WCCAP Report

CPC calibration workshop, Leipzig, November 2006

Condensation particle counters (CPCs) measure the integral particle number concentration of aerosol particles larger than a certain threshold diameter in the submicrometer size range. Because of the convenience of their operation, CPCs represent the most frequent used measurement instrument in atmospheric aerosol research. These counters are widely spread on measuring sites in Europe. Concerning their measurement properties, CPCs are characterized by the lower particle detection threshold diameter (so called d_{p50}) and their maximum asymptotic counting efficiency for particles larger than about 40 nm. Depending on the type of aerosol investigated and on the number concentration, these two parameters can become worse in the course of weeks to months of operation, because the CPCs get contaminated. The d_{p50} might increase by several nanometers and the maximum asymptotic counting efficiency can fall below 90 %, sometimes even down to 70 %. In this case, the CPC must be checked, cleaned, and calibrated.

In the framework of the EU project ACCENT, an integrating activity for quality assurance of atmospheric measurements is made. As part of this work package, in November 2006 (061112 to 061121) a CPC calibration workshop was conducted at the Leibniz Institute for Tropospheric Research in Leipzig, Germany. First, all instruments were checked for proper functioning and correct sampling flow rates. Seven instruments which were broken or contaminated had to be repaired and cleaned at the institute's workshop. All together 34 CPCs from 19 institutions in 14 European countries were checked and calibrated, partly twice. Therefore a multiple counter calibration setup was used (cf. Hermann et al., 2007). The particle number concentration measured by each CPC was compared to the reading of an aerosol electrometer, which can be considered as an absolute standard in this context. For each CPC at least two calibration curves with either sodium chloride, silver, or sulfuric acid particles were conducted. Raw data were corrected for electrometer offset, coincidence in the CPC optics, and diffusional losses in the sampling lines. The resulting final two counting efficiency curves for each CPC were averaged and a fitting function was applied to the data. Thereby the following equations were used to derive the counting efficiency „eta“ as function of the particle diameter „dp“:

for the CPC models 3025 $\quad eta = a - b / (\exp(c * \log(d_p)) - d)$

for all other CPC models, called „3010“ $\quad eta = a - b / (1.0 + \exp((d_p - c) / d))$

References

Hermann, M., Wehner, B., Bischof, O., Han, H.-S., Krinke, T., Liu, W., Zerrath, A., and Wiedensohler, A., Particle counting efficiency of new TSI condensation particle counters, submitted to J. Aerosol Sci., 2007.

Table 1: List of participants for CPC workshop in November 2006

Alfred Wiedensohler	Inst. for Tropospheric Research	Leipzig	Germany
Andreas Nowak	Inst. for Tropospheric Research	Leipzig	Germany
Angela Marinoni	University of Bologna	Bologna	Italy
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Erik Nilsson	University of Lund	Lund	Sweden
Erik Swietlicki	University of Lund	Lund	Sweden
Giedrius Radziukynas	Institute of Physics	Vilnius	Lithuania
Hanna Manninen	University of Helsinki	Helsinki	Finland
Hans Karlsson	University of Stockholm	Stockholm	Sweden
Hervé Venzac	University of Clermont-Ferrand	Clermont-Ferrand	France
Jorge Pey	Institute of Earth Sciences	Barcelona	Spain
Kestutis Senuta	Institute of Physics	Vilnius	Lithuania
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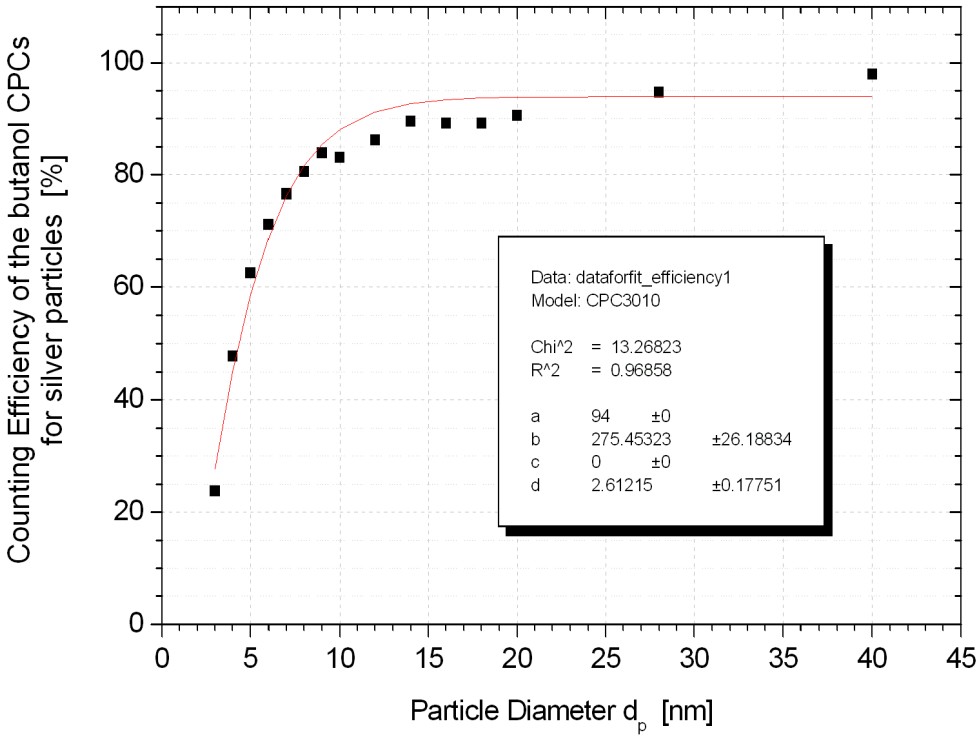
Laureline Bourcier	University of Clermont-Ferrand	Clermont-Ferrand	France
Marcel Moerman	Org. Applied Scientific Research	Den Hague	Netherlands
Markus Hermann	Inst. for Tropospheric Research	Leipzig	Germany
Mika Komppula	Finnish Meteorological Institute	Helsinki	Finland
Peter Tunved	University of Stockholm	Stockholm	Sweden
Sebastiao Santos	EC - Joint Research Centre	Ispra	Italy
Sterios Vratolis	Inst. of Nuc. Tech. & Rad. Prot.	Athen	Greece
Tuukka Petäjä	University of Helsinki	Helsinki	Finland
Vincent Michaud	University of Clermont-Ferrand	Clermont-Ferrand	France
Vladimir Zdimal	Inst. Chem. Proc. Fundamentals	Prag	Czech Republic

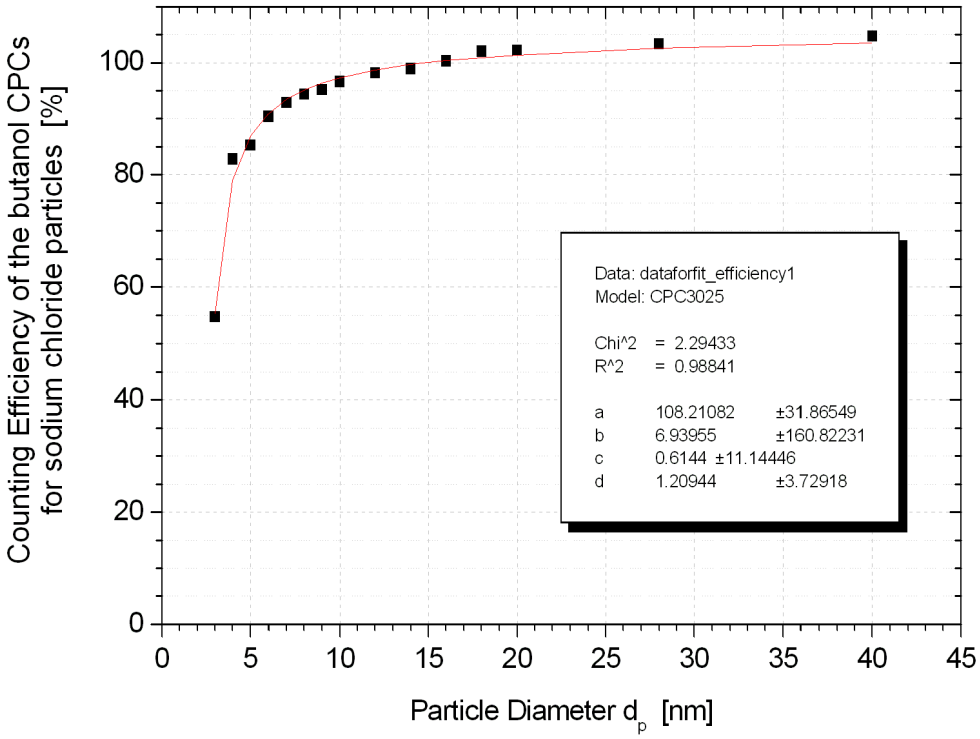
Mean CPC counting efficiencies calibrated in the ACCENT workshop in November 2006

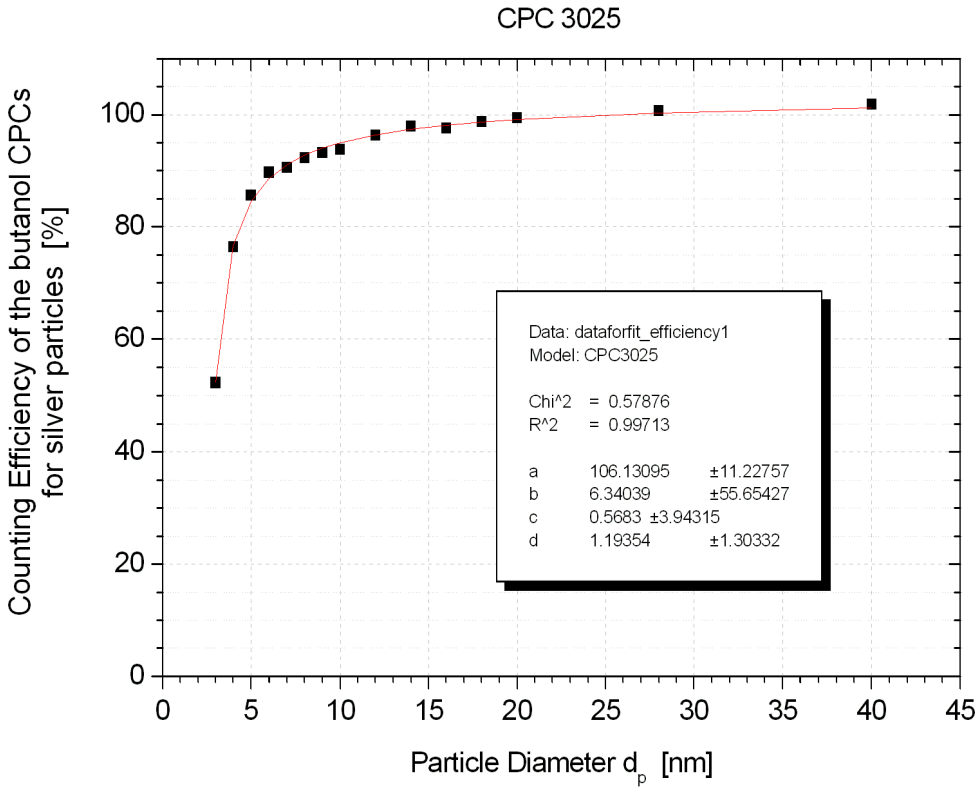
(data of the four new TSI CPCs 3781/3782 are not displayed)

