IOP Institute of Physics

Medical Physics in the UK: Opportunities and Challenges

A physics community perspective

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Executive Summary

Medical physics is a critical field at the intersection of healthcare and physics, playing a key role in diagnostics and therapy and leading to many medical device innovations. Despite significant contributions to the field, it faces challenges in the UK that hinder its full potential. These include misaligned funding structures, a complex regulatory landscape, and lengthy approval processes for medical devices and clinical trials. However, there are substantial opportunities for industrial growth driven by technological advancements that can address our increasing and evolving healthcare needs, essential to reducing the cost of healthcare in the long run.

This report, a community perspective convened by the IOP Medical Physics Special Interest Group, examines the challenges outlined above, and offers suggestions and proposed next steps towards creating a more supportive environment for medical physics in the UK.

Introduction

Background

The IOP Medical Physics Special Interest Group convened to highlight some of the challenges they encounter in their daily work. That community perspective is outlined in this report and is the culmination of a series of discussions held over two months, involving a core group of committee members along with additional invited participants.

Medical physics is essential in modern healthcare, driving innovations that enhance diagnostic accuracy, treatment precision, and patient safety. Medical Physicists and Clinical Engineers represent around 1% of NHS staff but contribute to nearly half of all diagnoses and treatments[1]. Various branches of physics significantly contribute to these advancements. The UK and Ireland boast a rich history of leading medical physics research, making global contributions and developing new solutions that benefit

[1] IPEM Spending Review Submission (2025) https://www.ipem.ac.uk/media/netpufoq/ipem-spending-review-submission-2025-final.pdf

patients and the medical industry. Notable contributions include magnetic resonance imaging (MRI), computed tomography (CT), radiotherapy, and proton beam therapy.

The UK has a large, diverse, and strategically important medical technology (MedTech) industry that plays a critical role in healthcare, with the NHS alone spending around £10 billion annually on MedTech products. The healthcare sector contributes significantly to the economy, providing skilled jobs nationwide, particularly through small and medium-sized enterprises (SMEs), which comprise most MedTech companies. While regions like the South-East, London, and East of England host a large share of employment (41%), strong regional clusters exist throughout the UK. Internationally, the UK is a key exporter, with MedTech exports exceeding £5.6 billion in 2021.[2]

However, several key challenges hinder the full realisation of medical physics innovations, many of which are highlighted in a series of recent reports published by CPI, which reveal systemic barriers facing UK MedTech startups and spinouts[3]. Regulatory barriers, fragmented interdisciplinary collaboration, and the slow translation of research into clinical practice — especially within the NHS — remain significant obstacles. Ensuring that UK and Irish-led research directly benefits their population and supports national industry requires a more coordinated and strategic approach.

Medical Physics

Medical physics applies principles and techniques from physics to medicine, especially for diagnosing and treating diseases. It is an interdisciplinary field, integrating physics principles with healthcare to advance medical diagnosis, treatment, and patient safety. This broad domain encompasses areas such as medical imaging (e.g., X-Ray, MRI, CT, ultrasound, nuclear medicine), radiation therapy for cancer treatment, radiation protection, biomechanics, and physiological measurements. It also includes the study of the physical principles underlying human body functions, such as blood flow dynamics and bioelectromagnetism. Medical physicists work in hospitals, research institutions, and industry, ensuring

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[2] UK Government Medical Technology strategy https://www.gov.uk/government/publications/medical-technology-strategy/medical-technology-strategy#:~:text=Medtech%20is%20a%20vital%20UK,of%20medtech%20products%20in%202021.&text=Figure%202%20illustrates%20the%20UK,4%2C190%20UK%20businesses

[3] CPI Reports Call for Action to Overcome Barriers in UK MedTech | CPI https://www.uk-cpi.com/news/medtech-industry-innovators-and-investors-call-for-urgent-action-to-unblock-uk-medtech-bottlenecks

the safe and effective use of technology in clinical practice and contributing to innovations that improve patient care.

Advancements in medical physics have a profound societal impact, enhancing the quality of life for a broad population through early disease detection, effective therapies, and supporting public health initiatives, generating benefits that extend far beyond the healthcare sector, and ultimately touching nearly every aspect of society.

Supporting Evidence

This section examines some of the strengths characterising the UK's contributions to medical physics research and illustrates several challenges that were identified during an intensive two-day workshop. This workshop specifically focused on translating groundbreaking quantum technologies into the healthcare market and the NHS to benefit UK society.

