Bilateral mammographic breast tissue asymmetry

Sweet and sour in Beijing

Prizes to be awarded to members for work

Career journey
From CERN to radiotherapy

P07 AAPM TG 119 REPORT
Its application to benchmark VMAT/IMRT treatment plans

P08 MINIATURE TELEMETRY
A wireless monitoring device for recording gastric slow wave data

P48 MEDICAL PHYSICS HISTORY
The first English medical physics textbook published in the USA
COMPASS – A unique system
3D patient dose verification with RTPS class accuracy

Innovations that count

- Assess the clinical significance of delivery errors.
- Automatic plan verification based on your clinical protocols.
- Highest accuracy, full detail RTPS class verification.
- Comprehensive approval report – verification for Physicist and MD.

COMPASS is manufactured by IBA and distributed in the UK and Ireland by Qados.

Contact Qados:
t: +44 (0)1252 878 999
e: sales@qados.co.uk
w: www.qados.co.uk
CONTENTS

THIS ISSUE

FEATURES

10 Cover feature: A career journey
From particle physics to radiotherapy: the career journey of a clinical scientist trainee who recently changed path

14 Bilateral mammographic breast tissue asymmetry
Using a computerised scheme to detect breast abnormalities and predict the risk of developing cancer

20 Sweet and sour in Beijing
A visit to the World Congress in Medical Physics and Biomedical Engineering in China followed by sightseeing

25 Award-winning work: prizes to be awarded
Celebrate the success of members who have won awards and bursaries from IPEM and nominate work for this year

MEETING REPORTS

30 International Radiation Protection Association Congress (IRPA13)
Tony Denman

31 South West Medical Physics and Clinical Engineering Meeting
Laura Douglas

33 Keeping up: online study programme in advanced methods
Jose Luis Dumont

34 Annual Medical Physics Expert Update: covering concerns
Ian Honey

35 Mayneord-Phillips Summer School: Cardiac Imaging and Modelling
David Broadbent, Christoph Kolbitzsch, Ricardo Petraco and Matthew Sinclair

40 Optical Radiation Update Meeting 2012
Fiammetta Fedele

HISTORICAL FEATURE

48 A history of medical physics
Francis Duck journeys to the USA to uncover the first medical physics textbook written in English

REGULARS

04 President’s letter MPEC 2012 reflections...

05 CEO’s column An introductory message

06 Editor’s comment A fresh start

07 News Clinical engineering and medical physics news items

42 Book reviews Medical physics and popular science textbooks
write this article shortly after returning from a vibrant annual scientific meeting in Oxford. I would like to reflect on two presentations which I believe it is important for us to heed and understand.

In the session headed ‘Science communication’, Dr Diana Garnham, CEO of the Science Council, shared her analysis of the makeup of the science workforce and the different roles that scientists undertake. With a view to helping us understand the public perception of science as a profession and the impact of this on the recruitment of the workforce of the future, she identifies ten types of scientist as follows:

- explorer,
- investigator,
- developer/translator,
- service provider/operational,
- monitor/regulator,
- entrepreneur,
- communicator,
- teacher,
- business/marketing,
- policy maker.

This analysis might equally well be applied to engineers. The full text of this analysis can be found on the Science Council website.1 For me, the presentation helped clarify the tensions that exist as we develop the concept of the healthcare scientist. From the ten types of scientist the whole thrust of the MSC programme would appear to be the development of the service provider/operational scientist, albeit at different levels of expertise but each focussed on using scientific knowledge and technology to deliver and improve healthcare services. This excludes a much broader range of scientific roles. If we fail to incorporate the other scientific and engineering roles into the healthcare economy, I believe the impact of science in healthcare will be diminished. This is not to say that all types will exist within all healthcare providers, indeed they will not, due in part to government policy and funding streams and priorities.

The development of Academic Healthcare Science Networks seeks to bring together a number of these science roles, facilitating the interaction of the investigator, developer/translator and the provider/operational scientist. It is imperative that there is clarity about the type of scientist we are developing within the MSC programme. Many recruits to the STP programme have expectations of being an investigator or developer/translator. Are these roles that will be valued in the modernised NHS? As we develop the HSST programme with the Royal Colleges we must be equally clear of the required output. Will the graduates from these programmes continue purely as operational scientists or will we acknowledge the need for scientists capable of wider leadership within the healthcare economy particularly supporting the roles of business/marketing, policy and communication? These competencies can be developed within HSST but will require Trusts to support the development of these more strategic roles.

This analysis also sheds light on tensions that exist within IPEM. Those that would position IPEM purely as a Learned Society select a subset of types of scientist as of greater value than others. Those that see IPEM as too NHS orientated perceive us focussing on operational science issues to the exclusion of the other roles. Some see IPEM as not being influential at a strategic level and thus not supporting the policy scientist role. The truth is that IPEM should, as a professional body, seek to promote physics and engineering within each of these areas and as members we must recognise the different skill sets and foci within the membership.

The second presentation I would like to highlight was entitled ‘The third healthcare revolution’ given by Sir Muir Gray (www.muirgray.net). This was a significant presentation for a very different reason since he outlined his vision of the revolution that must occur within healthcare if society is to meet the demands of an aging population with less resources than are currently available and with a significantly diminished carbon footprint. The first healthcare revolution was characterised by empirical observation, and the second by technological development and scientific understanding. The third, he argues, will be driven by:

- A focus on value, the relationship between outcome and cost.
- Accountability to the population as a whole.
- The development of integrated systems, networks and pathways.
- Knowledge management.
- Exploitation of the Internet and the smartphone.
- Creation of the right healthcare culture.
- An obsession with sustainability.

Have we yet grasped the significance of the challenge ahead of us?

1www.sciencecouncil.org/10-types-scientist
am delighted to have taken up the new post of Chief Executive Officer of IPEM at the beginning of August this year. Following on from Robert Neilson’s 16 years as General Secretary, this feels like quite a challenge. But it is also an opportunity to look afresh at how IPEM supports its members, and fulfils its charitable objective of promoting the advancement of physics and engineering applied to medicine, and advancing public education in the field.

My professional background is as a registered nurse, and I have worked in both hospital and community settings. After several years working for health authorities on GP contracts and practice development, I moved into the Department of Health for 4 years. My responsibilities there were policy development on non-medical prescribing, primary care services and R&D programmes. Working with lead professional officers, senior civil servants and Ministers, as well as liaising with numerous national medical and pharmacy bodies, should prove useful experience in my new role at IPEM.

After a couple of years working on the implementation of the European Working Time Directive for junior doctors, I moved to my most recent post, as Director of the Queen’s Nursing Institute. The QNI is a charity which has acted as a professional body for community nurses, engaged in education, standard setting and accreditation for more than 150 years. More recently, it has increased its role in lobbying and campaigning on workforce and quality issues, aiming to influence policy and protect the standards of patient care. Again, I see a lot of transferable experience from my role in managing this charity to my work at IPEM.

In summary, in spite of my professional background, I have spent more years working outside of the NHS than inside it! I do believe that experience working for contractor services (GPs), the Civil Service (DH) and in the charity sector (QNI) is invaluable in broadening one’s perspectives and widening one’s knowledge base. I am looking forward to working with scientists, engineers and technologists in industry, academia and independent service provision, as well as in the NHS.

**Considering future direction**

It is fortuitous that IPEM is conducting a review of its current strategy, and planning its future strategic aims, at this time. This has given me the opportunity to hear from a wide range of members and officers about their views on IPEM’s achievements, strengths and weaknesses – and their ambitions for its future.

It is clear that there is work to do to develop the support that the office can give to members, and to the committees and groups that undertake the bulk of the professional work of the Institute. There are growing pressures on members’ time, difficulty with availability and a busy external agenda that IPEM wants to engage with and influence. The more efficient and effective the office function, the better use we can make of the knowledge and skills of members. There are also challenges ahead about growing the membership, encouraging participation in IPEM activities and diversifying our income. I expect that all of these will feature in the new strategy that will be developed following our discussions in October, and which we will share in detail with members once it is ratified by the Trustees and Council.

For now, I am focussing on meeting members, and making the external contacts necessary to ensure our continuing influence on key developments. I have also been visiting some medical physics and clinical engineering services around the UK for a more close-up view of the specialities of IPEM members. Thank you very much to those of you who have made these visits possible. I look forward to meeting many more members at meetings and visits in the future, and to the busy years ahead for IPEM.
A fresh start

First of all, I would like to give a warm welcome to the new CEO of IPEM, Rosemary Cooke. If you haven’t already, please take a look at her inaugural article on page 5 where she introduces herself and discusses her view of the future direction of IPEM.

Meanwhile, there have been changes to the lineup of our editorial board since the last issue. Farewell to Ryan Lewis as International Editor, and thank you for all your work on Scope. I am excited to announce that we now have a new Technologist Editor – Frances Rye who works in Poole and is keen to reintroduce technologist articles into Scope. We have been without an editor in this field for some time and I have been aware that we are not adequately representing this important contingent of IPEM. Hopefully the recruitment of Frances will redress the balance.

Scope aims to reflect the wide and varied membership of IPEM; however, we can only publish articles that are submitted to us. If you feel your specialism is not being represented, then please write an article for us. We are more than willing to give help and guidance if you need it. At the moment we are on the lookout for an Academic Editor and an Engineering Editor. If you would like any more information about either role then please do contact us.

If you turn to page 25 you can join me in celebrating the successes of several keen IPEM members who have won awards this year. I would like to highlight the many awards and bursaries that IPEM distributes. These range up to £2,000 in value and are available for you, the members, to apply for. Please see the IPEM website for more details: www.ipem.ac.uk/professionalmatters/prizes andawards/. It is not too late to nominate or apply for awards this year and I encourage you to consider doing so.

Francis Duck concludes his series of articles. If the pedants among you may have noticed the Scope format has been jazzed up, I approve of its more contemporary design, for which we must thank our excellent publishers Century One. Well, that just leaves me enough space to wish you all compliments of the season and a very Happy New Year.

“ I would like to highlight the many awards and bursaries that IPEM distributes. These range up to £2,000 in value”

GEMMA WHITELAW EDITOR-IN-CHIEF
Application of AAPM TG 119 report: benchmarking VMAT/IMRT

Improvements in clinical outcome have been achieved by several technological advances in radiotherapy. IMRT and VMAT (volumetric modulated arc therapy) produce non-uniform beams to improve the conformity of the dose distribution around the target (tumour) and sparing of organs at risk (OAR). ‘RapidArc’ is a commercial approach to VMAT providing even greater degrees of freedom, e.g. gantry speed, dose rate and MLC leaf positioning, to optimise the dose delivery. The addition of online 3D IGRT verification on-set provides better certainty of the patient geometry, e.g. setup, target and OAR positions. The AAPM TG 119 report establishes test cases to benchmark the overall accuracy of IMRT planning and delivery.

Mynampati et al. (2012) set out to determine whether VMAT was capable of delivering plans of comparable quality to IMRT plans using TG 119 as a metric. The group generated two treatment plans: the first plan using seven to nine static dMLC IMRT fields and a second plan utilising one- or two-arc VMAT techniques. CT datasets of the test cases were downloaded from the AAPM website. Dose optimisation and calculations were performed using 6 MV photons and an Eclipse treatment planning system. Dose prescription, planning objectives and plans were set and scored according to TG 119 objectives. A default dose calculation accuracy of 2.5 mm was used with heterogeneity corrections applied. Treatment plans were compared using the conformity index (CI), the ratio between the volume covered by the prescribed isodose and target volume for reference dose and the heterogeneity index (HI, the dose difference normalised to dose prescription) for 5 per cent and 95 per cent coverage of the PTV. For the test cases (figure 1), prostate, head-and-neck, C-shape and multtarget, the prescription dose was 75.6, 50.4, 50.0 and 50.0 Gy, respectively. Absolute dose measurements were performed with a chamber array and gamma measurements using an IMRT software package.

VMAT dose distributions were comparable to dMLC IMRT plans and the planning results matched those in TG 119. For the treatment plans studied, CI (1.05–1.23) and HI (4.6–11.0 per cent) were similar for both IMRT and VMAT. The ratio of total monitor units necessary for dMLC IMRT to that of VMAT was in the range of 1.1–2.0. The number of beam ‘mode ups’ was reduced to one to two times for VMAT when compared to seven to nine times for an IMRT plan, saving on average 2–3 minutes of treatment time. The VMAT optimisation time was considerably higher than IMRT.

The various levels of complexity in the AAPM TG 119 test cases were found to be useful to generate VMAT benchmark plans and to gain confidence in the basic capabilities of the VMAT technique at the preclinical implementation stage.

Figure 1: AAPM TG 119 test structure set for prostate, head-and-neck, C-shape and multtarget. © AAPM, ‘Application of AAPM TG 119 to volumetric modulated arc therapy (VMAT)’, Dinesh Kumar Mynampati et al., J Appl Clin Med Phys 2012; 13(5)

Illuminating oxygenation

Quantification of tissue oxygenation during radiotherapy could potentially allow conditions to be optimised during the course of treatment. A research team lead by Dartmouth College (Hanover, NH, USA) is investigating the use of Cherenkov emissions generated by the treatment beam to indicate tissue oxygenation levels.

Cherenkov radiation is generated when charged particles travel through a dielectric medium at a speed greater than the speed of light for that medium. The emission spectrum generated by a radiotherapy beam contains haemoglobin absorption characteristics that may be used to quantify blood oxygen saturation [SpO2]. Additionally, the Cherenkov photons can also be used as an internal source to induce Cherenkov radiation excited luminescence (CREL).

Using Cherenkov imaging, the researchers determined SpO2 in a tissue phantom, in combination with CREL measurements of the oxygen-sensitive probe PtG4. Its phosphorescence emission lifetime is proportional to tissue oxygen partial pressure [pO2]. The phantom contained scattering and absorption components, with PtG4 added for pO2 analysis, and was imaged in oxygenated and deoxygenated states. The top surface of the phantom was irradiated with an 18 MeV electron beam, and the emitted light was guided by a fibre bundle to a spectrometer. Spectral analysis from phantoms with SpO2 levels at 92 per cent and 5 per cent clearly demonstrated a correlation with signal intensity.

MORE INFORMATION

This work was recently published in the open access J Appl Clin Med Phys 2012; 13(5). http://dx.doi.org/10.1120/jacmp.v13i5.3382

MORE INFORMATION

This story was first published on Medical Physics Web on 1st October: http://medicalphysicsweb.org/cws/article/research/50977
A miniature bidirectional telemetry system: in vivo gastric slow wave recordings

Stomach contractions are initiated and coordinated by an underlying electrical activity known as slow waves. Electrical dysrythmias have been associated with gastric dysmotility in several significant gastric disorders, notably gastroparesis and functional dyspepsia.

Electrical recordings taken directly from the stomach provide superior quantity and quality of data than cutaneous electrogastrography recordings, but are invasive and face greater technical constraints. Serosal or mucosal electrodes have cables that traverse the abdominal wall or a natural orifice, causing discomfort and possible infection and restrict mobility. These problems motivated the development of a wireless system, which according to the authors’ knowledge, is not available commercially.

The aim of this work was to develop a validated, accurate and reliable identification and monitoring device for recording gastric slow wave data. An ideal wireless system would be small, portable, implantable and power efficient, whilst reliable and dependable.

The bidirectional telemetric system constitutes a front-end transponder, a back-end receiver and a graphical user interface. The front-end module is designed to acquire data from four channels and consists of an analogue board and wireless system-on-chip which includes an ADC, a microcontroller and a 2.4 GHz transceiver. To prevent saturation, signals pass through a high-pass filter to an instrumentation amplifier and then through a second order band-pass filter. The filtered signals are sampled, digitised and loaded into data packets.

The system was validated in a benchmark study then validated in vivo in an anaesthetised animal approved as a gastric dysmotility study model using serosal electrodes connected simultaneously to a commercial wired system. Gastric slow wave activity resembles human gastric electrical activity in pattern and morphology. See figure 1 for an illustration of the system.

Benchtop tests demonstrated reliable communication within a distance range of 30 m, power consumption of 13.5 mW and 124 h operation when utilising a 560 mAh, 3 V battery. Analysis of the signals was performed using the Gastrointestinal Electrical Mapping Suite. In vivo slow wave frequencies were recorded identically with the wireless (without signal distortion due to tissue absorption) and wired reference systems (2.4 cycles.min⁻¹), and automated activation time detection was modestly higher via the wireless system (463 vs 386 μV; p < 0.001).

The system had an acceptable band-pass response in the range of 0.05–0.3 Hz, which matched the design. The dominant slow wave frequency for the wired device, by fast-Fourier transform, was 0.04 Hz, identical to the wireless system.

This telemetric system for slow wave acquisition is reliable, power efficient, readily portable (it weighs just 20 g and measures 35 x 35 x 27 mm³) and potentially implantable. The device will enable chronic diagnostic monitoring and evaluation of slow wave patterns in animals and patients. With further miniaturisation and power consumption reduction to prolong battery life by application-specific integrated circuits and software programming of the wireless module, the device could be coupled to endoscopic recording electrodes, introduced into the patient’s stomach. This would allow routine minimally invasive patient recordings for several days in both fasted and fed states. The device can also provide multiple channels for spatial signal mapping in studies.

Figure 1: The new telemetric system. (a) Schematic block diagram of the system design. A0-4: electrode channels; ADC: analogue-to-digital converter; µC: micro-controller. (b) Analogue front-end comprising filter and amplifier. (c) The fabricated front-end in comparison to a US quarter. (d) Flowchart for directional transmission. Figure 1 kindly supplied by Aydin Farajidavar, Smitha M. N. Rao and J.-C. Chiao, Department of Electrical Engineering, The University of Texas at Arlington, USA. © IoP Publishing, ‘A miniature bidirectional telemetry system for in vivo gastric slow wave recordings’, Aydin Farajidavar et al., Physiol Meas 2012; 33: N29–N37

More information
This work was recently published in Physiol Meas 2012; 33: N29–N37. http://dx.doi.org/10.1088/0967-3334/33/6/N29
Massachusetts General Hospital (Boston, MA) will construct a second proton therapy facility. The single-room unit will be in the Lunder Building which currently houses MGH’s six photon linacs and is adjacent to the existing proton therapy centre. It is expected to come online in approximately 2 years.

Photodynamic therapy (PDT) is limited by the penetration depth of visible light necessary for the activation of photosensitive drugs. However, researchers at the National University of Singapore have developed nanoparticles that convert near-infrared light—which can penetrate greater depths in tissue—into visible light, thus enabling PDT of deep-seated tumours.

Engineers from the University of Illinois at Urbana-Champaign have developed a handheld imaging device based on optical coherence tomography (OCT), designed to enable physicians to examine sites such as the middle ear and the eyes. The imager may prove beneficial for monitoring the retinal health of diabetic patients, who are at higher risk of developing retinopathy.

A team at Wake Forest University School of Medicine has recovered brain function in sufferers of brain disease and injury. Researchers placed a neural prosthesis—an array of electrodes that measure neuronal signals—into monkeys’ brains, and were able to recover, and even improve, the ability to make decisions when normal cognitive functioning was disrupted.

Researchers from the University of Michigan (Ann Arbor, MI) has adapted a technique known as parametric response mapping (PRM) to analyse whole-lung CT scans of patients with chronic obstructive pulmonary disease (COPD). There are two major components of COPD: functional small-airways disease (fSAD) and emphysema. PRM enables visualisation and quantification of the relative contributions of fSAD and emphysema, which could lead to individualised treatments and improved patient outcomes.

