The energy spectrum is a fundamental quantity used to describe the output of a radiation photon beam. Knowledge of the energy spectrum would improve dosimetry as many radiation quantities rely on individual photon energy information. Current beam characterization methods use measurements from detectors that have little energy dependence, which results in a loss of spectral information.

Conventional measurements of the energy spectrum are performed using pulse mode detectors. For high dose-rate photon beams, these detectors tend to saturate, which make measurements inaccurate. Measurements using a reverse-electrode germanium detector (REGe) detector and Monte Carlo (MC) simulations were performed in this work to characterize the energy spectrum of a G-10 ^{137}Cs irradiator and a Varian Clinac 21EX 6 MV linear accelerator. The dosimetric impact for each source investigated in this work is based on their utility.

The first study investigated the effects of beam modulation techniques on the energy spectrum of a ^{137}Cs irradiator. It was found that the addition of attenuators to modulate air-kerma substantially hardened the spectrum causing a change in mean energy of up to 9%, whereas distance from the source and room scatter showed little effect. Spectral variations quantified in this work impacts detector calibrations in ^{137}Cs as survey meters and personal dosimeters may have a non-uniform energy response.

A second study aimed to measure the spectrum of a 6 MV linear accelerator with the REGe detector and compare with MC simulations. It was found that the simulated and measured spectra showed good agreement, with all points falling within the uncertainty of the measurement. The measured spectrum was also compared with the spectrum that was generated using a treatment planning system (TPS) during clinical beam commissioning. The measured and TPS-generated spectrum showed a similar shape, but varied by up to 25% in certain low energy bins. A new beam model with the measured spectra was created and a patient plans were run with the new and commissioned beam models. It was found that variations in dose calculations were minimal, and more drastic spectral variations would have to be implemented for significant dose changes.