# Proton Beam Centers for Cancer Treatment

A Status Summary Update ~ March 2008

By Fuller C. Jones

The primary advantage of proton treatment for cancer is the precision of the proton beam and control of the dosage delivered to the tumor site. Unlike the standard radiation treatments that are available almost anywhere in the U.S. and in most other countries, the proton beam can be delivered directly to the cancer site with significantly reduced or no damage to surrounding healthy cells, tissue or organs. This is of particular advantage to prostate cancer patients with contained disease that has not spread; but *many other cancers can also be treated*, including head and neck tumors, eye tumors, certain lung cancers, abdominal cancers, and breast cancers.

Because the proton beam treatment is not available except in a very few locations, it is not well known. It is usually not recommended except in the centers where it is available or nearby areas where publicity has made it known. For the prostate cancer victim and others, this is now changing. The recognition of the availability of the treatment—and acceptance as a viable alternative to surgery, brachytherapy (seed implant), cryosurgery, and standard radiation treatment—is becoming more widely known, particularly for prostate cancer patients where the tumor is still confined to the prostate capsule. More and more cancer patients are discovering the non-invasive proton beam, as results are made public, and patients that received the benefits of proton therapy spread the word. Reported results indicate at least a comparable record to other treatment methods, but without some of the side effects, such as incontinence and impotency. *"The patient feels nothing during treatment… [and] experiences a better quality of life during and after proton treatment."* [i]

Recent long-term reports of treatment history and results have generated a rapid proliferation of planned "Centers of Excellence" and primary medical institutions that are investing in the extremely expensive facilities to administer the Proton Beam Therapy. In 2005, there were only three such primary proton beam medical facilities in the U.S. There are now (March 2008) five such centers with fully operational proton facilities that are currently treating cancer patients in a hospital environment: Loma Linda University Medical Center (LLUMC) at Loma Linda, California; Massachusetts General Hospital (MGH) in Boston; Midwest Proton Radiotherapy Institute at Indiana University, Bloomington; the M. D. Anderson Cancer Center in Houston, Texas; and the University of Florida Proton Therapy Institute at Jacksonville, Florida. One other, the facility at the University of California at Davis, treats eye cancer only. Worldwide, I have found references to twenty-eight Proton Centers currently treating patients, but some of these are in a laboratory setting rather than in a hospital-like environment. As of March 2008, nearly 50,000 proton treatments had been made worldwide.[ii] (See the Endnote reference and link for the centers.)

Of the U. S. centers with dedicated proton treatment, the Loma Linda University Proton Center has been in operation the longest (since 1990), and for almost ten years stood alone. Loma Linda currently has the highest patient treatment capability, and can process between 125 and 175 patient treatments per day. It is significant that as of March 2008, approximately one-fourth of all cancer patients worldwide who have been treated with protons were treated at the LLUMC Proton Treatment Center. In the case of prostate cancer treatments at LLUMC, normally forty-four or forty five treatments are required for a complete proton-only protocol, at 79.2 to 81.0 Gy [iii] delivered at 1.8 Gy per day.

In some cases, where there is a chance that cancer has spread within the prostate bed, photon (X-ray) treatment is also required and the proton protocol may be varied. As of March 2008, the

LLUMC Proton Center has treated well over 12,000 cancer patients with many types of cancer disease. More than half of these (actually about 65 percent) were victims of prostate cancer. The Texas and Florida centers have only been in operation for a short time (since mid-2006), but are now fully operational. There are minor variations at the different locations, depending on the facilities and doctors. However, the daily use of protons in the hospital environment has been proven (at LLUMC and the other active proton centers), and proton treatment protocols are well established.

Highlighting the growing recognition, progress, and degree of potential for proton beam treatment, there are several new centers either under construction or in the advanced planning stage within the U. S., most requiring an investment of $120 million to $200 million.

Hampton University in Hampton, Virginia, is planning a $183 million facility (groundbreaking has taken place). The 98,000 square foot facility is scheduled to open in 2010, and will treat approximately 125 patients daily (over 2,000 patients per year). It will feature ***four*** gantry rooms and one fixed beam room. This will be an increase in the norm; most other new centers have only two or three gantry rooms.

Construction is in progress on a private (for profit) Proton Center in Oklahoma City that is planned to open in 2009. [iv; v] It is being constructed by ProCure Inc., the developers of the Bloomington, Indiana facility.

