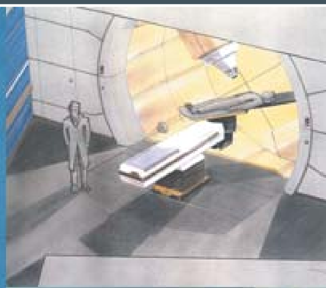
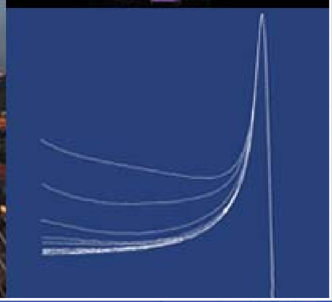
A Patient's Guide to Proton Radiosurgery



Northeast Proton Therapy Center

Massachusetts General Hospital

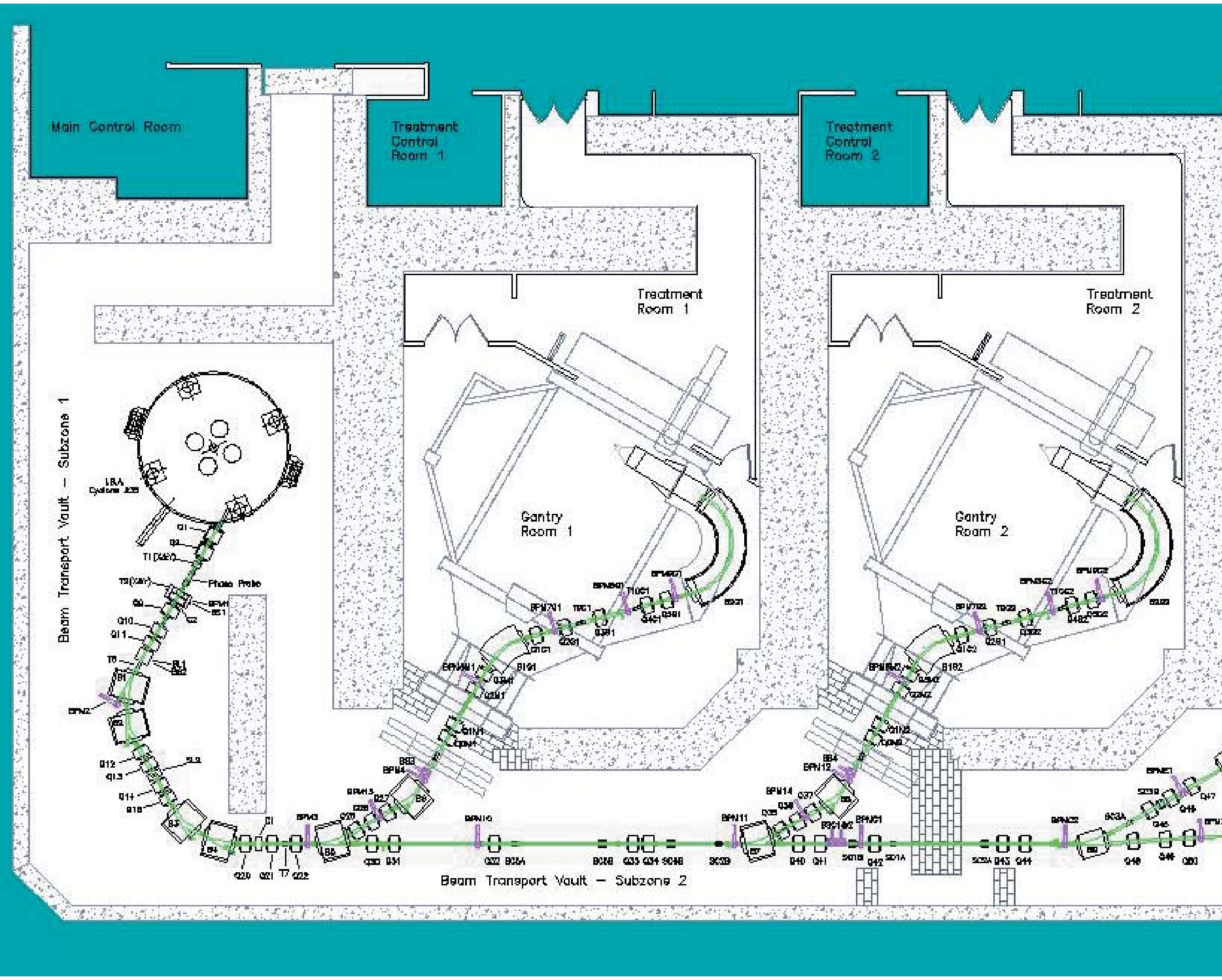
Boston, Massachusetts

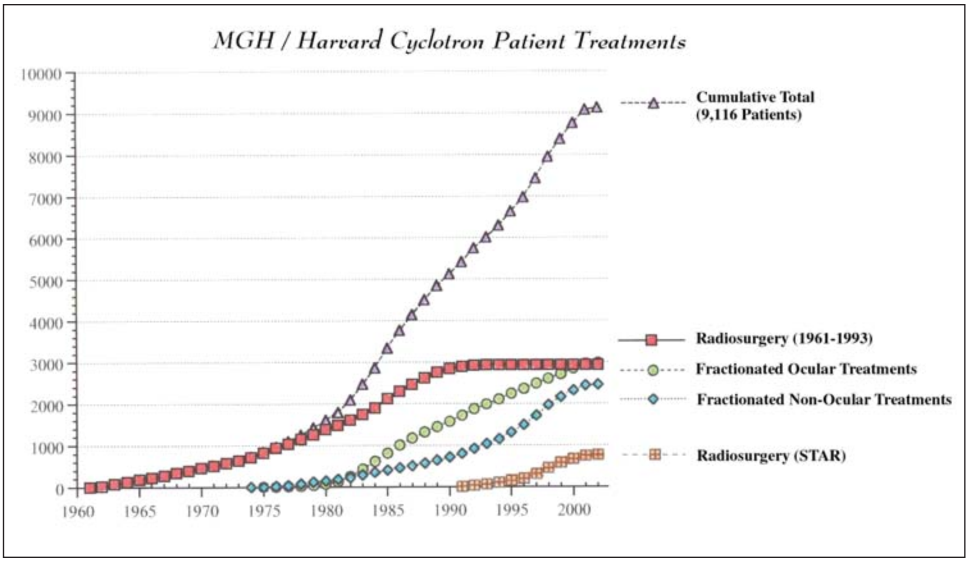