CT scans are acquired at full inhalation and full exhalation, and analysed using the PRM technique. Image pairs are digitally co-registered and then local variations in lung function are assessed by comparison of attenuation on a voxel-by-voxel basis. Individual voxels are classified as having Hounsfield unit values characteristic of normal (green), fSAD (yellow) or emphysematous (red) tissue. This process creates a 3D map of the patient’s lung function.

The group studied 194 CT scans of patients with varying degrees of severity of COPD and concluded that this technique can distinguish healthy lung tissue from areas of early stage damage and emphysema. There was also evidence to support the concept that ISAD precedes emphysema in the progression of COPD.

This study demonstrated the potential of PRM to track the progression of COPD over time, and the response of the disease to treatment.

Researchers from the University of Michigan (Ann Arbor, MI) has adapted a technique known as parametric response mapping (PRM) to analyse whole-lung CT scans of patients with chronic obstructive pulmonary disease (COPD). There are two major components of COPD: functional small-airways disease (fSAD) and emphysema. PRM enables visualisation and quantification of the relative contributions of fSAD and emphysema, which could lead to individualised treatments and improved patient outcomes.

CT scans are acquired at full inhalation and full exhalation, and analysed using the PRM technique. Image pairs are digitally co-registered and then local variations in lung function are assessed by comparison of attenuation on a voxel-by-voxel basis. Individual voxels are classified as having Hounsfield unit values characteristic of normal (green), fSAD (yellow) or emphysematous (red) tissue. This process creates a 3D map of the patient’s lung function.

The group studied 194 CT scans of patients with varying degrees of severity of COPD and concluded that this technique can distinguish healthy lung tissue from areas of early stage damage and emphysema. There was also evidence to support the concept that ISAD precedes emphysema in the progression of COPD.

This study demonstrated the potential of PRM to track the progression of COPD over time, and the response of the disease to treatment.

Researchers from the University of Michigan (Ann Arbor, MI) has adapted a technique known as parametric response mapping (PRM) to analyse whole-lung CT scans of patients with chronic obstructive pulmonary disease (COPD). There are two major components of COPD: functional small-airways disease (fSAD) and emphysema. PRM enables visualisation and quantification of the relative contributions of fSAD and emphysema, which could lead to individualised treatments and improved patient outcomes.

CT scans are acquired at full inhalation and full exhalation, and analysed using the PRM technique. Image pairs are digitally co-registered and then local variations in lung function are assessed by comparison of attenuation on a voxel-by-voxel basis. Individual voxels are classified as having Hounsfield unit values characteristic of normal (green), fSAD (yellow) or emphysematous (red) tissue. This process creates a 3D map of the patient’s lung function.

The group studied 194 CT scans of patients with varying degrees of severity of COPD and concluded that this technique can distinguish healthy lung tissue from areas of early stage damage and emphysema. There was also evidence to support the concept that ISAD precedes emphysema in the progression of COPD.

This study demonstrated the potential of PRM to track the progression of COPD over time, and the response of the disease to treatment.
The ATLAS detector installed 100 m underground in the cavern.

Image © CERN
ERN is the European Organization for Nuclear Research. Situated between the Jura mountains in France and Lake Geneva in Switzerland lies a tunnel 27 km in circumference and 50–125 m underground. This tunnel houses the Large Hadron Collider (LHC), designed to produce head-on collisions between two proton beams with a centre of mass energy of 14 TeV. This makes it the world’s highest energy particle accelerator. I consider myself privileged to have spent 2 life-defining years working at CERN as a scientific associate for the ATLAS experiment. It is a truly unique organisation, where people from all corners of the globe collaborate on large-scale projects and become part of the community and lifestyle that CERN offers.

**The ATLAS experiment**

Having graduated from Glasgow University in physics, I worked for a year training as a research technician at the Dutch National Institute for High Energy Physics (NIKHEF) in Amsterdam. There they helped design and construct one of the central inner detectors for the ATLAS experiment at CERN. The ATLAS detector is one of the largest particle detectors ever built. Standing at an enormous size – 45 m in length, 25 m in height and width and with a mass of 7,000 tonnes – ATLAS is almost equivalent to a five-storey building! It consists of three major components: an inner detector, a calorimeter and a muon spectrometer.

Having spent the whole year working with silicon detectors and front-end electronics, I was given the opportunity to continue my research as a PhD student working on the inner detector. The inner detector is embedded in a solenoid magnet which generates a field of 2 Tesla. The powerful magnetic field deflects the particles produced in the collision point and the
Curvature of their tracks reveals the momentum and electric charge of each particle. My topic for the remaining 4 years was ‘Commissioning and performance of the ATLAS semi-conductor tracker (SCT)’. The SCT is positioned second closest to the collision point of the ATLAS detector and consists of 4,088 high-resolution silicon strip detectors (6 million readout channels). Its purpose is to accurately provide eight precision measurements of each secondary particle track produced by the proton–proton collisions. The electronics for reading out each detector channel were incorporated into the silicon detector design and optical read-out fibres were used to send and receive data from each diode channel.

Transferring to CERN

Continuing my work in Amsterdam, I assisted in the construction, testing, read-out and monitoring of the detector. At the end of my first PhD year, I moved to CERN, awaiting the arrival of the detector en route from Amsterdam. For the next 2 years I worked for the majority of the time in a strictly clean environment, complete with lab-coat, electrostatic-safe Dutch clogs and a stunning matching blue hair net (who says physics isn’t sexy?). I carried out monitoring and testing of all the detectors above ground, followed by the integration within the ATLAS experiment underground in the cavern. Particle tracking was carried out initially, using cosmic rays from the atmosphere, and at the end of my PhD I was lucky enough to have data to analyse from the first LHC proton–proton collisions!

“I love the positive impact that my job has on people and their ability to fight back against cancer.”
Of course, many of the tools used at CERN such as particle accelerators, cutting-edge detector technology and computing have all played their role in medical advances. Therefore, after having successfully completed my PhD (and one nerve-racking public viva!) I wanted to make sure that I put all my newly acquired skills to good use, so I embarked on the clinical scientist training scheme, where my subject of specialisation is radiotherapy. I am now in my fourth year of training at Barts Health NHS Trust in London.

The transition between particle physics and radiotherapy was actually quite a natural step. Many of the key skills I had acquired from my research years were very much transferable and helped me adjust to working in a clinical environment. Just like my PhD, where I found myself working in a multi-disciplinary environment with engineers, physicists and technicians, my job role in radiotherapy also mirrors this. Working with particle accelerators where the main goal is not to find the Higgs Boson(!) was also personally very enriching. Being able to apply my problem-solving, computing and analytical skills within the department is rewarding on a daily basis. In addition, I very much like being part of a profession where continued development is highly valued. I have attended many conferences and courses in my 3 years of training, one of which involved presenting a poster at CERN at the ‘Physics for Health’ conference in 2010. The workshop, which was the first of its kind, brought together some 400 healthcare professionals, biologists and physicists to examine the increasingly important interface between physics and medicine.

For me, radiotherapy is a fantastic balance between working at the forefront of technology and keeping abreast of the continuous advancements made in the field. I am very lucky at Barts to be able to spend time on research projects that directly impact on the department. Lastly, but most importantly, I love the positive impact that my job has on people and their ability to fight back against cancer.
Bilateral mammographic breast tissue asymmetry

Xingwei Wang, Dror Lederman and Bin Zheng (University of Pittsburgh, Pittsburgh, PA, USA) have worked on breast cancer risk stratification

Assessment of the breast tissue pattern asymmetry on bilateral mammograms is routinely used by radiologists when reading mammograms. This study developed a computerised scheme to detect breast abnormalities and predict the risk of developing cancer based on bilateral mammographic tissue asymmetry. A digital mammogram database of 100 negative and 100 positive cases was established. Each case included four images of craniocaudal (CC) and mediolateral oblique (MLO) views of the left and right breasts. All of the 200 cases acquired from the baseline examinations were interpreted as negative without dominant masses or micro-calcifications. During the next sequential screening examinations 6 to 18 month later, 100 negative cases remain negative (not recalled), while 100 positive cases had abnormal lesions detected and were recommended for biopsy. Among these, 60 had cancer verified and 40 were benign. A set of 20 features was computed and tested to measure bilateral mammographic tissue asymmetry. A genetic algorithm was then applied to select optimal features and build an artificial neural network-based classifier to predict the likelihood of a negative case being positive in the next sequential screening examination. The leave-one-case-out validation method was used to evaluate the classifier performance. The results showed that: (1) using a single feature computed from the entire breast area in CC view, the maximum classification performance level measured by the area under the receiver operating characteristic curve (AUC) was 0.681±0.038; (2) using the optimised six features from the entire breast area in CC view, the classifier yielded higher performance (0.754±0.024) than that using ROI-based features (0.690±0.026), and (3) using a weighted average fusion method, the classifier achieved the highest performance with AUC = 0.781±0.023. The study demonstrated the feasibility of applying a computerised scheme to detect cases with a high risk of developing breast cancer based on the computed bilateral mammographic tissue asymmetry.

Introduction

Breast cancer is one of the leading cancers in women over 40 years old. Scientific evidence has shown that early detection of breast cancer substantially reduces patients’ mortality rates. Although mammography has been well established as a screening tool to detect breast cancer, visually interpreting mammograms and detecting cancer is quite difficult, due to a large variability of breast abnormalities and low cancer prevalence. As a result, the efficacy of mammography screening remains a very controversial issue to date. To improve the efficacy of breast screening programmes without increasing false-positive rates, accurately classifying women into high and low risk groups of developing breast cancer in the near term (e.g. ≤ 5 years after the negative examination in question) is important. Such a risk stratification approach may eventually help establish personalised breast cancer prevention and screening paradigms. Epidemiological studies have indicated that with the exception of age, mammographic breast tissue density is the strongest risk predictor among all other known risk factors in the prediction of developing breast cancer in women. For example, women with high breast density have a four to six times higher lifetime risk of developing breast cancer than age-matched women with low breast density. In mammographic screening practice, mammographic tissue density is routinely rated by radiologists using BI-RADS which are: (I) almost entirely fatty (<25 per cent fibro-glandular); (II) scattered fibro-glandular densities (25–50 per cent fibro-glandular); (III) heterogeneously dense (51–75 per cent fibro-glandular), and (IV) extremely dense (>75 per cent fibro-glandular). Figure 1 displays an example of four digital mammograms depicting breast tissue density in four BI-RADS categories. However, visual assessment of mammographic density into four BI-RADS categories is difficult and often inaccurate due to the large inter-observer variability.

To overcome the limitation of visual assessment of breast tissue, computerised schemes have been developed and tested to automatically segment and
compute breast tissue density. Many of these studies reported high correlation between automated results and the average visual assessment by radiologists in segmenting or rating dense breast tissue. Despite great efforts made in previous studies, one important fact is that breast cancer can be detected in individual women with breast tissue density in any of the four BIRADS categories and more than 60 per cent of breast cancers actually arise and are diagnosed in women without any known risk factors. For example, figure 2 shows a positive case with BIRADS I rating and a negative case with BIRADS IV rating. Although women with dense breast tissue may have a relatively high risk (i.e. four to five times higher) of developing breast cancer, measuring or computing the global tissue density depicted on each mammogram alone actually has a rather low positive prediction value for individual women.

To improve the discriminatory power of breast cancer risk prediction, we investigated a new approach that focuses on analysing and comparing the mammographic breast tissue differences between the left and the right breasts of the same woman. Our approach is based on several scientific evidences: (1) humans naturally show bilateral symmetry in paired morphological traits including two breasts; (2) breast asymmetry is one of very few radiographic image phenotypes that relates to the biology process and it is an important risk indicator; (3) radiologists routinely examine bilateral mammographic tissue asymmetry to detect early suspicious lesions, and (4) using computerised schemes can achieve more consistent results in assessing mammographic tissue density by avoiding the inter-observer variability. To test our hypothesis, we assembled a unique testing image dataset and developed a new computerised scheme to classify these cases into two groups of positive (or ‘high risk’) and negative (or ‘low risk’) for developing breast abnormalities or cancer.

**Materials and methods**

**An image dataset**

Under an Institutional Review Board approved protocol, we have ascertained fully anonymised full-field digital mammography (FFDM) examinations. A total of 200 cases were collected from an ascertained diverse FFDM image database and these cases had at least two sequential FFDM examinations. All FFDM examinations were conducted using Hologic Selenia (Hologic Inc., Bedford, MA) FFDM systems. Each examination contained four FFDM images representing both CC and MLO views. Thus, a total of 800 FFDM images were included in the dataset. Figure 3 describes BIRAD ratings of these 200 cases. The majority of cases, namely 28.5 per cent (57/200) and 61 per cent (122/200), were rated by radiologists as heterogeneously dense (BIRADS II) and extremely dense (BIRADS III), respectively. The first FFDM examinations (or the baseline) of 200 cases were interpreted as negative during the original screening mammography and no dominant masses and/or micro-calcifications were detected by radiologists. Based on the status change of the second FFDM examinations, these 200 cases were divided into two groups. The negative group includes 100 cases that remained negative during the next sequential examinations 6 to 18 months later. The positive group also includes 100 cases in which the abnormal findings were detected during the next sequential examinations and recommended for biopsy. The biopsy results indicated that 60 had verified cancer or surgically-removed high-risk lesions and 40 were benign.

**Computing image features to measure bilateral breast tissue asymmetry**

The first step of our computerised scheme is to automatically segment the breast tissue area on each FFDM image. From a large number of image features that have been previously investigated and used to quantify or classify mammographic tissue density or patterns by several research groups, we initially selected 20 features in our studies. In short, these 20 features can be divided into five groups: (1) the grey level histogram-related features; (2) statistic features about local pixel value fluctuation; (3) fractal dimension-based texture features; (4) statistic features about intensity pixel value distributions, and (5) automatic computed BIRADS rating features. For each testing case, 20 image features were separately computed from the entire segmented breast areas in two bilateral images in MLO and CC view. Meanwhile, we also computed 20 features from the selected regions of interest (ROIs) in CC view images. Unlike some of the previous studies that manually selected ROIs with 256 × 256 pixels.
located in the central region behind the nipple, our scheme automatically selected the ROI with sizes adaptively adjusted based on the imaged breast size. Specifically, the size of each ROI is defined as \( d \times d \), where \( d \) equals half of the distance between the nipple and the edge of imaged breast area (close to the chest wall). Figure 4 shows an example of two ROIs automatically extracted from two breasts with different sizes in CC view images. For each feature, the absolute difference (the subtraction) of two values computed from two bilateral images was calculated. These bilateral feature differences were used to represent the bilateral mammographic tissue asymmetry. A normalisation process was applied for values of each feature.

Risk prediction using an individual feature or a set of optimal features

In this study, we first compared and analysed the performance level of applying each individual density asymmetrical feature to classify these 200 testing cases into two groups of positive (‘high risk’) or negative (‘low risk’) of developing breast abnormalities or cancer using the ROCKIT program. The classification performance levels when using each of these 20 features were compared. Second, from the initial pool of 20 features, we developed and tested a multi-feature based classifier by selecting an ‘optimal’ feature set. For this purpose, we applied a genetic algorithm (GA) to select effective features and build an optimal artificial neural network (ANN) to predict the likelihood of the cases being positive having a high risk of developing breast cancers. The ANN built in this study has a simple three-layer feed-forward topology, which includes \( N \) input neurons connecting to \( N \) selected features in the first layer, \( M \) hidden neurons in the second layer and one output neuron in the third layer. During the GA optimisation process, a binary coding method was applied to create GA chromosome strings. Specifically, each GA chromosome includes 24 genes. Among these, the first 20 genes represent 20 features related to the bilateral mammographic tissue asymmetry. In these 20 genes, the code of 1 indicates that the feature represented by this gene is selected and implemented in ANN, and 0 means that the feature is discarded. The last four genes indicate the number of neurons. For example, the code of 0101 represents five hidden neurons. Due to the size limitation of our dataset and reduction of training bias, a leave-one-case-out training and testing method was implemented to train and assess performance of the ANN built by the specific GA chromosome. The ANN-generated detection (classification) scores of all 200 cases were read and analysed by a ROC curve fitting program (ROCKIT). The computed area under the ROC curve...
(AUC) was used as a summary index to assess ANN performance. If the ANN yielded higher performance, the corresponding GA chromosome has the higher probability to be selected by the GA program to generate the new chromosome in the next generation using the crossover and mutation process. The GA optimisation is terminated when no significant performance improvement can be achieved.

**Performance assessment**

After GA optimisation, the classification performance levels measured by the areas under ROC curves (AUC) were separately computed using the ROCKIT program. We compared the performance levels of three ANNs using the features computed from either the selected ROIs or the entire segmented breast area on CC or MLO images. To test whether the risk assessment performance can be further increased by combining the results acquired from bilateral images of different views, we also tested several ANN scoring fusion methods as reported in the previous study\(^3\) to select or combine the classification results acquired from CC and MLO views of the same test cases. We generated several sets of new detection scores \((S_{\text{new}})\) from the ANN-generated detection scores in CC \((S_{\text{CC}})\) and MLO \((S_{\text{MLO}})\) view, which includes selecting (1) the maximum score \(S_{\text{new}} = \text{MAX}(S_{\text{CC}}, S_{\text{MLO}})\), (2) the minimum score \(S_{\text{new}} = \text{MIN}(S_{\text{CC}}, S_{\text{MLO}})\) and (3) computing a set of weighted average detection scores \(S_{\text{new}} = (W_1 \times S_{\text{CC}} + W_2 \times S_{\text{MLO}})/2\), in which \(W_1\) and \(W_2\) are different weights ranging from 0.5 to 1.5 in this study. Each set of 200 detection scores for 100 positive and 100 negative cases were reprocessed by the ROCKIT program to generate a new performance index (AUC). The results of different fusion methods were analysed and compared.

**Results**

When applying each of the 20 features computed from the difference of two bilateral images to classify 200 cases in our dataset into positive and negative groups of developing breast abnormalities or cancer, the average performance level measured by the AUC is 0.590 ranging from 0.485±0.041 to 0.681±0.038 (figure 5). Table 1 shows and compares the classification performance levels of three ANNs optimised using three different pools of features computed from either the entire segmented breast areas depicted on CC or MLO view images, or from the adaptively selected ROIs in CC view images. The results indicated that due to the difference among the three methods to extract the bilateral mammographic tissue asymmetry, GA was able to adaptively select a small set of effective features and discard the majority of others based on the specific training feature pools. As a result, the GA-optimised ANN for each feature pool has its own unique structure including the selected input features and the number of hidden neurons. Figure 6 compares ROC curves generated by three ANNs and the areas under these three ROC curves are 0.690±0.026, 0.688±0.027 and 0.754±0.024, respectively. In addition, by applying three basic scoring fusion methods, the average, the minimum and the maximum of detection scores generated by these two ANNs optimised using features in CC and MLO view images are 0.728±0.023, 0.740±0.023 and 0.756±0.026. The results indicate that when using both maximum and minimum scores, the classifier yielded lower performance levels than using the scores generated from the ANN using features computed from the entire segmented breast area depicted on CC view images only, whilst using average scores, the classifier yielded comparable performance with AUC = 0.754±0.024 vs AUC = 0.756±0.026. Table 2 summarises and compares the performance levels of applying the weighted average scoring fusion method in which the weights varied from 0.5 to 1.5 on the detection scores generated by two ANNs that use the features computed from the entire breast areas depicted on either CC or MLO view images. The best classification performance was AUC = 0.781±0.023 achieved using the weight of 1.25 on the CC view and 0.75 on the MLO view images, which is significantly higher than using features computed only from CC or MLO view \((p < 0.05)\).

