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

Number 9 January 1992 Editor: Janet Sisterson Ph.D., HCL

This is the **ninth** 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. This issue has both more articles than ever before and a larger circulation, indicating that there is still a great deal of interest in particle therapy throughout the world. I would like to thank those of you who took the time to complete and return the facilities questionnaire. I am frequently asked to provide information about other facilities and now I hope I can give better answers. If you didn't return it to me, please do so, to avoid being asked again! As ever, I also thank all my correspondents for their interesting articles and updated figures for the 'world particle experience' table. Without correspondents, there is no 'Particles' newsletter.

Future e-mail and fax directories: I am still collecting e-mail addresses and Fax numbers. I may still include a directory in a future issue of Particles.

The deadline for the next newsletter is June 30 1992, so that Particles 10 can come out in July 1992. Address all correspondence to:

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

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 - this is also true for the text as well.

FUTURE PTCOG MEETINGS

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

PTCOG XVI	Vancouver, Canada	March 30 and March 31 1992
PTCOG XVII	Loma Linda, California USA	Fall 1992
PTCOG XVIII	Nice and Orsay, France	Spring 1993

For further information about **PTCOG XVI** 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 XVI

PTCOG XVI will be hosted by the British Columbia Cancer Agency and TRIUMF. It will be held in the Hotel Vancouver and registration is expected to begin at 8 am on Monday March 30 and the meeting will end at 1 pm on Tuesday March 31. The registration fee will probably be US$75 and will include the social event on Monday evening. A block of rooms has been reserved at the Hotel Vancouver; the room rate is $85 for a single or double, $115 for business class and $145 for entree gold. Reservations must be made by February 11 1992 to hold a room in the PTCOG block. Reservations can be made through USA 1-800-828-7447 or Canada 1-800-268-9411. The Sales Manager is Barbara Hicks, extension 2036. The hotel address is:-

Hotel Vancouver
900 West Georgia Street
Vancouver B. C. V6C 2W6
tel: 604-684-3131
fax: 604-662-1907

Please let Dan Miller know if you plan to attend this meeting and give him the title of your presentation if you wish to make one

Topics which are being considered for discussion at this meeting include:-

- Patient localization: positioning and immobilization;
- Clinical use of protons: protocols, comparative treatment planning etc.;
- Updates on the experiences of operating proton facilities;
- Plans for new facilities;
- Calibration and quality assurance;

It is planned to devote the better part of one day to the topic of patient positioning, divided into three approximately two hour sessions:

(1) Mechanics of chairs and head-holders;
(2) Mechanics of couches and other supports;
(3) Immobilization devices; alignment techniques; data on accuracy.

Abstracts for PTCOG XVI

Speakers are invited and encouraged to submit an abstract of their presentation for circulation to the PTCOG membership with the next issues of Particles. Abstracts will be collected at the meeting by Janet Sisterson or Dan Miller or may be faxed or mailed to those individuals by April 10 1992.

The maximum space allocated for each abstract is a rectangular box 7 inches (18 cm) wide and 3.5 inches (9 cm) deep. This box must include the title, authors and affiliations at the top. The remaining portion may be in any format, as long as it is legible, and may include graphs and diagrams.

PTCOG XV Darmstadt, Germany, September 1991

reports from the Editor and guest reporter Dr. Eleanor Blakely, LBL.

PTCOG XV was held at GSI, Darmstadt in September 1991 in conjunction with the Fourth Workshop on heavy charged particles in biology and medicine. Starting Sunday night with a welcome party at GSI and continuing through Wednesday evening when there was a reception in Heidelberg there were ample opportunities to learn all you wanted to known about proton light and heavy ion radiation therapy in the world and the effects of such radiation on cells. The session format had an invited speaker give a summary of the status of each scientific field, followed by presentations by participating contributors of new research. In keeping with the European location, the sessions were announced by the melodic calls of a Swiss cowbell rung with vigor by Gerhard Kraft.

The physics half of the program provided an great opportunity to hear progress reports from most of the operating facilities in the world. This past year has seen several new facilities begin to treat patients routinely with proton beams and it was very interesting to hear the progress made at Louvain, Orsay, Nice and Loma Linda. In addition, German and Italian groups presented plans for introducing proton therapy programs at existing accelerators. Many different accelerator designs and beam delivery systems are still being considered for use in a hospital-based facility. Ideas for upgrading existing cyclotrons were also presented.

The basic sciences were well represented at the meeting. Five scientific sessions were dedicated to providing overviews of track structure physics and modeling, damage induced by particles at both the DNA and cell level, as well as a review of chromosome aberrations, neoplastic transformation and mutation. In addition, there was a special session addressing radiobiological problems in space.

Several new reports were of interest. The problems of radiobiological research have stimulated atomic physicists to reconsider and to measure the emission of electrons in heavy ion-atom collisions. These experiments indicate that the conventional understanding of track formation may have to be revised and that there is still much biophysical research yet to be discovered. Differences noted in comparing theoretical models will have to be resolved with the acquisition of more experimental data. The DNA double-strand break remains a significant endpoint of interest, and several novel molecular methods have been developed to quantitatively measure the yield of these lesions and to determine whether or not they are repaired. The need to compare the fluence-dependent yields of the lesions measured with each became obvious during the discussion. A report was also made of success in using flow cytometry and several immunofluorescence methods to score radiation-induced micronuclei.

