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 8 June 1991 Editor: Janet Sisterson Ph.D., HCL

This is the **eighth** 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. My mailing list has increased again, more than 400 copies of this issue of Particles will be sent out which indicates that there is still a lot of interest in charged particle radiation therapy. I thank all my correspondents for their interesting articles and updated figures for the 'world particle experience' table.

Future e-mail and fax directories: I am still collecting e-mail addresses and Fax numbers. If there is enough interest, I might include directories in a future issue of Particles.

The deadline for the next newsletter is November 30 1991, so that Particles 9 can come out in January 1992. Address all correspondence to:

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Articles for the newsletter do not need to be extensive but 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. I usually don't indent the paragraphs and I leave a space between them. Graphs and line drawings are welcome, however if you fax the article to me I will do my best but 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 XV	GSI Darmstadt Germany	September 23-25 1991
PTCOG XVI	Vancouver Canada	Spring 1992
PTCOG XVII	Loma Linda California USA	Fall 1992

PTCOG XV

The PTCOG meeting will take place in conjunction with the Fourth Workshop on Heavy Charges Particles to be held at Darmstadt September 23-25 1991. On the Wednesday afternoon a visit to the Strahlenklinik and German Cancer research Center in Heidelberg is planned. The registration fee will be 200 DM for those who register by July 15 1991, with a reduced rate of 50 DM for students. For more information contact :-

Ms. Siglind Raiß
Gesellschaft für Schwerionenforschung mbH
Planckstr. 1
D-6100 Darmstadt
Germany

Tel:- x49-6151-359-1; Fax:- x49-6151-359-785.

The preliminary program lists the following overview talks for each session:-

1) LET, track structure and models.
2) DNA damage induced by particles.
3) Cell inactivation by particles.
4) Genetic changes and mutation.
5) Radiobiological problems in space.
6) Medical accelerators.
7) Beam delivery systems.
8) Clinical gains from improved beam delivery system,
9) 3D treatment planning.
10) Clinical indications for particle therapy.
11) Status reports of 10 minutes each.

For further information about **PTCOG XV** 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.

Abstracts for PTCOG XV

A book of extended abstracts of the presentations will be published as a GSI report and will be available at the beginning of the conference. Therefore, all abstracts (maximum 3 pages including figures, lists and references) have to arrive in Darmstadt before

August 15 1991

The overview talks at the beginning of the session will be published in Radiation and Environmental Biophysics after the conference.

PTCOG XIV Cambridge Massachusetts May 1991 - report from the Editor

PTCOG XIV was held at the Harvard Faculty Club during one of the warmest Mays on record in the Boston area. There were two and a half very full days of presentations and a reception at the Harvard Cyclotron Laboratory.

For the first time, speakers were encouraged to provide abstracts of their talks and the resulting document is included with this issue of Particles. It was a pleasure to hear the many contributions from our Russian colleagues as well as the reports of the progress of several of the new initiatives to develop proton therapy facilities.

PTCOG News

The following information was received by June 1991.

Update on Pion Studies at **TRIUMF, Canada**:

1) A total of 253 patients has been treated with pions at TRIUMF to February 1991.

2) In the prospective, phase 3 trials of pions versus photons we have randomized in the
a) Glioblastoma study: 19 patients to pions and 17 patients to photons, and
b) Prostate study: 28 patients to pions and 23 patients to photons.

3) The next pion run at TRIUMF is from 29 May to 16 August, 1991.

4) I retire 31 July 1991. Dr. C.J. Fryer is my successor. Dr. Fryer is an experienced radiation oncologist and paediatric oncologist. Currently he chairs the Radiation Therapy Committee of the Childrens Cancer Study Group in the U.S.A.

5) A proposal for a Proton Facility at TRIUMF is complete and funding is being sought.

