European Medical Physics News

Winter 2013/14

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Editorial

Dear Readers,

Welcome to the winter addition of the EFOMP newsletter. I take over from Virginia Tsapaki who has done an excellent job as the chairman of the EFOMP Communications and Publications Committee. I would like to thank her for all the hard work she has undertaken in this role. I look forward to maintaining the standards and qualities she has set and hope the newsletter will continue to inform members of EFOMP activities.

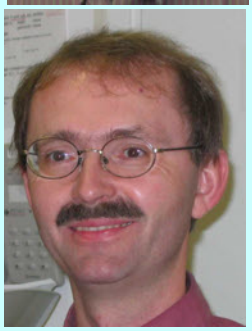
We have many events to report, for example, on page 4 of this issue is a full report from the meeting of the EFOMP council held at the International Conference on Medical Physics 2013 and 7th European Conference on Medical Physics in Brighton in the United Kingdom. Also worthy of note is the opening ceremony welcome from Professor John Mallard, one of the founder members of IOMP and an EFOMP medal holder, and just before the Opening Ceremony Prof. Francis Duck gave a fascinating lecture "Physicists and Physicians".

This is followed with an interesting article on the history of medical physics in Hungary, and we would encourage other members in different countries to submit overviews of their history of medical physics. We also have an article on PRIMO: a graphical Monte Carlo system for linac and dose distribution simulation, detail of the Eutempe project, an interactive dose calculator & simulator for risk management in interventional radiology and finally an interview with Professor Ben Mijnheer. If you are a medical physicist working in Radiation Oncology you may have read one of the papers by Ben or attended one of his lectures. He has been extremely active in clinical research in Radiation Therapy Physics and has a gift for teaching.

I would also like to take this opportunity to reminder readers of the ECMP this year to be held in Athens (www.efomp-2014.gr).

We are always on the lookout for news items or other contributions and encourage authors to contact myself, or one of the editorial team.

Prof Richard Bayford
Chair of Communications and Publications



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EFOMP council at Brighton

The annual meeting of EFOMP Council is the most important event in the year. It gives NMOs the opportunity to hear what the Board has been doing during the past year, to question them on their actions and, most importantly, to influence what EFOMP will be doing in the future.

So the role of the NMO representative is an important one and for this reason Council was presented with a suggested job description setting out the responsibilities of representatives. Council approved the document and suggested that it be sent to NMO Presidents. A copy of the job description can be found on the in the EFOMP Manual which is on the EFOMP website.

Prof. Sharp encouraged NMO's to celebrate the forthcoming International Day of Medical Physics planned for November 7th. Prof. Nüsslin asked everyone to support the day and also to give some thought as to how some form of global event could be arranged for future years.

Prof. Hartmann gave a short presentation during which he highlighted the concern of the Officers regarding the future management of The European School of Medical Physics (ESMP), which is held annually at Archamps.. He confirmed that EFOMP wished to continue to be connected to ESMP but that to some extent this was dependent upon the current concerns being resolved. A discussion took place on the future direction of ESMP and Prof. Nüsslin suggested that the school should concentrate on providing basic training for which there was a strong demand.

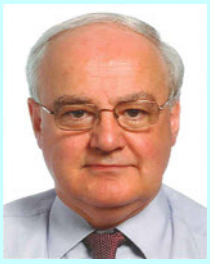
Prof Padovani gave an overview of the development of courses at International Centre for Theoretical Phusics at Trieste and how EFOMP is involved. Prof Sharp advised the meeting that collaboration with IOMP at ICTP was being discussed and that there was also the possibility of involvement by ESTRO. Following discussion the link to ICTP was supported provided that there was no financial contribution expected from EFOMP and that the proposed courses did not conflict with those at Archamps.

Dr. Brambilla reported on the success of the EFOMP summer school for medical physics experts (MPE) held in Prague in association with the CAMP. Prof Sharp explained that it provided MPE-level modules for the career development of Medical Physicists or CPD for existing MPE's. Dr. Brambilla gave an outline of plans for 2014 and said that EANM were happy to support the 2014 course but whether in the longer term the summer school would remain at Prague was yet to be decided

Prof. Bosmans reported that EFOMP had successfully been accepted as a partner in the EU-TEMPE-RX project and she gave an outline of the project aims and objectives. She also advised the meeting that EFOMP had been included as a partner in a tender for a project on paediatric DRLs which would be led by ESR, the outcome of this bid being due in October.

The NMO's represented at the meeting each gave a report on achievements, issues and current affairs in their country. Amongst topics raised were: the qualifications route towards becoming recognised as a Medical Physicist; the role of the RPE and RPO and how this impacts on the MP and MPE; problems with the recognition of the MPE and standards of operation in Portugal.

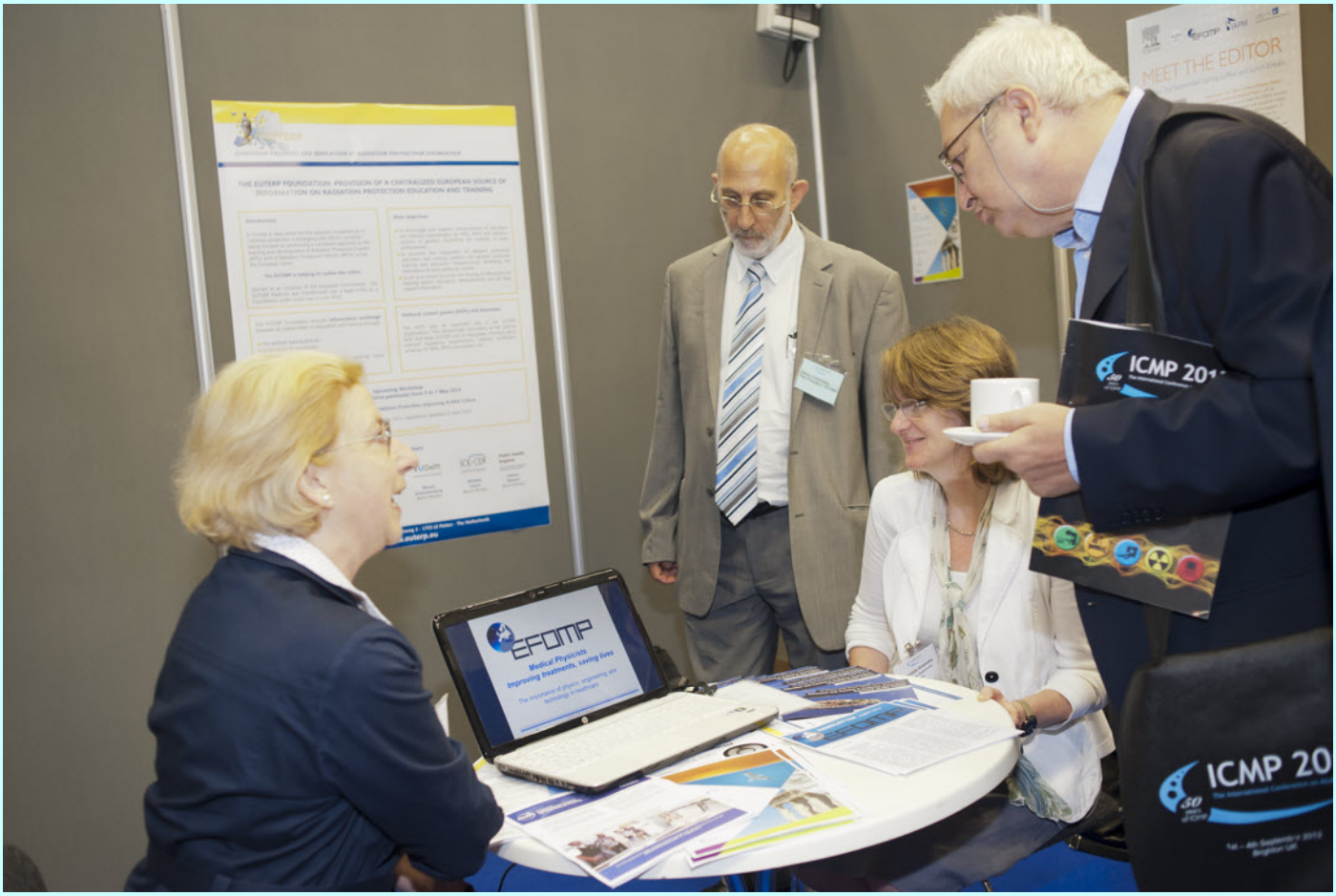
Prof. Sharp reported that there had been only one nomination from NMOs for the EFOMP Medal and that was for Paul Shrimpton from IPEM in the UK. The proposal was approved by Council.



Peter Sharp
EFOMP President

Honorary EFOMP members (from left to right: Philip Dendy, Fridthof Nüsslin, John Clifton, Alberto Del Guerra

International Conference on Medical Physics 2013 and 7th European Conference on Medical Physics



Oh! I do like to be beside the seaside
I do like to be beside the sea!
I do like to stroll along the Prom, Prom, Prom!
Where the brass bands play:
"Tiddely-om-pom-pom!"

So goes a popular British music hall song. But it could apply to those attending ICMP 2013 at its seaside venue in Brighton. Although there weren't any brass bands there was a temptation to stroll along the promenade which was just outside the doors of the Brighton Conference Centre. Fortunately there was an excellent scientific programme and this encouraged the 835 attendees to resist the charms of Brighton, at least until the evening.

This was a special conference celebrating the 50th Anniversary of the foundation of IOMP, of which EFOMP is a member. So together with IPEM, our UK hosts, EFOMP was a co-sponsor of this prestigious event.

The challenge of an anniversary event is to balance the desire to look backward on the 50 years with generating enthusiasm for the future. I will declare an interest at this point since as Conference President I was closely involved in the organisation of the meeting, although others did most of the work.

The past was acknowledged by an exhibition of posters showing the work of 50 distinguished medical physicists each nominated by their own country. The idea was to show the global breadth of medical physics and in this it succeeded. At the opening ceremony we had a videoed welcome from Professor John Mallard, one of the founder members of IOMP and an EFOMP medal holder. While John is now too frail to travel his talk

brought home just how far medical physics has travelled in the last 50 years. Just before the Opening Ceremony Prof. Francis Duck gave a fascinating lecture “Physicists and Physicians – stories from the history of medical physics” based on his new book “Physicists and Physicians: A History of Medical Physics from the Renaissance to Röntgen”, which is published by the IPEM.

The conference title was “New Horizons – Global and Scientific”, emphasising the scientific vigour of our discipline. The 312 international speakers covered topics ranging from “Innovations in image guided photon and particle therapy” to “Medical Physics Research in the era of genomic medicine” and “Translating fluoresence molecular imaging”. Conference abstracts can be accessed online from

www.mpijournal.org .

There were many distinguished speakers; Professor Molly Stevens, recognised as one of the world’s top young innovators, delivered the IPEM Woolmer lecture on “Designing biomaterials for ultrasensitive biosensing and regenerative medicine” while Harry Kim, Hewlett Packard's Director for Worldwide Health & Life Sciences, spoke on the development of the digital hospital.

