Dosimetry: devices used

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Disclosure

- **Larry DeWerd has a partial interest in Standard Imaging – manufacturer of Exradin chambers**

Dosimetry

- The accuracy and application of dosimetry depends on the devices in use.
- Brief overview of some of the instruments in use to determine dosimetry.
- Will Hanson discussed the quantities needed for dosimetric determination.

Importance for Dosimetry

- Masterson and Febo, Med Phys 19:649 (1992) measured in blood irradiators (sometimes used for cell irradiation)
- Results indicate differences of +5% to – 13% with manufacturer supplied calibrations and variations in relative dose rate over the irradiation volume from 70% to 180%.
- About 15% across the diameter

Devices

- The three devices in majority use to measure and calibrate the x-ray or cesium sources are ionization chambers, film and TLD (OSL).
- Each of these need calibration
- Ionization chambers have less variation and their calibration can be interpolated
- TLDs can have a great variation with energy if calibrated at Cs or Co and used at x-rays. OSL even worse

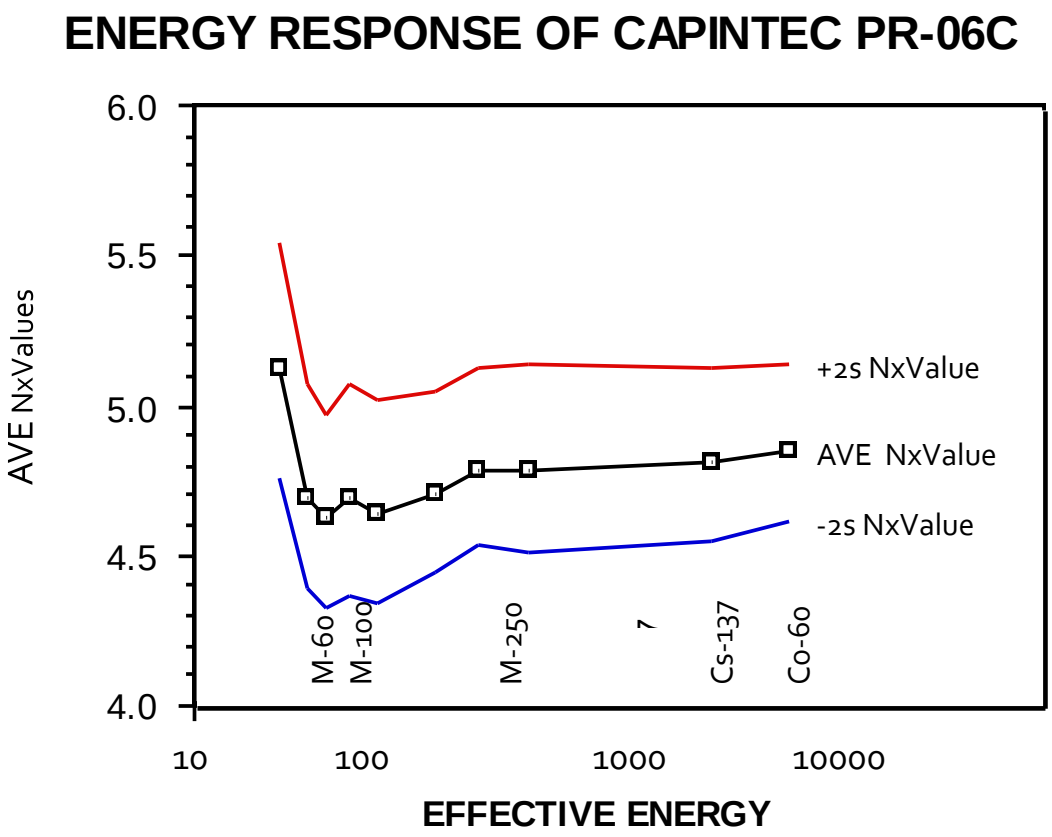
Devices

- The calibration of Ionization chambers is a part of a later talk
- This talk will address the measurement of HVL using an ionization chamber
- Characteristics of TLD affecting the measurement will also be discussed.
- Film should not be used for dosimetry since there is a great variation with it. Use it for relative or spatial measurements.

Variation of response with Energy

- As shown in the next slide, Ion chambers have relatively little variation with energy across the range of x-ray energies. However at low energies, the change can be significant.
- Attention should be given to make a correct measurement of beam (HVL) using an ionization chamber.

Energy Response of 0.6cc Farmer



To measure HVL

- Since the ionization chamber has a "flat response" (little variation with energy) it is appropriate to use.
- If it wasn't flat then a correction would need to be made to determine the correct HVL. Depending on the flatness of the energy response (or non-flatness) corrections of 5 % or more would be necessary

