Electronic Supplementary Material (ESI) for Catalysis Science & Technology.

Supplementary Information

Morphology-dependent reactivity of cobalt oxide nanoparticles in N_2O decomposition

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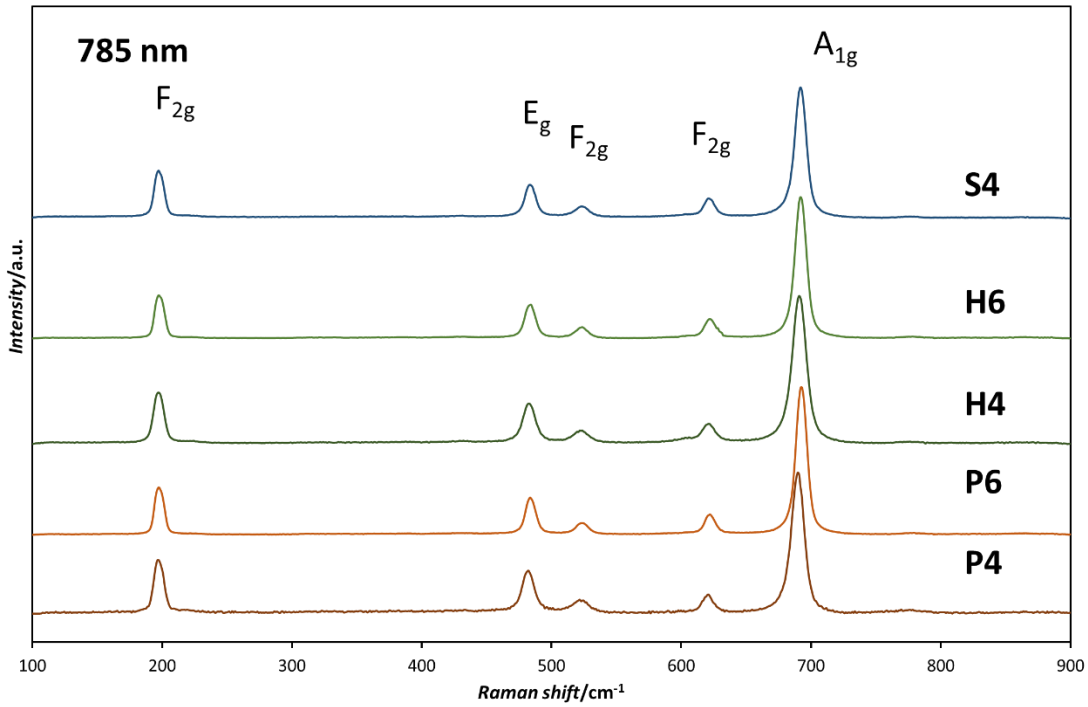
Raman

Additional Raman spectroscopic results.

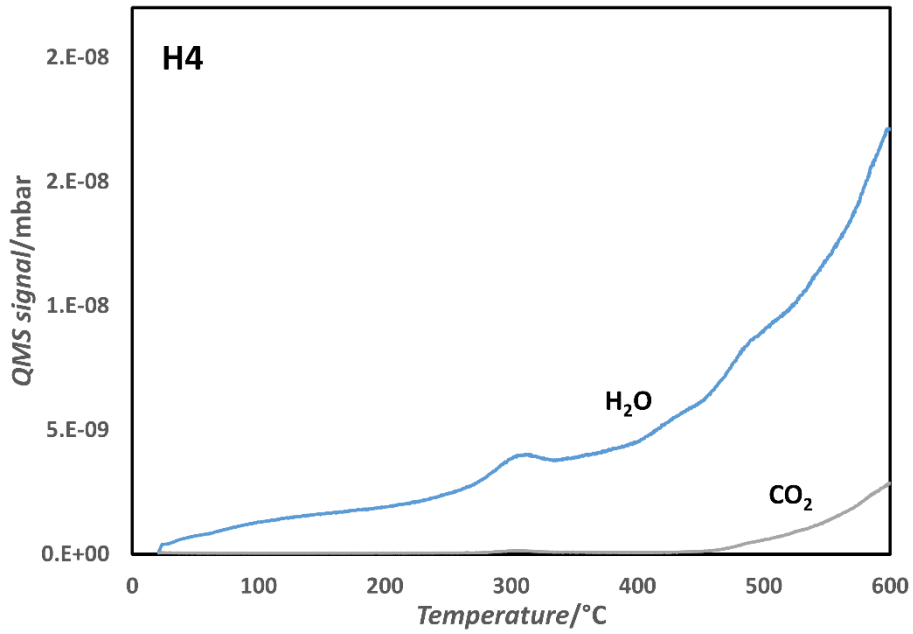
Fig. S1 Raman spectra obtained with a 785 nm laser.