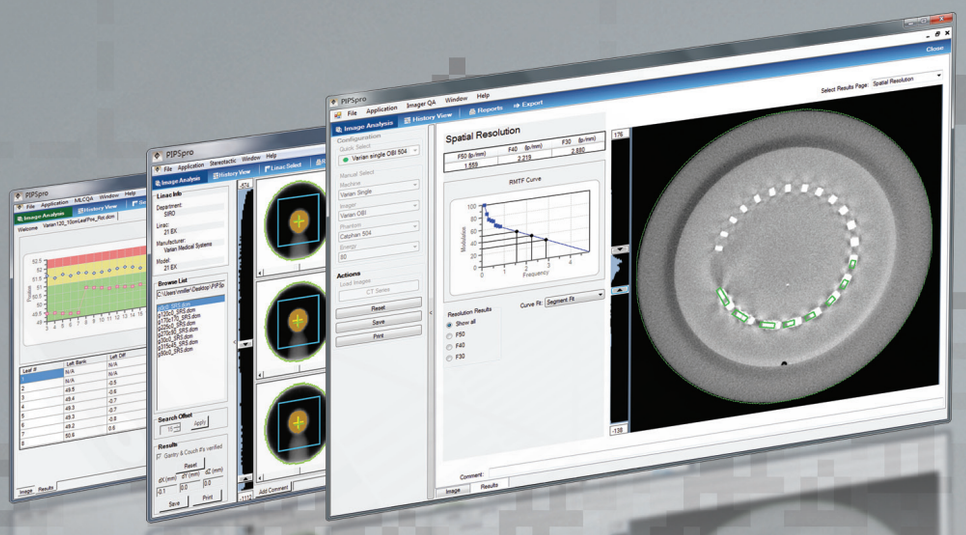
Prof Teresa Eudaldo, the recipient of EFOMP Honorary Membership, delivered her acceptance lecture on “The key role of medical physics education and training in patient protection.

There was a large poster section as well as an industrial exhibition at which EFOMP exhibited.

One of the innovations was a “Meet the Editor” session where journal editors, including EJMP’s editor, Paolo Russo, spoke to people on how to get their papers accepted for publication.

After 50 years many of us are thinking about retirement. But this conference showed that medical physics is thriving and eagerly looking forward to the next 50 years of applying physics and engineering for the benefit of patients.

Peter Jarritt, United Kingdom



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History of medical physics in Hungary

1. History of Medical Physicists in Hungary

Medical Physics as science is concerned with the application and development of the principles and techniques of physics to human beings including diagnosis, treatment and prevention of human disease. The clinical use of X-ray and Ra-226 isotopes was started in Hungary at the beginning of the 20th century. The first Hungarian application of isotope 226Ra in a special department was possible in a hospital of National Health Insurance Institute – now Uzsoki Hospital. The foundation of the Loránd Eötvös Radium and X-Ray Institute in 1935 can be regarded as the birth of medical physics with two famous Hungarian physicists: Dr. Johanna Toperczer (1903 – 1991), she was the first full time physicist in radiation therapy and Dr. László Bozóky (1911-1995) who joined in 1937 (Figure 1.).
Later, in 1952 the Ministry of Health reorganized the institute and established the National Institute of Oncology.

Figure 1.: Prof. László Bozóky (left) and Dr. Johanna Toperczer

The first patient in Hungary was treated by cobalt therapy more than sixty years ago at the National Institute of Oncology with Gravicert type equipment, which was designed by László Bozóky seven years after the first cobalt unit installation in the world in Canada. At the beginning, localization was performed with X-ray machines, while treatment planning was done manually. In 1965, a Rotacert type cobalt unit was installed at the same institute (Figure 2.).

This machine was already capable of making irradiation from multiple directions and it worked in rotating mode, as well. In Hungary, more cobalt units – first the Gravicert type, then foreign machines – were also gradually installed in other radiotherapy centres. The quality of treatments was significantly improved by the introduction of computerized treatment planning, and the foundation of the IAEA-supported National Treatment Planning Network in 1978 to be used on a central computer the planning software donated by van de Geijn. The next important development was the commencement of CT image based treatment planning in 1981.

2. Organization issues

The first step in July 1974 was the foundation of a Medical Physics Section (headed by Prof. Bozóky) in the Hungarian Biophysical Society (HBS). From 1994 the organisation worked as the Hungarian Association of Medical Physicists (HAMP) - still part of the HBS, moreover became a member of the International Organisation for Medical Physics (IOMP) in 1975 and of the European Federation of Organisations for Medical Physics (EFOMP) in 1980.

Figure 2: Left a Gravicert type equipment designed by László Bozóky at the National Institute of Oncology Right a Rotacert type cobalt installed 1965.

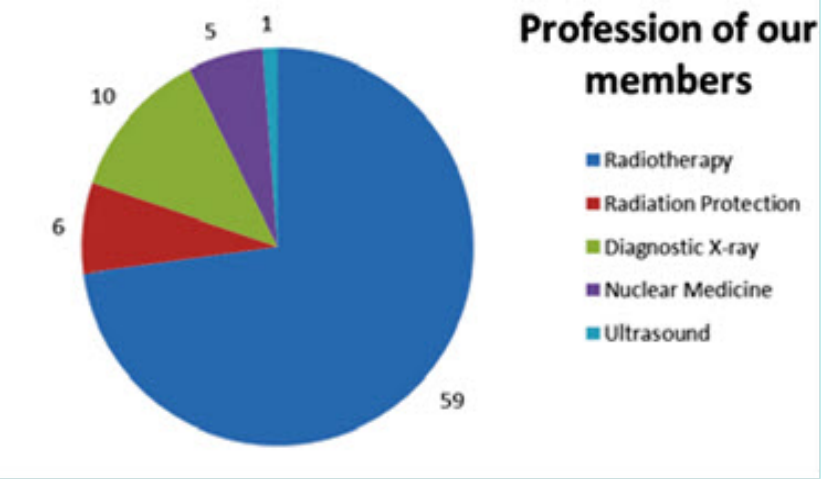

Figure 3: Profession of HSMP members

The first conference of the HAMP was organised in 1994 and the proceedings of the yearly conferences were published in English or in Hungarian as a Supplement of Radiológiai Közlemények (Radiological Communications, HU-ISSN 0133-2791, periodical of the National Institute for Roentgen and Radiation Physics, ORSI). After several decades of activity the institute was dissolved in 2005. The Hungarian Association of Medical Physicists as the Hungarian member society of EFOMP is entitled to prepare the Training Scheme, and has appointed a Training and Education Committee to administer the Training Scheme in 1996 [1,2].

in 2008, we reorganised our society: the medical physics community moved from the HBS and founded the new independent Hungarian Society of Medical Physicists (HSMP). The society is the professional community organized voluntarily by medical physicists working in the healthcare system. The purposes and activity of the Society:

1. Assists improvement of application of medical physics (primarily ionizing radiations) and information of the public on professional issues for the interest of the population.
2. In the regulation and development of healthcare it represents specific aspects and interests of medical physics.
3. It assists and supports research, education and training of its members in medical physics.
4. Through improvement of professional conditions it assists the creative work of its members and urges toward moral and financial appreciation of its members.
5. In international professional organizations it represents the interests and viewpoints of the company as a Hungarian charter organization and implements the application of condition system of the European Federation of Organizations in Medical Physics (EFOMP) in Hungary.

The great majority of the members work in the field of radiation therapy. Today we have 12 radiation therapy centres and several nuclear medicine, x-ray diagnostic radiology and MRI (Magnetic Resonance Imaging) departments in Hungary.

3. Biomedical engineering education

Biomedical engineering education in Hungary started in 1994, after a comprehensive investigation of similar European programs, as a joint program of three universities: Budapest University of Technology and Economics, Semmelweis University of Medicine, and University of Veterinary Sciences. It was the first high-level comprehensive education form in Hungary that granted an MSc degree in Biomedical Engineering [3,4]. A speciality of this education was medical physics, using the curriculum based on the Training Scheme of Hungarian Association of Medical Physicists (1998). That time Hungary used the German system of education (an MSc in physics being equivalent with Diplom Physiker, e.g.), therefore several medical courses started in the last two semesters followed by four additional full semesters usually sponsored by companies. This type of education was not successful because the hospitals had no funds to support full time education and the on job training was not implemented.

The Bologna Declaration aims at harmonizing the European higher education structure. In accordance with the Declaration, Hungary adopted the BSc/MSc system and biomedical engineering was offered as a master (MSc) course also in Hungary, from the year of 2009. Students could start their biomedical engineering studies in the eighth semester – usually in parallel with their first-degree course getting a second diploma at the end of the course. Consequently, the biomedical engineering course could have been considered as a master course even before the Bologna Declaration. Students had to collect 130 ECTS credits during the six-semester course. This was equivalent to four-semester full-time studies, because during the first three semesters the curriculum required gaining only one third of

the usual ECTS credits [5]. After the reorganisation of the Hungarian higher education, medical physics was defined as a speciality of physics (like in ISCO 08).

4. Medical physics education

In agreement with the Bologna process, the former university education was replaced by the two-step BSc and MSc education. As a specialisation of the physics MSc, the Department of Nuclear Techniques of the Budapest University of Technology launched a novel education module being the single medical physics education in Hungary. This MSc specialisation offers courses on medical imaging, nuclear medicine, X-ray diagnostics, MRI and radiotherapy. Medical courses; such as, anatomy and medical physiology are given by lecturers from the Semmelweis Medical University.

The Institute of Nuclear Techniques (BME NTI) of the Budapest University of Technology and Economics is a part of the Faculty of Natural Sciences. The institute consists of two structural units: the Department of Nuclear Techniques and the Department of Nuclear Energy. The mission of the institute is the education of physicists, environmental and power engineers in the field of nuclear measurement techniques and power generation.

At the end of November in 2009, the Senate of the University approved the Medical Physics module curriculum.
The medical physics specialisation aims at providing high level interdisciplinary theoretical and practical knowledge and readily applicable skills, which can be put into action in both the clinical and the R&D field. Strong connections with medical institutions and with medical equipment vendors assure that the courses remain up-to-date and the skills are readily applicable.

The applicant entering this profession normally has an appropriate degree (B.Sc.) in a physical science or an equivalent 3-year education. The duration of the medical physics MSc programme is 4 semesters, of which 3 are intended for theoretical education while the last is for preparing the Master's Thesis. The number of contact lectures are 104, resulting in a total of 120 credit points. The Module of Specific Lectures is put together on the basis of IPEM, EFOMP, AAPM and IAEA recommendations.