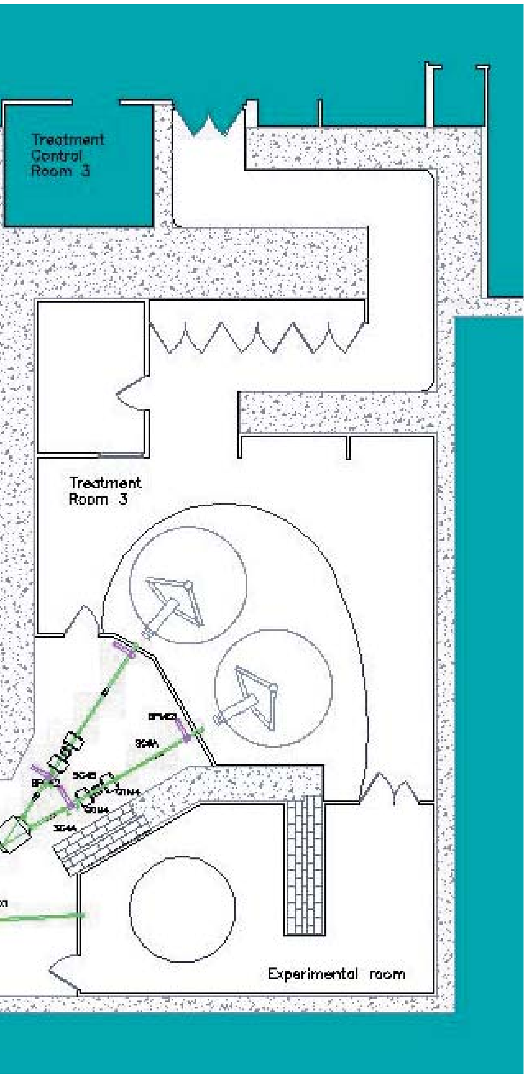
PARTNERS™ HEALTHCARE

MASSACHUSETTS GENERAL HOSPITAL

HARVARD MEDICAL SCHOOL


Main Control Room
Treatment Control Room 1
Treatment Control Room 2
Treatment Room 1
Treatment Room 2
Gantry Room 1
Gantry Room 2
Beam Transport Vault - Subzone 1
Beam Transport Vault - Subzone 2

