

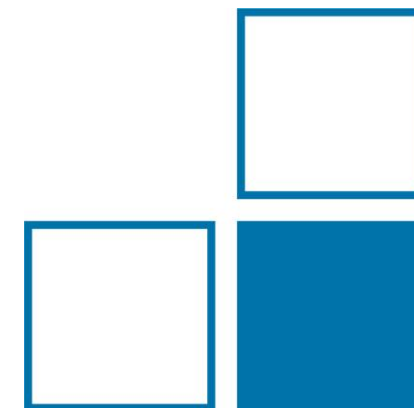
Spark discharge aerosol generator for field calibration of absorption photometers: Aerosol properties and stability

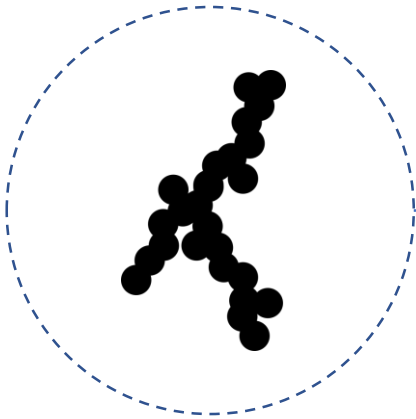
EGU2020: Sharing geoscience online
May 4th – 8th, 2020

Jorge Saturno¹, Andreas Nowak¹, Matthias Jahn¹, Tobias Klein¹, Thomas Müller², Volker Ebert¹

¹Physikalisch-Technische Bundesanstalt, Braunschweig, Germany.

²Leibniz Institute for Tropospheric Research, Leipzig, Germany.





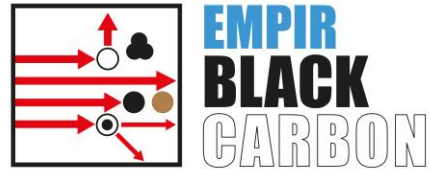
Desired particle properties

FRESH SOOT PARTICLES

Particle diameter (D_p)
50 – 100 nm

Single scattering albedo (SSA)
0.05 – 0.20

Absorption Angstrom Coefficient (AAC)
~1.0



Minimal fraction of **organic to elemental carbon**.

Criteria for a portable generator

Need of a field generator to calibrate absorption photometers

- Particles should have the desired properties of fresh soot.
- Minimal operation requirements (gas usage, portability).
- Good stability and repeatability.

