

Imperial College  
London

# Imperial Physics Postgraduate Taught Programmes

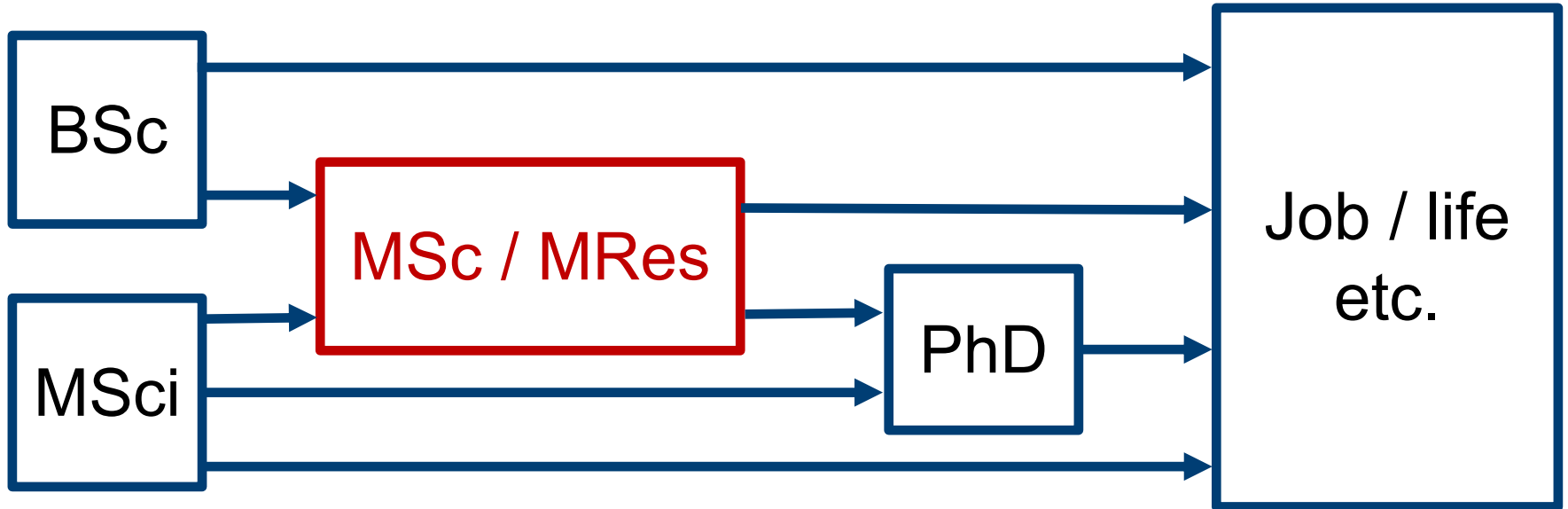
*Professor Toby Wiseman, Director of Postgraduate Teaching*

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# Plan

- Quick introduction and some practical details
  - Introduction to master's courses from program directors
  - Q & A
-

## Pathways through higher education



## Physics Taught Programmes at Imperial

- 3-year BSc (180 ECTS)
  - 4-year MSci (240 ECTS)
  - 12-month MSc or MRes (90 ECTS)
  - 2 x 9-month MSc with Extended Research (120 ECTS)
-

## There are 7 Physics PGT programmes

1. MSc Physics three streams:
    - I. MSc physics
    - II. with Quantum Dynamics
    - III. with Extended Research (2 x 9 months)
  2. MSc Optics & Photonics
  3. MRes Photonics
  4. MSc Quantum Field & Fundamental Forces
  5. MRes Machine Learning & Big Data
  6. MRes Soft Electronic Materials
  7. MSc Security & Resilience: Science & Technology
-

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### MSc vs MRes

- MSc\*: ~2/3 taught/practical modules, ~1/3 research project (June-September)
- MRes: ~1/3 taught/practical, modules, ~2/3 research project (January-September)

\* MSc Physics with Extended Research programme is ~50:50

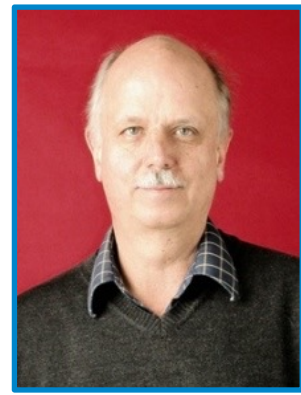
## Programme Directors



**Prof Stephen Warren & Prof Ben Sauer**  
MSc Physics,  
MSc Physics with Quantum Dynamics,  
MSc Physics with Extended Research

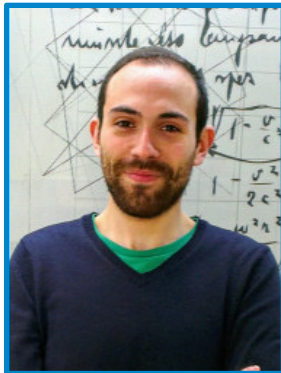


**Dr Kenny Weir & Prof Chris Dunsby**  
MSc Optics & Photonics, MRes  
Photonics



**Prof Kelly Stelle**  
MSc Quantum  
Fields and  
Fundamental Forces

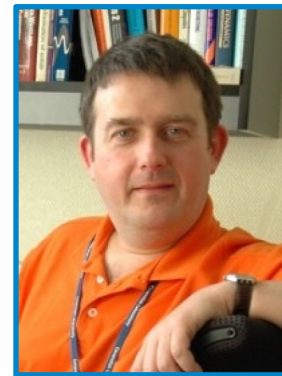
## Programme Directors



**Prof David Colling and Dr Nick Wardle**  
MRes Machine Learning and Big Data



**Prof Ji-Seon Kim**  
MRes Soft Electronic  
Materials



**Dr Bill Proud**  
MSc Security and  
Resilience: Science  
and Technology



## Practical details

### Tuition fees

- Details vary by programme (see College website); as an example, for 2024 entry to the MSc Physics it's £15,350 for Home students and £35,600 for Overseas students

### Scholarships

- Masters-level scholarships are few and far between, but worth checking specific schemes on the College scholarships website and sources in your home country
-

## Practical details

### Entry requirements

- Varies by programme, so check individual programme webpages – generally 1<sup>st</sup> or good 2.1

### Applications

- Apply online through the College online application portal
- Applications considered in rounds;

<b>Rounds</b>	<b>Applications Open</b>	<b>Application Deadline</b>	<b>Decision Deadline</b>
<b>Round 1</b>	2 October	3 November	16 December
<b>Round 2</b>	4 November	19 January	9 March
<b>Round 3</b>	20 January	29 March	11 May
<b>Round 4</b>	30 March	24 May	27 July
<b>Round 5</b>	25 May	5 July	3 August

## Practical details

### Why do an MSc/MRes?

- Specialist study/training in a particular topic
- Preparation for particular further research or employment
- Substantial research project component

### [MSci] vs [BSc + MSc/MRes] vs [MSci + MSc/MRes]?

- depends on your personal, professional & academic goals
  - financial considerations (loans, living costs etc)
  - visa implications for international students (eg, switching MSci to BSc)
-

