I R P S BULLETIN

Newsletter of the International Radiation Physics Society

Vol 10 No 1 **March/April, 1996**

From the Editor :

We have to ask ourselves the question: what will be the future of our Society? What will be the membership of the IRPS in the year 2000? What sort of science will the members be interested in? How should it be organized?

The IRPS is at the cross-roads as a Society, and the Jaipur meeting will decide what its future will be. We are too small to continue in the way we have since the Ferrara meeting. It is true that other interest groups such as the International Mössbauer Society and the XAFS Society have managed to survive with memberships not much larger than ours for an extended period of time. These Societies have a large scientific community, however, based on specific scientific techniques. In contrast, our Society is characterized by a very diverse range of scientific interests. We have no unique shopfront in which to display our wares like the other two Societies.

It is essential that:
either we must grow, and every member introduces a new member to the Society,
or become allied to a larger Society, such as one of the Societies falling within the ambit of the International Committee of Scientific Unions. ICSU encompasses Societies such as the International Union of Crystallography, the International Union of Pure and Applied Physics, and the International Union of Pure and Applied Chemistry, *et cetera*.

It may be that there are a number of other solutions, and I would be delighted to publish these as letters to the editor in future editions of the IRPS Bulletin.

As I have said on numerous occasions: every member has the right to air his views in this Bulletin, and no-one should be reticent in putting forward his own view on our Society and its relation to the real world.

Without effective communication between members our Society will become a microcosm of the world, and it will degenerate into a set of scientific tribes, each pursuing narrow factional interests. The whole essence and ethos of the Society will be lost.

We must therefore commence a very meaningful debate on the future of the IRPS, and the proper place for such discourse is this Bulletin.

Dudley Creagh

I S R P – 7

JAIPUR INDIA

24 – 28 February 1997

IRPS Bulletin is produced by the University College, UNSW

PP 299436/00/138

PRESIDENT'S COLUMN

John Hubbell

Some Reflections at My Two-Thirds Point

With one year remaining of my 1994-1997 tenure as your IRPS President, this seems a good time to reflect on my first two years, and also to look forward a little to my remaining time in office, and beyond.

The ISRP's: When We "Come Alive" (Brigadoon):

One of my favorite entertainments is the fantasy musical "Brigadoon," full of lilting tunes, kilted sword dancing and romance, set in the remote and misty highlands of Scotland. For some magical reasons, the entire village of Brigadoon vanishes and sleeps, except that every 100 years the village and its colorful denizens come back into active existence for a single day, then lapse back into their deep sleep in the mists for another 100 years, awaiting their recurring miracle. I like to think of our triennial ISRP's as the "Brigadoon-type" wake-up interludes for the general membership of our IRPS. Fortunately we sleep for only three years instead of 100 years, and our miracle lasts for five days instead of only one day. Then, at the ISRP's, we come alive, to meet and greet our far-flung global radiation physics colleagues and to share scientific accomplishments and aspirations as well as the hungered-for personal contacts.

Jaipur, India, in its Rajasthan semi-desert setting, offers a rather different terrain from the mist-shrouded highlands of Scotland, but the recurring miracle of our IRPS "Brigadoon" will take place in the "Pink City" of Jaipur as we again materialize out of the global mists and spring into life at ISRP-7 February 24-28, 1997. My wife Jean and I keenly look forward to meeting old friends and making some new friends, as always happens. Our ISRP-7 National Organising Committee, led by **Bikash Sinha**, **R.N. Singh**, **A.M. Ghose** and **B.K. Sharma** (Convenor, University of Rajasthan) are well along in their plans for the logistics of the conference. The ISRP-7 International Program Committee, led by **David Bradley** and **Franco Rustichelli** has assembled an excellent invited-speaker oral program under the general topical areas:

(1) Fundamental Processes in Radiation Physics,
(2) Radiation Sources and Detectors,
(3) Applications of Radiations in Fundamental Research,
(4) Radiation in Biophysics, Medicine and the Environment,
(5) Radiation in Technology, and
(6) Radiation in Archeometry, Earth and Space Sciences, and Cosmology.

Please Note: Following our established ISRP practice, all contributed papers will be presented by poster. Hence, for purposes of travel approvals and support by the participants' institutions, poster presentations at ISRP-7, as at all previous ISRP Symposia, are considered to be full-stature conference papers.

If you have ever dreamed of riding an elephant, this is an added incentive to join us at ISRP-7, where these lumbering conveyances will be available for the trip up the hill to the picturesque Amber Fort a couple of kilometers outside Jaipur. Inside Jaipur, the many attractions include the pink and yellow Royal Palace, and an architecturally and scientifically interesting array of astronomical instruments.

Looking back on our last IRPS "Brigadoon" wake-up interlude at ISRP-6 in Rabat, Morocco July 18-22, 1994, let me again, personally and on behalf of the entire IRPS membership, thank **Mohammed Berrada** and his colleagues for their organization and running of the conference, also similar thanks to **Malcolm Cooper** for his herculean editing of the ISRP-6 papers for their publication in Applied Radiation and Isotopes 46, Number 6/7 (June/July 1995).

IRPS Executive Council Meetings:

Between our "Brigadoon" triennial ISRP's, the IRPS is not totally asleep, as is obvious from your receipt of this newsletter (more on that later). The IRPS Council, the members of which are listed on the front page of this Bulletin, meets about twice a year, including at the ISRP's (usually the Sunday prior to the ISRP, and again during the week of the meeting). Besides our Council Meetings at ISRP-6 in Rabat July 1994, the Council met in Jaipur February 24-25, 1995, again at the University of Warwick, Coventry, UK November 9-10, 1995, and we plan to meet in Prague, Czech Republic May 9-10, 1996. The meetings generally involve no IRPS funding, but are at the Council members' personal or institutional expense. These Council meetings focus primarily on preparations for the next ISRP, but include a variety of agenda items such as logistics and survival of our newsletter, recruitment of new members, election slates and procedures, and ideas and actions toward better serving both the IRPS membership and the broader global human family.

The IRPS Bulletin:

The IRPS Bulletin is the "glue" that holds our IRPS together between ISRP's, during the "sleep phase" of our "Brigadoon" analogy. Currently, **Dudley Creagh** (Australia) is single-handedly editing, producing and distributing the IRPS Bulletin and for this he has my deep and breathless thanks and admiration, and I am sure I speak for the Council and entire IRPS membership with our appreciation. **Dudley** leads a very intense research and teaching life in addition to editing our newsletter, so I hope we can find some more permanent arrangement, spreading this monumental load over several people in the near future, before we lose **Dudley** through total burn-out (or melt-down, or whatever). At the very least, I urge all IRPS members, particularly our Council members, to write and send **Dudley** brief scientific articles on your (or someone else's) work (or your philosophy, etc.) and other appropriate news items, as he periodically requests in his front-page editorial, for publishing in the IRPS Bulletin. **Dudley's** front-page editorials, incidentally, are real jewels, in my opinion.

