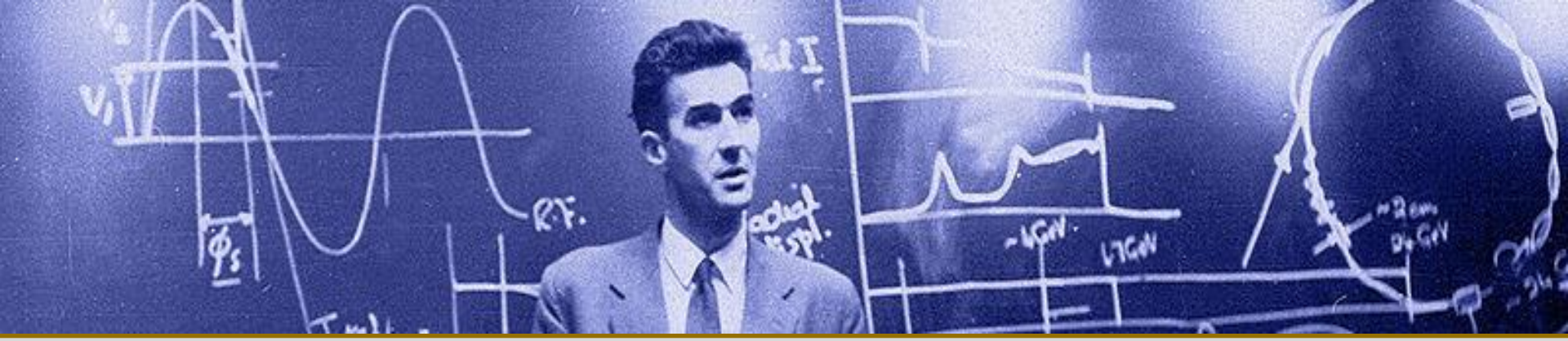


Update on Education & Training and Public Engagement at JAI

Emmanuel Tsesmelis
CERN & JAI University of Oxford

JAI Advisory Board 2023
27 March 2023

JAI John Adams Institute for Accelerator Science
Imperial College London
ROYAL HOLLOWAY UNIVERSITY OF LONDON
UNIVERSITY OF OXFORD

Introduction

- The JAI programme is organised around three pillars:
  - Research & development in accelerator science.
  - Training next generation of accelerator scientists.
  - Knowledge exchange, impact & 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 2022

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 & Zoom)

Graduate Accelerator Physics Course Term II January-March 2023

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 & Zoom)

* Lecture following proposal of JAI AB 2021

Graduate Accelerator Physics Course 2022-2023

- Number of Students
  - **University of Oxford**
    - Particle Physics (11) *
    - JAI Accelerator Physics (6)
  - **JAI Royal Holloway, University of London** (2)
  - **JAI Imperial College London** (6)

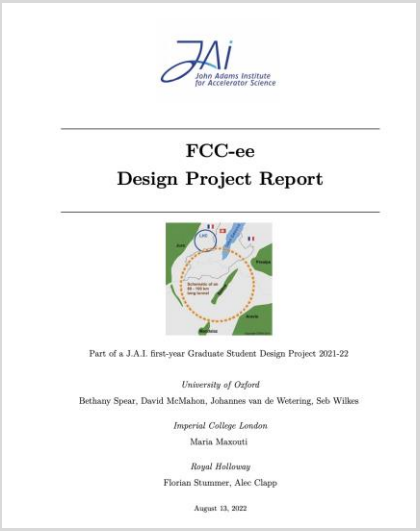
* *Registered for first three lectures and tutorial of Term I only*

Accelerator Design Project

- Accelerator Design Study for
  - **Electron SPS**: 2020-2021
  - **FCC-ee Booster Ring**: 2021-2022
  - **FCC-ee Positron Damping Ring:** 2022-2023
  - Design work consisted of study of the lattice, magnet systems and RF cavities.