We have just learned that Oklahoma City is going to have a second proton center. A recent announcement states that Oklahoma University Cancer Institute is to build a proton center on the Health Center campus. The size and cost of this facility is not known.

The University of Pennsylvania is building a large facility near Philadelphia, which is being partly funded by The Dept. of Defense in partnership with Walter Reed Army Hospital.[vi;vii] Construction of this facility is well underway. The cyclotron, built by IBA of Belgium, arrived in Philadelphia January 29, 2008.

The Seattle Cancer Care Alliance is planning a $120 million center in Seattle, Washington. A Letter of Intent was signed in February 2008; therefore this facility will probably not be on-line until late 2010 or 2011.

In October 2006 Northern Illinois University announced plans to build a world-class cancer treatment and research center in that will provide state-of-the-art proton therapy.[viii] The facility will be known as the Northern Illinois Proton Treatment and Research Center.

Central DuPage Hospital of Winfield, Illinois, a suburb of Chicago, is also pursuing development of a proton center. Barnes-Jewish Hospital in St. Louis, Missouri; Broward General at Ft. Lauderdale, and Orlando Regional at Orlando, Florida, are planning smaller units ($20 million; see reference to MIT proton development below) to be brought on-line in 2009 and later. There are about fourteen others in the proposed, pre-planning, or design stage in the U. S. and worldwide.[ix] Experts foresee up to 100 U.S. proton centers within the next few decades.[x]

It is quite evident that the Proton Beam Therapy for cancer treatment is a modality whose time has finally arrived.

There are on-going improvements in the present technology. LLUMC is now installing robotic positioning systems. Also at LLUMC and other locations “Image Guided” and “Active Scanning” proton delivery devices are being planned that will enable even more accuracy in proton delivery to target tumors. Some of these are already in use at some locations in Europe.

The future promises even more exciting developments. The great hindrance to universal use of the proton in cancer treatment is the size and cost of the cyclotron or synchrotron equipment and supporting facilities necessary. The Massachusetts Institute of Technology (MIT), in collaboration with a private development company, is working on a comparatively small (room size) accelerator to deliver the proton therapy to patients. If this development is successful, an even more rapid expansion of Proton Beam Therapy should almost immediately occur.

According to the MIT News Office, *"MIT proton treatment could replace X-ray use in radiation therapy. Scientists at MIT, collaborating with an industrial team, are creating a proton-shooting system that could revolutionize radiation therapy for cancer. The goal is to get the system installed at major hospitals to supplement, or even replace, the conventional radiation therapy now based on x-rays. The fundamental idea is to harness the cell-killing power of protons…. Worldwide, the use of radiation treatment now depends mostly [approximately 90 percent] on beams of x-rays, which do kill cancer cells but can also harm many normal cells that are in the way. What the researchers envision -- and what they're now creating -- is a room-size atomic accelerator costing far less than the existing proton-beam accelerators that shoot subatomic particles into tumors, while minimizing damage to surrounding normal tissues. They expect to have their first hospital system up and running in late 2007."* [xi] Note, this date was obviously optimistic; it is apparent that this machine will not be available until 2008 or later. One recent search found that the MIT technology was licensed to Still River Systems of Littleton, Massachusetts. The trade name given to the MIT-Still River systems device is "Clinatron-250™."

As has happened many times in the history of modern technology development, there are others concurrently working on the idea of a smaller, less expensive proton accelerator. The University of California Davis Cancer Center is actively engaged with a similar project. In the Fall/Winter 2006 "Synthesis" (Volume 9, No. 2), there is the following:
*"UC Davis Cancer Center and Lawrence Livermore National Laboratory join forces to make proton-beam therapy available to every major cancer center."* The story goes on to describe the coordinated efforts of UC Davis and the Lawrence Livermore Laboratory to develop the machine:

*"Size and cost have been the obstacles. A 90,000-square-foot building — bigger than many hospitals — is needed to house a state-of-the-art proton-beam accelerator. And the machines carry price tags of up to $150 million. But these barriers may be about to topple. Researchers from Lawrence Livermore National Laboratory and UC Davis Cancer Center are working on a subscale prototype of a "miniaturized" proton-beam accelerator. Led by George Caporaso of Livermore's Physics and Advanced Technologies Directorate, the research team aims to deliver a final machine that will be small enough to fit in a typical radiation oncology suite, powerful enough to treat cancer anywhere in the body and priced at about $10 to $15 million. The lab is currently seeking commercial partners to help construct a full-scale model."* [xii]

In the new technology transfer pact, Lawrence Livermore National Laboratory has licensed the technology to *TomoTherapy, Incorporated* of Madison, Wisconsin, through an agreement with the Regents of the University of California.

