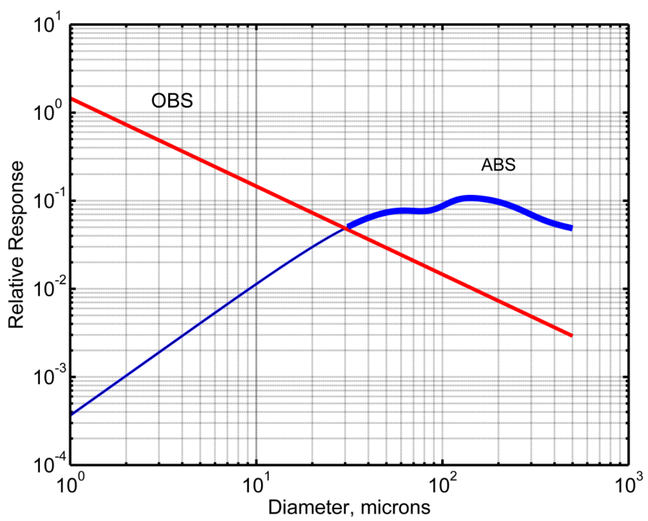
LISST-ABS 8MHz Sediment Sensor for Monitoring Applications

Sequoia Scientific, Inc. SEQUOIA Application Note ABS-01

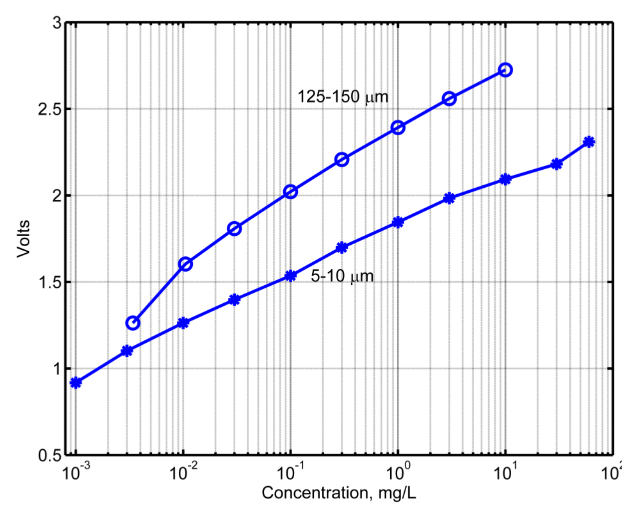
ACOUSTIC TURBIDITY SENSOR Sequoia Scientific , Inc. is proud to introduce its first *low-cost* acoustic sediment sensor, LISST-ABS. While not a competitor to our work-horse LISST-100X in either accuracy or detail of particle size distribution, the LISST-ABS advances monitoring technology with a few distinct advantages over optical turbidity sensors. First, the ABS is more tolerant to fouling. Second, acoustics turbidity method covers a much wider dynamic range of sediment concentration. And third, its calibration is superior to optical turbidity sensors: e.g. over the size range 30-400 microns, the ABS response varies by about ±30% from its mean value (see below, heavy blue line). In contrast, an optical turbidity meter changes calibration by over ±400% over this same range. The LISST-ABS is simply a superior turbidity sensor.



PRINCIPLE: The LISST-ABS has been designed specifically to monitor sediments at a point. Particular attention has been given to the stability of the transducer, corrections for temperature, and drift. The instrument transmits a fixed-strength acoustic pulse into water. Particles in the pulse at any instant scatter sound which is detected by the same transducer that emitted the pulse; hence the name acoustic backscatter. The backscatter energy received at any instant t after transmission of the pulse originates from particles at a distance of ct/2. The factor 2 arises due to round-trip travel time (c is speed of sound in water). The strength of the return signal depends on attenuation along the round-trip path, and on the scattering strength of the target particles. Attenuation depends mainly on beam spreading, and on particles but only in high concentration. Both attenuation and backscatter depend on grain size and concentration.

3 KEY FEATURES: The LISST-ABS embodies 3 unique choices that make it a valuable tool for sediment monitoring. First, by choosing 8MHz, the grain size where scattering strength transitions from following Rayleigh law, to geometric scattering is brought down to 60 microns (ka =1). This is the reason why the ABS covers a broad grain size range. The second feature is the short range from which backscattering is sensed. This short-range makes sediment attenuation mostly insignificant, except at extreme concentrations, e.g. 30g/L of 7μm particles. Regardless, the ABS internally measures backscatter from two adjacent range cells, 5.5cm apart. With the assumption of equal concentration at these two range cells, the difference in the two signals is attributed to attenuation. This is employed to de-attenuate the signal. Each measurement of backscattering strength is computed from 64 pings. The average scattering strength is output as a voltage that represents acoustic dB level, later converted to linear units in provided data processing formula.

The backscatter strength depends on $f(M/D\rho)^{1/2}$, [f is a form factor; M is mass concentration, D is grain diameter and ρ is grain density]. The square-root dependence on M gives LISST-ABS a wide working range of concentrations.



Shown here are some calibration data. Note the wide dynamic range, for fine *and* coarse sediments, nearly 5-decades. Further, even though the grain sizes are different by a factor of nearly 20, the signal strength changes by a smaller factor. This is due to the $(M/D\rho)^{1/2}$, relationship. This helps to keep the dynamic range wide for fine as well coarse grains. Such a wide range is not achievable with optical turbidity sensors without adding complexity such as gain switching. The LISST-ABS is simply a superior turbidity sensor for the sedimentologist's tool box.