

# Education & Training Public Engagement at JAI

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Imperial College  
London



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# Introduction

- The JAI programme is organized around three pillars:
  - Research in accelerator science.
  - Training next generation of accelerator scientists.
  - Public engagement.

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# EDUCATION AND TRAINING

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# Guiding Strategy

- Training in accelerator science & technology is **one of the pillars** of JAI mission and recognised by JAI Advisory Board to be **world-leading**.
- Objective is to **develop skills** of next generation accelerator scientists.
- JAI has provided **graduate & undergraduate training** in accelerator science & technology since first course delivered in 2005.
- Students participate in **comprehensive core formal training** through academic courses & projects and 3 years of cutting-edge research at state-of-the-art facilities (national & international).
- Many JAI academic staff invited to give courses & lectures at **international accelerator schools**.

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# JAI Graduates & Careers

- JAI training is **well aligned with STFC strategic aims** to address national demand for scientifically-skilled workforce to sustain UK's world-leading position in research & technology (***2017 STFC Accelerator Strategy Review***).
- **PhD graduates around 70**; all obtained **fruitful employment**; about **20% female**.
  - Alumni consistently pursue **careers in science & technology**
    - Destinations include **research positions** in universities, ASTeC, BNL, CERN, CI, DESY, LBNL, LLNL, NPL, RAL, SLAC, & PSI; some reached **full academic positions**; about **15% work in industry**.