IRPS Dues:

Up to now, dues collection in the IRPS has not been formalized. No dues renewal notices have been sent out on a regular basis. Instead, we have relied on the "honor system" and the sometimes-shaky memory of each individual member, in view of the postal cost and labor of sending out such notices. For those of us who regularly attend the ISRP's, our dues payments generally fall into synch with the triennial meetings, and we take advantage of the three-year discount (the preferred mode of payment) by paying our dues at the time of the meeting. For many others, an initial one-year or three-year dues payment is made at the time of joining, but because no renewal notice is sent, many members never pay again, even though we have up to now been keeping these members on our rolls for newsletter and ISRP Announcement purposes. At our Council meetings, it has been proposed that in the coming election (for the 1997-2000 Council) that only the ballots from paid-up members would be counted.

In the previous issue, IRPS Bulletin 9 (4) (December 1995/January 1996) I was delighted that **Dudley** had included the IRPS membership/address list, which goes beyond "glue" to "superglue" in serving and holding our IRPS together. If you will refer back to that issue (or look on your address label on this issue just received), you will find two (month/year) dates following your name, indicating the beginning and the end of the time span for which your dues have been paid, according to the records of **Suprakash C. Roy**, our IRPS Membership Coordinator. The record in your case may be in error, in which case you should communicate this to **Suprakash**. If it happens you are badly in arrears, we can forgive back dues, but we would appreciate your sending your dues for the coming year (or preferably the coming three years) to the person listed on the current membership form (attached to this newsletter) who can receive the currency most convenient for you, in the amount appropriate to your developed/developing/student status. As usual, a copy of your transmittal should be sent to **Suprakash Roy** for his records and to forward to **Dudley Creagh**. In the future, I am sure we will move toward regular renewal notices, to assist members with poor memories, but this will require either a paid office staff or some super-dedicated volunteers. Perhaps changing the dues periods to block calendar years might make the job more manageable.

Several IRPS members and potential members have asked me about the possibility of paying dues by credit card, which would indeed be a convenience. I have mentioned these inquiries at Council meetings. Others on the Council have pointed out that, due to our unusually low-cost dues the costs of the individual transactions, particularly for the one-year and for the developing-country dues payments, would exceed the amount of the payment. We will keep this channel in mind, and hope it may become feasible in the future.

IRPS Awards:

All mature scientific societies offer one or more awards to their members (and to non-members, in many cases) to recognize their accomplishments/excellence in the topical area of the society, or for exceptional service to the society, etc.. I think such recognitions are vital to the attraction and survival of any professional society.

As I have discussed with **Anselmo Paschoa**, who would be willing to chair an IRPS Awards Committee, I think we should move in this direction, perhaps starting modestly with "best contributed paper(s)" award(s) at ISRP-7 in Jaipur, and expanding to more major awards in the course of time, appropriate to our IRPS growth and resources. Cash awards are nice but not necessary, plaques and/or certificates are valued and useful to the recipients. Who among us does not enjoy (secretly, at least) public recognition and approbation by his/her peers, at a presentation ceremony at an ISRP, and/or being mentioned here in the IRPS Bulletin? We freely mention here the recognitions awarded by other bodies. I think it is time for the IRPS to offer some recognitions of our own.

In the above suggested example (best paper award), all Council members could be requested to look at all posters, and give each poster a score from 1 to 10, based on some prescribed criteria. The scores given by the Council members could be averaged for each poster, and the winner(s) thus determined. If such a competition were mentioned in advance, perhaps in the IRPS-7 Final Announcement, this would obviously have a plus, rather than a minus, effect on the clarity and attractiveness of the presented posters.

IRPS Advisory Board:

As I anticipate going off the Council at the end of my 1994-1997 term as IRPS President, I was pleased at the University of Warwick Council meeting November 1995 that the Council moved to establish an IRPS Advisory Board, consisting of all former members of the Council. These IRPS Advisory Board members would receive all core Council mailings, and be invited to all Council meetings as non-voting observers, to provide some "corporate memory" to this core group, and at the same time allow much-needed "new blood" to flow into our deliberations and prevent our stagnation. I think you will be pleased (as I am) with the slate of 1997-2000 IRPS Officers and Council members proposed by the current Nominations Committee chaired by **Leif Gerward**, with further refinements to this slate into its final form made at the Warwick Council meeting. I have enjoyed serving as your IRPS President, and following ISRP-7 in Jaipur February 1997 I anticipate enjoying my continued affiliation with the Council via the IRPS Advisory Board.

A Future for the IRPS (Growth or Die)?:

We are still somewhat below the critical mass for sustaining our society into the indefinite future. **Walter Gilboy** (Surrey, UK) was invited to the November 1995 Warwick Council meeting to help us brainstorm and develop some innovative and effective channels for attracting new members. From the very beginning in the early 1970's, in the formative discussions with **Anu Ghose** and others, it seemed clear to us that there was an unfilled niche (radiation physics) in the spectrum of existing scientific societies. The IRPS has established itself in this niche. I have

the impression, however, that the world has a vast number of researchers in a variety of disciplines but all holding "radiation physics" in common, who have never heard of us but who would find IRPS membership valuable to them.

The American Nuclear Society gives nice little lapel pins to members who bring in new members; I don't know if this approach would be something for the IRPS. For my own part (as many of you know), with all my regular NIST correspondence (technical inquiries, exchange of reprints, etc.) to researchers who are not already IRPS members, I enclose xeroxes of the last few issues of the IRPS Bulletin, three copies of the latest version of the membership application form (as **Dudley** generally includes as his end page of this Bulletin). I also enclose a listing of the countries of the world, with each country identified as "A" (Advanced) or "D" (Developing) for purposes of dues assessment. My word processor has a macro "IRPSPTCH" with a paragraph describing the IRPS, mentioning the last ISRP and the place and dates of the next ISRP, and inviting the person to join our merry band.

To attain our IRPS growth beyond the critical mass necessary for the Society's survival as well as for many member benefits not yet available, I urge every member, not only the Council members, to each develop whatever individual recruiting approach you think might be effective and feasible for your own situation. Any particularly good ideas, please communicate to **Walter Gilboy**. The future of the IRPS is in your hands.

ICRM'97

The International Committee for Radionuclide Metrology (ICRM) is pleased to announce that its next biennial conference will be held at the National Institute of Standards and Technology (Gaithersburg, Maryland, USA) from 19th to 23rd May, 1997.

