LICENSING OPPORTUNITY: PHOTONIC CALORIMETER

DESCRIPTION

Invention

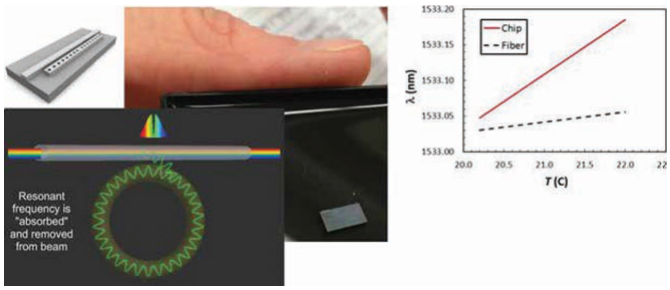
The calorimeter uses embedded, nanofabricated photonic sensors to enable micro-scale spatial resolution of dose (energy) distributions and gradients. It presents an alternative to thermistors used in conventional calorimeters for radiation dosimetry, comprising photonic sensors for in-situ dose and dose-gradient measurements in various materials (e.g., silicon, graphite, diamond, water, human tissue, etc.).

These new devices will have much higher spatial resolution, lower self-heating, reduced artifacts at sensor-absorber interfaces, and the capability for 2D and 3D imaging using arrays of sensors. Improves the capability to measure dose and dose gradients (near beam penumbrae and near surfaces or material boundaries) for measuring energy deposition from beams with low penetration depth (e.g., low-energy electrons, etc.).

BENEFITS

Competitive Advantage

- Leverages inexpensive commercial communications technology and chip fabrication for inexpensive manufacturing.
- Enables absolute dosimetry with potential for unprecedented micron-scale spatial resolution across six orders of magnitude of absorbed dose, from medical diagnostic and therapeutic procedures to industrial materials processing, sterilization, and aerospace applications.



In-situ micro-scale dosimetry and calorimetry technology leading to new chip-based metrology for industrial and medical applications. Increased sensitivity, spatial resolution, optical readout and multiplexing capabilities would yield new portable sensors for absolute dosimetry, enabling traceable measurements that reduce dependence on Co-60 sources and help close the loop on quantitative nuclear medicine. Graph inset shows plots of measurements obtained at NIST exhibiting linear temperature dependence for Fiber Bragg Gratings and Photonic Ring Resonators on a Chip.

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NIST TECHNOLOGY PARTNERSHIPS OFFICE

NIST Technology Partnerships Office
National Institute of Standards and Technology
100 Bureau Drive, Gaithersburg, MD 20899-2200

Meet **Zeeshan Ahmed, Ph.D.,**

Senior Scientist, National Institute of Standards and Technology

Why Do We Need To Measure Ionizing Radiation?

IBA Rhodotron DUO dual configuration for carton irradiation by either electron beam or X-ray. Image provided by IBA Industrial.

