NASA STTR 2022 Phase I Solicitation

T8.07 Photonic Integrated Circuits

Lead Center: GSFC

Participating Center(s): GRC, LaRC

Scope Title
Photonic Integrated Circuits

Scope Description
Photonic integrated circuits (PICs) generally integrate multiple lithographically defined photonic and electronic components and devices (e.g., lasers, detectors, waveguides/passive structures, modulators, electronic control, and optical interconnects) on a single platform with nanometer-scale feature sizes. PICs can enable size, weight, power, and cost reductions and improve the performance of science instruments, subsystems, and components. PIC technologies are particularly critical for enabling small spacecraft platforms. Proposals are sought to develop PIC technologies including the design and fabrication of PICs that use nanometer-scale structures and optical metamaterials. On-chip generation, manipulation, and detection of light in a single-material system may not be practical or offer the best performance, so hybrid packaging of different material systems are also of interest. Often the full benefits of photonic integration are only realized when combined with integrated electronics. This subtopic solicits methods, technology, and systems for development and incorporation of active and passive circuit elements for PICs for:

- PICs for in situ and remote sensors: NASA application examples include but are not limited to lab-on-a-chip systems for landers, 3D mapping and spectroscopic lidar systems and components, and optical spectrometers. We are also interested in the integration of active and passive components on chip allowing for optical processing and manipulation of laser spectra (such as optical phase lock loops) with detector bandwidths >30 GHz. Monolithic integration is preferred when plausible, but it is understood that hybrid and heterogeneous integration is also useful.
- PICs for analog radiofrequency (RF) photonics: NASA applications require new methods to reduce the size, weight, and power of passive and active RF, microwave, submillimeter, and terahertz signal processing. Example applications include terahertz spectroscopy, microwave radiometry, and hyperspectral microwave sounding needing integrated high-speed electro-optic modulators, optical filters with tens of GHz free-spectral-range and few GHz resolution. Ka-band operation of RF photonic up/down frequency converters and filters need wideband tunability (>10 GHz) and <1 GHz instantaneous bandwidth.

Expected TRL or TRL Range at completion of the Project
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

- Research
- Analysis
- Prototype
- Hardware

Desired Deliverables Description

Phase I does not need to include a physical deliverable to the government but it is best if it includes a demonstration of feasibility through measurements. This can include extensive modeling, but a stronger proposal will have measured validation of models or designs.

Phase II should include prototype delivery to the government. (It is understood that this is a research effort and the prototype is a best-effort delivery where there is no penalty for missing performance goals.) The Phase II effort should be targeting a commercial product that could be sold to the government and/or industry.

State of the Art and Critical Gaps

There is a critical gap between discrete and bulk photonic components and waveguide multifunction PICs. The development of PICs permits size, weight, power, and cost reductions for spacecraft microprocessors, communication buses, processor buses, advanced data processing, and integrated optic science instrument optical systems, subsystems, and components. This is particularly critical for small spacecraft platforms.

Relevance / Science Traceability


Science Mission Directorate (SMD): Earth, planetary, and astrophysics compact science instrument (e.g., optical and terahertz spectrometers and magnetometers on a chip, lidar systems and subsystems)

(See Earth Science and Planetary Science Decadal Surveys)

Space Technology Mission Directorate (STMD): Game-changing technology for small spacecraft navigation (e.g., laser ranging and gyroscopes).

Small Business Technology Transfer (STTR): Exponentially increasing interest in programs at universities and startups in integrated photonics.

Space Technology Roadmap 6.2.2, 13.1.3, 13.3.7, all sensors, 6.4.1, 7.1.3, 10.4.1, 13.1.3, 13.4.3, 14.3.3.
References

1. AIM integrated photonics: http://www.aimphotonics.com


