Volume 7 Number 1 1991

Medical Physics World

Bulletin of the International Organization for Medical Physics

Adhering National Organizations 1991

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President's Message

This will be my last "President's Message" in Medical Physics World. During the World Congress on Medical Physics and Biomedical Engineering in Kyoto, Japan, July 7-12, Dr. U. Madhvanath of Bombay, India, will take office and he will hold it for the next three years. This event will mark the first time that the president has come from a developing nation. It is an event that I welcome. I have known Dr. Madhvanath for some thirty years and I have confidence that he will put his imprint on the organization and that it will benefit thereby.

I would like to look back over my term of office, and note a few events that have happened during the last three years. Perhaps most important is that we have welcomed ten new members since our meeting in San Antonio. They are, in alphabetical order, Argentina, Bulgaria, Cyprus, Ghana, Korea, Malaysia, Romania, Tanzania, Turkey and Yugoslavia. A total of forty-four national organizations (representing forty-four countries) are now members of the I.O.M.P. This represents very close to ten thousand individual medical physicists. The objectives of the I.O.M.P. are to contribute to the advancement of medical physics in all of its aspects, and to encourage and advise on the formation of national organizations in those countries which lack such organizations. It has a special interest in developing countries, because in such settings the role of the medical physicist may be less well known and special attention may be needed. In this context, for the Kyoto meeting, the I.O.M.P. has awarded over $35,000 (U.S.) in travel grants. These comprise thirteen grants to member societies in the developing world, so that individual members, would could not otherwise do so, may attend. Twenty-five thousand dollars of this came from I.O.M.P. funds and ten thousand came from supplementary funds from our corporate members, of which we now have fifteen.

I would next like to say something about I.O.M.P. meetings, because they are the most important single events of our calendar. The next one, soon to be held, will be in Kyoto, Japan, July 7-12. At this Congress, two meetings of the I.O.M.P. council will be held. The council consists of the officers of the organization and designated delegates from each of the member organizations, and the chairman and secretary of each of the committees. The new president will take office at the end of the first council meeting. There will also be one General Assembly at which all members may attend. The site of the next-but-one meeting is decided at this meeting. The site of the next meeting was decided at the General Assembly held in San Antonio. It is to be Rio de Janeiro, Brazil in 1994.

I hope the attendance at Kyoto will be large. I know it will be a good meeting. I hope to see you there.

J. R. Cunningham, Ph.D., President, I.O.M.P.

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Secretary-General's Report

Since I took over as interim Secretary-General during Brian Stedeford's sudden illness just over three years ago, I have never ceased to be amazed at how many of the projects initiated by our past Officers have now developed and matured. I would like to devote this report to just some of those programs, especially where I can express our gratitude to those members responsible for their success.

Medical Physics World

The first issue of Medical Physics World was published in 1984. Looking back at that issue, I see that we had all of one-half a page of advertising, which certainly did not pay for the printing, let alone the mailing, which went to about 7,000 medical physicists by surface, often taking as long as three months to arrive. Richard Maughan assumed the role of Editor in 1988 and under his guidance, MPW now pays for itself, even though most issues are now mailed by air, with a circulation of about 10,000. A tremendous amount of volunteer work goes into this and Dr. Maughan should be congratulated for his superb efforts on our behalf.

Libraries Program

Of all our programs aimed at assisting our colleagues in developing countries, our Medical Physics Libraries have shown the most dramatic progress. Now under the able leadership of Curator, Cathy Warmelink, we have established about two dozen IOMP Medical Physics Libraries in developing countries all over the world. Support in the form of individual donations and generous grants from our Corporate Members has been impressive. This is a most worthy cause and I ardently hope that our more fortunate members, and our colleagues in Industry, will continue to support this program with their donations, and I sincerely thank all those who have done so already. I especially wish to thank the following Corporations for the establishment of Libraries:

Nuclear Associates/Victoreen:
Kuala Lumpur Library

Nucletron Corporation: Calcutta Library

Siemens Medical Laboratories, Inc.:
Bulgarian Library

We are also indebted to the Institute of Physical Sciences in Medicine (IPSM), the American Association of Physicists in Medicine (AAPM), and the Institute of Physics Publishing, Ltd. (IOPP), for their generous donations of journals and books to these Libraries. We are currently negotiating with several other national organizations and publishers in order to consummate new agreements of this nature.

Cathy Warmelink is doing a superb job as our Curator, as her report on page 6 shows.

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Officers of the Council/IOMP

Editorial and Business correspondence should be addressed to Dr. Richard Maughan.
Events information should be addressed to Mr. Geoffrey Ibbott. IOMP correspondence should be addressed to Dr. John R. Cunningham and Dr. Colin Orton.

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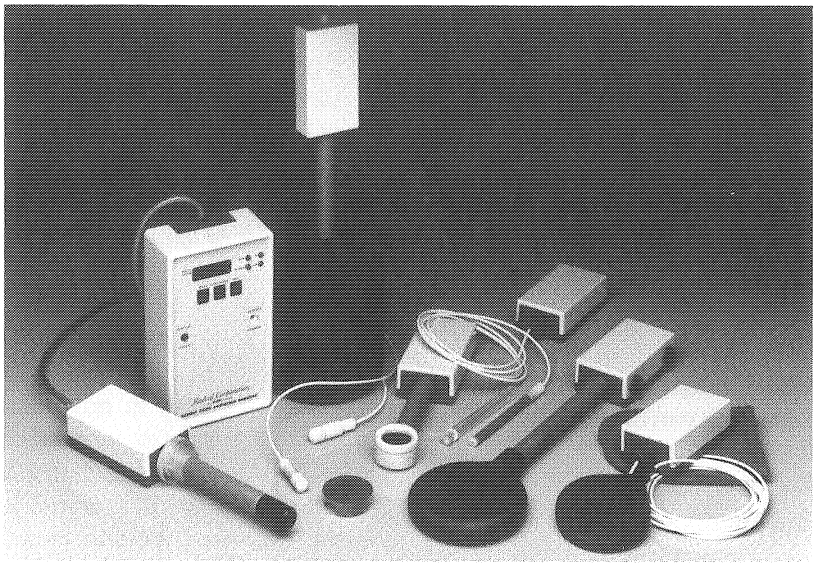

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Travel Grants

By far the greatest expenditure of IOMP funds has been toward travel grants. As shown by the separate report on page 7, the IOMP has provided or secured from Corporate Members a total of over $42,000 in travel grants for the Kyoto World Congress alone. In addition, we have provided grants for physicists to attend the Beijing International Congress on Medical Radiation Physics, May, 1990 ($1,000), the Medical Physics '90 Congress in Oxford, September, 1990 ($707), and the Training Course on Medical Radiation Physics in Beijing, June, 1991 ($600), giving a grand total of about $44,400. Although I have not reviewed all our past accounts, I suspect this is about four times the total of all funding provided for travel grants by the IOMP over the previous 15 years.

Most of this would not have been possible without the generous donations of our Corporate Members, and I especially want to thank the following:

Nuclear Associates/Victoreen (Mr. Hy Glasser):
Dr. Mariana L. de Cabrejas, Argentina (for Kyoto).

Siemens S.A. (Mr. Klaus Brieke):
Mr. German Ramirez Contreras, Colombia (for Kyoto).

C.D. High Tech. Pvt. Ltd. (Mr. E. E. Prasad):
AMPI, India (for Kyoto).

TSG Integrations (Mr. S. L. Kapoor):
AMPI, India (for Kyoto).

Gammex Lasers Corporation (Mr. Charles Lescrenier):
Mr. Oskar Chomicki, Poland,
Ms. Rodica Alecu, Romania and
Ms. Nisakorn Manatrakul (for Kyoto).

Nucletron Corporation (Mr. Eric van't Hooft):
Dr. P. S. Iyer, India (for Beijing, 1991).
Dr. Engin Kanan, Turkey (for Kyoto).

Theratronics: AMPI, India (for Kyoto).

Membership Directory

I happened to mention to my secretary, Ms. Hilda Grayson, that it would be nice if the IOMP had a Membership Directory, that we could send to the officers of our member societies and use to impress prospective national and corporate members. I was thinking of something rather modest, maybe about 10 pages long. Well, was I in for a surprise! We now have a 70-page 1991 Membership Directory, produced entirely in-house at minimal cost to the IOMP and which, as new data is received from member societies, is updated continuously. Congratulations and our sincere thanks go to Hilda for a magnificent job.

Copies have been sent to all Officers of our member societies and Corporate Members. Individual copies are available from my office, although we would prefer that you try to use the copies already distributed, if possible, so that we are not inundated with requests.

New Members

Although we have announced our new national and corporate members in past issues of MPW as they joined, it is interesting to note how significant has been our growth in the past three years since our last World Congress in San Antonio. Our adhering national society membership has increased 30% (see President's Report for details) and our Corporate Membership has grown 75% (see listing on page 2).

We welcome all our new members and thank your corporate colleagues for their continued support. As you have seen from the previous parts of my Report, we need each other in order to fulfill our objectives.

Sponsored Conferences

The IOMP has sponsored or co-sponsored the following meetings this year as satellites to the World Congress:

Conference on "Appropriate New Technology for Developing Countries" in Xian, Peoples' Republic of China.

"Asian and Pacific International Conference on Medical Physics 1991" in Guangzhou, Peoples' Republic of China.

"International Workshop on Radiotherapy Treatment Planning and Remote Afterloading Brachytherapy" in Seoul, Korea.

I realize that it is not possible to recognize all the many people who worked so hard to make these meetings successful, but I would like to thank the following individuals who I know were most responsible: Professor Ye-cho Huang and Dr. Dazong Jiang (Xian Conference), Professor Xie Nan-Zhu, Dr. Raymond Wu, and Dr. Ned Sternick (Guangzhou Conference), Dr. Wee-Saing Kang, Dr. Sung Sil Chu, Mr. Miles Mount, and Dr. P. S. Iyer (Seoul Workshop). We are greatly indebted to all these people and all their colleagues for dedicating so much of their time and effort, and also to the Nucletron Corporation for so generously co-sponsoring the Seoul Workshop.

Finally, I would like to take this opportunity at the end of my first (and maybe last, depending upon the elections in Kyoto) term of office as your Secretary-General, to tell you what a great pleasure and honor it has been for me to have served in this Office for the past three years. I have come to know so many of you in so many far-off places and it is an experience I will never forget and always cherish.

Colin G. Orton, Ph.D.

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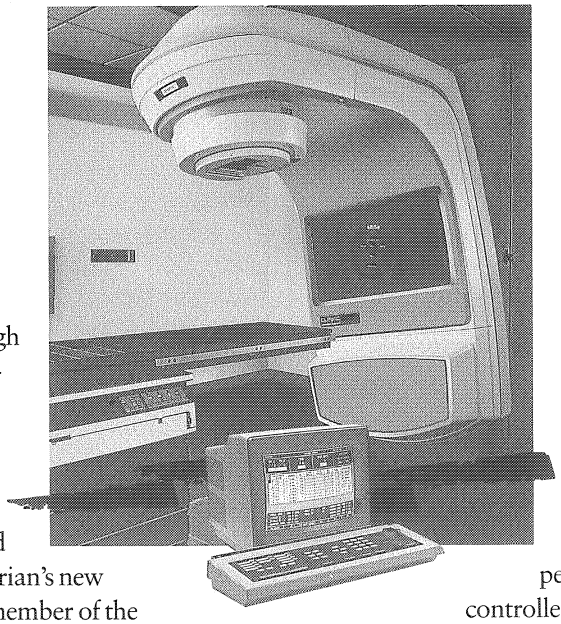

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Announcement

IOMP Libraries Program Flourishes

The IOMP Libraries Program is expanding so rapidly that ten newly established libraries have been initiated since the last issue of ***Medical Physics World.*** These locations are:

Ezeiza, Argentina	Islamabad, Pakistan
Sofia, Bulgaria	Poznan, Poland
Nicosai, Cyprus	Warszawa, Poland
Lahore, Pakistan	Dar-Es-Salaam, Tanzania
Peshawar, Pakistan	Bangkok, Thailand

We now have a total of 26 active IOMP libraries.

I want to take this opportunity to give special recognition to those corporations who have made contributions to the IOMP Developing Countries Libraries Program well beyond the call of duty. Specifically, Nuclear Associates, Nucletron Corporation and Siemens Medical Systems, who have each donated $1,000 toward the development of an IOMP library. These libraries are located in Kuala Lumpur, Malaysia; Calcutta, India; and and Ezeiza, Argentina, respectively. The money that has been donated allows the IOMP to purchase specially requested references for these libraries that may not otherwise be donated through volunteer effort.

Additionally, a deep thanks goes to the following organizations for their donations of publications:

— IOPP for sending 15 books to each of 13 IOMP libraries. as well as five books which will go to 11 more libraries and any new libraries in the future. Also, IOPP will send a complimentary copy of each new book in its *Medical Science Series* to all libraries on the IOMP Developing Countries Libraries list (up to a total of 100),

— AAPM, who will be sending ten complete sets of books to IOMP libraries,

— IPSM, who continues to send ten complimentary subscriptions each of *Physics in Medicine and Biology* and *Clinical Physics and Physiological Measurements* to various IOMP libraries.

