

# Traceability of Particle Measurement



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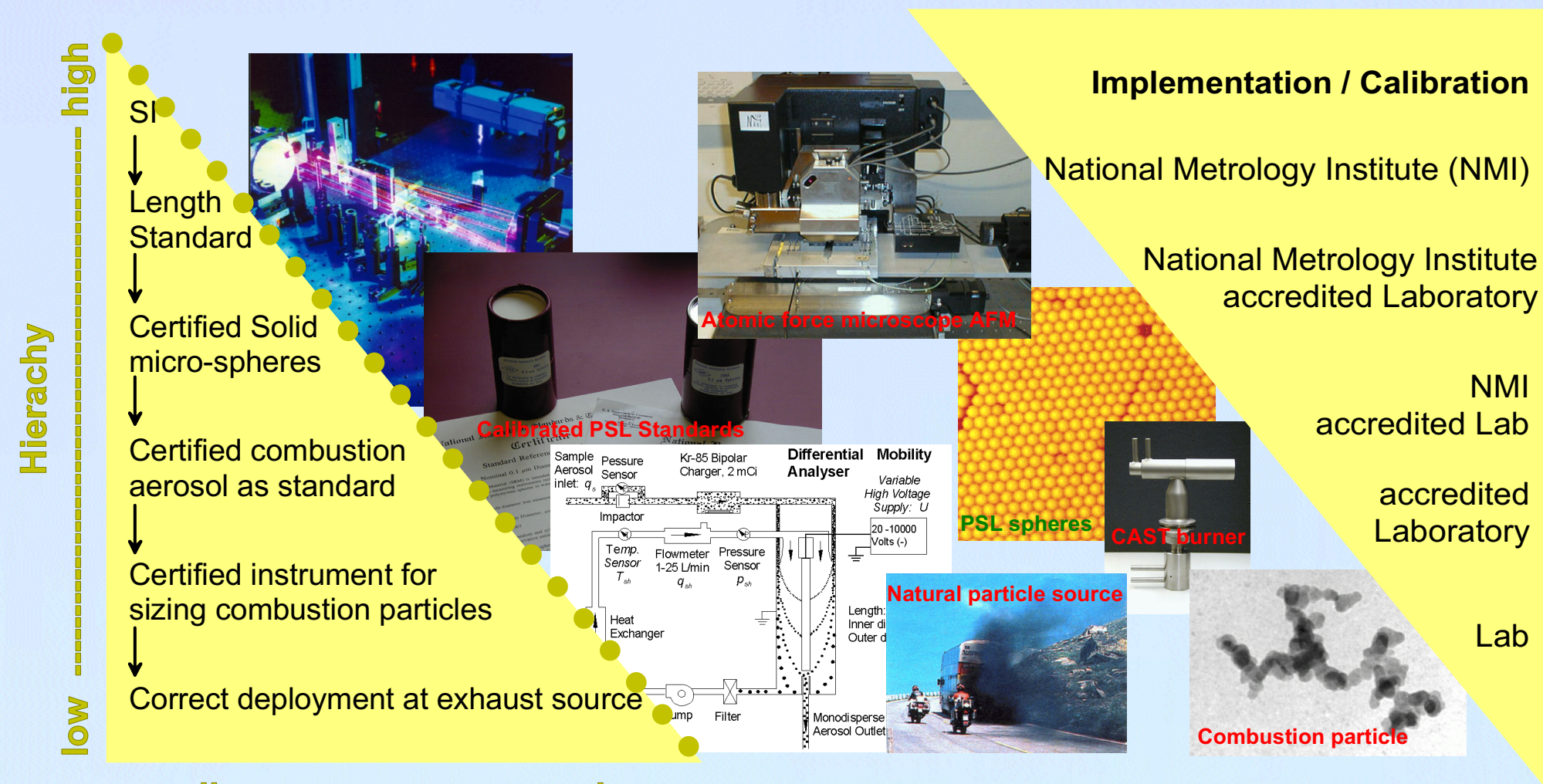
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Future limits for emissions from combustion engines are likely to be based on the particle size and the number concentration rather than on their total mass<sup>1)</sup>. On condition that the measuring technique is traceable to the International System of Units (SI) it can be applied for legislative tolerance limits. The particle diameter is defined as the equivalent diameter of a sphere with the identical electrical mobility. The number concentration is defined as the number of particle objects per volume unit.

The traceability chain for the particle diameter consists of following links: The geometrical diameter of micro-spheres is calibrated by specialised metrological laboratories and is made traceable to the international standard of length. Mixed in air these micro-spheres are used as a monodisperse aerosol for the calibration of particle mobility from measuring instruments. They subsequently allow the calibration of combustion aerosols from generators (e.g. Combustion Aerosol STandard, CAST<sup>2)</sup>). Finally the combustion aerosol represents a dynamically prepared reference material for particle mobility.