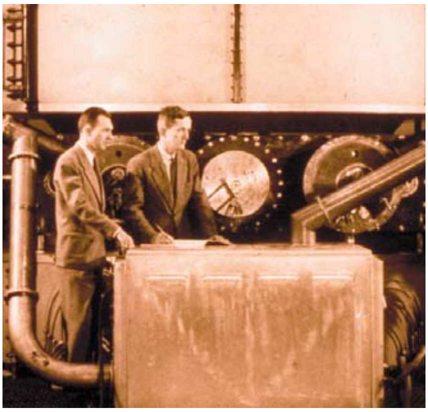

MGH / Harvard Cyclotron Patient Treatments
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
1960
1965
1970
1975
1980
1985
1990
1995
2000
Cumulative Total (9,116 Patients)
Radiosurgery (1961-1993)
Fractionated Ocular Treatments
Fractionated Non-Ocular Treatments
Radiosurgery (STAR)



The Northeast Proton Therapy Center (NPTC) has been designed specifically to provide proton treatments in a hospital setting with state-of-the-art technology and a full range of patient and research support services.The center is used for both cancer therapy research and for treatments already proven to be effective.The NPTC opened in November 2001 and when fully operational will have the capacity to treat 1,000 patients per year.

The program builds on the MGH experience gained using the 160 MeV proton beam at the Harvard Cyclotron Laboratory (HCL), Harvard University. There, MGH physicians and physics personnel, along with a clinical support team, collaborated to treat both benign and malignant disease from 1961 to the closing of HCL in April 2002. During that period 9,116 patients were treated.

The Northeast Proton Therapy Center (NPTC) has been designed specifically to provide proton treatments in a hospital setting with state-of-the-art technology and a full range of patient and research support services.



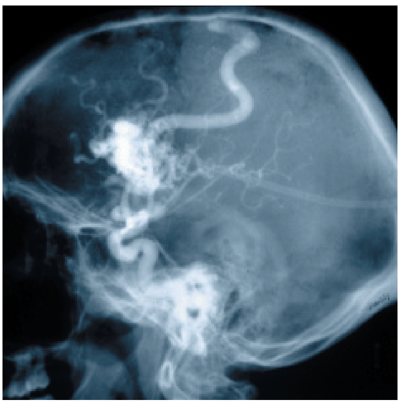
History

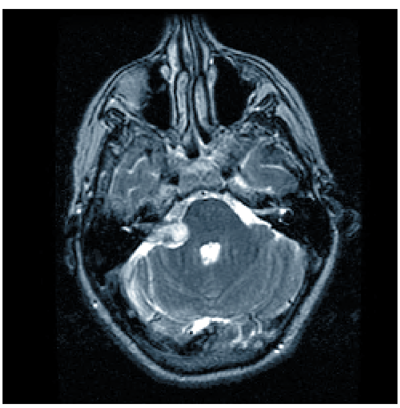
In 1961, MGH physicians from the Department of Neurosurgery began treating patients with the proton beam at HCL using a method known as stereotactic radiosurgery (treatment delivered in one or two high-precision sessions). By 1993, about 3,000 patients with a variety of brain tumors and vascular malformations had been treated by proton radiosurgery.At that time the Departments of Neurosurgery and Radiation Oncology collaborated to inaugurate an improved system of radiosurgical treatment known as STAR (Stereotactic Alignment for Radiosurgery). By the time HCL closed its doors in 2002, almost 800 patients had been treated using the STAR system. With the opening of NPTC, the STAR program is being transferred to the new facility.

In 1974, MGH physicians from the Department of Radiation Oncology treated the first patient using fractionated therapy (treatment delivered in 10 to 46 precision sessions). In 1975, physicians from the MGH and the Massachusetts Eye and Ear Infirmary, treated the first ocular melanoma patient.

From 1971-75, the National Science Foundation funded the development of techniques required to treat large target volumes and the treatment of the first few patients with fractionated proton therapy. The National Cancer Institute funded the development of fractionated proton therapy from 1971-75 and has funded clinical research from 1974 to the present time.

At HCL the relatively low proton energy and the fixed horizontal beams, which required rotating patients to aim the proton beam from various directions limited the types of patient treatments that could be delivered. However, the success of the HCL program led to the building of a dedicated proton therapy facility, the NPTC, on the main campus of MGH.





