



European Medical Physics News

Contents:

President's Letter	1
Editorial	2
Bursary Report	3
Interview with Suzanne Naudy	4
Cartoon	4
Medical Physics Education in Portugal	6
Cyprus Association of Medical Physics and Biomed Eng	7
Radiology comes to the people	10
Small Field Electron Dosimetry	12
EFOMP Congress	18
Meetings Timetable	18

News from EFOMP:

Election of new officers at EFOMP Council on 7th October 2006 at Malaga, Spain.

Don't miss the EFOMP Congress near Pisa in September 2007. See:
<http://efomp-2007.df.unipi.it>



Welcome to this first issue of the electronic European Medical Physics News! EFOMP wants to bring together Medical Physicists in all varieties of our profession in Europe. This re-launched publication will be a step to make EFOMP visible to all of you. But EFOMP does not want to play the primary role, this magazine is intended as a forum for YOU.

Nevertheless, let me focus on the most urgent topics that our federation has to deal with: Medical Physics as a science of applied physics, teaching Medical Physics, and our professional tasks and responsibilities arising from the fact that it is first of all a service within the health care system.

In my opinion EFOMP has to strengthen its scientific profile by initiating and participating in projects and networks related to Medical Physics on a European level. The communication of research results, either in publications or in conferences, is within the scope of EFOMP. We are very much looking forward to the next EFOMP conference to be held in conjunction with the Italian Medical Physics meeting at Pisa in September 2007.

In addition to that, I see the priority in launching the European Journal of Medical Physics as an official scientific journal of EFOMP. This was already very well prepared by our past president, and the official commencement of the journal will most likely be at the beginning of 2007.

The lack of scientific departments also entails teaching deficits in Medical Physics, and restricts continuing professional development. EFOMP activities in education and training are manifold: The European School for Medical Physics (ESMP) in Archamps; setting up recommendations for study paths, especially concerning the Masters degree in Medical Physics according to the Bologna conventions and the free movement of Medical Physicists through Europe by commonly recognized registrations.

Most Medical Physicists in Europe work in hospitals with tasks and duties comprising all aspects of the application of physical methods and technical equipment in diagnostics and therapy. EFOMP will continue to promote Medical Physics as a regulated profession on the basis of a homogeneous education and training programme, as defined by the EFOMP guidelines.

EFOMP has been working on these problems for the last 25 years, and progress has undoubtedly been made. EFOMP policy statements are internationally recognized and appreciated as valuable guidelines.

Let us continue on our way in and to Europe together!

Wolfgang Schlegel
(EFOMP President)

Editorial

Bienvenido-Bienvenue-Willkommen-
Welcome-Benvenuto-Καλώς ορίσατε-
Добро пожаловать...!

...to this edition of European Medical Physics News produced by EFOMP. The purpose of this electronic magazine is to provide a communications forum for medical physics organisations, and for medical physicists, across Europe. As many of you will know, 35 national organisations are currently members of EFOMP, and together they represent more than 5000 physicists and engineers working in the field of Medical Physics.

The editors would like to hear from you!

Developments in science, in education and in training are all relevant. Cross-border or international initiatives are particularly of interest, and these can be in any area of physics and engineering applied to medicine. Comparisons between the practice and organisation of medical physics in different countries are particularly welcomed. Contributions (which can be in your national language, with an English abstract) in electronic form, including a photo of the author if possible, should be sent to either of the editors.

You can register to receive this newsletter by e-mail via the EFOMP website. We are trying to keep the file size below 1 Mb, feel free to send in your comments and suggestions for further improvement of this magazine. We welcome co-workers from National Member Organisations who would like to assist with editing and developing European Medical Physics News, and cooperation with existing NMO bulletins.

We hope you will enjoy reading European Medical Physics News and we look forward to hearing from you.

Chris Gibson

Markus Buchgeister



European Medical Physics News is published by the EFOMP Communication and Publication Committee. It is distributed free of charge in electronic form.

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EFOMP Bursary Report on ESMP 2005

My name is Songül KARAÇAM. I am a medical physicist in Istanbul University, Cerrahpasa Medical Faculty. I have been working at Cerrahpasa Medical Faculty since 1996.

I heard about ESMP on brachytherapy from a colleague who thought it would provide a good understanding of the area. I had never been to a brachytherapy course before. I wanted to compare the procedures about brachytherapy techniques used in other countries. While surfing on the EFOMP website, I saw a link to school of medical physics - ESMP. I sent all the required documentation, (curriculum vitae and a letter of recommendation) and some months later I was chosen as the EFOMP ESMP Bursary winner for 2005. I had a chance to participate the European School of Medical Physics Brachytherapy week, it has given me the chance to compare the different procedures used in Turkey to those of other countries. I benefited much in learning new techniques with medical applications.



Songül Karacam and Filiz at CERN.

The school is located in Archamps, a small border town 7 km from Geneva. The European School of Medical Physics, is an annual event that runs for a period of five weeks from the end of October to the beginning of December. The courses run from Thursday to Tuesday with a break on Sunday.

When I arrived in Archamps I was pleasantly surprised. The venue was excellent. At the school, I found ESI administrators helpful and friendly. I received comprehensive notes, course programme and a map of venue.

The first day, Thursday, ESMP Director Yves Lemoigne welcomed about twenty six participants and presented the teaching staff. The first morning was devoted to the introduction and BT photon sources, the principles of QA, in the afternoon ra-

diation protection and patient safety.

