



# Funding and Strategic Alignment Guidance for Infusing Small Business Innovation Research Technology Into Science Mission Directorate Projects at Glenn Research Center for 2015

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# **Funding and Strategic Alignment Guidance for Infusing Small Business Innovation Research Technology Into Science Mission Directorate Projects at Glenn Research Center for 2015**

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## **Abstract**

This report is intended to help NASA program and project managers incorporate Glenn Research Center Small Business Innovation Research/Small Business Technology Transfer (SBIR)/(STTR) technologies into NASA Science Mission Directorate (SMD) programs/projects. Other Government and commercial project managers can also find this useful.

## **Introduction**

Incorporating Small Business Innovation Research (SBIR)-developed technology into NASA projects is important, especially given the Agency's limited resources for technology development. The program's original intention was for technologies that had completed Phase II to be ready for integration into NASA programs, however, in many cases there is a gap between Technology Readiness Levels (TRLs) 5 and 6 that needs to be closed.

After SBIR Phase II projects are completed, the technology is evaluated against various parameters and a TRL rating is assigned. Most programs tend to adopt more mature technologies—at least TRL 6 to reduce the risk to the mission rather than adopt TRLs between 3 and 5 because those technologies are perceived as too risky. The gap between TRLs 5 and 6 is often called the “Valley of Death” (Figure 1), and historically it has been difficult to close because of a lack of funding support from programs. Several papers have already suggested remedies on how to close the gap (Refs. 1 to 4).

## **SBIR Solicitation Process**

Understanding how the SBIR solicitation process works should help small businesses and Science Mission Directorate (SMD) project managers form partnerships to incorporate SBIR technologies into NASA programs and projects. For example, when SMD program managers identify specific SBIR subtopics that are likely to generate technologies that could apply to their programs or projects, the SBIR office would provide information about previously developed technologies that could be incorporated into their work. Small business principal investigators (PIs) would also benefit from understanding NASA program and project needs, thus increasing the likelihood that the technologies they developed will be infused into SMD programs and projects. The fiscal year (FY) 2015 and 2014 solicitations are posted at <http://sbir.gsfc.nasa.gov/solicitations>.

Integrating SBIR-developed technology into NASA programs and projects is important, especially given the Agency's limited resources for technology development. The SBIR program's original intent was for technologies that had completed Phase II to be ready for integration into NASA programs. Now the SBIR program supports its small business partners with three post-Phase II options that focus on creating opportunities for commercialization as well as technology integration. The Phase II Enhancement (Phase II-E), Phase II Expanded (Phase II-X), and Commercialization Readiness Pilot (CRP) options also

		TRL	Description
SBIR Phases I and II	Basic research	1	Basic scientific/engineering principles observed and reported
	Feasibility research	2	Technology concept, application, and potential benefits formulated (candidate system selected)
	Feasibility research	3	Analytic and/or experimental proof-of-concept completed (breadboard test)
	Technology development	4	System concept observed in laboratory environment (candidate system selected)
Technology demonstration "Valley of Death"	Technology development	5	System concept tested and potential benefits substantiated in a controlled relevant environment
	System development	6	Prototype of system concept is demonstrated in a relevant environment
System development	System development	7	System prototype is tested and potential benefits substantiated more broadly in a relevant environment
	Operational verification	8	Actual system constructed and demonstrated with benefits substantiated in a relevant environment
	Operational verification	9	Operational use of actual system tested with benefits proven

Figure 1.—Technology Readiness Levels (TRLs).

provide opportunities for Phase II technologies to be integrated and tested in the NASA system platform or in the space environment.

The three post-Phase II options, which typically last between 6 and 36 months, create more opportunities to advance technology maturity, reduce associated risks, and increase the likelihood for integrating technology into NASA, Department of Defense (DoD), or external entity programs.

- Phase II-E: This option advances Phase II innovations by extending existing Phase II contracts. Under Phase II-E extensions, NASA SBIR will match, investments in technology development that small businesses secure from eligible non-NASA SBIR third parties on a dollar-for-dollar basis. The minimum matching investment is \$25,000 and the maximum is \$150,000, extending projects by 6 to 12 months.
- Phase II-X: This option establishes a strong and direct partnership between the SBIR program and NASA programs and projects undertaking new technology development. Under Phase II-X expansions, NASA SBIR will double the funding that small businesses secure from non-SBIR NASA programs or projects. The minimum investment that NASA SBIR will double is \$75,000 and the maximum is \$250,000. Expanded projects last between 12 and 24 months.
- The Commercialization Readiness Program (CRP): This option accelerates transition of SBIR-developed technologies into NASA applications. Projects that request SBIR funding under the CRP option must (1) involve a technology that entered into either a Phase I or Phase II contract and (2) identify how more SBIR funding would accelerate development in response to NASA program or project needs. The minimum matching investment is \$100,000 and the maximum is \$1.5 million, extending projects by 24 to 36 months.

Table I summarizes the three post-Phase II options.

SMD subtopics that Glenn leads and participates in for FY 2015 Phase I are shown in Figure 2 and their descriptions are listed in Chapter 9 of the FY 2015 Phase I SBIR solicitation.



SMD subtopics that Glenn leads and participates in for FY 2014 Phase II are shown in Figure 3 and their descriptions are listed in Chapter 9 of the FY 2014 Phase I SBIR solicitation.

