Instrument Report

Instrument Details:
Name: SPECTRIX
Unit ID number: 300
Manufacture date: ~1994

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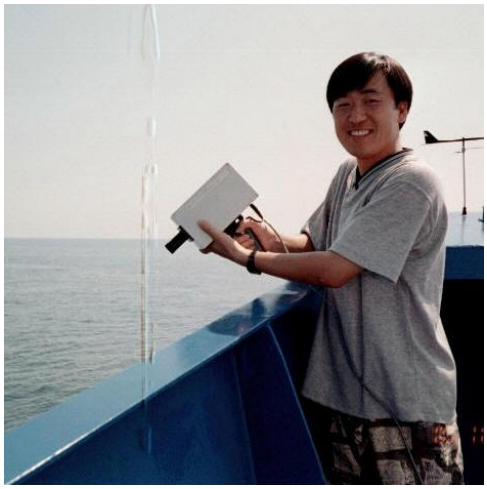
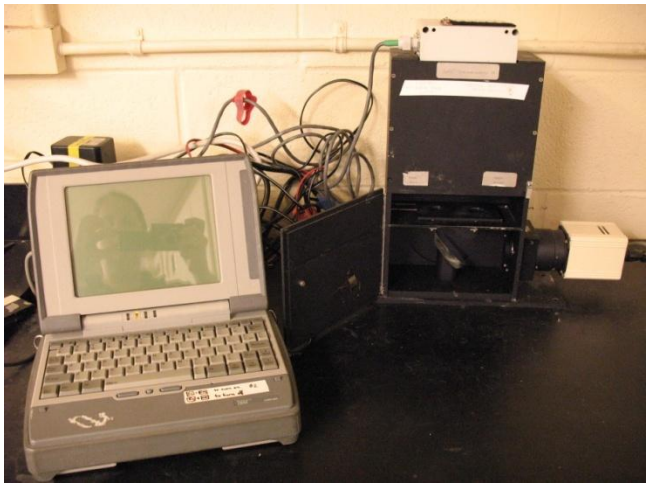
I) Introduction

Briefly, the SPECTRIX is a custom-built, handheld spectrometer that is capable of measuring optical spectra from ~330 to 880nm at <2nm resolution with a 3nm half bandwidth. The spectrometer includes a photodetector with a 512-element linear array. Data is collected internally by a 12-bit analog microprocessor and then transferred via RS232 communication to an external computer. See Section IV for a full system description.

The SPECTRIX can be used (1) in the field as a spectroradiometer for determining above-water remote sensing reflectance spectra, $R_{rs}(\lambda)$, and (2) in the lab as a filter pad transmissometer for determining particulate, $a_p(\lambda)$, and detrital, $a_d(\lambda)$, absorption spectra. Units have also been modified previously for use as a dual-path submersible radiometer and irradiometer.





II) Calibration / Maintenance

Spectral calibration is performed roughly twice per year using an Edmund Scientific mercury vapor lamp. Individual spectra are collected both when the lamp is first turned on (e.g.

when the argon lines in the red region are most pronounced) and again a few minutes later as the internal temperature of the lamp rises. Channel numbers corresponding to the following wavelengths (365, 404, 435, 546, 578, 764, 812, and 842nm) are recorded. A second-order polynomial equation is then fit to the data in order to determine wavelength from channel number. Coefficients of determinations (r^2) for this best-fit curve are always >0.999.

While radiometric calibrations were previously required when units were used as dual-path submersible radiometer and irradiometers, such calibrations are not required for determinations of above-water $R_{rs}(\lambda)$ because final calculations involve normalizing individual scans taken of the water or sky by scans collected off a calibrated standard diffuse reflectance panel (or "gray card"). Similarly, radiometric calibrations are also not required for determinations of $a_p(\lambda)$ or $a_d(\lambda)$ since transmission spectra of the reference and samples filters are normalized to one another and the SPECTRIX has been shown to respond linearly across a wide range in radiances.

III) Sample collection and Data processing

Each scan collected consists of a 1031-element ASCII array containing seven lines of header information (MM, DD, YY, HH, MM, SS, integration time (sec)) followed by 512 lines of scan data collected first with the shutter open and then 512 lines of dark current data collected with the shutter closed. Individual scans are corrected for dark current and normalized to a 1-second integration time prior to proceeding with normal data reduction techniques which vary depending on the mode of operation (e.g. remote sensing reflectance or Quantitative Filter Technique). Full sample collection and data processing information can be found in individual cruise reports.

IV) Additional Information

a. Full system description

The SPECTRIX is a handheld, high sensitivity, compact spectrometer that is capable of measuring optical spectra from 330 to 880 nm at <2nm resolution with a 3nm half bandwidth. The unit is composed of the spectrometer, microprocessor controller, power supply, and shutter.

The spectrometer is a patented Littrow design using a concave holographic grating (American Holigraphics, Inc.) over a 0.1m focal length to image the optical spectra on a 25 mm solid-state photodetector. The grating and a fixed mirror are the only optical elements of this instrument. The photodetector is a 512-element linear array with relatively large 50 micron x 2.5 mm photoactive elements. The silicon substrate is designed for enhanced blue sensitivity and minimized dark current noise. The array is sealed with a quartz window for maximum near-UV and blue transmission. Photosensitivity is a function of temperature. To determine an accurate baseline for measurements, the SPECTRIX has a simple shutter mechanism to close the entrance slit. Internal baffling has reduced stray light contamination to less than 0.03%. A long-pass filter is placed on the red end of the array to reduce out-of-band response to about 0.00003%.

A microprocessor with 12 bit analog digital converter and nonvolatile RAM has been incorporated into the device. It provides accurate timing, signal processing, and interim data storage. Exposure time (linear array integration time) from 0.06 to 2.55 seconds is sent by the microprocessor. Unlike a scanning spectrophotometer, all elements of the linear array are integrating at the same time and held until digitized. This is critical in accurately measuring spectra under dynamic conditions found at sea or when clouds are present. Under changing

conditions a scanning spectrometer will favor one portion of the spectrum over another. The linear array spectrometer will integrate the changes over the entire spectrum.

The Pad Transmissometer (PT) greatly extends the utility of the SPECTRIX field data. The PT mates with the SPECTRIX to permit measurement of the absorption spectra of filtered material such as phytoplankton pigments and detrital material. The PT consists of a regulated, blue-rich light source and filter holder in a light-tight enclosure. The filter holder optically aligns the sample filter pad and a blank (reference) filter pad so the SPECTRIX field of view is filled by the filtrate area. This allows quantitative measurements of the absorption to be accurately measured.