The IOMP is sincerely grateful for the outstanding efforts of these sponsors. They are really making a difference in the professional lives of the recipients.

The program is especially in need of the following journals: *Medical Physics, Health Physics, Physics in Medicine and Biology,* and *British Journal of Radiology.* If anyone has any of these journals or other pertinent books to donate, please contact me at: Gershenson ROC, Harper Hospital, 3990 John R, Detroit, MI 48201, U.S.A.

Catherine Warmelink, MS
Curator
IOMP Libraries Program

IOMP Corporate Members

The following corporations are Corporate Members in the IOMP for 1991:

C. D. High Tech PVT. LTD.
Ameerpet, Hydreabad-500 016 India

Computerized Imaging Reference Systems
Norfolk, VA 23513, USA

Computerized Medical Systems
Maryland Heights, MO 63043, USA

Gammex Companies
DataSpan/Gammex, Inc.
Gammex Lasers Corp.
Gammex-RMI Ltd.
Gammex-RMI GmbH
Gammex Foundation aka Wisconsin Innovarium Ltd.
Radiation Measurements, Inc.
Milwaukee, WI 53226-0708, USA

IOP Publishing, Ltd.
Philadelphia, PA 19102, USA

Keithley Instruments, Inc.
Cleveland, OH 44139, USA

Multiadata Systems Int'l Corp.
St. Louis, MO 63119, USA

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2600 MD Delft, The Netherlands

Radcal Corporation
Monrovia, CA 91016, USA

Siemens Medical Laboratories, Inc.
Concord, CA 94520, USA

Siemens Sociedad Anonima
Bogota, Columbia

Theratronics International, Ltd.
Kanata, Ontario K2K 2B7, Canada

TSG Integrations
New Delhi - 110 019, India

Varian Medical Equipment Marketing
Palo Alto, CA 94303, USA

Funding derived from these sources is allocated to the support of hospital physicists in developing countries. Corporations wishing to receive more information about Corporate Membership should contact: Colin G. Orton, Ph.D., Prof., IOMP Secretary-General, address on page 6.

Announcement

Kyoto Travel Grants

The IOMP awarded a number of Travel Grants to member societies to help individual members attend the Kyoto World Congress. These awards were based upon applications material received and reviewed by a panel consisting of the Officers plus the Chairman of the Developing Countries Committee. Criteria used included demonstration of need to attend the Congress (e.g. Delegate, presentation of paper), local availability of funds, and cost of attendance. Due to the large amount of funding requested, which exceeded the total in all IOMP accounts, societies were allocated only a fraction of the awards requested. In many cases, this was then supplemented by funding obtained from other sources, usually corporations.

Following is a list of the national societies which were granted these Travel Awards, with allocations in US $:

Country	Allocation	Supplementary Funds	Source
Argentina	1,500	1,000	Nuclear Associates/ Victoreen
Brazil	2,700	—	—
Bulgaria	1,400	—	—
Colombia	1,200	2,300	Siemens
Cyprus	2,500	—	—
India	3,000	500 500 2,075	C.D. High Tech. Pvt. TSG Integrations Theratronics International
Malaysia	1,400	—	—
The People's Republic of China	3,000	1,500	World Congress
Philippines	1,850	—	—
Poland	1,130	1,000 1,500	Gammex (1991) World Congress
Romania	3,500	1,500	Gammex (1990)
Tanzania	1,100	—	—
Thailand	530	1,000	Gammex (1991)
Turkey	1,000	400	Nucletron

In addition, the IOMP has awarded travel grants of $1,245 and $1,000 to the Executive-Secretary and Secretary-General, respectively, of our International Union (IUPESM) to enable them to attend the World Congress.

Colin G. Orton, Ph.D.
Secretary-General

News Item

First Latin American Workshop on Medical Physics Held in Brazil

The First Latin American Workshop on Medical Physics and Biomedical Engineering was held in Riberao Preto, Sao Paulo, Brazil, October 7-11, 1990. The Workshop was sponsored by the Association of Brazilian Medical Physicists (ABFM), the Brazilian Society of Biomedical Engineering (SBSB), and the University of Sao Paulo in Riberao Preto. The chairmen of the Workshop were Professor Thomaz Ghilardi Netto (president ABFM) and Professor Jose B. Paulin, both of the University of Sao Paulo in Riberao Preto.

This was the first Brazilian meeting combining medical physics and biomedical engineering. The meeting consisted of invited talks, contributed papers, refresher courses, round table discussions and posters. About 300 medical physicists and biomedical engineers from the United States, the United Kingdom, Japan, Germany, Israel, Italy, Norway, France and various Latin American countries participated in the Workshop, including about 30 participants from Argentina.

The meeting was also a planning meeting for the World Congress of Medical Physics and Biomedical Engineering to be held in Rio de Janeiro in August 1994. The co-presidents of the World Congress are Dr. Carlos Eduardo de Almeida (Medical Physics) and Dr. Ronney Panerai (Biomedical Engineering). Both are from Rio de Janeiro.

John Cameron, Ph.D., Lone Rock, Wisconsin, U.S.A.

Results of Survey By the Developing Countries Committee of the IOMP

Oskar A. Chomicki, M.Sc.
Secretary General Polish Society of Medical Physics
Ceglowska 80
10-809 Warszawa, Poland

In June 1990, after consultation with Professor Nan Zhu Xie (China), Chairman of the Developing Countries Committee of the IOMP, and Dr. Colin Orton, Secretary-General of the IOMP, I prepared and distributed among 13 countries such as Brazil, China, Colombia, Cyprus, Hong-Kong, India, Malaysia, Mexico, Nigeria, Philippines, Sri Lanka, Thailand and Turkey, a Questionnaire requesting information to form a basis for future programmes of assistance and cooperation between the IOMP member countries, especially those which find themselves in need of such help.

So far, I have received 7 replies which make it possible for me to draw some conclusions in respect to the aims set out in the Questionnaire. These are the basic data drawn from the Questionnaire:

1. Four respondents come from Far East countries (Hong-Kong, the Philippines, Sri Lanka and Thailand) which joined the IOMP only recently, i.e. in the years 1982-1988, and three are Cyprus, Turkey and Colombia.
2. The number of members in the national medical physics organizations per 1 million inhabitants is:

1. Colombia	(10):	0.3
2. Cyprus	(21):	31.0
3. Hong-Kong	(34):	7.5
4. Philippines	(32):	0.6
5. Sri Lanka	(6):	0.4
6. Thailand	(60):	1.2
7. Turkey	(58):	1.2

3. All the countries are newcomers to the IOMP, the date of joining the IOMP ranging between 1982 and 1989.
4. Except for three countries Cyprus, Colombia and Turkey, all the other national medical physics organizations belong only to the IOMP.
5. None of the national medical physics organizations publishes either a scientific journal, information bulletin or newsletter.
6. Except for one (Hong-Kong) all the respondents express their need to receive books, journals and other periodicals in the field of QA in Radiotherapy, Dosimetry, and especially "Physics in Medicine and Biology" and "Medical Physics."
7. The financial assistance for which five of the seven respondents will apply to or through the IOMP concerns travel grants to send delegates to international conferences, meetings, etc.
8. Five respondents (Cyprus, Colombia, the Philippines, Thailand and Turkey) are willing to accept candidates for training in radiation protection (the Philippines), and radiotherapy (Thailand and Turkey) for a period of 1-3 months, or students (Colombia).
9. Four respondents can send experts to other countries: the Philippines in radiation protection, Thailand in the use of SPECT and QA, Colombia in radiotherapy and Cyprus in medical equipment, radiation and QA in radiotherapy.
10. On the other hand, two countries are in need of experts from other countries: Hong-Kong in radiation dosimetry and the Philippines in MRI, QA, nuclear medicine, radiotherapy and non-ionizing radiations. Two countries (Sri Lanka and Turkey) expect such a need in the future. Two other countries (Colombia and Cyprus) need general help in seminars and legislation.

In general, the respondents expect the IOMP to offer assistance:

1. in obtaining medical physics publications;
2. in providing money for:
   a. travel and participation in international conferences,
   b. setting up scholarships for young medical physicists;
3. in establishing a forum for the developing countries to exchange experience (conferences, workshops) "Medical Physics World could possibly provide such a forum;
4. in providing experts;
5. in exchanging medical physicists between the developed and developing countries in order to upgrade the competence of physicists in developing countries and raise the status of the medical physicist;
6. in promoting joint research ventures in developing countries, with physicists from the developed countries;
7. in setting up regional medical physics centres in Asia, Africa, Latin America, etc.

It would seem that the needs, requirements and possibilities of some of the developing countries are such that they could have been expected before the Questionnaire had been completed (publications, financial assistance). However, a few new issues have come to light. Five countries (out of 7) are willing to accept candidates for training in radiation protection and radiotherapy. This is a very important and significant fact which indicates that some developing countries have already become emancipated, and instead of totally relying on developed countries, are becoming self-dependent and ready for exchange of their know-how with other countries. I sincerely hope that this trend should receive strong support from the Developing Countries Committee and the policy of self-reliance will be promoted in the future.

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The following conclusions concerning the questionnaire were reached after discussions with the Chairman of the Developing Countries Committee, Prof. Xie Nan-Zhu and the Secretary-General of the IOMP, Dr. Colin Orton:

1. Available medical physics publications should be allocated in the following order to (1) the Philippines Organization of Medical Physicists, (2) Sri Lanka Medical Physicists & Bioengineers Association, (3) Medical Physics Club, Thailand, (4) Medical Fizik Dernegi (Turkish Medical Physics Organization), (5) Sociedad Colombiana de Fisica Medica y Protection Radiologica Hospital, Universitario del Valle, (6) Cyprus Association of Medical Physics & Biomedical Engineering, Nicosia.

2. Available money for travel and participation in the forthcoming international events should be allocated on the priority basis to (1) the Philippines Organization of Medical Physics and (2) Sri Lanka Medical Physicists & Bioengineers Association.

3. Thailand can be the host for an international course or training center in the Southeast Asian region.

4. Exchange of experts from the Philippines, Thailand and Colombia should be arranged.

5. Hong-Kong, the Philippines and Colombia should receive expertise from other countries according to their needs.

6. The idea of establishing a forum for the developing countries to exchange experience (conferences, workshops, etc.) under the auspices of the Developing Countries Committee of the IOMP should be given serious consideration.

7. In view of the fact that none of the responding countries publish any scientific journals related to medical physics there is a need for "Medical Physics World" as a journal of the IOMP to include more information from these countries in the form of e.g. News in Brief.

Membership of IOMP Developing Countries Committee, 1989-91

Chairman
Prof. Xie Nan-Zhu
Medical Physics Department
Guangzhou Medical College
Dongfengxi Road
Guangzhou
The People's Republic of China

Secretary
Dr. Monica Gustafsson
Radiation Physics Dept.
University of Lund
Lasarettet
S-221 85 Lund
Sweden

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Announcement

IOP and IOMP Join Forces

The IOMP aims to help promote the growth of medical physics in developing countries under the terms of a new agreement with the publishing division of the British Institute of Physics (IOP).

IOP publishes a wide variety of research journals (including *Physics In Medicine and Biology,* an official IOMP publication) and has an extensive programme of book publishing under its Adam Hilger book imprint. The Medical Physics Handbooks (Series Editor Professor J. M. A. Lenihan) are well known to many readers of *MPW.* In recent years Hilger has maintained its strength in medical physics publishing with the development of the Medical Science Series under the editorship of Dr. Richard F. Mould, formerly Director of Medical Physics at Westminster Hospital and now with Nucletron International B.V. as their International Marketing Manager.

IOP and IOMP have agreed that the Medical Science Series should become an official book series of the IOMP. In return, copies of important Hilger titles will be distributed free of charge to medical physicists in over 90 developing countries throughout the world.

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Members:

Oskar Chomicki, M.Sc.
Klinika Endokrynologii
Szpital Bielanski
01-809 Warszawa
Poland

Dr. Seyfettin Kuter
Istambul Univ. Onkologii
Enstitusa
Tibbi Radyofizik Bilim Dali
Istambul
Turkey

Agnette Peralta, M.S.
Radiation Health Service
Department of Health
Rizal Avenue
Manila 1003
The Philippines

Dr. Ju-Tao Chen, Ph.D.
Department of Medical Physics
Guangzhou Medical College
Guangzhou City, 510182
The People's Republic of China

Dr. Andries van Aswegen
Biophysics Department
University of Orange Free State
P.O. Box 339
Bloemfontein 9300
South Africa

Dr. Michael J. Day
Claremont Cottage
Claremont Street
Newcastle-upon-Tyne
HE2 HAJ
United Kingdom

Ex-Officio Members:

Dr. John R. Cunningham
IOMP President
960 Teron Road, Apt. 910
Kanata, Ontario K2K 2B6
Canada

Dr. Caridad Borras
Chairman, Ad Hoc Long Range
Planning Committee
Pan American Health
Organization
HSD
525 23rd St., N.W.
Washington, DC 20037
U.S.A.

