Quantum Sensing in Predictive Health and Early Diagnosis Workshop

Innovate UK Business Connect **&** **National Physical Laboratory**

Matt Jones - Knowledge Transfer Manager Quantum
Cherie Burnett - Events Manager

Alex Jones - Senior Scientist
Ella Cross - Events Manager

10th October 2024

UKRI Innovate UK

NPL National Physical Laboratory

Session 1

Start	Finish	Activity	Presented by	Institution
09:30	09:40	UK Quantum Technologies Challenge	Dr Callum Stirling	Innovate UK
09:40	09:55	The Government's approach to quantum sensing in healthcare	Faiyaz Amin	Office for Quantum DSIT
09:55	10:10	Quantum Technologies for Life Sciences and Health	Dr Alex Jones	National Physical Laboratory
10:10	10:25		Professor Rachel McKendry	QBioMed Hub
10:25	11:10	UK National Quantum Technologies Programme Activities Discussion	-	-
11:10	11:40	Break	-	-

UKRI Innovate UK

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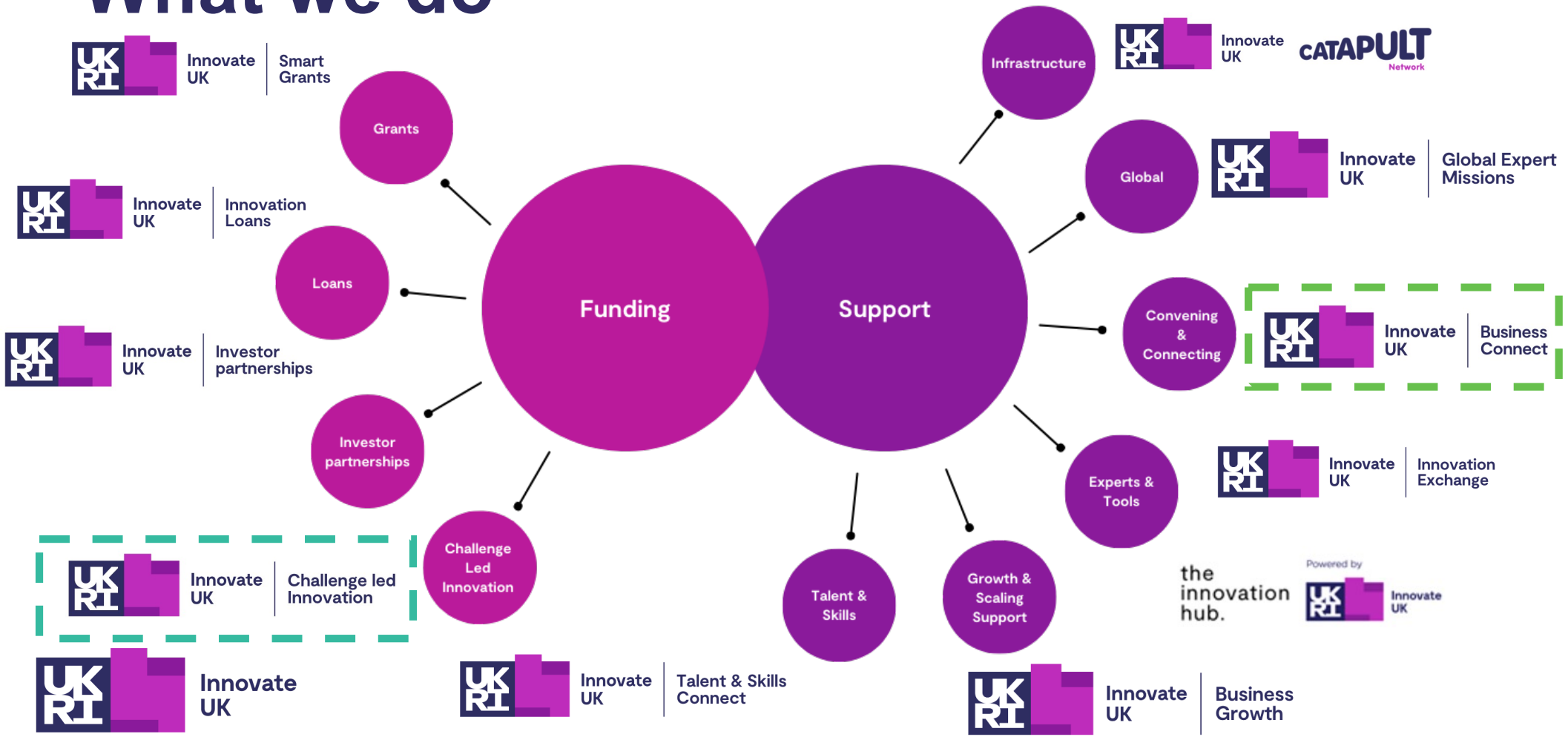
Quantum Sensing in Health

NQTP Activities – UK Quantum Technologies Challenge

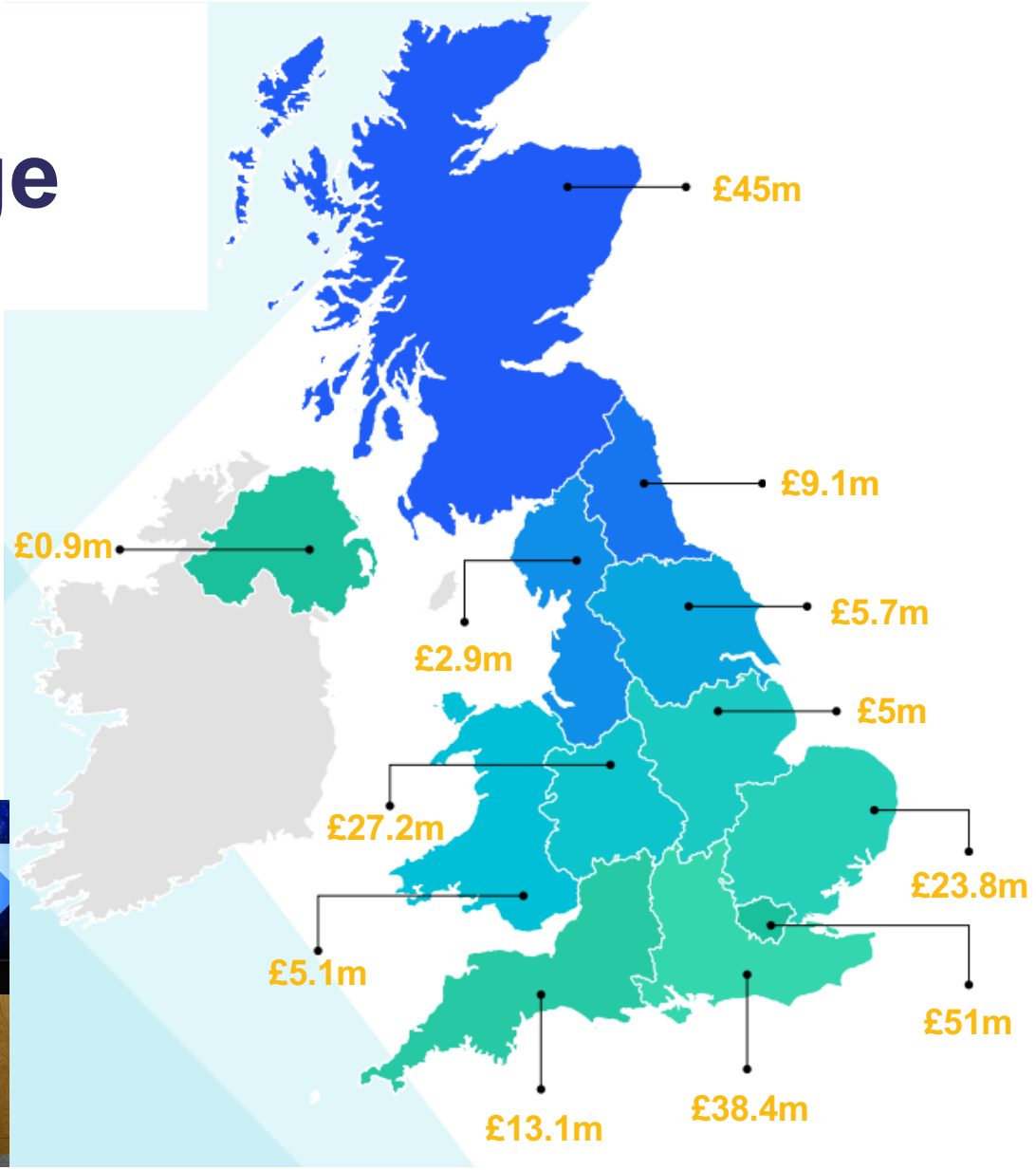
Callum Stirling, Innovation Lead – Quantum Technologies
10th October 2024

What we do


Innovate UK | Smart Grants
Grants
Innovate UK | Innovation Loans
Loans
Innovate UK | Investor partnerships
Investor partnerships
Innovate UK | Challenge led Innovation
Challenge Led Innovation
Innovate UK
Funding
Support
Infrastructure
Innovate UK CATAPULT Network
Global
Innovate UK | Global Expert Missions
Convening & Connecting
Innovate UK | Business Connect
Experts & Tools
Innovate UK | Innovation Exchange
the innovation hub. Powered by Innovate UK
Talent & Skills
Innovate UK | Talent & Skills Connect
Growth & Scaling Support
Innovate UK | Business Growth

Quantum Challenge

- Part of NQTP, started in 2018
- SMEs to large corporates, with RTOs & universities
- Products & services onto market
- Catalysing investment



Innovate UK

Quantum Challenge

£263m grants & contracts

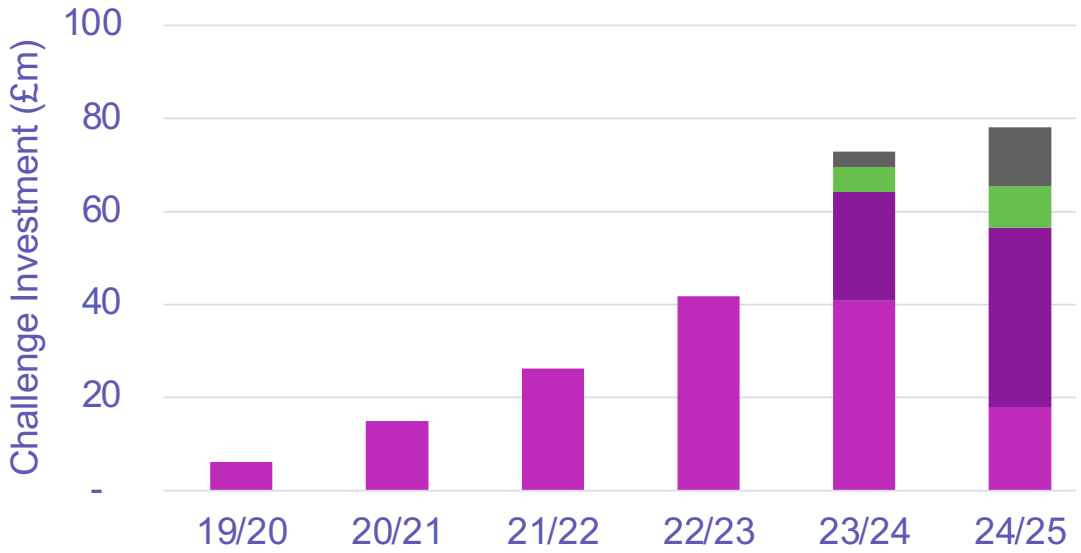
£337m of project activity

Approx. 200 collaborating organisations

£693m of investment raised

Innovate UK

Quantum Challenge



- Accelerated investment into growing a competitive UK industrial ecosystem.
- Targets industrialisation, supply chain development, and adoption.
- Continued industrialisation will to be central to National Quantum Strategy.

ISCF W3 (£163m)

TMF (£63m)

Catalyst Fund (£15m)

Quantum Networks (£10m)

National Quantum Strategy (£2.5bn)

Innovate UK

Diverse Quantum Ecosystem

- Imaging
- Sensing (magnetic)
- Materials companies (e.g. diamond)
- Components, equipment, systems and services
- New players, incl. start-ups & spin-outs
- “Just add quantum”: established players with existing products, incl. scale-ups and industrial giants
- Other quantum technologies: computing, privacy & security

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Projects

- Quantum technology enabled blood diagnostics for patient centric cancer care & treatment
- Quantum dots attached to cancer cells
- Brain Imaging Using OPM-MEG
- Transforming tissue differentiation via quantum digital tomosynthesis
- Quantum diamond magnetometry for magnetocardiography
- Developing operational healthcare applications using quantum computing techniques

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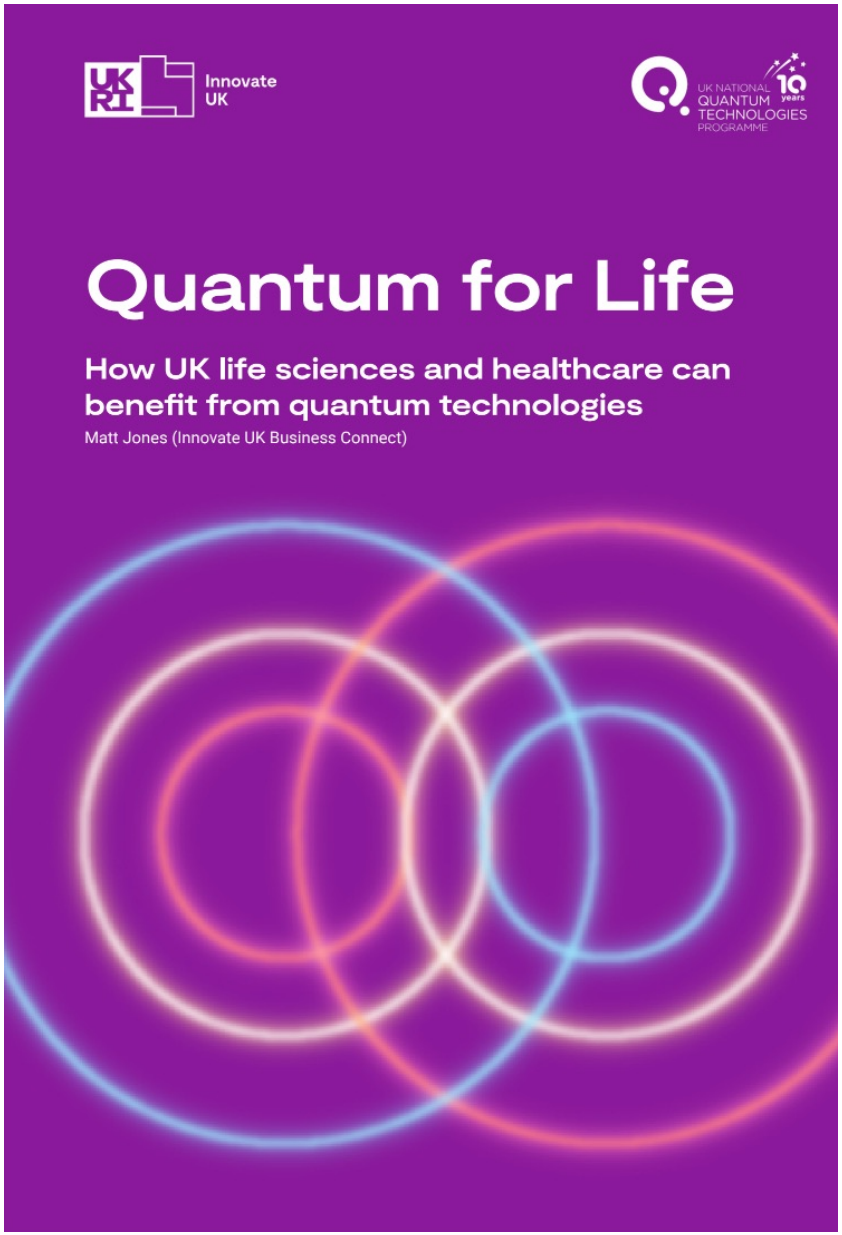
Find out more…

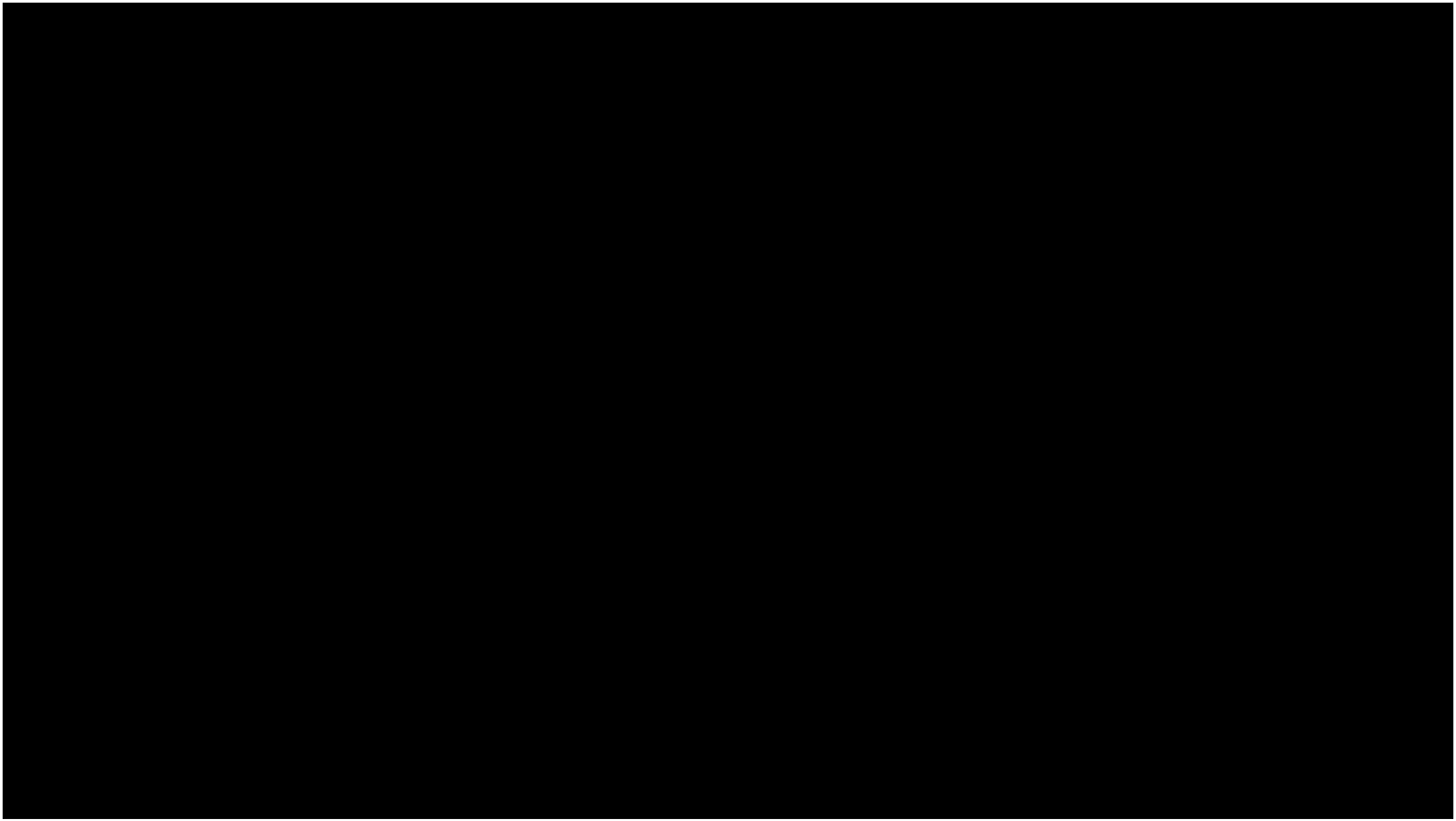
Innovate UK

Quantum for Life report

- For those in healthcare & life sciences
- Applications of Quantum Technologies
  - Diagnosis & monitoring
  - Optimising healthcare environments
  - Simulating novel drugs
  - Securing patient information
- Capabilities, current & future
- Contact: Matt Jones

Access it here

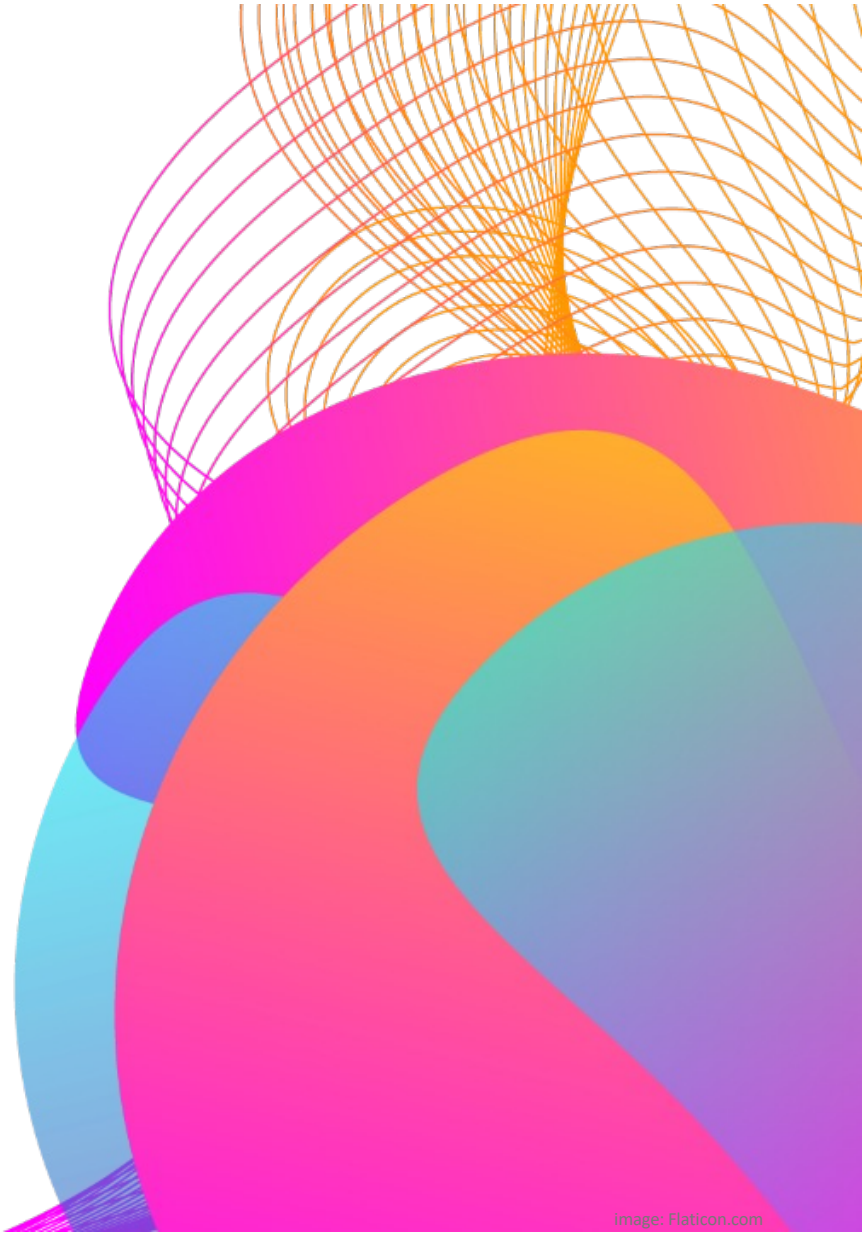




Department for Science, Innovation & Technology

The Government's approach to quantum sensing in healthcare

Faiyaz Amin – Office for Quantum (Department for Science Innovation and Technology)



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QUANTUM SPANS THREE GROUPS OF TECHNOLOGIES. ALL ARE EXPECTED TO HAVE SIGNIFICANT CROSS-SECTOR IMPACTS OVER THE NEXT DECADE.

Technology	Value	Maturity	Example of UK Case Studies	
Quantum computing Solve problems that even the most powerful classical computers cannot	$450-850 bn in the next 10-15 years*	10+ years until deployed at scale	**UK company developing quantum algorithms for solving net-zero challenges** Phasecraft are developing quantum computing applications to **tackle optimisation problems in energy grid planning**, and **model new materials**	
Quantum communications More secure communications	$8bn by 2030**	5-10 years until deployed at scale	**World's first commercial trial of a quantum secured communications network** **BT, Toshiba, EY** launched a world first quantum-secured network in London connecting customers with **secure transmission of valuable data**	
Quantum sensing Exponentially more powerful sensors	$5bn by 2030**	5-10 years until deployed at scale	**Wearable brain scanner with better sensitivity and lower cost** **Cerca Magnetics** is developing wearable brain scanners that promise a more accurate and accessible **diagnosis of neurological conditions**	

* Boston Consulting Group, July 2021, "What Happens When 'If' Turns to 'When' in Quantum Computing?
** McKinsey & Company, December 2021

Department for Science, Innovation & Technology

Programme Overview
UK National Quantum Technologies Programme

The story so far: £1.1bn National Programme

Department for Science, Innovation & Technology

Research

- **Centres of excellence:** building regional strengths through the hubs network
- **Unlocking new applications:** targeted research programmes

Innovation

- **Accelerating commercialisation:** Challenge programme involving 180+ UK companies
- **Driving public sector solutions:** through the Catalyst Fund

Infrastructure

- **National Quantum Computing Centre:** to accelerate scaling and readiness
- **Testing and assurance:** through the National Physical Laboratory

Skills

- **Developing, attracting and retaining talent:** through PhDs, fellowships and apprenticeships

UKRI Engineering and Physical Sciences Research Council · UKRI Innovate UK · UKRI Science and Technology Facilities Council · UKRI National Quantum Computing Centre · NPL · Ministry of Defence · dstl · GCHQ

The result: a world-leading ecosystem…

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World leading research and skills: 1st in Europe and 3rd in the world for the quality and impact of quantum research.

Thriving business community: 2nd for the number of quantum companies (11% of the world's quantum companies)

High-levels of private investment: 2nd in attracting private equity investment (12% of global private investment)

Broad capabilities: Quantum companies spanning computing, communications, sensing, timing, imaging, and the supply chain

...with real-world applications

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Reducing industrial emissions

QLM are using lidar to autonomously detect and measure methane emissions.

Resilient flight navigation

Infleqtion completed test flights with quantum-based navigation offering accuracy and resilience to satellite disruption.

Transforming brain scanning

Cerca's wearable brain scanner trialled in hospitals and is deepening our understanding of brain developments


Department for
Science, Innovation
& Technology
UK National Quantum Strategy

FOUR GOALS, FIVE MISSIONS

Department for Science, Innovation & Technology

- Ensure the UK is home to world-leading quantum science and engineering
- Make the UK the go-to place for quantum businesses
- Drive the use of quantum technologies in the UK to benefit the economy, society and security
- Create a national and international regulatory framework that supports innovation and the ethical use of quantum

By 2035 UK-based quantum computers capable of running 1 trillion operations that provide benefits well in excess of classical supercomputers

By 2035, the UK will have deployed the world's most advanced quantum network at scale, pioneering the future quantum internet.

By 2030, every NHS Trust will benefit from quantum sensing-enabled solutions through early diagnosis and treatment, helping people live healthier, longer lives

By 2030, quantum navigation systems, including clocks, will be deployed on aircraft, providing independent next-generation accuracy for resilience

By 2030, mobile, networked quantum sensors will have unlocked new situational awareness capabilities, exploited across critical infrastructure

KEY AREAS OF FOCUS

Department for Science, Innovation & Technology

R&D & Skills

Announcement of new Hubs and Centres for Doctoral Training

Quantum skills taskforce progressing

Business Support

Industry engagement on quantum mission delivery

Adoption

End-user awareness & sector adoption plans

Regulation

Delivery of recommendations from quantum Regulatory Horizons Council report

International Partnerships

Delivering key international agreements and activity

Quantum Missions

Bring together the UK community to innovate and achieve key milestones

Clear and measurable outcomes that tackle major societal challenges

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Mission 3: Quantum sensing for health

Mission 3 benefits

Department for Science, Innovation & Technology

"By 2030, every NHS Trust will benefit from quantum sensing-enabled solutions, helping those with chronic illness live healthier, longer lives through early diagnosis and treatment."

Addressing major conditions: Particularly those that are set out in the DHSC Major Conditions Strategy

Earlier diagnosis and treatment: From the improved analytical sensitivity of quantum sensors

Efficiency: Especially where quantum enhanced imaging or in vitro diagnostic tests can free up hospital capacity

Personalised medicine: Improving diversity of options that cater to individual circumstances or biomarkers

We have heard a heard a range of challenges

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- Lack of interdisciplinary research and poor understanding of end user requirements
- Challenges in the regulatory and adoption pathway
- Barriers to spin out and commercialisation
- Manufacturing capability and other cross-cutting challenges

UKRI Engineering and Physical Sciences Research Council · UKRI Innovate UK · UKRI Science and Technology Facilities Council · UKRI National Quantum Computing Centre · NPL · Ministry of Defence · dstl · GCHQ

Department for Science, Innovation & Technology

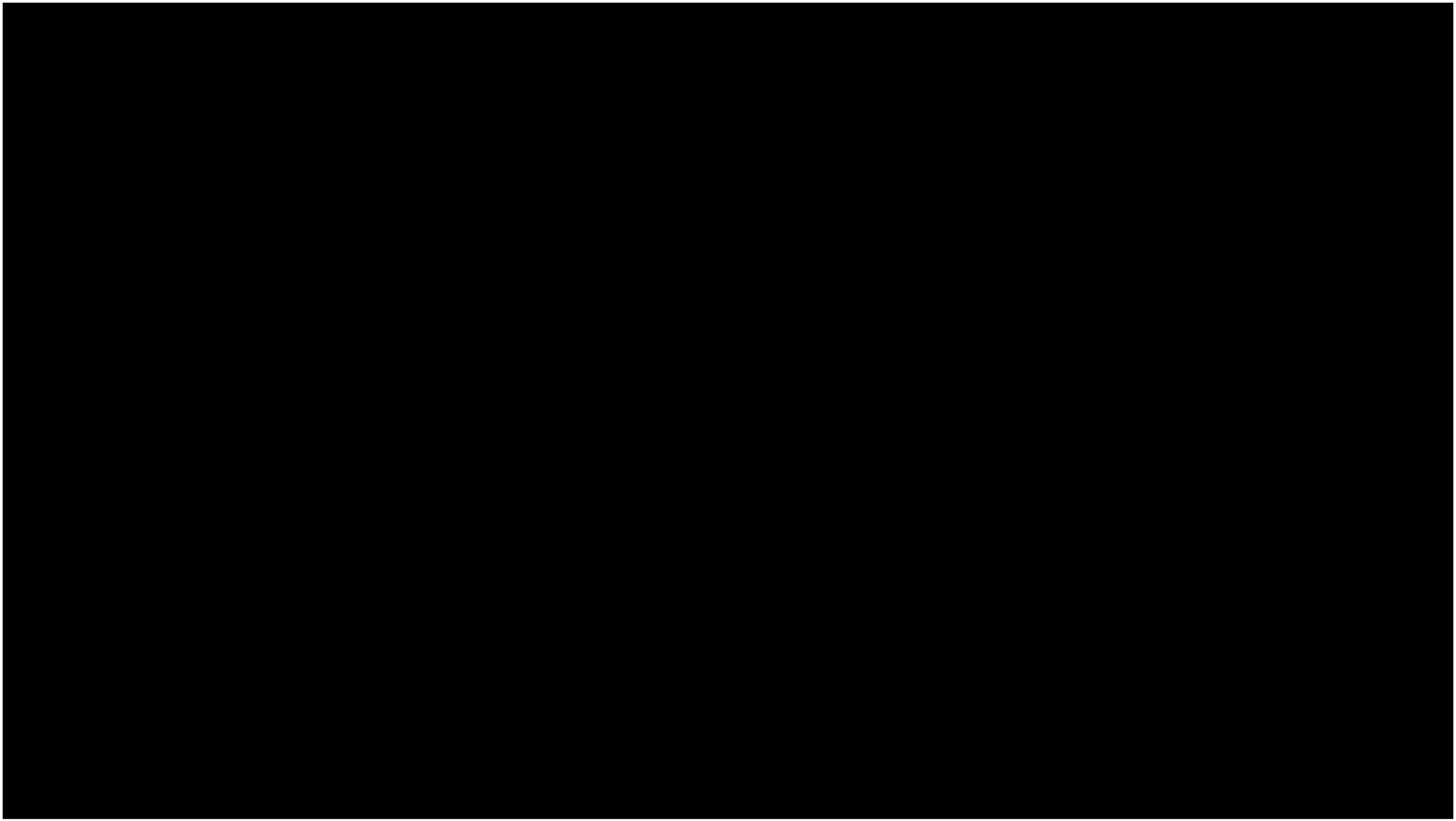
NEXT STEPS

Mission delivery plan – We are preparing detailed Mission delivery plans, including road mapping and infrastructure requirements.

- Get in touch with me or via **ofqenquiries**@dsit.gov.uk to feedback on the shape of mission delivery.

Spending review – OfQ & DSIT are involved in the current SR planning process to enable the next phase of the programme.

