Course book

MEDICAL PHYSICS SHORT COURSE

21.-22. June 2002
Ljubljana, Slovenia

EFOMP

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EFOMP

Medical Physics Short Course

ROLE AND STATUS OF MEDICAL PHYSICISTS,
DIAGNOSTICS & NUCLEAR MEDICINE,
NEW DEVELOPMENTS IN TELETHERAPY

and

Joint Meeting
of Medical Physics Section
of Slovenian Biophysical Society

&

Österreichische Gesellschaft Für Medizinische Physik

21.-22. June 2002 Ljubljana, Slovenia

Onkološki Inštitut Ljubljana
Institute of Oncology Ljubljana

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Dear participants,

We are honoured and pleased to welcome you to the EFOMP Medical Physics Short Course in Ljubljana.

Medical physics in diagnostics, nuclear medicine and therapy using ionising radiation, as well as in new modalities like MRI are growing in importance every day. Although the role of medical physics is not the same in all European countries, we are convinced that, without the support of physicists, medicine would lack quality and new developments. The main objective of EFOMP is to harmonise and promote the best practice of medical physics in Europe, to keep our profession on a high level and to establish new standards with regard to new developments. We hope, that this course will contribute to the improvement of your knowledge and skills.

Sophisticated techniques and new developments demand a profound knowledge in various fields of medical physics. Our explicit commitment should always be to spread this knowledge among and share it with colleagues all over Europe, and to ensure that all borders will be open to medical physics now. We hope our course will enrich your knowledge. At the same, this event is a unique opportunity to discuss medical physics issues of specific interest and significance and to make new friendships!

We wish you a pleasant and memorable stay in Ljubljana.

Božidar Casar
Werner Schmidt

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QA in Mammography[1]

A. Noel
Centre Alexis Vautrin Medical Physics Department, Nancy, France

The success of mammography especially for screening depends on the production of high-quality low-dose images. Production of such images is a complex and difficult task.

A French Committee, known as G.I.M., consisting of Radiologists, Medical Physicists, Bio-medical Engineer interested in mammography have formulated recommendations for the Quality Control of the Technical Aspects of Mammography Screening.

In order to ensure that high-quality low-dose mammography images are produced consistently, thus providing the best images possible for a dose »as low as reasonably achievable«, it is essential to set-up a quality control programme at each mammography site. The quality of technical aspects and their measurements are defined. The recommendations give a detailed description of the quality control tests which should be carried out and include acceptance limits for each technical parameter. The frequency of each test is clearly stated. Furthermore responsibilities of the Radiologist, the Technologist and the Medical Physicist are stated.

An active quality control programme will minimise but not completely eliminate problems. It should be stressed that quality is a philosophy and should be continuous. That is why radiologist and technologist must look at every film with quality control in mind. The recommendations formulated here are applicable to all mammography units.

1 Recommandations du Groupe Interdisciplinaire de Mammographie (G.I.M.) sur l'assurance de qualité en mammographie.
H. BOUHNIK, I. DESQUERRE-AUFORT, A. NOEL, J. STINES
Rev. Im. Med. (1994) 6 : 447-454

Optimisation of protection in interventional radiology

R. Padovani, G. Bernardi, A. Peterzol, E. Quai
S. Maria Hospital, Udine, Italy

Interventional cardiology (IC) procedures are the most frequent invasive radiological procedures and they have the potential for high patient and staff exposure; the largest number of reported patient skin injuries are from IC due, both, to the highest number of procedures performed and to the fact that they are mainly performed by cardiologists, with, in general, not sufficient knowledge of imaging technology and related radiation protection aspects.

Influence on patient and staff doses of technical and methodological parameters adopted are presented.

Typical patient and staff doses and maximum skin doses in IC procedures are discussed. Reference levels can represent an useful tool for exposure optimisation; methodologies, to extend the concept from simple to complex procedures, are discussed. Reference levels, in term of dosimetric and technical quantities, can be correlated with the procedures complexity; the proposed method and the results from DIMOND consortium are presented.

For the purpose to prevent deterministic injuries, the maximum skin dose must be assessed for patients submitted to long, complex and/or repeated procedures or when the threshold for deterministic effects can be exceeded. Dosimetric methods for online dose estimation are presented. The need and convenience to adopt a trigger level for each complex procedure type and x-ray room is discusses.

Targeted nuclear medicine therapy

A. Perkins

Academic Medical Physics University of Nottingham, UK

One of the unique strengths of nuclear medicine lies in the use of radiopharmaceuticals for both diagnosis and therapy. Since the first introduction of I-131 for therapy there has been a steady growth in the use of radionuclides for therapeutic use. The specificity of iodine uptake ([I-131]sodium iodide) for thyroid tissue has resulted in its continued application for the treatment of functioning thyroid carcinoma and thyrotoxicosis. Other conditions have been treated by either intravenous injection for example P-32 for polycythaemia or intracavitary injection, for example [Y-90]colloid for synoviorthesis.

We are now witnessing the production of new radiopharmaceutical formulations aimed at specific molecular targets. These include the specific processes of metabolic trapping, enzyme inhibition, receptor binding and antibody-antigen binding. Radiopharmaceuticals like [I-131]MIBG, [R-186]HDP and [Sm-153]EDMP are now well established therapeutic agents. In addition new radiotherapeutic agents are being developed such as those based on somatostatin receptors and monoclonal antibodies. One particular challenge for the Medical Physicist is the application of the most appropriate radionuclide for targeted therapy. The choice of therapeutic nuclide increasing and will depend upon matching the physical characteristics with the pharmacokinetics of the targeting moiety. Some examples of therapeutic nuclides are given below.

Nuclide	T1/2	emission	maximum path length in tissue
I-125	60.0d	auger	–>10nm
At-211	7.2h	alpha	––> 65nm
Cu-67	2.58d	beta/gamma	––––––> 2.2mm
I-131	8.04d	beta/gamma	––––––––> 2.4mm
Sm-153	1.95d	beta/gamma	––––––––> 3.0mm
Re-188	17.0h	beta/gamma	––––––––––> 5.0mm
P-32	14.3d	beta	––––––––––––> 8.7mm
Y-90	2.67	beta	––––––––––––––> 12mm

The importance of the appropriate design of these agents cannot be over emphasised, since a sustained hit-on-the-target will lead to effective targeted therapy.

