Site development of the HAWC γ-ray observatory in Sierra Negra

IBRAHIM TORRES[1], ALBERTO CARRAMIÑANA[1], JASON S. WALTERS[1], J. REYES[1] FOR THE HAWC COLLABORATION[2]
[1]*Instituto Nacional de Astrofísica, Óptica y Electrónica, Luis Enrique Erro 1, Tonantzintla, Puebla 72840, México*
[2]*For a complete author list, see the special section of these proceedings*
ibrahim@inaoep.mx,alberto@inaoep.mx
DOI: 10.7529/ICRC2011/V09/0912

Abstract: The HAWC (High Altitude Water Cherenkov) gamma-ray observatory is in the early installation phase at its 4100 m site in Sierra Negra, Puebla, México. The installation phase begins with the civil engineering design and construction of the approximately 20,000 m^2 platform for the tank array, the development of the physical plant, the installation of electrical power and internet connection. The platform has been designed to host 300 water Cherenkov tanks taking into account that the site is in a National Park. An adjacent physical plant area was designed for the support buildings and equipment for the project. A drainage collection system has also been designed to feed collected precipitation drainage to a storage area for use in the detector tanks and to return the drainage back to its natural course in case of overflow during tank installation, and permanently once the tank installation phase is complete. Construction is underway in compliance with strict environmental regulations and impacts to the natural habitat and wildlife at the site have been minimized. The demobilization plan for the site at the end of the ten year research phase of the HAWC project is under development and will include re-planting of native flora to restore the original habitat.

Keywords: gamma-ray instruments.

1 Introduction

The HAWC (High Altitude Water Cherenkov) observatory is a very high energy gamma-ray detector that will cover the 100 GeV – 100 TeV energy range with a 1.8 sr instantaneous field of view during ten years of continuous operations. Its original specifications call for a water Cherenkov detector of 22,500 m^2 in area, with a layer of 900 photomultiplier tubes at a depth of 4.5 m located above an altitude of 4000 m. In July 2007, the high altitude site of Sierra Negra was selected as the site of HAWC. The status of the installation currently in progress is described in this paper.

2 Sierra Negra: the HAWC site

Volcán Sierra Negra, or Tliltepetl, is a 460,000 year old volcano hosting several scientific facilities benefiting from its altitude and geographical location. The 4582 m summit was selected in February 1997 as the site of the Large Millimeter Telescope (LMT), now entering its early operational phase. Ten years later, the Northern base of Sierra Negra was chosen as the site of the High Altitude Water Cherenkov (HAWC) gamma-ray observatory, a wide field of view instrument to perform continuous monitoring of the sky in the 100 GeV - 100 TeV energy range [1].

The geometrical center of the HAWC platform is located at 4097 m above sea level, which corresponds to 625.6 mbar 638 g/cm^2 or 17.2 times the mean free path for $e^{\pm}$ pair production and bremsstrahlung interactions in air at sufficiently high energies. This allows for secondary particles generated in electromagnetic cascades of primaries with energies as low as 10 GeV to reach the ground detector. The geographical latitude of the site is 18.99°, which allows observations of objects over 2/3 of the sky culminating within 45° of zenith. HAWC will have considerable daily exposure to sources like Geminga, the Crab, Mrk 421 and 501, and the Cygnus region (fig. 1). HAWC will be able to reach even the Galactic Center as it culminates at 46° from the zenith and stays above 50° for two hours per day. The geographical longitude of the HAWC site, 97.31°W is similar to that of major observatories in Mexico, the United States and South America, facilitating multi-wavelength follow-up observations of HAWC triggered events. In particular, the LMT will be able to perform observations in the millimeter-wave regime during daytime.