**TABLE 1.** Comparison of AUC for using the same ANN structure and input features extracted from the entire segmented breast areas depicted on either CC or MLO view images as well as from the selected ROIs from CC images

<table>
<thead>
<tr>
<th>Topology</th>
<th>AUC</th>
<th>Selected input features</th>
</tr>
</thead>
<tbody>
<tr>
<td>Entire breast areas in CC view</td>
<td>0.754</td>
<td>1, 4, 8, 11, 12, 13</td>
</tr>
<tr>
<td>Entire breast areas in MLO view</td>
<td>0.688</td>
<td>3, 8, 10, 14, 20</td>
</tr>
<tr>
<td>Selected ROIs in CC view</td>
<td>0.690</td>
<td>1, 4, 11, 12, 13, 15, 17</td>
</tr>
</tbody>
</table>

**TABLE 2.** Comparison of the ROC performance levels measured by the area under ROC curve (AUC) and its standard deviation (STD) using a series of weighted average of detection scores generated by two ANNs using the features computed from CC and MLO view images

<table>
<thead>
<tr>
<th>Weight between CC and MLO view</th>
<th>0.5:1.5</th>
<th>0.75:1.25</th>
<th>1.0:1.0</th>
<th>1.25:0.75</th>
<th>1.5:0.5</th>
</tr>
</thead>
<tbody>
<tr>
<td>AUC</td>
<td>0.722</td>
<td>0.742</td>
<td>0.756</td>
<td>0.781</td>
<td>0.750</td>
</tr>
<tr>
<td>STD</td>
<td>0.024</td>
<td>0.026</td>
<td>0.026</td>
<td>0.023</td>
<td>0.025</td>
</tr>
</tbody>
</table>

\(\text{TISSUE ASYMMETRY}\)
**Discussion**

Although using the local-based bilateral mammographic breast tissue asymmetry has been tested to detect suspicious breast abnormalities, although this approach has not been implemented in any commercialised CAD schemes to date due to the difficulty of registration. Our approach to compute bilateral mammographic tissue asymmetry is different. Unlike the commercialised CAD schemes that focus on detecting subtle but visually detectable masses and micro-calcification clusters depicted on single digitised or digital mammograms, our scheme does not target and detect any specific lesions. We detected bilateral mammographic tissue asymmetry without performing automated image registration to avoid the potential registration error between two bilateral images. Hence, our computerised risk assessment scheme does not directly compete with conventional CAD schemes due to the different application purposes. All images in our database were interpreted as negative by the radiologists during the original mammographic screening. Without the dominant and visually detectable masses or micro-calcifications depicted on the images of these examinations, applying the conventional CAD schemes to process these images can only generate false-positive detections (marks) that cannot help radiologists in their interpretation of these images. However, our scheme is able to flag warning signs for cases with a high risk of developing breast cancer based on the detection and analysis of the bilateral mammographic tissue asymmetry. Using this or similar near-term risk assessment results, the high-risk women may be identified and can be monitored more closely in order to detect any cancer at an early stage, while the majority of low-risk women could be screened less frequently to reduce false-positive detections and screening costs. In summary, we investigated and compared the effectiveness of applying a number of bilateral mammographic tissue or density asymmetry related features computed from the mirror-matched ROIs or the entire segmented breast areas depicted on CC or MLO view images to classify women into two high and low risk groups of developing breast cancer in the near future. The results indicated that using this new mammographic image feature might yield higher discriminatory power than other currently available breast cancer risk factors used in existing risk assessment models. Although the results are encouraging, we recognise that this was a very preliminary study using a small dataset which cannot adequately cover or represent the actual population base in the clinical practice. The robustness of this prediction scheme needs to be further tested using large and diverse image databases in future studies.

---

**Dosimetry Check™**

**In vivo and transit dosimetry**

Dosimetry Check software provides an independent QA check using only the EPID. It works with all treatment techniques to provide a true volumetric measurement.

No equipment on the patient is required for pre-treatment QA or intra-fraction QA; enabling you to perform IVD on every patient, with no impact on machine throughput.

Pre-treatment QA, MU calc and MLC QA included as standard.

**World’s first commercial patient transit dosimetry**

www.osl.uk.com
enquiry@osl.uk.com
+44 (0)1743 462694
REFERENCES


Sweet and sour in Beijing

Christie Theodorakou (The Christie NHS Foundation Trust, Manchester) travelled to China to attend and present research at the World Congress on Medical Physics and Biomedical Engineering in Beijing. She also managed to do some sightseeing of this incredible city at the same time minutes before Swiss Air flight LX0196 touched down at the Beijing Capital International Airport, the lucky passengers sitting on the right side of the big Swiss bird enjoyed a spectacular sunrise. ‘My first sunrise in the Far East!’ I thought. My excitement got stronger, despite the fact that I had only one day to fight a 7-hour jet lag before the triennial World Congress on Medical Physics and Biomedical Engineering opened its doors to almost 2,000 delegates from around the globe.

After bargaining my taxi fare down to one-third of the original price, I arrived at the hotel which was situated minutes away from the Olympic Green built for the 2008 Olympics and the conference centre, both situated in the heart of the Central Business District. The hot weather did not stop me from going for a long walk in the Olympic Park and the financial district. The Beijing National Stadium, known as the Bird’s Nest, was truly amazing and captivating. The Central Business District is situated in the Chaoyang District which has traditionally been home to the working-class
residents. These days their numbers are decreasing as the homes are demolished to give their space to new high-rise apartment buildings, high-class international hotels, shopping centres and commercial complexes.

**Keynote and plenary lectures**

On Saturday, following the welcome address by Depei Liu (Congress Chair), Barry J. Allem (IUPESM), Herbert Voigt (IFMBE), Fridtjof Nüsslin (IOMP) and Don Jaron (ICSU), the congress began with an outstanding keynote lecture on signals and signalling mechanisms in the central nervous system given by Erwin Neher (Max Planck Institute, Göttingen, Germany), the Nobel Laureate in Physiology or Medicine. Professor Neher covered early work which led to the discovery of ion channels in cellular membranes and his talk was focussed on the ‘patch clamp technique’ for recording the ion currents flowing through individual channels. Towards the end of his talk, he reviewed the recent work on ion channels and molecular targets in drug discovery.

“Only around 30 per cent of children with pneumonia receive the antibiotics they need”

In the following 5 days, 1,314 oral and 786 poster abstracts were presented in over 200 oral sessions and 80 poster sessions. Topics ranged from radiation protection, medical imaging and radiation oncology to laser technology, hyperthermia therapy, nanotechnology, education, training and career development in medical physics, making this congress unique in its diversity of areas and topics. Plenary and keynote lectures, mini-symposiums and workshops were also organised and offered the opportunity to researchers to learn the current status and future directions of medical physics and biomedical engineering.

Adriana Velazquez Berumen (World Health Organization, Geneva, Switzerland) delivered a lecture on ‘Global perspectives of the health technologies’, raising awareness of the need for low cost, accessible and efficacious technology, focussing mainly on the low-income countries where ‘syringes could be as important as antibiotics’. She talked about pneumonia and the need for vaccination and antibiotics.

Pneumonia is the single largest cause of death of children worldwide. It kills 1.4 million children under the age of 5 every year – more than AIDS, malaria and tuberculosis combined. It is caused by viruses, bacteria or fungi and it can be treated with antibiotics, but only around 30 per cent of children with pneumonia receive the antibiotics they need. WHO and UNICEF launched the ‘Global action plan for the prevention and control of pneumonia’ in 2009, aiming to protect, prevent and treat pneumonia in children.

William R. Hendy (Medical College of Wisconsin, Milwaukee, WI, USA) in his plenary lecture discussed the need for ‘Safety and quality assessment of medical technologies’. He spoke about six levels of technology assessment: technical, diagnostic accuracy, diagnostic thinking and therapeutic measures which are the first four levels, and patient outcomes and societal benefits which are the fifth and sixth levels. Technical and diagnostic accuracy measures involve objective and subjective tests. In level 3, technology is assessed in terms of how much it has changed the probability distribution of diagnosis, likelihood of correct diagnosis and the clinician’s confidence in diagnosis. Level 4 measures the percentage of cases in series where it has helped in treatment planning and it has changed the treatment plan/decision. Level 5 involves patient outcomes, like change in quality-adjusted life years (QALY), morbidity avoided with the use of technology and percentage of improvement with or without that particular technology. The final level looks into societal benefit/cost analysis, societal cost-effectiveness analysis and average cost/QALY saved with technology.

**Medical physics is a shallow sea**

Charlie Ma (Fox Chase Cancer Center, Philadelphia, PA, USA), after giving a short introduction on medical physics professions, stated that: ‘Medical physics is a shallow sea – it may not be deep but it’s broad’. His plenary lecture focussed on current challenges in radiation therapy and the role that medical physicists play in a modern department. The talk reviewed the current status and future directions of target delineation and the errors involved in this process, patient immobilisation, target re-localisation using ultrasound, ‘CT on rails’, cone beam CT and the Calypso system 4D, treatment delivery with multileaf collimators, image-guided radiotherapy and electron beams. He highlighted the need of radiobiology input in radiation therapy and concluded with the scientific and economic status of proton and heavy particle radiation therapy.

Harald Paganetti (Massachusetts General Hospital, Boston, MA, USA) presented his keynote lecture on the remaining physics challenges on proton therapy. He talked about uncertainties when predicting and delivering doses for example, due to range degradation (shrinking tumours and presence of heterogeneities), CT imaging, calibration and CT conversion to tissue. An overall uncertainty in predicting the proton beam range in patients of 3–5 per cent was estimated. Xiaochuan Pan (University of Chicago, IL, USA) reviewed the status and future directions of CT technology during his keynote lecture on ‘Advanced computed tomography and its
This talk was followed by Maria del Rosario Pérez (World Health Organization, Geneva, Switzerland), who presented the topic of justification of medical exposures, as discussed in the International Basic Safety Standards (BSS) document. BSS represents the benchmark for radiation safety worldwide and an interim edition was published in 2011, and the adoption by all international cosponsoring organisations is expected to be completed during 2012. Justification is addressed in the first chapter and requires a special approach when applied to medical exposures. The third level of justification, the individual justification, is of primary importance to avoid unnecessary/unintended exposures to patients, the asymptomatic population (health screening programmes), volunteers as part of a research programme, female patients of reproductive capacity and breastfeeding population and nuclear medicine.

Wil van der Putten (Galway University Hospitals, Ireland) presented an overview of the education and training needs for medical physicists arising from the revised European Basic Safety Directive. The reason for the revised Euratom Basic Safety Standards was three-fold; scientific developments were not fully reflected in the current legislation, there were inconsistencies between existing pieces of legislation and the scope of the current directive does not fully cover natural radiation sources or environmental protections. Wil
emphasised that the European Basic Safety Directive is not equal to or the same as the IAEA Basic Safety Statement. He talked about the medical physics expert responsibilities and roles with regards to dosimetry, optimisation and quality assurance. He also discussed the responsibility of the member states to establish a legislative and administrative framework for radiation protection education and training and to make the necessary arrangements for the recognition of services and experts. He also talked about the qualification framework for the medical physics expert, including the education, clinical training, advanced experience and CPD, recognition and re-certification steps.

**George Xu** (Rensselaer Polytechnic Institute, Troy, NY, USA) reviewed the current status of computational phantoms during his talk on ‘Virtual dose software for CT dose tracking involving deformable and personalised phantoms’. The deformable and moving 4D computational phantoms are the latest addition to the computational phantom family of MIRD and voxel-based phantoms. The deformable phantoms have the same height but differ in weight, allowing the estimation of doses for obese patients. He also talked about the VirtualDose software ([http://www.virtualphantoms.com](http://www.virtualphantoms.com)), which is an MCNPX-based software for CT patient dosimetry using the RPI (Rensselaer Polytechnic Institute) computational phantoms family.

**Presentations on doses**

**Lingyuen Chen** (Mayo Clinic, Scottsdale, AZ, USA) gave a talk on dose reduction with Siemens CarekV software using abdominal phantoms of different sizes for a range of modulation strengths. Iodine contrast-to-noise ratios (CNRs) remained relatively constant (with respect to a 120 kV technique) with modulation strength for large phantoms, but an increase was observed for smaller phantoms. Dose reductions of up to 59 per cent relative to the reference technique were estimated. In conclusion, Siemens CarekV tube voltage modulation can results in dose reduction. However, the dose reduction is highly dependent on the patient’s size and diagnostic task. **Bob Liu** (Massachusetts General Hospital, Boston, MA) reviewed the current statutes of quality control for digital breast tomosynthesis. He also referred to the International Breast Phantom Working Group, a co-operation between AAPM and EUREF. The group aims to develop phantoms and evaluation techniques for two- and three-dimensional breast imaging systems.

I was extremely happy to have been selected to present two pieces of my research work as an oral and poster presentation:

1. ‘Patient skin doses for cerebral embolisation procedures using radiochromic films’ and
2. ‘Paediatric effective and organ dose conversion factors for dental cone beam computed tomography using MCNP5’.

The former looks into skin doses for cerebral embolisation in 25 patients using radiochromic films. Average doses of 1.6 Gy and 1.1 Gy for the posterior-anterior and lateral x-ray tubes were measured, respectively. The dose distributions showed that the number of radiation fields used in cerebral embolisation procedures is limited to one to three but there is a tendency of overlapping which gives rise to ‘hot spots’, making the use of radiochromic films an accurate method of measuring maximum skin doses in complex procedures. In addition, this study showed that a dose-area product of 200 Gycm², fluoroscopy time of 60 minutes and 450 images could be used as an indicator for exceeding skin doses of 3 Gy. My poster presentation described the set-up of the MCNP environment for dental cone beam CT (CBCT) and presented organ and effective dose conversion factors.
for a single dental CBCT machine and for a 10-year-old voxel-based phantom. This project was part of the SEDENTEXCT project (www.sedentexct.eu). Both presentations received very good feedback and I was approached by a number of young and senior scientists to discuss my methodology and the findings for both pieces of research.

Sightseeing in China
On Thursday afternoon the congress came to an end, and I ventured into getting to know Beijing. My exploration lasted about 5 days, which I would say is the minimum amount of time to get a good feeling of this amazing city. The weather was gorgeous, with an average temperature of 25–30°C and mostly dry. Beijing is as ‘flat as a pancake’, as they say, and walking around the city is relatively easy, but its size should not be underestimated. If walking is not your thing, Beijing offers a state-of-the-art subway and a taxi is always an option as long as you are ready to bargain your fare in Mandarin; unless, of course, you take a licensed taxi but then again, you spoil the fun of bargaining. If you don’t speak Mandarin, then you add one more challenge to your trip because language is a major barrier which might lead to a dishful of exotic insects instead of the Peking duck dish that you were planning to have as your dinner. Despite all the difficulties that you might face in a city where you do not speak the language, the history and culture of Beijing will pay off. A visit to the Forbidden City, Hutongs, Temple of Heaven, Bell and Drum Towers, Temple of the White Pagoda, Lama Temple, Tiananmen Square, Temple of Confucius and the ‘Legend of Kung Fu’ show at the Red Theatre would reward you for the 12-hour flight, a 7-hour jet lag, the continuous bargaining, the noisily spitting, the queue jumping, and the exotic way of driving and crossing the motorways. Personally, I found it extremely easy to blend in with the locals and even though I did not speak a word of Mandarin, apart from Xie-Xie, I managed to communicate, to taste some delicious and non-adventurous dishes and find my way to a number of different places. If you feel that you need a break from the city, then a very attractive choice is a visit to the Great Wall and the Ming tombs. Together with some other brave delegates, we climbed the West Juyongguan passage which is a very challenging trek. Our legs were not at all happy with the 1,700 steep steps but the Juyongguan is a relatively quiet passage and the West Wall is not only higher than the East but it combines spectacular views and sightseeing. Lastly, if you were wondering why the last Emperors of the Qing Dynasty left the ultra-luxurious Forbidden City to go and live in the Summer Palace, you need to take your already tired legs and visit this national heritage which is on UNESCO’s World Heritage list. The splendid halls, pavilions, temples, lakes and gardens are stunning. I visited the Summer Palace on my last day and I left Beijing the same night with a very sweet taste, a mind full of research ideas, beautiful pictures and a single thought: ‘I will visit this amazing land again’.

‘The longest journey begins with a single step’, a Chinese proverb says. Without the financial support from IPEM and The Christie Medical Physics and Engineering Department, The Christie NHS Foundation Trust, I would not have made that single step to the World Congress and to the Far East.
One way in which IPEM fulfils its charitable aim of advancing physics and engineering applied to medicine is through a programme of awards and prizes that facilitate, recognise or reward work in these fields. Yet it is surprisingly difficult for us to make these awards in some years.

All the awards on offer are open to self-nomination, so natural modesty or lack of awareness may explain the paucity of applications. But most are also open to nomination of a suitable individual by another IPEM member, which should ensure that there are plenty of candidates for the Prizes and Awards Advisory Group to consider. We all work with excellent trainees or colleagues, and both they and our departments would benefit from the recognition that winning an award brings. The application window for 2013 awards opens in January for 3 months, and this article is a reminder to members of the prizes available to be awarded in 2013.

The prizes and awards

The IPEM Travel Award of up to £2,000 aims to enhance research or development work by funding a structured visit to another country. Any IPEM member who can show evidence of an active career in physics or engineering applied to medicine or biology is eligible to apply.

The award offers:
- a 21-day excursion airfare, plus an allowance towards expenses for travel within that country;
- free attendance at the IPEM Annual Conference for one day, free attendance at the Annual Dinner and free accommodation for one night;
- an award certificate.

To apply for this award, you will be required to complete a straightforward application form and submit a CV.

We also need a commitment from the applicant that, following the 3-week period of travel, they will produce a report of the visit suitable for publication. They should be prepared to give seminars about their current work during the trip. Travel should take place after the Annual Conference in the year of the award and before 29th April of the following year.

The IPEM/RCP Essay Prize is worth £1,000. Its purpose is to increase public awareness of the contribution of physics and engineering to healthcare, and this award is made jointly to an IPEM member (of any category) and a Member (MRCP or FRCP) of the Royal College of Physicians. The submission for the award is a jointly written essay of up to 2,000 words on novel work between physical scientists or engineers and physicians, which has exploited or developed any aspect of physics and engineering in medicine and biology. The essay may be either a published article or written with a view to publication. Essays will be judged by referees appointed by the Awards Committee, and the award will be ratified by the President of the Institute and Registrar of the Royal College of Physicians.

The Founders’ Prize of £500 offers encouragement to members of the profession who have made significant contributions to medical physics and bioengineering at an early stage in their career. It is generally awarded to a member of IPEM of less than 5 years standing, who may be self-nominated or nominated by another member. The prize may be taken in books, instruments or cash. The Awards Committee requires a short description of the nominee’s work, together with details of his/her career, publications or other specific and relevant contributions in his/her chosen field. The award can be either for purely scientific aspects of work, or for the successful introduction and implementation of sound physical and engineering principles to clinical practice. We do particularly encourage Fellows to nominate colleagues for this award.

The Manufacturer’s Award, also of £500, recognises the successful introduction of new technology, or the improvement of existing technology, in the fields of physics and engineering applied to clinical practice. Again, the prize may be taken in books, instruments or cash and all that is required is a description of the individual’s contribution, with appropriate details and publications. Fellow members are particularly encouraged to nominate for this award.

The Roy Ellis Award focusses on clinical technologists. It provides £500 to recognise a clinical technologist who has made a significant contribution to the field of medical technology by way of a distinguished paper or project report. All clinical technologists who are IPEM members or associate members are eligible to nominate themselves, or to be nominated by another member. The recipient of this award is chosen by the Awards Committee on the recommendations of the Clinical Technologists’ Committee.

