VMAT Case study for patient specific virtual compensator algorithm EPID *in-vivo* dosimetry

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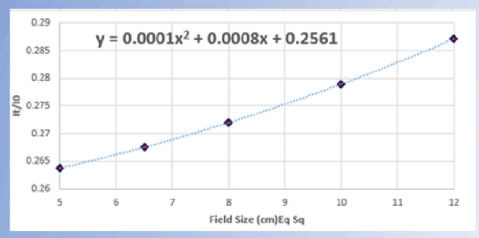
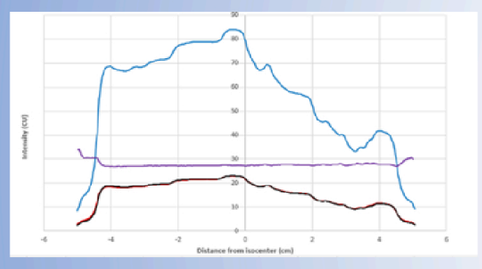
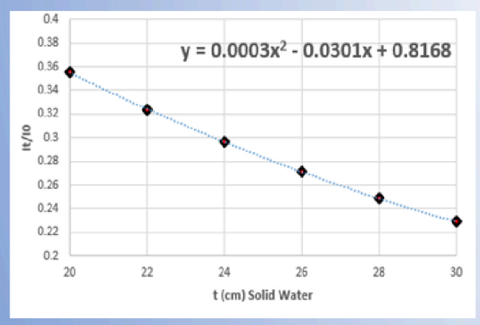
The algorithm presented is based on patient specific measurements and assures the accuracy required for *in vivo* EPID dosimetry to measure actual delivered patient dose using VMAT.

EPID *in-vivo* dosimetry is an essential part of external beam radiotherapy. Many systems require a dose calculation in the plane of the EPID and consequently involve a tedious commissioning process analogous to that of a treatment planning system. It is essential that the EPID dose be correct if it is to be used to accurately calculate the delivered patient dose. The algorithm presented in this work is based solely on patient specific measurements through a series of solid water slabs of varying thickness. The process is suitable for general implementation and can serve as a standard for clinical use, accrediting agencies, and acceptance testing of commercial products.

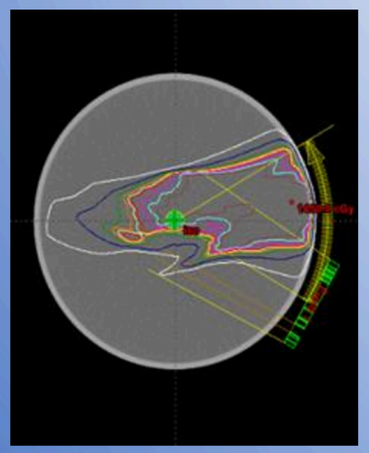


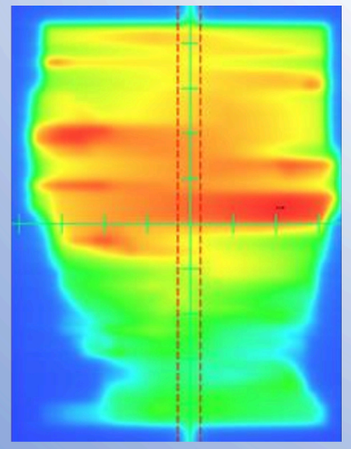


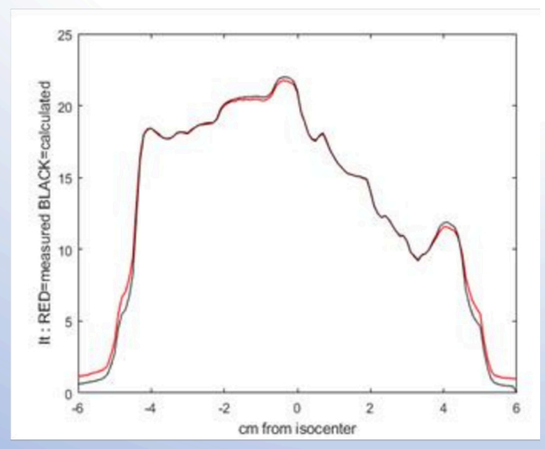


The EPID is calibrated per manufacturer for routine portal dosimetry QA in air. All measurements are 100MU 6MV at 150 SID using Varian equipment. The transmission ratio I_t/I_0 is defined at the center of the patient field through solid water of thickness t where I_0 is the in air value and I_t is the transmitted intensity. Shown on the left is the quadratic fit for t = 24.0 cm. Data is acquired for several representative depths and clinical field sizes. An in air scan is performed to determine the intensity I_0 in Calibrated Units (CU). A slab of solid water is then attached to the head of the linac so that the transmitted intensity I_t is measured throughout the VMAT arc. As shown on the left in purple the ratio I_t/I_0 for a fixed thickness t is constant. An off axis factor can be introduced for relatively larger fields. Using this value in the previously determined I_t/I_0 as a function of field size determines the field size equivalent square size. In the figure blue is I_0, red is I_t measured CU, purple is I_t/I_0, and black is I_t computed.

The VMAT patient specific field F is represented as a series of arc segments f that can be computed by creating a verification plan, F = SUM(f). The equivalent field size is computed from the measured transmission at one depth as described above. The transmission through thickness t is measured for the range of expected patient depth and field size. Both t and f can be interpolated within reasonable values and supplemented with measurements if needed. Therefore, at point r within field f that goes through a patient thickness t, the EPID response $I_t = I_0 \times I_t/I_0$. Basically the ratio I_t/I_0 acts as a compensator that attenuates the traditional in air portal dose I_0.







To test the hypothesis a 60 degree VMAT plan was created for a 26.5 cm water cylinder as shown left with the corresponding integrated image through the phantom. All images and ancillary data were transferred to MATLAB with the imaging toolbox. Use of the algorithm described in this work has very good results with a mean error in the central 80% of the field vertical axis of 0.4% and a standard deviation of 0.6%. Black curve is the measured data and red is the algorithm computed value.

The process is suitable for general implementation and can serve as a standard for clinical use, accrediting agencies, and acceptance testing of commercial products