NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY
U.S. DEPARTMENT OF COMMERCE

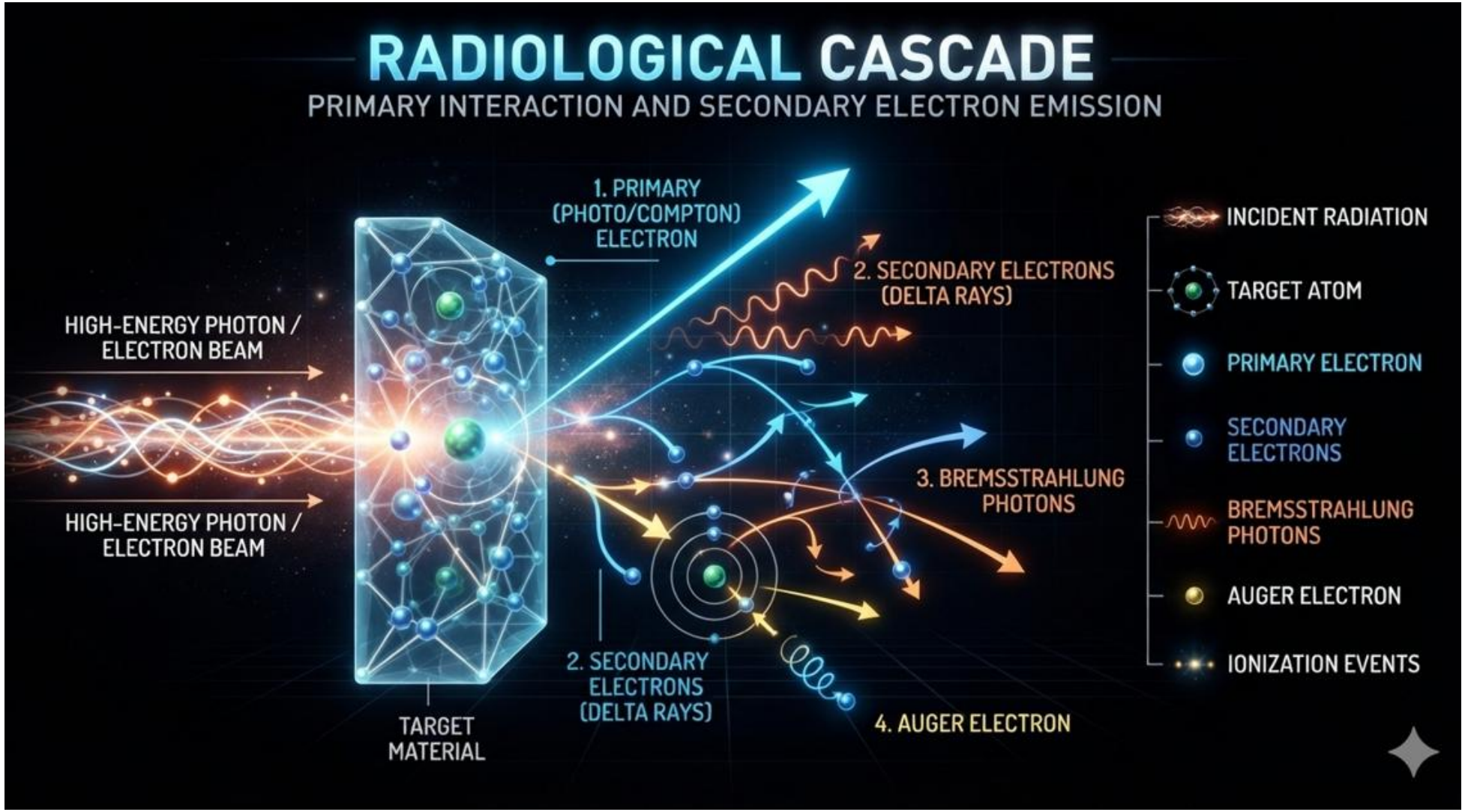
# Evolving Dosimetry Standards at NIST

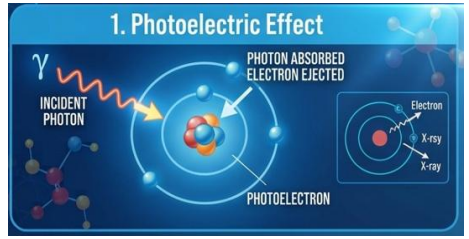
**Ronald E. Tosh**

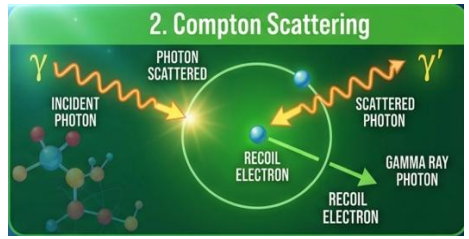
Dosimetry Group, Radiation Physics Division

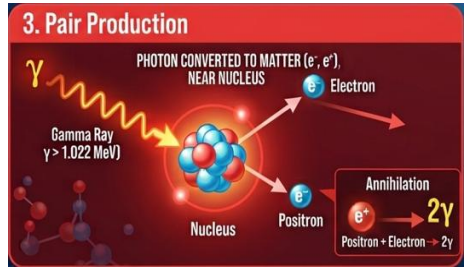
Physical Measurement Laboratory
National Institute of Standards and Technology,
Gaithersburg MD 20899

