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

Number 7 January 1991 Editor: Janet Sisterson Ph. D., HCL

This is the **seventh** issue of 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 was very pleased to receive so many interesting articles for inclusion. It seems that there is still an expanding interest in charged particle therapy as my mailing list is getting larger with each issue. Particles 7 will be sent to at least 375 people in 16 different countries.

The Harvard Cyclotron Laboratory would like to thank the officers of the following companies for their kind donations to be used expressly for the production of this newsletter. The gifts received from **AccSys Technology Inc.** and **American Proton Development Corporation** are very welcome and will help cover the expenses incurred.

Future E-mail and Fax directories: I am still collecting e-mail addresses and Fax numbers and may in the future include them in an issue of Particles.

The deadline for the next newsletter is May 30 1991, so that Particles 8 can come out in July 1991. Address all correspondence to:-

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

Telephone: (617)495-2885
Fax: (617)495–8054
E-mail address: BITNET%"SISTERSON@HUHEPL”

Information sent to me for inclusion in the newsletter does not need to be extensive but it should be "camera ready" if possible. I am using the following format; flush left; three quarter inch left and right margins; single spacing using 12 point New Century Schoolbook, if you have it, and Times or whatever, if you don't. Graphs and line drawings are welcome, however if you fax the article to me I can’t guarantee the quality of the graph or drawing unless I get a clean copy by mail as well.

FUTURE PTCOG MEETINGS

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

PTCOG XIV	Cambridge MA USA	May 20-22 1991	Wednesday May 22 will be a half day
PTCOG XV	GSI Darmstadt / Heidelberg Germany	Fall 1991	maybe the last week in September
PTCOG XVI	? Vancouver Canada	Spring 1992	

PTCOG XIV

The meeting will be held at the Harvard Faculty Club, Cambridge. The conference hotel is the Quality Inn of Cambridge, 1651 Massachusetts Avenue, Cambridge MA 02138. Telephone (617) 491-1000. Rooms will be held until April 19 1991.

Topics under consideration for discussion at PTCOG XIV include the following:-
a clinical discussion on protocols; a review of protocols; a discussion on the speed and accuracy of patient treatments.

For further information about **PTCOG XIV** 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.

Proposed new format for the Minutes of future PTCOG meetings

It is proposed that starting with PTCOG XIV in Boston, all speakers at PTCOG meetings should provide an abstract of their talk. These will be collected at the time of the meeting, copied and circulated with the following issue of Particles.

The maximum space allocated for each abstract is a rectangular box 7 inches (18 cm) wide and 3.5 inches (9 cms) deep. This MUST have the title of the abstract, authors and their affiliations at the top; other than that it can be in any format and can include graphs or diagrams.

PTCOG XIII Berkeley California November 1990 - report from the Editor

Over 100 people attended PTCOG XIII held in Berkeley in early November. The two day meeting had a very full agenda and included a tour of the Bevelac and a slide show of the trip to the Soviet Union by the American scientists participating in the exchange.

Two sessions were devoted to the presentation of new charged-particle initiatives and proposals; included were reports from ITEP, MGH, HIMAC and EULIMA. Two sessions were devoted to particle therapy delivery and included a status report from GSI,papers on features of beam delivery systems and shielding considerations. Two panel discussions covered the rationale for using high LET in therapy and how to design clinical trials. Other sessions covered image techniques for planning charged particle radiation therapy, new approaches to proton medical accelerators and the commissioning of the Loma Linda proton therapy facility.

Change of officers for PTCOG

New officers for PTCOG were announced at the Business meeting held at PTCOG XIII.

PTCOG	Chairman	Michael Goitein MGH
	Co-chairman	Joe Castro LBL
	Secretary	Dan Miller LLUMC
Accelerator Sub-committee	Chairman	Jose Alonso LBL
	Co-chairman	George Lawrence LANL
Facility Sub-committee	Chairman	Bill Chu LBL
	Co-chairman	Ken Gall MGH
Clinical Sub-committee	Chairman	Jerry Slater LLUMC
	Co-chairman	Norbert Liebsch MGH

PTCOG News

The following information was received by December 1990.

Pion Radiotherapy at **TRIUMF, Canada**:
227 patients have been treated with □-mesons at TRIUMF up to July 1990.

