

Chip-scale calorimetry for industrial dosimetry

Council of Ionizing Radiation Measurements and Standards

March 29, 2017

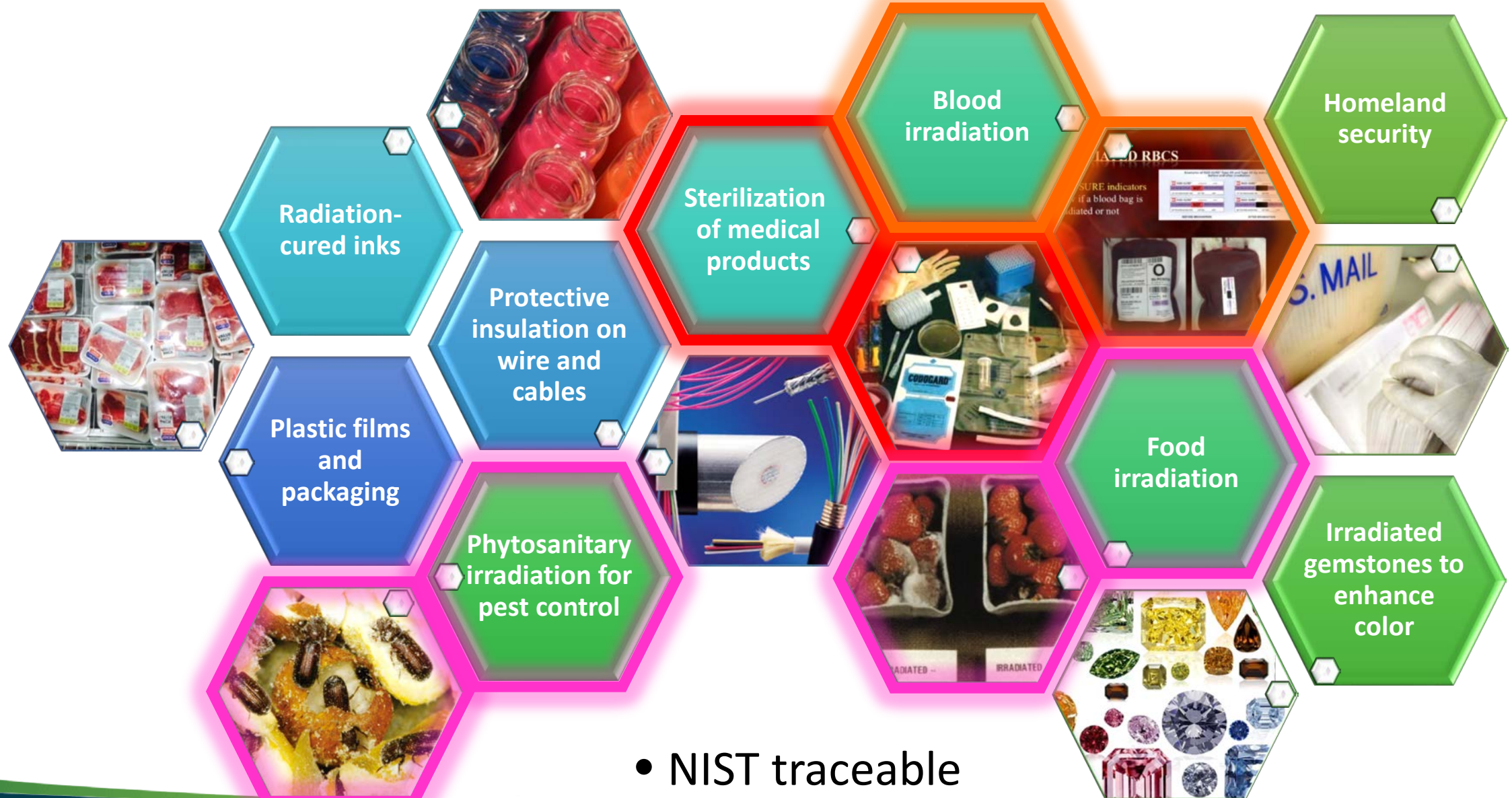
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Physical Measurement Laboratory