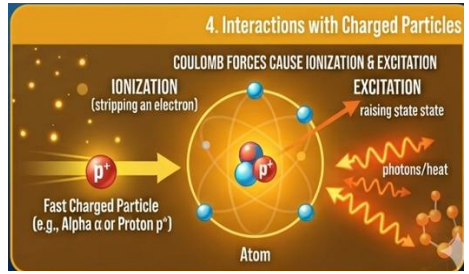
# Phenomenology to physics



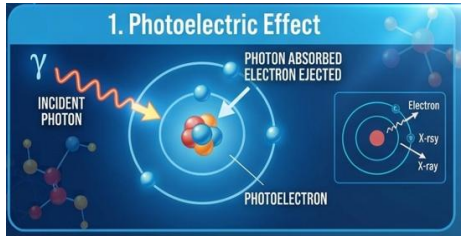



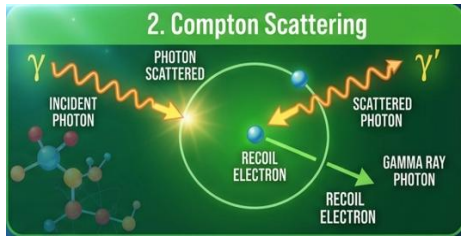



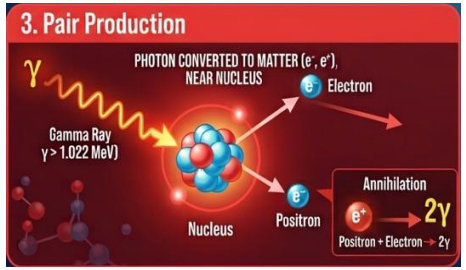



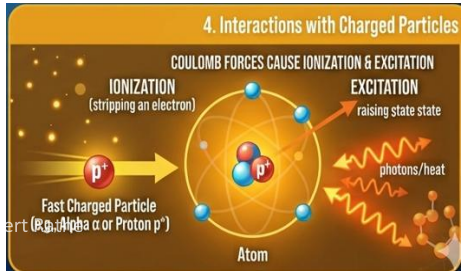

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# Physics to NIST traceability (standards)




| Energy Range | Clinical Application |
|---|---|
| < 25 keV | Mammography, Superficial Therapy |
| 100 keV – 1 MeV | Brachytherapy ($^{192}$Ir), Orthovoltage |
| 1 MeV – 10 MeV | Standard Linac (6 MV), TomoTherapy, CyberKnife |
| > 10 MeV | High-Energy Linac (15 MV, 18 MV) |

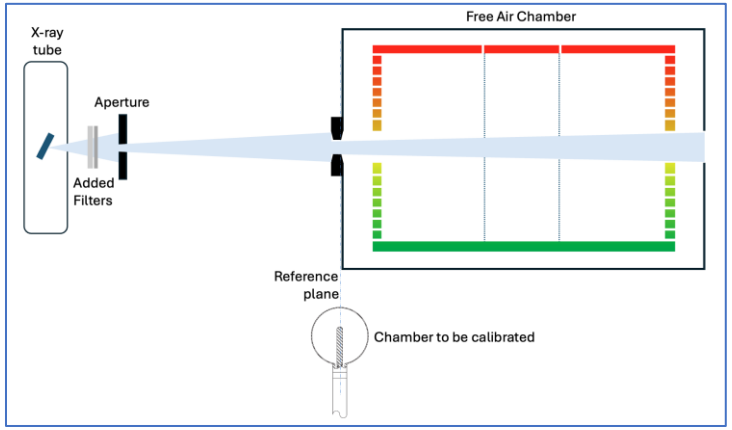
| NIST SKU | Service Description |
|---|---|
| 46011C<br>460505 P18 | Air Kerma Calibration of Radiation Instrument in X-Ray Beam |
| 47020C<br>470405 P8 | Low-energy Photon Brachytherapy Seeds, 125I, 103Pd, 131Cs Sealed Gamma-Ray Sources |
| 46010C<br>46050S P4 | Air Kerma Calibration of a Radiation Detector in a Cs-137, Co-60 Gamma-Ray Beam |
| 46110C<br>46050S P6<br>* 2027 | Absorbed Dose to Water Calibration of a Radiation Detector in a Co-60 Gamma-Ray Beam |

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# Evolving Standards – x-ray ranges



