PARTICLES

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PARTICLE THERAPY CO-OPERATIVE GROUP

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

Number 29 January 2002 Janet Sisterson Ph.D., NPTC

Costs: At PTCOG XIX, the Steering Committee decided that part of the registration fee for PTCOG meetings would be used to help produce both Particles and the abstracts of the PTCOG meetings. Only part of the costs is covered in this way, so more financial help is needed from the community. PTCOG is always happy to receive financial gifts; all such gifts are deductible as charitable contributions for federal income tax purposes. The appropriate method is to send a check made out to the "Massachusetts General Hospital" and sent to Janet Sisterson at the address given below. We thank Hitachi, Australia for their kind donation to Particles.

Facility and Patient Statistics: I continue to collect information about all operating or proposed facilities. Please send me your information. My latest published summary of the worldwide detailed patient statistics through 1999 is:
"Ion beam therapy: overview of the world experience." Author: J. M. Sisterson. CP576, Application of Accelerators in Research and Industry – Sixteenth Int'l Conf., eds. J. L. Duggan and I. L. Morgan, American Institute of Physics, (2001) p865-868. Copies available on request.

Particles on the Internet *** **new web page** ***:
The URL for the PTCOG and Particles Newsletter is now www.mgh.harvard.edu/depts/NPTC/index.htm.

This site is still under development. We have a PTCOG web page and links to the current issue of Particles and some of the recent back issues of Particles. In the future all the old Particles issues will be available.

Other proton therapy links:

- Harvard Cyclotron Laboratory: http://neurosurgery.mgh.harvard.edu/hcl/
- LLUMC, California: : http://www.llu.edu/proton
- U of California, Davis: http://crocker.ucdavis.edu/cnl/research/eyet.htm
- Midwest Proton Radiation Institute: http://www.iucf.indiana.edu/MPRI/index.html
- National Association for Proton Therapy: http://www.proton-therapy.org
- TRIUMF, Canada; protons: http://www.triumf.ca/welcome/proton_thrpy.html
- TRIUMF, Canada; pions: http://www.triumf.ca/welcome/pion_trtmt.html
- CPO, Orsay, France: http://www-sop.inria.fr/epidaure/personnel/bondiau/CPO_base/cpo_base.htm

- PSI, Switzerland: http://radmed.web.psi.ch
- TERA foundation, Italy: http://www.tera.it
- Catania, Italy: http://web2.lns.infn.it/catanaweb/default.htm
- GSI homepage: http://www.gsi.de
- HMI Berlin: http://www.hmi.de
- The Svedborg Laboratory, Sweden: http://www.tsl.uu.se
- Clatterbridge Centre for Oncology: http://synaptic.mvc.mcc.ac.uk/simulators.html
- ClatterBridge collaboration with the CASIM project: http://www.casim.ac.uk
- Rinecker Proton Therapy Center, Munich, Germany: http://www.rptc.de
- ITEP, Moscow, Russia: http://www.protontherapy.itep.ru
- Tsukuba, Japan - PMRC: http://www.pmrc.tsukuba.ac.jp/index.html
- HARIMAC, Hyogo, Japan: http://www.hibmc.shingu.hyogo.jp/ENGLISH/HIBMC_home.html
- HIMAC, Chiba, Japan: http://www.nirs.go.jp/ENG/particl.htm (ENG case sensitive)
- NAC, South Africa: http://medrad.nac.ac.za/index.htm

ARTICLES FOR PARTICLES 30

The deadline for articles for the Particles 30 is May 31 2002. Please Send all articles to:

Janet Sisterson Ph.D.
Northeast Proton Therapy Center
Massachusetts General Hospital
30 Fruit Street, Boston MA 02114

Telephone: (617) 724-1942
Fax: (617) 724-9532
E-mail: jsisterson@partners.org

Articles for the newsletter should **NOT** exceed two pages in length.

PTCOG BUSINESS and FUTURE PTCOG MEETINGS

The Chairperson, Secretary and Steering Committee members are listed below. The Chairperson and Steering Committee are appointed for 3 years. Their appointments run through June 2004.