Quantum technologies represent just one of the fields in physics that have medical applications; however, the challenges encountered are quite similar across other domains and serve as a pertinent example. By discussing the challenges and strengths faced in translating quantum technologies, we aim to underline the above statements.

UK Strengths in Medical Physics Research

There is a compelling reason to support the translation of medical physics research conducted in the UK, as it leads global research in this field.

To benchmark the UK against the rest of the world, we utilised SciVal to compare publications in the UK with those globally. We identified a list of the top 5% most highly cited papers in medical physics from 2014 to 2023 to define the publications. To avoid distortion, we included publications focused on medical physics technologies rather than those like Nature journals, which had a broader field focus. The list was created using relevant terminology and subsequently validated and expanded based on feedback from the IOP Medical Physics Special Interest Group Committee. Data from 2024 was not used, as the citation data was incomplete at the time of writing. The list is included in the Appendix.

Based on the number of outputs in the top 5% of the world's most highly cited articles (field weighted), the UK is fourth in the world for its research in medical physics.

Countries and territories	Scholarly output	Views count	Field-weighted citation impact	Citation count
United States	789	32,043	9.04	115,229
China	352	18,822	13.67	67,811
Germany	253	10,343	8.93	37,819
United Kingdom	231	11,719	9.64	37,636
Netherlands	205	9,967	10.30	35,296
Italy	166	8,695	9.98	22,845
Canada	147	7,011	10.04	24,663
France	125	5,767	9.85	19,138
South Korea	125	5,093	8.80	19,180
Switzerland	113	4,703	8.59	17,652

Regarding collaboration, the UK has a higher percentage of non-academic co-authors in their outputs, including corporate, government and clinical collaborators, potentially highlighting its ability to translate research into the medical market.

Entity	Academic-corporate collaboration	Academic-government collaboration	Academic-medical collaboration	Academic-other collaboration	Academic-only collaboration
Medical physics publications – top 5% cited in the world: 2014 - 2023	9.4	23.2	28.6	1.4	44.8
UK medical physics publications – top 5% cited in the world: 2014 - 2023	14.1	38.0	52.5	4.7	27.1

These data points underscore the UK's global prowess in medical physics and suggest a promising intention to translate research into real-world applications. There are strong foundations to leverage when contemplating translating physics research into healthcare.

Challenges Case Study

Cross-Community Engagement

To support the IOP's medical physics community in presenting a view of some of its translational challenges, this section highlights the outcomes of an event focused on quantum technologies, the Quantum Health Summit.

While concentrated on a narrow physics area, the event highlighted ongoing challenges in translating physics into clinical applications. It took place on 14-15 November 2024, in Stirling, Scotland. Attendees included physicists, engineers, medical researchers, charities, policymakers, and funders. This two-day event featured talks and discussions aimed at connecting physics, medical research, and clinical applications, allowing attendees to network and explore project ideas. Co-organised by the IOP's Medical Physics and quantum Business Innovation and Growth (qBIG) special interest groups, the summit was led by the Scottish Quantum and Brain Health Arc consortium, in collaboration with SUPA[4] and SINAPSE[5].

The summit included several presentations on quantum physics, medical research, and clinical implementation, which addressed the clinical and medical challenges and opportunities arising from recent advances in quantum technologies.

Images from the Quantum Health Summit presentation and roundtable discussions. Source: Brain Health Arc

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[4] SUPA: Scottish Universities Physics Association (SUPA is a collaboration that supports the physics community in Scotland) https://www.supa.ac.uk
[5] SINAPSE: Scottish Imaging Network: A Platform for Scientific Excellence (SINAPSE has built a Scotland wide, cross-disciplinary imaging network of scientists and clinicians) https://www.sinapse.ac.uk

Summary of challenges discussed

The following challenges were discussed during the summit. This list is not exhaustive and represents the views of the speakers and participants. However, it emphasises the complex frameworks and systems that people and organisations must navigate when translating medical physics into medical applications.

Translation Barriers:

- Robust validation is needed before clinical adoption, (i.e. following regulatory compliance and clinical trials, etc).
- Clear patient and clinical values must be demonstrated, as well as cost-effectiveness.
- High investment costs make stakeholders cautious about deploying novel technologies.
- There are lengthy time frames from concept to market entry.

