Measurement of Radiation: Quality

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Purpose

• To introduce the concept of radiation quality and to describe methods of measurement of radiation quality

Radiation quality

• A measurement of the penetrating ability of the radiation
Estimate

1. Dose rate at points within medium
2. Differences in energy absorption between regions of different composition
3. Biologic effectiveness of radiation

Specification of quality

- Quality completely specified by spectral distribution of photons – generally difficult to measure

Specification of quality

- Gamma ray beam – need only specify energy of gamma rays
- X-ray beam – must specify two parameters
  1. kVp – potential difference across x-ray tube
  2. HVL – half value layer
- Megavoltage beams – maximum photon energy (MV)
**Half-value layer**

- Definition: thickness of material that reduces the exposure rate to half its initial value

**Homogeneity coefficient**

\[ HC = \frac{1\text{st HVL}}{2\text{nd HVL}} \]

- HC is a measure of homogeneity of x-ray beam
- For homogeneous beam, HC = 1.00
- For heterogeneous beam, HC < 1.00

**HVL measurement**

- Place absorber in beam and measure attenuation
HVL measurement

1. Choice of absorber
   - 10 kV - 120 kV Aluminum
   - 120 kV - 3.5 MV Copper
   - 1 MV - 50 MV Lead

2. Requirement of narrow beam (“good”) geometry
   - avoids scattered radiation reaching detector

HVL measurement geometry

Effective energy

- Energy of photons in monoenergetic beam that is attenuated at same rate as x-ray beam
Factors affecting beam quality

- Electron energy
- Added filtration – selectively absorbs lower energy photons
- Combination filters Cu + Al or Sn + Cu + Al
- Thoraeus filters – Lower Z filter material absorbs characteristic x-rays produced by x-rays absorbed in higher Z filter