Dr. Udipi Madhvanath
IOMP Vice President
Head, Division of
Radiological Protection
Bhabha Atomic Research Centre
Bombay 400-085
India

Dr. Norman A. Baily
Chairman, Education and
Training Committee
Univ. of California, San Diego
Radiology Dept. M-010
La Jolla, CA 92093
U.S.A.

Dr. Colin G. Orton
IOMP Secretary-General
Gershenson R.O.C.
Harper-Grace Hospitals
3990 John R
Detroit, MI 48201
U.S.A.

CALENDAR OF EVENTS

Geoffrey S. Ibbott, Editor

1992

January 12 - 16

HPS Mid-Year Topical Symposium: Operational Measurements, Dearborn, Michigan, USA (Health Physics Society, 8000 Westpark Drive, Suite 400, McLean, VA 22101, USA).

April 5 - 8

EURODOP '92 (BMUS), Brighton, England (EURODOP '92, Bell Howe Conferences, 1 Willoughby St., Beeston NG9 2LT, UK).

April 7 - 9

Image Processing and its Applications, Maastericht, The Netherlands (Sheila Griffiths, IEE Conference Services, Savoy Place, London WC2R 0BL, UK [Tel: 01-240 1871, Fax: 01-240 7735]).

April 26 - May 1

6th International Symposium on Hyperthermic Oncology, Salt Lake City, UT, USA (Ms. Laura Fleming-Jones, Administrative Director, 1891 Preston White Drive, Reston, VA 22091, USA [703-648-3780, Fax: 703-648-9176]).

May 15 - 18

9th Annual Meeting of the American College of Medical Physics, Stowe, Vermont, USA (American College of Medical Physics, 1891 Preston White Drive, Reston, VA 22091, USA).

May 18 - 20

Radiology 92, 50th Annual Congress of the British Institute of Radiology, Birmingham, UK (Programme Office, The British Institute of Radiology, 36 Portland Place, London W1N 4AT United Kingdom [01-580-4085]).

May 25 - 27

Annual Brachytherapy Meeting of GEC-ESTRO, Nancy, France (ESTRO Secretariat, U.Z., St. Rafael, Department of Radiotherapy, Capucijnenvoer, 35, 3000 Leuven, Belgium).

May 31 - June 4

Sixth Symposium on the Medical Applications of Cyclotrons, Turku, Finland (Uno Wegelius, Turku Medical Cyclotron/PET Center, Turku University Central Hospital, 20520 Turku, Finland [Tel: INT 358-21-612770, Fax: INT 358-21-318191]).

June 7 - 12

Annual Meeting of the American Nuclear Society, Boston, Massachusetts, USA (Meetings Department, American Nuclear Society, 555 North Kensington Avenue, LaGrange Park, Illinois 60525, USA).

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June 10 - 13

6th International Symposium on Planning of Radiological Departments, Bergen, Norway, (ISPRAD Secretariat, PLUSreiser a/s, P.O. Box 946, 5001 Bergen, Norway [47-5 314500, Fax: 47-5 324376]).

June 14 - 16

1st World Congress for Electricity and Magnetism in Biology and Medicine, Buena Vista Palace, Orlando, Florida, USA (The First World Congress, c/o W/L Associates, Ltd., 120 West Church Street, Fredrick, MD 21701, USA [Tel: 301-663-1915, Fax: 301-663-0043]).

June 21 - 25

Health Physics Society Annual Meeting, Columbus, Ohio, USA (Health Physics Society, 8000 Westpark Drive, Suite 400, McLean, VA 22102, USA).

June 24 - 27

3rd Bath Conference on Bone Mineral Measurement, Bath, England (The National Osteoporosis Society, P.O. Box 10, Radstock, Bath, BA3 3YB, England [Tel: 0761 32472, Fax: 0761 37903]).

July 3 - 6

Congress of the International Society of Radiographers and Radiological Technicians, Vienna, Austria (Mr. Anton Helleparth, Simmeringer Hptstr. 34-40, A-1110 Vienna, Austria [Tel: 0222-74-83-67]).

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August 23 - 27

Canadian Organization of Medical Physicists Annual Meeting with AAPM, Ms. Karen Breitman, Medical Physics, Tom Baker Cancer Centre, 1331 29th St., NW, Calgary, Alberta T2N 4N2, Canada [Tel: 403-270-1790, Fax: 403-283-1651]).

September 1 - 4

11th Annual ESTRO Meeting, Malmo, Sweden (ESTRO Secretariat, U.Z. St. Rafael, Department of Radiotherapy, Capucijnenvoer 35, 3000 Leuven, Belgium).

September 6 - 8

7th International Brachytherapy Working Conference, Baltimore, Washington, Hosted by the University of Maryland Medical System (Nucletron Corporation, 9160 Red Branch Road, Columbia, MD 21045, USA [Tel: 301-964-2249, Fax: 301-964-0912]).

September 14 - 18

ESTRO Teaching Course on Radiation Physics For Clinical Radiotherapy, Leuven, Belgium (ESTRO Secretariat, U.Z. St. Rafael, Department of Radiotherapy, Capucijnenvoer 35, 3000 Leuven, Belgium).

October 24 - 26

Hyperthermia in Clinical Oncology, Trento, Italy (ESTRO Secretariat, U.Z. St. Rafael, Department of Radiotherapy, Capucijnenvoer 35, 3000 Leuven, Belgium).

November 15 - 20

International Meeting of the American Nuclear Society, Washington, D.C., USA (Meetings Department, American Nuclear Society, 555 North Kensington Ave., LaGrange Park, Illinois 60525, USA).

November 29 - December 4

Joint Meeting of AAPM with the Radiological Society of North America, Chicago, Illinois, USA (AAPM, 335 East 45th Street, New York, New York 10017, USA [Tel: 212-661-9404]).

◄ 1994 ►

August 20 - 26

World Congress on Medical Physics and Biomedical Engineering: 10th International Congress of Medical Physics and 17th International Conference on Medical and Biomedical Engineering, Rio de Janeiro, Brazil.

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*Readers are invited to send to the **Calendar of Events** Editor, Geoffrey S. Ibbott, M.S. (address on page 2), information on any events not listed in this issue of MPW and also additions or corrections to the items that are listed. Officers of national societies are especially encouraged to submit information on their future national meetings.*

Announcement

Membership of IOMP Committee on Education and Training 1990-92

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All India Inst. of
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Dept. of Medical Physics
Addenbrooke Hospital
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United Kingdom

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Harper-Grace Hospitals
3990 John R
Detroit, MI 48201, U.S.A.

Quality Control of Computer-Interfaced/ Scintillation Cameras

Audrey V. Wegst, Ph.D. and
Jon J. Erickson, Ph.D.
Diagnostic Technology Consultants, Inc.
4747 Troost
Kansas City, MO 64110

1.0 THEORY OF OPERATION

In its most basic form (see Figure 1) the camera consists of a thin, large-dimension sodium iodide [NaI(Tl)] crystal, viewed through a light guide by an array of photomultiplier (PM) tubes. The output of the PM tubes is fed to an analog circuit which determines the location of the interaction of each photon in the crystal. In the analog camera the X, Y coordinates of the interaction, along with a signal from a pulse height analyzer, indicating an acceptable energy, are provided to a cathode ray tube (CRT) display on which a single flash of light is produced at a location corresponding to the site of the photon interaction in the detector. The image is formed on a piece of photographic film as a result of the summation of thousands of these flashes of light. When a data processing system is connected to the camera these same signals are used to control the image acquisition in that system.

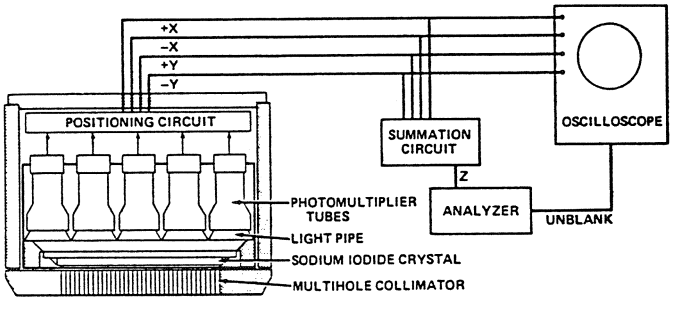

Figure 1. Block diagram of a scintillation camera.

The primary process of accumulating an image from a camera in a computer memory involves setting aside a specified area of memory in which each memory location represents a small area of the camera detector. Each interaction that occurs in a particular subregion of the detector causes the addition of a count in the memory location which corresponds to that area. During image collection, the analog X and Y position signals are converted to digital signals which in combination address the appropriate memory locations in the computer. The signal from the pulse height analyzer is used to tell the computer whether or not to process the event. In this manner, the events are collected and displayed as points on a CRT whose intensity are proportional to the number of counts in the memory locations. This results in an image of the activity distribution. This method of collection is often referred to as 'frame mode' or 'histogram mode.' A time series of frame mode collections (a dynamic collection) may be used to acquire data reflecting the change of activity distribution with time.

A second mode of collection is sometimes used. This method, referred to as 'list mode,' simply stores the digitized coordinates in lists which are later processed into sequential images. Also stored in the list are 'clock ticks' as an indication of elapsed time. Since the coordinates are stored in the same order as the events occur in the detector, the temporal relationship of the counts is always maintained. Images may be formulated many times in any desired temporal framing. This mode of collection is often used for research protocols and for studying very high speed processes, such as first pass cardiac studies.

The use of the computer to collect scintillation camera data is a double edged sword in terms of quality control. In one sense, it provides a very powerful tool with which one is able to obtain highly precise evaluations of the camera operation. On the other hand, it introduces a number of additional components which can fail and which, therefore, must also be monitored.

2.0 QUALITY CONTROLS

2.1 Quality Control Goals

The primary function of the computer-interfaced scintillation camera is to produce quantitative information, which may or may not be an image concerning the distribution of radioactive material which the camera is viewing. The quality of the information obtained is determined by a number of factors. It is assumed that the reader already has an understanding of the basic principles and operation of the camera as well as its proper setup and use. This aspect of quality control will not be discussed. Also, the detailed theory of operation of the computer system will not be discussed.

The performance of the scintillation camera, and therefore the computer-interfaced scintillation camera, are described by several operational characteristics. In the computer-interfaced camera system most of these are quantitative parameters which can be measured. Yet some of the tests described in this module will still rely on a visual evaluation of an image. The reason for this is that the versatility and complexity of the computer make it virtually impossible to design a quantitative evaluation process for every failure or combination of failures. In this section the reader will be given an understanding of the various evaluation techniques as well as guidelines for their interpretation and implication in clinical operation.

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The primary goal of the quality control tests discussed in this module is to provide the technologist and the physician with an assurance that the images produced during clinical studies accurately reflect the distribution of the radiopharmaceuticals in the patient. A secondary goal is to aid in the orderly operation of the imaging service by providing a prediction of service needs before the need becomes critical and interferes with clinical operation.

A discussion of acceptance testing of the computer-interfaced scintillation camera system is included since it is felt that measurements made on a newly installed system form a base line for quality control tests.

For many of the tests described in this section the reader will be referred to the section on Quality Control of the Scintillation Camera for details of source design, activities, and source positioning. This is done to remove unnecessary repetitious details with which the reader should be familiar.

In this section the term "analog image" will refer to the image conventionally collected on film by the camera without computer processing.

2.2 Testing Frequency

The frequency at which the following tests are performed varies widely. The operational checks which provide an indication of correct overall operation are performed on a daily or weekly basis. The more complete acceptance and reference tests are performed at longer intervals and provide a more rigorous evaluation of the camera. A chart is recommended testing frequencies is given in Table 1.

Table 1: Testing Frequency

Test	Acceptance	Reference/Operational (Frequency)
Log Book	Yes	No
Physical Inspection	Yes	Yes (Daily)
Intrinsic Uniformity		
(Tc-99m Clinical PHA)	Yes	Yes (Daily)
(Tc-99m Uniformity Corrector Off)	Yes	Yes (Weekly)
(Tc-99m Offset PHA Window)	Yes	Yes (Quarterly)
(Other Isotopes)	Yes	Yes (Quarterly)
Linearity	Yes	Yes (Weekly)
Spatial Resolution	Yes	Yes (Weekly)
Count Rate Response	Yes	Yes (6 Months)
Spatial Resolution and Uniformity at 75,000 cts/sec.	Yes	Yes (Quarterly)
Computer Timing	Yes	Yes (6 Months)

3.0 QUALITY CONTROL TESTS

3.1 Log Book

In instituting a QC program for the computer-interfaced scintillation camera, a log book must be organized. The book must contain all of the usual information, such as manufacturer, model, serial number, service numbers and installation information. For a computer system, information concerning the software must also be included. The version number of each separable software package must be recorded as well as the date of any software upgrades or patches. A loose leaf binder to which paper can be added and in which the films can be stored is perhaps the most practical thing to use. In many systems, a computer file may exist in which the data from the daily, weekly or monthly tests may be recorded.