With respect to chromosome damage, it was demonstrated that chromosomal breaks and the complexity of chromatid exchanges both increase with increasing LET from 31 to 140 keV/mm. The mean number of

chromosomes involved in a chromatid exchange is on the average higher for neon ions than for gamma rays, but the rate of chromatid exchanges decreases when the LET increases. Another group has found irradiation with iron or helium particles to induce more deletions than dicentrics, whereas X-irradiation produced a similar yield of these aberrations. These investigators also found a strong correlation between cell loss of colony-forming ability and the induction of acentric fragments. The number of acentric fragments at a radiation dose that kills 37% of the cells is about 1.7 for iron and 1.4 for helium suggesting that the tetraploid cells studied can survive with some loss of genetic material. It was also reported by GSI staff that due to major particle-induced division delays in cell cycle progression there is a late appearance of chromosomal damage in irradiated cells as well as in the second generation of cells that follow. This work highlights the importance of knowing the cell cycle stage irradiated so that one can correlate the observed damage to the appropriate cell generation.

Another program to analyze with molecular techniques the expression level of growth-related genes in radiation-induced transformed cells *in vitro* was described. cDNA libraries of primary, transformed and tumor cell lines have been constructed and polymerase chain reaction (pcr) techniques are being used to amplify interesting DNA sequences that may relate to the radiation-indued transformation process. In other studies the mutation spectrum of heavy-ion induced mutants are being analyzed at the molecular level also using multiplex pcr and mismatch methodology to fingerprint the nature of molecular damage induced by specific particle tracks. Finally the large number of open areas of space research requiring new data in several relevant disciplines for the successful establishment of a human presence on Mars in 2020, leave no doubt that radiobiology and biomedicine with charged particles will be a field of intense future research. The overview talks will be published in the Spring of 1992 in **Radiation and Environmental Biophysics**.

PTCOG News

The following reports were received by December 1991.

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

Clinical: Treatments began June 26, 1991, using the world's first proton treatment gantry beam line, and patients continue to be treated regularly on the horizontal beam line. As of December 1, 1991, 68 patients with ocular melanoma and various tumors of the brain and head and neck, had completed treatment. In addition, 7 patients with prostatic carcinoma and other pelvic tumors had completed treatment, as well as one patient with a thoracic neoplasm. The facility is serving 18 to 20 patients per day.

Accelerator and Clinical Physics: Since January, 1991, improvements have been made in the clinical capabilities of the accelerator and beam transport systems. Beam can now be switched between treatment rooms, at different energies, in less than five minutes without beam tuning procedures. This has allowed for doubled patient throughput, since technologists can now align patients simultaneously in the horizontal and gantry beam rooms. In addition, a 250 MeV beam has been delivered successively to both treatment rooms; patients requiring this energy are now being treated in the gantry room with a beam having an available range of 31.5 cm. Soon, patients requiring 250 MeV beam will be treated in the horizontal beam room also. The horizontal beam line presently delivers proton treatment energies of 155 and 200 MeV with maximum range values of 13.1 and 21.1 cm, respectively.

Anticipating the Proton Treatment Center's Phase II requirements for continuously-variable beam energy, studies are being done to fill in the energy gaps between 100 and 250 MeV. The gap is now filled in 5

MeV increments. In addition, spread-out Bragg peaks have been generated by delivering prescribed doses at several beam energies to dosimetry phantoms in the treatment room. Both of these efforts require further work to improve the speed and reliability of beam delivery.

Engineering: The personnel at Loma Linda University Radiation Research Laboratory produced the world's first proton-beam gantry-mounted delivery and motion systems. In addition, LLURRL produced a control system compatible with the ergonomic requirements of radiation therapy technologists accustomed to conventional radiation therapy equipment. Both accomplishments directly impact quality of patient care and treatment times and, indirectly, costs. Since early 1991, LLURRL staff have been fully responsible for all mechanical, electrical and software technology. During that time, there have been only two days when proton treatments could not be given due to minor failures in equipment. To ensure the continuation of and improvement in such a record, a rigorous program of quality assurance, upgrading of selected components, documentation control, preventive and unscheduled maintenance, and spare parts inventory is being implemented.

Networking: Radiation Medicine personnel at LLUMC can be reached at the following BITNET address: *RADSCI @ LLUVM*. Scientists at LLURRL proposed and received a grant from the National Science Foundation, allowing for an INTERNET connection. The address is <*username*> *@ proton.llumc.edu*.

