THIS ISSUE

08 COVER FEATURE
UNIVERSITY RESEARCH
More about the Research Assessment Exercise and what it means for universities and staff in terms of research funding

10 TUTORIAL
K-SPACE: THE FINAL FRONTIER An explanation of this tricky concept

15 TUTORIAL
PUBLISHING PROFESSIONAL WRITING (1) Why and where to publish

19 TRAVEL REPORTS
REWARDING TRAVEL TO THE UK American perspective on a trip to the UK

22 MEETING REPORTS
RPA UPDATE 2007
Navneet Dulai

23 MEETING REPORTS
STEREOTACTIC RADIOTHERAPY AND SMALL FIELD DOSIMETRY
Craig Edwards

26 MEETING REPORTS
MR SAFETY UPDATE MEETING
Liz Moore

28 MEETING REPORTS
BORON NEUTRON CAPTURE THERAPY
Cecile Wojnecki

30 MEETING REPORTS
PRESSURE AND BRAIN MONITORING, MECHANISMS AND TREATMENT
Iain Chambers

35 MEETING REPORTS
INTERNATIONAL SOCIETY FOR MAGNETIC RESONANCE IN MEDICINE
Sarah Peel

40 MEETING REPORTS
MOLECULAR IMAGING WITH POSITRON EMISSION TOMOGRAPHY
Lucy Pike, Elizabeth Harron, Anne Dawson, Anton Paramithas, Iain Murray

30 OBITUARY
ANTHONY FLYNN A man who dedicated his life to caring for patients

04 REGULARS
PRESIDENT’S LETTER Moments of inspiration
05 REGULARS
EDITORIAL Serve and reflect
06 REGULARS
NEWS Stories of interest making the headlines
45 REGULARS
MEMBER’S NEWS The winner takes it all
46 REGULARS
EXAM RESULTS Congratulations to those having passed recent exams
47 REGULARS
DIARY OF MEETINGS IPEM’s upcoming meetings
48 REGULARS
BOOK REVIEWS A packed issue with an imaging theme
The UNIVERSITIES RESEARCH ASSESSMENT EXERCISE

Peter F. Sharp (University of Aberdeen and Grampian Hospitals NHS Trust) explains more about the RAE and what it means for funding available to academic staff

Those of you with connections with universities will have heard a lot of talk about the Research Assessment Exercise (RAE) in the past two or so years. The fact that it is often accompanied by wailing and a gnashing of teeth might have convinced even the least empathic to deduce that this was an important, if somewhat challenging, exercise facing academic staff.

THE AIMS AND OUTCOMES OF THE RAE

The RAE is one of the most significant government initiatives to influence universities in the last 20 years. It is conducted jointly by the four bodies responsible for providing the core funding of universities: the Higher Education Funding Council for England, the Scottish Funding Council, the Higher Education Funding Council for Wales and the Department for Employment and Learning, Northern Ireland.

The aim is to assess the effectiveness of each university in its research activity. The outcome from the exercise, the quality profile, is then used to determine the grant for research to the institution. Since this involves billions of pounds, it is not surprising that it is the focus of attention of even university vice chancellors.

The first RAE was held in 1986, and there were further exercises in 1989, 1992, 1996 and 2001. The next will be in 2008. It is a massive exercise, the last one considered the work of almost 50,000 researchers in 2,598 submissions from 173 institutions.

REVIEWING THE RAE

With such a large investment of effort from university staff it is not surprising that there has been much navel gazing about how it should be carried out. Following the 2001 exercise the UK funding bodies commissioned a review, led by Sir Gareth Roberts, to consider how to assess research in the future. This was followed by a widespread consultation on its findings. Although some changes were made to the process as a consequence, there was very strong endorsement for the 2008 RAE to be based upon expert review by discipline-based panels considering submissions from HEIs.

This was supported by a report published in April 2002 by the House of Commons Science and Technology Select Committee. This report concluded that ‘the RAE has had positive effects: it has stimulated universities into managing their research and has ensured that funds have been targeted at areas of research excellence’. The report also advised that a further RAE should be carried out in 2008.

In July 2004, the Government published a 10-year investment framework for science and innovation. The report confirmed that the dual-support system for public funding of research in the UK should continue. So much for the democratic process! For despite this support for basically continuing the assessment in the same way, in 2006 Gordon Brown suddenly announced, in a little-noticed part of the budget speech, that the 2008 RAE would be the last. He wanted to ‘radically simplify’ the method of distributing research funding to universities. In fact, he expressed the view that if universities can agree on a replacement, the 2008 RAE did not have to happen at all. He proposed that in future, money will be distributed on the basis of ‘metrics’, such as the impact of published papers or the amount of income earned in research grants and contracts.

UNIVERSITIES’ RESPONSE TO THE REVIEW

Not surprisingly, this elicited a robust and somewhat panicky response from the universities. The older institutions wished to retain the present system
2008 was 30th November 2007. What then happens? Well, the results will be announced in December 2008. Each assessment will be expressed in terms of quality profiles that will show the proportions of research activity in a submission judged to meet each of four ‘starred’ quality levels, where four stars is the highest and denotes ‘Quality that is world-leading in terms of originality, significance and rigour’ and one star means that ‘Quality that is recognised nationally in terms of originality, significance and rigour’. In addition there is an ‘Unclassified’ grade defined as ‘Quality that falls below the standard of nationally recognised work’. After that it is up to the funding bodies to decide how they will use this to inform the allocation of resource to each institution.

WAITING TIME
So a lot rides on this exercise. Next time you complain about Agenda for Change or waiting time targets, spare a thought for your colleagues in universities whose future depends heavily on what is announced just before Christmas 2008.

FUNDING DECISIONS
So by now the research output will have been produced. The closing date for making submissions to the RAE 2008 was 30th November 2007. What then happens? Well, the results will be announced in December 2008. Each assessment will be expressed in terms of quality profiles that will show the proportions of research activity in a submission judged to meet each of four ‘starred’ quality levels, where four stars is the highest and denotes ‘Quality that is world-leading in terms of originality, significance and rigour’ and one star means that ‘Quality that is recognised nationally in terms of originality, significance and rigour’. In addition there is an ‘Unclassified’ grade defined as ‘Quality that falls below the standard of nationally recognised work’. After that it is up to the funding bodies to decide how they will use this to inform the allocation of resource to each institution.

The quality of teaching being carried out in universities will affect research budgets.

while the post-1992 institutions welcomed the change to a metric based system. However as so much effort had already been invested in meeting the requirements of the 2008 RAE it was agreed that this would go ahead as planned.

ASSESSMENT EXERCISE
So how does the RAE work? It is based on a two-tier panel system: 67 sub-panels of experts, one for each so-called unit of assessment, work under the guidance of 15 main panels. The panels are made up of staff from the HEIs and the wider research community. Under each main panel are broadly cognate disciplines whose subjects have similar approaches to research; these range from cardiovascular medicine, through allied health professions and physics, to art and design.

The main panels are made up of a chair, the chairs of each of the sub-panels within the main panel area, and a number of international and additional members giving a total of about 15 members. The idea of having international membership of the main panels is to ensure that international standards are maintained consistently across the exercise.

The main panels are responsible for reviewing and endorsing the criteria and working methods to be used by the sub-panels and deciding on the quality profile to be awarded to each submission. The sub-panels are responsible for undertaking the detailed assessment of submissions from HEIs and for making recommendations to main panels on the quality profiles to be awarded.

So how do the panels assess research quality? Each submission to a particular unit of assessment includes information on:

- Up to four research outputs per researcher, normally papers, published between 1st January 2001 and 31st July 2007.
- The numbers of full-time and part-time postgraduate research students and degrees awarded.
- The amounts and sources of external research funding.
- The research environment and indicators of esteem described in terms of the university’s research environment and organisation, information about their strategic investment in the unit of assessment, their strategies for promoting and developing research staff, etc.

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K-SPACE: THE FINAL FRONTIER

Gary P Liney, Robert Brackenridge and Mark Dobbs shed some light on the difficult and often misunderstood concept of k-space

FOR THE LAST IN MY series of MR tutorials, I am going to deal with the topic that most students of MRI invariably leave until the end to deal with: k-space. Together with phase-encoding, k-space is perhaps one of the least understood concepts in MRI. This is not helped by the slightly different interpretations given by the variety of MRI textbooks. At first glance, it seems a completely abstract concept that bears no resemblance to the final image. Perhaps the best [or most instructive] way of learning about k-space is to visually demonstrate the effects that manipulations of the data have on the resultant images. In an attempt to do just that I have been joined by my two recent Grade A trainees, Robert Brackenridge and Mark Dobbs, to write this edition’s tutorial. It will inevitably leave a few questions unanswered, but will hopefully address some of the most pertinent and practical issues.

INTRODUCTION

By way of an introduction it is useful to reconsider how the MR image is created. In the presence of a high magnetic field (from the scanner), MR-visible nuclei precess at a predictable frequency and in doing so create a small magnetisation. This can be perturbed by introducing an appropriate radio-frequency pulse (from the coil). A summation of signal from every resonant spin in the object or patient being examined is subsequently detected. For an image to be created this signal needs to be spatially encoded in some manner. In MRI, this begins with the application of gradients; that is, linear changes in the magnetic field. These can be applied in any single orthogonal direction or in combination to produce images of any orientation. The action of a gradient creates both changes in resonant frequency and phase of the signal and it is these two characteristics that are used to discriminate each in-plane direction. A [2D] Fourier Transform is then used to unscramble this signal and assign pixel values to their appropriate positions.

In routine imaging the frequency encoding gradient is turned on once in a given direction at the time of signal recording (the echo), and the frequency changes are sampled to discriminate signal in that direction. Phase encoding [not discussed in any detail here] is reserved for the second in-plane direction. The gradient responsible has to be applied a number of times with incremental steps in amplitude. This has the effect of altering the phase of the measured echo. The number of times this gradient is applied corresponds to the number of pixels in the phase-encoded direction, permitting the rate of change of phase (frequency) to be determined. Each recorded echo corresponds to a collection of data in k-space.

WHAT IS K-SPACE?

The simplest description of k-space is that it is an array of raw data that exists prior to the Fourier Transformation (FT). More specifically it is a matrix of complex numbers at different spatial frequencies that contain enough information about the object for the image to be fully reconstructed. There is no direct spatial relationship between positions in k-space and pixels in the final image, i.e. a pixel at a certain location in k-space, does not correspond to that pixel location in the final image. In fact one element of k-space contains information about all the pixels of the final image albeit at one specific spatial frequency. The image produced on the scanner console is the result of a two-dimensional FT of this complex raw data, i.e. it has been reconstructed by the time it appears on the screen.

In nearly all cases it is the magnitude component of the signal that is produced as a grey-scale representation. In a similar way, it is also possible to display either the real or imaginary (or even phase) part of this complex data. Reconstruction can in fact be turned off altogether, and in this case the k-space data (or rather the magnitude of it) is shown as the final ‘image’.

The motivation for this tutorial began as a Grade A project during Mark and Rob’s placement. In an attempt to demonstrate k-space on our 1.5 Tesla GE scanner we deliberately set an image control variable to turn off reconstruction, the aim being to display ‘k-space’ of the human brain. However, for some reason this did not work and undeterred we embarked on the following course of action. The signal data was intercepted at the level of the scanner’s raw database and transferred onto a lap-top. The problem was then how best to interpret and display this information. What began as an attempt to see what k-space looked like ended up in the development of software written in MATLAB (by Mark and Rob) allowing user interaction and manipulation of the data as an educational tool. All the images you see in this article have been produced using this code.

At this point you may still be left wondering, so what is k-space?! The ‘k’ itself actually refers to the wave-number, or the number of wave cycles per unit distance. It is therefore the spatial analogue to the more easily understood ‘cycles per second’ frequency. It is related to the application of the imaging gradients by k = γGt, where G and t are the amplitude and duration of the gradients respectively. The product Gt can be thought of as ‘the area under the gradient’ in commonly used pulse sequence diagrams. (Note: from the Larmor equation it can be shown that k is equivalent to a change of frequency with distance.)

If we construct k-space axes for both phase and frequency directions we can relate the actions of the gradients [as drawn in the sequence diagram] to positions in k-space. By convention, a high negative amplitude of the phase-encoding gradient corresponds to a k-space position below the origin. Similarly a large negative frequency-encoding gradient positions the data to the left of the origin.
In k-space terms, a line or row of data is collected each time the frequency gradient is applied. The phase-encoding increment merely controls the starting position of this line. All the spatial frequencies are needed to fully describe the object. By acquiring a complete set of phase- and frequency-encoding gradients the whole of this k-space is ‘filled’, creating enough data to produce an image. If part of this data is missing or incorrect (either deliberately or due to some problem), the image, as we shall see, will deviate from being a true representation of the object.

**EXAMPLES OF K-SPACE**

Before proceeding further it is instructive to describe two further properties of k-space. The k-space resolution, i.e. the separation of the lines of phase-encoding or the sampling of frequency points, determines the imaging field-of-view (FOV) and follows a reciprocal relationship:

\[ \text{FOV} = 1/\Delta k \]

Pixel resolution of the final image is determined by the maximum k-space value (the length of k-space or FOVk), and again there is a reciprocal dependence:

\[ \Delta x = 1/\text{FOV}_k \]

What follows are some examples relating k-space (and alterations made to it) with its corresponding 2D Fourier Transform, i.e. the image. Figure 1 shows our gold-standard data-set acquired on the scanner. This is a typical T2*-weighted image of a normal brain (well, Mark’s!) using a standard clinical sequence and a matrix of 384 × 384. The right-hand side is the reconstructed image and the left shows the k-space array prior to the FT. As we have mentioned, a full description (or filling) of k-space is needed to produce an accurate image. The central lines of k-space (acquired with small amplitudes of phase encoding) correspond to the bulk of the signal and contrast information. The outer lines (created by the higher gradient amplitudes) contain the spatial detail but lacks any signal weighting. In figure 2, this central portion alone has been preserved and the corresponding FT produces a blurred version of the image in figure 1.

**GRAPHICAL IMAGES OF K-SPACE**

Figures 1 to 3 serve to illustrate why filling k-space is important. However, the acquisition of every phase-encoding step takes time and some sequences take several minutes to acquire. Long scan times increase the risk of patient motion and image degradation. There are a number of techniques that cut down scan times by merely not acquiring so much of k-space. These take advantage of the symmetry of k-space where data rotated 180° about the origin is identical. What this means in practical terms is that a minimum of half of k-space can theoretically be acquired to obtain the image. When this is done for the top or bottom half of k-space (phase encoding) it results in a saving of time. Figure 4 shows what happens when only half of k-space is used. In fact the missing data is actually filled in from its symmetrical half (the imaginary component has the opposite sign), although copying data in this way is no substitute for real data acquisition. In practice slightly more than half of the lines are collected, those few past the origin are used to phase correct the data. In a similar way other fractions of k-space can be acquired with a less severe trade-off between image quality and time saving (e.g. ¾ and so on). There is a limit however; k-space data cannot be reduced to one-quarter as figure 5 shows.

