

# PARTICLES

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

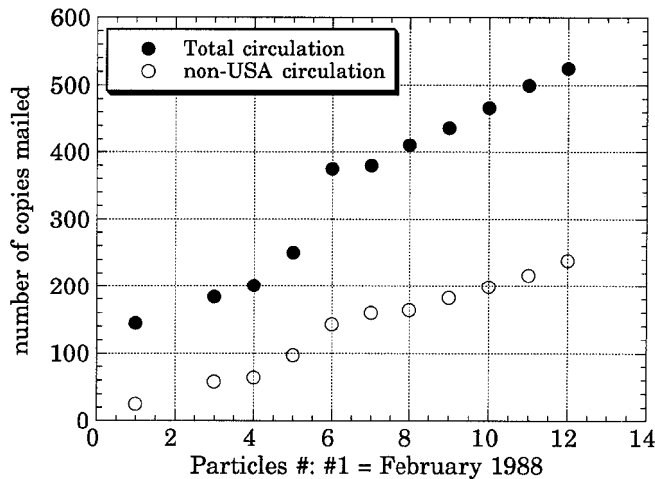
Number 12

July 1993

Editor: Janet Sisterson Ph.D., HCL

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

The graph below shows that the circulation of Particles continues to increase. If you are reading this issue and do NOT want to stay on the mailing list please let me know.



The costs of producing both Particles and the compilation of the abstracts from the PTCOG meetings, will continue to be covered in part by a portion of the registration fee for PTCOG meetings. I thank the organizers for PTCOG XVIII for their timely check, as there were not sufficient funds in the 'Particles' account to cover the costs of this newsletter. In addition, HCL is always happy to receive financial gifts to help cover the cost of producing Particles; all such gifts are deductible as charitable contributions for federal income tax purposes. The appropriate method is to send a check to me made out to the "Harvard Cyclotron Laboratory".

Facility and Patient Statistics: I am still collecting information about all facilities, both operating and proposed, regarding patient statistics, machine and treatment characteristics. I now have a good data base and used it to prepare my presentation at PTCOG XVIII on the status of proton therapy in 1993. I hope that I can get to the point where it only requires updating each year.

## ARTICLES FOR PARTICLES 13

The deadline for the next newsletter is November 31 1993, so that Particles 13 can come out in January 1994. Address all correspondence for the newsletter to:

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

Telephone: (617)495-2885  
Fax: (617)495-8054

E-mail address: BITNET%“SISTERSON@HUHEPL”  
or “SISTERSON@HUHEPL.HARVARD.EDU”

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

## FUTURE PTCOG MEETINGS

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

PTCOG XIX	Cambridge MA USA	Oct 31- Nov 2 1993
PTCOG XX	North America, but ? where	Spring 1994
PTCOG XXI	?	?

As of July 1993, the time and place of the next PTCOG meeting is the only one that is determined. However, it should be noted that the general policy of PTCOG is to hold two meetings in North America for every one held elsewhere, so the Spring meeting in 1994 is likely to be held somewhere in the United States or Canada. At PTCOG XVIII meeting in France, several European groups expressed interest in hosting a future PTCOG meeting, so maybe PTCOG XXI will be in Europe again.

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 XIX; October 31 - November 2 1993, Cambridge Massachusetts USA**

**PTCOG XIX** will be hosted by the Harvard Cyclotron Laboratory (HCL) and the Department of Radiation Oncology, Massachusetts General Hospital and held at the Cronkhite Graduate Center, Radcliffe College, 6 Ash Street Cambridge.

Local Organizing Committee:-

Janet Sisterson (Chair) & Andy Koehler  
Harvard Cyclotron Laboratory  
44 Oxford Street  
Cambridge MA 02138  
Tel: (617)495-2885  
Fax: (617)495-8054  
e-mail: sisterson@huhepl.harvard.edu.

Michael Goitein & Al Smith  
Department of Radiation Oncology  
Massachusetts General Hospital  
Boston MA 02114

**Registration** will begin at 1:00 PM on Sunday October 31 1993 and the meeting will end at 5:00 PM on Tuesday November 2 1993.

