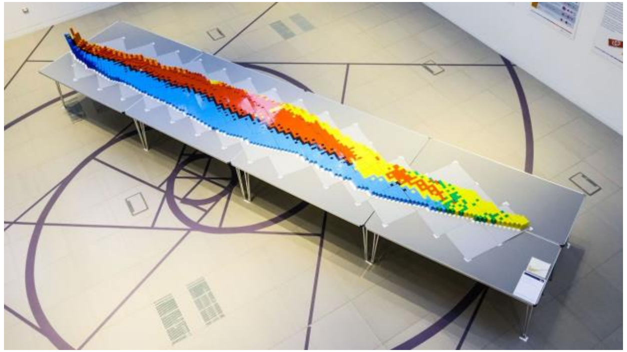
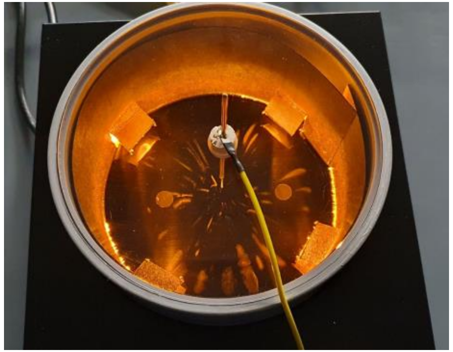
Binding Blocks

A National, Inclusive Programme for Nuclear Physics Education





Creating a world-leading nuclear physics programme that empowers teachers, schools, young people, and the nuclear physics research community.

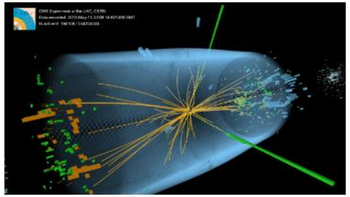
Joel Richardson, University of York

Binding Blocks
Building the Universe one nucleus at a time

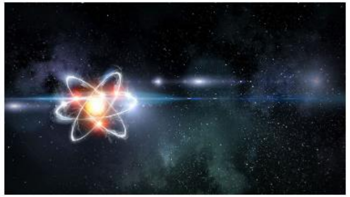
Three Main Areas

University of York

Module 1: Energy and Decay

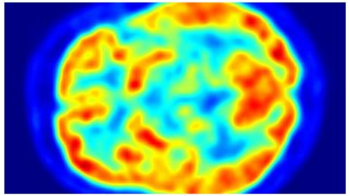


Module 2: Experimental Nuclear Physics

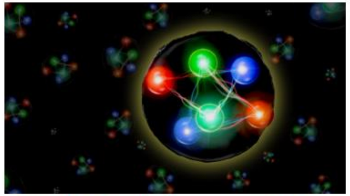


Module 3: Nuclear Astrophysics

Module 4: Fusion Technology



Module 5: Medical Physics



Module 6: Particle Physics meets Nuclear Physics

University of Birmingham
University of Brighton
University of Derby
The University of Edinburgh
University of Glasgow
University of Hull
University of Liverpool
Manchester 1824 The University of Manchester
Sheffield Hallam University
University of Surrey
University of York
pans Public Awareness of Nuclear Science

Nuclear Masterclass

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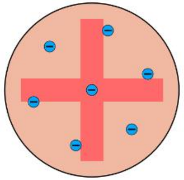
The Structure of the Atom

The idea of the atom originated in Ancient Greece, where philosophers named the smallest building blocks of matter **atoms**. They believed that these were indivisible, solid particles and that differences in atomic shape and size gave rise to the different properties of matter.

Modern atomic theory then began in the early 1800s with chemist and physicist John Dalton. His idea of atoms was very similar to that of the ancient Greeks - tiny, solid balls that could not be broken down into anything simpler. However, as experiments advanced, our understanding of the atom also developed.

Following the discovery of the negative electron, and knowing that atoms were neutral overall, JJ Thompson proposed the **Plum Pudding** atomic model. This saw the atom as a positively charged 'pudding', with negative electrons embedded as 'plums' throughout. This model of the atom was disproved by an experiment completed by physicists Rutherford, Geiger, and Marsden.

In the video below, Kayleigh Gates and Abby-Rhian Powell from the University of Glasgow explain more about the famous Rutherford experiment, and how the same technique of **scattering** is still used in cutting-edge experiments today.

