



Dual-DELTA Enhanced Resolution Profiler, PE-02-600W-T



Description

MZA's Delayed Tilt Anisoplanatism (DELTA) sensor measures turbulence strength along a line of sight. Dual-aperture DELTA imaging with integrated image processing provides enhanced resolution along the propagation path from sensor to target, similar to PROPS, MZA's Path Resolved Optical Profiling System. This sensor integrates MZA's target tracking software with DELTA and a rugged weather-proof mount for continuous atmospheric diagnostics for moving targets. The sensor also includes "Wx" weather measurements and automatic machine learning using MZA's Modular Atmospheric Sensor Software (MASS) suite, providing a weather-driven turbulence model which can be applied during subsequent weather measurements or modeling. When applied to standard numerical weather prediction (NWP) data downloaded from internet sources, turbulence forecasts are displayed by the sensor. The output model is also available for use with MZA's propagation modeling and simulation software.

Applications

- Passively profiles range-resolved 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

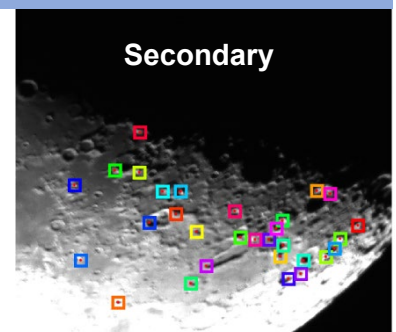
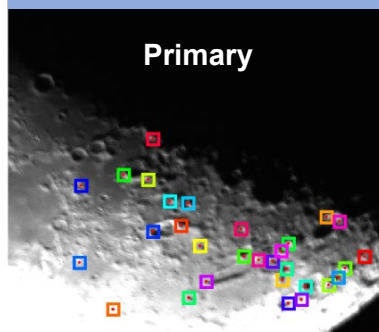
Unique Advantages

- Isolates C_n^2 turbulence strength along path
- Robust tracking control for dynamic target diagnostics
- Integrates DELTA-Wx weather-driven turbulence modeling
- 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
 - Polychromatic anisoplanatic correction
- Automatic collection, processing, and reporting of turbulence diagnostics, 24/7
- Passive operation—no external sources required for diagnostic target during daytime (IR optional for night)
- Output supports ATMTools, SHaRE, and WaveTrain

Operation

DELTA turbulence processing is performed on both the "Primary" and "Secondary" time-synchronized image sequences. Features from the Primary aperture are automatically transferred to the Secondary aperture. Feature pairs which are offset parallel to the aperture separation provide for path-isolation of turbulence for enhanced profiling compared either DELTA sensor operating independently. Imaging processing of the camera channel also gives integrated atmospheric refraction measurements to assess polychromatic turbulence and compensation limits and mitigation.

Feature Correlation and Joint Tracking

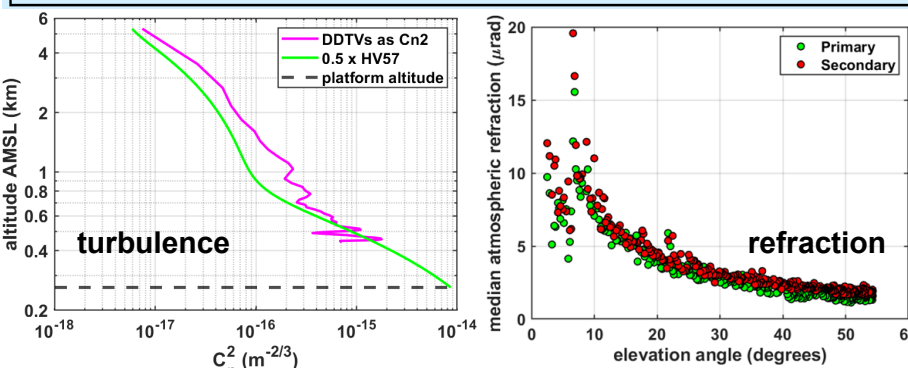
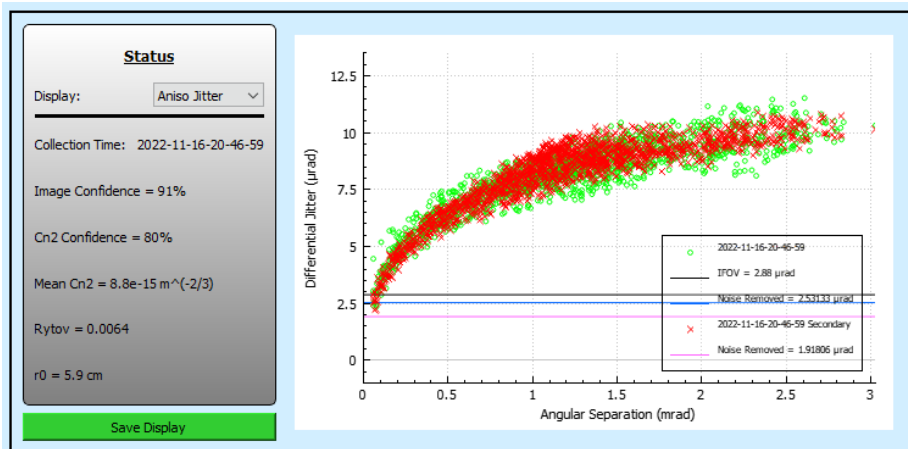
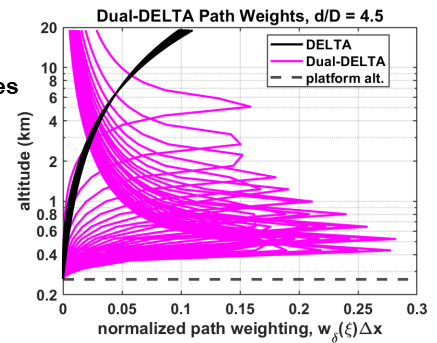
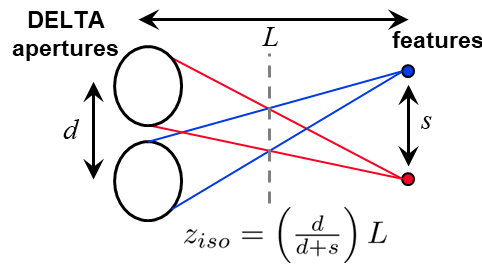




