A dual assembly multileaf collimator for radiotherapy

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Abstract

Medical physics seeks to provide methods to improve radiation therapy for cancer treatment. A multileaf collimator (MLC) for radiation therapy has been designed that splits each leaf bank into two vertically displaced assemblies or levels with each level consisting of alternate leaves and leaf spaces. The leaves in the upper level shield the spaces in the lower level. Each level can shift laterally, in the direction perpendicular to leaf motion by one leaf width. Following lateral movement of one level, the leaves align with the other level and radiation is transmitted through the collimator as multiple slit fields in a grid pattern. This transmission can be used to form an image of the external anatomy and would enable rapid double-exposure portal images to be acquired during the treatment..

The radiation profiles transmitted for image formation through the collimator design were investigated to examine their dependence on the collimator design features. The slit or leaf width was found to have the major influence on the transmitted profiles. As the slit width decreases the profiles become broader than the geometric slit projection resulting in a modulated image of the external anatomy, rather than a sampled or 'grid' image. The shielding of this design was found to be adequate provided the leaf faces of the adjacent vertically displaced leaves are at least aligned, therefore an overlap or tongue and groove is not required.

To examine the image quality of the modulated images, an algorithm to calculate the modulation transfer function (MTF) from an edge object image was developed. The effect of the algorithm on the measured MTF was investigated. To examine whether the spatial resolution of the image due to the source (geometric unsharpness) varies for the regions under the slits and under the leaves MTF measurements were made. The regions under the leaves were found to show poorer spatial resolution due to the more peripheral (extra-focal) source view. Image processing techniques were developed to remove the modulation from the images, including spatial domain and frequency domain methods. Finally, a prototype dual assembly multileaf collimator was constructed and the imaging and shielding properties were investigated.