

SMALL PARTICLES AND THE LOWER DETECTION LIMIT

Dustlight measures particles in the size range from **0.3 to 10 µm**. Smaller particles – nanoparticles below 100 nm in particular – are not detected. This is not a question of calibration or firmware, but a **physical property** of all optical light-scattering methods. For the vast majority of workplace dusts the limit has no practical consequence, because both the dust mass and the applicable exposure limits lie above this threshold. Where nanomaterials are handled deliberately, other measurement methods complement Dustlight – they do not replace it.

FOR	TOPIC	APPLIES TO	ISSUED
Occupational safety professionals, EHS managers, channel partners	Lower detection limit of optical dust measurement	Dustlight device	August 2026

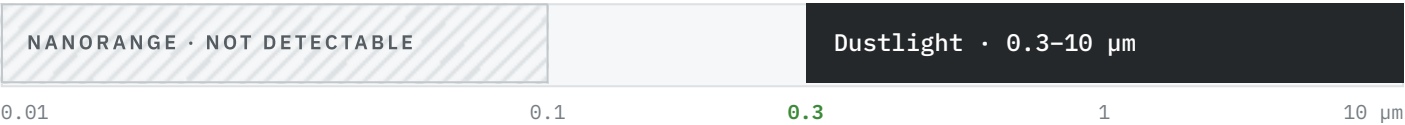
01 HOW DUSTLIGHT MEASURES

Inside Dustlight, a laser diode generates a beam of light at a wavelength of 660 nm, i.e. red light. A fan draws air through this beam. When a dust particle crosses the laser, it scatters part of the light sideways, and a photodiode registers this brief reflection.

The principle is familiar from everyday life: dust becomes visible in a shaft of sunlight because the particles scatter light. From the brightness of each reflection the sensor derives the particle size, and from the number of reflections the concentration. Together these yield the mass concentrations that Dustlight displays.

PRINCIPLE · LIGHT SCATTERING	
Laser wavelength	660 nm
Measuring range	0.3–10 µm
Output	Mass concentration

WHERE DUSTLIGHT MEASURES – AND WHERE IT DOES NOT



Logarithmic size scale. Below 0.3 µm lies the nanorange, which optical methods cannot resolve.

02 WHY THERE IS A LOWER LIMIT

What matters is the ratio between particle size and the wavelength of the light.

A particle considerably larger than the wavelength scatters a great deal of light and is therefore easy to see. Once it becomes smaller than roughly one sixth of the wavelength, scattering collapses. In this regime – known as the **Rayleigh regime** – the signal scales with the **sixth power** of the diameter.

