°Catalytic Instruments
hot technologies • clean solutions

BACKGROUND

Tube furnaces have been around since the 1980s [1,2]. However, there are not many commercial devices capable of generating stable and very high concentrations of aerosol in the nanometer size range. Such a source is not only useful for calibration but also as a steady supply of seed aerosol for more complex experiments.

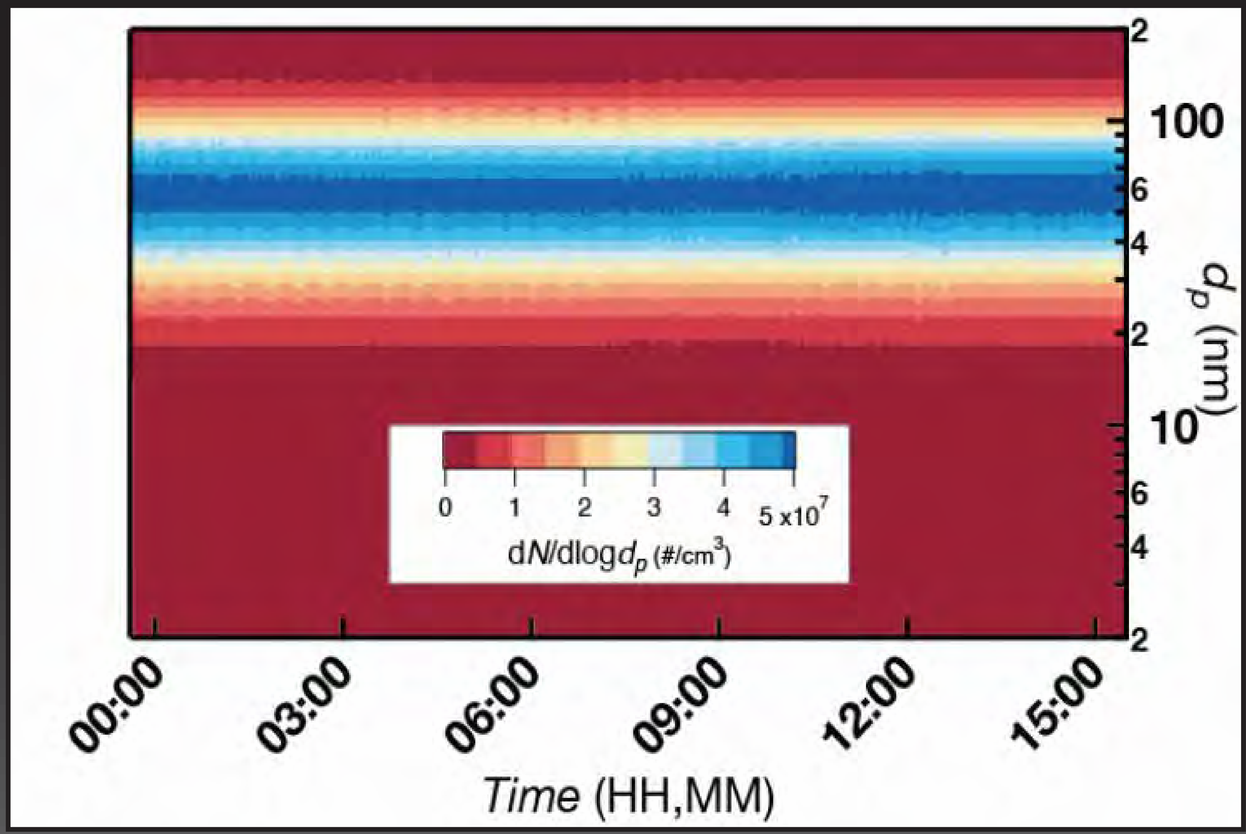
We present the Silver Particle Generator (SPG); a silver particle aerosol generator capable of supplying a steady stream of high concentration aerosol in the particle diameter range 1-200 nm.

