Precision and resolution achievable using Sympatec's NANOPHOX

Optimal sample preparation as well as correct use of the instrument settings are key requirements to achieve the best possible raw data. This is not discussed here but take for given pre-condition.

By its cross correlation method (PCCS) NANOPHOX is able to eliminate scattering information that is not due to Brownian motion as e.g. multiple scatter, cuvette surface inhomogeneity etc.. This results in the best possible raw data for evaluation.

Evaluation methods in PCS/PCCS have been advanced over the last 4 decades last but not least by progress in computing. This is why the oldest evaluation method, 2nd Cumulant with its minimal calculation demand is/should be replaced by more powerful ones today, as simply a mean diameter and a hint for the width of the distribution is not acceptable any more for real samples that are multi modal usually. (Except exactly mono modal material our world is not Gaussian at all!). A more modern evaluation method was introduced by Contin, this could already differentiate between modes but it was/is patented and this initiated a bundle of similar methods. The most sensitive method is NNLS (Non Negative Least Square) but this method needs exact setting of fit ranges and that needs some expertise of the operator or at least extended accurateness and skill.

Today most instrument development heads for black box performance independent of operator intelligence. This has lead to blinded instruments that produce fairly smoothened results only. In NANOPHOX the user has the choice between 2nd Cumulant, auto-NNLS (an operator independent evaluation mode for validation tasks) and the expert-NNLS mode (with guided manual fit range seting). Only the expert-NNLS is capable of achieving highest resolution and precision. The plausibility of each result can easily be controlled by the compliance of the correlation data or the original measurement to that of the presented result presented as an overlay diagram.

A recent request from a Chinese NANOPHOX user asked to explain why even using PCCS, that claims concentration independence as multiple scatter is eliminated, they anyway detected a certain relation to dilution. They had not taken into account that diluting with deionized water causes a change in the ionic surrounding and influences the thickness of the hydrodynamic layer. But the numbers at least give an impression how precise NANOPHOX is able to detect also slightest differences.

concentration	original	100ul+100uL	100ul+200uL	100ul+220ul	100ul+270ml	100ul+370ml	100ul+470ml	100ul+570ml	100ul+770ml	100ul+970ml	100ul+1170ml
mean value	27,25	28,18	28,83	28,97	29,08	29,38	29,8	29,92	30,32	30,48	30,59
STD	0,006807691	0,004860437	0,012266655	0,007010901	0,003088536	0,005377509	0,00877514	0,007658048	0,011430592	0,008580982	0,014040912

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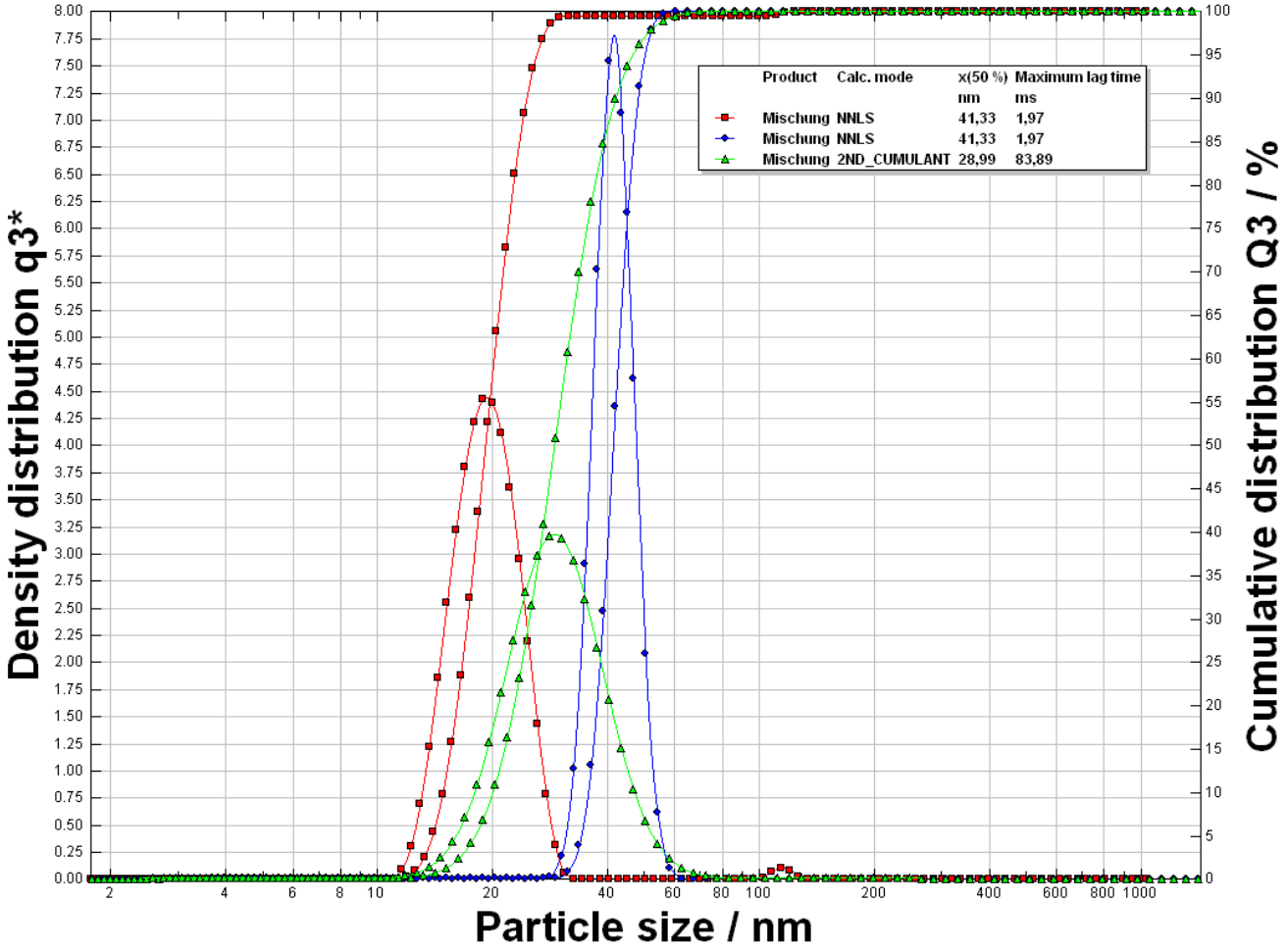
Here the different results due to different evaluation modes are shown for a simple mixture of two latices 20 nm and 100 nm.

