# NASA SBIR 2020 Phase I Solicitation

## S3.04 Guidance, Navigation, and Control

**Lead Center: GSFC**

**Participating Center(s): JPL, MSFC**

**Technology Area: TA5 Communication and Navigation**

### Scope Title

Guidance, Navigation, and Control

### Scope Description

NASA seeks innovative, groundbreaking, and high impact developments in spacecraft guidance, navigation, and control technologies in support of future science and exploration mission requirements. This subtopic covers mission enabling technologies that have significant Size, Weight and Power, Cost, and Performance (SWaP-CP) improvements over the state-of-the-art Commercial Off-The-Shelf (COTS) capabilities in the areas of Spacecraft Attitude Determination and Control Systems, Absolute and Relative Navigation Systems, and Pointing Control Systems, and Radiation-Hardened Guidance, Navigation, and Control (GNC) Hardware.

Component technology developments are sought for the range of flight sensors, actuators, and associated algorithms and software required to provide these improved capabilities. Technologies that apply to most spacecraft platform sizes will be considered.

Advances in the following areas are sought:

- Spacecraft Attitude Determination and Control Systems: Sensors and actuators that enable <0.1 arcsecond level pointing knowledge and arcsecond level control capabilities for large space telescopes, with improvements in size, weight, and power requirements.
- Absolute and Relative Navigation Systems: Autonomous onboard flight navigation sensors and algorithms incorporating both spaceborne and ground-based absolute and relative measurements. For relative navigation, machine vision technologies apply. Special considerations will be given to relative navigation sensors enabling precision formation flying, astrometric alignment of a formation of vehicles, robotic servicing and sample return capabilities, and other GNC techniques for enabling the collection of distributed science measurements. In addition, flight sensors and algorithms that support onboard terrain relative navigation are of interest.
- Pointing Control Systems: Mechanisms that enable milliarcsecond class pointing performance on any spaceborne pointing platforms. Active and passive vibration isolation systems, innovative actuation feedback, or any such technology that can be used to enable other areas within this subtopic applies.
- Radiation-Hardened Hardware: GNC sensors that could operate in a high radiation environment, such as the Jovian environment.

- Fast-light or Exceptional-Point Enhanced Gyroscopes and Accelerometers: In conventional ring laser gyros, precision increases with cavity size and measurement time. However, by using Fast-Light (FL) media or Exceptional Points (EPs) in coupled resonators, an increase in gyro sensitivity can be achieved without having to increase size or measurement time, thereby increasing the time for standalone spacecraft navigation. (The increased precision also opens up new science possibilities such as measurements of fundamental physical constants, improving the sensitivity-bandwidth product for gravity wave detection, and tests of general relativity.) Prototype FL- or EP-enhanced gyros are sought that can be implemented in a compact rugged design that is tolerant to variations in temperature and G-conditions, with the ultimate goal of demonstrating decreased angular random walk.

Phase I research should be conducted to demonstrate technical feasibility as well as show a plan towards Phase II integration and component/prototype testing in a relevant environment. Phase II technology development efforts shall deliver component/prototype at the TRL 5–6 level consistent with NASA SBIR/STTR Technology Readiness Level (TRL) Descriptions. Delivery of final documentation, test plans, and test results are required. Delivery of a hardware component/prototype under the Phase II contract is preferred.

Proposals should show an understanding of one or more relevant science or exploration needs and present a feasible plan to fully develop a technology and infuse it into a NASA program.

This subtopic is for all mission enabling Guidance, Navigation, and Control technology in support of SMD missions and future mission concepts. Proposals for the development of hardware, software, and/or algorithm are all welcome. The specific applications could range from CubeSats/SmallSats, to ISS payloads, to flagship missions.

**References**

- 2017 NASA Strategic Technology Investment Plan: https://go.usa.gov/xU7sE
- 2015 NASA Technology Roadmaps: https://go.usa.gov/xU7sy

**Expected TRL or TRL range at completion of the project:** 4 to 6

**Desired Deliverables of Phase II**

Prototype, Analysis, Hardware, Software

**Desired Deliverables Description**

Prototype hardware/software, documented evidence of delivered TRL (test report, data, etc.), summary analysis, supporting documentation.

**State of the Art and Critical Gaps**

Capability area gaps:

- Spacecraft GNC Sensors – Highly integrated, low power, low weight, rad-hard component sensor technologies, and multifunctional components.
- Spacecraft GNC Estimation and Control Algorithms – autonomous proximity operations algorithm, robust distributed vehicle formation sensing and control algorithms.

**Relevance / Science Traceability**

Science areas: Heliophysics, Earth Science, Astrophysics, and Planetary missions' capability requirement areas:

- Spacecraft GNC Sensors – optical, RF, inertial, and advanced concepts for onboard sensing of spacecraft attitude and orbit states

Spacecraft GNC Estimation and Control Algorithms – Innovative concepts for onboard algorithms for attitude/orbit

determination and control for single spacecraft, spacecraft rendezvous and docking, and spacecraft formations.