PARTICLES

sponsored by

PROTON THERAPY CO-OPERATIVE GROUP

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

Number 21 January 1998 Editor: Janet Sisterson Ph.D., HCL

Mailing Lists: I am continuing to update the mailing list. If you have an **update form** included with this issue of Particles, you **MUST** send it back **OR** send e-mail to **ptcog@huhepl.harvard.edu** to stay on the mailing list. DO NOT SEND E-MAIL TO ME!!! PLEASE update your address, telephone and fax numbers and e-mail addresses. I thank everyone who has already sent me their updated information.

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 are covered in this way, so more financial help is needed from the community. HCL 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 "Harvard Cyclotron Laboratory". We thank Dr. Donald Smith for his kind contribution.

Facility and Patient Statistics: I am still collecting information about all operating and proposed facilities, regarding patient statistics, machine scheduling, and treatment characteristics. Please send me up-to-date information.

Particles on the Internet: We have set up a home page for the Harvard Cyclotron Laboratory on the Internet with links to recent issues of Particles.

- The URL for the Harvard Cyclotron Laboratory is:-

http://neurosurgery.mgh.harvard.edu/hcl/ or http://brain.mgh.harvard.edu:100/hcl

Other proton therapy links: (I did try all these URLs but I am sure this list is not complete, so PLEASE send me your URL to include in the next issue).

- Northeast Proton Therapy Center: http://www.mgh.harvard.edu/nptc/nptc.htm
- LLUMC, California: http://www.llu.edu/proton
- U of California, Davis: http://crocker.ucdavis.edu/cnl/research/eyet.htm
- Indiana University: http://nike.iucf.indiana.edu/ptherapy/
- TRIUMF, Canada protons: http://www.triumf.ca/welcome/proton_thrpy.html

- TRIUMF, Canada pions: http://www.triumf.ca/welcome/pion_trtmt.html
- NAC, South Africa: http://www.nac.ac.za/~medrad/index.html
- KVI, The Netherlands: http://www.kvi.nl/disk$1/protonlib/www/homepage.html
- PSI, Switzerland: http://www1.psi.ch/www_asm_hn/asm_home_page.html
- Proton Oncological Therapy, Project of the ISS, Italy: http://top.iss.infn.it
- TERA foundation, Italy: http://www.tera.novara.it
- Tsukuba, Japan: http://www-medical.kek.jp/index.html
- Tsukuba, Japan - new facility plans: http://www-medical.kek.jp/devnewfac.html
- HIMAC, Chiba, Japan: http://www.nirs.go.jp/ENG/particl.htm

ARTICLES FOR PARTICLES 22

The **deadline for news for Particles 22,** the July 1998 issue, is **May 30 1998**. I will send reminders by fax or e-mail.

Address all correspondence for the newsletter to:

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Articles for the newsletter can be short but should **NOT** exceed two pages in length. The best way to send an article is by computer. If you mail or fax an article, remember that I scan them into the computer so I need a good clean copy of any figures.

PTCOG and FUTURE PTCOG MEETINGS

Chair: Michael Goitein
Department of Radiation Oncology
Massachusetts General Hospital
Boston MA 02114

Secretary: Janet Sisterson
Harvard Cyclotron Laboratory
44 Oxford Street
Cambridge MA 02138

Steering Committee Members

USA	Europe	Russia	Japan	South Africa
J. Castro	U. Amaldi	V. Khoroshkov	K. Kawachi	D. Jones
W. Chu	H. Blattmann		H. Tsujii	
M. Goitein	J.-L. Habrand			
D. Miller	G. Munkel			
J. Sisterson	E. Pedroni			
James Slater	A. Wambersie			
A. Smith				
L. Verhey				

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

PTCOG XXVIII	Loma Linda, CA USA	April 15 - 17 1998
PTCOG XXIX	Heidelberg, Germany	September 28 - 30 1998
PTCOG XXX	NAC, Cape Town, South Africa	April 12 - 15 1999

1997 NIRS International Seminar on Heavy Charged Particle Therapy
in conjunction with PTCOG XXVII
Chiba, Japan, November 17 - 19 1997

This was a very interesting and well attended meeting and an excellent opportunity to hear the Japanese experience and advances in proton and carbon ion therapy. All the attendees enjoyed the hospitality provided by our hosts.

