Status of the NASA SGSLR Gimbal and Telescope Assembly Build and Test

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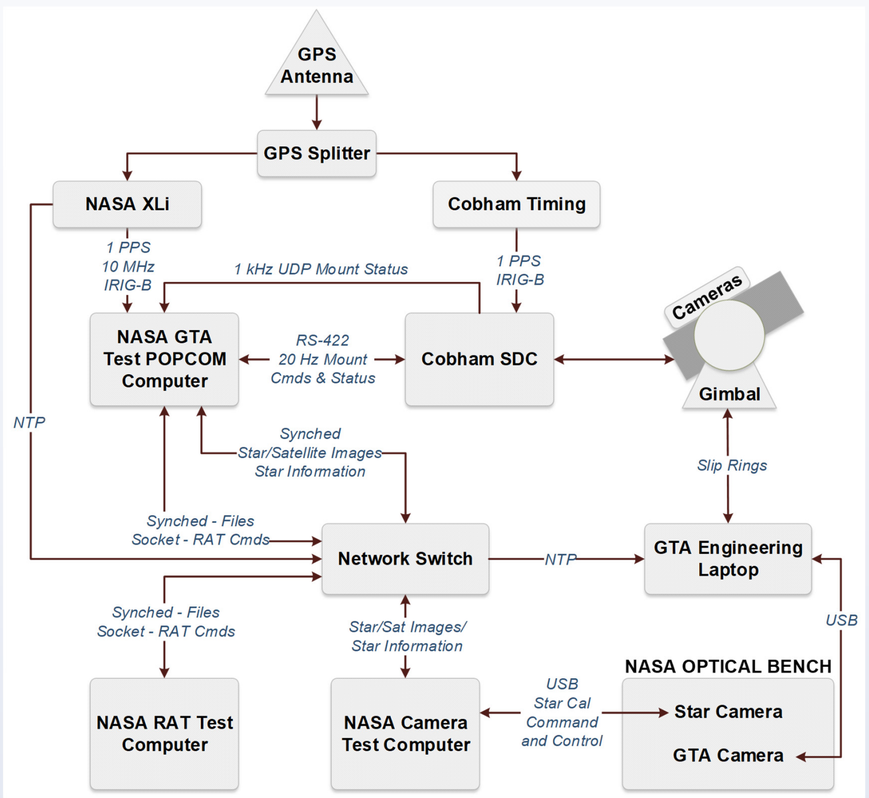
Abstract

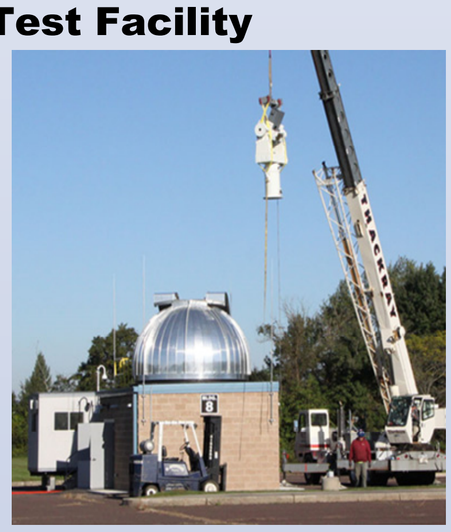
The NASA SGSLR Gimbal and Telescope Assembly (GTA), manufactured by Cobham Integrated Electronic Solutions in Lansdale, Pennsylvania, is a 50 cm clear aperture Cassegrain Optical Telescope Assembly (OTA) integrated into a highly accurate pointing gimbal. Because the NASA SGSLR will eventually be a fully automated SLR system with single photon detection, the GTA has been uniquely designed for extreme stability, high slew speeds, stringent pointing accuracies, the ability to hold pointing calibration for several months, as well as the establishment and accurate determination of the invariant point location during the fabrication and integration of the GTA. The SGSLR team has been preparing for a GTA Factory Acceptance Testing (FAT), scheduled to be completed in early 2019. In order to ensure the SGSLR GTA performance meets requirements at completion, the team has developed a detailed test plan that will be conducted in phases as the GTA build progresses. Over the last several months, the SGSLR team has developed a test bed for testing of the gimbal interfaces, stability, pointing, velocity, acceleration, slew, and tracking to ensure that the GTA requirements are met by the vendor during the FAT. Fixed pointing, simulated star pointing, and simulated satellite tracking are being conducted, where testing for smooth tracking, encoder resolution, and command vs. actual pointing angles are being performed. Cameras are attached externally on the gimbal of the GTA as well as installed on an optical bench to record light captured through the Coudé optical path during star and sunlit satellite tracking. The images captured on the optical bench cameras allow analysis of pointing accuracies through the entire GTA. This poster will describe the status of the GTA build along with testing preparations, early phases of testing and test analysis of the SGSLR gimbal at the vendor facility in preparation for the completion and acceptance of the SGSLR GTA.