Chair: Gudrun Goitein
Paul Scherrer Institute
Division of Radiation Medicine
Villigen PSI CH-5232
Switzerland

Secretary: Janet Sisterson
Northeast Proton Therapy Center
Massachusetts General Hospital
30 Fruit Street
Boston MA 02114

MEMBERS OF THE STEERING COMMITTEE
Appointed in June 2001

Canada	TRIUMF, BC	E. Blackmore
France	Orsay	G. Noel
Germany	GSI/Heidelberg	J. Debus
	HMI, Berlin	H. Kluge
Italy	Catania, Sicily	L. Raffaele
Japan	HIMAC, Chiba	H. Tsujii
	NCC, Kashiwa	T. Ogino
	PMRC, Tsukuba	Y. Akine
	HARIMAC, Hyogo	Y. Hishikawa
	Wakasa Bay, Japan	S. Fukuda
Russia	ITEP, Moscow	V. Khoroshkov
	JINR, Dubna	G. Mytsin
South Africa	IThemba LABS	D. Jones
Sweden	Uppsala	E. Blomquist
Switzerland	PSI	G. Goitein
UK	Clatterbridge	A. Kacperek
USA	NPTC-MGH/HCL, MA	S. Rosenthal
	LLUMC, CA	D. Miller
	MPRI, IN	N. Schreuder
	Berkeley, CA	W. Chu

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

PTCOG XXXVI	Catania, Sicily	May 29-31 2002
PTCOG XXXVII	Cape Town, South Africa	October 28-30 2002
PTCOG XXXVIII	Hosted by Clatterbridge, UK	Spring 2003
PTCOG XXXIX	Hosted by LLUMC, CA	Fall 2003

PTCOG XXXVI MEETING

May 29 (Wednesday) – 31 (Friday), 2002

Host Institute: Laboratori Nazionali del Sud, Istituto Nazionale di Fisica Nucleare (LNS-INFN), University of Catania, Catania City, Italy

Local Organizing Committee: Roberto Cirio, G.A.Pablo Cirrone, Giacomo Cuttone, Andrej Kacpereck, Salvatore Lo Nigro, Giuseppe Privitera, Luigi Raffaele, Giovanna Ruggieri, M.Gabriella Sabini, Vincenzo Salamone.

Contacts:

G. Cuttone
Tel: +39-95-542258
Fax: +39-95-542300
E-mail: cuttone@lns.infn.it

G. Ruggieri (Ms.)
Tel: +39-95-542300
Fax: +39-95-542300
E-mail: ruggieri@lns.infn.it

Mailing Address: Laboratori Nazionali del Sud, Istituto Nazionale di Fisica Nucleare (LNS-INFN), 44 of Santa Sofia street, 95123 Catania, Sicily, Italy.

Detailed information will be available: http://web2.lns.infn.it/catanaweb/ptcogweb/default.htm.

Deadlines:	March 29, 2002	oral/poster presentation
	April 29, 2002	meeting registration

Details are given below.

Registration Deadline for the Meeting Registration will be April 29, 2002.

Registration Fee will be **350,00** euro, it includes coffee breaks, lunches, social dinner and a tourist tour. Payment should be made by bank transfer or credit card Euro or US Dollars.

Call for papers: Deadline for the Oral/Poster presentation will be March 29, 2002.

Official Language: English.

Travel: Please refer to our Homepage: http://web2.lns.infn.it/catanaweb/ptcogweb/default.htm

Accommodation: Excelsior Hotel, Catania City

Meeting Place: Excelsior Hotel, Catania City.

Scientific Program: the meeting will be devoted to the dosimetry, prostate tumors, treatment planning, clinical results of eye treatments, active scanning system, (probably: proton vs IMRT prostate cancer).

Abstracts: Deadlines for submission will be March 29, 2002. Format: Word 97/2000, it must follow a specified style; a model will be available soon in ours web pages.

Social Programs: a starting cocktail, the visit of Taormina (including archaeological excavations) and Catania, the visit of the Laboratori Nazionali del Sud, and a social dinner will be organized during the meeting

PTCOG XXXVII
28 – 30 October 2002
iThemba LABS, South Africa

Dates: 28-30 October 2002

Venue: iThemba LABS

Accommodation: Breakwater Lodge
Cape Town Waterfront

Information: DAN JONES
[jones@nac.ac.za]

****************NOTE THE NAME CHANGE****************

On 30 November 2001 the National Accelerator Centre formally changed its name to iThemba Laboratory for Accelerator Based Sciences (iThemba LABS). iThemba is a Xhosa word meaning "hope" or "promise". Please note the following changes to co-ordinates:

iThemba LABS
P O Box 722
Somerset West
7129
South Africa
Tel: +27 21 843-1000 (Switchboard)
Fax: +27 21 843-3525 (General)
Fax: +27 21 843-3382 (Medical Radiation)
Web and e-mail addresses remain the same for the time being

International Symposium on
Standards and Codes of Practice in Medical Radiation Dosimetry
25 –28 November 2002
Vienna, Austria

Objective: The symposium will provide a forum where advances in radiation dosimetry during the last decade, not only in external beam radiotherapy but in all other areas of radiation medicine, can be disseminated and scientific knowledge exchanged. It will include areas which have been developed recently (intravascular therapy, heavy-ion dosimetry) together with classic areas where the standardization of dosimetry may not have reached a mature stage (diagnostic X-rays and nuclear medicine).