"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
John Adams Institute for Accelerator Science

FCC-ee
Design Project Report

Part of a J.A.I. first-year Graduate Student Design Project 2021-22

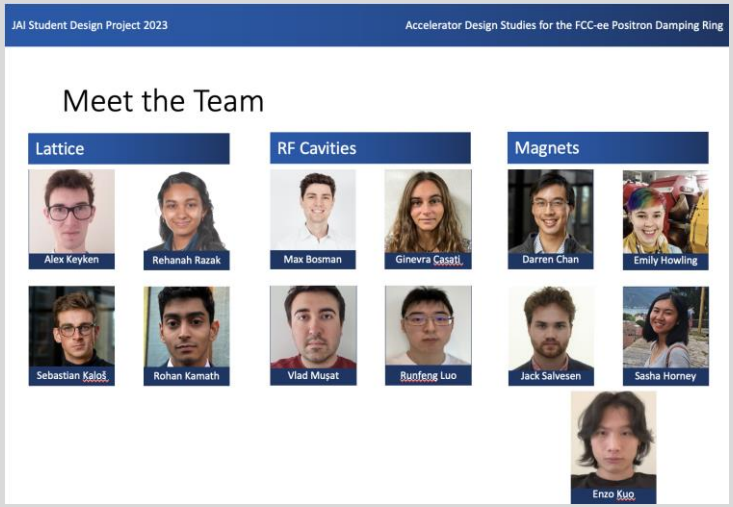
University of Oxford
Bethany Spear, David McMahon, Johannes van de Wetering, Seb Wilkes

Imperial College London
Maria Maxouti

Royal Holloway
Florian Stummer, Alec Clapp

August 13, 2022

For 2021-2022: FCC-ee Booster Ring Design Report published on CDS **(10.17181/CERN.GSBF.JG2K)** and students delivered JAI Seminar. on 9 March 2023.



FCC-ee Positron Damping Ring Design Report to be published on CDS & students delivered JAI Seminar on 9 March 2023

JAI AB Recommendation 2022

- Aspects of engineering and actual manufacturing of real accelerator components should be brought to the attention of the students.
  - *Student visits and presentations at CERN planned for June 2023, including visits to accelerator and technical infrastructure and exchange with experts on engineering and manufacturing aspects.*

- Students to make estimate of power consumption of facility as sustainability has become an area of highest relevance.
  - *Included in study (and presentation / report).*

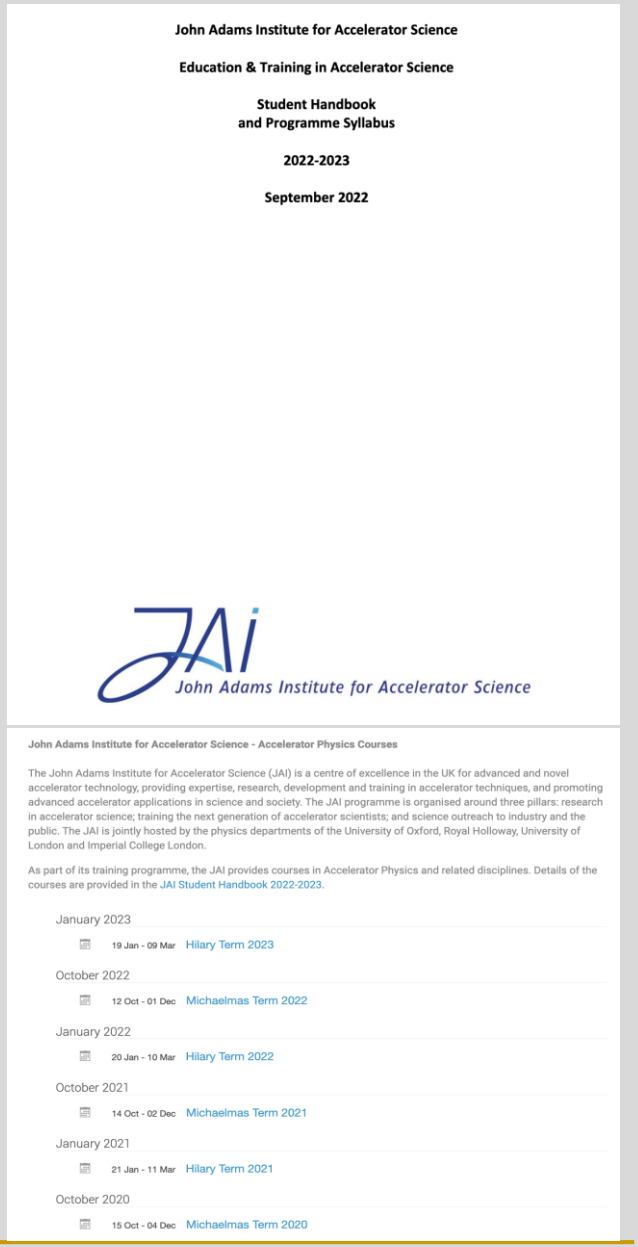
- Availability of toolbox of applications scripts.
  - *Students provided with software scripts for MAD-X (lattice), FEMM (magnets), and Superfish/CST (RF cavities).*