In the early 1970's, physicists and physicians at LLU pioneered the use of CT digital image files as the basis for radiation therapy planning. Our networking effort using public standards for formatting and transmitting such files, began about 1980. At about the same time, members of the American College of Radiology recognized the need for point-to-point image transmission standards that would allow digital imaging systems from various vendors to communicate with each other. Working with the National Electrical Manufacturers Association, they developed the ACR-NEMA Standard. We merged that standard with public networking standards. Emphasizing radiation therapy needs, then those of proton therapy, we developed and now have an operational therapy planning network, the Radiation Sciences Digital Imaging Network (RDIN), congruent with ACR-NEMA Version 2. Due to our continuing efforts we believe that what we now have operational will also be compliant with ACR-NEMA Version 3, to be published in 1992.

While RDIN began as a Local Area Network (LAN), it has now been duplicated at two remote sites and linked to the LLUMC network by satellite. Documentation is available to others who may wish to develop a similar implementation for their own local needs or for linking with Loma Linda. If you are interested in these documents, please address your inquiry to *James M. Slater, MD, Chairman, Dept. of Radiation Medicine, Loma Linda University Medical Center, P.O. Box 2000, Loma Linda, CA 92354.*

Proton Irradiation of AVMs at **Uppsala, Sweden:**

The reconstructed Gustaf Werner-cyclotron at the The Svedberg Laboratory in Uppsala has been used for proton therapy of eye melanomas since April 1989. In April 1991 the first patient with an arterio-venous malformation (AVM) in the brain was irradiated with a range modulated 100 MeV proton beam. So far, three AVM patients have been treated. The treatments were given in two fractions during two consecutive days to a total dose of 20 Gy. We have used titanium markers in the skull for accurate, repeated positioning of the target, very similar to the positioning of eye melanomas. A stereotactic frame was used only during the diagnostic procedures and the positioning in the treatment room could be repeated with

good precision, without refitting the stereotactic frame. *Anders Montelius, Avdelning f sjukhusfysik, Akademiska sjukhusct, S-751 85 Uppsala, Sweden.*

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

Dr. Goodman retired in June 1991, and Dr. C. Fryer is the new Medical Director at TRIUMF effective July 1991. We wish Dr. Goodman a happy and long retirement.

Clinical Program at TRIUMF to 20 December 1991:-

(1) PHASE 3 TRIAL OF ADULT GRADE III AND IV ASTROCYTOMAS (OPEN JUNE 1988): Enrollment 48 patients (pion 22, photon 26), total number required: 82. There is a possibility of an early Decadron dependent radiation edema occurring to a greater extent in the pion treated patients and this will be further evaluated. There is difficulty in differentiating tumour recurrence from necrosis, and we are investigating the value of thallium scanning in this regard.

(2) PHASE 3 PROSTATE TRIAL (OPEN JUNE 1990): 83 patients accrued (47 pion, 36 photon), total number required: 208 patients. No apparent difference in toxicity.
C. Fryer, *B.C. Cancer Agency, 600 West 10th Avenue, Vancouver, B.C. V5Z 4E6, Canada.*

News from the **National Accelerator Center, Faure, South Africa:**

Good progress has been made with the development of the proton facility. The treatment room has been prepared and the computer controlled chair for stereotactic radiosurgery has been installed.

The first treatment will likely be possible in the second half of 1992 and initially the shoot-through technique will be used. *F. J. Vernimmen, National Accelerator Center, P. O. Box 72, Faure, 7131, South Africa.*

News from **National Superconducting Cyclotron Laboratory, Michigan State University:**

Further site studies of a proton therapy system for Princess Margaret Hospital in Toronto are in progress. The new studies assume a stationary 3 tesla isochronous cyclotron and one or two gantries with the possibility of adding a third at a later time. Figure XXV from the report MSUCL-760a of March 1991 shows one of the layouts. Several alternate spatial arrangements for these same devices have been looked at. On September 12, 1991, at the neutron therapy facility at Harper Hospital in Detroit, the first patient treatment with the superconducting cyclotron occurred. On November 27, a licensing agreement was signed, designating Ion Beam Applications, Inc. of Belgium as the firm responsible for manufacturing and marketing of commercial neutron therapy units based on the Harper technology. *Henry Blosser, National Superconducting Cyclotron Laboratory, Michigan State University, East Lansing, MI 48824-1321.*

News from the **MRC Cyclotron Unit, Clatterbridge** :

Up to 30th November 1991 we have treated 189 patients with proton radiotherapy. All the patients were diagnosed for uveal melanoma, with both small posterior and large anterior tumours being treated.

Recently we have been hosts to two proton dosimetry intercomparisons, with visitors from both NAC, Faure and the Svedberg Laboratory/Akademiska sjukhuset, Uppsala. Both intercomparisons principally employed ionization chambers previously standardized by means of ^{60}Co irradiation.

Other work has included radiobiological RBE studies of melanoma cell lines, as well as further development of the EYEPLAN program to incorporate modelling of the eyelid.