The aim of ICRM'97 is to provide an opportunity for the exchange of information on techniques and applications of radionuclidic metrology, and to encourage international co-operation in this field. Conference topics include: alpha-particle, beta-ray, and gamma-ray counting and spectrometry; liquid scintillation (LS) counting; life sciences; low-level (environmental) measurements; radionuclidic metrology tecyniques (including direct qactivity measurements); nuclear decay data (measurements and evaluations); as well as related others. The topics may include, for example, source preparation techniques, reference materials and calibration standards, sample composition effects such as for LS counting, detector developments, internal gas counting, surface contamination monitoring, and new intrumental or calculational methods. Proceedings of the conference papers will be published.

For further information please contact

Dr J.M.R. Hutchinson
Radioactivity Group, NIST
Gaithersburg, MD20899, USA
electonic mail : jmrh@micf.nist.gov.

REPORTS FROM VICE PRESIDENTS AND COUNCILLORS

From Executive Councillor Lief Gerward (Denmark)

Election News – Election of Executives and Officers of IRPS

Articles 6.1 and 7.3 of the Constitution of the IRPS require that elections for the above posts take place every three years (*cf.* IRPS Bulletin vol. 9, No. 2, p. 4). Thus it is planned that the official election slate appear in the September/October issue of the IRPS Bulletin, obtaining returns prior to ISRP-7 in Jaipur, India, February 24-28, 1997. The result of the election will be announced during the Jaipur meeting. Executives and Officers of the society are elected by the individual members by secret mailed ballot as prescribed in Article 8 of the Constitution.

The Nominations/Elections Committee hereby proposes the following list of candidates:

President:
Bikash Sinha, Dept. of Atomic Energy, Variable Energy Cyclotron Centre, Calcutta, India.

Secretary:
*Richard H. Pratt**, Dept. of Physics, Univ. of Pittsburgh, Pittsburgh, USA.

Treasurer:
*Anton Ljubicic**, Inst. Rudjer Boskovic, Zagreb, Croatia.

Vice Presidents:

W. Europe:
*Malcolm Cooper**, Dept. of Physics, Univ. of Warwick, UK.

E. Europe & FSU:
Ladislav Musilek, Faculty of Nuclear Science and Physical Engineering, Czech Technical Univ., Prague, Czech Republic.

N. America:
Kimberlee Kearfott, Dept. of Nuclear Engineering and Radiological Sciences, Univ. of Michigan, Ann Arbor, USA.

S. & C. America:
Raúl T. Mainardi, Ciudad Univ., Córdoba, Argentina.

Africa & Middle East:
Rex. J. Keddy, Dept. of Medical Physics, Univ. of the Witwatersrand, Johannesburg, South Africa.

S.E. Asia & Pacific Region:
Prasanta Sen, Saha Inst. of Nuclear Physics, Calcutta, India.

N.E. Asia:
Feng Yongxiang, Applied Radiation Inst., Shanghai Univ., Shanghai, P.R. China.

Executive Councillors:

*David A. Bradley**, Asia Lab., Kuala Lumpur, Malaysia.

*Dudley Creagh**, School of Physics, Univ. of New South Wales, Canberra, Australia.

*A.M. Ghose**, Dept. of Atomic Energy, Variable Energy Cyclotron Centre, Calcutta, India.

*Takashi Nakamura**, Cyclotron and Radioisotope Center, Tohoku Univ., Sendai, Japan.

Additional candidates may be proposed with their consent for any position if a nomination petition signed by 5% of the membership of the society, to that effect, is received by the Nominations Committee by August 15, 1996, to allow appearance in the September/October issue of the IRPS Bulletin. Nominations should be sent to the Nominations Committee, care of:

L. Gerward
Department of Physics, Building 307
Technical University of Denmark
DK-2800 Lyngby, Denmark.

From Executive Councillor S C Roy (India)

100 years of x-ray observed

100 years of discovery of x-rays was observed at Bose Institute, Calcutta by holding a Regional Meeting on Radiation Physics sponsored by Department of Science and Technology, Govt. of India, International Radiation Physics Society and Saha Institute of Nuclear Physics during November 16-17, 1995. The meeting was attended by distinguished scientists from India and abroad. The meeting was inaugurated by Prof. P.N. Srivastava, Former Vice-Chancellor. Jawaharlal Nehru University, Delhi and was presided by Prof. A.M. Ghose, reputed radiation physicist at the Variable Energy Cyclotron Centre. Prof. S.C. Roy in his introductory remarks gave a brief account of life and work of Wilham Conrad Roentgen through some anecdotes. Dr. S.K. Saha of Bose Institute offered vote of thanks to the audience and persons contributed for the meeting.

In the technical sessions, various aspects of radiation physics ranging from fundamental physical processes to the application of radiation in the widely different areas such as environmental, medical and material studies. Prof. Richard Pratt of the University of Pittsburgh, USA discussed new accomplishments and issues in Compton scattering while Prof. S.C. Roy of Bose Institute talked on Raleigh scattering of x- and gamma rays. Prof. Thiraphat Vilaithong of the University of Chiang Mai, Thailand briefed the audience about the radiation work carried out in his university and Prof. A.A. Tajuddin of the University Sains Malaysia, Penang spoke on the developments of use of x-rays in medicine in Malaya and Malaysia. Prof. Viney Jain of All India Institute of Nuclear Medicine and Allied Sciences, Delhi talked about optimisation of tumor radiotherapy while Dr. G. Muthukrishnan of VECC talked on the development of radiation medicine since Roentgen and Prof. P.N. Srivastava gave an overview of development of imaging through the twentieth century. Prof. A.M. Ghose and Dr. I.J. De of VECC talked on symmetry in dosimetry in photon teletherapy and radiation damage in superconductors respectively. How a 2 MeV van de Graff machine is used in various useful analysis in the areas of biomedical, material, marine andenvironmental studies in the National University of Singapore was demonstrated in the lecture of Dr. I. Orlic.

In the concluding session Professors R.H. Pratt, Viney Jain and Bikas Sinha, Director, Saha Institute of Nuclear Physics and the Variable Energy Cyclotron Centre summarised the proceedings of the meeting and stressed the need for such meetings to exchange ideas and opinions. It was also stressed that it is our duty as radiation scientists to remove unfounded fears from the minds of general population of this country. A proposal to write a book on history and development of x-rays in lndia since the time of Roentgen was also proposed.

THE SECOND INTERNATIONAL WORKSHOP ON ELECTRON AND PHOTON TRANSPORT THEORY APPLIED TO RADIATION DOSE CALCULATION

Seattle, Washington, USA

June 2–6, 1997

The Second International Workshop on Electron and Photon Transport Theory Applied to Radiation Dose Calculation will be held in Seattle, Washington, USA on June 2–6 1997. The First Workshop, held in Seattle in September 1995, drew 42 outstanding scientists from around the world: from Canada, Japan, The Netherlands, New Zealand, Spain, Sweden, Switzerland and the United States. The idea of these workshops is for investigators actively working on the problem of dose calculation, using analytic, Monte Carlo and semi-empirical approaches, to come together in an informal setting to discuss their current work and to help each other with their insights. The Second Workshop will feature intercomparison of the predictions of various models for electron and photon calculation (one day for each modality), using certain standard configurations which are being determined by a committee of the workshop participants headed by Anders Ahnesjö at Helax in Sweden.

