Mobile Tracking Systems Using Meter Class Reflective Telescopes

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Figure 1. Vandenberg AFB, California.

Historically people have relied upon a large fixed site infrastructure in order to support and use meter class telescopes for their observations on the U.S. test ranges. Modern manufacturing capabilities today allow for larger and more versatile telescopes that are lighter, stronger, thermally inert, and allow for imaging from 100nm to 12 microns. Carbon composite meter class reflective telescopes such as offered by RC Optical Systems have become increasingly affordable and lightweight permitting new strategies for mounting and using these instruments. These telescopes have better light gathering capability and produce larger images with greater detail at a longer range than conventional refractive lenses. For example, a .86m RC Optical Systems telescope at 800 pounds can be fitted to a Photo-Sonics Cine-Sextant II mobile tracking system allowing for movement of the instrument to the best location to fit the mission requirements.

A mobile tracking system offers the advantages of being positioned in the optimal location for the observation. These systems may be airlifted to the appropriate latitude and longitude anywhere in the world. They may be located on a ship or barge at sea, an island, or land mass in a difficult to reach region. Mobile tracking systems may be placed in a hazardous environment and controlled remotely. They can be driven to a location and positioned there to capture a significant event that is the object of interest.

The challenge in putting large optics on a mobile system has been the requirement to support the large mass and physical size of these instruments and still maintain mobility. In addition to the mechanical performance of the tracking system, one must consider the instrument control platform environment, its power requirements, and its communications support systems. Fortunately many innovations have come together to support the miniaturization of the electronics and communications systems so that high speed networks and mobile support vehicles and trailers are all that is needed for a traveling observatory. The Photo-Sonics Cine-Sextant II mobile tracker and support system can be flown in and ready to go in a matter of hours. With GPS and star calibration the mobile tracker's position can be precisely fixed for extremely accurate data gathering capability. The Cine-Sextant II mobile tracking system uses 23 bit optical encoders and is able to track at sidereal rates. This mobile tracker is also fitted with a sophisticated auto tracker and can be used for tracking space debris during its descent toward earth or a missile's trajectory and flight path.

The following drawing depicts a Photo-Sonics Cine-Sextant II with an f/8 34" diameter 'meter class' reflective telescope made by RC Optical Systems on a center platform, with two f/8 24" diameter RC Optical Systems telescopes on each side platform.

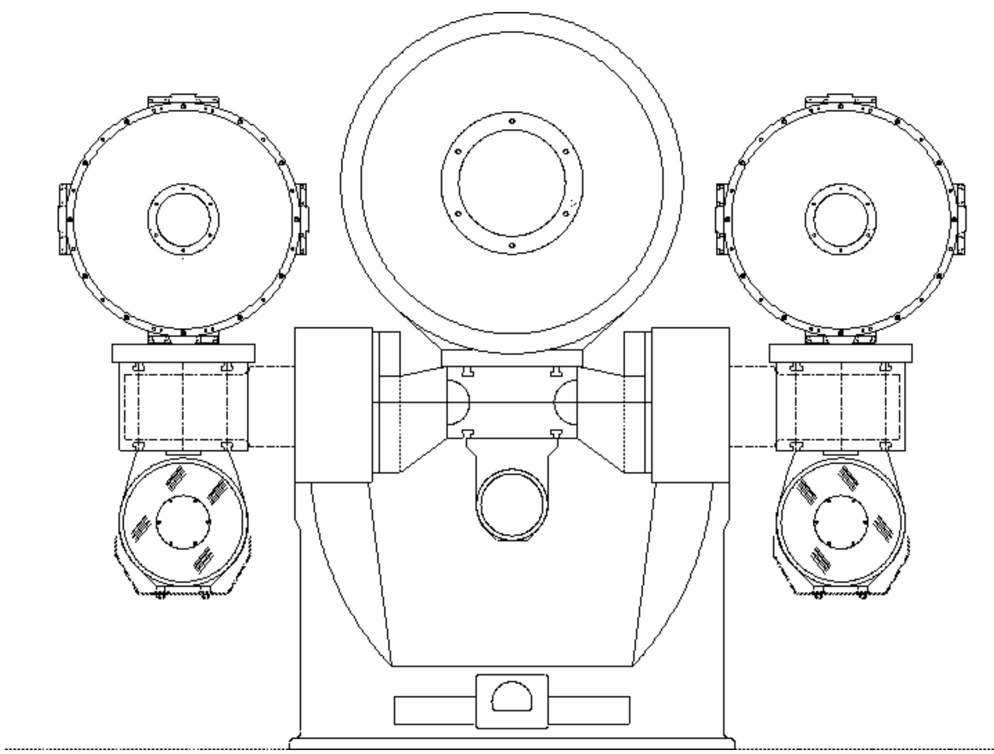

Figure 2. A Cine Sextant II mobile platform with three RC Optical Systems telescopes.