Spark discharge aerosol generator



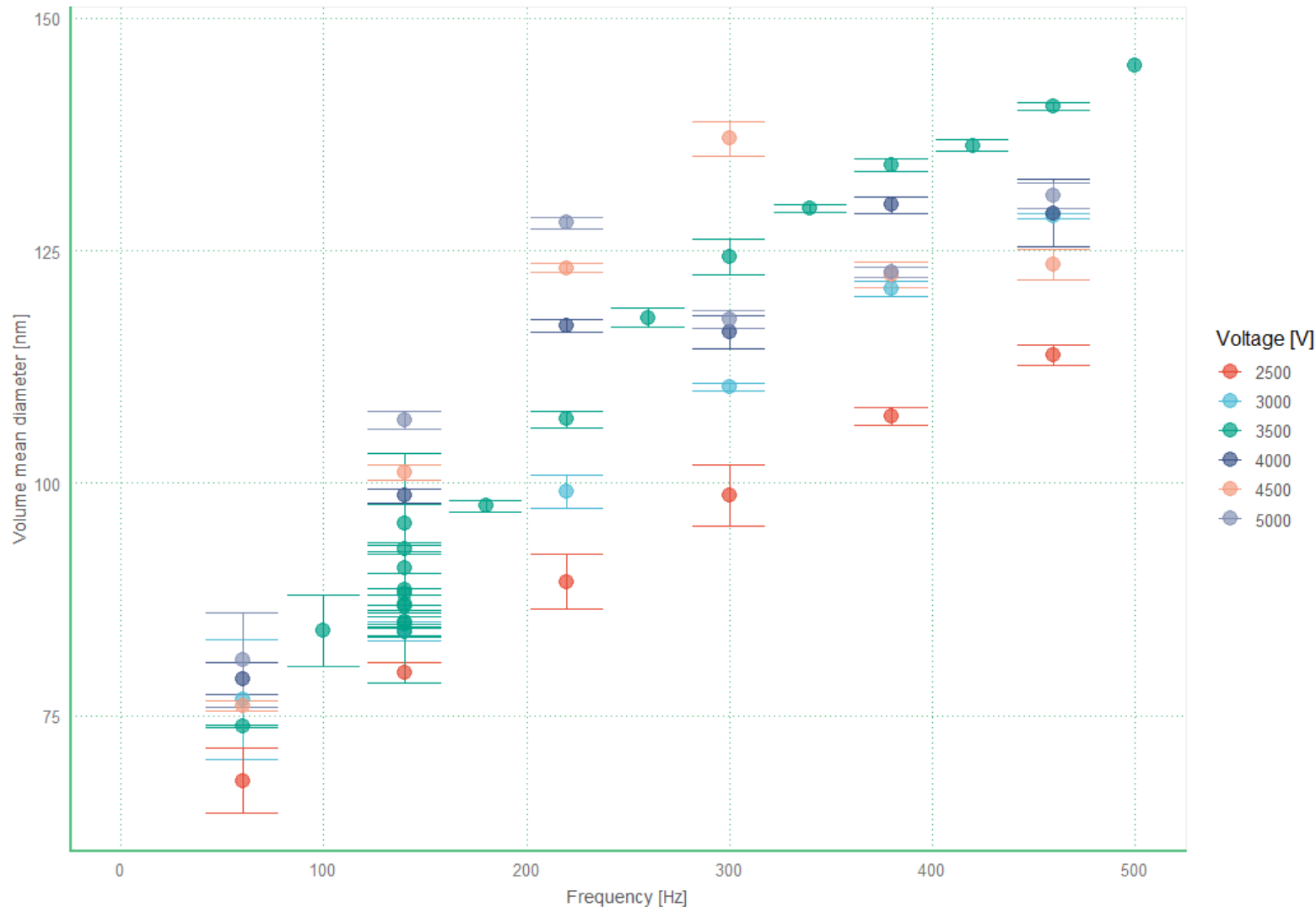
Spark discharge aerosol generator (SDAG)

Model: DNP digital 3000

Manufacturer: PALAS GmbH, Germany.

To improve portability, aerosol is produced using **no dilution air**.

The generators is operated by using only N_2 as carrier gas.