As with the travel award, all the above prizes are announced at the Annual Conference, and recipients are offered a free day’s attendance and overnight accommodation, as well as a place at the Annual Dinner, to collect their prize.

Steve Keevil (President Elect/Chair of Prizes and Awards Advisory Group) would like to remind members of the prizes available to be awarded in 2013.
With increasing collaboration between NHS and non-NHS service providers, and ever-strengthening links to industry and academia, there should be no shortage of eligible members to be nominated -- or to apply -- for these awards. The financial strictures in the NHS are making it more difficult to get support for training, travel and development, so even modest financial prizes, matched with free conference attendance, should be very attractive to colleagues at all stages of their careers. Names of recent winners are shown on page 28, and demonstrate that some awards have not been made for several years. It would be very satisfying if we could make a full set of awards in 2013.

Nominations for awards will be very welcome from January 2013 until April, so that winners can be ratified by Council mid-year and awards made at the Conference. Please look around at your colleagues -- and at yourself -- and consider making an application or a nomination in 2013.

An award winner’s experience

Winner of the 2012 Founders’ Prize: David Eaton, Physicist, Royal Free Hampstead NHS Trust, London

‘Since participating in the IPEM annual conferences as a trainee, I had been aware that the institute offered a range of prizes to recognise different contributions to medical physics and clinical engineering. It was a surprise however that some prizes were not awarded every year. Perhaps this is due to a lack of applicants in the belief that work done within a clinical department is not sufficiently novel to warrant such awards. Having moved to London after my training, I became involved in the technique of intraoperative radiotherapy at the Royal Free. Over the last few years, I have been able to present projects in this area at conferences, in print, and as part of a training course for new users. This body of work seemed to form a suitable application for the Founder’s prize, and my head of department was pleased to nominate me.

‘A few months later, I was delighted to discover I had been awarded the prize and would receive it from the president at the MPEC conference dinner. The dashing red cylinder now sits proudly on my desk, next to one of the bricks with which I performed some of the radiation protection measurements with the unit. I would strongly encourage other members to apply for this award, especially if like me the years are creeping by and you will soon be no longer in your early career. The quality of work presented at meetings and conferences around the UK is testament to the good work being performed in many centres and the application process was very straight-forward, so go for it!’

Winner of the 2011 Manufacturers’ Award: Victoria Curling, Specialist Rehabilitation Engineer, Kings College Hospital, London

‘In 2011, I was awarded the IPEM Manufacturers Award for my project entitled ‘A study of the occupant restraint path in a bespoke special seating system’. The work was completed as part of the Coventry University postgraduate diploma in Rehabilitation Engineering. Bob Appleyard from Unwins Safety Systems was also involved in the project. The study focussed on the needs of severely disabled wheelchair users who are unable to sit in a conventional seat. These people need a custom-made seat or seat insert which is created from a personal cast of their body shape taken while seated comfortably in a beanbag. The personalised seat is then bolted onto a basic wheelchair frame.

‘One of my colleagues at Kings College Hospital Rehabilitation Engineering Division saw the calls for nominations in the IPEM magazine and nominated my project. The nomination involved filling out a simple form which asked for reasons why the piece of work should be considered. An electronic copy of my report was sent off with the nomination form.

‘Coincidently, a month later, I was in a meeting with Bob Appleyard discussing further possible work and projects when I received an email informing me that I had won. Needless to say I was delighted. The award came with a sponsored day at the IPEM conference in Dublin and some prize money. I flew over to Ireland to collect my award and enjoyed the conference, meeting members of IPEM and spent the following weekend exploring Dublin.

‘The award was a great way of raising awareness of the issues highlighted in my project. I have been asked for copies of my work by others who are researching similar subjects. Since then I have been asked to present at conferences such as AREP and PMG’.

Winner of the 2012 Roy Ellis Award: Kate Jones, Trainee Rehabilitation Engineering, Rookwood Hospital, Cardiff

‘I am really grateful and amazed that I won the Roy Ellis Award as I didn’t expect to win!

‘The application process for the prizes and awards was easy and straightforward and you can nominate your own work so there really is no excuse not to get involved.

‘Even if you feel that your research isn’t leading-edge or didn’t produce very significant findings it is worth entering.

‘The prize has definitely helped me to promote the research I am doing and has given me many more opportunities for advancement than I had before’.


[CENTRE] Winner of the 2011 Manufacturers’ Award: Victoria Curling, Specialist Rehabilitation Engineer, Kings College Hospital, London

[RIGHT] Winner of the 2012 Roy Ellis Award: Kate Jones, Trainee Rehabilitation Engineering, Rookwood Hospital, Cardiff
...a full spectrum of *integrated* oncology care solutions

With Elekta, it’s reality.

Timely and accurate patient data remains a cornerstone of effective cancer care. Complicated by numerous unique therapies and technology platforms necessary to manage diverse patient needs, access to comprehensive and reliable patient information can be an extraordinary challenge.

Integrating Elekta’s world-class portfolio of linear accelerators, treatment planning solutions and dedicated radiosurgery and brachytherapy systems, MOSAIQ® Oncology Information Management System continues to set the standard for seamless hardware and software integration, HIS interconnectivity and open-vendor compatibility.

Achieve unsurpassed coordination of comprehensive cancer care with Elekta and MOSAIQ.
**2012 MPEC PRIZES**

**President’s Prize:** there were two prizes awarded this year

<table>
<thead>
<tr>
<th>Year</th>
<th>Winner</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>2012</td>
<td>Jim Daniel (Middlesbrough)</td>
<td>Middlesbrough</td>
</tr>
<tr>
<td>2011</td>
<td>Julia Snaith (Teddington)</td>
<td>Teddington</td>
</tr>
</tbody>
</table>

**Trainee Prize**

<table>
<thead>
<tr>
<th>Year</th>
<th>Winner</th>
</tr>
</thead>
<tbody>
<tr>
<td>2012</td>
<td>Siobhan McVey (Dundee)</td>
</tr>
</tbody>
</table>

**Poster Prize**

<table>
<thead>
<tr>
<th>Year</th>
<th>Winner</th>
</tr>
</thead>
<tbody>
<tr>
<td>2012</td>
<td>Mohammad Al sa’ed (Manchester)</td>
</tr>
</tbody>
</table>

**PAST WINNERS SINCE 2005**

<table>
<thead>
<tr>
<th>Year</th>
<th>Award</th>
<th>Winner</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>2012</td>
<td>IPEM Travel Award (formerly the IPEM/AAPM Travel Award)</td>
<td>Ms Therese Soderlund</td>
<td>London</td>
</tr>
<tr>
<td>2011</td>
<td>IPEM Travel Award (formerly the IPEM/AAPM Travel Award)</td>
<td>Mr Christopher Boylan</td>
<td>Manchester</td>
</tr>
<tr>
<td>2010</td>
<td>IPEM Travel Award (formerly the IPEM/AAPM Travel Award)</td>
<td>Dr Young K. Lee</td>
<td>Sutton</td>
</tr>
<tr>
<td>2009</td>
<td>IPEM Travel Award (formerly the IPEM/AAPM Travel Award)</td>
<td>Ms Lorna Tasker</td>
<td>Swansea</td>
</tr>
<tr>
<td>2008</td>
<td>IPEM Travel Award (formerly the IPEM/AAPM Travel Award)</td>
<td>Not awarded</td>
<td>Oxford</td>
</tr>
<tr>
<td>2007</td>
<td>IPEM Travel Award (formerly the IPEM/AAPM Travel Award)</td>
<td>Mr Andrew Reilly</td>
<td>Oxford</td>
</tr>
<tr>
<td>2006</td>
<td>IPEM Travel Award (formerly the IPEM/AAPM Travel Award)</td>
<td>Not awarded</td>
<td>Oxford</td>
</tr>
<tr>
<td>2005</td>
<td>IPEM Travel Award (formerly the IPEM/AAPM Travel Award)</td>
<td>Ms Catherine Coolens</td>
<td>Oxford</td>
</tr>
<tr>
<td>2012</td>
<td>RCP/IPEM Essay Prize</td>
<td>Not awarded</td>
<td>London</td>
</tr>
<tr>
<td>2011</td>
<td>RCP/IPEM Essay Prize</td>
<td>Not awarded</td>
<td>London</td>
</tr>
<tr>
<td>2010</td>
<td>RCP/IPEM Essay Prize</td>
<td>Dr Charlotte Platten, Dr J. P. Wylie and Dr F. E. Wood</td>
<td>London</td>
</tr>
<tr>
<td>2009</td>
<td>RCP/IPEM Essay Prize</td>
<td>Dr Panayiotis Kyriacou and Dr Andy Petros</td>
<td>London</td>
</tr>
<tr>
<td>2008</td>
<td>RCP/IPEM Essay Prize</td>
<td>Not awarded</td>
<td>London</td>
</tr>
<tr>
<td>2007</td>
<td>RCP/IPEM Essay Prize</td>
<td>Miss O’ Hara and Dr T. Clutton-Brock</td>
<td>London</td>
</tr>
<tr>
<td>2006</td>
<td>RCP/IPEM Essay Prize</td>
<td>Dr Paul White, Dr R. Kharbanda and Dr A. N. Redington</td>
<td>London</td>
</tr>
<tr>
<td>2005</td>
<td>RCP/IPEM Essay Prize</td>
<td>Not awarded</td>
<td>London</td>
</tr>
<tr>
<td>2012</td>
<td>Founders’ Prize</td>
<td>Mr David Eaton</td>
<td>London</td>
</tr>
<tr>
<td>2011</td>
<td>Founders’ Prize</td>
<td>Not awarded</td>
<td>Oxford</td>
</tr>
<tr>
<td>2010</td>
<td>Founders’ Prize</td>
<td>Not awarded</td>
<td>Oxford</td>
</tr>
<tr>
<td>2009</td>
<td>Founders’ Prize</td>
<td>Not awarded</td>
<td>Oxford</td>
</tr>
<tr>
<td>2008</td>
<td>Founders’ Prize</td>
<td>Mr Andrew Reilly</td>
<td>Oxford</td>
</tr>
<tr>
<td>2007</td>
<td>Founders’ Prize</td>
<td>Not awarded</td>
<td>Oxford</td>
</tr>
<tr>
<td>2006</td>
<td>Founders’ Prize</td>
<td>Not awarded</td>
<td>Oxford</td>
</tr>
<tr>
<td>2005</td>
<td>Founders’ Prize</td>
<td>Not awarded</td>
<td>Oxford</td>
</tr>
<tr>
<td>2012</td>
<td>Manufacturers’ Award</td>
<td>Not awarded</td>
<td>London</td>
</tr>
<tr>
<td>2011</td>
<td>Manufacturers’ Award</td>
<td>Ms Victoria Curling</td>
<td>Hull</td>
</tr>
<tr>
<td>2010</td>
<td>Manufacturers’ Award</td>
<td>Not awarded</td>
<td>London</td>
</tr>
<tr>
<td>2009</td>
<td>Manufacturers’ Award</td>
<td>Professor Andrew Beavis</td>
<td>Newcastle Upon Tyne</td>
</tr>
<tr>
<td>2008</td>
<td>Manufacturers’ Award</td>
<td>Dr Panayiotis Kyriacou</td>
<td>Sunderland</td>
</tr>
<tr>
<td>2007</td>
<td>Manufacturers’ Award</td>
<td>Dr John Allen</td>
<td>Newcastle Upon Tyne</td>
</tr>
<tr>
<td>2006</td>
<td>Manufacturers’ Award</td>
<td>Mr William Allan</td>
<td>Sheffield</td>
</tr>
<tr>
<td>2005</td>
<td>Manufacturers’ Award</td>
<td>Dr Iain Chambers and Dr A. Clark (joint winners); Dr B. Heller and Dr P. Bacon (joint winners)</td>
<td>Sheffield</td>
</tr>
<tr>
<td>2012</td>
<td>Roy Ellis Award</td>
<td>Ms Kate Jones</td>
<td>Cardiff</td>
</tr>
<tr>
<td>2011</td>
<td>Roy Ellis Award</td>
<td>Not awarded</td>
<td>Cardiff</td>
</tr>
<tr>
<td>2010</td>
<td>Roy Ellis Award</td>
<td>Ms Lucy Wills</td>
<td>Cardiff</td>
</tr>
<tr>
<td>2009</td>
<td>Roy Ellis Award</td>
<td>Not awarded</td>
<td>Cardiff</td>
</tr>
<tr>
<td>2008</td>
<td>Roy Ellis Award</td>
<td>Not awarded</td>
<td>Cardiff</td>
</tr>
<tr>
<td>2007</td>
<td>Roy Ellis Award</td>
<td>Not awarded</td>
<td>Cardiff</td>
</tr>
<tr>
<td>2006</td>
<td>Roy Ellis Award</td>
<td>Ms Mary Halewood</td>
<td>Newcastle Upon Tyne</td>
</tr>
<tr>
<td>2005</td>
<td>Roy Ellis Award</td>
<td>Not awarded</td>
<td>Newcastle Upon Tyne</td>
</tr>
</tbody>
</table>
Virtual phantoms for real QA

Deformable image registration, auto-contouring and IGRT are growing fast. How do you use hard phantoms to test these systems? Answer: You can’t.

ImSimQA™ is an essential tool for testing modern auto contouring, IGRT, deformable and rigid image registration, 4D planning software and more.

Use virtual phantoms or real DICOM images to transform, deform and create new DICOM data, then quantify and analyse results in ImSimQA.

Efficient QA, advanced techniques
If you want to ask questions, then Tweet or email us.’ So said the chairman of the first plenary session in the huge hall of the Scottish Exhibition and Conference Centre of the International Radiation Protection Association Congress (IRPA13) on the banks of the River Clyde in Glasgow in May.

Taking the theme ‘Living with radiation, engaging in society’, the congress embraced the technology of smartphones, iPads and notebooks, and there was even a conference app so that you could check what you should go to and where you should be.

The conference covered radiation safety in all its applications across the world, with 1,500 participants, plus a further 1,200 school children at the SRP schools day listen to Peter Marsden (University College London) speak about the exciting developments of the use of radiation in medicine.

Covering 5 days, with up to five parallel sessions, a large technical exhibition and maybe 1,000 posters, it is impossible to summarise, or pick up highlights – except personal ones – and maybe I missed the most important highlights! But at least the tradition of publishing full papers of each presentation provides a valuable resource to fill in any gaps.

The latest research on the effects of ionising radiation and electromagnetic fields was presented, including the increased risk of cardiovascular disease from ionising radiation. Proposed revised dose conversion factors for radon were presented, which are necessary to assess population risk from radon in view of the reducing numbers in the population who smoke. My own research, presented as an oral paper, demonstrated the impact of UK Government smoking cessation programmes on the reduction of radon-induced lung cancers.

**Poster presentations**

IPEM and the topics of radiation safety in medicine were well represented. We presented a poster on the development of the e-IRMER radiation safety training course for referrers and operators in diagnostic radiology – although we were unable to give a definitive date for the launch of the sessions, which are in the final stages of proofing, so maybe autumn 2012. There were a number of posters on radiation safety implications following unsealed isotope therapy, such as patient discharge following Yttrium-90 Dotatate, iodine therapy for a patient receiving regular haemodialysis, and death and repatriation of another patient after iodine therapy. There was an oral session on the implementation of the justification principle for patient exposures, and how this could be improved to further reduce unnecessary and inappropriate exposures of patients. I was intrigued by a poster which indicated that there was some variability of the implementation of procedures to check pregnancy status throughout the UK.

In line with the theme, there were a number of posters and presentations on public risk perception and communication of risk. There were many more posters and papers on these subjects, and, of course, radiation safety in other industries, which I do not have space to mention – or had the time to find out about at IRPA13 – but which you could track down on the conference website.

After days of calm Scottish efficiency, the congress dinner closed with an anarchic group of musicians with bagpipes and drums – I have never heard ‘Wild Thing’ by the Troggs played like that before! The only downside of the week was the dreich weather! (English meaning: damp, dizzily, cold wet weather – the kind that gets under your skin.)
A fter a successful meeting in Plymouth in 2011, the South West Annual Scientific Meeting was hosted by University Hospitals Bristol NHS Foundation Trust on 11th and 12th May. The meeting provided an excellent opportunity to celebrate success in the fields of medical physics and clinical engineering and to enable the sharing of ideas to improve services in the region. It included presentations on improving the understanding, detection and treatment of disease and disability in order to make a difference to patients.

**Opening the conference**

The conference started with a head of departments’ meeting on the Friday morning. This was followed by lunch on a boat trip around Bristol harbour accompanied by interesting stories about the SS Great Britain and other Bristol landmarks. This provided an ideal opportunity to catch up with colleagues in the sunshine. The day finished with a meal at Bristol Zoo Gardens (figure 1) with an hour spent exploring the grounds with a glass of Pimms. A fascinating after-dinner talk was given by Virginie Barberet (Bristol Veterinary School) about the challenges of medical imaging in the veterinary world. The animal theme was continued with a fun quiz identifying animals from x-ray images.

“This included raising the awareness of the contribution of healthcare science to patient care.”

The science discussion began early on Saturday morning at the Trust’s Education Centre. The meeting was opened by Sean O’Kelly (UH Bristol NHS FT) and promised a range of physics and engineering presentations from across the region. After Dr O’Kelly’s kind welcome, Diane Crawford (Regional Scientific Director, Bristol) updated the audience on the Health and Social Care Act and the implications for medical physics departments. This included raising the awareness of the contribution of healthcare science to patient care.

Jonathan Brooks (Clinical Research Imaging Centre, Bristol) presented his work measuring the functional response of the spinal cord to develop techniques in chronic pain management. Ipsilateral spinal cord responses were found using thermal and non-painful punctuate stimulation. Hannah Dalton (Salisbury NHS FT) presented a project which developed a functional electrical stimulation (FES) electrode positioning locator to improve patient motor skills. Many patients have difficulty placing the FES electrodes correctly so a locator device was designed to improve their quality of life.

The theme of radiotherapy

The presentations then moved on to the topic of radiotherapy. David Hall (UH Bristol NHS FT) presented work using FDG-PET CT as a biomarker in oesophageal cancer correlating imaging with pathological findings during surgery and overall survival. A correlation was found between a high total metabolic activity and a poorly differentiated tumour. The best presentation prize was awarded to Jennifer Young (Royal Devon and Exeter NHS FT) for her presentation on the clinical implementation of MOSFET detectors of in vivo dosimetry of electron beam.

**Figure 1. Conference dinner at Bristol Zoo Gardens**
treatments. The performance of the detectors under different beam and environmental conditions was investigated with promising results, and a suggested ±7 per cent tolerance for clinical measurements (figure 2).

Matthew Cann (Royal Devon and Exeter NHS FT) continued the radiotherapy theme with a study into the effectiveness of gold markers in the imaging of prostate patients to improve patient positioning. The largest positioning error was seen in the superior-inferior direction with a shift of 0.12 cm required when using the gold marker positions and 0.28 cm when using bony anatomy matching. Anne-Marie John (UH Bristol NHS FT) then discussed patient-specific IMRT QC that is performed in Bristol. The evolution from Gafchromic film and point dose measurements, the use of a 2D ionisation chamber array, to a full ‘offline’ Monte Carlo simulation of the treatment plan was summarised.

Moving on to the problems of software development, Paul Stevens (UH Bristol NHS FT) presented the challenges of testing bespoke software within medical physics departments. Automatic testing requirements, which can lead to a better software package, were discussed.

The topic then moved to diagnostic imaging with Liz Pitcher (UH Bristol NHS FT) discussing the merits of mammography image quality testing. The merits and limitations of different image quality measurements were presented with the difficulties of comparing measurements across sites. Andrew Gammie (North Bristol NHST) presented his engineering work in urodynamics. He emphasised the need for engineers to have a good clinical understanding and be involved with day-to-day clinical services to be able to effectively develop solutions to clinical problems.