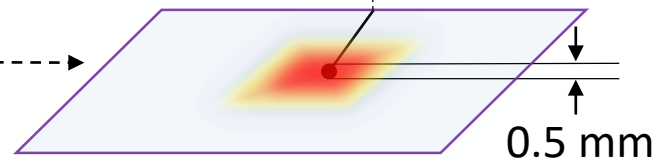
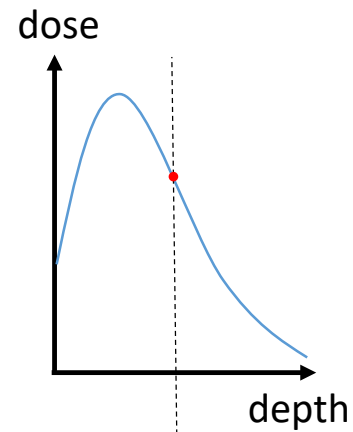
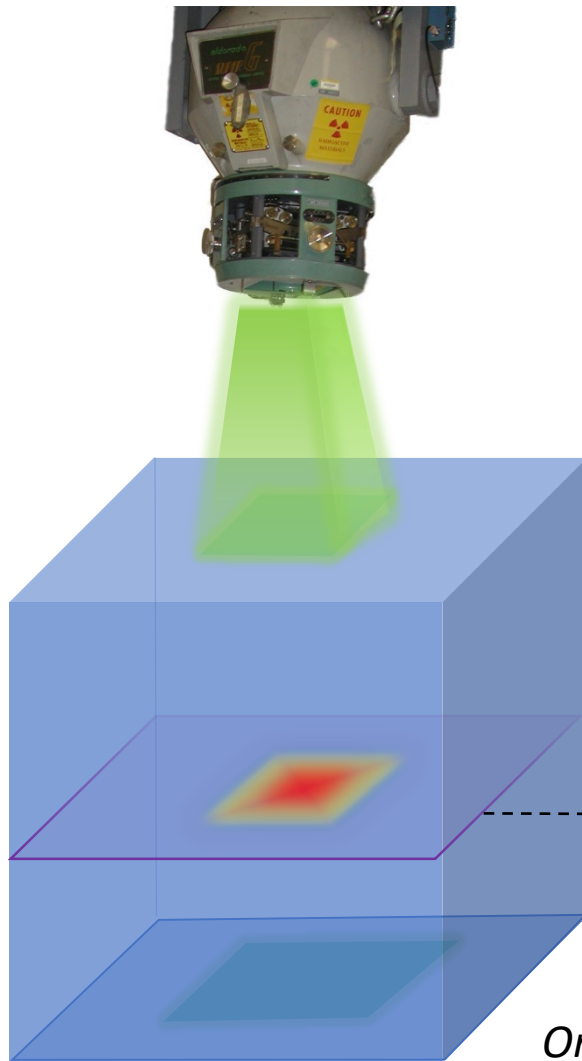
National Institute of Standards and Technology

