A nanoparticle dosimeter for easy workplace exposure monitoring

naneos particle solutions gmbh

Partector 2

Aerosol Dosimeter

Data File description

English

November 2023

CE RoHS Compliant

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Document information

Related device versions:	Partector 2, Partector 2 Pro
Related firmware versions:	≥ 298 Older firmware may not offer all features described in this manual
Document Date:	2023-11-30
Document Revision:	A

General description

The Partector 2 generates datafiles automatically on its SD card whenever it is operating. The files are human-readable text files, with a file header and a body consisting of the measurement data. The following description of the data file assumes that you have read the manual of the Partector 2, and have some general knowledge about aerosols / ultrafine particles.

File header

The file header contains a lot of information about the Partector 2, e.g. its serial number, the settings of the device, information about hardware and software versions, calibration date etc. This information is mainly useful when there is a problem with the instrument and it helps us to debug problems with your device. For the user, the information is not very relevant. A typical file header is shown in the image below.

```
Partector2 SN 8450
Firmware: rev 298
Hardware: rev 3.2
BLE firmware: rev 20
Calibration: 5.65, calibrated on 24.10.2023
Cal params 1: -2.31, 20.40, 3.64, 0.929, 0.00000563, 1.151, 60, 100
Cal params 2: -3.97, 46.28, 12.05, 0.888, 0.00000766, 1.059, 150, 360
Cal params 3: -27.80, 75.55, 39.82, 0.808, 0.00000902, 1.031, 300, 720
Start: 25.10.2023 13:32:26
statistics: 5603 LDSAmin, 1897 min, 57021 pulses
settings 1: 2.00 Idiff, 50 P, 100 D, 0.5 duty cycle, 2.0 pulse period, 1 zeroHV, 1 pulsing
settings 2: 3970 dp setpoint, 10 P, 500 I, 100 flow%
settings 3: 1 integration time, 1 adaptive DV, 0 multi DV, 0 multiDV on, 20 DV switchtime, 0 antispike, 90 RH shutdown,
settings 4: 999999 alarmlevel, 0 USBtransmit, 0 bluetooth, 15 brightness, 127 contrast, 1 low power, 1 selftest, 360000
environment: T 21.6...28.8, RH 10.6...85.1
gain    1639.0  1624.0
startup 1599.6  1585.2
ST: Ipump 0.0mA Display 16.4V   CE -24.2V       + 2.50V - -2.54V
```

File body (standard Partector2)

The file body consists of tab-delimited data. The first line of the file body contains the column headers describing the data in the corresponding column.
The column headers and the start of the data is shown in the image below.

time	number	diam	LDSA	surface	mass	A1	A2	idiff	HV	EM1	EM2	DV	T	RH	P	flow	bat	Ipump	error	PWMpump	2f1	2f2
1.0	1891	53	5.50	38.27	1.14	0.973	0.508	0.02	283	-1.43	0.44	360	23.8	0	965.5	0.500	4.04	25.15	0	0	0.0	0.2
2.0	4401	30	7.00	28.51	0.48	1.239	0.367	2.00	3315	8.23	1.75	359	23.8	47	965.5	0.500	4.05	25.15	0	0	0.3	0.1
3.0	3650	35	6.81	31.92	0.62	1.205	0.426	0.02	281	-6.30	-0.19	361	23.8	47	962.6	0.497	4.05	24.85	0	0	0.5	0.0
4.0	4559	32	7.87	34.42	0.63	1.392	0.452	2.00	3314	2.62	1.87	361	23.8	47	962.6	0.500	4.05	25.45	0	0	0.4	0.1
5.0	4240	33	7.43	32.97	0.61	1.315	0.435	0.02	279	-1.31	-0.56	361	23.9	47	962.6	0.500	4.05	25.45	0	0	0.4	0.1

The most important individual columns are:

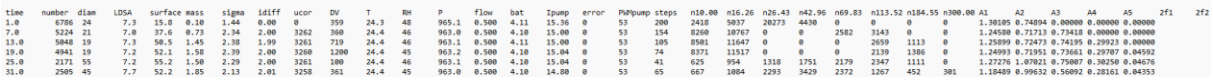
- Time: Time since measurement start in seconds. The start time of the measurement is given in the file header as “Start: “.
- Number: Particle number concentration, in #/cm^3.
- Diam: Average particle diameter, in nm.
- LDSA: Lung-deposited surface area concentration, in μm^2/cm^3.
- Surface: Total surface area concentration, in μm^2/cm^3.
- Mass: UFP mass concentration (PM0.3), in μg/m^3.