RAYLEIGH REGIME

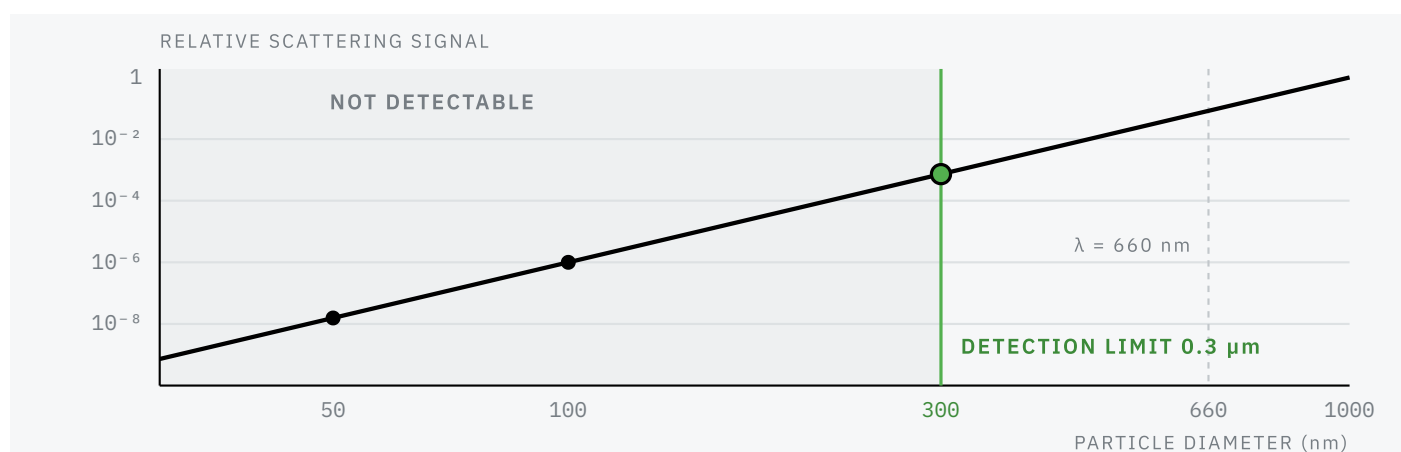
$$\text{Signal} \propto d^6$$

Diameter halved	1/64
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Diameter reduced tenfold	1/1,000,000
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A 50 nm particle therefore returns only about one hundred-thousandth of the signal of a 300 nm particle. That signal disappears into the optical background noise of the measuring chamber – comparable to trying to spot a candle next to a floodlight.

This is why the lower detection limit of optical particle counters has remained at approximately 0.3 μm for decades, irrespective of manufacturer. Instruments that do capture smaller particles operate on a fundamentally different measurement principle (see section 05).



Log-log representation: every halving of particle size costs a factor of 64 – between 300 and 50 nm lie roughly five orders of magnitude.

03 WHY THE LIMIT IS RARELY CRITICAL IN PRACTICE

Mass concentration and particle number behave in entirely different ways. The mass of a particle grows with the third power of its diameter, so small particles are numerous yet contribute almost no mass.

NEEDED FOR 1 $\mu\text{g}/\text{m}^3$

8,500 particles/ cm^3

at 50 nm diameter, density approx. 1.8 g/cm^3

Even a high number concentration therefore remains virtually invisible in the mass balance. This matters because the applicable occupational exposure limits – the general dust limit, the respirable dust fraction, and substance-specific limits such as those for respirable crystalline silica – are defined on a **mass basis**. They refer to precisely the size range that Dustlight covers.

Typical workplace dusts sit in the same range: quartz and mineral dust, wood dust, cement and gypsum dust, grinding and abrasive dust, and metal dust. For these applications the 0.3 µm lower limit imposes no restriction.

MASS-BASED LIMITS IN THE MAJOR JURISDICTIONS

JURISDICTION	RESPIRABLE CRYSTALLINE SILICA	GENERAL DUST	NOTES
EU / Germany	EU binding limit value of 0.1 mg/m³ (respirable fraction) under Directive 2004/37/EC as amended by Directive 2017/2398; several Member States apply stricter national values	General dust limit of 1.25 mg/m³ respirable (mineral density 2.5 g/cm³) and 10 mg/m³ inhalable	German framework: GefStoffV, TRGS 900, TRGS 559
United States	OSHA PEL 50 µg/m³ as an 8-hour TWA, with an action level of 25 µg/m³	OSHA PEL 5 mg/m³ for respirable particulates not otherwise regulated	29 CFR 1910.1053 (general industry) and 1926.1153 (construction); the ACGIH TLV of 25 µg/m³ is advisory rather than enforceable
Australia	WES 0.05 mg/m³ as an eight-hour TWA; a further reduction to 0.025 mg/m³ is under consideration as part of the December 2026 transition	10 mg/m³ for the inhalable fraction	From 1 December 2026 the Workplace Exposure Limits (WEL) list replaces the WES list nationally, following a harmonised transition period ending 30 November 2026; the rename signals that these are limits not to be exceeded.

Every one of these values is a mass concentration in a defined size fraction. None of them is expressed as a particle number or as a nanofraction – which is precisely why an instrument measuring from 0.3 µm upwards is the appropriate tool for compliance-oriented monitoring.

Note for Australian users: Exposure data gathered before a limit changes does not remain fit for purpose afterwards. Where a limit is tightened in the December 2026 transition, earlier assessments should be reviewed against the new value.

04 NANOSCALE AND FIBROUS MATERIALS

Two points are worth noting briefly for anyone assessing engineered nanomaterials.