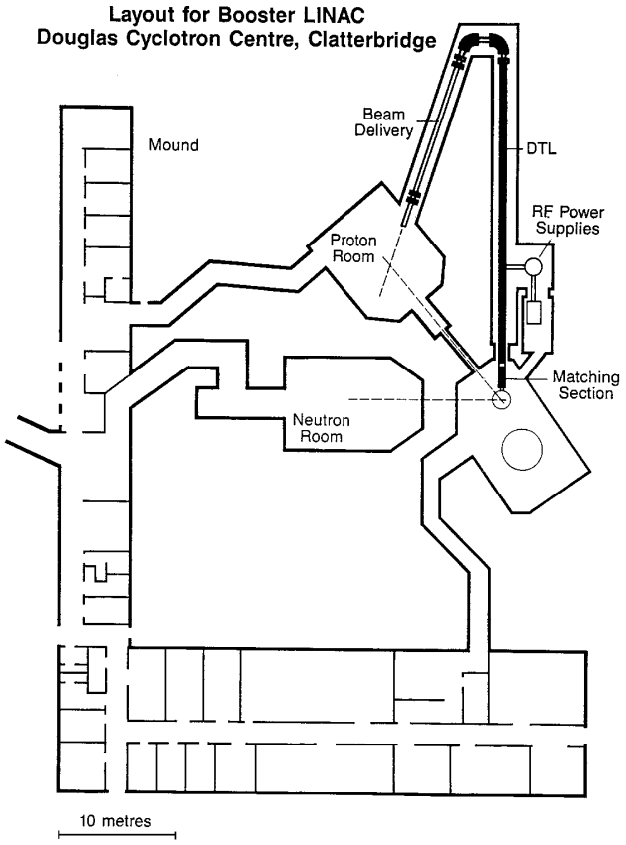
A technical feasibility study is under way to examine the possibility of an 'add-on' proton linac booster to the existing 62 MeV cyclotron - see article by Neil Griffiths in this issue. *Andrzej Kacperek, MRC Cyclotron Unit, Clatterbridge Hospital, Bebington, Wirral, L63 4JY, U.K.*

Feasibility Study for the **Clatterbridge** Proton Booster:

A Feasibility Study to examine the potential for boosting the beam energy of the Douglas Cyclotron at Clatterbridge using a linear accelerator is progressing well. The aim is to take the 62 MeV proton beam currently used for 'low energy' proton therapy and neutron therapy, and boost it to 180 MeV. The application is initially specifically focused on the head and neck lesions treated successfully by protons at other centres. This allows a number of cost reductions in the design, the main one being the energy of the output beam which, at 180 MeV, is the optimum for treatment of these sites. The advantage of a linear accelerator in this role is that it provides an essentially "modular" system where further tanks can be added at a later date to increase the final energy to 200 or 250 MeV. Cost has been the major influence in choosing this approach and continues to be the major force in the selection of a final design. Preliminary design calculations indicate that boosting a cyclotron with a linac is a feasible and cost effective solution to the problem of widening the availability of proton treatment. Consequently the booster project at Clatterbridge is gaining wide support.

A number of design options, with differing linac designs and RF systems, are currently being considered. The booster would incorporate a short matching section to modify the temporal and spatial characteristics of the cyclotron beam for injection into the linac, a linac of 26 metres or shorter (depending on the design), a pulsed RF system and a beam delivery system. The RF power consumption will be approximately 200 kW during treatment and nominally 5 kW on standby.

The layout of the Douglas Cyclotron Centre is particularly well suited to this approach having the option of delivering the final beam to the existing proton room. Within the treatment room one or more fixed beams are delivered and the patients will be positioned using a stereotactic chair/couch.



The present Feasibility Phase is due to be completed in February 1992, followed by completion of a Design and Costing Phase by the end of 1992. Assuming funding continues to be made available as planned, construction of the booster could be complete by the end of 1994. *Neil Griffiths, Beam Science and Technology Department, AEA Technology, Culham Laboratory, Abingdon, Oxforshire OX14 3DB, U.K.*

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

The long awaited treatise on multiple scattering is now available as a Harvard Cyclotron Internal Report. Copies are available, please request HCL 11/19/90 “Multiple Coulomb Scattering of 160 MeV protons”. The results of this more-than-twenty- year project can be summarized as follows:- Use Molière's theory - or for convenience the Highland formula - to describe multiple scattering as this paper shows that Molière theory, carefully evaluated, has an average error no more than 1% and a *maximum* error no more than ±5% for protons. This paper also shows that contrary to popular belief, Molière theory is valid for mixtures, compounds and thick targets (up to thicknesses ≈97% of the mean proton range).

The new cooling tower has been installed and is working.

Catherine Nauraye, a Ph. D. student form Orsay, France is spending a few months at HCL to learn our techniques. *A. M. Koehler, Harvard Cyclotron Laboratory, 44 Oxford Street, Cambridge, MA 01238.*

News from **ITEP, Moscow**:

At ITEP in Moscow , the design and development work is underway on the six-room PTF based on a H^- synchrotron. At the same time, ITEP is developing the smaller version, a three-room PTF with a total construction area of less than 500 m^2 and a few storeys high. *Ye. I. Minakova, Medical Physics Department, ITEP, Bolshaya Cheremushkinskaya 25,Moscow, 117259, USSR.*

Beam Characteristics of the **IUCF Proton Therapy Beam Line :**

The Indiana University Cyclotron Facility (IUCF) and the Department of Radiation Oncology at Indiana University at Indianapolis have been collaborating to develop a proton radiation therapy capability. Intense proton beams with energies from 185 to 200 MeV are frequently delivered to nuclear physics researchers. During about 50% of scheduled operation, a beam splitting system is used to deliver beam to two different users. Nuclear physics research can therefore continue even when the beam is required for the proton therapy beam line.