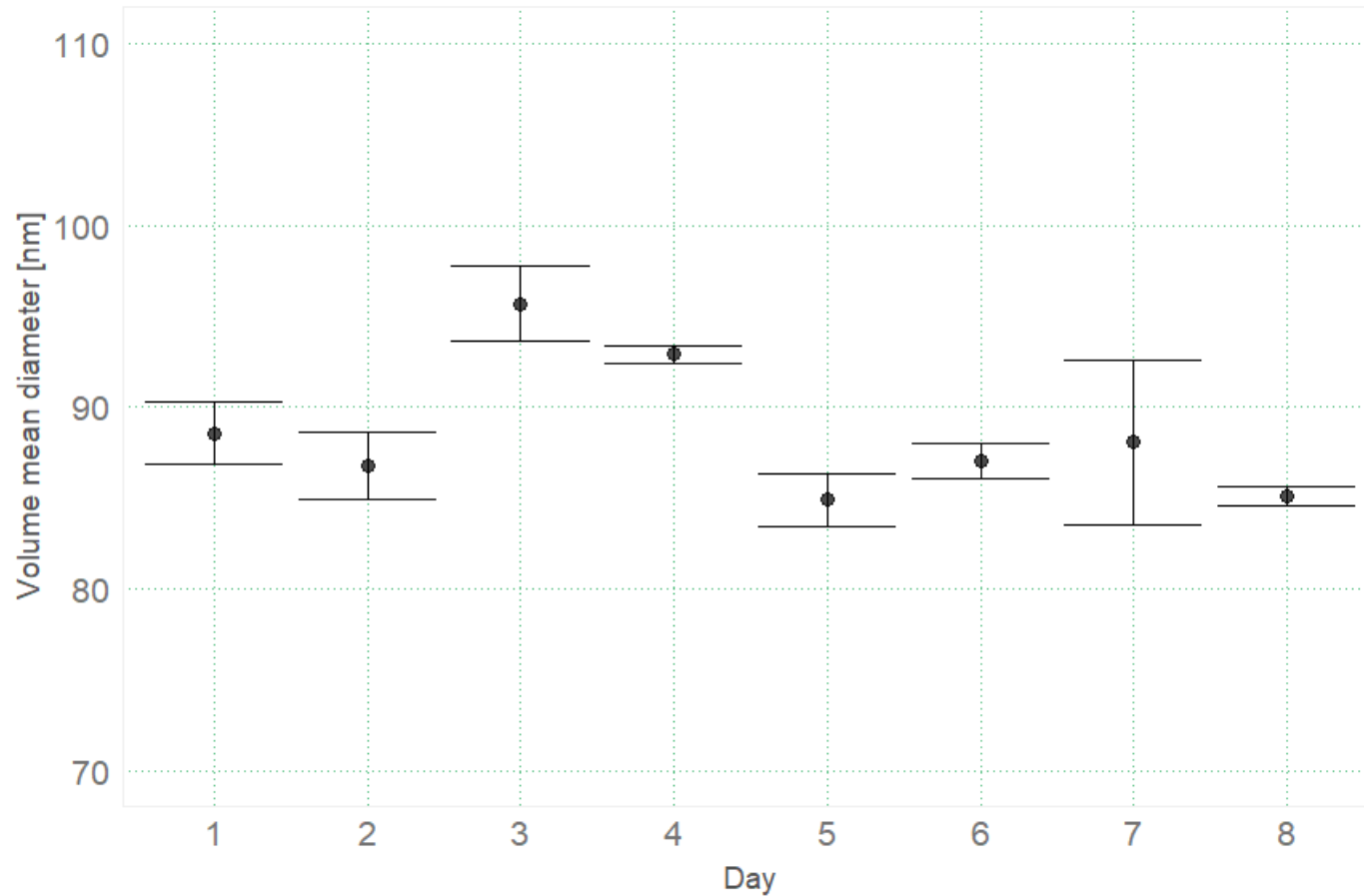
Volume mean diameter (VMD) is shown (y-axis).

Reaches plateau above ~500 Hz.

Number mean diameters are between 55 and 100 nm.

Number concentration:
 $8 - 11 \times 10^6 \text{ cm}^{-3}$

Although the nominal frequency of the spark discharge can go up to 1000 Hz, frequencies higher than 600 Hz are not reachable in the practice. The higher the voltage, the lower maximum frequency that can be reached.