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. Dosanjh (Oxford), M. Fraser (CERN), H. Garcia-Morales (Oxford/PickleTech), A. Gerbershagen (Groningen), D. Kelliher (RAL), S. Lawrie (RAL), S. Mangles (ICL), I. Martin (Diamond), A. Milanese (CERN), Z. Najmudin (ICL), S. Patel (RAL), C. Plostinar (ESS), M. Schippers (PSI), F. Tecker (CERN), E. Tsesmelis (CERN/Oxford), Rob Williamson (RAL)
  - Lecturers / instructors from **JAI universities** and from external institutes – **CERN, Uni. Groningen, 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

Education & Training in Accelerator Science

Student Handbook
and Programme Syllabus

2022-2023

September 2022

John Adams Institute for Accelerator Science

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 2022-2023.

January 2023
19 Jan - 09 Mar Hilary Term 2023

October 2022
12 Oct - 01 Dec Michaelmas Term 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

New Graduate Students 2023-2024 Academic Year

- **Oxford**
  - Cory Lehman – Fast Beam Loss Monitor System for Diamond-II and Machine Learning Applications (Oxford / Diamond funding)
  - Carl Jolly – ISIS (part-time student, ISIS Staff)
  - Shaun Preston – Applications of Machine Learning Techniques for Online Optimisation of Synchrotron Light Sources (Oxford / Ada Lovelace Institute funding)

- **RHUL**
  - Mark McCallum, RF Electronics for Beam Position Monitor (STFC JAI quota, joined in January 2023)
  - N.N. for a JAI STFC quota.
  - Studentship expected on EIC (Electro-Optic BPM), potentially with US funding is being planned.
- **ICL**
  - Jasmin Hills – Laser Wakefield Acceleration (JAI STFC funding)
  - N.N. – Development of Time Resolved X-ray Absorption Spectroscopy Using LWFAs (CLF/JAI funding)
  - Additional recruitment on laser wakefield acceleration.

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

Graduate Student Funding

- Since 2019, JAI included in **STFC quota** PhD studentships scheme receiving three studentships per year. Expect four per year as of 2024.

- 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.

- For future: Developing new **Doctoral Training Alliance** (DTA) application on plasma accelerators together with University of Warwick and funding mechanism through **EIC/US**.

Continue to explore wide range of possibilities for sustainable funding.

Undergraduate Accelerator Physics Summer Student Internships

- Oxford University Internship Programme (CERN in July/August annually)
  - **Two 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 **Imperial College & 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 held in person and via videoconference and scheduled so that the graduate student body can attend.