The second day consisted of lectures on treatment planning systems and treatment units. Having said that a welcome break came on Saturday afternoon, with a visit to CERN, after a morning of lectures on radiobiology and intraluminal BT. Yves Lemoigne explained that the particles, which travel close to the speed of light, are accelerated one hundred meters underground below vineyards, and they cross the border between France and Switzerland millions of times. Because of weekend we hadn't a chance to see it. After this, the bus took us to the "Hôpital Cantonal de Geneva". They showed us the prostate seed planning and brachytherapy device in Radiation Oncology Department. On Sunday there were no lectures. A trip was organised by the school to Annecy. It was a very snowy day, we visited Musée-Chateau. Back on Monday morning, we had an overview of BT beta sources and the Paris dosimetry system for interstitial BT. The afternoon involved a practical session on the examples of application of the Paris system. The final day of the course consisted of lectures on BT for intraocular tumours, reports, quality assurance for all the BT procedures. Finally, at the last minute we had the examination

Small groups of colleagues from different countries Germany, Australia, Portugal, Romania, Morocco, Egypt, Denmark, Italy, Bulgaria, Israel, Iran, Ukraine created a friendly atmosphere.

Attending these lectures also gave me the chance to compare the procedures used in different countries with those carried out in Turkey. Of particular interest was the difference in the dosimetry systems used in gynaecological applications and the use of MRI and CT in brachytherapy treatment planning.

I would wholly recommend the ESMP to any physicist looking to broaden their knowledge of medical physics and meet fellow physicists from all over Europe. Also, I would like to take this opportunity to thank EFOMP for giving me chance to attend the school. Thank You!

Songül Karaçam

Cerrahpaşa Medical Faculty, Radiation Oncology Department, İstanbul/Turkey

The next European School of Medical Physics (ESMP 2006) will be held from Nov 2 to Dec 5 at the Centre Universitaire de Formation et de Recherche, Site d'Archamps, F-74166 Archamps, France.

**<http://www.cur-Archamps.fr/esi>
e-mail: info@esi.cur-archamps.fr**

Have a word with me: **Suzanne Naudy**



At the end of 2005 you left your position as Secretary General of EFOMP. What did you think, when you started your job?

SN: Being able to present our NMO strategy as compliant with European common statements greatly helped me to strengthen the position of Medical Physics in France. Giving part of my time to keep such a variety of people working together was just a fair return.

During your time in office, what was difficult, what was good?

SN: Difficult is sometimes the communication with the NMOs. From some, you just do not get any response on the first attempt. I hope, this journal will help to improve this! Nice is, when you finally see that things will work out on time, well, almost on time.

What will be in your eyes the most important issue to European Medical Physicists in the coming years?

SN: The recognition of Medical Physics as a regulated profession is the challenge worldwide.

Do you have advice for your successor?

SN: Well, I had the advantage to take over from my French colleague, Alan Noel, with whom I was used to work. But as it is always, you have to arrange things the best way for you to get the job done.

Since you have now met a lot Medical Physicists from all over Europe. Could you think of 'the European Medical Physicist' made out of the best characteristics from the various parts of Europe?

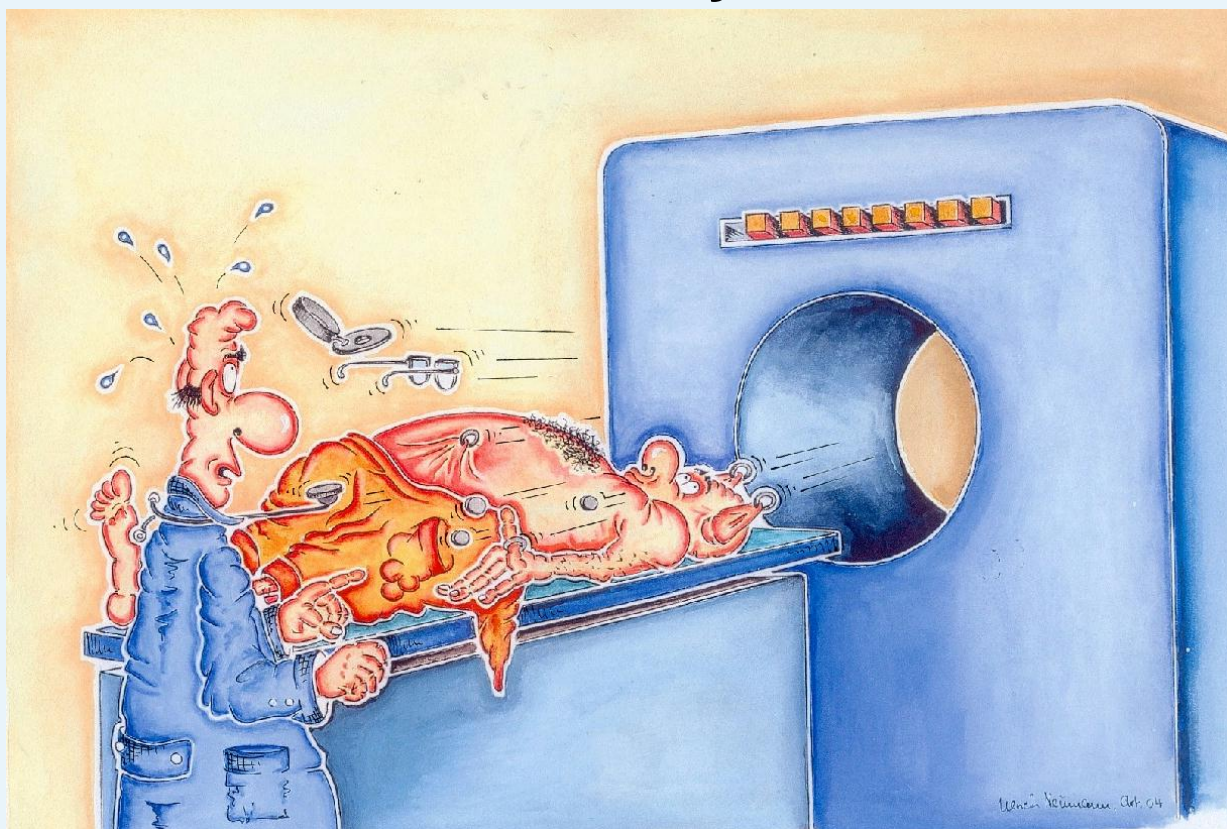
SN: I prefer to think of "an European Medical Physics team" made of various scientists actively involved in the development and application of their sciences areas to the clinical needs.

