

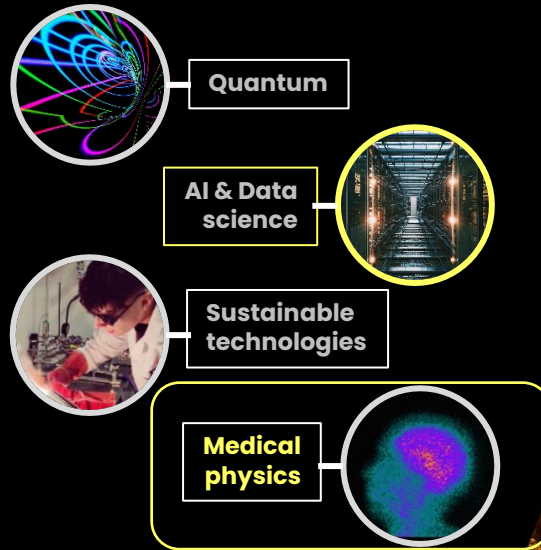


UNIVERSITY OF
LIVERPOOL

Introduction

Monica, Tim + Laura → James

9/7/2025



Welcome

- Welcome to James Ingham who will take over from Laura ☺



- James already very engaged, see his contributions to this meeting
- Plans for the group include also to offer a platform for PhD students in medical physics to present and share their work in an informal and broader environment
 - Overview of some of the projects today



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Reminder of activities

■ Accelerator Science:

Gas jet-based beam monitoring applicable to hadron therapy (Carsten Welsch).

Contacts with: Adaptix (radiology company); ViBo Health (USA/Portugal personalised health start-up); D-Beam (Quasar spin-out to commercialise technologies such as gas-jet).

■ Condensed Matter:

Blood brain barrier model for drug discovery and toxicology studies (Joe Forth). Studying agrochemicals with Syngenta.

Granulated microgels for accelerated wound healing (Joe Forth).

IR spectroscopy for cancer diagnosis (Peter Weightman). Commercialisation with University support (LDIR wand).

Magnetoencephalography using optically pumped magnetometer. Use includes test of brain function to identify source of epilepsy seizures (Brianna Heazlewood).

• From previous meetings and discussions

■ Particle Physics

HV-CMOS instrumented phantom for proton therapy (Gianluigi Casse, Jon Taylor).

AI applied to healthcare, in particular study of age-related macular degeneration. (Monica D'Onofrio).

■ Nuclear Physics

Applications of gamma-ray imaging (Laura Harkness-Brennan, Andy Boston...)

■ Other

Tamponades for treating retinal detachment (Michael Day)

■ Common themes include:

Proton/heavy ion therapy (gamma-ray camera, phantom, beam diagnostics...)

Lots of work on eyes.

AI being applied in several areas.

- Also relevant is the Department's taught PG provision, with 120 registered students (Helen Boston).

NHS commissioned Clinical Scientist Training programmes (STP).

Radiometrics (now renamed!) training taken by both MSc students and nuclear industry candidates.



Reminder of activities: write up

• Prepared to facilitate discussions with institutional initiatives



MEDICAL SCIENCE: ACTIVITIES IN THE PHYSICS DEPARTMENT

(JUNE 2025, MONICA D'ONOFRIO, TIN GREENSHAW, LAURA HARKNESS)

Executive summary: Several research activities in healthcare and medical science are taking place in Physics, capitalising on the Department's expertise in accelerators, detector development and data analysis. Activities are supported by our expert scientific and technical staff as well as excellent in-house facilities, such as the Liverpool Semiconductor Centre, the Advanced Materials Laboratory and the Nuclear Physics Laboratory, all in the Oliver Lodge building. Collaborations with national and international laboratories, such as Daresbury and CERN, provide access to facilities and specialised equipment not available within the Department. Activities include: applied accelerator research (non-invasive beam and dose monitoring for proton and ion beam cancer therapy); development of systems for proton therapy for cancer; development of AI-based procedures for cancer diagnosis; design and testing of phantoms to study cancer treatment; and design of medical diagnostic tools. Medical imaging techniques are also investigated, using novel approaches such as magnetic particle imaging. The Department also leads MSc programmes in Medical Physics and Clinical Scientific Computing which form part of the NHS clinical scientist training programme. In 2024, a Medical Physics group was formed within the Department to improve the coherence of our medical physics activities, to strengthen existing and develop new collaborations and to create critical mass in areas that have been under-staffed. It is hoped these measures will help the Department to attract more funding and exploit investments aligned with the University's Strategy 2031 initiatives.

