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CHERENKOV TELESCOPE ARRAY (CTA)

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Gamma-ray astronomy has a huge potential in astrophysics, particle physics and cosmology. CTA is an international initiative to build the next generation ground-based gamma-ray observatory. CTA will consist of two arrays for full sky coverage and will be operated as an open observatory. It will provide a deep insight into the high-energy universe.

The Cherenkov Telescope (CTA) is a project to build the next-generation of ground-based gamma-ray observatories. Besides guaranteed high-energy astrophysics results, already advanced by the current facilities, CTA will have a large discovery potential in key areas of astronomy, astrophysics and fundamental physics research. These include the study of the origin of cosmic rays, their sources and their impact on the constituents of the Universe, as well as the examination of the ultimate nature of matter and of physics beyond the standard model. These will in turn be achieved through the investigation of astrophysical particles accelerators, the exploration of the nature and variety of black hole accelerators, via the study of the production and propagation of extragalactic gamma-rays, as well as through searches for dark matter and the effects of quantum gravity.

CTA will consist of two arrays of Cherenkov telescopes, which aim to: (a) increase sensitivity by one order of magnitude with respect to current installations; (b) boost significantly the detection area and hence detection rates; (c) increase the angular resolution and hence the ability to resolve the morphology of extended sources; (d) provide uniform energy coverage for photons from some tens of GeV to beyond 100 TeV; and (e) enhance the sky survey and monitoring capability and flexibility of operation.

CTA will be operated as a proposal-driven open-observatory, with a Science Data Centre providing transparent access to data analysis tools and user training. Brazil is an official member of CTA since the Spring 2010, and the South American continent is now a potential site to host the array.

The Imaging Atmospheric Cherenkov Technique (CTA) uses the Cherenkov light produced by eletromagnetic cascade electrons and positrons in the atmosphere to establish the properties of the primary gamma-ray; the gamma-ray direction is determined by imaging the cascade, whereas the gamma-ray energy is derived from the Cherenkov light yield. Stereoscopic imaging is a technique which allows for a full 3-D reconstruction of the shower axis, so that parameters such as direction, core location and height of shower maximum can be determined in an event by event basis.

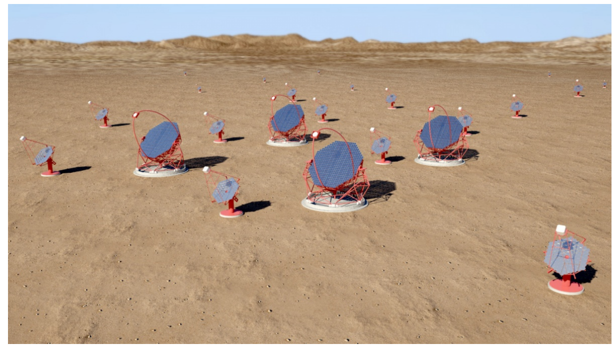

Fig. 1. Artist's impression of the final constructed Cherenkov Telescope Array. Courtesy: G. Perez, SMM, IAC.

The current generation of ground-based observatories have led the way to broad-band studies of well over 100 sources. Both these results show an abundance and ubiquity of cosmic particle accelerators. About half of the objects detected by the ground-based instruments are of extragalactic nature, the rest being associated with the Galaxy. Among the galactic TeV gamma-ray sources are pulsars and pulsar-wind nebulae (PWN), supernova remnants (SNR), as well as some 15-20 objects whose identification is unclear.

Given the wide energy range to be covered, a uniform array of identical telescopes, with a fixed spacing, is not the most efficient solution for the CTA. The array is therefore separated in three energy ranges: the low-energy range, for photons below 100 GeV, consisting of about 4 very large telescopes; the core energy range, from about 100 GeV – 10 TeV, with circa 20-25 telescopes of 12-m diameter; and the high-energy range, above 10 TeV, formed by 30 6-m telescopes (SSTs).

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