These columns contain the UFP measurements made by the Partector 2. In addition, there are lots of further parameters that are recorded, that are not very relevant for the user, but which can help us to understand issues with the instruments:

- A1: Electrometer 1 amplitude in mV
- A2: Electrometer 2 amplitude in mV
- Idiff: Diffusion current, in nA
- HV: High voltage of corona charger, in V
- EM1: Electrometer 1 latest reading in mV
- EM2: Electrometer 2 latest reading in mV
- DV: Deposition voltage at precipitator, in V
- T: Temperature of the device, in °C
- RH: relative humidity of the air inside the device, in %
- P: Absolute pressure, in mbar
- Flow: Flow rate in the instrument, in liters/minute
- Bat: Battery voltage in V
- Ipump: Pump current in mA
- Error: Error code (0 means no error)
- PWMpump: Pump control signal in %
- 2f1 and 2f2: Internal signals.

File body (Partector 2 Pro)

The Partector 2 Pro will additionally record a calculated particle size distribution. Therefore, its data file is slightly different. The file header is very similar, and like in the standard Partector 2, it is mainly used for internal purposes at naneos. The file body is different; an example of its column headers is shown below:



time	number	diam	LDSA	surface	mass	sigma	idiff	ucor	DV	T	RH	P	flow	bat	Ipump	error	PWMpump	steps	n10.00	n16.26	n26.43	n42.96	n69.83	n113.52	n184.55	n300.00	A1	A2	A3	A4	A5	2f1	2f2
1.0	6786	24	7.3	15.8	0.10	1.44	0.00	0	359	24.3	48	965.1	0.500	4.11	15.36	0	53	200	2418	5037	20273	4430	0	0	0	0	1.30105	0.74894	0.00000	0.00000	0.00000		
7.0	5224	21	7.0	37.6	0.73	2.34	2.00	3262	360	24.4	46	963.0	0.500	4.10	15.00	0	53	154	8260	10767	0	0	2582	3143	0	0	1.24580	0.71713	0.73418	0.00000	0.00000		
13.0	5048	19	7.3	50.5	1.45	2.38	1.99	3261	719	24.4	46	963.1	0.500	4.11	15.00	0	53	105	8501	11647	0	0	0	2659	1113	0	1.25899	0.72473	0.74195	0.29923	0.00000		
19.0	4941	19	7.2	52.1	1.58	2.39	2.00	3260	1200	24.4	45	963.2	0.500	4.10	15.04	0	53	74	8371	11517	0	0	0	2139	1386	0	1.24993	0.71951	0.73661	0.29707	0.04592		
25.0	2171	55	7.2	55.2	1.50	2.29	2.00	3261	100	24.4	46	963.1	0.500	4.10	15.04	0	53	41	625	954	1318	1751	2179	2347	1111	0	1.27276	1.07021	0.75007	0.30250	0.04676		
31.0	2505	45	7.7	52.2	1.85	2.13	2.01	3258	361	24.4	45	963.0	0.500	4.10	14.80	0	53	65	667	1084	2293	3429	2372	1267	452	301	1.18489	0.99632	0.56092	0.28161	0.04353		

Many of the columns are identical to the standard Partector 2. The following list only describes the additional columns:

- Sigma: Geometric standard deviation of the particle size distribution
- Steps: Number of iterations of the data inversion algorithm

- N10.00: Number concentration of 10nm-particles, as dN/dlogD
- N16.26 etc. Number concentration of 16.26nm-particles etc (dN/dlogD)
- A1…A5 Electrometer amplitudes in mV used for calculation of size distribution.

Please note that the 8 concentrations for the size distribution are given as dN/dlogD (number concentration per diameter decade), rather than as dN (number concentration for this particular diameter).