Single operation point

10 l/min N₂

No dilution air

140 Hz

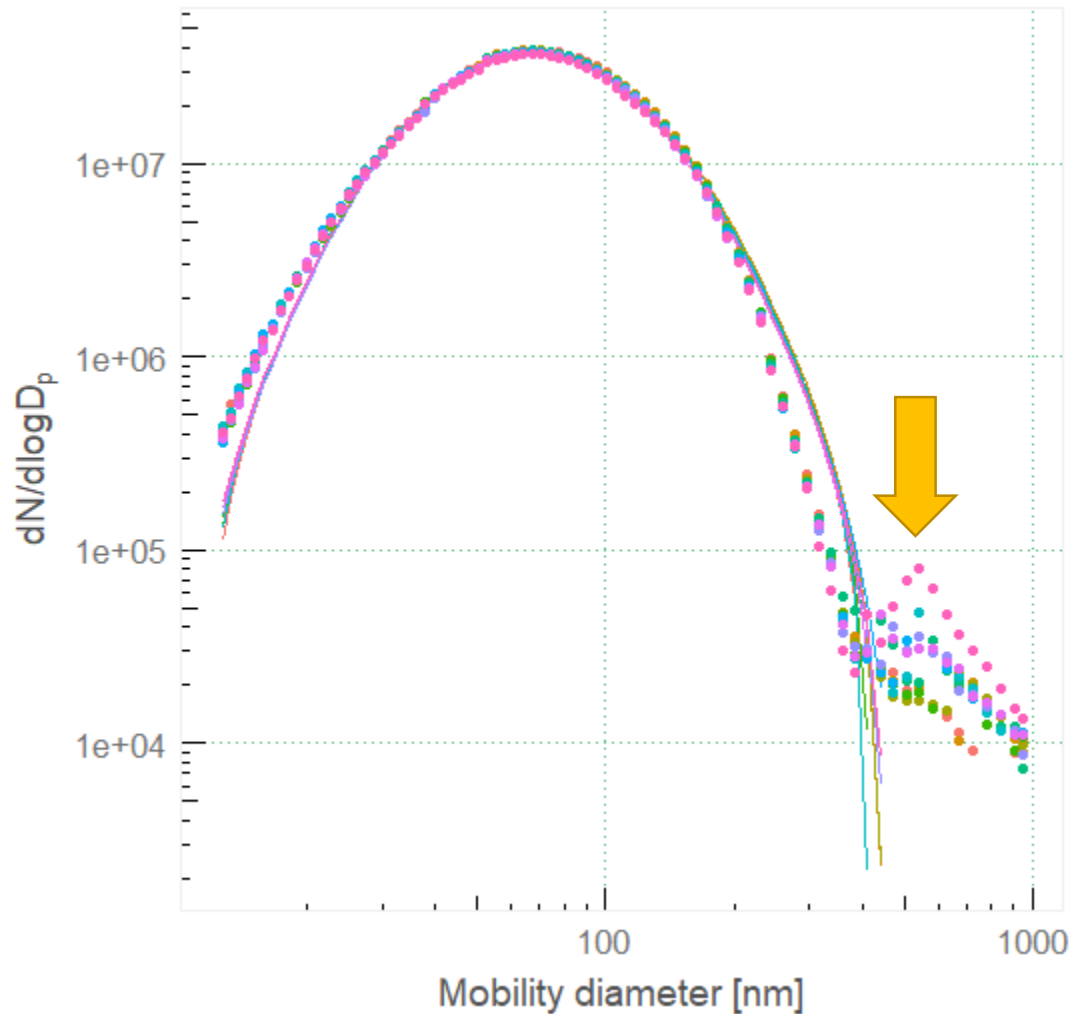
3500 V

30-min measurement points
measured on 8 different days.