## Further information

- **Programme information**

<https://www.imperial.ac.uk/physics/students/postgraduate-admissions/master-level-programmes/>

- **Programme Directors and course handbooks (2023)**

<https://www.imperial.ac.uk/physics/students/current-students/taught-postgraduates/>

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## Further information

- **Fees and funding**

<https://www.imperial.ac.uk/students/fees-and-funding/>

- **International Student Support**

<https://www.imperial.ac.uk/students/international-students/>

# Imperial Physics Postgraduate Taught Programmes

Some more detailed information slides from each programme

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# Physics MSc at Imperial College

Stephen Warren, Director Physics MSc

**MSc Physics** (12 month)

**MSc Physics with Quantum Dynamics** (12 month)

**MSc Physics with Extended Research** (2x9 month)

# MSc Programme Structure

Quantum Dynamics streams is similar – main difference is fewer electives (more compulsory)

Component	Term	ECTS
Compulsory: ACP and Maths Methods	1	7.5 + 7.5
4 electives: no more than two at level 6 (inc. ACP) Quantum Dynamics 3 compulsory specialised modules	1 & 2	30
Self study project	1 or 2	7.5
Research Computing Skills	1 & 2	7.5
Professional Skills (Graduate School)	1 & 2	
Research project ( <b>Extended Research stream</b> )	<b>3 (year 2)</b>	<b>30 (60)</b>
<b>Total (Extended Research stream)</b>		<b>90 (120)</b>



# MSc Physics Projects

- Three month or nine month (extended research stream) full time research project in association with a research group.
- May be hosted at Imperial or off site (e.g. at the NPL, RAL, Culham etc.) with an additional Imperial co-supervisor.
- For MSc with Quantum Dynamics – project must be in the field.
- MSc projects can be individual or with a partner

# Entry requirements

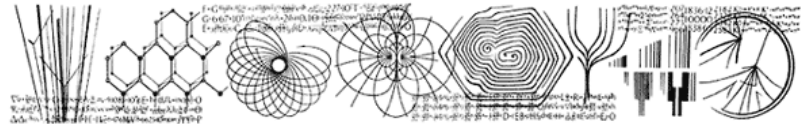
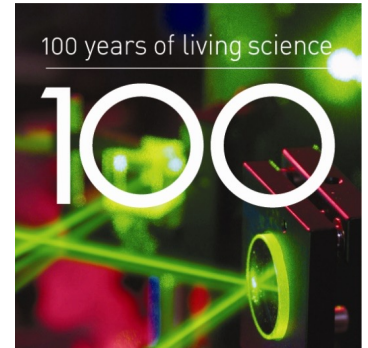
- Require 1<sup>st</sup> Class Honours
- Usually in Physics
- Engineering/Maths may be acceptable provided degree included significant physics content

# MSc Optics and Photonics and MRes Photonics

**Course co-directors: Chris Dunsby, Mary Matthews  
James McGinty and Mark Neil,**

*Department of Physics PG event  
11<sup>th</sup> December 2023*

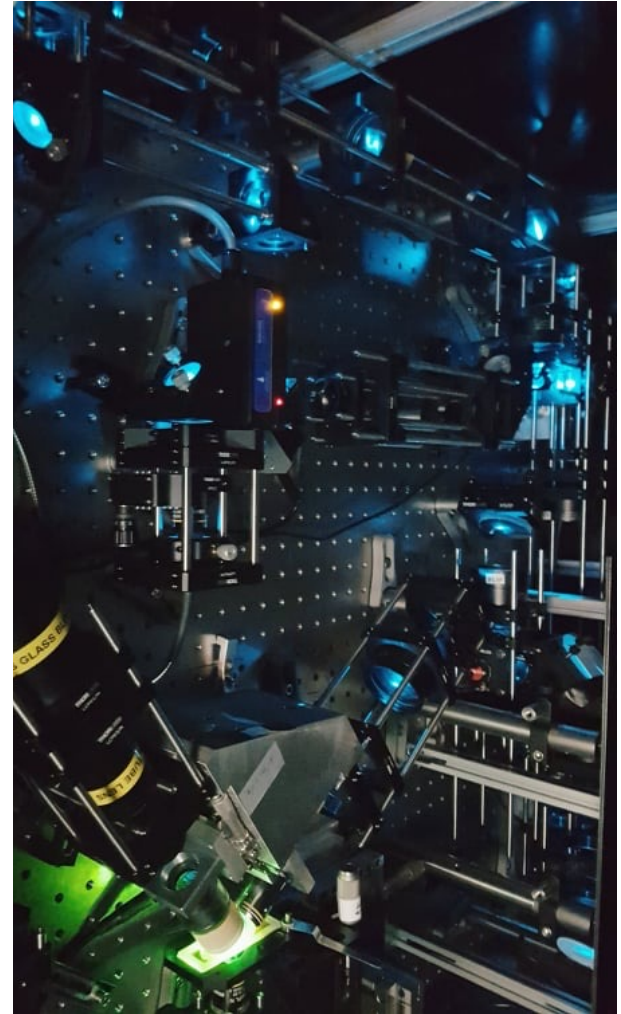
**Light Community, Department of Physics  
Imperial College London**  
[www.imperial.ac.uk/research/photronics](http://www.imperial.ac.uk/research/photronics)



# MSc Optics and Photonics

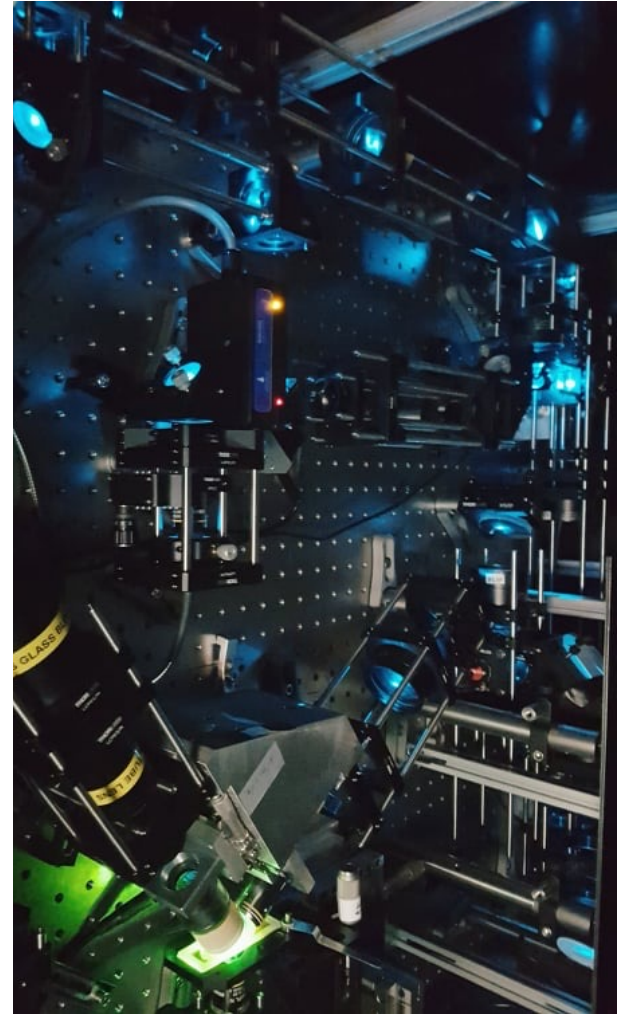
We enable people to develop advanced technical and professional skills in optics that are in demand in industry and academia