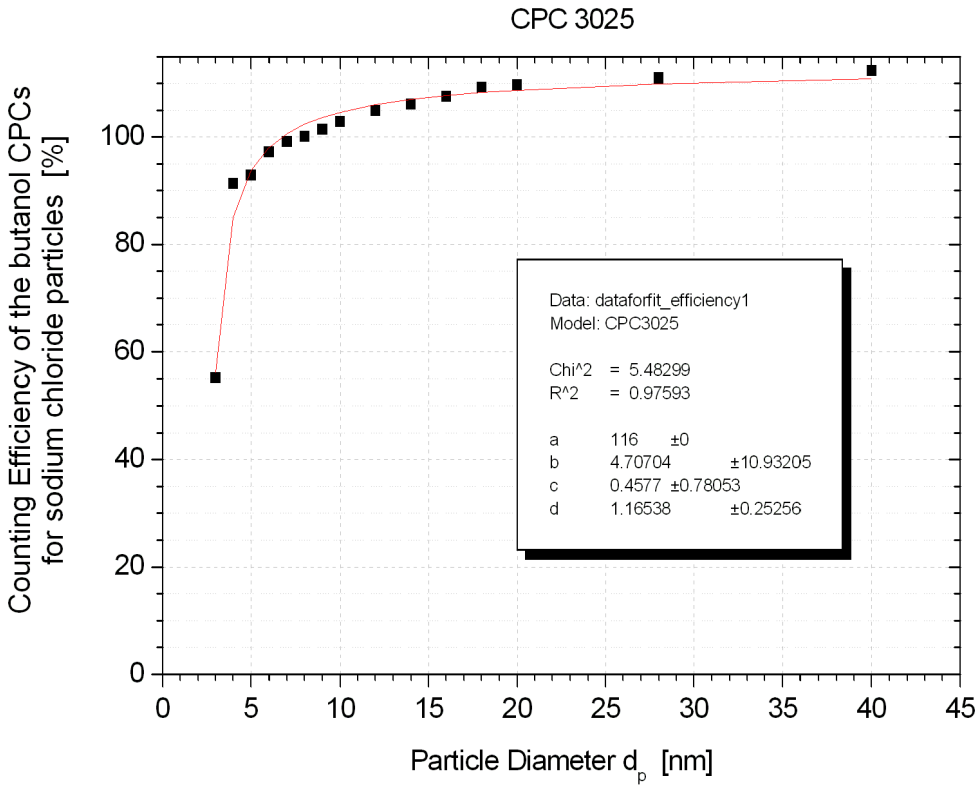
CPC 3022

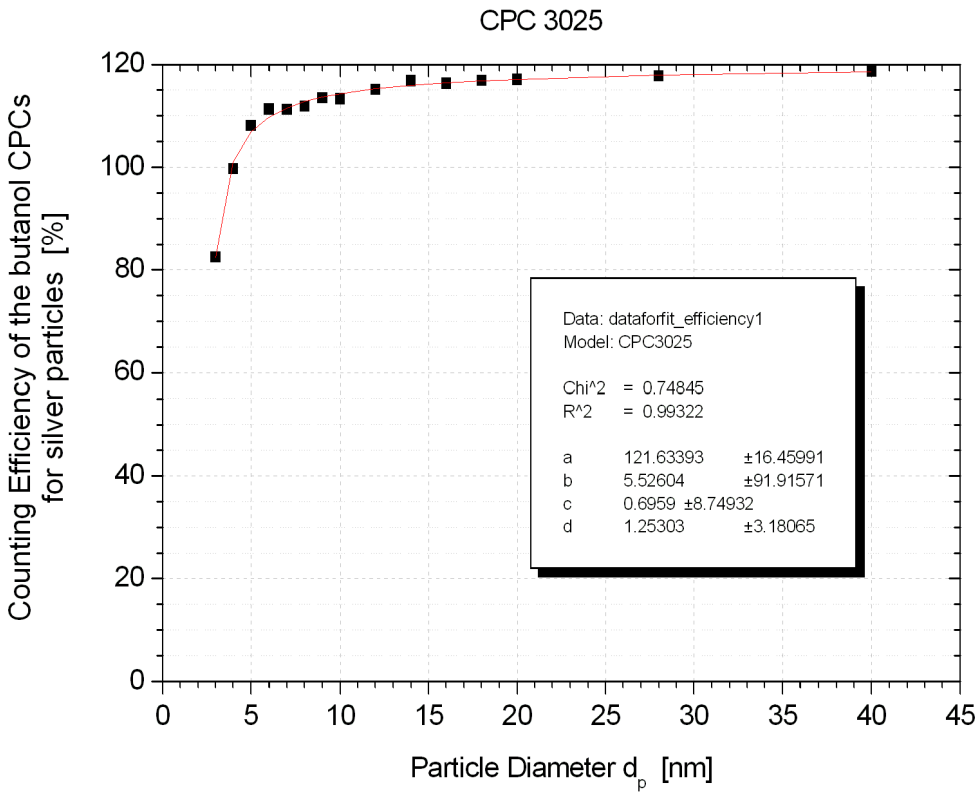


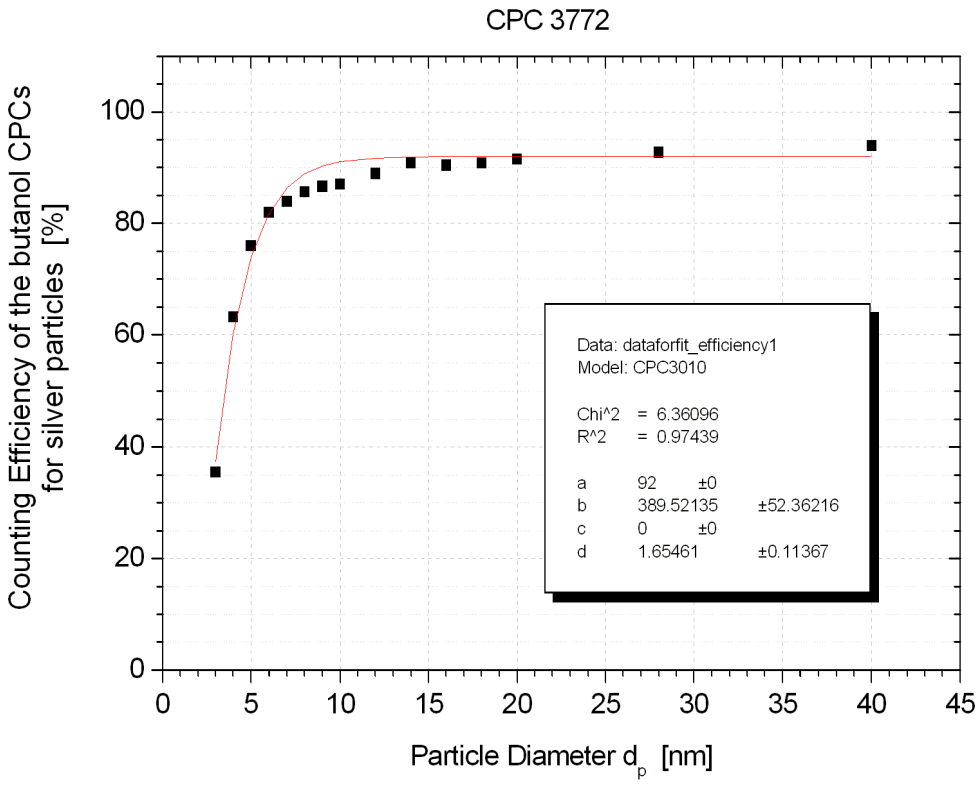
CPC 3025

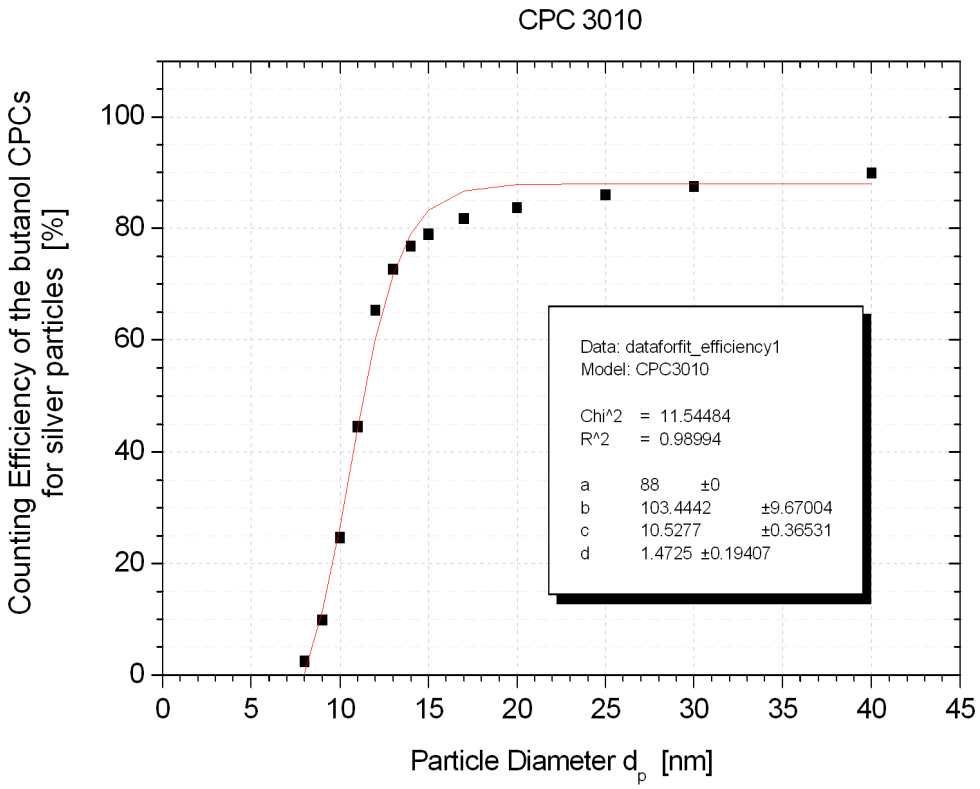


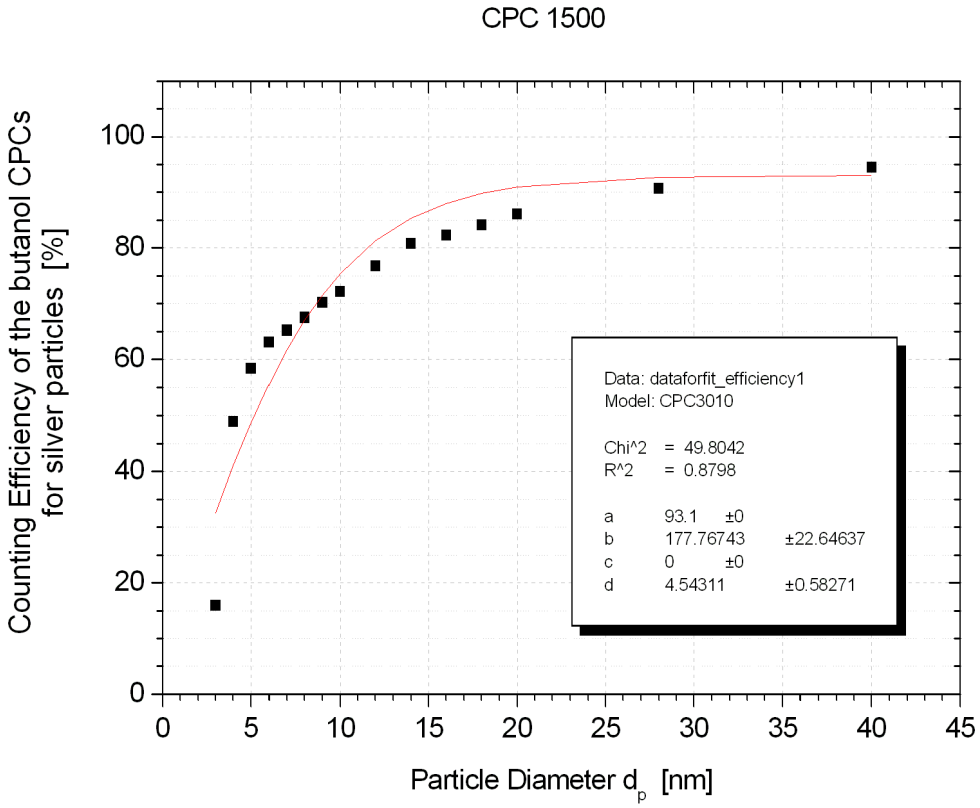

CPC 3025
Counting Efficiency of the butanol CPCs for silver particles [%]
Particle Diameter d_p [nm]
Data: dataforfit_efficiency1
Model: CPC3025
Chi^2 = 0.57876
R^2 = 0.99713
a 106.13095 ±11.22757
b 6.34039 ±55.65427
c 0.5683 ±3.94315
d 1.19354 ±1.30332

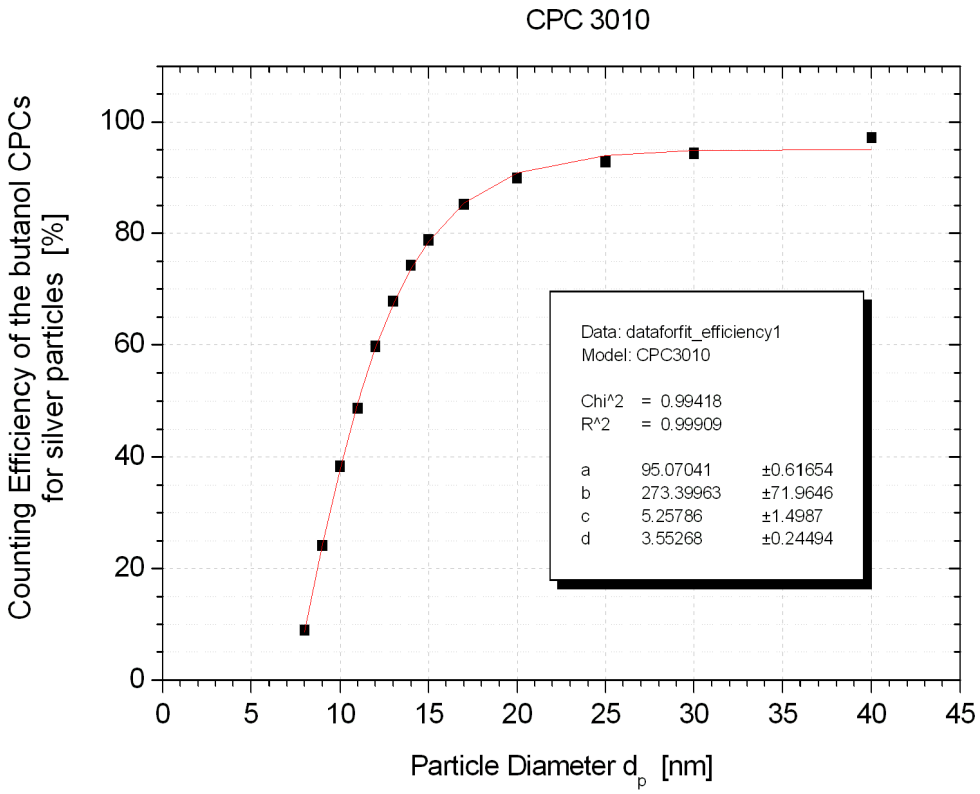

CPC 3025
Counting Efficiency of the butanol CPCs for sodium chloride particles [%]
Particle Diameter d_p [nm]
Data: dataforfit_efficiency1
Model: CPC3025
Chi^2 = 5.48299
R^2 = 0.97593
a 116 ±0
b 4.70704 ±10.93205
c 0.4577 ±0.78053
d 1.16538 ±0.25256

