

Comparative Analysis of Beam Qualities: Commercial Small Animal Cabinet Irradiators vs. NIST Beams

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Purpose: This study presents a comparative analysis of beam qualities between commercial small animal cabinet irradiators and the National Institute of Standards and Technology's (NIST) light (L), moderate (M), and heavy (H) filtered beam series. Small animal cabinet irradiators are equipped with x-ray beams with added filtration that is less attenuating than the NIST M-series beams. However, these cabinet irradiators are recommended to be operated at higher constant potentials than found for the NIST L-series beams. Because dosimeter response depends on radiation types and energy, it is important for the calibration beam to closely resemble the research beam to reduce uncertainty in the dose determination.

Methods: A Varex NDI-451Be x-ray tube with adjustable kV and mA settings was employed in conjunction with custom filters to develop eight beams matching those in commercial small animal cabinet irradiators. High purity aluminum or copper attenuators were positioned midway between the x-ray tube anode and the aperture of a medium energy free air chamber (ME-FAC). Measurements were taken to create attenuation curves for determination of half-value layer (HVL) and quarter-value layer (QVL) for each beam, with supplementary curves analyzing the effects of mA, kVp, and anode-to-aperture distance on the outcomes.

Results: This investigation revealed notable differences in beam qualities between small animal cabinet irradiators and the NIST beam series. The experimental aluminum and copper HVLs had an average difference of 22% and 175% from the NIST M-series beams, respectively. Adjusting the current setting did not result in significant changes in the determinations of the HVL or QVL. Altering the measurement distance from the anode to maximum cabinet irradiator distance of 70 cm impacts the beam quality by 4% compared to the standard 100 cm distance.

Conclusions: This study reveals the need for an additional NIST traceable beam series that more closely matches small animal cabinet irradiator beams or correction factors to account for the beam differences. Additionally, a correction will need to be developed to account for the differences in distance measurements in calibration compared to the smaller distances used in small animal cabinet irradiators.

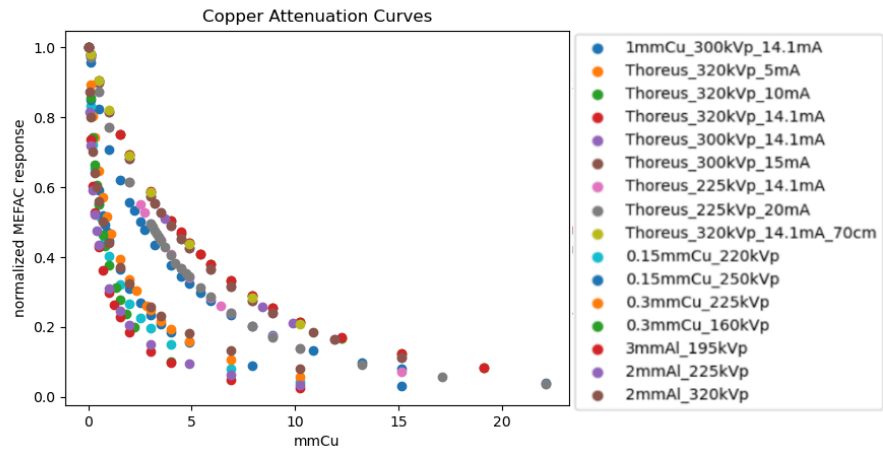


Figure 1: Copper Attenuation curves for various filter, mA, and kVp combinations relevant to small animal cabinet irradiators

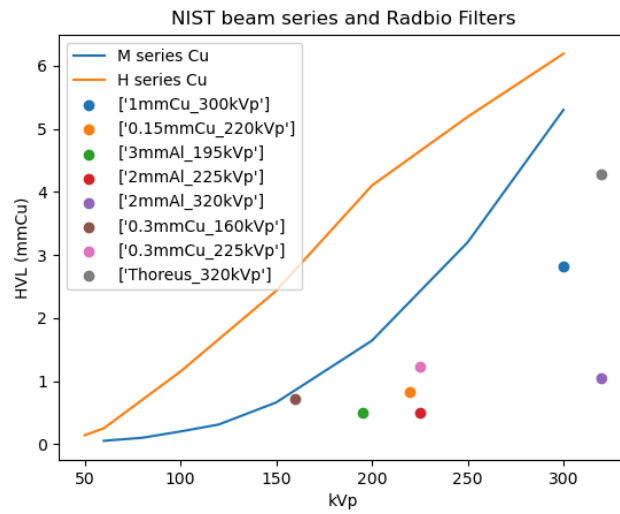


Figure 2: NIST M and H series using copper half-value layers and common commercial filter and kVp combination half-value layers.