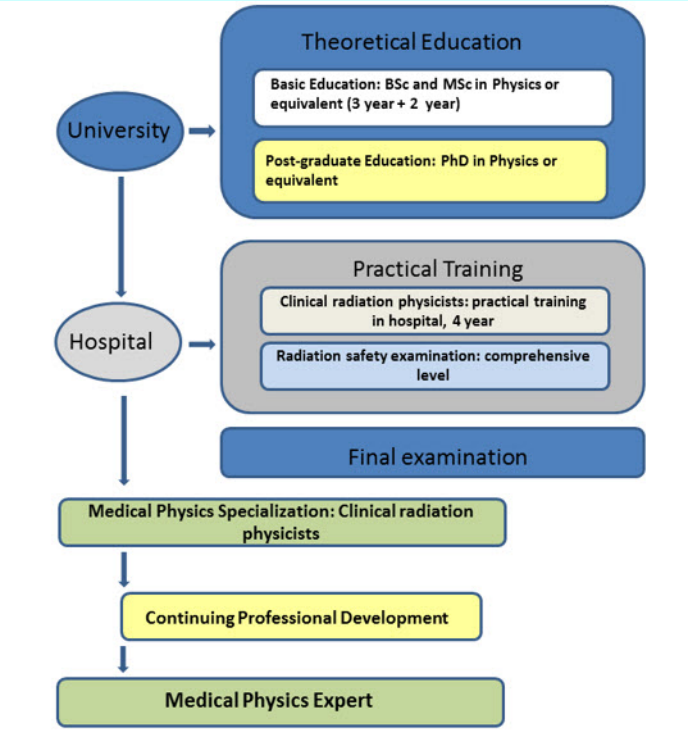

Figure 4: The structure of the present education system of qualified medical physicists in Hungary

Module Specific Lectures
(lecture/practical/experimental/credit)

- Functional Anatomy (2/0/2/4),
- Physiology (3/1/0/4),
- Ethical Aspects of Medical Research (2/0/0/2), Radiobiology (2/1/0/3),
- Radiation protection (2/0/2/4),
- Physical basis of Radiotherapy (2/0/2/4),
- Radiotherapy II. (2/0/0/2),
- Brachytherapy (2/0/0/2),
- Quality Assurance and Legislation (2/0/1/3), Medical Imaging (3/1/0/4),
- Physical basis of X-Ray
- Diagnostic (2/0/0/3),
- Nuclear medicine (2/0/1/3),
- Magnetic Resonance and clinical applications (2/1/0/3),
- Introduction to Optics (2/2/0/5),
- Microscopy (2/0/0/2),
- Physical Basis of Laser Medical Applications (2/0/0/2),
- Spectroscopy and structure of matter (2/0/0/3), Neutron and gamma transport calculation techniques (2/2/0/5),
- Monte Carlo Methods (2/0/2/4),
- Ultrasound (2/0/0/2)

Students' interest in the program is high and it has become one of the most popular specialities of physics at the university. Institutes that are involved in the training: National Institute of Oncology, BME, Institute of Physics, "Frédéric Joli-

Course	Credits	Semester
Basic Lectures		
Mathematical problem solving practical	2	1
Computer applications for technical and physics problems	2	1
Investments	2	2
Fundamental Lectures		
Molecular and atomic physics	3	1
Material physics	3	2
Nuclear Physics	4	2
Particle physics	4	3
Computer simulation in statistical physics	3	1
Physics laboratories	6	1
Module Specific Lectures		
Seminars I-IV	2+2+2+2	1,2,3,4
Individual laboratories I-II.	7+12	2,3
Module Specific Lectures	10+10+10	1,2,3
Master's Thesis	30	4
Lectures of choice	2+2+2	1,2,3
Language Training		
Foreign language	4+4	1,2

Table 1.: Courses in medical physics M.Sc. program at Budapest University of Technology and Economics, full 2-year of studies 120 credits.

ot-Curie" National Research Institute for Radiobiology and Radiation Hygiene, Semmelweis University, Mediso Ltd.

5. Special training for Clinical radiation physicists in Hungary

The duration of the training is 48 months (4 years) with a theoretical and practical exam at the end. After a successful exam the physicist is qualified as a *Clinal radiation physicist* and registered by the Office of Health Authorisation and Administrative Procedures.

To enter the training programme the applicant has to have an MSc (or an equivalent) degree in physics, physics teacher or bioengineering, and basic education with a min. 30-hour course in physiology, functional anatomy and radiobiology. The three main medical physics fields are radiotherapy, nuclear medicine and radiology. The training programme consists of 4 main parts.

a. Practical training I (17 months)**:**
radiotherapy (4 months), nuclear medicine (3 months), radiology (4 months), radiation protection (2 months), medical image processing (3 months), health informatics (1 month)
Having finished the Practical training I. the trainee has to select a specialization field, and he/she is supposed to spend the remaining 20-month period in that field.

b. Practical training II (20 months)**:**
Radiotherapy or nuclear medicine or radiology (20 months)

c. Theoretical courses (6 months)**:**
2 months in the field of interest
- radiotherapy
- nuclear medicine
- radiology 2 months
- physical and technical module
- comprehensive radiation protection
- radiations, atomic and nuclear physics
- nuclear measurement methods
- methodology of scientific research
- health informatics
- biomedical statistics

1.5 months - medical field module
- basics of oncology
- health organization and management
- bioethics
- laws in health care
- basics of quality management

0.5 month – comprehensive radiation protection

d. Scientific work(5 months)**:**
The trainee conducts a scientific work in the selected medical physics field which results in a written essay or a paper for publication in a scientific journal

	Basic level (hour)	Extended level (hour)	Comprehensive level (hour)
Consultation	2	4	4
Radiation Physics principles	2	4	6
Radiation protection principles, dose limits, authority monitoring system	4	12	14
Dosimetry principles		2	2
Health Physics principles, radiobiology		2	6
Practical work		2	4
Radiation accidents and medical attendance of radiation injured people			2
Nuclear accident prevention			2
Sum E&T	8	26	40

Table 2: Summaries of lessons for various levels of E&T.

6. Radiation safety examination

Education and Training (E&T) could be considered as the baseline of the implementation for safety of nuclear and radiological protection. The legal base for the E&T in Hungary was laid down in 2001, as the 31st decree of the Minister for Health ("decree"). Thus, the harmonisation of the 97/43/EURATOM directive had been done before the accession of Hungary to the European Union in 2004. Several revisions throughout the years were issued but all of them left E&T unchanged. The last revision, just before the issuance of the new EU BSS which would surely have an impact on the matter at hand, a new issue of the decree is underway. The most important changes would affect E&T, but are based on our past experiences and these would surely improve the quality of education.

Basic level education is required for any person who comes into contact with radioactive material or machines which could emit ionising radiation, altogether: source of radiation. Extended level educations are required by those who operate the source of radiation and comprehensive level training is required by those who supervise and authorise the use of given sources. Comprehensive level educations and trainings: Radiation protection officers (RPO) working as supervisors of licensees must have a certificate of comprehensive level E&T. If a licensee has multiple workplaces and has several organisational subdivisions and divisions (an important hospital with several radiological workplaces and therapeutic modalities etc.), a leader must employ of the radiation protection service and each subdivision using ionising radiation has to have at least one person with extended level education.

Comprehensive level is compulsory for the following workers and decision-makers, who:

a) independently fulfil or manage or supervise activities accompanied by risk of high exposure to ionizing radiation, or monitor such activities from radiation protection point of view.
b) are involved in the planning of the radiation protection of work sites exposed to radiation hazard or in the evaluation such schedules from radiation protection point of view.
c) are involved in the design, management or supervision, from radiation protection point of view, of medical therapy procedures using ionizing radiation, in health welfare institutes,
d) perform authority inspections of work sites exposed to radiation hazard,
e) perform Health Physics or radiation protection expert activities,
f) give lectures or conduct examinations for advanced or higher grade radiation protection trainings,
g) are authorized managers, in the field of nuclear accident prevention entitled to give instructions in emergency.

A well prepared individual, educational institution or a training centre which could be part of a university or could work as a company may be eligible to organise E&T after a thorough accreditation process. The licensees have to prove that they or their employees could give lessons and were properly trained and have acquired experience in the given field.

The Office of the Chief Medical Officer (OCMO) and the "Frédéric Joliot-Curie" National Re-

search Institute for Radiobiology and Radiohygiene (NRIRR), work together under the institutional organisation of National Public Health and Medical Officer Service (NPHMOS). A training centre is found eligible if its E&T curriculum meets the requirements of the decree and was found as such at the NRIRR during an accreditation process. If the future licensee acquires the NRIRR's opinion and it states that the requirements are met, after a simple authorisation process at OCMO, the license is handled to them. This system gives some flexibility, which is necessary, as it would be mindless to teach a radiographer about the know-how of handling other sources of radiation than X-ray machines.
The validity of the above licenses vary one by one, but the attendee's certificate who have successfully passed the exam at the end of the given course, remain valid for five years. The certificate is required to fulfil certain jobs, thus the certificate has to be renewed after five years, and otherwise the owner of it would be ineligible to fulfil the job requirements.

7. Continual professional development and life-long learning

The aim of life-long learning is well known, thus the members of our society are always encouraged to develop their skills further and improve knowledge. To achieve the above mentioned goals, the society supports its members by financing their participation at international conferences, but in return the participant member is required to share the acquired information with the society members (in a presentation during the annual conference of the HSMP).

8. Structure of the present education system for QMPs

A new structure for education was established in 2010, when the medical physics MSc education was started; in the meantime, the qualification of a medical physicist was considered a post-graduate education by the Ministry of Health. This education comprises of four parts: theoretical education, practical training, radiation safety examination and final examination. The structure of the present education system for QMPs is summarized in figure 3, and presented in more detail below. Based on the requirements and duration of the QMP education, it can be considered as one of the most extensive ones in Europe

Figure 5: Medallion for Hungarian medical physics

9. Membership in 2013

Currently, we have 81 members in our society which represents more than 80% of physicists working in the medical field. According to a survey about the age and profession of our members, the average age is 45 years and most of us are working in the field of radiotherapy (Figure 4.). We are continuously trying to acquire new members and struggle to emphasize the importance of our profession.
In 2008 the HSMP founded the medallion for Hungarian medical physics (Figure 5.). The medallion is given to a physicist whose life-work remarkably has contributed to the application of medical physics for patient care.