Radiation-induced materials modifications

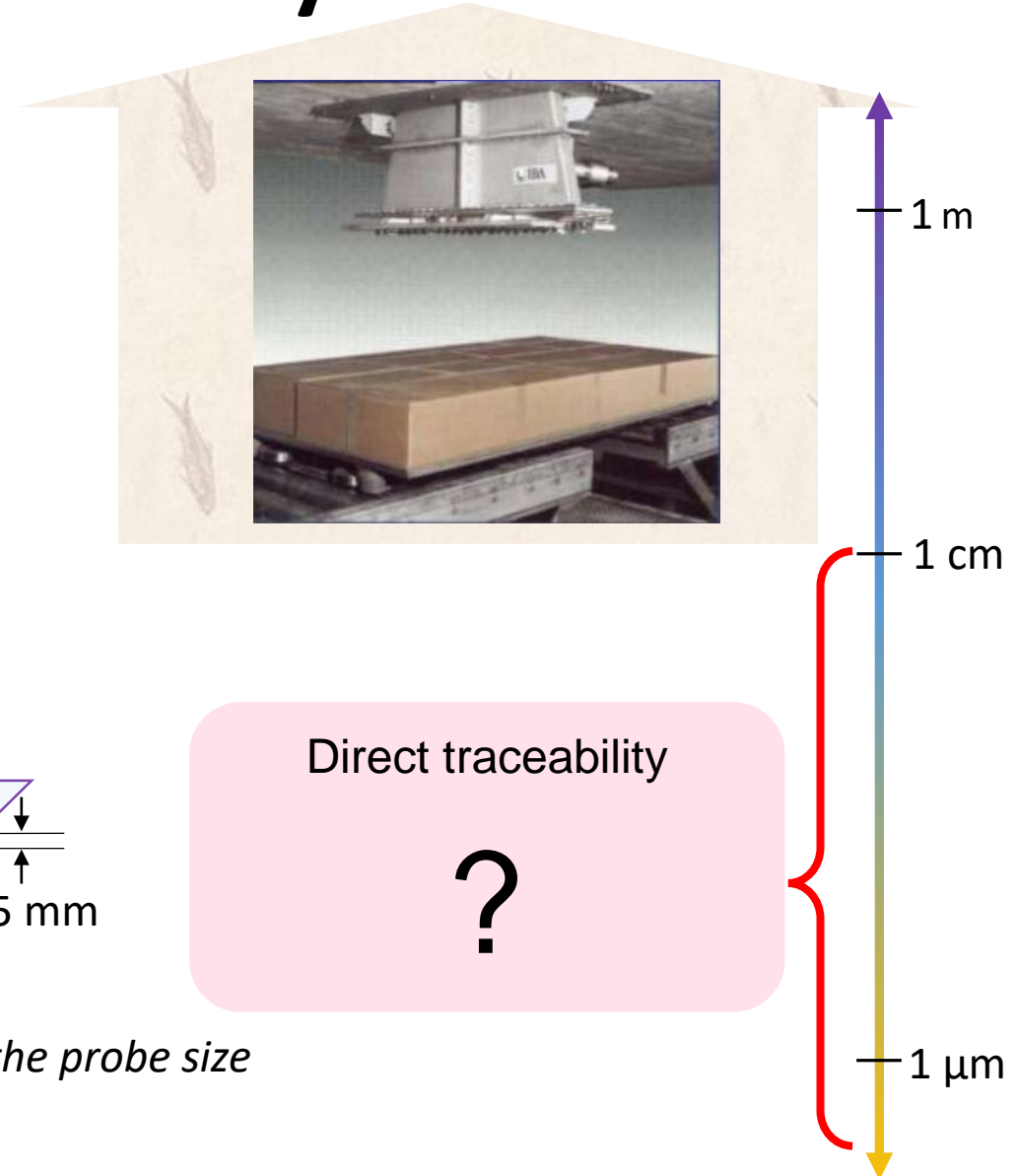


• NIST traceable

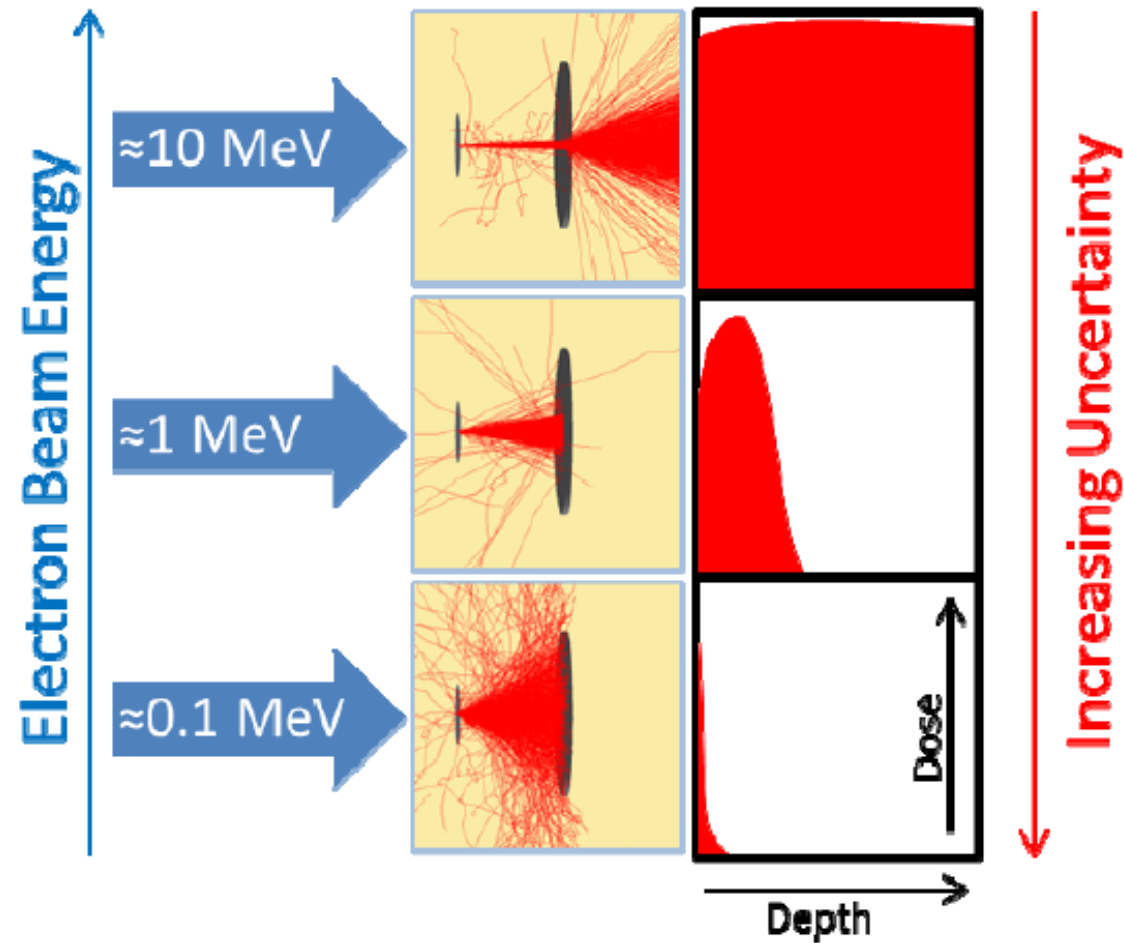
Macro-scale calorimetry



Only valid for fields uniform for 10x the probe size



Radiation-induced materials modifications



Lack of traceability leaves industries without support needed to meet regulatory requirements.