Audience: The symposium is addressed to a broad spectrum of experts in medical radiation dosimetry with responsibilities in the following fields:

- external radiotherapy
- brachytherapy
- heavy-ion therapy
- diagnostic X-rays and mammography
- nuclear medicine

List of Topics

- Development and intercomparisons of primary and secondary standards for dosimetry in external beam radiotherapy.
- Dosimetry protocols and codes of practice for external beam radiotherapy: new developments and comparisons with previous codes.
- Standards of measurement and dosimetry protocols for brachytherapy sources; developments in intravascular dosimetry.
- Standardization of diagnostic X-rays including mammography: primary standards and codes of practice.
- Transfer dosimetry: measurements in on-reference conditions, relative dosimetry, interface dosimetry
- Dose quality audits: certification of reference and non-reference dosimetry, national and international quality audit networks, postal and on-site based audits.
- Radiation dosimetry for advanced radiotherapy applications: dynamic wedges, MLC, IMRT, dosimetry using EPID, dosimetry of narrow beams, IORT, monitor unit calculations.
- Dosimetry in nuclear medicine: laboratory standards and internal dosimetry.
- Monte Carlo calculations for dosimetry (all fields).

Papers and Posters: Papers are invited form participants on any of the topics being covered by the symposium. In order to provide ample time for discussion, the number of papers that can be accepted for oral presentation is limited. If the number of papers submitted exceeds the limit, some will be selected for poster presentation.

Key deadlines

15 March 2002 – submission of abstracts, participation forms and applications for grants
13 Sept. 2002 – submission of full papers

There is no registration fee. The symposium will be held in English.
Information on: participation, submission of papers, registration and grant can be obtained from www.iawa.org/worldatom/Meetings/2002/index.html

Contact persons:

Scientific matters and paper submission
Mr. Ken Shortt
Symposium Scientific Secretary
International Atomic Energy Agency
Tel: +43 1 2600 21664/21662
Fax: +43 1 26007 21662
Email: dosimetry@iaea.org

Participation, grants and administrative matters
Ms. Regina Perricos
International Atomic Energy Agency
Tel: +43 1 2600 21315/21311
Fax: +43 1 26007
Email: r.perricos@iaea.org

Please include reference number CN-96 in your written contacts.

8th Workshop on Heavy Charged Particles in Biology and Medicine
Fall 2002 Austria

Starting in 1982, six workshops were held at Darmstadt, Germany, and one in Baveno, Italy. These workshops covered the broad spectrum from the physical interaction of heavy ions with material, radiation chemistry and dosimetry, particle radiation biology, space research and tumor therapy. The intention of these meetings was to have an intense discussion on new results sometimes only on one question as for instance RBE at the last meeting. Beside the scientific values, these meetings had also a large and positive impact on the development of the GSI therapy project: the public attention not only in local newspapers but also in scientific journals helped to enhance the awareness for the therapy project. Now, the GSI project is well under way and it was decided that the workshop might serve other European projects in the same way. A first request to all heavy ion projects yielded the Austron project as the organizer (Dr. Thomas Auberger: Thomas.Auberger@uibk.ac.at) of the next, the 8th workshop to be held in Austria in fall 2002.

At this meeting the future organisation of the workshop series will be decided.

Christoph Schmeler Award 2001

The Christoph Schmelzer Award 2001 for an outstanding Ph.D and diploma thesis in the field of heavy ion therapy was given to Dr. Akifumo Fukumura from the Tohuku University in Chiba Japan and to Konstanze Gunzert from the Technical University Darmstadt, Germany by the *Association for the Advancement of the Ion Beam Tumor Therapy*. A. Fukumura was honored for his Ph.D thesis on the dosimetry of heavy ions and his contribution to the international comparison of ion beam dosimetry. Konstanze Gunzert measured in her diploma thesis the neutron angular and energy spectra produced by carbon impact on thick water targets and on patients. Both awardees contributed with their work in an important way to the success of ion beam therapy as was pointed out by Stephan van der Heyde, the director of the Hessian Central Bank and president of the Association.