Examples of research activities are listed in the following:

• Applied accelerator research:

The expertise in beam diagnostics of the Liverpool accelerator science group has led to the development of gas jet beam monitoring systems applicable to proton and ion therapy. Current industry partners in the activity include Adaptix (radiology company); ViBo Health (USA/ Portugal personalised healthcare start-up); D-Beam (Quasar group spin-out to commercialise technologies such as the gas-jet). *Contact: Carsten Welsch, Alex Hill.*

Academics in the Department are engaged in developing LhARA (the Laser-hybrid Accelerator for Radiobiological Applications), a project conceived as a new, highly flexible, source of radiation that can be used to study the mechanisms by which the biological response to ionising radiation is determined by the physical characteristics of the beam. In the longer term, the goal is that the LhARA accelerator and treatment system will transform the clinical practice of proton- and ion-beam therapy by creating a fully automated, highly flexible system to harness the unique properties of laser- driven ion beams. *Contact: Tim Greenshaw, Carsten Welsch.*

• Cancer research - diagnosis:

The Liverpool Diagnostic infrared wand (LDIR Wand) is a device being developed in the Department, in collaboration with surgeons and chemists, for cancer diagnosis. The LDIR Wand is able to predict the prognosis of oral cancer lesions by analysing infrared spectral images using machine learning, leading to better and earlier diagnosis of the likely progression of oral epithelial dysplasia and increased chance of successful treatment while being cheaper and less invasive than current approaches. A patent has been granted for the machine learning algorithm¹. A number of ways of translating this advance into the clinic are being explored with funding secured from the National Institute of Health-Care Research and Cancer Research UK. Applications to other type of cancers (e.g. breast cancer) are in development. *Contact: Peter Weightman, James Ingham.*

• Device development research (for cancer and beyond):

Development of instrumentation for cancer proton therapy treatment systems arises from tracking detector development for high-energy collider experiments (*HV-CMOS instrumented phantom for proton therapy*). Custom, fast HV-MAPS sensors are used to track individual protons and provide improved assessment of the dose delivered to patients during treatment. Work is in progress with industry partners, with the aim of further progression towards the future deployment of our instruments in clinical applications. A [patent](#) now recognized also in the US and Japan have been established, and contacts with hadron therapy accelerator and instrument manufacturer are in progress. *Contact: Gianluigi Casse, Jon Taylor.*

Liverpool is involved with (and previously led) the [STFC Cancer Diagnosis Network+](#), a multidisciplinary community with academic, clinical and industry members aiming to collaboratively address clinical challenges in the diagnosis of cancer. We work with partners such as the Clatterbridge Cancer Centre to develop novel medical imaging technologies for cancer diagnosis and therapy. *Contact: Laura Harkness.*

Gamma-ray imaging projects include optimization of CZT-based gamma-ray imaging systems for low-dose molecular breast imaging, development of the same systems for dosimetry during radio-nuclide therapy, and imaging of prompt gamma-rays during proton beam radiotherapy. *Contact: Andy Boston, Ellis Rintoul.*

• Applications of AI/ML to healthcare research:

The Department is investigating the application of analysis techniques developed for fundamental research to medical science. In particular, studies of [age-related macular degeneration and diabetic retinopathy](#) using convolutional and graph neural networks are being pursued with the Department of Ophthalmology and the Institute of Life Course and Medical Sciences at the UoL (Prof Yalin Zhang and Dr Philip Burgess). A PhD project in this area is partly supported by ARO (previously AIMS). *Contact: Monica D'Onofrio, Nikolaos Rompolis.*

Initiatives to take high-energy physics AI methods and apply them to improve analysis and modelling in neuroscience, with focus on explainability and interpretability, include the MUCCA consortium, <https://sites.google.com/uniform1.it/mucca-project/> with studies produced by partners on study of brain tumours, pulmonary diseases and neuroscience. *Contact: Monica D'Onofrio.*

• Other activities building on the expertise in condensed matter physics:

- Tamponades for treating retinal detachment: a novel silicone oil tamponade delivering improved surgical treatment of retinal detachments has been developed and commercialised, resulting in significant impacts on health and wellbeing. See [REF 2021 impact case for details](#). A new case is also in development with further, novel progress. *Contact: Mike Day*
- Blood brain barrier model for drug discovery and toxicology studies. Studying agro-chemicals with Syngenta. *Contact: Joe Forth – joint with Chemistry*
- Granulated microgels for accelerated wound-healing. *Contact: Joe Forth – joint with Chemistry*
- Magnetoencephalography using optically pumped magnetometer. Use includes test of brain function to identify source of epilepsy seizures. *Contact: Brianna Heazlewood.*

The Department believes that establishing a more coherent approach to medical physics-related activities while strengthening existing and establishing new collaborations, can open new avenues for funding and further develop our research portfolio; (early) diagnostic could be possible from various perspectives (devices and through AI/ML analyses of current data).

