PARTICLE ACCELERATORS: SYNCHROTRONS & CYCLOTRONS

Today's proton therapy delivery systems are more affordable, smaller, and easier to use – widening access to the therapy for many more patients. One of the driving factors in this expansion is the advancement of proton therapy technology. Particle accelerators, used to manipulate the behavior of ions for use in treatment, play a central role in delivering proton therapies.

Oftentimes, these machines also represent the single largest expense for medical facilities. When determining what system best fits the needs of their constituency, medical facilities administrators and stakeholders should consider the unique features of each.

USING PARTICLE ACCELERATORS TO DELIVER PROTON THERAPY

Particle accelerators are used to deliver proton therapy, a type of radiation treatment that uses a beam of high-energy particles. Unlike traditional radiation therapy though, which utilizes photons (x-rays), proton therapy uses an intense beam of isolated protons.

Particle accelerators, used to manipulate the behavior of ions for use in treatment, play a central role in delivering proton therapies. The two types of accelerators most commonly used are the synchrotron and cyclotron. Oftentimes, these machines also represent the single largest expense for medical facilities. When determining what system best fits the needs of their constituency, medical facilities administrators and stakeholders should consider the unique features of each.

CYCLOTRONS

To achieve the acceleration of ions, a cyclotron employs a large, circular electromagnet and the application of oscillating voltage. When ions are initially injected into the center of the magnet, they begin traveling in a curved path. Upon experiencing the voltage, the ions take on more energy – causing the travel path to grow larger and the ions to spiral outward. The ions travel around their paths in the magnet at the same frequency as the voltage oscillates. As the ions achieve the desired level of energy, they travel on an orbit on the outermost edge of the electromagnet. It is at this point the ions can be extracted for treatment.

The determining factor of ion depth penetration is energy. For ions to reach treatment sites deep within the body, ions require more energy. For surface-level treatment sites, ions require lower energy. To treat sites with lower energy than the full energy of extraction, ion beams are passed through an energy degrader when the beam's energy is reduced.

The energy degrader presents significant and unique challenges for treatment facilities. When a beam is passed through the degrader, secondary scatter radiation is produced. Large and costly shielding walls, sometimes as much as 15 feet thick, are required in order to protect against the cyclotron's undesired output of scatter radiation. This can have a significant impact on the cost required to run and maintain the system. In addition, beam quality degradation – which may happen when beams are passed through the energy degrader – can lead to less precise targeting for treatment sites.

SYNCHROTRONS

Like cyclotrons, synchrotrons also use electromagnets to bend the ions while an oscillating voltage accelerates them. Unlike a cyclotron, the frequency of the oscillation and the strength of the magnetic field are not constant, but rather are ramped synchronously from a lower level to values that correspond the desired energy. Once the desired energy is reached, the ions are extracted and delivered for use in treatment.

Because an energy degrader is not required, use of the synchrotron eliminates many of the cyclotron's disadvantages. Synchrotrons have low secondary neutrons and scatter radiation, which lowers the risk of unnecessary and unwanted radiation to the patient and facility. Additionally, by scaling beam energy up to meet the required dosing, rather than scaling down as the cyclotron does, the synchrotron is the more energy efficient choice of the two particle accelerators. Add to that the cost savings of thick shielding wall installation and an easier installation, and the synchrotron becomes the top choice for proton therapy facilities.

THE RADIANCE 330® PROTON THERAPY SYSTEM

Radiance 330® has the smallest synchrotron footprint in the market. The small footprint combined with a modular design that includes interchangeable sub-systems allows for Radiance 330® to be installed in purpose-built or existing facilities. This design also allows for future expansion and for the upgrade of individual components.

Radiance 330® supports single, multi-room and expandable configurations. The beam transport system is a beam-line that guides the proton beam from the synchrotron to the treatment room and is expandable to as many as three treatment rooms.

ABOUT PROTOM INTERNATIONAL

ProTom International is a leading device manufacturer of proton therapy technology.

We are steadfast in our mission to transform cancer treatment by expanding the accessibility of proton therapy and by developing proton tomography technology.

Collaboration fuels innovation. We have long-standing partnerships with the Massachusetts Institute of Technology, Bates Research and Engineering Center, Massachusetts General Hospital.

Learn more at www.protominternational.com