187 people attended the meeting; 130 from Japan; 21 from the USA; 12 from Taiwan; 6 from Russia; 5 from Belgium; 4 from Germany; 3 from Austria; 2 each from Switzerland and South Africa and 1 each from Italy and the People's Republic of China.

Contributed papers (after a due referee process) will be published as a special issue of the journal of the Japanese Society of Therapeutic Radiology and Oncology.

1998 PTCOG XXVIII
Rancho Mirage, California
April 15 – 17, 1998
Hosted by Loma Linda University Medical Center

The meeting of PTCOG XXVIII will be held on Wednesday April 15 through Friday April 17, 1998 at the Marriott's Rancho Las Palmas Resort in Rancho Mirage, California in the Palm Springs area. The meeting is sponsored by Loma Linda University Medical Center.

Registration: **Deadline for registration is March 6, 1998.** Please return the enclosed registration form as soon as possible with your presentation plan.

Registration Fees: $240.00; this includes a reception on Tuesday evening, transportation to and from LLUMC, lunch, and an evening social hour at LLUMC on Wednesday, and the conference dinner on Thursday.

Accommodation: Marriott's Rancho Las Palmas Resort is offering a special rate for the meeting, effective from Tuesday, April 14 – Friday, April 17. The room rate will be $162.00 for single/double occupancy per room, per night plus tax. **Deadline to reserve a room at the special rate is March 17, 1998.** A hotel registration form is included in this mailing.

Optional Accommodations:

Days Inn Suites 69151 E. Palm Canyon Drive Cathedral City, CA (760) 324-5939	Studio w/queen or 2 doubles $95.00 + tax per night Approx. 4 miles east of meeting site
Holiday Inn Express 74675 Highway 111 Palm Desert, CA (760) 340-4303	$109.00 + tax per night (includes continental breakfast) Approx. 15 minutes east of meeting site
Travelers Inn 72332 Highway 111 Palm Desert, CA (760) 341-9100	$90.00 - tax per night Approx. 1/2 mile east of meeting site

The Marriott's Rancho Las Palmas Resort is located in the Palm Springs area. From fall through late spring, days are warm and nights are cool. The average daily minimum – maximum temperature for the month of April is 57 – 94 degrees. Rancho Mirage is approximately 15 miles east of Palm Springs, which is the nearest airport. The next closest airport is the Ontario International Airport which is approximately 75 miles west of Rancho Mirage and then LAX Airport which is approximately 130 miles west of Rancho Mirage.

Transportation: Hertz has been selected as our official car supplier. When calling to reserve cars please use our **identification # 24577**. The numbers to use are, if you are calling from within the **U. S., (800) 654-2240**, from within **Canada, (800) 263-0600**, or from within **Toronto (416) 620-9620**.

Contact Person: Gwen Houston
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Abstracts: Contributors are invited and strongly encouraged to submit an abstract of their presentation that will be published in the July 1998 issue of Particles. The abstract should be about one half page in length, include authors and affiliations. Abstracts will be collected at the meeting or may be sent to Janet Sisterson by one of the means listed earlier in this newsletter. THE BEST METHOD is by e-mail to Sisterson@huhepl.harvard.edu.

Tentative Schedule

Day	Time	Site	Events
Tuesday, April 14	6:00 p.m.	Marriott	Registration and Social Hour
Wednesday, April 15	8:00 am	LLUMC	Bus transport to LLUMC
	10:00 – 12:00	LLUMC	Physics Session
	10:00 – 12:00	LLUMC	Protocol Working Group
	1:00 – 4:30	LLUMC	Operations and Integration
	5:00 – 6:30	LLUMC	Tour of Proton Area
	7:00 – 8:30	LLUMC	Social Hour
	9:00	LLUMC	Bus transport to Marriott
Thursday, April 16	8:30 – 10:00	Marriott	Physics Session
	10:15 – 12:00	Marriott	Radiation Biology Session
	1:00 – 2:30	Marriott	Clinical Session
	2:45 – 5:00	Marriott	Clinical Session
	6:30	Marriott	Conference Dinner
Friday, April 17	8:30 – 9:00	Marriott	Business Meeting
	9:00 – 10:00	Marriott	Physics/Biology Session
	10:15 – 12:00	Marriott	Clinical Session/Protocol Group Report
	12:30 – 2:30	Marriott	Mixed – Focus Session

Emphasis: The Operations and Integration session will emphasize efficiency and quality improvement measures that assist the operation of a high-volume proton therapy facility. Clinical sessions will focus on treatment protocols and clinical results. Suggestions for physics emphasis include Variable Energy Beam Delivery, Acceptance Testing, Commissioning and QA Procedures, Intensity Optimization, Uncertainties in Treatment Planning and Dose Delivery, and Biological Response Modeling.