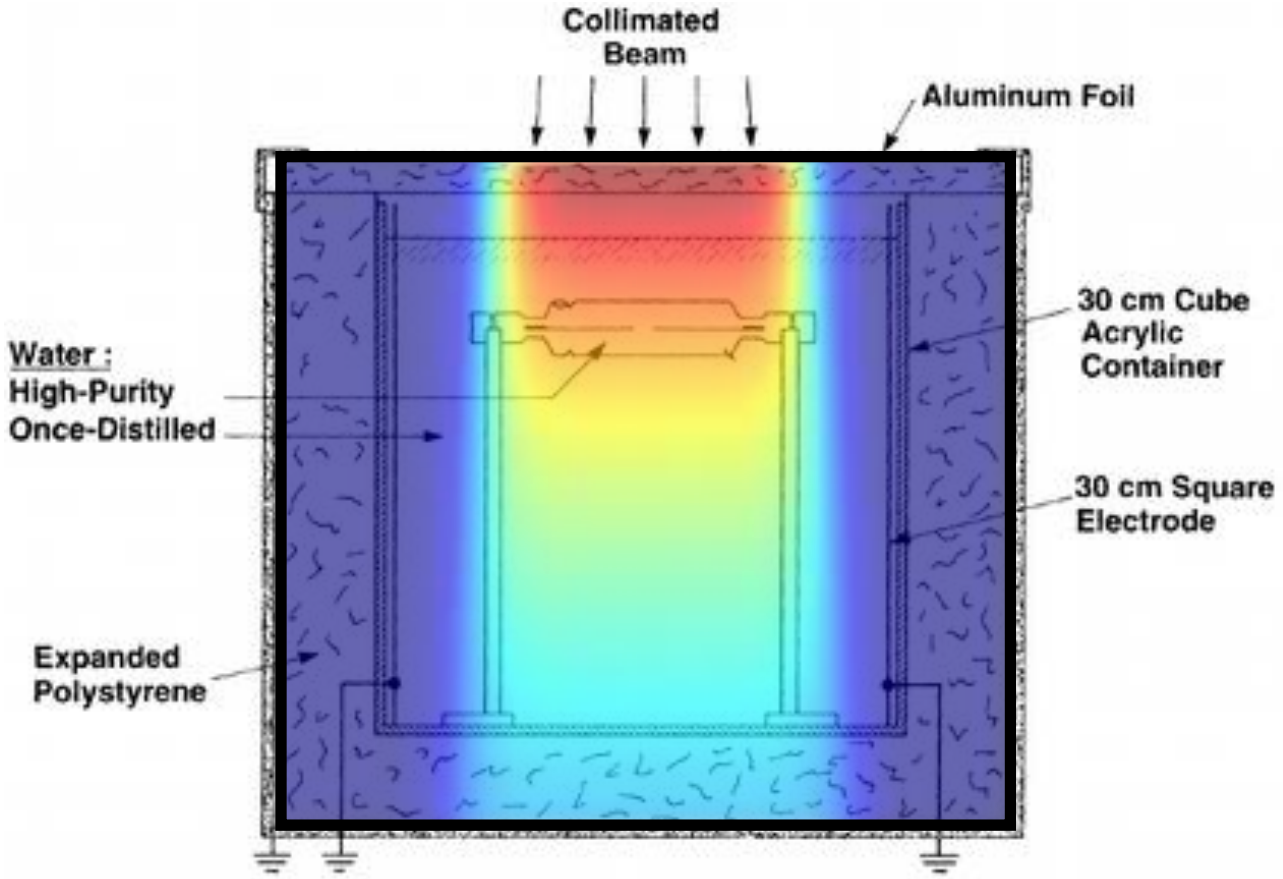

Source, standard, and customer chamber

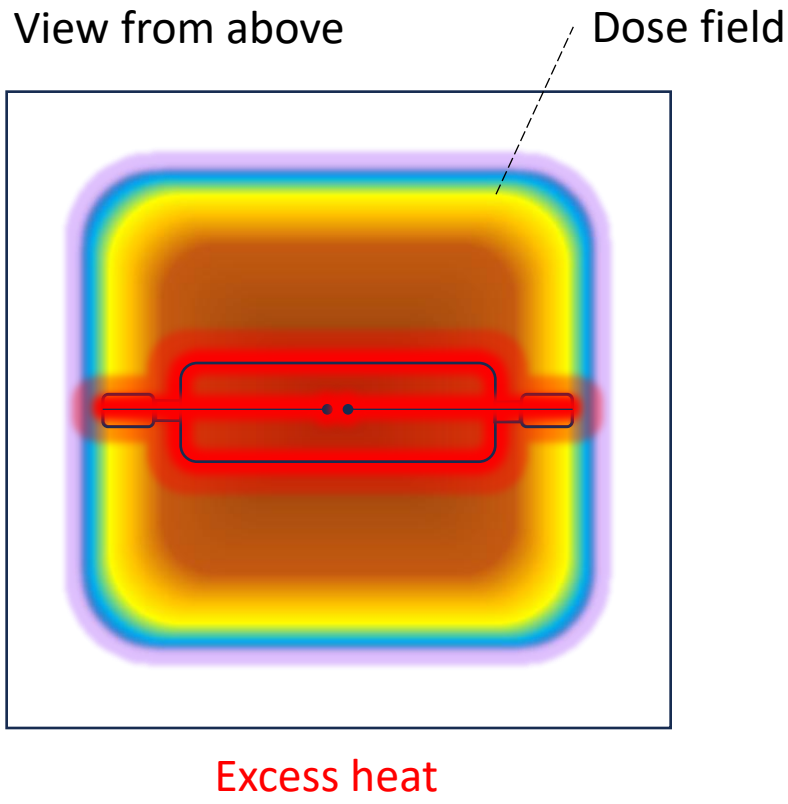


Example customer chambers

Slide content credit: Csilla Szabo-Foster (NIST)