DESIRE FOR A STABLE AEROSOL PARTICLE SOURCE

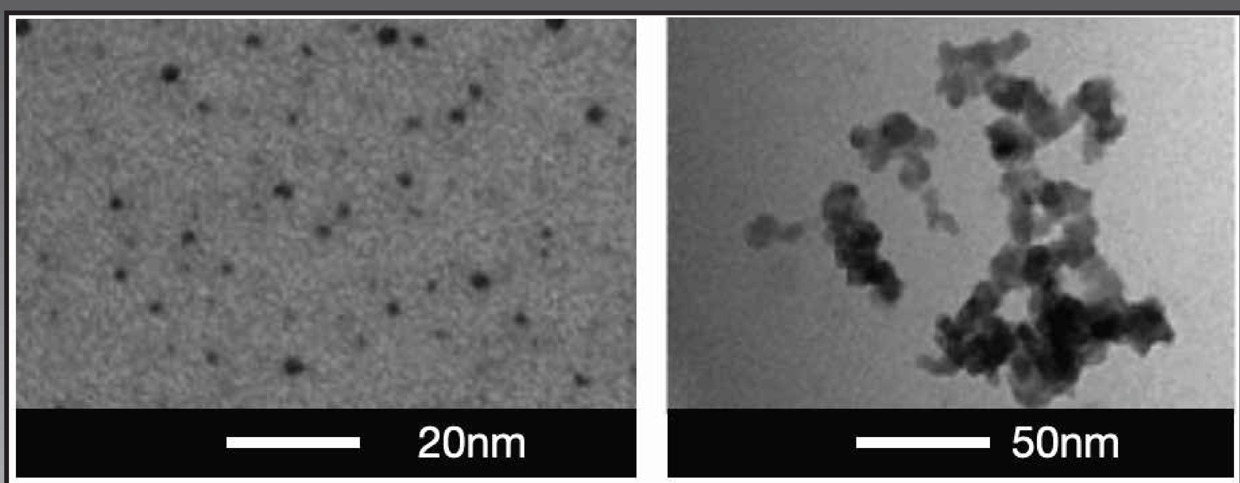
It is rare for calibrations, and aerosol experiments in general, to take less than an hour to perform. A high concentration stable aerosol source is a challenge to find commercially today.

The Silver Particle Generator was designed from the outset to be a one-touch aerosol generator, of high repeatability and accuracy.

Figure 1: (top) SMPS image plot showing 15 hours of continuous aerosol generation from the SPG. (bottom) TEM image of the silver aerosol particles



Characterising the Silver Particle Generator – a pathway towards standardising aerosol generation



DESIGN

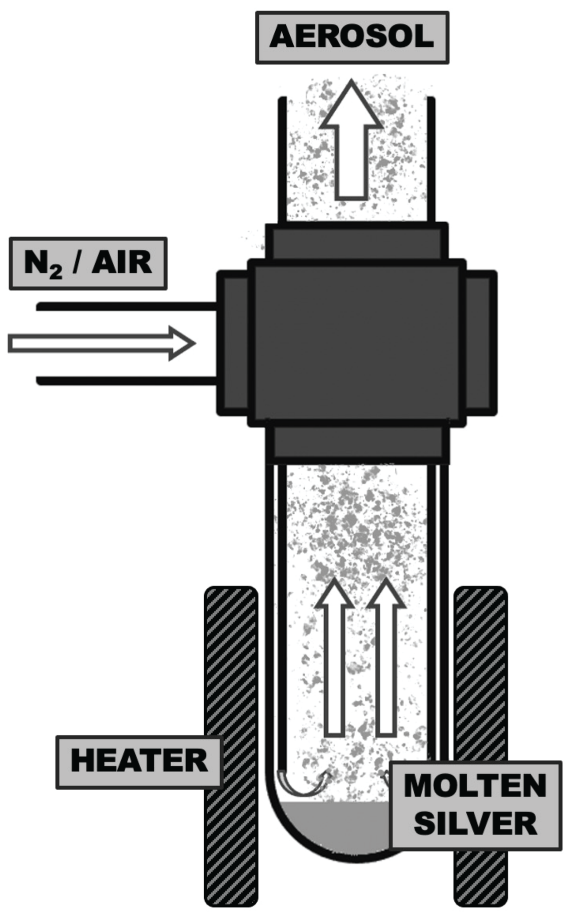


Figure 2 (left): Illustration showing the principle for the generation of aerosolized silver.

