



Inspiring & Involving



**Nuclear Physics
Outreach and Public
Engagement**

**Dr Elizabeth Cunningham
*Particle & Nuclear Physics
Outreach Officer***

**Nuclear Physics UK
Community Meeting
2019**

amazing Science ☐ Inspirational People ☐ Astounding Places



STFC Public Engagement

- Our vision and mission

Enabling you

- STFC funding and support

Successful nuclear physics outreach awards

- Examples of excellence!

STFC nuclear physics public engagement

- What have I been doing?

Impact

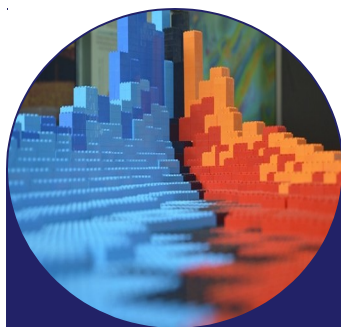


Why do public engagement?

Why is public engagement important?



To tell people about your research?



To get people to take an interest in your subject?



To inspire the next generation of researchers?



To encourage participation?

To build relationships or gain influence?



To improve trust and understanding?



You should also do it...



Why does STFC engage the public?

Our vision is of a society that values and participates in scientific endeavour

Our mission is to use our stories, communities, and facilities as the basis of world-class public engagement that inspires and involves people with our science and

INSIDE THE ATOM: nuclear activity in the UK

Security and the environment
In order to access the 13 uranium nuclear power reactors currently licensed in the UK and innovative ways to detect and monitor radiation, the advanced detectors developed for fundamental research can also be used for other tasks, such as monitoring the movement of radioactive materials and the detection of illicit nuclear materials, which are important issues both in order to protect national security and to ensure that the UK remains a world leader in the development and construction of advanced forms of nuclear energy.

Nuclear applications
Research into nuclear physics has enabled the development of science and technology that directly benefits us. Whether it's saving lives through nuclear medicine or investigating a long dead civilisation using radiometric dating, nuclear physics really is a matter of life and death! Here are just a few examples of how nuclear processes and ionising radiation are being used to improve our lives and address the future needs of the UK.

Nuclear power
Using nuclear techniques to identify the different amounts of stable and radioactive isotopes in a sample, along with the knowledge of how they are produced naturally or by man, has led to a wide range of applications. This technique has been used to date medieval, historical and archaeological artefacts and to monitor the movement of pollutants in the environment. It has also been used to identify the number of different radioactive isotopes that decay at different rates, nuclear dating techniques have been used to provide a stable industry. One of the most well-known facts of radiometric dating is carbon-14 dating.

Radiometric dating
The half-life of carbon-14 is 5730 years, so it can be used to date things up to about 40,000 years old. However, with extremely long half-lives, such as uranium-238 with a half-life of 4.5 billion years, which is to be more exact, nuclear clocks by looking at the proportion of various isotopes in materials, compared with the elements involved when they were first formed, the age of the Earth has been determined to be 4.54 billion years.

Nuclear fusion
Harnessing the nuclear fusion reactions that power the Sun could provide a clean and inexhaustible source of energy to help meet the world's needs. To generate energy from fusion on Earth needs a few billion of hydrogen isotopes – deuterium and tritium – to be heated to 100 million degrees Celsius to ignite the fusion reaction. To help regional demands that can withstand these temperatures, and the various potential benefits, nuclear fusion in the UK are studying the potential of the nuclear reactors likely to occur in these reactors.

Nuclear medicine
Every day, we know someone who has benefited from a special procedure based on isotopes from nuclear physics. Whether they have had a routine X-ray or undergone radiotherapy to treat cancer, nuclear medicine is important for both diagnosis and treatment of disease.

