

## NATURAL GAS HOMOGENEOUS CHARGE COMPRESSION IGNITION COMBUSTION R&D

**Salvador Aceves**

Lawrence Livermore National Laboratory

This presentation describes the homogeneous charge compression ignition (HCCI) research activities being currently pursued at Lawrence Livermore National Laboratory and at the University of California, Berkeley. Current activities include analysis as well as experimental work. HCCI is an old combustion technology that may now be developed with expectations of high efficiency, low NO<sub>x</sub>, and low particulate matter emissions; in short, an alternative to diesel engines.

On analysis, we have developed two powerful tools: a single-zone model and a multi-zone model. The single-zone model has proven very successful in cylinder pressure, indicated efficiency, and NO<sub>x</sub> emissions. This model is being applied to develop detailed engine performance maps and control strategies and to analyze the problem of engine startability. The multi-zone model has applicability to the optimization of combustion chamber geometry and operating conditions to achieve controlled combustion at high efficiency and low emissions.

On experimental work, we have done an evaluation of operating conditions in a 4-cylinder Volkswagen TDI engine. The engine has been operated over a wide range of conditions by adjusting the intake temperature and the fuel flow rate. Satisfactory operation has been obtained over a wide range of operating conditions. Cylinder-to-cylinder variations play an important role in limiting maximum power; expectations are that each cylinder will be individually controlled to achieve best performance.