The Christoph Schmelzer Award for 2002, donated with EUR 1000, will be given for a diploma or master thesis in November 2002. Nominations should be sent before Sept. 30 to Dr. H. Zeitträger, GSI, Planckstr. 1, 64291 Darmstadt, Germany.

PTCOG Information/News/Reports:

The following reports and articles were received by January 2002.

Update on the **Northeast Proton Therapy Center**, Massachusetts General Hospital, Boston:

The first patient was treated at the NPTC on November 8, 2001. This long-awaited event occurred after several months of intense acceptance testing, beam commissioning, QA tests and simulated treatments. The team, from both MGH and IBA, that was involved in these pre-treatment activities is shown in Figure 1 (unfortunately not all who participated were present when the photograph was taken, notable examples being Miles Wagner and Bernie Gottschalk from the HCL). Unfortunately, Michael Goitein was also not present - he is now living in Switzerland. As most of you know, Michael's contributions to proton therapy in general and to the NPTC in particular have been enormous.

Figure 1.

The first patient, a businessman from Connecticut diagnosed with meningioma, was pleased to be the first to be treated in the new facility, but, understandably, was also somewhat anxious because he was the first. The first treatment was flawless, much to the relief of both the clinical team and the patient.

Figure 2 shows one of the 4 treatment fields for the first patient - in Figure 3 you see the happy patient (front center) and the relieved clinical team immediately after the first treatment.

Figure 2.

Figure 3.

This milestone triggered the beginning of our transition of the clinical program from the venerable HCL to the NPTC. This transition is planned to take 6 months and, by the end of April 2002, the entire program should be running smoothing in the new facility. Large-field patients will be transferred at the rate of three per month; the ocular melanoma program will be transferred in March; and the radiosurgery program will be transferred in April. In April, we plan to begin treatments on Gantry #2.

During the transition period we will also be starting patients in new disease categories in preparation for the funding of the NCI funded clinical research grant and the opening of several new clinical trails. The first protocols to open will be prostate and pediatric medulloblastoma followed by paranasal sinus and retinoblastoma. As we write this article, 4 patients (2 meningioma, 1 pituitary adenoma, and one sarcoma) have finished treatment. By the end of January 11 patients will be under treatment (9 patients in disease categories that we treated at the HCL) and 2 prostate patients.

Unfortunately, our experience to date has not been without problems. In December, the cyclotron was down for a week during which we treated all patients at the HCL. The problem was elusive but turned out to be due the use of silicon grease on an O-ring rather than the specified carbon-based grease. It took several days to find and clean up this problem that caused arcing and loss of RF power in the cyclotron. Also, there have been continuing small software and hardware problems that are expected during the first months of operation in a new facility. All in all, we are quite happy with the operation of the facility and the enormous dedication and assistance that we have received from the IBA crew during the past year. Already, for most treatments we are able to schedule 2-3 fields in a 30-minute time slot while more complex treatments take longer.

We appreciate the concern and support of the proton therapy community during the time that we were having labor pains. The birthing of our new facility gives us great happiness and we hope that the NPTC will advance proton therapy to a new level of safe-efficient operation and increased numbers of patients treated with proton beams. *Al Smith, Jay Flanz, Northeast Proton Therapy Center, Massachusetts General Hospital, 30 Fruit Street, Boston, MA 02114.*

News from **ITEP, Moscow, Russia:**

In 2001 about 150 courses of proton treatment were carried out at the ITEP Proton Therapy Facility. The preparations of means and techniques for proton therapy of prostate and orophagus tumors are completed. The first patients with these localizations will be irradiated in the beginning of 2002. The prostate cancer will be irradiated in one of the three treatment rooms, stopped 10 years ago. The dose planning system ProGam is completed both for independent proton planning, and combined proton and gamma planning. *V.S. Khoroshkov and M.F. Lomanov, Institute for Theoretical and Experimental Physics, B.Cheremushkinskaya 25, Moscow, 117218, Russia.* mailto:khorosh@vitep5.itep.ru