Interquartile range

86 – 90 nm

$2\sigma = 8 \text{ nm}$



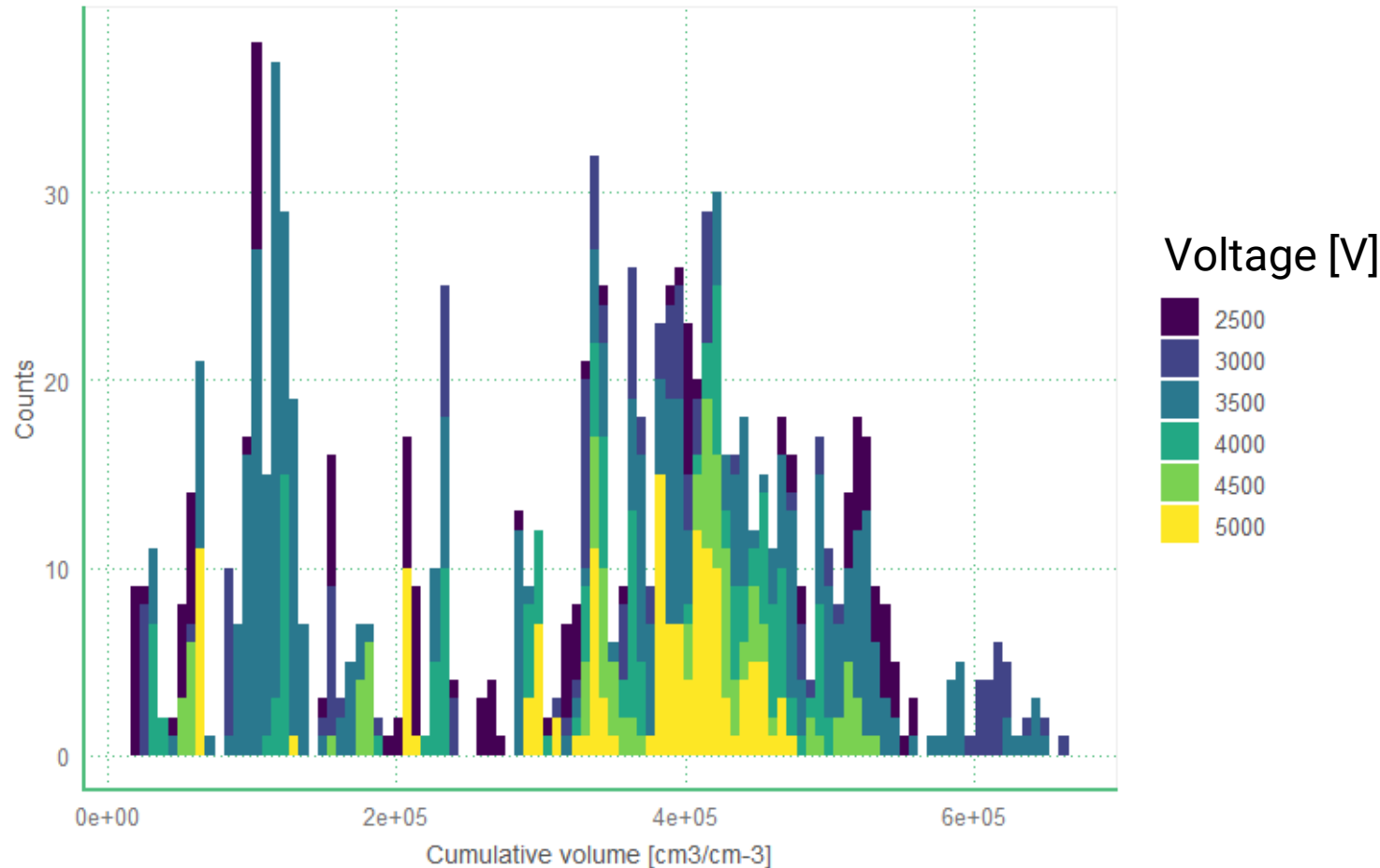
Large particles are produced

Particles with diameters between 500 and 1000 nm are produced at all operation settings.

Contribution of large particles is relevant in terms of mass. Therefore, affecting absorption measurements. The desired OP is the one with the minimal amount of these large particles.

