RAL

DESIGN & DISCOVERY

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RUTHERFORD APPLETON LABORATORY

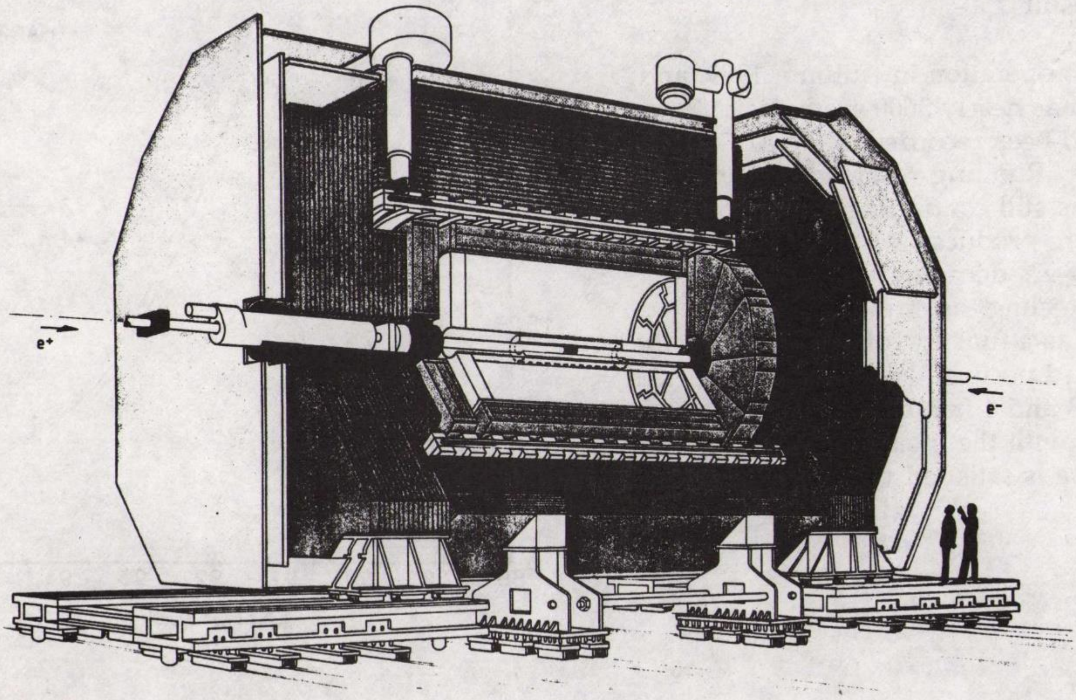
SCIENCE AND ENGINEERING RESEARCH COUNCIL

The ALEPH experiment

Aleph - an experiment at LEP

ALEPH is a particle physics experiment now in operation at LEP, the world's largest colliding beam accelerator, at the European Laboratory for Particle Physics (CERN) Geneva. The accelerator is a ring of 27km in circumference buried 100m beneath the Franco-Swiss border. LEP accelerates counter-rotating beams of electrons and their antiparticles, positrons, which collide head-on at the centre of the ALEPH detector. The particles which are produced in the collision are observed in the different layers of the apparatus. Each performs a distinct function of measurement and identification and together they form a succession of cylindrical detectors closed at each end by circular 'endcaps'. The apparatus is approximately 12m long, 12m in diameter, and weighs around 3000 tonnes.

This large project is the result of collaboration between 20 groups from 10 countries and has a total of over 300 physicists working on it. Groups from the UK taking part are from the Universities of Glasgow, Edinburgh, Lancaster, Sheffield, Imperial College London and Royal Holloway and Bedford New College, together with Rutherford Appleton Laboratory.



The motivation

Particle physicists study the building blocks of matter and the forces which act between them. The particles have been observed to follow regular repeated patterns and come in similar 'families'. At present three such families are known. A natural question to ask is: are there more families? There are four fundamental forces - gravity, electromagnetism, and the strong and weak nuclear forces. Over the past two decades attempts have been made to unify these forces, regarding each as but one aspect of a 'unified' force. With the discovery of a very heavy force-carrier, the Z, came confirmation that the weak and electromagnetic interactions could be combined into a single 'electroweak' force.

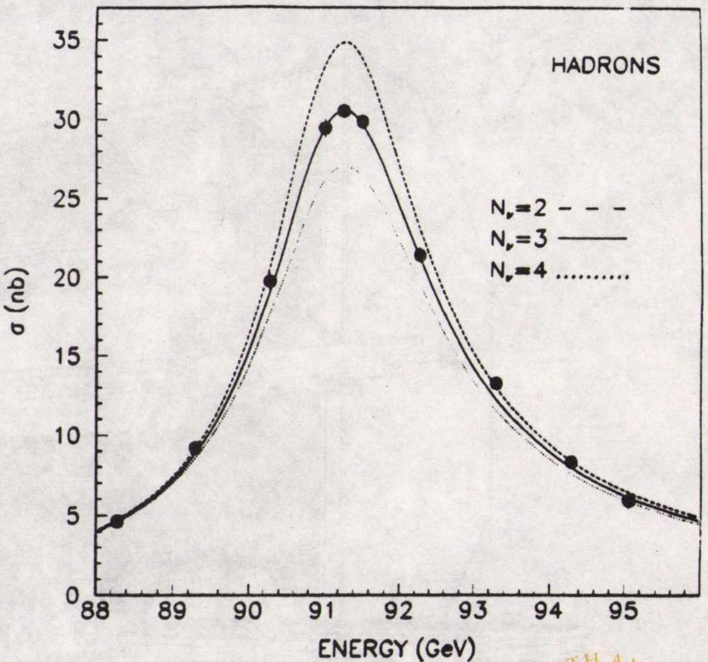
At LEP it is possible to create Z's in very large numbers from collisions between electrons and positrons. From the detailed way in which the Z is observed to decay into other particles, the theory can be tested to a precision impossible before the operation of LEP. Any deviation from our expectation is exciting. Either the theory is wrong (which would be most interesting), or the measurements reveal that it is incomplete: more particles, as yet unseen, could have observable effects.

The part played by Rutherford Appleton Laboratory

Apart from its function in supporting the university groups, the main task of RAL was to design and build the endcap electro-magnetic calorimeter, a device for measuring and identifying electrons, positrons and photons. This calorimeter is described in more detail in another information sheet. RAL also made large contributions to the microelectronics for the whole of the ALEPH experiment, and to the design and implementation of the highly advanced system for collecting the data from the half-million channels of electronics. Physicists from RAL are active in the analysis of the data accumulated so far.

Physics results

LEP began operation in Autumn 1989, and by Christmas nearly 3000 examples of Z decays had been recorded in the ALEPH apparatus. Running resumed in Spring 1990 and is still continuing. Significant results were produced very quickly. The number of Z's decaying to 'hadrons' (particles feeling the strong interaction) was measured as a function of the energy of the electron and positron beams. The expected rate for 2,3 and 4 families is shown, compared with the measurement. It is clear that Nature is satisfied with just three families.



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