# Graduate Accelerator Physics Course

## Term I October-December 2020

### Lectures (23)

Types of Accelerators\*

Application of Accelerators\*

Live Connection – LHC Control Centre\*

Transverse Optics

Longitudinal Dynamics

Momentum Effects

Lattice Design

Beams & Imperfections

Basic Plasma Physics Concepts for Plasma Accelerators

Plasma-based Electron Acceleration

Plasma-based Ion Accelerators

RF Cavities

Beam Diagnostics & Instrumentation

Synchrotron Radiation

Wigglers & Undulators

Radiation Damping & Excitation

Hamiltonian Dynamics\*\*

Parameters for eSPS Student Design

### Exercise Classes (6)

Introduction to Accelerators\*

Transverse Dynamics

Longitudinal Dynamics

RF Cavities

Hamiltonian Dynamics\*\*

Synchrotron Radiation

\* *Combined Particle Physics / Accelerator Physics cohort*

\*\* *Newly incorporated into Graduate Accelerator Physics Course*

**Course carried out online due to Covid-19**

# Graduate Accelerator Physics Course

## Term II January-March 2021

### Lectures (19)

Magnet Design

Non-linear Dynamics

Beam-beam Effects

Space Charge Tune Shift

Beam Transport

Linear Colliders

Instabilities

Beamlines for Fixed-target  
Experiments

Cyclotrons for Various Applications\*

Injection, Beam Transport &  
Extraction

Particle Sources

Free Electron Lasers

Vacuum and Surface Science

Accelerator Science & Particle  
Therapy\*\*

### Exercise Classes (2)

Magnet Design

Introduction to eSPS Design Project

### Tutorials (8)

eSPS Design Project

\* *New as of Term II 2020*

\*\* *New as of Term II 2021*

**Course carried out online due to Covid-19**

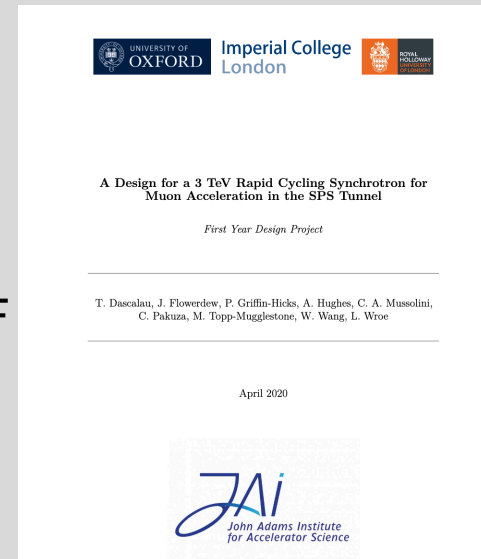
# Consolidated Accelerator Course

- Graduate lecture course includes plasma lectures provided by ICL, as part of development of **integrated accelerator-laser-plasma training**.
- **Lecturers & Instructors**
  - M. Fraser (CERN), Hector Garcia-Morales (Oxford)\*, A. Gebershagen (CERN)\*, David Kelliher (RAL)\*, S. Lawrie (RAL), S. Mangles (ICL), I. Martin (Diamond), A. Milanese (CERN), Z. Najmudin (ICL), S. Patel (RAL), C. Plostinar (ESS), Marco Schippers (PSI)\*, F. Tecker (CERN), E. Tsesmelis (CERN/Oxford), Rob Williamson (RAL)\*
    - \* *New lecturers since previous JAI AB*
  - Lecturers / instructors from **all JAI universities** and from external institutes – **CERN, DIAMOND, ESS, PSI, RAL**.



# Accelerator Design Project

- Accelerator Design Study for
  - **Muon Collider:** 2019-2020
  - **Electron SPS:** 2020-2021
  - Design work consisted of study of the lattice, magnet systems and RF cavities.
- Student visits and presentations at CERN delayed due to Covid-19.

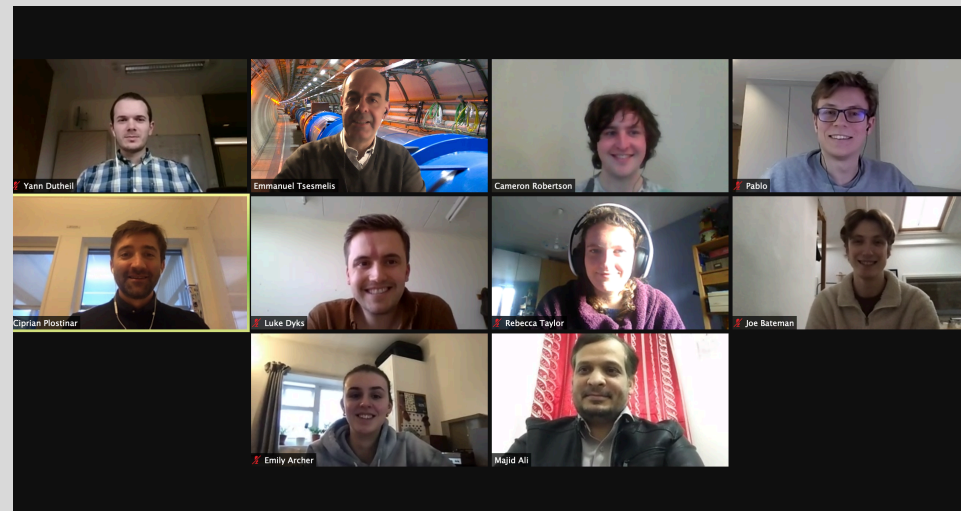


Muon Collider Design Report published on CDS (DOI 10.17181/CERN.YA66.G3H6) and students delivered AI Seminar.

eSPS Design Report to be published on CDS & delivered JAI Seminar (Zoom)

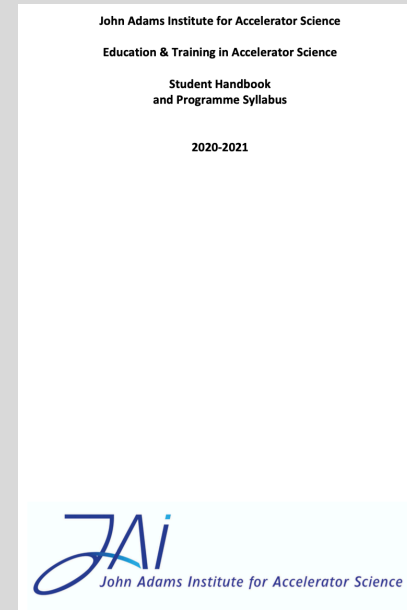
*“The design project significantly contributes to the value of a PhD at the JAI, and is a very effective learning tool ... it played an essential role in helping me to find a postdoc.”*

*“To me, the design project was by far the best part of the course. It puts the material taught into context and bridges the gap between lectures ... and a DPhil project ... .”*



# JAI Student Resources

- **Student Handbook** provides information to the students of the training programme in accelerator science at JAI.
  - Syllabus & course content, course resources, assessment, evaluation, recommended textbooks.
  - Supplementary information (public engagement, lecture series, summer student programme etc.)
- Dedicated site on **INDICO**
  - <https://indico.cern.ch/category/5869/>
  - Timetable, slides / documents, Zoom connection