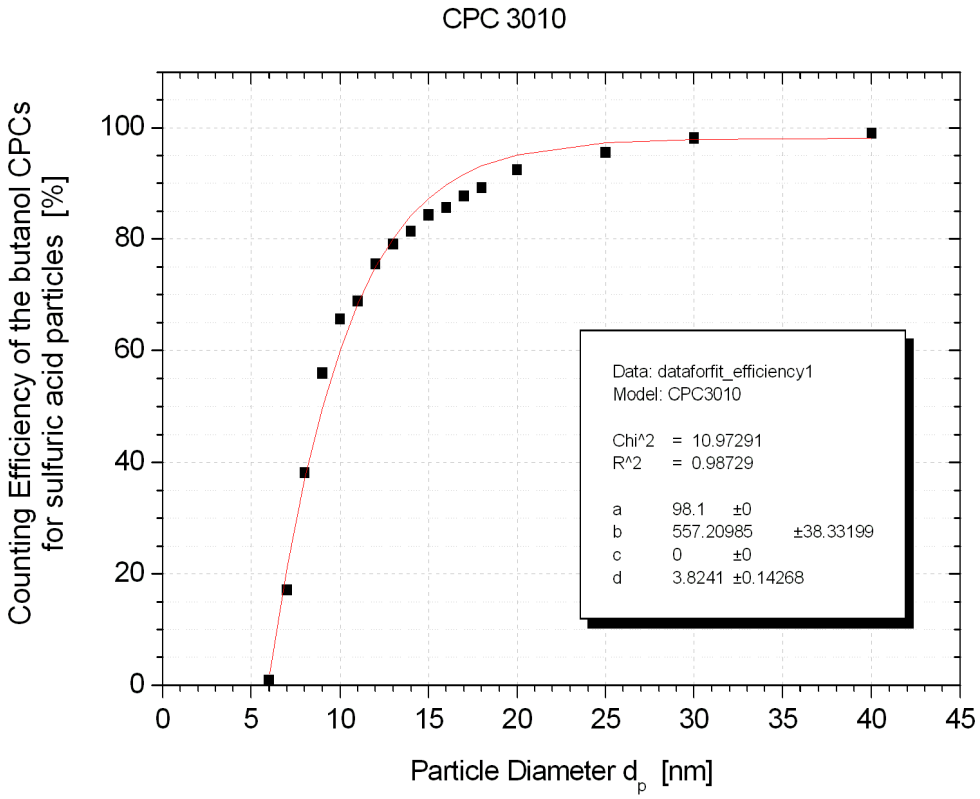

CPC 3025
Counting Efficiency of the butanol CPCs for silver particles [%]
Particle Diameter d_p [nm]
Data: dataforfit_efficiency1
Model: CPC3025
Chi^2 = 0.74845
R^2 = 0.99322
a 121.63393 ±16.45991
b 5.52604 ±91.91571
c 0.6959 ±8.74932
d 1.25303 ±3.18065


CPC 3772
Counting Efficiency of the butanol CPCs for silver particles [%]
Particle Diameter d_p [nm]
Data: dataforfit_efficiency1
Model: CPC3010
Chi^2 = 6.36096
R^2 = 0.97439
a 92 ±0
b 389.52135 ±52.36216
c 0 ±0
d 1.65461 ±0.11367

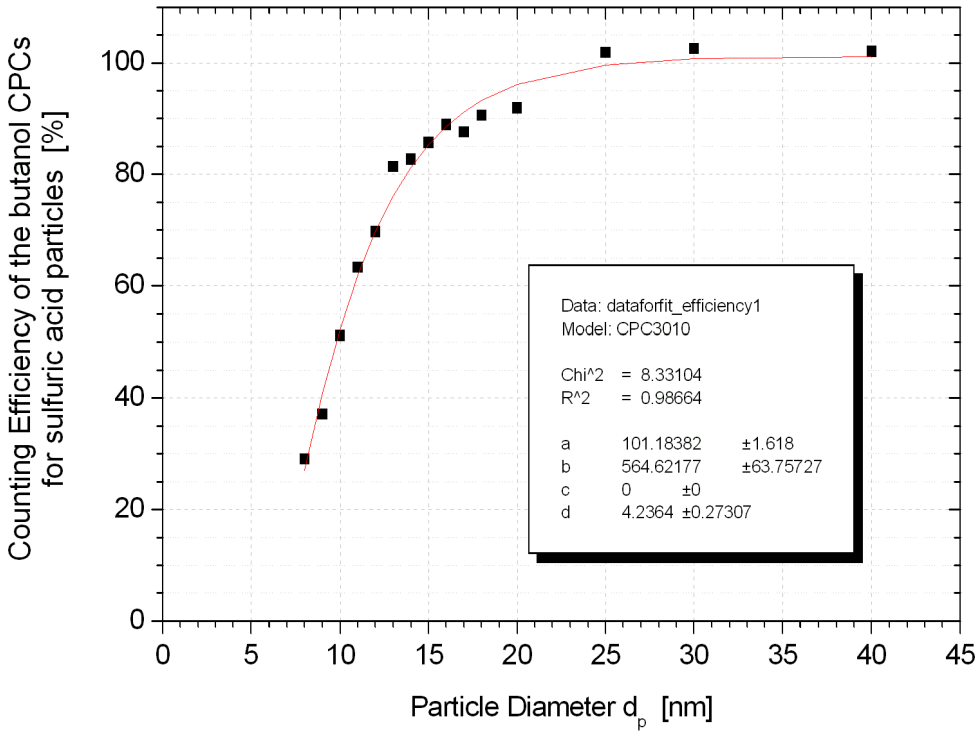

CPC 3010
Counting Efficiency of the butanol CPCs for silver particles [%]
Particle Diameter d_p [nm]
Data: dataforfit_efficiency1
Model: CPC3010
Chi^2 = 11.54484
R^2 = 0.98994
a 88 ±0
b 103.4442 ±9.67004
c 10.5277 ±0.36531
d 1.4725 ±0.19407