Shown as ***density distribution***



The green curve represents the result of the 2nd Cumulant evaluation method.

The blue curve represents the result of the auto-NNLS evaluation method.

The red curve represents the result of the expert-NNLS evaluation method.

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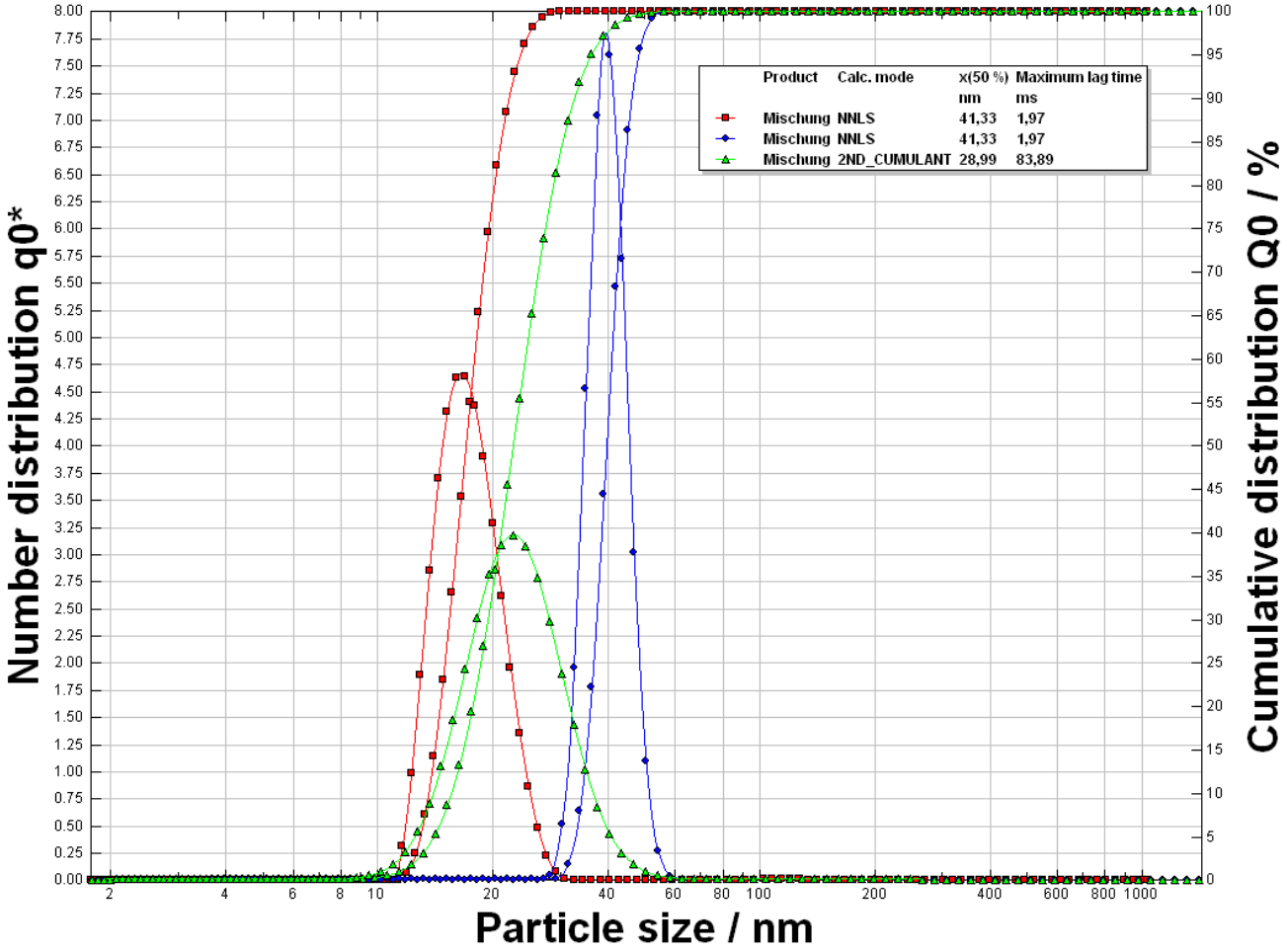
Shown as ***number distribution***