## John Adams Institute for Accelerator Science - Accelerator Physics Courses

The John Adams Institute for Accelerator Science (JAI) is a centre of excellence in the UK for advanced and novel accelerator technology, providing expertise, research, development and training in accelerator techniques, and promoting advanced accelerator applications in science and society. The JAI programme is organised around three pillars: research in accelerator science; training the next generation of accelerator scientists; and science outreach to industry and the public. The JAI is jointly hosted by the physics departments of the University of Oxford, Royal Holloway, University of London and Imperial College London.

As part of its training programme, the JAI provides courses in Accelerator Physics and related disciplines. Details of the courses are provided in the [JAI Student Handbook 2020-2021](#).

### January 2021

📅 21 Jan - 11 Mar [Hilary Term 2021](#)

### October 2020

📅 15 Oct - 04 Dec [Michaelmas Term 2020](#)

### January 2020

📅 23 Jan - 12 Mar [Hilary Term 2020](#)

### October 2019

📅 17 Oct - 06 Dec [Michaelmas Term 2019](#)

# New Graduate Students 2021-2022 Academic Year

## ■ Oxford

- Bethany Spear, AWAKE or FCC, STFC
- Seb Wilkes, Diamond II, Joint JAI/Diamond
- Florian Stummer – admitted subject to funding; following Brexit, difference in tuition fees for EU and UK students needs to be covered.

## ■ RHUL

- Joint RHUL-CERN Doctoral Studentship
- Joint RHUL-Diamond Studentship
- HL-LHC Project Studentship
- STFC-JAI Studentships (1 or 2)
- UK National Health Service (medical accelerator student)

## ■ ICL

- Annabel Gunn, *Mid-infrared Laser Sources for Laser Wakefield Accelerators*, EPSRC Doctoral Training Partnership
- Maria Maxouti, *The Laser-hybrid Accelerator for Radiobiological Applications*, STFC (JAI/PPD) - admitted subject to funding; following Brexit, difference in tuition fees for EU and UK students needs to be covered.

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*Process for graduate student selection on-going at all JAI universities.*

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# Graduate Student Funding

- Since 2019, JAI included in **STFC quota** PhD studentships scheme receiving three studentships per year.
- This **leverages additional funding sources** allowing JAI to recruit typically an additional 6 PhD students / year.
- **Various funding sources** include the universities, the Royal Society, STFC CASE, EPSRC DTP, DLS, and RAL/ISIS, as well as the CERN Doctoral Student programme, the European Research Council, Helmholtz Foundation, Marie Curie Fellowships, Thai government fellowships and other non-UK sources.

**Continue to explore wide range of possibilities for sustainable funding.**

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# Undergraduate Accelerator Physics Courses

- Undergraduate training has been provided at the **University of Oxford** and independently annually at **RHUL** with dedicated accelerator physics courses.
  - The **Oxford** course was offered as a **Short Option (12 h)** for physics students in their 3<sup>rd</sup> year, while the **RHUL** course offers an annual **intercollegiate** undergraduate course for 4<sup>th</sup> Year MSc students of the University of London.
  - There are also **BSc/MSci/MSc.** project students at **RHUL**.
- We plan to **restructure the Oxford undergraduate module** to make it more attractive for students by including accelerator applications and hands-on laboratory sessions.

# Undergraduate Accelerator Physics Summer Student Internships

- Oxford University Internship Programme (CERN in July/August annually)
  - ❑ **Two students** to join **CLEAR** accelerator project supervised by Oxford faculty & graduate students.
  - ❑ Participate in **CERN Summer Student** lecture series and in an accelerator project.
- Imperial College
  - ❑ Around **4 students** appointed annually.
  - ❑ Spend 8 weeks working at **RAL**.
- RHUL
  - ❑ Around **2 students** appointed annually.
  - ❑ Carry research work at **RHUL**.