# Evolving standards - calorimetry

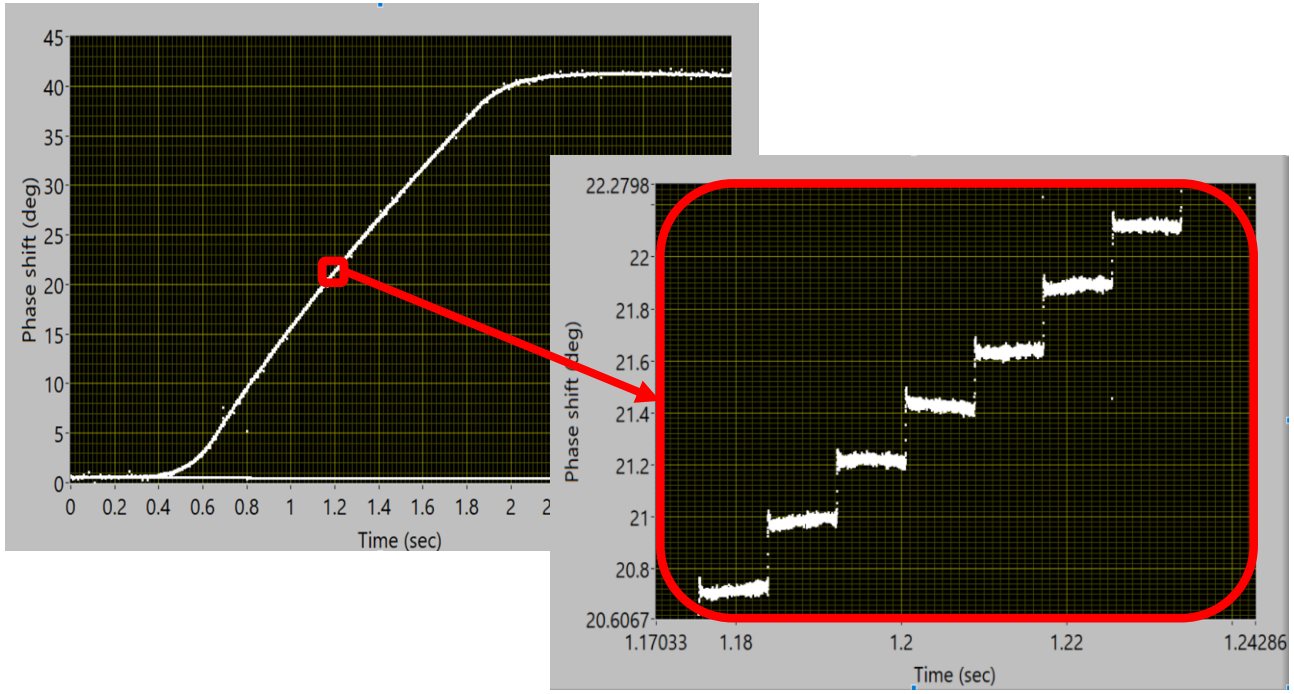


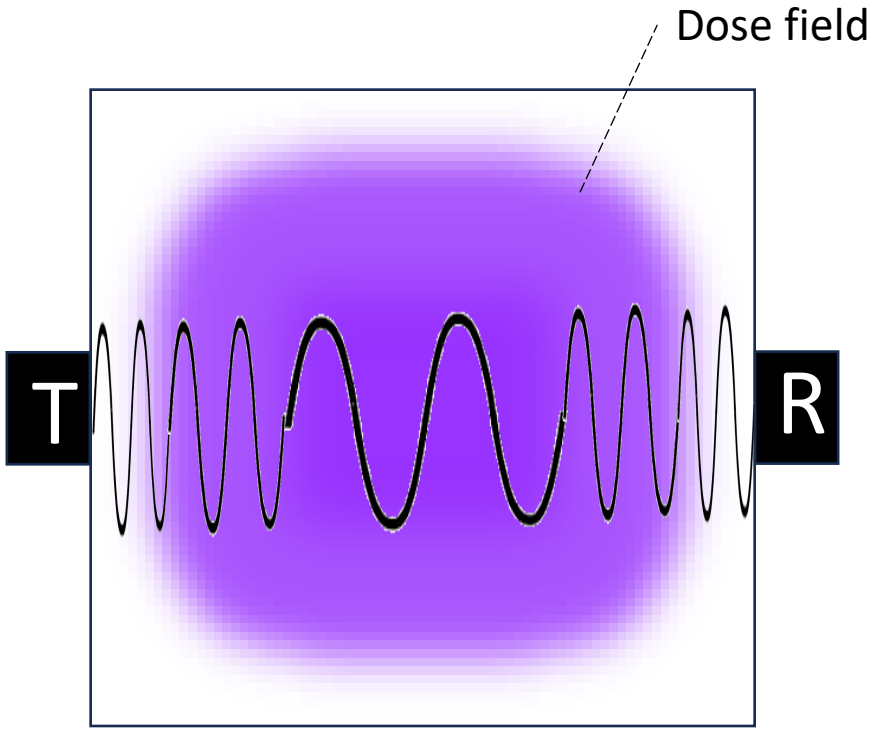



# Evolving standards - calorimetry

## Calorimetry without a calorimeter

- Speed of sound depends on temperature
- Dose field modulates ultrasound

