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COMMUNICATIONS OFFICE
1515 HOLCOMBE BOULEVARD • HOUSTON TX 77030 • 713-792-0655
www.mdanderson.org/newsroom

News Backgrounder

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Contact: Lindsay Anderson
gabbegroup
212-220-4444
lindsay.anderson@gabbe.com

Laura Sussman
713-745-2457
lsussman@mdanderson.org

Advances in Proton Therapy, Pencil Beam Technology Reach Patient Care

HOUSTON – It is the radiation oncologist's mantra. Deliver the maximum dose of radiation to the malignant tumor, while limiting damage to healthy surrounding tissue. In proton therapy, achieving this balance is equally one part particles and another part contriving the particles, once accelerated to nearly the speed of light, to mimic the shape of a tumor with sub-millimeter precision.

Today more than ever, new tools are enabling physicians at the Proton Therapy Center at The University of Texas M. D. Anderson Cancer to harness supercharged proton particles and conform them more closely to the rugged landscape and uneven contours of a cancer tumor. Using a technology known as *pencil beam scanning*, also known as spot scanning, protons are given the mission: home in on cancer cells and destroy. As much an art form as a war tactic, pencil beam has the ability to treat the most complex of tumors, like those of the prostate, brain, base of the skull and eye, while leaving healthy tissue and critical structures untouched. The powerful coupling of strength and accuracy offers unmatched capacity to treat a patient's tumor without compromising quality of life.

In nearly a decade since pencil beam's birth in a Swiss physics institute, the world's leading practitioners in radiation science at M. D. Anderson's Proton Therapy Center will integrate the tested technology into the institution's multidisciplinary approach to cancer care and translational research.

A BEST IN CLASS FACILITY

The Proton Therapy Center at M. D. Anderson stands as an international center of excellence for proton therapy, research and education. Within its 94,000 feet of space the Center houses three treatment rooms quipped with giant gantries – three stories tall, 35 feet in diameter, weighing 190 tons and resembling giant ferris wheels – each capable of maneuvering the proton beam to precisely target the patient's tumor. A fourth room utilizes a stationary beam with two treatment areas for irradiating eye tumors and for larger tumors in the body, including tumors of the pelvis. Pencil beam technology is currently installed in one of the gantry rooms.

The Center offers patients:

- Access to the most advanced radiation therapy stateside and M. D. Anderson's world-renowned research, faculty and multidisciplinary patient care.
- Treatment for the most comprehensive range of disease sites including pediatric cancers and cancers of the head and neck, eye, prostate, brainstem, esophagus and lung, among others.
- Reduced side effects and minimal damage to healthy tissue, which contribute to quality of life during and after treatment and enable patients to live longer, more fulfilling lives.

A New Frontier for Proton Therapy

Proton therapy derives its advantage over conventional forms of radiation from its ability to deliver radiation doses to a targeted tumor with remarkable precision that avoids the surrounding tissue, generates fewer side effects and improves tumor control. Most proton patients are treated with a form of therapy known as *passive scattering* which uses apertures to shape the proton beam and deliver a uniform dose to the tumor. Since opening in the spring of 2006, M. D. Anderson's Proton Therapy Center has treated more than 1,000 patients with this passive scattering technique.

Pencil beam for proton therapy delivers a single, narrow proton beam (about a centimeter in diameter) that is magnetically swept across the tumor, depositing the radiation dose like a painter's brush strokes, without the need to construct beam shaping devices. The technology continues to build on the patient benefits already offered with proton therapy – more targeted, higher tumor dose, shorter treatment times, reduced side effects and increased treatment options – to treat complicated tumors perilously close to critical structures, such as the eye, brain and esophagus.

"The difference between passive scattering and pencil beam is like painting something with a can of spray paint versus using an airbrush," said Andrew Lee, M.D., M.P.H., associate professor in

the Department of Radiation Oncology at M. D. Anderson, and the director of the Proton Therapy Center. “Pencil beam is more like an airbrush. Instead of needing a stencil to master the shape, the proton beam is made ultra fine to define the contours and landscape of a tumor.”