6) Dr. Fryer will be pleased to host PTCOG in Vancouver. G*eorge Goodman, B.C. Cancer Agency, 600 West 10th Avenue, Vancouver, B.C. V5Z 4E6, Canada.*

News from **Loma Linda University Medical Center, U.S.A.**:

Clinical
Treatments began in March 1991, using the head and neck beam line. As of May 31, 1991, 19 patients with ocular melanoma and various tumors of the brain and head and neck, had completed treatment. The facility is serving 8 to 10 patients per day. Commissioning of the first gantry is expected to be completed by the time this newsletter is published; patient treatments will begin promptly thereafter. Patients with pelvic tumors will be treated first, and preparations are underway to treat patients with disease in other anatomic sites.

Clinical and Accelerator Physics

The proton medical accelerator now operates continually through the week, except for Saturday shutdown and scheduled maintenance. Currently, six hours per day are reserved for patient treatments, at beam energies of 100, 155, and 200 MeV in the horizontal beam room. About twelve hours per day are devoted to beam studies on the first gantry, which will soon be ready for patient treatment; this time is divided between the accelerator and radiological physics groups. At present, 155 and 200 MeV proton beams are routinely transported through the gantry structures, at angles of 0, 90, 180, and 270 degrees. Beam tuning at 250 MeV, as well as at other gantry angles, began in June. Currently, it requires less than ten minutes of beam tuning to switch treatment rooms, beam energies, or gantry angles. Much of the recent effort has been devoted to developing procedures for tuning beam to a treatment room after the patient is already aligned there. This will allow more efficient use of beam time by allowing a patient to be set up in one treatment room while another is being treated in the other room.

Engineering

Loma Linda University Radiation Research Laboratory (LLURRL) engineering personnel have been fine-tuning the gantry nozzle positioning system and are in the final stages of developing and installing the gantry motion system, which rotates the gantry to the desired treatment angle. The patient tables and the x-ray holder/positioning system have been installed and tested in the first of three gantries. The engineering team continues to improve the treatment system and presently is developing a sophisticated control system for clinical applications. In the past six months, LLURRL software engineers completed the treatment planning system, the treatment system (eye, horizontal and gantry beams), the accelerator system, and the device-manufacturing systems. All are operational.

In the next six months, the engineering team will be performing on-going maintenance as well as developing design enhancements to the beam transport control system. In collaboration with the physics teams and with physicians, the team is developing treatment room enhancements to allow more patients to be treated daily. The software team will continue to enhance the current software, and will integrate all systems by networking, again to increase patient throughput.

Charged Particle Database

Another PROLIT update will be send to current subscribers in August, 1991. PTCOG members and others are reminded that contributions of articles to the database, both for expanding the citations and for building up the archive, are welcome. *James Slater, Loma Linda University Medical Center, P.O. Box 2000, 11234 Anderson Street, Loma Linda CA 92354.*

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

On 9 April 1991, Dr. Chapman treated the first patient at HCL using the stereotactic positioner STAR designed by Product Genesis Inc., thus adding to the versatility of treatment options here. Meanwhile, detailed design work for the upgrading of process cooling for the cyclotron has been completed by our consultants. Construction work is scheduled to start within a few weeks. *A. M. Koehler, Harvard Cyclotron Laboratory, 44 Oxford Street, Cambridge MA 02138.*

The Proton Therapy Programme at Louvain-la-Neuve

A proton therapy programme was initiated at the isochronous variable-energy cyclotron of the Université Catholique de Louvain (UCL) at Louvain-la-Neuve. The protons can be accelerated at an energy up to 90 MeV; the maximum penetration is 5.5 cm in water. Only superficial tumours can be treated.