As the HAWC site is within the Parque Nacional Pico de Orizaba, it is located on federal property and access is granted by permit from the Secretaría del Medio Ambiente y Recursos Naturales (SEMARNAT) based on the review and approval of the environmental impact declaration. All environmental permits were obtained by March 2009 and the access road to the site was open in July of the same

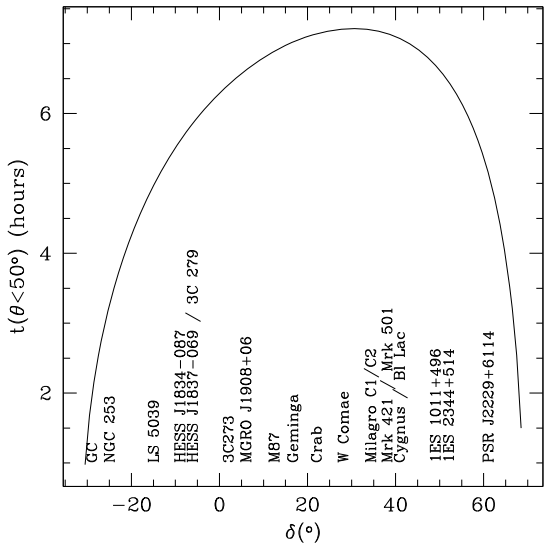

Figure 1: Time above 50° for known γ-ray sources as viewed from Sierra Negra.

year. The site permit establishes four stages for the HAWC project: installation in three years; ten years of operations; three years for dismantlement and two years for environmental site recovery.

3 Site preparation

The HAWC site was preselected using the topographic maps of Instituto Nacional de Estadística y Geografía (INEGI) with 20 m contour levels. Data analysis of site topographic surveys of three potential locations resulted in the selection of the final location for HAWC. The area has a 8% slope which must be leveled to a plane with a 2% slope to conform to the tank array platform design. The most relevant criterion for selecting the site was the volume of soil movement required to achieve the constant 2% slope, which was estimated numerically on the basis of the topographic surveys. The platform where the HAWC site is to be installed will be a roughly square 6-sided 22,395 m^2 polygon centered in {678 144 E, 2 101 108 N}. The geometrical center of the platform will be at 4096.4 m, with a 3m altitude difference between the higher, southern extreme and the lower, northern end. Site preparation started in May and is due to finish in July (2011).

In parallel, the design, permits and installation of a 720 m underground extension of the electrical power line to the LMT by the Compañía Federal de Electricidad and Internet are now proceeding and are expected to be ready by August. The electrical power line will be installed together with optical fiber for network communications in the physical plant area, which has an area of about 3600 m^2, sufficient to hold the water filtration plant, auxiliary buildings and parking area.

The average precipitation on the site is 1 m per year, which would be sufficient to fill 50 of the 200 m^3 tanks in the same period of time if precipitation on the platform alone could be collected with an efficiency of just 45%. The current system for procuring water for HAWC is via trucking from a well in the nearby town of Atzitzintla. The incorporation of water from precipitation will represent a savings in both time and budget. The stormwater runoff and snowmelt will flow in the direction of the 2% slope, which will be 16° West of North. Drainage lines will intersect the slope and direct the water toward a storage system which will allow use of the precipitation in the detector array. The drainage collection system has been designed to be able to store 1800 m^3 of water, matching the volume expected under severe precipitation events (100 mm) on the platform area (22,395 m^2), accounting for 20% losses due to infiltration into the soil.

Tank deployment is set to start in September 2011, with HAWC-30, the first science array of 30 tanks, due by September 2012. HAWC will grow to 100 tanks in 2013 and its final 300 tank configuration in 2014. Each tank will have a cover and its own cover drainage system that will transfer precipitation via piping from the cover down into the platform drainage system. With the culmination of the installation of 300 tanks, approximately 56% of the platform area will be covered by the 7.3 m diameter tanks. With the installation complete, it will no longer be desirable to collect water, and the water capture portion of the platform drainage system will be modified to direct the precipitation back toward the natural flow pathway North of the platform.

References

[1] Carramiñana, A., et al., proceedings ICRC 2007.