CPC 1500
Counting Efficiency of the butanol CPCs for silver particles [%]
Particle Diameter d_p [nm]
Data: dataforfit_efficiency1
Model: CPC3010
Chi^2 = 49.8042
R^2 = 0.8798
a 93.1 ±0
b 177.76743 ±22.64637
c 0 ±0
d 4.54311 ±0.58271

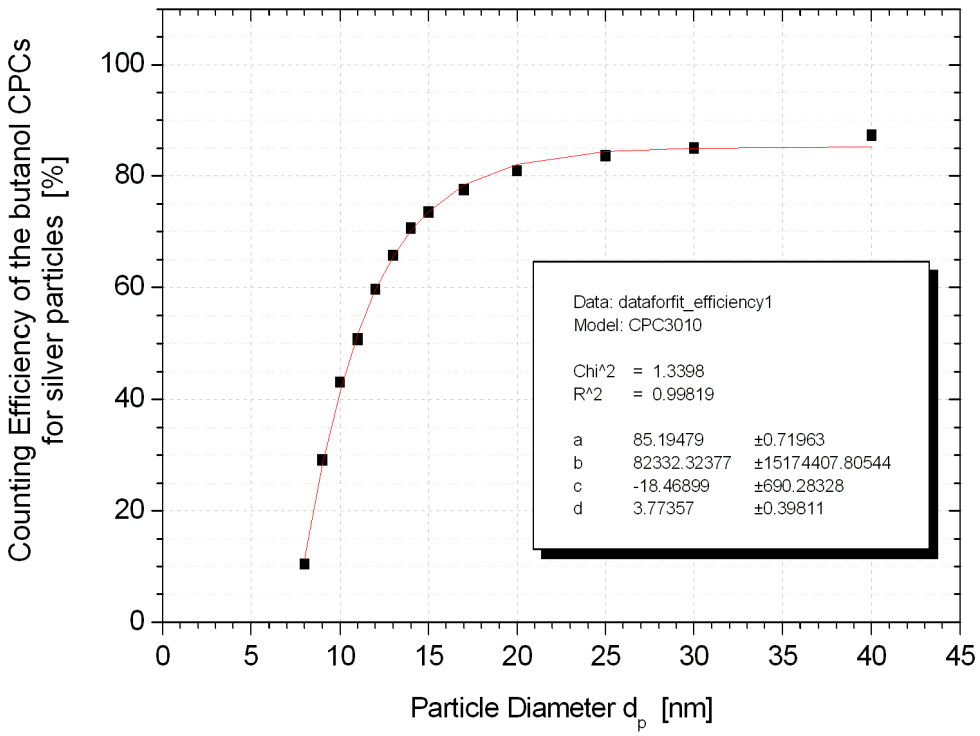

CPC 3010
Counting Efficiency of the butanol CPCs for silver particles [%]
Particle Diameter d_p [nm]
Data: dataforfit_efficiency1
Model: CPC3010
Chi^2 = 0.99418
R^2 = 0.99909
a 95.07041 ±0.61654
b 273.39963 ±71.9646
c 5.25786 ±1.4987
d 3.55268 ±0.24494

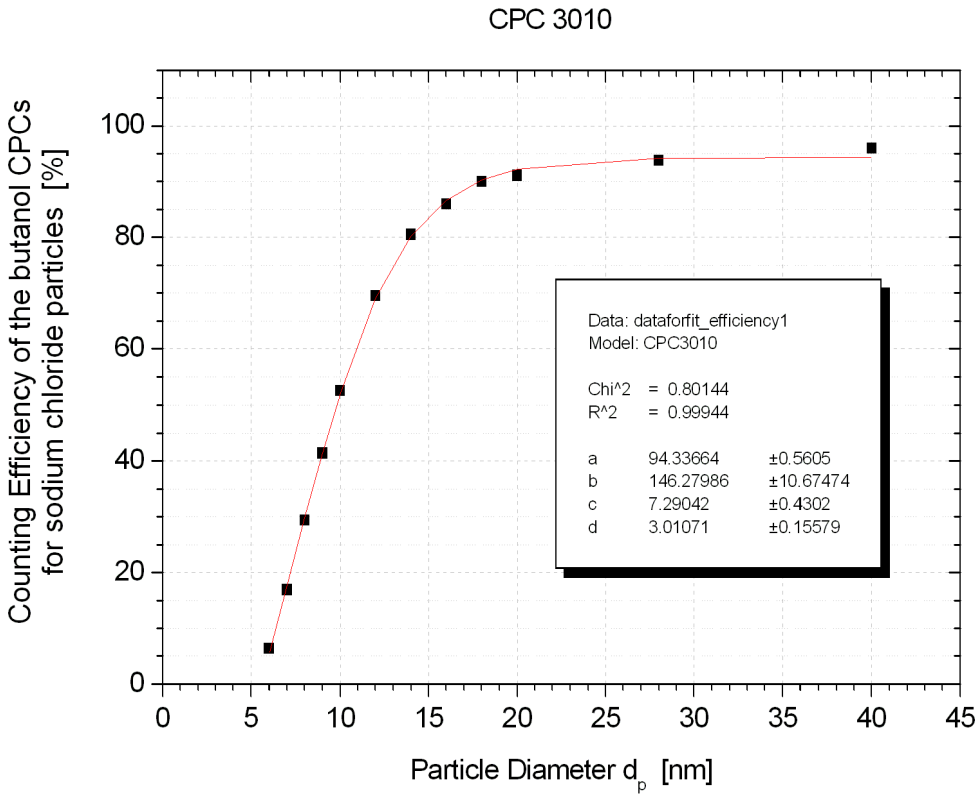

CPC 3010
Counting Efficiency of the butanol CPCs for sulfuric acid particles [%]
Particle Diameter d_p [nm]
Data: dataforfit_efficiency1
Model: CPC3010
Chi^2 = 10.97291
R^2 = 0.98729
a 98.1 ±0
b 557.20985 ±38.33199
c 0 ±0
d 3.8241 ±0.14268