Like the First Workshop, the Second Workshop is being sponsored by the Lawrence H Lanzl Institute of Medical Physics in Seattle, with an organizing committee composed of Alex Bielajew of the National Research Council of Canada, David Jette of the Lanzl Institute and Edward Larsen of the Nuclear Engineering Department at the University of Michigan. Current information about plans for the workshop is posted on the Internet at the World Wide Web site http://sequoia.lanzl.com/secondworkshop. In order to ensure a works-in-progress atmosphere for the Second Workshop, the number of participants will be limited to 40–50. (So far, the 26 confirmed participants are from Canada, Great Britain, Italy, Japan, The Netherlands, Spain, Sweden and the United States.) If you are interested in attending, please contact David Jette at

206-545-1141 (voice)

206-545-1347 (fax)

dave@lanzl.com

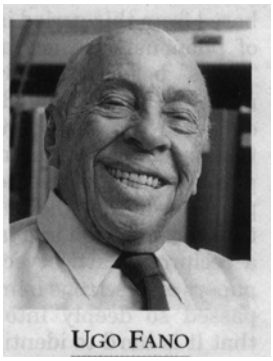
or write to him at

Lanzl Institute
3876 Bridge Way N
Suite 300
Seattle WA USA 98103-7951

NEWS ITEMS

Ugo Fano receives 1995 Fermi Award

John Hubbell
President, IRPS



I was delighted to learn that my former boss and mentor **Ugo Fano** was one of the two researchers selected by U.S. President Clinton to receive the 1995 Enrico Fermi Award, carrying a $100,000 honorarium and a gold medal, given "for a lifetime of achievement in nuclear energy." His selection was based on his "pioneering contributions to the theory of atomic and **radiation physics**, work that has been important to the development of both the gas laser, a tool now used in virtually all the physical and biological sciences, and radiation diagnostic and therapeutic medical applications."

Born in Turin, Italy in 1912, where he also received his Sc.D at the University of Turin in 1934, **Ugo** came to the United States in 1939. **Ugo** was Chief of the U.S. National Bureau of Standards (now National Institute of Standards and Technology) Radiation Theory Section from 1949 to 1960. During this period, his seminal and pioneering works such as "Gamma-Ray Attenuation" (in Nucleonics, 1953), "Penetration of X- and Gamma Rays to Extremely Great Depths" (J. Res. NBS, 1953), "Principles of Radiological Physics" (Ch. 1 in Radiation Biology, Vol. 1, McGraw-Hill 1954), and his co-authored opus with **Lewis Spencer** and **Martin Berger** "Penetration and Diffusion of X Rays" (in Encyclopedia of Physics 38/2, Springer 1959) were the foundation for much of my own work then and later.

Ugo's interests, explorations and creativity are much broader than the above x-ray physics, extending into genetics and biology as well as frontier mathematical topics. Books he has authored include (with **G. Racah**) Irreducible Tensorial Sets 1959, (with wife **Lilla Fano**) Basic Physics of Atoms and Molecules 1959, and (with **A.R.P. Rao**) Atomic Collisions and Spectra 1986. In 1966 he joined the University of Chicago Physics Department and James Franck Institute as a Professor, where since 1982 he has remained as Professor Emeritus.

When **Ugo** was at NBS, he once told me "John, you don't have quantum mechanics in your bones," and he was quite right. I still rely on his wealth of knowledge in radiation and atomic physics, and within the past year have forwarded to him two very knotty inquiries received from colleagues (in the U.K. and India) who are under the mistaken impression that I do "have quantum mechanics in my bones." Characteristically, **Ugo** immediately cut through the apparent paradoxes and provided beautiful, simple and convincing answers. This reminds me of his tenure at NBS, when at seminars he would ask the speaker the "simple" questions the rest of us were afraid to ask, for fear of appearing stupid, but were vital to a full understanding of the speaker's main points. **Ugo**, in 1996, still has the knack of transforming the complex into the simple, and in general making our cosmos friendlier and more understandable.

The IRPS congratulates **Ugo Fano** on this well-deserved recognition and honor.

Ugo Fano in 1955 and his NBS Radiation Theory Section (after a Section lunch at the Peking Restaurant, Washington, DC, USA)

Left to right : Ugo Fano (Section Chief 1949-60), Hazel Baumer (Secretary), Evans Hayward, Anne Nelms, Gladys White Grodstein, Martin Berger, John Doggett, Irwin Oppenheim, Ida Hornstein Reingold, Lewis V Spencer, Frank Titus, Richard Bach.

Not shown : John Hubbel (photographer)

Ultraviolet light offers green solution

Richard Sietmann, Berlin

(Source : Physics World, March 1996, p.11)

The standard way to connect the tiny transistors, capacitors and resistors in a microelectronic circuit is to coat the entire surface with metal, and then remove all the unwanted metal. This involves covering the metal with a photoresist, writing a pattern with lithography, and then removing the resist and unwanted metal with chemicals. But "micro-wiring" could be made simpler by using light to combine two of these steps - metal deposition and patterning - claims Ross Hill, a photochemist at Simon Fraser University (SFU) in Canada. His team has already signed a joint development agreement with AZ Photoresist Products, a division of Hoechst.

"The current technology for making chips involves depositing evaporated metal on a wafer made of silicon, or other semiconducting material," says Hill. "Then, in a complex multistep process, unwanted deposits are removed, leaving only the metal lines and devices that form the microcircuit."

By contrast, the SFU process uses light to create the circuitry. "If we want to place a copper wire on the circuit, we make a solution of copper-containing molecules, then drop it on a spinning wafer, so it covers the entire surface," explains Hill. "Then we shine an appropriate wavelength of light on the wafer surface in the desired circuit pattern. The coating left on the surface illuminated by the light decomposes. The copper sticks to the wafer where the light was and forms a circuit."

Direct writing with the aid of light is not really new in microelectronics. There are a variety of surface-patterning techniques, such as photo-enhanced chemical vapour deposition (CD) or metal-organic CD (MOCVD), where lasers are used to break the bonds that attach metal atoms to "precursor" molecules in the vapour phase. But this approach is limited to certain precursors and both the pressure and temperature of the process must be carefully controlled.