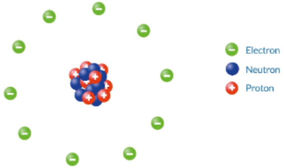


The plum pudding model of the atom, which was later disproved by Rutherford's experiment.
Kurzon, CC BY-SA 4.0, via Wikimedia Commons

Rutherford Model

We now understand atoms to be made of **protons** (positively charged particles), **neutrons** (neutral particles) and **electrons** (negatively charged particles). The protons and neutrons are at the centre of the atom in the nucleus, and the electrons surround the nucleus.

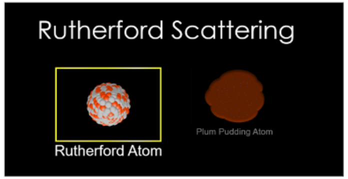
Most of the mass of an atom is concentrated in its nucleus: protons and neutrons make up most of the atomic mass. The mass of an electron is so tiny that it is often considered to be insignificant.



Activity 1.3
Models of the Atom

Use the PHET interactive simulation of Rutherford Scattering to investigate the plum pudding and Rutherford models of the atom:

1. Start by looking at the plum pudding model of the atom. What do you notice about the path of the alpha particles through the atom? Is this what was observed in Rutherford's experiment?
2. Now look at Rutherford's model of the atom. What do you notice about the paths of the alpha particles in this case? You can change between a single nucleus and multiple atoms using the icons in the top right corner of the screen.
3. What do you notice about the alpha particle's behaviour if you vary the number of protons in the nucleus?
4. What do you notice about the alpha particle's behaviour if you vary the number of neutrons in the nucleus?



PhET Simulation of Rutherford Scattering, University of Colorado Boulder

Activity 1.4
The Atomic Model and Scattering

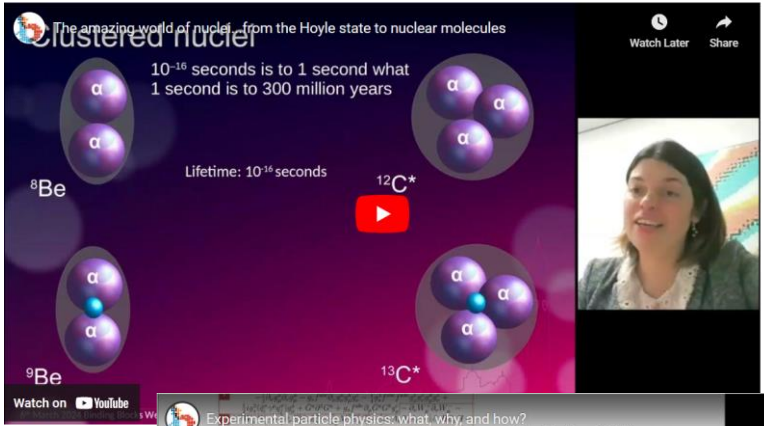
Log in to Isaac Physics and answer the question:

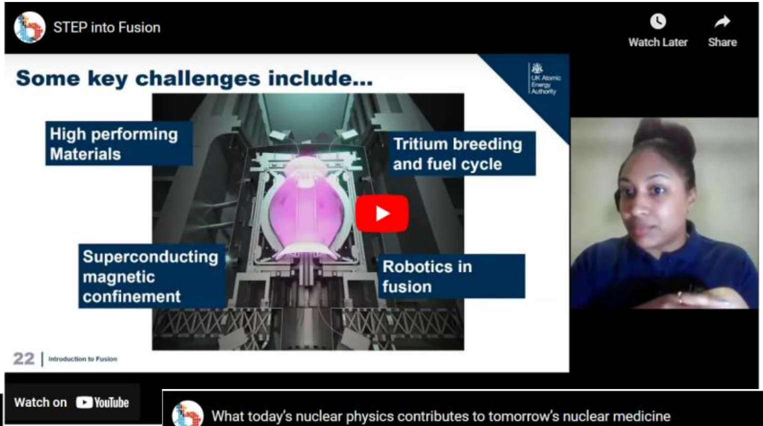
- Scattering and the Structure of the Atom

