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IRPS BULLETIN

Volume 15 No 2 July, 2001

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FROM THE EDITOR

Paul Bergstrom

Three months have passed rather quickly and it is time for yet another IRPS Bulletin. It was fortunate that I attended the recent meeting of the IRPS council in Exeter, UK as most of the contributions for this edition were obtained from the participants of that meeting, using a direct approach.

The council meeting was hosted by Professor David Bradley at the University. The spring flowers in the gardens made for a lovely setting. Discussions centered on future meetings of the Society and the council, membership, the Bulletin and other issues.

In this month's President's column, Professor Cooper will discuss a contest meant to elicit more contributions to the Bulletin. If you have a contribution to make and don't qualify for the competition, fear not! Your contribution is still much appreciated by the editor.

Other columns in this month's Bulletin discuss awards given by other organizations to members of the Society, a report on a meeting that should be of interest to those who use Monte Carlo transport methods, a discussion of the status of a new European scientific facility, and a report on an interesting form of therapy for cancer victims.

We have reports of the recent award to John Hubbell of the Health Physics Society of it's Distinguished Scientific Achievement Award and on the grant of an Associateship to Suprakash Roy by the Third World Academy of Science.

Professor Leif Gerward, a faithful contributor to these pages has written an account of the proposed TESLA project at DESY. It points to milestones achieved and

decisions that need to be made in order for this accelerator to be built.

Richard Hugtenburg's, report on the annual MCNEG meeting points to the increasing interest in Monte Carlo for radiation therapy. It also shows how a meeting can outgrow its original audience both in subject (MCNP) and nationality (UK).

Dan Jones, host of our upcoming symposium in Cape Town has contributed a review of fast neutron therapy for cancer. The review touches on most aspects of the field from the facility level to the biological level.

Enjoy!

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PRESIDENT'S COLUMN

Malcolm Cooper

It was a delight to see so many attendees to our Spring Council meeting which was held in May at Exeter University, whose mature campus is surely one of the prettiest in the United Kingdom, having started out as the grounds of a "stately" home. Paul Bergstrom, the new Editor of our Bulletin, was one of those present and able to inject fresh ideas as well as to reduce significantly the average age of the IRPS Council! There was certainly a positive feel about the future of the Society - we have now stemmed the haemorrhage of our meagre funds because most of you have agreed to receive this bulletin electronically: thank you. Now we need to build up our membership and hence our membership funds so that we can provide something more than "moral" support to Radiation Physics, especially to younger scientists working in our discipline. This is a task for all of us. Are your graduate students members? If not, why not?

The encouragement of young scientists begins now, right here in the Bulletin. We would like to publish a regular stream of scientific articles written by young scientists. These articles should be typically no more than 1000 word equivalent, including any diagrams and tables etc. and should briefly describe unpublished research work by graduate students or postdoctoral research workers, prior to its eventual publication in referreed journals. This

would not prejudice those detailed publications. It would be nice to anticipate a great flood of articles and we will publish as many as possible. There will be a prize of 100 US Dollars for “star” articles, as judged by the Bulletin’s Editor and me. [NB, in the European Union “young” is defined as no more than 35 years old: personally, I could not possibly agree with this definition, but let’s accept it for this purpose.]

The same principle will be extended to our next IRPS Symposium in Cape Town, South Africa in 2003. From the papers/posters offered by young scientists a number will be selected for short oral presentations in a special “competition” session and there will be significant cash prizes for the winners.

Please encourage your graduate students to use the Bulletin as a medium for publishing and publicising their research. Hopefully, one day, one of them will be writing this column!

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AWARDS TO MEMBERS

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Details of Award

Suprakash C Roy : **Named as TWAS-UNESCO Associate at Centers of Excellence in the South**

Details of Award

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DESY releases the TESLA Technical Design Report

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On March 23, 2001, DESY released the 5-volume TESLA Technical Design Report, describing the scientific perspectives and the technical realisation of a new accelerator project, including a time table and cost estimates. The report marks the beginning of a one-year survey by the German Wissenschaftsrat , a scientific council advising the government on scientific matter, and by various international advisory boards. At the end of this phase, the German government is expected to decide on the TESLA project. The projected total investment for the TESLA project amounts to 3,877 million Euro (about 3,300 million USD), over a period of 10 years. It is assumed that 50% of the cost will be paid by the Federal Republic of Germany, the rest being provided by international collaborations. The total construction work corresponds to 7000 man-years.

The new acelerator project, TESLA, is being planned and developed in an international collaboration at the Research Center DESY in Hamburg, Germany. If approved, the project could be realized by the year 2011. TESLA should open new perspectives for basic science and industrial applications in a large number of research fields. The 33 km long linear accelerator, based on superconductor technology is to be built underground. It will generate collisions between electrons and positrons with 500 GeV energy (which can be extended to 800 GeV). At the same time it should be an extremely powerful source of x rays with wavelengths in the range from 0.1 to 1 nm and with laser qualities (the so called Free-Electron Laser, cf. a paper in the IRPS Bulletin 14(4), p. 5, Dec. 2000). The scientific perspectives and the realization of TESLA were themes of a two-day international colloquium March 23-24 at DESY that attracted more than 800 participants.