TABLE I.—NASA SBIR POST-PHASE II FUNDING OPTIONS

Criteria	Phase II-E	Phase II-X <sup>a</sup>	CRP
Purpose	Advance SBIR technology by extending current Phase II contracts	Establish partnerships between NASA programs and projects and non-SBIR companies	Accelerate transition of SBIR-developed technologies into NASA applications
Funding source	Any eligible non-NASA SBIR third party	NASA program or project	Either eligible NASA program or project or non-NASA SBIR third party
Minimum, dollars	\$25,000	\$75,000	\$0
Maximum, dollars	\$150,000	\$250,000	\$0
SBIR match	1:1	2:1	Up to \$1,500,000
Performance period, months	6 to 12	12 to 24	24 to 36

<sup>a</sup>Beginning in FY 2012

S1 Sensors, Detectors, and Instruments

- S1.06 In-situ Sensors and Sensor Systems for Lunar and Planetary Science
- S1.07 Airborne Measurement Systems

S3 Spacecraft and Platform Subsystems

- S3.01 Power Generation and Conversion
- S3.02 Propulsion Systems for Robotic Science Missions
- S3.03 Power Electronics and Management, and Energy Storage
- S3.04 Unmanned Aircraft and Sounding Rocket Technologies
- S3.07 Thermal Control Systems

S4 Robotic Exploration Technologies

- S4.03 Spacecraft Technology for Sample Return Missions
- S4.04 Extreme Environments Technology

Figure 2.—SMD subtopics that Glenn leads and participates in for FY 2015 Phase I.

S1 Sensors, Detectors, and Instruments

- S1.06 In-situ Sensors and Sensor Systems for Lunar and Planetary Science

S3 Spacecraft and Platform Subsystems

- S3.01 Power Generation and Conversion
- S3.02 Propulsion Systems for Robotic Science Missions
- S3.03 Power Electronics and Management, and Energy Storage
- S3.04 Unmanned Aircraft and Sounding Rocket Technologies
- S3.07 Thermal Control Systems

S4 Robotic Exploration Technologies

- S4.03 Spacecraft Technology for Sample Return Missions
- S4.04 Extreme Environments Technology

Figure 3.—SMD subtopics that Glenn leads and participates in for FY 2014 Phase II.

## Phase I and II Contract Awards

The number of Phase I and II contracts associated with Glenn SMD subtopics are summarized in Table II and Table III.

TABLE II.—CONTRACT AWARDS ASSOCIATED WITH SMD SUBTOPICS THAT  
GLENN LEADS AND PARTICIPATES IN FOR FISCAL YEAR 2015 PHASE I

Subtopic <sup>a</sup>	Awards
S1.06 In-Situ Sensors and Sensor Systems for Lunar and Planetary Science	5
S1.07 Airborne Measurement Systems	8
S3.01 Power Generation and Conversion	4
S3.02 Propulsion Systems for Robotic Science Missions	9
S3.03 Power Electronics and Management, and Energy Storage	5
S3.04 Unmanned Aircraft and Sounding Rocket Technologies	4
S3.07 Thermal Control Systems	8
S4.03 Spacecraft Technology for Sample Return Missions	3
S4.04 Extreme Environments Technology	3

<sup>a</sup>See Appendix A for contract titles.

TABLE III.—CONTRACT AWARDS ASSOCIATED WITH SMD SUBTOPICS THAT  
GLENN LEADS AND PARTICIPATES IN FOR FISCAL YEAR 2014 PHASE II

Subtopic <sup>a</sup>	Awards
S1.06 In-Situ Sensors and Sensor Systems for Lunar and Planetary Science	2
S3.01 Power Generation and Conversion	3
S3.02 Propulsion Systems for Robotic Science Missions	3
S3.03 Power Electronics and Management, and Energy Storage	1
S3.04 Unmanned Aircraft and Sounding Rocket Technologies	0
S3.07 Thermal Control Systems	2
S4.03 Spacecraft Technology for Sample Return Missions	1
S4.04 Extreme Environments Technology	2

<sup>a</sup>See Appendix B for contract titles.

## SMD Program and Project Summaries

FY 2015 and FY 2014 Glenn SMD topics and subtopics strategically align with SMD programs and projects, and support the directorate’s current needs and objectives. To help small business PIs and SMD project managers, it is important to understand how the SBIR subtopics are mapped to SMD programs and projects for FY 2015 and FY 2014, respectively, as shown in Figure 4 and Figure 5. SMD program and project descriptions follow.

