PROPS Tracking Stellar Wavefront Sensor, PR-WS-600-T

Applications

- Passively diagnoses atmospheric turbulence
- Measures atmospheric refraction (ray bending)
- Laser propagation path characterization
- Modeling and forecasting of propagation conditions
- Atmospheric imaging diagnostics
- Optical communications link performance
- Include turbulence profiles in wave-optics simulations
- Enables custom MATLAB analysis

Unique Advantages

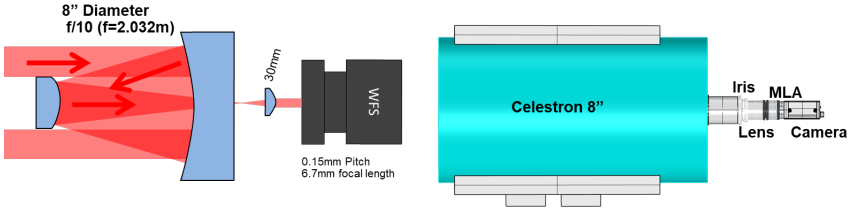
- Measures turbulence characteristics, ground-to-space
- Mount calibration
- Sky acquisition and pointing control
- Robust tracking control for dynamic target diagnostics
- Network capable for remote archive and monitoring
- Automatic computation of:
    - Rytov number (scintillation index)
    - Fried's coherence diameter
    - Isoplanatic angle
    - Cross-wind speeds
    - Greenwood and Tyler frequencies
- Automatic collection, processing, and reporting of turbulence diagnostics, 24/7
- Passive operation—works with stellar or LED sources
- Output supports ATMTools, SHaRE, and WaveTrain

Description

MZA's PROPS tracking stellar wavefront sensor provides fundamental turbulence characterization over extended atmospheric ground-to-space slant paths. Turbulent wavefront measurements are continually sampled with a telescope-mounted sensor inside an environmental enclosure on a motorized mount while tracking stellar sources. These wavefronts are processed to yield data products which address the spatial and temporal properties of turbulence in the path. Sensor outputs includes estimates of atmospheric propagation parameters such as coherence diameter (r_0), Greenwood frequency (f_G), outer scale (L_0) and inner scale (l_0). Analysis enables verification of turbulence power spectrum for discerning non-Kolmogorov turbulence conditions. Analysis also includes subaperture scintillation statistics and consistency with measured wavefronts. Data product is tailored for use with MZA's ATMTools for MATLAB and WaveTrain.

Operation

The stellar wavefront sensor has been designed for direct integration with the collecting telescope aperture. Subaperture size in output space has been optimized to provide adequate sampling of spatial statistics of the atmosphere while enabling operation with a wide range of stellar sources. The sensor software is equipped with a full-purpose mount calibration routine which enables pointing control when integrated with observatory software such as Stellarium. The tracking aperture is used to guide the calibration process and to enable automatic tracking control once locked onto a given star. Once acquired, the stellar source will maintain alignment of the stellar source onto the wavefront sensor. High-speed wavefront measurements are processed in real-time and are output in a standard files for post-test analysis with MATLAB or Python.