- Aimed at students wanting to develop a specialisation in optics with a view to a professional career in the field, either in Industry or Academia
- Students will have good BSc or MSci degree in physics (or a related discipline)
- A one-year (12-month) MSc



# MSc Optics and Photonics

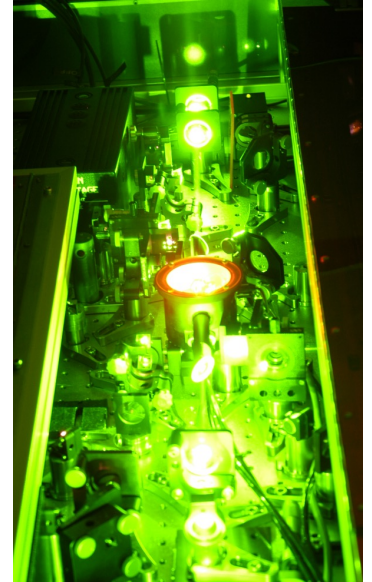
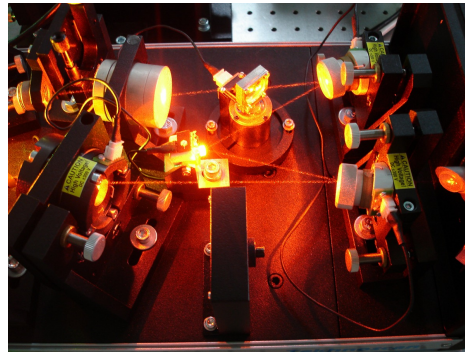
- Lectures
  - Foundation courses (Term 1)
  - From a set of option courses (Mostly term 2)
- Laboratory work
  - Demonstration experiments (Term 1)
  - Standard experiments (Term 1)
  - System-design project (Term 2)
- Self-study project (Term 2)
- Project (May-Sept)



# The Foundation Lecture Courses (MSc and MRes)

## Compulsory modules (Term 1):

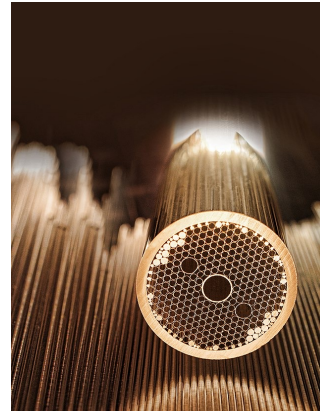
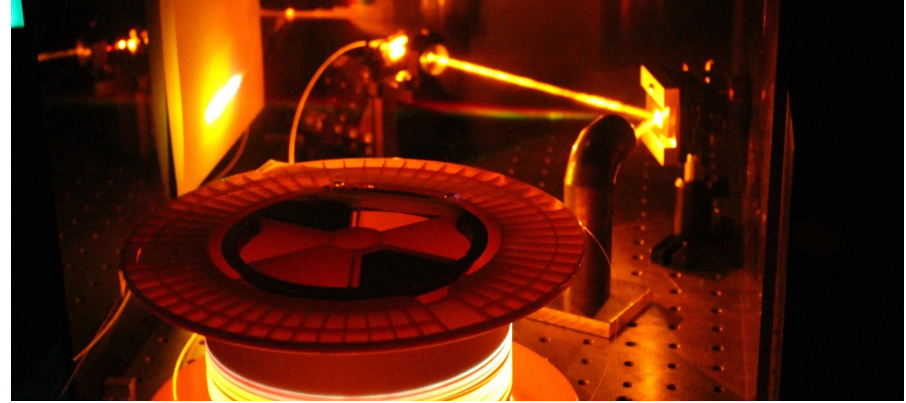
- Lasers
- Optical Measurements and Devices
- Imaging (Geometrical Optics and Wave Optics)



## Elective Modules (MSc)

- Fibre and Ultrafast Lasers
- Optoelectronic Devices
- Biomedical Imaging
- Optical Design
- Laser Technology
- Optical Communications

**MRes** students choose one or two options to support their project work



# Laboratory work (MSc)

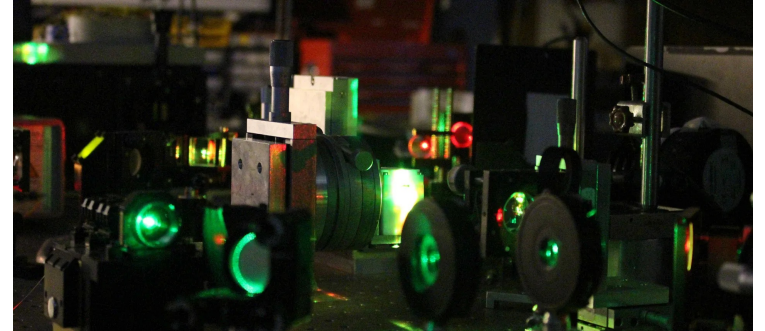
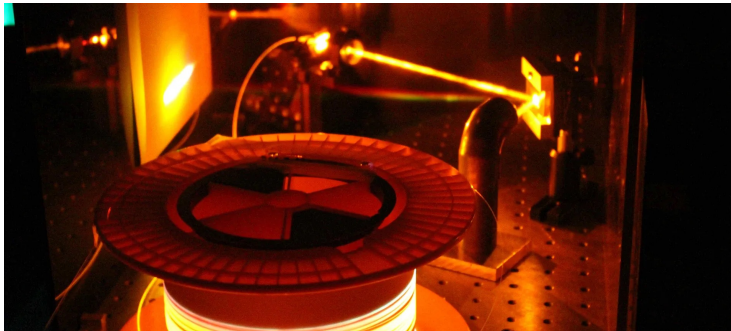
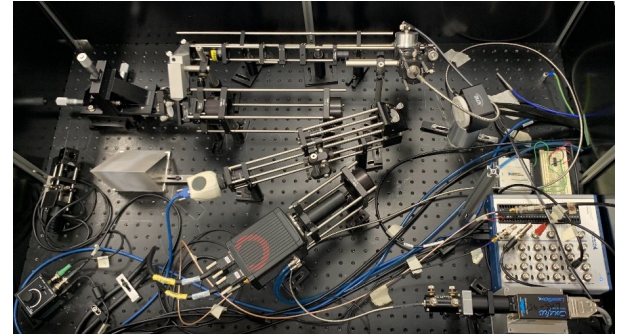
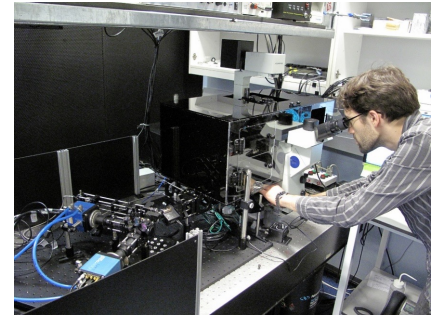
- Laboratory throughout Term 1 (also MRes)
  - Demonstration experiments (one afternoon)
  - Standard experiments (one week of afternoons)
- System-design project (Term 2)
  - A 5-week experiment building system from scratch





## Project work (MSc)

- Self-study project in Term 2
- Summer project (4 months)



## MRes (+PhD) in the Light Community

- Some PhDs may require applicants to take this course
- Fully-funded 4 year (MRes + PhD) studentships may be available for home students
  
- First term
  - Foundation courses same as for MSc in Optics and Photonics
  - Optics Lab: demonstration + standard experiments
- Long research project from January to September
  - Usually with future PhD supervisor

# Where do our graduates go afterwards?

## Position in Industry – graduates in high demand:

- Optical design
- Data Storage
- Imaging
- Optical equipment and components
- Optical engineering/design
- Remote sensing
- Biomedical applications of optics
- ...