Beam flattening is obtained with a double scattering system and a small brass annulus. The first scattering foil (500 μm lead) is situated at 4 m from the center of the target volume. the annulus and the second scattering foil (150 μm brass) are located at 2.5 m from this center. The required Bragg-peak spread is achieved with the conventional rotating vane with varying thicknesses. The beam is finally collimated with two collimators, the distal one having interchangeable inserts. Between the two collimators a double transmission chamber is sandwiched. Field sizes up to 10 cm x 10 cm are covered. The beam homogeneity (difference between minimum and maximum dose in 80% of the field) is less than 3% and the penumbra (between 80% and 20%) is 5 mm wide. For smaller field sizes (i.e. 4 cm x 4 cm) the penumbra can be reduced to 3.5 mm.

Dosimetry is performed following the "Code of Practice for Proton Dosimetry" with a Faraday Cup and two different types of tissue equivalent ionization chambers (FWT IC18 and Exradin T2). In the first two months of treatment, a calibration reproducibility within 1% was achieved. A dosimetry intercomparison between the centers of Clatterbridge, Louvain-la-Neuve, Orsay and Nice was held in Clatterbridge in the middle of December 1990 and a second intercomparison, including a A-150 calorimeter, was held in April 1991 at Orsay in a 75 MeV and 100 MeV proton beam.

The first treatment started in January 1991, 6 patients are treated by the end of May. As far as fractionation is concerned, three fractions of 3 Gy are given per week. The dose rate, measured at the level of the modulated Bragg-peak, is 1-2Gy/min.

The RBE of our proton beam was determined using cell survival in vitro. This system allows us to study steep dose gradients. CHO cells were irradiated with 85 MeV protons at different depths and for different widths of the spread-out Bragg peak with single and fractionated doses; control irradiations were performed simultaneously with a Cobalt-60 beam. RBE values between 1.0 and 1.1 were observed. A RBE of 1.1 was temporally assumed. *S. Vynkier, J. M. Denis, J.P. Meulders, J.Gueulette, F. Richard and A. Wambersie,* UCL-Cliniques Universitaires St-Luc, B-1200 Brussels, Belgium

Status Report GSI, Darmstadt Germany

The heavy ion synchrotron SIS started operation last year and is now producing ion beams for experiments in nuclear, atomic and bio-physics on a regular time schedule. SIS can accelerate the lighter ions to a final energy of 2 GeV/u with intensities more than sufficient for therapy.

In the next two years (1991 and 1992) technical components for heavy ion therapy will be developed and radiobiological and machine experiments will be performed in preparation for future heavy ion therapy at a dedicated machine or at GSI.

The major technical points of this program are: Development of a three-dimensional tumor conforming particle delivery system, tests and improvements of position sensitive transmission counters, comparison and tests of various types of positron cameras and the design of a dedicated therapy synchrotron. In the machine experiments, slow beam extraction with small intensity variations will be studied as well as the initiation of the particle acceleration by the raster scan and a fast cut off.

For the three-dimensional particle delivery system an active scanning system using magnetic deflection in two perpendicular axes has been constructed and installed in the biophysics experimental area. A pair of two fast scanning magnets is located 12 m upstream of the target point. The maximum angular deflection is ±0.5 degrees for a beam rigidity of 18 Tm corresponding to an image size of 20 cm x 20 cm at the target position. These magnets are connected to fast power supplies which are able to complete one image within half a second. The power supplies are tuned by a control system in which the optimal path of the particle beam over one target slice is dissected in 16 k position numbers. For each position the adequate particle numbers are calculated and both position and particle numbers are stored.

In order to achieve a homogeneous or pre-selected inhomogeneous intensity distribution over the whole area, the writing velocity is controlled by the flux of the incoming particle beam. Therefore, a set of transmission counters such as scintillators and secondary electron counters are installed in the beam line. A schematic view of the beam line is given in Figure 1. These counters monitor the beam intensities and are connected to the electronic control unit of the raster scan system. When the accumulated number of particles has reached a preset value for a given beam position the control unit switches the beam to the next position.