The green curve represents the result of the 2nd Cumulant evaluation method.

The blue curve represents the result of the auto-NNLS evaluation method.

The red curve represents the result of the expert-NNLS evaluation method.

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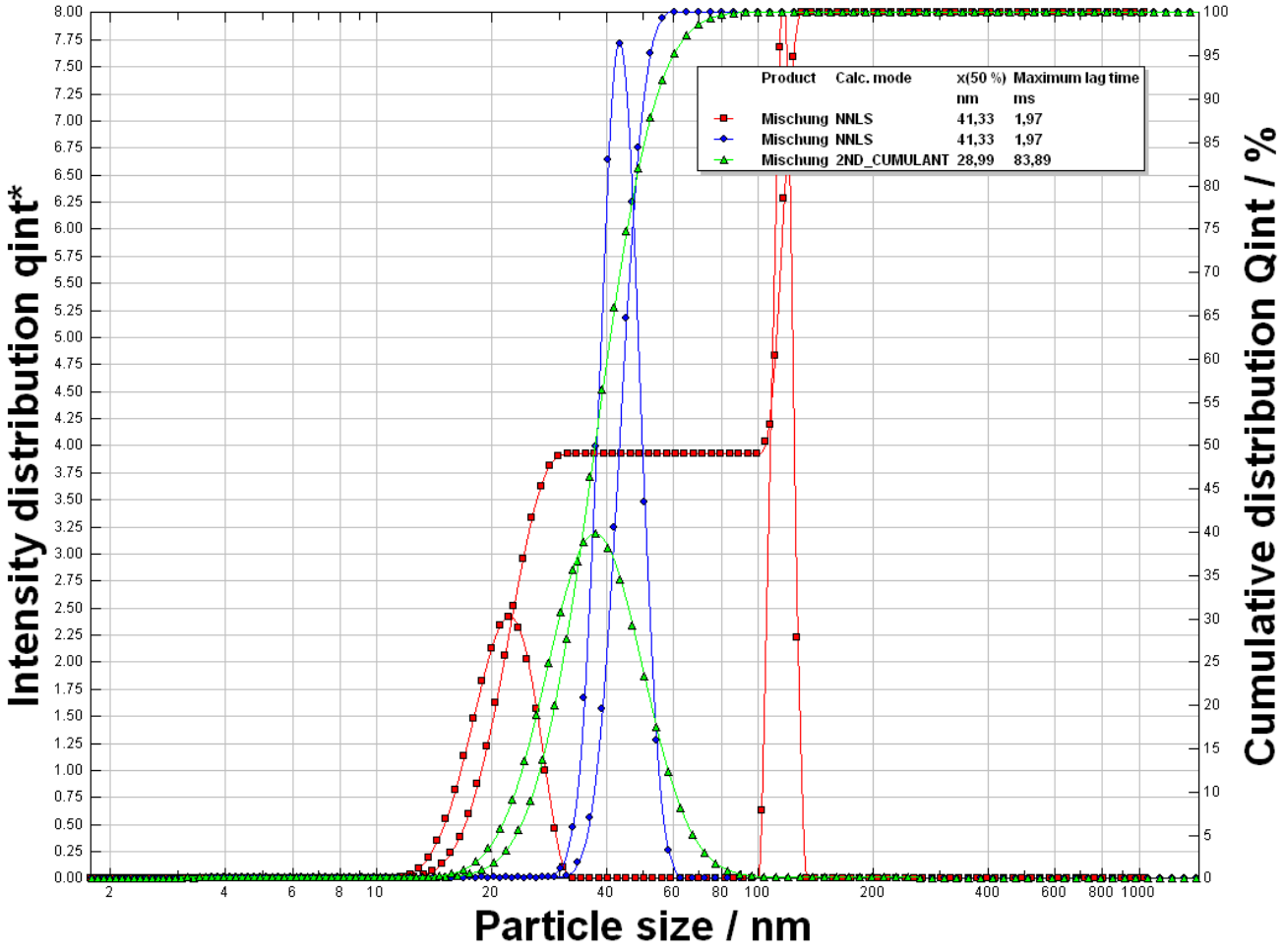
Shown as ***intensity distribution***



