar environment operations; (ii) Electric aircraft power systems (iii) Aircraft sensors; (iv) Infrastructure health monitoring (v) Electrical vehicle acceleration.
Duration: **24**

PROPOSAL NUMBER: 22-2- **S14.03-1829**

PHASE 1 CONTRACT NUMBER: 80NSSC22PA957

SUBTOPIC TITLE: Remote Sensing Instrument Technologies for Heliophysics

PROPOSAL TITLE: Compact All Sky Interferometric Doppler Imager (CASIDI)

Small Business Concern

Firm: **Atmospheric & Space Technology Research Associates, LLC**
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Summary Details:

Estimated Technology Readiness Level (TRL) :

Begin: 3
End: 6

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

Proposed here is a next generation Compact All Sky Interferometric Doppler Imager (CASIDI) capable of measuring a thermospheric wind field every few minutes, with a precision of 10s of m/s. The ability to measure the wind field two dimensionally over the visible thermosphere will provide greater measurement of gravity waves, energy transport, and interaction between the ionosphere and thermosphere.

The proposed sensor addresses key science goals in the Heliophysics Decadal Survey [NRC, 2013]. The first is to “Determine the dynamics and coupling of Earth’s magnetosphere, ionosphere, and atmosphere and their response to solar and terrestrial inputs.” The Decadal

Survey underscored the importance of the Magnetosphere-Ionosphere-Thermosphere (MIT) system by stating “Understanding ionosphere-thermosphere interactions is a major area of inquiry, especially during geomagnetic storms.”

The ionosphere exhibits significant day-to-day variability, which can seriously degrade important technological systems. Lack of ionospheric data, especially over the oceans, hinders scientific progress, and degrades the quality of existing nowcasting and forecasting systems. Ion-neutral coupling is a fundamental process that drives the evolution of the ionosphere and thermosphere. Recent observations of small-scale irregularities have been linked to neutral wind variability. Variations in neutral winds can drive complex and large-scale variability in the ionosphere.

In addition to the sensor, a rapid manufacturing technique for the interferometer itself has been demonstrated. The combination of both the sensor and a vertically integrated manufacturing methodology will allow for lower cost and faster production of these sensors, thus enabling not only deployments in arrays but also on buoys and autonomous sea-going vehicles. Etalons manufactured with this technique will have applications well outside of Heliophysics.
Potential NASA Applications (Limit 1500 characters, approximately 150 words):

The CDI as a standalone sensor can provide thermospheric wind maps that are needed by the Space Weather community. Specifically, CASIDI can aid in understanding the Sun-atmosphere interaction region of Earth and its dynamical response to external and internal influences. Over time, data from CDI will be important in developing a near-real-time predictive capability for quantifying the impact of dynamical processes at the Sun on human activities and in Earth’s ionosphere.
Potential Non-NASA Applications (Limit 1500 characters, approximately 150 words):

Access to global wind maps from one or more CASIDI instruments will significantly improve the specification and forecast of ionospheric responses to solar and geomagnetic disturbances. This improvement provides direct societal benefits due to optimized operation of communication, navigation, and surveillance systems. The data from CASIDI will also provide vital data for scientific studies.
Duration: **24**

PROPOSAL NUMBER: 22-2- **S14.02-2896**

PHASE 1 CONTRACT NUMBER: 80NSSC22PA926

SUBTOPIC TITLE: Particle and Field Sensors and Instrument-Enabling Technologies

PROPOSAL TITLE: Solar-Blind Solid-State Energetic Particle Detection for Next-Generation Instruments

Small Business Concern

Firm: **Advent Diamond, Inc.**
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Summary Details:

Estimated Technology Readiness Level (TRL) :

Begin: 1
End: 6

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

In this Phase II project, Advent Diamond continues development of particle detectors which utilize doped and undoped semiconducting diamond to enable new space-based particle detection instrumentation. The detectors will have multiple, independent active layers. The active layers are made out of intrinsic (undoped) semiconducting diamond. The top active layer thickness can be customized to meet customer needs, with sub micron thicknesses demonstrated in Phase I. This is anticipated to enable unprecedented measurement resolution. The first application targeted will be for measurements and identification of ions with energies in the range of MeVs. In this application, the envisioned implementation of the innovation in an instrument is to use the dual-sided diamond detector as the first detector in a telescope stack, and use conventional silicon energy loss detectors behind it. In addition, Advent Diamond will offer a suite of customization options to target other energies and applications. Unique features of the detectors include solar blind response, and separate top-side and back-side responsivity to various radiation is an additional instrument enabling feature. Essentially, this innovation will offer 2-in-1 measurements. These detectors represent a significant advancement over the state of the art, and will be the first diode-type diamond particle detectors and single-chip diamond telescope-type detectors available on the commercial market for space and terrestrial applications. Phase I prototypes have been successfully fabricated and tested, confirming the feasibility of this approach. In addition, collaborators, beta users and mentors have been identified for Phase II to ensure the successful development and insertion of the developed components.

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

Measurements of the composition, sources and properties of energetic particles can aid in understanding the complex processes in the solar system environment. This innovation is an instrumentation-enabling technology for measurements of charged particles. Missions which make use of particle measurements include the Parker Solar Probe, the Solar Dynamics Observatory, and the Solar Orbiter, and future missions include HERMES and the Geospace Dynamics Constellation.

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

The specifications which can be achieved with this innovation surpass the state-of-the-art detectors and will enable next-generation measurement technologies for non-NASA applications in: oncological radiation therapy safety monitoring, particle physics experiments, DoD spacecraft monitoring, NOAA instruments; and, ion beam calibration for space electronics testing.

Duration: **24**

PROPOSAL NUMBER: 22-2- **A1.02-1831**

PHASE 1 CONTRACT NUMBER: 80NSSC22PB055

SUBTOPIC TITLE: Quiet Performance - Aircraft Propulsion Noise

PROPOSAL TITLE: Advanced Phased Array Instrumentation and Processing for Engine Inlet Measurements

Small Business Concern

Firm: **Interdisciplinary Consulting Corporation**
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Summary Details:

Estimated Technology Readiness Level (TRL) :

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

The Interdisciplinary Consulting Corporation (IC2), in partnership with OptiNav, Inc., proposes to develop advanced phased-array instrumentation and processing capabilities for aircraft engine-inlet measurements. High channel-count, high-density, reduced cost-per-channel microphone arrays, using microelectromechanical systems (MEMS) piezoelectric microphones with backside contacts and advanced packaging technology, will be integrated into model-scale inlet design/build efforts to revolutionize engine-inlet phased-array measurement capabilities through increases in array density and channel count while significantly reducing the cost per channel. These measurement advances will be coupled with development of advanced array processing techniques to take full advantage of the enhanced measurement capabilities, including handling of the three-dimensional (3D) problem associated with nonuniform inlet geometries. This proposed technology is in response to the NASA SBIR 2022 Phase I solicitation subtopic A1.02 Quiet Performance – Aircraft Propulsion Noise where “improvements in propulsion noise prediction, diagnostics, and reduction are needed for subsonic and supersonic aircraft.” This work is aimed at addressing the aerospace industry’s need for technically feasible and economically viable engine-inlet array-measurement capabilities that enable required noise diagnostic capabilities including characterization of in-duct noise source spatial and temporal content.

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

The proposed instrumentation technology has the potential to be usable in multiple NASA facilities as well as implemented across government-owned, industry and academic institution test facilities. Potential NASA applications include use in nonuniform inlets such as the Source Diagnostic Test (SDT) inlet and non-axisymmetric inlets such as those on the Boundary Layer Ingestion (BLI) propulsion concept and the X-59 QueSST aircraft used in the Low Boom Demonstration Project.

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

The technology has applications for nonuniform inlets such as DARPA's Quiet Supersonic Platform. The emerging urban air mobility (UAM) market is a key target for the proposed technology. Additional possible customers include aircraft manufacturers and engine developers for aerospace or industrial applications.

Duration: **24**

PROPOSAL NUMBER: 22-2- **A3.02-1694**

PHASE 1 CONTRACT NUMBER: 80NSSC22PB098

SUBTOPIC TITLE: Increasing Autonomy in the National Airspace System (NAS)

PROPOSAL TITLE: Contingency Planning Toolkit for Advanced Air Mobility

Small Business Concern

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Summary Details:

Estimated Technology Readiness Level (TRL) :

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

NASA's Urban Air Mobility (UAM) and Advanced Air Mobility (AAM) concepts envision increasing autonomy, artificial intelligence, and machine learning to maintain operational efficiency while ensuring safety. Increasing autonomy while maintaining or improving efficiency and safety will require effective teaming between humans and automation in routine and contingency operations. The UAM and AAM concepts describe procedures for addressing contingencies, implicitly assuming automation will be able to coordinate well enough to address contingencies, with little or no human input, if procedures are pre-defined. However, if traditional air traffic operations are to be a guide, humans will need to be involved in coordinated contingency planning for UAM/AAM operations.

To address the need for coordinated contingency planning in UAM/AAM, we propose ***Contingency Planning Toolkit for Advanced Air Mobility (CPT AAMO),*** a collection of procedures and software for contingency planning and management and processes and capabilities to evaluate proposed procedures to support research, development, and certification. Its design is based on a systematic analysis of potential allocations of contingency planning functions. Metrics include function allocation coherency, operational tempo, and coordination load, enabling us to assess each candidate architecture according to properties like safety, resilience, equity, integration, and resistance to cyber-attack. This effort ***fills a gap in AAM concept development***, providing appropriate architectures and function allocations for contingency planning in a highly automated system.

In Phase I, Mosaic ATM proved the feasibility of our approach and derived functional and information requirements for various entities within the UAM ecosystem. In Phase II, we propose to harden and expand the offerings in the CPT AAMO Toolkit, maturing from *concept exploration* to early *technical implementation*, preparing the innovation for commercialization.

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

- Support validation of contingency planning roles, responsibilities, and procedures for AAM concepts in tabletop, simulation, and field evaluations.
- Integration with or transfer of software to NASA's *Freddie* capability to support future NASA demonstrations and evaluations.
- Participation in future AAM National Campaign demonstrations and evaluations to explore contingency planning and management in a distributed environment.
- Toolkit for performing contingency planning functions in a distributed work system.

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

- Toolkit for UAM and AAM fleet operators, Providers of Services to UAM (PSUs), and others to participate in coordinated contingency planning and management.
- Contingency planning and management software offered through software sales, licenses, and/or subscriptions.
- Evidence gathering for prospective UAM/AAM participants to gain FAA authorization to offer their services in the airspace.

Duration: **24**

PROPOSAL NUMBER: 22-2- **A1.05-2522**

PHASE 1 CONTRACT NUMBER: 80NSSC22PB038

SUBTOPIC TITLE: Computational Tools and Methods

PROPOSAL TITLE: Robust and Efficient WMLES Unstructured Grid Generation with HeldenMesh

Small Business Concern

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Summary Details:

Estimated Technology Readiness Level (TRL) :

Begin: 3
End: 7
Technical Abstract (Limit 2000 characters, approximately 200 words):

Mesh generation for wall-modeled large eddy simulations (WMLES) based CFD simulations represents a critical area of research as there are significant challenges which must be overcome before this technology can be adopted for widespread use. Two critical challenges associated with these scale-resolving simulations is mesh size and mesh quality. Mesh size represents a critical challenge as WMLES simulations require at least an order of magnitude increase in mesh size compared to current Reynolds-averaged Navier-Stokes (RANS) based simulations. This means required mesh sizes are measured in billions of nodes (exascale) rather than tens or hundreds of millions. Existing commercial mesh generators can take several days just to generate these large meshes. Mesh quality also represents a critical challenge as the WMLES solver is much more sensitive to element regularity, edge alignment, element type (hex, prism, pyramid, tet), maximum aspect ratio, and surface spacing than typical RANS simulations. The objective of our Phase II effort is to solve these significant challenges by developing an automated, scalable, and high-quality mesh generation capability for next generation CFD based WMLES applications. Our approach develops enhancements to our industry leading time-to-mesh HeldenMesh grid generator to improve its support for WMLES applications while also reducing current Reynolds-averaged Navier-Stokes (RANS) based mesh generation times. It also develops a new tool which rapidly generates the billions of nodes meshes needed for WMLES simulations using a robust and automated mesh refinement approach – reducing WMLES mesh generation times from days to seconds. Finally, it also proves the production readiness of these tools on several real-world WMLES applications while also establishing the best practices needed to ensure solution accuracy. Our program represents a key enabler for widespread adoption of WMLES.

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

The successful completion of this Phase I effort supports all NASA programs and projects that use CFD for advanced aircraft concept design, launch vehicle design, and planetary entry vehicles. The technology developed under this project will enable design decisions by Aeronautics Research Mission Directorate (ARMD) and Human Exploration Operations Mission Directorate (HEOMD).

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

Helden Aerospace has already successfully transitioned its existing HeldenMesh commercial grid generator to industry where it is widespread use. This Phase II effort further improves this CFD toolset by reducing its already industry leading mesh generation times and incorporating

new WMLES mesh generation capabilities. It results in a product with strong commercial near and far term viability.
Duration: **24**

PROPOSAL NUMBER: 22-2- **A2.01-1708**

PHASE 1 CONTRACT NUMBER: 80NSSC22PB161

SUBTOPIC TITLE: Flight Test and Measurement Technologies

PROPOSAL TITLE: Ruggedized MEMS-VCSEL with High Speed Data Acquisition for Fiber Optic Sensing System

Small Business Concern

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Summary Details:

Estimated Technology Readiness Level (TRL) :

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

Our phase I effort validated the ability of a properly designed micro-electromechanical systems vertical cavity surface-emitting laser (MEMS-VCSEL) to sense fiber bragg gratings at a distance of several meters, using reasonable Analog to Digital (A-D) converter rates of a few hundred MHz. In addition, we demonstrated that our electrically pumped MEMS-eVCSELs can be packaged with an amplifier in a single 14-pin butterfly package, which remains robust through vibration testing at peak accelerations exceeding 10g, using a standard MIL-SPEC vibration spectrum. These results form the foundation for our phase II effort, in which we will re-design the laser cavity to further reduce noise and enable fiber bragg grating sensing at >10meters. This work will progress through 5 objectives. In objective 1, we will develop a low-noise optically pumped device designed for >10meter sensing. Our subcontractor Sensuron will validate this device and develop detection electronics in objective 2. Objective 3 will duplicate objective 1 performance in a ruggedized electrically pumped version, which our subcontractor will integrate into a ruggedized sensing system under objective 4. In objective 5 we will develop an ultra-low noise MEMS-VCSEL source capable of sensing tens of meters.

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

This work will develop a new cost-effective ruggedized laser technology that will accelerate proliferation of optical frequency domain reflectometry (OFDR) fiber optic sensing of physical parameters such as shape, deflection, temperature, and strain. This will impact the structural engineering and testing of cutting-edge structures and vehicles for land, air, water, and space. This laser technology can also be embedded into vehicles for continuous in-flight structural and health monitoring.

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

This work will create a new rugged 1550nm widely tunable laser source which provides continuous single mode tuning with low size, weight, and power dissipation in an economical package. This source has non-NASA applications in structural monitoring of military and commercial aircraft, of wind turbines, and in metrology, spectroscopy, and medical shape sensing.

Duration: **24**

PROPOSAL NUMBER: 22-2- **A3.04-1460**

PHASE 1 CONTRACT NUMBER: 80NSSC22PB099

SUBTOPIC TITLE: Nontraditional Airspace Operations and Aerial Wildfire Response

PROPOSAL TITLE: A Toolkit for UAM Communications Management

Small Business Concern

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Summary Details:

Estimated Technology Readiness Level (TRL) :

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

Air/Ground (AG) communications (AG Comm) are well established for traditional National Airspace System participants, but for the Advanced Air Mobility (AAM) concept, the infrastructure, frequency bands, and related infrastructure build-outs are in their infancy. Initially, AAM pilots will be in the cockpit and AG Comm will use existing voice channels. However, for UAM Maturity Level 4 (UML-4) and onwards, vehicles are controlled by remote pilot. AG Comm will require higher bandwidths than AG Comm does today for transmitting video and reproducing the cockpit on the remote pilot's workstation (a digital twin of the aircraft).

TUCM targets this remote pilot concept, UML-4 and onwards. TUCM uses a combination of statistical and Machine Learning (ML) tools to estimate the signal strength as a vehicle traverses the airspace. The signal strength is a complicated function of direct line of sight, multipath interference due to reflections off the ground and nearby buildings, electromagnetic interference, and atmospheric effects. This problem is compounded by the movement of the vehicle. The signal strength computations are then packaged into a marketable toolkit that can be inserted as a module into existing AAM management tools, AAM simulations, or used as a stand-alone tool for engineering and health checking of communication systems. TUCM's purpose is to increase the resiliency and reliability of AAM AG Comm.

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

NASA Glenn Research Center actively investigates AG Comm issues for all aviation business models, including AAM. In addition, Langley and Ames Research Centers are testing concepts and platforms to support its High Density Vertiplex program associated with a UAM ecosystem. Both the ATM-X and the AAM Projects can productively use the TUCM tool. NASA also works with five state and local governments in MA, MN, TX, OH, and the City of Orlando to develop civic transportation plans to support emerging passenger-carrying air taxi services.

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

Target markets for TUCM include state and local governments planning AAM services. Provider of Support for UAM (PSUs) may also find the tool

useful. Communication engineers can use the tool to site AAM AG Comm towers and to determine when a tower may need repair. Avionics suppliers and AAM vehicle manufacturers will also find the tool useful.

Duration: **24**

PROPOSAL NUMBER: 22-2- **A1.01-1525**

PHASE 1 CONTRACT NUMBER: 80NSSC22PA974

SUBTOPIC TITLE: Aeroelasticity and Aeroservoelastic Control

PROPOSAL TITLE: Configurable Parametric Aeroservoelastic Reduced-Order Models for Aerostructural Sensing and Control

Small Business Concern

Firm: **CFD Research Corporation**
Address: **6820 Moquin Drive Northwest, Huntsville, AL 35806**
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Principal Investigator:

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Business Official:

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Summary Details:

Estimated Technology Readiness Level (TRL) :

Begin: 4
End: 5

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

The goal of the proposed effort is to develop a framework for configurable reduced-order modeling (ROM) for the development of novel aeroservoelastic (ASE) sensing and control approaches within a broad flight parameter space. Parametric ROM techniques developed by the proposing team present a considerable opportunity to extract dominant aerodynamic, structural dynamics, and control surface effects in a compact form that can be used to evaluate and optimize controllers for suppression of flutter and gust loads. The Phase I effort focused on development of the data generation, ROM training, and control synthesis workflow. The Phase I capability was demonstrated using ASE problems of interest to NASA (e.g., suppression of gust response and flutter). The Phase II efforts will focus on: (1) refinement of the aeroelastic simulation process for improved training and verification; (2) addition of late-breaking ROM techniques for improved characterization of the aeroelastic system; (3) implementation of more complex control schemes, sensor models, and actuator models to assess whether ROMs can be used for case studies with increased realism; and (4) extensive software validation and demonstration for ASE and flight control design of realistic aircraft of interest to NASA. The capabilities will be provided as a modular software environment for integration into NASA workflow for technology transition.

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

This research will deliver NASA a valuable tool to automate ASE ROM and control synthesis; design advanced aerostructural controllers; and perform real-time ASE simulation; and will markedly improve the process for considering aeroelasticity in controller development through rapid predictions of gust loads, ride quality, and stability and control issues. It will significantly decrease simulation validation and workflow lag time, reduce development costs and time. NASA projects like MUTT, SUGAR, and QueSST will benefit from the technology.

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

The non-NASA applications are vast, and will focus on aerospace, defense, and watercraft engineering for fluid-structural interaction and fatigue analysis, control and optimization, hardware-in-the-loop simulation, and others. The proposed development will provide a powerful tool which can be used for fault diagnostics, optimized design, simulation and experiment design and planning, and more

Duration: **24**

PROPOSAL NUMBER: 22-2- **A2.02-2214**

PHASE 1 CONTRACT NUMBER: 80NSSC22PA985

SUBTOPIC TITLE: Enabling Aircraft Autonomy

PROPOSAL TITLE: Enhanced Detect and Avoid Optical Sensing for Urban Air Mobility

Small Business Concern

Firm: **Circle Optics, Inc.**
Address: **260 East Main Street, Suite 6106, Rochester, NY 14604**
Phone: **(914) 233-4735**

Principal Investigator:

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Summary Details:

Estimated Technology Readiness Level (TRL) :

Begin: 2
End: 6

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

Circle Optics proposes a NASA SBIR Phase II project to build, flight test, and deliver, a 7-channel visible DAA visor system. This system would use Sony IMX530 sensors and provide staring type imaging over a ± 112-degree horizontal FOV, with a ± 15-degree vertical FOV, to support a detection range of ~ 3.8 Nm. At the beginning of the Phase II project, Circle Optics would confer with the NASA TPOC to account for any changes or new information that has occurred in the interim, whether at NASA, Circle Optics, or in the emerging industry. Circle Optics would then complete the lens design and lens barrel design and order the custom optics. In parallel, Circle Optics would complete the system mechanical design, including for camera channel alignment and mounting, vibration isolation, electronics support, and ownship mounting. Circle Optics would complete the development of the data path and imaging software, to enable the output of tracked bogey aircraft data to the Detect and Avoid (DAA) analysis software. These efforts would converge on the assembly and testing of the cameras and integrated visor system, first in the lab, and then initial in-flight testing at Griffiss Airport in Rome, NY. Circle Optics would then deliver to NASA, a completed visor system, supporting test data, an operations manual, and final reports on system performance and paths forward.

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

In the emerging future world of Urban Air Mobility (UAM), with vehicles flying in congested airspaces, robust reliable sensing and AI systems to prevent collisions will be needed. The FAA and NASA have recognized this risk and are collaborating to develop standards that recognize the need for sensing redundancy, and as a contributing solution, anticipates EO/IR imaging systems onboard eVTOLs or UAVs, to optically detect and track non-cooperative aircraft within a substantial Field of Regard. Circle Optics can fulfill this need.

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

This technology will enable growth in the commercial UAS sector. Autonomous drones, capable of self-localizing and automatically performing maneuvers like selecting a safe emergency landing location in case of a system failure will become more common. UAS capable of achieving high levels of autonomy, such as sense and navigate, will be the first to meet the FAAs requirements for BVLOS operation.

Duration: **22**

PROPOSAL NUMBER: 22-2- **A3.03-1229**

PHASE 1 CONTRACT NUMBER: 80NSSC22PB221

SUBTOPIC TITLE: Future Aviation Systems Safety

PROPOSAL TITLE: Controller-Pilot Voice Communication and Intent Monitoring for Future Aviation Systems Safety

Small Business Concern

Firm: **The Innovation Laboratory, Inc.**
Address: **2360 Southwest Chelmsford Avenue, Portland, OR 97201**
Phone: **(503) 242-1761**

Principal Investigator:

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Summary Details:

Estimated Technology Readiness Level (TRL) :

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

This effort combines speech analytics, Speed to Text (STT) translation software, and intent inference algorithms in order to assess aviation system safety. Each of these components has a different perspective on spotting potential off-nominal and anomalous conditions, for instance, in the way people speak under stress and high workload, the mis-communications and mishearing of key words in a dialog, or the intent to follow a command or not follow a command. The system being designed and built analyzes pilot-controller conversations in real-time, identifies key speech features, STT translations, and intent models to identify if the situation is nominal, off-nominal, or anomalous.

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

This effort directly relates to NASA's ISSA and IASMS:

- In-time System-wide Safety Assurance (ISSA) – Proactively mitigate risks and demonstrate innovative solutions while ultimately ensuring safety to the community on the ground and in the NAS.
- In-Time Aviation Safety Management System (IASMS) – A scalable and distributed system approach with a service-oriented architecture to address aviation safety needs in the NAS.

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

- FAA Air Traffic Control (ATC) system monitoring
- Airline pilot-controller monitoring
- Airline pilot-dispatcher monitoring

Additional commercial applications include stock trading voice communications workflow monitoring and regulatory compliance checking. The appropriate prime contractors are typically deeply involved with both voice and data communications.

Duration: **24**

PROPOSAL NUMBER: 22-2- **A1.04-2551**

PHASE 1 CONTRACT NUMBER: 80NSSC22PB040

SUBTOPIC TITLE: Electrified Aircraft Propulsion

PROPOSAL TITLE: Tail Propulsor Generator for NASA SUSAN Sub-Scale Flight Demonstrator

Small Business Concern

Firm: **Hinetics, LLC**
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Principal Investigator:

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Summary Details:

Estimated Technology Readiness Level (TRL) :

Begin: 2
End: 4

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

Hinetics performed a detailed study in Phase I to evaluate the integration of a lightweight, high efficiency 150 kW generator-drive subsystem within the SUSAN concept aircraft. Analysis on potential subsystem and system level integration strategies ensured stability and reliability were maintained across all operating conditions of the propulsion system and while maximizing the system level performance. This has set the stage for hardware development for a sub-scale SUSAN demonstration in this Phase II program, helping to increase the TRL of critical technologies for future low carbon aircraft. The Phase II project will include prototype construction of the machine and integration with a Lycoming O-360 engine to de-risk overall system considerations. Because the full scale SUSAN concept utilizes an aft turbine and our topology has clear weight and efficiency benefits at higher shaft speeds, Hinetics will design, build, and demonstrate a higher speed generator for mating to a COTS turboshaft. In parallel, a US-based subcontractor, Beehive Industries, will perform a study on the potential of improving turboshaft efficiencies in the 150 kW power range to become more competitive with combustion engine solutions while maintaining low system mass.

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

Subsonic Single Aft Engine (SUSAN) Electrofan would be the major targeted application for this motor design and system integration study. It will also be applicable to any of the drivetrain testing and qualification programs of NASA in a similar power scale with a few varying details such as cooling availability and drivetrain.

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

While this study is targeted at the generator coupled to aft engine, it is directly applicable to a distributed propulsor or the propulsor in any turbo-electric, hybrid-electric or fully electric concept. In addition, the drivetrain developers can potentially use this study to test the sub-systems and to validate the performance and reliability of electric aircraft drivetrains.

Duration: **24**

PROPOSAL NUMBER: 22-2- **A3.02-1179**

PHASE 1 CONTRACT NUMBER: 80NSSC22PB003

SUBTOPIC TITLE: Increasing Autonomy in the National Airspace System (NAS)

PROPOSAL TITLE: Vertiport Human Automation Teaming Toolbox

Small Business Concern

Firm: **Crown Consulting, Inc.**
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Summary Details:

Estimated Technology Readiness Level (TRL) :

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

Crown Consulting, Inc. in partnership with George Washington University and several industry leading expert consultants in heliport infrastructure propose to develop Vertiport Human Automation Teaming Toolbox (V-HATT). V-HATT is designed for real-time human-in-the-loop

simulations for vertiport arrival, surface, and departure operations on the airside of a vertiport. Human-machine teaming is a core component of V-HATT, and the simulation toolbox will be designed to toggle various teaming strategies with differing degrees of automation to examine the teaming relationship performance. The Federal Aviation Administration anticipates the development of future guidance on advanced vertiport operations including autonomy and high tempo facilities. As vertiports grow in capability and complexity, managing operations will require innovative concepts that adapt to scale with vertiport operational complexity. V-HATT will assist researchers, operators, manufacturers, and infrastructure developers to understand realistic operational bottlenecks and vertiport capacity considering human roles.

V-HATT can be decomposed by mission phases to illustrate the envisioned system capabilities.

1. **Pre-Mission:** The Pre-mission phase includes simulation set-up, design, adjusting teaming relationship parameters, vertiport and airspace design, operaitonal rules, selecting weather conditions, and identifying potential off-nominal scenarios.
2. **Mission:** The Mission phase includes running the simulation with a HITL to try and manage the flow of operations at a vertiport. A human vertiport operator will have controls that allow for scheduling, sequencing, and controlling arrival, surface, and departure traffic to ensure high-throughput operations at the vertiport.
3. **Post-Mission:** The Post-mission phase includes conducting human factors analysis, conducting bottleneck analysis, and comparing runs to look at the data of how simulation configurations compare.

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

NASA researchers could use V-HATT to investigate the human machine interactions with specific vertiport designs by creating different vertiport designs and analyzing human workload for each concept of operation. V-HATT is designed to integrate with existing vertiport interfaces already developed by NASA and other commercial operators. We intend to investigate joining the Air Traffic Management eXploration X-series. Other NASA applications may include supporting High Density Vertiplex, System Wide Safety, or AAM National Campaign.

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

Primary target markets include:

1. Heliports and Vertiport Operators
2. Standards Development Organizations and Regulators
3. Advanced Air Mobility Manufacturers and Airline Operators
4. Training and Certification Organizations

Crown is looking at integrating V-HATT into other commercial offerings, such as the Advanced Air Mobility Community Integration Platform (AAM-CIP) currently being developed.

Duration: **18**

PROPOSAL NUMBER: 22-2- **A2.03-1596**

PHASE 1 CONTRACT NUMBER: 80NSSC22PB235

SUBTOPIC TITLE: Advanced Air Mobility (AAM) Integration

PROPOSAL TITLE: Multipurpose Doppler Lidar Measurements

Small Business Concern

Firm: **TruWeather Solutions**
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Principal Investigator:

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Summary Details:

Estimated Technology Readiness Level (TRL) :

Begin: 3
End: 7
Technical Abstract (Limit 2000 characters, approximately 200 words):

Safe Unmanned Aerial Systems (UAS) operations and airspace management depend on accurate weather data to make critical decisions, plan fleet asset tasking, schedule cargo or people movements, reduce flight uncertainty and meet client expectations. Accurate weather data requires a robust, autonomous and reliable sensing platform capable of detecting multiple weather hazards across urban, suburban and rural domains.

Weather data are a crucial building block for Advanced Air Mobility (AAM), especially over urban areas where the operations are expected to become routine in complex environments. High-resolution weather measurements are necessary to detect relevant hazards in urban environments, and ultimately improve forecasts.

This Phase II effort consists on developing algorithms to retrieve ceiling, cloud base, and visibility to enhance the utility of Doppler lidars that will already be utilized to measure wind in urban areas, making lidars multipurpose sensors. This work will improve algorithms developed in the Phase I portion and quantitatively assess the value of Doppler lidars as part of an urban sensing network for business justification. Additionally, optimal scanning strategies will be

established as well as uncertainty metrics to inform risk-based decision making. These efforts will address significant gaps in urban airspace weather situational awareness critical to reach a mission safety level as required in the Urban Weather section of the NASA UAM UML-4 CONOPS.

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

This initiative enables NASA applications that depend on highly reliable and persistent non-government space, atmospheric and terrestrial measurements and predictions:

- Commercial space launches and human space travel
- ATM / UAS / UTM / UAM Systems, Industries, and Projects
- Satellite and communication systems

UAS and UAM is a “blue sky” mission area to demonstrate how weather monitoring systems, especially in urban areas, can reduce the impact of hazardous events to mission critical operations.

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

Our applications for this technology extend to FAA and commercial endeavors of the same mission areas that NASA is working in, namely:

- Commercial space launches and human space travel
- ATM / UAS / UTM / UAM
- Satellite and communication systems

We are also looking at how cities can use urban micro weather data as part of Smart City initiatives by deploying weather sensing platforms.

Duration: **24**

PROPOSAL NUMBER: 22-2- **A1.03-2154**

PHASE 1 CONTRACT NUMBER: 80NSSC22PA929

SUBTOPIC TITLE: Low Emissions/Clean Power - Environmentally Responsible Propulsion

PROPOSAL TITLE: Humidity Probe for Contrail-Cirrus Avoidance

Small Business Concern

Firm: **Aerodyne Research, Inc.**
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Principal Investigator:

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Summary Details:

Estimated Technology Readiness Level (TRL) :

Begin: 4
End: 7

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

Our proposal provides a measurement technology to detect atmospheric conditions that favor the formation and persistence of aircraft-induced cirrus clouds in real time. These clouds account for the major share of aviation's climate impact via radiative forcing. We need aircraft equipped with our technology that fly along the busiest flight corridors combined with adaptive flight routing as mitigation strategy. We are developing a new compact laser-spectroscopic instrument to measure the relevant humidity levels. During Phase I we achieved a relative uncertainty of 110 ppb (0.11 ppm) for real-time data recorded at 1 Hz with a short optical pathlength of only 30 cm. With further data averaging the relative uncertainty improved to ~25 ppb (0.025 ppm) for 1-minute averages. We have demonstrated excellent linearity of response of our Phase I benchtop system between 10 ppm and >6000 ppm. Based on simulated vertical profile measurements in the laboratory we estimate the accuracy of our Phase I benchtop system to be 1..2 ppm or ~2 %, whichever is greater. This performance makes our technology highly suitable for the proposed contrail avoidance application onboard aircraft.
In Phase II we will further refine the instrument design with a strong focus on manufacturability and low cost. Innovations include an optical-fiber based open-path-free optical system with collimation optics and detector integrated into the sample cell, and a fast and efficient look-up based spectroscopic fit. We are actively planning the demonstration of the Phase II prototype instrument during an aircraft deployment.

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

A simple-to-integrate, highly compact, and maintenance free water vapor instrument for NASA aircraft campaigns would be a great asset for many scenarios. This includes satellite validation where a NASA aircraft would perform profile measurements co-located with satellite observations. The project will enable commercial airspace management procedures that avoid contrail induced cirrus cloud, which has a significant short term climate benefit.

