1. Introduction
With the EURO5b/6 regulations measurements of particle number concentrations in engine exhaust gas are obligatory. The measurement systems were standardized by the particle measurement programme (PMP) and consist of a condensation particle counter with a 2 stage dilution system (PMP system). Such systems provide total number concentrations with a limited time resolution; however, particle size distributions (PSD) with better time resolution are very useful to characterize engine performance or the efficiencies of diesel particulate filters.

2. Setup and Measurement Principle
The GRIMM Fast Automotive Particle Emission Spectrometer (FAPES) measures number size distributions in engine exhaust gas in the size range of 6.3 nm to 484 nm with a sampling rate of 0.1s in a wide range of concentrations (~500 to 4x10^9 particles/cm^3), as shown in Fig.1.

Aerosols from the dilution system pass through the bipolar diffusion charger. The charged particles are classified with 10 DMAs operated in parallel. The DMA voltage is kept constant for each of the individual 10 DMAs. Each DMA is operated with a constant sample air and sheath air volume flow. The detection of particles is accomplished with 10 FCEs, one FCE for each DMA. The FCE signals are insensitive to mechanical shocks and vibration.

3. Typical Results
With GRIMM FAPES system, each signal originates from an individual DMA and corresponds to a well defined and narrow size range; therefore we achieve an excellent size resolution over the full size range. Moreover, the spacing of voltages facilitates a proper correction of multiple charged particles in the inversion algorithm. It enables simultaneous concentration measurements for 10 particle diameters in excellent accuracy and precision, and these data are used to reconstruct the number size distribution in 21 channels. Figure 4 shows a group of continuous measurement results for diesel engine 1.9l and gasoline fuelled engine 3.5l.

Parallel measurements were done with a PMP system and the FAPES, seen in Fig.5. The sample gas was drawn from a raw gas tunnel with a heavy duty EURO2 engine operated with the European Stationary Cycle (ESC) at the Korean Automotive Testing and Research Institute (KATRI). For the comparison of the two systems, we have calculated total number concentrations for particle sizes larger than 23 nm from the measured size distributions. These calculated number concentrations agree very well with number concentrations measured with the PMP system.

4. Applications
The FAPES finds a wide range of applications, from standard test measurements to fundamental research, from high concentrations in engine exhaust gas to normal environmental conditions, from dynamic behaviour in combustion processes to dynamic processes during nucleation events even at different temperatures, pressure levels or altitudes.