

LISST-VSF

Multi-angle Polarized Light Scattering Measurements

• VSF • Optical Transmission • Depth • Temperature

The LISST-VSF from Sequoia is the world's first commercially available submersible instrument for measuring the volume scattering function (VSF) of water *in situ* with some polarization discrimination capability. The instrument covers the angular range from 0.1-150 degrees. The range 0.1 to 15 degrees is covered with our standard ring detector optics, first employed in the LISST-100.

The larger angles, 15-150 degrees, are covered by a 'roving eyeball'. This eyeball views scattering from a part of a beam at any instant. As it spins, it views scattering from different points (hence different angles) along the beam. The received scattered light is split into its two polarization components and sensed by separate photomultipliers. This permits extraction of the particle scattering Mueller

matrix elements P12 and a somewhat noisy estimate of P22. [The VSF is identical to P11]. A full measurement is performed in about 3 seconds. Polarization information is only covered over the 15-150 degree range, At smaller angles, scattered light maintains the original laser polarization closely. The instrument is programmable and fully autonomous with battery for field use..



FEATURES

- In-situ measurements of P_{11} (VSF), P_{12} and P_{22} elements of the scattering Mueller matrix from 0.1-150°
- VSF (P_{11}) only at small angles, 0.1 to 15 degrees in 32 logarithmic steps in angles
- Integration of this VSF provides an accurate estimate of total scattering coefficient b .
- Beam attenuation measured with LISST-100X optics
- Roving Eyeball™ optics permit 1-degree resolution in angles between 15 -150°
- Approximately 3 sec per measurement set [involves 3 turns of Eyeball with unpolarized, vertical, and horizontal polarized laser].
- Daylight rejection by laser modulation
- Dynamic range in VSF measurements via laser power modulation
- Data from small and large angles in a single data stream, including depth and temperature

SPECIFICATIONS (subject to change without notice)

Parameters measured

- Small-angle VSF in 32 log-spaced angles, from 0.1 to 15°
- VSF, P_{12} and P_{22} over 15-150° in 1° steps
- Temperature from -5° to 50°C with 10 mdeg resolution
- Depth (20 m max depth @ 1 cm resolution)

Operating Concentration range

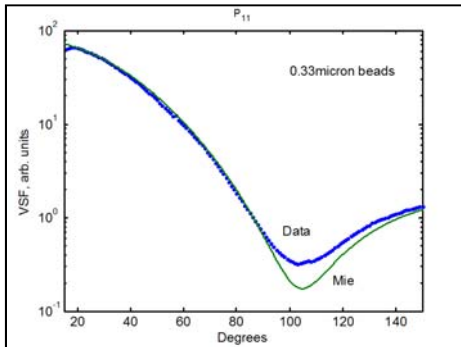
- Beam attenuation from 0.2 to 20 m^{-1}

Technology

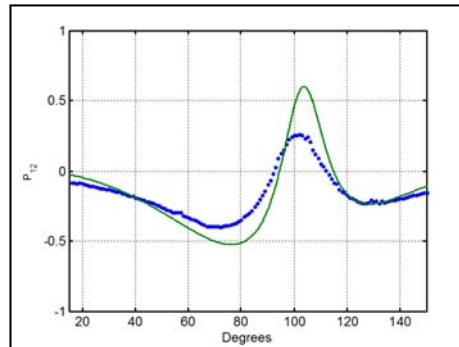
- Frequency-doubled-YAG laser @ 532 nm
- Ring Detector for small-angle VSF
- Roving Eyeball and PMT at 15-150°

Mechanical and electrical

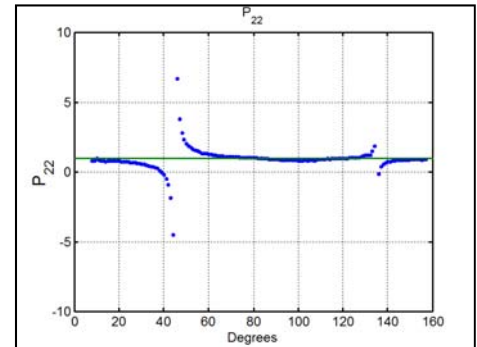
- Dimensions 12.7 cm (5.0") \varnothing × 114.3 cm (45.0") L
- Weight: 15.6 kg (34.4 lbs) in air
- 20 m depth rating
- Battery: 42 Ah @ 12V, enough for 3000 measurements.
- External power input: 9VDC nominal, 6-15VDC
- Sampling rate: 3 seconds per measurement
- Power drain: 1.1A measuring / 20mA quiescent
- Data storage: 7.9 GB



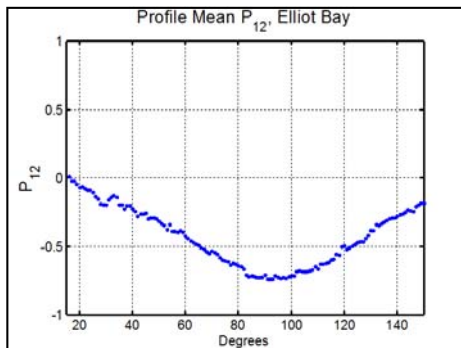
Measured P_{11} (VSF) of 0.33 μ m beads compared to Mie theory



P_{12} (normalized by P_{11}) of 0.33 μ m beads compared to Mie theory



P_{22} (normalized by P_{11}) of 0.33 μ m beads compared to Mie theory



In situ P_{12} (normalized by P_{11}) of water in Elliot Bay, WA, USA



Detail of the LISST-VSF optics path, showing the receive optics and the Roving Eyeball