3.2 Physical Inspection

Any QC procedure should begin with a visual inspection of the equipment. Loose or broken knobs, bent screws, or loose wires should be noted and reported to the manufacturer's service representative. At installation a number of hardware diagnostic programs will usually be run by the service engineer. The passing or failing of these tests by the system should be noted. In many cases, a system will fail a diagnostic program due to any one of a number of reasons. The most common is that the hardware does not exactly match the configuration for which the program was written. Any failures must be explained by the service engineer and the exact error messages recorded in the log book so that when the diagnostics are run in the future, similar failures can be anticipated and not interpreted as system failures.

3.3 Uniformity

A properly functioning camera exposed to a uniform flux of photons will produce an image which is uniform in intensity. Uniformity of this flood image is one of the most sensitive measurements of proper camera operation. It is also an important measure of proper operation of the computer-interfaced camera. As with the camera, the failures of other functions will often show themselves indirectly as nonuniformities in the flood image. For this reason, the daily flood image also forms the basis of the computer-interfaced camera QC program.

Uniformity tests are divided into two categories, those done without a collimator on the camera (intrinsic uniformity) and those done with the collimator mounted on the face of detector (extrinsic, or system uniformity). Intrinsic uniformity measurements evaluate only the image formation capability of the camera itself without consideration of the collimators. It can be expected to be the best uniformity the camera can provide. Extrinsic uniformity will not be discussed here. Evaluation procedures similar to those used for intrinsic measures can be used. However, extreme caution must be exercised during data collection to assure the required extended source is, in fact, uniform. For more information on extrinsic testing the reader is referred to the section on QC of the Scintillation Camera.

3.3.1 OPERATIONAL CHECKS

Routinely, uniformity is evaluated by collecting one or more flood images using a standardized protocol.

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Either an intrinsic (without collimator) flood or system (with collimator) flood can be performed. Since the goal of this test is to detect changes in the uniformity, the same collimator must be used every day for a system flood.

3.3.1.1 Materials

No special materials other than the sources appropriate for the flood image to be collected. If an intrinsic flood is collected, a lead mask should cover the outer edge of the crystal.

3.3.1.2 Procedure

Set-up the camera as for the collection of the routine analog flood image. Set-up the computer to collect a single static image in a 64 × 64 matrix. For daily floods to be evaluated visually, collect a total of 3 million counts, however, weekly collect a total of 14 million counts for quantitative evaluation. [Note: this collection protocol will produce approximately 310 counts per pixel in the camera image, so 8 bit (byte mode) collection is not adequate and word mode or its equivalent must be used.]

3.3.1.3 Evaluation of Results

Visual evaluation: A standard display protocol must be used for reliable evaluation of the image. One good method is to use the region of interest analysis to determine the average counts per pixel and then set the display contrast so that any pixels having more than the average plus two standard deviations will be displayed and any pixel having less than the average minus two standard deviations will be displayed in a different color or shade.

A hard copy of the standardized display of the computer image should be made and stored in the log book. The parameters to be recorded are: camera tested, number of counts collected, total time for collection of the analog image, total time for collection of the computer image.

The images should be examined for non-uniformities which have appeared since the last test image.

The image should also be examined for linear artifacts in either the x or y directions. These indicate a failure or malfunction of the analog to digital converter. (See Figure 2.)

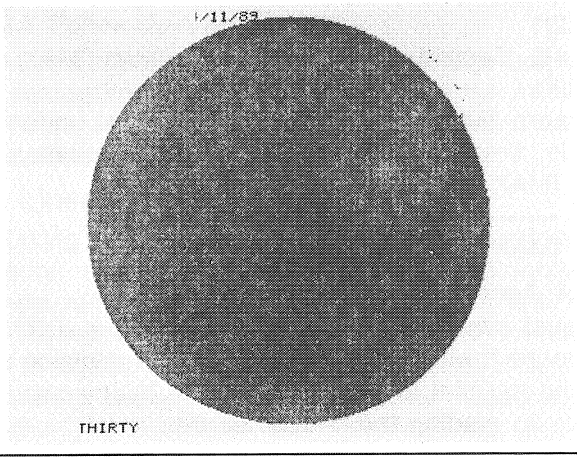

Figure 2: Linear artifacts in both x and y directions caused by malfunction of the analog to digital converter.

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Quantitative evaluation: If appropriate software is provided in the computer system, calculate the integral and differential uniformity for the useful field of view of the camera.

If a software package is not available to calculate the integral and differential uniformity, an approximation of the integral uniformity can be obtained using the routine image processing software in the following manner: First, smooth the image to be evaluated (if appropriate specify a 9 point smoothing with weights

$$\begin{matrix} 1 & 2 & 1 \\ 2 & 4 & 2 \\ 1 & 2 & 1 \end{matrix}$$

Second, determine the maximum (IMAX) and minimum (IMIN) pixel counts. The integral uniformity (IU) is then approximated by the calculation of

$$IU = \frac{IMAX - IMIN}{IMAX + IMIN}$$

3.3.1.4 Acceptability Limits

Visual evaluation: If serious defects are visible in the image it will be necessary to make a decision concerning the clinical use of the camera. In any case, the physician reading the clinical studies must be made aware of the findings.

Quantitative evaluation: No firm numerical cutoff value can be given for the uniformity indices since it will depend on the quality of the scintillation camera. Most properly tuned modern cameras will have an integral uniformity in the range of 4% to 6%. Again the important thing is day-to-day consistency and the absence of noticeable trends in the values obtained.

3.3.1.5 Follow-Up Actions

If the camera shows a degraduation in uniformity it must be decided if it is necessary to arrange for a service call. Linear artifacts in the computer image should be referred to the service engineer for evaluation and correction.

3.3.1.6 Additional Comments

The recommended QC of the scintillation camera includes the periodic collection of a flood image with uniformity correction circuits disabled, if possible. When this image degrades significantly, the service engineer should be called to retune the camera.

In many newer systems, the several correction matrices must be periodically acquired. The proper acquisition techniques must be used in all cases following the manufacturers recommendations. In some cases, correction matrices for each radionuclide imaged are required. Incorrect correction matrices may be the source of artifacts in the final uniformity image.

3.3.2 ACCEPTANCE TESTS

Upon installation and periodically thereafter, the camera must be subjected to more stringent tests than those provided by the operational checks. These tests are designed to uncover defects which are sufficiently subtle as to go unnoticed in clinical images but which will nevertheless degrade the image quality. In addition to the normal flood image, the following test images are also required for acceptance testing of the scintillation camera:

Tc-99m Centered PHA (Pulse Height Analyzer) Window with different Window Widths

Tc-99m — Offset PHA Window

Other Radionuclides of Interest

Other Pulse Height Analyzers

These images should be collected in the computer to allow quantitative evaluation so that a baseline value can be established for comparison with the periodic reference testing that will be performed.

3.3.2.1 Materials

No special materials other than the sources appropriate for the flood image to be collected. A lead mask should cover the outer edge of the crystal.

3.3.2.2 Procedure

Set-up the camera as for the collection of the routine analog flood image. Set-up the computer to collect static images as indicated.

Camera Uniformity

Collect an intrinsic flood image in a 64 × 64 or 128 × 128 matrix with at least 13 million counts.

Test For Proper ADC Operation

Collect one thirty million count flood image for each digital matrix available, i.e., 64 × 64, 128 × 128, 256 × 256. This will provide 9300. 2300 and 580 counts per pixel respectively in each image. If the computer system will not handle pixel count values of this magnitude collect the maximum number of counts possible in each matrix size.

3.3.2.3 Evaluation of Results

Camera Uniformity

Perform the quantitative evaluation described in the routine check for uniformity for each image. The images should also be examined visually to check for the presence of any unexpected or unusual defects not present in the analog camera images.

Test For Proper ADC Operation

There is no quantitative evaluation for these test images. The image display should be adjusted to provide a high contrast display and the flood images examined for vertical or horizontal stripes or lines. (See Figure 2.)

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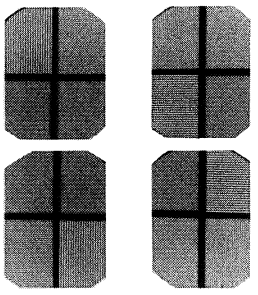

Figure 3. A test image of a bar phantom showing no spatial non-linearities.

3.3.2.4 Acceptability Limits

Visual evaluation: Although there should be no defects in the computer image that are not also in the analog image, the ability to produce a very high contrast display of the computer image may allow one to see defects not visible in the relatively low contrast film images. In order for a defect to be visible in an analog film image it must have a contrast on the order of 10 to 15%. Defects on the order of 5% or less may be seen in a high contrast computer image.

The thirty million count images used to test the ADC's will show some linear artifact in most systems even when the systems are properly adjusted. The artifacts should not be obvious, nor should they be visible in the routine 3 million count flood images.

Quantitative evaluation: If the acceptance test is being performed to evaluate a new camera, the results of the integral and differential uniformity calculations should be at least as good as the specifications published by the manufacturer. If the system is being tested to evaluate a new computer system, but not a new camera, then no firm numerical cutoff value can be given for the uniformity indices because they will depend on the quality of the scintillation camera.

There is no quantitative evaluation for the ADC test images.

3.3.2.5 Follow-Up Actions

Defects appearing in the computer image but not in the analog image should be referred to the manufacturer's service engineer. ADC artifacts should be corrected if possible.

3.4 Linearity

Making a meaningful quantitative measurement of linearity using a computer-interfaced scintillation camera requires both specialized software and hardware as well as test patterns. Although it is not reasonable to expect individual laboratories to have either the software or the special test patterns for measurements according to the NEMA test specifications, it is possible to perform some measurements which may provide some useful information.

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Linearity is the ability of the camera to reproduce accurately an image of radioactive line sources and it is evaluated by imaging a pattern produced by an array of slits in a lead plate.

Materials

Image distortion is best evaluated by use of a regular array of lead bars continuous across the entire field of view of the camera. One of three patterns recommended in the scintillation camera module is required, i.e., PLES, Hine-Duley or the orthogonal hole pattern.

Generally, the pattern used for computer analysis will have to be coarser, that is, have larger bars, than that used for the analog image evaluation.

A point source of approximately 7.5 MBq (200 microCi) of Tc-99m.

3.4.1 OPERATIONAL CHECKS

3.4.1.1 Procedure

Set-up the camera as for the analog linearity evaluation. Set-up the computer to acquire a static image in a 128 × 128 matrix and a total of 3 million counts.

Collect analog and computer images at the same time, if possible. If the PLES or Hine-Duley pattern is used, collect a second image of each type after rotating the pattern 90 degrees.

3.4.1.2 Evaluation of Results

Visual Evaluation: The digital images should be examined for localized distortions not appearing in the analog images. Both images should be examined for localized distortions which have appeared since the last test image. The visual evaluation is aided by placing a computer-generated profile adjacent to the section of the bar pattern under consideration and parallel to the bars (Figure 3). This eliminates the problem of distortion which may be present in the video display.

Quantitative Evaluation: Without specialized software and often a specialized bar pattern it is impossible to obtain a meaningful detailed quantitative evaluation of linearity.

3.4.1.3 Acceptability Limits

Both the digital and analog images may show localized areas of non-linearities in the bar pattern. However, there should not be a detectable difference between the images. Stability of the image from test to test is important.

3.4.1.4 Follow-Up Actions

If there is significant distortion in the digital image which is not present in the analog image the computer service engineer should be consulted and the system repaired or adjusted. In newer systems, reacquiring the linearity correction matrix may be necessary. This step is usually done by the service engineer.

3.4.1.5 Additional Comments

As with the uniformity test described above, the important consideration is stability over time and comparison with the reference image collected at acceptance.

With a knowledge of the hole size and spacing a semi-quantitative value for linearity can be obtained from the image of an orthogonal hole phantom by measurement of the image with a straight edge and estimating deviation from the displayed profile in millimeters. This must be done with caution however, because it is possible for the film recorder to introduce distortions which are not representative of the scintillation camera operation.

3.4.2 ACCEPTANCE TESTING

Evaluation of linearity during acceptance testing is identical to the routine evaluation. If a bar pattern is used for the test it must be imaged in two orientations so that distortion is tested in both the X and Y directions.

3.5 Spatial Resolution

Spatial resolution is the ability of an imaging device to resolve two sources as separate entities. For the scintillation camera it is the ability of the camera to demonstrate that two closely spaced sources are actually separate sources and not a single larger source.

Spatial resolution can be described in a number of ways. The full-width-at-half maximum (FWHM) of the line spread function obtained from the image of a line source is perhaps the most common measure. This is the distance across the digitized image of a line source between the two points on either side of the maximum value at which the intensity is one half of the maximum (see Figure 4). The modulation transfer function (MTF) is a mathematical analysis (a Fourier transform) of the line spread function which provides a more complete characterization of the camera response because it shows the response to the different spatial frequencies in the line spread function. Although it is a straightforward calculation, and quite simply programmed it is not usually available on clinical computer systems because of its specialized nature. The FWHM is more commonly used and will be described here.