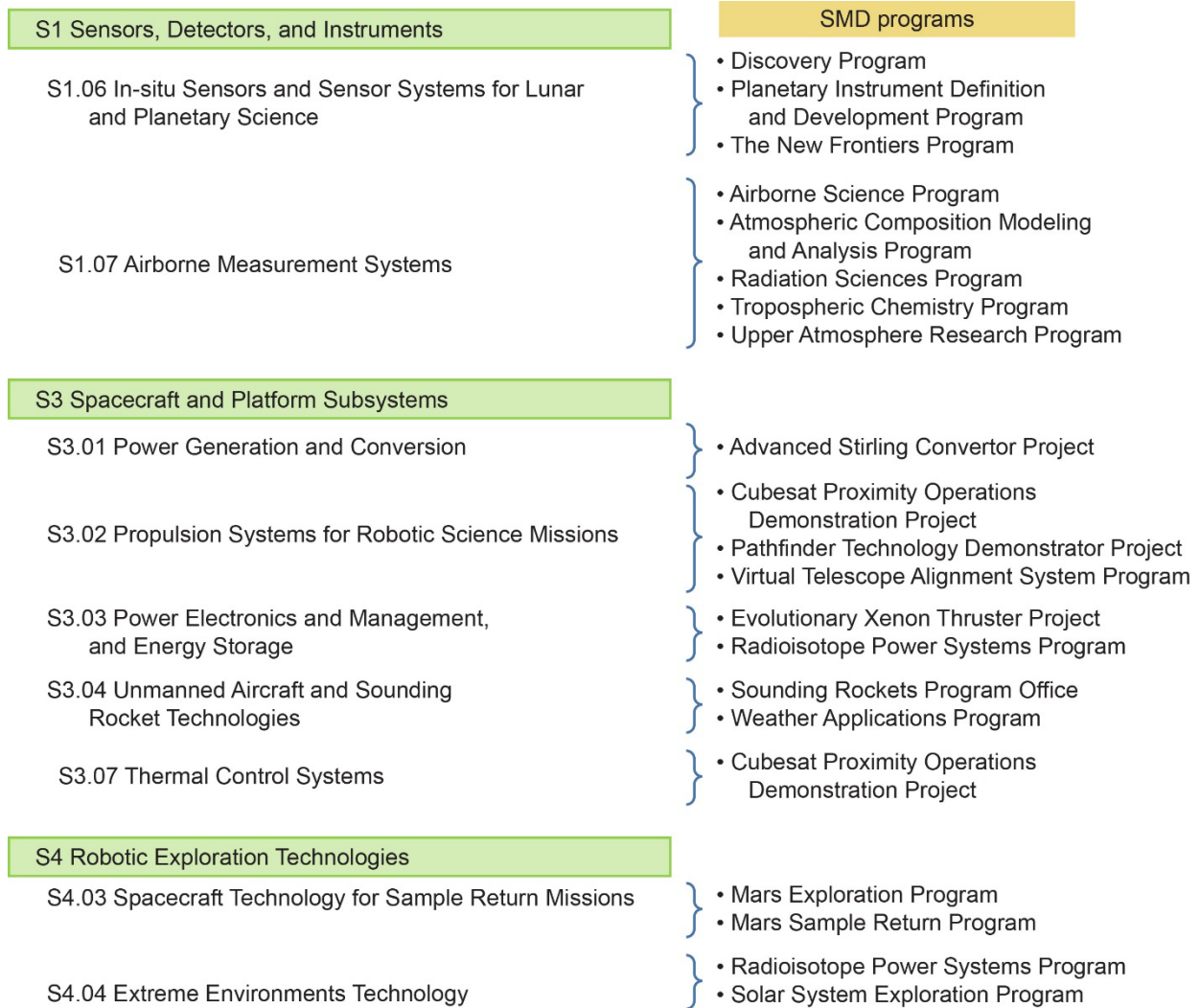


Figure 4.—Subtopics that Glenn leads or participates in mapped to SMD programs and projects for FY 2015.

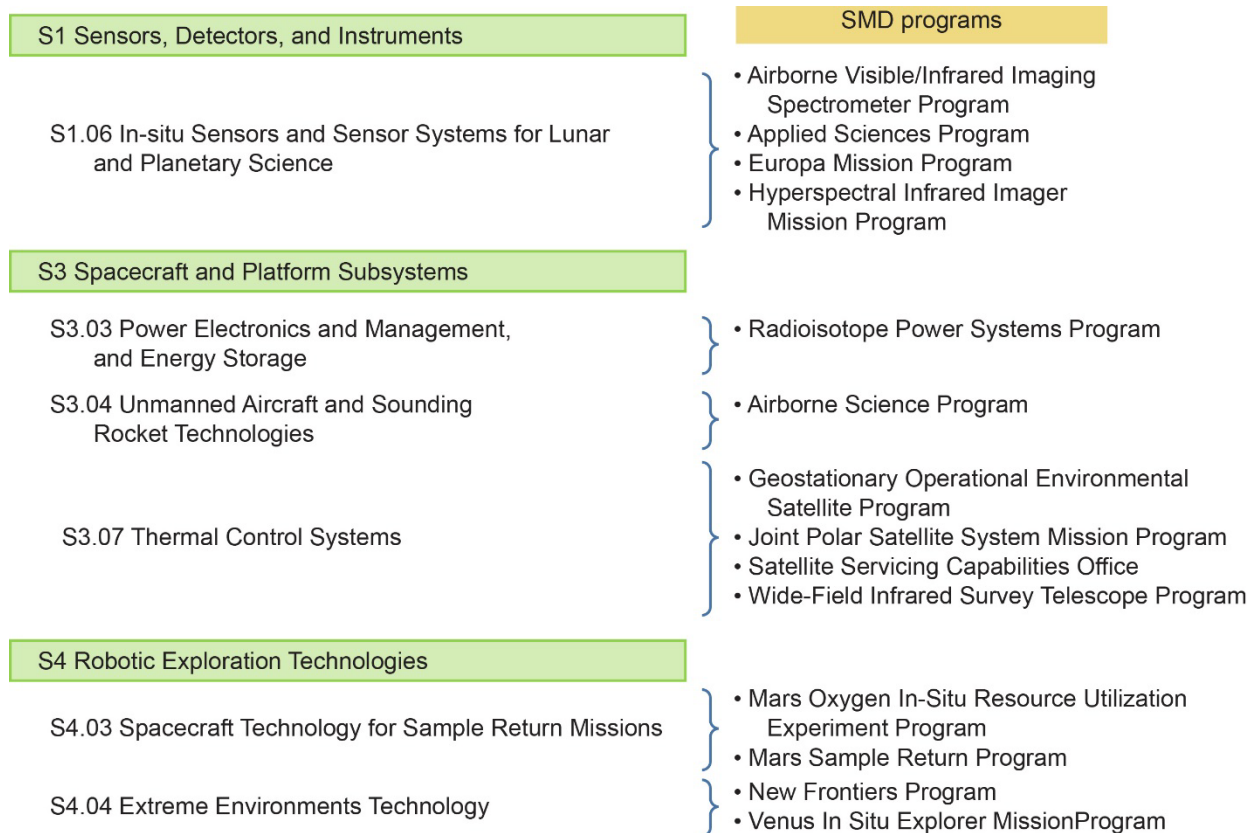


Figure 5.—Subtopics that Glenn leads or participates in mapped to SMD programs and projects for FY 2014.

### Discovery Program (DP)

DP gives scientists the opportunity to dig deep into their imaginations and find innovative ways to unlock the mysteries of the solar system. The main objective is to enhance our understanding of the solar system by exploring the planets, their moons, and small bodies such as comets and asteroids. The program also seeks to improve performance through the use of new technology and broaden university and industry participation in NASA missions.

