PARTICLES

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PROTON THERAPY CO-OPERATIVE GROUP

A Newsletter for those interested in proton, light ion and heavy charged particle radiotherapy.

Number 10 July 1992 Editor: Janet Sisterson Ph.D., HCL

This is the **tenth** issue of Particles, a newsletter devoted to matters of interest to all those involved, or planning to become involved in proton, light or heavy ion and heavy charged particle radiation therapy.

I am pleased that after 10 issues in 5 years Particles is still an interesting newsletter with an ever increasing circulation. This issue is no exception and once again I thank all the contributors as without their excellent articles there is no newsletter. The continuing interest in Particles is shown by the still increasing mailing list and the number of phone calls I receive requesting information.

For the past five years the Harvard Cyclotron Laboratory has supported the production of the newsletter with the help of very generous donations from the American Proton Development Corporation and AccSys Technology Inc. However, increased mailing costs and increased circulation (from ~100 copies for Particles 1 to ~470 for Particles 10) mean that HCL needs to seek financial help from the world-wide charged particle therapy community to help cover the increased out-of-pocket expenses. To do this, the registration fee for PTCOG meetings will be increased slightly to cover the costs of producing both Particles and the compilation of the abstracts from the PTCOG meeting. In addition, HCL would be happy to receive a financial gift from anyone with money to spare, and the appropriate method is to send a check to me made out to the "President and Fellows of Harvard College" with a letter dedicating this gift to Particles.

Facility and Patient Statistics: I am still collecting information about all facilities, both operating and proposed, regarding machine and treatment characteristics. I thank all of you who filled in and returned Questionnaire 1; I have data from nearly all operating facilities. To date, the data do not exist in any summarized form, but I would be happy to supply any information that you need. I am now collecting the world wide patient data, by year and site. Again, I thank all of you who took the time to fill in Questionnaire 2 to provide me with this information; a tedious job for those of you, who like HCL, have been in operation for a long time. When I have enough replies (those of you who DIDN'T send Questionnaire 2 back will get it again!), I plan on summarizing the data in a future issue of Particles and then updating it each year.

Future e-mail and fax directories: While I do have e-mail addresses and fax numbers for many people, I don't have enough information to publish directories. However, please feel free to contact me for information.

ARTICLES FOR PARTICLES 11

The deadline for the next newsletter is November 30 1992, so that Particles 11 can come out in January 1993. Address all correspondence for the newsletter to:

Janet Sisterson Ph. D.
Harvard Cyclotron Laboratory
44 Oxford Street
Cambridge MA 02138.

Telephone: (617)495-2885
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E-mail address: BITNET%"SISTERSON@HUHEPL"
or "SISTERSON@HUHEPL.HARVARD.EDU"

Articles for the newsletter can be short but should NOT exceed two pages in length. I DO need a good clean copy of your article and figures as I am using a scanner to get the text into the computer, but cut-and-paste the figures. If I only get a FAX copy, there may be typos! As far as I am concerned, the very best way to receive an article is by using e-mail as then I only have to down-load it from the VAX to my MAC; I would like to see more people make use of this method.

FUTURE PTCOG MEETINGS

The times and locations of the next PTCOG meetings are as follows:-

PTCOG XVII	Loma Linda, California USA	October 26, 27 1992
PTCOG XVIII	Nice and Orsay, France	Spring 1993

As of July 1992, this is ALL the information that is available about the future schedule.

For further information about **PTCOG XVII** or if you wish **to join PTCOG**, please contact the secretary of PTCOG, Dan Miller, Department of Radiation Oncology, Loma Linda University Medical Center, 11234 Anderson Street, Loma Linda CA 92354. Telephone (714) 824-4378.

PTCOG XVII

PTCOG XVII will be hosted by Loma Linda University Medical Center. Registration is expected to begin at 8:00 am Monday, October 26 and the meeting will end at 4:00 PM on Tuesday, October 27, 1992. The registration fee will be $75 to cover incidental expenses and the social event on Monday evening. Please make checks payable to LLUMC, PTCOG and note that no credit cards are accepted. Please contact Dan Miller (or Leimomi Song) at the address below, if you plan to attend the meeting, make a presentation, or to suggest other topics for the agenda.

Department of Radiation Medicine
Loma Linda University Medical Center
11234 Anderson Street
Loma Linda CA 92354

telephone: (714)824-4197 fax:(714)824-4083

Tour of the Proton Facility: There will be a tour of the Loma Linda University Medical Center Proton Facility on Sunday evening October 25, 1992. Please be sure to let the LLUMC folks know if you will be attending.