FIBROUS SHAPE Elongated shape does not compensate for a small diameter. Optical methods evaluate every particle as a volume-equivalent sphere. A fibrous object 50 nm in diameter and 500 nm long corresponds to a sphere of roughly 120 nm, and therefore remains below the detection limit. The scattering response of fibrous particles also depends on their orientation in the laser beam and cannot meaningfully be converted into a size.	AGGLOMERATES Airborne nanomaterials are usually agglomerated. Field measurements at sites processing carbon nanotubes and nanofibres show that the airborne material is predominantly present as agglomerates of several micrometres. Such agglomerates fall within Dustlight's measuring range and are recorded as mass, so release events and dust peaks become visible. Chemical identification and fibre counting remain outside the scope of any optical method.
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Regulation reflects this. Across all three major jurisdictions, exposure to nanomaterials is addressed through guidance values and laboratory methods rather than through enforceable limits verifiable in real time.

Germany	Activities involving nanomaterials fall under TRGS 527. For fibrous nanomaterials the IFA/DGUV cites a provisional assessment value of 10,000 fibres/m³, while explicitly noting that proven sampling and analytical methods for routine workplace monitoring are lacking.
United States	NIOSH recommendations for engineered nanomaterials are recommendations rather than OSHA permissible exposure limits, and are determined by laboratory filter analysis.
Australia	There are currently no legal workplace exposure limits or health monitoring requirements for nanomaterials at all; the guidance itself cites the lack of instrumentation sensitive to nanomaterials and the natural nanoparticle background in air as the reasons.

The practical conclusion is the same everywhere: quantifying a nanofraction is laboratory work. Keeping mass-based exposure under control and demonstrating that engineering controls are effective is the domain of real-time personal monitoring.

05 WHICH METHODS COVER THE RANGE BELOW 0.3 µm

MEASUREMENT TASK	METHOD	RANGE / REMARKS
Particle number in the nanorange	Condensation particle counter (CPC)	from approx. 10 nm, no size information
Size distribution	SMPS / DMAS per ISO 15900	approx. 10–500 nm, reference method, stationary
Personal nanoparticle monitoring	Diffusion charger (LDSA)	approx. 10–300 nm, surface-area metric instead of mass
Soot / elemental carbon	Thermal-optical filter analysis, absorption measurement	mass-based, size-independent
Fibre identification and counting	SEM / TEM following filter sampling	laboratory-based only

The European standard EN 17058 sets out a tiered approach for this: from information gathering, through orientation measurements with direct-reading instruments, to full expert assessment. The methods are thus not competing alternatives but successive steps.

06 DECISION GUIDE

DUSTLIGHT IS THE RIGHT TOOL WHEN ...

- exposure to respirable dust or substance-specific fine dusts needs to be assessed,
- dust events are to be made visible in real time in order to address causes and behaviour,
- the effectiveness of extraction, enclosure or wet methods needs to be verified,
- measurement is to be personal and cover a full shift.

COMPLEMENTARY METHODS ARE NEEDED WHEN ...

- nanomaterials are handled deliberately and the nanofraction itself must be assessed,
- exposure to fibrous materials needs to be evaluated,
- soot or diesel engine emissions constitute the dominant burden,
- substance-specific proof to a standardised reference method is required.

SOURCES

Sensirion, Datasheet SEN5x, version 2 (March 2022) – size ranges, laser wavelength, calibration aerosol

Atmospheric Measurement Techniques 13 (2020) 6343 – refractive index and absorption in optical particle sensors

NIOSH Current Intelligence Bulletin 65 – Occupational Exposure to Carbon Nanotubes and Nanofibers

EN 17058:2018 – Workplace exposure: assessment of inhalation exposure to nano-objects

Directive 2004/37/EC as amended by Directive (EU) 2017/2398 – binding limit value for respirable crystalline silica

29 CFR 1910.1000 Table Z-1 (OSHA) – particulates not otherwise regulated

Safe Work Australia – Safe handling and use of carbon nanotubes in the workplace

Aerosol and Air Quality Research – unchanged lower detection limit of optical particle counters at approx. 300 nm

IFA/DGUV – criteria for assessing protective measures against nanomaterials

Annals of Work Exposures and Health 59 (2015) 705 – CNT/CNF exposure assessment at 14 sites

TRGS 527 and TRGS 900 (Germany) – nanomaterials; occupational exposure limit values

29 CFR 1910.1053 and 1926.1153 (OSHA) – respirable crystalline silica

Safe Work Australia – Workplace exposure limits for airborne contaminants (WEL list), from 1 December 2026