A Medium Sized Schwarzschild-Couder Cherenkov Telescope Mechanical Design Proposed for the Cherenkov Telescope Array

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ABSTRACT

The Cherenkov Telescope Array (CTA) is an international next-generation ground-based gamma-ray observatory. CTA will be implemented as southern and northern hemisphere arrays of tens of small, medium and large-sized imaging Cherenkov telescopes with the goal of improving the sensitivity over the current-generation experiments by an order of magnitude. CTA will provide energy coverage from ~20 GeV to more than 300 TeV. The Schwarzschild-Couder (SC) medium size (9.5m) telescopes will feature a novel aplanatic two-mirror optical design capable of accommodating a wide field-of-view with significantly improved angular resolution as compared to the traditional Davies-Cotton optical design. A full-scale prototype SC medium size telescope structure has been designed and will be constructed at the Fred Lawrence Whipple Observatory in southern Arizona during the fall of 2015. This report will concentrate on the novel features of the design.

The prototype SC Telescope (pSCT) Mechanical Design

The pSCT is a two-mirror telescope with a counterweight structure. The mechanical Optical Support Structure (OSS) which supports the mirrors and camera will be mounted on a positioner composed of two main parts: the head and yoke, and the tower. The positioner provides the motion about the elevation and azimuth axes. The positioner is the baselined DESY Davies-Cotton medium-sized telescope (DC-MST) design. The pSCT mechanical design has been driven by the following criteria:

- PSF performance
- Minimization of shadowing
- Ease of fabrication of parts
- Ease of shipping and assembly on-site

The requirement for the PSF performance is less than 3 arcmin at 3 degree field angle. Simple beam and shell element models were created to evaluate the PSF performance based on design implementation. Baffles are required for the primary and secondary telescope structure, both to reduce the night sky background scatter and to contain the reflected sunlight during the daytime for safety reasons. Figure 1 shows different views of the pSCT telescope design and Figure 2 shows the baffle designs for the primary and secondary.

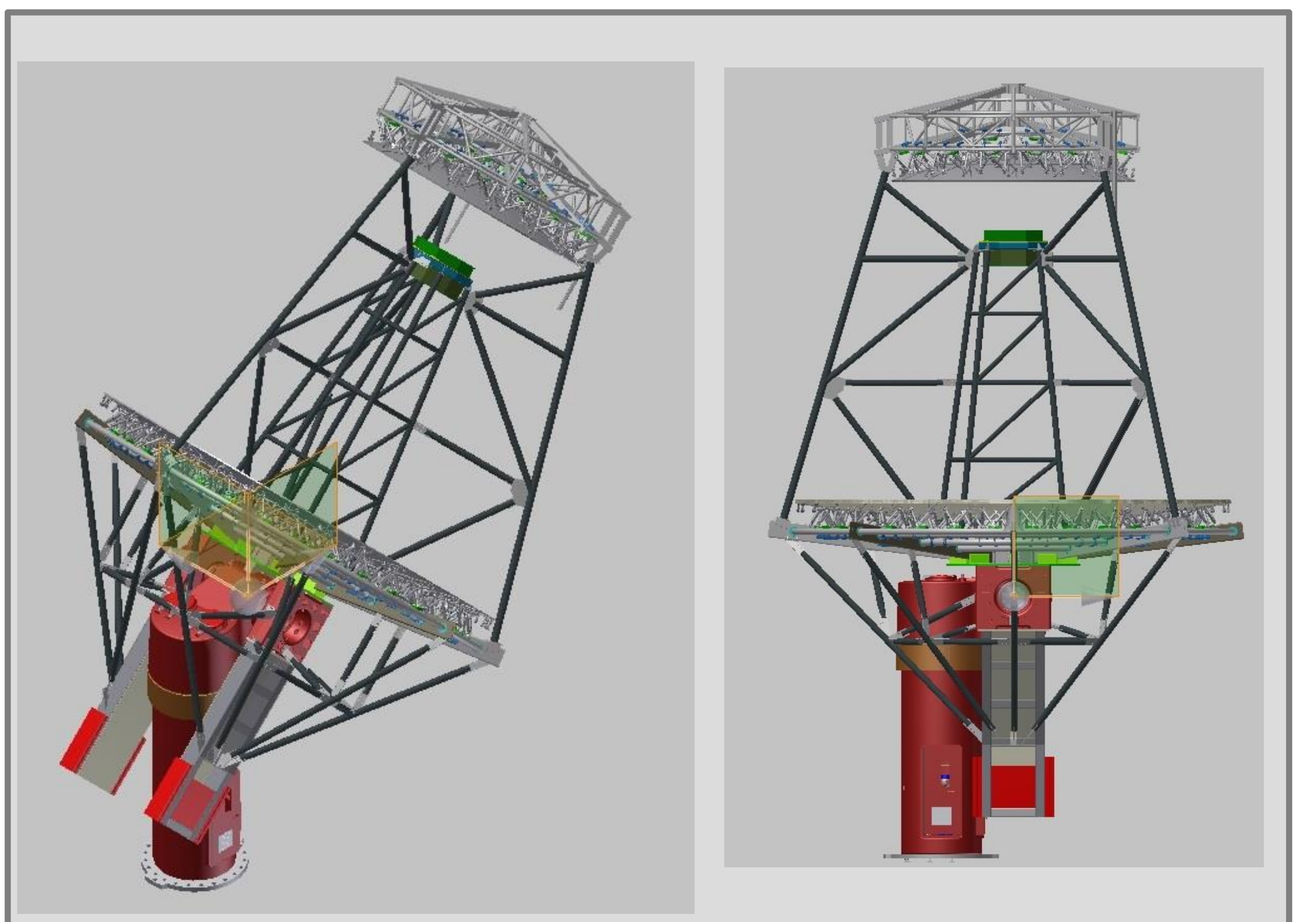

Figure 1. Different views of the pSCT telescope mechanical design.