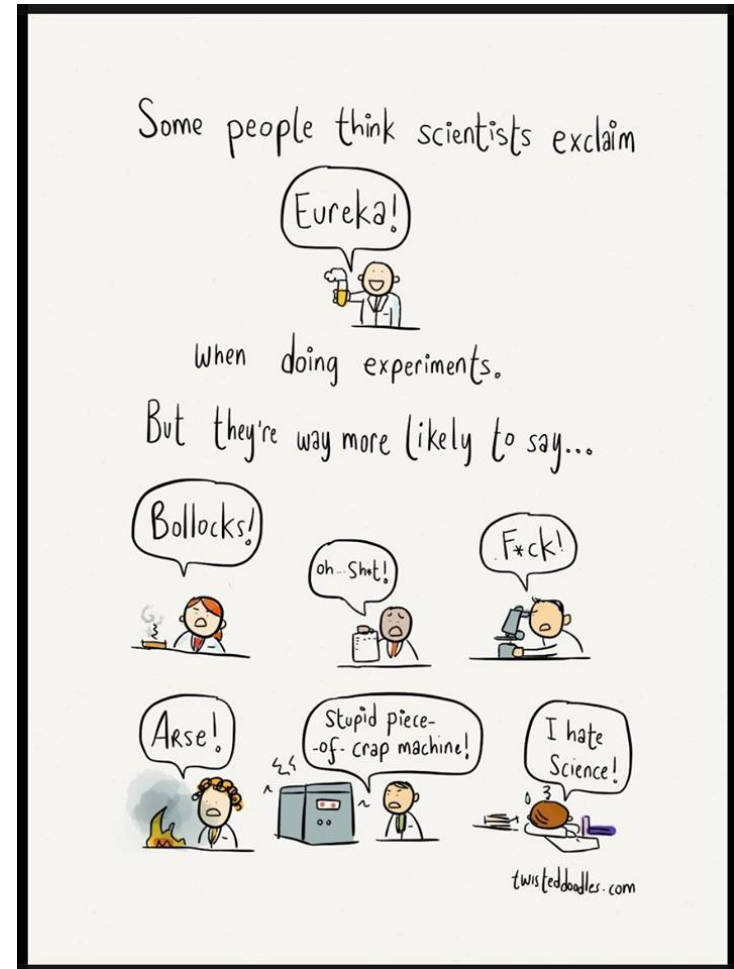
Nuclear physics in the home
The most common domestic smoke alarms use an ionisation source of americium-241, a radioactive isotope of the element actinium. Americium-241 is a very small amount, but it emits a steady stream of alpha particles that ionise the air between two electrodes that is open to the air. The air in this chamber becomes ionised, allowing a very small electrical current to flow. If smoke is present this current is blocked and the alarm sounds.

Nuclear laboratories
The STFC Discoverer Laboratory is the UK's largest laboratory for nuclear physics research. It is home to the UK's Nuclear Physics Centre. Additionally, Discoverer is home to the Accelerator Science and Technology Centre and the Central Facility of accelerator science.

National laboratories
The UK's national laboratories have world leading science and technology facilities. They offer a wide range of services, from the development of new materials and energy systems, to the development of new medicines and the development of new materials.

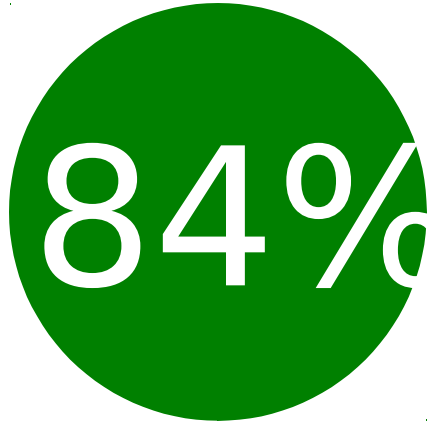
See the science
UK's national laboratories have world leading science and technology facilities. They offer a wide range of services, from the development of new materials and energy systems, to the development of new medicines and the development of new materials.

Science & Technology Facilities Council

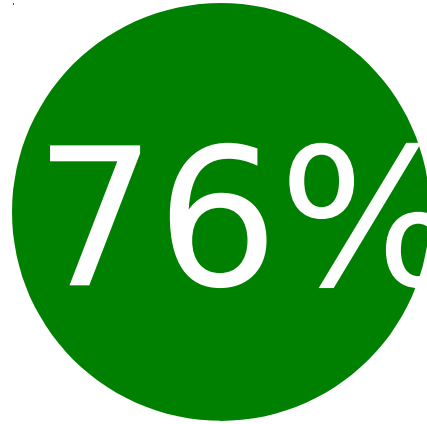


There are lots of positive messages...