At last a more personal question: Besides Medical Physics, what is the next most interesting subject for you?

SN: Well, when I don't have a pen in my hands, it's probably a hammer and a nail to refurbish someone place . I can't save myself from trying to build one thing or anotherthat's the way I am!

Interview by M. Buchgeister

MRI safety?



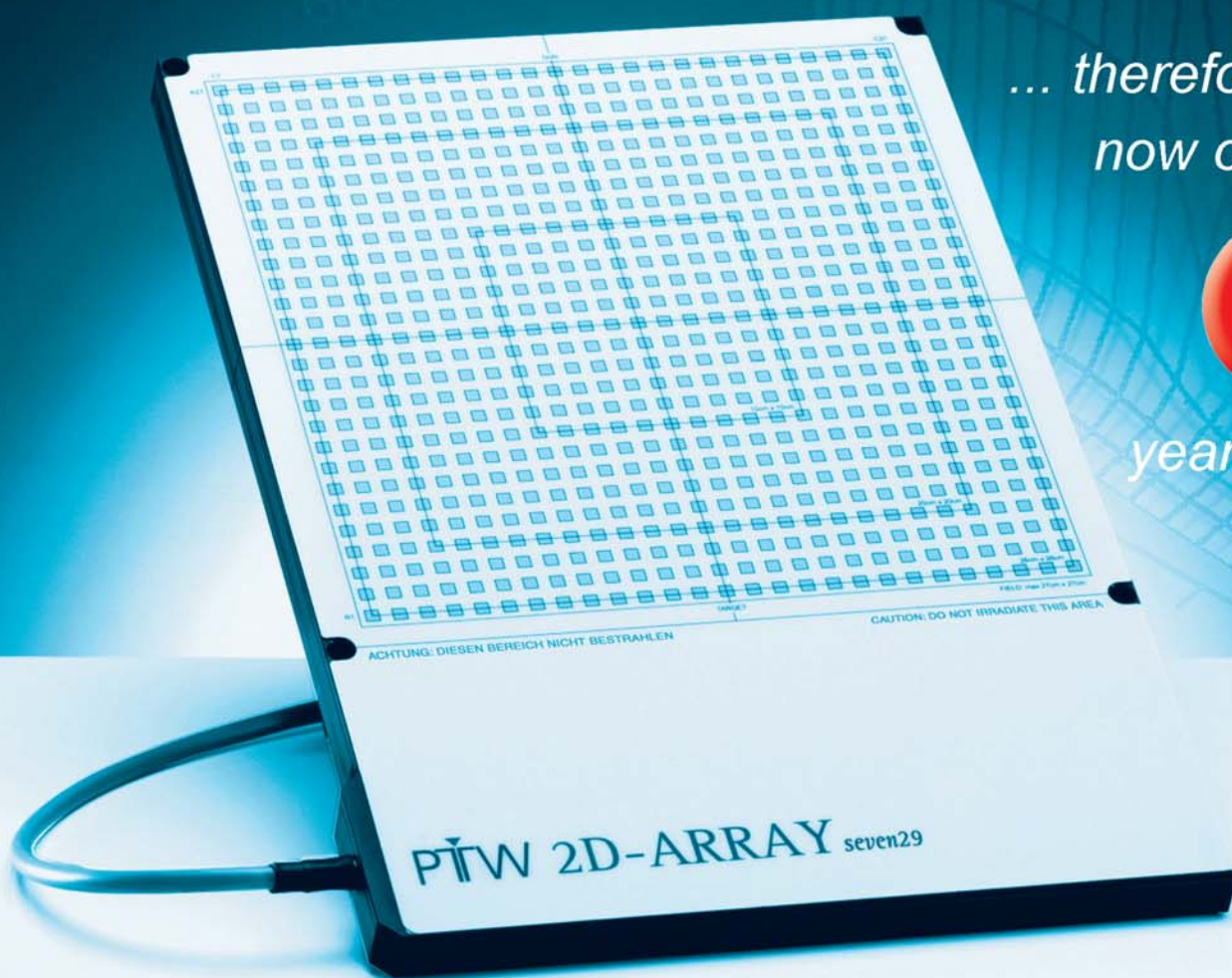
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A Proposal for Medical Physics Education and Training in Portugal

To be qualified as a medical physics in Portugal, it is essential to hold a first degree in physics or physics-based sciences and, following application, be offered a training placement with the duration of two years, within a clinical environment. The training includes a theoretical part (approximately one year) and practical part in clinical environment (approximately one year). To date, a limited number of hospitals (5) have been officially recognised to deliver this training.

The current Portuguese regulations indicate the main areas where the trainee should gain competences (radiology, radiotherapy and nuclear medicine). However, no standardized training programs have been established to assure that uniform training is undertaken across the various training centres.

As a first attempt to overcome this problem and also aiming to implement a progressive approach towards the full implementation of the EFOMP recommendations for education and training in Medical Physics, a new education programme has been created in Portugal.

This educational program is entitled "Specialization Course in Medical Physics and Radiations" and was developed in partnership between the Faculty of Sciences of the University of Lisbon and the School for Higher Education in Health Technologies of Lisbon (ESTeSL).

The target audience for this programme are graduates with a Physics or Physics-based degree (e.g. Physics Engineering). The course is also particularly suitable for graduates who are undertaking the training scheme in medical physics in Portugal, and aim to become Qualified Physicists in Medical Physics (as defined by EFOMP policy n.1, the European Directive 97/43, and also the current Portuguese legal framework (DL 180/02)).

The course was designed to provide a solid educational background in the areas of Radiotherapy, Nuclear Medicine and Diagnostic Radiology and is most suitable to become the currently non-existent formal education to complement the practical training received within the hospital environment. This education provides the essential background for in depth understanding of the principles of medical physics.

Alongside comprehensive modules in the three main areas of medical physics (Radiotherapy, Nuclear Medicine and Diagnostic Radiology) the course syllabus includes fundamental anatomy and physiology, pathology, medical instrumentation, quality control of diagnostic and therapy equipment, biophysics, computer simulation techniques, health management, among others.