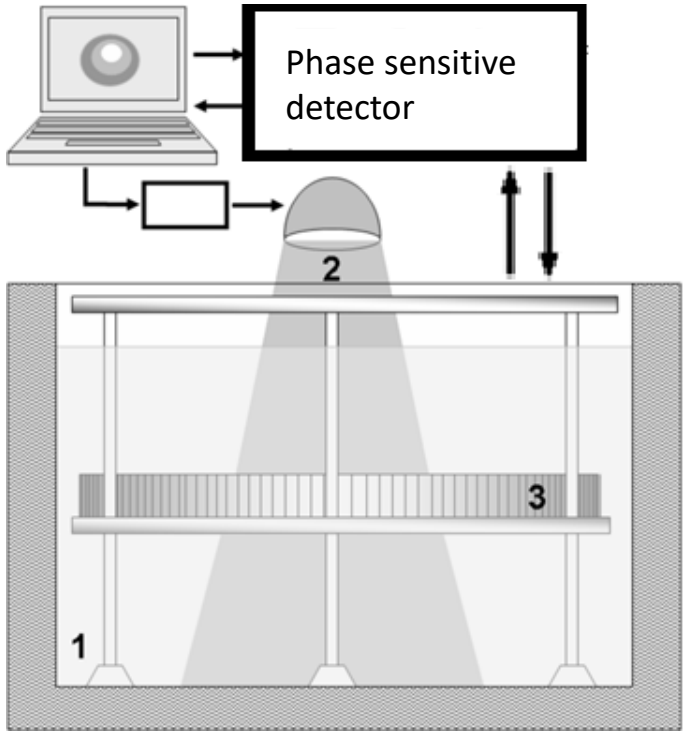


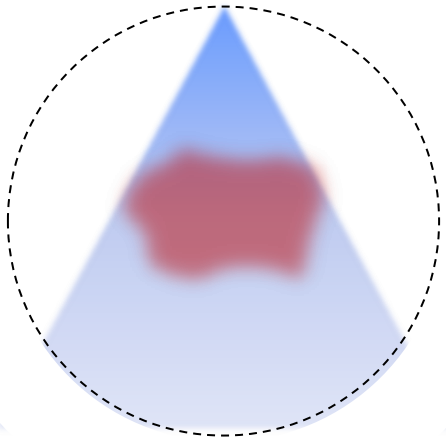



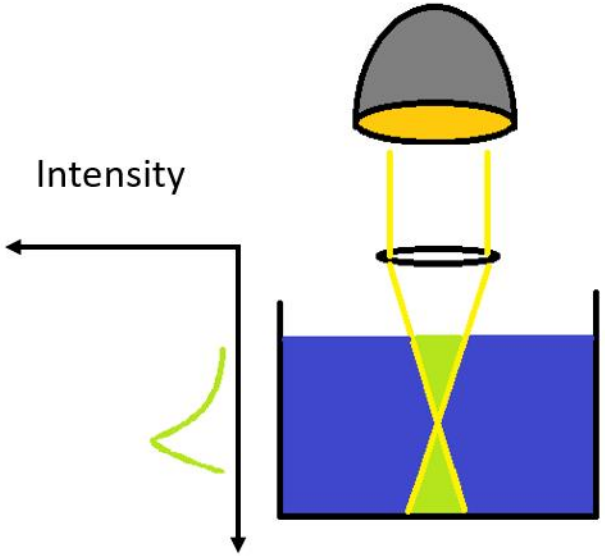
# Evolving standards - calorimetry

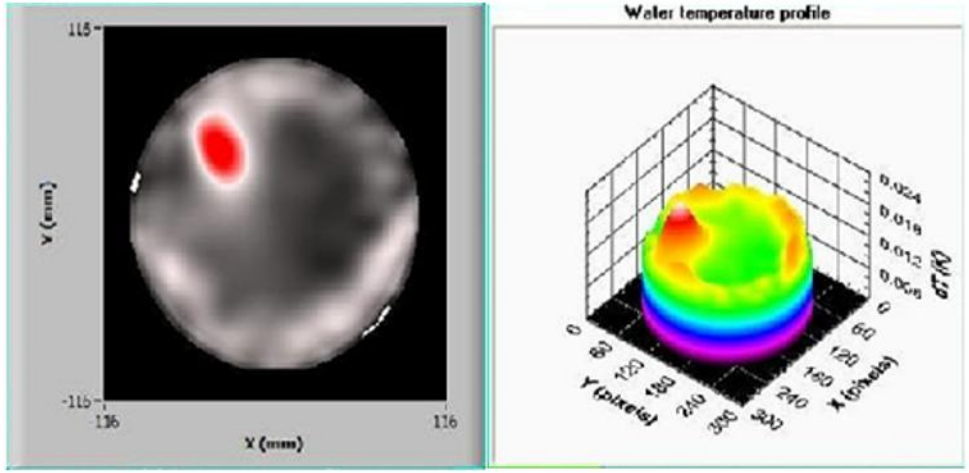
## Calorimetric imaging

- Speed of sound depends on temperature