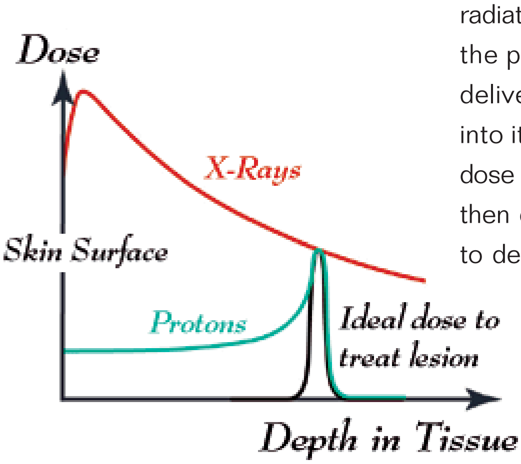
The construction costs of the NPTC were jointly funded by the National Cancer Institute and the MGH each contributing $20 million. MGH, through its Development Office, has been encouraged by efforts to recover its $20 million contribution and is seeking funds from loyal friends of the hospital for the remaining amount.

The NPTC has many advantages over HCL. The maximum proton energy at the NPTC is 230 MeV, resulting in a maximum tissue penetration of 32 cm. This allows tumors in most parts of the body to be treated. The proton beam at NPTC can be delivered by a rotating gantry, which allows the radiation to be directed toward the patient from any angle, a technique that greatly improves the ease and versatility of treatments. There are two such gantry treatment rooms, and a total of four treatment locations. This makes it more possible to meet the large and increasing medical demand for proton treatments. Because the NPTC is located on the MGH campus, patients and their families have easy access to all hospital support services. The NPTC will become an integral part of the Yawkey Center for Outpatient Care, now under construction.

RADIOSURGERY

Radiosurgery is a procedure that uses a neurosurgical technology known as stereotaxis to precisely aim an intense dose of radiation into a targeted abnormality, such as a brain tumor or vascular malformation. This is done so that the radiation dose to normal tissues surrounding the target is minimized. Radiosurgical treatments are typically performed in one or two sessions.

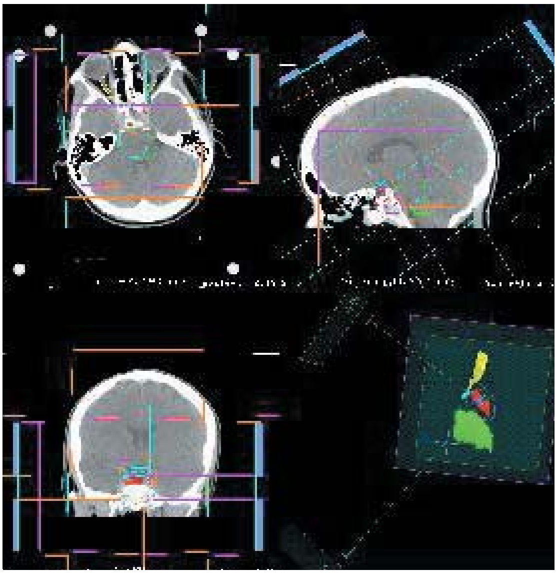
Radiosurgery may be done as an alternative to conventional neurosurgery for certain types of medical conditions. In other circumstances it may be used in conjunction with fractionated radiotherapy and/or surgery. The determining factors are the nature of the disease, its location, and its extent. Brain tumors commonly treated by radiosurgery include meningiomas, acoustic neuromas, and pituitary adenomas, as well as a variety of malignant tumors including gliomas and metastases. Vascular abnormalities of the brain, especially arteriovenous malformations, are also frequently treated.