This is effectively a two meter configuration with the opportunity to support multiple sensors on each of the three telescopes. The typical use would be the placement of high resolution digital cameras and IR cameras in a desired configuration for the best imaging performance. For example the center telescope might be optimized for Long Wave IR or Mid Wave IR, while the two telescopes mounted on the side platforms might be optimized for supporting high resolution color cameras or high speed long record digital cameras for slow motion viewing capability. This Ritchey-Chrétien telescope may be optionally fitted with a dichroic beam splitter from RC Optical Systems to allow both visible and NIR cameras to be used or mid and long wave cameras, on the same instrument.

The Argus digital control system of the Cine-Sextant II provides a calibration procedure that sets up each instrument. Orthogonal movement is calibrated and measured so that any errors can be normalized out in real time during the actual mission. The Argus system is operated from a remote console that can be located in an instrument van or trailer or even backhauled on a high speed network to a desired location. Full remote control of the mobile system is offered and all the cameras and sensor output can be virtualized to appear on any of the remote station's LCD monitors. The Argus system is capable of remote camera control and also operating the auto focus tables to achieve a precise focal point for each point during mission tracking.

Figure 3. Cine-Sextant II Mobile Tracker.

The high performance mechanical characteristics of the Photo-Sonics Cine Sextant II tracking system permits slew rates of 60° per second^2 under computer control. This is advantageous in missions where acquiring a high speed target or catching an anomaly such as an unpredicted trajectory of space debris on reentry is required.

Ritchey-Chrétien optics is made up of two hyperbolic mirrors, a primary mirror and a secondary mirror. There is no coma and no chromatic aberration or spectral dispersion in a true RC system. Ritchey-Chrétien optics offer the largest aberration free field of view of any reflective optical system and are ideal for imaging from visible to Long Wave Infrared.

The use of zero expansion substrates, such as Astro-Sitall, ULE, or Zerodur allows the optical figure to remain constant during temperature changes. Mirror spacing is maintained by the carbon composite structure, which also acts as a thermal insulator, so the telescopes will stay in focus during high and low temperatures. The primary mirror is a modern lightweight "dish" mirror for low thermal mass and is center supported/self balancing.

For MWIR and LWIR applications various mirror coatings are used such as Protected Silver or Gold to optimize the telescopes for these wavelengths. The aperture size of the telescope can be matched to the aperture of the IR camera or modified with a relay lens to fit the requirement. The current generation of IR camera sensors is supporting a 1000 x 1000 pixel array.

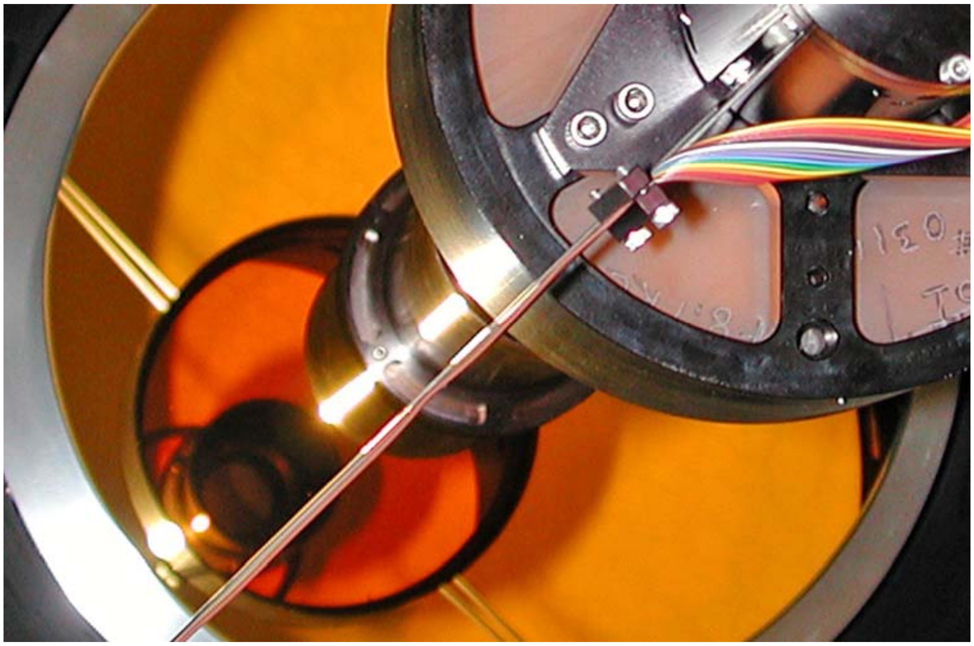

Figure 4. Reflective coatings are used to optimize performance for MWIR and LWIR.

The versatility of these meter class mobile tracking systems in obtaining images anywhere and anytime on short notice provides the capability to record and study significant objects entering the atmosphere from the optimal location on earth.