GTA Computer and Electronics Test Configuration

The block diagram above represents the NASA SGSLR Computer and electronics Test configuration during testing at the vendor facility. NASA Computers and Operational Test software interface to the Gimbal controller (SDC) using a serial connection whereas all NASA computers are connected through a Network switch. NASA software will control the new GTA to run through multiple tests that include velocity/acceleration, slew, satellite / star tracking (pointing), and encoder resolution to ensure that the GTA specifications have been met.

Cobham Outdoor Test Facility

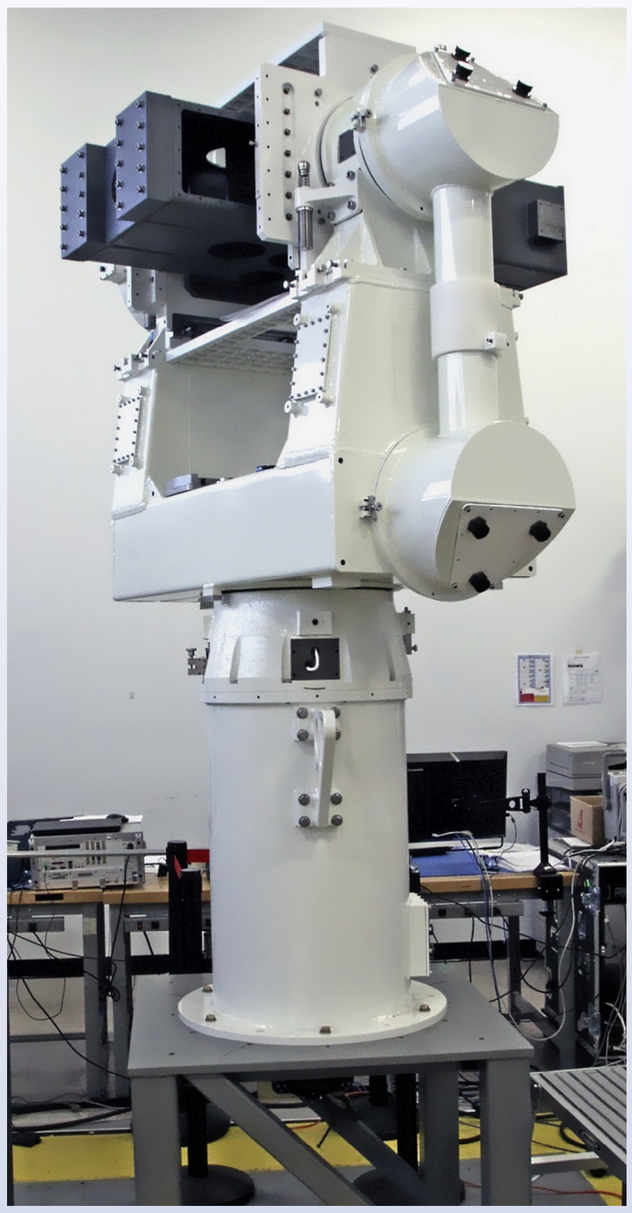


Cobham has built an outdoor test facility to ensure that all Factory Acceptance Testing can be performed at their facility prior to shipment to the GGAO at Goddard . The outdoor facility enables testing for star and sunlit satellite tracking as well as star calibration at the manufacturer. The SGSLR Gimbal and telescope mass simulator were moved into the test facility in October 2018.

