What Is Multiple Scattering?

The phrase “multiple scattering” refers to the phenomenon wherein photons scattered from the analyte are re-scattered from neighboring particles prior to reaching the instrument detector.

In dynamic light scattering, the correlation or “non-randomness” of the scattered photons is measured across very small time spans. Multiple scattering will increase the randomness of the scattering signal, thereby decreasing the correlation and making the particles appear to be moving much faster than they really are. The net result then, is that DLS size measurements in the present of multiple scattering will be biased toward smaller sizes. It is for this reason, that classical center of the cell light scattering instruments require that the samples be dilute.

Symptoms of the presence of multiple scattering in a DLS measurement are:

1) a decrease in the amplitude or Y intercept of the correlogram at higher concentrations.
2) a decrease in the apparent size of the analyte at higher concentrations.
3) an increase in the apparent polydispersity of the distribution at higher concentrations.

Figure 1 shows the concentration dependence of the amplitude (Y intercept) of the correlogram and the hydrodynamic size of a 200 nm latex standard, measured in the center of the sample cell with a Malvern Zetasizer Nano system. As the sample concentration is increased, both the amplitude and the apparent Z average size are decreased, indicative of the effects of multiple scattering. The effect of multiple scattering on the apparent distribution polydispersity can be seen in Figure 2, which indicates a distinct increase in the width of the distribution as the sample concentration is increased.

![Figure 1: Sample concentration dependence of the correlogram amplitude and the “apparent” Z average size of a 200 nm latex standard, measured in the center of the sample cell with a Zetasizer Nano system.](image-url)
2 Frequently Asked Questions

The effects of multiple scattering can be minimized by shortening the path length between the scattering center and the detector. The Malvern Zetasizer Nano system, utilizing patented NIBS (Non-Invasive Back Scatter) technology, can automatically compensate for multiple scattering effects. This compensation is achieved by movement of the sample cell to a position such that the scattering volume or optical center is near the surface of the cell, thereby minimizing the detection path length. Figure 3 shows a schematic describing the automated process. At low sample concentration, the Zetasizer Nano will automatically adjust the optical configuration to maximize the scattering volume and the subsequent sensitivity of the system. If the system detects the presence of multiple scattering however, the optical configuration is adjusted to collect data near the surface of the sample cell. This novel optical configuration accommodates dynamic light scattering measurements at concentrations never before achievable with classical 90 degree optical systems.

Figure 2: Effects of sample concentration on the measured size distribution for a 200 nm latex standard, measured in the center of the sample cell with a Zetasizer Nano system.

The true power of the Nano optical configuration over classical light scattering systems can be seen in Figure 4, which shows a comparison of the concentration dependent DLS results obtained for a 200 nm latex standard measured both at the center of the sample cell and at a position determined automatically by the Zetasizer Nano. As seen here, the Z average size and...
The size distributions for the automatic cell positioning measurements of the 200 nm latex standard are shown in Figure 5, which clearly indicates the absence of any multiple scattering effects.

**Figure 4:** Comparison of the concentration dependence of the Z average size and correlogram amplitude for a 200 nm latex standard, measured in the center of the cell and at a position determined automatically by the Zetasizer Nano system.

**Figure 5:** Effects of sample concentration on the DLS size distribution for a 200 nm latex, measured using the automated cell positioning capability of the Zetasizer Nano.