Note: I suspect that the final cost of such machines may be closer to $20-$30 million. This is of course much less than the cost of the current large-scale proton facilities, and is more within the range of possibilities for most large metropolitan hospitals. I also think that these new systems will probably incorporate the "scanning" method of beam delivery.

Further into the future are more exciting developments, such as using carbon ions or antiprotons, in the never-ending pursuit of new tools to fight cancer.

From a Web site called ACT, Advanced Cancer Therapy, "Committed to Increasing Knowledge of Advanced Cancer Therapies Using Particle Beams to Terminate Cancer Cells:"

*"Which particles are used in advanced particle beam cancer therapy*__*?*__ *Up to now the particle of choice was the proton, the nucleus of a hydrogen atom. 40+ proton beam therapy centers exist and have to date treated more than 50,000 patients worldwide.*

*In recent years research in Germany and in Japan has shown that carbon ions can have a much higher biological impact on cancer cells than protons and can therefore successfully treat tumors normally deemed "radio-resistant". Carbon ion treatments have yielded significantly improved treatment results in many types of tumors. But up to now only 3000 patients have received Carbon ion treatments.*

*Antiprotons, known to most of us only from science fiction, have already been shown to offer yet another increase of effective dose in the target area, have the potential to further decreasing the impact on healthy tissue in front of the tumor, and additionally would allow watching in real time where exactly inside the body the treatment is administered."* [xiii]

One such project is in the not-so-distant future. In July 2007, Touro University announced plans to build a center for particle therapy cancer treatment in California that will offer both proton and carbon ion therapy. Upon completion, it would be the first such center in the United States, and would be part of the school's future $1.2 billion health science research campus on Mare Island in the San Francisco Bay area.

---

*End Notes*

[i] National Association for Proton Therapy; a Web site article; <http://www.proton-therapy.org/howit.htm> Accessed Oct. 2006.

[ii] Oncolink. A Web site. Abramson Cancer Center of the University of Pennsylvania. Article, Cancer Treatment Information.
<http://www.oncolink.org/treatment/article.cfm?c=9&s=70&id=209> Accessed March 2008.

[iii] Gy: Gray: a unit of absorbed dose of ionizing radiation equal to an energy of one joule per kilogram of irradiated material. Abbrev. *Gy*.

[iv] KFOR-TV; Oklahoma City, OK. AP News Release. See <http://www.msnbc.msn.com/id/18040175/>Accessed Aug 2006.

[v] Business Wire, April 9, 2007. Procure Begins Construction on … First Proton Therapy Cancer Center.
<http://findarticles.com/p/articles/mi_m0EIN/is_2007_April_9/ai_n18792572> Accessed March 2008.

[vi] Army Health Care. A Web site; <https://www.goarmy.com/amedd/news.jsp> accessed March 2007.

[vii] University of Pennsylvania Health System. A Web site; <http://www.pennhealth.com/cam/proton/index.html>

[viii] News Release. Northern Illinois University. <www.niu.edu/PubAffairs/RELEASES/2006/dec/protonrfp.shtml>

[ix] Oncolink; Ibid.

[x] Dr. James Slater [Loma Linda Univ. Medical Center]. Article Health: "More U.S. Hospitals Offering Proton Beam Therapy;" News USA. A Web site. Accessed October 2006.
<http://www.proton-therapy.org/UShospitals_191A.pdf>

[xi] MIT New Office' a Web site article.
"MIT Proton Treatment …"; August, 2006. Accessed. Feb. 2007.<http://web.mit.edu/newsoffice/2006/proton.html>.

[xii] Synthesis, A Publication of the UC Davis Cancer Center.
<http://www.ucdmc.ucdavis.edu/Synthesis/issues/fall_winter_06-07/features/in_translation.html> Accessed August 2007.

[xiii] Advanced Cancer Therapy. A Web site. Accessed August 2007.
http://www.advanced-cancer-therapy.org/