II. Accomplishments:

A. What are the major goals of the project?

Photonic integrated circuits (PICs) with system-on-chip integrated feasibility have been identified as a potential signal processing component between the bulk optical or RF front end and the electronic processors. Also, explorations have been undertaken for using the on-chip phase array and emitters for short-distance Light Detection and Ranging (Lidar) applications. With the potential concerns of induced material degradation and temperature cycle related mechanical drift, a passive flight test of those optical and electronically packaged optical Lidar provides insight of collective impacts of the space environment on the devices. We aim to evaluate the post-flight component performance after exposition the packaged PIC Lidar on the Materials on the International Space Station Experiment (MISSE), to improve their technology readiness level (TRL) for future technical transitions. The performance matrix of the components will be carefully characterized before and after the flight exposure in the laboratory environment.

Primary goal: Evaluate the reliability of the packaged silicon photonic system-chip chip Lidar components in the near Low Earth Orbit (LEO) space environment to elevate their TRLs from 3 to 4, towards technical transitions from research to aerospace applications.

Objective: Evaluate the sensitivity of the coupling between fiber-array to silicon photonic optical phase array to the collective impact from cosmic radiation exposure, temperature cycle, micro-gravity, and mechanical vibration (laughing and splashing down).

Objective: Evaluate the potential degradation on the high-speed and delicate electronic packaging from ionizing particles related charging and displacement damage.

B. What was accomplished under these goals?

- We received one TAPEOUT to AIM photonics foundry, including desired LiDAR systems, with compact Tx and Rx antenna (from other funding sources)
- We delivered and received one another TAPEOUT to AIM photonics with the NASA collaborator/technical monitor
- We setup the fiber array coupler for measuring the components for LiDAR systems, and obtaining the ranging signals from the detectors
- We received the packaged (PIC and RF PCB) LiDAR system from the NASA collaborator and investigated the fiber coupling loss before flight.
- We obtained the UV radiation dosage for comparing the device results

C. What opportunities for development has the project provided to the Jurisdiction's Research Infrastructure as a whole?

We involved 3 undergraduate students and two graduate students to develop the integrated photonic test platforms.

We have discussed with NASA collaborator and planning to send graduate/undergraduate research interns for performing research in the collaborator’s laboratory.

D. How have the results been disseminated to communities of interest?

The group delivered two talks at top optics conferences (Optical Fiber Conference) of the research.

PI gives talks at Aerospace Inc workshop.

PI presented the research results at Jet Propulsion Laboratory early 2025.

E. What do you plan to do during the next reporting period to accomplish the goals?

Carefully characterize the devices' planning for space exposure with fiber arrays.
Finalize the flight schedule and plans for the testing devices with NASA technical monitor.

III. Products:

A. List Journal publications – Please only list papers that have been published.

Date Published	Published Paper (APA format)
01/2024	**Dun Mao, Lorry Chang, Hwaseob Lee, Anthony Yu, Bennett Maruca, William Matthaeus, Michael Krainak, Po Dong, Tingyi Gu, Space Qualifying Silicon Photonic Modulators and Circuits, Science Advances 10 (1), eadi9171 (2024)**

B. List Conference Papers – Please only list papers that are included in conference proceeding.

Conference Date	Conference Paper (APA format)
04/2024	**L. Chang, D. Mao, H. Lee, A. W. Yu, M. A. Krainak, T. Gu, Space Qualifying Silicon photonic modulators and circuits, Optical Fiber Communication 2024**

C. List Conference Presentation – Please list conference presentation.

Conference Date	Presentation Topic (APA format)
04/2024	**L. Chang, D. Mao, H. Lee, A. W. Yu, M. A. Krainak, T. Gu, Space Qualifying Silicon photonic modulators and circuits, Optical Fiber Communication 2024**
03/2025	**M. H. K. Anik, D. Mao, L. Chang, P. Dong and T. Gu, Multi-Modal RF-Photonic Characterizations of Cosmic Radiation Impacts on Nanoscale Optoelectronic Devices, MRS Spring Meeting 4209570, CH02.12 (2025)**

D. List Books and/or other Publications – Please include explanations, help us to learn about your accomplishments.

Date	Explanations (APA format -Book, Newspaper Op-Ed, …)
	None to report

E. List talk/presentation/event/outreach activity – Please include explanations, help us to learn about your accomplishments.

Date	List talk/presentation/event/outreach activity (APA format if applicable)
05/28/2025	**2025 Middle Atlantic Regional Meeting (MARM), South Orange, NJ (2025): *Adaptive optics on chip with integrated photonics* (delivered by postdoc Jeong)**
04/30/2025	**68th International Conference on Electron, Ion, Photon Beam Technology and Nanofabrication (EIPBN), Savannah, GA: *Nanofabrication of integrated photonic devices***
02/30/2025	**Jet Propulsion Laboratory, La Cañada Flintridge, CA (2025): *Space-qualifying silicon photonic modulators***
05/01/2024	**NASA Delaware Space Annual Research Symposium, Newark, DE (2024): Space Test of Chip-Scale Silicon Photonic Circuits for Laser Communications**
02/12/2024	**Microelectronics Reliability and qualification workshop, The Aerospace Corporation, El Segun-do, CA (2024): Space qualifying silicon photonic modulators**
02/10/2024	**Air Force Research Laboratory, Dayton, OH (2024): Reveal the atomic picture of cosmic radiation impacts on nanoscale optoelectronic materials and devices**