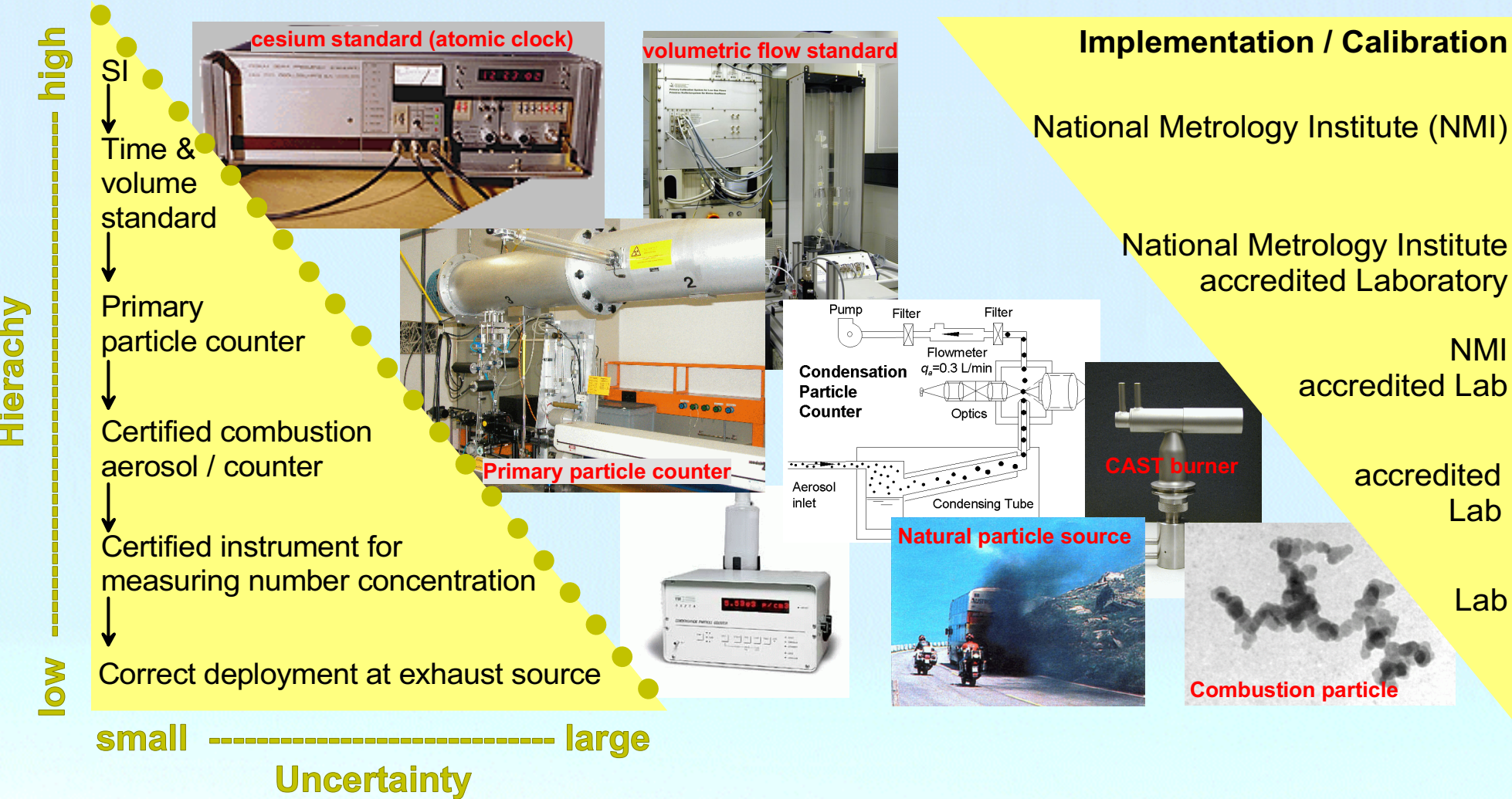
The traceability chain for the particle number concentration consists of following links: In the laboratory of METAS the measurement of the particle number concentration is realised with a primary particle counter. The sample-flow of the aerosol is calibrated with international standards of volume and time. The passing of each particle in the detection volume is counted with a known efficiency. The primary standard allows to calibrate particle generators and other particle counters.

**Definition of particle diameter:** The particle diameter is the diameter of a spherical solid body that has an equivalent electrical mobility (mobility diameter).



**Example:**  
The particle size distribution of the CAST combustion aerosol has a median mobility diameter in the range between 30 nm and 200 nm, and  $\sigma_g$  (geometrical standard deviation) of about 1.6. METAS can establish traceability to the SI and calibrate median mobility diameters with a typical measurement uncertainty of about 5 %.

**Definition of particle number concentration:** The particle number concentration is the number of solid or fluid particles per unit volume referred to 0 °C and 1013 hPa.



**Example:**  
The CAST combustion aerosol produces dynamically a particle concentration in a range from  $10^3 \text{ cm}^{-3}$  to  $10^7 \text{ cm}^{-3}$ . METAS can establish traceability to the SI and calibrate particle number concentration with a typical measurement uncertainty between 20 % and 30 %.

**References:** 1) e.g. ECE 47, ECE 49  
2) CAST-Combustion Aerosol Standard Short Specifications, Applications, ETH Workshop 2001 "Nanoparticle Measurement"