ACP/05/02

A dedicated cyclotron center for PET radiopharmaceuticals: One year operational experience and recent developments for the future

D. W. Becker

ARGOS Zyklotron Betriebs-Ges.m.b.H. Klagenfurt, Austria

The positron emission tomography (PET) is an unique, noninvasive, powerful diagnostic tool at the forefront of modern functional imaging in clinical nuclear medicine. Due to the quantitative measurement of the local and temporal distributions of the radiopharmaceutical the PET is capable of providing images of biological processes and physiological situations instead of mere anatomy. Nowadays it is widely established as a routine assessment of cancer, neurological disorders and coronary artery disease in humans. And the diagnostic fields are rapidly growing with the development of new bio-tracers and new positron emitting radioisotopes.

Traditionally PET is based on short-lived positron emitters (11C, 13N, 15O, 18F) which are produced by low-energy cyclotrons. Due to the short half-live fast technical and chemical processes are essential for the production and the synthesis of the radiopharmaceuticals. Also highly optimised logistics are necessary until their applications in a PET center.

The radionuclide 18F, mostly in the form of [18F]FDG, is suitable for long-distance distribution. The half-live of 109 min, fast synthesis times and high yields allow transportation of multiple dose vials over a 6 hours time gap. This gives the possibility to operate a cyclotron center on a commercial base and distribute PET radiopharmaceuticals to hospitals and private doctors over a certain distance.

This talk will give an overview of the installation and the routine operation of the ARGOS cyclotron center dedicated for the production and distribution of different PET radiopharmaceuticals for in house use (LKH Klagenfurt) and the European market. It will reflect the problems of the daily production and the logistical efforts. Finally there will be an introduction of some new PET tracers of the second generation and new radioisotopes.

The role of EFOMP in maintaining the standards and status of Medical Physicists in Europe

P. P. Dendy

Introduction

There have been several important developments in the education and training of medical physicists in the past 10-15 years and the 1997 Directive from the European Union on the health protection of individuals against the dangers of ionising radiation in relation to medical exposures will stimulate further changes.

This presentation will look back at what has been achieved and try to anticipate the future. It draws heavily on the work of the European Federation of Organisations for Medical Physics (EFOMP) but the views expressed are my own.

Medical Physicists – are we fit for purpose?

Two basic questions will be posed. What are the requirements of the employer? What are the expectations of the employee?.

The major duties and responsibilities of a scientist in health care will be considered in some detail. From the point of view of the individual employee, the principal requirements are:- a need for clear information and advice on recruitment and entry qualifications, a basic training programme, higher training and continuing education.

To meet the above needs a medical physicist requires

- A knowledge base
- A skills base (competencies)
- A means of keeping up-to-date

All the above have to be set up in a way that they can be properly assessed and accredited.

The role of EFOMP

Embedded in the EFOMP Constitution is a clear commitment to propose guidelines for education, training and accreditation programmes. The EFOMP policy on medical physics

education and training was first set out in 1984 and the fundamental principles have changed little since that time. One major development has been the formulation of a competency-based format for the more practical aspects of training in radiotherapy, nuclear medicine and diagnostic radiology. Five levels of competency have been proposed and examples will be given of the knowledge, skill and experience required at each level.

Implications of Directive 97/43 Euratom

This Directive has important implications for medical physicists. There is a new definition of a »Medical Physics Expert« and in the future the employer will look to the MPE to engage in a much wider role. To recognise this wider role, EFOMP has updated its policy statement on the MPE and the key features will be presented.

Medical Physicists – are we all working to the same standards?

It is extremely important to address this question because:

- Many decisions of medical physicists have a direct consequence for patients
- Freedom of movement of medical physicists in Europe requires comparable standards
- If we fail to work to the same standards we lose credibility (status).

Information will be given on the advice provided to National Member Organisations for setting up Registration Schemes and the current position on Registration Schemes in Europe will be presented.

Finally there will be brief reference to the work of the EFOMP Standing Committee on Registration, with comment on some important current topics including a) Further thoughts on Continuing Professional Development Schemes; b) MPE Staffing shortages in departments of diagnostic radiology; c) Proposals for setting up a »European Medical Physicist« diploma.

Conclusions

1. EFOMP has more than 18 years experience in providing advice on a co-ordinated programme of education and training in medical physics
2. The EU Directive of 1997 on health protection against the dangers of medical exposures of ionising radiation has substantially widened the role of the medical physics expert
3. The important question – »Are medical physicists trained in such a way that they are fit for purpose and competent to practice?« – must be kept to the forefront
4. »Are medical physicists all working to the same standards in the different EFOMP countries?« – is then an important supplementary

ESTRO-EQUAL radiotherapy dosimetry audit for high energy photon and electron beams

D. Georg,

Div. Medical Radiation Physics, Dept. Radiotherapy and Radiobiology, AKH Vienna

I. H. Ferreira[1], A. Dutreix[1], A. Bridier[1] and H. Svensson[2]

Since 1998 the European Society for Therapeutic Radiology and Oncology (ESTRO) has set up a TLD Quality assurance programme (EQUAL) with the Physics Department of the Institut Gustave Roussy (IGR, Villejuif, France) as measuring laboratory. The traceability of the dose calibration to the BIPM (Bureau International des Poids et Mesures) is assured through periodical reference chamber calibrations at the French Primary Laboratory and annual intercomparisons with the IAEA/WHO network and other TLD networks and SSDL (Secondary Standard Dosimetry Laboratories).

Till February 2002 more than 55% of all 800 European radiotherapy centres have participated in the EQUAL audit. This TLD postal dose assurance service addresses photon and electron beam checks in reference and non-reference conditions and is successful with more than 440 radiotherapy centres and 1500 beams checked. In the EQUAL programme, the accuracy in dose is checked on the central beam axis in reference and non-reference conditions.

The EQUAL program started with photon beam audits checking the following four dosimetric parameters: the reference beam output (RBO), the percentage depth doses (PDD), the beam output variation (BOV) for open and wedged fields and the wedge transmission factor (WTF). Considering the EQUAL experience and the request from radiotherapy centres the programme was extended to include electron beam checks. The electron external audits covered by the network are also based on measurements made with mailed thermoluminescent dosimeters (TLD). The purpose of the electron TLD audit is to check the beam output for different field sizes. For each energy, 4 electron beam output checks must be performed with the following field sizes: 10 cm x 10 cm; 15 cm x 20 cm and 7 cm x 7 cm.

