

# Current Practices in Providing Traceability to the National Standard for Dose

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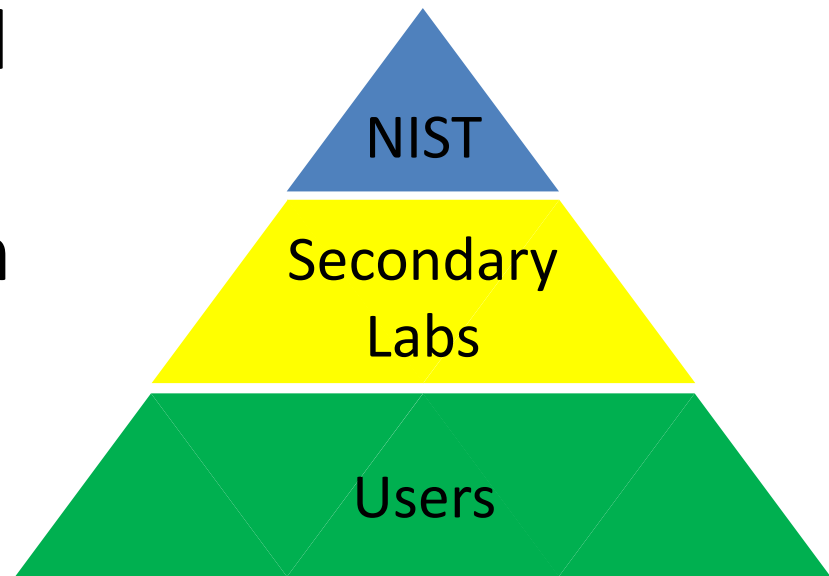
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# Mission of Dosimetry Group at NIST

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- Develop and maintain the *national standards* for radiation dose in SI units from **photon** and **electron** emitting sources (by way of a *Primary Measurement*)
- Disseminate the standard to users **through calibrations** and radiation measurements in SI units



# Radiation Dose Quantities Maintained at NIST

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Quantity	Unit	Symbol= Definition
Air Kerma	Gray	1 Gy = 1 J kg <sup>-1</sup>
Absorbed Dose to Water	Gray	1 Gy = 1 J kg <sup>-1</sup>

# Components of a Primary Measurement

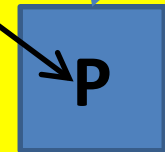
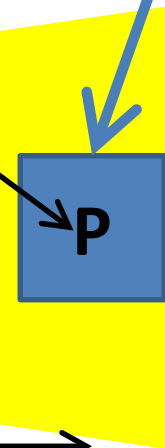
Goal: Determine the *RADIATION DOSE* in **SI units** at a point P with well know uncertainty using a primary instrument

Primary Instrument

Radiation Source



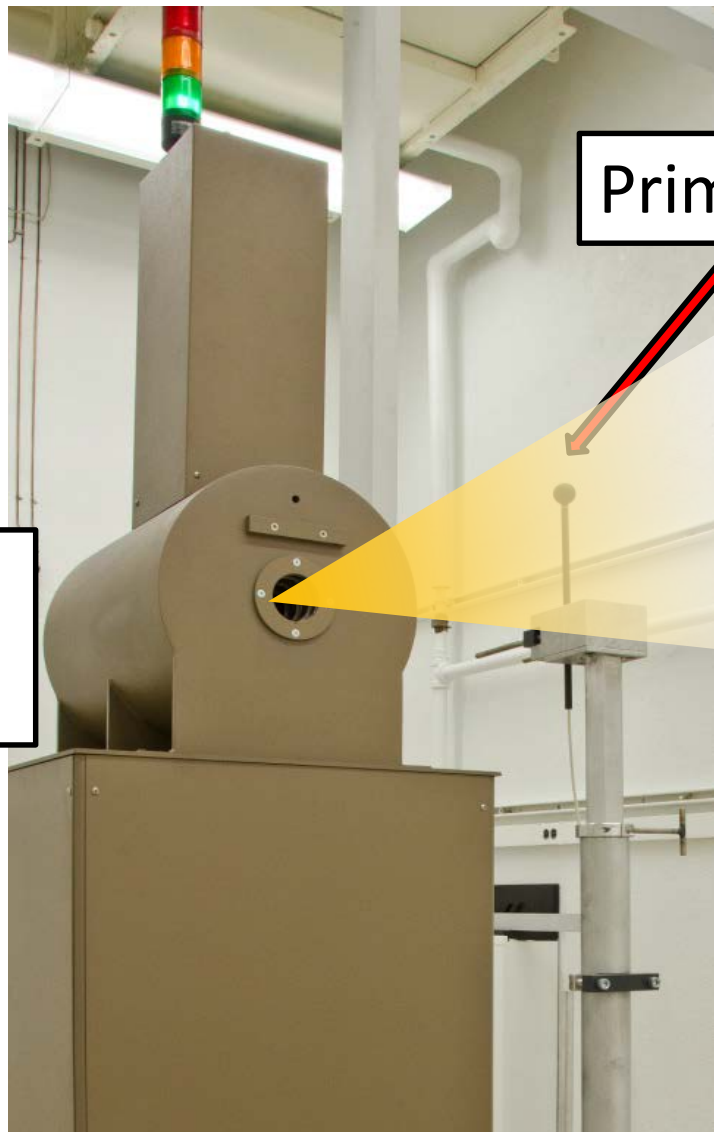
Source to detector distance (m)