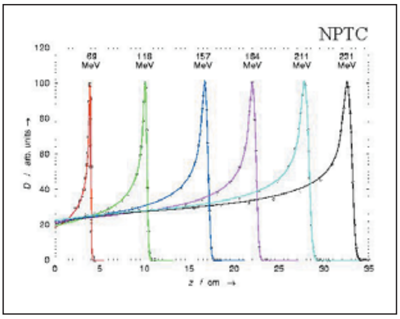


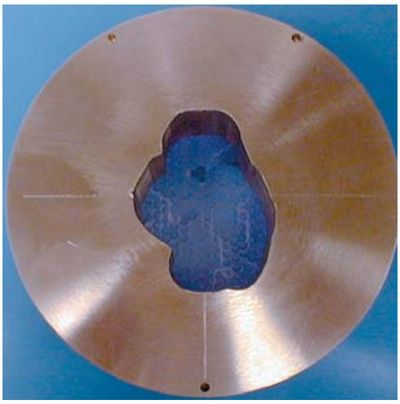
Radiosurgery can be performed with any type of beam of ionizing radiation. This includes photon beams such as gamma rays and x-rays, as well as particle beams, which include protons. When gamma or x-rays are directed at tissue, the radiation dose received by that tissue is most intense near the point of penetration. Progressively less radiation is delivered to the tissue as the beam passes more deeply into it. When protons are directed at tissue, the radiation dose gradually increases as the beam passes more deeply, then drops to near zero beyond the target depth.In order to deliver a high dose of radiation to a target deep within the brain or other organ while sparing the surrounding tissues from the same radiation dose, it may be necessary to aim the beam at the target from multiple directions, thus focusing an intense spot of radiation on the target. This also allows the radiation dose to conform more closely to the margins of the target.

Proton Radiosurgery

Small targets that tend to be spherical can be effectively treated using gamma or x-ray radiosurgery. However, with larger and more irregularly shaped targets, it becomes increasingly difficult to deliver a uniform dose of radiation within the target and spare surrounding normal tissues. In







this circumstance, the unique characteristics of proton radiation are a significant advantage for performing radiosurgery.

Protons have a physical advantage over x-rays and gamma rays when it comes to sparing normal tissue. Protons deposit most of their radiation energy in what is known as the Bragg peak, which occurs at the point of greatest penetration of the protons in tissue. The exact depth to which protons penetrate and at which the Bragg peak occurs is dependent on the energy of the beam. This energy can be very precisely controlled to cause the Bragg peak to fall within the tumor or other tissue that is targeted to receive the radiation dose. Because the protons are absorbed at this point, normal tissues beyond the target receive no radiation.

In order to further reduce the amount of radiation received by normal tissues in the path of the proton beam, beams are aimed at the target from multiple directions. For each of these directions special devices called apertures are fabricated to shape the radiation to the target profile. Other devices called compensators control the radiation depth within tissue. These devices are custom designed to further help each beam conform to the unique shape of the target volume.

GENERAL INFORMATION

MGH / Partners

http://www.massgeneral.org
http://www.partners.org

Neurosurgery

Office of Dr. Paul Chapman (617) 726-3887
Secretary: Sylvia Weld
http://neurosurgery.mgh.harvard.edu/

Radiation Oncology

Office of Dr. Jay Loeffler (617) 724-1548

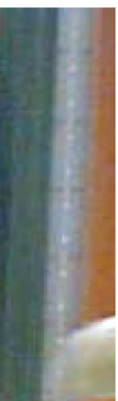
Nurses: Patricia McManus (617) 726-0922
Ena Chang (617) 726-0923

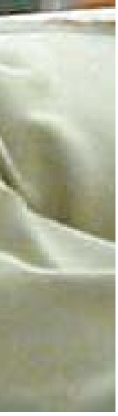
http://cancer.mgh.harvard.edu/cancer_home.htm

Registration

All MGH outpatients must have a current blue hospital card for hospital services. You may get one at Patient Registration in the Cox Building Lobby or on the first floor of the Wang Building next to the outpatient pharmacy, Monday through Friday from 8:00 am to 4:30 pm. Please arrive 15-30 minutes prior to your scheduled appointment if you need to register for a blue card. Remember to bring all your insurance cards with you. You may also register in advance by phone by calling Patient Registration at (617)726-9090 or toll free at (877)726-9090. Please remember to bring your blue hospital card for all visits.

When you arrive, please check in with the receptionist. You will find it helpful to bring a date book or calendar to keep track of your appointments and tests. We also encourage you to bring someone with you.





RESTRICTIONS

Unless otherwise advised, none of the procedures leading to your treatment will require you to restrict your diet.