Medical Research:

- *Cross-disciplinary collaboration*: Translating physics into the medical sector fundamentally requires collaboration across disciplines among physicists, healthcare professionals, data scientists, regulatory experts, and others. Forming interdisciplinary teams to further advance medical physics should be an ongoing endeavour.
- *Funding*: The funding gap was highlighted for early-stage research involving promising yet unproven approaches. The multidisciplinary nature of medical physics poses a funding challenge, as it may fall between the funding categories of various organisations.
- *Access to infrastructure / facilities for validation of new technologies*: Facilities need to be available that can test and validate new imaging technologies.
- *Patient recruitment for clinical trials*: Clinical trials are limited to a selected group within a population, which may not represent the whole. The number of applicable individuals who can participate in trials may also be insufficient. Additionally, recruitment challenges can increase the time required.
- *Data*: There are challenges in moving and replicating large datasets for research, as well as the limited representativeness of clinical trial data.

Clinical Adoption:

- *Healthcare system preparedness*: Existing healthcare infrastructure needs to be prepared to incorporate new testing methods and technologies.
- *Clinical workflow adaptation*: Healthcare professionals need training and protocols to use new technologies and methodologies effectively.
- *Cost and resource allocation*: Implementing new technologies in clinical settings, such as hospitals, requires significant financial investment and resource planning.
- *Data integration*: There are challenges in integrating varied data types (genomics, imaging, device data). New data should not interfere with ongoing patient care. There are also limitations arising from the current data infrastructure in the NHS concerning capacity and speed, as well as strict patient data protection rules.

Others:

- *Scalability*: It must be ensured the technology can be consistently and effectively deployed across different healthcare settings.
- *Patient acceptance*: Patients generally accept tests, but broader systemic integration remains complex.

The meeting underscored the importance of collaborating with various communities and emphasised the necessity of recognising the differences that medical researchers and clinicians encounter (e.g. hospital clinicians experience varied pressures, influenced by their specific service demand and capacity). It is therefore crucial to comprehend their workflows and areas of focus. For instance, in the Emergency Department, the ability to triage swiftly is more critical than the precision of measures.

Another issue that emerged from the roundtable discussions was the necessity for training on new equipment (such as a new diagnostic tool) and integrating it into existing data systems. Without addressing these issues, progress on translation is hindered. Time constraints and costs can also pose obstacles.

One discussion emphasised the importance of involving patient groups - an increasingly recognised trend[6]. The National Institute for Health and Care Research (NIHR) acknowledges that involving patients enhances acceptability among the wider population and supports successful translation outcomes. The involvement of patient groups is seen as crucial at an early stage, as public acceptance of new technologies is vital, as is ensuring that there is value for patients.

In summary, the Quantum Health Summit emphasised the wide range of stakeholders and communities that must be involved in translating medical physics research into applied healthcare, along with the necessity for effective coordination.

[6] National Institute for Health and Care Research – Going the extra mile: Improving the nation's health through public involvement in research https://www.nihr.ac.uk/going-the-extra-mile#:~:text=Relevance%20and%20usefulness%20of%20research,issue%20for%20third%20sector%20organisation

Current Challenges in Translating Medical Physics into Commercial Applications

Translating physics research into clinical practice presents several challenges including a stretched workforce and critical skills shortages[7]. Though not all the challenges will be covered here, some of the more impactful ones are outlined below.

Misaligned Funding Sources

Government-provided funding, (such as that which is provided through UKRI or NIHR) is not optimally structured or easy to navigate to support medical physics innovation. Promising projects can fall into the 'gaps' between funding categories, making it difficult for researchers to secure the financial backing needed for translational research and new technology development.

In the United Kingdom, medical physics research is primarily funded by a combination of government agencies, charitable organisations, and independent trusts. Key funding sources include:

1. Government Agencies

- **National Institute for Health Research (NIHR):** Funded by the Department of Health and Social Care, the NIHR is the nation's largest funder of health and care research. It collaborates with the NHS, universities, and other partners to fund research that translates scientific discoveries into practical health benefits.

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[7] The Institute of Physics and Engineering in Medicine (IPEM) has highlighted critical shortages in the medical physics and clinical engineering workforce, attributing these issues to insufficient funding for training programs. In June 2023, IPEM called for urgent action, recommending an additional £8 million annually over five years to expand training posts and develop workforce skills. They warned that without this investment the workforce would struggle to deliver safe and effective services within the NHS.

IPEM: Crucial funding needed to tackle workforce shortages https://www.ipem.ac.uk/news/crucial-funding-needed-to-tackle-workforce-shortages

In Scotland, similar concerns have been raised. IPEM reported a 10% vacancy rate across medical physics specialisms, including radiotherapy and nuclear medicine. The lack of funding for Clinical Scientist training places has been identified as a threat to patient safety, with calls for immediate investment to address the shortfall.

