Six Degrees-of-Freedom Quality Assurance Phantom for Radiation Therapy Linear Accelerators

Published date: Feb. 13, 2019

Technology description

The Need

6DoF treatment tables allow for 2 additional degrees (pitch and roll) compared to traditional 4DoF (vertical, lateral, longitudinal, and yaw) when correcting for patient setup during image-guidance prior to treatment delivery. These tables allow for more accurate patient treatments and could potentially increase efficacy in target delivery while decreasing side effects to normal tissues. Since this 6DoF technology is relatively new, few quality assurance (QA) devices have been developed in order to test this new technology in a streamlined manner.

The Technology

Integrated 6DoF table QA

The 6DoF phantom is the first of its kind to fully integrate multiple routine QA tests specifically for a six degrees-of-freedom linac table. This user friendly phantom streamlines multiple routine QA tests in a quick and consistent manner. The phantom has the capability to verify table translation (vertical, lateral, and longitudinal) and rotation (pitch, roll, and yaw) movements, verify volumetric image registration, test isocentricity of mechanical and radiation isocenter, and validate external laser alignment while following the most stringent TG-142 tolerances.

.

Streamlined six degrees-of-freedom table repositioning verification

With an established reference CT using an accompanying leveler to achieve a straightened position, the phantom is designed with known translation and rotation offset marks. This phantom was designed without leveling pins. Thus, one cannot accidentally adjust the rotation of the phantom from the reference imaging. This allows for quick and consistent setup for routine QA.

.

Unique volumetric image registration verification

The design and shape of the phantom includes complex geometry that allows for a better registration via the vendor’ s automatic registration algorithm. This is exemplified by the unique registration structures on the faces of the phantom, which can be customized to any shape or font the manufacturer desires. These structures also provide a visual verification at the registration console for the user to assess the quality of the registration.

.

Winston-Lutz isocenter verification

An embedded ball bearing is included in the center of the phantom for the purpose of Winston-Lutz isocentricity delivery. After translation and rotation adjustments are performed via volumetric imaging, the final table position places the center of the ball bearing at the mechanical isocenter. A plan with small fields and electronic portal imaging acquisition can be delivered at representative cardinal angles for gantry, couch, and collimator positions. Winston-Lutz analysis can be performed offline once delivery is completed.

.

External laser alignment verification

Visual verification of the external lasers can be performed once table adjustments and Winston-Lutz delivery is completed. The phantom includes two sets of marks: initial offset alignment marks and final isocenter marks indicating the center of the ball bearing. The mark thickness is designed to test the most stringent TG-142 tolerance for laser verification. Lasers will run flush along both sets of offset and isocenter marks, as they have the appropriate rotational orientation for both initial and final table position.

The medical physics group in the Department of Radiation Oncology has devised a 6DoF phantom that is the first of its kind to fully integrate multiple routine QA tests specifically for a six degrees-of-freedom linac table.

Institution

Ventech Solutions

Inventors

Jeffrey Woollard
Nilendu Gupta
Ahmet Ayan
Kyle Woods

联系我们

叶先生

电 话：021-65679356

手 机：13414935137

邮 箱：yeyingsheng@zf-ym.com