

Particle Physics in the UK

The UK has been at the forefront of research and technology development for more than 50 years, providing expert support and leadership to many UK and international flagship particle physics experiments. 25 UK universities and research institutes are involved in particle physics theory and experimentation.

UK particle physics projects range from huge experiments investigating the origins of the Universe to medical applications vital for society such as cancer therapy.

UK academics, engineers, detector specialists and computer professionals supply the infrastructure needed to construct complex particle physics experiments, as well as exploiting technology for commercial and medical applications.

Energy Frontier

- Higher energy collisions allow for the creation of more exotic particles and the discovery of new physics.
- The UK plays a major role in the operation and future development of both flagship energy-frontier experiments, ATLAS and CMS.

Quark Flavour

- Using the LHCb and NA62 experiments at CERN, the UK is helping to establish the difference between matter and antimatter to understand the excess of matter observed in the Universe, and explain our very existence.

Neutrino physics

- A better understanding of neutrinos may help explain matter-antimatter asymmetry and the unification of the fundamental forces, shedding some light on the nature of the very early Universe.
- The UK is contributing through participation in the MINOS (USA) and T2K (Japan) experiments.



Muon chambers surrounding the beam-pipe in the end-cap region of the ATLAS detector at CERN

Society and Skills

- 1 million people in the UK are employed in physics-based businesses (4% of the workforce).
- 8.5% of the UK's economic output (more than £77bn per year) comes from physics-based businesses.
- More than 12,000 undergraduates are currently studying physics in UK universities.
- UK universities and institutes run Particle Physics Masterclasses for more than 1000 A' level students every year. The students work with real data from CERN experiments.
- Almost 1000 UK teachers have taken part in the CERN Teacher Programme to find out about the latest developments in particle physics. Their enthusiasm is inspiring students around the UK about CERN and particle physics.

New technologies

- Transformational technologies don't come along very often and, like the invention of the laser, it can sometimes take many years for an application to come into routine use.
- In 1990 at CERN, British engineer and computer scientist, Tim Berners-Lee, designed the 'World Wide Web' to make it easier for scientists in different locations to work together. Today, the web is an essential international tool for business, communication, education and leisure.
- A £60 billion industry world-wide relies on particle accelerators. Many accelerators use the Rutherford Cable, a superconducting cable developed at the Rutherford Appleton Laboratory, UK for superconducting magnets used in particle physics experiments. The LHC uses more than 7600km of Rutherford Cable.

Health and medicine

- Oncologists and physicists are collaborating on a new £250M proton beam therapy (PBT) service to be based at UCLH in London and The Christie Hospital in Manchester. PBT uses a precision high-energy beam of particles to destroy cancer cells. The treatment is particularly suitable for complex childhood cancers, increasing success rates and reducing side-effects. The new service will start in 2017 and around 1500 patients will be treated each year once it is fully operational.
- UK company Advanced Oncotherapy is collaborating with CERN and one of its spinout companies to develop a smaller, cheaper and clinically superior PBT machine that could significantly increase access to this form of treatment.
- Another UK collaboration is using high-energy physics expertise in the storage and handling of large quantities of image data, and the use of grid computing techniques to identify tumours and surrounding organs during the planning and delivery of radiotherapy treatment. Tracking the change in position and volume of these structures as the patient breathes is a complex problem and performing these calculations in real time for a single patient would require approximately 100 times the power of a standard PC workstation.

Energy and Environment

- Scintillating crystals that respond to X-rays and gamma-rays are components in particle-detection systems. This technology is being developed by UK company Corus and the University of Sheffield to detect fissile material. Physicists have also developed devices that generate neutrons which, when combined with scintillators, can identify the characteristic signatures of explosives and drugs in air cargo.
- A novel way to transmit data over power lines has recently been patented in the UK. A new process called 'serial powering' addresses energy concerns by providing electrical power with enhanced reliability and reduced complexity.
- Carbon storage could play a major part of UK and global environmental policies to tackle global warming but still allow us to generate clean, affordable energy. UK particle physicists are working with geoscientists and engineers to examine the potential of using sub-atomic particles from cosmic rays – known as muons – to measure on-going levels of CO₂ in any potential carbon store.