IMPACT ACTIVITIES AND KNOWLEDGE-EXCHANGE

Healthcare-related impact cases in progress: development of marketable instruments and approaches for: cancer diagnostics (*A novel infrared imaging instrument for early diagnosis of cancer – IP in place*) and treatment (*Novel Tissue Equivalent Phantom – IP in place*); digital radiography systems (*Medical Imaging*); treatment of eye diseases (*Improved Treatment of Retinal Detachments Using Novel Tamponade Agents – IP in place*). Partnerships include NHS, Micron Electronic, Adaptix Ltd, Clatterbridge Cancer Centre, Fluorom.

Commercialisation of novel devices: underpinning the long-standing expertise in particle and nuclear physics instrumentation at Liverpool, innovative detector devices are at the core of two cases, based on

germanium (*Gamma Camera Commercialisation*) and silicon (*Radiation-hard CMOS sensor – IP in dev.*) detector technologies, respectively. These are only marginally related to medical applications, but have still potential for further development. Partnerships include Mirion Technologies. Commercialisation and evidence collection might be too tight for this REF round and will depend on progress in 2025.

RELEVANT TRAINING PROGRAMMES AND PLANS

Post-graduate (PGR): The Department currently employs **122 (+5 part time) PhD students (census Jan 2025)**, supported by funding agencies (STFC DTP) and CDT programmes. Relevant projects on healthcare and medical physics are either self-supported or sponsored through

- STFC CDT [Big Data Science \(LIV DAT\)](#) (ended) [Innovation in Data Intensive Science \(LIV INNO\)](#) – **3 PhD projects** in progress (i.e. as particle / medical physics).
- Past programme: EU ITN [Medical Accelerators](#) (ended 2024)
- [SATURN CDT](#) (Nuclear skills, driven by University of Manchester) – renewed in September 2024.

CPD, PGT and plans for UG programmes: An NHS-commissioned programme led by the Department of Physics offers [PG provision](#) for the Clinical Sciences Training programme (STP) and radiometrics training taken by both MSc students and nuclear industry candidates. **About 120 students are registered on the programme.**

The Clinical Sciences (Medical Physics) and Clinical Sciences (Scientific Computing) are in place and only open to NHS staff. The programmes are described here: <https://nshcs.hee.nhs.uk/programmes/stp/> and the universities involved are detailed here: <https://nshcs.hee.nhs.uk/services/accreditation/list-of-accredited-higher-education-institutions/stp-academic-courses/>.

Plans include the introduction of a new Y4 module "Application of Physics in Medicine" and offer of MPHys in applications of physics to healthcare (goal of the across area group in the department). We also aim at maintaining the Medical Physics and Clinical Scientific Computing MSc programmes, possibly supported with the possibility of extending the provision to level 7 apprenticeships and adding a joint position or positions with the Clatterbridge Cancer Centre, funded from the PGT programmes.



Discussions with CHIL

- In May, met with Iain Buchan and team to discuss about synergies and opportunities between medical physics and CHIL - **Civic Health Innovation Labs**
 - <https://www.liverpool.ac.uk/civic-health-innovation-labs/>
CHIL aims to build a sustainable critical mass of research and innovation that tackles global health challenges and drives positive change for the people of the Liverpool City Region. Our approach cross-fertilises existing funded programmes and develops new initiatives that target key science and technology gaps health systems need to fill in order to innovate.
- Programmes include NIHR and others where connections and collaborations already exist. See more in <https://www.liverpool.ac.uk/civic-health-innovation-labs/research/programmes/>
- Follow-up on how technologies and innovations are introduced into the university through the Data Action Accelerator (DAA)
- **HOW-TO: organize a dedicated meeting with them?**



ILCAMS RESEARCH AWAY DAY

- Very detailed notes from Tim ☺

<https://hep.ph.liv.ac.uk/~green/MedPhys/ILCaMSresearchAwayday-130625.pdf>

INTRODUCTION

SCHEDULE OVERVIEW

10:00 Strategy and Resources

10:20 Departmental Research Presentations

11:35 Short break

11:50 Collaboration Sprint – Initial Connections

12:15 Faculty Research Presentations (HLS, S&E, HSS)