PTCOG Information/News/Reports:

The following reports were received by January 1998.

Heavy-ion therapy at **GSI, Darmstadt, Germany:** First patients treated.

Two days after having received the legal approval, patient treatment started at Darmstadt, on Saturday December 13 1997. Two patients suffering from tumours at the base of skull were treated with five and four fractions of carbon ions respectively, within the course of their high precision radiotherapy at the German Cancer Research Centre in co-operation with the radiological clinic of the University, both at Heidelberg.

In each fraction, two target doses ≈0.4 Gy were applied in opposite fields using the novel raster scan technique. Up to 60 energy slices, sometimes extending over many hundreds of pixels had to be used to

cover the extended tumour volume. Set-up time for one field was approximately half an hour, treatment time about 12 minutes.

Beam position and intensity were monitored on-line and compared to the precalculated values. A 3-dimensional reprojection of the position of the stopping radioactive carbon isotopes was provided by an on-line PET system developed by the group of FZ Rossendorf, a few minutes after irradiation. A full reconstruction was available after one hour. In both cases, on-line position monitoring and PET reconstruction showed no discrepancies within the accuracy of both methods.

Patient treatment will restart in the second half of 1998 after the installation of a new physics Cave, that was postponed in order to start the therapy program first. *Gerhard Kraft, GSI Darmstadt. Planckstrasse 1, D-64291 Darmstadt, Germany.*

Status of the Northeast Proton Therapy Center, Boston Construction:

The Northeast Proton Therapy Center is on the main campus of Massachusetts General Hospital. The center will be used to conduct cancer therapy research and to provide treatments which have been proven to be effective. It is designed with a capacity to treat up to 1000 patients, delivering 10,000 treatment fractions, per year. The NPTC will contain three treatment rooms, two with isocentric rotating Gantries and one with horizontal beam lines that can be used for eye treatments, and for large field beams for research and dosimetric studies. Proton beams in the energy range 70 to 235 MeV will be provided with rapid (2 sec) energy switching. The Gantries will be capable of delivering beams for different beam spreading methods including passive scattering, wobbling and scanning. A robotic patient positioner is designed to provide patient positioning to submillimeter accuracy. The NPTC construction is being jointly funded by the National Cancer Institute and the MGH.

The cyclotron, which was installed in June of 1997, has been operated frequently while studying the beam parameters and has proven to be reliable.

The installation of the first Gantry began in October, 1997. The Gantry structure allows the isocenter to point within ±0.5mm of the intended location. Factory construction of the Patient Positioner is almost complete. Preliminary testing gives reproducibility results on the order of ±0.2 mm or less. Although effects such as elastic deflection result in some additional inaccuracy, studies using the actual data show

that most of the inaccuracy of the PPS is due to deflection and can be corrected very close to the level of the reproducibility.

Over the next few months the remainder of the equipment will be installed. After the second Gantry is installed, the finishing touches will be put on the building. The projected schedule continues to foresee treating our first patient in the Fall of 1998 using the first Gantry. *J. Flanz, S. Bradley, S. Durlacher, M. Goitein, J. Loeffler, A. Smith, and S. Woods, Massachusetts General Hospital, 30 Fruit Street, Boston MA 02114*

Update from **Indiana University,** Indiana, USA:

Construction of the eye treatment line has been completed. The initial treatments will be a clinical trial on choroidal neovascular membrane in age-related macular degeneration. Those treatments should begin in March.

Plans have begun for a second treatment room. This will be a large-field horizontal beam line. The beam will be spread magnetically rather than using scattering foils. This will give a maximum range in water of 28 cm for the 210 MeV beam. Present plans call for this room to be operational in the beginning of 1999.

Indiana University has started screening applicants for the medical director position, and hopes to have this person on board this summer. *Chuck Bloch, Indiana University Cyclotron Facility, 2401 Milo B. Sampson Lane, Bloomington, IN 47408-0768*.

