New Reference Beam Model Method for Commissioning Elements Treatment Planning Suite: Beam Data Acquisition for Pencil Beam and Monte Carlo Dose Calculation Algorithms

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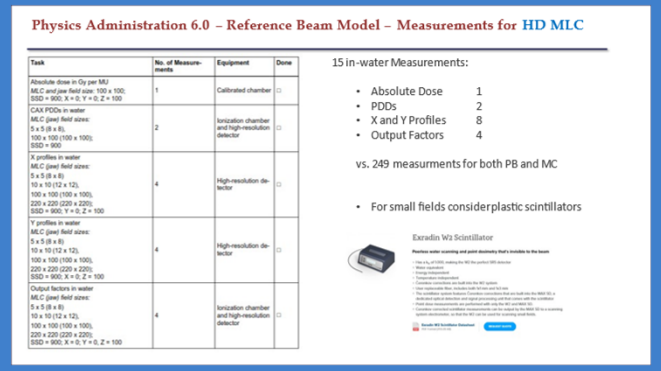
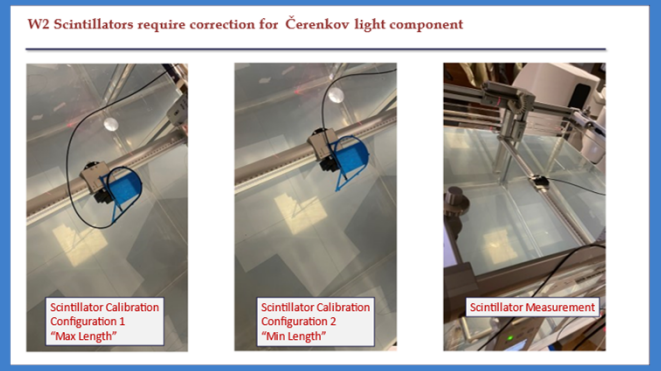
Purpose

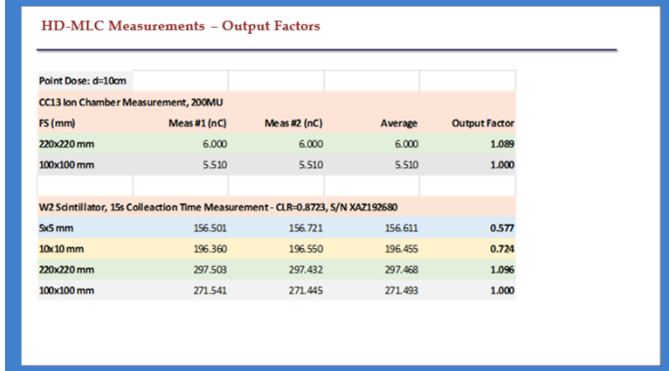
To communicate the details of the newly established Reference Beam Model (RBM) method for commissioning the Elements treatment planning suite and present a set of beam data acquisition.

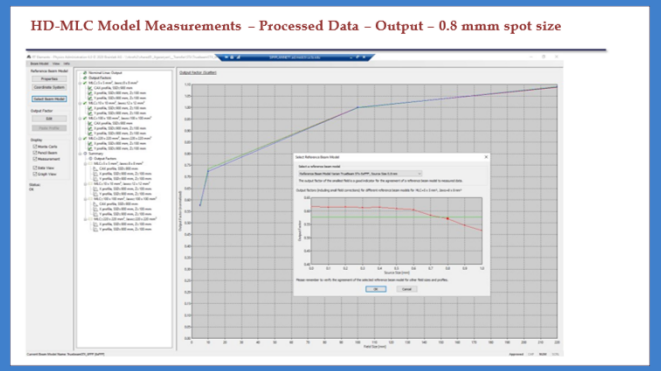
Methods and Materials

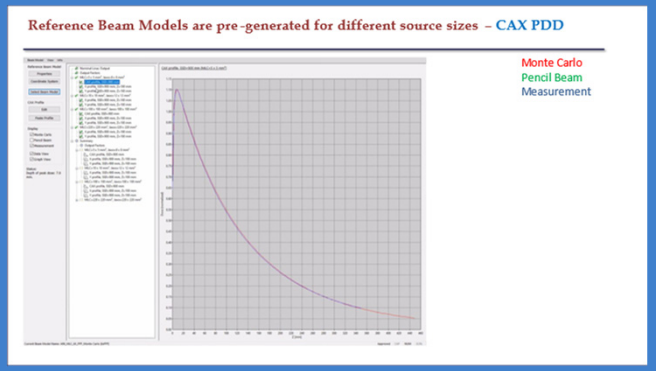
Reference Beam Model (RBM) method of commissioning requires 15 in-water measurements. The 15 measurements include 1 absolute dose output, 2 percent depth dose, 8 profile, and 4 output factor measurements. The commissioning measurements are common for the Pencil Beam and Monte Carlo dose calculation algorithms and do not require in air measurements. Pencil Beam and Monte Carlo reference beam models are pre-generated for different photon source sizes, corresponding to electron spot sizes in the bremsstrahlung target. After beam data acquisition, the user selects a spot size best corresponding to the measured data for both algorithms. The use of IAEA TRS No. 483 small field output correction factors is mandatory with the new RBM method. These correction factors are 1.000 for plastic scintillator detectors; hence, W2 plastic scintillator was used in this specific study. However, additionally, Čerenkov Light Ratio (CLR) needs to be measured for the W2 detector with the minimum and maximum length calibration method.

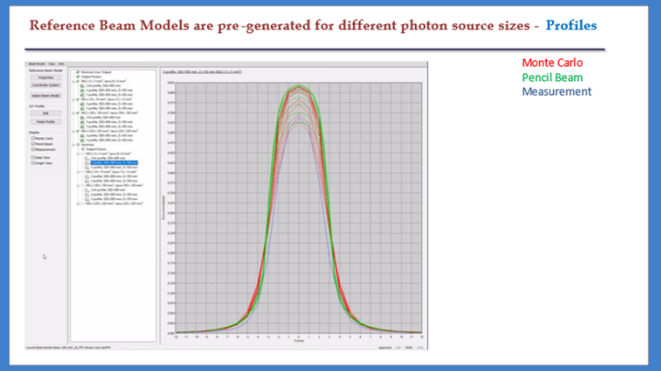












Results

The RBM data acquisition in this study took a half day. In this study, spot size of 0.8 mm provided the best agreement between the measurements and RBM model when considering the output data, depth dose curves, and beam profiles. When measuring output factors, the Čerenkov Light Ratio (CLR) for the W2 scintillator was measured to be 0.8723. The measured output factors were within 2% of the selected RBM.

Conclusions

RBM commissioning method provides streamlined and consistent beam acquisition. Another advantage of the RBM method is the extremely reduced in-water beam data measurements, compared to the original beam data acquisition method, which requires 249 measurements for the Pencil Beam algorithm and 137 measurements for the Monte Carlo algorithm, some of which were in-air measurements. Brainlab RBMs contain consistent PB and MC beam models that are pre-generated for different photon source sizes. The models take advantage of similarities between machines from the same vendor, model type and energy while accounting for machine inherent differences. RBMs are used for dose calculation in RT Elements in the same way as regularly commissioned Pencil Beam and Monte Carlo beam models while benefitting from much shorter commissioning duration and having both algorithms (PB and MC) available for dose calculation in RT Elements.