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

Persistent contrail avoidance has emerged as a mitigation strategy for airlines to reduce their climate burden. The sensor enables a global system that quantifies the atmospheric state in real time, where contrails could be avoided with minor adjustments. The additional benefit of the technology developed here will involve assimilation of the water data by meteorological modeling systems.

Duration: **24**

PROPOSAL NUMBER: 22-2- **A3.04-1919**

PHASE 1 CONTRACT NUMBER: 80NSSC22PB233

SUBTOPIC TITLE: Nontraditional Airspace Operations and Aerial Wildfire Response

PROPOSAL TITLE: UAS Traffic Management (UTM) Prototype for 24 Hour Aerial Firefighting

Small Business Concern

Firm: **Trident Sensing LLC**
Address: **6300 Sagewood Drive, Suite H206, Park City, UT 84098**
Phone: **(435) 640-9236**

Principal Investigator:

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Summary Details:

Estimated Technology Readiness Level (TRL) :

Begin: 5
End: 7
Technical Abstract (Limit 2000 characters, approximately 200 words):

Climate change is increasing the frequency and severity of western wildfires. Threats to people and infrastructure are growing with more population living in the wildland-urban interface. Blindly throwing more resources at the problem while doing things the same way is not a cost-effective. Extending manned and unmanned aerial firefighting to 24-hour, second-shift operations will provide a major increase in firefighting effectiveness and efficiency. During the night, winds die down, temperatures decrease and humidity increases making night time a more productive time to fight fires from the air. But, existing airspace management processes are visual, manual, and not conducive to Unmanned Air Systems (UAS) participation. Hence, firefighting is largely restricted to manned, daytime, clear air mass visual operations. By applying emerging technology in innovative ways, firefighting will transition to round-the-clock operations with UAS picking up much of the workload.

During Phase II, a full prototype Second-Shift Aerial Supervision Module (SSASM) will be developed to extend aerial firefighting to second-shift operations while supporting simultaneous UAS support missions such as search and rescue, surveillance and resupply. SSASM eliminates the daytime overhead stack and allows manned/unmanned tanker loads to be delivered on arrival, vastly improving efficiency and lowering cost. Night operations are de-conflicted through the use of innovative 4-D corridors and airspace containers. Progress is monitored on AirBoss displays with automatic detection of traffic conflicts during planning and execution. SSASM supports ground based, manned and unmanned tanker mission planning, tasking, and 4D trajectory guidance from ingress, retardant delivery, and egress. Mission metrics are down linked for evaluation of drop effectiveness. Real-time, persistent surveillance enables night firefighting operations. Line-of-Sight and SATCOM data communication architectures are demonstrated.

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

This research supports NASA Wildfire projects:

- SSASM is closely aligned with NASA's new Advanced Capabilities for Emergency Response Operations (ACERO) initiative and directly supports the ACERO Wildfire Airspace Management, Second Shift, and Aircraft Safety objectives.
- This SBIR research is aligned with NASA's Science Mission Directorate (SMD) FireSense program. Commercialization of our technology directly supports fielding capabilities to operational agencies with the goal of measurably improving wildland fire management.

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

- Federal & State wildland firefighting agencies: USFS, BLM and CALFIRE. Each SSASM license will save hundreds of hours of flight time through better airspace management and by eliminating the overhead aerial supervisor and lead plane aircraft at night. Lower cost and improved effectiveness will drive adoption.
- State and Local Emergency Services will benefit from improved situational awareness.

Duration: **24**

PROPOSAL NUMBER: 22-2- **A3.04-2854**

PHASE 1 CONTRACT NUMBER: 80NSSC22PB044

SUBTOPIC TITLE: Nontraditional Airspace Operations and Aerial Wildfire Response

PROPOSAL TITLE: Portable Traffic Management Tool for Wildfire Operations

Small Business Concern

Firm: **Improving Aviation, LLC**
Address: **6001 South 3rd Street, Tampa, FL 33611**
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Principal Investigator:

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Summary Details:

Estimated Technology Readiness Level (TRL) :

Begin: 6
End: 7

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

A comprehensive UTM solution for wildfire operations is proposed based on real-time 3-D visualizations of wildfire management operations that include a common operating picture of participating actors, the location and predicted propagation of the wildfire front, and dynamic airspace management capabilities for UAS operators to define flight intent polygons and deconfliction volumes dynamically.

The platform will retrieve imagery from multiple aircraft in a common tool, as well as atmospheric data. Improving Aviation has developed a wildfire spread and ember spotting model that predicts near-term spread using the wildfire perimeter and in situ wind speed and direction information. The model will be integrated into the SkyTL platform to provide a predicted wildfire propagation perimeter and risk hotspots using in-situ atmospheric parameters. The information on fire propagation and risk hotspots will be used for resource allocation, strategic deconfliction, and the definition of dynamic flight intent volumes. A 3-D real-time visualization includes a real-time common operating picture, the wildfire perimeter, and predicted progression. Deconfliction algorithms implemented in the platform check if the position of the UAS is within the boundaries

of the flight intent polygon. Additional functionality will be developed that includes deconfliction algorithms to offer UAS operators an alternative flight intent polygon if two or more flight intent polygons intersect. An API will be used to share the collected in-situ data with external partners and applications in standardized open-source formats. Analysis and quality control processes will be implemented by assigning quality control parameters associated with each data field. Enhancements to the SkyTL platform will be performed to enable implementation, scalability, and interoperability with current solutions.

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

The proposed platform is envisioned to support NASA's efforts by offering a solution for airspace strategic and dynamic deconfliction, allowing resource tracking of manned and unmanned aircraft and emergency responders on the ground, and contributing to an extended UTM network suitable for wildfire management. It supports real-time information flows through increased communications throughput and a reduction data transfer latency, enhancing situational awareness and ensuring safe, efficient, and scalable complex multi-purpose operations.

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

The platform may be used by UAS operators to conduct emergency response-related missions and obtain strategic and dynamic deconfliction, or by incident managers for situational awareness. The data retrieval and wildfire spread prediction capabilities offer many potential applications, from enhancements of fire perimeter maps, to the delivery of in-situ data for model initialization and training.

Duration: **24**

PROPOSAL NUMBER: 22-2- **A2.03-1182**

PHASE 1 CONTRACT NUMBER: 80NSSC22PA948

SUBTOPIC TITLE: Advanced Air Mobility (AAM) Integration

PROPOSAL TITLE: Developing Local Knowledge for Advanced Air Mobility (DLK)

Small Business Concern

Firm: **Architecture Technology Corporation**
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Summary Details:

Estimated Technology Readiness Level (TRL) :

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

NASA has identified a clear and pressing need for education of both local decision makers and the local flying and nonflying public to enable AAM operations to commence in a timely manner. The goal of this research effort is to develop a robust and cost-conscious capability to support local organizations and local decision makers with materials that support community education, engagement, and outreach for AAM. Developing Local Knowledge (DLK) for AAM will address this need by establishing the capability to provide local community partners with educational materials for AAM that are tailored specifically to their community education and engagement efforts. DLK will enable and enhance the ability for local, regional, and state agencies to provide community education, engagement, and outreach for AAM tailored for their constituencies.

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

The DLK effort directly supports NASA Aeronautics Research Mission Directorate (ARMD) AAM mission its contributing projects. While the focus of this work is on developing materials to support local community education for AAM, the methods, tools, and materials also support education of the public regarding NASA's role in aviation research and development, and aviation research being conducted under ARMD programs and projects.

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

The target market for our DLK web-portal and DLK services includes municipal, regional, state, and federal agencies that are involved in or affected by AAM planning, design, development, testing, and implementation activities. In addition, DLK web-portal and DLK services could be of use to non-government organizations including business associations and trade groups with an interest in AAM.

Duration: **24**

PROPOSAL NUMBER: 22-2- **A1.06-1369**

PHASE 1 CONTRACT NUMBER: 80NSSC22PA981

SUBTOPIC TITLE: Vertical Lift Technology for Urban Air Mobility -Electric Motor Fault Mitigation Technology

PROPOSAL TITLE: Single Fluid Tuned Winding Induction Motors

Small Business Concern

Firm: **CGC Ultramarin, Ltd.**
Address: **8848 Stonehenge Drive, Pickerington, OH 43147**
Phone: **(614) 260-1406**

Principal Investigator:

Name: **Codrin-Gruie Cantemir**
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Business Official:

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Phone: **(614) 260-1406**

Summary Details:

Estimated Technology Readiness Level (TRL) :

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

This proposal focusses in the development of two high power density and high reliability asynchronous lift motors for Electric Vertical Takeoff and Landing (eVTOL) while being relevant to the NASA Revolutionary Vertical Lift Technology (RVLT) Project. This motors are proposed in response to NASA's A1.06 Vertical Lift Technology for Urban Air Mobility -Electric Motor Fault Mitigation Technology request of advanced technologies supporting electric/hybrid-electric propulsion for the advance air mobility, specifically, to the area of Single Fluid Motor with High Power Density and High Reliability.

The key issues in the Phase II program are the redesigning - scale down of the present highly successful Ohio State University megawatt class induction motor to, (1) optimize overall design (poles, topology, size, etc.) from 1 MW class to a 200 kW class UAM eVTOL motor as well as, (2) to operate with single fluid bearings and (3) synergistically integrate the lubrication with cooling in order to operate a single fluid and to achieve maximum power density and reliability.

During this program, two full-size motors (with shaft equivalent performances) based on different electromagnetic solutions will be fabricated in order to allow a complete shaft-to-shaft testing program and an apple-to-apple comparative analyze. Both motors will develop 500 kW

continuously at 5000 rpm using a proprietary single fluid & semi-evaporative cooling and lubrication method.

At the end of Phase 2, both motors will be thoroughly tested on a custom built bench test.

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

The innovations (related to cooling and lubrications) may be directly and immediately applied to the other area (the first area) of the A1.06 solicitations: Electric Machine/Motor Fault Detection and Fault Mitigation and Megawatt electric propulsion systems in the A1.04 Electrified Aircraft Propulsion subtopic.

In addition to eVTOL, UAMs and electric passenger aircraft, NASA can benefit for many applications where lightweight power components are required such as smaller land-based motors and generators.

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

The results of this work can lead to various applications related to high power density rotating machines in a plethora of fields which are not traditionally electrically driven. Transportation and energy are two major relevant application areas with immediate applications for aircraft turbogenerators, aero-propulsion motors, marine propulsion and portable emergency power systems.

Duration: **24**

PROPOSAL NUMBER: 22-2- **A3.03-2163**

PHASE 1 CONTRACT NUMBER: 80NSSC22PB222

SUBTOPIC TITLE: Future Aviation Systems Safety

PROPOSAL TITLE: Multi-Objective Risk Prediction and Hazard Evaluation/optimization for Urban Air Services (MORPHEUS)

Small Business Concern

Firm: **The Longbow Group, LLC**
Address: **2 Eaton Street, Suite 1202, Hampton, VA 23669**
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Principal Investigator:

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Summary Details:

Estimated Technology Readiness Level (TRL) :

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

In the Phase I, The Longbow Group, LLC (LONGBOW), with Daniel H. Wagner Associates, Inc. (DHWA) as a subcontractor, demonstrated the feasibility of developing key components of a future In-Time Aviation Safety Management System (IASMS) and commercializing those components as IASMS Services, Functions, and Capabilities (SFCs) within one or more Supplemental Data Service Providers (SDSPs) supporting Uncrewed Aircraft Systems (UAS) Traffic Management (UTM). Phase I laid the groundwork for Phase II prototype development of a **Multi-Objective Risk Prediction and Hazard Evaluation/optimization for Urban air Services (MORPHEUS),** which will support (1) pre-flight planning to assess and mitigate risk (e.g., to the populace, infrastructure, airframe/payload/mission); (2) in-flight monitoring and mitigation of risk; and (3) post-flight analysis of risk and model and database updates. MORPHEUS will leverage LONGBOW's development of PEGASUS which will soon be used to demonstrate safe, effective, and efficient UAS operations in Hampton, VA, as well as

- NASA Langley Research Center's (LaRC) Ground Risk Assessment Service Provider (GRASP),
- DHWA's experience with AI and Machine Learning (ML) and commercialization of a NASA Langley Phase II SBIR for UAS route evaluation/optimization with respect to weather
- LONGBOW's Space Act Umbrella Agreement SAA134272 for uncrewed systems collaborative testing with NASA LaRC at LONGBOW's Unmanned Systems and Research and Technology Center (USRTC) at Fort Monroe, and
- Ph II NASA SBIRs to develop an Urban Weather Testbed (UWT) and Weather Sensor Data Monitoring System (WSDM) for UAS operations in Hampton

Ph II prototype development will result in a functional MORPHEUS system as a Minimum Viable Product (MVP) ready for transition to PEGASUS and other UTM systems. Benefits to NASA and the UAS commercial enterprise will include safer and more efficient flights in the NAS.

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

MORPHEUS will directly support NASA programs/projects related to UAS/eVTOL safety and risk mitigation such as the High Density Vertiplex (HDV) program, which used GRASP data in a recent FAA COA Safety Case application for BVLOS operations at NASA LaRC, and particularly the AOSP System Wide Safety (SWS) initiative. MORPHEUS would also benefit programs involved in human-autonomy teaming (e.g., the HAT Lab), providing multi-objective optimization for humans to review and understand, accept/reject, and/or modify.

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

With FAA recognition as a Risk Assessment and Mitigation tool for UAS/eVTOL operations over populated areas, the market opportunity for a fully developed MORPHEUS, as a stand-alone SDSP or as part of a scalable, expandable end-to-end PEGASUS Urban Air Services platform,

are excellent and valuable for air cargo logistics and air taxi companies to gain regulatory approval inside urban environments

Duration: **24**

PROPOSAL NUMBER: 22-2- **A3.01-1451**

PHASE 1 CONTRACT NUMBER: 80NSSC22PB097

SUBTOPIC TITLE: Advanced Air Traffic Management System Concepts

PROPOSAL TITLE: Alternate Route Availability Tool

Small Business Concern

Firm: **Mosaic ATM, Inc.**
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Phone: **(800) 405-8576**

Principal Investigator:

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Business Official:

Name: **Chris Brinton**
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Phone: **(703) 980-3961**

Summary Details:

Estimated Technology Readiness Level (TRL) :

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

The basic concept of the Alternate Route Availability Tool (ARAT) is to use available Traffic Management Initiatives (TMI) from the Digital Information Platform (DIP), correlate it with weather data, and produce a tool that can both determine if an alternate route is feasible given the constraints and assess the impact of the alternate route. Alternate routes are obtained from NFDC data, with additional logic definitions added to acquire preferred routes from the dataset. While weather information is available from many publicly available sources, Mosaic chose to use Aviation Weather Center as our weather data source due to ease of use for the data formats and already accessible application programming interfaces (APIs). The impact of alternate routes is assessed using a route scoring algorithm initially implemented as a stoplight approach in Phase I. Phase II expands this logic to assess delay, wind miles along each route, and severity of impact from significant weather phenomena.

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

Potential NASA applications include registration of decomposed ARAT services with the Digital Information Platform, enabling DIP's mission to expose external services to the Platform's participants. This would include direct integration with NASA's Collaborative Digital Departure Reroute (CDDR) tool, adding weather impacts to compute benefits more accurately on alternate routes.

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

Integration with existing airline flight planning tools to address the shortfalls of Traffic Management Initiatives (TMIs) not included in the current set of digital information.

Duration: **24**

PROPOSAL NUMBER: 22-2- **A2.04-2874**

PHASE 1 CONTRACT NUMBER: 80NSSC22PB165

SUBTOPIC TITLE: AERONAUTICAL INFORMATION SYSTEM SECURITY (AISS): Aircraft Systems

PROPOSAL TITLE: Avionics Intrusion Detection and Attack Identification

Small Business Concern

Firm: **QED Secure Solutions**
Address: **105 Olympia Lane, Coppell, TX 75019**
Phone: **(214) 489-7767**

Principal Investigator:

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Summary Details:

Estimated Technology Readiness Level (TRL) :

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

Cyber threat identification includes the ability to detect, track, and disrupt advanced persistent threats. While emerging avionics system architectures support limited cyber hygiene and rudimentary defense, well-tailored cyber-attacks remain elusive to current detection technology. Additionally, the inherent structure of avionics systems makes monitoring and detection difficult. To meet the NASA need, QED proposes the Cyber *Overwatch* tool that provides a host-based threat detection capability for identifying and correlating attacks targeting aircraft avionics. Overwatch is based on QED's history of developing and evaluating avionics malware for assessment and testing of aircraft and the positive results demonstrated during the Phase I effort.

Overwatch epitomizes the innovations expected of a NASA sponsored project. To date, there is very little focus on host-based intrusion detection capabilities for embedded device real-time operating systems. The focus of this SBIR effort is novel in that the solution resides at the host-level and provides an ability to encompass end-point security for embedded systems, with flexibility to address the varying communications protocols. The solution also provides systematic reporting to enable in-depth analysis and event correlation. Overwatch shall be tested and validated in a relevant environment to include multiple instances of real-world avionics systems against associated sample malware. We anticipate that by the end of Phase II, we shall demonstrate the ability of Overwatch to detect malware targeting aircraft avionics systems while adhering to the stringent requirements of operating in the aviation environment.

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

Expected benefits and applications for NASA:

- Ability to readily deploy host-based intrusion detection and distributed attack identification for air-vehicle based systems.
- Monitoring of critical systems to detect cyber-based attacks in real-time to mitigate safety of flight and operations concerns.
- Expand novel techniques for embedded device cybersecurity.
- Integration with In-Time Aviation Safety Management System.
- Leverage QED advanced experts in the area of avionics cybersecurity.

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

Expected applications extending beyond NASA:

- Ability to apply solution to commercial fleet of aircraft.
- Transition technology to Department of Defense.
- Integration with existing solutions for safeguarding National AirSpace System.
- Leverage QED relationships to coordinate efforts with Department of Homeland Security, National Labs and industry.
- Extension to consumer IoT devices.

Duration: **24**

PROPOSAL NUMBER: 22-2- **A1.08-2059**

PHASE 1 CONTRACT NUMBER: 80NSSC22PB073

SUBTOPIC TITLE: Aeronautics Ground Test and Measurement Technologies

PROPOSAL TITLE: Robust Optical Interrogators for Electric Propulsion Applications

Small Business Concern

Firm: **Luna Innovations, Inc.**
Address: **301 1st Street Southwest, Suite 200, Roanoke, VA 24011**
Phone: **(540) 769-8400**

Principal Investigator:

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Business Official:

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Summary Details:

Estimated Technology Readiness Level (TRL) :

Begin: 6
End: 7
Technical Abstract (Limit 2000 characters, approximately 200 words):

Luna Innovations has partnered with magniX, a leading manufacturer of electric propulsion units (EPUs) for electric-powered aircraft, to develop and test an EMI hardened version of its proven Hyperion® fiber optic sensing platform to support critical testing needs for ground and flight based Electrified Aircraft Propulsion (EAP) applications. The Hyperion is a versatile instrument, compatible with a variety of fiber optic sensor types, including temperature, strain, pressure, and acceleration sensors based on Fiber Bragg Grating and Fabry-Perot technologies. The Hyperion can simultaneously monitor as many as 1,024 sensors at data rates up to 5kHz.

During Phase I Luna tested the Hyperion at magniX on a 650kW electric aircraft motor driving a propeller and characterized the EMI environment during the test. In addition, the Hyperion was exposed to high levels of EMI through formal testing at an EMC laboratory. The Hyperion performed within specifications during all of the test campaigns proving initial viability for EAP applications. A detailed plan for creating a robust EMI and flight hardened unit was developed incorporating standard DO-160G requirements.

The proposed Phase II will result in the development of a ruggedized, flight capable Hyperion interrogator that can withstand the high EMI and demanding physical operational environment of emerging electric aircraft applications. This system, coupled with distributed fiber optic strain and temperature sensors, will establish the commercial viability of the platform. During the Phase II effort, Luna will work with its partners to build a prototype system, test it at extremes of temperature, vibration and EMI exposure, and demonstrate its successful operation in relevant EAP test scenarios. magniX will provide facilities, equipment and test opportunities to enable the evaluation of the system, culminating in a final technical demonstration of the rugged Hyperion in an operational environment.

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

The proposed research will directly address NASA’s need for an optical interrogator that is immune to EMI. This system will find potential applications in electric powered aircraft such as the X-57 Maxwell, SUSAN, STARC-ABL, N3-X and other vehicles being developed under the Revolutionary Vertical Lift Technology (RVLT) and Electrified Aircraft Propulsion Technologies (EAPT) projects. It may also be useful for ground testing at the NASA Electric Aircraft Testbed (NEAT) or for other applications under the AATT or EPFD programs.

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

Electric powered aircraft are poised to become commonplace in the coming years given the decreased cost of operation and lower environmental impact of electrified aircraft propulsion technologies. The proposed EMI-hardened Hyperion will find a ready market for instrumentation in commercial EAP applications due to the challenges presented by conventional wired electronic systems.

Duration: **24**

PROPOSAL NUMBER: 22-2- **H3.08-1742**

PHASE 1 CONTRACT NUMBER: 80NSSC22PA920

SUBTOPIC TITLE: Challenges in Carbon Dioxide Removal and Reduction: Carbon Particulate and Thermal Management

PROPOSAL TITLE: Novel Vapor Chambers for Heating and Cooling of Advanced Sorption Systems

Small Business Concern

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

Principal Investigator:

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Address: **1046 New Holland Avenue, PA 17601 - 5688**
Phone: **(717) 205-0618**

Business Official:

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Phone: **(717) 205-0602**

Summary Details:

Estimated Technology Readiness Level (TRL) :

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

The Carbon Dioxide Removal Assembly (CDRA) is a subassembly of the Environmental Control and Life Support (ECLS) system on the International Space Station (ISS). The function of the CDRA is to remove CO_2 from cabin air, ideally turning it into a useful resource such as water or methane. This is accomplished using a sorbent material, zeolite, to adsorb and desorb CO_2.

Zeolite has a highly porous molecular structure, and CO_2 can favorably bond within these pores at certain temperatures and pressures. This molecular bonding process is exothermic during CO_2 adsorption and endothermic during CO_2 desorption. Thus, the zeolite material on the CDRA must be heated and cooled to very specific temperatures for the most efficient desorption and adsorption of CO_2, respectively. The current CDRA operates most effectively when the sorbent bed is cooled to 20°C for adsorption and heated to 220°C for desorption. The zeolite material has poor heat transfer characteristics, making a well-designed thermal management system a priority on the CDRA. Advanced Cooling Technologies (ACT) has developed an additively manufactured (AM), titanium-water, vapor chamber to heat and cool the zeolite material in the CDRA. ACT's proposed thermal management system is designed to heat and cool the zeolite to these specific temperatures at faster rates and more uniformly than the state-of-the-art design, which utilizes a cartridge heater and aluminum fin. ACT's titanium water vapor chamber design has additional benefits over the state-of-the-art such as reduced size, weight, and power (SWaP) and adaptability to future sorbent materials.

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

The proposed vapor chambers are applicable to the Carbon Dioxide Removal Assembly, which is a subset of the Environmental Control and Life Support System on the International Space Station. The vapor chambers will be used to heat and cool the sorbent material to sequester CO_2 from the cabin air on the ISS. The vapor chambers may also be applicable to future manned missions to lunar or Martian surfaces, such as those proposed under NASA's Space Launch System.

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

These vapor chambers are designed to heat and cool sorbent material to adsorb/desorb CO_2, thus can find non-NASA applications in any application using a similar sorbent material. This could be direct air capture systems, CO_2 capture systems in coal and power plants, or certain air filtration systems.

Duration: **24**

PROPOSAL NUMBER: 22-2- **H5.02-2035**

PHASE 1 CONTRACT NUMBER: 80NSSC22PB115

SUBTOPIC TITLE: Hot Structure Technology for Aerospace Vehicles

PROPOSAL TITLE: Localized 3-D Fiber Reinforcement in Carbon and Ceramic Composites

Small Business Concern

Firm: **North Country Composits, LLC**
Address: **17 Marquis Drive, P.O. Box 408, Colebrook, NH 03576**
Phone: **(603) 996-1054**

Principal Investigator:

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Business Official:

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Summary Details:

Estimated Technology Readiness Level (TRL) :

Begin: 4
End: 6

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

This proposal addresses technology for reusable propulsion and vehicle hot structures specified in topic H5.02:

Propulsion systems for Commercial Space industry supporting NASA efforts.

Upper stage engine systems, such as those for Space Launch System.

Lunar/Mars lander descent/ascent propulsion systems.

Aerodynamic structures for aeroshells, control surfaces, and leading edges for hypersonic flight vehicles.

North Country Composites (NCC) worked with Lancer Systems to adapt their commercial ceramic matrix composite (CMC) manufacturing methods to produce affordable, high performance rocket engine components. The components are showing the ability to operate in highly oxidative and corrosive environments to temperatures above 4000^{o}F for significant periods of time. This is occurring without the use of expensive coatings. Through the utilization of low cost ISO 9001 controlled manufacturing methods, affordable, high performance components can rapidly be transitioned for commercial use. In addition, NCC successfully utilized 3D reinforcements of the fiber preforms to significantly increase (3X) interlaminar strength properties with only a mild decrease in in- plane properties.

The high strength, light weight and high temperature capabilities of these structures will significantly increase the performance of space vehicles by increasing the thrust to weight, operational temperatures, and pay-load capabilities.

In parallel to the Phase II program, our industrial partner will be performing significant rocket exhaust testing of UHT-CMC components. They, however, will not be generating thermal-mechanical material properties. As a result, NCC's overall Phase II objective is generate material properties over the temperature range from room temperature to at least 4200^{o}F. These properties can then be used in finite element models to optimize the design of CMC component designs. Because this work is completed as an SBIR, the properties will be available to the community at large.

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

Human Exploration & Operations Mission Directorate (HEOMD) would benefit by utilizing the technology in spacecraft and launch vehicles to provide improved performance and to enable advanced missions with reusability, increased damage tolerance and durability. Potential NASA users of this technology exist for a variety of propulsion systems, including:

- Upper stage engine systems, such as those for the Space Launch System.
- Lunar/Mars lander descent/ascent propulsion systems.
- Propulsion systems for commercial space companies supporting NASA

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

The CMC technology would be enhancing to systems already in use or under development and enabling for missions that necessitate improved high temperature composite technology. The Air Force is interested in such technology for its Evolved Expendable Launch Vehicle, ballistic missile, and hypersonic vehicle programs. Other non-NASA users include Navy, Army, and the Missile Defense Agency.

Duration: **24**

PROPOSAL NUMBER: 22-2- **H3.09-1890**

PHASE 1 CONTRACT NUMBER: 80NSSC22PB238

SUBTOPIC TITLE: Human Accommodations

PROPOSAL TITLE: Ultra-Fast Ultrasonic Clothes Washer/Dryer Combination for Moon, Mars and ISS Applications

Small Business Concern

Firm: **Ultrasonic Technology Solutions**
Address: **10820 Murdock Drive, Suite 104, Knoxville, TN 37932**
Phone: **(352) 870-3714**

Principal Investigator:

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Summary Details:

Estimated Technology Readiness Level (TRL) :

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

Ultrasonic Technology Solutions (UTS) is based in Knoxville, Tennessee, and formed as a spin-off start-up from Oak Ridge National Laboratory (ORNL) is proposing to develop an ultra-fast ultrasonic washing and dryer combination for space applications.

NASA's Life Support and Habitation Systems Focus Area seeks key capabilities and technology solutions that enable extended human presence in deep space and on planetary surfaces such as the moon and Mars, including Orion, ISS, Gateway, Artemis and Human Landing Systems. One of the critical technological gaps listed includes a clothing washer/dryer combination for use on the moon (1/6g) or Mars (1/3g) that can clean up to 4.5kg of cotton, polyester, and wool clothing in less than 7 hours using <50kg machine mass, <0.3m3 external machine volume and <300W electrical power (Note: 101.3kPa habitat pressure may be assumed for prototype development).

Through multiple publications, our team demonstrated five times higher drying energy efficiency for clothing (1/5th of the energy input) and two times faster drying rates than state-of-the-art residential clothes dryers. This innovative drying technology was highlighted on over 350 websites, including CNN, BBC, DOE, and the prestigious Federal Laboratory Consortium (FLC) calendar. The technology also showed strong promise for removing water from liquids and semi-liquid materials such as human feces. The UTS team successfully demonstrated effective fecal drying technology, and NASA is currently in the process of infusion/investment in the technology demonstration in the relevant environment.

Under SBIR Phase I, we successfully collected critical data supporting the feasibility and superiority of the proposed clothes combo washer/dryer technology. Under SBIR Phase II, we propose developing a transformative combo washing and drying machine for space applications where the ultrasonic components are the backbone of the technology.

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

Crew clothing currently accounts for ~1/4 of crew supplies for ISS. Significant mission mass and volume reductions can be realized with an integrated crew clothing washing/drying system approach. UTS efforts to wash and dry clothes with very little energy and water can help achieve this goal by making clothing reusable.

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

One of the direct markets for the proposed tabletop-size ultra-fast clothes washing/dryer product will be student housing, dorms, rental properties, hotels, and hospitals. Also, the system may be used for hotels, beaches, and recreational vehicles. A lot of people who are taking vacations do not have access to in-house clothes washing and dryer.

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Duration: **24**

PROPOSAL NUMBER: 22-2- **H9.03-2217**

PHASE 1 CONTRACT NUMBER: 80NSSC22PB200

SUBTOPIC TITLE: Flight Dynamics and Navigation Technologies

PROPOSAL TITLE: CETACEAN: Autonomous and Modular Onboard Relative Navigation Software for On-Orbit Proximity Operations & Docking

Small Business Concern

Firm: **Starfish Space, Inc.**
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Principal Investigator:

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Business Official:

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Summary Details:

Estimated Technology Readiness Level (TRL) :

Begin: 5
End: 7
Technical Abstract (Limit 2000 characters, approximately 200 words):

A robust relative navigation software capability is a key enabler of all RPOD missions, and therefore an essential technology to unlock ISAM capabilities. There are two areas of development that are needed to advance relative navigation towards onboard autonomous viability: 1) Improvement of machine vision and image processing performance in spaceflight applications and 2) Development of a navigation filter architecture that can fuse machine vision measurements with a combination of sensor types to enable flight software and hardware modularity. Starfish Space is continuing development of **CETACEAN, a relative navigation software package designed to autonomously and reliably determine the relative state between two spacecraft given customizable combinations of onboard sensors**. Specifically, CETACEAN will offer the ability to estimate accurate position, velocity, attitude, and rotation rate information. **In this Phase II, Starfish Space proposes to mature CETACEAN's image processing algorithms using actual imagery gathered from an in-space mission. This imagery will be used to create a Vision-in-the Loop (VIL) system for continued CETACEAN development**. The initial purpose of this VIL system is to provide a controlled environment for CETACEAN to ingest this imagery and conduct full end-to-end testing of the relative navigation hardware and software Training on the authentic in-space imagery represents a significant step forward, as the machine vision techniques used in CETACEAN have not yet been applied in space at scale.

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

Starfish Space has held discussions with NASA regarding application of CETACEAN to the following missions: On-orbit inspection of the ISS or crewed spacecraft; Approach and positioning for assembly of elements, delivery, repair, and inspection for Gateway logistics/assembly; Enabling safe approach for station keeping, repairing, upgrading, or refueling of NASA science satellites; Relative navigation for Hubble for boost or end-of-life. Further applications are detailed in Table 1 of the technical volume.

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

Autonomous relative navigation enables commercial missions: inspection, servicing and life extension, logistics, assembly, manufacturing, and space debris removal , and has potential to unlock a new layer of the in-space economy. Commercial satellite operators are interested in life extension in GEO and end-of-life disposal in LEO, provided by CETACEAN-enabled Otter satellite servicer.

Duration: **24**

PROPOSAL NUMBER: 22-2- **H6.23-2442**

PHASE 1 CONTRACT NUMBER: 80NSSC22PB189

SUBTOPIC TITLE: Spacecraft Autonomous Agent Cognitive Architectures for Human Exploration

PROPOSAL TITLE: Virtual Explanation Reasoning Agent (VERA)

Small Business Concern

Firm: **Soar Technology, Inc.**
Address: **3600 Green Court, Suite 600, Ann Arbor, MI 48105**
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Principal Investigator:

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Business Official:

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Summary Details:

Estimated Technology Readiness Level (TRL) :

Begin: 4
End: 5

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

On-board autonomy will be critical to the success of manned deep-space missions. Deep space missions will not have the same level of contact with ground-based mission control, and so the astronauts themselves will have to deal with novel situations that were impossible to anticipate and prepare for prior to launch. This fact requires a successful autonomy solution to be able to improvise and synthesize novel solutions to novel problems from pre-existing procedures and available resources in absence of ground-based support. SoarTech, teamed with Tietronix, are developing the Virtual Explanation Reasoning Agent (VERA), an AI-based software system that provides automated procedure identification and generation to address novel situations for which no procedures have been written ahead of time. VERA captures expert knowledge of spacecraft systems and diagnostic procedures from detailed SysML spacecraft models to identify situation-specific diagnostic requirements and identify or author appropriate and viable diagnostic procedures. To improve procedure generation, VERA can learn from interactions with astronauts.

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

For NASA, VERA would help astronauts in deep space missions when contact with Mission Command is infeasible or too slow (e.g., 40-minute round trip communication from Mars). Additionally, any fully autonomous probes or stations (e.g., Gateway when no one is on board) could benefit from VERA.

