

1nm SCANNING MOBILITY PARTICLE SIZER™ (SMPS™) SPECTROMETER MODEL 3938E77 SPECIFICATIONS

TSI's SMPS™ spectrometer is widely used as the standard for measuring size distributions of aerosols below 1 micrometer. With the addition of the Model 3777 Nano Enhancer and Model 3086 Differential Mobility Analyzer (1nm-DMA), the SMPS spectrometer's size range has been expanded to 1 nm.



Features:

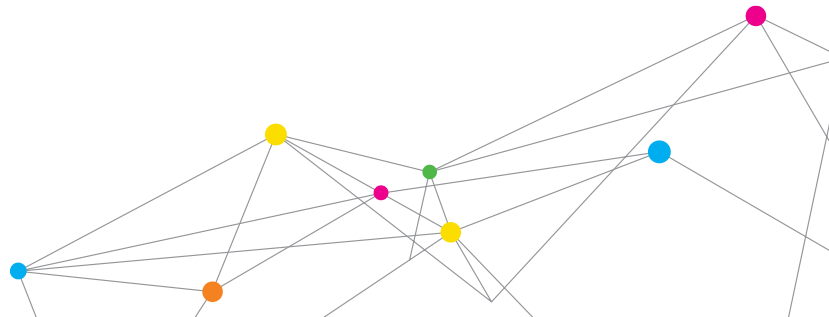
- The following features assume an SMPS spectrometer consisting of: 3082 Electrostatic Classifier, 3086 1nm DMA, 3777 Nano Enhancer, 3772 Condensation Particle Counter
- + High resolution particle size distributions;
 - + 64 channels per decade
 - + >109 channels between 1 and 50 nm
 - + Component design for maximum flexibility
 - + Broad size range from 1 nm to 50 nm
 - + Ability to measure over three decades of size from 1 nm to 1 μm with addition of 3081A Long DMA
 - + Optimized for minimal diffusion losses and system integration
 - + Unified system operation with Aerosol Instrument Manager (AIM) Software
 - + Discreet particle measurement: works well for multimodal samples

Applications:

- + Materials science studies
- + Atmospheric and climate research
- + Fundamental aerosol research
- + Particle nucleation and growth studies
- + Combustion and engine exhaust research
- + Filter and air cleaner testing
- + Health effects studies



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NANO ENHANCER MODEL 3777

SPECIFICATIONS

The 1nm Nano Enhancer Model 3777 enables researchers to measure the number concentration and size (if integrated in an SMPS spectrometer system) of aerosols with high resolution and speed from 1 nm. Ideal for a variety of applications including materials science, atmospheric research, health effects, and combustion emissions research, the Nano Enhancer empowers researchers to study gas to particle conversion, engineered nanoparticle synthesis, particle nucleation and growth, reaction kinetics, and much more. The Model 3777, together with TSI's 1nm-DMA Differential Mobility Analyzer Model 3086 have been optimized for minimal diffusion losses, and can be integrated within an SMPS spectrometer capable of sizing from 1 nm to 50 nm and expandable from 1 nm to 1 μm with the 3081A Long DMA.

Operation:

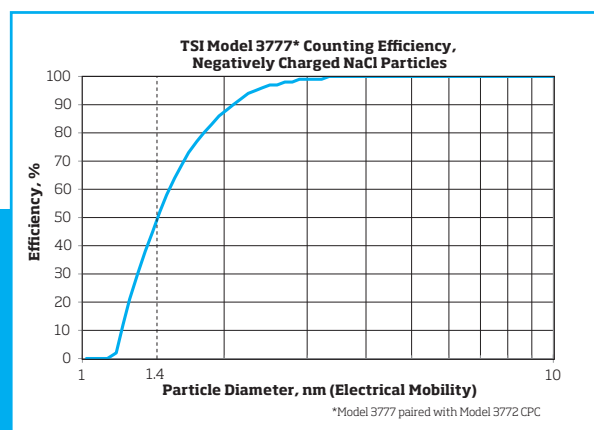
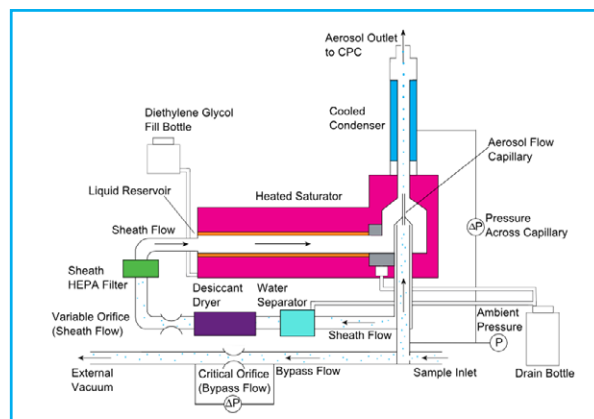
The physical properties of the working fluid in conventional CPCs (alcohol, or water) limit the lower detection limit (D_{50}) of these CPCs to 2.5 nm. By using diethylene glycol (DEG) as a working fluid, the Nano Enhancer Model 3777 initiates condensation on particles as small as 1 nm (1.1 nm geometric diameter, 1.4 nm electrical mobility diameter). The Model 3777 continuously draws an aerosol sample through a heated saturator in which DEG is vaporized and diffuses into the sample stream. The aerosol and DEG vapor pass through a cooled condenser where the DEG vapor becomes supersaturated, forcing the DEG vapor to condense on the particles in the sample stream. As the DEG vapor condenses on the particles, they grow. The Nano Enhancer is optimized to prevent homogeneous nucleation of the working fluid, keeping the false count rate below 0.01 particle/ cm^3 , based on a 12-hr average.