A large-scale interdisciplinary and international research campus will be created around the TESLA facility, providing unique possibilities for studying elementary particle physics, condensed matter physics, chemistry, materials science and structural biology. Elementary particle physicists expect new findings regarding the Higgs particle, supersymmetry and super-string theories and dark matter. In radiation physics and chemistry, great expectations are connected with the x-ray free-electron laser. This facility should provide coherent, polarized x-ray beams with a brilliance that is more than 100 million times higher than present-day sources. The availability of a coherent, parallel x-ray beam will certainly stimulate the development of new diffraction and imaging techniques. Moreover, the x rays will be delivered in flashes with a duration of 100 femtoseconds or even less, allowing the observation of extremely fast processes.

In structural biology there are suggestions to use the free-electron laser to image nanometer scale biomolecular assemblies with atomic resolution. The x-ray laser is also expected to play an important role for the analysis of large molecular complexes, which are difficult to crystallize and which hardly can be studied by present-day methods. Traditional experimental techniques in condensed matter physics, such as neutron scattering and x-ray diffraction, have severe limitations when it comes to studies of ultra-fast processes in nanostructured materials. The x-ray laser, on the other hand, can be used to probe dynamic states of matter and fast transitions between different states of matter. These non-equilibrium states are important for tailoring materials properties in nanoscale devices.

Further information on the TESLA project can be found at the web site

http://tesla.desy.de

Source: Press Release March 23, 2001, DESY Information.

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MEMBER'S PAPER

FAST NEUTRON THERAPY

Cures for the Incurable

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1. Cancer Incidence and Treatment

Cancer can broadly be defined as the uncontrolled growth and proliferation of groups of cells, the triggering of which is not yet fully understood. In industrialised societies about 30% of people suffer from cancer and about half of these die from the disease. More than half of all cancer sufferers receive radiation therapy (possibly in conjunction with surgery and chemotherapy). The prognosis in individual cases varies greatly and depends on tumour type, stage of diagnosis, general health of the patient, etc. A patient who survives for 5 years after commencement of treatment without further symptoms is regarded as having been cured. The overall 5-year survival rate of all treated cancer sufferers is about 45%.

Cells from the primary tumour can metastasize (spread to other parts of the body) and about 30% of all cancer patients have metastases at diagnosis. Radiotherapy and surgery are both localised forms of treatment. They are used, alone or in combination, to treat the primary tumour and are responsible for about 90% of cancer cures (50% surgery, 40% radiotherapy alone or combined with surgery). In addition, radiotherapy - even at moderate doses - is particularly effective for palliative treatment of metastases, especially for pain relief. Chemotherapy is used to treat metastases and the 5-year survival rate is about 5% (about 10% of all cures).

From the above statistics it is clear that even modest improvements in cancer treatment will benefit a large number of people. A very important factor to also consider when assessing the cost-benefit of cancer treatment is the cost of not curing a patient.

This can be very high and may involve risky salvage surgery, chronic health care costs, and other costs. These costs may be as much as 4-5 times the cost of curing a patient.

2. Radiation Therapy

The objective of radiation therapy is to maximise the effect of the radiation on the target lesion and to minimise the effect on surrounding normal tissue. This is done by increasing either the physical dose differential or the biological effect differential between the target and normal tissue. This requires accurate lesion delineation, proper treatment planning, precise patient positioning and other factors.

Radiation is usually not administered in a large single dose (except in special circumstances) but is divided into several treatment sessions or fractions (up to 30 or more, depending on the condition being treated and the modality used). This technique allows normal healthy cells which suffer sublethal damage (i.e. they sustain some damage but are not killed) in the previous session to repair and recover, while the unhealthy cancer cells are unable to recover during this period. The dose limiting factor in radiation therapy is the amount of damage which normal tissue can sustain.

Radiation therapy machines are expensive, high technology equipment, but a sterile environment is not required; few people are involved in patient treatment, which does not necessarily require the daily presence of a radiation oncologist or any other clinician; most patients are treated as out-patients and therefore do not occupy scarce and expensive hospital beds; irradiation is not traumatic for patients, who are not normally anaesthetized (except possibly in the case of small children) and usually do not get sick from the treatment; there is little after-care and usually no expensive intensive care or extended hospitalisation are necessary. Radiation therapy is therefore cost-effective and often cheaper than the alternatives of surgery, chemotherapy or health care for the chronically ill.

3. Rationales for Neutron Therapy

The biological effects of different radiations depend not only on the dose delivered, but also on the microscopic dose distribution which is expressed in terms of LET (linear energy transfer). Densely ionizing radiations such as neutrons, pions and heavy ions are high-LET radiations while photons, electrons and high-energy protons are low-LET radiations. The higher the LET, the greater the biological effect of a given type of radiation. The lower the energy of a particular radiation the higher is its LET and therefore its biological effect.

For a given physical dose high-LET radiations are more efficient at killing cells than low-LET radiations. This is quantified in terms of the rbe (relative biological effectiveness) which is defined as the ratio of the dose of a reference radiation (usually 60Co) required to produce a specified biological effect to the dose of the given radiation required to produce the same effect *(Fig. 1)*. With low-let radiations a larger proportion of cells suffer sublethal (repairable) damage than with high-let radiations, where the damage is largely irreparable.

One of the main rationales for high-LET therapy lies in the so-called oxygen effect. Because the rapidly proliferating tumour cells can reduce the blood supply to the centre of large tumours, the cells in this region can become deprived of oxygen. Cells which lack oxygen are resistant to low-LET radiations (photons and electrons) but are much less resistant to high-LET radiations which therefore have a better chance of effecting a cure. The oxygen effect is quantified in terms of the OER (oxygen enhancement ratio) which is defined as the ratio of the dose of radiation required to produce a specified biological effect under anoxic conditions to the dose required to produce the same effect under well-oxygenerated (aerated) conditions *(Fig. 1)*.