- Dose field modulates ultrasound

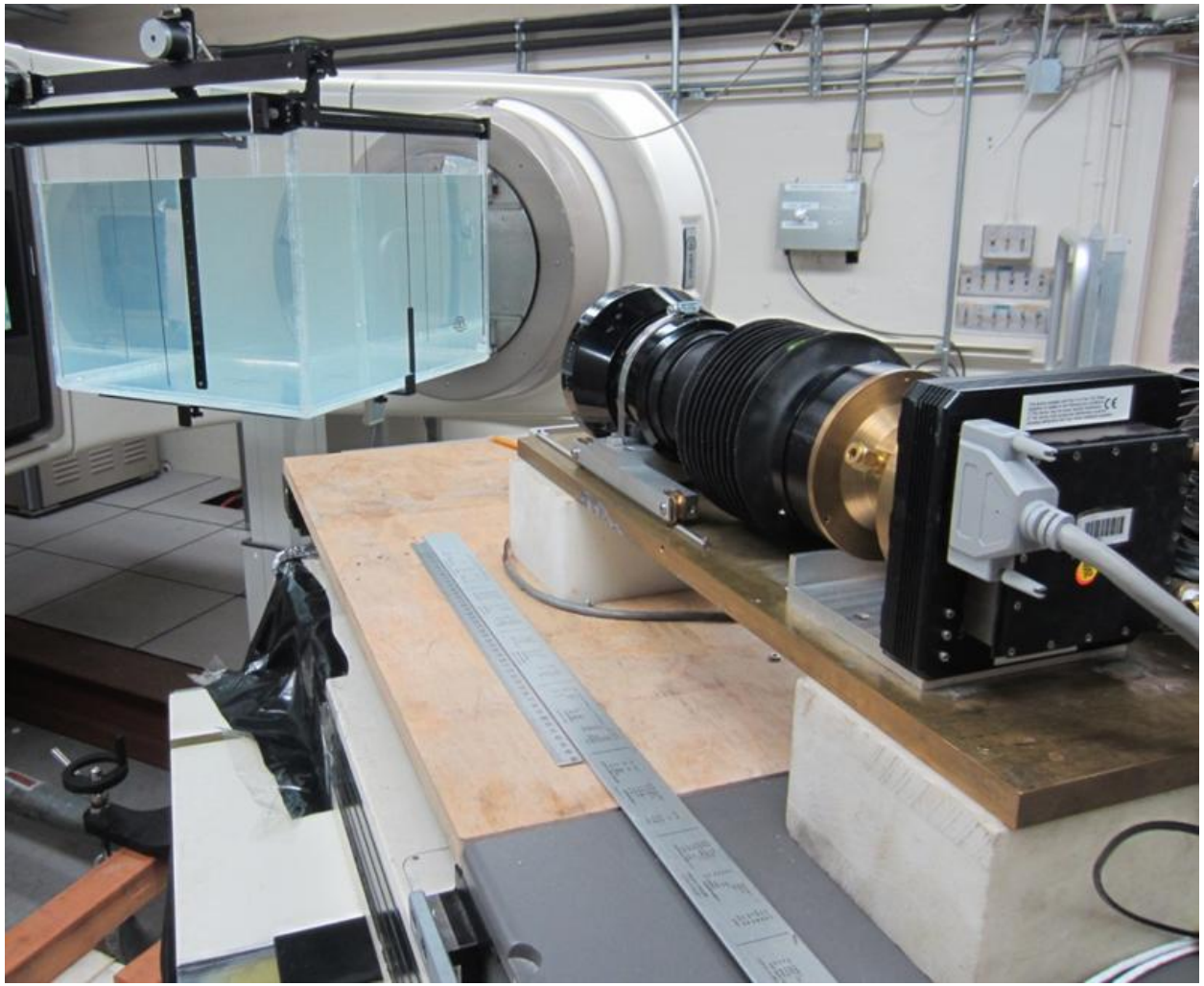


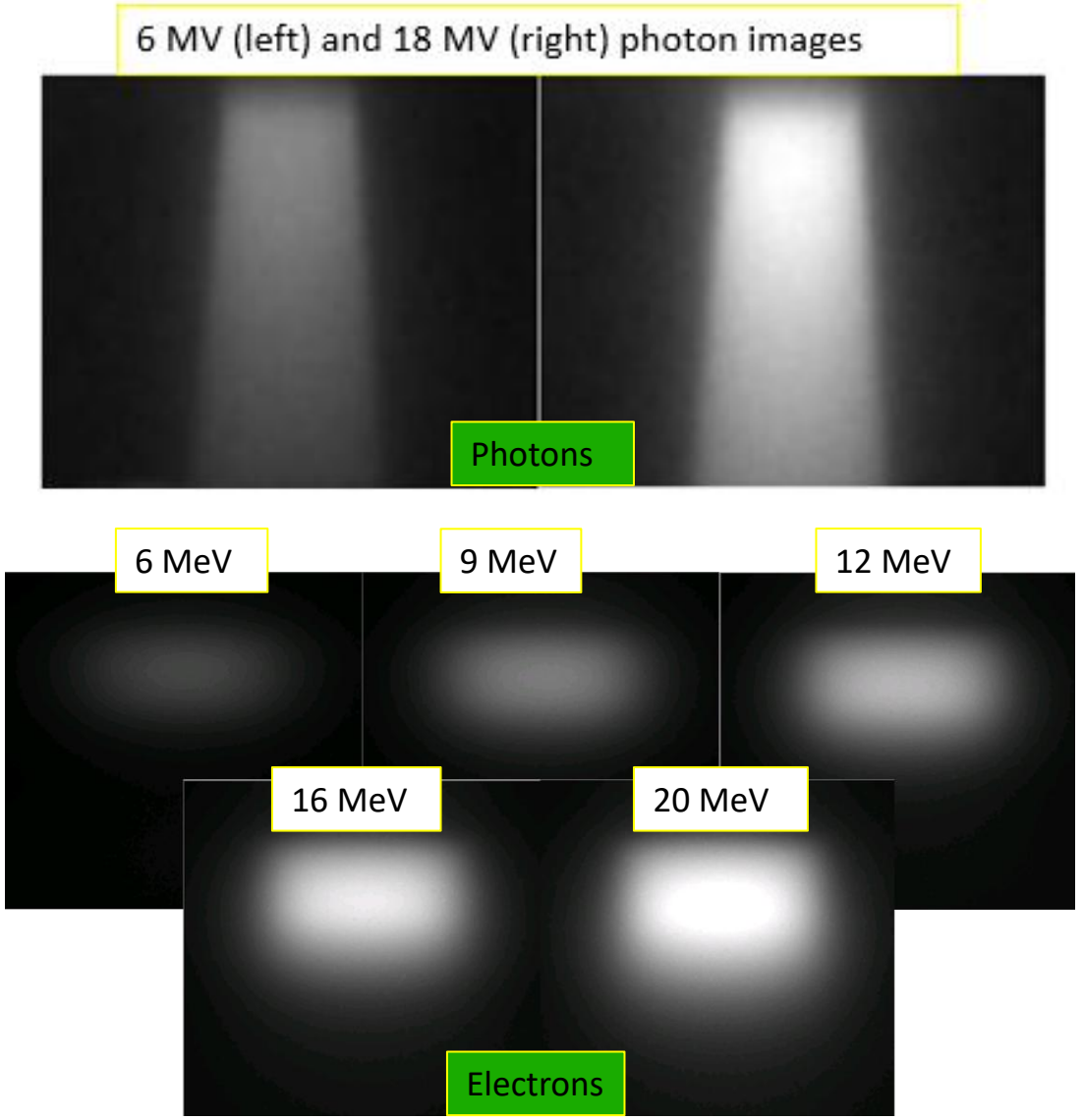





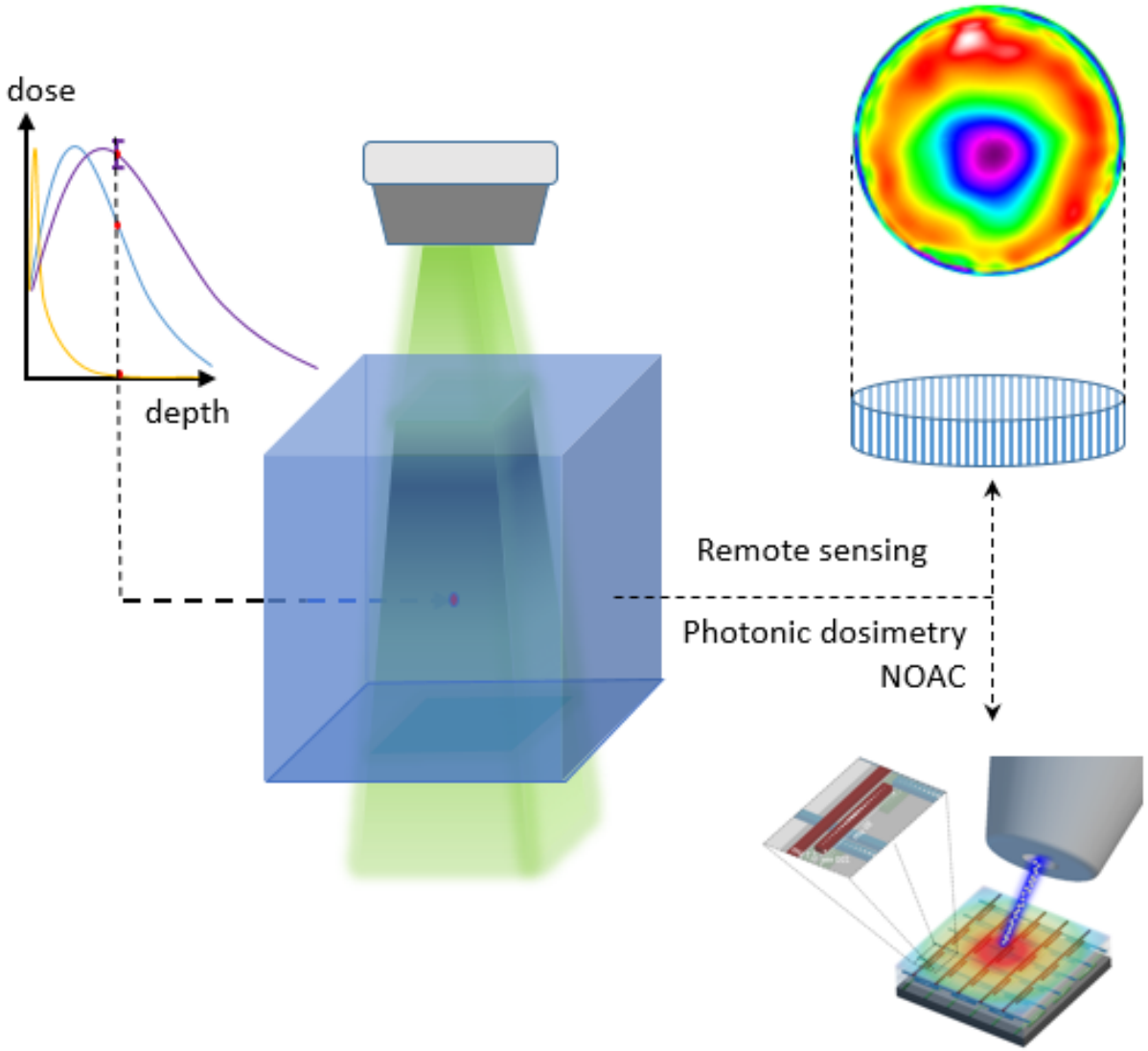
# Evolving standards – Cherenkov






Slide content credit: Fred Bateman (NIST)

