miniDiSC application note #4: on measured and calculated values

This application note is intended to educate you on some properties of your miniDiSC, as well as measurements in general.

Aerosol measurements nearly always rely on some assumptions, regardless of what instrument you are using. For example, photometers will display a mass concentration although they are measuring scattered light – the underlying assumption (which, by the way is mostly incorrect) is that the mass concentration is proportional to the amount of scattered light. This is also true for the miniDiSC. The miniDiSC measures (and reports) two currents in units of fA. From these it calculates particle number, diameter and lung-deposited surface area. The table below explains the underlying assumptions, and the inaccuracies in these values. Problems in upper rows of the table will propagate downwards, i.e. if particles are strongly pre-charged this will affect LDSA, number and diameter determination!

The table may appear to be long, and many things could go wrong. This does not mean that the miniDiSC is a bad instrument – it just means that we are honest about it. For most other aerosol instruments a similar table can be made.

What	Assumption	What can go wrong
Stage currents	Electrometers are operating properly	Zero offsets drifting, overrange
LDSA	LDSA is a multiple of the sum of the two electrometer currents. Particles are essentially smaller than 400nm. Particles are not strongly pre-charged	Charger not operating properly, underlying assumption of compact particles wrong (fractals/agglomerates). A good correlation between LDSA and total current only exists for particles in the size range of about 10-400nm, for larger particles LDSA is underestimated. If a significant proportion of particles you are measuring is large, the interpretation of the reading as LDSA is incorrect. However, the total current is always approximately proportional to the total length of the aerosol per volume. Strongly precharged particles (e.g. after an electrofilter) may not be brought to the assumed charge state in the unipolar charger.
Particle number	Particles are essentially smaller than 300nm	The deposition of particles in the diffusion stage decreases monotonically with particle size until it reaches a minimum at about 300nm. Particles larger than ~300nm will have increased deposition again, and the calculation of the particle diameter will be wrong, which also affects the particle number calculation. Particles larger than 400nm will show up as a much larger number of smaller particles.
Particle diameter	Geometric standard deviation of the particle size distribution is 1.9	To calculate the average particle diameter, the miniDiSC has to assume a width of the particle size distribution. If the true width is larger, the diameter is overestimated, if it is smaller, it is underestimated. For example, a monodisperse aerosol of 50nm diameter will show up as ~35nm.