## University Research:

- Short-pulse high-power lasers
- Laser development
- Displays
- Quantum optics
- Adaptive optics
- Thin films
- Waveguides
- Solar energy
- ...

# Examples of Summer Projects

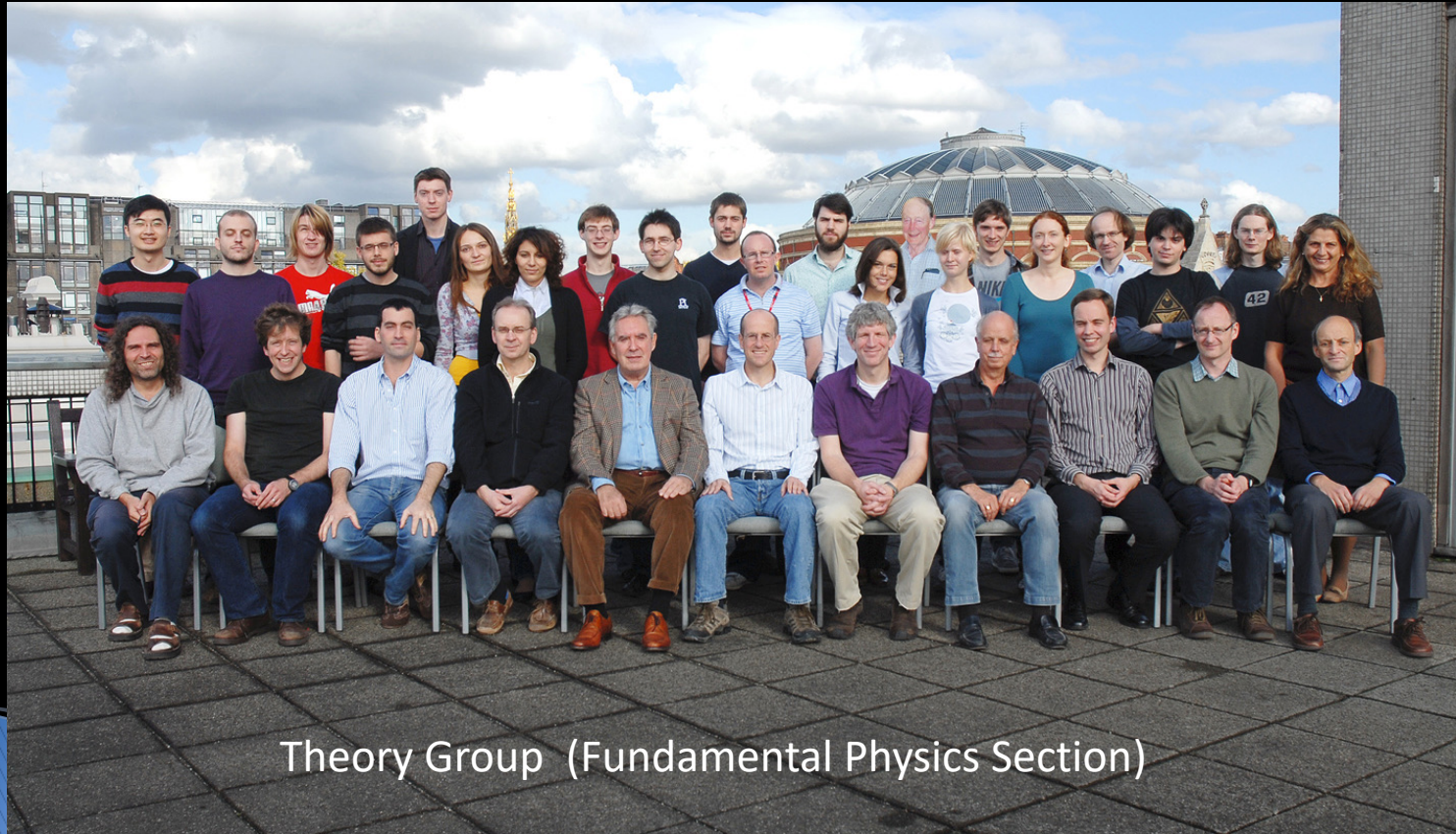
- Development and applications of attosecond lasers
- Quantum dot spintronics
- High-power diode-pumped solid-state lasers
- All-fibre-integrated sources based on photonic crystal fibres
- Shaping of sub-ps laser pulses
- Polymer LEDs
- Adaptive holography for remote sensing
- Spatial-light modulators
- Measurement of the properties of birefringent and chiral thin films
- Frequency resolved optical gating
- 3D fluorescence lifetime imaging
- Optically-sectioning microscopy
- Shortening and optimising femtosecond pulses using self-phase modulation and pulse shaping
- Quantum optics in asymmetrical quantum wells
- Wavelength-dependent loss in 2D photonic crystals
- Surface-enhanced Raman scattering

# Examples of Self-Study Projects

- Applications of high speed 3-D optical imaging
- Quantum-dot single-photon sources
- Colour definition for organic LED displays
- Femtosecond pulse shaping
- Photonic engineering
- Optical switching and methods for very high-rate optical networks
- Mid-infrared photonics for gas sensing
- Lightning generated by femtosecond lasers
- Photonic crystal fibres
- Fibre lasers
- Ultra-stable lasers
- Optical cavity QED
- Polymer photovoltaics for solar energy conversion
- Coherence
- Negative refractive index—the current status
- Atmospheric phenomenon
- Polymer LEDs
- Quantum Cryptography
- Photon-counting detectors
- Electromagnetically induced transparency