### New Frontiers Program (NFP)

NFP represents a pivotal step in the advancement of solar system exploration. The missions in the program tackle specific solar system exploration goals identified as top priorities by consensus of the planetary community. The New Frontiers strategy is to explore the solar system with frequent, medium-class spacecraft missions that conduct high-quality, focused scientific investigations designed to enhance our understanding of the solar system.

### Planetary Instrument Definition and Development Program (PIDD)

PIDD supports the advancement of spacecraft-based instrument technology that shows promise for use in scientific investigations on future planetary missions. The goal is to define and develop scientific instruments or components of such instruments to the point where the instruments may be proposed in response to future announcements of flight opportunity without additional extensive technology development.

## **Airborne Science Program (ASP)**

ASP within the Earth Science Division is responsible for providing aircraft systems that further science and advance the use of satellite data. The primary objectives of this program are to: (1) Satellite Calibration and Validation Provide platforms to enable essential calibration measurements for the Earth observing satellites, and the validation of data retrieval algorithms, (2) Support New Sensor Development, providing sub-orbital flight opportunities to test and refine new instrument technologies/algorithms, and reduce risk prior to committing sensors for launch into space. (3) Process Studies: Obtaining high-resolution temporal and spatial measurements of complex local processes, which can be coupled to global satellite observations for a better understanding of the complete Earth system.

## **Upper Atmosphere Research Program (UARP)**

UARP concentrates on observations to study processes that control ozone concentrations in the upper troposphere and stratosphere, and therefore surface ultraviolet radiation. The program funds laboratory studies, ground-based network observations, and field campaigns that contribute to quantifying scientific understanding of ozone changes. These activities complement the observations from and data analysis using the NASA EOS Aura satellite as well as other satellites that observe the upper troposphere and stratosphere.

## **Tropospheric Chemistry Program (TCP)**

TCP seeks to improve the utility of satellite measurements in understanding of global tropospheric ozone and aerosols, including their precursors and transformation processes in the atmosphere. Ozone and aerosols are fundamental to both air quality and climate. The program emphasizes suborbital and ground-based measurements acquired during focused field deployments. Along with the other Atmospheric Composition programs, TCP also sponsors interpretation of these comprehensive but infrequent measurements to improve the continuous monitoring of tropospheric ozone and aerosols from space and the improvement of prognostic models. TCP also supports limited laboratory studies that are directly relevant to improved understanding of tropospheric chemistry.

## **Radiation Sciences Program (RSP)**

RSP strives to develop a quantitative and predictive understanding of how aerosols, clouds, and radiatively active gases scatter and absorb radiation (including both solar and terrestrially originated radiation) in the Earth's atmosphere, especially as it relates to climate variability and change. The program supports studies to improve the theoretical understanding of radiative transfer as well as field measurements of aerosol and cloud particle concentration, composition, microphysics, and optical properties. These measurements include both airborne and surface-based remote and in situ measurements. The program also supports the analysis of satellite remote sensing and field data as well as the development of process models, which contribute to an Earth system modeling capability.

## **Atmospheric Composition Modeling and Analysis Program (ACMAP)**

ACMAP supports studies of air quality and oxidation efficiency in the troposphere, how pollution-sourced aerosols affect cloud properties, stratospheric chemistry and ozone depletion, and interactions between atmospheric chemistry and climate. Studies of long-term trends in atmospheric composition are also of interest, where the connection between cause and effect is elucidated using models. The program

is particularly interested in studies that integrate observations from multiple instruments with models to address attribution and predictions. Use of satellite and suborbital data sets and ground-based measurements are encouraged for modeling constraints and verification where applicable.

### **Advanced Stirling Convertor Project (ASCP)**

ASCP is being developed by Sunpower, Inc. for NASA's Glenn Research Center (Glenn) with critical technology support tasks led by Glenn. The goal of the ASC project, which is funded by NASA's Science Mission Directorate, is to develop a highly efficient, low mass, reliable power convertor for future Radioisotope Power Systems (RPS). The high efficiency is a requirement for future missions in order to minimize the fuel needed.

### **Cubesat Proximity Operations Demonstration Project (CPODP)**

CPODP demonstrates rendezvous, proximity operations and docking using two three-unit (3U) cubesats. This mission will validate and characterize several miniature, low-power avionics technologies applicable to future NASA projects. CPODP will demonstrate the ability of two small spacecraft to remain at determined points relative to each other (called station-keeping) as well as precision circumnavigation and docking using imaging sensors and a multi-thruster cold gas propulsion system.

### **Pathfinder Technology Demonstrator Project (PTDP)**

PTDP tests the operation of a variety of novel CubeSat technologies in low Earth orbit, providing significant enhancements to the performance of these small and effective spacecraft. Each Pathfinder Technology Demonstrator mission consists of a 6-unit (6U) CubeSat weighing approximately 26 lb (12 kg) and measuring 12- by 10- by 4-in. (30- by 25- by 10-cm), comparable in size to a common shoebox.

### **Virtual Telescope Alignment System Program (VTAS)**

VTAS is a multi-year effort focused on the development, integration, and testing of the VTAS using commercial CubeSat-class hardware and in-house developed software.

### **Evolutionary Xenon Thruster Project (NEXTP)**

NEXTP is developing next generation ion propulsion technologies under the aegis of NASA's Science Mission Directorate In-Space Propulsion Technology Project. NEXTP is producing engineering model system components that will be validated (through qualification-level and integrated system testing) and ready for transition to flight system development.

### **Radioisotope Power Systems Program (RPSP)**

RPSP is a technology development effort, managed by NASA that is strategically investing in nuclear power technologies that would maintain NASA's current space science capabilities and enable future space exploration missions. NASA, working in collaboration with the U.S. Department of Energy (DOE), invests in research and development efforts on the Advanced Stirling Radioisotope Generator (ASRG). NASA also works with DOE to maintain the capability to produce the Multi-Mission Radioisotope

Thermoelectric Generator (MMRTG), which serves as the power source for the Mars Science Laboratory rover.

