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ELPI in Automotive Exhaust Measurement

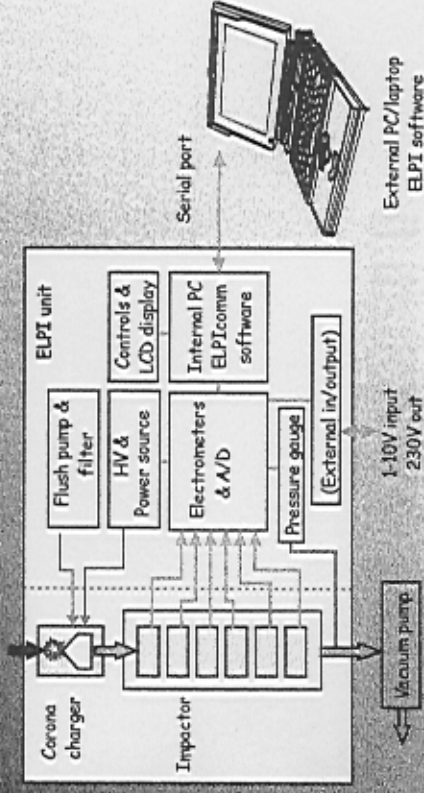
ELPI IN AUTOMOTIVE EXHAUST MEASUREMENT

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- ELPI overview
- Sampling in Exhaust Measurements
 - Dekati diluter & measurement set up
 - dilution ratio measurement
 - results
- ELPI time constant
 - measurement set up
 - results
- ELPI sensitivity
 - metal shielded Teflon insulators
 - charging efficiency at different charger set ups
- Conclusion

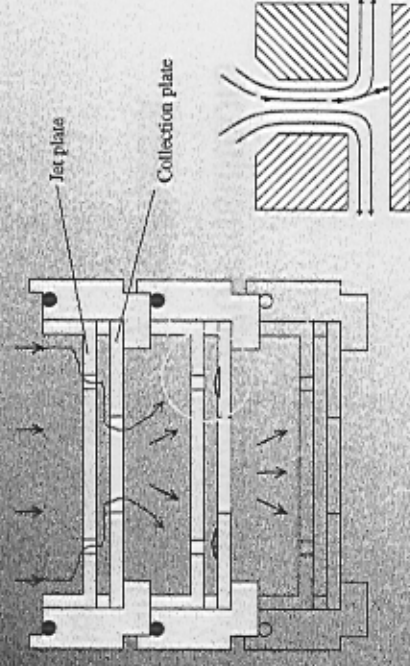
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• Electrical Low Pressure Impactor (ELPI)

- real time size distribution and concentration measurement
- measurement range 30 nm - 10 μ m
- collective measurement - enables subsequent chemical analysis on the collected sample in 13 size fractions
- dynamic range > 100 dB
- 10 and 30 LPM versions available

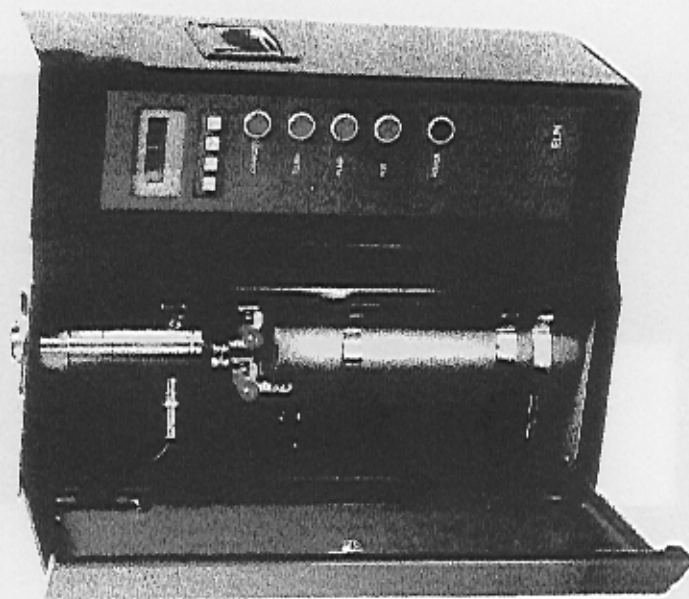
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• Size fractionation by inertial impaction

