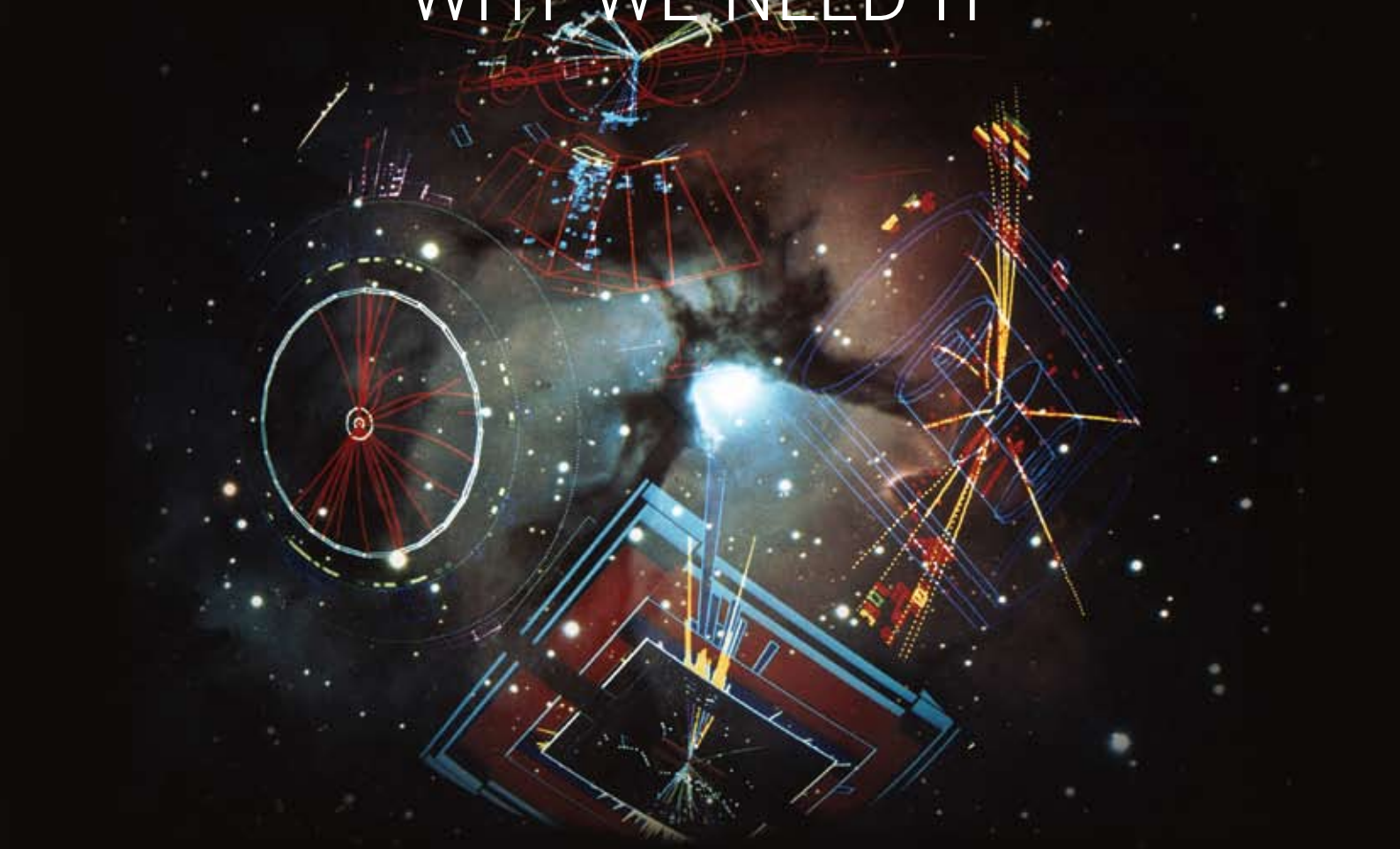
PARTICLE PHYSICS

WHY WE NEED IT



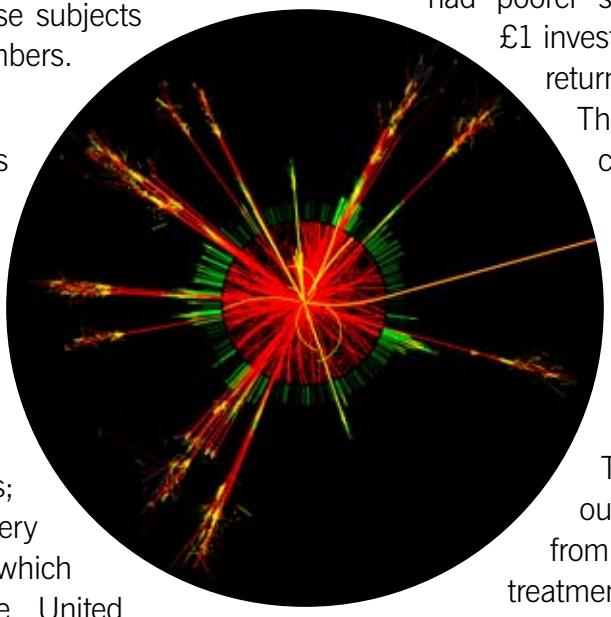
Particle physics is the study of the smallest and most fundamental constituents of the universe and how the forces that govern them determine its evolution. Paradoxically, these smallest particles can only be studied by using large machines to accelerate particles to almost the velocity of light and concentrate this energy in the smallest possible space. This recreates the conditions that occurred fractions of a second after the Big Bang that created our universe. Particle physics and cosmology work hand in hand; both are essential to understand our origins and the universe as observed through our largest telescopes.

This document does not make the case for the importance of this science; it is brilliantly made elsewhere, in the writings of Stephen Hawking and others. Rather, in these austere times, it makes the case for its *economic* importance. The UK has too few science and engineering graduates, particularly in chemistry, physics and engineering, where numbers have stagnated over the past 15 years despite an overall 35% increase in graduate numbers and an increased demand from industry. The three factors determining whether students study physics at a higher level are known to be: access to a teacher with a physics degree; good role models; and interest in the subject.

The vicious cycle of insufficient physics teachers leading to an ever-decreasing number of physics graduates can only be broken by increasing the number of children interested in physics.

PRODUCING TRAINED PEOPLE

Particle physics, astronomy and nuclear physics are cited by 90% of students as the main subjects which attracted them to take a physics degree. Particle physics has the largest "significant interest" (72% of students). This is also demonstrated by the media coverage of particle physics. Although students are attracted to study physics at university by particle physics, only 10% remain in the field to PhD level; most of the 2,500 physics graduates per year pursue careers in other high-tech, high net-worth areas of the economy. To maintain this cycle requires world-leading activities in particle physics and astronomy in the UK, since the inspiration provided by these subjects is key to increasing student numbers.



WORLD-LEADING RESEARCH

Rresearch in particle physics and astronomy forms 40% of research activity in UK university physics departments, concentrated in the most research-active universities. Indeed it is these two areas in which the UK genuinely excels in international comparisons; particle physics is one of a very few scientific disciplines in which Europe unarguably leads the United States, continuing a proud tradition established over a century ago in the UK by Sir J.J. Thomson, the discoverer of the electron, and Lord Rutherford, who split the atom.