Instead of obtaining fractions of k-space in the phase direction, frequency acquisitions can also be shortened. This is equivalent to sampling only part of the signal echo and permits shorter minimum echo times. Both of these techniques may be referred together as ‘partial k-space’ although they are subtly different (the latter is often specifically termed partial echo while the former is partial Fourier).

Further manipulations of our k-space data can be used to demonstrate the effects of interference. In figures 6–8 an erroneously high intensity data point has been inserted into the matrix at various positions. This re-creates a problem in the k-space integrity.
Figure 5. (left) Using only the top left quadrant of k-space is not enough to provide a proper image (right).

Figure 6. (left) Inserting an erroneously high value near the centre of k-space (red circle). (right) The image now displays banding artefacts.

Figure 7. (left) This data point has now been moved further away from the centre of k-space (red circle). (right) The artefacts are present with a higher frequency.

Figure 8. (left) The data error is at the same distance from the centre as in figure 7 but at an angle of 45° (red circle). (right) This has caused the angle of the artefact to change.

A usual cause, for example, by an RF interference spike. Fourier theory tells us that FT of a high intensity point (a delta function) results in a cyclic pattern across the image (a sine wave). The actual frequency and direction of the ensuing artefact depends on the position of the error. In figure 6 the datum responsible has been created near the centre of k-space (indicated by the red circle). In this case the low frequency effect creates a wide banding across the image. Compare this to figure 7 where the problem has been created further away from the centre of k-space. This causes a higher frequency pattern, the characteristic Herringbone artefact. In figure 8, the data point is at the same distance from the origin but at a different position. Note that the artefact therefore has the same frequency but the angle of propagation changes. Interestingly the artefact is perpendicular to a line drawn from the k-space origin to the data point concerned (in this case 45°).

ZERO-FILLED INTERPOLATION
An apparent improvement in resolution can be achieved with no time penalty using the method of zero-filling (sometimes called ZIP, Zero-filled Interpolation). As the name suggests, zeroes are added to the edges of the k-space array extending the size of the k-space matrix [FOV / Δx] with the effect of producing a larger image. As only zeroes are added there are no improvements in signal or a worsening of noise. The final image is an interpolation; it does not actually have the resolution of an image that has been fully phase encoded to the same extent. An example of this is shown in figure 9. On the left the k-space matrix has been zero-filled to a 768 (a power of two is another feature of ZIP). On the right the resultant image is bigger (take our word for it). To prove that the resolution is not as it should be, we can look at images acquired in a resolution phantom. This consists of a series of plates of varying separations and distances. Taking a line profile across these demonstrates a signal modulation and establishes whether or not the pattern at the nominal resolution is achieved. In figure 9, example images of this phantom are shown for various resolutions. The area in the phantom highlighted in red has been shown on the right-hand side for images using a 256 matrix (top), a 512 matrix (middle) and a 256 matrix with a ‘ZIP 512’ option (bottom). The three bar patterns highlighted have separations of 0.5 mm, 2.0 mm and 1.0 mm respectively. A comparison of these for each case shows that the zero-filling improves resolution somewhat but it does not resolve detail as well as a true 512 imaging matrix.

Figure 10 also serves to illustrate the presence of another common artefact: Gibb’s ringing. It is most obvious at high contrast boundaries and is the result of finite sampling. High spatial detail requires infinite k-space values but the finite maximum k-space dimension causes a truncation of the Fourier series, causing the characteristic ringing appearance. It can be seen to be present in figure 10 around the edges of the phantom and the blocks within it.

CLINICAL APPLICATIONS
In certain situations it may be desirable to alter the order in which k-space data is collected. This is referred to as differences in k-space trajectory. Commonly k-space is filled in a sequential manner beginning with the highest negative phase-encoding step and moving through the centre until the maximum positive phase-encoding amplitude. Other trajectories may be followed whereby the central lines are filled in first followed by outer lines (centric). The opposite route may also be followed (concentric). Other more efficient and technically challenging trajectories are possible (for example spiral k-space).

K-space order may be particularly important in methods where the timing of the data collection in relation to some physiological event is critical. A good example of this is in contrast-enhanced MR angiography. In this scenario, images are acquired following the intravenous administration of a contrast agent. The blood signal enhances so that the vasculature appears brighter than surrounding tissues. For a good quality arteriogram the contrast should be captured before it has the chance to produce venous enhancement. If the peak arterial enhancement does not occur at the same time as the central data lines are acquired the resulting images may be blurred.

An extension of this idea is so-called ‘key-hole’ imaging. Again this is often utilised in contrast-enhanced...
angioigraphy or any dynamic series where image slices need to be repeatedly scanned as quickly as possible. In this technique a full k-space image is acquired once and subsequently only the centre (or keyhole) of k-space is collected from frame to frame. As we have seen, partial k-space improves the acquisition speed and in this instance the temporal resolution of the scans is greatly improved. It is particularly useful in this situation where only the signal contrast is expected to change from image to image. The image detail from the first full acquisition is used to fill-in the missing portions at the end.

PEAR AND PROPELLER

Another use of k-space ordering is in the reduction of the effects of periodic motion. In PEAR (Phase Encoded Artefact Reduction) and ROPE (Respiratory Ordered Phase Encoding) there is an optimum ordering of data collection which is timed so that consecutive k-space lines are acquired at identical points of the respiratory cycle. The result is images that are gated or compensated allowing artefact-free abdominal images. Non-periodic motion is much harder to negotiate but again k-space order can be manipulated to the best advantage. A relatively new sequence that does this is PROPELLER (Periodically Rotated Overlapping Parallel Lines with Enhanced Reconstruction), which reduces the effects of random motion. In this method, lines of k-space are acquired through the origin at different angles (analogous to the blades of a propeller) leading to an oversampling of the central data. The result is a sequence that is robust with respect to movement which would otherwise create problems in sequential trajectories. An example of its effectiveness is shown in figure 11. In both (a) and (b) the subject was asked to move their head and in (a) the effect of this motion is apparent with the presence of severe phase-encoding ghosts. However, in (b) PROPELLER was selected as an imaging option for an otherwise identical sequence. The difference is dramatic and this sequence is extremely useful for uncooperative or difficult patients (e.g. children and the elderly), improving the quality of scans without the need for sedation. Furthermore, the technique improves other motion-sensitive methods such as diffusion weighted imaging.

One of the more groundbreaking techniques in recent years has been parallel imaging. It can be only be used when multiple coil elements are available. The sequence is made to run faster by omitting certain lines of k-space. As we saw earlier, the increased separation of the k-space lines \( \Delta k \) results in a smaller imaging FOV. This causes a wrapping of the image where certain portions are mis-mapped onto opposite sides. Knowledge of the coil sensitivity profiles are used to unwrap the final image (for reconstruction techniques in imaging space like SENSE). In this way ‘coil encoding’ can be seen to replace some of the time-intensive ‘gradient encoding’. The speed-up factor is related to the number of lines that have been missed out. An example of this is shown in figure 12. On the left every-other line of k-space has been removed to simulate the omission of these phase-encoding steps (equivalent to a speed-up factor of two). The resultant image on the right demonstrates the wrapping due to the smaller field-of-view. Although the time of the scan has been reduced SNR is compromised (as shown in the last article). Theoretically the image time can be reduced by a factor equal to the number of separate coil elements used to acquire the signal. Many new modern RF coils are multiple elements designed to take advantage of this technique.

SUMMARY

Hopefully this article has helped in some way to explain k-space. As can be seen from this brief introduction, a little understanding of k-space helps a great deal in explaining how and why some of the imaging techniques have been developed. For further reading I would recommend the excellent Picture to Proton book, now in its second edition. Finally, I would like to thank out-going editor Mark McJury, who approached me about 12 months or so ago for a series of MR-related articles. I hope they were as interesting to read as I found them challenging to write, each time that deadline came along!

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FIGURE 9. (left) Here the edge of the array is padded with zero entries to twice the original size. (right) The image is now interpolated.

FIGURE 10. Example of the effect of zero-filling on actual image resolution. This resolution phantom has been imaged using three different resolution settings. The area highlighted in red is shown on the right for (top) 256 matrix, (middle) 512 matrix and (bottom) 256 matrix with ‘ZIP 512’ option. The bar patterns (0.5 mm, 2.0 mm and 1.0 mm) provide a visual comparison and show that zero-filling offers some improvement over 256 but not as good as 512.

FIGURE 11. Imaging in the presence of head motion. (a) Shows ghosting artefacts that are completely remedied by using PROPELLER in (b).

FIGURE 12. (left) Removal of every-other line of k-space data is equivalent to a SENSE factor of two in parallel imaging. (right) The image is wrapped due to the reduced FOV and will need coil sensitivity profiles to produce the final image.
Following Gary’s last tutorial on QA, Elizabeth Moore (Philips Medical Systems) sent us the following comments:

‘Gary Liney’s tutorial Quality Assurance in MR Imaging in the September edition of Scope provides a very helpful quick guide to MR QA. However, in the section on parallel imaging (PI), he does not mention the crucial point, that the g-factor is spatially variant. Not only that, the g-factor depends critically on the position of the coil elements relative to the phantom (or patient) being scanned. Image-based PI methods [SENSE, ASSET] are prone to rather abrupt variations of g-factor, whereas k-space-based methods (SMASH, GRAPPA) have smoother spatial variations. Thus the noise spectrum is also spatially variable across the slice and varies from one slice to another.

The standard methods for measuring SNR – the NEMA subtraction method and the noise-in-the-background method – are not relevant for images acquired using parallel imaging methods even if the acceleration factor is 1.

Other methods have been proposed, for example Kellman and McVeigh [Mag Res Med 2005; 54; 1439–47]. However it is probably fair to say that these are not widely available. Physicists should exercise caution in interpreting SNR measurements for different acceleration factors.’

Gary’s answer was as follows:

‘I take Liz’s comments on board. The complex relationship and SNR issues in parallel imaging was beyond the intended scope (no pun intended) of the article. I think I mention that the g-factor should not be treated as a ‘constant’ without going into too many details. To be honest I can’t remember which SNR method I followed for the SENSE images, and it does not mention any specific method in the text either. The choice of which SNR measurement to use is often raised (even for routine images) and Liz provides a valuable recommendation.’

Good to see people are reading the tutorials in such detail!
THIS TUTORIAL OFFERS an overview of how, why and where to publish a professional article. The Scope tutorial format is by nature brief, so the topics covered here are only touched on. In attempting to cover a large number of issues, we have prepared a pair of tutorials; the second is in the June issue.

There are many reasons why people choose to write and also many different media in which they publish; a consequence of the latter results in different styles that must be adopted to convey their message. In this first tutorial we start by trying to understand reasons why people publish, thereby establishing the driving forces and values of this activity. We address questions of assessing the usefulness of the message, where to send the manuscript and its format and authorship. In the second tutorial we move to some practical tips on how to write and we outline the process of submitting an article for publication and some advice about the steps to getting your work published. There are some suggestions for further reading at the end, which provide extra ‘meat’ on each topic.

Broadly speaking, writing for professional purposes can be divided into two categories – scientific and journalistic (though these are not necessarily mutually exclusive). By ‘scientific’, we mean articles presenting or reviewing original research and generally published in the peer-reviewed scientific literature. ‘Journalistic’ articles refer to those presenting more qualitative reviews and opinions, and generally published in the more popular press. We will attempt in these tutorials to address both styles.

WHY PUBLISH?

External and internal factors motivate people to publish. Here are some of the reasons you might be considering:

- To share research findings
- To stake a claim being first to solve a particular research problem
- To describe an innovative project
- To meet expectations of your job
- To express a point of view
- To earn money
- To earn kudos from colleagues
- To maintain status
- To earn promotion

Being required to publish as an expectation of your job is a strong motivator; and to some extent the pressure of being viewed as somebody who holds a particular status within a profession with whom publishing is associated would have an effect too. Money is usually not a driving force for professional writing, as typically people are not paid or the amount of money involved is quite minor. For certain professions, in order to advance your career, a track record of publications is required. For some, publishing is their hobby as well as part of their routine job. These people like writing and they get an inner satisfaction from publishing their work. In general, publishing an article allows authors to put their work in a place where it: (i) can be accessed for future reference, (ii) acknowledges them as the originator, and (iii) can be disseminated widely. Science is by nature incremental – theories are postulated but then continually altered and refined in the light of new evidence. Publishing, especially in peer-reviewed journals, is our opportunity to get involved with this process.

IS IT WORTH IT?

Firstly, before embarking on writing the article, you must be confident it is a contribution to the literature worth making. Has this information/opinion already been published? Knowing what’s in the literature is crucial and an extensive literature search is always required. To be accepted for publication by a journal, the message in the article must be new, or make a significant additional contribution to current knowledge. Importantly, the question it addresses must also be of current interest to the particular research/clinical community.

WHERE AND WHAT TO SAY?

Given the range of publication media available, and their inherent styles, it is important for an author to decide early on where they wish to see their article, particularly for journalistic articles.
You must choose your audience, and know who your readers will be, to be able to pitch your writing at the correct level and with focus. The scientific peer-reviewed journals have their kudos, but this comes with a cost of high rejection rates. Generally peer-reviewed journal articles tend to be read by people following a line of enquiry for research purposes. Professional magazine/journals, by contrast, tend to be read more widely. The nature of these journalistic articles being easier to read can result in a broader readership which can allow for more people to access your message. The downside of these publications is their variable quality. Of course the two alternatives are not mutually exclusive. Clearly, it is important to recognise that all media have value in conveying information, and it is up to the author to decide which will convey their message to the right people in a timely and meaningful fashion. Inherent in this decision is the need to formulate an article that complies with the expectations of the media in which it will be published.

For scientific writing, this decision of where to send the manuscript can be put off until later in the process. Writing in scientific journals has broadly the same tone, with small differences in format set out in the Instructions for Authors. The main differences between journals in a particular field/subject is the target audience (researchers, clinicians, academics) and ‘status’ of the journal (reflected in the competition to get published in a particular journal). A journal’s impact factor is an index of the status of the journal and signifies how difficult it may be to have an article accepted by the referees. It is an independent measure based on the numbers of citations articles in the journal receive over a set time period. There is therefore extra kudos to publishing in a journal with a high impact factor. In academic audits of departmental performance, impact factors will be taken into consideration when assessing the publication record.

Alongside the decision of where to send the manuscript, the format or type of article must also be considered. Typical examples of article types are:

- An original research article
- A technical note/communication
- A case report
- A literature review
- A letter to the editor
- A book review

A research article will clearly set out arguments and data to answer a question or hypothesis. It should offer significant new information or a novel perspective on existing work in the field. A technical note is generally significantly shorter than an original research paper, perhaps with a strict limit on the number of words and figures. Clinicians often write up particular patient cases when they feel it is especially unusual/novel and reporting on it will add to current knowledge of disease or improve practice. Case studies might also be a methodological approach, being quite different to a clinical case review. Literature review articles are somewhat different in that they tend to be invited from an author rather than submitted proactively to a journal. Authors will generally be workers with a significant track record of research and publication in the particular field under review. A systematic review is based on a methodological approach that is more rigorous than a simple review of articles.