Latest Session in January – March 2023

Title	Speaker
The Perle Project Plans and Status	Maude Baylac (LAL, Orsay), Walid Kalib (LAL, Orsay)
Clinical Proton Beam Therapy: A Look into the Future	Richard Amos (University College London)
Search for the Electric Dipole Moment of the Muon Using the Frozen-spin Method	Philipp Schmidt-Wellenburg (PSI)
Linacs to Narrow the Radiotherapy Gap	Manjit Dosanjh (JAI)
Towards a High-power Cyclotron	Huiwen Koay (TRIUMF)

JAI AB Recommendation 2022

- Add lectures on societal applications and technology transfer to course curriculum.
- Incorporated into the UK Accelerator Institute Seminar Series.

Title	Speaker
Distributed Coupling Linear Accelerators and their Applications	Sami Tantawi (SLAC)
Lessons Learnt in Building a Research Capability for Proton Therapy	Karen Kirkby (University of Manchester)
Societal Impact of CERN Accelerator Technologies: from Cancer Therapy to Artwork Analysis	Maurizio Vretenar (CERN)
Machine Learning Project Development in Particle Acceleraors: A Business Perspective	Hector Garcia Morales (Pickle Tech)
Synchrotron Light Illuminates the Origin of the Solar System	Tomoki Nakamura (Tohoku University)
Clinical Proton Therapy: A Look into the Future	Richard Amos (University College London)
Linacs to Narrow the Radiotherapy Gap	Manjit Dosanjh (JAI)

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).
  - York Fusion Frontiers Lecture Series – Laser Plasma Accelerators (Z. Najmudin)
  - Culham Summer School on Plasma Physics - Laser Wakefield Accelerators (S. Mangles)

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) in few special cases & 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.

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

Public Engagement & Schools Outreach

‘Particle Accelerators: from Higgs Bosons to Curing Cancer’

Delivered 40 times in pre-pandemic decade

First post-pandemic talk: November 2022 at nearby school: >100 attendees

Feedback from female GCSE student:

‘It meant a lot to me that you spent your time discussing my ambition to have a career in physics once I am older. I greatly appreciate that you talked with me and I thank you for the advice you gave me.

Our discussion really inspired me and I am more determined than ever, … at the moment I am likely to be the only student at my school taking Physics and Further Maths A-Level, but this will not deter me.’

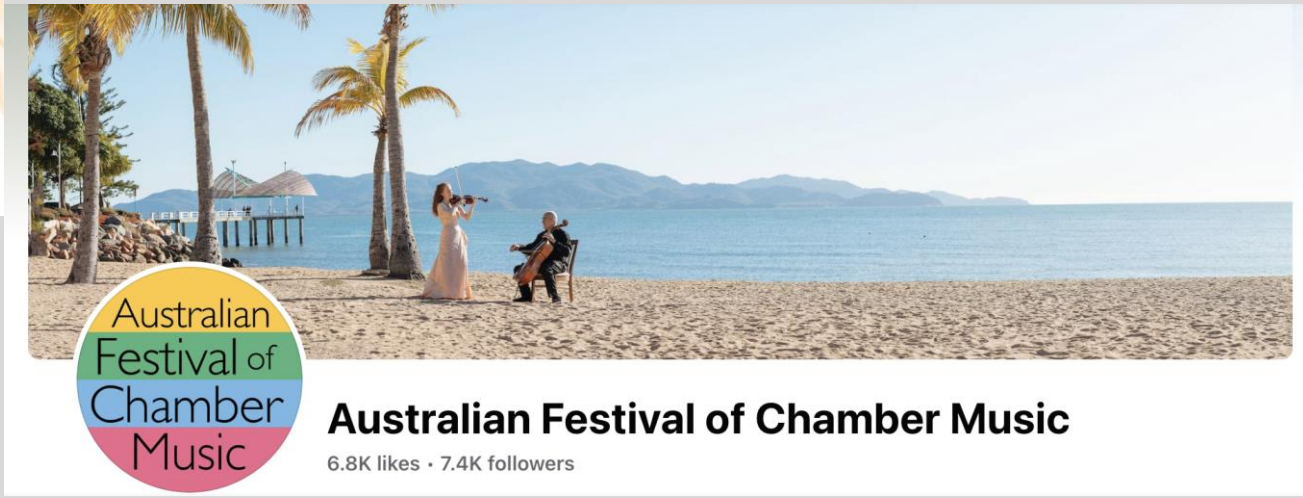
Phil Burrows

Public Engagement & Music

- ***Oxford May Music Festival*** (April/May 2022).