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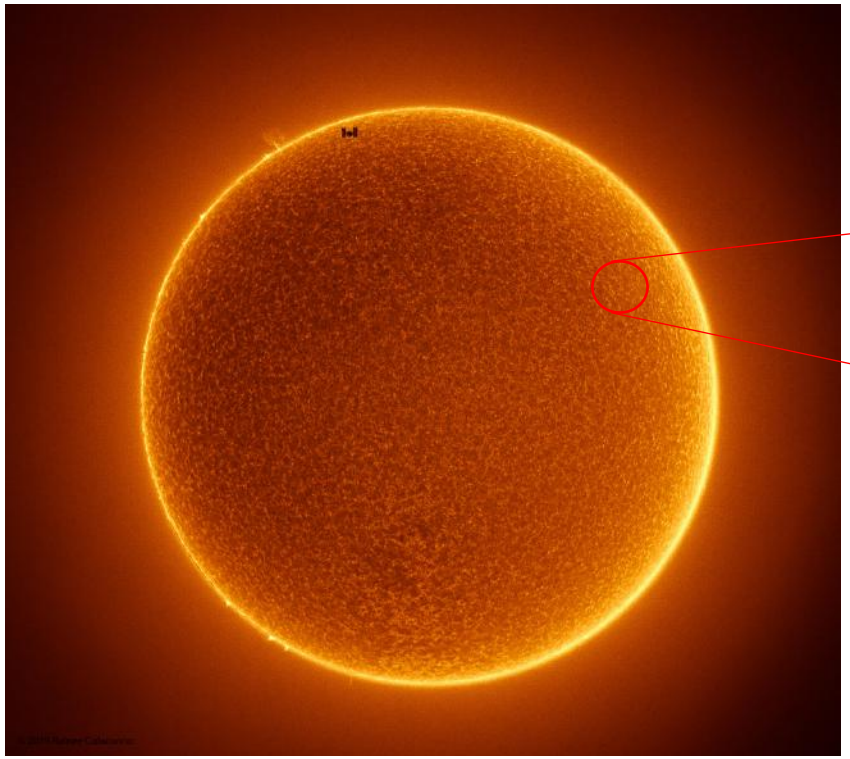
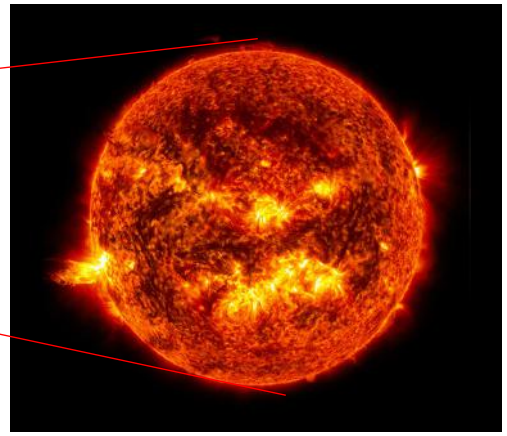
Problem



How we think of Radiation beams



But if you zoom in things look a lot different

‘Mo Power, ‘Mo Problems

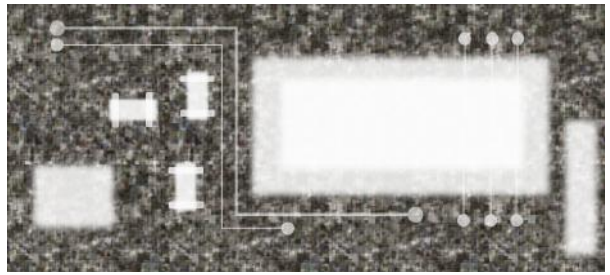
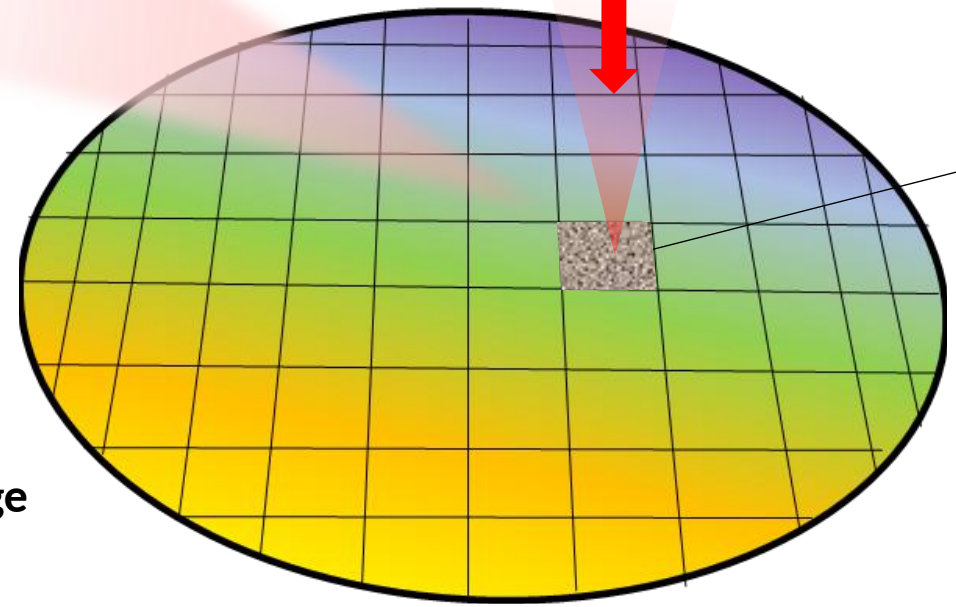


