Preface

Physics at the high-energy frontier: the Large Hadron Collider project

This issue of Philosophical Transactions A is devoted to the proceedings of the Royal Society Discussion Meeting on ‘Physics at the High Energy Frontier—The Large Hadron Collider Project’ held on 16th and 17th May 2011. The purpose of this meeting was to draw together the many aspects of a remarkable scientific endeavour, from its birth through to the results emerging from the analysis of the first year of data taking, looking forward to the expected ground-breaking scientific discoveries.

The meeting started with a survey of the current theoretical and experimental situation. The great success of the standard model (SM) of particle physics that links the electro-weak and electro-strong interactions has been experimentally tested to great accuracy. However, the SM has many problems that are either unsolved or that it does not address; for example, the large number of arbitrary constants, why there are three families of quarks and leptons, the size of the matter–antimatter asymmetry in the Universe and the possible unification of the fundamental forces. Scenarios for physics beyond the SM, addressing these problems were described. It was emphasized that further progress now urgently requires new experimental input at high energy and the Large Hadron Collider (LHC) and its detectors were the ideal tools.

The LHC accelerator and its suite of detectors were described in some detail and the conceptual and engineering challenges, as well as the R&D needed to meet the extreme performance criteria, were discussed. Not only were many of these at or beyond the cutting edge, but because of their size and scale they posed logistical challenges.

At the time of the meeting, the LHC had been operating for just over a year with steadily increasing intensity and already more than 80 papers had been published. The main results from these were reviewed; as expected, at this stage, no major new discoveries had been announced, but many of the SM physics results of the previous decade had been verified. This demonstrated not only that the detectors were working extremely well, but also were well understood and that the very complex data acquisition, reduction and analysis systems were working. This gives us confidence that once the LHC reaches its full luminosity by the end of 2011, new discoveries should quickly follow with even more following when the energy is upgraded in 2014.
Finally, there were talks on the history of the project and how such a large, complex technical and scientific international enterprise was so successfully organized at CERN.

The stage is now set for the LHC and its detectors to provide the new data, which is needed to progress our understanding of the subnuclear world, whether this follows the current thinking of ‘physics beyond the standard model’, i.e. the ‘known unknowns’ or whether it reveals something unexpected, i.e. the ‘unknown unknowns’; to paraphrase Donald Rumsfeld, only time will tell.

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