- Budgets for 25-26 expected by early 2025, with full multiyear plans confirmed by the summer

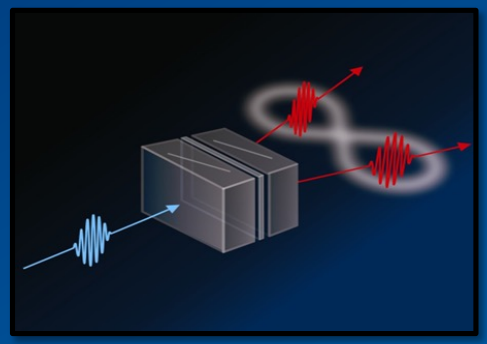


The National Physical Laboratory

NPL

- **The** UK's National Metrology Institute
  - **Metrology** is the **science of measurement**
- Since 1900 NPL has maintained the nation's primary measurement standards
  - These standards **ensure accuracy and consistency** of measurement across the UK and the world
- NPL:
  - Studies measurement **uncertainty**
  - Designs and develops **new measurement technologies**
  - Provides measurement **service**

NPL
National Physical Laboratory



Quantum Technologies for Life Sciences and Health

Alex R. Jones

Principal Scientist, Biometrology

National Physical Laboratory

National Quantum Strategy

- **Building on strong foundations / UK strengths**
  - **Life Sciences** identified as a key user sector / "critical for … **healthcare**"
- **Enabling quantum technologies**
  - "increase resilience, …, productivity, and competitiveness across critical sectors [like] **health**…"
- **Goal 3: Driving the adoption of QTech in the UK**
  - "where quantum will deliver the most value for the UK" include **health** and **engineering biology**
  - "drive early adoption in key sectors such as … **life sciences**"
  - "UK as a world leader in **health** and **life sciences**… **better, cheaper imaging**"
  - "Supporting other UK priority technologies…This includes…**health**…"
  - Accelerate the … National Quntum Computing Centre SparQ Applications Discovery programme, with specific workstreams … within the … **healthcare sector**…"
- **Conclusions**
  - "…benefits and opportunities of QTech are vast and will offer advantages in meeting our… **health**… aims"

QTech for Life Sciences and Health

NPL

1. Sensing

2. Communications

3. Computing

Mixing Metaphors…

1. Sensing

2. Communications

3. Computing

NPL Workshop, Bushy House, 18-19 June ‘24

Committee: Prof. Ian Gilmore, Prof. Alexandra Olaya-Castro, Prof. Ivette Fuentes-Guridi, Prof. Sir Peter Knight

Universities: UCL, Southampton, Oxford, Nottingham, Edinburgh, York, Bristol, Imperial, Helsinki, Ulm, Cambridge, Glasgow, Dundee

NPL Workshop, Bushy House, 18-19 June ‘24

1. Quantum Computing
2. Advanced Technologies for Life Sciences and Health
3. Quantum Metrology
4. Quantum Sensing

NPL Workshop, Bushy House, 18-19 June ‘24

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THE UK QUANTUM BIOMEDICAL SENSING RESEARCH HUB

UK Quantum Technology Hub Sensors and Timing

1. Quantum Computing
2. Advanced Technologies for Life Sciences and Health
3. Quantum Metrology
4. Quantum Sensing

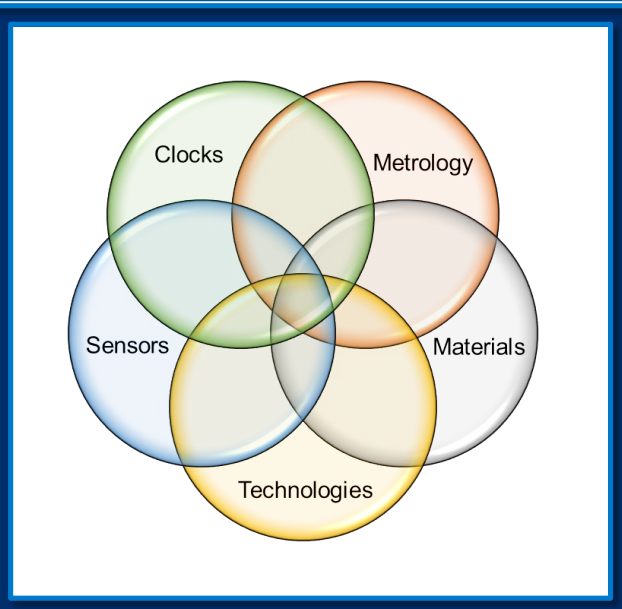
Some take-home messages

- **Quantum computing**
  - Promise: better scaling, drug outliers, expressivity, “complete” solutions, energy, investment,…
  - Challenges: speed, data quality, non-linearity, algorithm development,…
  - **“Years of basic research required…” Anon., 2024**
- **Adoption of**
  - 1. Regula
  - Challenge
- **Metrology**
  - Standards
  - **All vital for successful adoption**
- **Sensing**
  - Quantum light; single photon detection; nanodiamond; optically-pumped magnetometry;…
  - **Happening now**

“By 2030, **every NHS Trust** will benefit from **quantum sensing**-enabled solutions, helping those with chronic illness live healthier, longer lives through early diagnosis and treatment.”

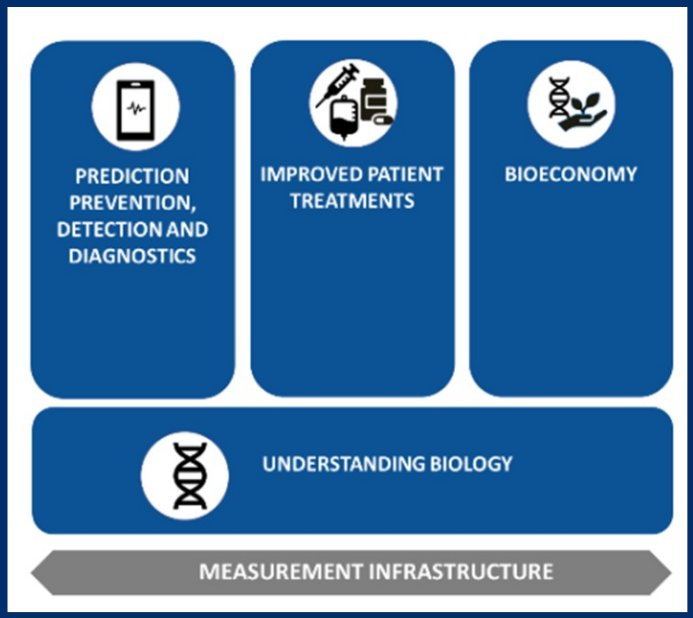
NPL Quantum Programme

- Building quantum measurement facilities and infrastructure supporting innovation across the UK, plus research, standards, access, skills.
- Projects aligned with the quantum technology hubs
- Quantum product development projects led by industry
- Quantum technology for fundamental physics



NPL

NPL Life Sciences and Health



And addressing national health challenges

NPL
National Physical Laboratory

Get 20 days of quantum consultancy, at no charge*

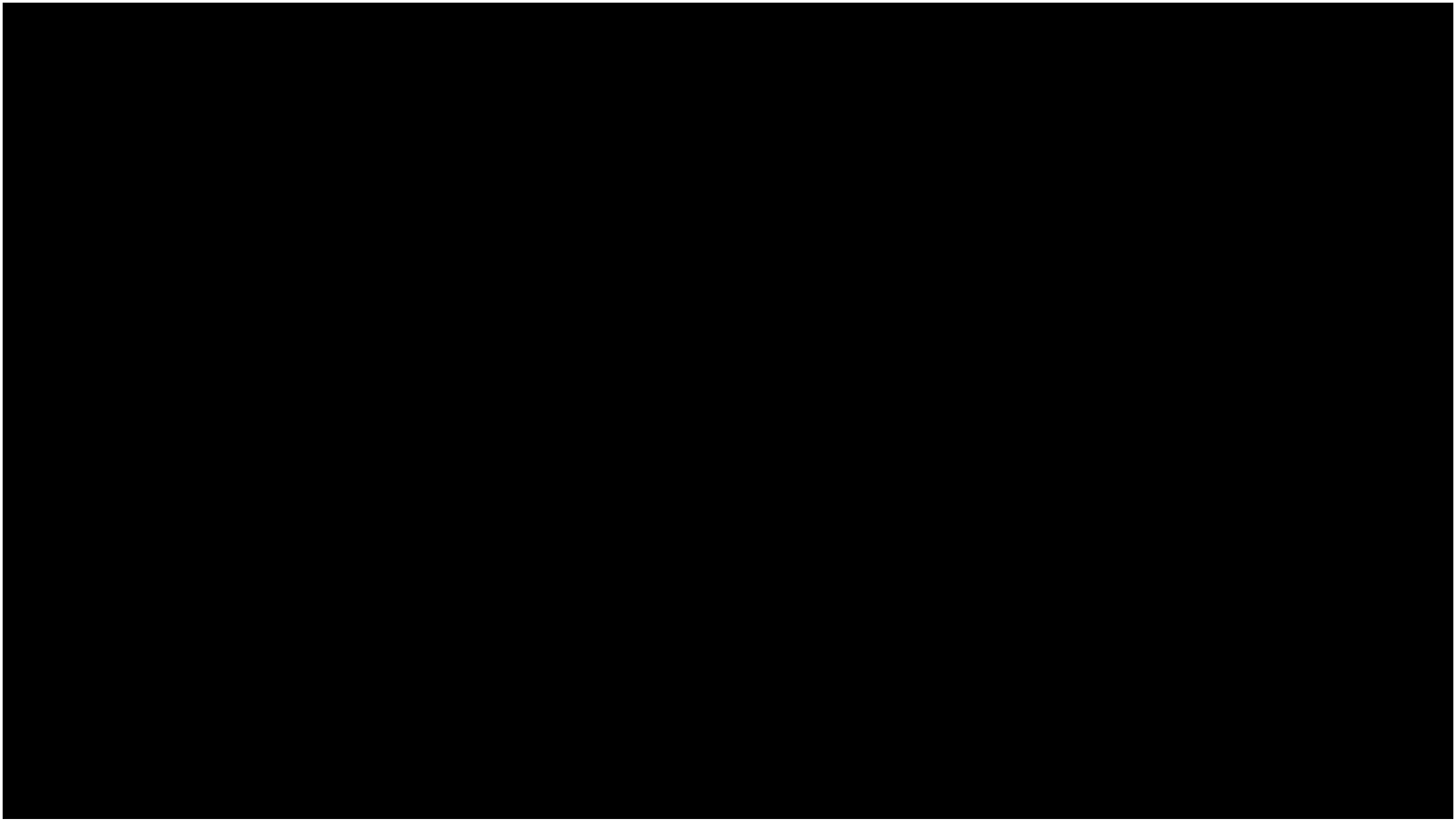
Could your business benefit from quantum measurement expertise?
The National Physical Laboratory's (NPL) Measurement for Quantum (M4Q) programme provides up to 20 days of specialist support at no charge*.

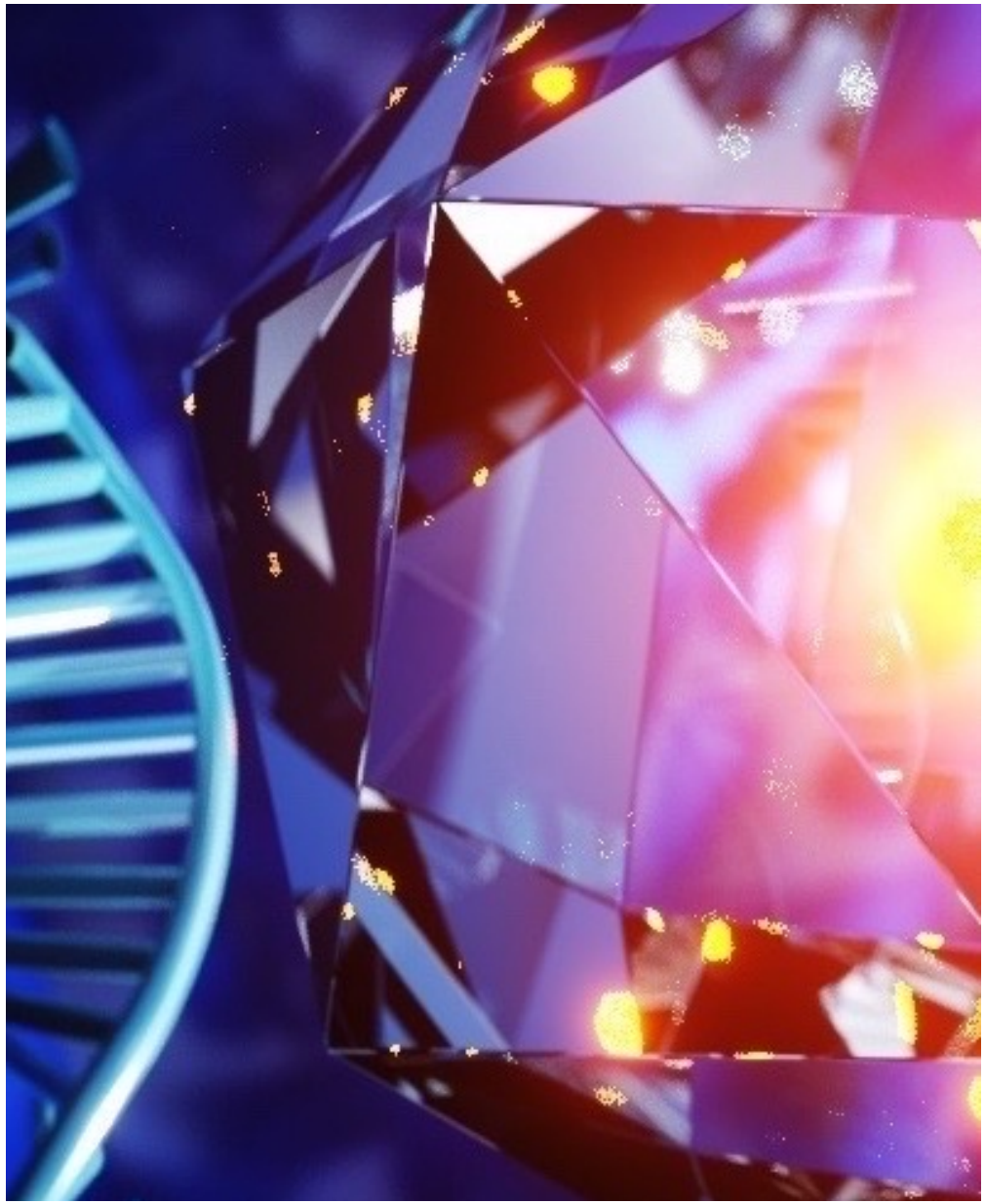
Learn how M4Q can help your business innovation challenges:

www.npl.co.uk/measurement-for-quantum

*Eligibility criteria applies. See website for full terms and conditions.

npl.co.uk





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UK Quantum Biomedical Sensing Research Hub

Professor Rachel McKendry
London Centre for Nanotechnology
and Division of Medicine UCL

Quantum Sensing in Predictive Health and Early Diagnosis Workshop
10th October 2024

1) Introduction: Prof. Rachel McKendry

Professor Biomedicine and Nanotechnology UCL
Prev. BSc and PhD Chemistry Durham Cambridge
Junior Research Fellow Cambridge, IBM Zurich

London Centre for Nanotechnology
UCL, Imperial & Kings College

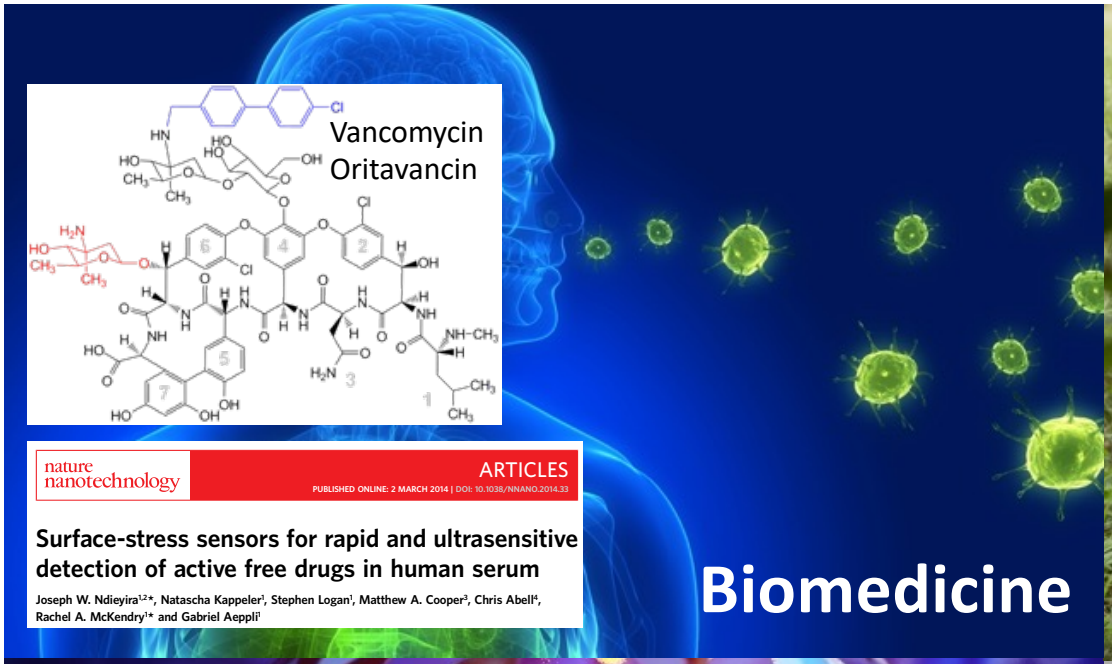
Division of Medicine UCL

Email: r.a.mckendry@ucl.ac.uk

Brief Introduction: McKendry group@UCL

£20M i-sense EPSRC IRC in Early Warning Systems for Infectious Diseases and AMR (2023-24)
£5M EPSRC Digital Health Hub for AMR: https://www.digitalamr.org
£24M Q-BIOMED Hub (starts Dec 2024): https://www.qbiomed.org.uk

Collaborations; academic, clinical, public health and industry partners, including UCL, Imperial, Oxford, Cambridge, UCLA, Johns Hopkins, the NHS, UCLH, GOSH, Public Health England/ UK Health Security Agency, Africa Health Research Institute, Uganda Virus Research Institute, CESHHAR Zimbabwe, icddr,b, Google and Microsoft



nature nanotechnology

ARTICLES

PUBLISHED ONLINE: 2 MARCH 2014 | DOI: 10.1038/NNANO.2014.33

Surface-stress sensors for rapid and ultrasensitive detection of active free drugs in human serum

Joseph W. Ndieyira[1,2]*, Natascha Kappeler[1], Stephen Logan[1], Matthew A. Cooper[3], Chris Abell[4], Rachel A. McKendry[1]* and Gabriel Aeppli[1]

Biomedicine

nature medicine

LETTERS

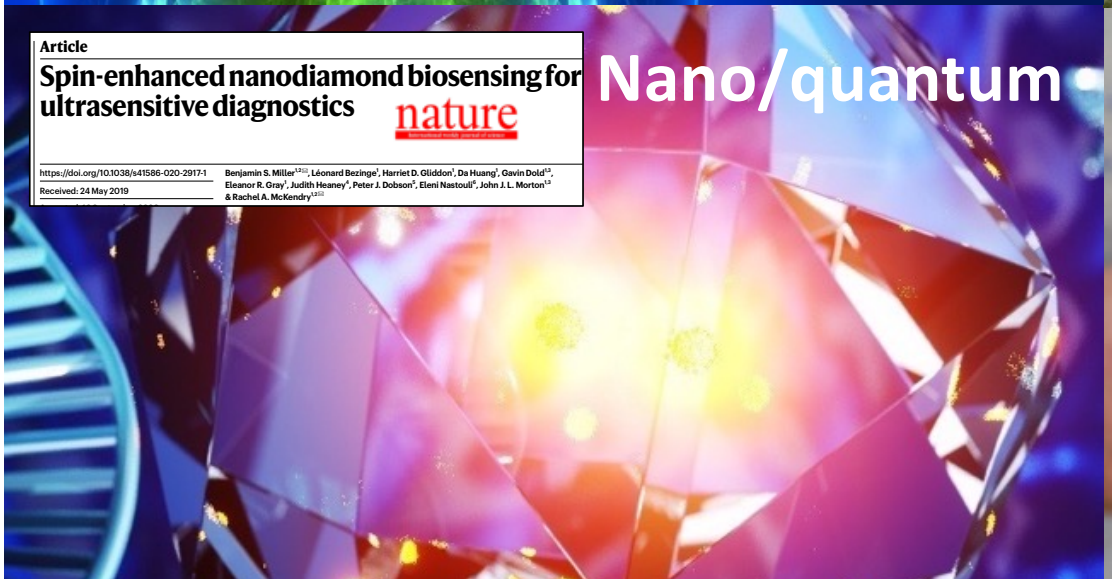
https://doi.org/10.1038/s41591-021-01384-9

Check for updates

Deep learning of HIV field-based rapid tests

Valérian Turbé[1,15], Carina Herbst[2], Thobeka Mngomezulu[2], Sepehr Meshkinfamfard[1], Nondumiso Dlamini[2], Thembani Mhlongo[2], Theresa Smit[2], Valeriia Cherepanova[3], Koki Shimada[3], Jobie Budd[1,4], Nestor Arsenov[5], Steven Gray[5], Deenan Pillay[3,6], Kobus Herbst[2,7] ✉, Maryam Shahmanesh[2,8] ✉ and Rachel A. McKendry[1,4] ✉

Global health



Article

Spin-enhanced nanodiamond biosensing for ultrasensitive diagnostics

nature

https://doi.org/10.1038/s41586-020-2917-1

Received: 24 May 2019

Benjamin S. Miller[1,2] ✉, Léonard Bezinge[1], Harriet D. Gliddon[1], Da Huang[1], Gavin Dold[1,3], Eleanor R. Gray[1], Judith Heaney[4], Peter J. Dobson[5], Eleni Nastouli[6], John J. L. Morton[1,3] & Rachel A. McKendry[1,2] ✉

Nano/quantum

nature medicine

REVIEW ARTICLE

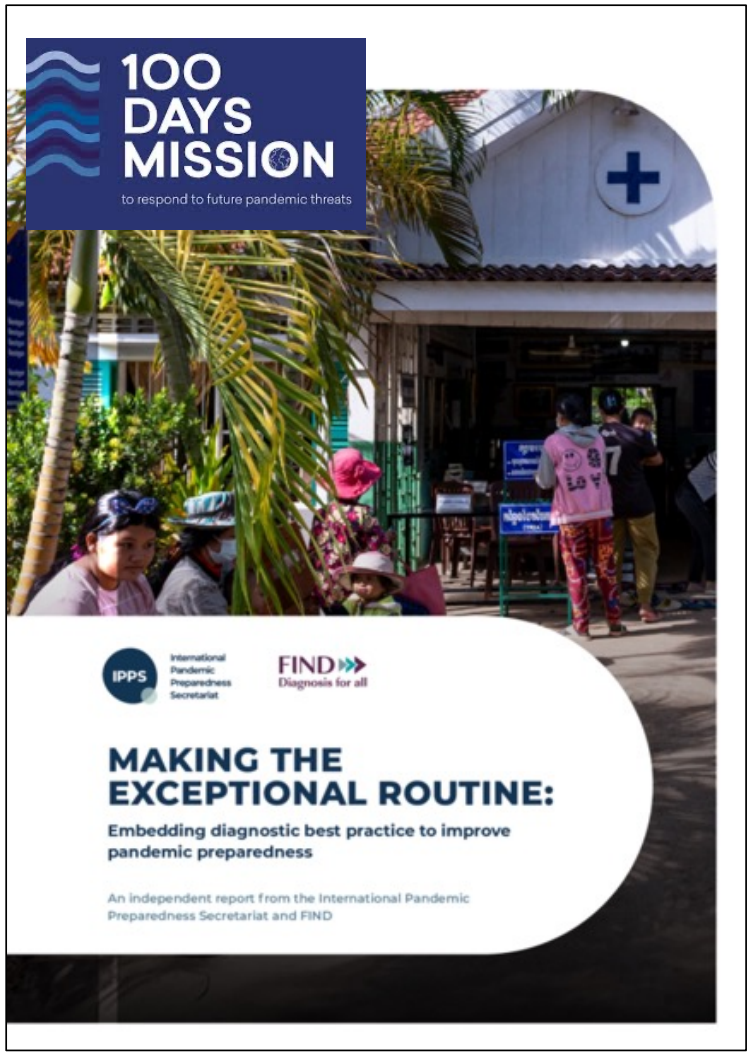
https://doi.org/10.1038/s41591-020-1011-4

Check for updates

Digital technologies in the public-health response to COVID-19

Jobie Budd[1,2], Benjamin S. Miller[1], Erin M. Manning[1], Vasileios Lampos[3], Mengdie Zhuang[4], Michael Edelstein[5], Geraint Rees[6], Vincent C. Emery[7], Molly M. Stevens[8], Neil Keegan[9], Michael J. Short[10], Deenan Pillay[11], Ed Manley[12], Ingemar J. Cox[3,13], David Heymann[14], Anne M. Johnson[15] and Rachel A. McKendry[1,2] ✉

Digital health



Policy Roles:

UK National Quantum Technologies Programme Quantum Mission for Health Working Group

WHO Public Health Research Agenda for Influenza 2024

100 Days Mission Scientific and Technical Advisory Board Diagnostic Implementation Report

Chaired Advisory Group to UKHSA NBN Programme

Co-lead Digital Health Theme of Topol Review

Cross council Steering Committee on AMR

Quantum for health

MRI

LASERS

SQUID-MEG

New wave quantum technologies
powered by ability to access individual quantum systems
– such as single atoms, photons and other coherent effects.

The future of healthcare

EARLY DIAGNOSIS & PRECISION MEDICINE

COMMUNITY CARE

PREVENTION

Department of Health & Social Care

Independent report

Summary letter from Lord Darzi to the Secretary of State for Health and Social Care

Updated 25 September 2024

"I would love to see a world in my lifetime in which no antibiotic could be prescribed without a diagnostic test and that diagnostic test has to be quick and available"

Lord Darzi, Executive Chair of the Fleming Initiative September 2024

The Kings Fund

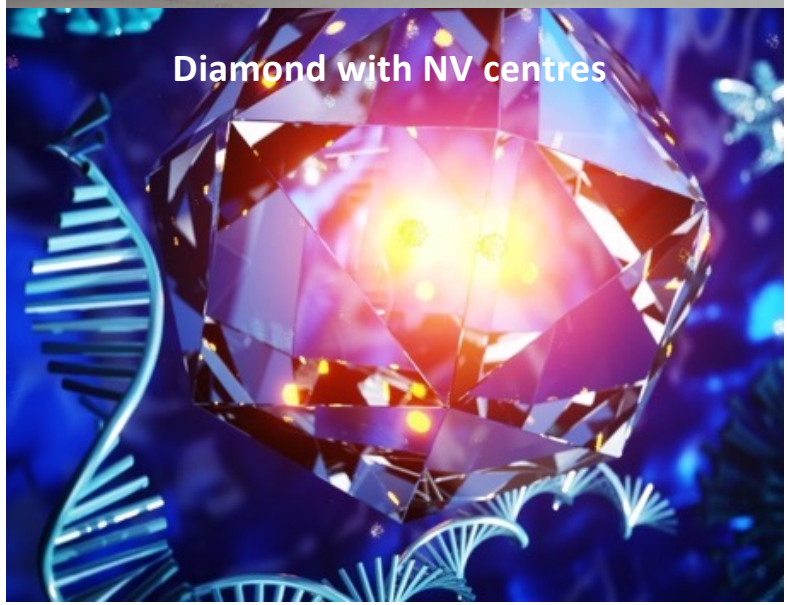
“Diagnostics are tests or procedures used to identify a person’s disease or condition.

Finding out what is wrong with someone is vital to treating them

more than 85% of people seeking NHS care require diagnostics.

Prompt diagnosis can save lives
Early diagnosis of cancer substantially improves survival rates, for example **saves time and money, and avoids worsening patient outcomes**.

Diagnostics also have an important role to play in **preventive health** by improving early detection of illness”



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Emerging new quantum sensors

Quantum sensors have the potential for many advantages over classical sensors:

- Greater sensitivity – orders of magnitude
- Size, spatial and temporal resolution
- Complex backgrounds
- Lighter and more portable
- Energy-efficient
- Cost-effective

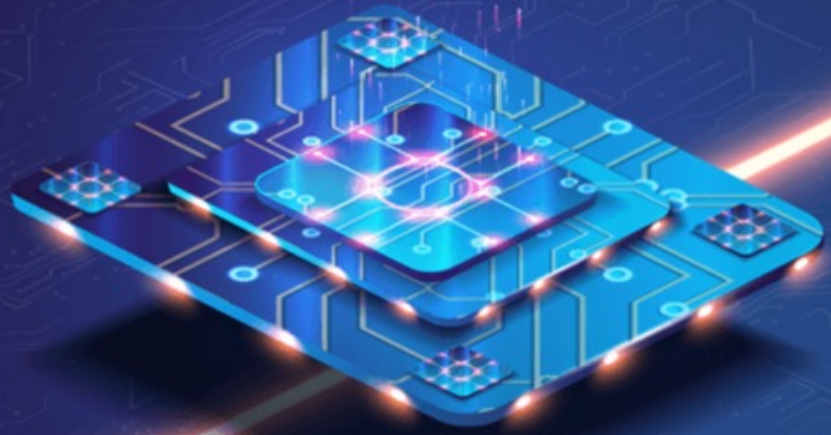
nature reviews physics
https://doi.org/10.1038/s42254-023-00558-3
Review article
Check for updates

Quantum sensors for biomedical applications

Nabeel Aslam[1,2,3], Hengyun Zhou[1], Elana K. Urbach[1], Matthew J. Turner[4,5], Ronald L. Walsworth[4,5,6], Mikhail D. Lukin[1] & Hongkun Park[1,2]

Transforming the world with quantum technology

UK NATIONAL QUANTUM TECHNOLOGIES PROGRAMME



Our achievements so far

470+ **PhD candidates** supported

14 **Fellowships** funded, with more due in 2022

120+ **Hub industrial partners**

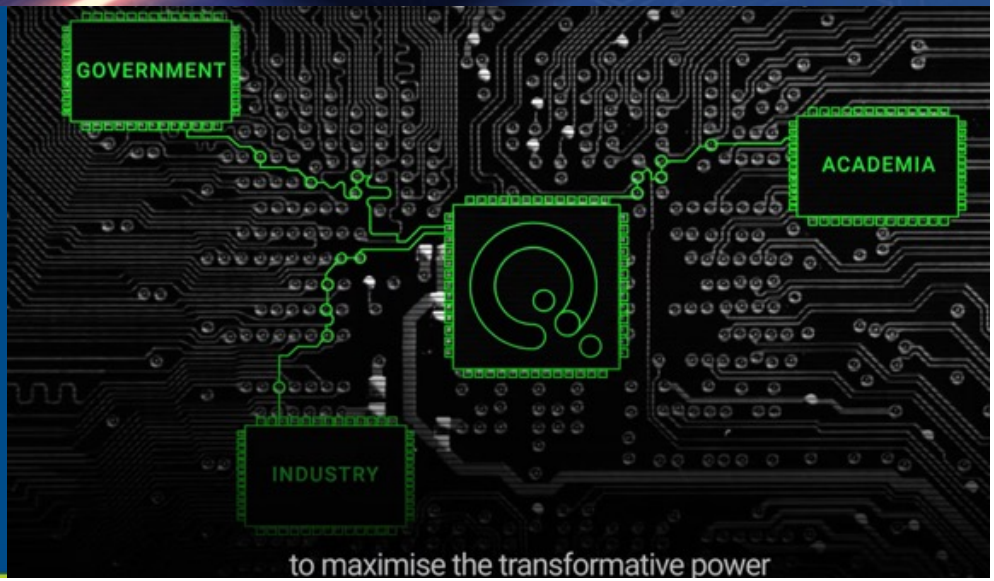
49 **Start-ups** generated

£147m awarded to the **Industrial Strategy Challenge Fund**

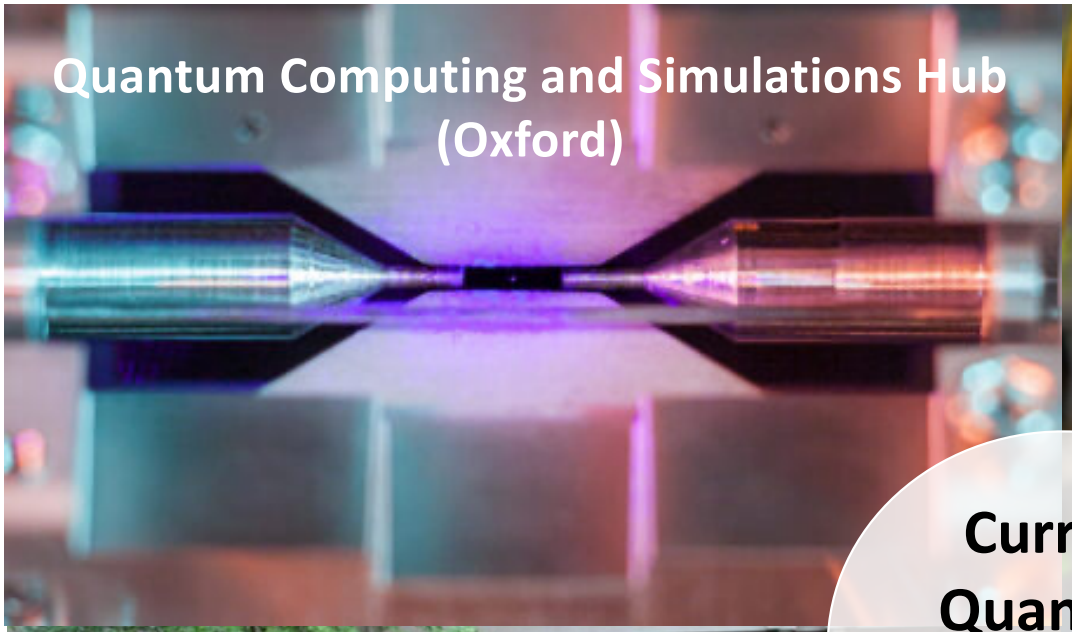
£93m invested in the **National Quantum Computing Centre**

£214m invested in **Quantum Technology Hubs**

£40m of **Quantum Technology for Fundamental Physics** projects funded

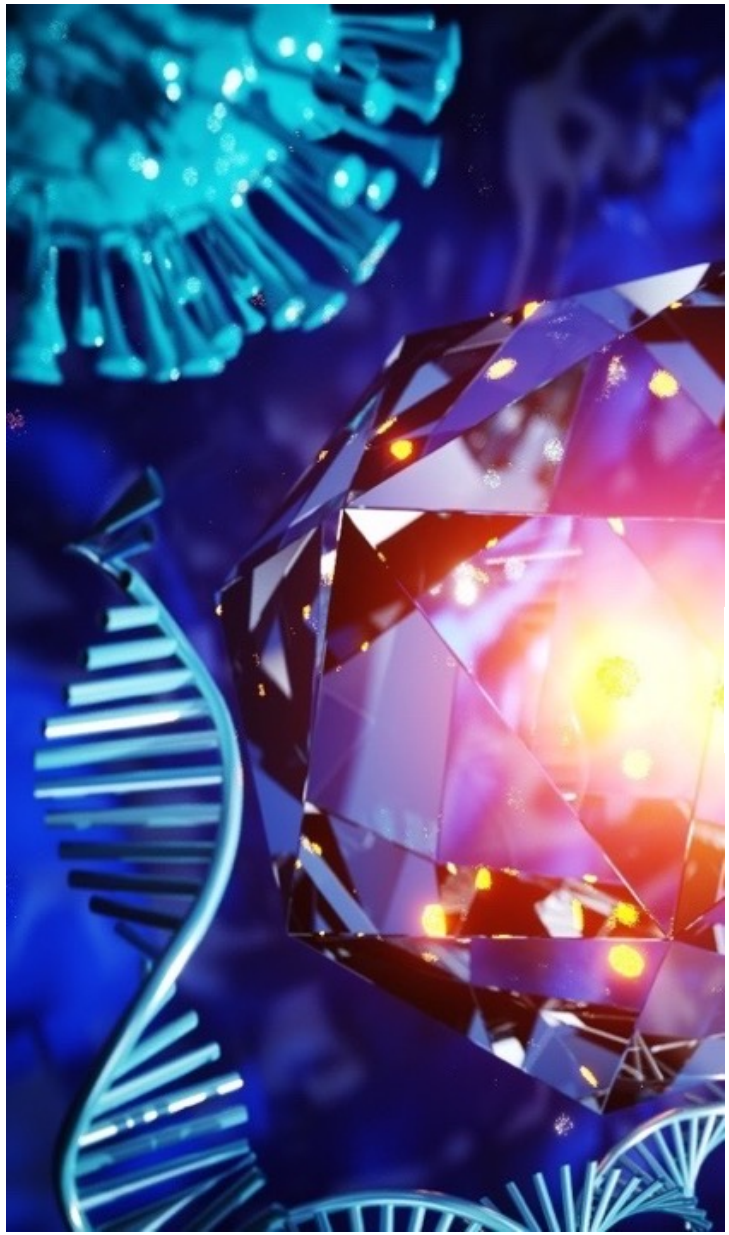


to maximise the transformative power



Current Quantum Technology Hubs

Healthcare, energy, transport, civil engineering, manufacturing, defence, gravity sensors for surveying, quantum clocks for global navigation satellite systems



