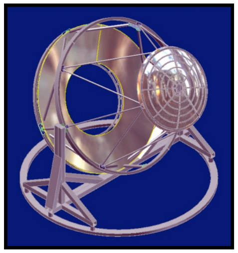

The Advanced Gamma-ray Imaging System (AGIS)
– Telescope Mechanical System Designs –

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Abstract

The concept of a future ground-based gamma-ray observatory, AGIS, in the energy range 40 GeV-100 TeV is based on an array of imaging atmospheric Cherenkov telescopes (IACTs). The anticipated improvements of AGIS sensitivity, angular resolution and reliability of operation impose demanding technological and cost requirements on the design of IACTs. The relatively inexpensive Davies-Cotton telescope design has been used in ground-based gamma-ray astronomy for almost fifty years and is an excellent option. We are also exploring alternative designs and in this submission we focus on the recent mechanical design of a two-mirror telescope with a Schwarzschild-Couder (SC) optical system. The mechanical structure provides support points for mirrors and camera. The design was driven by the requirement of minimizing the deflections of the mirror support structures. The structure is also designed to be able to slew in elevation and azimuth at 10 degrees/s.

Telescope Mechanical Designs:

Several different types of structures are being examined for supporting the primary/secondary and camera of the Schwarzschild-Couder and Davies-Cotton designs.

Schwarzschild-Couder Mechanical Design:

The design of the Schwarzschild-Couder telescope presents additional challenges compared to a Davies Cotton design because of the tighter requirements on the deflections (for telescopes of similar size) and the additional moment caused by the secondary mirror structure. Figures 1 and 2 show the basic layout of the SC Serrurier truss design. The telescope consists of a primary and secondary mirror and a camera. The mechanical structure provides support points for mirrors and camera. The design was driven by the requirement of minimizing the deflections of the mirror support structures. The structure is also designed to be able to swivel in elevation and azimuth at 10 degrees/sec. The design assumes a camera weight of 3,000 lbs, and a primary and secondary mirror weight of 1355kg and 510kg respectively. The Optical Support Structure (OSS) weight without the mirrors is 17,000 lbs.

An alternative structure that is similar to HESS and is shown in Fig. 3. In each of these designs the mirror structures are constructed from concentric rings of structural tubing. The rings provide mounting points for the mirrors. There is a main structural support that these concentric rings are mounted to and which provides the stiffness needed for the entire structure. An attempt has been made to separate the main structural components from the structure that directly supports the mirrors in order to minimize weight and the mirror deformations. Figure 4 shows the Point Spread Function versus field angle for these designs. AP1 is the Serrurier truss design concept and AP2 and AP4 are the alternative design concepts.

Motion Control:

The OSS is rotated in elevation by two bearings mounted on the main support ring and OSS support structure. A dual servo-motor drives the elevation. Since the CG of the OSS is at the center of the main support ring the torque needed to rotate the OSS is minimized. The OSS support structure will be mounted on a rail on the ground to achieve the azimuth rotation. Discussions are currently occurring with vendors to determine the best bearings to use (Hilman, THK) and the drive mechanism (friction roller, chain/sprocket).

Fig. 1 SC Serrurier Design

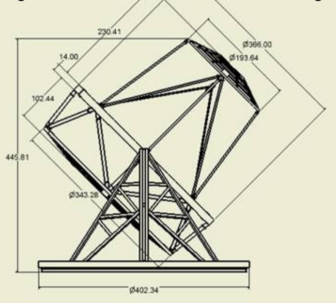


Fig. 2 SC Serrurier Design

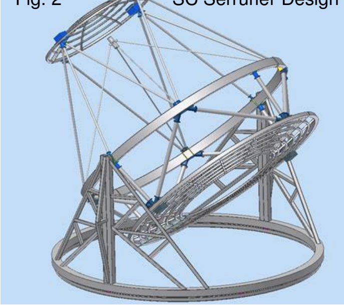


Fig. 3

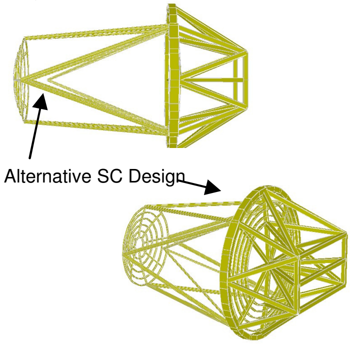
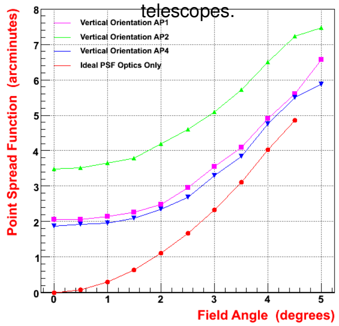


Fig. 4: Point spread function of Schwarzschild-Couder telescopes.



Analysis:

Structural analysis has been done on the OSS in the horizontal and vertical positions under gravity, wind, and inertial loading. Work is continuing on finalizing the design of the OSS support structure to minimize the deformations during rotation of the OSS. Also, work is ongoing to finalize the motions systems. Preliminary funding has been obtained to construct a prototype OSS in the upcoming year.

Fig. 5: Davies Cotton,

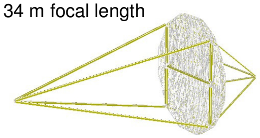
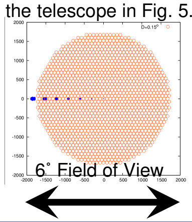


Fig. 6: Point spread function of the telescope in Fig. 5.



Davies-Cotton and Parabolic Telescope Designs:

Davies-Cotton and parabolic telescopes may be chosen to build very large telescopes with mirror areas between on 150 m^2 and 500 m^2. Excellent angular resolution over the entire 6° diameter field of view requires rather large focal length to mirror diameter ratios. Fig. 5 shows the mechanical design of a 20m diameter telescope with a focal length of 34 m. Fig. 6 shows the point spread function of such a telescope for the ideal case of no mirror deformation. Detailed tradeoff studies between cost and performance of all the telescope designs shown here are underway.