**Expect programmes to attract undergraduate students to accelerator science.**

# JAI Accelerator Science Seminar Series

- As of January 2021, renewed series of **JAI Accelerator Science Seminars** delivered by distinguished speakers from JAI and from laboratories / universities world-wide.
- Seminars are scheduled so that the graduate student body can attend.
- As of April 2021, JAI is teaming up with ASTeC and the Cockcroft Institute to organise jointly the new **UK Accelerator Institutes Seminar Series**.

Presenter	Title	Date
JAI Graduate Students.	Design Project on the eSPS Facility at CERN	Thursday 11th March 2021
Dr. John Thomason (STFC-RAL).	Upgrade of the ISIS Facility - "ISIS 2"	Thursday 4th March 2021
Dr. Alexander Gerbershagen (CERN).	Physics vs Cancer: What are the Hot Topics in Particle Therapy Accelerator Development?	Thursday 25th February 2021
Dr. Makoto Tobiyama (KEK).	The SuperKEKB Accelerator	Thursday 18th February 2021
Prof. Lucio Rossi (University of Milano and INFN Milano).	Superconducting Magnets: An Enabling Technology for Physics Research and Society	Thursday 11th February 2021
Prof. Shinichiro Michizono (KEK).	The International Linear Collider	Thursday 4th February 2021
Dr. Frank Zimmermann (CERN).	The FCC-ee Higgs and Electroweak Factory	Thursday 28th January
Prof. Steinar Stapnes (CERN).	The eSPS Facility at CERN	Thursday 21st January 2021

Attendance has been excellent – averaging around 40 participants / seminar

# External Training Commitments (Abridged)

- JAI participates in external training initiatives
  - EU Integrating Activity Projects on Training, Communications & Outreach in Accelerators – TIARA 2011-2014, ARIES 2017-2021, I.FAST 2021-2025 (P- Burrows serves as WP Leader).
  - CERN Accelerator School CAS (various JAI faculty and staff).
  - Joint Universities Accelerator School (JAI is partner institute, P. Burrows serves on JUAS AB).
  - *Laser Electron Acceleration and its Applications*, ELI Summer School 2020 (Z. Najmudin).
  - Cockcroft Institute graduate accelerator physics course (S. Gibson).
  - University of London intercollegiate undergraduate & graduate accelerator physics courses (S. Gibson, P. Karataev).
  - University of Melbourne Medical Accelerator Physics Programme (S. Sheehy).
  - Nanyang Technological University and University of Saskatchewan undergraduate & graduate lectures on accelerator physics (E. Tsesmelis).



# Future Programme - Training

- **Proposal & plan** for the future education & training programme at JAI:
  - World-class **graduate & undergraduate training** in accelerator science & technology.
  - **Collaboration with outside institutes** through student accelerator design projects.
  - **Strengthened integration of the 3 universities** by fostering & supporting student exchanges, common lectures and seminars, and other events, e.g. the JAI Fest.
  - Established **joint JAI and CI programme of lectures** on dedicated aspects of advanced accelerator physics & applications.
  - **Pre-PhD programmes** - Summer studentship programmes at all 3 universities; BSc, MSci and MSc. programmes at RHUL; restructured undergraduate module at Oxford making it more attractive.
  - **UK Accelerator Institutes Seminar Series** – regular events with external high-profile visitors.
  - Benefits to school pupils by training high-school teachers through **APPEAL**, the ‘Accelerator and Particle Physics Education at A-Level’ programme.
  - JAI academic staff delivering courses & lectures at **international accelerator schools**, thus providing important accelerator community service.

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# PUBLIC ENGAGEMENT

# Guiding Strategy

***The JAI has an embedded public engagement culture***

**Core PE activities, leverage universities' PE teams**

*e.g. In the last grant period there were 82 live events reaching >34,000 people.*

**APPEAL**  
Teacher training

**'Accelerate!'**  
shows

**School &**  
public lectures

**Professional**  
partnerships



*JAI members learn through both established PE practice and training:*

- Accelerate! Shows
- Writing for JAI news
- University, STFC and IoP training events

- Royal Society
- Royal Institution
- STFC
- SEPNet
- Café Scientifique
- TED
- Media
- Publishing

# Award-winning Public Engagement

***The JAI continues with award-winning public engagement and influencing at local, national and international level.***



- 2017 SEPNet Award (RHUL)
- 2016 IoP HEPP Science in Society Award (Sheehy)
- Oxford Vice Chancellors Public Engagement Award