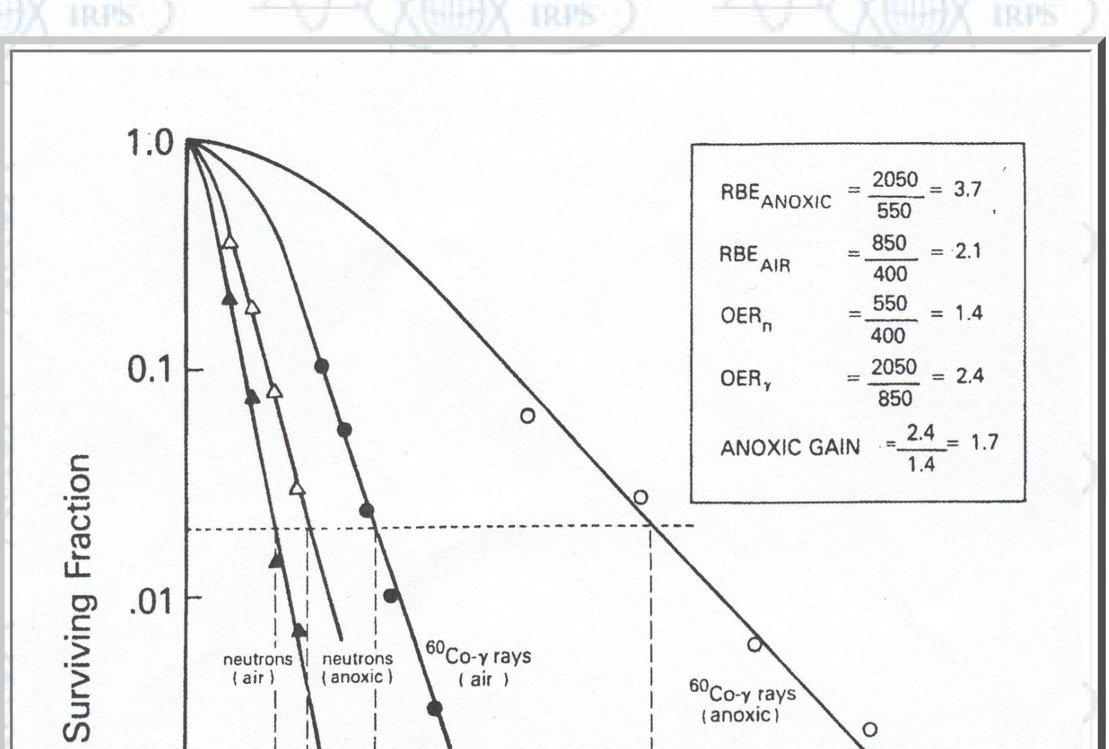

Fig. 1 : Typical survival curves for cells irradiated in ^{60}Co and fast neutron beams under well-oxygenerated (exposed to air) and anoxic conditions. RBE and OER values are given at the survival level illustrated (1 Gray = 100 rads)

Another important reason for using these radiations concerns the cell cycle effect. Cells are most sensitive to radiation in the mitotic (dividing) phase of the cell cycle. However, they are relatively tolerant in the S (DNA synthesising) phase, and since slowly growing tumours contain a larger proportion of cells in this phase at any given time these tumours are resistant to conventional radiations. The variation in radiosensitivity between cells in different stages of the cell cycle is much less for fast neutrons and other high-LET radiations *(Fig. 2)* which are therefore generally used for treating large, slow-growing or radioresistant tumours.

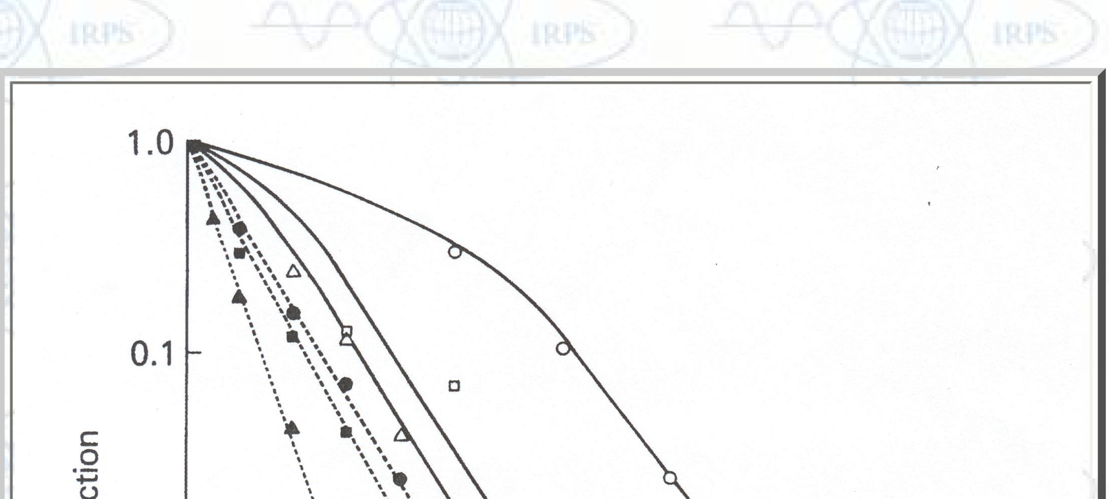

Fig. 2 : Typical survival curves for synchronised cells irradiated in ^{60}Co and fast neutron beams at three different positions in the cell cycle : mitosis, late G1/early S, mid to late S phase. The magnitude of the cell cycle-dependent variations in radiosensitivity is about a factor of 4 less for neutrons in this case (1 Gray = 100 rads)

The physical characteristics of high-energy fast neutron beams are similar to those of high-energy x-ray beams *(Figs. 3,4)*. A RBE value of about 3 is typically used for clinical fast neutron beams.