The lecturing staff is composed of a group of professionals with complementary experience which includes academics (from both institutions involved in the coordination of the programme with qualifications at PhD and MSc level), experts in medical physics with vast clinical experience and in the supervision of the training scheme, and also experts in health management from the Portuguese health authorities.

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 CURSO REALIZADO EM COLABORAÇÃO COM:
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Av. D. João II, Lote 4.69.01 1990 - 096 Lisboa

Poster used to disseminate the „Specialization course in Medical Physics and Radiation“ when it first started in 2004/2005. The second edition of the course is currently ongoing.

International experts in Radiology and Radiotherapy from institutions such as King's College London in the United Kingdom, East Kent Hospitals NHS Trust and Universidad Complutense in Spain have also been invited lecturers on the course.

The specialization course has the duration of one academic year and the classes take during two full days per week (Friday and Saturday). The official language of the course is Portuguese with exception of the lectures of invited speakers, which are held in Spanish or English. The first edition of the course was offered in 2004/2005 and was well participated with the overall performance of the students achieving very satisfactory levels. The professional outcomes of the course were gratifying with 80% of the students finding a training placement or employment in the areas of radiotherapy and radiology, shortly after the completion of the course. Due to popular demand and successful results a 2nd edition was offered in the academic year of 2005/2006 and is currently ongoing.

An important characteristic of this specialization

course is the alternative to pursue it towards an MSc degree. The students who continue the programme for a second academic year are offered a research project, in a relevant area of medical physics / healthcare sciences. The submission of a thesis and its successful assessment during a viva voce examination entitles the student to an MSc degree awarded by the Faculty of Sciences of the University of Lisbon.

This program was submitted to EFOMP for comments and is in the process of evaluation, aiming at an official recognition by the Portuguese Health authorities.

Katia Jacob

Physics Engineer at the Hospital Cuf Descobertas, Lisbon, Portugal

Nuno Teixeira (Ph.D)

Professor at the School for Higher Education in Health Technologies (ESTeSL), Lisbon, Portugal

The Cyprus Association of Medical Physics and Biomedical Engineering



The Cyprus Association of Medical Physics and Biomedical Engineering, CAMPBE for short, was created in 1988.

It is an "umbrella" type organisation encompassing Medical Physicists, Biomedical and Hospital Engineers, Medical Doctors and other professionals whose work is related to Physics or Engineering in Medicine.

CAMPBE is an affiliated member to the following international organisations:

- *International Organisation of Medical Physics (IOMP)*
- *European Federation of Organisation for Medical Physics (EFOMP)*
- *International Federation of Medical and Biological Engineering (IFMBE)*
- *International Radiation Protection Association (IRPA)*

CAMPBE is an independent, non-governmental, non-unionised and non-profit making body. Its resources are exclusively used to foster and promote the objectives of the Association, as laid down in its constitution, with the ultimate goal of furthering knowledge and understanding in its fields of interest and thus contributing to the enhancement of health care delivery.

Since its creation CAMPBE has been promoting, developing and disseminating technology and science related to Medical Physics and Biomedical Engineering as well as enhancing Radiation Protection by promoting relevant knowledge, information and training for the benefit of the public. Interdisciplinary collaboration and activities are fostered by organising every year a conference, and by running training courses on radiation protection. Members are kept informed through the Association's web site at www.campbe.org.

CAMPBE honours its international commitments and two delegates have represented it at the World Congresses of Medical Physics and Biomedical Engi-

neering that take place every 3 years since 1991. An effort is being made to represent Cyprus in the annual European Medical Physics meetings of EFOMP and of the IFMBE. Members of our Association are actively involved in the various committees of the above international organisations.

Three major international conferences were successfully held in Cyprus, the two first ones were co-organised by CAMPBE and the Computing Department of the University of Cyprus.

- In May 1994 the MPBE'94, was the first International Conference on Medical Physics and Biomedical Engineering to be held in Nicosia and was opened by the President of the Republic Mr. Glafkos Clerides. About 90 foreign participants, some leading world experts in their specialisations, attended it.
- In June 1998, the MEDICON'98, the VIII in the series of regional meetings of the IFMBE in the Mediterranean was held in Lemesos. More than 100 foreign scientists participated. The proceedings of Medicon'98 are available on CD providing immediate access and easy retrieval of information. Medicon '98 was honoured to host the IFMBE Administrative Council and the National Secretaries Committee Meetings. CAMPBE was represented at the MEDICON conferences since 1992.
- In April 2004, the II Mediterranean Conference on Medical Physics, the second in the series of regional meetings of EFOMP in the Mediterranean was also held in Lemesos. 73 participants from various European Countries participated. All the presentations were published on a CD as full-length papers together with all the Workshop material.



EFOMP Council 2004 participants at Limassol, Cyprus which was held in connection with the II Mediterranean Conference on Medical Physics.

The Association holds scientific lectures regularly and it occasionally organises visits to scientific departments and installations. CAMPBE is quite active and the hope is to be kept active for the benefit of its members and society's in general.

To encourage research and to provide a vehicle of interdisciplinary collaboration the Biomedical Research Foundation (BRF) was set up in 1990 as a philanthropic institute and is an on-going activity of CAMPBE.

The BRF participates in projects on various topics among them:

- The measurement of Radon levels in Cypriot homes
- MANOMEQ, a MedCampus course on Medical Equipment Management
- The Acceptance Testing and Calibration of Medical Equipment at the Bank of Cyprus Oncology Centre
- Measurements of Prostate Specific Antigen levels
- The evaluation of the radiation dose in a paediatric x-ray department.
- SENTINEL (Safety and Efficacy for New Techniques and Imaging using New Equipment to Support European Legislation), a European Coordinated Action.

The BRF is governed by an appointed board and has its own constitution.

Stelios Christofides
Cyprus

The XIXth Winterschule für Medizinische Physik will be held at Pichl/Steiermark in the Austrian Alps, from 5th to 16th March 2007.