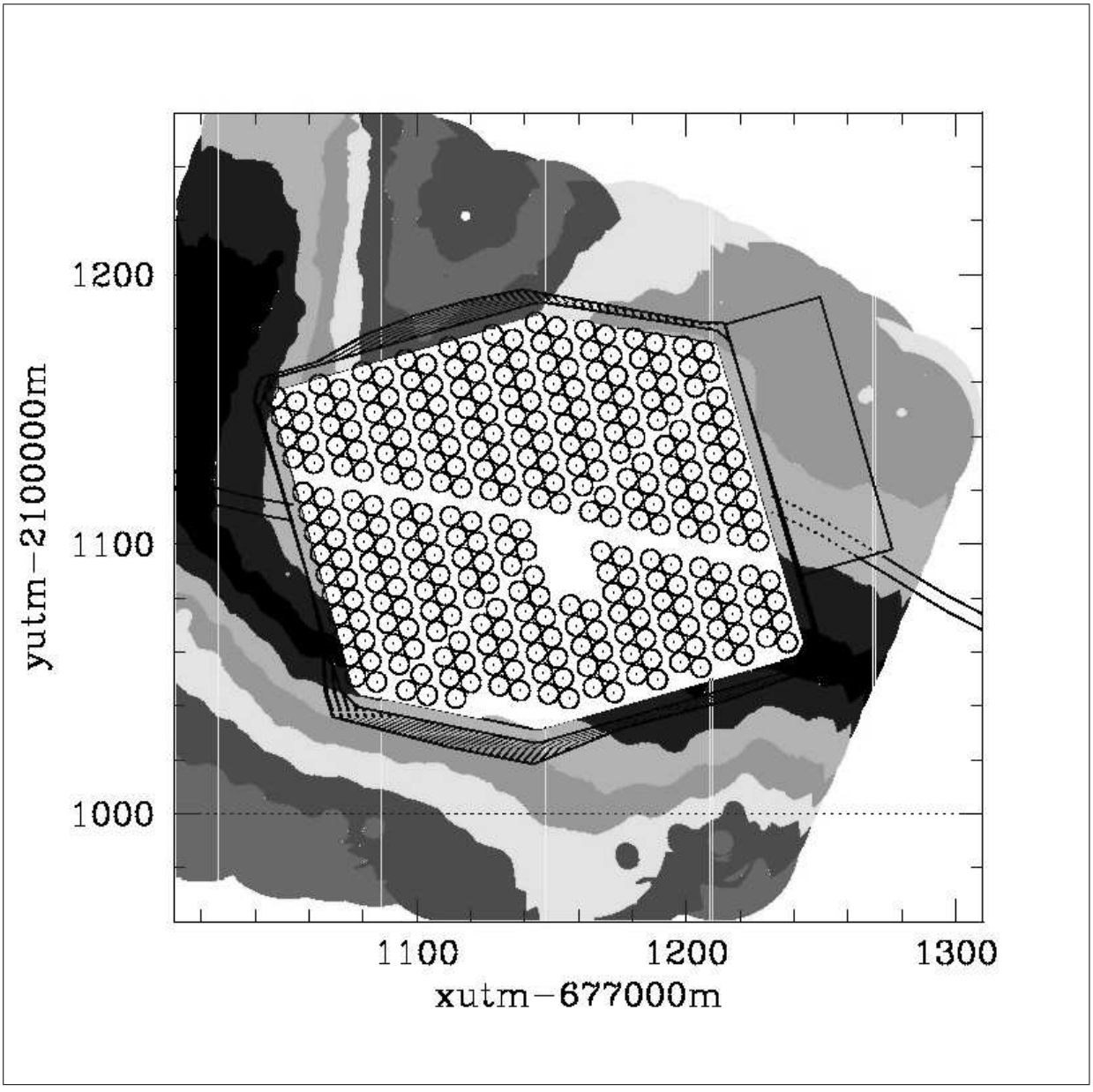

Figure 2: HAWC tank layout on topographic contours. Colors change every 2m.