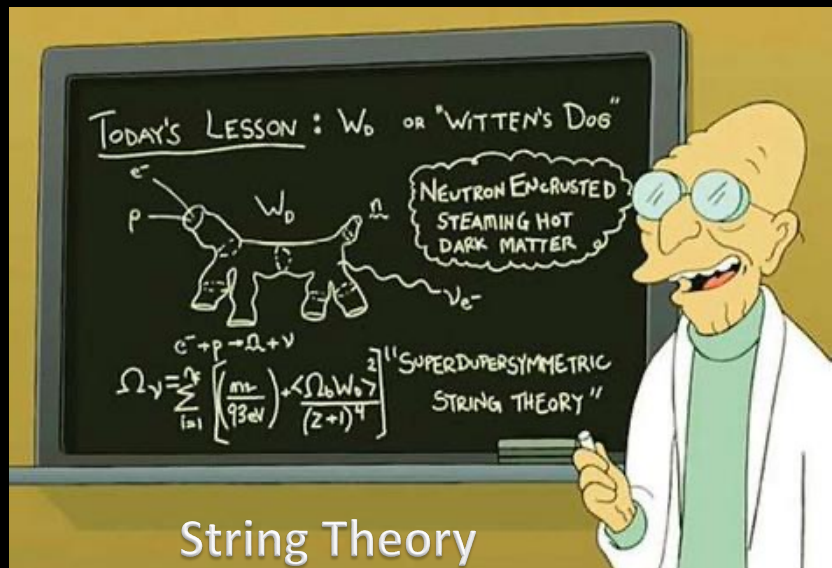
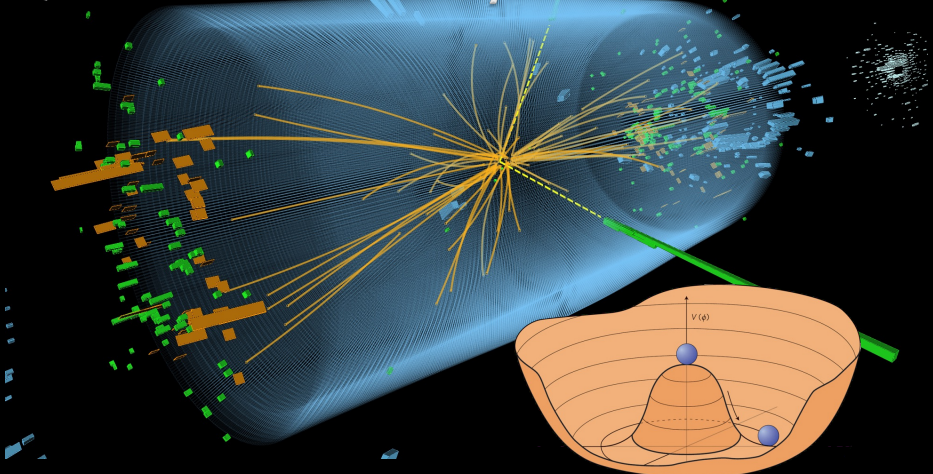


# MSc in Quantum Fields and Fundamental Forces

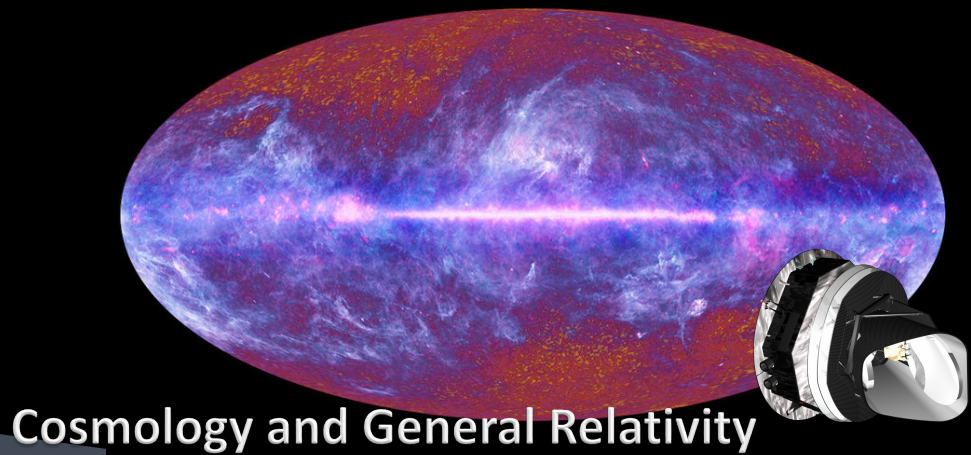


Theory Group (Fundamental Physics Section)

# Quantum Field Theory



# Quantum Mechanics





# Theory Group

- ▶ String Theory

- Dr S. Chester
- Prof J. Gauntlett
- Prof A. Hanany
- Prof C. Hull FRS
- Prof K. Stelle (MSc dir)
- Prof A. Tseytlin
- Prof D. Waldram (HoG)
- Dr T. Wiseman

- ▶ Quantum Foundations

- Prof J. Halliwell (MSc Adm)
- Prof F. Dowker

- ▶ Quantum Field Theory

- Dr T. Evans
- Prof A. Rajantie

- ▶ Cosmology and General Relativity

- Prof J. Magueijo
- Prof C. Contaldi
- Prof. A. Tolley (PhD adm)
- Prof C. de Rham

Postdocs and Visitors (10)

PhD students (30)

MSc students (45)

# MSc in Quantum Fields and Fundamental Forces

- ▶ Preparation for PhD studies in fundamental theoretical physics:
  - Theory, techniques, applications
  - Graduate-level lectures  
(attended also by PhD students)
  - Research skills: Dissertation project
  - 12 months full time / 24 months part time

# Lecture Courses


## ▶ Compulsory

- Particle Symmetries
- Quantum Field Theory
- Quantum Electrodynamics
- Unification –  
the Standard Model

## ▶ Optional ( $\geq 4$ )

- Advanced QFT
- Black Holes
- Differential Geometry
- Particle Cosmology
- String Theory
- Supersymmetry
- Foundations of QM (UG)
- General Relativity (UG)
- Group Theory (UG)
- Quantum Information (UG)
- Quantum Theory of Matter (UG)

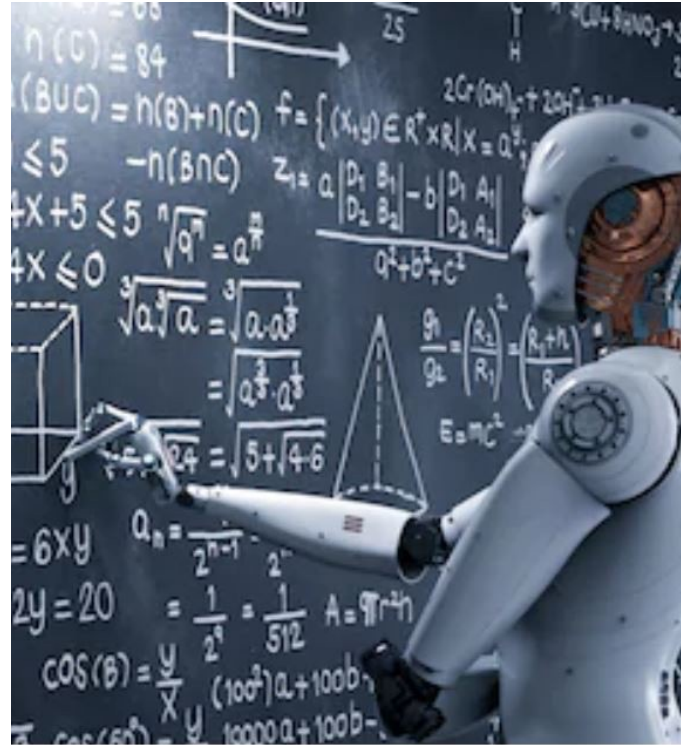
# For Imperial Students

- ▶ Two options:
  - ▶ 4+1 MSci then MSc. Students better prepared but fewer (or in some cases no) choice of MSc courses, more expensive.
  - ▶ 3+1 BSc then MSc. Quicker and cheaper. Some students find BSc insufficient preparation.
- 
- ▶ 1<sup>st</sup> in physics (or maths) required
- 