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

For the DoD, similar situations arise, such as repairing components on a submarine or repairing vehicles while in combat when there is no time to call an expert. Commercially, we would pursue the austere environment repair and maintenance market, initially in defense, and then later in commercial spaces such as manufacturing and automotive.

Duration: **24**

PROPOSAL NUMBER: 22-2- **H4.07-2376**

PHASE 1 CONTRACT NUMBER: 80NSSC22PB246

SUBTOPIC TITLE: Low Volume, Power and Mass CO2 and Humidity Control for xEMU

PROPOSAL TITLE: Vacuum Regenerable Sorbents For CO2 and Humidity Control within the xEMU

Small Business Concern

Firm: **XploSafe, LLC**
Address: **712 Eastgate Street, Stillwater, OK 74074**
Phone: **(918) 813-2955**

Principal Investigator:

Name: **Mallikharjuna Rao Komarneni**
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Summary Details:

Estimated Technology Readiness Level (TRL) :

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

In this Phase II SBIR, XploSafe will build on its Phase I work to advance the development and evaluation of sorbents identified during the Phase I. Phase I results demonstrated the feasibility of sorbent candidates as viable replacement for the current carbon dioxide and humidity control solution. The developed materials exhibit significant advantages including higher CO_2 capacity and easier regeneration under vacuum. For Phase II, XploSafe will further investigate physical properties as it is related to specific NASA requirements, expand experimental measurements of the capacity and kinetics for the sorption of carbon dioxide and humidity and vacuum regeneration, and develop and verify sorbent performance integration into the xEMU RCA unit. The researchers will focus on developing sorbents with long operational life and reduced or ideally eliminated outgassing of undesired contaminates such as ammonia. A targeted goal will be to use regeneration and potentially a larger CO_2 capacity per gram to reduce the required sorbent mass, with respect to SA9T, while also maintaining the CO_2 and humidity control under operating conditions. A fully regenerable sorbent with no irreversible binding site and little outgassing, could also reduce both the RCA and TCC total mass by allowing smaller units with less sorbent mass. In Phase II, XploSafe will construct several testing apparatuses to simulate conditions that match the requirements of the xEMU in relation to the RCA unit. The testing apparatuses will enable evaluation of the sorbent media prior to being provided to NASA for possible on-site evaluations. Samples of the developed sorbent prototypes will be provided for formal review by NASA starting after month 12 followed by updated sorbent prototypes that will be available for periodic reviews, and the final sorbent material will be delivered at the end of the project.

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

Successful development of the proposed technology will advance the state of the art in CO_2 and humidity removal via a pressure swing adsorption system. As a part of the Exploration Portable Life Support System (xPLSS) and the Exploration Extra-vehicular Mobility Unit (xEMU) units, the platform technology will advance the viability of NASA's crewed deep space exploration objectives.

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

Long service life CO_2 scrubbers are desired in hospitals, clean rooms as well as industrial applications including mining and firefighting. Commercial demand arises from applications such as CO_2 scrubbers in high altitude aerospace applications, recreational diving, submarines and rescue capsules.

Duration: **24**

PROPOSAL NUMBER: 22-2- **H4.06-1580**

PHASE 1 CONTRACT NUMBER: 80NSSC22PB147

SUBTOPIC TITLE: Low-Power Multi-Gas Sensor for Spacesuits

PROPOSAL TITLE: Power Efficient, Miniature Mid-Infrared Sensor

Small Business Concern

Firm: **Pendar Technologies, LLC**
Address: **30 Spinelli Place, Cambridge, MA 02138**
Phone: **(857) 413-9339**

Principal Investigator:

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Business Official:

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Summary Details:

Estimated Technology Readiness Level (TRL) :

Begin: 4
End: 7

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

The subtopic described the need for a multi-gas sensor that is power efficient, consistent with a wearable form factor, and can reliably operate under a wide range of temperature, humidity, and pressure conditions. We propose an integrated carbon dioxide and ammonia gas sensor that can reach the required dynamic range, accuracy, and sensitivity even under significant environmental variation. We employ distributed feedback quantum cascade lasers (QCLs) to perform intrapulse spectroscopy in the mid-infrared, which allows us to reach targeted sensitivities with ultra-low duty cycle measurements to dramatically reduces power consumption and system complexity. Pendar's expertise in monolithic quantum cascade laser integration will enable integration of multiple quantum cascade lasers to incorporate detection of several gases, all within a system footprint compatible with spacesuit sensing applications.

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

The proposed system is directly relevant to the design of the new Exploration Extravehicular Mobility Unit (xEMU). The intended goal of the proposed gas measurements is to ensure that the spacesuit maintains a safe environment without drawing significant power.

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

The proposed CO2 sensor can be adopted for capnography (CO2 detection in breath), and for indoor/outdoor air quality control by measuring CO2 in ambient air. The miniaturized sensing platform can also be easily adapted to target chemical threats for Department of Homeland Security, and natural gas leaks for Department of Energy and the oil and gas industry.

Duration: **24**

PROPOSAL NUMBER: 22-2- **H5.05-2174**

PHASE 1 CONTRACT NUMBER: 80NSSC22PA915

SUBTOPIC TITLE: Inflatable Softgoods for Next Generation Habitation Systems

PROPOSAL TITLE: Flexible Multifunctional Structural Health Monitoring Systems for Inflatable Space Habitat Structures

Small Business Concern

Firm: **Acellent Technologies, Inc.**
Address: **835 Stewart Drive, Sunnyvale, CA 94085**
Phone: **(408) 745-1188**

Principal Investigator:

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Business Official:

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Summary Details:

Estimated Technology Readiness Level (TRL) :

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

Inflatable structures are being pursued as candidates for long-term habitats in space. The ability to monitor and assess the structural health of an inflatable module is an important factor in determining the feasibility of using inflatable technologies for habitat requirements, especially in the presence of micrometeoroid and orbital debris (MMOD) threats. There is therefore a need for Structural Health Monitoring methods to perform impact detection and localization to the inflatable structures throughout the structure's mission. This capability must be accomplished within real constraints for sensor volume, mass, and crew resources, including being able to perform effective damage monitoring of the inflatable habitat layers automatically during a mission either on a routine basis or as a quick- response basis. Acellent has extensive experience in developing space and field-ready Structural Health Monitoring (SHM) diagnostic systems. This program will focus on development, maturation, assembly and automation of "**Flexible multifunctional Structural Health Monitoring systems for inflatable space habitat structures**". The program will enable the low-cost manufacturing of integrated sensing capabilities in inflatable softgoods material systems that are needed to monitor impact detection in situ and measure load/strain on softgoods components. The Phase II effort will focus on developing a complete system for SHM for inflatable habitats and testing on a sub scale inflatable habitats. Integration of sensors into the inflatable materails will be a key development conducted during the Pkhase II. The work will be done in close co-ordination with NASA and subcontractors that will provide Vectran materails, manufacture the sub scale inflatable and perform testing.

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

*NASA is currently looking for SHM technologies that are **small and lightweight** to provide **onboard monitoring capabilities** and are **easy to install**.* The proposed system has several critical future exploration applications including support of technologies for self-assembly, in-space assembly, in-space maintenance & servicing, and highly reliable autonomous deep-space systems. These technologies have the potential of significantly increasing safety, reliability, affordability, and effectiveness of NASA missions.

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

The proposed SHM system can be used in several different platforms including Commercial and Military fixed wing, rotorcraft and unmanned Aircraft, Commercial and Military space structures, Mining, Bridges, Buildings and other platforms.

Duration: **24**

PROPOSAL NUMBER: 22-2- **H3.08-2836**

PHASE 1 CONTRACT NUMBER: 80NSSC22PB082

SUBTOPIC TITLE: Challenges in Carbon Dioxide Removal and Reduction: Carbon Particulate and Thermal Management

PROPOSAL TITLE: Continuous Wire 3D Printed Sorbent Structures

Small Business Concern

Firm: **Mainstream Engineering Corporation**

Address: **200 Yellow Place, Rockledge, FL 32955**
Phone: **(321) 631-3550**

Principal Investigator:

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Summary Details:

Estimated Technology Readiness Level (TRL) :

Begin: 4
End: 6

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

To improve size, weight, and power (SWaP) of spacecraft carbon dioxide (CO_2) and water removal systems, Mainstream Engineering Corporation (Mainstream) developed the process to embed resistive wires directly into an additively manufactured (AM) sorbent bed for optimized regeneration. This process drastically reduces the thermal contact resistance compared to the current system of heating elements. In Phase I, Mainstream focused on developing the mechanism and process for embedding the resistive wire into the sorbent beds (three patents in progress). In Phase II, Mainstream will focus primarily on scaleup, testing, and optimization. We will optimize our paste and scale paste manufacturing to fabricate larger structures, and create separate paste formulations for CO_2 and H_2O adsorption. Additionally, we will improve our control system by adding additional optimization features (e.g., intra-layer wire spacing) and manufacturing improvements (e.g., refining wire lead location for wire management). We will also design an electrical control system capable of controlling current output and monitoring wire health. We will fabricate sub-scale and full-scale wire-embedded structures using these refined components for testing. We will use the sub-scale structures for accelerated life testing where we will perform accelerated adsorption cycles with standard desorption cycles to simulate long-term use. Finally, we will perform full-scale testing at representative flow rates and adsorbate concentrations to validate the integration's feasibility and expected service performance.

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

For NASA, the ability to 3D print adsorbent and catalysts beds that include embedded heating/cooling elements will immediately impact various applications. We see this technology making the most significant impact for NASA in space exploration where SWaP is at a premium. Given this Phase II is expected to run until mid-2025 if awarded, with an expected TRL at completion of 6, we foresee this technology making NASA debut on DRM 8a Crewed Mars Orbital (based on the technology need date of 2027 according the NASA Technology Roadmap rev. 2015)

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

One or all of the advantages of our technology are beneficial to a variety of critical and high-value markets, including industrial scrubbers, pharmaceutical production, fuel cells, breathing apparatuses, and deep-sea exploration. For example, we have already proposed this technology for use in a small military submarine concept where reducing power consumption and size are paramount.

Duration: **24**

PROPOSAL NUMBER: 22-2- **H3.08-2852**

PHASE 1 CONTRACT NUMBER: 80NSSC22PB083

SUBTOPIC TITLE: Challenges in Carbon Dioxide Removal and Reduction: Carbon Particulate and Thermal Management

PROPOSAL TITLE: Combined Sub-Micron Particle Separators for Carbon Removal System

Small Business Concern

Firm: **Mainstream Engineering Corporation**
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Principal Investigator:

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Summary Details:

Estimated Technology Readiness Level (TRL) :

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

Currently, oxygen in space is recovered through an advanced oxygen recovery system, which does not fully recover the oxygen. Future missions may use technologies such as the Plasma Pyrolysis Assembly (PPA) or Bosch process, both of which recover oxygen, but generate large amounts of carbon particulate (0.2 – 50 µm) that must be removed for proper operation and crew safety. In Phase I, Mainstream developed and demonstrated a high-efficiency carbon removal system (CRS) to safely collect, remove, and dispose of sub-micron carbon particulates that consists of a 1st-stage cyclone separator that removes 85% of the particulate (focused towards larger particles), a 2nd-stage electrostatic precipitator that removes another 8% (focused towards small particles), and a final porous metal filter which removes the remaining ~7% for a total removal efficiency of 99.93% at 0.3 µm and 99.69% from 0.3 µm to 10 µm.

The CRS system was designed to operate in high-temperature steam (Bosch) or hydrogen (PPA) without issues. It is <0.1 ft^3, 4 lb, and consumes <20 W of power with a pressure drop of <50 torr including all components and electronics. Phase I culminated in a final validation of operation independent of gravity (i.e., tested upside down), high loading (>10 g/min), and in high-temperature steam.

In Phase II, Mainstream will iterate on the CRS prototype with our optimized computation fluid dynamics models, focus on practical carbon removal from the subsystems, and experimentally evaluate long-term CRS performance, pressure drop, and regeneration at relevant carbon loadings and operation conditions (e.g., reduced pressure, gravity, PPA, Bosch). The verified CRS undergo PPA and Bosch relevant lifetime testing and mature hardware delivered to NASA for evaluation.

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

The developed technologies on this program are unique in that they provide HEPA-level filtration, with no consumable components and can reduce the need for consumables by 95%, all while requiring minimal increase in air pressure and a very low power consumption. This provides a direct and enabling technology for NASA for future moon and Mars missions where carbon particulate capture is necessary for full recovery of oxygen for long-term space flights and eventual bases.

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

Mainstream sees many other dual-use applications in the industrial sector. We see the largest areas for this application in the large-scale industrial solid separation for air particulate and pollution control as well as in the specialty chemical manufacturing area, where recovery of expensive precious metal catalysts is a necessity.

Duration: **24**

PROPOSAL NUMBER: 22-2- **H8.01-2777**

PHASE 1 CONTRACT NUMBER: 80NSSC22PB009

SUBTOPIC TITLE: Low-Earth Orbit Platform and Microgravity Utilization for Terrestrial Applications

PROPOSAL TITLE: Space Enhanced Crystals (SPECS)

Small Business Concern

Firm: **DSTAR Communications**
Address: **4531 Dulcinea Court, Woodland Hills, CA 91364**
Phone: **(805) 501-9399**

Principal Investigator:

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Business Official:

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Phone: **(805) 501-9399**

Summary Details:

Estimated Technology Readiness Level (TRL) :

Begin: 6
End: 8

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

To meet NASA's goal of commercial in-space production of materials with the level of quality and performance superior to that on Earth, DSTAR Communications Inc. develops Space-Enhanced Crystals (SPECS). This customer-driven effort is based on initial sales of Minimal Valuable Products (MVPs). The technology uses the microgravity-driven enhancement of crystal formation in microgravity in combination with a set of novel process controls to establish commercially sustainable manufacturing on board of International Space Station (ISS). The program leverages a unique modular ISS manufacturing platform to maintain U.S. leadership in the area of commercial in-space production.

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

NASA applications include infrared sensors and probes for both ground facilities and flight instrumentation. The improved infrared materials and fibers could benefit Exoplanet research and exploration. The thermal imaging and situational awareness systems using the space-enhanced crystals offer enhanced performance for robotic platforms and space assets. The

longer wavelength pigtailed quantum cascade lasers could be implemented in environmental sensing solutions.

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

The improved crystals and polycrystalline optical fibers provide a high power delivery option for carbon monoxide and carbon dioxide laser systems. The materials offer improved performance for medical endoscopes and diagnostics equipment. The materials would enable advanced industrial and environmental sensing platforms.

Duration: **24**

PROPOSAL NUMBER: 22-2- **H4.07-1817**

PHASE 1 CONTRACT NUMBER: 80NSSC22PB170

SUBTOPIC TITLE: Low Volume, Power and Mass CO2 and Humidity Control for xEMU

PROPOSAL TITLE: High Capacity RCA Sorbents for Increased Cycle Times

Small Business Concern

Firm: **Reaction Systems, LLC**
Address: **17301 West Colfax Avenue, #160, Golden, CO 80401**
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Principal Investigator:

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Business Official:

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Summary Details:

Estimated Technology Readiness Level (TRL) :

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

NASA is interested in improving the method to control CO_2 and water in the Exploration Extravehicular Mobility Unit (xEMU) to meet the ambitious objectives of the Artemis program, which includes human presence on the surface of the Moon and Mars. The technology that is planned to be used is the RCA which utilizes two beds that are alternately used to remove CO_2 and H_2O and then are regenerated by exposure to space vacuum. The RCA utilizes an amine-based sorbent (SA9T), and although it has good reversible CO_2 uptakes, higher capacities are desired to maintain lower CO_2 levels and to reduce power consumption and O_2 losses. In addition, this sorbent emits low levels of ammonia which must be removed from the suit using a separate technology.

In the SBIR Phase I project, Reaction Systems successfully developed new sorbents that outperformed SA9T and reduced ammonia emissions. Tests carried out on selected sorbents and SA9T over a wide range of CO_2 partial pressures indicated that a new sorbent had cycle times that were over a factor of two greater than for SA9T at the higher CO_2 pressures, which results in a 44% reduction in number of half cycles in the Standard EVA. Ammonia emissions are also over an order of magnitude lower for the new sorbent compared to SA9T.

In the Phase II project, Reaction Systems will continue developing the new sorbent to a TRL that will allow it to be incorporated into new space suits for advanced missions. Tasks include optimizing the composition and preparation, performing lifetime measurements, evaluating the effect that contaminants could have and finally testing at full scale. The full scale tests will be carried out in a custom CO_2 control module similar in design to the RCA but will have more accessibility to the sorbent beds. In addition, the module will be installed in Reaction Systems' full scale ventilation loop that can simulate pressures, flow rates, and humidity levels encountered in the suit during an EVA.

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

In addition to its use in the space suit, this technology could be used for CO_2 control in a space craft cabin. The current technology, the CDRA, uses pressure and temperature swing adsorption cycle to remove CO_2 and the thermal cycling causes the molecular sieve sorbent to break down into dust particles, which clog filters or end up in the cabin air. A sorbent that does not require a temperature increase for regeneration could reduce power consumption and eliminate dust.

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

The technology could also be used for control of CO2 emissions from power plants. The concentration of CO2 in the atmosphere has increased from 280 ppm to over 400 ppm over the last 50 years primarily due to CO2 emissions from fossil fuel combustion. An effective method could be used to remove CO2 from the effluent and compress it into a concentrated liquid for sequestration, storage, or use.

Duration: **24**

PROPOSAL NUMBER: 22-2- **H10.02-2523**

PHASE 1 CONTRACT NUMBER: 80NSSC22PA942

SUBTOPIC TITLE: Autonomous Operations Technologies for Ground and Launch Systems

PROPOSAL TITLE: Semiautonomous Anomaly Monitoring and Early Detection (SAMY) System

Small Business Concern

Firm: **American GNC Corporation**
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Phone: **(805) 582-0582**

Principal Investigator:

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Business Official:

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Summary Details:

Estimated Technology Readiness Level (TRL) :

Begin: 4
End: 6

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

NASA Ames Research Center (ARC)'s innovative autonomous operations technologies (AOT) for ground and launch systems require minimized or even eliminated human iteration/intervention, and presence due to hazardous operational environments. Towards this goal, American GNC Corporation (AGNC) and The University of Texas at Arlington (UTA) are proposing the "Semiautonomous Anomaly Monitoring and Early Detection (SAMY)" System to advance NASA's operations and maintenance (O&M) infrastructure while increasing ground system availability to support mission operations. The SAMY system is to provide innovative

Prognostics and Health Management (PHM) technology for planetary or lunar surface-based infrastructure that are related to the preparation of launch vehicles and payloads for flight. SAMY can also improve NASA's Stennis Space Center (SSC) test stand infrastructure by taking into account earth applications. The system builds upon: (i) automated anomaly detection, analysis, and characterization (ADAC) to identify incipient fault conditions and benign new operational conditions; (ii) generalized prognostic methodology based on optimized Multilayer Perceptron (MLP) discriminant; and (iii) suite of cutting edge algorithms operating collaboratively, including semiautomated incremental learning, selected deep learning paradigms, and inference methods for both Fault Detection and Identification (FDI) and guidance in maintenance operations.

Phase II design constraints include: (a) developing a sound framework that can handle with concept drift and structured data (e.g., multi-source, distributed, and heterogenous); (b) automated new knowledge assimilation once that change is detected and found a new condition; (c) developing a generalized prognostics scheme to provide Remaining Useful Life estimations; (d) blending strengths of advanced machine learning paradigms and achieving collaborative operation while for Prognostics and Health Management system; and (e) thorough V&V

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

The primary target is NASA ground and launch systems for planetary and lunar surface infrastructure. The applications are numerous since SAMY is a PHM software product that supports AOT and O&M infrastructure, being examples: Advanced Ground Systems Maintenance (AGSM) and Integrated Health Management (IHM) Architecture at the Kennedy Space Center; NASA Ames autonomous systems, space habitats, and spacecrafts; and NASA Stennis Space Center (SSC) space launch systems (SLS) such as vacuum jacketed pipelines, and liquid nitrogen high-pressure pump.
Potential Non-NASA Applications (Limit 1500 characters, approximately 150 words):

SAMY focus to anomaly detection, prognostics, & FDI based on cognitive systems ensemble, puts it apart from current commercial products. Potential markets include Condition Based Maintenance, Smart Sensors, Internet of Things, & Autonomous Systems. Specific applications are avionic systems, manufacturing, structural health monitoring, fluid distribution systems, chemical processing plants.
Duration: **24**

PROPOSAL NUMBER: 22-2- **H6.22-2330**

PHASE 1 CONTRACT NUMBER: 80NSSC22PA971

SUBTOPIC TITLE: Deep Neural Net and Neuromorphic Processors for In-Space Autonomy and Cognition

PROPOSAL TITLE: Adaptive Neuromorphic Processors for Cognitive Communications

Small Business Concern

Firm: **Brisk Computing, LLC**
Address: **1191 Red Ash Court, Centerville, OH 45458**
Phone: **(937) 765-7742**

Principal Investigator:

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Business Official:

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Summary Details:

Estimated Technology Readiness Level (TRL) :

Begin: 4
End: 7

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

The objective of this work is to develop highly Size, Weight, and Power (SWaP) efficient neuromorphic processors that can train deep learning algorithms. The training phase for deep learning is very compute and data intensive. Being able to train a network on the satellite eliminates the need to send large volumes of data to earth for training a new network. However, this requires an extremely energy efficient deep learning training processor. We will develop resistive crossbar neuromorphic processors, with the primary target being to train deep learning algorithms. We will look at multiple type of networks, including for cognitive communication applications, anomaly detection, and imaging. We will also look at processing networks for other data sets. The key outcomes of the work will be the processor design, processor performance metrics on various applications, prototype system, and software for the processor.

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

Potential NASA applications include various deep learning training and inference tasks on satellites. These include cognitive communications, processing sensor outputs, and scientific experiments. Additionally, the developed system could be used for UAVs.

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

The non-NASA market would be primarily for edge processing, where power is highly limited. The market includes both the DoD and the commercial market. DoD applications include cognitive communications, sensor processing, cognitive decision making, and federated learning. Commercial applications include communications systems, automobiles, consumer electronics, and robots.

Duration: **24**

PROPOSAL NUMBER: 22-2- **H4.06-2650**

PHASE 1 CONTRACT NUMBER: 80NSSC22PB085

SUBTOPIC TITLE: Low-Power Multi-Gas Sensor for Spacesuits

PROPOSAL TITLE: Compact, Low Power, Multi-Parameter Astronaut Life Support Sensor (M-PALSS)

Small Business Concern

Firm: **Makel Engineering, Inc.**
Address: **1585 Marauder Street, Chico, CA 95973**
Phone: **(530) 895-2771**

Principal Investigator:

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Summary Details:

Estimated Technology Readiness Level (TRL) :

Begin: 4
End: 6

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

Makel Engineering, Inc. (MEI) proposes to continue to development of a highly compact Multi-Parameter Astronaut Life Support Sensor (M-PALSS) for use in the portable life support system (PLSS) for the new Exploration Extravehicular Mobility Unit (xEMU). M-PALSS will consist of an array of low power chemical microsensors for oxygen, carbon dioxide, water vapor, and pressure to monitor the major constituents in the gas stream circulated by the PLSS and/or exhaled from the astronaut in the rebreather loop. In Phase I, highly miniaturized chemical microsensors were

packaged with electronics in a compact physical envelope and low power consumption. Phase II will develop and test prototypes ready for PLSS integration and will coordinate design and requirements with NASA, Collins Aerospace, and Axiom Space. Additional sensing capability for ammonia, carbon monoxide, and other chemical sensing gaps will be evaluated for integration. In Phase II, two generation of prototypes will be developed and tested to mature the technology to TRL 6 by the end of the program.

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

The primary NASA application for the technology is to support human exploration activities by providing enhanced sensing capability to new generation of space suit life support systems including xEMU and the PLSS module. The technology is also applicable to ISS, Gateway, and future lunar outpost life support systems.

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

Non-NASA Applications include commercial and military diving rebreathing systems which have similar sensing requirements. Medical applications for the technology are portable oxygen generators and respirators.
Duration: **24**

PROPOSAL NUMBER: 22-2- **H5.01-2879**

PHASE 1 CONTRACT NUMBER: 80NSSC22PB010

SUBTOPIC TITLE: Lunar Surface 50 kW-Class Solar Array Structures

PROPOSAL TITLE: Motorless Expandable Solar Array (MESA)

Small Business Concern

Firm: **Dynovas, Inc.**
Address: **12250 Iavelli Way, Poway, CA 92064**
Phone: **(508) 717-7494**

Principal Investigator:

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Business Official:

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Summary Details:

Estimated Technology Readiness Level (TRL) :

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

Dynovas' Motorless Expandable Solar Array (MESA) system provides a novel solution that specifically addresses NASA's call for technologies enabling structural and mechanical innovations for a 50-kW-class solar array that can be relocated and deployed at least 5 times. The system is designed for an efficiency of > 75 W/kg and a volume efficiency >22 kW/m^{3}. This solution was developed based on previous technologies that have proven track record such as inflatables and bistable composites and new technologies for deployment and packaging that specifically address the unique mission requirements for large deployable solar arrays. The MESA system will be demonstrated at TRL 6 in Phase II via sub/full scale operation of key elements of the system, including array deployment, tower erection and retraction, and solar tracking. All systems are designed for the lunar environment (-80 °C to + 130 °C, under vacuum), including lunar dust. The Phase I successfully fabricated a scale model of the MESA system, with demonstrations of several key technologies, such as, bistable booms, inflatables, tensioned guy wires and a collapsible tower.

In Phase II, Dynovas will demonstrate the prototype MESA major sub-systems at TRL 6. The Phase II technical objectives will bridge the gap between the proven concept and readiness for flight testing opportunities. The Phase II objectives include:

1. Full scale demonstrations of key subsystems, including: tower mechanism, self-tensioning guy wires, deployable solar arrays, and solar tracking.
2. Structure and system packaging conceptual design package
3. Empirical testing of the proof-of-concept to validate the technologies potential
4. Progress reporting
5. Final report detailing Phase I success, Phase II objectives, and path to commercialization

The TRL 6 MESA System, delivered at the completion of Phase II, provides NASA and others a complete power generation system for use from 50 kW-300kW power stations.

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

The MESA system builds on near term NASA initiatives: Vertical Solar Array Technology (VSAT) project, Watts on the Moon Challenge, and Artemis Lunar Landings. The increased scale of MESA to 50 kW enables application to large power stations (300 kW+), habitats, recharging stations, and power substations. The overall scalability and redeployability also enables MESA to support smaller exploratory missions. The robust inflatable boom can also apply to surface conforming arrays for the moon and Mars exploration and habitation.

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

The NASA specific lunar missions will also have parallel commercial efforts to which MESA applies. In addition to lunar exploration other dual use applications exist, including: refueling stations; orbiting debris removal; and terrestrial pop-up power and communications towers.

Duration: **24**

PROPOSAL NUMBER: 22-2- **H9.01-1621**

PHASE 1 CONTRACT NUMBER: 80NSSC22PB151

SUBTOPIC TITLE: Long-Range Optical Telecommunications

PROPOSAL TITLE: Ground Based Uplink and Beacon Laser for Long Range Communication

Small Business Concern

Firm: **Physical Sciences, Inc.**
Address: **20 New England Business Center , Andover, MA 01810**
Phone: **(978) 689-0003**

Principal Investigator:

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Summary Details:

Estimated Technology Readiness Level (TRL) :

Begin: 3
End: 5

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

For deep space optical communications (OC) at astronomical distances (AU) such as Mars and beyond, a multi-kW average power laser that can be coded to send data is needed. OC will revolutionize space-based science and exploration capabilities by supplying data rates up to 100 times faster than the currently used radio frequency (RF) based systems. In response to that, PSI proposed to develop a laser to use as a ground beacon and uplink laser transmitter. The innovation is to develop a simple tapered fiber design that can produce high energy pulses at low pulse repetition rate (PRF) and also low energy pulses at high PRF. The versatility of the design fills the gap between these two types of lasers. In Phase I the laser was operated at 1 MHz with 150 uJ of pulse energy and also operated at 30 MHz with 5 uJ of energy. Former is suitable for long link distance to Mars and the latter is suitable for high data rate at 60 Mb/s. The proposed technology can also be applied to Er doped fiber to produce near 1.5 micron wavelength suitable for downlink laser.

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

The proposed technology is applicable to NASA for communicating between satellites, space crafts or to the ground. The LCRD mission will demonstrate the first two-way rely optical communication. Future Psyche mission, which is a journey to Psyche-16 between Mars and Jupiter, will test this new technology that encodes data in photons to communicate between a probe in deep space and Earth. In this mission, deep-space optical communications technology using lasers will demonstrate link length extending from 0.1 to farther than 2 AU.

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

High power and narrow-linewidth fiber lasers are necessary tools for the applications in gravitational wave detection, coherent LIDAR. A low-cost and high-data-rate optical communication terminals such as proposed here are required by SpaceX, Google, Facebook, Amazon, and Airbus who are pursuing High Altitude Platforms and very large LEO satellite constellations for global internet deployment.

Duration: **24**

PROPOSAL NUMBER: 22-2- **H5.05-2588**

PHASE 1 CONTRACT NUMBER: 80NSSC22PB219

SUBTOPIC TITLE: Inflatable Softgoods for Next Generation Habitation Systems

PROPOSAL TITLE: Accelerated Creep Test Methodologies for Space Habitat Softgood Structural Materials

Small Business Concern

Firm: **Texas Research Institute Austin, Inc.**
Address: **9063 Bee Caves Road, Austin, TX 78733**
Phone: **(512) 263-2101**

Principal Investigator:

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Business Official:

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Summary Details:

Estimated Technology Readiness Level (TRL) :

Begin: 3
End: 6

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

Space habitat inflatable structures require complex material configurations and manufacturing processes. There is a need to develop a standardized accelerated creep test methodology with analysis capability to compute the master creep curves for high strength Vectran webbing to ensure long-term habitat structural stability. Texas Research Institute Austin, Inc. (TRI Austin) proposes to develop a modified Step-Isothermal Method (SIM) and alternative Accelerated Life Testing methods that can be used for Vectran webbing and yarn based on our Phase I efforts. In Phase II of the program TRI Austin is teaming with Dr. Brown of Clemson's Center for Advanced Engineering Fibers and Films to characterize the tensile properties of Vectran fibers, as well as using techniques to identify the effect of fiber microstructure, molecular architecture, and intermolecular interactions on Vectran long-term creep behavior. Bally Ribbon Mills will provide expertise in webbing design and manufacturing processes used in its construction and currently manufactures the 24K 2-inch webbing for ILC Dover's prototype space habitat. OTEX, who manufactured the 12.5K 1-inch Vectran used in Phase I, will assist by supplying new webbing and yarn with QA/QC lot testing data. The Phase II program has 14 technical objectives based on our discoveries and theories from the Phase I evaluations that will be addressed in Phase II. In Phase II we can test and address the impact of manufacturing defects, long-term storage, packaging (folding), transportation to space, and final deployment in space with accelerated aging protocols. These test articles will then be assessed with the developed testing protocols to determine mission profile-based reliability performance calculated based on probability and confidence level to estimate field use life.

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

The primary NASA application is inflatable Softgoods for Next Generation Habitation Systems. This research development effort will develop and document creep test methodology and analysis capability to compute master creep curves for Vectran webbing generating relevant lifetime material performance predictions. The developed testing methodologies should be included in Vectran webbing qualification testing and certification plan for human-rated inflatable space structures.

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

It is anticipated that with a variety of corporations including Bigelow Aerospace LLC, ILC Dover, Maxar Technologies, Inc., The Boeing Co., Sierra Nevada Corporation, Northrop Grumman Corp., Lockheed Martin, Blue Origin, and Virgin Galactic, among others, entering the area of space travel, that demand for evaluating the creep behavior of inflatable structures will increase in the coming years.

Duration: **24**

PROPOSAL NUMBER:	22-2- **H10.01-1221**
PHASE 1 CONTRACT NUMBER:	80NSSC22PB007
SUBTOPIC TITLE:	Advanced Propulsion Systems Ground Test Technology
PROPOSAL TITLE:	Monitoring and Advisory System for Solenoid Operated Valves

Small Business Concern

Firm: **D2K Technologies**
Address: **5062 Nighthawk Way, Oceanside, CA 92056**
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Principal Investigator:

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Summary Details:

Estimated Technology Readiness Level (TRL) :

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

The proposed innovation is a monitoring and advisory system for health management of solenoid operated valves (SOV) used in industrial applications. The proposed software application would assist maintenance personnel and equipment owners to optimize system operation and maintenance activities by providing up-to-date information of key health metrics. The relevance and significance of the proposed innovation lies in the possibility to improve the capabilities to predict and model the behavior of SOV's. More generally, this proposal seeks to develop technology for health determination and fault management, prediction, prognosis, and anomaly detection. The proposed innovation addresses a gap between academic research and actual available commercial applications for monitoring the health status of real, field-deployed, industrial systems. The few options commercially available require the incorporation of additional hardware (sensors, signal conditioning modules, etc.) with obvious impacts to system cost and complexity. In relation to this, the proposed approach will make use of non-intrusive, low-cost techniques for measuring a coil's resistance or impedance, which in combination with calibrated models that correlate resistance and temperature, will allow to 1) determine if the coil's insulation has been subjected to operating temperatures higher than its rated class, 2) estimate cumulative damage based on total operating hours, and remaining useful life, 3) detect shorted coils, 4) assess internal leakage of the valve by detecting deviations in measured impedance (ac valves) from nominal values, and 5) provide confirmation of a valve operation in case of limit switch failures (ac valves). Furthermore, the proposed system would allow processing of historical usage data to estimate and maintain reliability curves, thus providing operators with additional insight to better understand and expose risk.

