COMMENTARY

Joint STFC Futures/BIR workshop “Cancer care: new detector and sensor technologies and their potential impact”, Harwell Oxford, 5–6 October 2011

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ABSTRACT. The workshop “Cancer care: new detector and sensor technologies and their potential impact”, organised jointly by the Science and Technology Facilities Council (STFC) and the British Institute of Radiology, brought together representatives from the cancer community (clinicians, medical physicists, National Health Service representatives and general practitioners with an interest in cancer) and STFC-supported scientists involved in basic research in physics and technology. The workshop aimed to raise awareness of the cancer challenge, share knowledge and identify novel solutions in the area of detectors and sensors to addressing the cancer challenge. A further aim of this workshop was to commence discussion on the formation of new multidisciplinary community networks. The workshop identified the synergies between the two communities and the potential for developing new collaborative ideas and projects.

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The Science and Technology Facilities Council and the Futures Programme

The Science and Technology Facilities Council (STFC) [1] is one of the seven Research Councils UK [2] and is an independent, non-departmental public body of the Department for Business, Innovation and Skills. The STFC is the main government body that funds basic physics science in the UK in the areas of astronomy and particle and nuclear physics. The STFC operates large facilities (such as a spallation neutron source) that are accessible to external users and manages international subscriptions to organisations such as the European Space Agency and the particle physics laboratory CERN (European Council for Nuclear Research) in Switzerland. STFC is also the major funder of the Diamond Synchrotron Light Source at Harwell, UK, and of two institutes for accelerator physics—the John Adams Institute in Oxford, UK, and the Cockcroft Institute in Warrington, UK.

The STFC Futures Programme was set up in January 2009 to effectively harness the STFC’s key strengths in science and technology, developed for fundamental research to help address the global challenges presented in the areas of energy, environment, healthcare and security.

The workshop—held at Harwell near Oxford, UK, on 5–6 October 2011—was a 2-day event that covered the medical aspects of the cancer challenge and identified future directions of collaborative research, the synergies between the cancer and the STFC scientific community and the potential for developing new collaborative ideas and projects in the area of detectors and sensor technologies.

Workshop report

A full workshop report is available from the STFC [3].

Day 1

The workshop was opened by Janet Seed, Associate Director of the STFC Science Programmes, who gave a brief overview of the STFC and its Futures Programme. The STFC’s strategy is to increasingly align its key strengths and expertise to the global challenges.

Tim Cooper, Associate Director of the National Cancer Action Team, reviewed the government’s strategy for improving cancer outcomes. The Department of Health believes that, by 2014/15, 5000 additional lives can be saved each year.

Neil Burnet, Honorary Consultant Clinical Oncologist, Addenbrooke’s Hospital, Cambridge, UK, reviewed the cancer challenge from an oncologist’s perspective. The improved precision, required for radiotherapy to achieve

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a higher cure rate with associated lower toxicity, can only be achieved through technological advances.

Phil Evans, Professor of Medical Radiation Physics at the Institute of Cancer Research and Royal Marsden Hospital, London, UK, reviewed the technological challenges in X-ray external beam radiotherapy. The first challenging area is imaging, in which advances are needed to improve the current limitations of functional imaging and to image the tumour motion. The second area is the development of new dose calculation and planning systems capable of dealing with the effects of combining different forms of treatment.

Ranald Mackay, Director of North Western Medical Physics at the Christie Hospital, Manchester, UK, reviewed the technological challenges in proton radiotherapy. The planning, delivery and verification of proton treatments do still present many challenges. Better models of dose deposition in the patient are required, along with effective methods of verifying the complex beam configurations required. Delivery requires in-room imaging. The verification of proton treatments requires the development of new online verification systems. Throughput must also be improved.

Anant Sachdev, GP Cancer Lead at the Thames Valley Cancer Network, Oxford, UK, reviewed the cancer challenge from the perspective of a general practitioner (GP) and brought into the discussion the human dimension of the disease. A large number of initiatives are under consideration to address the cancer challenges in primary care.

Richard Farrow, from the STFC, reviewed the STFC key technologies, skills and capabilities relevant to addressing the cancer challenge.

Vicky Goh, Professor of Clinical Cancer Imaging at King's College London, London, UK, reviewed the challenges in the area of cancer imaging. What is needed is to improve the characterisation and profiling capabilities of imaging systems, which must be developed to the point that allows the early assessment of the tumour response to treatment. The question remains of how best to translate technological advances into clinical advances.

Following the plenary talks, the attendees took part in breakout sessions that looked in more detail at the technological challenges within cancer. The aim was to have a shared understanding of what the key issues were.

Day 2

This day was dedicated to the discussion of a new call for community networks to be launched by the STFC Futures Programme. Catherine Ewart, Head of the STFC Futures Programme, gave an overview of the call, its structure and aims.

Chris Nutting, Director of the Head and Neck Unit at the Royal Marsden Hospital, London, UK, reviewed the role of radiotherapy in oncology and its link to physics and technology. To ensure the successful translation of technological advances into improved clinical outcomes it is mandatory to maintain a continuously developing dynamic interaction between physics and the clinic.

The workshop was closed by Barbara Camanzi, STFC Cancer Care Strategy Leader, who summarised the

highlights and achievements of the workshop. New links between the cancer and STFC scientific community were created. New synergies were identified. Discussions on the formation of new cross-disciplinary networks have started.