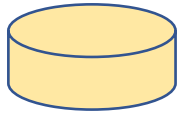
Image quality and magnification

Increased risk of radiation damage

Focused x-ray beam



Ionization chamber

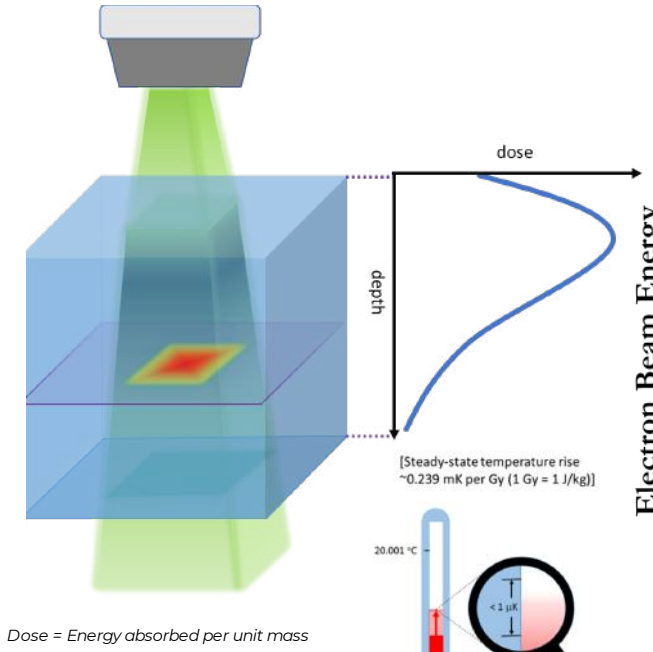


Alanine-EPR dosimeters

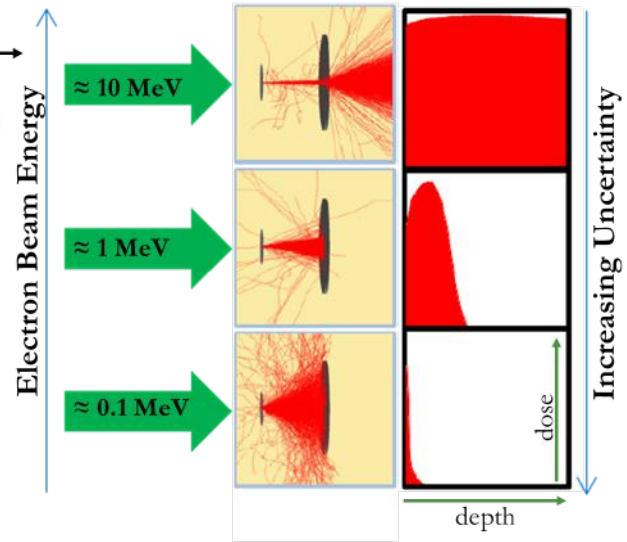
https://en.wikipedia.org/wiki/USB_flash_drive#/media/File:USB_3.0_Flash_Drive_PCB.jpg

Our solution:
Realize Gray using Photonic Thermometers

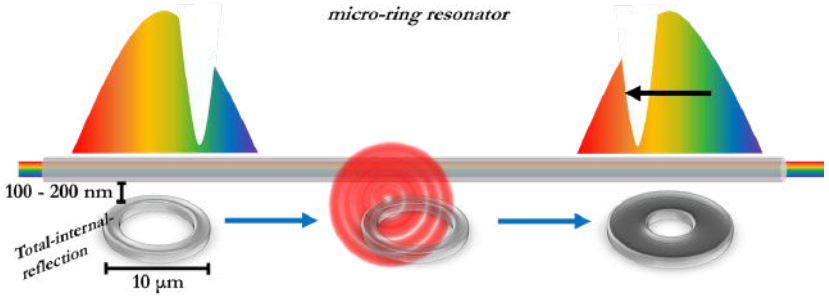
Ionizing radiation consists of highly energetic photons, electrons or heavier particles from a radioactive source or produced by an accelerator

