SDL/11-634D

THE BLACK HOLE

STRAY LIGHT MEASUREMENT FACILITY

The Space Dynamics Laboratory (SDL) Black Hole Stray Light Measurement Facility is used to measure the off-axis rejection performance of space-borne telescopes. High off-axis rejection systems are very difficult to characterize terrestrially due to scattered light from the test setup. The large, specular black chamber dramatically reduces setup corruption by redirecting the scattered light away from the sensor's entrance aperture.

HARDWARE AND SOFTWARE

Instrument under test mounted on a rotary table

SDL'S STRAY LIGHT FACILITY HERITAGE

This is the third generation SDL stray light measurement facility. Previous versions tested several sensors which have all flown successfully in space.

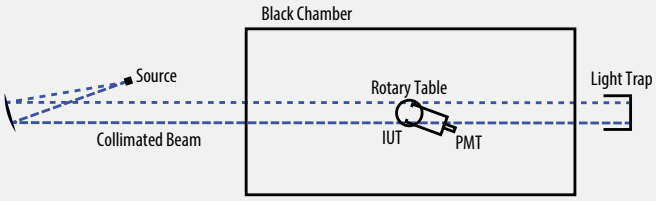
SAMPLE OF TESTED INSTRUMENTS

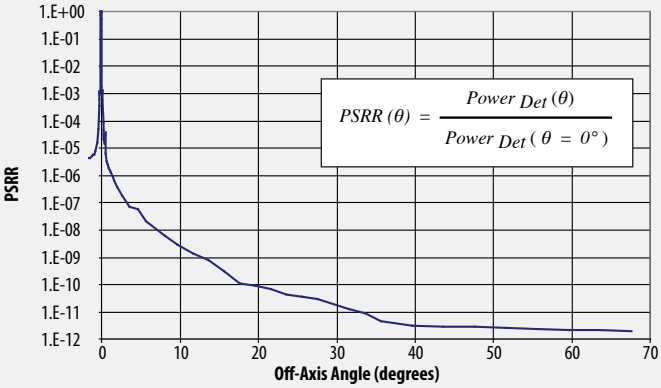
- Optical Navigation Camera (ONC) for Mars Reconnaissance Orbiter (MRO)
- Sounding of the Atmosphere using Broadband Emission Radiometry (SABER) for Thermosphere Ionosphere Mesosphere Energetics and Dynamics (TIMED)
- Cassini Narrow Angle Camera (NAC)
- Galileo Solid State Imaging (SSI) Camera

CAPABILITIES

- System level stray light measurements at ultraviolet, visible & infrared wavelengths
- Accommodates sensors with apertures up to 24 inches
- Tests are performed in a 100 foot, dark clean room
- Automated data collection
- Data is reported in peak normalized form (i.e. PSRR), but can easily be converted to other forms such as PSRR/μsr & NDI
- Setup is transportable

TEST SETUP





Demonstrated Performance: The off-axis response of the instrument under test (IUT) was measured nearly twelve orders of magnitude lower from the peak on-axis response, demonstrating a very low noise floor.