You cannot calculate the total particle number by summing up the 8 concentrations of the 8 particle diameters. Rather, the unit of the individual diameter channels is given as dN/dlogD, which is common in aerosol science but may be confusing at first. dlogD describes the spacing of two diameter channels on a log scale, i.e.

dlogD = log(diameter n+1 / diameter n)

For the Partector 2, this is about 0.211 (e.g. log(16.26 / 10)). To calculate the number of particles per size channel (dN), one must obviously multiply dN/dlogD with dlogD, i.e. by 0.211.

The reason for choosing dN/dlogD as metric for particle size distributions is that it makes measurements of instruments with different size resolutions comparable. The Partector 2 Pro has only 8 size channels between 10 and 300nm, whereas a lab-grade scanning mobility particle sizer will have a lot more channels. If the concentration is measured as dN, then the concentrations per channel will be smaller if more channels are used, and therefore, it is not possible to directly compare data of instruments with different size resolution. By normalizing per diameter decade, one can plot data of instruments with different size resolution in the same graph, and they will be comparable.

As an example, consider the following graph of a paper by C. Asbach et al. comparing particle size distributions measured by a Partector 2 Pro and an SMPS:

https://doi.org/10.5194/ar-2023-10
Preprint. Discussion started: 21 August 2023

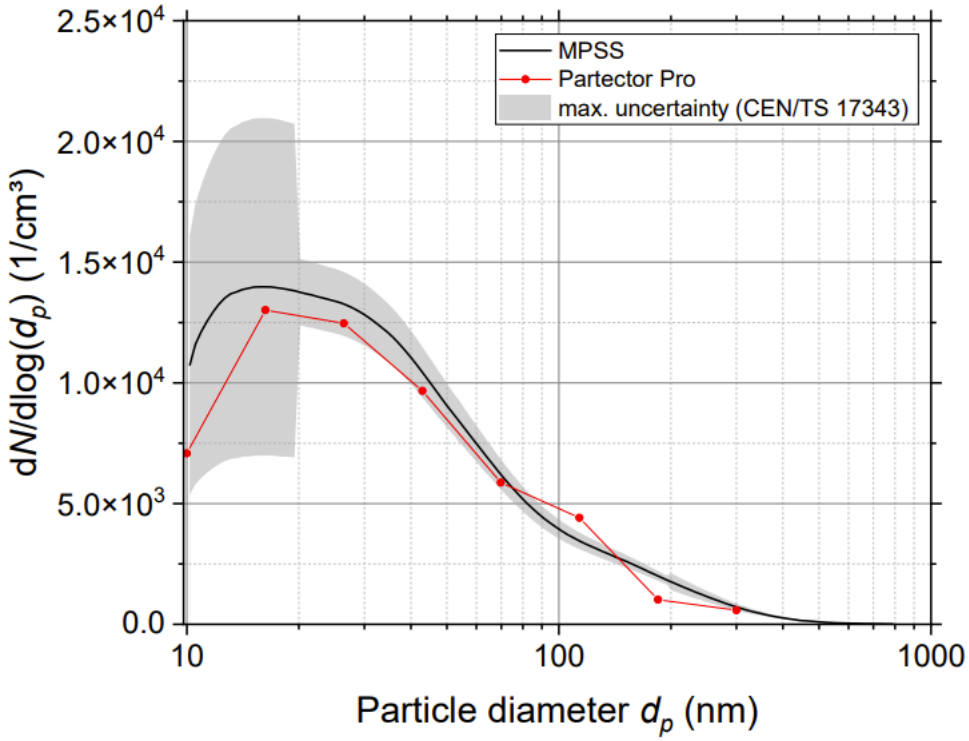


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Figure 4: Mean particle size distribution during the measurement period, measured with the MPSS and Partector Pro; grey shaded area illustrates the allowed uncertainty range according to CEN/TS 17343

Even though the SMPS has many more channels than the Partector 2 Pro, the graphs now are comparable.

Also note that using the dN/dlogD metric allows graphs with a logarithmic diameter scale to be read easily. Consider the red area shown in the graph below. On the diameter axis, the difference of log(100) and log(10) is exactly 1, and on the y axis, 10^4 pt/cm^3 is marked. The red area thus corresponds to 10^4 pt/cm^3. Looking at the whole area under the curve of the size distribution, we can therefore easily estimate the total particle number concentration to be a bit more than 10^4 pt/cm^3.