A method of splitting a beam from the cyclotron to two different beam lines using a fast switching magnet and Lambertson septum magnets has been in use at IUCF since 1986(1). The peak beam intensity delivered to either user can be individually adjusted using a beam intensity modulation system timed to the period of the switching magnet. For proton therapy, initial characterization and set up of the beam before patient treatment can be completed as a secondary user, with little affect on the primary user. During the actual treatment, 100% of the beam would be used for less than 2 minutes, causing minimal impact on the nuclear physics research program. Proton beams can be delivered in the range from 5 nA to 500 nA or more within a phase space area of about 2.5(π)mm-mrad horizontal by 2.0(π)mm-mrad vertical, with energies from 185 to 200 MeV.

Layout of the proton therapy beam line with the beam spreading system, the range modulator and the beam and dose monitoring diagnostics are shown in Figure 1. Beam position at the beam spreading system is monitored using 1 mm thick plastic scintillator material viewed with a television camera. A secondary electron monitor is located at the exit of the beam spreading system to monitor beam flux. Dose profiles are measured in a water phantom with a reference ion chamber at its proximal surface and a signal ion chamber attached to a robot arm controlled by a Multidata computer dosimetry system. Data files from the Multidata can be graphically displayed and can be sent to the local Vax cluster over a serial link using Kermit.

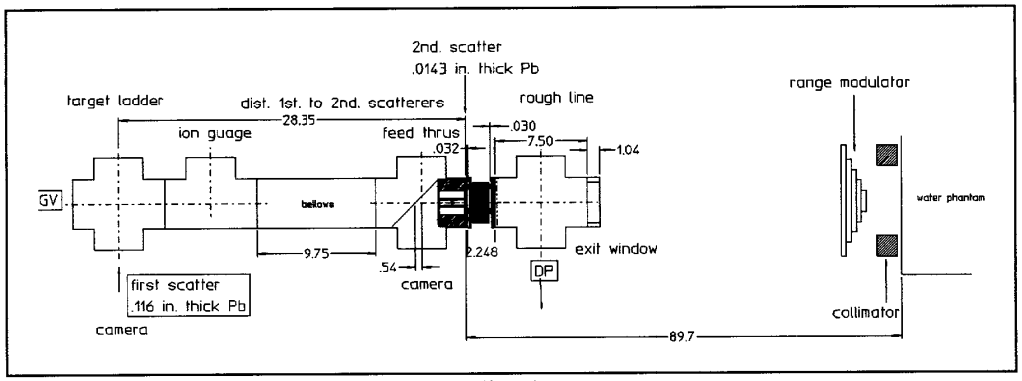


Figure 1 IUCF proton therapy beam line layout.

Lateral beam spreading is accomplished with two scattering foils and an occluding-ring assembly(2). Systems were designed with the Harvard beam spreading program, NEU(3), for three field sizes:10, 15, and 20 cm. The range of the Bragg peak is modulated using a propeller type range modulator(4). Typical measurements are shown in Figure 2: an 8 cm 200 MeV SOBP and a 15 cm horizontal profile (taken at the Bragg peak).

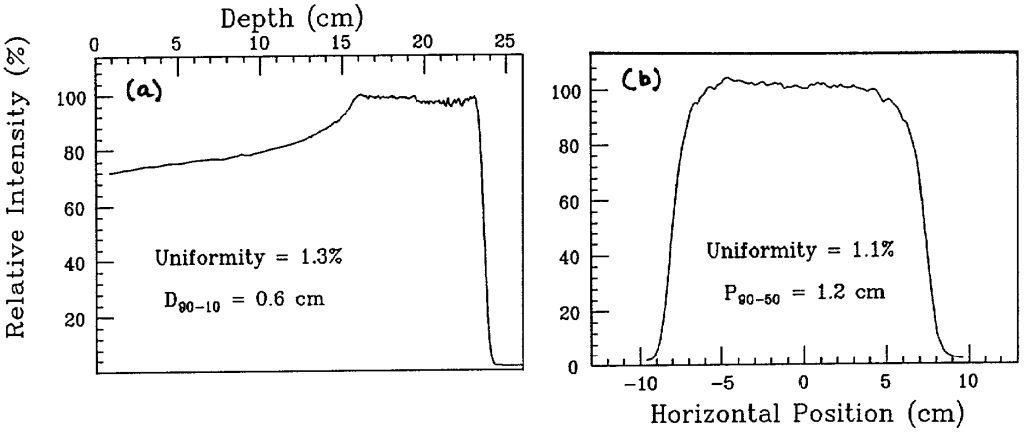


Fig. 2. 200 MeV protons: (a) 8 cm SOBP; (b) 15 cm horizontal profile (at the Bragg peak).