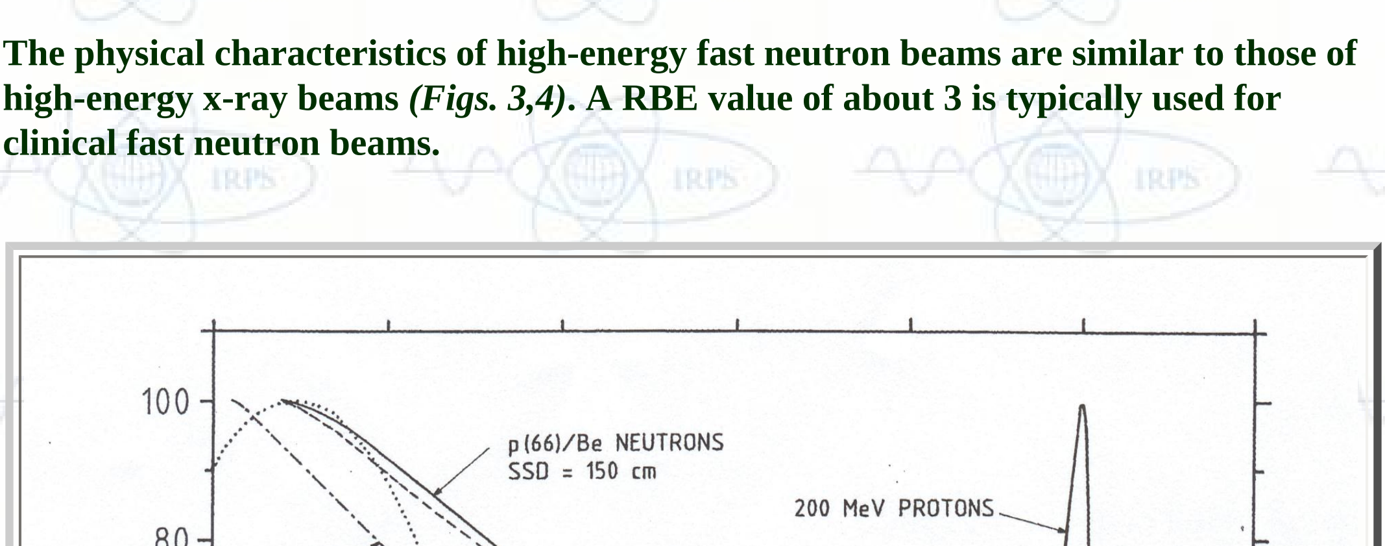

Fig. 3 : Depth dose curves for a p(66)+Be neutron therapy beam compared with other radiotherapy beams

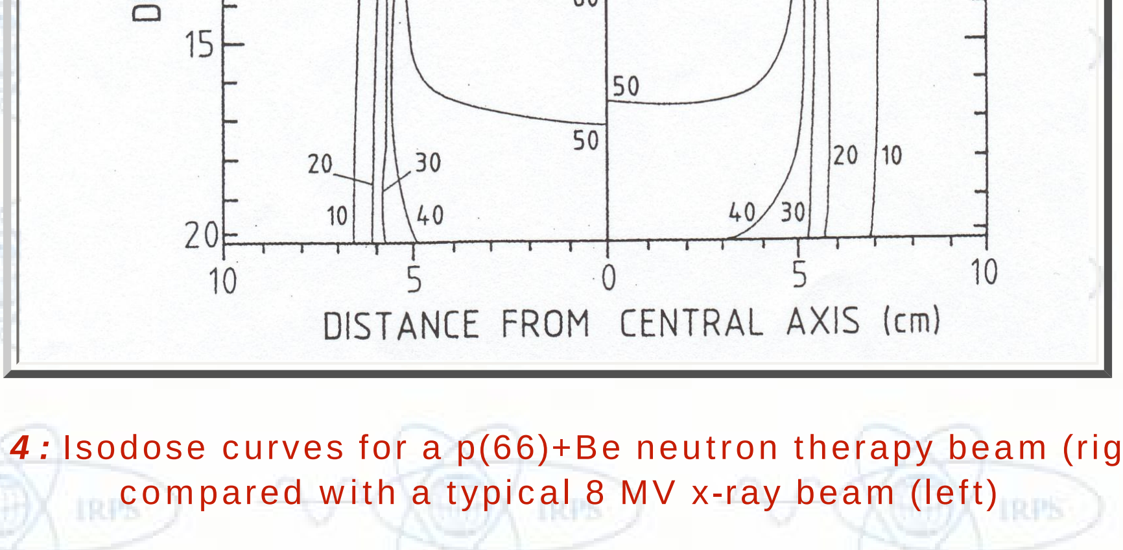

Fig. 4 : Isodose curves for a p(66)+Be neutron therapy beam (right) compared with a typical 8 MV x-ray beam (left)

An additional advantage of fast neutron therapy lies in the fact that fractionation schedules are not as critical as with low-LET radiations. Neutron therapy can be delivered in a fewer number of fractions and therefore patient distress is reduced and patient throughput can be increased, resulting in more cost-effective treatments.