Since EQUAL started its services dosimetric problems in the beam calibration, errors in beam data used as input to the treatment planning system (TPS), and in the

1 ESTRO-EQUAL Measuring Laboratory, Service de Physique, Institut Gustave-Roussy, 94805 Villejuif, France.

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algorithms used in the TPS could be detected and corrected. The obtained results stimulated the interest of ESTRO and of the participating radiotherapy centres to start a new task. Considering the increasing number of treatment units using Multileaf Collimators (MLC) in European Radiotherapy centres, the EQUAL programme was extended to include dose checks in photon MLC fields on axis. The purpose of the new TLD audits is to check dosimetric data for fields tailored by a MLC as used for patient treatments. The dose at reference depth is checked for six fields in this protocol: the reference field (10 cm x 10 cm) and five other fields with shapes and dimensions defined by the MLC. In a next step the program is extended to cover as well open and wedged asymmetric beams. Currently a modified TLD holder is investigated offering possibilities for off-axis measurements.

All services provided by EQUAL are supported by the European Commission ('Europe against Cancer programme') and are free of charge and available to all European countries. A memorandum of understanding has been signed with the IAEA and the service can be offered to the neighbouring countries, in agreement with IAEA, when there are no national possibilities.

For more information contact the EQUAL secretary: Mrs. Aline Mechet; ESTRO-EQUAL Secretariat; IGR Physics Department, 39 Rue Camille Desmoulins; F-94805 Villejuif cedex, France, Fax +33/1/42.11.52.99, Tel: +33/1/42.11.50.50; e-mail: equal@igr.fr, or see web: www.estro.be.

Virtual simulation in radiation oncology

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Introduction

The most important goal in radiation oncology is to give as much dose to the tumour as is required to kill the tumour cells while applying as a low dose as possible to the surrounding tissue as is possible to avoid complica-tions. For this reason modern treatment planning systems are used to calculate the irradiation for the individual patient anatomy. The patient is scanned with a x-ray CT-scanner so that a three dimensional model of anatomy can be created with the treatment planning system. At the end of the treatment planning process the location of all treatment fields according to this computer model of the patient is fixed.

Any »simulation« in radiation oncology has to do the following tasks: The coordinates of the radiation fields have to be transferred from the 3D computer model to the living patient. Marks have to be drawn on the patient to enable a correct positioning of the patient at the treatment machine. The »simulation« is also used to create reference images of the patient anatomy from the direction of the radiation fields (»beam's eye view images«). These images can be used for a comparison with images that are taken at the treatment machine to verify the correct positioning of the patients during the irradiation.

Conventional simulation

For the »conventional simulation« a special x-ray device called a »simulator« is used to check the proper align-ment of the patient. Usually bony landmarks of the patient are reference coordinates to set up the position of the radiation fields. Fluoroscopic images of the patient are taken until the moveable couch of the simulator is in the correct position. After this the position of the central axis and the shape of the radiation fields can be marked on the patient's skin. There is no direct link between the 3D patient model in the treatment planning system and the position of the patient on the simulator table. The simulator is also used to create x-ray »simulation images« from the beam's eye view.

Virtual Simulation

The virtual simulation process that I am going to describe is a mixture of what I have learned at the Department of Radiation Oncology, Washington University School of Medicine, St. Louis, Missouri (USA) and what is being implemented in my clinic, the University Hospital Hamburg-Eppendorf (UKE, Germany), right now. So far there is no standard definition for what is meant by »virtual simulation«. In this document I would like to define it as follows:

The virtual simulation is

- a series of steps
- and methods for quality assurance
- with the goal to simplify the »conventional simulation«
- or to replace the »conventional simulation« by other procedures
- and with the aim to get a higher precision at the application of the radiation fields.

Hardware requirements

A powerful CT scanner is needed to create a precise model of the patient anatomy within the treatment planning system [Mut02]. A CT scan with a spacing of two or three millimetres may be required [Pur99]. Small markers have to be used to define reference coordinates that are visible on the patient's skin and also in the CT images. To get the same alignment of the patient on the CT couch and on the treatment table an index patient positioning system has to be used. For this purpose patient fixation devices like thermoplastic head masks and alpha-cradles or vacuum cushions have to used as well. A system of moveable lasers is required for the patient set up at the CT scanner. Such a system can be used to mark the central axes and also the shape of the radiation fields. For the verification of the patient alignment at the treatment machine special projection plates have to be used that can indicate the position of the central axis in the portal images. Portal films that are very sensitive to radiation have to be used to allow double exposure images with a minimum dose.

Software requirements

For the virtual simulation a treatment planning system is required that allows the calculation of beam's eye view images in high quality. The quality of these images has to be good enough to replace the x-ray images that are taken at a conventional simulator. For this reason the treatment planning system has to be able to handle a large number of CT slices. Up to 200 images may be required for each patient. The treatment planning system will also have to calculate the coordinates of the central axes or the corners of the radiation fields in relation to the markers that have been used as reference points for the CT scan. Most advanced treatment planning systems will also generate coordinate-files that can be used to mark the position and the shape of the radiation fields on the patients skin with a computer controlled laser marking system.

Virtual Simulation Setup at the University Hospital Hamburg-Eppendorf (UKE)

At the UKE a Siemens Somatom Emotion® CT-scanner is used for the virtual simulation (»CT simulator«). The tube of this single slice scanner can spin with a speed up to 0.8 s per rotation and has a maximum acquisition time of 100 s without tube cooling. A carbon fibre couch top from MedTec® with an index patient positioning system is mounted at this scanner. The patients are irradiated with a Siemens Primus® linear accelerator that has also a MedTec® carbon fibre couch top with the same index positioning system. Vacuum cushions, alpha cra-dles, and head mask systems can be index on the tables with the MedTec lock bar®. With this system the patient fixation devices are always in the same position on the couch.

The CT simulator is equipped with the LAP IsoMark® system which has five line lasers. With a manual or PC control each of them can be moved forward and backward in one direction. Two lasers, left and right of the couch, can move upward and downward. Two lasers which are mounted left and right of the patient on the ceil-ing of the room can simultaneously move in the longitudinal direction. One laser, that is also mounted on the ceiling, can travel from the left to the right side of the patient. With this laser system any coordinate on the pa-tient skin can be marked with a cross produced by two lasers within their moving range.