Q-BIOMED

THE UK QUANTUM BIOMEDICAL SENSING RESEARCH HUB

Delivering the quantum-enabled future of early disease diagnosis and treatment

UKRI Engineering and Physical Sciences Research Council

NHS National Institute for Health Research

UCL | University of Cambridge | University of Oxford | Warwick | Heriot-Watt University | Cardiff University / Prifysgol Caerdydd

NIHR | University College London Hospitals Biomedical Research Centre

NIHR | Great Ormond Street Hospital Clinical Research Facility

NIHR | Barts Biomedical Research Centre

NIHR | Moorfields Biomedical Research Centre

NIHR | Barts Biomedical Research Centre

NHS The Royal Orthopaedic Hospital NHS Foundation Trust

Addenbrooke's NHS Trust

Cancer Research UK

Alzheimer's Society

AHRI Africa Health Research Institute

Other partners: 17 industry, government, regulators, standards

Call opened January 2023; July 2024 £24M funding announced (2024-29)

Policy paper

National Quantum Strategy Missions

Updated 14 December 2023

Mission 1 Quantum Computers

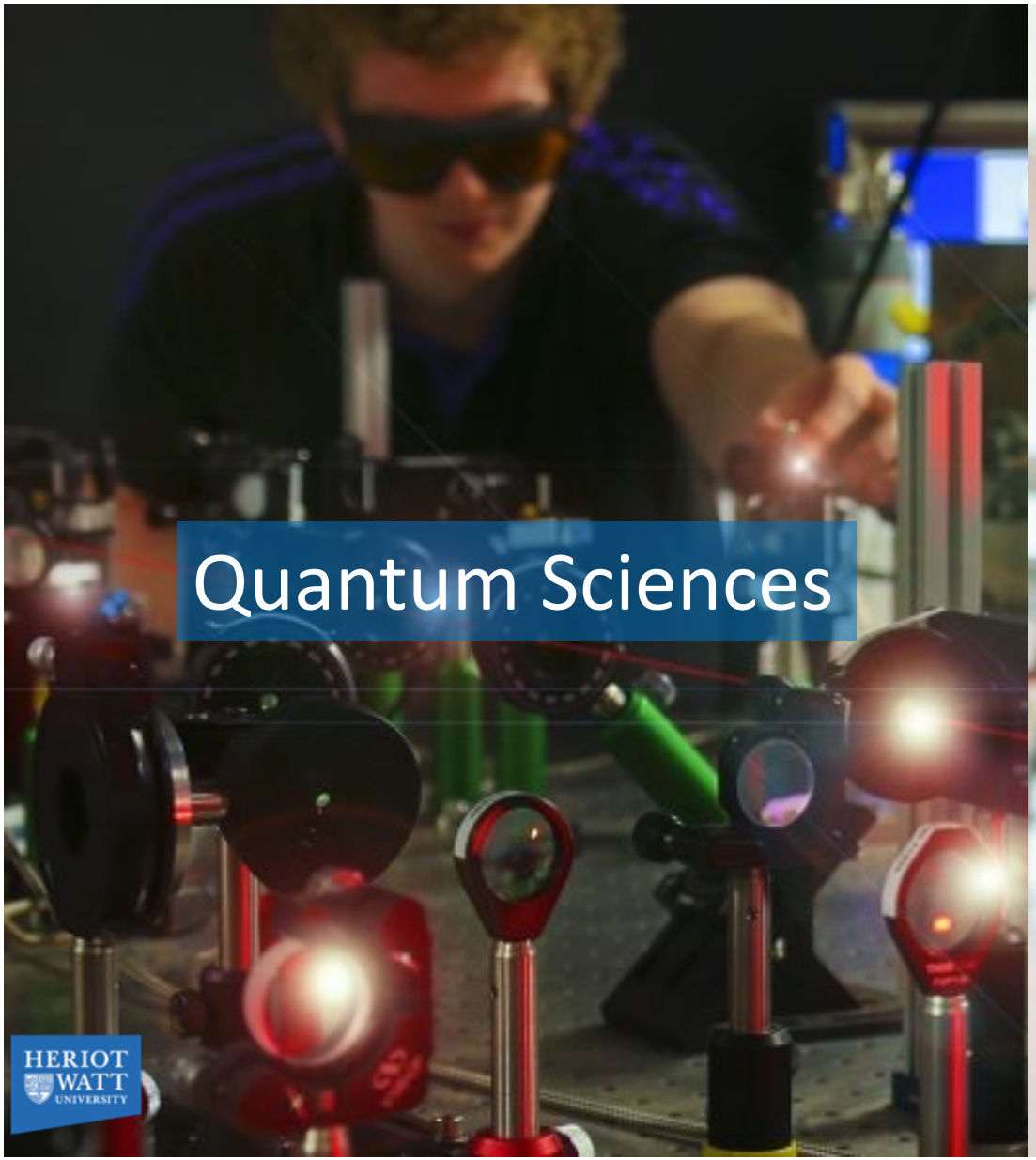
Mission 2 Quantum Networks

Mission 3 Quantum Sensing for Health

By 2030, every NHS Trust will benefit from quantum sensing-enabled solutions, helping those with chronic illness live healthier, longer lives through early diagnosis and treatment.

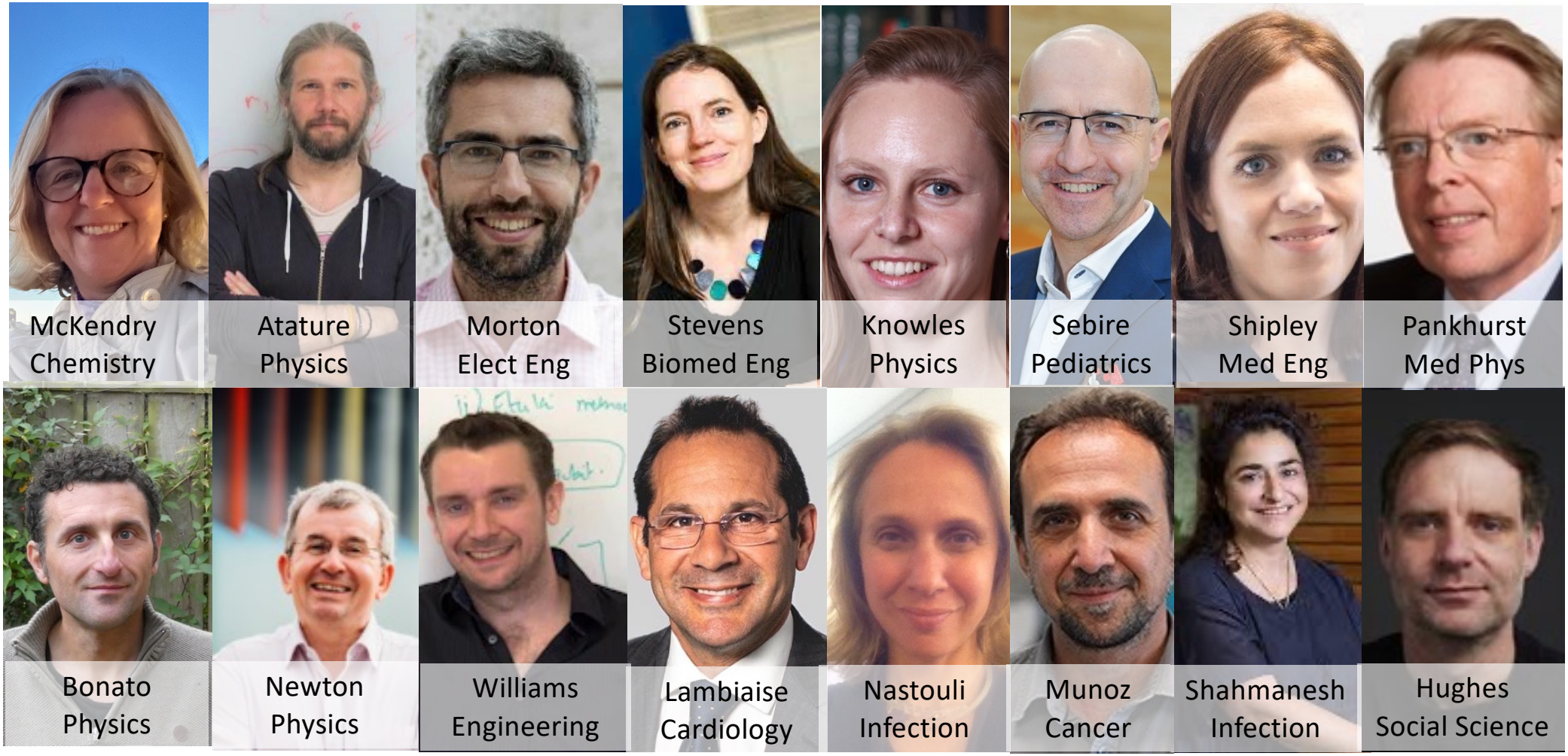
Mission 4 Quantum Navigation Systems

Mission 5 Networked quantum Sensors.


Quantum Sciences
HERIOT WATT UNIVERSITY


Biomedicine
UCL

Our management team:



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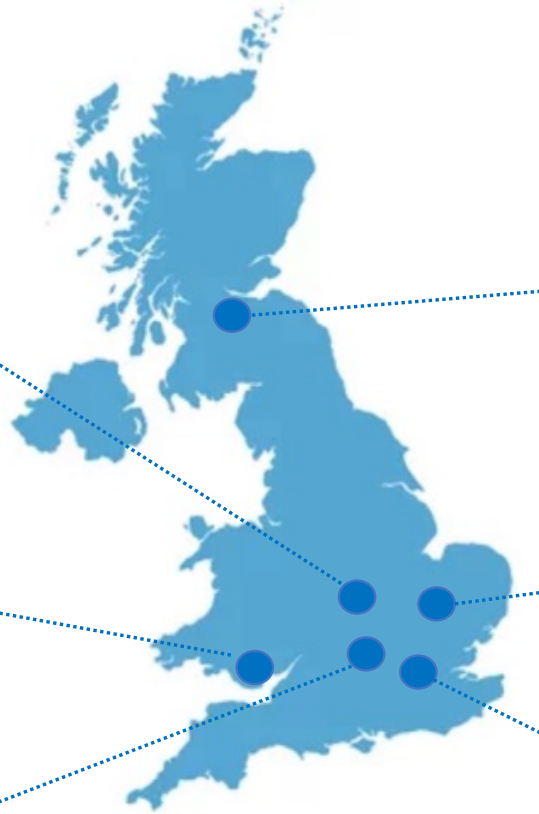

Clinical partners

AHRI

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Selection of industry partners (17 in total):

Roche

PHILIPS

endomag

ABHI

element six
DE BEERS GROUP

ADÁMAS nano
Brilliant Diamond Solutions

RESONANT CIRCUITS LIMITED

AstraZeneca

QDTI

FDA

Aim to grow new collaborations to create an innovation ecosystem

WP1: Systems-level Perspective of User Needs

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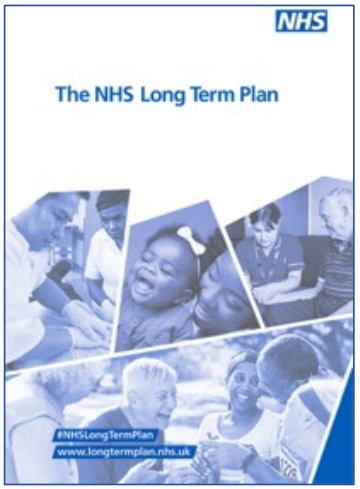
Professor Becky Shipley OBE
Professor of Healthcare Engineering, UCL; Chief Research Officer & Director of Academic Health Science Centre UCL Partners

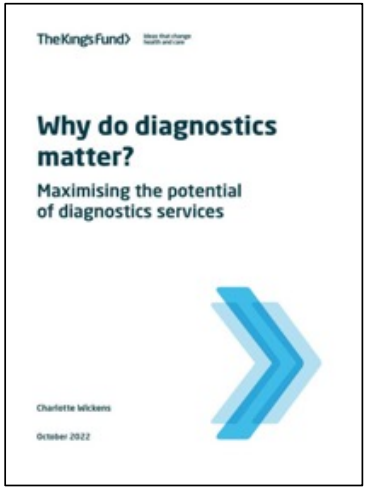
Professor Neil Sebire
Professor of Pathology and Chief Research Information Officer (CRIO) Great Ormond Street Hospital, Previous HDR UK Chief Clinical Data Officer

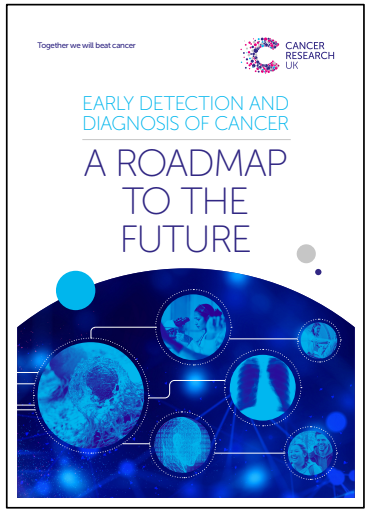
Round tables: clinical, patients, charities, industry, government, regulators, public, international

Use cases: Screening, early diagnosis, stratification, prognosis, response to treatment etc

Inequalities and responsible innovation







WP2: Core Research Programme

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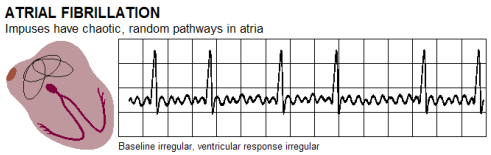
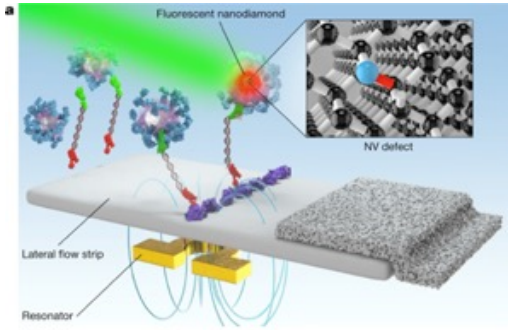
Biomedical Imaging and Physiology



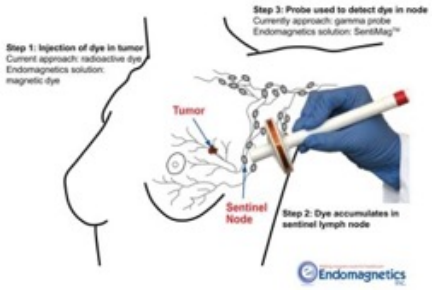
NIHR | Barts Biomedical Research Centre

In-Vitro Diagnostics



Interventions

Surgery & Treatment



Quantum biosensing for biomedical research

Flagship 1: Biomedical Imaging MASER enhanced MRI

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Exploring new imaging paradigms and faster scans to help to cut waiting times and ease pressure on the NHS

MASERs (microwave amplification by stimulated emission of radiation)

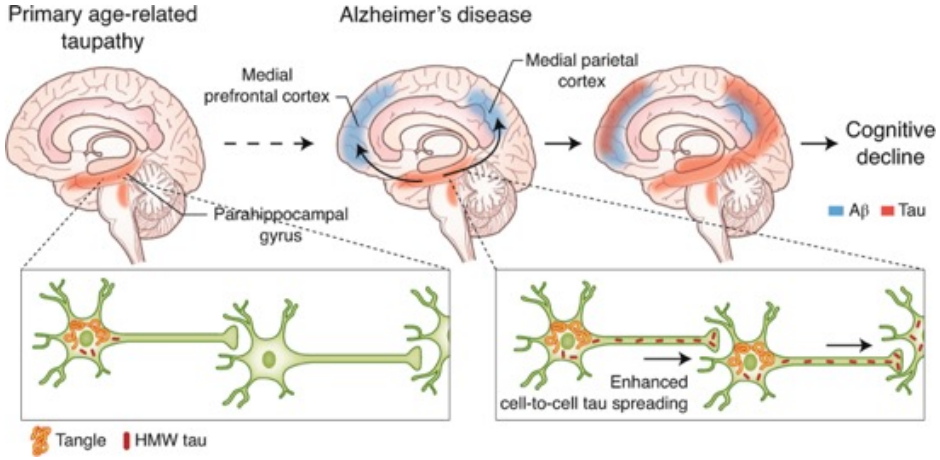
NIHR | University College London Hospitals Biomedical Research Centre
NIHR | Great Ormond Street Hospital Clinical Research Facility
NHS The Royal Orthopaedic Hospital NHS Foundation Trust
NIHR | Moorfields Biomedical Research Centre

Can we harness quantum sensors to detect the earliest stages of Alzheimer's disease?

UCLQ Quantum Science & Technology Institute

UCL QUEEN SQUARE INSTITUTE OF NEUROLOGY

UK Dementia Research Institute



Estimated 900,000 people with Alzheimer's Disease in the UK

Alzheimer's Society

Aim to detect subtle changes in brain circuitry, with a focus on OPM-MEGs as well as NVs.

Impact: functional pre-symptomatic biomarker for access emerging treatments (e.g.. lecanemab) to slow cognitive decline prior to extensive neuronal loss.

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Flagship 2: Quantum-enhanced IVD and rapid tests

Exploring applications spanning infections, AMR, cancer, cardiovascular disease

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THE UK QUANTUM BIOMEDICAL SENSING RESEARCH HUB

Article

Spin-enhanced nanodiamond biosensing for ultrasensitive diagnostics

https://doi.org/10.1038/s41586-020-2917-1
Received: 24 May 2019
Accepted: 16 September 2020

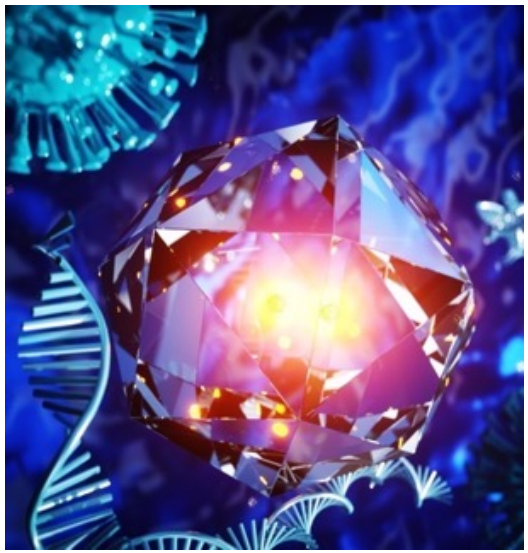
Benjamin S. Miller[1,2✉], Léonard Bezinge[1], Harriet D. Gliddon[1], Da Huang[1], Gavin Dold[1,3], Eleanor R. Gray[1], Judith Heaney[4], Peter J. Dobson[5], Eleni Nastouli[6], John J. L. Morton[1,3] & Rachel A. McKendry[1,2✉]

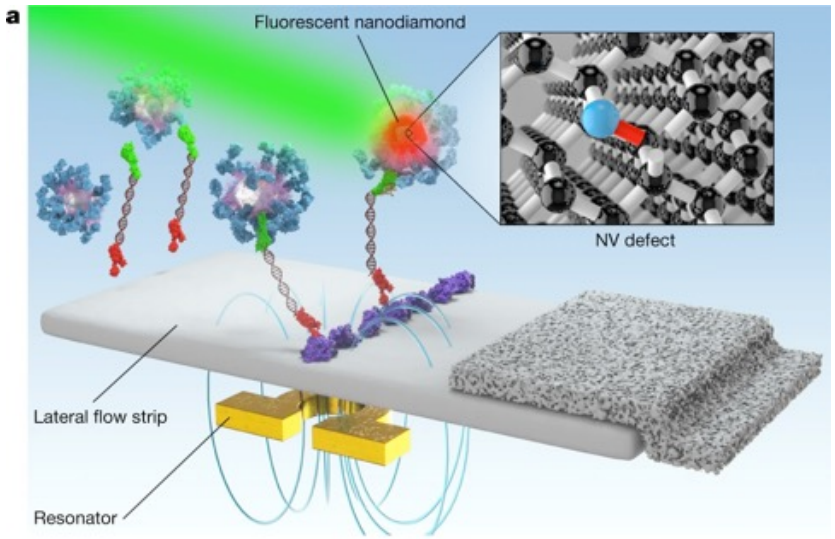
nature
International weekly journal of science

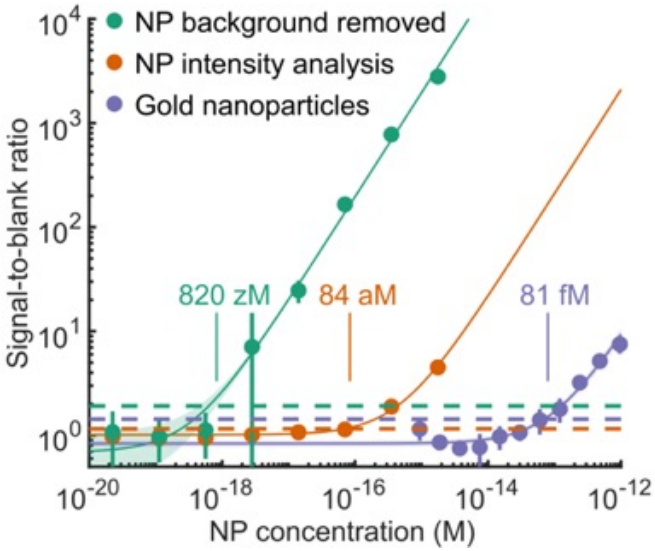
Nature **587**, 588 (2020)

100,000 fold more sensitive than gold nanoparticle fundamental sensitivity improvement

10^3-10^4 fold with clinical samples





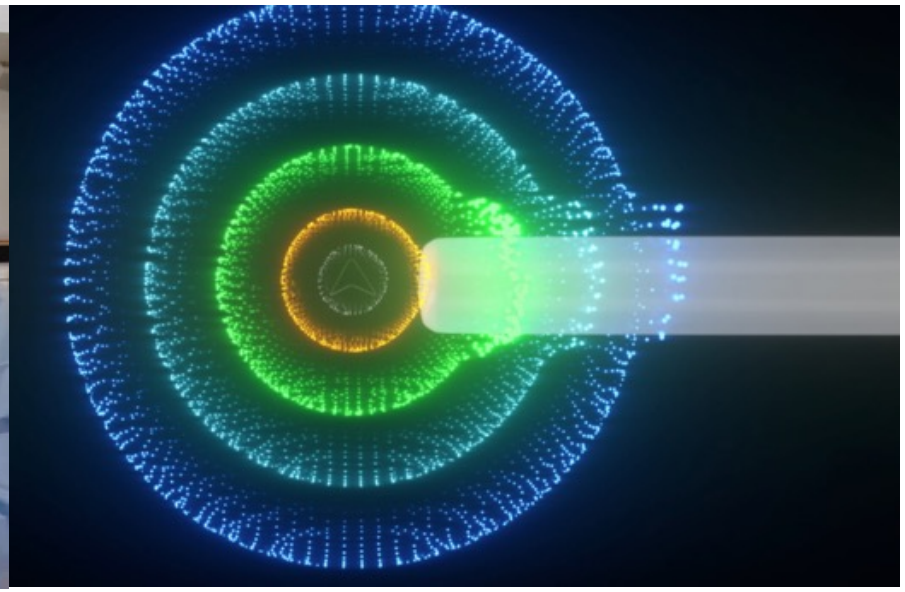


NIHR | University College London Hospitals Biomedical Research Centre

NIHR | Great Ormond Street Hospital Clinical Research Facility

AHRI AFRICA HEALTH RESEARCH INSTITUTE

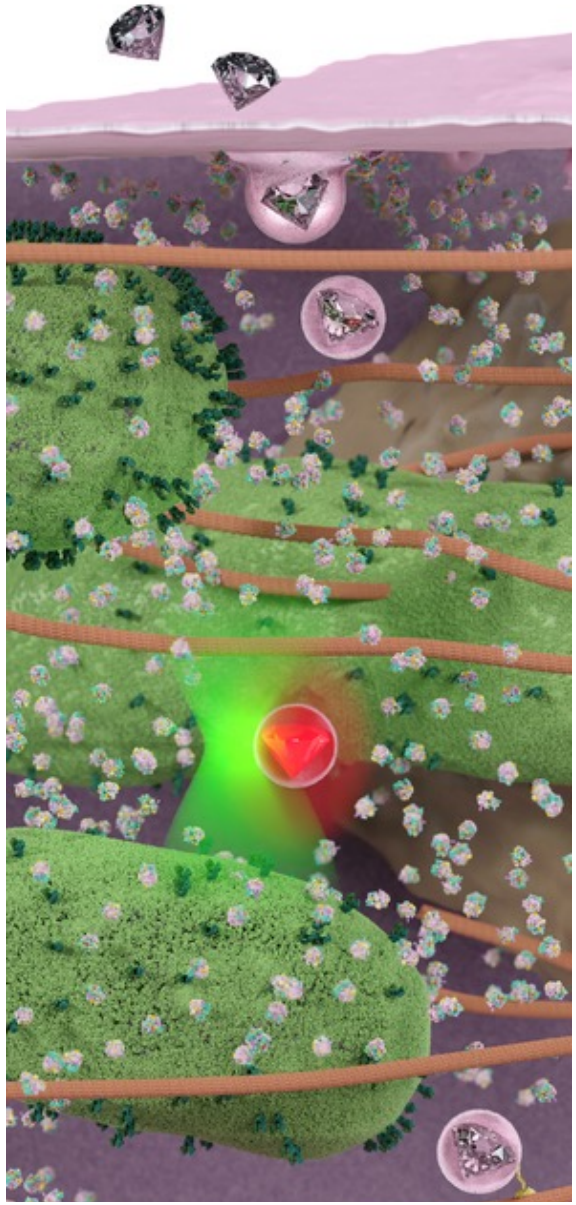
Flagship 3: Quantum Enhanced Interventional Tools



A magnetic marker liquid injected into people with invasive breast cancer will help surgeons discover if the cancer has spread, after the technology was recommended in draft NICE guidance.

www.NICE.org.uk

1000+ hospitals, 45+ countries. **400,000+ women** will have now accessed more precise and less invasive breast cancer treatment



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Flagship 4: Quantum for Biomedical Research

Multimodal quantum sensing in living systems
(Temperature, electron spins, nuclear spins, charge, micro rheology, magnetic fields, ions (Reactive oxygen species)

Single cell and single molecule lengths scales

Intracellular dynamics linked to cancer, neurodegenerative diseases and viral replication.

CANCER RESEARCH UK
Addenbrooke's NHS Trust
UCL
UNIVERSITY OF CAMBRIDGE
UNIVERSITY OF OXFORD
WARWICK
HERIOT WATT UNIVERSITY
CARDIFF UNIVERSITY PRIFYSGOL CAERDYDD

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THE UK QUANTUM BIOMEDICAL SENSING RESEARCH HUB

WP3 Accelerating Technology Impact

IP, patents, licensing, new industry partners, joint ventures, spinouts

WP4 Future Leaders Programme

WP5 Impact and Engagement

- National and international centre of excellence
- Working with NQTP, Quantum Hubs and NHS
- Growing innovation ecosystem with industry
- Giving balanced information to policy makers and the public

Growing international networks of excellence

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Q-BIOMED Quantum Biosensing Research Hub

NSF Quantum Leap Challenge Inst. for Quantum Sensing for Biophysics & Bioengineering (NSF QuBBE) University of Chicago

Copenhagen Centre for Biomedical Sensing

Centre of Quantum Biosciences University of Ulm

QBIC ARC Centre of Excellence in Quantum Biotechnology University of Queensland

Acknowledgements

UK Research and Innovation

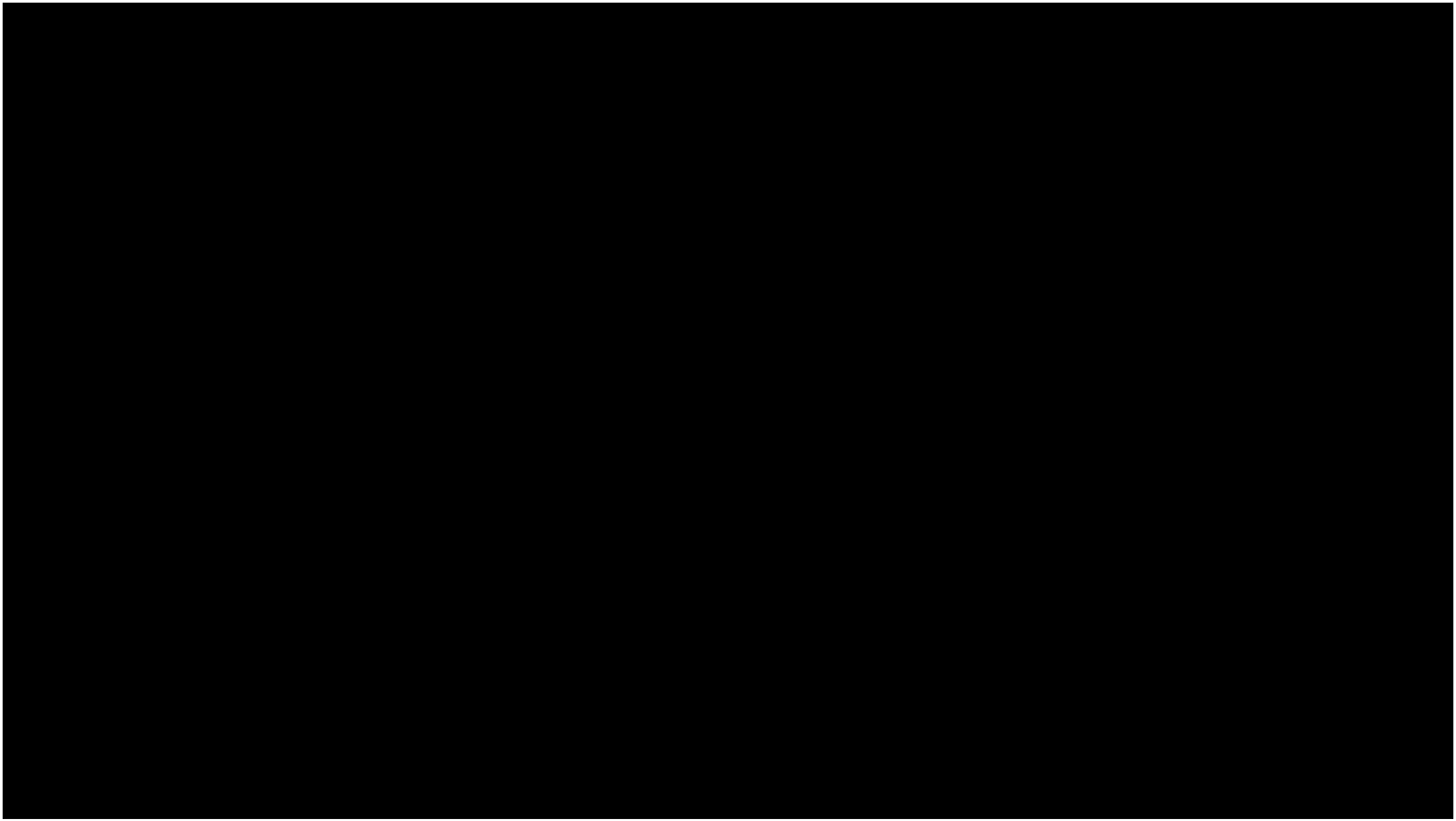
NHS National Institute for Health Research

Our Hub will start on 1st December Please go to www.q.biomed.org.uk to sign up to our newsletter

We are always open to new collaborations

UCL
University of Cambridge
University of Oxford
Warwick
Heriot-Watt University
Cardiff University
Prifysgol Caerdydd
NIHR | University College London Hospitals Biomedical Research Centre
NIHR | Great Ormond Street Hospital Clinical Research Facility
NIHR | Barts Biomedical Research Centre
NIHR | Moorfields Biomedical Research Centre
NIHR | Barts Biomedical Research Centre
NHS The Royal Orthopaedic Hospital NHS Foundation Trust
Addenbrooke's NHS Trust
Cancer Research UK
Alzheimer's Society
AHRI Africa Health Research Institute

31 Co-Investigators and 40+ partners



UK National Quantum Technologies Programme Activities Discussion

- This discussion aims to obtain general opinions of the quantum technology pipeline within healthcare based on the strategy and relevant opportunities. Examples include; committed strategy mission, funding and identified areas of interest. The second part of this discussion is to compare current/ past technology adoption and strategy (photonics, AI) and the successes/ problems these had.