4. Historical Aspects

The story of neutron therapy began with the construction by Ernest Lawrence and his associates of the first cyclotrons at Berkeley in the early 1930s. Shortly after the discovery of the neutron by Chadwick in 1932 at the Cavendish Laboratory in Cambridge, Ernest and his brother John Lawrence (a physician) along with their co-workers at Berkeley were experimenting with the effects of fast neutrons on biological systems. In a remarkable paper in 1936, Locher postulated on the therapeutic possibilities of both fast and slow (by means of the thermal neutron capture process). On the 26 September 1938, the first patients were treated with neutrons on the 37 inch cyclotron at Berkeley. The neutrons were produced in the reaction of 8 MeV deuterons on a beryllium target [designated d(8)+Be]. Single fractions only were administered. This pilot study on 24 patients was regarded as most successful and led to the construction of the dedicated 60-inch Crocker Medical Cyclotron. A total of 226 patients were given fractionated treatments with neutrons [d(16)+Be] on this latter machine between 1939 and 1943, before the cyclotron was expropriated for the atomic bomb programme.

Although some remarkable cures were obtained, many patients suffered severe side effects and neutron therapy fell into disrepute. Later analyses of the treatments showed that the increase in RBE when fractionated treatments are given was not taken into account as the effect was not known at the time. Only after extensive radiobiological investigations of the effects of neutrons was neutron therapy started again in the mid-1960s at Hammersmith Hospital, London, and later at many other centres.

5. Neutron Therapy Facilities

The most common accelerators currently used to produce neutron therapy beams are cyclotrons although a few electrostatic generators, linear accelerators and reactors have been used. Many of the early fast neutron therapy facilities were closed because of several factors: the physical beam properties were hopelessly inferior, the location of the facilities was inconvenient, beam configuration and collimation were inadequate or there were problems with patient accrual. Table 1 and Table 2 show existing low- and high-energy fast neutron therapy facilities respectively. The former have limited application because of inferior beam penetration.

As mentioned above high-LET radiations are most effective for treating large, slow growing or radiation resistant tumours such as those of the salivary gland, paranasal sinus, head and neck, prostate, bone and breast; soft tissue sarcoma, uterine sarcoma and melanoma. To date more than 20,000 patients are estimated to have been treated with fast neutrons.

For fast neutron therapy, the reactions d+T, d+Be and p+Be are used. Neutrons from the d+T reaction have inferior properties in terms of beam penetration, lateral penumbra and dose rate and this reaction is currently used at only a few centres. For modern high energy facilities, the p+Be reaction is preferred (except for the Detroit d + Be facility), since the same machine can accelerate protons to twice the energy of deuterons and thus provide more penetrating beams.

Although some fixed beam arrangements are still used, isocentric facilities are desirable. Nevertheless, with a versatile patient support system and good treatment planning, fixed beam facilities have given good clinical results for selected tumour types [eg. salivary gland, prostate, soft tissue sarcoma, bone sarcoma, paranasal sinus, adenocystic carcinoma, melanoma]. Flexible beam shaping (eg. multileaf and multirod collimators, multiblade trimmer) is desirable, but good dose conformation can be achieved with a variable rectangular collimator or fixed inserts if proper beam blocking is done. Sophisticated 3-dimensional treatment planning is essential.

6. National Accelerator Centre Faure, South Africa

Routine treatment began in 1989 on the neutron therapy unit. All the major facilities, with the exception of the neutron therapy unit, were locally designed. The main accelerator is a variable-energy separated-sector cyclotron, capable of accelerating protons to a maximum energy of 200 MeV. The medical complex includes three radiotherapy treatment vaults, a CT scanner, treatment planning stations, laboratories, offices, full medical physics and radiobiology facilities as well as a 30-bed on-site hospital. One of the treatment vaults contains the isocentric neutron therapy unit in which neutrons are produced by the reaction of 66 MeV protons on a thick beryllium target [p(66) +Be]. Neutron therapy is delivered in 3 fractions per week.

Most patients, including those from other parts of the country and from neighbouring territories, are referred to the NAC through one of the local university teaching hospitals, viz, Groote Schuur Hospital (University of Cape Town) or Tygerberg Hospital (University of Stellenbosch). Both hospitals are about 25 minutes by road from the NAC. Some private patients are also treated. Although many patients are housed in the on-site hospital for the duration of their treatments, others attend as out-patients.

The p(66)+Be neutron therapy facility incorporates an isocentric gantry *(Fig. 5)* capable of ± 185° rotation. A rotating collimator (360°) with a continuously variable rectangular aperture provides field sizes between 5.5 cm x 5.5 cm and 29 cm x 29 cm at a source-to-axis distance of 150 cm.

Fig. 5 : NAC neutron therapy gantry

A manually-controlled moving floor permits full rotation of the gantry. Downstream of the target are, in order, a pair of steel flattening filters (for small and large fields respectively), three tungsten wedge filters and a 2.5 cm thick polyethylene hardening filter, which removes unwanted low energy neutrons from the beam. A multiblade trimmer (blocking system) has recently been installed on the collimator to provide more flexible shielding *(Fig. 6)*. Neutron dose rates are typically about 0.50-0.60 Gy/min. A portal x-ray tube in the treatment head upstream of the collimator can be inserted on the beam axis and is used in conjunction with a neutron beam exposure for verification of the treatment field. The physical characteristics of the NAC neutron beam are rather similar to those of an 8 MV x-ray beam *(Figs. 1, 2)*.