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

It is expected that the proposed application would be of interest to most of NASA's research centers, testing centers, and launch sites, given the fact that solenoid valves (SOV) are basic components of most fluid systems. At SSC, there are currently more than 600 SOV's in operation, with a mean time between failures (MTBF) of 75 days. The Gateway Refueling System is another candidate for the deployment of technologies like the ones introduced in this proposal, since SOV's are one of the basic components of its present design.

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

Given their nature and function, solenoid-operated valves are ubiquitous in industrial applications. In this sense, it is expected that a monitoring and advisory application like the one proposed here could find widespread application throughout a diverse range of industries, as for example oil & gas, nuclear, manufacturing, power generation, chemical, food, and pharmaceutical among others.

Duration: **24**

PROPOSAL NUMBER: 22-2- **H6.22-2264**

PHASE 1 CONTRACT NUMBER: 80NSSC22PB113

SUBTOPIC TITLE: Deep Neural Net and Neuromorphic Processors for In-Space Autonomy and Cognition

PROPOSAL TITLE: Radiation-Tolerant, Scalable Neuromorphic Energy-Efficient Accelerator for Heterogeneous Processor Systems

Small Business Concern

Firm: **Niobium Microsystems**
Address: **444 East 2nd Street, Suite 250, Dayton, OH 45402**
Phone: **(937) 203-8117**

Principal Investigator:

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Summary Details:

Estimated Technology Readiness Level (TRL) :

Begin: 2
End: 5
Technical Abstract (Limit 2000 characters, approximately 200 words):

The accelerator developed by Niobium Microsystems, Inc. (Niobium) is scalable in terms of parallelism and memory capacity, so that it can be targeted towards a variety of platforms, from small battery operated devices to large high-performance compute systems. It also has the ability to perform online learning when operating on neuromorphic workloads, drawing inspiration from the Hebbian learning paradigm. Additionally, the accelerator is designed as a memory-mapped peripheral of a larger heterogeneous System-on-Chip (SoC) and as such it can utilize external memory and implement arbitrarily sized Neural Networks (NNs) and even multiple NNs at the same time.

Niobium is also prototyping several different approaches for incorporating radiation-tolerant features in the core by leveraging Niobium's novel digital circuit design flow, and incorporating magnetoresistive random-access memory (MRAM) where appropriate to harden the memory. As part of the Phase II effort, Niobium proposes to proceed with the implementation of the accelerator core with two additional innovations that are crucial to the NASA mission, but also have broader market potential in commercial and defense applications. Specifically, we plan to

utilize Niobium's asynchronous circuit design techniques to (1) enable broad Dynamic Voltage Scaling (DVS) for enhanced protection against long-term radiation effects as well as potential improvements in energy efficiency, and (2) incorporate low-overhead radiation-tolerant circuits that protect against transient radiation effects, commonly referred to as Single-Event Transients (SETs), while minimizing the overhead in terms of power, performance and area. Lastly, as part of the implementation effort, Niobium intends to perform a quantitative tradeoff analysis between MRAM and conventional ECC-protected static random access memory (SRAM) with redundancy for the system-level cache of the accelerator.

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

NASA's missions will establish a permanent presence on the moon this decade (Artemis), followed by similar efforts on Mars. The remote deployment, with long communication latency and limited bandwidth, requires more autonomous systems that can sense their environment, react accordingly and adapt over time. The Niobium chip will enable such capabilities AND allow for withstanding the radiation effects present in space.

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

These demonstrable capabilities are directly transferable to space systems, autonomous vehicles, and other sensor platforms. Niobium is engaging with DoD customers regarding this effort: AFRL/RV, AFRL/RYA, AFRL/RI. Additionally the growing commercial space market is seeking to establish a permanent presence in space which will require rad-tolerant features, not COTS hardware used by LEO solutions.

Duration: **12**

PROPOSAL NUMBER: 22-2- **Z1.06-1046**

PHASE 1 CONTRACT NUMBER: 80NSSC22PB176

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

PROPOSAL TITLE: SiC Mosfet with Radiation-Resistant Gate Oxide Performance to 600V

Small Business Concern

Firm: **Scdevice, LLC**
Address: **3359 Northwest 123rd Place, Portland, OR 97229**
Phone: **(503) 449-4193**

Principal Investigator:

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Business Official:

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Summary Details:

Estimated Technology Readiness Level (TRL) :

Begin: 1
End: 4

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

Single-event burnout (SEB) and gate rupture occur when high-energy ions strike SiC MOSFET devices in the OFF state. Heavy ion radiation caused irreversible damage (possibly owing to SEGR) at biases below 10% and catastrophic failure at biases below 40% of their nominal blocking voltage in commercial SiC power devices. Commercial SiC MOSFETs degrade for latent gate leakage even at 50V drain-to-source voltage (VDS). Heavy ion collisions produce high-concentration electron-hole pairs that cause gate damage. In an n-channel MOSFET, electric field produced by the positive drain bias causes the generated holes and electrons to flow in opposite directions. The gate oxide interface "accumulates" and "leaks" holes toward the source contact. When the oxide's electric field surpasses a threshold, it breaks down.

SCDevice has designed a SiC MOSFET device with a P+ shield layer that prevents SEB by maintaining temperatures well below the sublimation point of SiC (2973°K) and by diverting the holes away from the gate oxide. Remarkably, our simulations show that 600V SEB performance can be achieved with only a P+ shield layer. Simulations reveal that when subjected to an ion strike with a LET of 40 MeV-cm^2/mg, our devices biased at V_{DS}=600V show temperature rise under 750°K and electric field of less than 4.0MV/cm in the gate oxide. Our findings demonstrate more than sixfold increase in the device bias before gate degradation may occur, potentially enabling the use of SiC MOSFET in space applications. We intend to manufacture and market SiC MOSFET for space applications. Our innovation can be applied to Si MOSFET devices to enhance the radiation performance. During phase-II, SCDevice will design and fabricate the MOSFET, radiation test, use the data to calibrate simulation models, re-design and fabricate lot-2 and complete radiation testing to verify performance. During technology development and validation, SCDevice will identify and address customer needs and pain points.

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

Use of SiC devices allows increasing the power supply voltage on satellites, hence increase power for higher throughput, broader coverage and faster orbital positioning. SiC devices would reduce the satellite's volume and weight, a real asset given the high price per kilo launch. The result is either: smaller and lighter satellites for a given mission, or a higher performance payload for a given satellite. SiC devices' vulnerability to radiation damage hinders its usage in space. NASA space mission could directly benefit from our SiC MOSFET.

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

Power management represents 40% of the rad-hard electronics market. Radiation-resistant high-voltage SiC components will benefit the cost-competitive satellite sector. Lighter satellites should lower rocket launch greenhouse gas emissions like carbon dioxide and nitrous oxide.

Duration: **24**

PROPOSAL NUMBER: 22-2- **Z10.01-1870**

PHASE 1 CONTRACT NUMBER: 80NSSC22PA999

SUBTOPIC TITLE: Cryogenic Fluid Management

PROPOSAL TITLE: Compressor for Efficient On-Orbit Gas Transfer

Small Business Concern

Firm: **Creare, LLC**
Address: **16 Great Hollow Road, Hanover, NH 03755**
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Principal Investigator:

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Business Official:

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Summary Details:

Estimated Technology Readiness Level (TRL) :

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

Transfer of gaseous propellant in space is a critical technology for space exploration and for extending the useful life of satellites. A key component needed for in-space refueling is a compressor that can efficiently move gas from a resupply vehicle to the propellant storage vessel on board the receiver vehicle. High efficiency requires a very high pressure ratio, and operation on orbit requires that the compressor be compact, lightweight, and space worthy. We propose to develop a compact, high-pressure ratio compressor that meets these requirements. Our technology can efficiently transfer gas from a low-pressure supply vessel to a high-pressure receiver vessel using a highly reliable compression mechanism. In Phase I, we proved feasibility through demonstration testing of key components and materials, analysis and assessment of key design trade-offs, detailed conceptual design, and predictions of performance. In Phase II, we will build a prototype compressor and demonstrate operation under conditions that simulate propellant transfer in space.
Potential NASA Applications (Limit 1500 characters, approximately 150 words):

NASA's primary application is propellant transfer for space exploration. Resupply of xenon propellant for the Gateway space station will ultimately be developed by the Gateway Program and the Gateway Logistics Program Office. Transfer of helium pressurant gas for management of cryogenic propellant can support the recent Tipping Point programs awarded for cryogenic fluid management and managed through NASA's Glenn Research Center, Marshall Space Flight Center, and Kennedy Space Center.
Potential Non-NASA Applications (Limit 1500 characters, approximately 150 words):

The main commercial application is refueling with gaseous propellant or recharging helium pressurant to extend satellite life, reduce costs, and enhance capabilities. Customers will be companies that build and operate spacecraft for in-space servicing, assembly, and maintenance of orbiting spacecraft. These companies include new commercial ventures as well as established aerospace primes.
Duration: **24**

PROPOSAL NUMBER: 22-2- **Z10.05-2909**

PHASE 1 CONTRACT NUMBER: 80NSSC22PB086

SUBTOPIC TITLE: Rotating Detonation Rocket Engines (RDRE)

PROPOSAL TITLE: Rotating Detonation Engine Novel Injector Design

Small Business Concern

Firm: **Masten Space Systems, Inc.**
Address: **1570 Sabovich Street, Mojave, CA 93501**
Phone: **(888) 488-8455**

Principal Investigator:

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Summary Details:

Estimated Technology Readiness Level (TRL) :

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

Astrobotic will design, manufacture, and test a series of flight-like rotating detonation rocket engine (RDRE) injectors using its patent-pending PermiAM technology. In addition to the further development and test of these injectors, Astrobotic will also design an annular RDRE chamber that will be compatible with the injectors.

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

Injectors manufactured using PermiAM provide numerous benefits to NASA, including PermiAM's ability to evenly inject propellants across the detonation wave path, which helps to maintain the stability of the detonation wave in an RDRE. These injectors and compatible thrust chambers may be able to improve Isp by as much as 15%. Such RDREs could be used on spacecraft or launch vehicles for NASA missions and may be useful for developing new space and aviation propulsion systems.

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

Customers for the injectors proposed for this effort include commercial companies working to develop functional RDREs or seeking to improve the efficiency of their propulsion systems. The injectors, as part of a functional RDRE, could be sold as an efficient commercial propulsion system to private spacecraft and launch providers. RDRE technology is also a key research area for the Air Force.

Duration: **22**

PROPOSAL NUMBER: 22-2- **Z12.01-2721**

PHASE 1 CONTRACT 80NSSC22PA966

NUMBER:

SUBTOPIC TITLE: Extraction of Oxygen, Metal, and Water from Lunar Regolith

PROPOSAL TITLE: Feed and Removal of Regolith for Oxygen Extraction

Small Business Concern

Firm: **Blueshift, LLC**
Address: **575 Burbank Street, Unit G, Broomfield, CO 80020**
Phone: **(850) 445-3431**

Principal Investigator:

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Business Official:

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Summary Details:

Estimated Technology Readiness Level (TRL) :

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

Blueshift, LLC d/b/a Outward Technologies proposes to continue development of the Feed and Removal of Regolith for Oxygen Extraction (FaRROE) system. FaRROE enables the transfer of regolith from excavators to within a lunar oxygen extraction reactor, and the transfer of processed regolith from the reduction reactor to a holding hopper or the lunar surface. The system incorporates noncontact temperature measurements of the regolith within the reactor using a 2-color pyrometer to monitor regolith phase change and temperatures up to and exceeding 2,000 C. The innovative design of the FaRROE system incorporates non-mechanical valves at the reactor inlet and outlet to enable the continuous feed of regolith into and out of an enclosed reactor at high processing rates (>25 kg/hr) with no moving parts coming into contact with the regolith. Sealing of the reactor inlet is produced through a vertical tube hopper packed with unprocessed regolith, creating a tortuous path for product gases and preventing their escape from the reactor chamber. An extrusion nozzle at the reactor outlet enables the controlled removal of processed regolith and formation of a liquid seal preventing the escape of

product gases. Utilizing unprocessed and processed regolith as the sealing mechanisms reduces mass, complexity, and likelihood of mechanical failure of the system. The extraction of oxygen is monitored through two redundant systems to measure oxygen production rate, system efficiency, and leak rate. Mineral-oxide content is measured continuously at the unprocessed inlet feed and processed outlet feed. The oxygen and/or other product gases generated within the reactor are monitored through in-line gas analysis. FaRROE may be integrated with every known high-temperature oxygen extraction method for regolith to enable continuous processing at high feed rates through a lightweight, durable design to ensure long-term continuous operation in the harsh lunar environment

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

FaRROE addresses the limitations of current designs of lunar oxygen extraction reactors which lack a means to move regolith into and out of the oxygen extraction zone. These enabling capabilities address the needs of NASA TX07.1 In-Situ Resource Utilization through the improved production of oxygen from lunar regolith and TX07.2 Mission Infrastructure, Sustainability, and Supportability through the utilization of molten slag in a host of secondary processes including 3D printing and casting of structural members on the Moon.

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

Potential non-NASA applications include the commercial production of oxygen and glass-ceramic regolith parts and structures on the Moon. Other non-NASA applications include the improved design of non-mechanical valves for high-temperature industrial processes on Earth incorporating a pressure differential between the reactor and the inlet and outlet feeds.

Duration: **24**

PROPOSAL NUMBER: 22-2- **Z7.04-1530**

PHASE 1 CONTRACT NUMBER: 80NSSC22PA978

SUBTOPIC TITLE: Landing Systems Technologies

PROPOSAL TITLE: Rapid Parametric Sensitivity Analysis for Plume-Surface Interaction Simulations

Small Business Concern

Firm: **CFD Research Corporation**
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Principal Investigator:

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Summary Details:

Estimated Technology Readiness Level (TRL) :

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

NASA modeling and simulation activities are mandated to provide uncertainty characterization, quantification (UQ), and propagation for all of their simulation tools and results. In the Phase I of this project, CFD Research addressed this need by implementing two approaches for sensitivity analysis into the Gas Granular Flow Solver, Loci/GGFS, used by NASA for prediction of Lunar and Martian Plume-Surface Interaction (PSI) effects such as dust lofting, obscuration, debris transport, and surface cratering. The first method, the intrusive methodology Forward Automatic Differentiation (FAD), enables run-time sensitivity analysis and propagation of the underlying sub-model uncertainties through a simulation in a minimal number of runs. The second method was the nonintrusive Sensitivity Quantification for Uncertainty Analysis Toolkit (SQUAT). Both approaches quantified sensitivities in a PSI validation problem. In Phase II, CFD Research will mature both methodologies. The efficiency and applicability of FAD will be improved for a broad class of problems in Loci/GGFS and other Loci solvers including Loci/CHEM, which is used for a variety of applications by NASA. SQUAT will be extended to work with all Loci-based solvers. Both uncertainty analysis methods can also be adapted for implementation or integration with other CFD solvers to enable critically needed UQ and sensitivity analysis for a wide range of NASA and non-NASA applications. At the end of this project, a full suite of UQ tools will be available to the analyst for sensitivity analysis, allowing identification of dominant sub-model contributors of uncertainty, guide improvements, and provide a rapid propagation of critical uncertainties to the simulation output metrics. The resulting tools will be delivered to NASA for ready application to analysis of Lunar and Martian landers, including the Human Lander System, to aid in quantifying and propagating uncertainties in current simulations.

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

Immediate NASA applications include the improvements across the Loci-based solver family for a broad range of numerical simulations, especially in determining uncertainties present in models used therein. This work can be extended to other solvers with similar benefits. Identification and understanding of model uncertainties will have a direct impact on missions requiring propulsive landing and take-off, such as the Commercial Lunar Payload Services landers, for the Human Lander System, and future Martian robotic and human landers.

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

Uncertainties persist in a wide range of non-NASA sand and dust related military and civilian applications such as rotorcraft brownout, engine dust ingestion, and obscuring the warfighter. In addition, multiphase flows occur in many applications in chemical, and fossil-energy conversion

industries where accurate physics modeling plays a huge role in the flow behavior of real particulate systems.

Duration: **24**

PROPOSAL NUMBER: 22-2- **Z8.13-1573**

PHASE 1 CONTRACT NUMBER: 80NSSC22PB153

SUBTOPIC TITLE: Space Debris Prevention for Small Spacecraft

PROPOSAL TITLE: Self Propelled Energetic Electron Dispensers (SPEEDs) for Deorbit Applications

Small Business Concern

Firm: **Physical Sciences, Inc.**
Address: **20 New England Business Center , Andover, MA 01810**
Phone: **(978) 689-0003**

Principal Investigator:

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Address: **20 New England Business Center, MA 01810 - 1077**
Phone: **(978) 738-8265**

Business Official:

Name: **Dr. William Marinelli**
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Phone: **(978) 738-8226**

Summary Details:

Estimated Technology Readiness Level (TRL) :

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

Physical Sciences Inc. (PSI) is developing passive and active enhancements to heritage electrodynamic tether smallsat deorbit systems. Passive coatings based on flexible materials with negative electron affinity-enhanced triple-point electron emitters will enable deorbit propellantless deorbit from altitudes up to at least 1100 km by increasing the passively generated current through electrodynamic tethers. The active component of PSI's system, embodied by a robust, self-powered and self-regulated cold cathode electron gun, will further increase deorbit rate and altitude while also giving a host satellite control over deorbit parameters. This active deorbit system is entirely electric and requires no propellant, dramatically reducing their size, weight and power requirements versus traditional active deorbit systems and services. Both the active and passive deorbit components leverage past work PSI has performed for the US Space Force and for NASA. PSI is also partnering with Tethers Unlimited Inc. (TUI) to adapt the passive and active electrodynamic tether enhancement to their existing, heritage terminator tape (TT) deorbit systems. In Phase I, PSI demonstrated proof of concept for the new tether enhancement technologies. In Phase II, PSI will apply the new technologies to TUI's TT system, producing flight-ready prototypes available to NASA for deployment on demonstration missions following the Phase II program.

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

The innovation is applicable to smallsats, and possibly larger objects such as spent rocket stages having terminal altitudes up to at least 1100-1200 km. The application is controlled, rapid, propellantless deorbit of payloads in order to minimize further pollution of low Earth orbit (LEO) and mitigate the risk of spacecraft collisions. Further development may allow propellantless station keeping in LEO, as well as propellantless maneuver of spacecraft around other planets with natural magnetic fields such as Jupiter and Saturn.

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

The innovation is applicable to all smallsats, and possibly larger payloads such as spent rocket stages. The application is controlled, rapid, propellantless deorbit of payloads, minimizing further pollution of LEO and mitigating risk of spacecraft collisions. This innovation will also enable cost-effective compliance with regulations designed to mitigate space pollution.

Duration: **24**

PROPOSAL NUMBER: 22-2- **Z1.06-2089**

PHASE 1 CONTRACT NUMBER: 80NSSC22PB016

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

PROPOSAL TITLE: Single Event Burnout Hardened High-power Diamond Devices

Small Business Concern

Firm: **Euclid Beamlabs, LLC**
Address: **5900 Harper Road # 102, Solon, OH 44139**
Phone: **(440) 519-0410**

Principal Investigator:

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Business Official:

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Summary Details:

Estimated Technology Readiness Level (TRL) :

Begin: 4
End: 6

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

Electrical power management designed for use in space requires electronics capable of operating without damage in the galactic cosmic ray space radiation environment. Unfortunately, the adoption of SiC and GaN technology into space applications is hindered by their susceptibility to permanent degradation and catastrophic failure from single-event effect heavy-ion exposure. This degradation occurs at <50% of the rated operating voltage, requiring the operation of SiC/GaN devices at de-rated voltages.

Diamond is one of the candidate materials for the next-generation WBG semiconductor devices capable of overcoming the current limitations of SiC/GaN technology. In addition to having the highest breakdown field, it has the highest p-type conductivity, making it a unique p-channel material for power electronics. It also holds a solid hope to be hardened against single-event burnout (SEB) due to its superior thermal conductivity and ability to maintain excellent crystallinity under heavy ion exposure.

Euclid Beamlabs, in collaboration with Rensselaer Polytechnic Institute, will develop a new quasi-lateral diamond power MOSFET (QLDT) that will overcome current limitations by combining the inherent advantages of diamond material, SEB hardened transistor design with advanced 3D femtosecond laser writing capabilities of micrometer-scale conductive structure fabrication inside the diamond. The project's primary focus is developing a SEB-tolerant diamond transistor design with a 2D Hole Gas conductive channel and graphitized embedded connections. The targeted specifications are a 1,200+ V voltage rating with 1.0 mOhm-cm^2 specific on-resistance.

In Phase II, we will focus on the 3D simulations of QLDTs at supercomputer facilities. Then we evaluate the SEB performance of QLDTs under varying conditions. We will also fabricate a QLDT prototype following the fabrication process flow outlined in Phase 1. The prototype will be tested at the heavy-ion terrestrial facility.

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

The technology has immediate application for radiation-hardened power electronics circuits in exploring atmospheric planets, Moon to Mars, and Commercial Lunar Payload Services (CLPS) missions. It has a strong potential to advance current state-of-the-art electronics on revolutionary spacecraft design with reduced size, weight, and power while increasing overall system efficiency, longevity, and performance.

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

The developed technology has the potential to be commercialized for a wide set of goals with hostile environments and high-temperature operation regimes. It will overcome the limitations of current state-of-the-art high-temperature, cost-effective power electronics technology. The all-carbon technology will find its applications in military electronics, high-energy physics, and medical radiology.
Duration: **24**

PROPOSAL NUMBER: 22-2- **Z2.01-1555**

PHASE 1 CONTRACT NUMBER: 80NSSC22PB001

SUBTOPIC TITLE: Spacecraft Thermal Management

PROPOSAL TITLE: A Compact, Gravity-Insensitive Gas Trap for Extreme Temperature Environments

Small Business Concern

Firm: **Creare, LLC**
Address: **16 Great Hollow Road, Hanover, NH 03755**
Phone: **(603) 643-3800**

Principal Investigator:

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Business Official:

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Phone: **(603) 643-3800**

Summary Details:

Estimated Technology Readiness Level (TRL) :

Begin: 4
End: 6

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

NASA is working toward missions involving crewed habitats for extended stays within orbital platforms. Environmental control of these habitats is enabled by use of thermal control systems to maintain conditions within a tight temperature band. These thermal control systems must be highly reliable, lightweight, and able to effectively control cabin and equipment temperatures to within several degrees under varying heat loads in conditions of low gravity. For existing spaceborne habitats and survival of payloads, thermal control is established by pumped liquid coolant loops, often employing low-surface-tension fluids. Ensuring reliable operation of the coolant pump is paramount; methods to reduce operational risk to the pump are needed to enable long-term human presence. To address this need, Creare has developed a compact, gravity-insensitive gas trap capable of passively sequestering, then venting non-condensable gas buildup in liquid coolant loops with low surface tension fluids. In Phase I, we proved the feasibility of this approach by developing a preliminary gas trap design, demonstrating key processes involved in fabrication of the gas trap including development of novel microporous materials. We assembled a subscale dual-membrane gas trap and characterized its performance through laboratory testing. This allowed us to demonstrate that the gas trap accumulates gas, can passively vent to a coolant loop accumulator gas manifold, and ultimately to the cabin. In Phase II, we will further develop the gas trap technology through expanded trials, we will fabricate a full-scale gas trap capable of serving a multi-kW spaceborne thermal coolant loop, demonstrate its steady state and transient performance in a laboratory coolant loop. We will then conduct microgravity flight tests of the gas trap within an aerated coolant loop, using our anticipated concept of operations. Finally, we will deliver the prototype to NASA for further performance evaluation.

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

Gas traps are needed for enhanced reliability in thermal control for NASA missions including on-board the ISS. The current proposed effort would enable high reliability coolant loops for use in future lunar habitats or extreme environments circulating low-surface-tension fluids. Other governmental applications (e.g., DoD) are similar to NASA uses, specifically high reliability coolant loops operating in extreme environments for aircraft, ships, and ground vehicles.

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

The superhydrophobic membrane development has commercial applications for various chemical industries including steam separation and chemical processing with two-phase caustic chemical flows. The gas trap itself has application in high reliability coolant with minimal available maintenance such as in nuclear power plants or in other remote power stations.

Duration: **24**

PROPOSAL NUMBER: 22-2- **Z8.02-1723**

PHASE 1 CONTRACT 80NSSC22PB024

NUMBER:

SUBTOPIC TITLE: Communications and Navigation for Distributed Small Spacecraft Beyond Low Earth Orbit (LEO)

PROPOSAL TITLE: Adapting 100G Optical Comm to Unique NASA Small Satellite DSM Applications

Small Business Concern

Firm: **Fibertek, Inc.**
Address: **13605 Dulles Technology Drive, Herndon, VA 20171**
Phone: **(703) 471-7671**

Principal Investigator:

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Summary Details:

Estimated Technology Readiness Level (TRL) :

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

We proposed to expand the bandwidth of free space optical (FSO) communications to 100G for lunar and Lagrange points while using available low-cost and low size, weight, and power (SWaP) technologies. We propose to develop 100G space laser transceiver technology that specifically address the unique properties of these longer-range missions and bridging the gap between terrestrial and Geo, Lunar and L1/L2 mission applications. This is in contract to LEO efforts where the range is 1000km.

This program will develop Cubes, Small and Large Satellite, mission ready, TRL 6 technology ready for program infusion in an ultra-compact 1 kg, < 1 U CubeSat form factor with the expected reliability for long duration missions. The program leveraging cost effective terrestrial fibercom 100G, photonic integrated circuits, coherent modules for long-range space-based free space optical (FSO) links.

Our link budget indicates that 100G-200G is feasible with a ground station telescope of 1-6 meters in diameter, with smaller 10-20 cm satellite telescopes.

The proposed technology is supports GEO downlink, GEO-GEO, Lunar, and potentially L1 and L2 ranges with sufficient ground station receiver aperture.

- Supports NASA Scan office roadmap for 100G everywhere in space.
- Support very long-range utilizing NASA's Optical and RF combo Telescope and antenna system currently under development. The telescope diameter is 5-10 meter telescope being developed by NASA for DSN applications.
- High bandwidth is a key enabler to expand NASA human spaceflight operations, telerobotic, astronaut HD video and SMD science for Lunar missions.
- Enables NASA Heliophysics vision for affordable, sun sensing SmallSat constellations at L1, L2 for space weather, astronaut safety missions and SMD heliophysics science.
- Technical approach leverages terrestrial fibercom photonic integrated circuit (PIC) providing advanced technology at low cost for space.
- Ready for program insertion in 2025.

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

- Support Lunar Artemis human exploration missions
- NASA state-of-the-art mesh networked lasercom capability to support SCaN deployment of optical communications
- Deep Space & Heliophysics – Space weather, Sun studies out to L1, L2 at 100 Gbps
- Near Earth science missions – Increased data rate for SmallSat sensors
- Near Earth GEO and cis-lunar, lunar orbital, Lagrange Point L1, L2
- Future NASA SmallSat and CubeSat constellations with science missions that need optical coms to support high data rates including multispectral imaging sensors

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

- DoD and U.S. Government for intelligence imagery. GEO, MEO, LEO
- CLPS commercial lunar payload services companies
- High data-rate, low-cost commercial optical communications from LEO/GEO satellites

Duration: **24**

PROPOSAL NUMBER: 22-2- **Z13.02-1981**

PHASE 1 CONTRACT NUMBER: 80NSSC22PB095

SUBTOPIC TITLE: Mechanisms for Extreme Environments

PROPOSAL TITLE: Regolith Dust and Radiation-Tolerant Bearing

Small Business Concern

Firm: **MillenniTEK, LLC**
Address: **631 Barbrow Lane, Knoxville, TN 37932**
Phone: **(865) 966-2170**

Principal Investigator:

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Business Official:

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Summary Details:

Estimated Technology Readiness Level (TRL) :

Begin: 3
End: 5

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

A radiation-resistant and superhard material for dust-resistant mechanical bearing applications on the lunar surface will be tested and demonstrated under this project. This highly incompressible ceramic material is able to be formed into intricate bearing geometries directly from powder to create dense, hard, geometrically precise, and wear-resistant bearing surfaces. This new material is more than 30% lighter than the chrome steel commonly used for bearings, and about 15% lighter than Nitinol, which NASA has been recently investigating for bearing applications. A roller bearing using this new material that is tolerant of regolith dust will be designed, fabricated, and performance tested. Radiation resistance testing of this material will also be performed in partnership with Idaho National Laboratory. Performance testing of assembled bearings from this material will be tested for lunar dust resistance, and at temperature extremes ranging from -240 C to 130 °C. At the conclusion of the Phase II, a functioning roller bearing would have been tested in the simulated conditions and delivered to NASA for further evaluation.

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

The new bearing being developed will be applicable to small, precision mechanical bearing applications that can operate reliably without environmental protection housing in the extreme environments of NASA missions. Many conventional bearing materials and required lubricants are not tolerant of these environments. The proposed material is radiation-resistant and capable of operation without lubricant, at a significantly lower mass than current bearing metal alloys.

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

This fully-ceramic bearing material technology has the potential to be utilized in high temperature and corrosive bearing applications in the oilfield, refinery, chemical processing, and metal processing industries. Additionally, non-bearing uses include exploiting the high hardness of the material within the industrial forming, cutting, and grinding tool industries.

Duration: **24**

PROPOSAL NUMBER: 22-2- **Z14.02-2297**

PHASE 1 CONTRACT NUMBER: 80NSSC22PA967

SUBTOPIC TITLE: Extraterrestrial Surface Construction

PROPOSAL TITLE: Lunar Articulating Mirror Array

Small Business Concern

Firm: **Blueshift, LLC**
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Principal Investigator:

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Business Official:

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Summary Details:

Estimated Technology Readiness Level (TRL) :

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

Blueshift, LLC d/b/a Outward Technologies proposes to continue development of a Lunar Articulating Mirror Array (LAMA) for enabling lunar surface construction of large-scale infrastructure. The technology utilizes concentrated solar power to heat lunar regolith at a distance of meters to tens of meters from the mirror array. The configuration of the design allows for precise control over the solar flux and solar flux density delivered to the target surface. Phase I demonstrated feasibility of this technology through fabrication, assembly, and control of a physical prototype demonstrating the translation of a spot of highly concentrated solar energy across a receiver surface; ray tracing models matched to Phase I prototype results confirming validity of these models; extension of the ray tracing models to mid- to large-scale LAMA systems for solar conditions found on the Moon; generation of selectively solar melted and liquid-phase sintered surfaces of a lunar highlands regolith simulant; evaluation of performance of selectively solar melted surfaces for bearing loads equivalent to those that would be imposed by a lander footpad; and evaluation of reducing ejecta from selectively solar sintered regolith surfaces when exposed to a simulated plume-surface interaction. These efforts will be extended in Phase II to develop a medium-fidelity LAMA prototype and evaluate its performance in a relevant test environment to advance the TRL from 4 to 5. Selectively solar melted and sintered regolith surfaces will be produced in air and in vacuum conditions. Specimens generated from selective solar melting will be exposed in controlled thermal pulse tests representing impingement by superheated gases from an 80 ton lunar lander. Plume-surface interactions of selective solar sintered surfaces will be explored in vacuum conditions. Finally, a demonstration Landing/Launch Pad measuring 1m in diameter will be evaluated through multiple hot-fire tests from a large solid rocket motor.

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

NASA applications include construction of large horizontal structures, layer-wise additive construction, treatment of regolith surfaces to minimize ejecta from PSI's, and solar-thermal power generation on the lunar surface. These capabilities primarily address technology taxonomy areas TX12, TX12.X, TX03.3, and TX07.1. Through continued funding and development, LAMA will provide a robust construction tool for addressing NASA's needs for establishing permanent lunar infrastructure while relying on abundant solar-thermal power and ISRU materials.

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

Potential non-NASA applications include: increased pointing accuracy of heliostat fields for higher efficiency concentrated solar-thermal power plants on Earth; improved design of heliostat geometries to enable higher temperature solar-thermal reactors for industrial decarbonization; and In-Space Servicing, Assembly, and Manufacturing (ISAM) in low-Earth orbit for DoD and commercial customers.

Duration: **24**

PROPOSAL NUMBER: 22-2- **Z10.05-2755**

PHASE 1 CONTRACT NUMBER: 80NSSC22PB194

SUBTOPIC TITLE: Rotating Detonation Rocket Engines (RDRE)

PROPOSAL TITLE: Optimization of Multiphase Injector Dynamics for Rotating Detonation Rocket Engines

Small Business Concern

Firm: **Spectral Energies, LLC**
Address: **4065 Executive Drive, Dayton, OH 45430**
Phone: **(937) 266-9570**

Principal Investigator:

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Summary Details:

Estimated Technology Readiness Level (TRL) :

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

Designing an ultra-high-performance Rotating Detonation Rocket Engine (RDRE) is challenging due to the lack of in-depth understanding of many key mixing and combustion processes. The design of ultra-high-performance RDRE injectors requires improved understanding of how the injector design affects its response and performance under the highly unsteady and impulsive detonation environment. These injectors must be optimized for (i) the ability to improve and control gaseous and liquid injector diodicity, while also minimizing the forward direction injector pressure drop to improve overall system performance, (ii) the ability to optimize the relative injector response and recovery of the fuel and oxidizer to achieve the desired mixture ratio and minimize deflagration losses, and (iii) the ability to control the mixing rate to ensure reliable detonation at the ideal lift-off position. The proposed research effort will develop ultra-high-performance injector solutions that meet these requirements. The Phase II overall goals are twofold: (1) design, test, and evaluate high diodicity single-element monophase and multi-element multiphase injectors in cold flow and hot-fire RDE experiments, with the CFD design optimization driving some of the injector concepts, and (2) initiating the development of a design methodology that is supported by CFD optimization and experimental validation. These steps will guide the transition and development beyond Phase II for infusion into more relevant and practical systems. The outcomes of the effort will lead to the development of validated accurate

rules and tools that can be used for designing ultra-high-performance RDRE injectors. The expansion of scientific knowledge regarding injector design, detonation combustion, and global performance will provide NASA an experimental dataset to anchor future modeling and simulations.