Summary
Haidong Liang (UH Bristol NHS FT) spoke about developments in continuous wave ultrasound Doppler tomography to improve the spatial resolution of ultrasound imaging. Using both amplitude and phase information, a spatial resolution of 0.19 wavelengths can be achieved. The final presentation of the day was given by Francis Duck (Bath University). He gave a fascinating talk about Edith Stoney, the first woman in medical physics. From designing the first physics course at the London (Royal Free) School of Medicine for Women, to establishing and operating radiographic and electrotherapy facilities in field hospitals during the war, her life took many interesting turns.

During the breaks delegates were able to explore the exhibition and poster area. At the end of the day delegates were also given the opportunity to tour the Simulation Centre in Bristol, where elaborate dummies, which can be programmed to respond in different ways to external stimuli and pharmaceuticals, are used to train medical staff.

Overall, the meeting received lots of positive feedback, with delegates praising the quality of the presentations, the variety of interesting research and the friendly, inspiring atmosphere. The support of all those involved in organising the meeting was greatly appreciated. Here’s to next year in Taunton![4]
After a year in the online study programme of Heidelberg University on Advanced Physical Methods in Radiotherapy, I want to look back and evaluate. What did this give me in terms of personal growth? What did I learn?

Well, I’ve learned that we are lucky, all of us, living in an unprecedented period of change and evolution, with our wonderful technology opening countless doors for us. This technological world has endless possibilities. We are fortunate enough that we can work and cover all our physical needs just by using the knowledge we have in a particular field. It is a commodity as important as a farm, a shop or a gold mine, and sometimes even more productive. We can glide through this ever-smaller world with no barriers, and we can travel light, just needing a passport, a credit card and the capabilities of our trained brains. Everything else can be obtained wherever we go.

What has been the answer?

But this marvellous technological world is also a demanding one. We have to keep up, we can never sleep, what we know today may be important, but tomorrow is less so, and the next day may be useless; like all my Fortran coding skills are useless in the object-oriented programming world.

And we know that, so we keep learning as we live, continuous education is more than a process, it is a way of life, it’s what keeps us sharp and in the crest of the wave, it’s what keeps our asset valuable, it’s what makes us competitive, what keeps the shop open. Sometimes we can be fortunate enough to work in cutting edge technological developments, but most of the time we nurture from the work of others, and try to assimilate as much as we can whilst we do other things.

I, like many others, have been doing this for many years, but I’ve always missed the intensity and the disciplined approach to learning that I enjoyed in my college years, the depth of study, the heavy demand, the organisation of subjects and elements that even though they seemed disconnected sometimes, all made sense in the grand finale of the course completion.

So how to keep up and enjoy the benefits of organised study? We can do it as it is traditionally done, having journal subscriptions, buying books, attending meetings, etc., etc., but we can also look at the possibilities of our information era. This wonderful technology, so demanding to keep up with, also has the answer to it in the form of online study.

More and more first-class universities are offering online postgraduate study programmes, in all fields, and medical physics is no exception. So when I discovered that Heidelberg University was offering a Masters online in Advanced Physical Methods in Radiotherapy, I knew it was a good idea even for someone who has been working in the field for almost 15 years; a good way to get a formal review of all the new things that came to the field in recent times, from a somehow standard technology nowadays like IMRT to less accessible ones like carbon ion therapy (this only available in three countries).

Being halfway through the programme, I can look back and evaluate, I can ask myself ‘how is it so far’?

This has been a great experience, to go back to college whilst still working in the field, to be able to round-up my knowledge of many crucial areas of modern-day practice, to learn new things in the field, to re-learn concepts I thought I knew already but that could certainly use a refresh, to take the time to do an in-depth study of every particular area of modern medical physics practice, to learn from the masters, from theory to instrumentation, from anatomy to physics, the view of the physicist and the view of the physician, all under the umbrella of a world-class university that I had as one of my wish list items when I was an undergrad student.

Exciting possibilities

We are clearly lucky. Because of all the tools of the information era, one can attend an online study programme that gives the same (or more) benefits as traditional learning. Online lectures complemented with on-site visits and attendance phases are powerful learning tools; one can attend the classes from anywhere in the world and participate and ask questions of the professors, then re-attend the classes as many times as desired, just by replaying the recorded video lectures, with electronic libraries that put all the journals and books of the field at the fingertips. And we can do all that in the time we choose to, or stop it in the middle to go and check on a newborn son, and come back later to it.

How many people couldn’t keep up with college study under the demands of work or family life? Well, all that is gone. We can work and study, raise a family and study, travel to the other side of the world and still keep current with the study programme. I have attended the lectures from the US, Europe, Argentina and Japan, all whilst travelling for business or pleasure, so online study is truly a great way to study.

So these great times we live in give us exciting albeit demanding technological possibilities, and give us the tools to stay current in those technologies. Online study is certainly here to stay, is the learning way of the future, already in our present, and I plan to keep making good use of it. I plan to keep up.

We can work and study, raise a family and study, travel to the other side of the world.

“\n
So how to keep up and enjoy the benefits of organised study? We can do it as it is traditionally done, having journal subscriptions, buying books, attending meetings, etc., etc., but we can also look at the possibilities of our information era. This wonderful technology, so demanding to keep up with, also has the answer to it in the form of online study.

More and more first-class universities are offering online postgraduate study programmes, in all fields, and medical physics is no exception. So when I discovered that Heidelberg University was offering a Masters online in Advanced Physical Methods in Radiotherapy, I knew it was a good idea even for someone who has been working in the field for almost 15 years; a good way to get a formal review of all the new things that came to the field in recent times, from a somehow standard technology nowadays like IMRT to less accessible ones like carbon ion therapy (this only available in three countries).

Being halfway through the programme, I can look back and evaluate, I can ask myself ‘how is it so far’?

This has been a great experience, to go back to college whilst still working in the field, to be able to round-up my knowledge of many crucial areas of modern-day practice, to learn new things in the field, to re-learn concepts I thought I knew already but that could certainly use a refresh, to take the time to do an in-depth study of every particular area of modern medical physics practice, to learn from the masters, from theory to instrumentation, from anatomy to physics, the view of the physicist and the view of the physician, all under the umbrella of a world-class university that I had as one of my wish list items when I was an undergrad student.

Exciting possibilities

We are clearly lucky. Because of all the tools of the information era, one can attend an online study programme that gives the same (or more) benefits as traditional learning. Online lectures complemented with on-site visits and attendance phases are powerful learning tools; one can attend the classes from anywhere in the world and participate and ask questions of the professors, then re-attend the classes as many times as desired, just by replaying the recorded video lectures, with electronic libraries that put all the journals and books of the field at the fingertips. And we can do all that in the time we choose to, or stop it in the middle to go and check on a newborn son, and come back later to it.

How many people couldn’t keep up with college study under the demands of work or family life? Well, all that is gone. We can work and study, raise a family and study, travel to the other side of the world and still keep current with the study programme. I have attended the lectures from the US, Europe, Argentina and Japan, all whilst travelling for business or pleasure, so online study is truly a great way to study.

So these great times we live in give us exciting albeit demanding technological possibilities, and give us the tools to stay current in those technologies. Online study is certainly here to stay, is the learning way of the future, already in our present, and I plan to keep making good use of it. I plan to keep up.

We can work and study, raise a family and study, travel to the other side of the world.

“\n
So how to keep up and enjoy the benefits of organised study? We can do it as it is traditionally done, having journal subscriptions, buying books, attending meetings, etc., etc., but we can also look at the possibilities of our information era. This wonderful technology, so demanding to keep up with, also has the answer to it in the form of online study.

More and more first-class universities are offering online postgraduate study programmes, in all fields, and medical physics is no exception. So when I discovered that Heidelberg University was offering a Masters online in Advanced Physical Methods in Radiotherapy, I knew it was a good idea even for someone who has been working in the field for almost 15 years; a good way to get a formal review of all the new things that came to the field in recent times, from a somehow standard technology nowadays like IMRT to less accessible ones like carbon ion therapy (this only available in three countries).

Being halfway through the programme, I can look back and evaluate, I can ask myself ‘how is it so far’?

This has been a great experience, to go back to college whilst still working in the field, to be able to round-up my knowledge of many crucial areas of modern-day practice, to learn new things in the field, to re-learn concepts I thought I knew already but that could certainly use a refresh, to take the time to do an in-depth study of every particular area of modern medical physics practice, to learn from the masters, from theory to instrumentation, from anatomy to physics, the view of the physicist and the view of the physician, all under the umbrella of a world-class university that I had as one of my wish list items when I was an undergrad student.

Exciting possibilities

We are clearly lucky. Because of all the tools of the information era, one can attend an online study programme that gives the same (or more) benefits as traditional learning. Online lectures complemented with on-site visits and attendance phases are powerful learning tools; one can attend the classes from anywhere in the world and participate and ask questions of the professors, then re-attend the classes as many times as desired, just by replaying the recorded video lectures, with electronic libraries that put all the journals and books of the field at the fingertips. And we can do all that in the time we choose to, or stop it in the middle to go and check on a newborn son, and come back later to it.

How many people couldn’t keep up with college study under the demands of work or family life? Well, all that is gone. We can work and study, raise a family and study, travel to the other side of the world and still keep current with the study programme. I have attended the lectures from the US, Europe, Argentina and Japan, all whilst travelling for business or pleasure, so online study is truly a great way to study.

So these great times we live in give us exciting albeit demanding technological possibilities, and give us the tools to stay current in those technologies. Online study is certainly here to stay, is the learning way of the future, already in our present, and I plan to keep making good use of it. I plan to keep up.
The annual Medical Physics Expert (MPE) update was held on 9th July 2012 with a packed lecture theatre at Cardiff University. The meeting was jointly organised by the diagnostic radiology and nuclear medicine special interest groups (DRSIG and NMSIG) covering areas of concern for MPEs in diagnostic radiology, nuclear medicine and radiotherapy.

The day began with Stephen Evans (Northampton General Hospital NHS Trust) discussing the role of the MPE as well as education and training requirements. It was reported that the revised basic safety standard will require that ‘an MPE shall be involved’ with standardised therapeutic nuclear medicine practices as well as in radiodiagnostic and interventional radiology practices. This appears to represent a strengthening of the role of an MPE in radiology, when compared to the Ionising Radiation (Medical Exposures) Regulations, which require that an MPE is involved as appropriate for consultation on optimisation.

The talk went on to discuss the proposed framework for the training and accreditation of MPEs in Europe. The requirements will be based on European qualification framework 8. It is expected that each member state will designate a competent authority for the recognition through registration of MPEs.

Some of the issues confronting lead MPEs for clinical research trials were discussed by Elly Castellano (Royal Marsden NHS Foundation Trust, London), including: how to do dose reports for trials that appear open ended; difficulty in deciding what constitutes routine clinical care; NDRLs are often not representative (e.g. CT); inadequate and often incorrect information being included in patient information sheets (PIS), and exams involving ionising radiation not always being declared in study protocols.

Giles Morrison (Sheffield Teaching Hospital NHS Foundation Trust) presented an update from the National Research Ethics Service (NRES) Radiation Committee. He reported that work on new guidance is expected to begin in September 2012. It is anticipated that this guidance will provide a better definition of what constitutes a research exposure, and enable proportionate and suitable MPE reports, as well as providing templates for these reports. Giles suggested that when all exposures form part of routine clinical care, risks are very small (2 mSv or less) or the prognosis of the study group is very poor, then a proportionate report, perhaps even a generic template, should be adopted. For moderate risk procedures greater scrutiny is required from the MPE’s report, with due consideration being given to the age range, prognosis and sex of the cohort. Suggested generic PIS statements were also presented.

Debate on holding a central database
A lively debate was held between Elly Castellano and Ed McDonagh (Royal Marsden NHS Foundation Trust, London). The issue at stake was whether anonymised electronic dose data should be submitted to a central national repository, from where it could be freely accessed by all. The debate focussed on two main areas – whether such a system is feasible and whether it is desirable. Ed contended that the technology is available to easily support such a system, while Elly countered that issues with different data formats from different systems may make implementation very difficult. This point was supported in a later talk by David Platten (Northampton General Hospital), where he described difficulties in obtaining any dose data which he had confidence in from the local radiology information system. Ed contended that a central database would allow users to view the data in different samples, perhaps providing additional information to inform research and optimisation. Elly had concerns about integrity of the data, and perhaps more fundamentally about the data being used inappropriately by individuals that did not fully understand the data, to form reports and league tables. A show of hands indicated that the audience was split, but with a significant majority against the idea.

Andy Bradley (Manchester Royal Infirmary) spoke in the afternoon about some optimisation work they had been doing in Manchester on myocardial perfusion imaging. They had initially tried reducing administered activity by 50 per cent with the joint motivations of dealing with Technetium shortages and reducing patient dose. It was found that this reduction could not be tolerated with some scans becoming undiagnostic; however, further work showed a 30 per cent reduction could be tolerated. This has allowed a 30 per cent patient dose reduction, and a cost saving of £1,400 per week in the department.

The day covered a wide range of issues affecting MPEs from different modalities. There was opportunity for lots of lively discussion during which a number of helpful solutions to problems were suggested. A further MPE update will be held in 2014.
From 2nd–6th July 2012, 35 early-career researchers from a range of disciplines, including imaging physicists, computational biologists, clinicians and mathematicians, attended the 2012 Mayneord–Phillips Summer School at Queen’s College, Oxford (figure 1). The Mayneord–Phillips Trust was established in 1991 by the Institute of Physics, Institute of Physics and Engineering in Medicine and the British Institute of Radiology to commemorate the pioneering work of Professor W. V. Mayneord and Major C. S. Phillips in the field of radiation physics applied to medicine.

The Trust provides education to early-career researchers in medical physics and related fields through biennial summer schools. Previous schools have covered either specific modalities (such as PET, radiotherapy and ultrasound) or have focussed on a specific part of the body (such as the lungs and the brain). This year it was the turn of the cardiovascular system, with the title of the school being ‘Cardiac imaging and modelling: principles, methods and clinical relevance’.

The timetable for the summer school promised a busy week with a range of educational and interactive sessions, and opportunities to present our own work as well as a visit to a clinical MRI centre. There was also plenty of chance for informal discussions between delegates and the faculty, with most of the latter staying for the duration of the week.

A key strength of this event was the mix of people in attendance from across the UK and further afield. This included scientists and clinicians from academic, healthcare and industrial sectors with interests in a wide range of topics within the remit of this year’s school. In our role as scientists we necessarily have to focus on a relatively narrow field and one of the most important lessons from this course was that we all have a need to maintain an awareness of what other modalities can offer, and of course keeping in mind the limitations of our own field. Communication across fields and multidisciplinary working is clearly necessary to address this, and facilitating this amongst early career researchers was a key aim of the organising committee.
Monday

The course opened on Monday morning with an enthusiastic welcome from Trustees Alan Murray (Newcastle University) and John Ridgway (Leeds Teaching Hospitals). This was followed by the first keynote lecture from Alejandro Frangi (University of Sheffield and Universitat Pompeu Fabra, Spain). This talk highlighted the explosion of data that is becoming available to clinicians through integration of multiple modalities and the trend towards true four-dimensional (spatial plus temporal) data acquisition.

Following a chance for everyone to introduce their own background and expectations of the summer school, Tobias Schaeffter (Kings College London) provided an excellent overview of cardiac anatomy and physiology.

The rest of the day’s talks focussed on the theory and practice of a range of cardiac imaging modalities. Andrew Davies (University of Leeds) opened with an overview of x-ray angiography, covering the physics behind the production and detection of the x-ray beam and generation of the final image, through to a discussion of clinical applications of the technique and the concerns regarding radiation dose. Alison Noble (University of Oxford) followed with an overview of echocardiography, focussing on the move towards three-dimensional imaging and the use of ultrasound as a quantitative tool. Techniques such as speckle tracking and microbubble enhancement were discussed, along with the challenges of co-registration of ultrasound images with those from other modalities such as MRI, where the image properties are often significantly different.

Dr Ridgway introduced the basics of magnetic resonance imaging physics and moved on to specific cardiac MRI applications. This talk highlighted the wide range of data, both structural and functional, that can be obtained using this highly versatile technology. The last of the imaging talks covered cardiac CT and was presented by Ed Nicol (Royal Brompton Hospital, London). Dr Nicol described first of all some of the technological developments of cardiac CT before moving on to describing a range of clinical questions which are well addressed by this technique (while acknowledging those where other modalities are preferred).

To bring the day to a close all of the speakers returned to the stage for the first forum of the summer school, comparing the advantages and limitations of the various imaging modalities available in clinical cardiology today. This stimulated a lively conversation to bring the educational content of the first day to a close.

Tuesday

Following on from a day of talks about cardiac imaging, Tuesday transitioned to modelling cardiac mechanics, starting with a talk by Philip Kilner (Royal Brompton Hospital, London) about cardiac form and structure in relation to fluid function. His talk provided a thought-provoking look at the presence of increasingly sophisticated structural features in the heart associated with increasingly complex vertebrates.

The keynote speaker, Dominique Chapelle (INRIA-Rocquencourt, France), presented a systematic overview of how a whole-heart electrically-coupled mechanics model could be constructed based on phenomena occurring at different spatial and temporal scales. The clinical relevance of the model was then demonstrated by showing impressive correlations between the predictions of the model and functional MR data.

Professor Schaeffter delivered his second presentation of the week, tying together the themes of the first two days by providing an overview of how current imaging techniques can obtain information about the mechanics of the heart.

Phillippe Moireau (INRIA-Rocquencourt, France) then talked about estimation techniques for fitting model parameters based on minimising discrepancies between imaging data and cardiac model simulations. A take-home message from this talk was ‘balancing model complexity with predictivity’, ensuring that the model parameters are biophysically representable and that the model is able to serve some predictive purpose. This opened the floor to discussion during the forum session about model design and utility and provided
high-level perspectives from the panel on these modelling issues.

The cardiac electrophysiology (EP) workshop was led by Richard Clayton (University of Sheffield) and was an opportunity for students from all backgrounds to ask questions on the topic. The discussion began with the relationship between calcium transients and myocyte contraction, and quickly delved into the mechanisms behind the development of calcium transients. The concepts of resting membrane potential and ion fluxes yielding action potentials over the course of a heart cycle were discussed. Focus then turned to the origin of these action potentials in cardiac pacemaker cells and the conduction pathways along which action potentials are propagated. This workshop provided a helpful precursor to the electrophysiology lectures to follow on Wednesday.

Wednesday
The focus of Wednesday was cardiac electrophysiology. T. Alex Quinn (Imperial College London) gave the keynote lecture on different strategies to model the electrophysiology of the heart, providing a history of the development of the models from their birth as simple circuit diagrams in the early 1950s.

He was followed by Sabine Ernst (Royal Brompton Hospital, London) who explained the clinical protocol of EP studies. Furthermore, she presented different case studies and showed how novel techniques such as fusion of pre-acquired 3D anatomical information can improve the outcome of EP studies. Dr Ernst concluded by detailing a wish list of what could further improve EP studies to the audience, hopefully inspiring and motivating future project ideas.

Dr Clayton then discussed several different software packages which can be used for EP modelling, providing some tricks and tips for those wishing to use these methods in their own work. The last talk of the day was given by Mikael Wallman (University of Oxford) on patient-specific EP models. This talk identified the differences between the two sides of modelling – predictive modelling to estimate observable outcomes from a given set of parameters and the reverse problem of using measured data to estimate potentially unobservable parameters.

