NASA SBIR 2012 Phase I Solicitation

S1.04 Detector Technologies for UV, X-Ray, Gamma-Ray and Cosmic-Ray Instruments

Lead Center: GSFC

Participating Center(s): JPL, MSFC

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, 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, Vision Missions, and Earth Science Decadal Survey missions. Details of these can be found at the following URLs:


Specific technology areas are listed below:

- Significant improvement in wide band gap semiconductor materials, such as AlGaN, ZnMgO and SiC, individual detectors, and detector arrays for operation at room temperature or higher for missions such as Geo-CAPE, NWO, ATALAST and planetary science composition measurements.
- Highly integrated, low noise (Large format UV and X-ray focal plane detector arrays: micro-channel plates, CCDs, and active pixel sensors (>50% QE, 100 Megapixels).
- Advanced Charged Couple Device (CCD) detectors, including improvements in UV quantum efficiency and read noise, to increase the limiting sensitivity in long exposures and improved radiation tolerance. Electron-bombarded CCD and CMOS detectors, including improvements in efficiency, resolution, and global and local count rate capability. In the X-ray, we seek to extend the response to lower energies in some CCDs, and to higher, perhaps up to 50 keV, in others. Possible missions are future GOES missions and International X-ray Observatory.
- Wide band gap semiconductor, radiation hard, visible and solar blind large format imagers for next generation hyperspectral Earth remote sensing experiments. Need larger formats (>1Kx1K), much higher
resolution:

- Solar blind, compact, low-noise, radiation hard, EUV and soft X-ray detectors are required. Both single pixels (up to 1cm x 1cm) and large format 1D and 2D arrays are required to span the 0.05nm to 150nm spectral wavelength range. Future missions include GOES post R and T.
- Visible-blind SiC Avalanche Photodiodes (APDs) for EUV photon counting are required. The APDs must show a linear mode gain >1E6 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.
- Large format 1D (1 x 2k) and 2D (2k x 2k) SiC arrays (operating temp 170-300K; D* = 3x1015) including Schottky diodes, PINs and ADPs for instruments on future outer planets missions.
- Imaging from low-Earth orbit of air fluorescence, UV light generated by giant air showers by ultra-high energy (E >10E19 eV) cosmic rays 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 (~106), low noise, fast time response (2. Focal plane mass must be minimized (2g/cm² goal). Individual pixel readout is required. The entire focal plane detector can be formed from smaller, individual sub-arrays.
- Large area (3 m²) 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. Future instruments are JEM-EUSO and OWL.
- Large area (m²) X-ray detectors with 85%). Future instrument is a Phased-Fresnel X-ray Imager.
- Improve beyond CdZnTe detectors using micro-calorimeter arrays at hard X-ray, low gamma-ray bands (above 10 keV and Below 80 keV).
- Technologies to improve spatial resolution for the hard X-ray band to 10 and ultimately to 5 arc-second resolution.
- High-density, low-temperature electrical interfaces: In microcalorimeter and cryogenic IR detector assemblies, the large number of electrical connections required on the low-temperature stage (below 4 Kelvin) requires high-density, miniaturized cryogenic connectors. NASA needs suitable nano-miniature connectors that can connect to superconducting wires (Nb or Al) deposited on a high density flex cable. The metal traces will likely be layered into a stripline configuration to minimize cross-talk, leading to pads onto which the connector is attached. This type of flex cable has extremely low thermal conductivity. A modular connector, easily integrated into or removed from the superconducting flex cable, is sought.