3.5.1 OPERATIONAL CHECKS

3.5.1.1 Materials

The bar pattern and source used to check the analog camera.

3.5.1.2 Procedure

Set-up the camera with the bar pattern as for the analog check of resolution. Set-up the computer to collect a static image in the finest digital matrix available (i.e., 256 × 256), image zoom of at least 2.0 and two million counts total.

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PTW-PRODUCT INFORMATION

MP 3-System, a modern, fast and reliable water phantom system for measurement of dose distribution in radiotherapy.

Measures a profile of 45 cm length within 25 seconds.

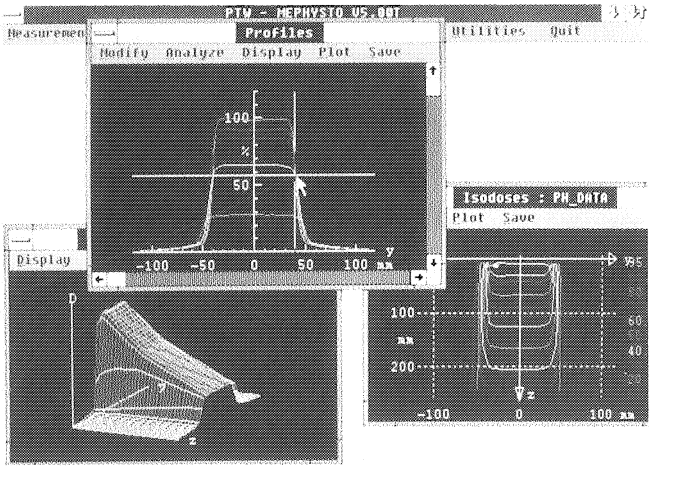
The MP 3-system is now equipped with a fast dual-channel electrometer which allows a reduction of the required measuring time down to 10 ms per measuring point. This feature, combined with the high moving speed of 50 mm/s maximum between the measuring points, yields the extreme low measuring time for a complete scan.

The measuring data are acquired by dose integration on every point of a scan, measuring step by step with programmed step sizes. This proceeding secures high accuracy and reproducibility. When measuring curves with high dose rate gradient (e.g. profile slopes or low-energy electron depth dose curves) speed reductions or smoothing functions are not required. Only the original data are stored.

Together with our new software package MEPHYSTO the water phantom system MP 3 is the latest state-of-the-art system.

MEPHYSTO

MEDICAL PHYSICS TOOL



Microsoft Windows software for data acquisition using the PTW water phantom MP 3, for data evaluation and data management.

- Graphic user interface Microsoft Windows 3.0 and mouse control
- Programming language Microsoft C 6.0
- Data base for data management
- Multitasking for simultaneous presentation of profiles, depth dose curves, isodoses and 3-D graphics; disk data presentation even during phantom measurements
- Proven water phantom measuring routines for any inclined measuring plane
- Useful evaluation programs and formatting modules for data transfer to therapy planning systems.

Further advantages of MP 3-System (a selection):

- Moving range of A co-ordinate: 600 mm (500 mm are not sufficient for complete profile measurements of 40 cm x 40 cm field sizes, especially in the depth)
- Measurements in arbitrary inclined planes possible
- High positioning accuracy by stepper motors (200 steps/mm approx.)
- High mechanical stability of stainless steel moving mechanism
- No displacement of water by parts of the moving mechanism dipping in water when measuring from the water surface into the depth. Thus the adjusted source surface distance SSD will not be displaced.
- Simultaneous digital display of the three co-ordinates on the control pendant, resolution: 0.1 mm
- Scan optimization for beam evaluation of accelerators with scanning electron beam

For further information please contact:

PTW-FREIBURG

PHYSIKALISCH-TECHNISCHE WERKSTAETTEN DR. PYCHLAU GMBH

West-Germany
D-7800 Freiburg
Loerracher Str. 7
Phone 07 61 / 4 90 55 - 0
Telex 7 721 439 ptwf d
Telefax 07 61 / 49 21 95

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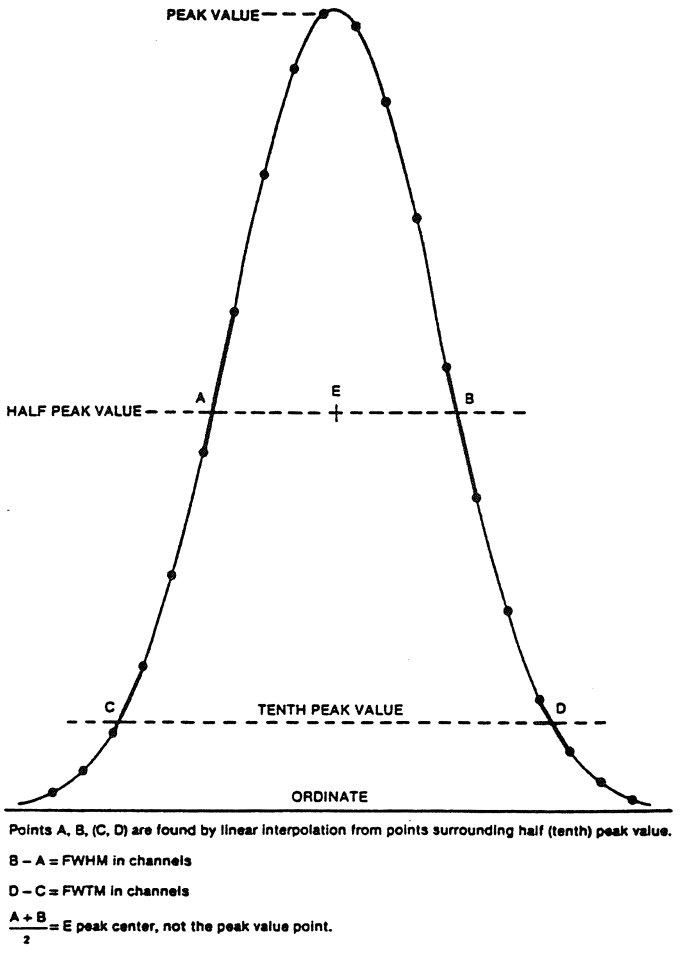


Figure 4. Spatial resolution determined by the full width at half maximum of the line spread function.

3.5.1.3 Interpretation of Results

The computer should be examined to check if the smallest pattern spacing visible on the analog images is also visible on the computer images.

3.5.1.4 Acceptability Limits

The spatial resolution of the computer images and analog camera images should be the same. However, it should be recognized that the digital matrix may limit the digital resolution, as described below.

3.5.1.5 Follow-Up Actions

If the computer image shows a resolution degraduation compared to previous checks without a corresponding degraduation in the analog images the computer system servicemen should be asked to check the system.

3.5.1.6 Additional Comments

The image produced by collection of an image of a regular lead pattern, i.e. a bar pattern or orthogonal hole pattern, in a computer is dependent on the digital matrix and the size of the camera image that is to be digitized. If the original matrix is too course the collected image will either diplay Moiré patterns, like those seen in the analog images collected through a collimator, or there will be no detail at all because the bar patterns are simply blurred out. Table 2 lists the bar width that one could expect to see in various digital matrix sizes.

Table 2: Detectable Bar Width

Camera FOV	40.00 cm.			20.00 cm.		
Matrix/Zoom	1.00	2.00	2.50	1.00	2.00	2.50
512.00	1.56mm	0.78mm	0.63mm	0.78mm	0.39mm	0.31mm
259.00	3.13	1.56	1.25	1.56	0.78	0.63
128.00	6.25	3.13	2.50	3.13	1.56	1.25
64.00	12.50	6.25	5.00	6.25	3.13	2.50

It can be seen from this table that if one has a large field of view camera able to resolve 2mm bars in the analog image then a zoom factor of at least 2.0 and matrix of 256 would be needed to show the bars in the digital image.

3.5.2 ACCEPTANCE TESTING

3.5.2.1 Materials

A 3mm thick lead mask plate with one or more 1mm slits at least 30mm apart or two Tc-99m line sources less than 1mm in width placed parallel to one another at known spacing of approximately 30mm. A point source of Tc-99m - 7.5Mbq (200 microCi).

3.5.2.2 Procedure

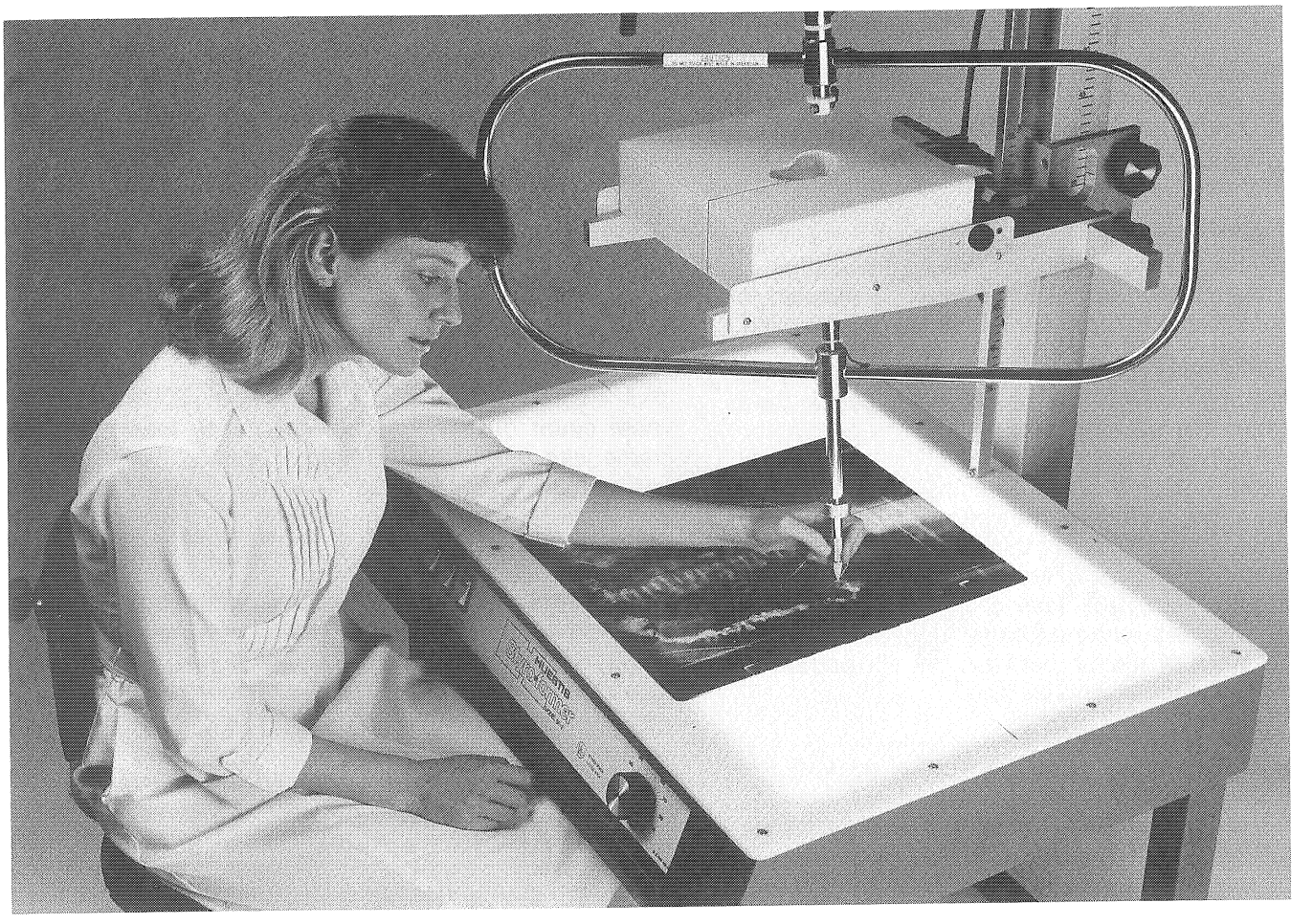
Set-up the lead slit pattern on the uncollimated camera, being careful to accurately align the slit with either the horizontal or vertical axis of the computer image. Use the standard source holder for the point source, if using the slit pattern the camera to source distance should be ×5 detector diameters, use clinical PHA seeting (e.g., 20% width, centered on 140 keV).

Set the computer for a 2.0 to 2.5 zoom factor, with the finest digital matrix available which can generate a profile collect until at least 10,000 counts are recorded in the peak channel. Collect two images with the slits rotated 90 degrees between images to measure the X and Y resolution.

3.5.2.3 Evaulation of Results

Using the profile analysis software, construct a profile through the slit or line source image at least 5 pixels wide. Obtain the numerical values for the data points in the profile and plot them on a sheet of linear graph paper. Calculate the full-width-at-half maximum for both line spread functions as shown in figure 4. The millimeters per pixel calibration is obtained from the known spacing between the slits or sources and the number of pixels between the peaks of the lines spread functions.