The workshop session ‘Hands on flow’ (figure 2) turned out to be a literal description of what to expect. Dr Kilner had drawn on his scientific and clinical experience, as well as that gained in his other career in sculpture, to set up a wide variety of experiments to demonstrate often counter-intuitive flow effects. They ranged from simple trays filled with different liquids mixed with micro-dust to sesame seeds in little bowls. Students and speakers watched fascinated as Dr Kilner visualised different flow patterns with very simple aids, and students were surprised at how difficult it can be to qualitatively explain the outcomes of these simple experiments. This workshop also made the attendees eager to get their hands on micro-dust in order to be able to repeat his experiments at home.

Thursday
Thursday’s talks focussed mainly on coronary blood flow, with the keynote lecture given by Sarah Waters (University of Oxford) on ‘Mathematical modelling of physiological flows’. Her talk demonstrated the impact of blood vessel curvature on the distribution of wall shear stress using a finite element model of coronary blood flow. She presented a mathematical model to investigate the relation between regions of low wall shear stress and susceptibility to atherosclerosis. The results demonstrated how asymmetric cross-sectional flow profiles are generated in curved vessels yielding variations in wall shear stress, which could be useful in assessing susceptibility of patients to coronary atherosclerosis. Further modifications to the model for more realistic flow were then discussed, including coupling fluid flow to cardiac wall motion and mechanics.

Interventional cardiologist Justin Davies (National Heart and Lung Institute, Imperial College London) then discussed analyses of coronary artery haemodynamics in health and disease with a presentation on wave intensity analysis (WIA). An explanation of the forward and backward travelling waves in WIA and their relation to features of blood flow during the cardiac cycle was given, with examples of how these waves are affected in diseases such as coronary artery disease, hypertrophic cardiomyopathy and amyloidosis. The concept of fractional flow reserve (FFR) and its measurement using invasive catheterisation was also explained, and demonstrated that even a simple model could provide powerful predictive value in a clinical context, here specifically on the severity of a coronary stenosis. Finally, instantaneous wave-free ratio (iFR) was briefly introduced as a potential clinical game-changer providing an alternative to FFR without the need for the undesirable stress testing required for its calculation.

Another approach to analysing coronary blood flow was then presented by Amedeo Chiribiri (Kings College London) who talked about the growing clinical utility of first-pass perfusion (FPP) MRI. The superior spatial resolution of FPP-MRI compared to the traditional technique of single-photon emission computed tomography (SPECT) in cardiac perfusion imaging was shown, which allows for the delineation of transmural perfusion defects in the heart wall and assessment of the coronary microcirculation. The routine clinical use of FPP-MRI looks to become more widespread, with recent studies showing the superior sensitivity and specificity of this modality over SPECT in detecting coronary artery disease.

The final talk of the day was delivered by Graeme Penney (Kings College London) on methods of image registration to guide clinical interventions and to merge structural and functional information from different imaging modalities. An excellent overview of the theory behind the most widely used image registration methods was given, which was framed very much from a modelling perspective in the sense that registration techniques themselves are models which can describe the deformation between two images, and thus need to be chosen according to the adequacy of their parameters for said description. Applications of image registration presented were speckle tracking in cardiac ultrasound to assess cardiac wall motion, registration of anatomical MRI images to real-time invasive angiography for image-guided interventions and 3D flow quantification from Doppler ultrasound.

Thursday’s talks provided a fascinating look at coronary flow modelling, flow analysis and perfusion imaging for assessing coronary function and demonstrated the wide range of applications for image registration. It ➤
was also exciting to see advances emerging in these fields and how they are ultimately being translated to applications in a clinical setting.

On Thursday afternoon a visit to the Oxford Centre for Clinical Magnetic Resonance at the John Radcliffe Hospital took place. An overview of different cardiac pathologies which are routinely diagnosed and assessed with MRI at this hospital was followed by visits to 3T and a newly acquired 7T MRI systems.

The image obtained from a pineapple with the 7T scanner demonstrated impressively the possibilities of high field strengths. Cardiac in vivo cine images also showed some of the difficulties which have to be overcome before such scanners could be used in routine patient examinations.

A few standard clinical MR protocols were demonstrated in a volunteer at the 3T MR system and showed the excellent anatomical information which can be obtained with MRI alongside additional functional information such as quantitative blood flow.

**Friday**

Friday’s talks addressed the current challenges and unmet needs facing the field of cardiac modelling, with the keynote lecture given by Peter Kohl (University of Oxford and Imperial College London) introducing some concepts of the philosophy behind multi-scale modelling. The lecture began with a definition of the word ’model’ as ‘a simplified representation of reality’, which should be ‘as simple as possible, [and] as complex as necessary’. A vision of how computational modelling and systems biology have the capacity to integrate information spanning from gene expression to proteins to cells to tissues to organs and to an organism was given, with reference made to the Virtual Physiological Human Project. Peter then talked more specifically about modelling cardiac electrophysiology, presenting recent work on cell models and the latest ex vivo techniques for acquiring high-resolution muscle fibre architecture.

Dr Kilner then provided a complementary perspective on modelling with a talk about the utility of physical models in understanding blood flow. Specifically he discussed the design and construction of a physical impedance pump model which ultimately aided the development of a surgical procedure for the treatment of congenital defects in young patients needing a Fontan operation. He also talked about how efficient flow can be facilitated in the heart by the asymmetry of the heart chambers, which influences the development of helical patterns of blood flow. Ricardo Petraco (National Heart and Lung Institute, Imperial College London) then presented findings that demonstrated the limitations of using luminal narrowing quantified from angiography as a surrogate metric for FFR in determining
the physiological severity of a coronary stenosis. He showed how computational fluid dynamics (CFD) simulations demonstrate that a coronary lesion with a non-significant narrowing, but whose geometry causes flow disturbances, can have just as severe an effect on flow reduction as a narrowing with more pronounced luminal reduction. This has implications for clinical practice and highlights potential future applications of cardiac modelling alongside high-resolution image data acquisition to more accurately assess coronary artery stenoses.

The final talk of the summer school was given by Nicolas Smith (Kings College London) on the limitations and applications of computational cardiac models. A major limitation highlighted was the use of data collected on cell models from a range of species to parameterise a model of a single species. This is something that needs to be addressed especially with many research centres now moving cardiac models into a clinical context with the aim of creating personalised patient models.

On the topic of clinical applications, current developments in a range of computational cardiac models were presented. These included the simulation of fluid–structure interactions of the blood flow in the left ventricle for optimising the design of a left ventricle assist device (LVAD); the simulation of coupled mechanics–electrophysiology in a biventricular model for the prediction of cardiac resynchronisation therapy (CRT) response, and the development of a coronary perfusion and contrast agent transport model to optimise the design of perfusion MRI protocols. These applications require the combined expertise of imaging scientists, clinicians and computational modellers to shift the current clinical paradigm to one which utilises patient-specific models to inform patient care.

Friday’s lectures were followed by the final discussion forum of the summer school, with the day’s speakers forming the panel. One of the major themes to come out of the discussion was the benefit of sharing information and tools between and across research groups and disciplines. Such actions will make for better understanding and clearer communication of the needs and limitations of both modellers and clinicians, helping to facilitate the translational work that we are aiming to produce together.

Student presentations
From the outset it was clear that the aim of this summer school was not just to provide a week of lectures for the students, but also to provide a forum to allow discussions of our own research interests. To facilitate this each student prepared a poster and a short talk to be presented in sessions throughout the week. Students presented a wide range of projects across the scope of cardiac imaging and modelling. Some presented completed work whilst other projects described were still in progress or in the preliminary phases, allowing students to seek ideas from both peers and experts alike. These presentations successfully stimulated discussions both within the sessions and less formally throughout the course of the week, and it was this interaction which many students felt to be the most valuable aspect of the school.

A clinician’s perspective
The meeting provided a unique opportunity for young researchers with different backgrounds to discuss in an informal and pleasant environment the potential applications of cardiac modelling. This has enabled cardiology trainees to gain insights on the technical foundations of cardiac modelling from different perspectives, such as mathematics, physics and engineering. The lectures were highly technical, albeit mostly easy to understand given the quality of the speakers. The discussions were particularly useful, as they permitted opinions and personal views to be presented and challenged in a very friendly atmosphere. The cardiac modelling Mayneord–Phillips Summer School was undoubtedly one of the highest quality meetings that a clinician would aim to attend during working towards a PhD, and the only shame is that it doesn’t happen every year!

Social activities
Whilst the packed programme kept everyone busy during the day there was plenty of time to relax with fellow attendees of the summer school as both accommodation and meals were provided within the college. The evenings were spent exploring some of Oxford’s many fine pubs (figure 3) and enjoying meals (including the four-course gala dinner on the Thursday) in the grandeur of Queen’s College dining hall. Sadly the British summer weather scuppered the plans of taking in the sights of Oxford from the water as no-one fancied punting in the pouring rain. There was, however, time to enjoy some of Oxford’s more interesting indoor attractions (such as the Museum of Natural History and the Museum of the History of Science) on the Friday afternoon following the morning sessions that brought the summer school to a close.

Closing remarks
From talking to others on the course it was clear that both students and lecturers had thoroughly enjoyed the week. Throughout the course of the week we all had a chance to put forward our own ideas as well as hear about developments in our own fields and those less familiar to us. This allowed us to appreciate the strengths and limitations of the multitude of techniques that can be utilised in modern cardiology and highlighted the importance of multidisciplinary working.

The standard of teaching was excellent but more importantly the school brought a wide range of students, post-docs and senior figures from a range of modalities together and gave them space and time to discuss ideas freely with each other. To any PhD students, trainees or post-docs reading this; if the next Mayneord–Phillips Summer School is relevant to you then we can’t recommend it highly enough.

Following this meeting the idea arose to set up an email list to maintain the professional and personal contacts made in Oxford. Richard Walton (Hôpital Xavier-Arnouz, France) has established a database of attendees and their research interests that we hope will enable us to continue the dialogue we started during the summer school.

ABOUT THE AUTHORS
David Broadbent is completing his clinical scientist training at Leeds Teaching Hospitals before taking up an NIHR Doctoral Research Fellowship this autumn. This will be in quantitative cardiac MRI methods and based with the Multidisciplinary Cardiovascular Research Centre at the University of Leeds. His attendance at this summer school was supported by an IPEM bursary. Christoph Kolbitsch is a PhD student in the Division of Imaging Sciences and Biomedical Engineering at King’s College London, focussing on accelerated MRI and motion modelling for whole-heart MRI. Ricardo Petracco is a cardiologist Specialist Registrar and research fellow at The International Centre for Circulatory Health and National Heart and Lung Institute at Imperial College London. Matthew Sinclair is a fellow PhD student in the same division as Christoph, working on understanding microvascular coronary flow. Photos are provided courtesy of Mikael Kanski, a PhD student in the Cardiac MR Group at Lund University, Sweden.
The biannual Optical Radiation Update meeting was held in Manchester on 19th July 2012 (figure 1).

Fifty-two participants (including delegates and speakers) from all over the UK met to discuss the scientific developments in the field of optical radiation and the latest legislation and safety guidelines, and they were welcomed by Ian Negus (Bristol Royal Infirmary), chair of the IPEM Special Interest Group in Ultrasound and Non-ionising Radiation (UNIRSIG).

In my opinion, this year’s meeting was a well-balanced mixture of science, legislation and technology and it started with a focus on legislation. Invited speaker John O’Hagan (Health Protection Agency, Didcot), chair of the British Standards Institute (BSI) Committee on Optical Safety and Laser Equipment (EPL/76), introduced the forthcoming updates in the BSI and guidance for the general and medical laser and intense pulsed light devices (IPLs). One of the proposed changes in the guidance is, for example, the introduction of a Class 1C, for laser products that are safe if they are used in contact with the skin (figure 2). Another invited speaker, James Taylor (Health and Safety Executive, Bedford), focussed on the main protection issues that HSE inspectors found at those sites not compliant with the Control of Artificial Optical Radiation at

**FIGURE 1.** Ian Negus, chair of the UNIR IPEM Special Interest Group, welcoming delegates

**FIGURE 2.** Label suggested in the BSI guideline to cover for lasers intended for use in contact with the skin or non-ocular tissue. Image courtesy of John O’Hagan

**FIGURE 3.** Harry Moseley, Ninewells Hospital and Medical School, Dundee) presenting the SCENIHR report

**FIGURE 4.** PUVA spectrum (dotted line) and spectrum of the light transmitted through a pair of UV spectacles. Image courtesy of Mr Trevelyan Foy
Work Regulations 2010. Several laser and photobiology units in the UK still seem to be unaware of the existence of the regulation and the need to protect staff from either laser or non-laser radiation.

The most interesting talk of the scientific session was from invited speaker Harry Moseley (Ninewells Hospital and Medical School, Dundee), who presented the results of investigations of the Scientific Committee on Emerging and Newly Identified Health Risks (SCENIHR) on the health effects of energy efficient artificial light, such as compact fluorescent lights (CFL) and halogen bulbs (figure 3). SCENIHR concluded that although energy efficient lights emit some levels of UV, these are unlikely to cause short-term health effects in healthy people; however, epidemiological studies on long-term health effects are still not conclusive. At present, light emitting devices (LEDs) or double envelope bulbs, which emit no UV or negligible UV, are certainly a better option for light-sensitive patients.

The issue of optical safety of general purpose light sources (GLs) for sensitive patients was addressed again later in the day, when I presented the results of a survey on the safety of GLs for xeroderma pigmentosum (XP) patients that we performed at Guy’s and St Thomas’ Hospital NHS Foundation Trust to support the national XP service. No energy efficient lights except LEDs seem to emit levels of UV negligible enough to be used without additional UV filtering. Joseph Bastin (The Christie NHS Foundation Trust, Manchester) talked about an investigation on laser emission levels from broken optical fibres, showing that a significant proportion of the total power can be emitted at large angles. Trevelyan Foy (Royal Cornwall Hospital, Truro), a previous member of the UNIRSIG, guided the audience through the IPEM AORD draft guidance document, which contains directions on the optical assessment of optical sources of medical interest. He then showed in another talk how broadband UV radiometers could be used for optical hazard measurements. Foy invited assessors to be aware that the light transmitted through a pair of UV protective spectacles could differ significantly from that of the source the meter has been calibrated for (figure 4).

Talking of radiometry and calibrations, Paul Miller (National Physical Laboratory, Teddington) presented the much-awaited results of an intercomparison study that a few years ago involved 10 sites across the UK involved in either calibration or dosimetry. Some discrepancies were found, mainly due to a misinterpretation of the instructions accompanying the artefacts, and artefacts’ dependence on temperature. However, in general a good agreement (within 0.2 nm) was found in wavelength calibration of spectroradiometers. Moving away from protection and calibration, Joe Dewhurst (The Christie NHS Foundation Trust, Manchester) presented an interesting talk on the use of Monte Carlo modelling to combine external and interstitial photodynamic therapy for basal cell carcinoma patients.

The last talk of the day was from Stuart Watson (Salford Royal NHS Foundation Trust, Salford) who presented an exciting technical innovation for patients’ phototesting; a prototype array system that exploits LEDs to deliver monochromatic light at different wavelengths simultaneously on all testing sites (figure 5). UV LEDs currently available on the market are not efficient enough to make the system available in the short term, but are certainly an exciting development to look forward.

The meeting concluded with a wide-ranging discussion chaired by Helen Amatiello (Gartnavel Royal Hospital, Glasgow), UNIRSIG secretary and scientific organiser of the meeting, and Ian Negus on the direct vs indirect methods for dosimetry of UV phototherapy cabins. The audience agreed that following the HSE guidelines to avoid any unnecessary staff exposure indirect methods should be adopted, but that there was also a need for standardisation.
Welcome to another issue of Scope ‘Book Reviews’! A special thanks to our reviewers who have supplied ample book reviews once again! Textbook reviews cover both the medical physics and popular science genres. A list of the reviewed titles with reviewers can be found in table 1.

As with each Scope issue, there are a number of new medical physics textbooks in the ‘Just Published’ section such as Cobalt Blues, describing the development of the first Co-60 unit, and Encyclopaedia of Medical Physics, endorsed by the IOMP. You will find some interesting reports listed in the ‘New Reports’ section. Reader(s) interested in reviewing listed/unlisted books should get in touch with me, so I can arrange to send you the required material directly from the publisher. Some reports are freely available to download from the respective websites.

A warm welcome to our new book reviewer who recently joined us on Ubidesk: Dr David Hall. He is a consultant clinical scientist specialising in nuclear medicine. He is Head of Nuclear Medicine Physics, based at the Department of Medical Physics and Bioengineering, University Hospital Bristol NHS Foundation Trust (UK).

We require additional book reviewers to allow us to hit our adjusted quarterly target of seven book reviews. Please drop me an email if you are interested in becoming a reviewer. The reviewing process is relatively relaxed, and there are no tight deadlines. We have frequent reminders of deadlines via Ubidesk and occasionally deadline dates are also extended. If you are new to reviewing, there is a process document on finding your way around Ubidesk as well as a guidance document on reviewing textbooks. Don’t forget that reviewing also counts towards your CPD.

Usman I. Lula, Clinical Scientist, Radiotherapy Physics, Poole Hospital NHS Trust (UK)
Email: usman.lula@poole.nhs.uk

I have just a couple of criticisms. The index is not as extensive as it might be, although clues can always be obtained from related entries. I was somewhat surprised not to find some things which I expected from the title. For instance, although there is a great detail on how the body works, blood pressure gets only a brief mention and there is nothing at all on the sphygmomanometer, one of the basic first line tools of investigation. Neither of these detracts from the usefulness of the book, and at a very reasonable hardback price of £49.99, I can recommend it highly to MSc and PhD students.

Professor Angela Newing is a Retired Director of Medical Physics for Gloucestershire NHS Trust, UK

**Physiology, Biophysics and Biomedical Engineering**

This excellent series for students of medical physics and bioengineering now covers almost every topic required by postgraduate physicists on the NHS training scheme. This latest, produced by physicists and clinicians from Australia is a useful addition. The title suggests a more clinical approach than most bioengineering textbooks, and indeed we have this here.

The first chapter on physiology starts with the basic structure and purposes of body cells and general metabolism. The reader then learns about electrical circuitry, how electrical apparatus is used, and what results might be expected from monitoring to show how the body works. The physics rapidly gets more complicated in later chapters. A lot of mathematics is featured throughout the book requiring, in my view, advanced knowledge, but there are many worked examples to show how to do various calculations.

Some of the physics normally found in textbooks on other specialisms in medical physics comes later in the book. Chapter 23 is entitled ‘Medical Imaging’ and contains well written sections on ultrasound, nuclear medicine, x-rays and MRI. This last has clear explanations of RF absorption, FID, field gradients, etc.

I was very much looking forward to receiving this book, as an up-to-date reference on the topic of IGRT is inevitably going to be a very useful addition to any radiotherapy.

**Image-Guided Radiation Therapy**

Some of the physics normally found in textbooks on other specialisms in medical physics comes later in the book. Chapter 23 is entitled ‘Medical Imaging’ and contains well written sections on ultrasound, nuclear medicine, x-rays and MRI. This last has clear explanations of RF absorption, FID, field gradients, etc.