# MRes: Machine Learning and Big Data in the Physical Sciences

Physics Department  
Open Day

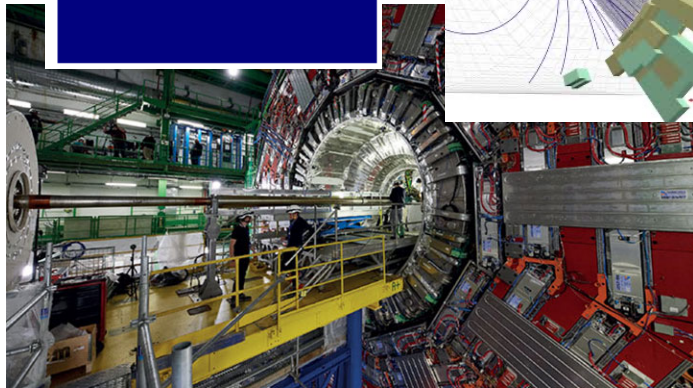
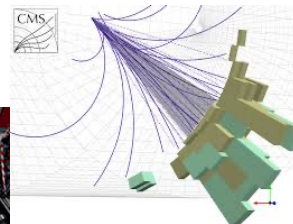
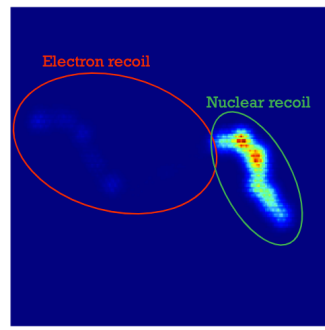
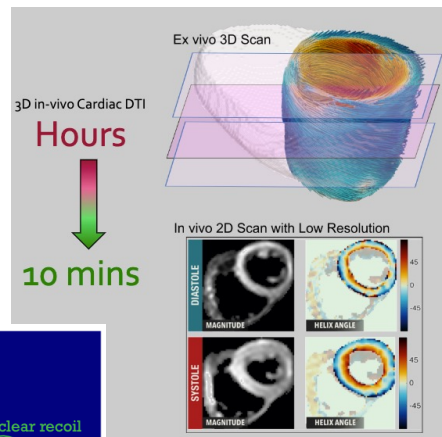
Nicholas Wardle



## Why machine learning and big data in research?

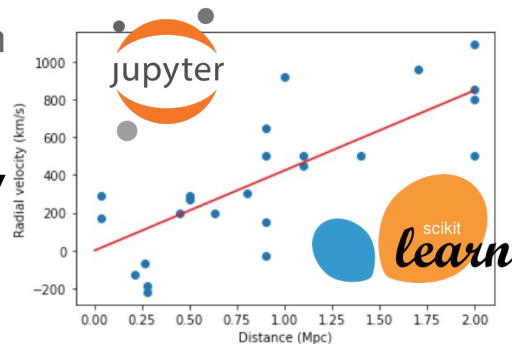
Science is driven forward by  
**data! Datasets in the physical  
sciences can be huge!**

Machine learning has a massive  
impact on research from improving  
**MR imaging** to discovering new  
particles at the **LHC!**



# What will you learn?

Learn the **tools** and **techniques** used  
in **data-intensive research** in  
science and industry!



## Core modules: Term 1

- Statistical Methods for Experimental Physics
- Practical Data Analysis and Machine Learning in the Physical Sciences

## Terms 2&3

- Research Project

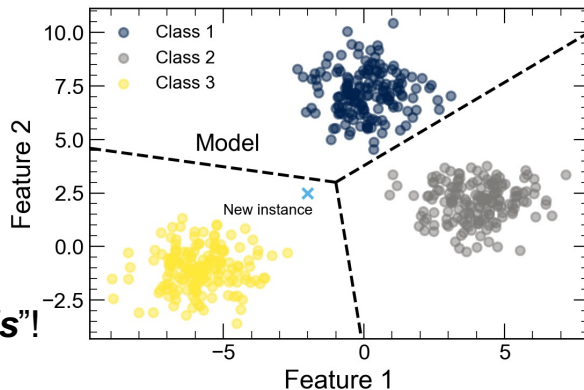
PYTORCH



## 2x Elective modules:

Lvl 6&7 UG&MSc options including

***“Accelerated processing for big data analysis”!***



## Research Focused

Use your **expertise in machine learning and big data** to contribute to some of the **most challenging** data-intensive fields of **research**

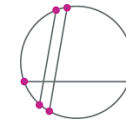
Work **hands on with data** and **world-leading experts** from our research groups in your **nine-month research project!**

Example projects from previous years:

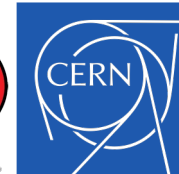
- “Using Machine Learning to classify Higgs boson interactions”
- “Photogrammetry/computer vision for upright radiotherapy patient positioning”
- “Machine Learning in the SHARKS Survey - a near-IR Survey of 20 Million Galaxies”
- “Searching for the Migdal Effect in nuclear scattering”
- “Interpretable Machine Learning for Space Weather Forecasting”
- “Applying machine learning to analysis of data of attosecond pulses from the LCLS X-ray laser”



**MIGDAL**  
Migdal In Galactic Dark mAtter exPLoration



**LEO**  
Cancer Care

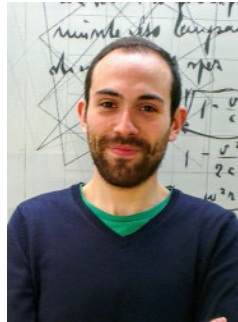




# Who are we?



Prof. David Colling  
Programme Co-Director  
d.colling@imperial.ac.uk



Dr. Nicholas Wardle  
Programme Co-Director  
n.wardle09@imperial.ac.uk

Visit the website:

<https://www.imperial.ac.uk/study/pg/physics/machine-learning-physical-sciences/>

Interested in  
multidisciplinary  
research with  
real-world  
applications?