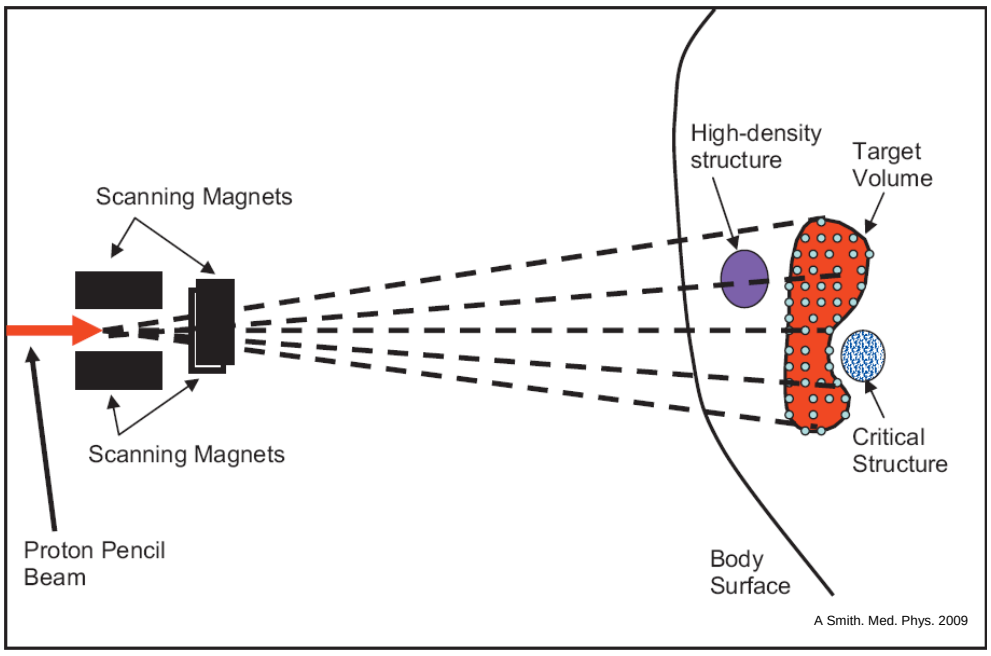
Rapid Fire with Exquisite Precision

The Proton Therapy Center, which began treating patients with pencil beam in May 2008, was the first in North America and one of only three clinical centers in the world to employ this technology. Because pencil beam does not require any shaping devices the treatment is less time consuming than passively scattered beams, with most treatments only taking a few minutes.

Using rapidly fired pulses, the pencil beam hits each planned spot within the tumor with a set dose of radiation, starting at the deepest layer and working in succession, layer by layer, until the whole tumor is covered. Lee estimates that a typical tumor will have between 1,000 to 2,000 separate spots arranged in up to 24 layers in a single pencil beam treatment. “We are able to maximize the protons generated and deposit more energy directly into the tumor,” Lee said.

THOUSANDS OF TARGETED PROTON BEAMS

Powerful scanning magnets direct thousands of ultra fine proton beams, one by one, toward a patient’s tumor. Intricate treatment planning allows for the protons to deposit their potent dose of radiation to the exact dimensions of the tumor, leaving nearby healthy tissue and critical structures untouched.



He notes that pencil beam could ultimately be applied to any tumor site where proton therapy is used, including cancers of the prostate, eye and head and neck. It is an especially attractive future option for solid tumors in children, who are generally more sensitive to the adverse effects of radiation. “Without the apertures, pencil beam deflects fewer neutrons into healthy tissue, which have been shown to increase the risk of second malignancies in young, still growing patients.” M. D. Anderson has treated over 40 patients with pencil beam to date.

Eloquent Treatment Planning Masters Complex Tumors

Pencil beam is only as good as the complex and intricate treatment planning systems used to direct the beam’s motion, depth and strength. As these systems evolve to the extent of pencil beam’s capabilities, the team at M. D. Anderson’s Proton Therapy Center will tackle cancer’s most difficult tumors based on their shape and location in the patient.

“The beauty of pencil beam is that we have the ability to target the tumor with exquisite sensitivity to surrounding healthy tissue and structures,” said James D. Cox, M.D., professor and head of the Division of Radiation Oncology at M. D. Anderson. “It’s best utilized when we need to conform high doses of radiation to irregularly shaped tumors embedded near or wrapped around critical structures in the head and neck, such as the eye or brain.” The advantage lies in the beam’s capacity to approach the tumor from multiple directions, creating a “U” shape around these structures and avoiding them entirely during treatment. Side effects common after radiation therapy are reduced and healthy organs are preserved because the radiation is confined to the tumor.

The future introduction of *intensity modulated proton therapy* at M. D. Anderson will also be possible as pencil beam delivery is further developed. Intensity modulated proton therapy uses the same pencil beam configuration, but the energy or intensity of the proton beam can be changed at any time to penetrate the tumor at varying depths. “This is the holy grail of radiation therapy,” Lee said. “Without pencil beam we could not achieve this degree of sophistication for our patients.”

Zeroing in on Advances for the Patient

A pioneer in radiation oncology, M. D. Anderson has paved the way for more effective radiation therapy around the world. The Proton Therapy Center will continue to make strides in the field by making the combination of precision and potency found in pencil beam technology accessible to increasing numbers of patients in a clinical setting. Each patient who receives pencil beam treatment will be part of a growing body of research protocols at M. D. Anderson, examining proton therapy's benefits over conventional radiation therapy and refining the technology to care for future generations of cancer patients with the best therapies available.

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About M. D. Anderson

The University of Texas M. D. Anderson Cancer Center in Houston ranks as one of the world's most respected centers focused on cancer patient care, research, education and prevention. M. D. Anderson is one of only 41 Comprehensive Cancer Centers designated by the National Cancer Institute. For four of the past six years, M. D. Anderson has ranked No. 1 in cancer care in "America's Best Hospitals," a survey published annually in U.S. News and World Report.

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