The registration fee will be set later but is expected to be approximately \$100; it will cover the incidental expenses, the evening functions and some of the direct costs of producing both the abstracts and the next issue of Particles. At the appropriate time, please pay in US dollars and make checks payable to "Harvard Cyclotron Laboratory". Note NO credit cards are accepted. Pre-registration will be encouraged.

If you plan to attend the meeting send back the form on Page 11. For general questions, contact Gail Bradley or Alice Coggeshall at Phone: (617)495-2885 or Fax: (617)495-8054.

To make a presentation indicate this on the form and to discuss it, contact Janet Sisterson by Phone: (617)495-2885, Fax: (617)495-8054 or e-mail. Presentations will be limited to leave ample time for the scheduled discussion periods in each session.

**Hotel Information**

Blocks of rooms have been reserved at hotels in Cambridge within easy walking distance of the meeting venue, and at the YMCA in Charlestown. The Charlestown YMCA is a new, modern and pleasant facility near the harbor and provides a reasonable low cost option. It is about three miles from Cambridge. For those staying in Charlestown, transportation to Cambridge will be arranged.

You must make your own reservations at the hotels by September 30 1993 in order to reserve a room in the PTCOG block.

Harvard Manor House  
110 Mt. Auburn Street  
Cambridge MA 02138  
Tel: (617)964-5200 or 1-800-458-5886  
Fax (617)864-2409  
contact person: Penny Faul  
Room Rate \$98/night single or double  
Armed Forces YMCA

Sheraton Commander Hotel  
16 Garden Street  
Cambridge MA 02138  
Tel: (617)547-4800  
Fax (617)868-8322  
contact person: Tammo A. Goudsmit  
Room Rate \$150/night single/ double  
Inn at Harvard

150 2nd Avenue  
Charlestown MA 02129  
Tel: (617)241-8400  
Fax (617)241-2856  
contact person: Cami D'Amato  
Room Rate \$50/night single or double

1201 Massachusetts Avenue  
Cambridge MA 02138  
Tel: (617)491-2222  
Fax (617)491-5020  
contact person: Sarah Willis  
Room Rate \$135/night single/ double

Free accommodation in area homes can be arranged for a limited number of students. Contact Al Smith at Phone: (617) 724-1197, Fax: (617) 724-9532.

**Evening Activities:** On Sunday evening a banquet will be arranged. On Monday evening, from 7:00 - 9:00 PM, HCL will provide wine and a light supper, with opportunities to tour the facility. The cost of both these activities will be included in the registration fee.

Guests are welcome at both the evening events but will be charged \$25 for the banquet and \$10 for the HCL evening, payable at time of registration.

### **Preliminary Agenda:**

#### **Sunday October 31 1993**

1:00 PM on	Registration
1:30 – 3:30 PM	Dosimetry of protons
1:30 – 3:30 PM	Clinical protocols
4:00 – 6:00 PM	Radiobiology of protons
7:00 PM	Banquet

#### **Monday November 1 1993**

8:30 AM – 12:30 PM	MGH/NPTC status Optimizing patient throughput Discussion panel: What to do about dose and RBE? Business meeting
12:30 – 2:00 PM	Lunch will be provided
2:00 PM – 5:00 PM	Clinical retrospective: What have we learnt from these studies?
4 invited talks:-	<ul style="list-style-type: none"><li>• Pions</li><li>• Heavy Ions</li><li>• Neutrons</li><li>• Radiosurgery</li></ul>
5:00 – 6:00 PM	Panel discussion
7:00 – 9:00 PM	Ongoing projects and technical innovations: Part I
9:00 PM — midnight	HCL tours, beer, wine and a light supper. The local bar scene

#### **Tuesday November 2 1993**

7:00 AM	Breakfast meeting of the Steering Committee
9:00 AM– 12:30 PM	Advances in gantry design Control system experiences Recent clinical results
12:30 — 2:00 PM	Lunch
2:00 – 4:30 PM	Ongoing projects and technical innovations: Part II

## **Abstracts for PTCOG XIX**

Speakers are invited and encouraged to submit an abstract of their presentation, which will be circulated AFTER the meeting with the next issue of Particles. These abstracts will be collected at the meeting or they may be sent to Janet Sisterson.

The abstract must include the title, authors and affiliation and not exceed 1/2 page in length. Line drawings and graphs are welcome.