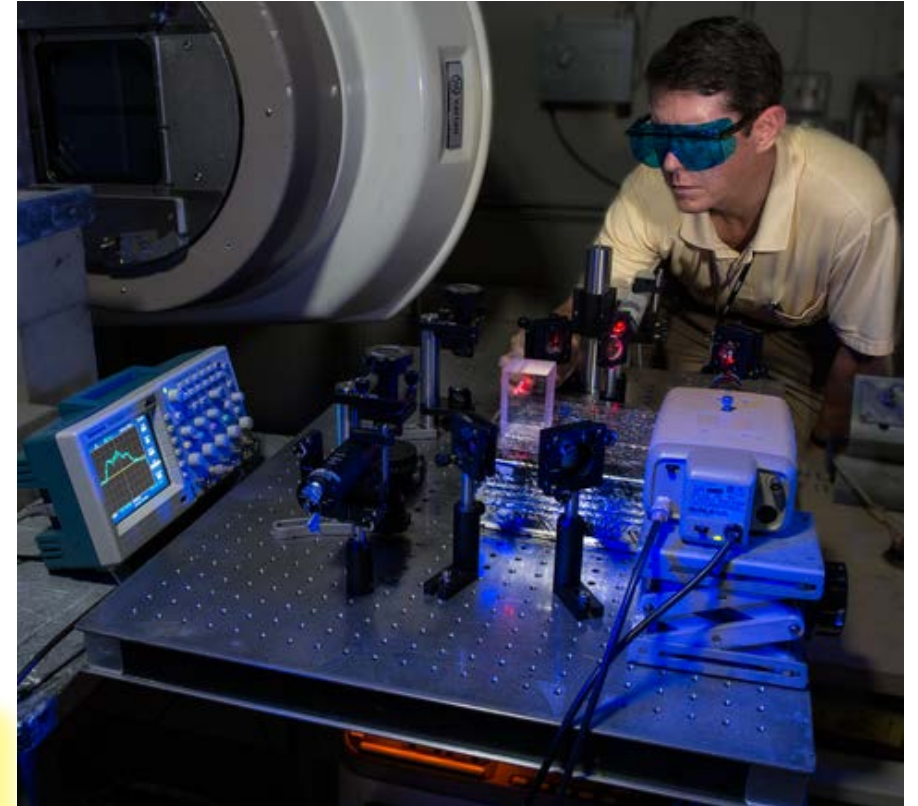
Calorimetry research

Graphite Calorimetry

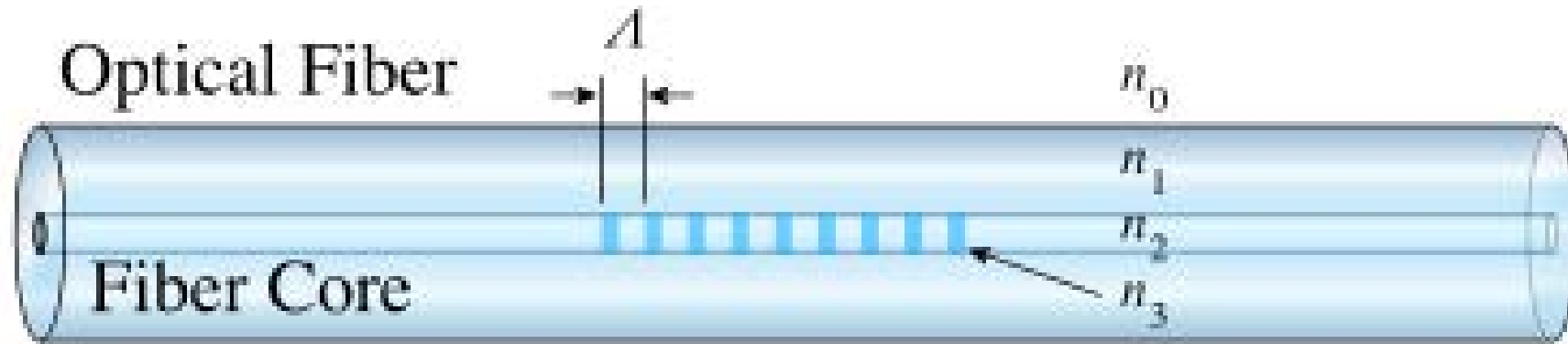
Ultrasound