The green curve represents the result of the 2nd Cumulant evaluation method.

The blue curve represents the result of the auto-NNLS evaluation method.

The red curve represents the result of the expert-NNLS evaluation method.

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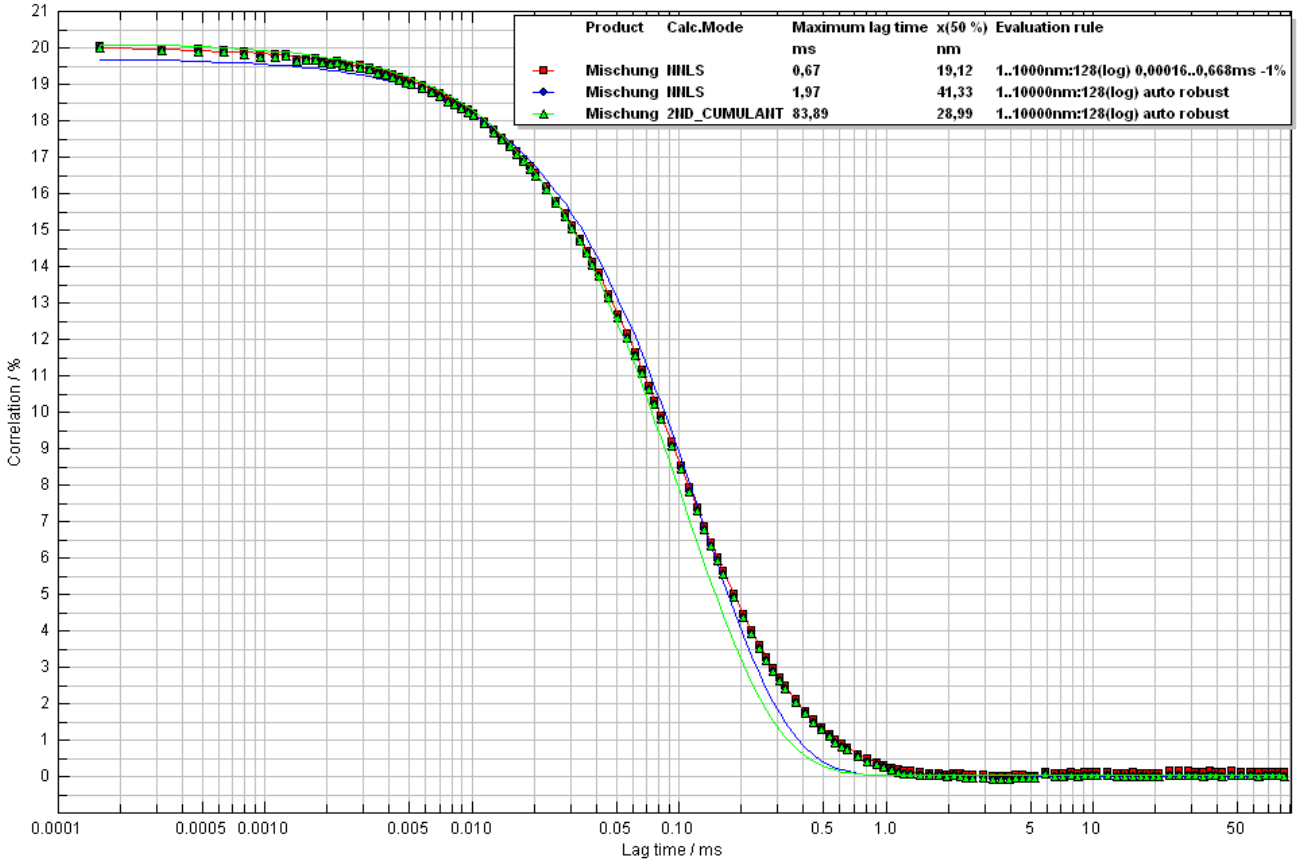
The plausibility of the different results are getting obvious by the compliance of the calculated data to the measured data in the correlation diagram:



The 2nd Cumulant result as well as the auto-NNLS result don't follow the dotted measured data.