A heating element constructed from SiC is used to elevate the temperature of a silver reservoir held in place to above its melting point. Either N_2 or compressed air is brought across the molten silver, carrying silver ions up the tube. As the gas rises, it is passively cooled, forcing the silver to homogeneously condense, forming a nucleation-mode aerosol. This aerosol can then be diluted with an optional dilution flow.

By adjusting the temperature and flow parameters, the resultant aerosol distribution can be fine-tuned for either the smallest (~ 2nm) or largest (~ 200 nm) aerosol generation. The GMD can be controlled between 1 and 70 nm.

Figure 3 (right): A photograph of the SPG.

Operational setpoints are input via a high-resolution touchscreen controller. The user has the option to fine-tune their own set points, as well as set the instrument to start-up in this mode. This allows for a quick and repeatable operation.

From cold, the SPG generates stable aerosol, in around 15 mintes—the same as most commercial CPCs.

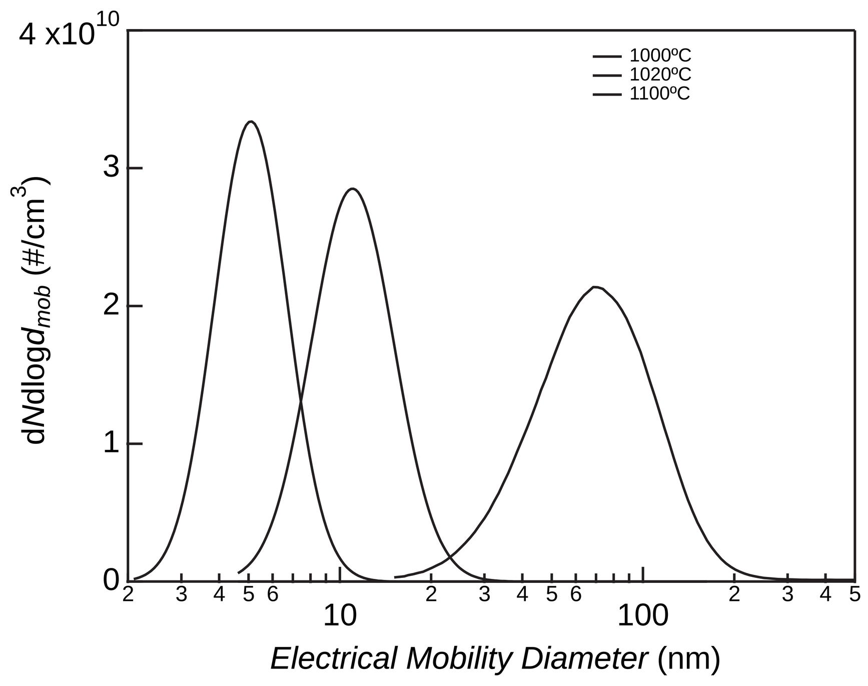
BENEFITS

- aerosol within 15 minutes
- GMD 1–70 nm
- particles over 200 nm
- stable aerosol (c.a. 1 %)
- high concentration
- soot like aggregates
- user-selectable set points
- 1-touch aerosol generation

SIZE

Figure 4 to the right, shows 3 different SMPS scans of the SPG aerosol, for different temperature settings. The user has full control over the temperature, from ambient to 1100°C.