INTERNATIONAL PARTNERSHIP

Particle physics is typical of modern research in requiring access to large international facilities. In 1954 the UK was a founder of CERN, the international laboratory in Geneva, which has been the blueprint for international collaborative science. Without CERN, particle physics research in the UK would collapse, devastating student recruitment.

COSTS

Particle physics research in UK universities, which cannot be done at all without sophisticated and expensive equipment, costs approximately the same as astronomy and twice that of other areas of physics or chemistry. This is excellent value for money, given the potential to increase physics undergraduate recruitment and hence meet the demands of industry. The cost per researcher of the UK's participation in CERN is comparable to many other international facilities.

BENEFITS

The construction of the Large Hadron Collider, the world's largest scientific instrument, was led by a UK physicist; contracts worth £60M were placed with UK industry. These collaborations enhance the capabilities of UK industry and ensure access to new markets.

RETURNS

As a result of CERN contracts, 38% of companies developed new products, 42% increased their international market exposure and 52% would have had poorer sales without CERN contracts; £1 invested through CERN in a company returns approximately £3 of utility. These economic returns are comparable to those of curiosity-driven medical research.

SPIN-OFFS

It is the challenging nature of the technology required to pursue particle physics that drives technological innovation. The applications and spin-out from particle physics range from accelerators, vital in medical treatments and whose use permeates the entire scientific community as well as the micro-chip industry, through to superconducting cables, medical imaging technologies and smart-phone touch-screen technology. Perhaps the greatest spin-off is the world-wide web, which has revolutionised all of our lives.

In conclusion, the UK, through its membership of CERN, remains a world leader in particle physics. The cost is similar to other disciplines and the economic returns are at least as great as other curiosity-driven subjects, which provide the paradigm shifts that transform the industrial landscape. The subject also serves as a beacon in attracting future generations of physics students, who are essential for future economic growth. Continued investment is not only a contribution to our culture; it is also manifestly in our economic self interest.

Produced by the Particle Physics Action Group: contact b.foster@physics.ox.ac.uk. For details and references, see www.pp2020.info