## Festivals/events

### LEAD:

- Oxford May Music Festival

### PARTICIPATE:

- Great Exhibition Road Festival
- RS Summer Science Festival
- Cheltenham Science Festival
- Big Bang Fair
- Other music & science festivals



TED talk: 6000 live  
1.75M video views

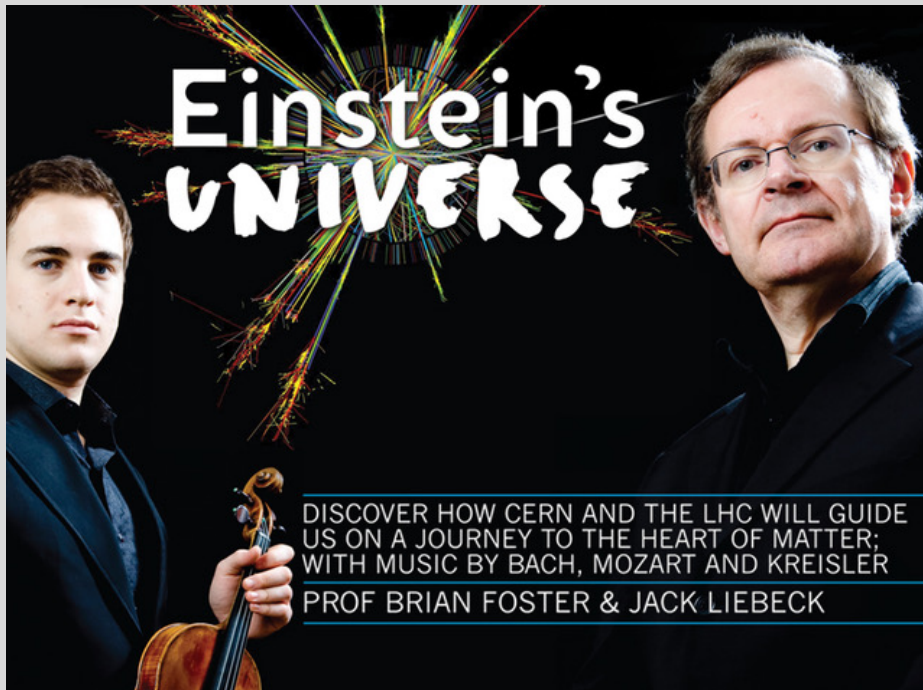
## Leadership + Policy

Royal Society PE committee (Foster)  
Uni. Oxford. Academic Advisory  
Group on PE w. Research (Sheehy)  
RHUL Outreach Coordinator (Gibson)  
JAI members regularly referee STFC  
PE grants

## Media/publishing

- Media appearances
- Work w. press offices
- Popular science publishing:
  - Sheehy and Foster

# Public Engagement & Music



- ***Oxford May Music Festival*** (1 May 2021)
  - Lecture by Nobel Laureate Venki Ramakrishnan (PRS)
- ***Einstein Lecture*** at Australian Chamber Music Festival 2022
- ***Einstein's Universe*** events in UK

# Public Engagement & Teachers

- **Accelerator and Particle Physics Education at A-Level (APPEAL)**

- Annual training since 2010

- **APPEAL-10 2019**

## ***Future Accelerator Projects Big Science at the Energy Frontier***

- **APPEAL-11 2020**

## ***Particle Accelerators and Plasma Technology The Wave of the Future (postponed due to Covid-19)***

### **APPEAL 10 - Future Accelerator Projects Big Science at the High Energy Frontier**

With the road-map for particle physics in Europe – the so-called European Strategy for Particle Physics – being currently updated, now is a great time to discuss with A-level pupils the future direction of particle physics research at the high-energy accelerator frontier, both in Europe and elsewhere.

The University of Oxford is organising in collaboration with CERN a one-day school to give A-level teachers an opportunity to learn about particle physics and future accelerator projects at the high-energy frontier, including circular colliders such as the Future Circular Collider (FCC) and linear colliders such as the Compact Linear Collider (CLIC) and the International Linear Collider (ILC). The school will also include lectures on admission to undergraduate studies in physics and on applications of accelerators as well as a lab class.