A secondary electron monitor (SEM) is used to measure total beam current as well as dose delivered. Initially the SEM is cross calibrated with a Faraday cup for absolute flux measurement. For dose delivery, the SEM is calibrated against a Markus ion chamber, which is cross calibrated against a Farmer type cylindrical ion chamber that has been calibrated by an accredited dosimetry laboratory. There is no measurable difference in dose delivered between continuous 100% duty cycle beam and beam from the beam splitter at 10% duty cycle. Presently, a conventional beam-stop is used to start and stop the delivery of beam based on a visual reading of integrated charge on a current integrator.

Beam position upstream of the beam spreading system is ascertained with a segmented collimator. This collimator consists of four wedge shaped brass segments oriented to read horizontal and vertical beam position errors. A 1.0 cm aperture in the center of the collimator is sufficient to allow 100% beam transmission. Current on each of the segments is read out by the IUCF cyclotron control computer. In addition, there are two thin mylar foils, coated with a fluorescent paint, mounted on the upstream side of the beam spreading system and the SEM. The beam spot on the foils is viewed at the accelerator control console on television monitors hooked up to cameras in the proton therapy area. Split ion chambers will be used to monitor field uniformity.

The basic devices for a proton therapy system are in place and functioning. The next task is to create an integrated computer control/monitor system suitable for patient treatments. Beam diagnostics will be added to beam lines upstream of the proton therapy area so that beam can be monitored and tuned for best field uniformity without using the scintillators in the patient treatment area. This will allow reliable delivery of beam to the beam spreading system with the correct position and trajectory necessary to produce a uniform field. Much work is yet to be done before patient treatments, but we are optimistic and are making good progress towards this goal.

References: (1) IUCF Scientific and Technical Report, 142 (1986). (2) A.M. Koehler, R.J. Schneider, and J.M. Sisterson, "Flattening of proton dose distributions for large-field radiotherapy", Med. Phys. 4, 297 (1977). (3) B. Gottschalk, "Proton Nozzle Design Program NEU", Harvard Cyclotron Lab internal note. (4) A.M. Koehler, R.J. Schneider, and J.M. Sisterson, "Range modulators for protons and heavy ions", Nucl. Instr. Meth. 131 437 (1975). *Vladimir Derenchuk, Indiana University Cyclotron Facility, 2401 Milo B. Simpson Lane, Bloomington IN 47408.*

Plans for a New Proton Therapy Center at **KFA, Jülich, Germany:**

For those who are not familiar with the Forschungszentrum (KFA) Jülich, here is the institution at a glance: It is the largest of 13 national research centers (GSI is also one of them) with a staff of approx. 4700. Its research is mainly in the areas of material properties and new materials, information technology, nuclear and renewable energies, environmental issues and health.

At present, the KFA is building a new accelerator for medium energy physics. It is a cooler synchrotron and storage ring, called "COSY-Jülich". Construction work and assembly will be finished in the second quarter of 1992 and start of users' operation is scheduled for spring 1993. COSY-Jülich will deliver protons at energies of 50 to 2500 MeV and hence includes the whole range of interest for medical applications. It has the option to accelerate He, C, O and Ne, as well. Storage capacity will be $2x10^{11}$ protons and $2xl0^{10}$ protons/sec will be extractable. Positioning of the beam should be better than ± 0.5 mm and energy variation from pulse to pulse is better than 10^{-3} . COSY-Jülich will permit ultra slow beam extraction (≥ 5 s) and a minimum spot size of about 2 mm, options which should facilitate beam scanning. These few data might suffice to illustrate the suitability of COSY-Jülich for proton therapy. A first proposal describing the properties and advantages of the facility for potential medical applications was well received and we hope to obtain the necessary financial support. In addition to providing the essential accelerator, the KFA offers further benefits for a proton therapy site: its Institute of Medicine has years of experience in imaging techniques, in particular PET, and there is even a nuclear medicine clinic on the KFA grounds.

We would like to express our interest and appreciation for any help and support from the many experts in the field, be it drafts, sketches, concepts, cost estimates, etc. Please, address your correspondence to *Ute Linz, Forschungszentrum Jülich GmbH, IKP, Postfach 1913, W-5170 Jülich, Germany*.

News from Centre de Protonthérapie d'Orsay (CPO), France:

A clinical eye-treatment program has been implemented at the **C**entre de **P**rotonthérapie d'**O**rsay, (CPO) on September 17, 1991. By late November, 13 patients were treated (12 ocular melanomas, 1 hemangioma), in 3 groups with increasing number of patients per series (1, 4 and 8). Patients are being irradiated one week per month, and the expected number for the following series is around 10 to 12

patients per treatment week. Dose-fractionation is similar to that used in PSI, Villigen (4 consecutive sessions of 15 CGE each for ocular melanomas).

In parallel, radiobiological experiments are conducted in rats in collaboration with the Orleans neutron unit. A preliminary RBE value of 1.17 was obtained (full modulated beam) but the 1.10 value adopted by others teams is used.

Dosimetric investigations are being pursued concerning microdosimetry, in collaboration with the Birmingham group, and dosimetric intercomparisons (ionisation chambers, Faraday cups and calorimetry, with Clatterbridge, Nice, Louvain, Faure and the LPRI, the primary French laboratory). A good agreement has been obtained between chambers, but 5% differences between chambers and calorimetry.