13:00 Lunch

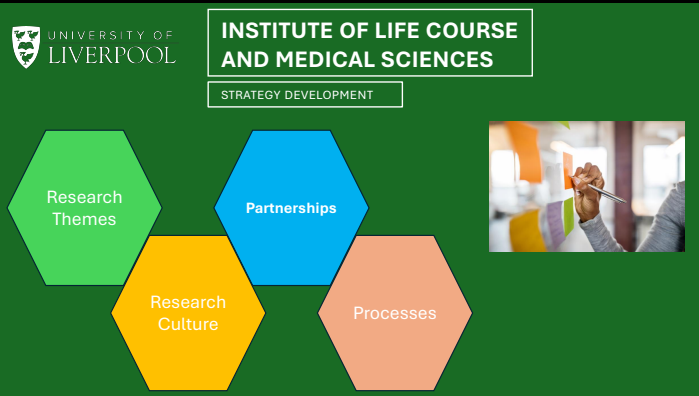
14:00 Large/interdisciplinary grant examples

15:00 Collaboration Sprint – Making Connections (ideas and opportunities)



liverpool.ac.uk | We are the original redbrick

Slides now posted in **TEAMS**
Several areas where we can collaborate
E.g. Large/interdisciplinary grants
See dedicated set of slides from Tim



INSTITUTE OF LIFE COURSE AND MEDICAL SCIENCES

Research Themes

Early life driving healthspan

Complex later-life diseases

Health inequalities

Microbiome and infection

Therapeutics

Musculoskeletal

Eye and Vision

Cardiovascular and metabolic

Women and children's health

Dentistry

Discovery science

Biomarkers

Tissue engineering and regenerative medicine

Biomechanics

Big data, multi-omics and AI

Clinical interventions

Health services delivery and care innovation

SDG 3. Good health and wellbeing

SDG 5. Gender equality


SDG 9. Industry, innovation and infrastructure

SDG 10. Reduced inequalities



ILCAMS RESEARCH AWAY DAY (2)

- Grants opportunities, as well as provided support also followed and documented



Communications, events and seminars

Health and Safety

Research Support

- Research Support Group (RSG)
- Funding Opportunities
- Pre-Award Application Process
- Post-Award Support
- Fellowships Support
- Research and Impact Strategy
- Research Integrity
- Research Idea Pitch Meetings
- Research Outputs Support

A - Z

EDIW within ILCAMS

Institute of Population Health (IPH)

Institute of Infection, Veterinary and Ecological Sciences (IVES)

Institute of Systems, Molecular and Integrative Biology (ISMIB)

Health and Safety

Equality, Diversity and Inclusion (EDI)

Research and Impact Strategy

Please find the ILCaMS Research and Impact Strategy.

- Grant opportunities
- Grant Submission - Pre-Award
- Peer Review
- Post Award Support
- Research Impact
- Research outputs support

<https://www.liverpool.ac.uk/intranet/health-and-life-sciences/ilcams/research-support/>

- Set joint MPHYS projects, for proof-of-concept
 - ideas include ML/AI applications on healthcare, but could also span on devices and diagnostic ?



Other items of interest

- Projects (PhD, MPhys, BSc)
- Routes to commercialisation – challenges and possibilities
- For today's meeting

12:30 → 12:50 Introduction - Medical Physics: summary from HLS Away Day and other news
Speakers: Prof. Laura Harkness (University of Liverpool), Monica D'Onofrio, Timothy Greenshaw (CTA)

🕒 20m 

12:50 → 13:05 PhD projects on-going - LDIR Wand group and HEP
Speakers: Dr James Ingham (University of Liverpool), Jon Taylor

🕒 15m 

13:05 → 13:20 Challenges towards commercialisation in medical physics
Speaker: Dr James Ingham (University of Liverpool)

🕒 15m 

13:25 → 13:35 Medical Physics and AI: AI NVIDIA day and ideas for projects
Speaker: John Anders

🕒 10m 

13:40 → 13:50 AI for healthcare: June event summary
Speakers: Alexander Hill (University of Liverpool), Carsten Welsch (University of Liverpool)

🕒 10m 

14:00 → 14:15 Introduction - AI/Data Science: Computing Collaboration Partnerships, EU initiatives and other opportunities
Speakers: Carsten Welsch (University of Liverpool), Monica D'Onofrio

🕒 15m 

14:20 → 14:30 PhD Project: Using machine learning for multipole magnet design
Speaker: Ms Sophie Gresty (University of Liverpool)

🕒 10m 

14:35 → 14:55 Discussion and next steps
ALL

🕒 20m 