Headwall DATASHEET

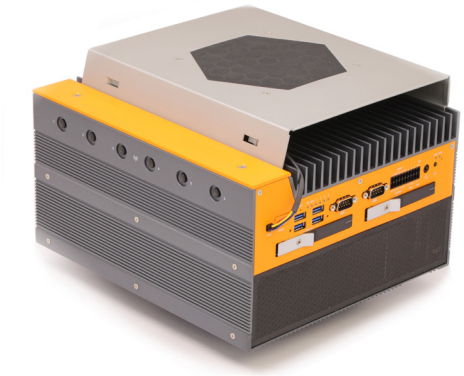
analytik

Solar-Induced Fluorescence Imaging Sensor

671–780 nm at 0.3 nm FWHM

OSA The Optical Society | 100 Since 1916

Paul F. Forman Team Engineering Excellence Award



FEATURES

- Designed for Chlorophyll Fluorescence Imaging
- All-reflective concentric imager design
- Spectral resolution: ≤0.3 nm
- Spatial pixels: 1,600
- Scientific-grade data for O_2-A and O_2-B
- Spectral passband: 671-780 nm
- Weight (including lens): 6 kg / 13.23 lbs
- Size: 300 x 200 x 180 mm

Headwall's Solar-Induced Fluorescence (SIF) imaging sensor excels at collecting data present in the Oxygen-A and Oxygen-B bands where weak but valuable fluorescence signals are found. With this data, environmental scientists may gain a better understanding of plant physiology and stress.

REV0125

UNDERSTAND PLANT PHYSIOLOGY

WHAT IS SOLAR-INDUCED FLUORESCENCE?

A fraction of the light absorbed by chlorophyll molecules in plants is re-emitted at longer wavelengths. This signal can serve as a proxy for plant photosynthetic activity. While SIF is often measured by single point instruments, the Headwall SIF imaging sensor features sub-nm spectral resolution, high spatial resolution, and the optimal wavelength range to detect and image the SIF signal. Note that Headwall does not supply algorithms to separate the SIF signal but captures data for researchers to utilize with their own methodology.

BENEFITS TO UTILIZING SIF AS A PROXY

Photosynthesis is a key process to plant health, crop production and atmospheric CO_2 reduction/carbon cycle. Measurement is critical to understanding the factors/ mechanisms that are beneficial or harmful. Symptoms can be detected using SIF before they become visible by eye or by using other means.

SPECIFICATIONS	
Wavelength Range	671 – 780 nm
Spectral Resolution	≤ 0.3 nm
Working f-number	f/2.5
Angular FOV (swath width)	23° (nominal)
Spectral Pixels	2,134 px
Number of un-binned spatial pixels	1,600 px
FPA Technology	TE-cooled sCMOS
Maximum Frame Rate, no binning, using High-Capacity HDPU* to disk	≤ 52 Hz
Camera Bit Depth	16 bits
Maximum Power Consumption	19 W typical, 32 W peak power
Input Voltage	12 - 24 V DC
Shutter	electricro-mechanical
Lens	Headwall 25mm VNIR Telecentric
Camera Interface	CameraLink HS Fiber
Operational Temperature Range	+10 to +40 °C
Athermalization	Passive by design; soak @ equilibrium assumed
Operational Humidity	10 - 80% RH
Weight	6 kg / 13.23 lbs**
Size (spectrometer only)	320 x 200 x 180 mm / 12.6 x 7.87 x 7.08 in**

*Higher frame rates attainable with certain configurations

**Pre-production estimates, values may change.

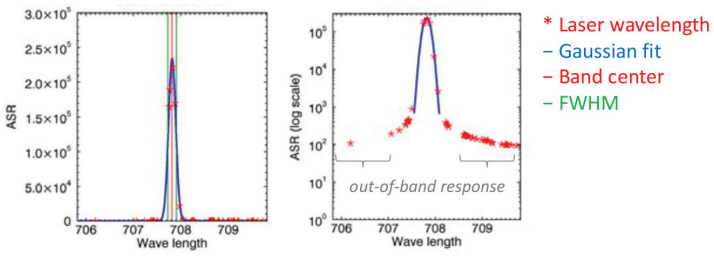


Figure 1: Example of absolute spectral response (ASR) functions on a particular band. The actual observations (red stars) are interpolated with a Gaussian function (blue line) to calculate the full width at half maximum (FWHM) (green lines) for the band center (red line). Provided by NASA Goddard Laser for Absolute Measurement of Radiance (GLAMR). (Paynter, Ian, Bruce Cook, Lawrence Corp, Jyoteshwar Nagol, and Joel McCorkel. 2020. "Characterization of FIREFLY, an Imaging Spectrometer Designed for Remote Sensing of Solar Induced Fluorescence" Sensors 20, no. 17: 4682. https://doi.org/10.3390/s20174682)

