AbstractID: 13588 Title: On rotational measurements with the ArcCHECK 3D diode array

Purpose: The ArcCHECK 3D diode array dosimeter (Sun Nuclear Corporation) represents a novel approach to detector placement. We investigate the effects this design can have on the rotational measurements' accuracy and suggest correction factors that could sometimes improve it.

Method and Materials:
The ArcCHECK design places 1386 0.8x0.8mm^2 diodes arranged on a 1x1cm helical grid on a cylindrical surface 21cm in diameter inside a doughnut-shaped phantom.. Beam arrangements tested in this work include single static beams, simple open arcs, and VMAT plans based on the AAPM TG119 test suite. Field size dependence, angular dependence, phantom inhomogeneity effects, and calculation angular-discretization effects were investigated separately.

Results:
Unlike an existing device using the same diodes (MapCHECK), ArcCHECK exhibits non-negligible field size dependence in detector response, likely due to the increased phantom volume. Angular-dependent detector response is also shown, evidenced by measured beam profiles deviating from the calculations and ion chamber measurements by more than 2% for field widths exceeding approximately 15 cm. The issue is being addressed by the manufacturer. There is an additional small disagreement between measured and calculated exit doses (1.5%) due to the inhomogeneous phantom structure. Simple arc measurements demonstrate strong influence of the small changes in field width (e.g. 9%/mm at 2cm), while the isocenter dose is essentially unchanged. This is inherent and expected given the device design. The average gamma analysis passing rates for a well-commissioned VMAT system were 98.4 and 92.9% at the 3%/3mm and 2%/2mm error thresholds, respectively. They improved to 98.7 and 94.2%, respectively, after manual application of the field size correction factor.

Conclusion: Despite hypersensitivity to field width in the simple arc geometry, the VMAT gamma analysis results are in line with expectations based on independent dosimetry measurements. Introduction of correction factors for angular and field-size dependence would further improve measurement accuracy.