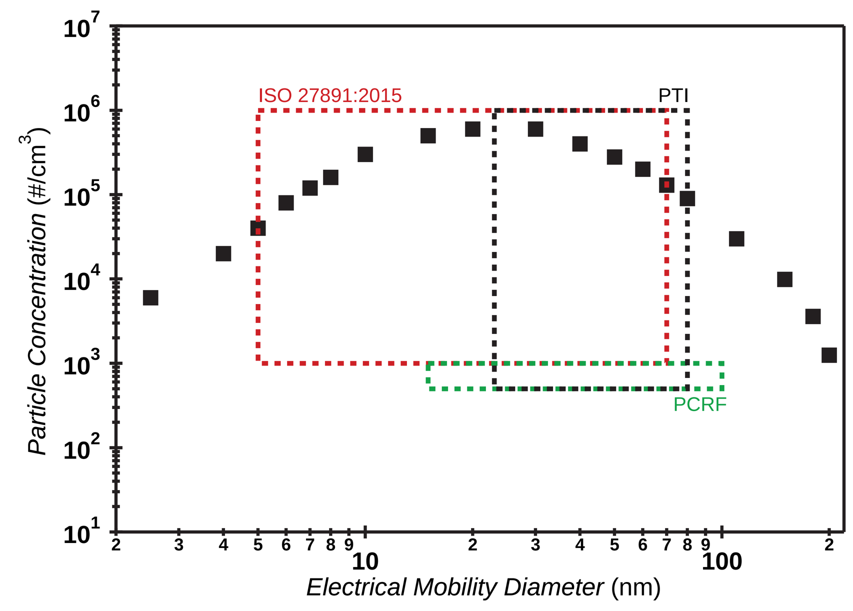
The resultant aerosol size distribution is depenedent on sampling configuration; a long DMA with low sample flow will lose more particles to diffusional loss than a short DMA with high sample flow.



NUMBER

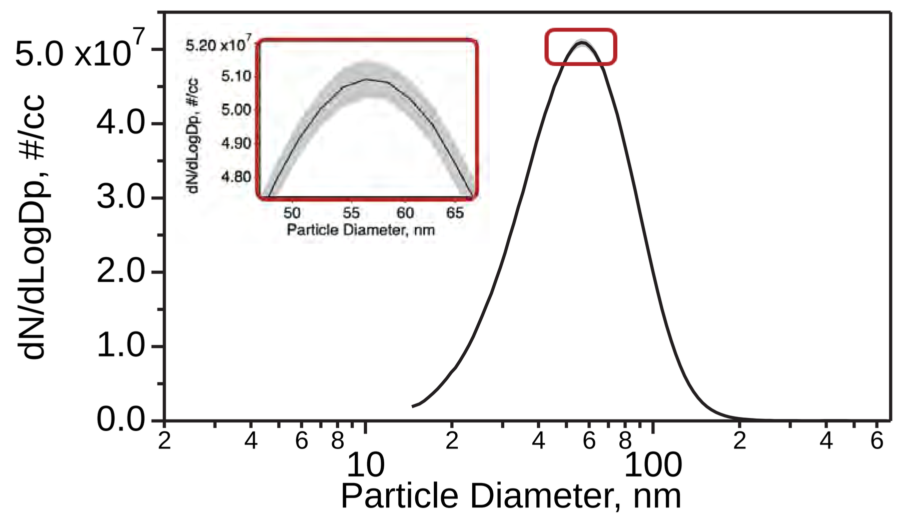
Figure 5 shows CPC concentrations downstream of a DMA selected to a single diameter. Different DMAs, and sample flows, were selected to transmit the largest concentrations of aerosol.

The red box illustrates the desired region for CPC calibrations according to the ISO standard; the black box is for Periodic Test Inspection (PTI); and the green box for particle concentration reduction factor (PCRF) which is part of Euro 6 & 7 standards.