Gimbal Vendor Specifications

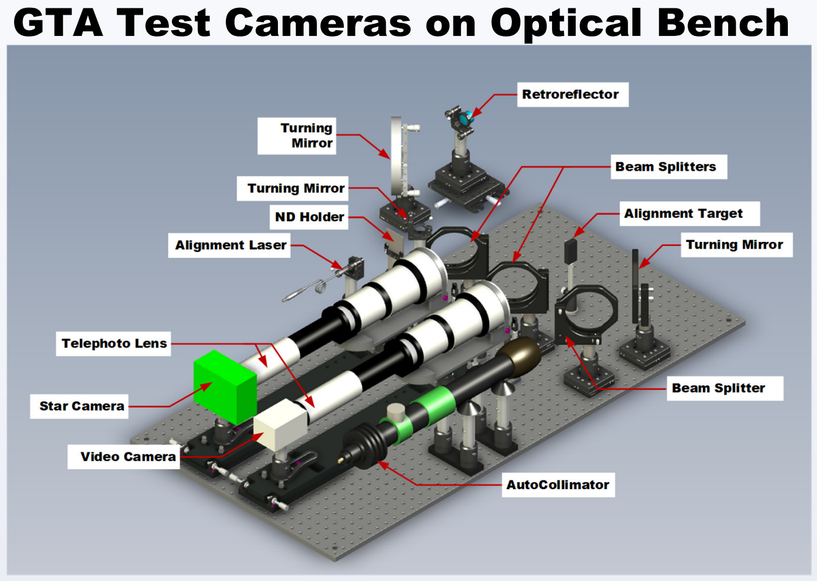
Title	Specification	
Maximum Azimuth and Elevation Slew Rate	Velocity:	≥ 20 deg/sec
	Acceleration:	Maximum
Absolute Pointing / Tracking Velocity and Acceleration	≤ 3.0 arcseconds RMS *(after modeling: star calibration, encoder, motor, etc.)*	
	Jitter:	≤1 arcsecond RMS
	Azimuth Velocity:	0.0 to ±10.0 deg/sec
	Azimuth Acceleration:	0.0 to ±1.0 deg/sec^2
	Elevation Velocity:	0.0 to ±2.0 deg/sec
	Elevation Acceleration:	0.0 to ±0.5 deg/sec^2
	Azimuth:	From 0° to 360° *(continuous)*
	Elevation:	From 7° to 90°
Step Response	Servo controller interpolates discrete position velocity and acceleration data into a smooth tracking profile	
	GTA accurately points along the satellite trajectory synchronous with the 2 kHz laser fire rate	
	2.0 millidegree steps or less settle in less than 0.1 seconds *(critically damped/no overshoot)*	
	Steps from 2.0 millidegrees to 1 degree settle in less than 1 second	
	Steps greater than 1.0 degree settle in less than 5 seconds	

SGSLR Gimbal with Telescope Mass Simulator



The above picture shows the first of 3 SGSLR Gimbals at the Cobham facility. The gimbal is currently being tested and optimized with a mass simulator prior to telescope integration. The mass simulator has optical capability to view ground targets and bright stars. The NASA SGSLR test team traveled to Cobham for a week this summer to interface to the gimbal controller and test the SGSLR operational test software with the gimbal. Interface, velocity, acceleration, slew, azimuth, elevation, step function, pointing and tracking tests were successfully conducted with the gimbal. *Photographs courtesy of Cobham Integrated Electronic Solutions*

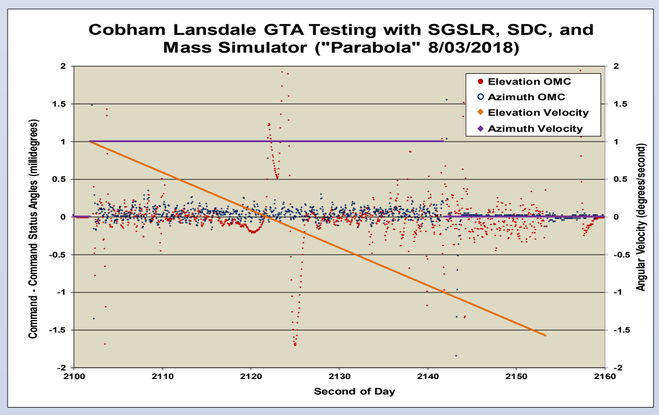
GTA Test Cameras on Optical Bench



Camera configuration on the GTA Test Optical Bench which records video/stills of star and sunlit satellite tracking for evaluation of the GTA specifications.