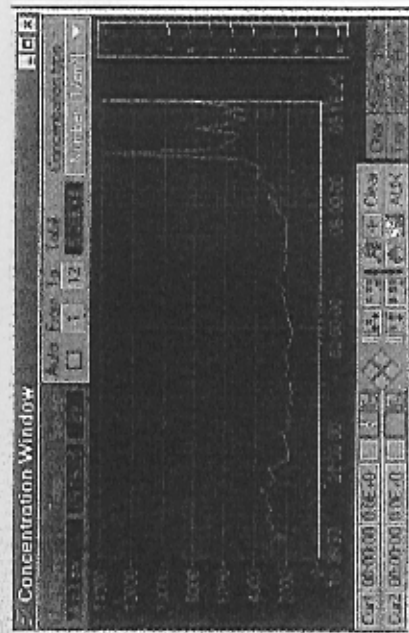
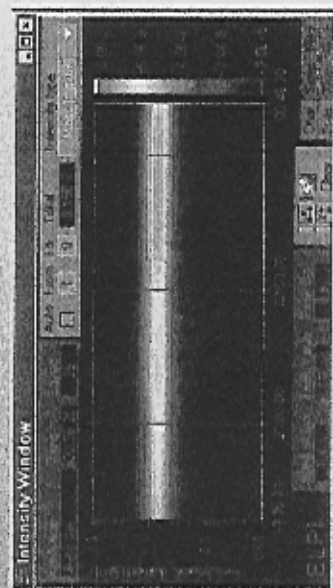
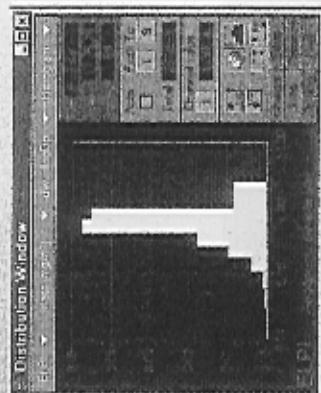
- Gravimetric method
 - mass distribution
 - slow, insensitive
- Electrical detection
 - current distribution - directly proportional to number distribution
 - fast, sensitive

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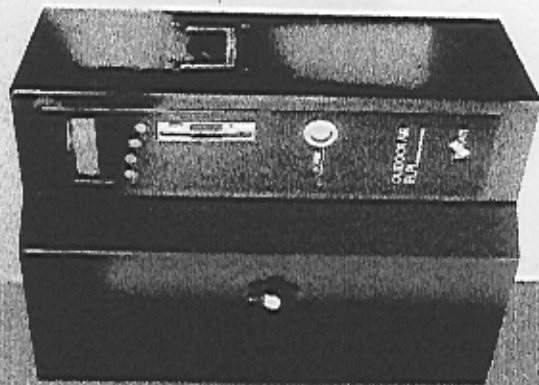
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Outdoor Air ELPI