Beam Diagnostics Cave A
Kr-Run 24.Apr.91

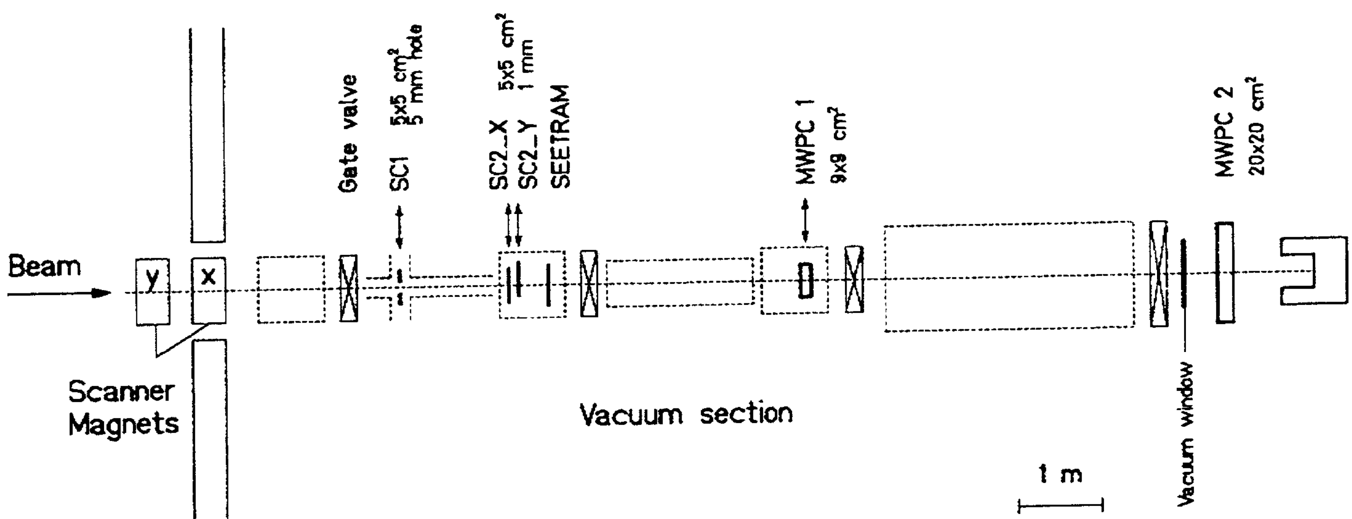

Fig. 1 Beam diagnostic elements In Cave A consisting of three independently movable scintillation counters (SC), a secondary electron monitor (SEETRAM), and two position-sensitive multi-wire proportional chambers (MWPC). The scale is valid beam direction only.

In first experiments using Xenon and Krypton beams the function of the individual components of this set up and their reliability has been tested. Various regular and irregular shaped two-dimensional patterns were produced by the raster scan and recorded on-line by the position sensitive multiwire proportional counter (Figure 2).

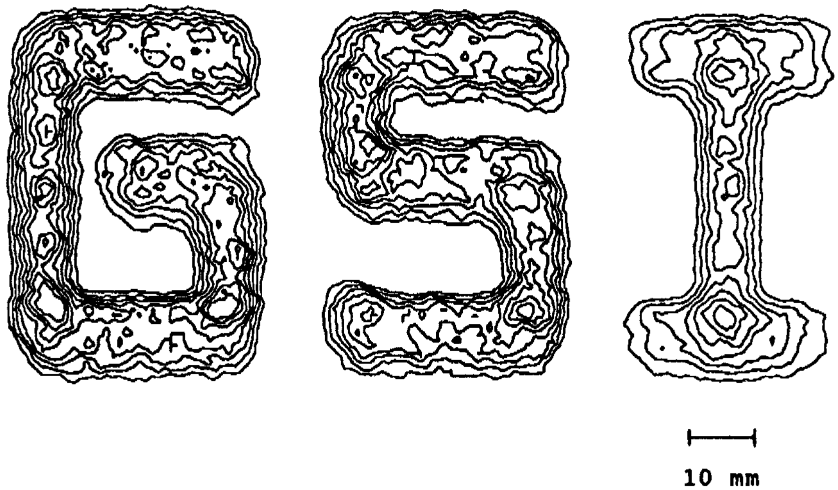

Figure 2: Image produced with a 400 MeV/u Xenon beam using the raster scanner. The scan pattern was recorded on-line by a MWPC.