Desorption during work function *in-situ* measurements

A quadrupole mass spectrometer (RGA 200, SRS) mounted onto the vacuum chamber was used to monitor the gas phase composition during thermal conditioning of the samples P4, H4 and S4. The gases followed were: CO_2 (m/z = 44), N_2 (m/z = 28), O_2 (m/z = 32) and H_2O (m/z = 18). Similar desorption patterns were obtained for all the samples. A representative graph is presented in the Fig. Desorption for the H4 sample. Only signals from CO_2 and H_2O were recorded during the heat treatment process.

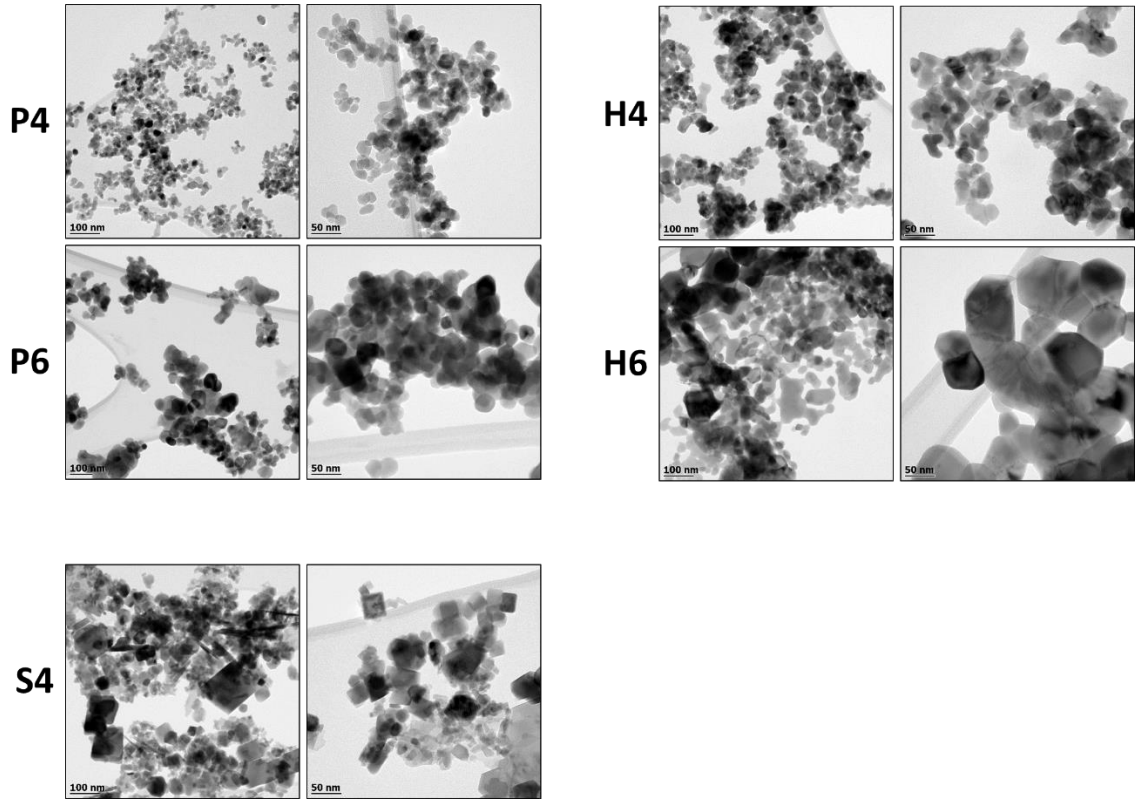
Fig. S2 Desorption of the CO_2 and H_2O during thermal conditioning of the H4 sample prior the *in-situ* work function measurements.



TEM

Additional TEM images of the investigated samples.

Fig. S3 TEM images taken at lower magnifications.