# Primary Measurement of Air Kerma: Example

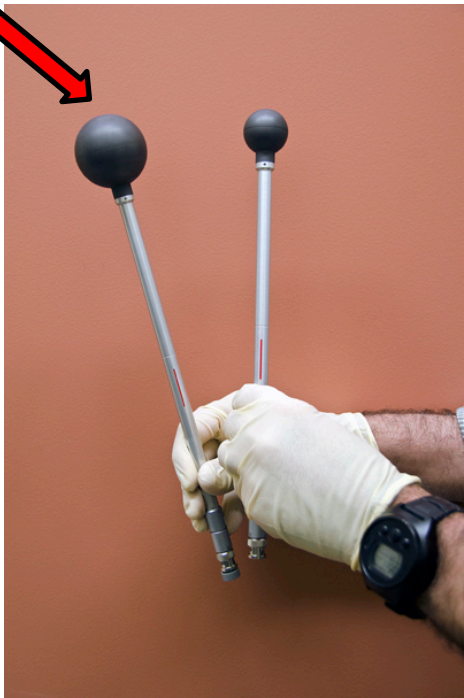
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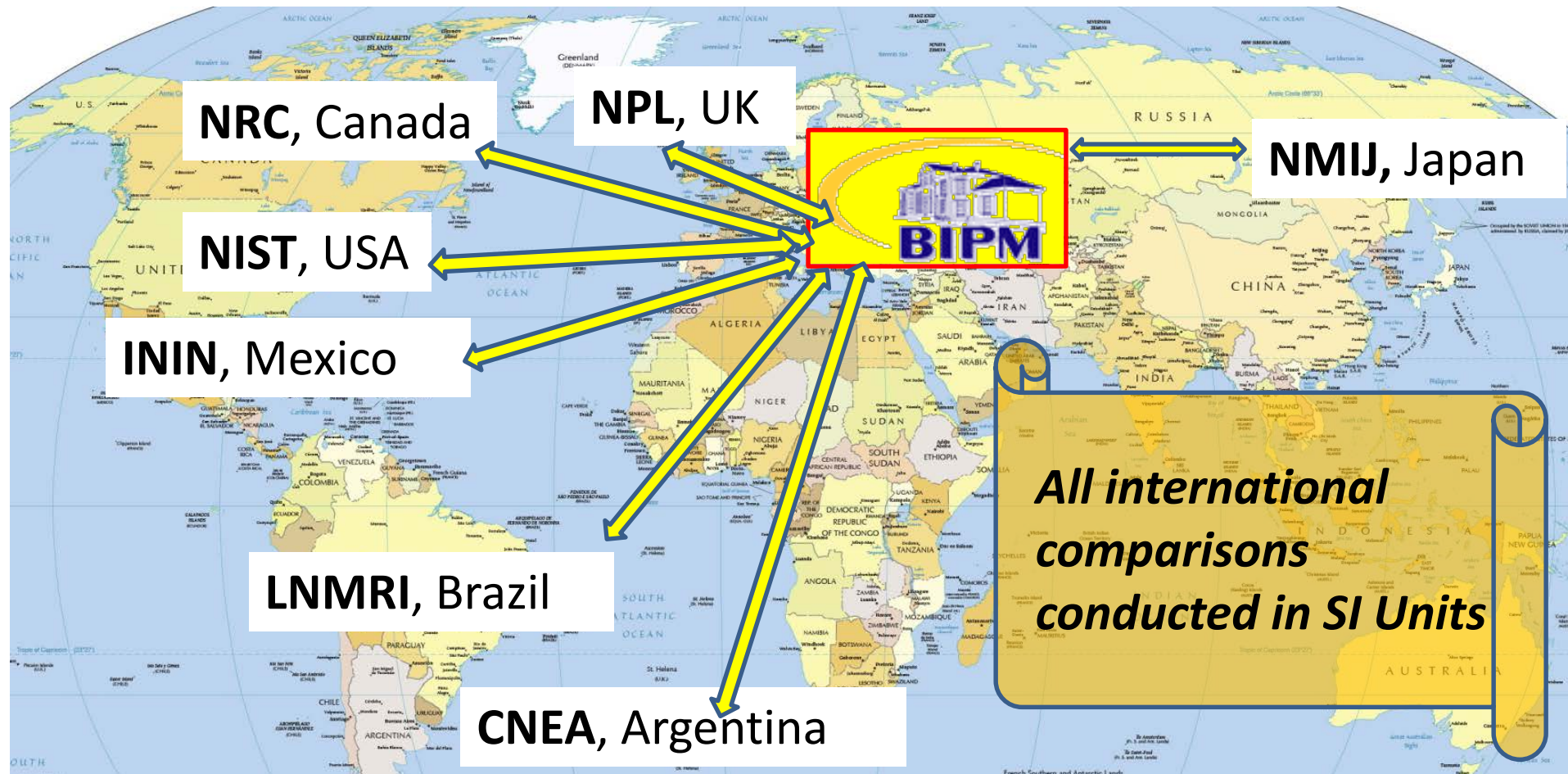
Radiation Source