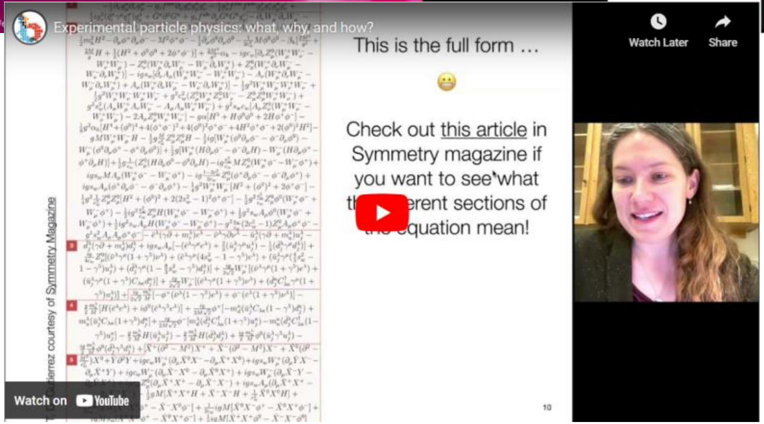
Don't forget to log in to Isaac Physics!

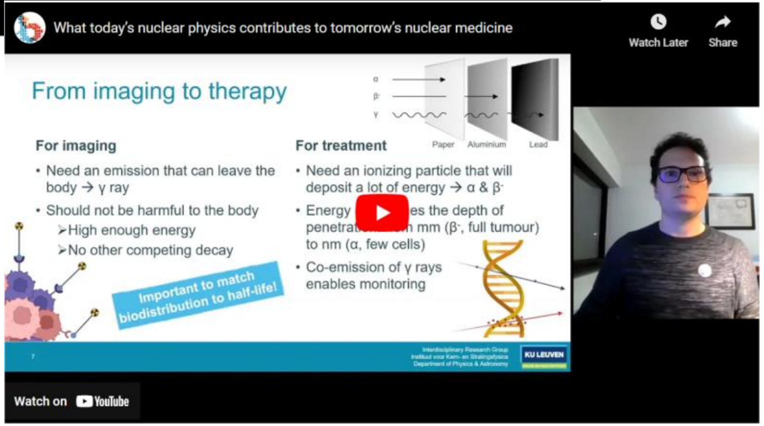
isaac Physics. You work it out.

Masterclass Webinars









Teacher Loan Kit

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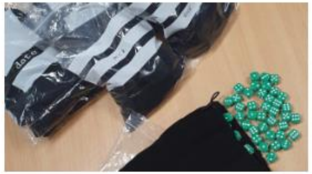
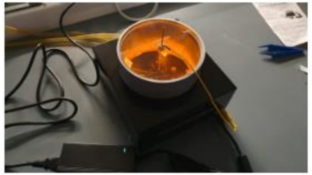
LEGO Chart