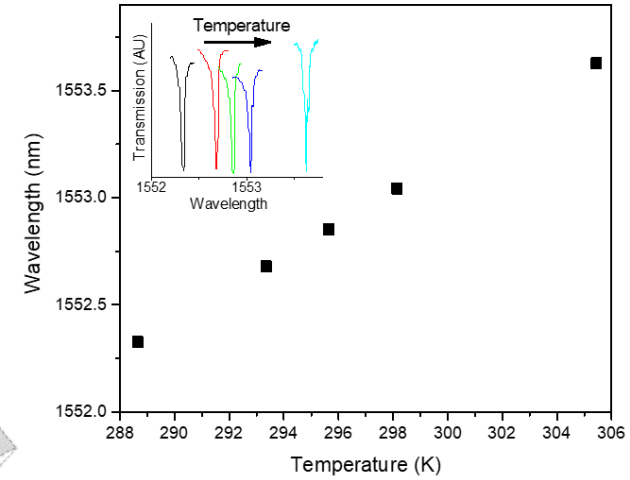


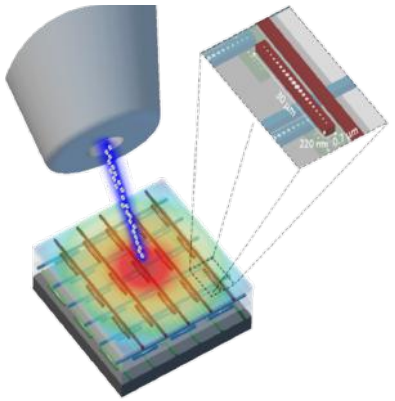
Dose = Energy absorbed per unit mass



Monte Carlo simulations of electron beams on 2 mm graphite wafer, NIST internal, Fred Bateman







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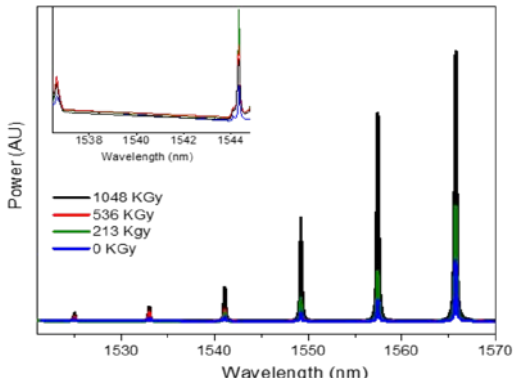
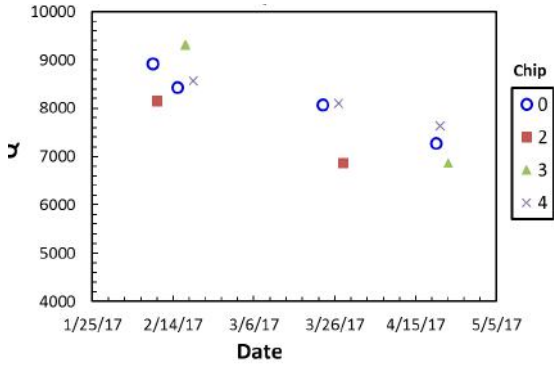
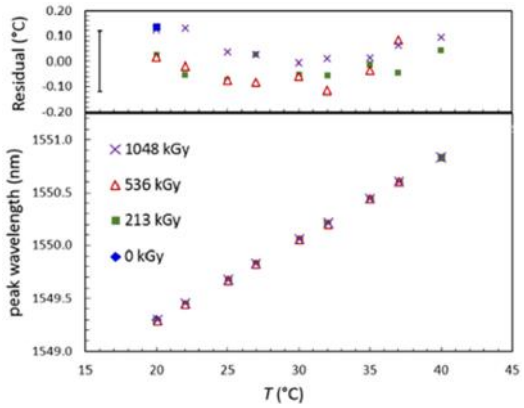
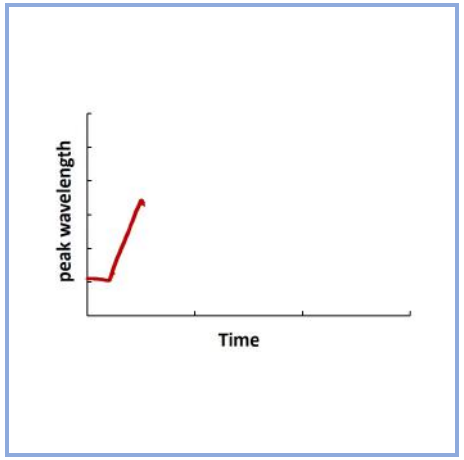
What Have We Accomplished?