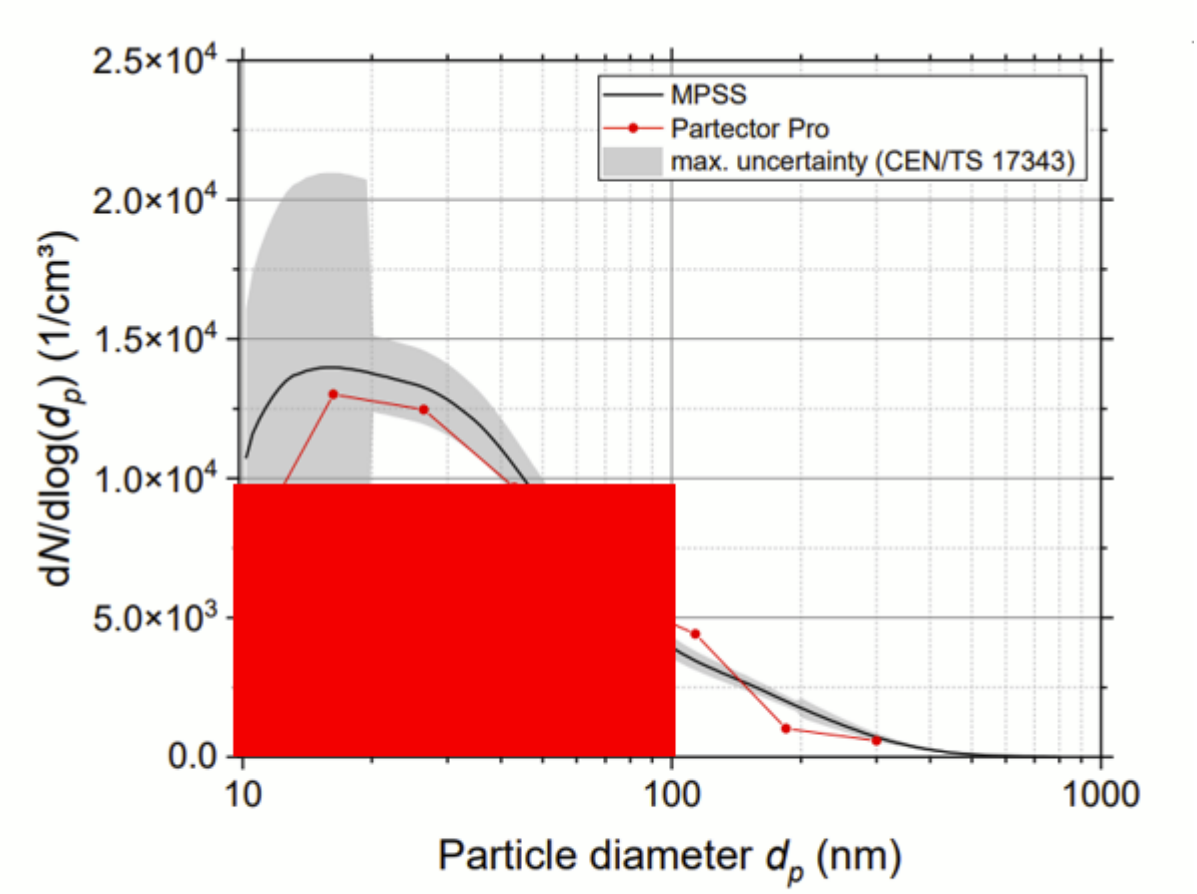

Figure 4: Mean particle size distribution during the measurement period, measured with the MPSS and Partector Pro; grey shaded area illustrates the allowed uncertainty range according to CEN/TS 17343

Related documents

Partector 2 quick start guide:
www.naneos.ch/pdf/partector2_quick_guide.pdf

Partector 2 data analysis tool quick start guide:
www.naneos.ch/pdf/javatool_quick_guide.pdf

In-depth explanation of lung-deposited surface are (LDSA)
www.naneos.ch/pdf/LDSA.pdf

Error codes and decoding in the data file
www.naneos.ch/pdf/Partector2_Errors_and_Limits.pdf

Customer service & contact

naneos particle solutions gmbh

Alte Spinnerei 9
5210 Windisch
Switzerland

Mail: info@naneos.ch
Phone: +41 56 560 20 70

www.naneos.ch