The treatment planning system CMS Focus 3.2.1® is used to create the treatment plans, to calculate the coordi-nates for the virtual simulation and to generate high resolution beam's eye view images (digitally reconstructed radiographs: DRR). CMS Focus can also produce ASCII-files that are transferred over the network to control the LAP IsoMark system.

For the Siemens linear accelerator a special plate of perspex has been constructed that can be inserted in the wedge holder. It is equipped with metal sticks with a diameter of 1 mm and a length of 6 mm that mark the posi-tion of the central axes in double exposure verification images and that define a scale in the images.

Example: Prostate cancer

Patients with prostate cancer can be immobilized by a vacuum bag or alpha cradle at the CT simulator that is indexed with a lock bar. Some reference points are marked on the patient's skin with a pen and »Beekley CT-spots«® that consist out of small metal balls that are visible in the CT-scan and can stick on the patient's skin. Three of them define a reference plane for all further calculations of the coordinates for patient setup. A CT scan with a spacing of 3 mm or 5 mm is taken to get high quality DRR. After the CT scan was executed the patient can leave the CT simulator and a treatment plan is generated with CMS Focus. The DRR calculated replaces the x-ray images that would be taken on a conventional simulator.

For the virtual simulation the patients have to come back to the CT simulator. They are repositioned in their indexed vacuum bag or alpha cradle on the couch of the CT scanner. At least one reference scan has to be taken to make sure that the patient is in his

original position. The ASCII-file from CMS Focus for the LAP IsoMark system can be used now to project the central axes and contours of the radiation fields on the patient's skin. Corner by corner all contours can be marked with a pen on the patient's skin or the fixation devices.

For all setups at the linear accelerator the index positioning system is used again. The marks on the patient's skin and the fixation devices are used to double check proper alignment of the patient. For the verification of the correct positioning of the patient during the irradiation double exposure images are taken that show the size and localization of the radiations field and the surrounding bony landmarks of the patient. In this case there is no more need for a conventional simulator.

LITERATURE

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[Pur99] Purdy JA, Starkschall G. A practical guide to 3-D planning and conformal radiation therapy. Madison, Wisconsin: Advanced Medical Publishing, 1999.

Acknowledgements

I want to thank Dr. Sasa Mutic (St. Louis, USA) for the draft of the AAPM TG-66 report and other information about the virtual simulation process.

The implementation of IMRT: The Leuven experience

D. P. Huyskens, A. Van Esch
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Intensity Modulated Radiotherapy Treatments (IMRT) are performed at the radiotherapy department of Leuven (Belgium, Europe) with a Varian Clinac 2100 C/D equipped with a dynamic MLC (80 leaves). Treatment planning is performed with the inverse planning modules Helios-Cadplan. Portal imaging and associated QA is done with the Portal Vision EPID and the associated Vision software environment. The Cadplan modules have also special Varian research software, the portal dose image prediction algorithms.

The following steps were performed/introduced to implement and validate IMRT treatments in the department:

a) Commissioning/acceptance of the TPS:

Quality assurance of the treatment planning system (TPS) including the inverse planning modules of Helios was performed using the multipurpose phantom. The system was tested under extreme conditions, e.g. three different doses at a fixed depth, three identical doses at different depths. Dose distributions calculated by the treatment planning system were compared to dose distributions measured with film dosimetry. From these tests it appeared that the shape of the kernel introduced in Cadplan was very important to obtain good agreements between predicted and measured dose distributions.

Secondly the use of artificially created plans offered the possibility to assess the specific values of some MLC parameters such as leaf transmission and dosimetric leaf separation. Their impact is much more important for dynamic than for static beams (e.g. leaf transmission, dosimetric leaf separation, etc...).

b) QA of the dynamic MLC:

QA of the dynamic MLC was performed following the protocol developed at Memorial (Chui et al., LoSasso et al., etc.). These tests include the 'garden fence' test and the routine dosimetric check of position of the central leaf pairs. It is worthwhile to

mention that for the QA of the DMLC the electronic portal imaging device is extensively used, reducing considerably the workload compared to film evaluation.

c) Pre-treatment verification of IMRT treatments (patient-specific QA):

For the first cohort of patients treated with IMRT for a given treatment site, individual fields were checked by film dosimetry in a phantom. To do so, Helios supports the transfer of individual patient fluences onto a phantom. The dose distribution, recalculated in the phantom, can be exported for comparison with e.g. film measurement. Absolute dose measurements were performed by ionisation chamber measurements in the same phantom. In a second step these time consuming phantom measurements were replaced by a comparison between dosimetric images acquired with the EPID and the dose distributions predicted by the treatment planning system at the level of the imager. By doing so the time needed to check e.g. a five field IMRT plan could be reduced from about 5 hours to about half an hour (in optimal conditions).

As a conclusion the implementation of IMRT at the radiotherapy department of Leuven was a smooth process because of the existence of the appropriate tools for QA at the patient level: Helios export tools, EPID dosimetry in dynamic mode and portal dose prediction algorithms.

IMRT - from research to routine

W. F. O. Schmidt[1]; W. Nespor; K. Pavlas; R. Hawliczek
Institute for Radiooncology, Donauspital Vienna

In spring 2002 in Vienna IMRT is performed already in 3 departments with different linacs and planning systems (VARIAN/HELIOS, ELEKTA/HELAX, SIEMENS/CORVUS); a fourth planning system (CMS, Donauspital Vienna) is starting to get into routine. Also in a fourth department IMRT with compensators is in preparation (SIEMENS/PLATO). So it is possible to compare how the different planning systems work, how to integrate them into routine and to take a look into different requirements and developments.

The first step (linac and planning system technical setups for IMRT) has become routine meanwhile. Also production and verification of compensators seems to be possible with 3D cuuting devices and film dosimetry (after some important developments in image comparison). More problems arise from verficiation measurements (for planning systems and for patients). No standard for phantoms and measurement devices has been established yet. Also comparison of measurement and planning is different, examples shall be presented in a short overview. Still it is important to be aware, that IMRT-verification is not completely independent from planning systems.