- ***Einstein and the LHC*** at Australian Chamber Music Festival, Townsville, July 2022.

Brian Foster



Public Engagement and Medicine

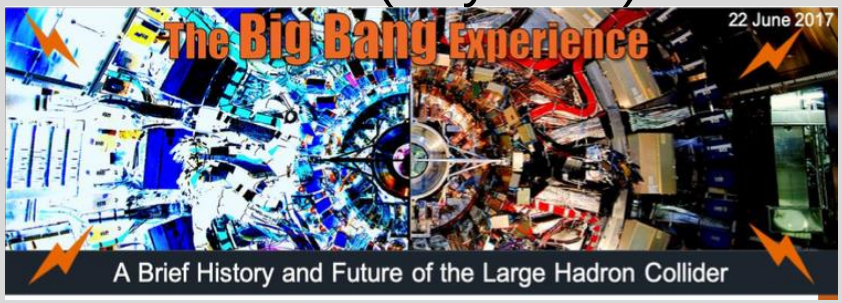
- **Patient and Public Engagement (PPI)**
  - With Amato Giacca (Oxford Institute for Radiation Oncology), LhARA initiative was presented at Queen's University Belfast (QUB) and followed up with discussion with the QUB PPI group.
  - With the PPI representatives LhARA is now planning
    - A "4-nation" PPI activity to **raise the profile of novel approaches to proton and ion beam therapy** and the LhARA initiative as a coordinated discussion at Maggies cancer charity centres in the UK.

Ken Long

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-started in-person events at RHUL following Covid-19.
  - Annual Physics Taster Days (June 2022)
  - Particle Physics Masterclass: A-level students (March 2023)
  - Royal Holloway Science Festival (May 2023)
  - Girls into AstroPhysics residential (July 2023)



Public Engagement & Literature

Popular Science Book *Suzie Sheehy*

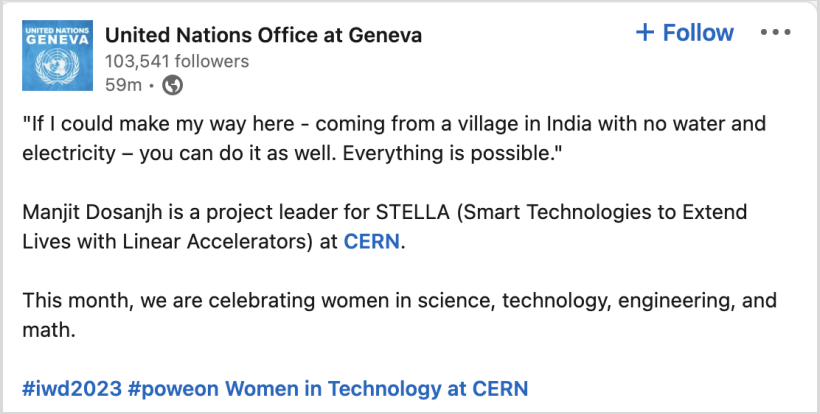
Outreach events and coverage around launches in the UK (April 2022), Australia (May 2022) and US (January 2023).

Public Engagement & the SDGs

- ***SDG 3 – Good Health and Well-being***
  - Climate Change and Health Task Force Meeting (World Health Organization).
  - Member of Conference of Non-Governmental Organizations in Consultative Relationship with the United Nations (CoNGO) Board and Invited Speaker at WSIS 2022.

- ***SDG 5 – Gender Equality***
  - Committee on Status of Women - Geneva (CSW-Geneva)
  - UK Civil Society Women's Alliance (UKCSWA)

Manjit Dosanjh



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 - continue strengthening existing portfolio and encourage new & innovative ideas.