OUTDOOR
AIR

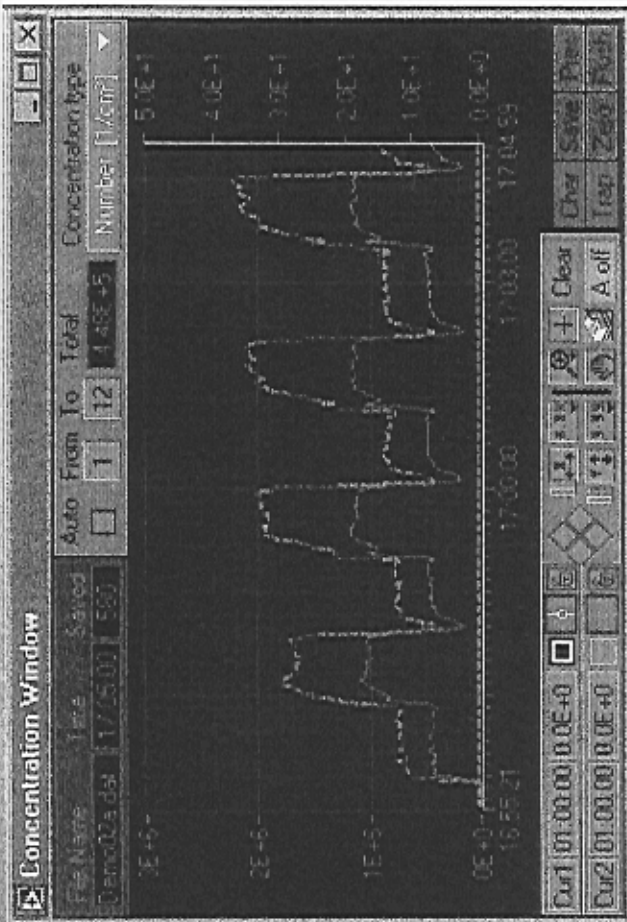


ELPI

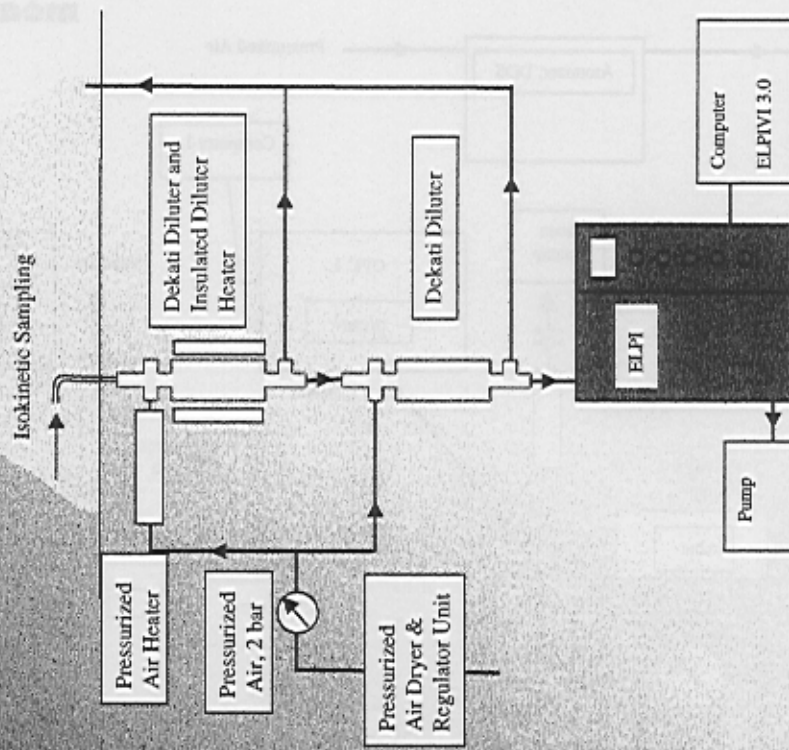
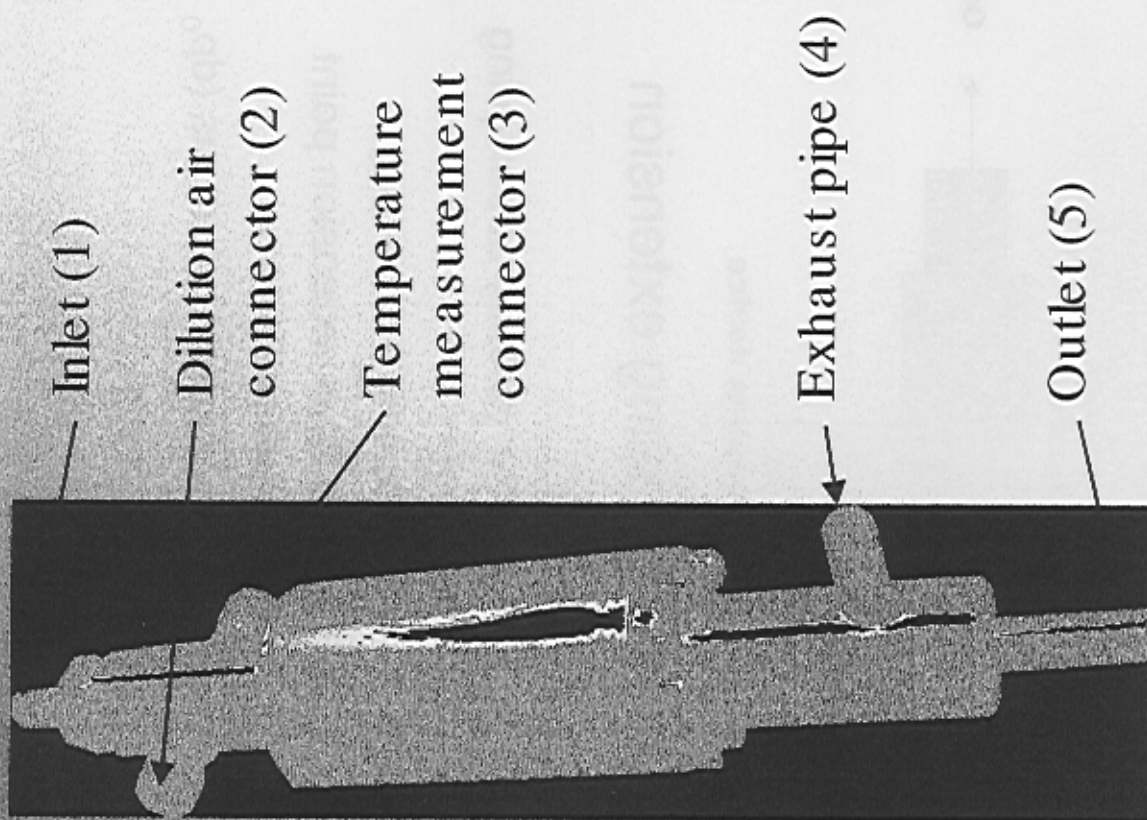
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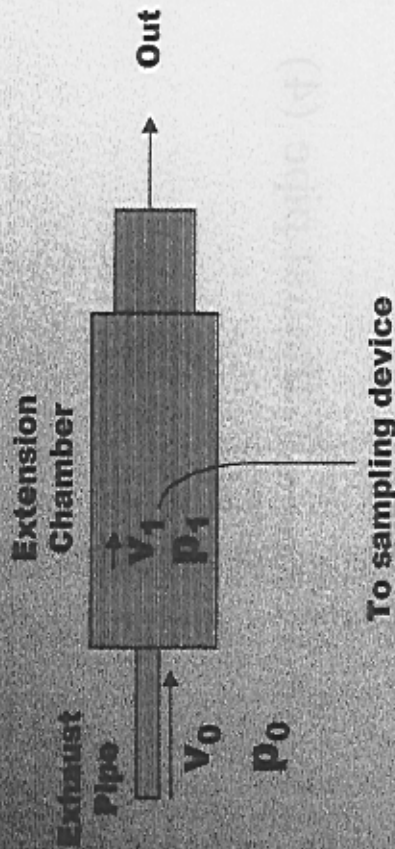
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Auxiliary Data
Display