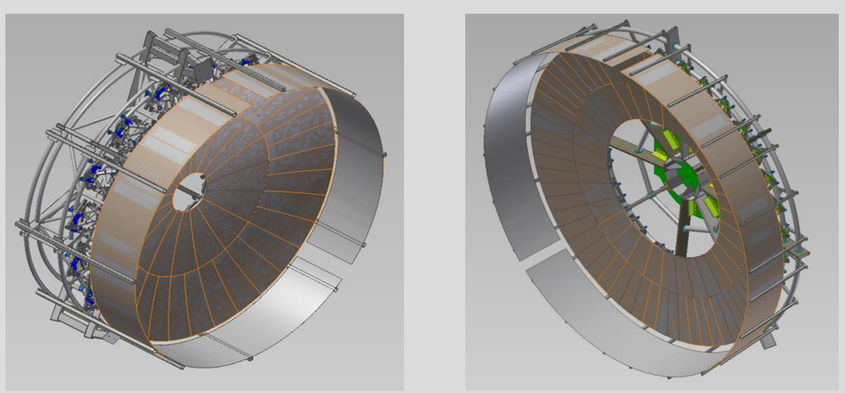

Figure 2. (Left) Secondary Baffle; (Right) Primary Baffle

pSCT Panel Module

A pSCT panel module includes the mirror, Stewart Platform (SP) and support base. The panel module is shown in Figure 3. The layout of the OSS begins with the surface of the mirrors. The thickness of the mirror and the distance from the mirror to the support base is identical for every panel module. The design of the OSS began by placing the inner surface for the primary and secondary mirrors in their correct positions in the optical coordinate system. The steel structure of the OSS that supports each panel module was then located so that it provided support to the mirror assemblies.

Figure 3. The pSCT panel module which shows a typical mirror mounted to the SP and base. The electronics box is shown in yellow and green..

Camera and Mirror Mounting

The mounting and access of the camera poses many challenges that are not present in a DC telescope where there is full access to the camera. The camera must be accessed through the structure that supports the secondary. In addition, access on the back side of the camera is limited by the structure supporting the camera. The required PSF performance is premised on having a very stiff camera frame. The camera will be mounted with the telescope horizontal and either lowered by crane or lifted from the ground using a portable lift. Once at the correct height the camera will be moved horizontally to slide into the existing framework and bolted into place. Figure 4 shows how the camera body is bolted to a stiff frame

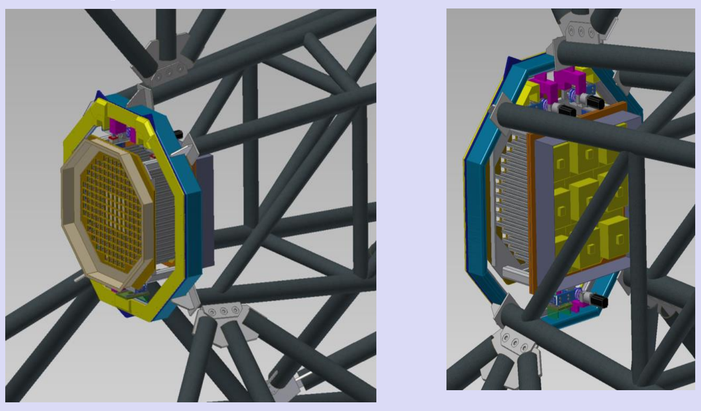

Figure 4. Camera mounting on the OSS.

The mirrors for the pSCT will be mounted to the hexapod SP which in turn will be mounted to a triangular base that is mounted to the curved beams of the primary and secondary. The triangular base has to be located on the OSS within 10mm and the SP has a large enough range of adjustment to accommodate this tolerance. The mounting of the mirrors is shown in Figure 5.

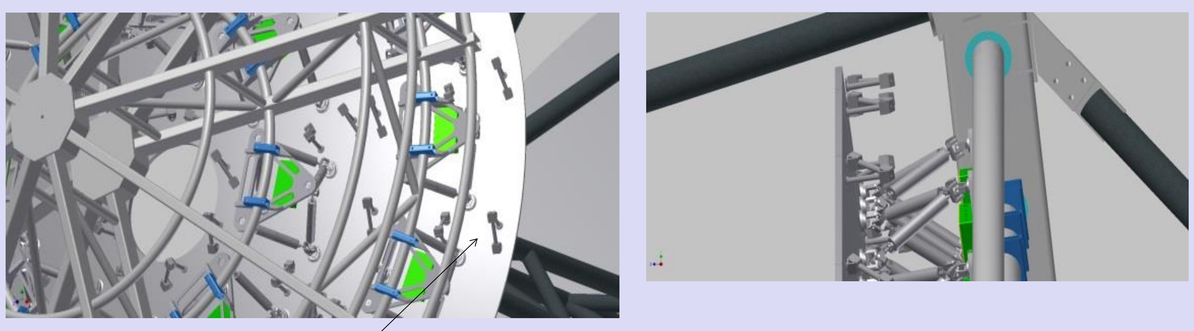

Figure 5. (left) Mirror mounting on the secondary. The green triangle bases and edge sensors are shown. (right) Side view of mirror mounting to the primary.

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