You may wish to write up a certain case study with a methodological approach rather than a clinical case review.

AUTHORSHIP

Early on in the process, the authorship of the article should be addressed. Often, articles will have several co-authors and deciding who and in what order those names appear can prove to be contentious. Good practice dictates inclusion of authors based on contribution to ideas and labour (study conception, design, data acquisition, analysis or interpretation, input into the writing of the manuscript). Accepted guidelines are available (reference 1). Broadly, the base of the authorship sequence is often alphabetical. On top of that base, the person who has done the majority of the work on the study may go first. Often the research/study group leader/supervisor will go last in the author list.

SUMMARY

In this first tutorial, we have tried to cover issues of why to publish, and how to decide on the form of article to write. Early decisions on where to send an article and author selection have also been addressed. In the next tutorial, we will focus on the practicalities of getting down to actually writing, revising and submitting a manuscript.

REFERENCES

REWARDING TRAVEL TO THE UK: TO SHARE VISIONS AND PRACTICE

MARK OLDHAM Duke University Medical Centre, Durham, NC 27710, USA

“A traveller! By my faith, you have great reason to be sad: I fear you have sold your own lands to see other men’s; then, to have seen much and to have nothing, is to have rich eyes and poor hands.” (William Shakespeare, As You Like It (1599), Act 4, Scene 1.)

Had I listened to these words 10 years ago I would perhaps never have left the UK to explore a career in medical physics in the US. But I did leave. Now, with 10 years experience in American medical physics, and quite contrary to this gloomy perspective from Shakespeare, I felt truly enriched by the opportunity to return to the UK in May 2007 as the travelling AAPM–IPEM fellow. The aim: to share visions of the eyes and improve the practice of the hands.

ROYAL MARSDEN (RMH/ICR)
The Joint Department of Physics of RMH/ICR (Royal Marsden Hospital and the Institute of Cancer Research, Sutton) is a very special place for many reasons, just one being a top-flight tradition of academic and clinical excellence in radiation therapy. For me especially so, as this is where in 1992 I started my career in medical physics as a postdoctoral researcher. I felt fortunate to be given this opportunity, having no prior experience in medical physics (my PhD being in non-Newtonian gravity), and an unusual story having just returned broke from 6 months living in a tent, working for a conservation organisation in East Africa. My new boss, Professor Steve Webb, was unperturbed however, and immediately directed me to work on inverse planning algorithms for IMRT. I worked at RMH for over 5 fantastic years. This was my first visit back, and was needless to say a most poignant moment. The innovative quest continues at RMH/ICR, and I learned about ongoing research into the effects of motion on IMRT, image guidance, IMRT trials and multi-modal imaging, to name a few. Jim Warrington introduced me to the extensive new bunker facility at RMH Sutton, which will house five new state-of-the-art linear accelerators, and the TrackLeaf device which they were about to commission for real-time therapeutic tracking (figure 1). I gave two lectures at RMH, one at each site (Sutton and Fulham Road, respectively), and each conferenced live to the other site. The first was on IMRT and IGRT at Duke, and the second on my recent research on optical tomographic imaging of tissue. Two true highlights (from many) were meeting Dr Roy Bentley, co-inventor of the famous Rad-8 treatment planning system first used at RMH in 1971, and to spend an afternoon at Professor Webb’s home workshop, observing first hand the intricacies and art of live steam engineering (figure 1). Professor Webb proved quite an authority on this subject.

UNIVERSITY OF SURREY
The next stop was the University of Surrey, where a fortuitous set of coincidences had resulted in a mini-gathering of leading lights of optical-CT/3D-dosimetry. This was a great opportunity to review the state of the art, and engage in...
general brainstorming about the urgent need for realisation of clinical 3D dosimetry systems. Figure 2 shows a tantalizing glimpse of Dr Doran’s latest scanning-laser optical-CT scanner, incorporating precise rotating mirror galvanometers. This device preserves the high signal-to-noise of laser systems, with high speed, and represents a substantial innovation to the field.

**BRISTOL ONCOLOGY CENTRE**

The first medical physicist I ever met was Dr Alan Mackenzie, Chief of Physics at Bristol Oncology Centre, in 1991. I originally contacted Alan as preparation for the post-doctoral interview at RMH, because the BOC is only a 45-minute drive from where I grew up in south-west England. Alan very kindly showed me around his department one afternoon, and encouraged me to pursue the post-doctoral option at RMH. Dr McKenzie’s department was just about to start commissioning an IMRT system, and so there was a great deal of interest to hear about our experiences in this area. It was a great moment to return to Bristol and feel able to give back in some manner to this department where I gained first insights into the profession of radiation oncology physics. It was also interesting to learn about the novel imaging of cervical brachytherapy applicator placement in the new (2006) MRI scanner, an effort lead by Dr Cornes.

**CLATTERBRIDGE ONCOLOGY CENTRE**

Leaving the delightful countryside of the west country, I headed north to meet Professor Alan Nahum and Philip Mayles at the Clatterbridge Oncology Centre. The CCO is unique in England, having a low energy proton facility, used primarily to treat ocular melanomas (figure 3). I had lots of questions for Dr Kacperek, especially regarding the nature of proton QA, who gave an exceptionally good guided tour of the facility. In the lunchtime seminar I reviewed some of the recent data from my collaborator Professor Geoffrey Ibbott (Director of the Radiologic Physics Center (RPC), Houston, Texas), which documents the alarmingly high failure rate of...
institutions in the US for the head-and-neck IMRT credentialing test. This data prompted a lively debate about the challenges and non-triviality of implementing a high quality IMRT program. In the afternoon Dr Nahum drove me to the annual conference Medical Physics on Merseyside, where I gave the introductory lecture. The conference, organised by Dr Nahum, brought together researchers from all over Merseyside, and included a very interesting range of topics, from detectors to small field measurement. It was a privilege to have the opportunity to give the opening lecture.

UNIVERSITY OF HULL

England is really quite a small island. Travelling from Merseyside to the University of Hull involved driving right across England, from west to east coast, and an early start at 6am ensured arriving in time for breakfast at 9.15am! I had long been looking forward to visiting Hull. I’d known my host, Professor Andy Beavis, since we did our Doctorates in the Department of Physics at Newcastle University in 1990. Andy also started in a non-medical field, and it is by coincidence that we both ended up in radiation oncology physics. Andy showed me around the very impressive new state-of-the-art six-machine facility at Hull, which is nearing completion of construction. In the afternoon we visited his collaborative partners in the University of Hull Computer Science Department. It is here that pioneering work is progressing to develop a life-size virtual-reality simulation that models linear accelerator based radiation therapy, complete with full linac control using a physical hand-pendant (figure 4). The utility of the tool, in the first instance, is as a training aid for radiation therapists. Experiencing the inherent quality and flexibility of the virtual environment (digital linac/patient, set-up simulation, visualization of organ motion, fluence delivery, etc.) convinced me that this approach has real potential in many areas of training, and will set the standard for the future.

CHRISTIE HOSPITAL

The last stop on my travels was to the famous Christie Hospital in Manchester. The Christie is at the forefront of IGRT implementation in the UK, and I had a particularly informative and enjoyable time discussing and observing IGRT implementation with many staff there, including several outstanding therapy staff. I was keen to also find out about current brachytherapy treatment approaches, and Mr Simpson and Mrs Julian obliged with a fascinating tour of the brachy suites (figure 5). There is a wonderful old English pub called the Red Lion, next to the Christie Hospital, occasionally frequented by hospital staff. The end of my trip was rounded out by a pleasant couple of pints of local draught English ale, watching the local team play some lawn-bowls in the pub garden.

ACKNOWLEDGEMENTS

In summary, this was a fantastic trip on both a personal and professional level. It is difficult to place a value on the wealth of experience it provided. I am very grateful to the AAPM–IPEM travel award for enabling the trip. Also, thanks go to the people who hosted my visits and provided such a wonderful stay, most especially to Professor Steve Webb, Dr Simon Doran, Dr Alan Mackenzie, Professor Alan Nahum, Professor Andy Beavis and Dr Ranald Mackay. Thank you.
RPA UPDATE 2007: DISCUSSION OF CURRENT RADIATION PROTECTION ISSUES

NAVNEET DULAI  King’s College Hospital

UNIVERSITY OF GLASGOW  4th June 2007

THIS ANNUAL ONE-DAY meeting was organised by the Radiation Protection Special Interest Group (RPSIG) and was attended by over 80 delegates.

The chair of RPSIG Stephen Evans (Royal Marsden Hospital, London) opened the meeting by describing the three-part layout of the sessions: The new wave’, talks on new developments within different areas; ’Professional matters’, talks on RPA certification matters; and ‘Emergency response’, which dealt with lessons learnt from the recent polonium incident in London.

THE NEW WAVE

The meeting was started by Chris Lawinski (KCARE – King’s Centre for the Assessment of Radiological Equipment, London) who talked about recent innovations in mobile radiography. Mr Lawinski first discussed the introduction of hand-held dental x-ray units to the market and the various legislative issues linked with using such units. Several examples from the Medical and Dental Guidance Notes were given to highlight legislative compliance problems, for example tube housing should never be handheld during exposure. The issues were brought to the attention of a manufacturer who justified the use of the units as: firstly, they were designed to be handheld and, secondly, they appeared on the market after the Guidance Notes were produced. However it was argued that the units should be provided with some form of mounting to allow them to be used with a stand and doses must be shown to be kept as low as reasonably practicable (ALARP).

Mr Lawinski then discussed the special importance of routine patient dose measurements and quality assurance of digital (both DDR and CR) mobile general radiography units which are now becoming commonplace.

To continue this session of new wave technologies Derek D’Souza (University College London Hospital) gave an account of the protection issues surrounding mobile radiotherapy. Intraoperative radiotherapy (IORT) allows oncologists to treat patients during surgery and hence when the tumour is clearly visible. IORT is now in more common use due to the availability of mobile accelerators and kilovoltage units that can deliver radiotherapy in the theatres. It is important that shielding requirements are considered and monitoring regimes established prior to any IORT undertaking. Mobile lead shields and lead aprons may also be utilised.

John Davis (Royal Sussex County Hospital, Brighton) gave a summary of personal monitoring methods used both in the past and in the present and had a look at the potential future of personal monitoring. One key point made was that the commonly used dosimetry techniques employing film and thermoluminescent dosimeters can measure down to dose levels that satisfy current legislation and that alternate or new dosimetry systems are unlikely to take a strong foothold in the foreseeable future. It was however noted that there are economic pressures on film-based systems. The other point made was that there is no real surrogate for personal dosimetry and it will be required as long as we continue to use ionising radiation in hospitals and other environments. It was also stressed how important it is for users to consider their requirements carefully, for instance it may be more important to monitor feet and ankles rather than thyroids in interventional radiography.

PROFESSIONAL MATTERS

Anthony Hudson (RPA 2000, West Yorkshire) started the second session by giving a concise report on the revised RPA 2000 accreditation procedure. This revision was needed to comply with the revised HSE statement on RPAs. RPA 2000 now provides clear instructions for the creation of a portfolio of evidence for RPA certification. The number of areas requiring detailed understanding (DU) has been greatly reduced down to 5. The areas of DU include matters such as demonstrating an understanding of the IRR99 and being able to advise on the minimisation of risk. It was emphasised that assessors will be looking for quality rather than quantity. It is anticipated that this simplified approach will make it easier for suitable applicants to demonstrate to the assessors they have the qualities required of an RPA and the processing time required should be reduced.

James Taylor (HM Principal Specialist Inspector (Radiation) HSE, Luton) expanded on the new HSE statement and highlighted the changes. The review looked at whether the existing statement was proportionate or created unnecessary burdens. It was highlighted that the portfolio of evidence required from an applicant should take into account the applicant’s qualifications, training and experience. Someone with many years’ experience should not need to submit the same quantity of evidence as someone with little experience. Assessors should also make use of the balance of probabilities when deciding whether or not to award a certificate. These changes should be viewed in the light of there being a shift of emphasis by the HSE from the RPA to the radiation employer.

EMERGENCY RESPONSE – LESSONS LEARNT FROM RECENT EVENTS

The polonium-210 incident in late 2006 sparked a lot of interest within the radiation protection community. This session was therefore of particular interest. Ciaran McDonnell (HPA, Oxfordshire) started the session, giving a detailed account of the HPA’s emergency plan used during the polonium incident. This tested the logistics and operations of the plan in a way that mock incidents could not and therefore provided useful information for future developments of the plan. It was noted that each emergency is likely to be different and
Stereotactic radiotherapy is a precise form of radiation therapy used primarily to treat tumours and other abnormalities of the brain. Small field dosimetry is one crucial aspect of this which also impacts on other disciplines such as intensity modulated radiotherapy. Therefore the aim of this one-day meeting organised by the Radiotherapy Specialist Interest Group of IPEM was to bring together the professions involved in all aspects of stereotactic radiotherapy and small field dosimetry.

The meeting was well attended, with 57 delegates donning hard hats to enter the Queen Elizabeth Postgraduate Centre, Birmingham, hidden within the University Hospital's new building site. Scientific organiser Craig Edwards (University Hospital of North Staffordshire, Stoke-on-Trent) welcomed the delegates and introduced the program for the day. Half a day was assigned to each arm of the meeting, with 13 presentations delivered. The final speaker of the session was Peter Marsden (University College London Hospitals) who is the RPA at the hospital where Mr Alexander Litvinenko was treated. Dr Marsden gave a detailed insight into the complicated involvement they had both during the incident and in the clean-up operation afterwards. The need for good communications between all involved parties and the need for the hospital to keep an eye on compliance with relevant legislation was a good lesson for us all to take home.

The meeting concluded with a lively question and answer session with all speakers of the afternoon talks taking part. All the talks were well received and considered to be extremely informative by the delegates.
e.g. Sc at dmax, 1000mm FAD

Spread of 20% over all detectors at 5 mm

FIGURE 2. Superposition matching of reference and CBCT data.

FIGURE 3. Relative collimator scatter at Dmax.
STEREOTACTIC RADIOTHERAPY

The first half-day session was devoted to stereotactic radiotherapy and was opened by Jim Warrington (Royal Marsden Hospital, Sutton). His presentation provided a thorough overview of how the patient fixation systems used in stereotactic radiotherapy evolved from those pioneered by neurosurgeons. Early frames and fiducial systems were pinned into a patient’s skull during surgery to provide precise immobilisation and positioning (figure 1). Over time, these fixation systems have become much less invasive, utilising orthodontic mouth bites, velcro, orfit and vacbags into the patient’s shell. Extensive studies into reproducibility of these newer fixation systems have shown treatment isocentre variations of the order 1 mm.