### **Sounding Rockets Program Office (SRPO)**

SRPO plans, organizes, and directs the NASA Sounding Rockets Program (NSRP). The SRPO provides program interface with NASA Headquarters, other government agencies, universities, private industry, and the international community; Provides suborbital services (consultation, vehicles, hardware, payload services, and launch operations; and Provides technical management for R&D and new technology efforts (feasibility studies, design studies, carrier and systems development, test and evaluation, and data analysis and reporting).

### **Weather Applications Program (WAP)**

WAP supports in-depth, end-to-end projects, as well as feasibility (or prototype) projects in the use of Earth Science research (including satellite observations) to improve decision-making for weather-affected economic interests. The projects address a variety of themes including, but not limited to, the impact of weather on air travel, numerical weather prediction enhancement, space weather, the environmental impacts of air travel, and maritime transportation.

### **Mars Exploration Program (MEP)**

MEP is a science-driven program that seeks to understand whether Mars was, is, or can be, a habitable world. The key to understanding the past, present or future potential for life on Mars can be found in the four broad, overarching goals for Mars Exploration: (1) Determine whether life ever arose on Mars, (2) Characterize the climate of Mars, (3) Characterize the geology of Mars, (4) Prepare for human exploration

### **Mars Sample Return Program (MSRP)**

MSRP is a proposed mission to return samples from the surface of Mars to Earth. The mission would use robotic systems and a Mars ascent rocket to collect and send samples of Martian rocks, soils and atmosphere to Earth for detailed chemical and physical analysis.

### **Europa Mission Program (EMP)**

EMP is the mission that conducts detailed reconnaissance of Jupiter's moon Europa and investigate whether the icy moon could harbor conditions suitable for life. The mission will place a spacecraft in orbit around Jupiter in order to perform a detailed investigation of the giant planet's moon Europa—a world that shows strong evidence for an ocean of liquid water beneath its icy crust and which could host conditions favorable for life. The mission will send a highly capable, radiation-tolerant spacecraft into a long, looping orbit around Jupiter to perform repeated close flybys of Europa.

### **Hyperspectral Infrared Imager Mission Program (HIIMP)**

HIIMP studies the world's ecosystems and provide critical information on natural disasters such as volcanoes, wildfires and drought. HypsIRI will be able to identify the type of vegetation that is present and whether the vegetation is healthy. The mission will provide a benchmark on the state of the world's

ecosystems against which future changes can be assessed. The mission will also assess the pre-eruptive behavior of volcanoes and the likelihood of future eruptions as well as the carbon and other gases released from wildfires.

### **Airborne Visible/Infrared Imaging Spectrometer Project (AVIISP)**

AVIISP is to identify, measure, and monitor constituents of the Earth's surface and atmosphere based on molecular absorption and particle scattering signatures. Research with AVIRIS data is predominantly focused on understanding processes related to the global environment and climate change.

### **Applied Sciences Program**

Applies Science Program funds projects that enable innovative uses of NASA Earth science data in organizations' policy, business, and management decisions. The project results and enhanced decision making improve the quality of life and strengthen the economy.

### **Airborne Science Program (ASP)**

ASP within the Earth Science Division is responsible for providing aircraft systems that further science and advance the use of satellite data. The primary objectives of this program are to (1) Satellite Calibration and Validation—Providing platforms to enable essential calibration measurements for the Earth observing satellites, and the validation of data retrieval algorithms, (2) Support New Sensor Development—Providing sub-orbital flight opportunities to test and refine new instrument technologies/algorithms, and reduce risk prior to committing sensors for launch into space, (3) Process Studies—obtaining high-resolution temporal and spatial measurements of complex local processes, which can be coupled to global satellite observations for a better understanding of the complete Earth system.

### **Wide-Field Infrared Survey Telescope Project (WFIRSTP)**

WFIRSTP is a NASA observatory designed to perform wide-field imaging and surveys of the near infrared (NIR) sky. The current design of the mission makes use of an existing 2.4 m telescope, which is the same size as the Hubble Space Telescope. WFIRSTP is the top-ranked large space mission in the New Worlds, New Horizon Decadal Survey of Astronomy and Astrophysics. The Wide Field Instrument will provide a field of view of the sky that is 100 times larger than images provided by HST. The coronagraph will enable astronomers to detect and measure properties of planets in other solar systems.

### **Joint Polar Satellite System Mission Program (JPSSMP)**

JPSSMP produces data on a daily basis which include early warnings of hazardous weather conditions, enhanced weather prediction capabilities, and real-time storm tracking. Data and imagery obtained from the Joint Polar Satellite System will increase timeliness and accuracy of public warnings and forecasts of climate and weather events, thus reducing the potential loss of human life and property and advancing the national economy. The restructured program will better ensure continuity of crucial climate observations and weather data in the future.



## **Geostationary Operational Environmental Satellite Program (GOESP)**

GOESP is a joint effort of NASA and the National Oceanic and Atmospheric Administration (NOAA). GOES help meteorologists observe and predict local weather events, including thunderstorms, tornadoes, fog, hurricanes, flash floods and other severe weather. In addition, GOES observations have proven helpful in monitoring dust storms, volcanic eruptions and forest fires.

## **Mars Oxygen In-Situ Resource Utilization (ISRU) Experiment Project (MOXIEP)**

MOXIEP focuses on addressing key knowledge gaps, including (1) demonstration of In-Situ Resource Utilization (ISRU) technologies to enable propellant and consumable oxygen production from the Martian atmosphere, and (2) characterization of atmospheric dust size and morphology to understand its effects on the operation of surface systems.

## **New Frontiers Program (NFP)**

NFP represents a pivotal step in the advancement of solar system exploration. The missions in the program tackle specific solar system exploration goals identified as top priorities by consensus of the planetary community. The New Frontiers strategy is to explore the solar system with frequent, medium-class spacecraft missions that conduct high-quality, focused scientific investigations designed to enhance our understanding of the solar system. The program objective is to launch high-science-return planetary investigations on an average of one every 36 months. Added to the NASA budget for the first time in 2003, New Frontiers builds on the innovative approaches used in NASA's Discovery and Explorer Programs, but provides a mechanism for identifying and selecting missions that cannot be accomplished within the cost and time constraints of Discovery.