1st week: Radiologie
2nd week: Biomathematik/Medizinische Technik

The language of the Winterschule will be German, for more information see:
<http://www.dgmp.de> (click on 'Winterschule Pichl')
e-mail: juergen.kopp@physik.zk.augsburg-med.de

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Radiology comes to the people

The CT- and MR-simulator of the German DGMP

Intention: to demonstrate Medical Physics to the people using a 'replica' of a large radiological machine. The simulator has been in action so far at schools, shopping centers and science-events (e.g. the "Highlights of Physics" of the German Physical Society 'DPG').



Exhibition inside a shopping mall at Nuremberg that was linked to the ICMP 2005.

The simulator is a portable device and not specific to any manufacturer. It is about the same size as a real tomograph whether a CT or MR or even in future a PET. A volunteer can be (fake) examined by putting him on a moveable couch into the examination cylinder. Loudspeakers inside the simulator play the real sound of the device under simulation. This is so realistic to the fake patient that most believe they have had a real exam when they see the pictures afterwards. This is most impressive for the



Spin-Flip experience by hand with wooden spin-up tops in a shopping center at Erlangen Ger-

MR as this has the most characteristic 'sounds'. The visitors see real pictures of anonymous patients on the monitor or projector image (a projector has to be provided locally if necessary). Even a functional MR exam of the brain while controlling the movement of the hand can be simulated. Little experiments, video clips and demonstration

objects help to explain the physics behind the diagnostic technique. Posters on Röntgen/X-rays and MR can be displayed. The simulator consists of:

- Transport box (115 x 152 x 57 cm³, ca. 120 kg) for shipment via truck or car trailer; instructions for setup and storage of the simulator with many photos (currently only in German)
- Siemens Syngo MR Workstation with demo data and software for simulations (German)
- Siemens MR-head coil, glass-X-ray tube with rotating anode disk
- Poster on X-rays and magnetic resonance (German)
- Quiz on X-ray and medicine (German)
- Spin-Up tops to visualise precession and spin flips
- Simulation software on image reconstruction of CT, video clips/animations on X-ray and magnetic resonance
- Simple html based software for simulation of real patient exams in German (suited for pupils to do the exam)



CT-MR-Simulator at a presentation at a Highschool at Bad Urach, Germany.

The usual presentation time at schools is one 45 minute lesson, if no basics have been discussed in prior lessons. If physical principles have already been introduced, more detailed information can be given and discussed.

With the help of the simulator the working field of Medical Physicists as well as radiological physicians or radiographers can be presented in real action. An extension of the simulator to simulate PET-examinations is possible. The realisation of this demonstration object was supported by the Schering AG and the Siemens Medical Systems AG, Germany.

Markus Buchgeister
Germany

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DOSIMETRÍA DE HACES PEQUEÑOS DE ELECTRONES MEDIANTE UN MÉTODO SENCILLO BASADO EN PELÍCULA RADIOGRÁFICA

Irene Torres¹, José Pérez-Calatayud¹, Françoise Lliso¹, Joan Roselló³, Emilio Casal², Vicente Carmona¹, Vicente Puchades¹, Cleverson P. Lopes¹ y Eva Tomás¹.

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ABSTRACT

For electron beams, when the field size is smaller than the value of the practical range, the dosimetric characteristics can differ from the standard ones. There are clinical situations which require specific measurements for the insert in order to obtain the actual output factor and depth dose.

The ready pack film (X-OmatV) together with a document scanner with the ability of transparency input are used. Multiple irradiation on the same film are performed for well known doses with a standard applicator and for the "problem" insert at several depths. The method has been evaluated for:

- 6 MeV electrons, 2 cm in diameter field, defined by a lead insert on skin.
- 10 MeV electrons, 3 cm in diameter field, defined by a cerrobend insert at the applicator (5 cm from skin).

The film measurements were compared against thermoluminescent dosimeters, which was calibrated for these energies, showing a good agreement.

The method has been incorporated on a program that allows to obtain the absolute dose at each depth, the depth-dose information and the isodose distribution.

Keywords: Clinical dosimetry, Film dosimetry, Electron dosimetry

RESUMEN

En haces de electrones, cuando alguna dimensión del campo es menor que el rango práctico, los parámetros dosimétricos varían respecto a los correspondientes a "campos estándar". Así pues existen situaciones clínicas en las que se han de realizar medidas específicas para obtener los datos necesarios.

El método desarrollado en este trabajo utiliza la película X-OmatV y un escáner de sobremesa con posibilidad de digitalizar transparencias. Se realizan múltiples irradiaciones en una misma

película, un conjunto para dosis conocidas con un aplicador estándar y otro con el inserto problema a diferentes profundidades. El método se ha evaluado para 2 casos:

- Electrones de 6 MeV, campo de diámetro 2 cm, definido mediante plomo sobre la piel.
- Electrones de 10 MeV, campo de diámetro 3 cm, definido mediante recorte de cerrobend en el aplicador (a 5 cm de la piel).

Las medidas con película se han comparado con medidas con dosímetros termoluminiscentes, calibrados para esas energías, obteniéndose resultados compatibles, es decir los valores solapan teniendo en cuenta los intervalos de incertidumbre. El método ha sido incorporado a un programa que permite obtener de forma automática la dosis absoluta a cada profundidad, la distribución de dosis en profundidad y las curvas de isodosis.

Palabras clave: Dosimetría clínica, Dosimetría por película, Dosimetría de electrones

INTRODUCCIÓN Y OBJETIVOS.

Como está descrito en la literatura¹⁻⁶, la dependencia de los parámetros dosimétricos de los haces electrones frente al tamaño del campo de irradiación, es despreciable en tanto que sea mayor o del orden del rango práctico (R_p) de éstos en el tejido. Sin embargo cuando las dimensiones que definen el área, o una porción de ésta, son menores que R_p para la energía en uso, las características dosimétricas varían respecto a los datos de referencia adquiridos para tamaños de campo estándar, debido a la pérdida de equilibrio electrónico lateral. Así pues, para cada caso concreto, en estas situaciones de campos pequeños o con estrechamientos, se requiere una dosimetría individualizada y de ahí la importancia de disponer de un método sencillo que proporcione la precisión adecuada.