A prospective randomized trial for glioblastoma multiforme began in 1988. 28 patients have been accrued into the study, 15 patients to the pion arm and 13 to the photon arm. 82 patients are required for completion of the study. Accruals have been slower than were originally estimated, due to stringent requirements of the study.

Another prospective, comparative study of pions vs photons for patients with clinical stage C or D (clinical stage T3 or T4, NO or Nx, MO) adenocarcinoma of the prostate began in June 1990. 23 patients have been randomized, 16 to the photon arm of the study and 7 to the pion arm of the study.

The next treatment run at TRIUMF begins December 1990. *George Goodman, B.C. Cancer Agency, 600 West 10th Avenue, Vancouver, B.C. V5Z 4E6, Canada.*

News from the **Harvard Cyclotron Laboratory, U.S.A**:
The first contoured compensated scatterer ordered by LLUMC was delivered on schedule, but delivery of the balance has been delayed at LLUMC request pending commissioning of their second fixed beam station.

The appointment of Charles Mayo as postdoctoral research fellow at HCL promises to provide us with a valuable increment of scientific manpower. Chuck very recently completed his Ph. D. in the Physics Department at the University of Massachusetts at Amherst.

The stereotactic alignment device STAR (Product Genesis Inc. Cambridge Massachusetts) has met performance criteria of ±0.5 mm iso-centricity under a variety of conditions. Testing was unfortunately delayed by the need to replace a long-delivery drive motor and other factors. Plans for first clinical use are moving rapidly.

The design studies to modify our treatment rooms led to cost estimates most of which seemed prohibitive in view of the plans for a new facility to become operational at MGH in about 5 years. One scheme providing no new treatment room but increasing the shielding between rooms and toward the outside world is still being considered for possible funding. *A. M. Koehler, Harvard Cyclotron Laboratory, 44 Oxford Street, Cambridge MA 02138.*

News from **Massachusetts General Hospital, U.S.A**:
Plans for a proton medical facility on the campus of MGH are gearing up. We were selected in September as one of two groups to receive money from DHHS for planning such a facility. This is allowing progress on several fronts, including site selection, selection of the type of accelerator, gantry design and shielding requirements. We intend to complete the conceptual design phase by the end of summer and have firm enough plans by fall in order to submit a CoN application. It is hoped that construction will start in 1993. We are still looking for a person to direct the project.

Unfortunately, Dr. Lynn Verhey has decided to move to the other US coast and join the world of X-rays and electrons. We wish him the best as Chief of Physics and Vice-chairman of the Department of Radiation Oncology at UCSF, but his experience and expertise in proton therapy will be sorely missed. He assures us that he will maintain an interest in particles and a presence in PTCOG.

Several physicians are spending time with us as fellows, learning our techniques of proton radiotherapy and contributing to our research efforts. They include: Dominique Pontvert M.D., from the Institute Curie, Paris France; Willem duBois M.D., from the Netherlands; Jacek Maciejewski M.D., from the Sklodowska-Curie Memorial Institute, Gliwice, Poland and Veronique Benk M.D., from the Hospital de Lyons, Lyons France. *Marcia Urie, Massachusetts General Hospital, Boston MA 02114.*

News from **National Superconducting Cyclotron Laboratory, Michigan State University**:
Medical accelerator developments:-A new operating mode has recently been tested at the K100 superconducting neutron therapy cyclotron at Harper Hospital, namely, to pulse the rf drive on a 20% duty cycle with 60 hertz repetition. In this mode the cyclotron still easily produces the design 10 microamp time average beam current (the instantaneous current during the pulse is 50 microamps), the rf power is reduced to 1/5 of the CW level, and the stability of the complete system is amazingly improved so that the cyclotron now really operates like a light bulb, i.e. turn the switch and the beam is on. This operating mode could be applied with an even smaller duty cycle in an isochronous proton therapy cyclotron and rf power would thereby be largely eliminated as an operating limit; with this new concept the attractiveness of an isochronous proton therapy cyclotron is greatly increased and a design study of an isochronous superconducting proton therapy cyclotron has therefore been initiated.