INITIAL CONSULT/REVIEW

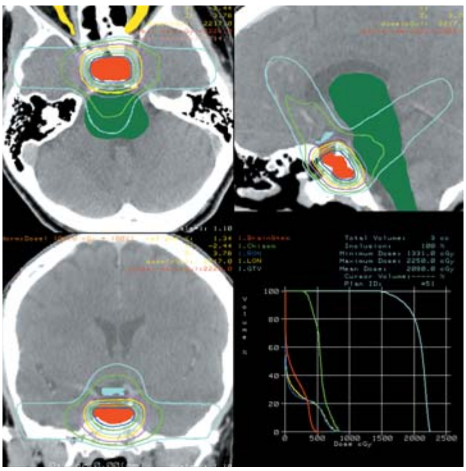
A senior neurosurgeon and radiation oncologist reviews each case. These physicians will assess your medical and treatment history, medications and prior imaging studies to determine the best treatment course for your particular condition. Further diagnostic imaging such as MRI or angiography may be required. You will have the opportunity to meet with these physicians to discuss their recommendations.

SKULL MARKERS (FIDUCIALS)

Depending on the location of the treatment site within the skull, three or four tiny (1mm diameter) stainless steel beads may be implanted in the surface of your skull using a small needle and local anesthesia. The procedure is done on an outpatient basis and takes about 20 minutes. These markers allow us to aim the proton beam very precisely at the target when you are treated. The alignment process uses sophisticated computer technology similar to that used by global positioning satellites. As part of the pre-treatment work-up, a complete blood test will also be done.

HEAD IMMOBILIZATION AND CT SCAN

After the skull markers have been placed, a CT scan will be performed, usually on the same day. The purpose of the CT scan is to carefully identify the area to be treated and to create a precise three-dimensional picture, which includes the skull with the implanted markers, the brain, and the lesion to be treated. This becomes the framework for making the necessary radiation dose calculations and custom designing the treatment to be given. At the time of the CT scan, you will also have a dental mold and head cup fabricated. These immobilization devices are used to hold your head still during the CT scan and later at the time of your treatment. Please let us know about any concerns or discomforts, since the immobilization devices being made will be used for your CT imaging and treatment.



Treatment Planning

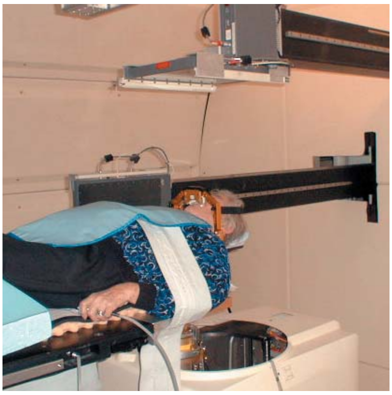
The physicians will use the CT scan, in addition to other studies you have had, to outline the target and to note important brain structures. The size of the target, as well as its relationship to these structures, is critical in calculating the prescribed radiation dose. It also determines the directions from which the proton beam will be aimed through the brain to the target. The medical physicist will now design the treatment plan, which is reviewed once again by the physicians. Once the treatment plan has been finalized, customized equipment is fabricated which shapes the proton beam so that the radiation dose matches as closely as possible the shape of the target. This equipment is designed for each direction from which the beam will be aimed.

Consent

Prior to the treatment a physician will discuss the details of your treatmentwith you. The physician will remind you about the potential risks and benefits of the treatment. You will need to sign a consent form, which says that these details have been reviewed with you. Please feel free to ask any questions and express any concerns you may have at this time.

Treatment

Treatment does not involve any invasive procedures. The head frame with its dental mold, which was fitted at the time of your CT scan, will again be strapped to your head in a manner which is as comfortable as possible. You will then be positioned for treatment with the head frame secured, which will help you keep your head as still as possible during the treatment. X-rays will be taken to locate the skull markers and the bony anatomy. Based on your position, adjustments will be made to bring the lesion we are treating into the proper alignment in relation to the proton beam. The beam will then be turned on to deliver the precise radiation dose. This process is repeated two to four times in order to aim the beam at the target from a number of different directions.