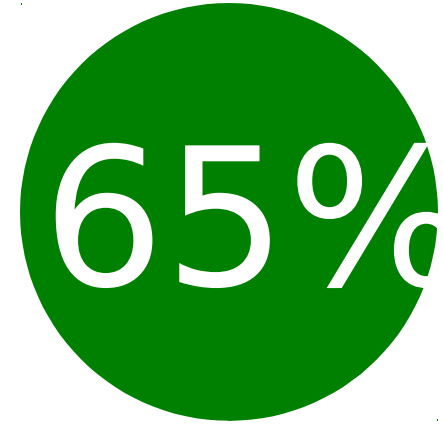
Public attitudes to science



Believe everyone should take an interest in science



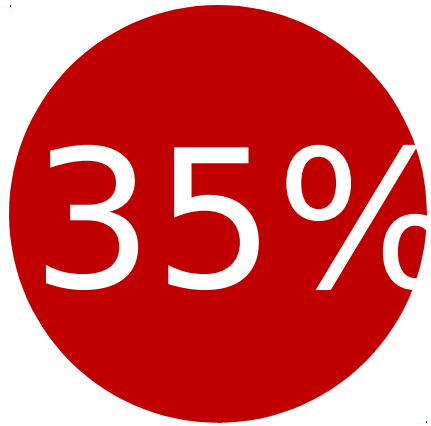
Consider science to make a direct contribution to economic growth



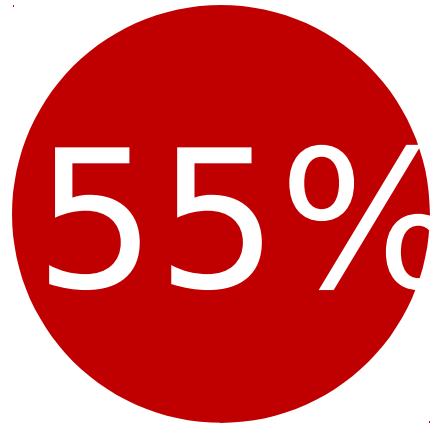
Disagree that science funding should be cut

...but there are also causes for concern.

Public attitudes to science



Think scientists
adjust findings
to get the
answers they
want



Believe science
is too
specialised for
them to
understand



Characterise
scientists as
secretive

STFC not only has the best science...

...It also has the best public engagement programme of all the research councils

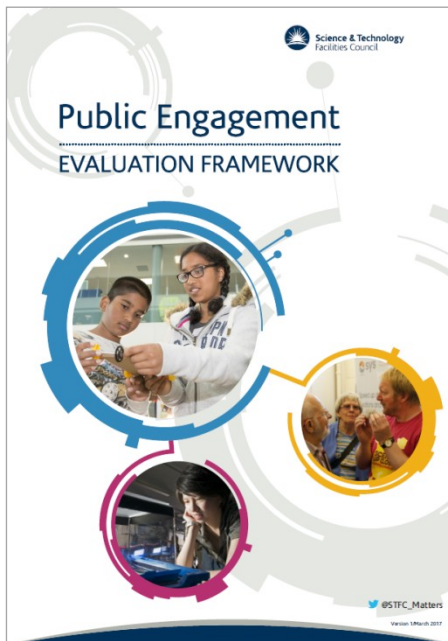


<http://www.stfc.ac.uk/public-engagement/strategy-and-reports/our-strategy-for-engagement/>



Every year, we reach over 1.4M people with our public engagement.

