In Brief: The relocation of Telescope 1 has improved the sensitivity of VERITAS by 30% (60% observing time needed).

VERITAS Telescope 1 Relocation: Details and Improvements

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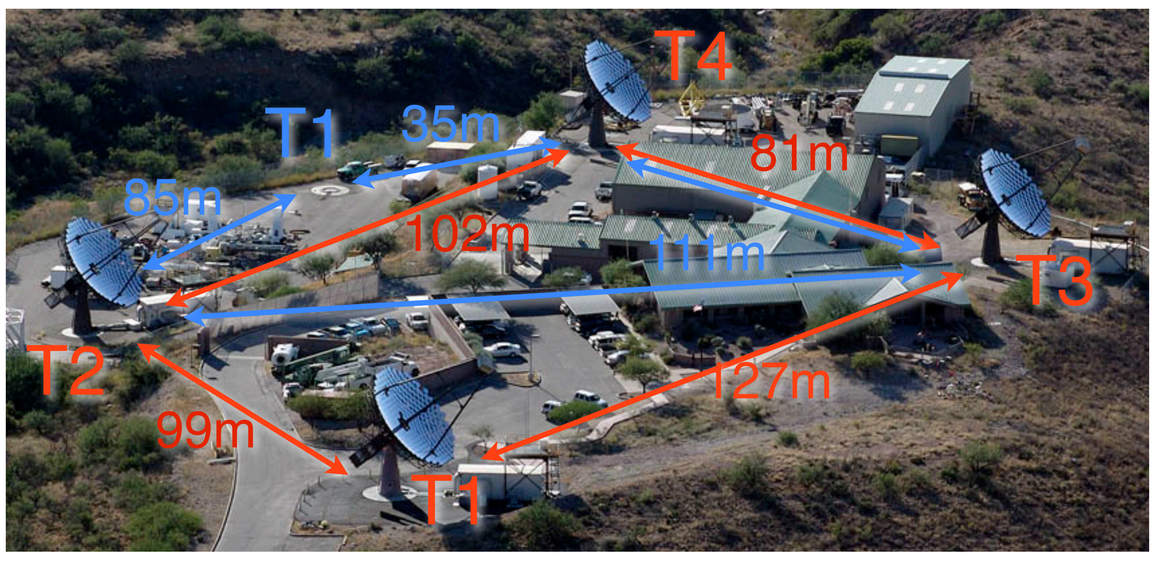
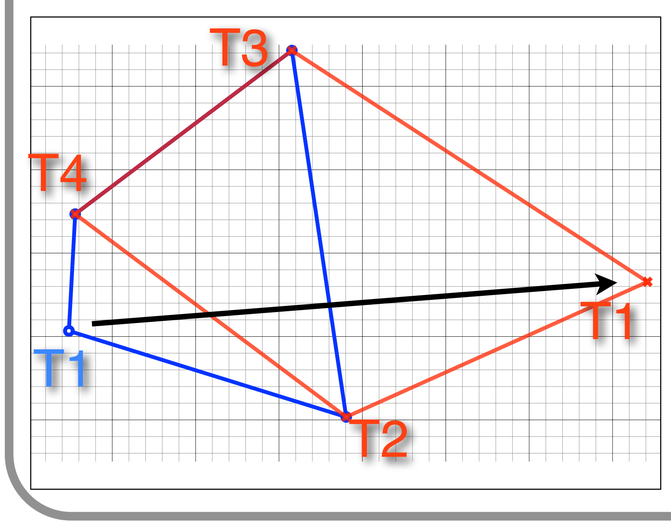
Abstract and Introduction

The first VERITAS telescope was installed in 2002-2003 at the Fred Lawrence Whipple Observatory (FLWO) and was originally operated as a prototype instrument. Subsequently the decision was made to locate the full array at the same site, resulting in an asymmetric array layout. As anticipated, this resulted in less than optimal sensitivity due to the loss in effective area and the increase in background due to local muon initiated triggers. In the summer of 2009, the VERITAS collaboration relocated Telescope 1 to improve the overall array layout. This has provided a **30%** improvement in sensitivity corresponding to a **60%** change in the time needed to detect a source.