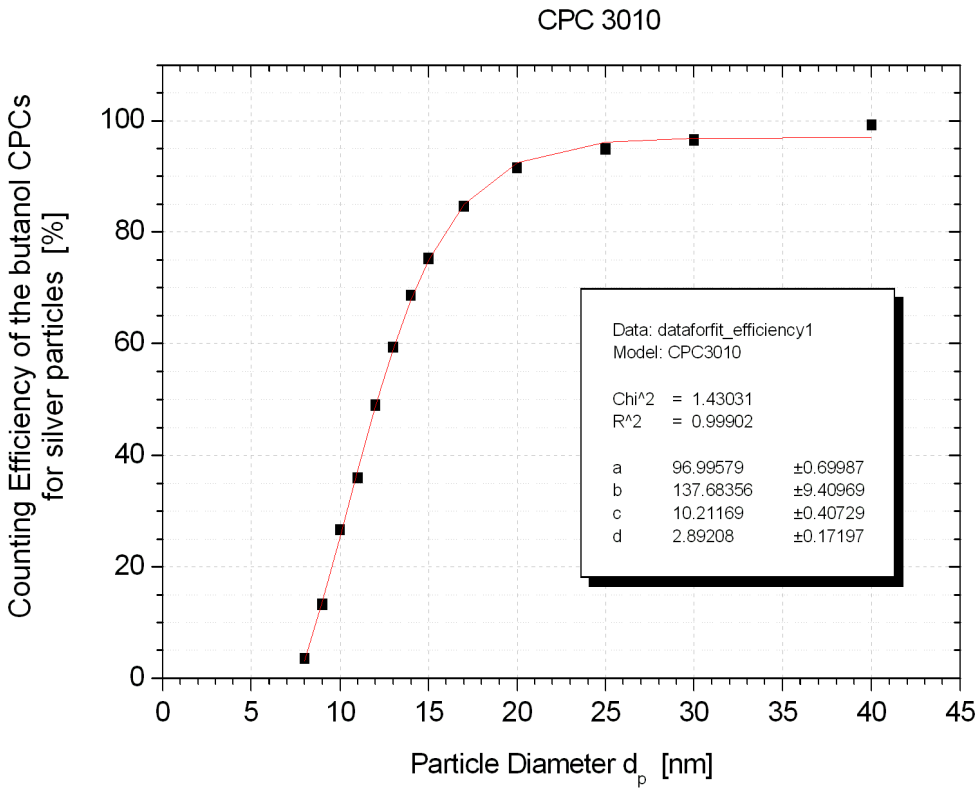
CPC 3762

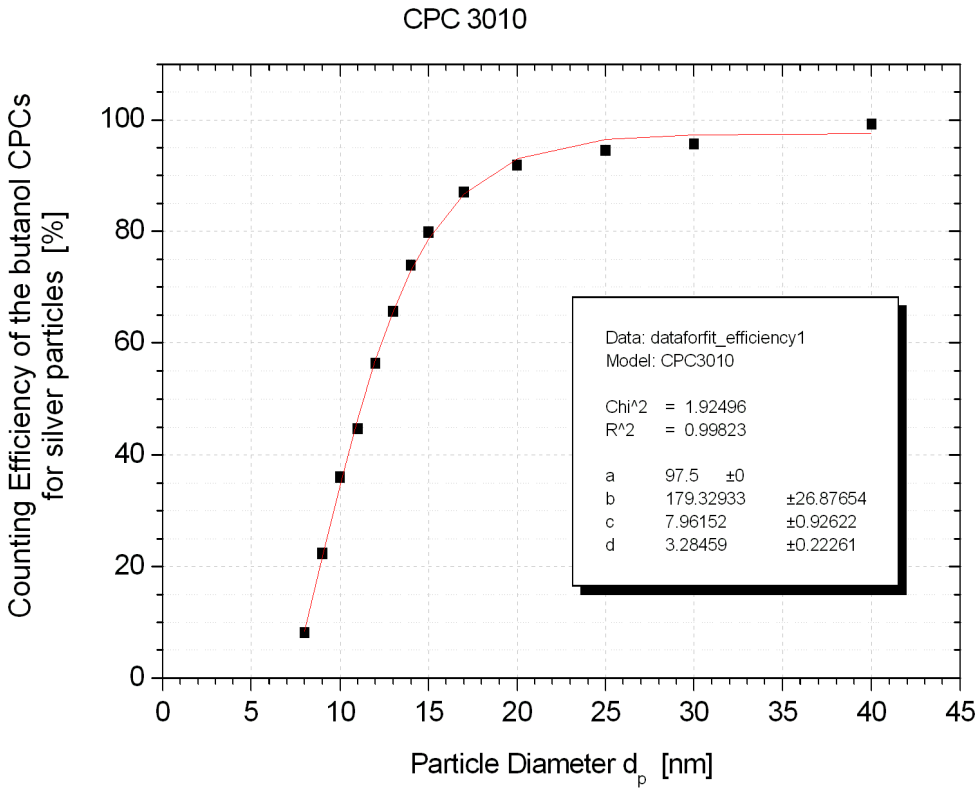


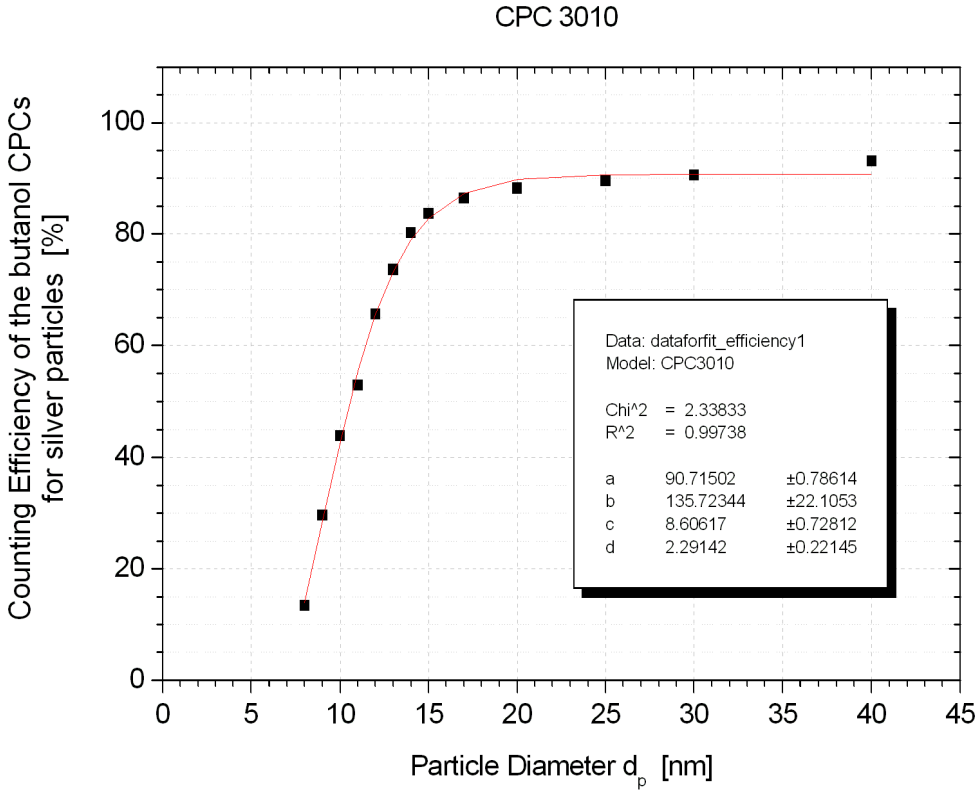
CPC 3760



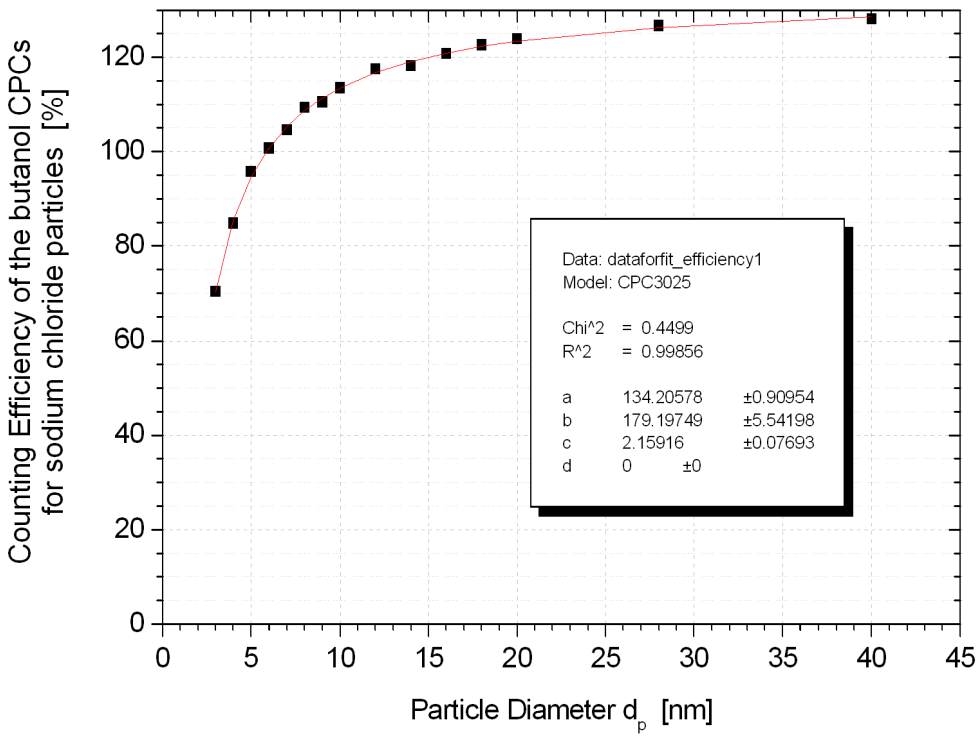

CPC 3010
Counting Efficiency of the butanol CPCs for sodium chloride particles [%]
Particle Diameter d_p [nm]
Data: dataforfit_efficiency1
Model: CPC3010
Chi^2 = 0.80144
R^2 = 0.99944
a 94.33664 ±0.5605
b 146.27986 ±10.67474
c 7.29042 ±0.4302
d 3.01071 ±0.15579


CPC 3010
Counting Efficiency of the butanol CPCs for silver particles [%]
Particle Diameter d_p [nm]
Data: dataforfit_efficiency1
Model: CPC3010
Chi^2 = 1.43031
R^2 = 0.99902
a 96.99579 ±0.69987
b 137.68356 ±9.40969
c 10.21169 ±0.40729
d 2.89208 ±0.17197

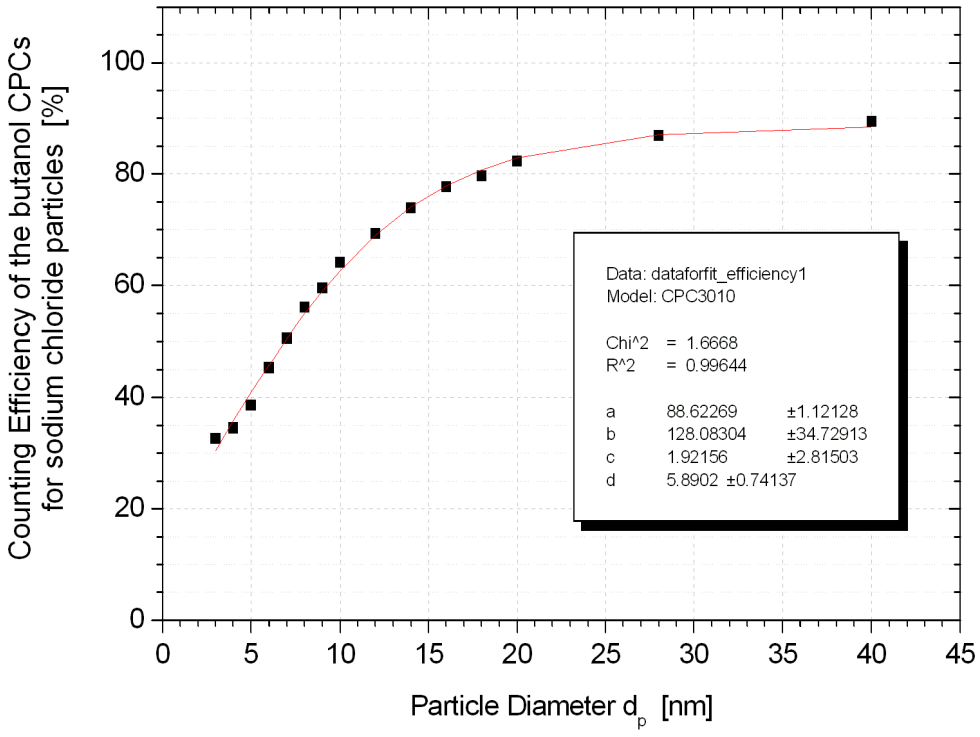

CPC 3010
Counting Efficiency of the butanol CPCs for silver particles [%]
Particle Diameter d_p [nm]
Data: dataforfit_efficiency1
Model: CPC3010
Chi^2 = 1.92496
R^2 = 0.99823
a 97.5 ±0
b 179.32933 ±26.87654
c 7.96152 ±0.92622
d 3.28459 ±0.22261


CPC 3010
Counting Efficiency of the butanol CPCs for silver particles [%]
Particle Diameter d_p [nm]
Data: dataforfit_efficiency1
Model: CPC3010
Chi^2 = 2.33833
R^2 = 0.99738
a 90.71502 ±0.78614
b 135.72344 ±22.1053
c 8.60617 ±0.72812
d 2.29142 ±0.22145

