Evaluation of a dense planar diode array for true composite SRS measurements

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INTRODUCTION
Stereotactic radiosurgery (SRS) is a single fraction high dose technique used for the treatment of multiple small lesions deemed to be surgically inoperable. The SRS treatments are very complex due to widely distributed targets, tight PTV conformity with steep dose gradients and non-coplanar arcs (beams). These treatments therefore, pose certain challenges for pre-treatment patient-specific dosimetric QA requiring high spatial resolution dosimeters suitable of measuring non-coplanar beams. SRS MapCHECK (SMC) is a planar diode array (size 7.7 x 7.7 cm²) with detector spacing of 2.5 mm intended for SRS true composite measurements. The device consists of 1013 diodes arranged in two face-to-face PCBs in such a way that the active area of the diodes are at the same plane. The SMC is used in a cylindrical head-like PMMA phantom (StereoPHAN). The depth of the diode array when installed in the phantom is 7.62 cm. The assembly can accommodate the couch angles up to ±45°.

AIM
This study is aimed at evaluating a 2D detector array from Sun Nuclear Corp.) for SRS plan verification.

RESULTS

1. Angular response of SMC
   - Axial angular response for the CAX diode
   - Angular response of diode at CAX and selected off-axis positions at 6MV (upper row) and 6MVFFF (lower row) for various combinations of gantry and couch angles.

2. Dose rate dependence
   - The response was verified against plastic Scintillator detector. The measurements were performed for the gantry angles irradiating the electronics.

3. Field size dependence
   - The phantom was scanned on a Big Bore scanner and two additional 2 cm diameter target was placed at isocenter for ion chamber measurements. Single isocenter VMAT plans were optimized using Pinnacle v.14.0 with a 6MV and 6MVFFF beams thus giving four plans in total. Each plan had four arcs (2 without and 2 with couch rotation up to 30°). The dose was calculated with 2° control point increment and 2 mm isotropic grid.
   - GafChromic EBT-XD films were used for the measurements. Scanning was performed after 24 h of irradiation using Epson flatbed 48 bit scanner. RT113 v.6.6 was used. Digital Gamma analysis with 3%/1mm and 2%/2mm criteria with global error normalization and 10% low dose threshold was performed at RIT.

4. Cross profiles
   - Cross profiles of SMC vs. Scintillator detector for various field sizes. (a) 6MV; (b) 6MVFFF

CONCLUSIONS
- The response of the calibrated SMC for the dependence on beam incidence angle (axial, azimuthal plane or gantry-couch combinations), dose rate and small field output factors was found in a good agreement <2% with the ion chamber and/or scintillator measurements for both energies.
- SMC exhibits common sensitivity variation when the beam is nearly parallel to the detector plane which does not meaningfully affect the composite dose.
- The average gamma analysis between SMC and film was 98.5% for both 3%/1mm and 2%/2mm gamma criteria with global normalization and 10% low dose threshold.
- Our results show that the calibration is sufficiently accurate and the device is feasible for the true composite SRS measurements.

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