UKRI Innovate UK

NPL National Physical Laboratory

Session 2 – Chaired by Jonathan Legh-Smith

Start	Finish	Activity	Presented by	Institution
11:40	11:55	Monitoring Metastasis	Dr Manfredi San Germano	Beyond Blood Diagnostics
11:55	12:10	Digistain mid-IR Cancer Diagnosis; Saving Lives with Quantum Entanglement	Dr Nathan Gemmell	Digistain
12:10	12:25	Robust Quantum Sensing	Dr Joe Smith	RobQuant
12:25	13:10	Quantum Sensing and Imaging Applications Discussion	-	-
13:10	14:20	Lunch	-	-

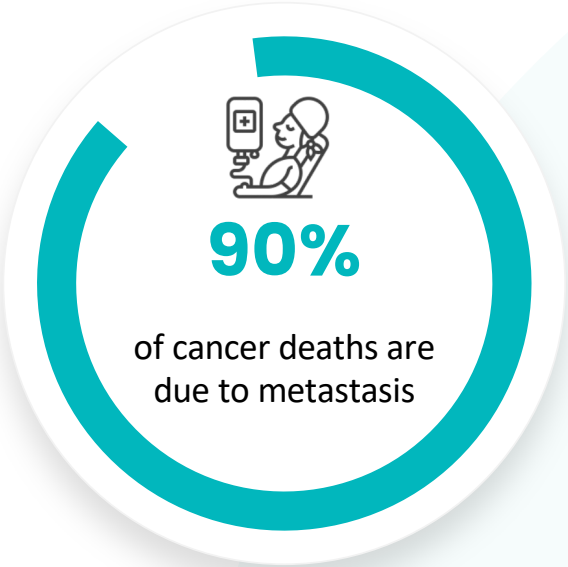
UKRI Innovate UK

NPL National Physical Laboratory

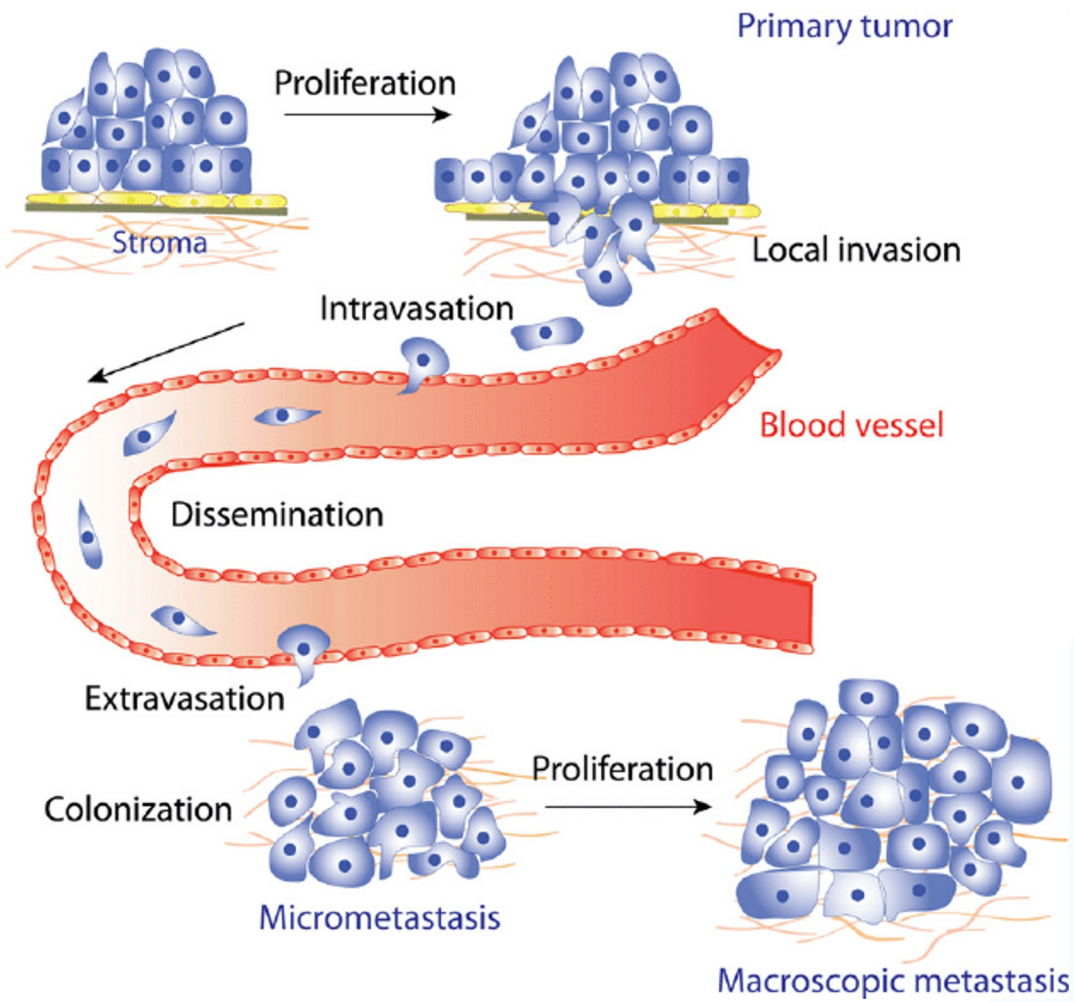
Beyond Blood
Diagnostics

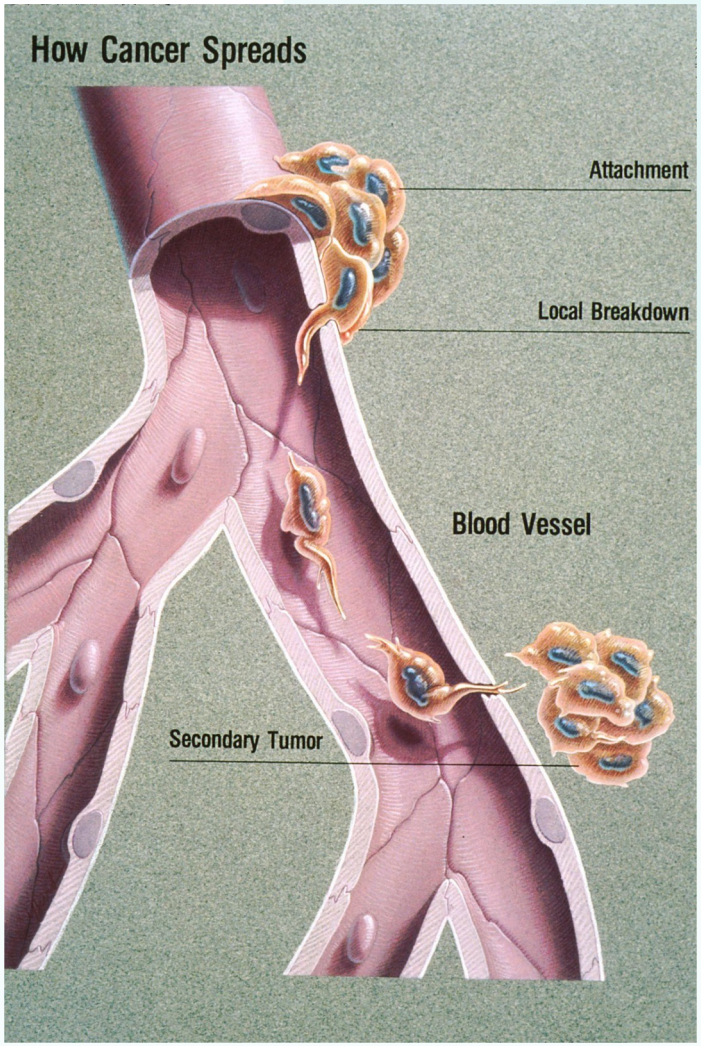
Monitoring Metastasis

Problem



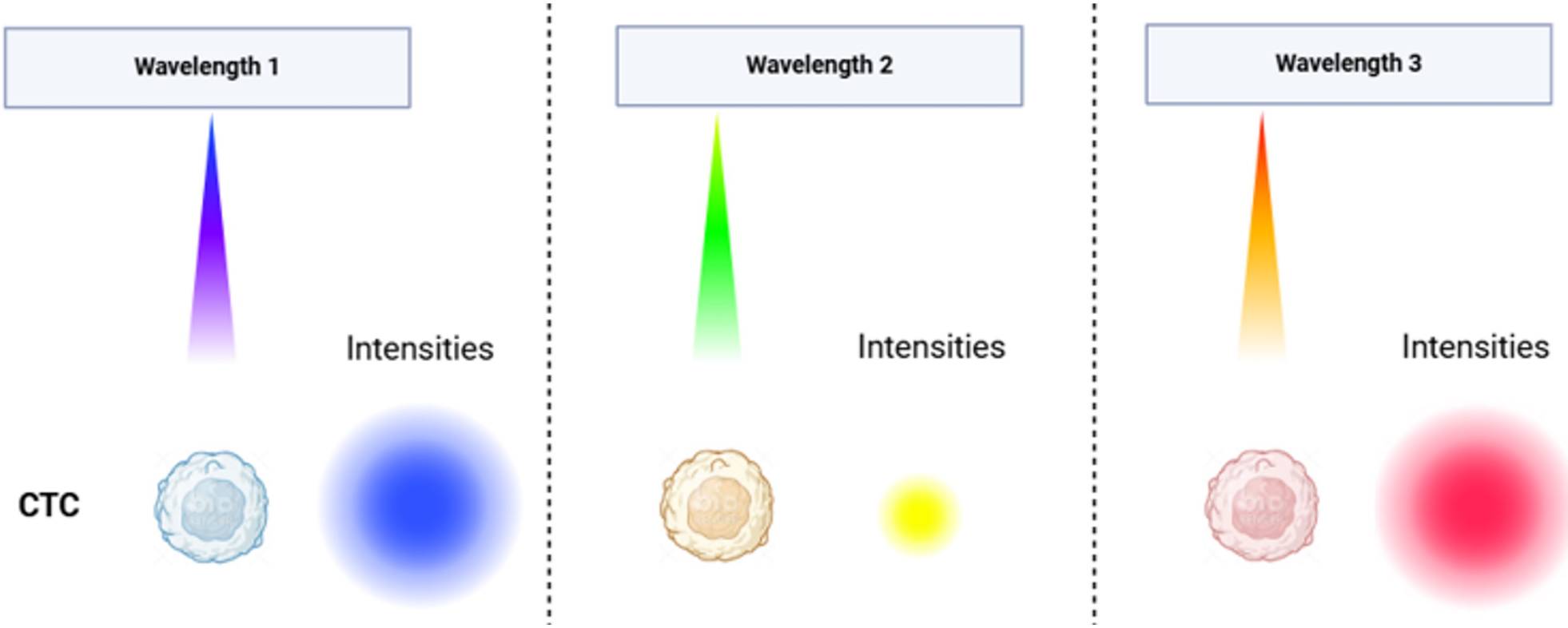
Problem


Primary tumor
Proliferation
Stroma
Local invasion
Intravasation
Blood vessel
Dissemination
Extravasation
Colonization
Proliferation
Micrometastasis
Macroscopic metastasis

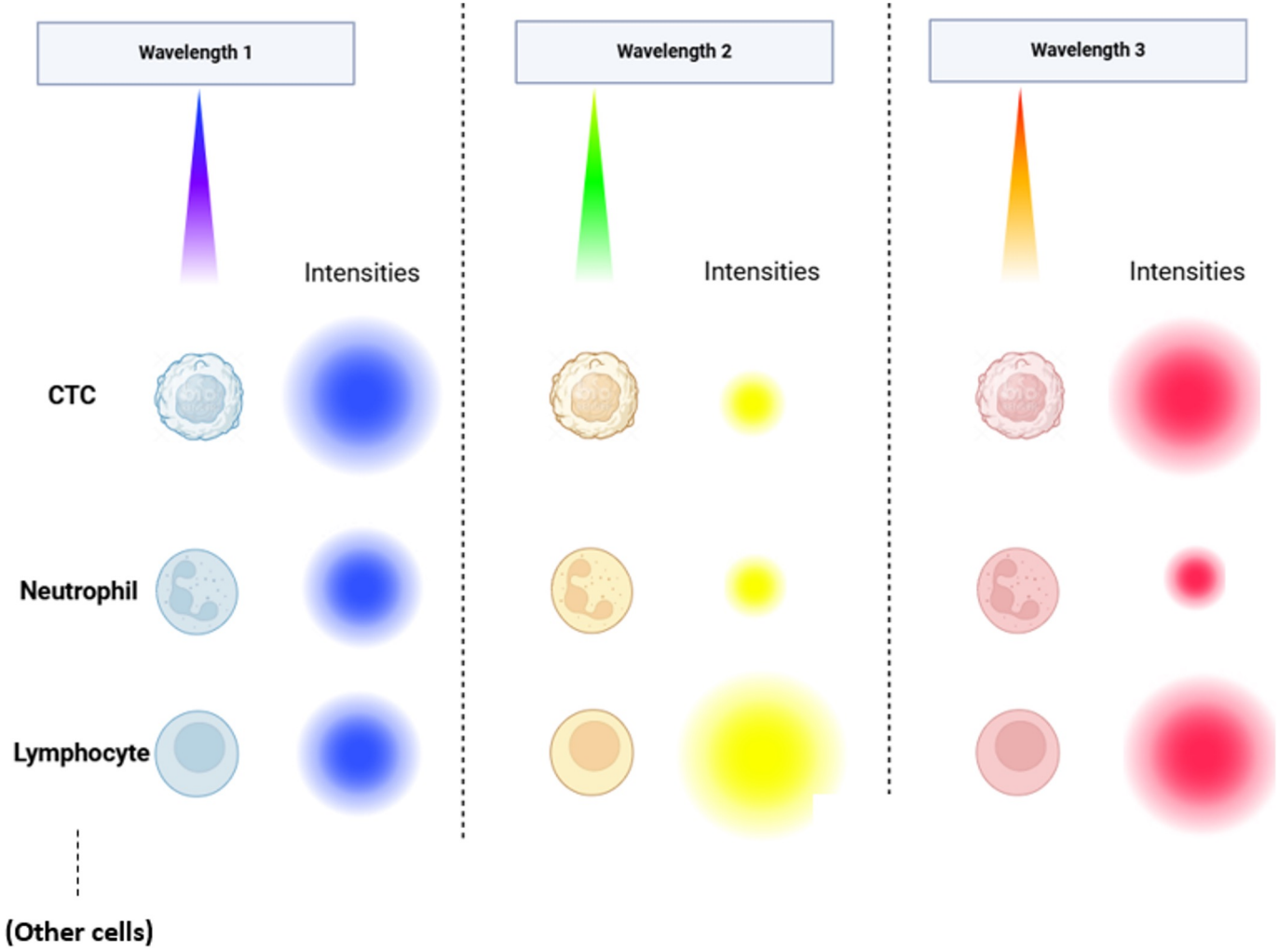

How Cancer Spreads
Attachment
Local Breakdown
Blood Vessel
Secondary Tumor

Quantum Sensing?

Label-Free CTC Detection Using Autofluorescence

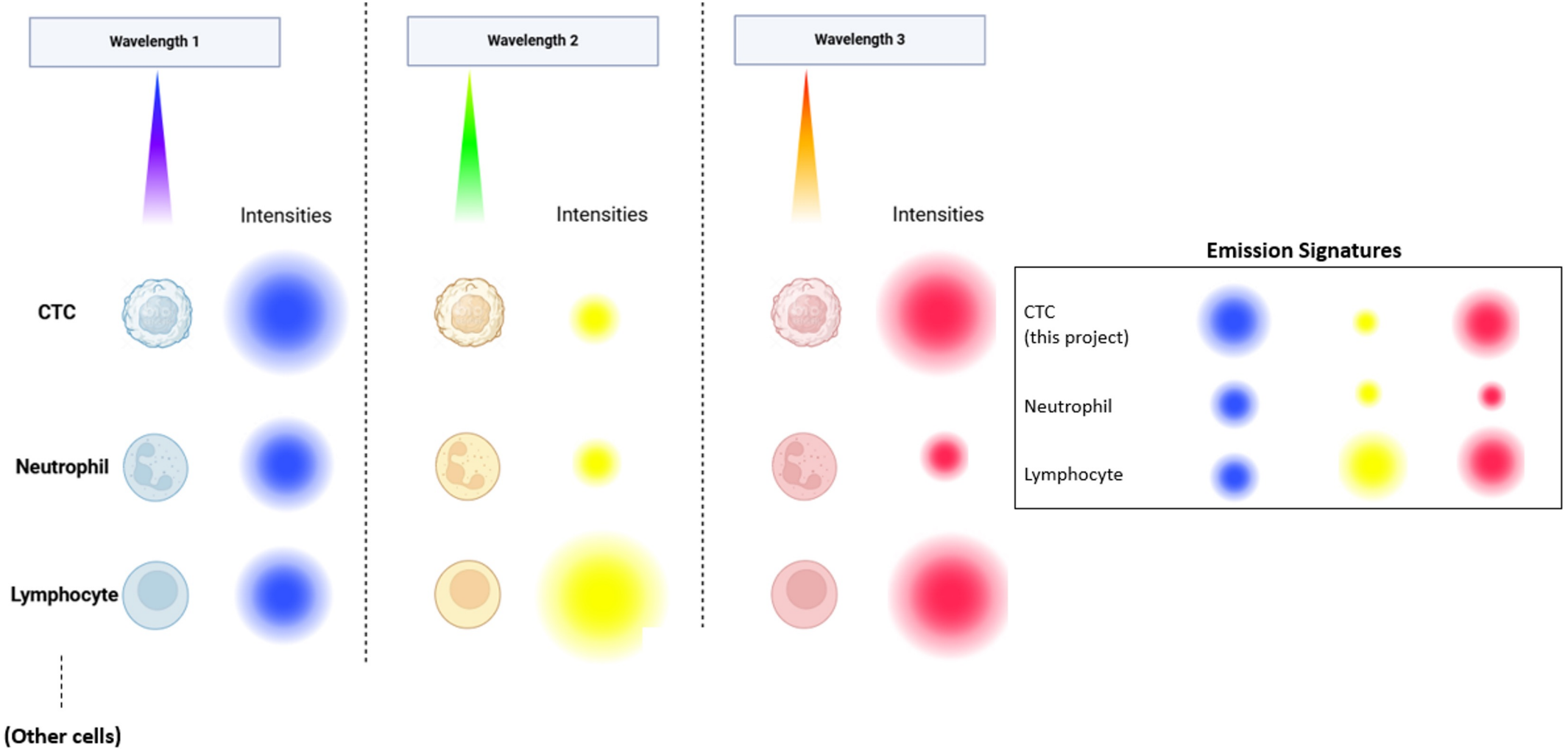


Label-Free CTC Detection Using Autofluorescence



Note: This illustration conceptually represents label-free cell detection via autofluorescence. The specific excitation wavelengths and emission intensities are backed by data from existing literature.

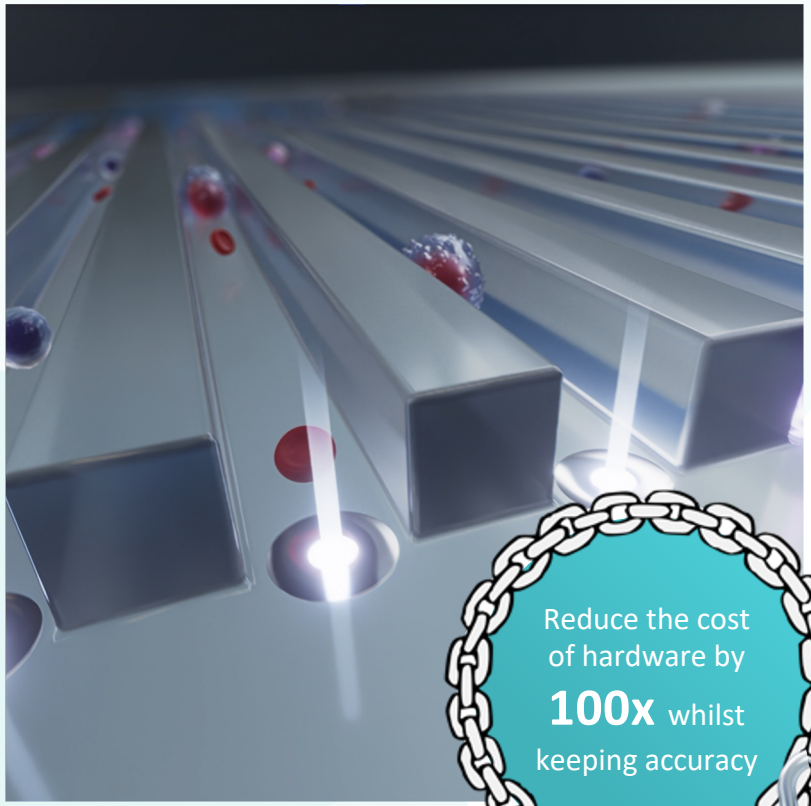
Label-Free CTC Detection Using Autofluorescence

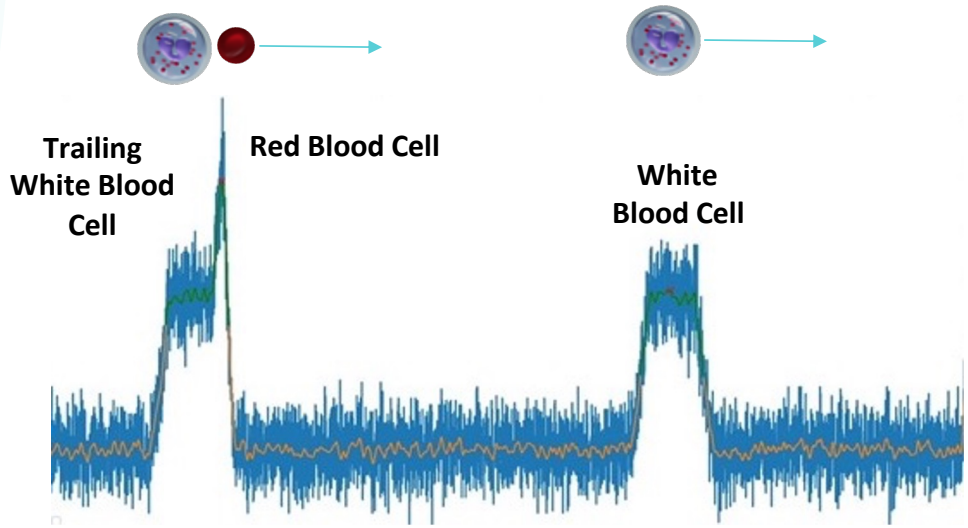


Note: This illustration conceptually represents label-free cell detection via autofluorescence. The specific excitation wavelengths and emission intensities are backed by data from existing literature.

Superpower

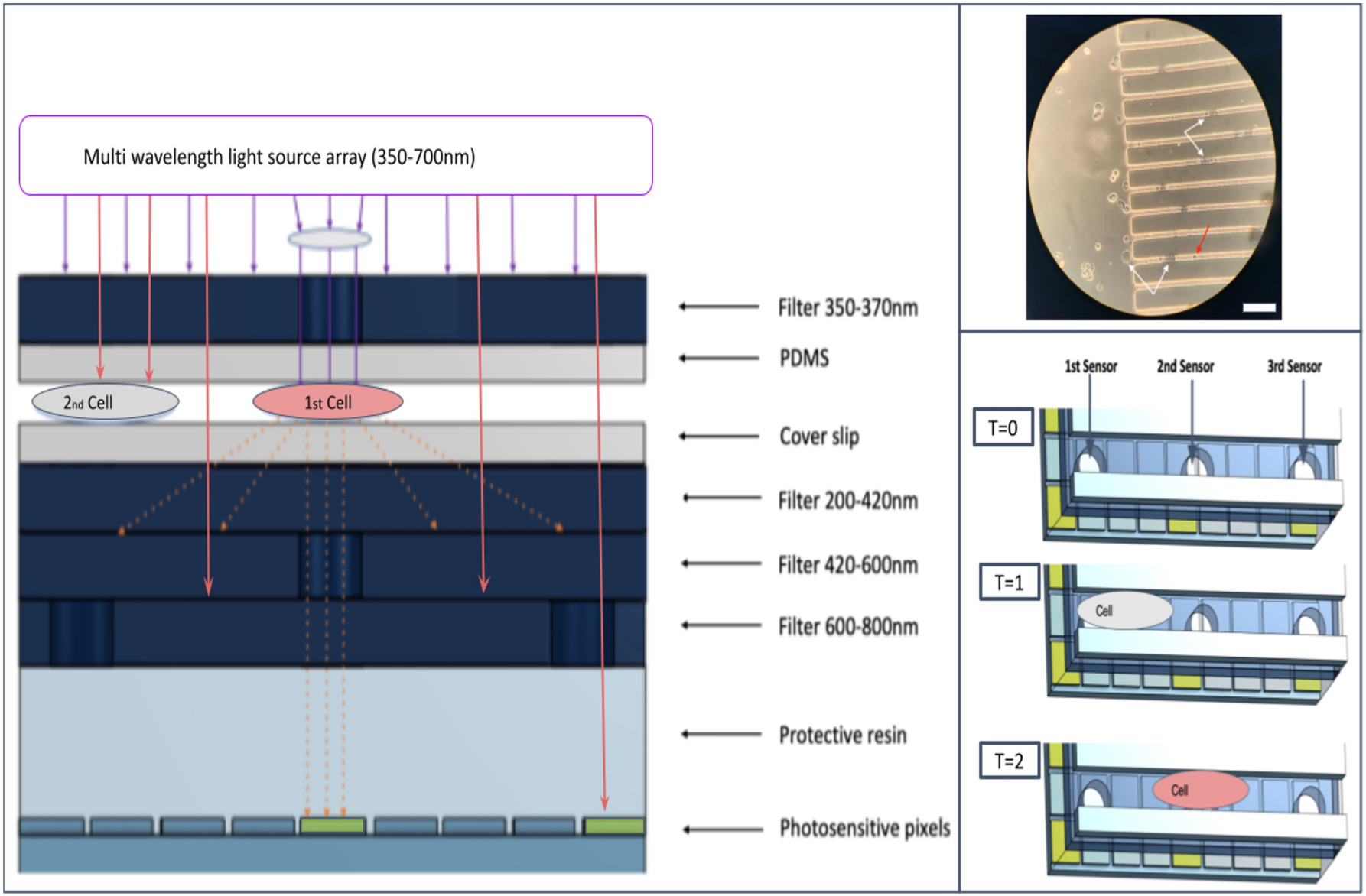
Technology info





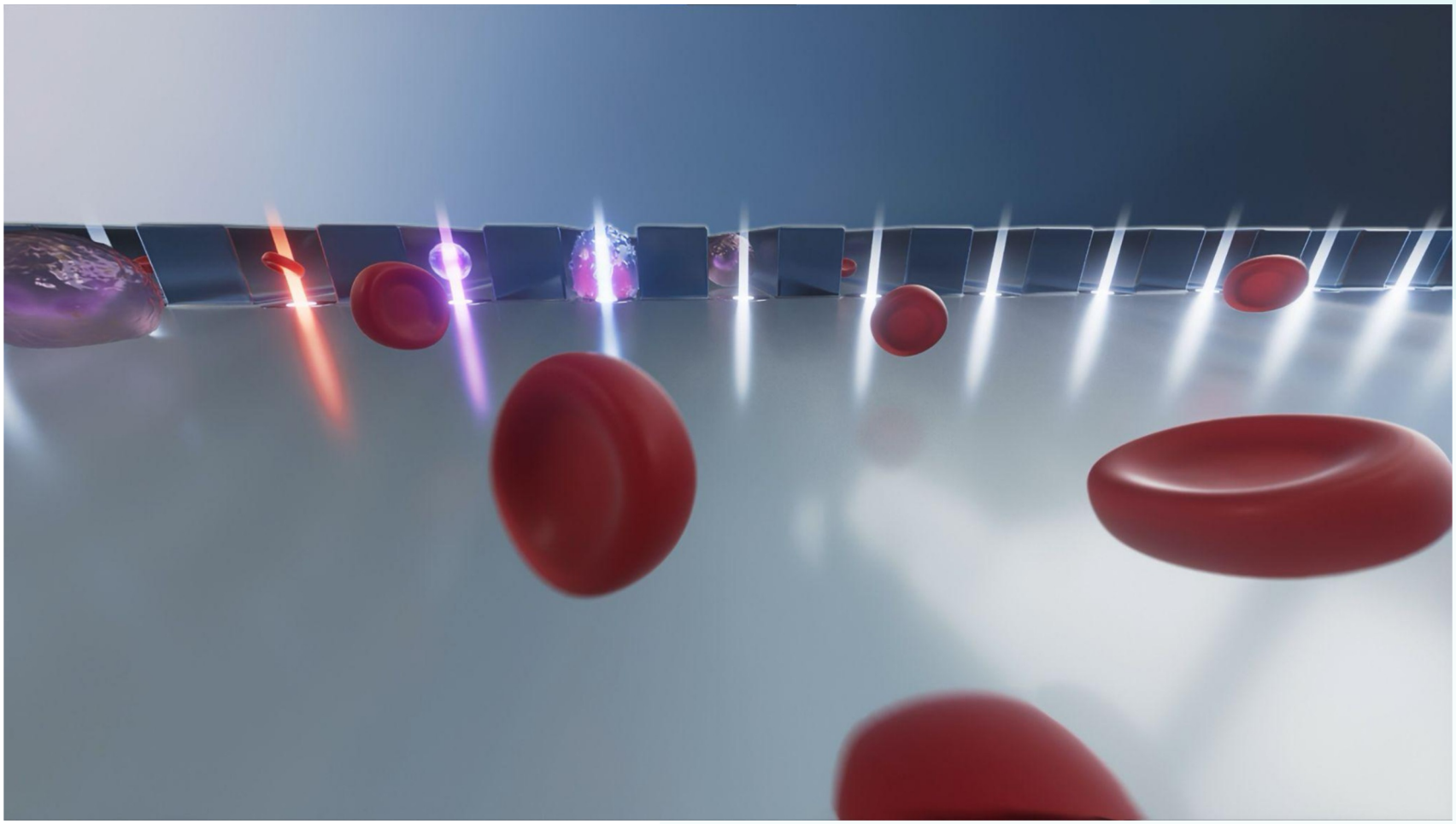
How our tech works

- Cells shine at different intensities
- Our hardware design enables us to align cells individually in channels to detect the light emitted by each cell
- Our AI processes the signal generated by the hardware, improving constantly


Multi wavelength light source array (350-700nm)
2nd Cell
1st Cell
Filter 350-370nm
PDMS
Cover slip
Filter 200-420nm
Filter 420-600nm
Filter 600-800nm
Protective resin
Photosensitive pixels
1st Sensor
2nd Sensor
3rd Sensor
T=0
T=1
Cell
T=2
Cell

Wider Benefits To Healthcare

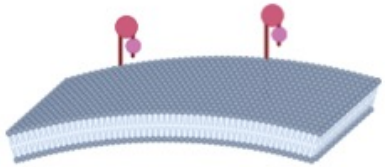
Autofluorescence



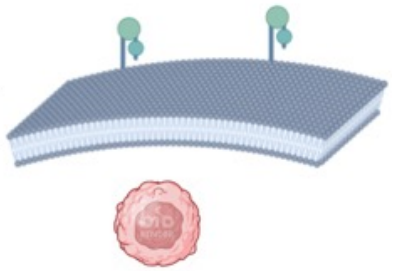
Antibody Drug Conjugate (ADC) Treatment Guidance

1. Circulating Tumour Cells (CTCs) with Unique Antigen Profiles

CTC 1



CTC 2



Cellular level (CTC)

Legend

CTC Surface

Antigen 1 (Eg: EpCam Variant 1)

Antigen 2 (Eg: EpCam variant 2)

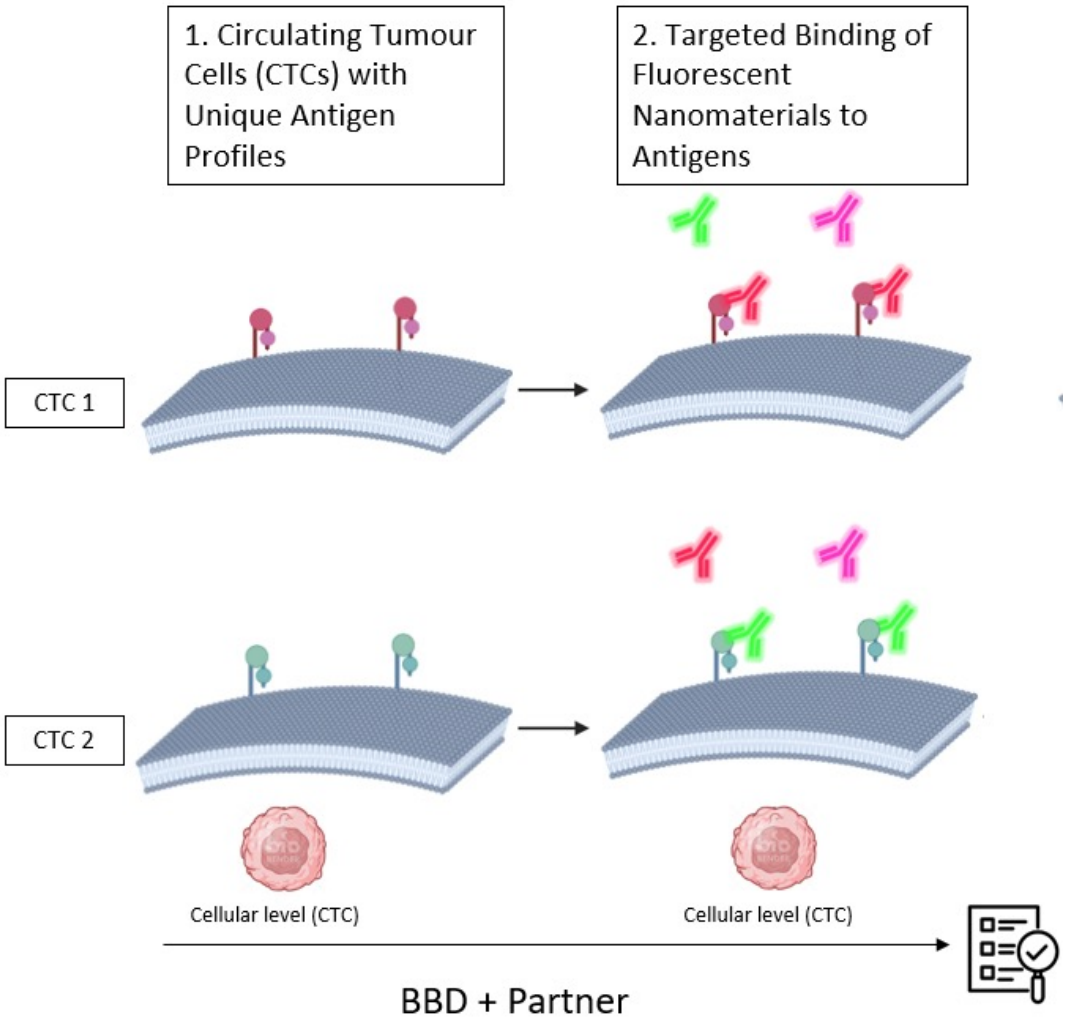
Fluorescent particle designed to bind only to Antigen 1

