Improved collimator scattering factor ($S_c$) measurements for small fields using build-up caps in robotic radiosurgery

**Introduction:** The MultiPlan (Accuray, Palo Alto, CA) treatment planning system is used for all CyberKnife (Accuray, Palo Alto, CA) robotic radiosurgery cases. This software’s source distribution generating function is typically commissioned with in-air output measurements. Direct measurements are challenging for fields smaller than 10 mm due to the lack of lateral charged particle equilibrium (CPE) in the detector’s sensitive area. In this study, the SFD diode detector (IBA Dosimetry, Germany) was used to make in-air measurements with and without build-up caps in order to quantify the CPE effect.

**Material and Methods:** Two custom-made acrylic build-up caps of 1.5 cm and 5 cm thickness were used. These 1.5 and 5 cm thicknesses correspond to $D_{\text{max}}$ of the CyberKnife’s 6 MV photon beam and a depth which is beyond the range of electron contamination, respectively. The diode was oriented parallel to the beam axis at 80 cm SAD for all measurement schemes. Twelve cone sizes ranging from 5 to 60 mm were measured.

**Results:** Figure 1 shows the normalized collimator scattering factor ($S_c$) for no buildup cap, 1.5 cm buildup, and 5 cm buildup. Figure 2 shows the difference between $S_c$ factors with no buildup cap and either 1.5 or 5 cm buildup. There is greater than a 15% discrepancy demonstrated for small fields, presumably due to lack of CPE. In fact, the buildup results do not agree within 2% until a 40 or 50 mm cone is used. The 1.5 cm buildup yields comparable results to 5 cm buildup but the differences do suggest an electron contamination effect.

**Conclusion:** Small field dosimetry is a challenging subject due to loss of lateral CPE. The choice of build-up materials and thickness greatly affect in-air output ratio. More accurate measurement and future Monte Carlo verification of this study should be used to provide more precise $S_c$ values for small cone sizes.

**References:**