<b>International Symposium on Hadron-Therapy</b> (Treatment of Tumours at Ion Beam Accelerators) - Announcement
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The International Symposium on Hadron-Therapy will be held in Como, Italy, on October 18-21, 1993. The Symposium is intended as an international forum to review clinical, radiobiological and technical aspects of cancer treatments with protons and other ion beams. The first day of the Symposium will be an introduction to the field open to a wide audience. The other sessions will deal both with low and high LET irradiations and other modern modalities such as photodynamic therapy. The Symposium will be based on invited talks and submitted contributions. A poster section is also foreseen. The programme will include status reports from the working facilities and updates of the various projects.

The members of the Scientific Committee are: J. Alonso (Berkeley), U. Amaldi (Milan/CERN), P. Chauvel (Nice), G. Gademann (Heidelberg), K. Kawachi (Chiba), V. Khoroshkov (Moscow), P. Kleihues (Zurich), B. Larsson (Zurich, Chairman), A.E. Nahum (Sutton), J. Slater (Loma Linda), H. Suit (Boston), G. Tosi (Milano), A. Wambersie (Louvain-la-Neuve).

The first bulletin has been distributed at the end of May. The second and final circular will be mailed in mid-September to those who have sent their reply. Information can be requested to: International Symposium on Hadron-Therapy, Centro di Cultura Scientifica "A. Volta", Villa Olmo, Via Cantoni 1, 22100 Como, Italy, Fax : + 39 31 573395.

Marco Silari, Consiglio Nazionale delle Ricerche, Istituto Tecnologie Biomediche Avanzate, Via Ampere 56, 20131 Milano, Italy

<b>PTCOG News</b>
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The following reports were received by June 1993.

### **News from TRIUMF, Vancouver, Canada:**

The preparation for the eye therapy facility based on the use of a 70-120 MeV proton beam line at the TRIUMF cyclotron is underway, with the first eye patient scheduled to be treated in April 1994. This is a joint project between the Eye Care Center of the Vancouver General Hospital, the British Columbia Cancer Agency and TRIUMF. Because of the limited resources and funding, the basic design of the facility will follow closely many of the established proton facilities.

The 70-120 MeV proton channel was originally designed for neutron radiobiological studies. Hence both the beam line control system and the irradiation room can be quickly adapted for proton irradiation.

The eye treatment chair is locally designed. It has six degrees of motorized control: I. head tilt, II. head frame height, III. seat height, IV. chair forward/backward, V. chair transverse, VI. chair base rotation. These extra degrees of freedom will enable the same chair to be used in the future for the treatment of head and neck tumors and neuroradiosurgery using a higher energy proton beam which is being developed.

The treatment planning is based on the improved version of the EYEPLAN program (which takes into account the eyelids explicitly) as obtained from Clatterbridge Center for Oncology. For the graphics display the most recent version of the graphics package GRAPHX, developed by PSI, has been implemented and linked to EYEPLAN. We are now incorporating the TRIUMF beam specific parameters into the source code.

A preliminary experiment was performed to examine the possible spatial correlation between the proton-induced positron activity as measured by PET with the proton dose/stopping profile. The rationale is to use PET scans as a non-invasive method of dose verification in patients. We observed that for a proton energy of 116 MEV the activity profile is constant with depth and decreases sharply at the Bragg peak region. This is contrary to what we expected from the known cross-section of  $C^{11}$  production at different proton energies. Laterally, the activity profile was observed to follow very closely the dose profile.

Radiobiological measurements are planned to determine the depth-RBE variation of various range-modulated beams in order to verify the RBE values and the uniformity of biological effect. The gelatine technique (cells suspended in gelatine) developed for our pion program will be used. *E. Blackmore, S. Atkins, E. El Khatib, G. Lam, M. Nicolich, U. Oelfke, K. Paton, T. Pickles, J. Rootman and J. Vincent, TRIUMF, 4004 Wesbrook Mall, Vancouver, B.C. V6T 2A3, Canada*

#### Plans for proton therapy center on the basis of electron synchrotron at **Erevan Physics Institute, Armenia:**

At the Erevan Physics Institute (YerPhI) an electron synchrotron is in operation since 1967, having a maximum energy of 6.0 GeV. A great number of investigations concerning fundamental, accelerator and applied physics have been carried out during the accelerator functioning. A scientific program for the current decade has been developed, including the modernization of the accelerator and experimental facilities. However, the economic and energy crises in Armenia hinder the realization of the outlined program. The normal functioning of the accelerator can be secured only due to sharp reduction of its power consumption and at the same time, under supplementary self financing. These requirements can be satisfied when using the accelerator both for nuclear physics purposes and cancer treatment.

