Multi-Element Ion Beam Range and Intensity Modulator for Radiation Therapy

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Technology description

External beam radiation therapy is a tumor treatment technique that directs one or more high-energy radiation beams to the tumor. External beam radiation systems treat tumors with multiple X-ray fan beams that can be rotated around the patient. Each beam consists of individual "beamlets" whose intensity can be controlled to allow for the treatment of complex tumor shapes. An alternate beam radiation therapy technique involves the use of ions, such as protons, to treat tumors. This technique dramatically reduces the radiation dose to healthy tissue when compared with X-ray radiation therapy using photons.

The dose intensity from protons is not uniform along the beam path and rises to a "Bragg peak" near a point where the proton beam stops completely. Controlling the placement of the Bragg peak so it is located on the tumor reduces the amount of radiation delivered to the patient's healthy tissue. Unlike X-ray radiation therapy, ions allow for separate control of the total dose of radiation (intensity) and distance the Bragg peak occurs (range).

Existing proton therapy techniques utilize different beam application methods. The spread out Bragg peak (SOBP) approach spreads the ion beam out into an "area beam" to cover the entire tumor in one exposure. This method is fast, but is less precise and requires a special compensator to adjust for the tumor shape. The magnetic spot scanning (MSS) approach uses the original ion "pencil beam," but due to multiple exposures the process is slow and results in missed "cold spots." Recent development of a new technique (see WARF reference number P07282US) has led to the ability to convert the pencil beam into a fan shape that reduces neutron contamination and improves beam delivery efficiency. UW–Madison researchers have developed a radiation treatment system that uses a shutter modulation device to individually control separate beamlets of an ion fan beam. The fan beam technique combines the benefits of parallel treatment of portions of the tumor such as SOBP with the precise control of small portions of the beam like MSS. With the use of ions the device can control the beam's range, but when used with photons it can control the beam's intensity. The device increases both treatment speed and precision.

The shutter system works by using an array of elements containing leaves that lie in the cross section of the fan beam. Each element can be positioned in or out of the beam by the use of individual linear actuators for each element. The purpose of the elements is to decrease the strength of the incoming ion beam fan by allowing attenuation of the beam. The elements can consist of variable thicknesses

and be made of any sort of homogenous material. Multiple elements with different weights can be stacked in a row to allow for substantially more control with fewer elements.
The Wisconsin Alumni Research Foundation (WARF) is seeking commercial partners interested in developing a radiation treatment system that uses a shutter modulation device to individually control separate beamlets of an ion fan beam.

Additional Information

For a collimator that can be used in conjunction with this technology, see WARF reference number P07279US.
http://www.warf.org/technologies/summary/P07279US.cmsx
WARF reference number P07282US describes a radiation treatment system that uses magnetic deflection to convert a pencil beam into a fan beam made up of individually controllable beamlets.
http://www.warf.org/technologies/summary/P07282US.cmsx

Application area

External ion beam radiation therapy fan beam modulation for the treatment of tumors

Advantages

Reduces neutron contamination to the patient
Increases treatment speed
Increases ion beam precision
Can be used with ions or photons

Institution

Wisconsin Alumni Research Foundation

Inventors

Patrick Hill
Thomas (Rock) Mackie
Jihad Al-Sadah

联系我们

叶先生

电 话：021-65679356

手 机：13414935137

邮 箱：yeyingsheng@zf-ym.com