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

The proposed work seeks to modernize the injector technology for RDEs for rocket applications. This includes design methodology, manufacturing, and hardware designs capable of providing high injector diodicity at reduced injector pressure drops. Detailed designs and measurements of the injector behavior will be compared to numerical simulations, and multidisciplinary design optimization will produce optimized injector designs that will be evaluated in an RDE test rig. This will benefit new technologies in air-breathing and rocket propulsion.

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

Non-NASA applications of the proposed efforts include ultra-high-performance injector technology for RDE applications, enabling the infusion of pressure gain and combustion size benefits into practical systems. Commercial applications include air-breathing propulsion, missiles, stationary power generation.

Duration: **24**

PROPOSAL NUMBER: 22-2- **Z4.05-1921**

PHASE 1 CONTRACT NUMBER: 80NSSC22PB071

SUBTOPIC TITLE: Nondestructive Evaluation (NDE) Sensors, Modeling, and Analysis

PROPOSAL TITLE: High-Throughput and High-Sensitivity Terahertz Scanners for Non-Destructive Evaluation of Non-Conductive Coatings and Thermal Protection Systems in Space Applications

Small Business Concern

Firm: **Lookin, Inc.**
Address: **12016 Washington Place, Apt 112, Los Angeles, CA 90066**
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Principal Investigator:

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Summary Details:

Estimated Technology Readiness Level (TRL) :

Begin: 4
End: 7

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

To address NASA's need for advanced non-destructive evaluation (NDE) sensors, Lookin, Inc. proposes to develop a novel multi-pixel terahertz scanner, a transformative diagnostic tool to identify and localize visually inaccessible defects and damages in non-conductive coatings and thermal protection systems with significantly higher throughputs and over significantly larger volumes compared to what can be offered by existing NDE tools.

During the Phase I SBIR program, Lookin performed feasibility studies and proved the suitability and superiority of its multi-pixel terahertz imaging systems for finding/localizing defects in materials commonly used as insulators in space applications, such as spray-on-foam insulator and cork, with a laboratory prototype multi-pixel terahertz scanner system.

With the successful results obtained during the feasibility studies of the Phase I program, Lookin, Inc. proposes to extend its technological capabilities and develop a compact and portable field prototype multi-pixel terahertz scanner with enhanced resolution and scanning speed to be used for NDE of non-conductive coatings and thermal protection systems in field settings. More specifically, Lookin proposes to develop a contactless multi-pixel terahertz scanning system capable of capturing three-dimensional terahertz images of samples with a 5×5×15 cm^3 volume at a scan rate of 10 Hz, while providing a signal-to-noise ratio of >60 dB and lateral/depth resolution of at least 100/10 μm. This terahertz imaging system is controlled by a data analysis algorithm that can create B- and C-scan images of the sample and automatically determine the position of the structural defects, such as cracks, voids, and delamination, within the samples.

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

The primary application of the proposed terahertz scanner is non-destructive inspection of non-conductive coatings for identification of inaccessible defects and damages on and below the surface with high resolution, precision, and throughput. The instrument can be used in ground inspection facilities for NDE and structural health monitoring of non-conductive insulation materials of spacecrafts, such as spray-on-foam insulators and cork panels.

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

The proposed terahertz scanner is capable of inspecting many non-conductive polymers and composites including glass-fiber reinforced plastic, teflon, polyethylene. Thus, the same instrument can be used for NDE of many industrial products that heavily use non-conductive composites and other non-conductive polymers, such as those in battery, auto, aerospace, construction, and oil & gas industries.

Duration: **24**

PROPOSAL NUMBER:	22-2- **Z2.02-1613**
PHASE 1 CONTRACT NUMBER:	80NSSC22PB173
SUBTOPIC TITLE:	High-Performance Space Computing Technology
PROPOSAL TITLE:	Fault Tolerant RISC-V Flight Computer with Coprocessor Support

Small Business Concern

Firm: **Resilient Computing**
Address: **269 Terrance Loop, Bozeman, MT 59718**
Phone: **(406) 451-8138**

Principal Investigator:

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Business Official:

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Summary Details:

Estimated Technology Readiness Level (TRL) :

Begin: 4
End: 6

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

This Phase II project aims to prototype a novel technology that can advance the state-of-the-art in high performance space computing. The base computer technology, called “RadPC”, brings together a suite of fault recovery mechanisms that enable Commercial-off-the-Shelf (COTS) Field Programmable Gate Arrays (FPGAs) to operate reliably in the presence of space radiation that causes single event effects (SEEs). The RadPC concept has been matured for over 12 years in the research labs of Montana State University (MSU). Through over $6M in NASA

research funding, RadPC has been tested on high-altitude balloons (8x), sounding rockets (2x), the International Space Station (3x), and on small satellites (2x). In 2024, the RadPC base computer will be tested on a lunar mission through the NASA Lunar Surface Instruments and Technology Payloads (LSITP) program to stress its SEE recovery mechanisms while passing through the Earth's radiation belts and operating outside of the Earth's magnetic field. In 2021, RadPC was licensed to Resilient Computing to begin its commercialization efforts. Through a 2021 NASA SBIR Phase I award, the MSU version of RadPC was refined to use a RISC-V architecture to make the computer suitable for real space missions. Through a 2022 NASA SBIR Phase I award, a feasibility study was conducted to evaluate if coprocessors could be embedded within the RadPC architecture in order to accelerate computation while still maintaining the reliability that RadPC's SEE recovery procedures provide. The 2022 Phase I study devised a strategy to successfully include coprocessors into RadPC to perform computationally intense tasks while being able to be repaired through the existing recovery procedures. This Phase II project aims to develop a prototype of the RadPC+coprocessor system to test its computational performance and reliability while conducting object detection algorithms on real-time camera data.

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

- Replacing ~20 year old rad-hard processors with a lower-cost, higher performance, commercial-based technology.
- Accelerating computationally intense algorithms such as real-time science data processing, autonomy, and navigation using coprocessors.
- Control & data handling for NASA small satellites.

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

- Small satellites needing increased reliability and performance, but at a price-point below current rad-hard computers.
- Earth image processing (climate monitoring, disaster mitigation, agriculture).
- Communication networks.

Duration: **24**

PROPOSAL NUMBER: 22-2- **Z2.02-1771**

PHASE 1 CONTRACT NUMBER: 80NSSC22PB248

SUBTOPIC TITLE: High-Performance Space Computing Technology

PROPOSAL TITLE: Pelican: Radiation-Tolerant Computational Storage

Small Business Concern

Firm: **Zephyr Computing Systems, Inc.**
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Principal Investigator:

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Business Official:

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Phone: **(781) 454-9040**

Summary Details:

Estimated Technology Readiness Level (TRL) :

Begin: 3
End: 8
Technical Abstract (Limit 2000 characters, approximately 200 words):

Zephyr proposes to continue work on Pelican, a radiation-tolerant computation storage device. This storage device provides high-capacity solid state storage through the use of 3D-NAND technology and a custom flash-controller implementation. Pelican is designed from the ground up to mitigate the adverse effects of radiation while providing high performance with low Size, Weight, and Power (SWaP). In addition, Pelican provides onboard compute resources with both general purpose and AI-enabled processors attached to the flash memory to accelerate IO intensive workloads by co-locating them with the storage. This allows for the generation of data products on the storage device itself, reducing processing time and effectively increasing the bandwidth between Pelican and a host device. The complete storage device simplifies integration by using the industry standard form factor, PC104. The primary data interface is Non-volatile Memory Express (NVMe) protocol over a Peripheral Component Interconnect Express (PCIe) Interface, though it will be possible to customize this as needed. Storage capacity in the first version will be at least 2 TB of usable space. This is not raw capacity, but instead accounts for the redundancy and over-provisioning required to meet reliability requirements. Future versions of the product will increase the capacity to 6 TB and beyond. Sequential reads and write speeds support modern Earth observation workloads with 2,000 and 1,000 MB/s respectively.

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

The improved data storage capability that Pelican will offer will benefit various NASA programs by providing high performance, highly reliable data storage and facilitating onboard data analysis with minimal size, weight, and power

Examples of relevant applications include:

• science missions, particularly those requiring capturing and managing large amount of data

• facilitating onboard AI/ML processing.

• rendezvous and proximity operations.

• terrain relative navigation.

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

Zephyr has conducted extensive discussions with potential clients and industry experts. Relevant commercial applications include:

• Data storage for Earth observation constellations.

• Onboard processing for synthetic aperture RADAR and hyperspectral imaging.

• Payload controller - command and data handling system.

• Filesystem storage for flight and payload computers.

Duration: **18**

PROPOSAL NUMBER: 22-2- **Z2.02-2344**

PHASE 1 CONTRACT NUMBER: 80NSSC22PB068

SUBTOPIC TITLE: High-Performance Space Computing Technology

PROPOSAL TITLE: High Multi-Speed Time-Triggered Ethernet

Small Business Concern

Firm: **Lewiz Communications, Inc.**
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Principal Investigator:

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Summary Details:

Estimated Technology Readiness Level (TRL) :

Begin: 1
End: 6
Technical Abstract (Limit 2000 characters, approximately 200 words):

LeWiz Phase 1 research showed strong needs for US based time-triggered Ethernet (TTE) solutions for use by US agencies and their contractors. TTE is an SAE AS6802 standard for aerospace applications. Current market leader is an Austrian company. NASA used 1Gbps foreign solution in Artemis projects and called for TTE development by US companies in its 2022 SBIR Z2.02 topic. The US Navy also has requested for US based TTE solution. In NASA Phase 1, we developed a TTE IP core - scalable to speed up to 100Gbps. We also developed a working relationship with NASA to do joint testing for potential use in the Artemis program. LeWiz also worked with the US Navy to develop low-end IP core to target endpoint ASIC devices – specifically for slower sensors and other end systems. In NASA Phase 2, we propose to further develop the hardware and software to target high performance TTE switching systems suitable for backbone network and others. LeWiz's works with NASA and the Navy will produce a comprehensive solution for both endpoint and switching applications. By working with actual end-user experts from Artemis Program, LeWiz products will meet requirements for space travel including radiation hardened and fault tolerant capabilities - more suitable for commercialization to the Navy and others for hypersonic and aerospace applications.
Proposed Phase 2 TTE switch would support 1G to 10Gbps, scalable in port count with speed up to 100Gbps - allowing us to quickly create a family of products to meet different customer requirements. Products achieved extremely high accuracy timing rate, designed for low-latency, support priority-based, mixed traffic: PCF, TT, RC, BE; Arinc664p7 compatible, interface to copper or fiber, support high end/rugged OpenVPX or low-end/low-cost form factors. In addition, Phase 2 will also develop application software and easy to use tool for designing TT network. Also validate them with the developed hardware.

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

NASA applications: sensors and backbone on-board networks for flight control, landing control, instrumentations, payloads, navigation systems, networking, scientific processing, image processing, communication sub-systems for satellites, space stations, vehicles, space habitats. NASA is the leader in using TT Ethernet. NASA JSC has approved and provided equipment for testing LeWiz implementation with NASA equipment for potential deployment to the Artemis program - further strengthen this implementation for use by Navy and others

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

Non-NASA applications: sensors and on-board networks for flight control, landing control, instrumentations, payloads, navigation systems, networking, image processing, communication sub-systems for satellites, space stations, air/space/ground/sea vehicles, hypersonic/weapon systems. TTE used in wind turbine, commercial aircrafts, Army copters. We also worked with US Navy targeting TTE endpoint.

Duration: **24**

PROPOSAL NUMBER:	22-2- **Z8.13-1205**
PHASE 1 CONTRACT NUMBER:	80NSSC22PB005
SUBTOPIC TITLE:	Space Debris Prevention for Small Spacecraft
PROPOSAL TITLE:	Quick Turn Pulsed Plasma Thruster (QT-PPT) for Deorbiting Applications

Small Business Concern

Firm: **CU Aerospace, LLC**
Address: **3001 Newmark Drive, Champaign, IL 61822**
Phone: **(217) 239-1703**

Principal Investigator:

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Business Official:

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Summary Details:

Estimated Technology Readiness Level (TRL) :

Begin: 5
End: 6

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

CU Aerospace (CUA) proposes the further development of the Quick Turn Pulsed Plasma Thruster (QT-PPT) in configurations up to 3200s specific impulse that will provide CubeSat deorbit capability at end-of-life for LEO missions. While classic PPT technology is mature, it has historically been limited by its size and propellant load. CUA developed the Fiber-fed PPT (FPPT) and developed miniaturized electronics subsystems including life-tested high-density energy storage via MLCC capacitors, low-erosion discharge geometry, negligible-erosion

regenerative carbon igniters, compact power electronics, electromagnetic thrust vectoring, and high-performance filament feed of non-toxic solid Teflon propellant. QT-PPT Phase I sought to further the miniaturization and simplification of the subsystems – specifically energy storage and fuel feed. In this Phase II, CUA will leverage the prior work to build a QT-PPT system with lower size, weight, power, and cost (SWaP-C). The entire system including the PPU is tightly integrated onto a stack of PCBs approximately 0.5U in size, which offloads most of the manufacturing and quality control to the specialized PCB manufacturer, and enables the “Quick Turn” PPT system integrated by CUA. Recent FCC deorbit rule changes require more total impulse than was anticipated at the onset of Phase I, but QT-PPT with a fiber feed system can achieve a full 2000 km deorbit for a 12 kg spacecraft from a 0.7U thruster. The total impulse can be varied via fuel loading and capacitor energy selection, and thrust vectoring is also an option. For comparison, the baseline 0.5U configuration is estimated to have a specific impulse of 1400s and a total impulse of 1700N-s, enough to lower a 5.5 kg CubeSat from 1000 km to 400 km. CUA’s long-term goal will be to establish the QT-PPT as a mature integrated system solution with standard lead times under 6 weeks. One flight-like QT-PPT will be delivered to NASA at the end of the Phase II program.

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

The practice of Responsible Space and deorbit capability of LEO satellites is critical for the prevention of an escalation of space debris. Deorbit from up to 2000 km is possible at end-of-life with only power and attitude determination available from a CubeSat to guide the thrust-vectored propulsion system (no reaction wheels or magnetorquers required). Unlike drag-based deorbit systems, QT-PPT also provides an “as needed” collision avoidance option for the entire mission.

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

Commercial interest in nano-/small-satellites continues to grow, and it is more important than ever that these satellites have access to a technology for end-of-life deorbiting. The QT-PPT provides a compact, light-weight, non-hazardous, high total impulse propulsion technology solution available in a family of sizes to meet the differing mission needs of users in DOD/industry/academia.

Duration: **24**

PROPOSAL NUMBER: 22-2- **Z10.04-1388**

PHASE 1 CONTRACT NUMBER: 80NSSC22PA919

SUBTOPIC TITLE: Materials, Processes, and Technologies for Advancing In-Space Electric Propulsion Thrusters

PROPOSAL TITLE: High Emissivity Channel Materials

Small Business Concern

Firm: **Advanced Ceramics Manufacturing**
Address: **7800 South Nogales Highway, Tucson, AZ 85756**
Phone: **(520) 547-0850**

Principal Investigator:

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Business Official:

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Summary Details:

Estimated Technology Readiness Level (TRL) :

Begin: 3
End: 7

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

Electric propulsion for space is attractive for NASA, military, and commercial missions. NASA has identified manufacturing issues that have resulted in significant costs to achieve performance repeatability and hardware reliability. To date, these materials have ongoing challenges with performance/hardware reliability related to thermal management. As Hall Effect thruster power is scaled-up for missions with large payloads, thermal management poses a major design challenge for temperature-sensitive areas of the thruster. State-of-the-art Hall-effect thrusters use borosil ceramics for the discharge channel. ACM has identified emissivity modifiers that can be added to conventional channel materials that will create a High Emissivity Borosil (HEB). This will increase the total channel emissivity. Compared to a coating, this method will offer lifetime performance enhancement that will not spall, fail, or outgas due to cyclic power cycles. Our Phase I results improved emissivity by 13%. In Phase II, ACM will scale-up material processing, produce test channels, and conduct thruster testing.

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

The resulting technology will allow more efficient, higher reliability, and longer lifetimes for electric propulsion systems. The technology will find use in NASA Science Mission Directorate (SMD) and Human Exploration and Operations Mission Directorate (HEOMD) and commercial satellites.

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

The new channel materials will find use in commercial satellite propulsion systems used to maintain orbit.

Duration: **24**

PROPOSAL NUMBER: 22-2- **Z12.01-2885**

PHASE 1 CONTRACT NUMBER: 80NSSC22PA955

SUBTOPIC TITLE: Extraction of Oxygen, Metal, and Water from Lunar Regolith

PROPOSAL TITLE: High Purity Oxygen Separation from a Pyrolysis Gas Mixture by Rapid Solid Oxide Ion Transport

Small Business Concern

Firm: **A-Terra, LLC**
Address: **3645 Candlewood Court, Keizer, OR 97303**
Phone: **(541) 602-4153**

Principal Investigator:

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Summary Details:

Estimated Technology Readiness Level (TRL) :

Begin: 4
End: 5

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

With the Artemis program, NASA currently plans to land the first woman and next man on the moon by 2025, using innovative technologies to explore more of the lunar surface than ever

before. The need for oxygen extraction from lunar regolith has been identified by the STMD (Space Technology Mission Directorate). Successful oxygen extraction from the abundant regolith resources would enable extended astronauts' stays and repeated/further travels at substantially lower costs. Such a technology, if successful, is expected to benefit growing aerospace activities from both government agencies and the private sector.

The A-Terra's solid state ion transport vacuum pyrolysis technology is fully renewable-energy based, which empowers rapid production of 99%+ high purity oxygen and metals from the lunar regolith. A-Terra now shifts to Phase II where a bench scale oxygen extraction apparatus will be constructed based on their successful Phase I outcomes. The Phase II system will have the same basic components as the Phase I model, however, it will be tactically redesigned and upgraded to produce the oxygen at a rate of 100 kg/year or higher, assuming approximately 180 days of sun light availability on the moon and no battery utilization is considered for supplemental night operations.

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

The proposed technology is applicable to NASA's lunar and planetary explorations where oxygen supplies are critical for life support and propellant needs to enable extended astronauts stays and repeated/further travels from the moon (Artemis program).

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

The target markets for the proposed technology would be aerospace (private industries) and resource industries (mining, suppliers, utilization, smelting, etc.). The proposed technology is renewable energy based and expected to 'cleanly' produce high purity metals such as silicon as byproduct at competitive costs.

Duration: **24**

PROPOSAL NUMBER: 22-2- **Z14.02-2040**

PHASE 1 CONTRACT NUMBER: 80NSSC22PB077

SUBTOPIC TITLE: Extraterrestrial Surface Construction

PROPOSAL TITLE: Ultra-Electrical-Efficient Process to Perform Regolith Additive Manufacturing of Complex Structures

Small Business Concern

Firm: **Lunar Resources, Inc.**
Address: **6721 Portwest Drive, Houston, TX 77024**
Phone: **(646) 455-8382**

Principal Investigator:

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Summary Details:

Estimated Technology Readiness Level (TRL) :

Begin: 5
End: 6
Technical Abstract (Limit 2000 characters, approximately 200 words):

Lunar Resources, an American pioneering space industrial company proposes to NASA the maturation of the Pulsed Electrical Discharge Additive Manufacturing Lunar Surface Construction system (PE3D-LSC). A novel additive manufacturing system optimized for lunar regolith and the lunar environment. The technology does not use binders or reagents to additively manufacture unadulterated regolith and is highly power efficient. During the Phase I effort, the technology was shown to successfully melt lunar regolith in air and vacuum with a quarter of the power required by state-of-the-art laser systems. In addition, a unique regolith feed system was also successfully tested to be able to feed the PE3D-LSC with regolith without mechanical mechanisms. During the Phase II effort, the PE3D-LSC will be advanced, with a focus on reducing power input and increasing quality of regolith additive manufacturing parts/structured in vacuum to enable the additive manufacture of lunar structures from regolith in geometries and complexity not before possible on the Moon.

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

The PE3D-LSC will support NASA and private sector goals of producing in-situ infrastructure on the lunar surface. Key applications include the additive manufacturing of lunar regolith to produce vertical and horizontal structures (landing pads, unpressurized facilities, roads, habitats, pressurized facilities), in-situ photovoltaic substrates, structural elements, concave or parabolic functional structures, radiation shields, and other structures on the Moon.

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

The PE3D-LSC will support the private sector in constructing and maintaining lunar surface infrastructures such as landing pads, roads, and buildings. It can also be utilized to produce structural elements which can be launched off the Moon and assembled in Cislunar. And the technology can perform additive manufacturing of new high-temperature materials on Earth.

Duration: **24**

PHASE 1 CONTRACT NUMBER: 80NSSC22PA931

SUBTOPIC TITLE: Landing Systems Technologies

PROPOSAL TITLE: Wall Shear Measurement Technology for Plume Surface Interactions

Small Business Concern

Firm: **Ahmic Aerospace**
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Phone: **(937) 272-5880**

Principal Investigator:

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Business Official:

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Summary Details:

Estimated Technology Readiness Level (TRL) :

Begin: 4
End: 6

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

Exploration of the Moon, or Mars, will require the development of landing vehicles, whose primary task is to decelerate its cargo and safely touch down on the surface. However, this is not a trivial task for these types of environments. As the jet/plume from the rocket engine, used to decelerate the vehicle, encounters the surface, the low atmospheric pressure, low gravity, and cohesive soil properties result in large dust clouds and even crater formation. These phenomena are called plume surface interactions (PSI). Incremental progress is being made to study PSI through a series of proposed test campaigns being conducted at multiple NASA Research Centers and utilizing large vacuum chamber facilities, such as the MSFC TS300 or LARC 60' Sphere, and tested under relevant conditions. One critical instrumentation need that NASA has identified is direct surface (wall) shear stress measurements. In the Lunar environment, surface shear stress is the primary driving force by which surface erosion occurs. To overcome this

technology gap, Ahmic and our assembled team propose to adapt our state-of-the-art wall shear measurement technology to target surface erosion environments occurring in plume surface interactions.

In Phase II, Ahmic will develop two wall shear sensor capabilities. The first will target wall shear measurements at the extremely high temperatures produced in rocket plumes – exceeding 2000 K. The second will target wall shear measurements at the extremely low magnitudes produced in simulated Lunar and Martian environments where the ambient pressure is a low vacuum. The sensors will then be validated in clean-flow wind tunnel facilities before being tested in jet/plume impingement environments, including hot-flow and vacuum facilities. In addition, the sensors will also be used to expand a test methodology of reducing active surface erosion testing to a series of discrete static-surface contour geometries to be instrumented and tested in a PSI environment.

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

The proposed wall shear diagnostic techniques present a direct solution for NASA's PSI ground testing needs. As part of the recent project focused on advancing modeling and simulation capabilities, PSI validation data was acquired in a campaign known as the Physics Focused Ground Test (PFGT). Much of this initial work was carried out in NASA's Marshall Space Flight Center (MSFC) in the Test Stand 300. Ongoing test campaigns similar to this would directly benefit from Ahmic's proposed instrumentation and methodology.

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

The Air Force and SpaceX represent non-NASA markets for the proposed diagnostic techniques. These entities are currently investigating the technical feasibility of using rockets for point-to-point transport of high-value cargoes to remote landing sites. To do this safely will require knowledge of PSI, viscous erosion physics, and how the granular particles will be ejected from the surface.

Duration: **24**

PROPOSAL NUMBER: 22-2- **Z4.07-2655**

PHASE 1 CONTRACT NUMBER: 80NSSC22PA968

SUBTOPIC TITLE: Advanced Materials and Manufacturing for In-Space Operations

PROPOSAL TITLE: Solar On-Orbit Welder for Assembly, Repair, and Manufacturing

Small Business Concern

Firm: **Blueshift, LLC**
Address: **575 Burbank Street, Unit G, Broomfield, CO 80020**
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Principal Investigator:

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Business Official:

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Summary Details:

Estimated Technology Readiness Level (TRL) :

Begin: 4
End: 5

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

Outward Technologies proposes to continue development of a Solar On-Orbit Welder for Repair, Assembly, and Manufacturing (SO-WARM) to enable In-Space Servicing, Assembly, and Manufacturing (ISAM) for commercial satellites, robotic science, and human exploration. This innovative technology utilizes concentrated solar energy as the primary heat source for welding and joining materials in space. Through continued development, SO-WARM may be used to assemble structures in space, thereby enabling the fabrication of crewed habitats, space telescopes, antennas, and solar array reflectors which are not possible with current technology due to their large size or due to their designs being unable to withstand vibrational loads during launch. Repair of these structures also becomes possible with SO-WARM to mitigate potential damage to structures caused from micrometeorites or orbital debris. These enabling capabilities are made possible through a lightweight, versatile design with significantly reduced electrical power requirements as compared to electron beam, electric arc, or laser power sources. SO-WARM relies on direct solar-thermal heating of materials to weld metals including titanium and aluminum, and join non-metal materials such as PEEK thermoplastic. By relying on the abundant power of the sun, SO-WARM is lightweight, scalable, and versatile to fit the near- and far-term needs of the evolving ISAM market.

Results in Phase I showed feasibility of the concept through a low fidelity prototype demonstrating the ability to weld titanium, aluminum, and PEEK. The proposed Phase II will target the design and fabrication of a medium-fidelity SO-WARM system prototype and demonstrating overall performance in a relevant vacuum and microgravity environment, thereby progressing the technology from TRL 4 to 5. These steps are critical for advancing the innovative SO-WARM technology and addressing the growing needs of governments and private companies for ISAM products and services.

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

Potential NASA applications include welding, joining, and repair of structures in space. These enabling capabilities target NASA TX12.4: Manufacturing and TX12.4.1 Manufacturing Processes for in-space fabrication, assembly, and repair. Secondary applications include TX13.2 Test and Qualification through a solar welding testbed on the ISS. SO-WARM may be incorporated into NASA in-space construction efforts such as OSAM-1, OSAM-2, and the lunar Gateway. It can also be used as a free-flying module servicing satellites and structures on-orbit.

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

The SO-WARM technology addresses current and future needs by the DoD and other federal agencies seeking ISAM services and products. Commercial satellites may also be serviced, assembled, and/or repaired using the SO-WARM system and methods. Disassembly of structures in space also becomes possible through solar-thermal melting and vaporization of metals and non-metal materials up to 2,300 C.

Duration: **24**

PROPOSAL NUMBER:	22-2- **Z12.01-1662**
PHASE 1 CONTRACT NUMBER:	80NSSC22PB037
SUBTOPIC TITLE:	Extraction of Oxygen, Metal, and Water from Lunar Regolith
PROPOSAL TITLE:	Pyrometer for Regolith-Extracted Oxygen

Small Business Concern

Firm: **Hedgefog Research, Inc.**
Address: **1891 North Gaffey Street, Suite 224, San Pedro, CA 90731**
Phone: **(310) 935-2206**

Principal Investigator:

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Business Official:

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Phone: **(310) 935-2206**

Summary Details:

Estimated Technology Readiness Level (TRL) :

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

Hedgefog Research Inc. (HFR) is developing a multicolor Pyrometer for Regolith-extracted Oxygen (PyRO) for use in foundries designed to extract oxygen from lunar regolith on the surface of the Moon. The flexible design of the sensor allows for accurate temperature determination for systems with well-known emissivity values as well as accurate high-temperature measurement for systems in which the temperature- and wavelength-dependent emissivities are unknown. Crucially for this application, the sensor will be constructed to operate in a dust-proof, non-outgassing package under significant radiant heating loads and a highly corrosive environment without polluting extracted oxygen/water/metals. While optimized for several methods of resource extraction from lunar highland regolith, PyRO is adaptable for non-contact temperature measurement of any practical system. The vacuum-compatible design and low size, weight and power requirements will allow for a portable version to be developed for use by human or robotic settlers beyond Earth. In Phase I, HFR built a PyRO prototype, evaluated its performance in non-contact temperature measurement, and down-selected key components and enabling technologies for future development. We have also produced a preliminary design for the fully-packaged PyRO prototype optimized for temperature stability, corrosion resistance, and lunar deployment that will be constructed during the Phase II effort.

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

Accurate non-contact temperature measurement is a ubiquitous requirement in all types of material processing. Any long-term extraterrestrial human settlement must necessarily have well-developed facilities for in-situ resource utilization. Optimizing these utilization processes requires careful control of all experimental parameters, including temperature. In addition, a compact, extremely rugged non-contact temperature sensor will find use in non-destructive component inspection and performance evaluation for high temperature devices.

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

A pyrometer optimized for operation in vacuum and under harsh process conditions will find use in an array of material processing and laboratory environments requiring non-contact high temperature measurements. Commercially available pyrometers are tailored for chosen industrial processes. The flexibility and process tolerance of PyRO will make it an attractive commercial technology.

Duration: **24**

PROPOSAL NUMBER: 22-2- **Z5.04-2604**

PHASE 1 CONTRACT NUMBER: 80NSSC22PB156

SUBTOPIC TITLE: Intravehicular Robot (IVR) Technologies

PROPOSAL TITLE: An Affordance Driven, Human-in-the-Loop Perception Framework

Small Business Concern

Firm: **PickNik, Inc.**

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Phone: **(720) 513-2221**

Principal Investigator:

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Business Official:

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Summary Details:

Estimated Technology Readiness Level (TRL) :

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

Despite continued advances in robotics, it has been difficult to deploy robots for non-trivial tasks in unstructured environments in a fully autonomous way. As a result, for such tasks there is often a human in the loop to create supervised autonomy. We are proposing to develop a flexible software-based solution that enables operators to easily command robots by leveraging more computer vision. The key innovation of this proposal is to connect a perception pipeline that recognizes instances of known classes of objects with affordances: a description of how an object should be inspected or manipulated. For example, given a depth image of a scene, the system will recognize a hatch door handle and its hinge and annotate the scene to automatically inform the user how a robot could open the hatch. The user can then confirm the desired action to have a robot open the hatch door autonomously. The proposed work will result in a software tool that enables the training of perception pipelines using domain randomization. The perception capabilities will be demonstrated in inspection and manipulation tasks that are relevant to IVR scenarios such as inspection of hatch seals, and manipulation of buttons, switches, and handrails. Experiments will be performed in simulation and on hardware using a UR5e and the Astrobee platform.

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

The initial focus is on enabling higher levels of autonomy for IVA such as inspection, cargo unloading and science experiment tending. The technology may also be applicable to EVA and ISAM-related robotic activities. In the long run, we also envision applications in, e.g., construction and assembly on the moon and other planets.

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

The same applications that are of interest to NASA are also of interest to the rapidly expanding commercial space industry. Terrestrial applications that are enabled by the proposed work include inspection and maintenance of industrial sites and offshore platforms.

Duration: **18**

PROPOSAL NUMBER: 22-2- **Z8.02-2283**

PHASE 1 CONTRACT NUMBER: 80NSSC22PA983

SUBTOPIC TITLE: Communications and Navigation for Distributed Small Spacecraft Beyond Low Earth Orbit (LEO)

PROPOSAL TITLE: Lunar Inter-Spacecraft Optical Communicator

Small Business Concern

Firm: **Chascii, Inc.**
Address: **1879 East Altadena Drive, Altadena, CA 91001**
Phone: **(626) 590-4268**

Principal Investigator:

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Summary Details:

Estimated Technology Readiness Level (TRL) :

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

Based on our successful Phase 1 studies, we are proposing the construction and fully testing of an inter-spacecraft omnidirectional optical communicator (ISOC) that will provide fast connectivity and navigation information to small spacecraft forming a swarm or a constellation in cislunar space. The ISOC proposed for cislunar applications operates at 1550 nm, employs a dodecahedron body holding 6 optical telescopes and 20 external arrays of detectors for angle-of-arrival determination. The proposed ISOC will provide full sky (4π steradian) coverage and gigabit connectivity among smallsats forming a swarm or constellation. It will also provide continuous positional information among these spacecraft including bearing, elevation, and range. We also expect the ISOC to provide fast low-latency connectivity to assets on the surface of the moon such as landers, rovers, instruments, and astronauts. During Phase 2 we propose to build and fully-test a lunar ISOC including all its transceivers, optics and processing units. We will also perform outdoor testing of the resulting ISOC to verify its key capabilities. We believe the ISOC, once fully developed, will provide commercial, high data rate connectivity to future scientific, military, and commercial missions around cislunar space and beyond.

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

The proposed ISOC will allow unparalleled ultrafast wireless data transfer for many space applications. NASA applications include short range inter satellite communications such as formation flying and constellations of spacecraft (e.g., LunaNet). It should also provide fast connectivity to landers, rovers, instruments and astronauts.