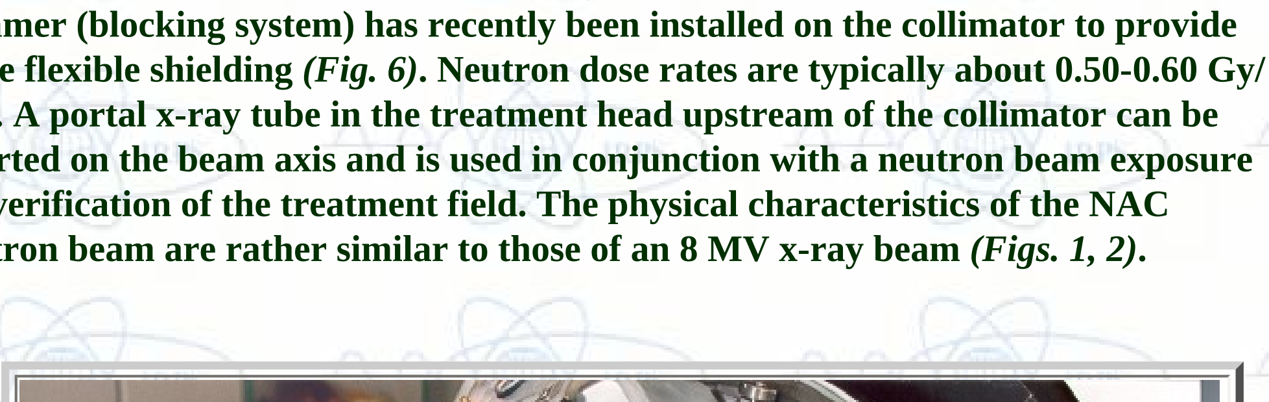

Fig. 6 : The multiblade trimmer attached to the NAC collimator assembly

In order to verify the dosimetry and treatment prescriptions, international radiobiological and national and international dosimetry intercomparisons have been undertaken. The results obtained were highly satisfactory, showing good agreement between participating centres. Several other radiobiological measurements have been made and the RBE (relative biological effectiveness) and OER (oxygen enhancement ratio) of the NAC's neutron therapy beam have been found to be similar to those measured at other high-energy p+Be neutron therapy facilities. The energy spectra of the neutron beams for various irradiation conditions have been measured in air using the pulsed beam time-of-flight technique and in phantom using recoil methods and agree well with Monte Carlo calculations.

Several clinical trials are currently being undertaken at NAC, including treatments of tumours of the head and neck, salivary gland and breast and treatments of soft tissue and bone sarcomas, uterine sarcomas, paranasal sinuses and mesotheliomas. The results of a pilot study of prostate treatments are presently being evaluated. A significant number of non-trial patients are also being treated (Table 3).

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REPORT ON MONTE CARLO USERS' GROUP

The U.K. based Monte Carlo user group, MCNEG, becomes increasingly international

Richard Hugtenburg

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MCNEG is an annual meeting held in the United Kingdom of users of the Monte Carlo method for neutron, electron and gamma radiation problems. It draws a wide range of participation and an increasingly international one. The meeting has been held at a different venue each year offering a local flavour. In particular, last year's meeting at Clatterbridge Hospital in Cheshire included a tour of their proton therapy facility. Attendees have discussed medical, industrial and military uses of radiation and the increasing role that Monte Carlo methods play in these fields. This year's 2001 meeting, the 7th of its kind, was held at the Royal Marsden Hospital, Fulham Road, London on 9-10 April. The centre is renowned for its contributions to Monte Carlo-based techniques in radiation treatment planning and dosimetry.

Medical radiation techniques are usually well represented at the meeting and this year was no exception.

The first invited speaker, Dr Charlie Ma, of Stanford University, talked about the use of Monte Carlo in the planning of intensity modulated therapies and kicked off a series of presentations from workers who were successfully simulating therapy devices and patient dosimetry, including contributions from the near Velindre Hospital in Cardiff, the not so near Ghent University, and the far Dr Helen Liu from M.D. Anderson Cancer Center in Houston. A novel, accelerator based, neutron source for boron neutron capture therapy (BNCT) which utilises the D-T fusion reaction was described by Dr Juan Esposito of the University of Pisa. Such work is important for the practical implementation of the technique in a hospital setting, given the current reliance on reactor-based sources.

The second invited speaker, Dr Laurie Waters of Los Alamos National Laboratory, introduced MCNPX, which extends the classic Monte Carlo code MCNP to "all" particles and energies, and presented its utilisation in high energy physics and medical applications including proton therapy and BNCT. Other big science topics included the modelling of the JET tokamak, by Dr Michael Loughlin of the Culham Science Centre who made mention of the computational intensity of

the task and the parallel computing solution that had been advanced. Dr Ion Stamatelatos of the NCSR, Athens, described large sample neutron activation analysis at the 'Demokritos' research reactor, a non-destructive facility for biomedical, archaeological and environmental composition studies. Meanwhile, Dr Angela Barr of ESPCI in Paris presented her modelling of a xenon-filled multi-wire proportional chamber and her efforts to transfer this technology, normally associated with high-energy physics at CERN, to nuclear imaging applications.

Participants at MCNEG meetings use a variety of Monte Carlo codes and their spin-offs including EGS4, MCNP and GEANT. The group also has a strong interest in comparable and complimentary computational techniques including discrete ordinates methods, Markov chain and adjoint modelling techniques. Given the wide range of codes and techniques available, of interest is a European initiative to assess the use of computational tools in radiation dosimetry described by Dr Rick Tanner of the NRPB. Workers will be given a set of 'exam' style problems to solve, each requiring the use of a computational method. The survey is expected to give information about the accuracy and usage of the widely known codes as well as in-house developments.