IPEM: Threat to patient safety in Scotland over lack of funding for Clinical Scientist training places https://www.ipem.ac.uk/news/threat-to-patient-safety-in-scotland-over-lack-of-funding-for-clinical-scientist-training-places

- **Medical Research Council (MRC):** Part of UK Research and Innovation (UKRI), the MRC invests in a broad spectrum of medical research aimed at improving human health. It supports projects across various disciplines, although to a lesser extent medical physics.
- **Engineering and Physical Sciences Research Council (EPSRC):** Also a part of UKRI, EPSRC funds research in engineering and physical sciences, including areas pertinent to medical physics such as healthcare technologies and bioengineering.

2. Charitable Organisations

- **British Heart Foundation (BHF):** As the UK's largest independent funder of cardiovascular research, the BHF supports studies that may involve medical physics applications, particularly in imaging and diagnostics related to heart and circulatory diseases.
- **Cancer Research UK (CRUK):** CRUK is the world's largest independent cancer research charity, funding research into the prevention, diagnosis, and treatment of cancer, which often encompasses medical physics methodologies like radiotherapy and imaging.
- **British Lung Foundation (BLF):** The BLF funds research aimed at preventing and treating lung diseases. While primarily focused on respiratory health, some of their funded projects may involve medical physics techniques, especially in diagnostic imaging.
- **BMA Foundation for Medical Research:** The BMA Foundation offers grants to support medical research across various disciplines. Their funding opportunities are available to both members and non-members, supporting projects that can include aspects of medical physics.
- **The Wellcome Trust:** A global charitable foundation, Wellcome funds health-related research, including medical physics. It provides grants for fundamental and applied research in biomedical imaging, radiotherapy, and other physics-related healthcare technologies.

These organisations collectively provide support for medical physics research in the UK, fostering advancements in healthcare technologies and improving patient outcomes through innovative scientific endeavours.

Regulatory Complexity

Navigating the regulatory landscape for medical physics applications is complex and multifaceted. Companies must comply with various legal frameworks across different regions, as each market (e.g. the UK, EU, and USA) has its own requirements. The main challenges are obtaining initial regulatory approvals, adapting to evolving standards, ensuring compliance with frequent updates, and managing multiple regulatory bodies simultaneously. Researchers and developers often struggle to meet compliance requirements, which can delay innovation and adoption. Addressing these compliance issues can also be quite expensive.

Medical Device Approval Challenges

According to a market study, the UK has the sixth largest medical device market globally[8]. However, new technologies are sold globally to maximise the return on investment, and there are significantly larger markets such as the USA and Germany. Selling into those markets is attractive, but companies must obtain approval from the respective regulators. The UK's medical device approval process lacks seamless integration with international regulatory bodies. This misalignment creates barriers to wider market adoption, slowing the translation of research into commercial and clinical applications. It may also mean that first clinical use will not be in the UK, and so the benefit to UK patients is not immediate. Without streamlined approvals, UK-developed medical devices risk falling behind in global competitiveness.

Lengthy Clinical Trial and Validation Processes

Clinical trials and validation processes for innovations in medical physics are crucial for ensuring patient safety. However, these processes can be lengthy, often stretching over several years. Additionally, securing funding for large-scale clinical trials and collecting sufficient real-world data to demonstrate long-term efficacy adds further complexity, leading to delays in widespread implementation. This prolonged timeline and the associated challenges can pose significant barriers to introducing new technologies to patients, ultimately slowing the pace of innovation.

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[8] An overview of the UK Medical Device Industry https://www.jonexglobal.com/post/the-uk-medical-device-industry#:~:text=The%20UK%20has%20the%20third,strong%20players%20in%20the%20market

Conclusion and Suggested Next Steps

Medical physics has immense potential to revolutionise healthcare, and promote applied physics in this domain, but structural and regulatory barriers must be addressed to fully realise this potential in the UK. Addressing the challenges and finding innovative ways of overcoming them could help increase the adoption of UK medical physics research outcomes, which would benefit the UK in multiple ways:

- UK patients will benefit from UK research.
- UK companies will become more competitive and enable the UK to capture a more significant market share.
- NHS challenges will be actively addressed.
- Ultimately, a healthier UK population will benefit the UK economy.

To effectively tackle the challenges, an initial step could be a coordinated approach to bringing this diverse community together, (spanning the research communities, medical practitioners, industry, NHS officials, government, and both public and private funders) to initiate a collaborative dialogue and create a platform for participants to share their unique perspectives and brainstorm innovative strategies, aimed at addressing some of the pressing issues at hand.