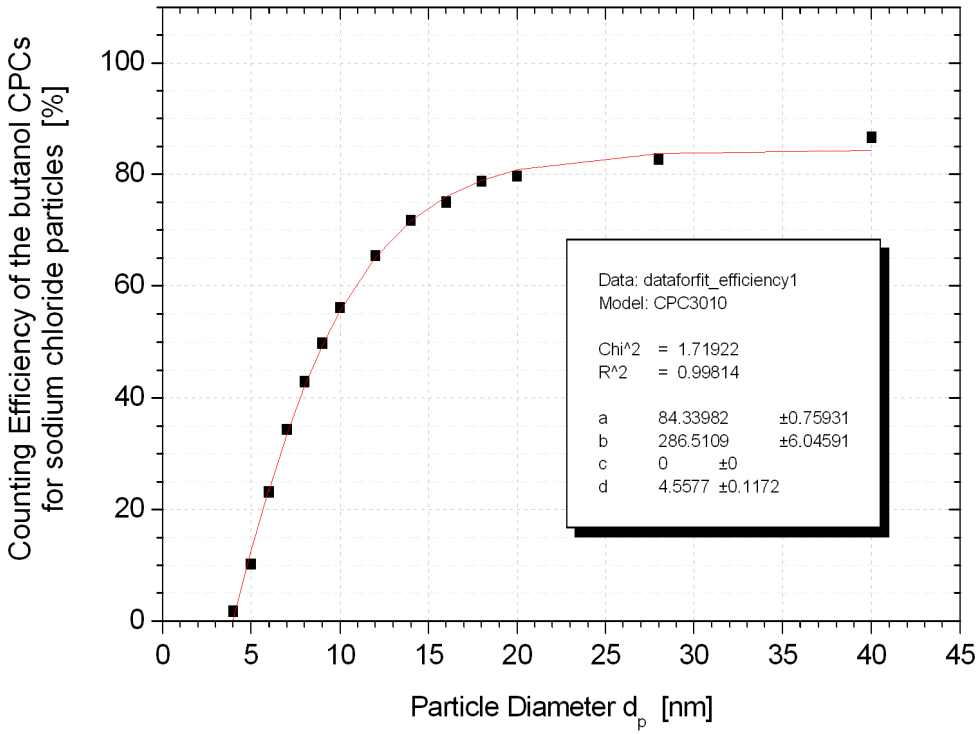
CPC 3025



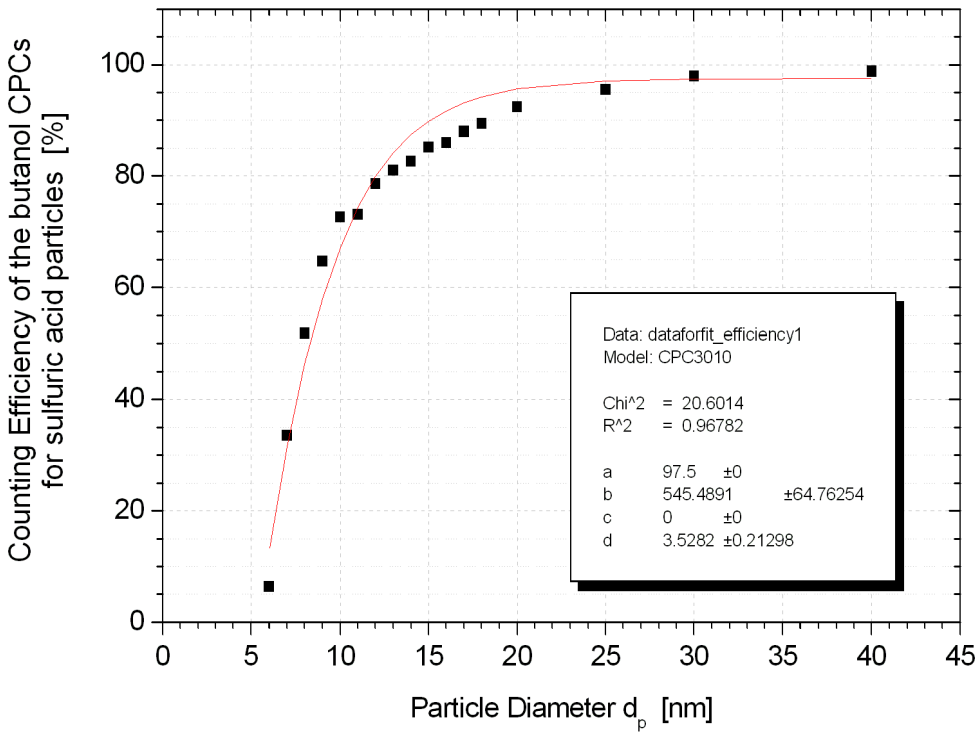
CPC 3022

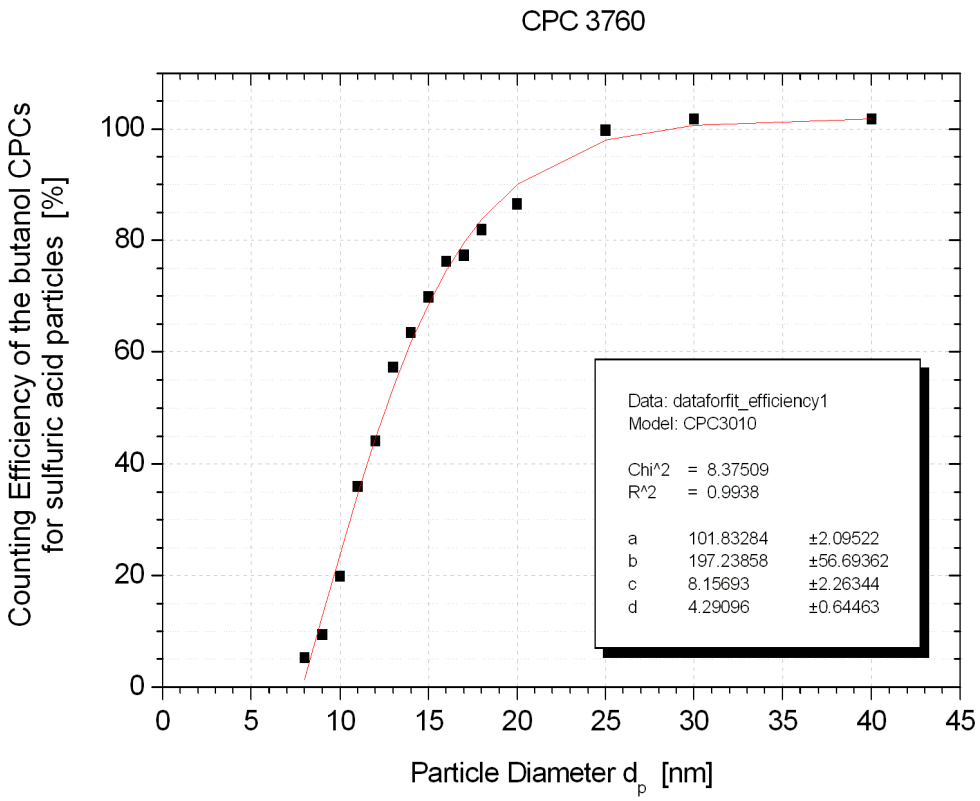


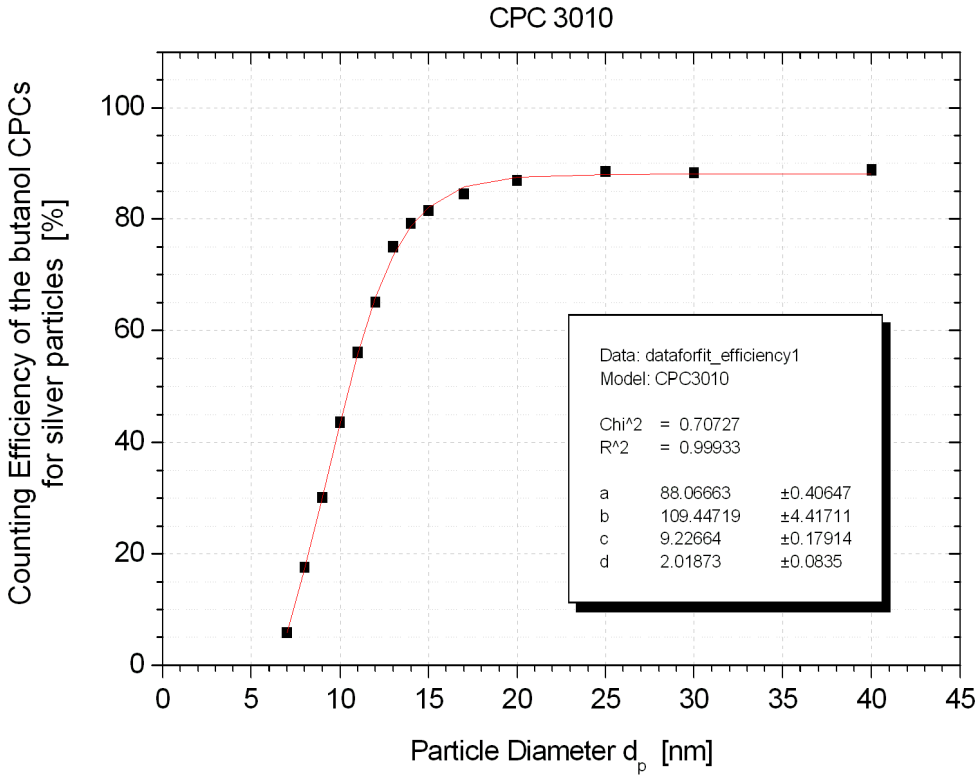
CPC 3022

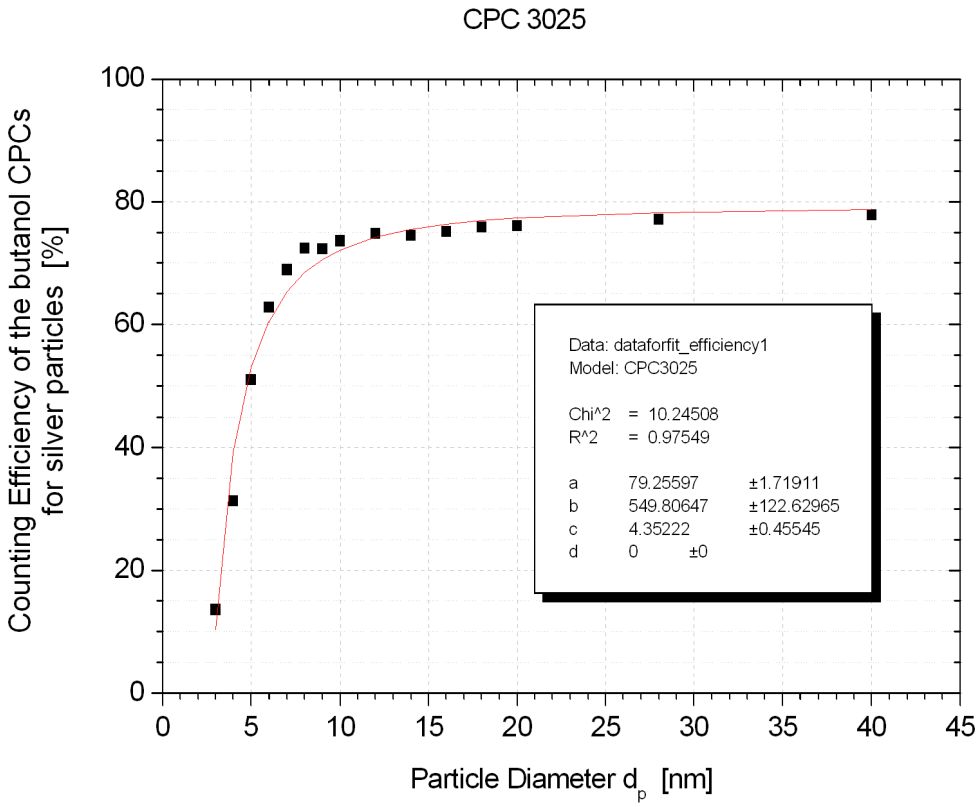


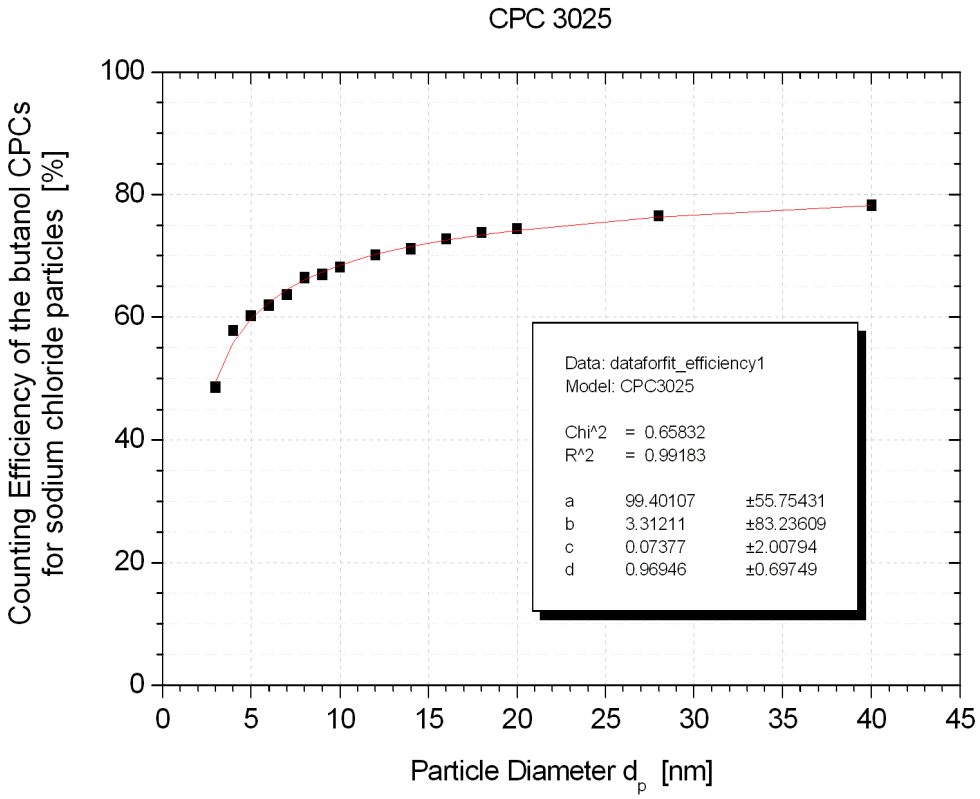
CPC 3762



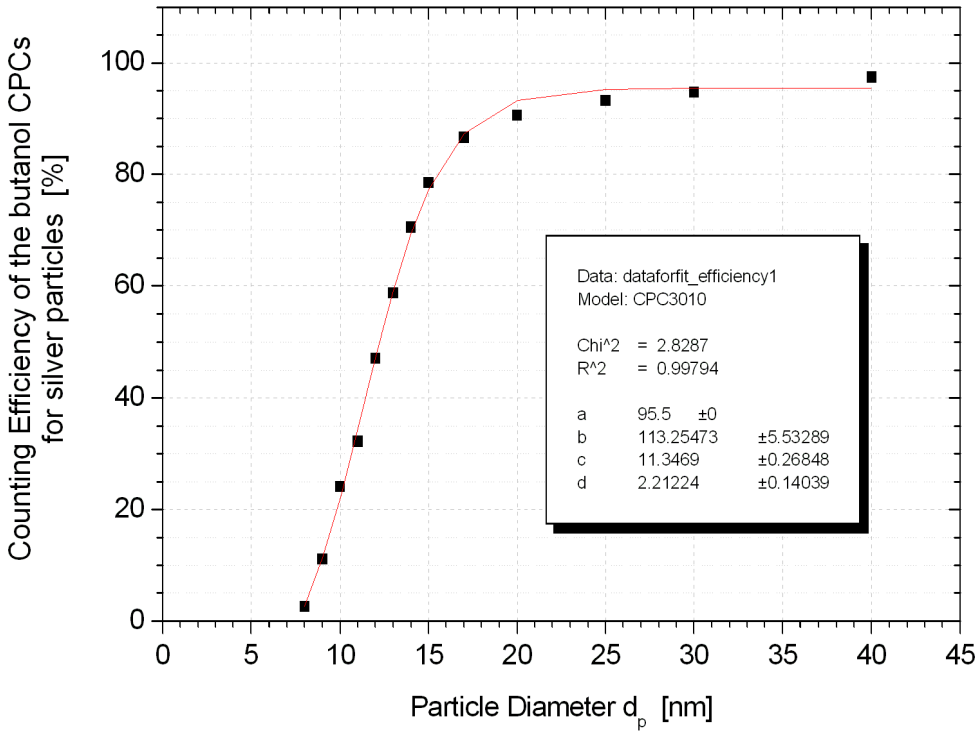

CPC 3760
Counting Efficiency of the butanol CPCs for sulfuric acid particles [%]
Particle Diameter d_p [nm]
Data: dataforfit_efficiency1
Model: CPC3010
Chi^2 = 8.37509
R^2 = 0.9938
a 101.83284 ±2.09522
b 197.23858 ±56.69362
c 8.15693 ±2.26344
d 4.29096 ±0.64463


CPC 3010
Counting Efficiency of the butanol CPCs for silver particles [%]
Particle Diameter d_p [nm]