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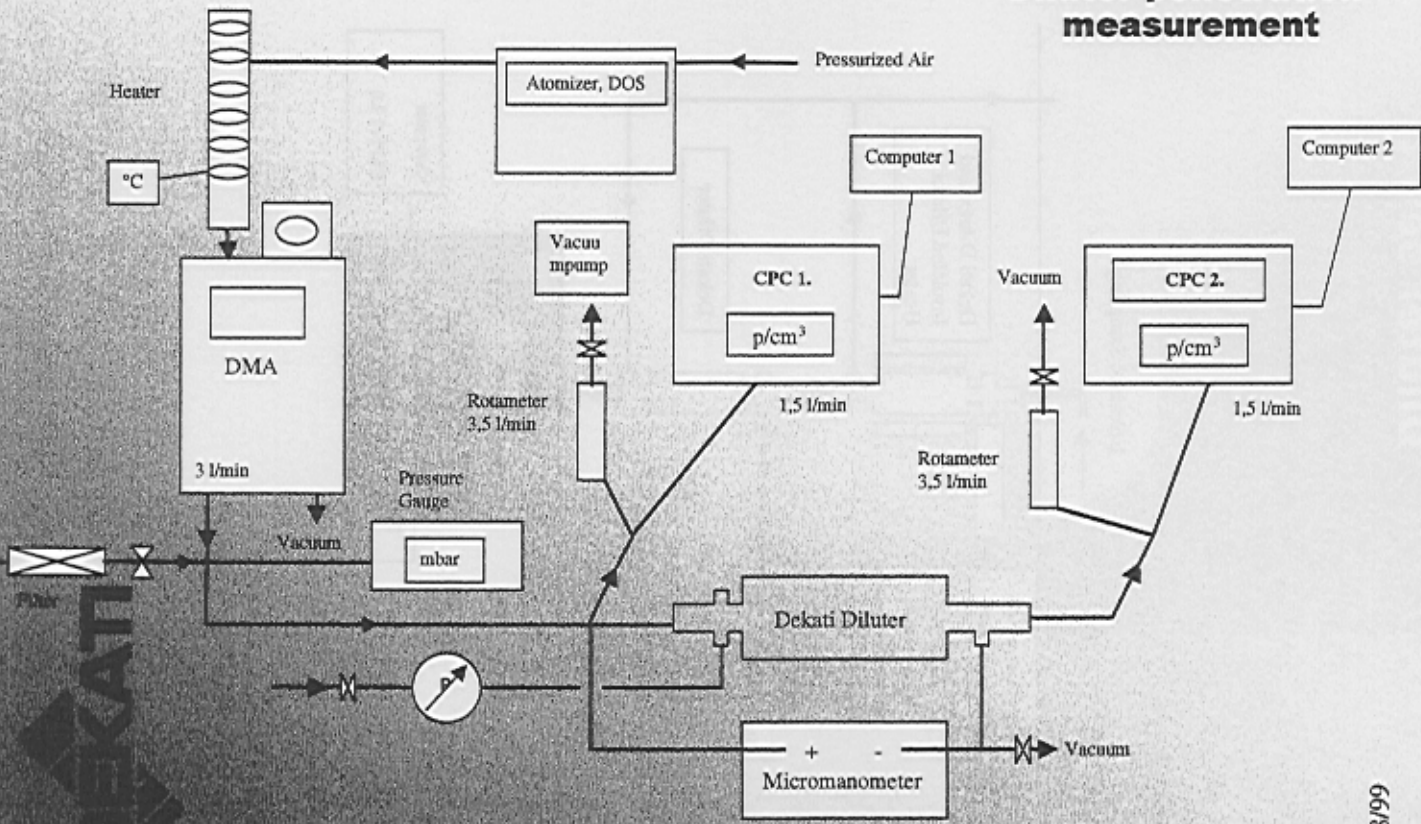