# Evolving standards – dose imaging




$10^{1}$ cm — "Traditional" applications in medicine, defense and industry

$10^{0}$ — Non-standard beams, dose imaging in bulk materials

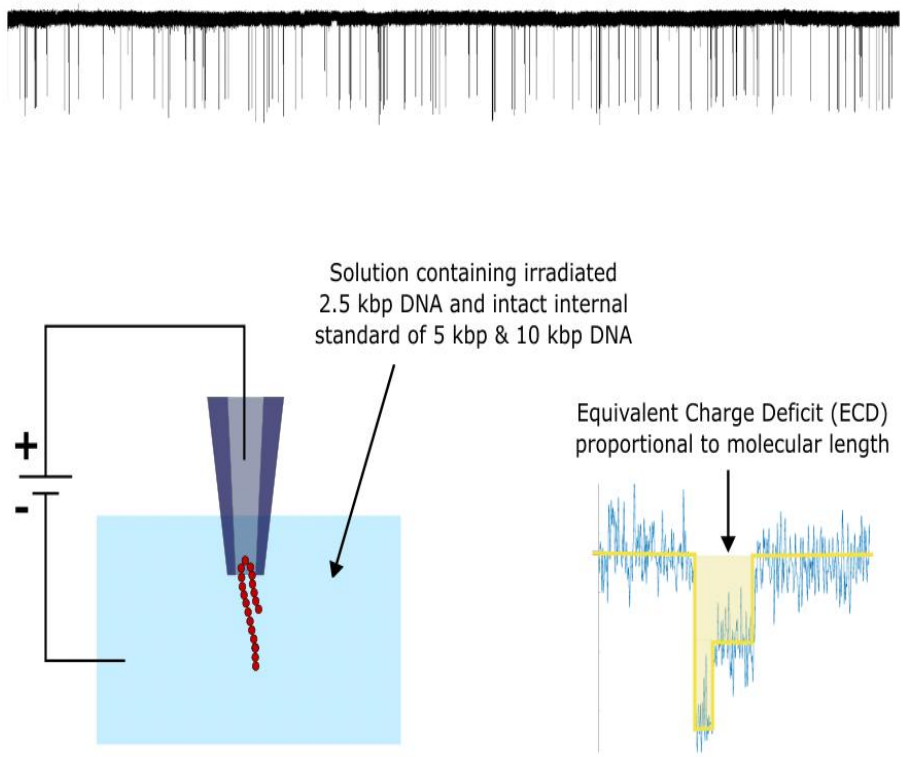
$10^{-1}$ — Field-deployable chip sensors