Tibor Major, Csilla Pesznyak, Pál Zaránd

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Presentation of the EUTEMPE-RX Project

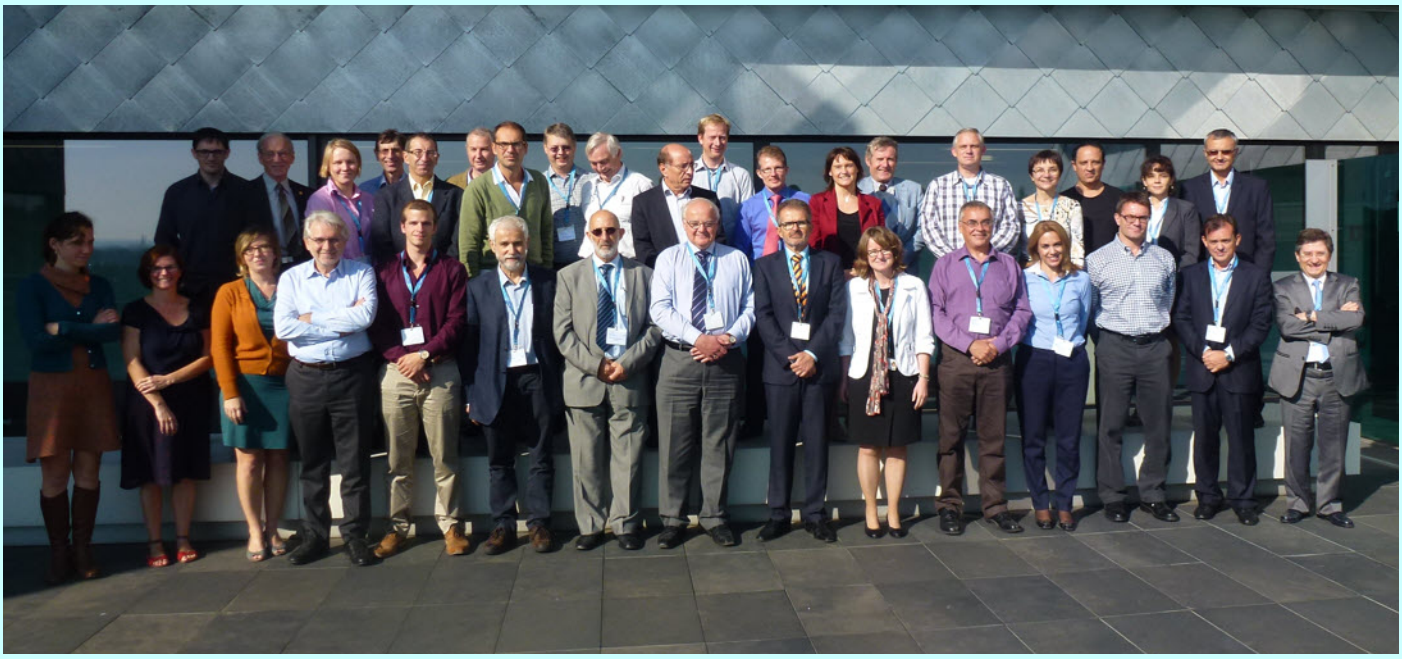

Figure 1: EUTEMPE-RX consortium during the kick off meeting

The impetus to develop further the role of medical physics experts (MPEs) in the area of diagnostic and interventional radiology has been reinforced in the draft of the Council of the European Union Directive laying down basic safety standards for protection against the dangers arising from exposure to ionising radiation (new European Basic Safety Standards or BSS) document. It follows from the steadily growing trend in the number of exposures for medical applications, the growing public awareness of the effects of ionizing radiation and the growing complexity of medical imaging devices and techniques both for optimization and for assessing dose and performance. In parallel to this, the 'European Guidelines on Medical Physics Expert' project has defined knowledge, skills and competences (KSC) for medical physics and stipulated EQF level 8 for the medical physics expert. In practice, most EC member states don't have the capability to offer a series of courses in medical physics in diagnostic and interventional radiology up to EQF level 8. The main goal of the EUTEMPE-RX project is to create a standard programme of courses for the medical physicist to be trained to EQF level 8. This will be achieved by the project consortium that groups teachers in European centres of excellence along with specialists in education and teaching and professional organisations. The project will develop 12 courses on a range of topics, with radiation safety and efficacy being prevalent in the course topics, and broadly covering the KSCs listed in the 'European Guidelines on Medical Physics Expert'.

The courses will target medical physicists in hospitals, industry and regulatory organizations, who are aspiring to be recognized as medical physics experts in diagnostic and interventional radiology as well as PhD students. The project will use modern technologies to make the courses more easily accessible via an on-line teaching platform, and will strive to get the courses accredited and make the programme sustainable. The ultimate goal is to raise the overall level of medical physics training in radiology in Europe, such that better patient protection and optimization can be guaranteed.

To ensure the quality of these courses, the EUTEMPE-RX consortium has created a network of European experts and also a scientific advisory board that brings into the project expertise from international organisations, industry and regulatory authorities. The knowledge-skills-competences that will be covered in the modules will be

Figure 2: EUTEMPE-RX consortium and advisory board discussing in the kick off meeting.

outlined and the courses will be quality assured through the development of a quality manual to ensure consistency across the modules and teaching at the requested EQF level 8.

The main projected outcomes of the 3 year project can be briefly summarized as follows:

- To develop and run courses that broadly cover the KSCs as defined in the 'European Guidelines on Medical Physics Expert' project. To ensure the quality of the course modules, a quality manager has been appointed and a quality manual will be developed.
- To set up an e-learning platform with online lectures, audio and video files, self-assessment tests, online discussion groups, etc. Using this platform face-to-face contact can be reduced making the courses more accessible and more sustainable. This platform will also run some preparatory sessions prior to the actual course modules. A website is under development to attract participants.
- To strive for a harmonization in Europe of the certification recognizing the achievement of the KSCs required for an MPE and accreditation of courses at EQF level 8

A business plan will be developed to address the issue of the sustainability of the project.

Hilde Bosmans, past-chairman
EFOMP Projects Committee

ECR 2014
Vienna
March 6–10

PRIMO: a graphical Monte Carlo system for linac and dose distribution simulation

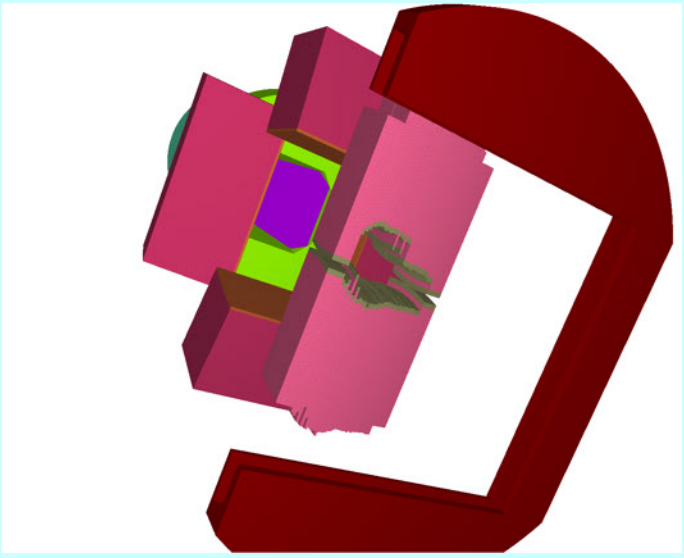

Figure 1: Image of the simulated geometry of a Varian Clinac 2100 C/D with a multileaf collimator 120 high definition.

Monte Carlo simulation is considered the state-of-the-art for the study of radiation transport problems in radiotherapy, in particular for modelling medical linear accelerators (linacs) [1]. Despite this fact, most treatment planning systems for external beam radiotherapy are still partly based on analytical methods to determine absorbed dose distributions in patients [2]. These analytical methods are faster to calculate but, in principle, less accurate than Monte Carlo algorithms. Simulation speed alone is not the only reason that has hindered the wide use of the Monte Carlo method in the daily clinical practice. The skill and effort required for linac simulation and the subsequent computation of the dose distribution in the patient also play a decisive role. The process involves coding the linac blueprints into the Monte Carlo system, preparing the physics configuration files, programming variance-reduction techniques to reduce simulation time and, finally, processing the obtained results. Thus, the medical physicist willing to embark into a simulation project should be versed in computer programming, in stochastic and numerical methods, and in radiation physics.

To surmount the aforementioned difficulties we have developed the computer program PRIMO [3], which is based on the well-known Monte Carlo code PENELOPE [4]. PRIMO simulates radiation fields produced by a variety of Varian (600 C, 600 C/D, Unique, the series 18, 21 and 23, and TrueBeam) and Elekta (SL/i and MLCi series) linacs (figure 1) [5].

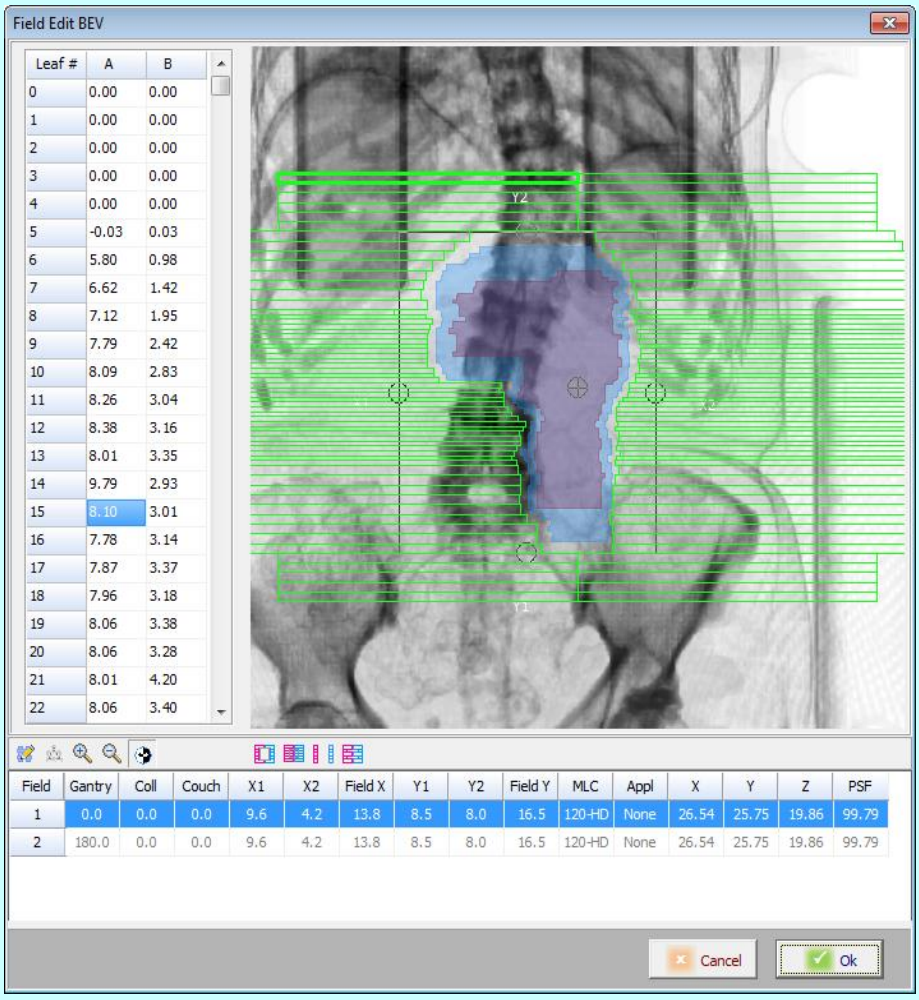

Figure 2: Screenshot of PRIMO depicting the beam's eye view of the irradiated field conformed with the Varian multileaf collimator 120 high definition. The field appears superimposed to the digitally reconstructed radiograph of the patient.

