AbstractID: 8663 Title: On the influences of the detector size and sampling frequency on IMRT verifications with 2D arrays

Purpose:

The influences of single detector size and sampling frequency of detector arrays on IMRT verification are discussed.

Methods and Materials:

The 2D-ARRAY Type 10024 (PTW-Freiburg, single chamber cross section 5×5 mm², center-to-center distance between chambers 10 mm) is analyzed as an example. Due to scattering effects at the ridges between the chambers, the Full-Width-At-Half-Maximum of the lateral detector response function is approximately 7 mm. By shifting the array in 3 steps of 5 mm, re-measuring the dose distribution and arranging the data in a matrix, the sampling rate of 0.1 mm^{-1} can be increased to 0.2 mm^{-1} (sampling distance of 5mm).

Results:

The measurement process with detector arrays can be described as a two step process: 1. Convolution of the dose distribution with the response function of a single chamber of the array. 2. Sampling of the convolved dose distribution with the chosen sampling rate.

Step 1 results in a small deviation of measured and real doses in the region of steep dose gradients. A mathematical model is introduced to estimate the deviation by consideration of detector size and initial dose penumbra. For the chosen array, the deviation in the region of clinical relevant doses is shown to be approximately 1mm.

In the Fourier space, step 2 leads to a periodic replication of the Fourier Transform of the convolved dose distribution in intervals of the sampling frequency 0.2 mm^{-1}. For various IMRT distributions we can show that the maximum spatial frequency does not exceed 0.1mm^{-1}. According to the Nyquist theorem this means that the sampling frequency is sufficient.

Conclusions:

With a sampling distance of 5 mm, the measurement of typical IMRT dose distributions with the 2D-ARRAY complies with the Nyquist criterion. The results can be generalized to other arrays to analyze the limits of applicability for IMRT verification measurements.