Primary Instrument



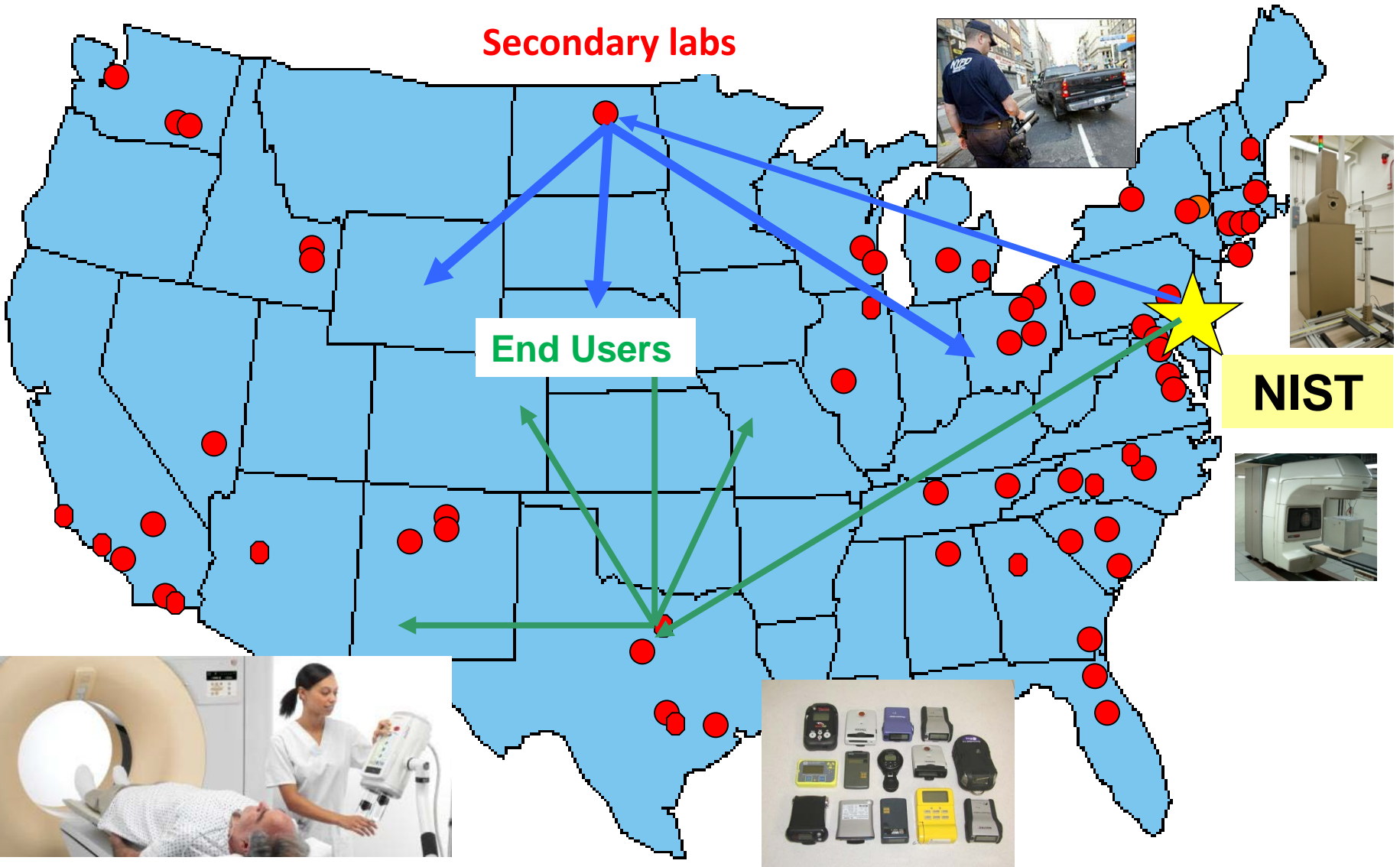
# International Comparisons

**BIPM** coordinates and documents all international comparisons. Examples shown.



[http://www.bipm.org/utils/common/pdf/final\\_reports/RI/RI\(I\)-K1/BIPM.RI\(I\)-K1\\_NIST\\_2011.pdf](http://www.bipm.org/utils/common/pdf/final_reports/RI/RI(I)-K1/BIPM.RI(I)-K1_NIST_2011.pdf)  
[http://www.bipm.org/utils/common/pdf/final\\_reports/RI/RI\(I\)-K5/BIPM.RI\(I\)-K5\\_NIST\\_2011.pdf](http://www.bipm.org/utils/common/pdf/final_reports/RI/RI(I)-K5/BIPM.RI(I)-K5_NIST_2011.pdf)

# Traceability Chain in the US - Starts at NIST





# Dissemination of Air Kerma Standard

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*Example of instruments sent to NIST for Air Kerma calibrations from:*

- Secondary Calibration Facilities
- Hospitals and Clinics
- Instrument Manufacturers
- Power plants
- Military, Federal Agencies
- Other

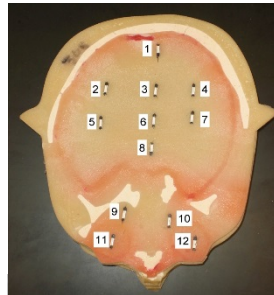


Medical Physics 33 (4), (2006) p.1074  
Applied Radiation Isotopes, 65 (2007) p. 401



# End Users and Applications

- Navy, Army, Air Force
- Radiation Workers
- Industrial Processing
- Power Plants
- DHS: Coast Guard, TSA, CBP, etc...
- Hospitals, Medical Field
- DOE
- HAZMAT Teams



# Impact of a Mixed System of Units

## (SI and non SI)

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### Summary so far:

- NIST determines radiation dose quantities in SI units.
- NIST compares with National Metrology Institutes (NMIs) around the world in SI units.
- NIST disseminates the standard within the US in SI units.
- In the US, some users of radiation instruments use SI units (*mostly in the medical field*)

*However ...*

*Users that do not use SI units must apply conversion factors and coefficients ...*