## **Venus In Situ Explorer Mission Program (VISEMP)**

VISEMP addresses fundamental unanswered questions of the history and current state of Venus through a characterization of the chemical composition and dynamics of the atmosphere of Venus, and/or measure surface composition and rock textures.



## Appendix A.—Contract Titles Associated With Subtopics That Glenn Leads and Participates in for Fiscal Year 2015 Phase I

Abstracts of these Phase I contracts below are posted at <http://sbir.nasa.gov/SBIR/abstracts/15-1.html>

S1.01-8695	Compact, Rugged and Low-Cost Atmospheric Ozone DIAL Transmitter
S1.01-8825	Development of a High Energy Er-Fiber Amplifier for a Space-based Wind, Aerosol, and Range Lidar Sensor
S1.01-8972	Highly Efficient 2 Micron Wavelength Fiber Laser
S1.01-8973	Radiation-Hardened 1.55 Micron Fiber Laser for Coherent LIDAR
S1.01-9021	High-Power Tunable SeedLaser for Methane LIDAR Transmitter
S1.01-9731	Integrated Miniature DBR Laser Module for Lidar Instruments
S1.01-9810	3D Imaging Cubesat Lidar for Asteroid and Planetary Sciences
S1.01-9914	Novel Solid State Lasers for Space-Based Water Vapor DIAL
S1.02-8978	Radiation-Hard Ka-Band Power Amplifier for CubeSats
S1.02-9012	Scalable Architectures for Distributed Beam-Forming Synthetic Aperture Radar (DBSAR)
S1.02-9069	Robust Microfabricated Interconnect Technologies: DC to THz
S1.02-9216	ROC-Rib Deployable Ka-Band Antenna for Nanosatellites
S1.02-9271	Cubesat Collapsible Composite Antenna
S1.02-9516	Low-Loss Ferrite Components for NASA Missions
S1.02-9911	Frequency Multipliers for 200-400GHz
S1.03-9136	Antimony-Based Focal Plane Arrays for Shortwave-Infrared to Visible Applications
S1.03-9391	Type II SLS Materials Development for Space-based FPA Applications
S1.03-9811	Spaceflight 2 um Tm Fiber MOPA Amplifier
S1.04-8822	Large Area Silicon Carbide Photodiode Active Pixel Sensor
S1.04-9563	Highly Scalable SiC UV Imager for Earth & Planetary Science
S1.05-8714	Space-Qualified Compact Optical Magnetometer
S1.05-8837	Electric Potential and Field Instrument for CubeSat (EPIC)
S1.05-9590	Curved Microchannel Plates for Spaceflight Mass Spectrometers
S1.06-8989	Compact High-Resolution, Time-Resolved Intensified Image Sensor
S1.06-9561	A SiC-based Microcontroller for High-Temperature In-Situ Instruments and Systems
S1.06-9575	Lunar Heat Flow Probe
S1.06-9844	Compact High Performance Spectrometers Using Computational Imaging
S1.06-9867	Low Power Miniature Colloidal High Vacuum Pump
S1.07-8840	Real-Time Airborne Infra-Red Carbon Dioxide Analyzer
S1.07-8995	14-Decades Calibration in Airborne Detectors for Environmental Science (14DeCADES)
S1.07-9270	Mobile Passive MWIR Gas Imager
S1.07-9285	Instrument for Airborne Measurement of Carbonyl Sulfide
S1.07-9520	eVADE: Volcanic Ash Detection Raman LIDAR

S1.07-9654 A Multi-Wavelength Seed Derived Laser for In-Situ Validation of Airborne Remote Sensing Instruments

S1.07-9700 Compact 3D Wind Sensor for Unmanned Aerial Vehicles

S1.07-9996 3-color DPAS Aerosol Absorption Monitor

S1.08-8855 Novel Microfluidic Advances Enabling Autonomous, Long-Duration, Analysis of Nitrite/Nitrate

S1.08-9386 Instrument for Measurement of Oceanic Particle Size Distribution from Submicron to Mesoplankton

S1.08-9925 Multi Wavelength Greenhouse gas LIDAR (MUGGLE)

S1.09-8674 Robust Frequency Combs and Lasers for Optical Clocks and Sensing

S1.09-8809 Stabilized Portable External Cavity Laser (SPECL)

S1.09-9462 Miniature Optical Isolator

S1.10-8676 Shielded 3T HTS ADR Magnet Operating at 30-40 K

S1.10-8853 A High Efficiency 30 K Cryocooler with Low Temperature Heat Sink

S1.10-9837 CubeSat Cryocooler System (CCS)

S2.01-8685 Single Crystal Piezoelectric Stack Actuator DM with Integrated Low-Power HVA-Based Driver ASIC

S2.01-9488 Improved Yield, Performance and Reliability of High-Actuator-Count Deformable Mirrors

S2.01-9534 Switching Electronics for Space-based Telescopes with Advanced AO Systems

S2.02-9221 Dimensionally Stable Structural Space Cable

S2.02-9994 Macro-Fiber Composite-based actuators for space

S2.03-8703 High Performance Consumer-Affordable Nanocomposite Mirrors with Supersmooth Surfaces, Precise Figuring, and Innovative 3D Printed Structures

S2.03-9125 Additive Manufactured Very Light Weight Diamond Turned Aspheric Mirror

S2.03-9297 Diffusion Bonded CVC SiC for Large UVOIR Telescope Mirrors and Structures

S2.03-9591 Additive Manufacturing for Lightweight Reflective Optics

S2.03-9856 Ultra-low Cost, Lightweight, Molded, Chalcogenide Glass-Silicon Oxycarbide Composite Mirror Components