Continued on page 22



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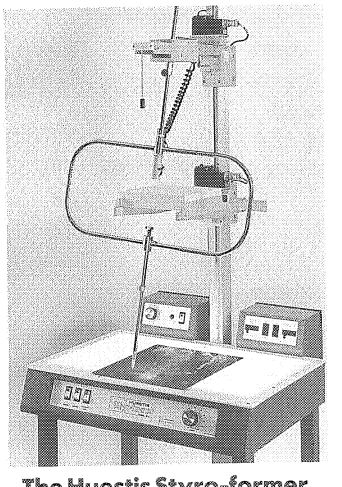

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3.5.2.4 Acceptability Limits

At acceptance, the measured intrinsic spatial resolution should be at least as good as the manufacturer's specifications. The resolution should be an average of the X and Y directions.

3.5.3.5 Follow-Up Actions

Any failure to meet manufacturer's specification or regional degraduation of resolution must be reported to the manufacturer's service representative for correction.

3.5.2.6 Additional Comments

This method of resolution measurement can be used to determine the system resolution of the collimated camera. For high energy collimators the thick septa may cause problems when attempting to measure resolution at the surface of the collimator. The parallel line sources are preferred for this measurement. Manufacturers generally specify resolution at a distance of 10 centimeters from the face of the collimator. The response with and without scatter can be tested by placing a stack of plastic between the slit pattern or line sources and the collimator face.

3.6 Count Rate Response

The computer provides a quantitative analysis for many clinical studies. The accuracy of the quantification often depends on the accuracy with which the counts in the image and the changes in the counts represent the activity and changes in activity in the patient. The camera will introduce some loss in observed counts through its inherent deadtime. The computer may introduce some further losses due to data transfer rates in addition to that produced by the camera. In most cases, the deadtime of the system should not be greater than that of the analog camera by itself.

3.6.1 OPERATIONAL CHECKS

There are no specific tests of count rate response that are performed routinely on a daily, weekly or even monthly basis. All of the tests for evaluating this parameter are repeated at quarterly or semi-annually intervals and these are essentially repetitions of the tests performed at acceptance.

3.6.2 ACCEPTANCE TESTS

3.6.2.1 Procedure

Five parameters of operation for the analog camera are of interest at acceptance. These are:

1. The maximum observed count rate
2. Count rate response with or without scatter
3. The observed count rate at which 20% of the incoming counts are lost, with or without scatter
4. The spatial resolution at 75,000 counts/second
5. The flood field uniformity at 75,000 counts/second.

All of these should be measured in the computer system as well as in the analog system if possible. The presence of scatter will only affect analog camera operation.

Maximum Observed Count Rate

Set-up the camera and source as in the analog measurement of maximum count rate. Set-up the computer for a dynamic collection of 30 frames of 1 second each. Start the computer collection and move the source slowly from a distance of approximately 3 meters towards the camera. The source should be moved the entire distance of 3 meters from the camera through the point at which the count rate is maximum on the analog camera in the 30 seconds of data collection. Upon termination of the collection draw a region of interest around the entire digital image and plot the count rate versus frame number. The maximum count rate can be determined by locating the frame with the largest number of counts. Record this value on the log book for future reference.

Intrinsic and System Count Rate Response (Deadtime)

Two measurements of deadtime should be made at acceptance of a camera. Both measurements are made using two sources of activity which result in count rates low enough so that the system responds as a non-paralyzable system. The only difference is the source configuration and the collimation of the camera. One being performed with a scatter free source and no collimation and the second being performed with the scattering source and a collimated camera.

The two source deadtime measurements should be performed as described in the scintillation camera section but with the additional step of collecting the data in the computer in a series of static images (64 × 64 matrix, no zoom, 100 seconds collection time) at the same time as it is collected on the analog camera. The analysis and determination of deadtime is identical to the analog camera analysis. The counts used for the background, first source, combined source and the second source are the total counts in the respective images. The count rate of the combined sources should approximate the observed 20% count rate loss.

Only an overview of the two source deadtime measurement will be given since it is discussed in detail in the scintillation camera section. The procedure consists of the following:

1. Set-up the camera as desired for the measurement (i.e. PHA setting, collimation, etc.)
2. Obtain a 100 second background count.
3. Count one source for 100 seconds.
4. Add the second source and count the combined sources for 100 seconds.
5. Remove the first source and count the second for 100 seconds.
6. Calculate the deadtime by the equation:

$$T = \frac{2\,R_{12}}{(R_1 + R_2)^2} \ln \frac{R_1 + R_2}{R_{12}}$$

Continued on page 24

Continued from page 22

Where R_1 and R_2 are the count rates of the first and second sources and R_{12} is the count rate of the two sources together, all in counts/second. The deadtime will be in seconds.

7. Calculate the count rate at which 20% of the counts are lost by the equation:

$$C_{20} = 0.8\,\frac{1}{T}\ln\frac{10}{8} = \frac{0.178}{T}$$

The count rate at which one loses 20% of the incoming counts is significant in clinical studies because it is nearly the point at which one would have to add 10% more activity to increase the observed count rate by only 5% (the point of diminishing return).

3.6.2.2 Interpretation of Results

There should be no significant difference (< 10%) between the deadtime values obtained for the camera/computer system and those obtained for the camera alone.

3.6.2.3 Follow-Up Action

If the camera/computer system and the analog camera appear to have significantly different count rate responses the service engineer should be consulted.

3.6.2.4 Additional Comments

The format and adjustment of the digital collection can greatly affect the deadtime measured for the camera/computer system. If the incoming camera image is digitized in such a way that some of the analog camera image is not included in the digital image (either because of offset or gain) then the counts from the area must be processed by the computer in the collected image. The same effect is present when collecting data in a zoomed mode. This effect is important in clinical applications in which a zoomed image is collected from a particular anatomical area, e.g. the heart, but there is activity radiating counts from anatomical regions not imaged by the computer, e.g., the stomach or the spleen. In this case the apparent count rate response can often be significantly increased by shielding the camera from the extraneous radiation.

3.7 Spatial Resolution and Flood Uniformity At 75,000 Count/Second

The section on scintillation camera QC discusses the testing of the camera itself at high count rates. The combined camera/computer system must also be tested at high count rates because there are analog electronic components in the image collection chain whose response can vary with count rate. The measurement techniques for the combined system are identical to those for the analog system.

3.7.1 MATERIALS

80MBq (2mCi) of Tc-99m in a syringe.

3.7.2 PROCEDURE

These tests are the same as those used for evaluation of the system under lower count rate conditions with the exception that more radioactivity is used. If the camera has a special 'high count/rate mode,' the tests should be performed with and without this mode enabled.

3.7.3 EVALUATION OF RESULTS

Evaluation of the high count rate images is the same as that described above in Section 3.3.1.

3.7.4 ACCEPTABILITY LIMITS

Visual evaluation: There may be some degraduation in the visual appearance of the high count rate flood (See Figure 5), but it should not have defects which would prevent the system from being used clinically.

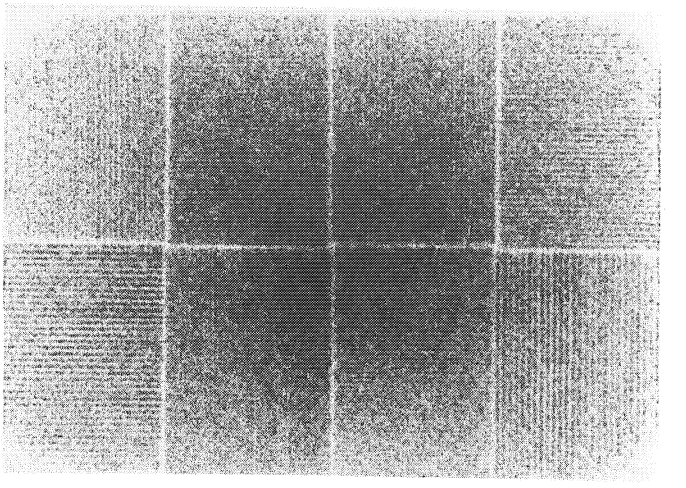

Figure 5. Scintillation camera image of a resolution bar phantom taken with a count rate of 75,000 cps. The increased count density in the center of the image does not occur with low count rates. In this camera, if one were to collect a uniformity correction matrix with a high count rate, the images would be overcorrected in the center causing a "cold" central area.

Quantitative evaluation: No firm numerical cutoff value can be given for the uniformity indices since it will depend on the performance of the scintillation camera. Most properly tuned modern cameras will have a low count/rate integral uniformity in the range of 4% to 6% and a high count/rate uniformity only one or two percentage points greater.

The camera manufacturer's specifications must be consulted to determine the acceptable amount of degraduation.

3.7.5 INTERPRETATION OF RESULTS

Sometimes the digital image collected in the high count rate mode will be noticeably poorer in resolution and uniformity than one collected in the low count rate mode. If there is not a corresponding degraduation of

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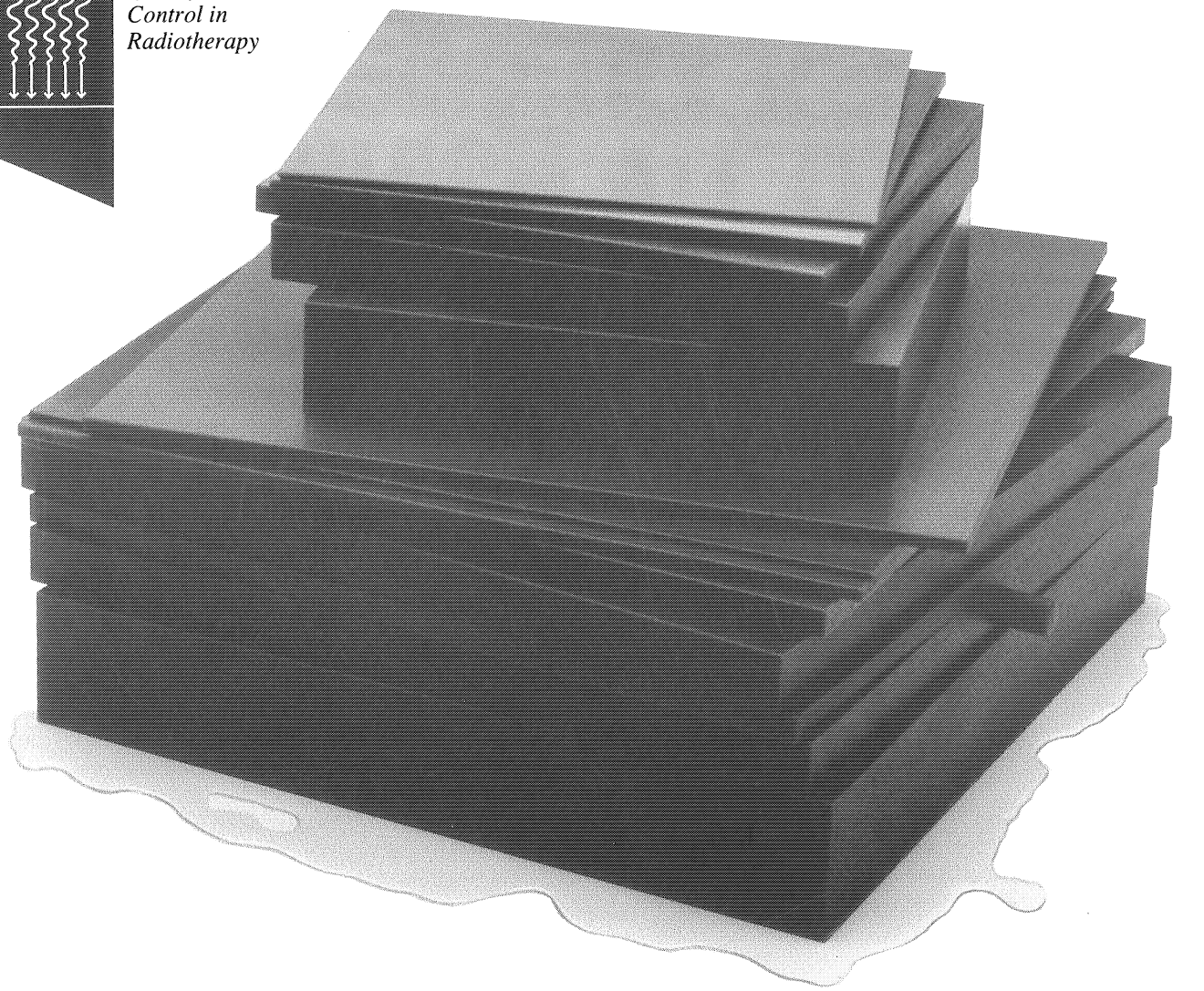

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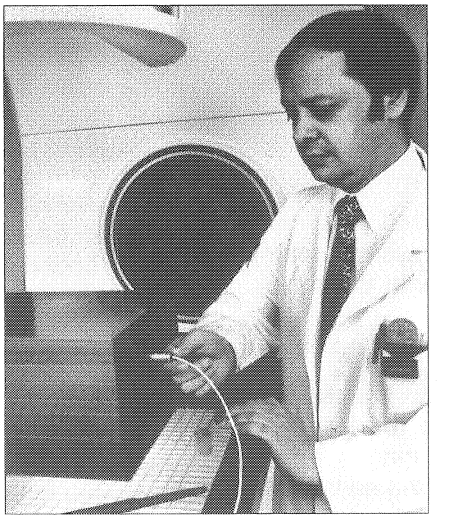

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the analog image a problem exists in some portion of the system beyond the image forming electronics of the camera.