Hotel Information: A block of rooms has been reserved at the San Bernadino Hilton and the meeting will be held in the hotel. The room rate is $55 for a single or double room. Reservations must be made by October 4 1992 in order to reserve a room in the PTCOG block. The hotel address is

San Bernadino Hilton
285 East Hospitality Lane
San Bernadino CA 92408

telephone:(714)889-0133 fax:(714)381-4299

Airport Information: The closest airport to the San Bernadino Hilton is Ontario International Airport. This is located approximately 30 minutes from the Hilton. There is a shuttle service available from the hotel, however, you must make arrangements with them in advance.

Agenda: Special emphasis will be given to clinical topics such as

Treatment protocols
Treatment results
Comparative planning
Radiation biology
Treatment delivery

Anyone having contributions relating to these areas is encouraged to make a presentation. Requests for time on the agenda for PTCOG standard topics including facility updates, plans for new facilities, accelerators, gantries, beam delivery systems and patient positioning are also solicited.

Abstracts for PTCOG XVII

Speakers are invited and encouraged to submit an abstract of their presentation for circulation to the PTCOG membership with the issue of Particles following the meeting. Abstracts will be collected at the meeting by Janet Sisterson or Dan Miller; or may be mailed or faxed to Janet Sisterson at the address etc. given on a previous page of this newsletter. As mentioned earlier, an even better method of sending your abstract to Janet Sisterson is to use e-mail.

Abstracts should be limited to 1/2 page including the title, authors and affiliation at the top. The remaining portion may be in any format and may include graphs and diagrams.

PTCOG News

The following reports were received by June 1992.

News from the **Superconducting Super Collider Laboratory, Dallas, U.S.A.:**

In December 1991, The University of Texas Southwestern Medical Center at Dallas contracted with the Superconducting Super Collider Laboratory to perform a conceptual study for a Proton Therapy Facility at the SSC.

The study participants included representatives of Lawrence Berkeley Laboratory, Particle Accelerator Corporation, Aguirre Associates Inc., and the SSCL. The effort was conducted in two phases.

The first phase involved a series of trade studies. Three alternative approaches to beam formation were examined. They were: 1) using the SSC linac beam directly with intensity reduction techniques, 2) using a pulse stretcher ring attached to the linac, and 3) using a small synchrotron attached to the linac. The relative costs of the three approaches were evaluated and the program flexibility of each was examined. Such factors as implications on nozzle design, dose rate adjustability, perturbation on the linac operation, potential radioisotope production, possibilities for B-N Capture Therapy, and Proton Radiography were weighed. Additionally, such features as gantries, vertical beams, and variable collimators were covered.

The second phase of the study focused on a detailed costing of a specific subset of the options presented in phase one. This subset was selected jointly by SMC and the SSCL. It consisted of using the linac beam directly with appropriate intensity reduction techniques, one fixed beam room with intersecting vertical and horizontal beams, one gantry room, and a radioisotope production facility.

The results of the studies and a detailed cost estimate were summarized in a formal report and presented to the SMC on April 6, 1992.

Shortly after the presentation, SMC indicated to the SSCL their intent to proceed with the project and began exploring various options to facilitate the meshing of the Proton Therapy Facility with the construction schedule of the SSC linac.

On June 16, 1992 a press conference was held at Southwestern Medical Center where representatives of SMC and the SSCL announced their intent to build the Proton Therapy Facility at the SSC. As announced, Southwestern Medical Center plans to spend approximately two years raising funds for the

facility. This would allow construction to be completed in time to begin operation concurrently with the SSC linac in 1996, assuming Congress sees fit to keep the project on track. *Ben Prichard, Superconducting Super Collider Laboratory, 2550 Beckleymeade Ave, Suite 125 MS 1042, Dallas TX 752337-3946.*

News from **Indiana University Cyclotron Facility, Bloomington, U.S.A.:**

The present effort is directed toward automated dose delivery and patient positioning. A real time computer system will be used to observe the output of all beam monitor devices. This system will stop treatment when the proper dose has been reached, or if the beam fails to meet certain criteria. Eventually, feedback loops will be added so that the system will try to correct problems with the beam (such as a beam position error) based on the information provided by the various beam monitors. We have acquired a chair that will allow a patient to be positioned for treatment of head and neck tumors. Additional systems which we have acquired for patient alignment include: a laser alignment system, a light field port verification system, and an x-ray port verification system. Our expectations are that the entire system will be completed and ready for patient treatment by the end of this calendar year. *Charles Bloch, Indiana University Cyclotron Facility, 2401 Milo B. Simpson Lane, Bloomington IN 47408.*

News from the **Douglas Cyclotron Unit, Clatterbridge, England:**

The above is not a new facility but the former MRC Cyclotron Unit. We have ceased to be administered by the Medical Research Council and now we are part of the Clatterbridge Centre for Oncology, which is a Trust within the National Health Service. We are a Supra-regional Unit, funded by the Ministry of Health, to treat large eye melanomas. Therefore, apart from a change of 'label', the staff and facility remain as before.