STFC support: key engagement publications



Our framework
to keep us
improving



Our picture of
the STFC
community

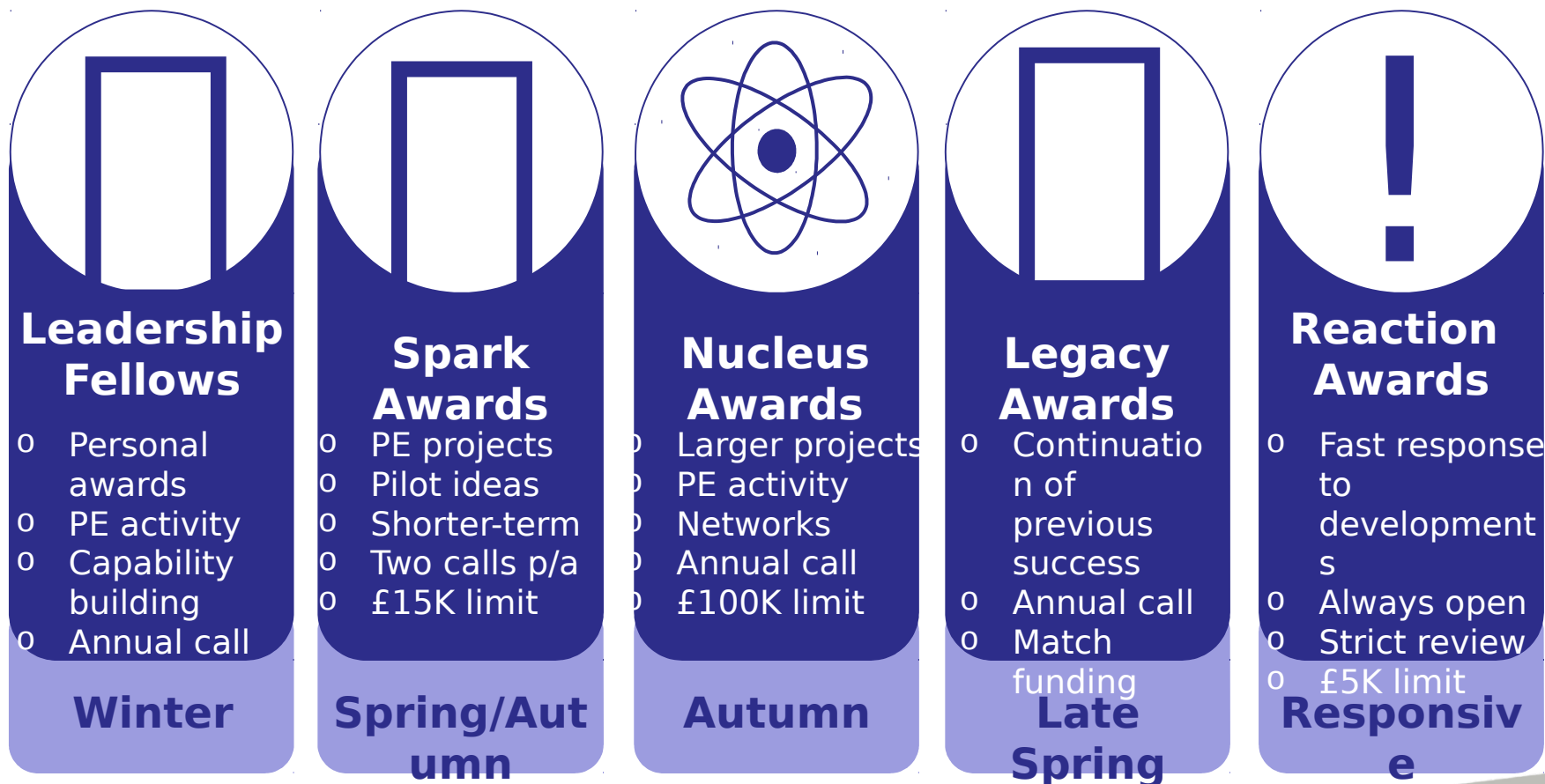


Reflections on
PE in Pathways
to Impact

Find these documents at:

<https://stfc.ukri.org/public-engagement/strategy-and-evaluation/evaluation-and-our-evidence-base/>

Enabling you – refreshed grant schemes



Enabling you – STFC PE funding

Good track record of nuclear physics related public engagement grants being awarded.

Dr Christopher Edmonds (Liverpool)

'acceleratAR'
£9,668

Virtual tours of the
accelerator facility
at Daresbury



Ms Rae Hoole (Daisi)

'Lise Meitner: The Battle for Ultimate
Truth' £9,800

A day long school
event, to encourage
more young women
into physics



Dr Thomas Elias Cocolios (Manchester)

How to handle a
radioactive nucleus
£7,401

ISOLDE 50th
anniversary robot
competition



Enabling you – STFC PE funding

Good track record of nuclear physics related public engagement grants being awarded.