Optical interferometry

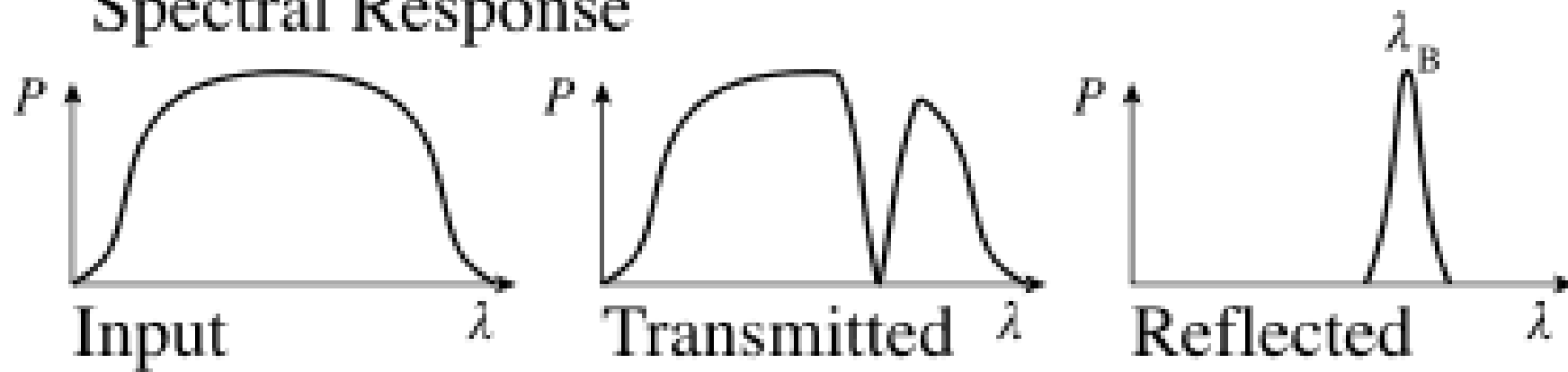
Chip-based photonic thermometry



Fiber Bragg grating



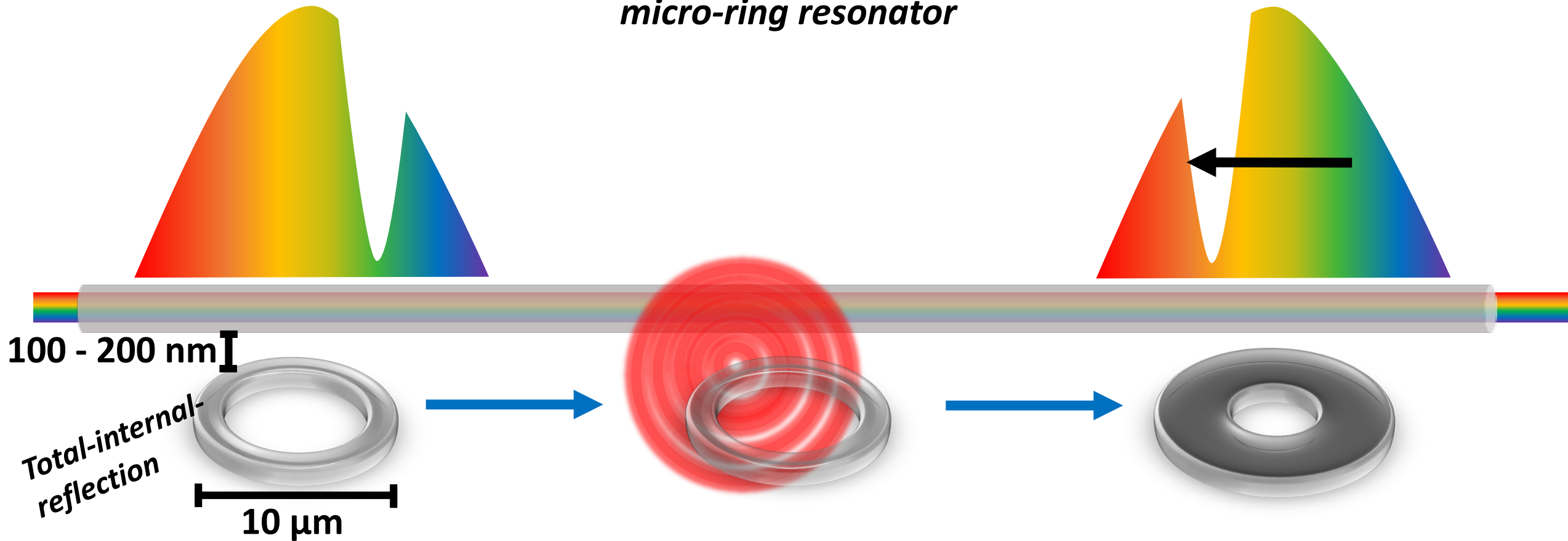