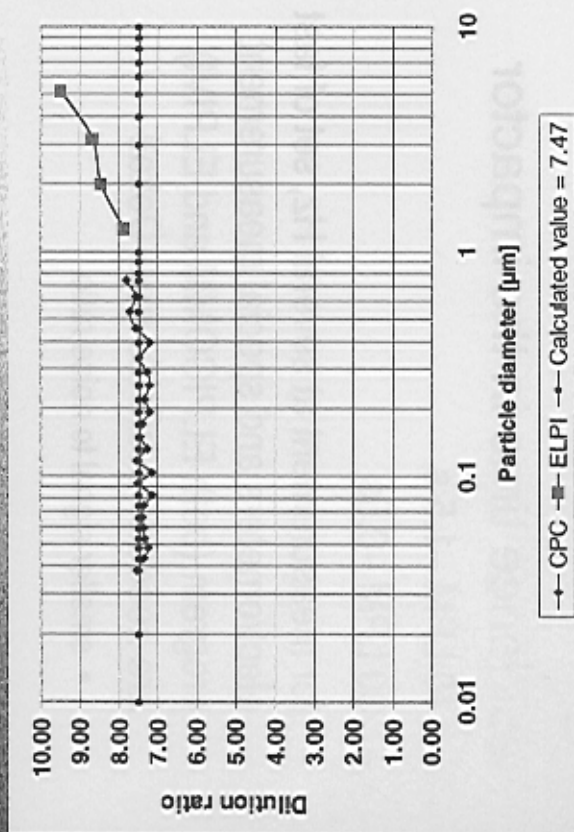


Benefits of using extension chamber

- decreased flow velocity at sampling point ($v_0 \gg v_1$)
 - larger opening for isokinetic sampling
- turbulent mixing at extension point
 - prevents flow channelling errors
- decreased pressure fluctuations ($dp_0 \gg dp_1$)

