

Particle Counting
Technology For Almost
Every Application.

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New sensor to support high performance filtration evaluation

**Michael Schumacher
technical manager**



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Current situation :

- Modern particle counting system can detect particle sizes down to $3\mu\text{m}_{(c)}$ or $1\mu\text{m}$ Latex.
- Systems are using light extinction as operation principle
- Good concentration limits (>150000 p/ml)
- Widely accepted in the filter industry because of reliable operation and good performance.

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New demand :

- Advanced filter media for fuel filtration requires smaller detection sizes $< 3\mu\text{m}_{(c)}$
- Water filtration needs smaller detection size ($< 1\mu\text{m}$)

These sizes cannot be detected with extinction light sensors,
only possible with scattering light sensors!

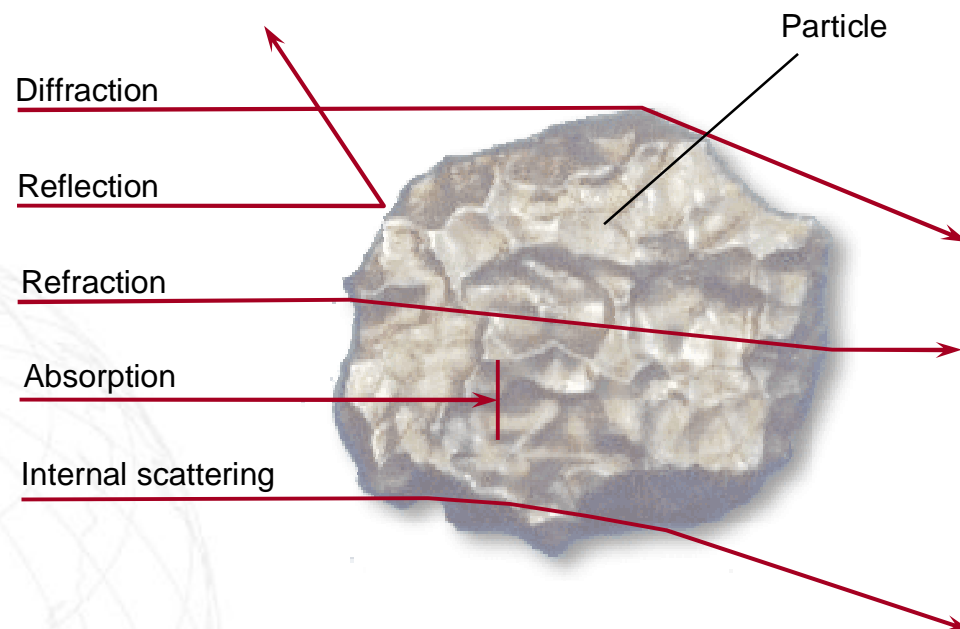
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Light Interaction with a Small Particle





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Specific features of scattering light sensors :

- Good detection limits to sizes well below $3\mu\text{m}_{(c)}$ or $1\mu\text{m}$
- Systems available with detection limits of $0.1\mu\text{m}$
- Limited max. concentration (<5000 p/ml)
- Very strong dependency of material and size detection
- Typically used to determine absence of particles

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Specific features of scattering light sensors :

A new system needs to be optimized to:

- Good detection limits to sizes well below $3\mu\text{m}_{(c)}$ or $1\mu\text{m}$
- $1\mu\text{m}_{(c)}$ would be good
- Systems available with detection limits of $0.1\mu\text{m}$
- Limited max. concentration (<5000 p/ml)
- Concentration must be significantly higher (>10000 p/ml)
- Very strong dependency of material and size detection
- No problem because of controlled environment
- Typically used to determine absence of particles

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Result:

- Detection limit $1\mu\text{m}_{(c)}$ or $0.5\mu\text{m}$
- max. concentration (>10000 p/ml)
- Rugged design (p_{max} 20bar, vibration insensitive solid state laser)