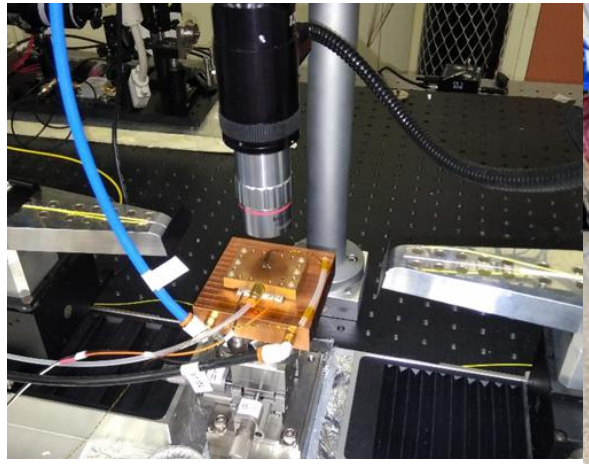
No systematic impact of radiation (up to 1 MGy dose) were found on passivated silicon chip devices, indicating the extreme durability under harsh conditions

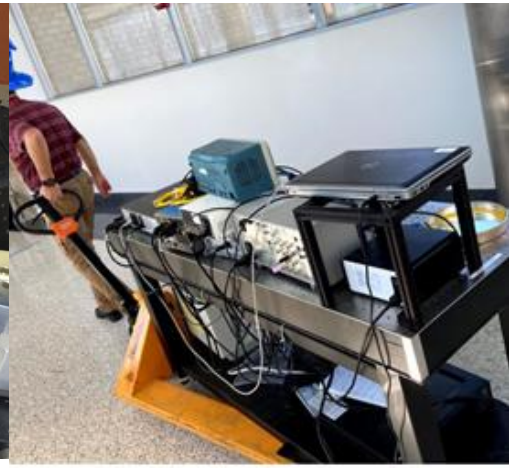












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PHOTONIC CALORIMETER

THE TECHNOLOGY

U.S. Patent Number 10,782,421

The calorimeter uses embedded, nanofabricated photonic sensor arrays to enable micrometer-scale spatial resolution of dose (energy) distribution and gradients. It replaces thermistors (used in conventional radiation calorimeters) with photonic sensors of various designs embedded in numerous possible materials (such as graphite, diamond, water, human tissue, silicon, etc.) for in-situ dose and dose-gradient measurements.

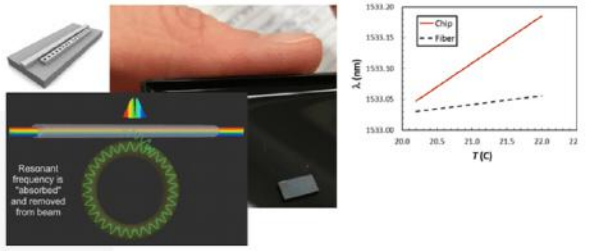
INEXPENSIVE

SMALL SCALE MEASUREMENT

IDEAL FOR CELLULAR DOSIMETERY

These new devices will have much higher spatial resolution, lower self-heating, reduced artifacts at sensor-absorber interfaces, and capability for imaging using arrays of sensors on a chip (2D) and arrays of chips (3D). Improves capability to measure dose and dose gradients (near beam penumbrae and near surfaces or material boundaries) for measuring energy deposition from beams (photon, electron, etc.) with low penetration depth.

Chip-based photonic thermometry



An in-situ nano-scale dosimetry and calorimetry leading to new chip-based metrology for industrial and medical applications. Increased sensitivity, spatial resolution, optical readout and multiplexing capabilities could redefine the meaning of "dose", reduce dependence on Co-60 sources, enable new portable sensors, and help close the loop on quantitative nuclear medicine.

Graph shows linear curves using slopes measured at NIST for Fiber Bragg Gratings and Photonic Ring Resonators on a Chip.

BENEFITS

Leverages inexpensive commercial communications technology and chip fabrication for inexpensive manufacturing and operation.

Technically superior by enabling absolute dosimetry at an unprecedented physical scale due to micron-scale spatial resolution across six orders-of-magnitude of absorbed dose, from medical diagnostic and therapeutic procedures up through industrial materials processing, sterilization, and applications leading to commercialization of space.

CONTACT

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