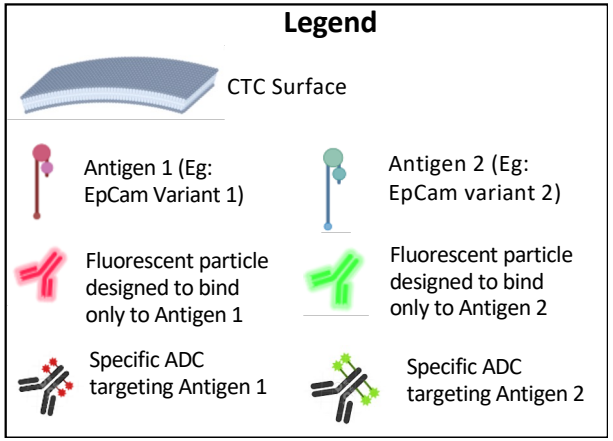
Fluorescent particle designed to bind only to Antigen 2

Specific ADC targeting Antigen 1

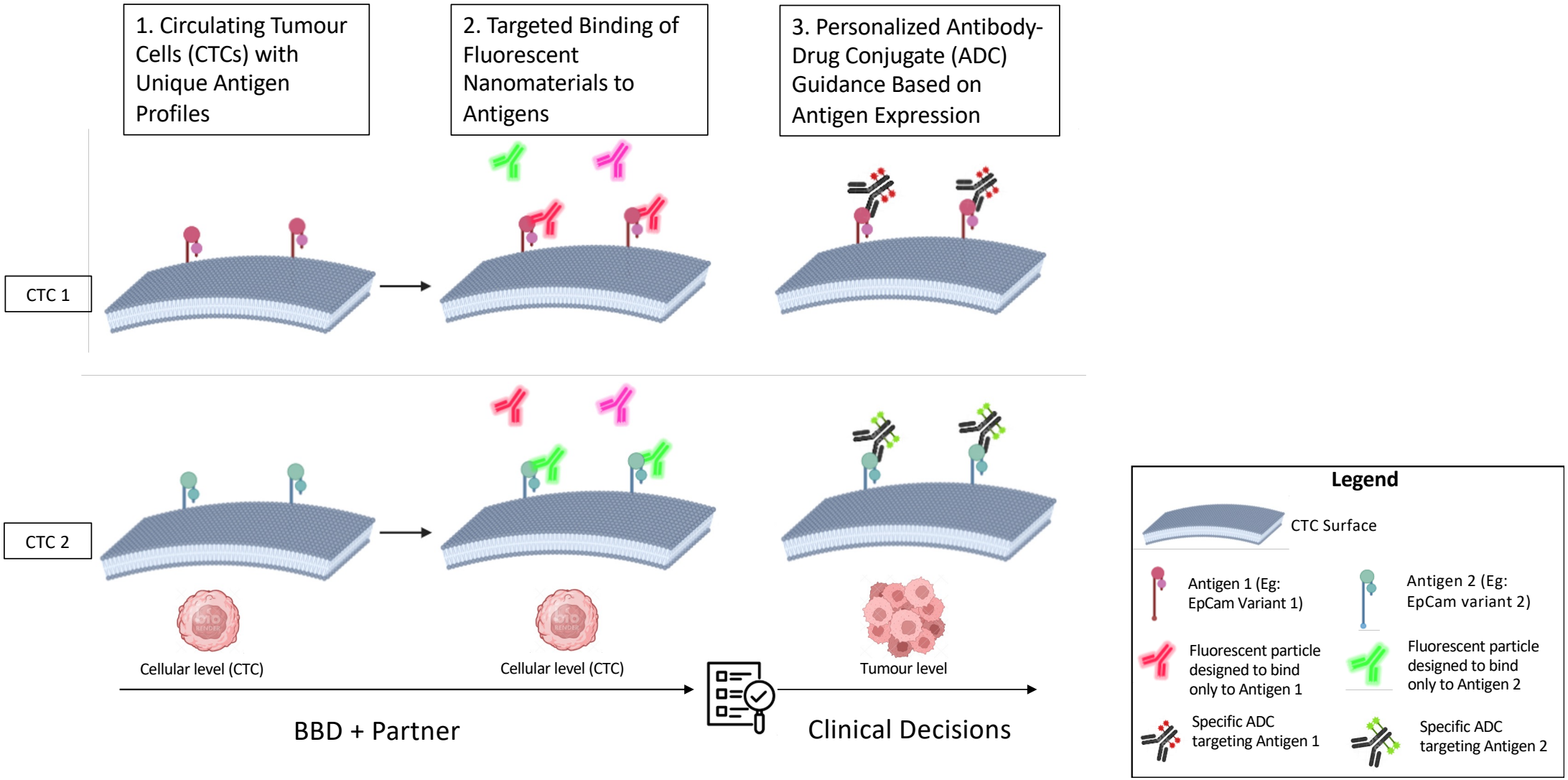
Specific ADC targeting Antigen 2

Antibody Drug Conjugate (ADC) Treatment Guidance



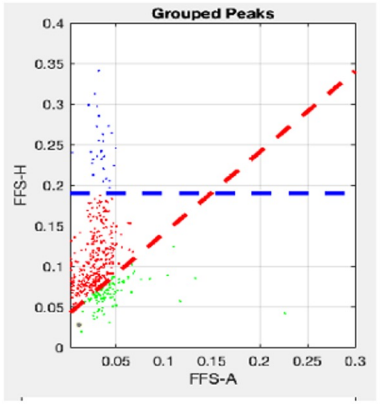


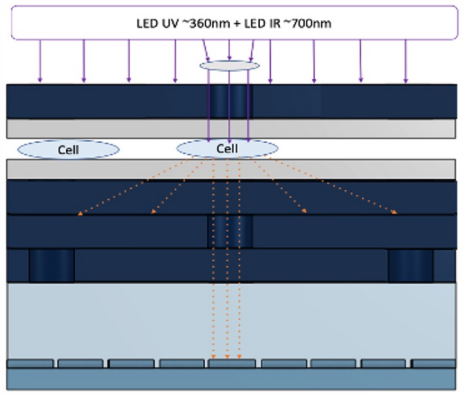
Antibody Drug Conjugate (ADC) Treatment Guidance

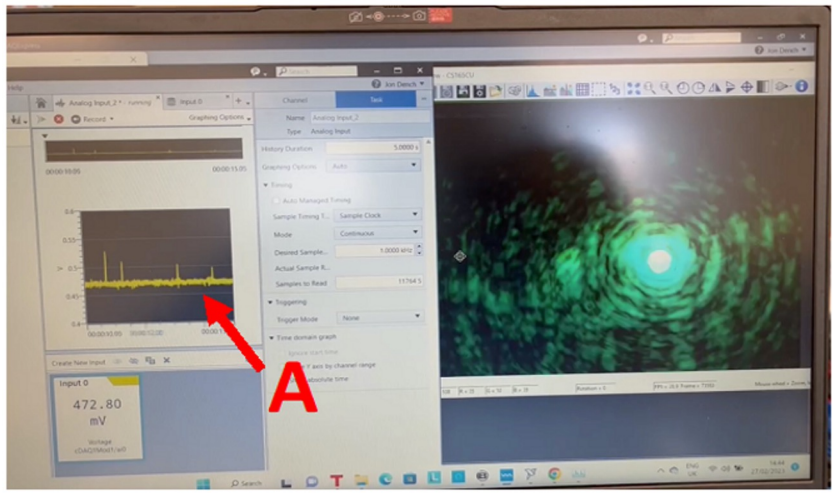


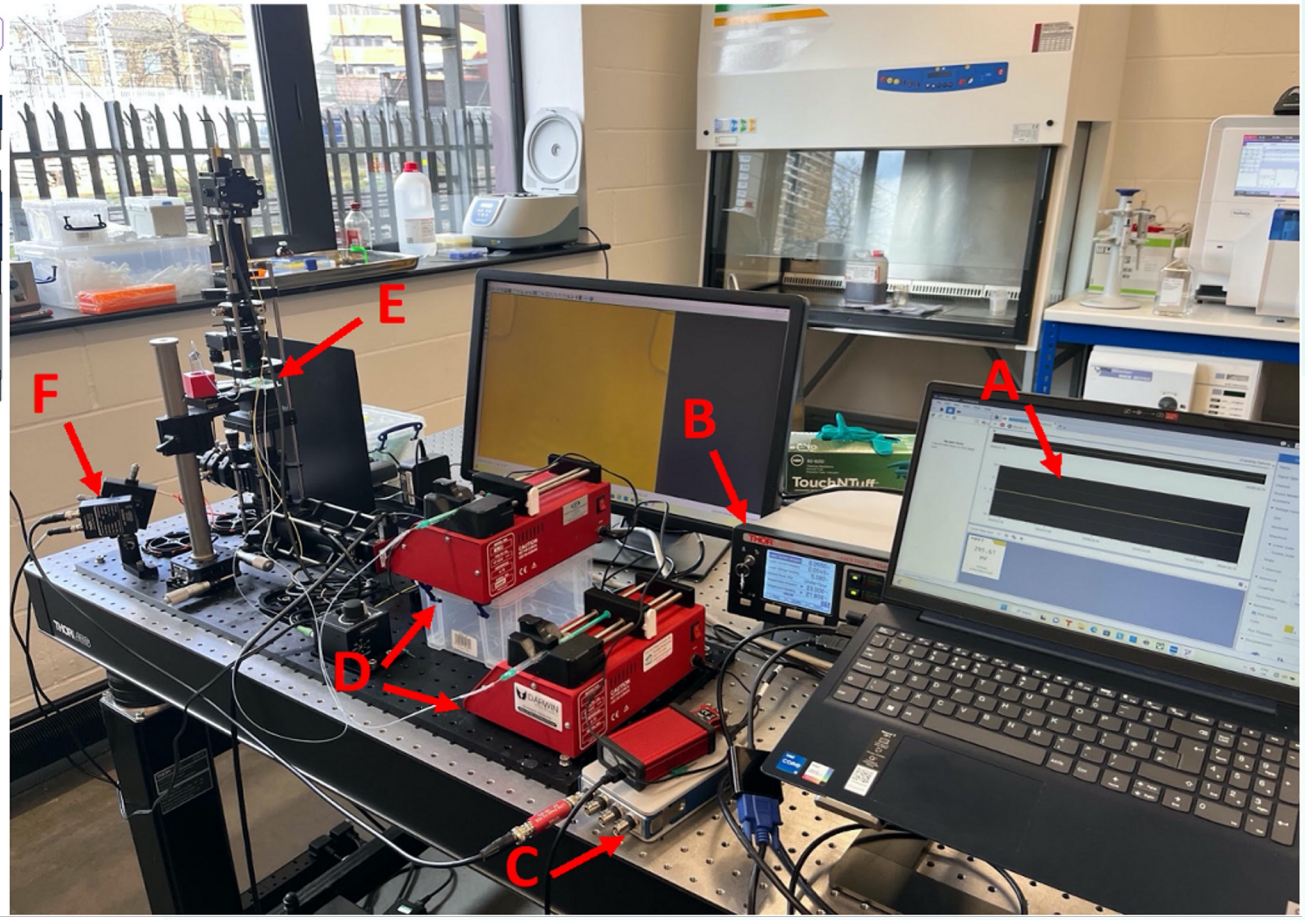
Stage of Prototype?

August 2022 - Rare Cell Count (CTCs) - TRL 2

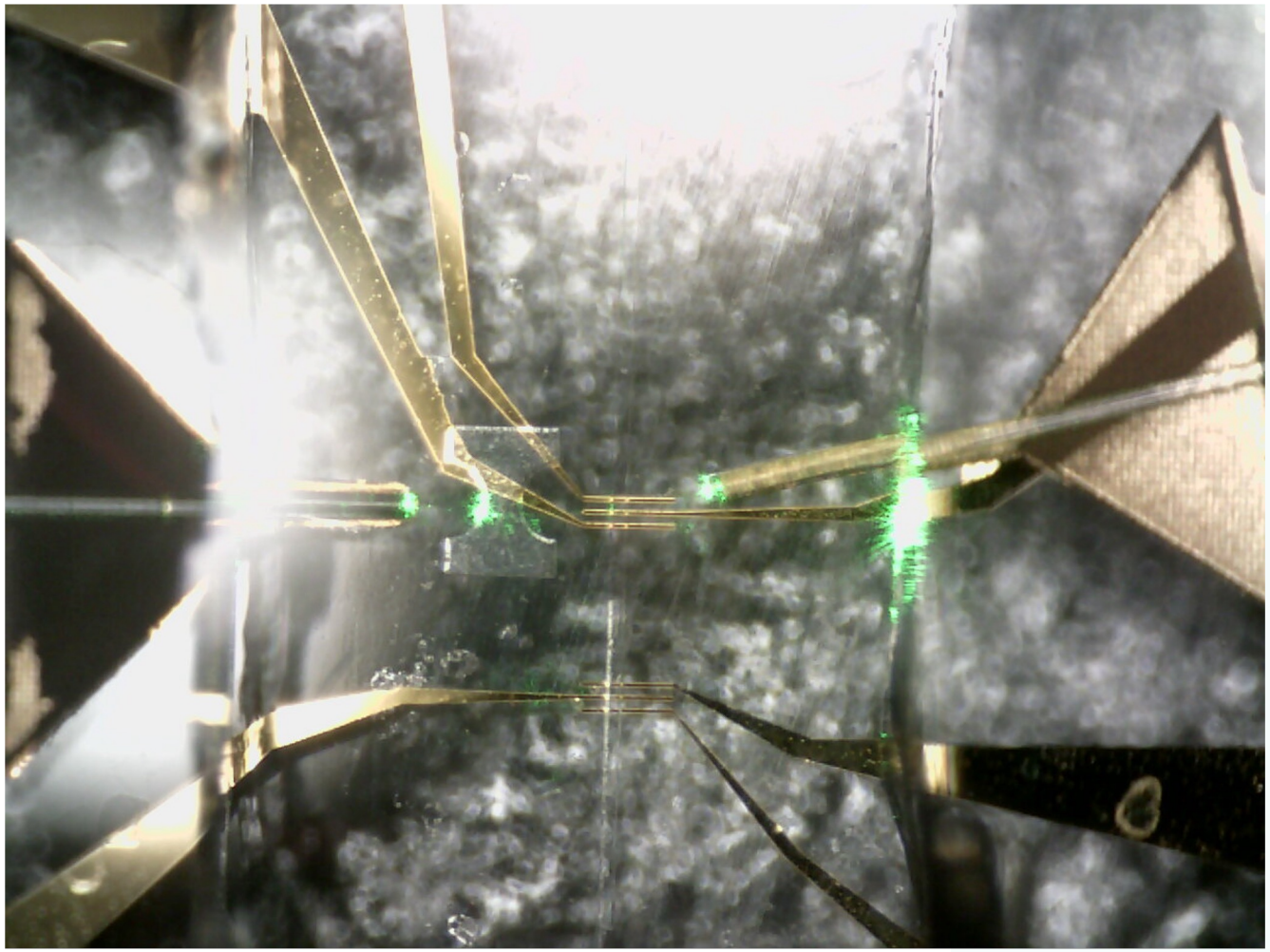


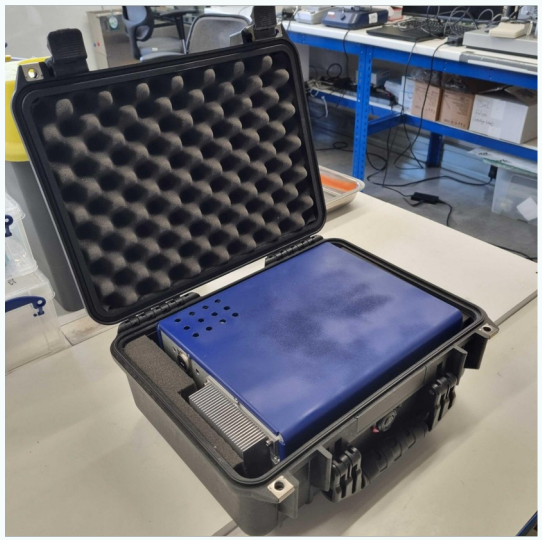






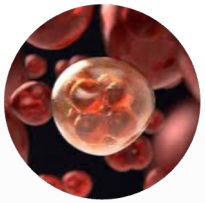
August 2024 - Rare Cell Count (CTCs) - TRL 4



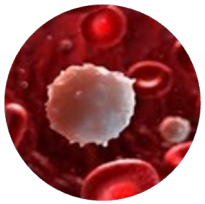


Circulating Cancer Cell Detection

Technology Potential



CTCs



White Blood Count

Platelets

Red Blood Count

Partners and Support

UKRI Innovate UK

CVD Hub

King's College London

NHS Blackpool Teaching Hospitals NHS Foundation Trust

thriva

Imperial College Advanced Hackspace

Institute of Chemical Biology Centre for Doctoral Training

Applied Quantum Materials Inc.

University of Alberta

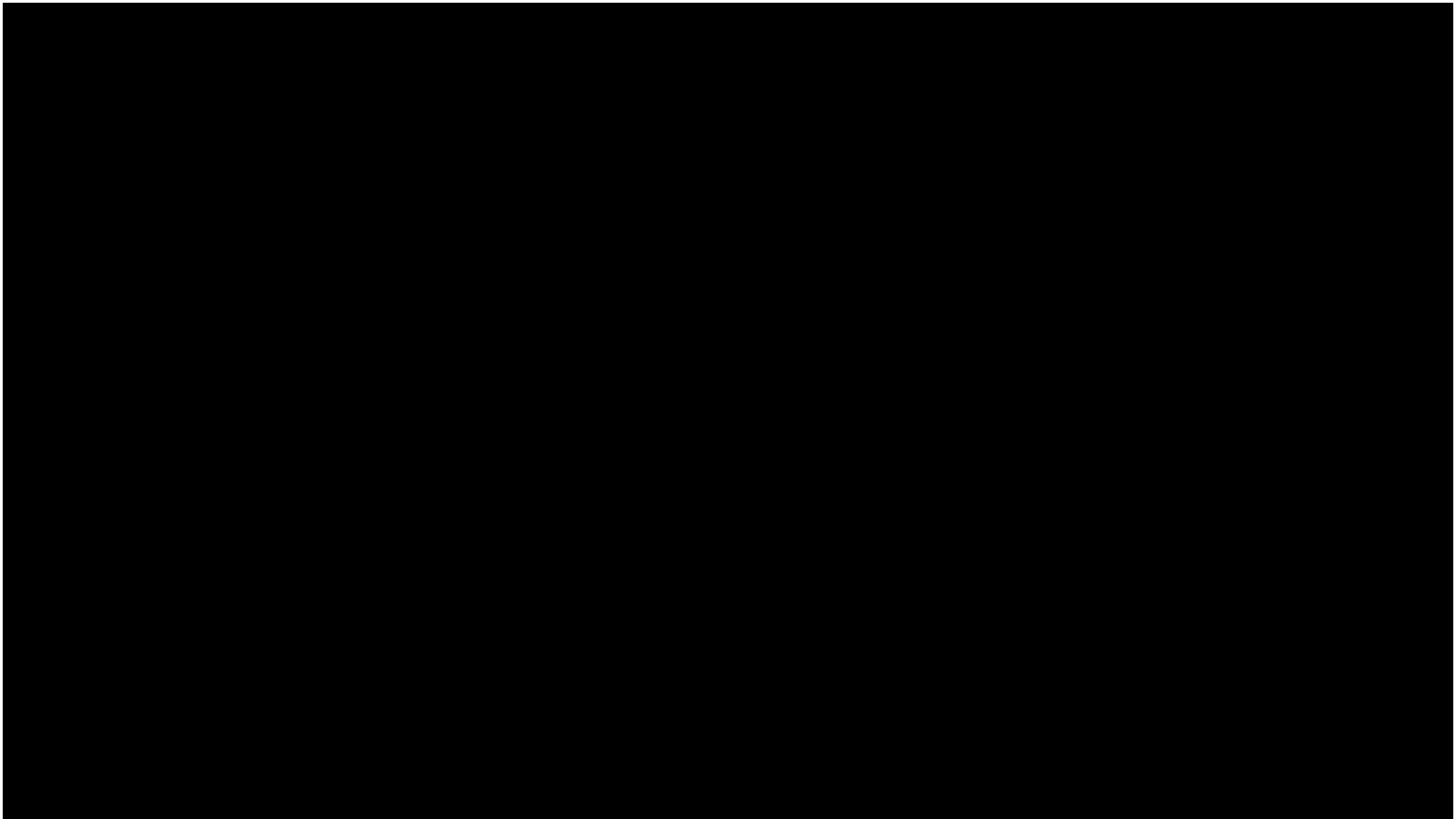
NHS Imperial College Healthcare NHS Trust

BGI 华大

OMNIPHARMA S.A.L.

Physiomics

Cinference



IMPERIAL

Digistain mid-IR Cancer Diagnosis; Saving Lives with Quantum Entanglement

Nathan Gemmell, Rupert Oulton, Chris Phillips

Physics Dept., Imperial College London.

EPSRC

THE ROYAL SOCIETY

NHS National Institute for Health Research

CANCER RESEARCH UK

digistain

IMPERIAL

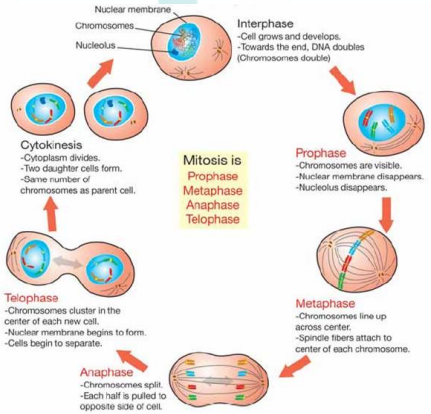
Taking the Guesswork out of Cancer Diagnosis.

* Uncertainty in H+E diagnosis generates ~60% of unnecessary Chemo.

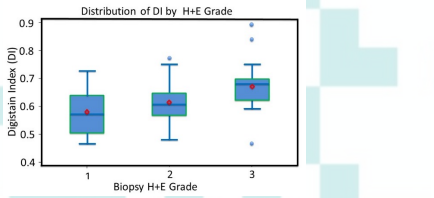
* We measure increase in DNA accompanying Breast Cancer objectively, using mid-IR spectroscopy.

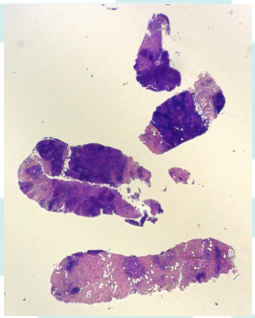
* A YCombinator Company, with multiple successful trials, grants and prizes.

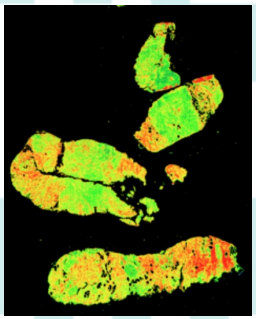
* IP portfolio, and Regulatory approval for US and UK.

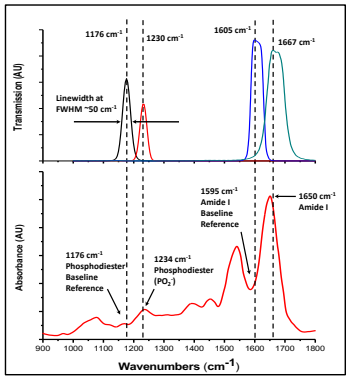


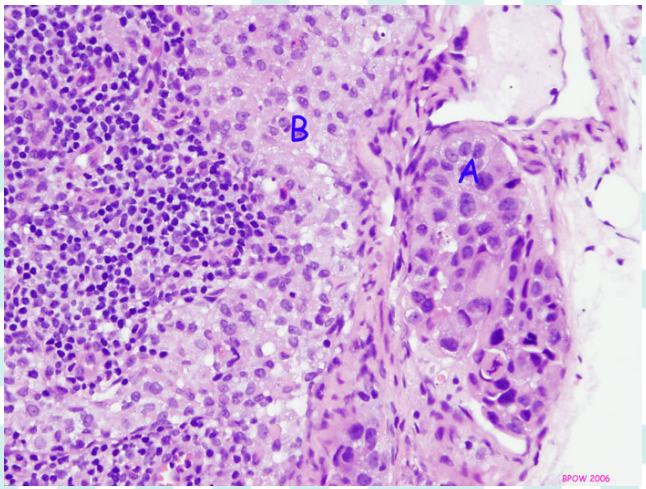
Hemmel Amrania PhD











Digistain IR-based Breast Cancer diagnosis technology, an N = 801 validation study

Charles Coombes[1] · Christina Angelou[1] · Zamzam Al Khalili[1] · William Hart[1] · Darius Francescatti[2] · Nicholas Wright[3] · Ian Ellis4 , Andrew Green[4] , Emad Rakha[4] , Hemmel Amrania[1] , Carlo Palmieri[5] and Chris C. Phillips[1]

1 Imperial College London, South Kensington Campus, London SW7 2AZ, UK.
2 Rush Medical College, Chicago, USA.
3 Barts Cancer Institute, London, UK.
4 Nottingham University Hospital, Nottingham, UK
5 University of Liverpool, Liverpool, UK.

Royal Society Innovation Award Presented By HRH

Institute of Physics Innovation Award

Imperial College President's Award For Outstanding Research

Cancer Research UK Pioneer Award

digistain

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*"Budget Impact Analysis"

Commissioned by Innovate UK (on SMART Award)

"The results indicate that Digistain® can lead to statistically significant cumulative savings of an average of GBP 286.7 million for an LN0 intermediate-risk patient population once rolled out as a substitute for Oncotype DX® (Table 1 , Scenario 2 – LN0 patients). "

"The secondary outcome modelled as the impact of Digistain® on health outcomes as quantified by life years saved (LYS) shows the biggest impact for a LN1-3 patient population once rolled out as a substitute to the currently used PREDICT tool for risk stratification (Table 2 , Scenario 2 – LN1-3 patients), where the model predicts a statistically significant result of an average of 1266 Life Years Saved. "

***Figures only for UK and Breast. Much larger worldwide/other Cancers**

Health Tech Enterprise

Health Enterprise East Ltd
St John's Innovation Centre
Cowley Road, Cambridge
CB4 0WS

+44 (0) 1223 422422
enquiries@healthtechenterprise.co.uk
www.healthtechenterprise.co.uk

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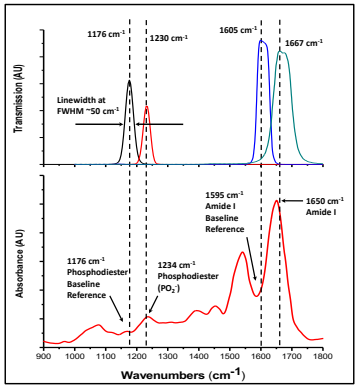
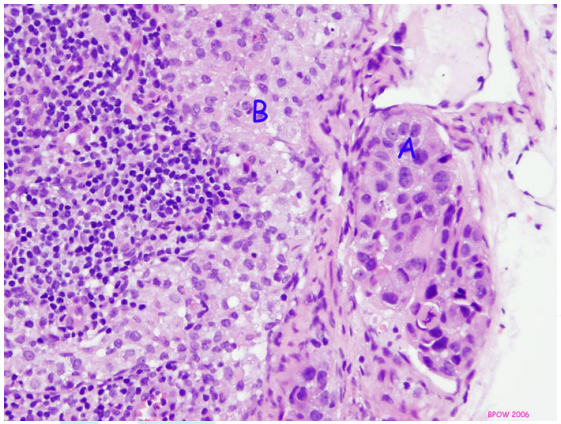
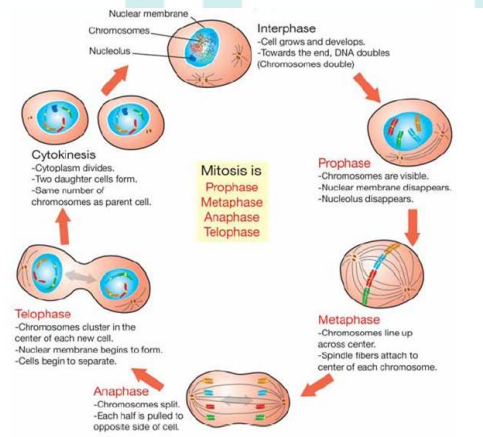
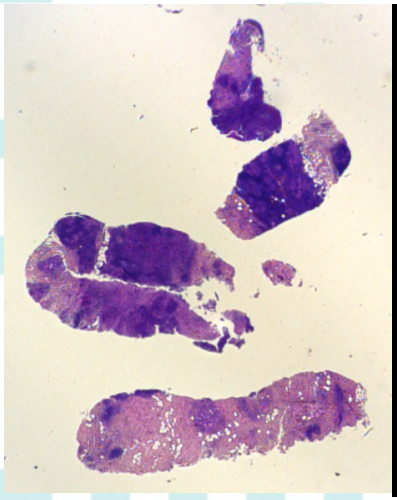
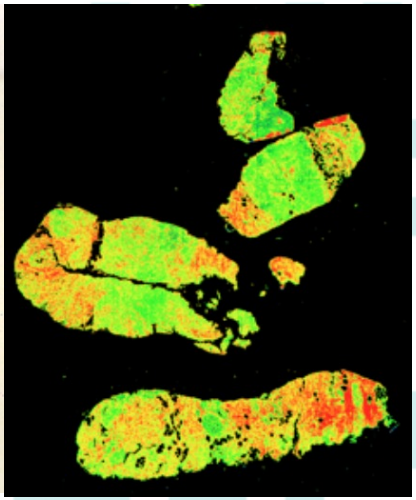
The “300K Thermal Background” problem.











Ever present 300K Blackbody radiation fluctuates with a 1/f intensity distribution and can’t be removed.

Hemmel Amrania PhD

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The “300K Thermal Background” problem.

Thermal IR (λ~10μm) beckons for
- *Undetectable ranging
- *Chemical Imaging
- *Remote sensing

BUT… it adds Poisson noise

Aka “BLIP” Limits to IR detection sensitivity

AND… it Fluctuates.

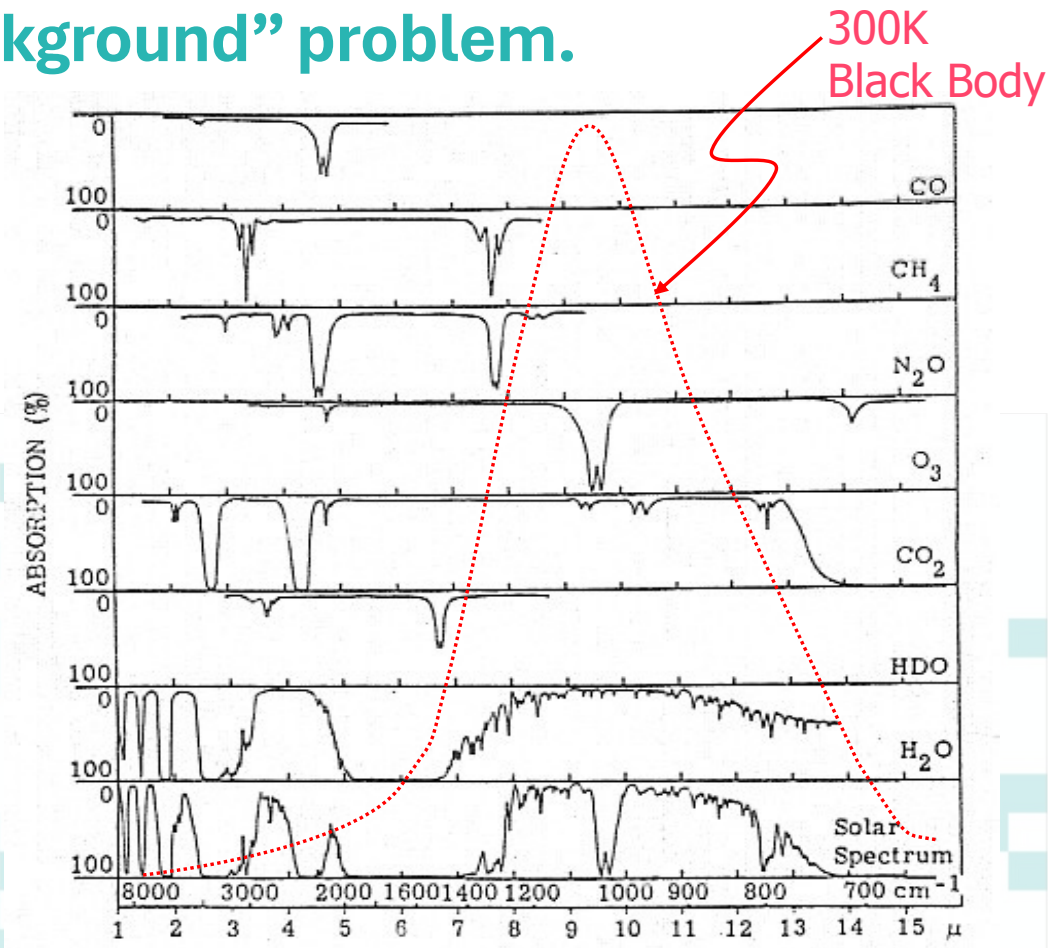

FIG. 6-59. Low-resolution solar spectrum from 1 to 24 μ.

