

Update on Education & Training and 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.

EDUCATION AND TRAINING

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**.

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 more than 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 2021

Lectures (23)

Types of Accelerators*

Applications of Accelerators*

Live Connection – LHC Control Centre*

Transverse Optics

Longitudinal Dynamics

Momentum effects

Lattice Design

Beams and Imperfections

Basic Plasma Physics Concepts for Plasma Accelerators

Plasma-based Electron Acceleration

Plasma-based Ion Accelerators

RF Cavities

Beam Diagnostics and Instrumentation

Synchrotron Radiation

Wigglers and Undulators

Radiation Damping & Excitation

Hamiltonian Dynamics

Parameters for FCC-ee Student Project

Exercise Classes (6)

Introduction to Accelerators*

Transverse Dynamics

Longitudinal Dynamics

RF Cavities

Hamiltonian Dynamics

Synchrotron Radiation

** Combined Particle Physics & Accelerator Physics cohort*

**Course carried out in hybrid format
(in person & videoconference) due to Covid-19**

Graduate Accelerator Physics Course

Term II January-March 2022

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 and Particle Therapy
Introduction to Radiobiology and its Applications to Accelerator Science*

Exercise Classes (2)

Magnet Design
Introduction to FCC-ee Student Project

Tutorials (8)

FCC-ee Student Project

JAI Seminar (1)

FCC-ee Student Project

**Course carried out in hybrid format
(in person & videoconference) due to Covid-19**

* New lecture following proposal of JAI AB 2021

Graduate Accelerator Physics Course 2021-2022

■ Number of Students

■ **University of Oxford**

□ Particle Physics (9) *

□ JAI Accelerator Physics (4)

■ **JAI Royal Holloway, University of London (2)**

■ **JAI Imperial College London (1)**

■ **Humboldt University of Berlin (2) ****

Following cooperation agreement with University of Oxford

■ **University College London (1) ****

* Registered for first three lectures and tutorial of Term I only

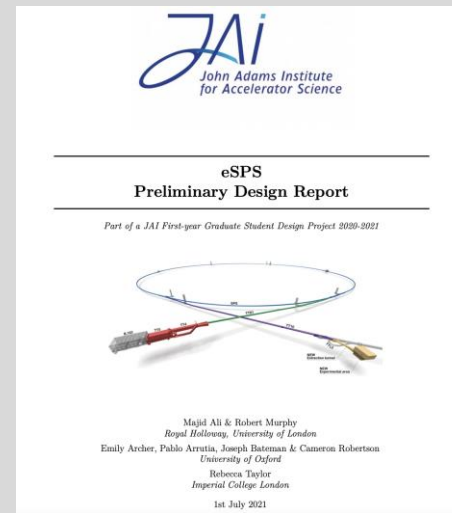
** Registered for Term I only

Accelerator Design Project

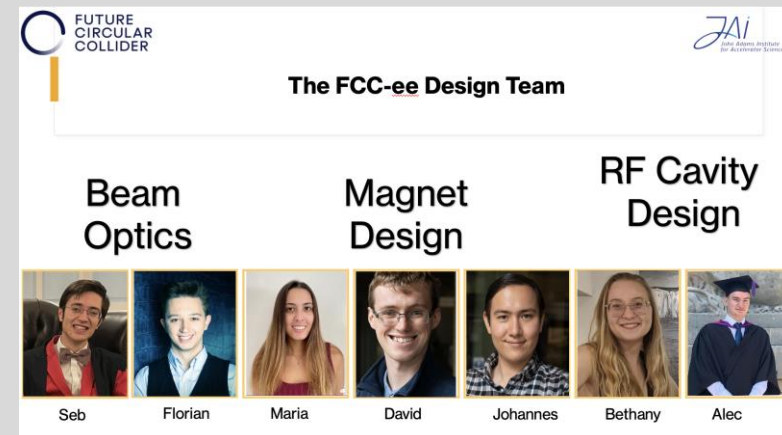
- Accelerator Design Study for
 - **Electron SPS**: 2020-2021
 - **FCC-ee**: 2021-2022
 - Design work consisted of study of the lattice, magnet systems and RF cavities.
- Student visits and presentations at CERN planned for June 2022.

