



National Aeronautics and Space Administration
Goddard Institute for Space Studies

Photopolarimetry Measurements of Aerosols

The Research Scanning Polarimeter

Instrument Description

In order to demonstrate the capabilities of polarimetry an instrument that can make either ground-based, or aircraft measurements, the Research Scanning Polarimeter (RSP) has been developed by [SpectIR Corporation](#). This instrument has similar functional capabilities to the proposed EOSP satellite instrument. The picture above shows the assembled RSP instrument with its liquid nitrogen dewar on the left side and scanner assembly on the right. Currently data acquisition is performed on a laptop, which is shown here and gives an indication of the size of the instrument. The scientific requirements for the polarimetric measurements are satisfied by the RSP through its high measurement accuracy, the wide range of viewing angles measured and by sampling of the spectrum of reflected solar radiation over most of the radiatively significant range. The RSP instrument uses a polarization compensated scan mirror assembly to scan the fields of view of six boresighted, refractive telescopes through $\pm 60^\circ$ from the normal with respect to the instrument baseplate. The refractive telescopes are paired, with each pair making measurements in three spectral bands.



One telescope in each pair makes simultaneous measurements of the linear polarization components of the intensity in orthogonal planes at 0° and 90° to the meridional plane of the instrument, while the other telescope simultaneously measures equivalent intensities in orthogonal planes at 45° and 135° . This approach ensures that the polarization signal is not contaminated by uncorrelated spatial or temporal scene intensity variations during the course of the polarization measurements, which could create false polarization. These measurements in each instantaneous field of view in a scan provide the simultaneous determination of the intensity, and the degree and azimuth of linear polarization in all nine spectral bands.

Specifications

Spectral bands: The instrument has nine spectral channels that are divided into two groups based on the type of detector used: visible/near infrared (VNIR) bands at 410 (30), 470 (20), 550 (20), 670 (20), 865 (20) and 960 (20) nm and shortwave infrared (SWIR) bands at 1590 (60), 1880 (90), and 2250 (120) nm. The parenthetic figures are the full width at half maximum (FWHM) bandwidths of the spectral bands.

Scanner: The desired polarization-insensitive scanning function of the RSP is achieved by the use of a two-mirror system with the mirrors oriented such that any polarization introduced at the first reflection is compensated for by the second reflection.

Optics: The optics are simple refractive telescopes that define the 14mrad field of view. Dichroic beam splitters are used for spectral selection, interference filters define the spectral bandpass and Wollaston prisms are used to spatially separate the orthogonal polarizations onto the pairs of detectors.

Detectors: The detectors for the VNIR wavelengths are pairs of UV-enhanced silicon photodiodes. The detectors for the SWIR wavelengths are pairs of HgCdTe photodiodes with a 2.5 μm cutoff cooled to 163K (-110°C).

Electronics: With the exception of the dual preamplifiers located near each detector pair, the RSP electronics is contained within three stacked, interconnected modules. The electronics provides the amplification of the signals detected by the 36 detector channels, sampling and 14-bit analog-to-digital conversion of the resultant signals, the servo control of the scanner rotation and the temperature of the SWIR detectors, and the control logic that formats the instrument signal and housekeeping data and supports transmission of the digital data to a personal computer for storage.

Cooler: A liquid nitrogen dewar is used to cool the SWIR detectors during both ground and airborne operation. To optimize the performance of the SWIR channels the temperature of the detectors is servo controlled at 163K during operation.

Data Handling: Digital data from 152 scene sectors (IFOVs) over 121 degrees of scan, dark samples from 10 sectors and instrument status data are formatted by the RSP electronics and transmitted each scan to a personal computer for storage. The average data rate of 110kbps provides readout of the 36 signal channels together with instrument status data at a scan rate of 71.3 rpm. This scan rate results in an IFOV dwell time of 1.875 ms and yields contiguous (scan line-to-line) coverage at nadir when the aircraft is travelling at a V/H ratio of 0.017 s^{-1} ,

e.g., 100 knots at an altitude of 3048m (10,000 ft.).

Mass: 24kg (including LN2).

Size: 48 x 28 x 34 cm (Length x Width x Height) including dewar.

Power: 18W (27W peak).

[RSP Overview](#) | [Instrument Description](#) | [Data and Analysis](#)
[Image Gallery](#) | [Synergy with Satellite Measurements](#)



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