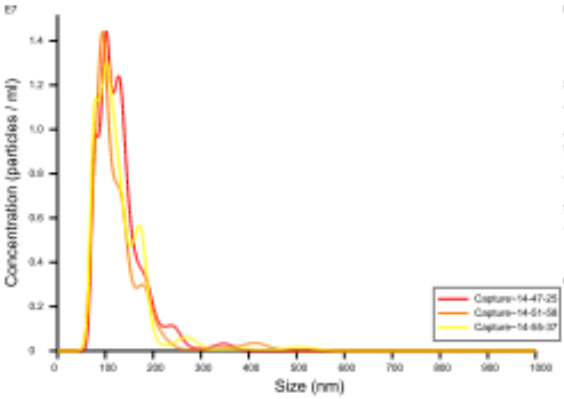
Nanoparticle tracking analysis, NTA

Nanoparticle tracking and analysis was carried out on a NanoSight LM10-HS (NanoSight Ltd., UK, 405 nm laser beam), using a version of NTA 3.0 software (Malvern Instruments Ltd). Three videos, each 60 s long, were recorded and analyzed in batch mode to ensure better statistics. Powder samples were thoroughly ground in an agate mortar prior the dispersion in water. Next, a small amount of powder was put in a glass beaker with 100 ml of water and sonicated for 5 min. Despite grinding, some of the material underwent sedimentation. The transparent brown liquid from the middle of its volume was further diluted by transferring 2-4 ml of suspension into 50 ml of water. Each time before recording a video the suspension was sonicated again, for 1 min.

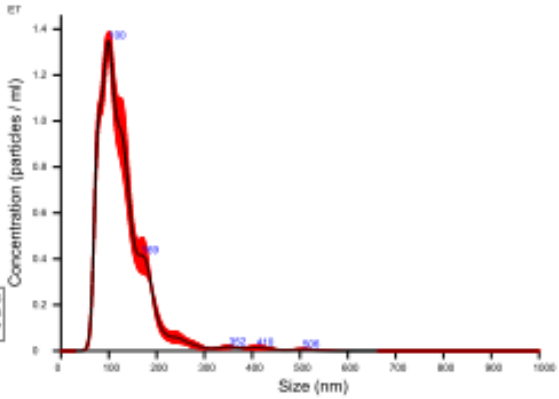
The combined reports of the investigated materials are presented below (**Fig. S4 – S8**)

NANOSIGHT

Fig. S4 Combined experiment P4 report



FTLA Concentration / Size graph for Experiment:
Combined experiment S4



Averaged FTLA Concentration / Size for Experiment:
Combined experiment S4
Error bars indicate + / -1 standard error of the mean

Included Files

Capture 2015-06-19 14-47-25
Capture 2015-06-19 14-51-58
Capture 2015-06-19 14-55-37

Details

NTA Version:	Unknown
Script Used:	
Time Captured:	
Operator:	
Pre-treatment:	
Sample Name:	
Diluent:	
Remarks:	Created from combined experiments: Capture 2015-06-19 14-47-11.nano, Capture 2015-06-19 14-51-47.nano, Capture 2015-06-19

Capture Settings

Camera Type:	sCMOS
Camera Level:	8
Slider Shutter:	317
Slider Gain:	15
FPS	25.0
Number of Frames:	1499
Temperature:	23.6 - 23.9 °C
Viscosity:	(Water) 0.911 - 0.918 cP
Dilution factor:	Dilution not recorded

Analysis Settings

Detect Threshold:	2
Blur Size:	Auto
Max Jump Distance:	Auto: 12.2 - 12.7 pix

Results

Stats: Merged Data

Mean:	129.6 nm
Mode:	99.2 nm
SD:	58.7 nm
D10:	78.0 nm
D50:	114.5 nm
D90:	185.9 nm

Stats: Mean +/- Standard Error

Mean:	129.5 +/- 0.9 nm
Mode:	99.5 +/- 2.7 nm
SD:	58.7 +/- 4.9 nm
D10:	78.1 +/- 1.3 nm
D50:	114.1 +/- 3.1 nm
D90:	186.2 +/- 2.4 nm
Concentration:	1.09e+009 +/- 6.32e+007 particles/ml
	55.3 +/- 3.2 particles/frame
	58.8 +/- 3.3 centres/frame