“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”



eSPS Design Report published on CDS
(DOI 10.17181/CERN.Q29A.V5M6)
and students delivered JAI Seminar.



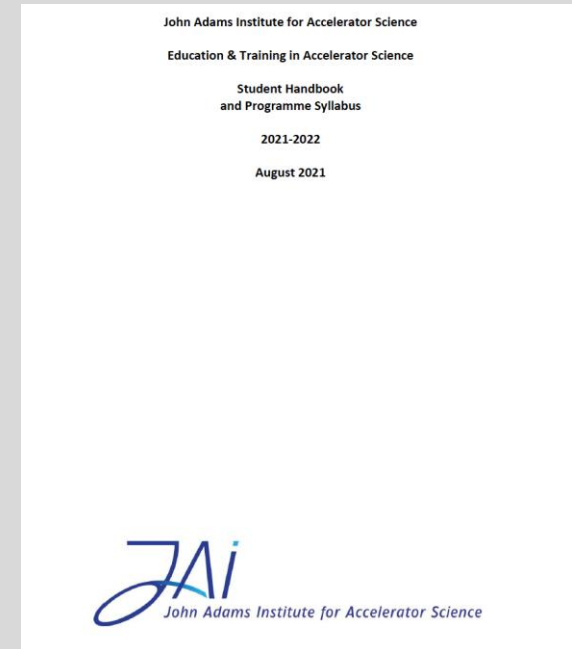
FCC-ee Design Report to be published on CDS & students delivered JAI Seminar

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)
 - Lecturers / instructors from **all JAI universities** and from external institutes – **CERN, DIAMOND, ESS, PSI, RAL**.
 - **Following Brexit, all non-UK lecturers require permit/visa to lecture in person.**

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 2021-2022](#).

January 2022
 20 Jan - 10 Mar Hilary Term 2022
October 2021
 14 Oct - 02 Dec Michaelmas Term 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

New Graduate Students 2022-2023 Academic Year

■ Oxford

- Vlad-Costin Musat, Development of an inverse Compton scattering source based on CLIC technology, CERN Doctoral Studentship.
- Emily Howling, AWAKE or FCC-ee, STFC or CERN Doctoral Studentship.
- CERN Doctoral Studentship on FCC-ee beam instrumentation (with CERN/BI).
- Dosimetry for VHEE/FLASH beam therapy (partly STFC supported).

■ RHUL

- HL-LHC-UK-Phase II STFC Project Studentship on EO-BPM beam instrumentation with long term attachment for Run 3 beam tests at CERN.
- 2 JAI STFC studentships (selection in progress).
- Thomas Hyatt, p/t PhD funded by the UK Health Security Agency on medical applications.
- Thomas Bass, MSc. / CERN Technical Studentship on RF slow extraction techniques (with CERN SY-ABT-BTP).

■ ICL

- Rehanah Razak (JAI/ISIS).
- Recruitment on the muon programme (JAI/PPD).
- Ginevra Casati - Laser Generate Ion Beams (JAI/CLF)
- Runfeng Luo - Wakefield based radiation sources (self funded).

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 universities, the Royal Society, STFC CASE, EPSRC DTP, DLS, CLF and RAL/ISIS/PPD, as well as the CERN Doctoral Student programme, European Research Council, Helmholtz Foundation, Marie Curie Fellowships, Thai government fellowships, industry (e.g. TRUMPF Scientific Lasers) & other non-UK sources.

Continue to explore wide range of possibilities for sustainable funding.

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 3rd year, while the **RHUL** course offers an annual **intercollegiate** undergraduate course for 4th 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 / three students** 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 out research work at **RHUL**.

Expect programmes to attract undergraduate students to accelerator science.

UK Accelerator Institutes Seminar Series

- JAI has teamed up with ASTeC and the Cockcroft Institute to organise jointly the new **UK Accelerator Institutes Seminar Series**
<https://indico.cern.ch/category/13863/>
- Delivered by distinguished speakers from the participating institutes and from laboratories / universities world-wide.
- Seminars scheduled so that the graduate student body can attend.