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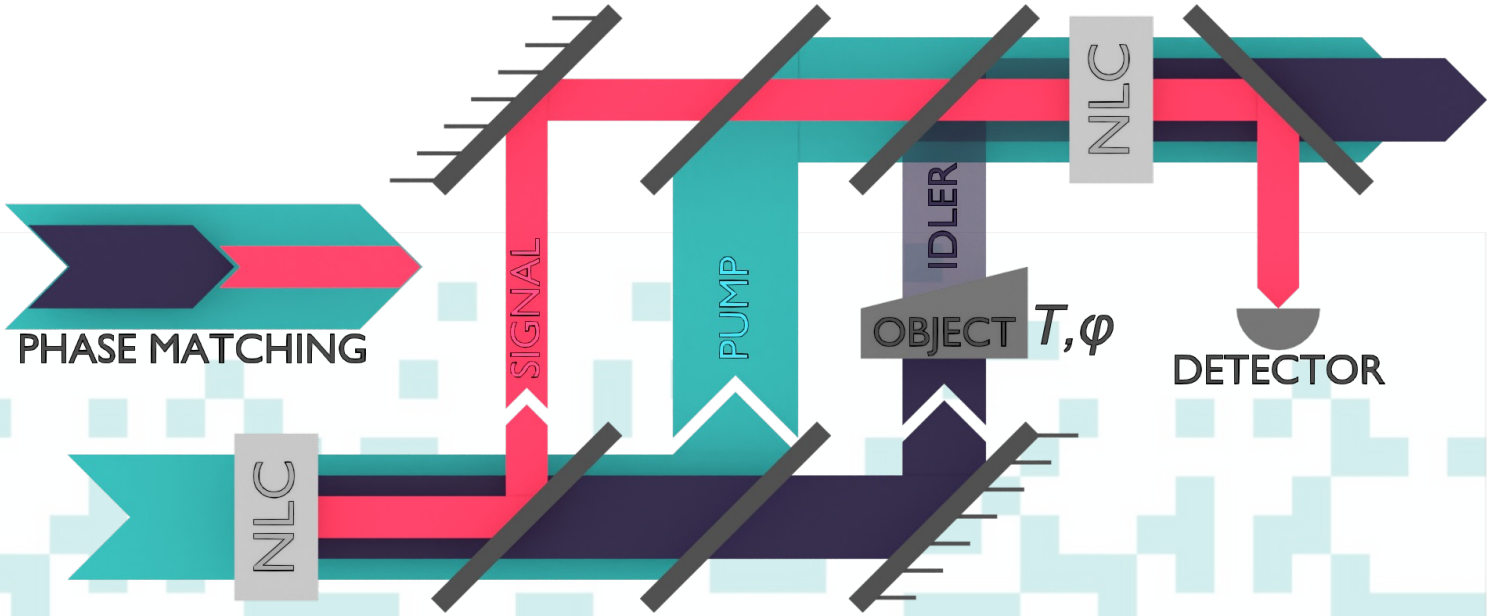
Quantum Imaging with Undetected Photons

Uses TWO identical entangled photon pair sources (Non-Linear Crystals, NLCs).

"Signal" beams are overlapped onto camera: you can't tell which NLC source they came from.

Interference is only seen as long as you can't know which NLC the photons came from => stops if you block the "Idler".



Zeilinger's group Lemos et al. " Quantum Imaging with undetected Photons" Nature 512, 409-413, (2014).

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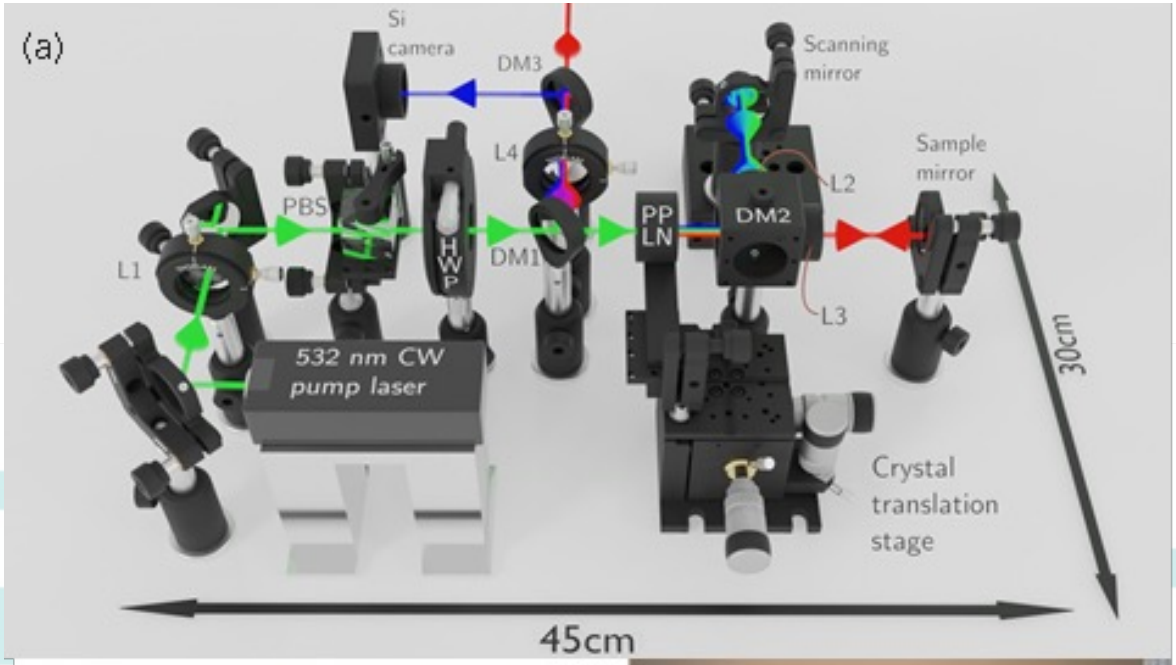
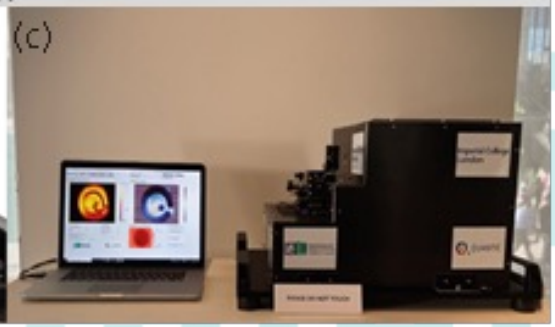
“EntangleCam” Mk 1

QUANTIC

The UK Quantum Technology Hub in Quantum Enhanced Imaging

UK NATIONAL QUANTUM TECHNOLOGIES PROGRAMME





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“EntangleCam” Mk 2

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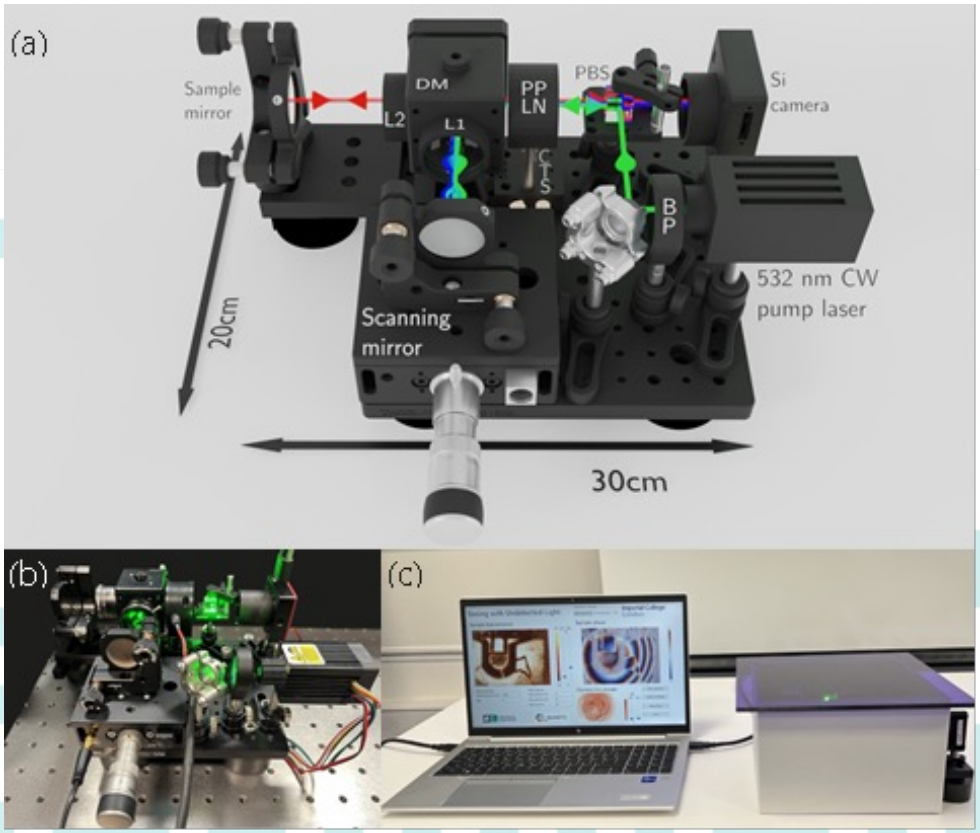

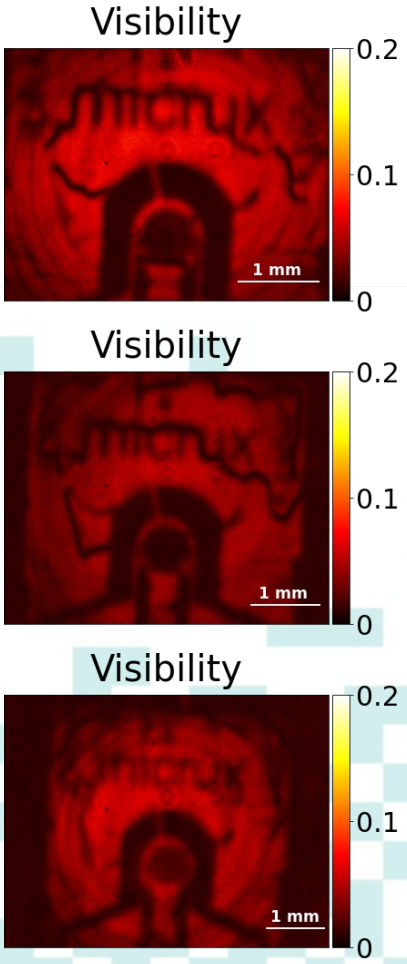

Emma Pearce, * Nathan R. Gemmell, Jefferson Flórez, Jiaye Ding, Rupert F. Oulton, Alex S. Clark, and Chris C. Phillips “Practical quantum imaging with undetected photons” **Optics Continuum**. Vol. 2, Issue 11, pp. 2386-2397 (2023)

QUANTIC
The UK Quantum Technology Hub in Quantum Enhanced Imaging

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“EntangleCam” Mk 2

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Emma Pearce, * Nathan R. Gemmell, Jefferson Flórez, Jiaye Ding, Rupert F. Oulton, Alex S. Clark, and Chris C. Phillips “Practical quantum imaging with undetected photons” **Optics Continuum**. Vol. 2, Issue 11, pp. 2386-2397 (2023)

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The UK Quantum Technology Hub in Quantum Enhanced Imaging

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Thermal background left behind...

PHYSICAL REVIEW A **108**, 032613 (2023)

Eliminating thermal infrared background noise by imaging with undetected photons

Yue Ma, Nathan Gemmell, Emma Pearce, Rupert Oulton, and Chris Phillips
Blackett Laboratory, Imperial College London, London SW7 2AZ, United Kingdom

(Received 15 March 2023; accepted 18 July 2023; published 21 September 2023)

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London, Glasgow, San Francisco, Munich...

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Acton...

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To be “realigned” by HMG security…

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Houses of Parliament

Andrew Griffith,
Minister of State, DSIT.
(HoC Nov 2023)

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The Future...

"In the event that EntangleCam performs in accordance with the assumptions made in this report, there is the opportunity for the technology to compete for some of the share within the £1bn imaging and microscopy segment of the anatomic pathology market and/or the £15bn biomarker industry. More specifically, improvements to the current Digistain platform could lead to >£100m of incremental growth over the coming 6-year period."

Independent report by Beacon Advisors (Commissioned through EPSRC)

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National quantum strategy

Mission 1

By 2035, there will be accessible, UK-based quantum computers capable of running 1 trillion operations and supporting applications that provide benefits well in excess of classical supercomputers across key sectors of the economy.

Mission 2

By 2035, the UK will have deployed the world's most advanced quantum network at scale, pioneering the future quantum internet.

Mission 3

By 2030, every NHS Trust will benefit from quantum sensing-enabled solutions, helping those with chronic illness live healthier, longer lives through early diagnosis and treatment.

Mission 4

By 2030, quantum navigation systems, including clocks, will be deployed on aircraft, providing next-generation accuracy for resilience that is independent of satellite signals.

Mission 5

By 2030, mobile, networked quantum sensors will have unlocked new situational awareness capabilities, exploited across critical infrastructure in the transport, telecoms, energy, and defence sectors.

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National quantum strategy

Chancellors Autumn Statement 2023……

Cancer detection: By 2030, new quantum imaging technologies for breast cancer detection will be in use across hospitals in the UK, significantly reducing the need for unnecessary chemotherapy. Hospital trials across a wide range of cancer types will also be well advanced.

https://www.gov.uk/government/publications/national-quantum-strategy/national-quantum-strategy-missions

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Many thanks to…

- *George Greaves[1], Hemmel Amrania[1] , Zamzam Al-khalili[1], Emma Pearce,[1],* Nathan Gemmell,[1] Jefferson Flórez,[1] Jiaye Ding,[1] Rupert Oulton, Alex Clark, Yue Ma.*
- *William R Otto,[2] Nicholas A.Wright,[2,3]*
- *Charles Coombes[4], Sami Shousa[4], Laura Woodley[4] and Charlotte Wihelm-Benarzi[4], Matt Fuchter5, Alex Porter[6], Eric Aboyage[4],*
- *Leanne Allison[7], Perdro Machado[7], Corinne Morfill[8] and Roland Fleck[7,8]*
- *[1] Experimental Solid State Group, Physics Dept., Imperial College, London, SW7 2AZ, UK*
- *[2] Histopathology Laboratory, Cancer Research UK, London Research Institute,44, Lincolns Inn Fields, London, WC2A 3LY.*
- *[3] Centre for Digestive Diseases, Barts and the London School of Medicine and Dentistry, Queen Mary University of London*
- *[4] Department of Cancer and Surgery, Faculty of Medicine, ICTEM, Room 145, Du Cane Road*
- *London W12 0NN.*
- *5 Dept Chemistry, Imperial College, London, SW7 2AZ, UK.*
- *6 Dept Materials, Imperial College, London, SW7 2AZ, UK*
- *7 Centre for Ultrastructural Imaging, Kings College London, SE1 1UL, United Kingdom*
- *8 Randall Centre for Cell and Molecular Biophysics, Kings College London, SE1 1YR, United Kingdom*

EPSRC

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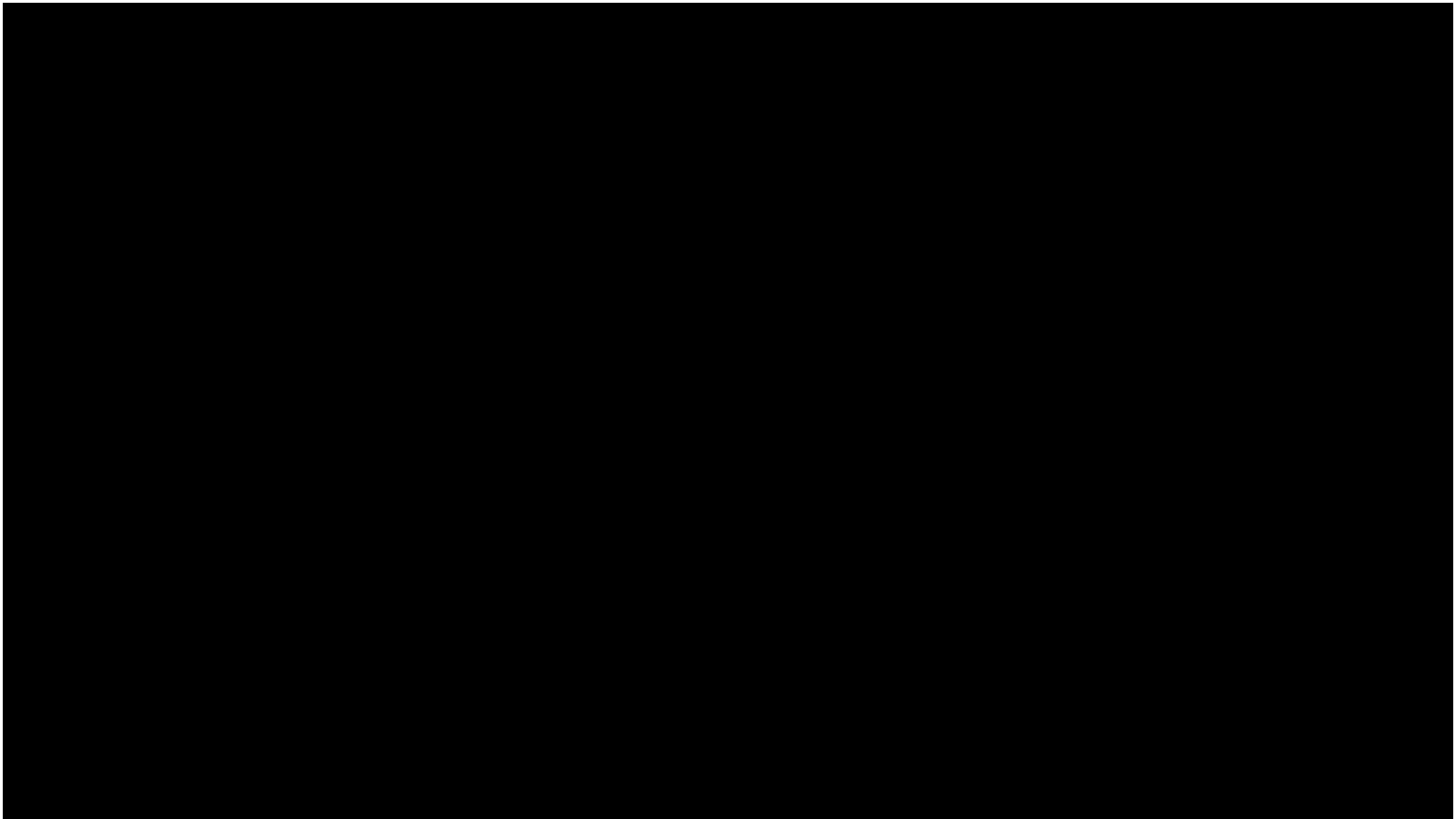
Further.

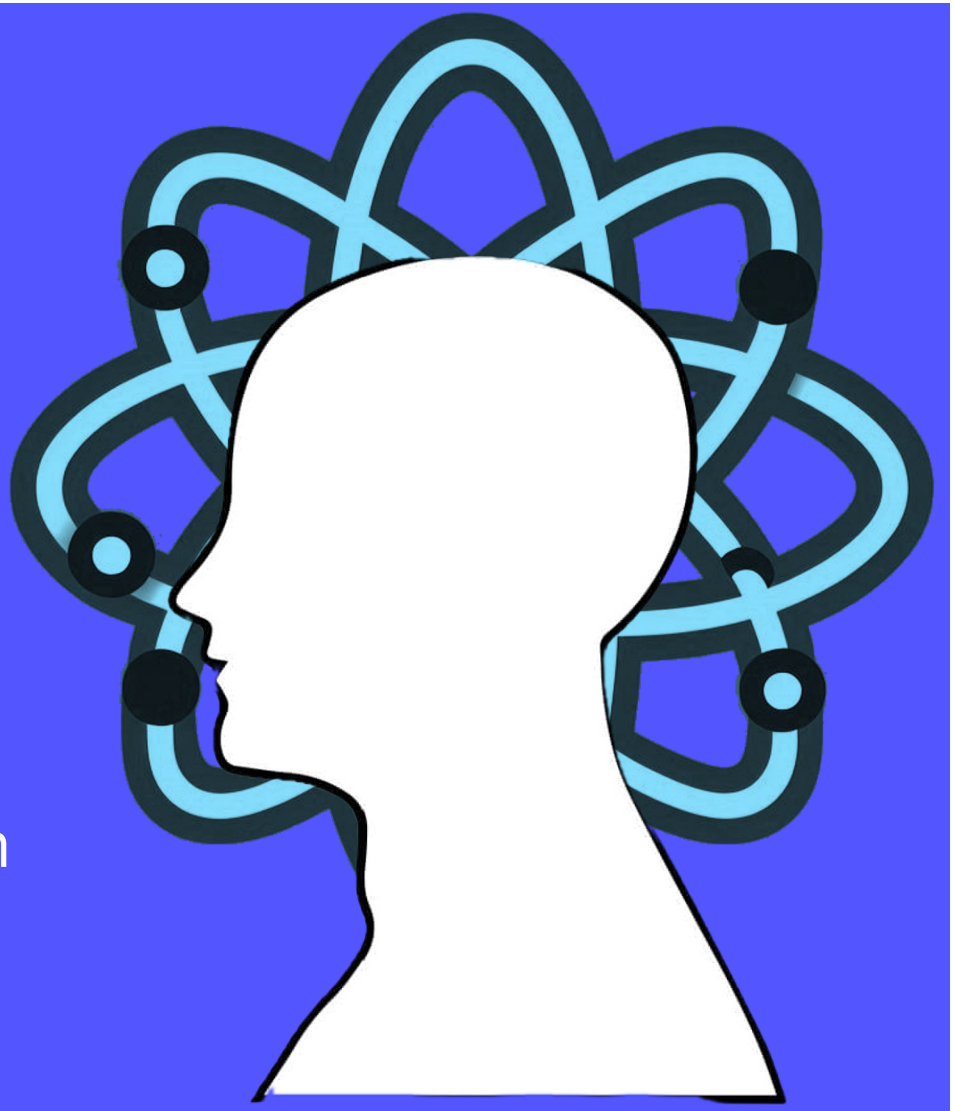


ROBQUANT

Robust quantum sensing

Dr Joe Smith
Chief Scientist

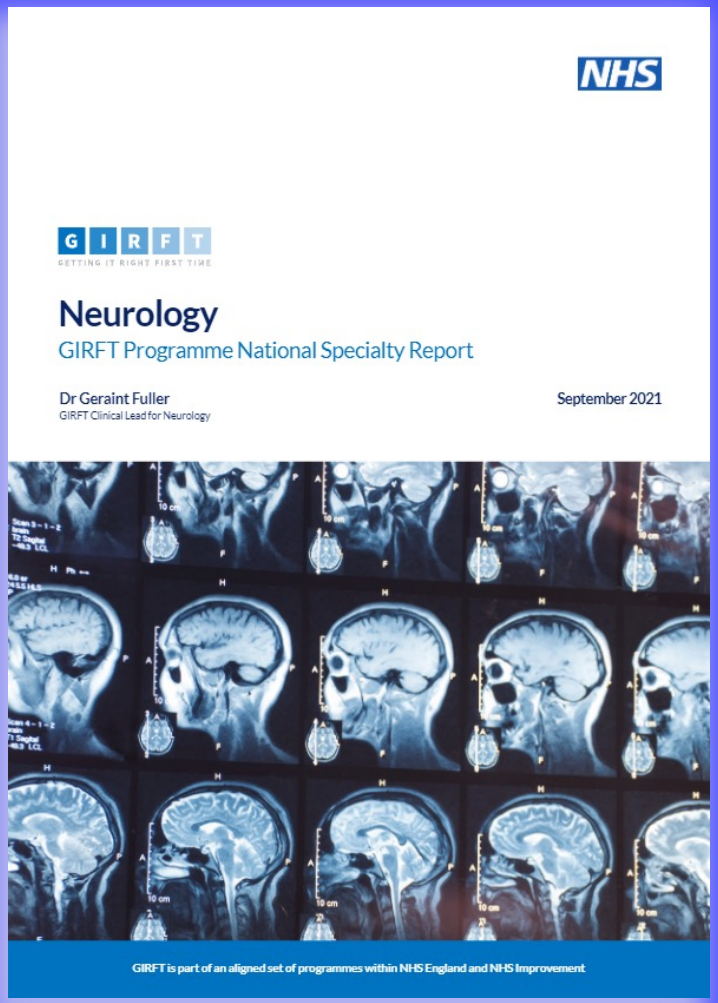
Quantum Sensing in Predictive Health and Early Diagnosis Workshop, InnovateUK, October 2024



Problem Statement

1-in-six in the UK have a known neurological condition such as

- Dementia
- Strokes
- Epilepsy



Joe Smith joe@robquant.com

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Solution: Early diagnosis (Predictive health)

© The Guardian

© BBC

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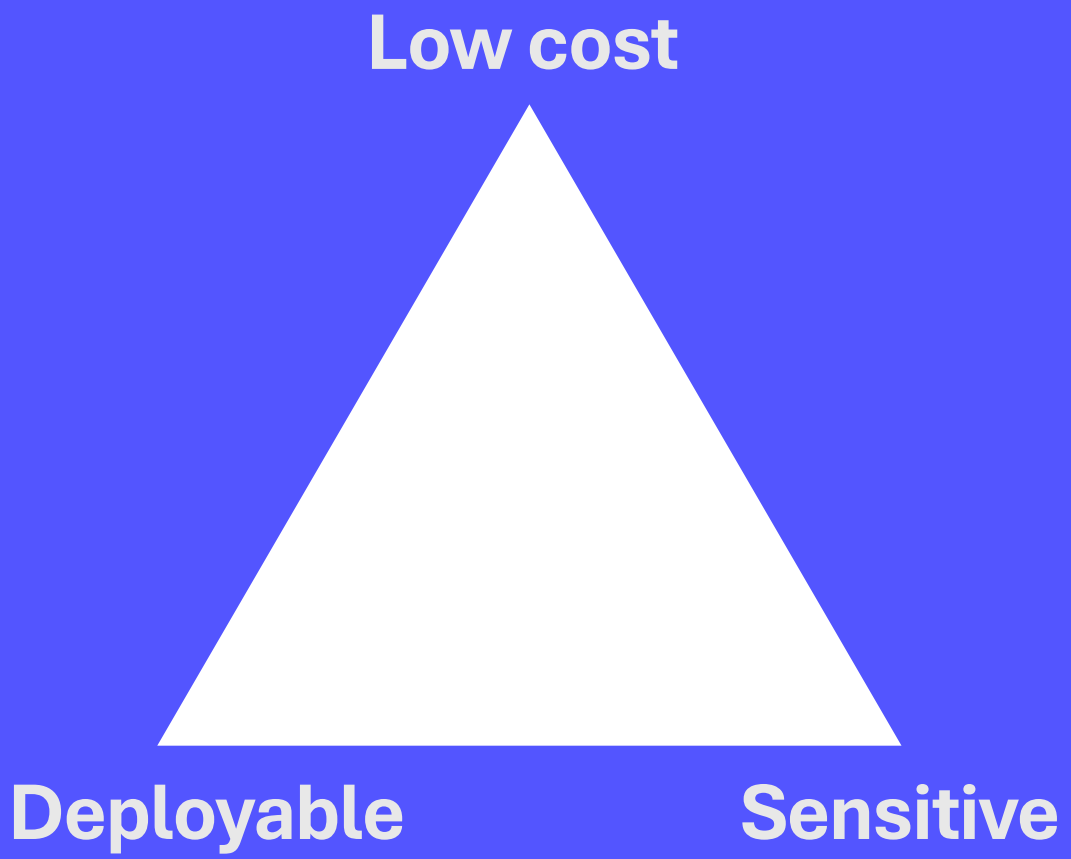
Barriers



Joe Smith joe@robquant.com

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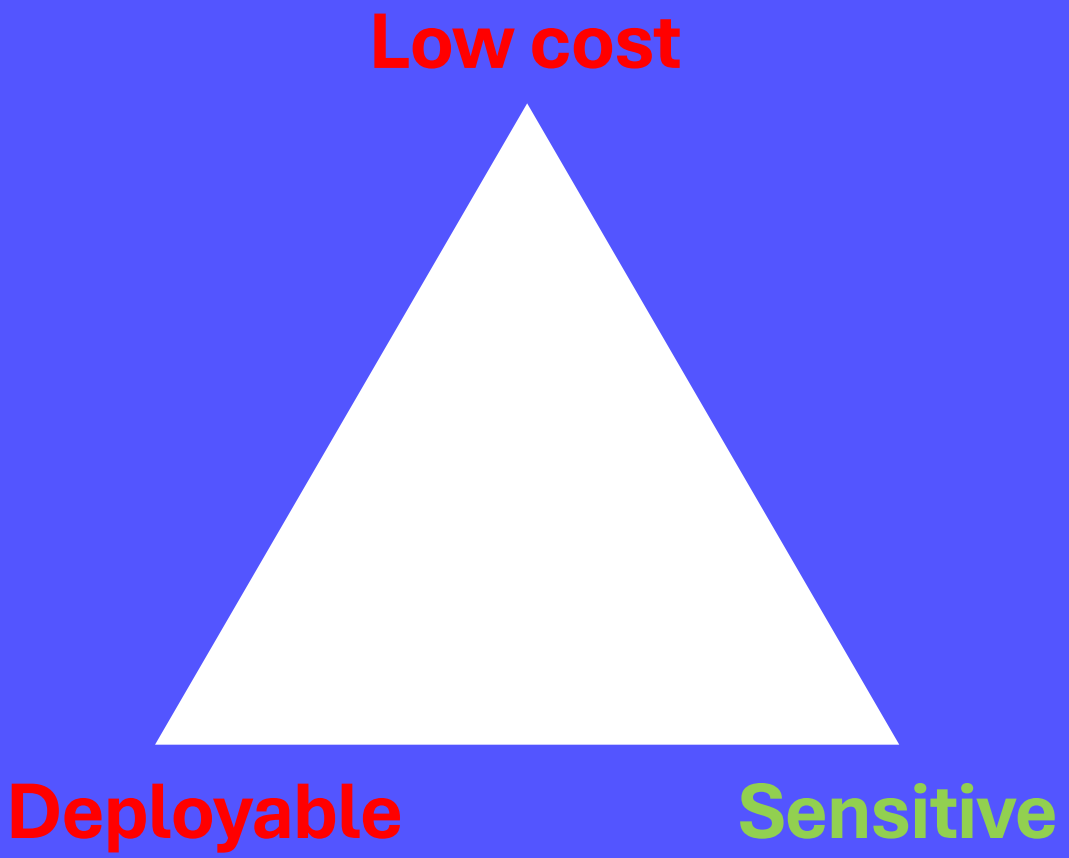
Current brain imaging: fMRI



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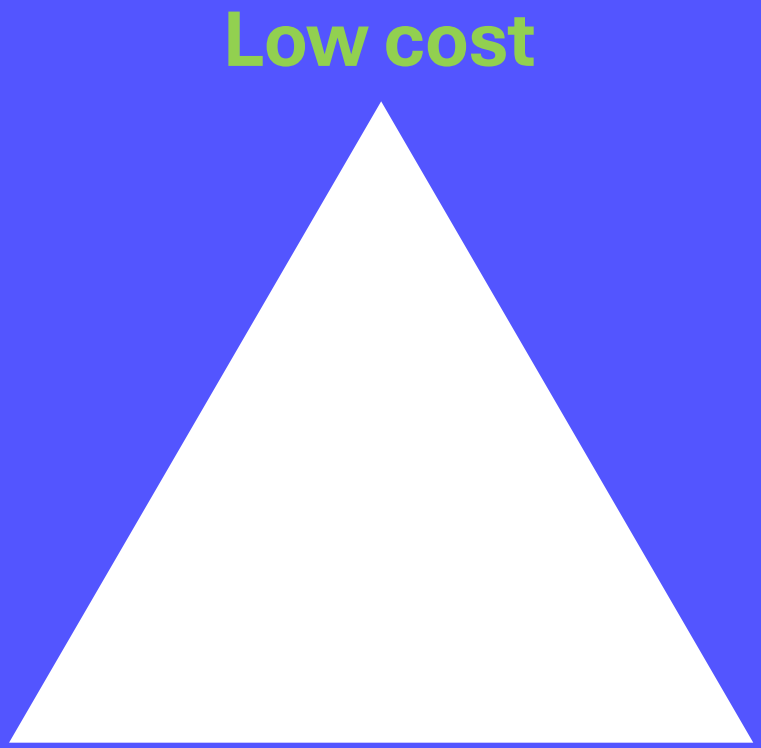
Current brain imaging: fNIRS

© Global fNIRS



Joe Smith joe@robquant.com

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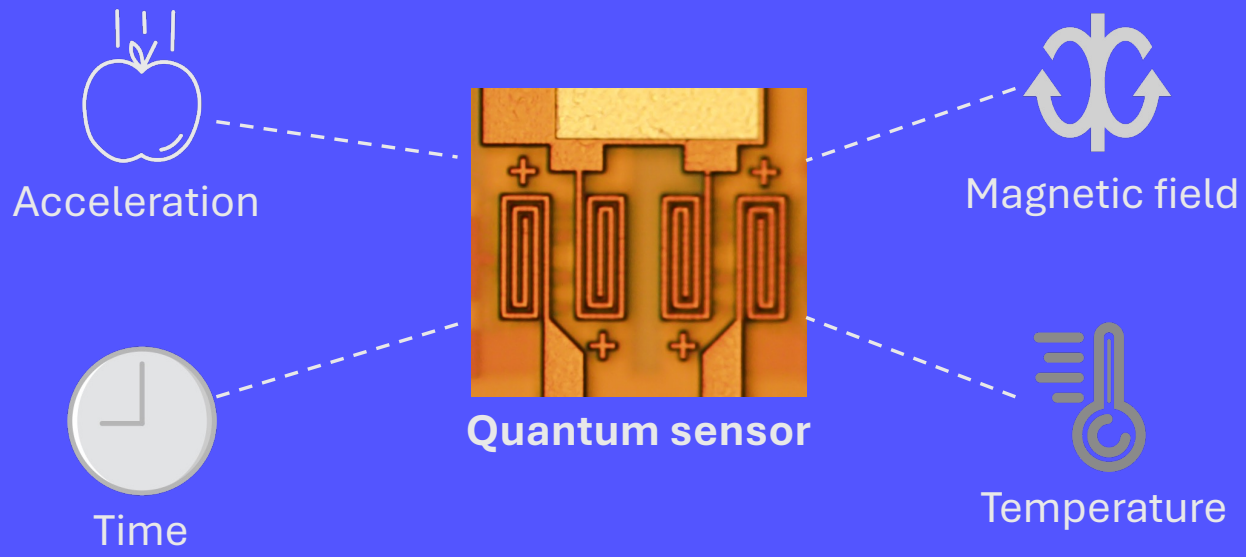
What about quantum sensors?



Quantum sensors can be used to measure a wide range of physical quantities with high sensitivity and precision.

Joe Smith joe@robquant.com

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Quantum sensing in healthcare: Magnetoencephalography

Superconducting Quantum Interference Device

- Established 1960s
- In 10 centres UK-wide
- Despite promise: Too bulky, too expensive (including to maintain)

Atom vapour cells from CercaMagnetics and quSPIN
(£ 1.7 M Feb 2023). In ~5 hospital trials across UK, Canada, US.

