

Preface

The International Symposium on Future Directions in Ultra High Energy Cosmic Ray (UHECR) Physics took place at CERN on 13-16 February 2012. It followed up on a smaller meeting held in Nagoya, Japan, in December 2010 and aimed at discussing the science and technological challenges in detecting the most energetic particles in the Universe and at looking to the next steps in terms of a future large-scale ground based observatory. Originally planned as a meeting with about 100 experts from the particle and astroparticle physics community, the symposium attracted more than 230 participants from 24 nations around the world, reflecting the strong interest in the current results and future prospects for cosmic rays at the highest energies of 10^{20} eV and beyond.

Three large-scale observatories, each operated by international collaborations, are currently taking data and trying to provide answers about the origin and nature of these extreme particles. The Pierre Auger Observatory in Argentina – the flag-ship in the field – covers 3000 km^2 ; the more recently commissioned Telescope Array (TA) in Utah samples an area of 700 km^2 ; and the smaller Yakutsk Array, which now covers about 10 km^2 , operates in Siberia.

To make progress in understanding the data from the different observatories, new ground was broken in preparing for the symposium. Prior to the meeting, five topical working groups were formed composed of members from the different collaborations. They were charged with addressing differences between the collaborations in the measurement and analysis methods, studying their impact on the physics results, and delivering a report at the symposium. This type of co-operation, inspired by the former working groups for CERN's Large Electron-Positron Collider, marked a new direction for the community. Their reports on the energy spectrum, mass composition, arrival directions, multi-messenger studies, and comparisons of air-shower data to simulations were true highlights of the Symposium. They were complemented by invited overview talks, contributed papers and a large number of posters addressing various topics of analyses, new technologies, and concepts for future experiments at ground and in space.

Parallel to pushing for a new giant ground-based observatory, space-based approaches, most notably by JEM-EUSO to be mounted on the International Space Station, were discussed in a number of presentations.

An important aspect common to all observatories of UHECR is the necessity of understanding the development of extensive air showers. This is because properties like the cosmic ray primary energy and mass have often to be inferred from comparisons of shower observables with Monte Carlo predictions, the latter being subject to uncertainties of hadronic interaction models at extremely high energies. As demonstrated at the meeting, many constraints – so far without surprises – are provided by the LHC. However, despite the good overall description of showers, significant deficits in the muon densities at ground level are observed and deserve further attention. Nevertheless, proton-air and proton-proton inelastic cross-sections have been extracted from Auger, HiRes, and Yakutsk data at c.m. energies much higher than that of LHC, demonstrating the particle-physics potential of high-energy cosmic ray measurements.

The open and vibrant atmosphere of CERN contributed much to the meeting's success and was highly appreciated by all participants, who agreed to continue the joint working groups and discuss further progress at future symposia.

The organisation of this Symposium has been a great pleasure and we express our warmest thanks to CERN for hosting the meeting and providing excellent administrative and practical support without which this event would have been impossible. We are most grateful also to the inter-collaborative working groups for comparing at great depth the analysis strategies and results of the different UHECR observatories and reporting the results, to the invited speakers who accepted the challenge of introducing

EPJ Web of Conferences

the various topics and for reporting on the theoretical aspects, and to the many presenters of contributed papers for covering a wide range of theoretical and technological topics related to UHECR physics. Last but not least, we would like to thank the scientific and local organising committees for their valuable contributions.

Finally, we hope that the gathering of active researchers has helped to engender contacts between collaborations that will help take this subject forward in the exciting years to come.

Karl-Heinz Kampert, Masaki Fukushima, Ralph Engel, and Bryan Pattison