Spectral Response



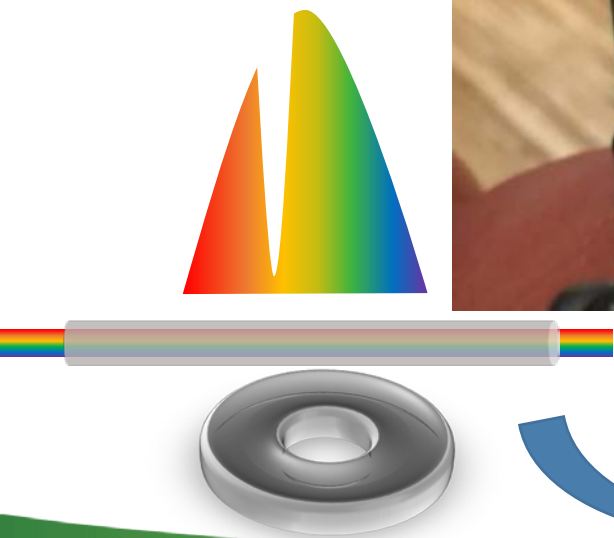
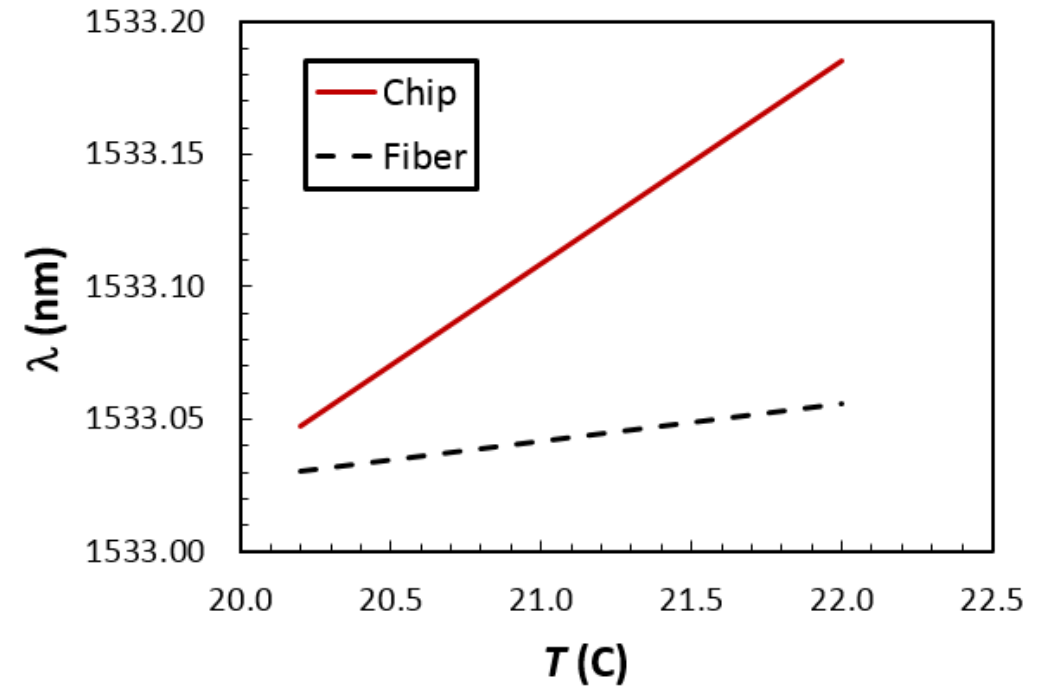
Chip-based photonic thermometry