Dr Christian Aaen Diget University of York

LEGO Chart of Nuclides: Inspiring
Future Physicists - £7,970

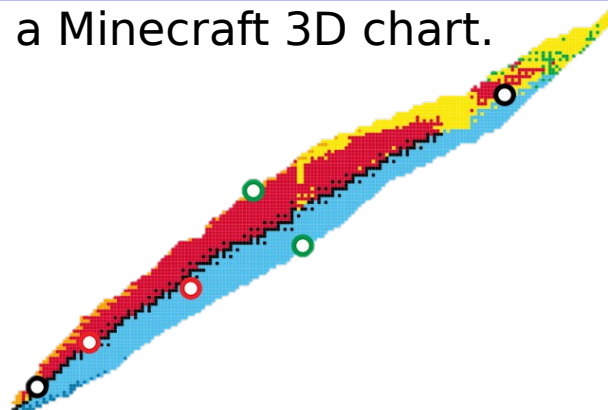
Hands-on LEGO activity to
engage students & teachers with



Dr Alessandro Pastore University of York

Virtual Binding Blocks: from plastic
to digital bricks - £9,000

Creation of interactive online
material including educational
videos, a digital nuclear 3D chart
and a Minecraft 3D chart.



Nuclear Physics Leadership Fellowship in PE

*Dr Christian Diget (University of York)
Engaging Education with Binding Blocks*



activity for teachers & students:

underlying principles of nuclear
nuclear physics, astrophysics,

range of nuclear applications

generation of nuclear physicists

Integrate Binding Blocks within UK A-level (and equivalent) delivery of nuclear physics through:

- nuclear physics masterclasses
- teacher training
- online resources/course
- postgraduate internship programme in PE



Enabling you – Resources

Free of charge publications for your events:
www.stfc.ac.uk/pub-order-form/

Borrow the Moon for your events.

Website: Nuclear Physics for You!
www.stfc.ac.uk/NuclearPhysicsForYou

The collage features several educational materials:

- Core:** A diagram of the Sun's core at 15 million °C, described as the "engine room of the Sun" where nuclear fusion occurs. It includes a diagram showing a proton and a neutron combining to form a deuteron.
- Units of distance:** A diagram showing the scale of the universe, from the size of a proton to the size of the observable universe.
- Supernova elements:** A diagram showing the formation of heavy elements during a supernova explosion.
- Proton-proton chain:** A diagram showing the first step of the proton-proton chain, where two protons combine to form a deuteron, releasing a positron and a neutrino.
- Teaching STEM through Inside the Atom:** A book cover featuring a child in a space helmet.
- Collider (LHC) at CERN:** A diagram showing the Large Hadron Collider (LHC) and the elements it produces.
- Website Interface:** A screenshot of the "Nuclear Physics for You" website, showing a search bar, navigation menu, and a list of resources.

Monthly Newsletter

collaboration now continues by The University of Manchester with an aim to better understand the evolution of single-particle behaviour in this region of the nuclear chart where significant changes in shell structure have been observed. The characteristic kinematic lines from this

when plotting the position along the excitation energy ^{29}Mg shown in Figure

UK Nuclear Activity

d. ISOL Success
 A milestone in the ISOLDE Solenoidal Spectrometer (ISS) project has been reached with the successful completion of the first two physics measurements with radioactive beams. The ISS project is part of the £4M UK ISOL-SRS project funded by STFC. The nuclear physics groups of the Universities of Liverpool and Manchester and STFC Daresbury Laboratory have led the ISS work. An ex-MRI 4T super-conducting solenoid (Figure 1) has been recommissioned and given a new lease of life as a magnetic spectrometer for the study of direct reactions.

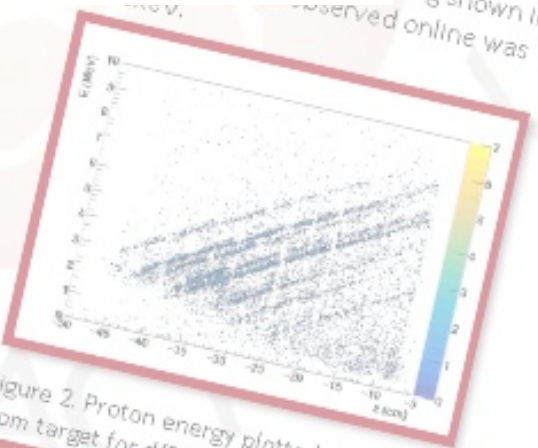


Figure 2. Proton energy plotted against distance from target for $d(^{28}\text{Mg}, p)^{29}\text{Mg}$ reaction.



