RevMexAA (Serie de Conferencias), **40**, 141–144 (2011)

THE HIGH ALTITUDE GAMMA RAY OBSERVATORY, HAWC

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RESUMEN

El volcán Sierra Negra en Puebla, México fue seleccionado para albergar a HAWC (High Altitude Water Cherenkov), un observatorio de gran apertura (2π sr), único en el mundo, capaz de observar contínuamente el cielo a energías de 0.1 a 100 TeV. HAWC consiste en un arreglo a una altitud de 4100 m sobre el nivel del mar de 300 contenedores de 7.3 m de diámetro y 5 m de altura llenos de agua pura y sensores de luz que observan partículas sumamente energéticas provenientes de los eventos más violentos del universo y será 15 veces más sensible que su antecesor Milagro. Las aportaciones científicas de Milagro han demostrado las capacidades únicas de este tipo de observatorios. En este trabajo se presentará HAWC y se discutirá brevemente su caso científico y capacidades.

ABSTRACT

The Volcano Sierra Negra in Puebla, Mexico was selected to host HAWC (High Altitude Water Cherenkov), a unique obervatory of wide field of view (2π sr) capable of observing the sky continously at energies from 0.5 TeV to 100 TeV. HAWC is an array of 300 large water tanks (7.3 m diameter $\times$ 5 m depth) at an altitude of 4100 m. a. s. l. Each tank is instrumented with three upward-looking photomultipliers tubes. The full array will be capable of observing the most energetic gamma rays from the most violent events in the universe. HAWC will be 15 times more sensitive than its predecesor, Milagro. We present HAWC, the scientific case and capabilities.

Key Words: acceleration of particles — cosmic rays — gamma rays: general — intrumentation: detectors

1. INTRODUCTION

Ground-based telescopes have revealed a sky rich with objects that emit TeV gamma rays. Atmospheric Cerenkov Telescopes (ACT) have proved their remarkable sensitivity to discover and study individual sources and to perform surveys over a limited area of the sky. On the other hand, all-sky telescopes have shown their capabilities to perform all-sky surveys, to discover extended sources and to monitor the sky for TeV transients. For instance, Milagro has achieved the first detection of TeV gamma-ray emission from the Galactic plane (Atkins et al. 2005), and the discovery of sources of TeV gamma rays in the Galactic plane of which several sources appear to be extended (Abdo et al. 2007a,b). The mapping of the diffuse Galactic gamma-ray emission at TeV energies (shown by Milagro) including the Cygnus Region will help us to understand the origin of the cosmic rays.

The communities of both types of telescopes (ACTs and all-sky) have realized the need of a telescope with higher sensitivity in a broader energy range with large field of view. In order to achieve this, the ACT community is designing the future generation of ACT telescopes as one or two arrays of tens of individual atmospheric Cerenkov telescopes. The sensitivity is expected to be improved by a factor of 5–10 in the current energy range and the energy range will be extended below 100 GeV and up to 100 TeV. However, the duty cycle will remain low to look for transients, the total cost is of several tens of millions of dollars and the construction time might be beyond 6 years (considering that the construction time of the actual ACTs is $\geq$3 years). The High Altitude Water Cerenkov Observatory, HAWC, is the next generation of all-sky telescopes. HAWC combines the all-sky Milagro water Cerenkov technology with a very high altitude site to achieve an improvement in sensitivity of a factor of 15 over Milagro. In this paper HAWC design, capabilities and science goals are discussed.

The gain in sensitivity of HAWC over Milagro is the result of the higher altitude, larger physical area and the optical isolation of the PMTs. Since there are about $\sim$6 times more electromagnetic particles in an extensive air shower (EAS) at 4100 m than at 2600 m (Milagro altitude), the energy threshold is reduced giving significant effective area at energies below a TeV and down to 100 GeV for low

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