Applications: civic infrastructure, aerospace, telecommunications, *dosimetry?*

micro-ring resonator

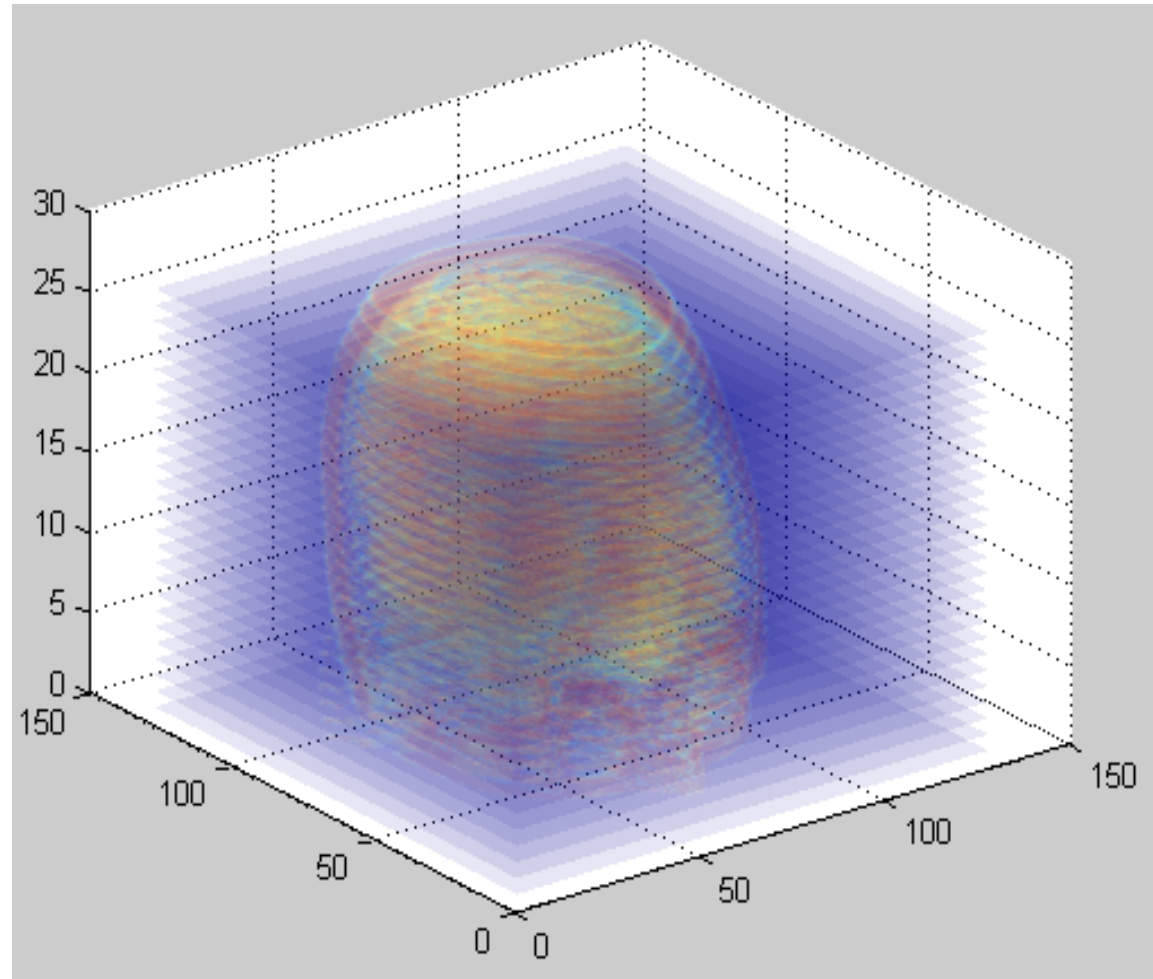
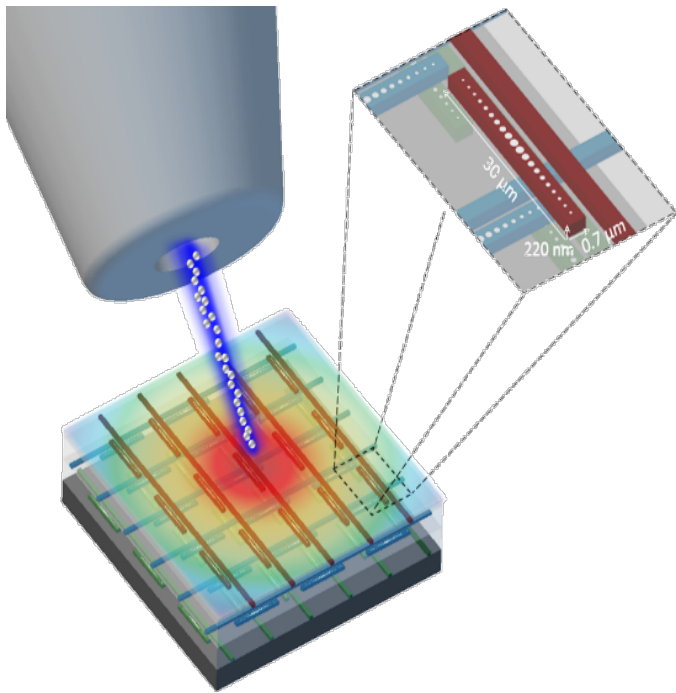