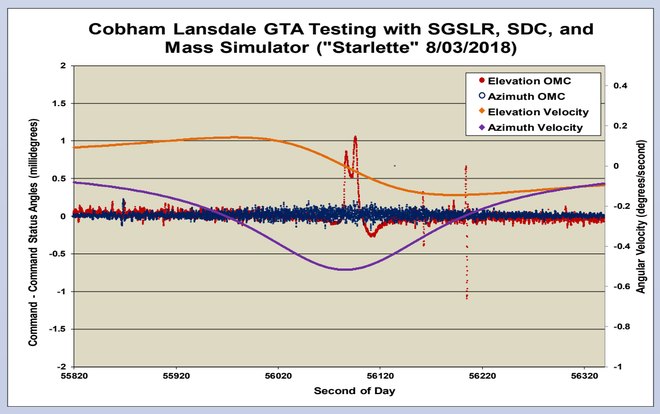
Image software for star and satellite pointing analysis

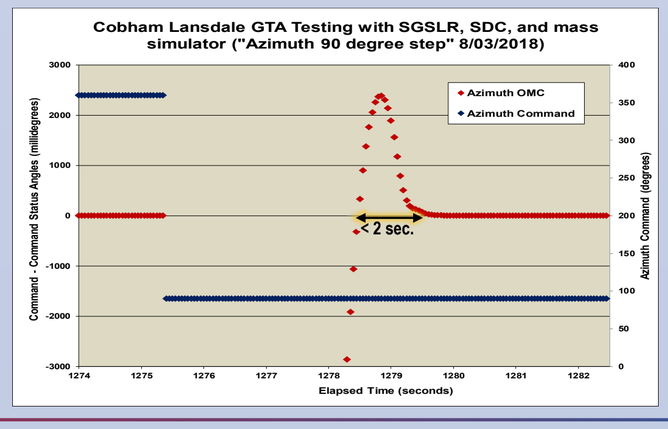
Software, shown here on the left, has been developed to analyze video of star and satellite tracks to measure movement throughout the FOV of the test cameras. The image software will compute statistics of the star/satellite movement including X & Y min/max, mean, and RMS values. This data will help to verify the SGSLR GTA pointing capability.

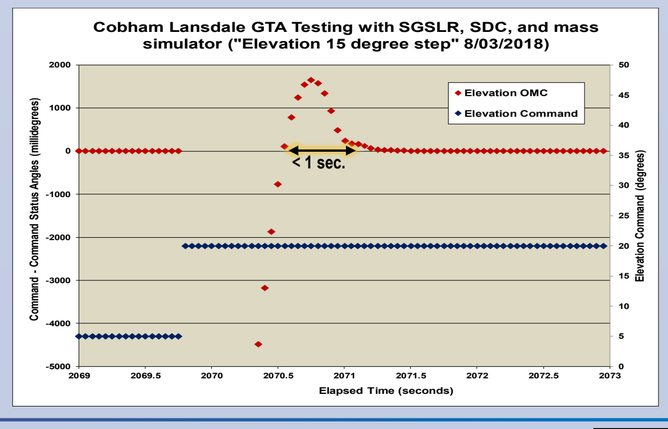


Gimbal Testing in Summer 2018

GTA Test Team in July-August 2018 here on the right, to test the SGSLR gimbal interface and to execute initial test scenarios with the gimbal and telescope mass simulator. Many tests were conducted and a few are shown below, including a simulated Starlette pass, simulated parabola and test for step responses. Test results show that the gimbal is performing very well. Settle times are less than requirement times, and even though the OMC charts show that the system is yet to be optimized, the gimbal is well on its way to factory acceptance.







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