Later in the session, John Shakeshaft (Clatterbridge Centre for Oncology, Wirral) presented a study performed at the Clatterbridge Centre, which has access to a number of commercial systems. Prior to treatment the patient is positioned using the fiducial coordinate system with orthogonal planar and low dose cone-beam CT (CBCT) images taken. These are compared to reference images and although the majority of patients were able to be repositioned with isocentric variations of < 2 mm (figure 2), some have not been so reproducible. This led the Centre to question whether the fiducial box is obsolete, with just CBCT being used for positioning. Although it was concluded this is possible, it was felt that there would be little gain in the overall reproducibility of positioning (~ 1 mm) and the additional concomitant dose may not be justified given that there is a simple mechanical method available.

SMALL FIELD DOSIMETRY

The second session was devoted to small field dosimetry and opened by David Thwaites (Cookridge Hospital, Leeds), the first of the two invited speakers. His presentation encompassed a number of practical approaches to small field dosimetry. A review of the properties which need to be considered when choosing a small field ‘point’ detector was presented together with a number of general points regarding the pitfalls which exist when measuring various parameters. For instance, the results produced by several detectors to record the relative collimator scatter of a Varian 600C linear accelerator (amongst others) showed a spread of 20 per cent depending on which device was used (figure 3).

The second invited speaker, John Byrne (Newcastle General Hospital, Newcastle), began his update report of the IPEM Small Field Working Party by asking ‘Can we safely plan and treat small photon fields on conventional linacs?’ The main aims of the working party were to summarise and clarify the physics of small MV beams, elicit advice from manufacturers on measuring devices and ultimately to provide guidance on measurement. The chapter headings of this comprehensive report were presented (figure 4), with a first draft completed by the end of 2007 and publication in 2008. Dr Byrne’s presentation dipped tantalizingly into what we can expect to see in each chapter, for instance Chapter 2 will review the differences in results when using dedicated stereotactic collimators compared with conventional, and Chapter 3 will review the characteristics of over 10 different detectors in relation to an idea system. The presentation ended by answering the original question with ‘only with care’.

SUMMARY

Overall the meeting was well received by delegates with more questions being raised than answered during discussions over coffee and at the meeting close. Hopefully this get-together will encourage further cogitation and collaboration in these challenging areas of radiotherapy.
MR SAFETY UPDATE MEETING: IMPACT OF THE PHYSICAL AGENTS DIRECTIVE

LIZ MOORE  Philips Medical Systems

ROYAL MARSDEN HOSPITAL, LONDON  29th May 2007

THE MR SIG HAS established a tradition of biennial MR Safety Update meetings. Previously these have been held in the autumn; however this year it was decided to bring it forward to the spring, in view of the rapidly changing situation concerning the Physical Agents (Electromagnetic Fields) Directive (PAD). Nearly 80 delegates met in London to hear a strong programme of invited and proffered papers.

OVERVIEW OF THE PHYSICAL AGENTS DIRECTIVE

By way of introduction Steve Keevil (Guy’s and St Thomas’, London) provided an overview of the PAD’s purpose, which is to protect workers from occupational exposure to EM fields. The problem for MRI is that the precautionary limits are set so low that several common practices will become illegal, including radiographers or nurses staying with a patient during a scan in order to provide comfort, and in particular the developing field of interventional MRI will be stifled. Steve reviewed the evidence for the limits and then went on to describe the efforts of the MRI community in the UK and Europe to mitigate the negative effects of the PAD.

EVIDENCE OF EM FIELDS EXPERIENCED

Five separate talks (two invited and three proffered papers) provided detailed evidence of the EM fields likely to be experienced by workers, both by moving through the static fringe field and from the gradient fields during actual scanning (figure 1). The two invited papers were from Phil Chadwick (MCL Ltd, Newbury) and Jeff Hand (Imperial College, London), each describing work which has been sponsored by the HSE as part of the UK’s efforts to persuade the EC of the real problems for MRI. Jill Bradley (Oxford Radcliffe Hospitals) and David Price (MagNET, Imperial College, London) described different elements of a collaborative study on six MR systems, concerning EM field exposure and acoustic noise respectively.

PRESENTATIONS OF EXPERIMENTAL RESULTS

Martin Leach (Royal Marsden Hospital, Sutton) also showed experimental results from two clinical 1.5T systems. Simulations and experimental data all showed two particular problems. First, standing near the magnet during scanning will expose workers above the PAD limits, whatever the sequence used. Second, moving around the systems will also exceed the limits even at very slow walking speeds (figure 2). Interestingly, the latter result is rather independent of the main magnetic field strength. Initially counter-intuitive, it begins to make sense when one considers the effect of active (or passive) shielding which compresses the flux lines into a smaller space. Moving through this space creates a correspondingly high dB/dt.

Although the PAD is a top priority for many MR safety advisors at the moment, other safety matters were not ignored. Caroline Renaud (MagNET) reminded the meeting of the importance of careful site planning, with examples where poor design led to potential safety issues. Yan Li (Imperial College, London) showed her results on modelling SAR deposition, a companion study to Jeff Hand’s work. The safety of Gd-based contrast agents provided one of two ‘hot topics’: Gill Nelson (GE Healthcare) summarised the evidence, linking Gd administration with Nephrogenic Systemic Fibrosis (NFS) and informed the meeting of the latest dosing guidelines. Labelling for Nycomed’s agent (Omniscan) is being changed, advising clinicians that it should not be administered in patients with GFR below 30 ml/min.

The second hot topic concerned the safety of Eligiloy, a metallic alloy used in a number of medical devices. Maria-Benedicta Edwards (UK Heart Valve Registry, Imperial College, London) presented her work on a small number of heart valves which leads her to recommend that patients with Carpentier-Edwards valves should not have MRI scans. However in discussion it was pointed out that the MHRA does not currently endorse this view.

QUESTION-AND-ANSWER SESSION

The final session of the meeting was an open question-and-answer session, with a panel of representatives from the MHRA (David Grainger), the HSE (Jane Lumb), the MR manufacturers (Liz Moore) and MR users (Steve Keevil). The audience generated plenty of questions related to the PAD and other safety issues, and the discussion was wide ranging and engaged not only the panel but many members of the audience. After the formal meeting closed at the end of the afternoon an informal discussion group continued in a local pub, another fine tradition endorsed by the MR SIG.

FURTHER DETAILS

For further details of the PAD’s limits, and studies which demonstrate the EM fields close to MR scanners, readers can consult the following papers and web sites:

- Crozier’s report for HSE:
  http://hse.gov.uk/research/rrhtm/rr570.htm
### Compliance when gradient is 10mT/m

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**FIGURE 1.** Maximum current densities at various positions near the gradient set (courtesy of Jeff Hand, Imperial College London).

**FIGURE 2.** Induced currents when walking towards a 1.5T system (courtesy of Sophie Riches and Martin Leach, Royal Marsden Hospital, Sutton).

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**FIGURE 1.** Maximum current densities at various positions near the gradient set (courtesy of Jeff Hand, Imperial College London).

**FIGURE 2.** Induced currents when walking towards a 1.5T system (courtesy of Sophie Riches and Martin Leach, Royal Marsden Hospital, Sutton).
BORON NEUTRON CAPTURE THERAPY (BNCT) is a treatment technique that brings together two components that can be manipulated independently. The first component is the loading of the tumour cells with a boronated compound containing the stable, non-toxic and non-radioactive isotope boron-10. The second is the exposure of the loaded tumour cells to a thermal neutron beam. The combination of these two components at the site of the tumour is a thermal neutron capture reaction that leads to the production of an energetic α-particle and a recoiling lithium-7 nucleus. These heavy charged particles, which carry the excess energy as kinetic energy, have a short range and a high linear energy transfer. They therefore deposit most of their energy within the diameter of the tumour cells (which is about 10 m) leaving adjacent cells largely unaffected.

BORON NEUTRON CAPTURE THEORY: HOW IT WORKS
These characteristics make BNCT a theoretically ideal system for selective damage of cancerous cells such as Glioblastoma Multiforme (GBM) where malignant cells have infiltrated into healthy tissue. However, one limiting factor is that the neutron capture reactions also occur with hydrogen and nitrogen in normal cells. Nitrogen capture leads to the emission of a 0.58 MeV proton and a carbon-14 recoil nucleus. Through hydrogen capture, a 2.2 MeV α-ray is emitted. Therefore the upper limit of the neutron dose that can be delivered to a tumour is ultimately determined by the tolerance of the surrounding tissue to radiation. As a consequence, BNCT associates several physical radiation dose components, each of which has its own spatial distribution and biological effects. In order to reduce the background dose (non-boron-10 dose), it is essential that a high concentration differential for boron-10 is achieved between normal and malignant cells. Two boronated compounds have been selected so far for their performance. They are borocaptate sodium (known as BSH) and p-boronophenylalanine (BPA).

CLINICAL TRIALS OF BNCT
All the current clinical trials of BNCT under way use research nuclear reactors for producing their filtered epithelial neutron beams. However, there has been an increasing interest in the use of accelerator-based epithelial neutron sources over the past 20 years. At the University of Birmingham, the facility uses a 3MV DC accelerator that is capable of accelerating protons. The generation of epithelial neutrons is based on the \( ^7\text{Li}(p,n)^{\text{Be}} \) reaction, in which a heavy water-cooled lithium target is bombarded by 2.8 MeV protons. The design is based on a moderator made from aluminium fluoride, aluminium and lithium fluoride sintered composite material. A 20 cm-thick graphite reflector is used behind the target and around the moderator to maximise the fluence rate of epithelial neutrons and to act as a shield. The epithelial neutron beam is delimited using a 2.5 cm-thick natural lithium-doped polyethylene shield with a 12 cm diameter aperture (see figure 1).

INTERNATIONAL CONGRESS ON NEUTRON CAPTURE THERAPY
Every two years, an International Congress on Neutron Capture Therapy is organised. In October 2006, it was held in Takamatsu, Japan for a week. Thanks to the IPEM travel award, I was able to attend the conference and present my work on the refinement of the dual ionisation chamber dosimetry analysis. It was a great opportunity to meet young researchers working on this specialised matter, to exchange ideas and to discuss the common difficulties encountered. This has shown how important exchanges between groups are, and it motivated us to organise a dosimetry inter-comparison exercise using the Birmingham BNCT facility. Collaborators will come to Birmingham with their ionisation chambers to perform the thermal neutron sensitivity measurements and the photon calibration of their chambers before measuring the in-phantom neutron and photon dose components in the therapy beam. A preliminary study was initiated in September 2007 with the groups of Petten (Netherlands) and Obninsk (Russia) and it is hoped to lead to a broader exercise. This project falls into the ‘Dosimetry Exchange’ main study started a few years ago by the MIT group (Boston).

RESULTS OF CLINICAL TRIALS AND THE SOCIAL ACTIVITIES!
Most importantly, very encouraging clinical results were presented and gave faith to the whole community that BNCT can improve on conventional treatment. Here are a few clinical outcomes. In Helsinki, where protocols for brain tumours and recurrent SCC head and neck cancers are followed, BNCT referral has become quite routine. More than 100 patients had been treated at the time of the meeting. For the recurrent SCC head and neck cancers, the median survival times were quoted of around 10 months, which are substantially more than the expectation for this patient population. Latest clinical results have just been published.¹ The group of Tsukuba, Japan, reported early results on a group of ten newly diagnosed GBM patients treated with a combined BSH, BPA and external radiotherapy protocol. At the time, it was 14 months since the first patient had been treated and all ten patients were still alive, well and with no recurrence. The Japanese group lead by Dr Miyatake has recorded the best performance in terms of median survival time for five newly diagnosed GBM patients in a protocol that involved the administration of BSH and BPA. The median survival time for this group was 23 months post diagnosis. ▶
FIGURE 1. The future BNCT treatment room at the University of Birmingham.

FIGURE 2. The singers lead by their master.
International meetings are also great places for socialising with colleagues of various groups. The Symposium held in Takamatsu did not fail in consolidating friendships and collaborations around fantastic Japanese food and cool beers! That even helped us singing (though not in Japanese) at the traditional Karaoke and finding out that Professor Barry Allen is indeed an excellent crooner (see figure 2)! Also shown are John Townley, Stuart Green and me (last row, second from the left).

Following the enthusiasm experienced in Takamatsu, an informal two-day meeting has been organised at the University of Birmingham this autumn with the financial support of Cancer Research UK, Ion Beam Applications, Belgium and the EPSRC Network on Biomedical Applications of Ion Beams. The announcement of the meeting (supported by the ISNCT) that was originally intended to Young Researchers has received a great response from the whole BNCT community. More than 50 participants (including 20 from the UK) came to Birmingham to listen to the latest results of the research lead in the various BNCT fields. A follow-up article will be published in the near future to provide the latest clinical results presented with the Japanese groups that were well represented at the meeting with ten participants.

ACKNOWLEDGEMENTS
I would like to reiterate my great thanks to IPEM for allowing me to attend the conference with the excellent company of my colleagues and friends, Stuart Green and John Townley, and for enabling me to discover the fantastic country that Japan is. As it can be seen from this article, attending the meeting has lead to great collaborations and meetings that would not have been initiated without the enthusiasm generated in Japan in October 2006.

REFERENCES
FIGURE 1. The Golden Gate Bridge.

FIGURE 2. Cable car at the terminus turntable.
and went on until 6pm. Walking to the conference each day it was noticeable that the city started work very early and made me think that for those in the UK who think they work long hours, a 9am start is quite late in comparison to many other parts of the world.

On first inspection the scientific programme was very different to the normal format for such meetings. Gone was the very strict classification of abstracts into exact disciplines, instead the programme had been deliberately mixed up and although sessions had a main theme there were other unrelated talks interspersed to allow participants to hear about areas outside their main interests. Each session was started by an introductory speaker followed by shorter oral presentations.

ICP MANAGEMENT - PAST, PRESENT AND FUTURE

The meeting started with an overview by Tony Marmarou (Medical College of Virginia, USA) entitled ‘ICP management – past, present and future’ and was outstanding. Tony has been a leader and contributor to the field for over 30 years. An engineer by training, he developed models of the CSF system using electrical equivalents which are still used some 30 years later. Starting with Niels Lundberg’s work in 1961, demonstrating the utility of ICP monitoring, Tony’s presentation covered nearly half a century of endeavour; a huge amount of which he has been closely involved with. Always a good speaker the talk combined a who’s who in the world of ICP, their particular research contribution and how that fitted into the developmental timeline. That was followed by various talks on surgical decompression, autonomic dysfunction, brain compliance and brain chemistry. After the session a welcome reception in the Garden allowed us to marvel at the splendour of the architecture and space within the hotel.

The difference between cardiac and brain trauma was made by a stark comparison. If you suffer a heart attack there are more than 20 different types of monitoring and over 200 different drugs available. In addition artificial support can be provided for the organ and transplant may be an option. These are considered normal for most hospitals. In comparison for brain trauma, many (but not all) centres use intracranial pressure monitoring, transcranial Doppler is sometimes used, and there are only four drugs in routine use. ‘Time is brain’ is a message that is starting to emerge in the stroke community and it may not be long before this is adopted in brain injury.