A further favorable result from operating experience in Detroit is that no "unexplained" quenches have occurred and the cyclotron has now been in operation since August 13; this experience thus supports the hypothesis that the unexplained quenches experienced in operating the system at NSCL were due to the high level of random pressure fluctuations in the NSCL helium system. (The NSCL helium system serves some 50 magnets with numerous servo connections and on-off valves which create pressure fluctuations; the Harper helium system in contrast serves only one magnet and has no fluctuating servo controllers so that the pressure in the system is normally steady; the helium systems of future superconducting medical cyclotrons will therefore include features to insure smooth control of the helium pressure.) *Henry Blosser,*

National Superconducting Cyclotron Laboratory, Michigan State University, East Lansing MI 48824-1321.

Progress report from the **Clatterbridge Cyclotron Unit**, England:
The treatment of the 100th patient in October of this year was seen as a significant milestone. Clinical results so far have been encouraging although it is too early for the presentation of meaningful observations. There has, however, been a change in our original plans particularly in the light of the recent publication by Seddon et al. (1990) dealing with relative survival rates. It is now felt that proton therapy is the treatment of choice for larger melanomas.

This means that we will not now conduct a prospective randomized trial between enucleation and proton irradiation for these tumours. An alternative trial comparing proton irradiation with plaque therapy for smaller tumours is now being planned.

We are also now in the process of considering the possibility of boosting our proton energy from 62 MeV to perhaps 180 MeV, but these plans are in a very early stage and will be reported on in the future if they become viable.

Reference: Seddon J.H. et al. "Relative Survival Rates after Alternative Therapies for Uveal Melanomas." Ophthalmology **97** 769-77 1990. *Dave Bonnett, MRC Cyclotron Unit, Clatterbridge Hospital, Bebington Merseyside L63 4JY, England.*

News from **Loma Linda University Medical Center, U.S.A.**:
Clinical: The first patient was treated at the new facility in late October 1990. By late November, three patients had completed treatment. In the meantime, plans have been made for treating patients with brain and head and neck tumors beginning in February 1991. Patients with cancers in other sites of the body will begin treatments in Spring 1991, when the first gantry is commissioned.

Clinical and Accelerator Physics: The proton medical accelerator is running reliably, Commissioning of the eye treatment system was completed in October. This provides ocular melanoma treatments with a beam energy of 100 MeV. Treatment fields up to 3 cm in diameter are produced by a single scattering, range absorption for treatment depth control; range modulation is achieved by rotating modulator wheels. The beam delivery system is computer-controlled, except for safety backups.

Of the fifteen treatments given for the three patients treated thus far for eye tumors, only one was delayed; this occurred because of a problem with the beam delivery system. Most of the operations have been at 100 MeV because of the clinical requirements for eye treatment. Presently, the accelerator is delivering 8.5×10^{11} protons per minute to the eye beam line, yielding a dose rate of about 10 Gy per minute. In addition, all other energies required for Phase I operations (155, 200 and 250 MeV) have been extracted with high efficiency. Development work is now concentrated on minimizing beam losses and improving intensity. The system which controls the beam extraction rate from the synchrotron is currently being tuned to improve spill uniformity. This will be particularly useful for the Phase II scanning program.

Commissioning of the horizontal beam line for head and neck treatments has begun. Control software has been tested and radiological physics measurements began in early December 1990. Other activities include beam transport through the first gantry. At present, beam energies of 155 and 200 MeV have been

successfully transported through the gantry; work is underway to complete assembly of the nozzle hardware.

Engineering Division: The engineering team tested the horizontal beam nozzle prior to its commissioning phase, which began in early December. Presently, the team is participating in testing the first gantry, and continues to apply mechanical, electronic and software enhancements to the accelerator and beam transport system. Additionally, the team has completed a mouse-driven interface for the MGH microvax-based treatment planning system.

ACR-NEMA Image-Data Files and Therapy Planning: The computer networking team has successfully adapted the ACR-NEMA format standard for image-data-file transfer, and has adopted it as input for radiation treatment planning. Every scanner has a proprietary image-data-file format, which must be decoded and adapted to a therapy planning system. Recognizing the need to cope with a "Tower of Babel" situation developing in the diagnostic digital imaging community, the American College of Radiology sponsored the development of ACR-NEMA 300/1988 (Version 2), a standard for digital image files. This scanner-vendor-independent approach is now used at Loma Linda for planning conventional radiation treatments, and will be the basis of proton therapy planning. A description of Loma Linda's adaptation is available on request, to facilities involved in developing or acquiring radiation treatment planning systems.

