The Spectral Dependence of the Polarity Effect in Electron Dosimetry

Parallel-plate ionization chambers are the instrument of choice for use in electron calibration and dosimetry, but these chambers may exhibit large polarity effects. The polarity effect is a phenomenon encountered when using ionization chambers for electron measurements in which the measured readings vary significantly depending upon whether the bias applied to the chamber is positive or negative.

In this work, the spectral dependence of the polarity effect was evaluated by taking measurements using the same parallel-plate ionization chamber and electrometer combination on various Varian, Mitsubishi, and Siemens linear accelerators. Measurements were also taken on the same Varian 2100C, first with a mica, and then with a kapton beam monitoring chamber.

The polarity effect was evaluated using the "polarity error" formalism, where the correct reading (true ionization charge) is defined as the average of the magnitudes of the positive and negative voltage readings. The "polarity error" is defined as the fractional error between the reading taken at positive bias and the correct reading

The magnitude of the polarity error at low energy varied for each linac due to differences in the electron energy spectrum. For the Varian 2100C, the maximum polarity error was 4% with mica chamber and 2% with the Kapton chamber. However, the maximum polarity error was less than 1% for the Mitsubishi EXL-17DP. Differences in the dose monitoring chambers, energy defining slits or electron collimators can result in differing polarity errors for the same electrometer and chamber combination.