

# U.S. Participation in the next-generation gamma-ray facility, the Cherenkov Telescope Array

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## ABSTRACT

The Cherenkov Telescope Array Observatory (CTAO) will be the major next-generation facility for observations of very high-energy (VHE) gamma-ray sources, having sensitivity for energies 20 GeV – 300 TeV. Funding has now been secured and construction is beginning for the “Alpha Configuration”, consisting of observatories in the Atacama Desert (Chile) in the southern hemisphere and at La Palma (Spain) in the northern one. The Alpha Configuration will achieve sensitivity as much as an order of magnitude better than existing instruments. The Astro2020 Decadal Survey has recommended U.S. participation in CTAO as part of the Multi-Messenger Program for the 2020s, and in particular recommends support for the addition of ten Schwarzschild-Couder Telescopes (SCTs), which would be an enhancement to the southern array. An international consortium of CTA members, led by the U.S., has developed and prototyped the 9.7-m-aperture SCT, which uses a novel design incorporating a secondary mirror to achieve superior performance over the core 100 GeV–10 TeV energy region of CTAO. CTAO will be the first open observatory in the VHE band, accepting proposals from and executing observations for any scientist from a country contributing financially to its construction and operation; U.S. participation in CTAO would unlock this access for all scientists based in the U.S.

With support from



## The CTA Observatory

CTAO will have three sizes of telescopes to cover the wide 20 GeV–300 TeV energy range: large, 23 m, LST; medium, 10–12 m, MST; and small, ~4 m, SST. The Alpha Configuration will consist of 14 MSTs and 37 SSTs in the south and 4 LSTs and 9 MSTs in the north. Its construction is about to start, with completion expected in five years. The sensitivity of the Alpha Configuration is shown in Fig. 1.

Key Science Projects (KSPs) are planned for several topics. They include surveys of the Galactic Center, Galactic Plane, LMC and ¼ of the remaining sky. Representative PeVatron candidates, star forming systems, AGNs and galaxy clusters will also be observed. Transient follow-up is a central component of the multi-messenger astrophysics program. The dark matter program will search for gamma-ray signatures of the dark matter annihilation or decay. KSPs are designed to deliver legacy datasets that will be useful in their own right and as inspiration for individual proposals. For details see *Science with the Cherenkov Telescope Array*, Singapore: World Scientific (2019), arXiv:1709.07997 and poster no. 46.

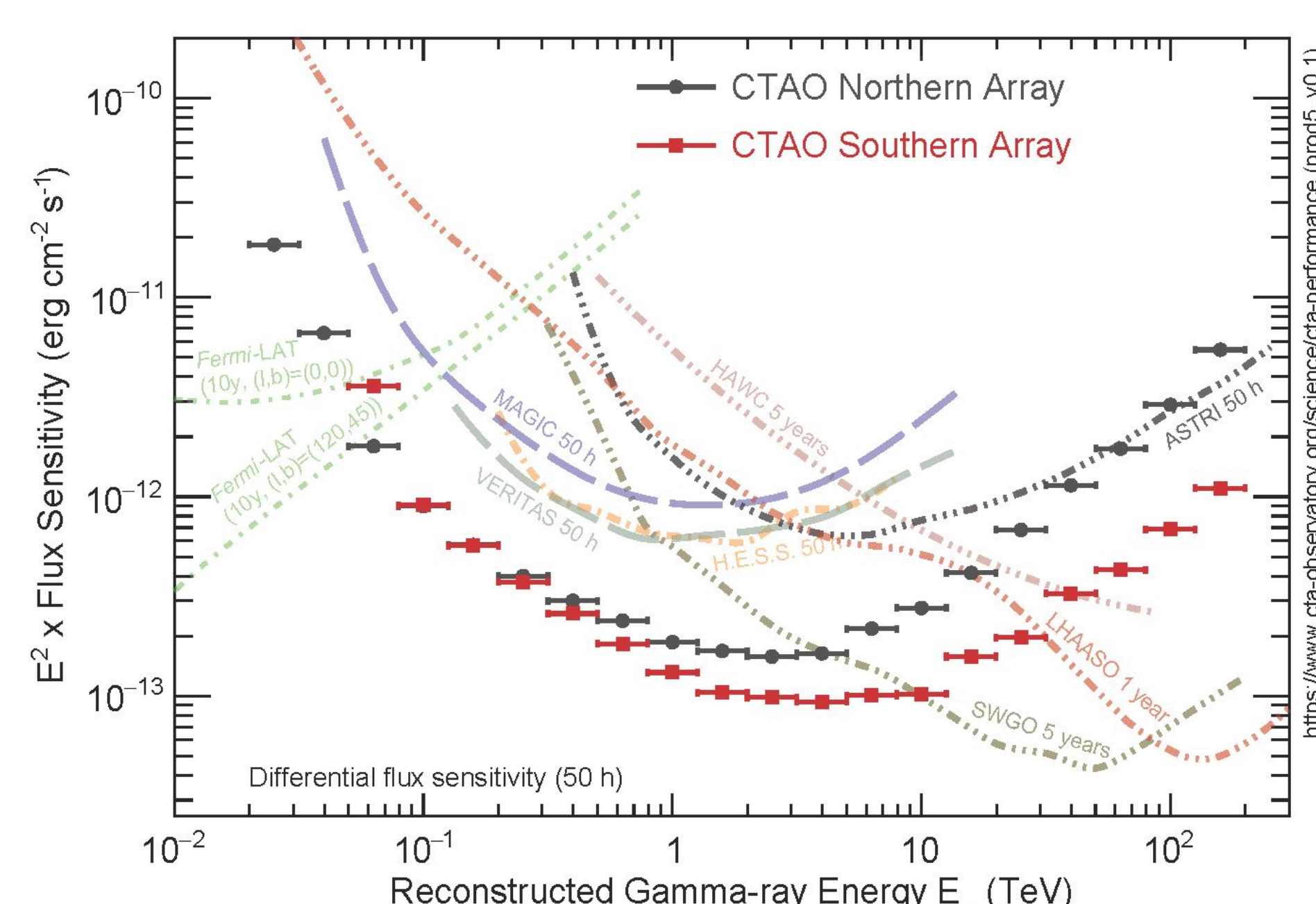


Fig. 1: Differential flux sensitivity of CTAO in 50 hours in comparison to other instruments.