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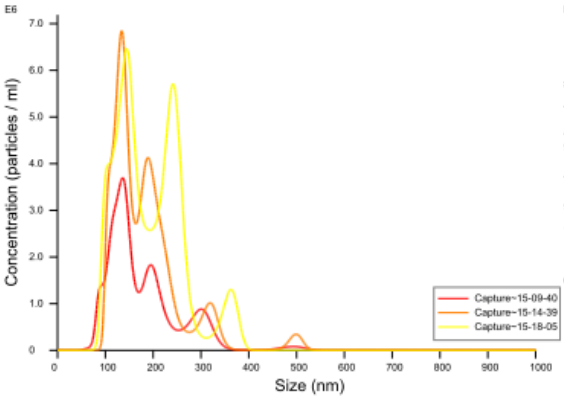
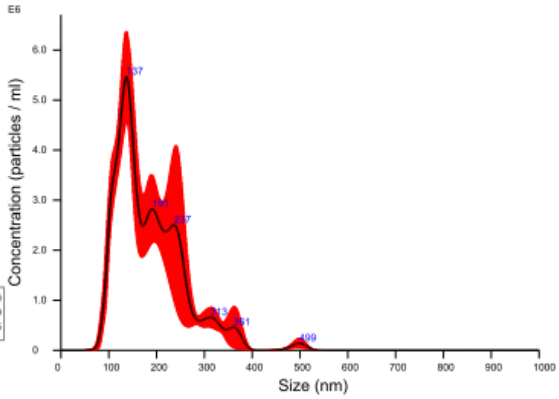
Fig. S5 Combined experiment P6 report



FTLA Concentration / Size graph for Experiment:
Combined experiment S6



Averaged FTLA Concentration / Size for Experiment:
Combined experiment S6
Error bars indicate + / -1 standard error of the mean

Included Files

Capture 2015-06-19 15-09-40
Capture 2015-06-19 15-14-39
Capture 2015-06-19 15-18-05

Details

NTA Version:	Unknown
Script Used:	
Time Captured:	
Operator:	
Pre-treatment:	
Sample Name:	
Diluent:	
Remarks:	Created from combined experiments: Capture 2015-06-19 15-09-26.nano, Capture 2015-06-19 15-14-28.nano, Capture 2015-06-19

Capture Settings

Camera Type:	sCMOS
Camera Level:	6 - 8
Slider Shutter:	86 - 317
Slider Gain:	15
FPS	25.0
Number of Frames:	1499
Temperature:	24.0 - 24.4 °C
Viscosity:	(Water) 0.901 - 0.909 cP
Dilution factor:	Dilution not recorded

Analysis Settings

Detect Threshold:	2
Blur Size:	Auto
Max Jump Distance:	Auto: 10.2 - 12.0 pix

Results

Stats: Merged Data

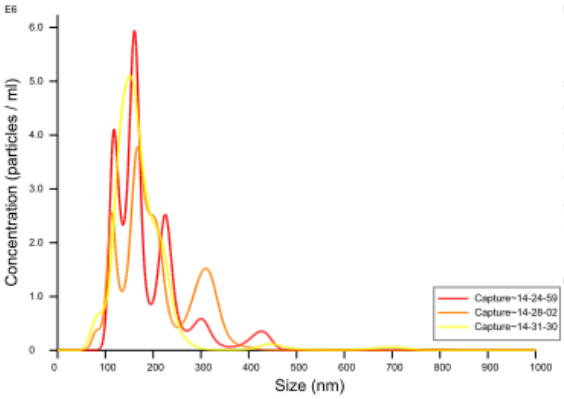
Mean:	186.4 nm
Mode:	137.0 nm
SD:	72.4 nm
D10:	110.4 nm
D50:	168.1 nm
D90:	278.3 nm

Stats: Mean +/- Standard Error

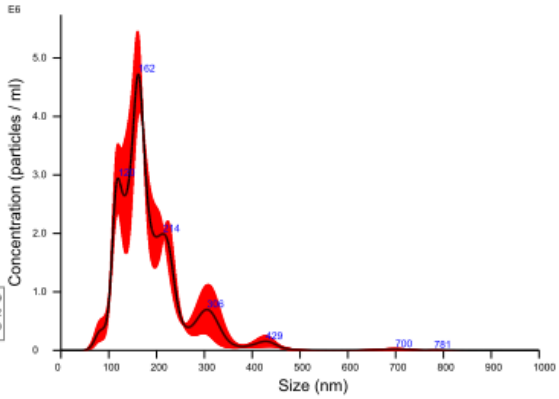
Mean:	184.4 +/- 4.7 nm
Mode:	138.3 +/- 3.2 nm
SD:	72.8 +/- 1.8 nm
D10:	109.3 +/- 3.3 nm
D50:	165.4 +/- 8.5 nm
D90:	279.9 +/- 6.3 nm
Concentration:	6.04e+008 +/- 1.33e+008 particles/ml
	30.7 +/- 6.8 particles/frame
	40.2 +/- 8.6 centres/frame