Some measurements are conducted at higher energies in the same room, mainly to analyse the use of the degrader in the room. For ophthalmological treatments the degrader will be kept upstream of the last deviating magnet (better peak to plateau ratio).

The medical, technical and administrative staff is being complemented (around 20 persons with contracts with the four partners of the project: Assistance Publique, Institut Curie, Institut Gustave Roussy and Centre Rene Hugenin, and from the Institut de Physique Nucléaire, the old owner of the synchrocyclotron). Sabine Delacroix has joined the CPO group as medical physicist; Pierre Schlienger (MD) and Laurence Desjardins (MD) - from Curie Institut - have been in charge of the first series of patients.

Several physicists visited us after the Darmstadt meeting. One PhD student, Catherine Nauraye is visiting Harvard to learn their techniques, and one master student from Toulouse is coming next year to contribute to our measurements. *Jean Louis Habrand, MD, Institute Gustave Roussy, rue Camille Desmoulins, 94805 Villejuif Cedex, France ; Ale Mazal, Centre de Protonthérapie d'Orsay, Campus Universitalre Bat. 101, 91400, Orsay, France.*

The Protontherapy Programme at **Centre Antoine-Lacassagne, Nice, France:**

Protontherapy of choroidal melanomas started in France, by June 17th 1991, in Nice.
In January 1987, the Centre Antoine-Lacassagne (CAL) was authorized to install the Medicyc Cyclotron for protontherapy and neutrontherapy. The construction of the final building to house the cyclotron and the radiotherapy, radiobiology and maintenance services began in January 1988 and has been completed in July 1989, allowing the reinstallation of the cyclotron, construction of the beamlines and installation of the treatment rooms.

The final energy has been raised in September to its design value of 65 MeV which gives a range of 32.2 mm in eye tissue.

The main feature of the Medicyc Cyclotron is the acceleration of negatively charged H ions produced in a multi-cusp source, supplied by IBA, mounted on a platform at 33 kVolts vertically above the cyclotron yoke. The H^- ions are then axially injected into the cyclotron. A 46% yield for the high intensity beam has been reached (64μA-DC injected beam, 30 μA on the cyclotron extraction radius). The H^- ions are extracted by a stripping foil whose radius can be remotely controlled.

The transport consists of a quadrupole pair at the cyclotron exit and a FODO channel (two identical bending magnets and three equally spaced quadrupoles) which has unit magnification. The beam leading to the proton treatment room is left to spread freely from the last dipole magnet and is collimated to 35 mm before entering the treatment area. A 0.05 mm thick scattering tantalum foil has been introduced in the beamline, before the first collimator more for security reasons than for scattering necessity, only the central part of the widely spread-out beam being selected by collimation. Therefore, for an initial proton beam intensity of 120 nA at extraction, only 1 nA is transmitted to the patient.

The protontherapy room is located in front of the beamlines deviation area, over the maze of access to the neutrontherapy room. Inside the treatment room, the vacuum pipe has been continued close to the optical bench. The arrangements of this bench closely follow those of the initial version in Clatterbridge, in order to benefit from the best possible range: two parallel-plate chambers, the range shifter and the modulator wheel are installed between two 35 mm diameter brass collimators. After the second collimator are placed the Polaroid axial X-ray film holder, cross-wires, retractable light systems for field area and central fixation, final 35 mm brass pipe bearing patient collimator.

Dosimetry is performed according to the "Code of Practice for Proton Dosimetry", and our team participated in dosimetry intercomparisons between Clatterbridge, Louvain-la-Neuve, Orsay and Nice, in December 1990 in Clatterbridge and in April 1991 in Orsay. Two different types of tissue equivalent ionization chambers (FWT IC 18 and X.Radin T2) and a Faraday cup are used. Depth dose curves and profiles are measured using small silicon photo-diode and mini-beam explorers built in Clatterbridge as well as the proton treatment chair.

The depth of penetration measured to the distal 90% isodose is 32.2 mm of eye tissue, the thickness of the unmodulated peak is 3 mm at the 50% isodose. The penumbra (10%-90%) varies as a function of modulation: for an unmodulated beam, the mean value is 1.4 mm, while for a fully modulated beam, the mean value is 3.1 mm. The energy of 65 MeV being now available, by the end of the year the modulator and range shifter will be placed upstream in the beamline, to decrease the penumbra and make it almost independent of modulation, as previously published by the Clatterbridge team.

Radiobiological experiments have now started in order to determine the RBE of this proton beam, using cell survival in vitro for different conditions of doses, depth and modulation. Presently the classical value of 1.1 is used for dose calculations.

Simulation and treatment planning are performed 10 to 15 days after tantalum rings have been inserted by the surgeons participating in the cooperative group set-up around the Centre Antoine-Lacassagne. The group includes the Cancer Comprehensive Centers and University Hospitals in South of France and adjacent regions in Italy and Spain.

