Supporting Document

A dynamic 3-D dosimetry phantom suitable for commissioning and QA of gated RapidArc radiotherapy treatment

We designed and constructed a high precision dynamic dosimetry phantom which is shown in the drawings figure 1. The phantom facilitated the insertion into designated position precisely inside the phantom of an ion chamber insert, radiochromic film insert or an alignment insert (figure 2). The latter had a 3mm stainless steel ball to indicate the effective measurement point of the ion chamber or the centre of the films. The phantom was designed and constructed with a geometrical accuracy of 0.05mm. The motor-actuators could be programmed to generate 2-D motions of different amplitudes and frequencies to simulate patient lung motions. Comparison of measured and TPS calculated dose at reference point in phantom:

TPS calculated dose at reference point: 2.010Gy
Mean of measured dose over 5 treatment fractions: 1.977 Gy +/-0.002 Gy (1SD)
Mean deviation of measured dose from TPS calculation: -1.64%

Figure 1 showing the dynamic phantom with stepping motors and actuators for generating 2-D motions.

Figure 2 showing some of the dose measurement inserts. The insert on the left is for film measurement, the ion chamber insert is in the middle and the alignment insert with a 3mm steel ball

Figure 3 showing two of the design drawings of the phantom.

Figure 4 showing result of a test run on the stability and precision of the phantom motion in one of the movement axes.

Figure 5 showing the phantom in position for 4-D CT scan

Figure 6 showing the phantom in treatment position in a TrueBeam.

Figure 7 showing the dose distribution measure by film with 3 cm phantom motion excursion and 6 cycles per minute

Figure 8 showing dose distribution measured with 1.5 cm motion excursion and 5 cycles per minute