Charged Particle Database: PROLIT will be updated and disk copies mailed to all subscribers. A Macintosh version will be available. PTCOG members and others are encouraged to contribute articles to the database, both for expanding the citations and for building up the archive, as described in PARTICLES 6. *James Slater, Loma Linda University Medical Center, P.O. Box 2000, 11234 Anderson Street, Loma Linda CA 92354.*

News from **ITEP, Moscow, U.S.S.R.**:
The Medical Physics Department of ITEP and its collaborators continue to accumulate their clinical experience in the 3-treatment room facility at ITEP which exists now.

In 1989, the Public Health Ministry of the USSR provided financial support for a new PTF with a dedicated accelerator to be built in Moscow. Main features of the facility are now clear enough. The facility will contain a H^--synchrotron for 60–250 MeV and 5 Mz repetition rate. The beam intensity in each of the treatment rooms will be ~ 10^{10} protons/sec. The treatment rooms are placed around the accelerator. All the rooms will work simultaneously and independently from one another. Three of them will be equipped with horizontal beams, two with gantries, and the last one will be used for experimental and preclinical investigations. Beam energies and intensities, as well as the time schedule, are to be chosen independently in each room and will not depend on the work done–or not done–in other rooms.

ITEP is the leader of the projects, several medical institutions working with ITEP for many years are responsible for the medical part of the project and the Moscow Physical Technical Institute is busy with its technical part. *V. Khoroshkov, ITEP, B. Cheremushkinskaya 25, 117259 Moscow, U.S.S.R.*

News from the **Radiotechnical Institute** Moscow:
In 1989 by the USSR Health Ministry order, Moscow Radiotechnical Institute of the USSR Academy of Sciences has developed a technical proposal for a treatment complex based on a special medical proton accelerator.

In the project developed, the treatment complex is presented as a 3-storey building with the zero mark dimensions of 72 x 72 m. The complex comprises a proton synchrotron with an energy of 250 MeV, beam transport arrangement, treatment rooms provided with all the medical equipment demanded, power supply systems, the accelerator and irradiation parameters control and management systems, and the engineering structures necessary.

Therapy takes place in 6 treatment rooms; 4 rooms are specializing in the head and neck, inskull, eye and orbit target treatment by means of a horizontal beam and also the urologic sphere treatment. Two boxes are intended for the "GANTRY" system equipment. The complex design capacity is 100 ray therapy runs per 24 hours. *Klionov Gennady Ivanovich, MRTI, Warsaw Highway 132, Moscow, USSR 113519.*

News from the **National Accelerator Centre, South Africa**:
Construction of the NAC's somewhat delayed 200 MeV horizontal proton radioneurosurgical facility is slowly getting into top gear. The beamline to the end of the vacuum system is in place and interior construction work in the treatment room will begin early next year. The design of the patient support system is complete and manufacturing has commenced. The stereophotogrammetric patient positioning system (SPGPPS) has been tested and no problems are envisaged. Areas which are receiving attention at present include treatment planning and the transfer of diagnostic information to SPGPPS. Dosimetry measurements are in progress using the horizontal post in the neutron therapy gantry. We hope to commission the proton facility towards the end of 1991, finances permitting. We anticipate treating 50–100 patients per year initially, at least until the problem of competing with other users (neutron therapy, isotope production, physics research) is resolved. Until then the proton therapy beam will probably only be available for 3–4 days every 3 months. For the record we have treated 166 patients on our p(66)/Be neutron therapy facility since treatment commenced in February 1989. *Dan Jones, National Accelerator Center, P.O. Box 72, Faure 7131, South Africa.*

Ion Beam Applications, Belgium starts proton therapy prototype project:
Ion Beam Applications S.A. of Louvain-la-Neuve, Belgium, has obtained a governmental loan worth over 4 million US$ to finance part of the development of a new proton therapy system and to begin immediate construction of a prototype. The agreement was signed with Mr. Albert Liénard, Minister of Technology and Research of the Walloon Region of Belgium.