The treatments are delivered on the basis of 60 Gy Cobalt Equivalent given in four consecutive fractions, the duration of a fraction being between 20 and 30 sec. By December 21st, a total number of 45 patients will have completed their treatments, according to the estimations. *P. Chauvel, P. Mandrillon, N. Brassart, F.J.M. Farley, J. Hérault, A. Courdi, F. Demard, Centre Antoine-Lacassagne, Cyclotron Biomédical, 227 avenue de la Lanterne, 06200 NICE France.*

News from **Ion Beam Applications, Belgium:**

In the field of treatment of cancer tumors, ION BEAM APPLICATIONS, SA, from. Louvain-la-Neuve, Belgium and SUMITOMO HEAVY INDUSTRIES, Ltd, from Tokyo, Japan have reached a major agreement.

The agreement ratifies a joint effort of both partners, to develop and distribute worldwide, on an equal base, a new proton therapy system. This new system consists of a 230 MeV fixed energy cyclotron, beam transport equipment, isocentric or fixed gantries, dose monitors and computerized controls. It is designed for in-hospital operation and will be delivered as a complete, turn-key facility. It can perform over 20,000 therapy sessions per year.

According to the agreement, the development of the cyclotron will be shared equally between the two partners, on a subsystem by subsystem basis. In addition, isocentric gantries will be developed by IBA, while fixed gantries will be developed by SUMITOMO.

Concerning production and distribution, IBA will be responsible for the American and European markets and SUMITOMO will take charge of Asia.

The concept of the new system was presented for the first time in November 1989 at the 26th European Cyclotron Progress Meeting by Yves Jongen, IBA's President. According to Yves Jongen: " By applying to proton therapy the design principles developed for IBA's CYCLONE 30 and PET-dedicated cyclotrons, we have come out with this new system which is compact, very reliable and economical, costing substantially less than any comparable facility. And it is simple to operate. A 230 MeV cyclotron can easily deliver the higher intensity, continuous beams required by proton therapy".

The agreement was signed in Tokyo on October 15 by Yves Jongen and Atsushi Naitoh, Executive managing director, Quantum Equipment Group of SUMITOMO at the initiative of Dr. Kunizo Shinano, General Manager, Corporate Technology Operation Group of SUMITOMO. *Yves Jongen, Ion Beam Applications S.A., Chemin du Cyclotron 2, B-1348 Louvain-la-Neuve, Belgium.*

Charged Particle Database — PROLIT

PROLIT will be updated through the end of 1991 and will be available in February, 1992. It will be available in an IBM-PC-compatible version only; however, Macintosh users may employ it with the help of PC-emulator software. Plans are underway to make PROLIT available on other computer platforms as well. Since the initial subscription time has expired, current users who desire the update, and others wishing to use it, will need to subscribe. A subscription entitles the buyer to the February and August, 1992, updates. The cost is $50.00. You may subscribe by xerocopying and returning the form below:

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attn: Leimomi Song
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Loma Linda University Medical Center, B-121
P.O. Box 2000
Loma Linda, California, 92354
USA

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WORLD WIDE CHARGED PARTICLE PATIENT TOTALS
January 1 1992.

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		5419	Dec-91
Dubna	U.S.S.R.	p	1964	— 1974	84	
Moscow	U.S.S.R.	p	1969		2200	Dec-91
Los Alamos	NM. U.S.A.	π-	1974	— 1982	230	
Leningrad	U.S.S.R.	p	1975		719	Jun-91
Berkeley	CA. U.S.A.	heavy	1975		433	Jun-91
Chiba	Japan	p	1979		74	May-91
TRIUMF	Canada	π-	1979		283	Dec-91
PSI (SIN)	Switzerland	π-	1980		478	Dec-89
Tsukuba	Japan	p	1983		242	Aug-91
PSI (SIN)	Switzerland	p	1984		1150	Nov-91
Dubna	U.S.S.R.	p	1987		13	May-91
Uppsala	Sweden	p	1988		23	Nov-91
Clatterbridge	England	p	1989		189	Dec-91
Loma Linda	CA. U.S.A	p	1990		76	Dec-91
Louvain-la-Neuve	Belgium	p	1991		8	Sep-91
Nice	France	p	1991		45	Dec-91
Orsay	France	p	1991		13	Dec-91
					991	pion beams
					2487	ion beams
					10358	proton beams
				TOTAL	13836	all particle beams

Proposed NEW FACILITIES for PROTON & ION BEAM Therapy

INSTITUTION	PLACE	TYPE	DATE 1ST RX?	COMMENTS
N.A.C.	South Africa	p	1992	1st room ready & equipped for stereotactic radiosurgery.
G.S.I Darmstadt	Germany	ion	1992?	experiments for therapy and radiobiology in progress.
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.
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.
Indiana Cyclotron	IN U.S.A	p	?	200 MeV; other light ions possible.
Sacramento	CA U.S.A	p	?	new proton therapy facility to be built at U.C. (at Davis) M.C.
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; location not yet decided.
Antwerp	Belgium	p	?	proton therapy facility
Jülich (KFA)	Germany	p	?	Plan to develop a proton therapy beam line at COSY.