<table>
<thead>
<tr>
<th>Book title</th>
<th>Reviewer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physiology, Biophysics and Biomedical Engineering</td>
<td>Angela Newing</td>
</tr>
<tr>
<td>Image-Guided Radiation Therapy</td>
<td>Keri Owen</td>
</tr>
<tr>
<td>Adaptive Motion Compensation in Radiotherapy</td>
<td>Keri Owen</td>
</tr>
<tr>
<td>Dictionary of Biomedical Optics and Biophotonics</td>
<td>Elizabeth Berry</td>
</tr>
<tr>
<td>Nucleus – A Trip into the Heart of Matter</td>
<td>Jennifer Lowe</td>
</tr>
<tr>
<td>Nuclear Medicine Physics – The Basics</td>
<td>Sarah Cade</td>
</tr>
<tr>
<td>An Introduction to Radiation Protection</td>
<td>Lisa Davenport</td>
</tr>
<tr>
<td>Practical Biomedical Signal Analysis Using MATLAB®</td>
<td>Lukasz Priba</td>
</tr>
</tbody>
</table>

**TABLE 1**

- **Book title**
  - Physiology, Biophysics and Biomedical Engineering
  - Image-Guided Radiation Therapy
  - Adaptive Motion Compensation in Radiotherapy
  - Dictionary of Biomedical Optics and Biophotonics
  - Nucleus – A Trip into the Heart of Matter
  - Nuclear Medicine Physics – The Basics
  - An Introduction to Radiation Protection
  - Practical Biomedical Signal Analysis Using MATLAB®

- **Reviewer**
  - Angela Newing
  - Keri Owen
  - Elizabeth Berry
  - Jennifer Lowe
  - Sarah Cade
  - Lisa Davenport
  - Lukasz Priba
department – indeed within a few days of it arriving I had already lent it out to three of my colleagues and I had to fight to get it back so I could write this review!

It thoroughly covers the technical and practical aspects of a wide range of current IGRT technologies in a series of essays. Almost every kind of imaging applied to radiotherapy verification is included here: optical, ultrasound, in-room CT, cone-beam CT, megavoltage CT, 4DCT, 4DPET/CT, digital tomosynthesis and imaging for brachytherapy. The only omissions are good-old portal imaging and the combined MRI-linac for which no clinical data yet exists.

It offers a snapshot of the current options open to us from a number of manufacturers but what it doesn’t do is directly compare them. Rather, the essays stand alone as individual references on each topic with a good balance of positive and negative points, and the conclusions are left to the reader.

Many of the essays are by authors who have worked on the development of these technologies, and therefore you get a great deal of information on the mathematical and physical workings of the devices. For example, image reconstruction, artefacts, noise, radiation dose, accuracy and quality assurance are all discussed. Any affiliations to companies are clearly disclosed (e.g. the essay on tomotherapy IGRT is written by authors employed by Tomotherapy Inc.) and the book remains unbiased.

Because of the essay-based format it is a bit of a mixed bag as to what information is given for each topic. The history of IGRT is covered repeatedly in many essays, whereas the important subject of clinical IGRT protocols is covered in some, but not all, essays and to varying extents. For example, the section on clinical workflow in the essay on MV CBCT is very good and full of very practical tips. On the other hand, the kv CBCT essay, whilst bursting with mathematical expressions describing artefacts and noise, has only a small section on clinical applications and mainly consists of a collection of references to published work.

Credit is due to the editor who has recognised the importance of image registration as a topic in its own right, and hence there is an essay devoted to this topic. It includes discussions on different registration algorithms for both rigid and deformable registration, the importance of choosing regions of interest to match on and uncertainties and errors.

As an all-round reference on IGRT the book works very well, and essays can be read independently of each other if just researching one topic. It will provide good background reading for anyone wishing to learn about any modern IGRT techniques, but will not provide the answers on how to apply them in clinic.

Keri Owen is a Principal Clinical Scientist specialising in radiotherapy physics and is based at the Medical Physics Department, Queen Alexandra Hospital, Portsmouth, UK.

**Adaptive Motion Compensation in Radiotherapy**

Adaptive Motion Compensation in Radiotherapy comes at an interesting stage in the development of radiotherapy. Research into how to deal with a moving target during treatment has moved beyond infancy; I’d say we’re in the troublesome teenage stage of adaptive motion delivery as it starts to assume its final form with the emergence of the latest devices on the market. In order to reach maturity we now have to learn how best to utilise these developments, and this book summarises the options.

A well-rounded summary of current technology is presented but without much focus on how to actually treat a patient – a reflection of where we currently are. It is very much of-the-moment and therefore could well become out of date fairly quickly but that just reflects the dilemma faced by the authors who have tried to produce a book that aims to be at the forefront of a rapidly changing topic.

There is much focus on the key emergent technologies – no surprises to see Cyberknife feature heavily throughout. However, the authors have tried to avoid too much bias and give fair mention to a range of other manufacturers. Dynamic MLC tracking, gating and treatment planning are all covered to varying degrees. Couch-based real-time motion compensation is also discussed, a topic not regularly encountered. The book also looks to the future and a good proportion is taken up presenting the current status on technologies such as the combined MRI-linac (MRL) which is still in the development stage.

Compiled from a series of essays from authors in the field it starts off with an overview of tumour tracking systems and moves on to describe some of the theoretical aspects of tumour tracking, planning and delivery. Although not an in-depth study (respiratory gating is discussed in just over six pages, for example), it certainly gives the reader a sense of the issues involved. The reference listings are comprehensive and therefore this is a good starting point for directing literature research on the topic.

Some of the mathematical concepts required for predictive motion modelling, tumour tracking and image detection are discussed; therefore, researchers may find this book useful if they are just embarking in this area and need a starting point. Students would particularly gain from this book as it is currently the only work dedicated to this topic, but as the price tag is not student friendly it would be better suited as a library addition.

If you’re a centre that has already purchased one of the devices discussed then I believe it would be of limited use as practical reference and would need to be complemented with more in-depth reading. However, if you are a centre that has decided on the path of motion...
compensation but does not yet have a direction, this book would be ideal.

Keri Owen is a Principal Clinical Scientist specialising in radiotherapy physics, based at the Medical Physics Department, Queen Alexandra Hospital, Portsmouth, UK

Dictionary of Biomedical Optics and Biophotonics

Need to check the relationship between transmittance and absorbance? Want to clarify the meaning of TOAST and MONSTIR? Searching for a list of scattering media that can be used to model tissue optical properties in the near infrared? Can’t quite recall the various layers of the epidermis? Or desperate to define raffinose? Then this dictionary will be ideal for you.

The author is an authority in the fields of biomedical optics and biophotonics, and has written several books that are important references for those working in this specialist area. Indeed, this dictionary is based on glossaries that have appeared in two editions of one of his books – Tissue Optics. Even if you own a copy of Tissue Optics, you will probably be tempted to buy this new dictionary as many of the definitions have been expanded, and this 3 cm-thick paperback is considerably easier to handle!

It is correct to describe the book as a dictionary. It contains an alphabetical list of short definitions, so it is definitely not a textbook nor is it an encyclopaedia. The definitions are too brief for that, and the only illustration is a photo of the author.

The dictionary is intended for researchers, practitioners, and professionals in biomedicine, as well as professionals in other disciplines, such as laser physics and technology, fiber optics, spectroscopy, material science, biology, and medicine … Graduate and undergraduate students studying biomedical physics and engineering, biomedical optics and biophotonics, and medical science’. This is certainly the core readership, but as the field grows, and with the development of hybrid imaging systems that combine radiological and optical imaging techniques, researchers and practitioners in medical physics and engineering should be added to this already long list.

The dictionary is easy to use as it is organised in alphabetical order and has extensive cross referencing. For the examples I tried, the cross referencing was robust and didn’t lead to annoying infinite loops. All the definitions are for full text terms. So, for example, for the definition of PDT you have to look up ‘photodynamic therapy’. This arrangement sounds like it might cause problems if you don’t know the meaning of your abbreviation, but fortunately the glossary starts with a list of abbreviations and acronyms, together with their full text meanings. I came across just one anomaly: ‘deoxyribonucleic acid’ is listed slightly out of alphabetical order – it is just where you’d expect to find ‘DNA’ if abbreviations were included in the list.

This affordable, very useful book is one that many people have been waiting for, and it should be high on the wish list of anyone even peripherally involved with biophotonics and biomedical optics.

Dr Elizabeth Berry is the Director of Elizabeth Berry Ltd (Leeds) and specialises in medical imaging. She lectures at the Open University and is a Fellow of both IPEM and IoP

Nucleus – A Trip into the Heart of Matter

You can’t judge a book by its cover. However, this text made a very good first impression with its eye-catching glossy hardback cover enveloping a compact (~140 page) A4-ish book. Of the four physicist authors, I know the name of Jim Al-Khalili as a frequent science communicator and as a member of the Department of Physics at the University of Surrey where I studied medical physics.

The short introduction gave a clear overview of the material to be covered and some fundamental questions to be answered. The text follows a vaguely historical path through the discoveries that led to our current understanding of the nature of matter. The book is divided into ten chapters and starts gently by introducing sizes (nuclei to galaxies), radioactivity and early atomic models. In Chapter 3 I enjoyed being reminded of just how counter-intuitive wave-particle duality is and the weirdness of quantum mechanics. In Chapter 4 I needed more concentration once more on familiar territory with specific applications of nuclear physics. Following chapters look at the bigger picture: neutron stars, creation of elements and elemental abundance. Chapter 10 concludes with the Big Bang. A page of further reading references, a useful glossary of nuclear physics terms and an index are included at the back.

The prose is well written in a relaxed and friendly style, presumably aiming not to alienate non-scientists. The text is neatly complemented throughout by relevant photographs, diagrams and graphs in colour. Equations have been...
avoided (though an exception has been made for the obvious one). The selection of illustrations includes photographs of many deceased physicists from Young (1773–1829) to Bethe (1905–2005). However, I was also very pleased to see a photo of Jocelyn Bell Burnell from whom I learnt about pulsars. The four authors also appear to be looking fairly lively in a photo with the preface. The images are very clearly referenced in bold within the text, making it easy to determine their relevance to the written material, without needing journal-style figure numbering. I was distracted at one point by the text layout which is not fully justified yet frequently manages to hyphenate words of unremarkable length, though this was a minor distraction. This 2011 second edition supersedes the 2001 edition, reflecting advancements over that 10-year period. I look forward to the potential third edition revealing the advances of the next 10 years (Higgs boson?) and can cheekily offer to highlight the mere handful of typos/errors I found on my way through this second edition.

I expect non-scientists to find this book fully accessible without being superficial and I would highly recommend it to anyone with an interest. More specifically, it would be an excellent introduction for an A-level physics or chemistry student or even an enthusiastic and capable GCSE student. Personally I found it to be a great read for the physicist who wants to enjoyably remind themselves of what they once knew (without any maths) and also have a clear explanation of current research and theories.

Jennifer Lowe is a Clinical Scientist specialising in radiotherapy physics. She is currently on a career break living in Falls Church, VA, USA

**NUCLEAR MEDICINE PHYSICS – THE BASICS**

| **Edition**: Second |
| **Publisher**: The Johns Hopkins University Press |
| **ISBN-13**: 978-1421403519 |
| **Format**: Paperback |
| **Pages**: 114 |
| **Price**: £19 on Amazon.co.uk |

This book is mainly targeted at nuclear medicine physicians in training and technologists. As such it aims to be simple and concise, explaining the basic principles and underlying concepts but only including mathematical detail where essential. At just over 200 pages the book has an approachable feel and a quick flick through is unlikely to put anyone off as true to its aims there is very little maths and plenty of diagrams.

This seventh edition text has clearly been updated and now includes information on solid state gamma cameras as well as traditional scintillation cameras. However, in places references to older technology are presented as normal practice. I was particularly interested to see the use of exponential tables as the recommended method of calculating radioactive decay, as I would guess that most current students have never used them and would be much more comfortable performing these calculations on their phones than using tables!

The book covers all the topics one would expect from a basic nuclear medicine text. The book starts with a review of the structure of matter before introducing radioactive decay processes and moving on to some commonly used radiopharmaceuticals. A section on the interactions of radiation with matter is followed by a chapter on radiation dosimetry. Unfortunately for the British reader, at this point it becomes clear that this book is written for an American audience as units of μCi and rads dominate. Conversions between these non-SI and SI units are given in a number of places but the examples which are used to support the explanation are unlikely to be as easy to follow for readers who are more familiar with the use of SI units.

The next chapters cover the detection of radiation and both in vivo and in vitro measurements before moving on to more detailed information about the operation and quality control of gamma cameras. The section on quality control explains the parameters which are of interest when considering gamma camera performance and the factors affecting them. These chapters are, as promised, low on mathematical detail but the use of clear, well labelled diagrams makes the concepts easy to understand. The final section on imaging covers both SPECT and PET. Whilst brief, this chapter manages to provide a clear explanation of both the image acquisition and reconstruction processes.

The book ends with a section on the safe handling of radioactive materials and legislation. Whilst the guidance is well presented and relevant, the legislation section only considers the US and as such is likely to be of limited relevance to readers from other countries.

I would recommend this book as an overview for medical students and junior doctors or radiographers working in other areas who are interested in an overview of nuclear medicine as it covers all aspects. However, it probably does not have sufficient depth to be of lasting interest to nuclear medicine physicists or technologists.

Sarah Cade is an Imaging Physicist based at the Medical Physics and Bioengineering Department, Royal United Hospital, Bath, UK. She is also undertaking a part-time PhD in medical imaging at the Institute of Nuclear Medicine, University College London, UK

**NUCLEAR MEDICINE PHYSICS – THE BASICS**

| **Publisher**: Lippincott Williams and Wilkins |
| **Format**: Paperback |
| **Pages**: 203 |
| **Price**: RRP £41.95 |
**An Introduction to Radiation Protection (6th edition)**

Aimed not only at people working with medical radiation, but also at those in the nuclear industry, this book covers a lot of ground and is bursting with practical advice (and nuclear reactor physics).

It is all very concise, and necessarily so given the breadth of the subject and the smallness of the book. This sometimes results in a slightly fragmented read. However, what I really like about the book is that it summarises all the important things you need to know (such as key ICRP103 recommendations) and that it is up to date.

This book is useful practically and is an excellent teaching resource. This edition contains a new section describing how to carry out a risk assessment which would be useful if you haven’t done much of that before. Each chapter has summaries and revision questions, and example calculations are given where applicable. There is even a companion website which has teaching slides available for download.

A whole chapter on the physics of detection and measurement of radiation is one of a few areas where I felt it could be pretty intimidating if you weren’t already familiar with the subject. It describes ionisation chambers, solid state detectors and their associated electrical circuitry in mere paragraphs. This comes ahead of the sections on personal dosimetry and contamination monitoring and I thought it would possibly be clearer if the application had been introduced first rather than the other way round, but having said that, the revision questions encourage the reader to consider the applications of each detector.

In the external radiation hazards chapter I would have preferred to have had more examples relevant to my job instead of the diagnostic radiology stuff having to make way for neutron shielding. On the other hand, it is nice to have the somewhat mystical sounding ‘criticality locket’ alongside the boring old film badge. Generic chapters on radioactive waste, analysis of samples, controlling hazards and design of areas contain useful nuggets of information to be hunted down by people working in nuclear medicine.

There are also dedicated chapters for the nuclear industry, non-nuclear industries and medicine. The medicine chapter has two pages on general principles and a page on the disposal of radioactive materials. Then there are a couple of pages each for x-ray, radiotherapy, nuclear medicine and radioisotope therapy in which basic principles, applications and radiation protection techniques specific to each are covered. Like I say, it is pretty concise but there is loads of relevant information to be found throughout the book.

From a medical physics point of view I’d say this book is probably slightly more applicable to nuclear medicine than x-ray or radiotherapy but it is still a good general resource for all. It would be really useful for RPS training and is a recommended purchase for a department.

*Lisa Davenport* is a Clinical Scientist specialising in radiation protection and is based at the Radiation Physics section of Bradford Teaching Hospitals NHS Foundation Trust, Bradford, UK

---

**Practical Biomedical Signal Analysis Using MATLAB®**

This book aims to provide an introduction to the area of biomedical signal analysis. It is divided into two distinct parts, covering an introduction and principles of signal processing in the first part, and a discussion of methods and their applications in specific examples in the second part.

The first part introduces the idea of signal analysis covering types and properties of signals, sampling theorem and Fourier transforms, and explains the basic statistical tests. The next two chapters focus on single channel and multiple channel signals and methods of their analysis. This part is highly mathematical, but the authors try to avoid complex derivations and lengthy proofs, providing key steps and assumptions to carry on with discussion.

The second part covers how the analysis methods introduced in the first three chapters are applied to different biomedical signals. It discusses problems encountered with each type of signal and helps readers choose the appropriate method for a given task and data. When discussing applications of certain methods, the authors provide cross-references between sections where the methods are described, which makes searching through the book quick and easy. The extensive references to studies using particular methods provides further reading to the more interested.

The area in which the book particularly excels is that it provides names of freely available MATLAB functions and toolbox packages (with URLs from which they can be downloaded) useful for each particular task. It is a well illustrated book, which helps with visualising how certain methods process input signals and has a colour insert with 14 figures visualising...
EEG data. It should be mentioned that the book does not provide solutions to problems, such as example MATLAB syntax or instructions to recommended toolboxes.

Having not worked in the field of biomedical signal analysis, I cannot say if there are any notable omissions in the book. What I found missing from it was a list of MATLAB functions and toolboxes in the index.

As with most of the books in the series, this book serves as an overview and introduction to the use of signal processing techniques for biomedical applications and how to avoid common problems by choosing an appropriate method. Overall, it is a good textbook, aimed at graduate students and researchers, but should be thought of as an addition to a more thorough coursebook.

Lukasz Priba is a Part II Trainee in MRI/diagnostic radiology at the Medical Physics Department of Ninewells Hospital (NHS Tayside), Dundee, UK.

**PRACTICAL BIOMEDICAL SIGNAL ANALYSIS USING MATLAB®**

**Series:** Medical Physics and Biomedical Engineering  
**K.J. BLINOWSKA AND J ZYGIEREWICZ**  
**Publisher:** CRC Press  
**ISBN:** 978-1-4398-1202-0  
**Format:** Hardback  
**Pages:** 324  
**Price:** £63.99

---

**Just Published!**

**Radiation Protection in Nuclear Medicine** by Christoph Hoechsten and Soren Mattsson (Springer) details all aspects of radiation protection in nuclear medicine, including measurement quantities and units, detectors and dosimeters and radiation biology. This is an ideal textbook for students and a source of useful information for nuclear medicine specialists and medical physics experts.

**Stereotactic Body Radiation Therapy** by Simon S. Lo, Bin S. Teh, Jiade J. Lu and Tracey E. Schefter (Springer) is written by world renowned experts in SBRT and provides a fresh account of the technological, biological and clinical aspects of SBRT, examining retrospective studies and prospective clinical trials for various organ sites. It will be necessary reading for oncologists and medical physicists.

**Cobalt Blues** by Pater Almond (Springer) describes the development of the first cobalt-60 unit in the USA, used in radiation treatments for cancer, and the man behind it, Leonard Grimmett. It tells the story of the development of one of the world’s largest cancer centres and medical physics programmes.

**Statistical Methods in Radiation Physics** by James E. Turner, Darryl J. Downing and James S. Bogard (Wiley) fills a notable gap in the field of radiological, medical and health physics. Statistical concepts and tools for health physics are presented in one single book for the first time. It explains broadly applicable statistical methods and their use in outcome and decision making.

**Monte Carlo Calculations in Nuclear Medicine – Applications in Diagnostic Imaging, 2nd Edition** by Michael Ljungberg, Sven-Erik Strand and Michael A. King (Taylor & Francis) covers the applications of Monte Carlo calculations in nuclear medicine and critically reviews them from a diagnostic perspective. New chapters in this edition cover codes and applications in pre-clinical PET and SPECT.

**Digital Mammography: A Practical Approach** by Gary Whitman and Tamara Haygood (Cambridge University Press) provides current, practical and clinical information on every aspect of digital mammography to aid radiologists and physicists using this technology. It includes key topics such as digital detectors, monitors, image acquisition and storage, retrieval and transfer, image interpretation and efficacy.