By contrast, Hill's precursor is a liquid complex that is spin-coated as an amorphous film onto the surface. The deposition is achieved by direct photolysis via a mercury lamp and a lithography mask. The process works with a variety of materials. "We have demonstrated that almost all the transition metals, or their oxides, may be deposited in this way," says Hill.

The tough part, of course, has been to find the right precursors, which is where chemistry comes in. The metal-containing molecules must form stable or metastable amorphous thin films, and they must have an "antenna" to absorb the photons and effectively deliver the energy to the bond holding the metal atom to the molecule. These are complicated compounds, but "the complexes we found were all obtained with adaptations of published procedures,"says Hill.

"This is certainly new," comments Karen Maex, an interconnection expert at the IMEC microelectronics institute in Belgium. "If it works, that would be interesting. But I wonder", adds Maex, "if they can get the purities needed."

Another key issue is the resolution that can be achieved. Using the 254 nm and 366 nm lines from a mercury lamp, Hill and co-workers have demonstrated patterns with feature sizes down to a few microns. However, chip manufacturers are currently producing chips with 0.2 mm features. "Better resolution should be possible using a shorter wavelength source such as an electron beam," says Hill. But e-beams can only write one pattern at a time, whereas mask lithography can write many patterns at once.

The SFU process, however, may have implications in an area where minimum feature size is much less critical. Etchants are widely used to remove surplus copper during the manufacture of printed circuit boards. Such boards are used throughout the electronics industry. For economical as well as ecological reasons, researchers are looking for new ways to make such boards. Photolithographic deposition by ultraviolet exposure of thin films could well reduce waste and reduce the need for the costly "end-of-the-pipe" recapturing of valuables.

"Initial testing suggests it is workable," Hill told *Physics World*. "However, as with all the products there is still development to be done to demonstrate that the method is economical."

US slashes tokamak research

Peter Gwynne, Boston, MA

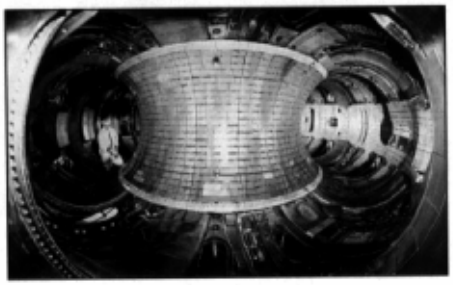
(Source : Physics World, March 1996, p.9)

Fusion research is one prominent casualty of the recent budget cuts by the US government. Spending on fusion by the Department of Energy has fallen from $370m in 1995 to less than $250m this year, and there is little chance of the fusion budget increasing significantly in the near future. The Princeton Plasma Physics Laboratory is the biggest loser its TFTR tokamak is due to be closed down and Princeton's proposed follow-up device, the Tokamak Physics Experiment (TPX), is unlikely to be built. Other fusion labs are laying off staff.

To plan for the future, the Department of Energy (DOE) turned to its Fusion Energy Advisory Committee (FEAC) for advice. Bowing to political realities, and the budget being a *fait accompli,* the committee recommended two levels of annual funding, $250m and $275m, and concluded that the fusion programme should focus on plasma physics, fusion science and basic fusion technology.

FEAC members and fusion researchers hope that, by taking the lead in adapting to the new budget situation, they will gain enough political credibility to maintain funds for fusion R&D at a survivable level. "The community is acting in a sensible way to redesign the programme," says Cliff Surko, a University of California, San Diego physicist who lase year chaired a National Research Council report on opportunities in plasma science and technology.

The realism included the recognition that only two of three major projects supported by DOE - TFTR at Princeton, Alcator C-Mod at the Massachusetts



Budget casualty – the TFTR tokamak

Institute of Technology, and DIII-D at General Atomics in San Diego - could survive. According to FEAC chairman, Robert Conn of the University of California at Los Angeles, the committee recommended that TFTR should cease operations first because "it has only about two years of life left anyway". Alcator and DIII-D, by contrast, "have enough scientific value for about six years."

Managers of the 14-year-old TFTR accept the project's likely fate, although with regret. "TFTR is in an extraordinary period of productivity," Davidson told *Physics* World. Indeed, only a few months ago TFTR and DIII-D made a major breakthrough in the confinement properties of tokamaks (see p23). "It is the only facility in the world operating routinely with deuterium and tritium plasmas. We hope that its

experiments will continue through 1997 and 1998," says Davidson.

FEAC did not ignore the international implications of its recommendations. Europe has committed roughly twice as much to fusion as the US level of about $250m, and Japan about three times as much. At the suggested levels of spending, says Conn, "the US could participate in international activities, such as ITER [a $6bn tokamak that the US, Europe, Japan and Russia are currently designing, but have not agreed to build]. We've told the DOE that the kind of leadership role that the US has taken in the past may no longer be feasible. Hence there is a need for international co-operation. " Davidson sees the US contributing internationally through its traditional creativity. "Scientifically," he says, "the capabilities of the US are enormous."

One positive result to emerge from recent studies concerns the fate of graduates of US fusion programmes. Surko's report, and an informal survey by Miklos Porkolab, director of the Plasma Fusion Center at MIT, indicate that plasma physicists receive - and accept - a wide range of professional opportunities outside their field. Their knowledge of systems, in particular, makes them attractive to the semiconductor industry. "I don't think there's a problem of finding employment if people are flexible," says Porkolab.

PAPERS

Becquerel's discovery of radioactivity - a centenary

Stig Steenstrup[1] *and Leif Gerward*[2]

[1]*Niels Bohr Institute, Oersted Laboratory, Copenhagen, Denmark*
[2]*Department of Physics, Technical University of Denmark, Lyngby, Denmark*

Abstract

The discovery of radioactivity, made by Henri Becquerel in Paris on 1st March 1896, has had a profound influence on science, medicine and industry. In the literature there is an abundance of myths about what actually happened, when Becquerel recognized the unexpected phenomenon. The present note, which is based on Becquerel's own accounts, is an attempt to view the discovery in its proper context.

Introduction

No doubt, Europe at the last *fin de siècle* was a paradise for science, in particular for radiation physics and chemistry. Numerous phenomena were just waiting for somebody to discover them. For the contemporary scientist, however, it was a time of hard work, searching bewilderedly, literally in the dark. Wilhelm Conrad Röntgen's spectacular discovery of the X-rays provoked a turmoil of scientific activity, but the outstanding problem of the nature of the new kind of rays was to remain unsolved for nearly two decades.

On 1st January 1896, Röntgen had mailed reprints of his first X-ray paper to a number of colleagues in Germany and abroad. One of the recipients was the renowned mathematical physicist Henri Poincaré in Paris. In a letter of reply, Poincaré made some thoughts on the generation the X-rays. He suggested that the emission of the X-rays was caused by, or somehow related to the strong fluorescence at the spot where the cathode rays hit the glass wall of the discharge tube. Following this idea, several experimenters announced that the intensity of the X-rays could be increased by inserting a phosphor in the beam path. In February 1896, Henri Becquerel initiated a series of experiments with uranium salts, the phosphorescence of which was known to be of a very short duration. Becquerel wanted to know whether phosphorescing substances emit rays similar to the X-rays. Although this tentative hypothesis proved false, it did lead to his discovery of radioactivity.

