High-energy physics

End of a HERA for particle accelerator

Electrons and protons raced around the 6.3 km-circumference HERA accelerator for the last time in June, as it was shut down after 15 years of service. By colliding these two very different types of particles, the veteran accelerator at the DESY laboratory in Hamburg, Germany, was unique among particle-physics facilities. It was able to probe the internal structure of the proton with extremely high resolution, making it effectively the world's largest electron microscope. "When HERA started in 1992, we only had vague notions of the structure of the proton," says Rolf-Dieter Heuer, director for particle-physics research at DESY. "The measurements from HERA showed that the interior of the proton is like a thick, bubbling soup in which gluons and quark-antiquark pairs are continuously emitted and annihilated."

Four experiments were sited round the HERA ring, with the H1 and ZEUS detectors designed to observe the collisions of protons and electrons at an energy of 318 GeV. This allowed researchers to confirm properties of the strong nuclear force that had been predicted by David Gross, David Po-

Gone but not forgotten
The HERA accelerator at the DESY lab in Hamburg has been wound down.

litzer and Frank Wilczek in 1973, leading to the three being awarded the Nobel prize in 2004. H1 and ZEUS also confirmed the unification of the electromagnetic and weak nuclear forces at high energies. Meanwhile, the HERA-B experiment collided the proton beam with a fixed target to investigate the properties of bottom quarks; and the HERMES experiment used the electron beam to probe the spin of protons and neutrons.

There was excitement in 1997 when data from HERA hinted at the discovery of the "leptoquark" – a particle not predicted by the Standard Model of particle physics. However, the collection of more data showed this to be merely a statistical anomaly. In 1999 the German particle-physicist Hans

Grassmann sparked controversy by writing in the newspaper *Der Spiegel* that HERA "produces only boring and irrelevant results", thus "duping" the German taxpayer. However, scientists leapt to the defence of the accelerator. Although no "new physics" was found at HERA, its precise measurements of the structure of the proton will be vital to the Large Hadron Collider (LHC), which will collide two beams of protons when experiments begin at CERN next year.

"Everyone working at HERA would have loved to have found evidence for new physics in their data, but it was not to be," says Tim Greenshaw of the University of Liverpool, a former spokesperson for the H1 experiment. "However, HERA measurements will play an important role in the continuing search for supersymmetry, dark matter and other exotica at the LHC."

With the focus of particle physicists moving to CERN, the DESY lab has no plans to replace HERA. Indeed, the PETRA accelerator that makes up part of HERA will be recycled into a synchrotron-radiation source; and the lab will push ahead with plans for the XFEL free-electron laser, due to open in 2013. Meanwhile, particle physicists expect to continue analysing the mounds of data collected by HERA well into the next decade.

Martin Griffiths

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