Scatterer

Dice



Cloud Chamber



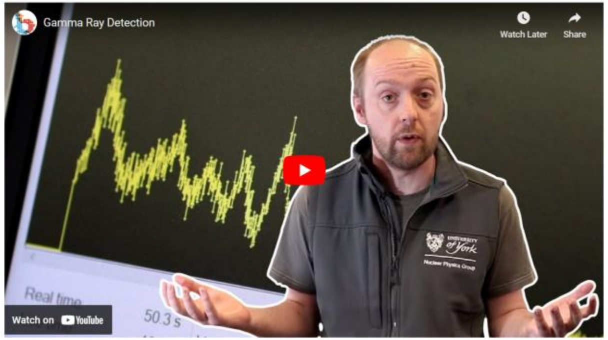
Geiger Counter

D3S Detector

Particle Zoo

VR Headsets

Hot CNO Cycle



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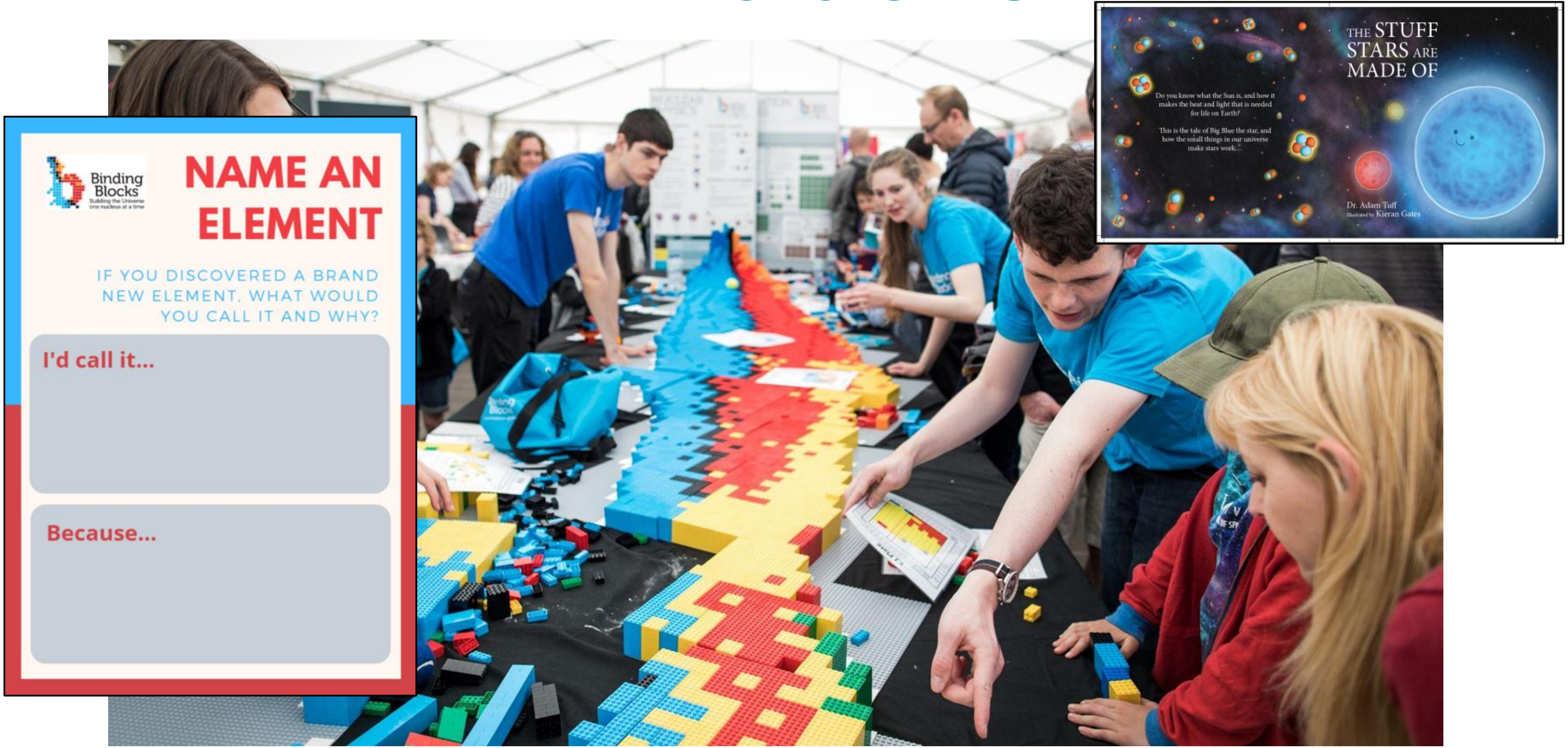
Exhibitions

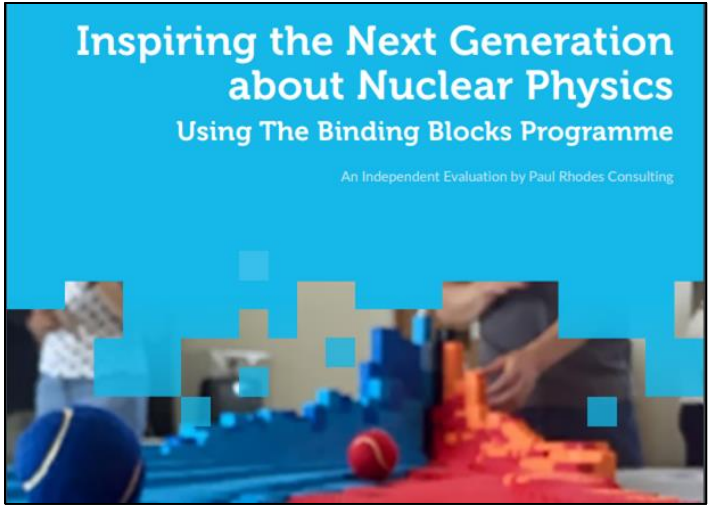


National Outreach

- 30,000+ young people and members of public
- 56,000+ views online
- 375+ UGs, PGs, and researchers trained
- 390+ teachers engaged
- 20+ partnerships with the nuclear physics community