Only the expert-NNLS evaluation method gives a correct answer.

As the detail view below shows.

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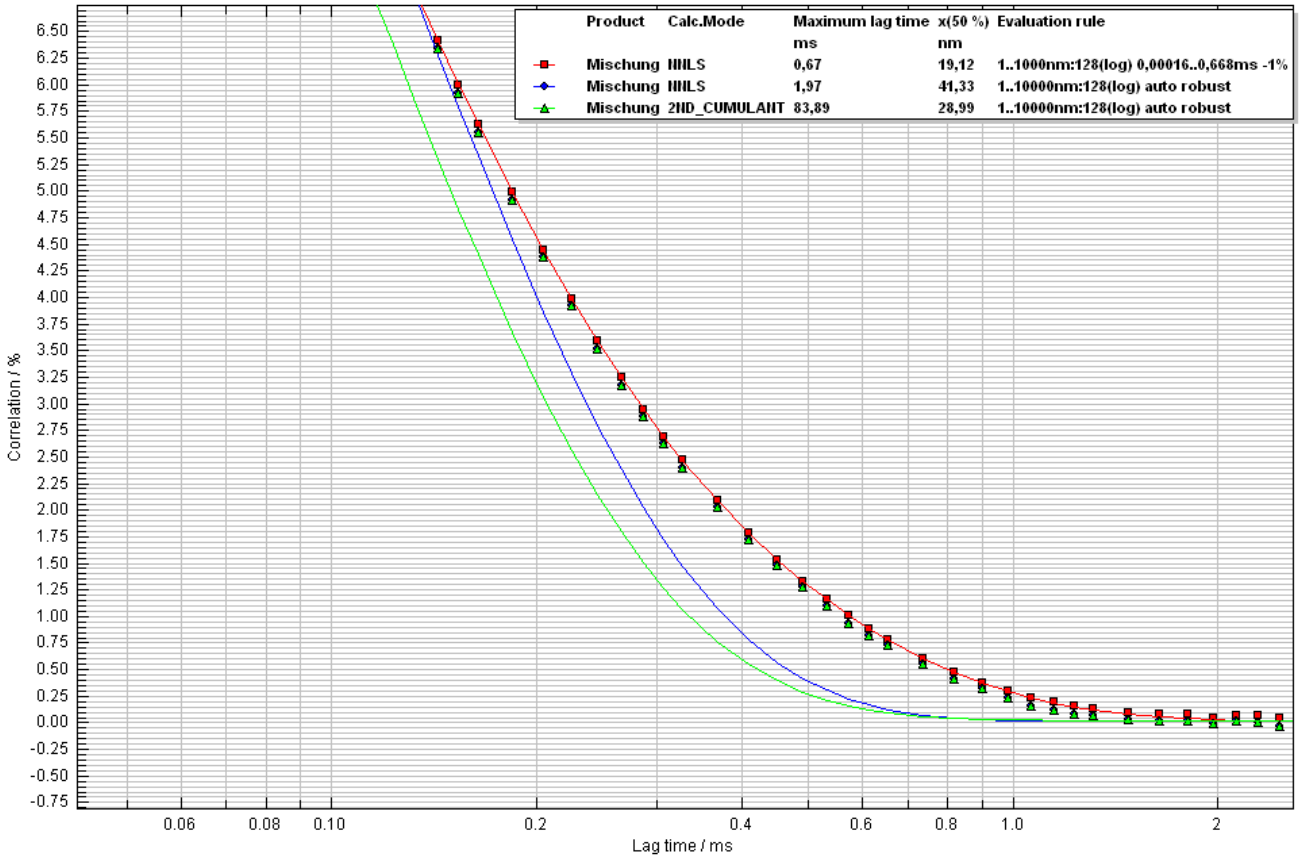

The 2nd Cumulant result as well as the auto-NNLS result don't follow the dotted measured data.

Only the expert-NNLS evaluation method gives a correct answer.

As the detail view shows.

In general terms it may be expected that at least a size ratio of modes bigger than 1:4 will always be possible to resolve as long as the scattered light intensity of the bigger particles (caution! 10^6 relation in the Rayleigh area) will not outshine the fines. There is no other limitation to number or location of modes in a sample.

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