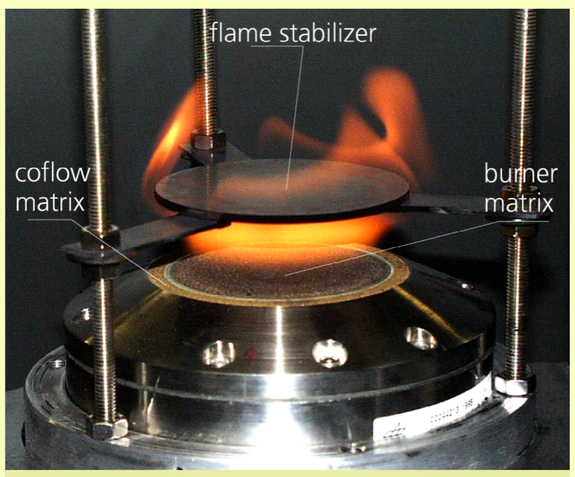
Deutsches Zentrum für Luft- und Raumfahrt e.V.

Validation of Soot Measurement Technique

C. Wahl, M. Kapernaum, M. Aigner
Institute of Combustion Technology
Pfaffenwaldring 38-40, D-70569 Stuttgart
e-mail: claus.wahl@dlr.de

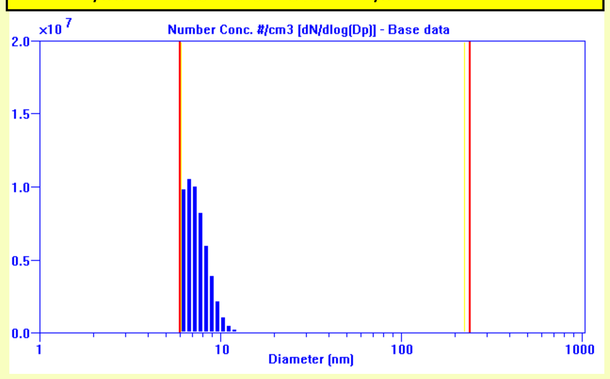
Soot Source: DLR Soot Generator

Deutsches Patent- und Markenamt: No. 102 43 107.0

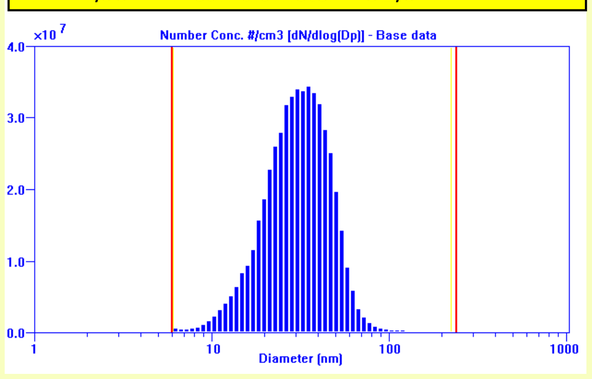


variable soot generator

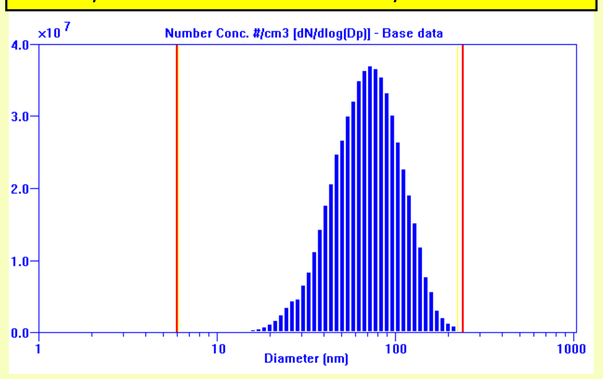
Phi = 1,85 mean diameter = 7,5nm



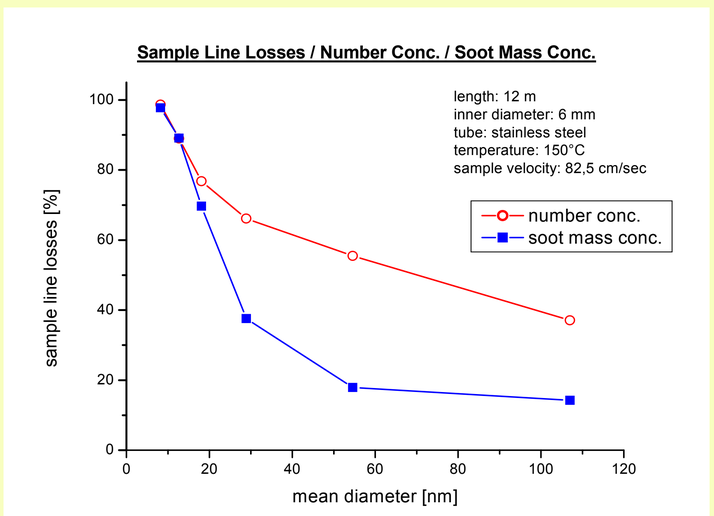
Phi = 1,95 mean diameter = 32,8 nm

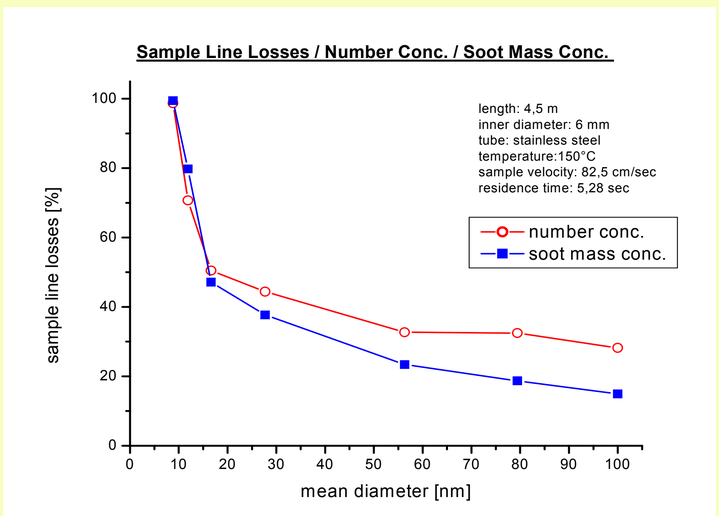


Phi = 2,10 mean diameter = 76,3 nm



Sample Line Losses:

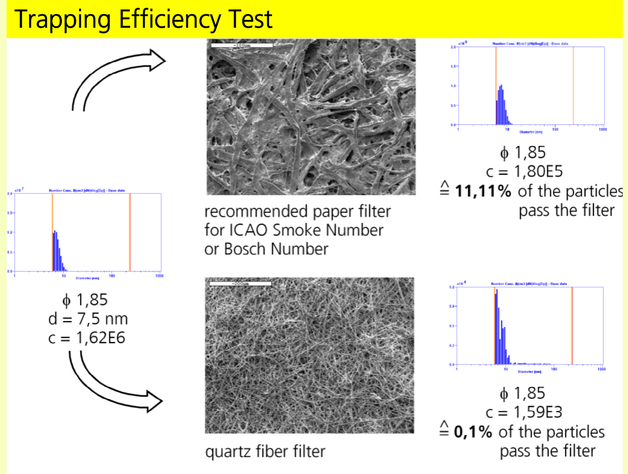




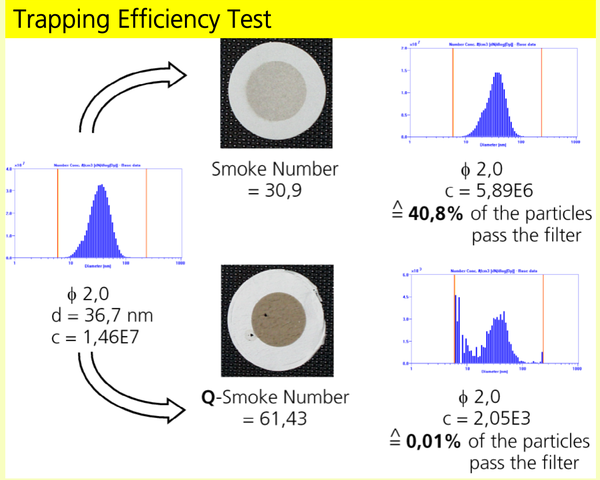
Results:
- sample line losses are extremely size dependent
- up to 99% loss for particles < 10 nm !!!!
- particles < 10 nm are trapped in the sample line
- losses in number concentration > losses in mass conc.
- only particles > 10nm grow by agglomeration