S2.04-9193 InTILF Method for Analysis of Polished Mirror Surfaces

S2.04-9249 Low Coherence, Spectrally Modulated, Spherical Wavefront Probe for Nanometer Level Free-Form Metrology

S2.04-9355 Freeform Optics: A Non-Contact "Test Plate" for Manufacturing

S2.04-9666 Precollimator Manufacturing for X-ray Telescopes

S2.04-9683 Manufacture of Monolithic Telescope with a Freeform Surface

S3.01-9275 Flexible ELO Solar Cells with Ultra-High Specific Power and Areal Power Density

S3.01-9281 Large-Area, Multi-Junction, Epitaxial Lift-Off Solar Cells with Backside Contacts

S3.01-9314 Dwell Mechanism for Increasing Free-Piston Stirling Engine Specific Power and Efficiency

S3.01-9476 Novel Ring-Configuration Double-Acting Free-Piston Stirling Converter

S3.02-8693 Electride Hollow Cathode

S3.02-8905 Low-Cost, Lightweight, High-Performance CMC Combustion Chamber for HAN-Based Monopropellant Engines

S3.02-8908 Green Monopropellant Secondary Payload Propulsion System

S3.02-8954 High Performance Iodine Feed System

S3.02-8993 Iodine-Compatible C12A7 Electride Hollow Cathode

S3.02-9159 Nitrous Ethane-Ethylene Rocket with Hypergolic Ignition

S3.02-9325 Miniaturized Lightweight Monopropellant Feed System for Nano- and Micro-satellites

S3.02-9769 Green Electric Monopropellant (GEM) Fueled Pulsed Plasma Thruster

S3.02-9803 Micropump for MON-25/MMH Propulsion and Attitude Control

S3.03-8858 Wide Temperature, High Voltage and Energy Density Capacitors for Aerospace Exploration

S3.03-8980 Wide Operating Temperature Range Ruggedized Ultracapacitor For Deep Space Exploration

S3.03-9105 Extreme Environment Compatible Ceramic Enhanced PEBB Devices (EE-PEBB)

S3.03-9258 Rad-hard 1200 V SiC MOSFETs and Schottky Rectifiers for a 30 kW PPU

S3.04-9392 Cloud Droplet Characterization System for Unmanned Aircraft

S3.04-9526 Miniature UAV Wind LIDAR & Flight Extension System

S3.04-9554 Optimization Of Fuel Consumption Using Atmospheric Vertical Air Currents

S3.04-9800 Precision Guided Parafoil System For Sounding Rocket Recovery

S3.05-8747 Compact Ultrasensitive Erbium-doped Waveguide Optical Gyros

S3.05-9525 Miniature HD6D Navigation and Rendezvous LIDAR & Software

S3.05-9717 Innovative Fiber-Optic Gyroscopes (FOGs) for High Accuracy Space Applications

S3.06-9331 VORTEX Gimbal

S3.06-9407 Advanced Onboard Energy Storage Solution for Balloons

S3.07-9239 Flexible 2-Phase Thermal Strap for Small Sats

S3.07-9409 Two-phase Pumped Loop for Spacecraft Thermal Control

S3.07-9425 Innovations for the Affordable Conductive Thermal Control Material Systems for Space Applications

S3.07-9437 Coupling Existing Software Paradigms for Thermal Control System Analysis of Re-Entry Vehicles

S3.07-9570 Modified Ionic Liquids for Thermal Properties in CubeSats

S3.07-9621 High heat flux Enhanced Acquisition and Transport system for Small spacecraft

S3.07-9949 Silicon Cold Plate for CubeSat/SmallSat Thermal Control

S3.07-9989 Ultrasonic Additive Manufacturing for Capillary Heat Transfer Devices and Integrated Heat Exchangers

S3.08-9199 Slow-Light-Enhanced Spectral Interferometers

S3.08-9443 Study of Sensitivity Enhancement and Dead Band Elimination in Laser Gyros

S3.08-9455 Fast Light Enhanced Active and Passive Gyroscopes, Accelerometers and Fiber- Optic Sensors

S3.08-9572 Slow and Fast Light

S3.09-8661 Miniaturized System-in-Package Motor Controller for Spacecraft and Orbital Instruments

S3.09-9203 Non Invasive Instrumentation For Single Event Effects (NIISEE)

S3.09-9398 Software Redundancy Framework for COTS SoC FPGAs

S3.09-9956 Radiation Hardened ARM Micro Controller Module

S4.01-8929 3D Flash LIDAR Megapixel High Speed Array

S4.01-9469 A Next Generation Imaging for Space Application

S4.01-9473 High Resolution, High Sensitivity LIDAR for Robotic Space Operation Support

S4.01-9888 Terminal Descent Lidar System

S4.02-9332 ARACMO: Advanced Regolith Anchoring for Cable-assisted Mobility

S4.02-9372 Industrial Electrostatic-Gecko Gripper

S4.03-9675 High-Performance, Pump-Fed Propulsion for Mars Ascent Vehicle Applications

S4.03-9756 High Performance Nozzle for Mars Ascent Vehicle

S4.03-9958 Single-Stage, Gelled Hydrazine System for Mars Ascent Vehicle Propulsion

S4.04-8951 Ultra-High Temperature Solid State Ultracapacitor Operating at 300C For Extreme Environments

S4.04-9151 Dual Axis Controller for Extreme Environments

S4.04-9341 Extreme Environment Electronics based on Silicon Carbide

S4.05-9420 Development of a Hermetically Sealed Canister for Sample Return Missions

S4.05-9450 Development of Non-Contact Trace Contamination Detection Methods and Instrumentation for Spacecraft Cleaning Validation Using Deep UV Chemical Imaging

S5.01-8794 A Scheduling-Based Framework for Efficient Massively Parallel Execution

S5.01-9614 Accelerating Memory-Access-Limited HPC Applications via Novel Fast Data Compression

S5.02-8861 Cloud-Based Open Data Environment and Flow-based Aggregation Science Tool (CODEFAST)

