



## NASA SBIR 2021 Phase I Solicitation

### S1.12 Remote Sensing Instrument Technologies for Heliophysics

Lead Center: GSFC

Participating Center(s): HQ

Scope Title:

Remote-Sensing Instruments/Technologies for Heliophysics

#### Scope Description:

The 2013 National Research Council's, Solar and Space Physics: A Science for a Technological Society (<http://nap.edu/13060>) motivates this subtopic: "Deliberate investment in new instrument concepts is necessary to acquire the data needed to further solar and space physics science goals, reduce mission risk, and maintain an active and innovative hardware development community." This subtopic solicits development of advanced remote-sensing instrument technologies and components suitable for deployment on heliophysics missions. These technologies must be capable of withstanding operation in space environments, including the expected pressures, radiation levels, launch and impact stresses, and range of survival and operational temperatures. Technologies that reduce mass, power, volume, and data rates for instruments and instrument components without loss of scientific capability are of particular importance. In addition, technologies that can increase instrument resolution and sensitivity or achieve new and innovative scientific measurements are solicited. For example missions, see [https://science.nasa.gov/missions-page?field\\_division\\_tid=5&field\\_phase\\_tid=All](https://science.nasa.gov/missions-page?field_division_tid=5&field_phase_tid=All). For details of the specific requirements see the Heliophysics Decadal Survey. Technologies that support science aspects of missions in NASA's Living With a Star and Solar-Terrestrial Probe programs are of top priority, including long-term missions like Interstellar Probe mission (as called out in the Decadal Survey).

Remote-sensing technologies are being sought to achieve much higher resolution and sensitivity with significant improvements over existing capabilities. Remote-sensing technologies amenable to CubeSats and SmallSats are also encouraged. Specifically, this subtopic solicits instrument development that provides significant advances in the following areas:

- Light detection and ranging (LIDAR) systems for high-power, high-frequency geospace remote sensing, such as sodium and helium lasers.
- Technologies or components enabling auroral, airglow, geospace, and solar imaging at visible, far and extreme ultraviolet (FUV/EUV), and soft x-ray wavelengths (e.g., mirrors and gratings with high-reflectance coatings, multilayer coatings, narrowband filters, blazed gratings with high ruling densities, diffractive and metamaterial optics).
- Electromagnetic sounding of ionospheric or magnetospheric plasma density structure at radio-frequencies from kHz to >10 MHz.

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- Passive sensing of ionospheric and magnetospheric plasma density structure using transmitters of opportunity (e.g., global navigation satellite system (GNSS) or ground-based transmissions).
  - Technologies that enable the development of dedicated solar flare sensors with intrinsic ion suppression and sufficient angular resolution in the EUV to soft x-ray wavelength range such as fast cadence charge-coupled devices and complementary metal-oxide semiconductor devices.
  - Technologies that enable x-ray detectors to observe bright solar flares in x-ray from 1 to hundreds of keV without saturation.
  - Technologies that attenuate solar x-ray fluences by flattening the observed spectrum by a factor of 100 to 1,000 across the energy range encompassing both low- and high-energy x-rays—preferably flight programmable.
  - X-ray optics technologies to either reduce the size, complexity, or mass or to improve the point spread function of solar telescopes used for imaging solar x-rays in the ~1 to 300 keV range.
  - Technologies, including metamaterials and micro-electro-mechanical systems (MEMS) that enable polarization, wavelength, or spatial discrimination without macroscale moving parts.

Proposers are strongly encouraged to relate their proposed development to NASA's future heliophysics goals as set out in the Heliophysics Decadal Survey (2013-2022) and the NASA Heliophysics Roadmap (2014-2033). Proposed instrument components and/or architectures should be as simple, reliable, and low risk as possible, while enabling compelling science. Novel instrument concepts are encouraged, particularly if they enable a new class of scientific discovery. Technology developments relevant to multiple environments and platforms are also desired. Proposers should show an understanding of relevant space science needs, and present a feasible plan to fully develop a technology and infuse it into a NASA program. Detector technology proposals should be referred to the S116 subtopic.

**Expected TRL or TRL Range at completion of the Project:** 3 to 5

**Primary Technology Taxonomy:**

Level 1: TX 08 Sensors and Instruments

Level 2: TX 08.1 Remote Sensing Instruments/Sensors

**Desired Deliverables of Phase I and Phase II:**

- Analysis
- Prototype
- Hardware
- Software

**Desired Deliverables Description:**

Phase I deliverables may include an analysis or test report, a prototype of an instrument subcomponent, or a full working instrument prototype.

Phase II deliverables must include a prototype or demonstration of a working instrument or subcomponent and may also include analysis or test reports.

**State of the Art and Critical Gaps:**

Remote-sensing instruments and technologies are essential bases to achieve Science Mission Directorate's (SMD) Heliophysics goals summarized in National Research Council's, *Solar and Space Physics: A Science for a Technological Society*. These instruments and technologies play indispensable roles for NASA's Living With a Star (LWS) and Solar Terrestrial Probe (STP) mission programs as well as a host of smaller spacecraft in the Explorers Program. In addition, there is growing demand for remote-sensing technologies amenable to CubeSats and SmallSats. To narrow the critical gaps between the current state of art and the technology needed for the ever increasing science/exploration requirements, remote-sensing technologies are being sought to achieve much higher resolution and sensitivity with significant improvements over existing capabilities—and at the same time with lower mass, power, and volume.

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**Relevance / Science Traceability:**

Remote-sensing instruments and technologies are essential bases to achieve SMD's Heliophysics goals summarized in National Research Council's, Solar and Space Physics: A Science for a Technological Society. These instruments and technologies play indispensable roles for NASA's LWS and STP mission programs, as well as a host of smaller spacecraft in the Explorers Program. In addition, there is growing demand for remote-sensing technologies amenable to CubeSats and SmallSats. NASA SMD has two excellent programs to bring this subtopic technologies to a higher level: Heliophysics Technology and Instrument Development for Science (H-TIDeS) and Heliophysics Flight Opportunities for Research and Technology (HFORT). H-TIDeS seeks to advance the development of technologies and their application to enable investigation of key heliophysics science questions. This is done through incubating innovative concepts and development of prototype technologies. It is intended that technologies developed through H-TIDeS would then be proposed to HFORT to mature by demonstration in a relevant environment. The H-TIDeS and H-FORT programs are in addition to Phase III opportunities.

**References:**

- For example missions, see: <https://science.nasa.gov/missions>
- For details of the specific requirements, see the National Research Council's, Solar and Space Physics: A Science for a Technological Society: <http://nap.edu/13060>
- For details of NASA's Heliophysics roadmap, see the NASA Heliophysics Roadmap:  
[https://explorers.larc.nasa.gov/HPSMEX/MO/pdf\\_files/2014\\_HelioRoadmap\\_Final\\_Reduced\\_0.pdf](https://explorers.larc.nasa.gov/HPSMEX/MO/pdf_files/2014_HelioRoadmap_Final_Reduced_0.pdf)