In further experiments the fast cut off of the slowly extracted beam could be verified (cut off time < 500 μsec) and the initiation of the beam acceleration triggered by the raster scan has been studied.

These first experiments demonstrated that the concept of three dimensional beam scanning seems to be possible using a modern synchrotron. However, in further experiments it still has to be demonstrated that it is also possible to integrate the active energy variation by the machine from pulse to pulse by the synchrotron.

Because of the different approach of using active energy variation and active beam deflection compared to the passive methods using degraders and scattering foils, basic physical and biological parameters like nuclear fragmentation and inactivation cross sections under various cellular conditions have to be re-determined. This program will begin in the near future. The experiments are supported by Eulima and the German government.

In the workshop on Heavy Charged Particles in Biology and Medicine which will be held September 23-25 at GSI some of those problems will be discussed in great detail as well as basic questions of particle action and the space related problems. *Gerhard Kraft GSI-Darmstadt, Postfach 11 05 52, D-6100 Darmstadt, West Germany.*

Ion Beam Applications, Belgium: Capital Increase:

On May 21,1991, the Board of Directors of Ion Beam Applications S.A. , Belgium, convened an Extraordinary General Meeting of shareholders in order to increase its registered capital by BEF 130,000,000, bringing it to a total amount of nearly BEF 195,000,000 (USD 5,400,000). IBA's founding members and present shareholders have been joined by four new shareholders: EUROVENTURES, PARTECH, TVM, and NIVELINVEST. The former shareholders still retain the majority of shares.

This substantial increase in capital, together with the broadening of the shareholding basis, endows this young, medium-sized company with new financial resources more appropriately matching the scope of its achievements and plans for the future. After becoming a world leader in some fast developing sectors such as medical cyclotrons, IBA now aims not only to maintain, but to enhance its technological leadership. In the field of radiotherapy, IBA has developed a complete, turnkey proton therapy facility designed for in-hospital operation. *Yves Jongen, Ion Beam Applications S.A., Chemin du Cyclotron 2, B-1348 Louvain-la-Neuve, Belgium.*

The National Association for Proton Therapy

The National Association For Proton Therapy

The National Association for Proton Therapy (NAPT) was founded in 1990 as a non-profit public benefit corporation to promote the therapeutic benefits of proton cancer therapy in the U.S. and abroad.

The mission of the NAPT is to educate and inform the medical community, the U.S. Congress, and the general public about the opportunity to control the spread of tumors through the clinical application of proton therapy. Proton cancer treatment is a direct spin-off of federal government high energy and nuclear physics research that set the stage for the transfer of this technology to regional medical sites.

The NAPT has proposed to the Congress a government-supported Proton Therapy Technology Transfer Demonstration Program to help finance a limited number of qualified medical centers in the design, research and development of proton beam treatment facilities to increase the availability of this breakthrough technology nationwide. This legislative initiative in the form of a congressional bill calls for $150 million to be appropriated over a five year period. It is the goal of the NAPT to effectively spearhead this legislative effort resulting in the passage of a Proton Demonstration Act in the 1991 Congress.

The NAPT also works closely with the National Cancer Institute (NCI) and supports NCI's objectives for establishing the need for 5 state-of-the-art hospital based, dedicated proton research and treatment facilities in the U.S. In its recent report "Potential Effectiveness of Proton Beam Therapy" to the Congress, NCI addresses the potential advantage of proton beam therapy and concludes that this technology has resulted in greater tumor control rate, lesser morbidity, and no increase in marginal failures.