SOLAR-INDUCED FLUORESCENCE IMAGING SENSOR

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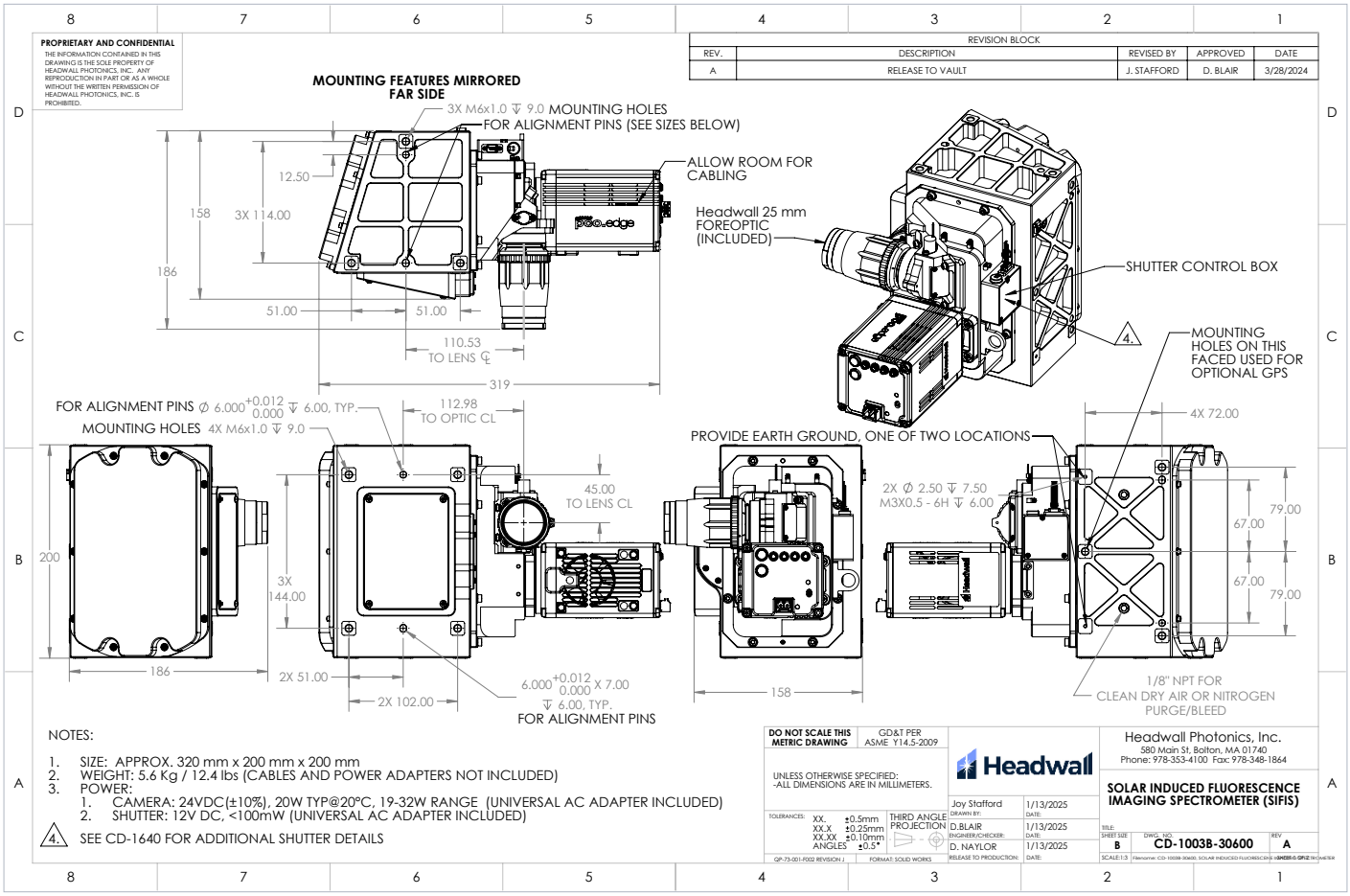
THE VALUE OF SOLAR-INDUCED FLUORESCENCE

Remote sensing of solar-induced fluorescence (SIF) is rapidly advancing as a technique in agricultural and environmental science, although it is founded upon decades of research, applications, and sensor developments in active and passive sensing of chlorophyll fluorescence. The extremely weak yet distinct SIF signal can be assessed remotely using this very high-resolution spectral sensor in tandem with your own algorithms to distinguish the emission from reflected and/or scattered ambient light.