En la práctica clínica la irradiación de lesiones superficiales de extensión relativamente pequeña se da principalmente en los casos de epitelomas,

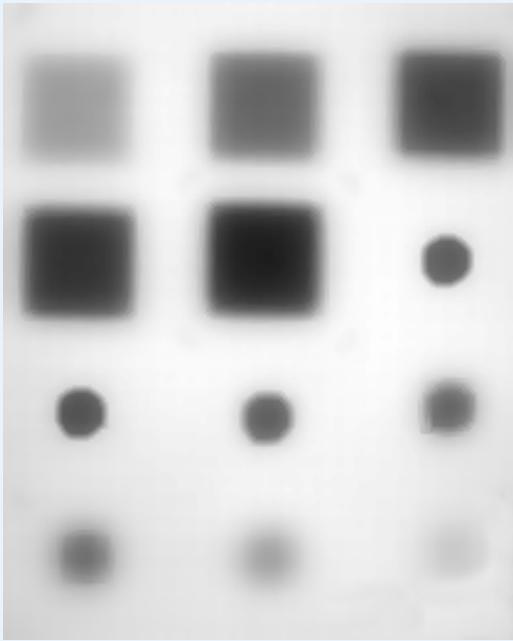


Fig. 1. Ejemplo de película irradiada con electrones 10 MeV. Se observan por un lado las irradiaciones con dosis conocidas correspondientes al aplicador 6x6 cm² y por otro lado las efectuadas con el inserto problema de diámetro 3 cm.

sarcomas de Caposi, etc. En nuestro Servicio, estas irradiaciones se han llevado a cabo hasta hace algunos años mediante RX en un equipo de terapia superficial (RT100, Philips), en la actualidad, debido a la retirada de este equipo, se tratan mediante haces de electrones de baja energía en el acelerador lineal SLi (Elekta). Por otro lado, la misma situación se daría también en el caso de irradiaciones con haces de electrones de alta energía con campos muy pequeños, alargados o de forma muy irregular.

Además de los trabajos dedicados a investigar este efecto, existen una serie de publicaciones que se centran en el método para llevar a cabo la dosimetría de estos casos en la rutina clínica⁷⁻⁹. Los diferentes autores proponen métodos basados en el uso combinado de cámaras de ionización planoparalelas de pequeña superficie, dosímetros termoluminiscentes (TLD), diodos y películas, poniendo de manifiesto que el uso de películas proporciona una precisión adecuada y supone una reducción en el tiempo empleado en la dosimetría.

El objetivo de este trabajo es el desarrollo y automatización de un método dosimétrico práctico para estas situaciones, basado en el uso de película y escáner informático convencional de transparencias.

MATERIAL Y MÉTODOS

Para el estudio se han utilizado películas radiográficas X-OmatV (33 x 41 cm²), situadas perpendiculares al haz en el seno de un maniquí de láminas de poliestireno. La película irradiada se

analiza en un escáner de sobremesa (Duoscan T1200, Agfa) con opción de adquisición en modo de transparencia, se procesa en el programa FAR que permite automatizar el proceso tal y como está descrito en detalle en Roselló et al.¹⁰. Las mismas películas se han analizado también mediante un isodensitómetro (Model 1705 – CMS, de apertura óptica 2 mm y paso 0.254 mm).

Las medidas se han verificado mediante detectores TLD, con chips (xd100) 3x3 mm² de área y espesor 0.38mm (lector: Harshaw 6600 tld reader).

Las irradiaciones se han realizado en el acelerador Sli (Elekta) que produce electrones de energías nominales 4, 6, 8, 10, 12, 15, 18 y 20 MeV. Este acelerador está dotado de colimadores fijos cuadrados de tamaños 6x6 cm², 10x10 cm², 14x14 cm² y 20x20 cm², tamaños definidos a una DFS de 95 cm (final del aplicador), en los cuales puede insertarse un recorte (inserto) de cerrobend que defina la forma de campo deseada. En nuestro Servicio, para definir la irregularidad del campo se utiliza el inserto de cerrobend en el aplicador para energías de 10 MeV o mayores y se utiliza un recorte de plomo de espesor adecuado, apoyado en la superficie del paciente, en el caso de energías menores. En todos los casos los tratamientos se realizan a una DFS de 100 cm¹¹.

Las diferentes irradiaciones se realizan en una única película, protegiendo el resto de la placa con láminas de plomo del espesor adecuado. Se realizan por un lado, 5 irradiaciones destinadas a obtener la curva de calibrado dosis-transmisión, es decir, el conjunto de valores de transmisión obtenidos a partir de dosis conocidas, todas ellas a la misma profundidad, aproximadamente la del máximo de dosis absorbida correspondiente. Se utiliza un inserto cuadrado cuyo tamaño no comprometa el equilibrio electrónico lateral y se administran dosis absorbidas conocidas en el rango adecuado teniendo en cuenta las características de la película X-OmatV, variando el número de unidades de monitor en cada irradiación.

Por otro lado se llevan a cabo las irradiaciones correspondientes al "inserto problema" para lo cual se sitúa la película a diferentes profundidades que van desde la superficie hasta aproximadamente Rp.