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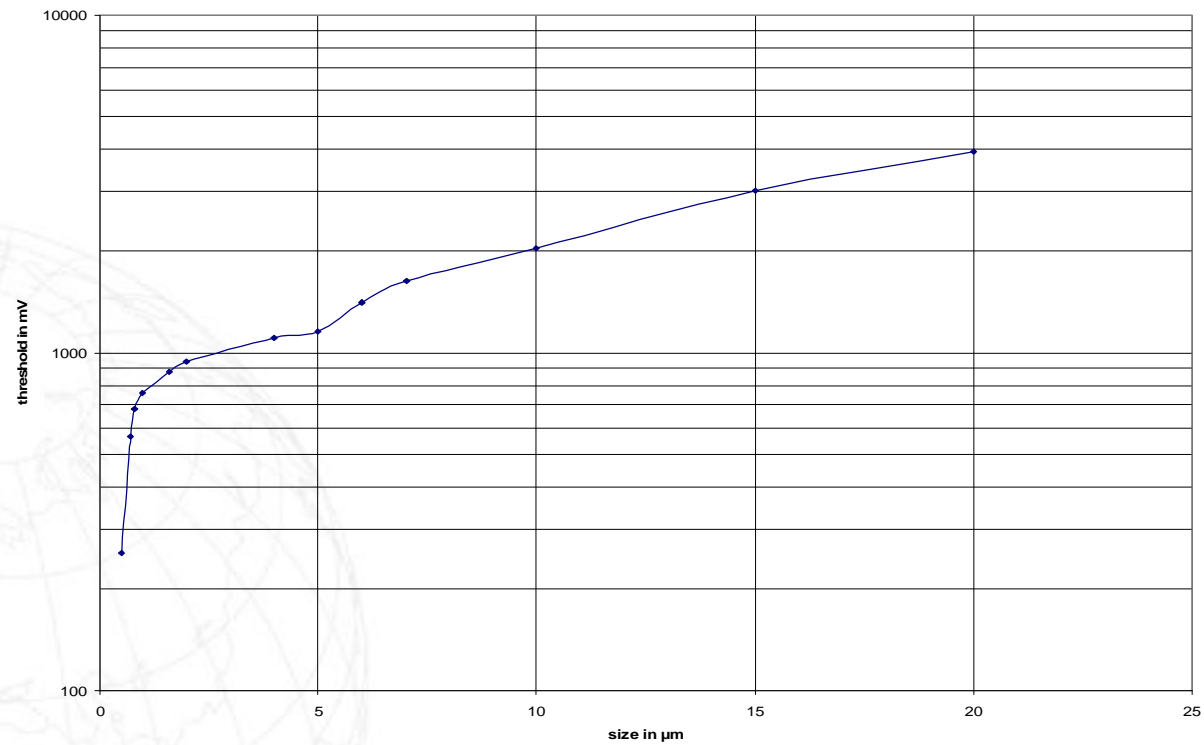


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Latex calibration (ISO21501-2 / ASTM F658-00a)

Calibration curve SLS



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Conclusion for latex calibration:

- Calibration curve smooth and strictly monotonic increasing
- Wide calibration range up to 20 μ m
- Sensitivity matches 0.5 μ m very well, S/N-ratio is $\gg 1.5$.

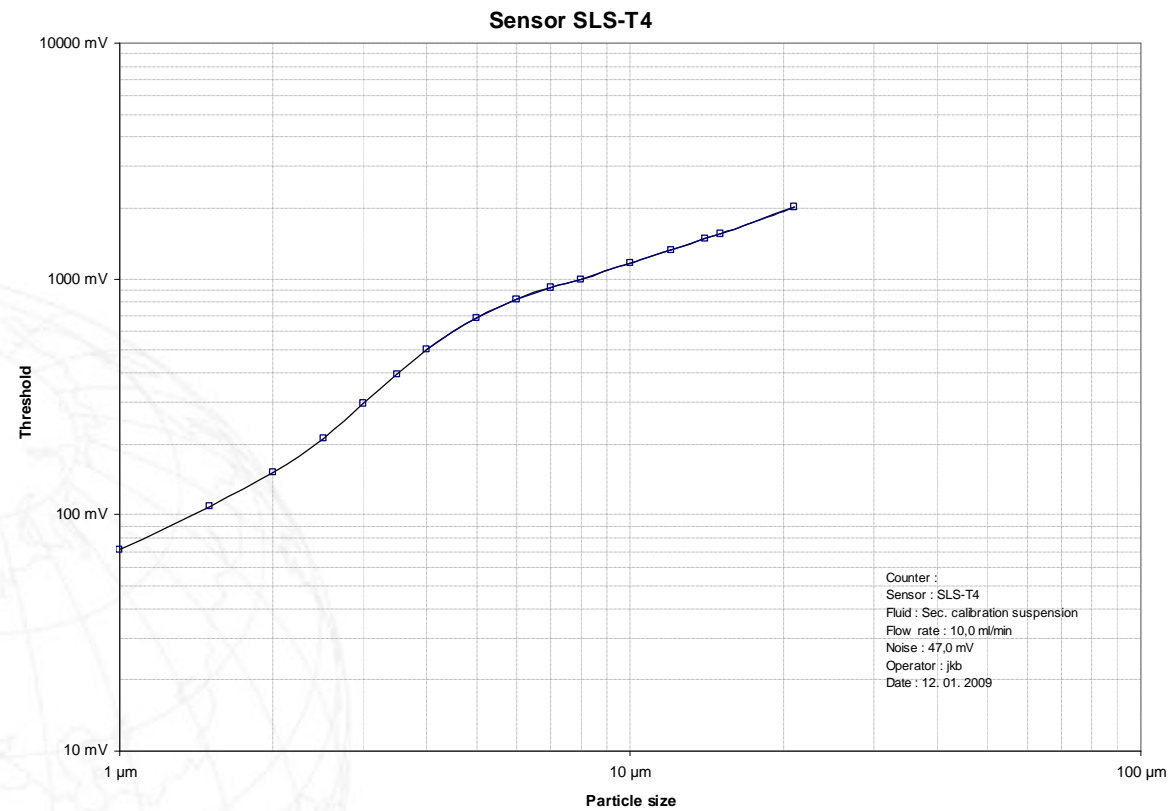
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Dust calibration (ISO11171)