Data: dataforfit_efficiency1
Model: CPC3010
Chi^2 = 0.70727
R^2 = 0.99933
a 88.06663 ±0.40647
b 109.44719 ±4.41711
c 9.22664 ±0.17914
d 2.01873 ±0.0835

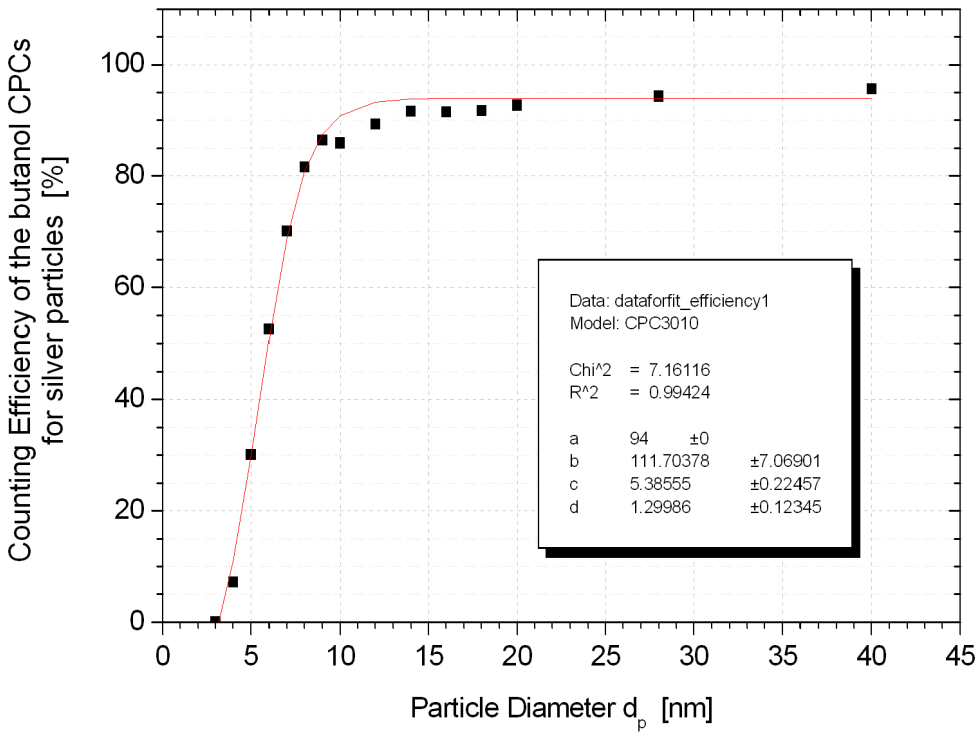

CPC 3025
Counting Efficiency of the butanol CPCs for silver particles [%]
Particle Diameter d_p [nm]
Data: dataforfit_efficiency1
Model: CPC3025
Chi^2 = 10.24508
R^2 = 0.97549
a 79.25597 ±1.71911
b 549.80647 ±122.62965
c 4.35222 ±0.45545
d 0 ±0


CPC 3025
Counting Efficiency of the butanol CPCs for sodium chloride particles [%]
Particle Diameter d_p [nm]
Data: dataforfit_efficiency1
Model: CPC3025
Chi^2 = 0.65832
R^2 = 0.99183
a 99.40107 ±55.75431
b 3.31211 ±83.23609
c 0.07377 ±2.00794
d 0.96946 ±0.69749