January – March 2022

Title	Presenters
The Brightest Light in Canada	Mark James Boland (University of Saskatchewan (CA))
Present Performance and Future Opportunities at the ORNL Spallation Neutron Source	Fulvia Pilat (Jefferson Laboratory), Fulvia Pilat (Department of Physics), Fulvia Pilat (ORNL)
Design and Operation of the MAX-IV Vacuum System based on NEG Coating	Eshraq al dmour (MAXIV)
Developments in Medical Applications of Accelerators	Karen Kirkby (University of Manchester)
THz Accelerators and their Application to Ultrafast Electron Diffraction	Emilio Alessandro Nanni (SLAC National Accelerator Laboratory, Stanford University)
EuPRAXIA - The Innovative and Compact Plasma Accelerator Facility for Europe	Ralph Wolfgang Assmann (DESY & INFN)
Space-Borne Accelerators	Quinn Marksteiner (Los Alamos National Laboratory)
Accelerator Physics at Fermilab's IOTA ring	Sergei Nagaitsev

Attendance has been excellent

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).
 - 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 cooperation agreements (e.g. Humboldt University Berlin) & student accelerator design projects.
 - **Strengthen integration of the 3 universities** by fostering & supporting student exchanges, common lectures and seminars, and other events, e.g. the UK Accelerator Institutes Seminar Series.
 - Establish **joint JAI and CI programme of lectures** on specialised topics 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.
 - JAI academic staff continue to deliver 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

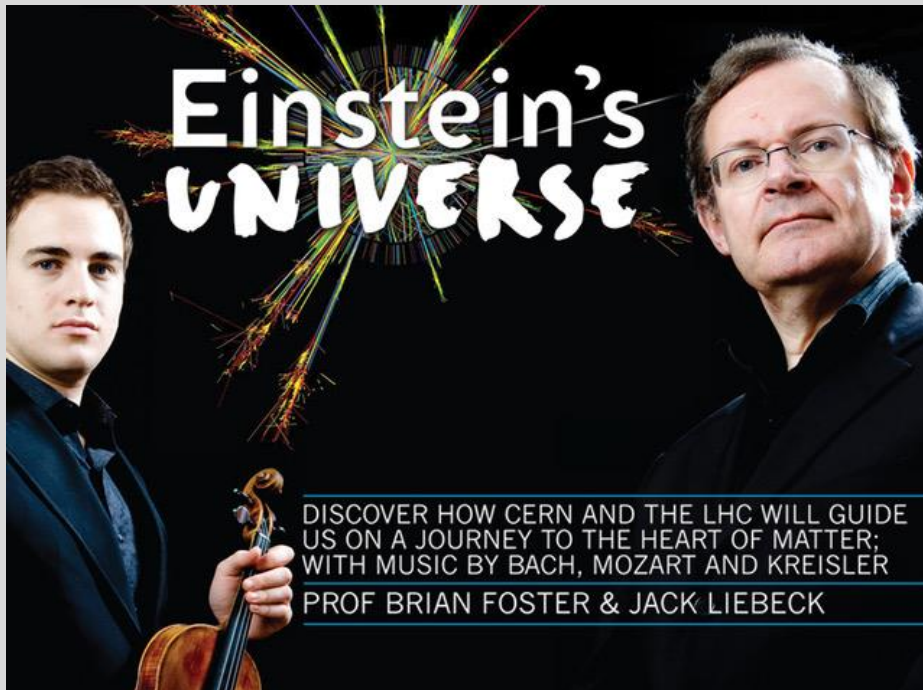
Leadership + Policy

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



- **Online Oxford May Music Festival** (1 May 2021)
 - Talk by Sir Venki Ramakrishnan (PRS) on his new book “The Gene Machine”, which was attended by about 100 over Zoom and followed by a concert.
- ***Einstein Lecture*** at Australian Chamber Music Festival 2022
- ***Einstein's Universe*** events in UK

Public Engagement and Medicine

- **Patient and Public Engagement (PPI)**

- Two patient representatives
 - Members of LhARA Institute Board, providing “**Lay Summaries**”.
- LhARA/JAI members (Long, Kurup) have made presentation at **Maggies cancer charity group**.