Joe Smith joe@robquant.com

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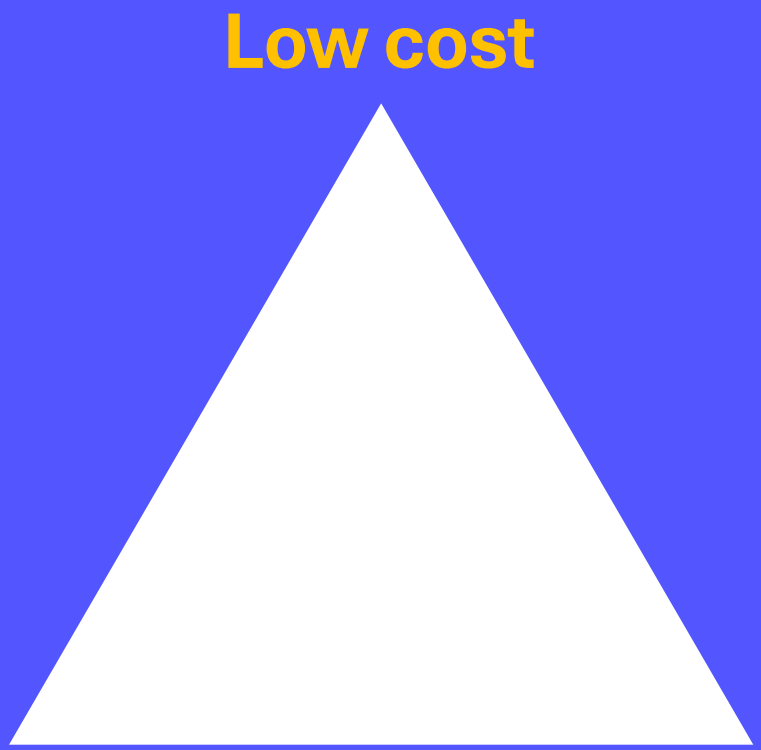
Current brain imaging: MEG

© Cercamagnetics



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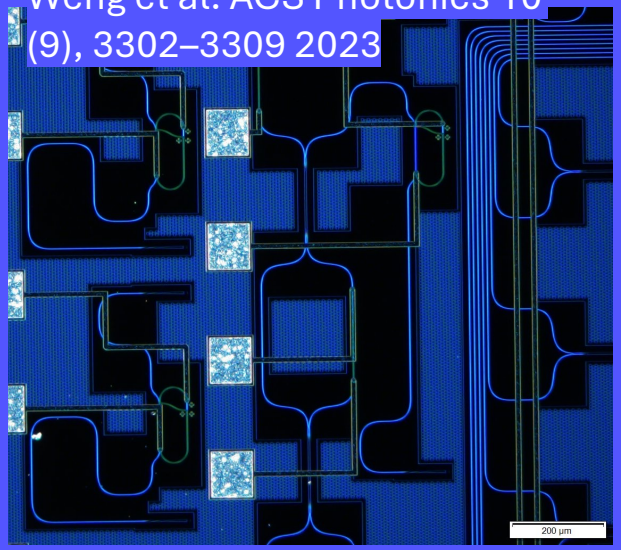
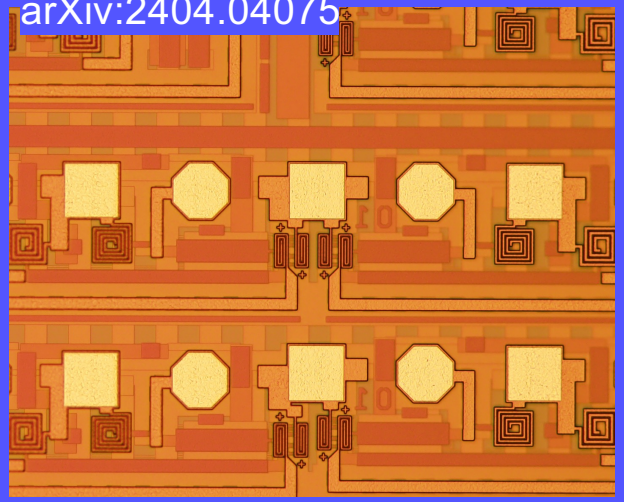
RobQuant's prototype sensor after > 10 years research at MIT and Bristol

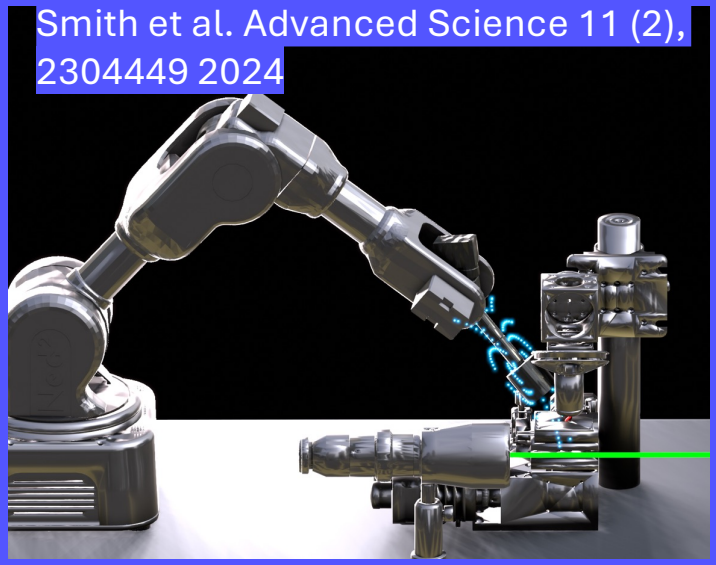
Weng et al. ACS Photonics 10 (9), 3302–3309 2023



Weng et al. *under review* arXiv:2404.04075



Smith et al. Advanced Science 11 (2), 2304449 2024



Pending patents

- GB2307741.5
- GB2404816.7

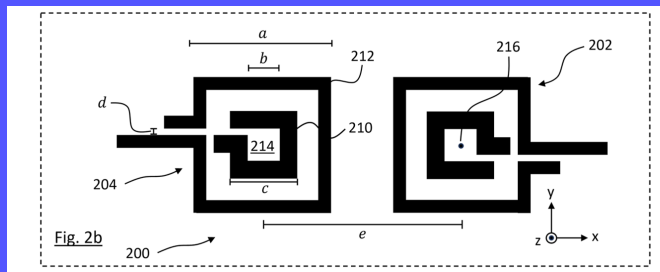


Fig. 2b

Joe Smith joe@robquant.com

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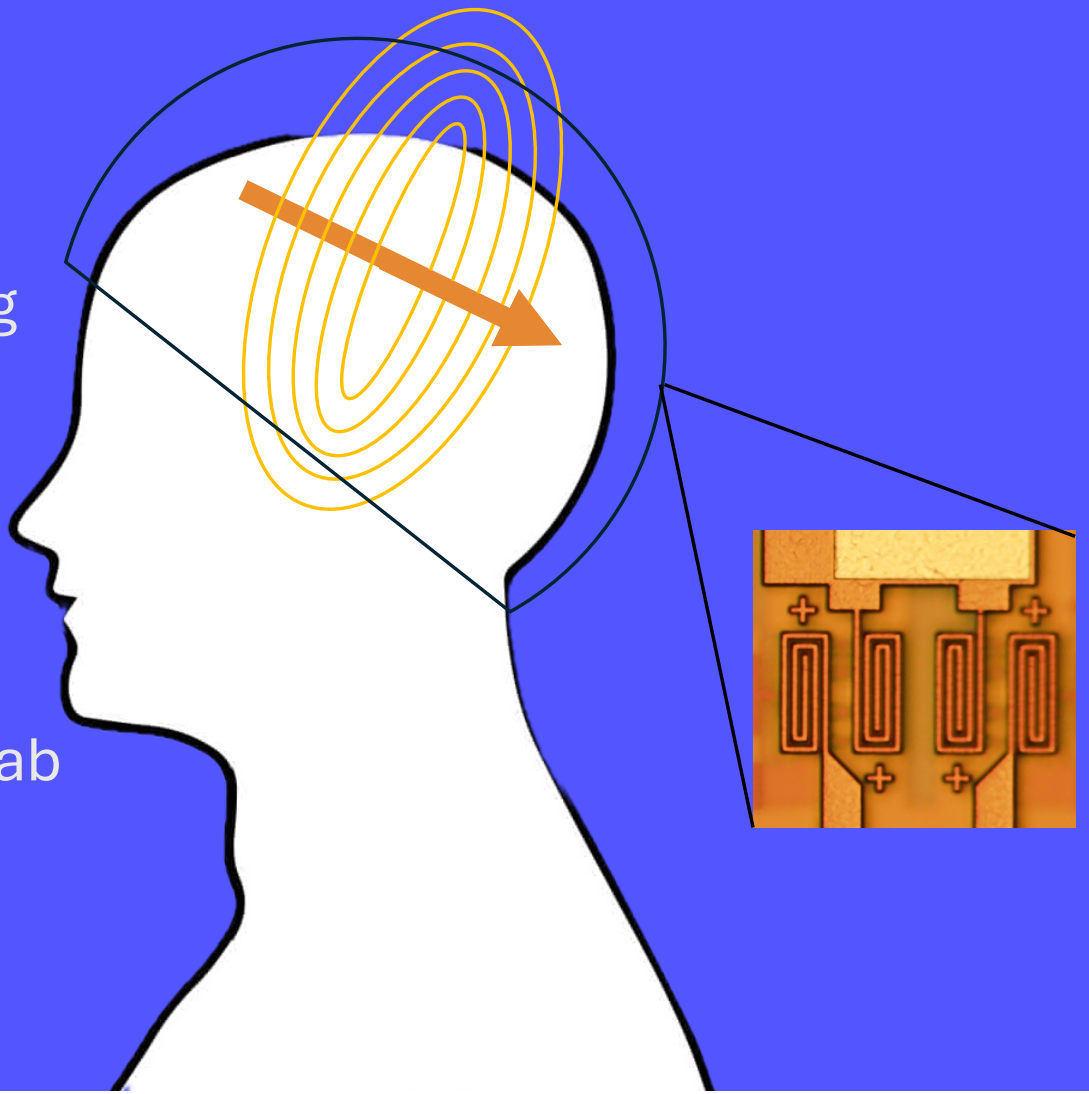
Our product:

- Non-invasive magnetic scanning
- Small and light-weight
- Wearable
- Does not require special room/lab
- Volume manufacturable



Joe Smith joe@robquant.com

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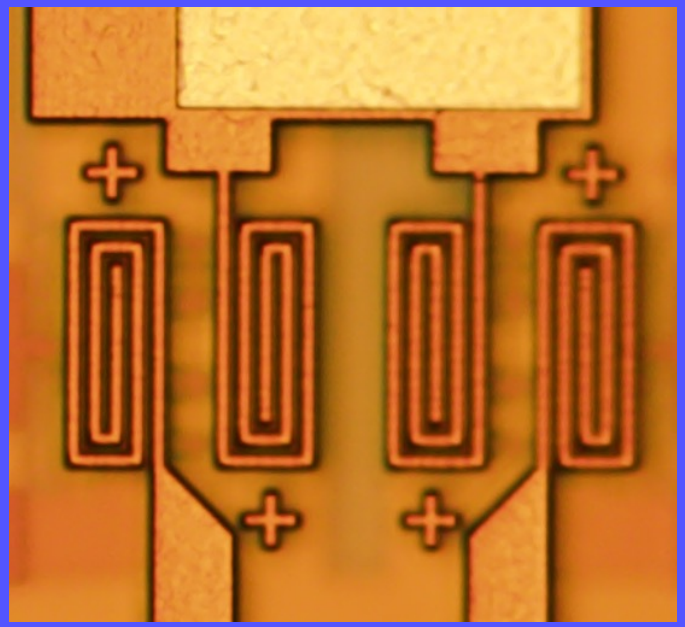
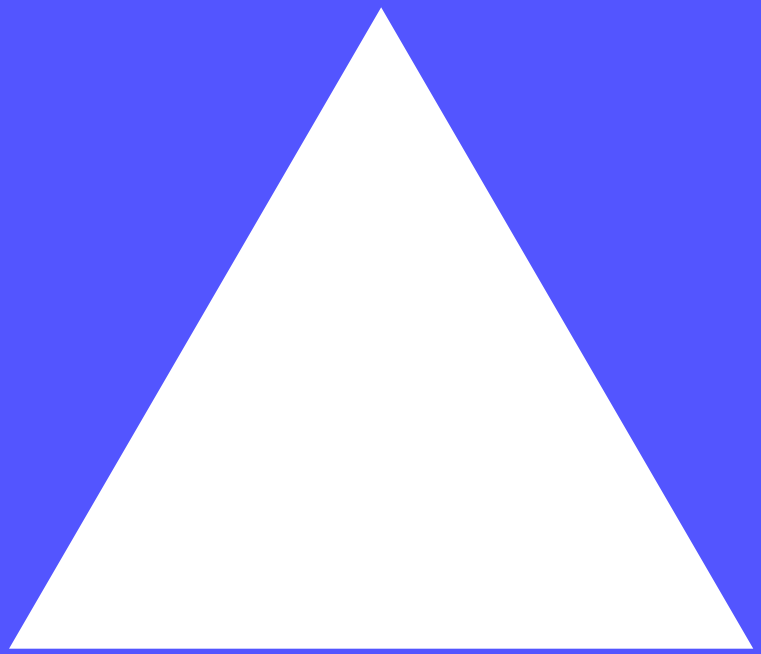


10 µm
(1/10 human hair width)



Joe Smith joe@robquant.com

RobQuant traction

SETsquared Bristol

- First market sales
- Grant income
- SETsquared incubated
- Growing team

Joe Smith joe@robquant.com

ROBQUANT

What's next?

- Initial cost to manufacture high. More units → lower cost
- Volume manufacture requires volume uptake: healthcare market tough!
- **We're here for conversations!**

Joe Smith joe@robquant.com

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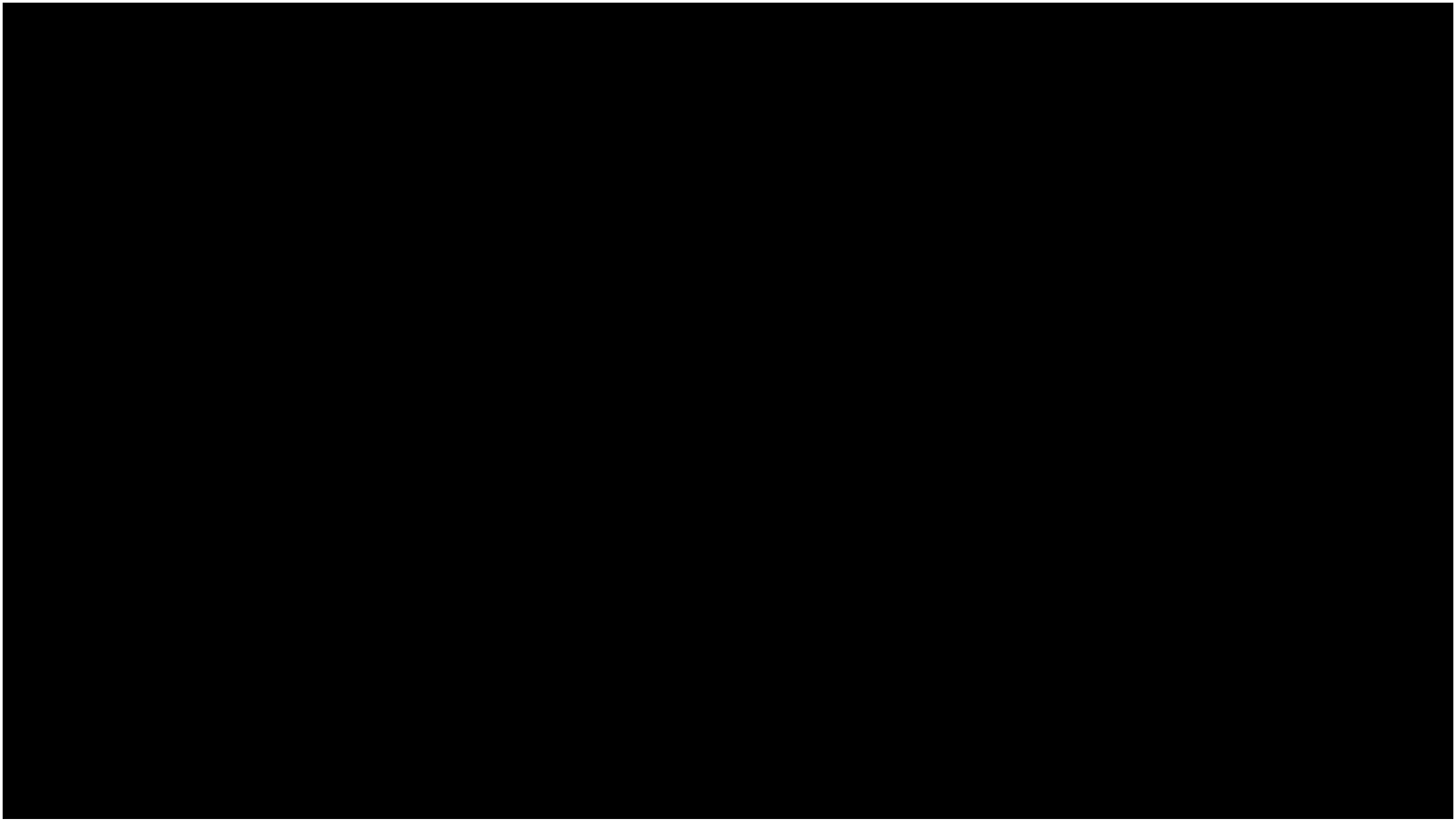


Quantum Sensing and Imaging Applications Discussion

- This second session will address additional areas where Quantum Sensing and Imaging would be useful and who else could use this technology. For example, Cerca Magnetics who use Optically pumped magnetometers for brain MEG based imaging, can be applied to sense magnetic fields from other parts of the body, such as the nervous system. Information can also be drawn from the what you have seen and the Innovate UK Quantum for Life Report. This session will also ask about what competing technologies do you know about and wider conversations about their benefits.

UKRI Innovate UK

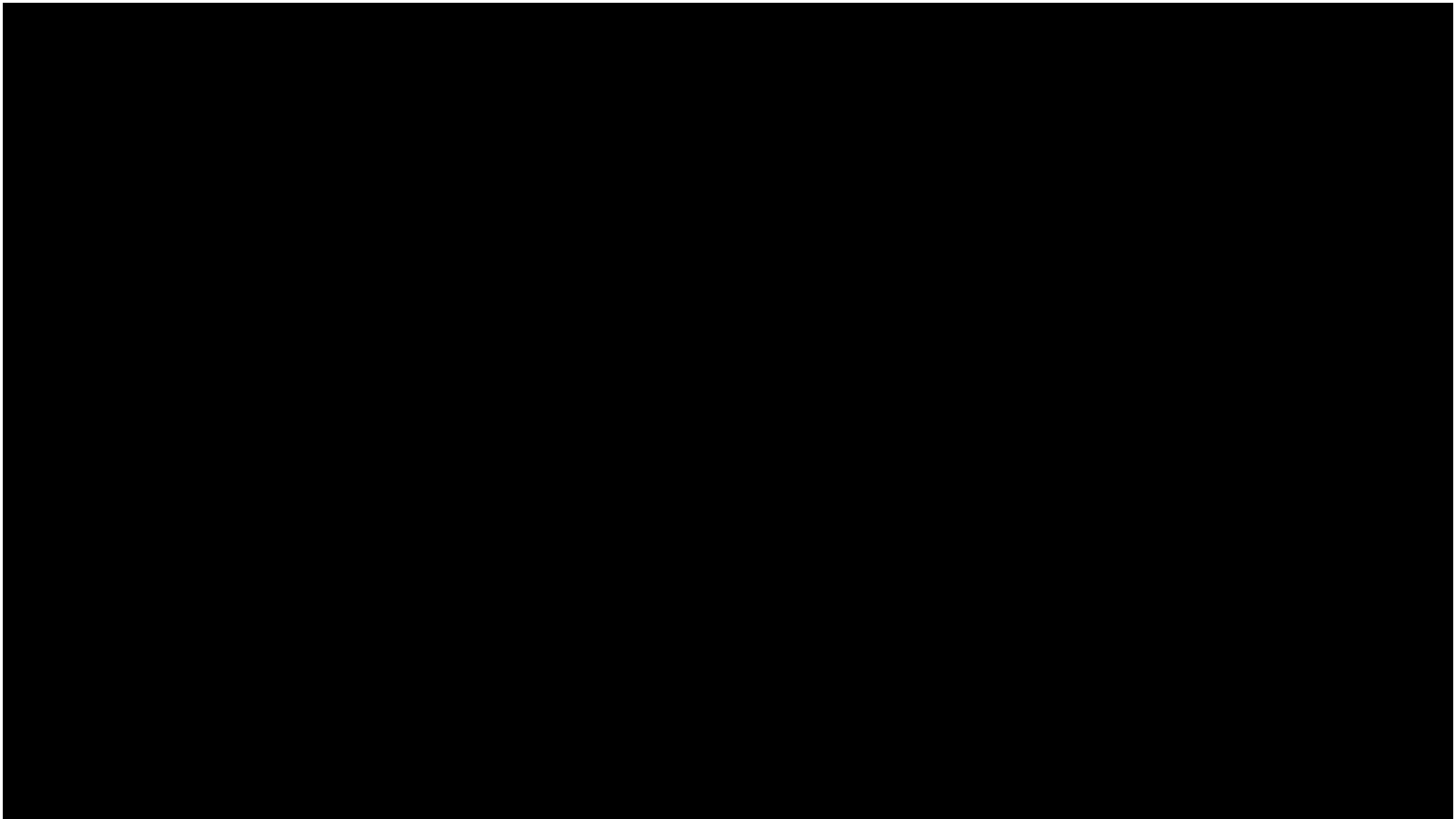
NPL National Physical Laboratory

Session 3 – Chaired by Amy Romaniuk

Start	Finish	Activity	Presented by	Institution
14:20	14:35	Saving Schrödinger's cat Glioma Radiogenomics for non-invasive genetic prediction of adult glioma	Dr Akshaykumar Kamble	Imaging Beyond
14:35	14:50	Design and development of medical devices – key issues to watch out for	Dr Tom Harvey	CPI
14:50	15:05	The Voice of Healthtech	Nishan Sunthares	ABHI
15:05	15:15	Product Development With Clinical Input	Dr Christin Henein and Dr Ben Hunt	UCL and Siloton
15:15	15:50	Health Infrastructure and Technology Translation Discussion	-	-
15:50	16:00	Quantum sensing: Revolutionising Predictive Health & Early Diagnosis - Final Comments	Professor Melissa Mather	Government Office for Science | University of Nottingham

UKRI Innovate UK

NPL National Physical Laboratory



Design and development of medical devices – key issues to watch out for

Dr Tom Harvey

Chief Technologist, Healthtech

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www.uk-cpi.com

cpi

Focus areas

Medical devices

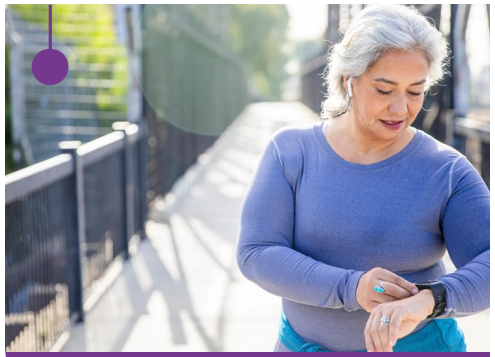
Fast-tracking MedTech, with **multi-disciplinary teams** supporting across technology verification, concept design and rapid prototyping to pre-clinical scale up process development

We **specialise in new materials, novel form factors** and the challenges of **scale up**

In-vitro diagnostics

Accelerating the development of specific, reproducible and affordable diagnostic solutions

CPI can support from synthesis, characterisation and scale up of **novel reagents** through to development of **new sensors**, assays, **custom readers** and **digital connectivity**



Wearable health

Making **next generation devices** lighter, smarter, stretchable and more **functional**, with integrated sensors and seamless data transfer

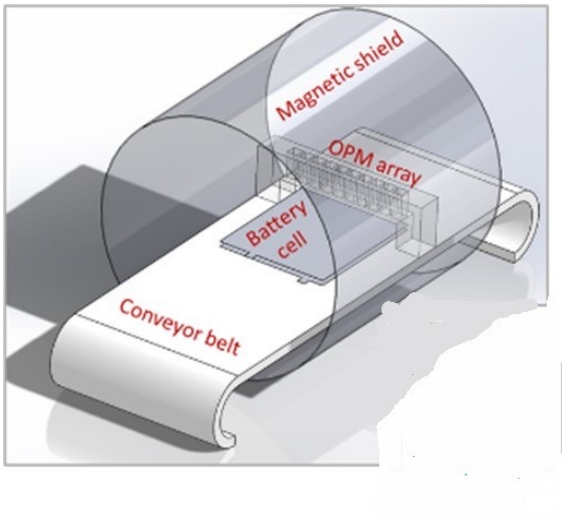
We specialise in additive manufacturing, anatomical phantoms, and converting traditional electronics to flexible hybrid circuits

Internet of medical things

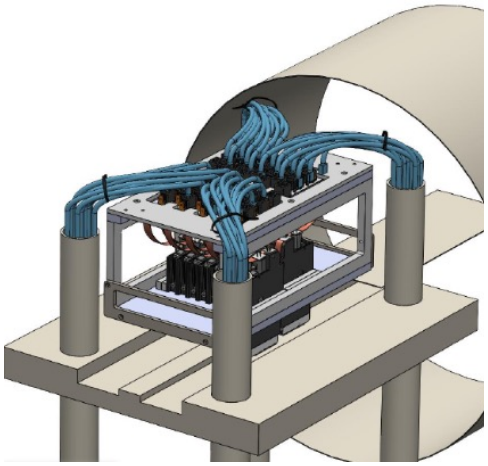
Developing **smart technologies** that **defy boundaries** to connect medical devices and bring digital HealthTech solutions to patients.

We have an **'end to end' offering** across sensor development, electrical, mechanical, firmware, and software including NFC, RFID, Bluetooth and 5G communication

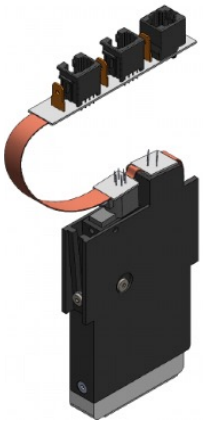
Example: Quantum sensing for End-of-Line Battery Testing. Innovate UK Project Number: 42186



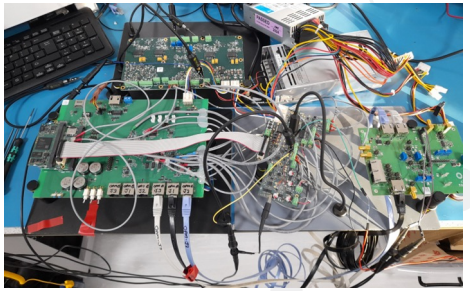
Product concept



Mechanical design



OPM module



Electronics & Firmware

Project partners: AMTE Power Ltd, CPI, Kelvin Nano Technology Ltd, University of Strathclyde, University of Sussex, Alter Technology Ltd, CDO2 Ltd, CSC, CST Ltd, Magnetic Shields Ltd.

Duration: August 2020 to May 2024.

HealthTech Regulatory and Innovation programme (HealthTRIP)

When: February 2022 to March 2023

How: It was delivered by **CPI**, in partnership with ABHI and Cambridge Design Partnership, and funded by Innovate UK.

What: It provided a wide package of support to the UK HealthTech industry to help in a changing regulatory environment

Why: Meeting medical device and IVD regulations remains a massive challenge for the industry as regulation remains prohibitively complex for SMEs without in-house expertise.

Products continue to be **withdrawn**, and innovative new devices **fail** to navigate to the market.

A

HealthTRIP - outputs

www.uk-cpi.com/HTRIP

www.uk-cpi.com/IVD-roadmap

www.uk-cpi.com/healthtech-scale-up-report

www.uk-cpi.com/healthtech-digital-health-report

Regulatory challenges – general findings

SMEs find regulations confusing

- Especially with all the recent flux

Some (early) SMEs struggle even with ‘simple’ regulatory concepts

- Demand for a clear “Regulatory Roadmap”

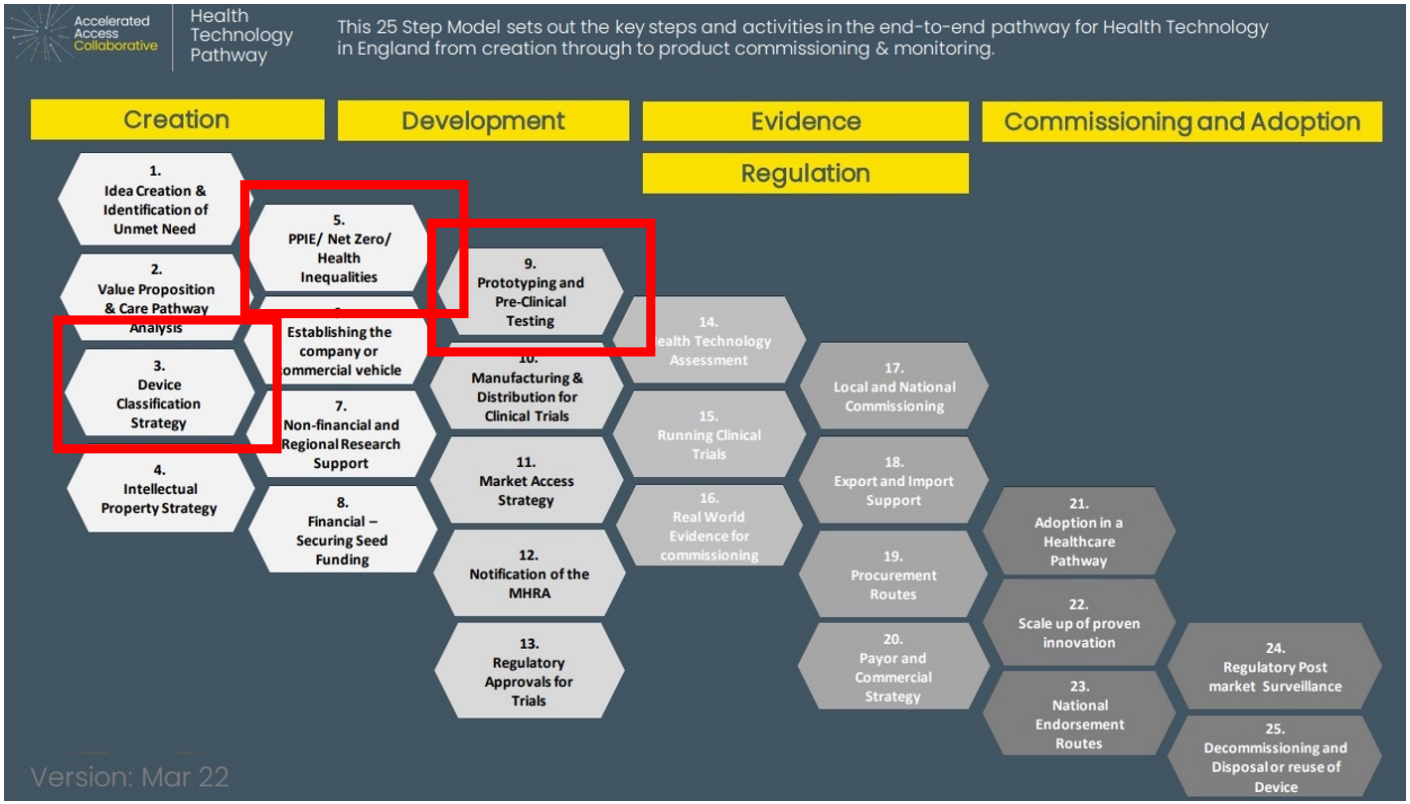
Most common comments and questions:

- “What do I do, when?”
- “What should I ask, and when?”

General CPI SME asks:

- “How long will regulatory take me?”
- “How much will it cost me?”

Accelerated Access Collaborative (AAC) Health Technology Pathway: Navigation Tool for Innovators in England



Ref: https://www.england.nhs.uk/aac/wp-content/uploads/sites/50/2023/04/aac005a-health-technology-pathway-map.pdf

Device Classification

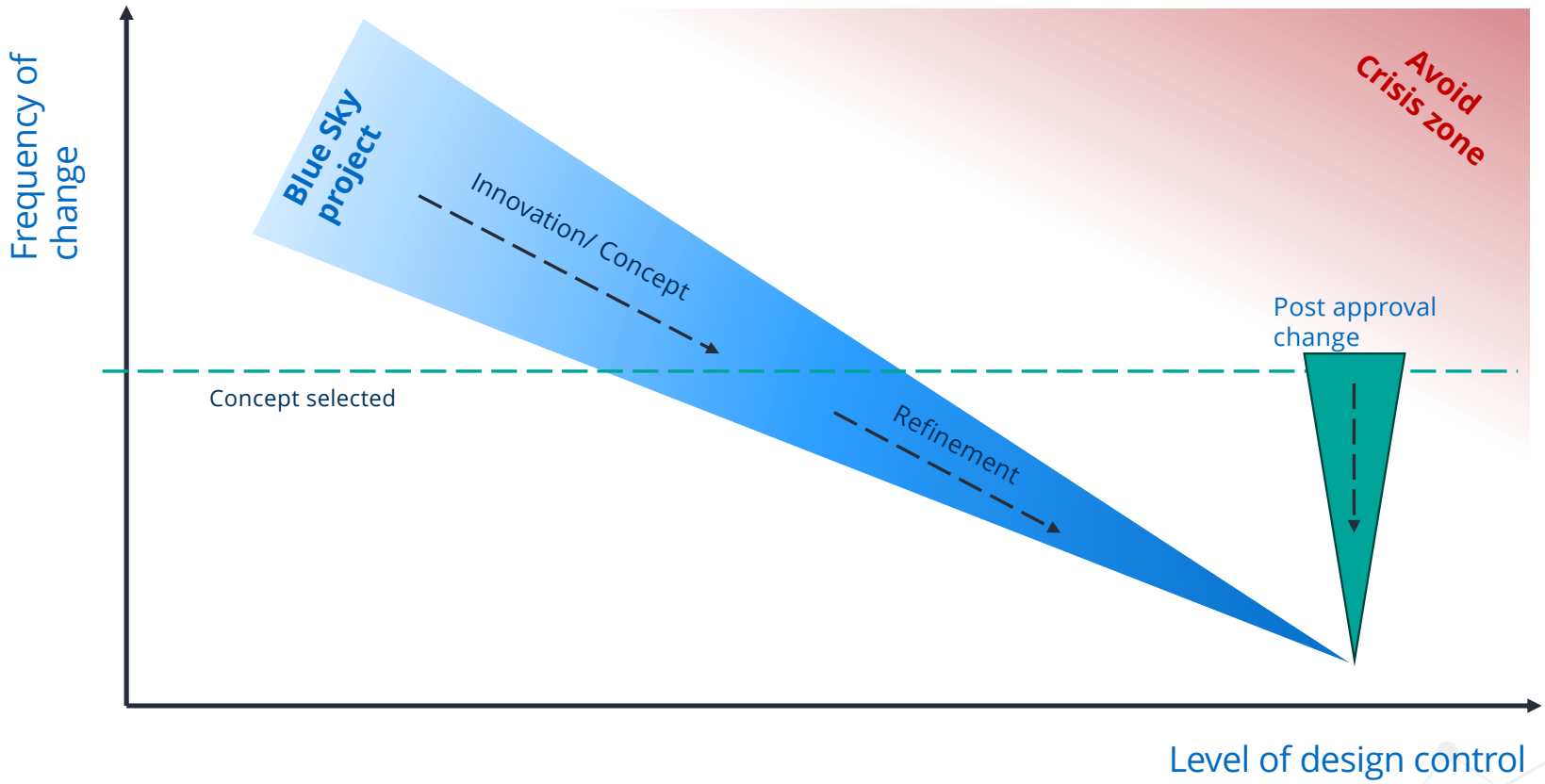
Key Points

- Determine if your product qualifies as a medical device or IVD medical device at an early stage to understand the **applicable regulations**.