4900 Lang Ave. NE, Suite 100
Albuquerque, NM 87109
505-245-9970

1360 Technology Ct, Suite 200
Dayton, OH 45430
937-684-4100

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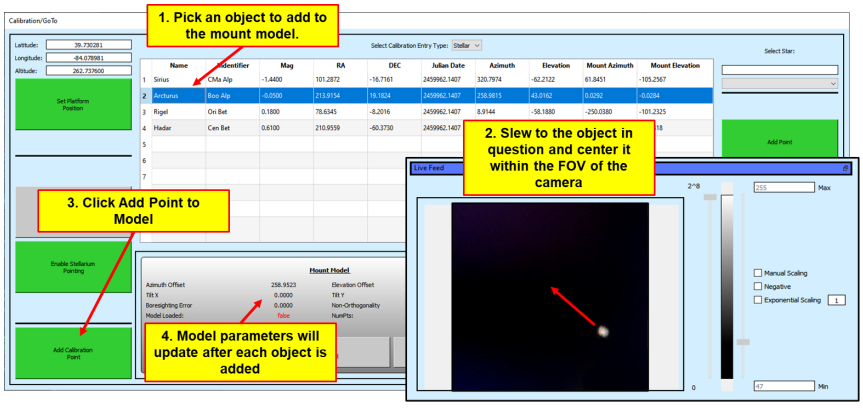
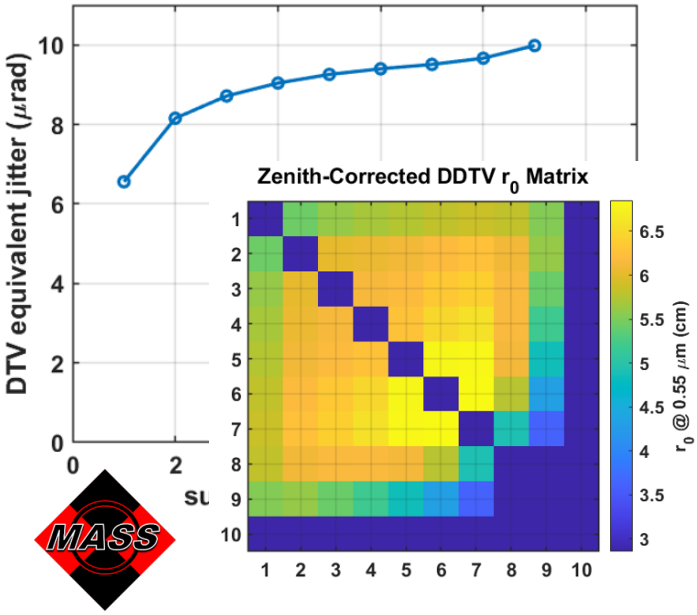
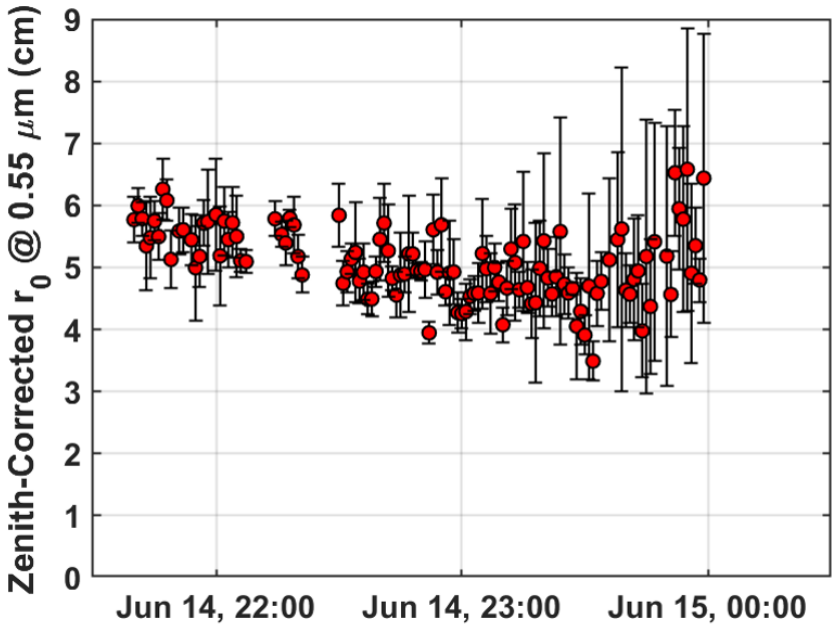
Sky Acquisition and Tracking with Noise-Tolerant Atmospheric Diagnostics



Mount calibration, sky acquisition, and image tracking software enable pointing to celestial targets. Mount calibration is completed using bright alignment stars which are pulled up from a built-in star catalog. Once the mount is calibrated, mount control can be turned over to observatory software for star acquisition. PROPS wavefront-processing software yields redundant slope-structure statistics as a function of subaperture offset. The PROPS difference of differential-tilt variance (DDTV) method automatically isolates atmospheric turbulence from sensor noise. An ensemble of r_0 values are computed from the slope-structure measures, enabling error bounds on r_0 to be output with the sensor data.





Sensor and Wavefront Data	Hartmann wavefront sensor processing, different slope calculations, and optional sensor image sequences.
C_n^2 Statistics	Turbulence statistics including C_n^2, Rytov number, and r_0, isoplanatic angle.
Weather Integration	Available options for integrated weather data acquisition, plotting, and machine learning for turbulence modeling.
Geometry & Additional Information	Full geometry, IFOV, embedded camera information (gain, shutter, etc.), wind speed estimates, timestamps, etc.
System Hardware	8" sensor aperture + track enclosure, tripod, gimbal, camera, and electronics in ~4' footprint for 24/7 operation. Network capable. Transportation cases included.

Electronics Enclosure, Tracking, and Control

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