Letter to the Editor

Comment on ''A Monte Carlo study of x-ray fluorescence in x-ray detectors'' [Med. Phys. 26, 905–916 (1999)]

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To the Editor,

Although the article by Boone *et al.* entitled ''A Monte Carlo study of x-ray fluorescence in x-ray detectors'' [Med. Phys. **26**, 905–916 (1999)] presented an interesting summary of x-ray detector material qualities, unrealistic input assumptions to the Monte Carlo model reduces the paper's usefulness. In the paper the authors discuss how detector resolution is affected by secondary excitation resulting from absorption of the laterally directed fluorescence x-rays that are produced when high-energy x-rays are stopped in the phosphor or photoresistor. The density of the phosphor or photoresistor material is a primary input to the Monte Carlo codes, which are used to determine the pathlengths of fluorescent x-rays in the material. In the paper the authors explain that this density is also used to adjust the physical thickness of the x-ray phosphors for the model.

Of the seven materials discussed, CsI and Se are assumed to be deposited as thin films. The other five, Gd_2O_2S, BaFBr, $YTaO_4$, $CaWO_4$, and ThO_2 are refractory materials that are not easily vapor deposited onto large surfaces and are usually made into x-ray screens by deposition of fine-grained powders of the phosphors. In light of this, the authors model these five materials as phosphors with a particular fractional binder weight and binder elemental composition. However, the authors then proceed to use densities for all the materials that are close to the bulk crystal densities. While this may be adequate for CsI and Se, it is certainly unrealistic for the five refractory phosphor powders because x-ray screens made of these materials usually have packing fractions roughly 60% or less of the bulk crystal density.

This impacts several of the results. First, in Fig. 2, the 90% stopping power of each material is compared. Gd_2O_2S, ThO_2, $YTaO_4$, and $CaWO_4$ are shown to be dramatically thinner (linear thickness in mm) than CsI or Se because of the phosphor density error. For example, Fig. 2 shows the CsI thickness to stop 90% of 80 keV x rays to be 1390 and 639 μm for Gd_2O_2S. In fact, the linear thickness of the Gd_2O_2S is a more comparable 1065 μm. Last, Figs. 6, 7, 8, and 9 report an underestimated radial distance the scattered x-rays travel in the film by approximately 40% in the phosphor materials, also because of the density error.

As a practical matter, the important questions are how the resolutions compare for detectors using the various materials analyzed by Boone *et al.* It is difficult to compare the effects of fluorescence in the different materials because realistic densities were used in some cases and not in others. More fundamentally, resolution comparisons must also include the effects of light spreading. In this regard, Boone *et al.* note that in LANEX, for example, under most conditions the resolution is limited by the diffusion of optical photons, rather than x-ray fluorescence. It is unclear if this would be the case if realistic densities were used. Boone *et al.* would make a truly important contribution if they were to perform an evaluation that both included realistic densities and realistic contributions due to the spreading of light.

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