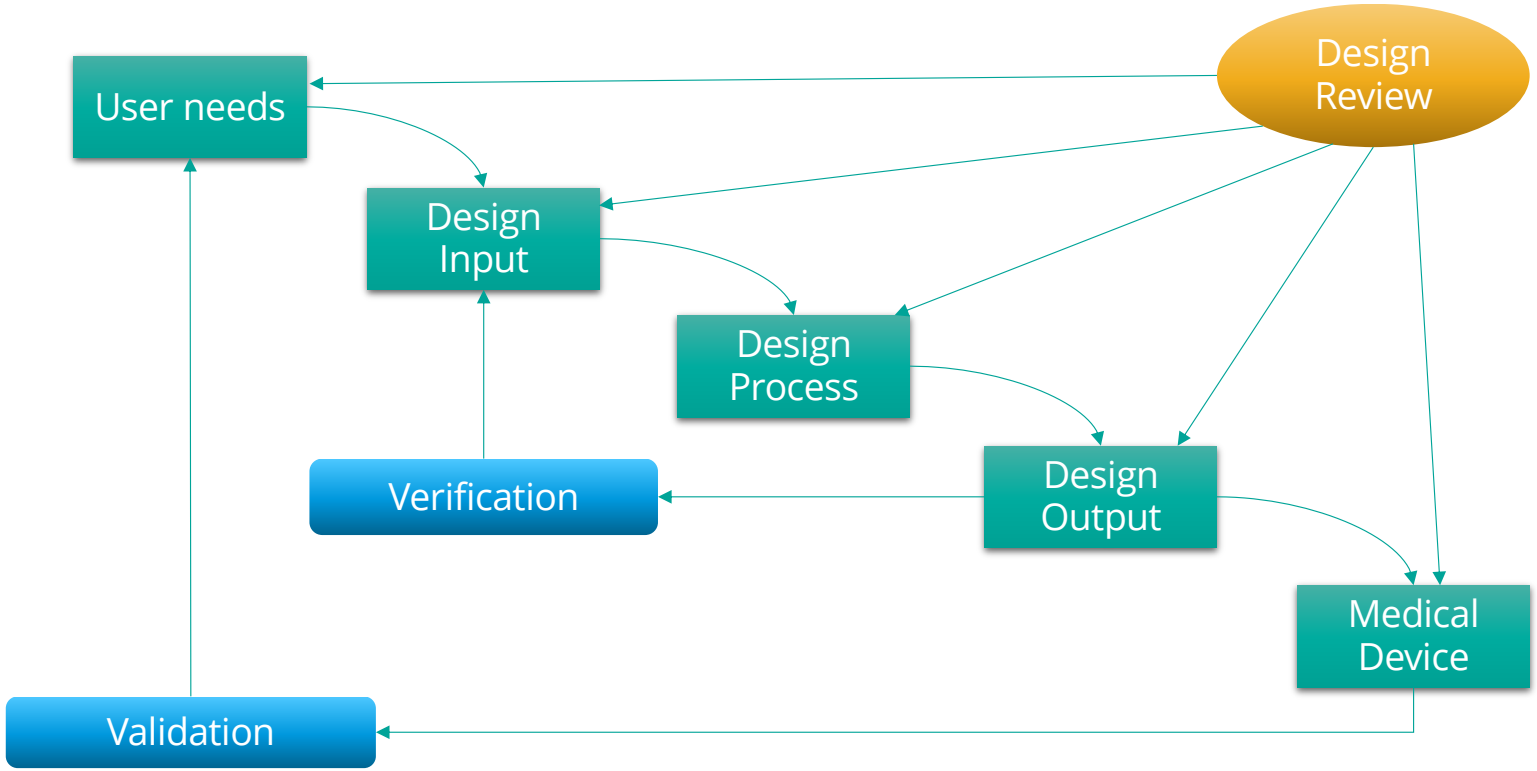
- Sufficiently clear **intended purpose** is key to meeting various aspects of the medical device regulations effectively.

- Carefully evaluate the **classification** of your devices based on its intended purpose, and associated functionality/composition etc. Seek clarification where necessary to ensure adequate consideration of regulatory requirements.

Design Control – When?



Medtech product development process

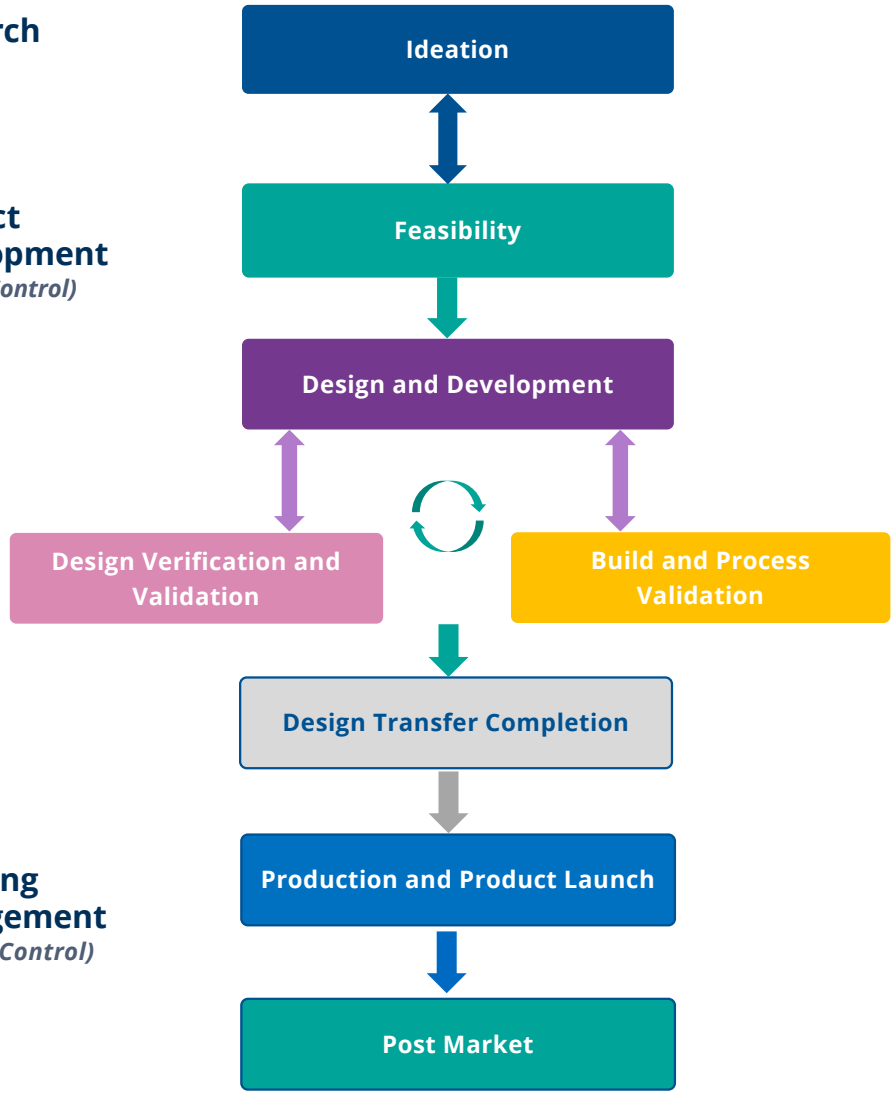


Average 3-7 years (US data from 2016)

Research

Product Development
(Design Control)

On-going Management
(Change Control)



Risk management & State of the Art Evaluation

Quality Management System

- ✓ State of the art evaluation

- ✓ Product Description & Intended Purpose
- ✓ Regulatory Strategy, Product classification
- ✓ Identification of Harmonised standard & Common Spec etc.
- ✓ User and Product Requirements
- ✓ Design Verification and Validation Strategy
- ✓ Manufacturing capability
- ✓ Clinical/Performance Evaluation Planning

- ✓ Design History File (DHF)
- ✓ Device Master Record (DMR)

- ✓ Clinical Investigation
- ✓ Clinical/Performance Evaluation Finalisation
- ✓ Technical Documentation
- ✓ Regulatory Submission & Approval (12-24months)

- ✓ Product Registration
- ✓ On-going Clinical Evaluation & Post-market surveillance (PMS)
- ✓ Change Management
- ✓ Vigilance

Public Patient involvement (PPI)

Key points

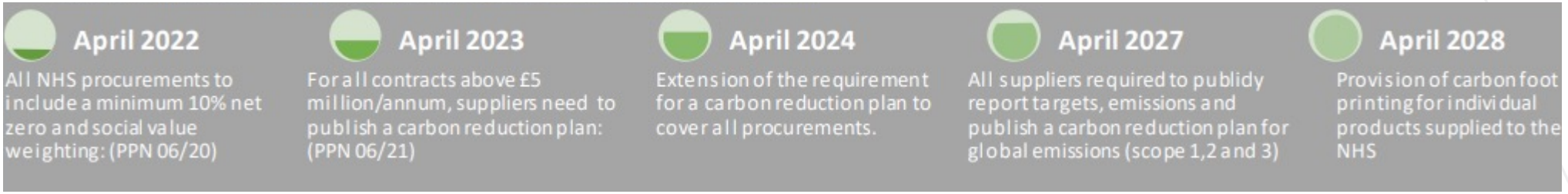
- Involve patients, people who access services, carers, charities, community groups and others into the development of new medical devices from the early stages.

Health Inequalities

Key points

- Health inequalities are unfair and avoidable differences in health across the population, and between different groups within society
- Ensure you have considered the impact of your innovation on Health Inequalities

NHS' Net Zero requirements



Key points

- Design from the start with Net Zero in mind
- Develop a strategy and map out the environmental impact
- Understand how to assess and report carbon emissions

Potential barriers specific to quantum sensing devices for Healthcare

- Lack of common harmonised standards to design to
- Complexity of verification and validation
- Scarcity of people with relevant expertise and skills
- Constrained manufacturing capacity

Thank you

For more information visit **www.uk-cpi.com**

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Chief Technologist

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Let's innovate together
www.uk-cpi.com

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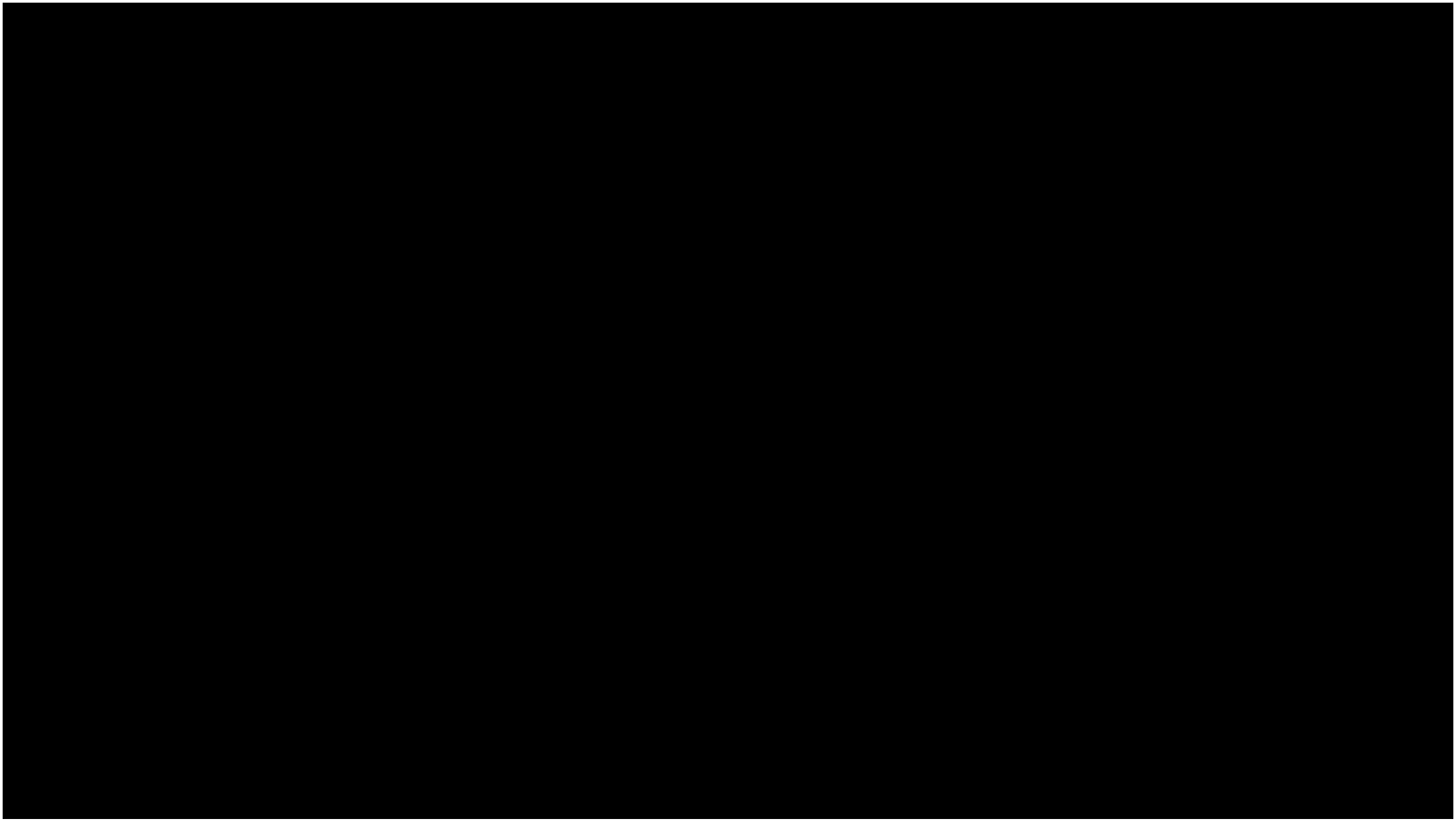


ABHI

ABHI

THE VOICE OF HEALTHTECH

10th October 2024

DISCUSSION POINTS

- ABHI – Who we are, what we do
- Innovation
- Building for success

ABHI

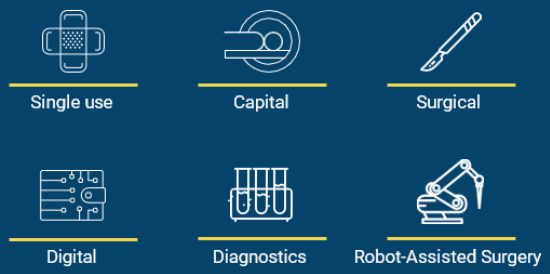

FUNCTIONS
STAKEHOLDER ENGAGEMENT
BUSINESS AREA
REGULATION
MARKET ACCESS
POLICY & PARTNERSHIPS
COMMUNICATIONS
NHS
GIG CYMRU NHS WALES
Health Innovation Network
NIHR National Institute for Health Research
MHRA
Office for Life Sciences
Department of Health & Social Care
Department for Science, Innovation, & Technology
NHS National Services Scotland
HM Treasury
NHS Providers
NICE National Institute for Health and Care Excellence
DIGITAL HEALTH
MEDICAL DEVICES
DIAGNOSTICS
INTERNATIONAL
POLICY CO-ORDINATION
SECTOR SPECIFIC PROGRAMMES

ABHI'S 2024 PRIORITIES

Key Work Areas

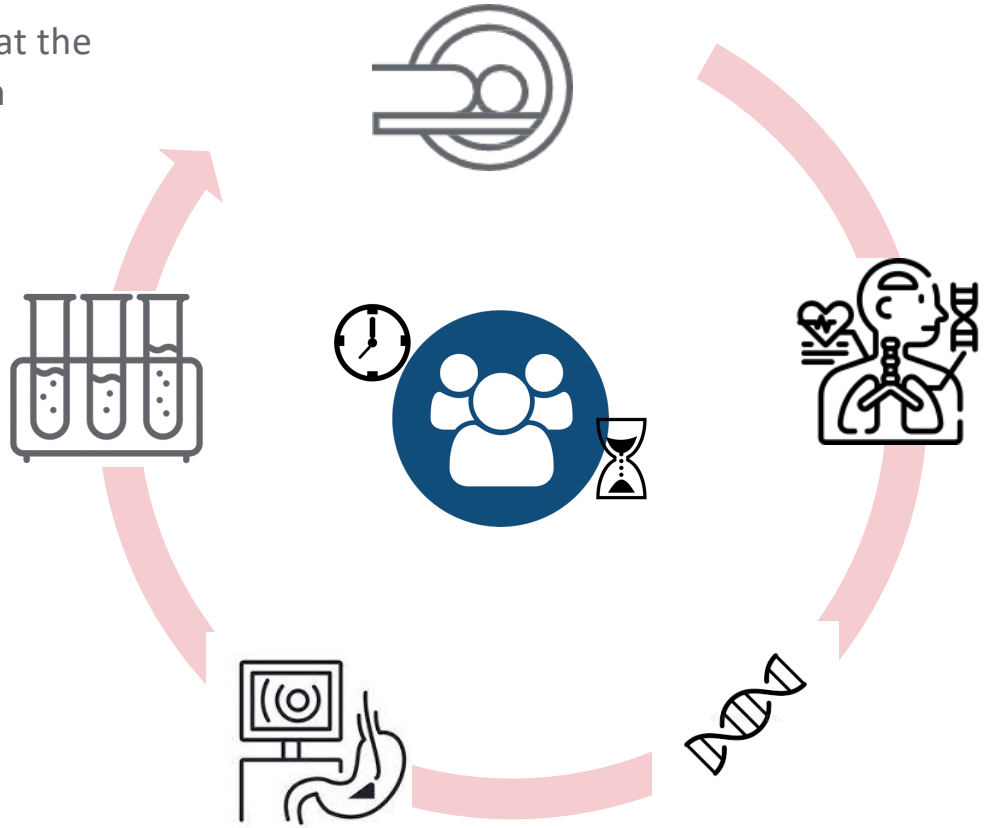
Strategic leadership provided by the ABHI Board, delivered through our network of member groups

Working across the full spectrum of HealthTech.



OUR EARLY DIAGNOSIS VISION

Early diagnosis at the centre of health management.
Multi-modality.



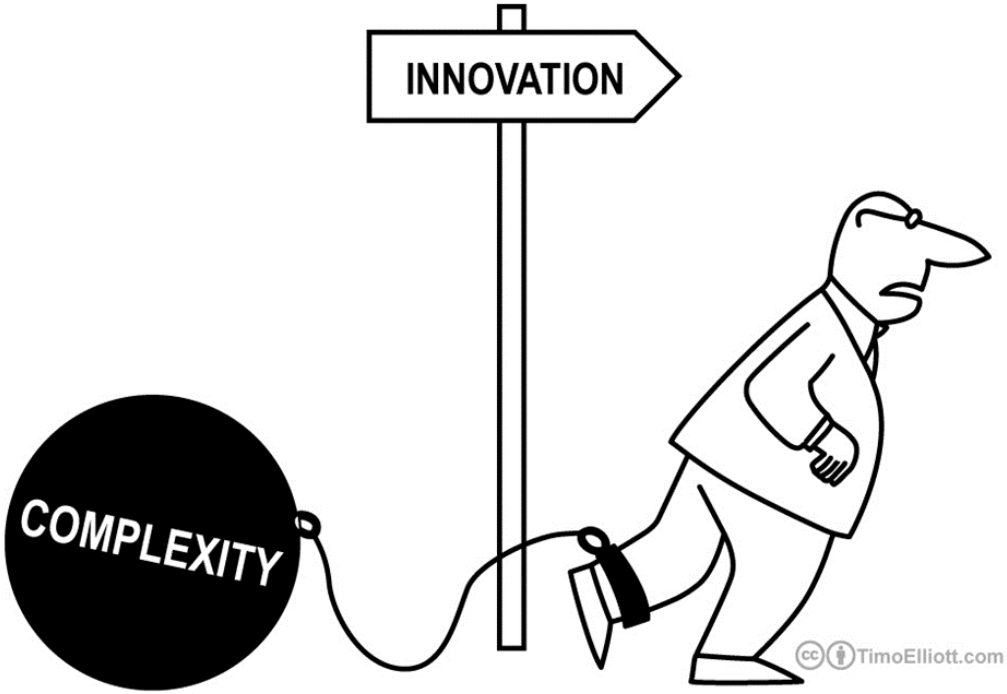
ABHI

OPPORTUNITIES LIE AHEAD…

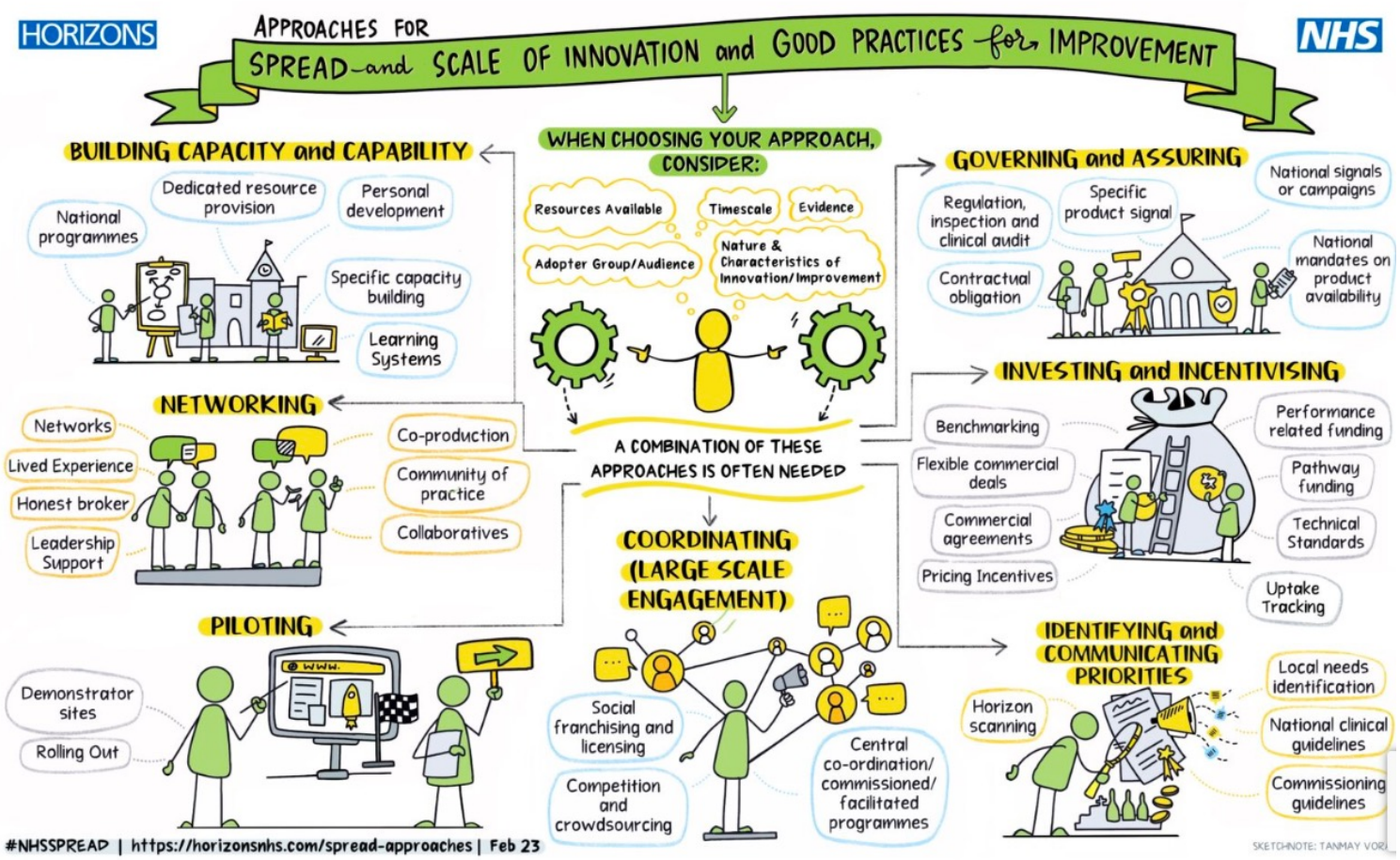
- Decentralised diagnostics
- Digital and artificial intelligence
- Genomics
- Productivity
- Sustainability
- Research

ABHI

…BUT INNOVATION UPTAKE MUST BECOME SIMPLER…



...ESPECIALLY IN THE NHS



BUILDING FOR SUCCESS

Our survey says…

- The UK surpasses the EU and US in having a research friendly environment and in its ability to evaluate technologies for effectiveness and value for money….but
- …it lags behind the EU and US in its provision of a translational research environment and its ability to adopt innovation at pace and scale.
- The single greatest thing, by a substantial margin, that the UK Government can do to support HealthTech is deliver an effective and efficient model of international recognition within our regulatory framework.
  - IR was identified as 'likely to considerably improve attractiveness' by four times as many companies, compared to any initiative in any other policy area by the UK Government.
- 1 in 3 companies are unable to meet the NHS target of Net Zero by 2045.
- Over 30% of companies surveyed intend to expand their R&D and manufacturing investments in the UK, indicating confidence in future opportunities.

ABHI

BUILDING FOR SUCCESS

Plan early to avoid pitfalls

-  Regulatory strategy
-  Clinical engagement
-  Unmet needs and value proposition
-  Sustainability
-  Partnerships

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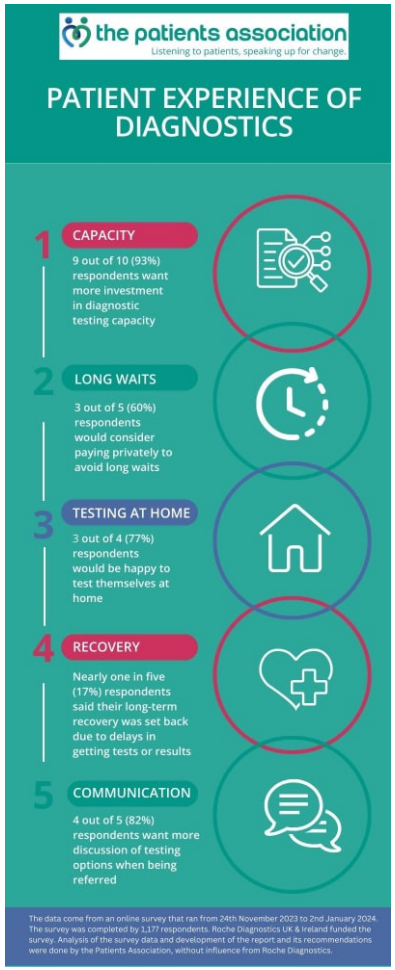
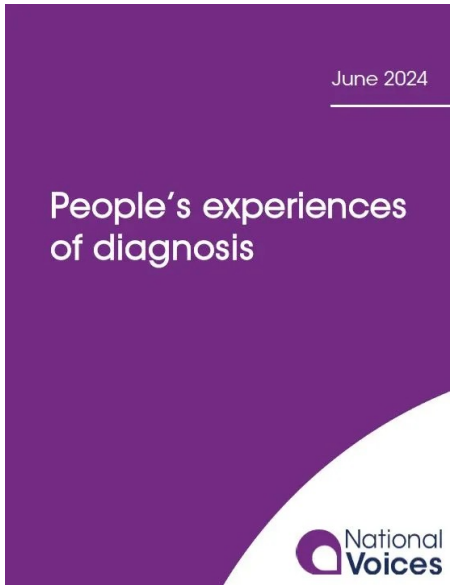
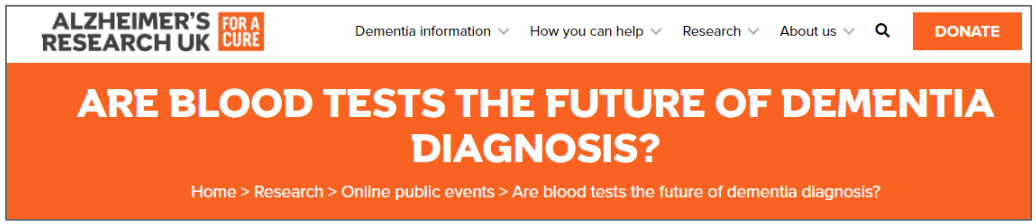
IT MATTERS!





"....[the] need to make it easier for people in all parts of the country to access diagnostic services so we can end the postcode lottery for accessing a diagnosis."



ABHI

MOMENTUM

ABHI HealthTech **for Life**

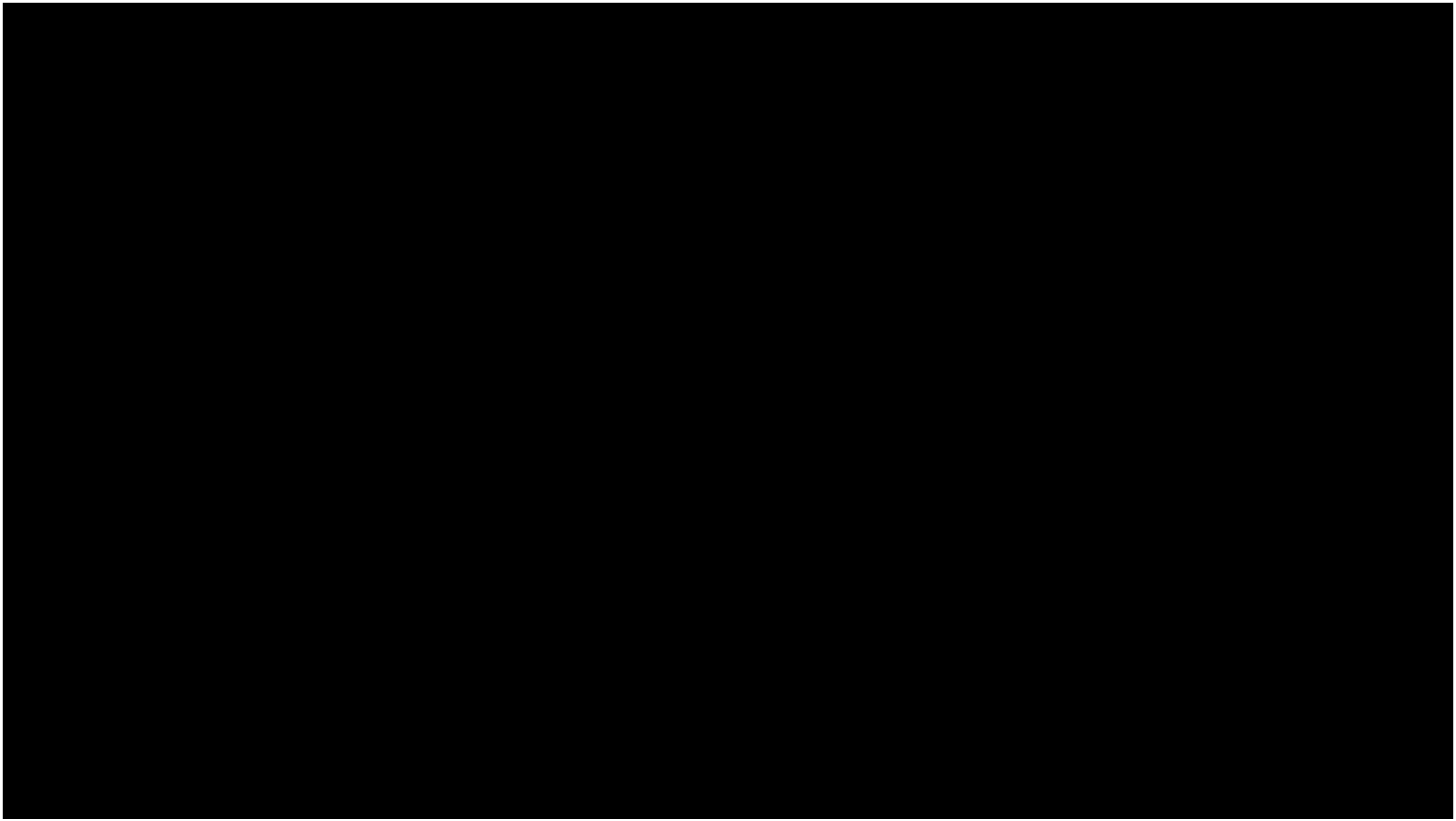
The Opportunities for **Quantum Sensing in Healthcare**

Venue: Online.

Start: Monday 25 Nov 2024 14:00

End: Monday 25 Nov 2024 15:15

ABHI



Siloton

Personal eye scanners: seeing a healthier future

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Christin Henein, MD, PhD
Clinical Lecturer in Ophthalmology,
NIHR Biomedical Research Centre for Ophthalmology
Moorfields Eye Hospital and UCL Institute of Ophthalmology

IOP Institute of Physics 2023 Business Start-Up Award

Clifford Paterson Medal 2023 IOP Institute of Physics

Startups 100 2024

MEDILINKUK FINALIST 2023

Health Infrastructure and Technology Translation Discussion

- The final discussion will look at adoption and any barriers you see to implementing technologies into healthcare. This can include any supporting technology needed, training, translation and any fears.

Innovate UK

NPL National Physical Laboratory

Quantum sensing:
Revolutionising Predictive Health & Early Diagnosis

Final Comments – Professor Melissa Mather

From Technology Adoption to Real-World Applications

Quantum Sensing is Gaining Momentum

Breaking Down Silos

Collaboration is Key to Unlocking Quantum's Potential

Quantum-Enabled Diagnostics

Unmasking disease at its earliest stage

UK Quantum

Leading the Quantum Revolution in Healthcare

Quantum Healthcare

Diverse Minds, Shared Vision, Transforming Patient Care