F. List of new or updated Website(s) or other Internet site(s).

URL	Short description of purpose of site
None to report	

G. Technology/Technique –

Technology/Technique	Short description of technologies or techniques
None to report	

H. List patent – Please include Patent Number/Patent Title/ Patent Abstract (or link to it).

Date Patent Issued	Patent Number/Patent Title/ Patent Abstract (or link to it)
	None to report

I. List Inventions – Please include Invention Title, List of Inventor(s) and Description.

Invention Title	List Inventor(s)	Invention Description
None to report		

J. List Licenses – Please include license issued, Invention Title, List of Inventor(s) and Description.

Date License Issued	License Assignees	License Title
	None to report	

K. List New/Revised Courses – Please include new/revised courses.

Course Number	Course Name/Title	Offering Institution
ELEG853	**Integration Photonics**	**University of Delaware**
ELEG682	**Optics and Photonics**	**University of Delaware**
ELEG640	**Optoelectronics**	**University of Delaware**

L. Others: List Databases, Physical collections, Audio or video products, Software or NetWare, Models, Instruments or equipment, Data & Research Material (e.g., cell lines, DNA probes, animal models) related to your EPSCoR research.

Accomplishments title	Short Description of accomplishments
None to report	

IV. Participants & Other Collaborating Organizations:

A. University Research Team Members (do not include names of minors).

Name	Project Role	Nearest person month worked	Contribution to Project	Funding Support
Kaleem Ullah	Contributor	5	Leader on characterizing materials	This grant
Yifan Li	Contributor	1	Leader on characterizing PDs	SRC
Lorry Chang	Contributor	1	Leader on characterizing circuits loss	SRC

B. NASA Collaborators.

Name	Title	NASA Center	Nature of the Collaboration
Nathan Dostart	Engineer	LRC	Space instrument development
Catherine Chen	Space communication engineer	JPL	Integrated photonics for space communication

C. Industry Collaborators.

Name	Title	Industry/Company Name	Nature of the Collaboration
Po Dong	Senior director	Coherent/II-IV	Technical collaboration on building high speed optoelectronic devices
Dun Mao	Senior RF Engineer	Coherent/II-IV	Technical collaboration on building high speed

			optoelectronic devices

D. New non-EPSCoR grants.

Funding Entity	Award Name	Value of New Grant
National Science Foundation	CAREER	$549,990
National Science Foundation	Supplementary fund	$55,000
AFOSR	Presidential Early Career Awards for Scientists and Engineers	$999,999

E. Other Organizations Involved as Partners.

Organization	Nature of the Collaboration	Benefit of Collaboration	Additional Information
None to report			

V. Changes/Problems

A. Changes in approach and reasons for change.

n/a

B. Actual or anticipated problems or delays and actions or plans to resolve them.

We are waiting for the arrangement of flight.

C. Changes that have a significant impact on expenditures.

n/a

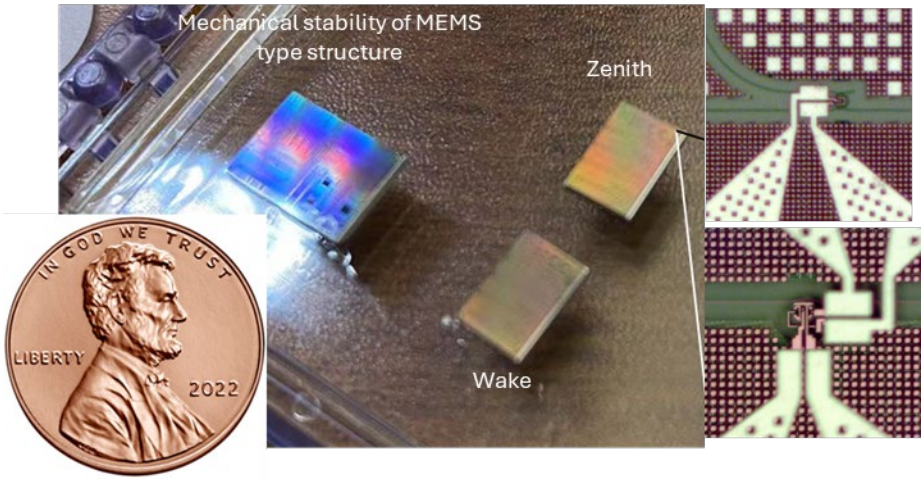
D. Significant changes in use or care of human subjects, vertebrate animals, and/or biohazards.

n/a

E. Change of primary performance site location from that originally proposed.

n/a

VI. Impact: Stimuli article (max 2,000 characters), a high-resolution photo, and a one-line caption. Obtain permission to publish photo from any recognizable person. ***Do not*** *include photos of minors.*



We delivered a few foundry-manufactured integrated photonic dies to ISS, exposing them to different orientations, and will compare the radiation-induced device response difference (from material level to device level), and test the feasibility of space operation.