Figure 1. The ISS 4T superconducting solenoid.

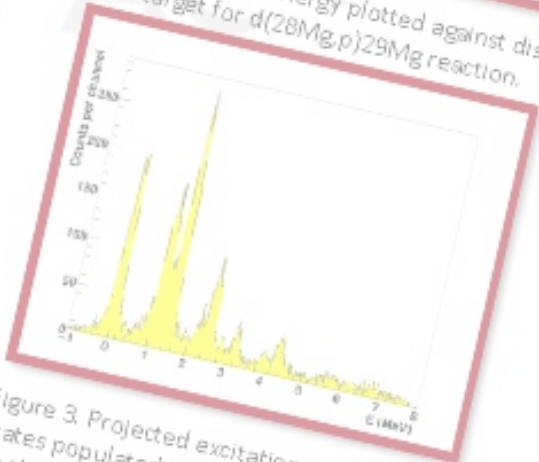


Figure 3. Projected excitation energy plot for states populated in ^{29}Mg - summing all detectors on the array.

Edited by Elizabeth Cunningham, STFC Particle and Nuclear Physics Outreach Officer.
Elizabeth.Cunningham@stfc.ac.uk or E.Cunningham@surrey.ac.uk

STFC PE Early-Career Researcher (PEER)

Forum

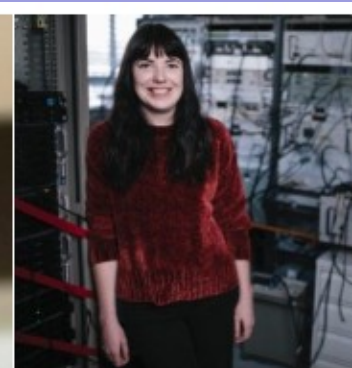
Supports talented scientists and engineers in the early stages of their career to develop their public engagement and outreach goals.

Established in 2018 as a result of the PEACE report:

'A significant proportion of STFC's PE is designed and delivered by scientists and engineers near the start of their career, who are working hard to balance the demands of establishing their careers alongside their passion for leading high quality public engagement and outreach.'

PEER Forum aims to:

- Create a network
- Improve understanding of what STFC offers
- Influence STFC's PE



<https://stfc.ukri.org/public-engagement/training-and-support/peer-forum/>

International Nuclear Physics Conference 2019

INPC2019: Outreach and Engagement Session – abstract deadline 25th January 2019.

IOP Institute of Physics



International Nuclear Physics Conference 2019

29 July – 2 August 2019, Scottish Event Campus, Glasgow, UK



Inspiring and involving

In 2016/17, our National Laboratories and university-funded engagement programmes communicating the inspiring nature of our science:

1.4 Million



Members of the public

337,000



School and further education students



36 grants and 3 Fellowships with a value of

£630,000

We ran 400 events at our National Lab sites which reached 36,000 people, including 9,700 pupils and 1,300 teachers.



Engineering Open House initiative at Daresbury in July 2017:

attracted nearly 700 members of the public and staff family members.

Developing STEM understanding

190

Young people per annum

Our work experience placements for 14-18 year olds at our National Laboratories



Undergraduates

from universities work at STFC on the internship programme



60+

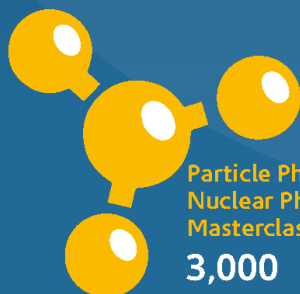
STEM Graduates

on STFC's 2-year graduate programme scheme



Open weekend at ROE, September 2017: attracted more than 3,000 people.

Developing skills for the UK research base



Particle Physics & Nuclear Physics Masterclasses

3,000

Sixth Form Students from over 60 schools

14,000

Training days provided to postgraduate students



Invested in postgraduate training and fellowships bringing total cohort to 870 PhD students



New CERN fellows selected from the UK totalling to 222 to date





Elizabeth.Cunningham@stfc.ac.uk
www.stfc.ac.uk/NuclearPhysicsForYou