Up to the end of June, 255 patients with uveal melanoma have been treated on our proton beam line.

The results from the Proton Dose Intercomparisons with visitors from the NAC, Faure and Uppsala, Sweden were satisfactory showing uncertainties of ±1.3% and ±0.7% respectively for ionization chamber measurements in a modulated beam.

Significant improvements have been made to EYEPLAN planning program, in particular the modelling of the eyelids by a curved, 'cylindrical' surface. Further work is in progress on an alternative spherical surface representation of the eyelids. Although these options and others are in the process of being tested, please address requests and enquiries to Martin Sheen at the address below.

Other work includes a M.Sc. project which will examine the use of TLDs in proton radiotherapy, as well as further work on the Faraday Cup as a local dosimetry standard.

The provisional results from RBE studies using melanoma cell-lines indicate values from 1.18 to 1.3 Further work showed significant decrease in Survival Fraction with depth, in the constant dose region of the spread out Bragg curve. This work was performed in collaboration with the Institute of Cancer Research and Moorfields Eye Hospital. *Andrzej Kacperek, Douglas Cyclotron Unit, Clatterbridge Centre for Oncology, Clatterbridge Road, Bebington, Wirral L63 4JY UK*

Status of particle therapy at the **National Accelerator Center, Faure, South Africa:**

The first phase of the proton therapy programme at NAC is the development of a 200 MeV small-field horizontal beam radioneurosurgical facility in the south treatment vault. A progressive expansion of this facility is planned. Initially multiport plateau irradiations will be undertaken. While this is not the optimal treatment procedure, it will permit personnel to gain experience with a relatively simple set-up and allow time to develop more sophisticated treatment planning techniques. The beam modification system is being designed so that it can easily be upgraded: firstly for Bragg peak irradiations of small intracranial lesions and then for general large-field applications. The north treatment vault can be utilized later for an additional proton therapy beamline, possibly utilizing a vertical or isocentric beam delivery system. Operating theatres have been built near this vault so that intraoperative proton therapy can be undertaken.

Internal construction of the treatment vault has almost been completed. Most of the beamline components have been installed. Design of beam modification devices, alignment, dose monitoring, beam control and safety systems have been completed and manufacture and installation of these components are in progress. The patient support system has been installed while the stereophotogrammetric patient positioning system has been delivered and is being tested.

The patient support and positioning systems have been designed and developed by the Departments of Mechanical Engineering and Surveying of the University of Cape Town and ensure the accurate positioning in the proton beam of the intracranial lesion to be treated. The basic components of the system are an adjustable chair, a series of video cameras and two personal computers.

A patient will undergo conventional scans (CT, MRI, angiography) to enable the size and the location of the lesion to be determined. For the scans small opaque targets will be affixed to the patient's head. This will enable the coordinates of the centre of the lesion to be determined relative to the targets. For proton therapy suitable targets will once again be fixed to the same spots on the patient's head. The images obtained from the video cameras will be analysed using stereophotogrammetric techniques. Since the position of the video cameras and the direction of the proton beam will be accurately known in space, it will be possible to calculate the position of the targets (and hence of the centre of the lesion) relative to the beam.

The computer which will carry out the calculations to determine the position of the lesion sends the required spatial correction information to a second computer which controls the chair on which the patient is positioned. Computer-controlled stepper motors will move the chair by the amount required to bring the lesion directly into the beam and for the beam to enter the patient's head at the correct point and angle. The chair can be moved in two orthogonal horizontal directions as well as vertically with an accuracy of 0.1 mm. It can be rotated about the isocentre and the backrest can be tilted (up to 90° from the horizontal) with an accuracy of 0.1°. The system will also incorporate safety features to ensure that if the patient moves from the desired position (the patient is not necessarily restrained), the beam is cut off. Besides automatic computer control, it will also be possible to operate the chair in manual mode, by means of a hand controller.

No experimental work has been undertaken recently in proton beams, pending the completion of the treatment vault, beamlines, and beam modification and control systems. It is anticipated that everything will be completed by October 1992 and it is hoped that patient treatment will commence early in 1993.