MAGGIE'S

Everyone's home of cancer care

- With the PPI representatives LhARA is now planning
 - A “4-nation” PPI activity to **raise the profile of novel approaches to proton and ion beam therapy** and the LhARA initiative as a coordinated discussion at Maggie's centres in the 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

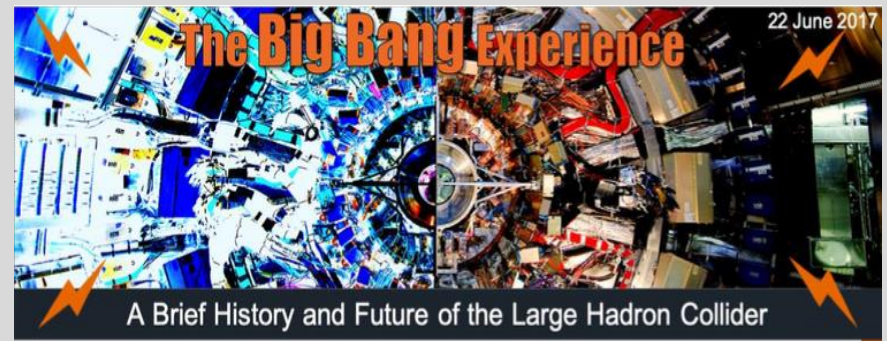
**Aim to re-start in-person events
following Covid-19**

Public Engagement & The Big Bang Experience!

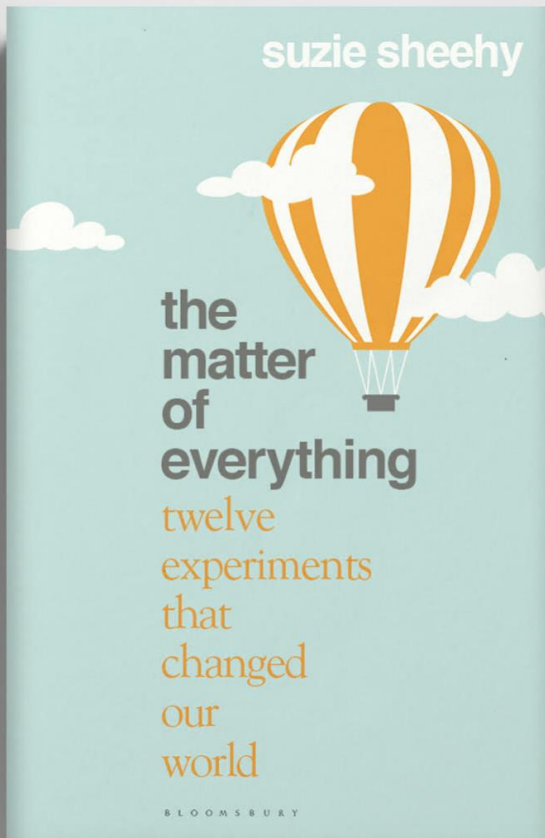
- Brief history and future of the LHC revealing wonders of the LHC at CERN and how it is unravelling mysteries of the universe.



- Re-starting in-person events following Covid-19.
 - Particle Physics Masterclasses
 - Open Days
 - *Girls into Physics* (with Smallpiece Trust)



Public Engagement & Literature



Popular Science Book

Outreach events in the pipeline around launches in the UK (28 April), Australia (3 May) and US (January 2023).

Public Engagement & the SDGs

- **SDG 3 – Good Health and Well-being**
 - Skeptics in the Pub: "From Higgs to Healthcare in low-resource regions."
 - Particle accelerators: from making Higgs bosons to curing cancer' for the Oxford Prospects Programme
 - Social Justice: Migration, Racism, and Health on SDG 3 - Ensure healthy lives and promote well-being for all at all ages (CoNGO 2021)
 - The importance of equality in the recovery from the COVID-19 pandemic and SDGs (UN GA Third Committee with Non-Governmental Organisations, Feb. 2022)
- **SDG 5 – Gender Equality**
 - Panels of U.N. Commission on the Status of Women Forum 66 (2022)
 - Disparities in Cancer Care for Women: An Urgent Global Need (Panel for CSW66 Forum, March 2022)
 - Women in STEM: Mind the Gap Panel for CSW66 Forum (March 2022)



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...

Summary

- JAI continues to deliver **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.