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# MRes in Soft Electronic Materials

# What is Soft Electronics?



# Targeted Research

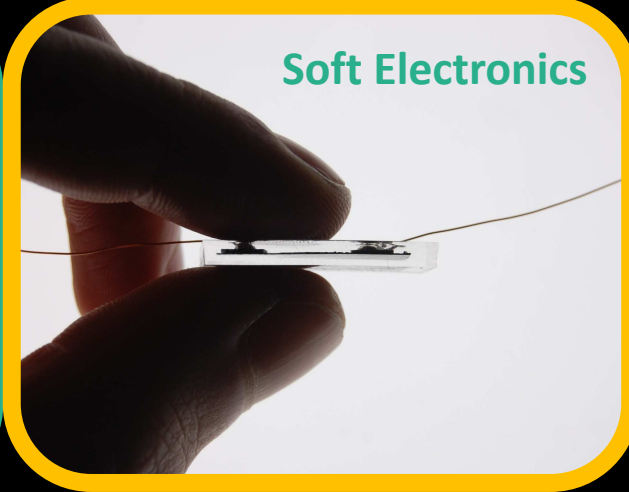
## Electronics with Functional and Processable Materials

### Materials for Sustainable Energy



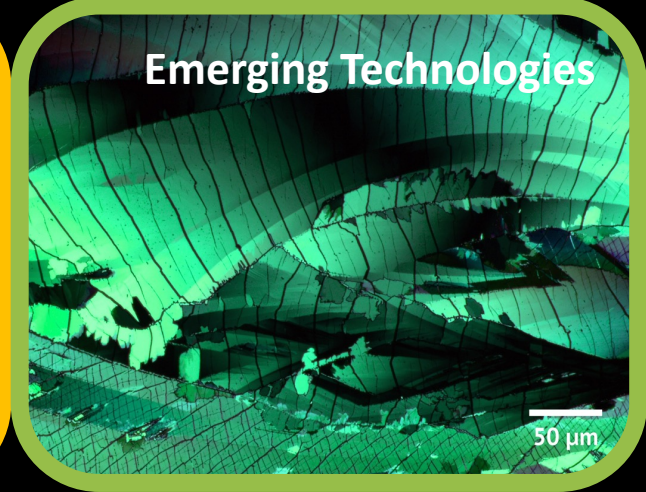
Energy generation (solar cells, solar fuels, thermoelectrics), conversion (LEDs) and storage (batteries, sustainable fuels and chemicals)

### Soft Electronics



Bioelectronics, wearable electronics and sensors

### Emerging Technologies



Chiral emitters and detectors, spintronics and neuromorphics

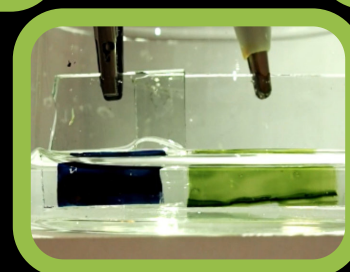
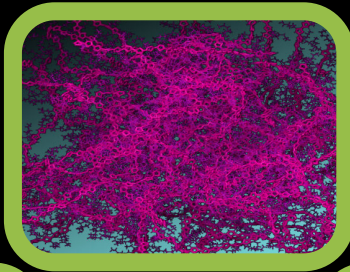
What Science is  
Involved?



Uniquely  
Multidisciplinary

**Physics, Materials, Chemistry, Bioengineering**

Synthesis, modelling, characterisation, processing and devices



# What does the Course Involve?

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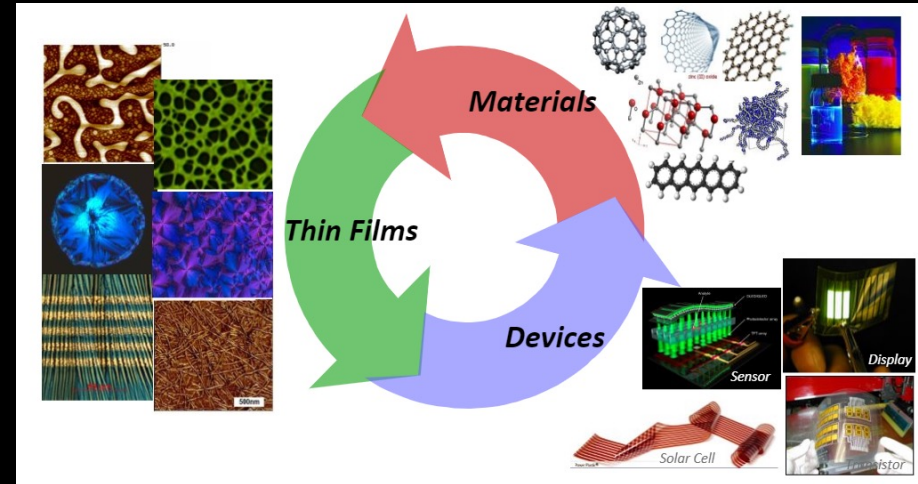
# Research Focused

## 1/3 Lecture Courses:

- Fundamentals of Organic and Inorganic Semiconductors and Optoelectronic Processes
- Materials Synthesis and Processing
- Materials Characterisation
- Device Physics and Applications

## 2/3 Project:

- Proposals from PIs in Physics, Chemistry, Materials, Chemical Engineering, Bioengineering
- List issued in October
- Range from theoretical to highly applied