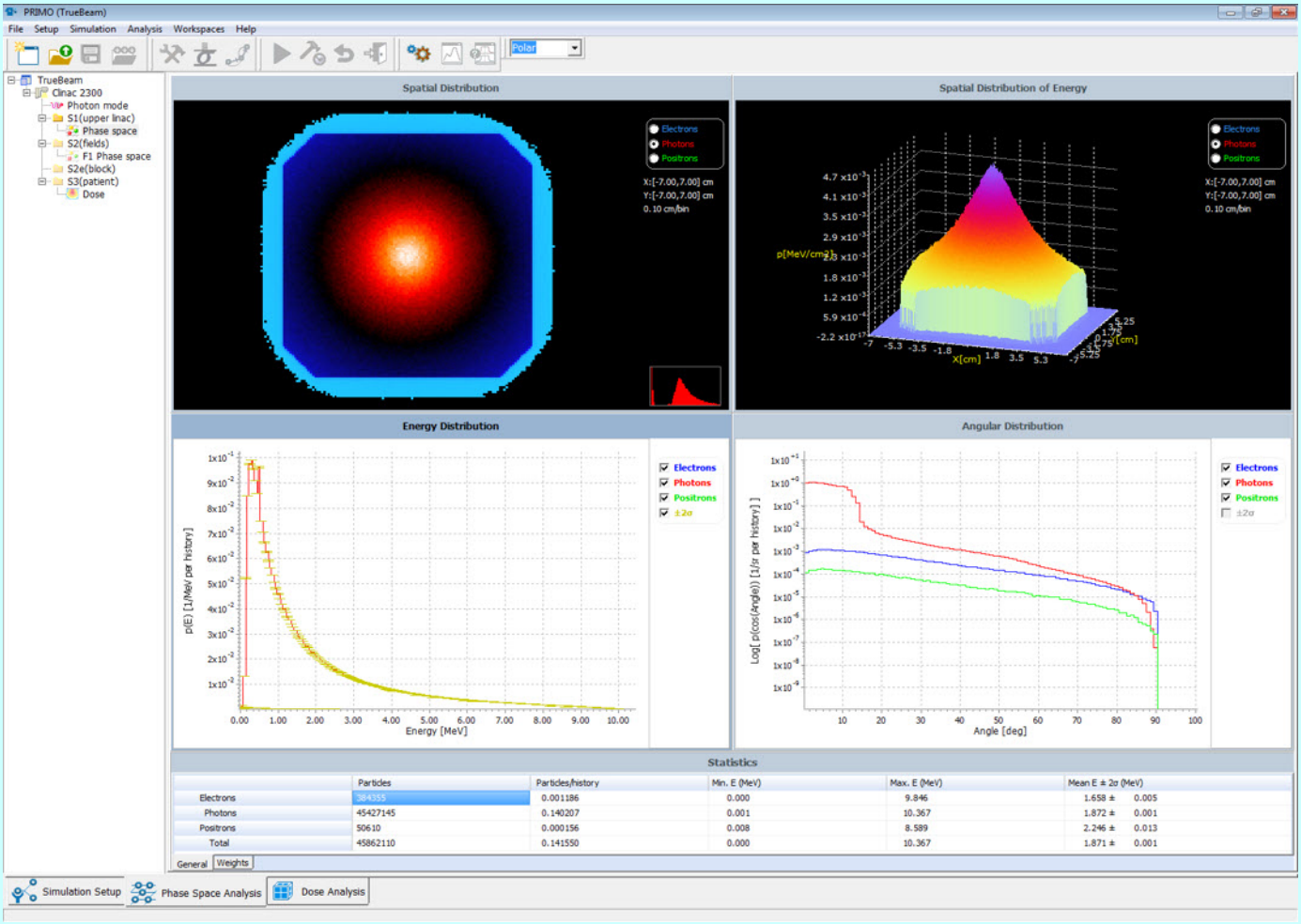

Figure 3: Phase-space file analysis window of PRIMO showing the characteristics of the TrueBeam phase-space file distributed by Varian.

Computed fields are employed to estimate dose distributions in water phantoms or computerised tomographies. DICOM-CT images and structures from an external treatment planning system, described using the DICOM-RT STRUCT standard, can be imported into PRIMO. If desired, structures can be delineated using the provided graphical tools (figure 2).

PRIMO can exchange data with other Monte Carlo codes via import and export of phase-space files written in the International Atomic Energy Agency (IAEA) format [6]. These phase-space files are a detailed description of intermediate radiation fields. The program contains a set of tools for the numerical and graphical analysis of both, phase-space files (figure 3) and dose distributions. Absorbed dose results are presented as 3D distributions superimposed to the computerised tomography volume for phantom. Experimental data from a dosimetry system can be imported for comparison, using the gamma test, with simulated results (figure 4).

To increase simulation speed we developed a set of dedicated variance-reduction techniques that are automatically applied. In addition, PRIMO can distribute the computing load in up to 24 processing cores of a single computer.

Simulation time required in most cases for the patient-dependent part (movable jaws, multileaf collimator/electron applicator and dose estimation) takes from 2 to 3 hours on a desktop computer with 8 processing cores. In that time, an average standard statistical uncertainty of 2% is reached using voxels of 2x2x2 mm^3.

PRIMO wraps all these features under a user-friendly graphical interface. The end result is a program that handles the process of preparing, executing and analysing the simulation of a linac and the computed dose distribution without requiring any previous knowledge about the Monte Carlo method or the geometrical details of the simulated linac. In a nutshell, PRIMO is an automated, fully Monte Carlo-based, linac simulator and dose estimator, which is both user-friendly and self-contained. PRIMO is free software that runs on Windows (XP and above). The code can be downloaded from the webpage http://www.primoproject.net.

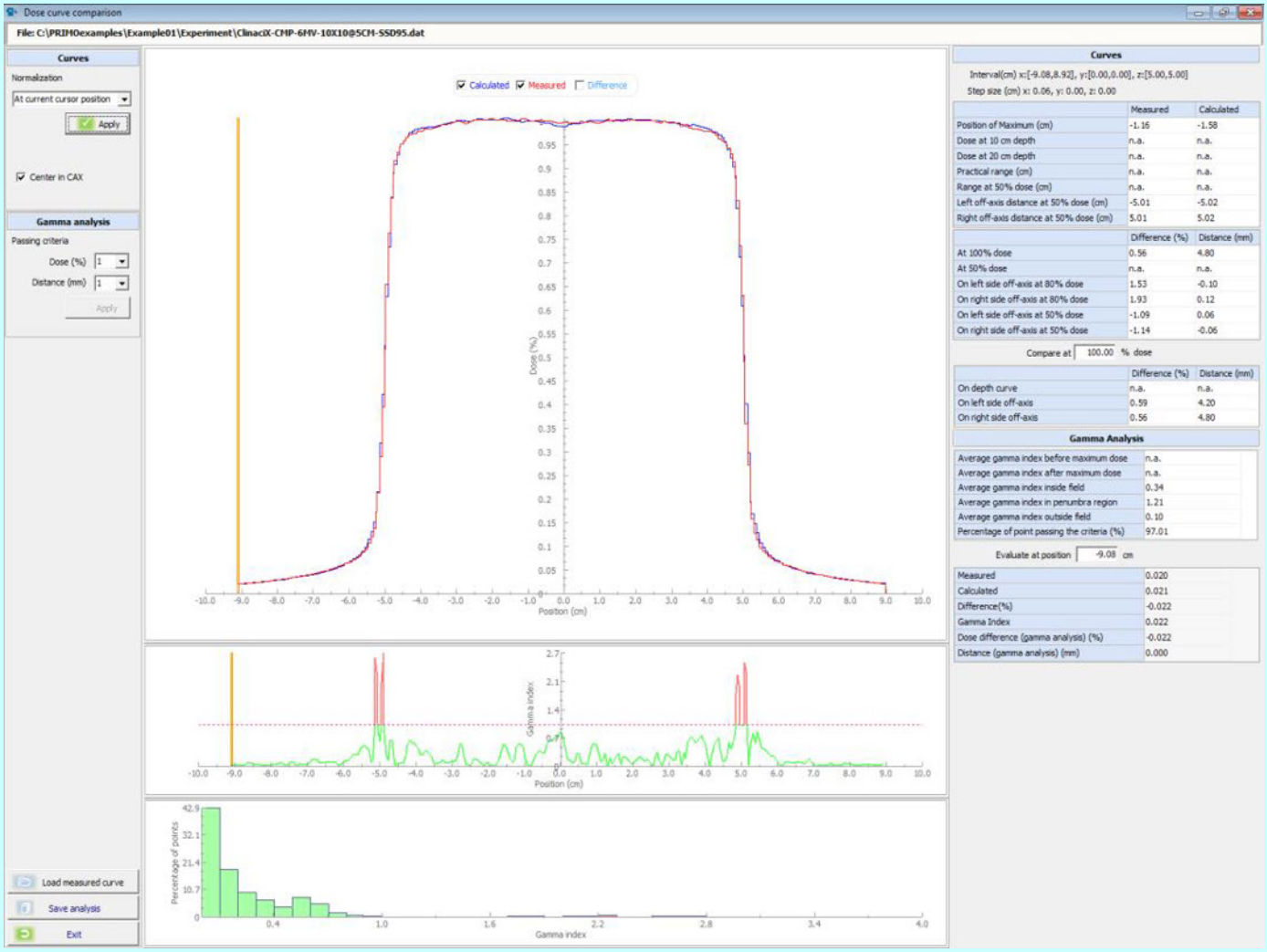

Figure 4: Comparison of simulated and experimental lateral profiles for a Varian Clinac iX for a 10x10 cm^2 field.

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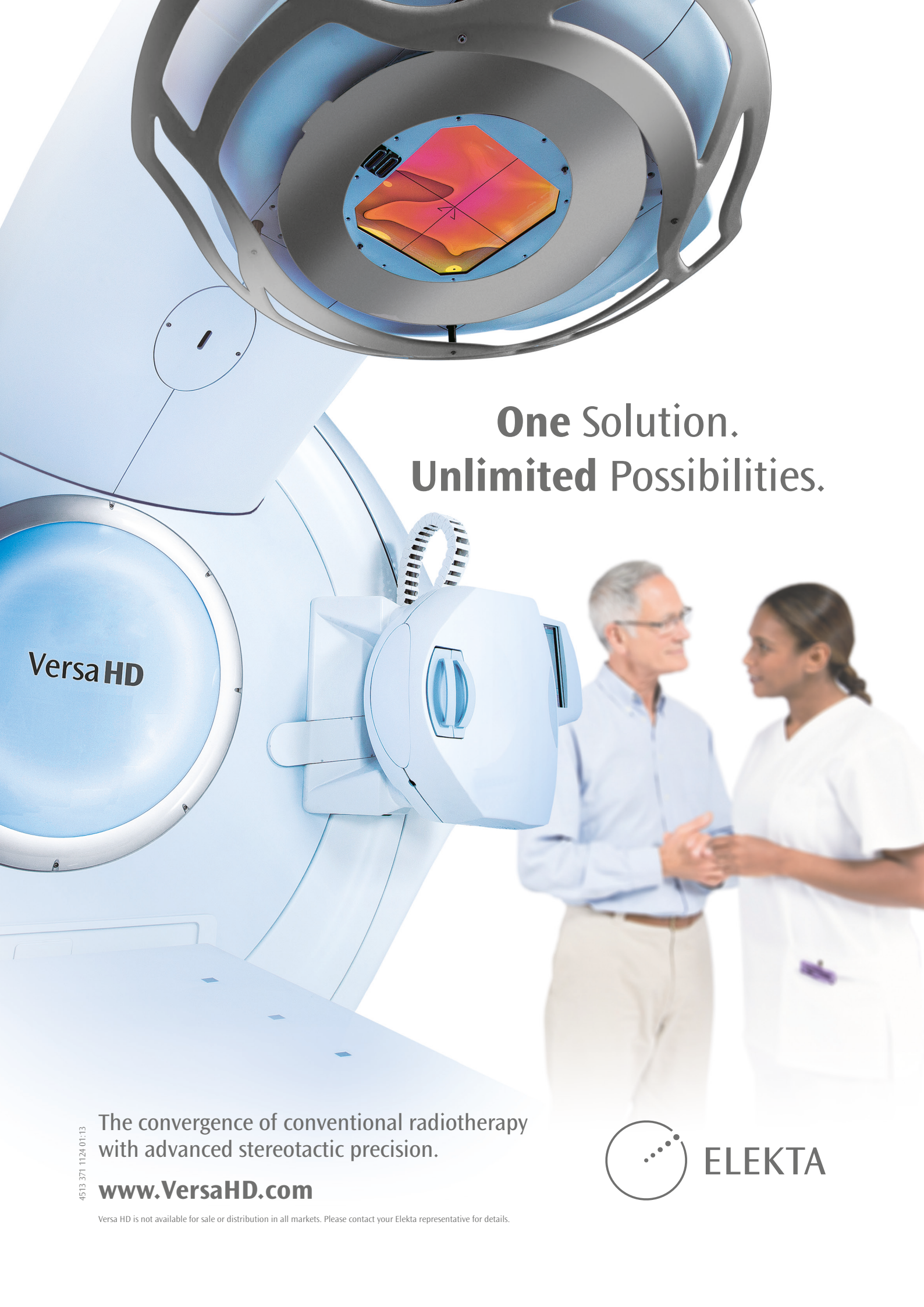