Up to now it is not possible to »compare« plans from different planning systems simply. In routine eg dose prescription to target volumes, under-/overdosage of critical organs and their weighting are different and strongly influence results. Point- or linedoses, DVHs or other planning criteria are not enough for treatment decisions; also overall treatment time, time efforts for verification, safety criteria etc may contribute.

But the main challenge is coworking of physicians, technicians and physicists. Design of target volumes including safety margins, dose escalation (with respect to radiobiology), validity of ICRU50/62 criteria and scatter doses to regions outside the target volume and the whole body have to be taken into account and may influence treatment indications and schedules.

So there is still some work to do to get IMRT into routine....

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The use of an EPID for QA of IMRT

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The Radiotherapy department of the University Hospital of Leuven (Belgium) is equipped with a Varian Electronic Portal Imaging Device (originally a liquid filled MarkII EPID, later on replaced by an amorphous silicon EPID) for dosimetry of IMRT. The software to support EPID dosimetry of IMRT fields consists of the Dosimetric Workspace (Vision, Varian Medical Systems) and a portal dose image prediction software (Cadplan, Varian Medical Systems).

a) Dosimetric aspects of the EPID in dynamic mode:

Varian has developed a special acquisition mode for acquiring IMRT dosimetric images. The mode is a fast acquisition mode, unsynchronised to the linac pulses. Basic corrections performed by the system are dark field corrections (electrometer offset) and flat field corrections (sensitivity variation). A dedicated module is integrated in the dosimetric workspace to calibrate the EPID for dosimetry. The assessment of the possibility to use the EPID in dosimetric mode was performed by comparison to ionisation chamber measurements and film dosimetry. The reproducibility of the EPID was excellent while the remanence effect (ghosting effect) turned out to be negligible.

b) Portal dose image prediction:

The portal dose prediction algorithms implemented in Cadplan are based on the algorithms developed by the Rotterdam group (Pasma et al., M. de Langen et al.). For each field it is possible to predict the dose distribution at the level of the electronic portal imaging device, either with patient or without patient in the beam. This module has been used to compare predicted images and acquired images (without patient); in a first step these modules were used for relative dosimetry (default normalisation to data point on the beam axis); however, this relative dosimetry still requires additional measurements of absolute dose (point dose measurements). Since point dose measurements may report artificially large discrepancies in large gradient regions, the EPID system was further developed to measure dose in absolute mode.

c) Pre-treatment in clinical routine:

Basic appropriate tools have been developed in the Vision environment to compare dosimetric image and portal dose prediction (isodose overlays, line profiles, image substraction etc.). It soon became apparent that there was a need for additional efficient and overall verification of 2-D distributions. Based on the work performed by Low et al, the gamma evaluation method - using a combination of dose differences and distance to agreement - was further refined to compare dosimetric images. The gamma algorithm was used to compare dosimetric images with portal dose predictions, dosimetric images of different treatment fractions and to evaluate error detection possibilities. Future tools will need to combine isodose overlays, profile measurements and gamma evaluations.

Austrian Society for Medical Physics

Österreichische gesellschaft für medizinische physik (ÖGMP)

W. F. O. Schmidt
Institute for Radiooncology, Donauspital Vienna

CURRENT STATUS:

~170 members (among them ~10 companies)

President: H. Leitner, Graz

Vice-President: H. Mandl, Salzburg

Secretary: G. Stuecklschweiger, Graz

Treasurer: R. Freund, Vienna

Homepage: www.oegmp.at

Members & main activities:

The ÖGMP was founded in 1980. Approximately 50% of its members work in hospitals, 60% of them in radiotherapy departments (12 centres with ~40 high-voltage machines), the others in nuclear medicine, radiology and various medical departments. 25% of the members work in research (universities and research institu-tions in Vienna, Graz and Innsbruck), 8% in departments for radiation safety , 15% for companies or government and 2% others.

The ÖGMP has a contact group with the ÖPG (Austrian Physics Society). Contacts are also established to the Society for Biomedical Techniques (ÖGBMT), to the Radiation Protection Societies (VMSÖ, ÖVS) and to Medical Societies like ÖGRO

(Radio-Oncology), ÖNG (Nuclear Medi-cine) and ÖRG (Radiology).

The ÖGMP works closely together with the German and Swiss Medical Physics Societies and is member of the EFOMP and IOMP. The yearly meeting is often combined with other physics´ or medical societies. Normally two one-day work-shops per year (mainly around Vienna) are held, partially together with other societies.

Also in collaboration with the German and Swiss Societies of Medical Physics the journal «Zeitschrift für Medizinische Physik« is published quarterly and a 2-week teaching course («Winterschule«) for continuing education of the members is organized every year.

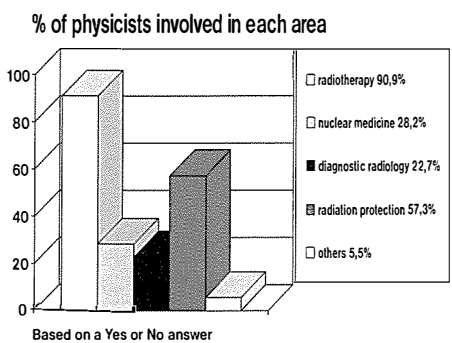
Special features

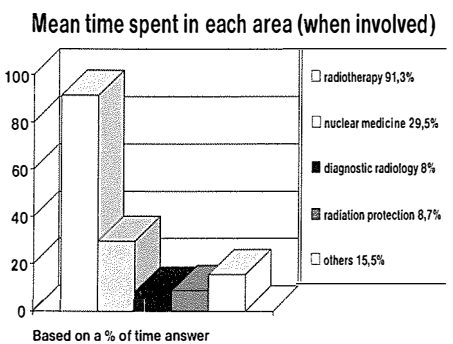
Since 1989 the University of Vienna and the ÖGMP offer a 3-year postgraduate »medical physics course«. Since 2001 the ÖGMP title «medical physicist«, according to the EFOMP regulations, is officially recognized by the ministry of health. The new draft of the radiation protection law mentions specifically the «medical physi-cist« as fulfilling the requirements of the »medical physics expert« defined by 97/43/EURATOM. At present appr. 50 physicists are qualified according to this directive. Therefore it is an important duty of the ÖGMP to control the requirements of qualification. In general, the ÖGMP is recognised by the Austrian government as a competent address for all matters of physics as applied to medicine.

