End of an era at HERA accelerator

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Fifteen years of scientific discovery came to an end on June 30th when the electrons and protons in the HERA accelerator made their final lap of the 6.3 km ring. The HERA ring has provided these particles and their anti-particle equivalents for use in particle and nuclear physics experiments, but is now being shut down to make way for new scientific facilities at the DESY Laboratory near Hamburg in Germany.

Experiments using HERA have produced results that have already found their way into textbooks – for example confirming the nature of the strong force and proving that the electromagnetic and the weak force can be unified into a single force.

UK research groups have worked at HERA since its start in 1992. Science and Technology Facilities Council CEO Professor Keith Mason said “The HERA facility and its experiments have made an indelible mark on the history of physics, advancing our understanding of structure and forces on the sub-atomic level.”

The H1 and ZEUS experiments were installed in 1992 to observe high energy particle collisions which allow scientists to study the internal structure of the proton and the fundamental forces of nature. HERA measurements confirmed the nature of the Strong force as it was predicted by physicists Davis Gross, David Politzer and Frank Wilczek for which they received the 2004 Nobel Prize. H1 and ZEUS were also able to show that electromagnetic force and the weak force have the same characteristics at high energies and can be unified into a single electroweak force – a first step towards the grand unification of all

fundamental forces into a single entity.

Professor Tim Greenshaw of the University of Liverpool said “Not only has HERA provided new insight into the structure of the proton and made possible new measurements of the electroweak force, it has also laid the foundations for the next generation of particle physics experiments at CERN’s Large Hadron Collider which start next year.”

The HERMES experiment was added to HERA in 1995. It studies the intrinsic angular momentum (known as “spin”) of protons and neutrons and the proportion of this that comes from their constituent quarks. HERMES was originally formed in response to the so-called 'spin crisis', when CERN measurements indicated in 1988 that the constituent quarks spins might not contribute to the overall spin of the proton at all. Earlier this year HERMES has finally published the most precise result on this topic worldwide – showing that only a third of the final spin of a proton can be attributed to the quarks forming it.

HERMES' most important role in high energy spin physics is that of a pioneering experiment that has carried out many measurements for the first time, especially in transverse spin physics and hard exclusive reactions. Particular milestones were the first ever measurements of transversity and of the beam spin asymmetry in deeply virtual Compton scattering.

During the last two years of data taking, HERMES has taken a huge amount of data on exclusive reactions that will take years to analyse. The physics programme of HERMES will find its natural continuation at JLab (Jefferson Lab) after the planned energy upgrade, where measurements under similar conditions will be possible, but at orders of magnitude higher luminosities.

Professor Ralf Kaiser of the University of Glasgow is at DESY to

witness the end of HERA and its experiments. He said “Yesterday evening I ran into a couple that had met as student and postdoc at HERMES and I learned that they now are married. HERMES has played a large role not only in our professional lives, but for many of us it has been a big part of our lives, period.”

The HERA-B experiment was also at DESY but was shut-down at an earlier date. It used protons to investigate the properties of heavy quarks.

Whilst data-taking ends with the decommissioning of HERA, analysis will continue well into the next decade and will also help interpretation of data at future experiments.

Source: Science and Technology Facilities Council