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

Commercial development of space is imminent. A key opportunity is to use space to provide internet services across the globe. There are 7.9B people on Earth from which 3.7B (47%) have no internet access. We believe that, once fully developed, the ISOC should be able to provide a viable solution to the global connectivity market.
Duration: **24**

PROPOSAL NUMBER: 22-2- **Z2.01-1749**

PHASE 1 CONTRACT NUMBER: 80NSSC22PA924

SUBTOPIC TITLE: Spacecraft Thermal Management

PROPOSAL TITLE: Hot End Thermal Management System for Nuclear Electric Propulsion

Small Business Concern

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

Principal Investigator:

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Business Official:

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Summary Details:

Estimated Technology Readiness Level (TRL) :

Begin: 4
End: 5

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

Nuclear electric propulsion systems provide a variety of benefits including increased science payload, reduced flight times and longer mission lifetimes. These advantages enable a wide range of missions such as manned missions to Mars, unmanned missions to the outer planets and deep-space. The thermal management system linking the reactor to the hot end of the power conversion system must be efficient, lightweight and reliable. These requirements become more challenging as the total power scales to the megawatt level. The Phase I program included successful demonstration of high-power heat pipes and the development of a reactor design.

In this Phase II SBIR program, Advanced Cooling Technologies will lead the development and maturation of a highly reliable, efficient, and lightweight heat pipe-based thermal management system for the hot end of the power generation system for nuclear electric propulsion. High-power heat pipes will be used be used to transport thermal energy, at the megawatt scale, to the hot end of the power conversion unit. The proposed system is passive and highly reliable with built-in redundancy.

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

The thermal management technology proposed here is relevant to several areas of NASA's Technology Roadmap, including "Power for In-Space Propulsion", "Fission Space Power and Energy Storage" and "Heat Transport for Thermal Control Systems". The system will benefit many space-based fission power systems such as nuclear electric propulsion and power generation on the lunar and Martian surface.

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

The proposed system is capable of transporting a significant amount of thermal energy from a nuclear reactor to a power conversion system. In addition to space-based applications, the thermal management system is relevant to small modular and micro nuclear reactors. Small reactors have several advantages including reduced capital investment, reduced construction time and scalability.

Duration: **24**

PROPOSAL NUMBER: 22-2- **Z7.03-2439**

PHASE 1 CONTRACT NUMBER: 80NSSC22PB136

SUBTOPIC TITLE: Entry and Descent System Technologies

PROPOSAL TITLE: GasPak: A High Output, Clean Gas Generator for Large Volume Deployable Aerodynamic Decelerators

Small Business Concern

Firm: **Outpost Technologies Corporation**
Address: **1601 Colorado Avenue, Santa Monica, CA 90404**
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Principal Investigator:

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Business Official:

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Summary Details:

Estimated Technology Readiness Level (TRL) :

Begin: 4
End: 7
Technical Abstract (Limit 2000 characters, approximately 200 words):

A large majority of commercial and NASA spacecraft mission types would benefit from the ability to have deployable aerodynamic decelerators. Beneficial applications include spacecraft returning to Earth from low Earth orbit, exploring other planetary bodies (e.g. descent to Mars, Venus, and Titan), and reducing the cost of access to space by enabling the recovery of launch vehicle assets.

Current deployable aerodynamic decelerators are constrained by existing blowdown system limitations including mass efficiency, and long term storage of high pressure gas. Hydrogen, while an ideal candidate for its storage capacity, has high leak rates when considering long duration missions and transits. Gas generators provide a solution that has a higher density than cryogenic liquid hydrogen, however, these hydrogen generators are yet to be a space qualified technology.

In this effort, Outpost Technologies Corporation (Outpost) will develop GasPak which is a low mass and clean gas generator that will be used for hypersonic inflatables on space missions. In order to achieve this goal Outpost will leverage its relationship with Dutch company TNO to procure commercial off the shelf nitrogen gas generators, building on our Phase I feasibility study to create a benchtop prototype. By the end of Phase II, the gas generator will reach TRL-8 by being demonstrated on an orbital Outpost mission with Earth return.

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

The primary NASA application will be Hypersonic Inflatable Aerodynamic Decelerators (HIADs) as planned for use on missions to planets and moons with atmospheres as well as returning payloads to Earth. Additionally, GasPak may be used in substitution for other single use pressurant systems such as deployment of spacecraft components and planetary landing impact suppression.

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

Outpost will use the GasPak technology in its own reusable satellites to deploy the heat shield for re-entry. Commercially, Outpost is enabling a new means of Earth return that allows satellites to be brought back to Earth and refurbished for future missions. Outpost also intends to sell the GasPak as a COTS component to the aerospace industry.

Duration: **24**

PROPOSAL NUMBER: 22-2- **Z7.01-1480**

PHASE 1 CONTRACT NUMBER: 80NSSC22PB109

SUBTOPIC TITLE: Entry, Descent, and Landing Flight Sensors and Instrumentation

PROPOSAL TITLE: Ultra-Wide Bandwidth, Nanomembrane-Based Pressure Transducers for Entry, Descent, and Landing Applications

Small Business Concern

Firm: **Nanosonic, Inc.**
Address: **158 Wheatland Drive, Pembroke, VA 24136**
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Principal Investigator:

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Business Official:

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Summary Details:

Estimated Technology Readiness Level (TRL) :

Begin: 4
End: 6

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

This NASA Phase II SBIR program would develop ultra-wide bandwidth, nanomembrane based pressure transducers for entry, descent and landing applications, using silicon-on-insulator nanomembrane techniques in combination with nanocomposite materials. The team has developed a wide bandwidth pressure transducer with a bandwidth from DC to 5MHz and has demonstrated these transducers in subsonic, transonic and hypersonic wind tunnels and shock tubes in both university and government facilities. Through this NASA program, the team will develop an improved mechanical and electrical model of semiconductor nanomembrane based sensor performance that will allow quantitative optimization of material properties and suggest optimal methods for sensor packaging and use for in-situ entry, descent and landing applications. The team will fabricate hermetically sealed sensors and internal electronics using optimized materials. Support electronics will be developed to acquire, multiplex, store and process raw sensor array data needed for near real-time entry, decent and landing aerostructure control. The team will also investigate how this normal pressure sensing technology could be extended to create shear stress sensors for entry, descent and landing applications.

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

The proposed ultra-wide bandwidth pressure transducers can be used in the entry, descent, and landing applications. Currently, there is no commercially available pressure sensor that meets engineering requirements for such missions. The team will transition the ultra-wide bandwidth pressure transducers from the prototype stage to gauge products of use for the entry, descent, and landing applications.

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

Primary customers will be university, government laboratory and industry researchers. Customers for ultra-wide bandwidth pressure transducers will be the high-speed vehicle and flight control system designers and manufacturers. Broader commercial sensor opportunities including oil and gas down-hole measurements may be also pursued.
Duration: **24**

PROPOSAL NUMBER: 22-2- **Z10.04-1751**

PHASE 1 CONTRACT NUMBER: 80NSSC22PA923

SUBTOPIC TITLE: Materials, Processes, and Technologies for Advancing In-Space Electric Propulsion Thrusters

PROPOSAL TITLE: Passive Two-Phase Thermal Management System for Hall Thruster

Small Business Concern

Firm: **Advanced Cooling Technologies, Inc.**
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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 lightweight, compact, and highly effective passive two-phase thermal management system (TMS) for extremely high power-density commercial magnetically-shielded Hall thrusters, aiming to enable NASA for its future cislunar and deep space missions. In Phase I, ACT performed a comprehensive heat pipe design trade study and developed two unique three-dimensional alkali metal heat pipe prototypes for 20 kW H9 Hall thrusters. Both heat pipe prototypes outperform the heat transfer requirement obtained in finite-element simulations by up to five times and can operate in any orientation irrespective of the presence or absence of electromagnetic fields. Passive two-phase HPs are integrated with a small hot radiator, being in radiative heat transfer with downstream while a relatively larger cold radiator attached to the back of the H9 Hall thruster, protects the temperature-sensitive components from overheating. Based on FEA, ACT's innovative passive two-phase TMS could decrease traditional cold radiator of a 20 kW H9 thruster by up to 40% in size and 1 kg in mass. In Phase II, followed by continuing to further optimize and mature the passive two-phase TMS, ACT will integrate its passive two-phase TMS on UMich. H9 Hall thrusters and experimentally measure thrust, efficiency, specific impulse, current oscillation etc. inside a large vacuum chamber. The final deliverable will be a passive two-phase TMS, consisting of down-selected heat pipes, hot and cold radiators.

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

The proposed passive two-phase thermal management system cooling system can effectively remove the waste heat from Hall thrusters to the heat sink. This will allow stability for a long-duration flight operation of high power-density Hall thruster in space. Many NASA programs will be benefited, including deep space Psyche, cis-lunar Gateway, electric propulsion to Mars and Planetary habitat, etc.

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

High power-density Hall thrusters will be a game-changer in the future spaceflight market. The "plug-and-play" components developed under this program, are adaptable for many commercial Hall thrusters serving in telecommunication and defense applications. SpaceX, Busek, Aerojet Rocketdyne, etc. will be potential customers of this ACT's passive two-phase thermal management technology.

Duration: **24**

PROPOSAL NUMBER: 22-2- **S16.04-1968**

PHASE 1 CONTRACT NUMBER: 80NSSC22PB012

SUBTOPIC TITLE: Unpiloted Aerial Platforms and Technologies for NASA Science Missions

PROPOSAL TITLE: Integrated Flight Validation of HALE UAP Avionics & Propulsion Systems for Science Missions

Small Business Concern

Firm: **Electra Aero, Inc.**
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Summary Details:

Estimated Technology Readiness Level (TRL) :

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

Electra, in conjunction with MIT and Harvard, has over the last two years been developing a stratospheric airborne climate observatory system (SACOS) based on solar-powered HALE UAPs for a variety of stratospheric climate science missions such as in situ measurements of atmospheric chemistry, radar surveys of ice sheets, and storm monitoring. In summer 2022, Electra built and successfully flew a 90-ft wingspan solar-electric HALE UAP tech demonstrator at the Manassas Regional Airport in Virginia; going from concept to first flight in less than five months. This tech demo is designed for an ice sheet radar survey science mission supported by Harvard University. The NASA SBIR Phase I effort advanced the conceptual design and avionics and propulsion system concepts; it also provided substantial stakeholder engagement opportunities for such science missions across NASA and other government agencies. This Phase II proposal consists of further avionics and propulsion system maturation followed by flight validation on a surrogate subscale platform. Once this has been done, Electra will integrate the systems onto its full-scale HALE UAP (which achieved first flight last summer, with simpler hobby-grade avionics) to execute flight validation on the large vehicle at low altitudes and eventually to include a stratospheric validation. A future Phase III will then consist of the development and delivery of the full HALE UAP capability objective vehicle to NASA.

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

Numerous climate science related missions identified by stakeholder engagements with the NASA Airborne Science Program (Matt Fladeland), Cryospheric Science Program (Thorsten Markus), and NASA Goddard (Dave Harding).

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

Science Missions: High Latitude Ice Observations (Antarctic Ice Shelf Collapse Forecasting, Greenland Glacier Flow Prediction), Direct Stratospheric Sampling (Sampling of Stratospheric Aerosols, In-situ Measurement of Storm Driven Stratospheric Chemistry), Drought, Wildfire, and Flood Monitoring (Coastal Flood Monitoring, Drought and Wildfire Prediction), Oceanic Surface and Cyclone Monitoring.

Duration: **12**

PROPOSAL NUMBER: 22-2- **S12.04-2190**

PHASE 1 CONTRACT NUMBER: 80NSSC22PB131

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

PROPOSAL TITLE: Wide Range Interferometric Probe

Small Business Concern

Firm: **OptiPro Systems, LLC**
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Principal Investigator:

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Summary Details:

Estimated Technology Readiness Level (TRL) :

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

From flagship observatories to small earth-observation satellites, many NASA missions require high performance optical components that are also cost-effective to manufacture and launch. Freeform optical components can reduce a telescope's size and weight (reducing launch costs) but are challenging to test and validate with traditional metrology tools due to their lack of symmetry and large changes in curvature (increasing manufacturing costs). Improved metrology systems for freeform optics have potential to improve performance and reduce manufacturing costs by avoiding prescription-specific null correctors or holograms. Metrology systems for freeform optics require a challenging combination of capabilities: high-resolution (ideally sub-nanometer) measurement of large deviations from a planar surface and steep surface slope. At OptiPro Systems, we have recently developed (in part through NASA SBIR projects) an interferometric probe capable of sub-nanometer metrology of optical surfaces, which is essential for precision optical components such as telescope mirrors. In Phase I, we designed probes capable of measuring large surface sag and steep surface slope, which would allow direct application of these probes to freeform optics.

We propose constructing, testing, and calibrating new prototype interferometric probes that will enable cost-effective metrology of freeform optics. These probes have long measurement range and wide acceptance angle while maintaining sub-nanometer performance. Using the results of our Phase I, we have completed a major redesign of the probe optical system. The Phase II project aims to finalize the optical design; construct, align, and calibrate these probes; and deliver a report detailing the prototype probes' performance and their potential use in metrology of high-performance freeform optics.
Potential NASA Applications (Limit 1500 characters, approximately 150 words):

Potential NASA applications include metrology of freeform and other optical components for NASA missions, including flagship/decadal missions, small satellites, and everything between. Some specific applications:

- Origins Space Telescope (OST) and Large UV/Optical/IR Surveyor (LUVOIR), which may use freeform optics.
- Lynx, Advanced X-ray Imaging Satellite (AXIS), and other X-ray telescopes.
- Large telescope mirrors, such as those for the Habitable Exoplanet Observatory (HabEx), OST, and LUVOIR, requiring sub-nanometer metrology.

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

The proposed metrology probe would benefit many applications, including:

- Metrology of high-precision optical components for commercial products
- Metrology of x-ray and neutron mirrors (Department of Energy)
- Vibration analysis of mechanical components and machines

Duration: **24**

PROPOSAL NUMBER: 22-2- **S13.05-1169**

PHASE 1 CONTRACT NUMBER: 80NSSC22PB065

SUBTOPIC TITLE: In Situ Instruments/Technologies for Lunar and Planetary Science

PROPOSAL TITLE: Automated Recovery and Isolation of Extraterrestrial Lipids (ARIEL)

Small Business Concern

Firm: **Leiden Measurement Technology, LLC**
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Phone: **(408) 351-6720**

Principal Investigator:

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Phone: **(510) 301-8980**

Summary Details:

Estimated Technology Readiness Level (TRL) :

Begin: 3
End: 4

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

LMT proposes to design an instrument for the Automated Recovery and Isolation of Extraterrestrial Lipids (ARIEL) instrument. ARIEL is a sample processing module that can isolate and concentrate fatty acids and amino acids from complex sample matrices (solid, liquid or mixed-phase). It provides concentrated samples cleaned of mineral grains, dissolved ions, and other non-target molecules to enhance detection limits, speciation, and avoids sample degradation during pyrolysis (or other) steps that analytical instruments may employ. ARIEL uses a combination of low-temperature ultrasonic assisted extraction (UAE), solid phase extraction SPE and novel engineering to outperform other sample processing instruments that otherwise expose the analytes to high-temperatures and pressures; are not compatible with organic solvents; only extract medium- and long-chain fatty acids; fail to isolate amino acids, and/or cannot process solid samples. ARIEL overcomes those challenges by operating as follows: a sample is first processed by two sequential ultrasonically-assisted solvent extractions with solvents chosen to target different analytes: (1) amino acids and short-chain fatty acids and (2) medium- and large-chain fatty acids. For each extraction step, the solvent and extracted analytes are filter-separated from the solids and passed through SPE columns that isolate and concentrate: (1) amino acids and short-chain fatty acids; and (2) medium- and large-chain fatty acids. Separate elution steps will be carried out on each column so that ARIEL will output concentrated (and de-salted) samples ready for analysis.

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

NASA has had a long-standing goal of detecting organic molecules throughout the universe. This knowledge provides information about chemical mixing (mainly from small bodies), sheds light on geochemical processes that occur on surfaces, and can provide evidence for extraterrestrial life. More specifically, NASA is interested in detecting amino and fatty acids which are in relatively low abundance. The ARIEL instrument both isolates and concentrates these molecules, thus boosting the detection limits of pre-existing analytical instrumentation.

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

Non-NASA applications of the ARIEL include research facilities that need an automated system for isolating amino and fatty acids. While there are a few processors on the market none have the properties of ARIEL. Another application for ARIEL is in the food and beverage industry. Specifically, quality control in the dietary supplement sector that includes fatty acids in various formulations.

Duration: **24**

PROPOSAL NUMBER: 22-2- **S16.06-1952**

PHASE 1 CONTRACT NUMBER: 80NSSC22PB184

SUBTOPIC TITLE: Command, Data Handling, and Electronics

PROPOSAL TITLE: Sigma-Netics Sensor Support Electronics (SN:SSE)

Small Business Concern

Firm: **Sigma-Netics, Inc.**
Address: **2 North Corporate Drive, Riverdale, NJ 07457**
Phone: **(716) 418-4194**

Principal Investigator:

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Phone: **(716) 435-0353**

Business Official:

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Summary Details:

Estimated Technology Readiness Level (TRL) :

Begin: 4
End: 7
Technical Abstract (Limit 2000 characters, approximately 200 words):

We intend on developing a hybrid microchip version of the MEDLI SSE that will meet the requirement of MIL-PRF-38534.

NASA wishes to equip all future planetary missions with a MEDLI like EDL system. Many planetary missions do not have the funding or project timeline to fly an EDL sensor suite similar to the MEDLI and MEDLI2. We will develop a low cost Data Acquisition System that can survive the rigors of space flight and be cost effective to fly on all planetary missions. A fully qualified target cost of less than $1 million is achievable by this approach.

In Phase two we will complete the integration of that base design into a hybrid microcircuit design and perform environmental testing. We will perform day in the life testing to fully demonstrate there is no loss of performance but huge cost and mass savings.
Potential NASA Applications (Limit 1500 characters, approximately 150 words):

This technology would be especially relevant to upcoming Science Mission Directorate (SMD) planetary missions, such as DAVINCI and VERITAS, but low-cost data acquisition systems with these capabilities would also be relevant to the other science lines of business, especially for future cost and volume-constrained and distributed systems missions.
Potential Non-NASA Applications (Limit 1500 characters, approximately 150 words):

Aerojet Rocketdyne, Astrobotic, Astranis, Masten Space Systems, Collins Space Systems, AVS-UK, Busek, Curtis Wright Nuclear, and CERN provide Sigma-Netics real time market intel to availability and opportunity for a product solution like the one proposed here. Success here will translate to higher volume opportunities with private and public companies, not just relevant space agencies.
Duration: **24**

PROPOSAL NUMBER: 22-2- **S17.04-1586**

PHASE 1 CONTRACT NUMBER: 80NSSC22PB029

SUBTOPIC TITLE: Application of Artificial Intelligence for Science Modeling and Instrumentation

PROPOSAL TITLE: Predicting 3D Atmospheric Structure from Geostationary Satellites

Small Business Concern

Firm: **Zeus AI, Inc.**
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Phone: **(978) 314-4847**

Principal Investigator:

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Business Official:

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Phone: **(978) 314-4847**

Summary Details:

Estimated Technology Readiness Level (TRL) :

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

The growing volume and quality of Earth observations offer improvements in data assimilation and weather forecasting that can only be fully realized by advances in AI. 3D atmospheric profiles, including temperature, humidity, and winds, are key missing observables in NASA's Earth Observation System (EOS) and presents large initial condition uncertainties in numerical weather prediction (NWP). Observations from radiosondes and microwave/infrared sounders as well as derived products like atmospheric motion vectors (AMVs) provide key inputs to data assimilation (DA). However, these observations are sparse and the spatio-temporal resolution of modern global DA systems have plateaued largely due to computational requirements. This stands in contrast with advances in artificial intelligence (AI) and computer vision (CV) that enable scalable and data efficient processing with the ability to synthetically generate variables not directly observed. Our work aims to fill EOS gaps and provide an alternative to traditional DA utilizing high-temporal resolution GOES-16/17 geostationary (GEO) satellites operated by NOAA/NASA and radiosonde observations with a probabilistic generative modeling approach. Variational autoencoders (VAEs) are used to independently compress GEO infrared bands and radiosonde profiles into latent representations. This enables us to learn a low-dimensional function between the latent representations to reconstruct temperature and humidity profiles on a pixel-wise basis. Our WindFlow model is applied to track the movement of humidity across sequences of frames to produce wind speed and direction. Lastly, a Neural Ordinary Difference Equation model is used to post-process the derived as a novel approach data-driven DA. The output of this proposal will include Zeus-Analysis, a novel 3D atmospheric dataset, with

comprehensive evaluation and user access development through an application programming interface.

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

Applications of 3D atmospheric profiles are numerous throughout NASA Earth science research and development. Assimilation of our data with systems operated at the NASA's Global Modeling and Assimilation Office (GMAO) has the potential to improve analysis and forecast products, including short-term and sub-seasonal. Dense atmospheric winds will also have implications to wildfire monitoring and subsequent air quality issues.

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

Commercially the developed technology has applications to renewable energy, aviation, and finance/insurance. Renewable energy markets are largely powered by weather conditions and must be accurately estimated for stable operation of the power grid. Forecasts help prevent flight diversions and can cause dozens of downstream flight delays.

Duration: **24**

PROPOSAL NUMBER: 22-2- **S11.04-2138**

PHASE 1 CONTRACT NUMBER: 80NSSC22PB140

SUBTOPIC TITLE: Sensor and Detector Technologies for Visible, Infrared (IR), Far-IR, and Submillimeter

PROPOSAL TITLE: A Signal Frequency Channelizer ASIC

Small Business Concern

Firm: **Pacific Microchip Corporation**
Address: **3916 Sepulveda Boulevard #108, Culver City, CA 90230**
Phone: **(310) 683-2628**

Principal Investigator:

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Business Official:

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Summary Details:

Estimated Technology Readiness Level (TRL) :

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

Far infrared and sub-mm astronomy instruments employ MKIDs for measurements of ultimate sensitivity and resolution exceeding 10,000 pixels. Detector array readout requires RF frequency division multiplexing and complex multichannel signal processing. An off-the-shelf ADC in combination with an FPGA based DSP block used for spectrum channelizing and power level measuring in each frequency bin suffers of unacceptable system size, weight and power (SWaP).

We propose to develop an ASIC which will channelize signal spectrum into 2048 frequency bins. These bins can be tuned with 0.954KHz per bin resolution to any portion of the spectrum within -500MHz to +500MHz. The ASIC will include two 12-bit 1GS/s ADCs, a data alignment and demultiplexing block, 2048 DFT cells, an accumulation/readout block and a high-speed Ethernet interface. Additionally, the ASIC will include a PLL for clock synthesis, a debug memory for storing of short duration raw digitized data or debug data from the DSP block. A digital control subsystem will handle the entire ASIC's operation and communication. In addition to minimized SWaP, the ASIC will tolerate TID and SEE. Within Phase I, we proved the ASIC implementation feasibility. Phase II will result in the silicon proven ASIC prototypes.

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

- Single photon sensitive focal planes from IR to X-ray
- Earth, balloon and space-based telescopes and radiometers
- Telescopes for FIR Probe and Flagship missions
- Missions: JPSS-2, 3, 4, PACE and TROPICS
- Spectrometer systems for remote sensing

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

- MKID based single photon sensitive imaging for remote sensing
- Specialized spectrometers for exploration of temperature, vapor and pollutants
- Infrared, visible light, UV and THz imaging in surveillance and security systems
- Generic spectrometers and spectrum analyzer instruments

Duration: **24**

PROPOSAL NUMBER: 22-2- **S16.05-1746**

PHASE 1 CONTRACT NUMBER: 80NSSC22PA922

SUBTOPIC TITLE: Thermal Control Systems

PROPOSAL TITLE: Hybrid Manufacturing Process of Loop Heat Pipe Evaporator

Small Business Concern

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

Principal Investigator:

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Summary Details:

Estimated Technology Readiness Level (TRL) :

Begin: 4
End: 6

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

Currently, to ensure the effective heat transfer of Loop Heat Pipes (LHPs), the Knife Edge Seal (KES) in the LHP evaporator is a key component that seals the primary wick and prevents high-pressure vapor from entering the lower-pressure interior of the evaporator and compensation chamber (CC). However, the KES may be susceptible to failure after long-time exposure to thermal cycles and vibration. Additionally, the KES insertion process is labor intensive and has an intrinsic risk that may increase the lead time and cost.

To address the challenge, Advanced Cooling Technologies, Inc. (ACT), in collaboration with FormAlloy, Inc., utilized Direct Energy Deposition (DED), an Additive Manufacturing (AM) technique, to eliminate the KES, improve the LHP reliability and performance, streamline the LHP manufacturing process, and further enable innovative LHP designs.

In the Phase I Program, we have successfully demonstrated using DED technology to deposit dense sealing layers on a testing specimen and thus eliminate the KES. The DED seal improves the overall LHP reliability and performance while lowering the cost and the lead time. Further, we have successfully demonstrated the operation of a complete LHP with a DED-sealed evaporator.

The Phase II Program will optimize the DED process and further leverage the DED to the LHP fabrication process. Specifically, we will optimize the DED conditions including laser power, scanning paths, etc. In addition, we will conduct reliability and lifetime tests for the DED-sealed parts. ACT will also compare the performance of KES-sealed LHP with that of DED-sealed LHP. Further, we will develop Functional Gradient Material (FGM) that transits from aluminum alloy to nickel to further streamline the LHP manufacturing process. Finally, we will leverage the AM nature of the DED process to enable different CC and the evaporator body shape designs. By the end of Phase II, a complete hybrid manufactured LHP is one major deliverable to NASA.

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

Ammonia and propylene LHPs are currently used in most NASA and commercial satellites. In comparison with Constant Conductance Heat Pipes (CCHPs), they carry much higher powers (1 kW vs. 100 W) over longer distances (10 m vs. 2-3 m). They also are better suited for ground testability. An LHP can operate with the evaporator 2 meters above the condenser, versus 2.5 mm for a CCHP. With the DED-sealed, hybrid-manufactured LHP, improved performance, shorter lead time, and lower cost are well expected.

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

For Universities and other Research institutes with a limited budget to perform space research, the reduced cost of the LHP via the hybrid manufacturing process will enable their adoption of the high-performance LHP to conduct high-heat-generation research activities such as space computing.

Duration: **24**

PROPOSAL NUMBER: 22-2- **S12.06-1903**

PHASE 1 CONTRACT NUMBER: 80NSSC22PA995

SUBTOPIC TITLE: Detector Technologies for Ultraviolet (UV), X-Ray, and Gamma-Ray Instruments

PROPOSAL TITLE: Integrated SiC Photodiode Arrays for UV-Spectroscopic Applications

Small Business Concern

Firm: **CoolCAD Electronics, LLC**
Address: **7101 Poplar Avenue, Takoma Park, MD 20912**

Phone: **(301) 405-3363**

Principal Investigator:

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Business Official:

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Summary Details:

Estimated Technology Readiness Level (TRL) :

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

We are developing unique Silicon Carbide (SiC) solar blind UV detectors with broad potential impacts in Planetary and Earth Sciences and Heliophysics. We propose to fabricate unique, passive and active, SiC UV linear sensor arrays. We will ultimately scale up our technology to fabricate 128x2 SiC active arrays with <40um pixel pitch, with a 3T amplifier readout circuit integrated directly into each pixel on-chip. In Phase 1, we designed and built prototype UV optical sensor array chips to demonstrate the proof-of-concept at TRLs 3 and 4. In Phase 2, we will enhance these to TRLs 5 and 6. Building upon Phase 1, we will fabricate a variety of arrays, including 128x2 arrays with a higher-fill-factor, 256x2 arrays for higher spectral resolution, and 32x2 and 64x2 active arrays with different readout integration. Deep trenches surrounding each pixel will provide electrical isolation to eliminate crosstalk between array elements. Readout circuits will use external signals to reset the sensors, buffer the output signal, and perform read-out selection by multiplexing. This work enjoins the unique advantages of SiC, such as its extremely low dark current, even at high temperatures, its inherent visible-blindness, and its capability to grow a native oxide, to the advantages of active pixel sensor technology, such as higher sensitivity and low power consumption, to revolutionize UV sensing in the 120 to 350 nm range. As a transformative technology, it can lead to advanced, flexible instrumentation with lower design complexity for UV spectroscopy, remote sensing, remote and in-situ characterization and imaging. By comparing SiC array characteristics with literature, and testing operational characteristics on validation systems we design, we will make first-order estimates for the arrays' use in applications like remote-sensing, and Raman and reflectance spectroscopy. We will thus identify the target next-gen specifications for applications in specific instruments and missions.

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

Visible-blind SiC UV sensors for in-situ/remote spectroscopy/imaging in Planetary and Earth Science, Heliophysics. For instance: Water signature detection, surface/atmosphere/plume characterization, mineralogy (e.g. UOP, MLE, Enceladus missions); LDEP and New Frontiers missions, LUVOIR Concept Study, CubeSat/SmallSat missions; future instruments like CUVIS (the DAVINCI+ probe); instrumentation development (PICASSO, MATISSE, DALI). Handheld units based on SiC sensors (no cooling/visible filter needed) can be of use in Artemis.

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

Applications for UV sensing, spectroscopy and imaging include: sanitation (e.g. water/air filtration monitoring), fire and rocket plume detection, bio-detection, instrumentation, industrial monitoring, high-resolution fault inspection, and oil/gas logging systems. The high-temperature capability and inherent visible blindness of SiC allow applications in extreme conditions and simpler designs.

Duration: **24**

PROPOSAL NUMBER: 22-2- **S13.02-2783**

PHASE 1 CONTRACT NUMBER: 80NSSC22PB236

SUBTOPIC TITLE: Spacecraft Technology for Sample Return Missions

PROPOSAL TITLE: Materials for Structural and Thermal Preservation of Sample Return Payload During Earth Entry and Landing, Phase II

Small Business Concern

Firm: **Ultramet**
Address: **12173 Montague Street, Pacoima, CA 91331**
Phone: **(818) 899-0236**

Principal Investigator:

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Business Official:

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Summary Details:

Estimated Technology Readiness Level (TRL) :

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

To maximize reliability, Earth entry/landing vehicles for robotic sample return missions will comprise an aeroshell, a crushable layer that will absorb the energy of the ballistic impact landing, and a sample container inside the crushable layer; parachutes will not be used. Lightweight cellular solids are being considered for the crushable layer, but many other engineered foams with different strengths and energy absorption capacities are available. By using foams of different materials with different mechanical properties and different relative densities, the crush behavior of the layer can be tailored. In addition to brittle crushing of carbon foams or ductile collapse of metallic foams, other energy-absorbing mechanisms are available, some of which have previously been tested at high strain rates for use as underbody armor on military vehicles to mitigate blast effects from improvised explosive devices. In this project, high strain rate compression test data for Ultramet's engineered foams will be used to mature the technology for impact absorption applications, with both brittle and ductile foams as a key element. The candidate impact absorption material database will be expanded via additional split Hopkinson bar testing, more detailed characterization of foam behavior will be performed, and an engineering model will be developed to quickly and easily determine the optimal foam architecture for a given set of mission (e.g. spacecraft and Earth impact) parameters. The results will be used to design and fabricate subscale and full-scale prototypes that will incorporate a minimum-mass, low thermal conductivity crushable layer that can be used for sample return missions with high impact velocities. The subscale unit and one full-scale unit will undergo drop testing to verify performance.

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

The primary NASA application will be sample return missions from solar system bodies including planets, planetary moons, dwarf planets, asteroids, and comets. Because the energy absorption characteristics of the material system can be tailored, it also has the potential to be used for landing payloads on these bodies. Likewise, for a mission to divert an asteroid from collision with Earth, this type of system could be used to transfer momentum to the asteroid over a tailorable time frame to minimize fracture/fragmentation of the target body.
Potential Non-NASA Applications (Limit 1500 characters, approximately 150 words):

Commercial applications for lightweight energy-absorbing structures include backing structures for automobile bumpers, crash barriers on highway exit ramps, and underbody armor for military vehicles to mitigate blast effects from mines and improvised explosive devices. Temporary structures in war zones could also be protected against blast effects with this technology.

Duration: **24**

PROPOSAL NUMBER: 22-2- **S14.01-2129**

PHASE 1 CONTRACT NUMBER: 80NSSC22PB025

SUBTOPIC TITLE: Space Weather Research-to-Operations/Operations-to-Research (R2O/O2R) Technology Development

PROPOSAL TITLE: Enhancement of the Geomagnetic Cutoff Models inside SIRE2 (SIRE2-Real)

Small Business Concern

Firm: **Fifth Gait Technologies, Inc.**
Address: **835 Puente Drive, Santa Barbara, CA 93110**
Phone: **(805) 964-1496**

Principal Investigator:

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Business Official:

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Summary Details:

Estimated Technology Readiness Level (TRL) :

Begin: 3
End: 8

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

The Space Ionizing Radiation Environment and Effects (SIRE2) toolkit was developed to provide the space radiation environment and effects community with state-of-the-art models that can be

used not just for satellites but also for arbitrary trajectories. In this Phase II effort, the SIRE2-Real capabilities will be tested and integrated into the SIRE2 toolkit. SIRE2-Real will provide benchmarking of space environments to historical measurements and spacecraft anomalies. The SIRE2-Real capabilities will allow the user to select a historical time range for SIRE2-Real to determine the peak flux, flux-time series, and mission-integrated fluence for the solar energetic particle (SEP) environment. SIRE2-Real will also use the historical Dst value for the geomagnetic activity at Earth during the user's historical time range and be able to perform geomagnetic cutoff calculations using the historical International Geomagnetic Reference Field (IGRF) epoch that is closest to the user's mission.