**Encyclopaedia of Medical Physics** by Slavik Tabakov, Franco Milano, Sven-Erik Strand, Cornelius Lewis and Perry Sprauls (Taylor & Francis) is an all-encompassing reference that covers x-ray diagnostic radiology, MRI, nuclear medicine, RP, RT, US and general medical physics terms. It is a work that is supported by the IOMP.

---

**NEW REPORTS**

- Nuclear Cardiology: Guidance and Recommendations for Implementation in Developing Countries. IAEA Human Health Series 23, STI/PUB/1566; 2012.
- Environmental Radioactivity Surveillance Programme: Results for 2011 including Monitoring Following the Fukushima Dai-ichi Accident in Japan, HPA-CRCE-041. HPA; 2012.
- Statement on Tissue Reactions/Early and Late Effects of Radiation in Normal Tissues and Organs, ICRP Publication 118. ICRP 2012; 41(1/2).
- HPA Response to the ICRP Statement on Tissue Reactions and Recommendations on Dose Limits for the Eye Lens. HPA; 2012.
- The Radiation Protection Implications of the Use of (CBCT) in Dentistry. HPA; 2012.
A history of medical physics: crossing the Atlantic

Francis Duck journeys to the USA to uncover the first medical physics textbook written in English and how the subject developed there at that time

Earlier articles in this series have shown how medical physics emerged as a separate discipline in Europe during the nineteenth century. In each country local conditions affected the rate and pattern of its development. At first, experimental philosophy was considered to be an important component of the broader education of a cultured physician. Then, elementary physics was slowly established as a mandatory requirement for entry to medical school, first in France, then in the German states and eventually in Great Britain. Slowly the new discipline coalesced alongside physiology and started to make an impact on clinical medicine and training. A broader comparison of medical education between Europe and America may be found elsewhere.

Thus, by the end of the nineteenth century, the subject of medical physics was established throughout Europe, and books under this title could be found on the shelves of many university libraries. The surprise, then, is that the first English medical physics textbook was not a translation from one of those available in continental Europe, nor was it even written in Great Britain. This article will describe how it came about that John Christopher Draper, a New York professor, became the author of the first book on medical physics to be written in English.

Natural philosophy in American medical schools

A student studying medicine in Philadelphia in the late 1760s could attend a course in natural and experimental philosophy, an opportunity to broaden his understanding of science. This course was given by the provost, William Smith (1727–1803), who had arrived in America from Scotland in 1751. Thus, at this time, the omens were good to embed physics into medical thinking. This was not to be, however. The 1776 Declaration of Independence, and the political, military and economic upheaval that followed, challenged many assumptions. Following Smith’s departure in the 1780s (he was suspected of loyalist sympathies) natural philosophy lapsed from the medical options, to re-emerge only briefly in 1810, when a new chair of natural philosophy was created in the Medical School of the University of Pennsylvania. Robert Hare (1781–1858) lasted in this post for only 2 years. In 1816, after this brief flicker of life, the chair of natural philosophy was removed from the medical department to form part of the Faculty of Natural Science.

The reason that Hare left so quickly illuminates the different approaches to medical training between the Land of the Free and the land of Liberté, égalité, fraternité. Hare’s course was elective and, as he had very few students, he gained very little income. At the same time in Paris, Jean Hallé’s annual salary was 6,000 francs, and his medical physics course was mandatory.

A similar pattern occurred in New York. Samuel Bard (1742–1819), founder of the first medical school in New York, was giving lectures on natural philosophy at Columbia in 1785. Later, Benjamin DeWitt (1774–1819) was professor of natural philosophy at the College of Physicians and Surgeons, the successor to the Columbia Medical School. But after DeWitt’s death, whilst inspecting the yellow fever quarantine grounds on Staten Island, his position was not refilled.

There followed a period of about 70 years during which there was no physics presence in medical colleges in the USA. One reason we have already seen: courses were elective and would have attracted very few paying students. The other had to do with the medical need. The USA was then a primarily agricultural nation with a very small cultural, city-based elite. Primary care dominated ideas for medical training, for which a practical knowledge of medicines, poultices, the mending of fractures and delivery of babies were seen to be more important than the physics of physiology and electrotherapy.

By the end of the century it had become abundantly clear that medical training in the USA had fallen well below European standards, especially in the associated sciences. The conditions were becoming sufficiently fertile for John Draper, then well into his career as professor of chemistry in New York, to consider preparing a medical physics text. Before speaking of this career, however, the scene needs to be set by considering his extraordinary father, John William Draper.

John William Draper (1811–1882)

John Draper (senior) was English by birth, born when his father, a Wesleyan minister, had care of a church in St Helen’s, Merseyside. Educated both at home and at Woodhouse Grove, a Methodist school in Yorkshire, he entered the newly-created University College of London in 1829. After his father’s death in 1831, and without graduating, he left England with his new wife Antonia, his mother and his three sisters on the 3-week voyage to the USA. 

...
John Christopher Draper (1835–1885)

The Draper household into which John Christopher was born on 31st March 1835 was thus one of intellectual vigour and independent thought. John was 5 years old when he moved with his family to New York, and this is where he spent the rest of his life. He was the eldest of six talented children. One brother, Daniel, became a noted meteorologist whilst Henry became widely known for his pioneering work on solar and stellar spectra.

Draper studied classics at New York University before entering medicine, graduating in 1857. His MD thesis added to the growing body of evidence against the current view that the fuel for muscular action was the muscle itself. In another study he analysed his own respiration. But the shadow of his father’s brilliance cannot be ignored.

These were two important but minor contributions when compared to his father’s widely ranging book on physiology, published in the same year.

Draper never practiced medicine. Now 22 years old, he first did a grand European tour, for which the nineteenth-century equivalent of his passport photo describes him as 5 feet 6½ inches in height, with black eyes and hair, stout nose, large mouth and a florid complexion. On his return to New York he entered academic life, first as professor of natural sciences in the University of New York, and then, in 1859, as professor of chemistry in the newly-opened Cooper Union for the Advancement of Science and Arts. Its founder, the industrialist and property investor Peter Cooper, had some years earlier asked John’s father for his advice in establishing this free educational institute for adult education. Draper’s lectures on chemistry and physics were given on Tuesday and Thursday evenings. The largest group in his class of 280 were ‘clerks, bookkeepers and salesmen’ but it also included 10 photographers, three physicians, four farmers, a hatter and a clergyman. The original Cooper Union building, where Abraham Lincoln spoke on 27th February 1860 on the regulation of slavery, remains today as one of New York’s architectural landmarks.

The civil war

In April 1861, after the southern states had broken from the Union, civil war broke out in America. By the following year, the northern states were mobilising troops as it became clear that the Confederate army posed a real threat. On 31st May 1862, John Draper enlisted as an assistant surgeon with the 12th New York Regiment. On 15th September he was amongst the 12,419 men captured at Harper’s Ferry, in the largest surrender of Federal forces during the civil war. Draper may at least have helped to care for the small number of casualties (44 Union soldiers were killed and 173 wounded).
As cancer care becomes increasingly sophisticated and complex, patient workflow steps that document and track a single patient’s healthcare journey have grown dramatically. As a result, the Oncology Information System (OIS) has also evolved over the last decade as a tool to centralize the patient's electronic medical record (EMR). However, the ability to customize and automate functions within the OIS is, in some cases, still in its infancy.

**The Challenge**

Oncology software vendors are challenged by how much flexibility and customization they can allow users without creating an unwieldy software maintenance problem. To bring more advanced customization to users means giving clinics more control of the software to shape the way their OIS behaves, the data it collects and how it is collected.

Quality Checklists (QCL) are critical for enabling clinical users to adapt MOSAIQ to suit the unique needs of their department. In essence, QCLs are “to-do” lists generated in MOSAIQ. These lists provide a logical workflow of tasks that must be completed (i.e., “checked off”) before advancing the patient’s case to the next phase.

**Workflow Enhancement**

Elekta’s new Workflow Manager is among the first OIS tools to enable advanced customization and automation. A core part of Workflow Manager technology is MOSAIQ® IQ Scripts™, a scripting tool that enables users to create or adapt rule-based logic to support, improve and automate clinical and administrative processes in a single clinic or across multiple sites. The creation of scripts that automatically execute a QCL when a previous QCL task is completed, can eliminate manual tasks and improve department efficiency. For example, generate a warning message based on observation data on order approval, launches an assessment based on order approval or QCL completion. IQ Scripts empowers physicians to change their OIS’s behavior and develop specific clinical pathways for a particular diagnosis and match plans to a specific disease. This automation translates to more time for patients.

**Clinical Experience**

One cancer centre in the UK is taking the lead in customizing its OIS. The St James’s Institute of Oncology in Leeds, is a purpose-built state-of-the-art oncology centre using MOSAIQ® to manage all aspects of their radiation oncology treatment. MOSAIQ is also the primary data source for Treatment Verification, Scheduling and capturing of HRG codes; used for costing & reporting.

St James’s has successfully completed a project to provide electronic Radiotherapy Referral pathways using MOSAIQ. A workflow paper process that originally entailed 23 steps was reduced to 12 steps using MOSAIQ assessments. Now, with MOSAIQ® IQ Scripts, this process has been reduced to four steps. Peter Enever, Advanced Practitioner-Radiotherapy at St. James’s explained, “The old paper process was extremely protracted and complex and involved too many people and processes. It also crossed many different staff groups with many handover points, leading to potential for errors. With MOSAIQ, we have made a major step forward. The improvement in this new process greatly reduced the number of workflow steps and decreased the referral pathway from as many as seven days to a current maximum of 24 hours. “IQ Scripts has taken this workflow a step further by automating many tasks and processes, such as removal of patient selection (doctors no longer need to select the correct patients; the item will be on their QCL as a prompt) which is a major safety feature and has reduced a 12-step process to just four. Fewer steps means fewer errors and that can only be a good thing for us and the patients.”

Find out more about MOSAIQ at [www.elekta.com/MOSAIQ](http://www.elekta.com/MOSAIQ)
Draper was undoubtedly relieved to return home in October. He left Cooper Union, and was appointed as Professor of Physiology and Natural History at the City of New York College, a ‘free academy for the purpose of extending the benefits of education gratuitously to persons who have been pupils of the common schools of the city and county of New York’. He also spent time with his father and brother in the Department of Analytical Chemistry of the University of New York, from where he generated a small research output relating physics to physiology, including measurements of diurnal light exposure (1859), insensible perspiration (1864) and adulterated coffee (1867). This last, unusual, project was of sufficient importance for his method to be published in the prestigious British Philosophical Magazine. He also wrote a physiology textbook, including in it his own and his father’s contributions to physiology, a strong section on the physics of the senses, and also an interesting section on hygiene. Each page carries a footnote with searching questions challenging the reader’s understanding, an educational innovation worthy of consideration even today.

Work was undoubtedly inhibited by the continuing civil war, when New York was alive with potential unrest. Confederate agents attempted to burn New York City in 1864, and Lincoln was assassinated shortly before the war ended the following year. John Draper senior, never at a loss for a project, immediately started writing his three-volume history of the civil war, which was considered for many years to be the definitive record of this violent period in American history.

New York soon recovered from the traumas of war. Draper had gained an additional appointment as professor of chemistry in the medical department of the University of New York; he later wrote a small notebook for use in his medical chemistry laboratory. In 1869/1870 he wrote a series of 14 articles for the monthly popular magazine The Galaxy on topics in nutrition, public health and hygiene. He had settled with his wife Charlotte at 429 Lexington Avenue, at the northern perimeter of urban New York, then still south of Central Park. He could have travelled to college on the 2nd Avenue elevated railway to 23rd Street Station, at first on a cable-driven car and later drawn by steam locomotive.

On 25th September 1869 the New York stock market crashed, taking with it fortunes and lives. The subsequent ‘long depression’, lasting for most of the 1870s, was paradoxically a period of enhanced scientific output for Draper. Publishing in the American Journal of Science, his papers ranged widely: plant growth; body heat; the polarisation angle of quinine. In a series of papers from 1875–1879, he described the design and use of an early slide projector (figure 1), making his own zirconium element as the intense light source when heated in a hydrogen flame. He concludes thus: ‘I have shown Frustulia saxonica [a diatom] magnified more than half a million times; a result which must be seen to be appreciated’. He then used this projector to extend his brother Henry’s observations of lines in the solar spectra that they attributed to oxygen. He sensibly did not speculate on whether these arose from a solar or an atmospheric origin, unlike the London Times, which
Deep Peroneal.
Points for application of electrodes.
trumpeted ‘Oxygen in the sun’. True (now estimated as 0.078 per cent of the sun’s atoms), but a premature and false call from Draper’s evidence.

A textbook of medical physics

Early in the 1880s, as the deficiencies in medical training started to become only too obvious, some states passed laws requiring students entering medical training without a degree to be examined for competence in elementary physics. John Draper was now in his mid-forties, balding and sporting a luxuriant black beard (figure 2). His career had touched on natural history, chemistry, botany, physics, physiology and hygiene. To this date, no American author had attempted to bring together all medical physics as a single body of knowledge. Draper set about doing just that, and in 1885 his 715-page Text-Book of Medical Physics was published on both sides of the Atlantic. Draper starts his preface thus: ‘The fact that a knowledge of Physics is indispensable to a thorough understanding of Medicine has not yet been as fully realized in this country as in Europe, where the admirable works of Desplats and Gariel, of Robertson, and of numerous German writers, constitute a branch of educational literature to which we can show no parallel’. Figure 3 summarises these acknowledged sources, together with those of the Glasgow physiologist Joseph M’Gregor-Robertson (1858–1925), taken from the introduction to his Physiological Physics.1 Draper reports that his book is based upon lectures ‘delivered during many years at the University of the City of New York’. He hopes that it should ‘call deserved attention to a subject hitherto slighted in the curriculum of medical education’. He gives his own title as ‘Professor of chemistry and physics (my italics) in the Medical Department of the University of New York’.

A review for the American Medical Association considered that the book, ‘… the first work on medical physics in this country, is the forerunner of a new era in medical education’, adding: ‘Thus far our colleges may, with but few exceptions, be said to have “thrown physics to the dogs”’. The review also notes approvingly the absence of mathematics, and applauds the detailed section on microscopy. In this and other ways Draper’s selection of material differed in emphasis from that of its European counterparts. There is little cover of physiological measurement, and the text includes several references to public health (figure 4). There is an extended discussion of the diagnostic and therapeutic uses of electricity (figure 5). He recognises the importance to physiology of the newly-established law of conservation of energy, using P.G. Tait’s Recent Advances in Physical Science as his primary source for this section. Elsewhere, he goes into detail on the passage of electricity through gasses (figure 6), demonstrating the physical basis for the discovery of x-rays 10 years later. These three figures selected from a total of 377 serve to demonstrate Draper’s broad view of the applications of physics to medicine.

John Draper’s legacy

The preface to Medical Physics is dated 1st June 1885. It was John Draper’s last work. On 20th December of the same year, still only 50 years old, he died suddenly from pneumonia. It is difficult be positive about the impact of Draper’s book. He was highly respected as an educator and the reputation of his physiology textbook resulted in a posthumous third edition. But, without the man to promote the topic, medical physics still floundered in the USA. Apart from a minor tutorial written by a New York lecturer in anatomy, Frederick Brockway,6 there were no further medical physics publications in America before the end of the century.

By contrast, when in 1944 Otto Glasser, Head of Biophysics in Cleveland, edited his 1744-page encyclopaedia on medical physics6 he was able to draw on the combined expertise of no less than 250 contributing authors. From ‘Air conditioning and heating’ to ‘Weighing’ (x-rays came under Roentgen rays), the 255 entries presented an astonishingly broad overview of the dependence of medicine on physics and physical principals. Sixty years after his death, Draper’s pioneering contributions were completely ignored. Hopefully this article goes some way to redressing this sad omission.

REFERENCES

3 Draper JC. On some of the most important facts respecting respiration. NY Med Times 1856; 5: 333–7.
6 Draper JC. A Practical Laboratory Course in Medical Chemistry. New York: Wood, 1882.
Like to further your career in

New South Wales, Australia?

New South Wales lies on the east coast of Australia and is the home of Sydney, Australia’s oldest and largest city. Set on one of the world’s most stunning harbours, Sydney is a great place to start your New South Wales working holiday.

When it comes to choosing your working holiday in Australia there is no argument – it’s New South Wales! Whether you are attracted to the surf and coastal lifestyle, nature and national parks, delicious food and wine, exciting adventure or a leisurely scenic journey, New South Wales has it all. With its iconic beaches and cosmopolitan lifestyle, Sydney is a must-do. Wine, dine and party the nights away. Stay along the North Coast and surf, hike, camp, or just relax on the endless stretches of golden beaches and subtropical rainforests. The Hunter Valley produces terrific wines, and festivals and jazz nights are a regular event for the wine lover’s diary. And don’t forget the Australian Outback with its vibrant colours and country adventure spirit. Whatever you’re after New South Wales can offer you.

Radiation Oncology Medical Physicists wanted!

NSW Health is offering sponsorship to experienced Radiation Oncology Medical Physicists to fill positions of up to two years, available in the fourteen publicly operated Radiation Oncology Departments servicing the state of New South Wales. The majority of medical physics services, including complex treatment procedures, are provided by the NSW public sector which has the largest number of Radiation Oncology Departments in Australia. Centres are located in both major metropolitan hospitals and large regional and rural centres, and have strong university links. This range of locations allows a diverse choice of lifestyles; from the beach to the mountains, from the vineyards to inner city living, from the outback to the coast. The Sydney based centres are located in Sydney suburbs of Liverpool, Penrith, Randwick, St Leonards, Camperdown, Kogarah, Darlinghurst and Westmead. The major regional Radiation Oncology Departments are located in Newcastle and Wollongong. Radiation Oncology Departments are also at the major rural cities of Port Macquarie, Coffs Harbour, Lismore. Centres in the rural and regional cities in Tamworth, Orange and Nowra are planned to open in the near future.

It’s not as hard as you think to come and work in Australia, and NSW Health Department will make it even easier!

NSW Health wish to appoint highly motivated Radiation Oncology Medical Physicists committed to providing excellent care for the patients of NSW. Sponsorship is offered by NSW Health to obtain business visas (through the individual Radiation Oncology Departments), relocation assistance in the form of an economy airfare and accommodation subsidy*. Do you want to know more?

To be considered for employment within NSW it’s as simple as contacting the Radiation Oncology Department directly, who will be able to provide you with further information. Visit the NSW HealthWeb site at: www.health.nsw.gov.au/jobs/ for more information on the individual Radiation Oncology Departments.

Like to know more?

Email the NSW Health, Sydney, Australia on romposrp@doh.health.nsw.gov.au

* Conditions apply photos courtesy Tourism NSW

NSW Health site: www.health.nsw.gov.au
OCTAVIUS 4D

Turnkey Solution for 4D IMRT QA

- True independent 4D dose verification
- Measurements inside the entire phantom volume, always perpendicular to the beam
- 3D volume analysis and patient CT overlay
- Suitable for use with other PTW detector arrays and FFF LINACS

Unique rotating phantom which aligns the detector perpendicular to the beam, allowing true isotropic dose measurements inside the entire phantom volume.

Powerful VeriSoft® with advanced tools for dose comparison, including 3D volume analysis and patient CT overlay.

WWW.OCTAVIUS4D.COM USA | LATIN AMERICA | CHINA | ASIA PACIFIC | INDIA | UK | FRANCE | IBERIA | GERMANY

OCTAVIUS and VeriSoft are registered trademarks of PTW.