Las irradiaciones dedicadas al calibrado han consistido en 5 campos cuadrados de tamaño 6x6 cm², a los que se han administrado 5 valores de dosis diferentes en un intervalo de entre 10 cGy y 40 cGy aproximadamente situando las películas bajo un espesor de poliestireno de 13 mm en el caso de 6 MeV y de 23 mm en el caso de 10 MeV. Estas profundidades se han convertido a profundidades equivalentes de agua¹² y se ha tenido en cuenta la dosis de referencia de cada

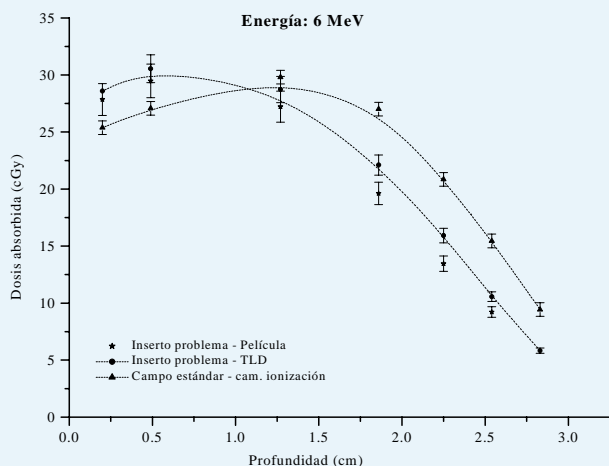


Fig. 2. Resultados obtenidos mediante la película radiográfica y mediante TLD para electrones de 6 MeV. Se incluye también la curva correspondiente al campo estándar obtenida con cámara de ionización.

energía, medida con cámara de ionización plana NACP, para asignar los valores de dosis.

Procesadas las películas mediante el programa FAR, en primer lugar se construyen las curvas de calibración, asignando los valores de dosis a los correspondientes valores de transmisión de la película y ajustando los datos a un polinomio de segundo orden. A continuación con estas curvas se analiza el inserto problema y por último se genera un informe en el que se obtienen la distribución absoluta de dosis en profundidad y la distribución de dosis en cada plano perpendicular al eje del haz, a la profundidad de medida. Todo el proceso (digitalización y análisis) se ha repetido 3 veces para estimar en la incertidumbre global la repetibilidad.

Para contrastar los resultados obtenidos con la película radiográfica se han realizado además un grupo de medidas con TLD previamente calibrados para las energías correspondientes cuyo adecuado comportamiento para este propósito se había estudiado en un trabajo anterior¹³. Los TLD se han colocado a profundidades coincidentes con las utilizadas con el inserto problema situando en cada profundidad 4 dosímetros.

Las mismas películas se han analizado también mediante isodensitómetro (CMS), para evaluar el proceso de análisis utilizando los datos de densidad óptica relativa. Estos datos se han ajustado externamente mediante una hoja de cálculo a un polinomio de orden 2, igual que con el programa FAR, y éste se ha usado para obtener la curva de dosis en profundidad, repitiendo el proceso 3 veces.

En la determinación de las incertidumbres de los resultados se ha llevado a cabo una estimación de las mismas. La incertidumbre correspondiente

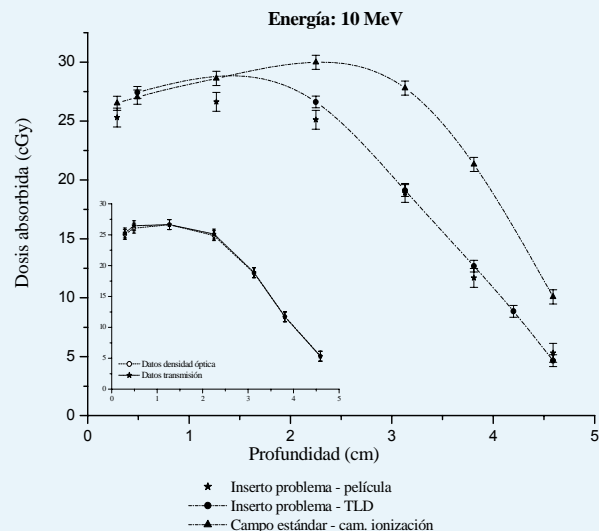


Fig. 3. Resultados obtenidos mediante la película radiográfica y mediante TLD para electrones de 10 MeV. Se incluye también la curva correspondiente al campo estándar obtenida con cámara de ionización y una gráfica comparativa de los datos obtenidos de los valores de transmisión frente a los de densidad óptica.

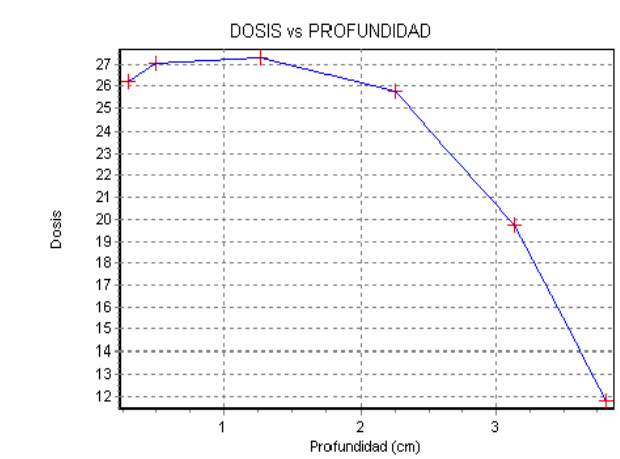
a la curva de dosis en profundidad del campo estándar se ha estimado tomando como referencia las indicaciones y valores que aparecen en Granados et al.¹⁴. Para los valores obtenidos con los TLD se ha asignado la incertidumbre basándose en los datos obtenidos por Casal et al.¹³. Para el inserto problema, en la estimación de la incertidumbre se ha tenido en cuenta el valor de la desviación estándar de la transmisión que proporciona el programa FAR, el introducido por la obtención a través del ajuste, el de la dosis de referencia y el correspondiente a la repetibilidad.

RESULTADOS Y DISCUSIÓN

Dadas las dimensiones de los campos objeto del estudio, en la película se pueden realizar 5 irradiaciones de calibrado, suficientes para obtener la curva de calibrado en el intervalo de dosis deseado¹⁵, y 7 irradiaciones para el inserto problema. Estas últimas son suficientes para obtener información de la zona de interés clínico. En la figura 1 puede verse un ejemplo de película irradiada.