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An interactive dose calculator & simulator for risk management in interventional radiology

Radiological risk in interventional radiology

Radiation protection has always been a strong issue in interventional radiology. These past years, several severe accidents (Balter 2010, Koenig 2001) reminded us painfully that protecting patient and workers is essential, though difficult task:

- There is more and more high dose (and high risk) procedures for patient, due to incredible progresses in radiation imaging instrumentation and image guidance - probably saving more patient, but significantly increasing patient dose;
- At the same time , dose to workers is also increasing, with a special attention of the dose to the eye lens these past years (Jacob 2011);
- There is huge heterogeneity among clinical protocols, devices, patients… and thus radiation dose to both workers and patients is known to be very dependant on local practic
- Last, in our knowledge, there is currently no commercial system able to provide a robust metric, such as peak skin dose or dose to organs, with enough confidence.

In France, the french nuclear safety authority conducted a deep analysis of declared accident in interventional radiology, and provide interesting arguments for a deeper involvement of professionals in these subjects ; they found that there is both a lack of radiation protection culture, too little training, insufficient dose optimization due partially to poor knowledge of technology, and poorly adapted patient follow-up.
The path to improved radiation protection is thus very clear, and the challenges of radiation safety in interventional radiology is two-fold:

- Enhancing professionals skills and knowledge on good practice of radiation protection;
- Providing medical staff with robust metrics, such as skin dose map and peak-skin dose in order to improve patient follow-up, especially after complex procedures.

Added value of simulation-based learning in medicine

Being a medical physicist or radiation protection officer in interventional radiology is not an easy job : being one among many risks for the patient, radiation protection is often not a priority, which is understandable in a context where patient regularly faces instant death or injury. Thus, optimizing doses and procedures is a very difficult task because of room availability, no possibility to train in clinical setting, difficulties to perform measurement, etc.
This context is not unique when facing risk management, and the first and easiest example that come to mind is the training of pilots aircrafts, where of course, no experimentation is possible. Back in the 70‘s, this domain was thus one of the first to develop a comprehensive training based on simulation for pilot - so-called Crew Ressource Management. The flight-simulator concept may have played a significant role in the huge drop in commercial flight accident (see figure 1).

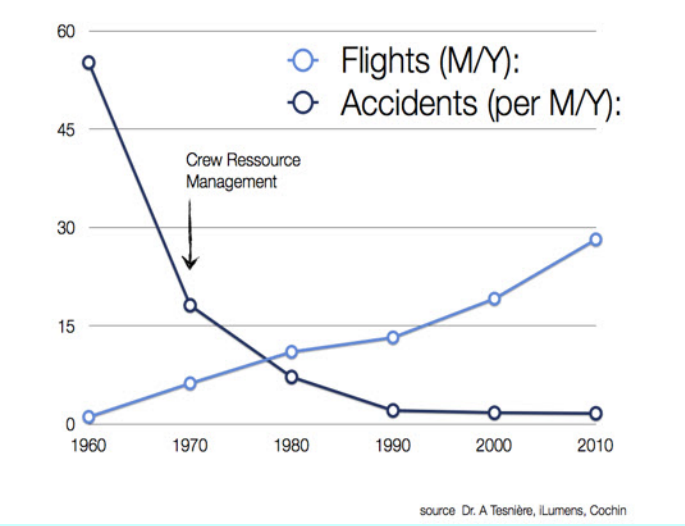

Figure 1: Trend of flight accident vs. number of flights and introduction of Crew Resource Management using simulation.

Simulation-based learning is now recognized has a valuable tool for teaching in medicine and the field of medical physics have seen the development of various examples of virtual tools, one of the most known being the VERT software for teaching and learning in radiotherapy (http://www.vertual.co.uk/). Some experiments were also reported in C-arm radiology with interesting results (Bott 2008, Bott 2011).

The benefits of simulation based-learning are endless :

- Opportunity for beginners to practice on a range of scenario;
- Using the tool during "free time", outside the operating room;
- Error-based learning;
- Use relevant and objective metrics to evaluate professional practices and standardize skills;
- Testing based on competence criteria instead on training time;
- Form the whole team, especially on difficult procedures, and evaluate the non-technical skills;
- And, of course, opportunity to train "in silico".

A tool dedicated to dose calculation and learning in interventional radiology

The esprimed simulator em.SIM (V1.0), jointly developed by a french medical physics start-up, esprimed, and the french nuclear energy agency (CEA-LIST) is a calculator and a virtual reality simulator that is able to accurately represent an interventional radiology operating room. It allows to calculate the dose to the patient and staff in two ways:

- A first Monte Carlo engine calculate accurately and precisely a personalized patient dose (dose to organs, skin dose map, peak skin dose) to improve patient follow-up and document its medical records,
- A second Monte Carlo calculation engine provide interactive real-time dose at any point in the room in a virtual environment and realistic clinical settings.

em.SIM is thus both :

- An advanced and powerful training tool that aims at improving the knowledge of professionals about the actual radiation risks, by allowing us to practice and evaluate the best ways to reduce them;
- A clinical evaluation and calculation tool that provide detailed information about the dose to patient and especially the skin dose map and peak skin dose

Organs	Dose measured using OSL*(mGy)	Calculated dose (mGy)	% Difference
Thyroid	1.986E-01	2.24E-01	12.8%
Clavicle	5.976E-01	6.13E-01	2.6%
Lung (in the field)	5.946E-01	5.63E-01	-5.3%
Thymus	1.393E-01	1.54E-01	10.5%
Lung (out the field)	1.798E-01	1.88E-01	4.6%
Rib	7.624E-01	6.67E-01	-12.5%
Heart	1.898E-02	1.93E-02	1.7%

Table 1: Dose measured with Optically Stimulated Luminescence detectors (* corrected for energy) and calculated with PENELOPE in em.SIM. the X-ray filed is projected toward the heart wall (typical cardiology angle)

How it works

em.SIM propose a fully interactive Interventional room, with all the degree of liberty of an actual fluoroscopy system.

The software is controlled via a tablet, a pedal with fluoroscopy and fluorography (similar to those found in clinical practice) and a "3D mouse" to manipulate the protection device (lead screen). This setup is described in figure 2.

A scripting option allows to describe a complete intervention, based on regular dose reports (kV, mA, s, typical instruction OAD/OAG, angles, table height..), workers position and movement, and then play the intervention. An example of typical clinical situation is given in figure 3.

The user has the opportunity to position a dose measurement sphere anywhere in the room ; during the intervention, the system display both dose rate and total dose at that point.
Using the same type of information, em.SIM can also reconstruct a 3D map of the dose distribution, allowing to derive easily the peak-skin dose and skin dose map. This calculation engine is based on PENELOPE, and needs more computing power, so at this time the calculation is performed on a server if one wants to.

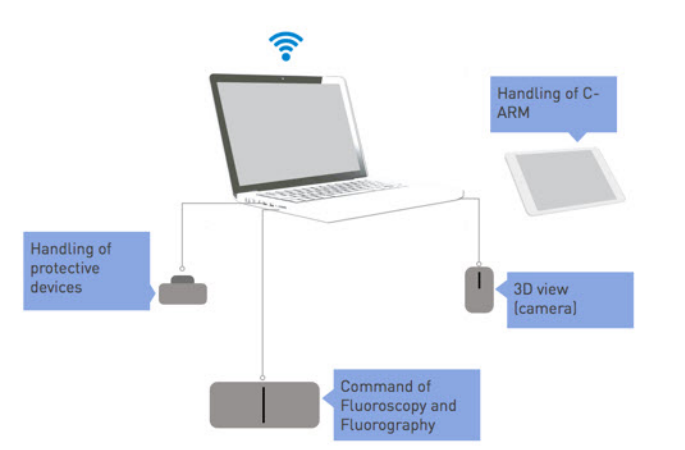

Figure 2: Setup for the em.SIM simulator.

Detailed patient dose for optimization and follow-up of post-interventional dose

em.SIM uses a validated model of the X-ray tube developed based on the PENELOPE Monte-Carlo code. Any tube can be modeled, using public data available on the classic spec sheet, or the user can choose to use a standard X-ray-tube.
Using standard data (kV, mAs, angle, field size, etc.) and, ideally, a DICOM RDSR file, em.SIM is able to calculate the dose in a voxel geometry based on standardized anatomy, or actual patient CT images.
Then, em.SIM provides all the key elements - to adapt patients follow-up : the Peak Skin Dose