Henri Becquerel was born in Paris on 15th December 1852, to a distinguished family of physicists. Both his father, Edmond Becquerel,and his grandfather, Antoine César Becquerel, were professors in physics at the Museum of Natural History in Paris. In 1892, Henri Becquerel succeeded to his fathers chair of physics at the same museum. Edmond Becquerel had been a leading authority on the subject of the phosphorescence of solids, and Henri Becquerel continued in his father's footsteps. Among other things, he investigated the phosphorescence of uranium salts and their emission spectrum.

The first communication

At the weekly meeting of the French Academy of Sciences in Paris on 24th February 1896, Henri Becquerel presented a short contribution, entitled "On radiations emitted by phosphorescence". Becquerel had placed some crystals of potassium-uranium sulfate on top of a photographic plate, which was wrapped in light-tight black paper, and subsequently exposed the crystal-plate arrangement to sunlight for several hours. After development, silhouetted images of the phosphorescing crystals could be seen on the photographic plate. In other, similar experiments, Becquerel produced shadow images of a coin and a pierced pattern in a metal sheet, these objects being placed between the phosphorescing crystals and the photographic plate. Chemical effects were excluded, as the shadow images were observed also when a thin glass plate had been inserted between the phosphor and the plate.

The second communication

At first sight Henri Becquerel's original hypothesis seemed to be confirmed: the shadow images had been produced by invisible, penetrating radiation, emitted through sunlight-induced phosphorescence. However, already at the following Academy meeting on 2nd March 1896, Becquerel was able to report new and extraordinary findings: the phosphors had been found to produce the same blackening of the photographic plate when they were kept in darkness as when they were exposed to sunlight. In his talk, Becqauerel went on explaining how he had arrived at his surprising conclusion.

Becquerel had performed some of his experiments on 26th and 27th February, on which days the sun appeared only intermittently, and so he had kept the crystal-plate arrangement in a drawer. As the sun did not appear during the following days, he decided on 1st March to develop the plates right away, expecting a

weak blackening only. To his surprise, the silhouettes appeared with a strong contrast. Becquerel repeated the experiment several times, taking great care to keep the phosphors in total darkness and to avoid any chemical influence by inserting a thin glass or an aluminium foil between the phosphors and the plate. The blackening persisted with a slight decrease in intensity when using the glass plate and a further decrease when using the aluminium foil. Becquerel's findings were so unbelievable, that he hesitated to formulate any final conclusion.

A hypothesis presenting itself rather naturally to the mind would be to suppose that these radiations, the effects of which are very similar to those produced by the radiations studied by Mr Lenard and Mr Röntgen, are invisible radiations emitted by phosphorescens, the duration of which is infinitely longer than the duration of luminous radiation from these substances. However, the present experiments, though not contrary to this hypothesis, do not allow such a formulation. The experiments that I am presently carrying out will hopefully cast some light on this new kind of phenomena (Becquerel, C.R. **122** (1896) 501-503).

Subsequent communications

Henri Becquerel continued his experiments during the spring of 1896 and he reported almost weekly to the Academy of Sciences. Thus one can follow his series of efforts to clarify the apparently unaccountable properties of the new kind of rays. Becquerel's manner of presenting his discoveries was very different from that of Wilhelm Conrad Röntgen. The latter told nobody about his experiments until he could present a final paper on the subject in question. The rapid publication by Becquerel was fortunate, in that at the same time Silvanus Thompson in London was doing similar experiments with phosphorescing uranium salts and photographic plates. The President of the Royal Society suggested that Thompson should publish his findings, but he was pre-empted by Becquerel.

Henri Becquerel made several attempts to determine the optical properties of the new kind of rays. He noticed their absorption in matter and claimed to have observed reflection, refraction and polarization, but he was unable to make any quantitative measurements. More convincing were his studies of the ionizing properties of the radiation using an electroscope. In a particular experiment, he compared the new kind of rays with X-rays from a Crookes tube. He found the latter rays to be four times more effective in ionizing air and he ascribed this effect to differences in wavelength between the two kind of rays.

Henri Becquerel repeated his crystal-plate experiments with other phosphorescent compounds with the result that only those compounds containing uranium salts were producing the blackening of the photographic plate. Remarkably, the intensity of the penetrating radiation from samples kept in darkness did not decrease noticeably after more than sixty hours. In a series of experiments, uranium salts were kept in darkness for a considerable time and then illuminated by various light sources. In each case, the observed blackening of the photographic plate was about the same. The emission of the penetrating radiation seemed to be independent of the phosphorescence. This result was confirmed in an experiment with uranium nitrate, known to be non-phosphorescent when hydrated. Becquerel found that also the hydrated uranium nitrate produced the by now wellknown blackening of the photographic plate.

In May 1896 Henri Becquerel made a crucial experiment using uranium metal. Also this sample was found to emit the penetrating radiation that caused blackening of the photographic plate. Thus Becquerel had demonstrated that uranium itself was the source of the radiation. He had discovered radioactivity - a new property of matter - although for quite a while he still considered the phenomenon to be an unusually long-lived form of phosphorescence. In the following years Becquerel collaborated with Pierre and Marie Curie and jointly with them was awarded the Nobel Prize for Physics in 1903. Half of the prize was given to Professor Henri Becquerel for his discovery of spontaneous radioactivity, and the other half to Professor Pierre Curie and Mme Marie Curie for their joint researches on the radiation phenomena discovered by Professor Henri Becquerel.

