Flatness as a measure of changes in photon energy for Megavoltage X-Ray radiotherapy

Changes in photon beam energy were produced by adjusting the bending magnet current (BMI) of the Linac. In our measurements, we were obtained stable dose rates with the BMI adjusted to ±15% for the nominal 6 MV and 18 MV beams.

Flatness and symmetry measurements: Flatness and symmetry were measured using the IC profiler which was calibrated based on the wide field calibration technique.[1,2] All energies were measured for a 30×30 cm^2 field size, the top of the device was placed at 100 cm SSD and a 1.0 cm slab of solid water was added for buildup. Two flatness metrics were used: (1) relative flatness (Flat) defined as the normalized maximum difference in dose across the profile.[3] (2) diagonal normalized flatness (F_{DN}) defined as the average of highest reading along each section of the diagonals from CAX to the beam edge normalized by the CAX reading.

PDD Measurements: PDDs were measured in a water phantom using 0.04 cc ion chamber. For each energy the tank was setup to 100 cm SDD for 3 × 3 cm^2 and 10 × 10 cm^2 field sizes.

Flatness (Flat) was measured for in-plane (Y), cross plane (X), positive diagonal (PD), and negative diagonal (ND). For ease of comparison we calculated the differences of flat and F_{DN} between each energy studies and the corresponding reference energy, 6 or 18 MV (Fig. 1).

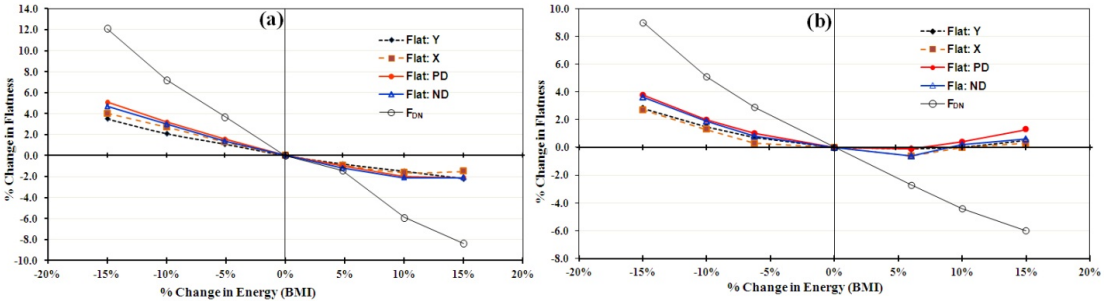

Fig. 1. Changes in Flat and F_{ND} as a function of energy for (a) 6 MV and (b) 18 MV beam.

The diagonal normalized flatness showed a near linear negative correlation of flatness change and energy change.

The metric that stood out in this work was diagonal normalized flatness (F_{DN}) which was sensitive to both increases and reduction of energy. This is evident when changes in PDD vs energy and changes in F_{DN} vs. energy are directly compared (Fig.2)

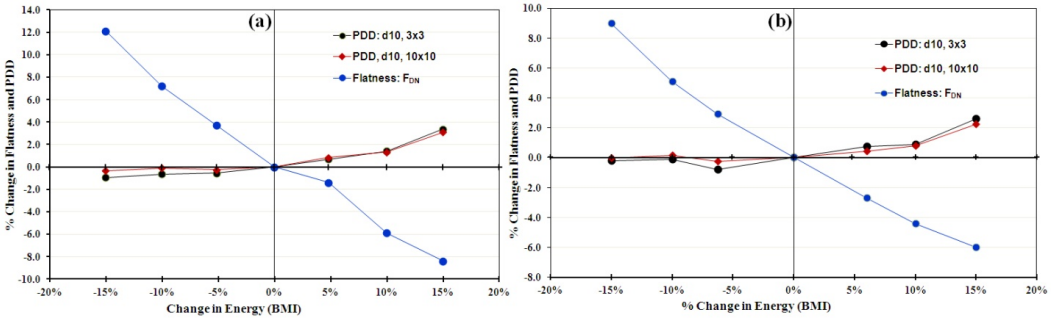

Fig. 2. Comparison of changes in F_{DN} and PDD vs. energy change. (a) 6 MV and (b) 18 MV.

References

[1] T. A. Simon, J. Kozelka, W. E. Simon, et. al, "*Characterization of a multi-axis ion chamber array*," Med. Phys. **37**, 6101-6111 (2010).

[2] T. A. Simon, W. E. Simon, D. Kahler, et. al, "*Wide field array calibration dependence on the stability of measured dose distributions*," Med. Phys. **37**, 3501-3509 (2010).

[3] Sun Nuclear IC profiler user guide, Rev. C, July 2010.