Mediante el programa FAR se han obtenido los 5 valores de transmisión para las 2 energías y de ahí las curvas de calibración se han ajustado a polinomios de orden 2. El valor concreto de estos parámetros puede variar con el revelado, pero esta variación afecta por igual a las irradiaciones con el inserto problema. Asimismo al utilizar sólo 5 puntos para el ajuste, el error estadístico de los

DOSIMETRIA DE RECORTES DE ELECTRONES



PROFUNDIDAD (cm)	DOSIS (cGy)
0.29	26.2064
0.49	27.0701
1.27	27.2962
2.25	25.7695
3.13	19.7030
3.81	11.7889

100%	80%
95%	50%
90%	20%

FACTOR RECORTE

0.897

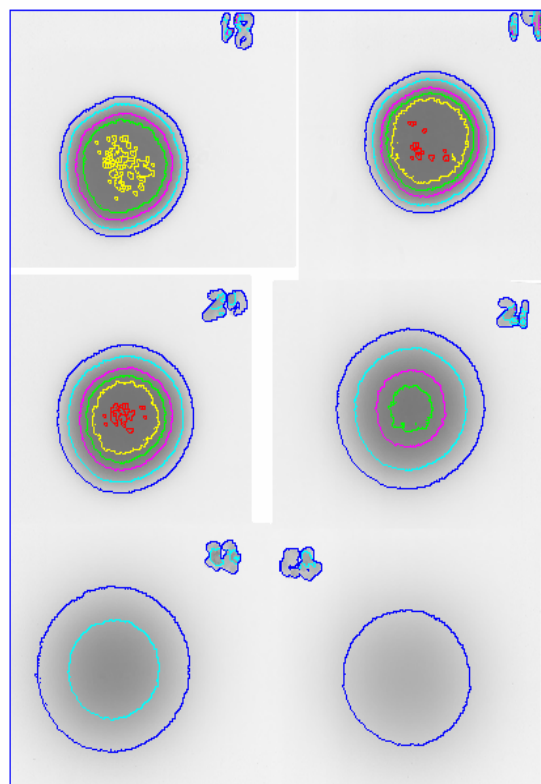


Fig. 4. Informe obtenido con el programa FAR para el ejemplo de película irradiada con electrones 10 MeV y el inserto problema de diámetro 3 cm.

parámetros es alto, pero dado que los valores de dosis escogidos para el calibrado abarcan el intervalo a utilizar y el término cuadrático es pequeño los resultados obtenidos a través del ajuste son correctos.

Introduciendo los datos de transmisión correspondientes a los "campos problema" se han obtenido las dosis absorbidas respectivas, construyendo las curvas de distribución de dosis en profundidad.

En las figuras 2 y 3 pueden verse los valores correspondientes a 6 MeV y 10 MeV respectivamente, obtenidos mediante la película y los obtenidos con los dosímetros TLD, en estas se han incluido también los datos de dosis en profundidad que corresponderían a la curva de rendimiento de "campo estándar" para la dosis de referencia actualizada. Se han unido los puntos obtenidos mediante TLD y cámara de ionización mediante curvas de tipo spline con objeto de que las líneas ayuden a la visualización del gráfico. Los valores de las incertidumbres relativas son 3% para la curva correspondiente al inserto estándar, 4% para los valores obtenidos mediante TLD y 5% para el inserto problema.

Las curvas obtenidas a partir del isodensitómetro coinciden con las obtenidas

mediante este proceso y por ello sólo se ha incluido una gráfica insertada a título ilustrativo en la figura 3.

En la figura 4 puede verse la presentación de resultados proporcionados por el programa FAR para el inserto de diámetro 3 cm correspondiente a energía 10 MeV, esto es, la curva de dosis en profundidad, el factor recorte (cociente entre la dosis absorbida para el "campo problema" y la dosis para el "campo estándar" correspondiente, en este caso 6x6 cm², en el máximo) y las isodosis correspondientes superpuestas a la película radiográfica digitalizada.

Aunque en las gráficas se aprecia que los valores obtenidos para 6 MeV mediante película no son, estrictamente hablando, compatibles con los obtenidos con los TLD, cabe indicar que en particular la incertidumbre de los resultados obtenidos mediante los TLD es difícil de estimar. En el estudio de Casal et. al.¹³ se apreció que, así como para los haces de fotones estudiados la respuesta del TLD no dependía de la energía, esta variaba mucho para los electrones estudiados (de energía 10 MeV), lo cual puede indicar que también ésta varíe con la degradación del haz, diferente balance de la componente primaria y secundaria, etc. En todo caso para estos tamaños

de campo tan pequeños no existe posibilidad de utilizar una cámara plana.

CONCLUSIÓN

Se ha estudiado un método para la dosimetría de haces pequeños de electrones basado en la irradiación de películas X-OmatV, películas que al presentarse, como ya es conocido, en "ready-pack" son de muy cómoda utilización.

Al tratarse de campos de dimensiones pequeñas, es suficiente una sola película para obtener la curva de calibrado y un número suficiente de puntos para reconstruir la distribución de dosis en profundidad, evitándose así las posibles discrepancias entre películas del mismo paquete.

La digitalización mediante un escáner de sobremesa hace el proceso muy rápido, siendo en la actualidad la existencia de este elemento muy común en los Servicios, y aportando una gran versatilidad a la hora de analizar la información.

El método es aplicable así mismo al estudio de campos muy irregulares o rectangulares muy alargados.

La automatización mediante el programa FAR permite obtener toda la información necesaria, esto es, distribución absoluta de dosis en profundidad y en los y en planos perpendiculares al eje del haz, en un tiempo muy corto, siendo el tiempo total de ocupación de Unidad y de análisis muy inferior al que se emplearía con otros métodos dosimétricos.

Los resultados obtenidos, a la hora de administrar el tratamiento son compatibles con la precisión requerida en la práctica clínica, aún así en una segunda fase de este trabajo se ha comenzado un estudio mediante simulación por Monte Carlo para analizar, entre otras, la posible dependencia de la respuesta del TLD con la variación de energía de los electrones con la profundidad.

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