This reduced cost proton therapy system, as presented by IBA at the last two PTCOG meetings in 1990, is based on a non-superconducting, high-field, isochronous 230 MeV cyclotron and on reduced diameter isocentric gantries using a beam scanning method and featuring an infinite source to patient distance.

Thanks to this loan, the development team, led by André Laisné from Orsay (France) and Yves Jongen, is rapidly growing and will total 17 people by the end of 1991. The orders for the first elements of the cyclotron magnet will be issued in the second quarter of 1991. According to the schedule, the prototype radiotherapy installation should be operational by mid-1994.

In the frame of this project, IBA is recruiting several accelerator physicists and engineers, as well as specialists in cyclotron beam dynamics, beam optics and dose monitoring devices. Candidates should send their resume to: Ion Beam Applications S.A., Attn. Yves Jongen President, Chemin du Cyclotron 2, B-1348 Louvain-la-Neuve, Belgium. Phone (32) 10 - 47 58 11, FAX (32) 10 - 47 58 10. *Yves Jongen, Ion Beam Applications S.A., Chemin du Cyclotron 2, B-1348 Louvain-la-Neuve, Belgium.*

The 1990 Scientific Exchange between the U.S.A and the U.S.S.R.

In September of this year, the first portion of an exchange of scientists between the U.S. and U.S.S.R. in proton therapy took place. This exchange program was initiated by John Lyman and Sandra Zink. The visit to the Soviet Union between September 15 and 29, included Jack Fabrikant and John Lyman from LBL, Lynn Verhey from Harvard, Sandra Zink and John Antoine from N.C.I. and M.R. Raju from Los Alamos plus their spouses. I.T.E.P. in Moscow acted as their hosts and they visited Gatchina (near Leningrad) and Dubna facilities as well. The main goals of the visit were to improve understanding and communication between the groups in the U.S. and those in the U.S.S.R. as well as to begin discussions on collaborative work in proton therapy. An agreement was signed which will make easier BITNET communication and which outlines a dosimetry intercomparison protocol which is now being implemented.

In November, three of our Soviet hosts came to the U.S. and spent time touring our particle therapy facilities. The scientists included Vladimir Khoroshkov and Lev Goldin from I.T.E.P. and Elizabeth Minakova from the Burdenko Neurological Institute in Moscow. They visited Harvard and Massachusetts General Hospital, Lawrence Berkeley Lab (attending PTCOG XIII), Los Alamos National Lab, Loma Linda University Medical Center and the National Cancer Institute. Speaking for the U.S. delegates, it seems that this exchange is only the beginning of what will be a fruitful and exciting collaboration of groups working in proton therapy. *Lynn Verhey, Department of Radiation Medicine, Massachusetts General Hospital , Boston MA 02114*

Other meetings of interest

February 28th and March 1st 1991.

A Proton Radiotherapy Workshop will be held at PSI, Villigen Switzerland sponsored by the proton therapy users group at PSI, the foundation for radiotherapy at PSI and the Swiss National Science Foundation, NFP18, Biomedical Technique.

Topics for discussion include the status of the proton therapy project at PSI; reports on heavy charged particle therapy projects; aspects of accelerators, beam delivery systems, treatment planning programs, patient positioning and verification; medical aspects from small volume precision treatment to large 3-dimensional irradiation using conformal therapy techniques; possibility of international cooperation; long range perspectives of heavy charged particle radiotherapy in hospitals.

The deadline for abstracts is January 18 1991 and for room reservations February 8 1991.
If you are interested in more information, please contact

Mrs. R. Füllemann,
Department of Radiation Medicine,
PSI, CH-5232 Villigen-PSI, Switzerland.
Telephone (056) 99 31 11 or (056) 99 35 24 (direct)
Fax (056) 99 32 94 PSI CH.

April 12th and 13th 1991

The **EORTC Satellite meeting** will be held in conjunction with the International Symposium on Tumor Response Monitoring and Treatment Planning, Munich Germany April 11-13 1991.

The program will include discussion of the multi-centre studies; review and discussion on clinical, physical or radiobioligical topics; status reports from each neutron therapy centre.
There is a special conference fee and registration forms should be sent to

GSF Conference Service Section,
Ingolstädter Landstrasse 1,
D-8042-Neuherberg
Fax 089/31 87-33 62

For more information contact

Professor A Wambersie,
Unite de Radiotherapie,
Cliniques Universitaires Saint-Luc,
Avenue Hippocrate 10,
200 Bruxelles, Belgium.