Planning for the 2002 meeting is already underway and is likely to be held at the North Staffordshire Royal Infirmary in Stoke-on-Trent. You can read about the activities of the MCNEG user group at

http://egroups.yahoo.com/group/mcneg

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NEW MEMBERS, ADDRESS CHANGES

Welcome to New Members :

Dr Neal Carron, ***U.S.A.***

Professor Nassef Comsan, ***EGYPT***

Professor Ahmed Abu El-Ela Ahmed, ***EGYPT***

Dr Polad M Shikhaliev, ***U.S.A.***

New Members' addresses are listed in the Contact Members' Details (click on country next to name)

Address changes of Members :

Mr Roland R Benke ***U.S.A.***

Members' new addresses are listed in the Contact Members' Details (click on country next to name)

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AWARDS TO MEMBERS

John H Hubbell

Awarded 2001 Distinguished Scientific Achievement Award

John H. Hubbell, the Society's Vice President for North America, was awarded the 2001 Distinguished Scientific Achievement Award on June 12, 2001 by the Health Physics Society at its annual meeting in Cleveland. John received this honor for his many contributions to the body of knowledge in radiation physics and for his service to the field of Health Physics. These contributions occurred during his long career at the National Bureau of Standards (now the National Institute for Standards and Technology) in Washington, DC.

The Distinguished Scientific Achievement award was established by the Health Physics Society in 1968. The award is given annually to a recipient who is in recognition of Outstanding Contributions of Fundamental Significance to the Profession of Health Physics. Previous recipients of the award include Robley D. Evans, James E. Turner and former NIST employees Lauriston S. Taylor, F. Herbert Attix and Robert Loevinger.

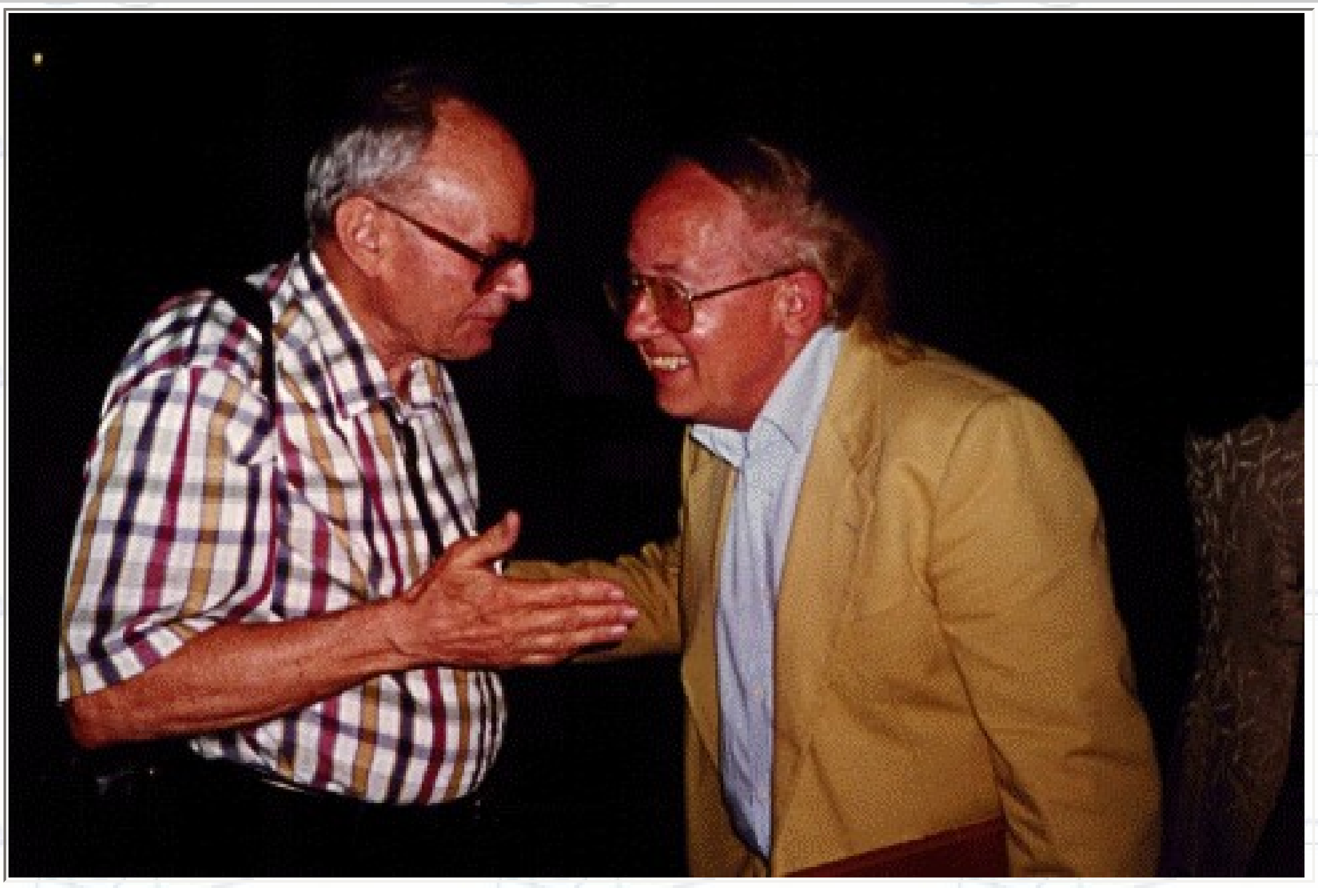
Among his other numerous honors and awards, John was previously honored by the Health Physics Society when he was named a Fellow of the Society in 1986.