INTEREST IN THE CLINICAL STUDIES AND THE POSTER SESSION

There was considerable interest in two clinical trials that are looking at whether there is any benefit in using surgical decompression (removing large parts of the skull to allow the brain to expand) in patients with intractable intracranial hypertension. Although there have been many small studies on this they have not had sufficient power to provide a good evidence for clinical practice. The danger in using this operation is that it may reduce mortality but with an increase in severe disability rather than improving the quality of life for survivors. Hopefully the results of these trials will provide the answer.

The first poster session was held on the Monday afternoon. Without the full size posters I had to make do with two A4 copies that I had in my hand luggage. They did look a bit ridiculous on an 8’ × 4’ poster board but (I
I managed to get the message of the work across and I did spot delegates reading them both before and after the session.

THE SIGHTS AND SOUNDS OF THE CITY OF SAN FRANCISCO
Traditionally Tuesday afternoon is set aside for a tour. We were taken around San Francisco seeing many of the sights including the Golden Gate Bridge (figure 1), the cable cars (figure 2) and the Victorian houses (figure 3) where Mrs Doubtfire was filmed (just round the corner from one of Robin Williams’ houses). Passing through Nob Hill, the impressive City Hall, the Financial District and finally thriving Chinatown we were shown the variety and vibrancy of the city.

EFFECTS OF NEW GUIDELINES ON THE OUTCOME OF HEAD INJURY
Wednesday dawned and I was in for a busy time. I was giving a presentation on the possible effect that new guidelines had on the outcome of head injury in Edinburgh. This was being done on behalf of a colleague who was unable to get to the meeting. It is always a difficult thing to present someone else’s work. First you do not know the work as well as them and second there are bound to be questions that you don’t know the answer to.

POSTER PRESENTATIONS AND THE BRAINIT NETWORK
The four poster presentations went well. There were some interesting discussions, some of which centred on our discovery of very slow waves in ECG rate, blood pressure and ICP. We postulated that these arose from autonomic function but nobody else could recall seeing these variations (maybe because nobody has looked).

In the afternoon I gave a 25 minute talk on the BrainIT network (www.brainit.org). This is a trans-national group of multi-disciplinary workers who have come together to collect a large but rich data source from patients who have suffered a head injury and to define standards for the way it has been collected. The database provides a resource for hypothesis testing and network a group of enthusiastic researchers who can undertake multi-centre studies in a comparable and compatible way. I was pleased with the way it was received. After an enormous amount of work from all the participants the network is starting to generate output in publications and presentations from the database.

The conference banquet was held on the Wednesday night. After the hectic day it was nice to relax. It was planned as a ‘roasting’ of Tony Marmarou whereby several eminent researchers who have known him a long time took a light hearted view of some of his foibles. It was a very good night and one that will be remembered for quite some time.

EXTRACURRICULAR VISITS TO ALCATRAZ AND THE VINEYARDS
After the end of the meeting some self funded R&R was in order. A visit to Alcatraz (figure 4) is a must and easy to book on the Net in advance. The gold rush spurred the building of a lighthouse on the island and by the time Civil War broke out in 1861 Alcatraz was an important part of the US army’s defence plan. It was used as a military prison from 1915 and in 1934 was transferred to the Department of Justice and used as a prison until 1963. Rule number 5 stated: ‘You are entitled to food, clothing, shelter, and medical attention. Anything else you get is a privilege.’ Strolling through...
the cellblocks that once housed famous criminals like Al Capone and Machine Gun Kelly and what remains of the buildings on the island gave a vivid impression of just how hard life in that prison would have been (figure 5).

An extracurricular trip to the Sonoma and Napa Valleys with the sensible precaution of using a guided bus tour allowed proportionate sampling of the local produce without fear of the local constabulary (figure 6). Driving over the Golden Gate Bridge and away from the bay we moved very quickly into a Mediterranean-like climate, which makes them some of the best winemaking provinces in North America. I learnt that white Zinfandel wine came about as the result of an accident when a batch of wine became stuck in fermentation when the yeast dried out before consuming all of the sugar. After tasting it and realising the sweet wine would sell, the winemaker then found he could sell more of that than anything else they had. Lunch was in Sonoma’s historic square followed by a visit to Domaine Chandon to sample some bubbly after seeing how it is made.

ACKNOWLEDGEMENTS

For me the major downside to San Francisco is the vagrant population. Given the very temperate climate (it never snows) sleeping on the street is not as difficult as it would be in Europe. The sheer number of homeless and beggars is very depressing although they are not intimidating. It was a thoroughly enjoyable meeting and trip. If you get the opportunity to visit San Francisco I would encourage you to go.

I am extremely grateful to IPEM for their support, without their help it would have been impossible for me to attend this meeting.
I was fortunate enough to receive an IPEM bursary to attend the Joint Annual Meeting of the ISMRM–ESMRMB in Berlin in May 2007. The meeting took place after the sad news that Dr Paul Lauterbur, founding member of the ISMRM and joint Nobel prize winner, had passed away in March, at the age of 77. After early work in NMR spectroscopy, it was in 1973 that Dr Lauterbur published his famous article in *Nature* describing a technique for constructing an image from nuclear spins. In the following years, he helped develop techniques to visualise relaxation rate differences, diffusion of materials, chemical shift and anatomical changes in biological specimens. He went on to investigate MRI contrast agents that could be visualised at extremely low concentrations and worked on sensitising MRI to changing physiological conditions. He was awarded the Nobel prize in 2003, along with Sir Peter Mansfield, for developing methods crucial to the genesis of MRI.

I was handed the doorstop of an abstract book and discovered that there were eight sessions running simultaneously throughout the week. I would either have to be selective or spend my time sprinting around the conference centre – not desirable in the 30 degree heat! As my role focuses on cardiac MR (CMR), I attended the Saturday session on ‘Cardiovascular MRI: from principals to protocols’. There were excellent presentations on the basics of clinical CMR as well as current and future research applications. Michael Markl (University Hospital Freiburg, Germany) discussed the quantification of flow and motion in the heart. He ended his presentation with some amazing animated images of time-resolved 3D phase contrast MRI (or 4D-flow) of blood flow in the thoracic aorta.

**STEPS INVOLVED IN 4D-FLOW DATA**

Figure 1 describes the steps involved in the data acquisition, reconstruction and visualisation of 4D-flow.
The first step is to acquire anatomical and three-directional velocity information for every voxel in the three-dimensional volume, at each point in the cardiac cycle. Retrospective electrocardiogram (ECG) gating is employed to capture the entire cardiac cycle along with respiratory compensation to reduce respiratory motion artefacts. The data is then reconstructed to form three velocity-encoded images in the x, y and z directions and a magnitude image for each cardiac phase. 3D streamlines are overlaid onto anatomical data and used to visualise blood flow over the cardiac cycle. The individual lines represent traces along the instantaneous velocity vector field in a systolic time frame and are colour coded according to velocity magnitude. The technique has been used to visualise altered haemodynamics and vortex formation in patients with aortic pathology compared with normal volunteers. Wall shear stress was also found to be lower along the inner wall in these patients. This suggests that the technique has the potential to characterise the link between altered flow dynamics and changes in mechanical wall properties. More information and images can be found at: http://www.uni-klinik-freiburg.de/mr/live/arbeitsgruppen/cardio_en.html

**Nephrogenic Systemic Fibrosis: Causes and Symptoms**

Tuesday’s programme included a symposium on the potential causal relationship between Gadolinium (Gd) contrast agents and Nephrogenic Systemic Fibrosis (NSF) and the implications for clinical and research policies. Shawn Cowper (Yale University, Connecticut, USA) described how NSF results in areas of thick and hardened skin along with subcutaneous oedema, which can develop anywhere between a few days to several months after Gd injection (see figure 2). The condition is debilitating and can cause or contribute to death in some patients. NSF is seen exclusively in patients with renal insufficiency and is strongly associated with prior exposure to intravenous Gd-based contrast material.

**Relationship Between NSF and Gd Exposure**

Henrik S. Thomsen (Copenhagen University, Denmark) described the relationship between NSF and Gd exposure and the apparent differences among Gd chelates. The great majority of NSF cases have involved the use of Omniscan® (gadodiamide). The European Agency for the Evaluation of Medicinal Products (EMEA) have recommended that Omniscan® should not be administered in patients with severe renal impairment or those who have undergone or are awaiting a liver transplant. They also advise careful consideration before using Omniscan® in neonates under 1 year. It also recommends careful consideration before the use of other Gd-containing MRI agents in patients with severe renal impairment. The ISMRM Symposium is available online along with the latest EMEA and FDA advice: http://www.ismrm.org/special/FDA.htm

**Physics for Clinicians**

I also attended the ‘Physics for clinicians’ sessions where Walter Kucharczyk (University of Toronto, Canada) took us through ‘spin gymnastics’. Donald Plewes (Sunnybrook & WCHSC, Toronto, Canada) presented a novel explanation of k-space in which the magnetisation...
**FIGURE 3.** (TOP LEFT)
NSF is characterised by areas of thick and hardened skin (courtesy of Shawn Cowper).

**FIGURE 4.**
Example coronary vein images in three healthy subjects: variations in coronary anatomy including size, existence, branching angle and location can be visualised (courtesy of Reza Nezafat).

**FIGURE 5.**
Clockwise: ‘Watching a Heartbeat’ (courtesy of Lowri Cochlin), Picasso Museum, ‘Colourful Contrast’ (courtesy of Nicole Mascheri), Berlin wall graffiti.

**FIGURE 6.** (TOP RIGHT)
Meal out in East Berlin with the Manchester MR Team.
vector is visualised as a sphere with one side coloured black and the other white. As the magnetisation rotates, the sphere revolves and there is a progressive change from black to white. This helps us visualise the progression of the phase of the spins as they experience different magnetic field gradients. I found this concept more intuitive than the traditional approach using rotating vector arrows. It elegantly relates the magnetisation vector of the spins to the spatial frequencies seen in the image without mention of Fourier Transforms. I will be happy to quote the website next time someone asks me to explain $k$-space in 5 minutes without the maths! (A pdf version of the talk can be downloaded from: http://swri.ca/groups/dbp/background). Figure 3 shows an image of the black and white spheres after the sequential application of Gy and Gx gradients as well as some images of Berlin with some (possibly far-fetched) relations to MR physics.

### IMPRESSIVE IMAGES OF CORONARY VEINS USING MAGNETISATION TRANSFER PRE-PULSE

Reza Nezafat (Harvard Medical School, Boston, USA) won the Young Investigator award for his group’s work on coronary vein imaging. He displayed his impressive images of the coronary veins (see figure 4) imaged using a 3D free breathing, ECG triggered gradient-echo Cartesian acquisition with fat saturation and respiratory navigators. They investigated the use of a magnetisation transfer (MT) pre-pulse to enhance the contrast between venous blood and myocardium without affecting venous blood. Phantom work was used to compare the images with and without the MT pre-pulse. In vivo studies were then performed on eight healthy volunteers to optimise the MT pre-pulse to yield the highest SNR and blood-myocardium. The sequence was then implemented in six patients with congestive heart failure (CHF) referred for cardiac resynchronisation therapy (CRT). This sequence could be used before a CRT procedure to help reduce the high failure rate (currently 30 per cent) in this patient group.

### COLLECTIONS OF BERLIN’S LESS FAMOUS WORKS OF ART

Berlin is famous for its art, including collections from Picasso, Matisse and Cézanne. The conference poster competition, entitled ‘Art and artefacts’, displayed some artistic offerings from the world of MRI. My favourite was Lowri Cochlin’s (University of Oxford) Warhol-inspired ‘Watching a Heartbeat.’ I also liked the image from Nicole Mascheri (Northwestern University, Chicago, USA) ‘Colourful Contrast’. These two posters are displayed in figure 5 along with some of Berlin’s more famous artworks.

### ACKNOWLEDGEMENTS

Many thanks to IPEM for giving me the opportunity to attend such an interesting conference and to the MR team at Manchester (figure 6) for keeping me company for the week.

Apologies for the strong bias towards hearts rather than minds; there are full conference proceedings available at: http://www.ismrm.org/07/ •

### REFERENCES


MOLECULAR IMAGING WITH POSITRON EMISSION TOMOGRAPHY

LUCY PIKE Addenbrooke’s NHS Trust, Cambridge
ELIZABETH HARRON Regional Medical Physics Department, Newcastle Upon Tyne
ANNE DAWSON Portsmouth Hospitals NHS Trust, Portsmouth
ANTON PARAMITHAS St George’s Hospital, London
IAIN MURRAY St Bartholomew’s Hospital, London

The Mayneord Phillips Trust is a charitable organisation that aims to promote the development of physical science techniques in medicine. It was founded by the Institute of Physics, the British Institute of Radiology and the Institute of Physics and Engineering in Medicine in 1991, and every 2 years the Trustees organise a week-long summer school aimed specifically at PhD level students. The subject for the week is chosen according to current research interests and as such this year’s topic was molecular imaging with positron emission tomography (PET). The summer school was set in the beautiful surroundings of St Edmund Hall in Oxford and was attended by 24 students from across the globe (figure 1). Further information on the Mayneord Phillips Trust and the next summer school scheduled for 2009 (which will be devoted to ‘21st Century Radiotherapy, for more information see below) is available at http://www.m-pss.org/index.html.

DAY 1: OVERVIEWS

The week started with a welcome to the summer school from organiser Paul Marsden (King’s College London). The lectures on Monday provided an excellent introduction to the history and future uses of PET and to the scanner hardware. Uses of pre-clinical PET, and developments in multi-modality imaging, namely PET-CT and PET-MRI, were covered later in the day.

Terry Jones (University of Manchester) gave an enthusiastic first lecture, entitled ‘Meeting the future challenges of PET-based molecular imaging’. He covered the development of PET since 1955, and went on to discuss recent innovations which have improved PET scanner performance, such as improvements in spatial resolution and increased axial field of view. Various reasons were given for why PET is such an exciting and useful imaging modality, and the challenges and potential solutions for future applications were outlined (see figure 2).

This was followed by an overview of PET scanner

![FIGURE 1. The students and course organiser, Paul Marsden, in the courtyard of St Edmund Hall, Oxford.](image-url)
Why is PET Exciting?

- Non invasive measure of normal and diseased tissue function
- Offers a tool for Experimental Medicine: new information on humans
- Offers a tool for Translational Research: laboratory to patient
- Provides information on mechanism of therapeutic action
- Provides information on efficacy of therapeutic action
- Offers an unique micro dosing method
- A multi-disciplinary field-large cake, many slices
- There is scope for improvement in sensitivity and specificity: Chemistry, Instrumentation, Physics, Biology, Image Processing and Analysis

Why PET/MRI?

- Like PET/CT provides:
  - “Near-perfect” registration of image data
  - Anatomically-guided interpretation of PET data
  - Anatomic priors for reconstruction and data modeling
- Additional Advantages
  - No additional radiation dose
  - Can exploit soft-tissue contrast of MRI
  - Can be combined with advanced MRI techniques such as fMRI, MRS, DWI and MR molecular imaging methods
- Additional Disadvantages
  - Does not directly provide attenuation correction for PET
  - Technically more difficult and likely more expensive
hardware by Sibylle Ziegler (Technische Universität München, Germany). After covering the basics of PET hardware and the ideal characteristics of a scanner, Sibylle discussed the possible future developments in hardware that could lead to improvements in spatial and energy resolution as well as timing resolution. One example could be the use of avalanche photodiodes (APD) instead of photomultiplier tubes (PMT). These have the advantage of being unaffected in magnetic fields, making them valuable in the development of PET-MRI.