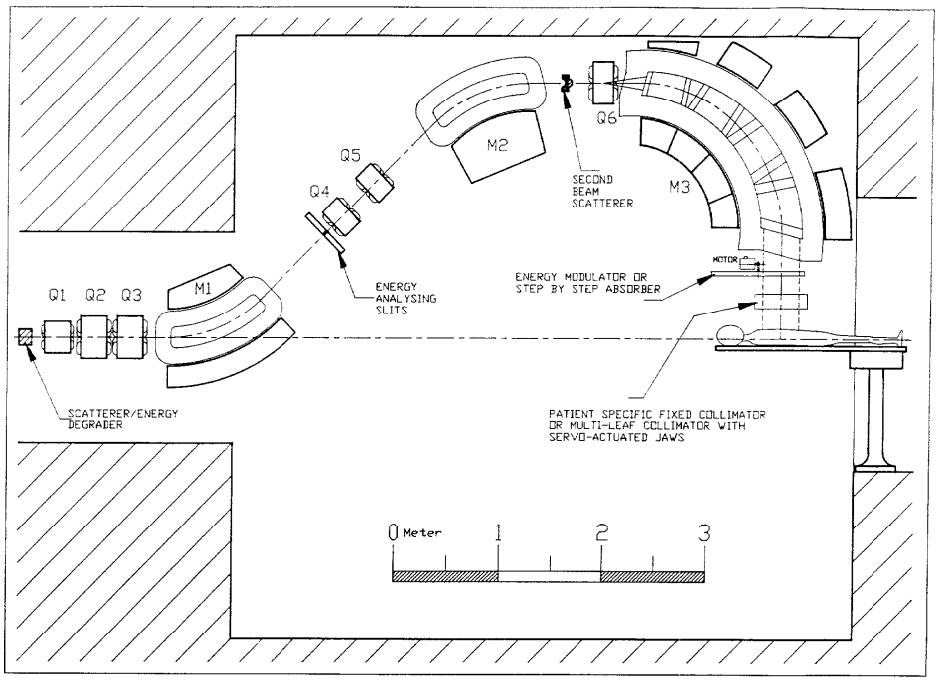
The p(66)/Be(40) isocentric neutron therapy facility continues to operate most satisfactorily. Routine patient treatment began in February 1989 and 332 patients have been treated with a total of 9268 fields up

to 30 April 1992. Of the 1428 treatment fractions scheduled during 1991 only 21(1.5%) had to be rescheduled because of technical problems. In addition to patient treatment, a wide variety of radiobiological and biophysical research projects have been undertaken on this facility.

Neutron therapy is currently undertaken between 08:00 and 16:00 on Tuesdays, Wednesdays and Thursdays. Changes in beam scheduling are currently under consideration in order to find an equitable distribution of beam time which will permit both fractionated neutron (3x/week) and fractionated proton (3x/week) therapy within the constraints imposed by the time taken to change beam energy (±4 hours) and the requirements of radioisotope production and physics research. *Dan Jones, National Accelerator Center, P. O. Box 72, Faure, 7131, South Africa.*

News from **Ion Beam Applications, Belgium:**
Design of a compact (radius = 2.80 m) isocentric gantry for large field (35 x 20 cm) scattered beam proton therapy.

The large uniform fields are obtained by the doubled scattering method developed by B. Gottschalk and the Harvard/MGH group. However, in this gantry, the two scatterers are located inside the gantry optical system. Taking advantage of the magnifying properties of the gantry optics, it is possible to reach those large fields with smaller scattering angles, thinner scatterers and, finally, reduced energy loss (less than 10 MeV at 230 MeV). Locating the energy degrader at the entrance point of the gantry allows a very good uncoupling from the upstream beam optics. Unlike previous IBA designs, the large acceptance of the gantry allows to perform the energy degradation and the beam flattening while preserving a fair proportion of the total beam intensity. The transmitted beam ratio is calculated to be approximately 20% for a beam degraded to 140 MeV and 10% for a beam degraded to 70 MeV. By including an energy analyzer in the gantry, a distal fall-off can be obtained which is quite similar to the distal fall-off of a mono-energetic beam. The design of the exit part of the gantry and mainly of the last 90° magnet is probably the most critical part of the study. The design of this last 90° magnet featuring an exit pole gap of 15 cm and a width of 40 cm is described in the article entitled “An improved isocentric gantry with reduced diameter for proton therapy by scanned beam”. This gantry can be used with the now classical energy modulating wheel and a patient specific fixed collimator. Alternatively, dose conformation would be possible using a step by step energy degrader and a fast, servo-actuated, multi-leaf variable collimator.



Schematic view of the proposed compact gantry

Yves Jongen, Ion Beam Applications, Chemin du Cyclotron, Rue Jean Lenoir 6, 1348 Louvain-la-Neuve, Belgium.