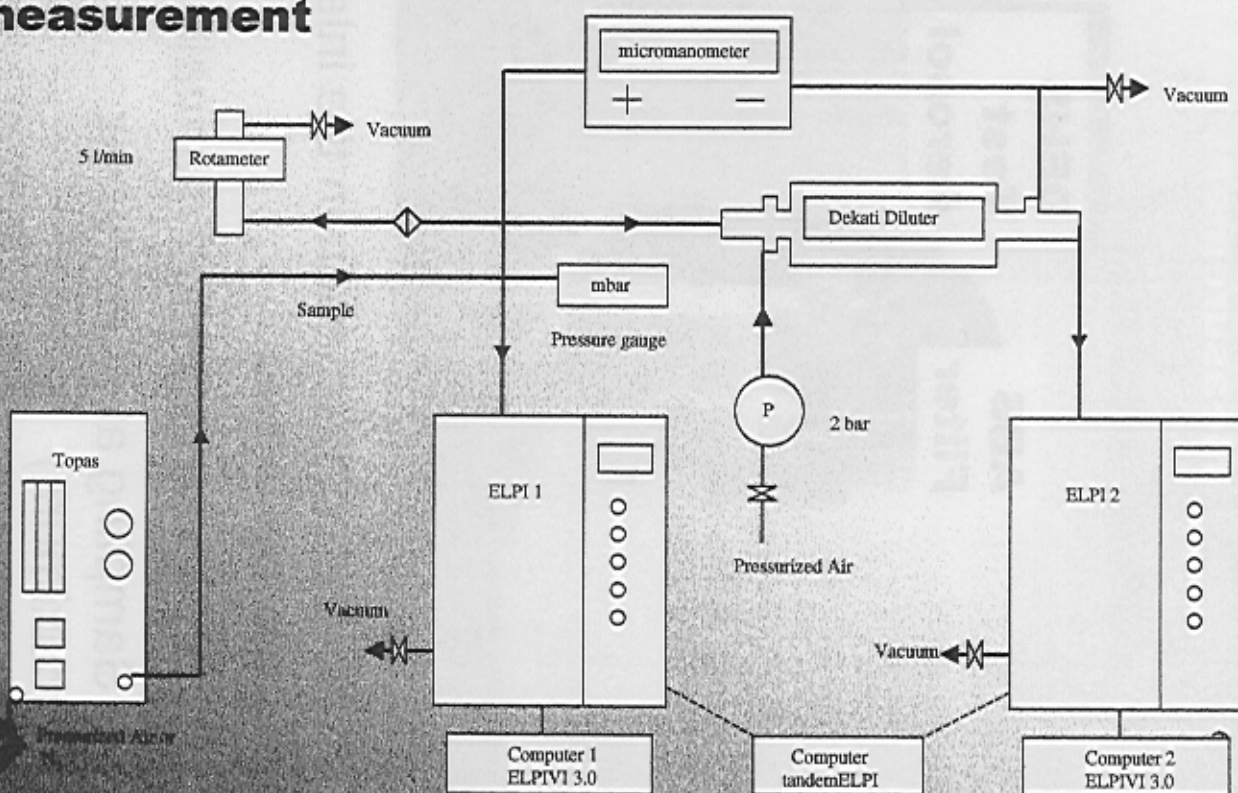
Diluter penetration measurement

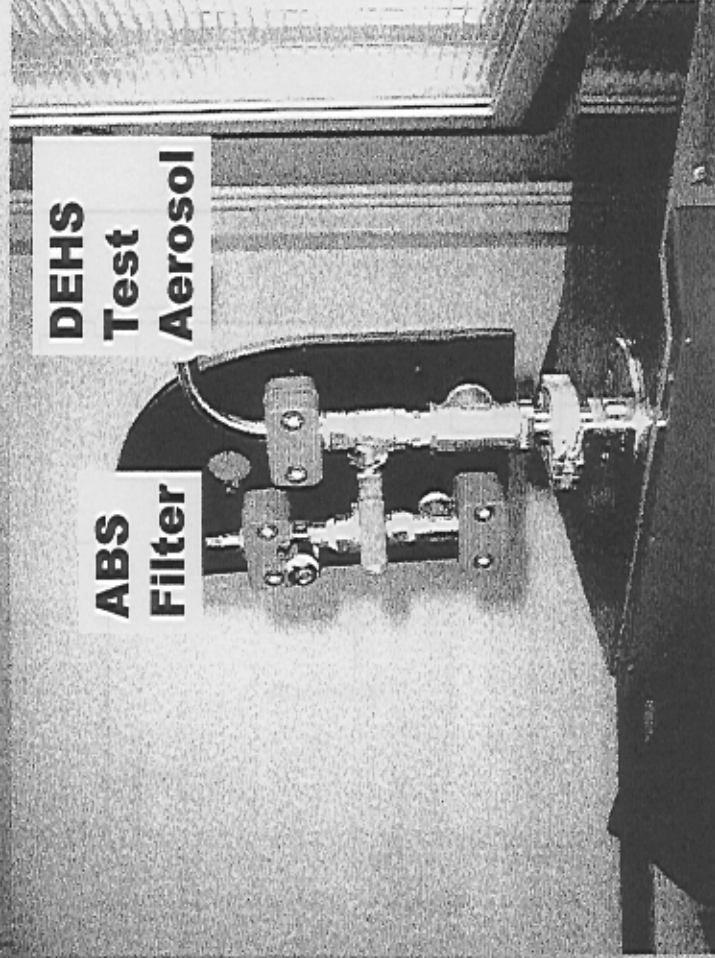




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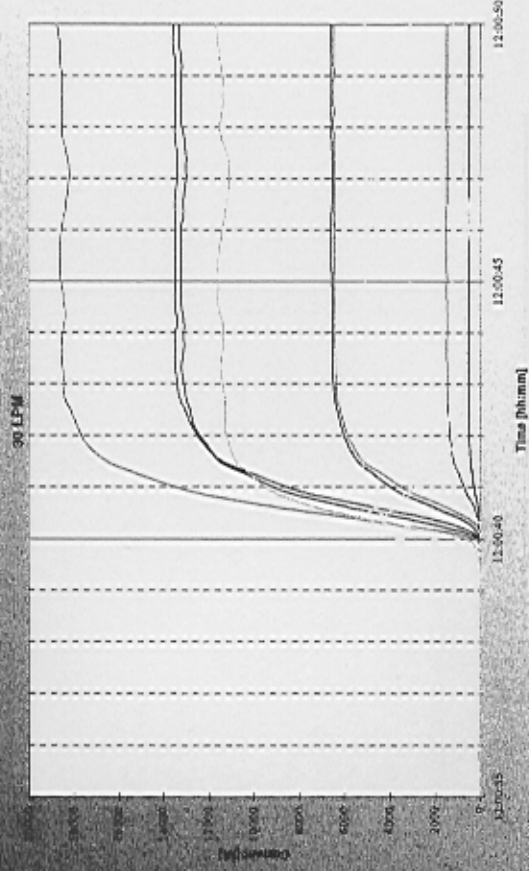
Diluter penetration measurement