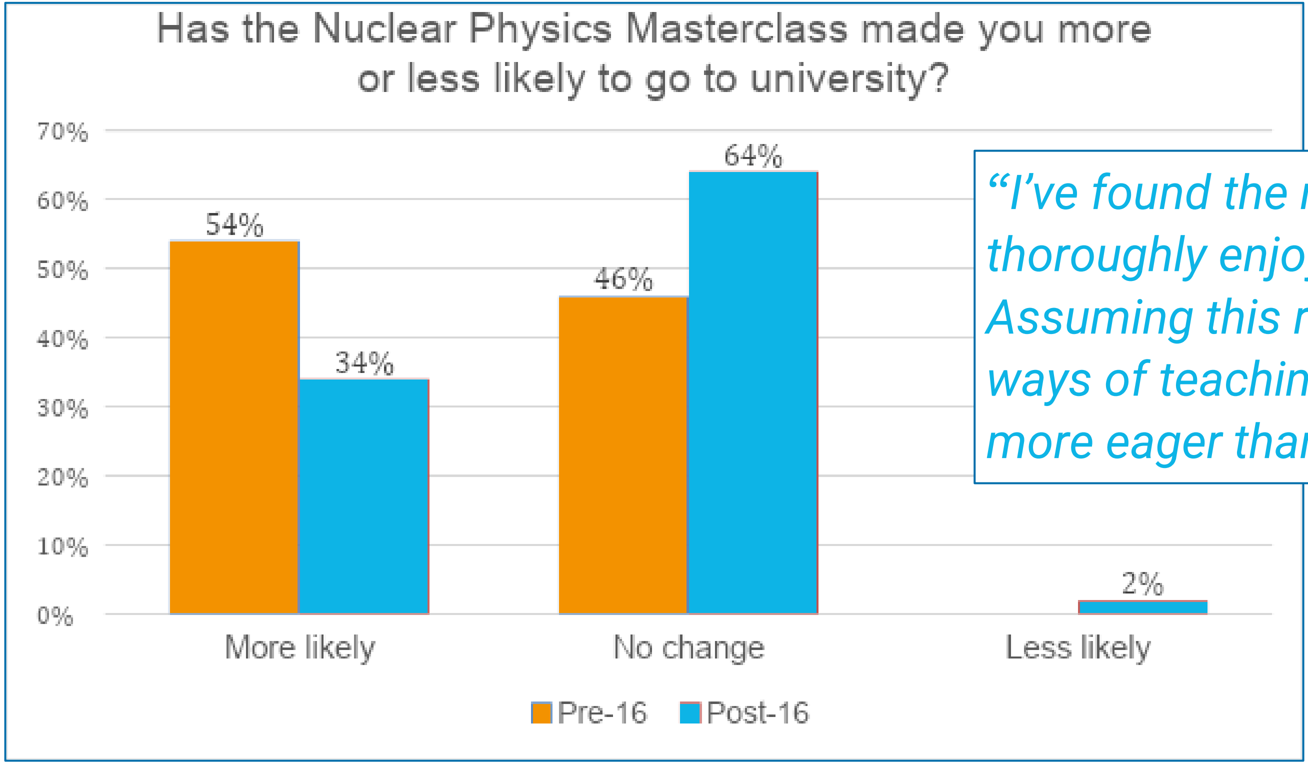
Evaluation

Independent consulting, based on masterclass participation, feedback, and focus groups



1. Does Binding Blocks inspire, and contribute to students wanting to study physics in the future?
2. Does Binding Blocks play an effective part in teaching the concepts of nuclear physics and developing confidence to talk about the subject?
3. Does Binding Blocks help to change people's views on nuclear physics?

Does it inspire?



"I've found the masterclass to be a thoroughly enjoyable experience… Assuming this reflects some of the ways of teaching at university, I am more eager than ever to pursue it."

Does it inspire?