Tim Fryer (University of Cambridge) moved away from clinical PET to microPET and the difficulties encountered in obtaining high resolution images of small animals. He described the stages required to obtain data for image quantification, right from animal preparation through to the correction and analysis of the data using reference tissue models. There are numerous uses for small animal PET and Tim outlined some interesting research projects carried out at the University of Cambridge, such as the use of PET to study endothelin receptors by imaging the biodistribution of the radioligand [18F]-ET-1.

The ability to combine the functional information from PET with anatomical information from CT or MRI was the subject of lectures by Thomas Beyer (University Hospital Essen, Germany) and Adrian Carpenter (Wolfson Brain Imaging Centre, Cambridge). PET-CT scanners are becoming more widespread in Europe, and the combined modalities are of particular use for cancer diagnosis and staging, and for outlining tumours for radiotherapy treatment planning. Thomas discussed the challenges for PET-CT, such as respiration artefacts, and possible solutions to these. Adrian outlined the advantages and disadvantages of PET-MRI, compared to PET-CT (figure 3). Although PET-MRI is technically more challenging than PET-CT due to problems such as interference between the two imaging modalities, Adrian was keen to point out that PET-MRI is a feasible option, with animal and human experiments taking place in 2007.

**DAY 2: DISCUSSIONS ON IMAGING AND SIMULATIONS**

Andrew Reader (University of Manchester) started the morning off with two comprehensive lectures focused on PET image reconstruction methods. The session benefitted greatly from Andrew’s decision to concentrate on the ML-EM (maximum likelihood-expectation maximisation) iterative reconstruction technique. This was based around a system matrix obtained using the line integral model. By providing step-by-step simulations of the stages involved the whole process was broken down into easily understood concepts, enabling the technique as a whole to be more fully appreciated. It also became very apparent how using such approaches to create the system model could be amended to incorporate new information such as time of flight and detector resolution/response models.

This led nicely into the next talk given by Kris Thielemans (GE Healthcare, London) concerning quantification in PET with both iterative and back projection based algorithms. Kris’s concise talk around the subject of bias and variance in these settings made it clear that in clinical situations the accuracy and precision of any parameters derived from PET images should not be taken for granted, particularly as quantitative measurements are increasingly used. Kris also covered the effects of motion in some detail. He explained the effects of blurring and attenuation mismatch due to respiratory motion on standardised uptake values (SUV) and included some very interesting results from NCAT simulations and
concentrated on the fundamentals of compartmental models. It provided a valuable overview of the subject with a series of common examples such as the Kety blood flow model and the Sokoloff deoxyglucose model. The talk then went on to demonstrate the use of the models in occupancy studies.

The second of the two lectures gave a review of some common PET compartmental models for the plasma input and the reference tissues. A general equation for plasma and reference input models was then derived that can be theoretically applied to model ‘any’ PET experiment. The last part of the talk concentrated on showing how different data-driven fitting methods are derived from this general equation. This included graphical methods such as Logan and Patlak plots, spectral analysis and basis function methods.

The lecture was followed by an interactive session where example spectra mimicking real situations were shown. The audience was then encouraged to select the appropriate model that best fit the scenario including parameterisation of the suggested models drawing on the fundamentals that had been taught in the preceding lectures. The audience’s fitting parameters were then input into a software modelling programme in real time so that the accuracy of the audience’s suggestions could be determined. The session was very beneficial as it allowed one to consolidate the theory and appreciate the practical implementation.

The afternoon was left free in order to give the attendees a chance to enjoy the sights of the historical city of Oxford and some of the students took advantage of this time to go punting along the River Thames. Then in the evening the students and lecturers all enjoyed a superb dinner alongside the river in the picturesque village of Moulsford.

DAY 3: PRINCIPLES OF IMAGE ANALYSIS AND MODELLING IN PET

The principles of image analysis and modelling in PET were covered on Wednesday morning. This comprised of two lectures given by Vin Cunningham and Roger Gunn (GlaxoSmithKline, London). The first lecture

FIGURE 5. GE PETtrace cyclotron opened for service (courtesy of GE and John Clark).

GE PETtrace

Cyclotron

opened for service

Weight 22 tonnes

Power consumption

80kW

Approx £1M
DAY 4: RADIOPHARMACEUTICALS FOR PET IMAGING

The Thursday morning session focused on radiopharmaceuticals for PET imaging. John Clark (University of Cambridge) started the session with a presentation about PET radionuclide production. He described how a cyclotron produces positron emitting radionuclides, in particular the GE PETtrace cyclotron which is used at the Wolfson Brain Imaging Centre in Cambridge (see figure 5).

Tony Gee (GlaxoSmithKline, London) talked about tracer labelling with $^3$C and $^15$F. Phil Blower (King’s College London) then talked about metallic radionuclides and tracers. He described the wide range of advantages of metals over organic positron emitters, such as the wider choice of half life and the potential for radionuclide therapy using metallic positron emitters. Particularly interesting was the use of $^{60}$Cu-ATSM for imaging hypoxia. Studies are currently being carried out on the use of this radiochemical to identify hypoxic tumours or ischaemic regions of the heart.

The final morning talk was given by Steve Mather (St Bartholomew’s and Royal London Hospitals, London) who talked about biological targets for radiopharmaceutical development in cancer. He described the molecular targets for radiopharmaceuticals as falling into two categories – functional and non-functional. Non-functional targets include neuropeptide receptors such as the somatostatin receptors expressed by neuroendocrine tumours. Functional targets include metabolic pathways such as the glucose pathway used for $^18$F-FDG imaging.

The afternoon session covered clinical uses of PET imaging and cancer research. Michael O’Doherty (King’s College London) began with a presentation on the clinical uses of PET-CT. The presentation focused on oncology imaging, which accounts for the majority of scanner workloads. Michael described the potential targets for oncology imaging, with the most common being glucose metabolism. However other targets are being investigated, including imaging apoptosis, blood flow and hypoxia. Eric Aboagy (Imperial College, London) then described how PET could be used in the development of new cancer therapies.

Tony Ng (King’s College London) finished the Thursday session with a talk about the establishment of multimodal imaging in cancer research. The presentation focused on optical imaging techniques for imaging cancer cells. One of the methods was the detection of Förster resonance energy transfer (FRET), which is the exchange of energy between interacting molecules. Using optical imaging to study the cancer cell protein network can give information on how the network is formed and biochemically regulated.

DAY 5: REAL WORLD EXAMPLES AND APPLICATIONS OF PET

The last day of the summer school began with another talk from Tony Gee on the applications of PET imaging in drug discovery and development. This talk covered the use of PET in the early stages of drug development and testing. He gave examples of how drug microdosing in combination with PET can identify drugs that have a different distribution from expected prior to clinical trials. This can potentially lead to significant time and money savings as well as reducing the risks to volunteers.

Laurence Reed (King’s College London) then spoke about the neuropsychiatric applications of PET. He highlighted several recent studies carried out at the PET Imaging Centre at St Thomas’ Hospital, London, in collaboration with the Institute of Psychiatry, where they have been using FDG-PET to research appetitive motivational networks. This has important uses in a wide range of areas such as addictions, psychiatric disorders, medical disorders and adolescence.

The subject for the next talk by Paul Marsden was PET-CT quality control. He went through the performance parameters that should be measured at acceptance and their significance. Paul also explained the protocols for daily QC procedures and interpretation of the results.

The final lecture was given by Brian Hutton (University College London). His lecture covered the principles of both PET and SPECT along with a comparison of the attributes of the two modalities. The talk also gave an overview of the new D-SPECT TM cardiac imaging system (produced by Spectrum Dynamics) which included a description of the new collimation system and how it compared to a conventional LEHR collimator. He also discussed recent developments in small animal imaging, such as the work carried out at the University Medical Centre in Utrecht, The Netherlands, in developing multi-pinhole SPECT and how this may be applied to clinical SPECT systems in the future.

GENERAL STUDENT PRESENTATIONS AND QUESTIONS

The course was rounded off with a general session for the students to present examples of their own work. Reynolds Cooper and David Oxley (Liverpool University Imaging Group, Liverpool) gave a fascinating presentation on their work as part of the SmartPET project which is investigating the development of Compton Camera PET imaging. Matthew Miller (GE Healthcare, London) spoke about his work in the research and development of new radiopharmaceuticals that target angiogenesis for use in oncology. The session also gave the students an opportunity to ask questions to the speakers and Paul Marsden kindly provided a helpful tutorial on the calculation of standardised uptake values (SUV) at their request.

2009 SUMMER SCHOOL: 21ST CENTURY RADIOTHERAPY

The next Mayneord Phillips summer school will take place in July 2009 and will be devoted to ‘21st Century Radiotherapy’. Topics to be covered will include: tumour imaging and localisation, biological effects and outcome prediction, beam generation and delivery, proton and heavy ion therapy and radiotherapy planning and verification. An international faculty will provide teaching and lead discussion in these areas. Look out for further announcements about the summer school. To register your interest in this event, please contact Colin Baker (colin.baker@liverpool.ac.uk).

Erratum (December issue, page 35):
Dr Elizabeth Dymond is employed by the North Bristol NHS Trust not the University of Bristol. The project she presented during the ASM, ‘Technology for Dignity’, falls under the Health Technology cooperative initiative.
ANTHONY FLYNN
The life and work of a caring and hard-working physicist who dedicated his life to patients, friends and family

STEVE SNOWDEN AND BRYAN STUBBS

Anthony Flynn, physicist, died 15th September 2007

Anthony (Tony) Flynn died from illness on 15th September 2007 at the age of 60.

He was born in Beverley, Yorkshire, and was educated at the Marist College in Hull and later at Durham University. In 1968 he was appointed basic grade physicist at Cookridge Hospital in Leeds and successfully completed an MSc in Medical Physics at Leeds University in 1975.

All of Tony’s working life was spent at Cookridge Hospital. He advanced through the various physicist grades until he reached that of consultant grade physicist.

PROFESSIONAL ACTIVITIES AND INVENTIONS
His specialty was brachytherapy – the treatment of cancer using intracavitary and interstitial radiation – and he led the brachytherapy physics team for many years until his retirement in 2005.

Tony has many scientific publications credited to his name, both in his own right and with physics and clinical colleagues. Together with Professor Joslin he has an intracavitary applicator named after him – the Joslin–Flynn applicator.

TREATMENT OF EARLY STAGE PROSTATE CANCER
In 1995 he led the physics team who, together with Dr Ash and Dr Carey, introduced into the UK the treatment of early stage prostate cancer using iridium seeds, based on techniques learned in Seattle.

Soon visitors from all over the world were coming to Leeds to learn these techniques with Tony playing a major role as teacher and course director.

Tony was a good teacher and there are many nurses, radiographers, physicists and doctors who have benefited from his straightforward, common sense wisdom.

Tony’s fame is not just local; he was an invited speaker at many events both in the UK and across the world including Australia, Singapore and Madrid.

But for all of this his best work, and where he devoted most of his time and effort, was in providing a sound, reliable brachytherapy physics service to support the treatment of cancer patients locally in Yorkshire.

TONY’S WONDERFUL PERSONAL QUALITIES
Tony had that rarest and most valuable of qualities in that if one was lucky enough to count him amongst one’s friends then one could be certain that one had at least one true and loyal friend. Never one to say ‘sorry, I’m too busy’ if anyone asked for help, he was also never one to put himself first. He and his wife Pat loved socialising, particularly if that involved large amounts of food and wine! But it didn’t matter where one was or what one was doing, if one was in the company of Tony and Pat it was always fun. Pure, simple, easy going undemanding fun where one could unwind and feel totally at ease.

He embraced life and the company of his many friends with a passion, overcoming long standing health difficulties with quiet courage and steely determination. One never saw him angry or depressed. What you saw was what you got; no frills and no self pity. Just an ordinary chap possessed of extraordinary stoicism and the will to get on with life regardless of what it threw at him. A warm, engaging and instantly likeable man with great generosity of spirit. He will be sadly missed by so many people.
Early one Sunday morning in late October I stood at the top of Box Hill on the North Downs, watching the changing shape of the landscape below as the morning mist drifted and dispersed in the bright autumn sunshine. Taking time to look helps me see things differently, and can lead to moments of inspiration and creativity. More rarely, we all experience events where something or someone takes us outside our usual domain, to a vantage point we didn’t even know existed, opening up a new vision and a deeper understanding. Moments like this are few and unpredictable but can have profound consequences.

INTEGRATED APPROACH
I found such a moment in November, sitting in a lecture theatre listening to Professor Leroy Hood speak with passion about systems biology and how it would revolutionise both medicine and our view of health. Professor Hood was presenting the UK Focus for Biomedical Engineering Annual Lecture. He expounded the benefits of an integrated approach to human biology, where the impact of molecular processes are understood at the level of cell and organism, disease is predicted and prevented and medicine is personalised and targeted. His prediction is that the technology that will flow from developing systems biology will be both cheap and easily translatable to the developing world. The potential and rewards are enormous, their achievement inevitable and progress is limited only by the rate at which funding will be provided. Look on the UK Focus website for a transcript of his talk.

PUBLIC IMPLICATIONS
The implications of genomics and proteomics are as much for the public and politicians as for medical researchers. As a throwaway comment, Professor Hood pointed out that funding arrangements for the NHS are the ones most likely to survive this particular revolution. The approaching future is one where health is normal and disease is due to lifestyle, accident or chance mutation. Intervention is early and effective and all citizens receive appropriate end of life care. In such a scenario, where genetic profiling predicts vulnerability to specific diseases, many individuals will become uninsurable. A taxation-based scheme then becomes the most practical way to provide essential healthcare to a national population.

COURAGE TO CHANGE
Glimpsing the future is one thing but grasping its implications is another. It takes time to assess, to consider what might or might not be and to appreciate the potential impact of change. Then it takes courage to go off in a different direction. As a profession, we must listen closely therefore to what our colleagues in the biological sciences are saying. Existing disciplines such as modelling of biological processes, molecular imaging, radiobiology and systems engineering will need closer integration with biologists, chemists and other life scientists if we are to help to shape the forthcoming revolution. Teams of experts from varied backgrounds are needed to tackle these problems, and these are exactly what are being set up internationally and in the UK. A parallel approach is needed across academia, industry and the health services, so that there is an integrated approach to translating new discoveries into clinical benefits.

The Institute is planning to make biology a major feature of its Annual Scientific Meeting in Bath in 2008. I would encourage you to attend, to contribute, to take part in discussion and to develop both your own and our profession’s understanding of what the future holds. This could not come at a more pivotal time.

