Abstract ID: 15395    Title: Statistical process control methodologies for predictive maintenance of linear accelerator beam quality

Purpose: This study prospectively applies statistical process control (SPC) methods as a predictive maintenance tool in linear accelerator photon beam quality.

Methods: Steering coil currents (SCC) are sampled and stored daily during morning warm-up. The transverse and radial - positioning and angle SCC for photon beams were evaluated using average and range (Xbar-R) process control charts (PCC). The weekly average and range values (subgroup n=5) for each SCC was used to develop the PCC. Control limits were calculated using the first sixteen subgroups. Run charts of the daily SCC values were maintained and updated weekly. PCC high alarm action limit was set at six standard deviations. Six subgroups in a row all increasing or decreasing were a low alarm indicator. A sustained high alarm of 3 subgroups in conjunction with a low alarm was used as our action threshold (i.e. independent verification of beam flatness and symmetry constancy).

Results: Data collection commenced September 2010, following beam steering adjustments during annual calibration. Only alarms received following establishment of limits (week sixteen) were considered valid indicators for deviation or an uncontrolled process. A high alarm was first detected on Jan 25 (15 MV – transverse position). Simulated intervention was triggered by 6 MV – radial angle SCC on February 18th. Beam scans taken and compared to those from the annual calibration indicated a change in symmetry in the transverse plane (0.6% - 6 MV and 1.0% - 15 MV) while the flatness remained effectively unchanged (<0.5%). There were no changes noted in the radial plane for either energy.

Conclusions: SPC techniques are able to effectively detect variations in beam steering currents. SPC monitoring of beam steering has the capability to ensure AAPM TG-142 constancy guidelines of +/- 1% are maintained. Further investigation is required to develop consistent intervention guidelines.