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Technical Note

A simple jig for the anti-parallel alignment of linacs' lasers

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Abstract

Background: Despite crossing at the isocentre, misaligned laser beams may cause significant positioning problems.

Purpose: The jig proposed here is to be used in addition to the quality assurance procedures employed with linacs and deals with possible misalignments of transverse lasers.

Materials and methods: It is an inverted T construction with a two-sided rectangular, slightly transparent mirror set vertical on a piece of glass serving as its base. The device is carried by a horizontally set spirit-level surface and placed on the couch-top so that the sagittal laser passes through the vertical mirror's plane. Then the therapy couch is translated along the Y direction until a laser beam shines on the corresponding side of the semi-transparent mirror. This spot is marked and is normally the linac's isocentre set through an independent procedure employing a rotating plate. If the laser had been set properly, then its beam should be reflecting back on its source. If not, the alignment can be corrected by rotating and/or translating the laser holder until it does that. At the same time, it should be ensured that the beam does not wander away from the isocentre spot on the mirror. When both are achieved, the beam ends up perpendicular to the linac's axis of rotation, while passing through the isocentre. The procedure can be repeated for the opposite laser.

Conclusion: The jig was simple to construct and has been found quite useful in practice. The accuracy of patient positioning will be restricted only by the size of the laser beam's cross-section.

Keywords: laser alignment; laser beam set up; patient positioning; radiotherapy

INTRODUCTION

Proper alignment of the laser markers is of great importance to the correct positioning of the patient in radiotherapy. To do this, the left-right lasers must intersect each other at the isocentre and the assessment of this is one of the basic aims of a linac's quality control procedures, which can be achieved through the use of an isocentric rotation plate.

However crossing at isocentre is not enough. The laser beams must be perpendicular to the linac's axis of rotation and also anti-parallel to each other and to the horizontal couch-top plane. In reality, problems may arise either during

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the original laser installation or when the permanent laser mounts on walls or on stands are accidentally disturbed. Consequently, if such a mismatch is not dealt with, the laser cross-hair on the patient body may wander in the vertical and longitudinal direction depending on the position of the patient on the couch as well as on the couch's lateral and vertical movements. Thus, the marking on the patient's skin will not guarantee precise positioning and it may even become useless.[1]

METHODS AND RESULTS

In order to achieve the proper direction of the laser beams with respect to each other and with respect to the rotation axis of a linac, a simple jig has been constructed. This can be used either to set up new or to assess and correct the alignment of existing lasers. The principle of operation is based on the reflection of the laser beams onto their respective sources, which will ensure that the angle of incidence will be 0. Although this principle has been used again in the past,[1–3] the devices presented then were complicated to use and required special, precise engineering that made the implementation both difficult and costly.

The set up presented here is an inverted T-shaped jig. It consists of a two-sided rectangular, slightly transparent mirror, firmly attached and exactly perpendicular to a rectangular, transparent piece of glass serving as base (Figure 1). The jig is used on top of a spirit-level surface which lies on the couch-top and which is adjusted to avoid tilts.

The proper alignment of a couple of new lasers can be achieved as follows. First, one of them is set up using the normal quality assurance (QA) procedure involving a rotation plate, making sure that the beam passes through the linac's isocentre. However, this does not necessarily mean that the beam will end up being perpendicular to the rotation axis. To achieve this, the jig plus spirit-level surface is placed on the therapy couch in such a way that the Y-axis (marked by the sagittal laser), passes through the vertical mirror's plane. Then the therapy couch is translated along

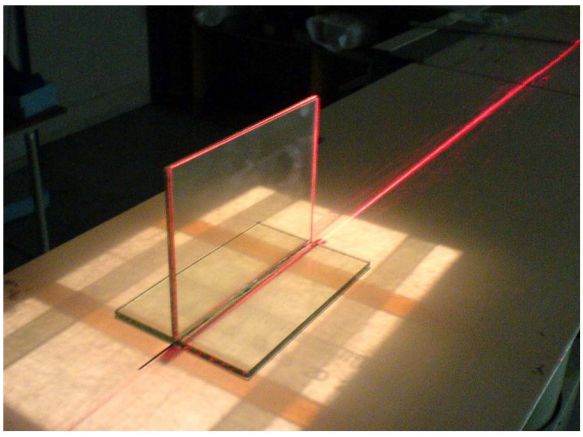

Figure 1. The jig on the couch aligned along the z-axis.