NANOSIGHT

Fig. S6 Combined experiment H4 report



FTLA Concentration / Size graph for Experiment:
Combined experiment H4



Averaged FTLA Concentration / Size for Experiment:
Combined experiment H4
Error bars indicate + / -1 standard error of the mean

Included Files

Capture 2015-06-19 14-24-59
Capture 2015-06-19 14-28-02
Capture 2015-06-19 14-31-30

Details

NTA Version:	Unknown
Script Used:	
Time Captured:	
Operator:	
Pre-treatment:	
Sample Name:	
Diluent:	
Remarks:	Created from combined experiments: Capture 2015-06-19 14-24-34.nano, Capture 2015-06-19 14-27-52.nano, Capture 2015-06-19

Capture Settings

Camera Type:	sCMOS
Camera Level:	8
Slider Shutter:	317
Slider Gain:	15
FPS	25.0
Number of Frames:	1499
Temperature:	23.6 - 23.9 °C
Viscosity:	(Water) 0.911 - 0.918 cP
Dilution factor:	Dilution not recorded

Analysis Settings

Detect Threshold:	2
Blur Size:	Auto
Max Jump Distance:	Auto: 10.1 - 11.5 pix

Results

Stats: Merged Data

Mean:	188.5 nm
Mode:	161.7 nm
SD:	77.8 nm
D10:	115.7 nm
D50:	167.8 nm
D90:	290.9 nm

Stats: Mean +/- Standard Error

Mean:	189.0 +/- 7.8 nm
Mode:	160.0 +/- 4.7 nm
SD:	76.8 +/- 2.0 nm
D10:	115.5 +/- 1.1 nm
D50:	169.6 +/- 7.7 nm
D90:	275.9 +/- 25.9 nm
Concentration:	4.48e+008 +/- 1.59e+007 particles/ml
	22.7 +/- 0.8 particles/frame
	29.9 +/- 2.2 centres/frame

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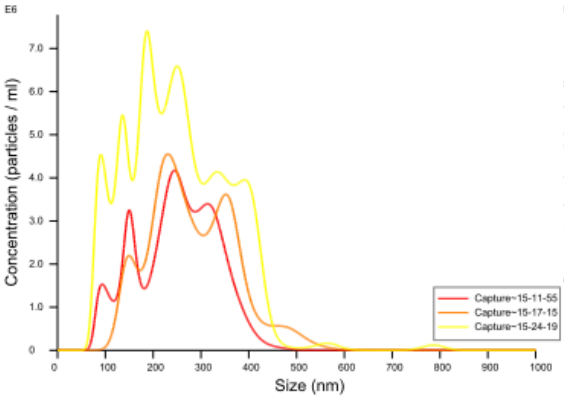
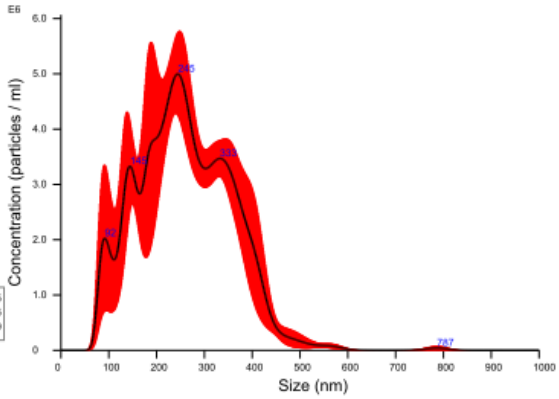
Fig. S7 Combined experiment H6 report



FTLA Concentration / Size graph for Experiment:
Combined experiment_H6



Averaged FTLA Concentration / Size for Experiment:
Combined experiment_H6
Error bars indicate + / -1 standard error of the mean

Included Files

Capture 2016-01-15 15-11-55
Capture 2016-01-15 15-17-15
Capture 2016-01-15 15-24-19

Details

NTA Version:	Unknown
Script Used:	
Time Captured:	
Operator:	
Pre-treatment:	
Sample Name:	
Diluent:	
Remarks:	Created from combined experiments: Capture 2016-01-15 15-11-47.nano, Capture 2016-01-15 15-17-04.nano, Capture 2016-01-15

Capture Settings

Camera Type:	sCMOS
Camera Level:	7
Slider Shutter:	165
Slider Gain:	15
FPS	25.0
Number of Frames:	1499
Temperature:	22.3 - 22.8 °C
Viscosity:	(Water) 0.935 - 0.946 cP
Dilution factor:	Dilution not recorded