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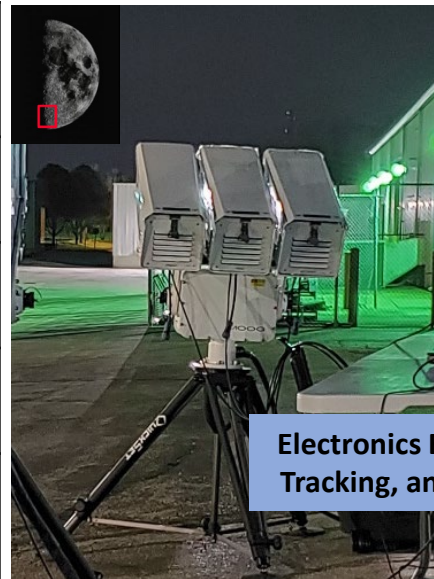
Enhanced Profiling, Sky Acquisition & Tracking, Weather-Driven Turbulence

Synchronized DELTA turbulence measurements are made with images from each aperture on a common feature set. The imaging geometry isolates turbulence effects along the path, providing enhanced C_n^2 resolution. Mount calibration, sky acquisition, and image tracking software enable pointing to celestial or terrestrial targets. Weather-driven turbulence forecasting is enabled by the DELTA-Wx daily machine learning.

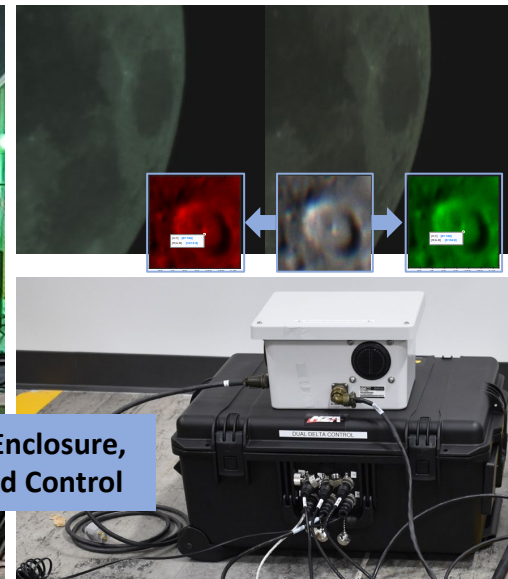


Terrestrial or Celestial Targets

Image and Feature Data	Image registration, feature correlation, subpixel tracking over synchronized image sequences, differential jitter, color channel refraction, and optional raw color images.
C_n^2 Profile	Turbulence statistics including C_n^2 profiles, Rytov number, and r_0 , isoplanatic angle, wind speed, atmospheric refraction.
Weather Station	Commercial weather station with integrated data acquisition, plotting, and machine learning algorithm.
Scene & Additional Information	Range, IFOV ($\sim 2.5 \mu\text{rad}$), embedded camera information (gain, shutter, etc.), wind speed estimates, timestamps, etc.
System Hardware	Dual 4" aperture + track enclosures, tripod, gimbal, camera, and electronics in $\sim 4'$ footprint for 24/7 operation. Network capable. Transportation cases included.



Electronics Enclosure, Tracking, and Control



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