A phantom for modelling patient movement

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Introduction

Respiratory motion is a major concern in radiotherapy for lung cancer patient, particularly if dose escalation is applied. Significant deviations between delivered and planned doses can occur in those cases. In order to study these movements by means of measurements, a phantom is needed which is able to model patient movements, especially respiratory motion. Furthermore, this phantom would be appropriate to validate different methods for motion management (e.g. RPM) as well as dose calculation algorithms for treatment planning. As a first step, this work aims in the construction of such a phantom for 1D patient movements.

Material and Methods

The phantom should fulfill the following criteria:

- Flexible design in terms of geometry and material of the moving phantom
- Position reproducibility within 0.2 mm for a load capacity of 30 kg
- Programmable interface for different movement patterns
- Controllable from outside the treatment room

Results

The phantom is shown in figure 1. In order to fulfill the criteria, a linear motor (Linmot, NTI AG) was attached to a ground plate. The ground plate can be easily placed on the couch. The motor is connected to a hardware interface equipped with a software control unit. The ground plate provides an area suitable to attach different phantoms.

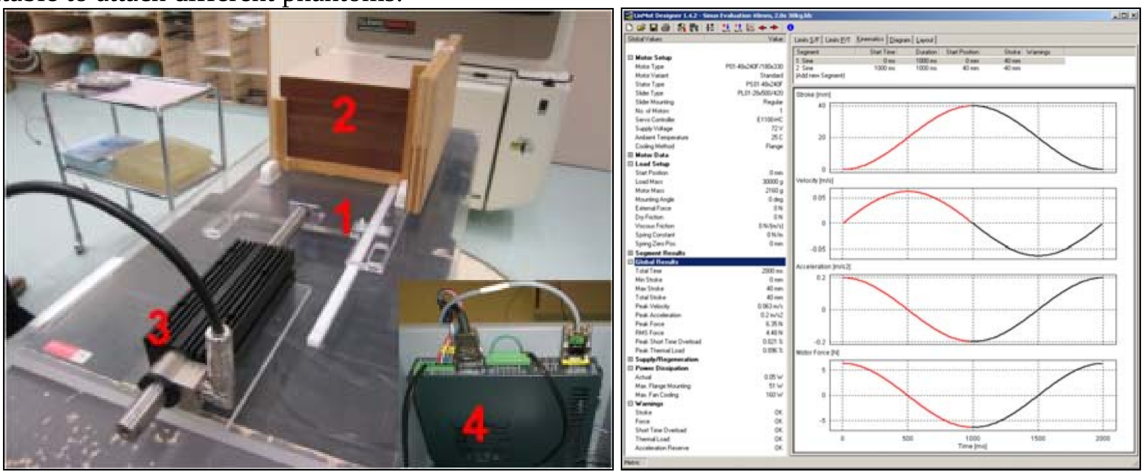

Figure 1: Left: Phantom setup, (1) ground plate placed on the treatment couch, (2) solid water phantom attached to the base plane, (3) linear motor and (4) motor interface to the software control unit located outside the treatment room. Right: Screenshot of the control unit showing a sinusoidal pattern as an example.

The control unit allows to program a pre-defined or on-line movement pattern as well as to control the motor from outside the treatment room. The positioning reproducibility was determined to be 0.17 mm. As a first test, ionization chamber and film measurements are compared with Monte Carlo calculated dose distributions for sinusoidal movement patterns of 4x4 and 10x10 cm^2 fields at a depth of 5 cm in a solid water phantom for 6 MV. The measured dose distributions are in good agreement with the Monte Carlo calculated dose distributions.

Discussion

In this work a flexible phantom has been constructed equipped with an interface to define movement patterns. It is also suitable for validation purposes of dose calculation algorithms. This work was supported in part by the Bernische Radiumstiftung.