News from **Joint Institute for Nuclear Research (JINR), Dubna** and **Cancer Research Center of Russian Academy of Medical Sciences, (CRC RAMS), Moscow, Russia:**

The six-compartment clinicophysical facility for radiation therapy with proton, negative pion and neutron beams was realized at the JINR phasotron after its conversion. The clinicophysical facility consists of several medical channels: three therapeutic proton beams with energies from 100 to 660 MeV; negative pion beam with energy up to 80 MeV; therapeutic neutron beam with the mean energy about 350 MeV and therapeutic gamma-unit with Co-60 source

The first treatment room for proton therapy is equipped for proton beam irradiations of large deeply located tumours (for example, cancer of oesophagus) by the method of linear and rotation three-dimensional scanning. The room contains the original physical and medical devices, which allow to perform all kinds of scanning, equipment for immobilization and centration of patient in sitting position. Motion of a patient during irradiation procedures and the Bragg peak position are controlled with a computer. Devices for proton and roentgen computed tomography are placed there too.

An original method of oesophagus cancer irradiation was realized. The oesophagus was irradiated with horizontal proton beam on several floors along its length. The Bragg peak and the tumour were overlapped at each floor under the control of a miniature silicon detector inserted inside the oesophagus. In the first session of rotation irradiation full depths of tissues from body's surface to tumour for all angles of rotating chair were measured. In all next irradiations these distributions were used for overlapping the Bragg peak with tumour by means of additional degrader before a patient. Roentgen computer tomography allows to check the reproducibility of the patient position in each session of irradiation.

The second room is intended for transvaginal cervix utery cancer proton irradiations. The depth-dose distribution is formed by means of the ridge filter. Regional limphatic nodules are irradiated at the gamma-unit.

The third treatment room consists of equipment for stereotactic converging irradiations of small intracranial targets with "fly-through" method with a narrow proton beam of 660 MeV

Radiation therapy was carried out by the medical personal from CRC RAMS and engineering personal from JINR. Up to December 1991 17 patients with cervix utery cancer and 3 patients with oesophagus cancer were treated.

In future we plan rotary irradiation of deeply located tumours, in which it is impossible to place the detector (such as cancer of lung), on the basis of calculations from roentgen tomographic views. *O.V. Savchenko, A.G. Molokanov, V.P. Zorin, G.V. Mitsin, V.M. Abazov, I.V. Mirochin. E.P. Cherevatenko. Laboratory of Nuclear Problems, Joint Institute for Nuclear Research, Head Post Office. P.O. Box 79, 1O1000 Moscow, Russia. and B.V. Astrakhan, V.K. Poidenko, V N. Kiseleva, Cancer Research Center of Russian Academy of Medical Sciences, 115478, Kashirsckoe schosse, 24, Moscow, Russia.*

News from **GSI-Darmstadt, Germany:**
Fast Energy Variation of SIS for the Raster Scan System

The 3-dimensional treatment of irregularly shaped tumor volumes can be achieved by combining the raster scan technique with a fast energy variation of SIS, which allows to shift the penetration depth (or Bragg peak position) within a selected range.

During the Dysprosium-run at the biophysics cave in March 1992 lateral beam scanning was successfully combined for the first time with the fast energy variation. Four set ups of the SIS accelerator with 200, 250, 300 and 350 MeV/u coexisted within a supercycle and were sequentially requested by the scanner control unit and delivered to the target area 150m downstream from the accelerator within approximately 2 seconds for each energy.

The beam position for each energy was absolutely stable (see figure 1), which confirms that the beamline components can be reliably operated in a pulsed mode. The magnetic rigidity of the four Dysprosium beams corresponds to ^{20}Ne-beams of 380...630 MeV/u having ranges of 15...30 cm in tissue, which is sufficient for the exposure of deep seated tumors. Figure 2 shows arbitrary test patterns produced by the raster scan technique using four different beam energies.

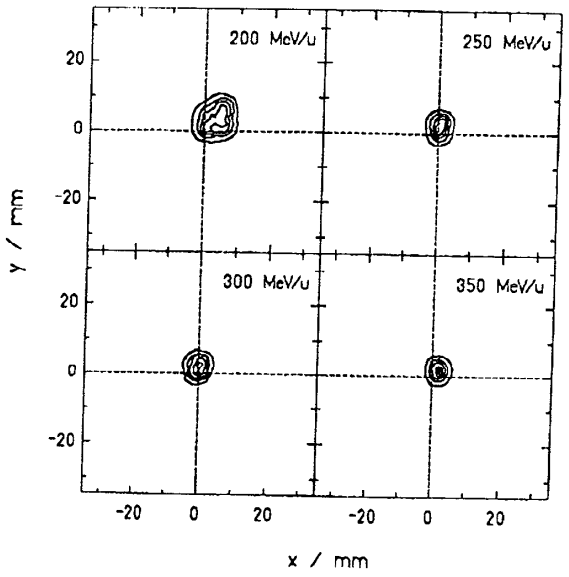


Figure 1: Four beam spots with different energies monitored by a multi-wire proportional chamber. In the SIS-supercycle the beam energy was switched every 2 seconds.

