

AbstractID: 6973 Title: Multi-leaf Collimator Quality Assurance Using Pulse Width Modulation Analysis

Purpose: To develop a quality assurance (QA) methodology for prospective mechanical maintenance of multi-leaf collimator (MLC) leaf positioning motors.

Method and Materials: Pulse width modulation (PWM) analysis was used to assess the current performance status of the MLC leaf positioning motors for three medical linear accelerators in our clinic. PWM is a software diagnostic tool available as a built-in component of the linear accelerator MLC controller computer interface (Varian Medical Systems, Inc. Palo Alto, CA). PWM probes the operational status of each MLC leaf motor by sending direct current (DC) pulses directly to the motor windings until each motor drives its individual leaf 2.0[mm] beyond four initial set positions. The DC pulse widths are incrementally increased by 2[ms] from an initial duration of 2[ms] to the length required for 2.0[mm] of MLC leaf displacement beyond the four set positions. The PWM values are stored for each position. Statistical process control (SPC) principles were applied to the data to establish process behavior characteristics. SPC limits were then applied to the PWM data and individual leaf performance statuses were analyzed. Our accelerator engineer serviced the MLC motors performing outside of the PWM SPC limits. The PWM analyses were repeated and compared with the previous results.

Results: The established SPC limits for PWM average and range were 10[ms] and 3[ms], respectively. Two MLC motors (corresponding to MLC leaves 25 and 26) on carriage bank B were performing well beyond the calculated SPC limits. The corresponding motors were investigated and found to have broken motor drive hardware. The motors in question performed within SPC limits after reanalysis.

Conclusion: PWM analysis for MLC mechanical QA required less than 5 minutes for data acquisition and was highly effective in diagnosing an MLC mechanical malfunction as part of a routine monthly QA procedure.