The area of radiation physics for which John is best known is dosimetry data. John's publication list includes many of the seminal papers in this area - three of his papers have been named "Citation Classics" by the Institute for Scientific Information. Among these are his compilation of photon cross sections attenuation coefficients and energy absorption coefficients from 10 keV to 100 GeV. The data contained in his compilations are the basis for databases and codes utilized worldwide by radiation physicists.

John's service to the scientific community has taken a number of forms. He has been editor of several scientific journals and is currently editor-in-chief (for radiation physics) of Radiation Physics and Chemistry. He also served on numerous advisory boards and as an officer of several scientific organizations. John helped found and served as President of the International Radiation Physics Society.

John started working at NBS in 1950. He soon found his way into the Radiation Theory group of Ugo Fano. There he worked first as an experimental physicist and then as a computational radiation physicist performing some of the earliest Monte Carlo simulations of photons in matter. In the mid-1960's he took over the Bureau's photon compilation efforts, the activity for which he is best known. He directed the X-Ray and Ionizing Radiation Data Center from 1963-1981.

John retired from NIST in 1988. However, there is still a very large cross section for running into him on the third floor of the Radiation Physics Building on most weekdays and Saturdays.



John Hubbell *(left)* in deep conversation with R. Cesareo

Award to Suprakash C Roy

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AWARDS TO MEMBERS

Suprakash C Roy

Named as TWAS-UNESCO Associate at Centers of Excellence in the South

One of the objectives of the Third World Academy of Sciences (TWAS) is to help provide competent scientists in developing countries with the conditions necessary for promoting their research work by facilitating their regular visits to Centers of Excellence located in the Third World. An appointment as Visiting Associate under TWAS-UNESCO Associateship at Centers of Excellence in the South has been awarded to Professor Suprakash C. Roy of Bose Institute, Calcutta, India, and Vice President for India of the Society, to work with Professor Raul T. Mainardi at the Fa.M.A.F., National University of Cordoba, Cordoba, Argentina. The appointment is for a fixed period of three years, during which time Professor Roy is entitled to visit the Institute twice for a period of two to three months each time.

Under the award, TWAS covers the cost of air travel for each visit, while the host institute arranges local hospitality and the facilities needed for the research work.

The University of Cordoba, founded in 1613, is one of the oldest in the Americas. It is also one of the largest in Argentina with over 110,000 students, a large share of whom come from nearby provinces to study law, engineering, medicine and many other disciplines.

The Faculty of Mathematics, Astronomy and Physics (Fa.M.A.F.) is less than fifty years old, one of the youngest faculties at the University of Cordoba. At its inception, it started a program to send students overseas to complete graduate work via reciprocal agreements. For this reason most of the Faculty members are at work full time, doing research under international standards. It is estimated that more than half of the alumni work overseas.

For the quality of their research Fa.M.A.F. has been chosen a Center of Excellence in the Third World.

Professor Suprakash C Roy

Award to John H Hubbell

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TABLES

Table 1: Low Energy Fast Neutron Therapy Facilities

Place	Country	Source Reaction	Mean Energy (MeV)	SAD (cm)	Beam Direction	Collimator Type
Obninsk	Russia	Reactor	-	-	-	-
Garching	Germany	Reactor	1.8	545	Horizontal	Inserts
Chelyabinsk	Russia	d(0.5) + T	14.3	-	-	-
Tomsk	Russia	d(14) + Be	5.9	-	-	-
Minsk	Belorus	d(14) + Be	5.9	-	-	-
Essen	Germany	d(14.3) + Be	6.0	125	Isocentric	Inserts

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Table 2: High Energy Neutron Therapy Facilities

Place	Country	Source Reaction	SAD (cm)	Beam Direction	Collimator Type	First Treatment
Orleans	France	p(34) + Be	169	Vertical	Inserts	1981
Beijing[a]	China	p(35) + Be	-	Horizontal	Inserts	1991
Detroit MI	USA	d(50) + Be	183	Isocentric cyclotron	Multirod	1990
Seattle WA	USA	p(50) + Be	150	Isocentric Horizontal	Multileaf Inserts	1984
Seoul[b]	South Korea	p(50) + Be	150	Isocentric	Variable jaws	1986
Nice[b]	France	p(60) + Be	170	Vertical	Multileaf	1993
Louvain-la-Neuve[b]	Belgium	p(65) + Be	162	Vertical Horizontal	Multileaf Inserts	1978
Batavia IL[a]	USA	p(66) + Be	190	Horizontal	Inserts	1976
Faure	South Africa	p(66) + Be	150	Isocentric	Variable jaws + multiblade trimmer	1988

[a] Linac [b] Operations suspended

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Table 3: NAC neutron therapy patients

(6 SEP 1988 - 30 JUNE 2001)

DIAGNOSIS	NUMBER OF PATIENTS	
	TRIAL	***NON-TRIAL***
Head and neck carcinoma[*]	154[+]	85
Salivary gland carcinoma	371	
Soft tissue sarcoma	101	
Breast carcinoma	101[#]	16
Uterine cervix carcinoma[o]	5	
Bronchus carcinoma[o]	6	
Uterine sarcoma	72	
Mesothelioma[*]	21	
Paranasal sinus carcinoma	42	
Bone sarcoma	98	
Malignant melanoma	56	
Sundry		52
Totals :	1027	153
Total Number of Patients :	1180	

[+] Includes 48 patients in photon arm

[#] Includes 11 patients in photon arm

[o] Trial discontinued

[*] Trial suspended for evaluation

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