## ACKNOWLEDGMENTS

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## The SCT Design

The Schwarzschild-Couder Telescope (SCT; see Fig. 2) is the first imaging atmospheric Cherenkov telescope design to use a secondary mirror, correcting aberrations to achieve unprecedented angular resolution, especially off-axis, and reducing the plate scale so that high-efficiency, low-cost silicon photo-multipliers can be used. The partially aligned telescope has successfully detected gamma rays from the Crab Nebula (Aph 128, 102562, 2021: arXiv:2012.08448). A camera upgrade (extending the FoV from 2.5 to 8 degrees) is underway, with completion anticipated in 2023.



Fig. 2: The full-scale prototype SCT at the Fred Lawrence Whipple Observatory.

## U.S. Participation in CTAO

The CTAO Alpha Configuration is being built without any U.S. funds and has 14 MSTs in the south compared to aspirations for 25. U.S. scientists have led the development of the SCT as a high-performing medium-sized telescope for CTAO and will be seeking U.S. support to add ~10 SCTs to the southern array. Preliminary estimates of the performance gains are shown in Fig. 3.

The Astro2020 Decadal Survey evaluated and recommended the addition of SCTs to CTAO as a mid-scale U.S. project. It improves the sensitivity significantly over the core 100 GeV–10 TeV energy range, especially off-axis, where single-mirror designs suffer from aberrations, enhancing the CTAO science capabilities, especially for transients, multi-messenger astrophysics, and dark matter searches.

CTAO will be the first open observatory in the very high-energy band, but it will only be open to scientists from nations contributing to construction and operations. U.S. funding to add SCTs to CTAO will therefore open access to all scientists based in the U.S.

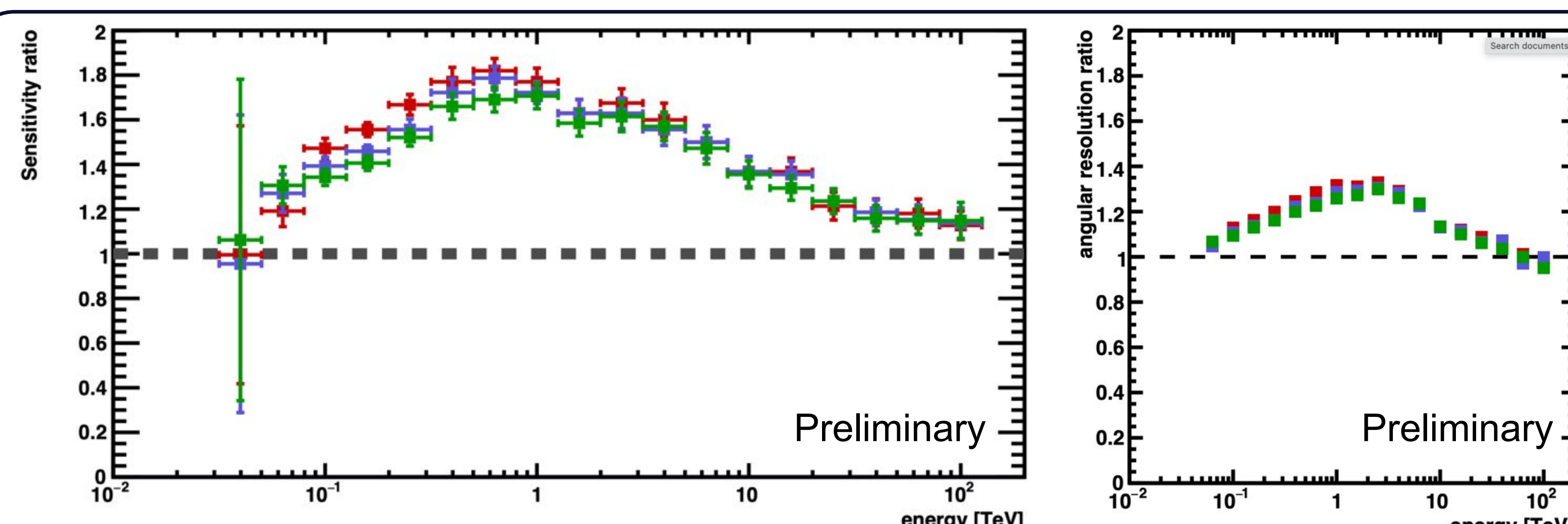


Fig. 3: Preliminary estimates of the factor by which the sensitivity (left) and angular resolution (right) improve as a function of energy by adding 11 SCTs to the CTAO Alpha Configuration in the south. The case shown is 3–4° off-axis at 20° zenith angle. The three colors correspond to slightly different layouts for the added SCTs. Note that the time needed to detect a faint source scales with the sensitivity squared.