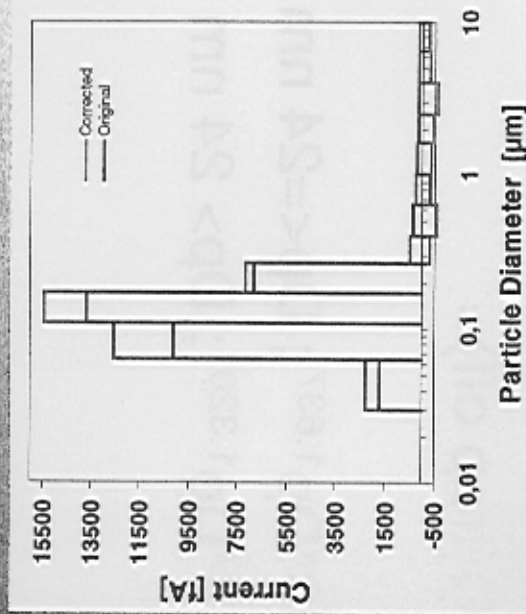
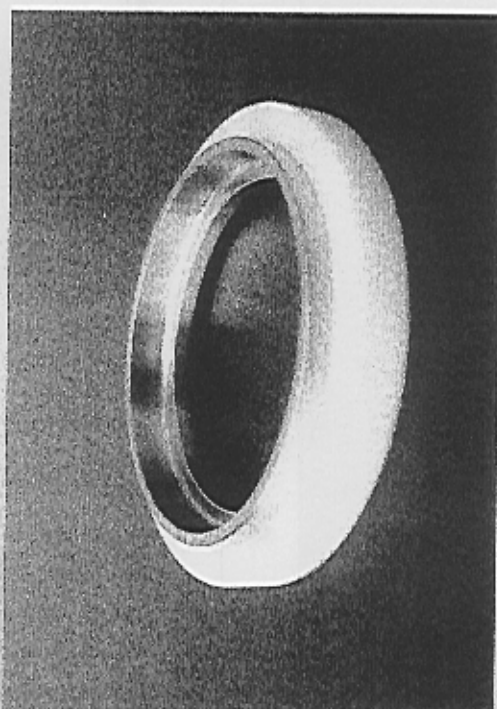
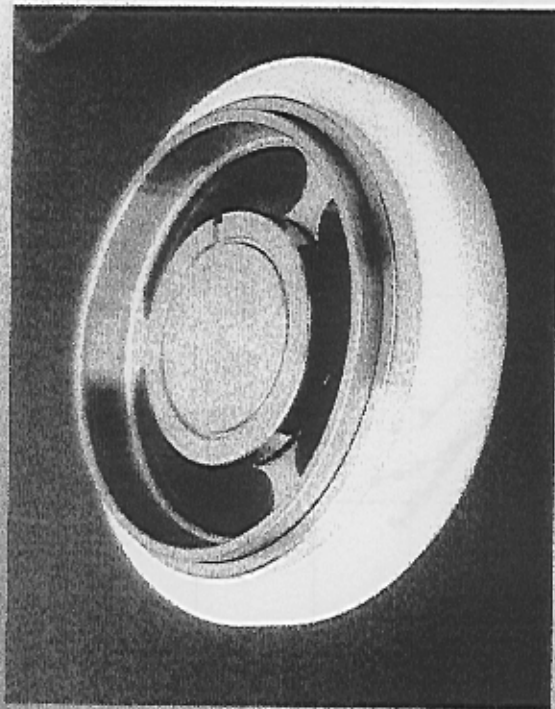
- Pressure fluctuation in the inlet was minimized
- Valve was operated manually
- Sampling at 3 Hz (10 Hz maximum)