It is proved at YerPhI, that the existing synchrotron can accelerate not only electrons, but protons as well at a relatively low cost of reconstruction. Transition to the proton mode implies minimal changes in the existing accelerator which mainly will touch upon the injector and RF-system. At present, YerPhI and Moscow Radiotechnical Institute are collaborating to carry out such reconstruction and to develop the Yerevan Center of Proton Therapy (YerCPT). The R&D will be finished during 1993 and reconstruction work and assembly are scheduled for 1994-1996, providing there is a necessary financial support. A proposal describing the properties of electron/proton accelerator as well as the abilities of YerCPT for medical applications is under preparation now. The reconstructed synchrotron will deliver either electrons at energies of 2.0 to 4.5 GeV for scientific aims, or protons at energies of 250-500 MeV for medical applications. It is supposed to provide the beam intensity up to  $10^{12}$  protons/s at the repetition rate of 3 Hz and burst duration of 50-100 ms. These preliminary data illustrate the suitability of reconstructed

synchrotron for proton therapy. The studies assume two treatment rooms with horizontal beams with the possibility of adding a third room with vertical beam. We offer additional opportunities: in the YerCPT Collaboration participate the Armenian Oncologic Research Center and the Institute of Medical Radiology, the latter being in the neighborhood of YerPhI. We would like to express our interest and appreciation for any help with any organizations, institutions or experts in this field, be it financial or technical support, drafts, sketches, concepts etc. Please, contact Albert Oganessian, Yerevan Physics Institute, Alikanian Brothers St. 2, Erevan, 375036, Armenia. e-mail: ERPHI@ADONIS.IAS.MSK.SU; fax: 8-885-350030. *R. L. Mkrtychyan, Director of Yerevan Physics Institute.*

### News from the Harvard Cyclotron Laboratory:

After 21 years of guiding HCL, Andy Koehler is happy to hand over the reins to Miles Wagner, who on July 1 1993 will become the Director of HCL. We are all glad that Andy will not be retiring but will now have more time to spend pursuing his many ideas to enhance techniques in proton therapy. If Andy's next 40 years at Harvard are as productive as his last 40 (which we celebrated in June 1993), proton therapy should certainly reach new heights. *Janet Sisterson, Bernard Gottschalk, Harvard Cyclotron Laboratory, 44 Oxford Street, Cambridge, MA 02138.*

### Pion therapy at PSI, Switzerland:

After 10 years of pion therapy at the Paul Scherrer Institut in Villigen/Switzerland (the former SIN) we renounced to restart the PIOTRON after the maintenance shutdown of the accelerator beginning of this year, due to persistent problems with cryogenic system of the coils. Because of problems before the end of the last beam period 1992, which led to interruptions in therapy courses, the equipment was tested extensively, some components were changed, but it is unclear if the reason for the failure has been eliminated. Further testing and exchange of more components, but primarily time and some money would be necessary before a next patient could be treated. In view of the progress of the proton therapy project and because future parallel operation between Piontron and Project Proton Therapy is excluded, it has been decided to concentrate all our resources on the new project.

Over 500 patients have been treated with pions at PSI, of whom 92 suffered from soft tissue sarcoma, we have seen 79 intracranial tumors, 64 bladder cancers, 59 carcinomas of the uterine cervix, 55 malignancies of the upper abdomen and intestine, 54 prostate cancers, 35 bone sarcomas, 32 miscellaneous histologies, 20 colorectal tumors, and 13 miscellaneous gynecological tumors. At present we are busy updating *all* charts in order to give a comprehensive review on pion therapy with dynamic 3-d conformal application technique.

The Project Proton Therapy is well under way, the mechanical installation will be finished at the end of fall. During the beam period 1994 we will do the measurements and safety tests, maybe also first patients will be treated.