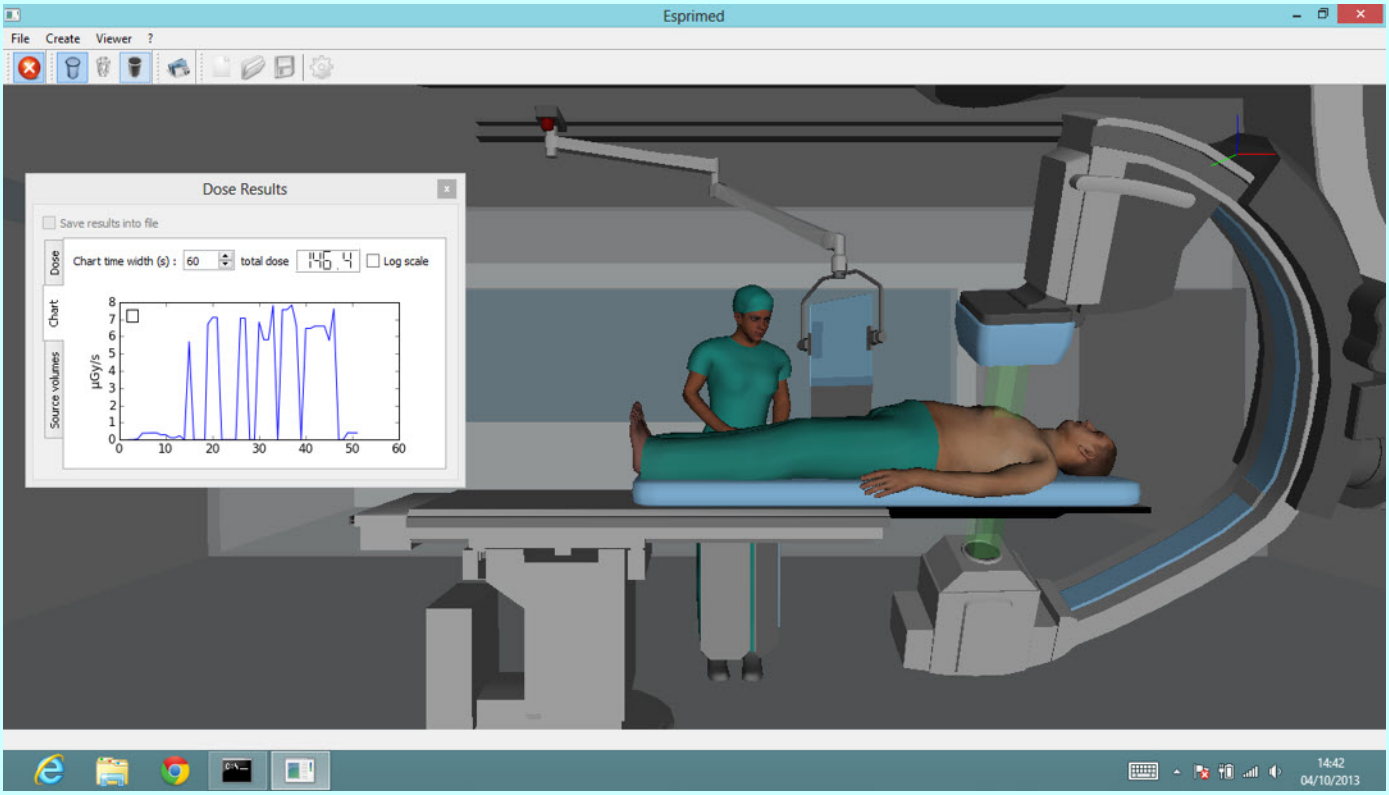

Figure 3: Typical configuration for the evaluation of a cardiologic procedure : the tube configuration and practitioner can be seen on the right, while the dose rate and total dose to the eye lens of the F workers can be seen on the left. © esprimed SAS.

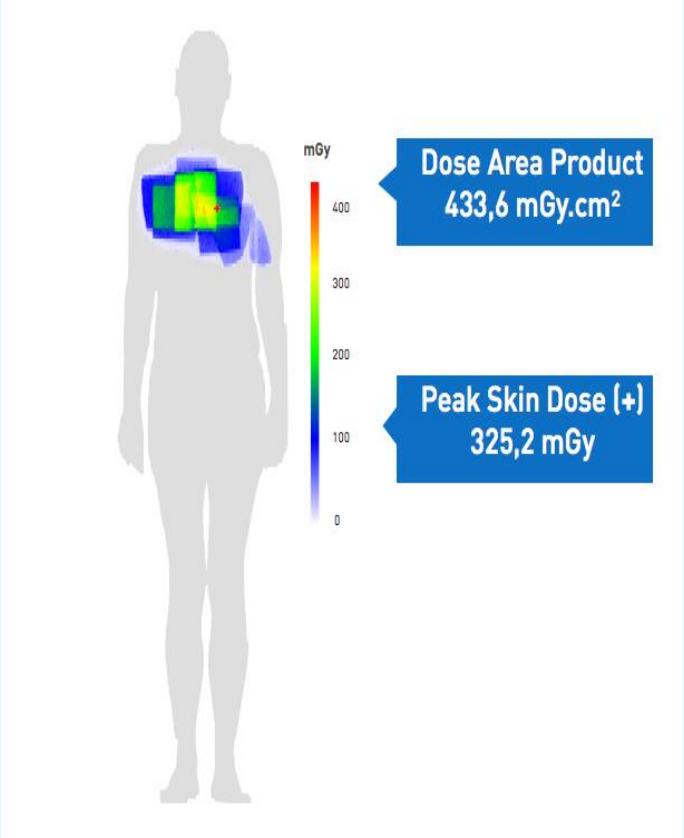

Figure 4: Skin dose map and position of the peak-skin dose calculated using em.SIM for a typical cardiology exam © esprimed SAS.

and the skin dose map, as recommended in international guidelines (Stecker 2011).

An example of skin dose map and peak-skin dose calculation is given in figure 4.

Fem.SIM is also able to provides an estimation of organ doses, although this data is only relevant for those who want to sum the dose from different exams. As well, it would be necessary to obtain such quantity from other devices, which is widely available at this moment.

The PENELOPE MC code has been validated against measurements in an anthropomorphic phantom and results show a good agreement for point located in the field (see table.).

The interactive calculation has not been validated yet, but a set of measurement is currently being collected in clinical conditions in order to fine tune the algorithm. The em.SIM virtual radiology system will be carefully evaluated in clinical settings, and a comprehensive set of clinical cases is expected soon. By now, em.SIM is currently able to calculate any skin dose map based on actual dose reports.

Perspectives

Our aim is to provide users with detailed information about their practices, local doses references, and help them to optimize both dose to workers and dose to patient. Our ambition is to give the user the power to deeply investigate its practice, train staff, and improve patient follow-up after intervention when necessary. Simulation-based learning using em.SIM should simplify the radiation protection process, by giving users instant knowledge about dose metrics in a clinically realistic setting.

We believe that simulation-based learning can be game-changing in medicine, and particularly in medical physics, by hiding physics complexity behind simple but reliable tools. We expect em.SIM to be a significant step forward

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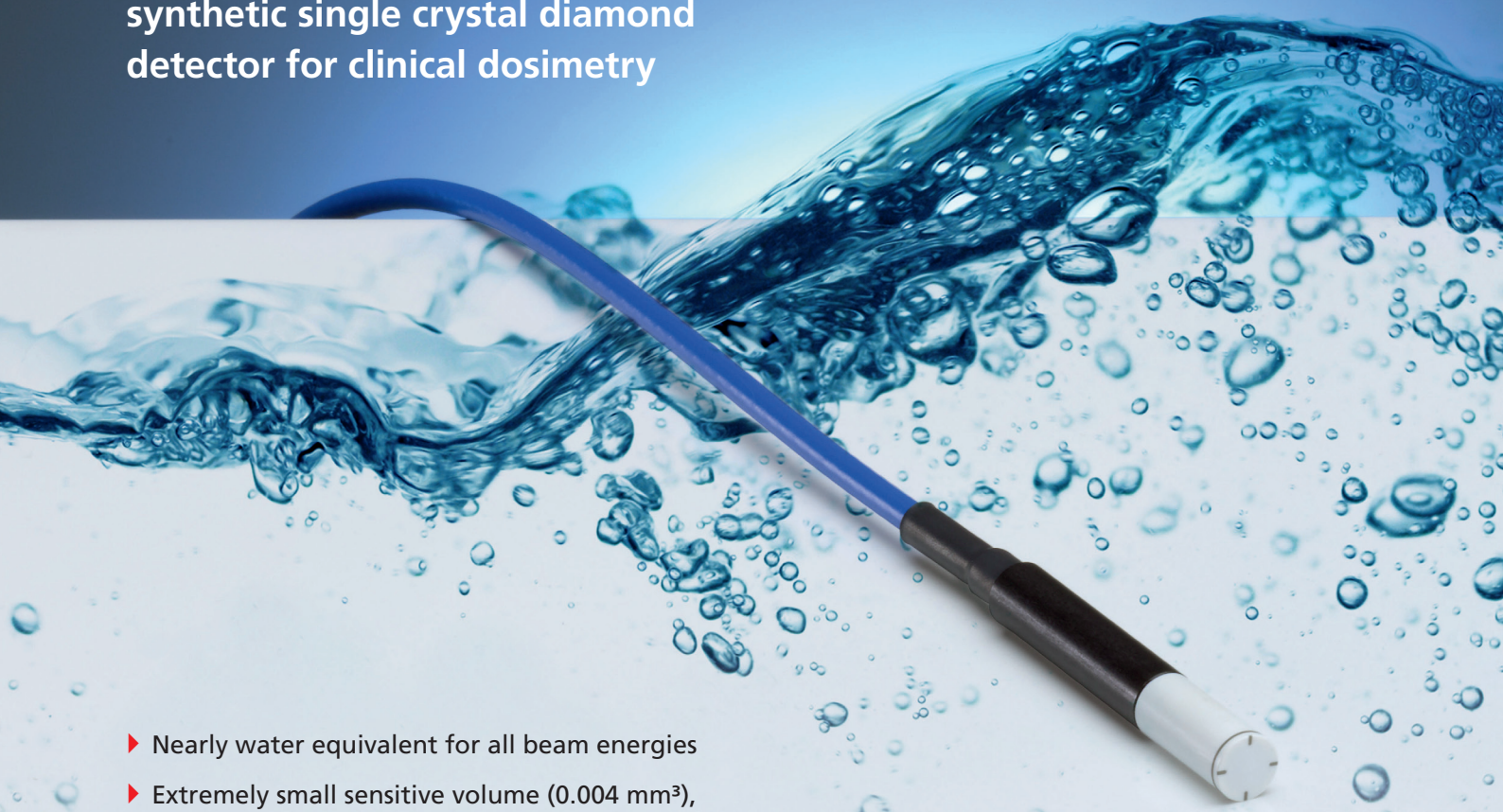

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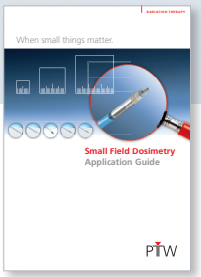

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Knowing what responsibility means

Interview with Ben Mijnheer

Núria Jornet: When and why did you decide to become a Medical Physicist?

Ben Mijnheer: In fact, I went first for a BSc degree in Chemistry. I was always, even as a child, very much attracted by Chemistry because of the sudden changes in properties of materials when different compounds were mixed. After that I chose for an MSc study in Radiochemistry. That decision was greatly influenced by my fascination for performing experiments guided by detection of only a few radioactive atoms. So, I didn't go directly to Medical Physics or Physics. However, when I moved to Radiochemistry and I started to do my experimental work in the Institute of Nuclear Physics Research in Amsterdam, I noticed that the inter-phase between Chemistry and Physics was a fantastic area of research. My professor in Radiochemistry suggested me to do my PhD thesis study in Neutron Physics. After getting my PhD I went two years as a postdoc to Belgium to work in the Central Bureau of Nuclear Measurements of Euratom. In this institute high precision measurements were performed for standardisation purposes, but it was outside the academic environment.

While I was there, a project on neutron therapy started in Amsterdam in the Netherlands Cancer Institute. It was in the early 70s and everybody at that time thought that neutron therapy would be an important treatment modality in the future. Because I had a PhD in neutron dosimetry I was offered a position to work on this project. It was there where my Medical Physics career started, and since then I have worked all the time in a hospital as a Medical Physicist.

Figure 1: Ben Mihnheer teaching.

You have always been very active in the European Society for Radiation Oncology (ESTRO); how did you become involved in ESTRO activities?