Before Masterclass

- 9 in 10 wanted to go to university
- 57% wanted to study physics

After Masterclass

- 65% were more likely to take physics

“The inspiring course offering really made me re-evaluate my options to consider studying physics.”

“The masterclass course as a whole really made me find my love for physics that I lost a while ago, and now I truly enjoy physics more than ever.”

Is it effective?

Students

- 97% enjoyed taking part in the masterclasses
- 93% rated 4 or 5 out of 5

Teachers

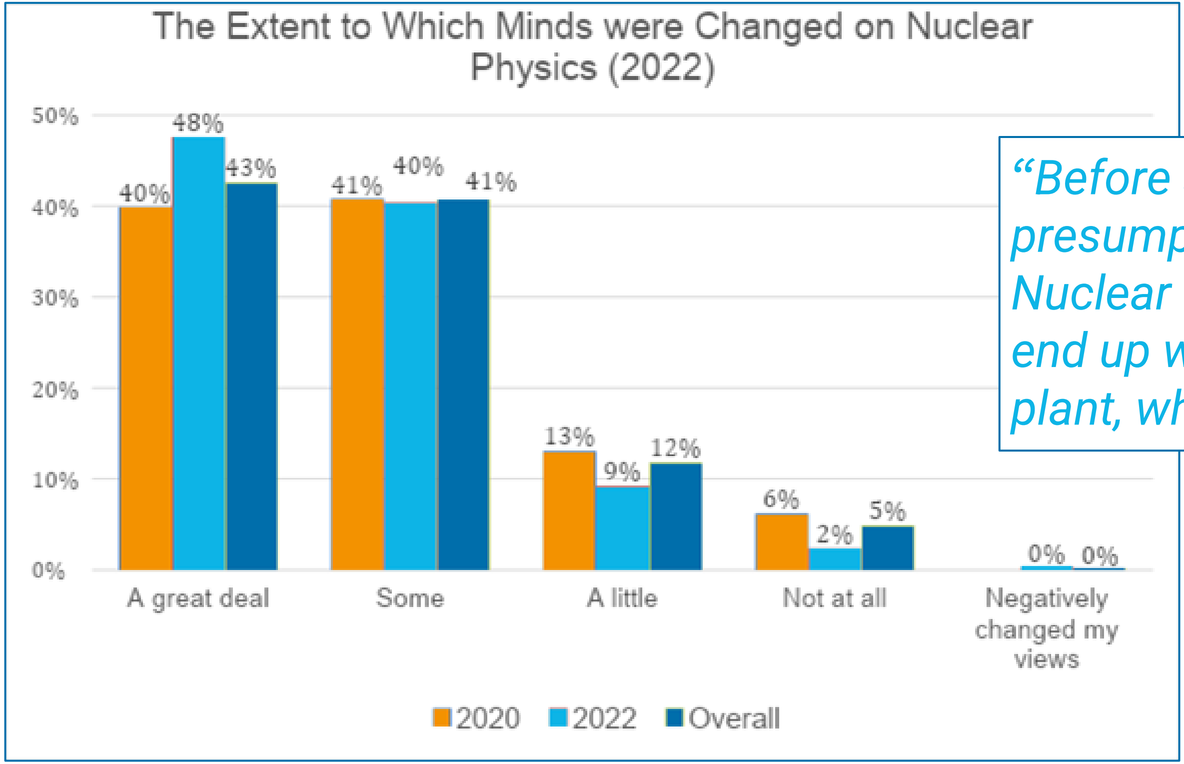
- 100% rated 4 or 5
- 94 % curriculum relevant
- 92% likely or very likely to recommend

Diversity of participants

- 48% female
- 43% from ethnic minorities

“[The masterclass] gave me opportunities to improve my subject knowledge and, consequently, the quality of my teaching.”

Does it change views?



"Before attending, I was under the presumption that anyone who studied Nuclear Physics is most likely going to end up working in a nuclear power plant, which is definitely not the case."

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Capacity Building

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Work in partnership and engage with training:

- Videos and online activities
- Physical resources
- Webinars
- Online forum
- Mentoring

Capacity Building

Previous STFC summer schools

- 2019 STFC NP
- 2022 STFC NP
- 2023 STFC Astronomy

STFC Nuclear Physics Summer School

- Durham University, August 2024
- Provide training to researchers
- Two 90-minute sessions on PE

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bindingblocks.org.uk

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