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Conclusion for dust calibration:

- Calibration curve smooth and strictly monotonic increasing
- Wide calibration range up to $21\mu\text{m}_{(C)}$
- Sensitivity not yet exactly at $1\mu\text{m}_{(C)}$, because S/N-ratio is 1.45. ISO11171 specifies S/N-ratio to 1.5.
- SRM2806 calibration material has no values for $1.5\mu\text{m}_{(C)}$, $2.5\mu\text{m}_{(C)}$, $3.5\mu\text{m}_{(C)}$. Interpolation is necessary! New SRM2806 certificate should include these values.



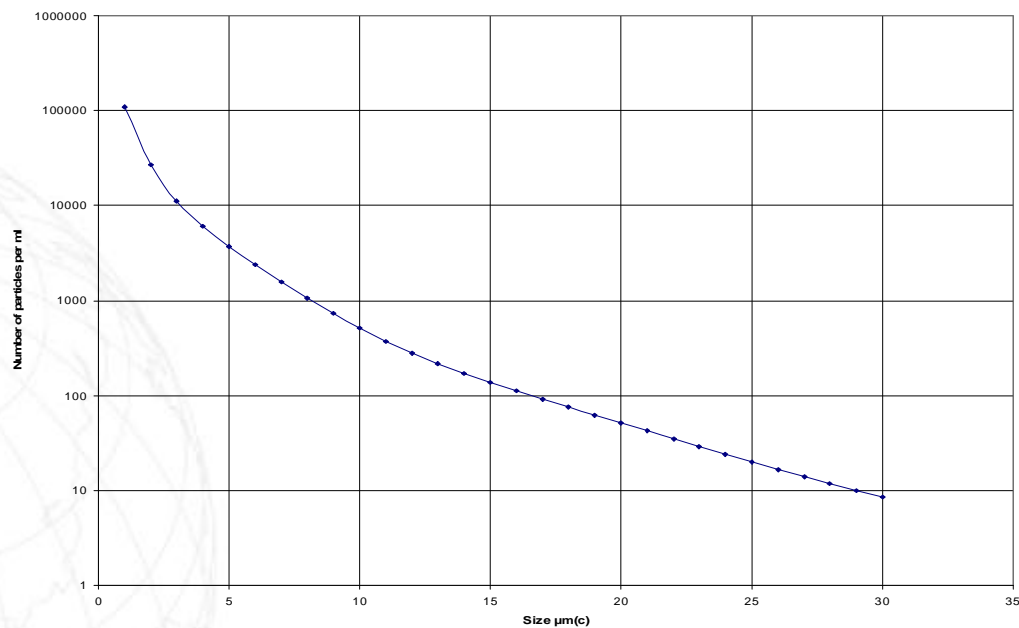
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Concentration consideration:

- Number of particles rises sharply for small sizes (from 11209 at $3\mu\text{m}_{(c)}$ to 108400 at $1\mu\text{m}_{(c)}$)

SRM2806 Size distribution



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Coincidence trials:

- Testing according to ISO11171 using ISO12103 UFTD
- Max. concentration is 0.56mg/l or 13300p/ml
- Analysis critical due to high cleanliness requirements for oil preparation

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Proposed test stand layout:

- New scattering sensors can be used downstream of test filter.
- Extinctions sensor should be used upstream of test filter to avoid over-concentration
- Very good detection size range allows to test high performance filters

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Conclusion:

- New scattering sensors extend the test range for fuel filters from $3\mu\text{m}_{(c)}$ to $1\mu\text{m}_{(c)}$.
- Rugged design promises easy application into test stands.
- Systems have a low max. concentration limit. This restricts use to low concentration zones in test stands.

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Any questions?

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