Analysis Settings

Detect Threshold:	5
Blur Size:	Auto
Max Jump Distance:	Auto: 8.2 - 9.4 pix

Results

Stats: Merged Data

Mean:	258.7 nm
Mode:	244.3 nm
SD:	98.1 nm
D10:	132.2 nm
D50:	251.5 nm
D90:	383.4 nm

Stats: Mean +/- Standard Error

Mean:	260.9 +/- 10.8 nm
Mode:	220.9 +/- 17.3 nm
SD:	93.0 +/- 7.0 nm
D10:	138.7 +/- 14.7 nm
D50:	254.4 +/- 8.8 nm
D90:	378.7 +/- 13.3 nm
Concentration:	1.14e+009 +/- 2.88e+008 particles/ml
	57.9 +/- 14.6 particles/frame
	89.1 +/- 26.5 centres/frame

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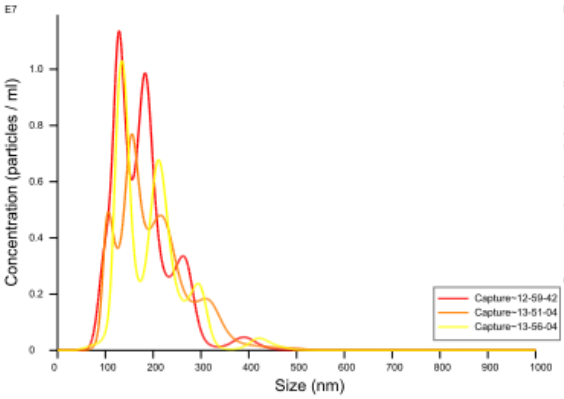
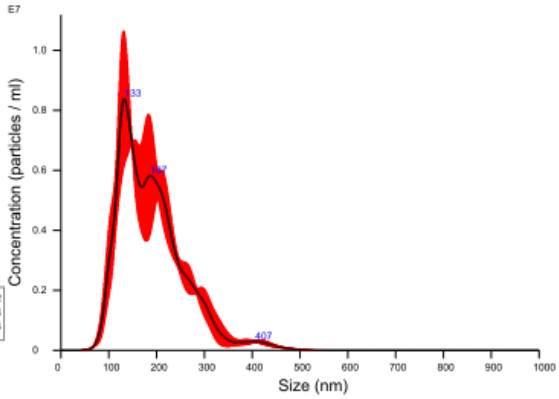
Fig. S8 Combined experiment N4 report



FTLA Concentration / Size graph for Experiment:
Combined experiment_N1



Averaged FTLA Concentration / Size for Experiment:
Combined experiment_N1
Error bars indicate + / -1 standard error of the mean

Included Files

Capture 2015-06-19 12-59-42
Capture 2015-06-19 13-51-04
Capture 2015-06-19 13-56-04

Details

NTA Version:	Unknown
Script Used:	
Time Captured:	
Operator:	
Pre-treatment:	
Sample Name:	
Diluent:	
Remarks:	Created from combined experiments: Capture 2015-06-19 12-59-24.nano, Capture 2015-06-19 13-50-50.nano, Capture 2015-06-19

Capture Settings

Camera Type:	sCMOS
Camera Level:	6
Slider Shutter:	86
Slider Gain:	15
FPS	25.0
Number of Frames:	1499
Temperature:	23.2 - 23.9 °C
Viscosity:	(Water) 0.911 - 0.926 cP
Dilution factor:	Dilution not recorded

Analysis Settings

Detect Threshold:	2
Blur Size:	Auto
Max Jump Distance:	Auto: 10.8 - 11.0 pix

Results

Stats: Merged Data

Mean:	190.1 nm
Mode:	132.5 nm
SD:	69.3 nm
D10:	115.6 nm
D50:	177.2 nm
D90:	281.7 nm

Stats: Mean +/- Standard Error

Mean:	191.0 +/- 6.4 nm
Mode:	139.7 +/- 8.1 nm
SD:	68.9 +/- 3.2 nm
D10:	115.3 +/- 3.9 nm
D50:	180.8 +/- 5.9 nm
D90:	285.3 +/- 12.3 nm
Concentration:	1.04e+009 +/- 8.05e+007 particles/ml
	52.6 +/- 4.1 particles/frame
	77.9 +/- 6.1 centres/frame