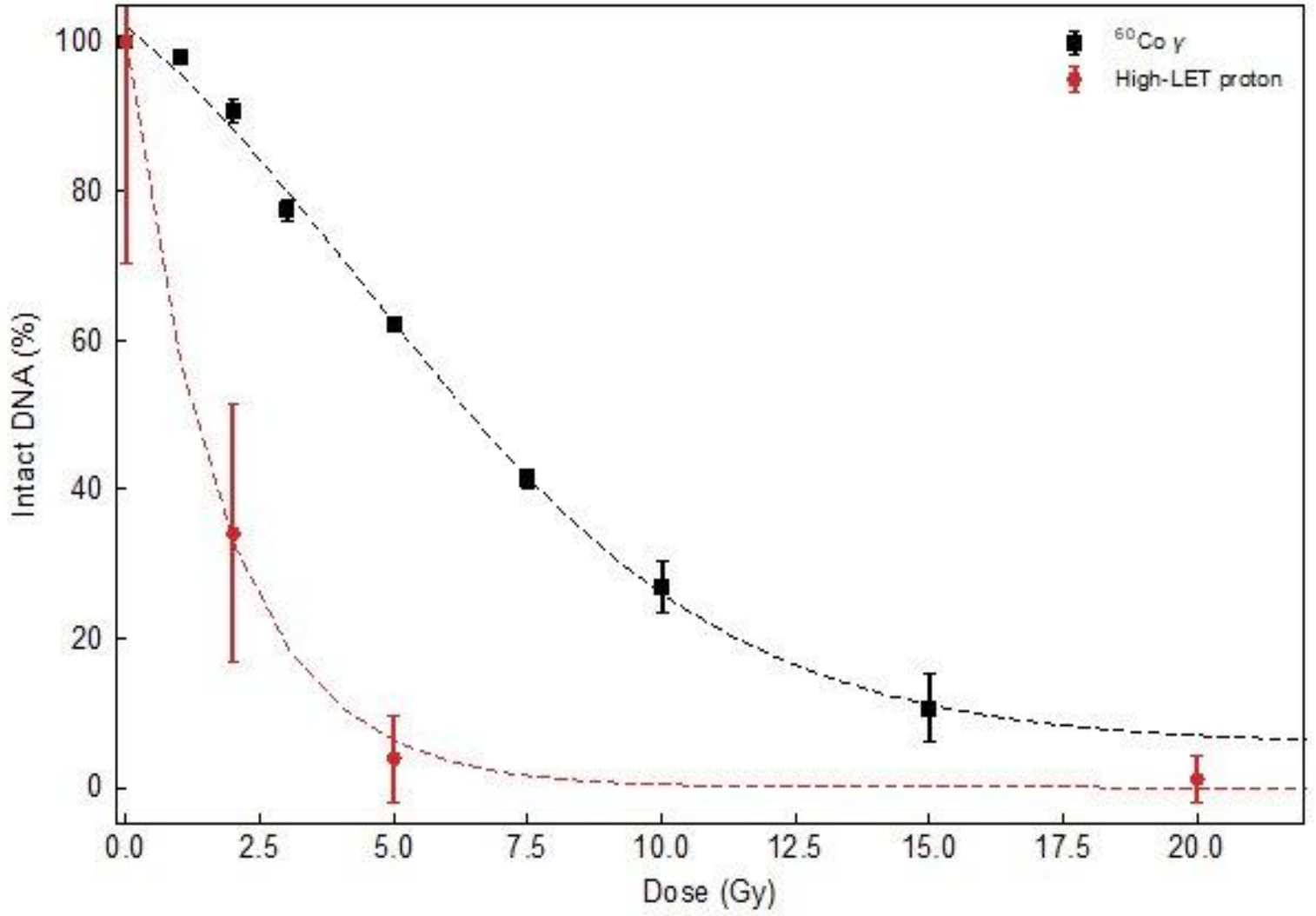
$10^{-2}$ — Surface sterilization, nanodevice hardening

$10^{-3}$ — Cell-scale dosimetry, molecular radiation sensors

$10^{-4}$ — Particle-track physics

# Evolving Standards - DNA




Slide content credit: Joseph Robertson (NIST)

# Acknowledgments


| NIST staff | Projects |
| --- | --- |
| Csilla Szabo-Foster | X-ray calibration standards and services<br>Brachytherapy calibration standards and services |
| Fred Bateman | UHDR electron beams<br>Cherenkov imaging<br>Linac irradiations |
| Joseph Robertson | DNA fragment spectroscopy |
| Ileana Pazos | |