On The Use Of The Laser Accelerators In Proton Therapy

In spite of a comparatively high rate of construction of hospital based proton therapy centers (PTC) during the last decade, their construction and operation costs still remain higher, in respect of patient rate, than those of the most expensive conventional beam therapy plants, namely medical linear electron accelerators, designed for radiation therapy. This situation is typical for the large-scale PTCs, developed according to the most economically rational scheme, with a single specialized medical proton accelerator being equipped with 3–5 treatment units. The cost of a PTC equipped with a “single” treatment unit (GANTRY) appears absolutely inadequate. For instance, the reduction of the number of treatment units from 4 to 1 merely halves the cost of a PTC (from $40–45M down to $20–25M), while the patient rate decreases by 4 [0,2]. At the same time the construction of such a “single” proton facility

is topical. In fact, there is a great lot of large and well-equipped radiation therapy departments and hospitals, that would complement their arsenal with just a "single" proton therapy unit for a medical treatment of 200–250 patients a year, but unable to do so due to high cost of either facility itself or medical treatment. Remarkably, it is quite obvious to every specialist in the field of radiation therapy, that the cost of accelerator, proton beam canals and GANTRY represent a considerable part of the high value of a PTC. However, as we see it, there exists a definite potential possibility to solve the problem.

At present, there are a number of laboratories possessing compact laser systems capable to produce ultra short pulse of a multi-terawatt and petawatt power [3]. Wide range of application of these lasers is based particularly on the high efficiency of laser energy to fast charged particles energy transformation in the course of interaction of laser radiation with plasmas.

Basically, the idea of the ion acceleration mechanism is fairly simple. During interaction with plasmas the laser pulse transfers its energy, in the first place, into that of the electrons leaving the area irradiated by the laser light. As a result, there appears a region of non-compensated electric charge, ions being accelerated in the electric field of electric charge separation.

The experiments on laser interaction with gas and solid targets revealed the generation of collimated beams of fast ions [4]. Also, this effect has been investigated in detail with multi-dimensional computer simulations [5]. The energy of fast electrons observed in the experiment [4] achieved hundreds of MeV, that of fast protons amounting to tens of MeV, the intensity of the proton beams being 10^{12}–10^{13} protons per pulse. Optimization of petawatt laser pulse and target parameters affords an opportunity to obtain proton beams with energy of a few hundreds of MEV, as was shown with the help of computer simulations [5].

Thus, the basic requirements for medical proton beam are easily met with nowadays level of laser acceleration technology. However, proton therapy claims two specific requirements for proton beam:

- Mono-energetic spectrum of the proton beam (**Error!**$\leq 10^{-2}$), and
- Duty-factor (i.e. the real part of a beam usage time) must be not less than 0.1–0.2 for the implementation of active dose delivery system, which means proton beam scanning all over the target volume.

Both experimental data and that obtained with computer simulation show that the energy spectrum of the fast ions does not satisfy the first of these requirements. Beam generated by laser accelerator includes particles within wide range of energies. The proton beam of such a spectrum does not qualify for the medical applications. The energy quality of a proton beam could be improved by cutting the beam in the energy space into beams of narrow bandwidth. However, this technique decreases the efficiency of the laser energy to fast particle energy transformation, and, which is more important, it depletes the beam of particles. The more attractive approach is based on the utilization of the multi-layer targets. The target is comprised of heavy ions and has a thin layer (about 1 μm in width) of protons on the rear. In the course of irradiation by ultra-short laser pulse heavy atoms undergo partial ionization, their electrons leaving foil and generating electric field of charge separation. Heavy ions, due to their inertia, remain at rest while protons, being much lighter, appear to be involved in acceleration. It is easy to show that in this case the energy spread of proton beam spectrum is proportional to the proton layer thickness.

As concerns the increase of duty-factor, there are two possible solutions to the problem. At the present time, the frequency of the required high energy (petawatt) laser-pulses is rather low. The proton pulse rate could be increased by implementation of an assembly of such lasers shooting at a single target in succession. It is also possible to apply acceleration to a bunch of protons repeatedly, each time increasing the energy of protons by several MeV. This may be achieved with the sequentially positioned targets and low-energy lasers, which nowadays have sufficiently high pulse rate.

Thus, the development of a low-cost ($3M–$4M) laser proton accelerator, with the size of 2–3 m and weighting a few tons, may greatly simplify construction and essentially lower the cost of a Proton

Therapy Center on the whole. In this case, in erecting large-scale PTCs, the role of central accelerator is assigned to a laser accelerator. Moreover, there is no need in proton beam canals any more, since laser pulse can be easily transported to the entrance of a treatment room containing a proton-emitting target. As with GANTRY, the laser beam can be transported as far as a GANTRY exit, the target being positioned at the exit instead of the last bending magnet, thus eliminating the necessity in heavy magnets and other structural elements of GANTRY.