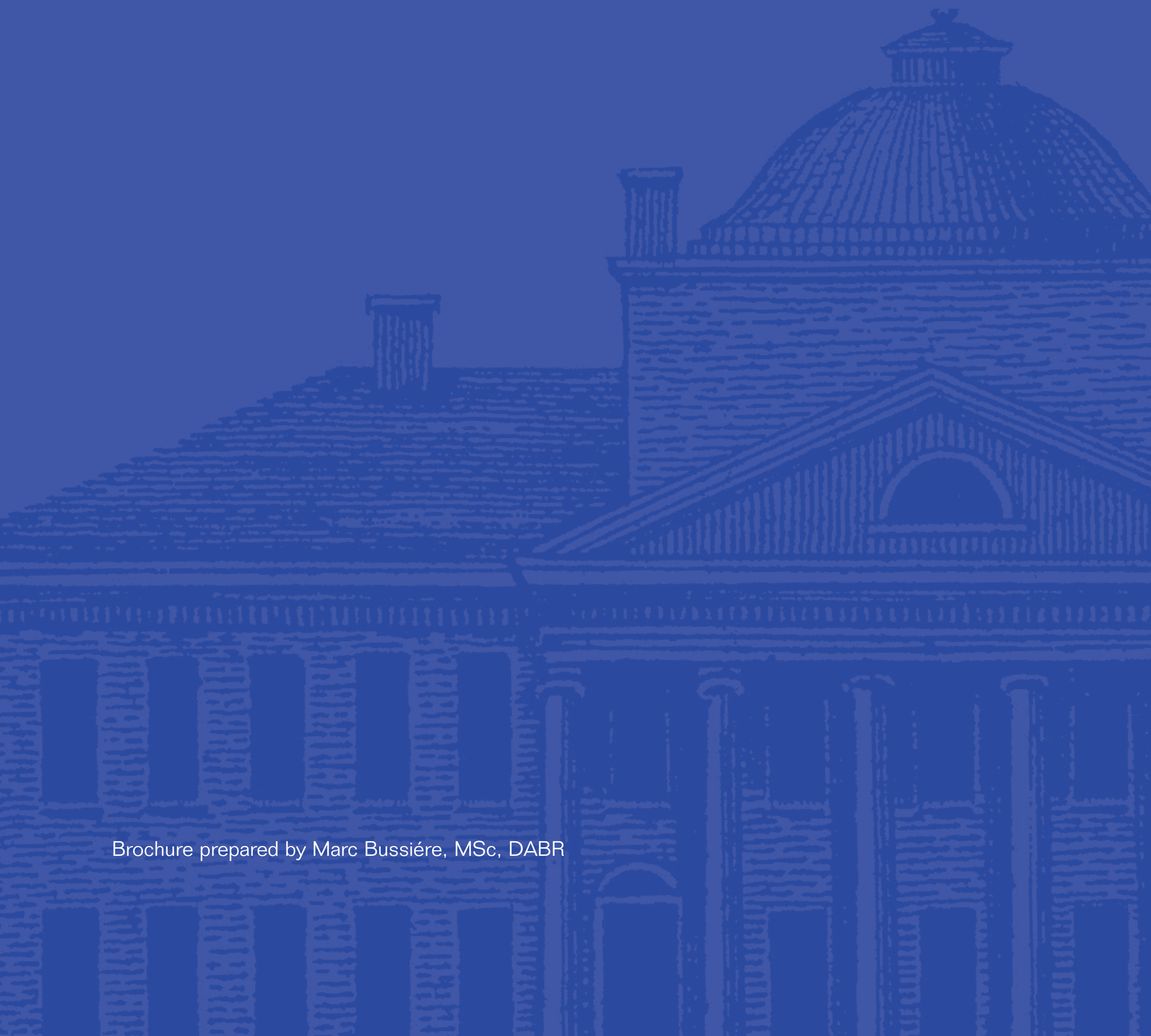
Each direction from which the beam is aimed is called a field. The time from the initial x-ray to treatment of the first field is usually 15 minutes. Setting up and treating each field thereafter takes about 10 minutes per field. The total time required for a typical treatment is about one hour.

During the treatment you will not feel the radiation. Although the head frame is fixed to the bed and you are required to remain as quiet as possible, medical personnel will be in the room with you much of the time. They will be very alert to your needs throughout the treatment. We ask that you do not speak once the procedure has started, since your positioning relies on the dental mold and any motion will prolong the procedure. You will be given a hand-held buzzer to signal any problems.

FOLLOW-UP

After the treatment, your physician will discuss your further care with you, including any immediate precautions and follow-up recommendations. You will be provided with the necessary instructions in the event of further symptoms related to your illness and/or treatment.

Northeast Proton Therapy Center
Massachusetts General Hospital
Fruit Street
Boston, MA 02114



Brochure prepared by Marc Bussiére, MSc, DABR