Euro VI without fuel penalty?
Experimental study on the impact of operating conditions and fuel composition on PCCI combustion

In current diesel combustion engines, legislated emission levels are generally met through emission aftertreatment systems. The investment in these systems and fuel penalty associated with their use implies a trade-off between emissions and operational costs.

Concept
The Premixed Charge Compression Ignition (PCCI) concept could break this trade-off by enabling premixing of fuel and air prior to combustion, thereby greatly reducing emission levels without increasing fuel consumption. With conventional hardware and diesel fuels a number of challenges are present, which should be overcome for viable PCCI.

Experimental approach
Experiments have been performed on the Cyclops HD mono-cylinder, which has a compression ratio of 12:1 and dedicated fuel, air and EGR systems. Intake pressure and temperature, fuelling rate and EGR level are varied for EU and US diesels, biodiesel and n-heptane.

Main results
An elongated mixing time efficiently reduces smoke and NOx emissions and increases CO and HC emissions and fuel consumption. These parameters correlate with the average mixing time, independent of how this is achieved. Although this mixing time may be easy to achieve, combustion phasing has to be optimized to lower pressure rise rates and fuel consumption.

Conclusion
By using the PCCI concept with diesel fuel, at low loads it is possible to reduce NOx levels by 94% to below Euro VI levels, without a penalty in fuel consumption. At higher loads a less reactive fuel, like US diesel is necessary to phase combustion correctly and limit pressure rise rates to acceptable levels.

Acknowledgements
The funding by NCM and SMO and technical support by DAF Trucks and Shell Global Solutions UK are greatly acknowledged.