- line losses are a complex function of : size distribution, number concentration, flow velocity = residence time, Reynolds number, gas viscosity, line length and diameter.....
- dilution should take place direct at the probe entrance

Smoke Number Filter Tests:

Trapping Efficiency Test



Trapping Efficiency Test

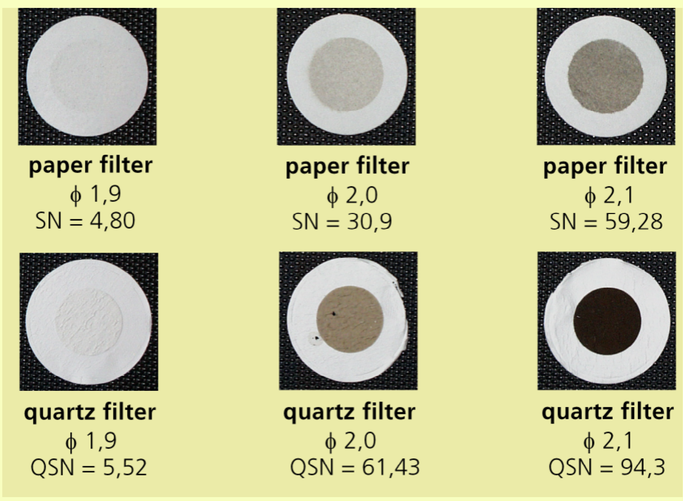


Filter efficiency for different particle diameters

Mean Diameter of PSD	Efficiency of recommended Paper filter	Efficiency of suggested fiber filter
7.5 nm	88.9 %	99.9 %
36.8 nm	59.2 %	99.99 %
122 nm	99.67 %	99.999 %

Paper Filter -->

Quartz Filter -->



Results
- trapping efficiency of the recommended paper filter is size dependent
- recommended paper filter shows up to 40% transmission for nanoparticles
- smoke number gives no information about the emitted black carbon aerosol
- quartz fiber filter traps 99.9% of the nanoparticles
- therefore determination of absolute soot mass fraction is possible (via CO_2 signal of burned black carbon, measured in FT-IR gas cell)

7th International ETH-Conference on Combustion Generated Particles, 18th - 20th August 2003 Zürich