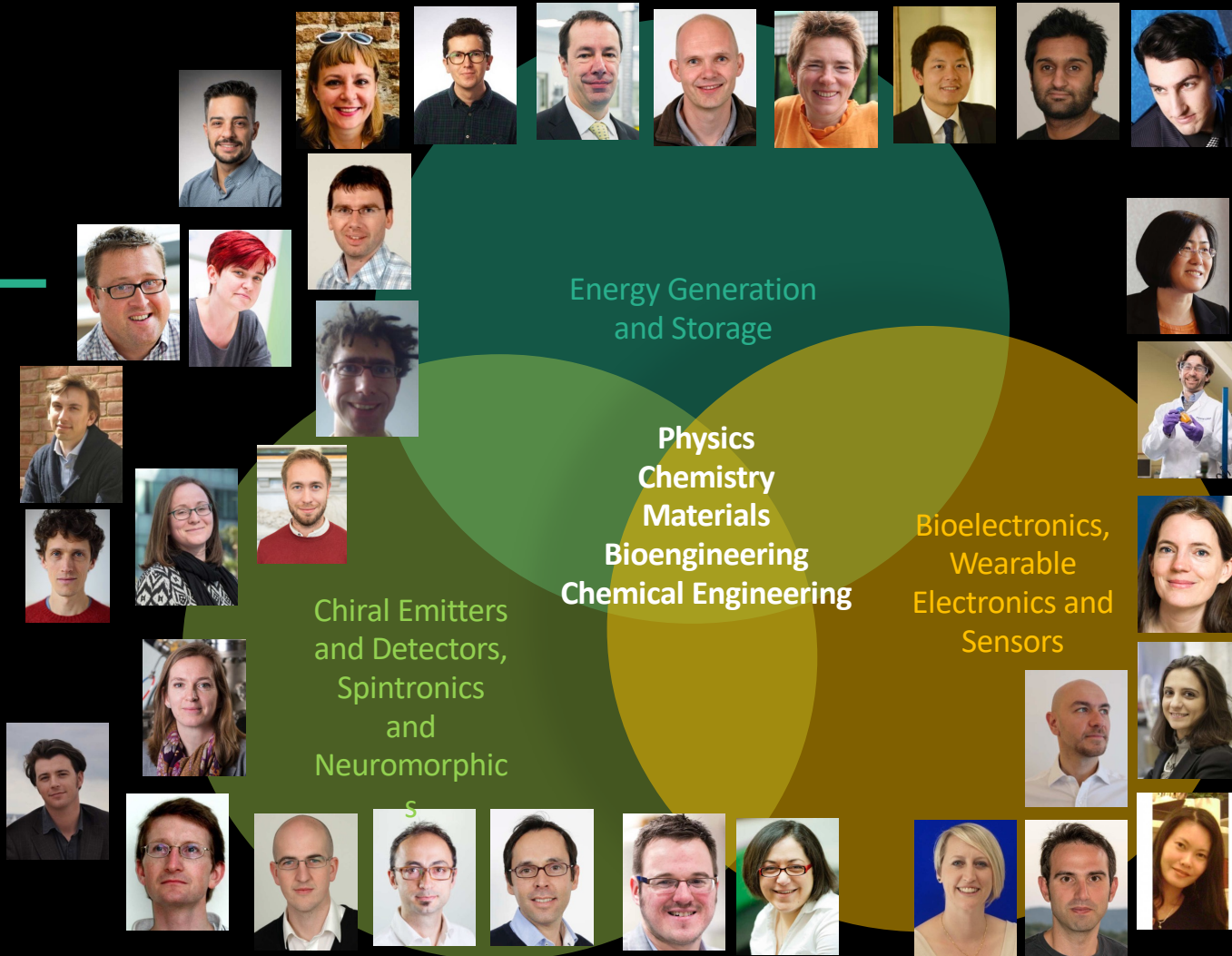


# Who Will I Work With on a Project?

PIs from across the Centre for Processable Electronics

>30 members of academic staff

Strong industrial collaborators worldwide



Want to Build a  
Broader Skill Set?

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A Course  
with More!

Cohort activities, trips and visits, outreach opportunities, presentations  
Summer School, Exhibition Road Festival, Annual Symposium,  
Journal Club, CPE Seminars and Symposia, Transferrable and  
Advanced Skills Courses, Alumni Talks



# Thank You!

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For more information:

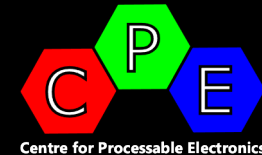
Visit our website <https://www.imperial.ac.uk/plastic-electronics-cdt/mres-in-soft-electronic-materials/>

Email our MRes Science Coordinator: Lisa Bushby [l.bushby@imperial.ac.uk](mailto:l.bushby@imperial.ac.uk)

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Course Director: Prof Ji-Seon Kim

Course Advisor: Dr Piers Barnes



Imperial College  
London



Imperial College  
London

# MSc Security and Resilience: Science and Technology

Hosted by **DEPARTMENT OF PHYSICS**



Institute for  
Security Science  
and Technology

[www.imperial.ac.uk/security-institute](http://www.imperial.ac.uk/security-institute)



## The Institute for Security Science and Technology

Founded in 2008 as one of Imperial's Global Challenge Institutes.

Global Institutes promote interdisciplinary working to meet the greatest challenges faced by society.

### Our vision

Geo-political uncertainties, climate change and changing cyber and physical attack methods give rise to a constantly evolving security landscape.

We envisage, design and coordinate the application of science and technology to answer the grand security challenges raised.

Imperial's hub for  
**security research,  
education,  
engagement and  
translation.**



## Cross cutting Institute

The ISST works across Imperial College London to co-develop and apply capabilities in security and defence, with a particular focus on applications in Critical National Infrastructure.



### Imperial's capabilities broadly sit under six umbrella areas:

1. Matter, materials and manufacturing
2. Sensors, sources and detection systems
3. Data processing and algorithms
4. Biosystems, medicine and human behaviour
5. Advanced machines and systems
6. Cyber, cyber-physical and information security, infrastructure resilience





# What we do Translation

## ISST Innovation Ecosystem

Working with multiple corporate and government partners, we drive new research projects and technology transfer in security and defence.

By operating a co-location model, we enable interaction and engagement to accelerate opportunity creation.

## Ecosystem partners



# What is Security and What is Resilience?

**Security** = preventing events which cause a threat to individuals, organisations and society from occurring.

**Resilience** = if an event occurs, how to respond immediately, in the medium-term and in the long-term to contain the effect, mitigate the consequences and recover. Use the experience to change and modify security

Threats can be classified into 3 broad areas:

**Natural** - climate, earthquake, biological, weather, tsunami etc.

**Accidents** – industrial, domestic, cyber (software updates), personal etc.

**Deliberate** – criminal activity, political activity, vandalism (physical and cyber), fake news, racial, gender etc.



# World View

- We divide the **HUMAN** world into 4 areas
- Need a broad view and technical understanding
- Strong linkages exist between the areas
- Activity in one area affects the others



# The Course has modules to address each

## PEOPLE AND THEIR BEHAVIOUR

**Behavioural Research Methods**  
**Behavioural Science and Security**

## PHYSICAL INFRASTRUCTURE

**Infrastructure and Transport Security**

## PHYSICAL WORLD: PHYSICAL THREATS AND DETECTION

**CBRNE: the Physical Threat Space**

**Sensors: Electronic and Natural**

## CYBER WORLD: INTERNET OF THINGS

**Network and Web Security (Dept of Computing)**



# The Course has modules which cover all areas

**PEOPLE AND THEIR BEHAVIOUR**

**PHYSICAL INFRASTRUCTURE**

## **Security In Context**

Involves active Practitioners, industry, govt and academia

## **Long Research Project**

individual theme decided, in part, by you!

**PHYSICAL WORLD: PHYSICAL THREATS AND DETECTION**

**CYBER WORLD: INTERNET OF THINGS**





# Real World involvement includes Summer Projects

Examples of Industrially linked projects

**AWE** – Magnetic Imaging Tomography of IEDS – feasibility study

**BAE Applied Intelligence** – Electronic Identities

**SynBioSys** – Ballistic Studies for lightweight structural protection

**FFI (Norway)** – Emerging technologies for point-of-care diagnostics of exposure to organophosphorus nerve agents

**Aerospace Corp** - Run-Time Hardware Trojan Detection And Response

Support **can** include a stipend, access to executive training courses, offers of internships etc.



## Compulsory modules

Security in Context
Behavioural Science and Security
CBRNE: The Physical Threat Space
Infrastructure and Transport Security*
Behavioural Research Methods
Network and Web Security**
Sensors: Electronic and Natural

Long summer research project

## Elective modules (x 2)

Global Challenges: Security Entrepreneurship
Introduction to Shock Physics
Electives from other Departments, including Physics, Mathematics, Computing, and Civil and Environmental Engineering (at discretion of the Programme Director).
Short Project



# Who do we recruit?

## Natural Scientists and Engineers, STEM graduates, high-performing social scientists

- Minimum 2:1 UG degree - Entry requirement

## For those with relevant industrial/government experience

- Entry level 2:2 UG degree + experience (interview required)
- **FULL-TIME** (12 months) and **PART-TIME** (24 months) available



## CONTACT US AT:

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