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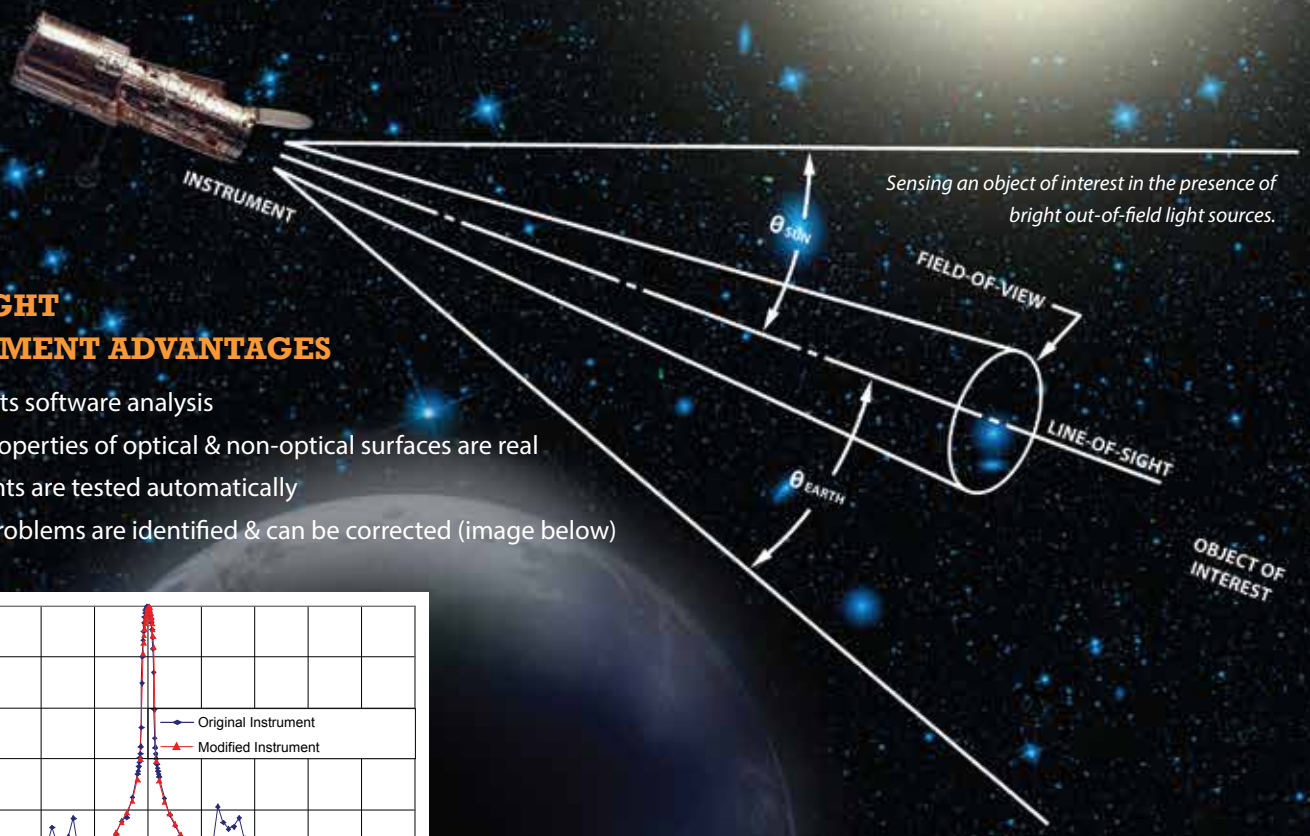
THE STRAY LIGHT PROBLEM

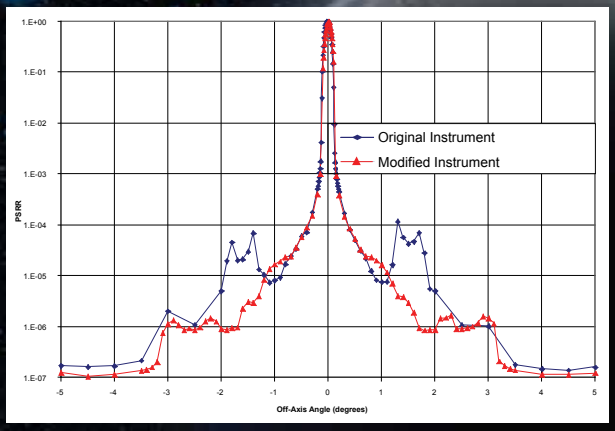
Because spaced-based sensors are becoming increasingly more sensitive, telescope design requires greater attention to stray light performance. Radiation from off-axis sources, such as the Sun and Earth, enters the telescope aperture where it scatters off system components and eventually reaches the focal plane. This stray light can degrade image quality and decrease the ability of the sensor to detect faint signals.



Sensing an object of interest in the presence of bright out-of-field light sources.

STRAY LIGHT MEASUREMENT ADVANTAGES

- Complements software analysis
- Scattered properties of optical & non-optical surfaces are real
- Misalignments are tested automatically
- Stray light problems are identified & can be corrected (image below)



During testing, a major stray light path was discovered in a sensor. Since stray light rejection was critical at small off-axis source angles, a correction was applied. The before and after stray light performance is depicted above.

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References: J.L. Stauder, A.E. Lowman, D. Thiessen, D. Day, and D.O. Miles. 2005. **Off-axis scatter measurement of the Mars Reconnaissance Orbiter (MRO) Optical Navigation Camera (ONC).** Current Developments in Lens Design and Optical Engineering VI, Proc. SPIE, 5874: 208–219.