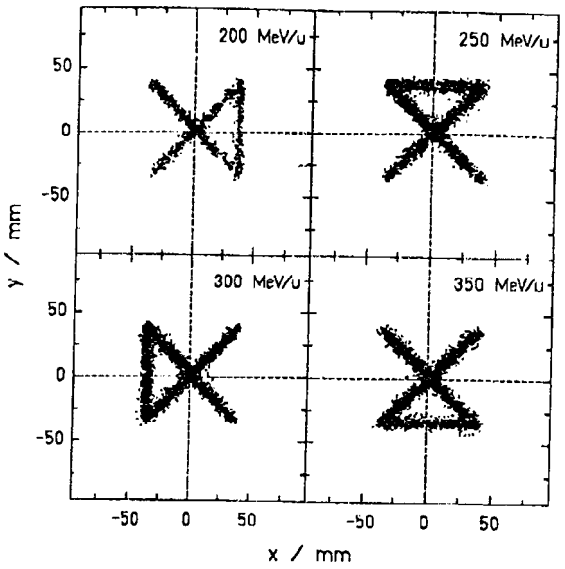


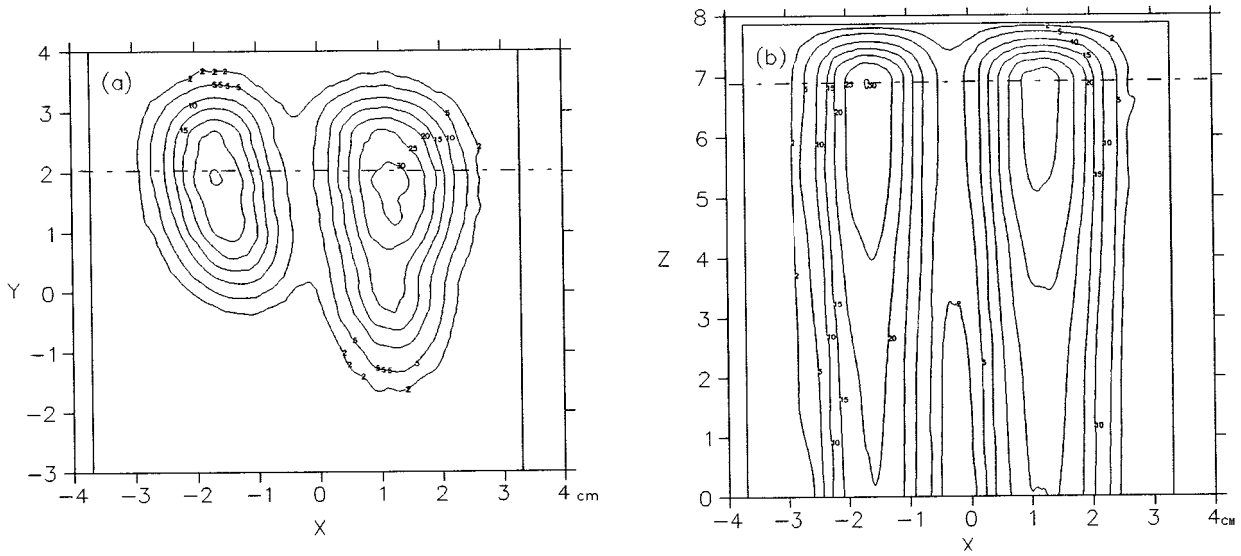
Figure 2: Raster scan patterns recorded with a multi-wire proportional chamber using four different beam energies.

With this experiment all essential technical aspects of tumor-conforming scanning have been tested separately. In the future the tested scanning strategy has to be combined with a dedicated algorithm to treat complex volumes. Th*. Haberer, W. Becher, D. Schardt and G. Kraft jointly with the accelerator crew, GSI-Darmstadt, Postfach 110552, D-6100 Darmstadt, Germany.*

News from the **Harvard Cyclotron Laboratory, Cambridge U.S.A**:

A second *numerically controlled milling machine* is now on line to help us keep up with increased demand for apertures and boluses from a higher patient load.

The long awaited *reduced material scanning phantom* (AKA the 'oilcan') has been commissioned. It has already done useful work and software is being written to facilitate the routine calibrations and complicated dose maps for which it was designed. (It uses an array of detectors to measure, over a small area, the depth dose in a small water tank which can be automatically and precisely positioned anywhere near isocenter.)