# Impact of a Mixed System of Units

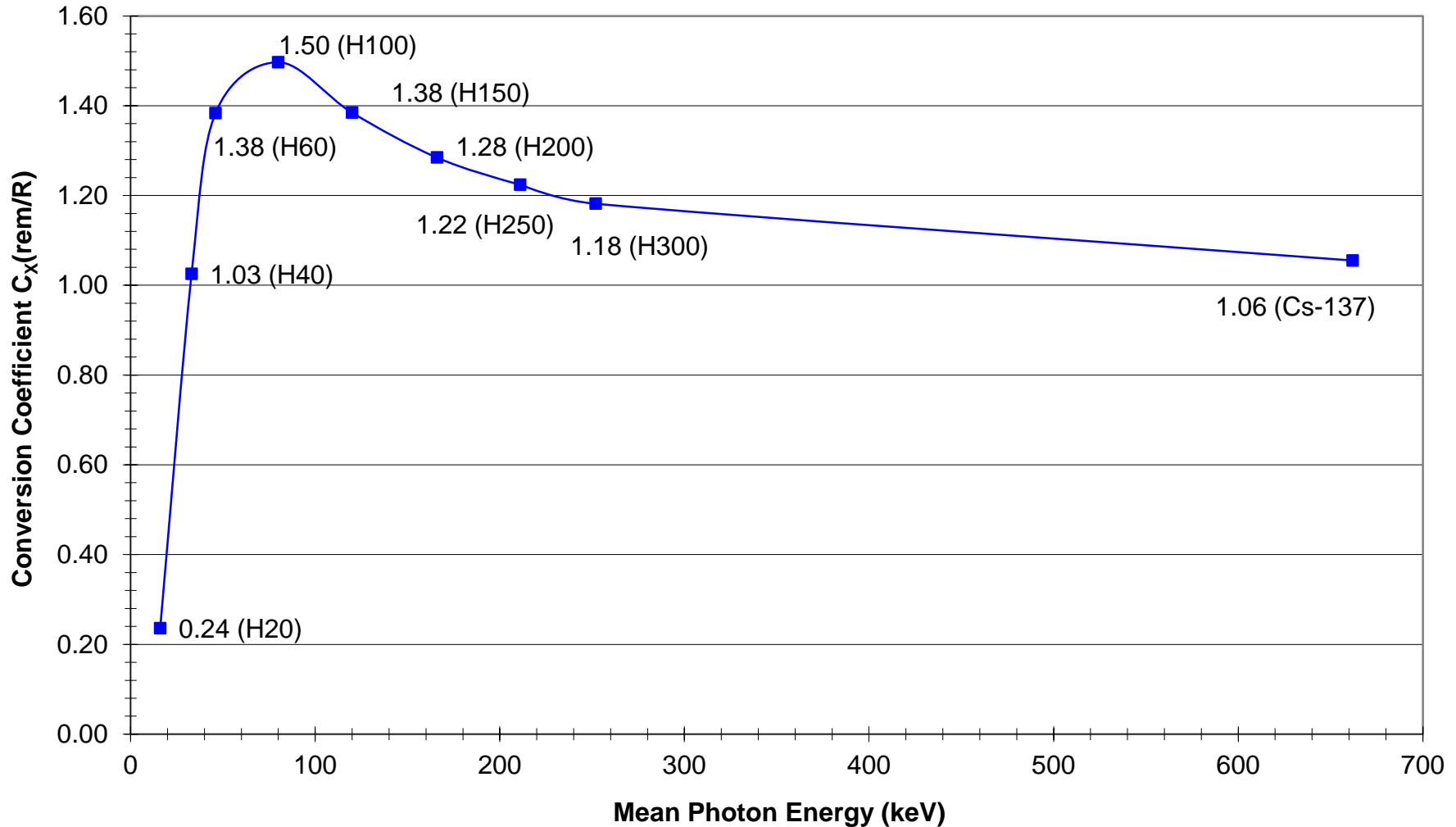
(SI and non SI)

Quantity	Symbol	SI Units	Non SI Units
Exposure	X	C/kg	Roentgen
Air Kerma	K	Gray	rad
Absorbed Dose	D	Gray	rad
Dose equivalent	Hp(10), H*(10) Hp(0.07) H*(0.07)	Sievert	rem

*In practice users sometimes mistakenly exchange **Roentgen** for **rem** and assume that the units are identical*

# rem/R vs. Mean Photon Energy

Ambient dose equivalent,  $H^*(10)$ , conversion coefficients,  $c_x$  (rem/R) vs. mean photon energy of NIST Beam qualities



# Impact of a Mixed System of Units

## (SI and non SI)

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- Unfortunately these conversions are often applied incorrectly and inconsistently due in part to the use of a mixed system of units.

### Results

- In such situations, radiation measurements result in incorrect values and are no longer traceable to the national standard.
- This is reflected during comparison measurements between facilities and also during blind tests conducted between NIST and end users.

Thank you for your attention!

Questions?