Chip-based photonic thermometry

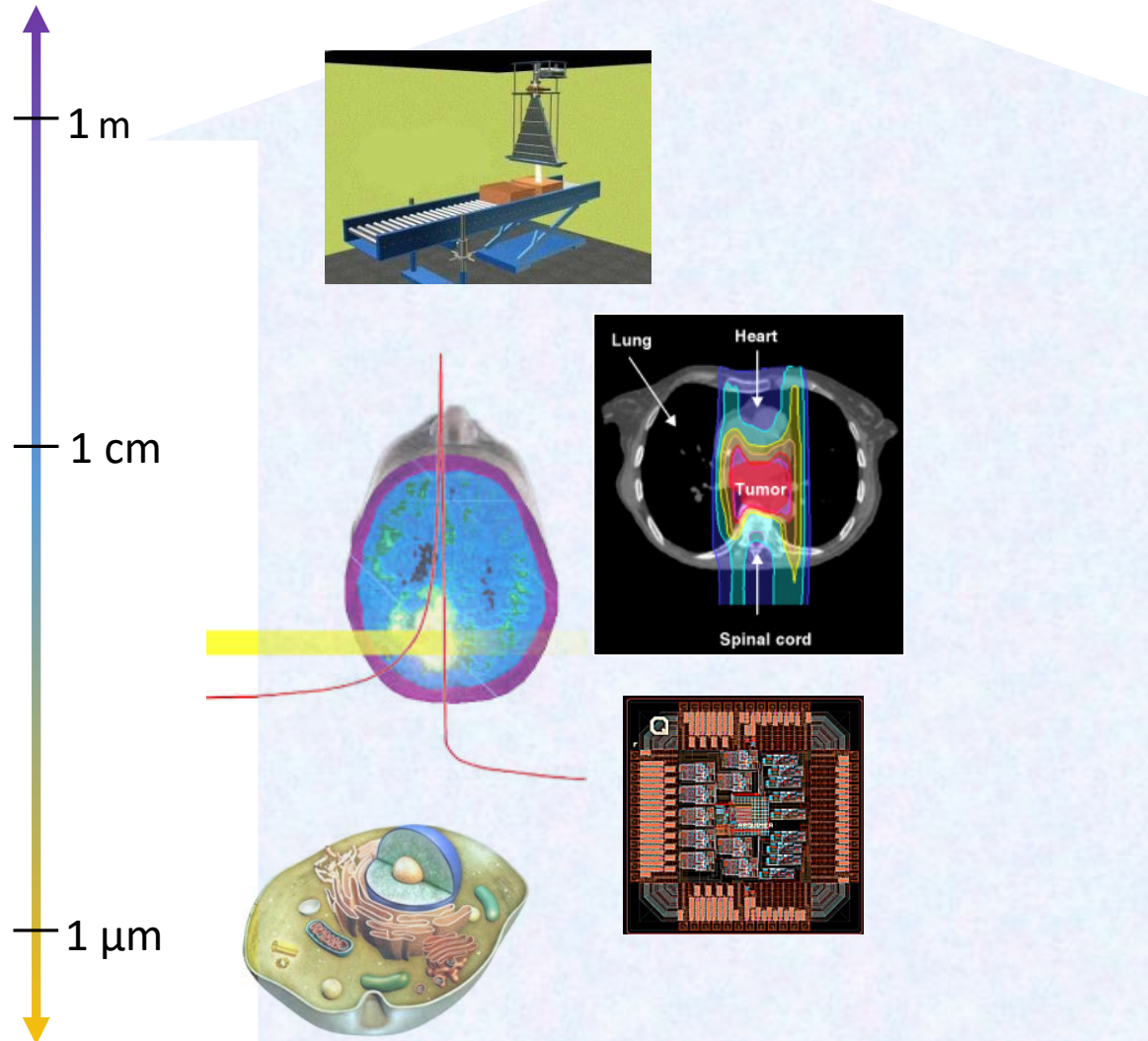


100s?
1000s?

Multiplexing for absolute dosimetry mapping



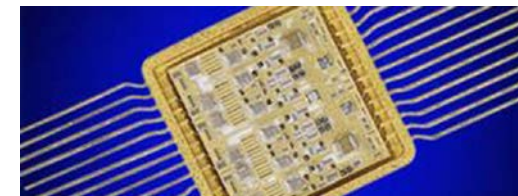
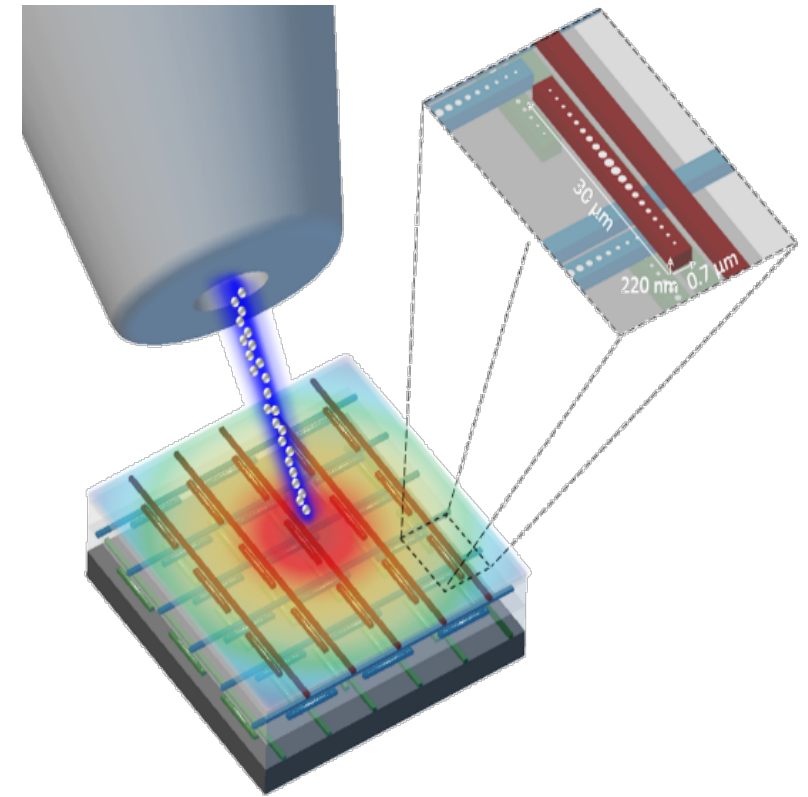
Goal: Micro-Scale Calorimetry



- Photonic thermometer embedded in a radiation-resistant substrate
- Calibration in electron beams at all energies used in industry
- Field-deployable chip-scale dosimeters
- microbeam therapy
- microelectronics
- cellular dosimetry

Challenges: Micro-Scale Calorimetry

- Radiation resistance of sensors?
 - Nanofab controls material doping
- Is radiation damage a problem or a feature?
 - Reproducible radiation damage could act as a dosimeter
 - Calorimetry and integrated dose?
- Temperature to dose?
 - Monte Carlo modeling?
 - Scaling?
- Multiplexing
 - Independently measure temperature from 1000s of sensors in a large array?



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NIST on a Chip Program