July 4th and 5th 1991.

A Workshop on Heavy Particle therapy will be held as a satellite meeting at NIRS in Chiba, in conjunction with the World Congress on Medical Physics and Biomedical Engineering, Kyoto Japan July 7-12 1991.

Topics for discussion at this workshop include:- present status and future plans for therapy facilities; beam delivery systems; physical and biological aspects, including dosimetry; patient positioning; 3D-treatment planning. Participants will be able to visit HIMAC, now under construction.

If you are interested in attending this workshop, please contact

Kiyomitsu Kawachi Ph. D.,
National Institute for Radiological Sciences,
9-1 Anagawa 4-chome, Chiba-shi 260, Japan.
Telephone: 0472 (51) 2111 Fax 472-87-0417.

October 14-18 1991

The **7th Symposium on Neutron Dosimetry** will be held in Berlin. Dan Jones of NAC South Africa asked that notice of this meeting be included in Particles.

WORLD WIDE CHARGED PARTICLE PATIENT TOTALS
January 1 1991.

WHO	WHERE	WHAT	DATE FIRST RX	DATE LAST RX	RECENT PATIENT TOTAL		DATE OF TOTAL
Berkeley 184	CA. U.S.A.	p	1955	— 1957	30		
Berkeley 184	CA. U.S.A.	He	1957	— 1987	899		
Uppsala	Sweden	p	1957	— 1976	73		
Harvard	MA. U.S.A.	p	1961		5120		Dec-90
Dubna	U.S.S.R.	p	1964	— 1974	84		
Moscow	U.S.S.R.	p	1969		1945	*	May-90
Los Alamos	NM. U.S.A.	π-	1974	— 1982	230		
Leningrad	U.S.S.R.	p	1975		685		Sep-90
Berkeley Bev.	CA. U.S.A.	heavy	1975		1422		Oct-89
Chiba	Japan	p	1979		65		Oct-89
TRIUMF	Canada	π-	1979		227		Jul-90
PSI (SIN)	Switzerland	π-	1980		478		Dec-89
Tsukuba	Japan	p	1983		178		Apr-90
PSI (SIN)	Switzerland	p	1984		913		Nov-90
Dubna	U.S.S.R.	p	1987		6		Sep-90
Uppsala	Sweden	p	1988		13		May-90
Clatterbridge	England	p	1989		114		Nov-90
Loma Linda	CA. U.S.A	p	1990		3		Dec-90
					935		pion beams
					2321		ion beams
					9223		proton beams
				TOTAL	12479		all particle beams

* Revised number; re-treatments excluded.

Proposed NEW FACILITIES for PROTON & ION BEAM Therapy

INSTITUTION	PLACE	TYPE	DATE 1ST RX?	COMMENTS
Louvain-la-Neuve	Belgium	p	1991?	variable to 90 MeV proton beam; add to neutron facility
Nice	France	p	1991?	MEDICYC; neutron & proton radiotherapy facility
Orsay	France	p	1991	adapt an existing cyclotron no longer being used for physics.
N.A.C.	South Africa	p	1991	200 MeV. 2 treatment rooms; 2 horiz. beam; 1 vert. or gantry.
P.S.I	Switzerland	p	1992?	210 MeV, variable energy, dedicated beam line
G.S.I	Germany	ion	1992?	Heidelberg/Darmstadt. He & higher ions. 3-dim. raster scan
Chiba	Japan	ion	1994	HIMAC design complete; funds are available to construct.
A.P.D.C.	IL U.S.A	p	1994	250 MeV accelerator; private facility.
Harvard	MA U.S.A.	p	1995?	new accelerator & facility to be built at MGH
Novosibirsk	U.S.S.R	p	1995?	180 - 200 MeV linear accelerator
TRIUMF	Canada	p	?	adapt existing proton beam lines to therapy use.
EULIMA	Europe	ion	?	European cooperative venture; location not yet decided.
Indiana Cyclotron	IN U.S.A	p	?	200 MeV; other light ions possible.
Berkeley	CA U.S.A	p, ion	?	to replace the Bevalac.
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
Antwerp	Belgium	p	?	proton therapy facility