In most cases, the uniformity and resolution will be poorer with the 'high count rate mode' enabled.

3.7.6 FOLLOW-UP ACTIONS

If the uniformity or spatial resolution suffer serious degraduation at high count rate the problem should be referred to the service engineer.

The images should be annotated and placed in the log book for reference.

3.8 Multiple-Window Spatial Registration

Note: This test applies only to cameras which can collect an image simultaneously through more than one PHA.

The section on scintillation camera QC discusses an analog method of evaluating the alignment of multiple energy images. A quantitative evaluation is also possible when a computer is available. However, it must be remembered that the quantitative measurement is still only a test of the camera. The computer system will not cause further energy dependent distortion.

3.8.1 OPERATIONAL CHECKS

3.8.1.1 Materials

A 7.5MBq (200 microCi) source of Ga-67 either in a container with 6mm thick walls and a 3mm diameter hole in the bottom (for use with the uncollimated camera) or as point source in a small syringe (for use on the collimated camera.)

3.8.1.2 Procedure

Set-up the camera to collect an analog image from the Ga-67 source. Set-up the computer to collect three images in a 256 × 256 matrix with a 2 to 2.5 zoom.

Position the source so that it is seen in the digital image. Collect three images of the source using each of the photopeaks in turn, that is, one image using the 93 keV photopeak, one image using the 184 keV photopeak and one using the 256 keV photopeak. Collect at least 10,000 counts in the peak channel.

3.8.1.3 Evaluation of Results

Display each of the digital images and using the profile analysis software of the computer system determine the x and y location of the pixel with the maximum count.

3.8.1.4 Interpretation of Results

If there is no displacement between the images obtained with the different energy photons the location of the peak will be the same in all three images. If the location is different in the various images the equivalent spatial displacement can be calculated from the calibration factor determined during the measurement of spatial resolution.

3.8.1.5 Acceptability Limits

As the computer system will not introduce further distortion, the camera manufacturer's specifications can be used to determine the limits of acceptability. A variation greater than ±2mm will degrade clinical images.

3.8.1.6 Follow-Up Action

If a misregistration is suspected the problem should be referred to the service engineer for evaluation.

3.8.2 ACCEPTANCE TESTS

The acceptance test for multiple window spatial registration is identical to the operational check. It must be performed at installation and after major repairs.

3.9 Computer Timing

3.9.1 ECG GATING

The gating system on a computer is a combination of hardware and software. The operation of the gating system can be checked as follows:

3.9.1.1 Materials

A point source of approximately 100 MBq (3mCi) of Tc-99m.

3.9.1.2 Procedure

Connect the ECG leads to a normal volunteer. Place a point source of approximately 100MBq (3mCi) in the field of the view of the collimated camera. Collect a gated acquisition using the same collection parameters as for a patient gated blood pool study.

3.9.1.3 Evaluation of Results

Draw a region of interest around the image of the point source. Construct a count versus frame curve for the region of interest. Print the values for the curve and calculate the average and maximum variation from the average for the first ¾ of the curve.

3.9.1.4 Acceptability Limits

The curve should be flat over the first ¾ of the curve. The last ¼ may fall off due to irregularities in the heart beat of the volunteer.

The average value should be approximately that expected based on the individual frame length, incoming count rate and total acquisition time.

The maximum deviation should be less than 3 standard deviations from the average.

3.9.1.5 Follow-Up Actions

If there are non-random fluctuations in the curve the gating system is suspect and should be checked more thoroughly. Before calling the service engineer, the experiment should be repeated with a second volunteer.

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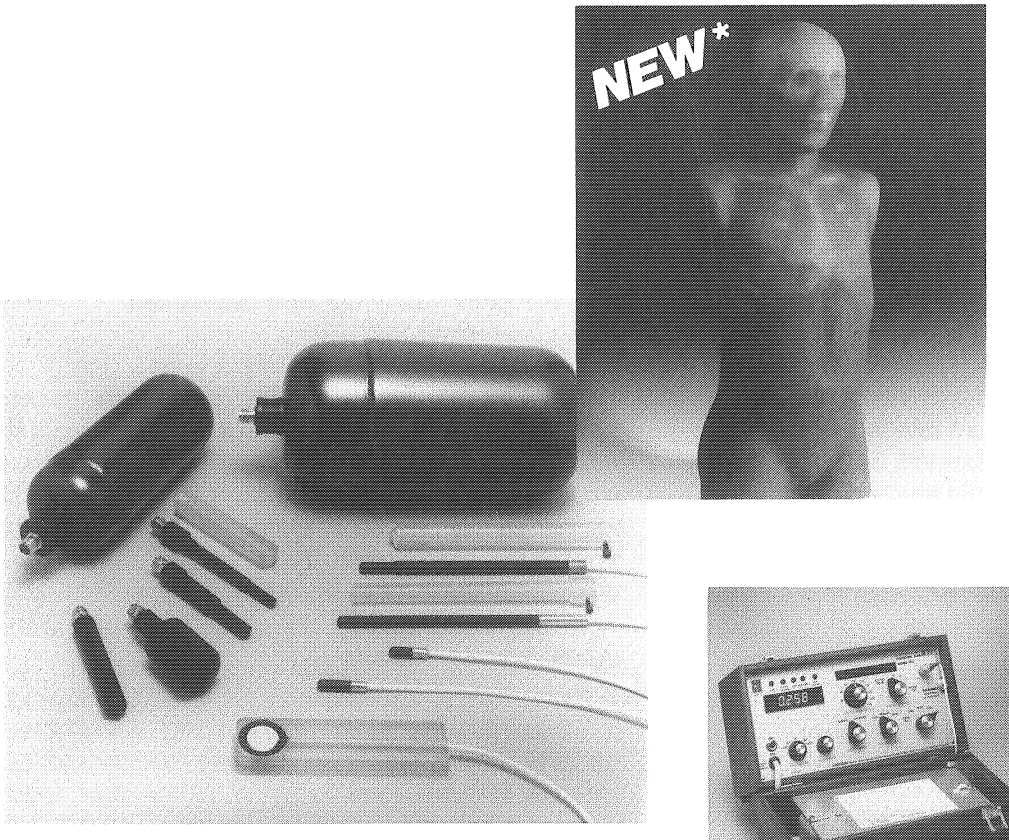

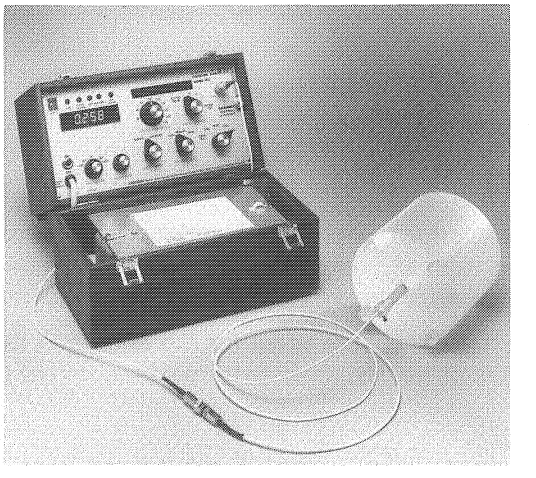

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3.9.1.6 Additional Comments

The use of a cardiac simulator will remove the uncertainties due to variation in the cardiac cycle length of the volunteer but the additional information gained is usually marginal. The cardiac simulator does, however, remove any questions concerning good skin contact of the ECG probes on the volunteer.

Noise spikes which simulate bad beats can be introduced by having the volunteer move an arm during collection. This could be used to evaluate any bad beat rejection software being used.

3.9.2 DYNAMIC ACQUISITION TIMING

A number of factors have an impact on the ability of the computer to accurately collect dynamic studies. The following protocol simply checks for correct operation and does not attempt to resolve the question of what aspect of the computer is at fault for failure to properly collect dynamic studies.

3.9.1.2 Materials

A point source of approximately 10 MBq (300 microCi) of Tc-99m and a stop watch.

3.9.2.2 Procedure

Place the source in the field of view of the uncollimated camera such that the count rate is approximately 20,000 c/s. Collect a static, unzoomed, 64 × 64, image for 20 seconds. Collect a dynamic study of 100 frames, 0.2 seconds in length, for a total collection time of 20 seconds. Start the stop watch and the data collection simultaneously. Record the stop watch time at the end of the dynamic acquisition.

3.9.2.3 Evaluation of Results

From a region of interest around the total frame or from image statistics, determine the total counts in the static image (Cs).

Using a region of interest and printing the time-activity curve values, determine the total counts (cf) in each of the frames of the dynamic study.

Calculate the Chi-square value for the counts in the first 10 frames of the dynamic study as determined in step 2.

Calculate the apparent frame length (Tf) for each of the first 10 frames:

$$Tf = \frac{Cf \times 20}{Cs}$$

Calculate the average frame length and the apparent total time (= (Average Tf) × 100).

3.9.2.4 Acceptability Limits

The average frame length and the calculated total dynamic study time should be within ±6% of the ideal values (0.2 seconds and 100 seconds).

An excessively large Chi-square value indicates an unexpected random variation in the frame lengths.

3.9.2.5 Follow-Up Action

If anomalous results are obtained repeat the test at a lower count rate (e.g. 5,000 cts/sec).

Further investigation is recommended if consistent results cannot be obtained even at lower count rates. The failure could be a hardware or a software problem. It is impossible to even make a reasonable suggestion as to the potential source of the problem.

3.9.2.6 Additional Comments

A number of timing problems may be present, but two are worth discussing here. The total elapsed time (measured with the stop watch) may be accurate but each frame may be too short. This results from time between frames during which collection is suspended and will produce an unexpected low count rate in the individual frames. The second case is one in which the total collection time (measured with the stop watch) is long or short but the average frame length, as calculated above, is also correspondingly too long or short. In this case the frames are inaccurately timed but there is no 'deadtime' between frames.

3.10 SOFTWARE EVALUATION

The versatility and variability of software packages makes it impossible to force the evaluation into a fixed format. Furthermore, the versatility also prevents one from performing anything remotely resembling a definitive evaluation of correct operation. The following will provide the reader with some suggested operational steps which will increase the confidence one should have in the software. They should not be taken as definitive and complete.

The potential for a computer system to produce erroneous results as a consequence of a software failure is almost limitless. Software failures can occur because of application to inappropriate data, input of inappropriate user selections, corruption of the disk on which the program is stored, alteration of the hardware on which the program runs, changes in the program which have unexpected effects in other parts of the software.

The basic premise of software evaluation is that application of a program to a known data set will produce known results. Generally there are three types of data that can be used for program evaluation, validated clinical data, data collected from a physical phantom, e.g. cardiac phantoms, and data generated by computer simulation. In each of these cases, the results to be expected from a data processing program are known. If a program is used to process the data and the results are not those expected, an investigation into the source of the erronous results should be made.

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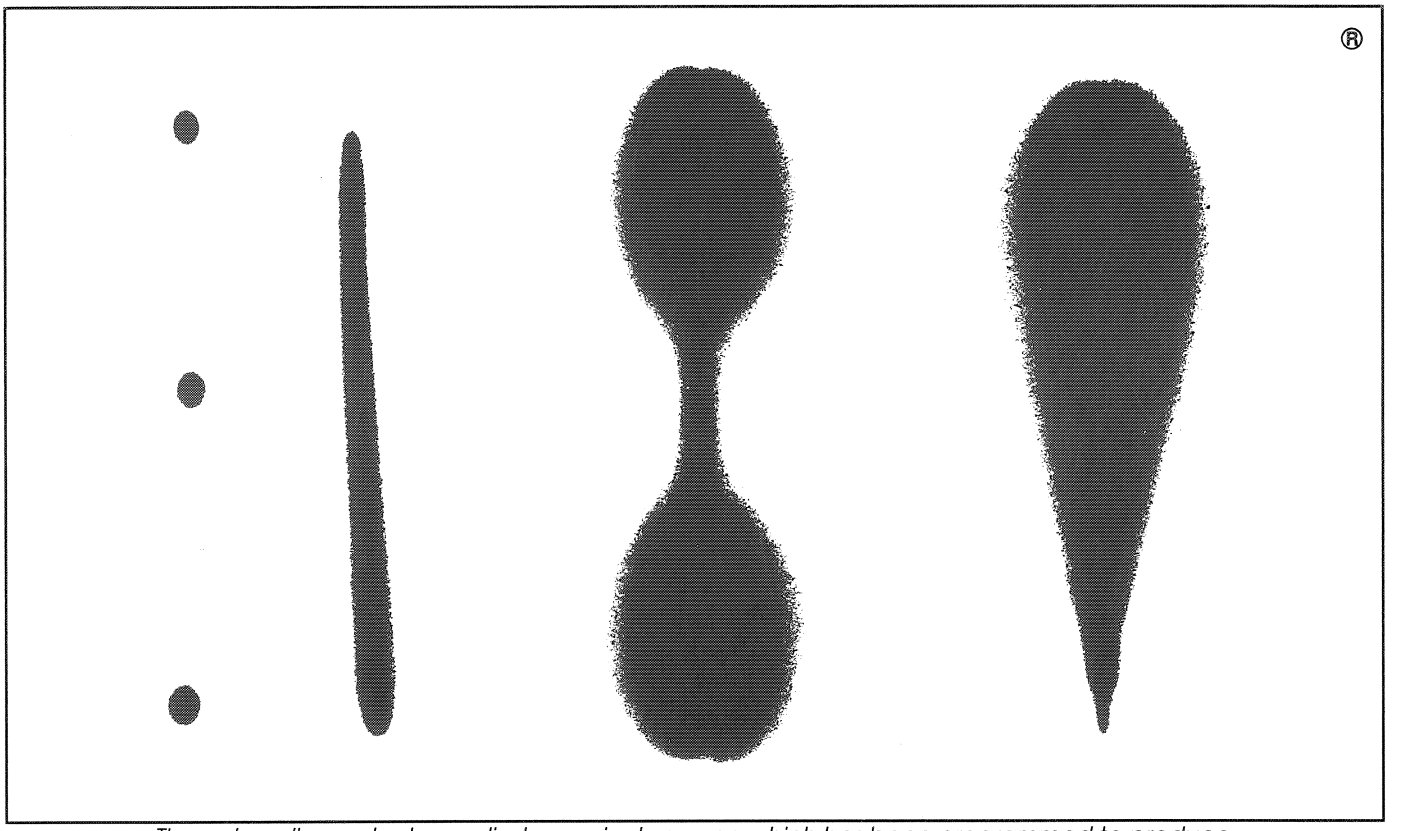