The placement of laser at the entrance and target at the exit of GANTRY affords an opportunity to develop a relatively inexpensive "single" treatment unit with a rotated proton beam.

S.V.Boulanov, General Physics Institute, Russian Academy of Science, Vavilova, 38, 119991, Moscow, Russia. V.S.Khoroshkov, Institute for Theoretical and Experimental Physics, B.Cheremoushkinskaya, 25, 117218, Moscow, Russia. khorosh@vitep5.itep.ru

References

1. Report of the Advisory Group Meeting on the Utilization of Particle Accelerators for Proton Therapy, IAEA, FI-AG-1010 (1998).
2. V. S. Khoroshkov, E. I.Minakova. Eur. J. Phys. 19, 523 (1998).
3. G. A.Mourou, C. P. J.Barty, M. D. Perry. Physics Today 51, 22 (1998).
4. S. P. Hatchett, C.G. Brown, T. E. Cowan, et al Phys. Plasmas 7, 2076 (2000).
5. Kh. Roul, S. V. Boulanov, T. E.Cowan, et al Phys. Plasmas 27, 411 (2001).

Protons in Australia:

The prospect of proton therapy in Australia is now a little closer following the announcement of funding for a feasibility study. The New South Wales State Government will fund a study to evaluate the medical, scientific and economic rationale for establishing an Australian National Proton Facility.

A group of oncologists, physicists, engineers and business people has been meeting regularly for the last two years to develop the proposal and lobby for funds. The Committee is based in Sydney and this is the likely site for the Facility. However, all options are being considered and it would be a national centre for the whole of Australia as well as treating patients from New Zealand and other parts of Asia and the Pacific.

An International Advisory Panel is being appointed and we will be asking for help from those who have prepared similar reports in the past. The study should be completed by September 2002. More information about our plans will soon be available on the Sydney Cancer Centre website at www.sydneycancer.com.au

Any useful advice would be gratefully received by *Dr Michael Jackson, Department of Radiation Oncology, Royal Prince Alfred Hospital, Camperdown, NSW 2050, Australia. Phone 61 2 9515 7113 Fax 61 2 9515 8115 Email mjackson@email.cs.nsw.gov.au*

News from **Dr M. R. Raju, West Godavari district, Andhara Pradesh, India**:

At the Mahatma Gandhi Memorial Medical Trust we are making considerable progress in our efforts to improve health and education in rural areas around here. Recently a group of four students from Harvard came here to do the volunteer work, which included updating the website. A new batch of two undergraduate and two graduate students are planning to come here to work with us this coming summer in helping indigenous population at the grass root level by interacting with them directly.

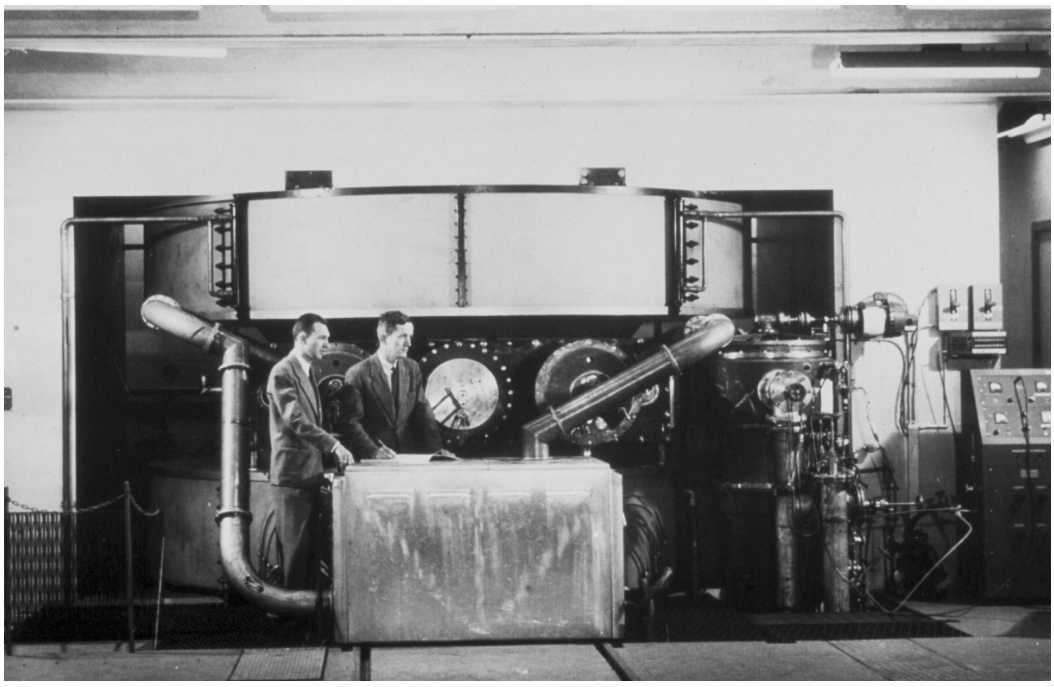
We are now planning to build a rural cancer centre in the trust premises with an emphasis on prevention and the importance of early detection of cancer. We have recently obtained the necessary permission from Babha Atomic Research Centre to build a radiation facility that will house a Cobalt unit, intracavitary brachytherapy, a simulator, treatment planning, mammography, etc. We plan to start the construction of the radiation facility soon. I need help.