With a view to fostering innovation and growth, discussions could potentially centre around the following questions:

- How could funding mechanisms be better aligned to support interdisciplinary research?
- How can an integrated regulatory framework be shaped to be more transparent?
- How can collaboration between academia, healthcare, and industry be strengthened?

From these discussions, a comprehensive list of actionable recommendations should emerge, thoughtfully tailored to meet the specific needs of each community whilst addressing the gaps identified and aiming to close them. Implementing such recommendations could potentially achieve a significant and positive transformation, paving the way for sustainable solutions and enhanced community cohesion.

To explore the details of these recommendations and identify pragmatic, implementable solutions, we propose that the IOP establishes an Impact Project to convene all the necessary stakeholders to discuss and address the key points outlined above.

Appendix

Research Excellence Publication Data

We used SciVal to benchmark the UK with the rest of the world based on publications. To define the publications, we identified a list of the top 5% most highly cited papers in the field of medical physics from 2014 to 2023. We did not use data from 2024 as the citation data is incomplete. To delineate the field, we utilised a list of international journals that cover various aspects of medical physics. The list of journals is provided below.

Entity	Scholarly Output	Output in Top 5% Citation Percentiles (field-weighted, %)	Output in Top 5% Citation Percentiles (field-weighted)
Applied Radiation and Isotopes	2967	1.1	34
Bioelectromagnetics	432	1.9	8
Biomedical Physics and Engineering Express	973	3.2	31
BMC Medical Physics	2	-	-
British Journal of Radiology	2418	2.4	57
Clinical Physiology and Functional Imaging	569	0.5	3
EJNMMI Physics	260	4.2	11
European Journal of Nuclear Medicine and Molecular Imaging	2240	21.3	476
European Journal of Radiology	2721	4.8	130
Health Physics	1291	2.6	33
IEEE Transactions on Medical Imaging	1781	19.7	350
IEEE Transactions on Nuclear Science	2730	3.3	91
IEEE Transactions on Radiation and Plasma Medical Sciences	288	8.3	24
International Journal of Radiation Oncology Biology Physics	4202	11	463
International Journal of Radiation Research	404	-	-
Investigative Radiology	715	17.8	127
Iranian Journal of Medical Physics	260	-	-
Japanese Journal of Health Physics	101	-	-
Japanese Journal of Radiology	752	2	15
Journal of Applied Clinical Medical Physics	1741	2.5	44
Journal of Biomedical Optics	2587	2.2	56
Journal of Biomedical Physics and Engineering	339	0.9	3
Journal of Biophotonics	1412	4	56
Journal of Cardiovascular Magnetic Resonance	1135	9.3	105
Journal of Digital Imaging	745	8.7	65

Journal of Lasers in Medical Sciences	387	1.6	6
Journal of Magnetic Resonance Imaging	2645	9.5	252
Journal of Medical Imaging and Radiation Oncology	986	0.4	4
Journal of Medical Imaging and Radiation Sciences	631	1.1	7
Journal of Medical Physics	285	0.4	1
Journal of Nuclear Medicine	2876	17.7	510
Journal of Radiation Research	849	2.5	21
Journal of Radiotherapy in Practice	429	-	-
Journal of Ultrasound in Medicine	2253	1.9	42
Korean Journal of Radiology	962	5.3	51
Lasers in Medical Science	1749	5.4	95
Magnetic Resonance in Medicine	3348	8.2	275
Medical Dosimetry	438	0.5	2
Medical Engineering and Physics	1246	1	13
Medical Image Analysis	910	24.7	225
Medical Physics	4172	6.2	260
NMR in Biomedicine	1196	2.3	27
Nuclear Medicine and Biology	662	0.3	2
Physica Medica	1643	2.5	41
Physics and Imaging in Radiation Oncology	221	4.1	9
Physics in Medicine	20	5	1
Physics in Medicine and Biology	4033	5.5	221
Physiological Measurement	1303	2.2	29
Polish Journal of Medical Physics and Engineering	130	-	-
Practical Radiation Oncology	984	2.4	24
Radiation Detection Technology and Methods	207	0.5	1
Radiation Oncology	1712	2.4	41
Radiation Physics and Chemistry	2986	4.3	128
Radiation Research	952	4.1	39
Radiological Physics and Technology	353	0.8	3
Radiology	3782	22.4	846
Radiotherapy and Oncology	2504	8.2	205
Reports of Practical Oncology and Radiotherapy	636	0.3	2
Technology in Cancer Research and Treatment	1075	0.4	4
Ultrasound in Medicine and Biology	2156	3	65
Ultrasound in Obstetrics and Gynaecology	2111	13.8	292

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