The NAPT has also taken the initiative to establish funding in 1991 for an independent Economic Analysis Study of Proton Therapy As A Cancer Treatment to determine the cost benefits of this new treatment modality when compared to the other forms of treatment such as conventional radiation therapy, surgery, and chemotherapy. This study will establish uniform criteria for selecting future proton beam sites within the medical community. NAPT will undertake the coordination and management of this study and distribute the completed report to all interested medical centers.

The NAPT is supported and sustained by member medical institutions and corporations committed to the transfer of proton beam technology for patient care. Dr. James M. Slater of Loma Linda University Medical Center serves as Board Chairman and Leonard Arzt is the Executive Director. The organization is headquartered at 7910 Woodmont Avenue, Suite 1303, Bethesda, MD, 20814; telephone:- (301)-913-9360

From the History Books

The conclusion reached by Andy Koehler and Bill Preston in their paper “Protons in Radiation Therapy” published in Radiation Physics in 1972 reads as follows:-

“.. CONCLUSIONS

Aside from its specialized application to the treatment of pituitary-related disorders, clinical work with proton beams has done little more than demonstrate that the gross effects of such beams on both malignant and normal tissues can be predicted with reasonable accuracy from experience with conventional radiations, assuming that equal doses (measured in conventional rad units) are compared. We have shown that the use of high-energy protons or other heavy charged particles makes possible a substantial improvement in the control of the geometric distribution of therapeutic radiations, compared to supervoltage x rays or electrons. Judging by the results of similar previous improvements, we can hope for better clinical control of some classes of malignant lesions as well as reduced complication rates if this advantage is exploited fully. We believe that an adequate clinical study should be undertaken at once, comparing protons to supervoltage x rays applied to one or more types of malignant lesions in which it appears most likely that the improved dose distribution will be advantageous. It is important that such a study include enough cases to assure statistically significant results..”

Any time that I have space in the newsletter, I would be happy to include a pertinent historical *moment or anecdote* such as the one above. So, all contributions welcome!

WORLD WIDE CHARGED PARTICLE PATIENT TOTALS
July 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	CA. U.S.A.	He	1957		2054	Jun-91
Uppsala	Sweden	p	1957	— 1976	73	
Harvard	MA. U.S.A.	p	1961		5268	Jun-91
Dubna	U.S.S.R.	p	1964	— 1974	84	
Moscow	U.S.S.R.	p	1969		2135	May-91
Los Alamos	NM. U.S.A.	π-	1974	— 1982	230	
Leningrad	U.S.S.R.	p	1975		685	Sep-90
Berkeley	CA. U.S.A.	heavy	1975		433	Jun-91
Chiba	Japan	p	1979		65	Oct-89
TRIUMF	Canada	π-	1979		253	Feb-91
PSI (SIN)	Switzerland	π-	1980		478	Dec-89
Tsukuba	Japan	p	1983		229	Apr-91
PSI (SIN)	Switzerland	p	1984		1035	May-91
Dubna	U.S.S.R.	p	1987		13	May-91
Uppsala	Sweden	p	1988		20	May-91
Clatterbridge	England	p	1989		158	Jun-91
Loma Linda	CA. U.S.A	p	1990		19	May-91
Louvain-la-Neuve	Belgium	p	1991		6	May-91
					961	pion beams
					2487	ion beams
					9820	proton beams
				TOTAL	13268	all particle beams

Proposed NEW FACILITIES for PROTON & ION BEAM Therapy

INSTITUTION	PLACE	TYPE	DATE 1ST RX?	COMMENTS
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	1992	200 MeV. 2 treatment rooms;2 horiz. beam;1 vert. or gantry.
G.S.I Darmstadt	Germany	ion	1992?	Synchrotron operating.Exps.3-dim. raster scan,radiobiology
P.S.I	Switzerland	p	1993	200 MeV, variable energy, dedicated beam line
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
ITEP Moscow	U.S.S.R	p	1996	6 treat. rms, 3 horiz. fixed beams,2 gantry,1 exp,H- accel.
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