S5.02-9041 ModelLab: A Cloud-Based Platform to Support Advanced Geospatial Modeling of Earth Observation Data

S5.03-9352 SparkRS - Spark for Remote Sensing

S5.04-9895 Application of SystemVerilog to Science Mission Simulation

S5.05-8971 Dynamic State-Based FM Design and Analysis Tool

S5.05-9573 Fault Management Technologies - Metrics Evaluation and V&V

S5.05-9897 Model-Based Off-Nominal State Isolation and Detection System for Autonomous Fault Management

## **Appendix B.—Contract Titles Associated With Subtopics That Glenn Leads and Participates in for Fiscal Year 2014 Phase II**

Abstracts of these Phase II contracts below are posted at <http://sbir.nasa.gov/SBIR/abstracts/14-2.html>

S1.01-8730	Tunable High-Power Single-Frequency Laser at 2050 nm
S1.01-9242	Digital Acquisition and Wavelength Control of Seed Laser for Space-Based LIDAR Applications
S1.01-9740	Methane LIDAR Laser Technology
S1.01-9773	Laser Transmitter for Space-Based Atmospheric and Oceanographic LIDAR
S1.02-8518	High Speed Digitizer for Remote Sensing
S1.02-9193	W-Band Solid State Power Amplifier for Remote Sensing Radars
S1.03-8828	Terahertz Quantum Cascade Laser Local Oscillator
S1.03-8987	Dualband MW/LW Strained Layer Superlattice Focal Plane Arrays for Satellite-Based Wildfire Detection
S1.03-9619	Large Format LW Type-II SLS FPAs for Space Applications
S1.04-8871	ZnMgO Nanowire Based Detectors and Detector Arrays
S1.05-9699	Rad-Hard Sigma-Delta 3-Channel ADC for Fluxgate Magnetometers
S1.06-8683	The Compact Hyperspectral Aberration-Corrected Platform (CHAP), an Instrument for Microspacecraft
S1.06-9443	A Pulsed Nonlinear Raman Detection of Trace Organics with SERS Enhanced Sensitivity
S1.07-8813	Chemical Microsensor Instrument for UAV Airborne Atmospheric Measurements
S1.07-9074	Three Color Particle Optical Extinction Monitor
S1.07-9635	Airborne Multi-Gas Sensor
S1.07-9837	Unmanned Aerial Vehicle Diode Laser Sensor for Methane
S1.09-8746	A Portable Source of Lattice-Trapped and Ultracold Strontium (PLUS)
S1.09-9245	Multi-Channel Tunable Source for Atomic Sensors
S2.02-9261	Optical Precision Deployment Latch
S2.03-9217	Advanced Mirror Material System
S2.04-9255	High Performance Computing-Accelerated Metrology for Large Optical Telescopes
S3.01-9098	Solid State Large Area Pulsed Solar Simulator for 3-, 4- and 6-Junction Solar Cell Arrays
S3.01-9237	High-Efficiency, Radiation-Hard, Lightweight IMM Solar Cells
S3.01-9745	Radioisotope Power Supply

S3.02-8682 Integrated Propulsion and Primary Structure Module for Small Satellite and CubeSat Applications

S3.02-8755 A Green, Safe, Multi-Pulse Solid Motor (MPM) for CubeSats

S3.02-9208 Additive Manufacturing of Ion Thruster Optics

S3.03-9774 Holomorphic Embedded Load Flow for Autonomous Spacecraft Power Systems

S3.05-9046 Ultraprecision Pointing Accuracy for SmallSat/CubeSat Attitude Control Systems

S3.05-9749 Interferometric Star Tracker - Phase II

S3.07-8767 Spacecraft Thermal Control System Not Requiring Power

S3.07-9060 A Robust Two-Phase Pumped Loop With Multiple Evaporators and Multiple Radiators

S3.07-9763 Hybrid Heat Pipes for High Heat Flux Applications

S4.02-9647 Pyramid Comet Sampler

S4.03-9814 A Miniature Compressor for In-Situ Resource Utilization on Mars

S4.04-9709 Radiation-Hardening of Best-In-Class SiGe Mixed-Signal and RF Electronics for Ultra-Wide Temperature Range

S4.04-9819 High Temperature Venus Drill and Sample Delivery System

S5.01-9332 Open|SpeedShop Ease of Use Performance Analysis for Heterogeneous Processor Systems

S5.02-9722 A Geospatial Decision Support System Toolkit

S5.03-9646 Multi-Sensor Ensemble Aerosol Assimilation - CERES, MODIS and VIIRS

S5.05-9456 Fault Management Technologies

S5.05-9517 Architecture Framework for Fault Management Assessment and Design (AFFMAD)

S5.05-9840 Model-Based Fault Management Engineering Tool Suite

S20.01-8853 Ku/Ka-Band Electrically-Scanned Line Array for Tri-Band Cloud and Precipitation Radar Applications

S20.01-9951 Low Power Digital Correlator System for PATH Mission

S20.03-9947 Radiation Hardened Structured ASIC Platform for Rapid Chip Development for Very high Speed System on a Chip (SoC) and Complex Digital Logic Systems



## References

1. Anderson, G.A.; and Iacomini, C.: Paragon's Experience in Successful Technology Development and Infusion Within the SBIR Program. 2009 IEEE Aerospace Conference, Big Sky, MT, 2009, pp. 1–9.
2. Zacny, K., et al.: Honeybee Robotics Approach to Technology Development and Infusion. 2010 IEEE Aerospace Conference, Big Sky, MT, 2010, pp. 1–7.
3. Kiefer, K.F.: Case Study: Small Business Technology Infusion. IEEE Aerosp. Electron. Syst. Mag., vol. 25, no. 10, 2010, pp. 4–9.
4. Comstock, D.A.: Technology Development and Infusion From NASA's Innovative Partnerships Program. 2008 IEEE Aerospace Conference, Big Sky, MT, 2008, pp. 1–11.