My contact with ESTRO started in 1983 when I was co-organisor with Hans Svensson of the physics programme of the second Annual ESTRO Conference in Bordeaux, France. Later in 1985 I was asked by the course directors, Hans Svensson and Andrée Dutreix, to contribute as a faculty member to the first Course on Physics for Radiation Therapy, in Leuven, Belgium.

Another event that was very important for the role that Medical Physicists would have in ESTRO was the start of the combined ECCO-ESTRO meetings in 1991. The programme of that meeting had only very few topics of interest for Medical Physicists. Emmanuel van der Schueren, who was ESTRO president at that time, accepted our proposal to have that year a separate meeting only for Medical Physicists. That's how the ESTRO Biennial Physics Meetings in Clinical Radiotherapy started. Emmanuel van der Schueren always gave a chance to physicists in ESTRO to start new things. He respected Medical Physicists and was convinced that Radiation Therapy needed a multidisciplinary team of people with different knowledge and background to grow and develop.

Has there been any person that has had a special impact on your career?

The first person I am thinking of was Professor Aten, my mentor and PhD supervisor at the Institute of Nuclear Physics Research. He had worked in several leading scientific centres in the world including Columbia University and Johns Hopkins University in the US, and the University of Copenhagen in Denmark. He worked with scientists that had won the Nobel Prize like Harold Urey, György von Hevesy and Niels Bohr. He was a kind of universal scientist and had a broad

vision on many issues. Together with the Philips Physics Laboratory a cyclotron was constructed in Amsterdam and Professor Aten and his group discovered there at least 20 new radioactive isotopes. He was not only involved in "isotope hunting", the chemistry of radioactive products and neutron physics, but was also curious in studying pieces of silver art, old coins and meteorites with non-destructive activation analysis techniques. He had a broad view on many aspects of life and was the person who had a very special impact both on my professional and personal life.

Do you remember any situation or fact that was a key issue in your career as Medical Physicist?

Yes, there were several but a very important situation was the period that I had my first contacts with patients. When you do measurements in a lab you are mostly on your own with your equipment. Then, quite suddenly I went to a clinical environment, working with many people of a completely different, often non-academic, background. I still had to do a lot of experiments in the hospital because we didn't have much experience in clinical neutron dosimetry at that time. But the next day the patient was there and had to be treated in that room. When I started I didn't know if I could cope with that new situation: leaving a laboratory environment and then working with patients. At that time there was no Medical Physics training programme to prepare you for such a situation. I thought "If I can stand the pressure of patient treatments, then I can handle this job; if not I should quit".

Figure 2: Ben Mijnheer's not alowed to photograph

When we started patient treatments with neutrons the RTTs refused to help. They didn't want to treat patients with neutrons because in their opinion it was not their responsibility as it was part of a research project. So, the first 50 patients were planned and irradiated by myself and a colleague. In that way I started as a Medical Physicist and obviously I could handle that situation. That was a very good learning process. I do think that it is very important for a Medical Physicist to be involved in the actual patient treatment at the accelerator. To develop skills not directly related to Physics should be an essential part of their training.

If you had to choose one of your contributions to the Medical Physics world that you feel particularly proud, what would you chose?

I would choose my contribution to the process of going from 2D to 3D radiotherapy and after that to IMRT in my institution. I am really happy that a considerable part of my professional career coincided with these key developments in radiation oncology. Discovering the new possibilities, but also the limitations, of new treatment planning and treatment delivery technology was, and still is, a continuous challenge. I feel privileged that I could add to these advances, particularly to the safe clinical implementation of this new equipment. Then, by means of courses and projects organised by ESTRO, IAEA, and the EU, I could do this not only in my own hospital but also at an international level at many places in the world.

If you could go back in time, would you change anything from your professional life?

Well, there were a few things that went less good… But if I have to choose one, it would be trying not to do everything by myself. When I was head of department, I had to spend quite a lot of time trying to solve problems that were not directly related to Medical Physics, such as difficulties in human relations, people that did not function well, complaints about working conditions, personal problems… I have not enough patience for that. Now, I would do it in a more professional way and would ask for help to solve these issues.

You've been head of the Physics Department of the Netherlands Cancer Institute in Amsterdam, where a lot of research is performed. Should

Research Physicists and Medical Physicists work independently?

It is not good to have a complete separation between research and clinical work in a hospital. In a clinical environment you need projects that are clearly linked to patient treatments. In such an environment research should be focused on issues that can be applied in the next three or four years and not on what might be beneficial for patients in ten years time. Also there is a potential danger if you have two different physics groups, one for research and another for clinical work, that findings from the research group will not quickly be put into clinical use. On the other hand Medical Physicists should also profit from the early availability of these new tools and not wait till they are commercially available. Ideally Medical Physicists in larger institutions should have an opportunity to work part-time on applied physics research projects.

Is there any particular moment in your career that you remember?

There are many of course in such a long period that I work as a Medical Physicist…. I just want to mention one that was not so spectacular but had a considerable impact on my way of working. At the beginning of the neutron therapy project we were with two persons doing all the routine quality assurance (QA) measurements ourselves. At a certain point, as usual at 11 o'clock in the evening or later, when removing all measuring equipment, I thought that this is not a good modus operandi. I should not do that too often; we need more persons to do this type of QA work. We have to create a system so that routine tasks could be delegated to physics co-workers, technicians, RTTs and other people. By doing so, Medical Physicists would be able to spend more time on the implementation of new treatment techniques and new technologies, and supervising routine measurements performed by others instead of doing this work by them self.

Are there things that changed your point of view when you became more experienced?

When starting as a Medical Physicist I thought that radiotherapy in the private sector was not a good approach; the type and quality of a radiotherapeutic treatment should not depend on financial issues. In many countries radiation oncology is for a (large) part a commercial process where money plays an important role, and not all patients can get an optimal treatment. On the other hand thinking that you can treat all patients with the best available technique is also not achievable in practice. Somewhere you have to find equilibrium, and now I see that this is not a black and white situation. It would be nice if international organisations, or some very rich people, could finance radiotherapy for patients that cannot afford these treatments in countries where the health system is not public.

How do you see our profession in ten years time?

Tricky question… A lot of things are still at the lower end or middle part of the learning curve, such as the implementation of Adaptive Radiotherapy (ART) or Volumetric-Modulated Arc Therapy (VMAT). On one hand, I think we should accept that in ten years time many of these techniques will become more or less routine practice. So a lot of the efforts now of Medical Physicists to become familiar with this technology will be reduced when those procedures become standardized practice. But at the same time new approaches using advanced technology such as proton and carbon ion therapy have to be implemented. Another long term challenge is to integrate imaging and radiobiology into routine clinical practice. We should not underestimate the time Medical Physicists and Research Physicists need to become familiar with the possibilities of these techniques and to safely implement them into Radiation Oncology. Also I know from my clinical experience that the factor unexpected is always bigger than you expect.

What about Adaptive Radiotherapy?

This is one of the areas where we don't know yet the answer. When and how should we modify a treatment? It is somewhat bizarre that we are looking to differences of a few per cent or a few mm between planned and measured dose distributions during so-called patient-specific phantom measurements, when we know that for the same patient during a series of fractions anatomy changes cause much larger differences. Basically we don't know yet how to handle that problem in a routine way in the clinic. When are we making a new plan taking the adapted anatomy into account? Nowadays, in clinical routine, the answer would in most cases be "not very often". We need new tools for this. This is probably one of the most challenging things in the near future; how to manage anatomy changes during a series of treatments in an automatic and non-time-consuming way. Adaptive Radiotherapy may not fundamentally change the success of radiothera-

py but it will certainly improve what we are doing in the clinic for an individual patient.

What do you think about the movement of Medical Physicists towards biology?

I am afraid that the role of Medical Physicists in biology can only be modest. Besides their role in understanding and implementing biological models in treatment planning and performing, for instance, small animal studies, I don't think they can contribute a lot to Radiobiology in the near future. There are many things in Radiotherapy we still don't understand and Radiobiology is very important to identify this missing knowledge. However, these fundamental biological processes are very complex and need study at the molecular level. It will take probably a long time before Medical Physicists will be able to use this knowledge in the clinic.

Free movement of Medical Physicists in Europe; is it a dream?

The main problem in Europe for the movement of Medical Physicists is that we have different national languages. Even if we agree on a common curriculum for medical physics education and training, the different languages will be a barrier when you are going to work in another country. We might however think of other movements of Medical Physicists in Europe. It might for instance be an attractive option to introduce a sabbatical half-year so that Medical Physicists could easily move to a department in another country, preferably on a mutual base, to exchange knowledge and clinical experience. That would broaden the mind of these Medical Physicists and the people in the host institutions, and may also help to standardize clinical practice in Europe.

Figure 3: Ben Mijnheer photograping in the Phoenix/USA botanical garden.

Three advises to young Medical Physicists

First, if you plan to work in Radiation Therapy you should realise that you are not only performing calculations or measurements with sophisticated equipment, but also have to cope with treating cancer patients. Can you handle that situation? If you are research minded, and if you feel shy of patient contact, then you should not work in a hospital as a Medical Physicist.

Second, you have to accept that your work is always a compromise between the quality of a solution for a specific problem, and how quick you have to solve that problem; in other words, you are a "problem solver" and have to accept to live with non-perfect solutions.

And last but not least, you have to deal with many different people, medical doctors, radiation therapists, engineers, IT people and a lot of others. They often have a completely different attitude to working in a Radiotherapy Department and diverse professional background. So be prepared to appreciate that situation otherwise you will become soon frustrated.

What are your hobbies?

I like meeting and having contacts with people from different countries. It broadens your interest on what is going on the world in a very direct way. It is also one of my motivations for teaching at international courses.

I love photography and during my whole life I was making pictures and going to photo exhibitions. I also had during a long time a dark room at home to develop and print my own pictures. There was even a moment when I was a student at the university to give up my study in Chemistry and to start a career as a photographer. Obviously Chemistry and photography have some overlap. I still like to look at objects, but also at problems, from different angles. Art and science go often together…….

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Info: www.aapm.org/meetings/2014SCM/

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Info: www.estro.org/congresses-meetings/items/estro-33

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Info:www.americanbrachytherapy.org/meetings/

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Info: www.eu-alara.net/

19-24 May 2014
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Info: siim.org/siim2014/meeting/welcome-siim-2014-annual-meeting

27–30 May 2014
The Second International Conference on Radiation and Dosimetry in Various Fields of Research
Nis, Serbia
Info: www.rad2014.elfak.rs

29-31 May 2014
6th AAMP Meeting.Alpe-Adria Medical Physics Meeting
Budapest, Hungary
Info: www.alpeadriamp2014.eu/

30 May-2 June 2014
2nd International Conference on Radiation Protection in Medicine
Varna, Bulgaria
Info: rpm2014.org

23-27 Jun 2014
4th European IRPA Regional Congress
Geneva, Switzerland
Info: www.irpa2014europe.com/

20-24 July 2014
AAPM 56th Annual Meeting
Austin, TX USA
Info: www.aapm.org/meetings/

27-30 August 2014
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SGSMP - ÖGMP - DGMP
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Info: www.medphys-kongress.de/

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Info: www.efomp-2014.gr/

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Info: rsna.org/

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