Dr. Ale Mazal of Paris not only contacted us but he also helped to make a strong case to "Medical Physicists Without Boarders", an organization similar to "Doctors Without Boarders" who received the Noble Prize for their work. Medical Physicists Without Boarders decided to give a priority in helping us to develop a rural cancer centre at the M.G.M.M.Trust. Dr. Andree Dutreix, a well-known medical physicist in France was asked to head this effort. I would very much like to see similar interaction from the medical physics community in the United States, Canada, Japan and other European countries. And also, I would like to see the participation of some of the likeminded people in the particle therapy field.

Please see our website www.mgmtrust.f2s.com or http://mgmtrust.webjump.com for detailed information *M. R. Raju, mgmtrust@vsnl.com.*

A Historical Moment: A picture from the archives

This picture shows the 160 MeV synchrocyclotron at the Harvard Cyclotron Laboratory, which was built originally for physics research and adapted later for medical applications. Lee Davenport and Norman Ramsey are pictured in 1949 when the cyclotron was completed and the first internal beams obtained. External beams were developed in the mid 1950s.



TREATMENT PLANNING SYSTEMS FOR PROTON THERAPY
July 2001

The following Table was originally presented in October 1999 by Skip Rosenthal, MGH at the Workshop on Treatment Planning Systems, PTCOG XXXI Please send corrections/additions to Janet Sisterson.

Year	Created By	System Name	Status
1979-93	LBL	LBL system	Not Available
1980	MGH	Rx	**Distributor MGH**
1980	MGH	EYEPLAN	**Distributor MGH – EYES only**
1990-96	MGH/Seimens	V-Treat(AXIOM)	Not Available
198?,1991	PSI	PSI system/Pion	**Distributor PSI**
1995	DKFZ/Royal Marsden	Voxelplan/Proxelplan	**Adapted by GSI, NAC, DKFZ**
1996	Radionics/MGH/HCL	P-Knife	Not Available
1997	LLUMC/PerMedics	OptiRad 3D	**FDA approved; commercial**
1998	Tsukuba	Hitachi system	In-house system
1998	DKFZ	OCTOPUS	**Under development – EYES only**
1994	Orsay/Curie	ISIS	Distribution ?
1998	CMS/MGH	FOCUS	**Commercial Release 1999**
1998	DKFZ	KonRad Plus Protons	Research Only
1989 – 2000	CCO, Clatterbridge, UK	EYEPLAN v1.6 (VMS)	Available free;eyes only; research only
2001	ITEP (Moscow)	ProGam	Adapted in PTF ITEP
2002	MDS Nordion	Helax-TMS	**FDA approved: commercial**
	RenderPlan		?
	Adac		?
	Michigan		?
	Varian		?