News from **TANDAR, Buenos Aires**, Argentina:

A cooperative program has started between the Physics Department of the Atomic Energy Commission of Argentina and the School of Science and Technology of the National University of San Martín on one hand and the Centre de Protontherapy d'Orsay, France on the other, to promote exchange of scientists and students and common research in physics and radiobiology with proton beams at the Tandem accelerator (TANDAR) in Buenos Aires and at the Synchrocyclotron in Orsay. This activity will also be the starting point for a feasibility study to eventually introduce protontherapy in Argentina.
Drs. A. Mazal, J.-C. Rosenwald and A. Touati gave a two weeks seminar on the physical and biological basis of radiotherapy and specifically protontherapy to physicians, physicists, radiobiologists and students interested in this project. This seminar was also supported by the French Embassy in the frame of the celebration of the centennial of the discovery of radioactivity. A first external proton beam of 20 MeV has been produced and used for dosimetric measurements and irradiation of mice as a first step to start a radiobiology research activity. *Andrés J. Kreiner, Departamento de Fmsica, TANDAR, CNEA, Avda. Libertador 8250, 1429 Buenos Aires, Argentina and Alejandro Mazal, Centre de Protontherapie d'Orsay, BP 65, Orsay cedex 91420, France*.

The Hadrontherapy Programme of the TERA Foundation

As far as the direct intervention of the TERA Foundation is concerned, the design and construction activities of the Hadrontherapy Programme are organised in four projects. The work done by the members of the Hadrontherapy Collaboration in these areas and in hadron radiobiology and dosimetry, with the continuous support of the National Institute of Nuclear and Subnuclear Physics (INFN), has been published in the *Blue Book* [1], the *Green Book* [2] and the *Red Book* [3].

1. The CNAO Project

From the beginning of 1992, the TERA Foundation is engaged in the design and realisation of the hadrontherapy centre CNAO based on a synchrotron which can accelerate protons to at least 250 MeV and carbon ions to at least 4500 MeV (i.e. 4500/12 = 375 MeV/u). This will be a centre of excellence devoted to tumour hadrontherapy of more than one thousand patients/year, to clinical research in cancer therapy and to R&D in the fields of radiobiology and dosimetry. Dr. Giorgio Brianti, past CERN Technical Director, is the Chairman of the CNAO Project Advisory Committee.

Five TERA staff members and two doctoral students from the AUSTRON Project (Vienna) participate in the study called PIMMS (PIMMS = *Protons and Ions Medical Machine Study*), started in 1996 at CERN, which aims at finding new optimised solutions for the synchrotron and the isocentric proton gantries. In spring 1996 Prof. Hans Specht, Director General of GSI (Darmstadt), decided that GSI will contribute by taking the responsibility for the design of the ion injector and of a gantry for carbon ions. This common activity of CERN, TERA, AUSTRON and GSI aims at a first document to be ready by summer 1998.

For a medical synchrotron the intensity of the extracted beams poses no special problem, since 10^{11} p/s and 3 10^{9} ions/s are enough. The issue is the time uniformity of the spill since, due mainly to the magnet ripples, synchrotron pulses have time structures at many frequencies; this makes the active spreading of the beams difficult.

The main features of the synchrotron design can be summarised as follows:

* during the extraction all optics functions are kept rigorously constant (stable orbits and beam sizes);
* a betatron core is used to accelerate the beam into the resonance. This element has the only power converter that changes during extraction (machine is very 'quiet');
* the betatron core will have smoothing applied to the DAC steps;
* the main converters will be combinations of a booster for ramping and a lower voltage converter (switch-mode if possible) for holding the flat-top;
* the beam entering the resonance has a range of momenta and betatron amplitudes that tend to compensate medium frequency ripple;
* a channelling bucket will be used to speed up the entry of the particles into the resonance in order to dampen the response to low-frequency ripple.

While initiating this European collaboration, in December 1995 the TERA Foundation offered to nine hospitals, oncological institutes of Milano and Pavia and universities to form a consortium and realise the CNAO in Milano. The instrument of understanding was signed by: *Salvatore Maugeri Foundation* (Pavia), *TERA Foundation* (Novara), *European Institute of Oncology* (Milan), *National Institute for Tumour Research and Cure* (Milan), *National Neurological Institute Besta* (Milan), *Ospedale Maggiore Polyclinic* (Milan), *San Matteo Polyclinic* (Pavia), *Polytechnical School* (Milano), *University of Milano, University of Pavia.*

The Polyclinic of Milano put at the disposal of CNAO a wonderful site located close to the *Mirasole Abbey*, South of Milano on the road going to Pavia[1]. The National Oncological Commission gave its positive opinion on the CNAO project in December 1995.

