SBIR/STTR
Small Business Innovation Research / Small Business Technology Transfer

NASA SBIR 2019 Phase I Solicitation

S1.05 Detector Technologies for UV, X-Ray, Gamma-Ray Instruments

Lead Center: JPL

Participating Center(s): GSFC, MSFC

Technology Area: TA8 Science Instruments, Observatories & Sensor Systems

Detectors

This subtopic covers detector requirements for a broad range of wavelengths from UV through to gamma ray for applications in Astrophysics, Earth Science, Heliophysics, and Planetary Science. Requirements across the board are for greater numbers of readout pixels, lower power, faster readout rates, greater quantum efficiency, single photon counting, and enhanced energy resolution.

The proposed efforts must be directly linked to a requirement for a NASA mission. These include Explorers, Discovery, Cosmic Origins, Physics of the Cosmos, Solar-Terrestrial Probes, Vision Missions, and Earth Science Decadal Survey missions. Proposals should reference current NASA missions and mission concepts where relevant. Specific technology areas are:

- Solid-state single photon counting radiation tolerant detectors in CCD or CMOS architecture for astrophysics, heliophysics, and planetary missions.
- Large area array, low noise, high efficiency CMOS, potentially in 3D stacked technology for the very large focal plane arrays of large aperture telescopes as well for heliophysics and planetary science measurements.
- Significant improvement in wide band gap semiconductor materials, such as AlGaN, ZnMgO and SiC, individual detectors, and detector arrays for operation at room temperature for astrophysics missions and planetary science composition measurements.
- Highly integrated, low noise (< 300 electrons rms with interconnects), low power (< 100 uW/channel) mixed signal ASIC readout electronics as well as charge amplifier ASIC readouts with tunable capacitive inputs to match detector pixel capacitance. See needs of National Research Council's Earth Science Decadal Survey (NRC, 2007).
- Visible-blind SiC Avalanche Photodiodes (APDs) for EUV photon counting are required. The APDs must show a linear mode gain >10E6 at a breakdown reverse voltage between 80 and 100V. The APD's must demonstrate detection capability of better than 6 photons/pixel/s down to 135nm wavelength. See needs of National Research Council's Earth Science Decadal Survey (NRC, 2007): Tropospheric ozone.
- Visible-blind UV and EUV detectors with small pixels, large format, photon-counting sensitivity and detectivity, low voltage and power requirements.
- Large area (3 m^2) photon counting near-UV detectors with 3 mm pixels and able to count at 10 MHz. Array with high active area fraction (>85%), 0.5 megapixels and readout less than 1 mW/channel. Imaging from low-Earth orbit of air fluorescence will require the development of high sensitivity and efficiency detection of

300-400 nm UV photons to measure signals at the few photon (single photo-electron) level. A secondary goal minimizes the sensitivity to photons with a wavelength greater than 400 nm. High electronic gain (10E4 to 10E6), low noise, fast time response (<10 ns), minimal dead time (<5% dead time at 10 ns response time), high segmentation with low dead area (<20% nominal, <5% goal), and the ability to tailor pixel size to match that dictated by the imaging optics. Optical designs under consideration dictate a pixel size ranging from approximately 2 x 2 mm^2 to 10 x 10 mm^2. Focal plane mass must be minimized (2g/cm^2 goal). Individual pixel readout is required. The entire focal plane detector can be formed from smaller, individual sub-arrays.
- Neutral density filter for hard x-rays (> 1 keV) to provide attenuation by a factor of 10 to 1000 or more. The filter must provide broad attenuation across a broad energy range (from 1 keV to ~100 keV or more) with a flat attenuation profile of better than 20%.
- Solar X-ray detectors with small independent pixels (< 250 Â¼m) and fast read-out (>10,000 count/s/pixel) over an energy range from < 5 keV to 300 keV.
- Supporting technologies that would help enable X-ray Surveyor mission that requires the development of X-ray microcalorimeter arrays with much larger field of view, ~105-106 pixels, of pitch ~ 25-100 um, and ways to read out the signals. For example, modular superconducting magnetic shielding is sought that can be extended to enclose a full-scale focal plane array. All joints between segments of the shielding enclosure must also be superconducting.
- Improved long-wavelength blocking filters are needed for large-area, x-ray microcalorimeters. Filters with supporting grids are sought that, in addition to increasing filter strength, also enhance EMI shielding (1 - 10 GHz) and thermal uniformity for decontamination heating. X-ray transmission of greater than 80% at 600 eV per filter is sought, with infrared transmissions less than 0.01% and ultraviolet transmission of less than 5% per filter. Means of producing filter diameters as large as 10 cm should be considered.Â

NASAÂ flagship missions under study areÂ LUVOIR, HabEx, Lynx, New Frontier-IO:

- http://luvoir.stsci.edu
- https://www.jpl.nasa.gov/habex/
- https://wwwastro.msfc.nasa.gov/lynx/
- https://science.nasa.gov/astrophysics/
- https://explorers.gsfc.nasa.gov

The desired deliverables are results of tests and analysis of designs and/or prototype hardware.Â The expected Technology Readiness Level (TRL) range at completion of the project is 3-5.

References:

- https://cor.gsfc.nasa.gov
- https://planetarymissions.nasa.gov
- https://ehpd.gsfc.nasa.gov