VERITAS [1,2] is an array of four 12m diameter imaging atmospheric Cherenkov telescopes located in southern Arizona at the FLWO at an altitude of 1268 m. VERITAS detects photons from astrophysical sources at energies between 100 GeV and 30 TeV. The relocation of Telescope 1 is part of an ongoing upgrade program [3] which recently included an improvement in the optical point spread function (PSF) [4]. This optical PSF improvement also contributes to the enhancement in sensitivity discussed here.

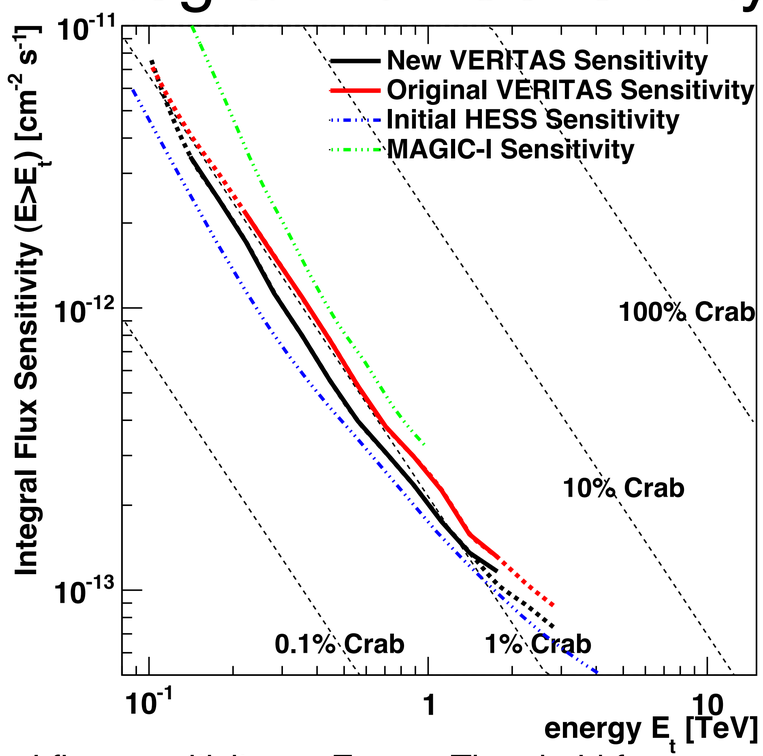
Array Layout: Before and After





Above: aerial view of the new VERITAS array layout with Telescope 1 relocated to the front of the FLWO administrative complex. The original array layout position is marked in blue while the new one is in red. Note the short distance (35m) between the original Telescope 1 position and the position of Telescope 4. **Left:** schematic of the array as viewed from directly overhead. The black arrow indicates the relocation of Telescope 1