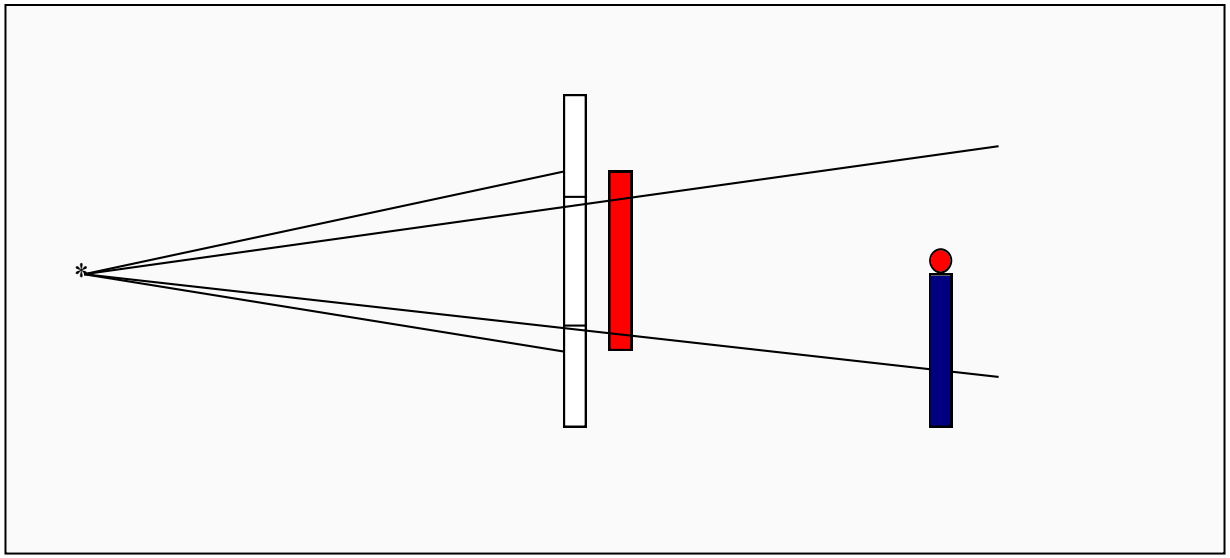
Importance of HVL

- Each of the x-ray energy beams would have different characteristics
- A measurement of HVL and HC can be used for characterization

Methodology to Measure HVL

- Setup so absorbers half way between focal spot and chamber, by collimation-absorbers away from source
- Limit x-ray field (Best to limit to size of chamber if possible.) because of things like scatter from collimators
- Amount of impurity in absorbers affects HVL measurement, especially for mammography
- Mammo 99.9% pure, Diagnostic 99% pure

Schematic for HVL



Procedure

- Determine First and Second HVL
- First HVL (HVL_1) when exposure is 50% of no absorber exposure
- Quarter Value Layer (QVL) (Where exposure is 25% of value with no absorber)
- Determine second HVL (HVL_2)

Second HVL =50% of exposure with First HVL

$$HVL_2 = QVL - HVL_1$$

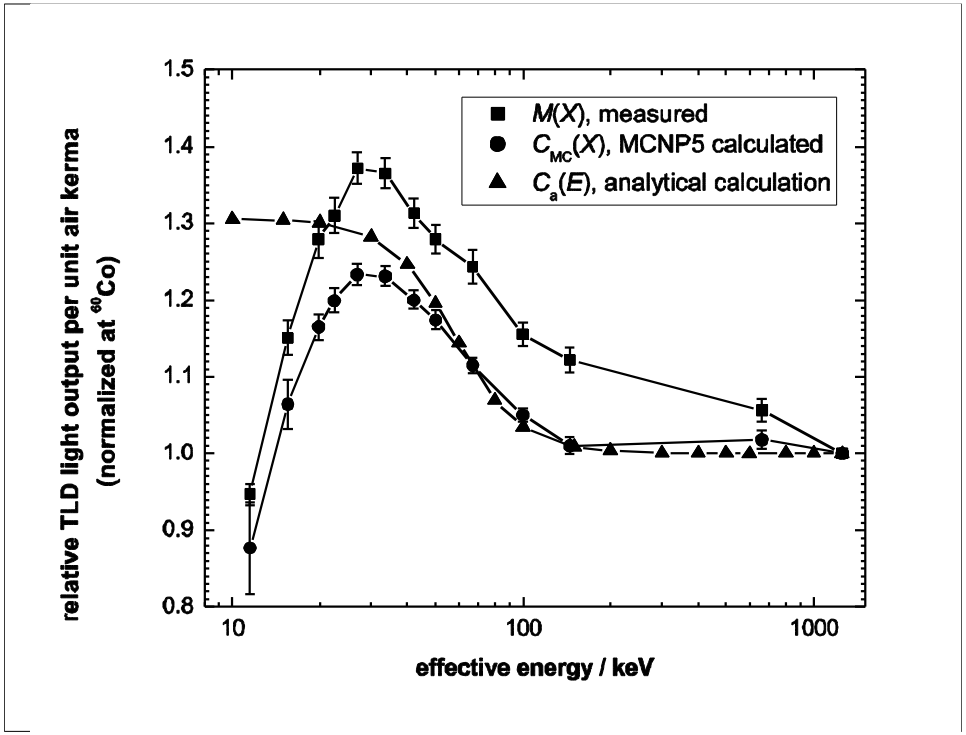
- **Homogeneity Coefficient (HC) is ratio of First HVL / Second HVL**

$$HC = \frac{HVL_1}{HVL_2}$$

TLDs

- The use of TLDs are advantageous especially for small fields or small places – depends on your irradiator
- For best precision, heat first to eliminate residual TL for best results: 400 °C for 1 hour and then 80 °C for 24 hours.
- Cool for half hour on aluminum block. This will rezero the TLDs. Keep track of calibration of individual chips for best precision.

Energy Response



- Measured TL output per unit air kerma as a function of photon energy normalized at the average ^{60}Co energy. All measurements were made in the linear region of the TLD output (Nunn *et al* 2008).

Variation of Response with Energy

- If the TLDs are calibrated at a higher energy – generally cesium or cobalt, there will be an overresponse at lower x-ray energies.
- Maximum over response is about 1.4 to 1.6 at about 100 kVp
- You think you have 40 % or more dose than you really have given it.
- Energy of calibration point is important
- OSL which is Al_2O_3 is more ~6 x

Summary of Devices

Device	Use	Ranking
Ion chamber	General – all dosimetry	+
TLDs	Relative dosimetry	o
Film	Spatial dosimetry	-

Other Devices

- There are other devices (diodes, mosfets, etc) but they all have their individual characteristics.
- They also can have greater variation in energy response and worse reproducible results.

- Basically know your instrument and what you are measuring.