Medical physics in France

H. Bouscayrol, S. Naudy, A. Noel,
on behalf of the French Society of Medical Physics (SFPM)

The medical physicist profession started in France when physicists were involved for the first time in the use of radiation for medical purpose mainly in radiotherapy departments, that was in 1950. Then the appointment of a full time physicist became mandatory, through a ministerial authorisation in 1969, in departments where a linear accelerator of E> 1.5 MV RX was in use. The following year the Diploma of Advanced Studies in Radiation Physics (DEA- 5th year university) was created at the Toulouse University and so the medical physicist profession became official. In 1972 a bunch of professionals created the French Society of Medical Physics (actual name)...Thirty years later over 300 medical physicists work mainly in the ionising radiation area in 180 centres (public, private or cancer dedicated) over the whole country. The education programme has naturally evolved. A one year on-site training based on Efomp recommendations is now required in addition to the DEA. The 20-25 students per year are expected to get introduced to the professional practice in the four major fields: radiotherapy, radiology, nuclear medicine and radiation protection including compulsory routine tasks within the 21 certified medical physics departments. The area of involvement has spread. The nuclear medicine departments are now required to employ at least part-time medical physicists (ministerial order of 1977) and the diagnostic radiology departments are starting to seek for the expertise of those professionals while still expecting the application of the European directive Euratom/97/43. The involvement of the medical physicists and the mean time really spent among the different area is as follow (SFPM 98 survey, more than 1 answer possible):





Furthermore the professionals are engaged in the promotion of their qualification and competence through continuing education. The Society set up a Register fully approved by Efomp since 2001 but not yet recognised by the national authorities.

The need for medical physicists is currently growing in France as the implementation of the directive 97/43 assert the dose delivered to the patient in any radiation based diagnostic procedure as one of the major concern. The education system will have to provide an increased number of students while maintaining a good quality programme.

Medical physics in Denmark: Education and employment

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Dept. of Radiation Physics, University Hospital of Herlev, Denmark

J. Carl
Dept. Radiation Physics, University Hospital of Aalborg, Denmark

Medical physics has a long history in Denmark. The use of radioactive sources for brachytherapy necessitated already around 1920 the service of physicists for calibration of the output.

In 1954 the first department for radiation physics was established at the Finsen Hospital in Copenhagen followed similar departments at the other radiotherapy centres.

Legal demands for the service of medical physicists came into force in 1991 with the laws on the medical use of accelerators for patient treatments. In this law the qualification and responsibility of the physicists were specified. A law on the use of closed radioactive sources for brachytherapy came in 1995.

The European Union directive on patient protection in 1997 necessitated new national legislation in 2000.This covered diagnostic radiology, nuclear medicine and radiotherapy.

The Danish Society of Medical physics was founded in 1982.A scheme for education and training of medical physicists for radiotherapy was the first major task. That was completed in 1985.

It was based on a master degree in physics. Since there is little physics taught at university level in Denmark supplementary courses in radiation physics and training were given while the physicists were employed at a radiotherapy centre. Courses run by ESTRO and EFOMP have been used quite extensively.

In 1995 a formal education scheme was agreed on with the Danish Board of Health. An education council under DSMF supervises education and training of all physicists and after successful completion of the scheme under the local responsibility of a qualified physicist the council proposes to the Board of Health that the physicist be recognised within the speciality chosen.

The new requirements for physicists in diagnostic radiology and nuclear medicine have meant a large increase in the number of physicists in training in these areas. These physicists are ususally directly employed in the diagnostic departments.

Present position and education of medical physicists in Croatia

M. Vrtar,
University Hospital Center Rebro, Zagreb

T. Viculin
University Hospital for Tumours, Zagreb

The total number of medical physicists in Croatia amounts about 30. In radiotherapy departments there are 18 and in nuclear medicine 6. Others are working in radiation protection and health care activities in medical and research institutes. The number of inhabitants in Croatia is 4.5 millions. The hospitals are equipped with 7 linear accelerators, 6 cobalt units, 12 gamma cameras and 6 radiotherapy simulators. The medical physicists are organized as Division of the Croatian Medical and Biological Engineering Society (CROMBES), which is a member of EFOMP. Until now, the education consisted of the following: After the regular 4 years study of physics, the 2 years postgraduate education could be continued in medical physics. It resulted in a Master of Science level. This year we expect the acceptance of the new specialist study, which is formed according the EFOMP recommendations. It means that together with the theoretical lectures (as in scientifically direction), a 4 years practical in-the-job training should be released in clinical hospitals. The title after the final specialist exam should be the Master of Medical Physics, Specialist. It is very important, because now the physicists are treated as non-medical workers. It results in degraded position in profession and in salary.

Society of medical physics and biophysics of the slovak medical society, Slovakia

G. Králik,
St. Elisabeth Cancer Institute, Bratislava, Slovakia

V. Laginová
St. Elisabeth Cancer Institute, Bratislava, Slovakia

The Society was established in 1976 as part of the Czechoslovak Medical Society as an association of physicists and biophysicists working in the field of protection against radiation. Its total membership included more than 100 members. After Czechoslovakia had been divided into the Czech Republic and Slovak Republic, the Society continued to exist only in Slovakia. At present it has 37 members.

President of the Society: Professor Vít Šajter, PhD.

Contact persons: RNDr. Soňa Kováčová, PhD., skovacov@ousa.sk

RNDr. Gabriel Králik, gkralik@ousa.sk

Among the main tasks of the Society is the exchange of experience concerning the problems in physics, dosimetry, biology and radiation hygiene. Discussions held in these meetings made it possible to choose methodological approaches and their harmonisation with European recommendations in agreement with the traditions started in 1981 when the first conference of physicists was held in Czechoslovakia also with the participation of internationally renowned specialists, among them e.g. also Professor John Clifton.

This was the first opportunity to create personal contacts with colleagues from Western Europe that had a positive influence on further co-operation and on our efforts to become a member of EFOMP.

Since then the situation has changed and the members have the possibility to participate in symposia and conferences not only in Slovakia but also abroad.

In the Society there are physicists working mainly in the field of radiotherapy and nuclear medicine, and besides their routine work they focus also on introducing new techniques and their verification within respective research projects.

Unfortunately, at present no physicists do work in our country at radiology departments. This must be changed within short.

A majority of the physicists work in government-owned hospitals.