Cumulative volume (400 to 1000 nm) - PALAS DNP3000

No dilution air, 10 l/min N₂



All data

Optimal operating conditons

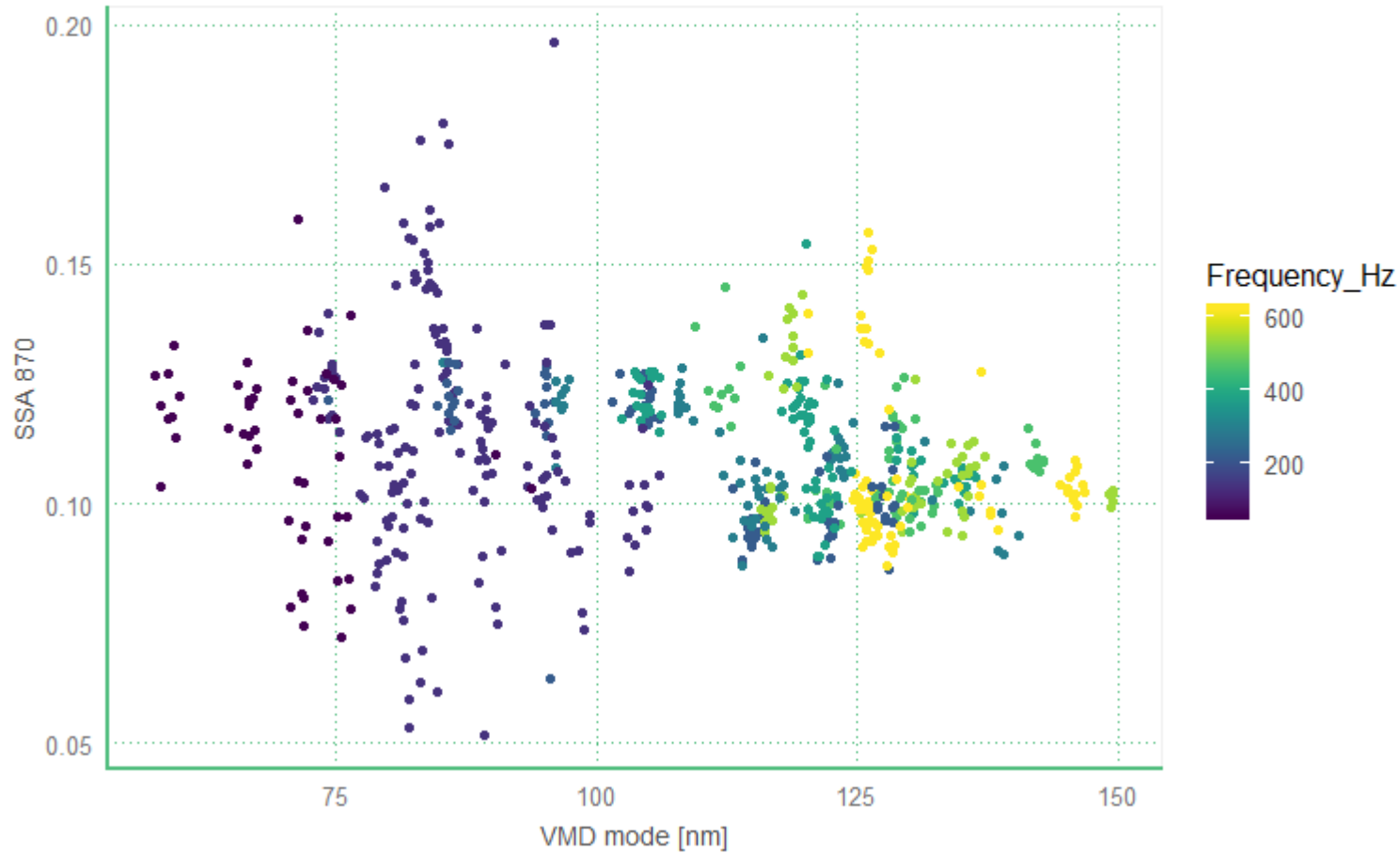
Large particles (500 to 1000 nm) are more likely to be produced when using lower voltage settings.

Optimal setting: 5000 V
-> Lower fraction of larger particles.

By using a virtual impactor, the fraction of large particles can be further reduced but not completely removed.

SSA vs. VMD - PALAS DNP3000

No dilution air, 10 l/min N2, all data

**Stable SSA at all settings**

The frequency setting affects size (VMD) but SSA remains constant within 10%.

Interquartile range
0.10 – 0.11
at 870 nm wavelength