While the use of DEG as a working fluid enables the 3777 to initiate the growth of particles down to 1 nm, DEG also limits the maximum size to which these particles can be grown. As the particles pass through the Nano Enhancer, they grow to a size which is still too small to be optically detected, but large enough to be measured by a conventional CPC. The DEG-enhanced particles are drawn out of the Nano Enhancer into a Model 3772 butanol-based CPC, which uses another saturation and condensation stage to further grow the particles until they are large enough to be optically detected and counted by a laser-based optical system.

The Nano Enhancer is optimized to be paired with a TSI Model 3772 CPC creating a 1nm CPC system.

Features and Benefits:

- + Sensitivity down to 1 nm
- + Diethylene glycol (DEG) working fluid
- + Optimized for use with TSI's existing SMPS spectrometer systems
- + High inlet flow rate to minimize diffusion losses
- + 300,000 particles/ cm^3 with continuous, live-time coincidence correction (when used in combination with a Model 3772 CPC)



SPECIFICATIONS

MODEL 3777 NANO ENHANCER

Particle Size Range

Min. Detectable
Particle (D_{50}): 1.4 nm (electrical mobility diameter,
1.1 nm geometric diameter),
verified with NaCl particles

Flow

Aerosol Flow Rate 2.5 L/min
Aerosol Outlet Flow Rate 1.0 L/min
Transport Flow Rate 1.5 L/min
Flow source External vacuum
Flow Control Volumetric flow control of transport
flow internal critical orifices. Aerosol
flow rate controlled by 3772 CPC.

Aerosol Medium

Recommended for use with air; safe for use with inert gases
such as nitrogen, argon, and helium (performance specifications
are for air)

Condensing Liquid

Working Fluid Diethylene Glycol (DEG, $\geq 99\%$)
Filling System Electronic liquid-level sensor initiates
automatic filling as needed, requires
connection to fill bottle
Water Removal Sheath air is dried using a water
separator and refillable desiccant dryer

Communications

Protocol Command set based on ASCII characters
Interfaces RS-232 9-pin, D-sub connector

Physical Features

Front Panel LCD TFT QVGA (320×240 pixel) 5.7-in.
color display, sample inlet, rotate/select
control knob
Rear Panel Power connector, 9-pin D-sub serial
connector, fan, DEG connector, drain
connector, pump-exhaust port, fill
bottle and bracket, desiccant dryer
connections and bracket, desiccant
dryer connections and bracket.
Side Panel DEG-level viewing window
Dimensions (H x W x D) 25 × 32 × 37 cm (10 × 13 × 15 in.),
not including tray and fill bottle
Weight 9.9 kg (22 lbs)

1nm CPC SYSTEM (MODEL 3777 NANO ENHANCER AND MODEL 3772 CPC)

Particle Size Range

Min. Detectable
Particle (D_{50}): 1.4 nm (electrical mobility diameter,
1.1 nm geometric diameter),
verified with NaCl particles

Particle Concentration Range

0 to 3×10^5 particles/cm³, single particle counting with continuous,
live-time coincidence correction

Particle Concentration Accuracy

$\pm 10\%$ at $< 1.65 \times 10^5$ particles/cm³
 $\pm 15\%$ at 3×10^5 particles/cm³

Response time

< 4s to 95% in response to concentration step change

False Background Counts

< 0.01 particle/cm³, based on 12-hr average



1nm-DMA DIFFERENTIAL MOBILITY ANALYZER MODEL 3086



Designed to be used with TSI's Model 3082 Electrostatic Classifier, the Model 3086 1nm-DMA features an optimized flow path that reduces diffusion losses and improves size resolution over the particle size range of 1 to 50 nm.

SPECIFICATIONS

Size range

1 to 50 nm

Resolution

R=4.7 at 1.47 nm

Flow rate range

(flows provided by Model 3082 Classifier and/or external source)

Aerosol flow rate	0.1 to 2.5 L/min
Sheath flow rate	2 to 25 L/min
Bypass flow rate	0 to 12 L/min

Specifications are preliminary and subject to change without notice

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KEY REFERENCES

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- + Jiang, J., Chen, M., Kuang, C., Attoui, M., and McMurry, P. H., 2011, "Electrical Mobility Spectrometer Using a Diethylene Glycol Condensation Particle Counter for Measurement of Aerosol Size Distributions Down to 1 nm," *Aerosol Science and Technology*, 45(4): 510-521
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