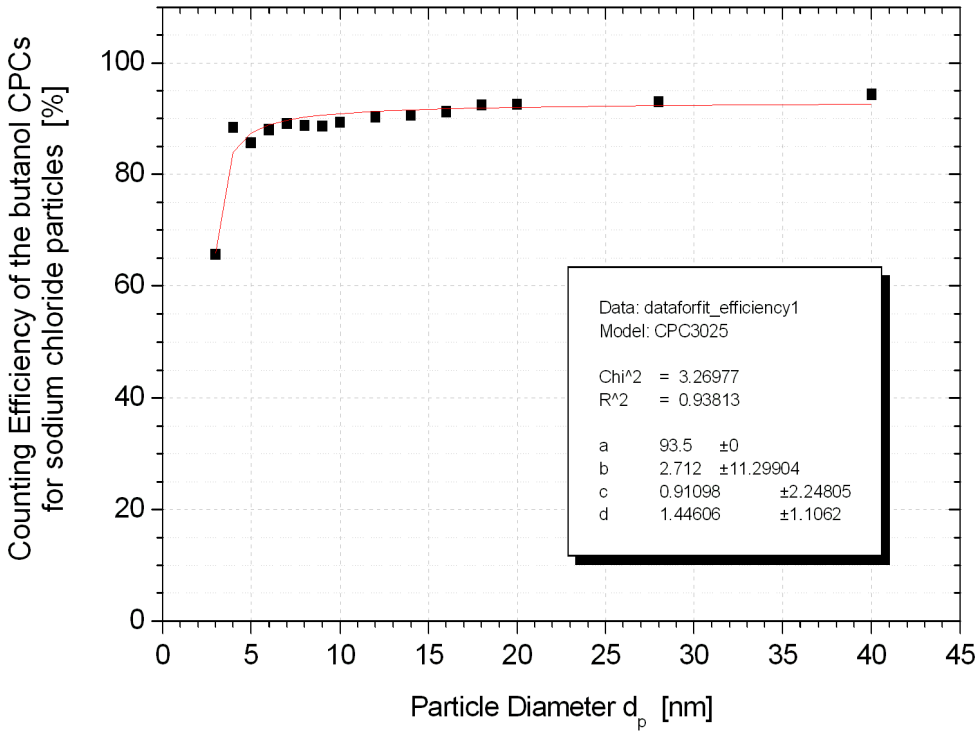
CPC 3010



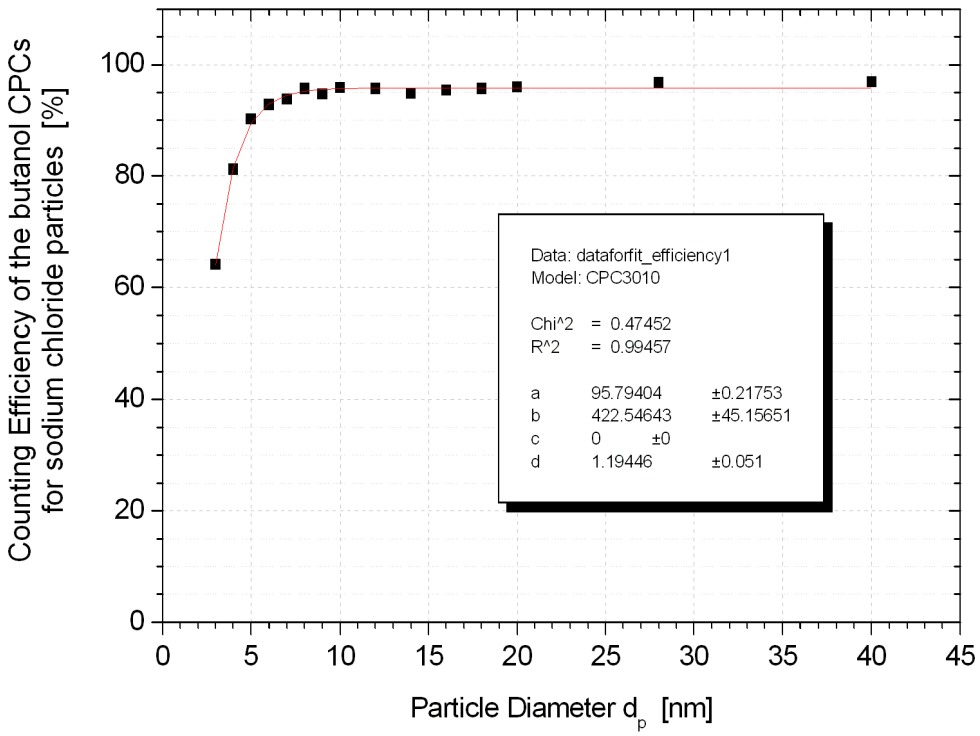
CPC 3034



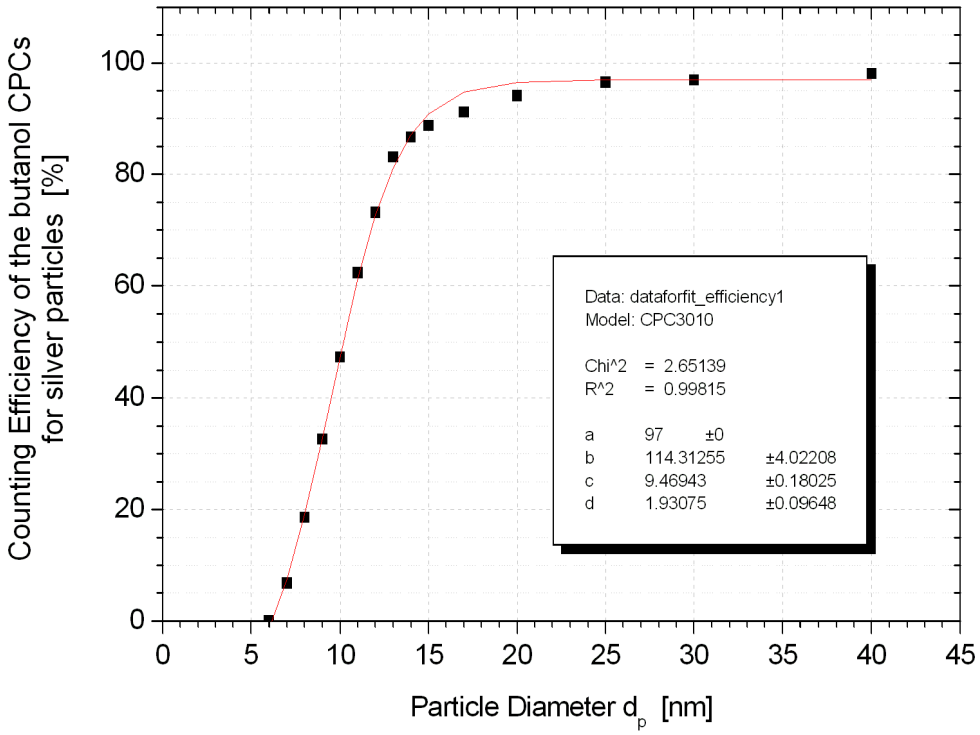
CPC 3786



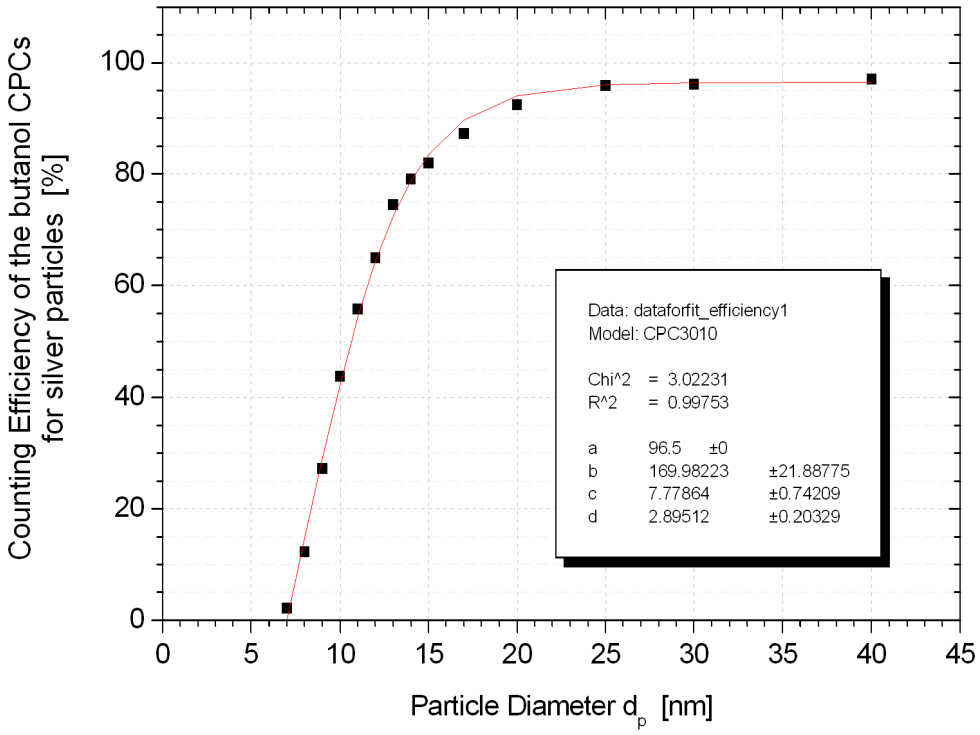
CPC 3785



CPC 3010



CPC 3010



ACCENT - S/DMPS Workshop - WP11 – Quality Assurance

Andi, hier dein Text bitte. ☺

List of participants for the ACCENT S/DMPS workshop in November 2006

Alfred Wiedensohler	Inst. for Tropospheric Research	Leipzig	Germany
Andreas Nowak	Inst. for Tropospheric Research	Leipzig	Germany
Angela Marinoni	University of Bologna	Bologna	Italy
Anna Lia Presicci	University of Birmingham	Birmingham	Great Britain
Chris Lunder	Norwegian Inst. for Air Research	Kjeller	Norway
Diana Rose	MPI für Chemie	Mainz	Germany
Erik Nilsson	University of Lund	Lund	Sweden
Erik Swietlicki	University of Lund	Lund	Sweden
Giedrius Radziukynas	Institute of Physics	Vilnius	Lithuania
Hanna Manninen	University of Helsinki	Helsinki	Finland
Hans Karlsson	University of Stockholm	Stockholm	Sweden
Hervé Venzac	University of Clermont-Ferrand	Clermont-Ferrand	France
Kestutis Senuta	Institute of Physics	Vilnius	Lithuania
Laureline Bourcier	University of Clermont-Ferrand	Clermont-Ferrand	France
Marcel Moerman	Org. Applied Scientific Research	Den Hague	Netherlands
Markus Hermann	Inst. for Tropospheric Research	Leipzig	Germany
Mika Komppula	Finnish Meteorological Institute	Helsinki	Finland
Peter Tunved	University of Stockholm	Stockholm	Sweden
Sebastiao Santos	EC - Joint Research Centre	Ispra	Italy
Sterios Vratolis	Inst. of Nuc. Tech. & Rad. Prot.	Athen	Greece
Tuukka Petäjä	University of Helsinki	Helsinki	Finland
Vincent Michaud	University of Clermont-Ferrand	Clermont-Ferrand	France