AbstractID: 13027 Title: Is distance-dependent energy correction needed for dosimetric measurements surrounding brachytherapy sources?

Purpose:
The answer depends on both the dosimeter's energy response and energy spectrum at distance (point of measurement) from the source. The latter is object of this study.

Method and Materials:
The spectra in water were calculated with Monte Carlo code MCNP5. The source point was centered within a spherical water medium, divided into concentric spherical shells of various thickness. The f4 fluence tally of MCNP, with fine energy bins, was used to register photon energy spectrum in thin shells (0.01 cm thick) centered at radii 0.2, 0.5, 1, 2, 3, …9 and 10 cm. One million particles were used for each MCNP run, to achieve good statistical uncertainty. Seven commonly used brachytherapy sources were studied: ^{60}Co (E_{avg}=1.25 MeV), ^{137}Cs (.615 MeV), ^{198}Au (.406 MeV), ^{192}Ir (.372 MeV), ^{131}Cs (.0304 MeV), ^{125}I (.0274 MeV), and ^{103}Pd (.0207 MeV).

Results:
For high energy sources: ^{60}Co, ^{137}Cs, ^{198}Au, and ^{192}Ir, the average energy has all decreased by about 50% at radius 10 cm.

For low energy sources: ^{31}Cs, ^{125}I, and ^{103}Pd, the average energy does not decrease with radius. For ^{103}Pd, the average energy increases from 21 keV at radius 0.2 cm to 30 keV at 10 cm. The beam hardening effect with ^{103}Pd is due to its two high energy photons: 39.8 keV and 42.5 keV, whose intensity increases substantially at 10 cm relative to that of the dominant 20.1 and 22.7 keV photons. Due to space limit, other spectral details will not be discussed in this abstract.

Conclusions:
Within10 cm range, the three low energy sources have demonstrated hardening of energy spectrum. For the four high energy sources, the energy spectrum all softens but the average energy is still higher than 100 keV, which may often justify a distance-independent energy dependence correction for the whole measurement range.