The Mission Specific Solar Radiation Environment Model (MSSREM) and the Smart-Shea 2022 geomagnetic cutoff model will need to be updated, tested, and integrated into SIRE2 to provide the SIRE-Real capability. The MSSREM model will provide the user with historical peak flux, flux time series, and mission-integrated fluence for a user's mission. The Smart-Shea 2022 geomagnetic cutoff model will need to be extended to allow the user to select between multiple IGRF epochs in the calculation.

The Fifth Gait team will also be looking to enhance the geomagnetic cutoff models inside of SIRE2. The first thing that will be examined is the use of the 20 km vs 450 km world cutoff grids in the Smart-Shea model to determine if there is any significant difference between using the two different grids. Penumbral transparencies and analysis of the October 20, 1989 shock interval are other areas of improvement in the geomagnetic cutoff models that will be examined during the Phase II effort.

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

When the Phase II effort is complete, NASA will have access to SIRE2-Real that can provide benchmarking of space environments to historical measurements. Spacecraft designers and operators will be able to use the benchmarking of space environments to assess spacecraft anomalies that would have occurred during the historical time range. With SIRE2-Real, NASA will be able to assess their spacecraft to historical measurements that have not been possible in the past, providing additional data on the survivability of their spacecraft.

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

Major prime contractors have noted interest in using a SIRE-Real capability to assess spacecraft anomalies investigations. Companies like Boeing, Lockheed, Northrop, Raytheon, SpaceX and Blue Origin can use SIRE2-Real to assess their spacecraft with the benchmarking of space environments to historical measurements and assess the potential for spacecraft anomalies from the historical SEP event.

Duration: **24**

PROPOSAL NUMBER: 22-2- **S15.01-2666**

PHASE 1 CONTRACT NUMBER: 80NSSC22PB043

SUBTOPIC TITLE: Plant Research Capabilities in Space

PROPOSAL TITLE: Focused LIBS for Elements in Water Identification (FLEW.ID)

Small Business Concern

Firm: **Impossible Sensing, LLC**
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Phone: **(314) 695-6993**

Principal Investigator:

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Phone: **(817) 600-1790**

Business Official:

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Summary Details:

Estimated Technology Readiness Level (TRL) :

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

Our innovation, Focused LIBS for Elements in Water IDentification (FLEW.ID), is a compact, cost-effective, and sensitive instrument for monitoring the elemental composition of aqueous solutions in plant growth systems on-board the International Space Station (ISS). FLEW.ID utilizes a miniaturized, low-pulse energy laser for performing laser-induced breakdown spectroscopy (LIBS) measurements that, when coupled with a compact optical assembly and spectrometer system, enables reductions in instrument size, weight, and power (SWaP) conducive to accommodation on the ISS for direct integration with currently-operating and/or future proposed plant growth systems. The enhanced benefit of FLEW.ID is that it is application agnostic, and therefore can be used for analyzing other fluid systems on the ISS such as in the closed-loop Water Recovery System or on future habitats on planetary surfaces.

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

FLEW.ID enables on-demand, in-situ, real-time elemental analysis of fluid samples in plant growth systems for qualitative and quantitative analysis of nutrient cycling. When integrated into a plant growth system on the ISS, FLEW.ID can provide online analysis without any sampling nor consumables. FLEW.ID is application agnostic and can be readily adapted to measuring other fluid systems, such as the closed-loop water recycling system on board the ISS, or solid samples, such as geological samples during planetary exploration.

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

FLEW.ID can perform in-situ analysis of heavy metals and ionic contaminants in public water systems for early pollution detection and continuous monitoring to ensure the maximum contaminate levels (MCLs) are not exceeded that may negatively impact public health.

Duration: **24**

PROPOSAL NUMBER: 22-2- **S16.04-1028**

PHASE 1 CONTRACT NUMBER: 80NSSC22PA934

SUBTOPIC TITLE: Unpiloted Aerial Platforms and Technologies for NASA Science Missions

PROPOSAL TITLE: Helium Transfer Scroll Pump System (HTSPS)

Small Business Concern

Firm: **Air Squared, Inc.**
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Principal Investigator:

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Summary Details:

Estimated Technology Readiness Level (TRL) :

Begin: 4
End: 6

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

In order to revisit Venus and explore its climate, atmosphere, and surface for the first time since the 1985 VeGa mission, NASA is interested in **de**veloping aerial vehicles capable of in situ investigation. One potential solution is an aerial platform that must float and fly between 52 and 62 km in the atmosphere while experiencing temperatures ranging from -30°C to 62°C, pressures from 80 kPA to 18 kPA, solar fluxes as high as 2,300 W/m2, and IR heat flux up to 830 W/m2. Balancing these three selection criteria, JPL identified variable altitude controlled robotic balloons, or aerobots, as an optimized and achievable solution for near-term Venusian in situ atmospheric exploration. **O**f particular interest is the development of an altitude modulation system incorporating a lightweight, high efficiency pump, isolation valves and venting orifices suitable for aerobot use. **T**he pump shall have a nominal flow rate of 250 liters per minute at a pressure rise of 30 kPa.

There will be two prototypes developed during the Phase II effort, an Alpha, and Beta. The Alpha-HTSP (Helium Transfer Scroll Pump) will be developed during year 1 to prove out an optimized scroll technology that is ideal for space applications. This spinning scroll compressor design minimizes mechanical losses, size, weight and power to provide compressed air for challenging applications such as this one.

After the Alpha-HTSP is built, performance tested and endurance tested, a Beta-HTSP design iteration will begin. This design effort will focus on further optimizing performance while ensuring that the design is robust enough for operating in the extreme environment of the Venetian atmosphere. The Beta compressor will be tested in extreme pressure and temperature environments for extended durations to prove its capabilities and durability.

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

The HTSP will define next-generation PSA for xPLSS xEMU in Mars and Deep Space exploration. Capable of operating over several different partial atmospheric environments in a compact footprint, the HTSP will provide flexible and reliable xPLSS design adaptable to varied NASA missions and provide a foundation for both Lunar Gateway habitation and human exploration of Mars. This will accelerate the HTSP's adaptability for the ORION Spacecraft. The HTSPC would fulfill a vital function of PLSS CO2 removal in advanced extravehicular activities.

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

Given the improved pressure and flow rate, adaptability as a compressor and vacuum pump, and reduced complexity of
spinning scrolls, several positive displacement solutions would benefit from the development of the HTSP. Qualified spinning scroll machines would upgrade the performance of aerospace environmental control systems, vacuum mass spectrometry, and the commercial space industry.

Duration: **24**

PROPOSAL NUMBER: 22-2- **S11.05-2053**

PHASE 1 CONTRACT NUMBER: 80NSSC22PB148

SUBTOPIC TITLE: Suborbital Instruments and Sensor Systems for Earth Science Measurements

PROPOSAL TITLE: Compact and Rugged Mid-Infrared Multi-Gas Open Path Sensor

Small Business Concern

Firm: **Pendar Technologies, LLC**
Address: **30 Spinelli Place, Cambridge, MA 02138**
Phone: **(857) 413-9339**

Principal Investigator:

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Business Official:

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Summary Details:

Estimated Technology Readiness Level (TRL) :

Begin: 5
End: 7

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

We propose a turn-key in-situ gas sensor that can reliably perform continuous measurements on airborne, ship-based, or other mobile platforms. Specifically, we emphasize that the proposed system is compact, lightweight, power efficient, and therefore can be mounted on small to mid-sized uncrewed aircraft systems. The sensor features an exposed beam path that allows ambient air circulation without active gas sampling. The proposed sensor is based on mid-infrared absorption spectroscopy using Pendar's proprietary distributed feedback quantum cascade laser array (QCLA) technology. Our monolithically integrated chip-scale coherent source can withstand harsh operating conditions while offering superior wavelength and intensity stability compared to other broadband mid-infrared sources. Broadband spectral coverage (up to 500 cm-1) combined with high frequency resolution (~100 MHz) enable a multi-tasking sensor capable of detecting a multitude of gases including toxic industrial chemicals, chemical warfare agents, greenhouse gases, and volatile organic compounds. The laser source can rapidly tune over a large bandwidth to provide fast spectral measurements, enabling >100 Hz time response.

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

The proposed sensor can be directly adopted for airborne missions such as on NASA's Airborne Science aircraft fleet, uncrewed aircraft systems and balloons to provide lower cost atmospheric gas measurements. The CO_2 sensing capability can be utilized to augment the space-based measurements of CO_2 dry air mole fraction under the OCO-2 project. The TEMPO project can also benefit from additional ozone and NO_2 measurements.

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

We believe our proposed sensing solution can be adopted for chemical threat detection, which would be of interest to the Department of Homeland Security. The broadband sensing capability is also applicable to selective volatile organic compound detection in the air, which is of interest to markets targeting air quality measurements.

Duration: **24**

PROPOSAL NUMBER: 22-2- **S11.05-2505**

PHASE 1 CONTRACT NUMBER: 80NSSC22PB179

SUBTOPIC TITLE: Suborbital Instruments and Sensor Systems for Earth Science Measurements

PROPOSAL TITLE: Optimized Miniature Spectrometer for Improved Trace Gas Monitoring and Satellite Validation

Small Business Concern

Firm: **SciGlob Instruments & Services, LLC**
Address: **4656 Tall Maple Court, Ellicott City, MD 21043**
Phone: **(410) 487-4707**

Principal Investigator:

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Business Official:

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Summary Details:

Estimated Technology Readiness Level (TRL) :

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

The development of miniaturized spectrometers has revolutionized a wide range of industries. However, traditional off-the-shelf spectrometer designs suffer from essential deficiencies that are limiting their usage in important fields such as medical diagnostics or environmental monitoring. We propose adopting a set of new technologies and machine learning processes in designing and developing a new generation of miniature spectrometers. By utilizing state-of-the-art "off-the-shelf" detectors, advanced technologies such as 3D printing, advanced materials, and machine learning, we aim to design and develop a miniature spectrometer that is more accurate, efficient, and cost-effective. 3D scanning combined with machine learning will enhance the optimization process by reducing the need for manual adjustments and providing more accurate and reliable data. In addition, adopting new technologies will improve the overall quality and traceability of production.

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

Several research groups within the NASA's Earth sciences **(atmospheric measurements, air quality)** will greatly benefits from this new design. This will be a major step in improving the Pandora NASA network retrievals.

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

We believe that this spectrometer will be of high interest to other US government agencies such as the, Environmental Protection Agency DOE Office of Environmental Management and the Bureau of Ocean Energy Management.

Duration: **24**

PROPOSAL NUMBER: 22-2- **S13.05-2406**

PHASE 1 CONTRACT NUMBER: 80NSSC22PB196

SUBTOPIC TITLE: In Situ Instruments/Technologies for Lunar and Planetary Science

PROPOSAL TITLE: Windspeed Sensor for Planetary Science Applications

Small Business Concern

Firm: **Sporian Microsystems, Inc.**
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Business Official:

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Summary Details:

Estimated Technology Readiness Level (TRL) :

Begin: 4
End: 6

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

In-situ instrumentation is needed that can withstand the harsh environments imposed by planetary atmospheres in order to make advancements in solar system exploration. Technologies that can withstand the corrosive/caustic gases, radiation levels, stresses, and high temperatures and pressures, while still producing reliable, real-time data are a major facilitator for planetary missions. To address this need, Sporian is developing a harsh environment wind speed and direction sensor targeted toward future Venus probe spacecraft. The proposed technology will be beneficial to NASA's planetary science mission by facilitating environmental chamber testing & validation, and wind speed and direction measurements in the Venus atmosphere and on the surface. The Phase I effort focused on heavily leveraging prior harsh environment, in-situ instrumentation development and, with input from current/prior NASA partners, to construct, test, and characterize prototype sensor suites, which was successfully completed demonstrating technology feasibility. Phase II efforts will include: continuing to work with stakeholders to guide technology development; developing processes and design required to realize next generation sensors; multiple generations of prototyping; and application environment relevant testing.

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

A harsh environment sensor that can provide real-time wind speed and direction information has the potential to provide major advancements in planetary science. The technology will target the Glenn Extreme Environment Rig and its capability to mimic planetary conditions such as those on Venus, but be directly applicable to both current and future NASA programs/directorates, and

facilitate innovations in vehicle performance monitoring, environmental testing, and atmospheric characterization of planetary bodies.

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

Land-based power generation systems, including nuclear and solar power plants, would benefit from a small flowmeter allowing for visibility of the conditions in supercritical CO2 Thermal Energy Storage (TES) and Heat Transfer Fluid (HTF) lines. Additional potential market areas include marine propulsion, rail locomotives, automotive, oil and gas refining, and government and academic laboratories.
Duration: **24**

PROPOSAL NUMBER: 22-2- **S16.07-1168**

PHASE 1 CONTRACT NUMBER: 80NSSC22PB004

SUBTOPIC TITLE: Cryogenic Systems for Sensors and Detectors

PROPOSAL TITLE: Three-Stage Cryocooler Cold Head for Advanced Heterodyne Sensors

Small Business Concern

Firm: **CU Aerospace, LLC**
Address: **3001 Newmark Drive, Champaign, IL 61822**
Phone: **(217) 239-1703**

Principal Investigator:

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Business Official:

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Summary Details:

Estimated Technology Readiness Level (TRL) :

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

Future advanced heterodyne sensors for submillimeter-wave receivers require 50 to 100 mW of cooling at 15 to 20 K for the sensor, and 1 to 2 W cooling at 80 to 120 K for the local oscillator, with size and input power suitable for use in a Small Sat. During Phase I, a detailed cryocooler configuration trade study was completed, and the 3-stage pulse tube configuration driven by the Lockheed Martin (LM) Midi compressor was selected based on efficiency and adaptability. An assessment of innovative regenerator materials and direct metal laser sintering (DMLS) additively-manufactured heat exchanger materials was completed, and the decision was made to include DMLS in the design, while keeping the advanced regenerator material as an option as a future improvement. Cooling powers of 100 mW at 20 K and 2 W at 120 K were selected, with 47 W compressor ac power predicted. A solid model of the 3-stage cold head was then generated in Phase I. CU Aerospace (CUA) will use innovative materials and low cost cold head design and assembly, coupled with LM's industry-leading multi-stage pulse tube expertise, to provide NASA with a compact, affordable cryocooler for submillimeter detectors. Our team proposes to:
1) Refine the 3-stage cold head solid model design initiated in Phase I, optimized to provide simultaneously 100 mW cooling at 20 K and 2 W cooling at 120 K, to improve manufacturability and decrease cost compared with heritage LM multi-stage cold heads.
2) Procure all hardware necessary to assemble the 3-stage cold head, and the gas transfer line to connect it to a LM-owned Midi compressor.
3) Assemble and weld 3-stage cryocooler cold head, perform proof pressure testing and leak testing.
4) Integrate cold head with LM Midi compressor and perform cryocooler performance testing over a range of operating conditions, varying the input power, ambient temperature and 1st, 2nd and 3rd stage temperatures to fully characterize cryocooler performance.

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

Three-stage cryocoolers are generally required when cooling to 15-20 K as required by heterodyne sensors. Staged pulse tubes are ideally suited for space applications because adding stages does not add moving parts, such as with Stirling or Brayton coolers, so reliability remains high. NASA heterodyne sensors, as well as other instruments requiring temperatures from 10-30K would benefit from a low-mass, reliable 3-stage pulse tube cryocooler to improve mission capability.

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

Multiple-stage cryocoolers can benefit all cryogenic space applications by cooling secondary components and intercepting parasitic heat loads at higher temperature, reducing power and mass. Applications including remote sensing satellite constellations, weather satellite constellations, earth science instruments, and deep space astrophysics instruments can all benefit from multiple-stage cooling.

Duration: **24**

PROPOSAL NUMBER: 22-2- **S11.01-1648**

PHASE 1 CONTRACT NUMBER: 80NSSC22PB023

SUBTOPIC TITLE: Lidar Remote-Sensing Technologies

PROPOSAL TITLE: Efficient ErYAG Amplifier for Water Vapor DIAL

Small Business Concern

Firm: **Fibertek, Inc.**
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Phone: **(703) 471-7671**

Principal Investigator:

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Summary Details:

Estimated Technology Readiness Level (TRL) :

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

Fibertek proposes to develop the technology for energy scaling a frequency-doubled single-frequency Er:YAG laser source with a fundamental wavelength of 1645nm and a frequency doubled wavelength of 822nm. This proposed work will provide an enabling technology for a space-based water vapor/methane DIAL instrument with the potential for scaling the energy of the Er:YAG water vapor DIAL transmitter by a factor of two compared to the current state-of-the-art system being developed under the ABLE IIP, further enhancing the transmitter capability by enabling day-time observations of water vapor. The proposed program will focus on developing a cryo-cooled laser amplifier to meet the performance needs of a space-based frequency-doubled single-frequency Er:YAG laser for a water vapor DIAL instrument. The phase I program focused on collecting temperature dependent spectroscopic data on Er:YAG to support development of an efficient amplifier design. The proposed phase II work outlines a systematic approach to optimizing the amplifier performance through parametric breadboard experiments studying the effect of doping concentrations, crystal lengths and temperature on amplifier performance. Data collected from the breadboard will enable a trade study of devices for space-based compatible cryo-cooling and identifying the most efficient system level approach for an

Er:YAG laser amplifier. A deliverable Er:YAG amplifier and frequency converter module will be designed and built that will be compatible with amplifying previously built single-frequency Er:YAG laser sources developed under SBIR funding.

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

The proposed work aligns with a current IIP program investigating a water vapor/methane DIAL space-based instrument. This instrument targets observables in the incubation (water vapor and planetary boundary layer height) and explorer (methane columns) classes identified in the 2017 ESAS decadal survey. An Er:YAG amplifier provides a path to scaling the laser energy which is enabling for daytime observations of water vapor. An energy scaled 1.65 Er:YAG system also provides a cross cutting application for high rep-rate 3D wind lidar.

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

The proposed amplifier has applications for scaling 1.65μm lasers for use as illuminators and long range lidar systems for the DOD, where requirements on eye safety dictate a need for wavelengths in the 1400nm to 1700nm band. An Er:YAG amplifier at 1.65μm is ideally suited to scaling power for these applications that increasingly require higher power for greater range and sensitivity.

Duration: **24**

PROPOSAL NUMBER: 22-2- **S12.01-1957**

PHASE 1 CONTRACT NUMBER: 80NSSC22PB119

SUBTOPIC TITLE: Exoplanet Detection and Characterization Technologies

PROPOSAL TITLE: Integrated Fourier Transform Spectrometer

Small Business Concern

Firm: **Obsidian Sensors**
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Principal Investigator:

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Summary Details:

Estimated Technology Readiness Level (TRL) :

Begin: 2
End: 6

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

The NASA/NSF commissioned EPRV Working Group's final report calls for the development of spectrographs with spectral resolution exceeding 100,000 operating across the visible/NIR spectrum to support the characterization of earth analogs orbiting solar-type stars through radial velocity measurements. While bulk optical instruments that require large volume/mass and complex environmental controls may work for the first phase that addresses the needs of ground-based telescopes, the development of an integrated instrument using photonic waveguide technology can adequately address the challenges posed by future mission concepts such as HabEx and LUVOIR where the demands of space deployment preclude bulky instruments. The Phase II effort will produce a demonstration of a Fourier Transform Spectrometer that operates over 700-900nm with a resolution of 10,000. The envisioned integrated Fourier Transform Spectrometer uses a two stage system design to implement the network of switchable optical path delays with 14 bits of control. One addresses the need to implement fine control of the optical path delay in the sub um to micrometers range while the other addresses the coarse delays in the range of millimeters of optical path. The former is implemented with a novel cladding mode modulator that can provide a selection of two refractive indices for the propagating mode and the other uses an exchange/bypass (sometimes called cross/bar) switch to select one of two waveguides of differing lengths for the light to follow. The system architecture should allow a very compact system to be realized, substantially reducing the volume and mass that needs to be temperature stabilized, a very important and practical system constraint.

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

EPRV instruments that are being contemplated for ground-based telescopes is the immediate outlet for the iFTS technology. Spectroscopy is a key scientific capability that is sought for missions and projects that are ground based and spaceborne. The market for such scientific instruments with performance goals that far outstrip any defense or commercial application is not large but significant for a small company like Obsidian Sensors.

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

The successful demonstration of iFTS for the EPRV application can directly impact much larger volume applications across the medical and even consumer markets where less challenging spectroscopy performed in real time in the molecular fingerprint regions of the infrared can be used for diagnosis and analysis.

Duration: **24**

PROPOSAL NUMBER: 22-2- **S17.03-1060**

PHASE 1 CONTRACT 80NSSC22PB167

NUMBER:

SUBTOPIC TITLE: Fault Management Technologies

PROPOSAL TITLE: Multidisciplinary Analysis of Fault Management Design for System Autonomy and Resilience

Small Business Concern

Firm: **Qualtech Systems, Inc.**
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Summary Details:

Estimated Technology Readiness Level (TRL) :

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

One of NASA's major technology needs is to increase system autonomy and resilience. To accomplish this, an important task is to connect fault management (FM) to systems engineering (SE) and operations. In highly reliable systems there must be some means to detect and respond to failure of those functions. Identifying and allocating the requirements and functions for these capabilities is the job of SE. There are recent trends to improve SE through the use of models to create model-based SE (MBSE). An approach for performing SE is the Goal-Function Tree representation, an improved variant of the classical functional decomposition which can be used for analysis of the physical system, and provides a physically accurate representation of requirements traceability in functional success space.

Despite their close relationship to SE in practice, SHM/FM practices have remained disjoint. Historically, SHM/FM has been designed into the system only after the nominal system is designed, which essentially makes it a band-aid of the problems without consideration of how these might have been prevented or mitigated. This lends itself to a large technology and knowledge gap that result in significant inefficiencies throughout the life cycle.

QSI plans to integrate TEAMS® with GFT to provide a multidisciplinary solution that connects an important SE approach with a tool that provides analytic capabilities for FM design and operations. It intends to integrate FM directly within SE from the beginning of a project, thereby suitable for FM of future spacecraft. This SBIR: (1) performs FM design analysis of a system design modeled in GFT, (2) enables the FM design to be evaluated comprehensively in an operational context by performing FM functions supporting extensive set of component-level physical and functional failure scenarios, (3) supports Trade Studies to evaluate merits of FM architecture; (4) enables “System” level assessment and visualization of FM qualities modeled in the GFT.

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

This FM capability is relevant to future SMD/HEOMD missions, such as Multi-Purpose Crew Vehicle, Human Landing System, Orion Crew Vehicle, and EUS system of SLS. Artemis Mission – Lunar Lander, cis-lunar infrastructure including Gateway and deep space human exploration such as Habitat, and Moon to Mars mission are prime targets. Other targets include Deep Space missions such as Europa Orbiter, InSight lander mission, and Mars Science Laboratory. Earth orbiters such as Landsat-9 are also targets. Arcus X-ray telescope is another target platform.

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

Commercial space launch vehicles (e.g., SpaceX), Geosynchronous earth orbit (GEO), Medium earth orbit (MEO), Low earth orbit (LEO), Space Command ground segments, DoD, USAF, US Navy, commercial aviation, military systems e.g., NORAD, JSF, Navy shipboard platforms, Submarine Commands, BMD systems, UAVs, UMGs, model-based design of space missions/satellites, supporting infrastructure Space services.

Duration: **24**

PROPOSAL NUMBER: 22-2- **S11.06-2757**

PHASE 1 CONTRACT NUMBER: 80NSSC22PB028

SUBTOPIC TITLE: Earth Science Decision Support Tools Focused on the Mitigation of Climate Change Impacts

PROPOSAL TITLE: Estimating Groundwater Dynamics from Artificial Intelligence and InSAR

Small Business Concern

Firm: **Geolabe, LLC**
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Principal Investigator:

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Summary Details:

Estimated Technology Readiness Level (TRL) :

Begin: 5
End: 7
Technical Abstract (Limit 2000 characters, approximately 200 words):

Groundwater represents about a third of global water withdrawals, and approximately half of global irrigation water. In many arid and semi-arid regions, groundwater is rapidly being depleted, which is affecting agricultural productivity over the long term. The over-exploitation of groundwater due to the current drought episode in South-Western U.S. has already led farmers to fallow hundreds of thousands of acres of farmland.

We leverage recent developments in artificial intelligence in order to improve deformation detection thresholds in Interferometric Synthetic Aperture Radar (InSAR). Our technology allows to deconvolve signal from noise in InSAR data, and lowers the detection threshold of surface deformation in spatially continuous InSAR time series of ground deformation by about an order of magnitude compared to the state-of-the-art. Phase I focused on separating ground deformation signals from atmospheric noise, and improving the time resolution of the associated InSAR time series. In this Phase II proposal, we focus on further improving detection capabilities by taking directly into account a second major source of noise in InSAR data, due to soil moisture.

We specifically train models on time series of seasonal depletion and recharge in order to study variations in groundwater levels in InSAR data, with the goal of allowing governments and organizations to take informed assessments and policies related to groundwater supplies.

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

NASA is about to launch a new satellite constellation for InSAR (NiSAR), with a planned launch date in 2023, and our proposed technology could be applied to data provided by this new constellation.

Moreover, our algorithm could be interfaced with InSAR interferogram data from NASA Earthdata, and can be used in combination with NASA code libraries (isce, AriaTools).

Last, the NASA Observational Products for End-Users from Remote Sensing Analysis (OPERA) project started in April 2021, and our proposed work could be coupled to OPERA products.

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

Our other commercialization applications are targeting several sectors: i) farming; ii) state and local governments, with the goal of helping monitor groundwater resources; iii) the insurance sector, and in particular insurance products related to flooding and drought; and iv) the finance sector, to help anticipate changes in the price of oil and gas, as well as water.

Duration: **24**

PROPOSAL NUMBER:	22-2- **S13.07-2071**
PHASE 1 CONTRACT NUMBER:	80NSSC22PB215
SUBTOPIC TITLE:	Energy Storage for Extreme Environments
PROPOSAL TITLE:	Solid-State Rechargeable Batteries for Extreme Lunar Surface Environments

Small Business Concern

Firm: **TDA Research, Inc.**
Address: **12345 West 52nd Avenue, Wheat Ridge, CO 80033**
Phone: **(303) 422-7819**

Principal Investigator:

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Business Official:

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Summary Details:

Estimated Technology Readiness Level (TRL) :

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

Future science missions to the Lunar surface and other planets and their moons will require advanced secondary battery systems that can operate at extreme temperatures. Advancements that address battery operation at extreme temperatures, combined with high specific energy and energy density, are critically needed. Conventional rechargeable Li-ion cells operate within a narrow temperature range of -20 to 40 ºC, and they suffer from capacity loss at lower temperatures. Improved batteries that minimize the need for strict thermal management, which adds to the mass of the spacecraft, are critically needed.

The solution to making rechargeable lithium-ion batteries that operate in extreme temperature environments is to develop a solid electrolyte that does not suffer from poor solid-solid lithium conductivity. New materials and methods for tailoring these solid-solid interfaces are also needed. It is also critical to combine this modified solid electrolyte with high voltage cathodes and stable anodes to produce the high energy density batteries that NASA needs. In this project TDA Research will develop solid electrolytes and surface modified electrodes that combine to make high voltage lithium rechargeable batteries suitable for the Lunar environment.
Potential NASA Applications (Limit 1500 characters, approximately 150 words):

The targeted NASA application is for energy storage (batteries) that do not require excessive thermal management on the Lunar surface. NASA has specifically identified this need, and it is the primary target application. Similarly, extreme temperature tolerant batteries would serve NASA for additional missions (Mars, Titan, etc.).
Potential Non-NASA Applications (Limit 1500 characters, approximately 150 words):

There is an immense dual-use commercial market for solid-state batteries on Earth. Electric vehicles, electric aircraft and numerous other energy storage applications would greatly benefit from being able to work below -40 ºC, and safety would be greatly enhanced by solid-electrolyte batteries that were not flammable and could survive temperatures above 100 ºC (for example, vehicle fires).
Duration: **24**

PROPOSAL NUMBER: 22-2- **S12.03-1490**

PHASE 1 CONTRACT NUMBER: 80NSSC22PB108

SUBTOPIC TITLE: Advanced Optical Systems and Fabrication/Testing/Control Technologies for Extended-Ultraviolet/Optical and Infrared Telescope

PROPOSAL TITLE: Low Viscosity, High Strength Adhesive Materials with Low CTE

Small Business Concern

Firm: **Nanosonic, Inc.**
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Summary Details:

Estimated Technology Readiness Level (TRL) :

Begin: 2
End: 5

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

NanoSonic has developed a low viscosity, UV curable epoxy technology for fast adhering of optical components to ceramic glass substrates. The aliphatic epoxy adhesive formulations have viscosities <10 Poise and the fully cured networks display glass transition temperatures higher than 70 °C using cationic photo initiation at ambient conditions. The adhesive formulation has successfully demonstrated curing inside of UV-opaque substrates via a dark cure mechanism. Dogbone specimens display tensile strength up to 36 MPa. Aluminum lapshear samples strength shows adhesive failure up to 26 MPa, while no ceramic glass lapshear failed in the bond area. CTE values for unfilled aliphatic epoxies were as low as 40 ppm °C.

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

A low viscosity, UV curable adhesive system that possess high strength, high glass transition temperatures (Tg), and low coefficient of thermal expansion can be used in precise bonding of Laser Interferometer Space Antenna (LISA) and other stable structure applications, as well as encapsulants in electronics and UV-stable coatings.

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

UV curable epoxy based-precursors and polymers are used as adhesives, UV-stable coatings, encapsulants for electronics, inks, and paints/varnishes applications. The low CTE and dielectric properties make these materials attractive for electronics and specialty application.

Duration: **24**

PROPOSAL NUMBER:	22-2- **S11.03-2143**
PHASE 1 CONTRACT NUMBER:	80NSSC22PB139
SUBTOPIC TITLE:	Technologies for Passive Microwave Remote Sensing
PROPOSAL TITLE:	Low-Power 28GHz Selective Spectrometer

Small Business Concern

Firm: **Pacific Microchip Corporation**
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Summary Details:

Estimated Technology Readiness Level (TRL) :

Begin: 3
End: 5

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

Pacific Microchip Corp. proposes to develop a 28GHz spectrometer ASIC including an 8-bit 56GS/s ADC coupled with a digital back-end for a digital poly-phase filter based parallelized Fast Fourier Transform (FFT) processing of a selected portion of the signal's spectrum. To achieve the 28GHz signal bandwidth, a previously developed 8-bit 56GS/s ADC with architectural enhancements will be employed. The introduced enhancements minimize the time interleaving

mismatches which results in significant reduction of unwanted artifacts in the output spectrum. Instead of overdesigning, when seeking to maximize the performance, the ADC will rely on parameter calibration using a built-in CPU. On-chip phase locked loops (PLLs) will be used for clock synthesis. For convenient interfacing with field programmable gate arrays (FPGAs), the ASIC will include a high-speed LVDS data interface for result readout and an I2C interface for the ASIC control. Phase I work provided the proof of ASIC feasibility – critical blocks were implemented and verified at the targeted technology node. At Phase II, the proposed ASIC will be designed, fabricated, tested, and developed ASIC samples will be provided.

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

An example is JUpiter ICy moons Explorer (JUICE) that includes a Submillimeter Wave Instrument (SWI) – spectrometer that operates in the 530–630 GHz and 1080–1275 GHz ranges. The OASIS proposed mission to MidEx is another example of instrumentation that calls for a wide-band, small-size, low-cost and low-power spectrometer solution. These and many other missions would benefit from the expanded spectral coverage and improved resolution offered by the proposed 28GHz bandwidth low-power spectrometer technology.

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

Spectrometers are employed on satellites, aircraft and air balloons for remote sensing and surveillance. EPA and NOAA require spectrometers for spaceborne, airborne and ground based remote sensing instruments for temperature, water vapor, pollutant, ozone and other exploration. Spectrometers are also used for synthetic aperture radar, sonar or visible light, infrared or UV image processing.

Duration: **24**

PROPOSAL NUMBER: 22-2- **Z14.01-2648**

PHASE 1 CONTRACT NUMBER: 80NSSC22PB124

SUBTOPIC TITLE: Lunar Surface Excavation

PROPOSAL TITLE: Adapting Novel Terrestrial Mining Technologies for Lunar Excavation

Small Business Concern

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Principal Investigator:

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Summary Details:

Estimated Technology Readiness Level (TRL) :

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

OffWorld is developing a system architecture to accomplish difficult tasks in harsh environments on earth, the moon, and beyond. Features of the swarm robotic industrial toolkit include a modular architecture, a common software stack, and shared AI and ML methodologies. OffWorld is developing these capabilities in revenue-generating markets on earth for adaptation off planet to the Lunar environment. By leveraging simultaneous and parallel development paths for terrestrial and Lunar applications, OffWorld can rapidly develop, test, and operationalize the variety of capabilities necessary to deploy a functional Lunar excavation system. By commercializing large terrestrial markets in the mining and infrastructure sectors, OffWorld can build these capabilities primarily with revenue earned from commercial contracts and augmented by investment and other capital opportunities. OffWorld's technology roadmap includes parallel development pathways of terrestrial and space capabilities to target specific hardware, software, and AI/ML functions. At the end of each of these projects, the hardware, software, and automation advances inform a data-driven evolution of the system architecture and CONOPs, until the system is ready for a demo in the Lunar environment. This NASA Phase II project affords the opportunity to continue refinement of the excavation toolset including the mechanical tooling and the force application approach, as well as the mobility approach and the control software for excavation. These lessons will incorporate into the full system design and move the architecture much closer to deployment. Once the applications of excavation and transport are refined and tested, additional functions will be added to the growing skill set of capabilities. The modular architecture of the OffWorld platform, combined with common software and AI methodologies enable rapid development of additional species of robots that can be used in additional industrial use cases.

