# Light Scattering for the Masses™

## Determination of size and shape of environmental particles

Particle size analysis of environmental colloids with Flow-FFF has become a common practice. But the heterogeneous and non-spherical nature of environmental particles demands a characterization in terms of particle size and shape. Determining particle shape *is* possible with the combination of MALS and FFF. It is achieved by calculating the ratio of RMS radius (MALS) to hydrodynamic radius (FFF) for each sample slice. The ratio increases with non-sphericity of the particles (from 0.775 for homogeneous spheres). For elliptically-shaped particles the rotational aspect ratios can be calculated.

The light scattering of heterogeneous non-spherical particles is described best with a first order Zimm fit found in ASTRA for Particles. With a DAWN the size range obtainable extends up to about 250 nm. We have found that a miniDAWN Tristar has a range of a little less than 150 nm.

We export the RMS radius values from ASTRA to MS Excel and, for each slice, the hydrodynamic radius is calculated using the FFF particle size function. The ratios are then computed in MS Excel. The results are weighted averages due to the *z*-average character of the RMS radius determined.

Synthetic iron oxides showed ratios $R_g/R_h$ around 1 (thick rods, aspect ratio < 5) while soil extracts showed values up to 1.6 (indicative of thin plates).

For most environmental samples values < 1 indicate nearly spherical particles while values > 1 indicate ellipsoids, thick rods or plates. For the geometry of an ellipsoid of revolution, the Perrin factor enables the calculation of aspect ratios reasonably well.

DAWN instruments are perfect tools to determine RMS radii from environmental particles after FFF fractionation. Data processing is somewhat different compared to polymers and spherical particles; nevertheless, particle shape and geometry can be determined.

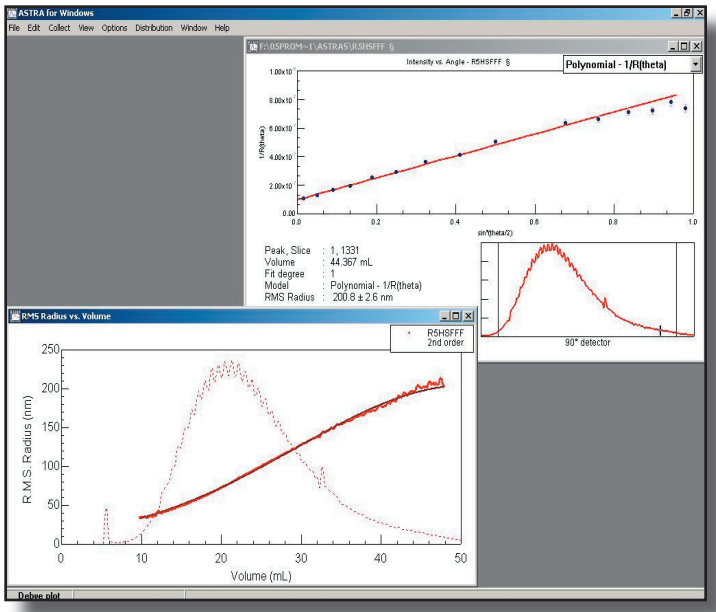


*Figure 1. FlowFFF-MALLS analysis of soil colloids. FlowFFF constant field run was applied and Astra particles mode used with a linear Zimm fitting. Nearly linear increase of RMS radius with elution volume and good linear Zimm fitting of LS data even with larger particles.*

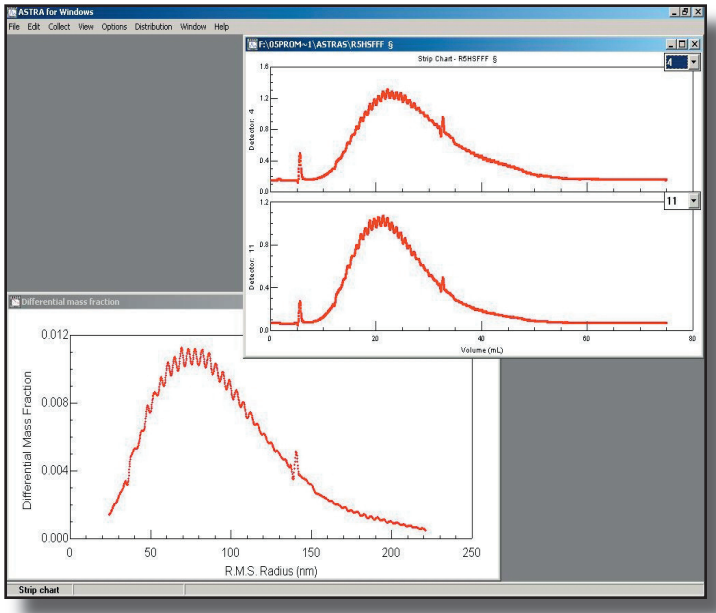


*Figure 2. Signal traces of the DAWN channel 11 and 4. The resulting differential distribution is given; However, particle shape must be calculated together with FFF data.*

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