2. The "compact" accelerators Project PACO

In the framework of the Hadrontherapy Programme, in the years 1993-1995 four working groups have designed four novel medical proton accelerators: two synchrotrons, a superconducting cyclotron and a high-frequency (3 GHz) proton linac. They are described in the Green Book. Since 1993 the Istituto Superiore di Sanità (ISS) in Rome decided to request special funds for the construction of a prototype of a

[1] In March 1997, the bylaws of the *Fondazione Medico Scientifica Mirasole*, a non-for-profit Foundation which will be responsible for the construction and the management of CNAO, have been approved. At the beginning of June 1997 Ospedale Maggiore asked officially funds for building the first lot of CNAO to the Government of the Lombardy Region.

"compact" accelerator (and its rotating gantry) and to finance R&D programmes in the fields of radiobiology, dosimetry, networking, pathology and treatment planning. In September 1995 the decision was to construct the first part of the high-frequency proton linac, whose injector will also be capable of producing PET isotopes. In 1997 an agreement is going to be signed between ISS, Institute Regina Elena (IRE), ENEA (Ente Nazionale per le nuove tecnologie, l'Energia e l'Ambiente) and TERA for the construction of the accelerator on a convenient site located in between the buildings of ISS and of IRE. This programme is now known as the *TOP Project* of ISS, where TOP stands for "*Terapia Oncologica con Protoni*".

3. The RITA network

The creation of an informatics and organisational network, called RITA (*Italian Network for Hadrontherapy Treatment),* which will connect the *Associated Centres* – distributed throughout Italy (and abroad) and situated in the public oncological institutions and in private clinics – with the Centres where proton and ion beams will be made available. The specialised medical and physics staff in these Associated Centres will be able to discuss in remote, through multimedia connections, the clinical cases with the experts of the Hadrontherapy Centre and those of the Protontherapy Centres by using the most modern informatics means. They will exchange diagnostics images and some of the physicians at these Associated Centres (sometimes after using conventional radiotherapies) will even be in such a position as to plan a successive treatment for their patients, which will then be irradiated in one of the Centres where hadron beams are available. The implementation of the RITA network is already well advanced, so that a first connection between two oncological centres has been tested and a multimedia clinical folder for radiotherapy has been released.

4. A 3 Ghz Linac Booster (LIBO) for Proton Cyclotrons

The design of a SCL linac used as a *booster* (from which the acronym LIBO = Linac Booster) of a 60-70 MeV proton cyclotron has been launched, in 1997, by the TERA Foundation. The development of this accelerator is very interesting because there are at least twenty 50-70 MeV cyclotrons in the world which could be transformed in facilities for protontherapy of deep tumours. In the Green Book the study was carried out with reference to the 62 MeV cyclotron of the Cyclotron Unit, Clatterbridge Hospital (UK). In a total length of 13 m, 9 modules formed of 4 tanks and powered by 9 klystrons take the proton beam from 62 to 200 MeV. The repetition rate is 400 Hz, which is good for a voxel active spreading of the beam. The overall linac capture efficiency, taking into account the fact that the linac acceptance is about three times the cyclotron emittance, is $1.5\ 10^{-4}$, so that the average proton current at 200 MeV is 10 nA. The power is about 100 kW. By switching off klystrons it is possible to vary the proton energy between 140 and 200 MeV.

References: [1] *The TERA Project and the Centre for Oncological Hadrontherapy*, Vol.I and Vol.II, U.Amaldi and M Silari Eds, INFN, Frascati, 1995. *Addendum*, D. Campi and M. Silari Eds. The whole collection is called the "*Blue Book*". [2] *The RITA Network and the Design of Compact Accelerator*s, U. Amaldi, M. Grandolfo and L. Picardi Eds, INFN, Frascati, 1996. The "*Green Book*". [3] *The National Centre for Oncological Hadrontherapy at Mirasole*, U. Amaldi Ed., INFN, Frascati, 1997. The "*Red Book*".