the Y direction until the laser beam shines somewhere on the corresponding side of the semi-transparent mirror and then immobilised. This spot is marked by a felt pen as the linac isocentre and if the laser has been set up properly, the beam should be reflecting back on its own source (Figure 2). If a deviation is detected, the laser holder is both rotated and translated slowly so that it does not wander away from the marked isocentre spot and until the reflection of the beam does fall exactly on its source. When this is achieved, the laser beam is perpendicular on its side of the mirror's surface and hence it is perpendicular to the linac's Y-axis and parallel to the X-axis, just as required.

If it is intended to place another laser on the opposing wall, then the jig is removed and the spot where the cross-hair appears on the opposite wall, is marked as the spot where the opposing laser's source should be. When its installation is finished the procedure must be repeated for the new laser. In the end, both lasers should be shining on their respective sides of the semi-transparent mirror and exactly on the same spot which marks the isocentre. If the lasers beams have been properly aligned both should also be reflecting right back on their respective sources. This would confirm that they are not only passing through the isocentre but that they are also anti-parallel to each other and perpendicular to the axis of rotation of the linac.

The jig presented here can also be used for the QA of lasers' alignment in an existing installation

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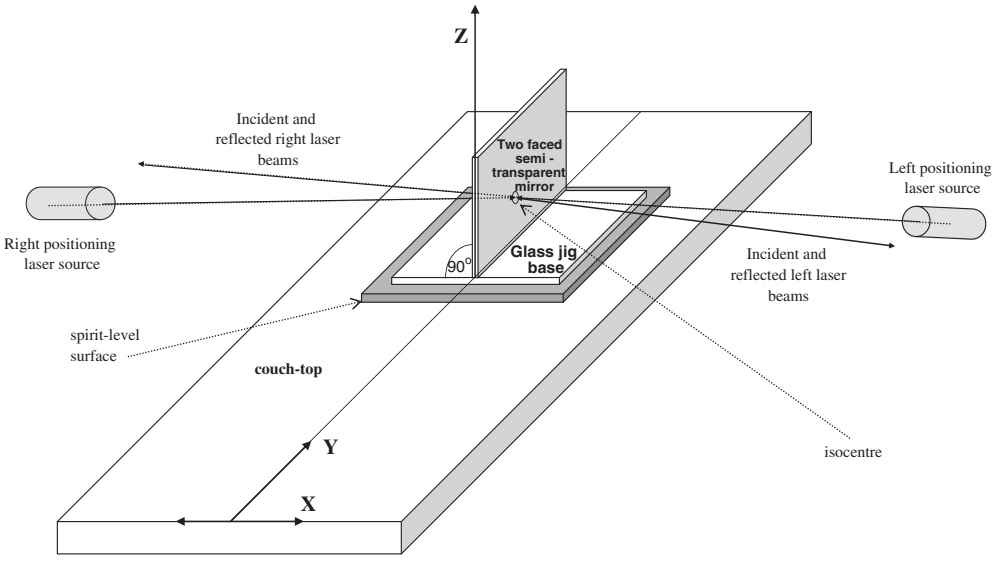

Figure 2. Diagram of the set up of the jig with respect to the linac's transverse lasers.

as well as for the re-alignment of any mismatched beams using the procedure presented above.

CONCLUSION

The use of the jig presented here has been found to work well with existing linac laser installations that suffer from slight beam deviations and with the set up of new installations. The construction of the jig is easy and cheap and the procedure is simple and quite reliable. The accuracy of alignment is comparable with the size of the laser beam cross-section and it is considered sufficient for the actual positioning of radiotherapy patients. Accuracy may be improved by increasing the distance between the jig and the laser source. However, within linac rooms of ordinary size, alignment accuracy is only restricted by the sharpness of vision.

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