(a) slice at z = 6.87 cm with 976 data points. (b) slice at y = 2.0 cm with 146 data points.

Isodose plots measured 6 cm downstream of a 2 aperture beam with bolus in place using the *reduced material scanning phantom*. 8.05 g/cm^2 preabsorber and 2.5 cm range modulation were used. A total of 3856 data points were measured in 9.21 minutes.

All dimensions are in cm. x= horizontal, y= vertical and z= depth in water.
Contour 30 = maximum dose.

Over the past few years we have spent a lot of time on *neutrons* since a precise understanding of shielding requirements will help reduce the cost of future proton medical facilities. This is now our main line of physics research. Projects include (a) detailed Bonner sphere maps of neutron fluence in a relatively clean geometry to test future shielding codes; (b) accurate measurements of effective dose from normal HCL operations in distant buildings, where it is well below the cosmic neutron dose; (c) preliminary Bonner sphere spectroscopy measurements to more accurately determine the fluence to effective dose conversion in higher-dose areas and (d) a review and critical evaluation of the shielding literature to see how well the standard calculations agree with each other and with measurements. *Bernard Gottschalk, Harvard Cyclotron Laboratory, 44 Oxford Street, Cambridge, MA 02138*

News from **Massachusetts General Hospital, Boston, U.S.A. (1):**

Progress continues on the planning and design of the Northeast Proton Therapy Center (NPTC) at Massachusetts General Hospital. The NPTC is expected to serve as a resource for the eastern region of the United States. The new facility, designed for a treatment capacity of 850 patients per year, will be located on the Massachusetts General Hospital campus and is expected to be open in 1997.

Preliminary architectural and engineering studies have been completed. These studies identified several design options for the site selected for the NPTC and provided costs for both cyclotron and synchrotron equipment for a typical facility. MGH staff are now preparing a request for proposals (RFP) document for the management, design, and construction of the NPTC facility. Parallel to this effort, MGH and Lawrence Berkeley Laboratory have collaborated on writing RFP's for six design studies to include:

beam intensity and stability studies for a medical synchrotron; and radiation shielding, gantry, control systems, and patient positioning studies for a proton medical facility. MGH is preparing an RFP for the design and construction of the accelerator equipment which is expected to be released in the fall of 1992.

MGH submitted an application to NCI in May, 1992, for funds to complete the planning and design of the NPTC building and equipment. Pending final approval, these funds will be awarded in September, 1992. It is anticipated that applications for construction funds will be submitted in February, 1993.

Since the last Newsletter, three important positions have been filled at MGH:-
1) Al Smith, Ph.D., has been named the Project Director of the NPTC as well as the Chief Physicist for the ongoing clinical research program conducted jointly by MGH and HCL. Al worked for several years on the Neutron Therapy Program at M.D. Anderson Hospital Cancer Center, then spent seven years on the Pion Therapy Project at Los Alamos National Laboratory.
2) Anne Levine, formally Director of Planning at the New England Medical Center in Boston, has been selected to be the Administrative Director for the NPTC program.
3) Chris Serago, Ph.D., is also a new member of the clinical physics team. Chris came to the proton therapy program from the Baptist Hospital, Miami, Florida, where he was the Director of Medical Physics and an expert in stereotactic radiosurgery.
There is a search underway for an accelerator physicist to work on the NPTC program. *Al Smith, Department of Radiation Oncology, Massachusetts General Hospital, Boston MA 02114.*

News from **Massachusetts General Hospital, Boston, U.S.A. (2):**
Paranasal Sinus Protocol

The first of a series of new protocols for the treatment of advanced head and neck malignancies has been introduced to the PROG. This hyperfractionated, accelerated fractionation trial is currently in progress for patients with advanced malignancies of the paranasal sinuses. This aggressive regimen builds on the MGH experience in hyperfractionation to include the increased targeting accuracy of proton therapy, hoping to spare patients morbid, extensive surgical resections of the orbital contents and premaxillary area. Patients are treated over a 6.5 week period with 3-dimensionally planned photon irradiation in the morning, followed at least 6 hours later by proton irradiation designed to spare the dose-limiting structures of optic nerves, chiasm, and brainstem.

The rationale for selection of paranasal sinus tumors derives from the relatively sparse lymphatic drainage pattern of this anatomic area; therefore, tumors of this area are late to develop metastatic disease and may represent a category of head and neck tumors for whom increased local control may translate into increased survival. Statistical predictions based upon dose-response data from pharyngeal wall tumors (similar in metastatic rate and growth patterns) suggest that a dose increase from current standards of 65 Gy to 75 Gy may result in as much as a 35% increase in local control.