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

A major NASA application for this system is the excavation of regolith from the lunar surface. This layer of regolith can be removed, transported and processed for production of water, oxygen, and hydrogen components that can be used as propellant. Additionally, oxygen and water will be necessary for human consumption to support NASA exploration activities. More advanced versions of the OffWorld robotic squads will be able to extract additional volatiles and other materials from the regolith to be used in other industrial applications.

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

Crucial commercial commodities in the developing cis-lunar economy are likely to be propellant, human consumables, energy, and mobility. These materials and services will be necessary for

virtually every commercial application. OffWorld will be able to adapt its modular systems into a variety of commercial use cases in mining, infrastructure, and transportation.

Duration: **24**

PROPOSAL NUMBER: 22-2- **Z1.05-2530**

PHASE 1 CONTRACT NUMBER: 80NSSC22PB209

SUBTOPIC TITLE: Lunar and Planetary Surface Power Management and Distribution

PROPOSAL TITLE: Radiation Hardened High Power Ga2O3 Based Isolated DC-DC Converter

Small Business Concern

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Principal Investigator:

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Business Official:

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Summary Details:

Estimated Technology Readiness Level (TRL) :

Begin: 2
End: 5
Technical Abstract (Limit 2000 characters, approximately 200 words):

Recently realized radiation-hardened Gallium Oxide (Ga2O3) Metal–Oxide–Semiconductor Field-Effect Transistor, (MOSFETs) offers the opportunity to increase efficiency and power density of space DC-DC power converters. The state of the art for space DC-DC power conversion trails its commercial counterparts in terms of power density and efficiency. One challenge that arises when designing for space environment is the harsh environment power converters need to operate in, and limited availability of space qualified components and field demonstrated converter topologies. Another challenge is the manufacturing process and reliability testing of reliable radiation hardened power MOSFETs. Ga2O3 MOSFETs not only have better electrical performance than power MOSFETs, they have also demonstrated inherent tolerance to radiation. This results in fewer structural device modifications required to make Ga2O3 MOSFETs operate reliably under high radiation compared to their Silicon counterparts. Syrnatec, an ITAR compliant, HUBZone, minority woman-owned small business has meet all the size, weight and power (SWaP) criteria set forth in Phase I. As the developed radiation hardened Ga2O3 based Fixed Frequency Isolated Phase Shifted Full Bridge DC-DC Converter supports 10 kW of power over a wide-temperature (-123ºC to 150ºC), provides high-power-density (>2 kW/kg), high-efficiency (>96%) power electronics with associated drivers for voltage regulation and can be applicable to Space based applications

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

Proposed 10KW WBG DC-DC converter will address Lunar and Mars base initiatives. This Power Converter will benefit other NASA Mission Directorates - Science Mission Directorate and Aeronautics Research Mission Directorate. Specific projects that could find value include Gateway, In-Situ Resource Utilization, Advanced Modular Power Systems, In-Space Electric Propulsion, Planetary Exploration and Electrified Aircraft Propulsion Technology. This technology will used for Artemis ,Mars, Asteroid research and search of life on other planets missions.

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

Off-highway, Mining and Construction Vehicles, Power, for Telecom Infrastructure, E-Vehicle Charging Stations, Renewable Energy Conversion Electronics, Combat Ground Vehicle Systems, Aviation Systems, Electrical Power Systems for Telecommunication Equipment .

Duration: **24**

PROPOSAL NUMBER: 22-2- **S13.05-2850**

PHASE 1 CONTRACT NUMBER: 80NSSC22PB035

SUBTOPIC TITLE: In Situ Instruments/Technologies for Lunar and Planetary Science

PROPOSAL TITLE: Low Size, Weight, and Power, High Gain 2D Material-Based Detectors for Mass Spectrometers

Small Business Concern

Firm: **Guardion, Inc.**
Address: **151 South Bedford Street, Unit 108B, Burlington, MA 01803**

Phone: **(603) 769-7265**

Principal Investigator:

Name: **Daniel Esposito**
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Address: **1 Davis Ct, Unit 1C, NH 03064 - 2341**
Phone: **(603) 769-7265**

Business Official:

Name: **Daniel Esposito**
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Summary Details:

Estimated Technology Readiness Level (TRL) :

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

This project will develop low power, high intrinsic amplification 2D material ion detectors shown in Phase I to work as low mass, low volume detectors for mass spectrometry from the feasibility stage to working examples. Guardion's proposed solution is to eliminate the need of high voltage electron multipliers utilizing patented 2D material-based ion detectors that provide intrinsic charge to current amplification values ranging between 1E6-1E9 A/C, and only require an operating bias of 0.1V. It further distinguishes between positive and negative ions, and works from atmospheric pressure through ultra high vacuum. Unlike conventional methods of detection used in mass spectrometry, our sensors will exploit a low-bias intrinsic quantum gain mechanism in nanomaterials to amplify the signal from trace amounts of ions. This eliminates the need for external amplification, eliminates high voltage requirements, and significantly reduces power consumption. We have shown that replacing sensors in a commercial residual gas analyzer with these detectors can sense trace gasses. We propose to modify two existing mass filter systems, one residual gas analyzer and one ion trap mass spectrometer with our detector assembly and demonstrate comparable performance to state of the art detectors while using 10,000x less voltage. We will then demonstrate sensor response to mass range, sampling rate, charge state, and ion energy. Finally, we will generate a demonstration and report assessing the sensor performance, benefits, and limitations with suggestions on what types of mass spec and missions would be benefitted for sensor adoption.

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

This innovation will directly impact NASA planetary, lunar, and terrestrial missions that rely on mass spectrometry. Successful development of this technology will eliminate the high voltage requirements, eliminate potting, and provide an amplification mechanism that works at a wider range of pressures. By lowering the SWaP of mass spectrometers and potentially reducing the

requirements on pumping systems, NASA will be able to pursue more ambitious mission concepts, improve analytical capability, and instrument durability.

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

Mass spectrometry is a critical analytical tool in a diverse set of industries - from drug discovery, forensic toxicology, clinical research, and homeland security. These new sensors will enable the next generation of mass spectrometers to be more portable, efficient, and resilient, opening up new market opportunities and allowing more access to mass spec systems in the lab and in the field.

Duration: **24**

PROPOSAL NUMBER: 22-2- **S13.01-2209**

PHASE 1 CONTRACT NUMBER: 80NSSC22PB128

SUBTOPIC TITLE: Robotic Mobility, Manipulation and Sampling

PROPOSAL TITLE: High Strain Composite Booms for Sampling, Mobility and Manipulation

Small Business Concern

Firm: **Opterus Research and Development, Inc.**
Address: **815 14th Street Southwest, Suite C200, Loveland , CO 80537**
Phone: **(505) 250-3006**

Principal Investigator:

Name: **Thomas Murphey**
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Business Official:

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Phone: **(505) 250-3006**

Summary Details:

Estimated Technology Readiness Level (TRL) :

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

The proposed innovation is to adapt Opterus' high strain composite boom and deployer technologies and apply the low-mass, low-power dust tolerant technology to robotic arms for low-gravity environments. A boom enabled robotic arm enables surface sampling, mobility, and manipulation in an extremely compact, low mass sub system. The high structural performance and low mass features of Opterus' booms and deployment mechanisms can support a greater range of end effectors for scooping, drilling, grasping, or otherwise acquiring samples or manipulating surface objects. Opterus is also investigating continuous roll-to-roll fabrication methods for kilometer scale HSC booms.

The objective of the proposed work is to fabricate prototype boom deployer mechanisms and experimentally demonstrate the technical feasibility of high strain composite booms applied to a variety of robotic mobility, manipulation, and sampling tasks through laboratory testing and ground demonstrations.

Opterus will employ an iterative development approach using the analysis, design, build, test cycle. In the course of HSC development programs, we have found a balance between build and analysis to be most effective and we expect to achieve 3-5 cycles in this program. New HSC booms often require 10-20 build iterations to achieve desired objectives. Development will be accelerated here because of Opterus' extensive experience with high strain composite booms.

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

HSC booms are enabling for NASA's next generation of robotic architectures for multiple small-body sample-return missions such as from Ceres, comets, and asteroids. Further, planetary missions such as the Ocean Worlds program with surface and deep drills for Europa, and future missions to Enceladus, Titan, and other planetary bodies with subsurface oceans. With a renewed interest in return to Earth's Moon, the mobility and sampling technologies will support future robotic missions to the Moon and Mars.

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

Non-NASA markets include similar operations but in-space rather than small bodies or planets. On-orbit servicing, assembly, and manufacturing is a key DoD market for the robotic arm architectures enabled by Opterus' HSC booms.

Duration: **24**

PROPOSAL NUMBER: 22-2- **Z10.04-2369**

PHASE 1 CONTRACT NUMBER: 80NSSC22PA916

SUBTOPIC TITLE: Materials, Processes, and Technologies for Advancing In-Space Electric Propulsion Thrusters

PROPOSAL TITLE: Improved Thermo-Mechanical Design of the VASIMR RF Coupler

Small Business Concern

Firm: **Ad Astra Rocket Company**
Address: **141 West Bay Area Boulevard, Webster, TX 77598**
Phone: **(281) 526-0518**

Principal Investigator:

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Phone: **(281) 526-0525**

Business Official:

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Phone: **(281) 526-0518**

Summary Details:

Estimated Technology Readiness Level (TRL) :

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

The proposed work on Phase II involves the design, manufacture, and test of a full-scale embedded RF Coupler for the plasma “heater” stage of the VX-200SS™ VASIMR® rocket core. The RF Coupler is a critical power component of the engine and, specifically, the heater stage RF Coupler delivers the largest fraction of the power to the VASIMR® plasma.

In 2021, an earlier innovation to the design of the RF Coupler-GCT assembly, called the “Trapped Coupler,” enabled the VASIMR® VX-200SS™ test article to reach thermal steady-state at a company record of 80 kW. With the “Embedded Coupler” design, the proposed innovation in Phase II of this SBIR, and the knowledge obtained from Phase I, the Ad Astra team looks to increase that power to ≥100 kW, an objective relevant to the Phase I Solicitation Subtopic, High-Power Electric Propulsion Thrusters for Mars-Class Missions.

In a “Trapped Coupler,” all heat coming from the ceramic must pass through its inner diameter surface. In contrast, the Embedded Coupler uses its walls as two additional surface heat pathways. Theoretical estimates conducted by the Ad Astra team show that the heat transfer area in the embedded design increases by roughly a factor of 3 and results in a lower steady-state temperature for the GCT.

To accomplish this, the RF Coupler will be machined-in-place in a high-purity copper vein pattern cast on a ceramic GCT host. The coolant within the coupler flows along two stacked counter-flowing channels, a feature required by the current RF electrical circuit. Other potential designs for this channel structure are possible and being explored outside of this SBIR but, in all cases, the manufacture requires a high-precision welding technique that Ad Astra has developed in-house and successfully demonstrated in the Trapped Coupler configuration.

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

- Lunar resupply missions with high-power solar and nuclear electric propulsion (SEP/NEP)

- Fast interplanetary robotic science missions with high-power NEP

- Cislunar NASA in-space transportation with high-power SEP/NEP

- Planetary defense missions with high-power SEP/NEP

- Orbital debris mitigation (could also be non-NASA)

- Multi MW-class human fast interplanetary missions with high-power NEP

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

- Lunar resupply missions with high-power SEP/NEP

- In-space "mining" missions with high-power SEP/NEP

- Cislunar commercial in-space logistics with high-power SEP/NEP

- DoD cislunar robotic applications with high-power SEP/NEP

- Mission extension, resupply, maintenance and repair vehicles with high-power SEP/NEP

- Reboost and orbit maintenance of large space stations in LEO with high-power SEP

Duration: **9**

PROPOSAL NUMBER: 22-2- **S11.01-1459**

PHASE 1 CONTRACT NUMBER: 80NSSC22PB227

SUBTOPIC TITLE: Lidar Remote-Sensing Technologies

PROPOSAL TITLE: Novel Ultraviolet Laser Source for Ozone Differential Absorption Lidar

Small Business Concern

Firm: **TIPD, LLC**
Address: **1430 North 6th Avenue, Tucson, AZ 85705**
Phone: **(520) 622-0804**

Principal Investigator:

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Business Official:

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Summary Details:

Estimated Technology Readiness Level (TRL) :

Begin: 3
End: 5

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

280-300 nm spectral region is part of ozone absorption spectrum, and lasers operating in this region are used for lidar measurements. The pulsed UV laser system in that region is used by NASA for the Langley mobile ozone lidar (LMOL). This system output is a train of alternating pulses at two distinct wavelengths from 285-300 nm spectral range. The laser active medium is a Ce:LiCAF crystal pumped by a quadrupled radiation from a Q-switched Nd:YLF laser. Such a laser scheme is complex and has low efficiency: with 0.2 W of UV output power the system consumes 2 kW, so overall wall-plug efficiency is 0.01%**.** TIPD proposes to develop a simple, compact, robust, and efficient laser source based on GaN diodes and Tb-doped gain materials to satisfy NASA's requirements. In this phase II program, TIPD will deliver Tb-based 291/294nm prototype to NASA and demonstrate 302/304nm laser source for the second DIAL wavelength.

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

Space exploration applications include follow on applications to NASA's Lidar Atmosphere Sensing Experiment (LASE) program, ablation and spectroscopic tools for the New Frontiers mission to the Jovian moons, and enhanced capabilities for the SHERLOC instrument package. The UV-B laser could be used in the search of life in the extra-terrestrial by detecting organic/inorganic molecules.

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

Commercial applications including advanced R&D and industrial manufacturing such as in the microfabrication of transparent materials such as GaN wafers, massless lithography for circuit

boards and electronics. UV-B light offers improved sensitivity over visible lasers atomic and molecular spectroscopy and chemical dynamics.
Duration: **24**

PROPOSAL NUMBER: 22-2- **S12.01-2830**

PHASE 1 CONTRACT NUMBER: 80NSSC22PA963

SUBTOPIC TITLE: Exoplanet Detection and Characterization Technologies

PROPOSAL TITLE: Next Generation Vector Vortex Waveplates for Astronomical Coronagraphs

Small Business Concern

Firm: **BEAM Engineering for Advanced Measurements**
Address: **1300 Lee Road, Orlando, FL 32810**
Phone: **(407) 734-5222**

Principal Investigator:

Name: **Nelson Tabirian**
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Business Official:

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Summary Details:

Estimated Technology Readiness Level (TRL) :

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

Vector vortex waveplates (VVWs) are highly promising technology enabling astronomical coronagraph masks for exoplanet imaging and characterization. Currently, the technology basics are well known, and there have been successful demonstrations of VVWs meeting several key operational requirements. The next generation of VVWs under development will make it possible to extend their spectral range of performance into infrared, further increase the contrast using novel materials, and would improve manufacturing to reduce cost. Yield and quality will be increased by eliminating internal and external sources of structural non-uniformities and defects and by employing novel minimally invasive manufacturing processes. Novel designs and device architectures to be developed in the Phase 2 of the project are intended to improve performance of VVWs to the levels that would not require polarization filtering thus increasing the throughput nearly twice. High contrast liquid crystal polymer broadband reflective VVWs to be developed wherein geometrical phase is insensitive to retardation would allow novel coronagraph architectures while minimizing dependence on process conditions and simplifying manufacturing. Furthermore, the next generation VVWs would allow reducing size and weight of coronagraphs by integrating VVW technology with other planar optics functions.

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

Astronomical coronagraphs, optical communications; quantum computing; super-resolution imaging

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

Free-space optical communication; optical tweezers and micromanipulation; bio-sensors; quantum computing; image processing; Shaping of high power laser beams

Duration: **24**

PROPOSAL NUMBER: 22-2- **S13.01-1600**

PHASE 1 CONTRACT NUMBER: 80NSSC22PB202

SUBTOPIC TITLE: Robotic Mobility, Manipulation and Sampling

PROPOSAL TITLE: Sediment Sequestration for Hot Water Drilling Cryobots

Small Business Concern

Firm: **Stone Aerospace, Inc.**
Address: **3511 Caldwell Lane, Del Valle, TX 78617**
Phone: **(512) 529-9778**

Principal Investigator:

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Business Official:

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Summary Details:

Estimated Technology Readiness Level (TRL) :

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

This Phase II proposal focuses on an innovation to resolve the sediment problem in deep ice drilling. Accumulated insoluble debris could hinder descent of a *cryobot* (ice-penetrating robot) on a mission to explore icy ocean worlds or ice strata on Mars. Section S13:01 of the 2022 SBIR solicitation stated: "*preference will be given to those proposals that would benefit in situ studies of icy ocean worlds, especially techniques that would be beneficial to systems that will descend through kilometers of cryogenic ice.*" The MJOLNIR innovation aims to address this call by mitigating the risk of debris accumulation for cryobots by periodically creating "side pockets" in the ice where debris can be sequestered. Phase I work used computational fluid dynamic particle tracking code to model a wide range of parameters that affect the ability to move collected insoluble material into sequestration pockets. We identified a feasible CONOPS: 1) downward closed-cycle hot water drill (CCHWD) jetting proceeds until the vehicle descent is slowed due to debris collection; 2) it switches to passive melting until the nose reaches the debris accumulation; 3) lateral jets near the nose cut deep side pockets; 4) jet flow turbulence moves the particles into the pockets; 5) the vehicle resumes passive melting to slowly move past the side pockets as particles settle out in the pockets; and 6) the vehicle resumes CCHWD jetting descent. Phase II focuses on three laboratory investigations: 1) measuring ground truth geometry of the sequestration pockets created under a wide range of jet parameters; 2) testing the ability to sequester a wide range of insoluble particles; and 3) examining the effect of ice temperature on the side pocket approach. The CCWD approach enables cryobots to breach debris-laden ice and the MJOLNIR innovation will provide debris mitigation enabling long descent distances. NASA mission applications include exploration of Mars polar ices and all ice-covered ocean worlds.
Potential NASA Applications (Limit 1500 characters, approximately 150 words):

MJOLNIR allows ice-penetrating cryobots such as THOR to breach debris-laden ice (ice fraction >50%), providing steady state debris mitigation over long descent distances. Potential NASA mission application include: Mars polar cap (2-3 km) subsurface access and sampling; Europa's 10-40 km ice crust with ocean access; Ganymede's rocky ice crust for strata and sampling studies; Enceladus's estimated 10-40 km thick ice crust with ocean or cryovolcanic access; and other icy ocean worlds

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

The MJOLNIR system may be implemented on terrestrial hot water drill rigs to manage sediment for glacial and astrobiological investigations: Basal access to bedrock layer through heavily

debris-laden ice at base of ice sheets in Antarctica and Greenland; heavy debris alpine glacier penetration for strata-based sampling, and access to subsurface water conduits; volcanic caldera glaciers

Duration: **24**

PROPOSAL NUMBER: 22-2- **S16.07-1786**

PHASE 1 CONTRACT NUMBER: 80NSSC22PA998

SUBTOPIC TITLE: Cryogenic Systems for Sensors and Detectors

PROPOSAL TITLE: Low Cost Radiation-Hardened Cryocooler Control Electronics for Space Missions

Small Business Concern

Firm: **Creare, LLC**
Address: **16 Great Hollow Road, Hanover, NH 03755**
Phone: **(603) 643-3800**

Principal Investigator:

Name: **Bruce Pilvelait**
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Phone: **(603) 640-2316**

Business Official:

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Summary Details:

Estimated Technology Readiness Level (TRL) :

Begin: 5
End: 6
Technical Abstract (Limit 2000 characters, approximately 200 words):

Many NASA and commercial space science missions require high performance electronics within strict budgetary limits. Many of these missions, therefore, use commercial-grade electronic products despite significant technical risk due to lack of radiation hardness. Creare proposes to evolve our commercial-grade, three-phase Brushless DC motor drive electronics to be adaptable for missions which require higher reliability, radiation-hardened cryocoolers at reasonable cost. During Phase I, we developed a drive electronics design which meets cost and radiation-hardness requirements for LEO and lunar missions. We will ensure compatibility for future missions by working closely with a leading developer of low-cost cryocoolers with dozens of space flight coolers delivered to date and with dozens more already known in the future pipeline. During Phase II, we will work closely with our partner to fabricate and qualify a radiation-hard, low-cost cryocooler-control electronics solution for space missions. Successful completion of this program will substantially expand the use of low-cost cryocoolers for space-borne science, surveillance, and reconnaissance missions.

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

The successful completion of this program will provide mission planners with high-performance and low-cost cryocooler control electronics that satisfy radiation-hardness requirements for small platform missions. The primary NASA application will be for cooling detectors, sensors, shields, and telescopes for planetary science missions.

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

The proposed cryocooler control electronics are ideal for small, cost-constrained satellite missions such as LEO CubeSats. Military applications include space-based surveillance for Operationally Responsive Space missions and Unmanned Aerial Vehicles.

Duration: **24**

PROPOSAL NUMBER: 22-2- **S17.03-1917**

PHASE 1 CONTRACT NUMBER: 80NSSC22PB168

SUBTOPIC TITLE: Fault Management Technologies

PROPOSAL TITLE: Damage Propagation Assessment - A Causal Model Approach for Design and Operations

Small Business Concern

Firm: **Qualtech Systems, Inc.**
Address: **100 Corporate Place, Suite 220, Rocky Hill, CT 06067**
Phone: **(860) 257-8014**

Principal Investigator:

Name: **Sudipto Ghoshal**
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Summary Details:

Estimated Technology Readiness Level (TRL) :

Begin: 3
End: 6

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

Qualtech Systems, Inc. (QSI) in collaboration with Dr. Stephen B. Johnson of Dependable Systems Technologies (DST) proposes a novel, causal graph-based model and a systematic modeling methodology for assessing damage propagation due to one or multiple originating faults and how the propagation affects and damages other components. In fault propagation, downstream components from the root-cause fault which rely on its function, may also fail. When the root cause is mitigated, those downstream components resume their normal operating behavior. During damage propagation, the originating fault's damage, leads to the failure effects in which physical damage to downstream components is a consequence, such that those components can no longer function nominally. Even if the originating fault recovers or is replaced or bypassed, the downstream damaged components do not recover and continue to remain in a failed state.
This proposal aims to create a new software module for QSI's TEAMS® tool suite that incorporates component damage as a failure cause and can identify the differences between components in which failure effects 'pass through' or cause only functional impairment versus those that can cause physical damage. This new capability will enable the modeler to represent damage induced component failure modes and their interaction with functional failure modes. Distinction between the two, where the functional failure mode can be caused by damage or bad inputs from impairments upstream, will allow TEAMS® to generate a more comprehensive and accurate assessment of the health of the components of the system and facilitate appropriate mitigation actions.

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

The proposed technology is aimed at facilitating effective usage of model-based systems engineering for improving fault tolerance and mitigation response capability during design, and the concomitant software tool for supporting its implementation, will allow NASA to better design, plan and execute future Science Missions. The proposed technology is positioned for direct applications for NASA missions that deploy complex equipment such as the Lunar Gateway, the Space Launch System, the Human Lander, Europa Clipper and rovers such as the VIPER.

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

We envisage the proposed technology to be of significant interest for DoD's Mission planning and Rapid design of space missions/satellites where model-based design processes will be used for supporting infrastructure Space services capabilities. QSI is currently working with the Army for fault management design of the Remote Combat Vehicle (RCV) and plan to apply this technology for that effort.

Duration: **24**

PROPOSAL NUMBER: 22-2- **S14.01-1861**

PHASE 1 CONTRACT NUMBER: 80NSSC22PA956

SUBTOPIC TITLE: Space Weather Research-to-Operations/Operations-to-Research (R2O/O2R) Technology Development

PROPOSAL TITLE: Dragster: An Ensemble Assimilative Model for Satellite Drag

Small Business Concern

Firm: **Atmospheric & Space Technology Research Associates, LLC**
Address: **282 Century Place, Suite 1000, Louisville, CO 80027**
Phone: **(303) 993-8993**

Principal Investigator:

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Business Official:

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Summary Details:

Estimated Technology Readiness Level (TRL) :

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

Due to the number of objects in orbit around Earth, NASA and the US Government need an upgraded operational capability to meet stringent Space Situational Awareness satellite trajectory accuracy requirements for many missions, including conjunction analysis. More accurate drag modeling will increase the safety margin and decrease false alarms, improving mission management, while maintaining rigorous safety standards. We propose a Space Weather specification & forecasting approach that potentially leads to both more accurate nowcasts of satellite drag and the quantification of orbital uncertainties in LEO altitude ranges (up to ~2,000 km), as well as 2- to 3-day forecasts of atmospheric drag effects on satellites. Dragster - a TRL 5 ensemble assimilative model developed by Orion Space Solutions, with SBIR and internal funding, provides such a drag model. The Dragster software framework delivers a comprehensive nowcast and forecast system for neutral density, winds, temperature, composition and satellite drag along any specified orbit. The current operational drag models do not satisfy operational satellite drag forecasting objectives. Validation studies have shown that Dragster already equals or outperforms the operational models and has the potential to meet drag specification and forecasting objectives out to 2,000 km for the first time. Dragster is currently at a NASA Software TRL level of 5. It is ready for transition to higher TRL levels and operational status. The focus of this Phase II R2O/O2R effort is to increase the Dragster TRL to 8, taking advantage of modern software tools and practices, and prepare it for transition to operations. NASA/CCMC and NOAA/SWPC are our target transition partners. NASA/CARA, NOA/SWPC, Space Force and various commercial entities will be the ultimate operational users.

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

NASA needs more accurate orbital and sub-orbital collision avoidance modeling up to 2000km. Using modern software tools and techniques the Dragster SSA technology is useful to NASA in multiple ways. Through a close relationship with CCMC/SWRC the computed neutral density, drag and uncertainty values could be assimilated into the CARA Operational Process. Dragster can utilize a variety of background models and assimilate orbital data sets that can be tailored to specific stakeholders and missions in ways that protect privacy and security.

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

Our innovative neutral atmosphere drag modeling framework called Dragster has strong commercial potential in the Space Traffic Management market. It is well suited for both U.S. Government and private sector applications, including the Department of Commerce, DoD, and commercial companies, which have interest in orbital drag, and space debris avoidance.

Duration: **24**

PROPOSAL NUMBER: 22-2- **S12.04-1446**

PHASE 1 CONTRACT NUMBER: 80NSSC22PB039

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

PROPOSAL TITLE: Binary Pseudo-Random Array (BPRA) Standards for Inspection and Calibration of Cylindrical Wavefront Interferometry

Small Business Concern

Firm: **HighRI Optics**
Address: **5401 Broadway Terrace #304, Oakland, CA 94618**
Phone: **(360) 402-4112**

Principal Investigator:

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Summary Details:

Estimated Technology Readiness Level (TRL) :

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

High-accuracy metrology is vitally important in manufacturing and optimally using ultra-high-quality free-form mirrors designed, for example, for space X-ray telescopes to manipulate X-ray light with nanometer-scale wavelengths. Due to the shorter wavelength, requirements on the surface figure (shape) and finish (roughness) of X-ray mirrors are many orders of magnitude more stringent than for visible-light optics. The metrology integrated into X-ray mirror manufacturing must ensure the accuracy of optical surface fabrication on the sub-nanometer level over a large area (on the scale of a meter and even more) strongly aspherical optical elements with the sagittal ROC on the order of a meter and less, whereas the tangential ROC can reach a few hundred meters. The absence of the required metrology is the major limitation of modern technology used for the fabrication of X-ray mirrors. As an adage says, "If you can't measure it, you can't make it."

Binary Pseudo Random Array test artifacts and accompanying data processing software offer unparalleled advantages to quantitatively characterize the instrument transfer function (ITF) of the metrology tools and enable data reconstruction to reveal the "true" surface. Previously,

BPRA Based methodology has been validated with planar wavefront. In this Project, BPRA-based test artifacts & data processing methodology is adapted for the Cylindrical Wavefront Interferometry for inspection and calibration for mid-long range spatial frequencies. In Phase II, we will develop BPRA test artifacts with adjustable Radius of Curvature, and Computer Generate Holograms combined with BPRA for thorough calibration, and then data reconstruction based on the measured calibration data. The final product will be the BPRA test artifact with user-friendly and GI-controlled software.

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

This product improves the integrated metrology process. The ability to assess the high accuracy and high-efficacy metrology is key to further improvement of the optical fabrication and lowering the cost of the X-ray optics.
Potential Non-NASA Applications (Limit 1500 characters, approximately 150 words):

Both precision optics manufacturers and metrology tool makers are strongly interested in this technology. They all agree on the importance of metrology to further improve the product quality in optics and provide better metrology tools (including interferometers) to the customers.
Duration: **24**

PROPOSAL NUMBER: 22-2- **S15.01-1352**

PHASE 1 CONTRACT NUMBER: 80NSSC22PB078

SUBTOPIC TITLE: Plant Research Capabilities in Space

PROPOSAL TITLE: Miniaturized Reagent Regenerative Ion Analyzer for Elemental Analysis

Small Business Concern

Firm: **Lynntech, Inc.**
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Principal Investigator:

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Summary Details:

Estimated Technology Readiness Level (TRL) :

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

NASA has been developing Bioregenerative Life Support Systems (BLSS), supplying food and oxygen and removing carbon dioxide, as complement of physical and chemical life support systems for the future space exploration, Martian missions, and the construction of lunar bases. As plant-growing systems mature and expand for future exploration missions, the need to generate, analyze, and manage nutrient solutions will increase. Thus, an in-situ capability is needed to analyze, on a near-real-time basis, plant nutrient solutions or feed water in space missions to better understand and manage plant nutrient delivery. The technology would need to be robust and miniaturized, operate with low power, and have minimal consumables, in addition to meeting safety criteria.
In a Phase I feasibility study, Lynntech successfully demonstrated a Reagent-regenerative, Microgravity-compatible, Miniaturized Ion Analyzer (RMMIA) as a potential onboard analyzer for the elemental composition of plant growth solutions. The Phase I study demonstrated the RMMIA's feasibility by carrying out a laboratory evaluation of key components and device sub-assemblies, with performance testing using representative plant nutrient solutions.
During the Phase II, an optimized RMMIA unit will be designed, fabricated, tested, and delivered to NASA. Testing will include nutrient solutions such as Hoagland solution. Deliverable items will demonstrate on-demand and in-line automated operation capabilities.

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

Direct NASA applications of the reagent-regenerative, microgravity-compatible, miniaturized ion analyzer (RMMIA) include the on-board elemental analysis device to analyze plant nutrient solutions or feed water to better understand and manage plant nutrient delivery on a near-real-time basis. The multi-analyte capability of the proposed technology will expand to measurements of ionic species in condensate, potable water, wastewater, byproducts of water treatment for manned space exploration missions beyond low Earth orbit.

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

Successful development of the reagent-regenerative, miniaturized ion analyzer (RMMIA) as a portable device will have a high commercial applicability to a wide range of industries where water quality assurance and control are vital, such as to monitor source and drinking water, wastewater, recycled water, and industrial effluent in many industries.

Duration: **24**

PROPOSAL NUMBER: 22-2- **H12.07-2147**

PHASE 1 CONTRACT NUMBER: 80NSSC22PB075

SUBTOPIC TITLE: Protective Pharmaceutical Packaging

PROPOSAL TITLE: DoseShield Packaging for Improved Pharmaceutical Protection in Space

Small Business Concern

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Summary Details:

Estimated Technology Readiness Level (TRL) :

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

The availability of pharmaceuticals necessary to crews during spaceflight is critical to mission success. This need becomes more significant for long-duration missions where the range of physiological and adaptive alterations on the body, in addition to the isolation and distance from Earth, can present additional challenges. Lunar and planetary exploration missions beyond low Earth orbit (LEO) in particular will require an expanded pharmacy that maintains appropriate stability throughout long-term 24- or 36-month durations. Studies have begun to evaluate the stability of pharmaceuticals in space, and a subset of drug products have been demonstrated to fail USP requirements prior to labeled expiration dates when flown in space. The environmental conditions of space introduce additional factors, and space radiation has been shown to significantly differ in the types, dose, and length of exposure compared to that experienced

terrestrially. Select medications are currently repackaged outside of manufacturer's packaging to conserve mass and volume on the spacecraft, and this will also affect the shelf-life of the drugs if the new package is not protective. To address this critical need, Luna Labs USA, LLC is developing DoseShield packaging. This protective packaging system includes two components. The first component provides protection of susceptible solid doses against environmental exposures known to affect stability (e.g. moisture, oxygen) without the typical costs to mass and volume. Additionally, a radiation-protective casing is under development to address the concerns of radiation exposure during spaceflight. The technology is expected to strengthen readiness for upcoming long-duration space missions.

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

The proposed packaging solution will be designed for easy integration into current NASA processes for medical kit packaging for spaceflight. The technology will be engineered to provide stability to pharmaceuticals by protecting them from environmental conditions such as temperature, humidity, and space radiation.

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

Additional non-NASA applications may include commercial spaceflight initiatives. Military and civilian operations that require a reduced pharmaceutical packaging footprint compared to that provided by manufacturer packaging would have applicability.

Duration: **24**