The OPTIS project is not touched by the above mentioned problems. Nearly 1500 patients have been treated since 1984, in cooperation with the Ophthalmological Clinic in Lausanne. *G. Munkel, H. Blattmann, Division of Radiation Medicine, Paul Scherrer Institute, CH-5232 Villigen PSI, Switzerland.*

Progress Report on The Northeast Proton Therapy Center to be located at the Massachusetts General Hospital, Boston, MA:

There has been considerable progress on the Northeast Proton Therapy Center (NPTC) during the last year. In this report we will describe that progress and also outline expected developments for the future.

During the course of the past year we developed the strategy for procurement of the building and equipment for the NPTC, initiated the procurement process and finalized the MGH management team. The procurement strategy we chose was to construct the facility through two prime contracts: 1) a Management-Design-Build contract to construct the building with a Guaranteed Maximum Price (GMP); and 2) a contract to design, build, install and commission the proton therapy equipment for a fixed-price. The management team for the building construction will exercise control over the design and build components of the building and also manage the cost-tracking and schedule for the equipment contract.

The MGH management team is now in place and its members are: Michael Goitein, project director; Alfred Smith, associate project director; Anne Levine, administrative director; Jacob Flanz, technical director (for the accelerator and the equipment); Stanley Durlacher, director for construction; Marcia Urie, Kenneth Gall and Stanley Rosenthal, medical physicists; and Susan Woods, accounting manager.

In December of 1992 the requests for proposals (RFP's) for both the building and equipment were issued. The individual RFP's contained requirements for a large measure of cooperation and interaction between the two contractors throughout the duration of both contracts. An essential component of this interaction is a requirement that the two entities work together early in the process to produce an Interface Document describing how the building and equipment would interface in order to achieve a fully integrated and harmonious facility.

Six, pre-qualified teams submitted proposals in response to the building RFP. In June of 1993 the prime contractor was selected and the contract is expected to be signed in July. We are expecting to receive proposals from three pre-qualified equipment contractors in late June. The anticipated milestones for the project are:

**NPTC MILESTONES**

<u>DATE</u>	<u>MILESTONE</u>
June 1993	Select Building Contractor
September 1993	Select Equipment Contractor
Fall 1993 to January 1995	Design Building and Equipment
January 1995	Begin Construction of Building & Equipment
May 1996	Building Completed
May 1997	Equipment Installation Complete
January 1998	First Patient Treated

Our plans are to build a facility having ultimately up to three treatment rooms with gantries and one treatment room with two horizontal beams, one for eye treatments and one for large field treatments. This facility will be located on the Massachusetts General Hospital campus across the street from the Massachusetts Eye and Ear Infirmary. The facility will likely have three levels, two of which will perhaps be underground, with a total of approximately 56,000 sq ft. We expect to treat about 850 patients per year in the new facility most of them being research patients who will be entered onto Phase III, prospective



clinical trials. We have formed relationships with several major academic radiation oncology centers in New England with the intent to establish an NPTC Affiliate Group whose members will be involved in the design and conduct of proton clinical trials.

We have received NCI funds to design the building and equipment and submitted an application May 1 to the NCI for necessary funds to carry out the remainder of the work. MGH has committed a major cost sharing component to the funding. At the writing of this report we have not received final word on the results of the review of our application. *Al Smith, Department of Radiation Oncology, Massachusetts General Hospital, Boston MA 02114.*

### Status of the GSI, Germany Therapy Project:

The biophysics experiments at the heavy ion accelerator SIS were mainly focused on the physical and biological characterization of oxygen beams i.e. on fragmentation and Bragg curve measurements and on inactivation measurements in single and fractionated exposure using pristine and decelerated oxygen beams of various energies. The goal of these measurements is to calculate the biological effectiveness of a penetrating beam based on the knowledge of beam fragmentation and the biological efficiency of the different ions. These calculations are a prerequisite for the use of a 3-dimensional scanning system and will be reported between in detail.

Beside these experiments the center point of the biomed discussion at GSI after the change in directorship to Prof. H. J. Specht was the question whether GSI should install a therapy unit for patient treatments or whether it would be sufficient to continue with pilot experiments only.

The opinion survived that GSI should install an experimental therapy exploiting the modern techniques of magnetic beam scanning and fast energy variation for tumor conform treatment combined with an improved knowledge on biological particle action.