This program has accrued 10 patients thus far, including 2 currently under treatment. Despite the complexity of treatment planning involved, we have been able to maintain the same timetable for post-operative treatment as for conventional planning, i.e., commencing irradiation within 4 weeks following limited surgery. Permanently implanted cranial fiducials, in concert with improved cranial immobilization using both thermoplastic masks and full denture prostheses, have resulted in daily positioning inaccuracies of less than 0.5 mm. Because of this patient set-up accuracy, we have been able

to treat tumors in close approximation to the visual system (optic nerves and chiasm) to radical (curative) doses, while maintaining standard radiation tolerances to these structures.

Toxicity has included the expected acute moist desquamation and nasal crusting. The increased targeting accuracy implicit in proton therapy has resulted in significantly less oral mucositis than realized with conventional therapy. Nasal crusting has been severe, due to the increased doses delivered. One patient developed a mucocutaneous fistula through an area of skin with vascular compromise and tumor infiltration.

For additional information or patient referral please contact Dr. Allan F. Thornton at MGH:(617) 724-1156 or HCL: (617) 495-2885. *Allan Thornton, Department of Radiation Oncology, Massachusetts General Hospital, Boston MA 02114.*

WORLD WIDE CHARGED PARTICLE PATIENT TOTALS
July 1992

WHO	WHERE	WHAT	DATE FIRST RX	DATE LAST RX	RECENT PATIENT TOTAL	DATE OF TOTAL
Berkeley 184	CA. U.S.A.	p	1954	— 1957	30	
Berkeley	CA. U.S.A.	He	1957		2054	Jun-91
Uppsala	Sweden	p	1957	— 1976	73	
Harvard	MA. U.S.A.	p	1961		5583	Jun-92
Dubna	Russia	p	1964	— 1974	84	
Moscow	Russia	p	1969		2200	Dec-91
Los Alamos	NM. U.S.A.	π-	1974	— 1982	230	
St. Petersberg	Russia	p	1975		719	Jun-91
Berkeley	CA. U.S.A.	heavy	1975		433	Jun-91
Chiba	Japan	p	1979		80	Jun-92
TRIUMF	Canada	π-	1979		283	Dec-91
PSI (SIN)	Switzerland	π-	1980		498	Dec-91
Tsukuba	Japan	p	1983		274	Mar-92
PSI (SIN)	Switzerland	p	1984		1246	May-92
Dubna	Russia	p	1987		20	Dec-91
Uppsala	Sweden	p	1988		23	Nov-91
Clatterbridge	England	p	1989		244	May-92
Loma Linda	CA. U.S.A	p	1990		76	Dec-91
Louvain-la-Neuve	Belgium	p	1991		14	Jun-92
Nice	France	p	1991		96	Jun-92
Orsay	France	p	1991		84	Jun-92
					1011	pion beams
					2487	ion beams
					10846	proton beams
				TOTAL	14344	all particle beams

Proposed NEW FACILITIES for PROTON & ION BEAM Therapy

INSTITUTION	PLACE	TYPE	DATE 1ST RX?	COMMENTS
Indiana Cyclotron	IN U.S.A	p	1992	200 MeV; other light ions possible.
N.A.C.	South Africa	p	1993	1st room ready & equipped for stereotactic radiosurgery.
P.S.I	Switzerland	p	1993	200 MeV, variable energy, dedicated beam line
Chiba	Japan	ion	1994	construction of HIMAC in progress.
A.P.D.C.	IL U.S.A	p	1994?	250 MeV accelerator; private facility.
Novosibirsk	Russia	p	1995?	180 - 200 MeV linear accelerator
ITEP Moscow	Russia	p	1996	6 treat. rms,3 horiz. fixed beams,2 gantry,1 exp. H- accel.
NPTC (Harvard)	MA U.S.A.	p	1997	new accelerator & facility to be built at MGH
Sacramento	CA U.S.A	p	?	new proton therapy facility to be built at U.C.(Davis) M.C.
G.S.I Darmstadt	Germany	ion	?	experiments for therapy and radiobiology in progress.
Antwerp	Belgium	p	?	proton therapy facility.
Clatterbridge	England	p	?	upgrade energy using booster linear accelerator.
TRIUMF	Canada	p	?	adapt existing proton beam lines to therapy use.
Tsukuba	Japan	p	?	230 MeV accelerator;2 treat. rooms;2 vert+1 h beam;2 vert.
Chicago	IL U.S.A	n,p	?	neutron, proton therapy; radioisotope production.
EULIMA	Europe	ion	?	European cooperative venture; future uncertain.
Jülich (KFA)	Germany	p	?	Plan to develop a proton therapy beam line at COSY.