STABILITY

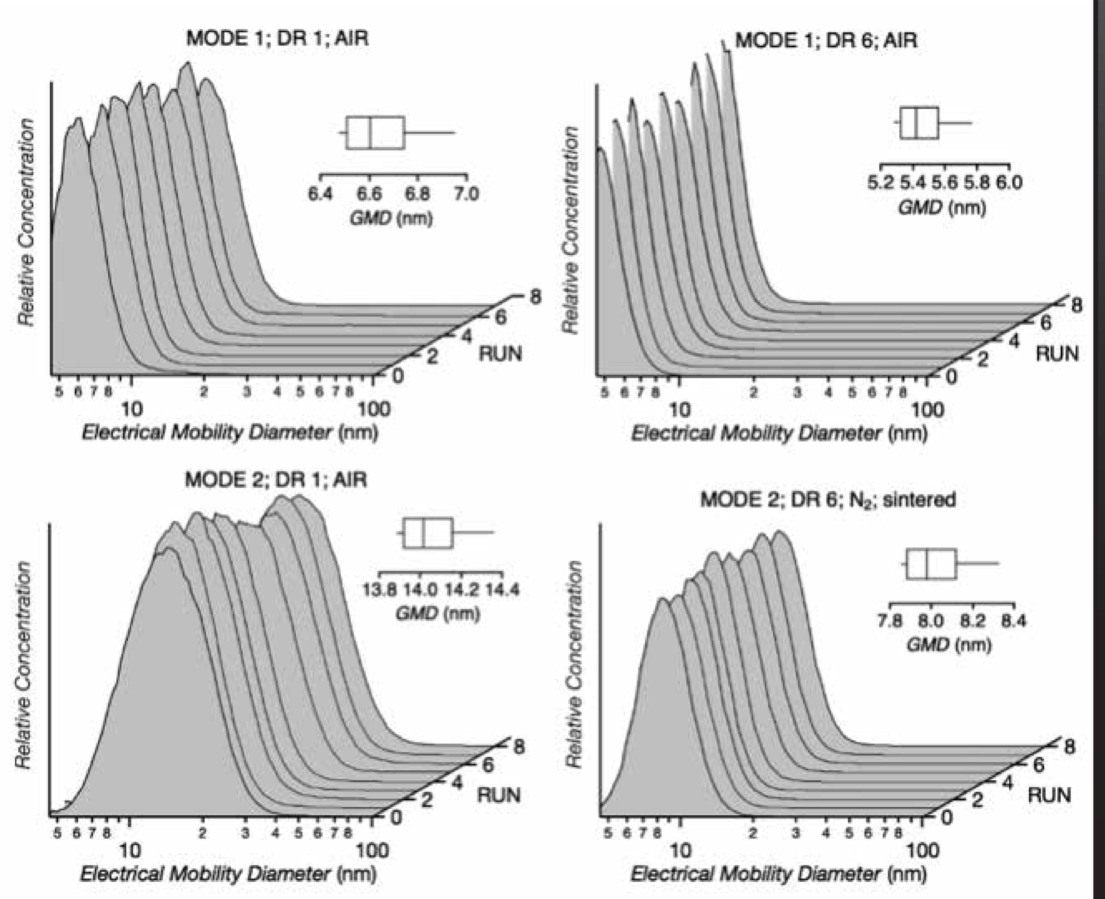
Figure 6 shows the high performance stability of the SPG. This graph is an average per size-bin of Fig. 1 in the top right of this poster. 15 hours of measurement shows around less than 2% variation in concentration and GMD generated by the SPG.



REPEATABILITY

A prototype SPG was used in different modes (temperature settings, and flows) on different days, and times of day (Fig. 7, right). The variation in daily use was to the order of 2%; inter-day concentrations varied by around 10%.

The production SPG has better repeatability, but data is being gathered at present, for future publication.



Acknowledgements

This work is co-funded from AiF project ZU4744101RE9, and characterisation undertaken at METAS as part of MetroPEMS

Patent Pending.

Catalytic Instruments GmbH
Zellerhornstr. 7
83026 Germany

info@catalytic-instruments.com

+49(0)80-3190-1777-0

SCAN ME

References

[1] Scheibel, H. G., & Porstendörfer, J. (1983). Generation of monodisperse Ag- and NaCl-aerosols with particle diameters between 2 and 300 nm. Journal of Aerosol Science, 14(2), 113–126.
[2] Schmidt-Ott, A. (1988). New approaches to in situ characterization of ultrafine agglomerates. Journal of Aerosol Science, 19(5).
[3] T. Hammer; M. Irwin; J. Swanson; V. Berger; U. Sonkamble; A. Boies; H. Schulz, K. Vasilatou (2022). Characterising the Silver Particle Generator; a pathway towards standardising silver aerosol generation. Journal of Aerosol Science, 2022.