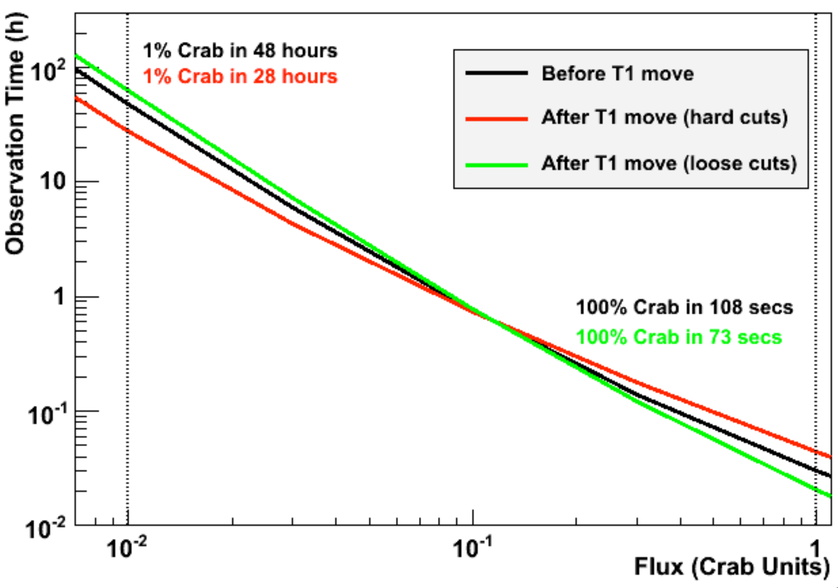
Integral Flux Sensitivity



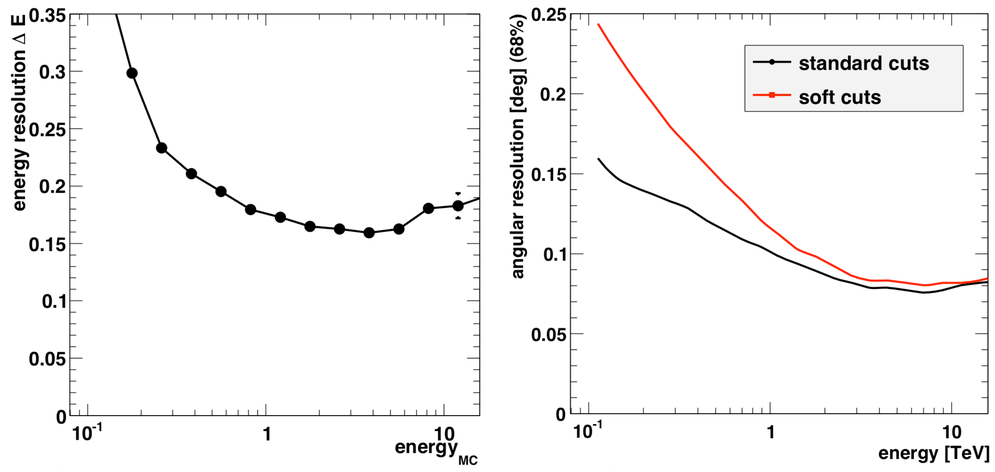
Integral flux sensitivity vs. Energy Threshold for several different instruments. In red is the original VERITAS layout while the new VERITAS layout is shown in black (based on Crab observations; the dashed sections are under evaluation). Initial HESS sensitivity [5] is shown as the blue dashed line and MAGIC-I [6] is shown as the green dashed line. Note that the integral flux sensitivity improvement of VERITAS above 300 GeV is **~30%**.

Observation Time vs Flux

The time needed to detected a source at the five sigma level vs. that source's flux in units of the Crab Nebula's flux. This is shown for the original array layout and for the new array layout with two different sets of event selection cuts. Note that it would take **48 hours** to detect a 1% Crab source with the original array layout and only **28 hours** with the new array layout.



Energy and Angular Resolution



Left: the energy resolution of VERITAS vs. simulated energy at 70 degrees. **Right:** the angular resolution (68% containment) of VERITAS vs. real energy at an elevation of 70 degrees for two different sets of event selection cuts (black is for a crab like source and red is for a softer spectrum source).

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Summary

The VERITAS collaboration relocated Telescope 1 and dramatically improved the optical PSF during the summer of 2009 as part of an ongoing upgrade program. These studies indicate that the upgrades have **improved the sensitivity of VERITAS by 30% resulting in a 60% change in the time needed to detect a source.**

[1] Weekes, T. C., et al. 2002, Astro. Phys., 17 221
[2] Holder, J., et al. 2008, in AIP Conf. Series, 1085
[3] Otte, A. N., et al. 2009, Proc. of the 31st ICRC
[4] McCann, A., et al. 2009, Proc of the 31st ICRC
[5] http://www.mpi-hd.mpg.de/hfm/HESS/pages/home/proposals/
[6] http://www.astro.uni-wuerzburg.de/mphysics/