Bibliography

Becquerel's papers on radioactivity are all published in the *Comptes rendus hebdomadaires des séances de l'Académie des sciences*, and include the following:

Sur les radiations émises par phosphorescence, **122** (1896) 420-421

Sur les radiations invisibles émises par les corps phosphorescent, **122** (1896) 501-503

Sur quelques propriétés nouvelles des radiations invisibles émises par divers corps phosphorescents, **122** (1896) 559-566

Sur les radiations invisibles émises par les sels d'uranium, **122** (1896) 689-694

Sur les propriétés différentes des radiations invisibles émises par sels d'uranium, et du rayonnement de la paroi anticathodique d'un tube de Crookes, **122** (1896) 762-767

Émission de radiations nouvelles par l'uranium métallique, **122** (1896) 1086-1088

Sur diverses propriétés des rayons uraniques, **123** (1896)

Sur la loi de decharge dans l'air de l'uranium électricé, **124** (1897) 438

Recherches sur les rayons uranique, **124** (1897) 800

Influence d'un champ magnétique sur le rayonnement des corps radio-actifs, **129** (1899)

Sur le rayonnement des corps radio-actifs, **129** (1899)

Contribution à l'étude du rayonnement du radium, **130** (1900)

Sur la dispersion du rayonnement du radium dans un champ magnétique, **130** (1900)

Déviation du rayonnement du radium dans un champ électrique, **130** (1900)

Sur la transparence de l'aluminum pour le rayonnement du radium, **130** (1900)

Note sur le rayonnement de l'uranium, **130** (1900) and **131** (1900)

Sur la radioactivité secondaire des métaux, **132** (1901)

Sur l'analyse magnétique des rayons du radium et du rayonnement secondaire provoqué par ces rayons, **132** (1901)

Sur quelques effets chimiques produits par le rayonnement du radium, **133** (1901)

Sur la radio-activité de l'uranium, **133** (1901)

Sur quelques propriétés du rayonnement des corps radioactifs, **134** (1902)

Sur le rayonnement du polonium et du radium, **136** (1903)

Sur une propriété des rayons du radium, **136** (1903)

ADDITIONS and CORRECTIONS TO LIST OF MEMBERS CIRCULATED WITH LAST BULLETIN

New Members :

Dr A Sharif Heger 10/95-10-98
Chemical and Nuclear Eng. Dept
The University of New Mexico
ALBUQUERQUE NM 87131 USA

Dr Feyzi Inanc 12/95-12/98
Iowa State University
Center for Nondestructive Evaluation
Applied Sciences Complex
1915 Schall Road
AMES IA 50011 USA

Dr Edwin M Leidholt, Jr 01/96-01/99
VHA Western Region
301 Howard Street, Suite 700
SAN FRANCISCO CA 94105 USA

Dr Arthur J Curtin-Sauaro 11/95-11/98(SM)
Medical Physics Unit
Montreal General Hospital
1650 Cedar Avenue
MONTREAL PQ
H3A 1A4 CANADA

Dr Dan M. Timus 12/95-12/98
Institute of Atomic Physics
Inst. of Physics & Technology for Radiation Physics
PO Box MG-6 R-76900 ROMANIA

Dr Stuart Green 96-99
Dept of Medical Physics and Bioengineering
Queen Elizabeth Medical Centre
BIRMINGHAM B15 2TH UK

Dr Tripurari P Sinha 01/96-01/99
Department of Physics
Bose Institute
CALCUTTA 700 009 INDIA

Dr Shiang-Huei Jiang 12/95-12/98
Department of Nuclear Engineering and Engineering Physics
National Tsing Hua University
HSINCHU TAIWAN

Address Changes

Dr. R. Gregory Downing
X-Ray Optical Systems Inc
90 Fuller Road
ALBANY NY 12205 U.S.A.

Dr Issa I.D.I. Fitian
3445 NW 44th St
Apt 103
FORT LAUDERDALE FL 33309 USA

Dr. Raj Kumar Batra
Institute of Foundation and Competition Courses
A-72, Madhu Vihar
DELHI 110092 INDIA

Mr. B. R. Kerur
Department of Physics
Gulbarga University
GULBARGA 585106 INDIA .

Prof Pedro Andreo
Head, Dosimetry Section, RIHU
International Atomic Energy Agency
PO Box 200
A-1400 VIENNA AUSTRIA

Dr. Lars Persson
Swedish Radiation Protection Institute
S-17116
STOCKHOLM SWEDEN

Dr. Ragnar B. Jonson
Hospital Physics Section
Department of Radiology
Lanssjukhuset, S-30185
HALMSTAD SWEDEN

Dr John Pardoe
32 Ross House
Red Sands Road GIBRALTAR

Corrections :

Prof. Ivo. Petr
Council for Nuclear Safety
7106 Hennopsmeer 6046
SOUTH AFRICA
(Delete Prague address)

Dr. Alexander S. Tsybin
The International Higher Education Academy of Sciences
6 Leninsky av.
MOSCOW 117933 RUSSIA
(Delete 115409 Moscow, Kashirskoe sh., 31 address)

Dr. Ian A. Henderson
Dept. of Electronic & Electrical Eng.
University of Strathclyde
Royal College Bldg.
204 George Street
Glasgow G1 1XW U.K.
("Ian", not "an"!)

Dr. Ahmet Cengiz
Uludag University
Faculty of Science and Literature
Deaprtment of Physics
Gorukle, Bursa 16059 TURKEY
(Country had been omitted)

Servo S H Kasi
Kajavankatu 6 B 45
FIN-04230 KERAVA FINLAND
(Listed twice)

Delete :

Dr Didier B. Isabelle
Dr Dominique M.P. Gignoux
Dr J. Swarup

RETURNED MAIL Can anyone assist with new addresses? (Former institute and country only shown)

Dr. J.S. Iwanczyk
University of South California
Marina del Ray, CA 94305 U.S.A.

Mr. Mariano A. Kornberg
Instituto de Astronomia Y Fisica
Buneos Aires 1428 ARGENTINA

Dr. Claude J.G. Barraud
External Strategies for Environmental Canada
Ottawa, Ontario K1N 1C8 CANADA

Dr. Robert S. Sanna
U.S. Dept. of Energy
New York, NY.10014 U.S.A.

Ms. Margarita Herranz
Manzarragena
C. Uresaranses
Gorliz, Vizcaya SPAIN

Dr. John M. Pacyniak
NARTI
Springdale, AR 72765 U.S.A.

Lary R. Martin
LR Martin & Associates
Virginia 23601 U.S.A.

Dr. Taichi Michikawa
Japan Radiation Engineering Co
Shibuya-ku, Tokyo 151 JAPAN

Mr Ferenc Hajnal
US DOE, EML
NEW YORK NY 10014 USA

Dr E Zukowski
University of Warwick
COVENTRY CV4 7AL U.K.

Mr A Brahmia
University of Warwick
COVENTRY CV4 7AL U.K.

Dr. Bhajan Singh
Punjabi University
Patiala 147 002 INDIA

Professor P Andrew
Intern. Atomic Energy Agency
A-1400 VIENNA AUSTRIA

Dr. Herbert Rief
IRC-ISPRA
I-21020 ISPRA(VA) ITALY

Dr. V.M. Badescu
Institute of Bucharest
BUCHAREST 79590 ROMANIA

Mr. Pedro Alberto Derose
Civdad Universitaria
5000 Cordoba ARGENTINA

Dr. Tamas Porubszky
Medicor R and D Institute
BUDAPEST H-1525 HUNGARY

Dr. Edward J. Dowdy
Los Alamos National Lab.
LOS ALAMOS, NM 87545 U.S.A.

