NASA SBIR 2022 Phase I Solicitation

A2.01 Flight Test and Measurement Technologies

Lead Center: AFRC

Participating Center(s): ARC, GRC, LaRC

Scope Title

Flight Test and Measurement Technologies

Scope Description

NASA continues to use flight research as a critical element in the maturation of technology. This includes developing test techniques that improve the control of in-flight test conditions, expand measurement and analysis methodologies, and improve test data acquisition and management with sensors and systems that have fast response, low volume, minimal intrusion, and high accuracy and reliability. By using state-of-the-art flight test techniques along with novel measurement and data acquisition technologies, NASA and the aerospace industry will be able to conduct flight research more effectively and meet the challenges presented by NASA and industry's cutting-edge research and development programs.

NASA's Flight Demonstrations and Capabilities (FDC) Project supports a variety of flight regimes and vehicle types ranging from low-speed, subsonic applications and electric propulsion through transonic and high-speed flight regimes. Therefore, this solicitation can cover a wide range of flight conditions and vehicles.

NASA also requires improved measurement and analysis techniques for acquisition of real-time, in-flight data used to determine aerodynamic, structural, flight control, and propulsion system performance characteristics. These data will be used to provide information necessary to safely expand the flight and test envelopes of aerospace vehicles and components. This requirement includes the development of sensors for both in situ and remote sensing to enhance the monitoring of test aircraft safety and atmospheric conditions during flight testing.

Flight test and measurement technologies proposals may significantly enhance the capabilities of major government and industry flight test facilities. Proposals may address innovative methods and technologies to reduce costs and extend the health, maintainability, communication, and test techniques of flight research support facilities to directly enhance flight test and measurement.

Areas of interest emphasizing flight test and measurement technologies include:

- Measurement technologies for in-flight steady and unsteady aerodynamics, juncture flow measurements, propulsion airframe integration, structural dynamics, stability, and control including related to turbulence, and propulsion system performance in order to validate and improve flight modeling for next-generation vertical takeoff and landing (VTOL) vehicles.
• Advancement of miniaturization or portability of in situ and/or onboard sensing and/or integrated secured remote services for use in real-time decision making.
• Prognostic and intelligent vehicle health monitoring for hybrid and/or all-electric propulsion systems using an adaptive embedded control systems. Note: Only sensors to detect failures and for vehicle health monitoring will be considered. Proposals relating to flight control changes and other algorithms that respond to health issues and damage detected by sensors are covered under Subtopic A2.02 and will be rejected in this subtopic.
• Improved ruggedized single-longitudinal mode wideband wavelength-sweeping laser system design for in situ flight structural health monitoring to be operated in aircraft, specifically for optical frequency domain reflectometry (OFDR) technology utilized in NASA's fiber optics sensing system (FOSS).
• Sensing technologies, such as wireless sensors, that can be used for flight test instrumentation and flight modeling verification for manned and unmanned aircraft. Emphasis should be on developing a variety of specialized low-profile sensors that are capable of participating in a synchronized, high data rate, and high data volume diverse wireless sensor measurement network with a capability to deliver time-stamped/encrypted data to a central node. For example, an interrogation unit should support the wireless sensor itself and communicate with the flight unit. This area also includes wireless (nonintrusion) power transferring techniques and/or wirelessly powering remote sensors.

The emphasis here is for articles to be developed for flight test and flight test facility needs.

The technologies developed for this subtopic directly address the technical challenges in the Aeronautics Research Mission Directorate (ARMD) Integrated Aviation Systems Program (IASP) and the Electrified Powertrain Flight Demonstration (EPFD) and FDC Projects. The FDC Project conducts complex flight research demonstrations to support multiple ARMD programs. FDC is seeking to enhance flight research and test capabilities necessary to address and achieve the ARMD strategic plan. Technologies for this subtopic could also support Advanced Air Vehicle Program (AAVP) projects: Commercial Supersonic Technology (CST) and Revolutionary Vertical Lift Technology (RVLT), as well as the Aerosciences Evaluation and Test Capabilities (AETC) Portfolio Office.

For technologies focused on ground testing or operations, please consider submitting to subtopic A1.08 Aeronautics Ground Test and Measurement Technologies, as ground testing technologies will be considered out of scope for this A2.01 subtopic.

For technologies with space-only applications, please consider submitting to a related space subtopic as space-only technologies will be considered out of scope for this A2.01 subtopic.

Proposals relating to flight control changes and other algorithms that respond to health issues and damage detected by sensors are covered under Subtopic A2.02 and will be rejected in this subtopic.

Proposals that focus solely on flight vehicle development rather than focusing on technologies applicable to flight test and measurement will be considered out of scope for the A2.01 subtopic.

Expected TRL or TRL Range at completion of the Project

3 to 6

Primary Technology Taxonomy

Level 1

TX 15 Flight Vehicle Systems

Level 2

TX 15.2 Flight Mechanics

Desired Deliverables of Phase I and Phase II

• Research
Desired Deliverables Description

For a Phase I effort, the small business is expected to develop a proof-of-concept demonstration of a technology and generate a midterm report showing progress of the work. A summary report is expected at the end of Phase I that describes the research effort's successes, failures, and the proposed path ahead.

For a Phase II effort, the small business should show a maturation of the technology that allows for a presentation of a thorough demonstration. Most ideally, a delivery of a prototype that includes beta-style or better hardware or software that is suitable to work in ground testing and can be proven, via relevant environment testing, to be working in flight environment. This relevant environment testing would satisfy NASA's technical readiness level expectations at the end of Phase II.

State of the Art and Critical Gaps

Current atmospheric flight systems cover a large range of uses from point-to-point drones to high-performance small aircraft, to large transports, to general aviation. In all areas, advancements can be possible if insights can be gained, studied, and used to create new technologies. New insights will require an evolution of current testing and measurement techniques, as well as novel forms and implementations. Known gaps include wireless instrumentation for flight, advanced telemetry technique, intelligent internal state monitoring for air and space vehicles, techniques for studying sonic booms, advanced techniques for capturing all dimensions of system operation and vehicle health (spatial/spectral/temporal), and extreme environment high-speed large-area distributive sensing techniques. Along with these comes secure telemetry of data to ensure informed operation of the flight system.

Relevance / Science Traceability

The technologies developed for this subtopic directly address the technical and capability challenges in ARMD's FDC Project. FDC conducts complex flight research demonstrations to support different ARMD programs. FDC is seeking to enhance flight research and test capabilities necessary to address and achieve ARMD's strategic plan. Also, they could support IASP and EPFD projects as well as CST and RVLT projects and the AETC Portfolio Office.

References

- NASA's Low-Boom Flight Demonstration mission: https://www.nasa.gov/X59
- Schlieren Images Reveal Supersonic Shock Waves: https://www.nasa.gov/centers/armstrong/features/shock_and_awesome.html
- NASA's Commercial Supersonic Technology (CST) project: https://www.nasa.gov/aeroresearch/programs/aavp/cst
- NASA's Revolutionary Vertical Lift Technology (RVLT) project: https://www.nasa.gov/aeroresearch/programs/aavp/rvlt
- NASA's Aerosciences Evaluation and Test Capabilities (AETC) Portfolio Office: https://www.nasa.gov/aetc