THE INSTITUTE’S PROGRESS
Meanwhile, across the Institute life goes on. Like any good organisation, we seek to be both visionary and adaptive. Progress is being made with identifying objectives, reorganising structures and committees, improving communication and helping to shape future training and national policy. We are operating in territory that has no map and no immediate destination. Like the early railroad pioneers, we are building tracks as fast as we travel along them. Like them, too, we need to go to the top of the next hill every so often and survey what lies ahead.
NEW TEAM, SAME OLD SCOPE

After a few months of administrative tasks, safely tucked in the background, the time of the dreaded first editorial has finally come. It only seems natural to start by thanking Mark McJury for his help during the transition and his many years of dedicated work for Scope. During his time, Mark managed to introduce new features and recently oversaw the successful transition to the new publisher. Quite a difficult act to follow.

To make my task easier, Gemma Whitelaw will take on the added role of assistant and will continue to work on book reviews with Sarah Misson-Yates.

Despite the changes in the editorial team don’t expect a revolution, but if everything works according to plan (when does it ever?), there will be some gradual changes here and there, new ideas creeping through, in short a gentle evolution.

So what can you find in this issue? Most of your usuals I guess. In the features, you will understand why your academic colleagues might not have been as relaxed as usual; nothing sordid, just the RAE coming back on their desks faster than a boomerang.

The tutorials include a double strength MRI and the first part of a tutorial on how to publish professional writings, co-authored by, he could not stay away for too long, Mark McJury!

If you want to discover what the PMB editor does in his spare time or confirmation that all parrots are indeed called Polly, turn to the travel report.

Unfortunately, some of the members’ news is sad with Anthony Flynn passing away in September last year.

As the ASM took centre stage in the last issue, we are playing catch with the meeting reports going as far afield as San Francisco and Japan, and as far back as …2006; shame on us! John provides us with his usual bite-size news and the book review section has a strong imaging flavour.

Dick’s anecdotes have come to an end and I would like to thank him for his regular contribution over the last two years. We are still working on a decent alternative, so watch this space.

Finally, I want to take this opportunity to remind everyone that Scope, as the magazine of IPEM, is there to serve and reflect the membership of the society; physicists, engineers, technologists, trainees and academics alike. However, the magazine only mirrors the submissions, there is no calculated bias. I have not (yet) the power or right to force you to submit and can only encourage every branch of the society to do so. To tickle your creativity and stimulate your writing talents, we are willing to give away some money, but not to everyone. The avid readers of the newsletter (do you really exist?) will probably have noticed the creation of the Endeavour prize. Providing we receive enough submissions, the prize will be awarded to the most dedicated student in the national and international fields.

So go on read this issue and make the next one better by submitting even more!
Passing of a Curie: sad loss of a peaceful heroine

Eve Curie Labouisse, the daughter of Marie and sister of Irène, died in New York on 22nd October 2007, aged 102. In a family with five Nobel prizes, Eve Curie might unfairly be remembered as the poor relation who only wrote ‘Madame Curie’, the much celebrated biography of her mother. Eve was also a journalist and an accomplished pianist. She received the Croix de Guerre for her role with the Forces Françaises Libres (the Free French Army during WWII) and the Légion d’Honneur, France’s highest honour for her humanitarian work mainly with the UNICEF.

If you want to learn more about her fascinating life you can start with Dick Mould’s obituary in the BIR newsletter or the one published in The Times [http://www.timesonline.co.uk/tol/comment/obituaries/article2740133.ece]. Dick is also preparing the first biography of Eve which will be published the Polish cancer journal Nowotwory Journal of Oncology.

Kalender gains award

Medical physicist Willi Kalender recently received the European Science Foundation’s (ESF) European Latis Prize. The prize recognises Kalender’s contribution to the field of medical physics and in particular his role in developing, testing and implementing spiral CT.

The prize was bestowed on Kalender at the recent ESF science policy conference in Strasbourg, France. On receiving the award Kalender remarked: ‘I am overwhelmed and truly happy. Medical imaging has gotten quite a bit of attention in recent years. It is generally acknowledged that the advances in 3D imaging with different modalities such as CT, MRI, PET and ultrasound have brought remarkable and practically relevant progress for diagnostic and therapeutic procedures’.

The main focus of Kalender’s research is diagnostic imaging, with a focus on volumetric spiral CT. In addition he also has an interest in radiation protection and the development of quantitative diagnostic procedures to assess osteoporosis, lung and cardiac diseases.

Kalender picked up 60,500 euros with his prize, courtesy of the Geneva-based Latis Foundation. The foundation recognises outstanding and innovative contributions in a field of research. ’I hope that the award of the European Latis Prize in 2007 to work in medical imaging will have a further positive effect on this field of research’, remarked Kalender.

This story was first printed on www.medicalphysicsweb.org on 11th December 2007.

Helping the developing world

Engineering World Health (EWH) is a charitable organisation which was set up to harness the resources of higher education engineering programmes for the benefit of hospitals in the developing world. EWH began in 2001 and has since forged a partnership with Duke University.

An example of the great work being performed by this organisation was recently illustrated in their magazine.

Over 50 volunteers from Duke, NC State and UNCEWH chapters as well as others were brought together to build more than 50 ‘bili-lights’. This device was conceived by the non-profit company PhotoGenesis which won last years Duke–EWH CURE competition. With some optimisation of the original students’ design, these devices, based on a series of blue LED lights, will help treat jaundice in infants in the developing world.

The blue LED emit most of their light in the wavelength 450–470 nm. This range of wavelengths coincides with the peak absorption wavelength at which bilirubin is broken down. Increased levels of bilirubin are responsible for jaundice and the lights provide a phototherapy treatment for this condition.

The volunteers’ devices were distributed in Africa and Central America in 2007 and hundreds of children have already been treated with them.

If you would like to find out more about the very worthwhile work being performed by the EWH please visit their website at www.ewh.org.
As good as gold: nanoparticles in the fight against prostate cancer

Researchers from the University of Michigan have been testing the use of targeted gold nanoparticles as a contrast agent to detect early stages of prostate cancer. They claim their photoacoustic imaging technique is more specific than existing methods including blood tests and rectal exams.

The technique works on the principle that light is efficiently absorbed by metal nanoparticles. The resonant wavelength can be tuned to within the tissue transparent window of 700–1000 nm. This allows deeper penetration into the skin of the probing light source.

The elongated gold rods, 15 nm diameter and 45 nm long, are conjugated to an antibody ligand specific to the HER2 receptor which is overexpressed in certain prostate and breast cancers.

The team verified the binding efficiency of the conjugated particle to prostate cells using a custom built photoacoustic microscopic probe. The technique works by converting light into sound waves and using laser light to illuminate the tissue, which instantly heats up and expands rapidly. The resultant sound pressure waves propagate from the expanding structure and are detected by an ultrasound transducer of high resolution.

They recorded that the conjugated particles bound strongly to prostate cells compared with non-conjugated ones. Tests were also performed on phantom structures to determine sub-millimetre resolution was achievable at a tissue depth of 2 cm.

The researchers also imaged the nanoparticles in a human cadaver prostate using the photoacoustic information overlaid on images obtained by standard ultrasound techniques. Combining images from the two techniques allow visualisation of both the anatomical detail of the tissue and the distribution of the nanoparticles.

The lead researcher, Shai Ashkenazi, commented: ‘In a real medical setting, gold nanoparticles would be injected into the blood, where they could accumulate in cancer tissue. Combined ultrasound and photoacoustic gives the best and most complete information – ultrasound provides structural images and photoacoustics provide nanoparticle distribution, reflecting cell expression as targeted by the specific ligand employed’. This story was previously reported on 20th November 2007 on www.medicalphysicsweb.org. J. McL.
Congratulations to the following member who has been elected to Fellowship of IPEM.
Mr Gordon Hosker, Manchester (elected December 2007), Dr C John Kotre, Newcastle-upon-Tyne (elected August 2007), Professor Ian Marshall, Edinburgh (elected December 2007), Mr Andrew Poynter, Ipswich (elected December 2007), Mr Keith Willson, London (elected August 2007)

Congratulations to the following who have recently been successful in the IPEM Viva Voce examinations for the Clinical Science Diploma of IPEM [DipIPEM(S)].

<table>
<thead>
<tr>
<th>Name</th>
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<tr>
<td>Miriam Barry</td>
<td>West Midlands</td>
<td>Pass</td>
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<tr>
<td>Christopher Boylan</td>
<td>Manchester</td>
<td>Pass with Merit</td>
</tr>
<tr>
<td>Robert Brackenridge</td>
<td>Hull</td>
<td>Pass with Merit</td>
</tr>
<tr>
<td>Charlotte Britton</td>
<td>South West</td>
<td>Pass with Merit</td>
</tr>
<tr>
<td>Owen Burke</td>
<td>Wales</td>
<td>Pass with Merit</td>
</tr>
<tr>
<td>Matthew Clarke</td>
<td>Manchester</td>
<td>Pass with Merit</td>
</tr>
<tr>
<td>Jonathan Cole</td>
<td>London South</td>
<td>Pass with Merit</td>
</tr>
<tr>
<td>Sally Derbyshire</td>
<td>Leeds</td>
<td>Pass with Merit</td>
</tr>
<tr>
<td>Mark Dobbs</td>
<td>Hull</td>
<td>Pass with Merit</td>
</tr>
<tr>
<td>Rosemary Eaton</td>
<td>East Anglia</td>
<td>Pass with Merit</td>
</tr>
<tr>
<td>Phillipa Evesham</td>
<td>South West</td>
<td>Pass</td>
</tr>
<tr>
<td>Mary Fitzpatrick</td>
<td>London North</td>
<td>Pass</td>
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<tr>
<td>Michael Germuska</td>
<td>London South</td>
<td>Pass</td>
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<tr>
<td>Carla Goncalves</td>
<td>Kent</td>
<td>Pass</td>
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<tr>
<td>Martin Green</td>
<td>Merseyside</td>
<td>Pass</td>
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<tr>
<td>Helen Grimes</td>
<td>London South</td>
<td>Pass</td>
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<tr>
<td>Garry Grogan</td>
<td>East Midlands</td>
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<tr>
<td>Matthew Gwilliam</td>
<td>Sheffield</td>
<td>Pass</td>
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<tr>
<td>Scott Harvey</td>
<td>Scotland</td>
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<tr>
<td>Joanna Hartwell</td>
<td>Sheffield</td>
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<tr>
<td>Nicola Holbrook</td>
<td>Oxford</td>
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<tr>
<td>Anne-Marie</td>
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<tr>
<td>Robert Johnstone</td>
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<tr>
<td>Caroline Jones</td>
<td>London South</td>
<td>Pass</td>
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<tr>
<td>Rachel Kirk</td>
<td>Surrey and South West London</td>
<td>Pass</td>
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<tr>
<td>Victoria Longden</td>
<td>East Midlands</td>
<td>Pass</td>
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<tr>
<td>Sophie Maniktelow</td>
<td>West Midlands</td>
<td>Pass</td>
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<tr>
<td>Susan Manoy</td>
<td>Surrey and South West London</td>
<td>Pass</td>
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<tr>
<td>Christie McComb</td>
<td>Scotland</td>
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<tr>
<td>Mohamed Mirghany</td>
<td>South West</td>
<td>Pass</td>
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<tr>
<td>Maruim Naem</td>
<td>London North</td>
<td>Pass</td>
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<tr>
<td>Thomas Okell</td>
<td>Oxford</td>
<td>Pass</td>
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<tr>
<td>Christine Padgham</td>
<td>Scotland</td>
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<td>Reshna Patel</td>
<td>London North</td>
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<tr>
<td>Mayur Patel</td>
<td>London North</td>
<td>Pass</td>
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<tr>
<td>Ross Penny</td>
<td>West Midlands</td>
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<tr>
<td>Alytr Podvoiskis</td>
<td>Southampton/Portsmouth</td>
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<tr>
<td>Katherine Potter</td>
<td>East Midlands</td>
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<tr>
<td>Nicola Purser</td>
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<tr>
<td>Jennifer Saley</td>
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<td>Pass</td>
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<tr>
<td>Anne Small</td>
<td>Merseyside</td>
<td>Pass</td>
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<td>Victoria Smith</td>
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<tr>
<td>Eskinder Solomon</td>
<td>London South</td>
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<tr>
<td>Donna Talbot</td>
<td>Kent</td>
<td>Pass</td>
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<tr>
<td>Rachel Trimble</td>
<td>London South</td>
<td>Pass</td>
</tr>
<tr>
<td>Gavin Wright</td>
<td>Leeds</td>
<td>Pass with Distinction</td>
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Congratulations also go to the following students who have successfully completed the Clinical Technology Diploma of IPEM [DipIPEM(T)].

<table>
<thead>
<tr>
<th>Name</th>
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<tr>
<td>Emma Harrop</td>
<td>Birmingham</td>
<td>Pass</td>
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</table>
MEMBER’S NEWS | SCOPE

IPEM EXAM RESULTS CONTINUED...

Congratulations also to the following students who have successfully completed the Viva Voce examination for Certificate in Part One Competencies in Clinical Technology of the Clinical Technologist Training Scheme.