Prof. Riad Mastafa Megahid
Nuclear Research Centre
Cairo, EGYPT

Dr William C. Lynch
Imdell Corporation
Waltham, MA 02154 U.S.A.

Dr Taichi Michikawa
Japan Radiation Engineering Co
Shibuya-ku, Tokyo 151 JAPAN

Dr Ravi Babu
University of Calicut
INDIA

LETTERS TO THE EDITOR

This column will be *filled* in our next edition with all those letters which you will be sending in to us concerning your views and ideas as suggested in this edition's Editorial!

C A L E N D A R

1996

April

14–19 *1996 International Congress on Radiation Protection (IRPA9)*, Congress Center Hofburg, VIenna, Austria;
WWW – http://www.tue.nl/sbd/irpa/9irpacon.htm #9th Int IRPA Con

May

7–10 *Sixth International Radiopharmaceutical Dosimetry Symposium*, Gatlinburg, Tennessee, USA; Audrey S Stelson, RIDIC.
Phone : 1 423 576 3450

20–24 *International Symposium on Ionising Radiation : Protection of the Natural Environment*, Stockholm, Sweden; The Swedish Radiation Protection Institute, Carl-Magnus Larsson, S-171 16 Stockholm, Sweden. Fax : 46 8 729 71 08

June

3–7 *Fourth International Conference on Radioactive Nuclear Beams*, Ohmiya, Japan; Mrs S Odai, RNB-4 Secretariat, Institute of Physical and Chemical Research (RIKEN), Linac Lab, 2-1 Hirosawa, Wako, Saitama 351-01, Japan
Fax : 81 484 62 4689; Phone : 81 484 62 111 ext. 4211; e-mail : RNB4@rikvax.riken.go.jp;
WWW http://www.rarf.riken.go.jp

9-15 *5th International Conference on Applications of Nuclear Techniques – "Neutrons in Research and Industry",* Crete, Greece; G Vourvopoulos, Dept of Physics, Western Kentucky University, Bowling Green, KY 42101, USA
Phone : 1 502 745-5277; Fax 1 502 745-5062
e-mail : vour@wkuvx1.wku.edu

TBA *15th Annual Panasonic International Dosimetry Symposium*, Lake Geneva, Wisconsin, USA; David Katzman, Panasonic, USA.
Phone : 1 201 348 5339

July

9–12 *International Workshop on Radiation Exposures by Nuclear Facilities : Evidence of Health Impacts,* Portsmouth, England; German Society for Radiation Protection. Dr M Schmidt, University of Portsmouth, School of Chemistry, Physics and Radiography, Park Building, King Henry 1 Street, Portsmouth P01 2DZ, England
Phone : 44-1705-842150; Fax : 44-1705-842157

21–25 *X International Conference on Small-Angle Scattering*, Campinas, Brazil; Prof. Aldo Craievich, LNLS, Cx Postal 6192, 13081-970 Campinas, SP, Brazil

September

9–11 *Second International Workshop on the Industrial, Medical and Military Applications of Radionuclides*, Salzburg, Austria. Workshop Secretariat, Institute of Physics and Biophysics, Hellbrunnerstr. 24, A-5020 Salzburg, Austria.
Fax : 43 662 8044 5704;
Phone : 43 662 8044 5700;
e-mail : physik@edvz.sbg.ac.at

18–20 *International Symposium on In Vivo Body Composition Studies*, Malmö, Sweden; Symposium Secretariat, Department of Radiation Physics, Malmö University Hospital, S-205 02 Malmö, Sweden.
Fax : 46 40 963185; Phone : 46 40 331235

October

6–9 *3rd Topical Meeting on Industrial Radiation and Radioisotope Measurements and Applications (IRRMA'96)*, Raleigh, USA; W.F. Troxler, IRRMA'96 Conference General Chairman, Troxler Electronic Laboratories, PO Box 12057, Research Triangle Park, NC 27709, USA. Phone : 1 919 549 8661

14–16 *International Symposium on Nuclear Energy and the Environment*, Beijing, China; Leng Ruiping, Wang Hengde, Chinese Society of Radiation Protection, PO Box 2102-14, Beijing 100822, China. Fax : 86 10 8539375; Phone : 86 10 8510370

21–25 *4th International Conference on High Levels of Natural Radiation*, Beijing, China; Prof. Tao Zufan, Secretary General of 4th ICHLNR, Laboratory of Industrial Hygiene, Ministry of Health, 2 Xinkang Street, Deshengmenwai, Beijing 100088, China.
Fax : 86 10 2012501
Phone : 86 10 2021166 ext. 378

November

3–7 *International Conference on Radiation and Health in Israel*, Ben Gurion University of the Negev, GBeer Sheva, Israel; International Conference on Radiation and Health, Ortra Ltd., 2 Kaufman Street, Textile Center, POB 50432, Tel Aviv 61500, Israel.
Fax : 972 3 5174433; Phone : 972 3 5177888
e-mail : ortra@trendline.co.il

3–8 *2nd International Symposium on Ionizing Radiation and Polymers*, Guadeloupe, France. Natacha Betz, IRaP96, CEA/Saclay, DSM/DRECAM/SRSIM, 91191 Gif sur Yvette Cedex, France.
Phone : 33-1 69 08 48 34 Fax : 33-1 69 08 96 00
e-mail : irap@drecam.cea.fr

1997

February

24–28 *7th International Syumposium on Radiation Physics (SIRP-7), Triennial Meeting of the International Radiation Physics Society (IRPS)*, Jaipur, India; B. Sinha, Director, Variable Energy Cyclotron Centre, 1 A/F, Bidhan Nagar, Calcutta 700 064, India
Fax : 91 33 346781; Phone : 91 33 370032

March

15–20 *Sixth Conference of Nuclear Sciences and Applications*, Cairo, Egypt; Prof Dr A I Helal, Atomic Energy Authority (ESNSAS) 101 Kasr El-Eini Street, Cairo, Egypt, Fax : +20 2 3543451

May

19–23 *ICRM'97*, Gaithersburg, Maryland, USA;
Dr J.M.R. Hutchinson, Radioactivity Group, NIST, Gaithersburg, MD20899, USA
Telefax : +1-301-926-7416; e-mail : jmrh@micf.nist.gov

June

2–6 *2nd International Workshop on Electron and Photon Transport Theory Applied to Radiation Dose Calculation*, Seattle, Washington, USA. David Jette, Lanzl Institute, 3876 Bridge Way N., Suite 300, Seattle, WA, USA 98103-7951
Phone : 1-206-545-1411; Fax : 1-206-545-1347
e-mail : dave@lanzl.com

July

21–25 *X International Conference on Small-Angle Scattering*, Campinas, Brazil; Prof. Aldo Craievich, LNLS, Cx Postal 6192, 13081-970 Campinas, SP, Brazil