U. Amaldi and Sandro Rossi, CERN, Geneva and TERA Foundation, Novara

Proposed NEW FACILITIES for PROTON & ION BEAM THERAPY
January 1998

INSTITUTION	PLACE	TYPE	1ST RX?	COMMENTS
Berlin	Germany	p	1998	72 MeV cyclotron; eye treatment beam line.
NPTC (Harvard)	MA USA	p	1998	at MGH; 235 MeV cyclotron; 2 gantries + 3 horiz.
Kashiwa	Japan	p	1998	235MeV cyclotron;2gantries;1horiz; under construction
INFN-LNS, Catania	Italy	p	1999	70 MeV; 1 room, fixed horiz. beam
Bratislavia	Slovakia	p, ion	2000	75 MeV cyclotron; p; ions; +BNCT, isot prod.
CGMH, Northern Taiwan	Taiwan	p	2000	250 MeV synchrotron, 3 gantries, I fixed beam
Hyogo	Japan	p, ion	2001	2 gantries; 2 horiz; 1 vert; 1 45 deg;under construction
NAC, Faure	South Africa	p	2001	new treatment room with beam line 30^{o} off vertical.
Tsukuba	Japan	p	2001	270 MeV; 2 treat rooms with gantries; 1 research room
Wakasa Bay	Japan		2001?	multipurpose accelerator; building completed mid 1998
Shizuoka Cancer Center	Japan		2002?	synchrotron 230? MeV; 2 gantries; 1 horiz; funded.
CNAO, Milan & Pavia	Italy	p, ion	2002?	synchrotron; 1 gantry;2 fixed beam rooms;1 exp. room
AUSTRON	Austria	p, ion	?	1p gantry;1 ion gantry;2 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	?	upgrade using booster linear accelerator.
TOP project ISS Rome	Italy	p	?	200 MeV linac;1eye room; gantry?;under construction
3 projects in Moscow	Russia	p	?	
HIRFL,Lanzhou	PR China	C ion	?	
Jülich (KFA)	Germany	p	?	exp. beam line; plans for therapy.
Krakow	Poland	p	?	60 MeV proton beam.
KVI Groningen	The Netherlands	p	?	plan:- 200 MeV accel.; 2 rms; 1 gantry; 1 fix.
Moscow	Russia	p	?	320 MeV; compact, probably no gantry
Proton Development N.A. Inc.	IL USA	p	?	300 MeV protons; therapy & lithography
PROTOX	England	p	2001?	existing RAL synchrotron; 250 MeV; 3 treat. gantry

WORLD WIDE CHARGED PARTICLE PATIENT TOTALS

January 1998

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		7432	Jan-98
Dubna	Russia	p	1967	— 1974	84	
Moscow	Russia	p	1969		2838	May-96
Los Alamos	NM. USA	π-	1974	— 1982	230	
St. Petersburg	Russia	p	1975		1028	Dec-97
Berkeley	CA. USA	heavy ion	1975	— 1992	433	June-91
Chiba	Japan	p	1979		96	Oct-96
TRIUMF	Canada	π-	1979	— 1994	367	Dec-93
PSI (SIN)	Switzerland	π-	1980	— 1993	503	
PMRC, Tsukuba	Japan	p	1983		547	July-97
PSI (72 MeV)	Switzerland	p	1984		2482	Dec-97
Dubna	Russia	p	1987		40	Dec-97
Uppsala	Sweden	p	1989		112	Apr-97
Clatterbridge	England	p	1989		764	July-97
Loma Linda	CA. USA	p	1990		3001	Dec-97
Louvain-la-Neuve	Belgium	p	1991		21	Nov-93
Nice	France	p	1991		1010	Jan-98
Orsay	France	p	1991		956	May-97
N.A.C.	South Africa	p	1993		243	Dec-97
IUCF	IN USA	p	1993		1	Dec-97
UCSF - CNL	CA USA	p	1994		144	Dec-97
HIMAC, Chiba	Japan	heavy ion	1994		301	Aug-97
TRIUMF	Canada	p	1995		37	Jan-98
PSI (200 MeV)	Switzerland	p	1996		9	Dec-97
G.S.I Darmstadt	Germany	heavy ion	1997		2	Dec-97

	1100	pions
	2790	ions
	20948	protons
TOTAL	24838	all particles

See Page 10
for
The Proposed New Facilities Table