The school will address questions that often fascinate students, such as “How does a particle accelerator work?” “What has been discovered at the LHC already?” “What are particle physicists looking for next?” “What will come after the LHC?” “Will accelerators just keep on getting larger?” and “What are the applications of particle accelerators in our daily lives?”.

Past **APPEAL** events were very successful and we are looking forward to a very interesting and thought-provoking event this year as well.

The APPEAL-10 event will take place on **Saturday, 6 July 2019** at the **University of Oxford**.

To take part in this school please register [here](#) before the **Friday, 28 June 2019**.

There are **no registration fees** for the teachers to participate in the event. The organisers are grateful for the support received from the following organisations:



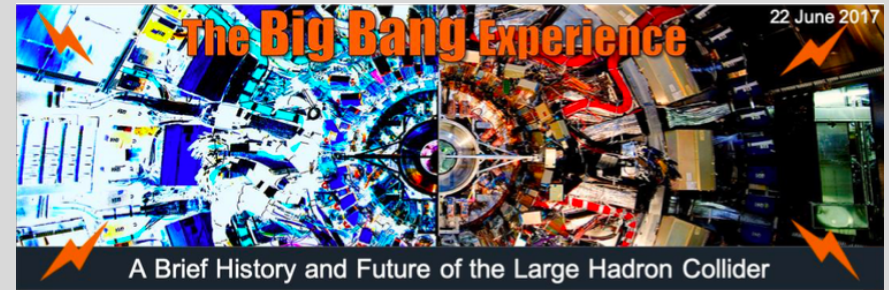
**APPEAL-10 in 2019**

# Public Engagement & The Big Bang Experience!

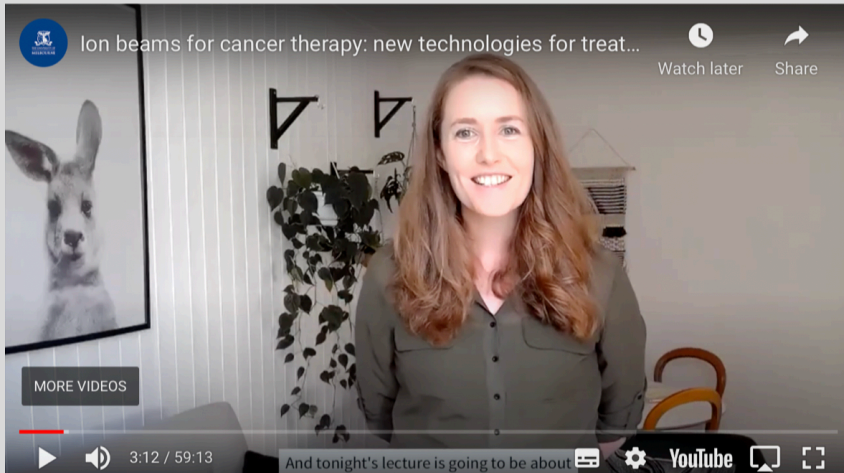
- Brief history and future of the LHC revealing wonders of the LHC at CERN and how it is unravelling mysteries of the universe.



RHUL Department of Physics wins three awards at SEPnet Expo 2017. Led by Stephen Gibson.



# Public Engagement & the Antipodes



Lecture on accelerators in medicine

Popular Science Book –  
***The Matter of Everything:  
The 12 Experiments that Made  
the Modern World***



ABC Australia comedy podcast ***The PopTest***



# Future Programme – Public Engagement

- We will continue strengthening our existing portfolio and encourage new and innovative ideas.

## Support for people + ideas

- Seed funds (University, Department)
- Open meetings on outreach
- Support JAI ‘STEM influencers’ for STFC PE funding

## Adapt to post-Covid “new normal”

- Explore “Zooming” some events
- More emphasis on publications - books and multimedia e.g. Sheehy and Foster books

## Work with and help adapt STFC PE strategy



Inspiring  
&  
Involving

Incredible Science • Inspirational People • Astounding Places



Our PE work is literally on the cover of the STFC PE strategy...

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# Conclusions

- JAI continues to deliver a **world-class** accelerator science **education & training** and **public engagement** programmes.
  - Intense accelerator physics course.
  - Innovative and educational accelerator design projects.
  - Successful placement of students once they enter professional careers.
  - Recognised and award-winning public engagement activities – with global reach.