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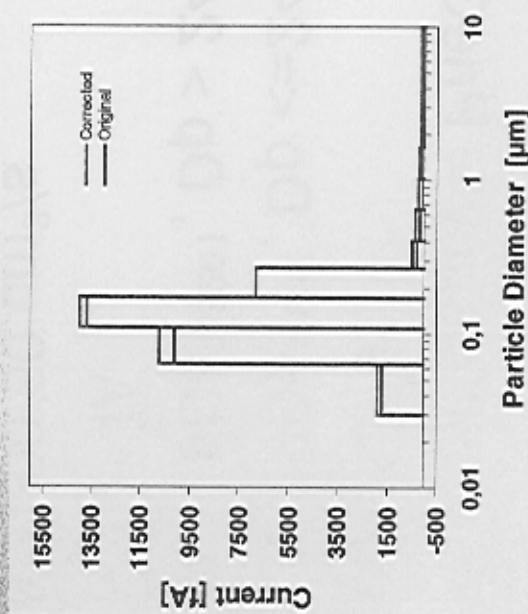


- Residence time in the impactor
 - 10 LPM ~1.5 s
 - 30 LPM ~0.5s
 - for measurement at several Hz, set of fast electrometers and special measurement program (both ELPICOMM and ELPIVI) are needed - available from Dekati
 - smaller signal to noise ratio

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Ordinary Teflon insulators



Metal Shielded Teflon insulators

Charging Efficiency = PnEQ

Pn from figure;

$Pn = 222.49 Dp^{1.637}$, $Dp \leq 24 \text{ nm}$

$Pn = 68.119 Dp^{1.3201}$, $Dp > 24 \text{ nm}$

$e = 1.6 \cdot 10^{-4} \text{ fA}$

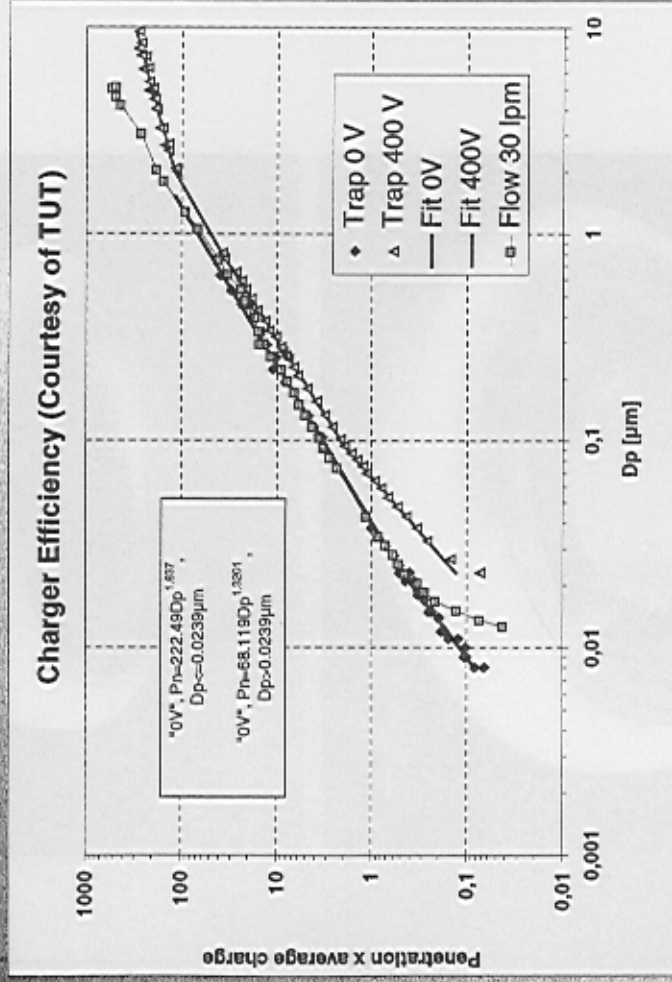
$Q = 10 \cdot 1000 / 60 \text{ cm}^3/\text{s}$

$PnEQ(\text{trap off}) =$

$5.933 \cdot Dp^{1.637}$; $Dp \leq 24 \text{ nm}$

$1.817 \cdot Dp^{1.3201}$; $Dp > 24 \text{ nm}$

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- Pay attention to sampling conditions
- 10 000 fA range not suitable for fast transients
- 10 LPM (Trap=0 V) more than doubles and
- 30 LPM ELPI (Trap=400V) multiplies the sensitivity by a factor of 7 in 30 nm size range
- Several Hz data recording possible with ELPI