In consequence a new cave for patient treatment and additional buildings for control and medical rooms were designed. The layout of an achromatic beam transport and an improved magnetic scanning system were calculated and the requirements of the beam diagnosis for this system were defined. An outline of the medical cave, the beam transport system and the annex building for the beam control and medical rooms is given in the figure.

In this version the beam is guided from the accelerator to the medical cave directly or via a fragment separator which enables to use radioactive ions if necessary. In the beam line between the last two deflection magnets diagnostic elements will be installed which guarantee the quality of the incoming beam necessary for the magnetic scanning system. The fast magnetic scanning system will be asymmetric with an offset in vertical direction in such a way that the beam passed over the patient in case of a failure of the system. This system provides a higher patient safety and avoid the difficult control small deflection angles.

For additional patient safety a position sensitive counter will control the beam position directly before the patient.

In the first stage only a horizontal beam is foreseen but the design of a superconducting gantry is in progress.

Presently the completion of the therapy cave and the necessary test phase is planned for 1995 and start of therapy in 1996. This is a joint project with the Radiological Clinic and the Cancer research Center at Heidelberg.

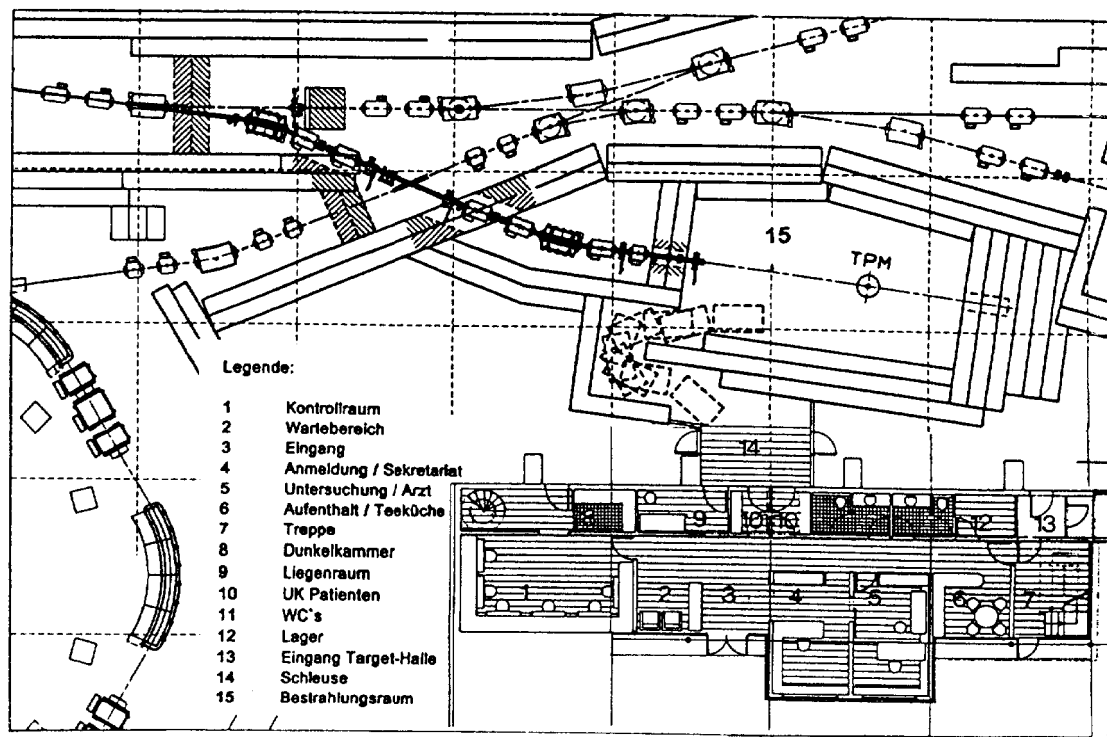


Figure: Layout of the new medical cave (15) at the SIS with control room (1) and medical rooms (2–10).  
*G. Kraft, Gesellschaft für Schwerionenforschung, Darmstadt, Planckstr. 1, PF 110552, DW-6100 Darmstadt, Germany*

