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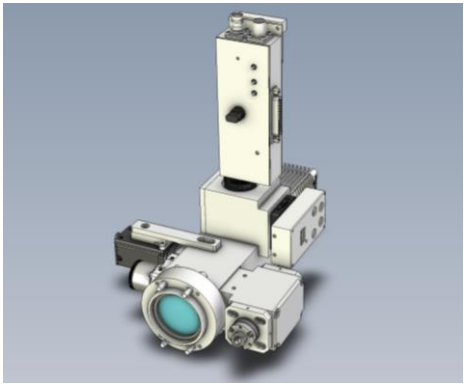
SOFA - Small OGS (Optical Ground Station) Focal-optics Assembly

A Fully Integrated Rx/Tx Head for optical LEO Downlinks with High Data Rates



Brief description

The Small Optical Ground Station Focal-optics Assembly (SOFA) is a low-cost instrument that supplements standard telescope optics, transforming astronomical observatories and commercial off-the-shelf (COTS) portable telescopes into optical ground stations.

Goals

Free-space optical communications (FSOC) have the potential to greatly impact space-to-ground transmissions. It is necessary to mitigate the impact of limited OGS availability due to cloud coverage by employing a network of distributed ground terminals. SOFA will make FSOC accessible to academic institutions, government agencies and commercial service providers.

Involved

DLR internal: KN, RSC^3
External: Baader Planetarium GmbH, WORK Microwave GmbH

Application

- Applied as an extension to Observatories and portable telescopes
- Compatible with most telescope optics
- Enables satellite links to an Optical Ground Station (OGS)
- For scientific, governmental or private satellite missions with high data bandwidth volumes

Perspectives

- More efficient satellite links
- Secure communication: Resistant to interception and jamming thanks to low beam expansion and extended cryptography options
- A network of optical Ground Stations ensures the availability of satellite links

Facts and figures

- Ready for 1550nm & 1064nm
- Integrated Optics
- Four Sensor Ports:
  - Pointing
  - Tracking
  - Data Acquisition
  - Signal Monitoring
- Beacon and Uplink Launcher
- Low Cost
- Easy Deployment
- Compact and Adaptable Design

8 DECENT WORK AND ECONOMIC GROWTH

9 INDUSTRY, INNOVATION AND INFRASTRUCTURE

16 PEACE, JUSTICE AND STRONG INSTITUTIONS

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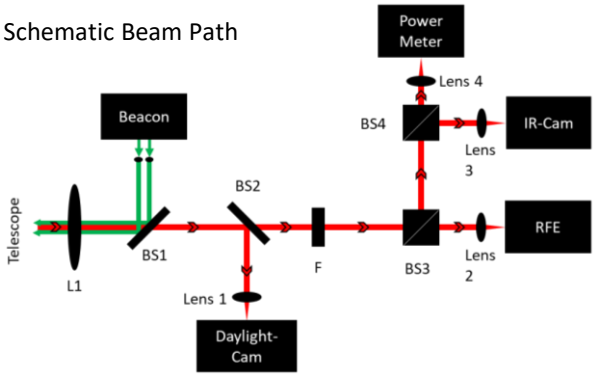
The design objective of the SOFA is to ensure compatibility with the most in-demand telescope optics on the market. It can be mounted on commercial off-the-shelf (COTS) optical tubes and integrated into typical astronomical observatories. Depending on the telescope's technical specifications, the only adaptations required are the use of corresponding spacers and correction lenses — the same as would be required for installing a camera or any other astronomical instrument.

The SOFA system comprises an enclosed optics bench, integrated optics, four sensors and laser-beacon coupling. The telescope optics focus the light emitted by the LEO satellite. The pupil lens (L1) then collimates the beam to an acceptable size inside the SOFA. The beam splitter (BS2) reflects the visible light to an astronomical camera (Daylight Cam), which is used to generate a telescope mount pointing model. It also transmits near infrared (NIR) wavelengths above 900 nm. The bandpass filter (F) allows only optical C-band reception at the receiver front end (RFE), the optical power meter (OPM) and the tracking camera (IR-Cam), which is used for closed-loop tracking. The beam is branched by two beam splitters (BS3 and BS4). Aspheric lenses then focus the collimated beam onto the sensors of each detector (Lenses 2, 3 and 4).

Schematic Beam Path



The signal strength is measured using the OPM, while the RFE performs the optical-electrical conversion of the incoming signal. Two spatially separated laser beacons employing transmitter diversity can be coupled into the system via the beam splitter BS1. Transmitting through the primary aperture uses the same beam path as the incoming light, which reduces co-alignment errors between the uplink and downlink signals.

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