Workshop outputs and next steps

Summary of the breakout session discussions

During the breakout sessions, the participants reached a shared understanding of the key issues within each of the three challenges: (1) technological challenge in X-ray and proton radiotherapy; (2) challenge in early diagnosis from a GP's perspective; and (3) challenge in imaging for cancer.

1. Technological challenge in X-ray and proton radiotherapy

- Key issue 1: links between the STFC, clinicians and industry

Linking STFC expertise in detectors and sensors, imaging, computing and accelerators with clinicians and industry as well as the procurement process would be highly beneficial. A strong link with the STFC would allow clinicians to access new detector and accelerator technologies developed in physics laboratories. A strong link between the STFC and the manufacturers would make it easier for the manufacturers to access the new technologies developed by the STFC and would ensure their commercial viability. It would also ensure a better optimisation of the new technologies developed. A collaborative approach to the cancer challenge that involves the STFC may help to change the current approach to the introduction of new technologies in the clinic that, being too conservative and overly cautious, tends to hinder innovation.

- Key issue 2: new technologies for imaging
Imaging is one of the areas most in need of new advanced technologies. There is a need for new technologies for fast real-time imaging that will allow efficient use of valuable clinician time.
- Key issue 3: new technologies for dosimetry
New technologies for dosimetry are needed that measure the dose delivered to the patient with higher precision, delivering information that can be used to ensure that the prescribed dose is not exceeded.
- Key issue 4: new accelerator technologies for proton radiotherapy
The main focus should be on development of new technologies for improving the proton radiotherapy machines that are currently commercially available and that would allow a better design of proton radiotherapy facilities.
- Key issue 5: software

The development of new software tools and algorithms should be more advanced within the UK. To this end, it would be very beneficial for the cancer community to have easy access to code and software

developed by the STFC scientific community. The cancer community would also like to access STFC expertise in Monte Carlo simulations. Another area that requires new software is the management of information for long-term patient follow-up.

2. Challenge in early diagnosis from a GP's perspective

- Key issue 1: education
The biggest issue, the human factor, can only be addressed through education.
- Key issue 2: screening
To make screening worthwhile and to expand its use, its effectiveness and success rate have to be increased. New cost-effective screening processes are needed that are cheap, easily available and fast and that provide the results in a short time while maintaining a high specificity.
- Key issue 3: new improved technologies
There is a clear need to develop new improved technologies that provide a clearer and easier interpretation of the data and that will therefore allow a reduction of false positives and false negatives. Technologies that could be used at home would be welcome.
- Key issue 4: imaging
The possibility of and need for developing high-resolution imaging more focused on early diagnosis has to be understood.
- Key issue 5: chemical analysis
It is not clear if chemical analysis is needed to detect early signs of cancer.
- Key issue 6: staff
Expanding screening programmes may potentially require more staff. Training programmes may also be required to interpret the results and to use new technologies that may become available.

3. Challenge in imaging for cancer

- Key issue 1: integrated approach to imaging
The biggest issue is that, although solutions may already be available, an integrated approach is still missing.
- Key issue 2: imaging for radiotherapy
Clinicians want imaging systems that will allow them to measure the dose distribution in real time to ensure delivery of the correct dose. Ideally one would want to see tumour cells during treatment.
- Key issue 3: imaging for surgery
There is a desire to be able to perform imaging at the cellular level during surgery that not only shows individual or groups of cells but recognises also which ones are cancerous cells.
- Key issue 4: imaging for staging
The ultimate goal of diagnosing and staging a tumour in one step and reducing the need for biopsy may be achieved with combined imaging.
- Key issue 5: microscopic imaging
Microscopic imaging is needed to understand how the tumour is spreading.
- Key issue 6: new improved imaging technologies
New advanced technologies need to be developed

that will overcome the limits of the existing ones. New systems will have to provide a reduced number of false positives and negatives. Wherever possible, the system should combine multiple imaging modalities. The dose delivered to the patient during imaging procedures should be reduced. The size of the current imaging systems should be reduced, ideally to the point that they can be used in GPs' surgeries. It is crucial that new technologies will be cheap and will provide clear clinical benefits. Another important line of work is the optimisation of existing technologies, such as MRI.

- Key issue 7: computing for imaging
More complex software would be needed that is capable of converting large imaging data sets and that would allow a more powerful automated analysis of images and automated detection of the disease. This software should also be capable of analysing multiple fused images, while at the same time handling the situation when the patient has moved between images. New computer infrastructure would be needed to handle the transportation of data and to allow collection of data from different centres.
- Key issue 8: standardisation of data formats
Standardisation is needed as different suppliers still provide data formats that are specific to their imaging systems.

The discussions of all breakout sessions will input to the STFC Cancer Care Strategy currently being developed.

Summary of the discussion on the formation of new community networks

Four ideas for new community networks were presented and discussed.

1. A network with a focus on imaging and radiotherapy planning.
2. A network with a focus on cancer diagnosis using non-ionising radiation.
3. A network with a focus on collection of clinical data.
4. A network with a focus on new technologies.

These discussions will help in forming proposals to be submitted to a new call for multidisciplinary community networks to be launched by the STFC Futures Programme.

Conclusion

The workshop brought together 100 participants from across the UK with the common interest of promoting medical research in the field of diagnosis and treatment of cancer. New links were created between the cancer community (clinicians, medical physicists, National Health Service representatives and GPs with interest in

cancer) and the STFC scientific community (physicists, technologists and computer scientists). The workshop identified the synergies between the two communities and the potential for developing new collaborative ideas and projects.

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