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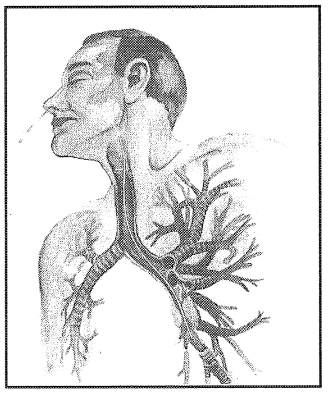

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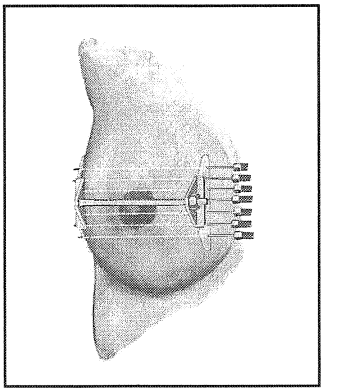

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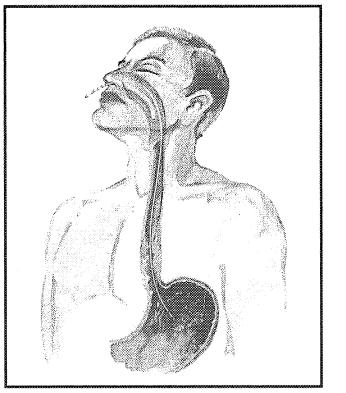
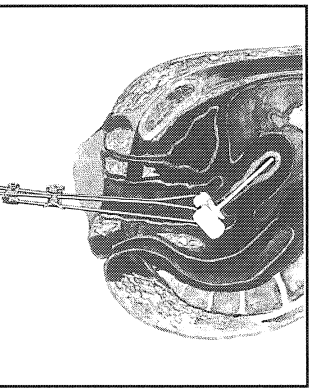


Esophagus



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Validated patient data would be data collected from actual patient studies and evaluated at a number of institutions to produce a set of expected and acceptable results. Analysis of these studies on the system being evaluated can provide assurance that the operator is making proper selections, the program is performing as expected and the hardware calculations are being performed correctly. Data from physical and mathematical phantoms could also be included in the data set.

Aside from these external reference data sets, a representative set of patient data could be collected in-house. This set of patient studies should then be retained for the life of the computer system. Any time there is a question concerning proper system operation, changes in the computer software or the introduction of a new operator this data set should be processed to provide assurance that the clinical results are consistent with past operation. Processing of new patient studies does not provide a comparison to earlier processing of other studies.

Complete software evaluation is virtually impossible. It is extremely important that the user be constantly vigilant to potential system failures. Any suspected failures of the system must be investigated and documented. New users often simply assume that they did something wrong and that the computer system does not fail or make mistakes. Nothing could be further from the truth and operation according that principle will surely invite inevitable disaster.

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Announcement

Appeal For a Cobalt Unit For Afghanistan

A Hungarian wall mounted cobalt therapy unit was donated to the Afghan Government in 1967 and was commissioned in 1978 at Kabul with a 3000 Ci source from Russia. Motors to actuate the source failed 4 years ago, and the source decayed to give an output of 20 cGy/min at present (60 cm). This is the only unit for the whole 12 million population of Afghanistan. The Afghanistan Government, unable to buy a new unit, solicits donors of old rotational units of the type Theratron 80R, Alcyon II, Picker MC 8 etc type with or without a source and with good QA test data. Dismantling and transportation charges would be borne by an International Agency. Donors may write to me by telex or fax. They may also write to Dr. A. R. Salim, Head, Radiotherapy Dept., Ali Abad Hospital, Kabul University, Kabul, Afghanistan.

Dr. U. Madhvanath
Vice-President, IOMP
Head, DRP, BARC, Bombay 400085, India
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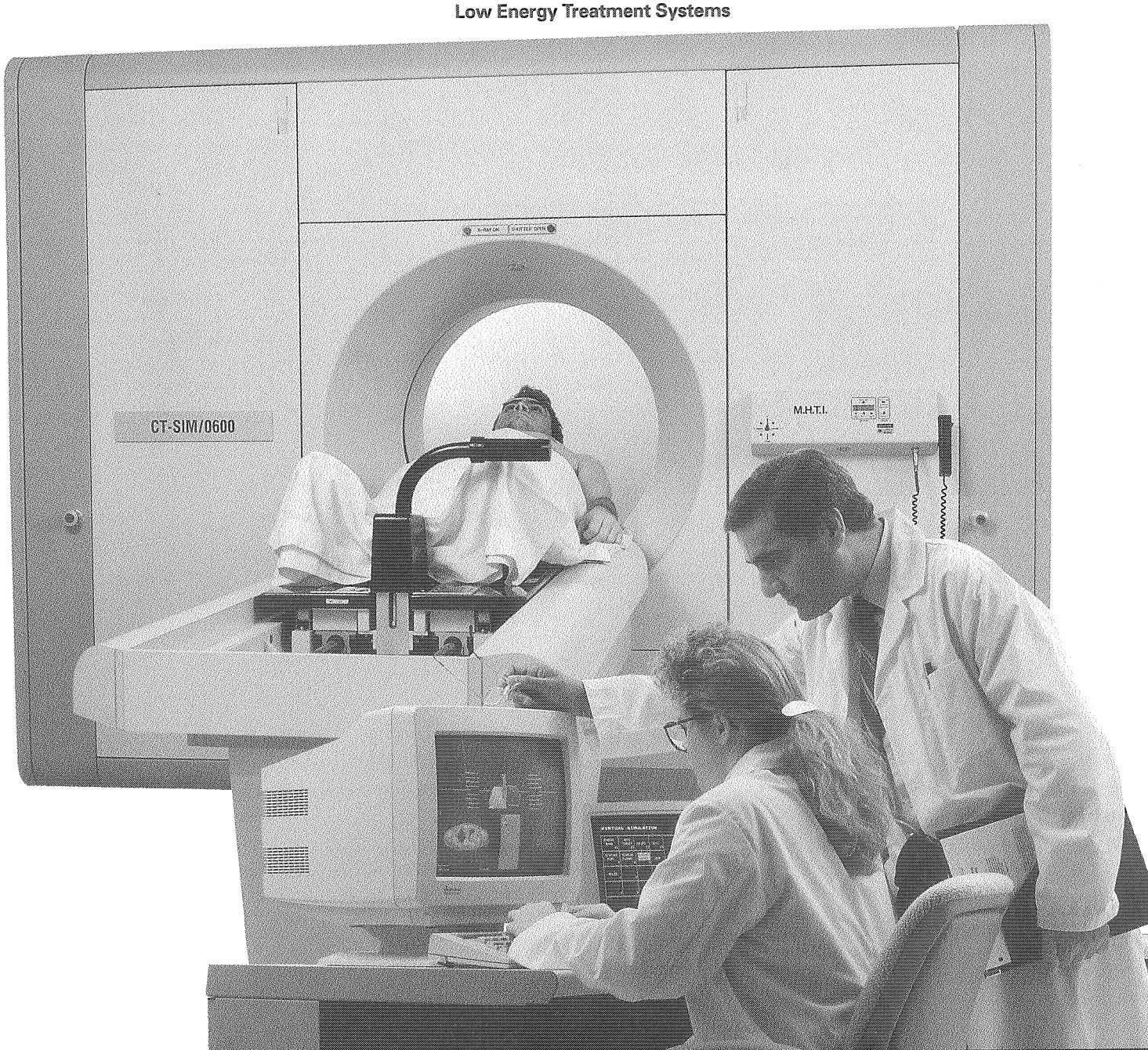

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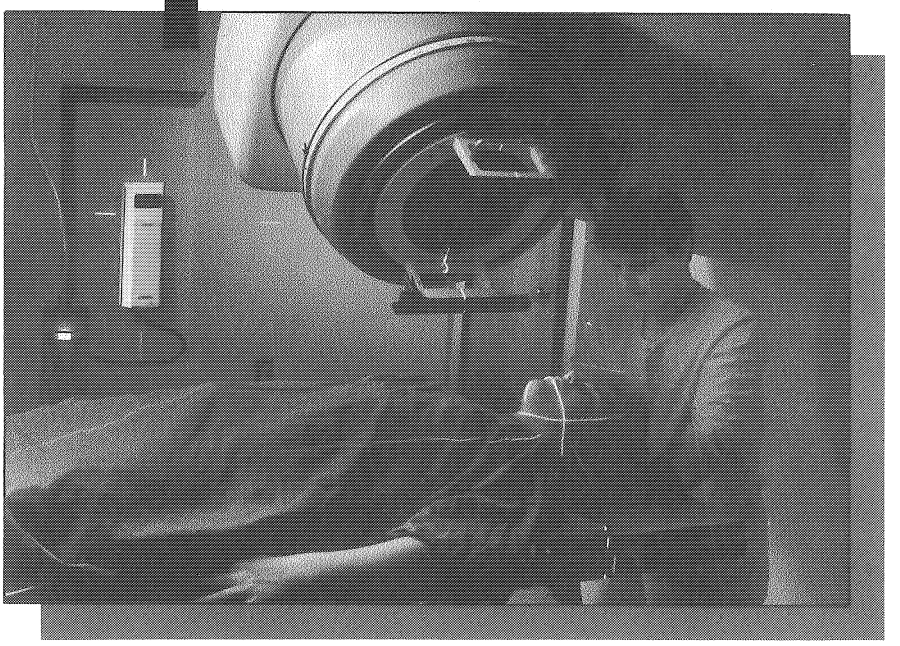

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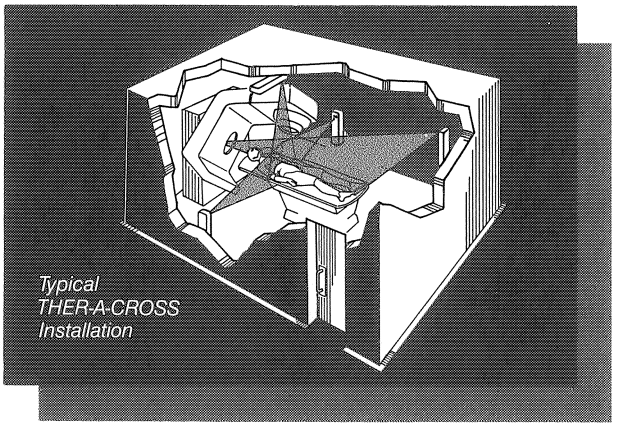

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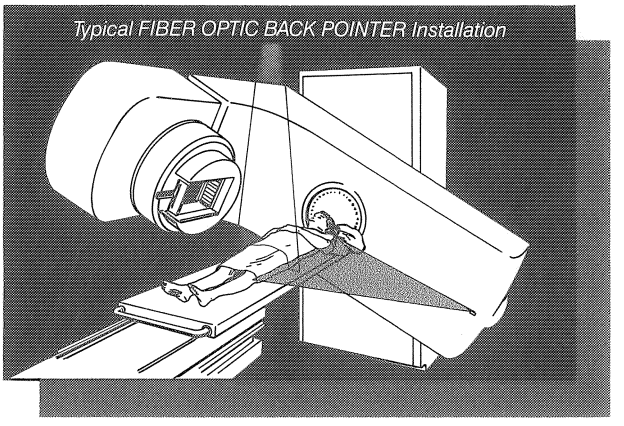

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