Proposed NEW FACILITIES for PROTON & ION BEAM THERAPY - July 2001

INSTITUTION	PLACE	TYPE	1ST RX?	COMMENTS
INFN-LNS, Catania	Italy	p	2002	70 MeV; 1 room, fixed horiz. beam
Wakasa Bay	Japan		2002	multipurpose accelerator; building completed mid 1998
Bratislava	Slovakia	p, ion	2003	72 MeV cyclotron; p; ions; +BNCT, isot prod.
IMP, Lanzhou	PR China	C-Ar ion	2003	C-ion from 100MeV/u at HIRFL expand to 900 MeV/u at CSR;clin. treat;biol. research;no gantry;shifted patients
Shizuoka Cancer Center	Japan	p	2003	synchrotron 230? MeV; 2 gantries; 1 horiz; funded.
Rinecker, Munich	Germany	p	2003	4 gantries, 1 fixed beam, 230 MeV, scanning beams.
PSI	Switzerland	p	2004	Extension of existing facility + 250MeV cyclotron, 2nd gantry, 1 fixed
IThemba LABS, Somerset West	South Africa	p	2006	230MeV,1 gantry,1 horiz.+30^{o} beams,1 horiz.+15^{o}.beams
CGMH, Northern Taiwan	Taiwan	p	2001?	250MeV synchrotron/230MeV cyclotron;3 gantry,1 fixed
Erlangen	Germany	p	2002?	4 treatment rooms, some with gantries.
CNAO, Milan & Pavia	Italy	p, ion	2004?	synchrotron; 2 gantry;1 fixed beam rooms;1 exp. room
M. D. Anderson Cancer Center	TX, USA	p	2004?	235MeV cyclotron; 3 gantries; 1 fix + 1 exp beam rooms
Heidelberg	Germany	p, ion	2005?	
AUSTRON	Austria	p, ion	?	2p gantry;1 ion gantry;1 fixed p;1 fixed ion;1 exp room
Beijing	China	p	?	250 MeV synchrotron.
Central Italy	Italy	p	?	cyclotron; 1 gantry; 1 fixed
Clatterbridge	England	p	?	230 MeV cyclotron; part of the CASIM project
TOP project ISS Rome	Italy	p	?	70 MeV linac; expand to 200 MeV?
3 projects in Moscow	Russia	p	?	including 320 MeV; compact, probably no gantry
Krakow	Poland	p	?	60 MeV proton beam.
Proton Development N.A. Inc.	IL USA	p	?	300 MeV protons; therapy & lithography

WORLD WIDE CHARGED PARTICLE PATIENT TOTALS

January 2002

WHO	WHERE	WHAT	DATE FIRST RX	DATE LAST RX	RECENT PATIENT TOTAL	DATE OF TOTAL
Berkeley 184	CA. USA	p	1954	— 1957	30	
Berkeley	CA. USA	He	1957	— 1992	2054	June-91
Uppsala	Sweden	p	1957	— 1976	73	
Harvard	MA. USA	p	1961		9067	Jan-02
Dubna	Russia	p	1967	— 1974	84	
Moscow	Russia	p	1969		3445	Oct-01
Los Alamos	NM. USA	π^-	1974	— 1982	230	
St. Petersburg	Russia	p	1975		1029	June-98
Berkeley	CA. USA	ion	1975	— 1992	433	June-91
Chiba	Japan	p	1979		133	Apr-00
TRIUMF	Canada	π^-	1979	— 1994	367	Dec-93
PSI (SIN)	Switzerland	π^-	1980	— 1993	503	
PMRC (1), Tsukuba	Japan	p	1983	— 2000	700	July-00
PSI (72 MeV)	Switzerland	p	1984		3429	Dec-01
Dubna	Russia	p	1987		88	May-01
Uppsala	Sweden	p	1989		236	June-00
Clatterbridge	England	p	1989		1102	Dec-00
Loma Linda	CA. USA	p	1990		6672	Dec-01
Louvain-la-Neuve	Belgium	p	1991	– 1993	21	
Nice	France	p	1991		1590	June-00
Orsay	France	p	1991		1894	Jan-01
iThemba LABS	South Africa	p	1993		408	Nov-01
MPRI	IN USA	p	1993		34	Dec-99
UCSF - CNL	CA USA	p	1994		284	June-00
HIMAC, Chiba	Japan	ion	1994		917	June-01
TRIUMF	Canada	p	1995		57	June-00
PSI (200 MeV)	Switzerland	p	1996		99	Dec-01
G.S.I Darmstadt	Germany	ion	1997		106	Jan-02
Berlin	Germany	p	1998		236	Dec-01
NCC, Kashiwa	Japan	p	1998		75	May-01
HARIMAC, Hyogo	Japan	p, (ion)	2001		30	Nov-01
PMRC, Tsukuba	Japan	p	2001		19	Jan-02
NPTC, MGH	MA USA	P	2001		2	Jan-02
					1100	pions
					3510	ions
					30837	protons
				TOTAL	35447	all particles

The Proposed Facilities List is on the previous page.