RESEARCH STUDY TOPICS UTILIZING SIF

Topic[1]	Space	Air/Field	Greenhouse
Absorbed PAR[2]	☑	☑	☑
Bacterial Infection	⊗	☑	☑
Fungal Infection	⊗	☑	☑
Diurnal Dynamics	☑	☑	⊗
Seasonal Dynamics	☑	☑	⊗
GPP & NPP[3]	☑	☑	⊗
Heat Effects	☑	☑	⊗
Herbicide Effects	⊗	☑	☑
Nitrogen Deficit	☑	☑	☑
Phenotyping	⊗	☑	☑
Stress Detection	☑	☑	☑
Water Deficit	☑	☑	⊗

[1] This list is not exhaustive. Source: https://doi.org/10.1016/j.rse.2019.04.030
[2] Photosynthetically Active Radiation
[3] Gross Primary Production & Net Primary Production (agriculture)



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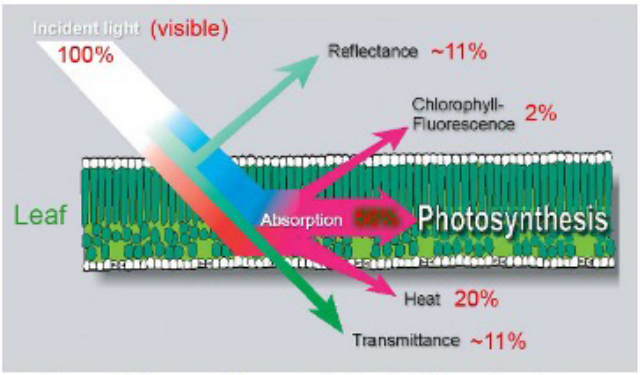
HEADWALL SIF IMAGING SENSOR

- Application-specific sensor for Solar-Induced Fluorescence
- High spectral and spatial resolution
- Performance-validated
- Deploy on aircraft
- Deploy on observation towers
- High-value, award-winning product
- Wavelength and radiometrically calibrated
- Working on package with pan-tilt stage for tower/tripod use.

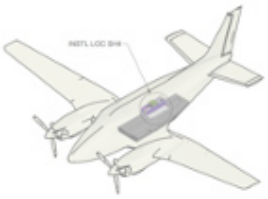


How light energy falling on a leaf is partitioned. About 78% of the incident radiation is absorbed, while the rest is either transmitted or reflected at the leaf's surface. About 20% is dissipated through heat and only 2% emitted as fluorescence, as a by-product of photosynthetic reactions occurring within the leaf itself.

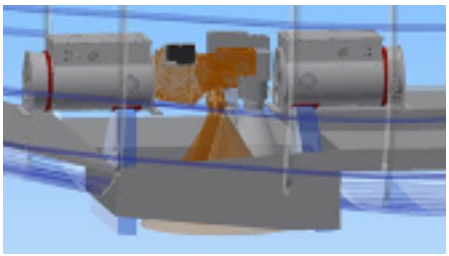
Mapping Photosynthesis from Space - a new vegetation-fluorescence technique ESA bulletin. Bulletin ASE. European Space Agency. 11/2003; 116:34-37.

EXAMPLE DEPLOYMENT: NASA GODDARD G-LIHT AIRBORNE OBSERVATIONS

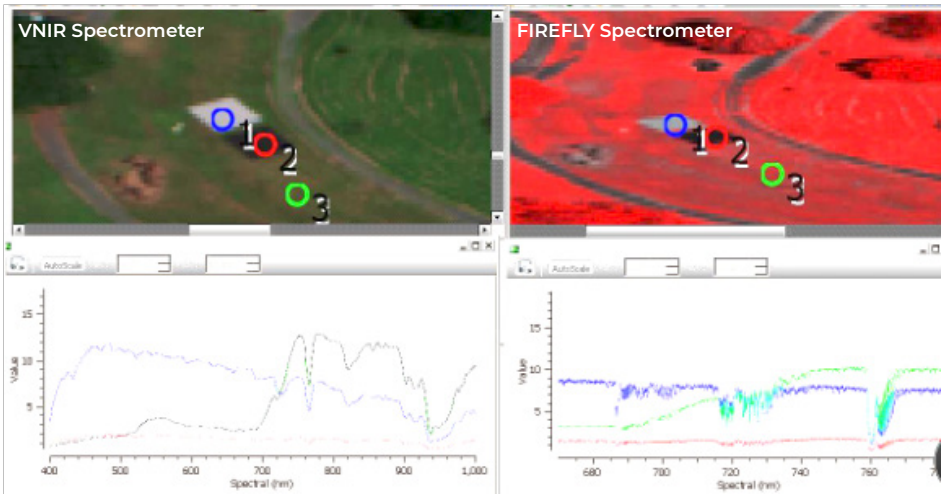
- Calibration tarps, vegetation at USFS Intl. Institute of Tropical Forestry (IITF)
- Native and exotic tropical tree species
- Botanical Garden of the University of Puerto Rico (UPR)
- Arboretum Parque Doña Inés
- USFS, NSF, Smithsonian and university ground plots (island-wide)



Fine-Resolution Stereo RGB



3D FOV Model. VNIR, SIF, thermal and RGB imagers



Manufactured by Headwall Photonics, distributed in the UK and Ireland by **analytik**.