<table>
<thead>
<tr>
<th>Name</th>
<th>Training Centre</th>
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<tr>
<td>Philip Ayre</td>
<td>Belfast</td>
<td>Pass with Merit</td>
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<tr>
<td>Natalie Bebbington</td>
<td>Birmingham</td>
<td>Pass with Distinction</td>
</tr>
<tr>
<td>Musa Bismillah</td>
<td>Coventry</td>
<td>Pass</td>
</tr>
<tr>
<td>Karen Bradley</td>
<td>Belfast</td>
<td>Pass with Merit</td>
</tr>
<tr>
<td>David Crosby</td>
<td>Bath</td>
<td>Pass with Merit</td>
</tr>
<tr>
<td>Kevin Duffy</td>
<td>Birmingham</td>
<td>Pass with Merit</td>
</tr>
<tr>
<td>Drew Fitzsimmons</td>
<td>Cambridge</td>
<td>Pass with Distinction</td>
</tr>
<tr>
<td>Daniel Gillet</td>
<td>Cambridge</td>
<td>Pass with Merit</td>
</tr>
<tr>
<td>Adam Gul</td>
<td>Coventry</td>
<td>Pass</td>
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<tr>
<td>Matthew Howells</td>
<td>Cardiff</td>
<td>Pass with Merit</td>
</tr>
<tr>
<td>Samantha Leith</td>
<td>Wolverhampton</td>
<td>Pass with Merit</td>
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<tr>
<td>Victoria Malysz</td>
<td>Derby</td>
<td>Pass</td>
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<tr>
<td>Paul Morgan</td>
<td>Cardiff</td>
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<tr>
<td>Andrew Penny</td>
<td>Coventry</td>
<td>Pass</td>
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<tr>
<td>Benjamin Rowberry</td>
<td>Plymouth</td>
<td>Pass with Merit</td>
</tr>
<tr>
<td>Katie Woods</td>
<td>Cambridge</td>
<td>Pass with Distinction</td>
</tr>
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DIARY OF MEETINGS 2008

PLANNED MEETINGS

<table>
<thead>
<tr>
<th>Meeting</th>
<th>Dates</th>
<th>Venue</th>
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<tbody>
<tr>
<td>Diagnostic Radiology User Group</td>
<td>28th April</td>
<td>Belfast</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Following the success of the last two meetings, this meeting will give attendees an opportunity to share information and experiences with all aspects of digital imaging.</td>
</tr>
<tr>
<td>Clinical Trials in Radiotherapy</td>
<td>13th May</td>
<td>SOCI, London</td>
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<tr>
<td></td>
<td></td>
<td>This meeting aims to provide an overview of the rationale behind radiotherapy clinical trials and their QA entry requirements.</td>
</tr>
<tr>
<td>Assessment of the active cardiovascular system</td>
<td>29th May</td>
<td>York</td>
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<tr>
<td></td>
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<td>This meeting intends to bring together scientists, engineers, physiologists and clinicians with an interest in dynamic cardiovascular behaviour and its measurement.</td>
</tr>
<tr>
<td>Wheelchair Stability</td>
<td>12th June</td>
<td>York</td>
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<td></td>
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<td>The meeting will focus on a range of issues related to wheelchair stability and user safety, including ways of assessment of wheelchair stability used in the clinical engineering practice.</td>
</tr>
<tr>
<td>RPA Update</td>
<td>19th June</td>
<td>MANDEC, Manchester</td>
</tr>
<tr>
<td></td>
<td></td>
<td>An update on current radiation protection issues for hospital RPAs. The programme will be relevant to those seeking RPA certification or who are maintaining awareness for re-certification.</td>
</tr>
<tr>
<td>Effects &amp; Management of Electromagnetic Fields in the hospital</td>
<td>8th July</td>
<td>York</td>
</tr>
<tr>
<td></td>
<td></td>
<td>The aim of this meeting is to identify sources of EMF’s, look at the interoperability of these sources and the factors that we need to consider for successful management of the EM environment.</td>
</tr>
<tr>
<td>Annual Scientific Meeting</td>
<td>2nd-4th September</td>
<td>Bath</td>
</tr>
<tr>
<td></td>
<td></td>
<td>This meeting will cover a range of topics and will offer some excellent presentations and a range of invited reviews educational sessions, and of course the exhibition.</td>
</tr>
<tr>
<td>Biennial Radiotherapy Meeting</td>
<td>2nd-3rd September</td>
<td>Bath</td>
</tr>
<tr>
<td></td>
<td></td>
<td>The aim of this meeting is to provide a update on recent developments in the UK and Europe in the field of radiotherapy.</td>
</tr>
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</table>

OTHER MEETINGS COMING SOON... Ultrasound QA and Challenges in Medical Equipment Development

The meetings department of IPEM is delighted to announce its upcoming programme of meetings. Our programme is regularly updated so please visit our website at www.ipem.ac.uk for the latest details. Abstract submission instructions, programmes and registration forms can be downloaded for each meeting.
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his packed issue has an imaging theme. We bring you two brand new book reviews and an updated edition of a very well-known book.

First is a review of a new CD entitled *Atlas of Cardiac Nuclear Medicine* by a nuclear medicine physicist. The second review is a new edition of the well-known *Farr’s Physics for Medical Imaging*. The final book is a new text on *Nuclear Medicine Therapy*.

Our regular ‘Just Published!’ section takes a look at the books which are due for publication over the next few months.

If you are interested in reviewing any of these, please contact the book review editors.

Gemma Whitelaw and Sarah Misson-Yates

**Atlas of Cardiac Nuclear Medicine: Volumes I and II**

As an atlas of cardiac nuclear medicine, this two CD set ‘does exactly what it says on the tin’. Having overcome some initial problems getting the CDs to run properly (screen resolution needs to be set to 1024 by 768), I found the overall layout clear and easy to navigate. Each CD contains about 20 case studies. (It is the aim of the authors to release subsequent volumes up to a total of 300 patients.) These are presented in a random order or they can be viewed in similar atlases of cases can be found free of charge on the internet. For a non-clinical audience, the inclusion of more technical information on the current legislation in place, most notably the Ionising Radiations Regulations 1999 and the Ionising Radiation (Medical Exposures) Regulations 2000, relevant to the FRCR course. It is a shame though, considering the publication of the *International Commission for Radiological Protection Report 103* in December 2007, that no mention of the updated tissue weighting factors was made, making this part of the book instantly out of date.

There have been some significant improvements since the first edition. Each of the main imaging modalities is dealt with in a logical order, starting with the fundamentals of x-ray imaging through to CT, introducing concepts such as image quality in greater depth as required along the way. Film/screen imaging is still discussed in some detail, but is grouped more usefully together with mammography, possibly the last bastion of this imaging modality. An entire chapter is now given over to digital radiography and associated technologies, including computed radiography and picture archive and communication system. It also gives fluoroscopy and computed tomography individual chapters, as opposed to merging

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**Farr’s Physics for Medical Imaging**

This easy-to-read, paperback book of 207 pages is a physics reference book for the non-physicist. It has adhered to the original intention of the first edition, providing a textbook based on the lectures given by R. F. Farr for the FRCR examination. To this end it serves its purpose admirably with good explanations of physics concepts as used in medical imaging with clear, useful diagrams whilst avoiding any heavy mathematics. More in-depth information is taken out of the main text into separate boxes for the interested reader.

It is laid out in a reader-friendly format, with an introductory chapter covering basic radiation physics and another covering radiation hazards and protection which has, sensibly, been brought further to the front of the book. It now contains updated information on the current legislation in place, most notably the Ionising Radiations Regulations 1999 and the Ionising Radiation (Medical Exposures) Regulations 2000, relevant to the FRCR course. It is a shame though, considering the publication of the *International Commission for Radiological Protection Report 103* in December 2007, that no mention of the updated tissue weighting factors was made, making this part of the book instantly out of date.

As a teaching resource this is a particularly useful feature

Interestingly, given the American Society of Nuclear Medicine guidelines, only two case studies used attenuation correction and none used quantitative processing features such as polar plots, perfusion scores and transient ischaemic dilation scores. A segmental model was not used for interpretation of the images. It is obvious that all of the results presented were obtained using the same processing software. Whilst this is good for consistency, it may be useful in later volumes for cases to be included using different processing packages which are available on the market.

My main criticism as a non-clinician is that a glossary of terms has not been included; this would have been useful to explain the abbreviations used. I had to ask my clinical colleagues to discover that an ICD is an implantable cardioverter-defibrillator. My medical dictionary told me that it stood for the International Classification of Diseases of the World Health Organisation!

In summary, this is a well presented, clear and concise teaching resource, to be recommended for clinicians training in nuclear cardiology, although in terms of value for money it should be noted that similar atlases of cases can be found free of charge on the internet. For a non-clinical audience, the inclusion of more technical detail and an explanation of the clinical terminology would significantly improve the usefulness of the atlas.

Helen Blundell
University Hospital of Wales, Cardiff

**ATLAS OF CARDIAC NUCLEAR MEDICINE: VOLUMES I AND II**

*Dr Diwakar Jain and Dr Archana Gowda*

Published by Informa Healthcare

Language: English


CD

List price: £120
them all into one as was done in the first edition. It then dedicates chapters to gamma imaging, ultrasound and magnetic resonance imaging.

Each chapter finishes with a summary of key points discussed in the chapter, but bizarrely the useful viva questions that concluded each chapter in the previous edition are no more. At £34.99 I felt that this book is good value for money. Not only is it an essential text for the trainee radiologist, and any physics department participating in their teaching, but it is also a useful reference book for the trainee physicist as it provides an introductory overview of diagnostic imaging.

Lauren Tedder
Charing Cross Hospital, London

FARR’S PHYSICS FOR MEDICAL IMAGING
PENOLEPE J. ALLISY-ROBERTS AND JERRY WILLIAMS
Published by Saunders Ltd.
Language: English
ISBN: 978-0702028441
Paperback, 216 pages, 2nd edition
List price: £34.99

Nuclear Medicine Therapy

The preface describes this as a handbook for the practitioner on ‘how to plan, carry out, and follow-up a nuclear medicine therapy’ and is thus primarily aimed at physicians new to the field. However, is it a relevant text for a multidisciplinary nuclear medicine department?

The opening chapters cover the basic principles of radionuclide therapy followed by a section identifying the radioisotopes currently in use, discussing their physical properties, emissions, chemistry and biodistribution. So far so good.

The remaining eight chapters are self-contained, each regarding a specific therapy application with contributions from a further 14 authors hailing from centres in the USA, Portugal and Germany. The aim of each section is to define the role of the physicist by describing the patient preparation, risks, indications and contraindications for treatment, patient follow-up and retreatment.

The chapters are well written and while containing details of the physiology and histology of the various malignancies remain accessible for the non-clinical reader. These chapters cover the treatment of thyroid carcinoma, palliation of bone pain, joint therapy, polycythemia vera and benign thyroid disease. In each case there is a comprehensive literature review highlighting cases where there is no consensus, discussing the pros and cons of the various radiopharmaceuticals available and practical advice including suggested protocols for administration and regimes for patient follow-up.

There are some basic radiation protection principles but as intended for an international audience the reader is often referred to their local regulations.

Two further chapters concern radioimmunotherapy (RIT) for solid tumours and lymphoma. Both chapters offer an extensive examination of the literature; however, as less well-established therapies they focus on clinical trials, toxicity and reported patient outcomes. The clinical content here probably goes beyond that necessary for the majority of clinical scientists/technologists and while mentioning the ongoing need for dosimetry there is little discussion of the practicalities.

While there is also a chapter devoted to 222RaCl2 for ankylosing spondylitis, notable omissions include 131-I-mIBG for neuroendocrine tumours and 90Y SIR-spheres.

Tables and flow charts are deployed well to present data and protocols but the quality of the post-therapy images is a little disappointing. The few images included were, in the main, small and had the appearance of dated archive images and were poorly reproduced. This edition is hardback and is fairly compact, just larger than A5 and fewer than 200 pages.

It is written as a reference for physicians, defining the role as the ‘captain of the ship’ for these procedures but retailing at around £100 it’s fairly expensive for the average nuclear medicine department if intended as a source of clinical information for physicists and technologists. There are less expensive books more tailored to a UK audience on the market.

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NUCLEAR MEDICINE THERAPY
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Just Published!

This quarter we have a wide range of books that have just been published. If you are interested in them or would like to try your hand at reviewing them please contact the book review editors.

Principles and Practice of Stereotactic Radiosurgery, William Regine and Lawrence Chin (Springer), covers both gamma knife and linac-based radiosurgery. The book is aimed at both neurosurgeons and radiation oncologists and is set out case by case. This text may be useful in giving the radiotherapy physicist a grounding in the clinical basis of these treatments.

SPECT – Basic Science and Clinical Applications, Dale Bailey and Steven Meikle (Springer), is set to come out in April. It is a guide to the underlying principles of this practice and would be useful for trainee physicists and other staff groups. The book is up-to-date and in-depth and is reported to be ‘the most complete book on SPECT fundamentals to date’.

A book that diagnostic radiology physicists may be recommending to their clinical colleagues is Mastering Physics for Radiology, Stuart Currie and Steven Kennish (Royal Society of Medicine Press). The book has a friendly style and simply presents the key physical concepts.

Another book for DR physicists is Computed Tomography From Photon Statistics to Modern Con Beam, CT Thorsten M. Buzug (Springer). As the title suggests this book is wide ranging and explores both the history and the physics of this imaging modality. The book is aimed at physicists, radiographers and other practitioners in this field.

Radiotherapy physicists may be interested to hear about the resource 3D Conformal Radiation Therapy, Multimedia Introduction to Methods and Techniques. Wolfgang Schlegel and Andreas Mahr (Springer). This is an e-book and includes new subject areas such as IMRT, IGRT and charged particle therapy.

Staying with the theme of radiotherapy: Technical Basis of Radiation Therapy: Practical Clinical Applications, S.H. Leit, James A. Purdy, Carlos A. Perez and Srinivasan Vijayakumar (Springer). This fourth edition has been completely updated and re-written. The book is split into two; the first part dealing with basic concepts and essential physics, the second describes the clinical applications.

Applied Biomedical Engineering Mechanics, Dhanunj N. Ghista and Ghista N. Ghista (CRC), explores advances in tissue, musculoskeletal, locomotive, orthopaedic, occupational, ergonomic, sports, cardiovascular, cardiac and pulmonary biomechanics and investigates how mechanics disciplines can be applied to a wide range of clinical applications.

Gemma Whitelaw
St Bartholomew’s Hospital, London
The winner takes it all

Steve Webb and (inset) the Barclay Medal, original pictures © Institute of Physics and IOP Publishing Ltd 2007

One of IPEM’s best known Fellows and Editor-in-Chief of PMB, Professor Steve Webb has received a new prize to add to his medal cabinet!

Steve is Professor of Radiological Physics at the Institute of Cancer Research and Royal Marsden NHS Foundation Trust. He could add more letters than available on a Scrabble board behind his name: PhD, DSc, CPhys, CSci, FIPEM, FInstP, FRSA. Steve was awarded the British Institute of Radiology’s Barclay Medal for 2006 in a ceremony in London last December.

THE MEDAL CEREMONY

The Barclay Medal was founded in 1952 in memory of Dr Alfred Ernest Barclay and is awarded annually to the person whose contribution to The British Journal of Radiology over a period of years has been of special merit, contributing materially to the science and practice of radiology.

Steve received the award in recognition of his publications in The British Journal of Radiology (27 in his 300-or-so-long publication list), which have significantly advanced practice in the fields of medical imaging and radiotherapy.

Steve admitted it was ‘the first time something as nice as this has happened to [him] without [...] having to give a lecture first’. He went on to ‘thank the British Institute of Radiology for this great honour and the Institute of Cancer Research and Royal Marsden NHS Foundation Trust for the almost-unique-in-the-UK scientific atmosphere that encourages the work [...] leading to this award’.

In his address Dr Stuart Green praised Steve’s impressive work and countless achievements in the field of radiation therapy and medical imaging: ‘his enthusiasm and drive have led to his success as a principal or co-investigator in the acquisition of research funding totalling several million pounds. He was one of the early pioneers in the development and application of cross-sectional imaging to radiotherapy, particularly using simulator-based CT and SPECT. His recent interests are typically both broad and deep and he has contributed with great originality to the theory and practice of IMRT, including the optimisation of treatment planning and delivery, robotic linacs and motion-compensated radiotherapy.’

For those of you who want to read it, the full citation can be found at: http://medicalphysicsweb.org/cws/article/research/32247

HOPES FOR THE FUTURE?

Steve joins a list of prestigious past winners that includes the likes of Professor F. W. Spiers, CBE (1967), Sir Edward Pochin (1970), Professor J. W. Boag (1974), Professor W. V. Mayneord, FRs, CBE (1982), Professor J. R. Mallard (1991), Professor Sir Peter Mansfield (1993) and many more. Sir Peter became a Nobel prize winner just 10 years after receiving the Barclay Medal. Can Steve follow in his footsteps and reach the ultimate prize?

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