University of Minnesota Nano Center

User Note: Calibration and Size Correction for the DLS

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The dynamic light scattering particle analyzer in Nanomaterials Lab, the Microtrac NanoFlex, is designed to measure the size distribution of particle dispersions with a specified accuracy. This accuracy depends on several parameters, namely

- particle size range
- particle optical properties (transparent or absorbing)
- the type of measurement you are doing (see below).

In general, you can assume that values of mean or peak particle diameter obtained with the NanoFlex using the volume distribution will be accurate to within about 5%. To verify measurement accuracy, the NanoFlex is periodically calibrated against NIST-traceable particle size standards. I record these calibration data and use them to derive particle size corrections. Use of these corrections can yield DLS data that should be accurate to within 1%. If you require these more exact values, this memo outlines several size correction functions that you can apply to your DLS measurements.

Background. The NanoFlex, like most particle analyzers, expresses the particle size distribution as a histogram of some particle parameter versus particle diameter. These parameters are

- Number: total number of all particles with a given diameter
- Surface Area: total surface area of all particles with a given diameter
- Volume: total particulate volume of all particles with a given diameter

These types of distributions are also known as perspectives. The NanoFlex also offers a fourth perspective, Intensity.

Being distributions, the results of a DLS measurement can only be fully described using statistical measures of distributions, such as mean, mode (peak height), peak width, standard deviation, etc. If you wish to obtain a single number to characterize your sample, you must a) select a perspective from the above choices, and then b) use either the mean value or the peak value of the distribution, both of which are given by the NanoFlex.

The mean value of a distribution is good to use if the distribution is smooth, symmetric, and monomodal, and does not have significant “tails”, i.e., material at either end of distribution. If the distribution does not meet these criteria, it is better to use the peak value, which can be obtained by reviewing the tabular data readout of the DLS measurement.

Which perspective to use? The Intensity distribution is based on raw scattered light signal from the sample, and is the type of measurement usually made by older DLS instruments. This raw measurement can be skewed by transparent particles, which create optical interference effects between scattered light and internally reflected light. The NanoFlex is designed to correct for this interference in the Volume perspective setting. Thus, **the most reliable results for most users will be obtained using the Volume distribution perspective.** In most cases, this will closely match the Intensity perspective, unless your sample is dominated by small transparent particles (e.g., lysosomes, lipid structures, some protein structures).

In any DLS measurement, the Surface Area and Number perspectives are derived from the Intensity (Volume) data; since they involve assumptions about particle shape, these perspectives are somewhat removed from the original data and may be less accurate for your measurement. If you have a sample where it is important to know the surface area (e.g., for catalysts) or number distribution (e.g., particle nucleation studies), please feel free to consult with MNC staff to determine how best to interpret these perspectives.

Corrections to your measured particle statistics. For highest accuracy, it is recommended that you apply corrections to your measured particle data. The following corrections are based on the most recent calibrations done on the NanoFlex (10/3/2014), and will be updated regularly. All parameters are in units of nm.

1. Distributions using the Intensity perspective
   a. Mean value. If m is the measured mean intensity (MI) value of the distribution in nm, the corrected mean particle size d in nm can be obtained as follows.

      i. For $m \leq 300$ nm, the correct mean particle diameter d is given by
      $$d = 0.0007m^2 + 0.773m + 13.0$$

      ii. For $m > 300$ nm, the correct mean particle diameter d is given by
      $$d = 1.2254m + 59.3$$

   b. Peak value. If p is the measured peak of the distribution under the intensity perspective, the corrected peak particle size d can be obtained as follows.

      i. For $p \leq 300$ nm, the correct peak particle diameter d is given by
      $$d = 0.00056p^2 + 0.83p + 9.4$$

      ii. For $p > 300$ nm, the correct peak particle diameter d is given by
      $$d = 1.059p - 9.93$$

2. Distributions using the Volume perspective
   a. Mean value. If m is the measured mean volume (MV) value, the corrected mean particle size d can be obtained as follows.

      i. For $m \leq 300$ nm, the correct mean particle diameter d is given by
      $$d = -0.00025m^2 + 1.01m + 8.2$$

      ii. For $m > 300$ nm, the correct mean particle diameter d is given by
      $$d = 1.177m - 65.2$$

   b. Peak value. If p is the measured peak under the volume perspective, the corrected peak particle size d can be obtained as follows.

      i. For $p \leq 300$ nm, the correct peak particle diameter d is given by
      $$d = 0.00053p^2 + 0.84p + 9.2$$

      ii. For $p > 300$ nm, the correct peak particle diameter d is given by

$$d = 0.0003p^2 + 0.68p + 75.0$$