The members of the Society have close co-operation with SRTBF that is a member of ESTRO. Owing to this, we managed to participate in several international programs that have been co-ordinated by the Department of Clinical Radiation Physics at the St. Elisabeth Cancer Institute, Bratislava.

At present we are a member of the SSDL network within IAEA and our task is the verification of clinical dosimeters from whole Slovakia.

Medical Physics in Slovenia

B. Casar,
Institute of Oncology

U. Zdešar
Institute of Occupational Safety

In 1996 the medical physicists in Slovenia were organized in the Medical Physics Section of Slovenian Biophysical Society. As the number of physicists involved in medicine was small it was not reasonable to found our own society. At the present MPSSBS has 20 members, half of them working in a hospitals: 25 % of physicist work in radiotherapy, 35 % in diagnostics, nuclear medicine and radiation protection, the rest are involved in research work and governmental duties. As the Slovenia is very small country, there is no special education program in the field of medical physics.

It is obvious, that the number of physicists involved in clinical work could not possibly cover all the duties which are required in modern clinical work. It is clear also if we look at the numbers of machines in hospitals in Slovenia:

30 clasical X-ray machines

96 X-ray machines with Image Intensifiers

33 mobile X-ray machines

30 Mammography X-ray machines

17 CT machines

5 MRI machines

7 laboratories for nuclear medicine (2 of them for therapy)

1 conventional simulator

1 simulator with CT option

1 CT for radiotherapy

2 Co-60 machines

3 linear accelerators

Relatively poor situation in medical physics is largely a consequence of our old and unadequate legislation, but new legislation which follows the requirements from 97/43/EURATOM and other European documents is already layed down before our parliament and we expect to be accepted soon.

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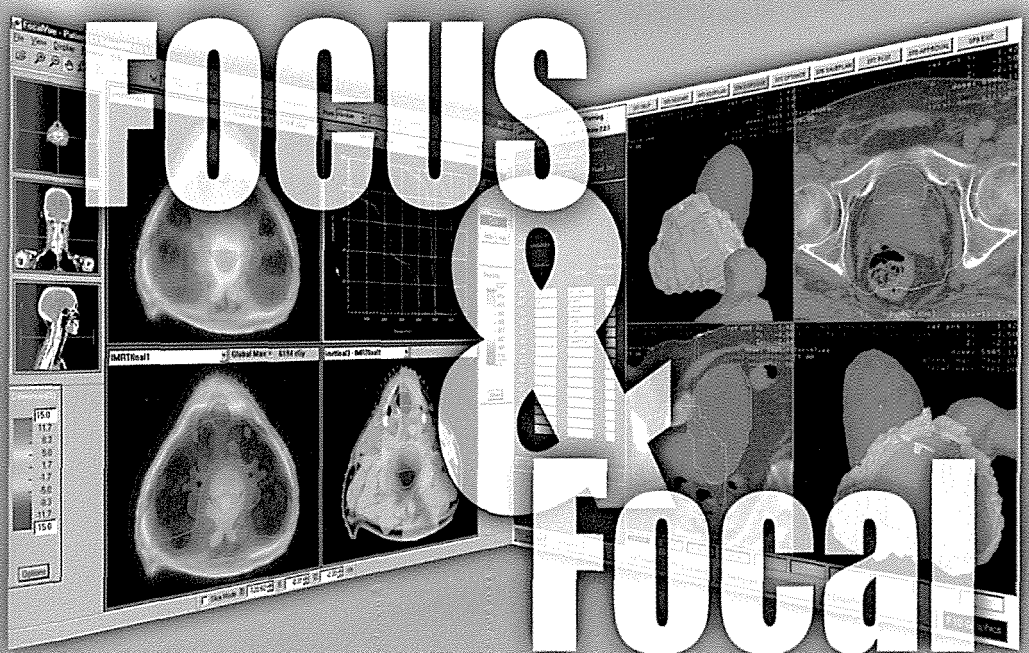

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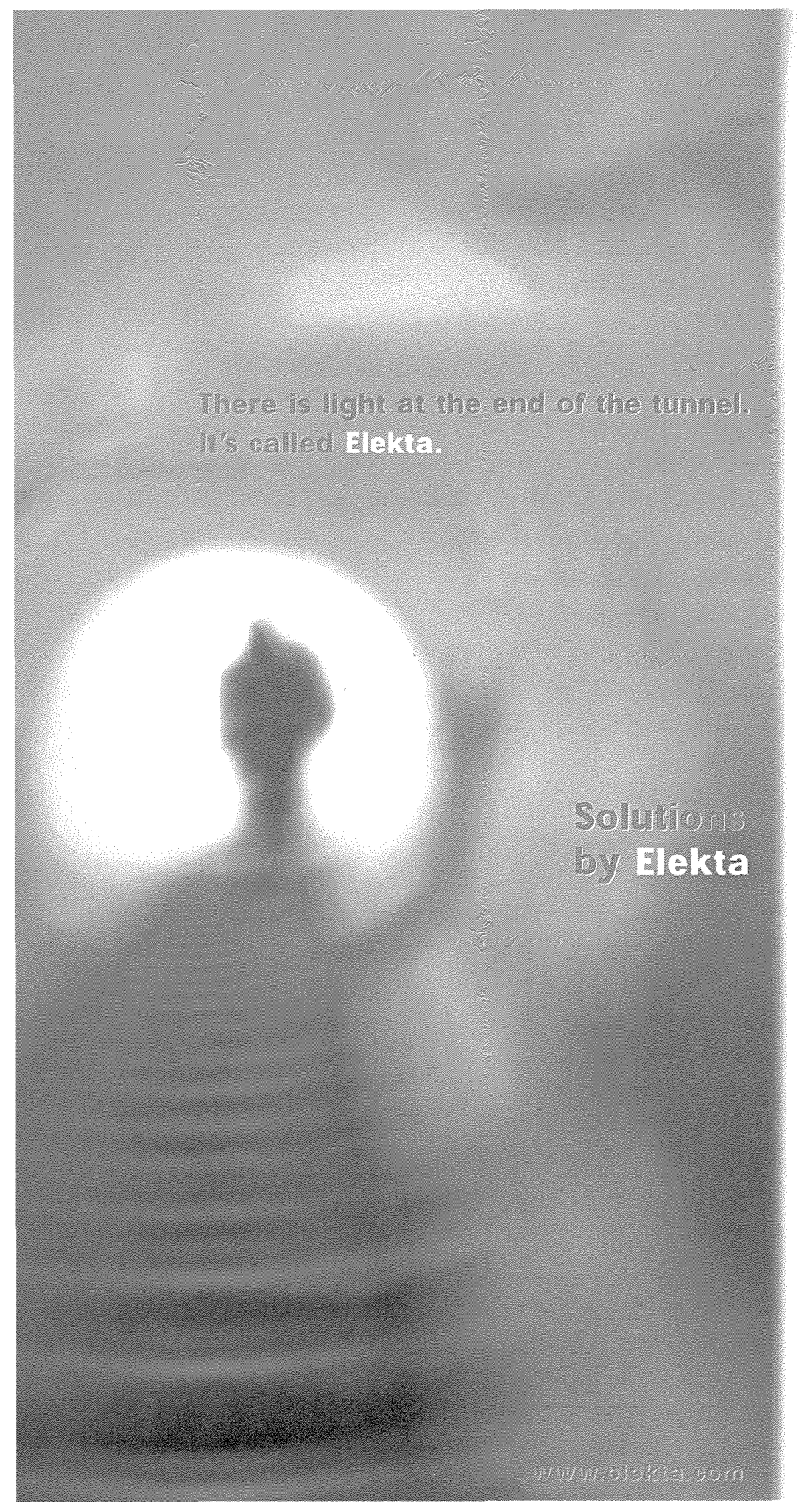