**PTCOG XIX**  
**October 31 - November 2 1993**  
**Cambridge Massachusetts**  
**USA**

If you plan to attend the meeting,

Mail or FAX this form back **AS SOON AS POSSIBLE** to:-

Janet Sisterson Ph. D.  
PTCOG XIX Local Organizing Committee  
Harvard Cyclotron Laboratory  
44 Oxford Street  
Cambridge MA 02138, USA  
Phone (617) 495 - 2885                      Fax (617) 495 - 8054

**NAME:**

**ADDRESS:**

**PHONE:**

**FAX:**

I expect to attend	the HCL evening	<input type="checkbox"/>	I may bring a guest	<input type="checkbox"/>
	the banquet	<input type="checkbox"/>	I may bring a guest	<input type="checkbox"/>

I would like to give a presentation titled:-

.....

.....

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## WORLD WIDE CHARGED PARTICLE PATIENT TOTALS

July 1 1993.

WHO	WHERE	WHAT	DATE FIRST RX	DATE LAST RX	RECENT PATIENT TOTAL	DATE OF TOTAL
Berkeley 184	CA. U.S.A.	p	1954	— 1957	30	
Berkeley	CA. U.S.A.	He	1957	— 1992	2054	Jun-91
Uppsala	Sweden	p	1957	— 1976	73	
Harvard	MA. U.S.A.	p	1961		5876	Jul-93
Dubna	Russia	p	1964	— 1974	84	
Moscow	Russia	p	1969		2550	Oct-92
Los Alamos	NM. U.S.A.	$\pi^-$	1974	— 1982	230	
St. Petersburg	Russia	p	1975		719	Jun-91
Berkeley	CA. U.S.A.	heavy ion	1975	— 1992	433	Jun-91
Chiba	Japan	p	1979		86	Jun-93
TRIUMF	Canada	$\pi^-$	1979		314	Jun-93
PSI (SIN)	Switzerland	$\pi^-$	1980	— 1993	503	Jun-93
Tsukuba	Japan	p	1983		298	Jul-92
PSI (SIN)	Switzerland	p	1984		1363	May-93
Dubna	Russia	p	1987		24	Aug-92
Uppsala	Sweden	p	1989		34	May-93
Clatterbridge	England	p	1989		369	May-93
Loma Linda	CA. U.S.A.	p	1990		369	Dec-92
Louvain-la-Neuve	Belgium	p	1991		14	Jun-92
Nice	France	p	1991		216	Apr-93
Orsay	France	p	1991		235	May-93
					1047	pion beams
					2487	ion beams
					12340	proton beams
				TOTAL	15874	all particle beams

### Proposed NEW FACILITIES for PROTON & ION BEAM Therapy

INSTITUTION	PLACE	TYPE	DATE 1ST RX?	COMMENTS
Indiana Cyclotron	IN U.S.A	p	1993	200 MeV; other light ions possible.
N.A.C.	South Africa	p	1993	1st room ready & equipped for stereotactic radiosurgery.
P.S.I	Switzerland	p	1994	200 MeV, variable energy, dedicated beam line
Chiba	Japan	ion	1994	construction of HIMAC in progress.
TRIUMF	Canada	p	1994	adapt existing proton beam lines to therapy use.
Novosibirsk	Russia	p	1995?	180 - 200 MeV linear accelerator
A.P.D.C.	IL U.S.A	p	1996	250 MeV accelerator; private facility.
G.S.I Darmstadt	Germany	ion	1996	new cave for patient treatment has been designed.
ITEP Moscow	Russia	p	1996	6 treat. rms, 3 horiz. fix beams, 2 gantry, 1 exp., H- accel.
Jülich (KFA)	Germany	p	1997	Plan to develop a proton therapy beam line at COSY.
KVI Groningen	The Netherlands	p	1997?	proposal to plan a 200 MeV accel.; 2 rms; 1 gantry; 1 fix.
NPTC (Harvard)	MA U.S.A.	p	1998	new accelerator & facility to be built at MGH
Sacramento	CA U.S.A	p	?	proton therapy facility to be built at U.C. (Davis) M.C.
Clatterbridge	England	p	?	upgrade energy using booster linear accelerator.
Tsukuba	Japan	p	?	230 MeV accel.; 2 treat. rooms; 2 vert+1 h beam; 2 vert.
Chicago	IL U.S.A	n,p	?	neutron, proton therapy; radioisotope production.