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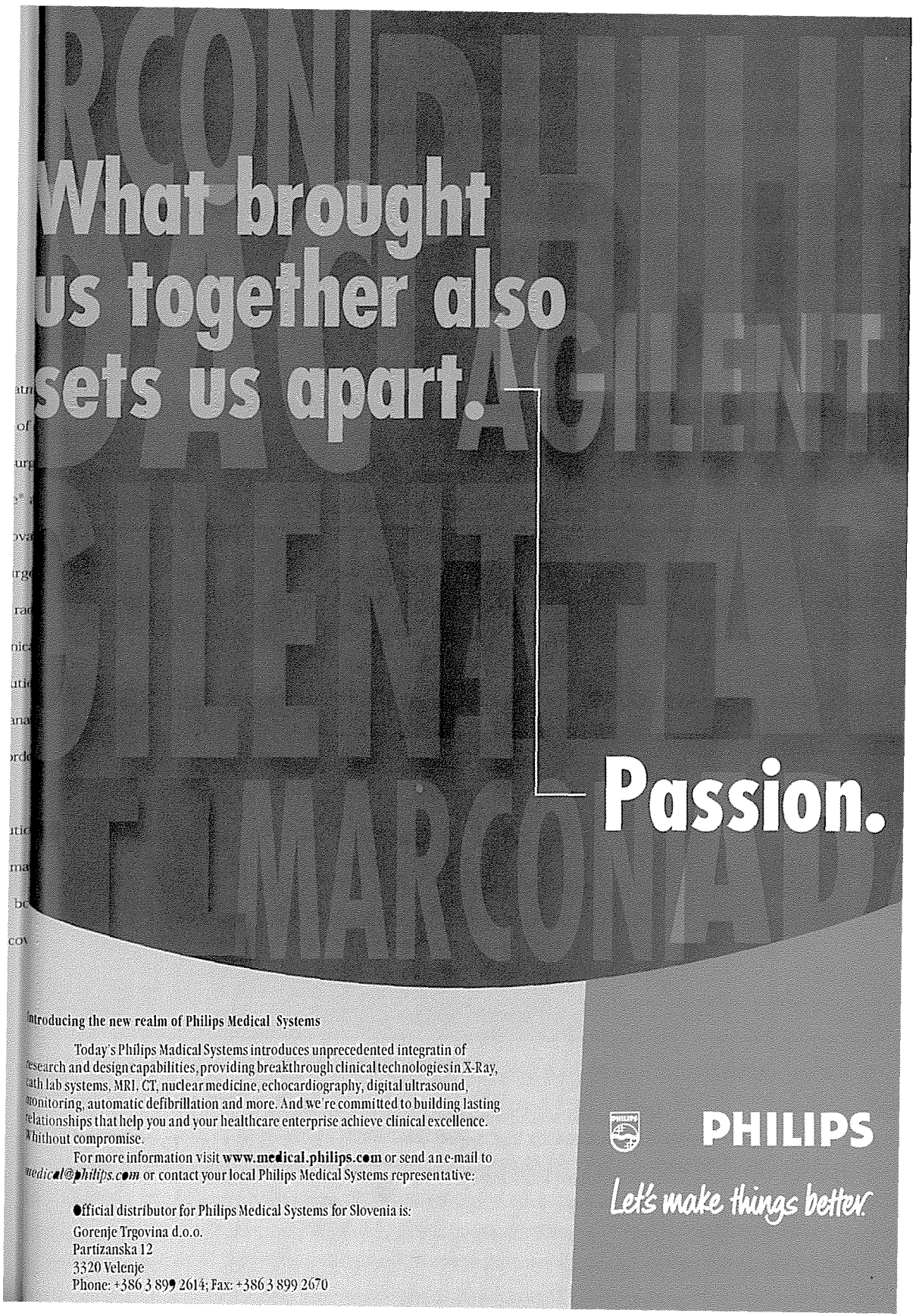

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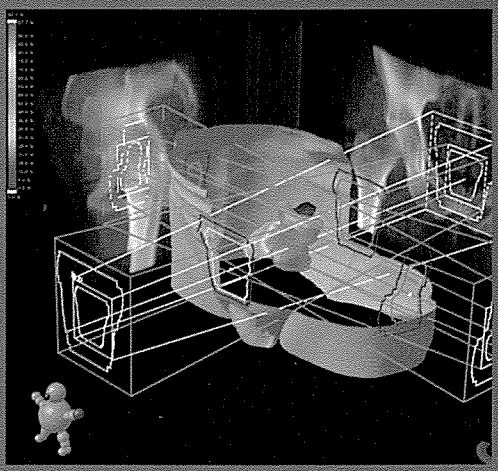

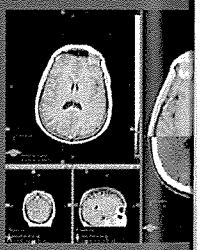

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